Applying a framework for climate change adaptation in the Central Hardwoods region

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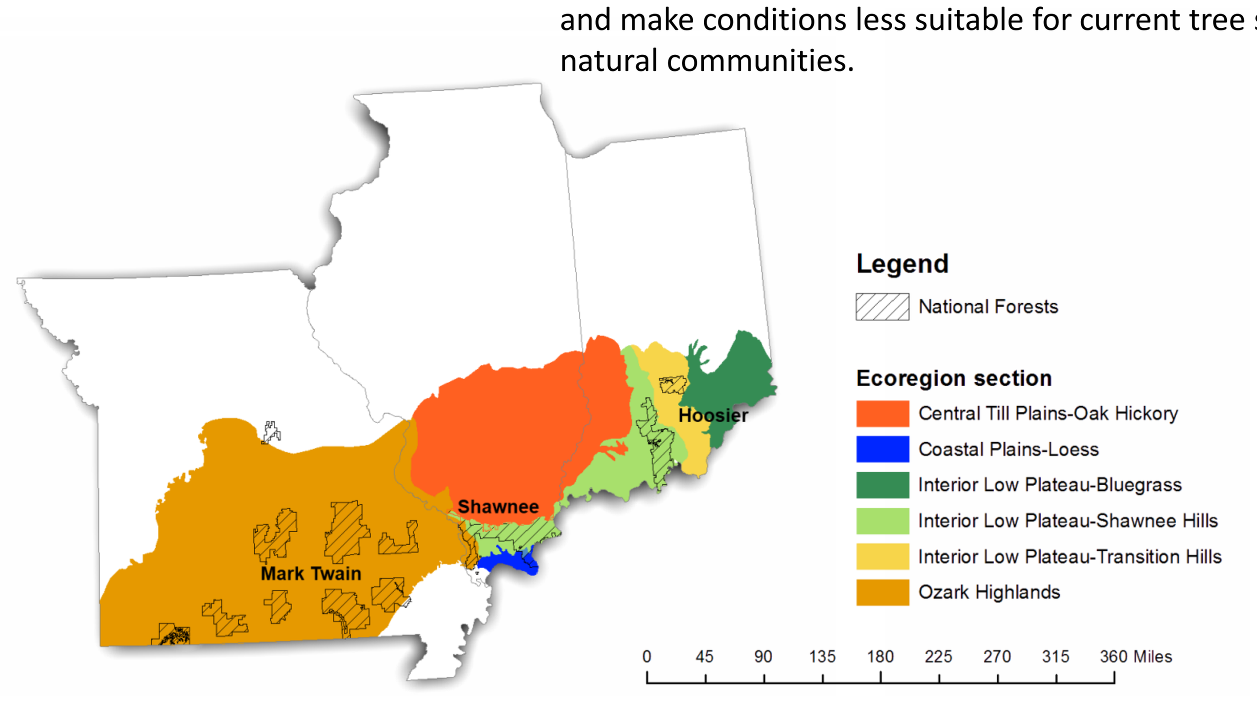
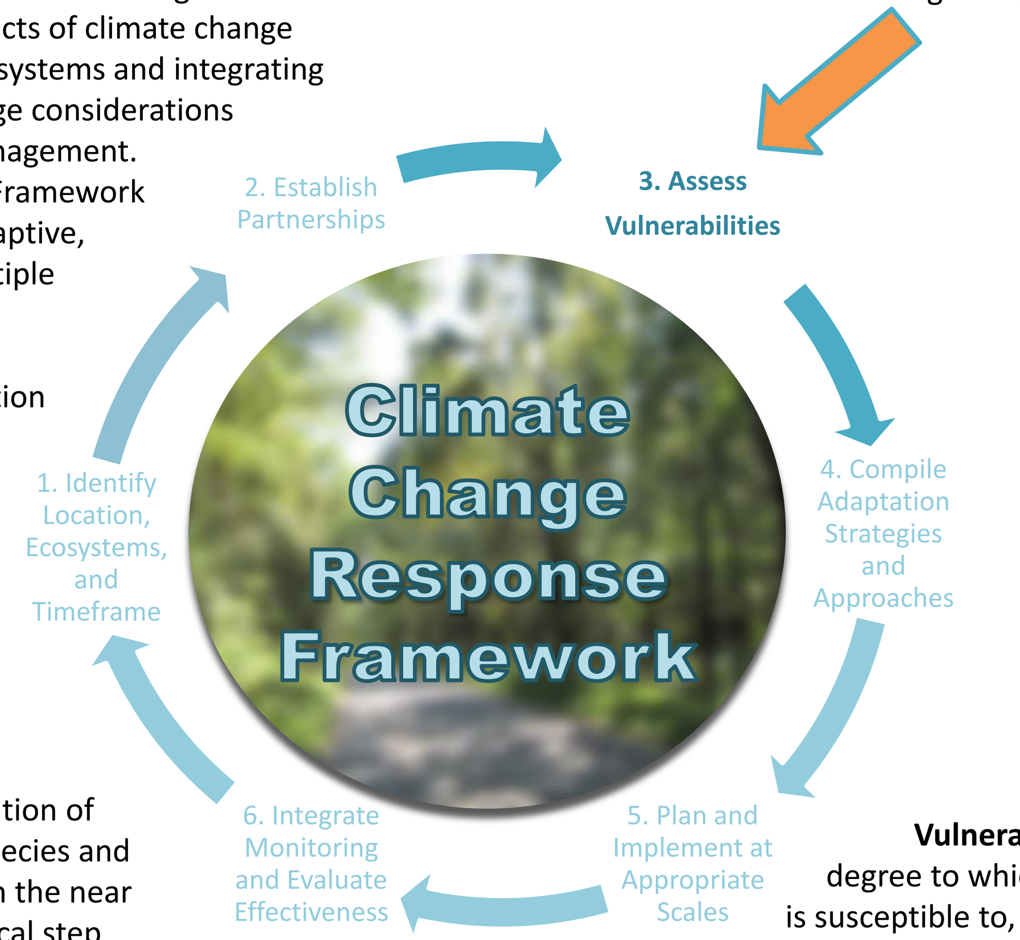
Study Area

