Climate Change Adaptation in Austin's Community Forest and Natural Areas

Northern Institute of Applied Climate Science

Chartered by USDA Forest Service, universities, non-profit, and tribal conservation organizations

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Michigan Technological University

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AMERICAN FORESTS

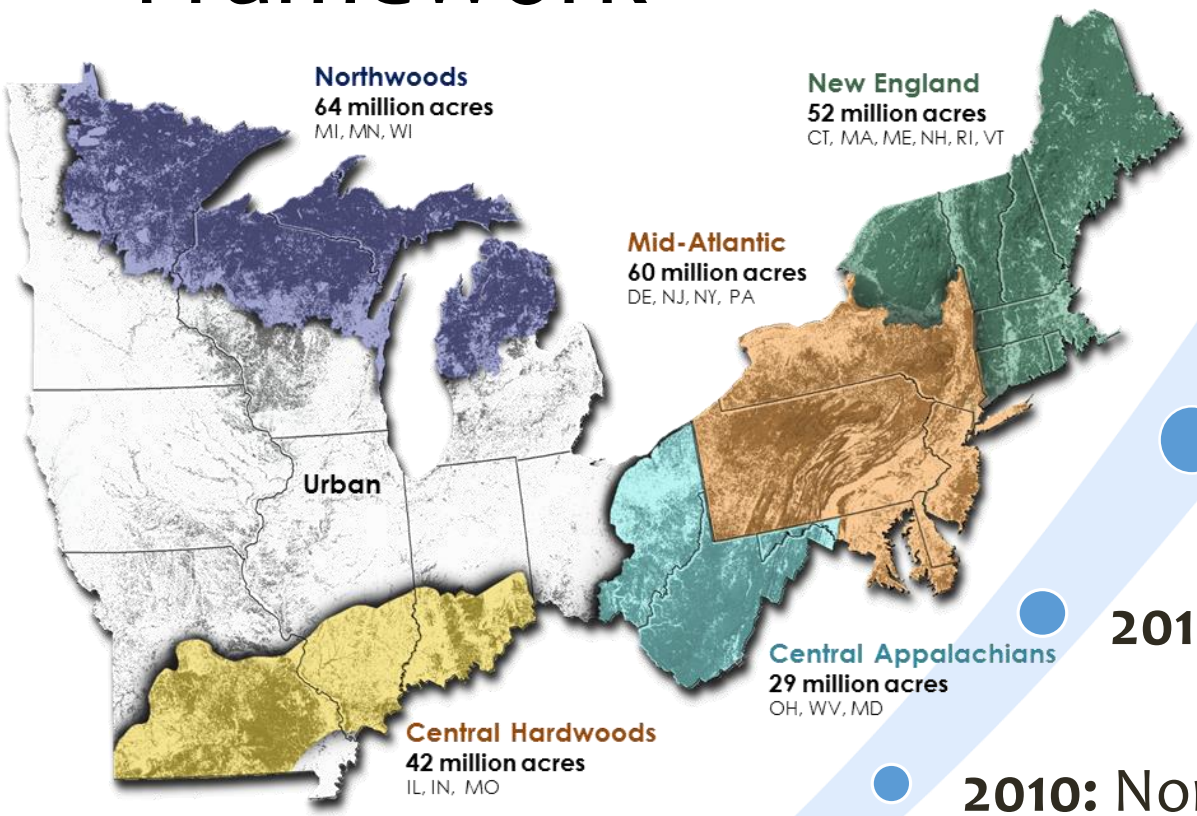
UNIVERSITY OF MINNESOTA

NCASI

Great Lakes Indian Fish & Wildlife Commission

USDA Climate Hubs

Climate Change Response Framework



2013-14:
New England
Mid-Atlantic
Urban

2012: Central Appalachians

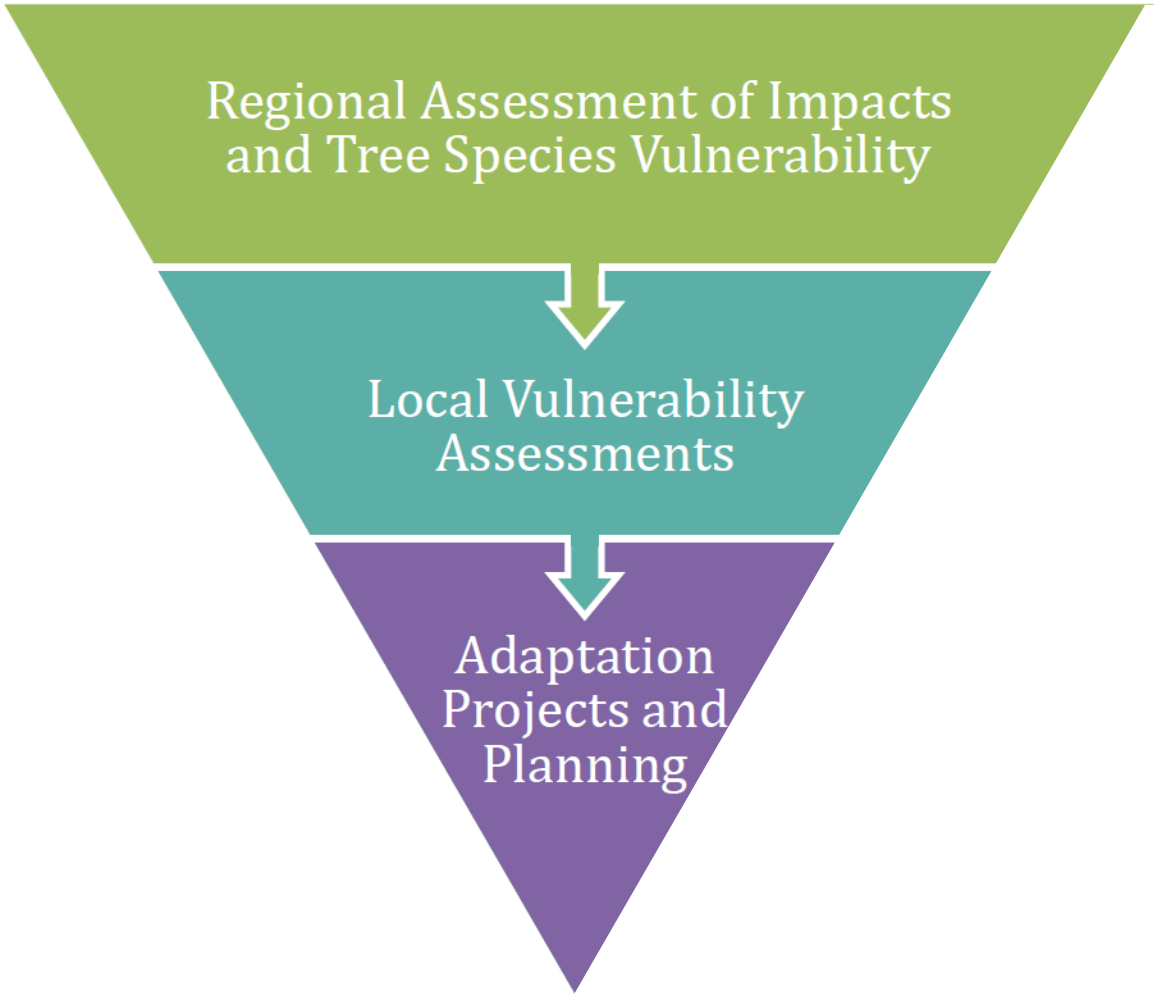
2011: Central Hardwoods

2010: Northwoods expansion

2009: Wisconsin pilot

www.forestadaptation.org

Urban Forestry
Climate Change Response Framework



Brandt et al. 2017. Environmental Science and Policy

Today's Objectives

- Learn more about current and anticipated effects of climate change on Austin's developed and natural green spaces, with an emphasis on trees and forests.
- Understand concepts of climate change vulnerability and adaptation and how to apply these concepts to their work.
- Share tools and approaches for incorporating climate change into managing Austin's natural and developed green spaces.

Vulnerability of Austin's Trees and Natural Areas

Leslie Brandt

Northern Institute of Applied Climate Science

Vulnerability

The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2007)

Figure: Glick et al. 2011

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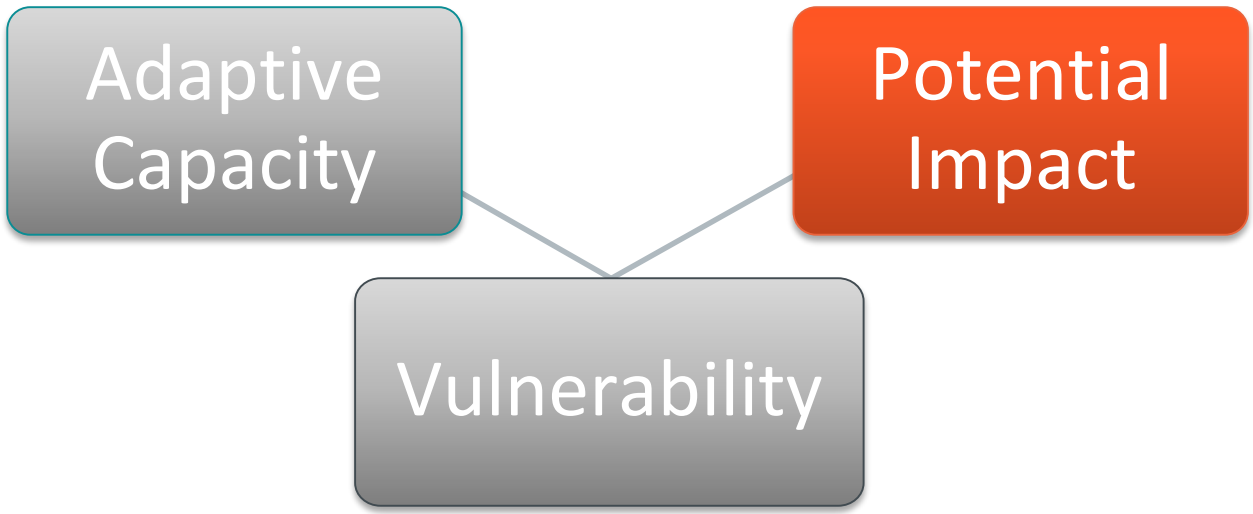
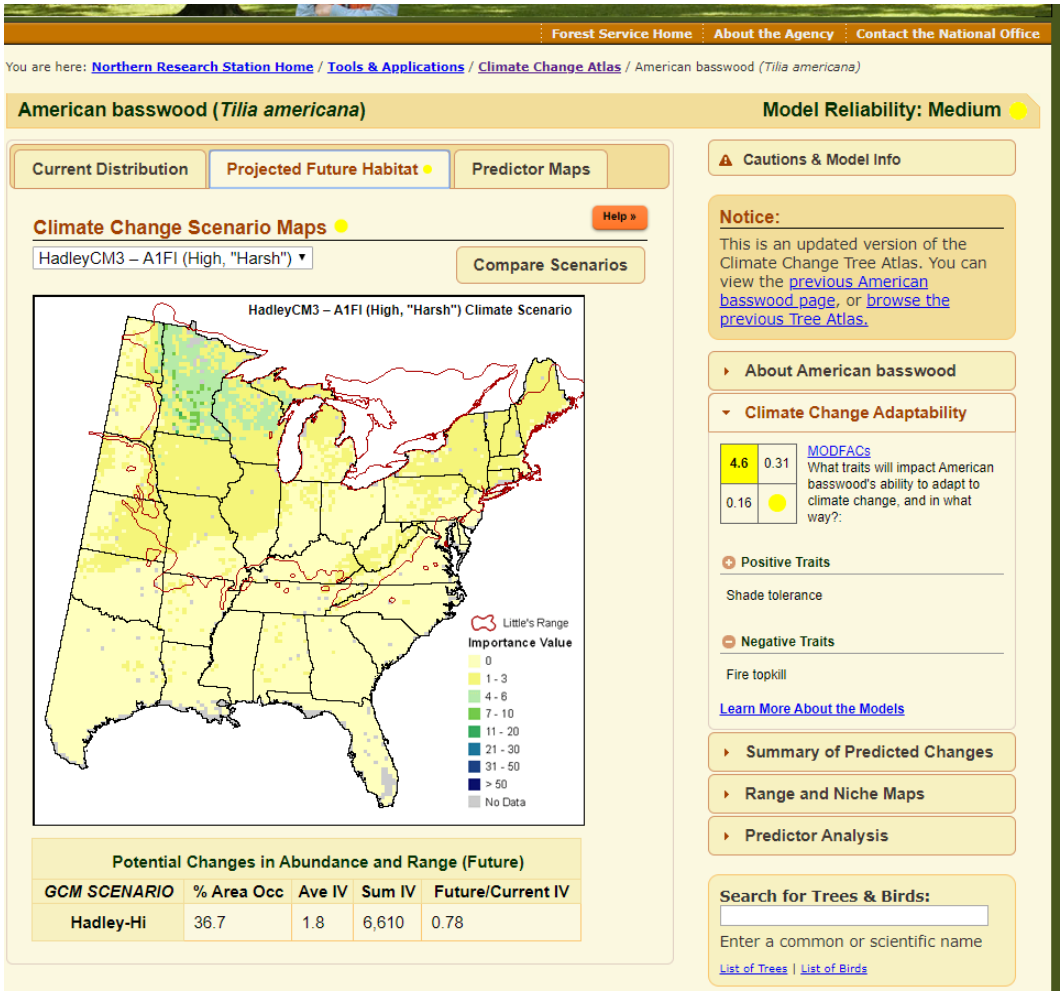


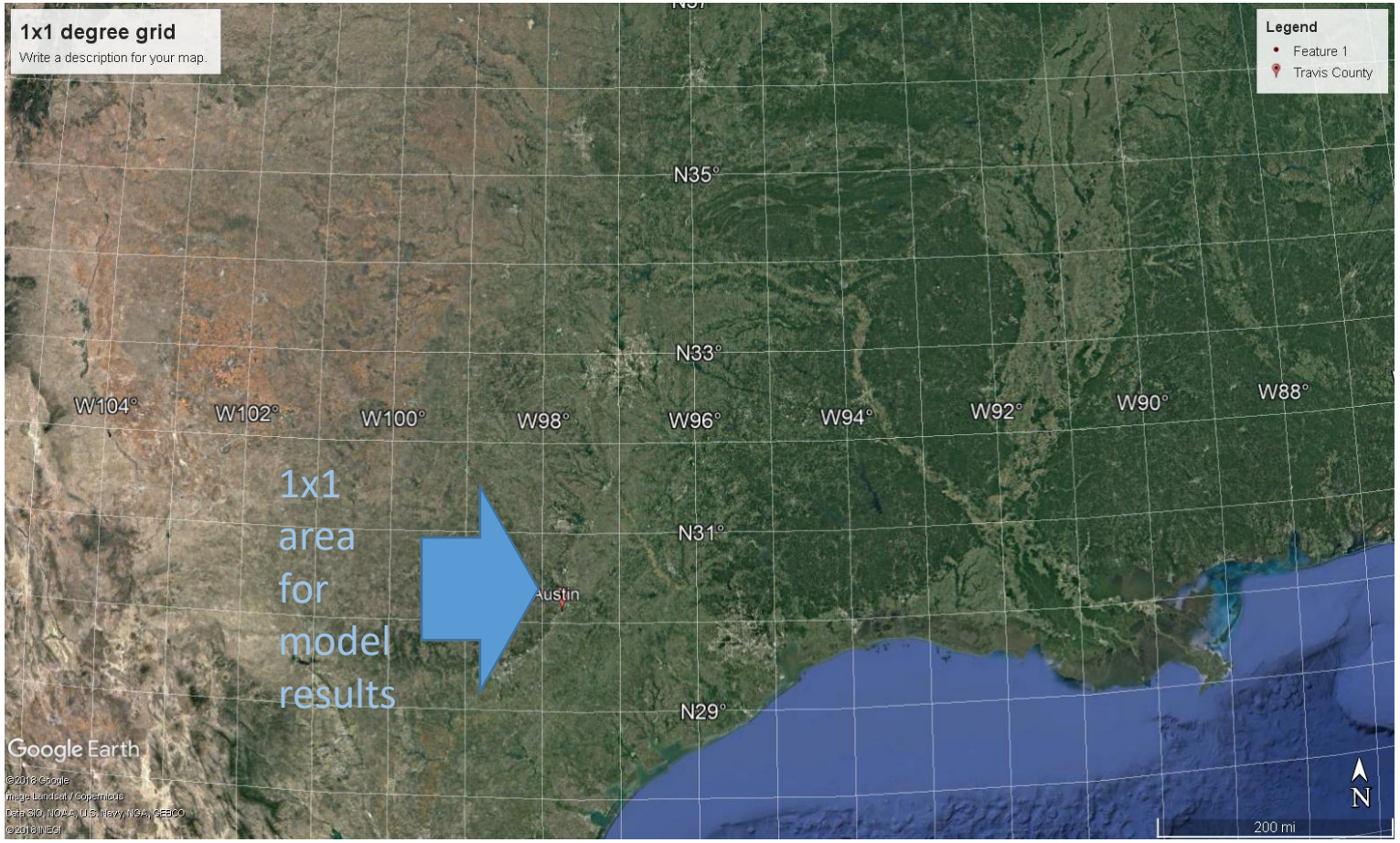
Figure: Glick et al. 2011

Climate Change Tree Atlas



https://www.fs.fed.us/nrs/atlas/

Summary Area 1x1 grid



Tree Atlas Results

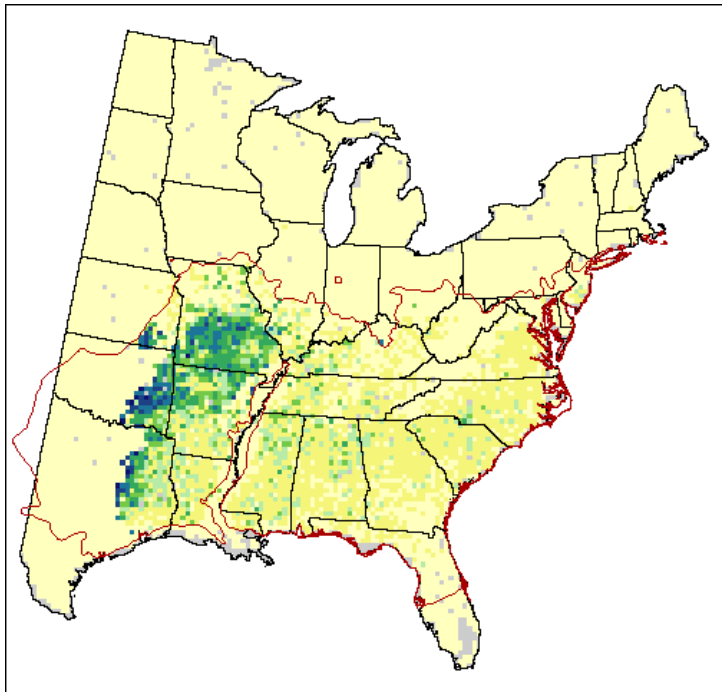
Losing Habitat

- Black walnut
- Eastern redcedar
- American sycamore
- Bur oak
- Post oak
- Black oak

Gaining Habitat

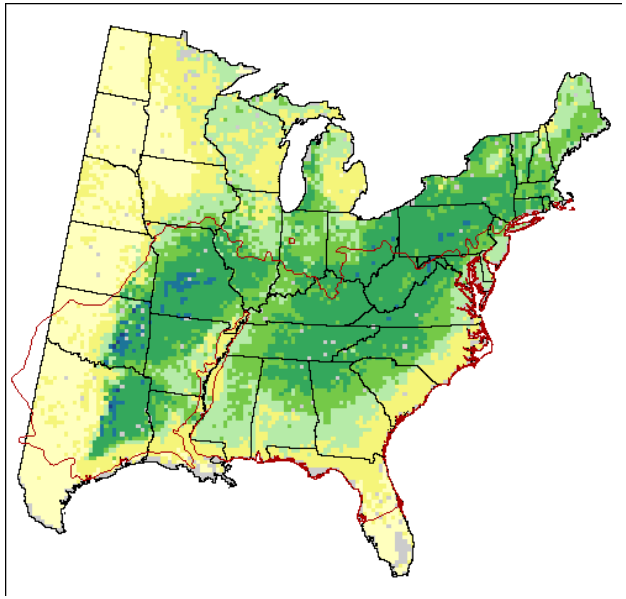
- Pecan
- Sugarberry
- Blackjack oak
- Water oak

Post Oak

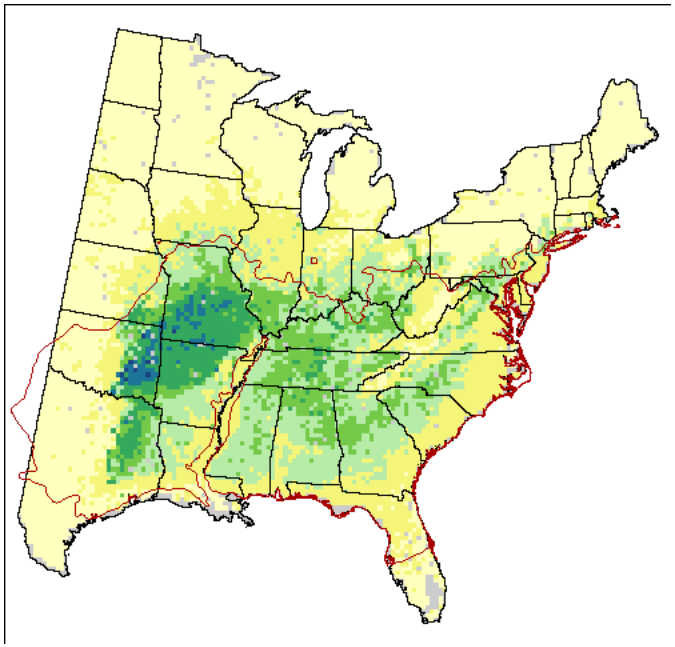


Current

High Emissions



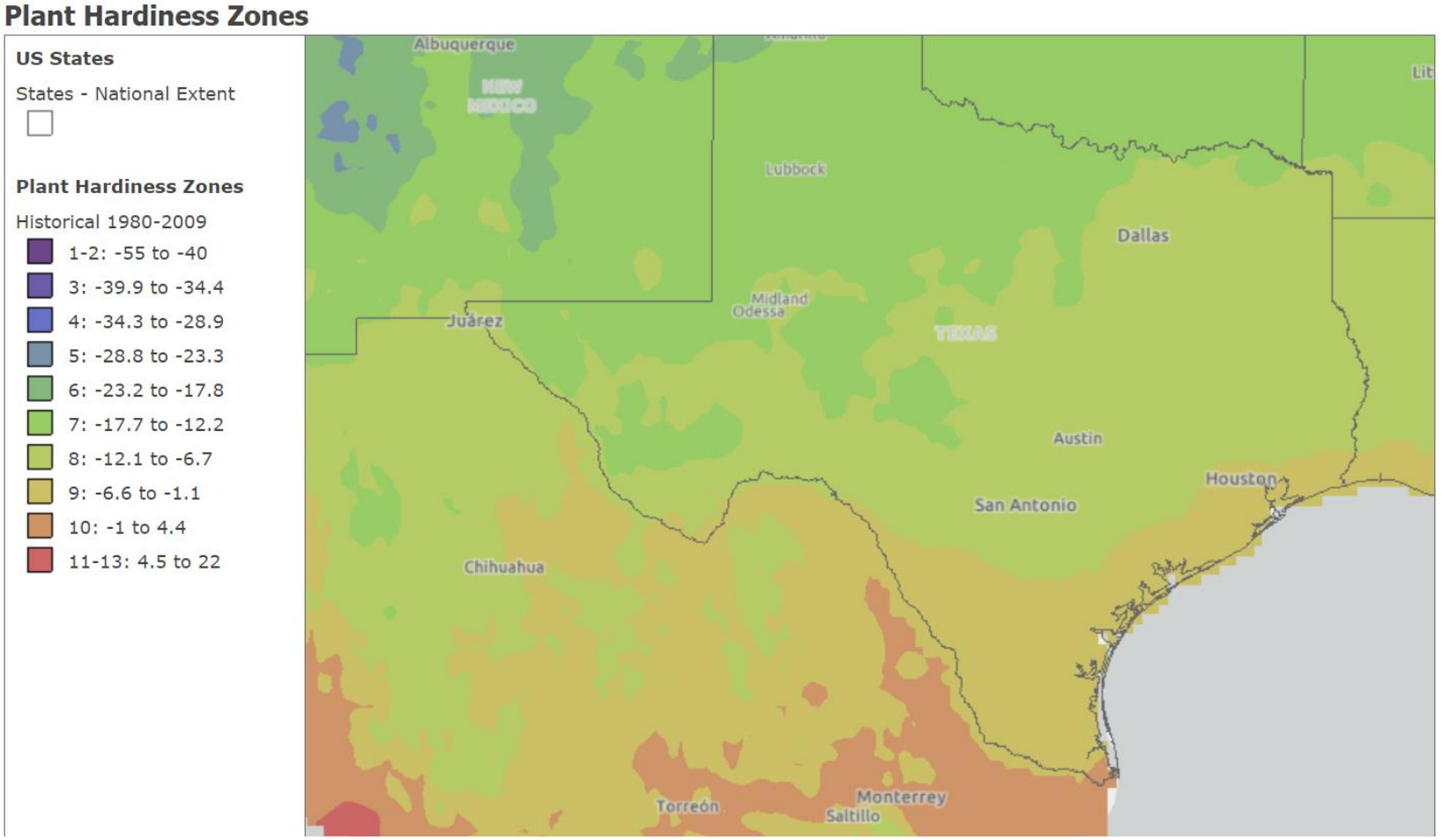
Low Emissions



Impacts:
Non-native, less common species, shrubs, and cultivars

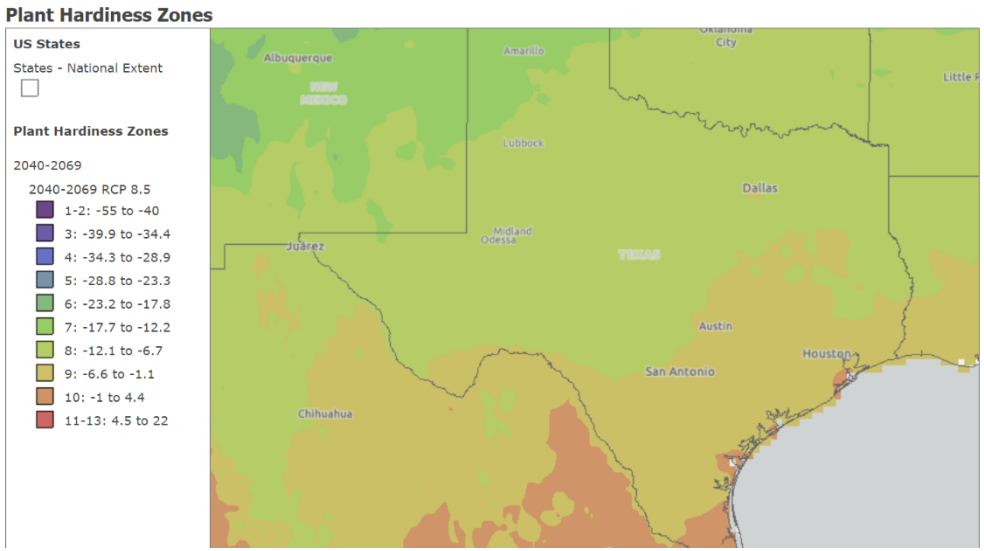
- Compared species' tolerances to projected changes in heat and hardiness zones for Austin region
  - Heat/hardiness zone projection exceeds species tolerance: potential negative effect
- Examined species ranges
  - South, west end of range: potential negative effect
  - Center of range: No effect
  - North/east end of range: potential positive effect

