Community Forest Vulnerability Workshop

Northern Institute of Applied Climate Science

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

NIACS
Northern Institute of Applied Climate Science

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

Michigan Technological University

The UNIVERSITY of VERMONT

AMERICAN FORESTS

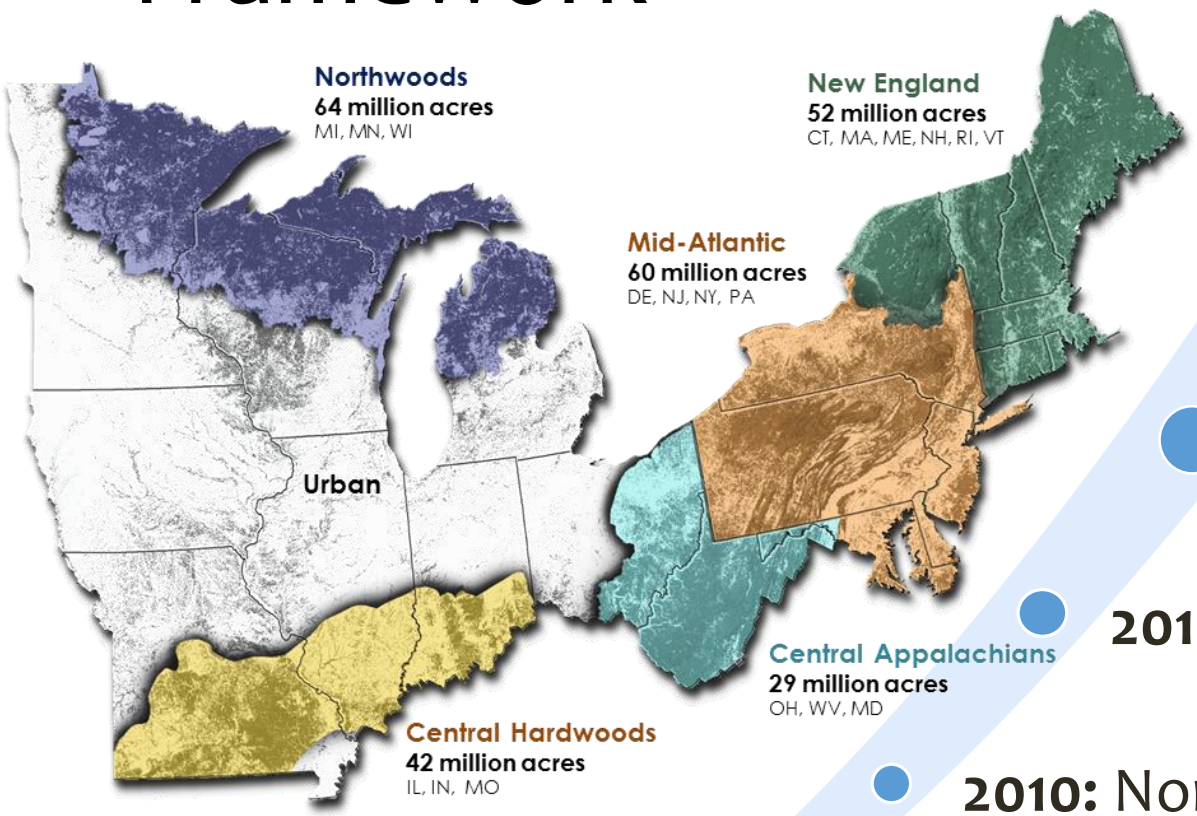
UNIVERSITY OF MINNESOTA

NCASI

Great Lakes Indian Fish & Wildlife Commission

USDA Climate Hubs

Climate Change Response Framework



2013-14:
New England
Mid-Atlantic
Urban

2012: Central Appalachians

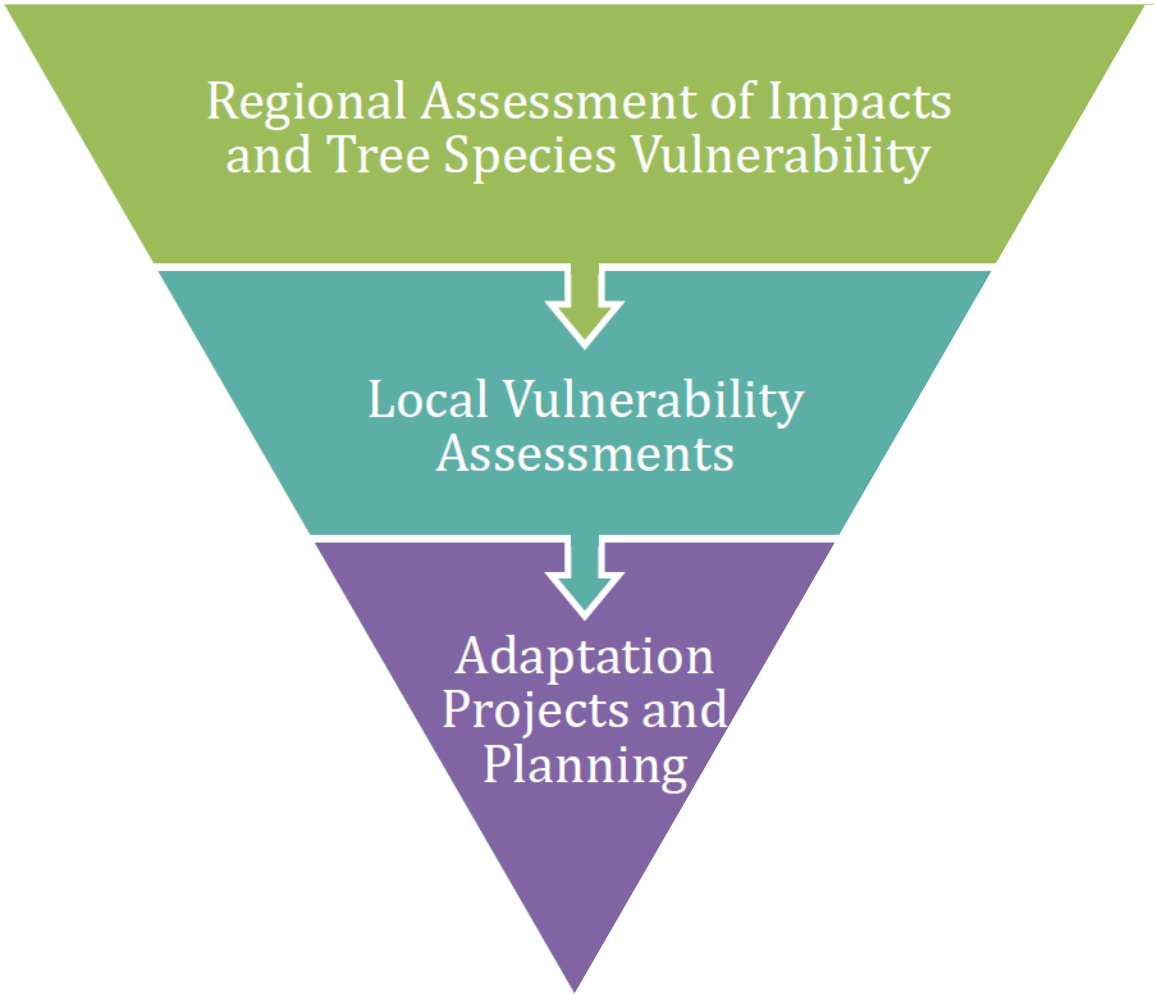
2011: Central Hardwoods

2010: Northwoods expansion

2009: Wisconsin pilot

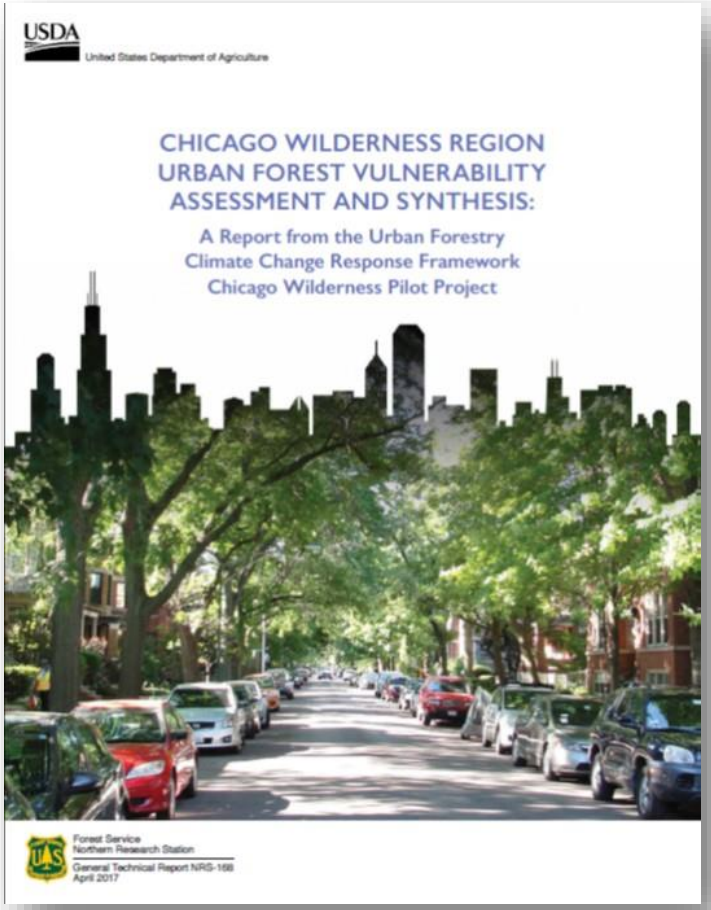
www.forestadaptation.org

Urban Forestry
Climate Change Response Framework



Brandt et al. 2017. Environmental Science and Policy

Vulnerability Assessment: Chicago Region



www.treesearch.fs.fed.us/pubs/54128

Objectives

- Understand key climate change impacts to Austin's community forest
- Provide feedback on species vulnerability list for Austin's trees
- Assess the vulnerability of the community forest in developed areas
- Assess the vulnerability of key natural ecosystems in the Austin region
- Develop vulnerability summaries for developed and natural areas to inform future adaptation strategies.

Workshop Product = Vulnerability Assessment

We are creating a vulnerability assessment for the **terrestrial ecosystems and developed urban trees** within the Austin region.

We will be focusing on **the present through end of the century** (2100).

Workshop participants and other contributors will be included as co-authors on the report.

We will synthesize the state of science using our best judgement. **We will not make recommendations about management or adaptation.**

Assessment Process & Expert Panel

Local Info

- *Current ecosystem conditions*
- *Climate trends*

Potential Ecosystem Change

- *Future climate*
- *Model results*
- *Literature review*

Expert Knowledge & Experience

(via workshop)

Assessment Process & Expert Panel

Local Info
- *Current ecosystem conditions*
- *Climate trends*

Potential Ecosystem Change
- *Future climate*
- *Published research*
- *Model results*

Expert Knowledge & Experience
(via workshop)

Ecosystem Vulnerability
& Confidence

Outcome: Vulnerability Determination

Community Type	Potential Impacts	Adaptive Capacity	Vulnerability
Northern hardwoods	Moderate-Negative	Moderate-High	Moderate
Aspen-birch	Moderate-Negative	Moderate-High	Moderate-High
Upland spruce-fir	Negative	Moderate-Low	High
Lowland conifers	Negative	Moderate-Low	High
Jack pine	Moderate-Negative	Moderate-High	Moderate
Red pine	Moderate-Negative	Moderate-Low	Moderate-High
White pine	Moderate-Negative	High	Moderate-Low
Oak associations	Moderate	Moderate-High	Moderate- Low
Lowland-riparian hardwoods	Moderate-Negative	Moderate	Moderate-High

Janowiak et al. 2014

Outcome: Vulnerability Description

Dry-Mesic Upland Forest

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

Increases in temperature, coupled with potential decreases in soil moisture and increases in wildfire, could be favorable for some species and detrimental to others. However, a wide distribution and high species diversity may enhance the adaptive capacity of dry-mesic systems and allow them to persist on the landscape.

Moderate Potential Impacts

Drivers—There is currently little evidence regarding the potential effects of climate change on several important factors for this type, including the potential severity of fire and frequency of intermittent droughts during the growing season. An increase in fire frequency is expected to have positive effects on overstory tree species, but may have negative impacts on the understory. If fires become too severe or frequent, this type could shift toward a woodland or savanna. If soil moisture decreases in the summer, it could have a negative impact on the system.

Dominant Species—The forest impact models tend to agree about how certain species are projected to decline or increase. Climate change is not projected to have a large influence on many of the dominant tree species in this community type (Table 18). Habitat suitability for shortleaf pine is projected to increase, while habitat suitability for sugar maple

area and a decrease in shortleaf pine in Missouri. If conditions improve for fire, and soil moisture decreases, these factors could lead to a reduction in this current stressor. Oak decline is expected to remain a threat to the red oak group, and may become a larger threat to trees that become stresse by increased drought frequency. Many nonnative invasive plant species are expected to continue to be a problem. However, one of the many invasive plants, garlic mustard, is relatively drought-intolerant and could decrease if conditions become significantly drier during the growing season. Southern pine beetle could become a new threat to the area as the area warms, especially if the shortle pine component increases.

High Adaptive Capacity

This community type is widely distributed on a variety of soils and topographies, making it probable that at least some of these areas will remain suitable in the future. This type also tends to have high tree

Brandt et al. 2014

Vulnerability Assessment of Austin's Trees and Shrubs

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

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)

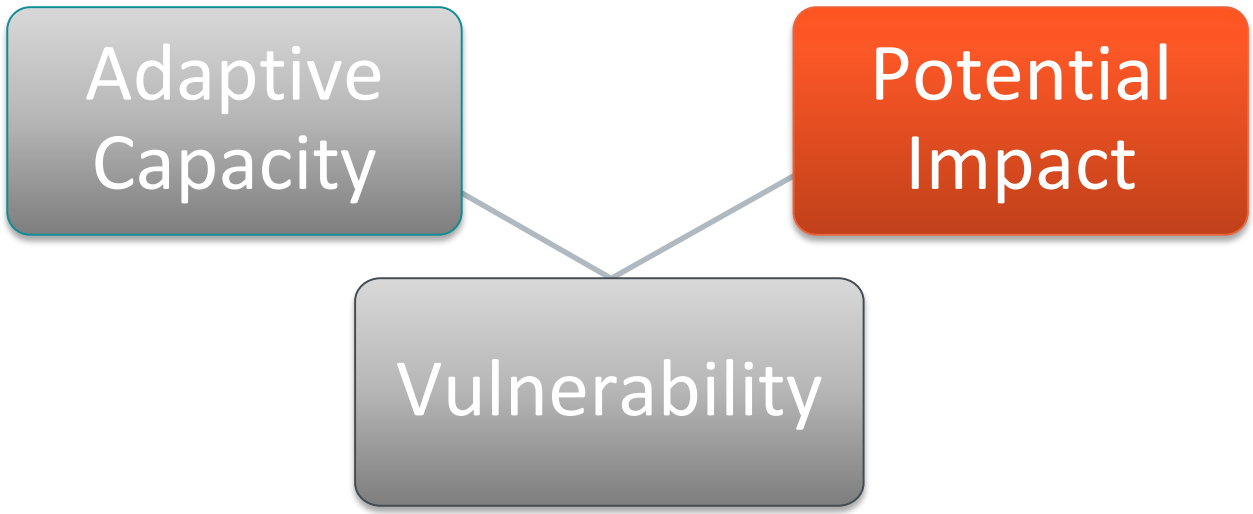
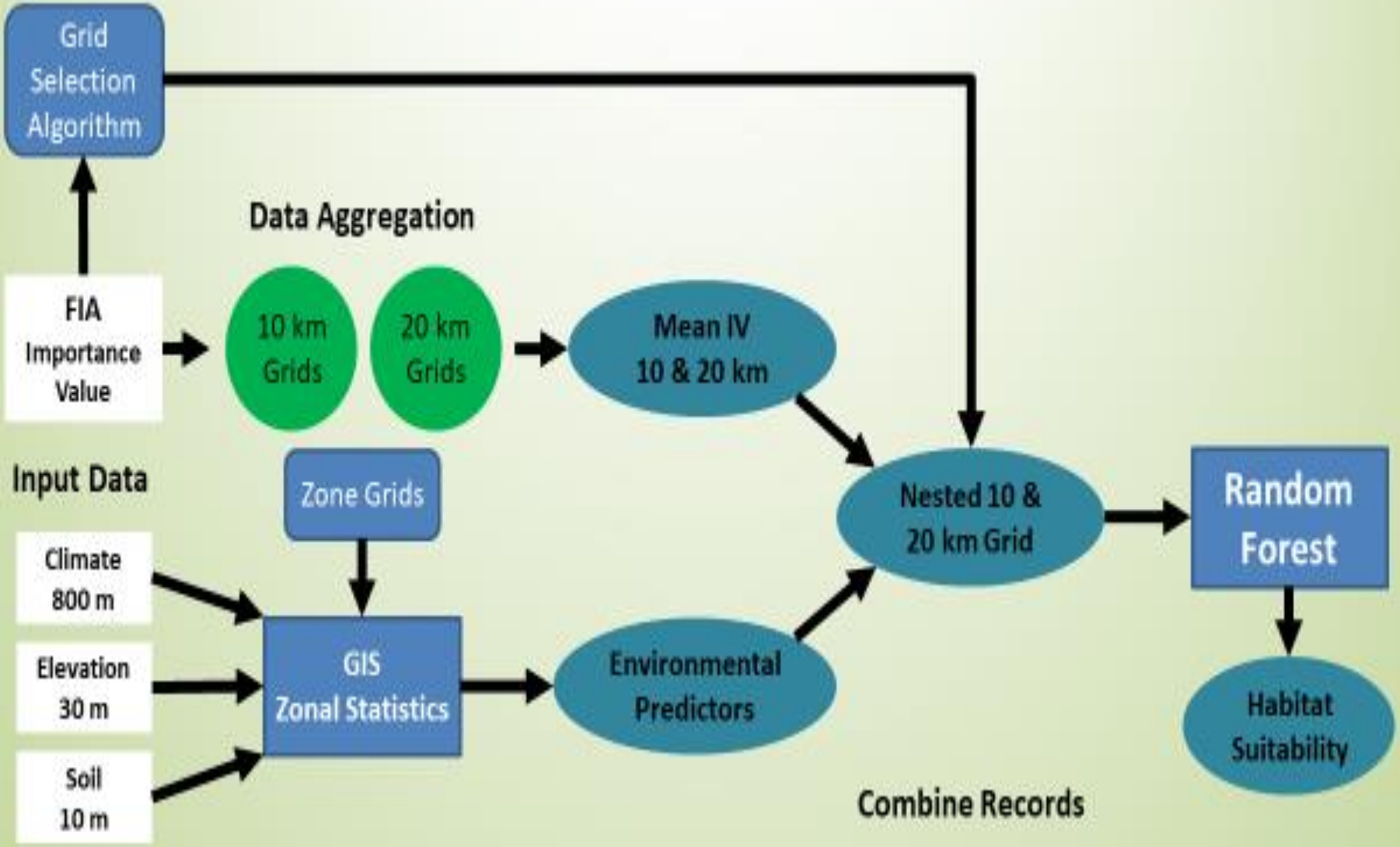


