An Overview of Climate Effects on Forestland Biodiversity in Maine

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Forest Climate Change Initiative

Forest Stewards Guild

putting the forest first

Science and Practice

Addressing Forest Climate Change in Maine

An Interactive Webinar Series for Stakeholders and the Interested Public

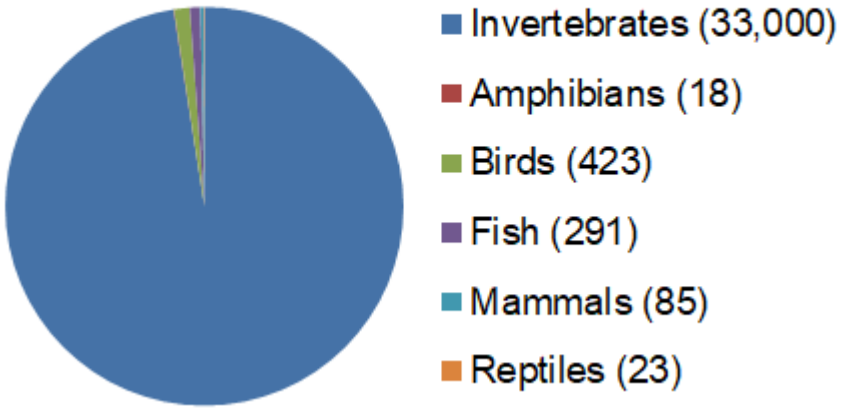
January 6, 2021

Presentation Overview

- How is climate change affecting Maine's species and forestlands?
- Case studies (6)
  - Lowland wetlands to mountaintops
- Conservation opportunities
- Discussion

Maine: An Ecological Transition Zone

Fish and Wildlife Species



Other Taxa Groups

Plants (2100), Phytoplankton (310), Macrophytes (271), Fungi (3500)

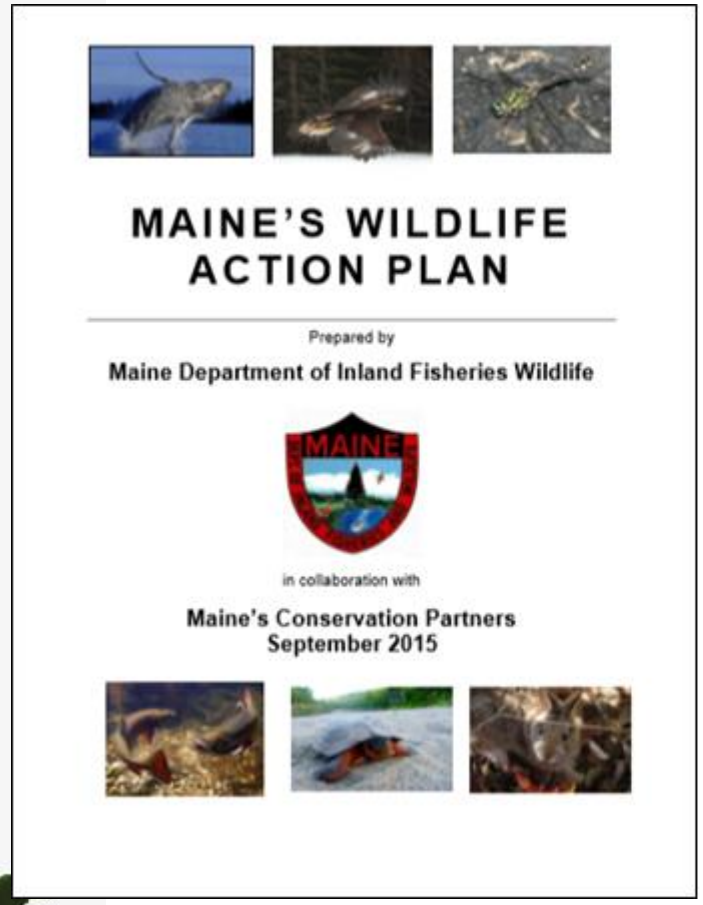
Maine's 2015 Wildlife Action Plan

Maine's Extraordinary Range in Climate

Figure 4 The climate gradient that exists in just three degrees of latitude in Maine occurs over 20 degrees of latitude in Europe, a distance approximately twice the length of California. Figure by K. Maasch.

Maine's Climate Future 2009

Climate Change Impacts to Biodiversity

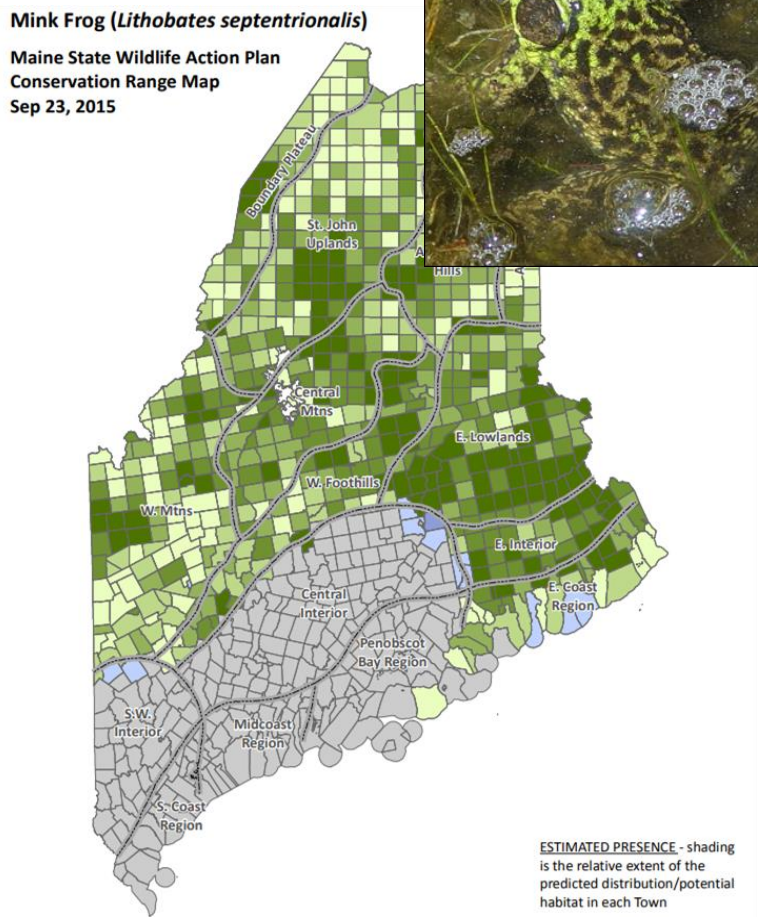


What makes a species vulnerable*?

