Chesapeake Bay Forestry Workgroup: **Climate Adaptation Tools and Strategies for Urban Forest Management**

October 4, 2023

An overview of resources from the Northern Institute of Applied Climate Science

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Northern Institute of Applied Climate Science

Climate

Carbon

The Northern Institute of Applied Climate Science (NIACS) develops synthesis products, fosters communication, pursues science, and provides technical assistance in climate change adaptation and carbon management.

Multi-institutional collaborative chartered by USDA Forest Service, universities, and non-profit and tribal conservation organizations

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Northern Institute of Applied Climate Science

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NCASI

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The UNIVERSITY of VERMONT

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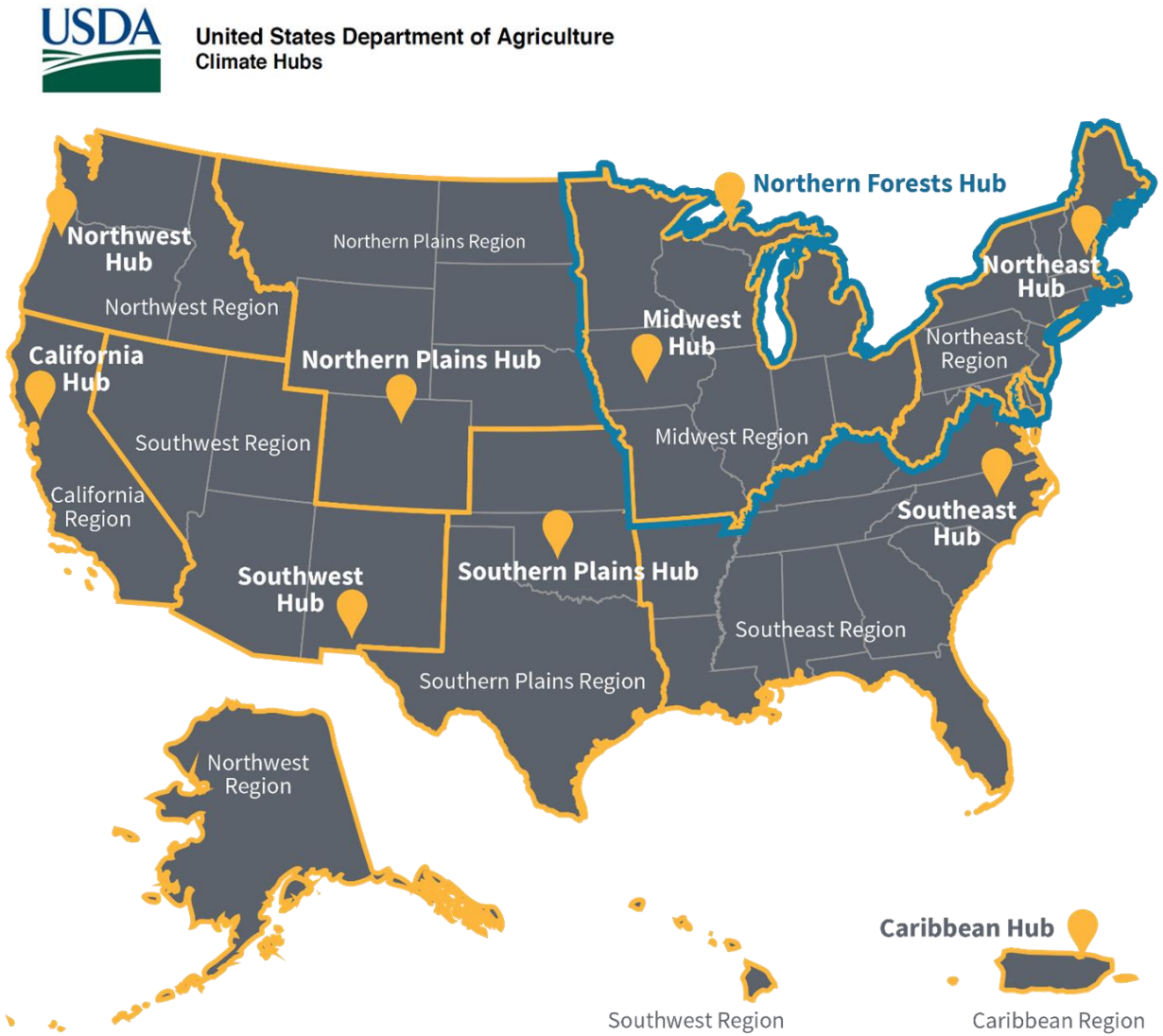
USDA Northern Forests Climate Hub (Operated by NIACS)



NIACS operates the USDA Northern Forests Climate Hub on behalf of the Forest Service (via the Northern Research Station)

Hubs Mission:

- Develop and deliver science-based, region-specific information and technologies to agricultural and natural resource managers that enable climate-informed decision-making, and to
- Provide assistance to implement those decisions

www.climatehubs.usda.gov/hubs/northern-forests

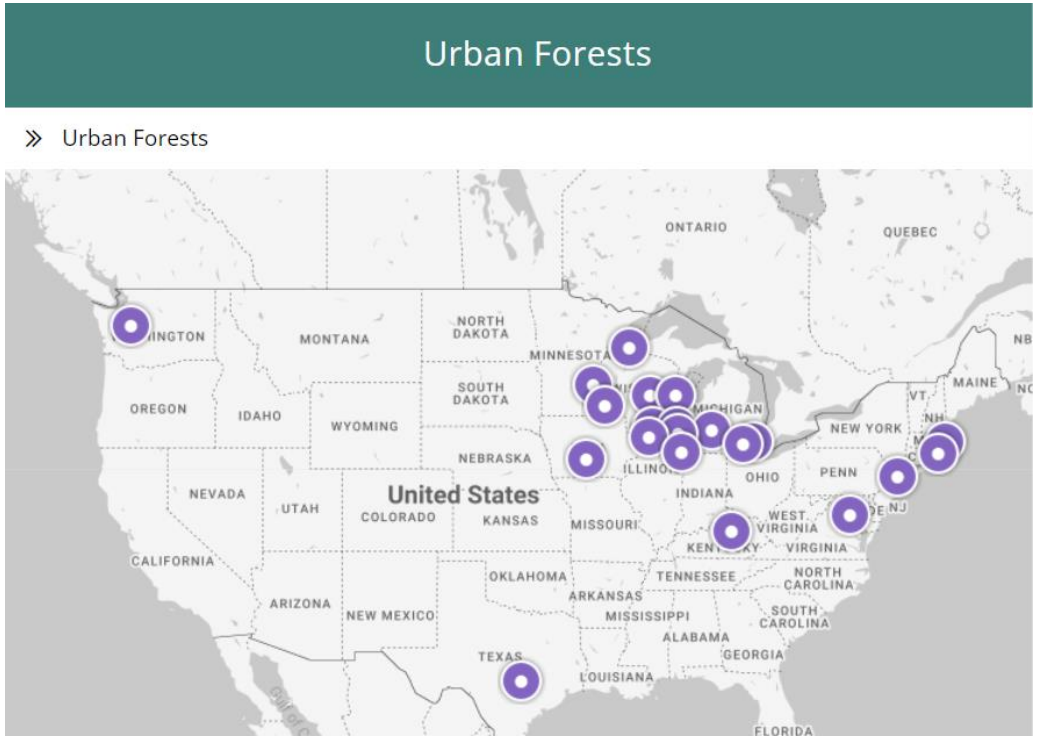
NIACS Urban Climate Change Response Framework

Urban Forestry ‘Menu of Adaptation Strategies’ and Approaches first published 2016

More than 70 real-world urban & community forestry demonstration projects using Adaptation Workbook and Menu!

Urban Forest Vulnerability Assessments and/or tree species vulnerability resources have been created for many cities:

- Chicago, IL
- Detroit, MI
- Twin Cities, MN
- Baltimore, MD
- Washington DC
- Providence, RI
- Austin, TX
- Phoenix, AZ
- Puget Sound, WA
- Boston, MA
- Indianapolis, IN



Learn more at: forestadaptation.org/urban

Climate Adaptation Planning in Urban Forests

Robust strategies are needed to help urban forests adapt to climate change

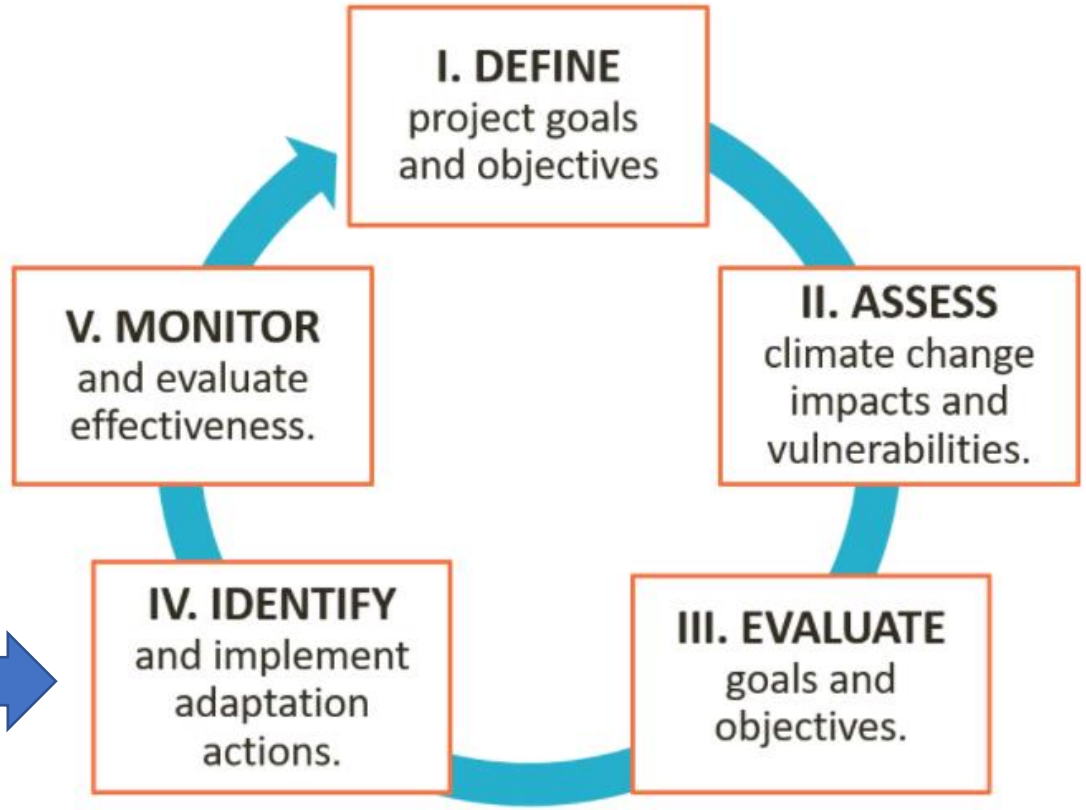
Urban forest managers and allied professionals need access to tools and information to support these efforts

