Session 3.4

Some Like it Hot: Creating and sharing new knowledge and supporting education on the contribution of forests and trees to adaptation and mitigation to climate change

Chair: Jacob Hendee

World Forum on Urban Forests

Which Plant Where - climate-ready plant selection for resilient urban forests

Michelle Leishman, Alessandro Ossola, Samiya Tabassum, Gwilym Griffiths

2nd World Forum on Urban Forests
Washington DC, 2023

Which Plant Where

MACQUARIE University

BENEFITS OF URBAN GREEN SPACE

Reduces obesity levels by increasing physical activity including walking and cycling

Manages stormwater, keeps pollutants out of waterways, and reduces urban flooding

Increases neighbourhood property values

Reduces stress by helping interrupt thought patterns that lead to anxiety and depression

Filters up to a third of fine particle pollutants within 300 yards of a tree

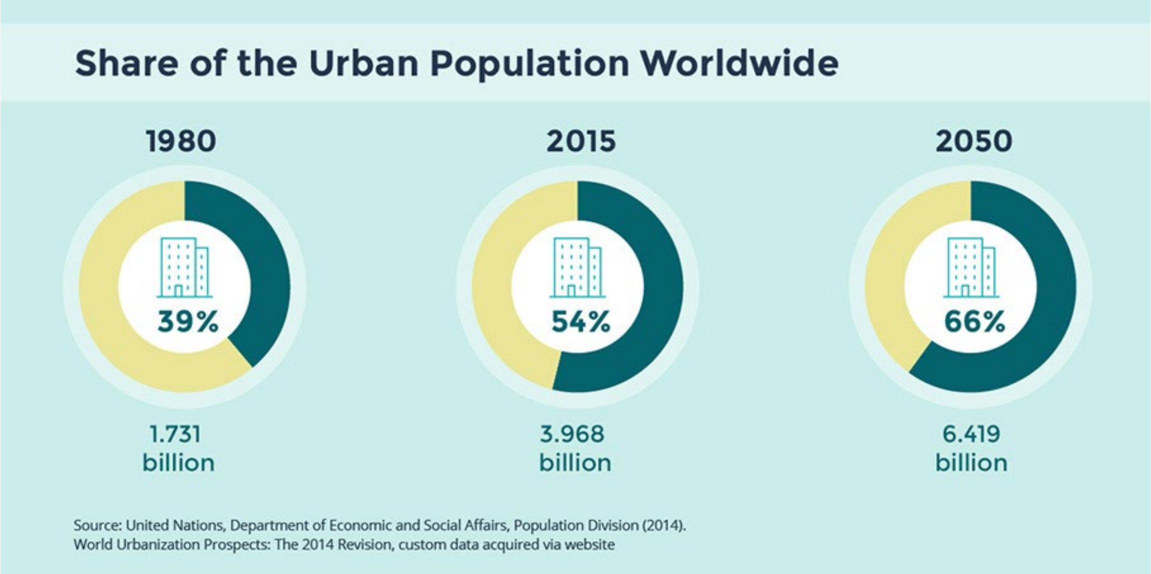
Cools city streets by 2-4° F, reducing deaths from heat and cutting energy use

Reduces rates of cardiac disease, strokes, and asthma due to improved air quality

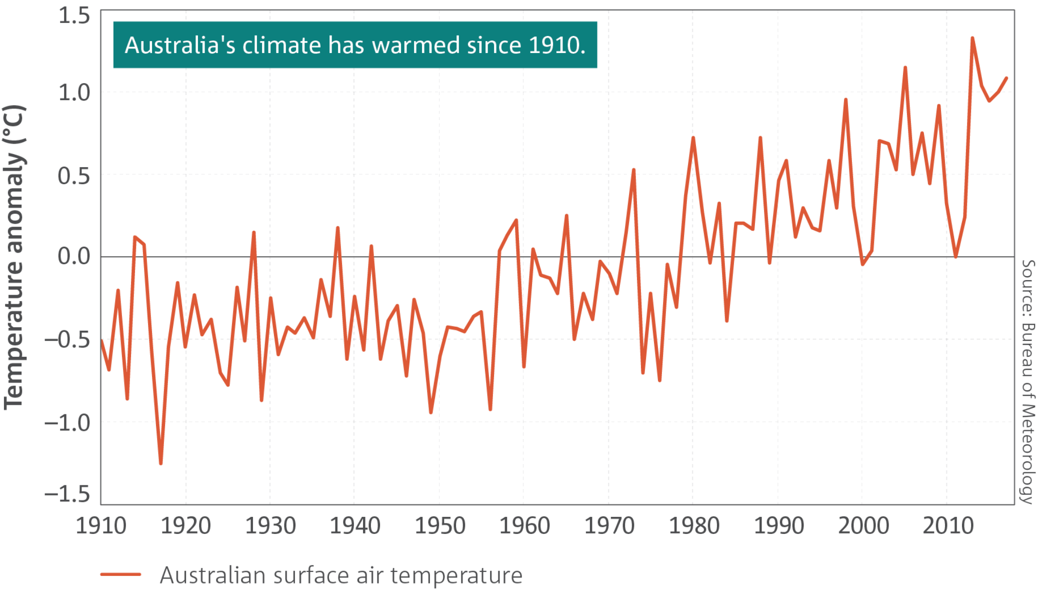
Protects biodiversity including habitat for migrating birds and pollinators

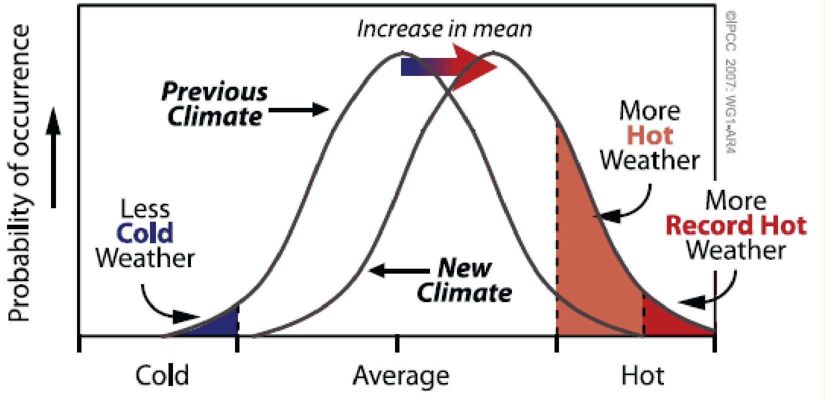
The Business Standard https://www.tbsnews.net/thoughts/urban-green-space-and-well-being-281461

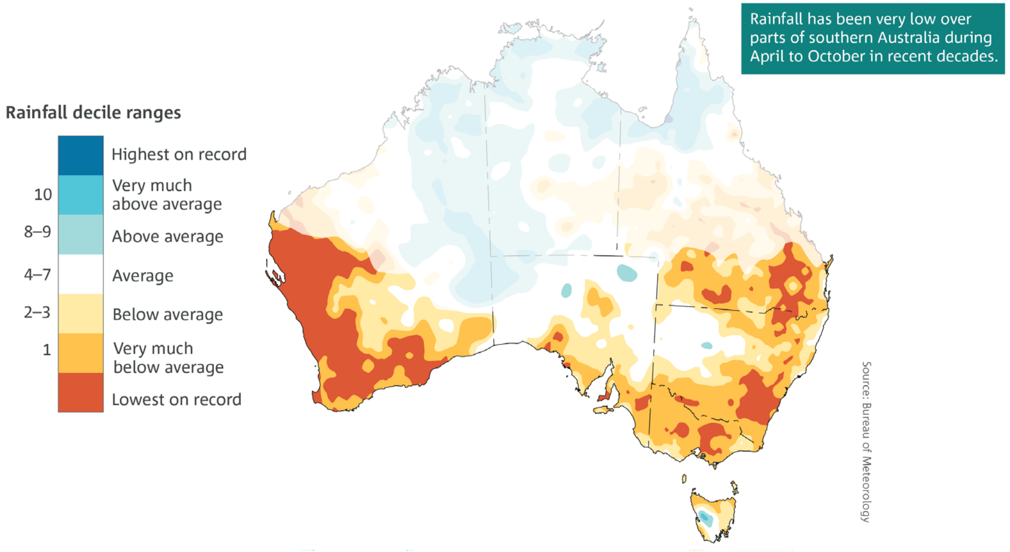
But our urban green spaces face many challenges

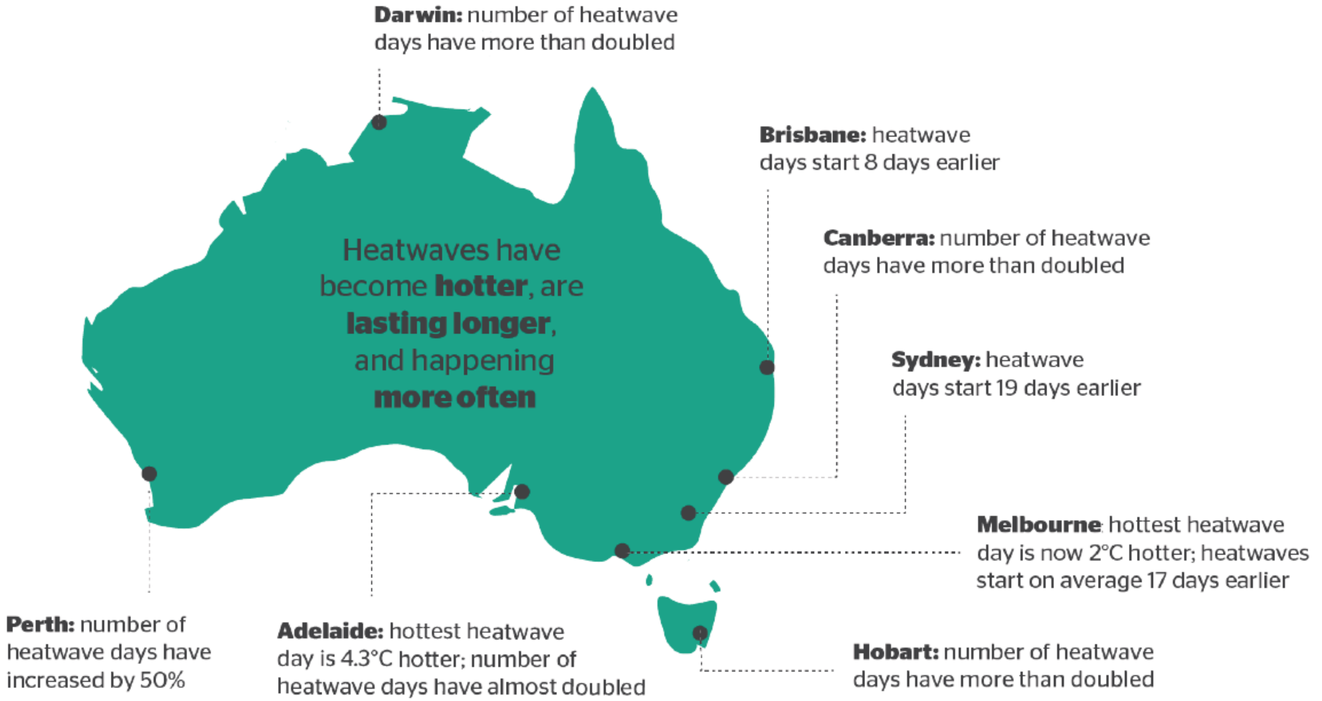


…including climate change









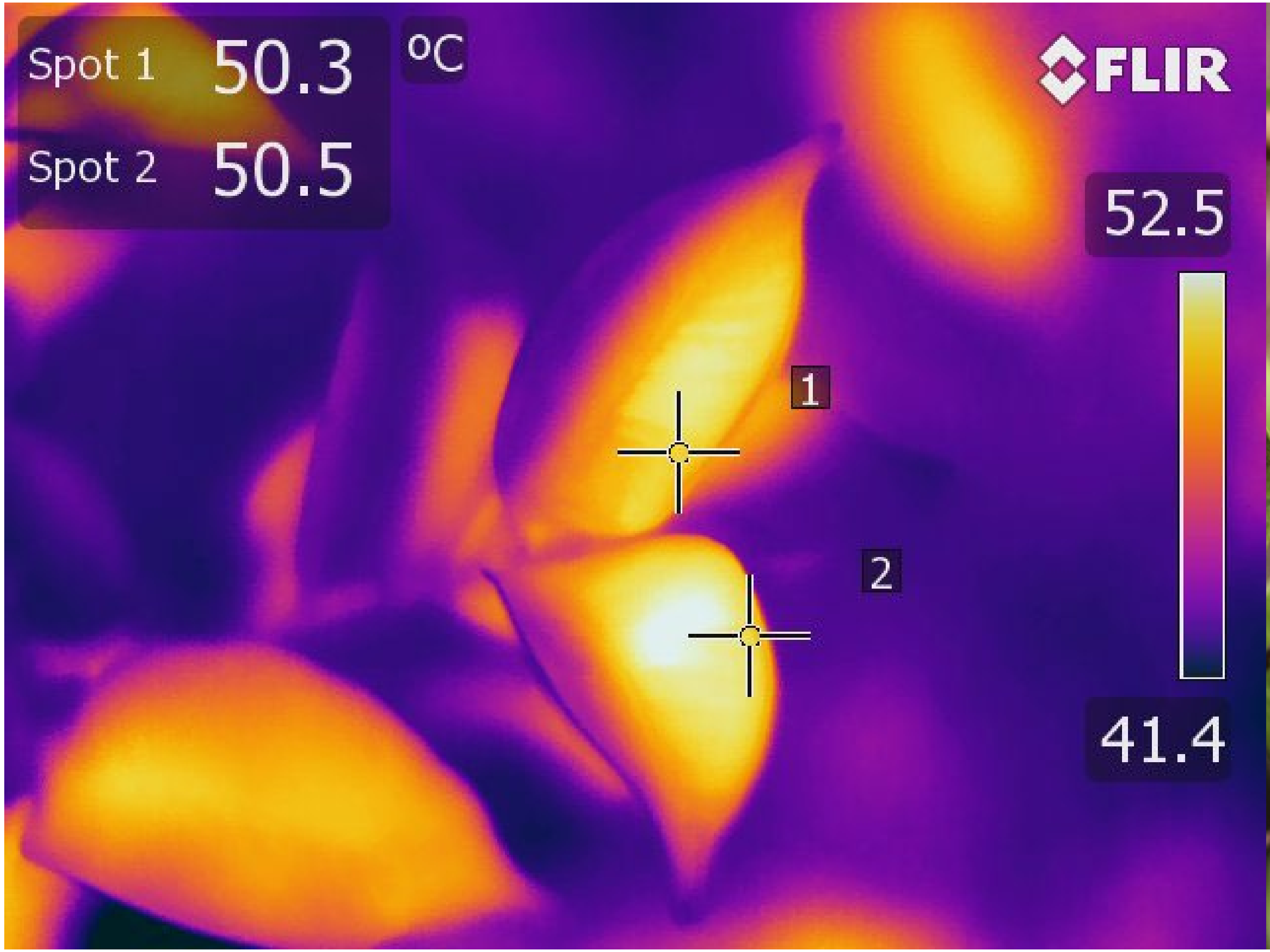
Study: Perkins & Alexander 2013. Image: ACF 2021

Some of our common species are feeling the heat

Platanus acerifolia
London planetree,
Richmond 9th Jan. 2018

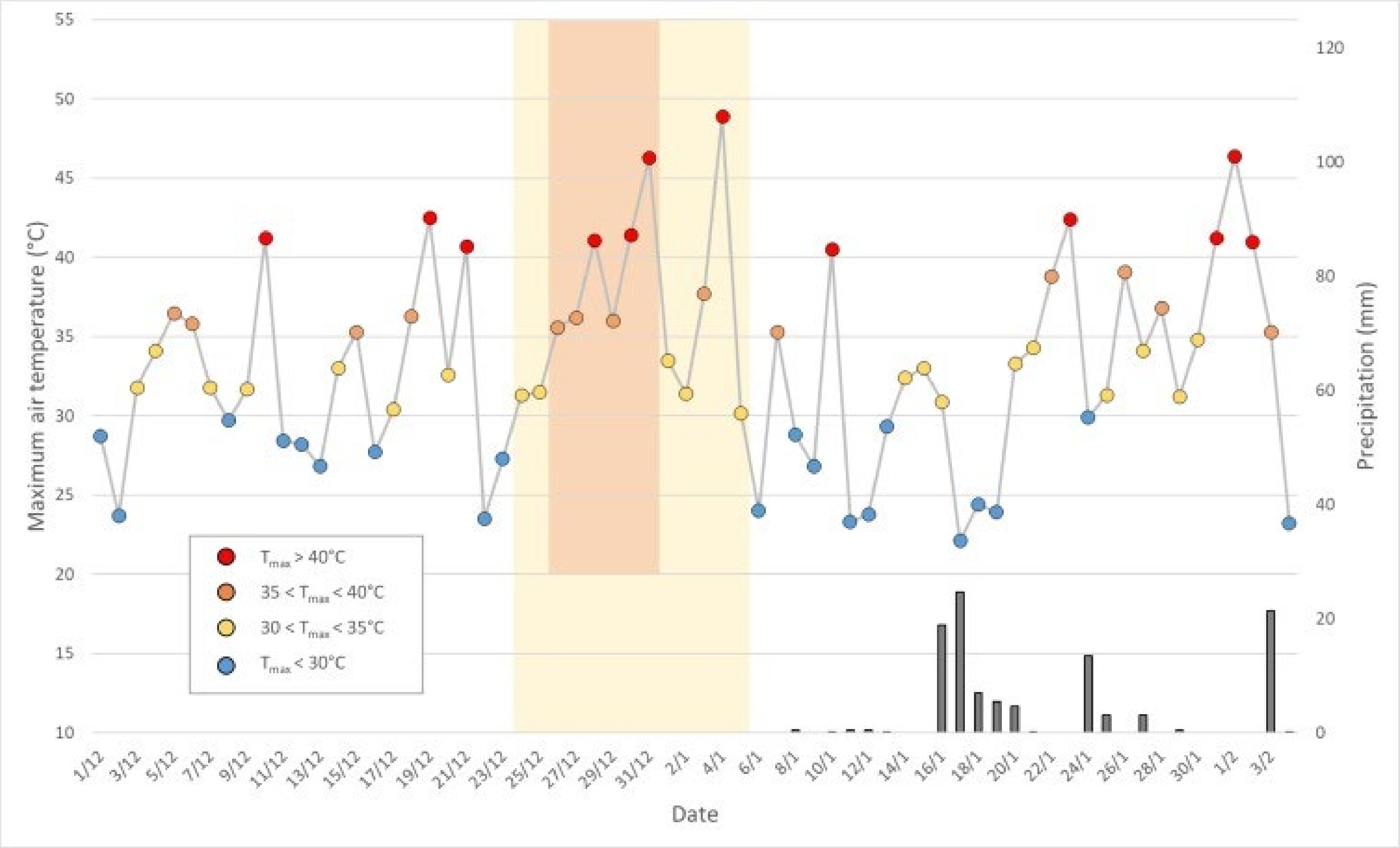
Banksia serrata
Old Man Banksia, Sydney
10th Mar. 2019

