Slide 1

Central Hardwoods Climate Change Response Framework

Shawnee National Forest

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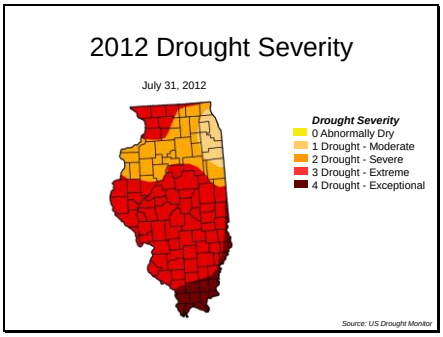
Northern Research Station and Eastern Region

Slide 2



This year's drought was the first "exceptional" drought Illinois has experienced in nearly 50 years. This drought has had tremendous impacts on the livelihoods and quality of life for the people of Illinois.

This July was the second hottest and 4th driest on record.

Slide 3

The corn crop has withered under hot, dry conditions, leading to total losses in some areas.

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The February 29th Tornado was one of the most devastating in southern IL history.

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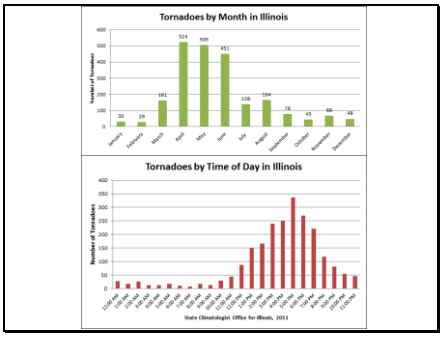


This event was rare in its time of year and time of day.

Slide 6

In spring 2011, major storms, combined with a heavy spring snowmelt, led to record-breaking flooding along the Mississippi and Missouri Rivers. To save the town of Cairo, Illinois and the rest of the levee system along the Mississippi River, the US Army Corps of Engineers blasted a two-mile hole in a levee flooding 130,000 acres (530 km^2) of farmland and displacing 200 residents in Mississippi County, Missouri.

Slide 7

Are events such as these becoming more common?

This may lead you to ask…

Slide 8

Is there a link to underlying changes in climate?

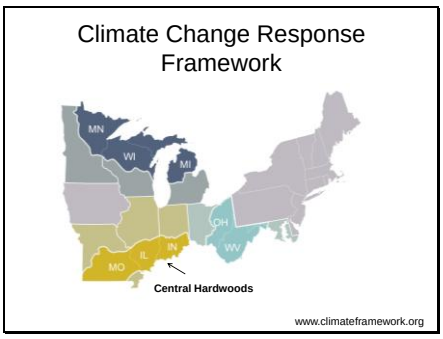
This may lead you to ask…

Slide 9

What does this mean to the land we manage?

This may lead you to ask…

Slide 10



To answer questions such as these, scientists and land managers at the Forest Service and their partners have come together to develop the "climate change response framework". Three ecoregional framework projects are currently underway. The Hoosier and its partners in southern Indiana are part of the Central Hardwoods Climate Change Response Framework project.

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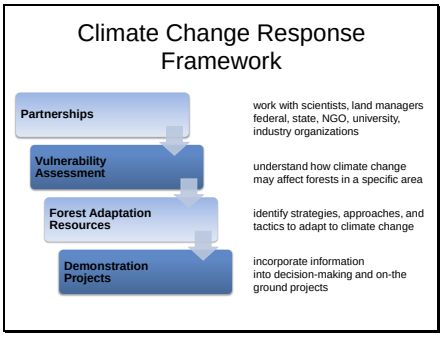
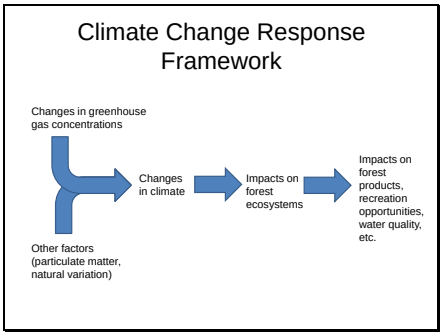


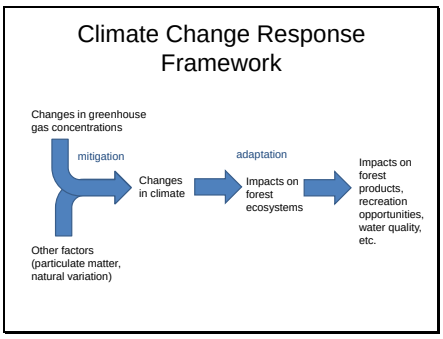
The Climate Change Response Framework has four major components: partnerships, vulnerability assessments, forest adaptation resources, and demonstration projects.