Will vary widely depending on geographic location, extent of development, ownership, and management goals

Consider community needs and values to guide planning, implementation, education and outreach, research, policy

https://www.vibrantcitieslab.com/guides/climate-health-action-guide/

Adaptation Workbook Process



Utilizing the *'Climate Adaptation Actions for Urban Forests and Human Health'* **report & adaptation menu**

Resources for assessing vulnerability: Urban Forest Vulnerability Assessments, **Tree Species Risks (Climate Change Tree Atlas)**

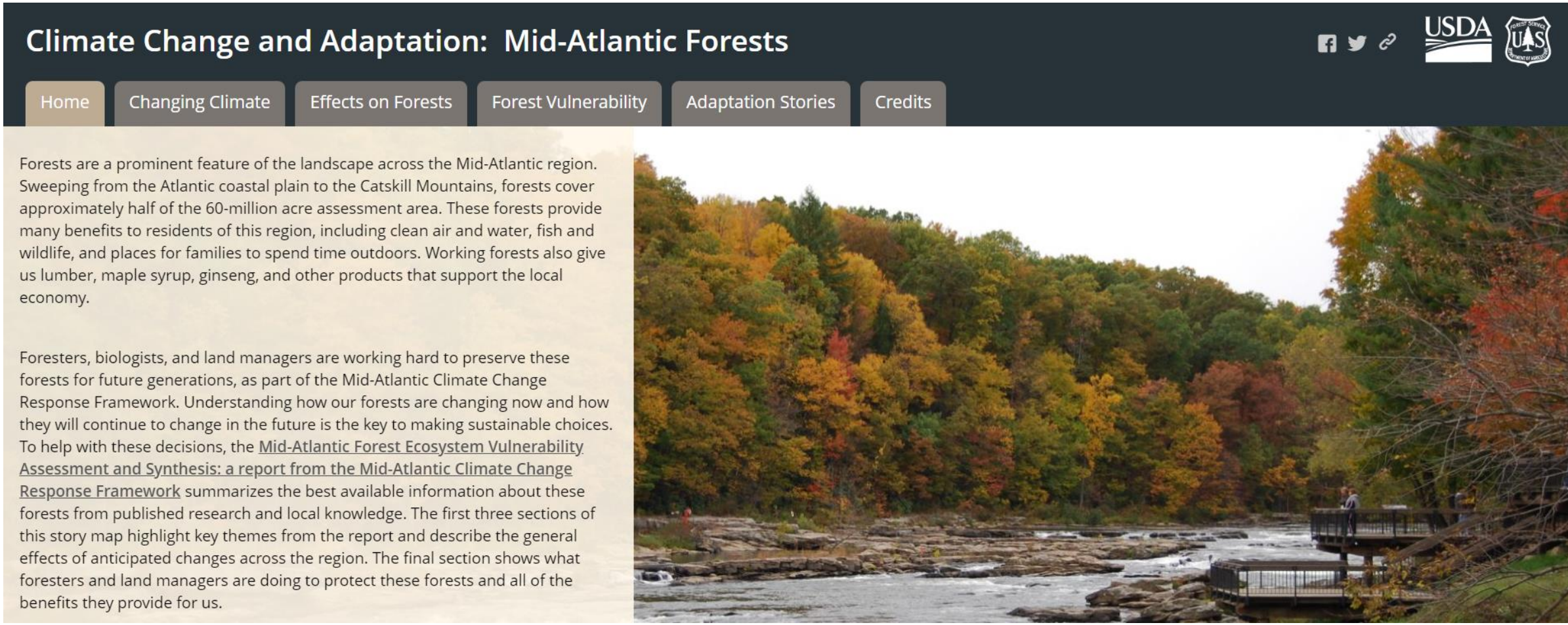
Swanston et al. 2016.

Mid-Atlantic Forest Ecosystem Vulnerability Assessment

- Series of reports for **natural resource professionals**
- Focus on **tree species and forest ecosystems**
- Examine a **range** of future climates
- Evaluate **key ecosystem vulnerabilities** to climate change
- Does **not make recommendations** or assess vulnerability to changes in mgmt., land use, policy

https://forestadaptation.org/assess/ecosystem-vulnerability/mid-atlantic

StoryMap



https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=8917a92ee63c48a2aa7c34ca665a486a

Climate Change Tree Atlas: About

- A tool used to describe tree habitat distribution and colonization under changed climate.
- Model results for 125 species (and relative abundance for 24 species)
- Information about colonization potential (SHIFT) and overall ability to tolerate future conditions (Capability)
- **New tutorials** and explanations throughout the site.

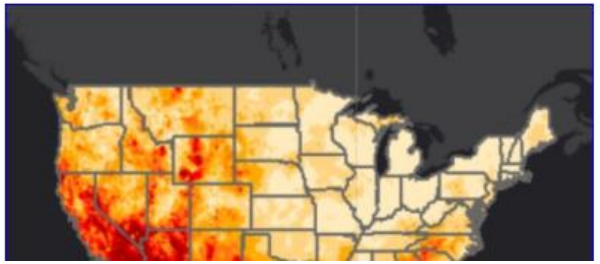
Regional Summary Tree Tables

Current and Potential Future Habitat, Capability, and Migration −

Summaries for tree species are available for a variety of geographies, in both PDF and Excel format. These summaries are based on Version 4 of the Climate Change Tree Atlas

- National Forest Summaries
- National Park Summaries
- HUC6 Watersheds
- Ecoregional Vulnerability Assessments (EVAS)
- USDA Forest Service EcoMap 2007 Sections
- National Climate Assessment (NCA) 2016 Regional Summaries
- 1 x 1 ° Grid Summaries
- Eastern United States
- Urban Areas

Other Products



Atlas site: fs.usda.gov/nrs/atlas/tree/

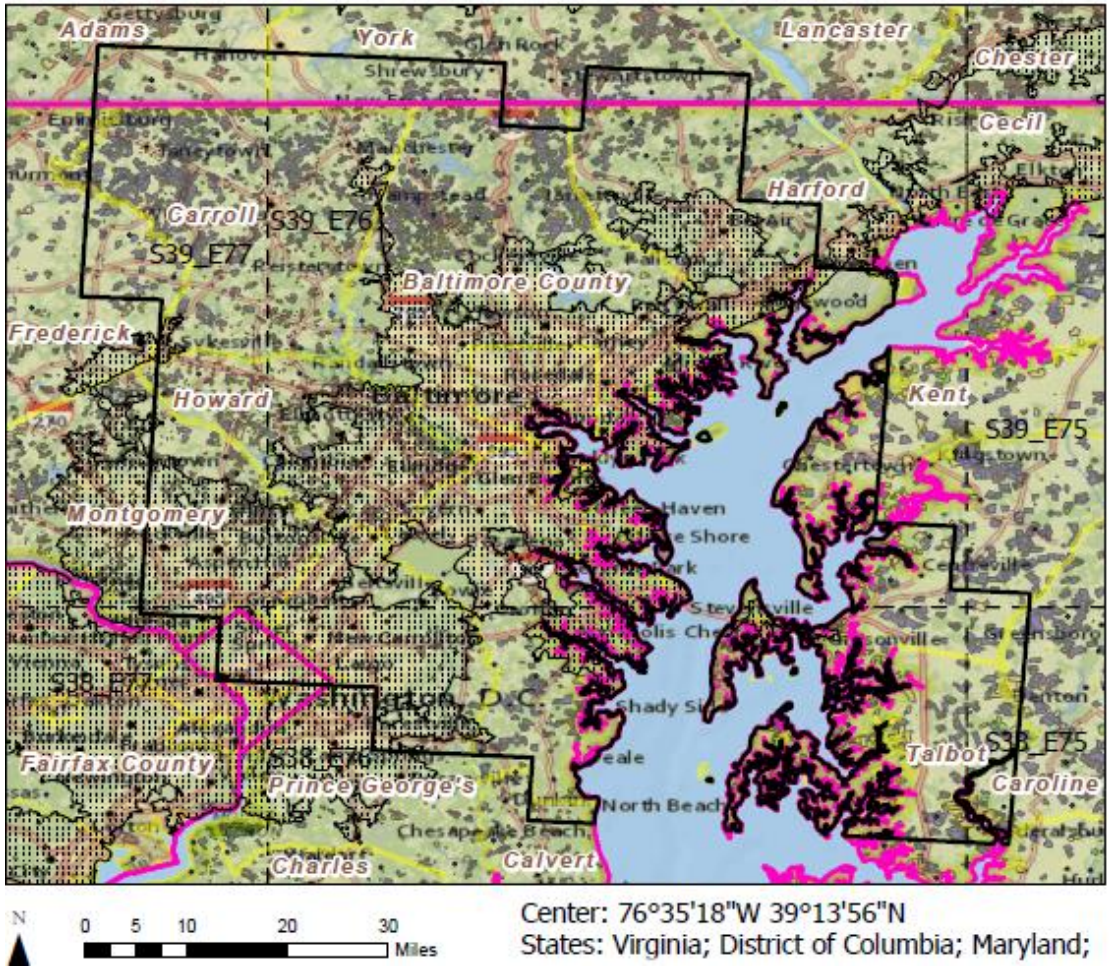
Climate Change Tree Atlas: Baltimore

Results describe trends across the greater Baltimore area

- Urban area (sq. km) = 1,922
- Urban buffer area (sq. km) = 9,137
  - 90 tree species modeled
  - 22% urban land cover

Rare, nonnative, or cultivar species are likely not modeled.

