Forest Adaptation Planning and Practices

~ Online Course ~

Session 2: Understanding and Evaluating Climate Change Vulnerabilities

Tuesday, January 29, 2019

Web session etiquette:

- Mute your phone/microphone unless you are speaking to the group.
- If using the phone, turn off your computer speakers to avoid feedback and terrible noises.

Welcome Back!

Please turn on your webcams if you have them.

Please turn off your computer speakers if using phone for audio.

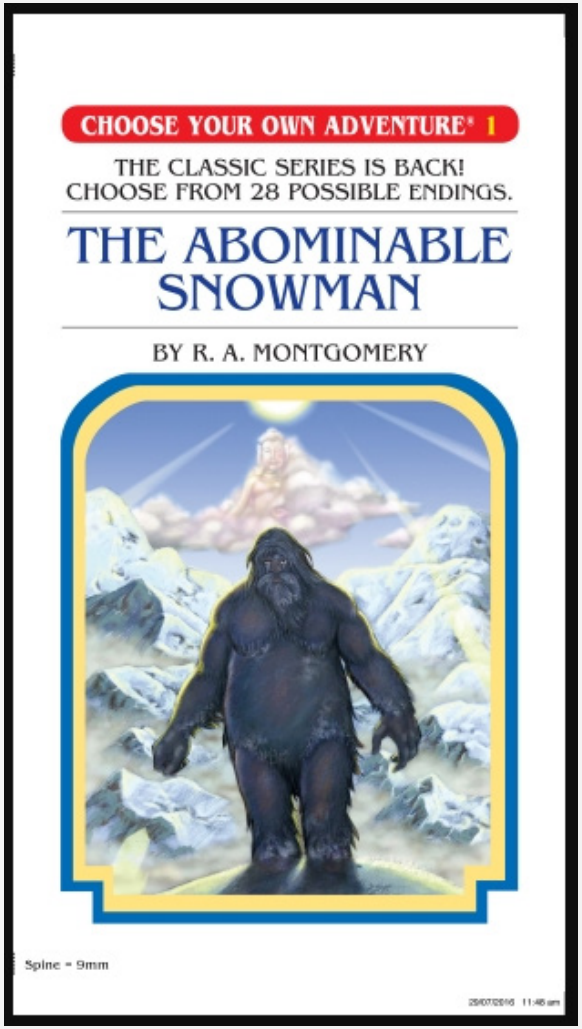
Today's Agenda

Discussion: 10:00-10:45 am

- Homework Review
- Share your project ideas
- 3 min/ project

Lecture: 10:45-11:30 am

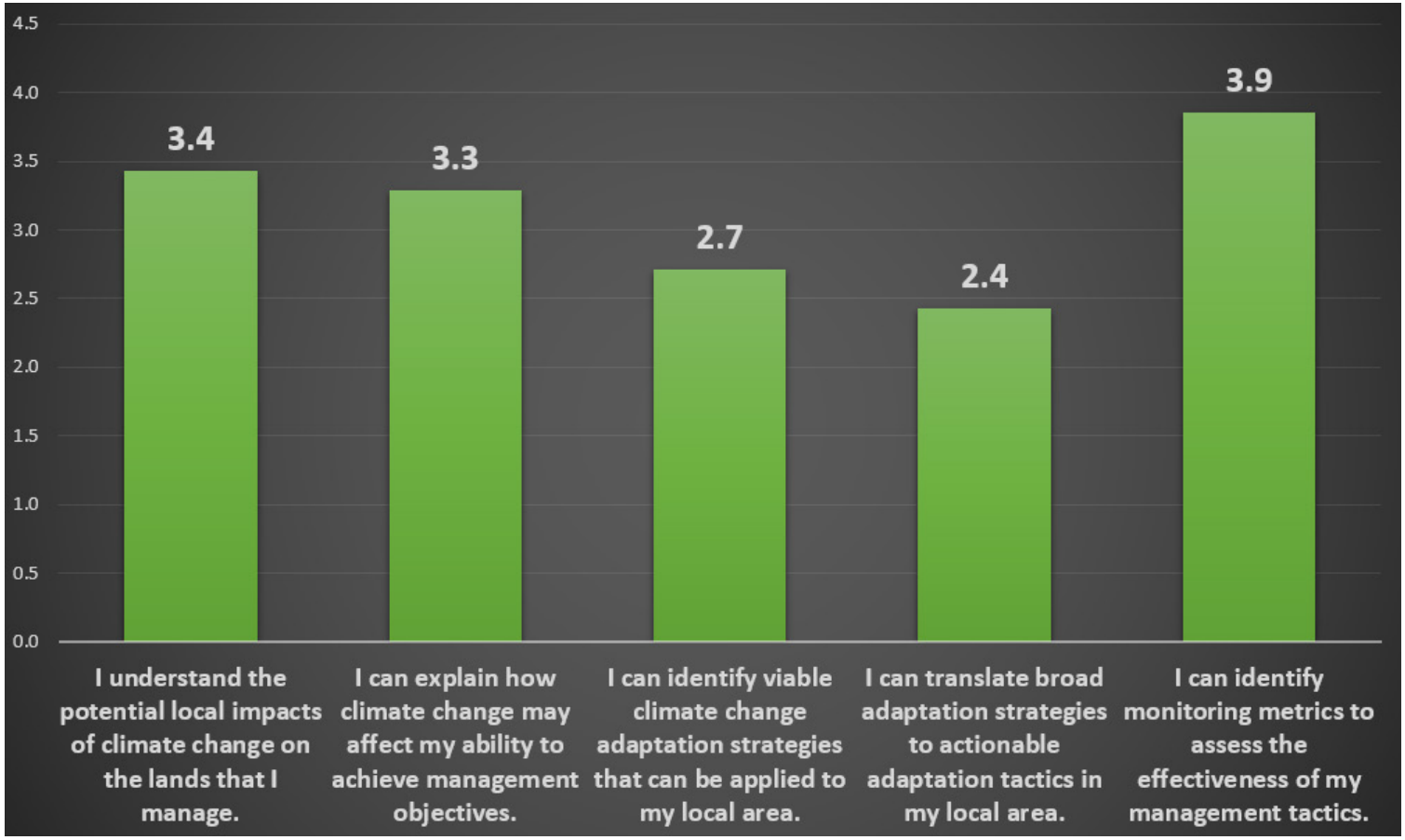
- Step 2 introduction
- Key resources and concepts
- Assignment #2 due Monday, February 4



Where are we now?

Average response

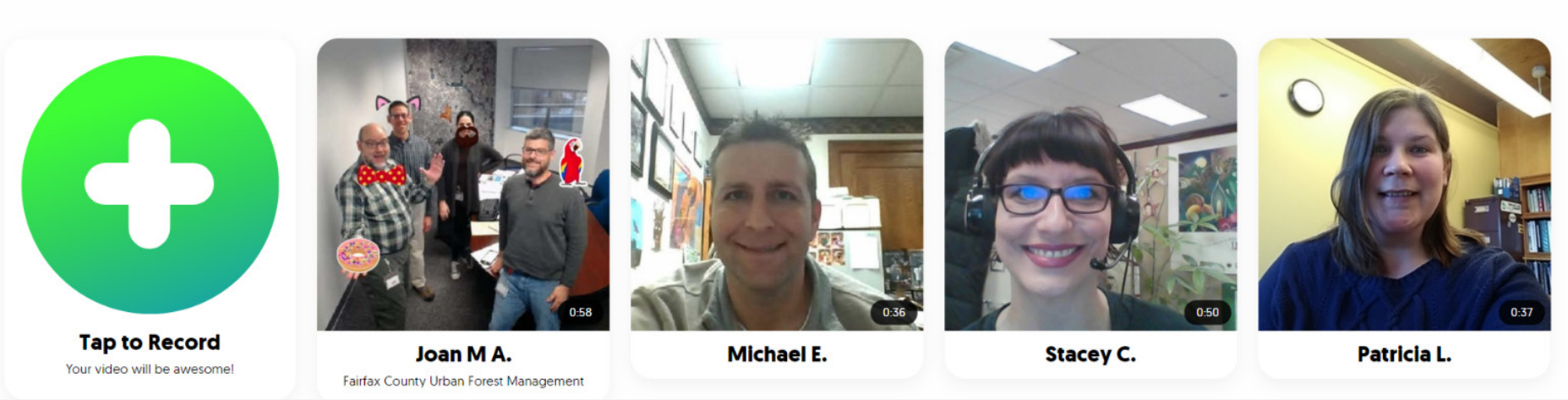
Respondents: 6 groups
Rating: Disagree 1 to Agree (5)



Topics you are interested in:

Topic	When we'll cover it
How land managers plan adaptation strategies on a variety of scales	Throughout the course
Expected shifts in forest composition due to climate change and the likelihood of natural migration of species	Step 2
Climate change impacts on the urban forest	Step 2
Deeper understanding on how assisted species migration might affect local forest ecosystems	Step 2
What exactly is "climate resilience" and how can we manage forests for climate resiliency.	Step 4
Understand the concept of Resistance, Resilience, and Transition along with their corresponding strategies	Step 4
How to use the Adaptation Workbook, how to assess and identify vulnerabilities for different regions, becoming more familiar with vulnerabilities and impacts of climate change and appropriate responses/alternative management options	Throughout the course

Get to know your classmates



Some of us have slacked, add your video today!

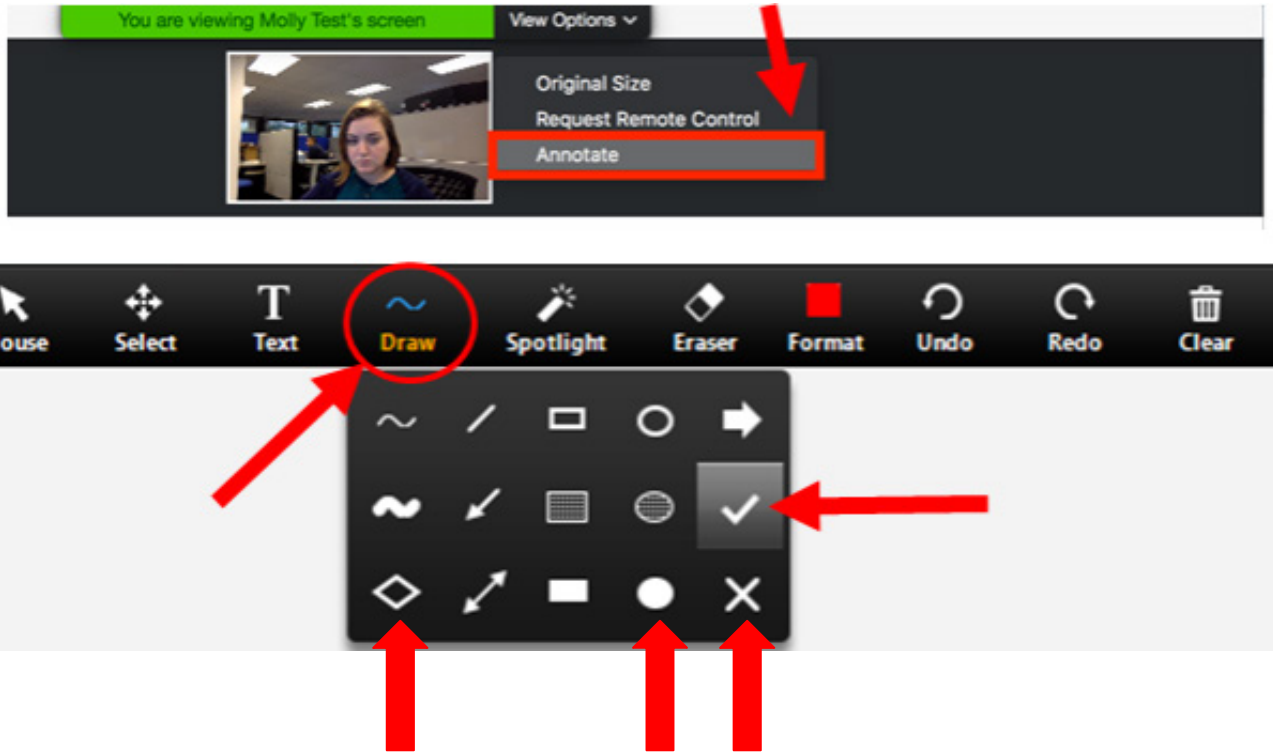
https://flipgrid.com/3df15679

Introduce your project

- Your name(s)
- Organization
- Project location
- What are your key goals and objectives?

Show us where your project is located!

- Use the Zoom **"annotate"** feature to add a **symbol** describing your project location.



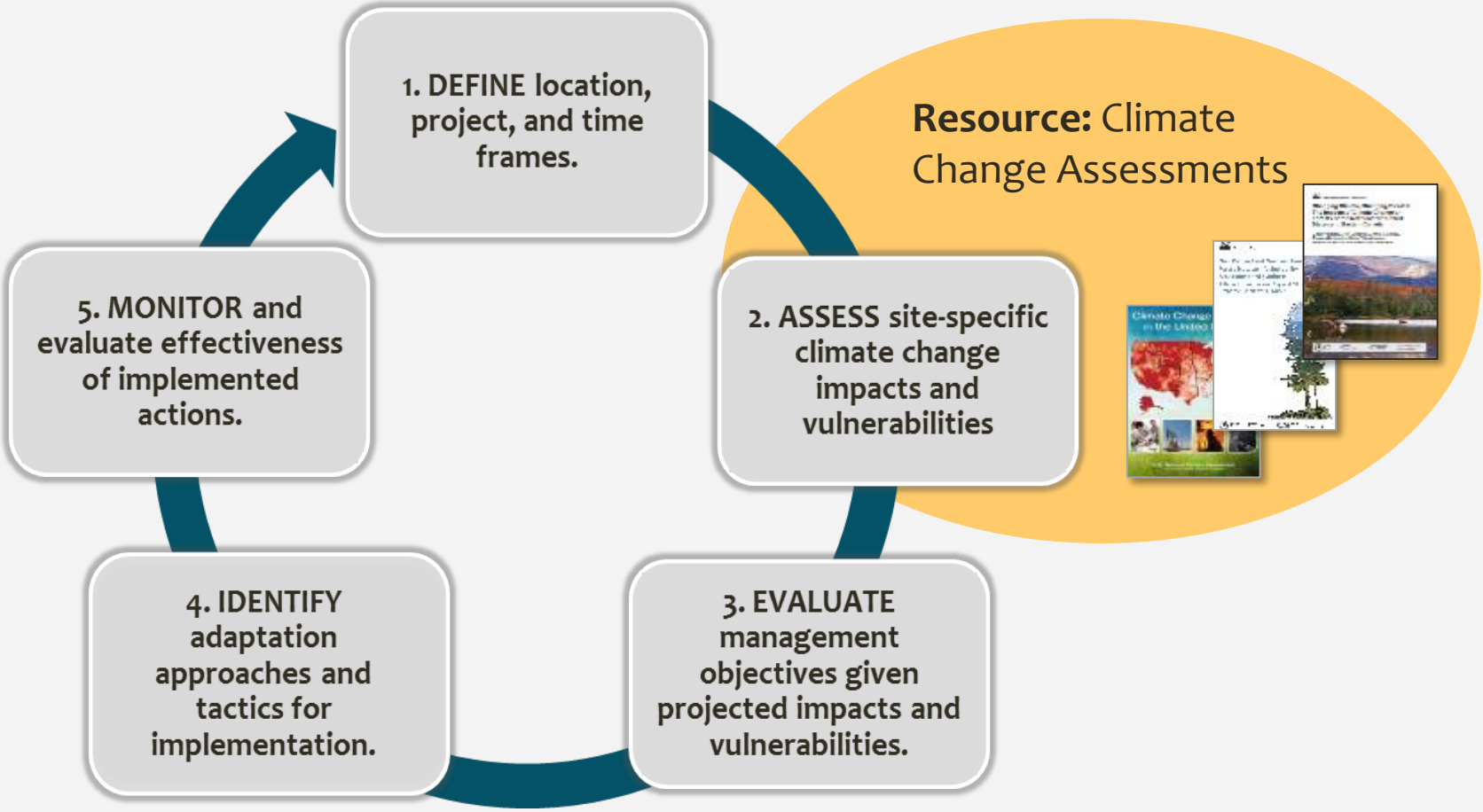
Project Locations

Questions?