Figure: Glick et al. 2011

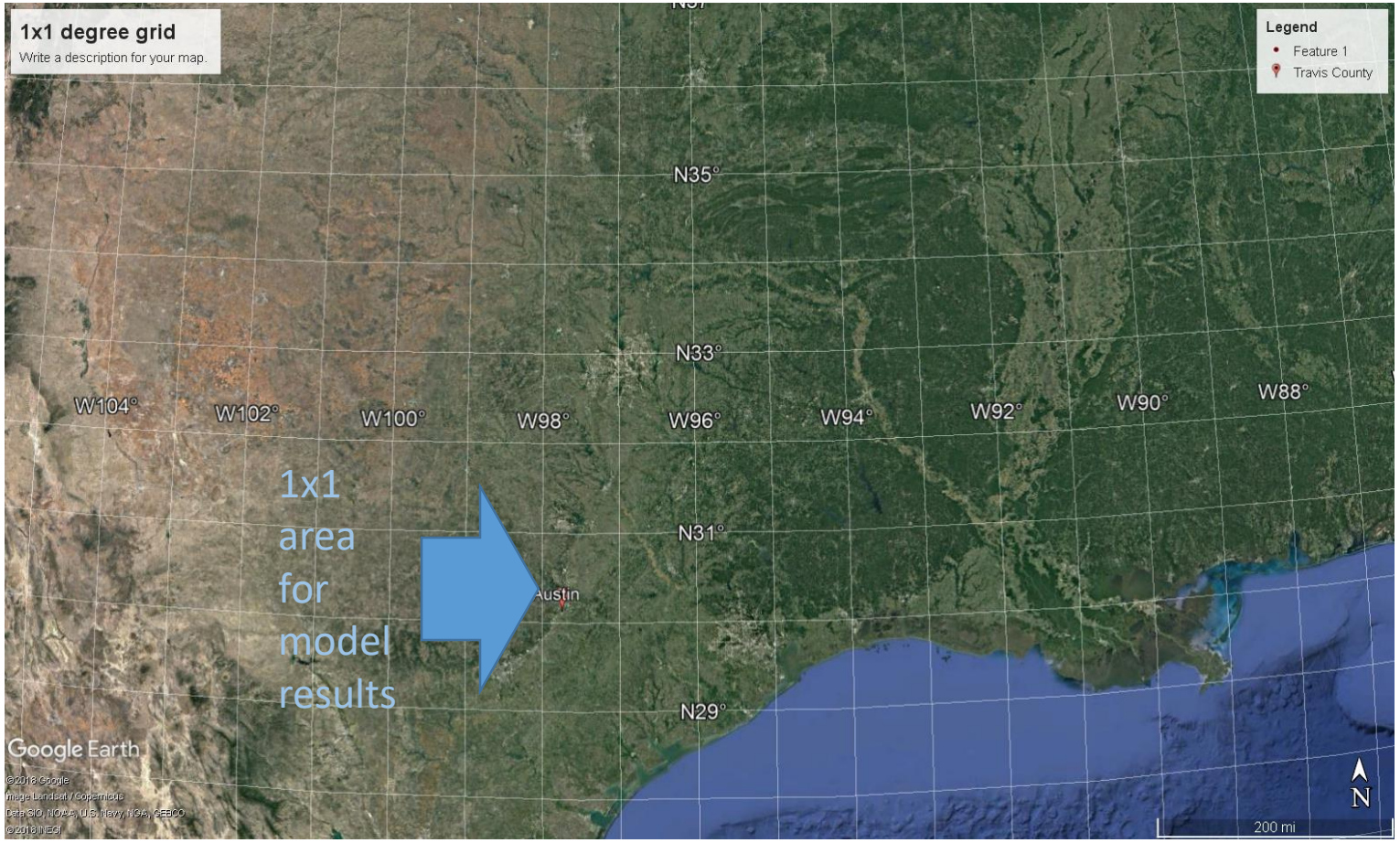
Native Trees
Model Projections: Climate Change Tree Atlas/Distrib-II

- Developed by Louis Iverson and the Landscape Change Research Group (part of NIACS)
- https://www.fs.fed.us/nrs/atlas/
- Based on Forest Inventory and Analysis Data (not urban FIA)
- Uses current climate, soils, topopgraphy and downscaled climate projections (through 2099)
- Model developed for the entire Eastern US.
- Summarized in 1x1 degree grids

Data Processing



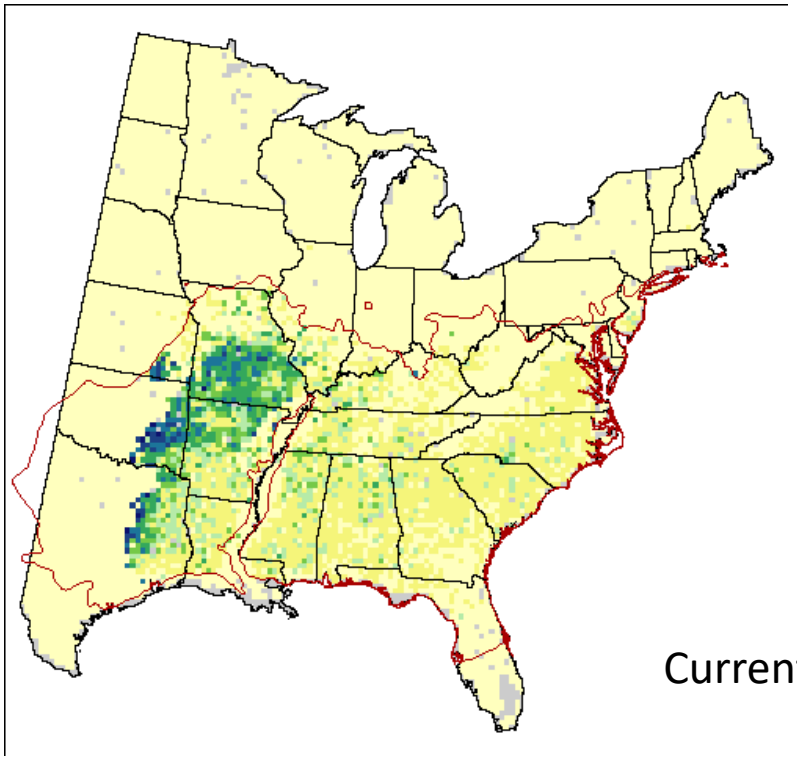
Summary Area 1x1 grid



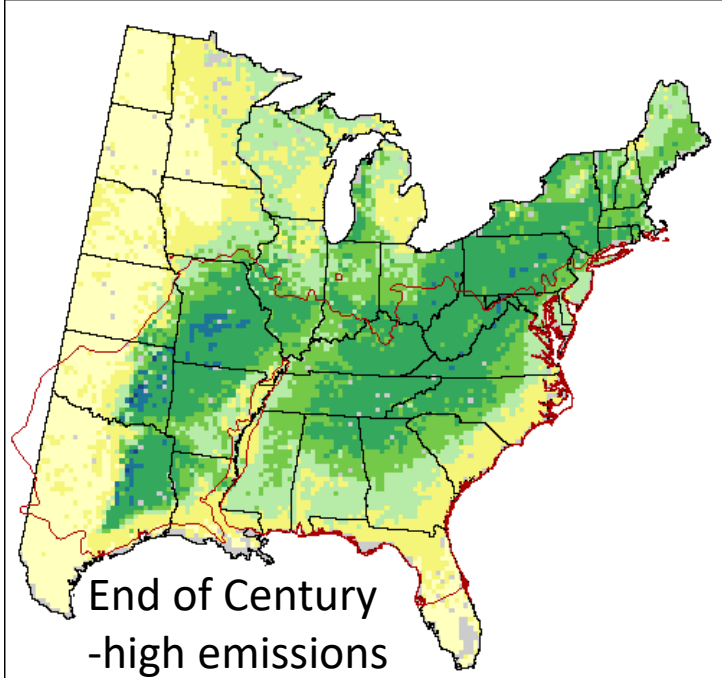
Species Expected to Lose Habitat (*from most to least abundant)

- ashe juniper (high emissions only)
- live oak
- post oak
- eastern redcedar
- pecan
- hackberry
- blackjack oak
- chittamwood/gum bumelia
- green ash
- American elm
- boxelder
- winged elm
- red mulberry (high emissions only)
- slippery elm
- flowering dogwood
- Black cherry (low emissions only)
- Honeylocust (low emissions only)
- Bitternut hickory

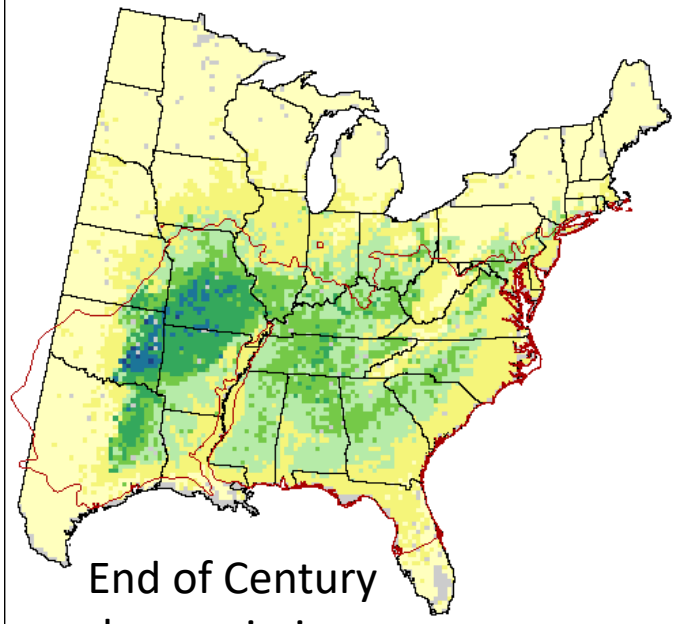
Post Oak



Current Habitat



End of Century
-high emissions



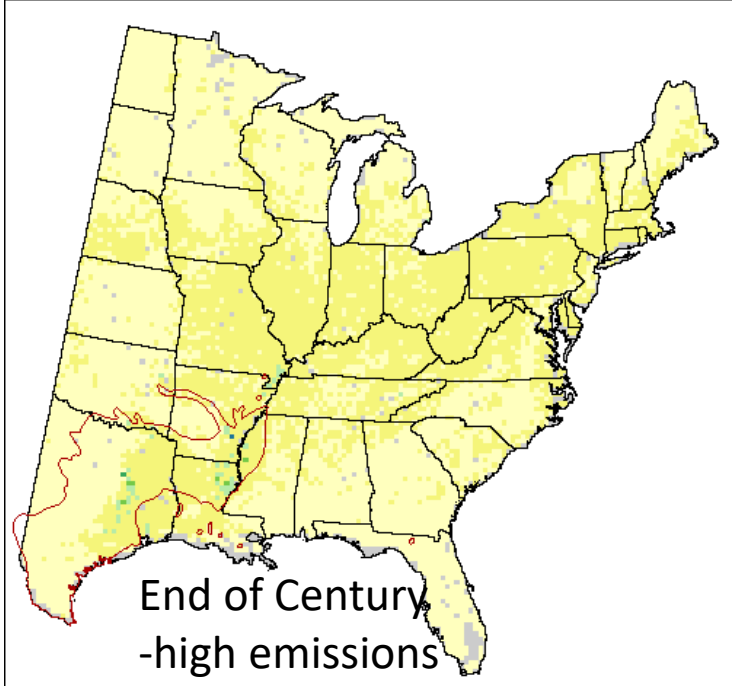
End of Century
-low emissions

Species Expect to Retain Habitat (*from most to least abundant)

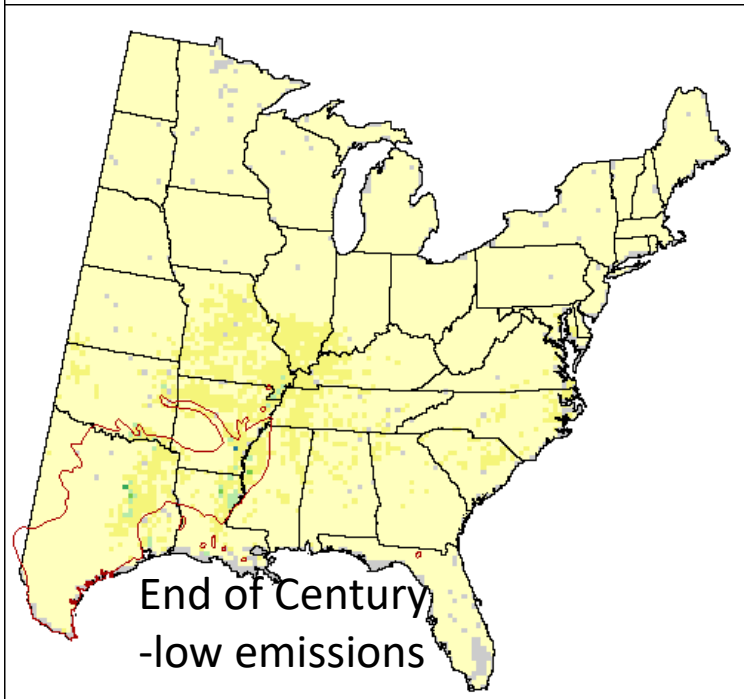
- cedar elm
- sugarberry
- black walnut
- Osage-orange
- sycamore
- Shumard oak
- water oak
- bur oak
- white ash
- black hickory

Cedar Elm

Current Habitat



End of Century
-high emissions

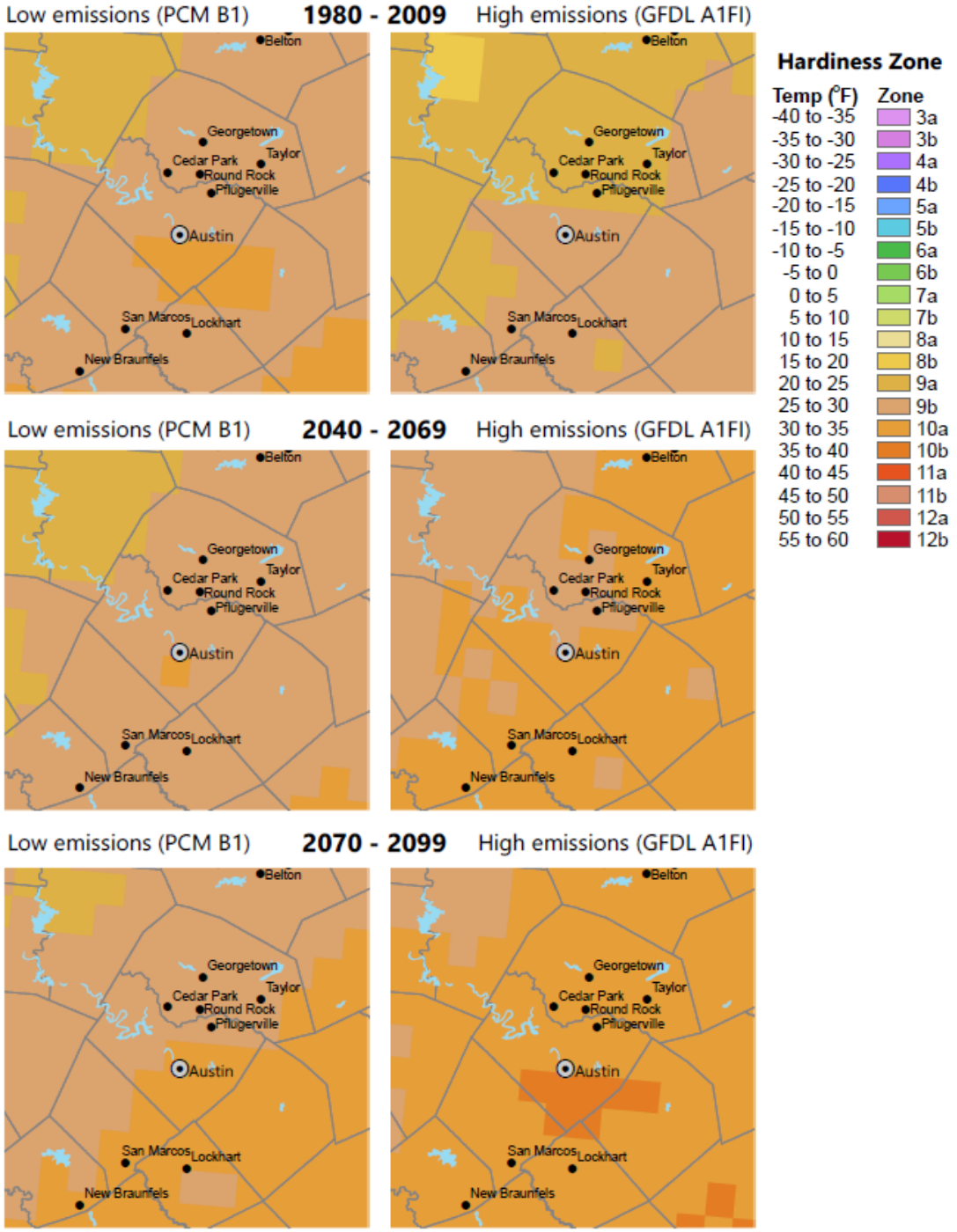


End of Century
-low emissions

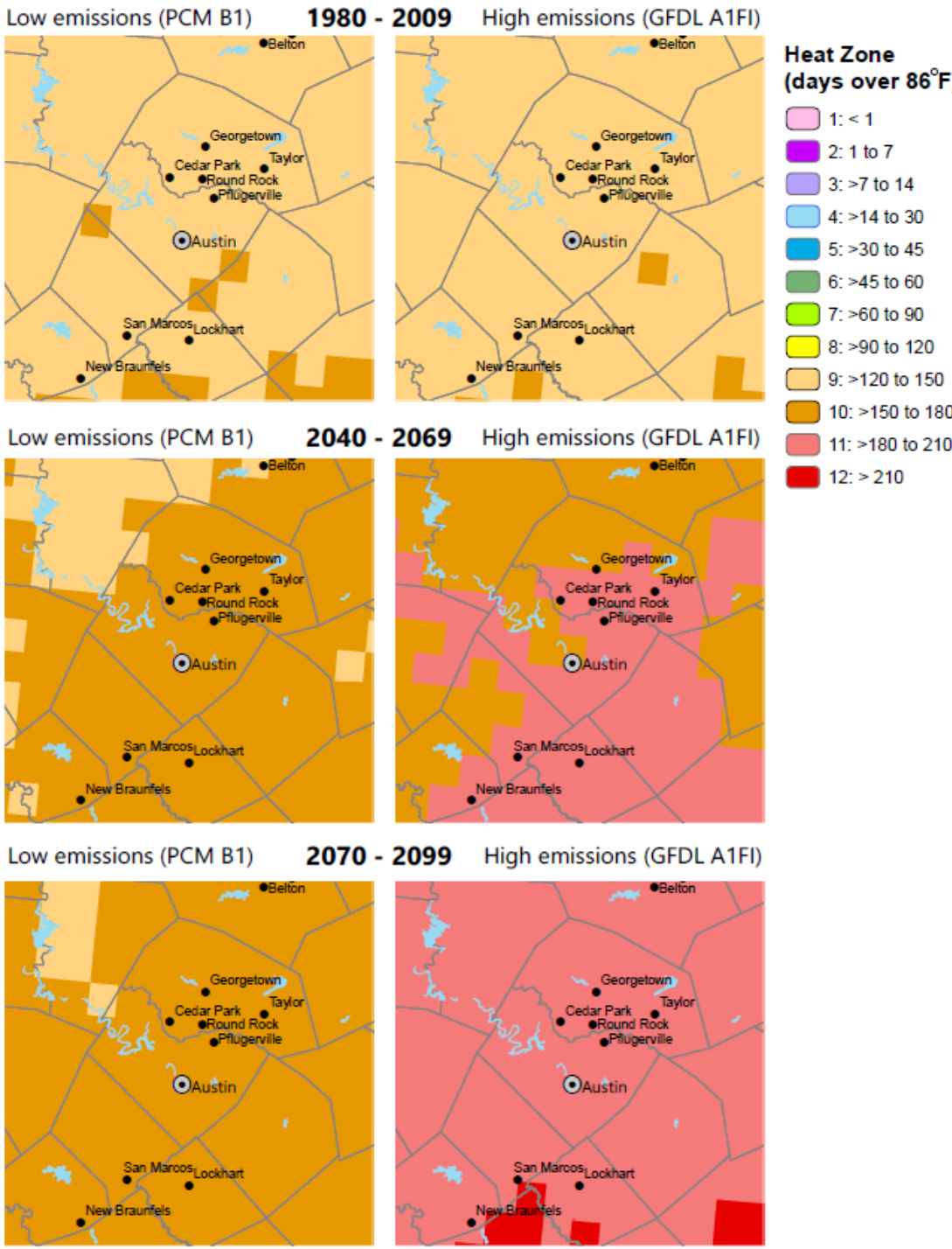
Impacts:
Non-native, rare species, shrubs, and cultivars