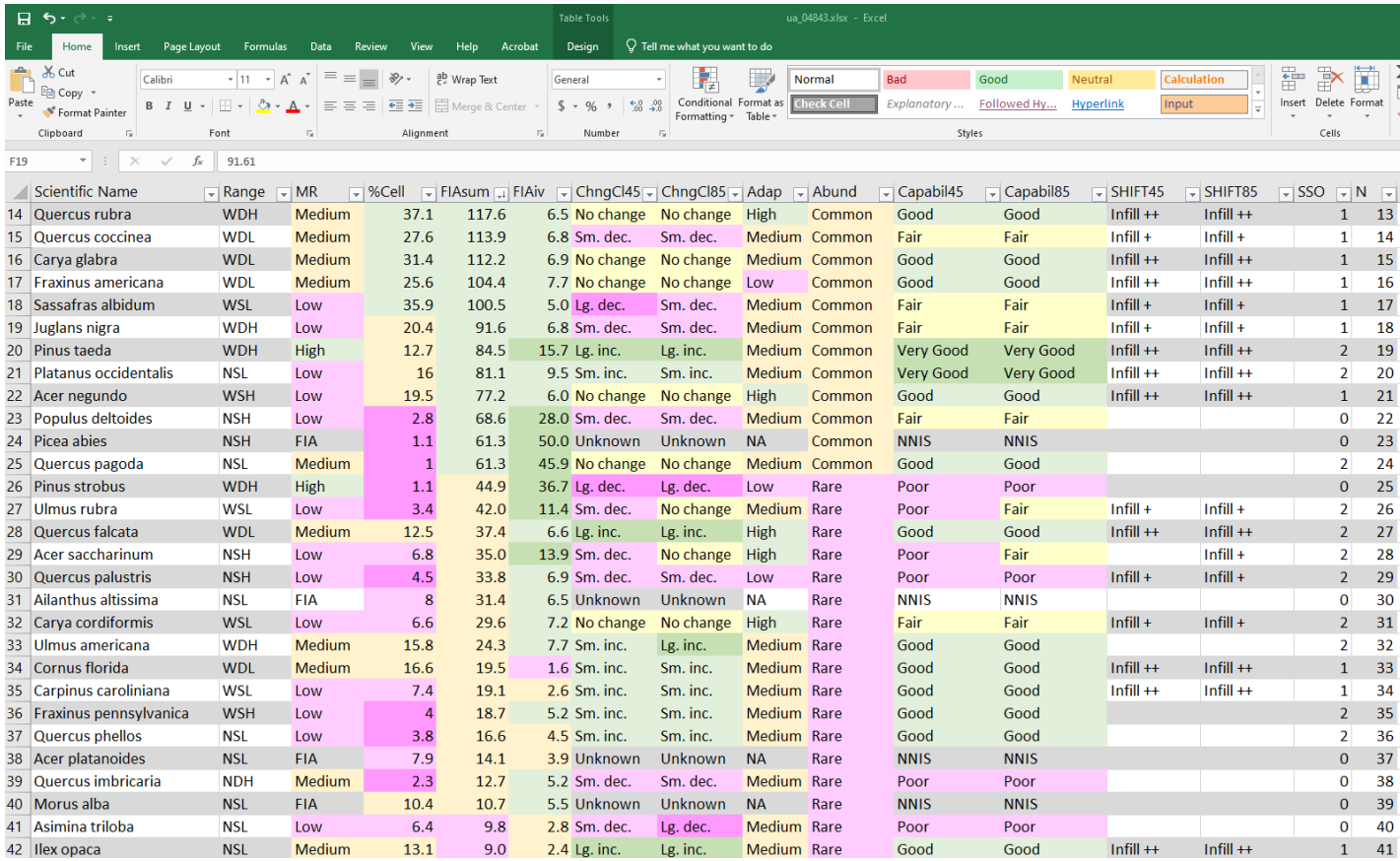
- These species may have vulnerability ratings based on projected heat and hardiness zones.



www.fs.fed.us/nrs/atlas/combined/resources/summaries/urb

Climate Change Tree Atlas: Baltimore

- Common and scientific names
- Range
- Model reliability
- FIA sum
- Habitat change class
- Adaptability
- Capability
- SHIFT



	Scientific Name	Range	MR	%Cell	FIAsum	FIAiv	ChngCl45	ChngCl85	Adap	Abund	Capabil45	Capabil85	SHIFT45	SHIFT85	SSO	N
14	Quercus rubra	WDH	Medium	37.1	117.6	6.5	No change	No change	High	Common	Good	Good	Infill ++	Infill ++	1	13
15	Quercus coccinea	WDL	Medium	27.6	113.9	6.8	Sm. dec.	Sm. dec.	Medium	Common	Fair	Fair	Infill +	Infill +	1	14
16	Carya glabra	WDL	Medium	31.4	112.2	6.9	No change	No change	Medium	Common	Good	Good	Infill ++	Infill ++	1	15
17	Fraxinus americana	WDL	Medium	25.6	104.4	7.7	No change	No change	Low	Common	Good	Good	Infill ++	Infill ++	1	16
18	Sassafras albidum	WSL	Low	35.9	100.5	5.0	Lg. dec.	Sm. dec.	Medium	Common	Fair	Fair	Infill +	Infill +	1	17
19	Juglans nigra	WDH	Low	20.4	91.6	6.8	Sm. dec.	Sm. dec.	Medium	Common	Fair	Fair	Infill +	Infill +	1	18
20	Pinus taeda	WDH	High	12.7	84.5	15.7	Lg. inc.	Lg. inc.	Medium	Common	Very Good	Very Good	Infill ++	Infill ++	2	19
21	Platanus occidentalis	NSL	Low	16	81.1	9.5	Sm. inc.	Sm. inc.	Medium	Common	Very Good	Very Good	Infill ++	Infill ++	2	20
22	Acer negundo	WSH	Low	19.5	77.2	6.0	No change	No change	High	Common	Good	Good	Infill ++	Infill ++	1	21
23	Populus deltoides	NSH	Low	2.8	68.6	28.0	Sm. dec.	Sm. dec.	Medium	Common	Fair	Fair			0	22
24	Picea abies	NSH	FIA	1.1	61.3	50.0	Unknown	Unknown	NA	Common	NNIS	NNIS			0	23
25	Quercus pagoda	NSL	Medium	1	61.3	45.9	No change	No change	Medium	Common	Good	Good			2	24
26	Pinus strobus	WDH	High	1.1	44.9	36.7	Lg. dec.	Lg. dec.	Low	Rare	Poor	Poor			0	25
27	Ulmus rubra	WSL	Low	3.4	42.0	11.4	Sm. dec.	No change	Medium	Rare	Poor	Fair	Infill +	Infill +	2	26
28	Quercus falcata	WDL	Medium	12.5	37.4	6.6	Lg. inc.	Lg. inc.	High	Rare	Good	Good	Infill ++	Infill ++	2	27
29	Acer saccharinum	NSH	Low	6.8	35.0	13.9	Sm. dec.	No change	High	Rare	Poor	Fair		Infill +	2	28
30	Quercus palustris	NSH	Low	4.5	33.8	6.9	Sm. dec.	Sm. dec.	Low	Rare	Poor	Poor	Infill +	Infill +	2	29
31	Ailanthus altissima	NSL	FIA	8	31.4	6.5	Unknown	Unknown	NA	Rare	NNIS	NNIS			0	30
32	Carya cordiformis	WSL	Low	6.6	29.6	7.2	No change	No change	High	Rare	Fair	Fair	Infill +	Infill +	2	31
33	Ulmus americana	WDH	Medium	15.8	24.3	7.7	Sm. inc.	Lg. inc.	Medium	Rare	Good	Good			2	32
34	Cornus florida	WDL	Medium	16.6	19.5	1.6	Sm. inc.	Sm. inc.	Medium	Rare	Good	Good	Infill ++	Infill ++	1	33
35	Carpinus caroliniana	WSL	Low	7.4	19.1	2.6	Sm. inc.	Sm. inc.	Medium	Rare	Good	Good	Infill ++	Infill ++	1	34
36	Fraxinus pennsylvanica	WSH	Low	4	18.7	5.2	Sm. inc.	Sm. inc.	Medium	Rare	Good	Good			2	35
37	Quercus phellos	NSL	Low	3.8	16.6	4.5	Sm. inc.	Sm. inc.	Medium	Rare	Good	Good			2	36
38	Acer platanoides	NSL	FIA	7.9	14.1	3.9	Unknown	Unknown	NA	Rare	NNIS	NNIS			0	37
39	Quercus imbricaria	NDH	Medium	2.3	12.7	5.2	Sm. dec.	Sm. dec.	Medium	Rare	Poor	Poor			0	38
40	Morus alba	NSL	FIA	10.4	10.7	5.5	Unknown	Unknown	NA	Rare	NNIS	NNIS			0	39
41	Asimina triloba	NSL	Low	6.4	9.8	2.8	Sm. dec.	Lg. dec.	Medium	Rare	Poor	Poor			0	40
42	Ilex opaca	NSL	Medium	13.1	9.0	2.4	Lg. inc.	Lg. inc.	Medium	Rare	Good	Good	Infill ++	Infill ++	1	41

fs.usda.gov/nrs/atlas/combined/resources/summaries/urban/

Climate Change Tree Atlas: Results for Greater Baltimore

NEW!

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES
GREATER BALTIMORE, MARYLAND

This list was developed to aid Greater Baltimore community forestry practitioners in selecting trees to reduce climate change vulnerability of their urban forests. It is meant to be a complement to other tree selection resources. Other factors may also need to be considered, such as aesthetics, local site conditions, wildlife value, or nursery availability. It is also important to note that some species may have climate benefits but may not be suitable for planting for other reasons, such as having invasive potential or susceptibility to pests or pathogens.

The Landscape Change Research Group recently updated the Climate Change Tree Atlas, and this handout summarizes information for the Greater Baltimore region. Full Tree Atlas results are available online at www.fs.fed.us/nrs/atlas/. Two climate scenarios are presented to "bracket" a range of possible futures. These future climate projections (2070 to 2099) provide information about how individual tree species may respond to a changing climate. Results for "low" and "high" emissions scenarios can be compared on the reverse side of this handout.

