

VULNERABILITY AND ADAPTIVE CAPACITY OF TREES IN THE BOSTON REGION

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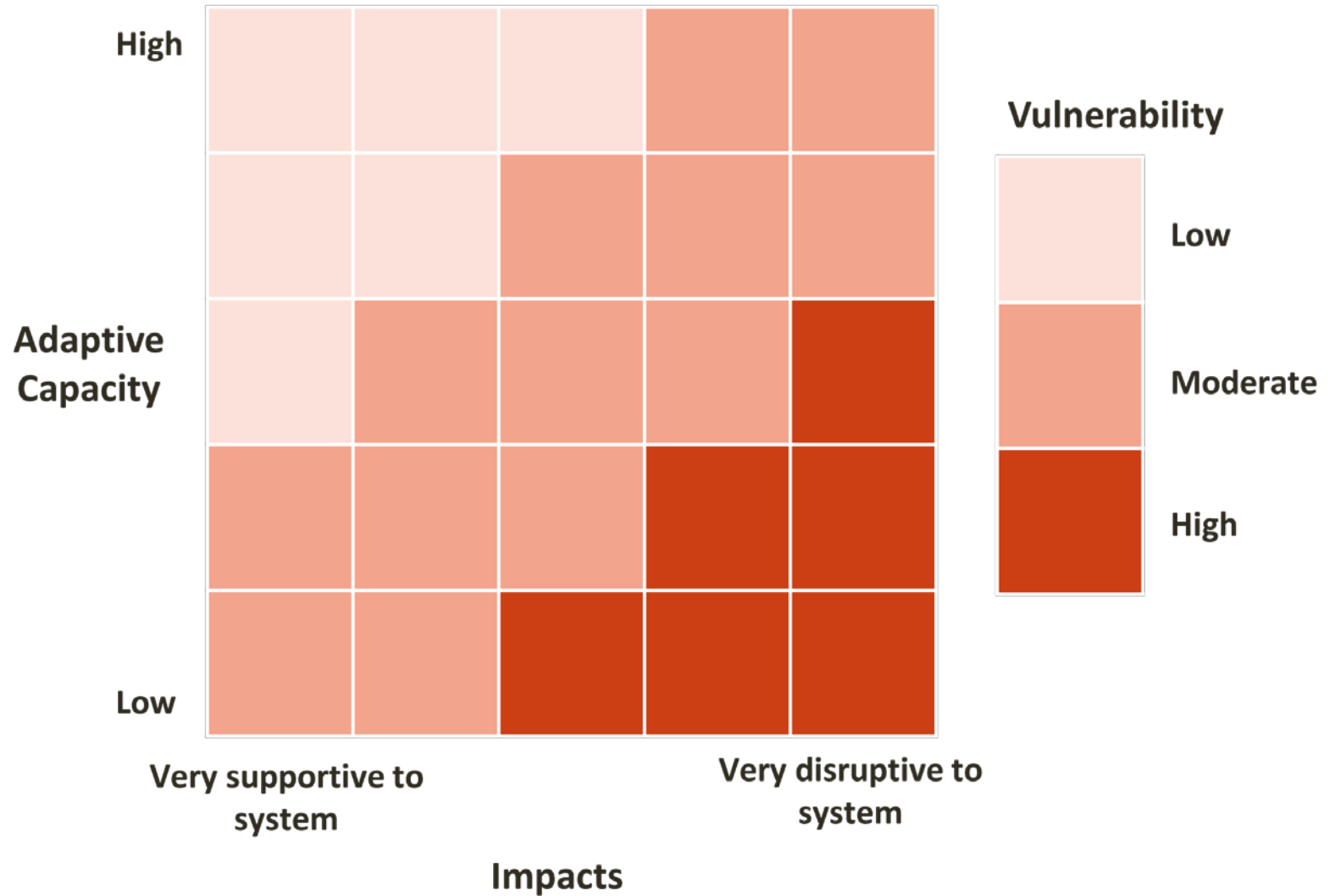
Climate Change Specialist



URBAN TREES ARE VULNERABLE TO...



WHAT IS VULNERABILITY?



FUTURE IMPACTS: NATIVE TREES

The screenshot shows the homepage of the Climate Change Atlas. At the top, there is a header with the USDA logo, the text 'United States Department of Agriculture Forest Service', and 'Northern Research Station'. Below the header is a navigation bar with links for 'Forest Service Home', 'About the Agency', and 'Contact the National Office'. The main content area features a large banner with the text 'Explore the Climate Change Tree Atlas' and three maps of the Eastern United States showing habitat shifts. Below the banner is a search box for trees and birds, and a section titled 'About the Climate Change Atlas' which describes the atlas's purpose and provides links to 'List of Trees' and 'List of Birds'. There are also sections for 'Featured Research' and 'Combined Species Outputs'. At the bottom, there are links for 'Climate Change Atlas', 'Learn About the Models', 'Products', and 'Get Help'.

USDA United States Department of Agriculture Forest Service Northern Research Station

Forest Service Home About the Agency Contact the National Office

You are here: [Northern Research Station Home](#) / [Tools & Applications](#) / Climate Change Atlas

Climate Change Atlas

Explore the Climate Change Tree Atlas

Explore the potential habitat shifts for 134 tree species

Search for Trees & Birds:

Enter a common or scientific name

[List of Trees](#) | [List of Birds](#)

About the Climate Change Atlas

The Climate Change Atlas documents the current and possible future distribution of **134 tree species** and **147 bird species** in the Eastern United States and gives detailed information on environmental characteristics defining these distributions. Please be sure to read the **warnings, cautions and questions**.

You can also **browse and view the previous version of the Tree Atlas**.

