Session 3.6

Do the right thing: Planning, designing and managing the urban forest to strengthen its resilience to external shocks

Chair: Alana Tucker

World Forum on Urban Forests

2nd World Forum on Urban Forests

Washington DC, 2023

Tree Diversity within Publicly Managed Urban Forests

Presented by

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NC STATE UNIVERSITY

Why is diversity important?

- Ecological benefits
  - wildlife (food supply, habitat)
  - pollinators
  - birds
- Aesthetic benefits
- **Resilience with respect to invasive pests and pathogens**

Motivation for this Analysis

- Previous analyses showed that the majority of street, park & public tree populations across North America failed Santamour's 10-20-30 rule, but that street tree populations generally were worse wrt to the 10-20-30 rule (97% of street tree populations failed to meet the 10-20-30 standard, Ambrose 2018)
- Even so, previous analyses showed that most street and park tree populations were species rich (Ambrose 2022)
- Desire to make urban forests more diverse
- Knowing which components of the urban forest are most/least diverse can inform where there is the **greatest opportunity to increase diversity**
- Understanding diversity patterns can suggest **appropriate approaches for increasing diversity**

Data & Methods

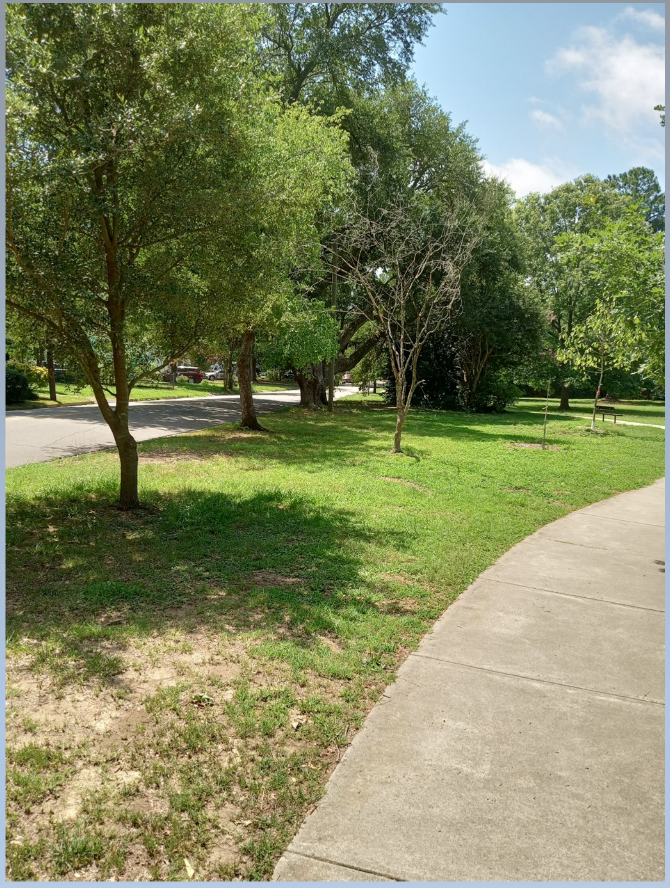
- Collected public tree inventory data from approx. 2,000 inventories covering over 1,600 North American cities
- Inventories completed from 2000 to the present
- Street tree, Park tree, or Public tree inventories
- Complete inventory, statistical sample, or partial inventory covering a “large” and/or clearly defined portion of a municipality
- *Most* trees must be identified to species
- Inventory sizes ranged from **100** to **650,000** trees
- *Excluded “problematic” datasets*

Difficult to Define Populations Categorize Datasets

- Inventory methods, approaches, purposes were not consistent (management data, not research data)
- For example, what is a street tree? What is a park tree?
- What about facility trees?
  - cemeteries, greenways, conservation areas
  - parking lots
  - City hall, fire stations, schools, other municipal buildings
- Does inventoried population depend on location or on who owns/manages the tree?
- **Limited data documentation**

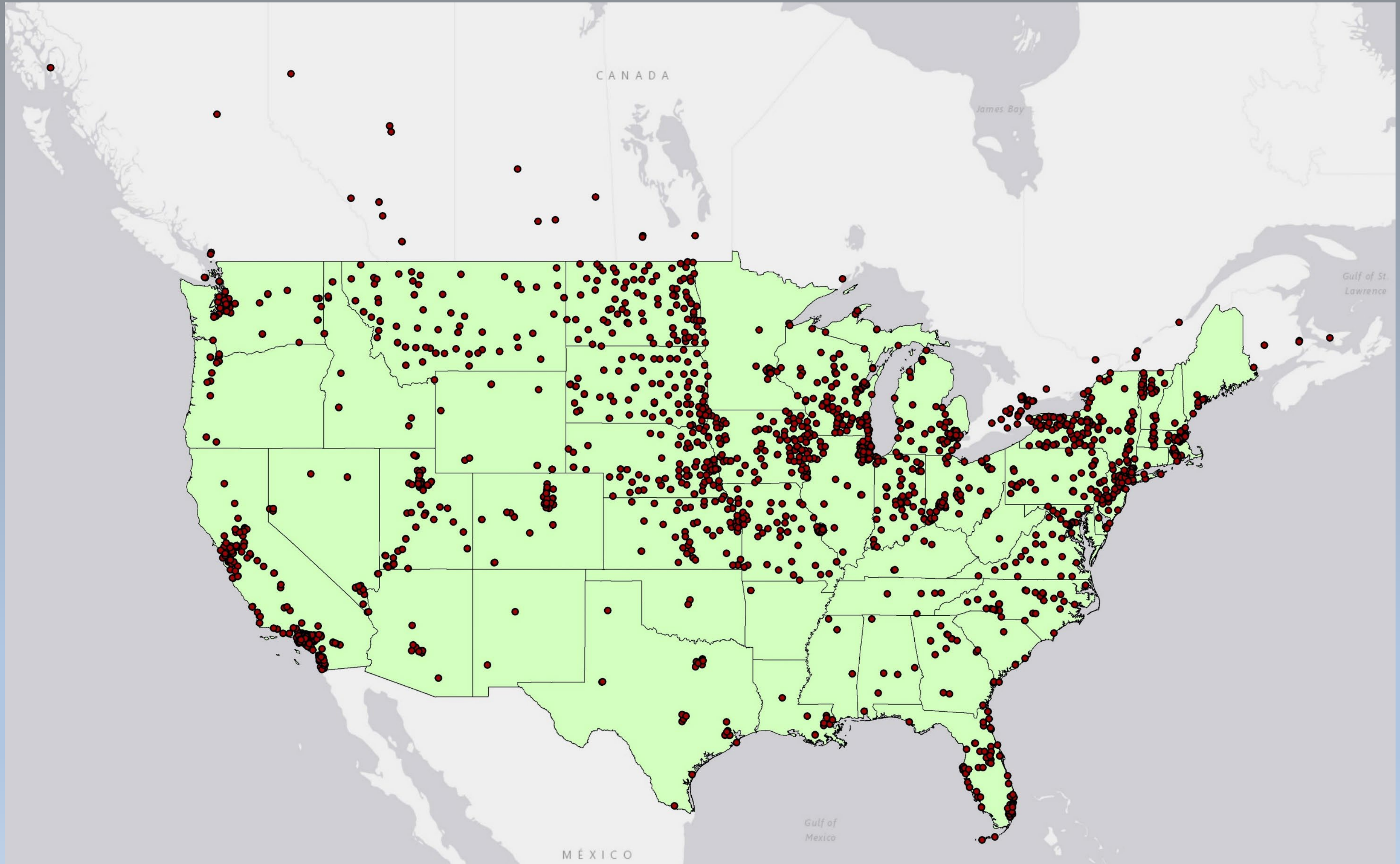
What is a street tree? What is a park tree?

What is a street tree? What is a park tree?



Natural areas in parks
What is inventoried?

Municipal inventory data



Methods (cont'd)

- For each municipal dataset, I calculated:
  - relative abundance for each species
  - species richness for each inventory (i.e., each dataset)
  - Simpson, Shannon-Wiener, & Reciprocal Simpson diversity indices
  - Determined most abundant species in each inventory

- Summarized results by region

Simpson's index

$$D = \Sigma(n_i * (n_i - 1)) / (N * (N - 1)),$$

where:

- n_i — Number of individuals in the i-th species; and
- N — Total number of individuals in the community.

Indicates the probability that two individuals, chosen at random from the population, are of the same species.

Ranges from 0 (infinite diversity) to 1 (no diversity; ie.,1 species).

Reciprocal Simpson Index

$$1/D$$

1/D = the number of species (i.e., richness) that, if perfectly even proportions of the population, would have the Simpson's value of D. Ranges from 1 (no diversity; ie.,1 species) to N (population species richness).

Diversity Results

Region	No. of inventories	Min species richness	Mean species richness	Max species richness
Alberta, Manitoba, Saskatchewan	19	20	67.26	138
Arizona & New Mexico	14	19	78.86	183
California	255	21	158.89	641
Colorado & Wyoming	38	19	92.26	286
DC, MD, VA & WV	42	25	103.67	271
Delaware, New Jersey & Pennsylvania	101	24	70.54	190
Eastern Canada (NB, ON, PEI, QC)	39	21	112.85	215
Florida	77	13	105.21	270
Iowa	104	15	49.37	196
Idaho & Montana	54	14	58.65	174
Mid-West (IL, IN, KY, & OH)	178	8	94.90	235
Missouri	67	19	88.88	264
New York & New England	232	12	76.46	267
Pacific Northwest (AK, BC,OR, WA)	62	17	111.29	343
Plains States (KS, NE, ND, SD)	314	7	37.79	119
Southeast (AL, AR, GA, LA, MS, NC, SC, TN)	71	13	87.62	323
Texas & Oklahoma	22	21	83.64	214
Upper Mid-West (MI, MN, WI)	201	11	78.27	212
Utah & Nevada	63	7	55.94	233

Diversity Results

Region	No. of inventories	Min species richness	Mean species richness	Max species richness	Min Reciprocal Simpson	Mean Reciprocal Simpson	Max Reciprocal Simpson
Alberta, Manitoba, Saskatchewan	19	20	67.26	138	2.93	7.69	15.57
Arizona & New Mexico	14	19	78.86	183	3.16	17.00	39.17
California	255	21	158.89	641	2.39	20.90	53.44
Colorado & Wyoming	38	19	92.26	286	4.09	15.39	33.96
DC, MD, VA & WV	42	25	103.67	271	6.69	22.43	48.46
Delaware, New Jersey & Pennsylvania	101	24	70.54	190	3.54	13.91	36.31
Eastern Canada (NB, ON, PEI, QC)	39	21	112.85	215	3.47	12.69	25.96
Florida	77	13	105.21	270	2.41	9.68	31.56
Iowa	104	15	49.37	196	3.53	11.91	34.39
Idaho & Montana	54	14	58.65	174	1.64	9.13	40.80
Mid-West (IL, IN, KY, & OH)	178	8	94.90	235	2.89	18.88	44.62
Missouri	67	19	88.88	264	1.64	18.54	51.03
New York & New England	232	12	76.46	267	1.62	12.23	38.17
Pacific Northwest (AK, BC,OR, WA)	62	17	111.29	343	4.23	16.94	42.56
Plains States (KS, NE, ND, SD)	314	7	37.79	119	1.53	9.20	29.20
Southeast (AL, AR, GA, LA, MS, NC, SC, TN)	71	13	87.62	323	2.90	12.55	43.22
Texas & Oklahoma	22	21	83.64	214	3.71	11.57	29.57
Upper Mid-West (MI, MN, WI)	201	11	78.27	212	2.21	13.54	45.34
Utah & Nevada	63	7	55.94	233	2.98	12.92	35.33

Diversity results

- Variation among cities in a state or region is typically greater than the variation among states/regions
- This suggests that environmental factors are not usually the most significant limitation on diversity
- Some, but not all, of the intra-regional variation appears to be related to the size of the urban forest populations

Street vs. Park Tree Populations

Paired population analysis

Hypotheses

- Street tree populations larger than managed park tree populations
- Park tree populations more species rich than street tree populations
- Park tree populations more diverse (in terms of diversity indices) than street tree populations

Results

Street Trees

Region	Number of cities	Inventory Size		Species Richness			Street Trees Richer
		Min.	Max.	Min.	Mean	Max.	
Alberta, Manitoba, Saskatchewan	5	3,552	211,946	20	67.4	101	1
Florida	12	858	67,542	34	137.2	233	10
Interior West	16	2,147	198,510	33	102.9	286	5
Midwest	47	409	163,700	32	110.2	208	37
Northeast	18	1,290	70,813	52	115.1	196	15
Plains (US)	52	145	47,590	15	42.7	111	28
South	9	606	91,576	37	138.3	261	6
West Coast	58	755	468,819	38	161.9	640	45
Overall	**217**	**145**	**468,819**	**15**	**109.4**	**640**	**147**

Park Trees

Region	Number of cities	Inventory Size		Species Richness			Park Trees Richer
		Min.	Max.	Min.	Mean	Max.	
Alberta, Manitoba, Saskatchewan	5	516	140,519	21	66.8	101	4
Florida	12	554	29,071	26	78.7	249	2
Interior West	16	1,700	54,595	25	118.3	224	11
Midwest	47	152	43,982	21	91.3	218	10
Northeast	18	221	45,458	21	87.6	157	3
Plains (US)	52	89	9,924	14	44.0	115	24
South	9	790	27,096	51	132.9	271	3
West Coast	58	381	93,663	30	120.7	472	13
Overall	**217**	**89**	**140,519**	**14**	**90.0**	**472**	**70**

Results

Street Trees:

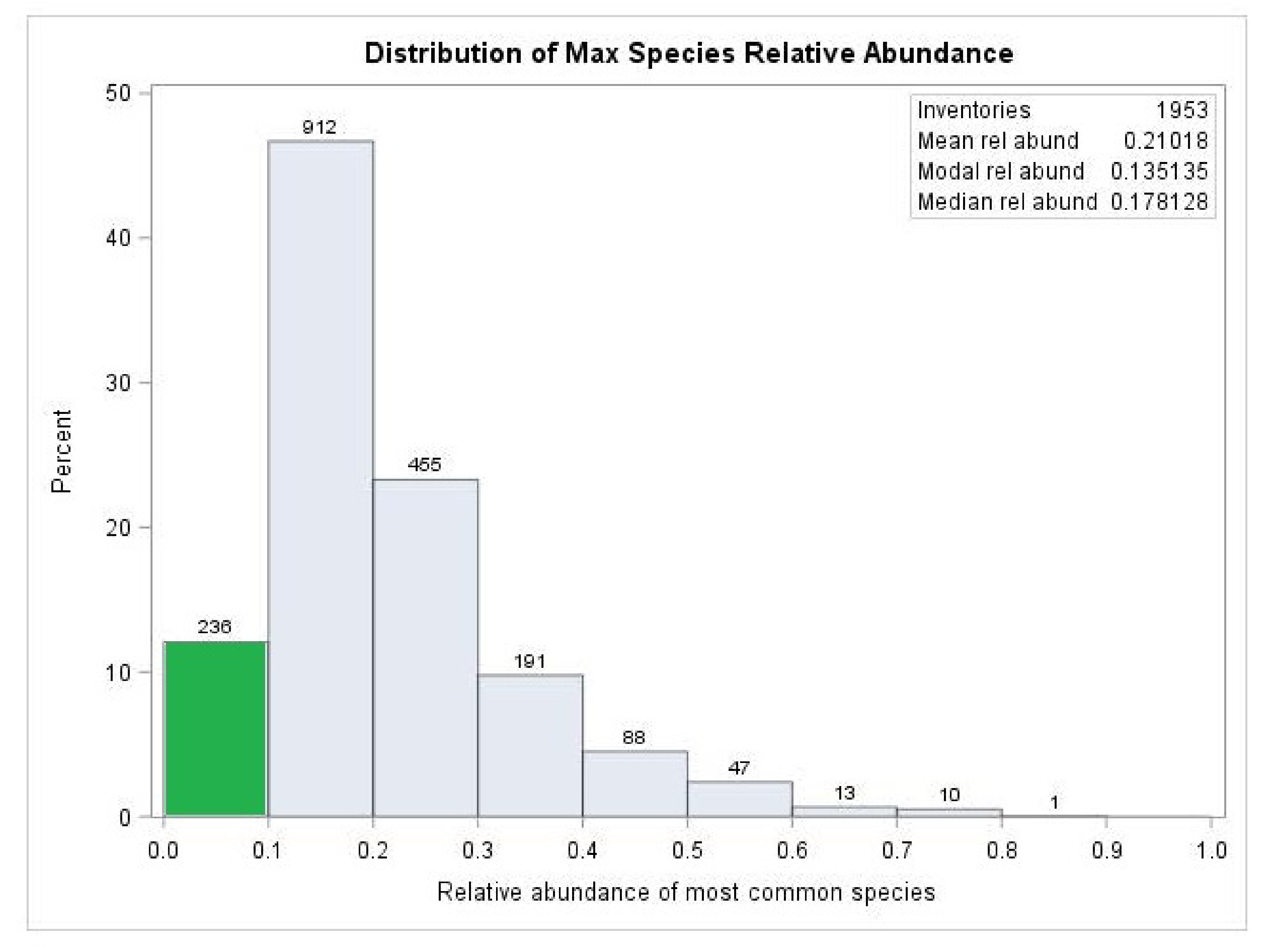
Region	Number of cities	Inventory Size		Species Richness			Reciprocal Simpson			Street Trees More Diverse
		Min.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	
Alberta, Manitoba, Saskatchewan	5	3,552	211,946	20	67.4	101	2.93	4.95	8.03	0
Florida	12	858	67,542	34	137.2	233	6.31	10.47	17.44	7
Interior West	16	2,147	198,510	33	102.9	286	2.14	17.36	39.17	5
Midwest	47	409	163,700	32	110.2	208	4.82	17.09	36.85	12
Northeast	18	1,290	70,813	52	115.1	196	7.05	12.66	22.34	2
Plains (US)	52	145	47,590	15	42.7	111	4.59	10.11	19.01	13
South	9	606	91,576	37	138.3	261	7.79	17.37	27.10	2
West Coast	58	755	468,819	38	161.9	640	5.25	19.29	38.93	27
Overall	**217**	**145**	**468,819**	**15**	**109.4**	**640**	**2.14**	**15.02**	**39.17**	**68**

Park Trees:

Region	Number of cities	Inventory Size		Species Richness			Reciprocal Simpson			Park Trees More Diverse
		Min.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	
Alberta, Manitoba, Saskatchewan	5	516	140,519	21	66.8	101	6.64	10.23	12.27	5
Florida	12	554	29,071	26	78.7	249	5.27	9.70	14.73	5
Interior West	16	1,700	54,595	25	118.3	224	4.73	23.12	40.80	11
Midwest	47	152	43,982	21	91.3	218	7.31	25.15	44.62	35
Northeast	18	221	45,458	21	87.6	157	9.22	20.40	36.31	16
Plains (US)	52	89	9,924	14	44.0	115	1.79	13.67	29.20	39
South	9	790	27,096	51	132.9	271	12.76	27.88	48.46	7
West Coast	58	381	93,663	30	120.7	472	2.97	20.95	53.44	31
Overall	**217**	**89**	**140,519**	**14**	**90.0**	**472**	**1.79**	**19.65**	**53.44**	**149**

Why are many street tree populations more species rich than park tree populations?

- Relative sizes of the populations
- Completeness of the inventories?
- Park tree populations tend to resemble (eastern) forests – dominated by relatively few species
- More frequent replacement of street trees???
- Assumption about kinds of trees planted in parks was wrong?


Distribution of Max Species Relative Abundance
Inventories 1953
Mean rel abund 0.21018
Modal rel abund 0.135135
Median rel abund 0.178128
Percent
50
40
30
20
10
0
236
912
455
191
88
47
13
10
1
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Relative abundance of most common species

Strategies to increase diversity will vary by region

Region	Scientific name	Common name	Percent of inventories where species > 10%
Eastern Canada	*Acer platanoides*	Norway maple	69.44
Florida	*Quercus virginiana*	southern live oak	42.11
	Sabal palmetto	cabbage palm	23.68

Strategies to increase diversity will vary by region

Region	Scientific name	Common name	Percent of inventories where species > 10%
Alberta, Manitoba, Saskatchewan	*Fraxinus pennsylvanica*	green ash	36.84
	Picea pungens	blue spruce	15.79
	Ulmus americana	American elm	36.84
Mid-West (IL, IN, KY, & OH)	*Acer rubrum*	red maple	11.72
	Acer saccharinum	silver maple	23.44
	Acer saccharum	sugar maple	10.16
	Fraxinus pennsylvanica	green ash	10.16

Strategies to increase diversity will vary by region

Region	Scientific name	Common name	Percent of inventories where species > 10%
Southeast	*Lagerstroemia indica*	crape-myrtle	39.71
	Quercus virginiana	Southern live oak	11.76

Conclusions

- In many cities, species richness is (very) high
- In many cities, the relative abundance (evenness) of tree species is responsible for lower diversity
- Environmental factors do not seem to be limiting the species planting palette in most regions
- No clear pattern to relative diversity of street vs. park trees

Conclusions

- Park tree species more even than street trees (i.e., populations less dominated by a few species)
- Opportunities to increase street tree diversity by improving the evenness of species distribution
- Opportunities to increase park tree diversity by increasing both species richness and evenness
- Strategies for increasing tree diversity will vary region and by city
- Need more data, and **more consistent** data

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Thank you

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Mechanisms affecting early establishment of native overstory trees in an urban forested natural area

Presented by

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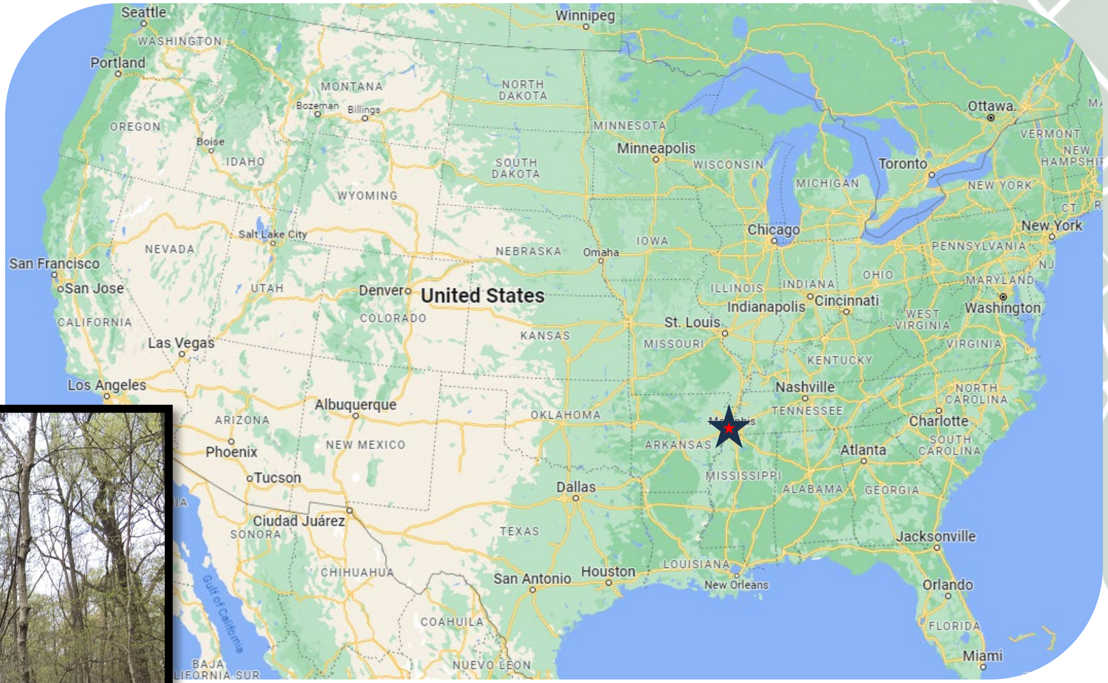
Urban Forested Natural Areas

- What are they?
  - – Remnant patches from larger forested setting
- Why are they important?
  - – Serve large proportion of urban population
  - – Substantial component of urban forest
    - NYC, NY ~ 5% land area; ~ 66% stem density
    - *- Pregitzer et al., 2019*
- Management is complicated
  - – Invasive species
  - – Pollution
  - – Altered disturbance regimes
  - – Urban silviculture – nascent field

Melissa McMasters

Old Forest State Natural Area

- Mixed mesophytic forest – *Braun, 1950*
  - ~ 56 tree species
  - 126 acres (51 hectares)
- Overstory – oaks, tulip poplar
  - 72″(183cm) dbh
  - 165′ (50m) height
  - 188 years (1835)