The updated Tree Atlas presents additional information helpful to interpret tree species changes:

- *Suitable habitat* - calculated based on 39 variables that explain where optimum conditions exist for a species, including soils, landforms, and climate variables.
- *Adaptability* - based on life-history traits that might increase or decrease tolerance of expected changes, such as the ability to withstand different forms of disturbance.
- *Capability* - a rating of the species' ability to cope or persist with climate change in this region based on suitable habitat change (statistical modeling), adaptability (literature review and expert opinion), and abundance (FIA data). The capability rating is modified by abundance information; ratings are downgraded for rare species and upgraded for abundant species.
- *Migration Potential Model* - when combined with habitat suitability, an estimate of a species' colonization likelihood for new habitats. This rating can be helpful for assisted migration or focused management (see the table section: "New Habitat with Migration Potential").

Remember that models are just tools, and they're not perfect. Model projections can't account for all factors that influence future species success. If a species is rare or confined to a small area, model results may be less reliable. These factors, and others, could cause a particular species to perform better or worse than a model projects. Human choices will also continue to influence forest distribution, especially for tree species that are projected to increase. Despite these limits, models provide useful information about future expectations. It's perhaps best to think of these projections as indicators of possibility and potential change.

CLIMATE CHANGE CAPABILITY

POOR CAPABILITY	
Bigtooth aspen	Pin oak
Black ash	Quaking aspen
Eastern white pine	Shingle oak
Pawpaw	Swamp white oak
FAIR CAPABILITY	
American beech	Eastern cottonwood
Bitternut hickory	Red mulberry
Black locust	Sassafras
Black walnut	Scarlet oak
Chestnut oak	Virginia pine
GOOD CAPABILITY	
American elm	Northern red oak
American holly	Pignut hickory
American hornbeam	Red maple
Black cherry	Shagbark hickory
Black oak	Southern red oak
Blackgum	Sugar maple
Boxelder	Swamp chestnut oak
Cherrybark oak	Sweetbay
Eastern hophornbeam	Sweetgum
Eastern redcedar	Sycamore
Flowering dogwood	White ash
Green ash	White oak
Hackberry	Willow oak
Loblolly pine	Yellow Poplar
Mockernut hickory	
MIXED RESULTS	
Silver maple	Common persimmon
Slippery elm	Black willow
NEW HABITAT WITH MIGRATION POTENTIAL	
Bald cypress	River birch
Blackjack oak	Shortleaf pine
Eastern redbud	Sourwood
Laurel oak	Sugarberry
Longleaf pine	Swamp tupelo
Overcup oak	Water oak
Pond cypress	Water tupelo
Post oak	Winged elm
Redbay	

SOURCE: This handout summarizes model results for the Greater Baltimore, Maryland area, available at https://www.fs.fed.us/nrs/atlas/combined/resources/summaries/urban/ua_04843.xlsx. More information on vulnerability and adaptation in the Mid-Atlantic region can be found at www.forestadaptation.org/mid-atlantic. A full description of the models and variables are provided in Iverson et al. 2019 (www.nrs.fs.fed.us/pubs/57857 and www.nrs.fs.fed.us/pubs/59105) and Peters et al. 2019 (www.nrs.fs.fed.us/pubs/58353).

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www.forestadaptation.org

ADAPTABILITY: Life-history factors, such as the ability to respond favorably to disturbance, that are not included in the Tree Atlas model and may make a species more or less able to adapt to future stressors.

+ HIGH *Species may perform better than modeled*
• MEDIUM
– LOW *Species may perform worse than modeled*

HABITAT CHANGE: Projected change in suitable habitat between current and potential future conditions.

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

ABUNDANCE: Based on Forest Inventory Analysis (FIA) summed Importance Value data, calibrated to a standard geographic area.

+ ABUNDANT
• COMMON
– RARE

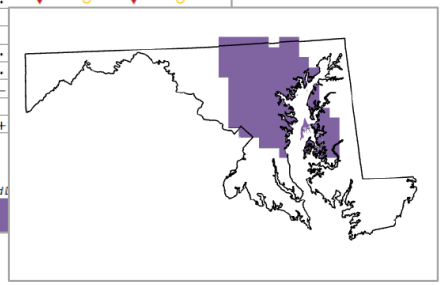
CAPABILITY: An overall rating that describes a species' ability to cope or persist with climate change based on suitable habitat change class (statistical modeling), adaptability (literature review and expert opinion), and abundance within this region.

△ GOOD *Increasing suitable habitat, medium or high adaptability, and common or abundant*
○ FAIR *Mixed combinations, such as a rare species with increasing suitable habitat and medium adaptability*
▽ POOR *Decreasing suitable habitat, medium or low adaptability, and uncommon or rare*

SPECIES	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5) HABITAT CHANGE	LOW CLIMATE CHANGE (RCP 4.5) CAPABILITY	HIGH CLIMATE CHANGE (RCP 8.5) HABITAT CHANGE	HIGH CLIMATE CHANGE (RCP 8.5) CAPABILITY
American beech	•	•	▼	○	▼	○
American elm	•	–	▲	△	▲	△
American holly	•	–	▲	△	▲	△
American hornbeam*	•	–	▲	△	▲	△
Bald cypress	•		★		★	
Bigtooth aspen	•	–	▼	▽	▼	▽
Bitternut hickory*	+	–	●	○	●	○
Black ash	–	–	▼	▽	▼	▽
Black cherry	–	•	●	△	●	△
Black locust*	•	•	▼	○	▼	○
Black oak	•	•	▲	△	▲	△
Black walnut*	•	•	▼	○	▼	○
Black willow*	–	–	●	○	▲	△
Blackgum	+	•	●	△	▲	△
Blackjack oak	+		★		★	
Boxelder*	+	•	●	△	●	△
Cherrybark oak	•	•	●	△	●	△
Chestnut oak	+	•	▼	○	▼	○
Common persimmon*	+	–	●	○	▲	△
Eastern cottonwood*	•	•	▼	○	▼	○
Eastern hophornbeam*	+	–	▲	△	▲	△
Eastern redbud*	•		★		★	
Eastern redcedar	•	–	▲	△	▲	△
Eastern white pine	–	–	▼	▽	▼	▽
Flowering dogwood	•	–	▲	△	▲	△
Green ash*	•	–	▲	△	▲	△
Hackberry	+	–	▲	△	▲	△
Laurel oak	•		★		★	
Loblolly pine	•	•	▲	△	▲	△
Longleaf pine	•		★		★	
Mockernut hickory	+	•	▲	△	▲	△
Northern red oak	+	•	●	△	●	△
Overcup oak	–		★		★	
Pawpaw*	•	–	▼	▽	▼	▽

SPECIES	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5) HABITAT CHANGE	LOW CLIMATE CHANGE (RCP 4.5) CAPABILITY	HIGH CLIMATE CHANGE (RCP 8.5) HABITAT CHANGE	HIGH CLIMATE CHANGE (RCP 8.5) CAPABILITY
Pignut hickory	•	•	●	△	●	△
Pin oak*	–	–	▼	▽	▼	▽
Pond cypress	•		★		★	
Post oak	+		★		★	
Quaking aspen	•	–	▼	▽	▼	▽
Red maple	+	+	▼	△	▼	△
Red mulberry*	•	–	●	○	●	○
Redbay*	+		★		★	
River birch*	•		★		★	
Sassafras*	•	•	▼	○	▼	○
Scarlet oak	•	•	▼	○	▼	○
Shagbark hickory	•	–	▲	△	▲	
Shingle oak	•	–	▼	▽	▼	▽
Shortleaf pine	•		★		★	
Silver maple*	+	–	▼	▽	●	○
Slippery elm*	•	–	▼	▽	●	○
Sourwood	+		★		★	
Southern red oak	+	–	▲	△	▲	△
Sugar maple	+	–	▲	△	▲	△
Sugarberry	•		★		★	
Swamp chestnut oak*	•	–	▲	△	▲	△
Swamp tupelo	–		★		★	
Swamp white oak*	•	–	▼	▽	▼	▽
Sweetbay	•	–	▲	△	▲	△
Sweetgum	•	•	▲	△	▲	△
Sycamore*	•	•	▲	△	▲	△
Virginia pine	•	•	▼	○	▼	○
Water oak	•		★		★	
Water tupelo	–		★		★	
White ash	–	•	▼	▽	▼	▽
White oak	+	•	▲	△	▲	△
Willow oak*	•	–	▲	△	▲	△
Winged elm	•		★		★	
Yellow Poplar	+	+	▲	△	▲	△

*Species with low model reliability based on five statistical metrics of the habitat models that affect change class. See maps and tables for more information (www.fs.fed.us/nrs/atlas/combined/resources/summaries).