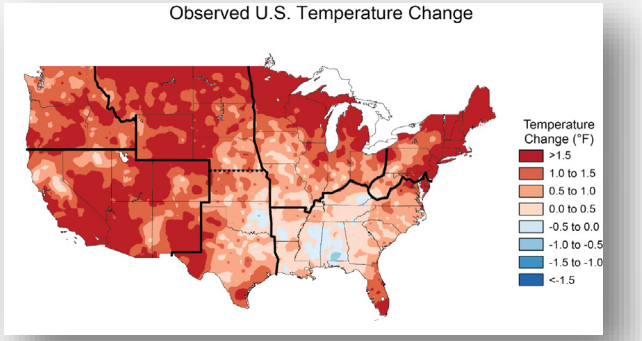

About Step #1?
Additional Tools or Resources?
Technological Difficulties?

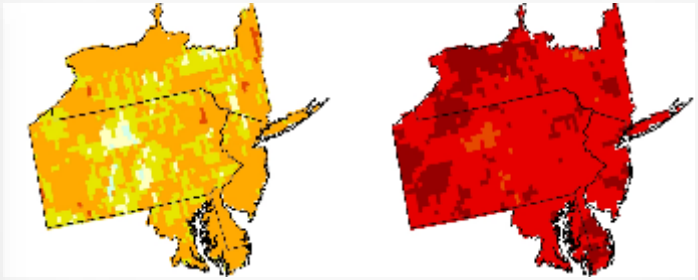
Need a break?

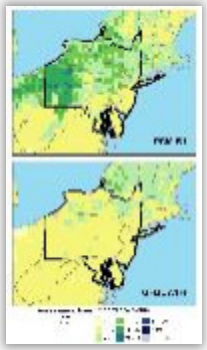
Adaptation Workbook – Step 2!

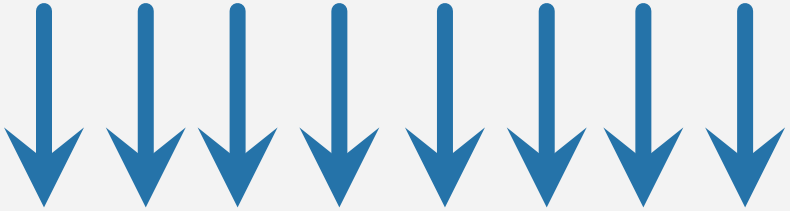


Considering Climate Change









Step 2

Key Question:

- How might the area be uniquely affected by climatic change and subsequent impacts?
- How might regional impacts be different in the project area?

Step 2

Regional Impacts:

Warmer temperatures

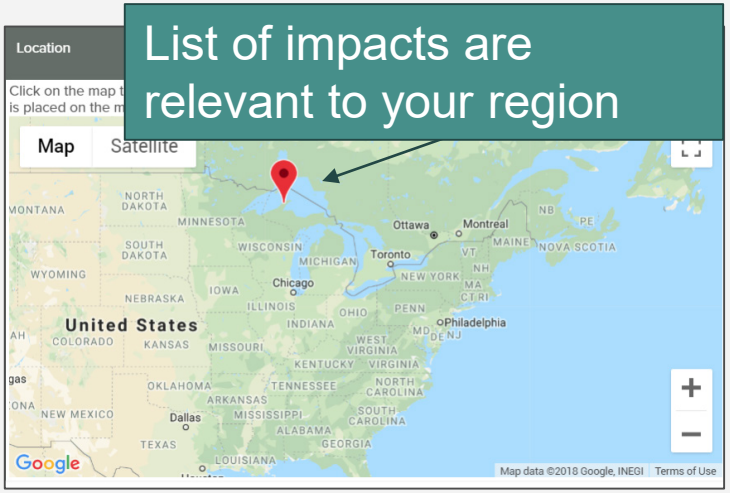
Altered precipitation

Longer growing seasons

Rising sea levels

More extreme events

Altered forest habitat



How will my site be uniquely affected???

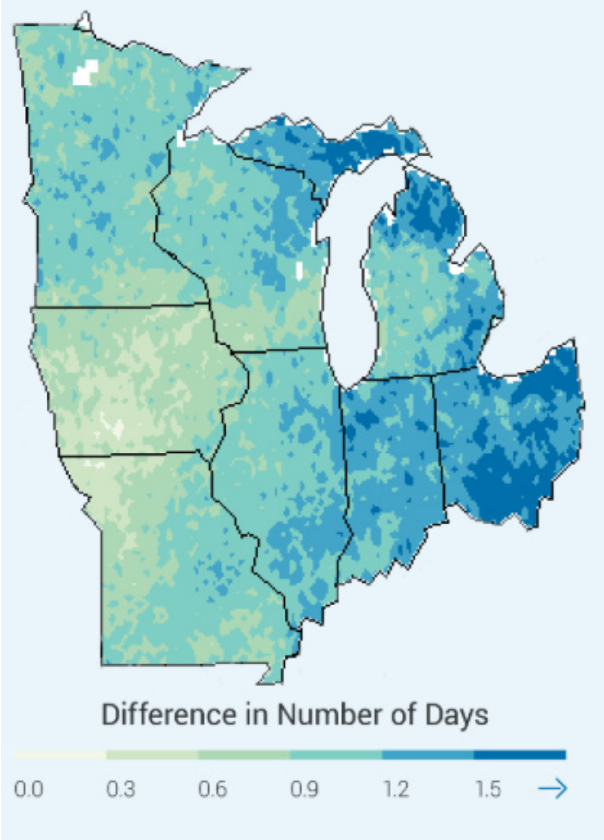
Step 2

Regional Climate Impacts

- Based on regional info

Site-specific Impacts

- Based on your expertise



National Climate Assessment (2014)
2041-2070 compared to 1971-2000
(High emissions A2 scenario). NOAA
NCDC / CICS-NC

Projected increase in the frequency of days with very heavy precipitation (the wettest 2% of days), raising the risk of floods and nutrient pollution.

Source: KQED

Step 2

Regional Climate Impacts

- Based on regional info

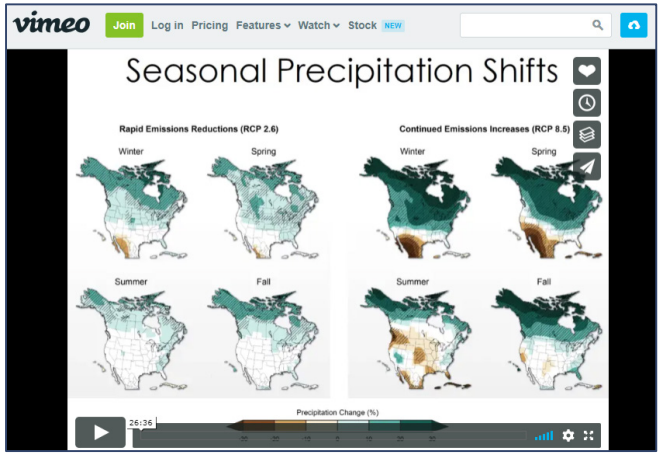
Site-specific Impacts

- Based on your expertise

Mgmt. Unit/ Topic	Climate Change Impacts and Vulnerabilities	
	Regional From vulnerability assessments	For the Property or Project Area Based on your knowledge of the site
Forest in Lot C	More extreme precipitation events	**Slope** on east side of property may deliver nutrients from neighboring ag fields
Riparian forest	Boreal species will face increasing stress	Hemlock is projected to decline; loss of our hemlock riparian trees may contribute to increased water temperatures

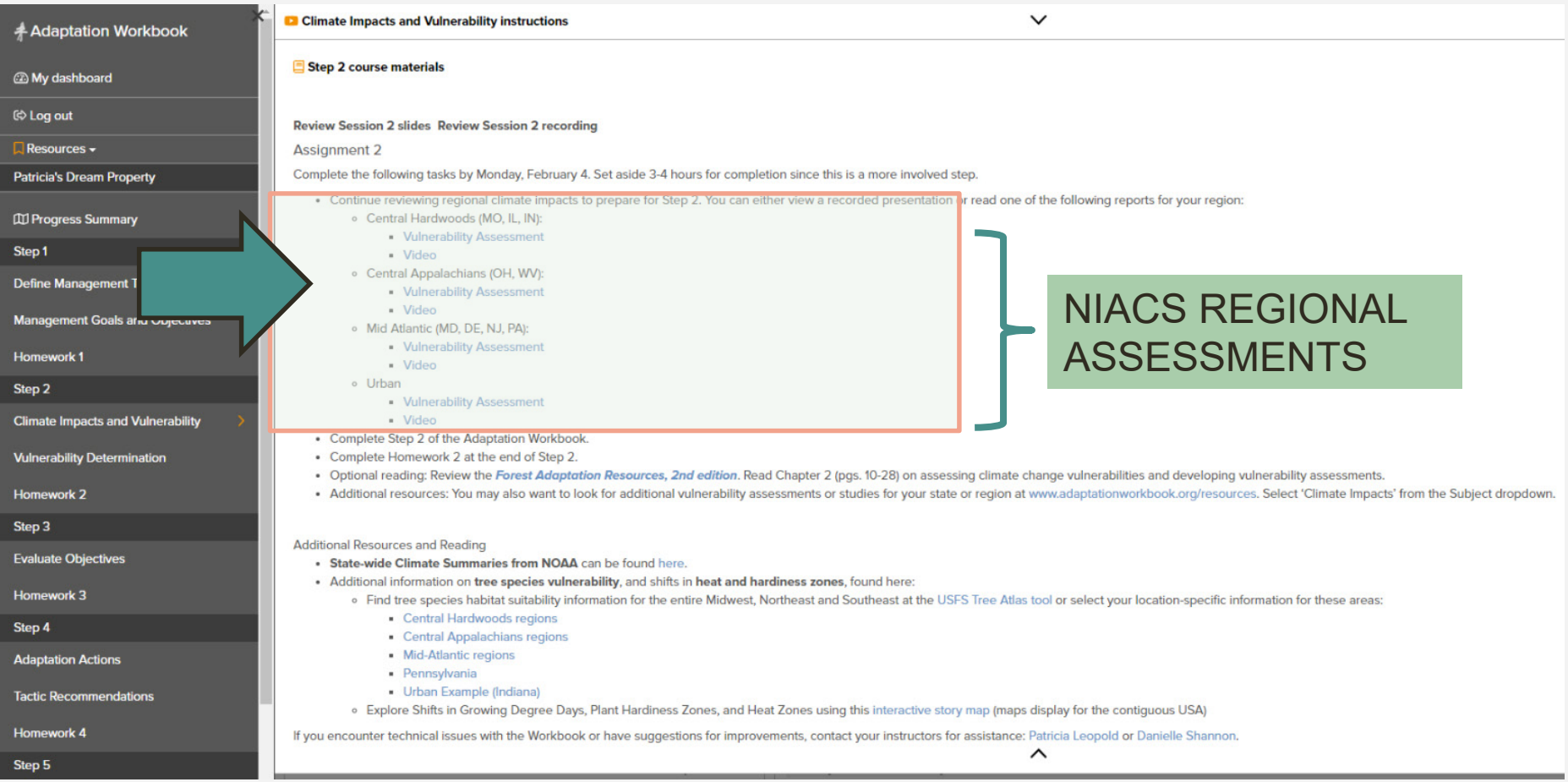
Before you begin this step

1. Watch the video for your region or urban forests **(~ 30 min)**
2. Assemble information about your project location, such as:
   - Tree species lists/inventories.
   - Landover, and flood maps
   - Soil maps
   - Digital elevation/topographic maps
   - Facilities, road & culvert
3. Review information specific to your project area as listed in the course materials.