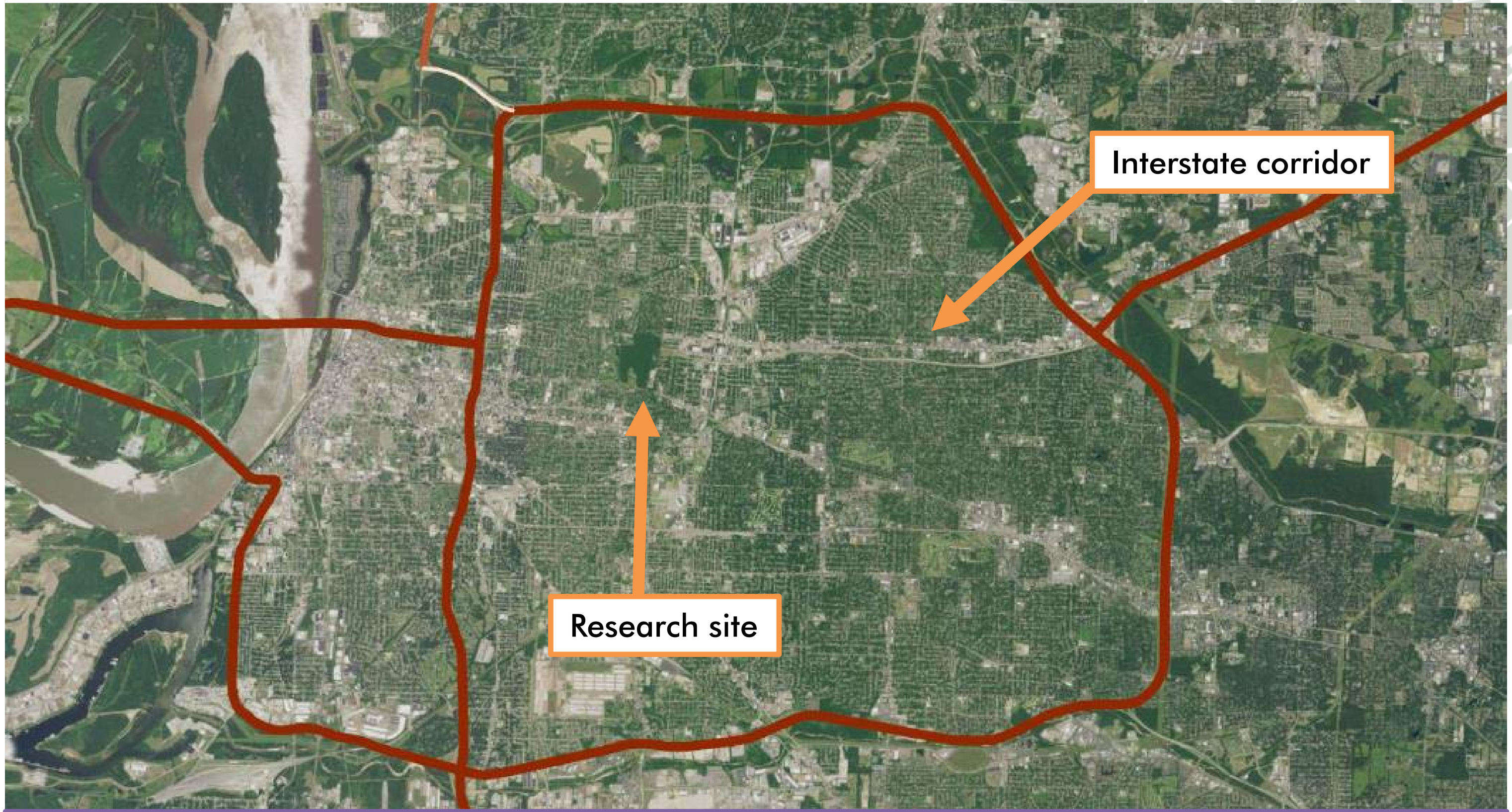


-- *google, INEGI, 2023*

Old Forest State Natural Area

- Visitation ~ 800,000/year
- US Supreme Court Case
  - *CPOP v. Volpe (1971)*

-- pbs.org



Sources: NAIP Natural Color Imagery at 1:360,000 scale & USA Freeway System

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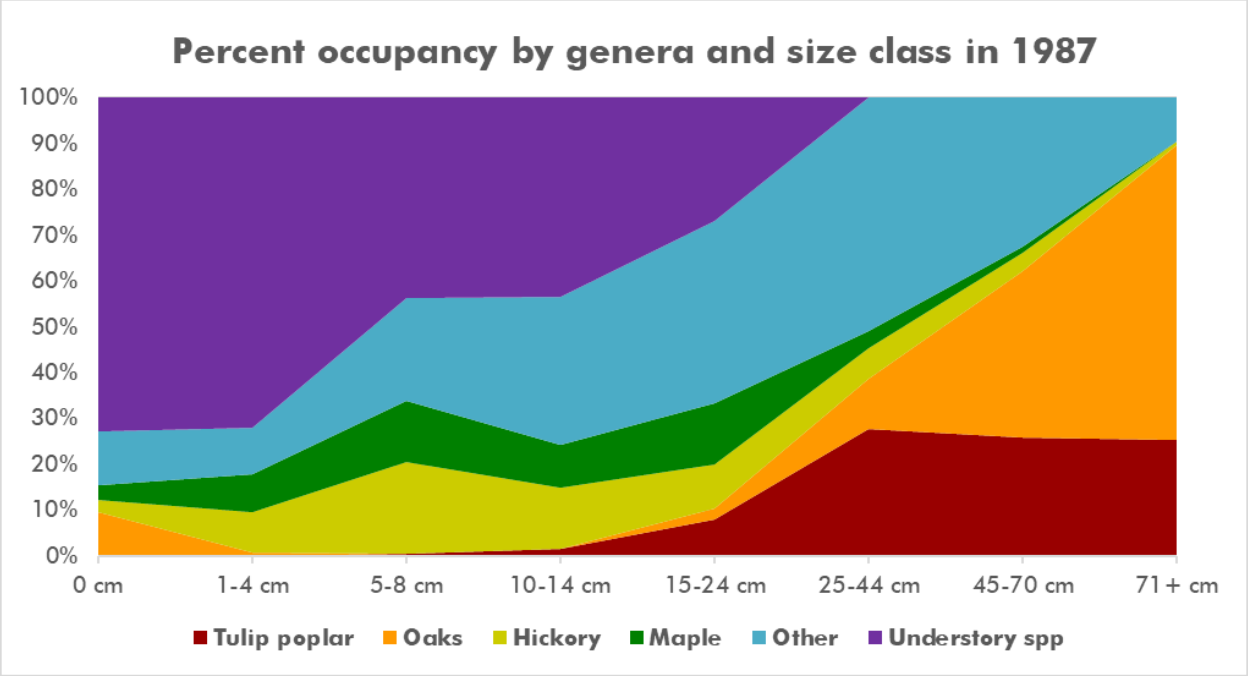
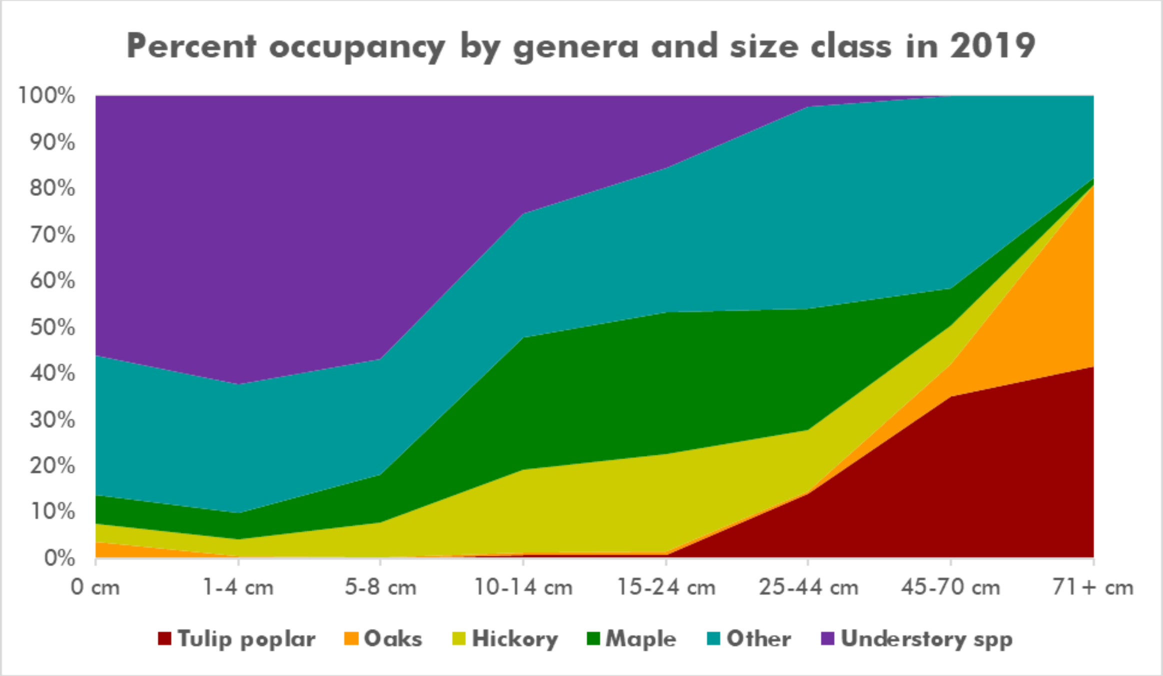
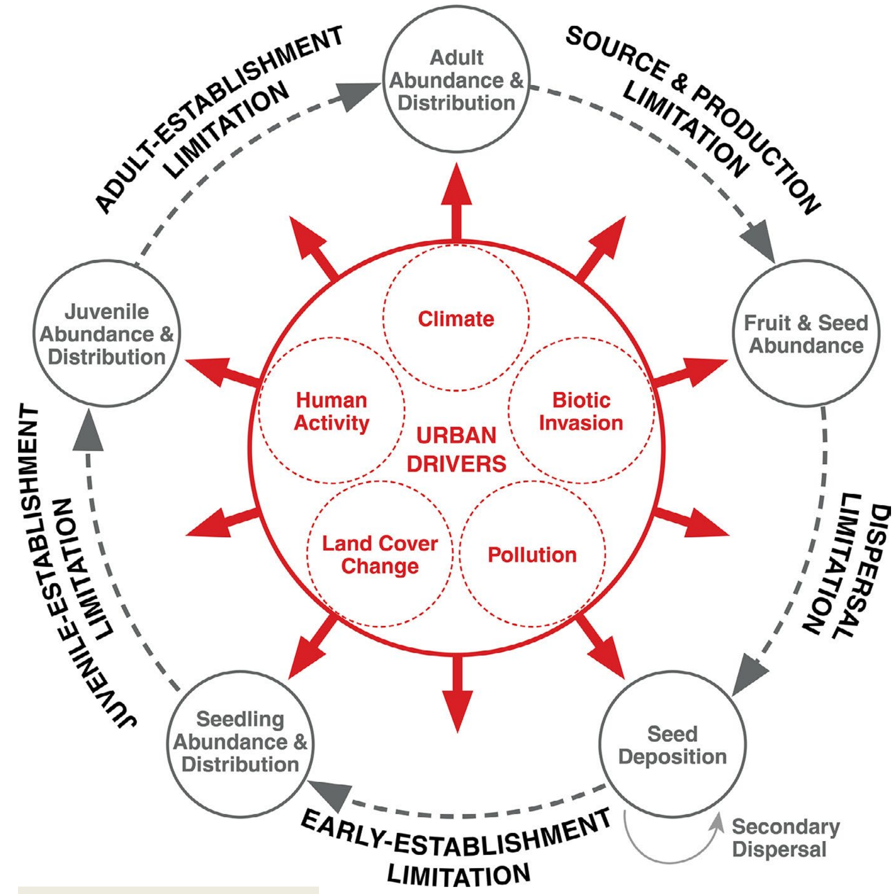
Problem Statement

- Lack of understory representation of dominant overstory trees
- Recruitment dynamics in Urban Forested Natural Areas (UFNAs) is poorly understood





Hypothesis

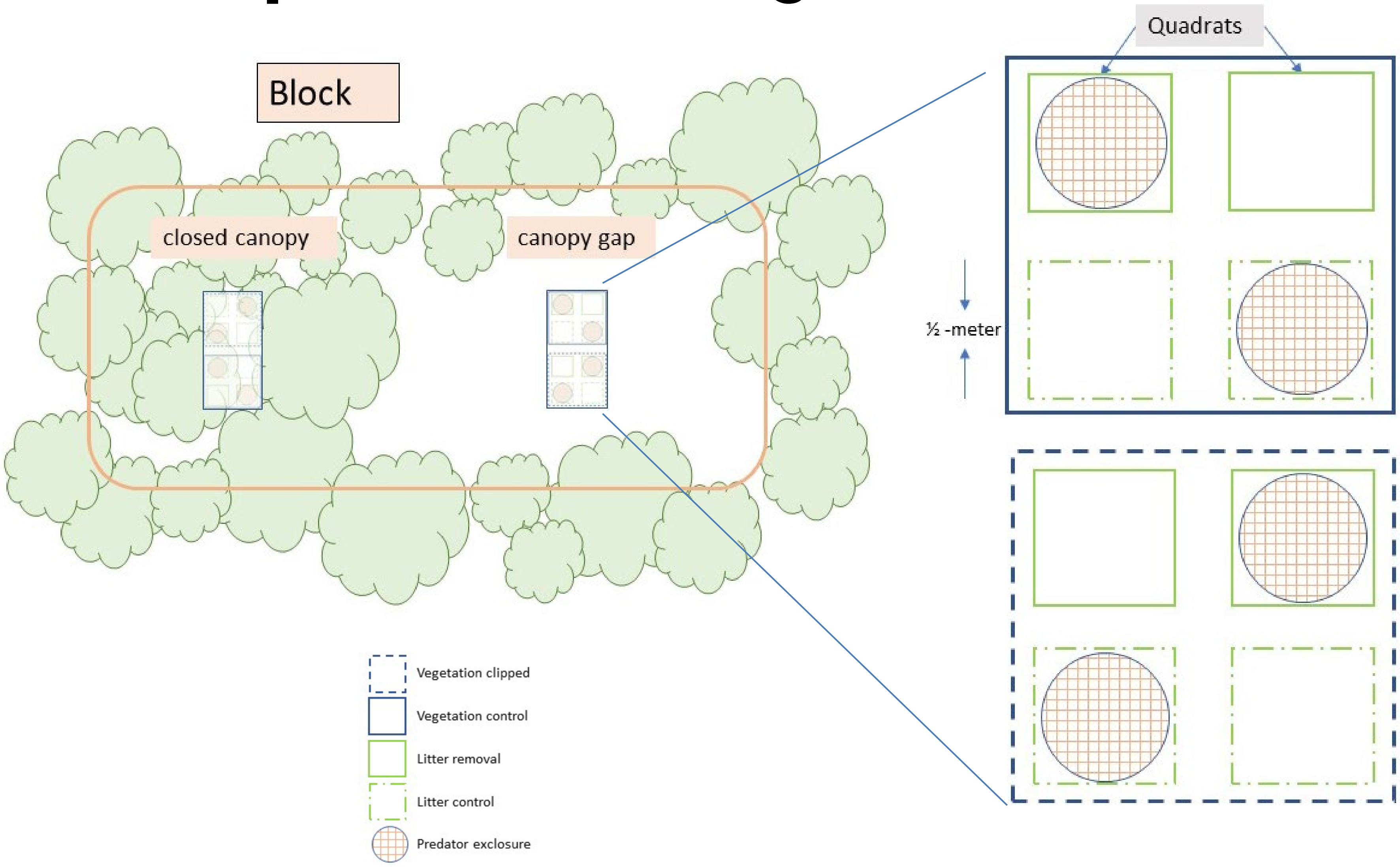


-- *Piana et al., 2019*

- Recruitment limitation framework
  - Seed & site limitation
  - *Clark et al., 2017; Piana et al., 2019*
- Germination & early emergence will be limited
  - Dense understory
  - Excessive leaf litter depths
  - High seed predation/removal levels
  - Interactions of the above factors

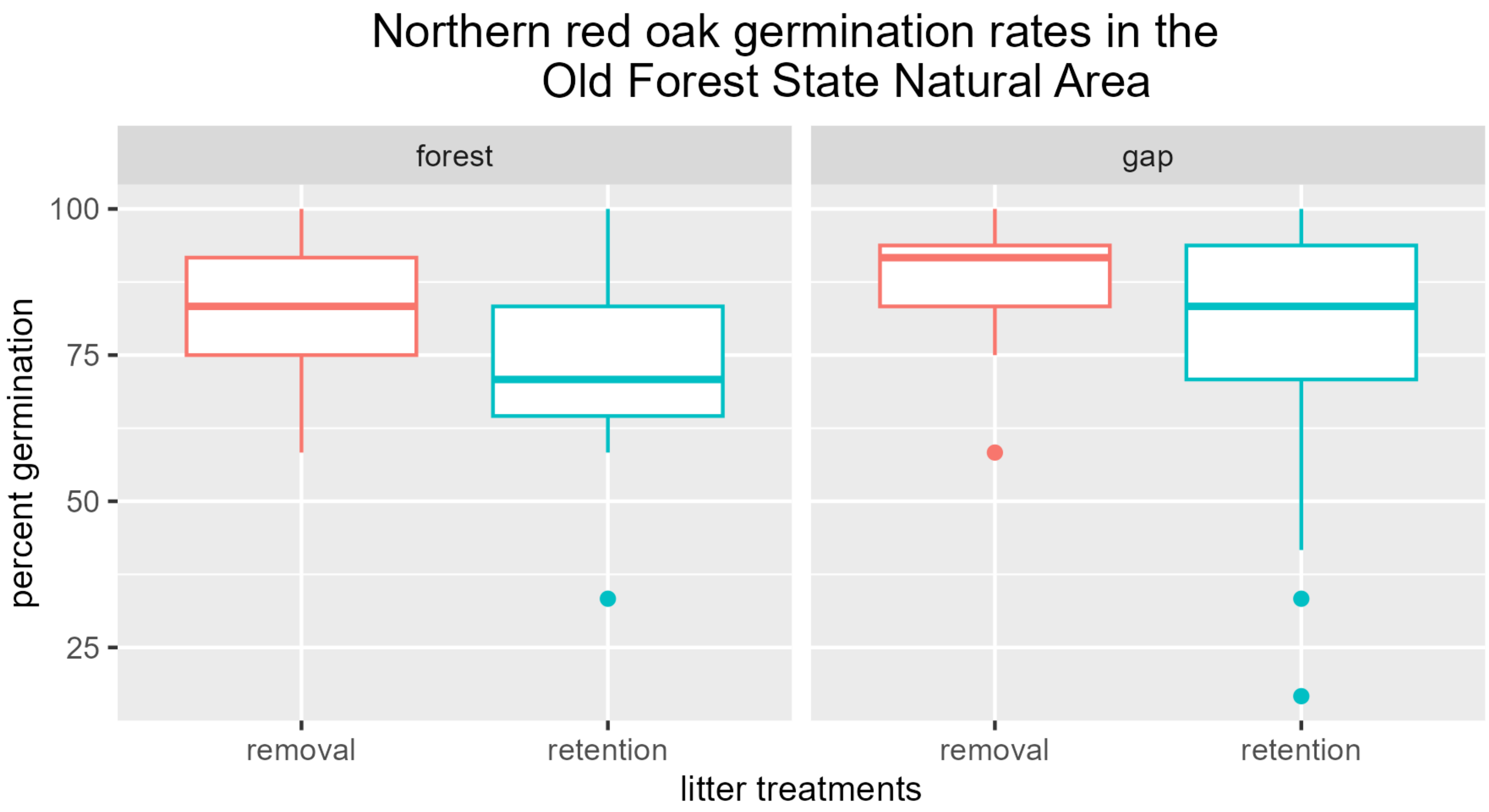
Experimental Design

- **4- way factorial split- plot RCBD**
  - Canopy
  - Vegetation
  - Leaf litter
  - Seed predator
- **12 replicates**
- **3 species**
  - Oak (*Quercus rubra*)
  - 12 acorns



Preliminary Results

- Mixed effects ANOVA
  - agricolae package in r
- Seed removal
  - 99.6% (1,147/1,152)
- Overall emergence
  - 81%
- Canopy treatment
  - Marginal (p=0.076)
- Leaf litter treatment
  - Significant (p=0.002)
- Vegetation treatment
  - Nonsignificant (p=0.529)



Discussion

- Seed predation/removal
  - Don't know fate of removed seeds
  - Elevated squirrel populations in urban areas – *Overdyck et al., 2013*
- Leaf litter
  - Lack of fire and associated temporary reduction in leaf litter – Royse et al., 2010
- Canopy gaps
  - Impact on understory environment
    - Light levels, soil temperature and moisture
- Interactions
  - Lack of significance was unexpected

Conclusions/ Implications

- Seed predation/removal levels
  - Direct planting may be required over seeding
  - Mutualism/antagonism in seed dispersal – *Bogdziewicz et al., 2019*
- Leaf litter depths
  - Use of Rx fire in urban areas
  - Increased oak recruitment in the absence of seed predators and drought – *Garcia et al., 2002*
- Dense understory
  - Large-seeded species germinate independent of light – *Baskin & Baskin, 1998*
- Student engagement
  - Opportunities to engage diverse student population
  - 12 undergraduate interns

Limitations and Future Directions

- Seedling survival
  - Canopy gaps
- More species
  - Lack of maple
- Role of invasive plants
  - Dense understory
- Multiple interactions
  - Generate statistical power
- Human dimensions
  - Values
  - Engagement in research
- Vandalism

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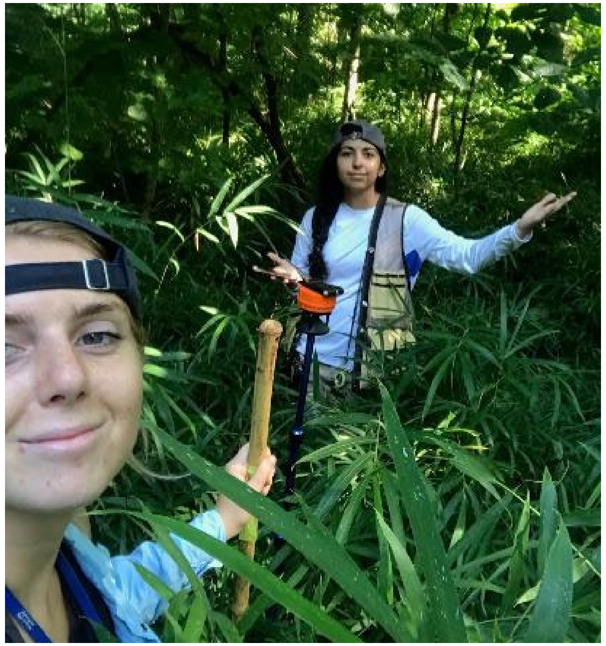

Thank you

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Franceschi E, Moser-Reischl A, Honold M, Rahman MA, Pretzsch H, Rötzer T

How do environment and climate change impact urban tree growth?

Reaction to drought and heat stress for a temperate city

Presented by
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Centre for Urban Ecology and Climate Adaptation

ZSK

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RQ
Methods
Growth & environment
Growth & drought events
Growth & climate change
Take-home message

Research Questions

- How does the species-specific growth differ in urban compared to suburban surroundings?

➢ ZONE/UHI EFFECT

- How do the urban tree species respond to and recover after drought events?

➢ SINGLE DROUGHT EVENT vs. ACCUMULATED DROUGHT STRESS

- What changes in the growth of different urban tree species can be detected under the recent climate change?