Vulnerability Characteristic	
Habitat Specificity	✓
Edge of Range	✓
Environmental Tolerances	✓
Interspecific or Phenological Dependencies	
Mobility	✓
Pathogens or Invasives	✓

1. Habitat specificity
2. Edge-of-range
3. Environmental or physiological tolerance
4. Interspecific or phenological dependence
5. Mobility
6. Pathogens or invasive species

*Or a combination of these plus other factors



Whitman et al. 2014, adapted from Foden et al. 2008 and Young et al. 2010

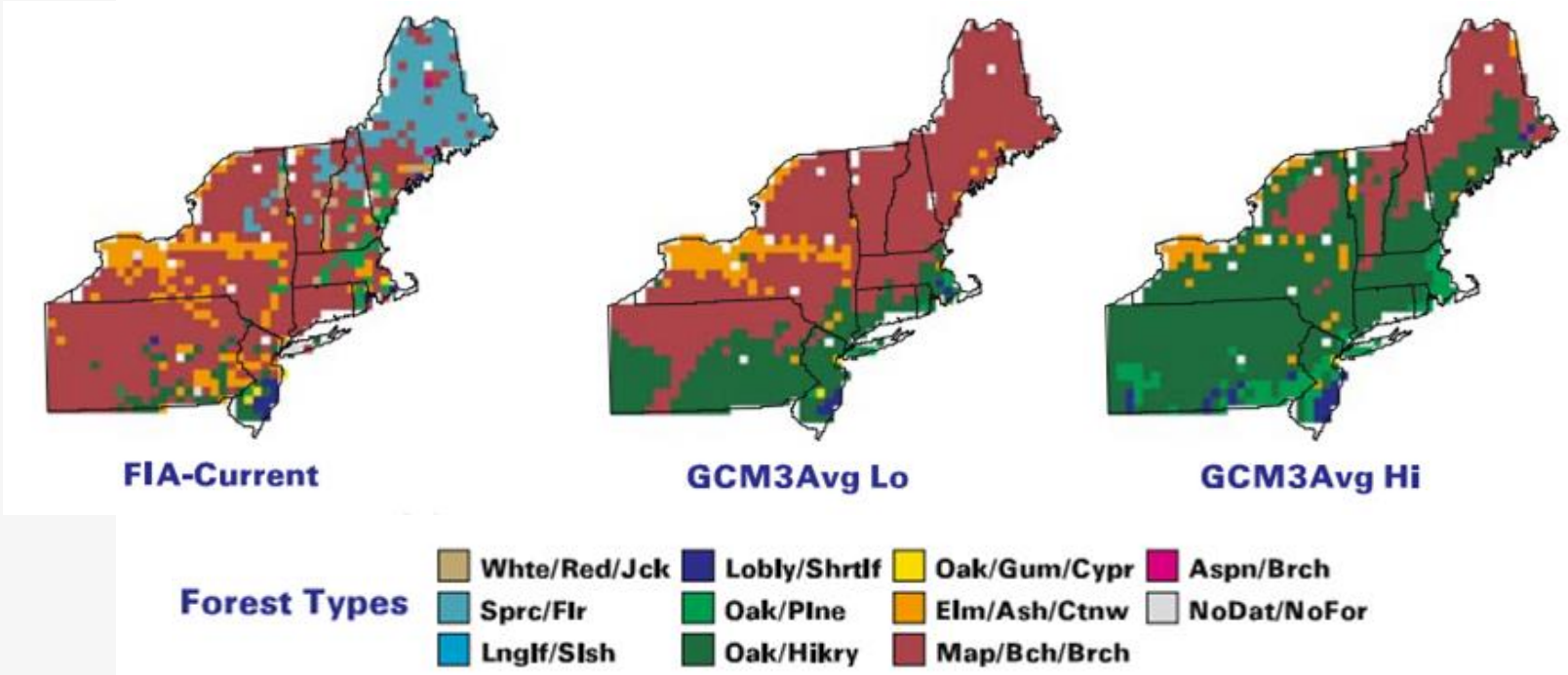
Impact Examples

- Changing forests
  - Spruce-fir decline
    - **Snowshoe hare**
- Warming winter
  - Declining snowpack and “early” spring
    - **Moose-tick**
    - **Vernal pools**
- Warming waters
  - “Cold” water fishery
    - **Brook trout**
- Disappearing refugia
  - Shifting treeline
    - **Alpine/Montane habitats**
- Stressor interactions
  - Fragmentation
    - **Wood turtle**

Changing Forests

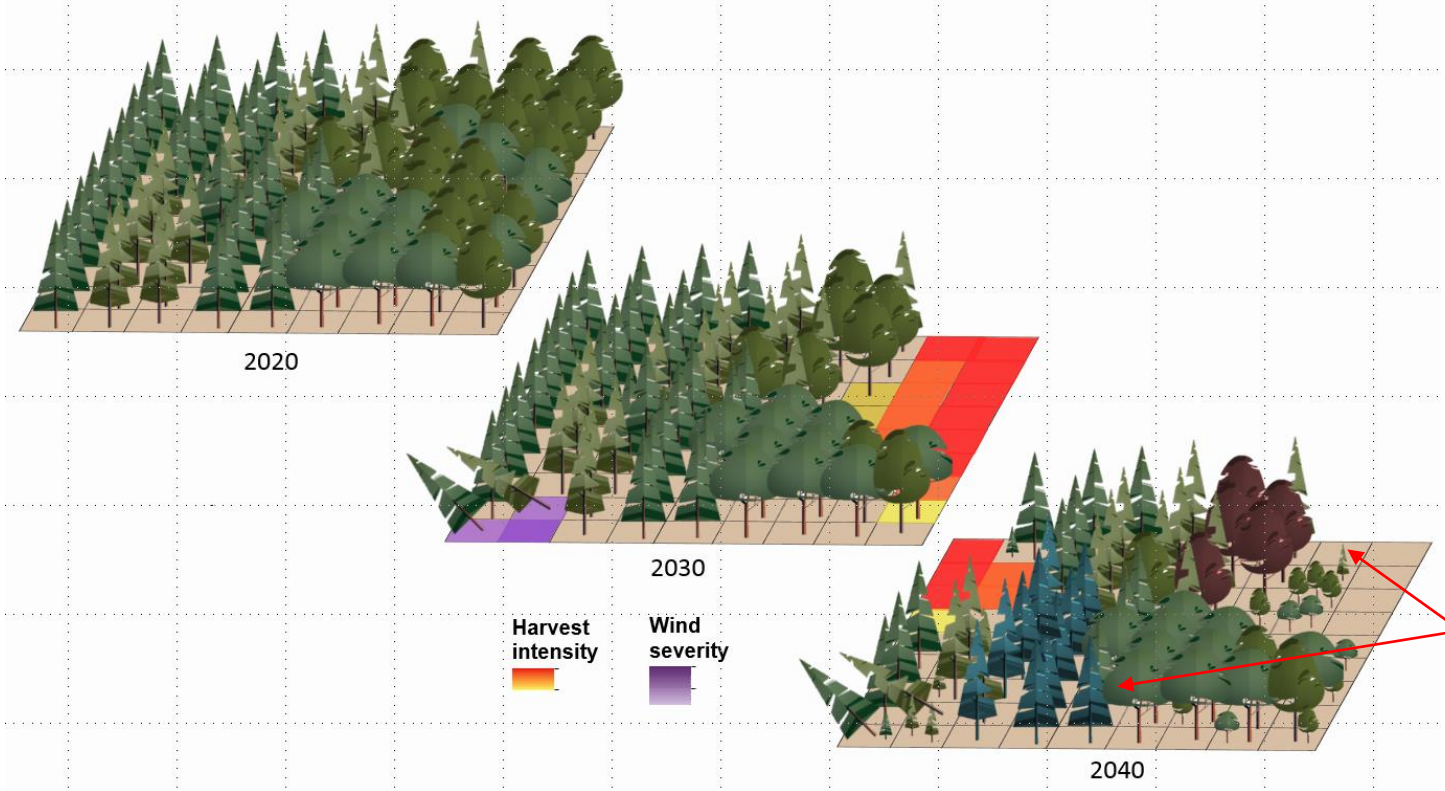
Modeling potential climate change impacts on the trees of the northeastern United States