- 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

Shifts in Hardiness Zones



Shifts in Heat Zone



Species that Could Benefit from Warmer Temps

- mescal bean (Texas mountain laurel)
- Desert willow
- Texas persimmon
- Berlandier ash
- Mexican white oak
- Jerusalem thorn (Retama)
- Lindheimer's silktassel
- sweet acacia (Huisache)
- Anacacho orchid tree
- Montezuma cypress
- Brasil
- Mexican olive
- Mexican redbud
- Catclaw
- Texas kidneywood
- Mexican sycamore

Species that Could be Negative Affected by Warmer Temps

- Durand oak
- bastard oak (White shin)
- Buckley oak
- American smoketree
- bur oak
- Chinese privet
- eastern redbud
- glossy privet
- roughleaf dogwood
- hackberry
- boxelder
- sugarberry
- Osage orange
- Wafer ash
- chinkapin oak
- eastern cottonwood
- winged elm
- Shumard oak
- chittamwood, gum bumelia
- eastern redcedar
- pecan
- post oak
- black walnut
- green ash
- Texas ash
- Ashe juniper
- Chinese elm
- cedar elm
- western soapberry
- black willow
- Mexican plum
- slippery elm
- Blackjack oak
- Possumhaw
- Red buckeye
- rusty blackhaw
- sweetgum
- American sycamore
- water oak
- red mulberry
- Black hickory
- carolina buckthorn
- Mockernut hickory

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)

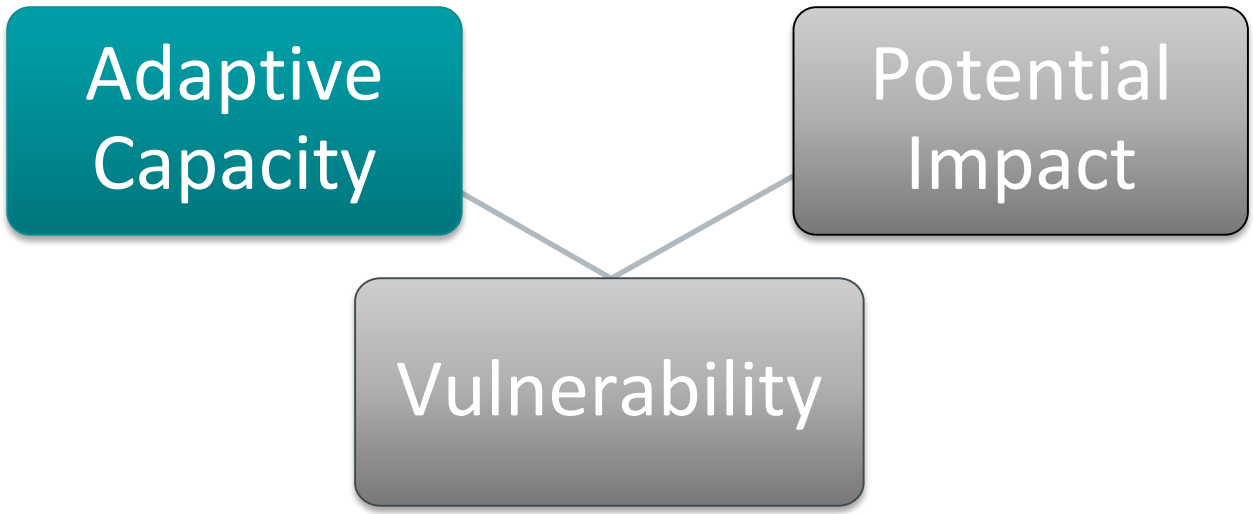
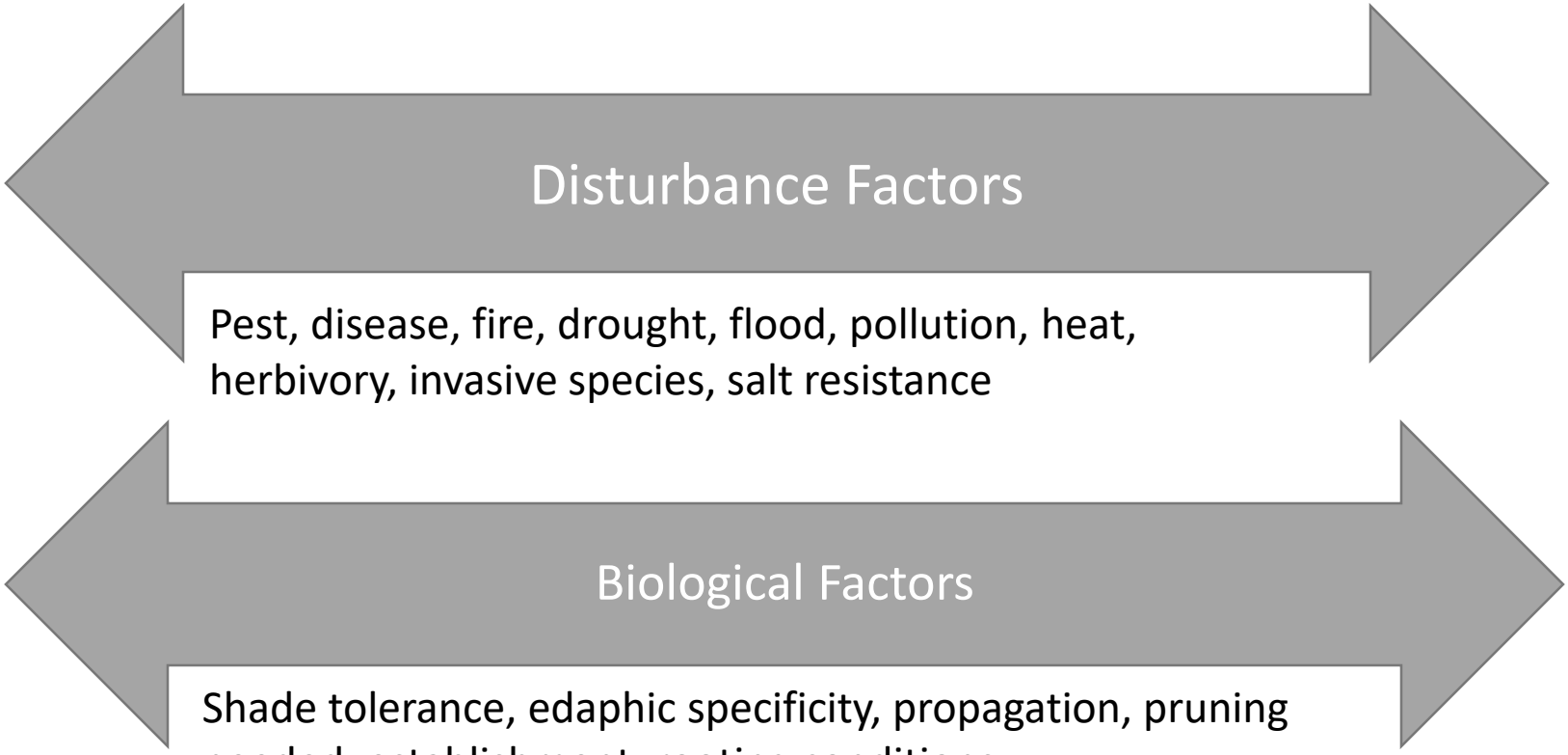


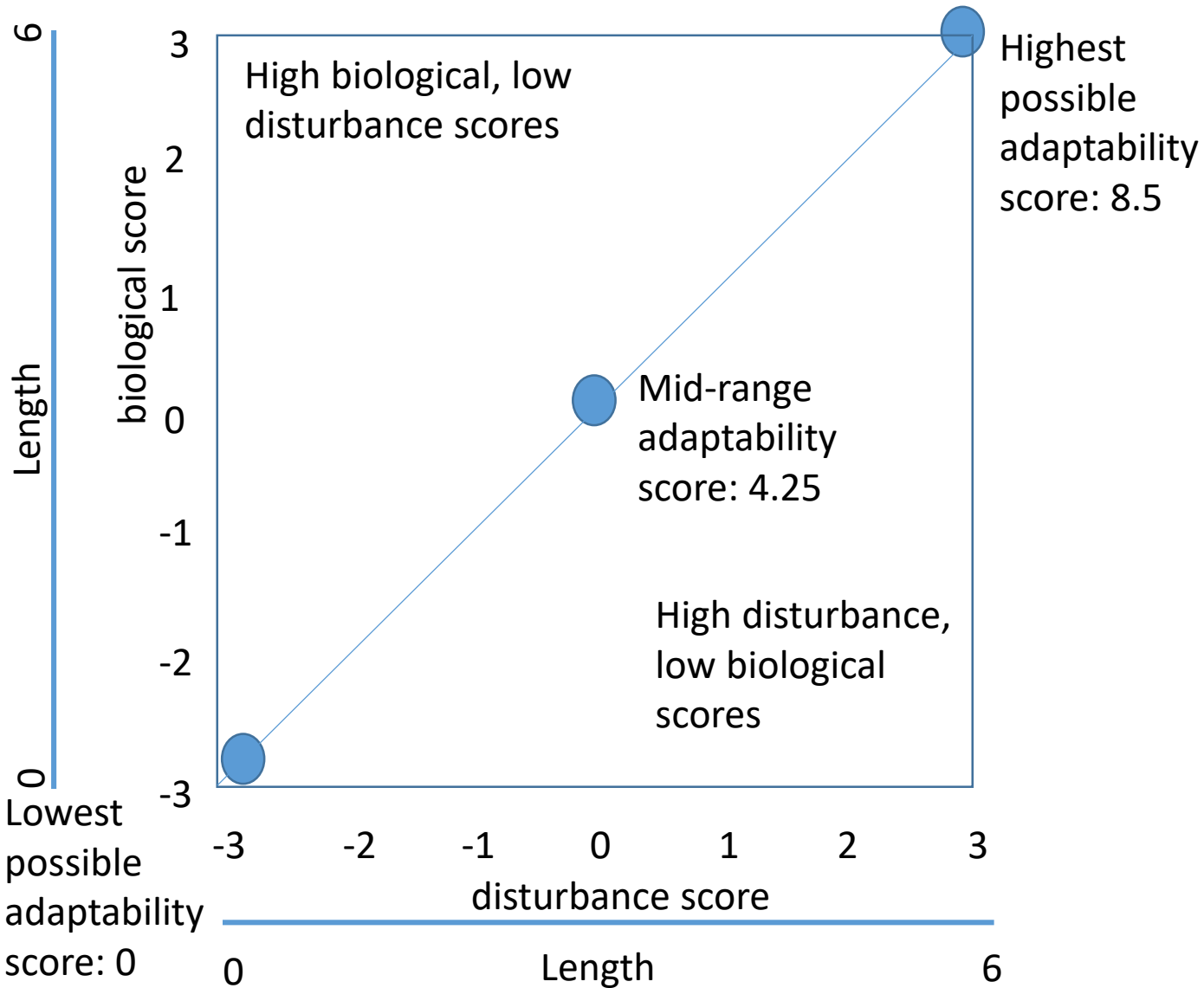
Figure: Glick et al. 2011

Adaptive Capacity Factors

Based on Matthews et al. 2011



ADAPTIVE CAPACITY SCORE



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

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

Most Adaptable Native Trees-Native trees in Natural Areas

- Fragrant sumac
- Boxelder
- prairie sumac
- roughleaf dogwood
- Crapemyrtle
- paper mulberry
- Prickly-ash,Tickle-tongue
- eastern redbud
- evergreen sumac
- Osage orange
- Hackberry
- bigtooth maple

Most Adaptable Trees-Planted Sites

- Texas red oak (Nutall Oak)
- eastern redbud
- bur oak
- goldenrain tree
- Chinese tallowtree
- baldcypress
- Chinese pistache
- Shumard oak
- Texas ash
- hackberry
- chittamwood, gum bumelia
- cherry laurel
- Chinese elm
- Mexican white oak
- western soapberry
- crapemyrtle
- yaupon
- glossy privet
- mescal bean (Texas mountain laurel)
- live oak

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

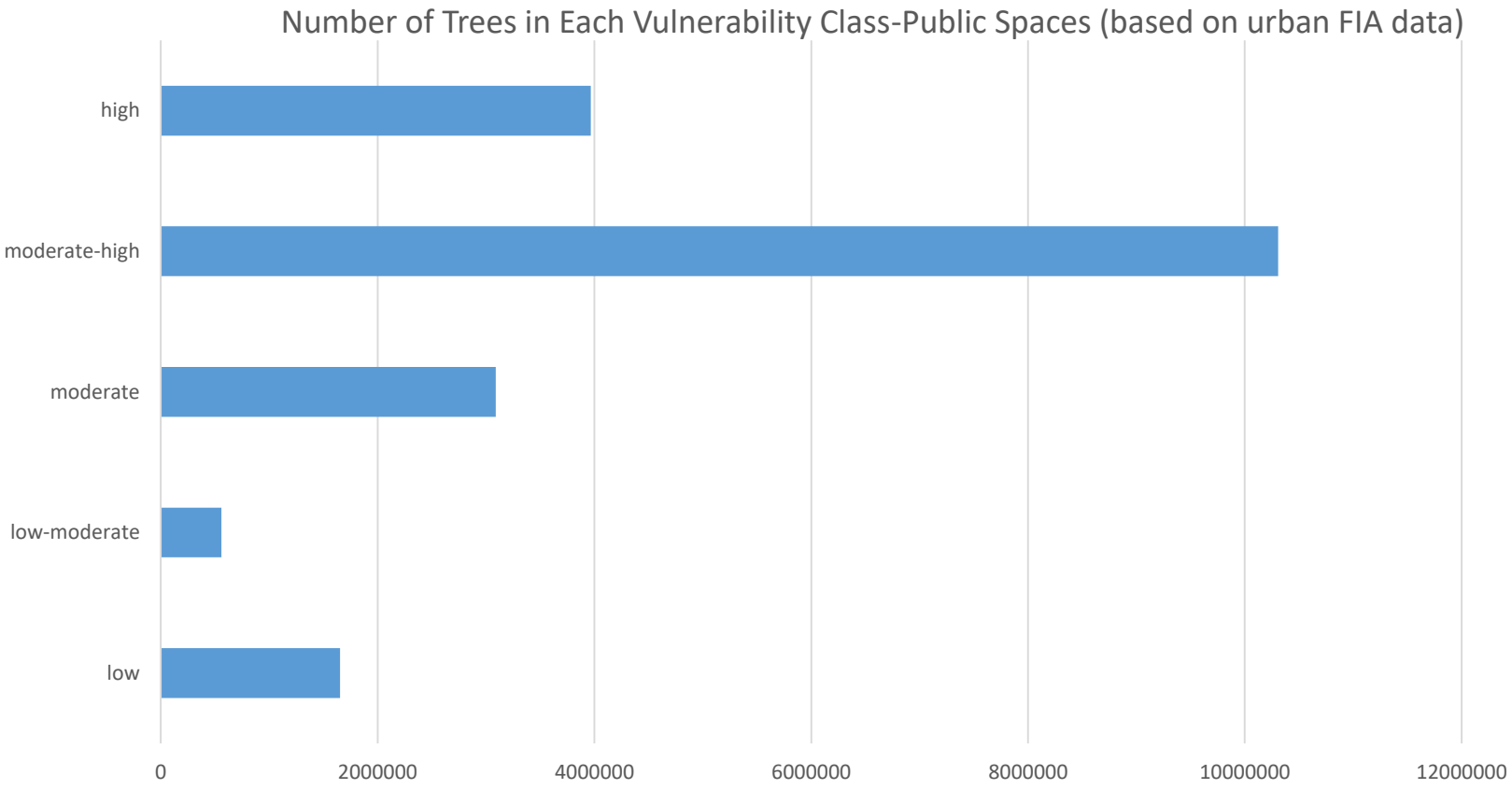
For species where information was available from the Tree Atlas, the following matrix was used to determine vulnerability:

	Adapt Class		
Projected Change in Habitat Suitability (Tree Atlas)	Low	Medium	High
decrease (both scenarios)	high	moderate-high	moderate
mixed results	moderate-high	moderate	low-moderate
no effect	moderate-high	low-moderate	low
increase (both scenarios)	moderate	low-moderate	low

For species where no model information was available, the following matrix was used to determine vulnerability:

	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

Vulnerability-Public Trees (based on natural adaptability)



Most Vulnerable Trees-Natural Areas

High Vulnerablity

- Durand oak
- bastard oak (White shin)
- Buckley oak
- cedar elm

Moderate-High Vulnerability

- Shumard oak
- chittamwood, gum bumelia
- eastern redcedar
- pecan
- western soapberry
- post oak
- black walnut
- green ash
- Texas live oak
- red mulberry
- Texas ash
- Ashe juniper