Featured Research

Ecosystem vulnerability assessment and synthesis: a report from the Climate Change Response Framework Project in northern Wisconsin

Combined Species Outputs

Potential Changes by Region, State, Forest Type or National Forest and Parks

Climate Change Atlas Videos

- Quick Start Guide
- An Introduction to the Climate Change Atlas: How does it work?
- An Overview of the Climate Change Atlas Components
- Exploring Current Species Information
- Modeled Future Habitats
- Combined Species Outputs

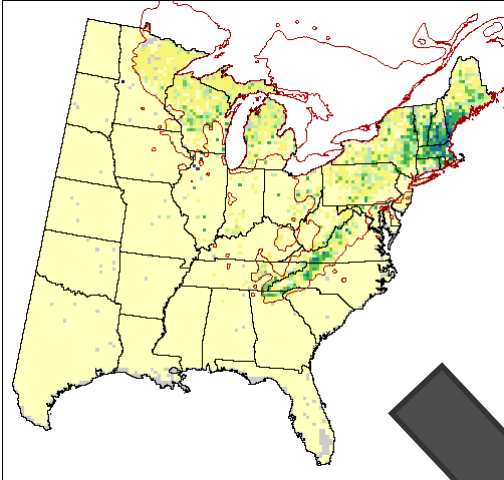
[Climate Change Atlas](#) [Learn About the Models](#) [Products](#) [Get Help](#)