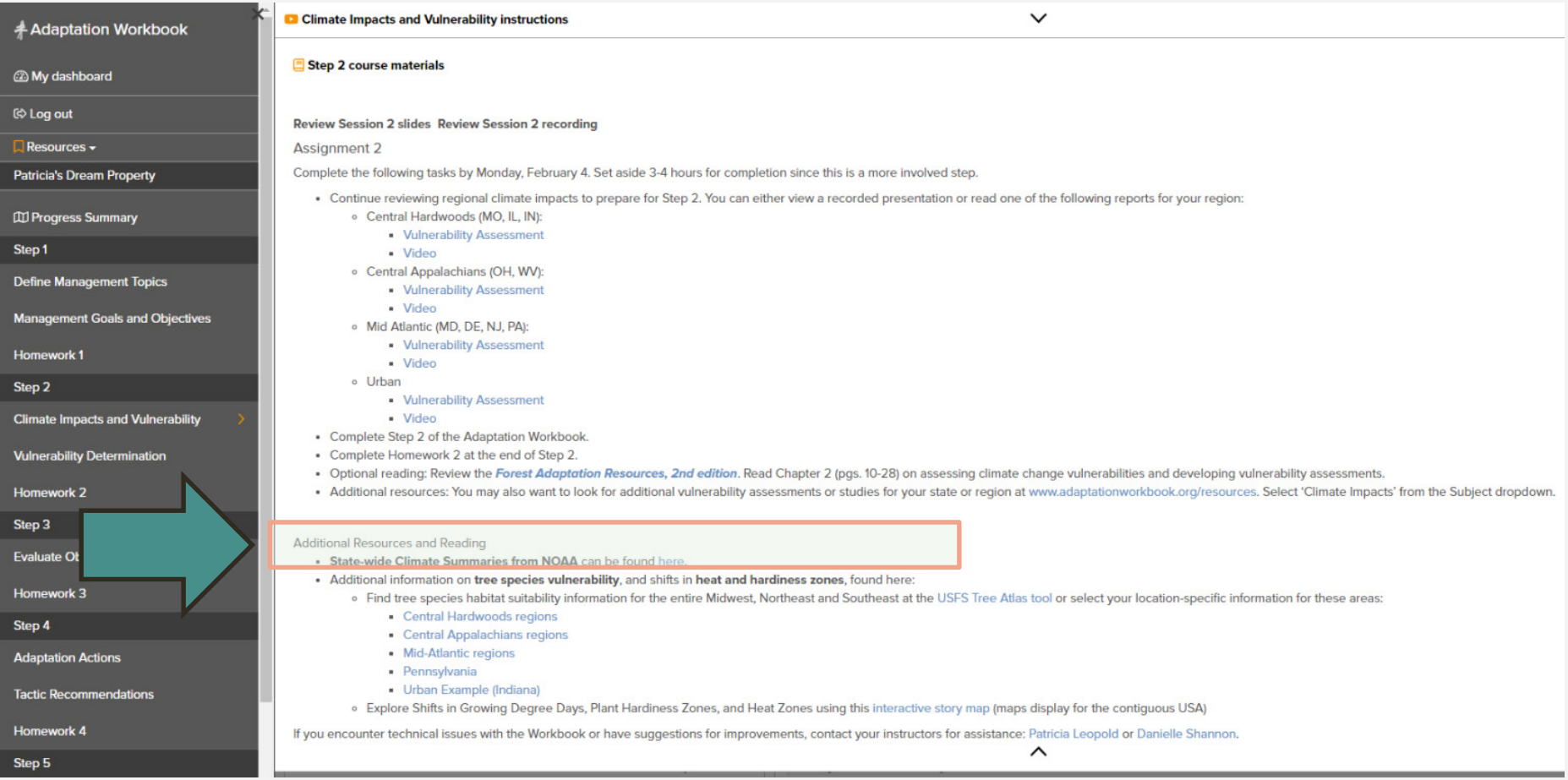


Watch a video:
Step 1 Course Materials

Step 2 landing page



Step 2 landing page



NOAA State Summaries

VIRGINIA

Key Messages

Average annual temperature has increased by about 1.5°F since the beginning of the … higher emissions pathway, historically unprecedented warming is projected by the end …

Naturally occurring droughts are projected to be more intense because higher tempera… evaporation rates, depleting soil moisture more rapidly and adversely affecting agricult…

The number and intensity of extreme heat and extreme precipitation events are projec… cold waves are projected to be less intense.

Virginia has a humid climate with very warm summers and moderately cold winters. The… regional variation due to the state's diverse geographic elements, which include the App… Blue Ridge Mountains in the west and the Atlantic coastal region in the east. Temperatu… patterns are highly influenced by these geographic features with the west and north bei… eastern coastal region. Statewide average temperatures range from 35°F in January to 7… rainfall generally decreases toward the west. For example, total annual precipitation is l… of the central mountain region of the state compared to around 50 inches along the tide…

Since the beginning of the 20th century, temperatures have risen approximately 1.5°F were very warm, followed by a period of generally below average temperatures during t… 1980s (Figure 1). Although the 5-year average highest number of very hot days (maximu… and corresponding number of very warm nights (minimum temperature above 75°F) occ… (Figures 2a and 2b), gradual warming has occurred since the early 1990s. Average annua… 21st century (2000–2014) have exceeded the previous highs of the 1930s. A winter warm… the below average number of very cold nights (minimum temperature below 0°F) since … summer temperatures in the most recent decade (2005–2014) exceeded those in the ea…

Observed and Projected Temperature Change

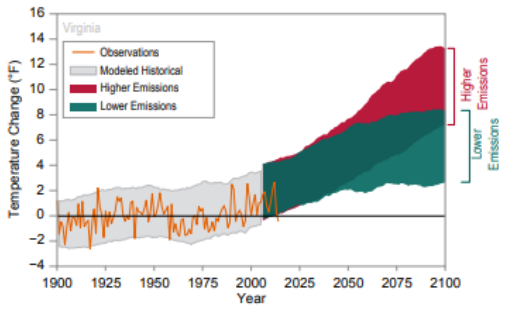


Figure 1: C… (compared t… surface air t… data are for … 2006–2100 … two possible… gas emissio… emissions) … gas emissio… emissions)[1]. … line) have ris… of the 20th… range of an… models. Obs… within the e… the historica… unprecedent… 21st century… lower emissi… about as war… record; gree… a high emiss…

about 11°F warmer than the hottest year in the historical record; red shading). Source: CICS-NC and NOAA…

[1]Technical details on models and projections are provided in an appendix, available online at: https://statesummaries.ncic…

ILLINOIS

Key Messages

Average annual temperature has increased by about 1°F since the beginning of the 20th century. There has been seasonal variation in this warming, with average spring temperature increasing by about 2°F and average summer temperature increasing very little. Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century.

Precipitation in spring and summer has generally been above average over the past two decades, affecting agriculture in both positive (adequate soil moisture) and negative (delays in spring planting) ways. Precipitation in winter and spring is projected to increase, which poses a continuing risk of spring planting delays.

Severe flooding and drought have occurred periodically in recent years. Future increases in extreme precipitation events and in evaporation rates may increase the intensity of both floods and droughts.

Illinois's location in the interior of the North American continent exposes it to a climate with large ranges in temperature with warm, humid summers and cold winters. The lack of mountains to the north or south allows very cold air masses from the Arctic in the winter and warm, humid air masses from the Gulf of Mexico in the summer to move into the state, further increasing the range of conditions that affect Illinois. Temperature varies widely across the state, with a range of about 10°F from north to south. In northeastern Illinois, Lake Michigan moderates the temperature, causing cooler summers and warmer winters. Topography and urban areas also have local impacts on climate.

Since the beginning of the 20th century, temperatures in Illinois have risen approximately 1°F (Figure 1). Temperatures in the 2000s have been higher than any other historical period, with the exception of the early 1930s "Dust Bowl" era. Warming has been concentrated in winter and spring while summers have not warmed substantially in the state, a feature characteristic of much of the Midwest (Figure 2). The lack of summer warming is reflected in a below average occurrence of very hot days (days with maximum temperature above 95°F) since the mid 1950s (Figure 3a) and no overall trend in very warm nights (minimum temperature above 75°F) since the beginning of the 20th century (Figure 3b). The winter warming trend is reflected in a below average number of very cold nights (minimum temperature below 0°F) over the past 25 years (Figure 3c).

Observed and Projected Temperature Change

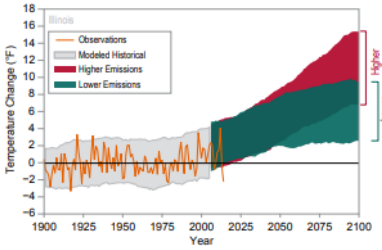
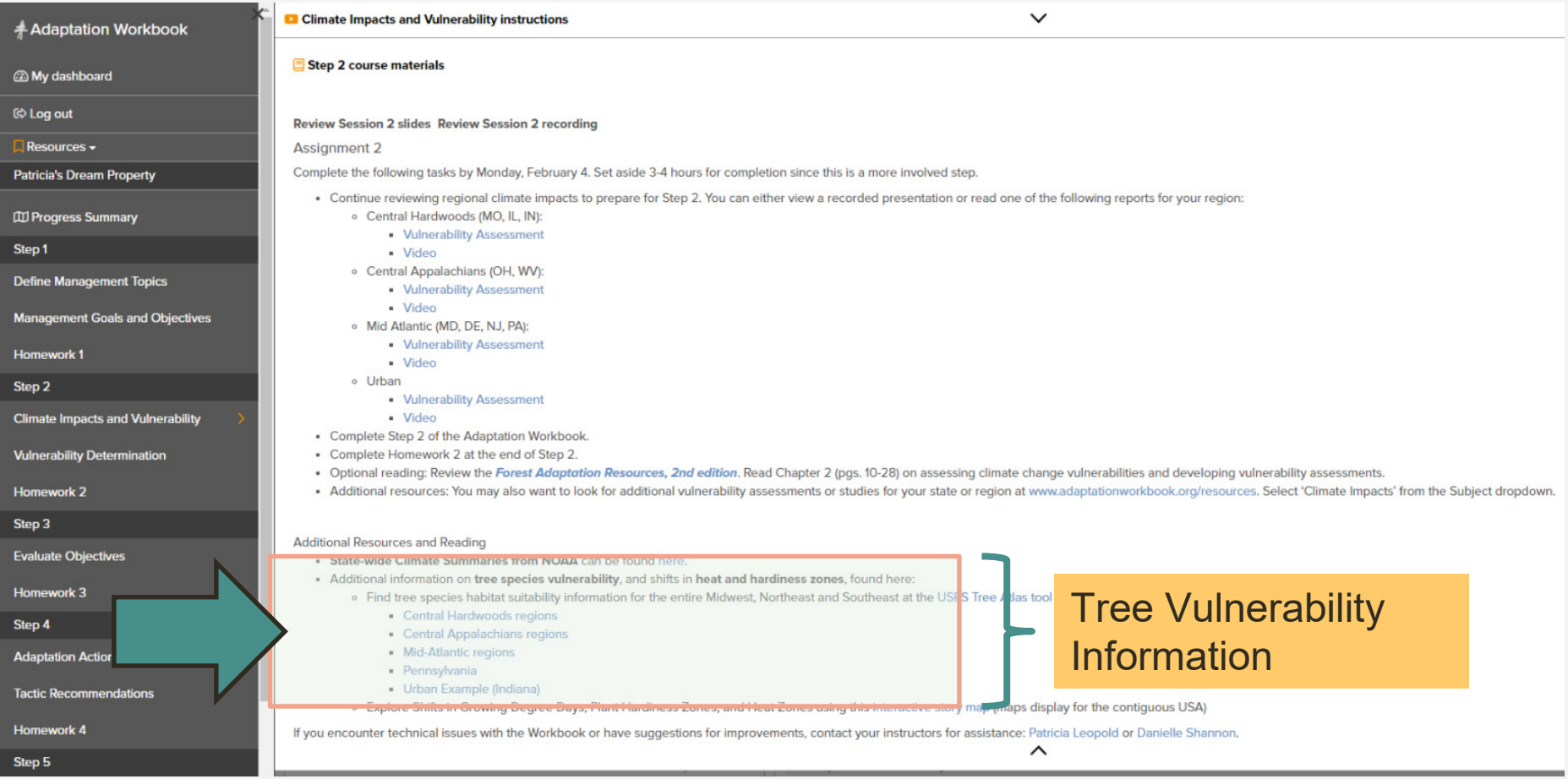


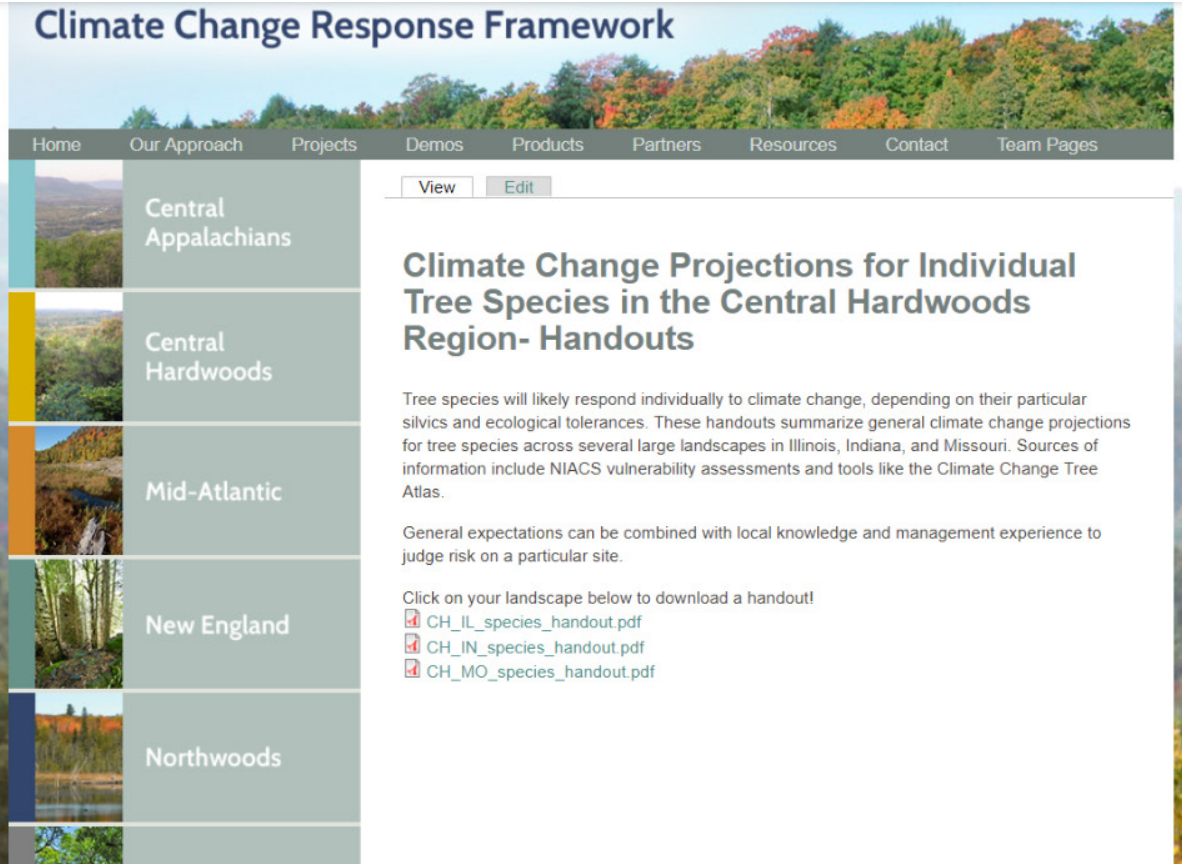
Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Illinois. Observed data are for 1900–2014. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions)[1]. Temperatures in Illinois (orange line) have risen about 1°F since the beginning of the 20th century. Shading indicate the range of annual temperatures from the set of models. Observed temperatures are generally within the envelope of model simulations of the historical period (gray shading). Historically unprecedented warming is projected during the 21st century. Less warming is expected under a lower emissions future (the coldest years being about as warm as the hottest year in the historical record; green shading) and more warming under a higher emissions future (the hottest years being about 10°F warmer than the hottest year in the historical record; red shading). Source: CICS-NC and NOAA NCEI.