Louis Iverson • Anantha Prasad • Stephen Matthews



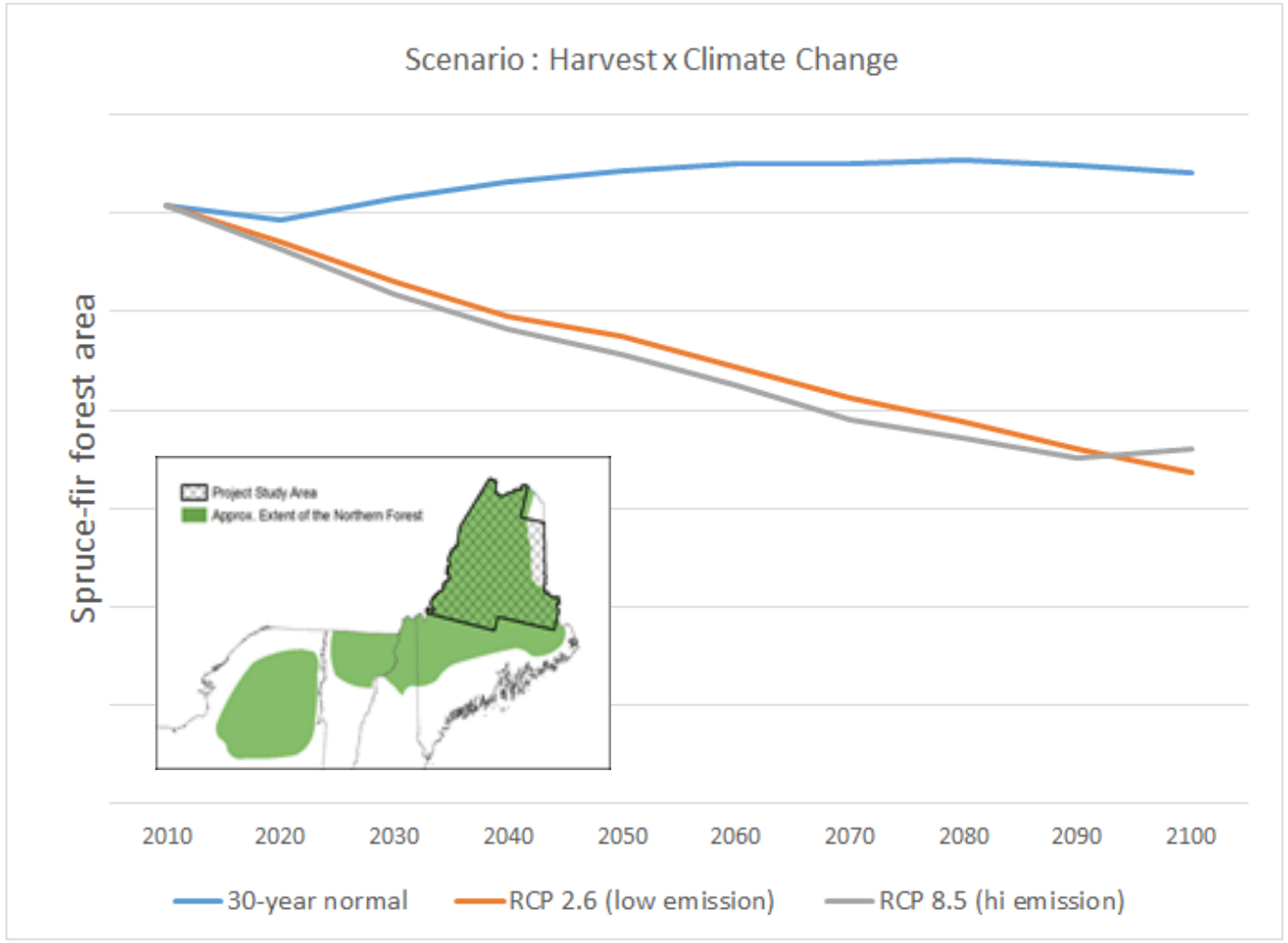
- Climate-envelope models suggest that climate change(s) will reduce habitat suitability for balsam fir and spruce trees
- Projections of suitability only, ignores persistence of current trees or interactions with other disturbances

Changing Forests



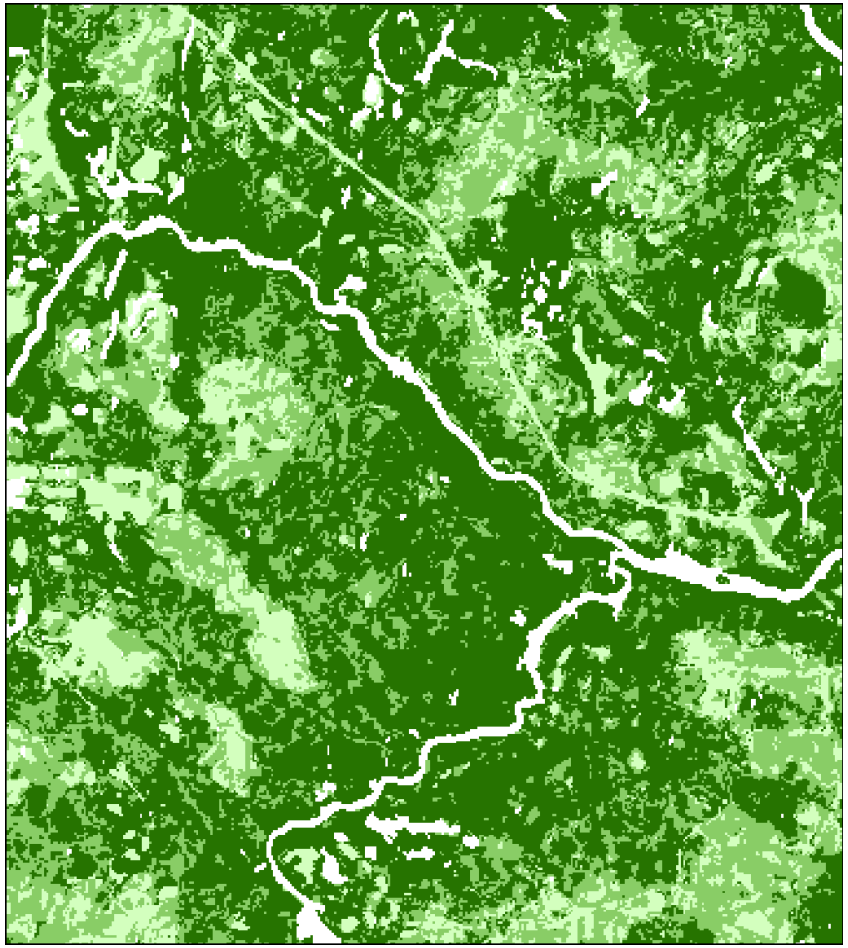
- Unlike the climate-envelope approach, LANDIS-II first models the current forest and then simulates future succession and disturbance, which can include climate change

