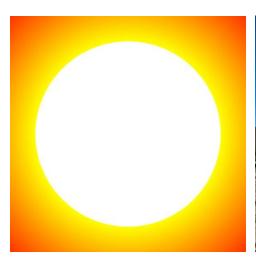
PRIMER ON CLIMATE IMPACTS AND RESILIENCY STRATEGIES TO TREE SPECIES OF THE HURON RIVER WATERSHED



CLIMATE CHANGE & RESILIENCY

- Climate change: the Earth's climate is changing at an unprecedented rate. The Huron River watershed is experiencing increasing extreme temperatures and precipitation events.
- Climate Resilience: The capacity of a system to prevent, withstand, respond to, and recover from a disruption.



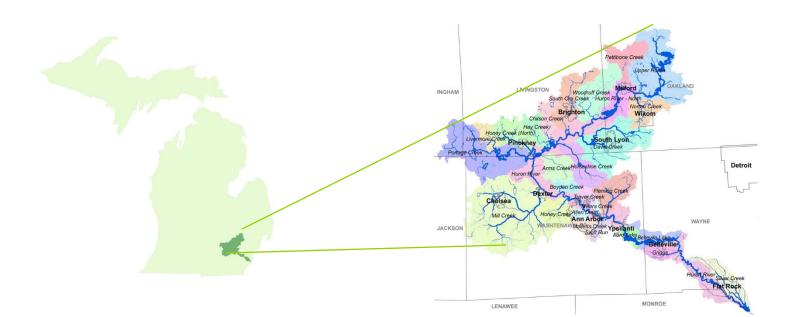




WHO IS THE PRESENTATION FOR?

- Natural Resource Managers
- Land Conservancies
- Urban Foresters

Geographic focus: Southeast Michigan and the Huron River Watershed.



GOALS OF PRESENTATION

- Understand how temperature and precipitation patterns are changing in southeast Michigan
- Know how these changes are expected to impact forest systems
- Learn emerging strategies for managing systems in a changing climate
- Ready you to disseminate info within this presentation and toolkit to your communities and constituents

Trees image credit: http://footage.shutterstock.c om/clip-1045822-stockfootage-short-clip-of-aspinning-view-of-tall-treesin-a-dense-forest-with-sunbeams-breakingthrough.html





TOOLKIT CONTENTS

- The Fundamentals
 - Comprehensive PowerPoint presentation
 - Review of climate impacts to tree species of the Huron River watershed
 - Fact Sheets for trees of the Huron River watershed
 - Report on strategies for building climate resilience



Review of climate impacts to tree species of the Huron River watershed



Download at: hrwc.org/tree-toolkit

TOOLKIT CONTENTS

- Deeper Knowledge
 - Historical Climatology reports for Ann Arbor & Southeast Lower Michigan
 - Climate Change Impacts on Natural Resources report
 - Annotated resource list:
 Further reading regarding resiliency-based management options

Historical Climatology: Ann Arbor, Michigan

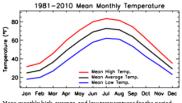




Map generated with Google Ma

Overview

Ann Arbor's climate is mostly continental and is strongly influenced by the movement of high and low pressure systems across the continent. It is characterized by larger seasonal temperature ranges than areas closer to the Great Lakes which have moderated temperatures. Prevailing westerly winds deliver some lake effect precipitation to the area, but it is essentially limited to increased cloudiness during the late fall and early winter. Diminished wind speeds or winds which do not traverse large unfrozen lakes often produce clearing skies and the colder temperatures expected at continental locations. While the day-to-day weather is highly variable, prolonged periods of hot, humid weather in the summer or extreme cold during the winter are relatively uncommon. Precipitation is well-distributed throughout the year, although the wettest months of the year tend to occur during the warm season. Summer precipitation comes mainly from afternoon thunderstorms.



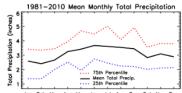
Mean monthly high, average, and low temperatures for the period 1981-2010.