➢ CLIMATE CHANGE EFFECT (1980-1999 vs 2000-2019)

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RQ

Methods

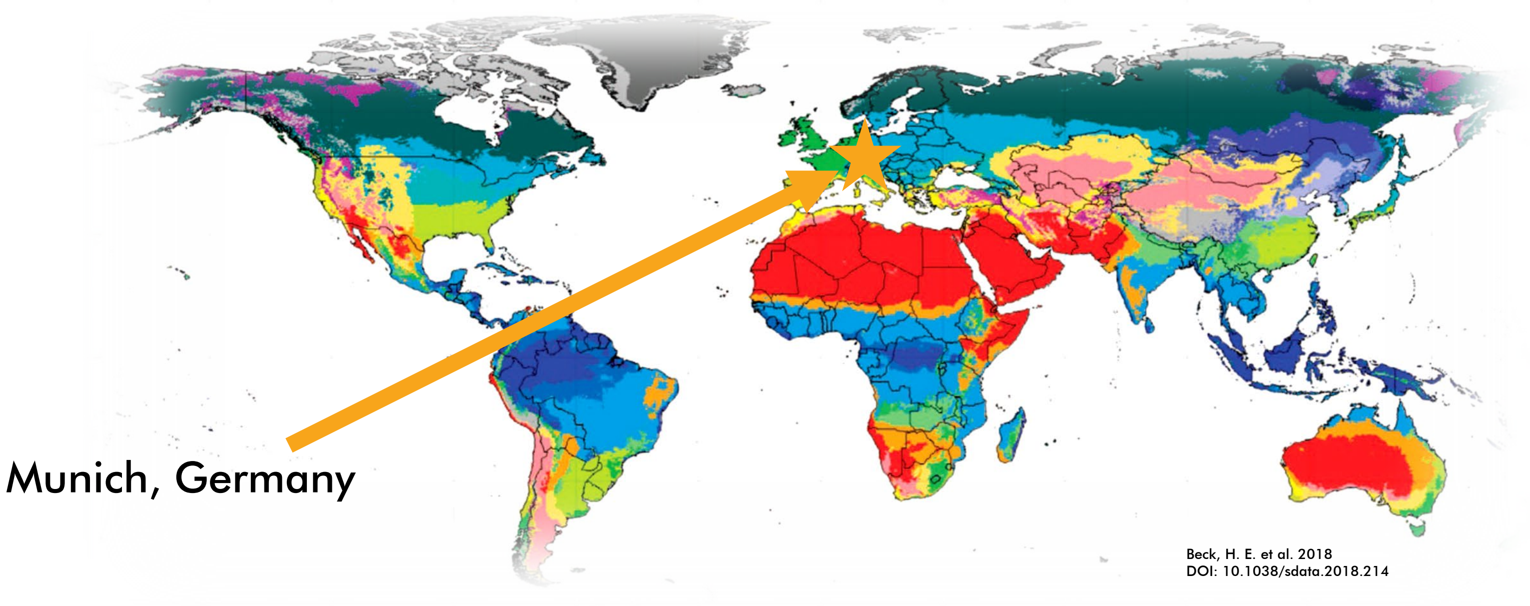
Growth & environment

Growth & drought events

Growth & climate change

Take-home message

Data and methods



	1961-1990	1991-2020
Mean annual air temperature [°C]	9.1	10.1
Annual sum of precipitation [mm]	974	940

Source: DWD CDC https://cdc.dwd.de/portal/

Data and methods

- Tree species selection
- Selection of trees within the city of Munich, Germany

	N (street, park)	dbh [cm]	tree height [m]	cr [m]
A. platanoides	40 (20, 20)	46.5 ± 16.6	16.9 ± 5.8	5.4 ± 1.4
F. sylvatica	20 (3, 17)	53.2 ± 7.2	22.8 ± 2.9	5.1 ± 1.3
P. x acerifolia	28 (16, 12)	55.4 ± 12.9	20.3 ± 3.9	7.2 ± 1.2
Q. robur	20 (2, 18)	53.7 ± 6.0	18.7 ± 2.9	5.4 ± 1.1
R. pseudoacacia	35 (22, 13)	45.5 ± 15.3	16.5 ± 4.1	4.8 ± 0.9
T. cordata	33 (21, 12)	45.8 ± 10.9	16.5 ± 2.9	5.0 ± 1.3

Drought tolerance and adaptation: very high, high-medium high, medium-low
(Source: Roloff 2013)

- Preparation of the increment core data
- Analyses, linear mixed models

RQ

Methods

Growth & environment

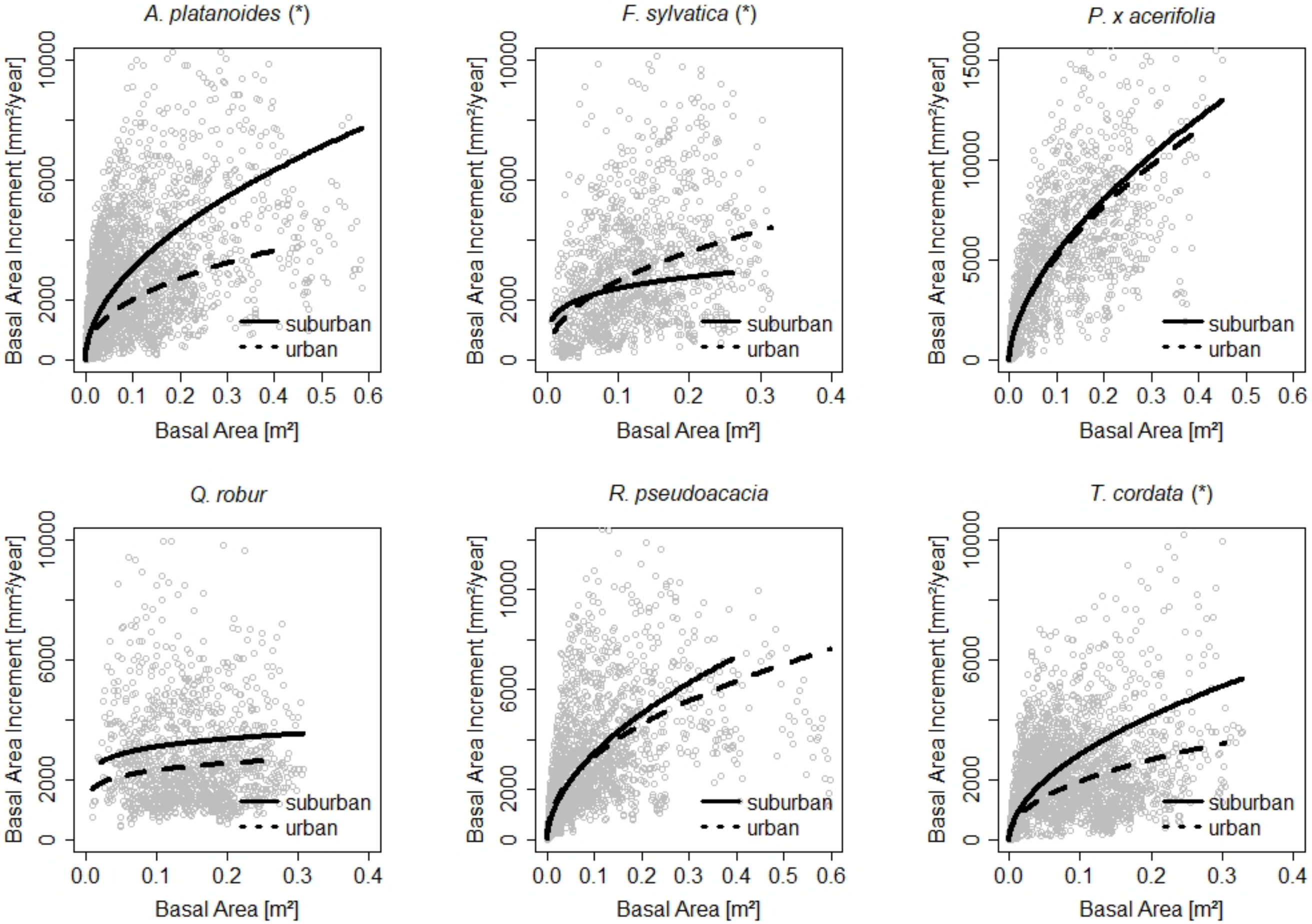
Growth & drought events

Growth & climate change

Take-home message

Growth and environment

The effect of the urban heat island

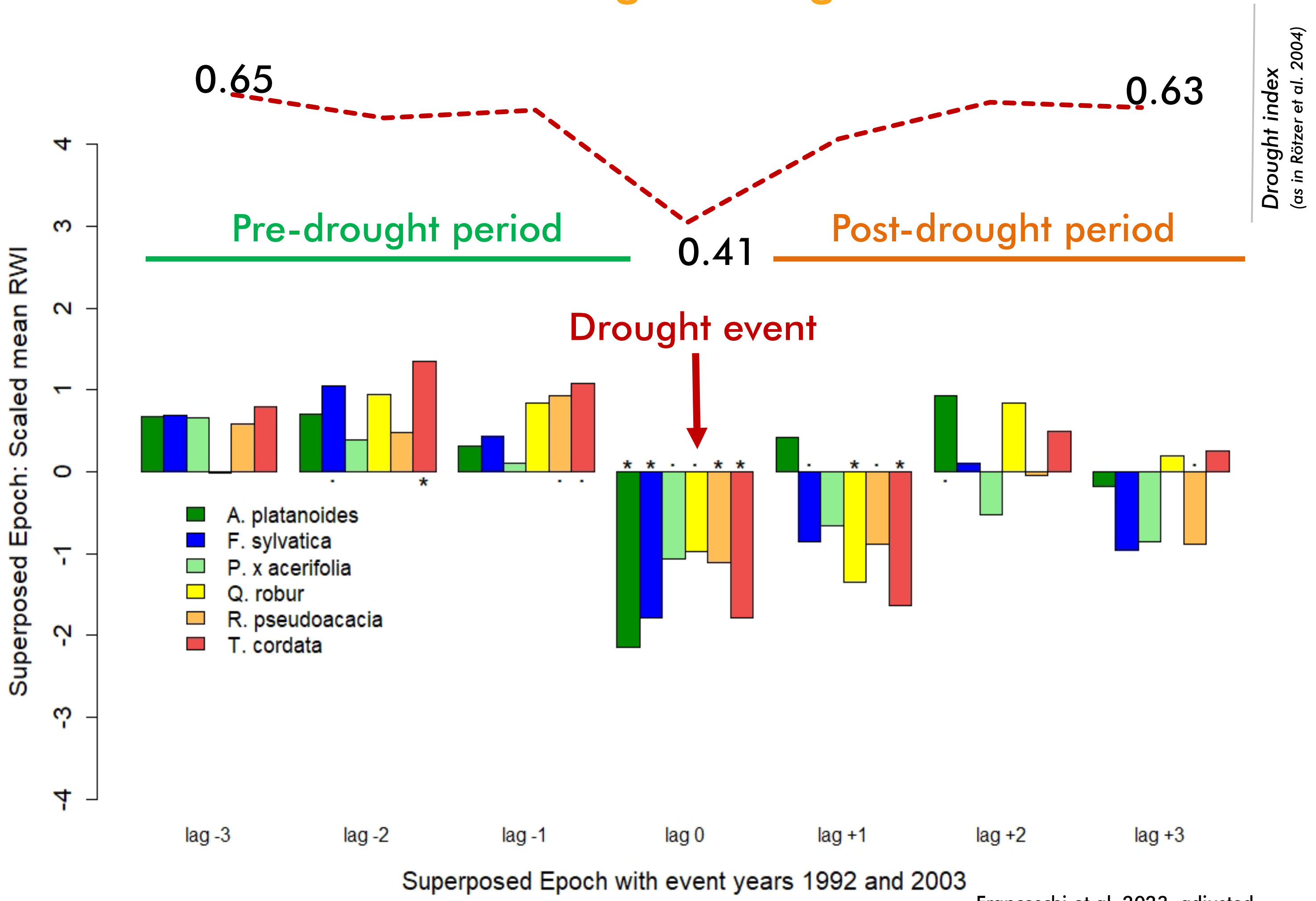


Franceschi et al. 2023

RQ
Methods
Growth & environment
Growth & drought events
Growth & climate change
Take-home message

Growth and drought events

The effect of single drought event

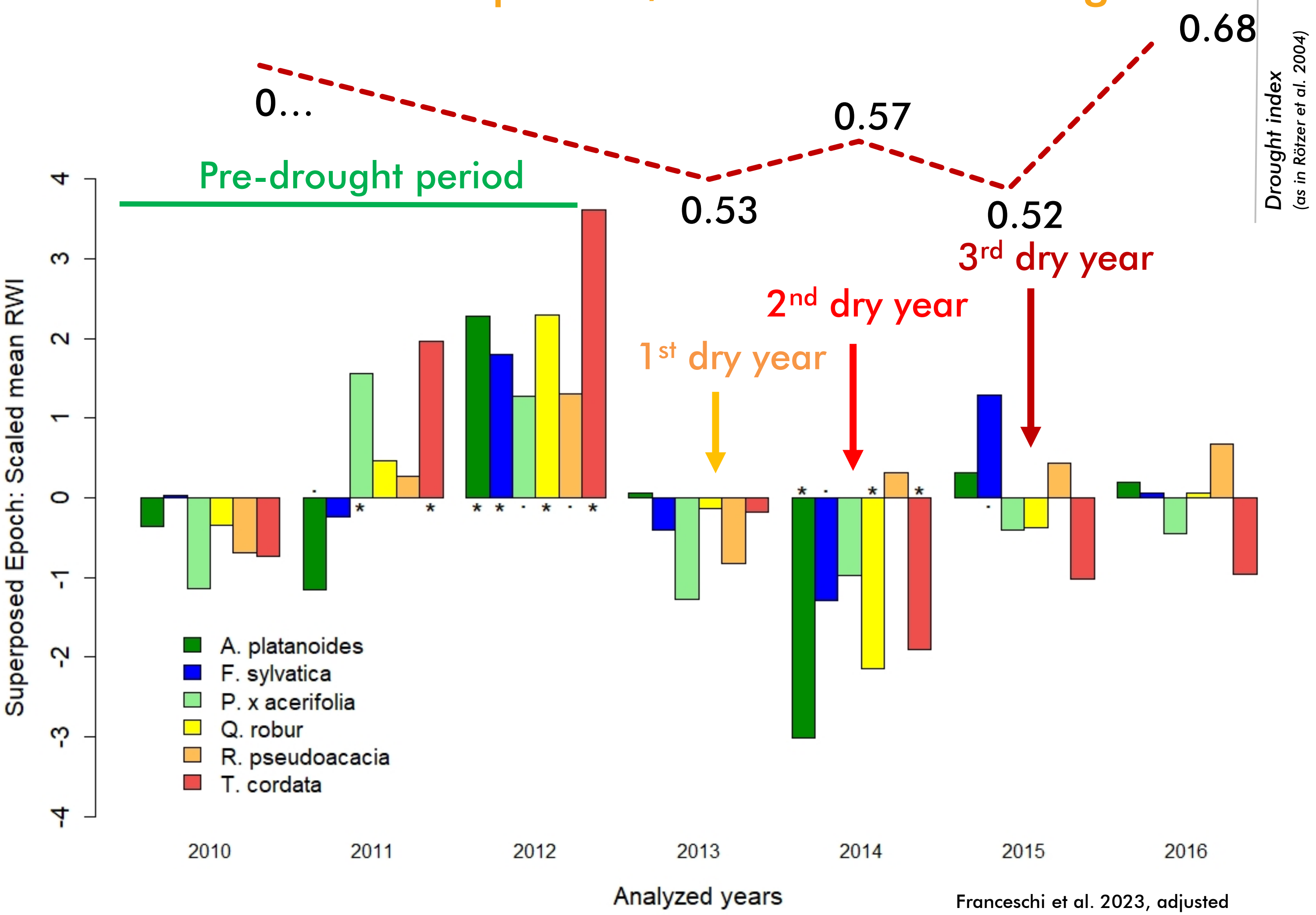


Franceschi et al. 2023, adjusted

RQ
Methods
Growth & environment
Growth & drought events
Growth & climate change
Take-home message

Growth and drought events

The effect of repeated/accumulated drought



Franceschi et al. 2023, adjusted

2nd World Forum on Urban Forests
Washington DC, 2023

RQ

Methods

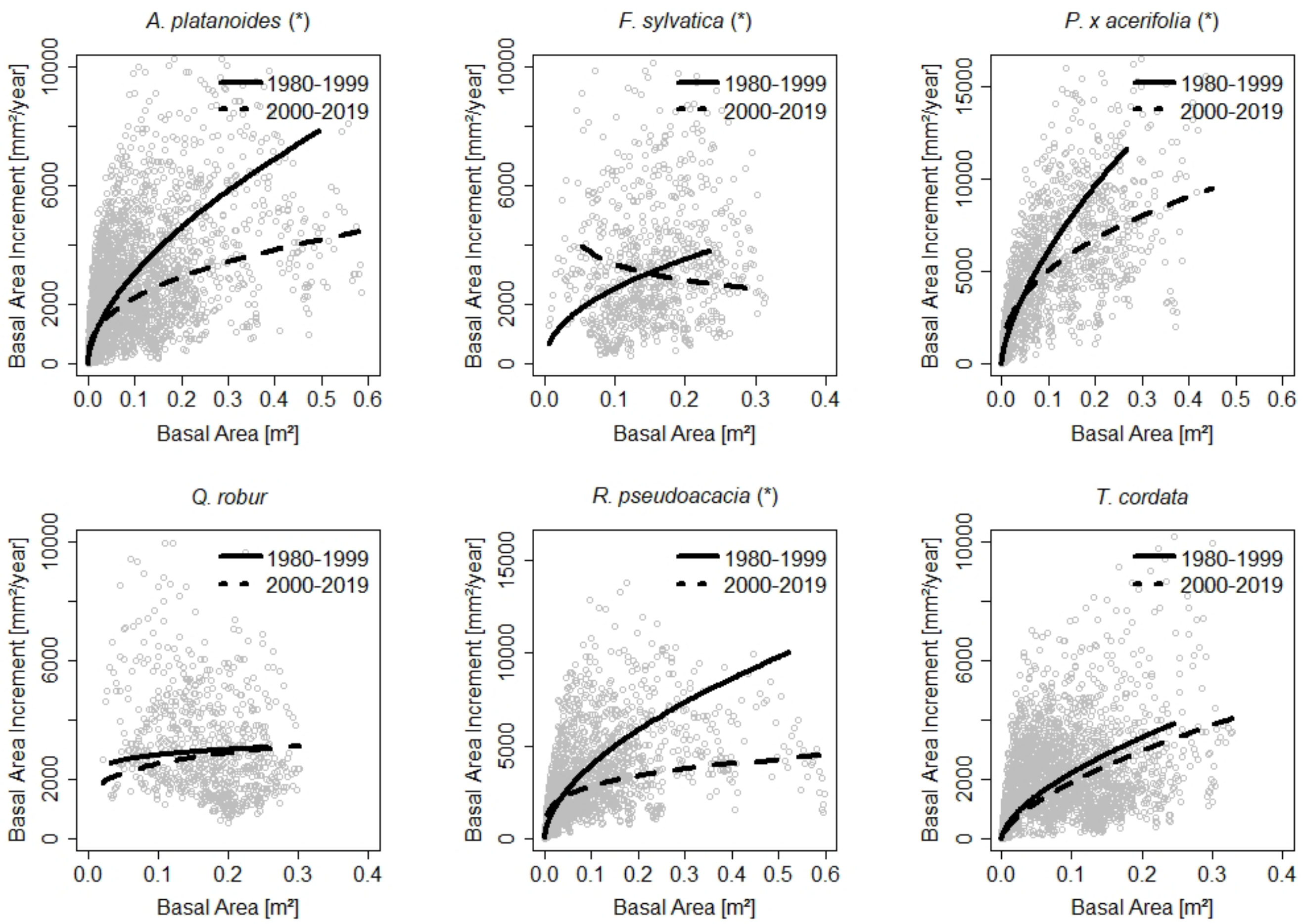
Growth & environment

Growth & drought events

Growth & climate change

Take-home message

Growth and climate change



Franceschi et al. 2023

	1980-1999	2000-2019
Mean annual air temperature [°C]	9.6	10.2
Annual sum of precipitation [mm]	946	947

Source: DWD CDC

RQ
Methods
Growth & environment
Growth & drought events
Growth & climate change
Take-home message

Take-home message I

What do we know now?

- *R. pseudoacacia* and *P. x acerifolia* showed high drought acclimation
- *T. cordata* was affected the most by drought events
- A. *platanoides* and Q. *robur* responded strongly to drought but recovered similarly fast
- A. *platanoides* and *T. cordata* grew significantly better in the suburban area, while F. *sylvatica* could benefit from the higher temperatures in city parks
- A. *platanoides, P. x acerifolia* and R. *pseudoacacia* were affected negatively by the climate of the last two decades.

Take-home message II

What do we need (to know)?

- Onsite specific growing conditions (soil sealing, rooting space, planting setting)
- coordinated studies for several areas
- how to ensure species-specific favourable growing conditions

Thank you

Eleonora Franceschi | Technical University of Munich

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Scan me to read the article!

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Arbor Day Foundation
POLITECNICO MILANO 1863
SISEF
ISA
Smithsonian

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2nd
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2023

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2nd World Forum on Urban Forests

Washington DC, 2023

5 Steps Towards Expanding Your Planting Palette with Climate-Ready Trees (Lessons Learned from California)

Presented by

Natalie van Doorn, PhD

USDA Forest Service, Pacific Southwest Research Station

Climate-Ready Trees Study

Co-PIs: Natalie van Doorn, Alison Berry, Greg McPherson

Collaborators: Janet Hartin, Jim Downer, Darren Haver, Ken Shackel, Joanna Solins

Objective

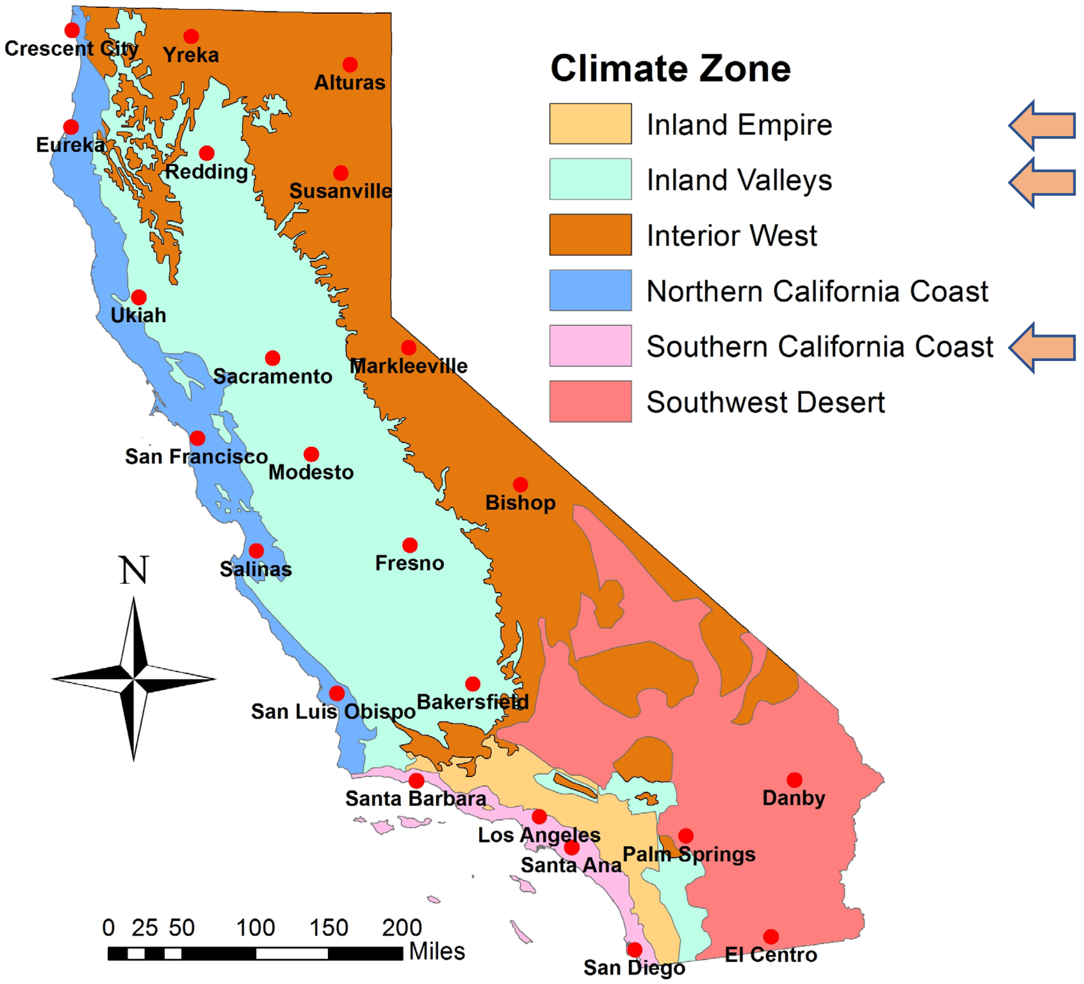
Help create a more resilient urban forest by shifting the palate of tree species, to those that perform well when exposed to climate stressors