“Current” Hardiness Zone

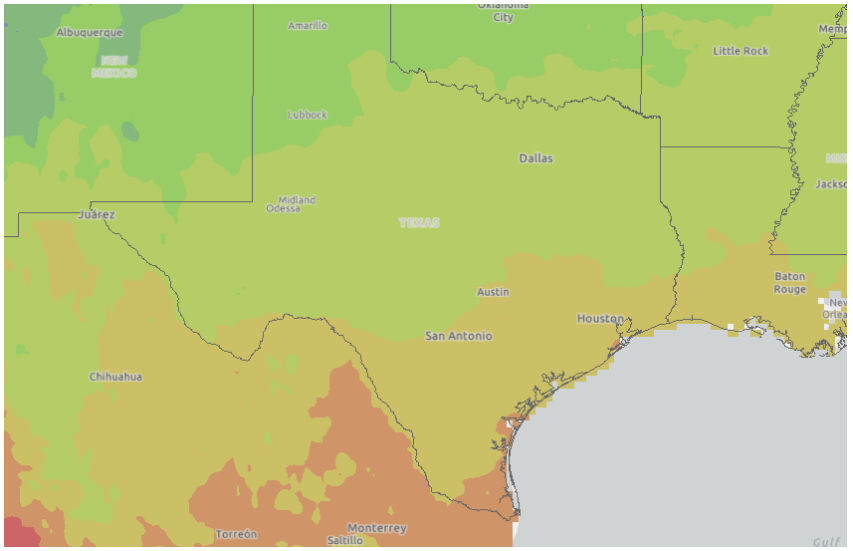


Source: https://usfs.maps.arcgis.com/home/webmap/viewer.html?webmap=611d3e5ac1774a21a6ff55aceb8f588c

Future Hardiness Zone: Mid-century



High Emissions

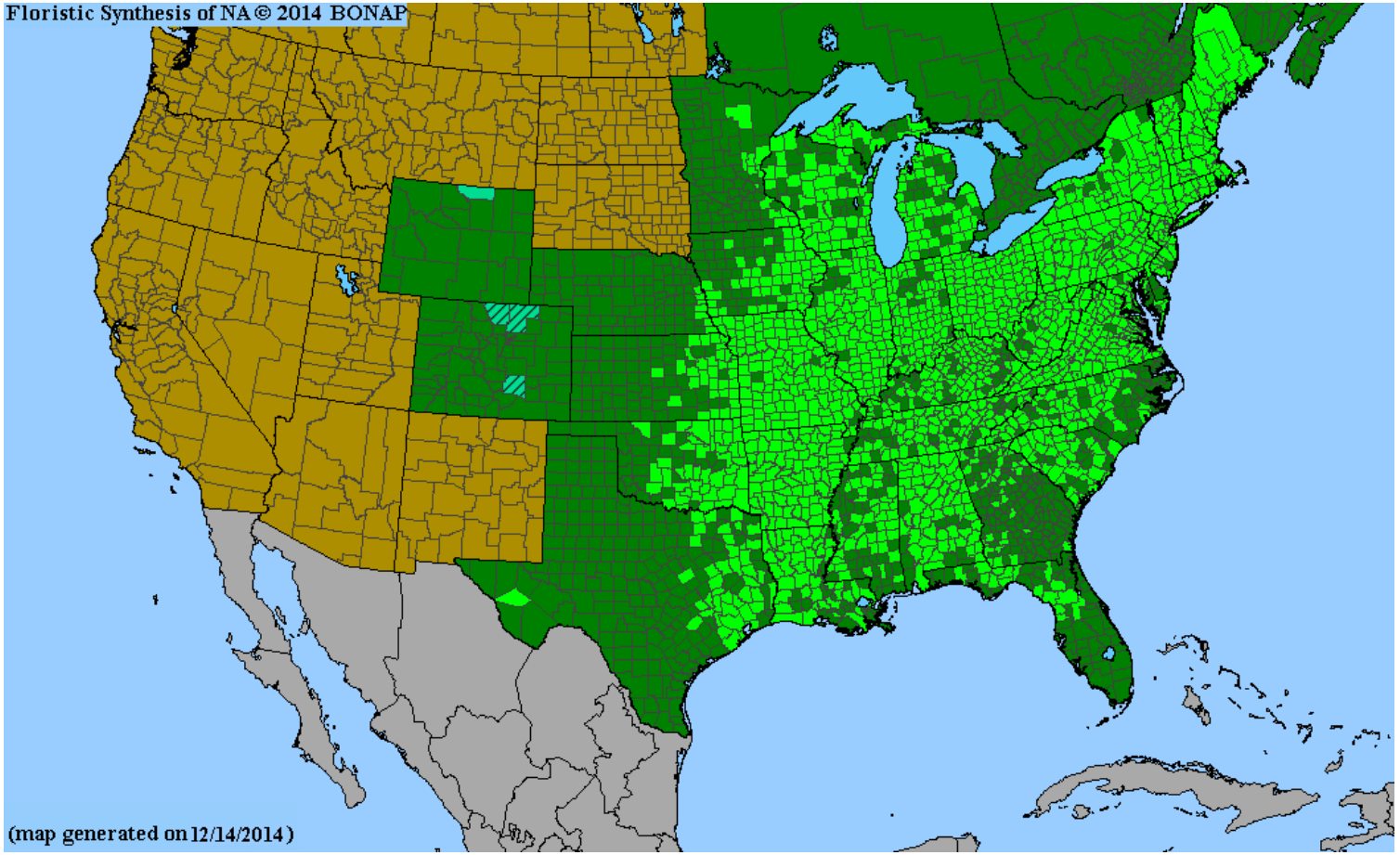


Low Emissions

Source: https://usfs.maps.arcgis.com/home/webmap/viewer.html?webmap=611d3e5ac1774a21a6ff55aceb8f588c

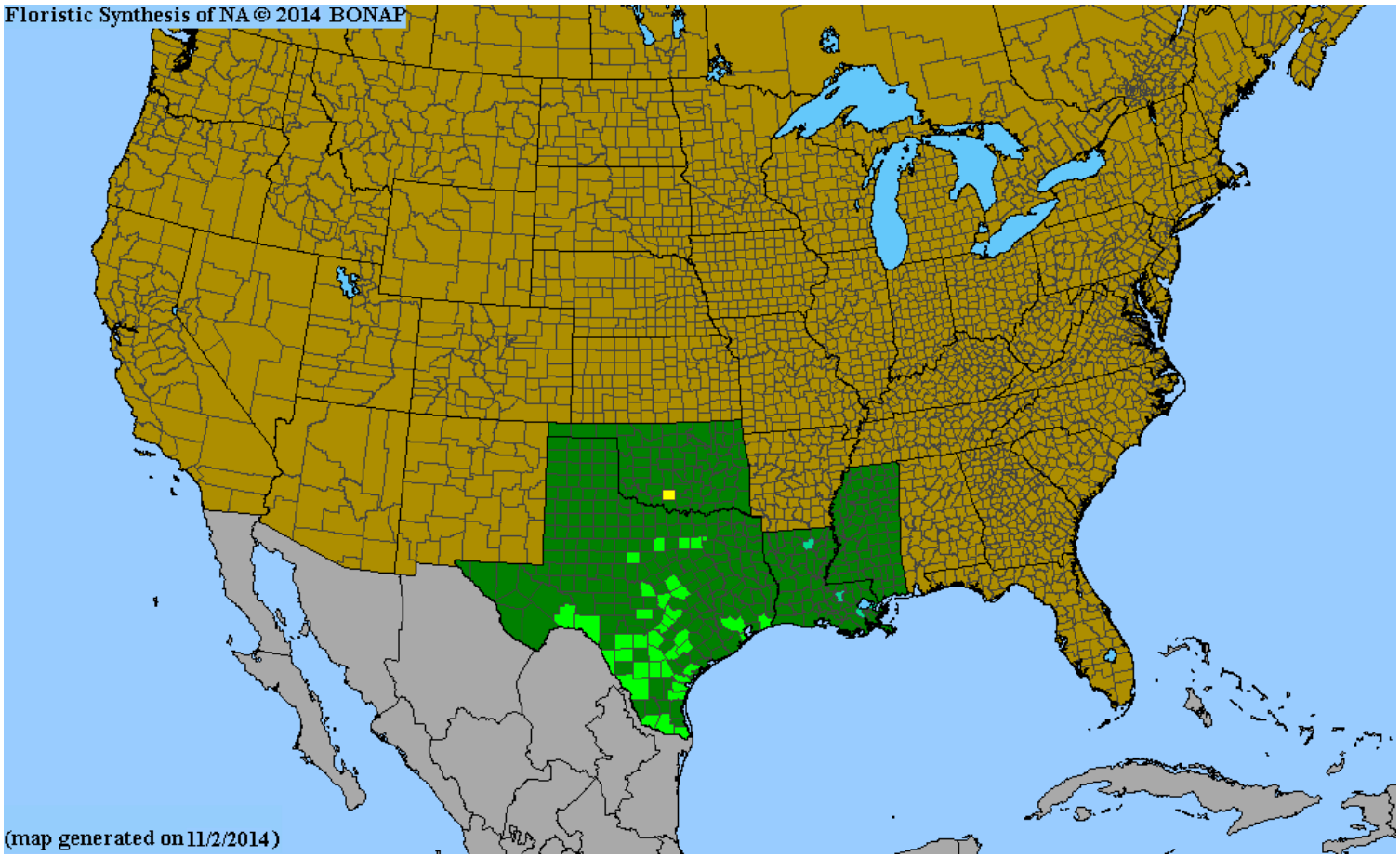
Bur oak (*Quercus macrocarpa*)
Hardy in zones 4-8

White ash (*Fraxinus americana*)



http://bonap.net/MapGallery/County/Fraxinus%20americana.png

Mexican ash (*Fraxinus berlandieriana*)



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Vulnerability

The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2007)

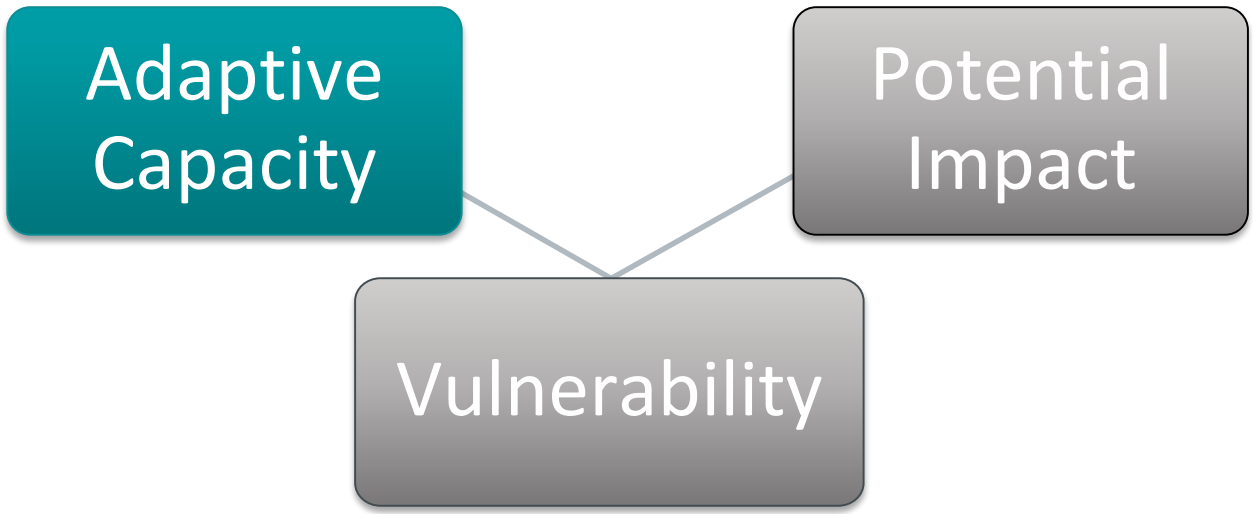
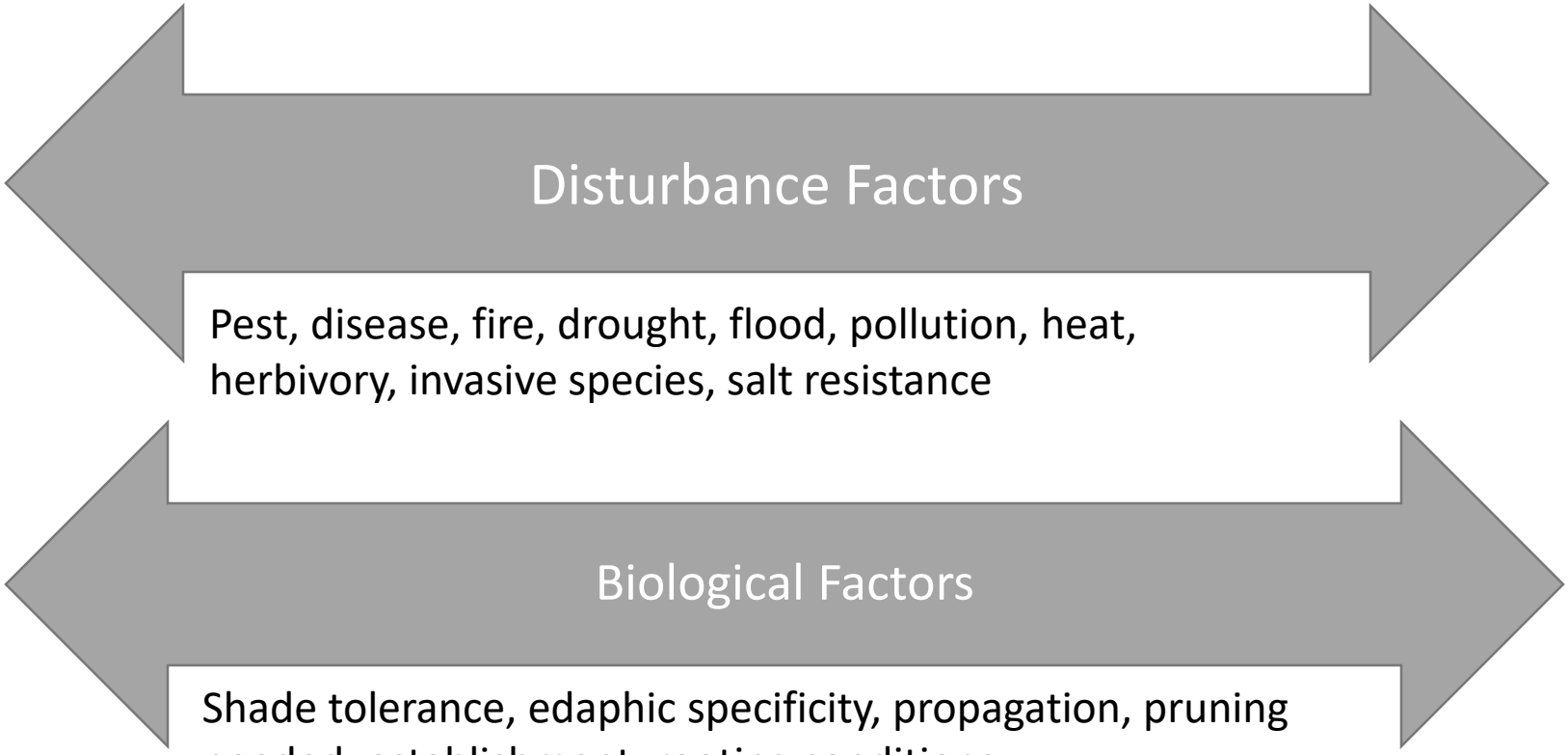


Figure: Glick et al. 2011

Adaptive Capacity Factors

Based on Matthews et al. 2011



2 Separate Scores

Planted/Developed

- Species that are or could be planted in yards, boulevards, parks, campuses
- Greater emphasis on pollution and heat tolerance
- Fire tolerance, invasive species competition, natural regeneration not factors
- Includes nursery propagation, restricted rooting conditions, maintenance, planting site

Natural

- Species that are native or naturalized to the area
- Less emphasis on pollution, heat, but still factors
- Includes invasive species competition, fire tolerance and post-fire regeneration
- Greater emphasis on shade tolerance
- Includes dispersal, seedling establishment, vegetative reproduction

Adaptive Capacity

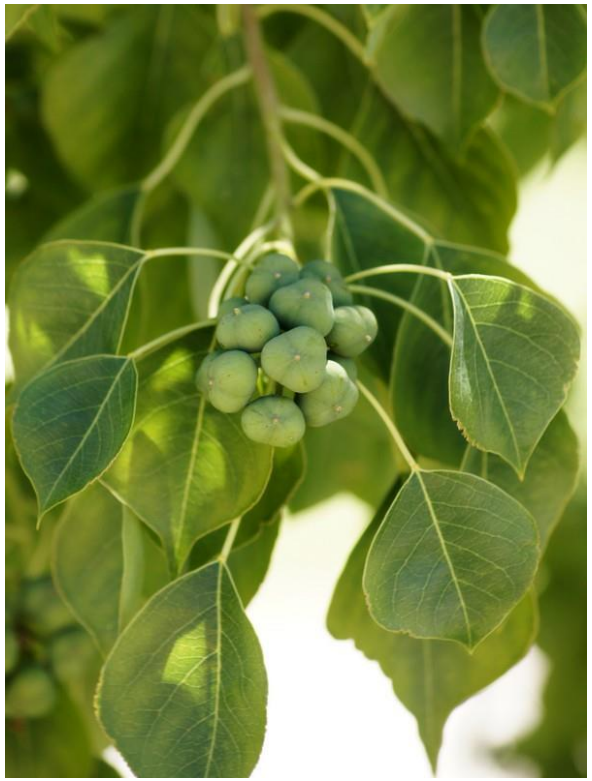
Low adaptive capacity example:

little walnut (*Juglans microcarpa*)

Narrow habitat requirements;
Can neither tolerate drought nor extensive flooding

High adaptive capacity:

Chinese tallowtree (*Triadica sebifera*)



Invasive=adaptable

Vulnerability

The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2007)

Figure: Glick et al. 2011

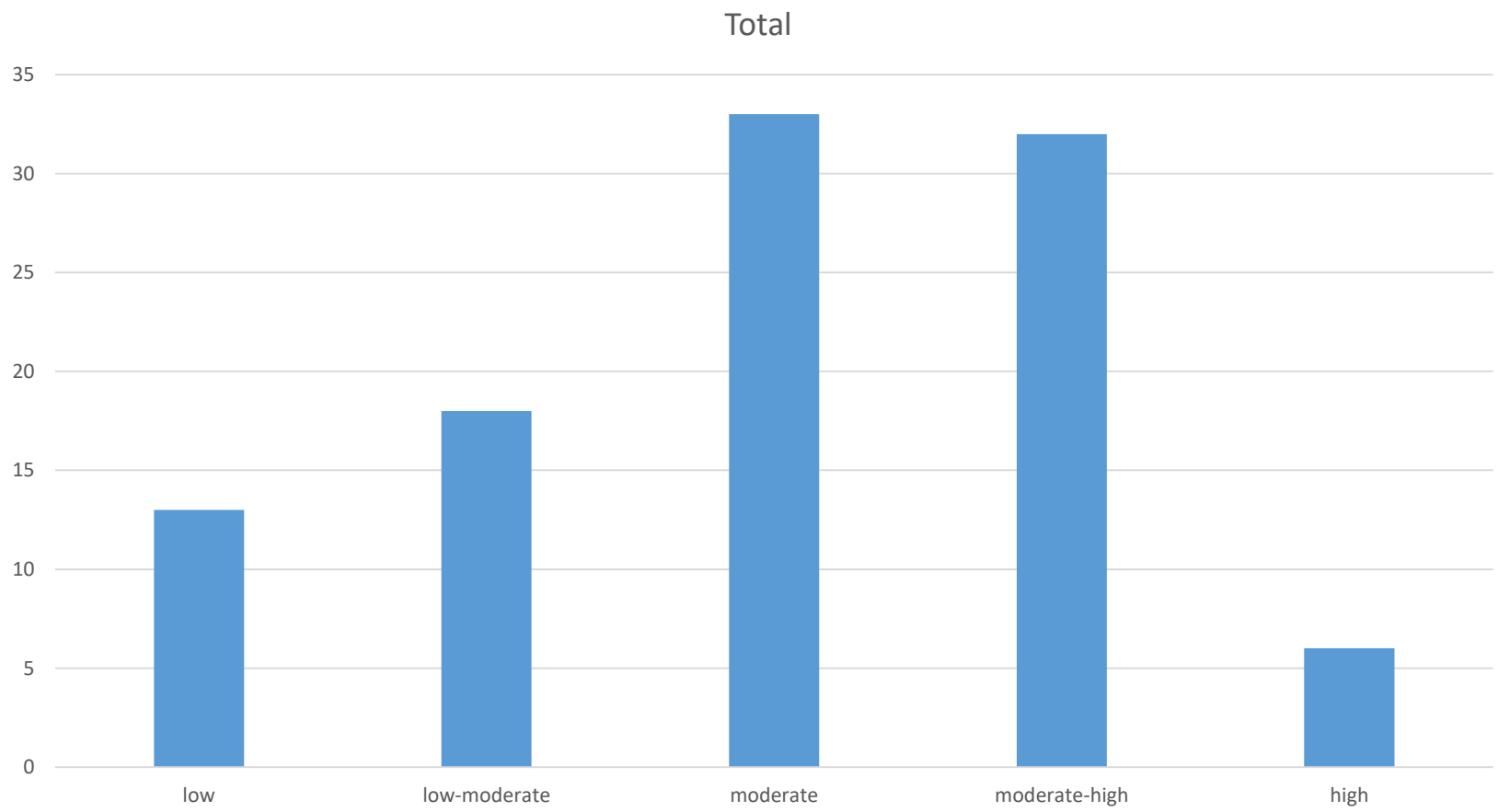
Tree Species Assessed

- 104 Species
  - 59 currently present (Urban FIA)
  - 45 additional species based on expert recommendations
- Canopy, sub-canopy trees native to the Austin region
- Non-native species and many cultivars of trees that are currently present
- Invasive tree species

Vulnerability Matrix

	Adapt Class		
Heat/Hardiness Zone Effect	Low	Medium	High
negative	high	moderate-high	moderate
no effect	moderate-high	low-moderate	low
positive	moderate	low-moderate	low

Number of Species in Each Vulnerability Category-based on natural areas score



Most Vulnerable Species that are common in natural areas

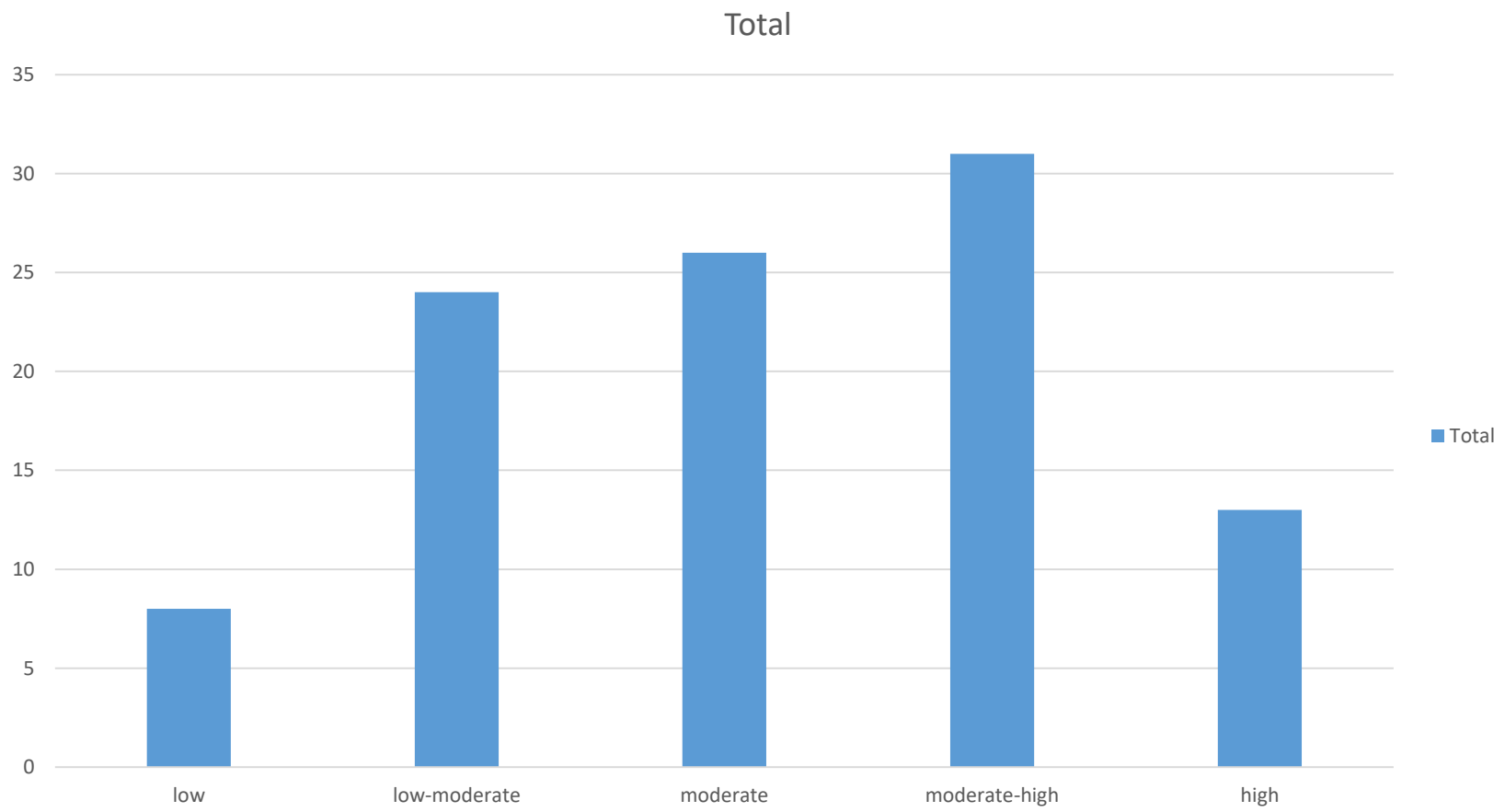
- bastard oak (White shin) (*Quercus sinuata)*
- Buckley oak/Texas red oak (*Quercus buckleyi)*
- cedar elm (*Ulmus crassifolia)*
- Durand oak (*Quercus sinuata var. sinuata)*