Geography

Ann Arbor, located in east central Washtenaw County, is 36 miles west of Detroit and about 40 miles north of the Ohio border. The Huron River flows southeastward through the city toward Lake Erie. The surrounding terrain is partially wooded and varies from gently undulating to moderately rolling hills. The city of Ann Arbor is primarily an engineered urban environment populated with many nature areas and manicured parks. The urban tree canopy provides 30-40% coverage within the city limits. Major agricultural activities in the area include corn, soybeans, and wheat. Soil textures range from sandy to silt loams.

1981-2010

Temperature and Precipitation Summary		
Mean Annual Temperature (°F)	49.8	
Mean Annual Minimum Temperature (°F)		
Mean Annual Maximum Temperature (°F)		
Mean Number of Days per Year that exceed 90°F	8	
Mean Number of Days per Year that fall below 32°F	122	
Lowest Mean Annual Temperature (°F)	47.8	
Highest Mean Annual Temperature (°F)	53.2	
Mean Annual Total Precipitation (inches)	37.4	
Lowest Mean Total Precipitation (inches)		
Highest Mean Total Precipitation (inches)		
Mean Number of Days/Year with > 0.1" Precip.	78	
Mean Number of Days/Year with > 0.25" Precip.	47	
Mean Number of Days/Year with > 0.5" Precip.	23	
Mean Number of Days/Year with > 1" Precip.	6	



Jon Feb Mor Apr Moy Jun Jul Aug Sep Oct Nov Dec Mean monthly total precipitation with the 25th and 75th percentiles for the period 1981-2010.

ww.glisa.msu.edu

Last updated: 1/8/2013

Provided in collaboration with the Michigan Office of the State Climatologis

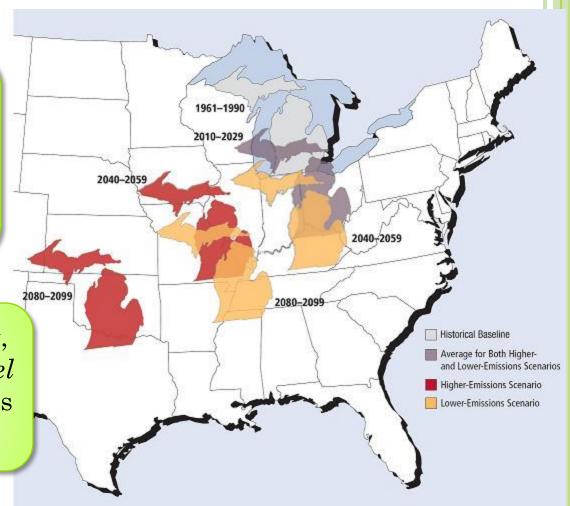
Download at: hrwc.org/tree-toolkit

CLIMATE OVERVIEW

A MIGRATING CLIMATE

The climate future generations experience will be fundamentally different than the climate today.

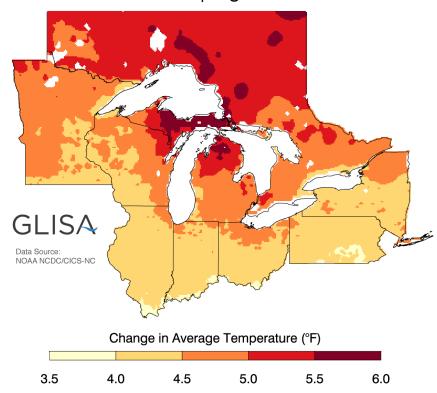
By the end of this century, Michigan summers will *feel* more like current summers in Arkansas.



Courtesy UCS 2009, original work by Hayhoe et al.