Extreme temperatures can result in leaf scorch

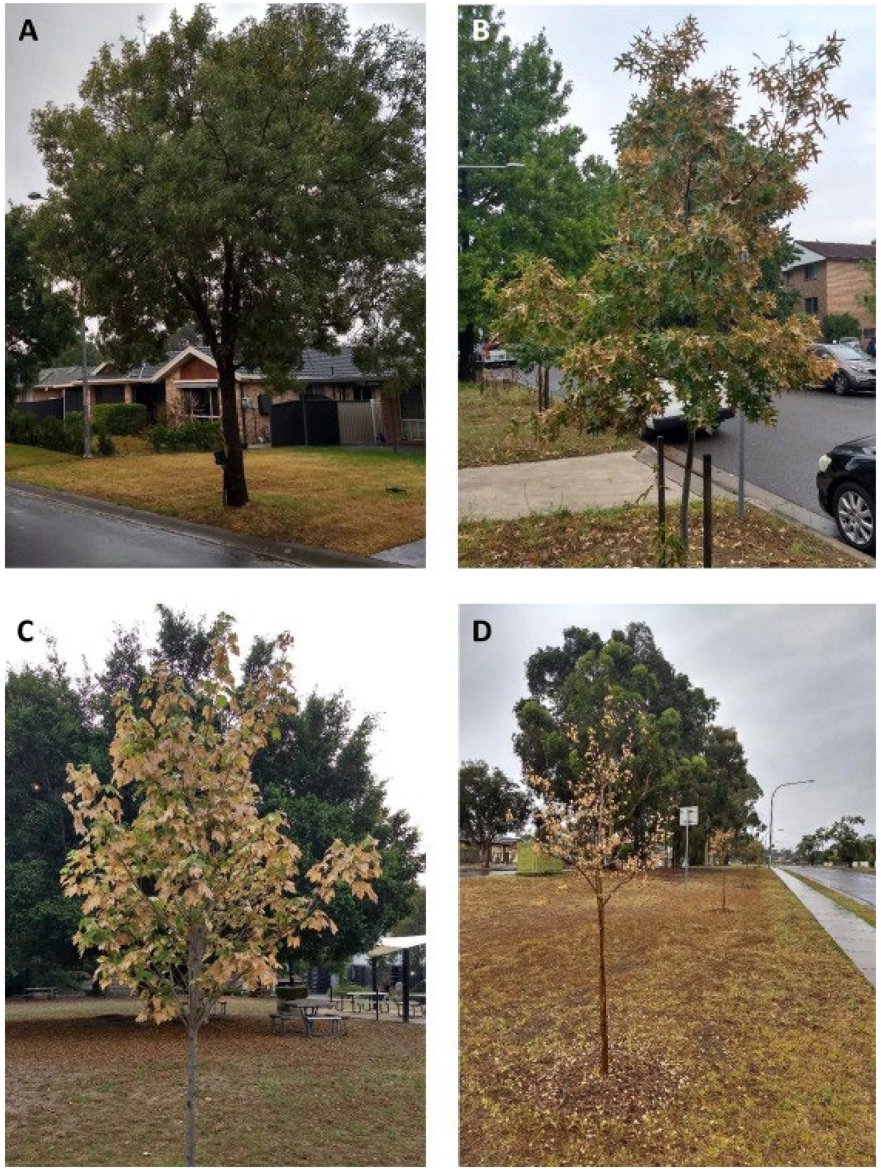


Measured in W. Sydney on 10th Feb. 2017, 14:00 AEDT, Air T = 40.7 °C, 32% RH

Western Sydney extreme heat 2019-20



Canopy assessment

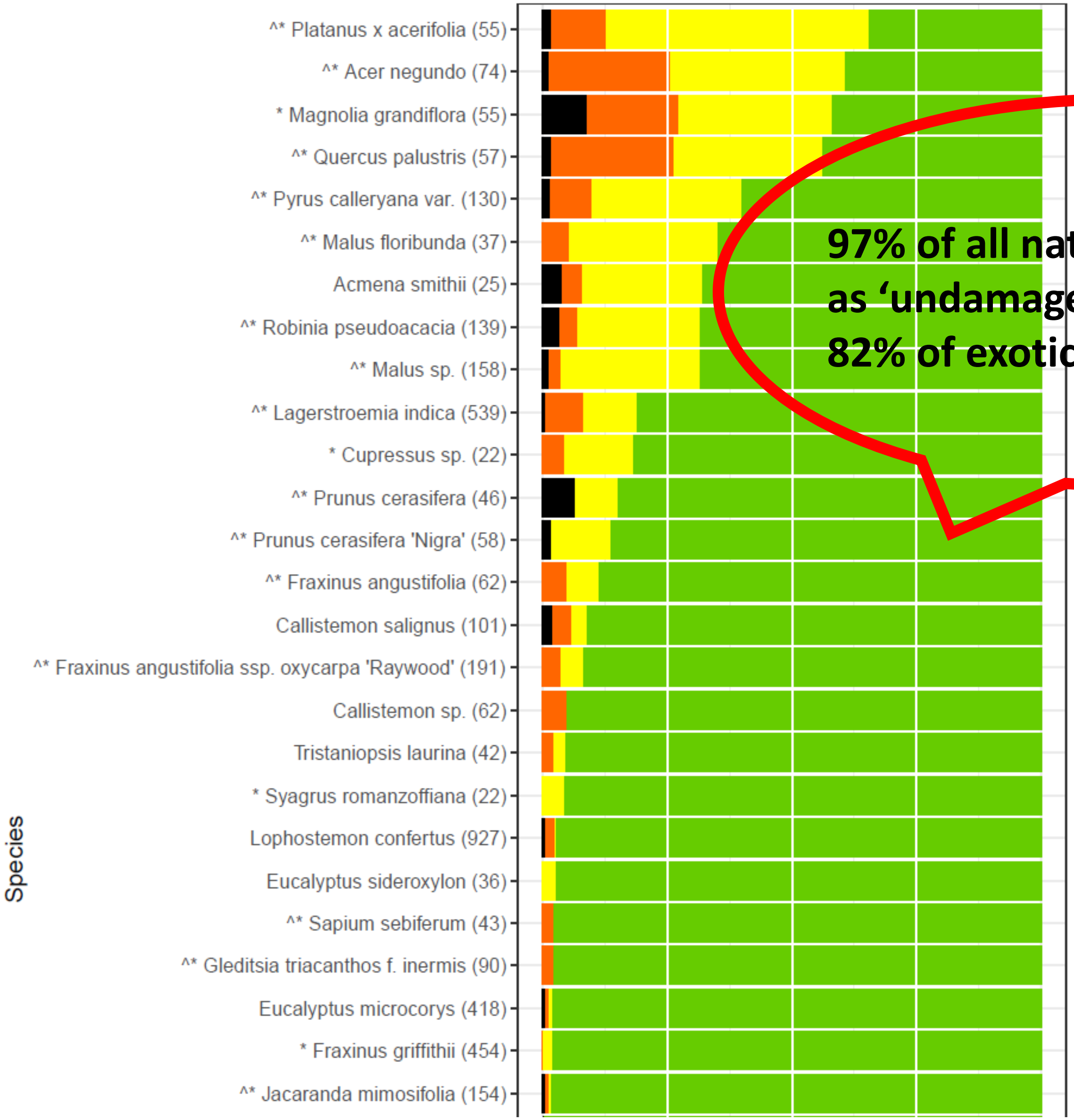


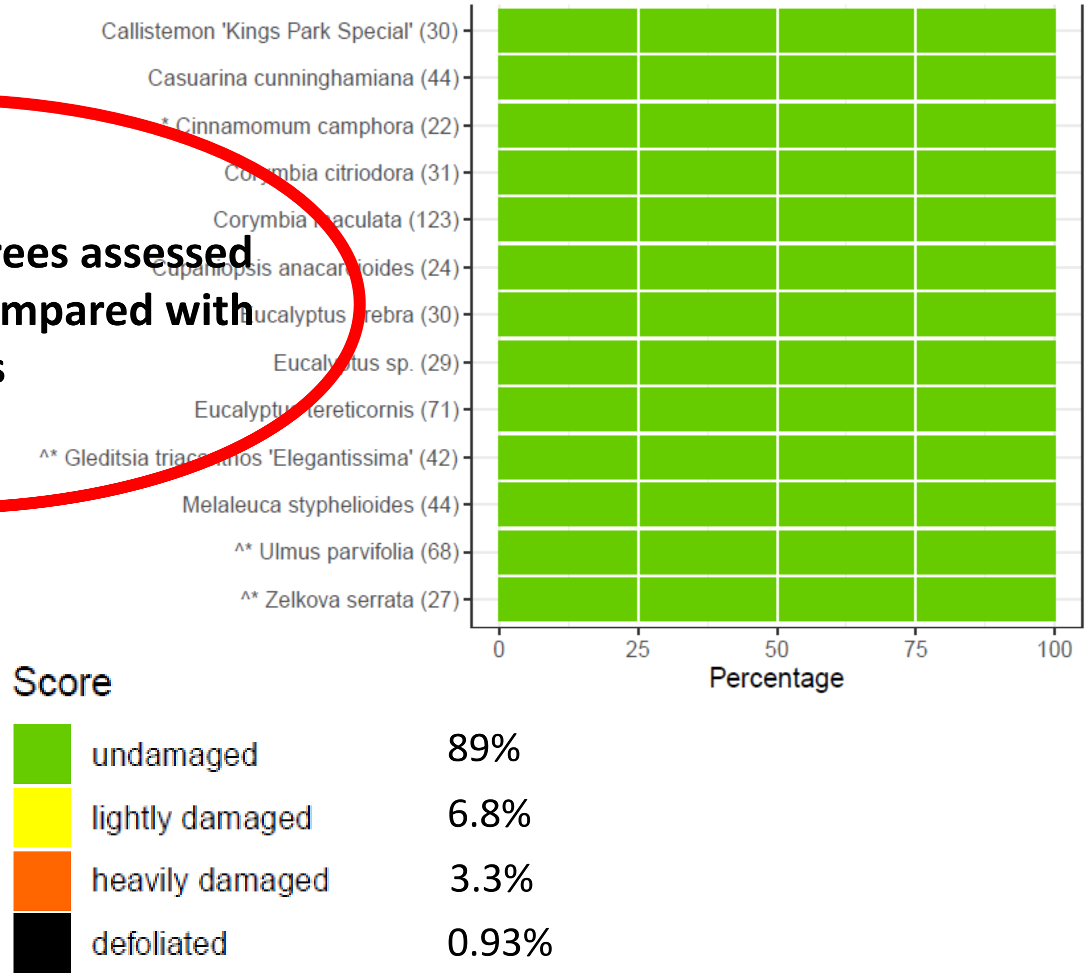
Visual canopy assessment of 5591 tree stems along 92.3 km of road.

Four categories of canopy damage:

(A) undamaged, 0-5% canopy damaged
(B) lightly damaged, 6-30% canopy damaged
(C) heavily damaged, 31-90% canopy damaged
(D) defoliated, 91-100% canopy damaged.

Foliage damage from extreme heat (western Sydney, January 2020)





Tabassum et al. (2021) *Urban Forestry & Urban Greening*

Economic impact on the urban forest

	Low cost scenario		High cost scenario	
Cost type	Cost (AUD)	Proportion (%)	Cost (AUD)	Proportion (%)
Establishment	$268,809	46%	$407,656	50 %
Maintenance	$292,682	50 %	$334,635	41%
Cost of mortality	$23,260	4%	$74,906	9%
Total	**$584,751**	100 %	**$817,197**	100 %

Breakdown of costs of replacement for heavily damaged and defoliated trees under the low cost and high cost scenarios. The low cost scenario involved replacement with juvenile trees while the high cost scenario involved replacement with advanced trees. Note that maintenance and cost of mortality were calculated for the first five years.

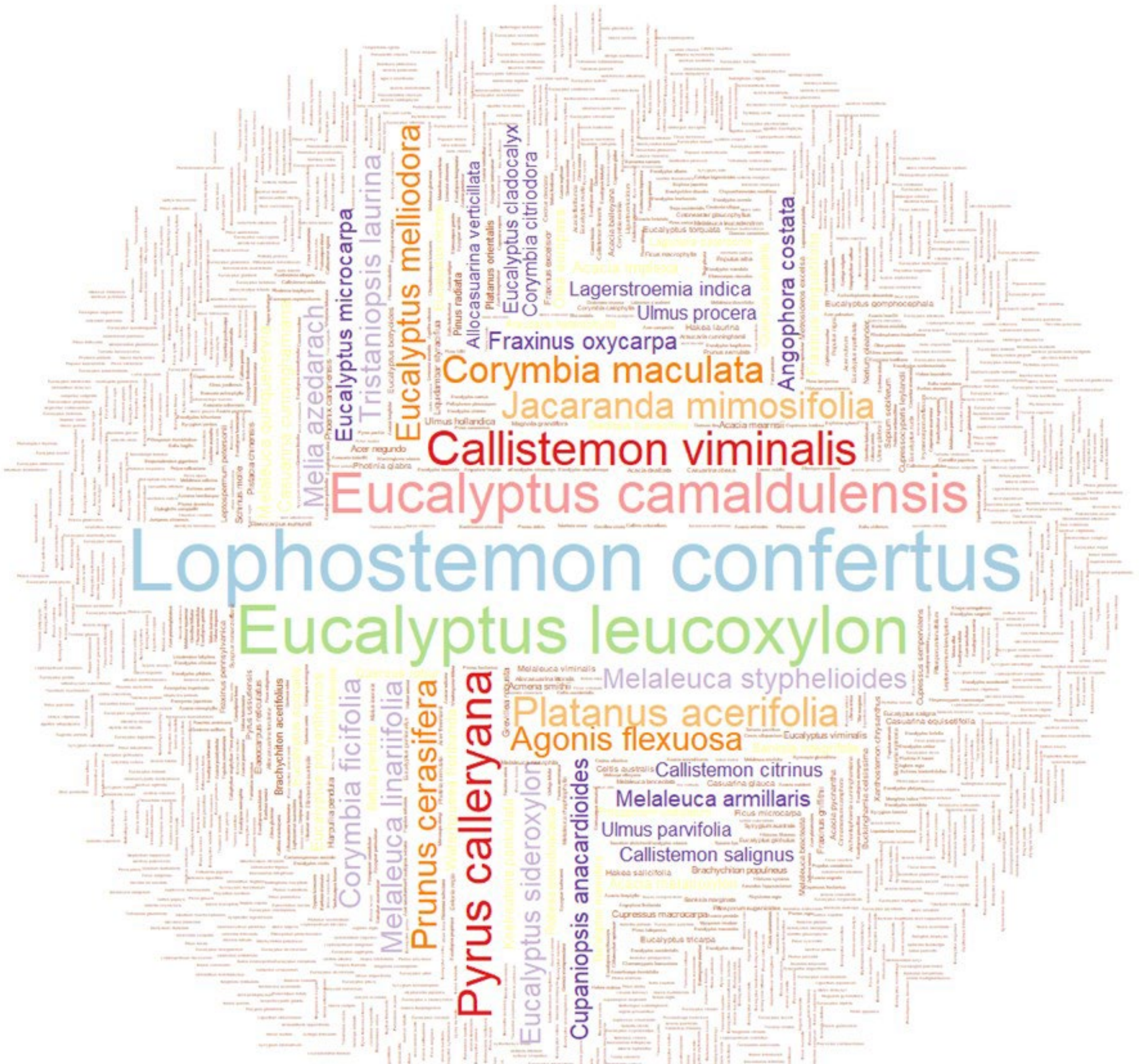
Tabassum et al. (2021) *Urban Forestry & Urban Greening*

Will our urban forest diversity provide resilience?

Tree inventory lists from 60 Local Government Areas across Australia:

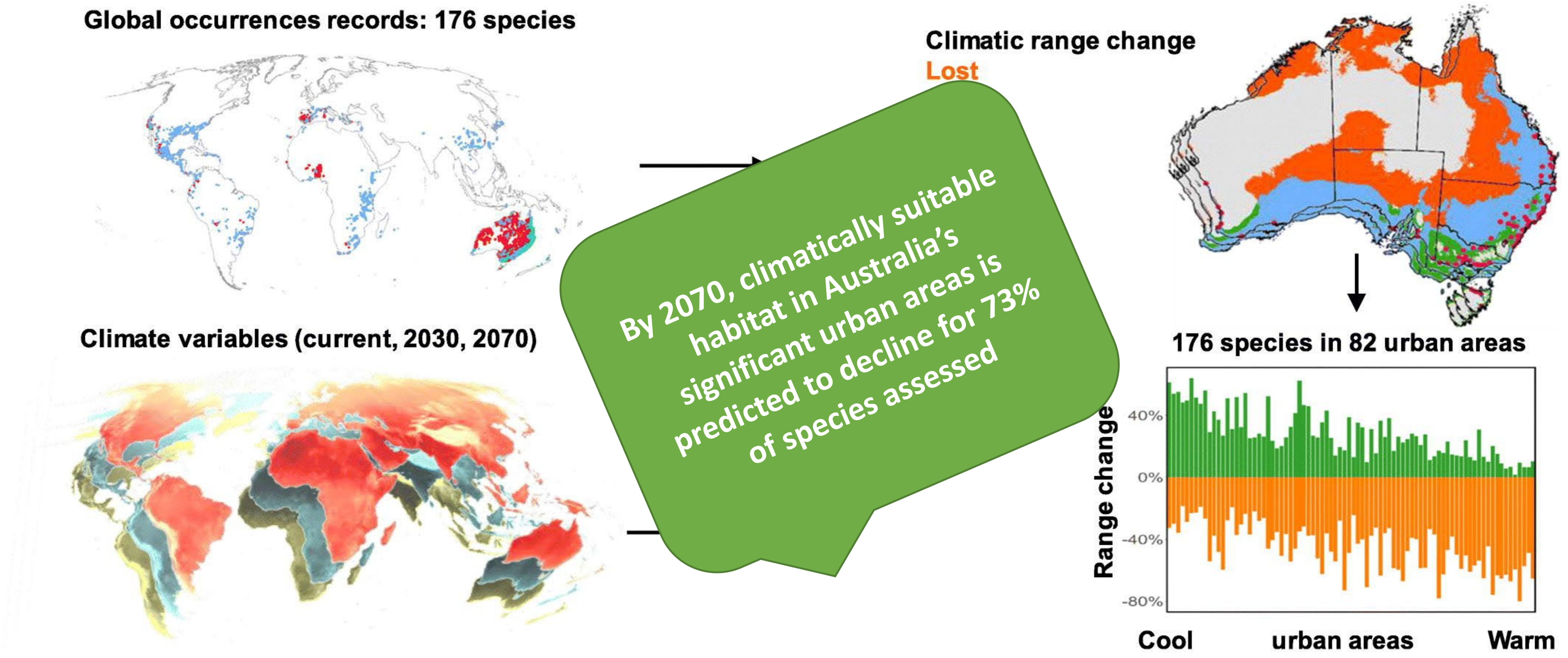
- 1.2 million trees
- 1,200+ species

The 30 most common species make up 53% of the urban forest



Ossola, 2019 - unpublished

Are our urban forest species future climate-proof?



Burley et al. (2019) Substantial declines in urban tree habitat predicted under climate change. *Science of The Total Environment* 685: 451-462, Ossola et al. (2019) Our cities need more trees, but some commonly planted ones won't survive climate change. *The Conversation* July 26th, 2019.

Building resilience of the Urban Forest

We need better species selection

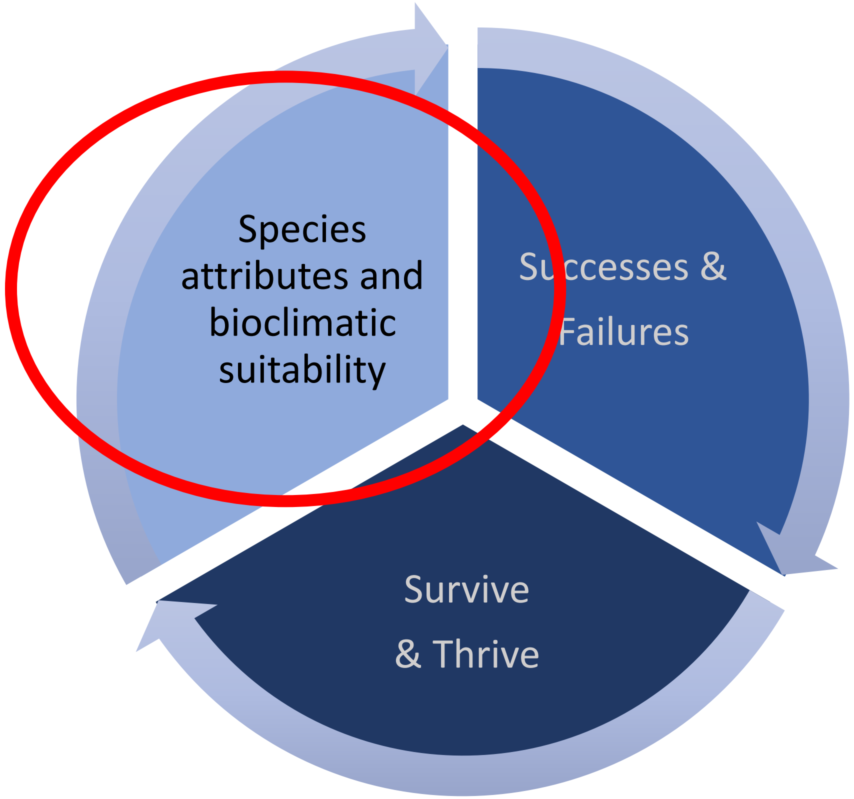
- Increase diversity
- Tolerance to low water availability
- Tolerance to extreme heat
- Tolerance to pests & pathogens

We need tools and resources

- Support species selection
- Facilitate successful planning
- Support effective management

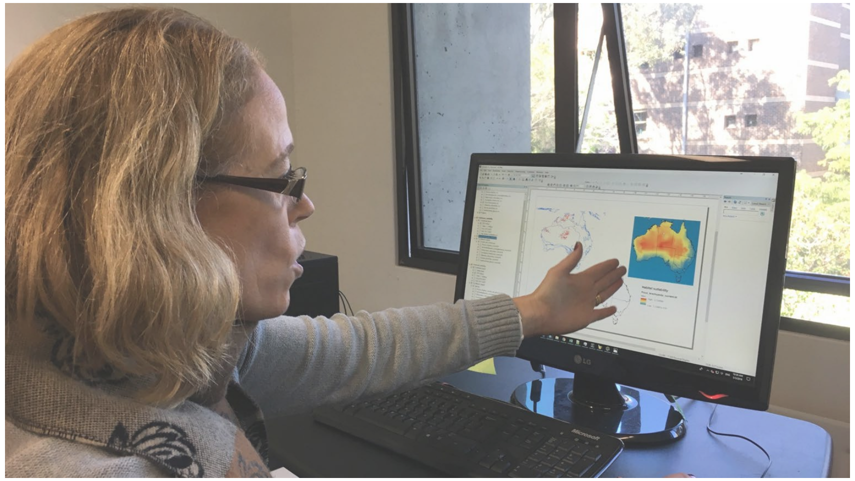
Which Plant Where

We built a climate-ready species selection tool



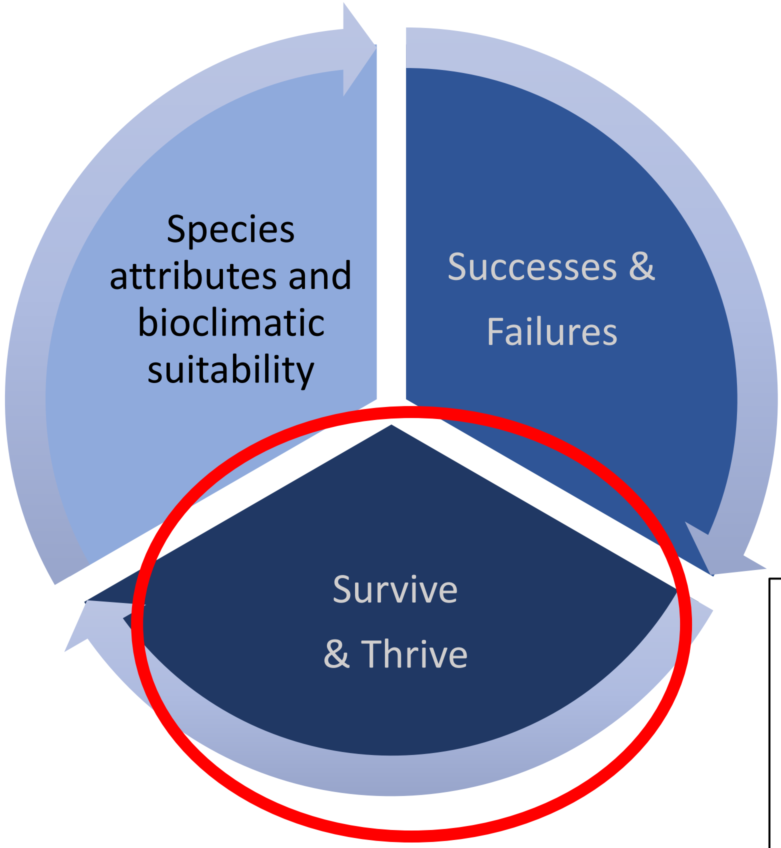
Bioclimatic models to estimate areas of climatic suitability for each species under a changing climate in 2030, 2050 and 2070.