Lower Vulnerability Trees-Natural Areas

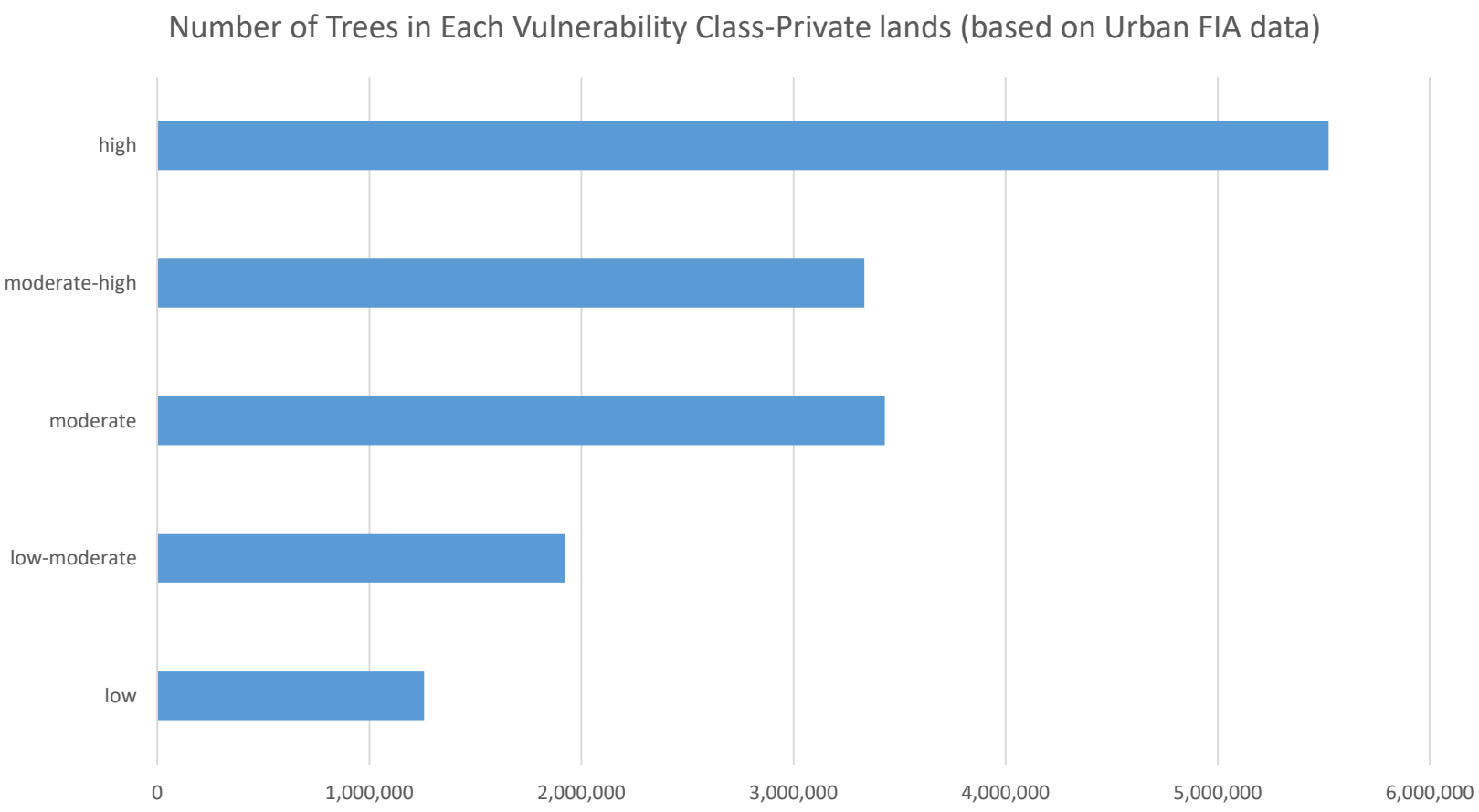
Low

- chinaberry
- prairie sumac
- paper mulberry
- yaupon
- Texas persimmon

Low-moderate

- Jerusalem thorn (Retama)
- honey mesquite

Vulnerability-Trees on private lands (based on planted/developed adaptability)



Most Vulnerable Trees-Developed Sites

High vulnerability

- mimosa, silktree
- black walnut
- post oak
- eastern cottonwood
- pecan
- Ashe juniper

Moderate-High Vulnerability

- edible fig
- water oak
- southern magnolia
- American elm
- chinkapin oak
- slippery elm
- Japanese privet
- velvet ash
- Buckley oak
- Chinese privet
- American sycamore
- winged elm
- boxelder
- sugarberry
- green ash
- cedar elm
- eastern redcedar

Lower Vulnerability Trees-Developed Sites

Low

- Mexican white oak
- yaupon
- mescal bean (Texas mountain laurel)

Low-moderate

- Texas madrone
- paper mulberry
- honey mesquite
- Berlandier ash
- chinaberry
- Texas persimmon

Key Points

- Species at southwestern extent of their ranges are expected to lose habitat
- Not many species expected to gain newly suitable habitat
- Species that are heat, drought, and flood-adapted and pest/disease resistant are least vulnerable
- Ashe juniper (the most abundant species) is considered vulnerable to loss of suitable habitat

Introduction to Assessment Process

Vulnerability

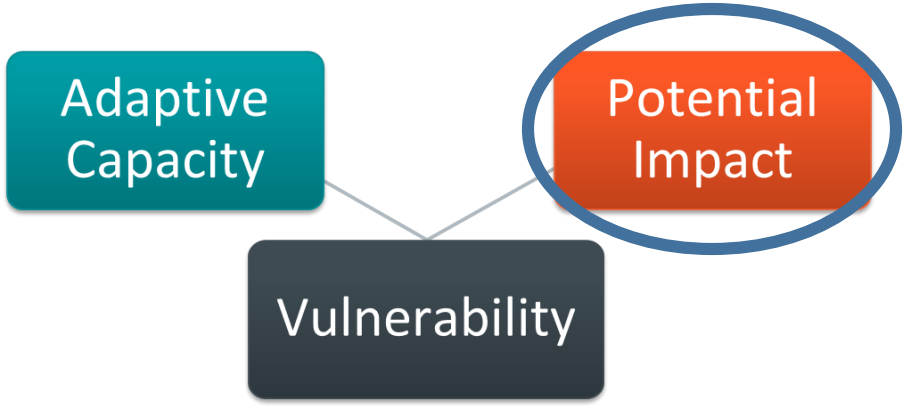
The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2007)

Figure: Glick et al. 2011

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
- Rate potential impacts

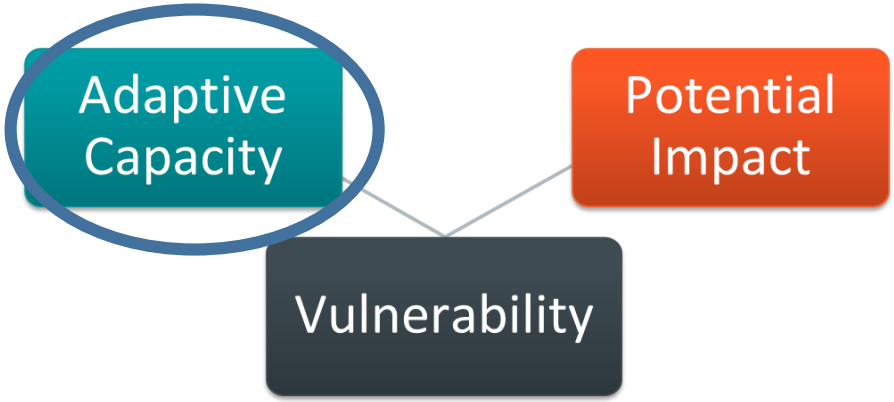
  (Positive ↔Negative)



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
  - **<u>Social, economic, organizational capacity</u>**
- Rate adaptive capacity

  (Low↔High)



Potential Impacts-Natural Areas

- Direct and indirect climate change effects
- For each ecosystem, how will climate change affect…
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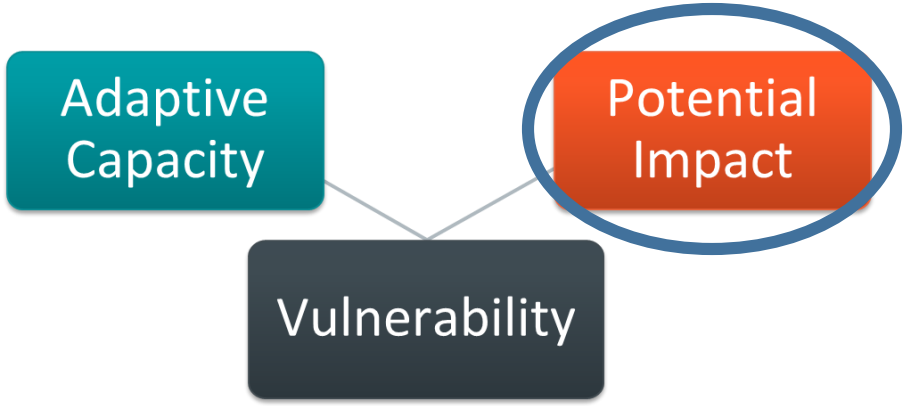
- Rate potential impacts

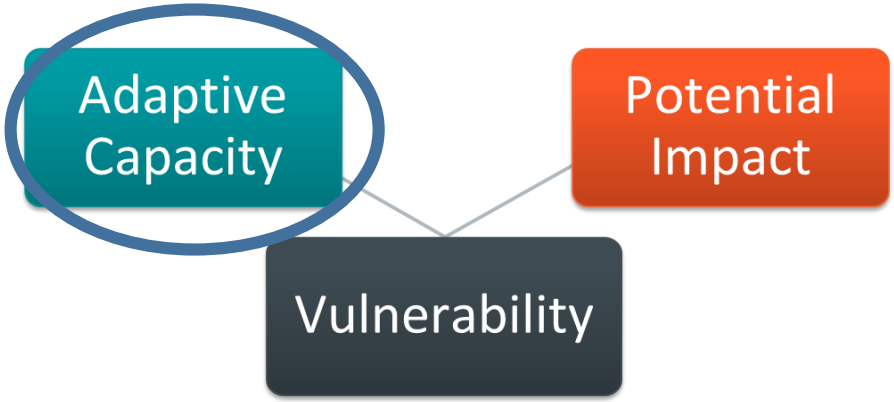
  (Positive ↔Negative)



Adaptive Capacity-Developed Sites

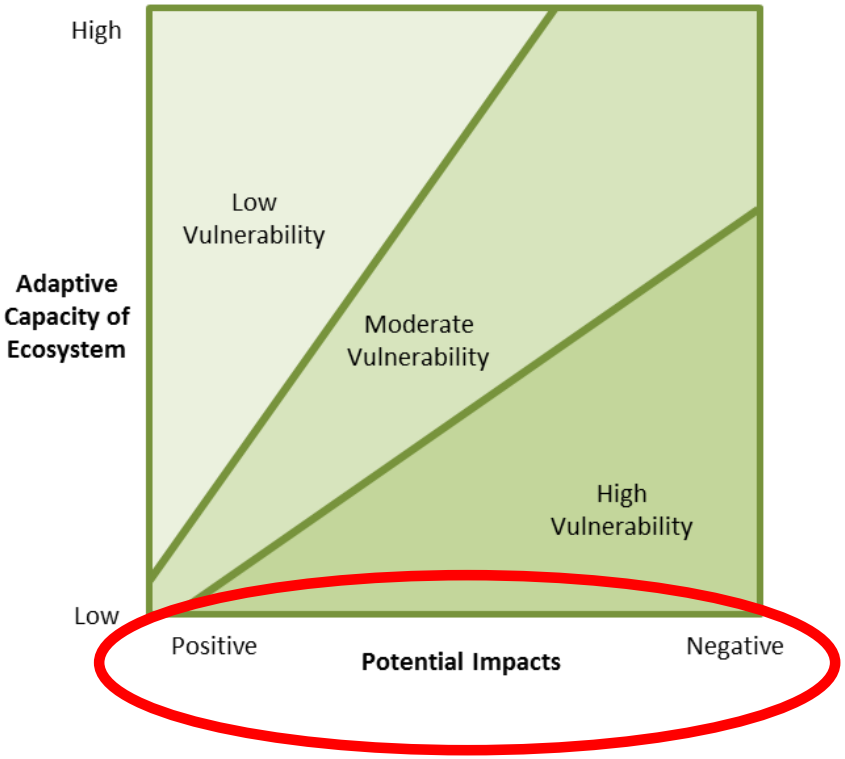
- Ability of ecosystem to cope with changes ….not management
- For each forest system, how resilient is it based on…
  - Dominant species response to environmental shifts *(phenotypic plasticity)*
  - Diversity *(e.g., species, functional, genetic)*
  - Response to enhanced disturbances
- Rate adaptive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

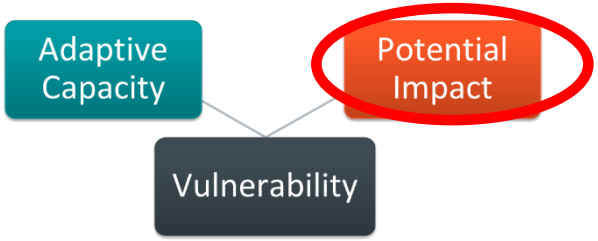
  (Low↔High)



Vulnerability Determination

1) Assess **impacts** on a system (individually)

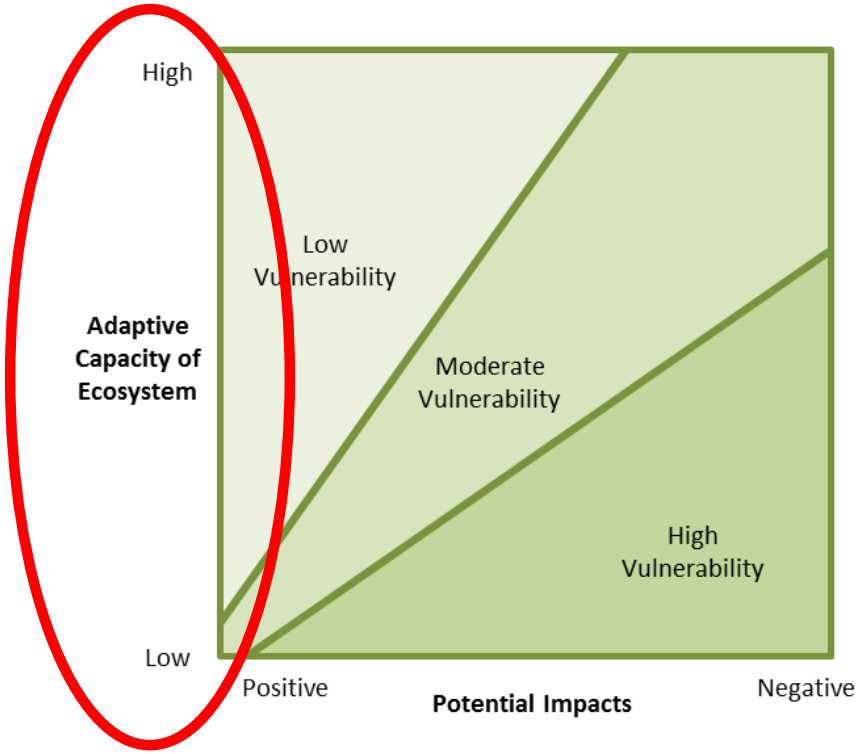




(On Worksheets)

Vulnerability Determination

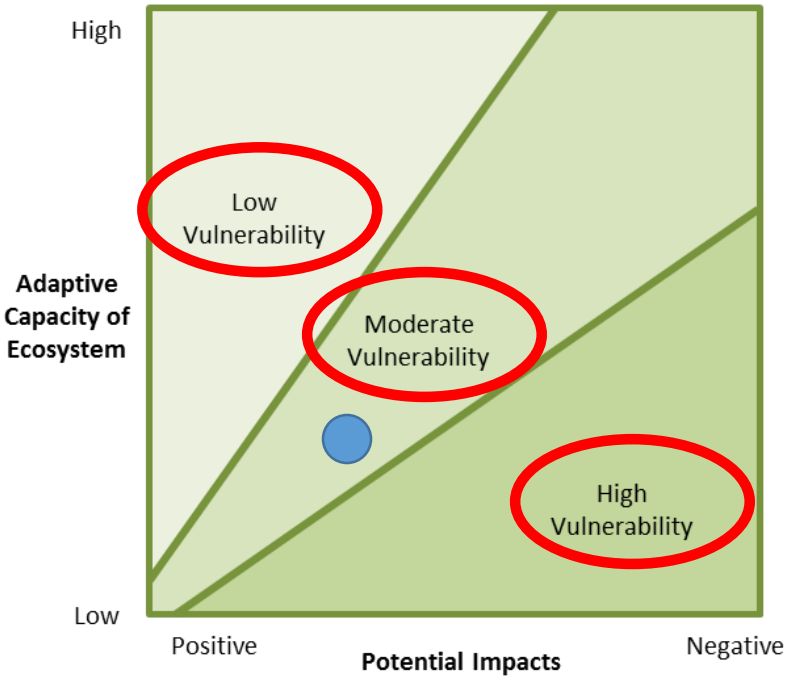
2) Assess **adaptive capacity** of a forest system (individually)



(On Worksheets)

Vulnerability Determination

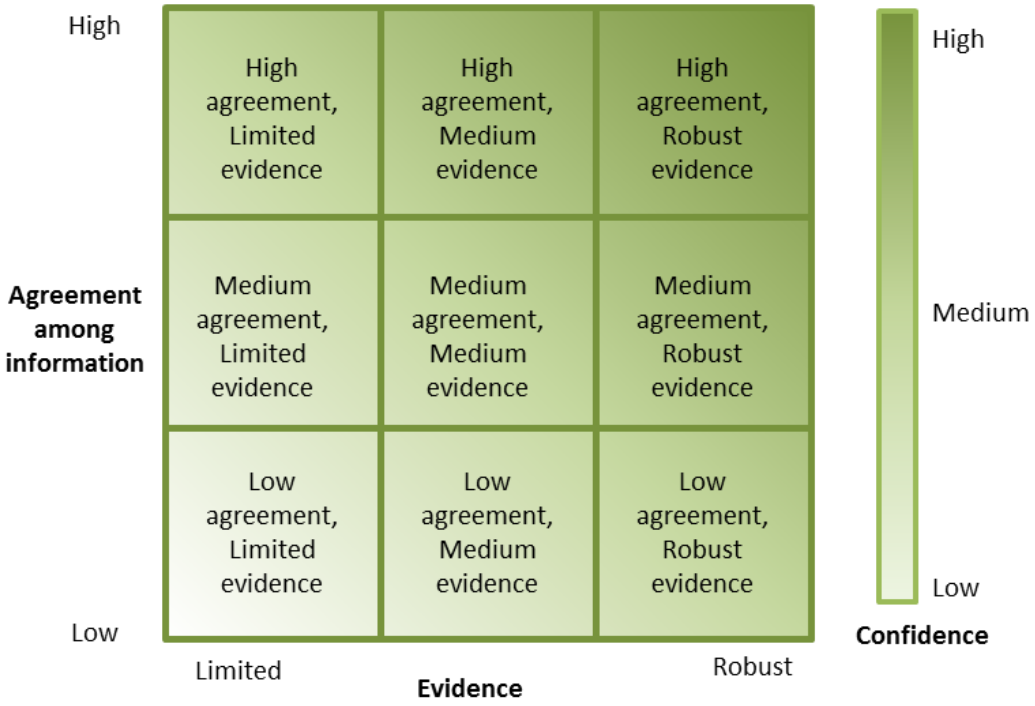
3) Determine the **vulnerability** based upon impacts and adaptive capacity (individually)