Texas red oak

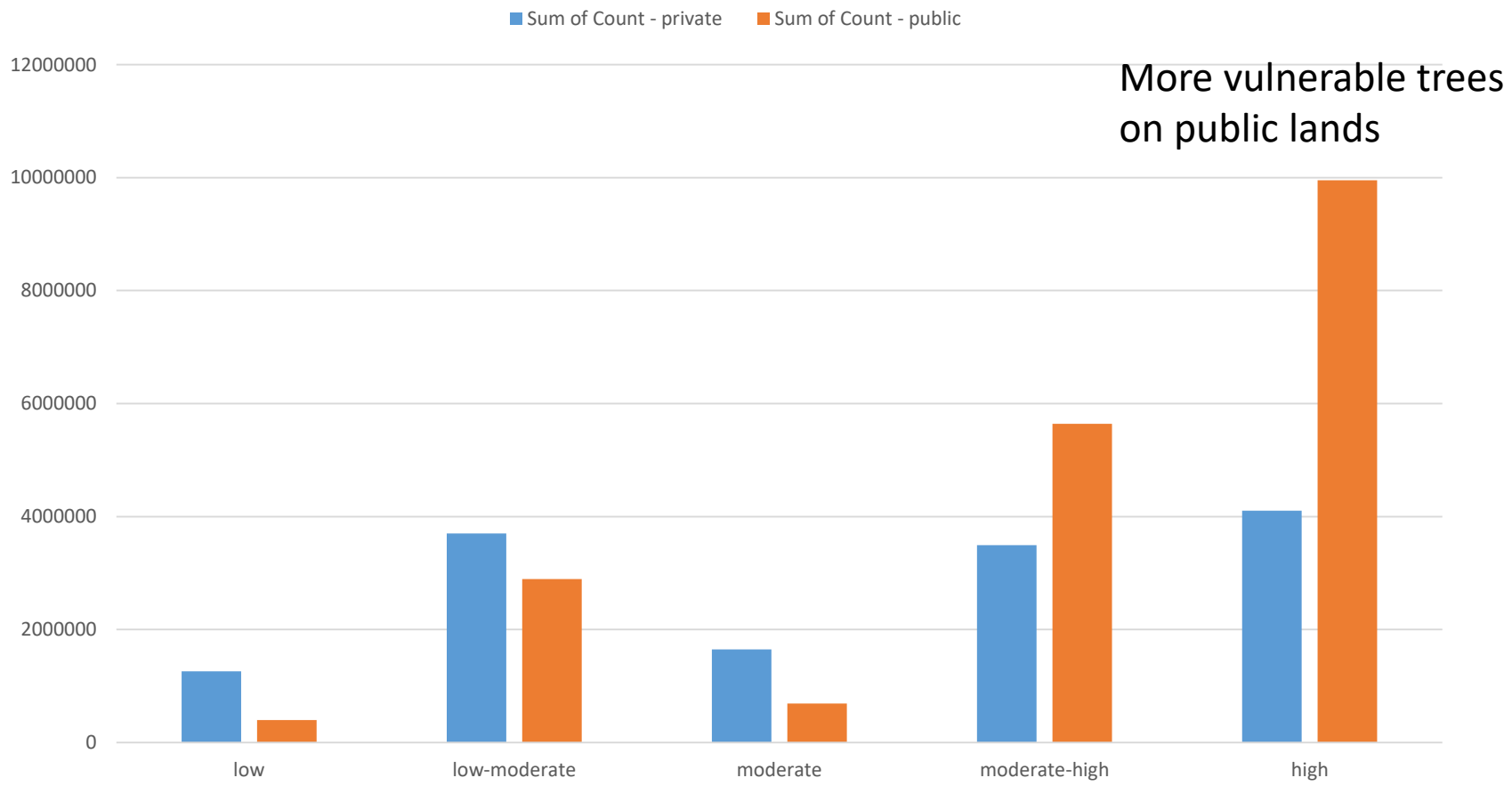
Least Vulnerable Species-Natural areas

- paper mulberry (*Broussonetia papyrifera*)
- Mexican redbud (*Cercis canadensis L. var. Mexicana*)
- Texas persimmon (*Diospyros texana*)
- Japanese privet (*Ligustrum japonicum*)
- Chinese privet (*Ligustrum sinense*)
- chinaberry (*Melia azedarach*)
- Mexican sycamore (*Platanus mexicana*)
- honey mesquite (*Prosopis glandulosa*)
- Fragrant sumac (skunkbush sumac) (*Rhus aromatica*)
- prairie sumac (flameleaf sumac) (*Rhus lanceolata*)
- evergreen sumac (*Rhus virens*)
- Texas Hercules' club (prickly-ash, tickle-tongue) (*Zanthoxylum hirsutum*)
- lotebush (*Ziziphus obtusifolia*)

Number of species in each vulnerability category-developed areas score



Number of Trees (based on urban FIA) in each Vulnerability Category based on developed area score



Vulnerability of Austin's top 20 most common trees

Common Name	Scientific name	Total	Vulnerability-Natural Areas	Vulnerability-Developed Areas
Ashe juniper	*Juniperus ashei*	13315759	moderate	high
cedar elm	*Ulmus crassifolia*	4583201	moderate	moderate-high
live oak (coast live oak)	*Quercus virginiana*	2862523	moderate	moderate
sugarberry	*Celtis laevigata*	2058386	moderate	moderate-high
Texas persimmon	*Diospyros texana*	2014199	low	low-moderate
yaupon	*Ilex vomitoria*	833143	moderate	moderate
green ash	*Fraxinus pensylvanica*	751788	moderate-high	moderate-high
honey mesquite	*Prosopis glandulosa*	655950	low	low-moderate
Texas mountain laurel	*Dermatophyllum secundiflorum*	648060	low-moderate	low
glossy privet	*Ligustrum lucidum*	623890	moderate	moderate
chinaberry	*Melia azedarach*	538729	low	low-moderate
Texas ash	*Fraxinus albicans*	438216	moderate-high	moderate
Texas red oak	*Quercus buckleyi*	419812	high	moderate-high
boxelder	*Acer negundo*	367930	moderate	moderate-high
paper mulberry	*Broussonetia papyrifera*	335755	low	low-moderate
loquat	*Eriobotrya japonica*	312427	moderate	moderate
white shin oak (scalybark oak)	*Quercus sinuata var. breviloba*	243656	moderate-high	high
pecan	*Carya illinoinensis*	196132	moderate-high	high
western soapberry	*Sapindus saponaria* var. drummondii	192371	moderate-high	moderate
Mexican ash (Berlandier ash)	*Fraxinus berlandieriana*	184758	low-moderate	low-moderate

Key Points

- Species at southwestern extent of their ranges are expected to lose habitat
- Species that are heat, drought, and flood-adapted and pest/disease resistant are least vulnerable
- Austin's most common trees represent a range of vulnerability, with some of its native oaks being among the most vulnerable
- Vulnerability of individual species can vary greatly between natural and developed areas

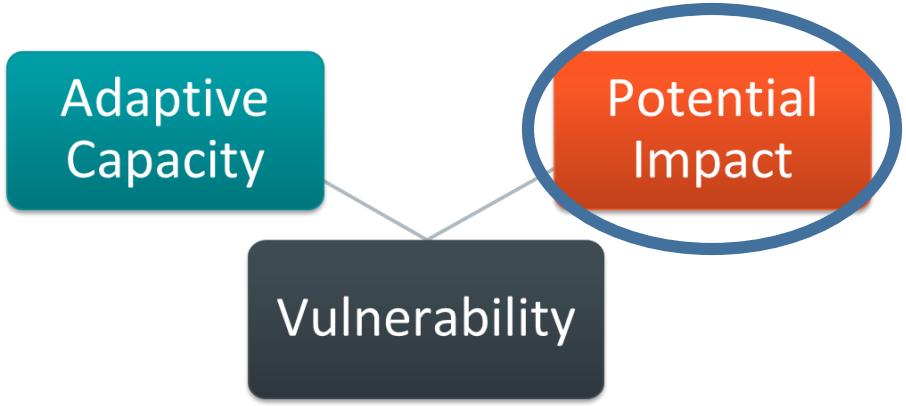
Community/Natural Area Vulnerability Assessment

Vulnerability Assessment Workshop

- June 2019
- 25 participants from the region

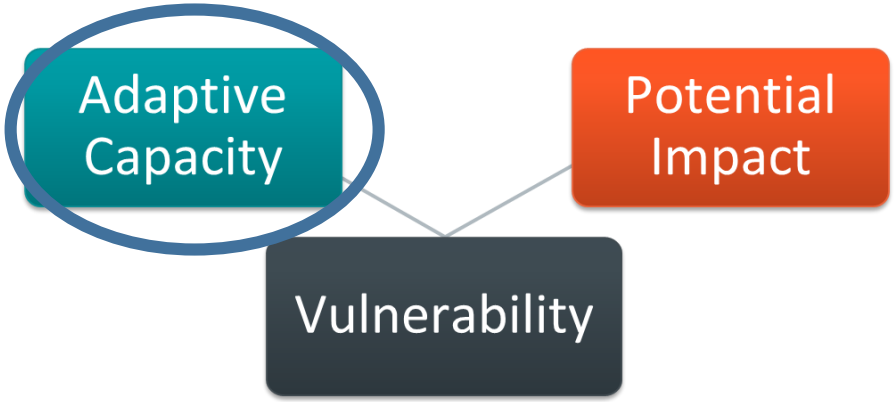
Potential Impacts-Developed Sites

- Direct and indirect climate change effects
- For each ecosystem, how will climate change affect…
  - **Conditions** *(e.g., soil or site conditions, disturbance dynamics)*
  - Dominant/important species
  - Stressors/threats *(e.g., invasive species, pests, diseases, fragmentation)*
  - Interactions



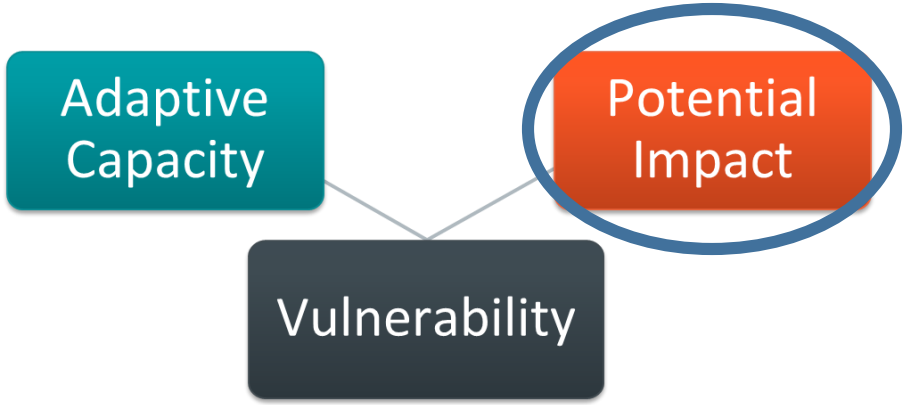
Adaptive Capacity-Developed Sites

- Ability of human-ecological system to cope with changes
- For each forest system, how resilient is it based on…
  - Dominant species response to environmental shifts *(phenotypic plasticity)*
  - Diversity *(e.g., species, functional, genetic)*
  - Response to enhanced disturbances
  - **Social, economic, organizational capacity**



Potential Impacts-Natural Areas

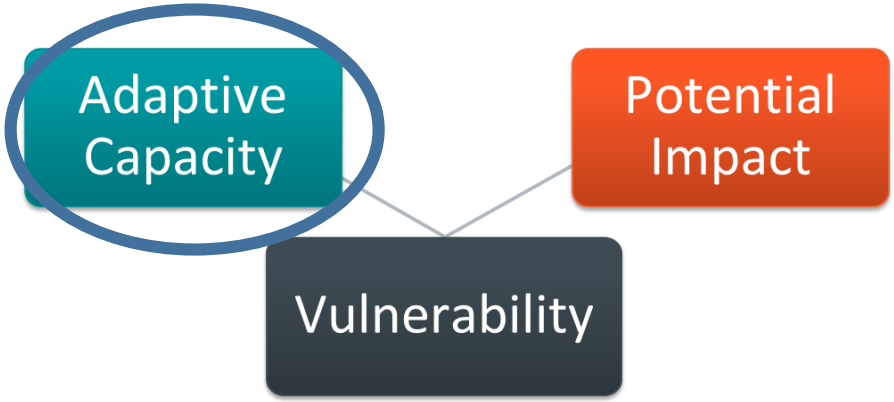
- Direct and indirect climate change effects
- For each ecosystem, how will climate change affect…
  - **Drivers** *(e.g., soil or site conditions, disturbance dynamics)*
  - Dominant/important species
  - Stressors/threats *(e.g., invasive species, pests, diseases, fragmentation)*
  - Interactions



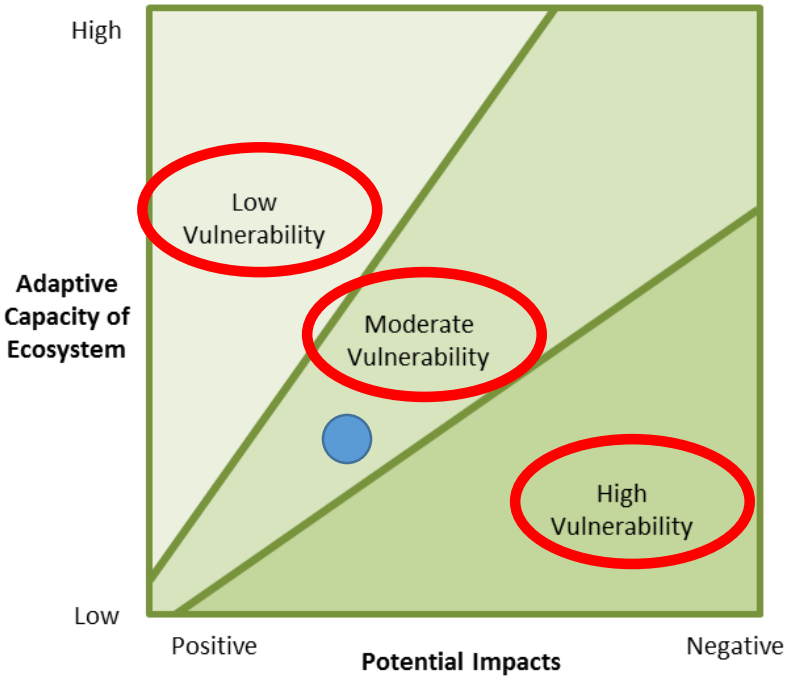
Adaptive Capacity-Natural Areas

- Ability of ecosystem to cope with changes ….not management
- For each forest system, how resilient is it based on…
  - Dominant species response to environmental shifts *(phenotypic plasticity)*
  - Diversity *(e.g., species, functional, genetic)*
  - Response to enhanced disturbances
- Rate adaptive capacity

  (Low↔High)

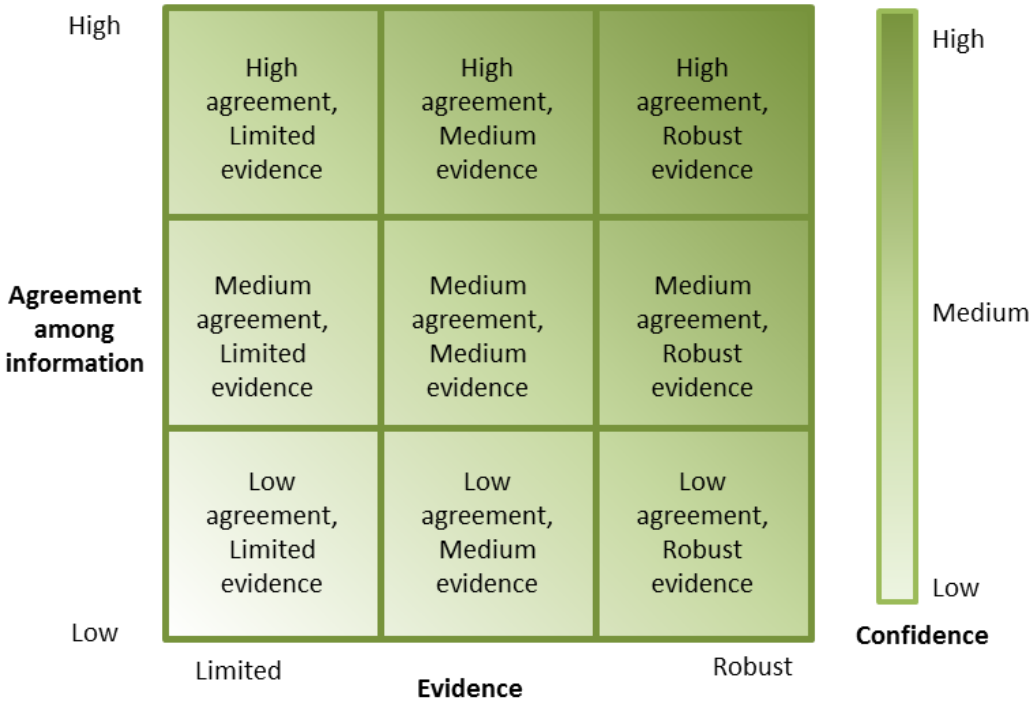


Vulnerability Determination

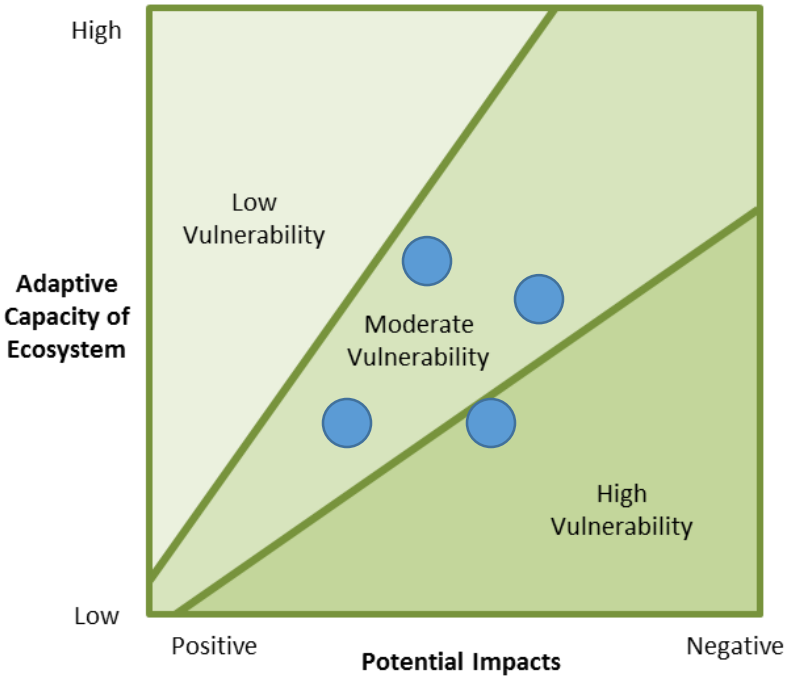


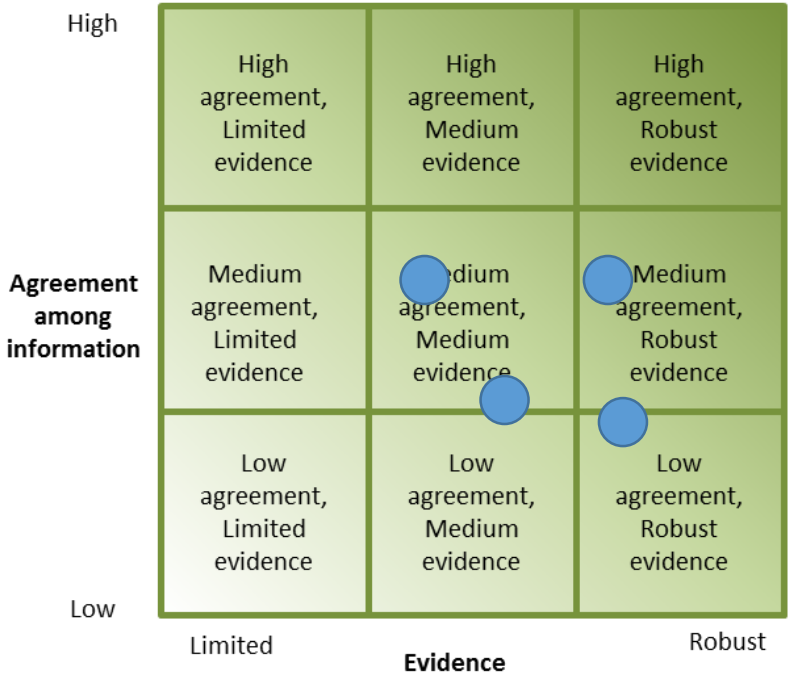
Confidence Determination

Consider **evidence** and **agreement** to rate your level of **confidence** in that vulnerability rating (individually)



Vulnerability Determination





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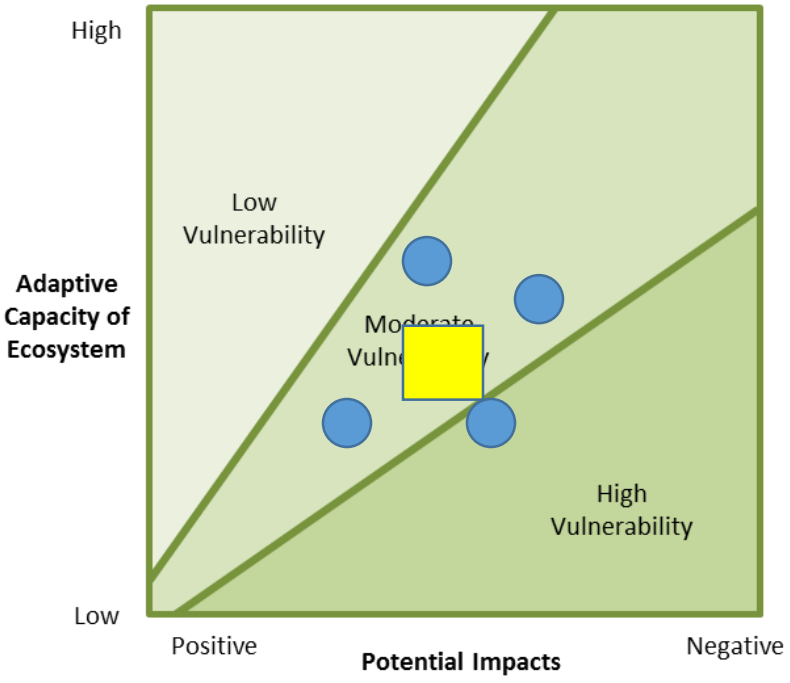
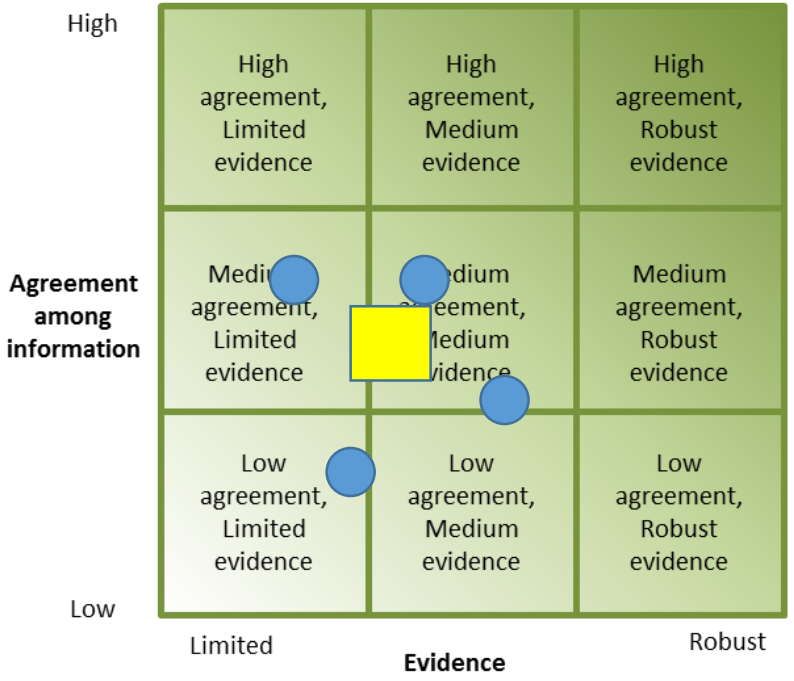


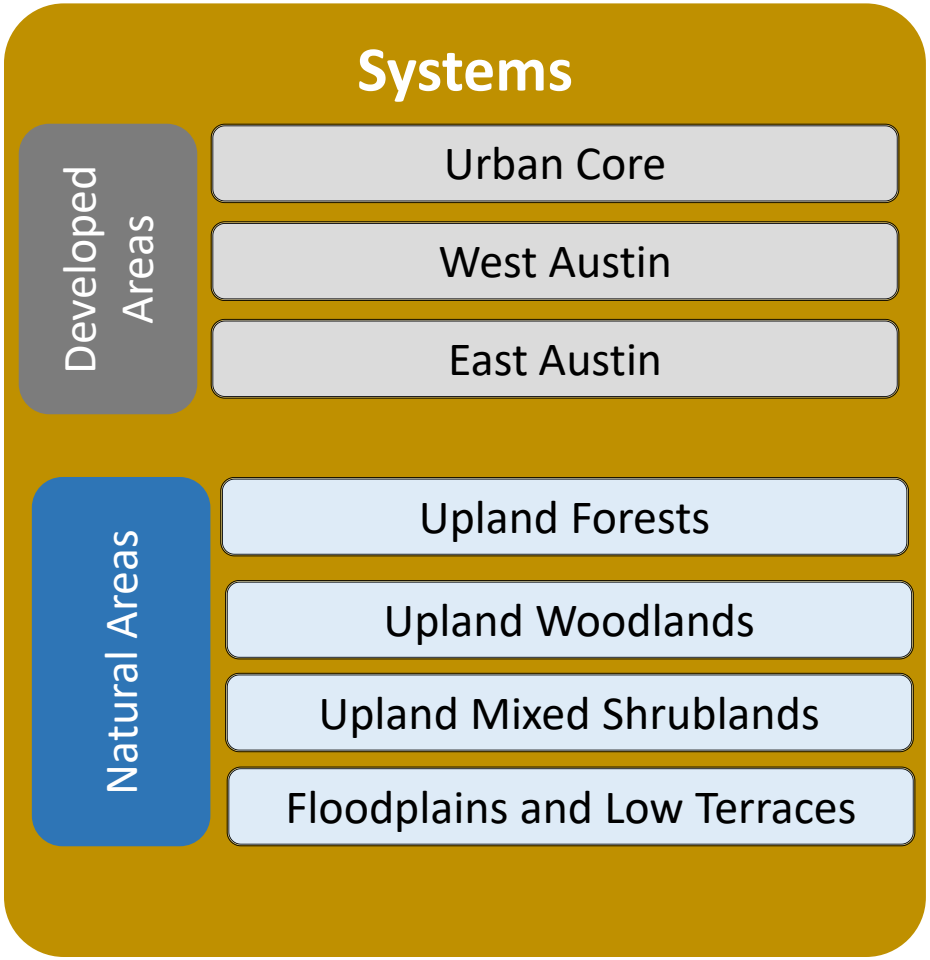


Systems We Considered

For each, considered current:

- Drivers
- Dominant/important species
- Stressors and threats
- Adaptive capacity

Then considered likely changes over the next 80 years

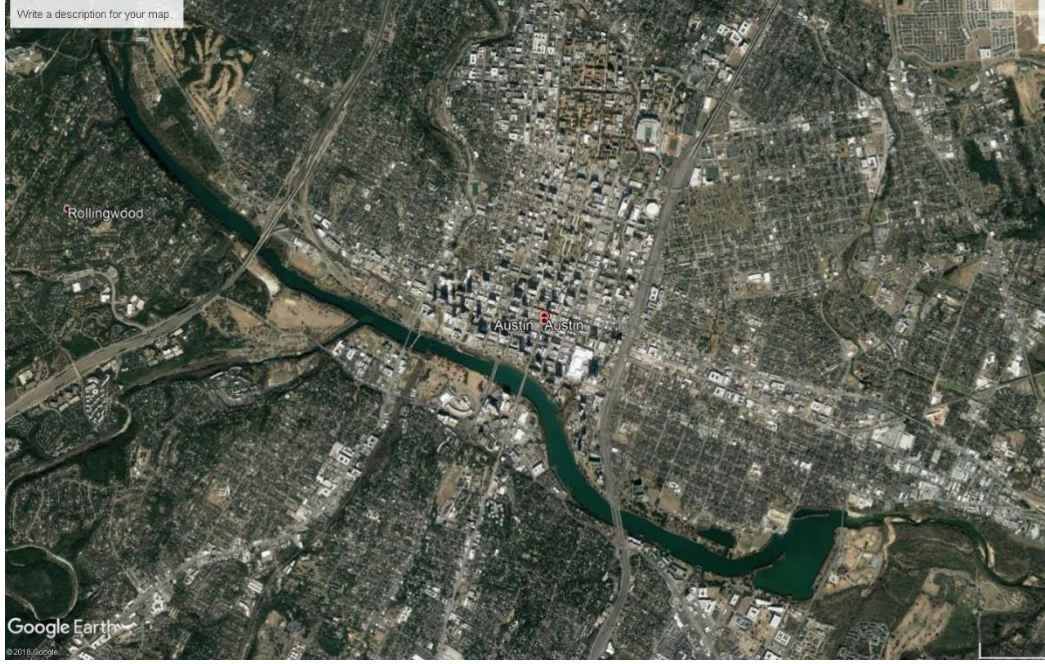


Summary of Vulnerability for Austin's regions and natural areas

	Developed or Natural Area	Impacts	Adaptive Capacity	Vulnerability	Evidence	Agreement
Developed	**Urban Core**	Moderately disruptive	Moderate	Moderate-High	Medium	Medium
	West Austin	Moderate	Moderate	Moderate	Medium	Medium
	East Austin	Moderate	Moderate-High	Moderate	Medium	Medium
Natural Areas	**Floodplains and Terraces**	Moderately disruptive	Moderate-High	Moderate	Medium	Medium-High
	Upland Mixed Shrubland	Moderately disruptive	Low-moderate	Moderate-High	Medium	Low
	Upland Woodland and Savanna	Moderate	Moderate	Moderate	Limited-Medium	Low-Medium
	Upland Forest	Moderately disruptive	Moderate	Moderate-High	Medium	Low