The Central Hardwoods Region includes a mosaic of forests, woodlands, and other ecosystems dominated by oak, hickory, and other hardwood species. Our study covers the part of Central Interior Broadleaf Forest Province that falls within five sections in the states of Missouri, Illinois, and Indiana. Our study also covers one section (Coastal Plains-Loess) in the Southeastern Mixed Forest Province. Current threats to natural communities within the Region include fire suppression, invasive species, oak decline, and habitat fragmentation. Climate change has the potential to exacerbate these threats and make conditions less suitable for current tree species and natural communities.



The Climate Change Response Framework[1] is a highly collaborative approach to understanding the potential effects of climate change on forest ecosystems and integrating climate change considerations into land management. The six-step Framework process is adaptive, works at multiple scales, and incorporates new information into existing planning processes.

The work presented here focuses on the third step in the Framework: assessing vulnerabilities.



The identification of vulnerable species and ecosystems in the near term is a critical step in long-term planning, and is used to develop adaptation strategies and on-the-ground adaptation tactics that are specific to a particular ecosystem.

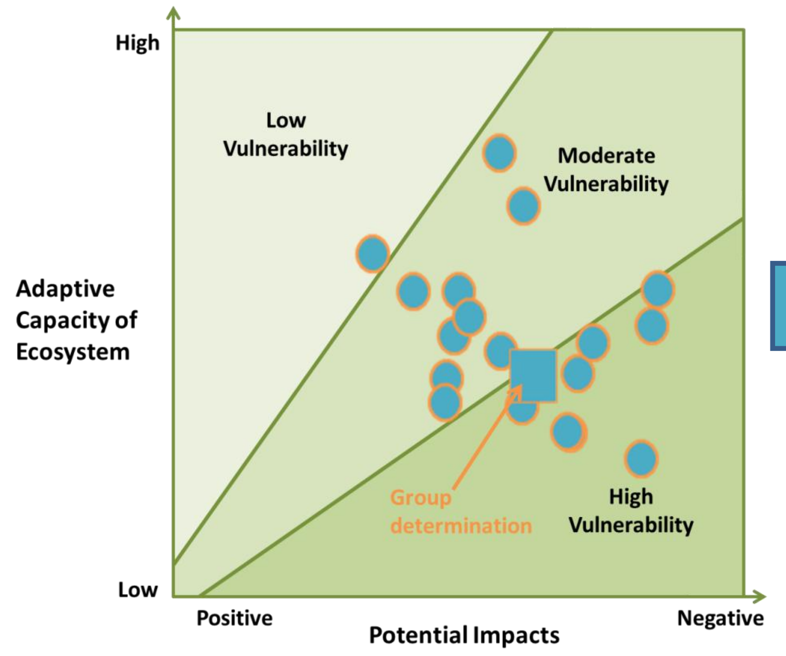
Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. A system's vulnerability is a function of its exposure to climate change, its sensitivity, and its adaptive capacity.