Changing Forests

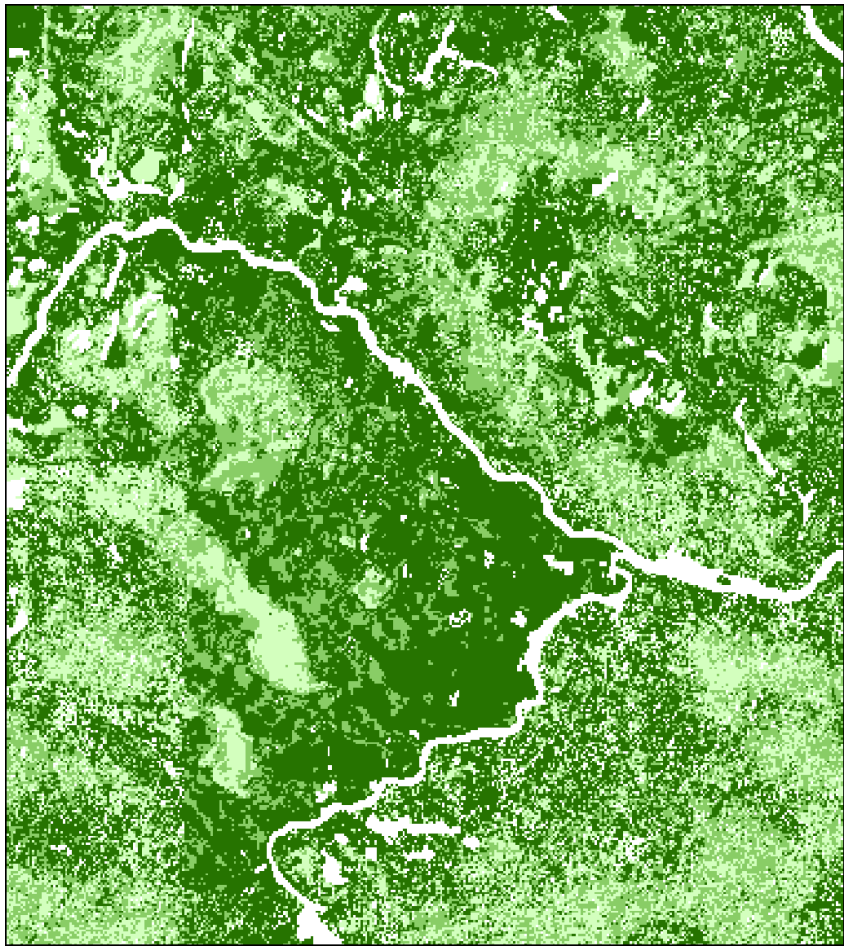


- Spruce-fir forest area stable when projected under 30-year normal climate
- But declining under climate change irrespective of RCP (low vs high emission).

2010



2100



Spruce-Fir
Mixed
Northern Hardwood

- Trend is for spruce-fir forest to transition to greater hardwood dominance after harvest, particularly along stand edges.
- In contrast, forest type relatively stable in unharvested areas.

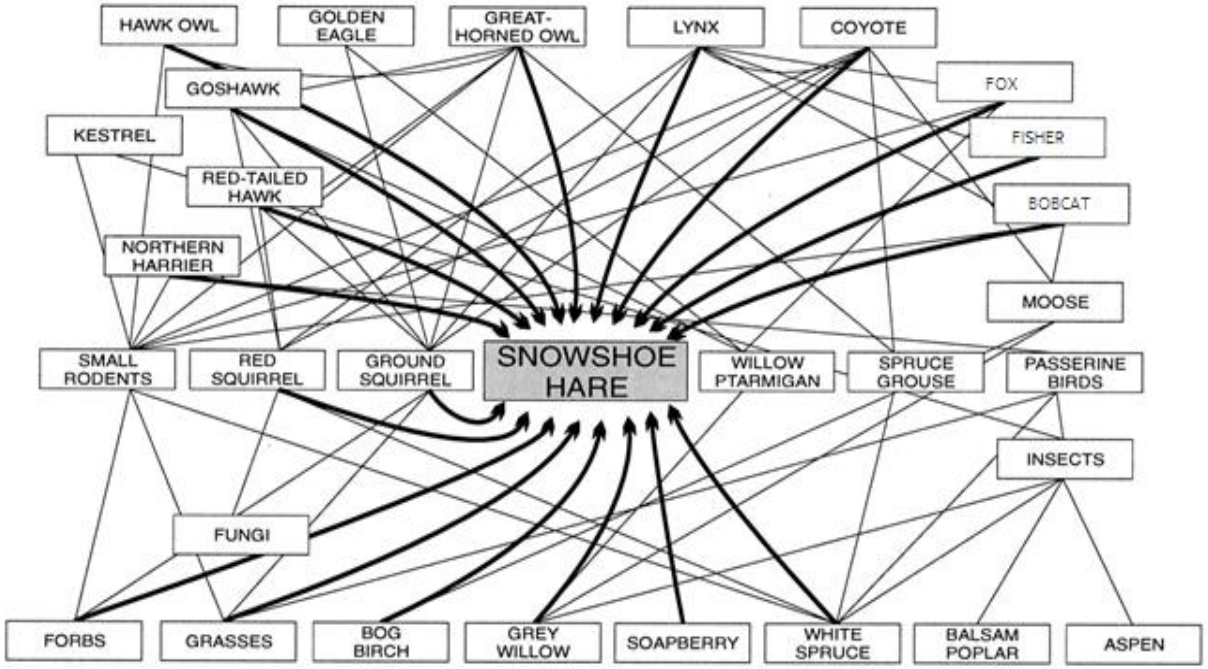
Changing Forests

Vulnerability Characteristic
Habitat Specificity
Edge of Range ✓
Environmental Tolerances
Interspecific or Phenological Dependencies ✓
Mobility
Pathogens or Invasives

Snowshoe hare/Canada lynx

- Range includes boreal, sub boreal and upper montane forests
- ~10 year population cycles

- Primary food item for the federally-threatened Canada lynx
- Regional “keystone” species



Adapted from Stenseth et al. 1997 https://doi.org/10.1073/pnas.94.10.5147

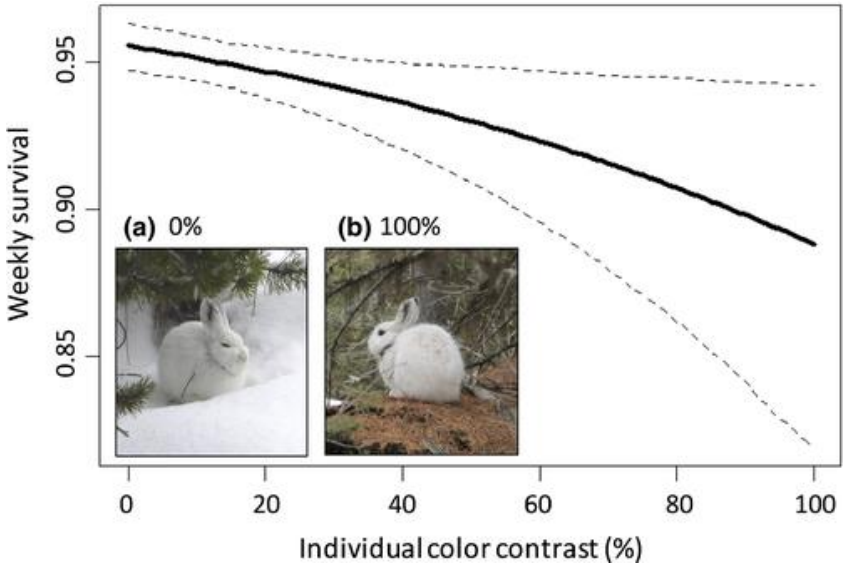
Changing Forests

Vulnerability Characteristic
Habitat Specificity ✓
Edge of Range ✓
Environmental Tolerances
Interspecific or Phenological Dependencies ✓
Mobility
Pathogens or Invasives