Urban Core: Moderate-High Vulnerability

Downtown and University of Texas



Key Characteristics

- Low canopy cover
- High impervious surface
- High development
- High population density

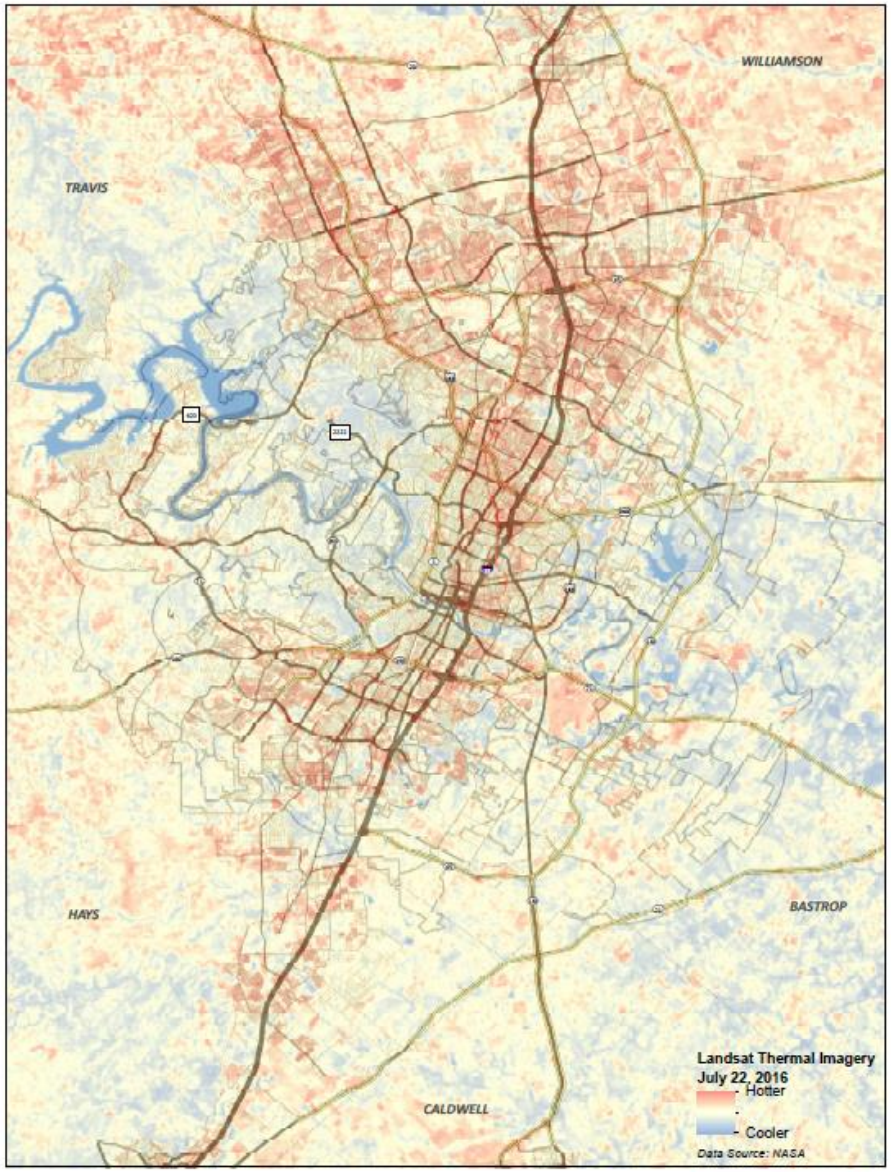
Dominant/Important Species

- Vulnerable: pecan, eastern cottonwood, post oak, American sycamore, Texas red (Buckley) oak, cedar elm, and green ash.
- Adaptable:Texas mountain laurel and Mexican white oak.

Key Stressors

- Urban heat island
- Stormwater runoff/localized flooding
- Air pollution
- Development
- Restricted rooting conditions

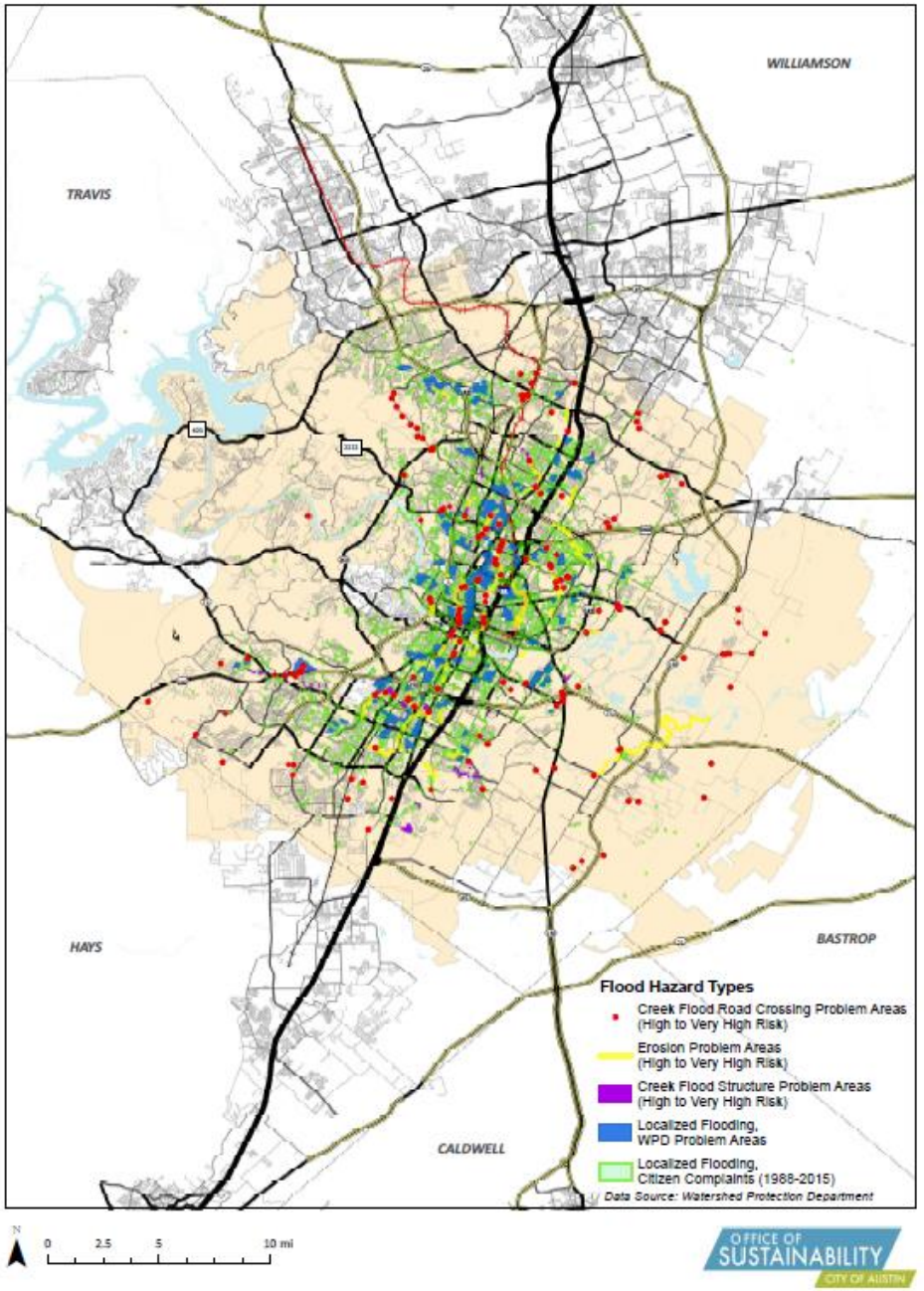
Urban Heat Island



Urban Heat Island

Climate Resilience Plan: Vulnerability Assessment
City of Austin, Printed January 6, 2017

Localized Flooding



Localized Flood Hazards

Climate Resilience Plan: Vulnerability Assessment

City of Austin, Printed January 6, 2017

West Austin: Moderate Vulnerability

Low-medium density developed areas west of mopac/ on Edwards plateau

Key Characteristics

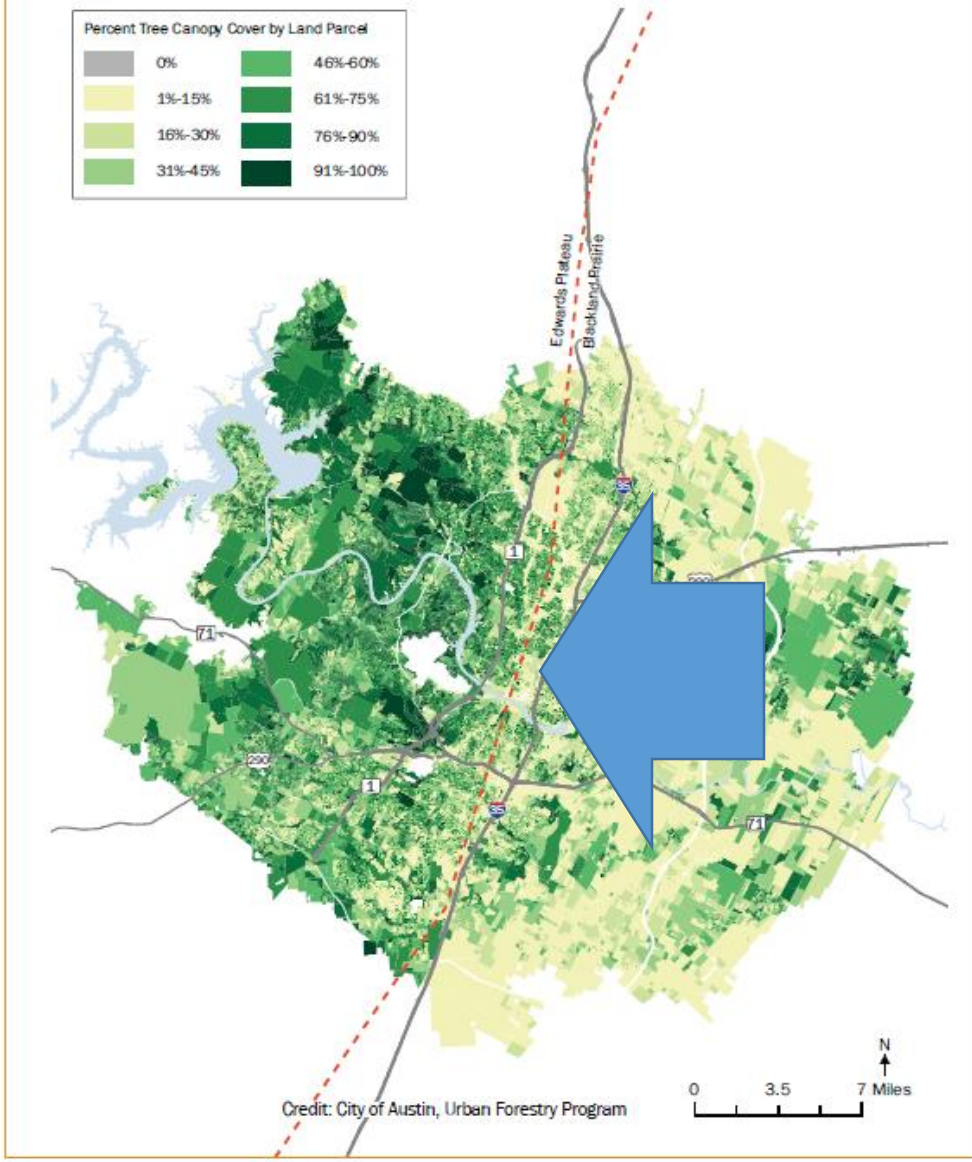
- Higher canopy cover
- Some impervious surface
- Low-medium development
- Medium population density

Dominant/Important Species

- Ashe juniper is the most dominant species in West Austin and is considered to be moderately vulnerable.
- Moderate-high vulnerability: Pecan, Cedar elm, velvet ash, southern magnolia, and Mexican plum.
- Adaptable: yaupon, Eve's necklace, Mexican white oak, and Texas mountain laurel.

Key Stressors

- Development
- Herbivory/wildlife
- Wildland-urban interface



East Austin: Moderate Vulnerability

Low-medium density developed areas east of Mopac/ on Blackland prairie

Key Characteristics

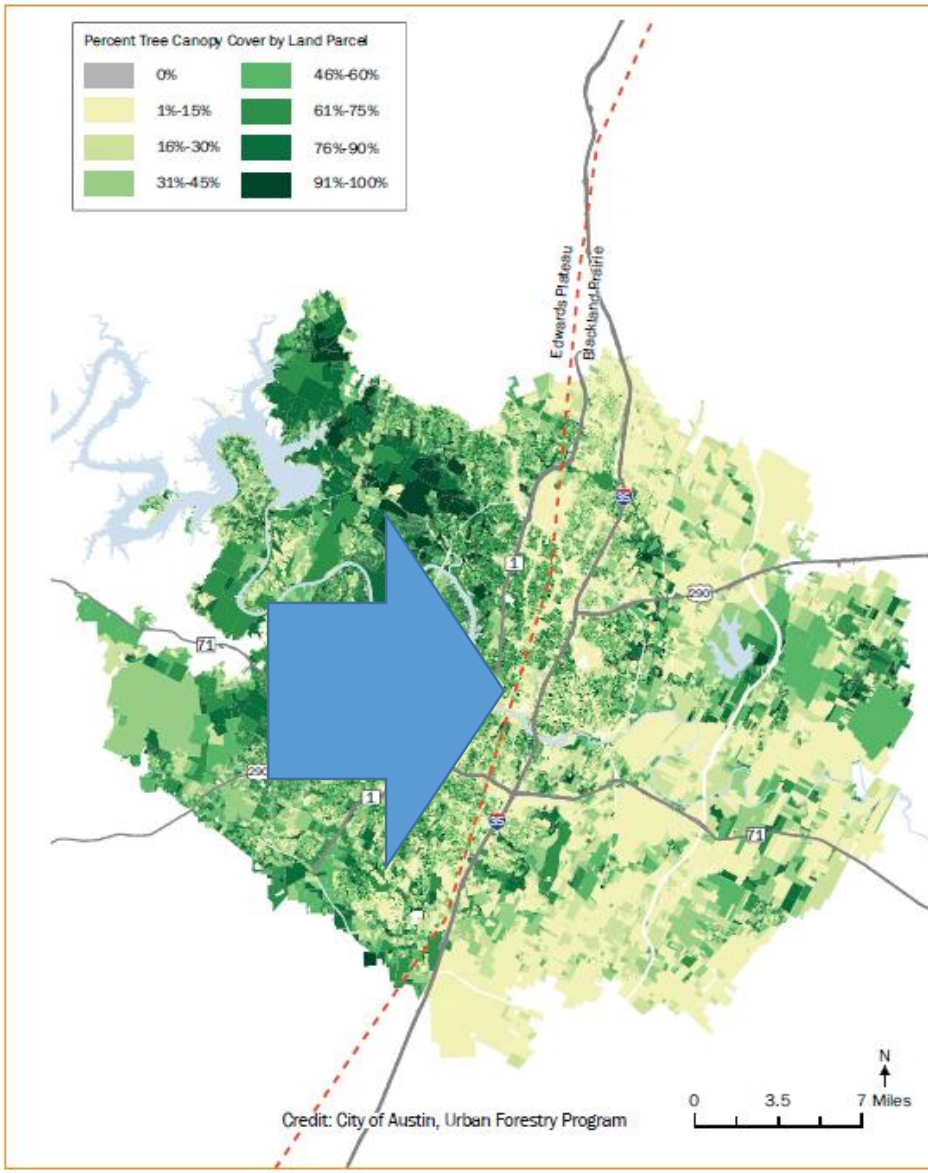
- Lower canopy cover
- Some impervious surface
- Low-medium development
- Medium population density

Dominant/Important Species

- Vulnerable: pecan, black walnut, eastern cottonwood, post oak, and black willow.
- Adaptable: live oak, yaupon, Mexican white oak, texas mountain laurel, Jerusalem thorn (retama), Texas persimmon, and Mexican sycamore.

Key Stressors

- Urban heat island
- Stormwater runoff/localized flooding
- Air pollution
- Development
- Restricted rooting conditions



Upland Forests: Moderate-High Vulnerability

More closed-canopy areas within the Edwards Plateau/Balcones Canyonlands

Drivers

- Closed canopy
- Fire resistant
- Mesic conditions
- Topographic relief

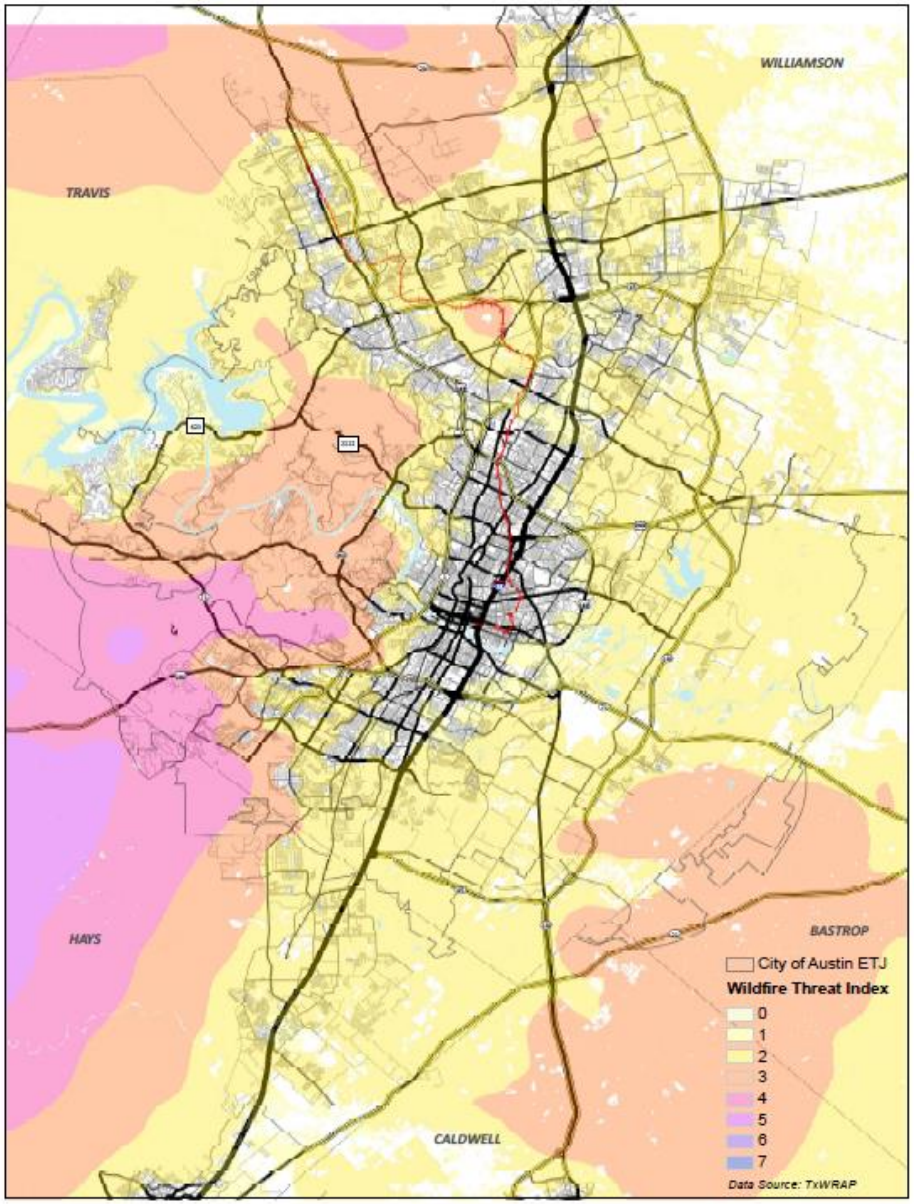
Dominant/Important Species

- Vulnerable: Texas red (Buckley) oak, white shin oak, Arizona walnut, cedar elm, and Mexican plum.
- Adaptable: evergreen and fragrant sumac, Texas persimmon, Texas madrone, and Texas mountain laurel.

Key stressors

- Wildfire
- Drought
- Oak wilt
- Invasive plants

Wildfire Hazards



Wildfire Hazard Zones

Climate Resilience Plan: Vulnerability Assessment
City of Austin, Printed January 6, 2017

Wildland-Urban Interface

http://silvis.forest.wisc.edu/data/wui-change/

Upland Woodland and Savanna: Moderate Vulnerability

Moderate canopy cover with herbaceous and graminoid layer.

Drivers

- Fire-adapted
- Topographic relief in some areas
- Dry-mesic

Dominant/Important Species

- More vulnerable: cedar elm and sugarberry.
- Adaptable: include yaupon, fragrant and evergreen sumac, Texas persimmon, honey mesquite, catclaw mimosa, and Texas mountain laurel.

Stressors

- Wildfire suppression
- Overgrazing
- Drought
- Oak wilt

Upland Mixed Shrubland: Moderate-High Vulnerability

Shrub-dominated systems within the Edwards Plateau and Blackland Prairie

Drivers

- Xeric sites and shallow soils
- Grassland-woodland transition
- Fire-driven

Dominant/Important Species

- Adaptable: prairie flameleaf and evergreen sumac, lotebush, honey mesquite, Texas persimmon, Texas mountain-laurel, Lindheimer silktassel, and catclaw acacia.
- Moderate-high vulnerability : Ashe juniper, escarpment live oak and white shin oak; Texas kidneywood, Texas redbud, and Mexican buckeye are considered less drought-tolerant.

Stressors

- Overgrazing
- Wildfire suppression
- Feral hogs

Floodplains and Terraces: Moderate Vulnerability

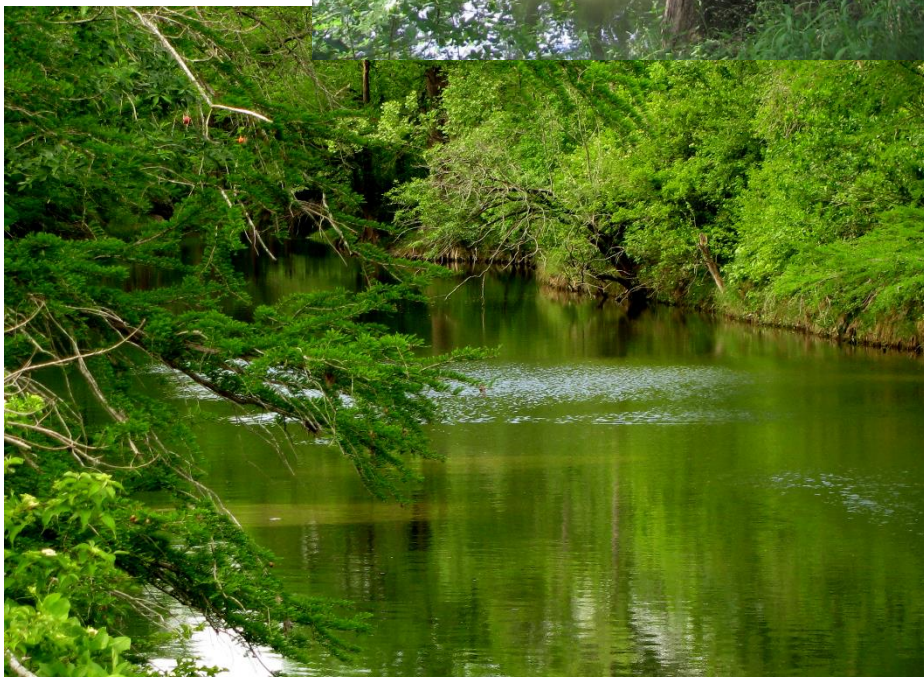
Forested floodplain and riparian areas within the Blackland Prairie and Edwards Plateau ecoregions.

Drivers

- Flooding
- Erosional processes

Dominant/Important Species

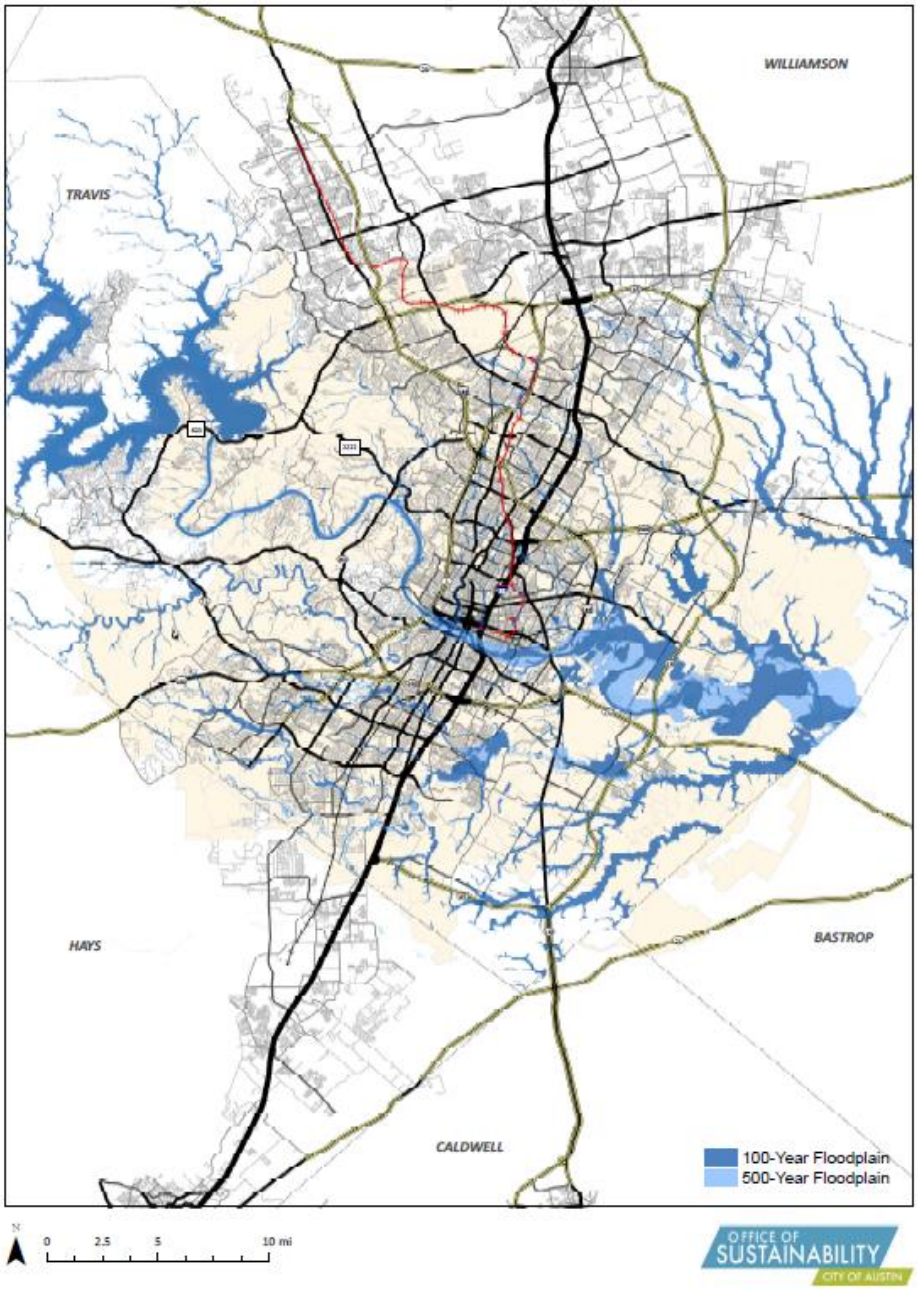
- Vulnerable: sugarberry, possumhaw, Chinese tallowtree, boxelder, American elm, black willow, green ash, American sycamore, eastern cottonwood, and western soapberry.
- Adaptable desert willow, yaupon, and the invasive Chinaberry.