[1]Technical details on models and projections are provided in an appendix, available online at: https://statesummaries.ncics.org/il.

Step 2 landing page



Tree Vulnerability Information



Tree Vulnerability Information

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES

ILLINOIS

The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in the Central Hardwoods region (Brandt et al. 2014). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full assessment.

TREE SPECIES INFORMATION:

This assessment uses two climate scenarios to "bracket" a range of pos futures. These future climate projections were used with one forest im (Tree Atlas) to provide information about how individual tree species r to a changing climate. More information on the climate and forest imp can be found in the assessment. Results for "low" and "high" climate sc be compared on page 2 of this handout.

SPECIES	ADDITIONAL CONSIDERATIONS
LIKELY TO DECREASE	
Black cherry	Limited drought tolerance and susceptible to some in
Shagbark hickory	Susceptible to insects and fire topkill
Shingle oak	Tolerant of a wide range of soils
Sugar maple	Disperses and regenerates easily but drought-intolera
White ash	Susceptible to emerald ash borer
White oak	Tolerant of fire
MIXED MODEL RESULTS	
American elm	Needs a particular type of habitat, affected by Dutch e
Black oak	Drought-tolerant
Black walnut	Susceple to thousand cankers disease
Common persimmon	Tolerant of shade and a wide range of soils
Green ash	Susceptible to emerald ash borer
Hackberry	Drought-tolerant
Honeylocust	Intolerant of shade
Northern red oak	Susceptible to some insect pests
Pignut hickory	Susceptible to insects and inteolerant of drought

NIACS Northern Institute of Applied Climate Science

www.forestadaptation.org

FUTURE PROJECTIONS

Data for the end of the century are summarized for the Climate Change Tree Atlas (www.fs.fed.us/nrs/atlas) under two climate change scenarios. Tree Atlas models future suitable habitat; additional data are available in the assessment.

- ▲ **INCREASE** *Projected increase of >20% by 2100*
- ● **NO CHANGE** *Little change (<20%) projected by 2100*
- ▼ **DECREASE** *Projected decrease of >20% by 2100*
- ★ **NEW HABITAT** *Tree Atlas projects new habitat for species not currently present*

ADAPTABILITY

Factors not included in the Tree Atlas model, such as the ability to respond favorably to disturbance, may make a species more or less able to adapt to future stressors.

- \+ high *Species may perform better than modeled*
- · medium
- – low *Species may perform worse than modeled*

SPECIES	LOW CLIMATE CHANGE (PCM B1)	HIGH CLIMATE CHANGE (HAD A1FI)	ADAPT
American basswood	▼	▲	·
American beech	●	▼	·
American elm	●	▼	·
American hornbeam	▲	▲	·
Baldcypress	●	●	·
Bitternut hickory	●	●	+
Black cherry	▼	▼	–
Black hickory	▲	▲	·
Black locust	▲	▲	·
Black oak	●	▼	·
Black walnut	●	▼	·
Black willow	●	●	–
Blackgum	▲	▼	+
Blackjack oak	▲	▲	+
Boxelder	●	▲	+
Bur oak	▲	▲	+
Butternut	▼	▼	–
Cedar elm	★	★	–
Cherrybark oak	▲	▲	·
Chestnut oak	▼	▼	+
Chinkapin oak	▲	▼	·
Common persimmon	●	▲	+
Eastern cottonwood	▲	▲	·
Eastern hophornbeam	●	▲	+
Eastern red cedar	●	●	·
Eastern redbud	▲	▲	·
Eastern white pine	▼	▼	–
Flowering dogwood	●	●	·
Green ash	●	▲	·
Hackberry	●	▼	+
Honeylocust	●	▲	+
Jack pine	▼	▲	·
Kentucky coffeetree	●	●	·
Loblolly pine	▲	▲	·
Mockernut hickory	●	●	+
Northern catalpa	●	●	·
Northern pin oak	▼	▲	+
Northern red oak	●	▼	+

SPECIES	LOW CLIMATE CHANGE (PCM B1)	HIGH CLIMATE CHANGE (HAD A1FI)	ADAPT
Ohio buckeye	▼	▼	·
Osage-orange	▲	●	+
Overcup oak	●	▲	–
Pawpaw	▲	▼	·
Pecan	●	●	–
Pignut hickory	●	▼	·
Pin oak	●	●	–
Post oak	▲	▲	+
Red maple	●	●	+
Red mulberry	▲	▲	·
River birch	▲	▲	·
Sassafras	●	▼	·
Scarlet oak	●	▼	·
Shagbark hickory	▼	▼	·
Shellbark hickory	●	●	·
Shingle oak	▼	▼	·
Shortleaf pine	▲	▲	·
Shumard oak	▼	▲	+
Silver maple	●	▲	+
Slash pine	★	★	·
Slippery elm	●	▼	·
Southern red oak	▲	▲	+
Sugar maple	▼	▼	+
Sugarberry	▲	▲	·
Swamp chestnut oak	▼	▼	·
Swamp tupelo	▲	●	–
Swamp white oak	▼	▼	·
Sweetgum	▲	▲	·
Sycamore	●	▼	·
Water locust	★	★	·
Water oak	★	★	·
White ash	▼	▼	–
White oak	▼	▼	+
Wild plum	●	▲	·
Willow oak	●	●	·
Winged elm	▲	▲	·
Yellow-poplar	▲	▼	+

SOURCE: Brandt, L.; He, H.; Iverson, L.; Thompson, F.R., III; Butler, P.; Handler, S.; Janowiak, M.; Shannon, P.D.; Swanston, C.; Albrecht, M.; Blume-Weaver, R.; Deizman, P.; DePuy, J.; Dijak, W.D.; Dinkel, G.; Fei, S.; Jones-Farrand, D.T. Leahy, M.; Matthews, S.; Nelson, P. Oberle, B.; Perez, J.; Peters, M.; Prasad, A.; Schneiderman, J.E.; Shuey, J.; Smith, A.B.; Studyvin, C.; Tirpak, J.M.; Walk, J.W.; Wang, W.J.; Watts, L.; Weigel, D.; Westin, S. 2014. Central Hardwoods ecosystem vulnerability assessment and synthesis: a report from the Central Hardwoods Climate Change Response Framework project. Gen. Tech. Rep. NRS-124. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 254 p. https://www.nrs.fs.fed.us/pubs/45430

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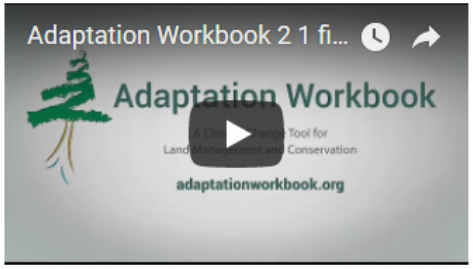
Step 2.1: Assess climate change impacts



The Adaptation Workbook allows you to consider how general climate change impacts might be modified by the unique characteristics of your property. The first section on this page asks you to think about how **regional** impacts might affect your particular management area and forests. The following sections ask you to think about more specific climate impacts related to **your chosen forest types and management topics**.

This is your opportunity to consider the particular site conditions that might affect whether your property is more or less vulnerable to climate change. Some of the things you will want to consider include **species and structural composition, soils, topography, past management, forest health issues, and the surrounding landscape.**

Several climate impact statements are presented from published resources for your general location and the pre-defined forest types you selected in Step 1.1. Please take time to explore the supporting information (click the "Show Evidence" button, or visit our resource library) to learn more about the projected risks and opportunities climate change may present for your location.

If you think any of the suggested impacts don't apply to your property, you can remove them from the list. If you want to add more climate impacts to the regional list or for any of your forest types, you can **add custom climate impact statements** at the end of each section.

For example:

Most areas in the country are expected to experience warmer temperatures by the end of the century. If your property sits on a north-facing slope, a sheltered landscape position, or next to a large water body, projected temperature increases might be moderated. You'd want to make note of that in the appropriate sections below.

Climate Impacts and Vulnerability Resources

- Hover to learn more about a particular item
- Expand/collapse a section
- Click to add a comment or specific information about your property

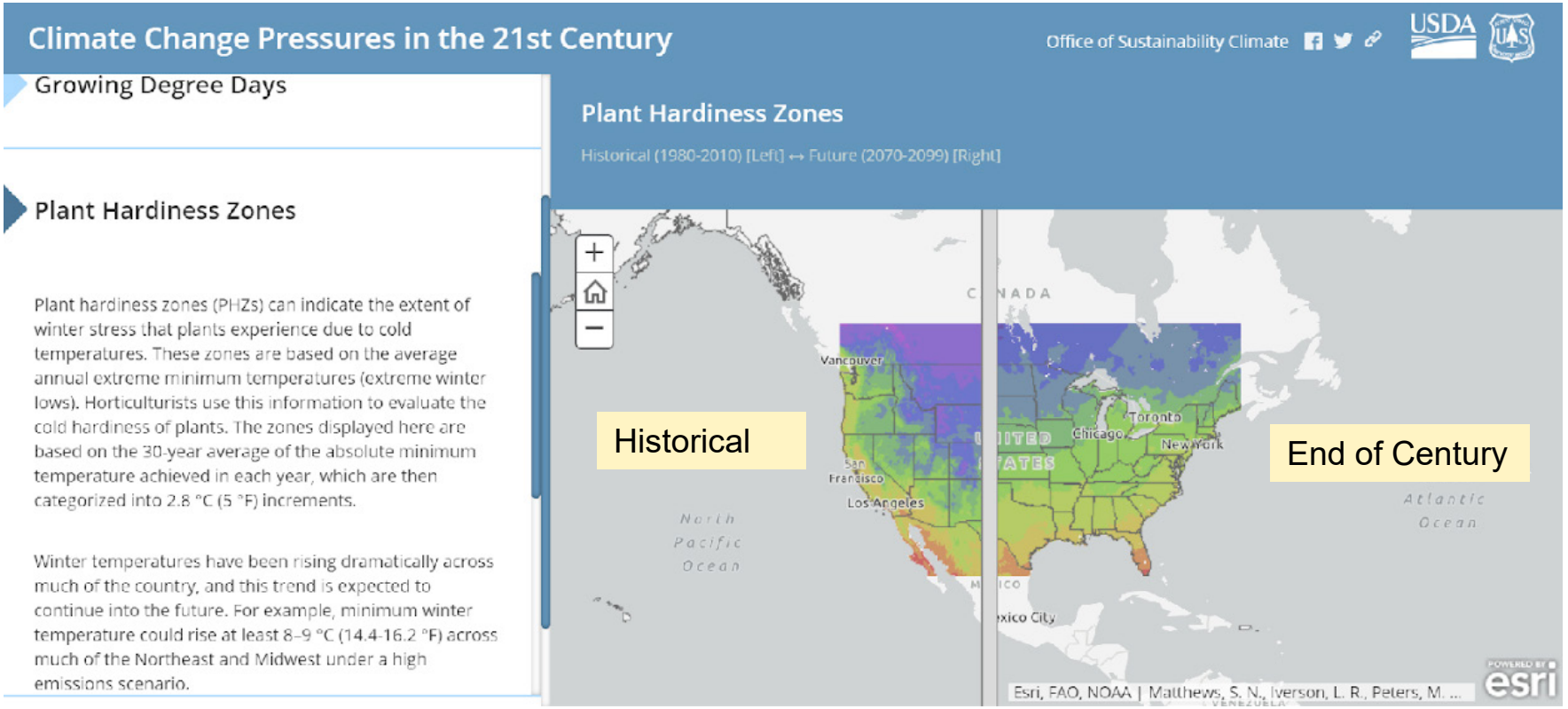
Precipitation patterns will be altered, with projected increases in annual precipitation and potential for reduced growing season precipitation in New England and northern New York.

How might this affect your property or project area?

Climate Change Tree Atlas

www.fs.fed.us/nrs/atlas

Heat and Hardiness Zones



https://goo.gl/iPpZCw

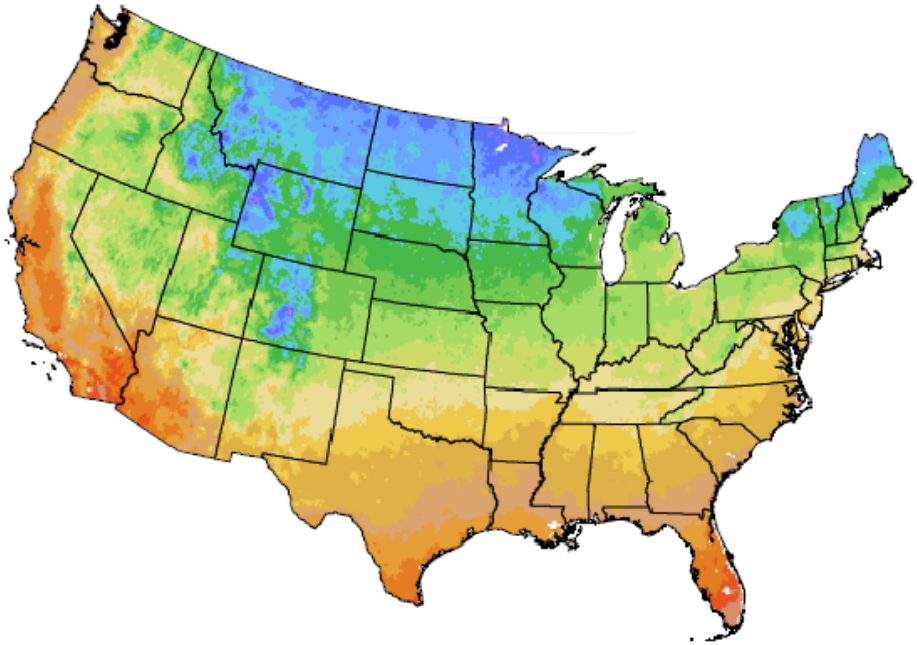
Explore "current" and projected end of century (high emissions: RCP 8.5):

- **growing degree days**
- **plant hardiness zones**
- **heat zones**

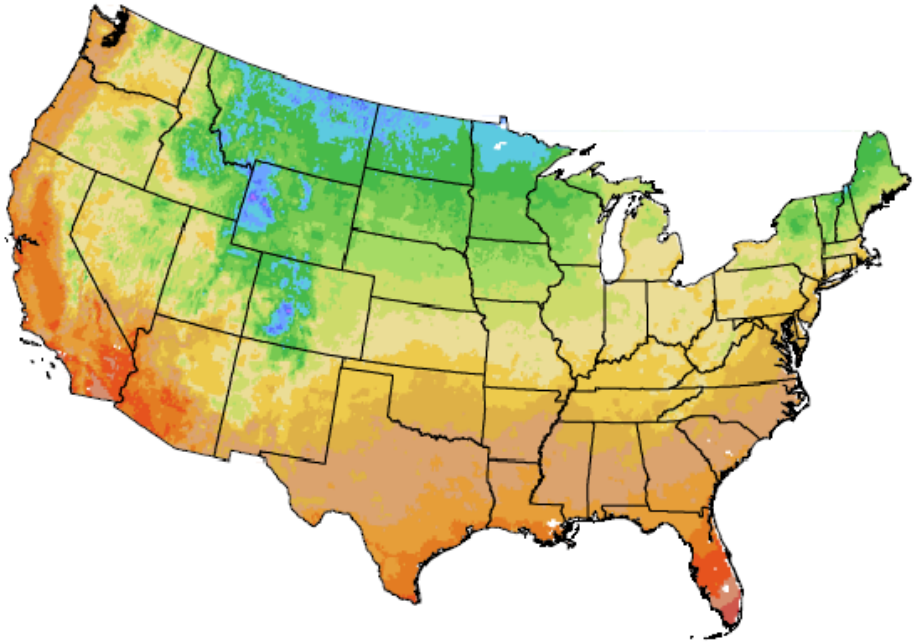
Non-natives, Cultivars, Rare

- Compare species heat and hardiness zone range tolerance to future, projected heat and hardiness zones.