<http://www.fs.fed.us/nrs/atlas/>

MODELS AND EMISSIONS SCENARIOS



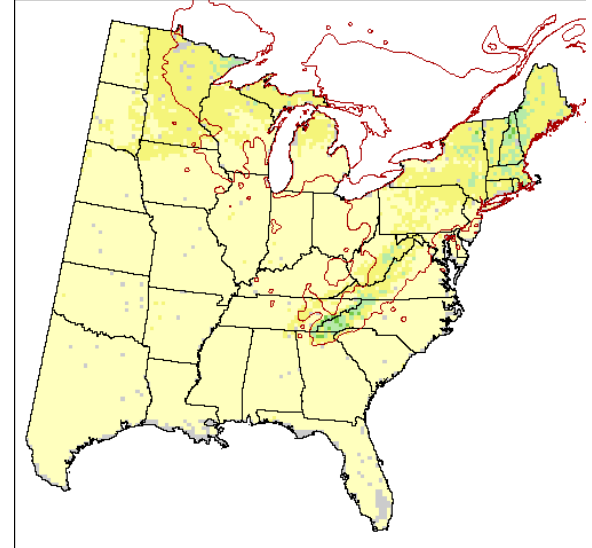
HABITAT SUITABILITY LOSS-WHITE PINE



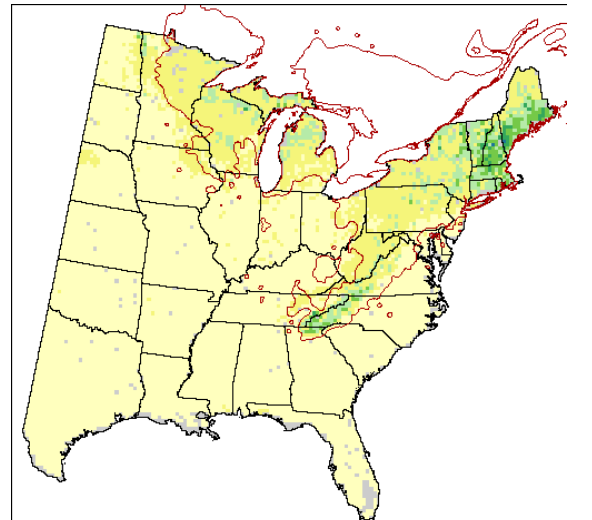
Current habitat



future habitat
high emissions



future habitat
low emissions



BIGGEST LOSERS



Balsam fir



Aspen



Birch



Chokecherry

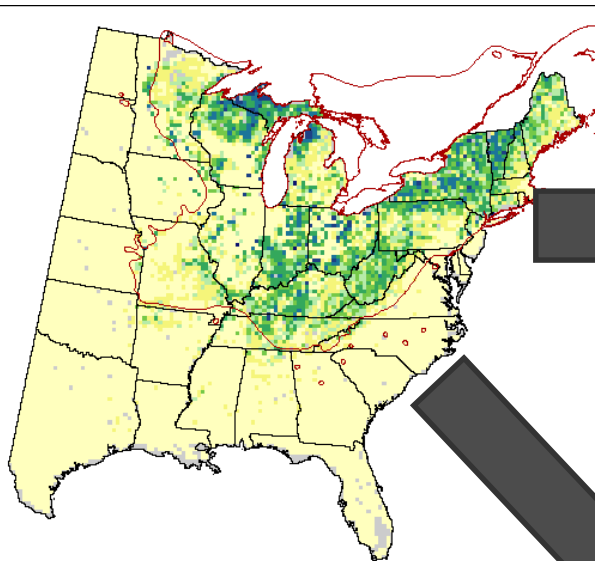


Red spruce

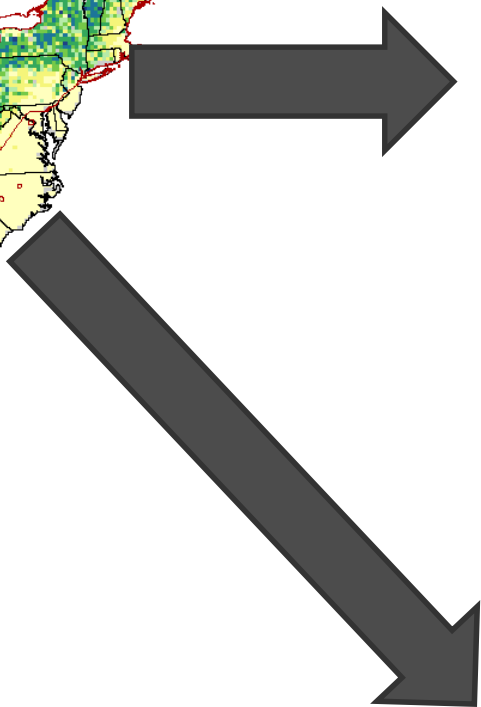


Red pine

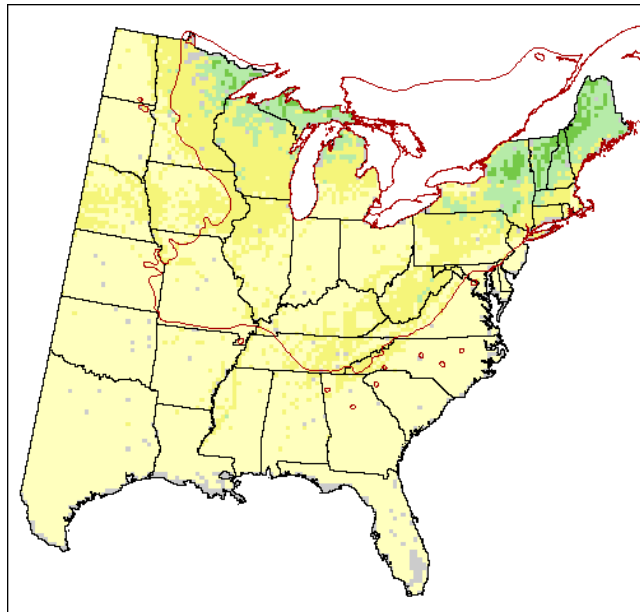