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Climate Change Tree Atlas: Results for Greater Baltimore

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Pawpaw	Swamp white oak

FAIR CAPABILITY	
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Black walnut	Scarlet oak
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GOOD CAPABILITY	
American elm	Northern red oak
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Black oak	Southern red oak
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MIXED RESULTS	
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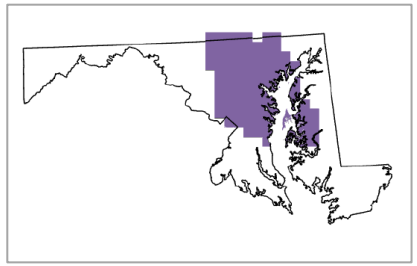

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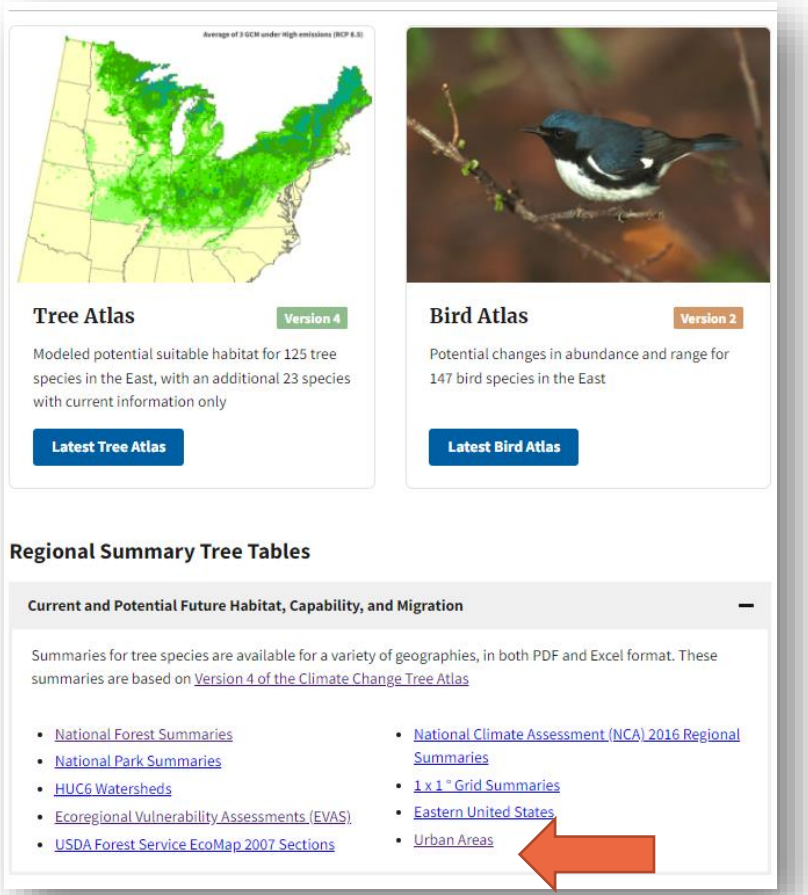
Tools to inform Baltimore tree planting

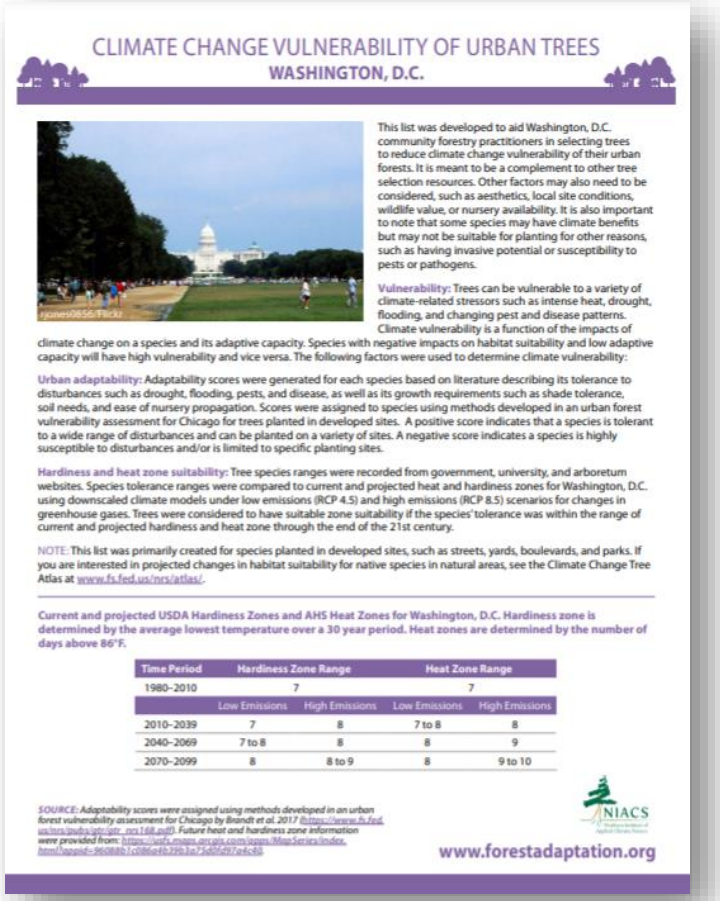
USFS Tree Atlas

Baltimore, MD



Heat & Hardiness Zones

Washington, DC



NIACS Washington DC climate change resources

Tree species projections (simplistic):

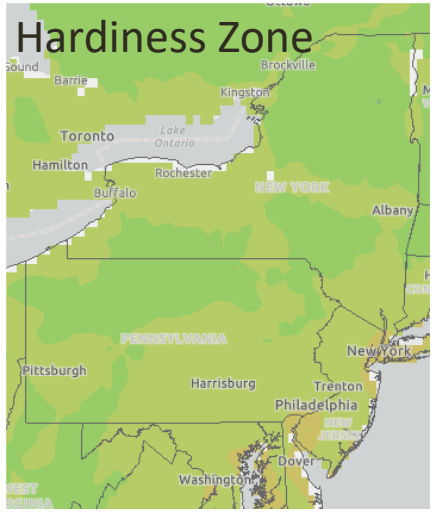
Tree characteristics

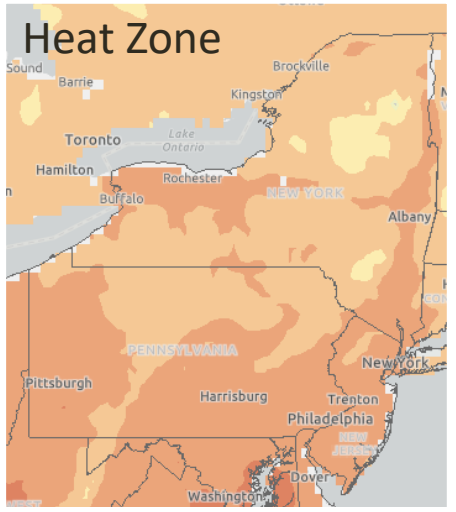
Adaptive capacity scoring

\+ **Future heat zone and hardiness zone projections**

Climate informed habitat projections

High Climate Change Scenario (RCP 8.5)





Time Period	Hardiness Zone Range		Heat Zone Range	
1980–2010	7		7	
	Low Emissions	High Emissions	Low Emissions	High Emissions
2010–2039	7	8	7 to 8	8
2040–2069	7 to 8	8	8	9
2070–2099	8	8 to 9	8	9 to 10

Current and projected USDA Hardiness Zones and AHS Heat Zones for Washington, D.C. Hardiness zone is determined by the average lowest temperature over a 30 year period. Heat zones are determined by the number of days above 86°F.

forestadaptation.org/washington-dc

NIACS Washington DC climate change resources

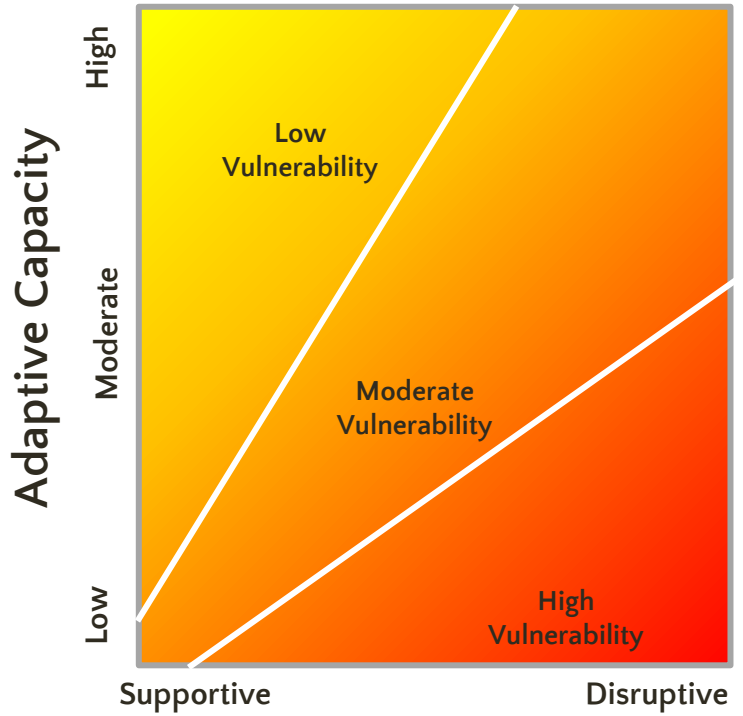
Tree species projections (simplistic):

Tree characteristics

Additional vulnerability considerations

\+ Future heat zone and hardiness zone projections

Climate informed habitat projections



ZONE SUITABILITY:

- ✓ ***Suitable***
- ✗ ***Not Suitable***

VULNERABILITY:

- ▼ ***Low:*** *Suitable zone, high adaptability*
- ● ***Low-moderate:*** *Suitable zone, medium adaptability*
- ⊖ ***Moderate:*** *Suitable zone, low adaptability or zone not suitable, high adaptability*
- ○ ***Moderate- high:*** *Zone not suitable, medium adaptability*
- △ ***High:*** *Zone not suitable, low adaptability*

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URBAN ADAPTABILITY:

- \+ ***High:*** *Species may perform better than modeled*
- · ***Medium***
- – ***Low:*** *Species may perform worse than modeled*

ZONE SUITABILITY:

- ✓ ***Suitable***
- ✗ ***Not Suitable***

VULNERABILITY:

- ▼ ***Low:*** *Suitable zone, high adaptability*
- ● ***Low-moderate:*** *Suitable zone, medium adaptability*
- ⊖ ***Moderate:*** *Suitable zone, low adaptability or zone not suitable, high adaptability*
- ○ ***Moderate- high:*** *Zone not suitable, medium adaptability*
- △ ***High:*** *Zone not suitable, low adaptability*

**Invasive species*

		LOW EMISSIONS ZONE		HIGH EMISSIONS ZONE	
COMMON NAME	ADAPT	SUIT	VULN	SUIT	VULN
Alleghany serviceberry	+	✓	▼	✗	⊖
American linden, Basswood	·	✓	●	✗	○
American sweetgum, fruitless	+	✓	▼	✓	▼
American beech	·	✓	●	✓	●
American elm	·	✓	●	✓	●
American sycamore	·	✓	●	✓	●
Amur corktree*	+	✗	⊖	✗	⊖
Amur maackia	+	✗	⊖	✗	⊖
Amur maple*	·	✗	○	✗	○
Bald cypress	+	✓	▼	✓	▼
Bipinnate goldenrain tree	+	✓	▼	✓	▼
Black alder	·	✗	○	✗	○
Black locust	·	✓	●	✗	○
Black oak	·	✓	●	✗	○
Black tupelo, Black gum	+	✓	▼	✓	▼
Black walnut	–	✓	⊖	✓	⊖
Blackjack oak	–	✓	⊖	✓	⊖
Boxelder	·	✓	●	✗	○