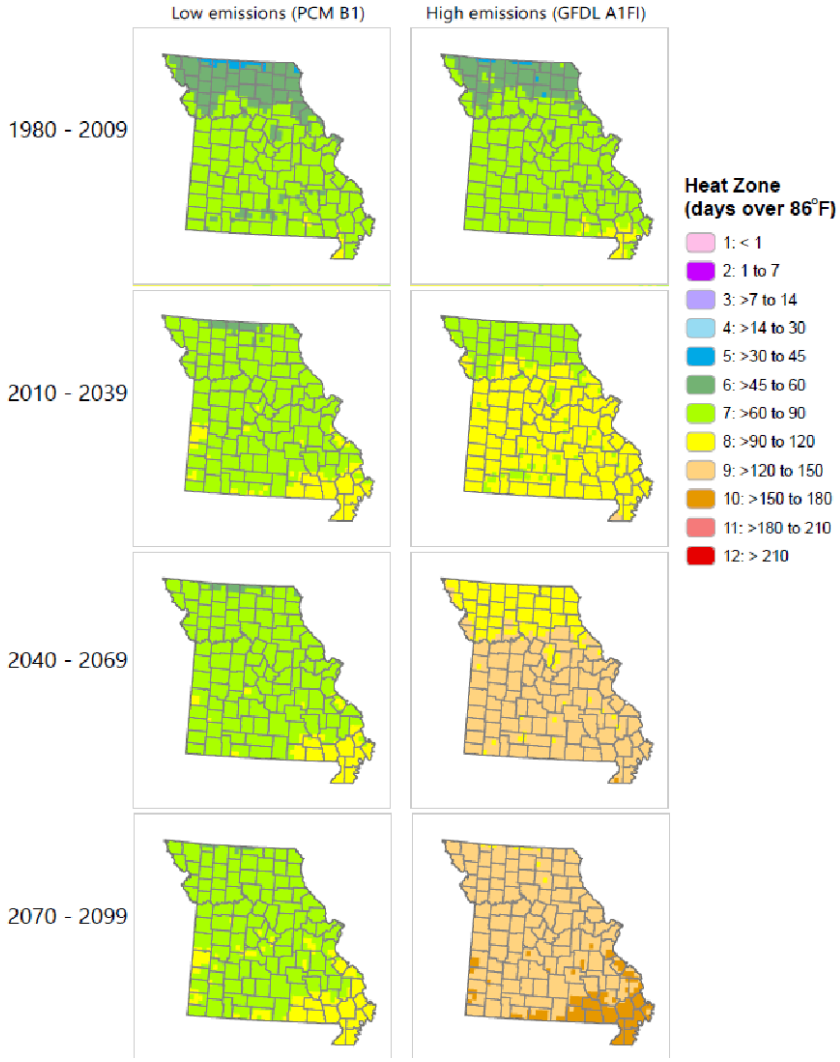
Low emissions (PCM B1)



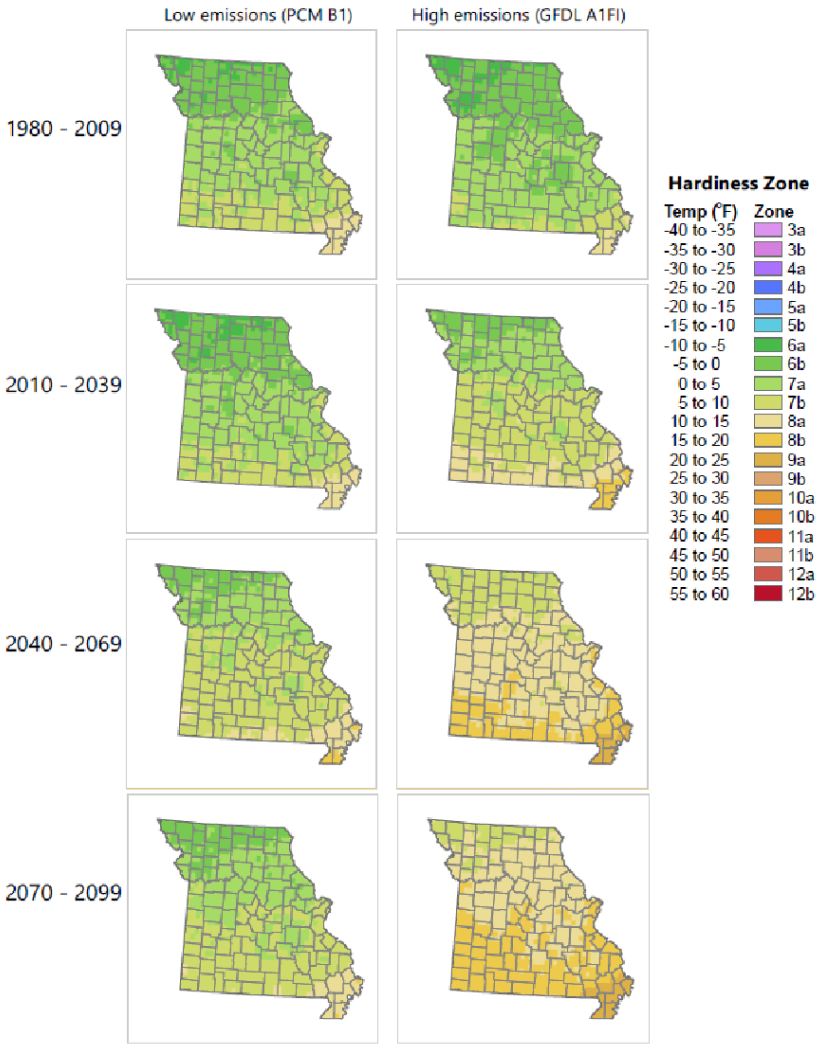
High emissions (GFDL A1FI)



Heat Zone Maps



Hardiness Zone Maps



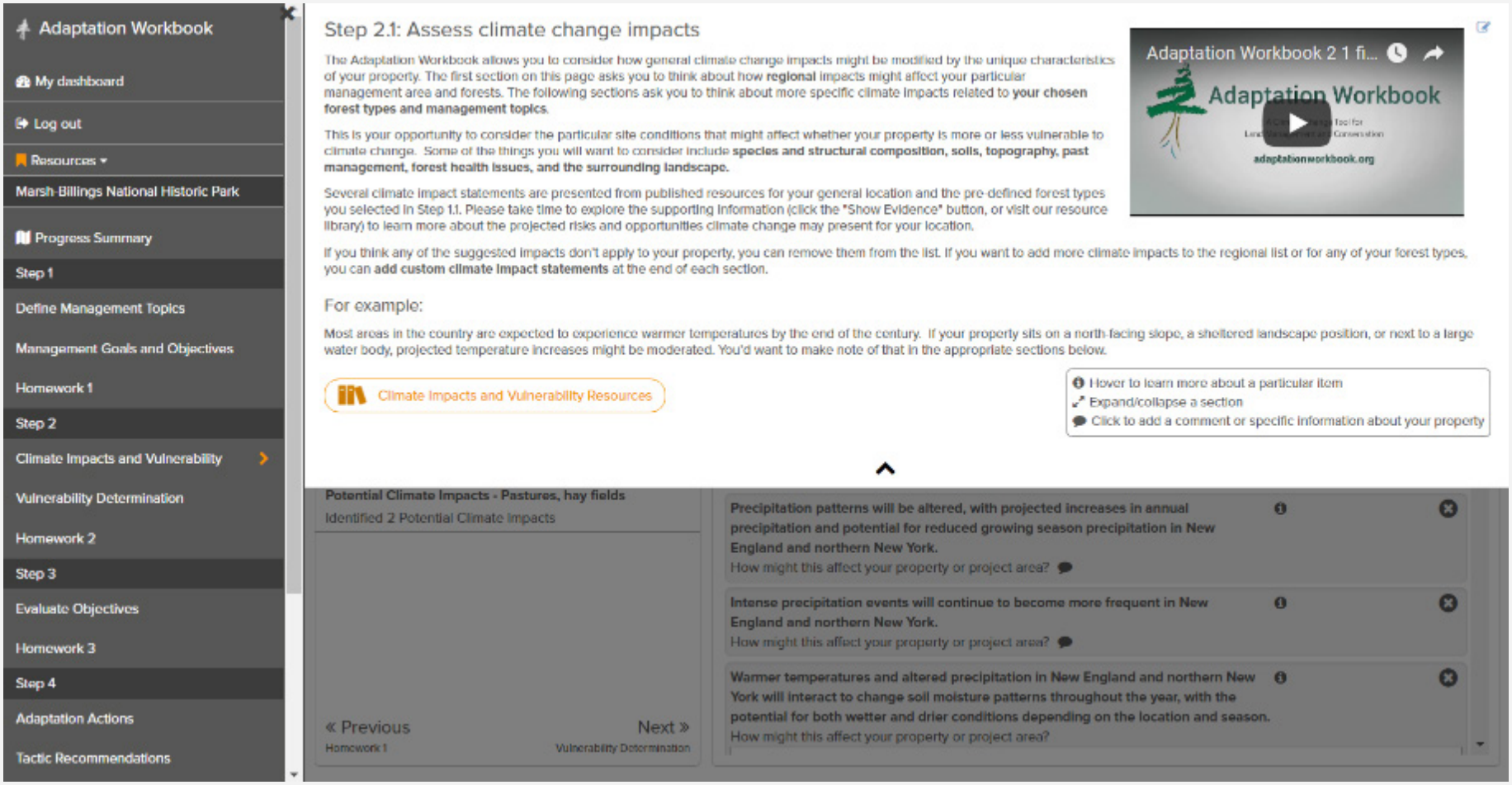
Making a climate informed species list: Native species with Tree Atlas Information

Species Name	Model Projections-low emissions	Model Projections-high emissions	Adaptive Capacity	Vulnerability
Red maple	No change	No change	High	Low
Red oak	No change	No Change	Medium	Medium
Sugar maple	Decrease	Decrease	Medium	Medium--high
Paper birch	Decrease	Decrease	Low	High

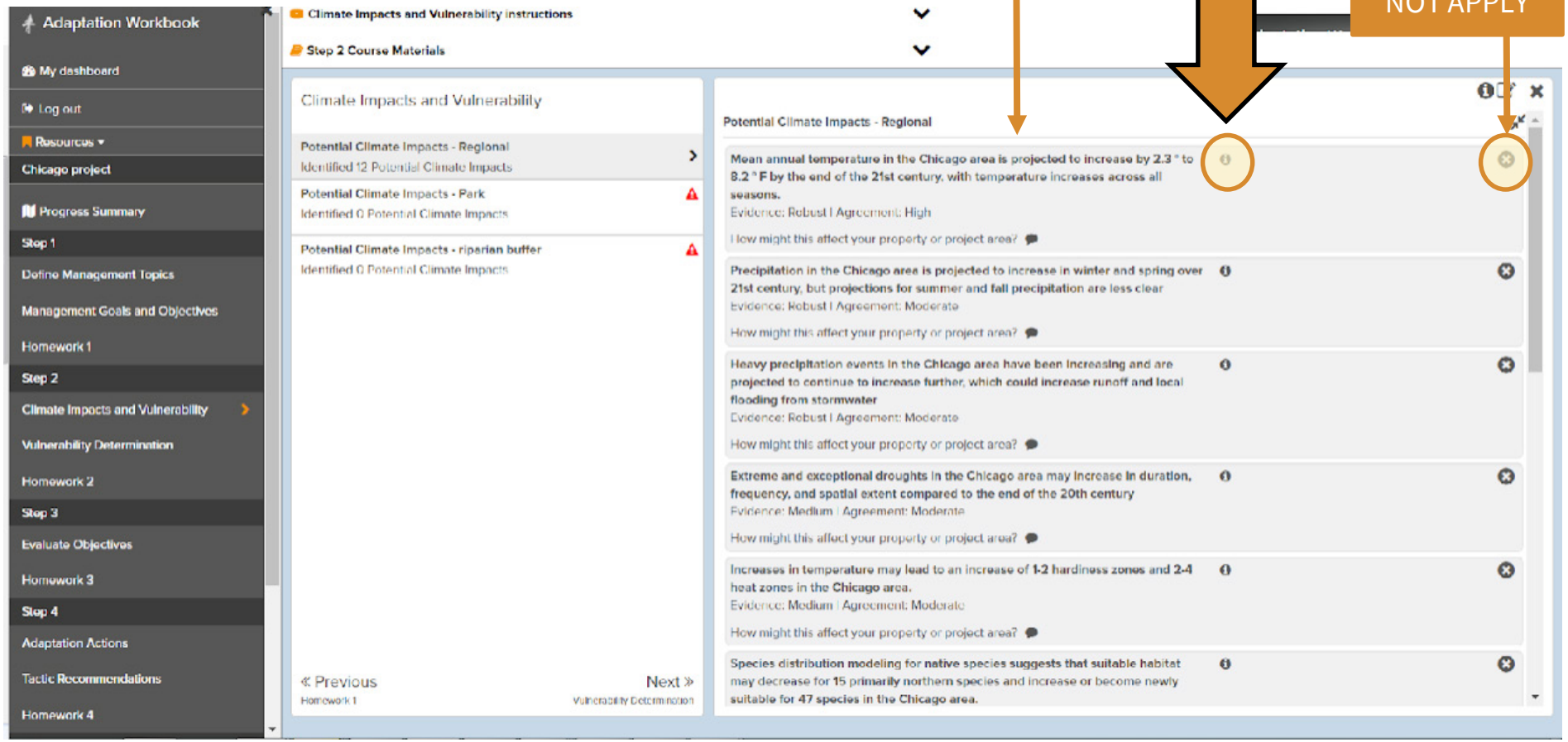
Making a climate informed species list: Species with *no* Tree Atlas information