RETAINS HABITAT- SUGAR MAPLE



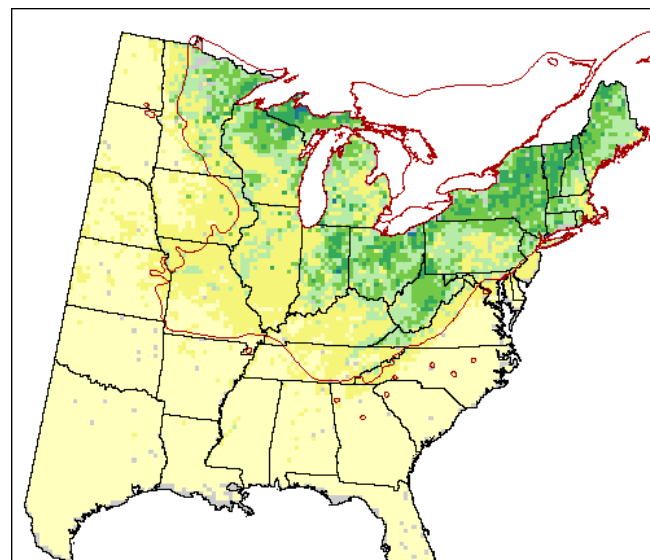
Current habitat



future habitat
high emissions



future habitat
low emissions



HOLDING STEADY



Atlantic white-cedar



American beech



Black cherry



American holly

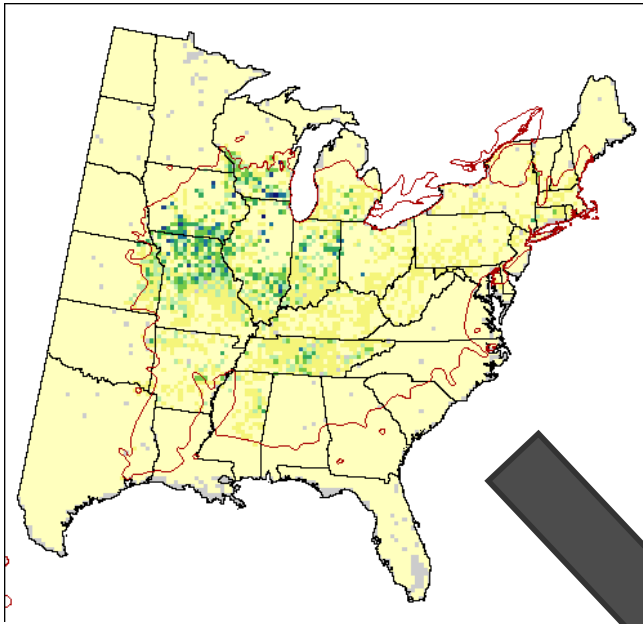


Pitch pine



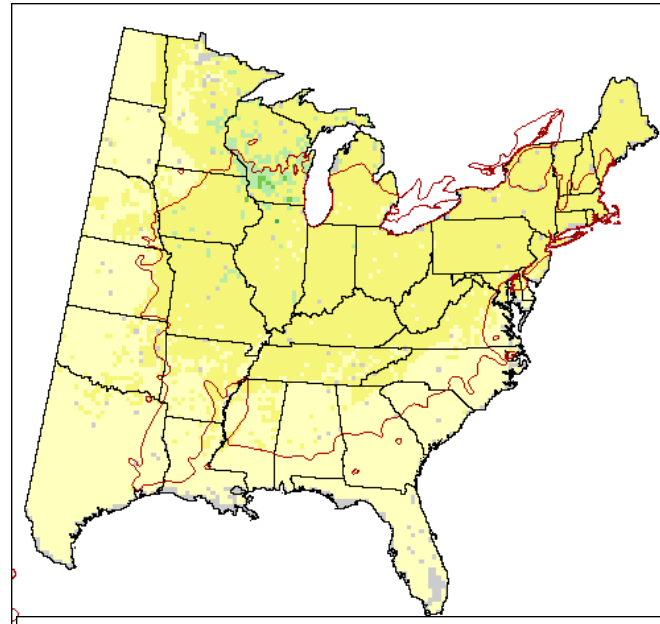
Swamp chestnut oak

GAINS HABITAT- SHAGBARK HICKORY

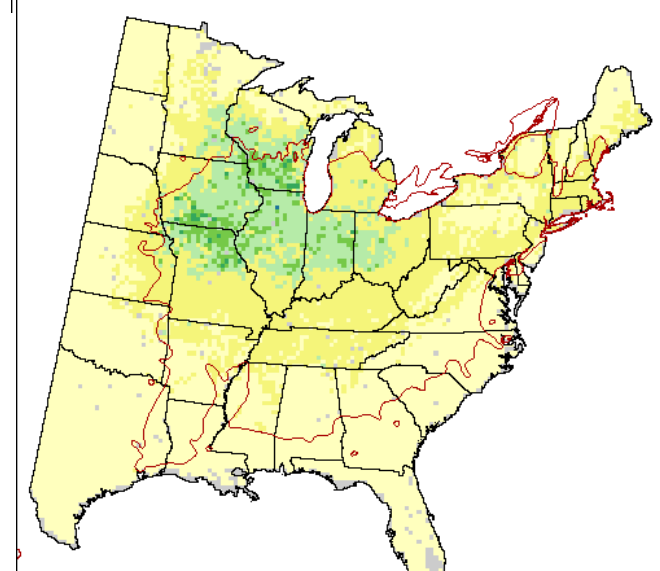
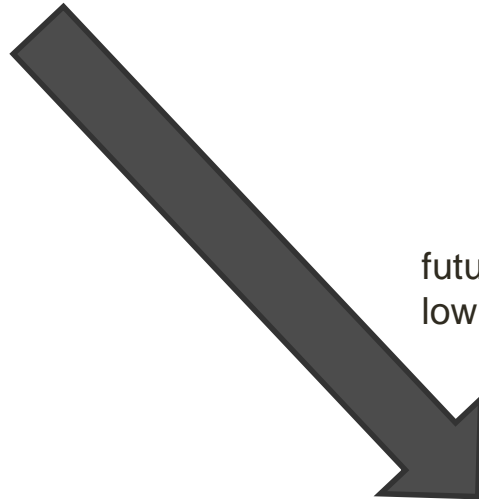