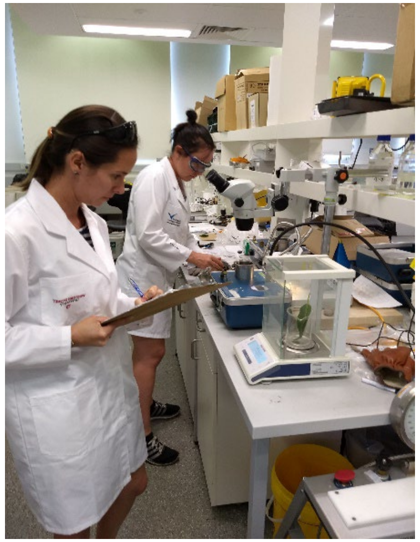
Trait database that includes information for >2500 species & cultivars on species' attributes (biology, tolerances, site context, hazards)

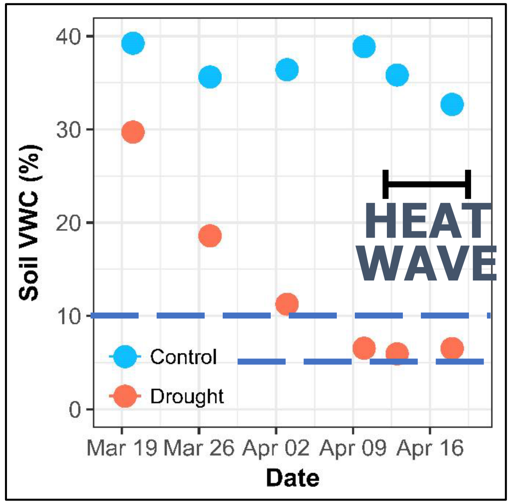


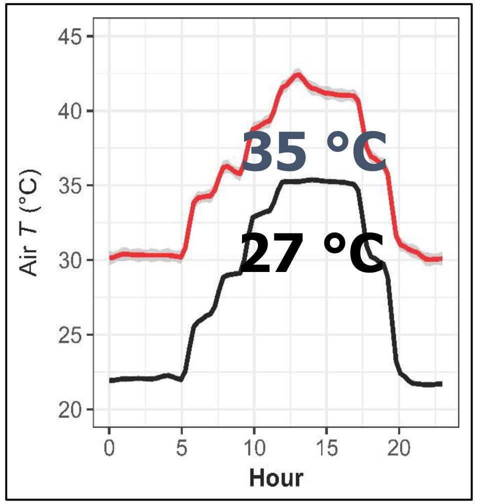
We built a climate-ready species selection tool

Which Plant Where



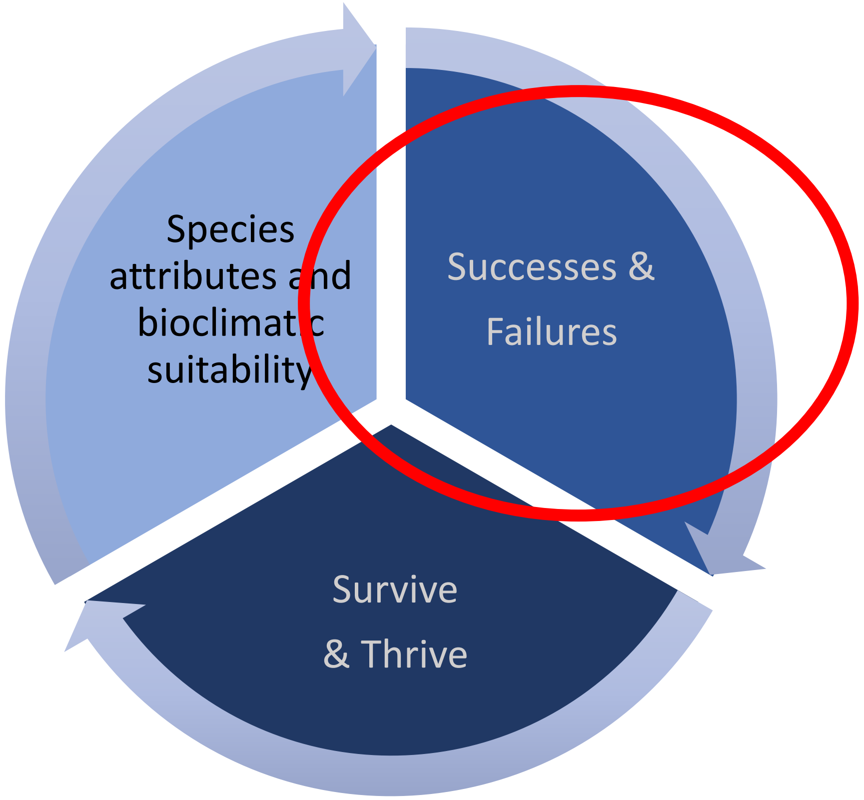


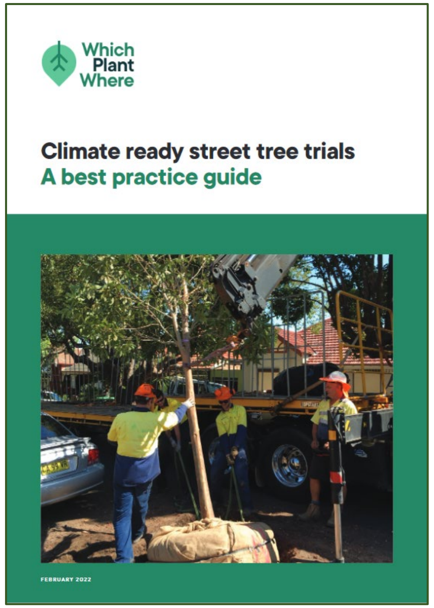


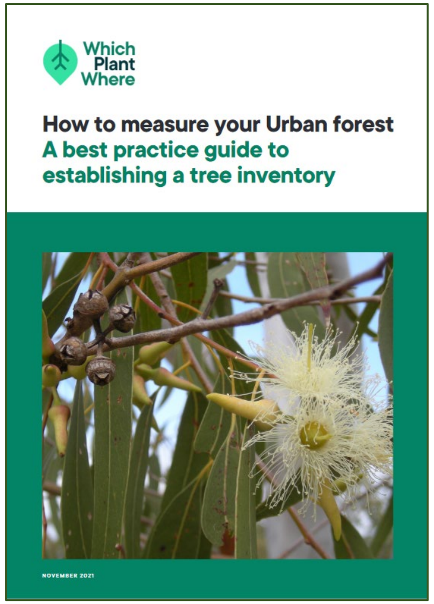


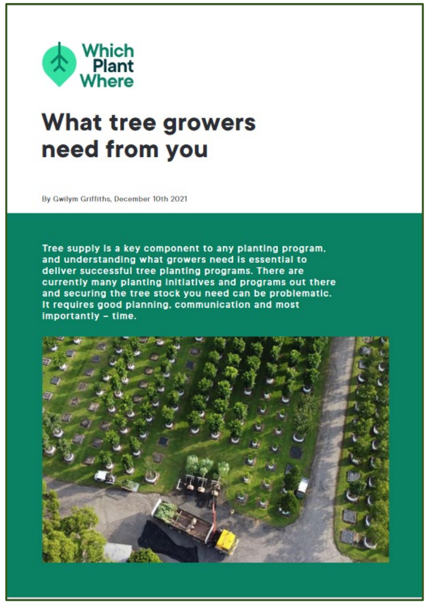
Lilly pilly (*Syzygium wilsonii*)
Heat sensitive

We built a climate-ready species selection tool

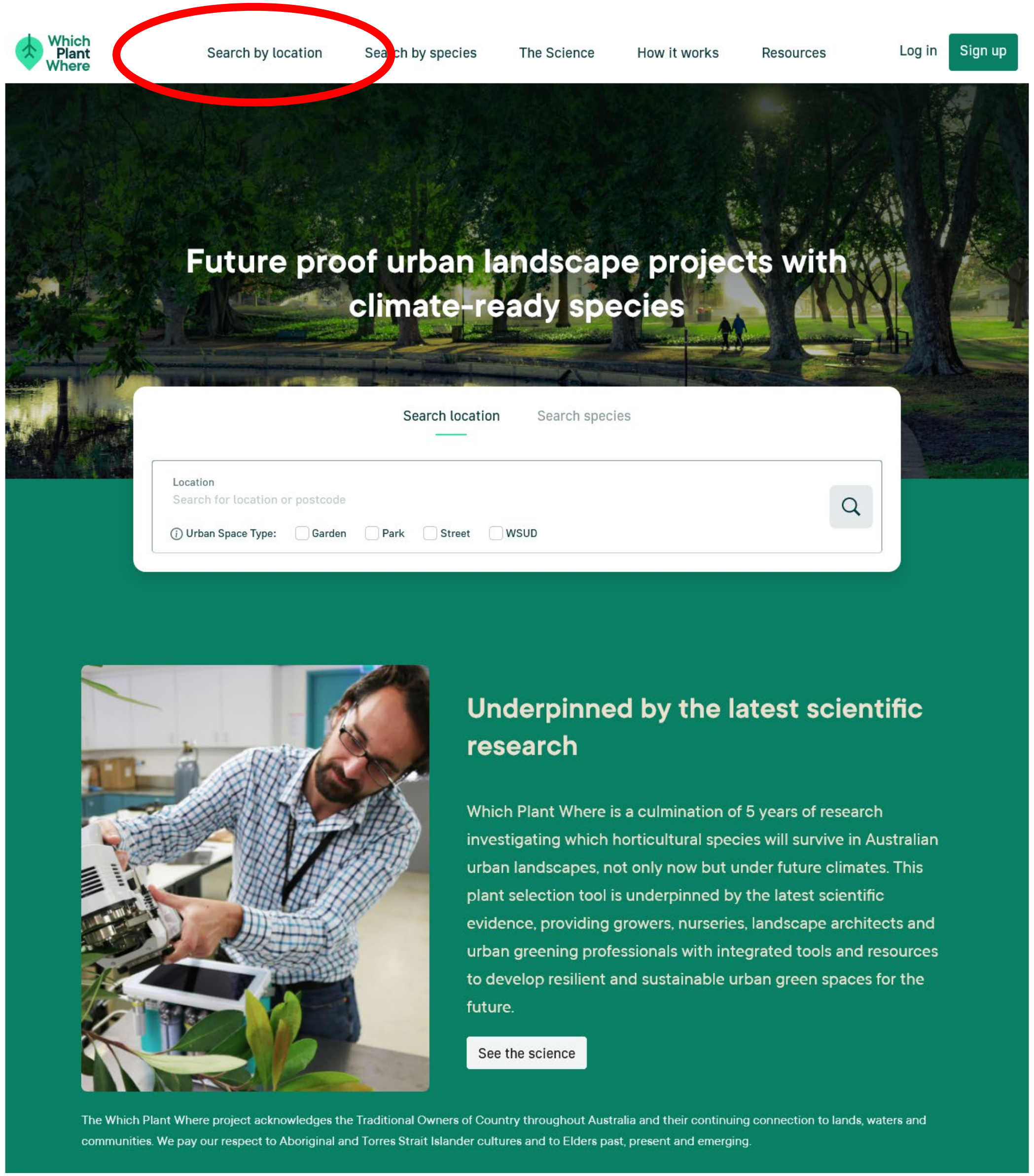


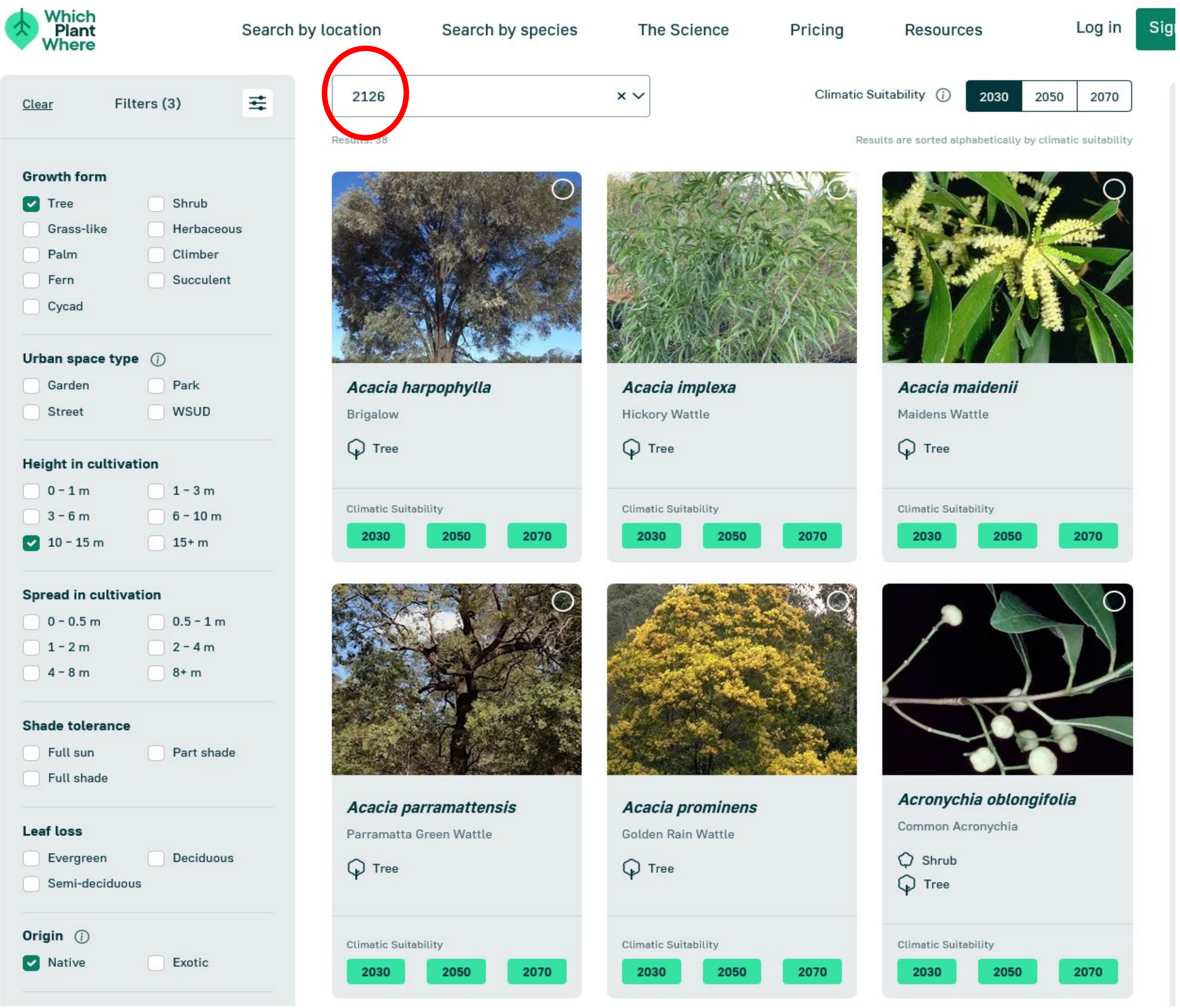






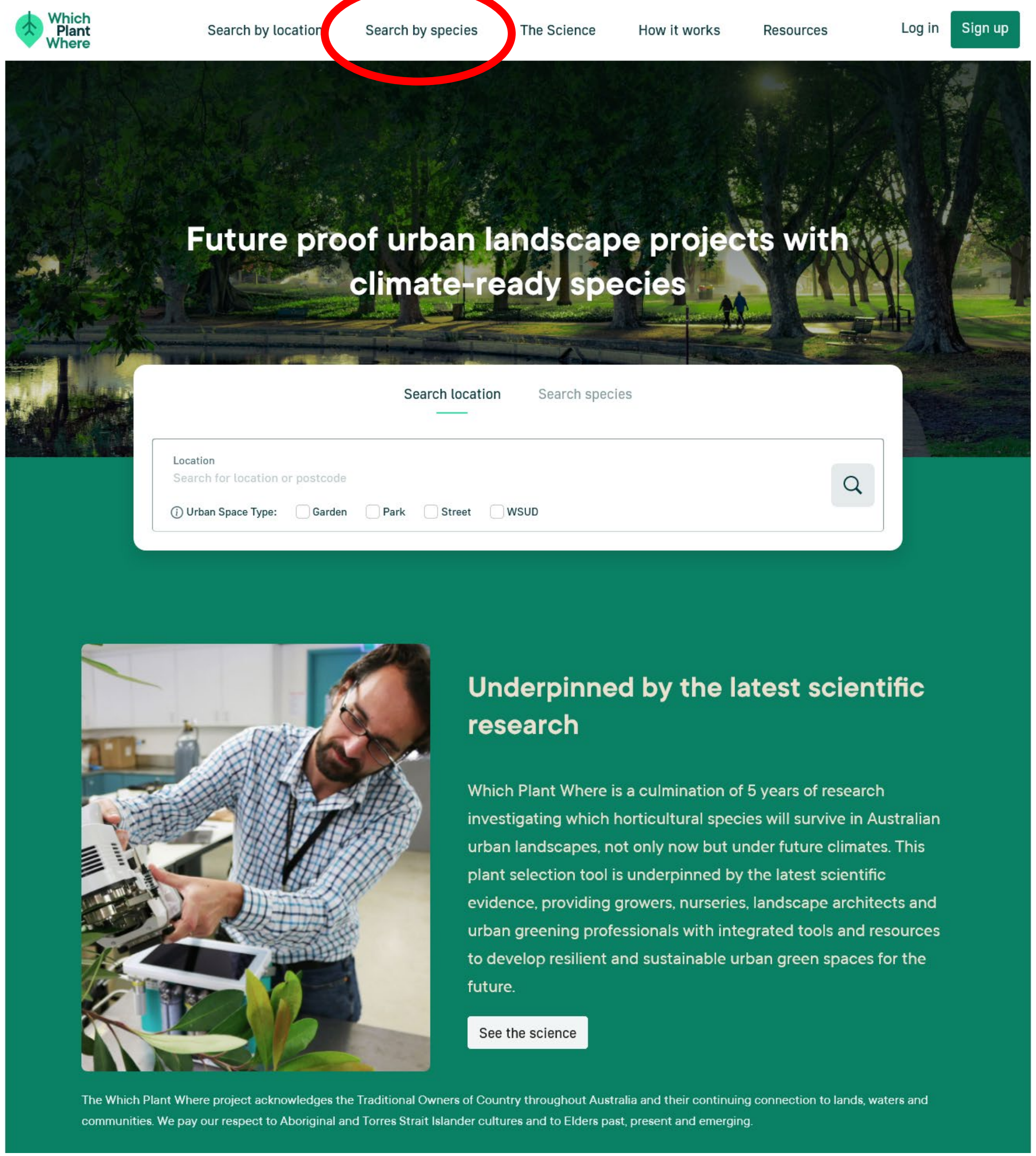
We built a climate-ready species selection tool

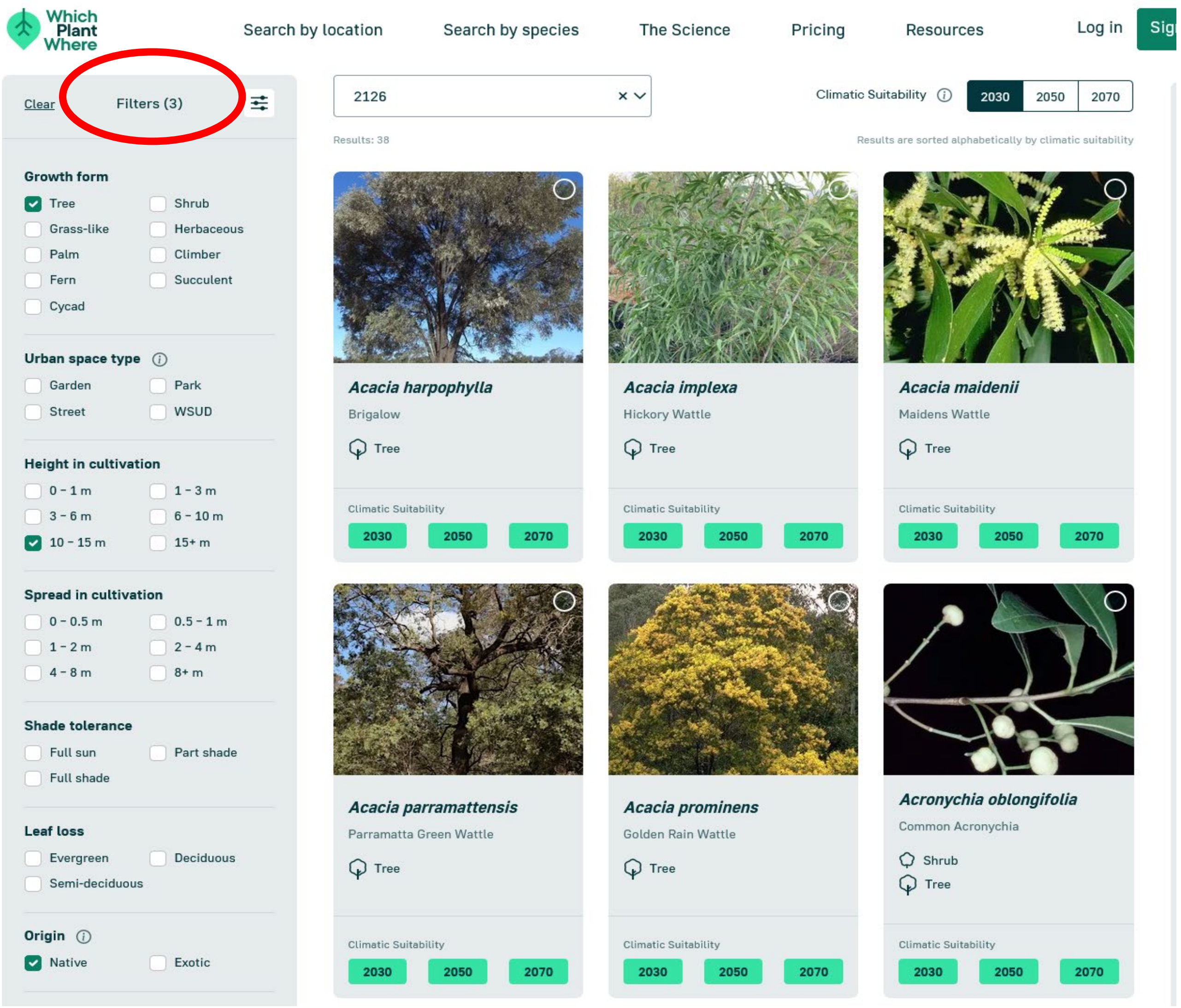




https://whichplantwhere.com.au

We built a climate-ready species selection tool





https://whichplantwhere.com.au

We built a climate-ready species selection tool

Lophostemon confertus

Brisbane Box

Tree

Climatic Suitability

2030 2050 2070

Angophora floribunda

Rough Barked Apple

Tree

Climatic Suitability

2030 2050 2070

Agonis flexuosa

Burgundy Western Australian Weeping Peppermint

Shrub

Tree

Climatic Suitability

2030 2050 2070

We built a climate-ready species selection tool

Which Plant Where

Search by location | Search by species | The Science | Pricing | Resources

Back · Share · Add to palette

Lophostemon confertus

Experiment species

Species

Tree

Family	Myrtaceae
Synonyms	Lophostemon arborescens, Tristania griffithii, Tristania macrophylla, Tristania subverticillata
Common names	Brisbane Box, Brush Box, Queensland Box, Queensland Brush Box, Scrub Box