Species Name	Effect from zone shift-low emissions	Effect from zone shift-low emissions	Adaptive Capacity	Vulnerability
Gingko	No change	No change	High	Low
Korean Fir	No change	No Change	Medium	Medium
Norway maple	Medium	Decrease	High	Medium
Gray birch	Decrease	Decrease	Low	High

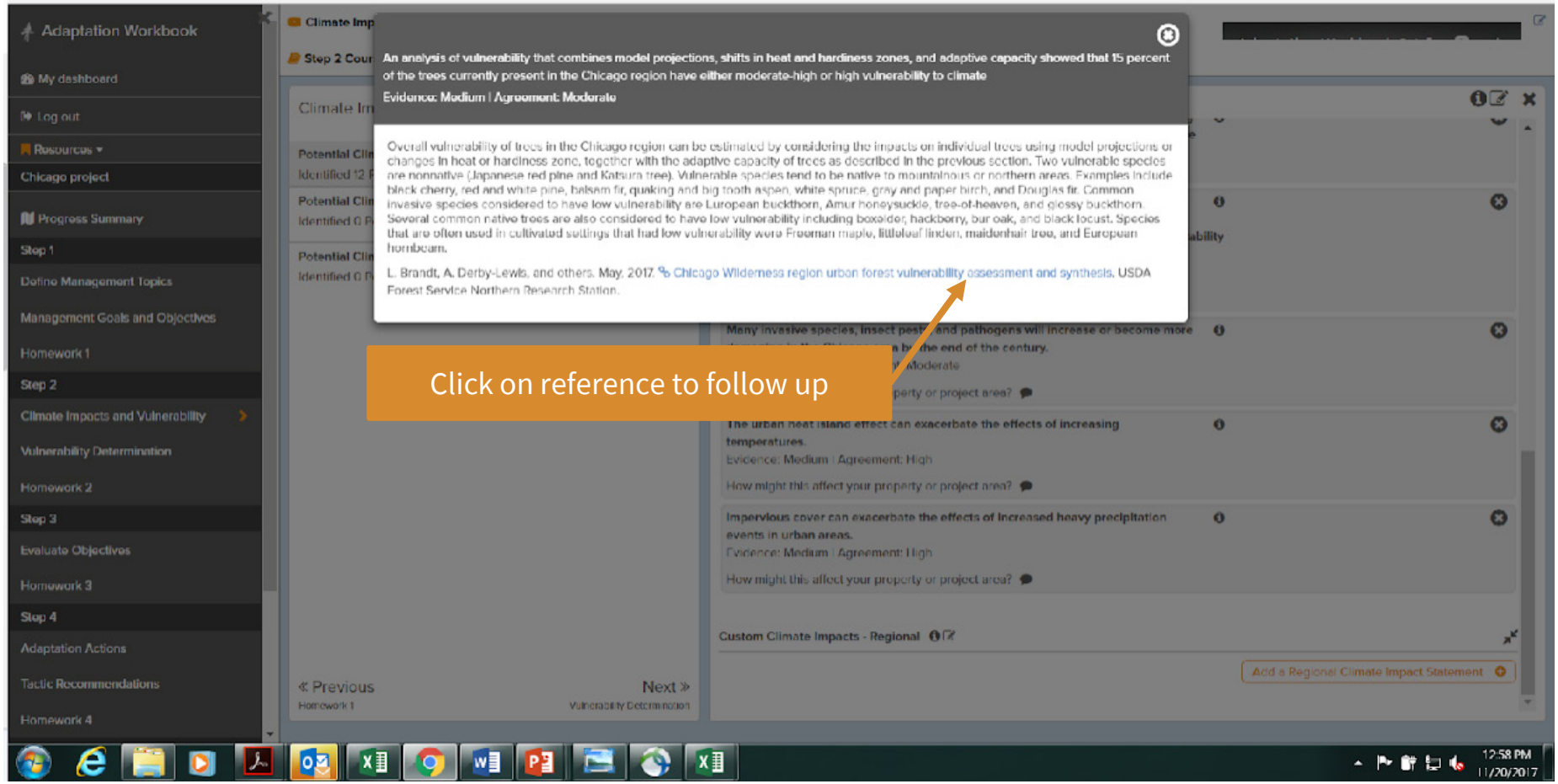
Starting Step 2.1



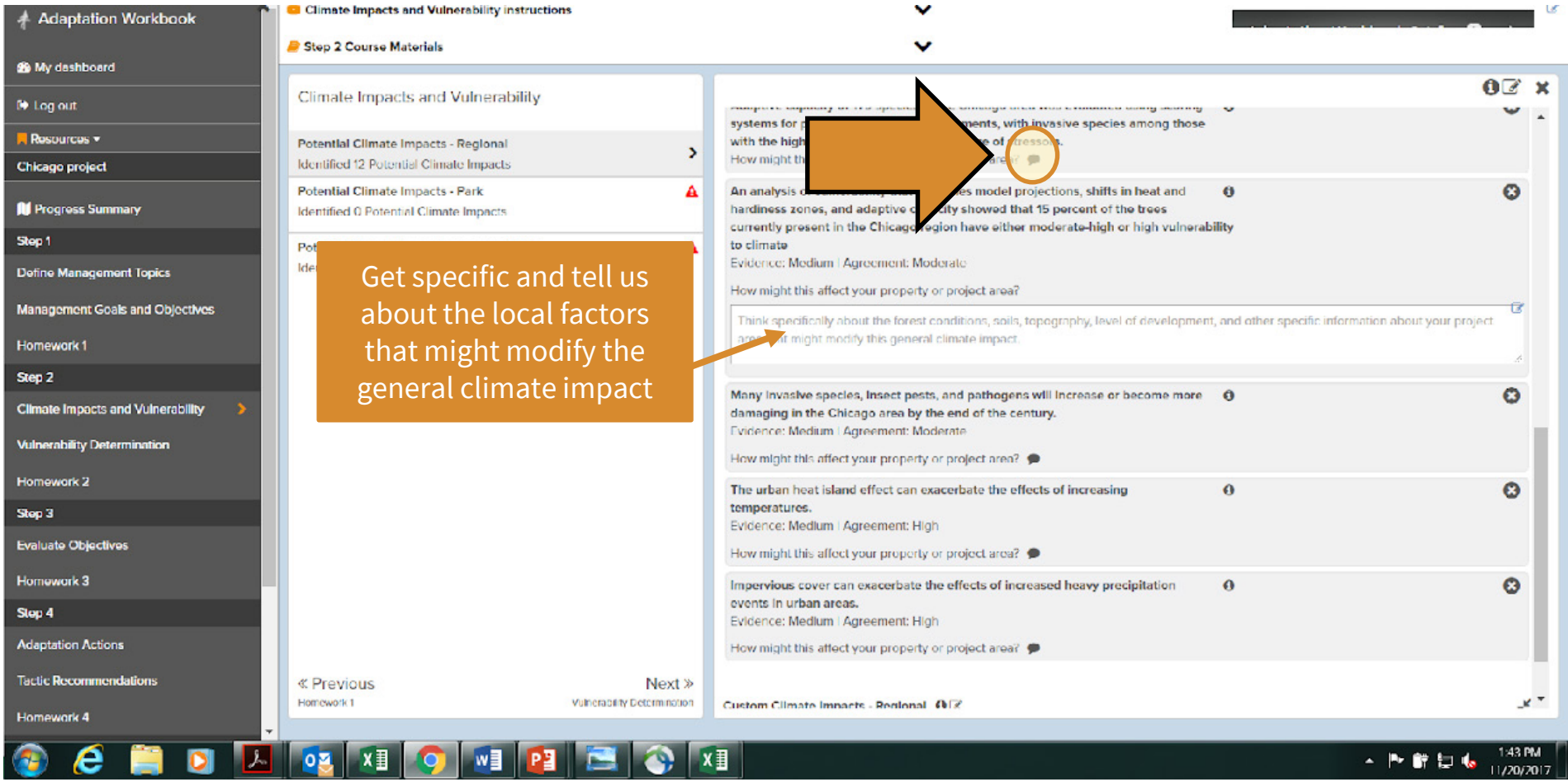
Step 2.1: List of impacts



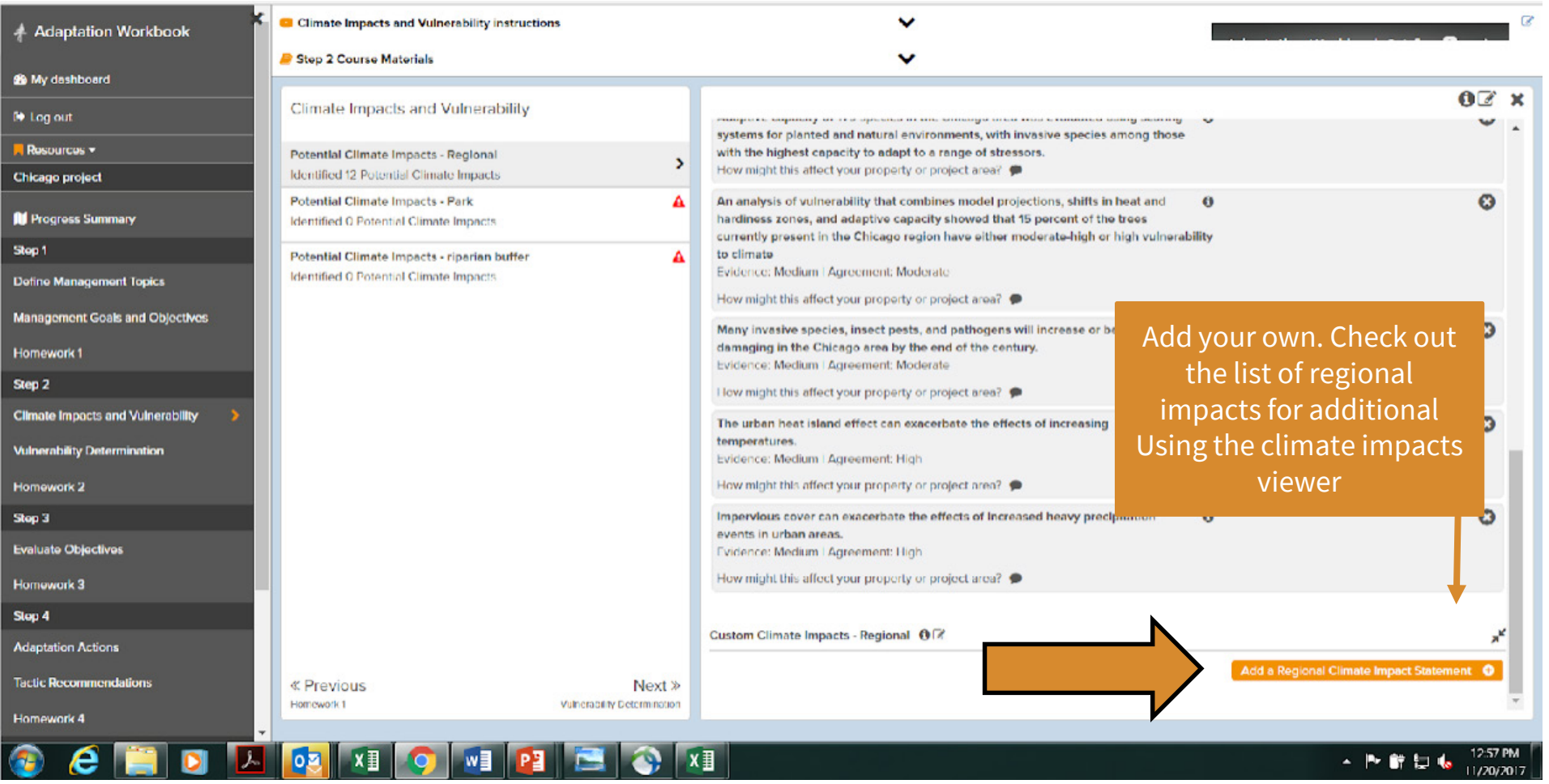
Step 2.1: Supporting documentation



Step 2.1: Add Local Information



Step 2.1: Add Custom Impact



Pro Tip: Stick to Impacts

Don't think about how these impacts will affect your management just yet.

For now, just focus how climate change will affect the project area.

Questions?

Step 2.2: Vulnerability Determination

How vulnerable is the forest type or management topic to climate change?

What is vulnerability?

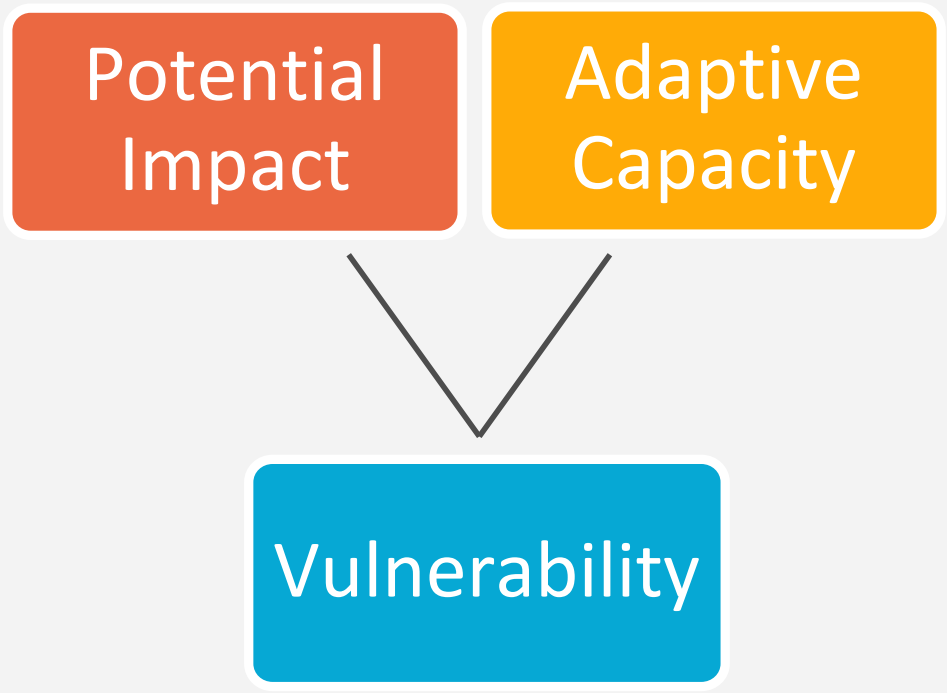
Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.

in other words:

Are climate change impacts going to cause substantial disruption to a particular system?