Slide 12



The climate change response framework seeks to understand how natural and human-induced changes in climate may impact forest ecosystems and the benefits they provide to aid in decision-making.
There are two important aspects of decision-making related to climate change:

Slide 13



Mitigation seeks to reduce human-induced change in greenhouse gas emissions.
Adaptation seeks to reduce the vulnerability of natural and human systems to actual or expected climate change effects.

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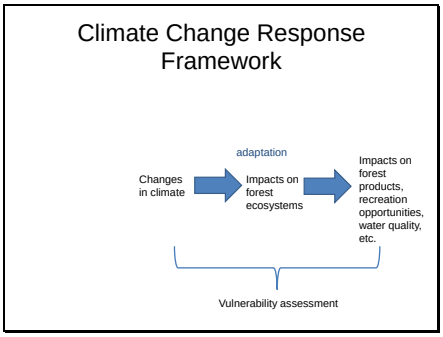
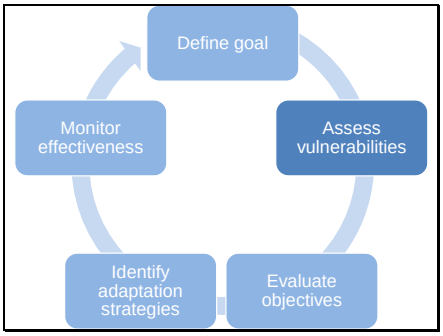


The climate change response framework focuses on adaptation.

The vulnerability assessment determines what the potential impacts may be assuming no adaptation actions are taken.

Slide 15

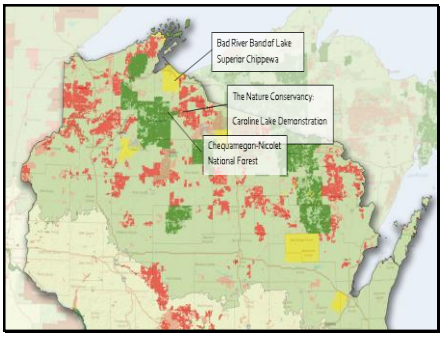


This vulnerability information can then be incorporated into planning using the workbook developed as part of the forest adaptation resources document.

Slide 16

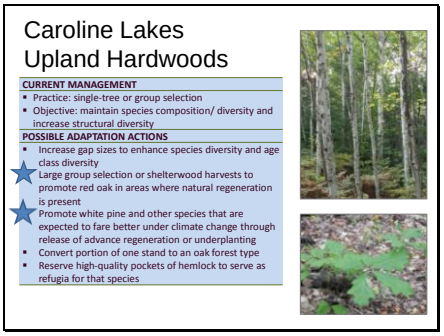
The ultimate goal is to use this information to identify areas where we may need to adjust our land management, or where actions we may already be undertaking may act as adaptation actions, and then apply them to actual management actions that are occuring. We call these "demonstrations" because they demonstrate the process of incorporating vulnerability information and adaptation strategies.

Slide 17



In northern Wisconsin, where a vulnerability assessment has already been completed, 3 demonstrations are currently underway focused on the bad river watershed.

Slide 18



For example, an upland hardwood stand was selected for a demonstration.Its current management practices and objectives were evaluated, and then 5 adaptation actions were identified that may be helpful in the face of climate change. Two of these have been selected for incorporation into a revision of TNC's land management plan.

Slide 19

Questions

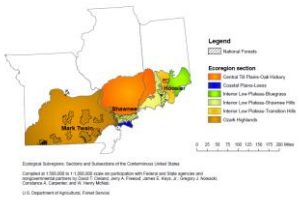
1. How has climate changed in southern Illinois over the past century?
2. How is climate projected to change in southern Illinois over the next century?
3. What does this mean for the forests we manage?

Today, I'm going to give you a sneak peak at some of the discoveries we have made in undertaking the vulnerability assessment for the central hardwoods region.

I will focus on three questions:

Slide 20

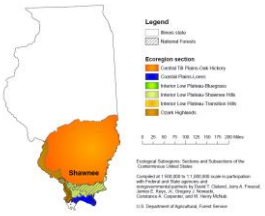
Assessment Area



The assessment covers ecological province 223, Central Interior Broadleaf Forest, of the national hierarchical framework or ecological units, in MO, IL, and IN. This area was selected based on a combination of political and ecological boundaries.

Slide 21

Today's Focus



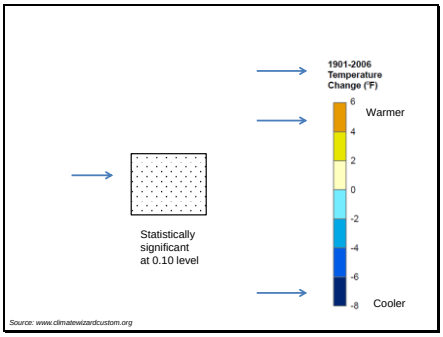
Today, I will just be focusing on the Illinois portion of the assessment area.