Credit: Leigh Stass

1 / 5

Climatic Suitability · Show map

Location

Cherrybrook (NSW 2126)

2030	2050	2070
Suitable	Suitable	Suitable

Form

- Height in cultivation: 10 – 25 m
- Spread in cultivation: 5 – 20 m
- Origin: Native
- Flower colour: Cream, inconspicuous flowers, white
- Flower period: Spring, Summer
- Leaf colour: Green
- Leaf loss: Evergreen
- Canopy area: 314 m^2
- Canopy shape: Pyramidal, Rounded, Spreading

Site

- Urban space type: Garden, Park, Street, Water Sensitive Urban Design
- Use: Erosion Control, Feature, Putatively Fire Retardant, Screen, Shade, Timber, Windbreak
- Soil texture: Clay, Loam, Sand
- Soil pH: Acidic, Alkaline, Neutral
- Planting & Maintenance: Fertile Soil, Poorly Drained Soil, Well Drained Soil

Performance

- Shade tolerance: Full sun, Part shade
- Tolerance: High drought, Moderate frost, High coastal
- Drought strategy: Avoider
- Heat: Tolerant
- Growth rate: Fast, medium
- Biodiversity: Bird, Insect, Pollinator

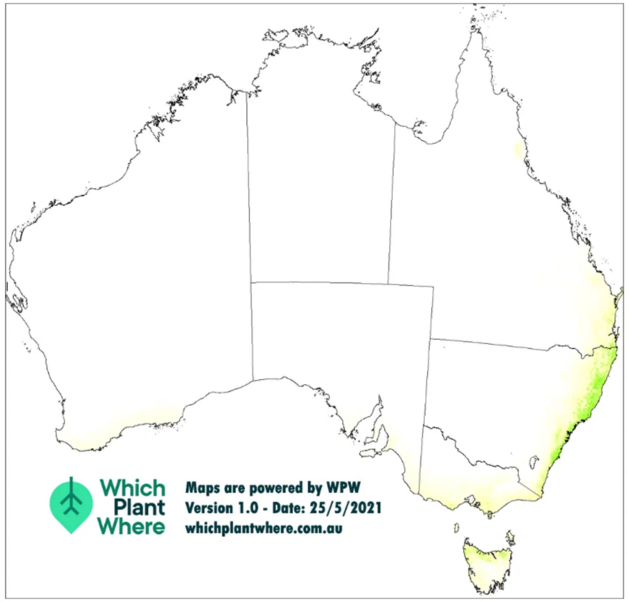
Climate Suitability | Local occurrence | Global occurrence

Climate suitability

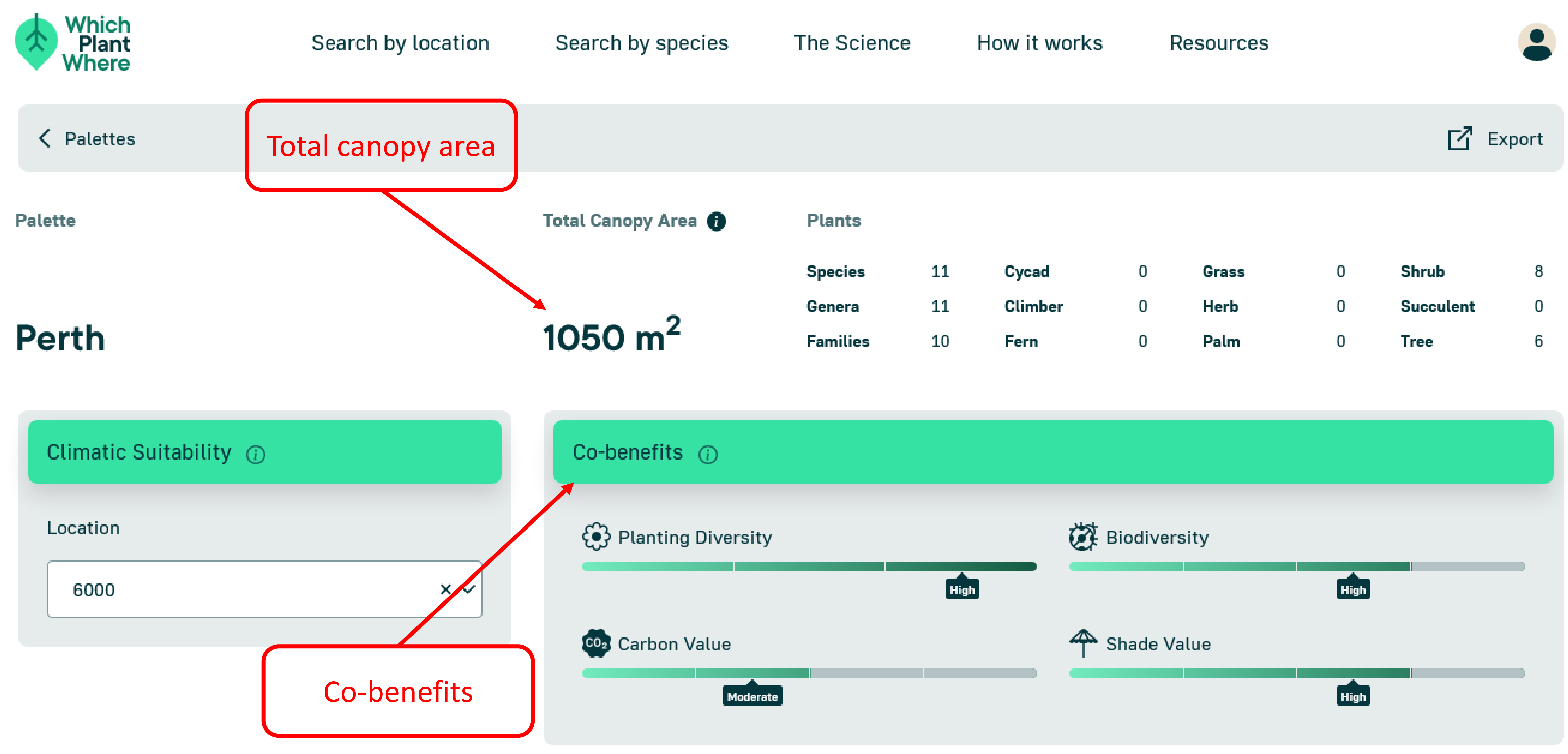
Unsuitable — Suitable

2030 · 2050 · 2070

Use the slider to see how climate suitability for this species is changing over time across Australia (2030, 2050 and 2070)



With a species palette co-benefits tool



And all the background science & resources

Which Plant Where

Learn About the Science Powering Which Plant Where

The Which Plant Where selection tool contains lots of useful information including where species will be climatically suitable in the future as well as benefits that species can provide in urban areas (e.g., attracting biodiversity, proving shade, carbon storage, etc). Below are links to technical guides that contain in-depth information on how these parameters were calculated.

How we calculated planting co-benefits in Which Plant Where (PDF, 157 KB)

How we calculated canopy cover in Which Plant Where (PDF, 92 KB)

How we calculated climate suitability in Which Plant Where (PDF, 162 KB)

How we measured drought and heat tolerance in Which Plant Where (PDF, 294 KB)

How we calculated planting diversity in Which Plant Where (PDF, 1 MB)

How we identified weed species in Which Plant Where (PDF, 3.95 MB)

Resources

Category: All posts Climate Change Community Engagement Monitoring and Maintenance Planning Resilient Urban Landscapes Uncategorized

wpw | Community Engagement

Protect what we love: look out for tree pests

wpw | Planning

What tree growers need from you

wpw | Planning

How to successfully establish your new trees

wpw | Monitoring and Maintenance

Best practice guideline for measuring your urban forests

wpw | Monitoring and Maintenance

Lessons from our Living Labs

wpw | Monitoring and Maintenance

Climate-ready street tree trials

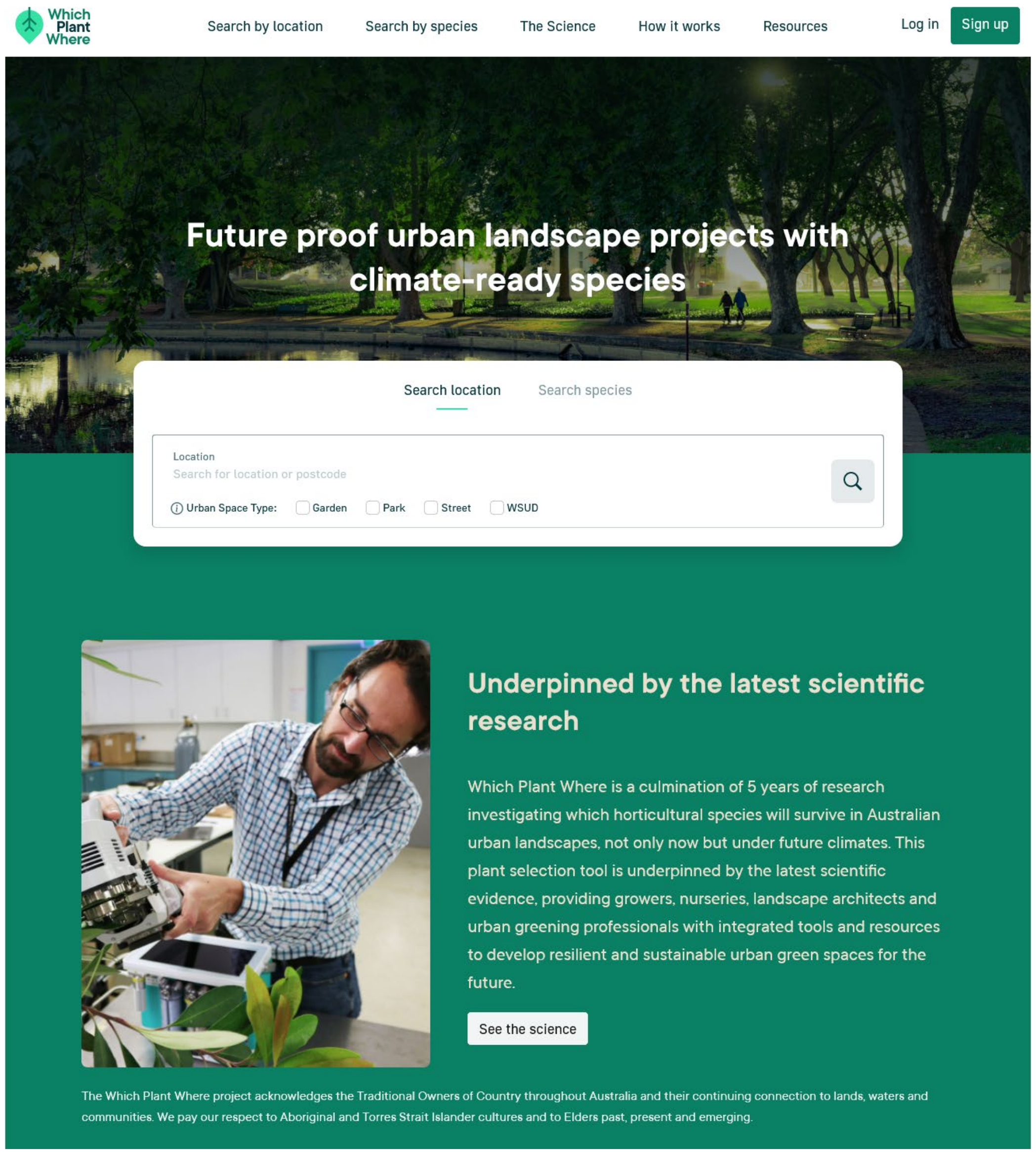
wpw | Planning

Water Sensitive Urban Design

wpw | Monitoring and Maintenance

Which Plant Where Living Lab Sites

What were the main challenges?



- Varieties, hybrids, cultivars can’t be modelled
- Natural distributions vs managed urban environments
- Obtaining good quality plant images
- Identifying weed species – location specific
- Long-term sustainability of the online tool – commercialisation vs accessibility

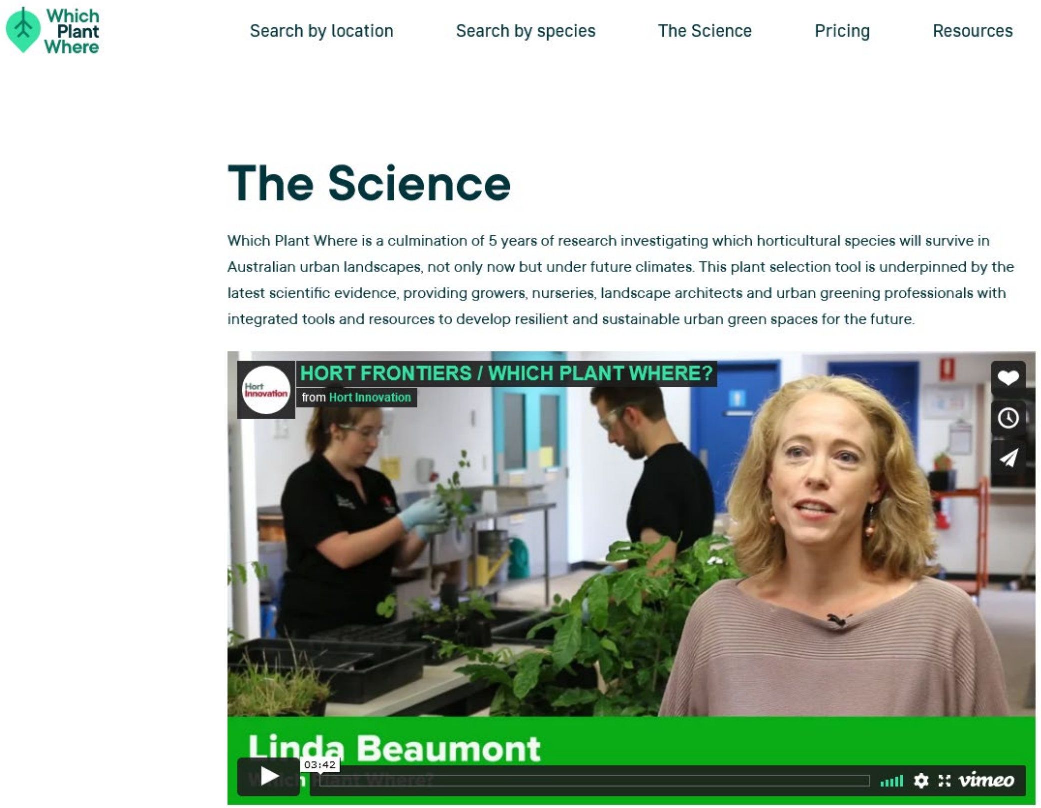
What is next?

Which Plant Where

- Trial of free access with new adoption plan development & implementation
- Expand species list
- Urban site requirements – soil volume, microclimate preference, maintenance requirements
- Improve co-benefits calculator (plant water use, carbon storage, cooling, biodiversity)
- Locally indigenous function
- Integration with other urban greening tools and resources (eg tree planting costs calculator, Gardening Responsibly)

Find out more

http://whichplantwhere.com.au



Tabassum et al. 2023. Which Plant Where: A Plant Selection Tool for Changing Urban Climates. *Arboriculture & Urban Forestry* 49, 190-210.

MACQUARIE University   WESTERN SYDNEY UNIVERSITY   NSW GOVERNMENT | Planning, Industry & Environment   hort frontiers Strategic partnership initiative | GREEN CITIES FUND

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Washington DC, 2023

Now, More than Ever

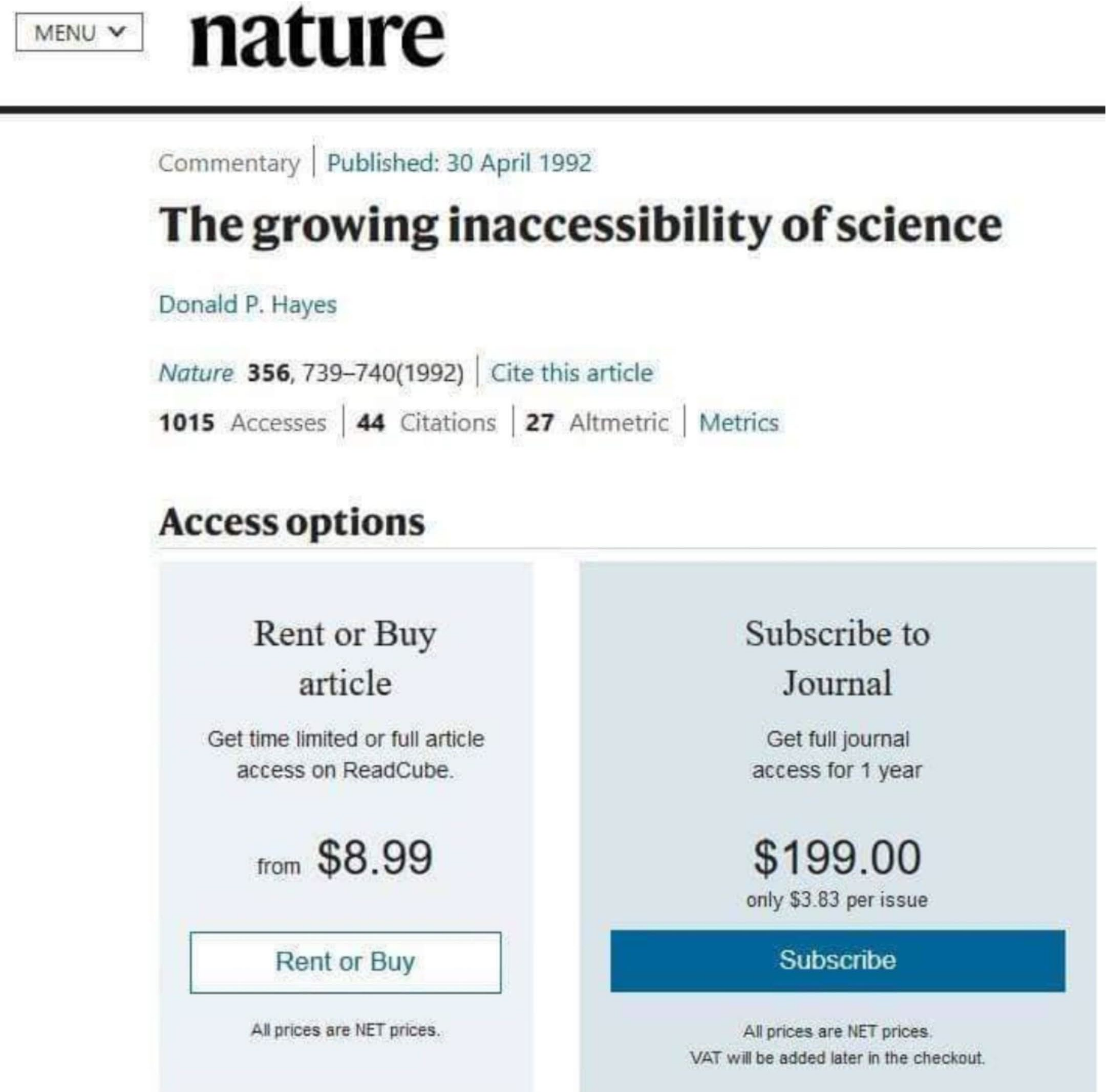
How Open Access Research is Helping Urban Forestry Professionals Face a Rapidly Changing World

Presented by

Lindsey E. Mitchell

Managing Editor, *Arboriculture & Urban Forestry*

International Society of Arboriculture



MENU
nature

Commentary | Published: 30 April 1992

The growing inaccessibility of science

Donald P. Hayes

Nature **356**, 739–740(1992) | Cite this article

1015 Accesses | **44** Citations | **27** Altmetric | Metrics

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- Research accessibility is a frustration for both researchers and the public
- Affects public perception of the reliability of science
- Affects the initial impact of research upon publication
- Affects the reputation of publishers and their values

https://doi.org/10.1038/356739a0

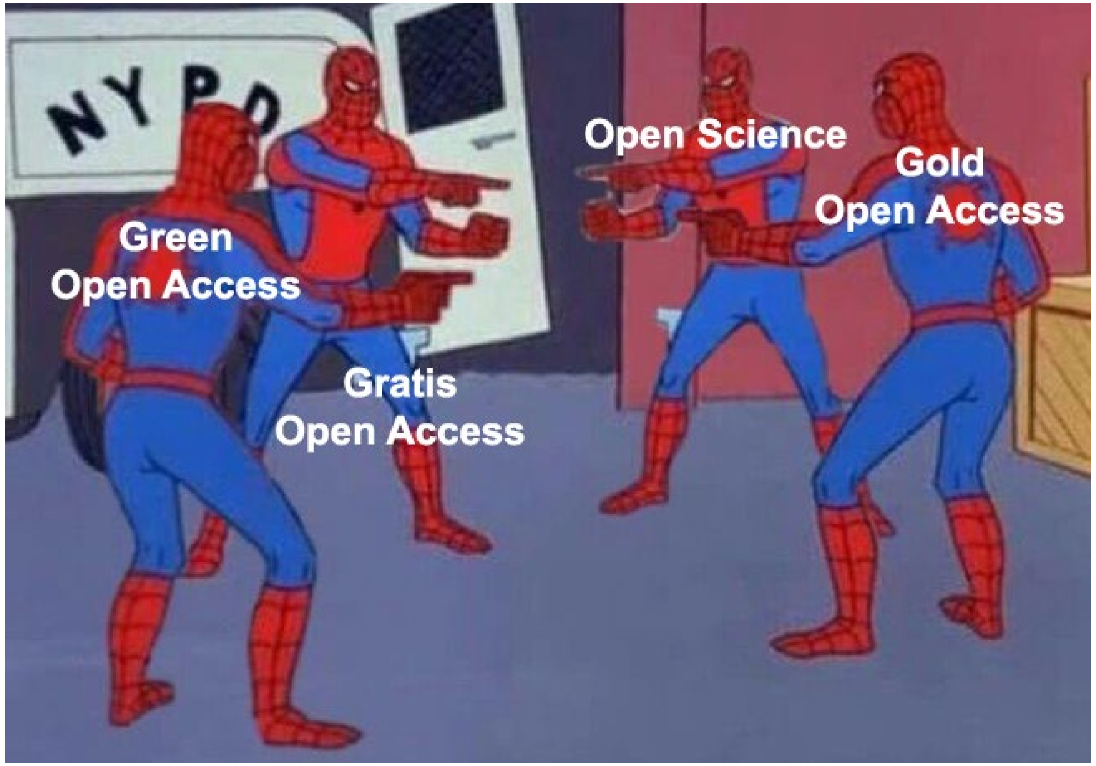
What is Open Access?