(On Worksheets)

Vulnerability Determination

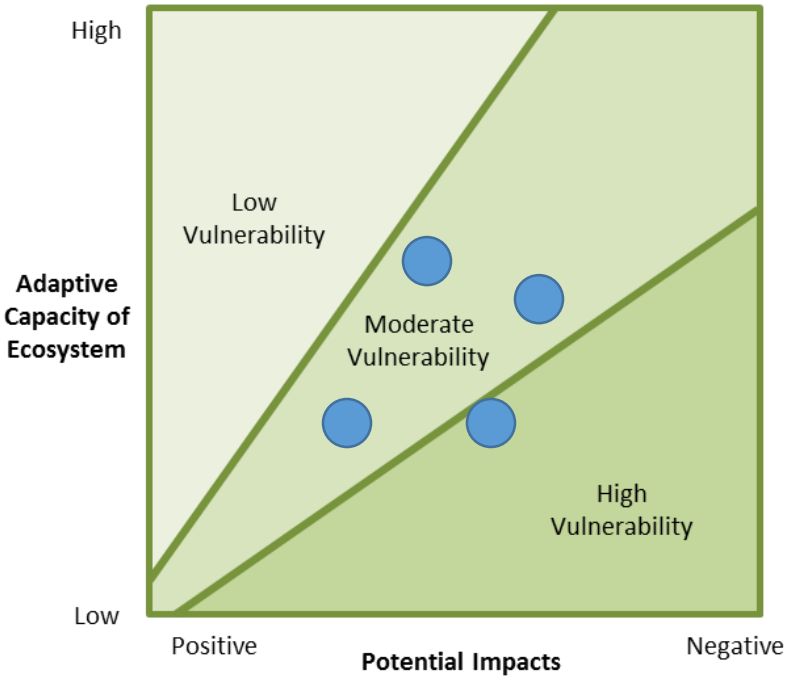
4) Consider **evidence** and **agreement** to rate your level of **confidence** in that vulnerability rating (individually)

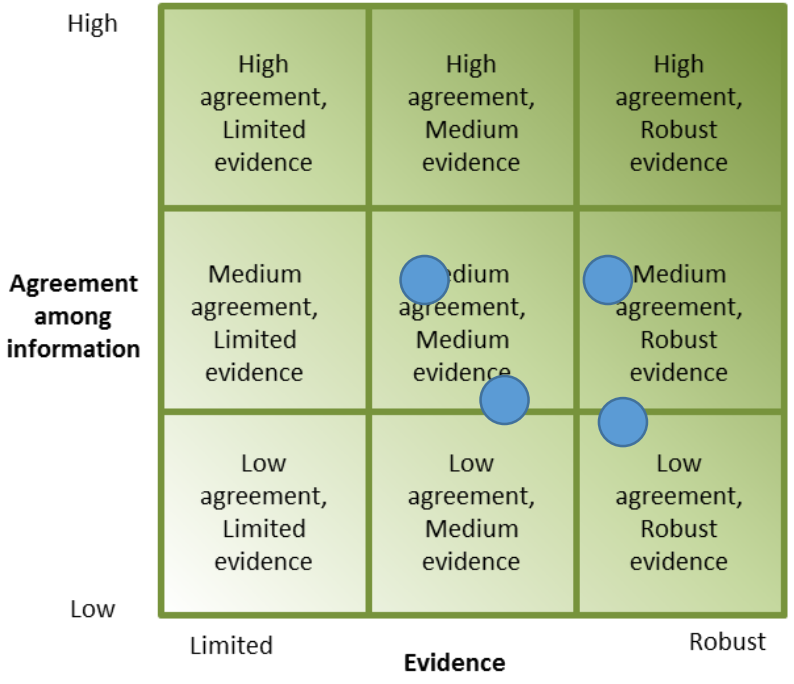


(On Worksheets)

Vulnerability Determination

5) As a group, consider individual ratings

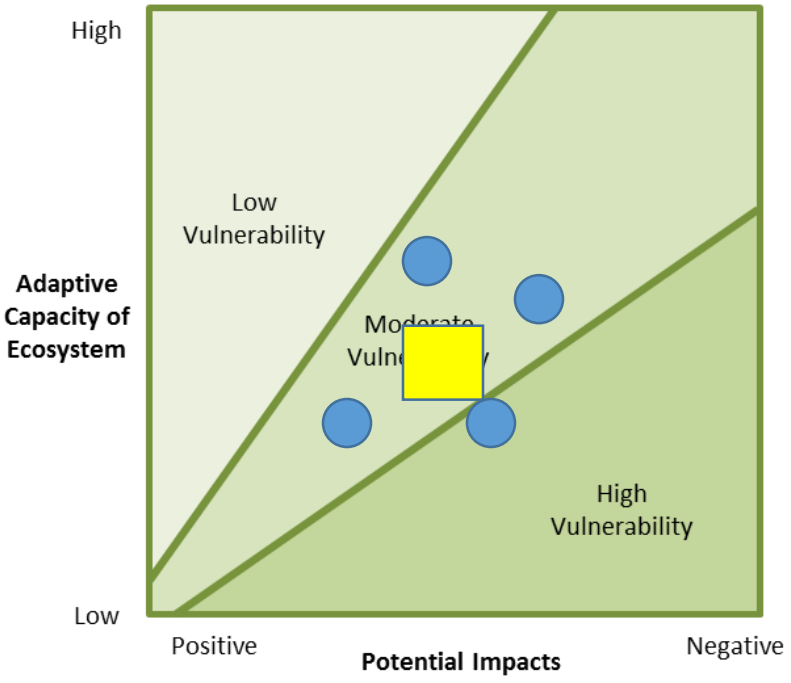


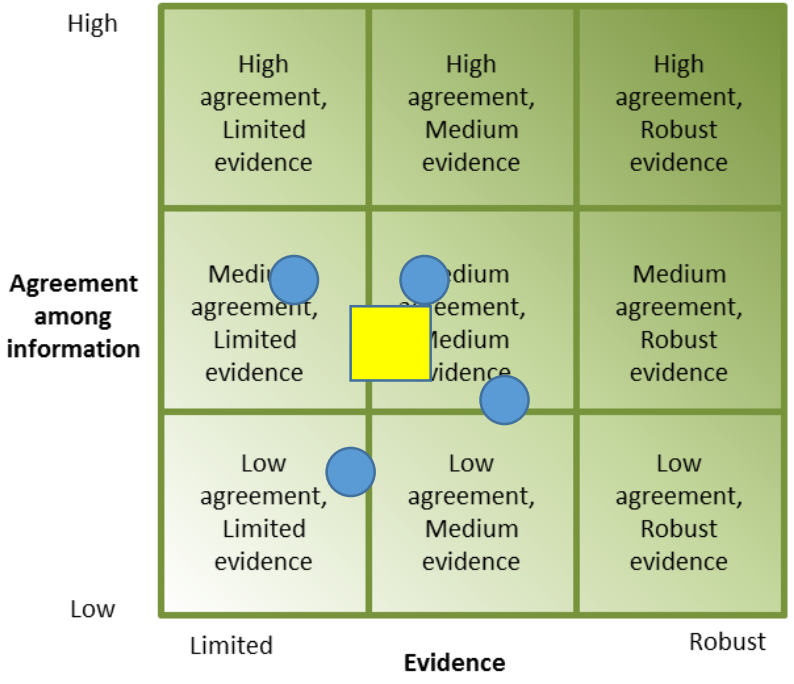


(On Large Poster)

Vulnerability Determination

6) As a group, come to consensus on overall **vulnerability** and **confidence** for each forest type





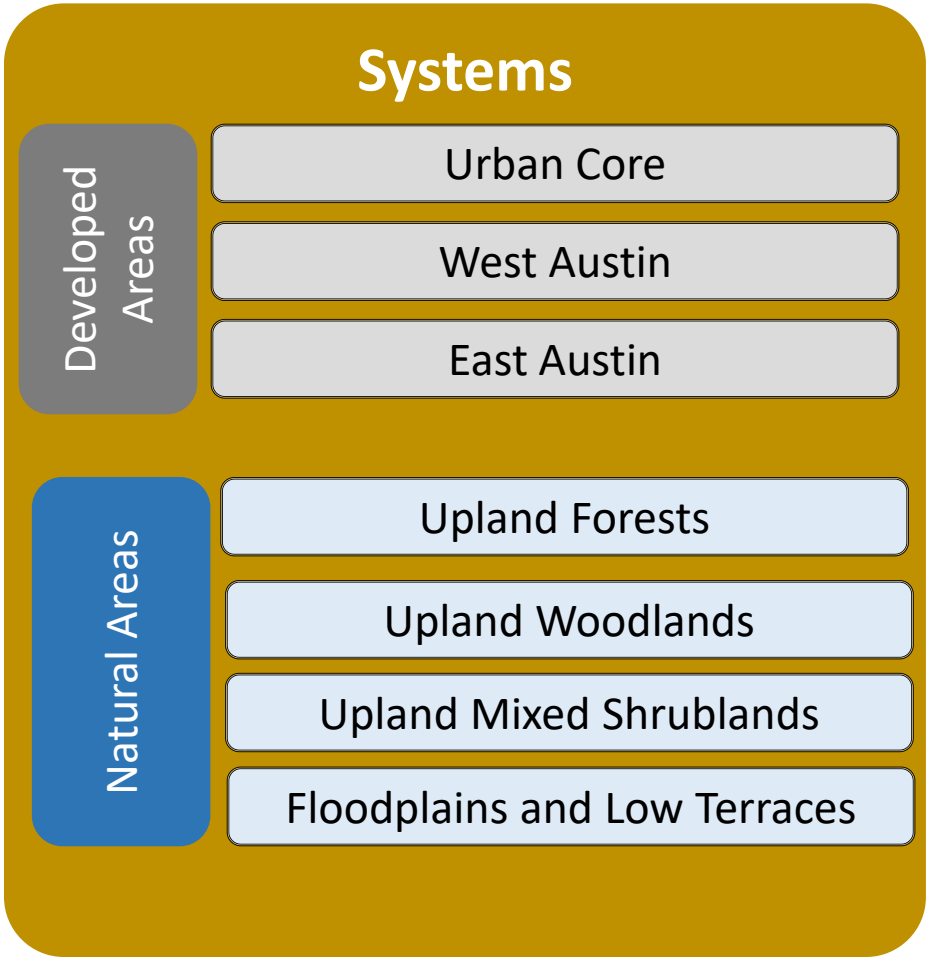
(On Large Poster)

Systems we will Consider

For each, consider current:

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

Then consider likely changes over the next 80 years



Urban Core

Downtown and other highly developed areas.

Key Characteristics

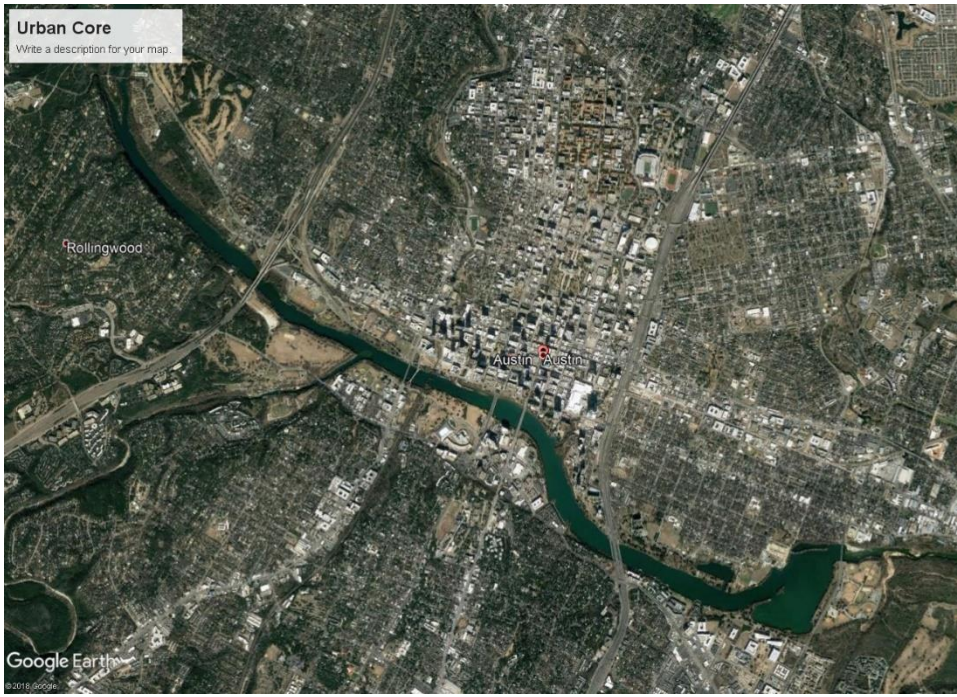
- Low canopy cover
- High impervious surface
- High development
- High population density

Dominant/Important Species

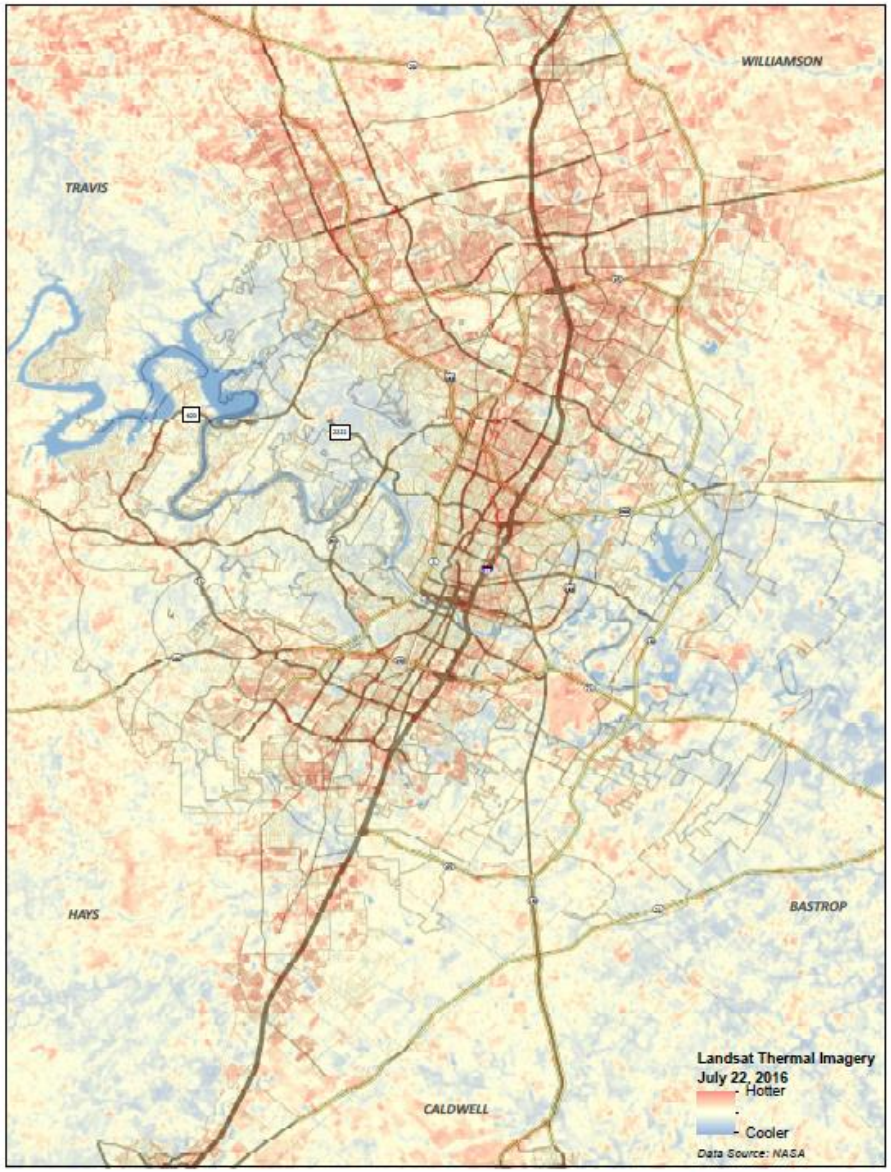
- Ashe Juniper
- Mescal Bean
- Live Oak

Key Stressors

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



Urban Heat Island



Urban Heat Island

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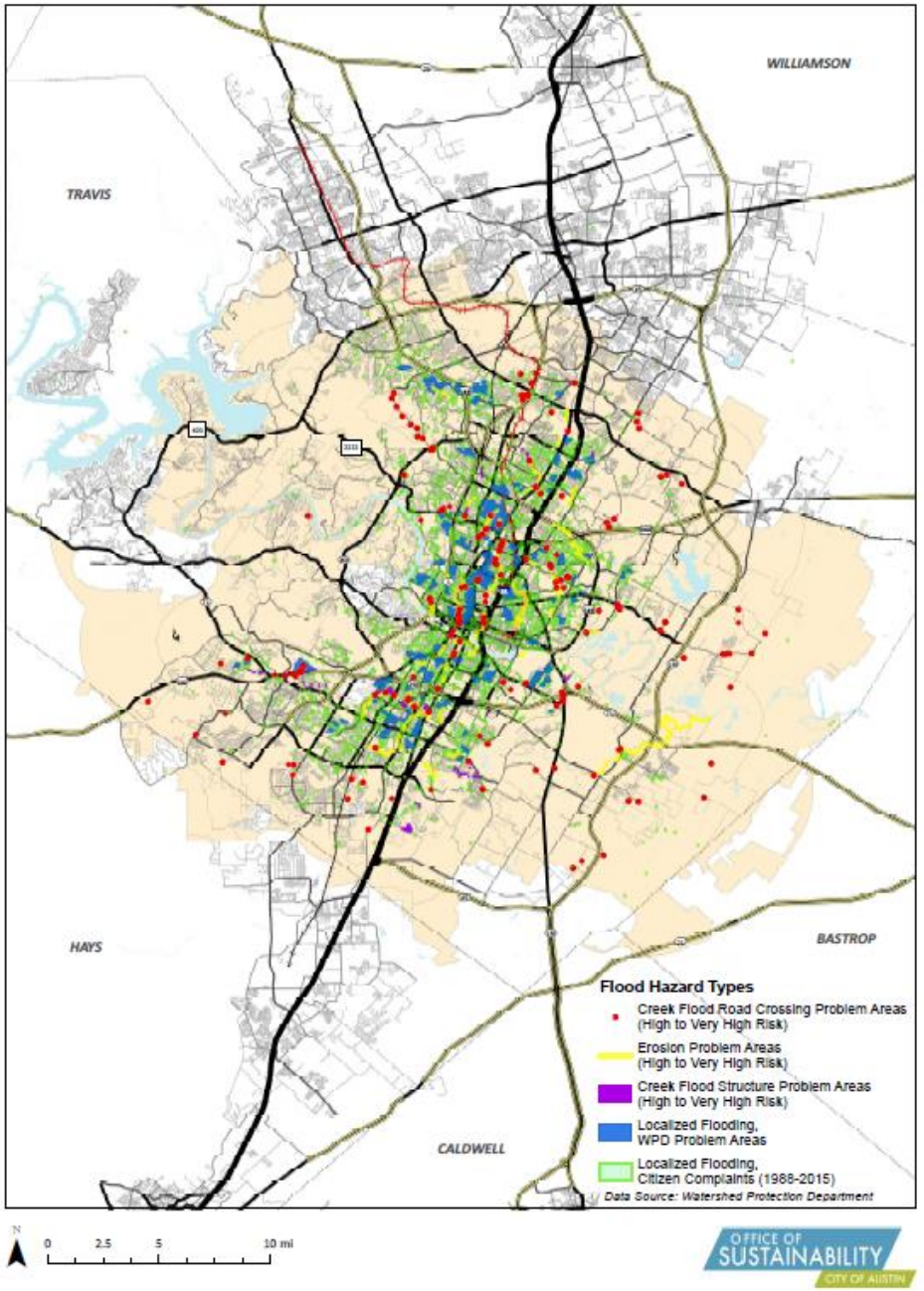
City of Austin, Printed January 6, 2017