		LOW EMISSIONS ZONE		HIGH EMISSIONS ZONE	
COMMON NAME	ADAPT	SUIT	VULN	SUIT	VULN
Honeylocust*	·	✓	●	✗	○
Ironwood	+	✓	▼	✓	▼
Japanese flowering cherry	–	✗	△	✗	△
Japanese pagoda tree	·	✓	●	✗	○
Japanese tree lilac	+	✗	⊖	✗	⊖
Japanese zelkova	+	✓	▼	✗	⊖
Jefferson elm	+	✓	▼	✓	▼
Katsura tree	–	✓	⊖	✗	△
Kentucky coffeetree	+	✓	▼	✗	⊖
Kousa dogwood	+	✓	▼	✗	⊖
Lacebark elm	+	✓	▼	✓	▼
Littleleaf linden	+	✗	⊖	✗	⊖
London planetree	·	✓	●	✗	○
Musclewood	+	✓	▼	✓	▼
New Harmony elm	+	✓	▼	✓	▼
Northern red oak	+	✓	▼	✗	⊖
Northern white cedar, Arborvitae	·	✗	○	✗	○
Norway maple*	+	✗	⊖	✗	⊖

More information: forestadaptation.org/washington-dc

What this data can and can't do

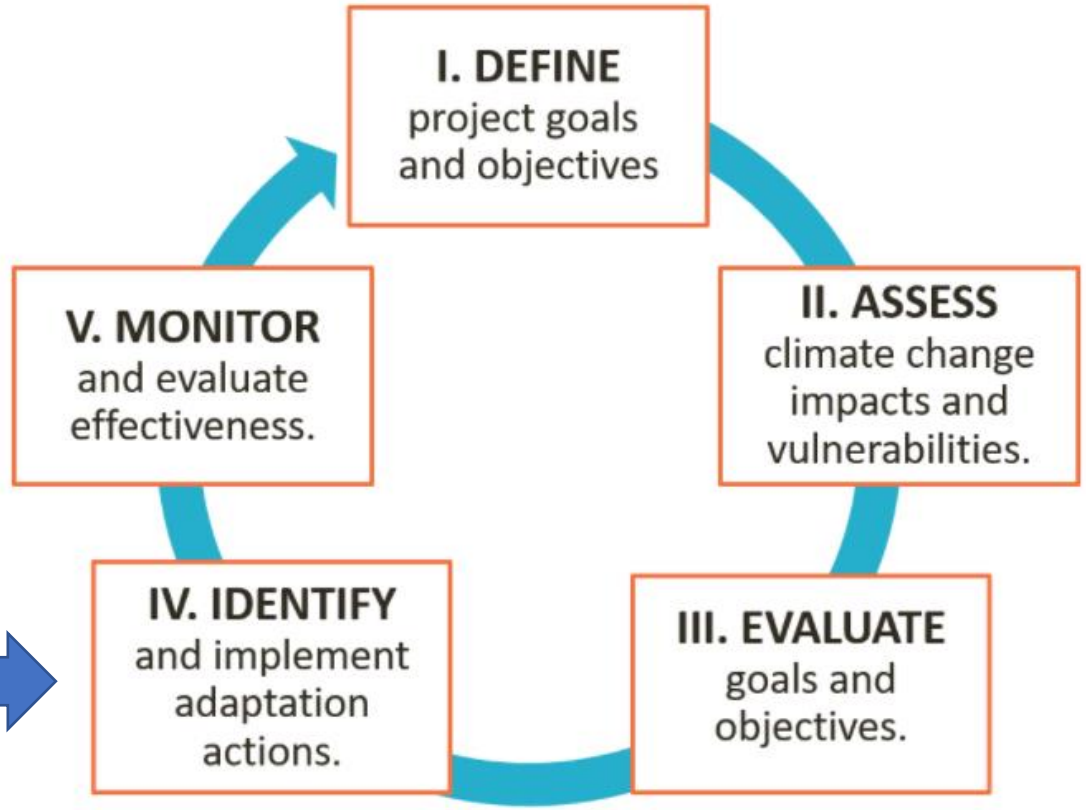
Can do -

- Describe regional habitat suitability for certain trees given climate change (from less warming to greater warming)
- Links to peer-reviewed, unbiased and scientific data on the topic
- Create connections to broader climate-informed thinking across the region through the NIACS urban effort.

Can't do -

- Tell you what to do.
  - These are model results and require additional **expertise** and **judgement** to determine site-level suitability

Adaptation Workbook Process



Utilizing the *'Climate Adaptation Actions for Urban Forests and Human Health'* **report & adaptation menu**

Resources for assessing vulnerability: Urban Forest Vulnerability Assessments, **Tree Species Risks (Climate Change Tree Atlas)**

Swanston et al. 2016.

Climate change adaptation spectrum

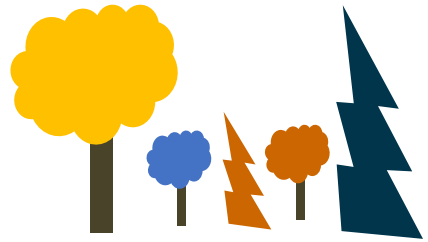
RESISTANCE

- Improve defenses of forest against change and disturbance
- Maintain relatively unchanged conditions

RESILIENCE

- Accommodate some degree of change
- Return to prior reference condition following disturbance

TRANSITION



- Intentionally facilitate change
- Enable ecosystem to respond to changing and new conditions

*Reduce impacts/maintain current conditions

*Forward-looking/promote change

Millar et al. 2007, Swanston et al. 2016, Nagel et al. 2017

Identifying Adaptation Actions – Using "Menus" of Strategies and Approaches

NIACS' adaptation menus provide a curated list of adaptation action options to help you *move from broad ideas to specific actions:*

- *Forests*
- *Forested watersheds*
- *Urban forests*
- *Recreation*
- *Agriculture*
- *Wildlife*
- *Forest Carbon*
- *and more. . .*

Adaptation Menus of Strategies and Approaches

A “menu” of **possible actions** that allows you to decide what is ***most relevant for a particular location and set of conditions.***

Brunch

Classics

Lemon Ricotta Pancakes Whipped Mascarpone Maple, Berries	15	**AJ's Omelet** Fontal Cheese, Spinach, Mushrooms	14
Cornflake Crusted French Toast Berries, Maple Syrup	15	**Eggs Florentine** Spicy Capicola, House-Made Cheddar Biscuit, Spinach	15
Bacon, Egg & Cheese Bacon, Two Eggs, Taleggio Cheese, Ciabatta	14	**Porchetta Hash** Poached Egg, Calabrian Chili Hollandaise	16
Avocado Toast Poached Eggs, Tomatoes, Chili Flakes, Sea Salt	15	**Chia Pudding** Chia Seeds, Toasted Coconut, Banana, Strawberry	14
Chicken Parmigiana Spicy Marinara, Fresh Mozzarella	22	**Farmhouse Breakfast** Two Eggs, House-Made Cheddar Biscuit, Chicken Sausage	14
Squid Ink fettuccine Vongole Little Neck Clams, Garlic, White Wine, Butter, Chili	22	**Chicken Kale Caesar** Chicken, Kale, Croutons	16

Create Your Own Pasta

Shapes

Rigatoni Semolina, All-Purpose Flour, Olive Oil	14
Cavatelli All-Purpose Flour, Durum Flour, Eggs, Ricotta	15
Tagliatelle All-Purpose Flour, Durum Flour, Eggs	15
Gluten-Free Rigatoni Gluten-Free All-Purpose Flour, Olive Oil, Eggs	16
Spaghetti Semolina, Durum Flour, Olive Oil	15
Four Cheese Herb Ravioli Fontal, Ricotta, Parmesan, Pecorino	18