Stressors

- Emerald ash borer
- Changes in flood regime
- Water use/withdrawal
- Invasive species
- Development

Flood Risks



FEMA Floodplains

Climate Resilience Plan: Vulnerability Assessment
City of Austin, Printed January 6, 2017

Activity: What Climate Impacts are you seeing?

- We will pass out large sticky notes
- Write down the one biggest climate change impact you've observed in your work or personal life here in Austin
- When ready, place up on the wall

Adapting to Climate Change

Leslie Brandt

Northern Institute of Applied Climate Science

Adaptation

Adaptation is the adjustment of human or natural systems in response to climate change.




Parry et al. 2007, SCBD 2009, Groves et al. 2010

Adaptation

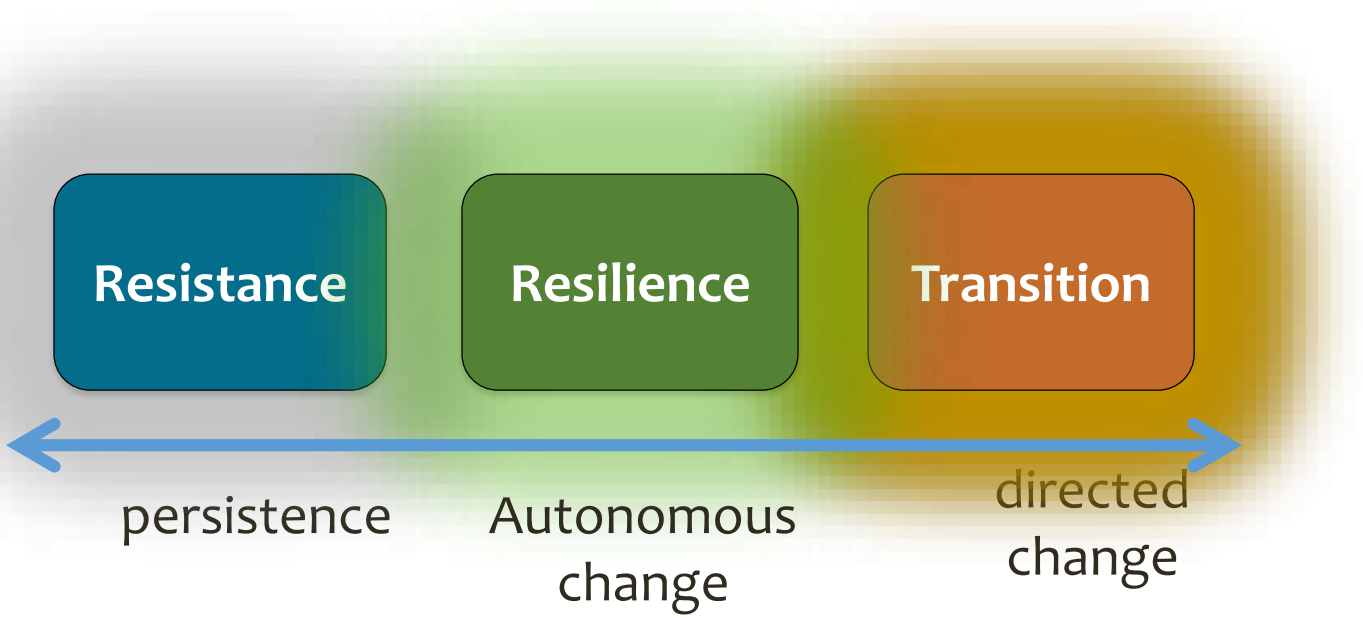
Adaptation is the adjustment of human or natural systems in response to climate change.




Adaptation activities can build on sustainable management, conservation, and restoration

Parry et al. 2007, SCBD 2009, Groves et al. 2010

Adaptation Options



See: Millar et al. 2007, Fisichelli et al. 2016

Adaptation Option #1: Resistance

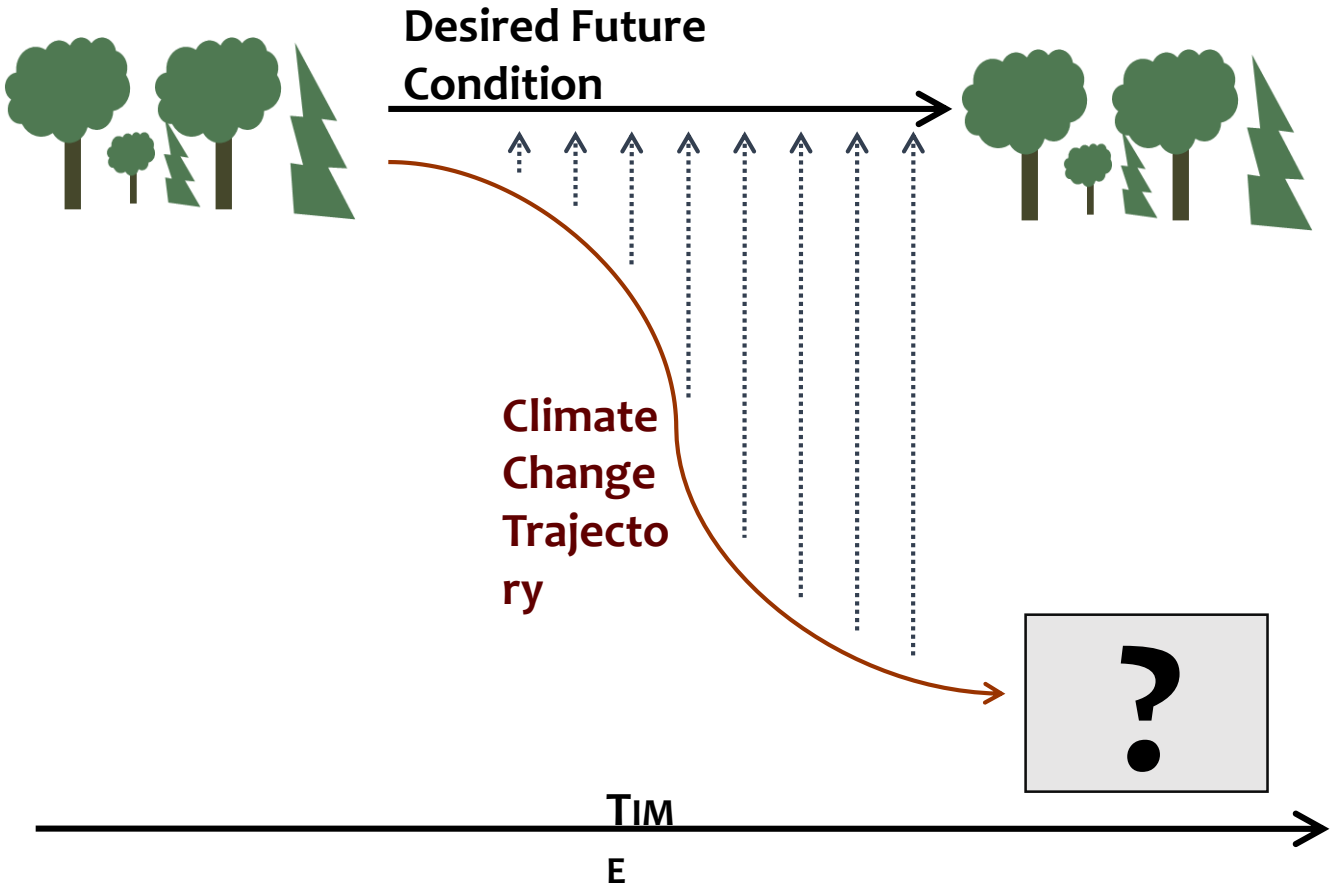
Improve the defenses against effects of change.

- Short-term
- High-value

Photo: USFS

Millar et al. 2007

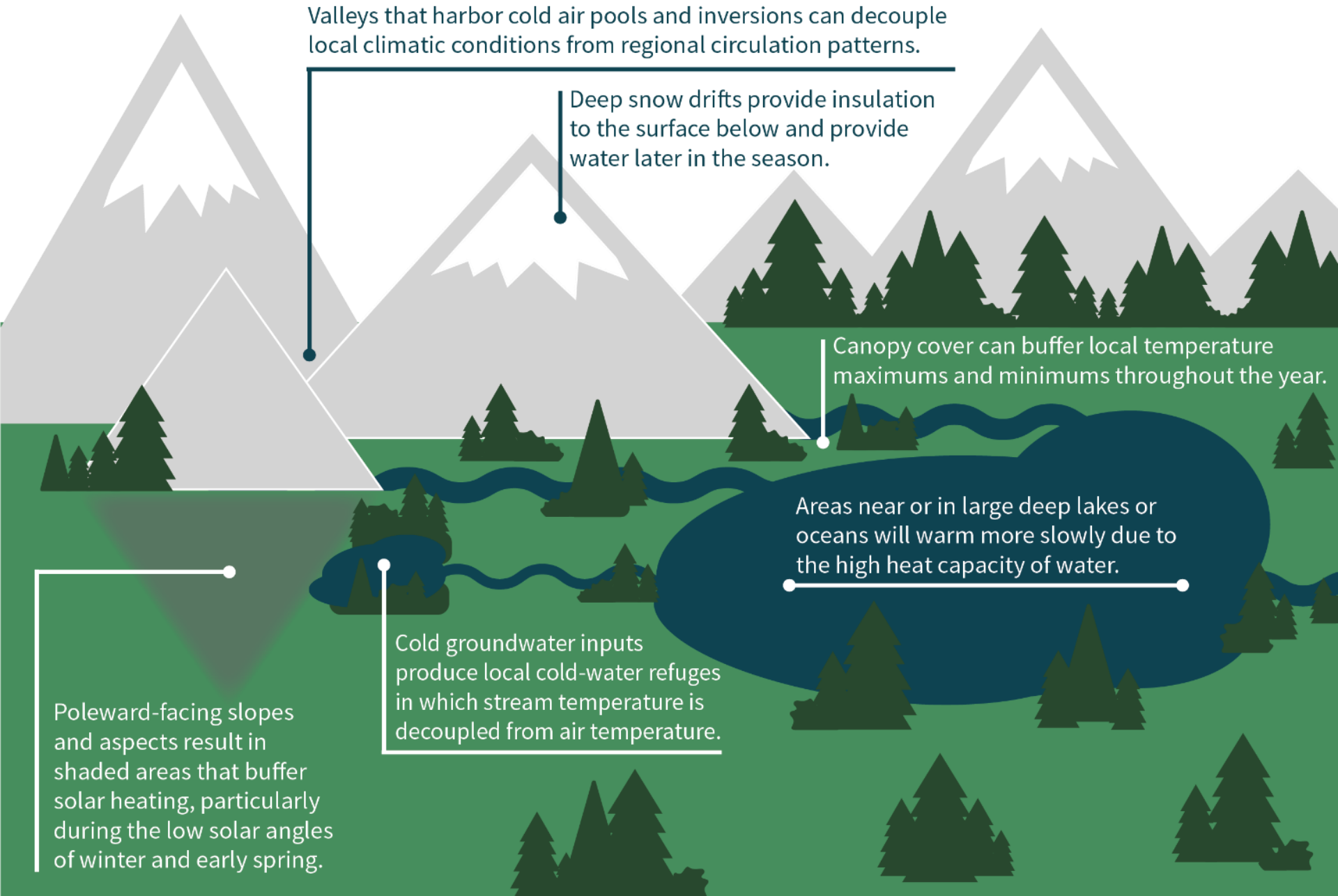
Adaptation Option #1: Resistance



Use structures to control flooding


Remove or
prevent the spread
of invasive species

Protect at-risk species and sites (e.g., identify refugia)



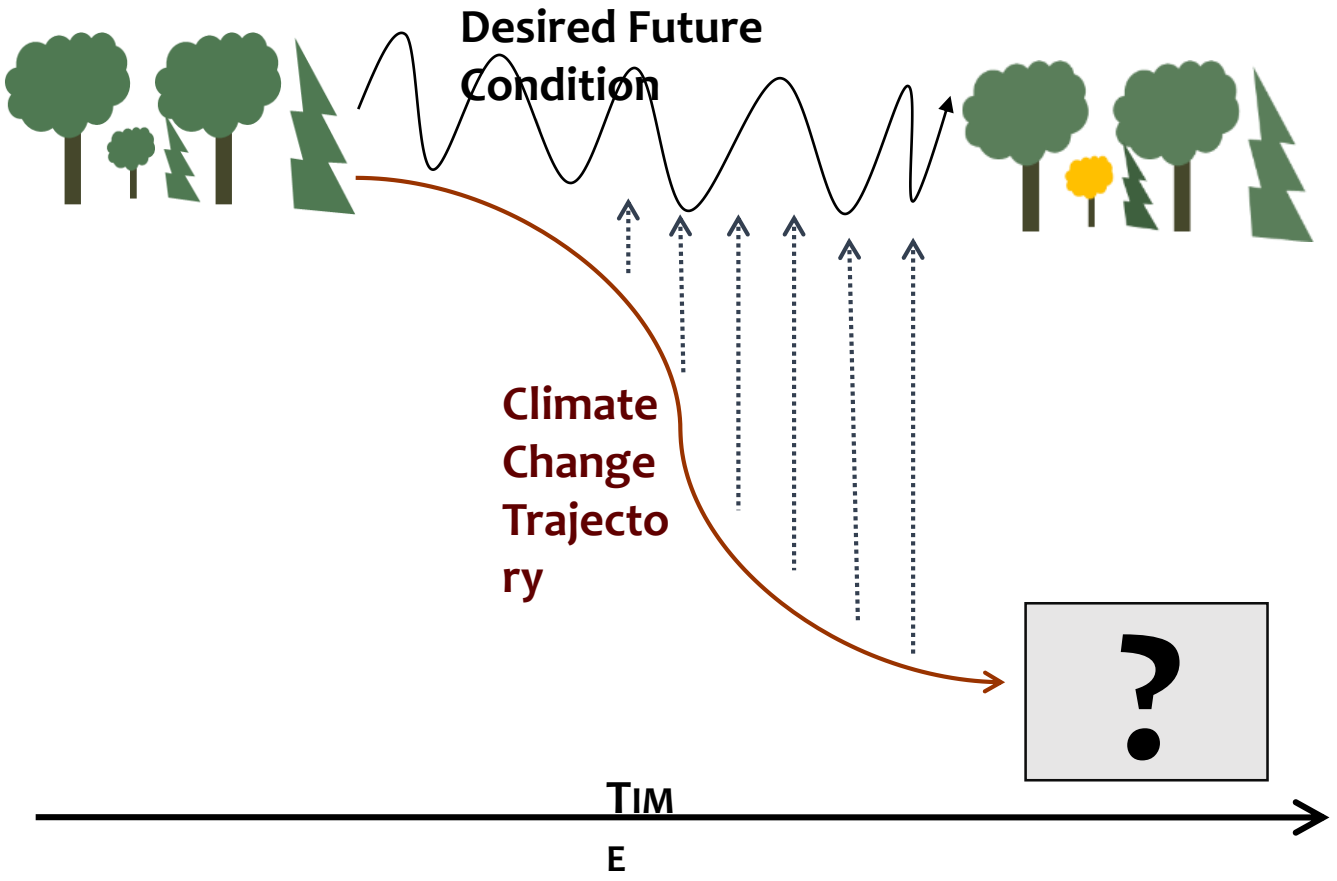
Adaptation Option #2: Resilience

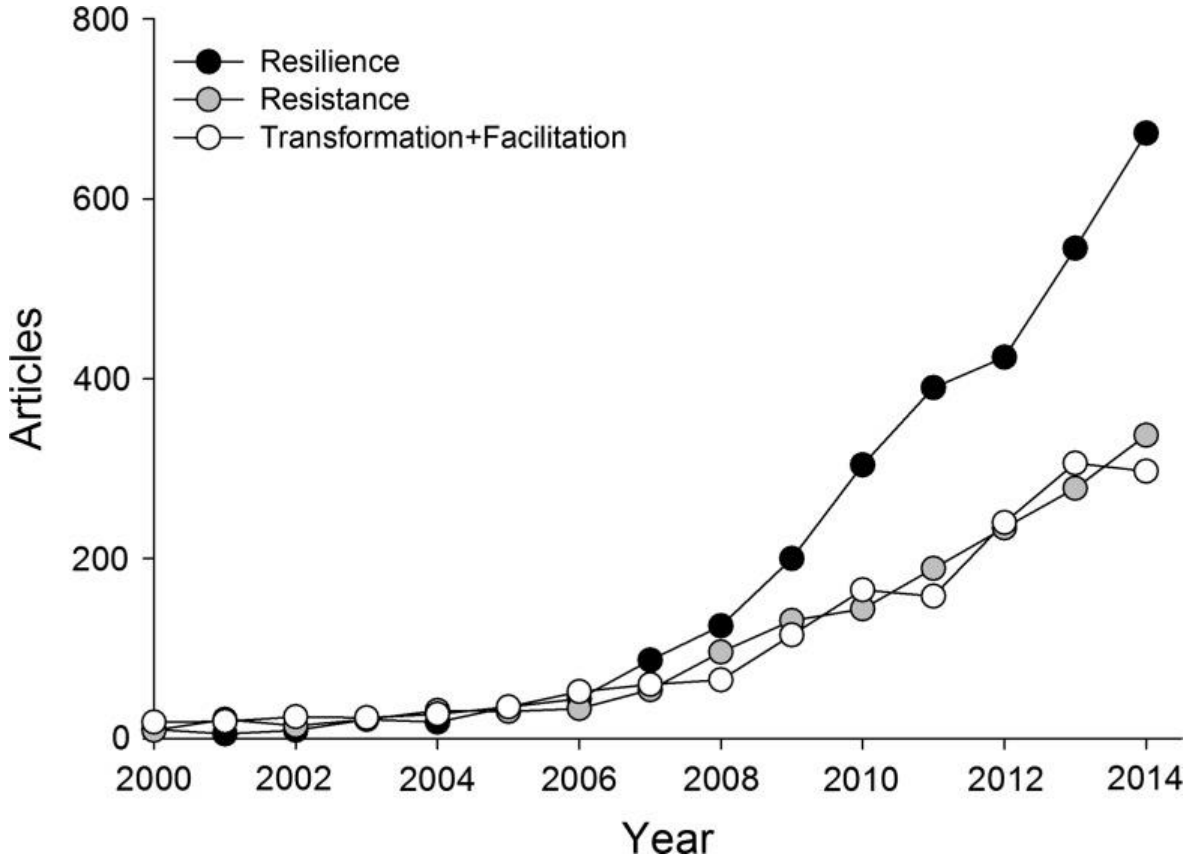
Accommodate gradual change, usually returning to a prior condition after disturbance

Photo: USFS

Millar et al. 2007

Adaptation Option #2: Resilience



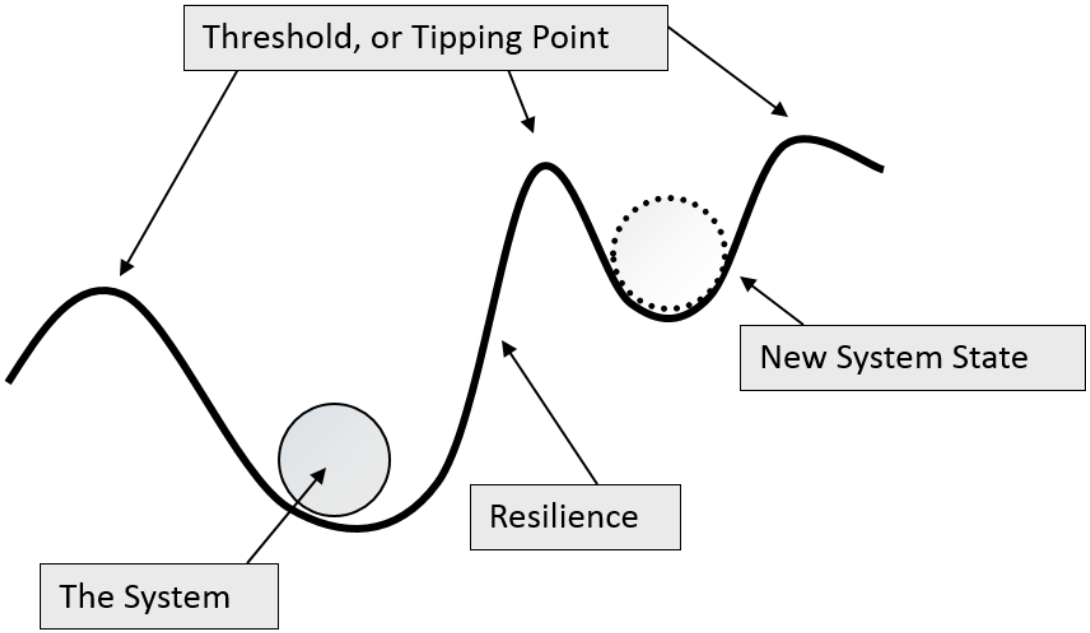


Resilience is trendy, but what does it mean?

Fisichelli et al. 2016. Is 'Resilience' Maladaptive? Towards an Accurate Lexicon for Climate Chan

What does resilience mean?

- ability of a system to maintain or return to a particular ecological state following a disturbance (e.g., Holling 1973, Griffith et al. 2009)




Restoring disturbance-adapted ecosystems

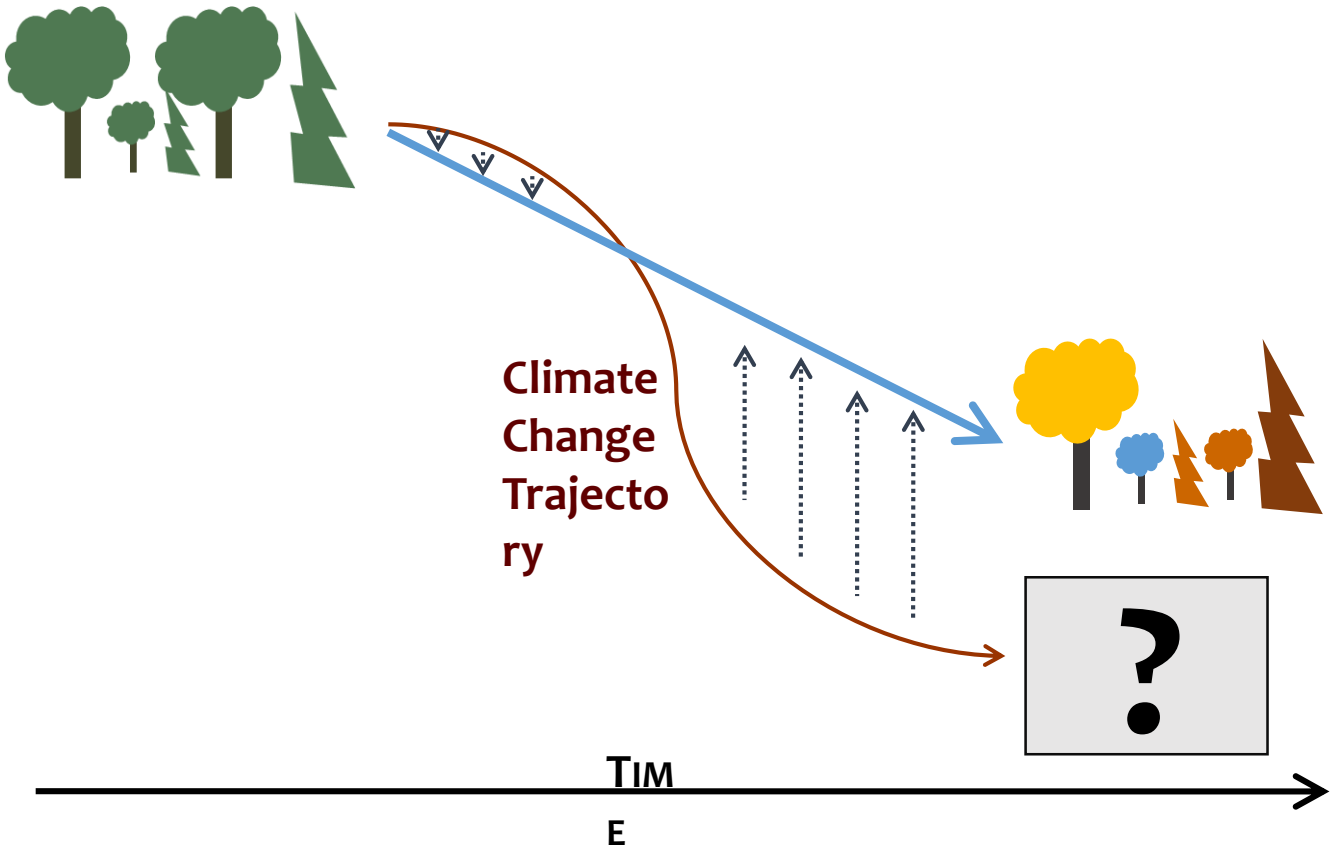

Increasing species and genetic diversity

Adaptation Option #3: Transition

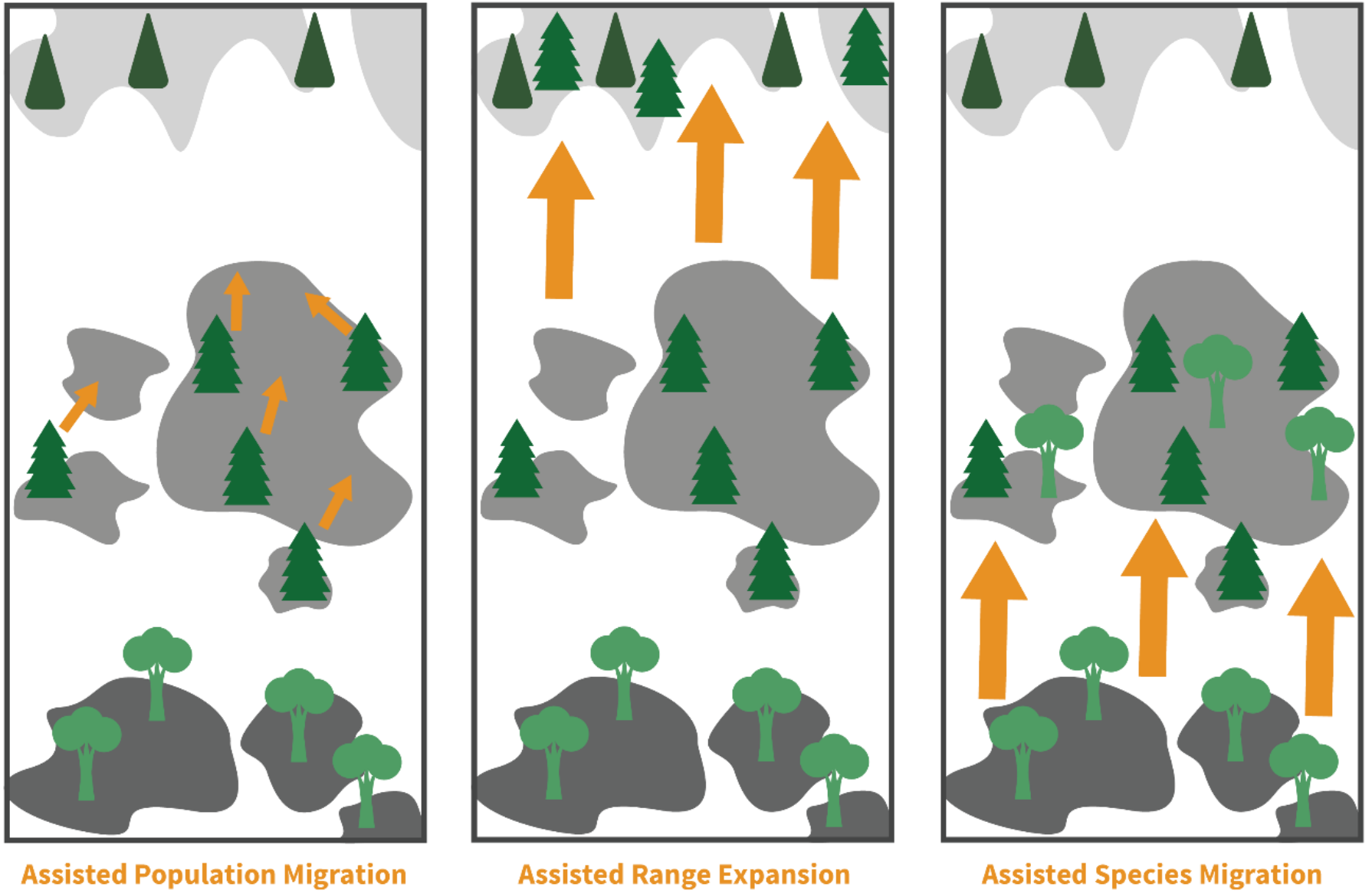
Intentionally encourage change, help ecosystems/communities respond in a targeted fashion