Localized Flooding



Localized Flood Hazards

Climate Resilience Plan: Vulnerability Assessment

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West Austin

Low-medium density developed areas west of I-35/ on Edwards plateau

Key Characteristics

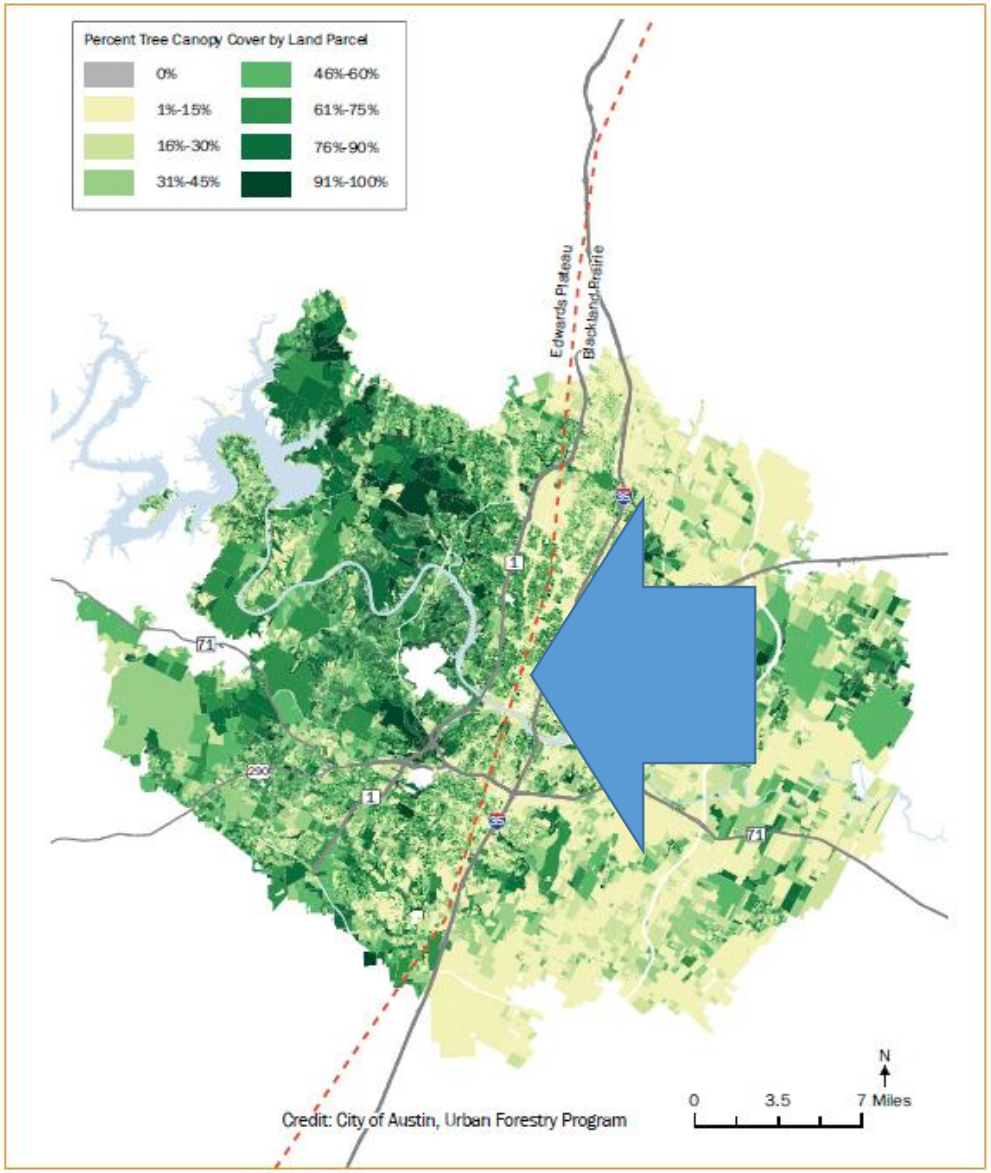
- Higher canopy cover
- Some impervious surface
- Low-medium development
- Medium population density

Dominant/Important Species

- Ashe juniper
- Live oak
- Texas persimmon
- Cedar elm

Key Stressors

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



East Austin

Low-medium density developed areas east of I-35/ on Blackland prairie

Key Characteristics

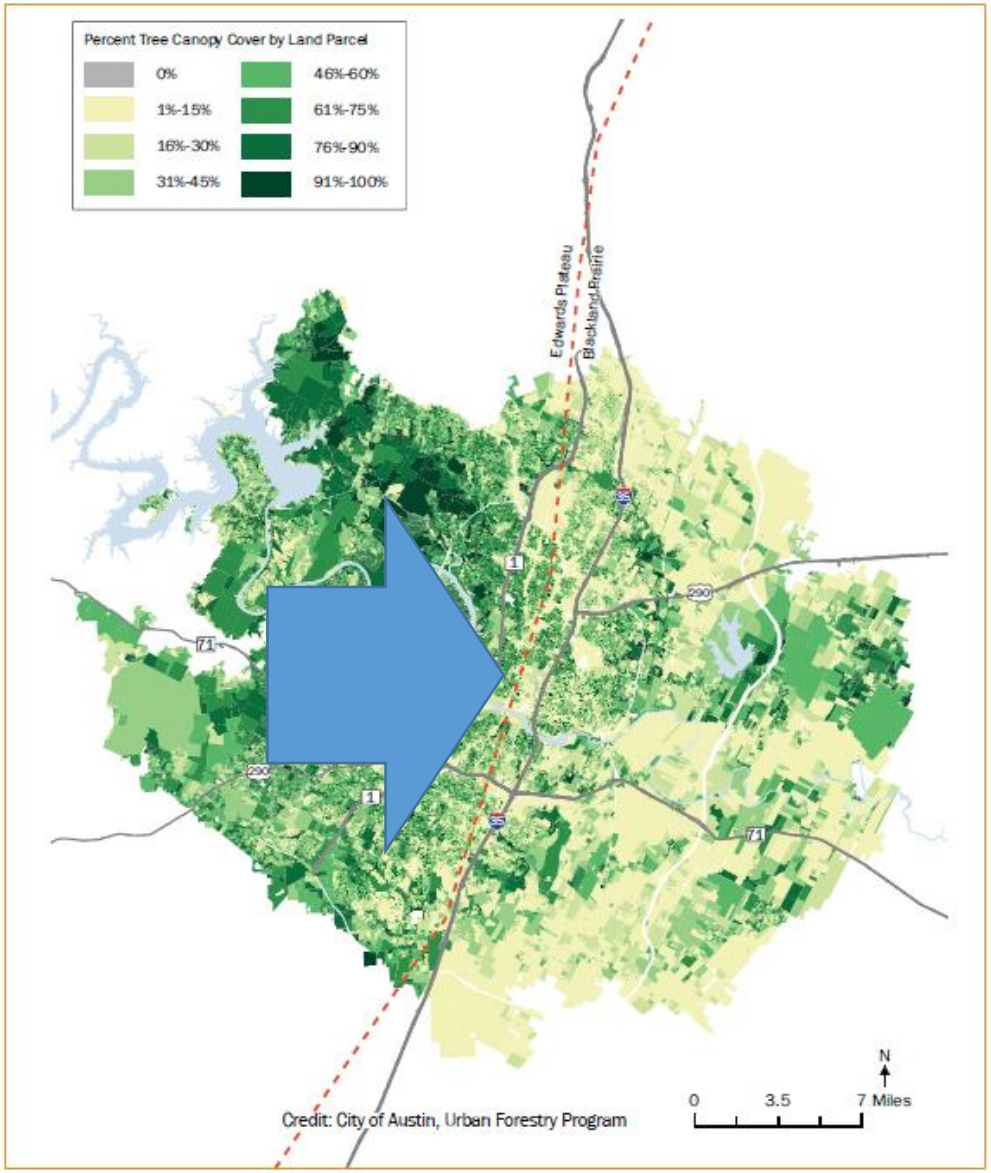
- Lower canopy cover
- Some impervious surface
- Low-medium development
- Medium population density

Dominant/Important Species

- Ashe juniper
- Live oak
- Texas persimmon

Key Stressors

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



Upland Forests

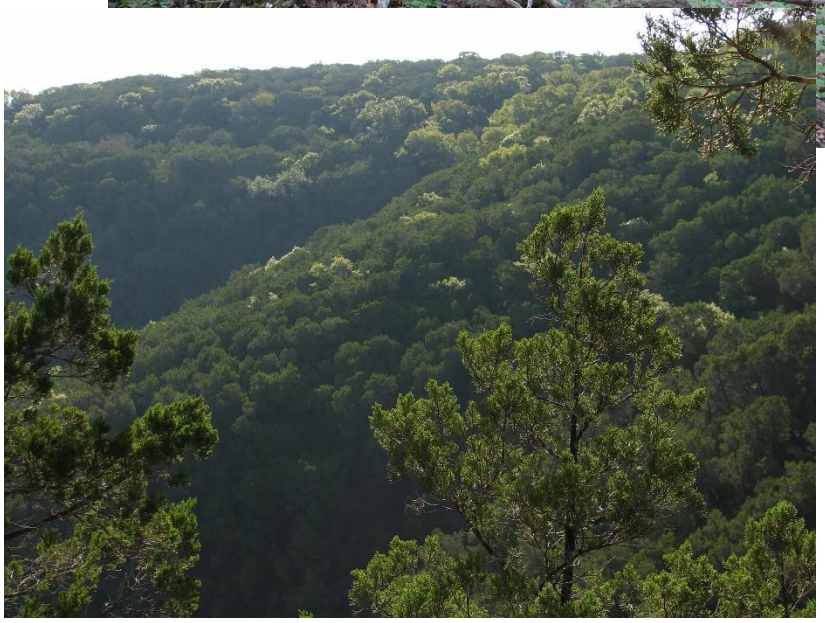
More closed-canopy areas within the Edwards Plateau/Balcones canyonlands

Drivers

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

Dominant/Important Species

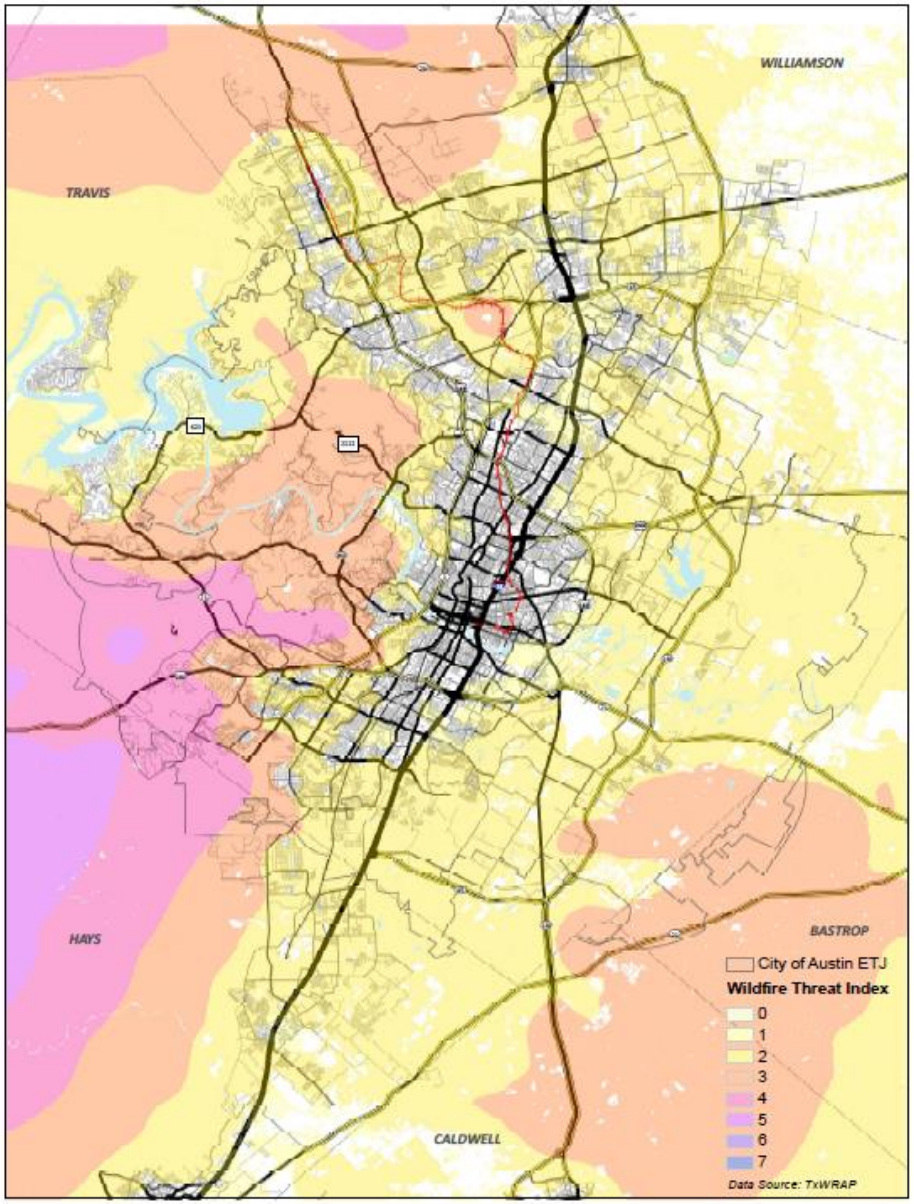
- Live oak
- Cedar elm
- Ashe juniper
- Texas persimmon
- Sugar hackberry



Key stressors

- Wildfire
- Drought
- Oak wilt
- Invasive plants

Wildfire Hazards



Wildfire Hazard Zones

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Wildland-Urban Interface

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

Upland Woodlands

Moderate canopy cover with herbaceous and graminoid layer.

Drivers

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

Dominant/Important Species

- Escarpment live oak
- Post oak
- Texas/buckley oak

Stressors

- Wildfire suppression
- Overgrazing
- Drought
- Oak wilt

Upland Mixed Shrubland

Shrub-dominated systems within the Edwards Plateau and Blackland Prairie

Drivers

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

Dominant/Important Species

- Escarpment live oak
- White shin oak
- Lacey oak
- Ashe juniper
- Post oak
- Live oak
- Honey mesquite

Stressors

- Overgrazing
- Wildfire suppression
- Invasive woody shrubs

Floodplains and Terraces

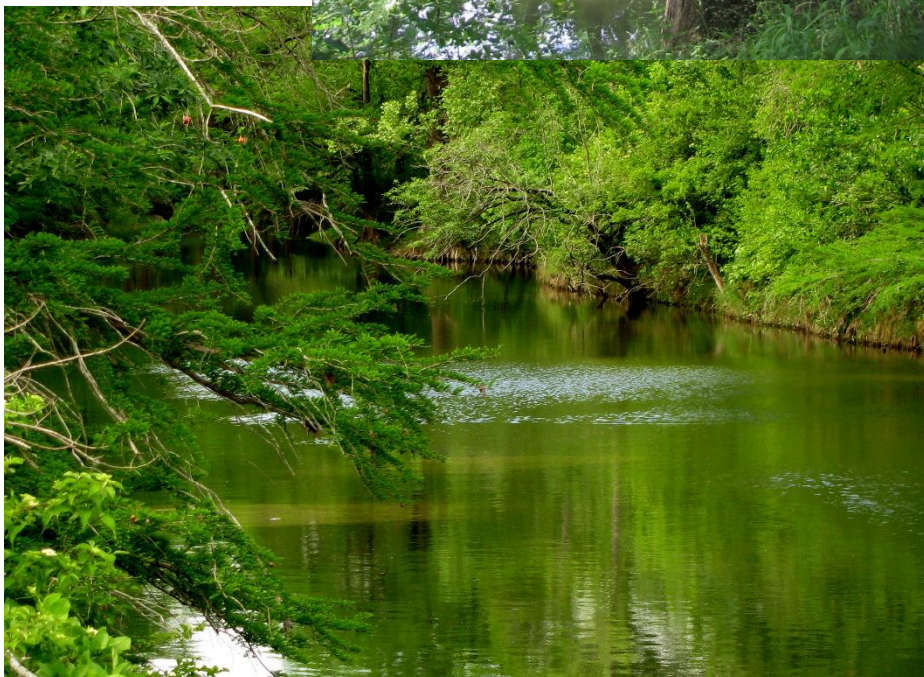
Forested floodplain and riparian areas within the Blackland Prairie and Edwards Plateau ecoregions.