Current habitat

future habitat
high emissions



future habitat
low emissions



BIG GAINERS



Silver maple



American hornbeam



Mockernut hickory



Flowering dogwood

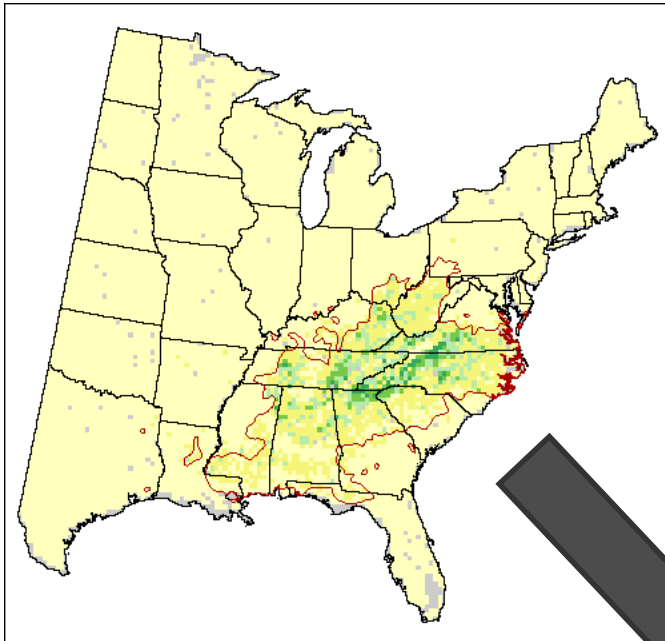


Eastern redcedar



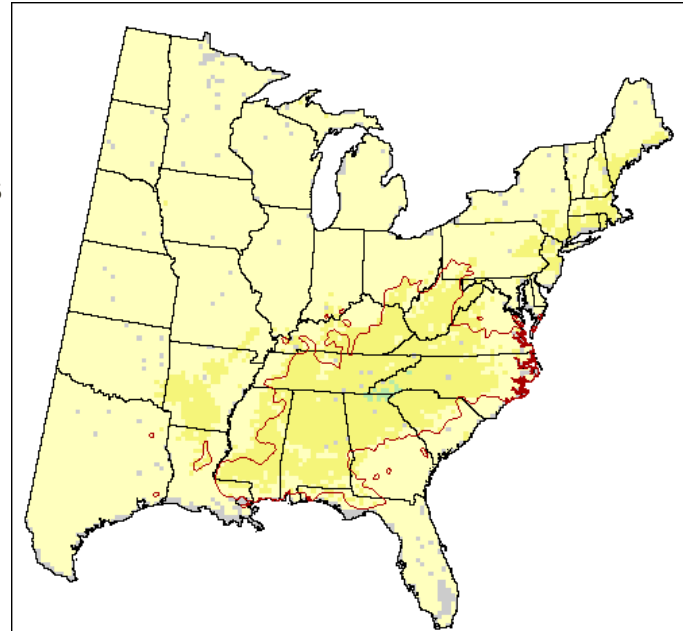
White oak

NEW HABITAT- SOURWOOD

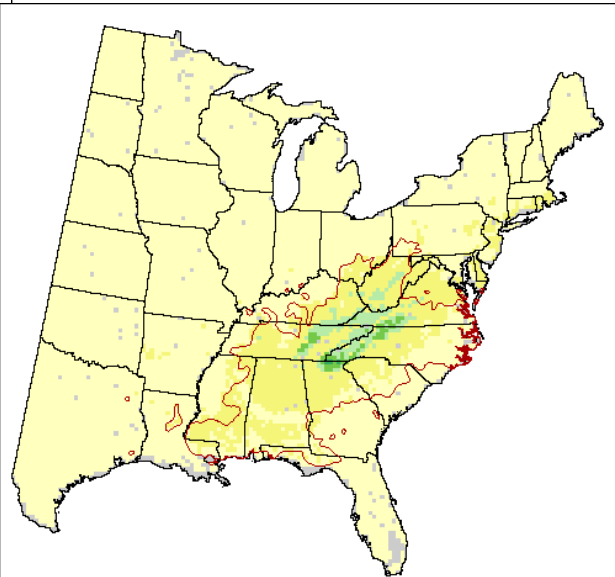


Current habitat

future habitat
high emissions



future habitat
low emissions



NEW SPECIES TO TRY



Pawpaw



Eastern redbud



Baldcypress



Tulip tree



Sweetgum

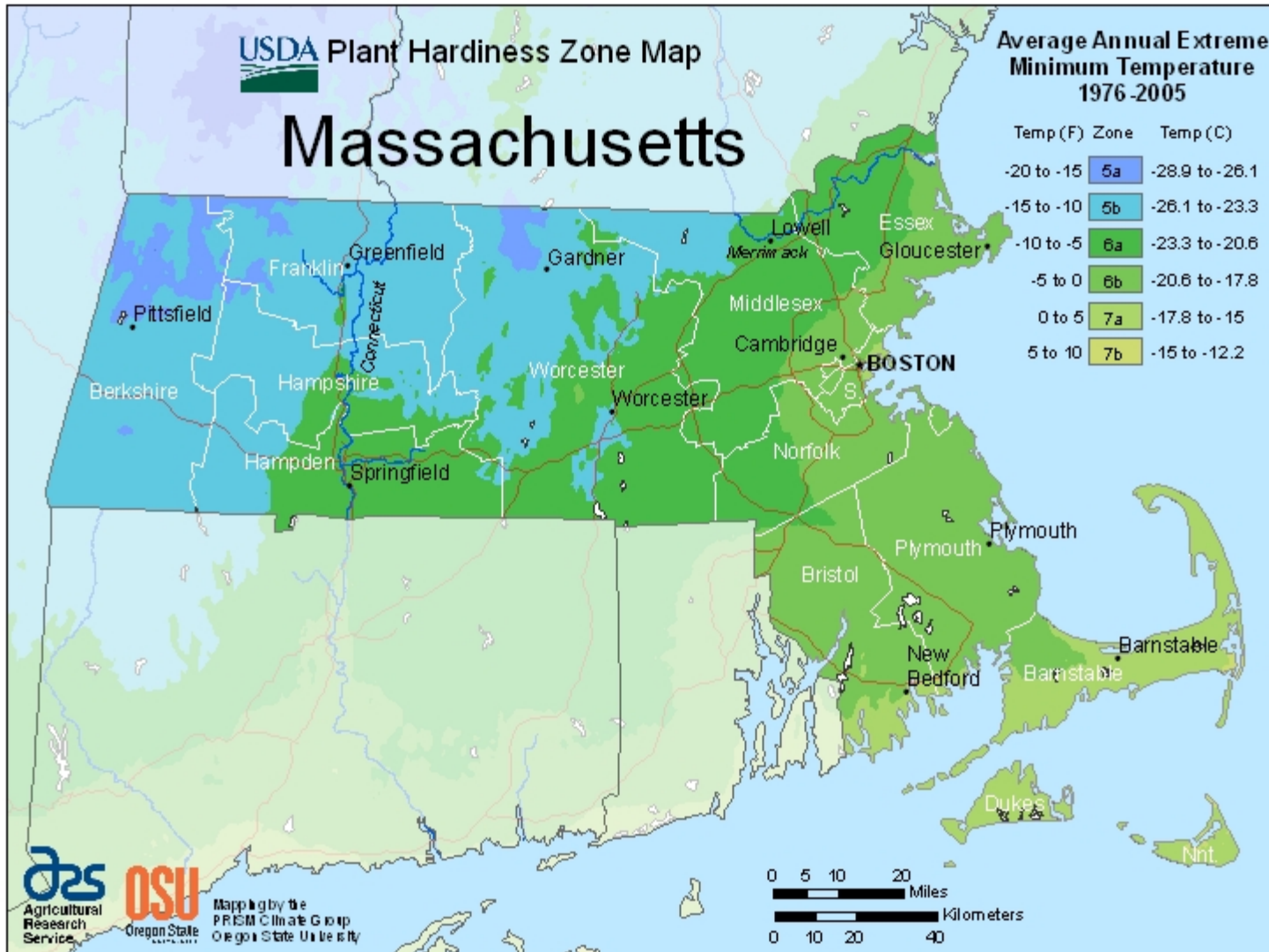


Persimmon

NON-NATIVES, INVASIVES, CULTIVARS?



CURRENT USDA HARDINESS ZONES

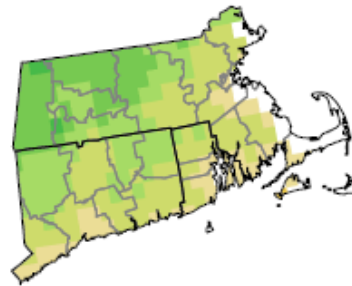
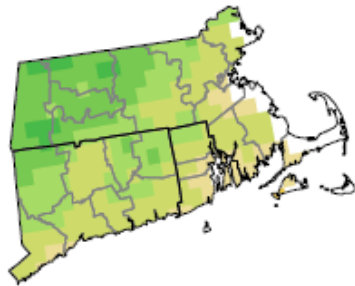


HARDINESS ZONE PROJECTIONS

Low emissions

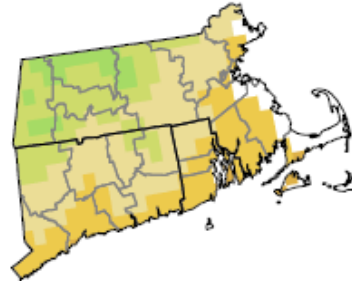
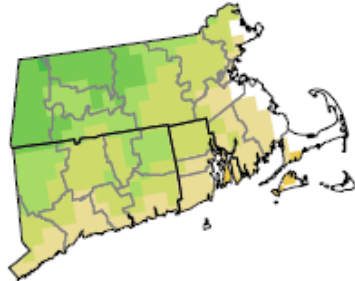
High emissions

2010 - 2039



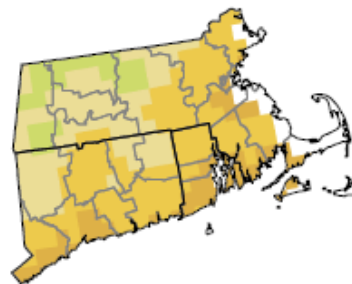
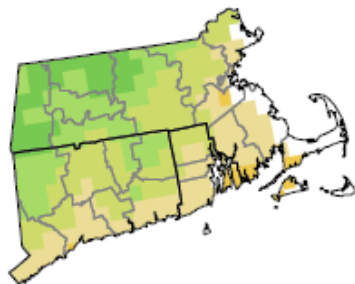
7b-8a

2040-2069



7b-8b

2070-2099



7b-8b

Hardiness Zone

| Temp (°F) | Zone |
|------------|------|
| -40 to -35 | 3a |
| -35 to -30 | 3b |
| -30 to -25 | 4a |
| -25 to -20 | 4b |
| -20 to -15 | 5a |
| -15 to -10 | 5b |
| -10 to -5 | 6a |
| -5 to 0 | 6b |
| 0 to 5 | 7a |
| 5 to 10 | 7b |
| 10 to 15 | 8a |
| 15 to 20 | 8b |
| 20 to 25 | 9a |
| 25 to 30 | 9b |
| 30 to 35 | 10a |
| 35 to 40 | 10b |
| 40 to 45 | 11a |
| 45 to 50 | 11b |
| 50 to 55 | 12a |
| 55 to 60 | 12b |

