An Overview of Climate Effects on Forestland Biodiversity in Maine

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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

- Invertebrates (33,000)
- Amphibians (18)
- Birds (423)
- Fish (291)
- Mammals (85)
- Reptiles (23)

Other Taxa Groups
- Plants (2100), Phytoplankton (310), Macrophytes (271), Fungi (3500)

Maine’s 2015 Wildlife Action Plan

Maine’s Climate Future 2009
Climate Change Impacts to Biodiversity
What makes a species vulnerable*?

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
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.
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).
- 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

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

Vulnerability
Characteristic

Habitat
Specificity

Edge of Range

Environmental
Tolerances

Interspecific or Phenological Dependencies

Mobility

Pathogens or Invasives

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

Snowshoe hare/Canada lynx

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

Vulnerability Characteristic

- Habitat Specificity
- Edge of Range
- Environmental Tolerances
- Interspecific or Phenological Dependencies
- Mobility
- Pathogens or Invasives

- Adapted for deep snow cover

Warming Winters

- 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

Later winter = more tick questing time

Less spring snow pack = ticks more likely to survive

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

WINTER TICK LIFE CYCLE

LATE SUMMER/EARLY FALL
The eggs hatch and larvae climb vegetation, "questing" for an organism to be their host.

FALL/WINTER
One tick can bring thousands of others using their interlocking limbs. Then, the thousands of ticks feed on the moose for all three developmental stages, consistently eroding the health of the moose for months.

EARLY SPRING
Female winter ticks drop off their host to seek leaf litter.

LATE SPRING/EARLY SUMMER
They lay up to 4,000 eggs.
Warming Waters

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

Eastern brook trout

- River and stream temperatures are rising

- Warmer water species are moving in

Vulnerability Characteristic

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

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.)

Vulnerability Characteristic

| Habitat Specificity | ✓ |
| Edge of Range | ✓ |
| Environmental Tolerances | ✓ |
| Interspecific or Phenological Dependencies | ✓ |
| Mobility | ✓ |
| Pathogens or Invasives | ✓ |
# Warming Winters

## 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)

## Vulnerability Characteristic

| Habitatspecificity | Edge of Range | Environmental Tolerances | Interspecific or Phenological Dependencies | Mobility | Pathogens or Invasives |
Disappearing Refugia

Subalpine/alpine habitats

- 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.

Only 34 km² in the Northeast

Disappearing Refugia

Subalpine/alpine habitats

- 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

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

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<th>Climate Vulnerability Characteristic</th>
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<td>Habitat Specificity</td>
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<td>Moose</td>
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Example: Vernal Pool Species

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<tr>
<td>Habitat Specificity</td>
<td>Identify and include vernal pools in forest management plans</td>
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<tr>
<td>Edge of Range</td>
<td>n/a</td>
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<td>Maintain canopy around pool</td>
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<td>Mobility</td>
<td>Provide canopy cover among pools</td>
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Forestry Management Guidelines for Vernal Pool Wildlife
Calhoun and deMaynadier 2004

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

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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