What is vulnerability?

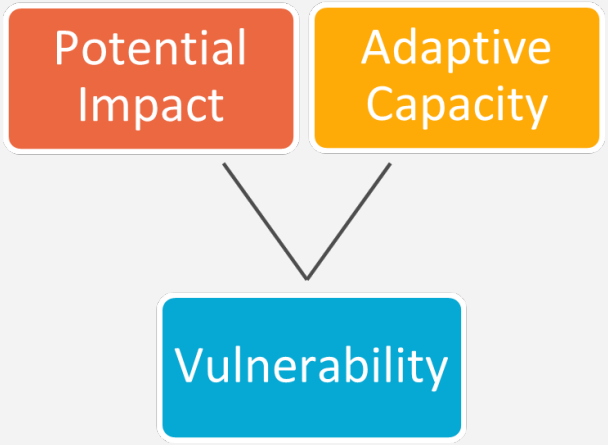
Two components:



What is vulnerability?

Potential Impacts consider

- What the system is **exposed** to
  - Changes in temperature, rainfall, storms, dominant species, stressors
- How **sensitive** the systems is to those changes



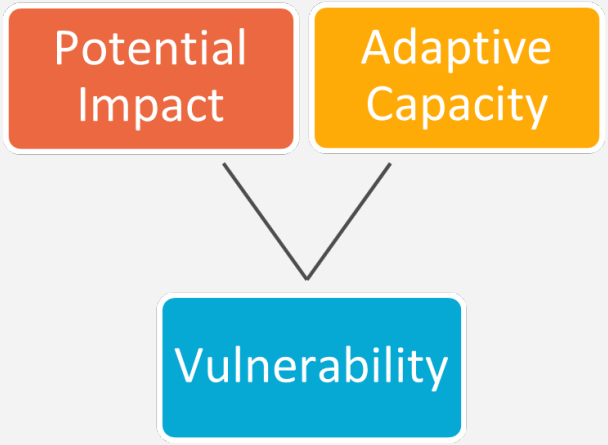
Example

- Two forests could both be exposed to 3ºF of warming
- A forest of spruce trees may be more sensitive to this impact than a forest of oak trees

What is vulnerability?

Potential Impacts consider

- What the system is **exposed** to
  - Changes in temperature, rainfall, storms, dominant species, stressors
- How **sensitive** the systems is to those changes



Big question:

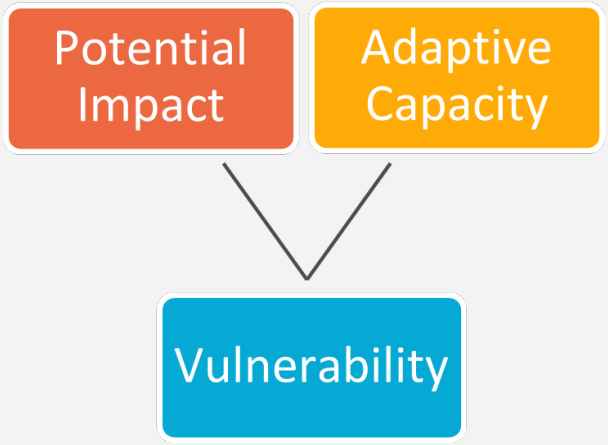
Are the potential impacts likely to **support** or **disrupt** the health and function of the system?

What is vulnerability?

Adaptive capacity considers

- How well the system can cope with the potential impacts.
- i.e., how resilient is the system?

(assuming no change in management intervention)



Example

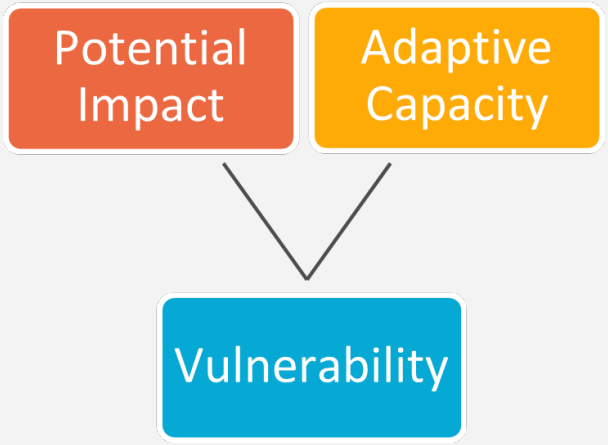
- A forest containing a variety of northern species may have a greater capacity to adapt to warming than a forest containing one northern species.

What is vulnerability?

Adaptive capacity considers

- How well the system can cope with the potential impacts.
- i.e., how resilient is the system?

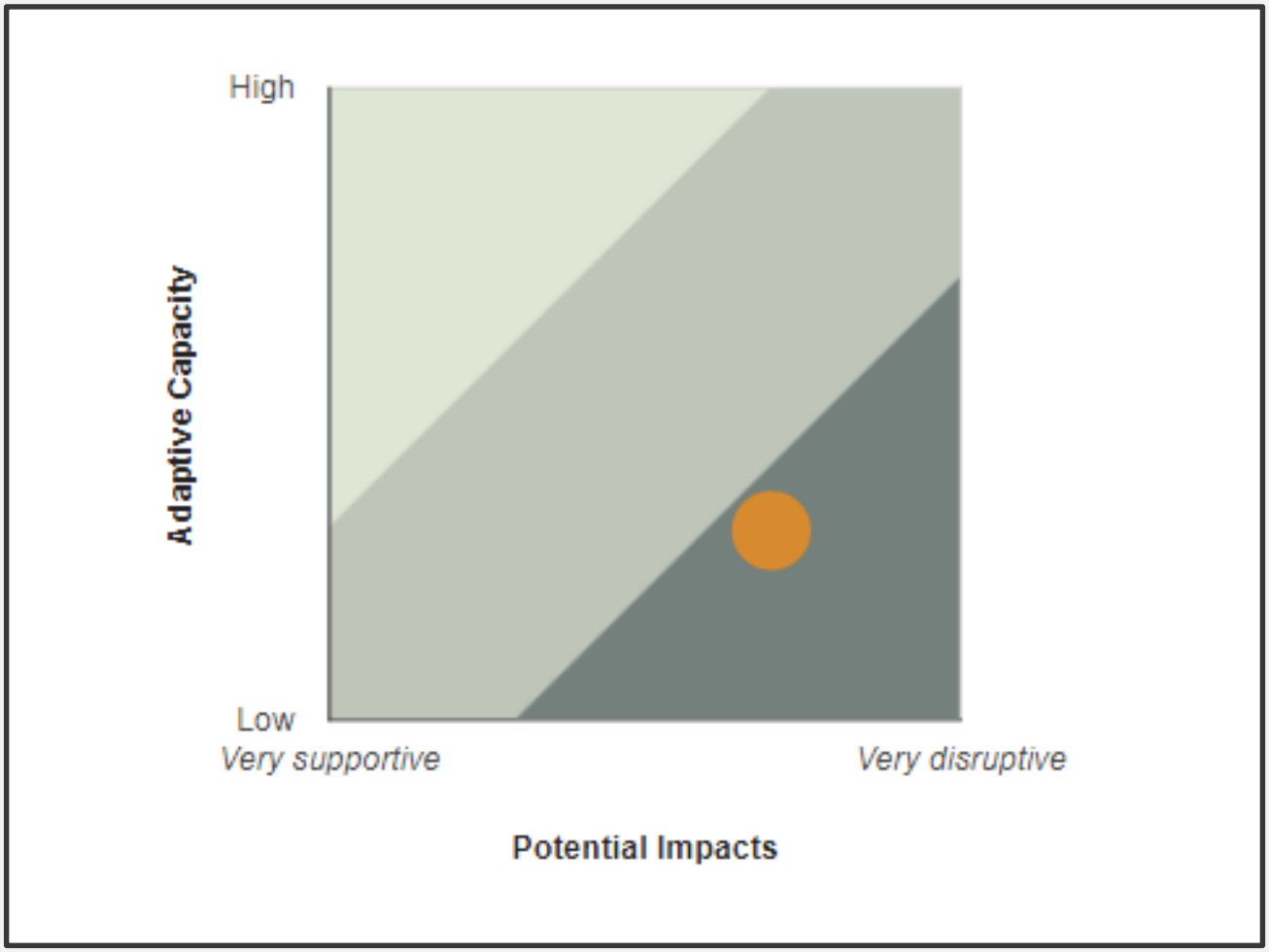
(assuming no change in management intervention)



Big question:

How **resilient** is the system to potential impacts?

What is vulnerability?



Vulnerability Ratings

Forest community	Potential impacts	Adaptive capacity	Vulnerability
Montane Spruce-Fir	Negative	Low	High
Northern Hardwood	Moderate-Negative	Moderate	Moderate-High
Central Oak-Pine	Moderate-Positive	Moderate-High	Moderate-Low
Woodland, Glades, and Barrens	Positive	Moderate-High	Low
Lowland and Riparian Hardwood	Moderate	Moderate	Moderate
Lowland Conifer	Negative	Moderate-Low	High
Forest community	**Potential impacts**	**Adaptive capacity**	**Vulnerability**
Coastal Plain Swamp	Moderate	Moderate-High	Moderate-Low
Coastal Plain Tidal Swamp	Moderate-Negative	Moderate-Low	Moderate-High
Coastal Plain Oak-Pine-Hardwood	Moderate-Positive	High	Moderate-Low
Coastal Plain Pine-Oak Barrens	Moderate	Moderate	Moderate-Low
Coastal Plain Maritime Forest	Negative	Moderate-Low	High

Mid-Atlantic Forest Ecosystem Vulnerability Assessment

Forest Vulnerability

Dry/Mesic Oak Forest

Low-Moderate Vulnerability (medium evidence, medium-high agreement)

This ecosystem supports a high number of tree species and occurs over a wide range of habitats. Many species are tolerant of dry soil conditions and fire, although young regeneration may be sensitive to severe drought and fire. Southern oak and hickory species are likely to benefit from projected changes in climate.

Positive-Neutral Potential Impacts

Drivers: Fire frequency was historically higher than it is currently, largely due to fire suppression over the last 50 years. Drier soil conditions in summer and fall, especially on south-facing slopes, may increase the risk of wildfire. Increased frequency of extreme weather events (e.g., windstorms and ice storms) may lead to more frequent large-gap disturbances. Increases in extreme precipitation events may increase the potential for erosion and channeling.

Dominant Species: Of the many species modeled, suitable habitat was generally projected to increase for the southern oaks and hickories, whereas other common species are projected to persist over a smaller extent. Models project that habitat suitability, basal area and trees per acre, and potential growth for pignut hickory and white oak will remain relatively stable or increase slightly under both scenarios. Results for northern red oak are highly variable across the assessment area, but suggest positive effects on regeneration where suitable habitat remains. Other common species are not expected to do as well, especially for GFDL A1FI: models project that suitable habitat, potential growth, and trees per acre will decrease for chestnut oak and scarlet oak. Black oak is projected to remain stable for PCM B1, but for GFDL A1FI suitable habitat is expected to increase while growth potential and trees per acre decrease. Mockernut hickory and shagbark hickory were modeled only by the Tree Atlas, and both are projected to increase in suitable habitat.

Stressors: Increased drought risk, especially during the growing season, may increase susceptibility to red oak borer, ambrosia beetle, gypsy moth, armillaria root disease, and other insect pests and diseases. Ailanthus, Japanese stiltgrass, and garlic mustard, which often outcompete native herbs and shrubs in this ecosystem, are expected to do well in warmer temperatures. Low-severity late-season drought generally favors oak species, although severe drought may hinder regeneration, or combine with other stressors to make individuals more susceptible to mortality or reduced productivity.

High Adaptive Capacity

A history of fire suppression and timber harvesting has facilitated a shift to more mesic soils and associated hardwood species (e.g., sugar maple, American beech, tulip tree). Increased fire frequency could help regenerate oak species and restore the understory composition. However, very frequent fires have the potential to kill young seedlings of any species, even those species that have relatively fire-resistant, thick bark as adults. This ecosystem is widely distributed, representative of a range of habitat conditions, and likely to expand on the landscape. American chestnut was historically a dominant canopy tree but now cannot grow past sapling size due to chestnut blight. Blight-resistant American chestnut variants are currently under development and experimental planting is already occurring, resulting in increased species diversity in select areas (Jacobs et al. 2013).