Slide 22

PAST CLIMATE

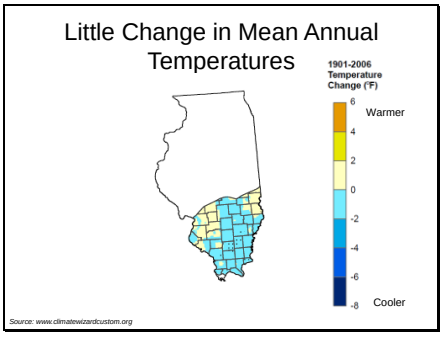
So how has climate changed in the past?

Slide 23



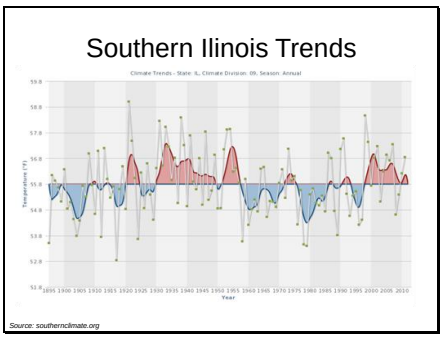
Historical measurements of climate are available back to about the start of the last century. I'm going to show you a series of maps that show trends in these historical records. Data from weather stations has been interpolated onto a grid and then analyzed for linear trends. Blue areas indicate that there is a trend toward cooler temperatures, while yellow, orange, and red areas indicate trends toward warmer temperatures.

Slide 24



If we just look at mean annual temperatures over this time period, we find that temperatures have not changed considerably in southern Illinois. Some areas are slightly warmer or cooler, but these are mostly within the range of statistical noise. Areas with stippling are where we have 90% confidence or greater that the trends are not due to chance alone.

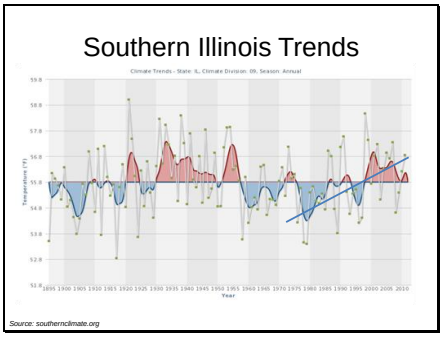
Slide 25



So, what's driving this pattern?

If you look at the year-to-year variation, what you see is that many of the warmest years on record were between 1920-1955, and a cooler period occurred during the 1960s and 70s. More recently, temperatures have been on the upswing again.

Slide 26



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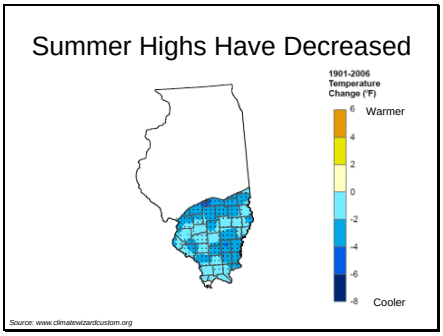
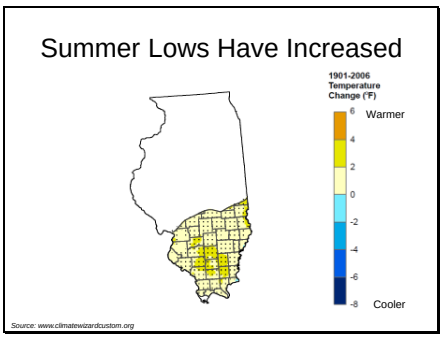


While there may not be any significant trends in annual temperature, there are some trends in seasonal highs and lows.

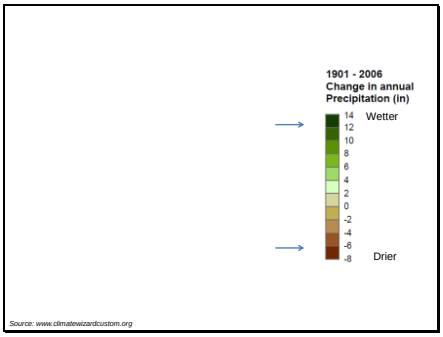
There has been a remarkable trend toward decreasing summer high temperatures in the area. There are some competing theories as to why, but one explanation is a local increase in aerosols (particulate matter in the air), which seems to be going away from tighter air quality regulations.

Slide 28



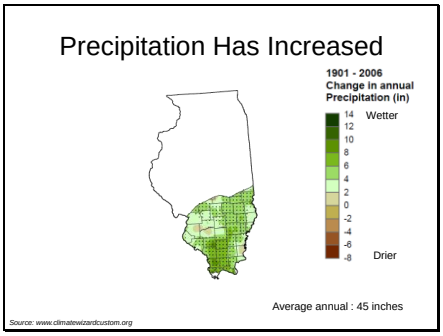
Related to this, summer low temperatures have been increasing slightly.