Snowshoe hare/Canada lynx

- Winter densities of hares are 3X higher in regenerating stands with high conifer stem densities (>12,000 stems/ha)

- Adapted for deep snow cover



Zimova et al 2016 doi: 10.1111/ele.12568

Laura Poppick

Warming Winters

Vulnerability Characteristic
Habitat Specificity
Edge of Range ✓
Environmental Tolerances
Interspecific or Phenological Dependencies
Mobility
Pathogens or Invasives ✓

- Moose/winter tick

- Maine: largest moose population in lower 48 states
- 70% annual calf mortality 2014-2016
  - Up to 70,000 ticks/calf

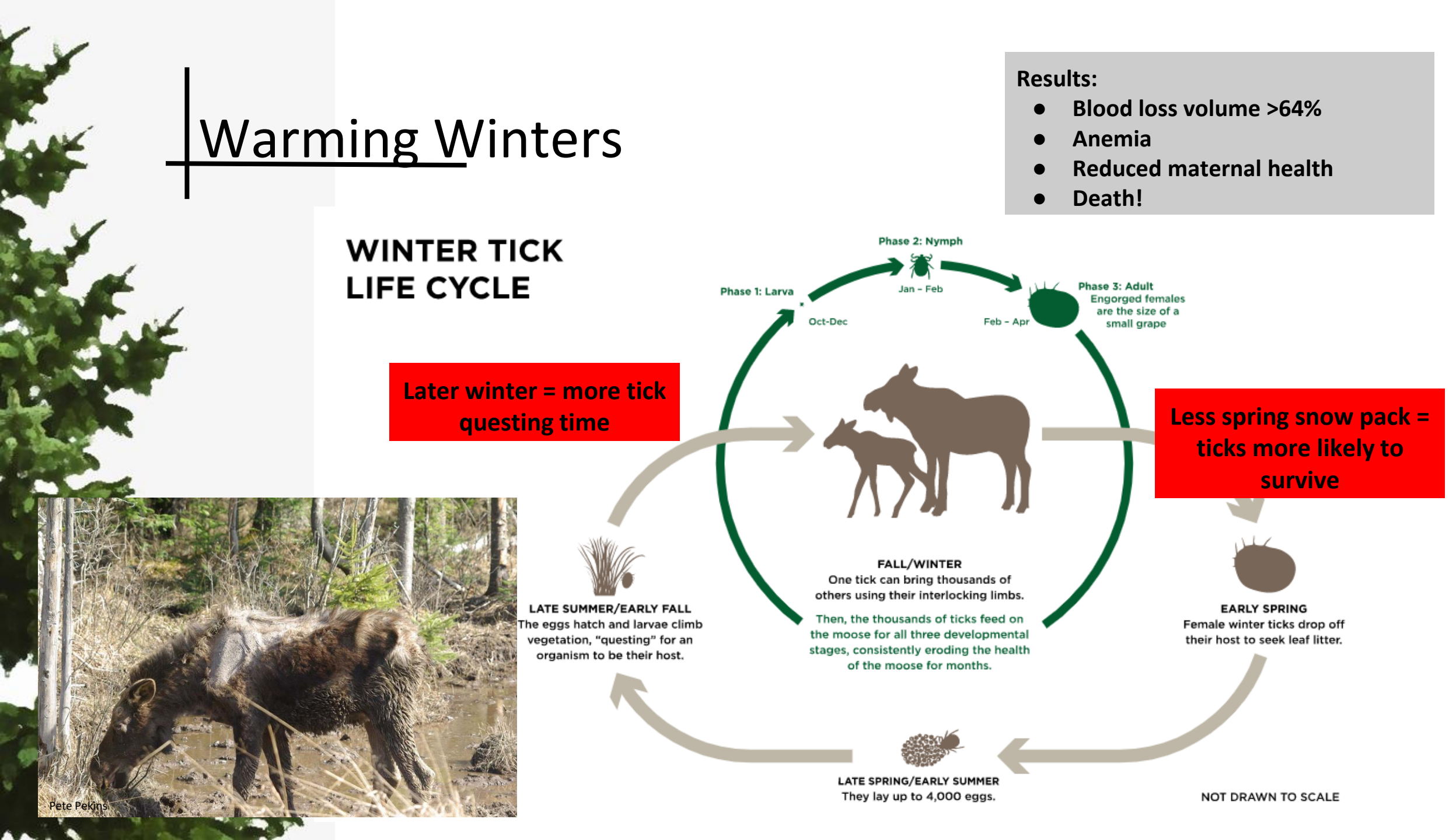
- Winter ticks recorded since 1930s
- Winter tick outbreaks in last 5 out of 10 years

Jones et al. 2019, NH Fish and Game, UNH - Pete Pekins, MDIFW - Lee Kantar

Warming Winters

Results:

- **Blood loss volume >64%**
- **Anemia**
- **Reduced maternal health**
- **Death!**