CLIMATE CHANGE IN THE GREAT LAKES RISING AVERAGE TEMPERATURES

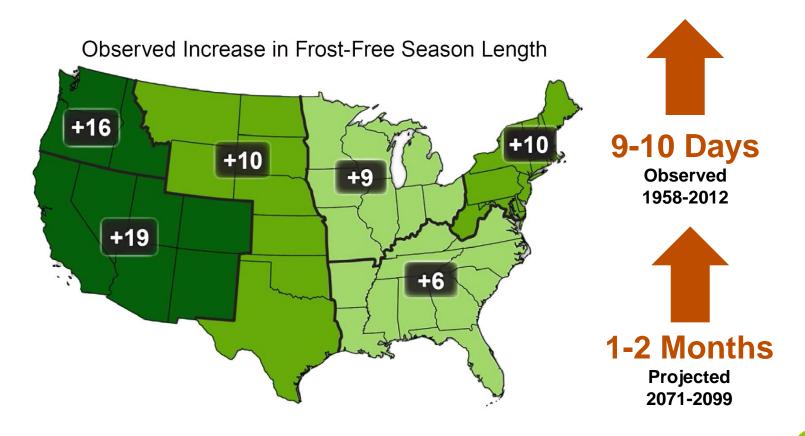
Projected Change in Average Temperature Period: 2041-2070 | Higher Emissions: A2







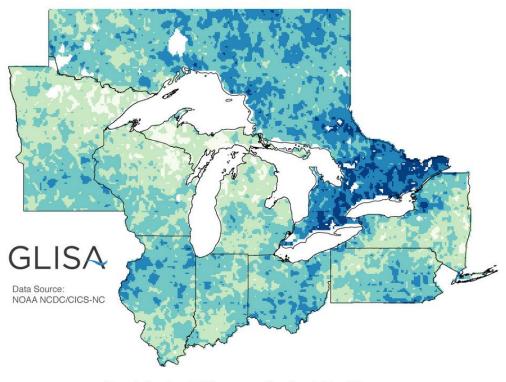
CLIMATE CHANGE IN THE GREAT LAKES LONGER FROST FREE SEASON

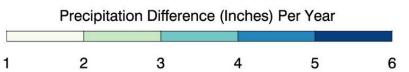


From the 3^{rd} National Climate Assessment, 2014

CLIMATE CHANGE IN THE GREAT LAKES INCREASED ANNUAL PRECIPITATION

Projected Change in Average Precipitation Period: 2041-2070 | Higher Emissions: A2







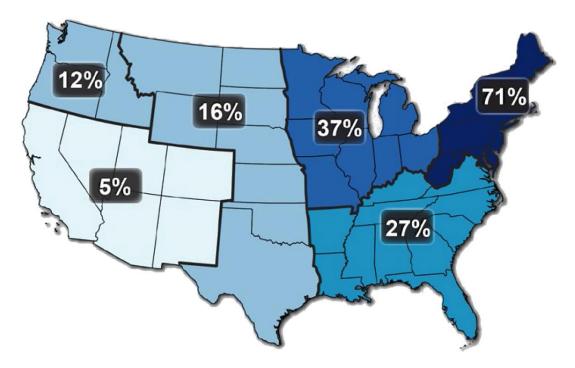
Observed (comparing

(comparing 1951-1980 to 1981-2010)



Projected 2041-2070

CLIMATE CHANGE IN THE GREAT LAKES OBSERVED EXTREME PRECIPITATION



The amount falling in the heaviest 1% of precipitation events increased by 37% in the Midwest from 1958 to 2012.