Slide 29



Next, I'm going to show you a series of maps that show changes in precipitation. Green indicates that things are getting wetter, while brown indicates things are getting drier.

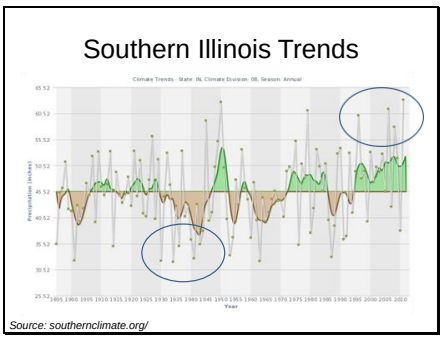
Slide 30



More dramatic than changes in temperature across the area are changes in precipitation.

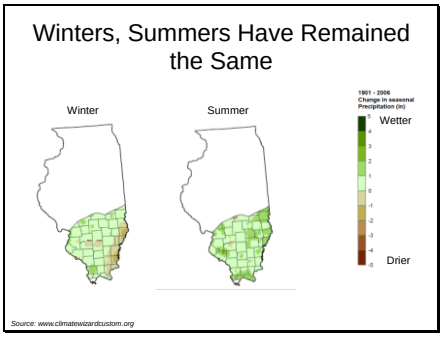
As you can see, southern Illinois is receiving about 4-6 inches more per year now than at the beginning of the 20th century.

Slide 31



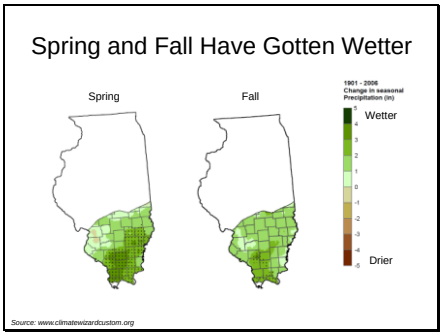
If you look back at the historical record, you see that extended periods of lower than average precipitation tend to be clustered toward the first half of the 20th century, while many of the wettest years have been in the past few decades.

Slide 32



Not all seasons are equal-winter and summer have actually not changed considerably.

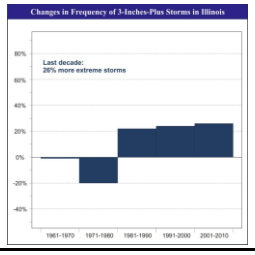
Slide 33



Spring and fall, however have gotten much wetter, particularly in the south.

Slide 34

Heavy Precipitation Events Have Increased



Saunders et al. 2012

While this might seem like good news, it is important to keep in mind that more and more of this precipitation has been falling as heavy rain events, which can't always be utilized by terrestrial ecosystems.

A recent report shows that the first decade of the 21st century had 26% more 3-inch rain events compared to the 1961-1990 average.

Slide 35

Other Observed Climate-Related Changes

- The frequency of extreme and exceptional droughts decreased between 1916 and 2007
- Earlier snowmelt and decreasing snow depth in the area
- Tornado detection has increased, but severe tornadoes have decreased

Sources: Diffenbaugh et al. 2008, Dyer and Mote 2006, Kunkel et al. 2008,

A number of other important trends can be seen from looking at the historical record.

Slide 36

Discussion Break

Do these trends line up with what you're seeing on the ground?

Slide 37

PROJECTED CLIMATE

What I just showed you was all based on actual measurements of climate and weather-related events.

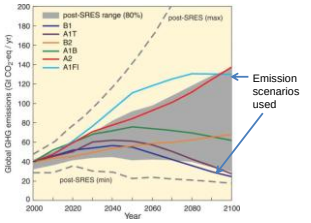
Now I'd like to switch gears and talk about how climate may change in the future.

Slide 38

We can't predict the future. Changes in population, technology, and policies will affect how much greenhouse gas emissions, and thus climate, may change in the future.

Slide 39

Emission Scenarios



Source: IPCC 2007

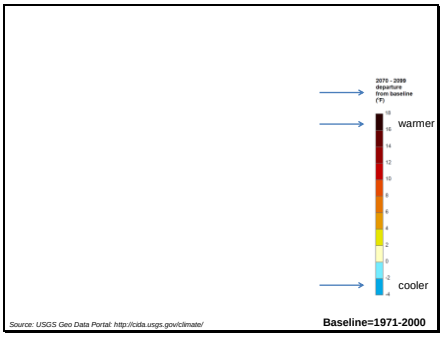
However, we can make projections. In order to do this, scientists have crafted storylines about how the world may change over the next century, and then calculated greenhouse gas emissions associated with those storylines.