Sauces

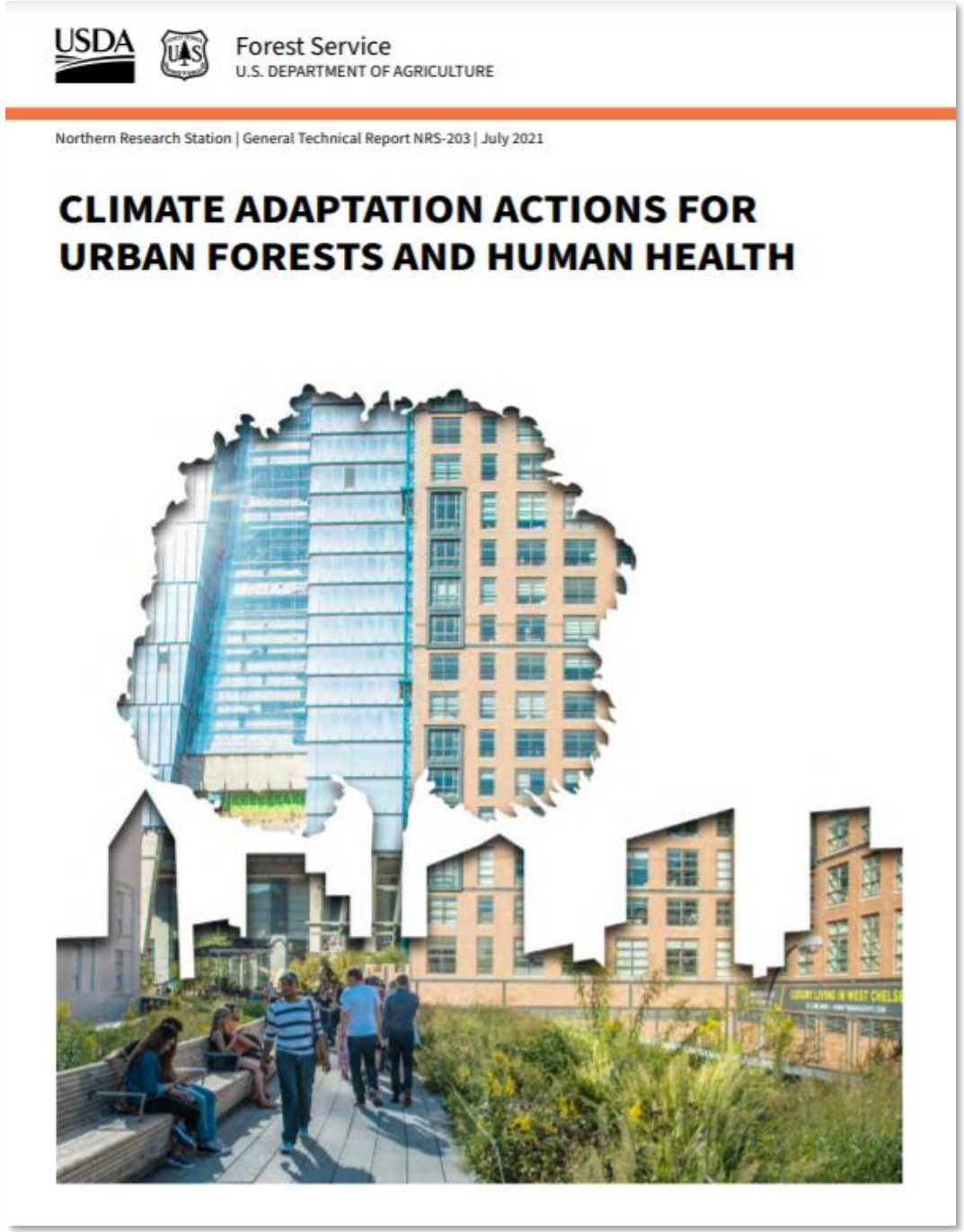
Marinara San Marzano tomatoes, Garlic, White Wine, Basil, Chili	
Arrabiata All-Purpose Flour, Durum Flour, Eggs, Ricotta	+1
Broken Meatball House Tomato Sauce with the Addition of Broken Meatballs	+4
Sunday Sauce House Tomato Sauce with Short Rib, Sausage, Veal	+4
Roasted Garlic Pecorino Semolina, Durum Flour, Olive Oil	+2
Carbonara Pancetta, Eggs, Peas, Pecorino	+3

Sides

Pecorino Truffle Fries	8
Potato Hash	6
Bacon	6
Turkey Sausage	6
Field Greens	7
Two Eggs Any Style	6
Beignets	8
Baked Goods	10

Brunch Cocktails

Bloody Mary Vodka, Spiced Fresh DOP Tomato Juice, Horseradish	10/45
Cointreau Spritz Cointreau Spritz, Aperol, Crème de Peche, Sparkling Wine	12/55
Green Side Reyka Vodka, Green Juice, Lemon	12/55
Morning Derby Bourbon, Grapefruit, Ginger, Carrot Juice	12/55
Sangria Red Wine, Fresh Fruit, Pisco, Crème de Peche	10/45
Firing Squad Milagros Tequila, Cointreau, Fresh Lime, Grenadine	12/55
Tall Mimosa Reyka Vodka, Cointreau, Jake's Mimosa Juice, Sparkling Wine	12/55



Climate and Health Adaptation "Menu" for Urban Forests

- Peer-reviewed list of adaptation strategies for climate adaptation and human health
- Supported by the best available science and practice
- Pick and choose based on your goals and needs

Available at: www.fs.usda.gov/treesearch/pubs/62807

Who should use these resources?

- Urban/community foresters
- Public health professionals
- Climate/sustainability professionals
- Non-profits & community groups
- Landscape architects
- Planners

STRATEGY 1:

Engage social systems to integrate climate change, urban forest, and human health actions

Adobe Stock

STRATEGY 2:

Reduce the impact of human health threats and stressors using urban trees and forests

Adobe Stock

STRATEGY 3:

Maintain or increase extent of urban forests and vegetative cover

Photos: Speak for the Trees Boston

STRATEGY 4:

Sustain or restore fundamental ecological functions of urban ecosystems

Using permeable paving, suspended surfaces, or Silva Cells to enable trees ample growing space and enhanced ability to capture runoff.

STRATEGY 5:

Reduce the impact of physical and biological stressors on urban forests

Implement structural pruning program to improve trees branching structure & ability to withstand extreme weather events.

STRATEGY 6:

Enhance taxonomic, functional, and structural diversity

Planting diversity of tree species, enacting tree preservation ordinances to protect older age classes of trees.

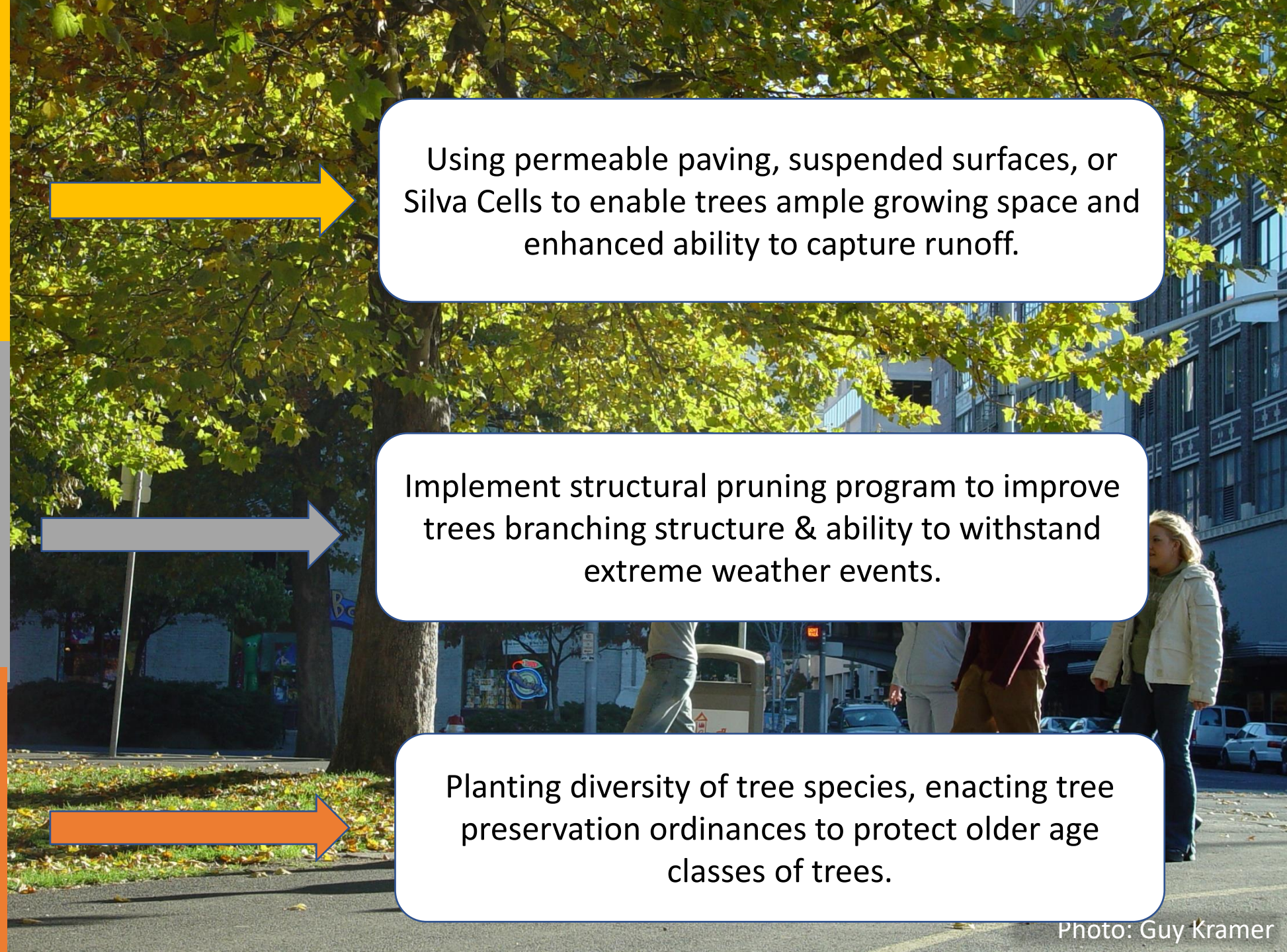
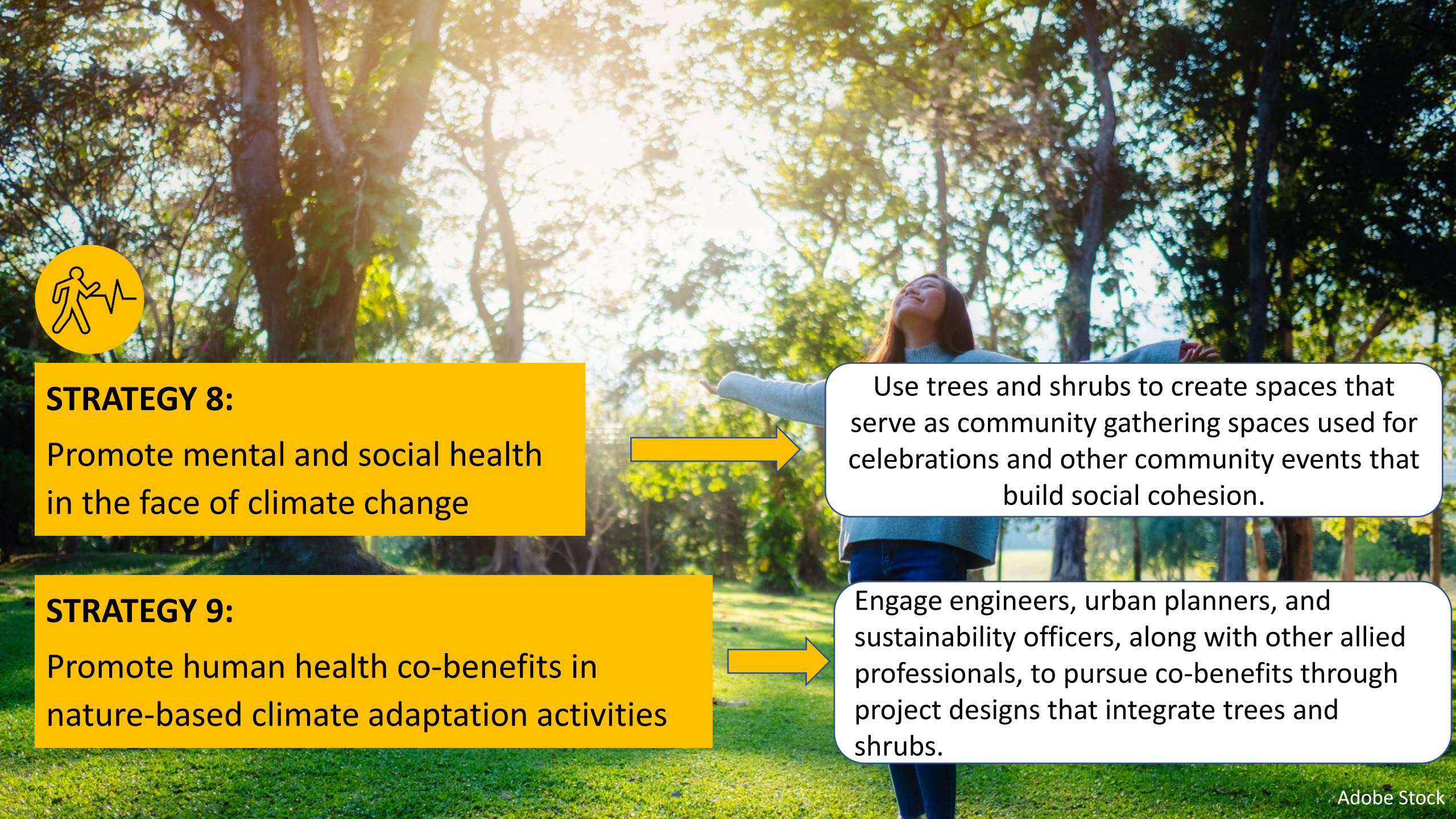