http://www.ecosacramento.net/2016/01/changes-to-sacramento-city-tree-ordinance/

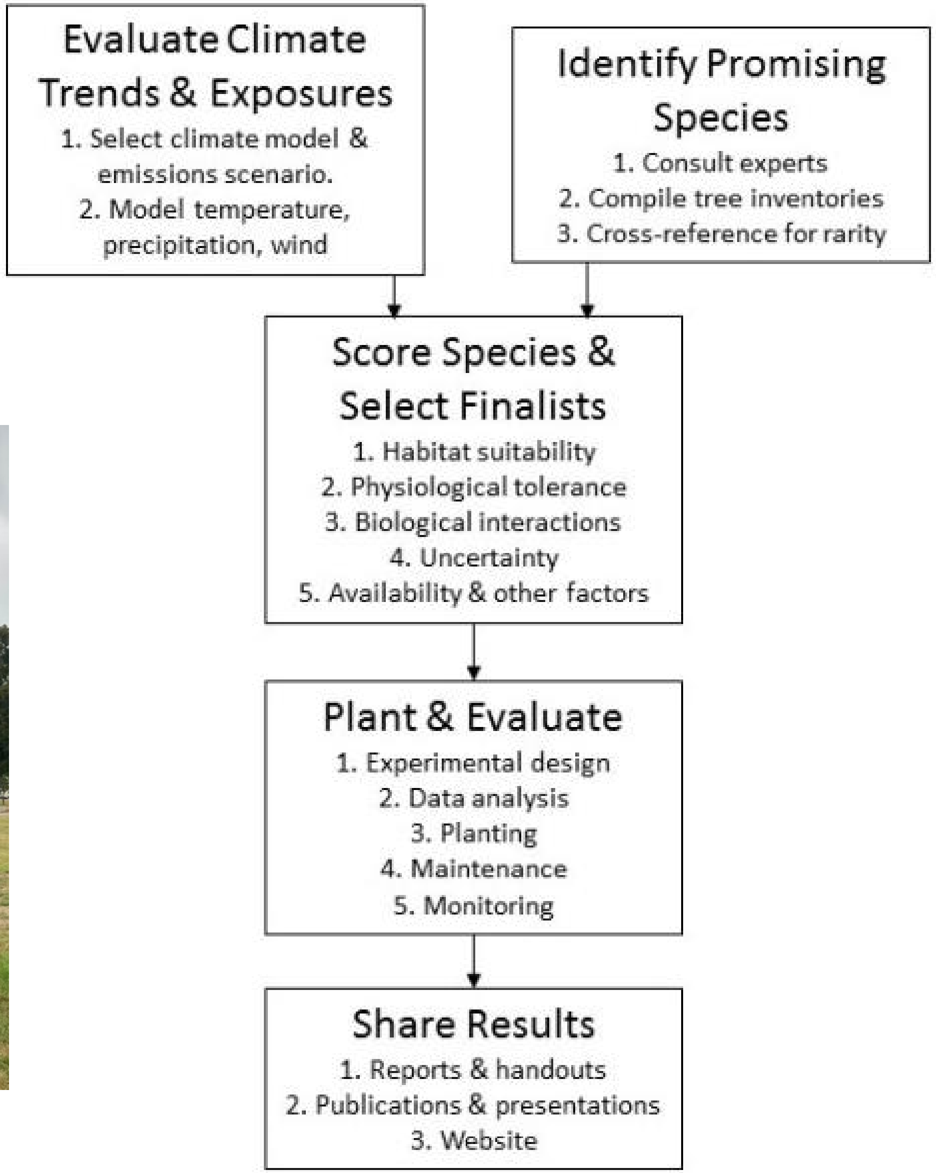
Approach

For promising tree species

- Evaluate survival & growth
- 3 climate zones in CA
- 20-year evaluation period



5-step process

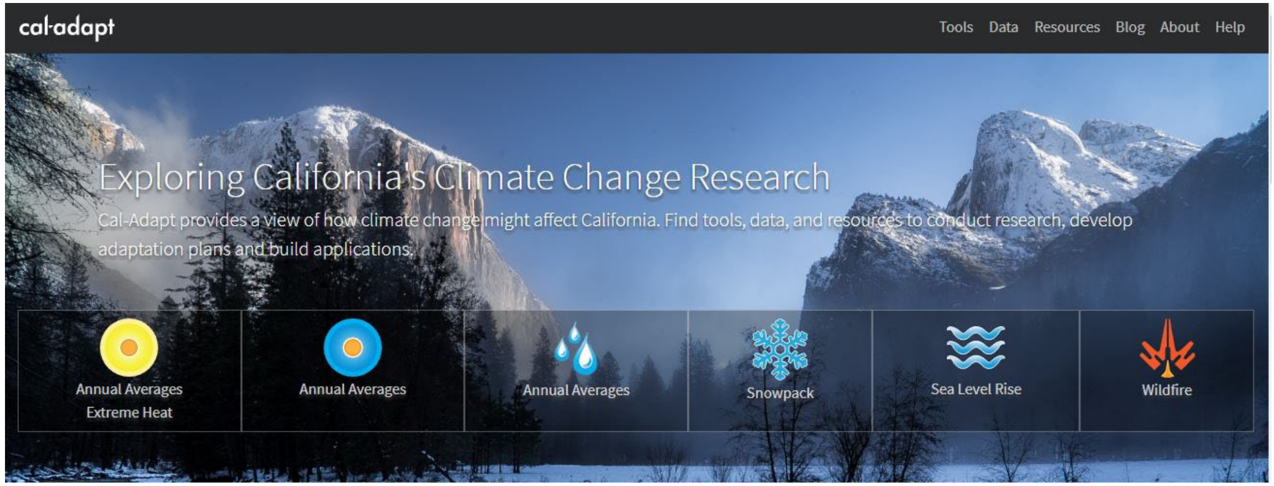


McPherson, E.G., A.M. Berry, and N.S. van Doorn. 2018. Performance testing to identify climate-ready trees. Urban Forestry & Urban Greening 29: 28-39. doi:10.1016/j.ufug.2017.09.003

Step 1: Evaluate Climate Trends and Exposures

CalAdapt Climate Model, Next 75 Years

Temperature: In each climate zone, model projects ~5°F increase in avg. min temps & ~6-9°F increase in avg. max temps



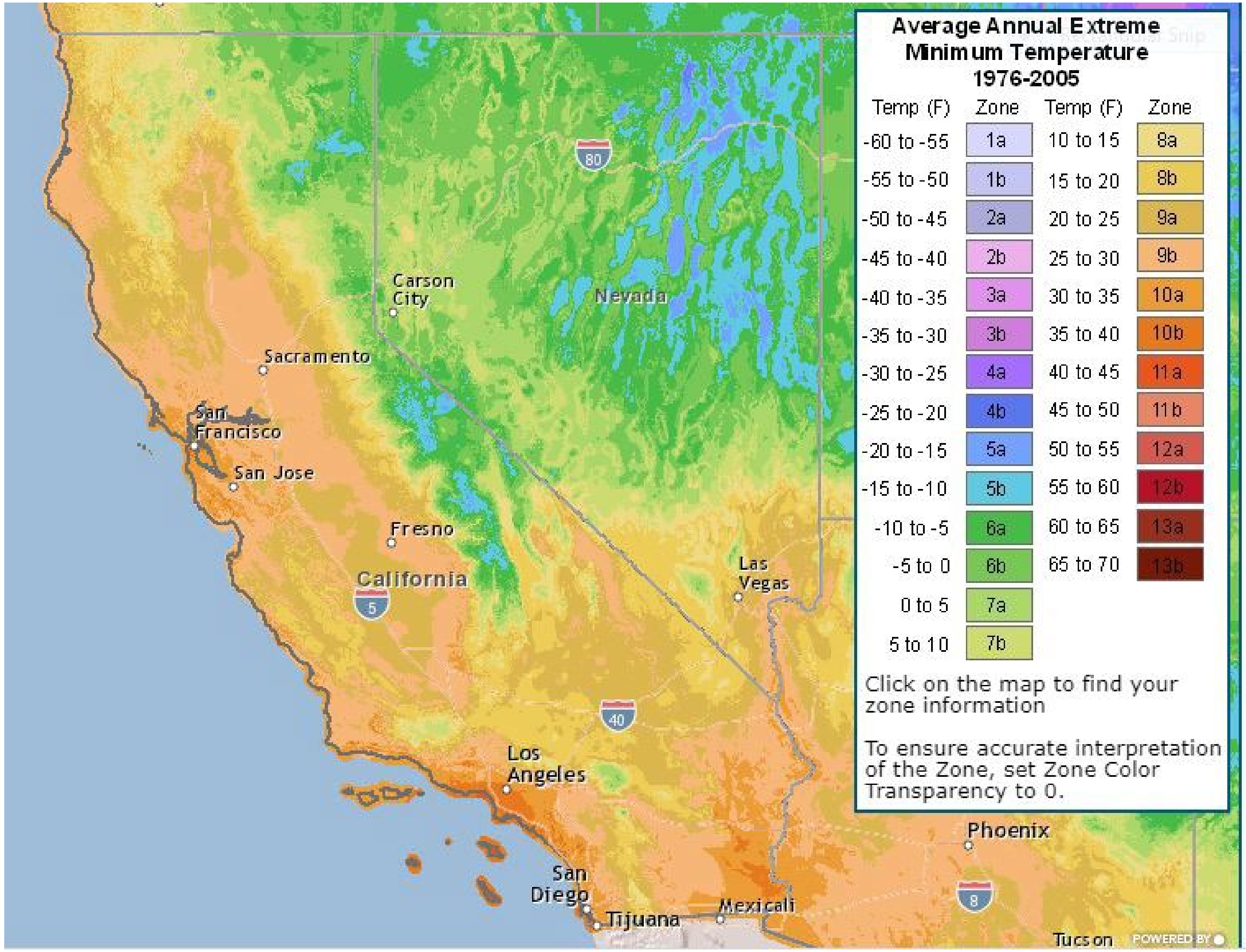
Precipitation: increased variability, more precipitation during each storm event, stronger winds but also mega-droughts

cal-adapt pcm1

http://cal-adapt.org/tools/

USDA Hardiness Zones

Expect half to whole zone increase over next 75 years



Step 2: Identify Promising Species

- Consult experts
- Compile tree inventories
- Cross-reference for rarity

DREAM TREE

Step 3: Score Species…

Tree Vulnerability Matrix

Habitat	Physiology	Biological Interactions
Soil Moisture	Drought Tolerance	Invasiveness
Soil Texture and pH	Wind Tolerance	Current Pest and Disease Threats
Sunlight Exposure	Salt Tolerance	Emerging Pest and Disease Threats
	Cold Hardiness	

System for Assessing Vulnerability of Species (Bagne et al. 2011) and Pest Vulnerability Matrix (Laćan & McBride 2008)

Added Considerations Important for Urban Systems

- Low biogenic emissions
- Low root damage potential
- High longevity and high biomass for its stature class
- Strong branch attachment
- High salinity tolerance (recycled irrigation water)

http://www.pasadenanow.com/main/councilmembers-want-city-responsibility-for-sidewalk-upkeep/#.WYlXhITyu00

http://invasivore.org/2014/04/species-profile-bradford-or-callery-pear/

Step 3: …Select Finalists

Australia	
Acacia aneura	Mulga
Acacia stenophylla	Shoestring acacia
Corymbia papuana	Ghost gum

Ghost gum

Southwest US	
Chilopsis linearis	Desert willow
Hesperocyparis forbesii	Tecate cypress
Mariosousa willardiana	Palo blanco
Parkinsonia x 'Desert Museum'	Desert Museum palo verde
Prosopis glandulosa x 'Maverick'	Thornless honey mesquite
Prunus ilicifolia subsp. lyonii	Catalina cherry
Quercus fusiformis	Escarpment live oak
Quercus tomentella	Island oak

Thornless honey mesquite

Palo verde “Desert Museum”

Step 3: Select Finalists

Oklahoma-Texas-Western US	
Celtis reticulata	Netleaf hackberry
Ebenopsis ebano	Texas ebony
Maclura pomifera 'White Shield'	White Shield osage orange
Quercus canbyi	Canby's oak

Canby’s oak

‘Emerald Sunshine’ elm

Dutch elm disease & elm leaf beetle resistance

Asia	
Dalbergia sissoo	Rosewood
Pistacia ‘Red Push’	Red Push pistache
Ulmus propinqua	Emerald sunshine elm
South America	
Cedrela fissilis	Brazilian cedarwood

Step 4: Plant & Evaluate

Experimental Design

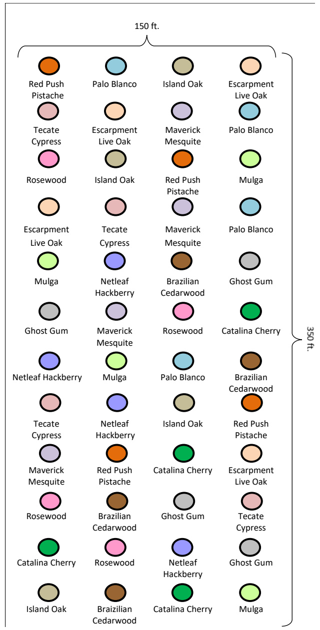
In Each Climate Zone:

4 Park Sites

- 2 reps per species
- 96 trees total

1 Reference Site

- 4 reps per species
- 48 trees total



Plant and Maintain

Many different contributors (one of the keys to success)

- City agencies
- Non-profits
- Volunteers
- Univ. staff

Monitoring

Every year for first 5 years, then every 2 years

- Survival; growth
- Tree structure, pest, disease…
- Stem water potential

Metrics for success

- High survivorship
- Low invasiveness
- Community buy-in
- Nursery uptake

Prelim results

Inland Valley Survival (2015-2020)	Park (%)	Ref. Site (%)	Total (%)
Acacia aneura	25	100	50
Acacia stenophylla	100	100	100
Chilopsis linearis ‘Bubba’	63	100	75
Corymbia papuana	38	50	42
Celtis reticulata	75	100	83
Dalbergia sissoo	38	100	58
Ebenopsis ebano	38	100	58
Maclura pomifera ‘White Shield’	64	100	73
Parkinsonia x ‘Desert Museum’	63	25	50
Prosopis glandulosa x Maverick	100	100	100
Quercus canbyi	100	100	100
Ulmus propinqua	50	100	67
Total	63	90	71

Acacia stenophylla

Inland Valleys Reference Site

Inland Valleys Park Site

Acacia stenophylla

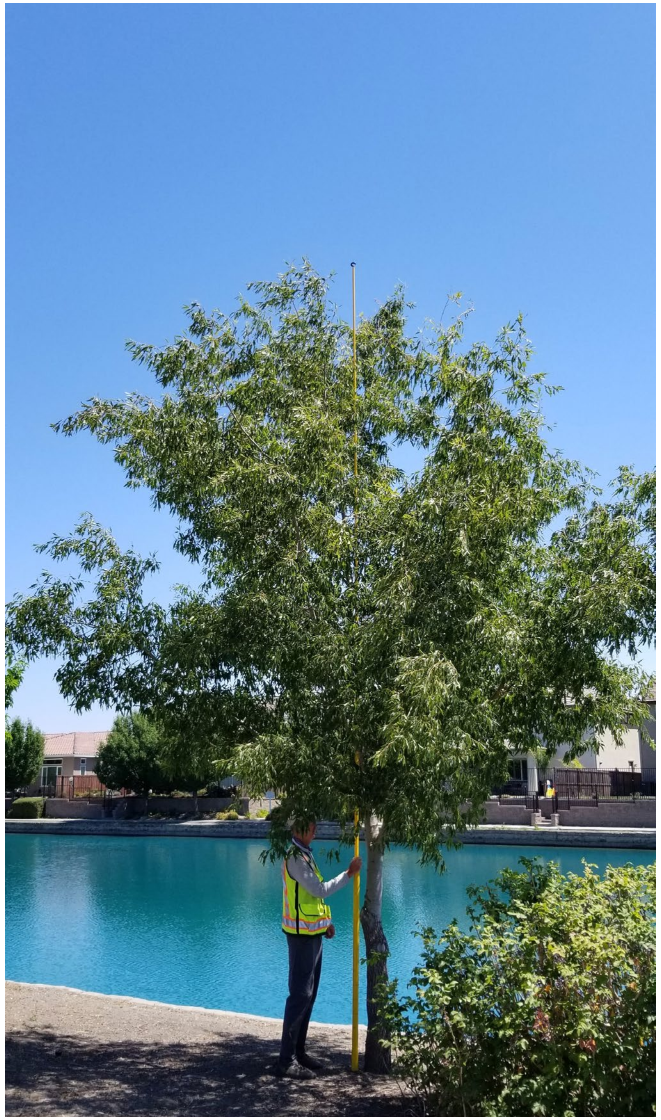
Root suckers and/or from seed

From seed

Quercus canbyi

Inland Valleys Reference Site

Inland Valleys Park Site



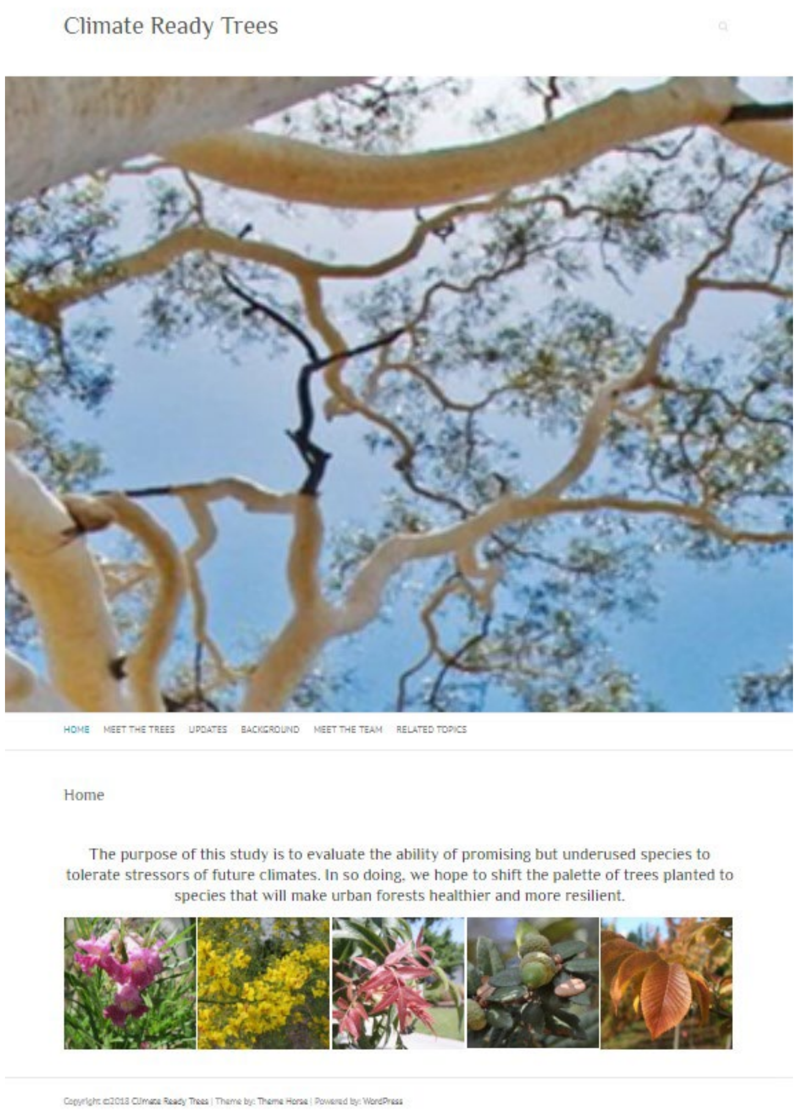
Prosopis glandulosa x Maverick

Inland Valleys Reference Site

Inland Valleys Park Site

Step 5: Share Results

- Reports & Handouts
- Website
- Publications & Presentations
- Media requests
- Consultations



http://climatereadytrees.ucdavis.edu/

Lessons learned

- Importance of the reference site (or unexpected issues in park sites)

Park site (now tiny home village)

Reference site

Lessons learned

- Value of park site for demonstration

Family enjoying shade from a ‘Red push’ pistache, 7 years after planting

Lessons learned

- The need for tree maintenance

Unpruned netleaf hackberry in NorCal park site, year 8 after planting

Pruned up netleaf hackberry in NorCal park site, year 8 after planting

Thanks to:

Tree Planting and Maintenance

- Sacramento Tree Foundation, Los Angeles Beautification Team & the many volunteers
- City of Sacramento; LA Dept. of Rec and Parks
- UC Riverside Citrus Research Center; South Coast Research and Extension Center; UC Davis

Trees graciously donated by:

- Mountain States Wholesale Nursery

Funding

- The Britton Fund
- LA Center for Urban Natural Resources Sustainability
- ISA Western Chapter
- US Forest Service, Pacific Southwest Research Station

Thank you

Natalie van Doorn | USDA Forest Service PSW

natalie.vandoorn@ usda.gov

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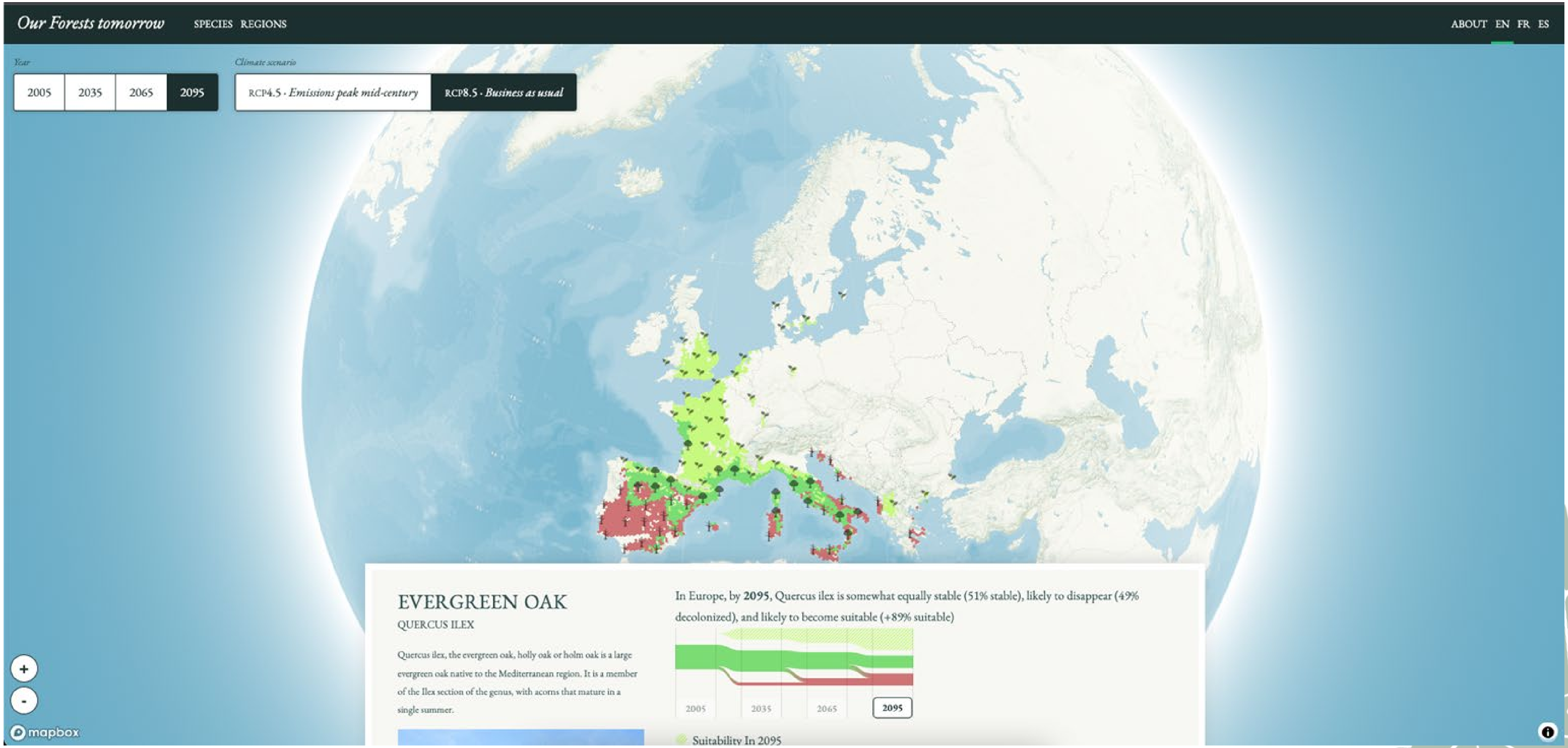
Our Forests Tomorrow

Turning Scientific Papers into Engaging Tools for the Public

Presented by

Hanbyul Jo, Development Seed



Our Forests Tomorrow Link

Who we are

Development Seed & Labs

Who we are

- We make Earth Data actionable with our expertise in massive earth data, cloud computing, geospatial AI, and thoughtful product development
- We work with mission-driven partners

SCIENCE & SPACE
NASA
MAXAR

HUMANITARIAN
unicef

DEVELOPMENT
THE WORLD BANK

HUMANITARIAN
IFRC

CLIMATE & ENVIRONMENT
openaq

CLIMATE & ENVIRONMENT
OCEANA

CLIMATE & ENVIRONMENT
USGS
science for a changing world

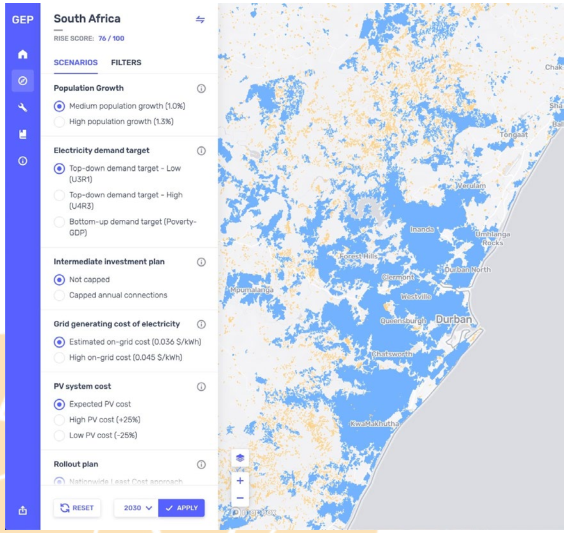
SCIENCE & SPACE
esa

SCIENCE & SPACE
mapbox

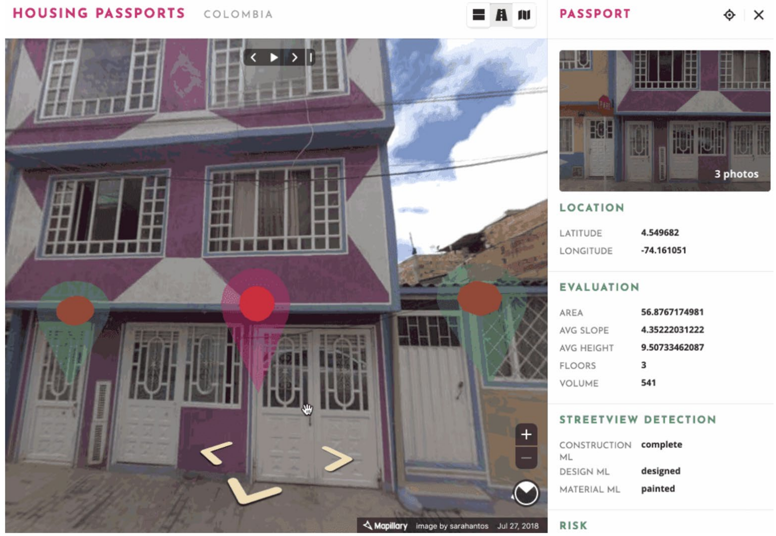
CLIMATE & ENVIRONMENT
Global Fishing Watch