Vulnerability Determination

Impacts and Adaptive Capacity

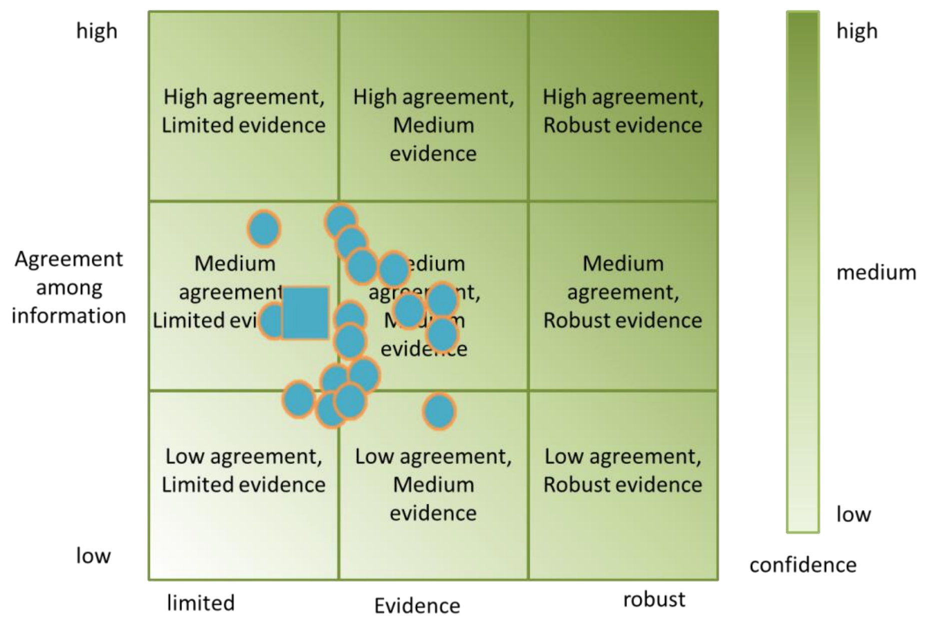
We determined potential impacts and adaptive capacity for nine natural communities within the region. We assessed potential impacts on dominant tree species within each community using a combination of model results from process (LINKAGES 2[2], LANDIS PRO[3]) and statistical models (Tree Atlas[4]). We gathered additional information using expert elicitation of 20 scientists and managers from across the Central Hardwoods Region.

Vulnerability



Each expert determined vulnerability based on a community's potential impacts and adaptive capacity. The experts then reached a group determination by consensus.