- **Accessibility**

  The content is freely available immediately upon publication as opposed to being released behind a paywall (subscription)

- **Reproducibility**

  Commonly, a copyright license is applied that allows for free use of the content without permissions from the authors or publisher



Seems Like a Good Idea! What's the Catch?

- **Article Publishing Charges (APCs)**

Instead of passing on the costs of publication to the subscriber, the cost is passed on to the author or their institution via APCs

ELSEVIER
$2,703 avg
$10,100 max

WILEY
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OXFORD UNIVERSITY PRESS
$3,375 avg
$7,256 max

Wolters Kluwer
$3,297 avg
$4,429 max

Springer
$3,278 avg
$11,690 max

Tension!

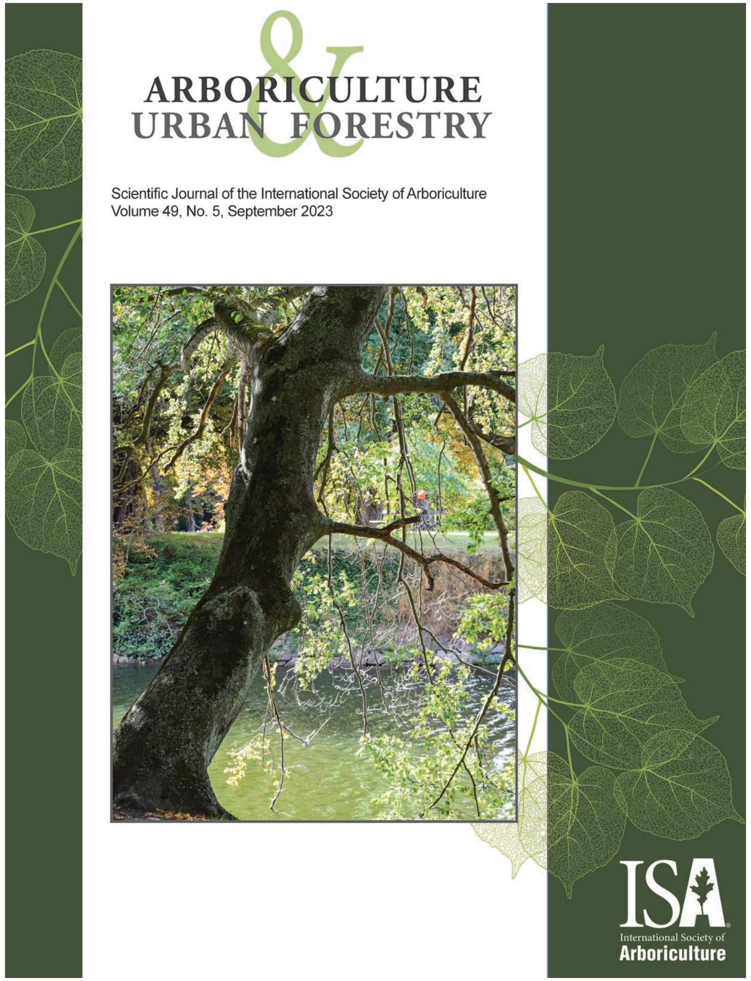
Publisher Costs

- Staff Salaries/Editorial Board Fees
- Peer Review Systems
- Copyediting, Layout, Proofreading
- Printing and Distribution
- Online Platforms
- Industry Partnerships

Researcher Challenges

- Academic Pressures
- Limited Funding
- Funder Requirements
- Submission Barriers
- Publishing Timelines
- Research Accessibility

ISA's Mission and *Arboriculture & Urban Forestry*



- Through research, technology, and education, the International Society of Arboriculture promotes the professional practice of arboriculture and fosters a greater worldwide awareness of the benefits of trees
- In support of this mission, *Arboriculture & Urban Forestry* transitioned to an Open Access model in September 2022 with no included APCs
- This transition was also made in anticipation of the launch of AUF's new online publishing platform, which became available spring of 2023

What the Data Shows Us

AUF Transitions to Open Access in September 2022

- September 2021–August 2022

  46,600 DOI* Interactions
- September 2022–August 2023

  63,873 DOI Interactions
- 37% increase in activity

AUF Online Platform Launches May 2023

- January 2023–April 2023

  15,823 DOI Interactions
- May 2023–August 2023

  31,276 DOI Interactions
- 98% increase in activity

*DOI (Digital Object Identifier; https://www.doi.org)

Top Articles in 2021

- Urban Tree Mortality: A Literature Review

  https://doi.org/10.48044/JAUF.2019.015

- Urban Resources Initiative: A University Model for Clinical Urban Forestry Education

  https://doi.org/10.48044/JAUF.2021.004

- How Tree Risk Assessment Methods Work: Sensitivity Analyses of Sixteen Methods Reveal the Value of Quantification and the Impact of Inputs on Risk Ratings

  https://doi.org/10.48044/JAUF.2020.030

Top Articles in 2022

- Grassroots Citizen Science in Urban Spontaneous Vegetation

  https://doi.org/10.48044/JAUF.2018.010

- Tree Measurements in the Urban Environment: Insights from Traditional and Digital Field Instruments to Smartphone Applications

  https://doi.org/10.48044/JAUF.2022.009

- The Influence of Biochar Soil Amendment on Tree Growth and Soil Quality: A Review for the Arboricultural Industry

  https://doi.org/10.48044/JAUF.2022.014

Most Read Articles* since Platform Launch

- Which Plant Where: A Plant Selection Tool for Changing Urban Climates

  https://doi.org/10.48044/jauf.2023.014

- A Literature Review of Resilience in Urban Forestry

  https://doi.org/10.48044/jauf.2020.014

- Examining Species Diversity and Urban Forest Resilience in the Milwaukee, Wisconsin (USA) Metropolitan Area

  https://doi.org/10.48044/jauf.2023.017

- Sustainable Smart Park Management—A Smarter Approach to Urban Green Space Management?

  https://doi.org/10.48044/jauf.2022.006

- Urban Tree Mortality: A Literature Review

  https://doi.org/10.48044/jauf.2019.015

*Articles with a focus on urban forestry and urban climate pressures

Thank you

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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

Some Like It Hot

Strange Paths to Paradigm Shift: How Steve Jobs Helped California Adapt To Climate Change

Presented by
Dave Muffly

www.oaktopia.org

dave@oaktopia.org

WIRED BACKCHANNEL BUSINESS CULTURE GEAR IDEAS SCIENCE SECURITY SIGN IN SUBSCRIBE

Apple Park's Tree Whisperer

Steve Jobs had a vision to resurrect pre-tech Silicon Valley in his new HQ. It was up to this hippie arborist to make it happen.


Kent Pl
BIKE FRIDAY.


Hello


Caution
Wildlife Afoot
Take Care When Opening
Outside Doors


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Soy Sauce


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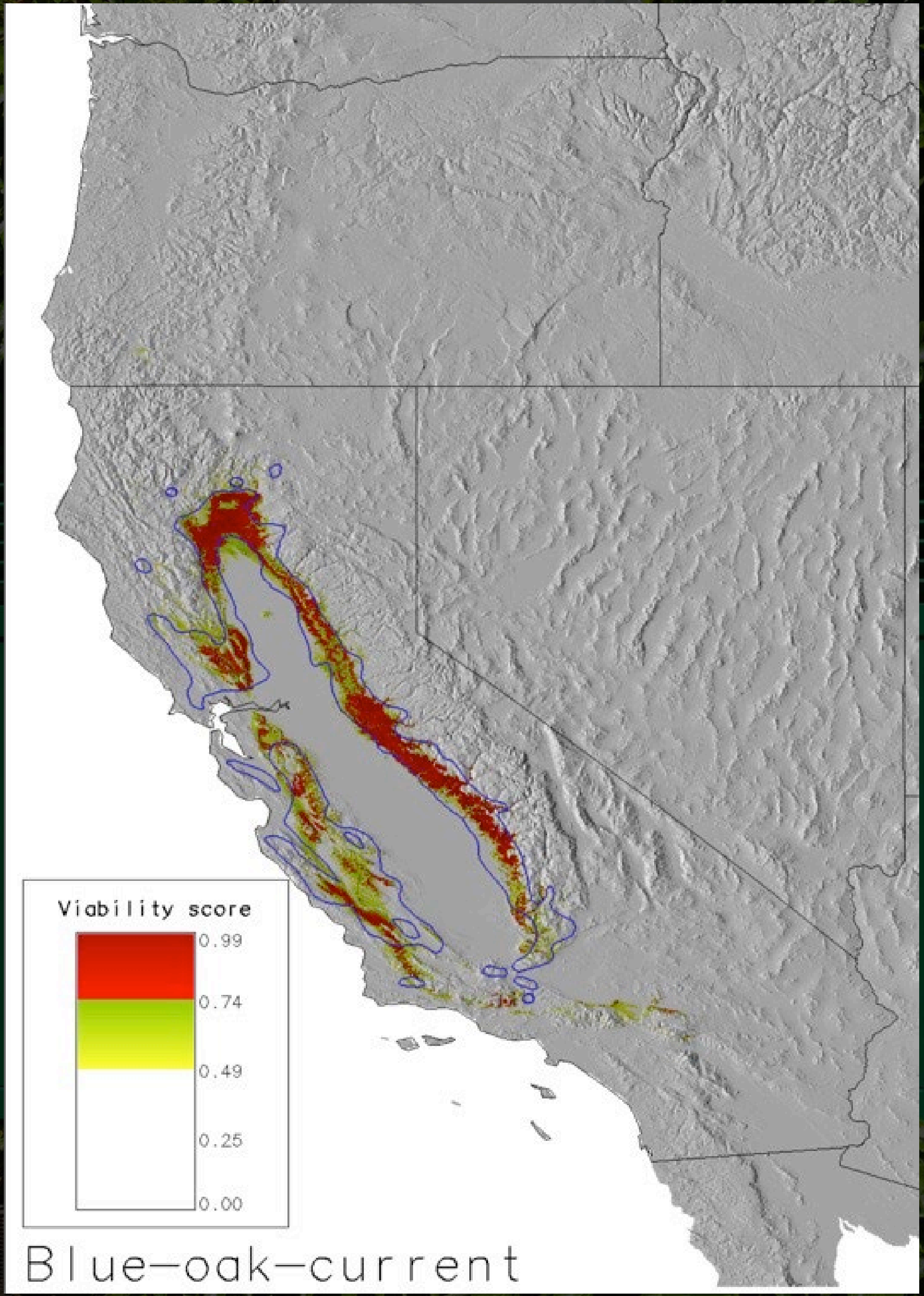
Viability score
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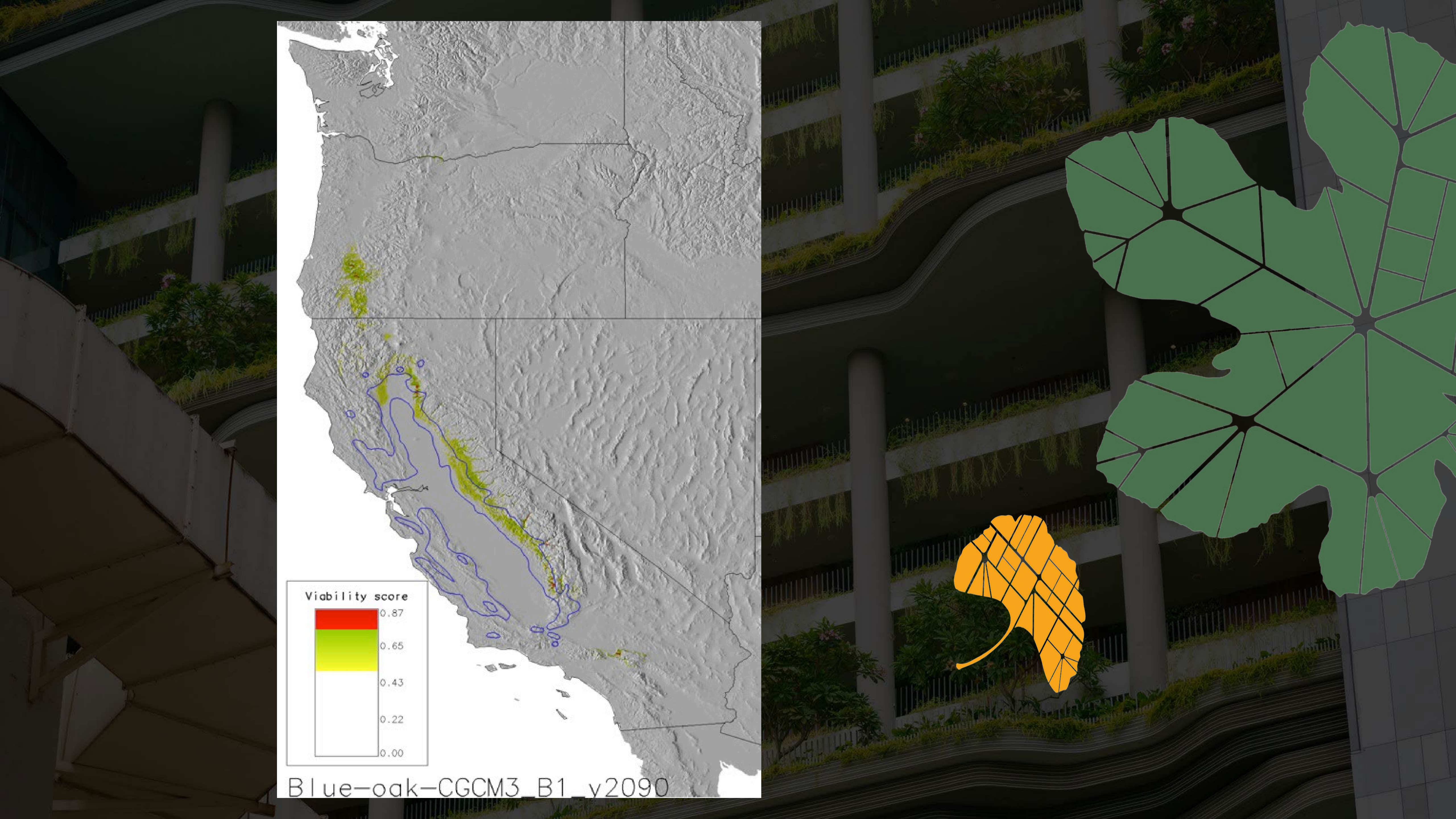
0.74
0.49
0.25
0.00
Blue-oak-current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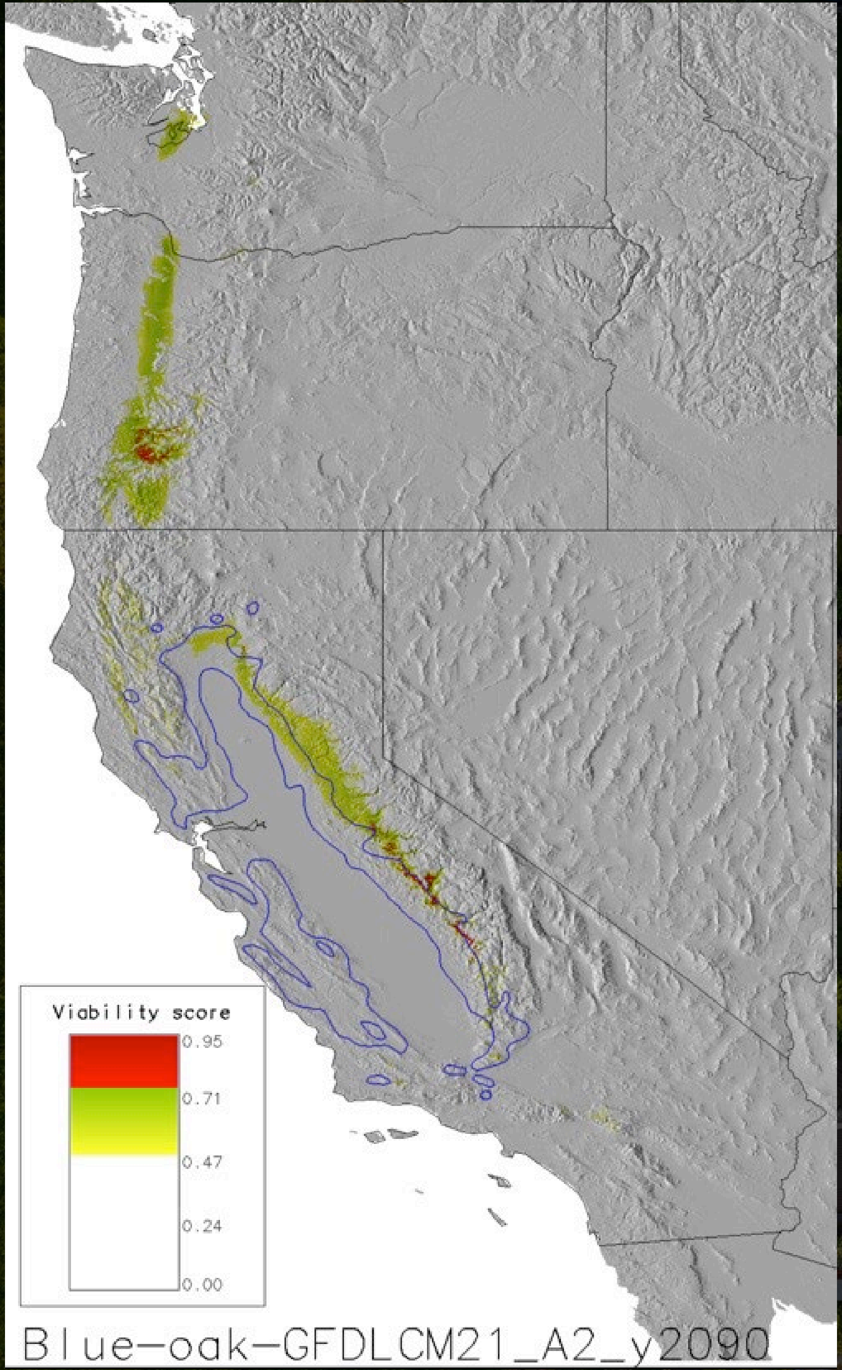
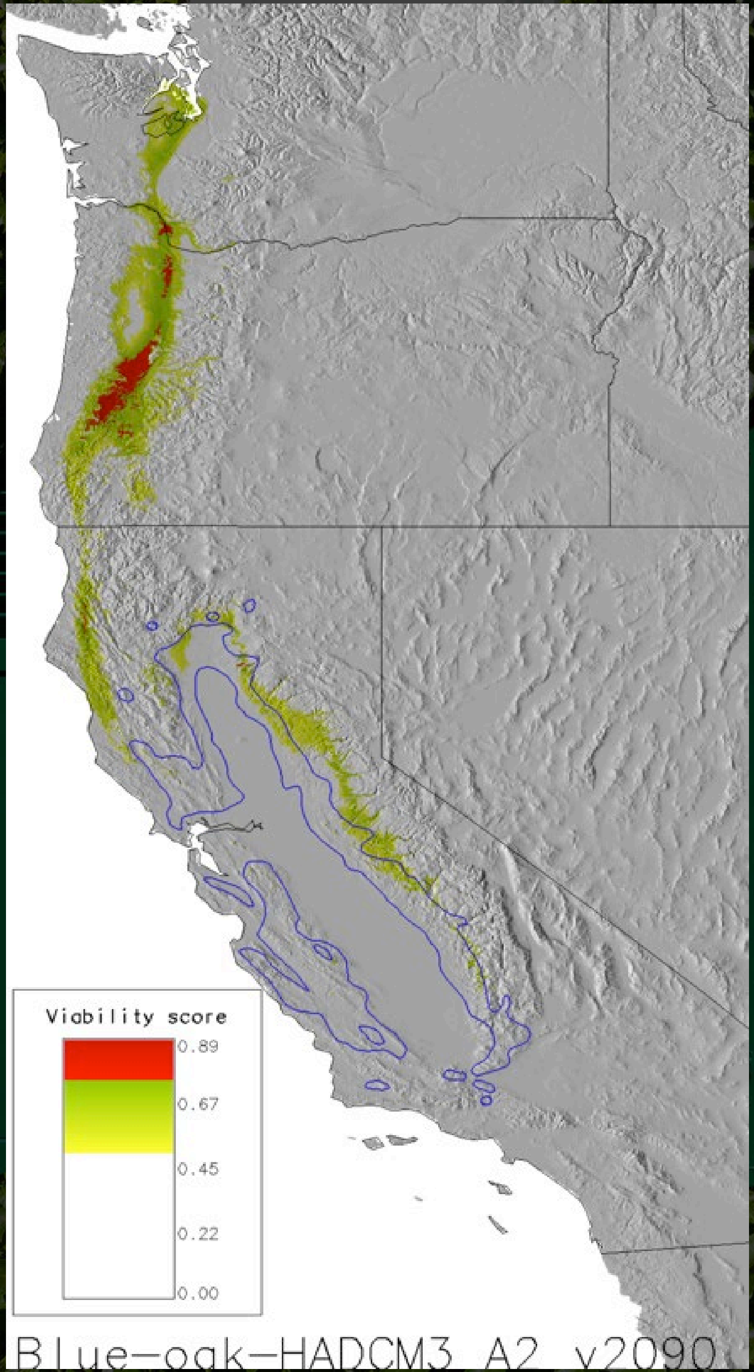
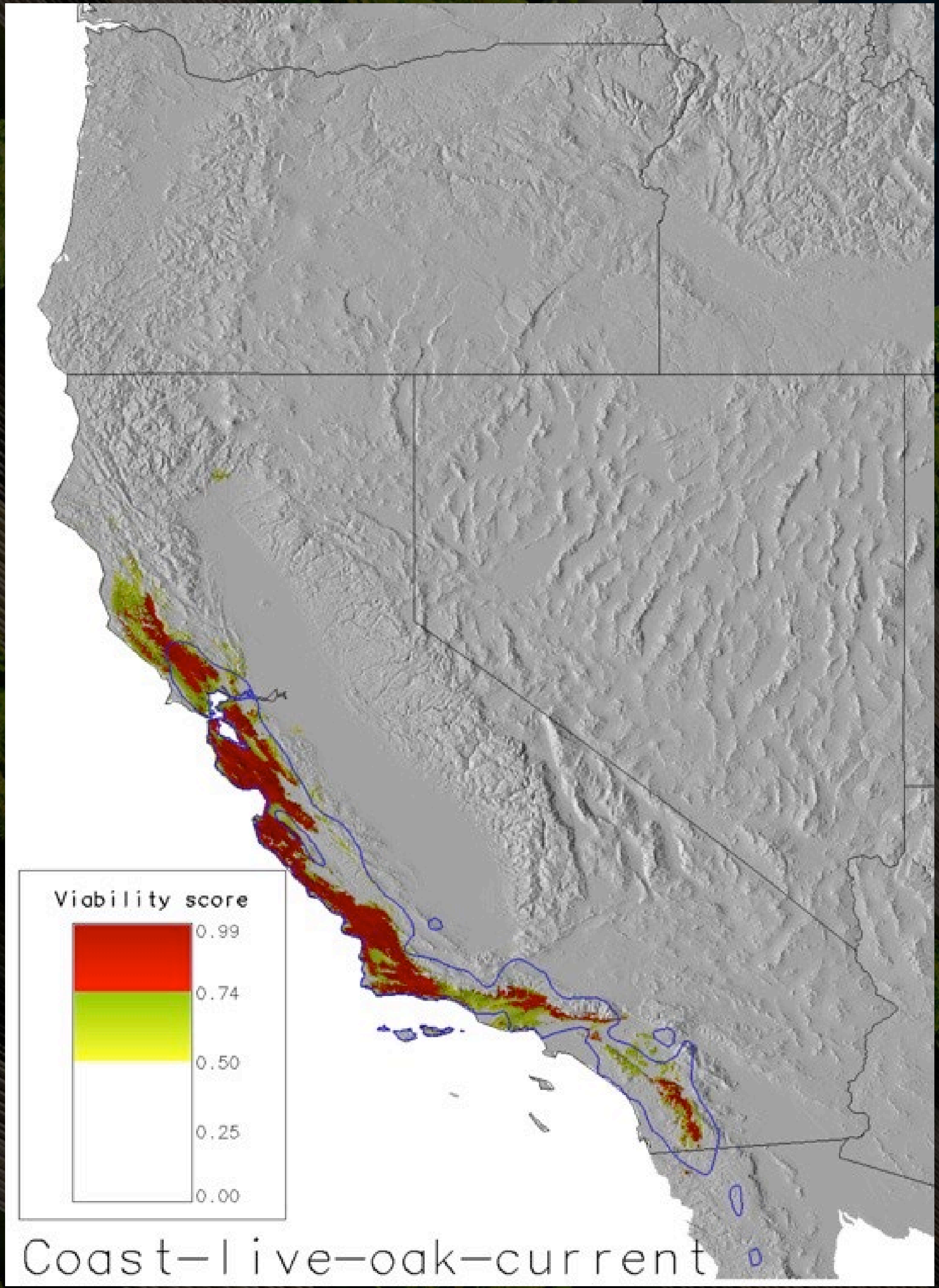
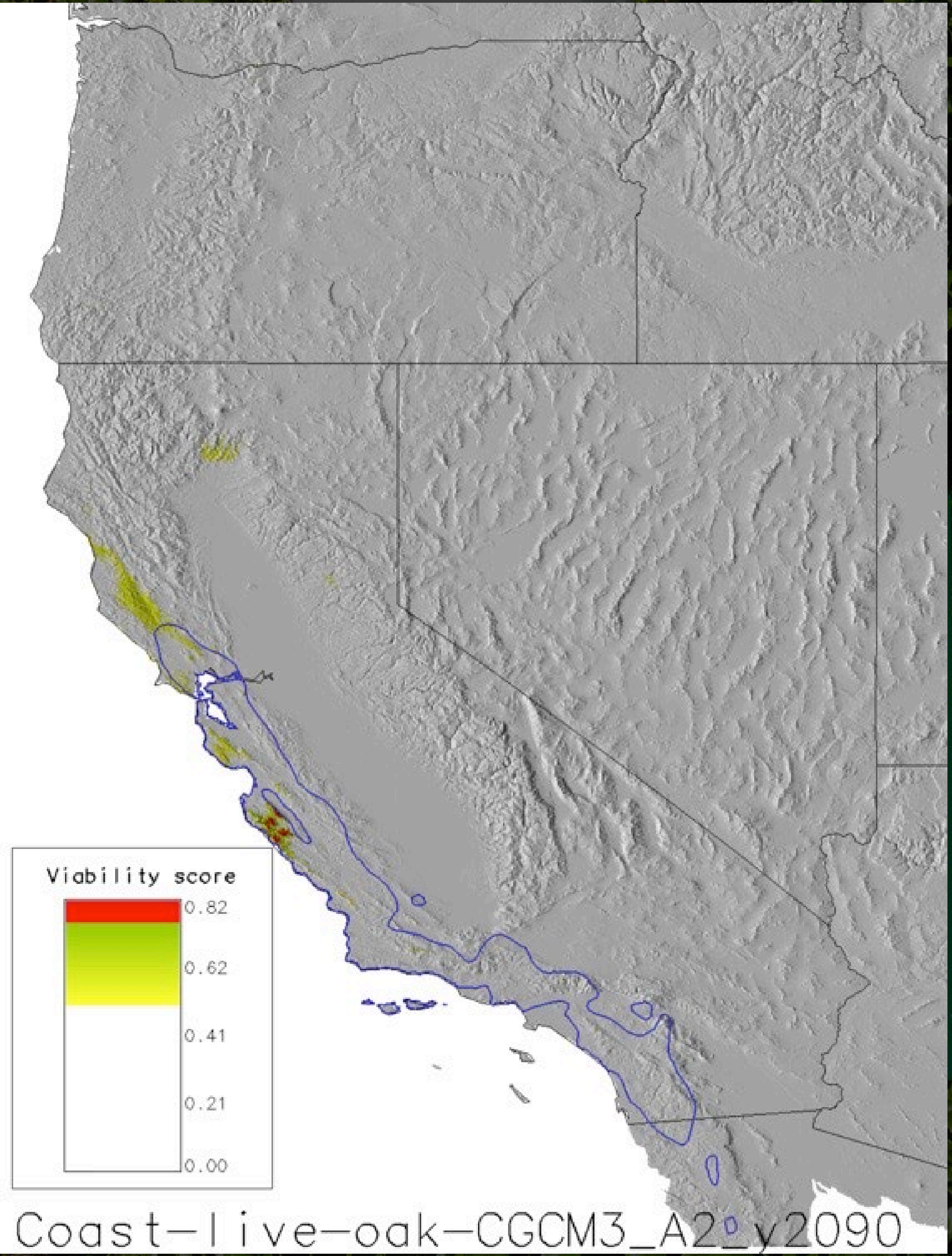
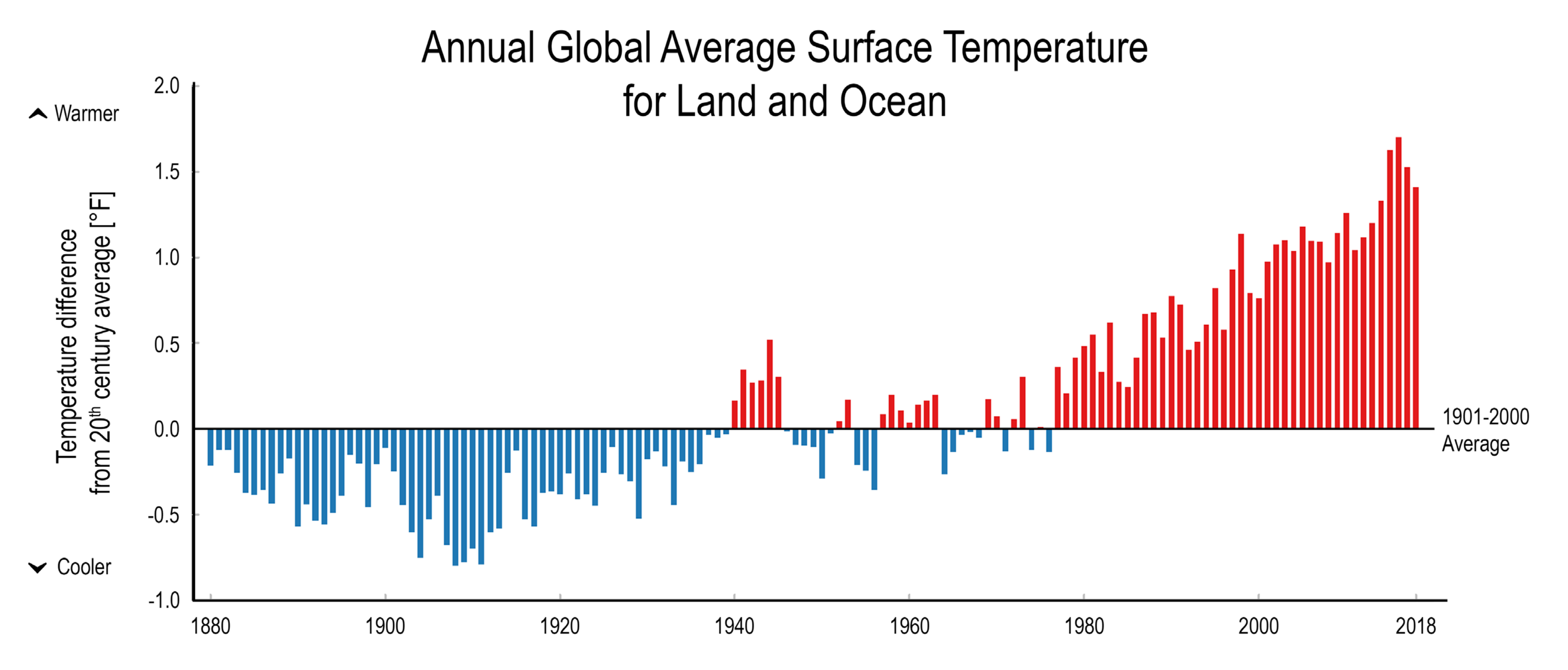
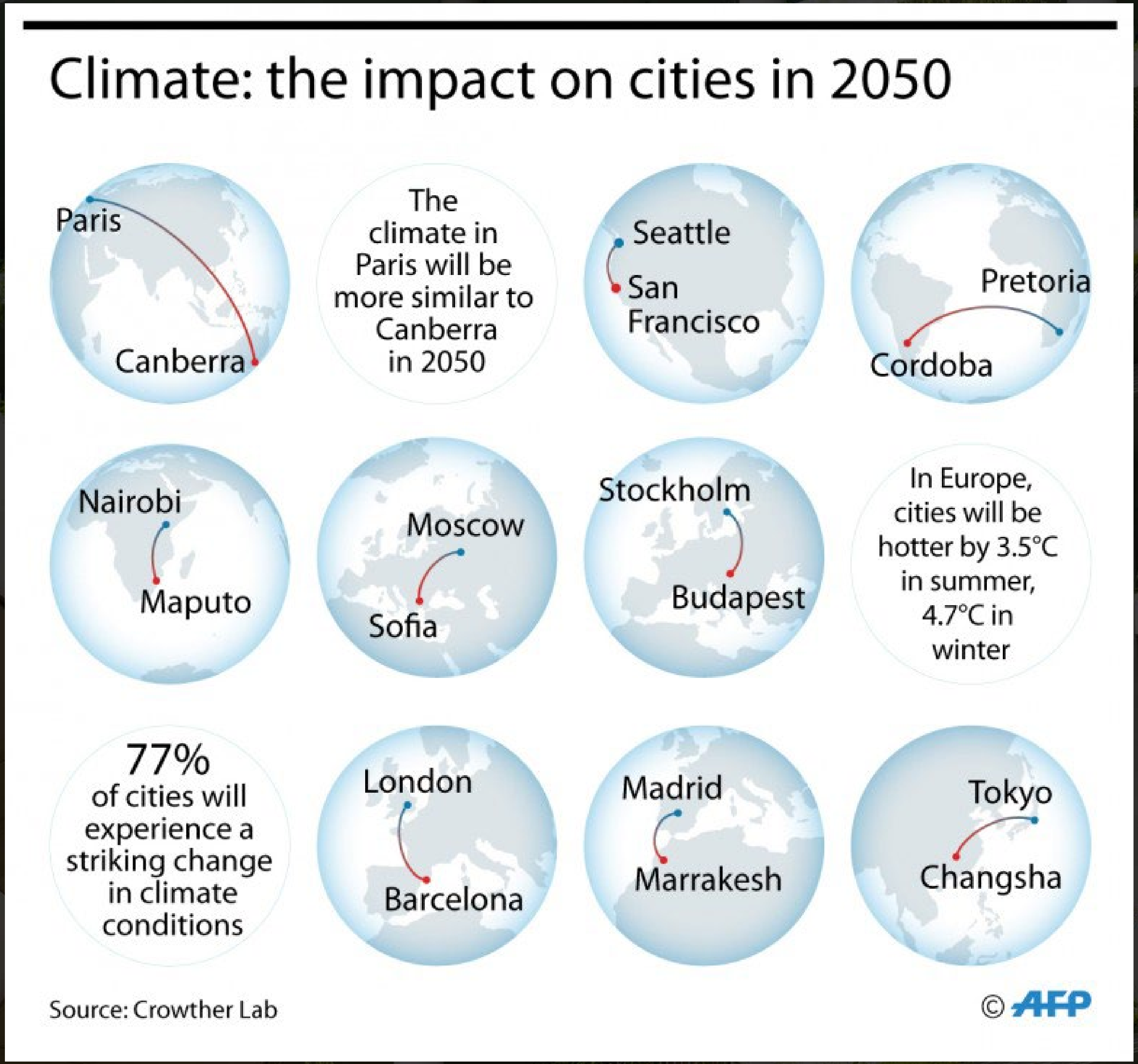