Millar et al. 2007

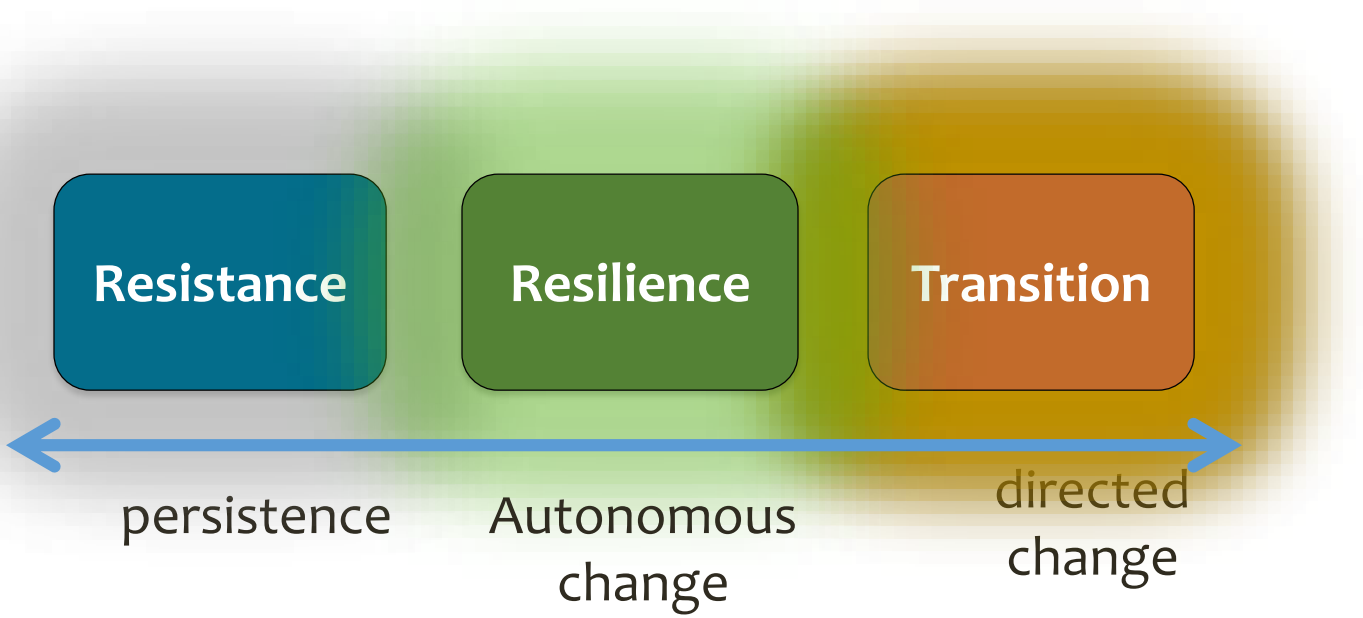
Adaptation Option #3: Transition



Assisted migration

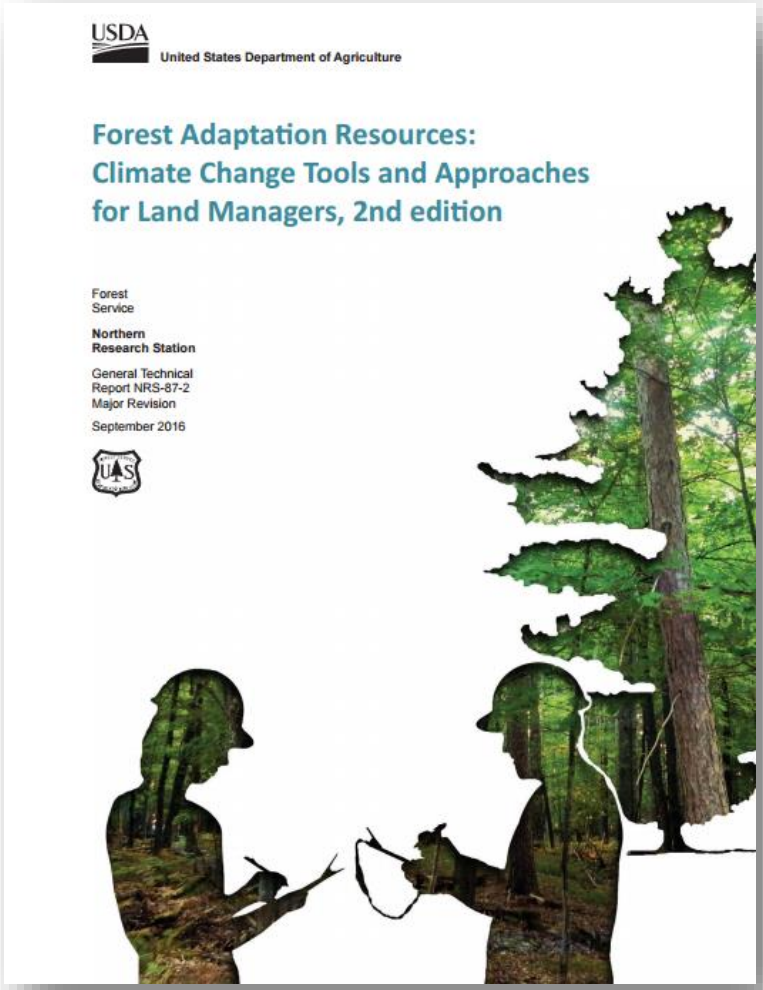


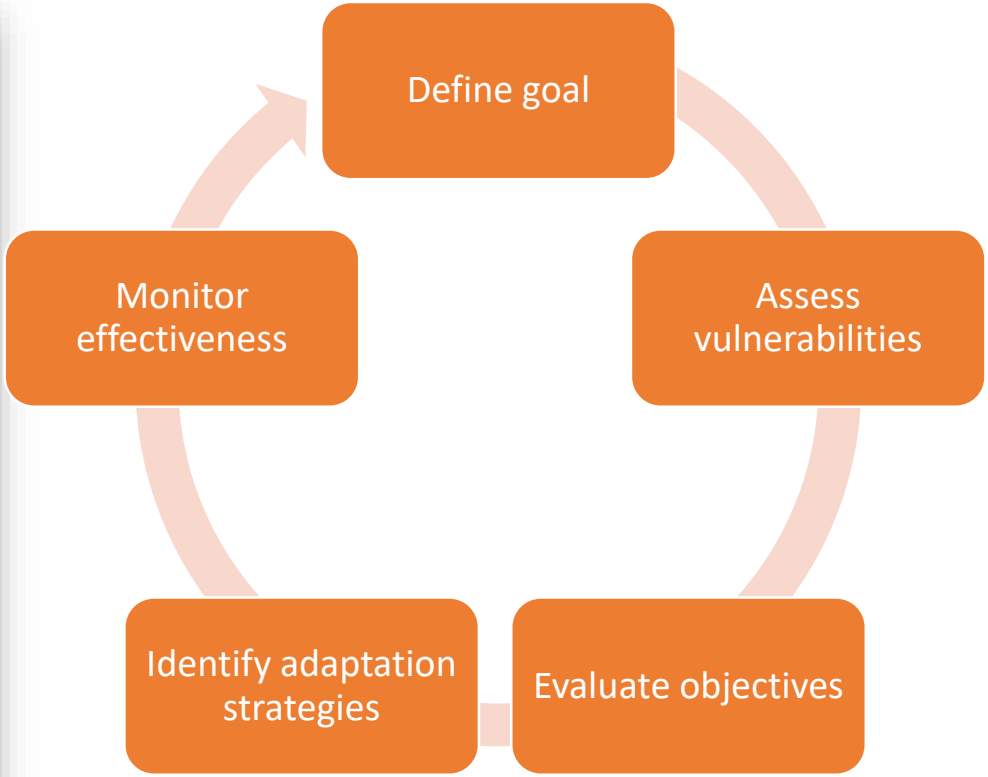
Adaptation Options



See: Millar et al. 2007, Fisichelli et al. 2016

Forest Adaptation Resources





www.fs.fed.us/nrs/pubs/gtr/gtr_nrs87-2.pdf

Urban Forestry Adaptation Menu

"**Urban**" sites: yard trees, parks, cemeteries, school grounds, corporate campuses, and unmanaged green spaces

"**Natural**" areas such as forest preserves and larger urban parks

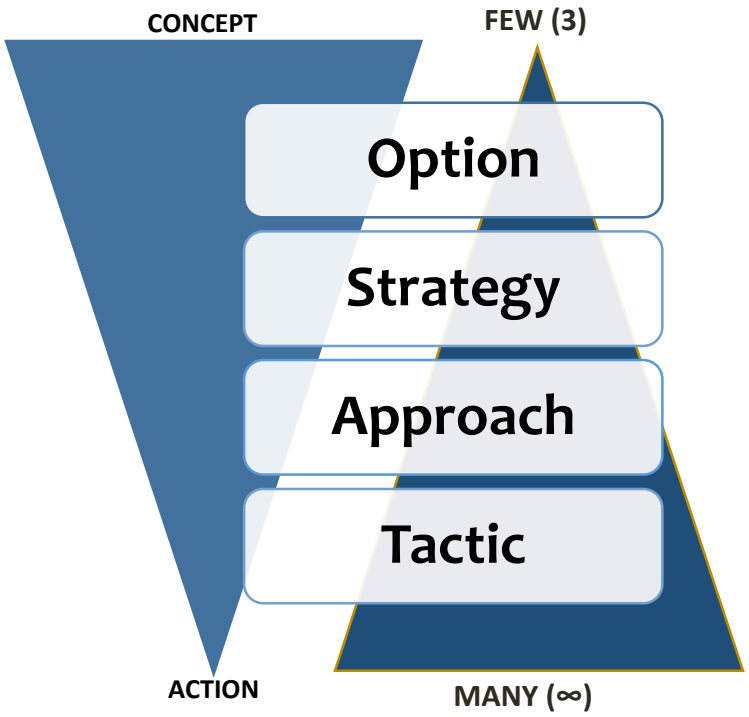
Urban Forests menu contains:

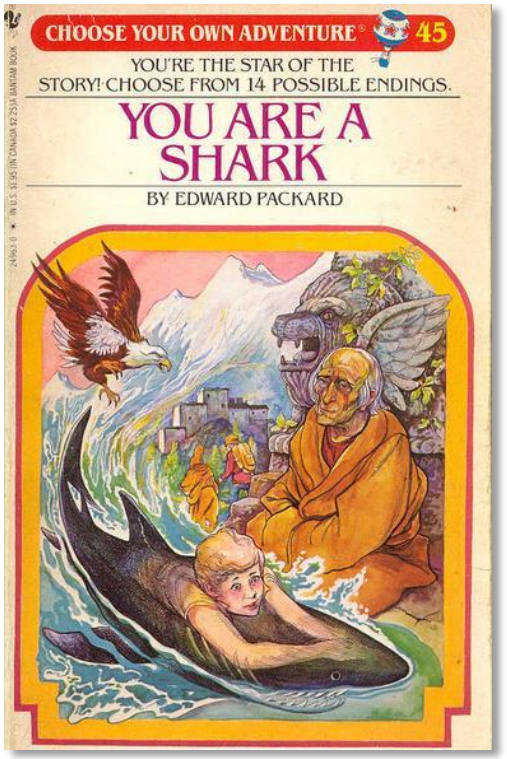
10 STRATEGIES

35 APPROACHES

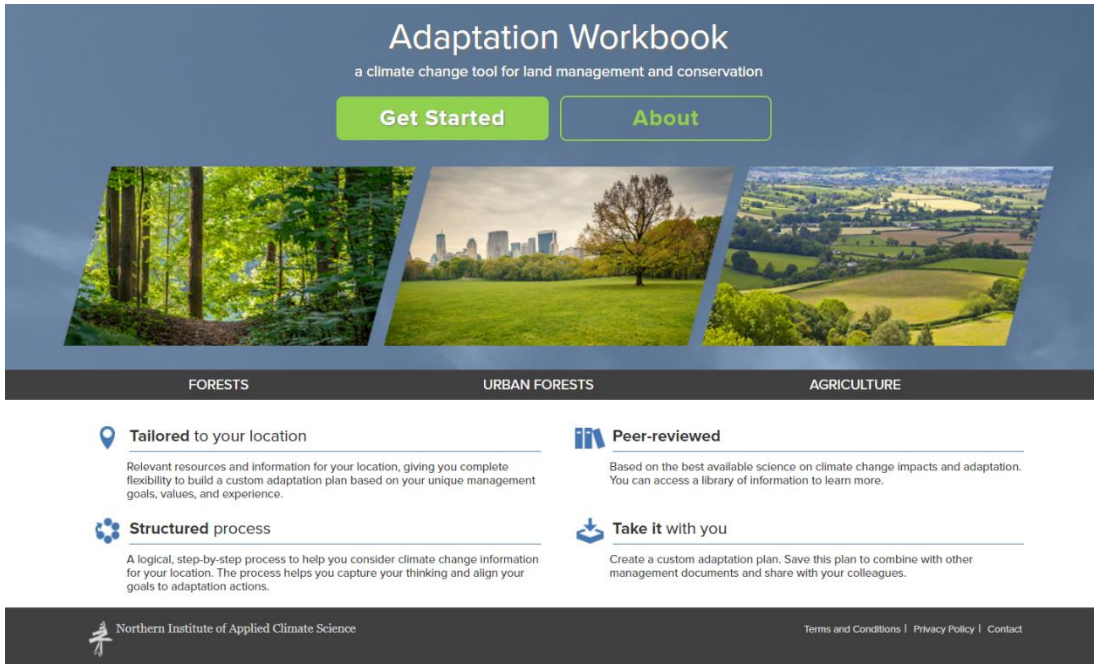
INFINITE TACTICS

Adaptation Strategies and Approaches





Online Workbook



Adaptationworkbook.org

onstration Projects | × Adaptation Workbook | ×

Secure | https://adaptationworkbook.org/niacs-project-dashboard

shboard Content Structure Appearance People Modules Configuration Reports Help 0 / 3 Hello Ib

Details

Name Nursery selection

Description project to expand selection of nursery trees

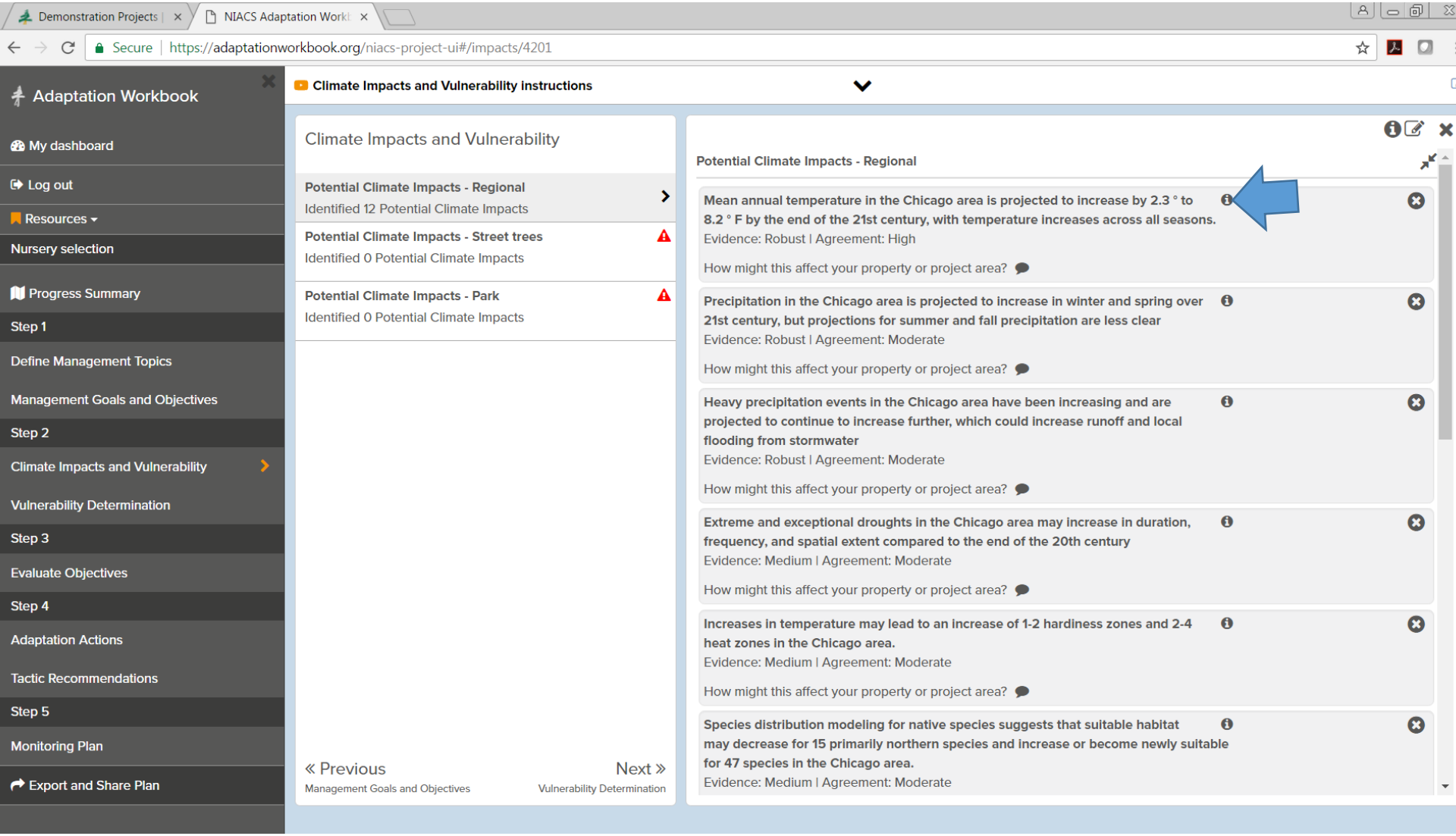
Acres How large is your project?

Size

Ownership Municipal

Project Type ○ Forest ◉ Urban ○ Agriculture

Cancel


Demonstration Projects
NIACS Adaptation Workl
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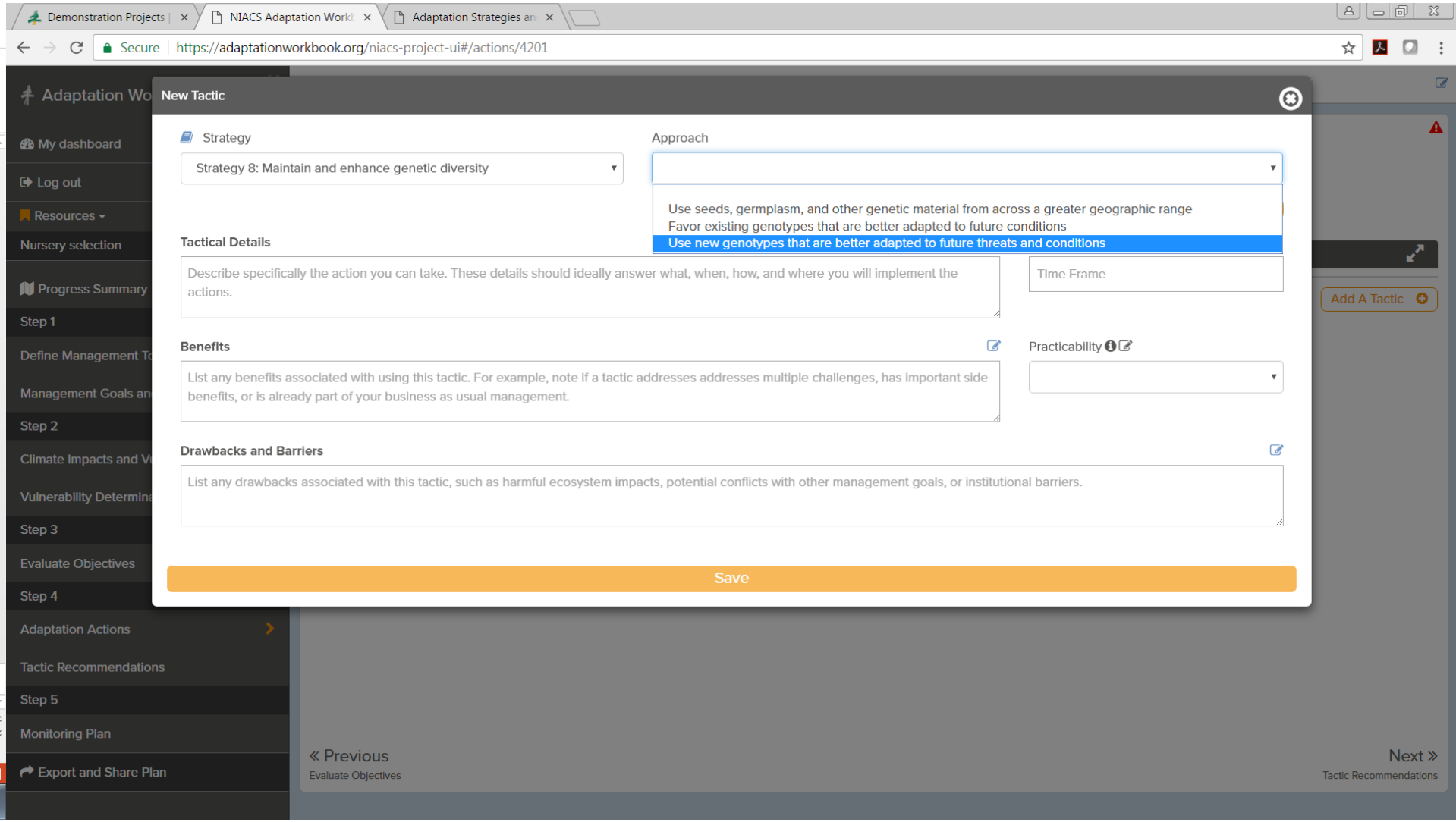
Adaptation Workbook
My dashboard
Log out
Resources
Nursery selection
Progress Summary
Step 1
Define Management Topics
Management Goals and Objectives
Step 2
Climate Impacts and Vulnerability
Vulnerability Determination
Step 3
Evaluate Objectives
Step 4
Adaptation Actions
Tactic Recommendations
Step 5
Monitoring Plan
Export and Share Plan
Climate Impacts and Vulnerability instructions
Climate Impacts and Vulnerability
Potential Climate Impacts - Regional
Identified 12 Potential Climate Impacts
Potential Climate Impacts - Street trees
Identified 0 Potential Climate Impacts
Potential Climate Impacts - Park
Identified 0 Potential Climate Impacts
« Previous
Management Goals and Objectives
Next »
Vulnerability Determination
Potential Climate Impacts - Regional
Mean annual temperature in the Chicago area is projected to increase by 2.3 ° to 8.2 ° F by the end of the 21st century, with temperature increases across all seasons.
Evidence: Robust | Agreement: High
How might this affect your property or project area?
Precipitation in the Chicago area is projected to increase in winter and spring over 21st century, but projections for summer and fall precipitation are less clear
Evidence: Robust | Agreement: Moderate
How might this affect your property or project area?
Heavy precipitation events in the Chicago area have been increasing and are projected to continue to increase further, which could increase runoff and local flooding from stormwater
Evidence: Robust | Agreement: Moderate
How might this affect your property or project area?
Extreme and exceptional droughts in the Chicago area may increase in duration, frequency, and spatial extent compared to the end of the 20th century
Evidence: Medium | Agreement: Moderate
How might this affect your property or project area?
Increases in temperature may lead to an increase of 1-2 hardiness zones and 2-4 heat zones in the Chicago area.
Evidence: Medium | Agreement: Moderate
How might this affect your property or project area?
Species distribution modeling for native species suggests that suitable habitat may decrease for 15 primarily northern species and increase or become newly suitable for 47 species in the Chicago area.
Evidence: Medium | Agreement: Moderate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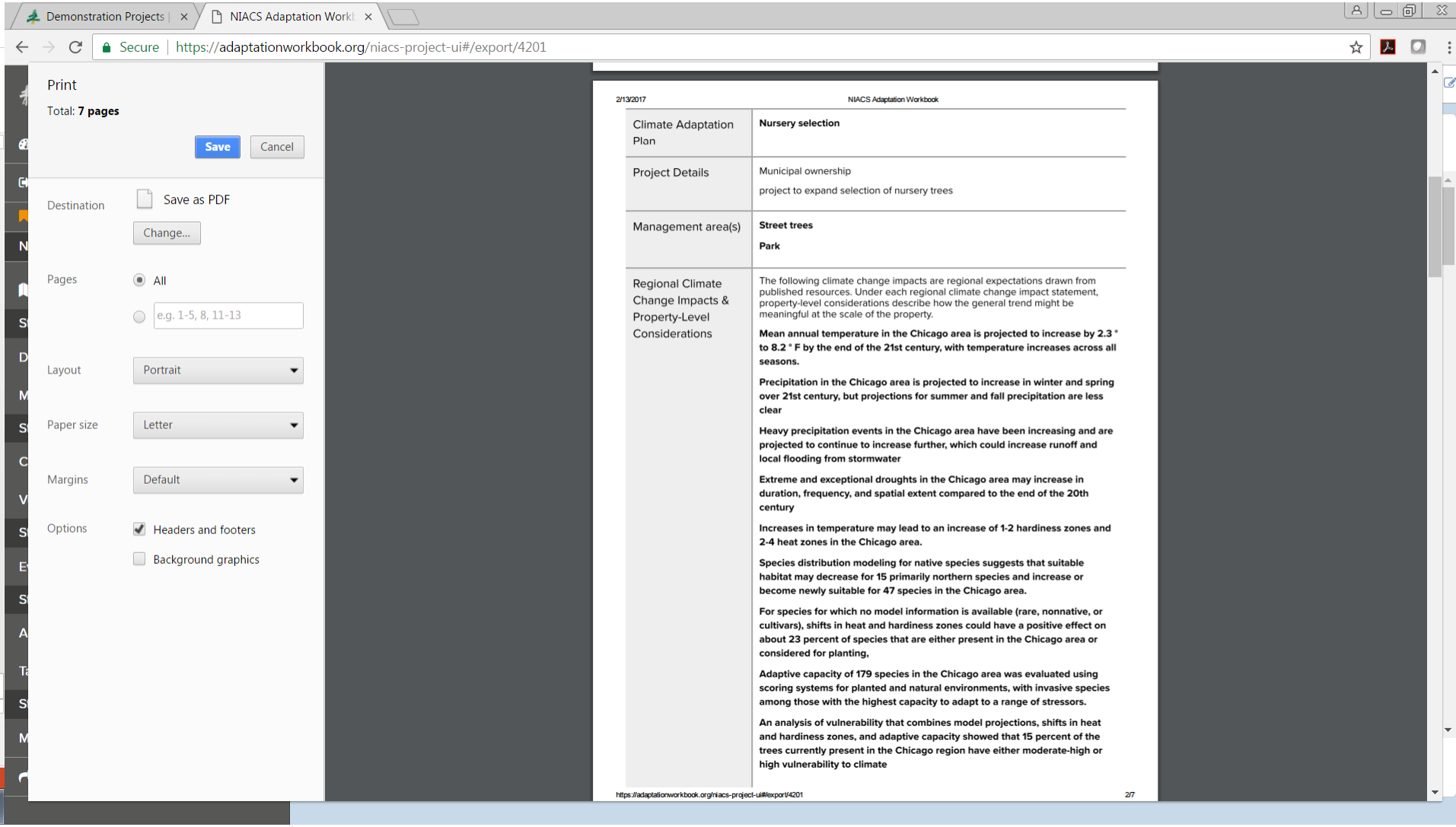
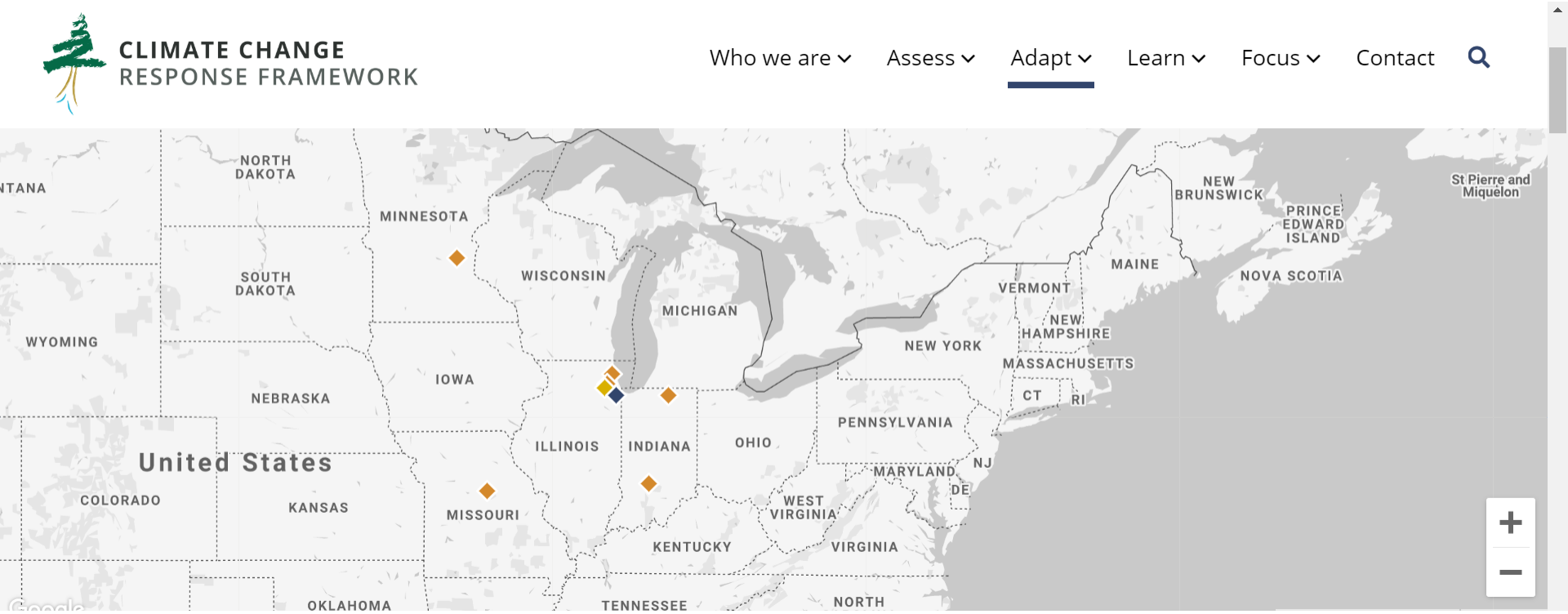
Vulnerability Determin
Step 3
Evaluate Objectives
Step 4
Adaptation Actions
Tactic Recommendations
Step 5
Monitoring Plan
Export and Share Plan
New Tactic
Strategy
Strategy 8: Maintain and enhance genetic diversity
Approach
Use seeds, germplasm, and other genetic material from across a greater geographic range
Favor existing genotypes that are better adapted to future conditions
Use new genotypes that are better adapted to future threats and conditions
Tactical Details
Describe specifically the action you can take. These details should ideally answer what, when, how, and where you will implement the actions.
Time Frame
Benefits
List any benefits associated with using this tactic. For example, note if a tactic addresses addresses multiple challenges, has important side benefits, or is already part of your business as usual management.
Practicability
Drawbacks and Barriers
List any drawbacks associated with this tactic, such as harmful ecosystem impacts, potential conflicts with other management goals, or institutional barriers.
Save
Add A Tactic
« Previous
Evaluate Objectives
Next »
Tactic Recommendations