Later winter = more tick questing time

Less spring snow pack = ticks more likely to survive

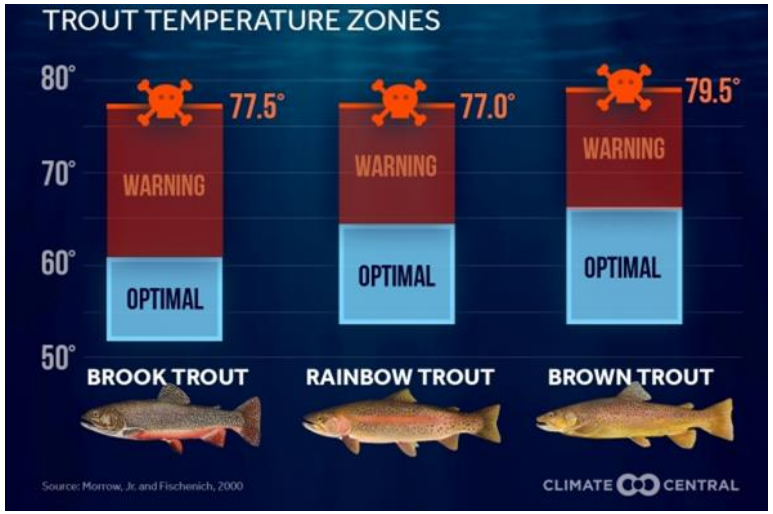
Pete Pekins

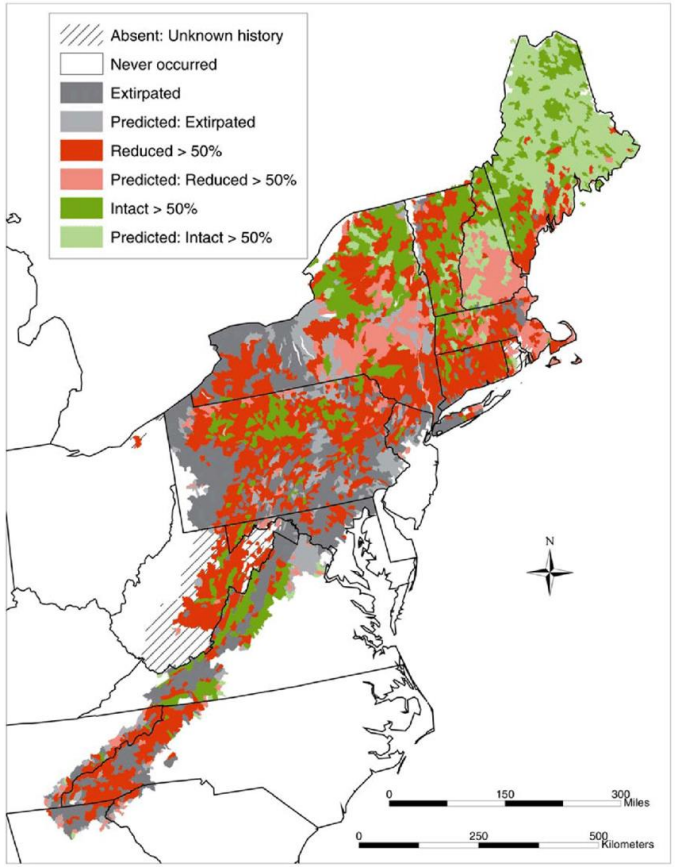
Warming Waters

Vulnerability Characteristic
Habitat Specificity
Edge of Range
Environmental Tolerances ✓
Interspecific or Phenological Dependencies
Mobility
Pathogens or Invasives

Eastern brook trout

- Maine is the only state with extensive intact populations of wild, self-reproducing brook trout in lakes and ponds
- Stream temperature controls distribution and abundance
- Adults can tolerate up to 65-67 deg F but prefer cooler
- Young trout survivorship drops above 60 deg F





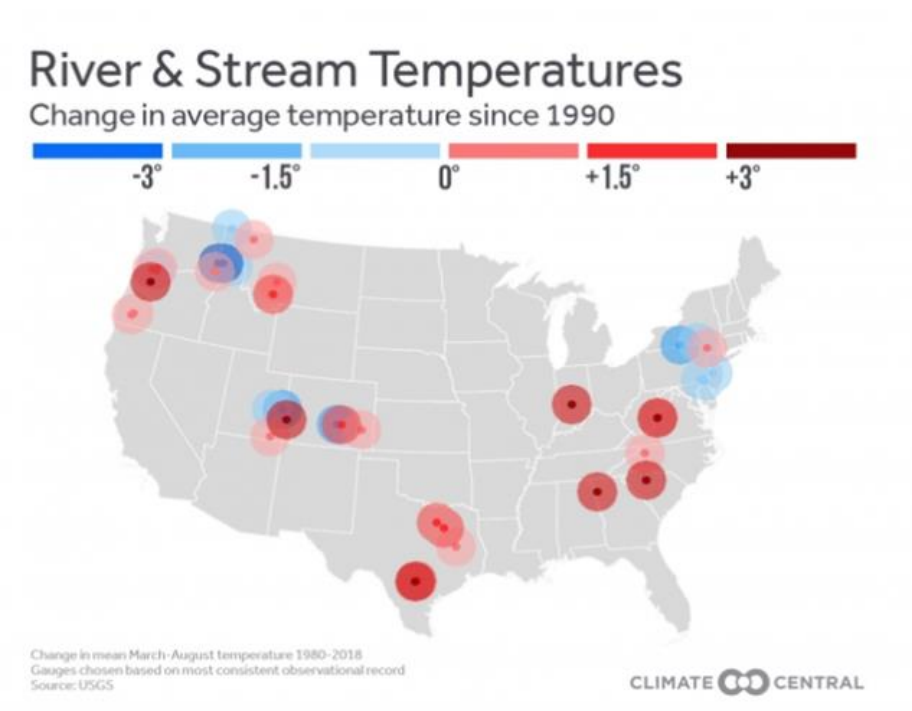
Smith & Sklarew 2013 https://doi.org/10.1016/j.swaqe.2013.08.001

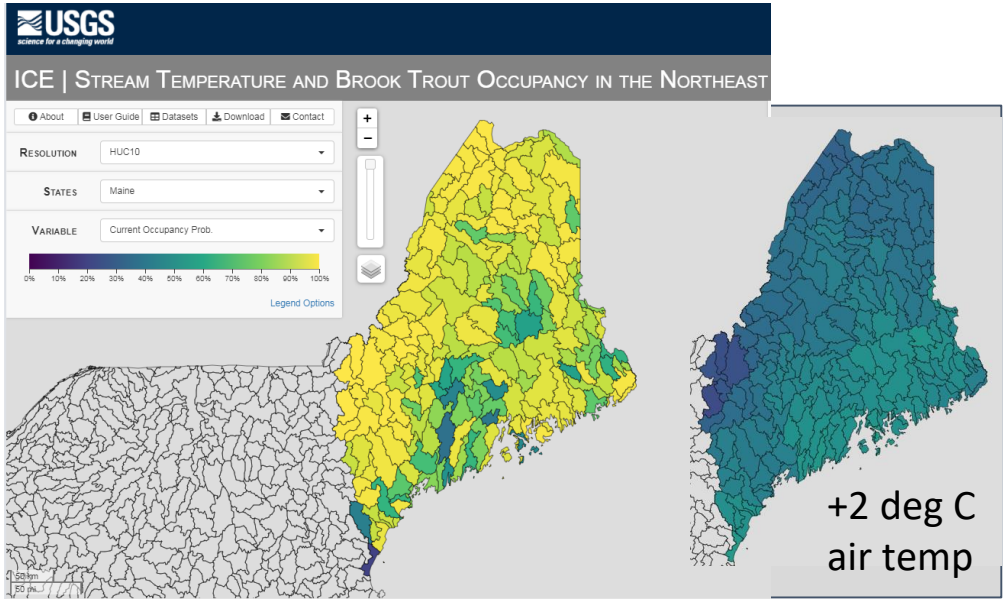
Warming Waters

Vulnerability Characteristic
Habitat Specificity
Edge of Range
Environmental Tolerances ✓
Interspecific or Phenological Dependencies ✓
Mobility
Pathogens or Invasives

Eastern brook trout

- River and stream temperatures are rising





https://www.usgs.gov/apps/ecosheds/ice-northeast/

- Warmer water species are moving in

Warming Winters

Vulnerability Characteristic
Habitat Specificity ✓
Edge of Range
Environmental Tolerances ✓
Interspecific or Phenological Dependencies ✓
Mobility ✓
Pathogens or Invasives ✓

Vernal pools species

- Highly specialized forest ecosystem
- Hydroperiod drives everything
  - Dependent upon snowpack and spring precipitation
- Four indicator species
  - But host many other species
  - Species tied to narrow temperature and chemical characteristics (oxygen, salinity, etc.)