HUMANITARIAN
HOT

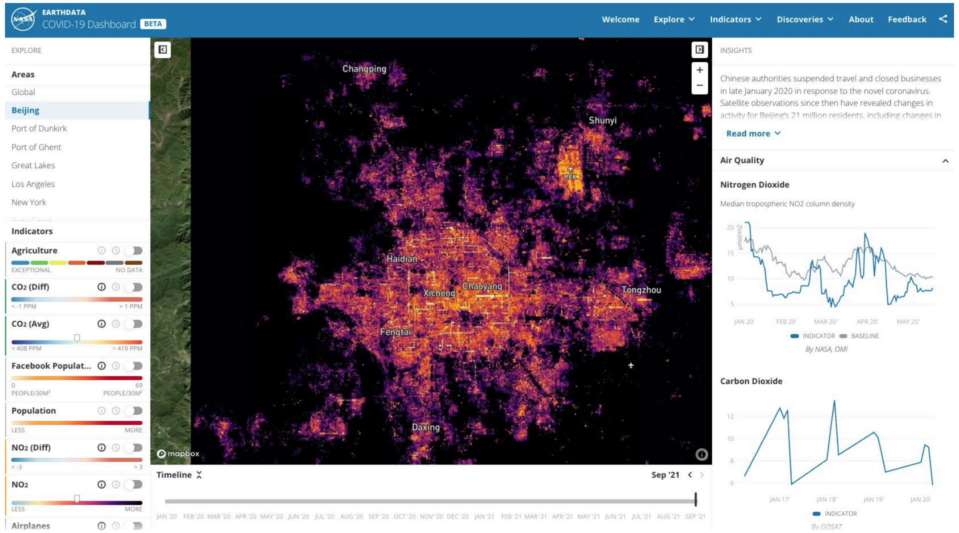
What we make



The Global Electrification Platform for World Bank Link



Housing Passport Project for World Bank Link

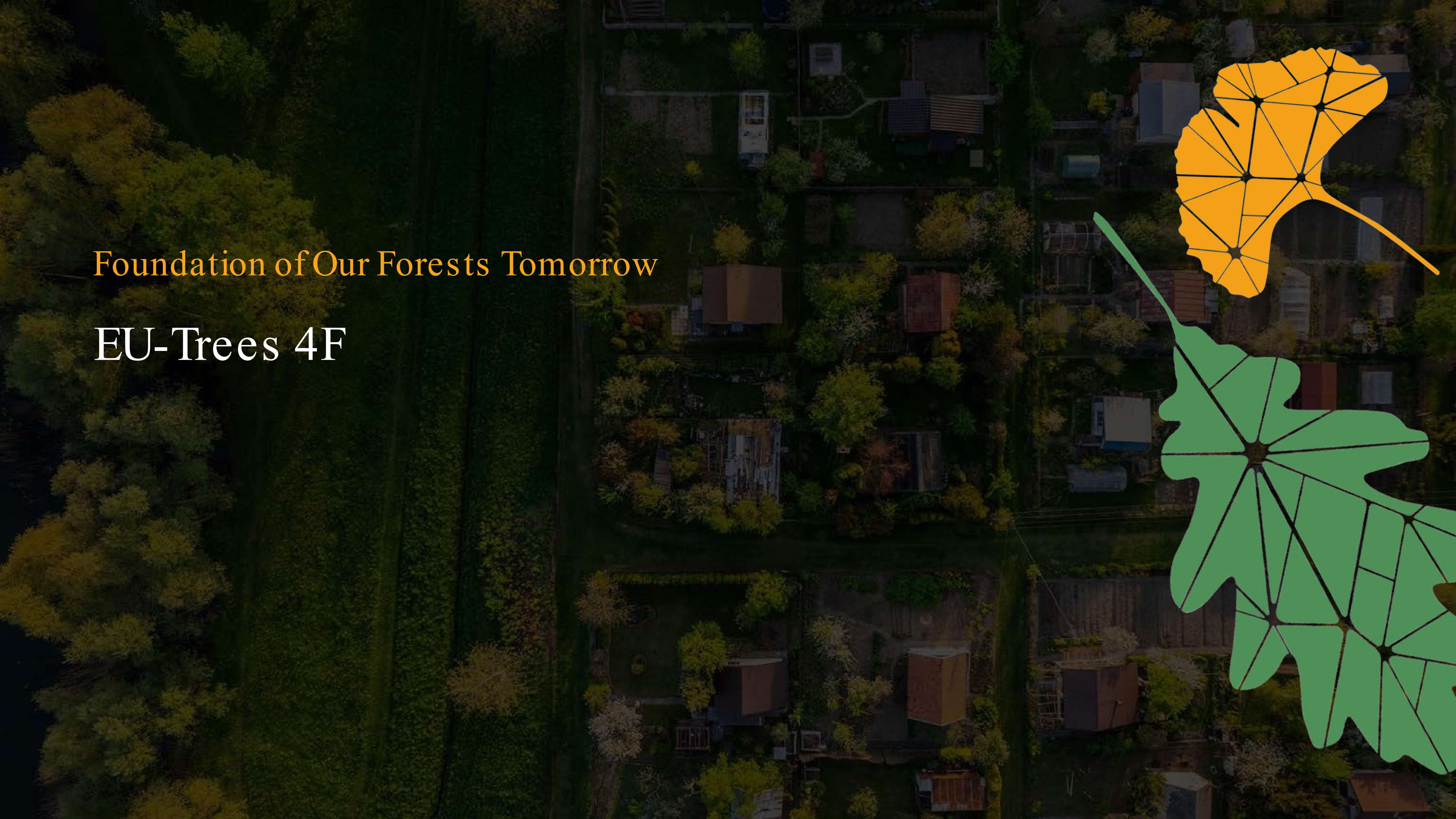


Covid Dashboard for NASA Link

Labs: Reinvestment for ourselves and community

Self-funded projects that align with our values

- To improve our collective knowledge, community that we are part of.
- To contribute to the issues aligning with our mission.
- To allow us to react fast/with more agility to the matters we care.



Foundation of Our Forests Tomorrow

EU-Trees 4F

www.nature.com/scientificdata

Search documents and filenames for text

scientific data

Check for updates

OPEN

DATA DESCRIPTOR

EU-Trees4F, a dataset on the future distribution of European tree species

Achille Mauri[1,2]✉, Marco Girardello[2], Giovanni Strona[1], Pieter S. A. Beck[2], Giovanni Forzieri[2], Giovanni Caudullo[2], Federica Manca[1] & Alessandro Cescatti[2]✉

We present "*EU-Trees4F*", a dataset of current and future potential distributions of 67 tree species in Europe at 10 km spatial resolution. We provide both climatically suitable future areas of occupancy and the future distribution expected under a scenario of natural dispersal for two emission scenarios (RCP 4.5 and RCP 8.5) and three time steps (2035, 2065, and 2095). Also, we provide a version of the dataset where tree ranges are limited by future land use. These data-driven projections were made using an ensemble species distribution model calibrated using EU-Forest, a comprehensive dataset of tree species occurrences for Europe, and driven by seven bioclimatic parameters derived from EURO-CORDEX regional climate model simulations, and two soil parameters. "*EU-Trees4F*", can benefit various research fields, including forestry, biodiversity, ecosystem services, and bio-economy. Possible applications include the calibration or benchmarking of dynamic vegetation models, or informing forest adaptation strategies based on assisted tree migration. Given the multiple European policy initiatives related to forests, this dataset represents a timely and valuable resource to support policymaking.

Background & Summary

Covering 35% of EU land[1], forests play a fundamental economic and ecological role. Besides their obvious contribution to biodiversity and the provision of wood and non-wood products, forests maintain a wide range

Mauri, A., Girardello, M., Strona, G. et al. EU-Trees4F, a dataset on the future distribution of European tree species. Sci Data 9, 37 (2022). https://doi.org/10.1038/s41597-022-01128-5

Inputs, Models and Outputs

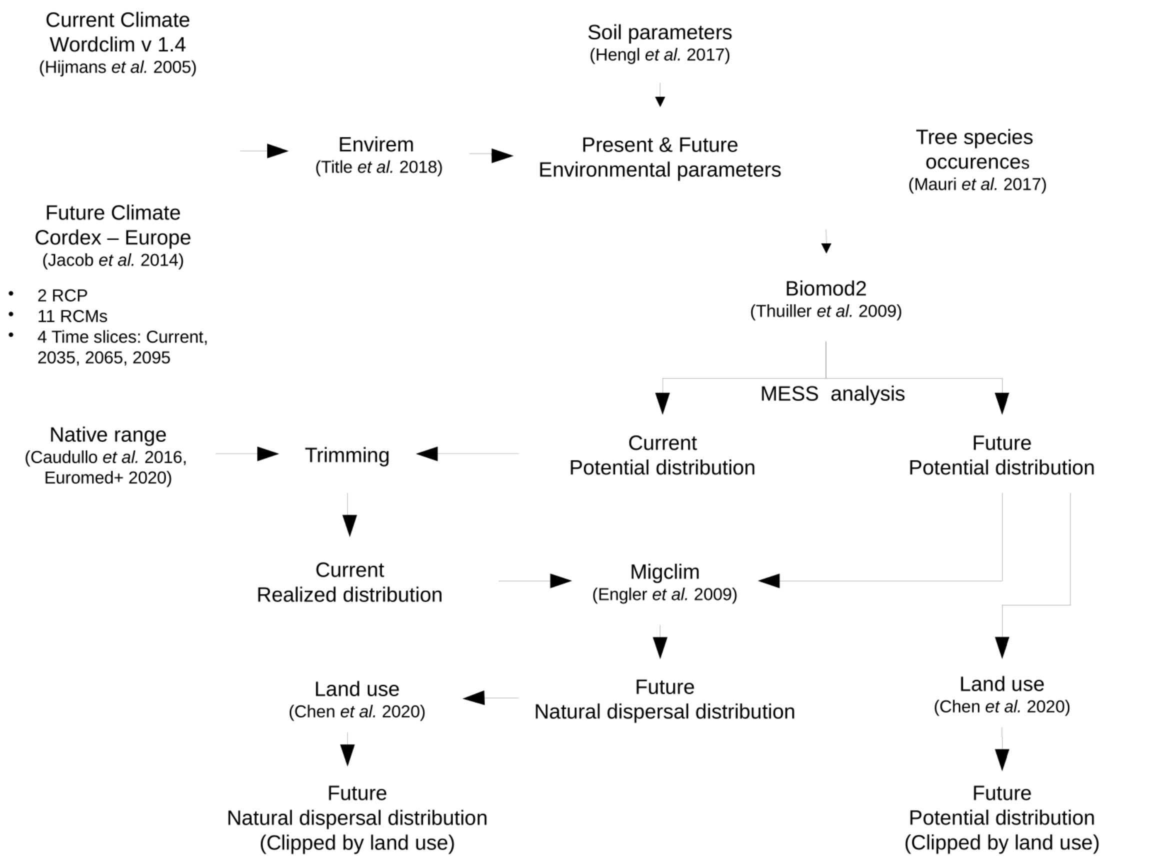


Fig. 3 Flowchart illustrating the various steps undertaken to produce the distribution maps.

67 species

4 time steps

2 emissions scenarios

2 simulation models

What does it mean to me?

Spain's prized jamón ibérico under threat from climate crisis

Rising temperatures and low rainfall threaten key ingredient of pigs' diet - acorns from the dehesa oak forests

Customers at an *ibérico* store in Madrid. Fewer acorns and a fall in price led to a 20% reduction last year in *jamón ibérico* production in Extremadura. Photograph: Denis Doyle/Getty Images

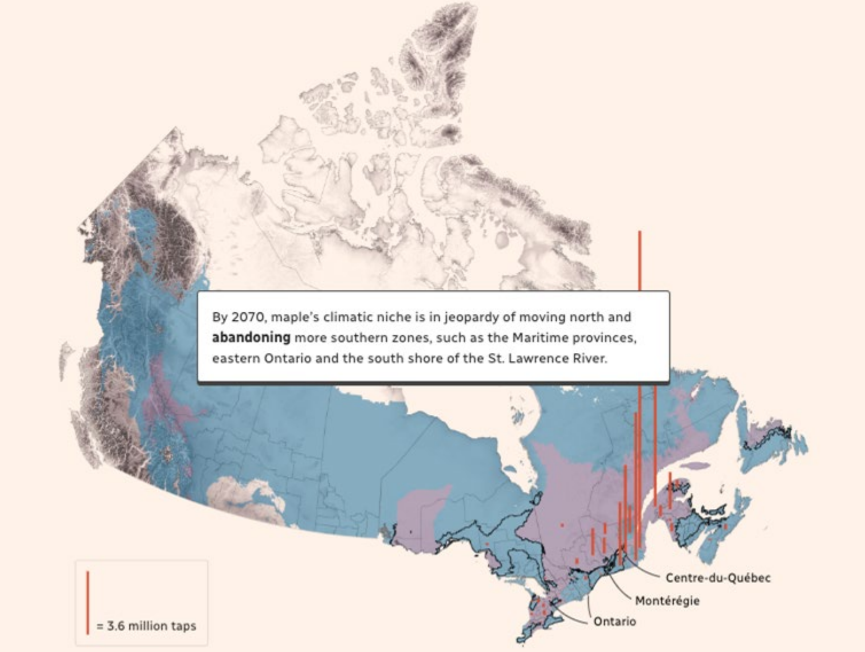
Spain's prized *jamón ibérico bellota* is under threat from the climate crisis as rising temperatures and low rainfall imperil a key ingredient of the pigs' diet - acorns.

The Guardian, https://www.theguardian.com/world/2023/jan/30/spains-prized-jamon-iberico-under-threat-from-climate-crisis

Maple syrup is under threat

By Daniel Blanchette Pelletier
March 31, 2023

Climate change threatens one of Quebec's most important jewels: maple syrup. This domestically produced golden syrup is the envy of the world but could be put to the test as the effects of global warming take shape in the next century.

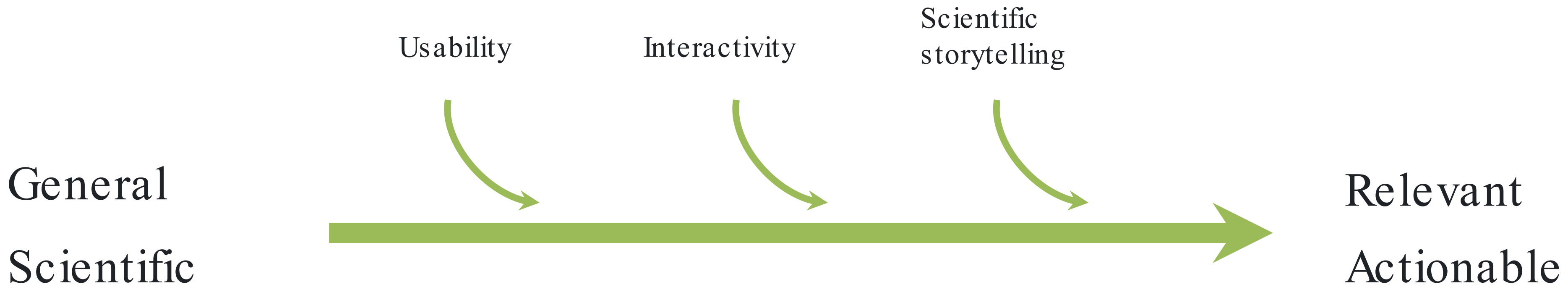


Radio Canada, https://ici.radio-canada.ca/info/2023/sirop-erable-rechauffement-climat-niche-production-acericole-cabane-sucre-printemps-seve-quebec/en/

Making Our Forest Tomorrow

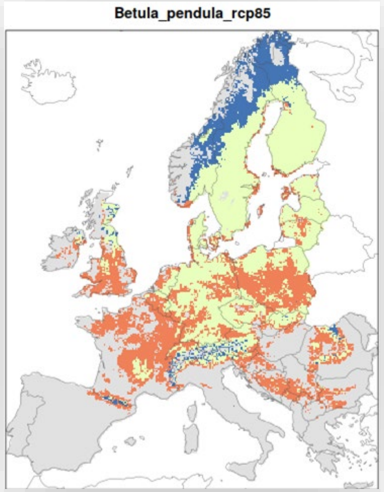
Filling the gap between scientific knowledge and public engagement