Over the next set of slides, I'm going to show you modeled projections for two emission scenarios. We chose a low-end and a high-end scenario to bracket the range of possible futures. However, it's important to note that current greenhouse gas emissions are tracking above the "high emissions" scenario.

Slide 40

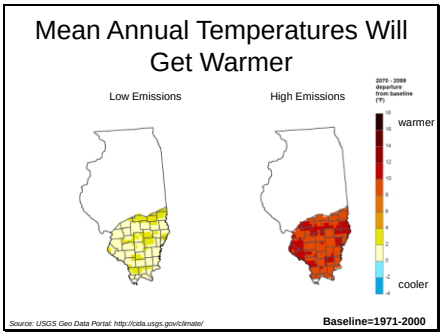
These scenarios are then incorporated into large-scale climate models. I'll spare you the details, and let's instead imagine we stepped into a time machine and can peer into the future… all the way to the end of the century.

Slide 41



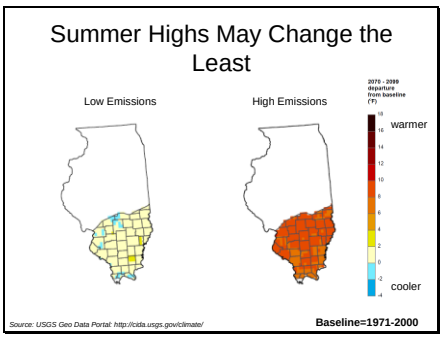
These maps show the projected average annual temperature for the years 2070-2099 compared to the average from 1971-2000. As before, "warmer" colors indicate warmer temperatures and blues equal cooler temperatures.

Slide 42



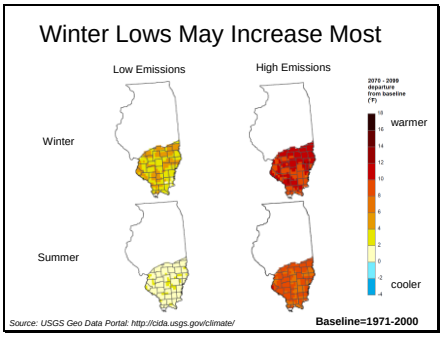
The low emissions scenario shows slightly higher temperatures on average, while the high emissions scenario shows increase of 8-12 degrees F.

Slide 43



These model projections indicate that summer high temperatures will change the least.

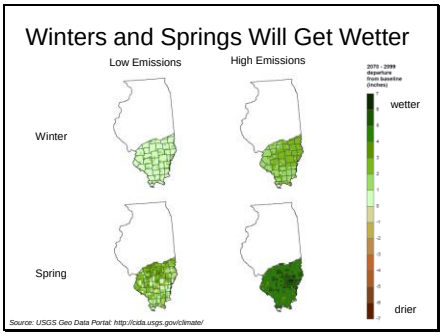
Slide 44



While increases in winter low temperatures will be some of of the most dramatic.

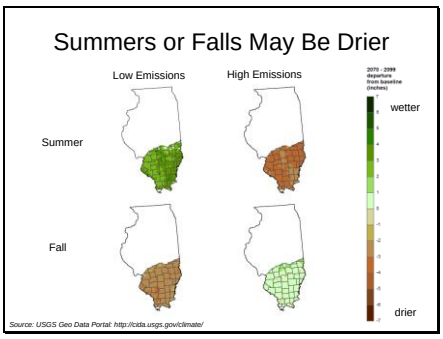
Overall, this means that there will be a greater reduction in extremely cold nights than an increase in extremely hot days. Which sound good, until you start thinking about insects, diseases, and invasive species.

Slide 45



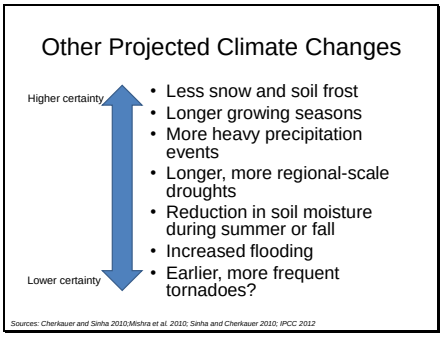
Under both emissions scenarios, it appears that winter and spring precipitation will increase from what it is today.

Slide 46



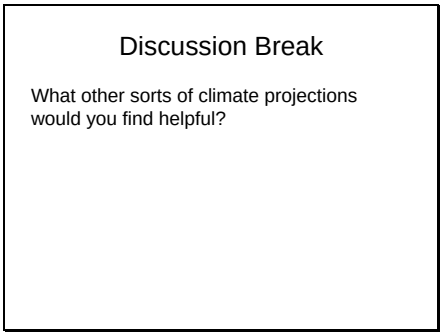
However, there is some uncertainty about how precipitation will change in the summer and fall. But there is a general suggestion that there may be a decline in available water at some point later in the growing season.