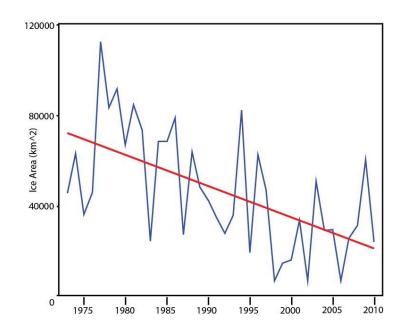
CLIMATE CHANGE IN THE GREAT LAKES DECLINING GREAT LAKES ICE COVER

Average Great Lakes Ice Coverage



Wang et al., 2012

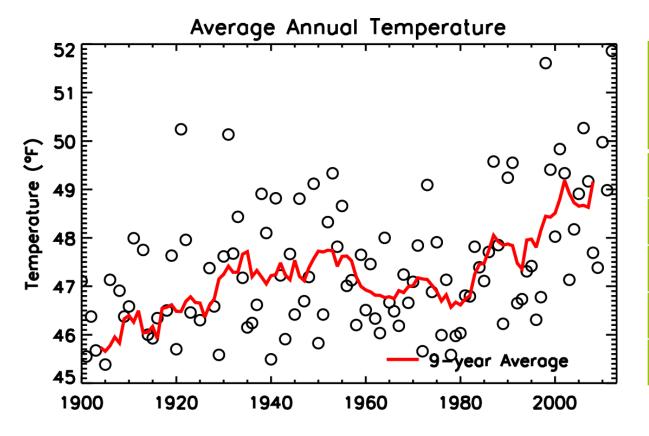
• Lake Superior is warming twice as fast as nearby air.



• Lake Superior could have little open-lake ice cover during a typical winter by mid-century.

Austin and Colman, 2007

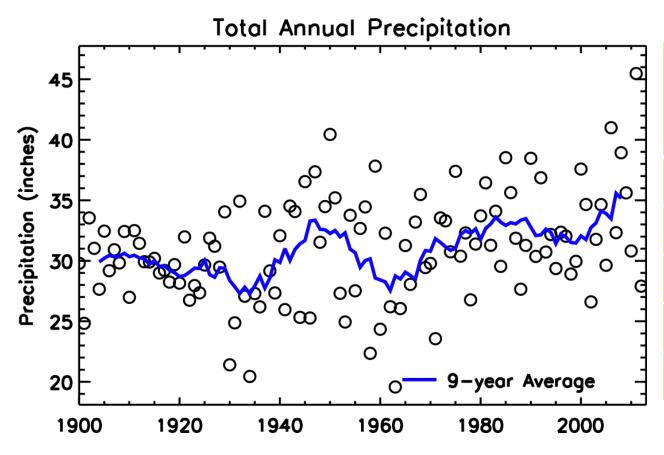
SOUTHEAST MICHIGAN TEMPERATURE



Changes in Mean Temperature (°F) from 1951-1980 to 1981-2010

Annual	1.1
Winter	2.0
Spring	1.3
Summer	0.7
Fall	0.5

SOUTHEAST MICHIGAN PRECIPITATION



Changes in Total Precipitation (%) from 1951-1980 to 1981-2010

Annual	9.5
Winter	7.3
Spring	2.0
Summer	4.5
Fall	27.7

KEY CLIMATE CHANGES FOR THE HURON RIVER WATERSHED

- Warmer average temperatures
- Warmer low and nighttime temperatures
- More potential for extreme heat
- Shorter winters
- More total precipitation
- More severe precipitation events







IMPLICATIONS FOR FORESTS AND TREES

IMPLICATIONS FOR TREE SPECIES

• Species with narrow climatic tolerances or at the edge of its range may not be able to tolerate new conditions

• Range envelopes expected to shift 450-500 miles north by 2100 to accommodate for a changing climate