Web application for public engagement



Prototype with the dataset + In-house design + Data science expertise

Dataset preparation - tiling

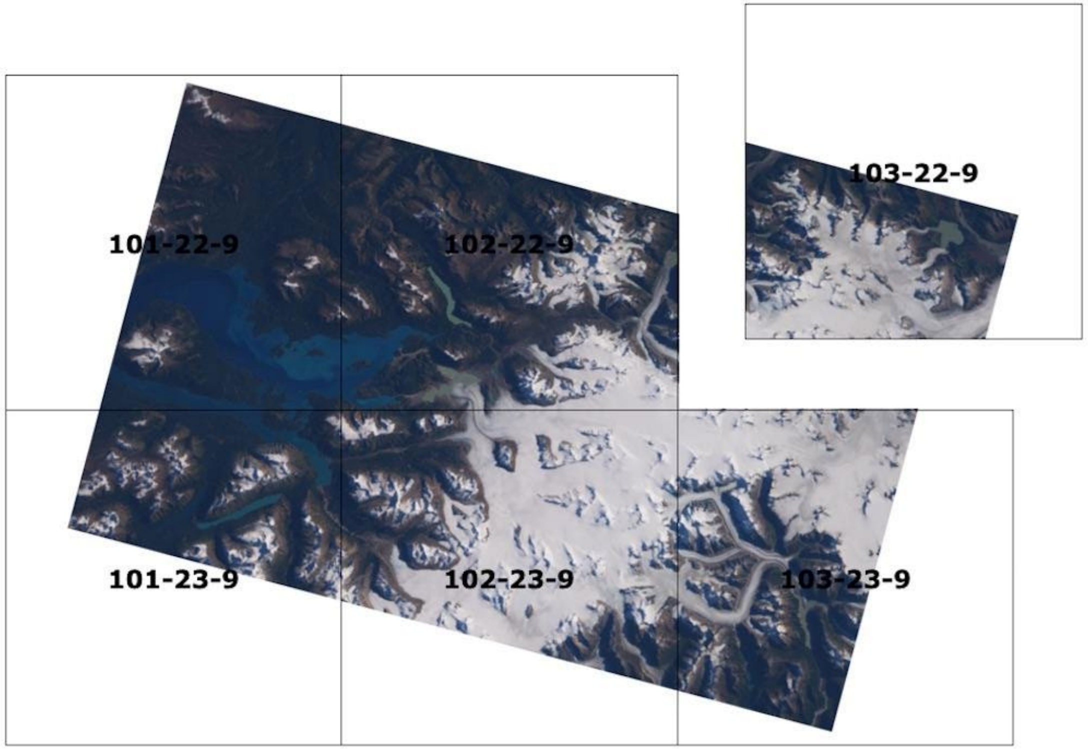


67 species

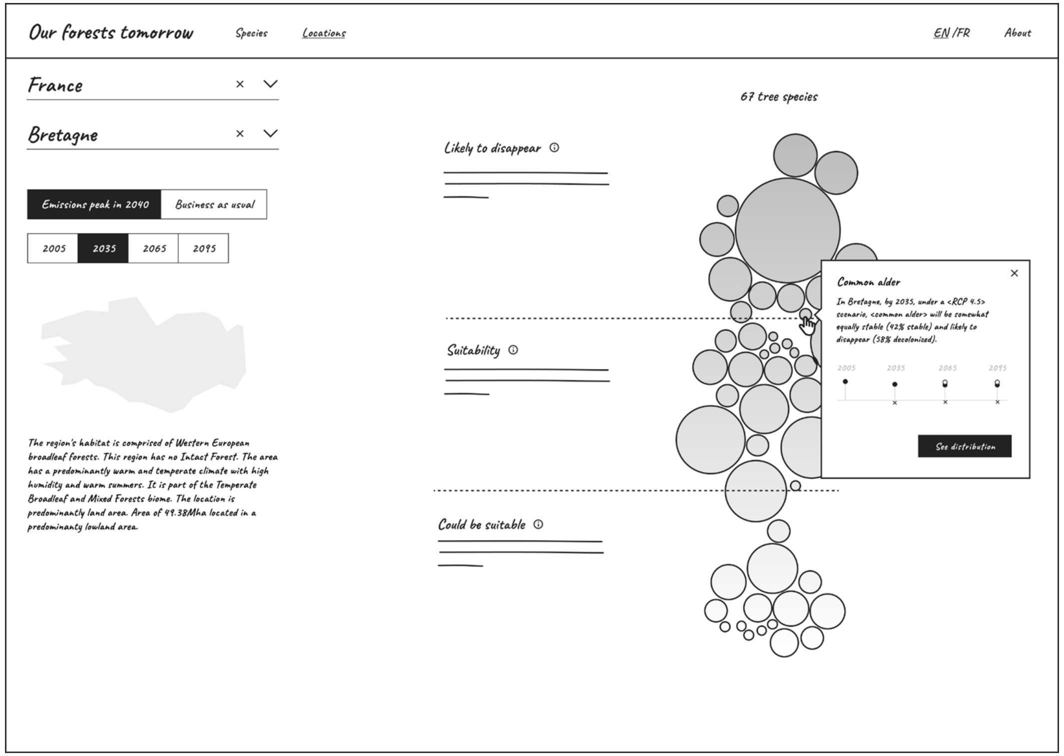
4 time steps

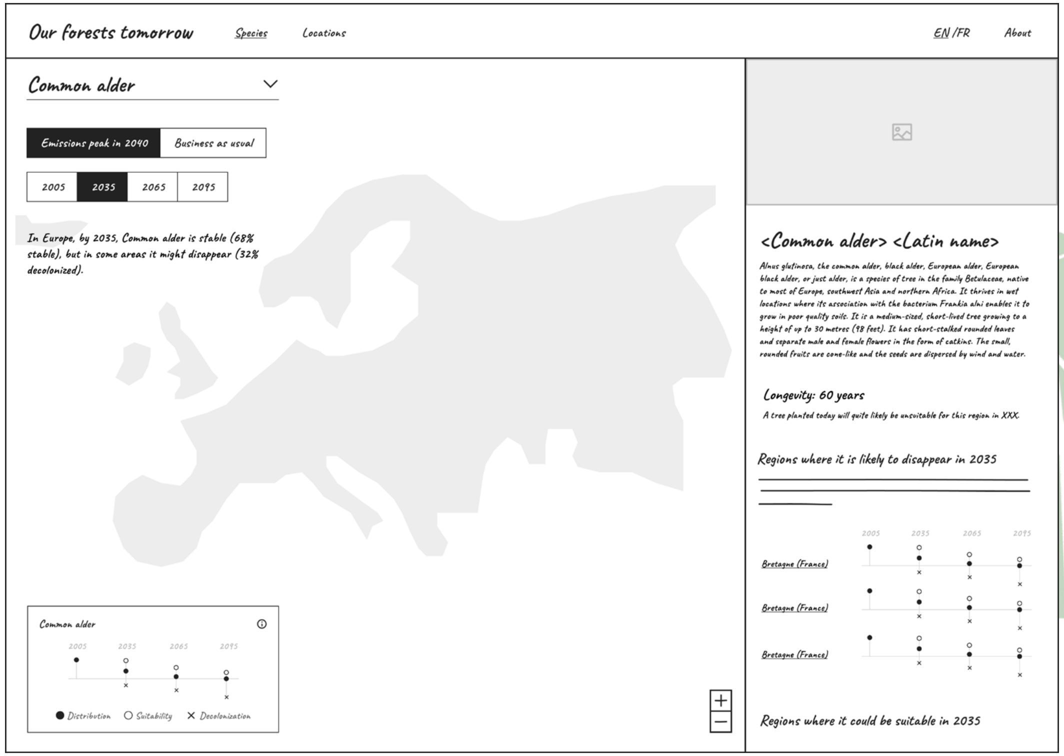
2 emissions scenarios

2 simulation models

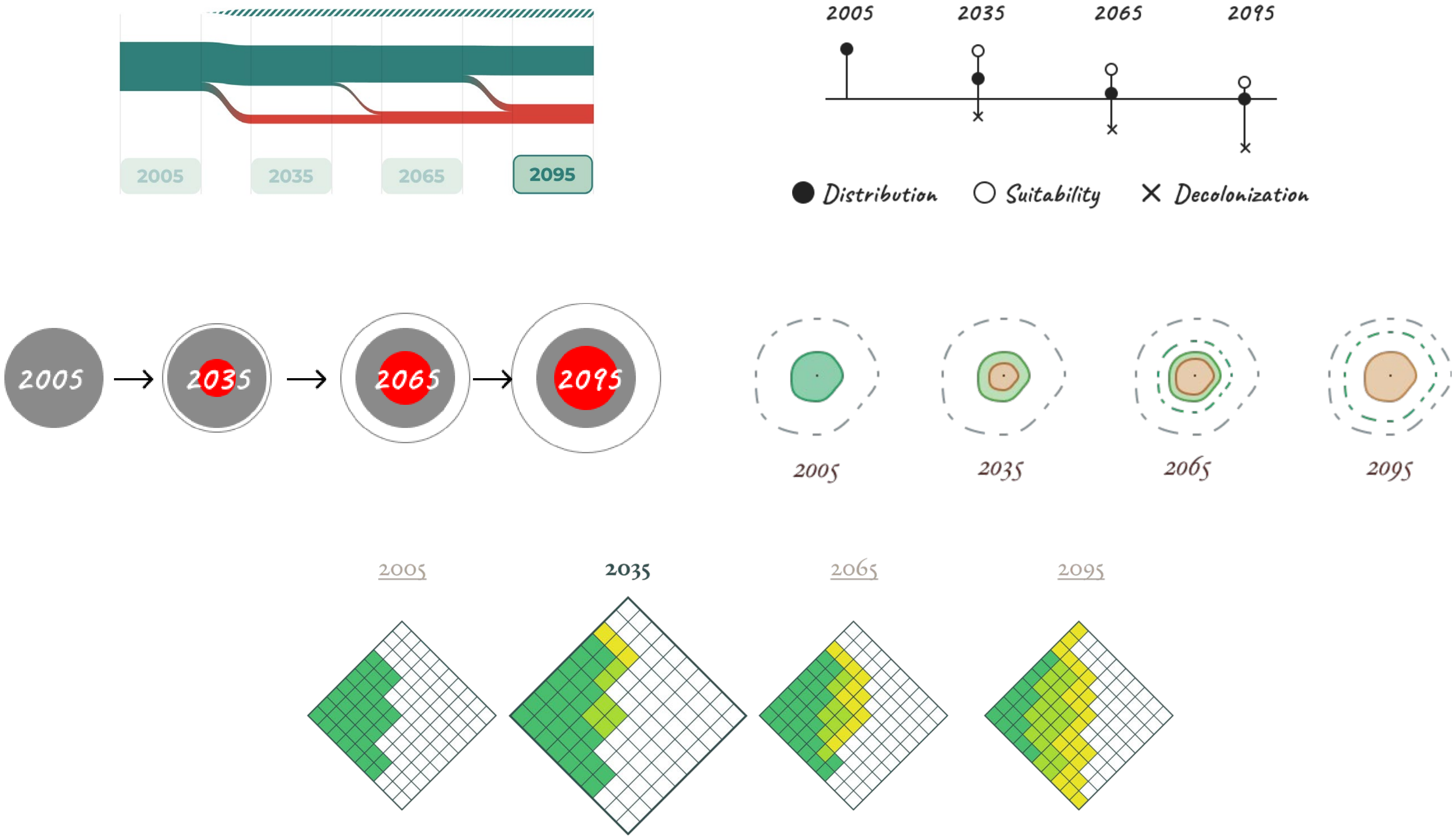


Layout wireframes / experiments



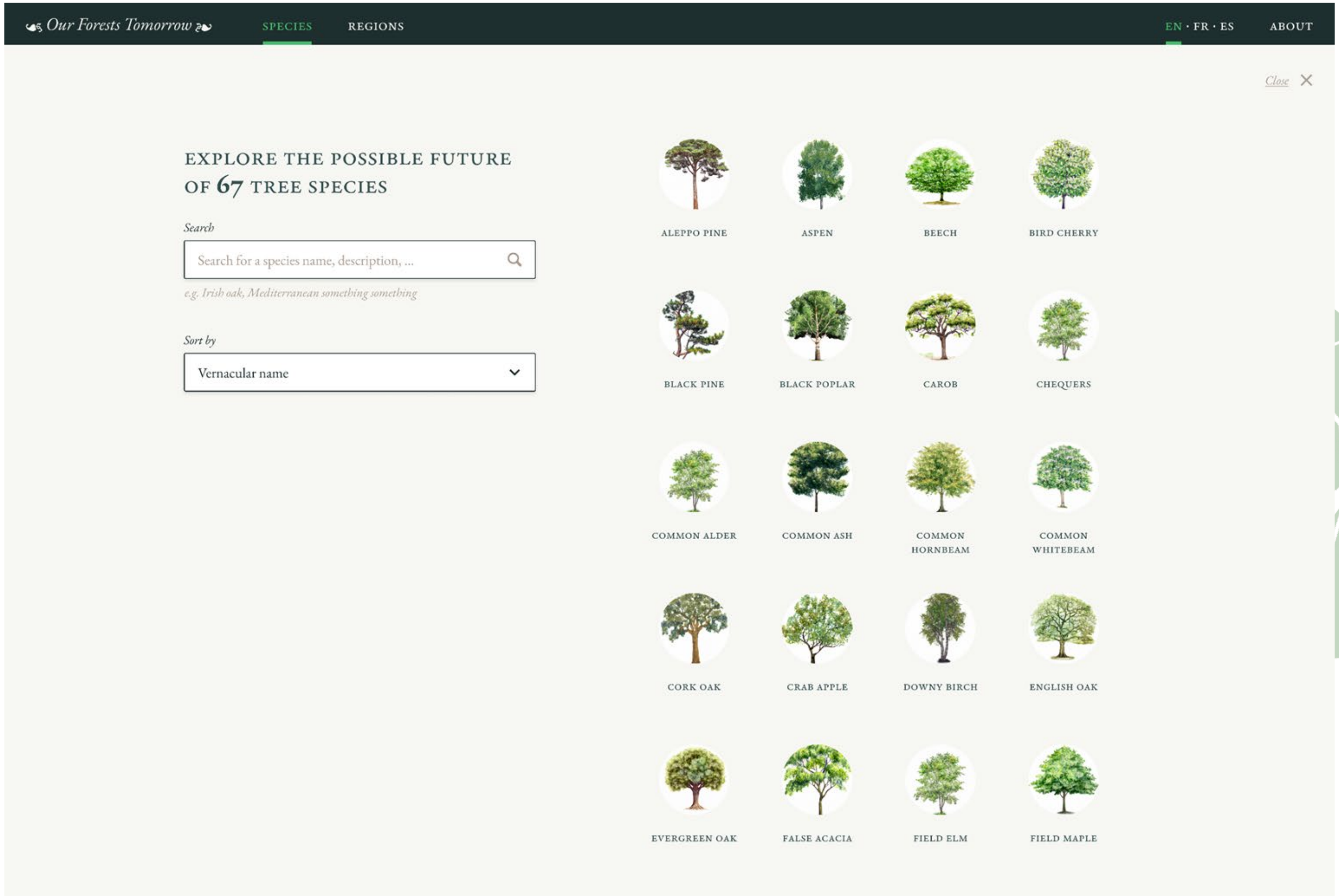


Data Viz/Graphics experiments

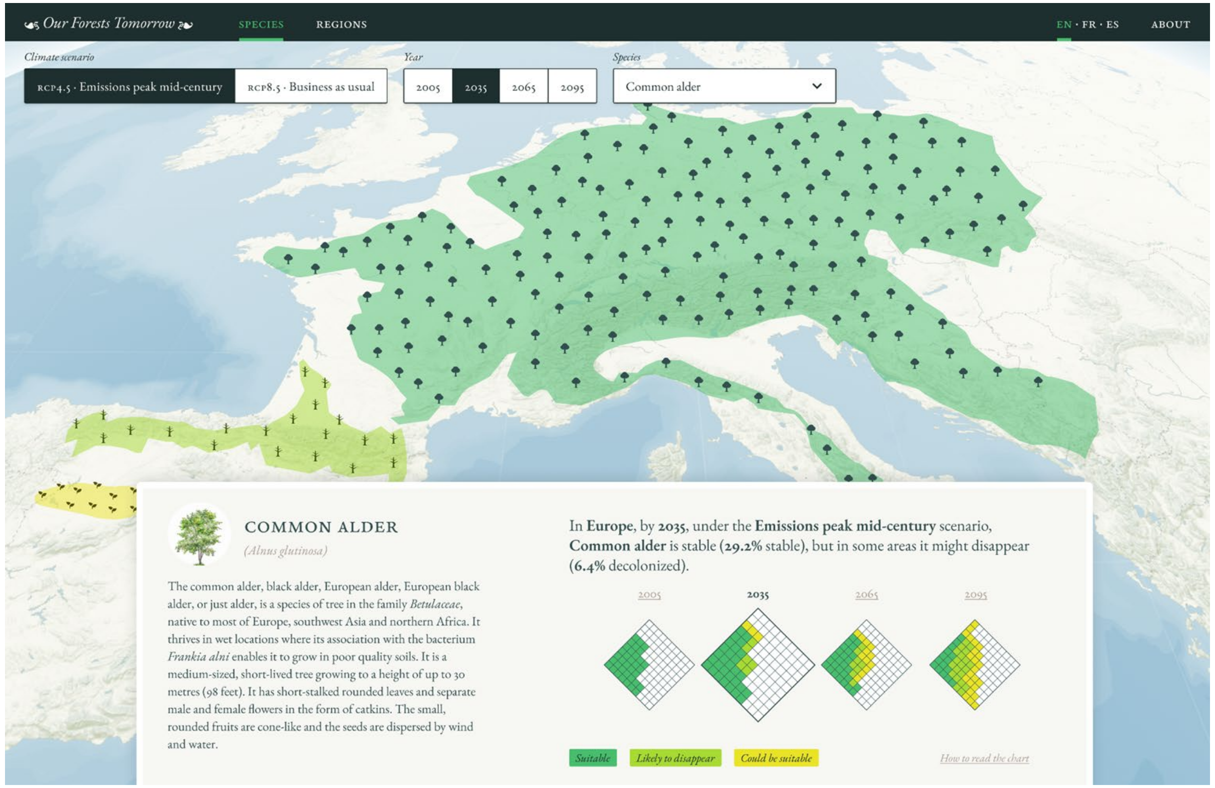


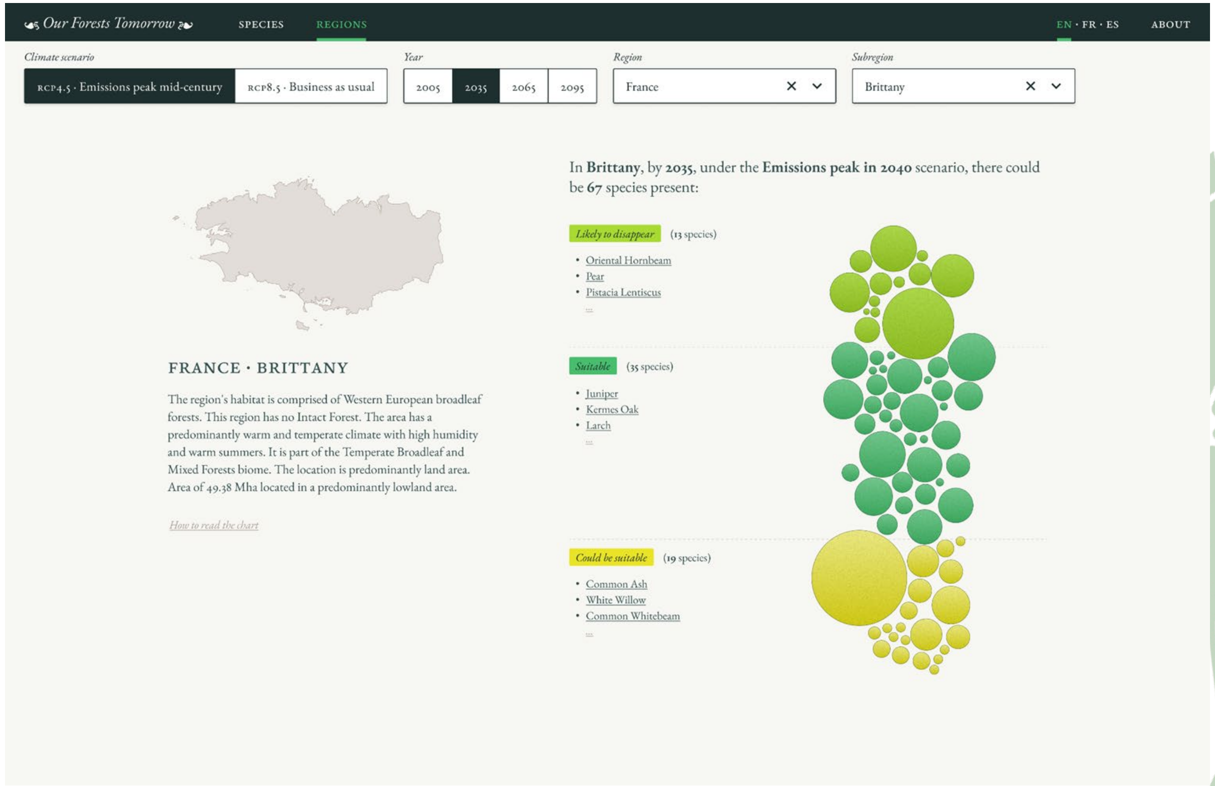
AI experiments

“a watercolor picture of a single common alder tree, alnus glutinosa, whole tree, entire tree, white background”



Visual design UI exploration





Case 1. Beech

BEECH

FAGUS SYLVATICA

Fagus sylvatica, the European beech or common beech is a deciduous tree belonging to the beech family Fagaceae.

In Europe, by **2095**, Fagus sylvatica is somewhat equally stable (72% stable), likely to disappear (28% decolonized), and likely to become suitable (+48% suitable)

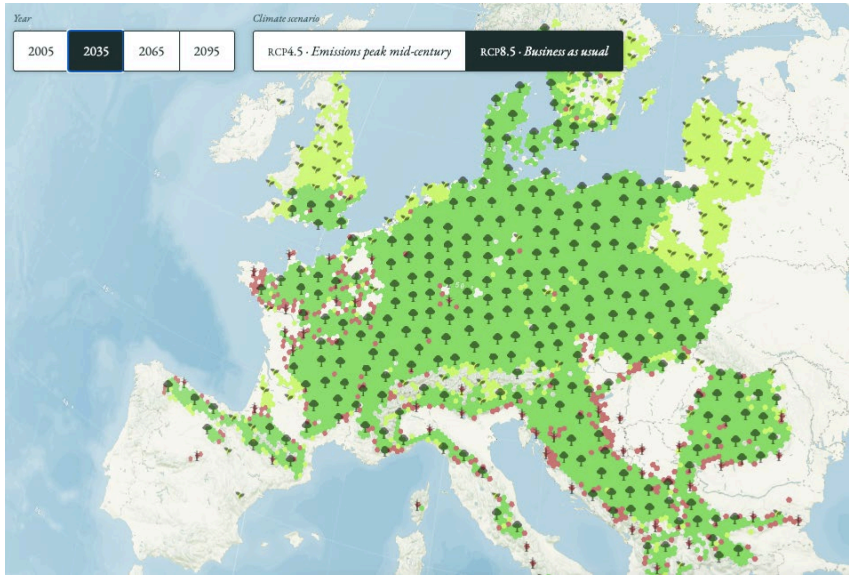
Suitability In 2095
Stable In 2095
Decolonization In 2095

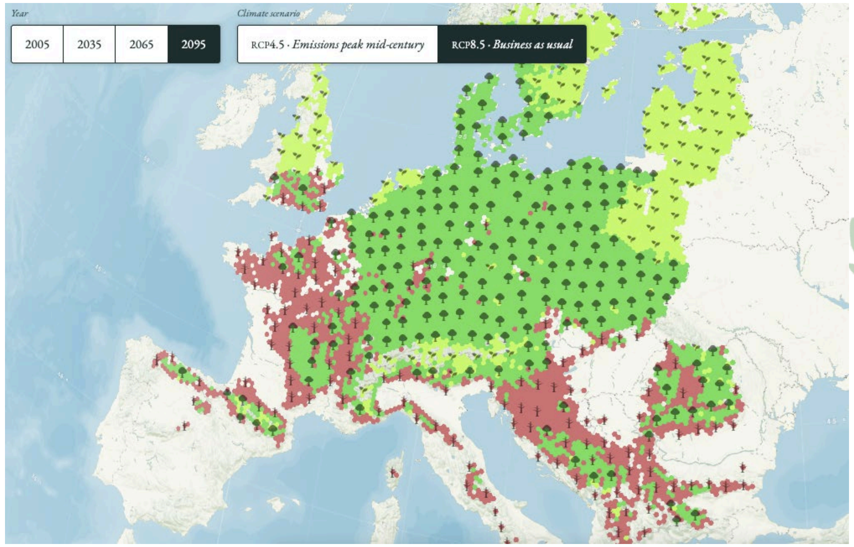
Today

- Fagus sylvatica is naturally present in Czechia, Bayern (Germany), Niedersachsen (Germany), Denmark, Austria and 158 more regions.

Tomorrow

- Fagus sylvatica is likely to disappear from Croatia, Centre-Val de Loire (France), Bosnia and Herzegovina, Serbia, Auvergne-Rhône-Alpes (France) and 116 more regions.
- However, by 2095 it could thrive in Latvia, Lithuania, England (United Kingdom), Estonia, Mazowieckie (Poland) and 129 more regions.





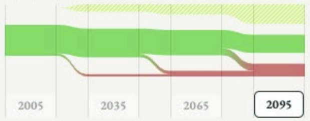
Case 2. Olive

OLIVE

OLEA EUROPAEA

The olive, botanical name Olea europaea, meaning 'European olive' in Latin, is a species of small tree or shrub in the family Oleaceae, found traditionally in the Mediterranean Basin. When in shrub form, it is known as Olea europaea 'Montra', dwarf olive, or little olive. The species is cultivated in all the countries of the Mediterranean, as well as in Australia, New Zealand, North and South America and South Africa. Olea europaea is the type species for the genus Olea.

In Europe, by **2095**, Olea europaea is somewhat equally stable (59% stable) and likely to become suitable (+64% suitable)



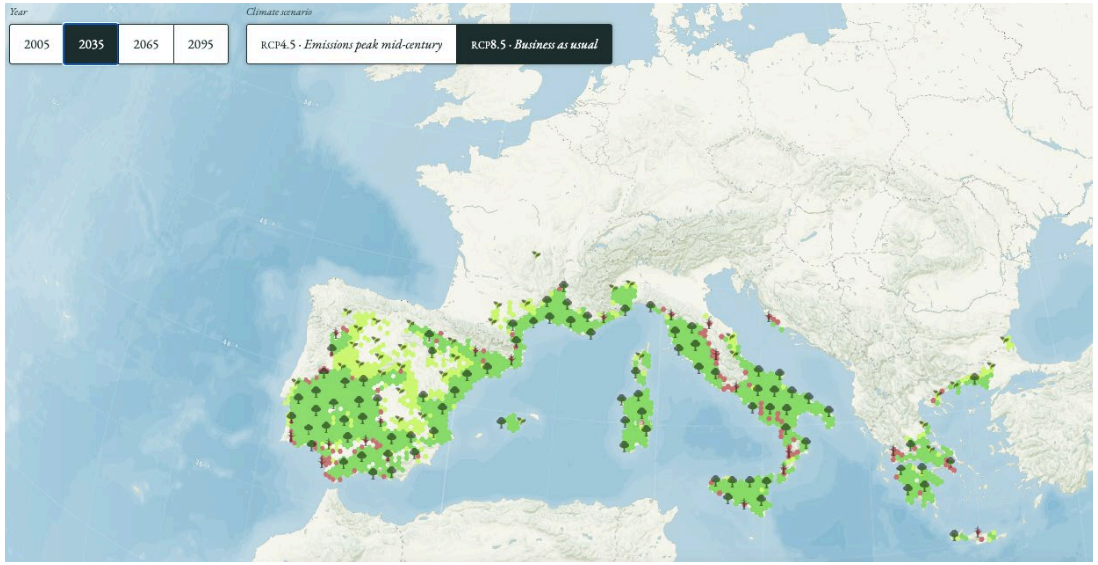
- Suitability In 2095
- Stable In 2095
- Decolonization In 2095

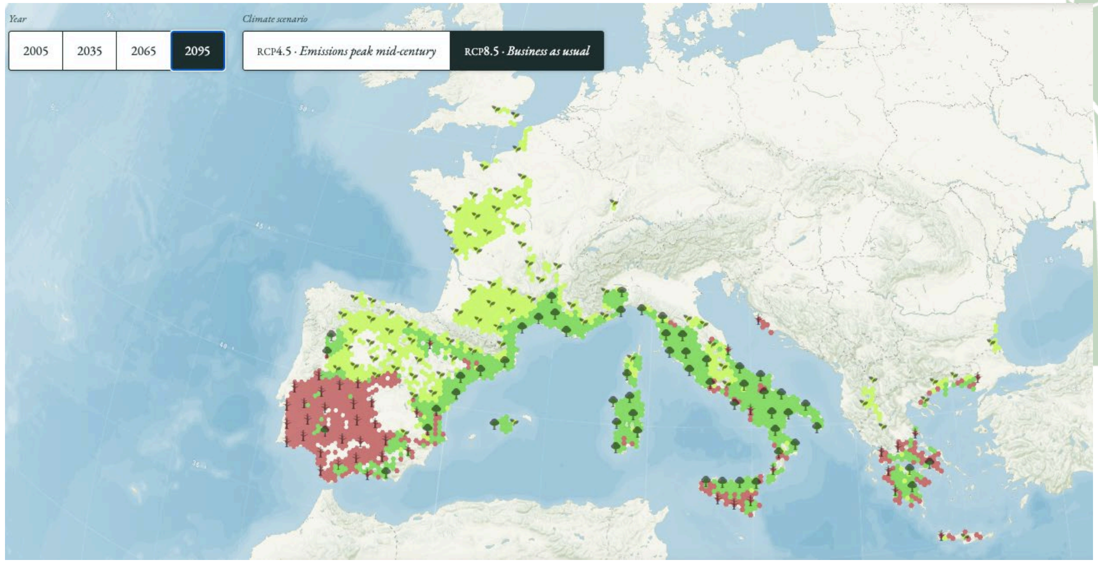
Today

- Olea europaea is naturally present in Andalucía (Spain), Portugal, Extremadura (Spain), Castilla-La Mancha (Spain), Cataluña (Spain) and 36 more regions.

Tomorrow

- Olea europaea is likely to disappear from Andalucía (Spain), Portugal, Extremadura (Spain), Castilla-La Mancha (Spain), Sicily (Italy) and 28 more regions.
- However, by 2095 it could thrive in Castilla y León (Spain), Occitanie (France), Nouvelle-Aquitaine (France), Centre-Val de Loire (France), Pays de la Loire (France) and 52 more regions.





Case 3. Walnut

[Link for story]

WALNUT

JUGLANS REGIA

Juglans regia, the Persian walnut, English walnut, Carpathian walnut, Madeira walnut, or especially in Great Britain, common walnut, is an Old World walnut tree species native to the region stretching from the Balkans eastward to the Himalayas and southwest China. It is widely cultivated across Europe.