Drivers

- List drivers

Dominant/Important Species

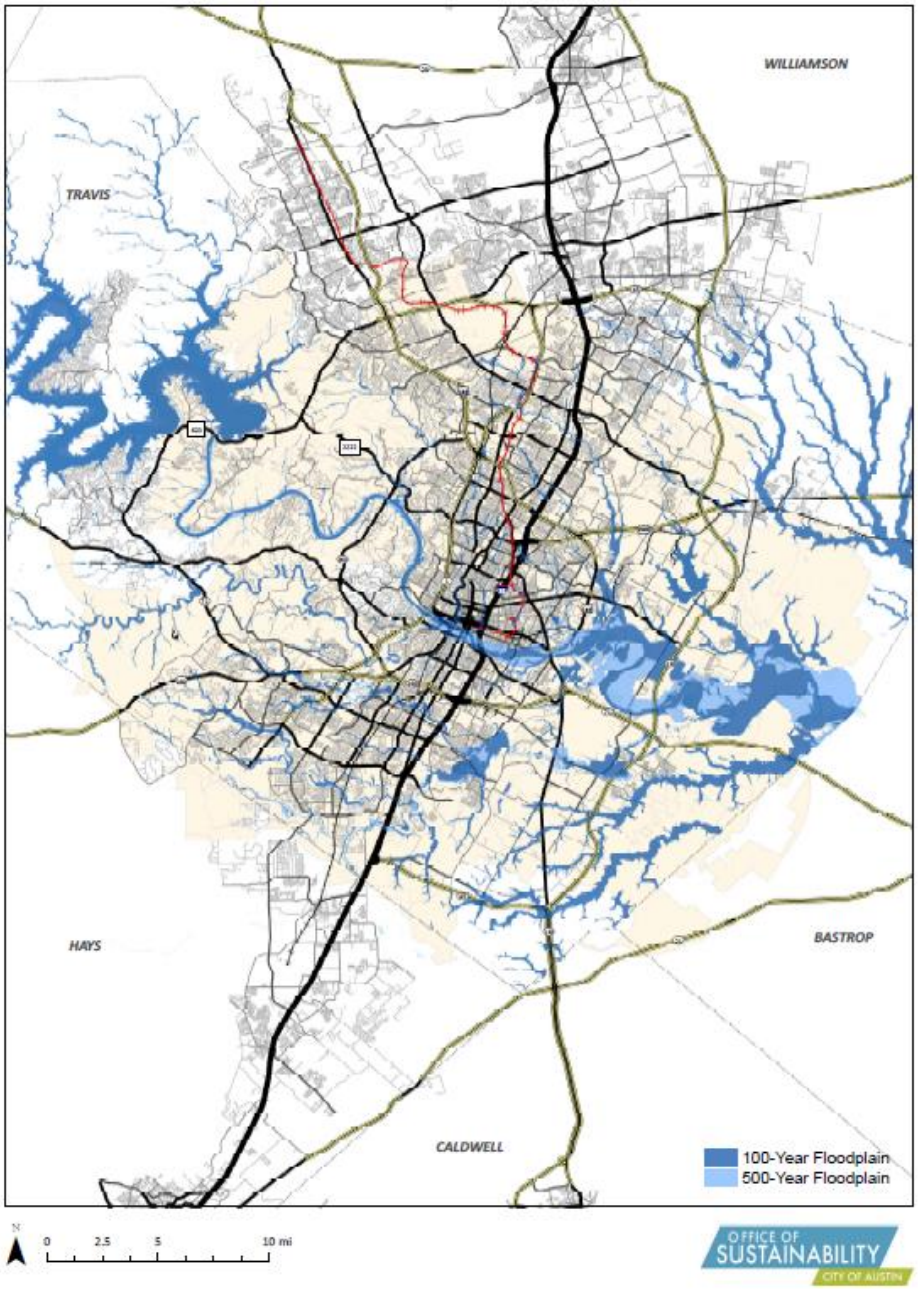
- Sugar hackberry
- Cedar Elm
- Green Ash
- American sycamore
- Eastern Cottonwood
- Pecan



Stressors

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

Flood Risks



FEMA Floodplains

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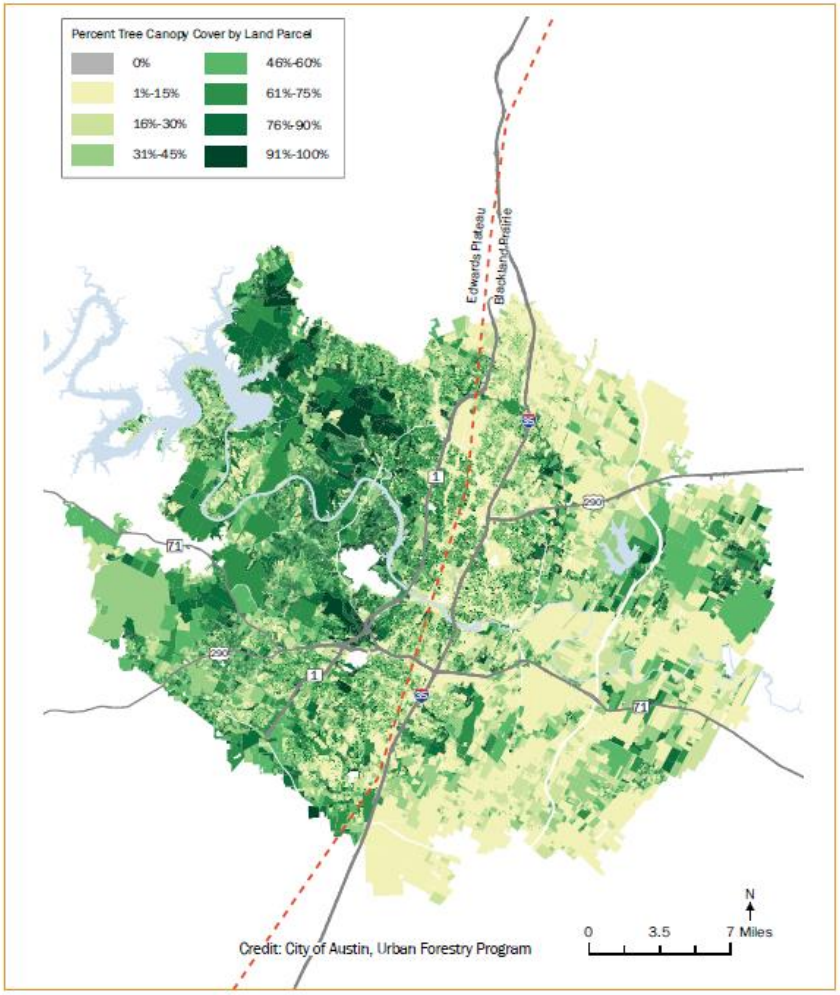
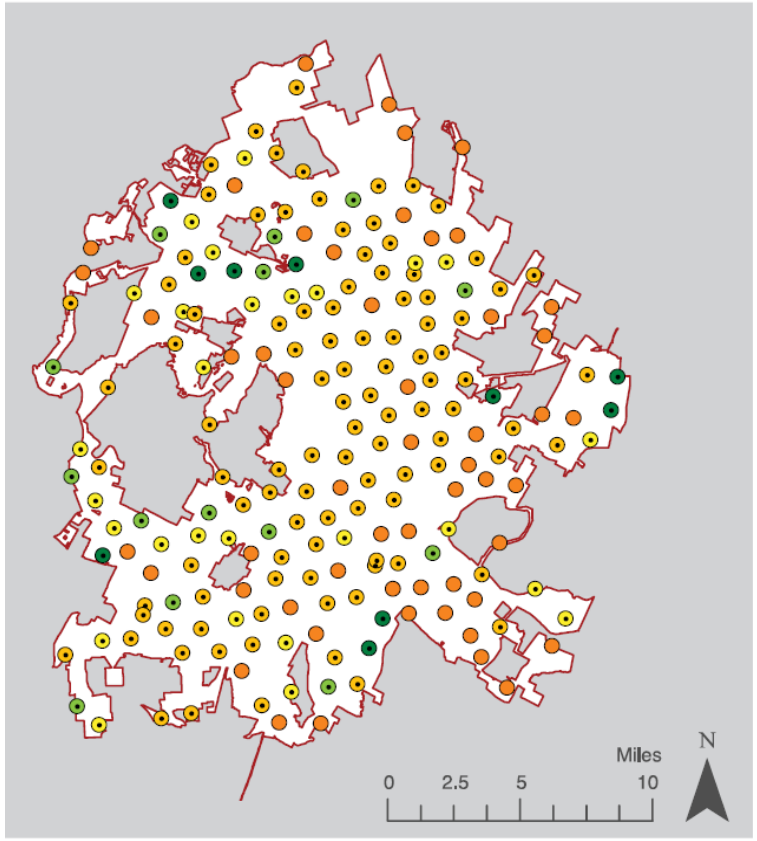
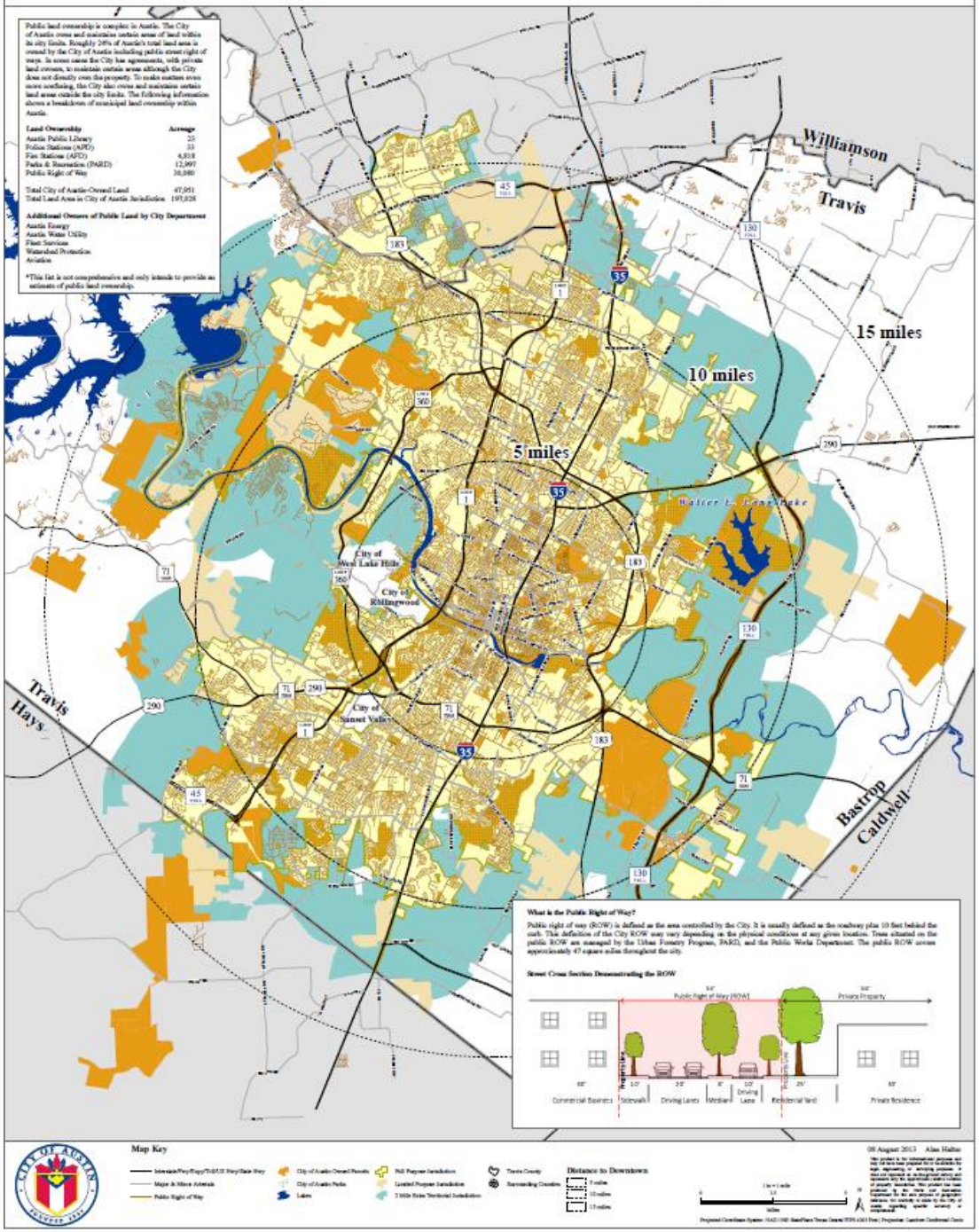
Additional maps and information





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

City of Austin Jurisdiction & Land Ownership



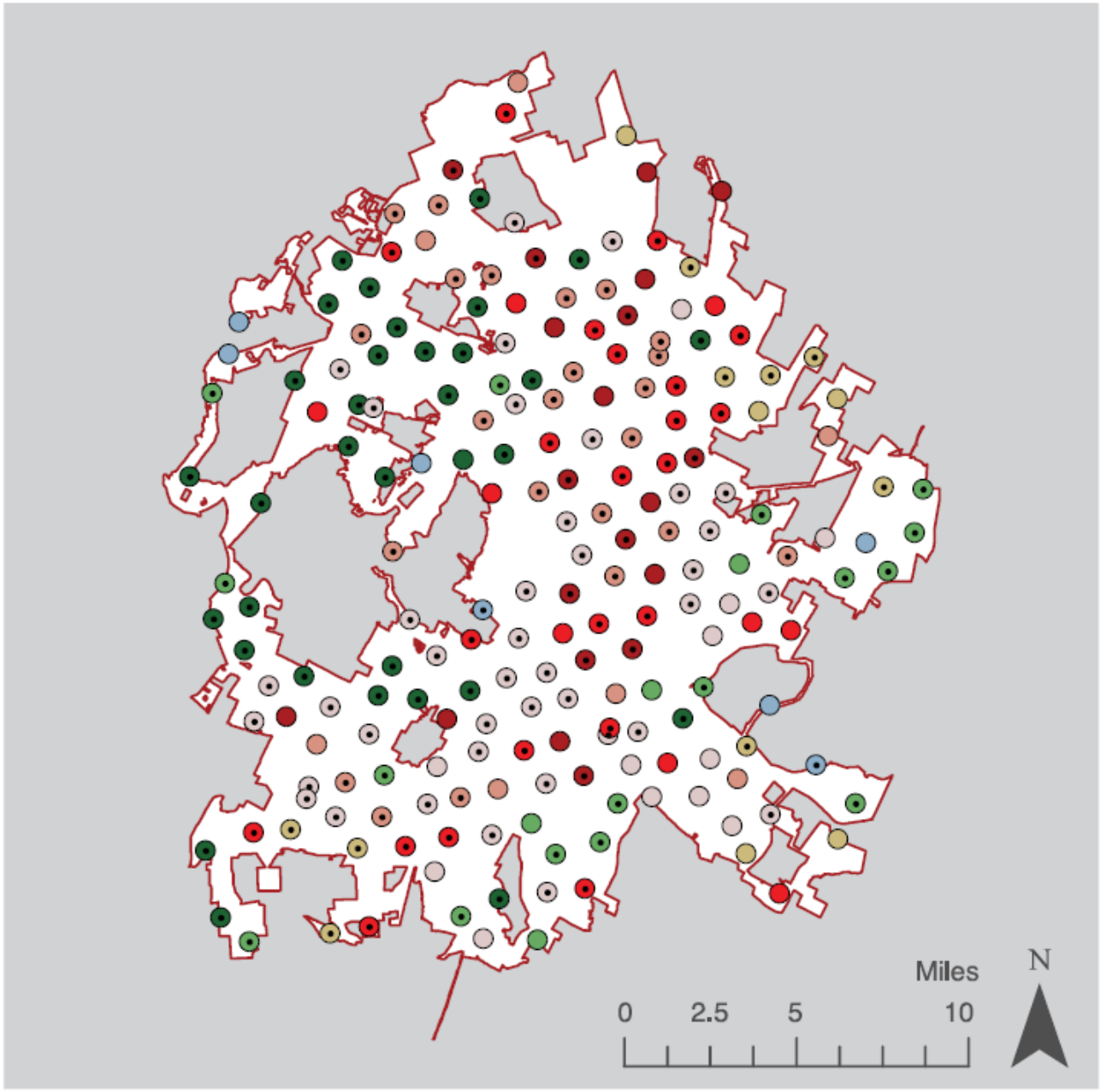


Figure 6.—Plot distribution by land cover, Austin, 2014.

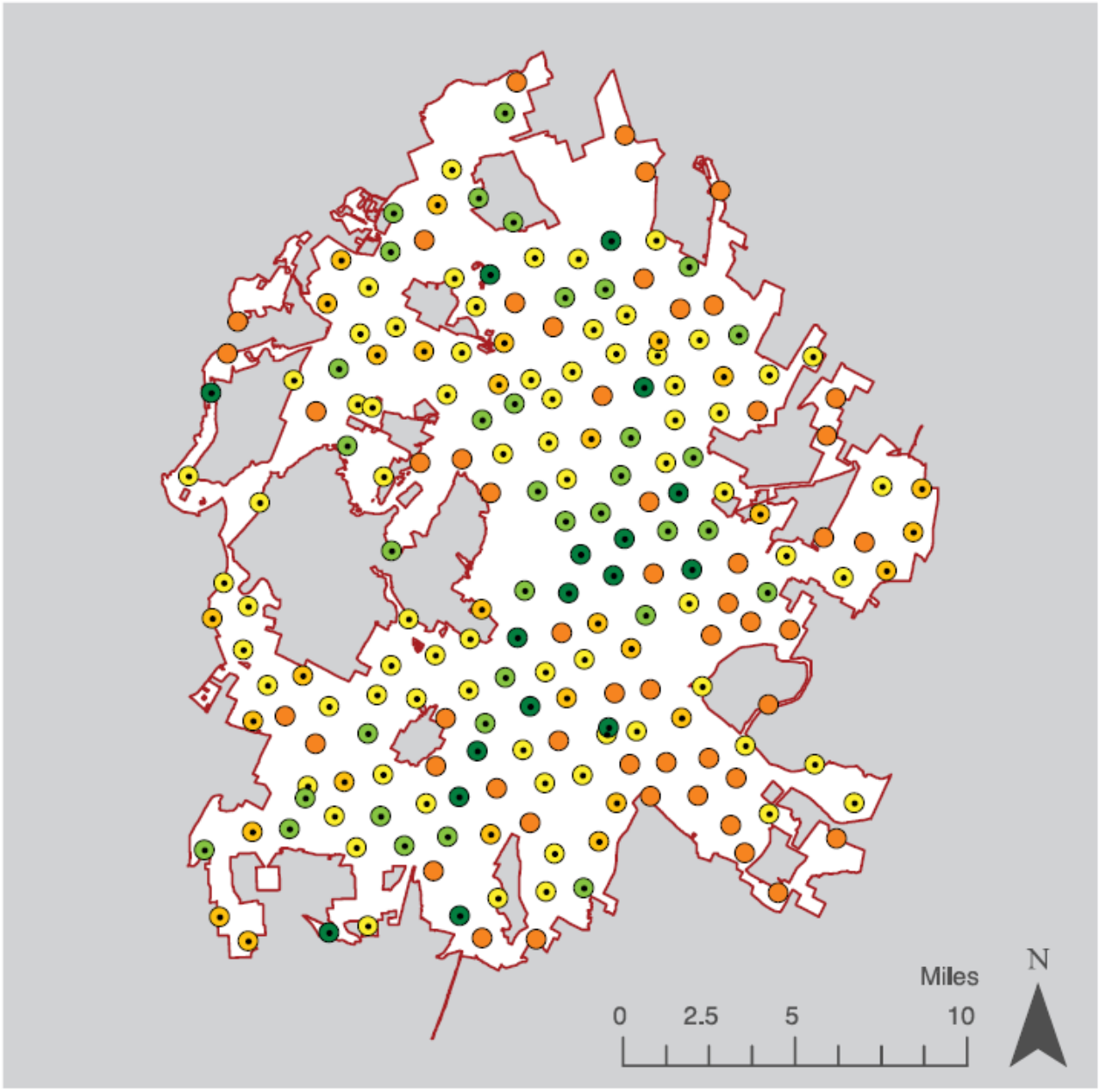
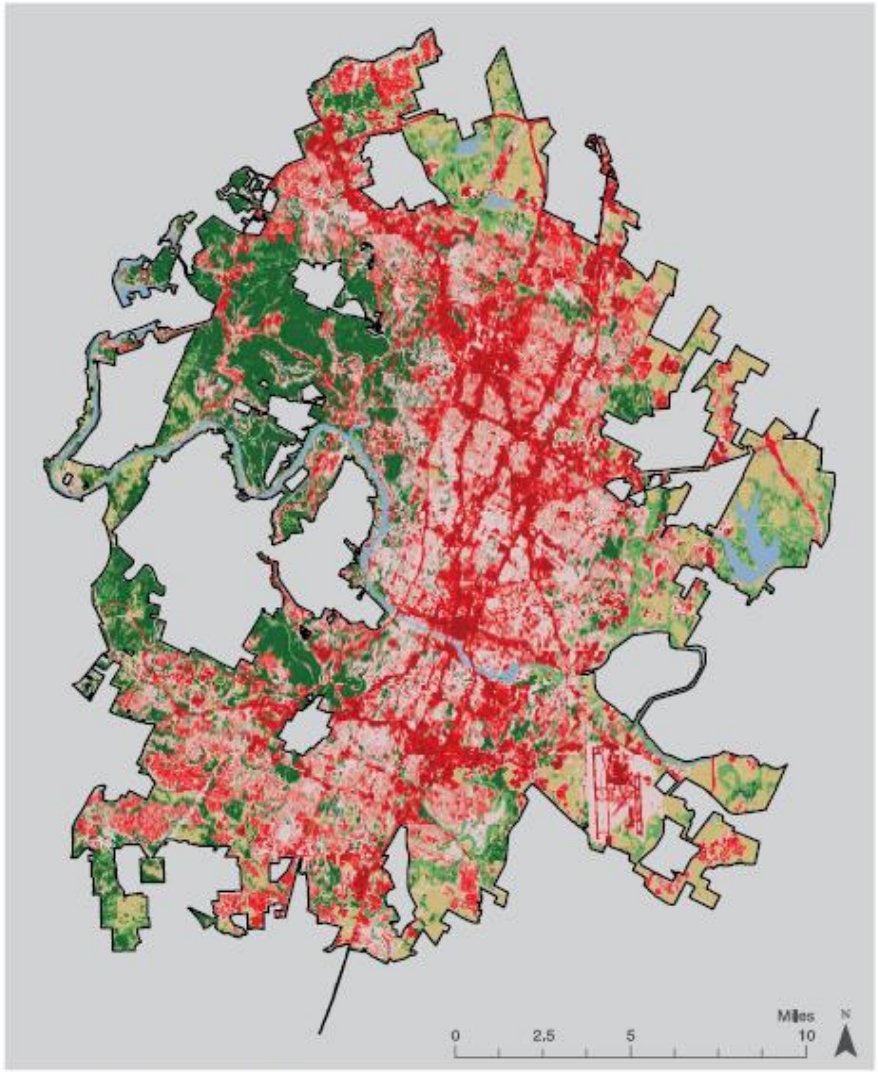