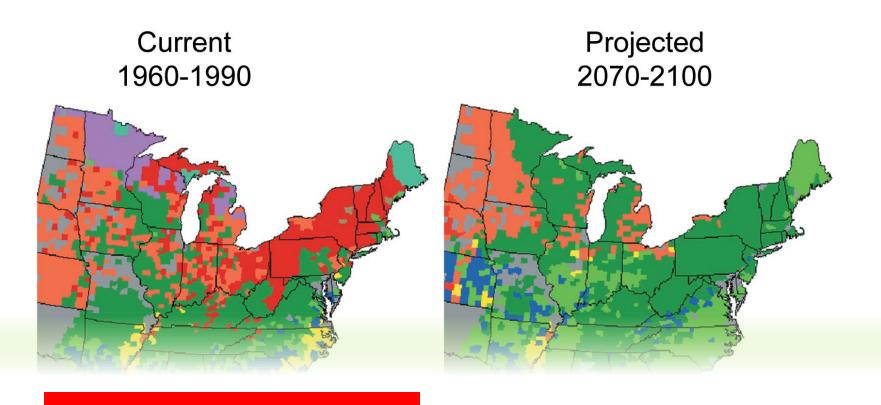


 $Left: http://oddhouseblog.files.wordpress.com/2013/08/il_003_suitcase_tree.jpg?w=450\&h=618\\ Right: http://www.clipartheaven.com/clipart/trees_\&_leaves/trees/tree_running.gif$

IMPLICATIONS FOR FORESTS

- Many tree species won't be able to keep up with shifts in range because
 - Slow migration rate
 - Lack of suitable establishment sites
 - Forest fragmentation
 - Shifts in natural disturbance regimes
 - Aggressive competition from non-native species
 - Threats from non-native insects and pathogens
 - Genetic maladaptation
- This has implications for species associations and natural community types.

SHIFTING FOREST TYPES



Maple, Beech, Birch

Aspen, Birch

Oak, Hickory

Current Fall Foliage



Image credit:

Top: http://www.bernerhof inn.com/blog/wpcontent/uploads/2011/ 08/iStock_000007478 801Small.jpg

Bottom: http://imgc.artprintim ages.com/images/artprint/raymondgehman-hardwoodforest-with-maplehickory-and-oaktrees-in-the-fall_i-G-30-3028-B8KBF00Z.jpg

Future Fall Foliage



ADDITIONAL IMPLICATIONS

Changing Climate makes systems vulnerable to:

- Disease
- Invasive species
- Pest Infestations
- Wildfire
- Floods





Distribution of kudzu in the United States. Image credit: EDDMapS. 2011. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/; last accessed December 08, 2011.

TREE SPECIES FACT SHEETS



- Fact sheets compare current tree ranges to model projections
- Projections couple current data with science to help predict future trends in climate change impacts and associated tree species responses
- Models come from USDA and Forest Service Climate Change Tree Atlas
 - Highly credible, peer reviewed research
 - http://www.fs.fed.us/nrs/atlas/

FAVORABILITY OF FUTURE CLIMATE TO TREES OF THE HURON

Major take-homes of analysis:

- Shift from Maple-Beech-Birch to Oak-Hickory communities
- Northern trees at southern edge of range currently in Huron River watershed going locally extinct
 - Esp. wetland species
- Southern trees at northern edge of range currently in watershed moving in

"+" indicates that the predicted future climate will be favorable to a species, "0" indicates the predicted future climate is not expected to significantly affect a species, and "-" indicates the predicted future climate will be unfavorable for a species.

Favorability of future climate to tree species in southeast Michigan American Basswood American Beech American Elm 0 American Hornbeam Black Cherry Black Oak Black Spruce Blackgum Box Elder Bur Oak Chinkapin Oak Eastern Hophornbeam Eastern Redbud Eastern White Pine Flowering Dogwood Hackberry Hickory species Honeylocust Kentucky Coffeetree Northern Red Oak Paper Birch Red Maple 0 Sassafras Serviceberry Sugar Maple Swamp White Oak 0 Sycamore Tamarack Tuliptree White Oak

USING THE FACT SHEETS

Climate Resilient Communities 💎



Trees of the Huron River Watershed in a Changing Climate

Where species can be found and general requirements for healthy growth

Current geographic range and predicted future suitable habitat

How climate change will affect this species

Associated natural community types

Vulnerability of associated natural communities

Sugar Maple Acer saccharum

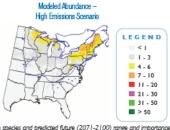
Sugar maple is found throughout the central Midwest states with its highest abundance in the north. It is a highly shade tolerant, long-lived, slow growing species that is found more in cool climates on rich, moist, well-drained sites. This species does best on highly fertile soils and can form almost pure stands. It is a keystone species of the mesic southern forest and therefore very important ecologically. It is also very economically valuable for timber and maple syrup production in the upper Midwest New England and Canada