SPECIES THAT COULD BENEFIT FROM HARDINESS ZONE SHIFTS



Dawn redwood



Kwanzan cherry

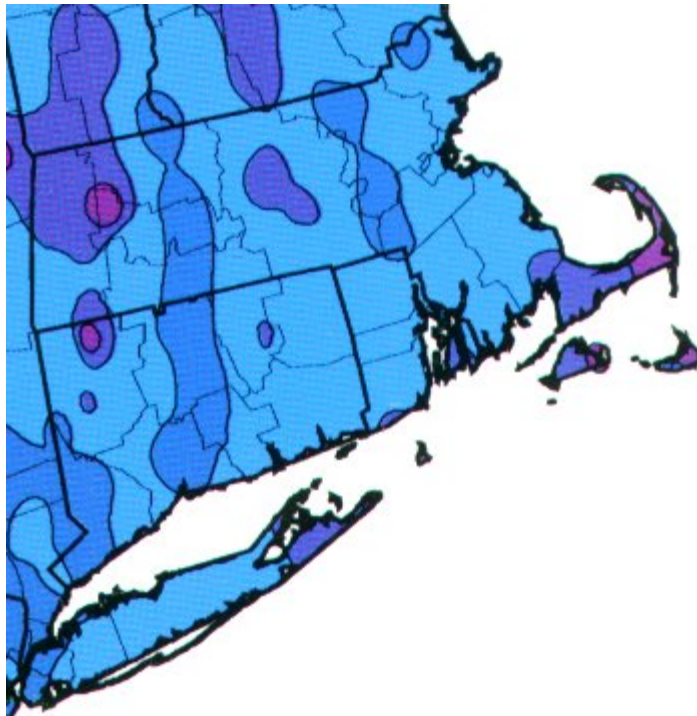


Weeping willow



Chinese elm

CURRENT AHS HEAT ZONES



**Average Number
of Days per Year
Above 86°F
(30°C)**

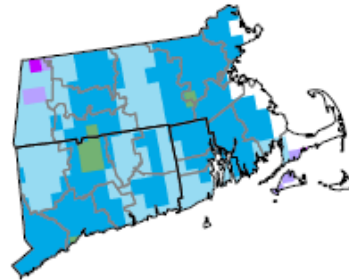
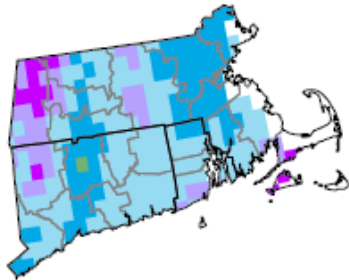
**Heat
Zone**

| | |
|--------------|----|
| < 1 | 1 |
| 1 to 7 | 2 |
| > 7 to 14 | 3 |
| > 14 to 30 | 4 |
| > 30 to 45 | 5 |
| > 45 to 60 | 6 |
| > 60 to 90 | 7 |
| > 90 to 120 | 8 |
| > 120 to 150 | 9 |
| > 150 to 180 | 10 |
| > 180 to 210 | 11 |
| > 210 | 12 |

HEAT ZONE PROJECTIONS

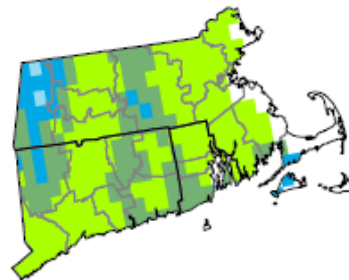
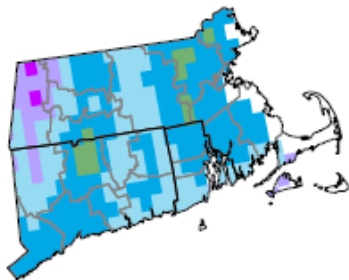
Low Emissions High Emissions

2010 - 2039



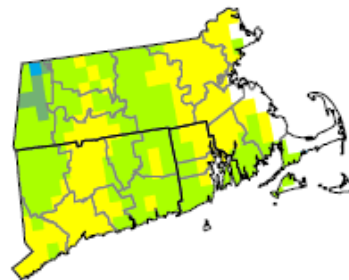
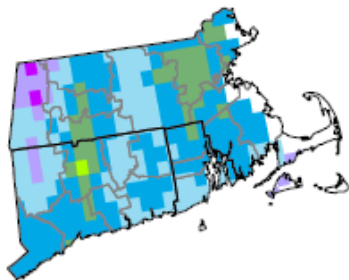
4-5