Figure 11.—Average tree diameter by plot, Austin, 2014.



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.

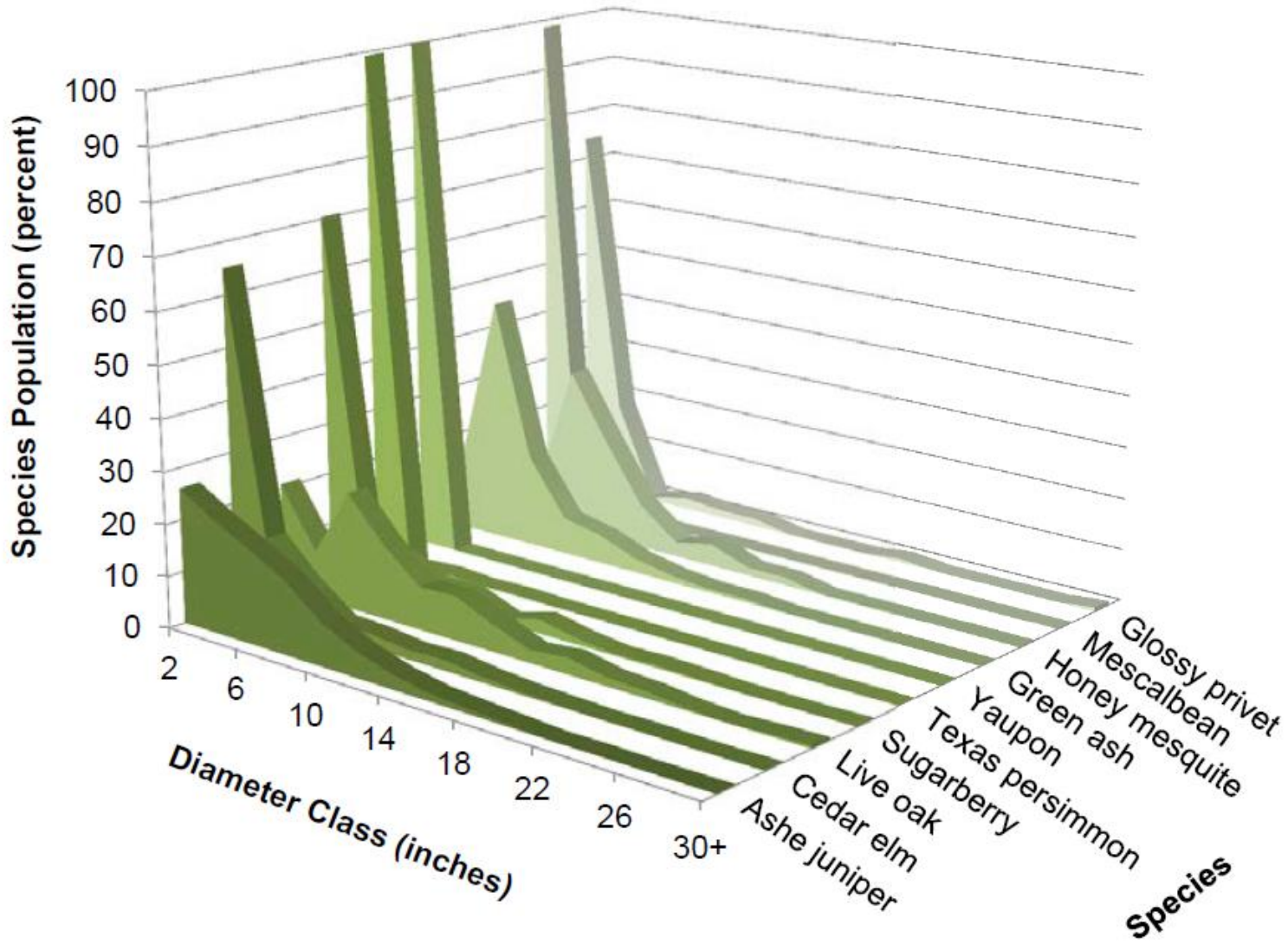


Figure 13.—Percentage of species population by diameter class for 10 most common species, Austin, 2014. Diameter classes are designated by their midpoint (e.g., 2 is actually 1 to 2.9 inches). Diameter measurements were taken at breast height (d.b.h.) or root collar (d.r.c.) for woodland species.

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		

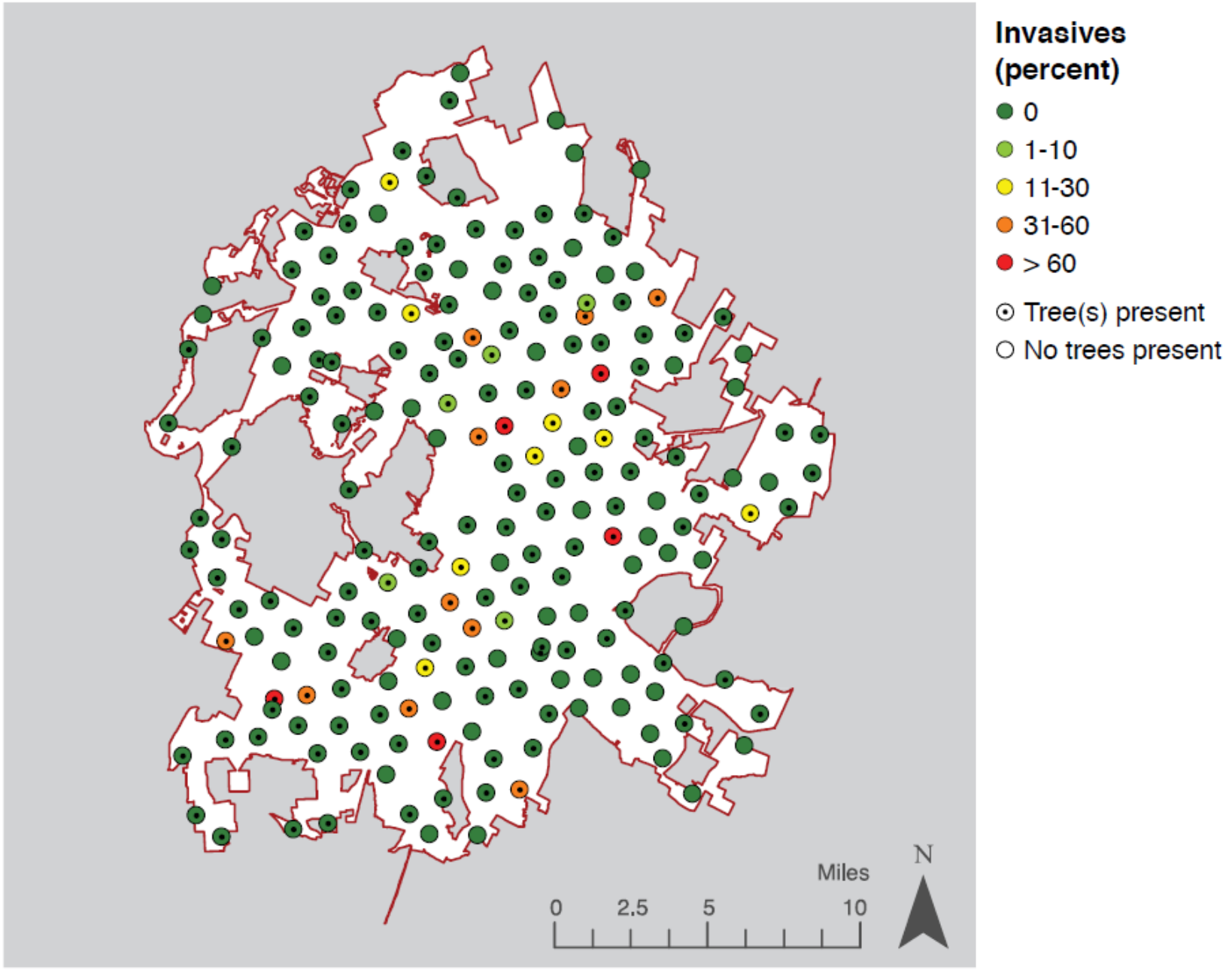


Figure 15.—Proportion of invasive trees as a percent of all trees, by plot, Austin, 2014.

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		

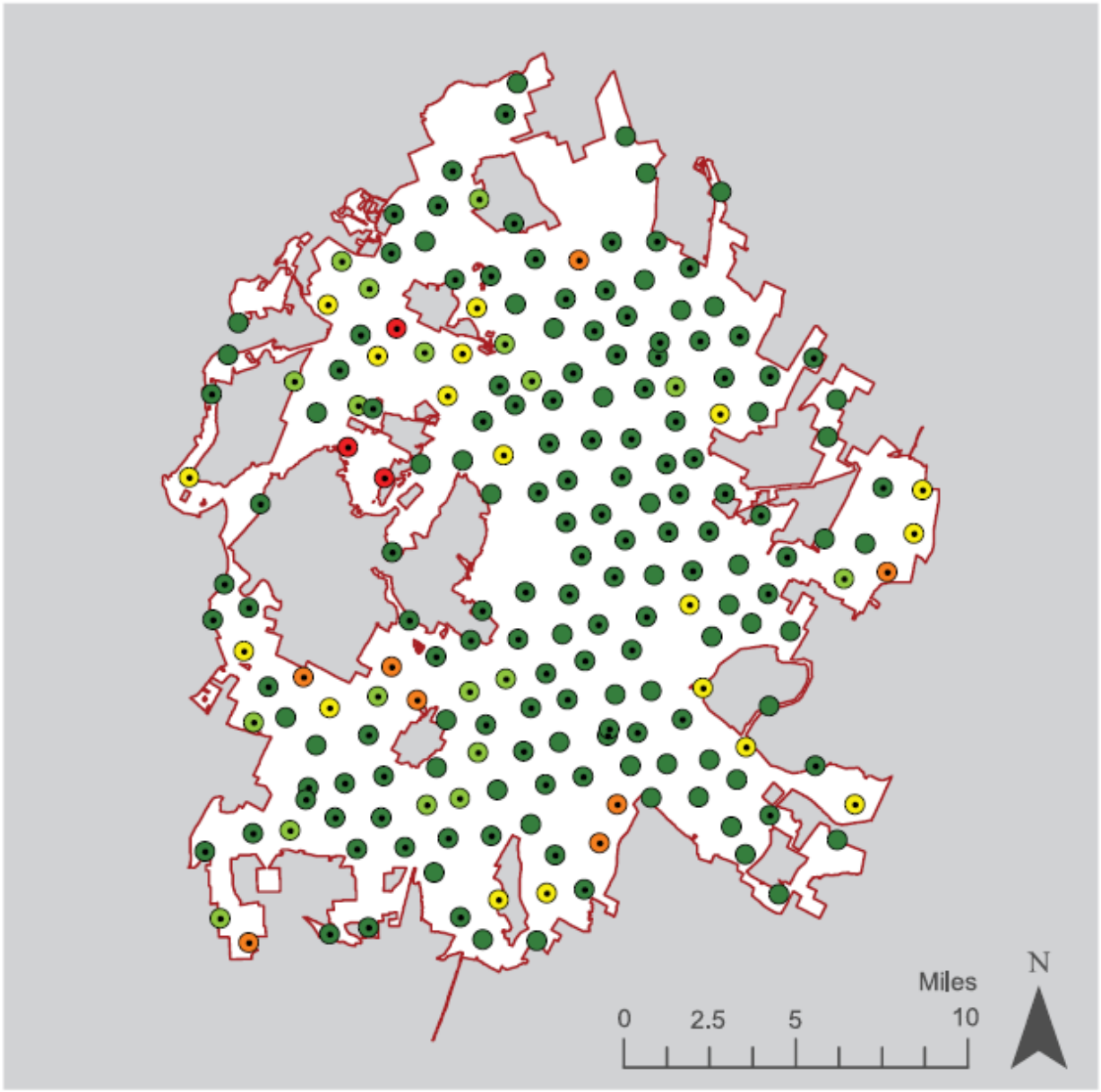


Figure 31.—Number of standing dead trees per acre by plot, Austin, 2014.

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

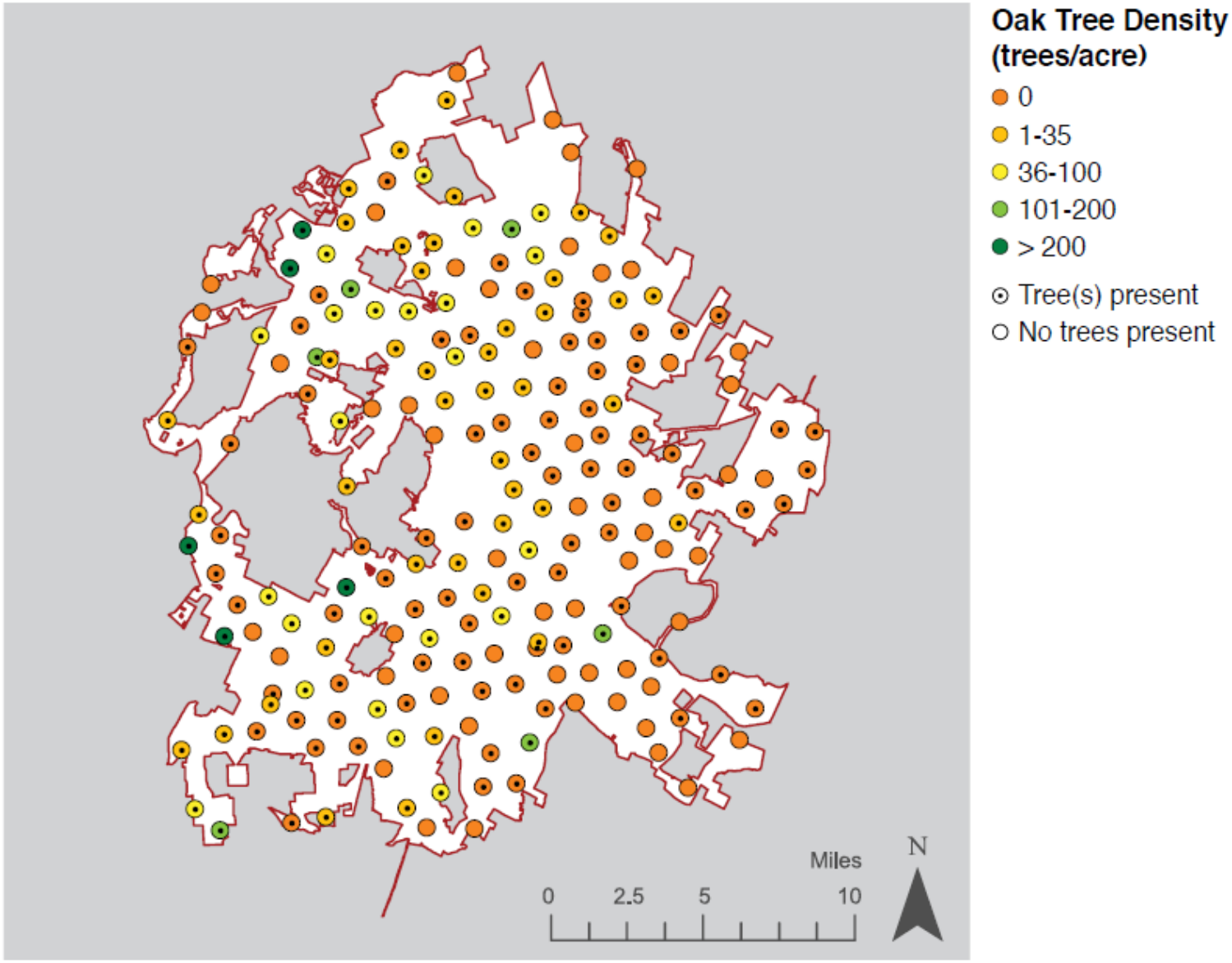


Figure 32.—Number of oak trees per acre by plot, Austin, 2014.