In Europe, by **2095**, Juglans regia is likely to become suitable (+130% suitable), while in some areas it is stable (67% stable)

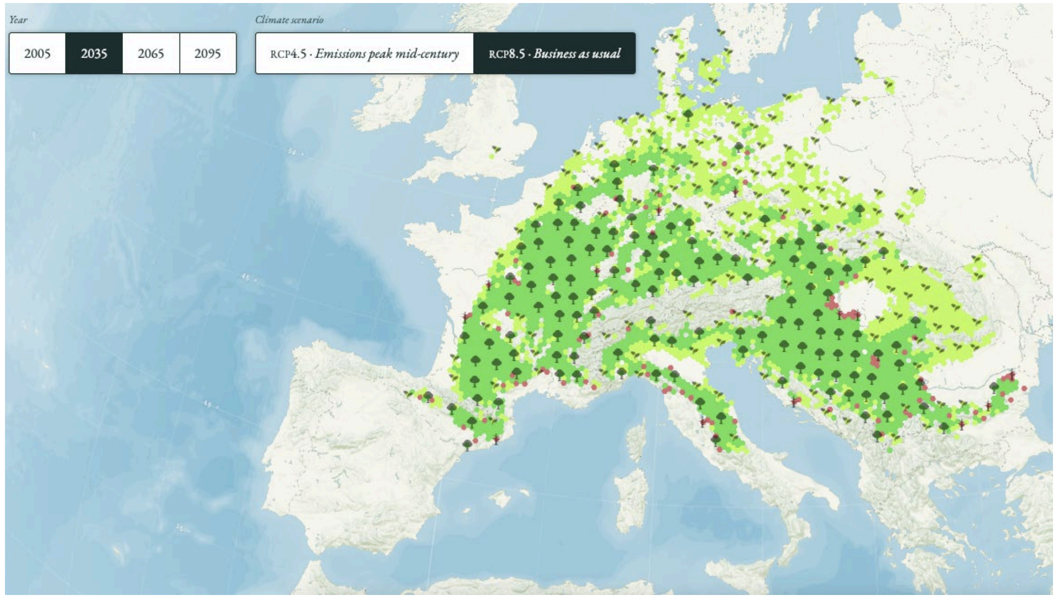
Suitability In 2095
Stable In 2095
Decolonization In 2095

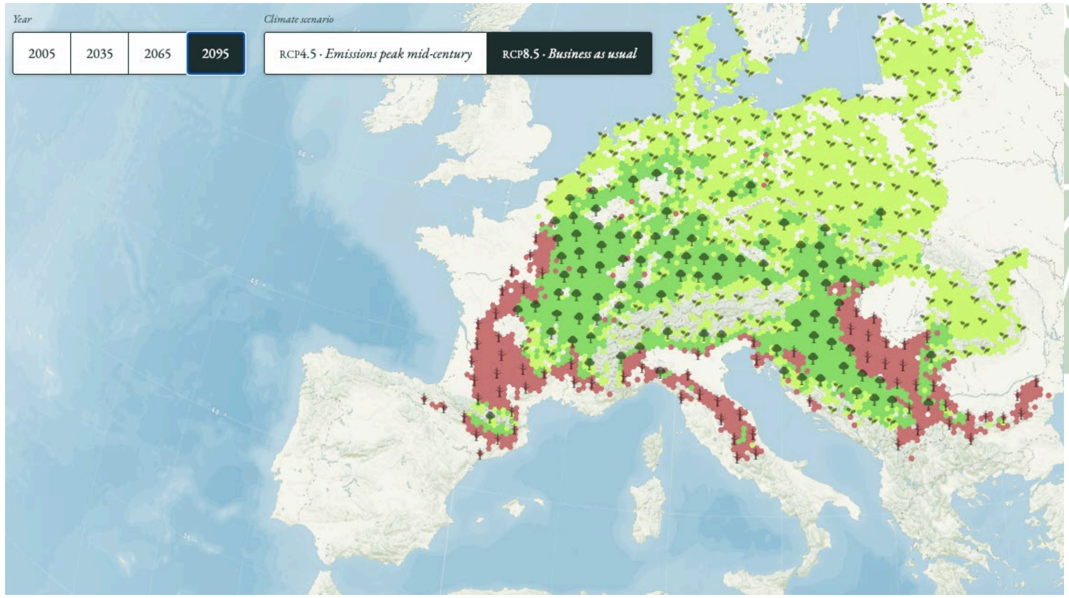
Today

- Juglans regia is naturally present in Serbia, Grand Est (France), Bayern (Germany), Hungary, Bourgogne-Franche-Comté (France) and 87 more regions.

Tomorrow

- Juglans regia is likely to disappear from Serbia, Occitanie (France), Nouvelle-Aquitaine (France), Hungary, Centre-Val de Loire (France) and 67 more regions.
- However, by 2095 it could thrive in Lithuania, Latvia, Denmark, Czechia, Niedersachsen (Germany) and 123 more regions.



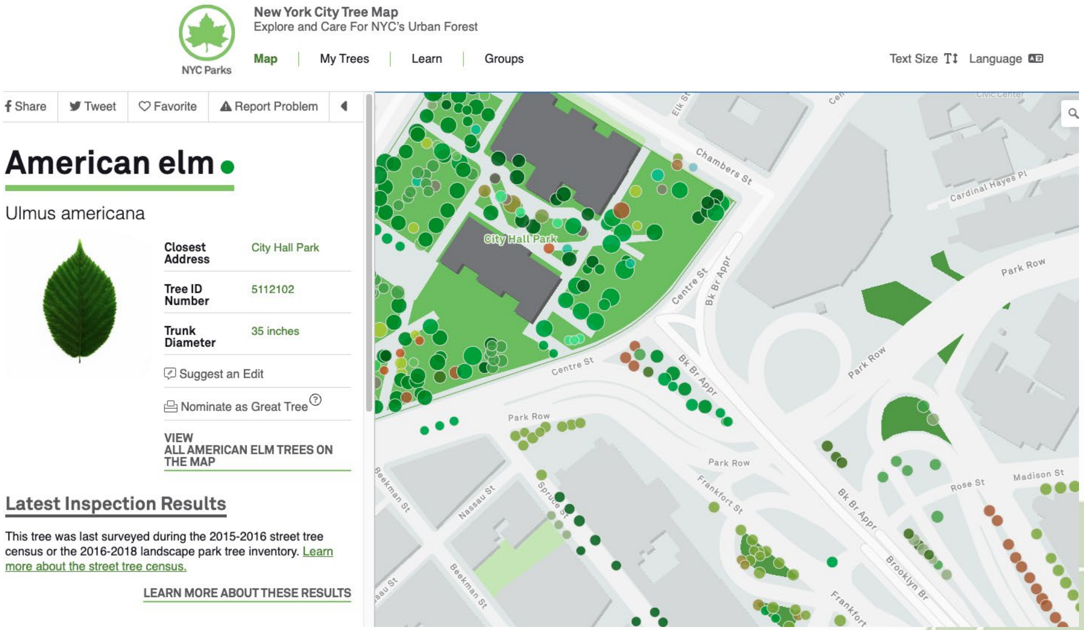


Try it and let us know what you think!

https://devseed.com/our-forests-tomorrow/


Open ideas

- Support a platform that can make use of this data to urge more actions from citizens?
- Monitor tree health with remote sensing data?
- Incorporate the tool/data into economic/urban forestry planning?



New York City Tree Map https://tree-map.nycgovparks.org/tree-map

Do you have ideas or a researches that need more public engagement?

We would like to solve them together.

Thank you

Hanbyul Jo | Development Seed

hanbyul@developmentseed.org

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2nd World Forum on Urban Forests

2023

World Forum on Urban Forests

2nd World Forum on Urban Forests

Washington DC, 2023

Do the right thing

A climate change vulnerability assessment framework for urban forests

Presented by

Leslie Brandt, PhD.

Office of Sustainability and Climate

USDA Forest Service

The Problem:

Urban forests are often seen as a natural climate solution.

BUT

Urban forests are themselves vulnerable to climate change.

What is vulnerability?

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

Climate Change makes urban forests vulnerable to:

Drought

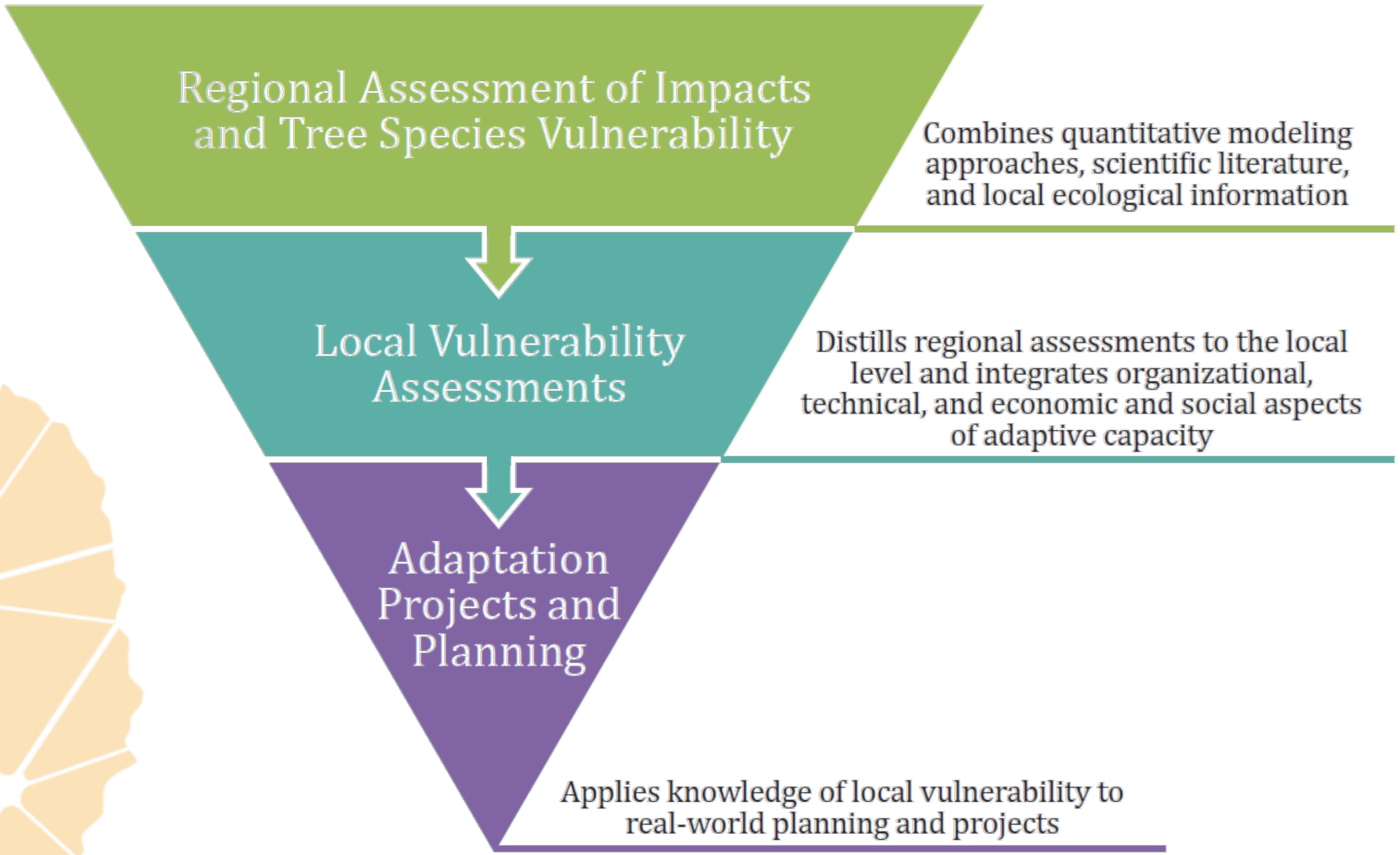
Extreme heat

Severe storms

New and more severe pests and diseases

Sea level rise

Urban Forestry Climate Change Response Framework



Brandt et al. 2016. Environmental Science and Policy

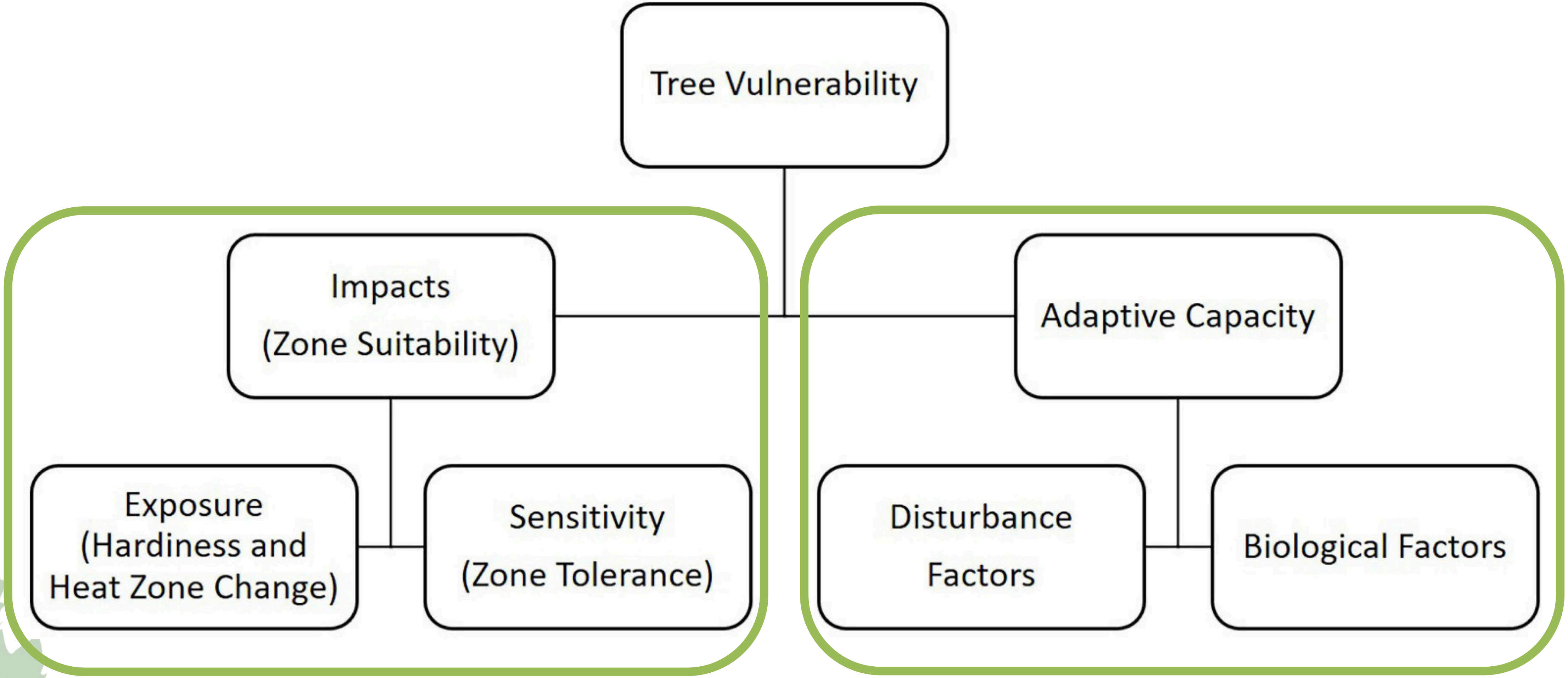
Urban Forestry
Climate Change Response Framework

Regional Assessment of Impacts and Tree Species Vulnerability

Combines quantitative modeling approaches, scientific literature, and local ecological information

Brandt et al. 2016. Environmental Science and Policy

Vulnerability assessment framework for urban trees



Brandt et al., 2021, Frontiers in Ecology and the Environment

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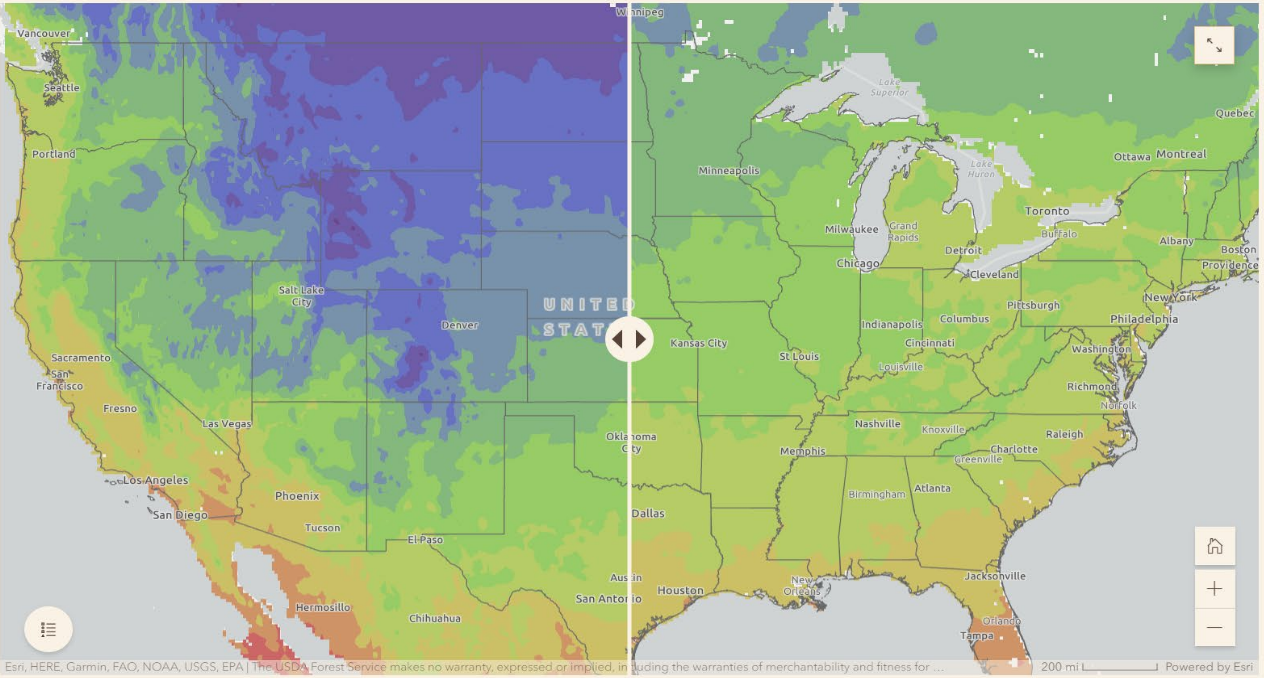
Washington DC, 2023

Assessing Impacts: Hardiness Zones

USDA Climate Change Pressures in the 21st Century ...

Introduction Growing Degree Days Plant Hardiness Zones Heat Zones

bottom-left. Maps of other time periods and emissions scenarios are available here.



Plant Hardiness Zones: Left Side (1980–2009) ↔ Right Side: 2070–2099). Hover over the button at the bottom-left to see the legend.

https://storymaps.arcgis.com/stories/9ee0cc0a070c409cbde0e3a1d87a487c

Assessing Adaptive Capacity: Scoring System

Disturbance Factors

Pest, disease, fire, drought, flood, pollution, heat, herbivory, invasive species, salt resistance

Biological Factors

Shade tolerance, edaphic specificity, propagation, pruning needed, establishment, rooting conditions

-3 0 3

Based on Matthews et al. 2011

List of Species Vulnerability

Climate Change Effect	Adapt Class		
	Low	Medium	High
Negative	High Vulnerability	Moderate-high Vulnerability	Moderate Vulnerability
No Effect	Moderate-high Vulnerability	Moderate Vulnerability	Low-moderate Vulnerability
Positive	Moderate Vulnerability	Low-moderate Vulnerability	Low Vulnerability

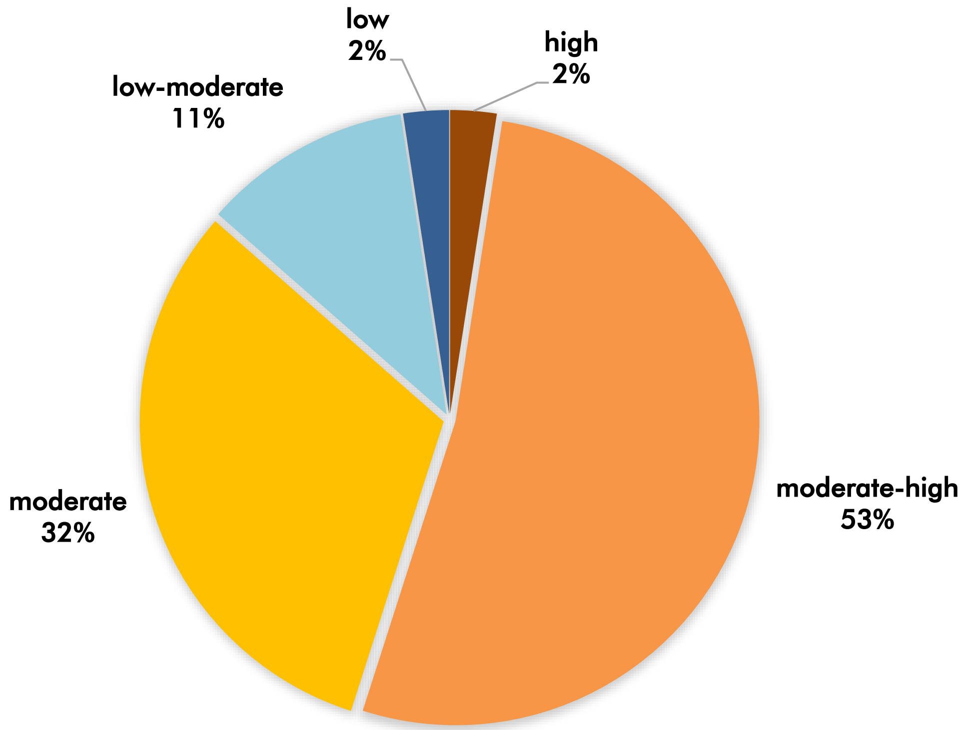
Table 3.7

Vulnerability Ratings for Natural and Developed Areas for Trees in the Austin Region. Estimated number of trees is based on 2014 Urban FIA sample (Nowak et al., 2016)

Common Name	Scientific Name	Estimated Trees Present in Austin	Vulnerability in Natural Areas	Vulnerability in Developed Areas
American elm	*Ulmus americana*	72,039	Moderate	Moderate-High
American smoketree	*Cotinus obovatus*		High	High
American sycamore	*Platanus occidentalis*	132,468	Moderate-High	Moderate-High
Anacacho orchid tree	*Bauhinia lunarioides*		Moderate	Low-Moderate
Arizona walnut	*Juglans major*		Moderate-High	Moderate-High
Arroyo sweetwood	*Myrospermum sousanum*		Low-Moderate	Low-Moderate
Ashe juniper	*Juniperus ashei*	13,315,759	Moderate	Moderate-High

www.climatehubs.usda.gov/hubs/northern-forests/topic/vulnerability-assessment-austins-urban-forest-and-natural-areas