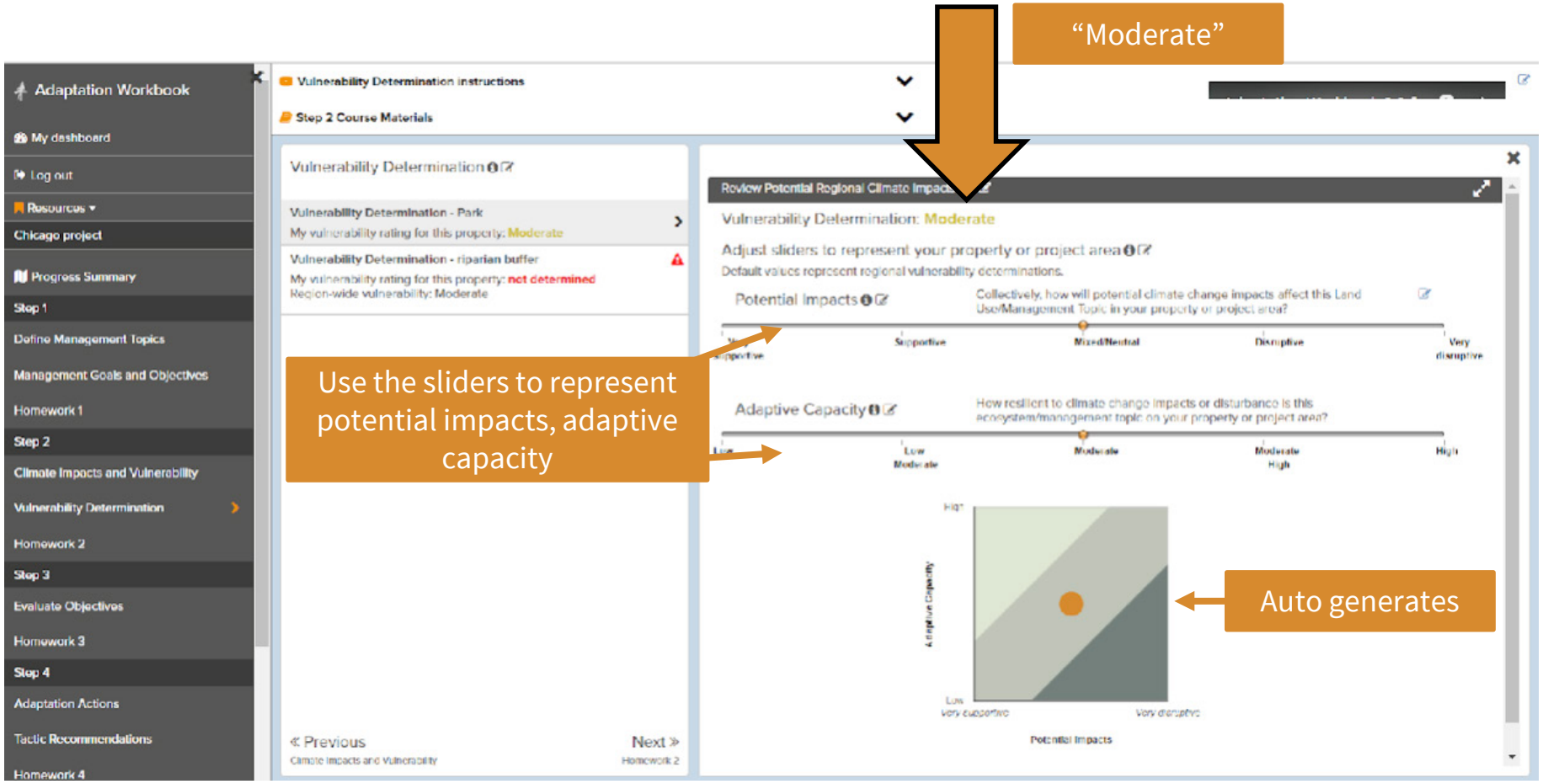
CHAPTER 6: FOREST ECOSYSTEM VULNERABILITIES

A mesic oak forest with maple regenerating in the understory. Photo by Brian Streets, West Virginia Division of Natural Resources, Natural Heritage Program, used with permission.

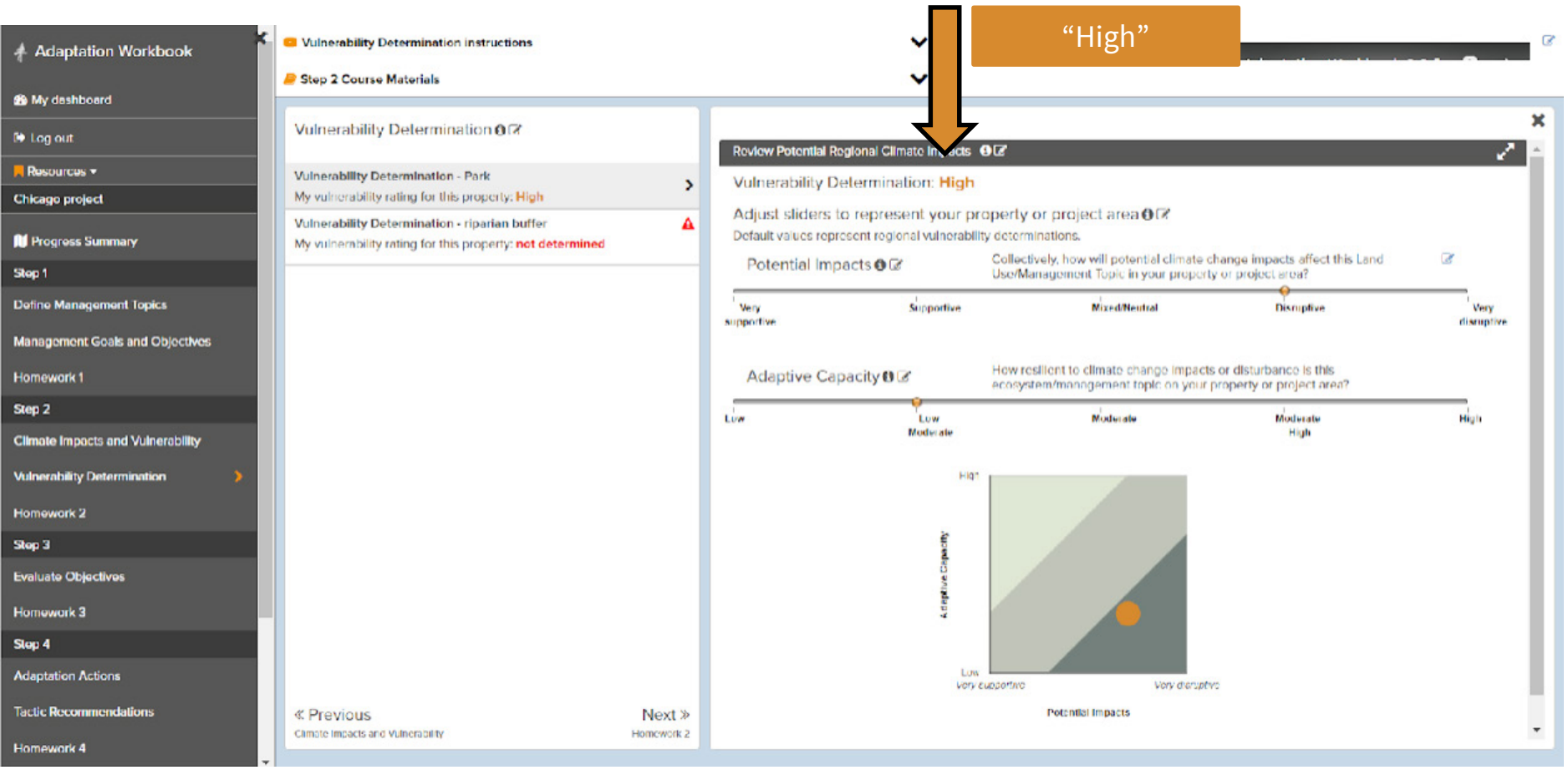
A dry oak forest with grasses dominating the open understory. Photo by Jim Vanderhorst, West Virginia Division of Natural Resources, Natural Heritage Program, used with permission.

A dry/mesic oak forest. Photo by Jim Vanderhorst, West Virginia Division of Natural Resources, Natural Heritage Program, used with permission.

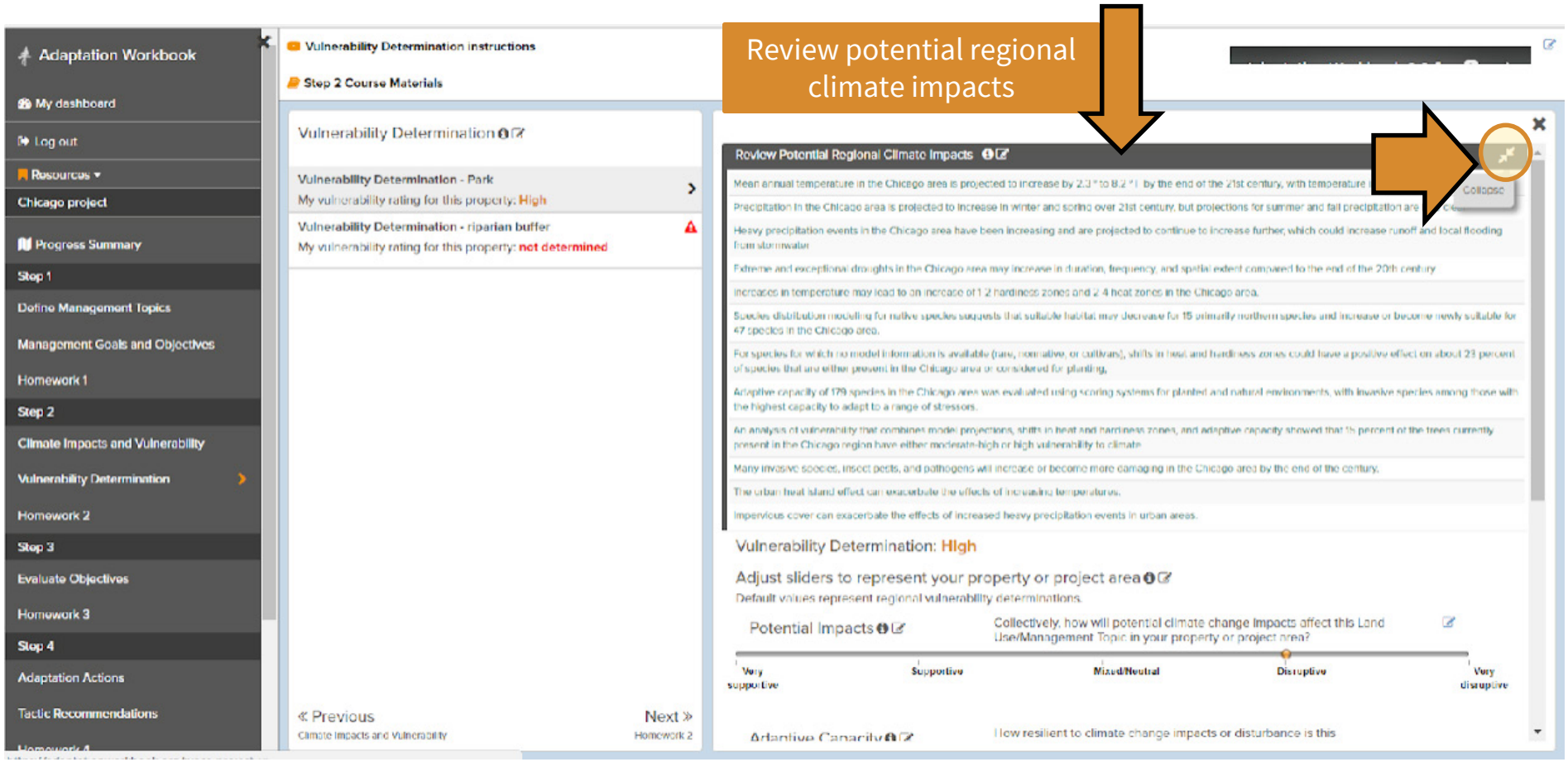
Step 2.2: Vulnerability Determination



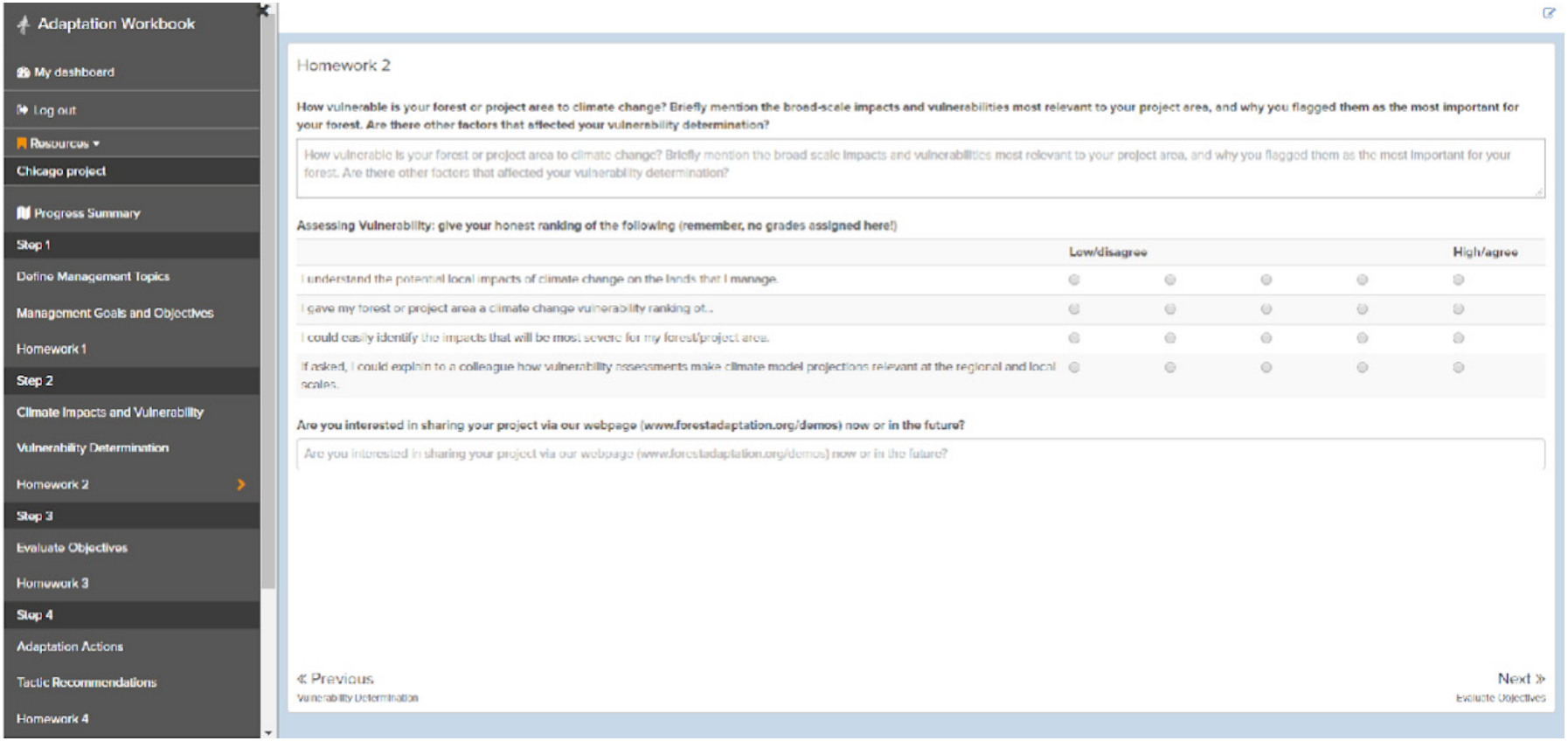
Step 2.2: Vulnerability Determination



Step 2.2: Vulnerability Determination



Step 2 Homework!



Questions?

Homework

- **Look at climate change impacts and vulnerability resources for your state and/or area**
- **Watch the video presentation** Impacts of Climate Change on Urban Forests
- **Complete Step 2:** Assessing Impacts & Vulnerability
- **Complete the Homework** section following Step 2
- **Come to Session 3 (Tuesday, February 5th)** ready to talk about your project area's top vulnerabilities

Questions?