2040-2069



5-7

2070-2099



5-8

**Heat Zone
(days over 86°F)**



SPECIES THAT COULD POTENTIALLY BE NEGATIVELY AFFECTED BY HEAT ZONE SHIFTS



Norway maple



Amur maackia

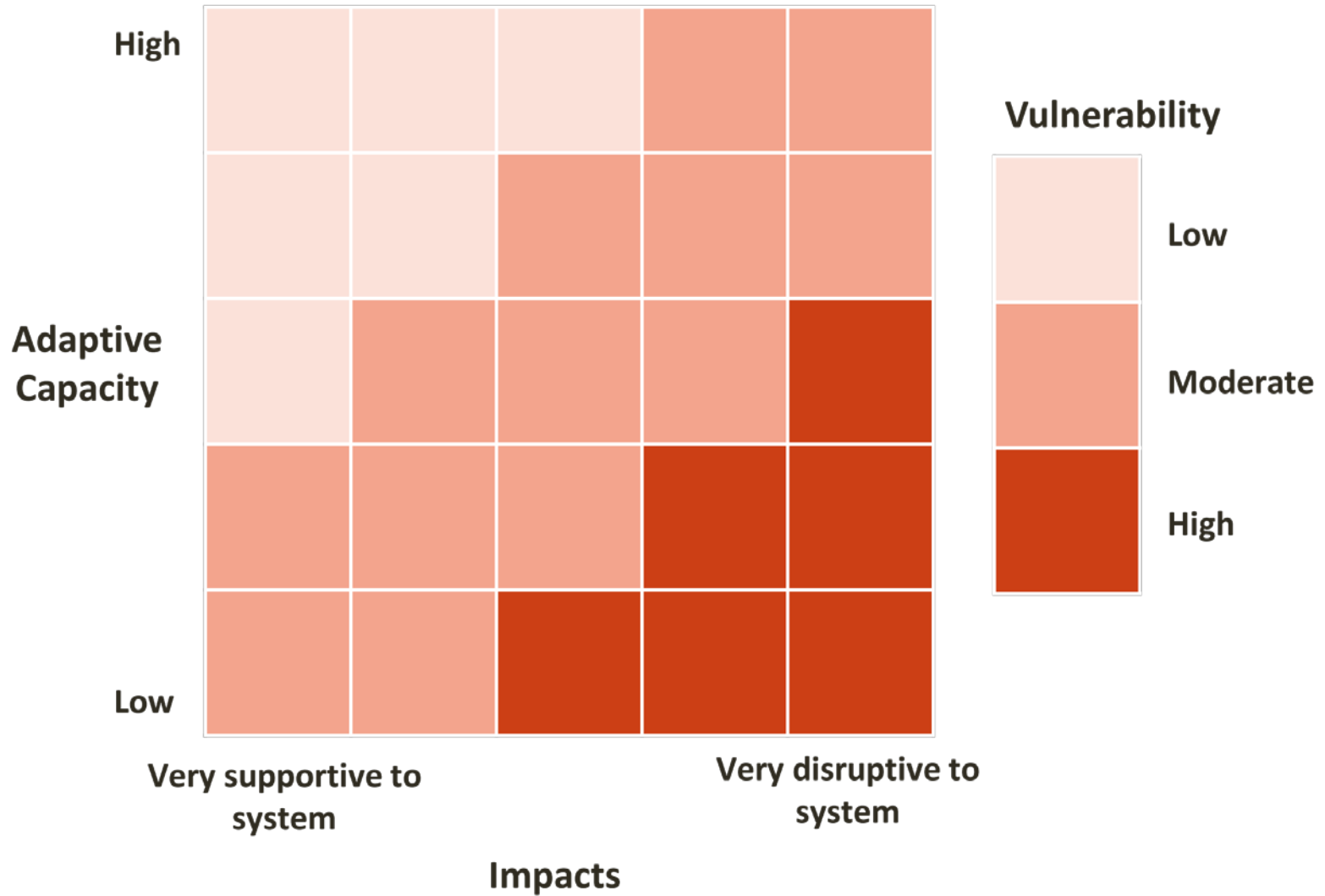


Japanese tree lilac



Littleleaf linden

VULNERABILITY

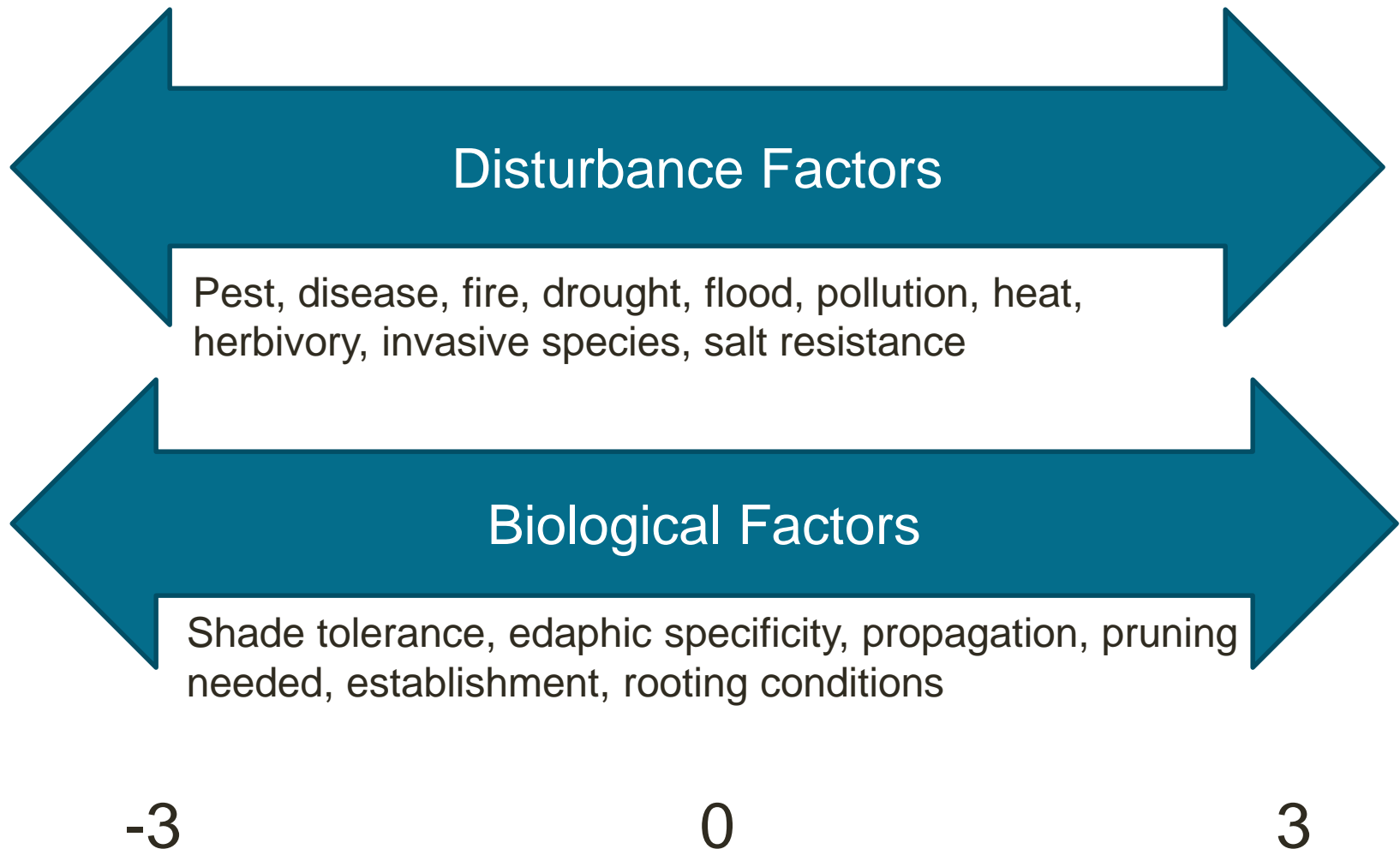


ADAPTIVE CAPACITY

the ability of a system to accommodate or cope with potential climate change impacts with minimal disruption.