Warming Winters

Vulnerability Characteristic	
Habitat Specificity	✓
Edge of Range	
Environmental Tolerances	✓
Interspecific or Phenological Dependencies	✓
Mobility	✓
Pathogens or Invasives	✓

Habitat Impacts

- Less snowpack/more episodic precipitation plus greater evapotranspiration = earlier drying (Brooks 2004)

Species Impacts

- Less snow = lower hibernacula quality (Groff et al. 2016)
- Warmer springs = earlier breeding; mismatched phenology (Gibbs and Breisch 2001)

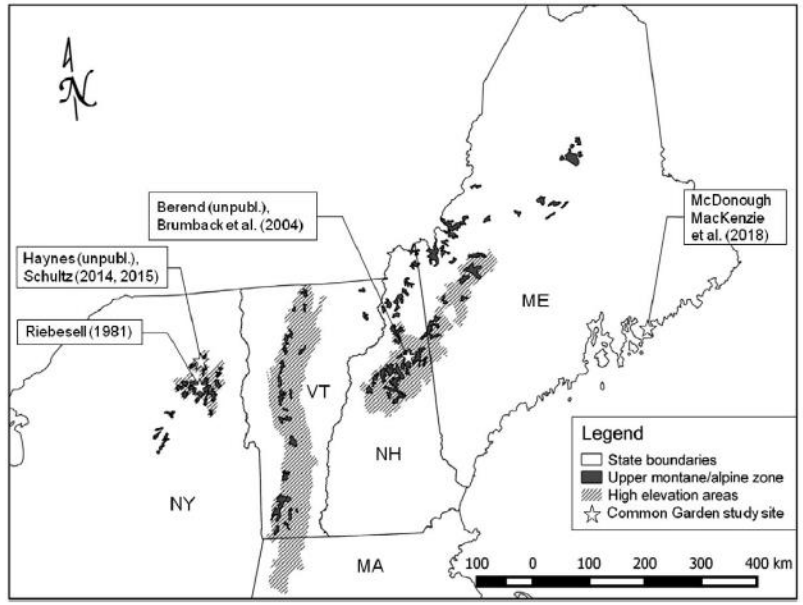
Disappearing Refugia

Subalpine/alpine habitats

Vulnerability Characteristic
Habitat Specificity ✓
Edge of Range ✓
Environmental Tolerances
Interspecific or Phenological Dependencies ✓
Mobility
Pathogens or Invasives

- Transitional zone between forest (fir-spruce) at lower elevations and alpine tundra at higher elevations (>1100 m).
- Areas of rare, specialist species and unique biodiversity (lichens, mosses, low-growing plants).
- Tree establishment limited by harsh winter conditions.

Doug Weihrauch/northwoods.org



- Only 34 km^2 in the Northeast

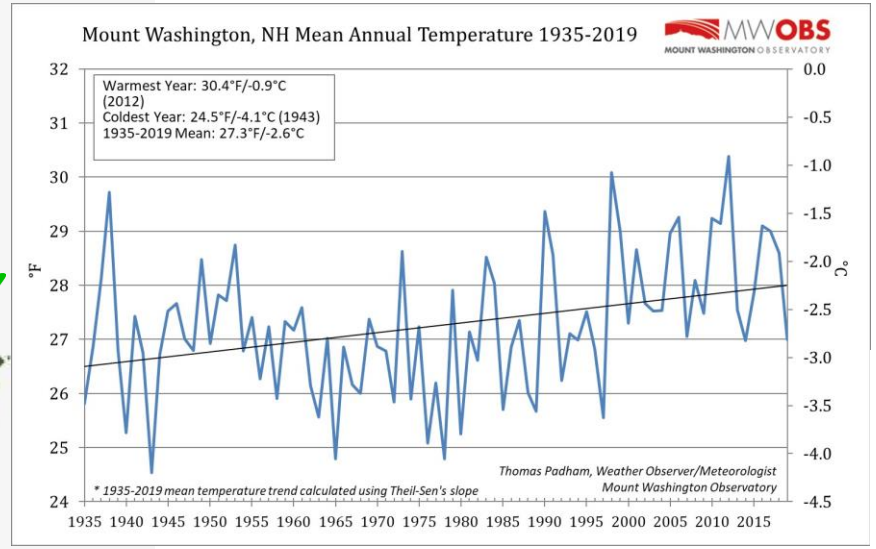
Berend et al. 2019 doi: 10.3119/18-16, Kimball & Weihrauch 2000

Disappearing Refugia

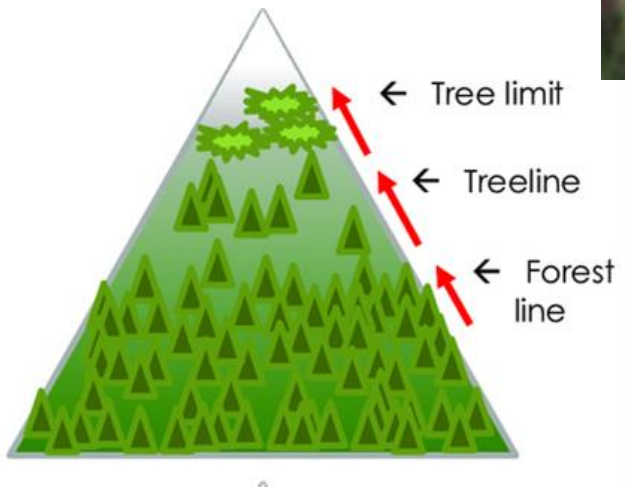
Subalpine/alpine habitats

Vulnerability Characteristic	
Habitat Specificity	✓
Edge of Range	✓
Environmental Tolerances	
Interspecific or Phenological Dependencies	✓
Mobility	
Pathogens or Invasives	

- Mountaintops are getting warmer (e.g., 1-3 deg F on Mount Washington)



- Warmer temps (w/ less ice, slower wind?) may allow tree encroachment



Habitat Fragmentation: Exacerbated by Climate Change

Vulnerability Characteristic	
Habitat Specificity	✓
Edge of Range	
Environmental Tolerances	
Interspecific or Phenological Dependencies	
Mobility	✓
Pathogens or Invasives	

Wood Turtle

- Long-lived species (> 58 years) associated with streams and riparian habitats
- Farthest ranging turtle in Maine
  - 2.3 miles along streams
  - 623 feet into uplands
- Biggest stressors
  - Habitat fragmentation
  - Road mortality
  - Illegal collection
  - Two adult mortalities per year: extirpated in 80 years (Compton et al. 2002)