Slide 47



In addition to projected changes in seasonal averages, we can also look at some other factors that may be important in decision-making. We have greater certainty in some things than others.

Slide 48



Slide 49

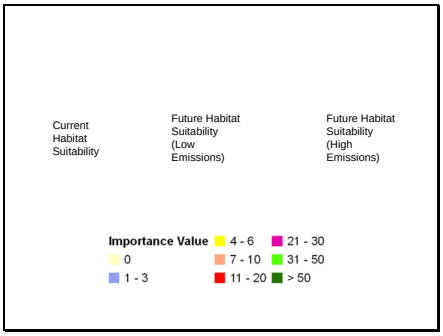
IMPACTS ON FORESTS

Changes in climate are important to understand. But, ultimately, we want to know what this means to forests.

Additional modeling has been done using the climate data I just showed you as inputs into forest impact models.

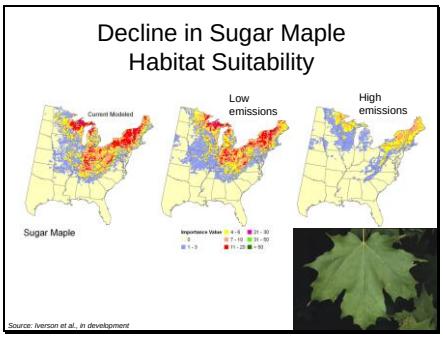
I'm going to show you some results we have so far from Louis Iverson's group at the Northern Research Station.

Slide 50



The next couple of maps show changes in importance values (an index of species abundance). On the left is the current habitat suitability for maple, the center shows habitat suitability under low emissions, and the right shows habitat suitability under high emissions.

Slide 51



This modeling shows that under the low emissions scenario, sugar maple habitat will likely remain stable in Illinois. However, under high emissions, no habitat is projected to remain suitable in southern Illinois.

Note: this is a projection of habitat suitability not a prediction of where species will be.

Slide 52

Other “losers”

	Species
Extirpated	American basswood, eastern white pine, Ohio buckeye
Large decreaser	shagbark hickory, shingle oak, white ash, northern red oak, sugar maple, black walnut, American beech, northern catalpa, rock elm, swamp white oak, scarlet oak, chinkapin oak,
Small decreaser	American elm, black cherry, black oak, boxelder, hackberry, black locust, pawpaw

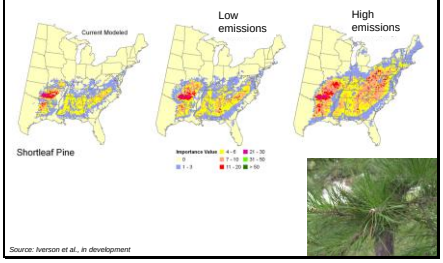
Source: Iverson et al., in development

This same modeling was done for about 75 tree species in southern Illinois. Of these, 22 species were expected to decline or be extirpated.

Many of these include more northern species, such as sugar maple, beech, and basswood.

Slide 53

Increase in Shortleaf Pine Habitat Suitability



Source: Iverson et al., in development

This general northward migration of habitat suitability will open up new opportunities for more southern species. Suitable habitat for shortleaf pine in southern Illinois, for example, is projected to increase under high emissions.

Slide 54

Other “winners”

	Species
Small Increaser	honeylocust, mockernut hickory , osage-orange, red maple, yellow-poplar, common persimmon, eastern red cedar, red mulberry, river birch, Am. hornbeam:musclewood,Shumard oak
Large Increaser	post oak, sweetgum, cherrybark oak, overcup oak, black hickory, blackgum, blackjack oak, loblolly pine, pecan, shortleaf pine, southern red oak, sugarberry, willow oak, winged elm
New migrants	cedar elm, water oak, longleaf pine, slash pine

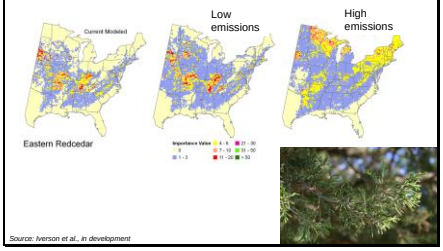
Source: Iverson et al., in development

Suitable habitat for 29 species is projected to increase or become newly available.

Many southern oak, hickory, and pine species fall into this category.

Slide 55

Habitat May Remain Suitable for Eastern Redcedar



Source: Iverson et al., in development

Finally, some species may not change considerably in abundance in southern Illinois. Eastern redcedar, while changing elsewhere, is projected to remain relatively stable in this part of the country.