Change Maps for Sugar Maple

Modeled Abundance -Current Abundance





Abundance change maps for sugar maple showing current (1961-1990) range and importance of the species and predicted future (2071-2100) range and importance using an average of three low emissions climate models. The Imbortance Value ranges from 0 to 100 and gives a measure of the abundance of the species.

Implications of Climate Change

models show a dramatic and nearly complete loss of this species throughout the south-central Midwest including Michigan except it its northernmost latitudes. Und scenarios, sugar maple will be far less abu River watershed. Given that both rest should be considered at risk and these and other changes. For planting and

Natural Communities Associations

Canopy dominant in mesic southern forest. Canopy associate

in floodplain forests (above influence of floodwaters), southern hardwood swamp, and wet mesic flatwoods.

Vulnerability of Natural Communities³

Mesic southern forests, in which sugar maple are a dominant canopy species, are likely to expand in range northward. However, the sensitivity of sugar maple indicates that this species will not do well in lower Michigan and may only be a significant part of this community in its northernmost latitudes. Under drier, warmer conditions southern hardwood swamps and wet mesic flatwoods will be negatively impacted as local hydrology is altered.

Prasad, A. M., L. R. Iverson, S. Matthews, M. Peters. 2007-ongoing, A. Climate Change Atlas for 134 Forest Tree Species of the Eastern United States [database]. http://www.nrsfsfedus/atlas/bree,

Michigan Natural Features Inventory, www.mnfiansmsu.edu/communities

Lee, Y. M. A. Kost, J. G. Cohen, and E. H. Schools. 2012. Climate Change Vulnerability Assessment and Adaptation Strategies for Natural Communities in Michigan, Focusing on the Coastal Zone. Michigan Natural Features Inventory Report No. 2012-18, Lansing, MI



COST OF LOSING SPECIES AND SYSTEMS

- Ecological costs
 - Forest and tree resources at risk of being fundamentally altered
 - Loss of biodiversity and ecosystem services
- Economic costs
 - High numbers of planted trees lost and requiring replacement
- Infrastructure costs
 - Loss of municipal services such as stormwater infiltration, clean air, urban heat island mitigation
- Cultural costs
 - Impacts on recreational amenities such as parks and natural areas





Management Options for Resilience

- Report including:
 - Executive summary
 - Full length report
 - Detailed summaries of each management strategy
 - In-text citations
- Organized into FOUR key management sections
 - Long-term planning and policy formulation
 - Site scale recommendations for natural areas
 - Site scale recommendations for urban areas
 - Evaluating and adapting existing conservation plans

A Review of Management Options for Improving Climate Resiliency in the Huron River Watershed's Forest and Tree Resources

HURON RIVER WATERSHED COUNCIL

Climate Resilient Communities Natural Infrastructure

> Written by: Michael Kaminski Rebecca Esselman

> > June 2013

HIGHLY RECOMMENDED OPTIONS

- Long-term planning and policy
 - Reserve planning
 - Improving landscape connectivity
 - Inventory urban forest resources
 - Development ordinances promoting resiliency
 - Be wary of relying on historical tree species ranges in planning efforts
 - Improving stakeholder communication and community engagement





HIGHLY RECOMMENDED OPTIONS

- Site-scale recommendations
 - Increase tree species diversity
 - Ensure healthy distribution of age classes and growth rate
 - Manage for processes instead of species and manage for ecosystem redundancy
 - Practice "right tree, right place"
 - Prepare for high incidence of pests and diseases