Confidence Rating

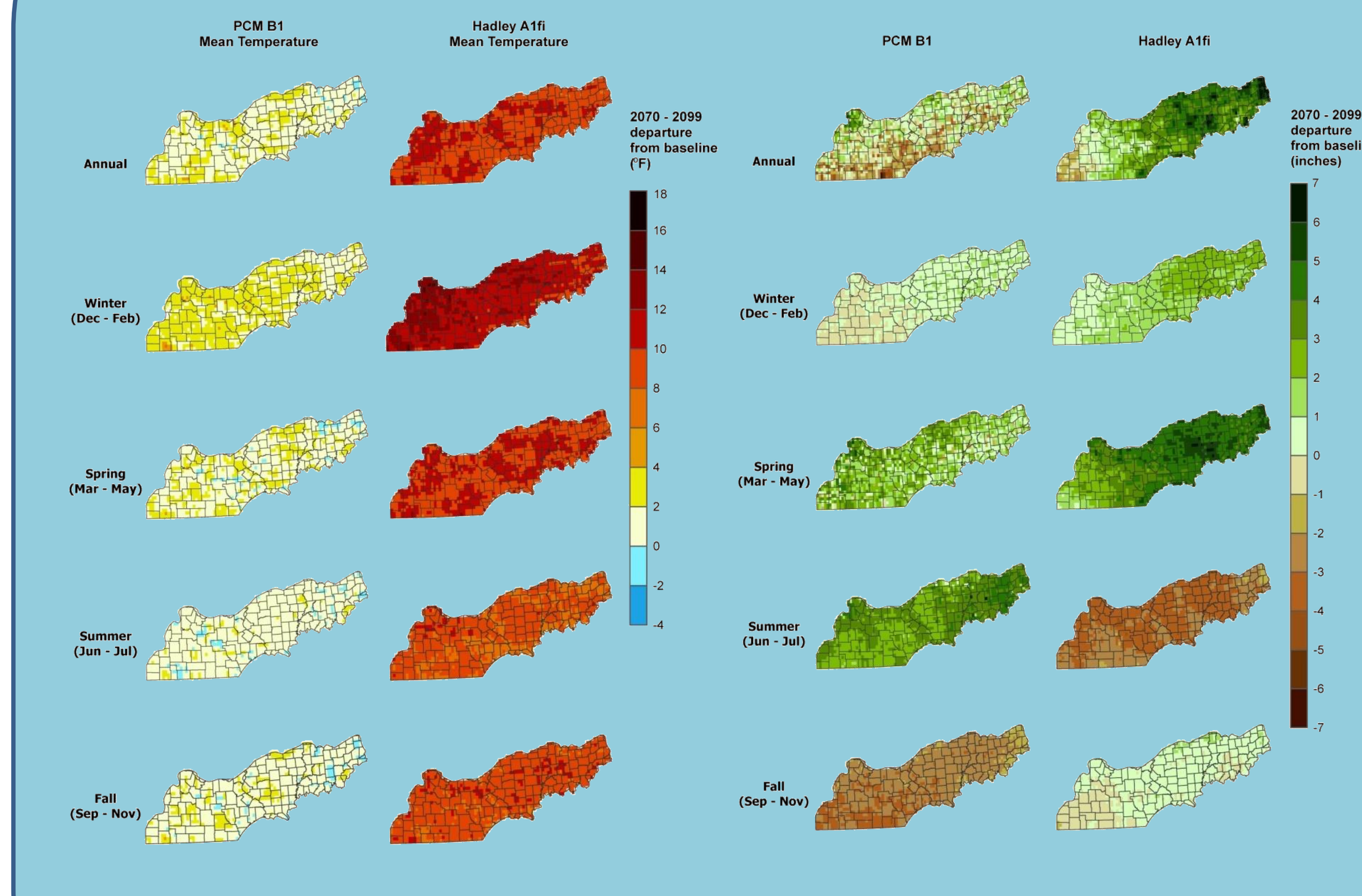


Each expert rated their confidence in each vulnerability determination based on the level of agreement among information presented to the group and the amount of evidence,

1. Projected Climate Changes

Temperatures will Increase

Precipitation Patterns will Change



We used projections from two climate model-scenario combinations to bracket potential future climate changes. The Hadley A1FI combination couples a higher sensitivity model with high greenhouse gas emissions. The PCM B1 combination couples a lower sensitivity model with low greenhouse gas emissions. Projections were averaged for three 30-year periods (2010-2039, 2040-2069, 2070-2099) and compared to a 1971-2000 baseline. These model projections were used as inputs into three forest impact models and as a framework for discussion of potential impacts on other system components.

2. Potential Impacts

System Drivers

- Conditions more favorable for fire (both natural and prescribed)
- Increase in flood risk (especially in late winter)
- Decrease in soil moisture at end of growing season
- Increased temperatures across all seasons

Dominant Species

- Potential increasers: shortleaf pine, blackjack oak, sweetgum
- Little change: many oak and hickory species, red cedar
- Potential decreasers: sugar maple, beech, basswood

Stressors/Threats

- Increased susceptibility to oak decline for red oak group
- Potential new invasion by southern pine beetle
- Potential increase in soil erosion from floods
- Many current invasive plant species are drought-tolerant and have the potential to increase

3. Factors That Increase Adaptive Capacity

- High species, genetic, and topographic diversity
- Widely distributed community type
- Adapted to drought, flooding or fire
- Current management regimes will remain effective in the future
- No significant impacts of pests or disease
- Dominant species have high dispersal ability
- High connectivity
- Dominant species are tolerant of a wide range of environmental conditions
- Ability for community to expand to new areas
- Invasive species are kept in check

4. What's Vulnerable?

Community Type	Potential Impacts	Adaptive Capacity	Vulnerability	Confidence
Barrens	Moderate	High	Low	Medium-high agreement; Medium evidence
Closed Woodland	Positive	High	Low	Medium agreement; Limited evidence
Open Woodland	Positive	High	Low	Medium agreement: Medium to Limited evidence
Dry-Mesic Upland Forest	Moderate	High	Low-Moderate	Medium to high agreement; Medium evidence
Flatwoods	Slightly Positive	Moderate	Low-Moderate	Medium agreement.; Limited to medium evidence
Glade	Slightly Positive	Moderate	Low-Moderate	Medium to high agreement; Medium evidence
Mesic Bottomland Forest	Moderate	Moderate	Moderate	Medium agreement; Medium to limited evidence
Wet Bottomland Forest	Slightly Negative	Moderate	Moderate- High	Medium agreement; Medium to limited evidence
Mesic Upland Forest	Negative	Low	High	Medium-high agreement; medium evidence

Conclusions

Some communities may fare better than others:

- Working to maintain and restore communities with low vulnerability may be a potential climate smart management strategy.
- Communities that are highly vulnerable may require additional management actions to help them adapt to a changing climate.

There are information gaps that lowered confidence in vulnerability determination:

- Information on extreme events like fire, floods, and drought.
- Additional modeling on non-woody species and hydrology.

Results from this study will be used to develop adaptation strategies, approaches, and demonstration projects as part of the Climate Change Response Framework.

References

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