Slide 56

Other "non-changers"

	Species
Non-Changer	pignut hickory, baldcypress, sassafras, chestnut oak, silver maple, jack pine, slippery elm, Kentucky coffeetree, sycamore, shellbark hickory, white oak, water tupelo, eastern redbud, wild plum, pin oak, bur oak, black willow, bitternut hickory, eastern cottonwood, eastern hophornbeam, flowering dogwood, green ash

Source: Iverson et al., in development

22 species are not supposed to change dramatically in suitable habitat.

Many of these species have wide ranges and are able to persist under a wide variety of conditions, such as silver maple, white oak, and cottonwood.

Slide 57

Other Forest Impacts

- Increased probability of wildfire by end of century
- Greater susceptibility to non-native species invasions
- More pest and disease outbreaks
- Carbon dioxide fertilization

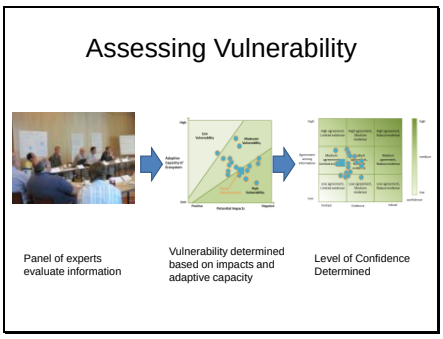
Sources: Moritz et al. 2012, Dukes et al. 2009, Lenihan et al. 2008

The results presented above are just based on changes in temperature and precipitation.

Other factors will also influence the distribution and abundance of species and will likely change with climate change.

These include: (read slide)

Slide 58



To assess how vulnerable forests in southern Illinois are to all these impacts,

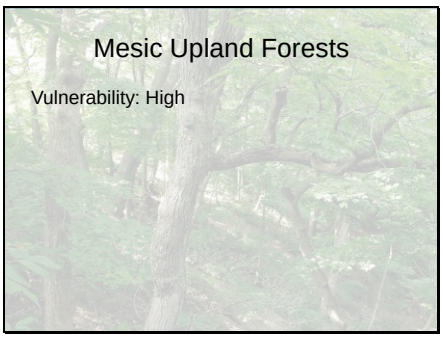
- we assembled a panel of experts to evaluate the current state of our knowledge on climate change impacts in the central hardwoods region
- For 9 broad forest community types, this panel assessed whether impacts tended to be more positive or negative
    - They also assessed the adaptive capacity of the system (the ability of the system to accommodate change)
- Each expert also evaluated the amount of evidence and how much that evidence tended to agree to assign a level of confidence in that vulnerability determination.

I'm now going to give you a couple of examples of what we found.

Slide 59

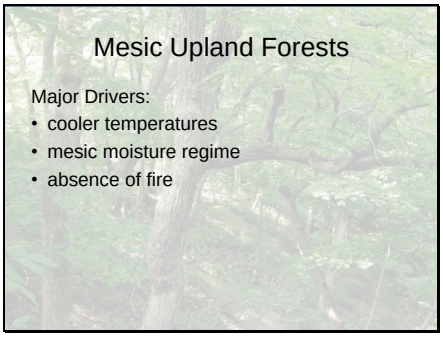
One forest community type we assessed was mesic upland forests

Slide 60



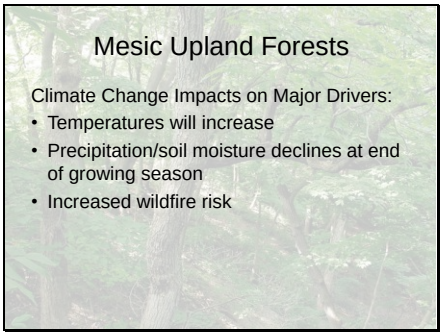
The expert panel determined that the vulnerability of this system was high.

Slide 61



Major drivers of this system are:

Slide 62

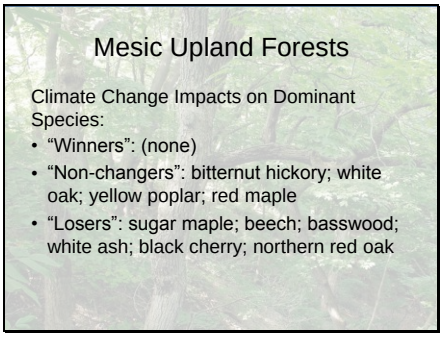


Climate change will likely have negative effects on these drivers.

Slide 63

Dominant species in this community type include species such as sugar maple, beech, and basswood.

Slide 64



Based on the modeling results, many of these species are projected to decline, and none of these species are projected to increase

Slide 65

Major stressors to this community type include deer overbrowsing, EAB, and invasive species.

Slide 66

Mesic Upland Forests

Climate Change Impacts on Major Stressors:

- Potential increase in EAB spread with longer growing season

Climate change is unlikely to reduce these stressors and may increase the spread of EAB.