Viability score
0.95
0.71
0.47
0.24
0.00
Blue-oak-GFDLCM21_A2_y2090


Viability score
0.89
0.67
0.45
0.22
0.00
Blue-oak-HADCM3 A2 y2090


Viability score
0.99
0.74
0.50
0.25
0.00
Coast-live-oak-current


Viability score
0.82
0.62
0.41
0.21
0.00
Coast-live-oak-CGCM3_A2_y2090


Annual Global Average Surface Temperature
for Land and Ocean
Warmer
Cooler
Temperature difference
from 20th century average [°F]
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1880
1900
1920
1940
1960
1980
2000
2018
1901-2000
Average


Climate: the impact on cities in 2050
Paris
Canberra
The climate in Paris will be more similar to Canberra in 2050
Seattle
San Francisco
Pretoria
Cordoba
Nairobi
Maputo
Moscow
Sofia
Stockholm
Budapest
In Europe, cities will be hotter by 3.5°C in summer, 4.7°C in winter
77% of cities will experience a striking change in climate conditions
London
Barcelona
Madrid
Marrakesh
Tokyo
Changsha
Source: Crowther Lab
© AFP


Shifting Cities
How Hot Will Summers Be By 2100?
Summer highs in Los Angeles, United States could be more like San Jose, Costa Rica by 2100 with moderate emissions cuts.
type city here
Los Angeles, United States
80.9°F
Belize City, Belize
88.3°F
San Jose, Costa Rica
83.9°F
°C

Madrean Pine-Oak Woodlands

forest ecology

Preparing for Climate Change: Forestry and Assisted Migration

Mary I. Williams and R. Kasten Dumroese


STOP


11-27-2021
QUERCUS
ENGELMANNII
SX 2-2-2022
11-16-2021 #
ENGELMANNII
SX 2-1-22
416


N Wolfe Rd
Cupertino, California
Google
Street View - Apr 2015
Currently shown: Apr 2015
2015
2019
Apr 2015
The Hamptons
artment Homes
Google
Image capture: Apr 2015
© 2021 Google
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Report a problem


N Wolfe Rd
Cupertino, California
Google
Street View - Jul 2016
Currently shown: Jul 2016
2008
2019
Jul 2016
The Hamptons
artment Homes
Google
Image capture: Jul 2016
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Report a problem


N Wolfe Rd
Cupertino, California
Google
Street View - Oct 2017
Currently shown: Oct 2017
2008
2019
Oct 2017
The Hamptons
Google
Image capture: Oct 2017
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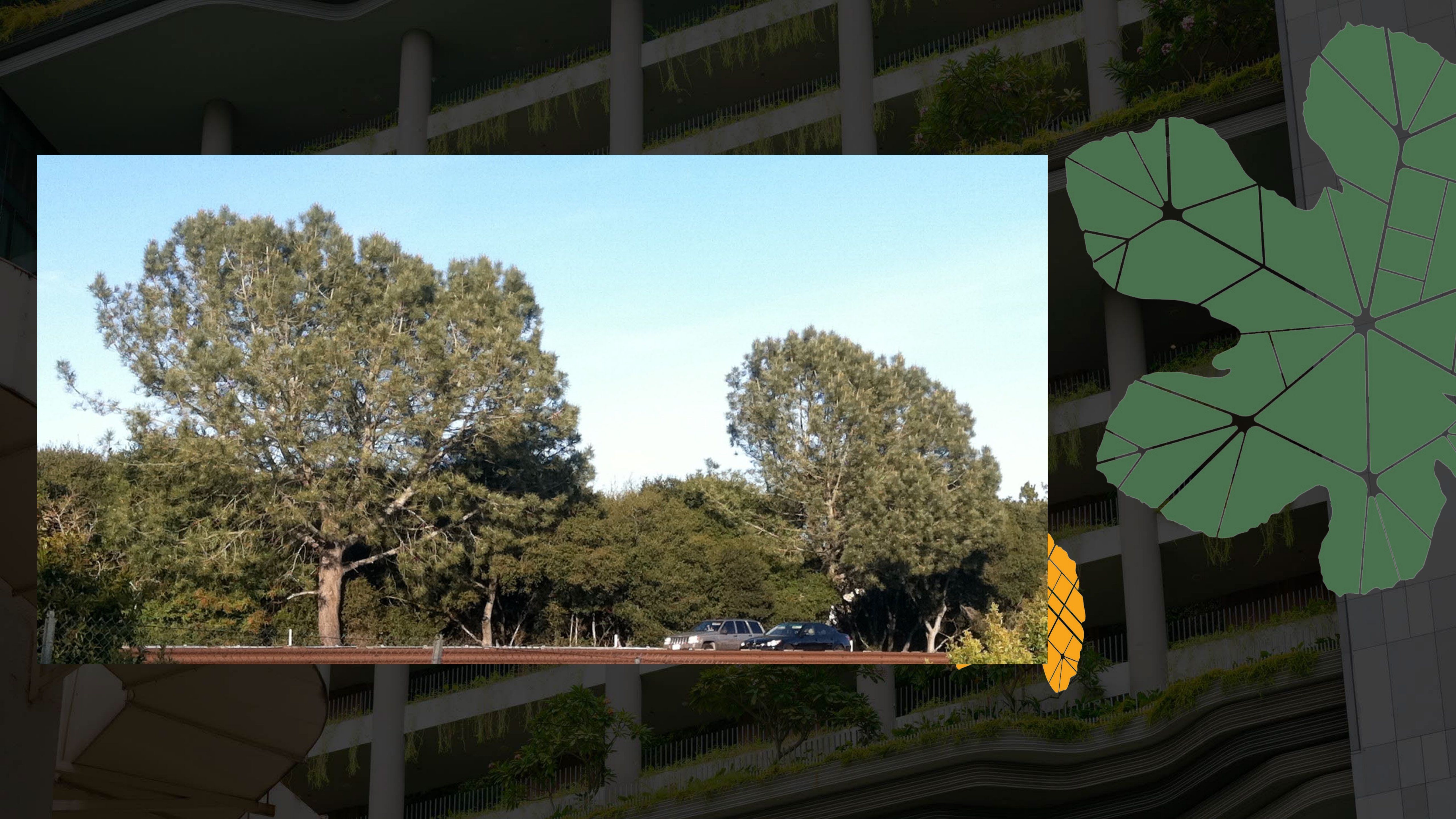
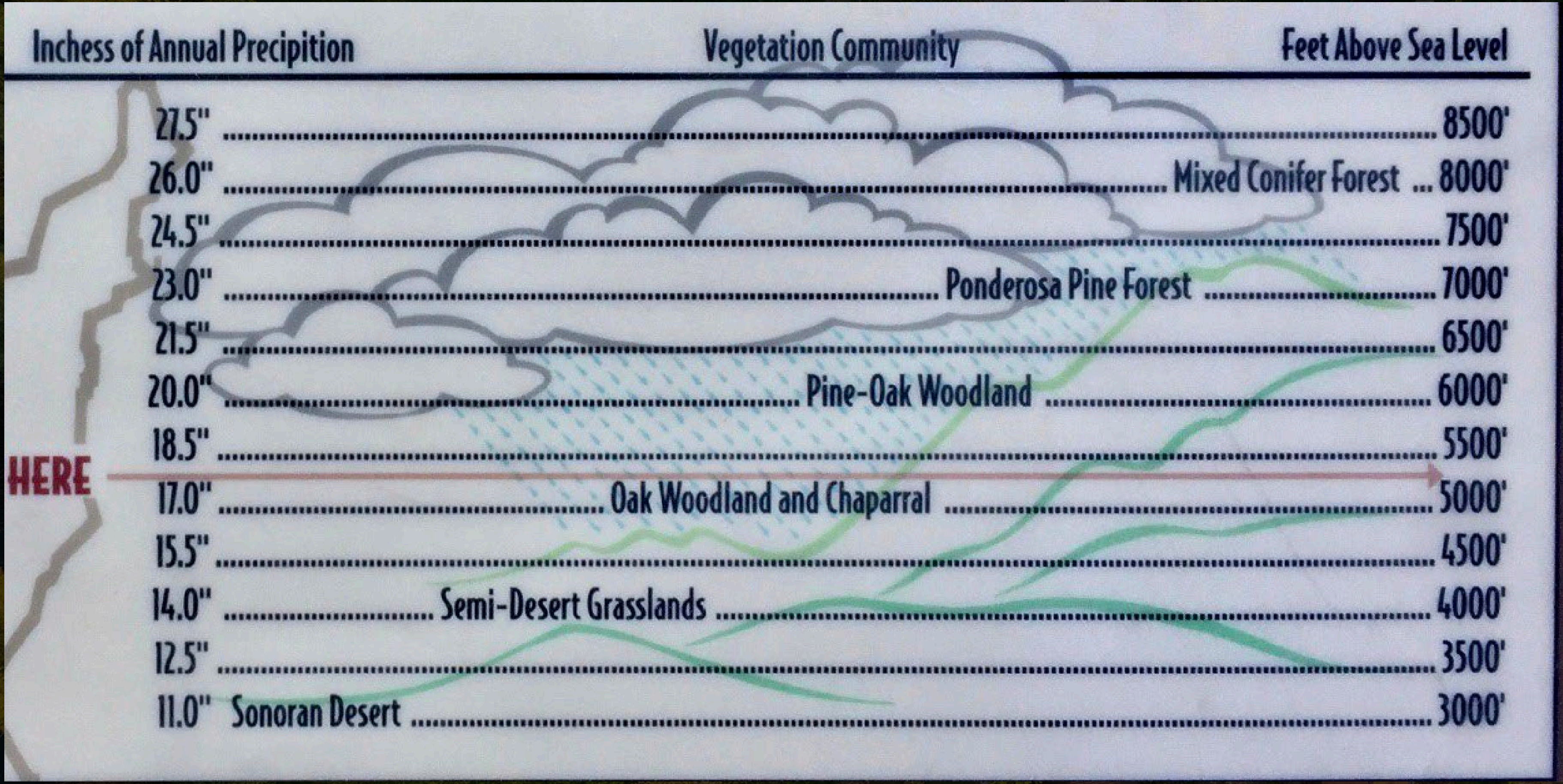
Report a problem


GET YOUR FLU SHOT NOW.