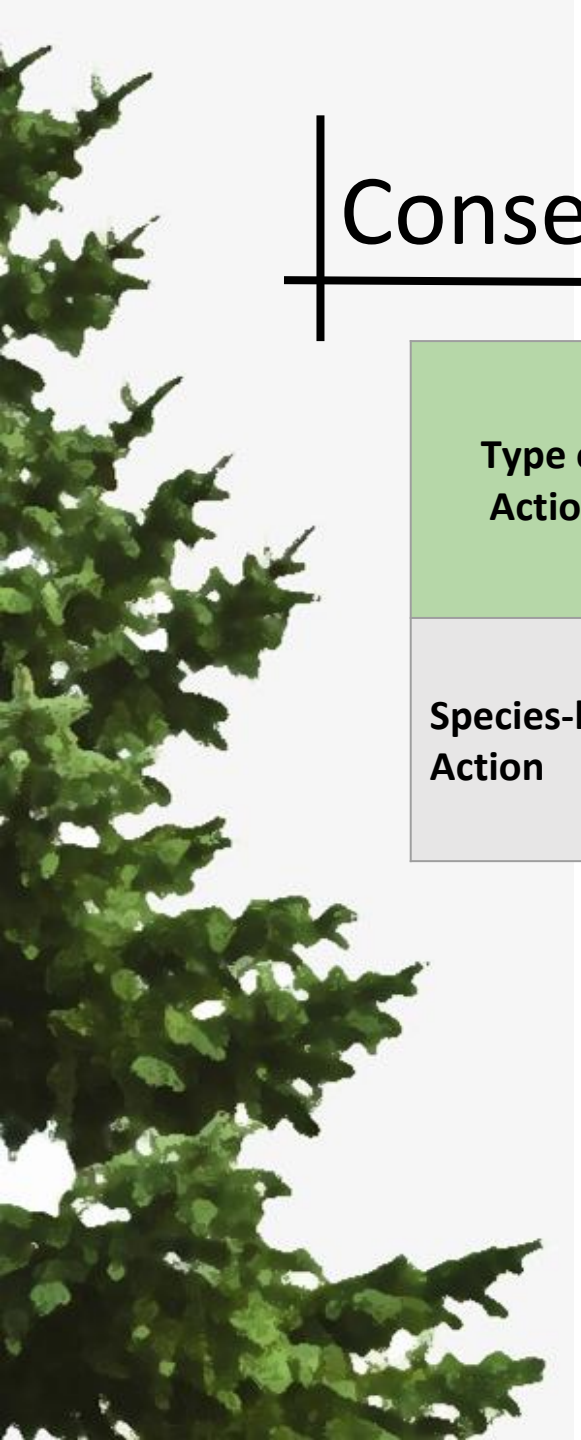
A Newer, Compounding Stressor: Climate Change

- Streams: need some flow to maintain gravel bars for breeding but not so much as to completely destroy them

Summary

High Impact or Certainty | **Moderate Impact or Certainty** | **Low Impact or Certainty**

Case Studies	Climate Vulnerability Characteristic					
	Habitat Specificity	Edge of Range	Environmental Tolerances	Interspecific or Phenological Dependencies	Mobility	Pathogens or Invasives
Snowshoe Hare & Canada lynx				Predation/ Competition		Pathogens?
Moose		At southern edge				Epizootics
Vernal Pool Organisms						
Brook Trout				Competition		Invasive species
Alpine & Katahdin Arctic Butterfly				Metamorphosis		
Wood Turtle						



Conservation and Management Opportunities

Type of Action	Habitat Specificity	Edge of Range	Environmental Tolerances	Interspecific or Phenological Dependencies	Mobility	Pathogens or Invasives
Species-level Action	-	**Assisted migration, planting**	**Conserve genetically diverse populations**	**Conserve genetically diverse populations**	**Assisted migration, planting**	**Population and pest management**

Conservation and Management Opportunities

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Species-level Action	-	Assisted migration, planting	Conserve genetically diverse populations	Conserve genetically diverse populations	Assisted migration, planting	Population and pest management
Habitat-level Action	Identify and map habitats; conserve habitats and buffers	Maintain and restore habitat connectivity	Conserve a range of habitats and connections among them; Conserve habitat quality	Conserve a range of habitats and connections among them; Conserve habitat quality	Maintain and restore habitat connectivity	Maintain and restore healthy habitats that are more resistant to pest invasions

Example: Vernal Pool Species

Vulnerability Characteristic	Management Action
✓ Habitat Specificity	Identify and include vernal pools in forest management plans
Edge of Range	n/a
✓ Environmental Tolerances	Maintain canopy around pool
✓ Interspecific or Phenological Dependencies	Maintain canopy around pool
✓ Mobility	Provide canopy cover among pools
✓ Pathogens or Invasives	Maintain canopy around pool

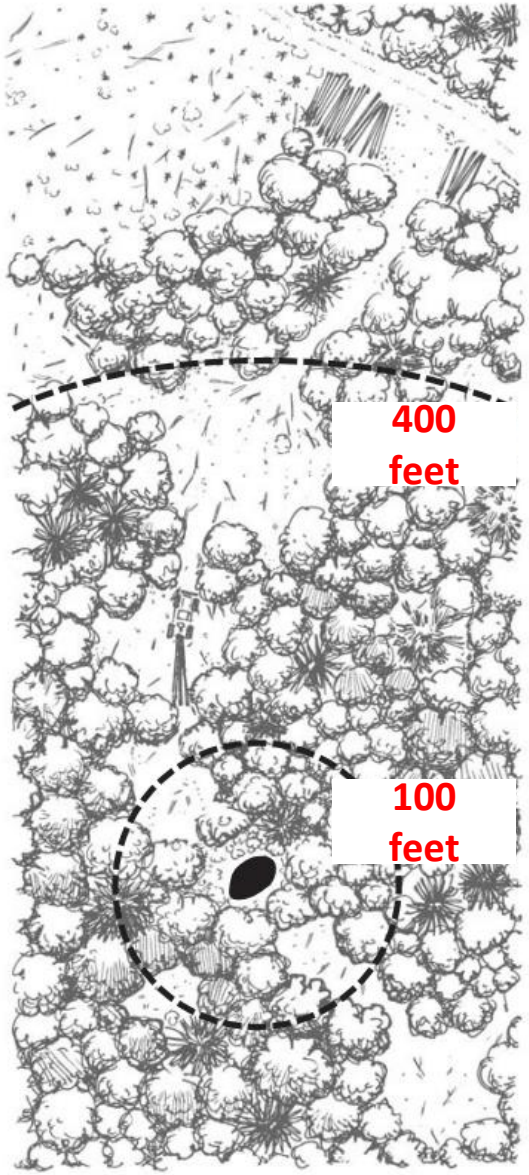

FIGURE 3: Ecologically sensitive forest management activity around a vernal pool (dark oval at bottom center) located in a mature mixed forest. Note that implementation of the vernal pool Habitat Management Guidelines (HMGs) calls for decreasing timber harvest intensity with increasing proximity to those pools with breeding evidence of amphibian indicator species. HMG zones are drawn to scale. (M. McCollough)

Forestry Management Guidelines for Vernal Pool Wildlife Calhoun and deMaynadier 2004

Discussion

In your work, what are you doing on the ground now that may help mitigate climate vulnerability?

Habitat Specificity	Edge of Range	Environmental Tolerances	Interspecific/ Phenological Dependencies	Mobility	Pathogens/ Invasives
Identify and map habitats; conserve habitats and buffers	Maintain and restore habitat connectivity	Conserve a range of habitats and connections among them; Conserve habitat quality	Conserve a range of habitats and connections among them; Conserve habitat quality	Maintain and restore habitat connectivity	Maintain and restore healthy habitats that are more resistant to pest invasions

Final Thoughts

- How do we know if our actions are successful?

Climate Change Impacts to Habitats

- Most vulnerable habitats and natural communities (out of 21)
  - Alpine and montane systems*
  - Peatlands*
  - Northern rivershores
  - Spruce flats
  - Cedar lowlands

*Contain highest percentage of highly vulnerable species

Whitman et al. 2014