Photo: Guy Kramer

STRATEGY 7:

Alter urban ecosystems toward new and expected conditions

Photo: Guy Kramer



STRATEGY 8:

Promote mental and social health in the face of climate change

Use trees and shrubs to create spaces that serve as community gathering spaces used for celebrations and other community events that build social cohesion.

STRATEGY 9:

Promote human health co-benefits in nature-based climate adaptation activities

Engage engineers, urban planners, and sustainability officers, along with other allied professionals, to pursue co-benefits through project designs that integrate trees and shrubs.

Adobe Stock

CLIMATE CHANGE
RESPONSE FRAMEWORK

Who we are | Assess | Adapt | Learn | Focus | Contact

Adaptation Demonstrations

Home » Adapt » Demonstrations

Click for case study info!

+500

Real-world projects using the Adaptation Workbook

Forestadaptation.org/demos

Search on the map by location or filter by keyword

Urban Adaptation Demos

Urban Forests

Providence, RI: Climate & Health Adaptation on a Neighborhood Scale

The project area is primarily residential and light commercial. It is bordered by I-95 and the industrial Port of Providence to the

forestadaptation.org/adapt/urban

Demonstrations

City of Columbia: Street Tree Management Plan

Columbia, Missouri, is home to the University of Missouri and is Missouri's fourth most-populous city, with an estimated 120,612 residents

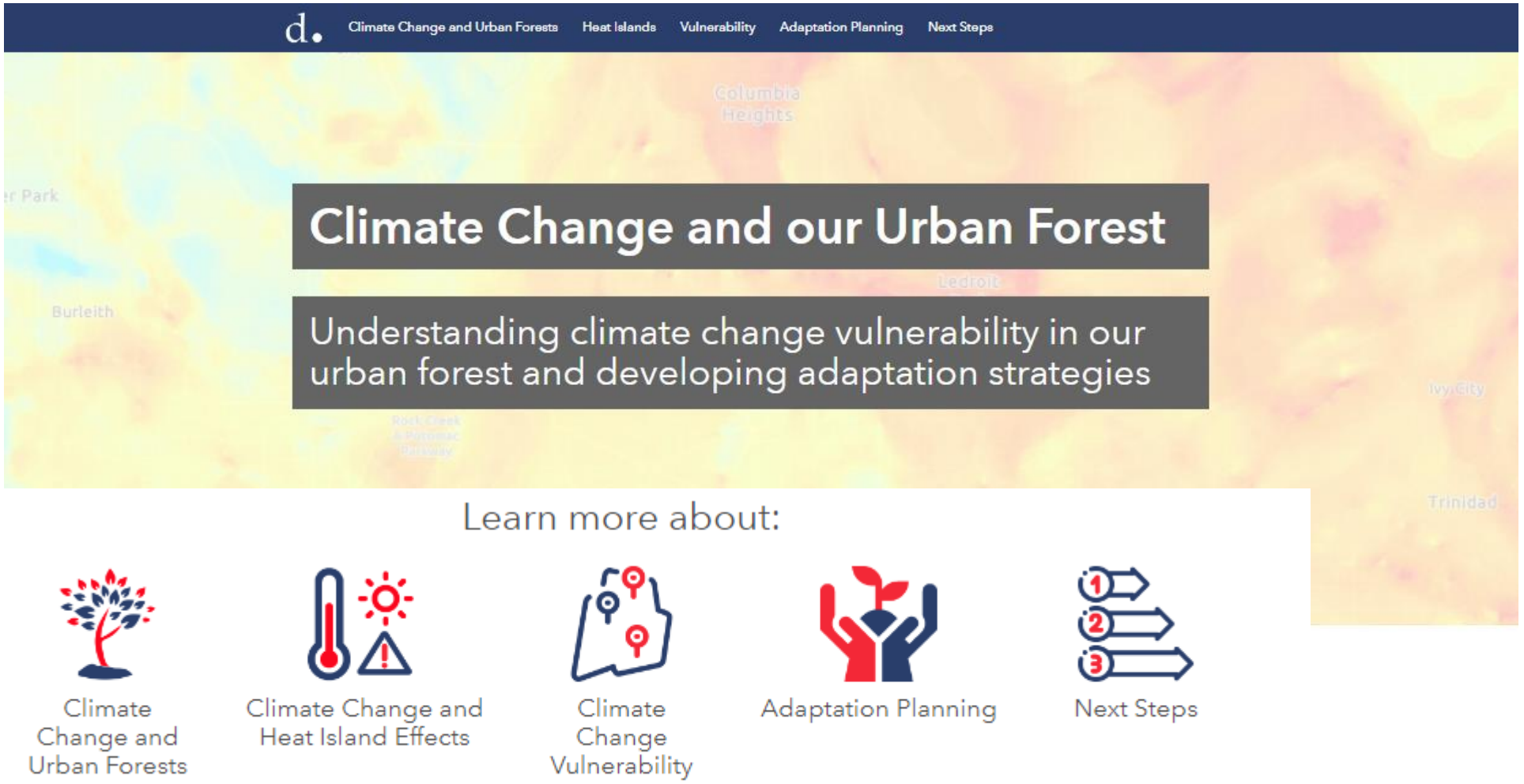
forestadaptation.org/adapt/demonstration-projects

(filter by focus: urban forests)

Mid-Atlantic Urban Adaptation Demos

- Maryland-National Capital Park and Planning Commission: Sligo Creek Reforestation with Climate Adaptation in Mind
- Friends of the Lower Appomattox River: Appomattox River Trail
  - Working to incorporate climate change considerations into the development of the Appomattox River Trail blueway and greenway.
- Fairfax County Urban Forest Management Division: Climate Change Adaptation Plan
  - Making better tree planting and preservation recommendations as well as natural resource management decisions in Fairfax County.
- Longwood Gardens: Planning Future Plantings in a Changing Climate
  - More than 9,000 identified and tagged trees, as well as several successional forest plots of different ages on the property.

Climate Change & DC's Urban Forest



StoryMap: https://climatereadyforests.dc.gov/

NIACS is Here to Help

Consultation

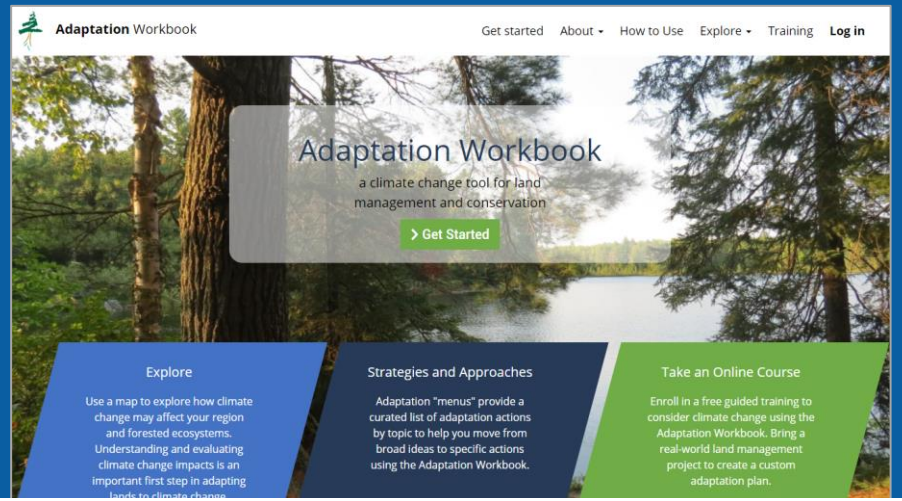
- Adaptation considerations and planning
- Large-scale or property-level planning
- Just get in touch – this is our job!
- Technical assistance by regional experts

www.forestadaptation.org/contact

Online Training

- FREE distance learning course
- Develop a custom plan with your own project
- 8 weeks, 1 session per week
- Continuing ed credits

www.forestadaptation.org/training



Adaptationworkbook.org

Additional reading: Urban tree species assessment

Read a technical description:

Brandt, Leslie A., Gary R. Johnson, Eric A. North, Jack Faje, and Annamarie Rutledge, “Vulnerability of Street Trees in Upper Midwest Cities to Climate Change” Frontiers in Ecology and Evolution (2021): 623. https://doi.org/10.3389/fevo.2021.721831

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