Ziploc
Smart Zip Seal
Q. tomentella 11-19-12




PALM
ARBORETUM

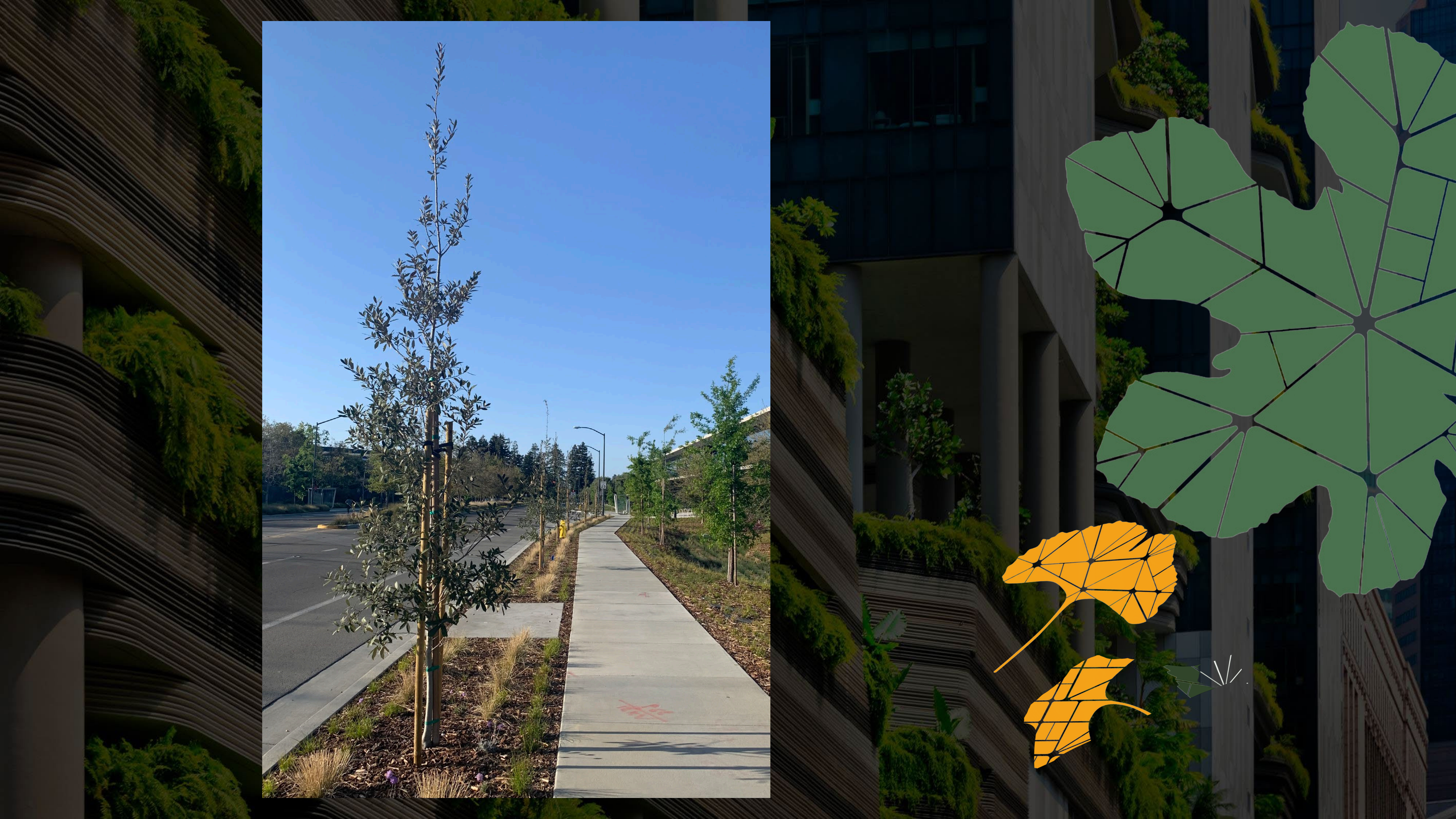


Inchess of Annual Precipition
Vegetation Community
Feet Above Sea Level
27.5" 8500'
26.0" Mixed Conifer Forest 8000'
24.5" 7500'
23.0" Ponderosa Pine Forest 7000'
21.5" 6500'
20.0" Pine-Oak Woodland 6000'
18.5" 5500'
HERE
17.0" Oak Woodland and Chaparral 5000'
15.5" 4500'
14.0" Semi-Desert Grasslands 4000'
12.5" 3500'
11.0" Sonoran Desert 3000'


Hoyt
Arboretum


3999 SW Fairview Blvd
Portland, Oregon
Google
Street View - Aug 2019
Currently shown: Aug 2019
2007
2019
Aug 2019
Hoyt
Arboretu
Washington Park
Google
Image capture: Aug 2019 © 2021 Google United States Terms Privacy Report a problem


TO PICNIC SITES



The New York Times

Why We Should All Be Chasing Acorns

Oct. 17, 2022


Dave Teuschler

Thank you

Dave Muffly

www.oaktopia.org

dave@ oaktopia.org

2nd World Forum on Urban Forests

2023

World Forum on Urban Forests

2nd World Forum on Urban Forests

Washington DC, 2023

Clean Air Calculator: Bridging Science and Practice

Presented by

Alan White

Climate Adaptation Chair- Canadian Nursery Landscape Association

Chairman-Green Cities Foundation

The Clean Air Calculator

Partners

Collaborative approach:

- Climate Adaptation Committee-Canadian Nursery Landscape Association-CNLA
- Dr. Eric Lyons, Director of the Guelph Turfgrass Institute- University of Guelph
- Environmental Systems Research Institute-Esri

The Clean Air Calculator

- A web application tool built on ArcGIS Software (Environmental Systems Research Institute- ESRI
- The literature reviewed (key published studies and sources).
- Our goal is to create awareness about the benefits of plants in urban areas and their value in sustaining life in Canadian communities while mapping the planted urban environment.

What are the parameters measured?

CO_2 Carbon dioxide sequestration

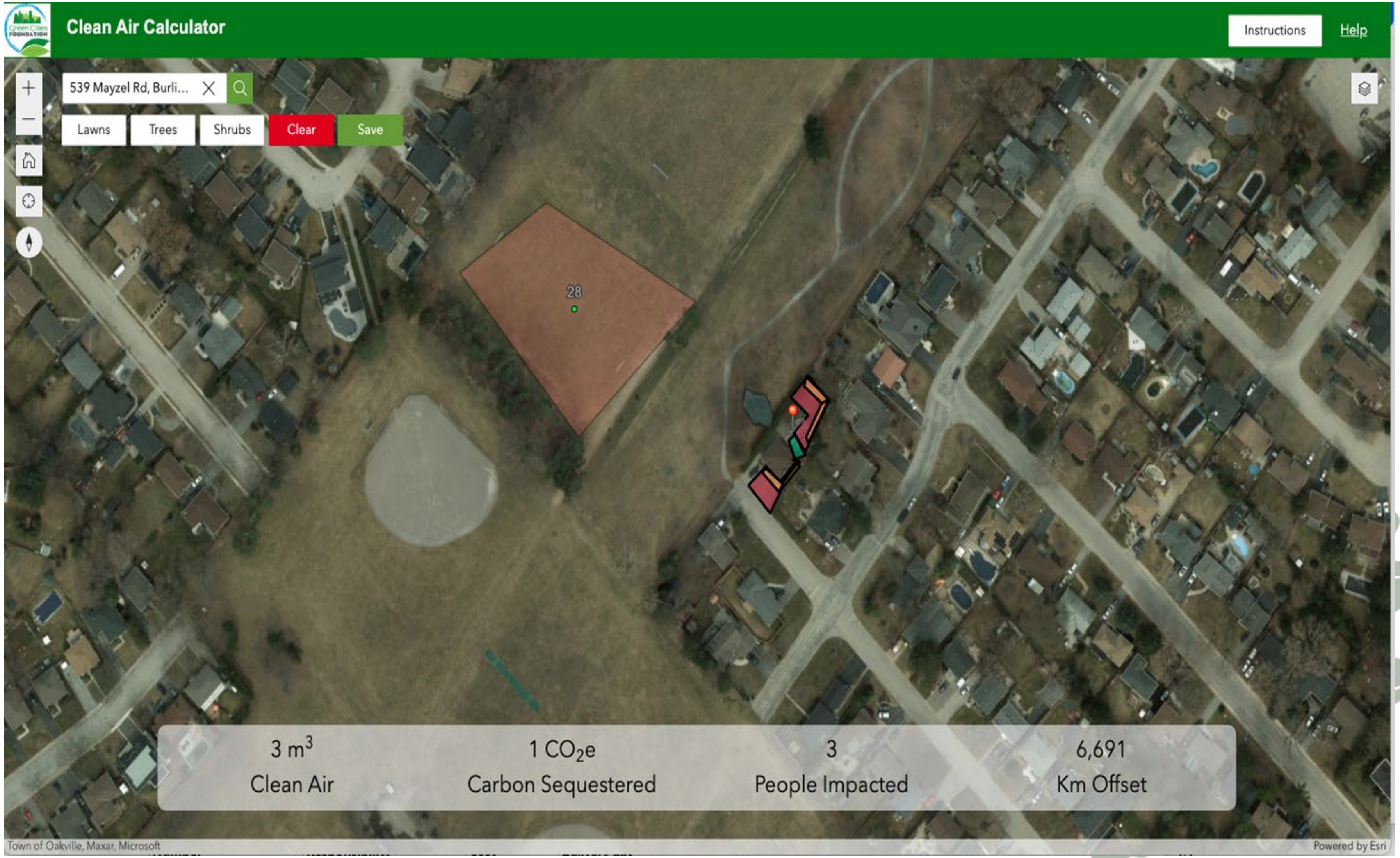
Number of people benefited

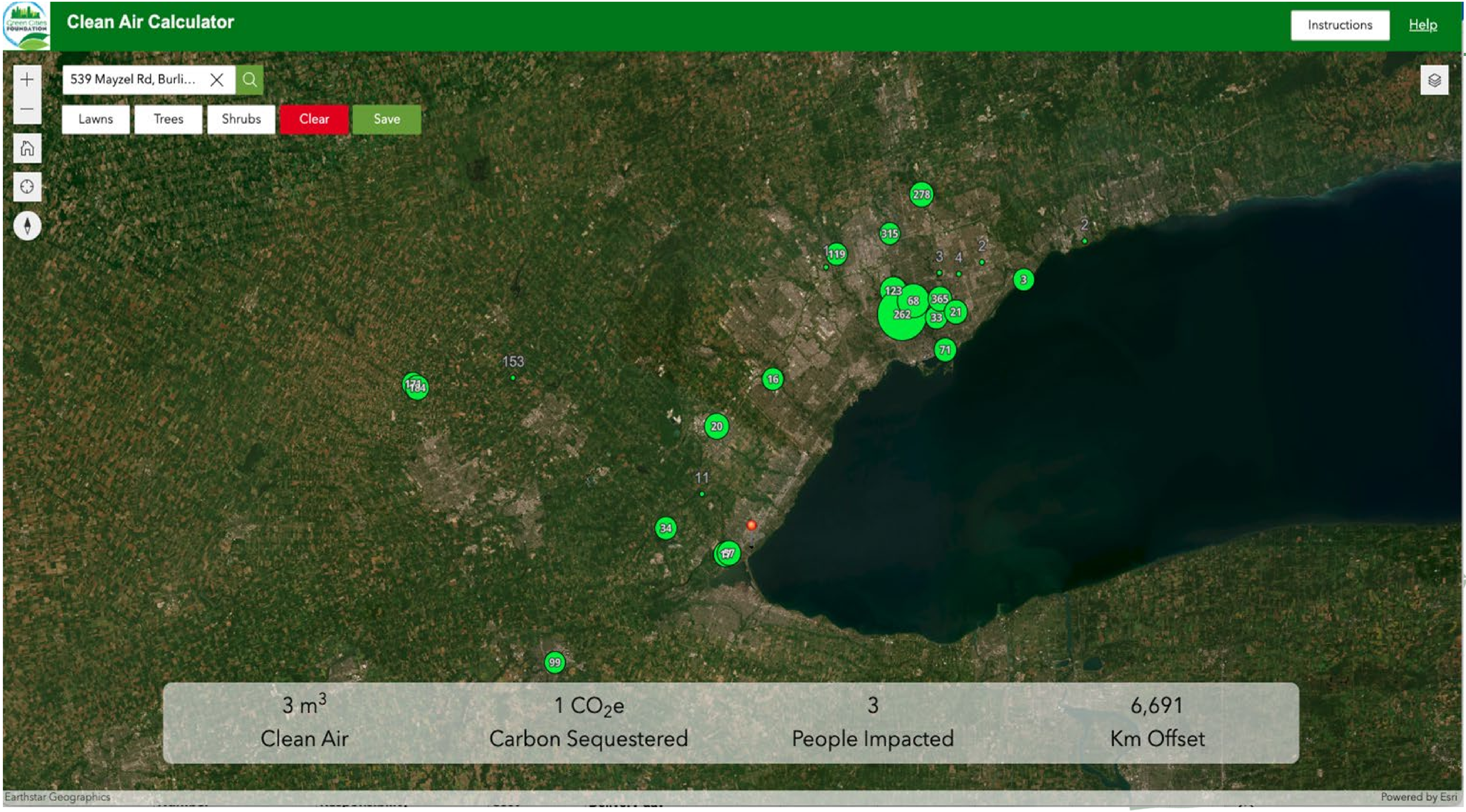
Clean air

Car emissions offsets

How to use the Clean Air Calculator?

- Step 1 - Find Your Location.
- Step 2 - Choose Your Land Cover- Lawns, Trees, and Shrubs
- Step 3 - Define Your Area
- Step 4 - Explore Your Clean Air Results




Clean Air Calculator
Instructions
Help
539 Mayzel Rd, Burli...
Lawns
Trees
Shrubs
Clear
Save
278
315
119
3
4
2
2
3
123
68
365
262
33
21
71
16
153
20
11
34
99
3 m³
Clean Air
1 CO₂e
Carbon Sequestered
3
People Impacted
6,691
Km Offset
Earthstar Geographics
Powered by Esri

1 2 , 5 1 3 . 4 m³

TOTAL CLEAN AIR IMPACT OF OUR PROJECTS

CALCULATE YOUR CLEAN AIR

DONATE

HOME | OUR PROJECTS | MAKE AN IMPACT | OUR STORY | GREEN SUPPORTERS | MY IMPACT

Our 2023 achievements so far

Total of Urban Green Space
Target 930,000 m^2
5,159,680 m^2 (555%)

Total of Clean Air
Target 5,463 m^2
12,512 m^2 (229%)

Population Positive Impacted
Target 5,082 people
11,785 people (232%)

The total of submissions
Target 100 submissions
31 submissions (31%)

Green Cities FOUNDATION

Why The Green Cities Foundation?

- GCF is a community connecting plants & people for a greener, healthier urban environment. The foundation recognizes the importance of engaging individuals at the grassroots level, whether it's through their personal efforts in their yards or balconies or by participating in community initiatives like **#GreenMyCity.**

- By involving people at both the individual and group levels, the foundation empowers them to play an active role in making their communities greener and healthier.

- The tool allows people to measure and quantify the positive impact of plants, shrubs, understory landscapes, grass, and green spaces on the environment.

- When people have the tools to measure their contributions, they are more likely to take ownership of their role in creating a healthier and more sustainable urban climate.

- In summary, the Green Cities Foundation's work is not only about creating greener urban spaces but also about empowering people to take an active role in achieving this goal. Through tools like the clean air calculator, they are providing individuals and communities with the means to measure and understand their contributions, ultimately leading to a more hopeful and engaged populace committed to creating healthier urban environments.

Clean Air Calculator Research & Methodology

- Net Primary Production
- Development of formulas
- Intentional simplicity

Clean Air Calculator Model

Literature Review

Green Space= (Area) (Carbon Sequestration rates)

Literature Review

	Applicable Studies												Conversion to Mg C ha -1 year -1		
	Article	Authors	Year	Type of lan	Type of gra	Mean	Min	Max	Units	Measurement	Gross or Net	Location	Mean	min	max
Turfgrass	Net Carbon Sequestration Potential and Emissions in Home Lawn Turfgrasses of the United States	Selhorst and Lal	2013	Homelawn	cool seaaso	2.8	0.9	5.4	(Mg C ha-1 year-1)	Mean SOC sequestratio	gross	Multiple US Sites	2.8	0.9	5.4
	The residential landscape: fluxes of elements and the role of household decisions	Fissore et al.	2012	Homelawn	cool seaaso	0.51	-	-	(kg C m-2 year-1)	Total C Input	gross	Minnesota, USA	5.1	-	-
	Carbon budgeting in golf course soils of Central Ohio	Selhorst and Lal	2011	Golf Course	cool seaaso	0.44	-	-	(Mg C ha-1 year-1)	Net Sequestration	gross	Ohio, USA	0.44	-	-
	Assessing Soil Carbon Sequestration in Turfgrass System Using Long-Term Soil Testing Data	Qian and Follet	2002	Golf Course	cool seaaso	-	0.9	1	(t C ha-1 year-1)	Change in SOC	gross	Colorado and Wyoming, USA	0.95	0.9	1
	Biogeochemical cycling of carbon and nitrogen in cool-season turfgrass systems	Law and Patton	2017	Homelawn	cool seaaso	1518.5	1408	1629	(kg C ha-1 year-1)	Net Carbon accumulati	gross	Indiana, USA	1.075	0.86	1.29
	Modeling Carbon Sequestration in Home Lawns	Zirkle et al	2011	Homelawn	cool seaaso	-	46	235.1	(g C m-2 year-1)	Net SOC including HCC	gross	Multiple US Sites	1.45	0.46	2.35
	Carbon sequestration and greenhouse gas emissions in urban turf	Townsend-small and Cz	2010	Homelawn	cool seaaso	0.14	-	-	(kg C m-2 year-1)	Accumulated Organic C	gross	California, USA	1.4	-	-
	Soil Organic Matter Accumulation in Creeping Bentgrass Greens: A Chronosequence with Implications fo	Carley et al.	2011	Golf Course	cool seaaso	59	-	-	(g m-2 year-1)	Estimated Soil Carbon	gross	North Carolina, USA	0.59	-	-

Trees	Article	Authors	Year	Mean	Min	Max	Units	Measurement	Gross or Net	Location	Conversion to Mg C ha -1 year -1	min	max
	Carbon storage and sequestration by trees in urban and community areas of the United States	Nowak et al.	2013	0.28	0.128	0.513	(kg C m-2 yea	Net Sequestration	gross	Multiple US Locations	2.8	1.28	5.13
	Carbon storage and sequestration of Urban Street Trees in Beijing, China	Tang et al.	2016	1.3	-	-	(mg ha-1 year	C Sequestration	gross	Beijing, China	1.3	-	-
	Carbon storage and sequestration by urban forests in Shenyang, China	Liu and Li	2012	2.84	1.16	4.78	(t ha-1 year-1	C Sequestration	gross	Shenyang, China	2.84	1.16	4.78
	Impacts of urban forests on offsetting carbon emissions from industrail energy use in Hangzhou, China	Zhao et al.	2010	1.66	0.82	3.02	(t ha-1 year-1	C Sequestration	gross	Hangzhou, China	1.66	0.82	3.02
	Comparison of carbon storage, carbon sequestration and air pollution removal by protected and maintair	Martin et al.	2012	-	291	1758	(kg C ha-1 yea	C Sequestration	gross	Alabama, USA	1.02	0.29	1.76
	Carbon reduction and planning for urban parks in Seoul	Jo et al.	2019	3.5	1.2	8.4	(t ha-1 year-1	C Sequestration	gross	Seoul, Republic of Kore	3.5	1.2	8.4

Shrubs	Article	Authors	Year	Mean	Min	Max	Units	Measurement	Gross or Net	Location	Conversion to Mg C ha -1 year -1	min	max
	Vegetation ecology and carbon sequestration potential of shrubs in tropics of Chhattisgarh, India	Jhariya	2017	-	0.71	1.57	t ha-1 yr-1	net carbon sequestratio	net	India	1.14	0.71	1.57
	The Application of Stem Analysis	Beets	2014	1.15	0.15	3.23	t ha-1 yr-1	carbon stock increase	net	New Zealand	1.15	0.15	3.23
	Carbon sequestration and growth of six common tree and shrub shelterbelts in Saskatchewan, Canada	Amichev et al.	2016		1.31	6.64	Mg ha-1 yr-1	carbon stock increase	net	Sasketchewan, Canada	3.98	1.31	6.64

Clean Air Calculator Research

- Assessment of Carbon Sequestration in the US Residential Landscape. Gina Zirkle. 2010.
- Oxygen Production by Urban Trees in the USA. David J. Nowak, Robert Hoehn, and Daniel E. Crane. 2007
- Carbon storage and sequestration by urban trees in the USA. USDA Forest Service. Nowak, D; Crane, D. 2013
- Air Pollution Removal by Urban Forests in Canada and its Effect on Air Quality and Human Health. David J. Nowak, Mark Mcgovern. 2017
- Estimating Net Primary Production of Turfgrass in an Urban-Suburban Landscape with QuickBird Imagery. Jindong Wu, Marvin E. Bauer. 2012
- Net Carbon Sequestration Potential and Emissions in Home Lawn Turfgrasses of the United States. Selhorst , A; And Lal. 2013

Link to the Paper:

[Development of an Urban Turfgrass and Tree Carbon Calculator for Northern Temperate Climates]

Open Access Article

Development of an Urban Turfgrass and Tree Carbon Calculator for Northern Temperate Climates

by Corey Flude [1], Alexandra Ficht [1], Frydda Sandoval [2] and Eric Lyons [1,*]

[1] Department of Plant Agriculture, University of Guelph, 50 Stone Road East, Guelph, ON N1G 2W1, Canada

[2] Canadian Nursery Landscape Association, 7856 Fifth Line South, Milton, ON L9T 2X8, Canada

[*] Author to whom correspondence should be addressed.