Climate Adaptation Plan	**Nursery selection**
Project Details	Municipal ownership project to expand selection of nursery trees
Management area(s)	**Street trees** **Park**
Regional Climate Change Impacts & Property-Level Considerations	The following climate change impacts are regional expectations drawn from published resources. Under each regional climate change impact statement, property-level considerations describe how the general trend might be meaningful at the scale of the property. **Mean annual temperature in the Chicago area is projected to increase by 2.3 ° to 8.2 ° F by the end of the 21st century, with temperature increases across all seasons.** **Precipitation in the Chicago area is projected to increase in winter and spring over 21st century, but projections for summer and fall precipitation are less clear** **Heavy precipitation events in the Chicago area have been increasing and are projected to continue to increase further, which could increase runoff and local flooding from stormwater** **Extreme and exceptional droughts in the Chicago area may increase in duration, frequency, and spatial extent compared to the end of the 20th century** **Increases in temperature may lead to an increase of 1-2 hardiness zones and 2-4 heat zones in the Chicago area.** **Species distribution modeling for native species suggests that suitable habitat may decrease for 15 primarily northern species and increase or become newly suitable for 47 species in the Chicago area.** **For species for which no model information is available (rare, nonnative, or cultivars), shifts in heat and hardiness zones could have a positive effect on about 23 percent of species that are either present in the Chicago area or considered for planting,** **Adaptive capacity of 179 species in the Chicago area was evaluated using scoring systems for planted and natural environments, with invasive species among those with the highest capacity to adapt to a range of stressors.** **An analysis of vulnerability that combines model projections, shifts in heat and hardiness zones, and adaptive capacity showed that 15 percent of the trees currently present in the Chicago region have either moderate-high or high vulnerability to climate**

Demonstration Project Summaries



https://forestadaptation.org/adapt/demonstration-projects

(filter by focus: urban forests)

Demonstration Project Summaries

KEYWORDS: Choose some options | STATE: - Any - | LANDOWNER TYPE: - Any - | STATUS: - Any - | FOCUS AREA: Urban Forests | GO

Bloomington Urban Forestry Research Group: Forested Watersheds and Urban Forest Patch Connectivity in Bloomington, IN

The project area is largely on the west side of Bloomington, where the Griffy Lake watershed to the north of the city meets the Clear Creek watershed to the south. The planting area includes municipal...

> Learn more

edit

Morton Arboretum: Private Suburban Homeowners Association in DuPage County, IL

This townhome community was built in the mid-1980s and is located in Naperville, Illinois. The project will analyze existing tree inventory to be used in forecasting climate adapted future tree...

> Learn more

edit

Three Rivers Park District: Climate Change Planning for the Natural Resources Program

The Three Rivers Park District manages regional parks in the western Twin Cities, Minnesota. The Three Rivers Park District Natural Resources Management department is responsible for restoring and...

> Learn more

edit

City of Goshen, IN: Goshen Tree Benefits Campaign

Goshen is a small city (pop. 32,000) in northern Indiana. The City needs to raise awareness of the benefits of its urban forest – especially in a warming world – and needs its forest to grow and adapt...

> Learn more

edit

Natural Areas Conservancy and New York City Department of Parks and Recreation

Resistance

Transition

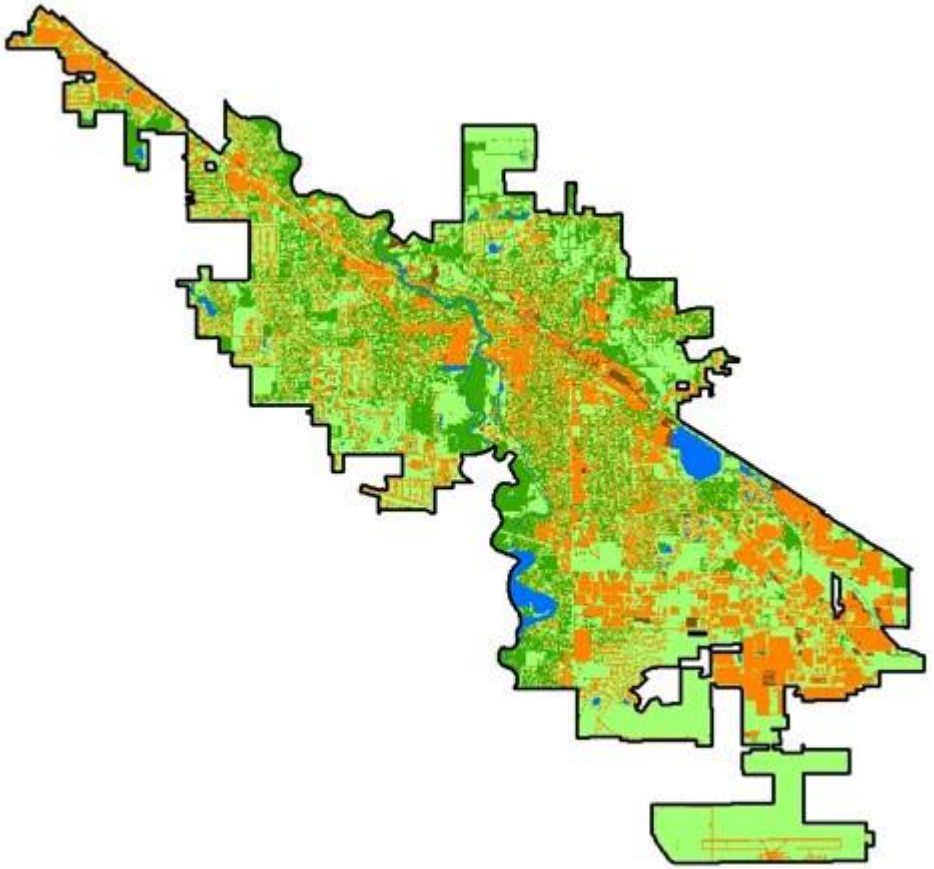
- **4.2. Prioritize and maintain sensitive or at-risk species or communities.**
  - continue to manage and protect rare species
- **8.1. Use seeds, germplasm, and other genetic material from across a greater geographic range.**
  - incorporate southern genetic variants of northern species

Goshen, IN

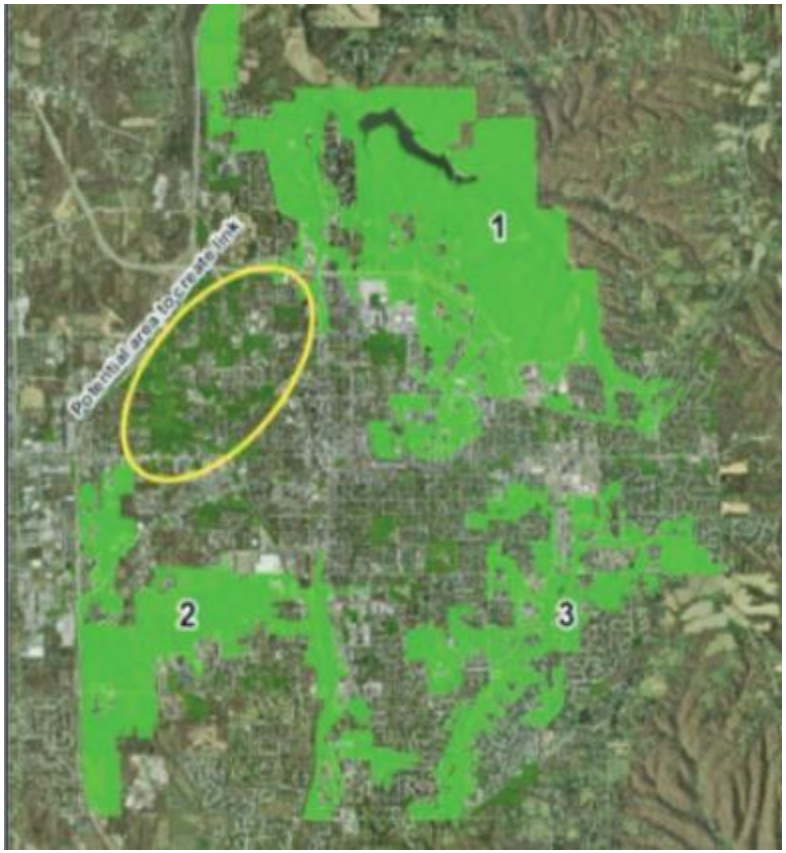
Resistance

Resistance

- **4.2. Prioritize and maintain sensitive or at-risk species or communities**
  - Grow stock from locally important survivor individuals, in order to preserve genetic memory and potentially stronger gene suites.
- **Urban Strategy 10. Realign urban ecosystems after disturbance**
  - Pass tree preservation ordinance which will require maintenance of salvageable trees after storms or other disturbances.



Bloomington, IN



Transition
- **7.2. Maintain and create habitat corridors through reforestation or restoration.**
  - Connected forest patches

Transition
- **9.7. Introduce species that are expected to be adapted to future conditions.**
  - Include southern Midwest natives

https://forestadaptation.org/adapt/demonstration-projects/bloomington-urban-forestry-research-group-forested-watersheds-and

Hennepin County, MN

Transition

8.1. Use seeds, germplasm, and other genetic material from across a greater geographic range

- S. MN hickory seeds
- Use root-pruning grow pots to eliminate tap roots

Transition

9.7. Introduce species that are expected to be adapted to future conditions

- Zone 5 species
- Grow in gravel bed nursery to develop strong root structure

https://forestadaptation.org/adapt/demonstration-projects/hennepin-county-gravel-bed-nursery-and-planting-program

Adaptation: Key Points

- Adaptation options are on a spectrum from managing for persistence to managing for change
- Adaptation workbook and menu provide an organizing framework to select adaptation options that will reduce vulnerability while achieving your management goals
- Other cities are using the workbook and menu.
  - One size does not fit all
  - Managers can pick and choose from the menu
  - Can be a mix of resistance, resilience, and transition strategies

Activity

Current management challenge	What are ways this challenge will be affected by climate change?	What are some general approaches for responding?	What are examples of specific tactics for responding?
1)			
2)			
3)			

PROBLEM/ISSUE

POTENTIAL ADAPTATION

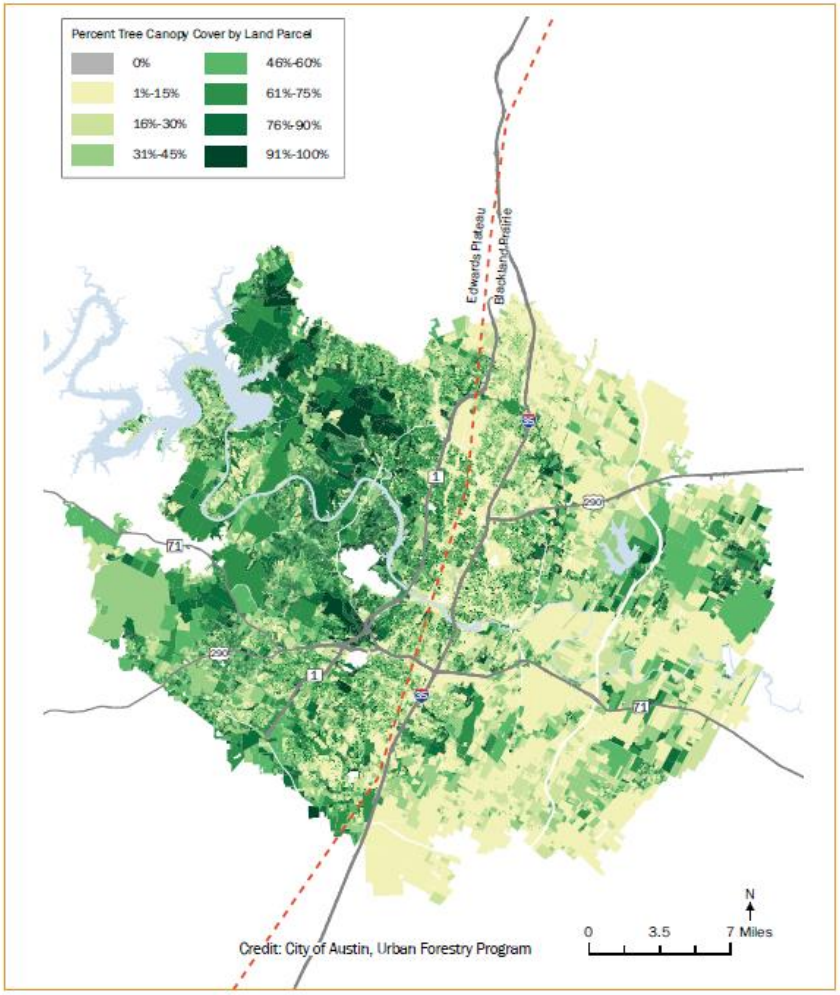
Activity

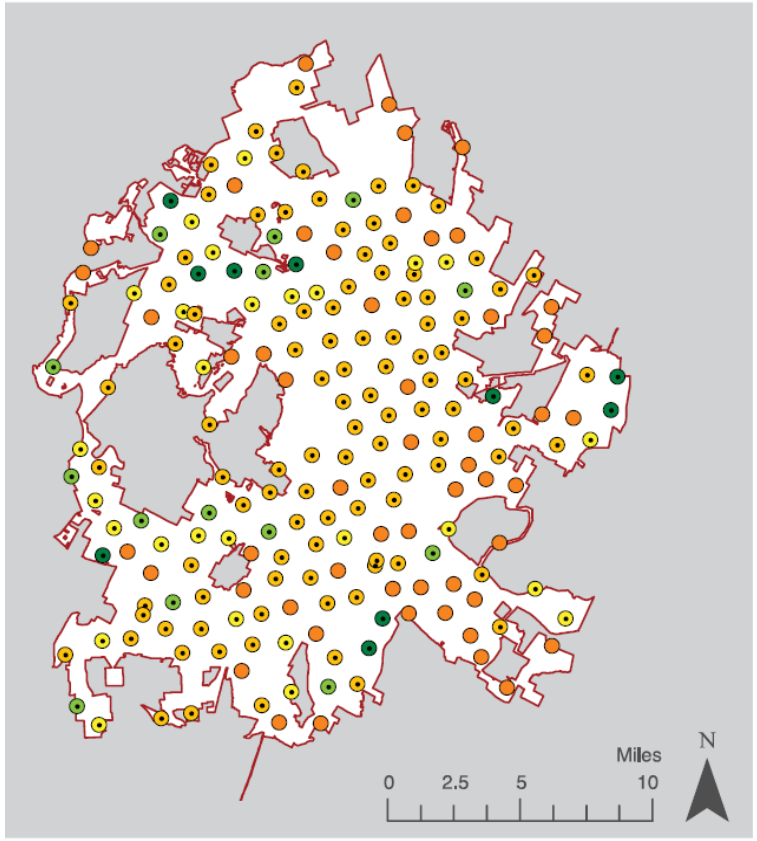
- 10 minutes on your own, fill out 1-3 challenges
- 30 minutes: discuss in your groups
- 20 minutes: group reports

Group Reports

- *What were some of the commonalities in terms of climate change challenges amongst your group?*
- *What were some examples of adaptation actions?*
- *Did your adaptation actions tend to focus on resistance, resilience, or transition?*
-

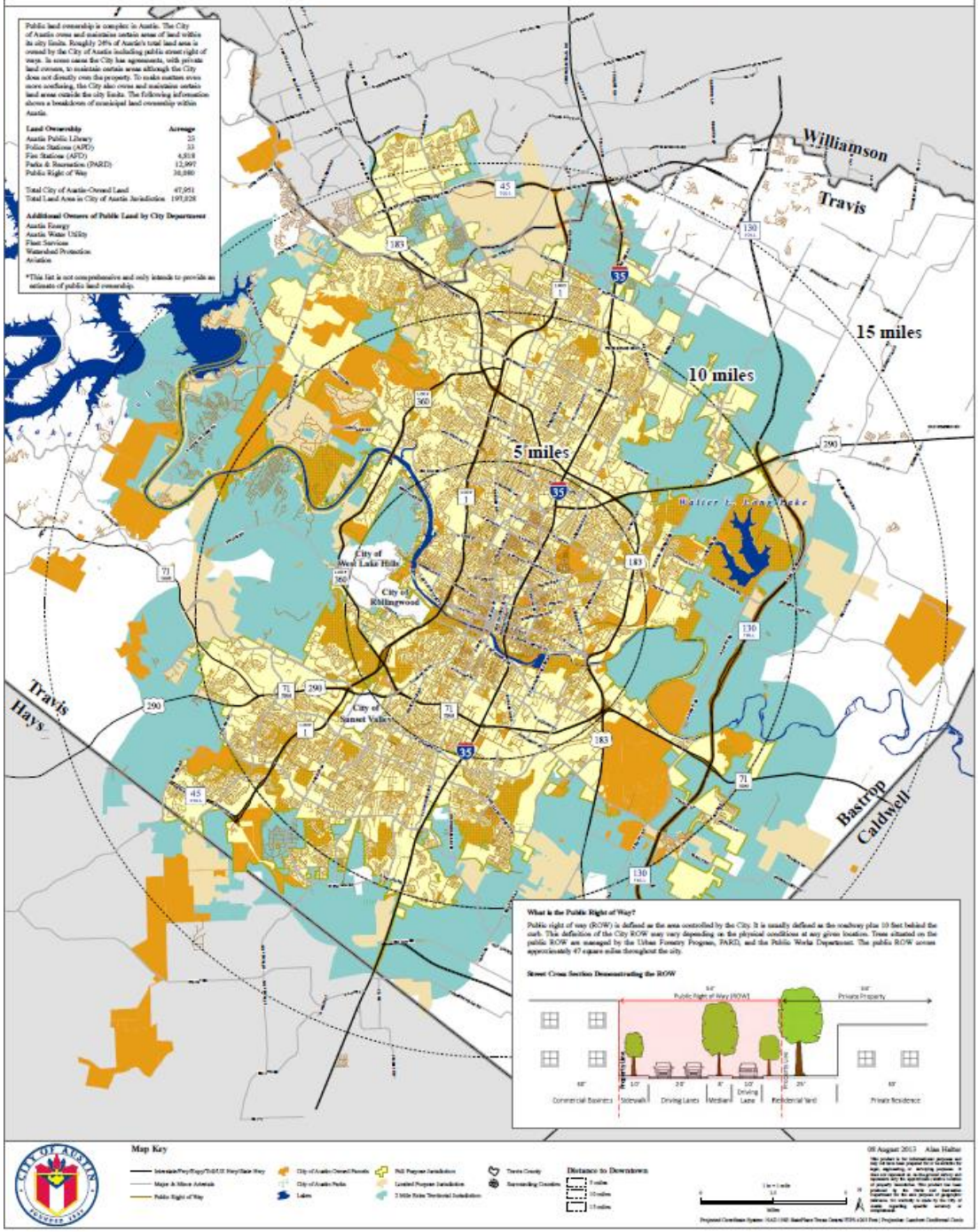
Additional maps and information





3.—Tree density by plot, Austin, 2014.

City of Austin Jurisdiction & Land Ownership



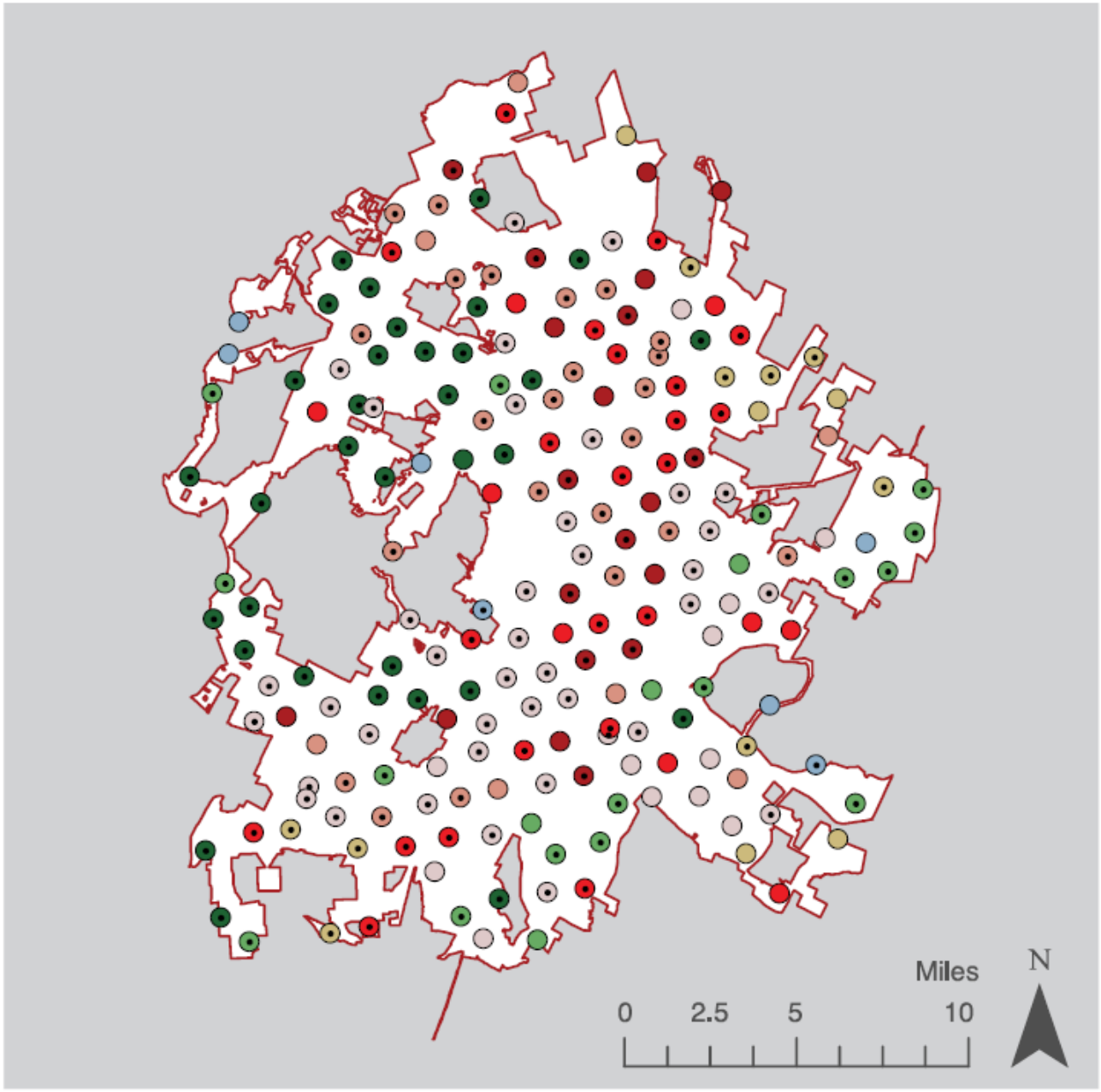


Figure 6.—Plot distribution by land cover, Austin, 2014.