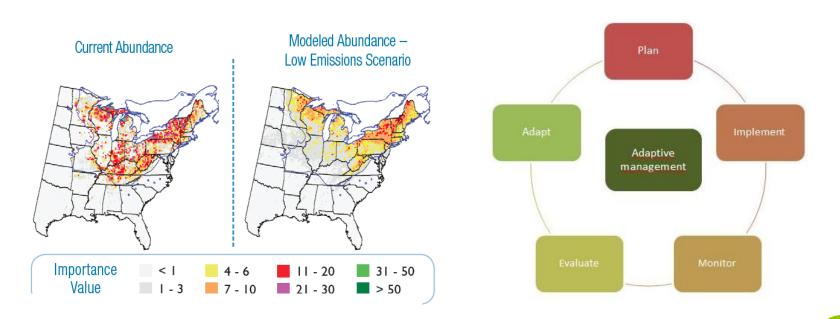




 $Left: http://leisurelanelegers.blogspot.com/2009_07_01_archive.html\\ Right: http://img-cache.cdn.gaiaonline.com/0d42db5bbb3ae32fbd22373fa9fd5c6f/http://i263.photobucket.com/albums/ii153/Lotiswit/Fantasy/multiLayerForest.jpg$

HIGHLY RECOMMENDED OPTIONS

- Evaluating and adapting existing conservation plans
 - Incorporate climate data and models into conservation plans
 - Utilize adaptive management framework for planning



THERE ARE NO ONE-SIZE-FITS-ALL SOLUTIONS

- Management Options Report = "Toolbox" approach because there are no one size fits all solutions with climate change
- Up to the manager to decide which combination of tools makes the most sense
 - Unique understanding of forest resources
 - Each case faces a unique set of vulnerabilities to climate change







Examples of Management Options

- The situation:
 - High numbers of street trees needing replacement
- Management options:
 - Inventory urban forest resources
 - Incorporate tree range models in planning
 - Development ordinances that promote resiliency
 - Update planting lists
 - Protect existing trees
 - Increase tree species diversity
 - Ensure healthy distribution of ages classes and growth rates
 - Plant drought resistant species
 - Management plan audits to update for climate resiliency

Examples of Management Options

• The situation:

- Tree stand
- Dominated by a two or three different tree types
- Dominant species showing signs of declining health

• Management options:

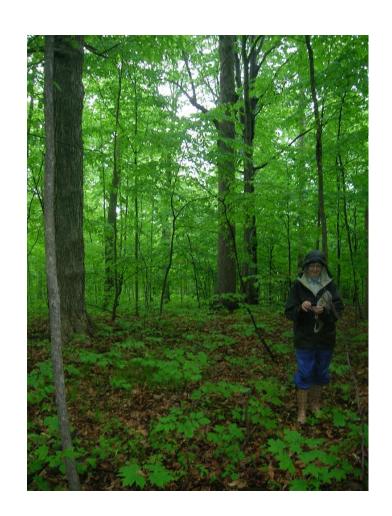
- Incorporate tree range models in planning
- Increase stand diversity
- Natural regeneration
- Enrichment planting
- Thinning the stand
- Triage approach



Image credit: http://buroaklandmanagement.com/img/large/PA240009.jpg

ADDITIONAL BENEFITS OF RESILIENCY MANAGEMENT

- Simply good forestry practice
- Resilience is the ability to recover from any impact.
 - Drought years
 - Pest and disease outbreaks
 - Invasive species
 - Fragmentation
 - Land use change



TREE RESILIENCE TOOLKIT

www.hrwc.org/tree-toolkit

OKAY, NOW WHAT?

- ✓ Take time following this presentation to consider how this information affects your:
 - Plans
 - Acquisitions
 - Management actions, etc.
- ✓ Please share this presentation with others in your field.



Image credit: http://www.property-in-the-sun.com/images/Blog/feb_2007/oak_tree_04.jpg

Contact: Rebecca Esselman – <u>resselman@hrwc.org</u>