Percent Vulnerable Trees



Percentage of trees in the region within each vulnerability category-Austin, TX

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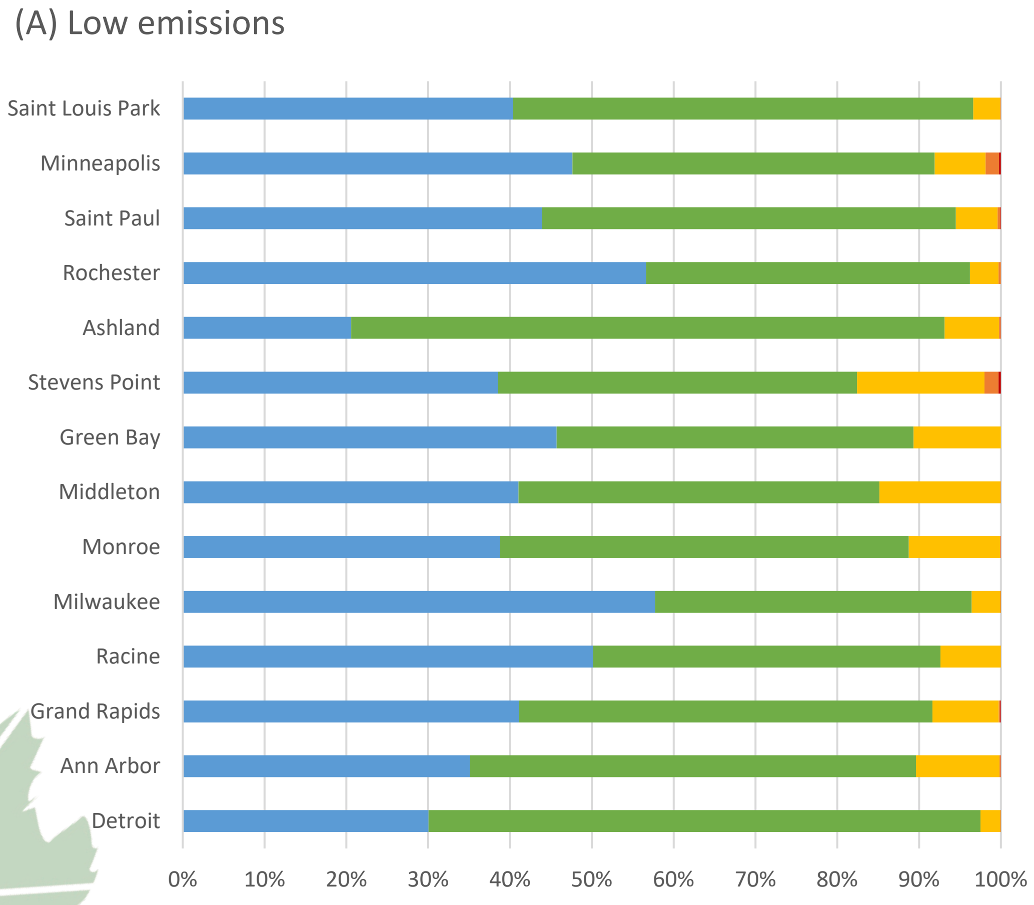
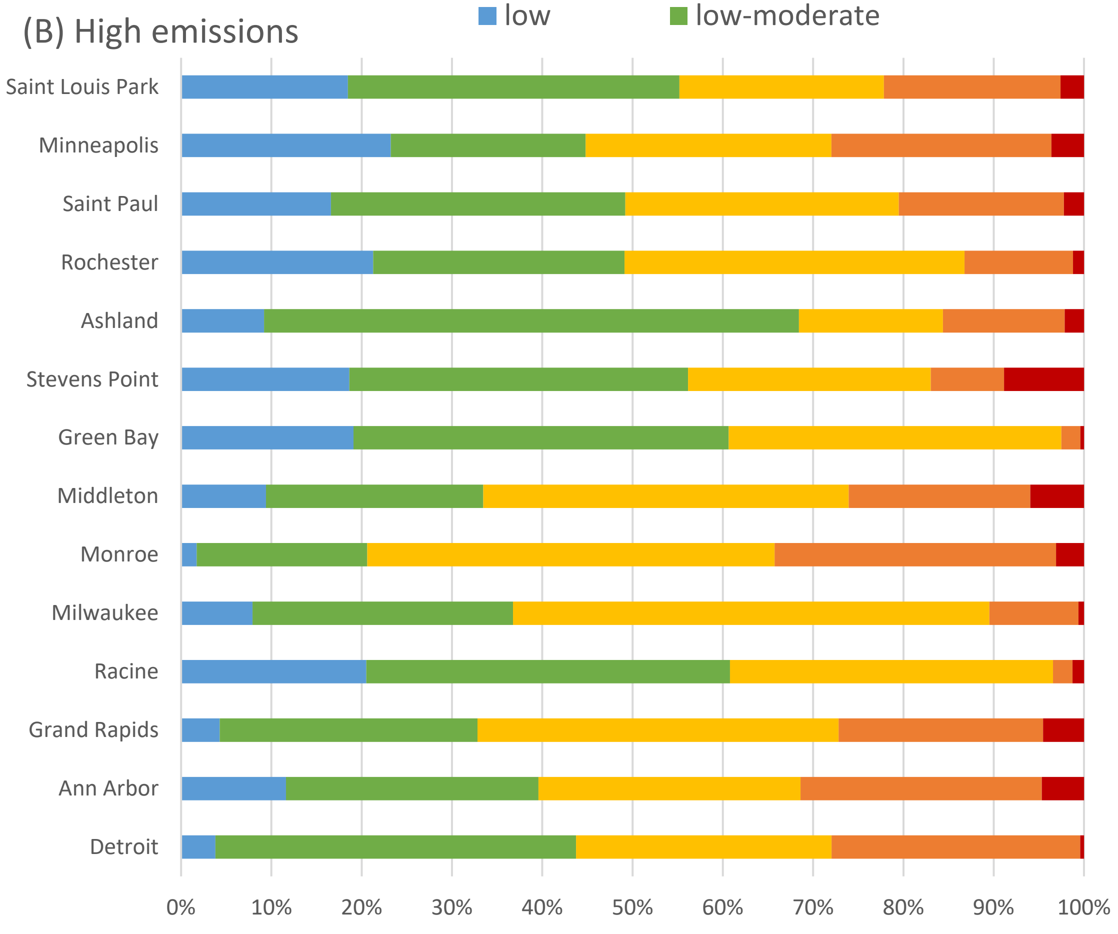
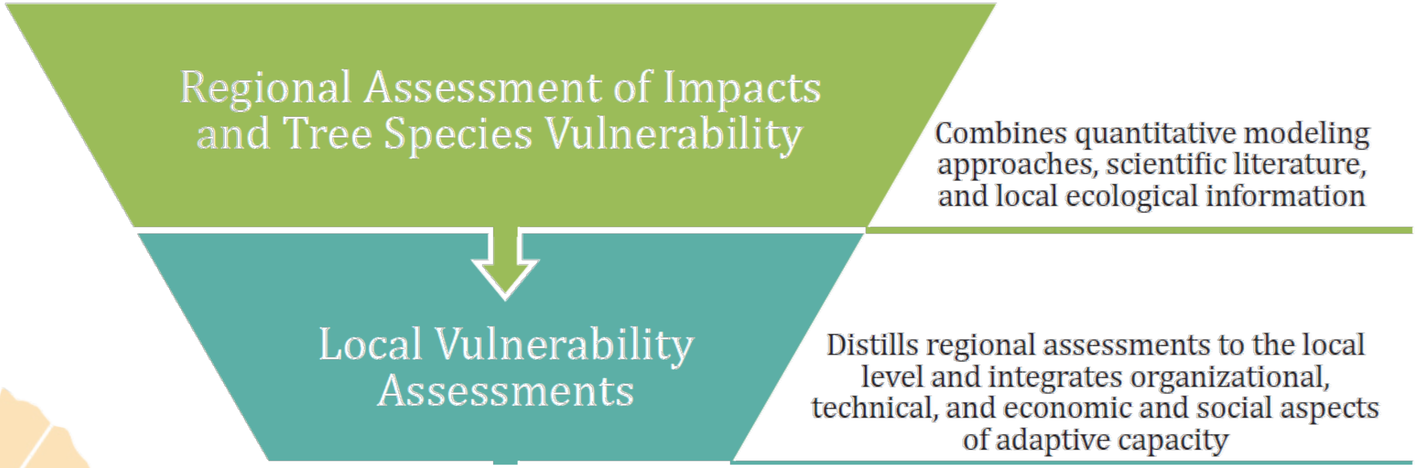
Comparing Vulnerability: US Midwest





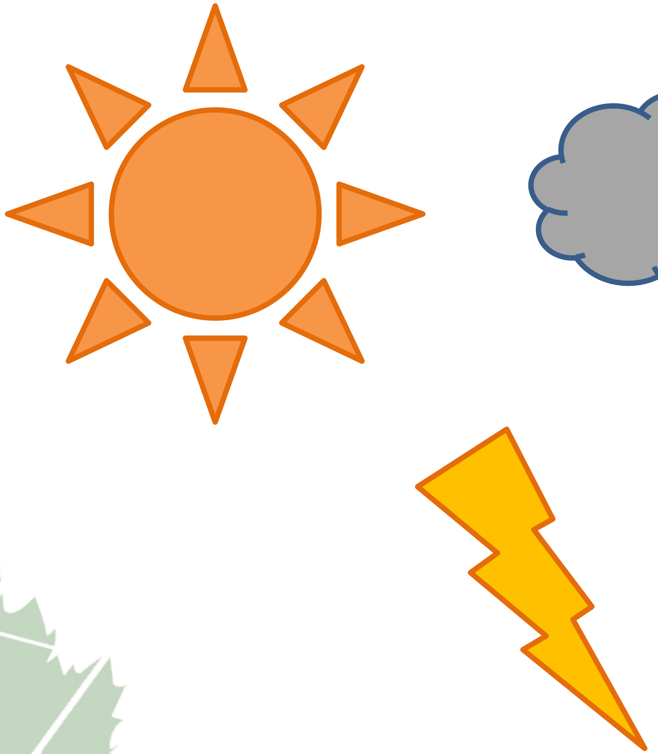
Urban Forestry Climate Change Response Framework



Brandt et al. 2016. Environmental Science and Policy

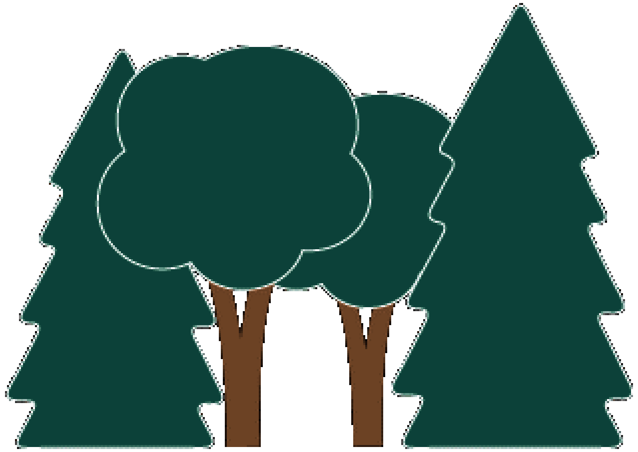
Vulnerability Components

Impacts

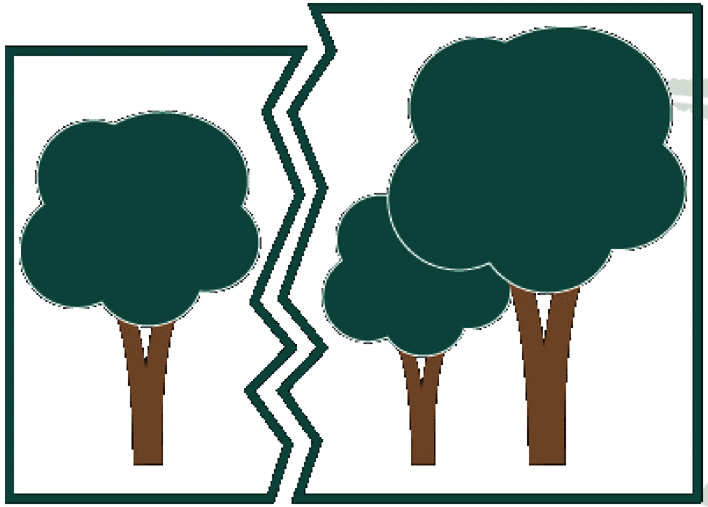


Adaptive Capacity

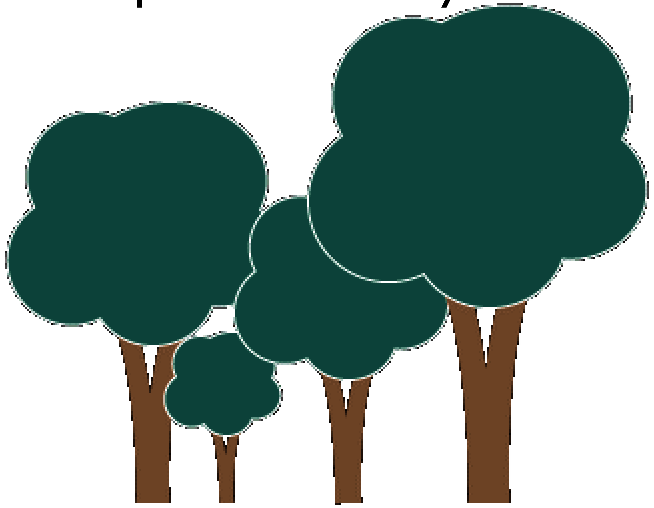
Ecological Adaptive Capacity Factors



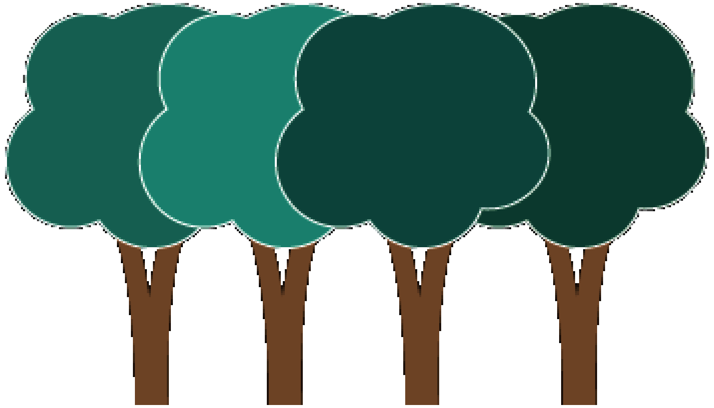
Species diversity



Connectivity



Age class diversity



Genetic diversity

Adaptive Capacity of Urban Forests: Human Factors

Organizational	Economic	Social
• Plans, policies • Trained, sufficient staffing	• Budgets • Ability to get grants	• Community support • Volunteer base

Vulnerability Assessment Workshop

- Local experts in urban forestry and climate
- "Expert panel" process to determine vulnerability

Local Summaries: Austin

East Austin neighborhood. Photo by Leslie Brandt USDA Forest Service.

Floodplains and Terraces

Moderate Vulnerability; Medium Evidence, Medium-High Agreement

These areas are vulnerable to increased flashiness from heavy rain events and are susceptible to non-native invasive species, but high biodiversity and connectivity along with extensive management enhances their adaptive capacity.

Impacts: Moderately Disruptive

Key characteristics

These systems include forests in large alluvial floodplains along the Colorado River and its tributaries with bottomland soils influenced by outwash from the surrounding landscape. They are also riparian forests along smaller streams that tend to have more gravelly erosional soils along steep slopes. In both areas, flood regime tends to be the dominant driver of species composition and structure. These areas could be extremely vulnerable to increased flashiness from periods of extremely high rain followed by periods of drought.

cottonwood, and western soapberry. Species common in floodplains and low terraces that may be most adaptable to both increased temperature and flooding are desert willow, yaupon, and the non-native invasive Chinaberry.

Stressors and threats

This area is susceptible to invasion by non-native woody species (Chinaberry, Chinese tallow, glossy privet) and grasses (bermudagrass, King Ranch bluestem, Johnsongrass, arundo). These non-native invasive species may be able to take advantage of increased disturbed area from flash floods and erosion and colonize new areas. Hydrology of many of these areas has been altered through structures such as dams and reservoirs, making the systems less adapted to natural flood regimes. In some areas, a lack of tree seed sources, among other factors, has converted some riparian and floodplain forests to herbaceous plant community types. This type of conversion could become more common if tree seedling recruitment and survival are reduced with higher temperatures and altered flood regimes.

Riparian area along the Colorado River in East Austin. Photo by Leslie Brandt USDA Forest Service.

Upland Mixed Shrubland

Moderate-High Vulnerability; Medium Evidence, Low Agreement

Shrubs and grasses in these systems are tolerant of hot, dry conditions, but these areas are heavily fragmented and exist on dry, shallow soils and are thus at risk for conversion to grassland or desert.

Impacts: Moderately Disruptive

Key characteristics

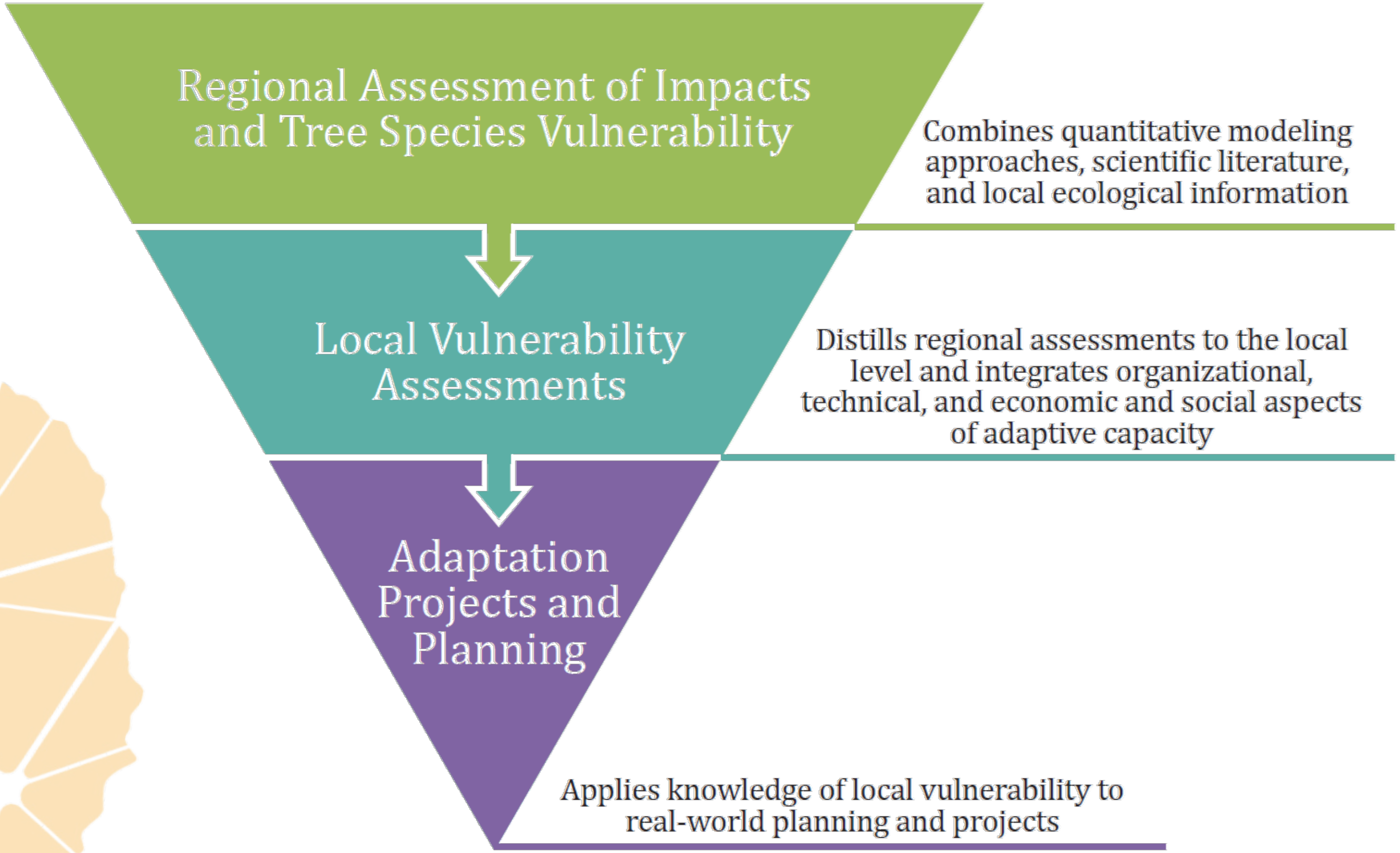
Shrublands tend to occur on more xeric sites with shallow soils. These areas were historically cleared and/or burned due to anthropogenic or natural causes. Due to the shallow soils, trees do not dominate the canopy and tend to be stunted. With grasses interspersed among the shrubs, these areas tend to be higher risk for wildfire

vulnerable to increases in temperature. Texas kidneywood and Mexican buckeye are considered less drought-tolerant. It is also important to note that even some drought-tolerant species like Texas persimmon suffered negative effects during the most recent 2011 drought, and thus even seemingly drought-tolerant species may be vulnerable to extreme and exceptional droughts.

Stressors and threats

Shrublands are threatened primarily from loss of habitat and fragmentation as well as altered disturbance regimes (lack of fire, overgrazing/browsing). Overgrazing/browsing may Fragmentation may decrease the ability of shrubland species to colonize newly suitable habitat. Altered disturbance regimes have led to a reduction in species diversity and loss of dominance of some species that may be better adapted to warmer conditions. As herbivores

Urban Forestry
Climate Change Response Framework

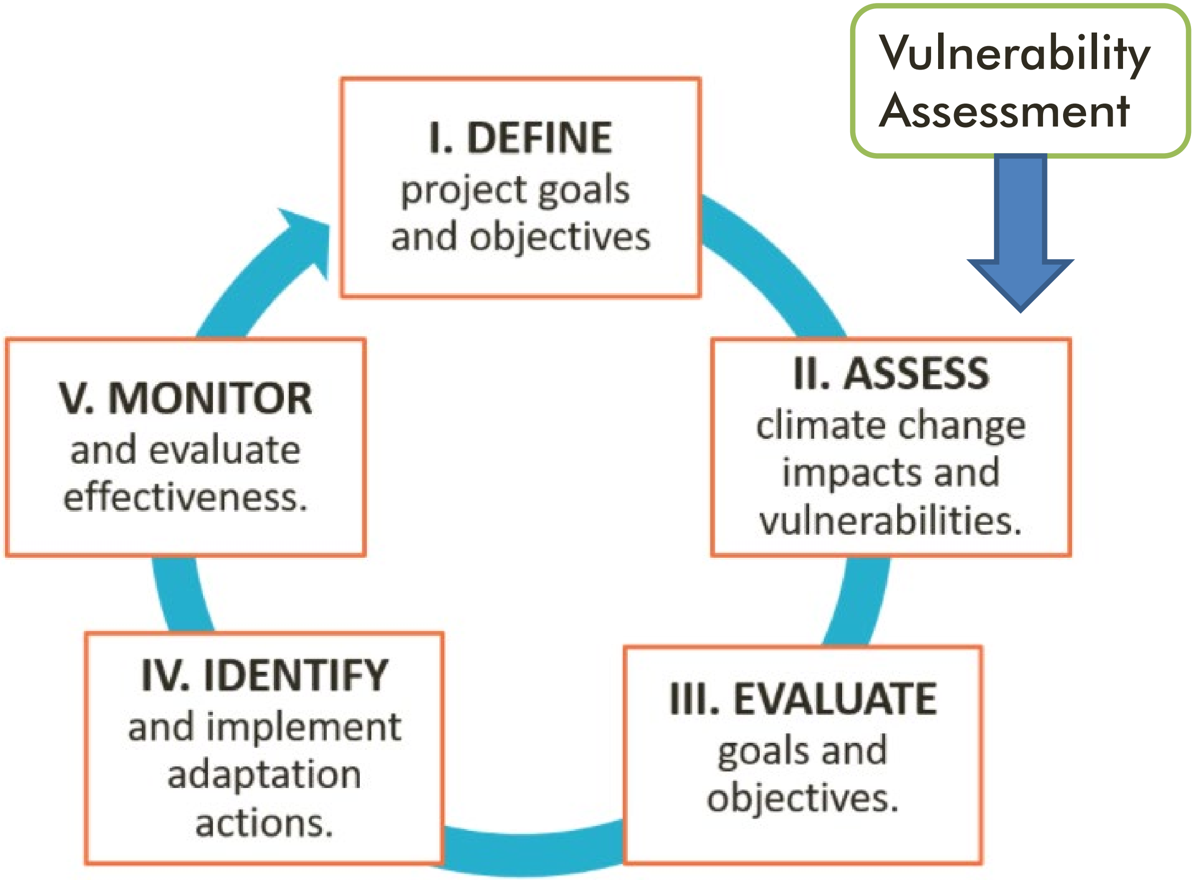


Brandt et al. 2016. Environmental Science and Policy

Climate and Health Action Guide

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

Climate and Health Action Guide: Adaptation Workbook



Janowiak et al., 2021

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Adaptation Menu

A collection of vetted, peer-reviewed strategies and approaches to adapt people and trees in cities to a changing climate.

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

URBAN FOREST CLIMATE & HEALTH MENU AT A GLANCE

The following list of strategies and approaches offers a glance at the Urban Forest Climate and Health Menu.[1] The full document includes descriptions of each strategy and approach as well as example adaptation tactics.

Strategy 1: Engage social systems to integrate climate change, urban forest, and human health actions
Approach 1.1: Address socio-ecological systems in early, comprehensive response
Approach 1.2: Integrate urban forestry in climate planning and policy
Approach 1.3: Address climate and health challenges of socially-disadvantaged communities and vulnerable populations

Strategy 2: Reduce the impact of human health threats and stressors using urban trees and forests
Approach 2.1: Reduce extreme temperatures and heat exposure
Approach 2.2: Improve urban air quality conditions
Approach 2.3: Anticipate and reduce human health impacts of hazardous weather and disturbance events

Strategy 3: Maintain or increase extent of urban forests and vegetative cover
Approach 3.1: Minimize forest loss and degradation
Approach 3.2: Maintain existing trees through proper care and maintenance
Approach 3.3: Restore and increase tree, forest, and vegetative cover
Approach 3.4: Sustain locations that provide high value across the landscape

Strategy 4: Sustain or restore fundamental ecological functions of urban ecosystems
Approach 4.1: Maintain or restore soils and nutrient cycling in urban areas
Approach 4.2: Maintain or restore hydrologic processes in urban forests
Approach 4.4: Restore or maintain fire in fire-adapted ecosystems

Strategy 5: Reduce the impact of physical and biological stressors on urban forests
Approach 5.1: Reduce impacts from extreme rainfall and enhance water infiltration and storage
Approach 5.2: Reduce risk of damage from extreme storms and wind
Approach 5.3: Reduce risk of damage from wildfire
Approach 5.4: Maintain or improve the ability of forests to resist pests and pathogens
Approach 5.5: Prevent invasive plant establishment and remove existing invasive species
Approach 5.6: Manage herbivory to promote regeneration, growth, and form of desired species

Strategy 6: Enhance taxonomic, functional, and structural diversity
Approach 6.1: Enhance age class and structural diversity in forests
Approach 6.2: Maintain or enhance diversity of native species
Approach 6.3: Optimize and diversify tree species selection for multiple long-term benefits
Approach 6.4: Maintain or enhance genetic diversity

Strategy 7. Alter urban ecosystems toward new and expected conditions
Approach 7.1: Favor or restore non-invasive species that are expected to be adapted to future conditions
Approach 7.2: Establish or encourage new species mixes.
Approach 7.3: Introduce species, genotypes, and cultivars that are expected to be adapted to future conditions
Approach 7.4: Disfavor species that are distinctly maladapted
Approach 7.5: Move at-risk species to more suitable locations
Approach 7.6: Promptly revegetate and remediate sites after disturbance
Approach 7.7: Realign severely altered systems toward future conditions

Strategy 8: Promote mental and social health in the face of climate change
Approach 8.1: Provide nature experiences to ease stress and support mental function
Approach 8.2: Encourage community and social cohesion for climate response

Strategy 9: Promote human health co-benefits in nature-based climate adaptation activities
Approach 9.1: Co-design large scale green infrastructure and systems to promote health
Approach 9.2: Provide micro-scale experiences for health promotion and healing

Summary

- Urban forests are vulnerable to climate change.
- You can assess the vulnerability of trees by using downscaled projections of heat and hardiness zones and assessing adaptive capacity to different disturbances.
- Inventory data can be used to estimate the number of vulnerable trees in an area.
- Other aspects of urban forest vulnerability, such as biodiversity, social, and economic factors are also important to consider.
- Resources and tools are available to help urban forest managers adapt to changing conditions.

Thank you

Leslie Brandt | USDA Forest Service

https://forestadaptation.org/assess/ecosystem- vulnerability/urban

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Session 3.6: Do the right thing: Planning, designing and managing the urban forest to strengthen its resilience to external shocks

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