Slide 67

Mesic Upland Forests

Adaptive Capacity:

- Not resilient to drought, fire
- Few places on the landscape to serve as refugia

This system also has low adaptive capacity because it is not resilient to disturbances and it already occupies the coolest, wettest upland sites in the area.

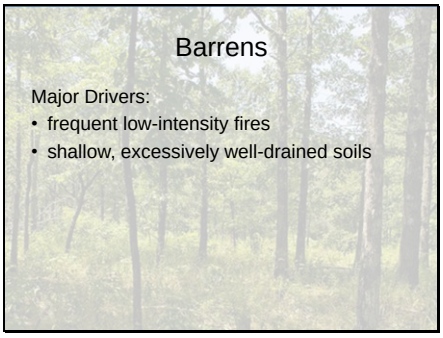
Slide 68

Another community type we evaluated was barrens communities.

Slide 69

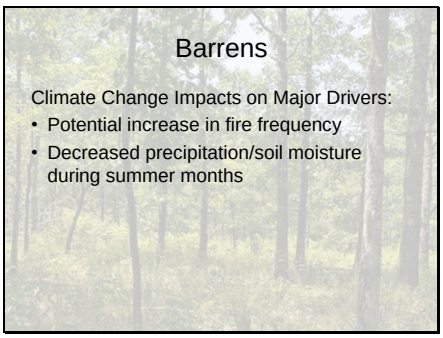
The panel determined that the vulnerability of this community to CC was low.

Slide 70



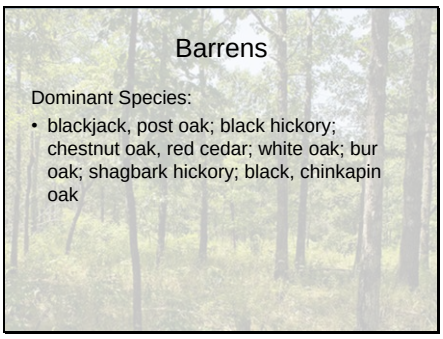
Major drivers to this system are frequent fires and low soil moisture

Slide 71



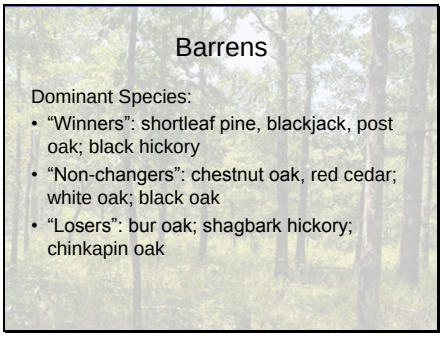
These conditions will likely be exacerbated in the future.

Slide 72



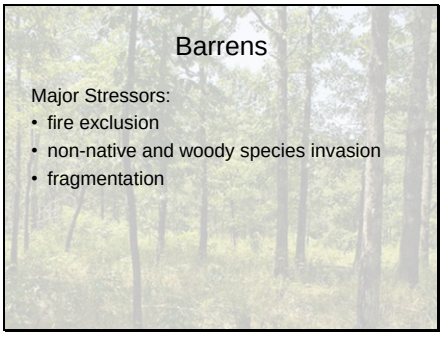
Dominant species in this community type include many drought-and fire-adapted oak and hickory species.

Slide 73



In contrast to the mesic upland systems, a number of species in the barrens community type are projected to increase, and few are projected to decline (and these are mostly "small declines").

Slide 74



Major stressors to this type include exclusion of fire, invasion, and fragmentation

Slide 75

Barrens

Climate Change Impacts on Major Stressors:

- An increase in wildfire could reduce woody species invasion; non-woody species could increase

Some of these stressors may be reduced, while others may increase

Slide 76

Barrens

Adaptive Capacity:

- Success depends on whether systems are managed with prescribed fire
- Systems could potentially expand if open woodlands convert to this type

This system's adaptive capacity largely depends on:

Other more closed systems could convert to this type if conditions become drier and more fire-prone.

Slide 77

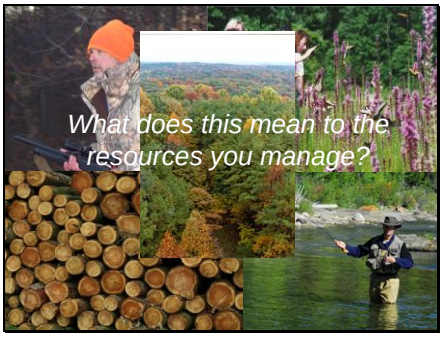
Other Communities Assessed

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

In addition to the two community types shown here, we also evaluated 7 other community types.

Vulnerability ranged from low-high; and experts generally felt that we had a medium level of evidence to support those determinations.

Slide 78



Slide 79