ADAPTIVE CAPACITY FACTORS

Based on Matthews et al. 2011



2 SEPARATE SCORES

Planted



Includes nursery propagation, restricted rooting conditions, maintenance, planting site

Naturally-Occurring



Dispersal ability, regeneration capacity

SPECIES WITH HIGH ADAPTIVE CAPACITY

- Not generally susceptible to pests, disease that lead to mortality/reduced growth
- Drought-tolerant
- Flood-tolerant
- Not susceptible to breakage/mortality from wind and/or ice
- Tolerates a wide range of temperatures
- Tolerates urban conditions like salt, pollutions, restricted rooting conditions
- Shade-tolerant
- Can be planted on a range of sites, soils
- Easily propagated and established once planted

HIGH ADAPTIVE CAPACITY: KENTUCKY COFFEETREE



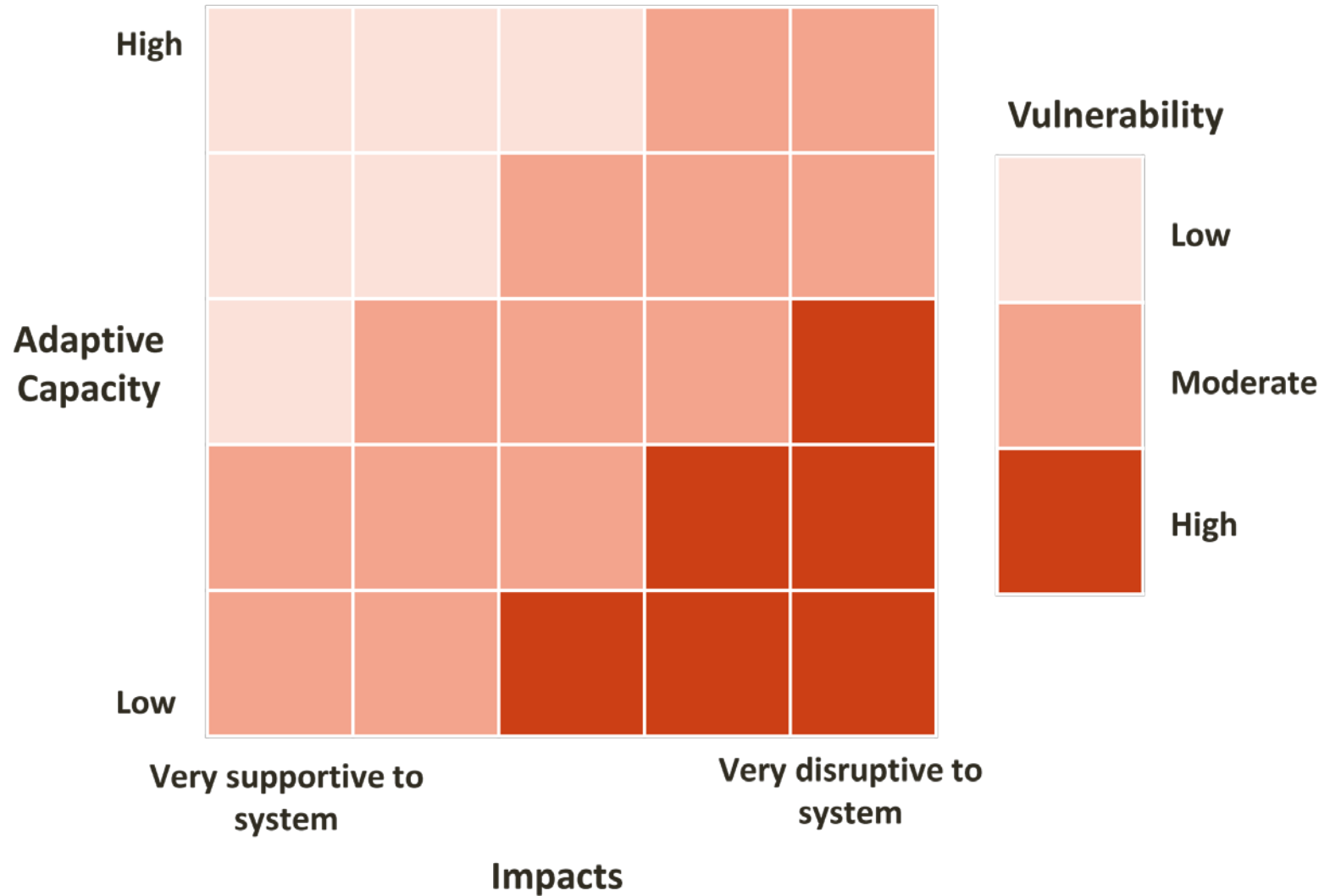
- No major pest/disease issues
- Adaptable to a range of soils, climates
- Urban-tolerant
- Low maintenance
- Widely available

LOW ADAPTIVE CAPACITY: PAPERBARK MAPLE



- Susceptible to Asian longhorned beetle
- Drought-intolerant
- Susceptible to leaf scorch
- Difficult to propagate

VULNERABILITY



OVERALL VULNERABILITY

Most Vulnerable

- Red pine
- Pitch pine
- Eastern white pine
- Bigtooth aspen
- Quaking aspen
- Canadian hemlock

Least Vulnerable

- Eastern redcedar
- Blackgum/Black tupelo
- Mockernut hickory
- Eastern hophornbeam/ironwood
- American Hornbeam
- Serviceberry species
- Yellowwood
- Kousa Dogwood
- Ginkgo
- Kentucky Coffeetree
- Persian Ironwood
- Yoshino Cherry
- Snowgoose Cherry
- Okame Cherry
- Japanese zelkova

SUMMARY

- Vulnerability=Impacts + adaptive capacity
- We expect a decrease in suitability for northern trees and an increase for southern trees
- Hardiness zones may shift by 1 to 2 full zones by the end of the century.
- Heat zones may shift by 1-4 zones, meaning up to four months each year may be above 86 degrees F
- Trees vary in their capacity to adapt-consider multiple factors
- Overall, more northern trees that are susceptible to pests, disease, and disturbances will be the most vulnerable
- The least vulnerable trees are those that can tolerate a range of environmental conditions and are at the center or north end of their range here.