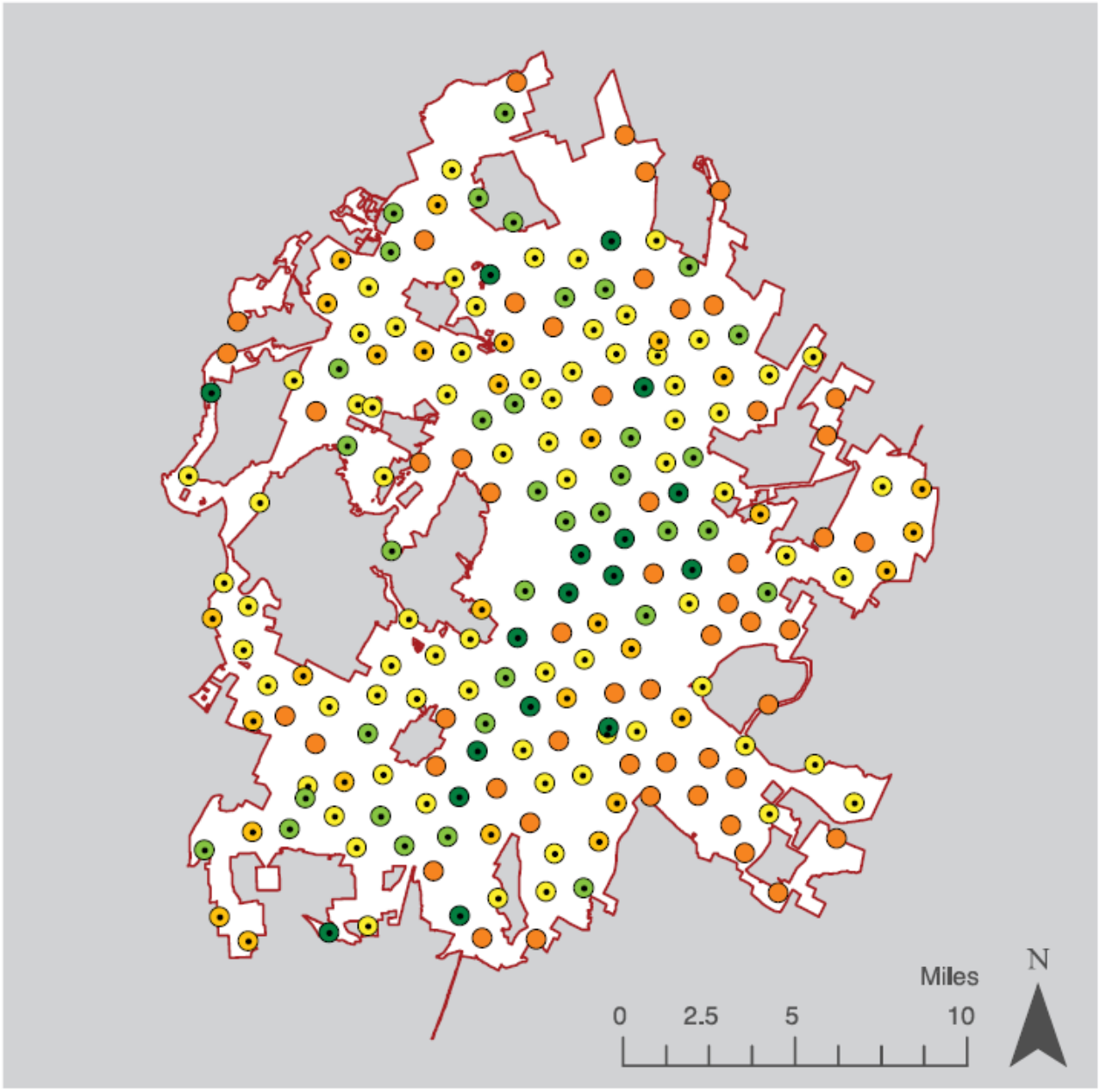
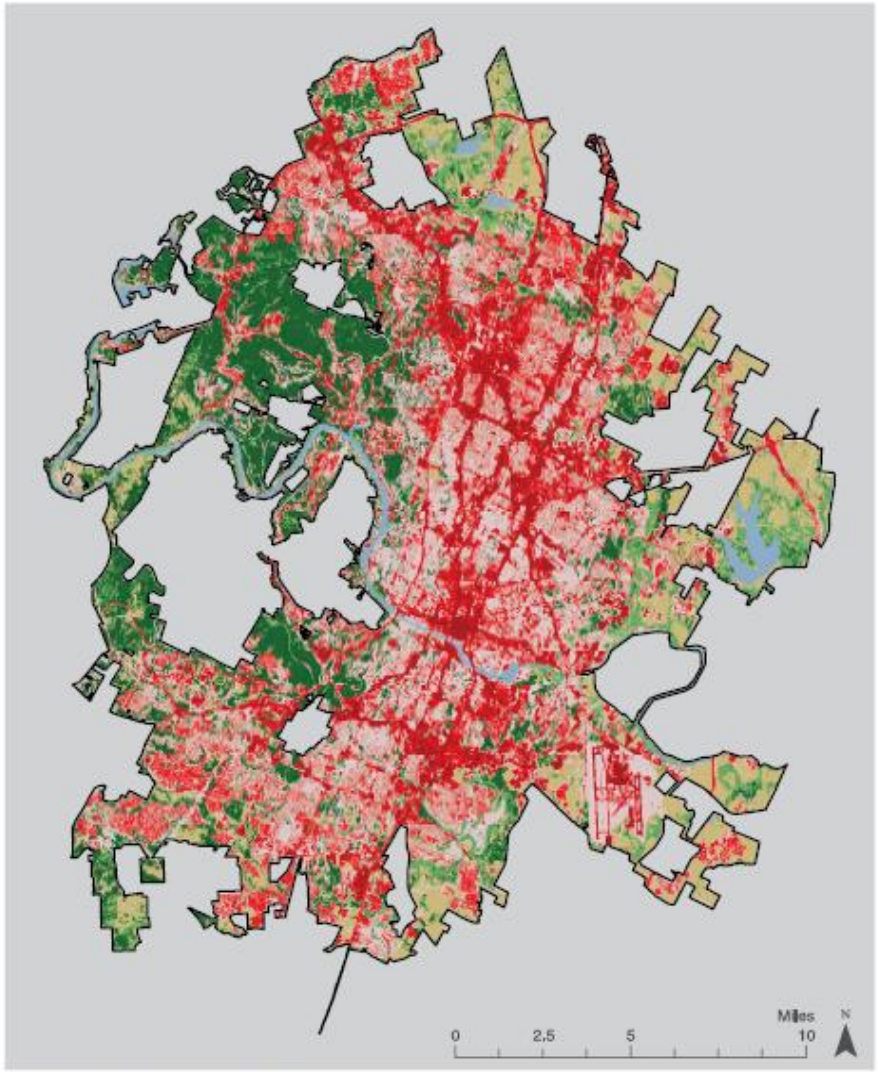


Figure 11.—Average tree diameter by plot, Austin, 2014.



Land Cover and Percentage of Total

- Developed–Open (20%)
- Developed–Low (16%)
- Developed–Medium (16%)
- Developed–High (8%)
- Deciduous/Mixed Forest (8%)
- Evergreen Forest (17%)
- Shrub/Herbaceous (12%)
- Water/Barren (3%)

Figure 5.—Land cover distribution based on National Land Cover Database (Homer et al. 2015), Austin, 2014. Land was classified into one of eight land cover classes.

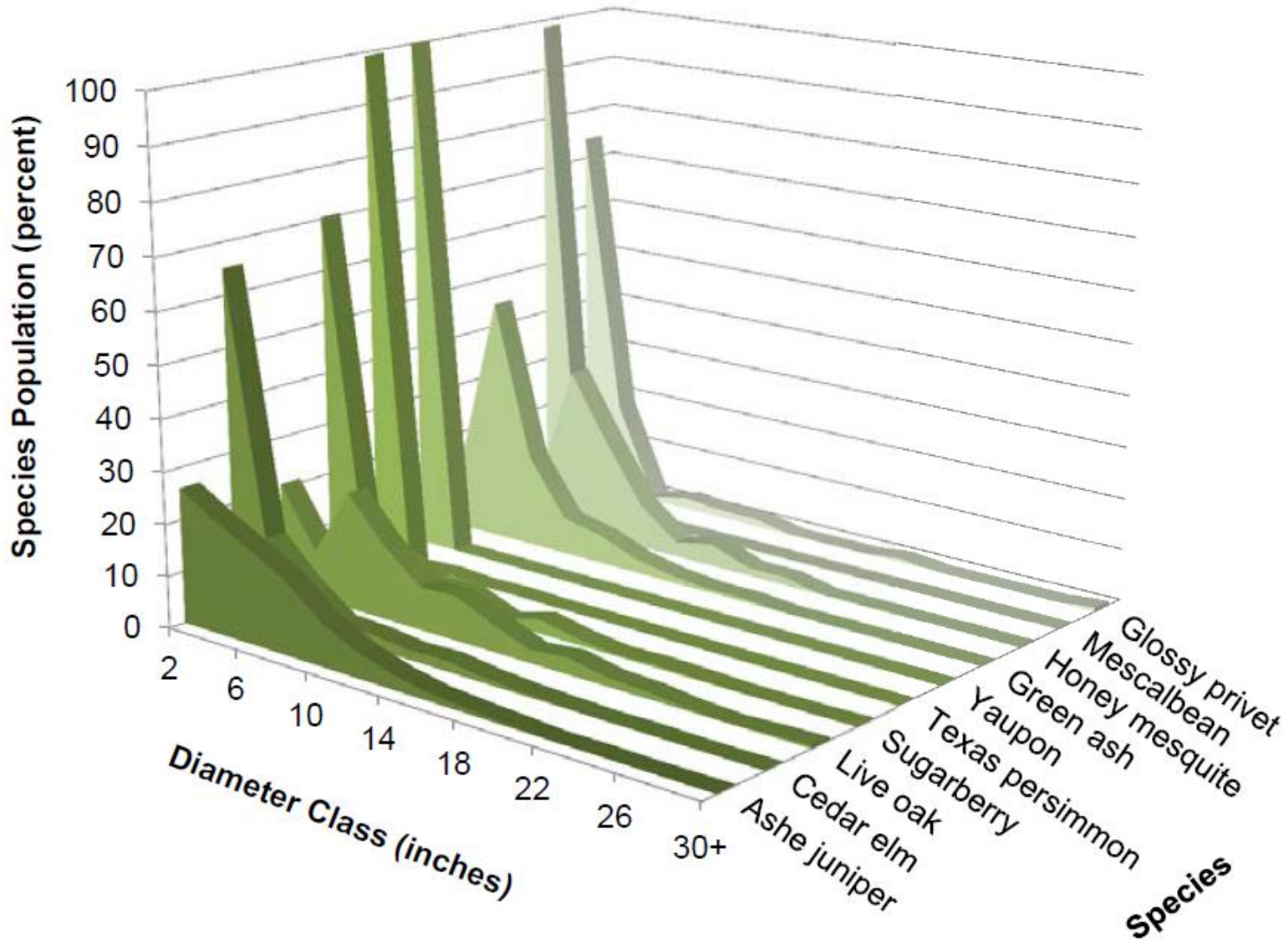


Figure 13.—Percentage of species population by diameter class for 10 most common species, Austin, 2014. Diameter classes are designated by their midpoint (e.g., 2 is actually 1 to 2.9 inches). Diameter measurements were taken at breast height (d.b.h.) or root collar (d.r.c.) for woodland species.

Table 4.—Percentage of total population and leaf area and importance value of species with the greatest importance values, Austin, 2014

Common name	Population	Leaf area	IV[a]
	percent	*percent*	
Ashe juniper	39.3	41.2	80.5
Cedar elm	13.5	10.9	24.4
Live oak	8.4	13.1	21.5
Sugarberry	6.1	7.4	13.5
Texas persimmon	6.0	1.2	7.2
Green ash	2.2	2.8	5.0
Buckley oak	1.2	2.9	4.1
Honey mesquite	1.9	1.4	3.3
Chinaberry	1.6	1.2	2.8
Yaupon	2.5	0.2	2.7
Pecan	0.6	2.1	2.7

[a] IV = Population (%) + Leaf area (%)

Table 5.—Tree species that are classified as invasive[a] and were observed in the inventory, Austin, 2014

Common name	Proportion of all trees	Leaf area as a proportion of all leaf area	Number of plots found
	percent	*percent*	
Glossy privet	1.8	0.7	6
Chinaberry	1.6	1.2	9
Paper mulberry	1.0	0.9	3
Chinese privet	0.4	0.5	8
Tallowtree	0.1	0.1	4
Japanese privet	0.1	0.2	2
Chinese pistache	0.1	0.1	2
White mulberry	<0.1	0.1	1
Mimosa	<0.1	0.1	1

[a] Species is listed on Texas invasive species list (Watershed Protection Development Review, n.d.)

Table 7.—Percentage of trees in maintained areas (minimum sample size = 10 trees) by species, Austin, 2014. For example, 100 percent of velvet ash trees are in maintained areas.

Species	Trees	Species	Trees
	percent		*percent*
Velvet ash	100.0	Live oak	24.2
Chinese privet	100.0	Sugarberry	18.7
Common crapemyrtle	100.0	Buckley oak	15.8
Mexican ash	90.1	Cedar elm	10.2
Pecan	80.4	Texas ash	7.8
Mescalbean	62.9	Northern hackberry	5.7
American sycamore	58.4	Glossy privet	4.4
Chinaberry	51.0	Ashe juniper	0.7
Yaupon	28.4		

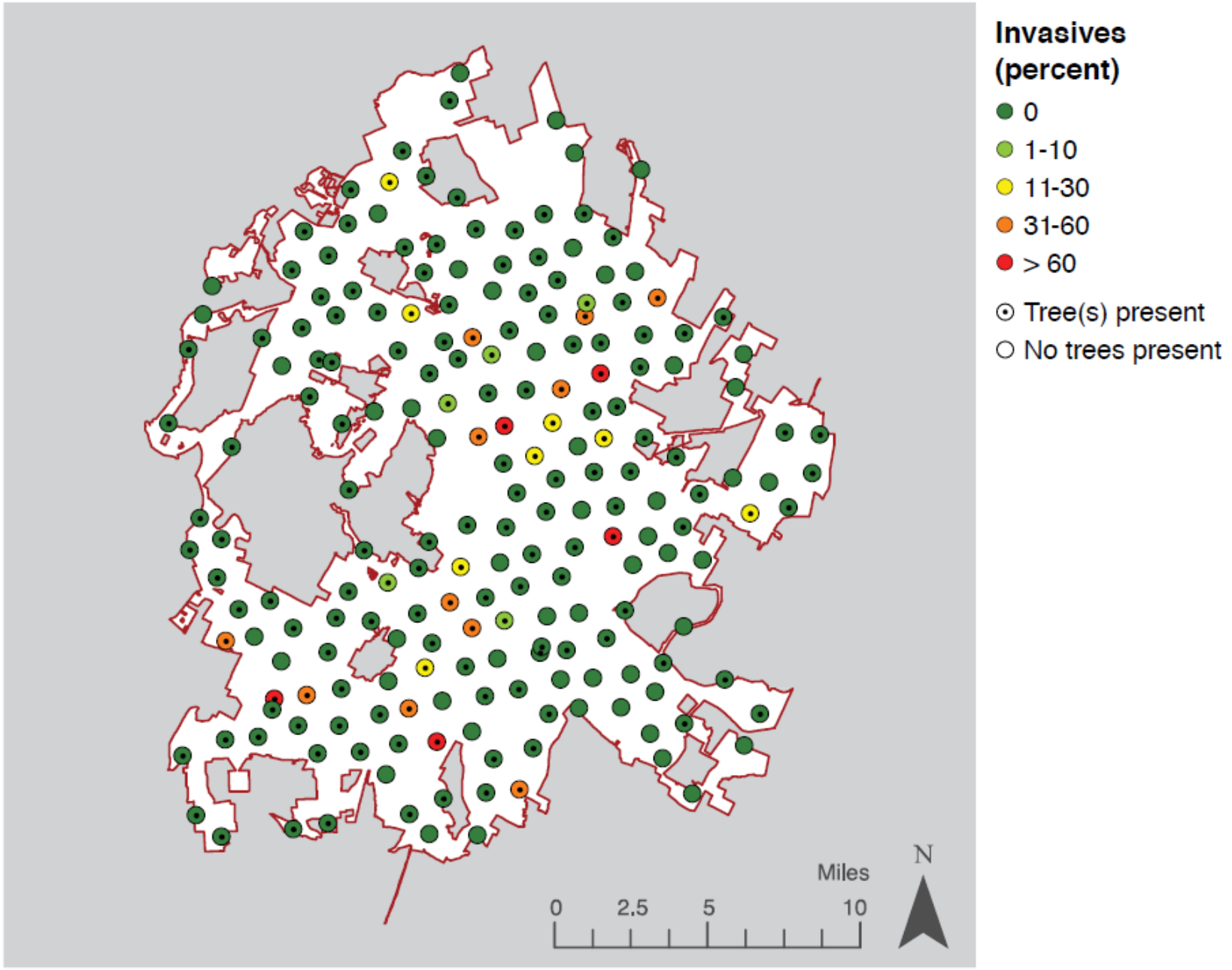


Figure 15.—Proportion of invasive trees as a percent of all trees, by plot, Austin, 2014.

Table 8.—Species composition in maintained areas, Austin, 2014. For example, 16.3 percent of trees in maintained areas are live oak.

Species	Trees	Species	Trees	Species	Trees
	percent		*percent*		*percent*
Live oak	16.3	American sycamore	1.8	Black walnut	0.2
Cedar elm	11.0	Buckley oak	1.6	Bur oak	0.2
Mescalbean	9.6	Velvet ash	1.4	Goldenrain tree	0.2
Sugarberry	9.1	Shumard oak	1.0	Southern magnolia	0.2
Loquat tree	7.4	Texas ash	0.8	Eastern cottonwood	0.1
Chinaberry	6.5	Glossy privet	0.6	Eastern redbud	0.1
Yaupon	5.6	Common fig	0.5	Gum bully	0.1
Common crapemyrtle	4.1	Chinese pistache	0.4	Mimosa	0.1
Mexican ash	3.9	Japanese privet	0.4	Texas red oak	0.1
Pecan	3.7	Baldcypress	0.3	American elm	0.1
Chinese privet	2.9	Slippery elm	0.3	Florida thatchpalm	0.1
Ashe juniper	2.1	Chinkapin oak	0.3	Plum spp	0.1
Netleaf white oak	2.0	Tallowtree	0.3	Water oak	0.1
Chinese elm	1.8	Northern hackberry	0.2		
Common cherry laurel	1.8	Post oak	0.2		

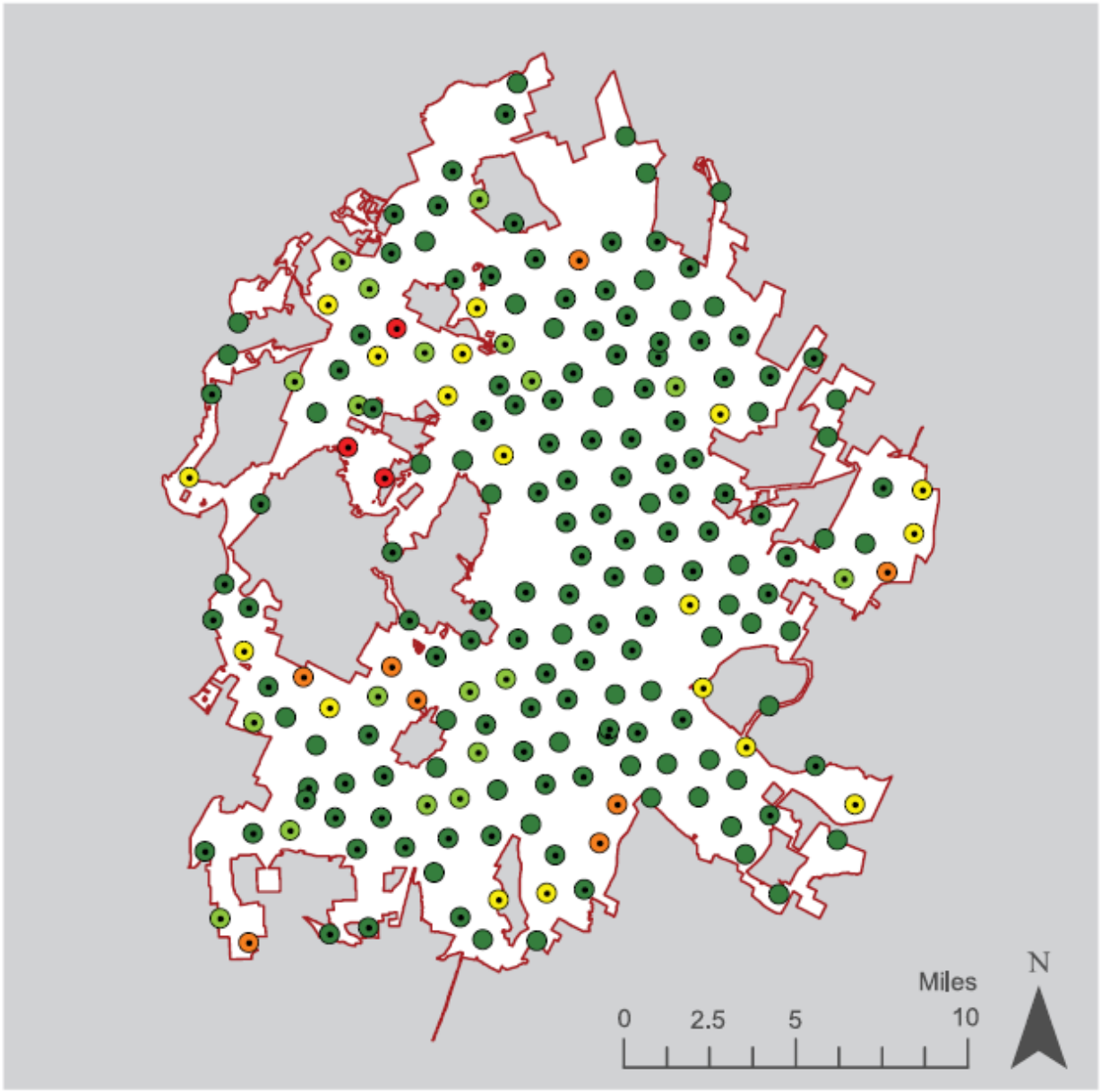


Figure 31.—Number of standing dead trees per acre by plot, Austin, 2014.

Table 15.—Species with the largest proportion of its population classified as dead, Austin, 2014

Species	Total population	Dead
	number	*percent*
Eastern red cedar	38,000	62.5
American elm	72,000	48.9
Tallowtree	28,000	16.4
Northern hackberry	162,000	13.9
Honey mesquite	655,000	13.1
Ashe juniper	13,300,000	6.8
Black walnut	105,000	6.1
Green ash	751,000	4.4
Buckley oak	419,000	4.0
Live oak	2,859,000	3.7

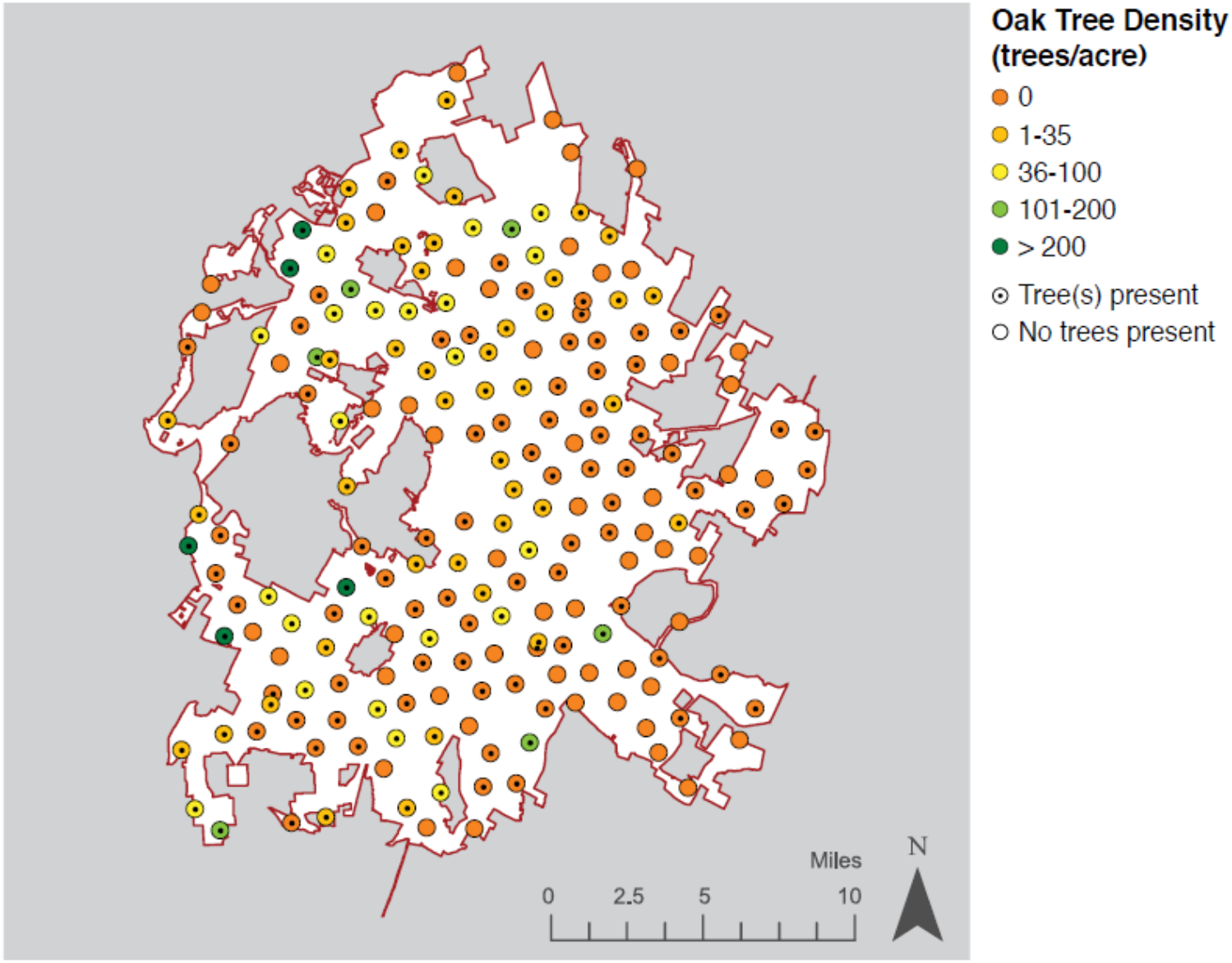


Figure 32.—Number of oak trees per acre by plot, Austin, 2014.