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Received: 25 July 2022 / Revised: 22 September 2022 / Accepted: 27 September 2022 / Published: 29 September 2022

Thank you

Alan White|CNLA

alan.white@canadanursery.com

Link to the CAC website:
https://www.experiencebuilder.gardenconnect.com/ExperienceBuilder/?page=Map

Food and Agriculture Organization of the United Nations · Arbor Day Foundation · POLITECNICO MILANO 1863 · SISEF · ISA · Smithsonian · Forest Service U.S. Department of Agriculture

2nd World Forum on Urban Forests

2023

World Forum on Urban Forests

2nd World Forum on Urban Forests

Washington DC, 2023

How healthy, diverse urban forests can support threatened trees in the wild and mitigate the impacts of climate change

Presented by

Murphy Westwood, PhD

Vice President of Science and Conservation

The Morton Arboretum

Global Tree Assessment (GTA):

Assessing the extinction risk of all ~60,000 tree species by 2020

GTA Global Tree Assessment

BOTANIC GARDENS CONSERVATION INTERNATIONAL

GTSG GLOBAL TREE SPECIALIST GROUP

- Launched in 2015
- >60 institutional partners
- >500 tree experts from around the world

The U.S. effort for the GTA

- Christina Carrero, Bard College and The Morton Arboretum
- Emily Beckman Bruns, The Morton Arboretum
- Anne Frances, USDA Agricultural Research Service
- Diana Jerome, The University of Edinburgh
- Wesley Knapp, NatureServe
- Abby Meyer, Botanic Gardens Conservation International U.S.
- Ray Mims, United States Botanic Garden
- David Pivorunas, USDA Forest Service
- DeQuantarius Speed, The Morton Arboretum
- Amanda Treher Eberly, NatureServe
- Murphy Westwood, The Morton Arboretum

… and dozens of other botanists and plant experts!

The Morton Arboretum | THE CHAMPION of TREES
United States Botanic Garden
Botanic Gardens Conservation International
NatureServe
Forest Service, U.S. Department of Agriculture

The starting point for U.S. trees (2017)

Two threat assessment frameworks in the U.S.

IUCN RED LIST©

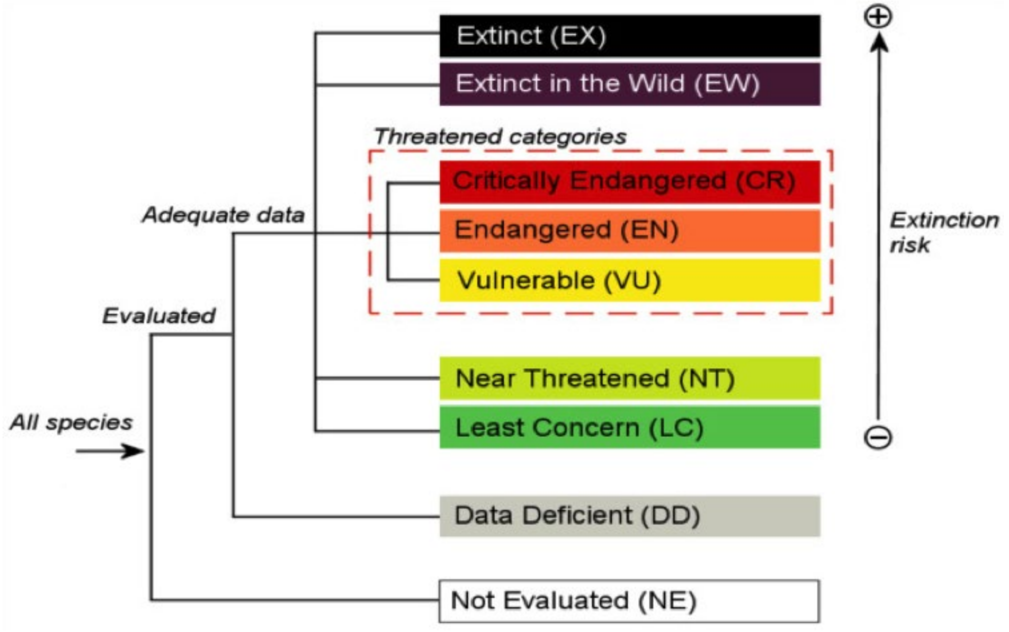
- Est. in 1964, used globally
- GTA assessment platform of choice
- Assessments compiled by global network of scientists and conservationists
- <300 U.S. tree species assessed

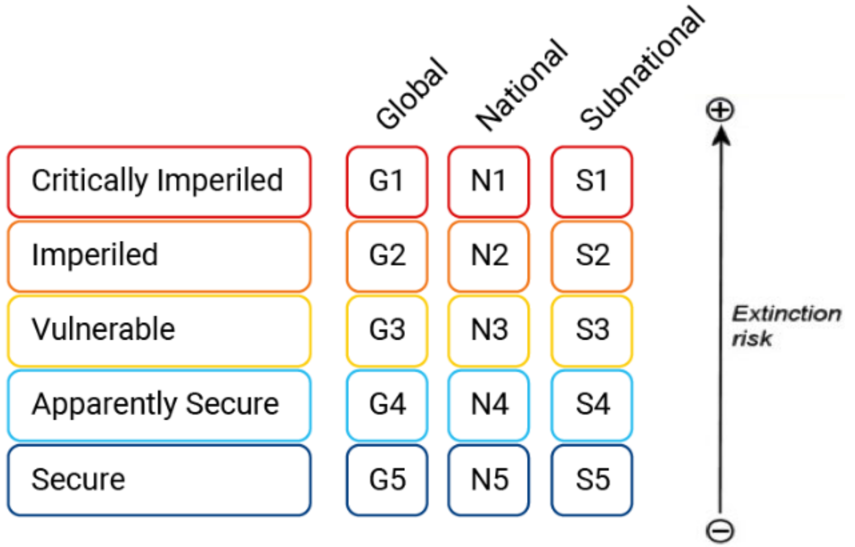
NatureServe

- Est. in 1978, used in N. America
- Assessments compiled by its network of Natural Heritage Programs
- ~97% of species assigned Global Rank, but 75% of those were >10 years old

Carrero et al., 2022. *Plants, People, Planet*

IUCN Red List categories and NatureServe global ranks





U.S. Tree Assessment Goals

- Address the lack of U.S. tree species on IUCN Red List and out of date NatureServe global ranks
- Ensure U.S. was contributing to Global Tree Assessment initiative
- Create easily accessible checklist of U.S. tree species (for the contiguous 48 states)
- Develop a comprehensive picture of the state of extinction risk of U.S. trees
- Streamline data sharing between IUCN Red List and NatureServe

Results: The state of U.S. trees

Plants People Planet

Received: 31 January 2022 | Revised: 27 June 2022 | Accepted: 28 June 2022
DOI: 10.1002/ppp3.10305

Plants People Planet PPP Open Access

RESEARCH ARTICLE

Data sharing for conservation: A standardized checklist of US native tree species and threat assessments to prioritize and coordinate action

Christina Carrero[1,2] | Emily Beckman Bruns[1,6] | Anne Frances[3] | Diana Jerome[4] | Wesley Knapp[5] | Abby Meyer[6] | Ray Mims[7] | David Pivorunas[8] | DeQuantarius Speed[1] | Amanda Treher Eberly[5] | Murphy Westwood[1]

[1]The Morton Arboretum, Lisle, Illinois, USA
[2]Bard College, Annandale-On-Hudson, New York, USA
[3]United States Department of Agriculture (USDA) Agricultural Research Service, Beltsville, Maryland, USA
[4]The University of Edinburgh, Edinburgh, UK
[5]NatureServe, Arlington, Virginia, USA
[6]Botanic Gardens Conservation International U.S., San Marino, California, USA
[7]United States Botanic Garden, Washington, D.C., USA
[8]United States Department of Agriculture (USDA) Forest Service, Washington, D.C., USA

Correspondence
Christina Carrero, The Morton Arboretum, Lisle, IL, USA.

Societal Impact Statement
Understanding the current state of trees within the United States is imperative for protecting those species, their habitats, and the countless communities they support, as well as the ecosystem services they provide. We present an updated checklist of all tree species native to the contiguous United States, their state distribution, extinction risk, and most common threats. Knowledge of national threat "hotspots" and conservation priorities facilitates efficient conservation efforts and the allocation of resources to safeguard the 11–16% of US tree species that are threatened. These results lay the groundwork for tree and ecosystem conservation efforts in the United States that contribute to achieving critical international conservation goals, including the United Nations Decade for Ecosystem Restoration and the Global Tree Assessment.

Summary

The checklist of U.S. trees
Data included:

- Family
- Genus
- Species
- Taxonomic authority
- Country-level and state-level distribution
- Endemicity to the contiguous U.S.
- IUCN Red List and NatureServe assessment and year
- Endangered Species Act listing
- Number of ex-situ collections

Carrero et al., 2022. *Plants, People, Planet*

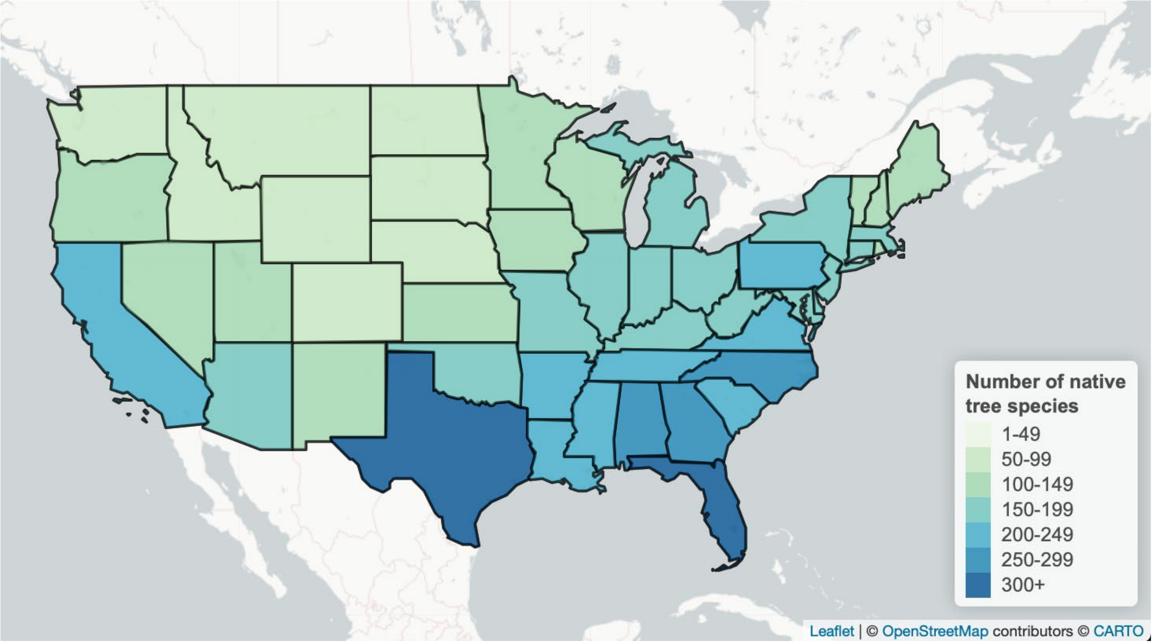
The checklist of U.S. trees

- Checklist contains: 79 families, 269 genera, 881 species of trees
- 294 species endemic to the contiguous 48 states
- Oaks (*Quercus*; 85 species) and hawthorns (*Crataegus*; 84 species) dominate tree flora
- Nine other genera with >10 tree species

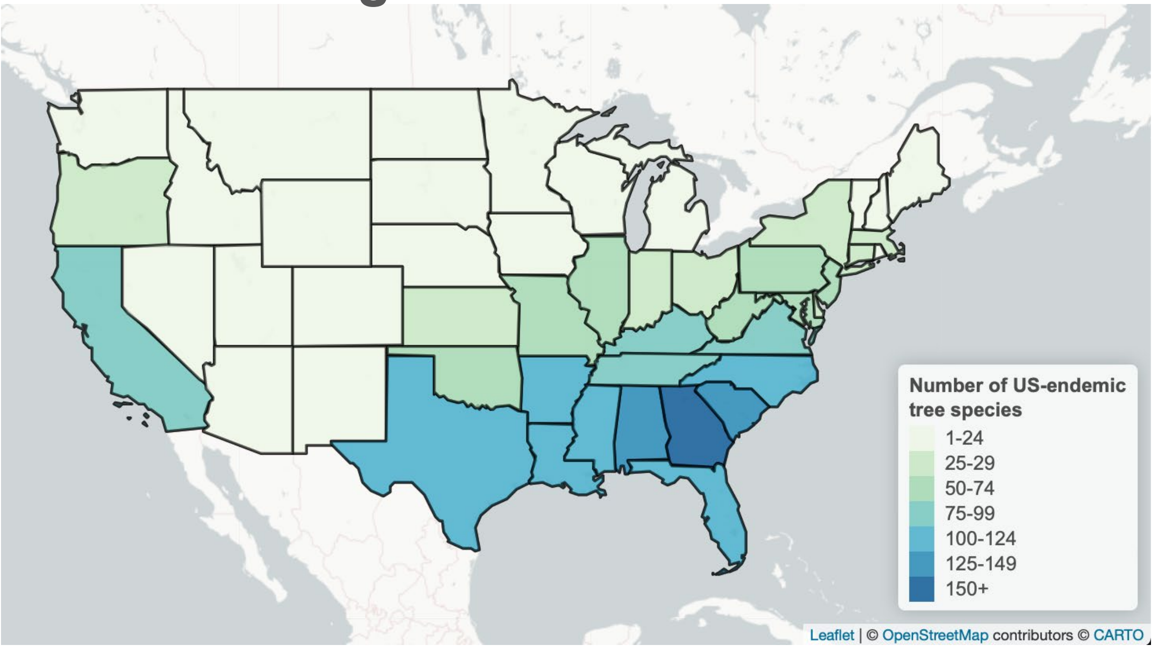
Carrero et al., 2022. *Plants, People, Planet*

Native tree hotspots

Native Trees



Contiguous U.S. Endemic Trees



Carrero et al., 2022. *Plants, People, Planet*

Threat assessments completed

IUCN RED LIST©

563 species
(3-fold increase)

96.7%
of U.S. tree species assessed

NATURESERVE

109 species

96.3%
of U.S. tree species assessed

Developed **crosswalk methodology** to facilitate data sharing between IUCN and NatureServe databases

Carrero et al., 2022. *Plants, People, Planet*

Threat assessment results

RED LIST

NATURESERVE

94 species (11%) threatened

135 species (16%) threatened

165 species (19%) threatened

Federal protections for trees

<u>Compare to</u>

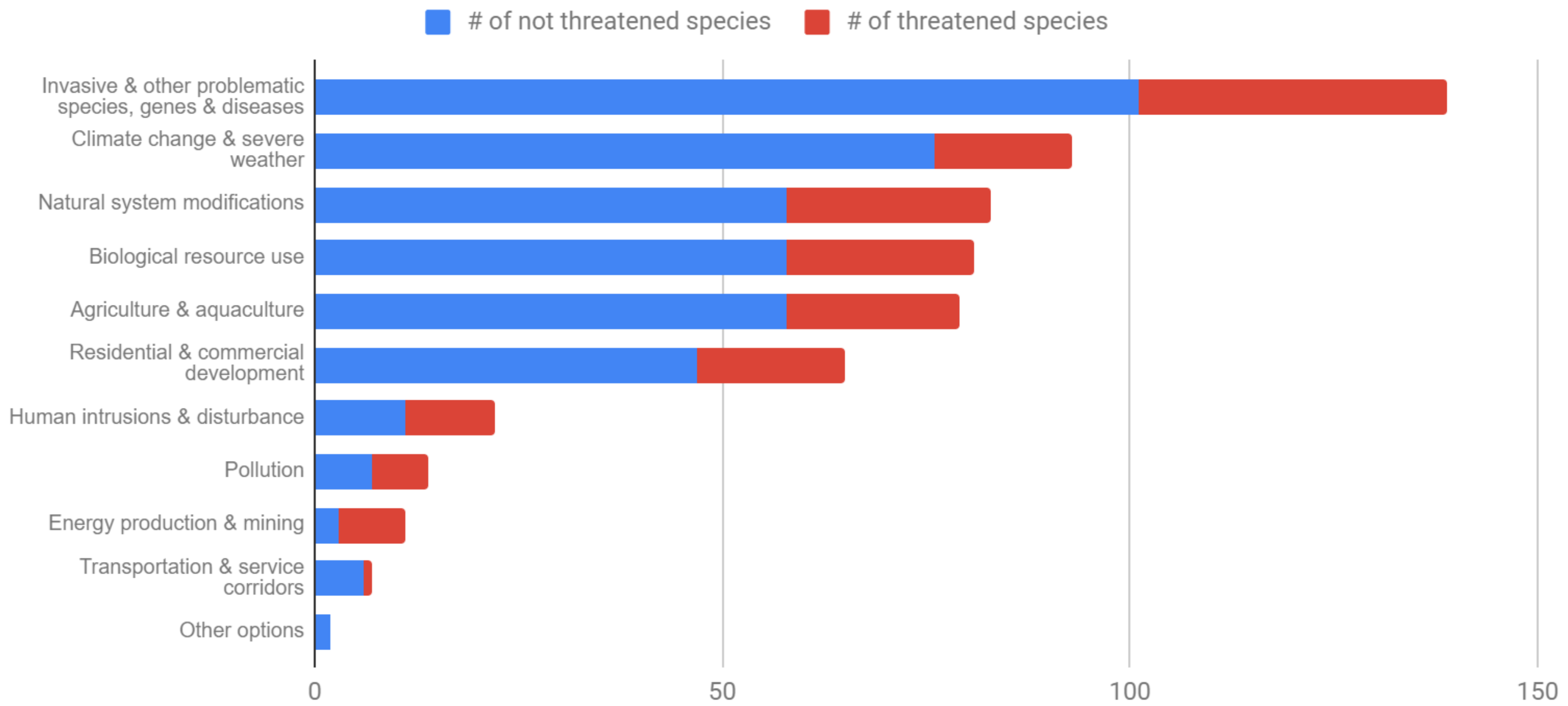
IUCN Red List:
94 spp. Threatened

NatureServe:
135 spp. At-risk

Species name	Federal Listing Status	IUCN Red List Category	NatureServe Ranking
Asimina tetramera	Endangered	EN	G1
Betula uber	Threatened	NE	G1
Cercocarpus traskiae	Endangered	CR	G1
Chionanthus pygmaeus	Endangered	EN	G2
Consolea corallicola	Endangered	CR	G1
Fremontodendron mexicanum	Endangered	EN	G2
Torreya taxifolia	Endangered	CR	G1
Ziziphus celata	Endangered	EN	G1

Carrero et al., 2022. *Plants, People, Planet*

Most common threats facing U.S. trees



Carrero et al., 2022. *Plants, People, Planet*

Phylogenetic patterns of threat

Genera with the most threatened species

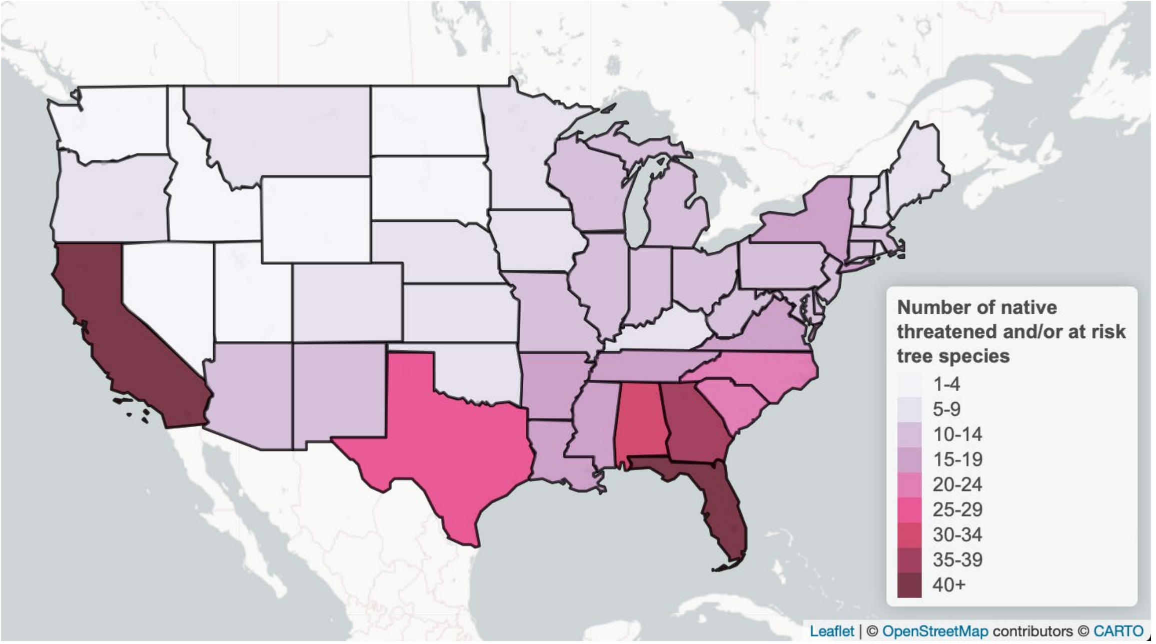
Genus	Number of species threatened/at-risk	Total number of native US tree species	% of genus threatened/at-risk
Crataegus	29	84	34.5%
Quercus	17	85	20.0%
Fraxinus	7	15	46.7%
Pinus	6	38	15.8%
Arctostaphylos	4	10	40.0%
Cupressus	4	6	66.7%

77 out of 269 tree genera have at least one threatened and/or at-risk species

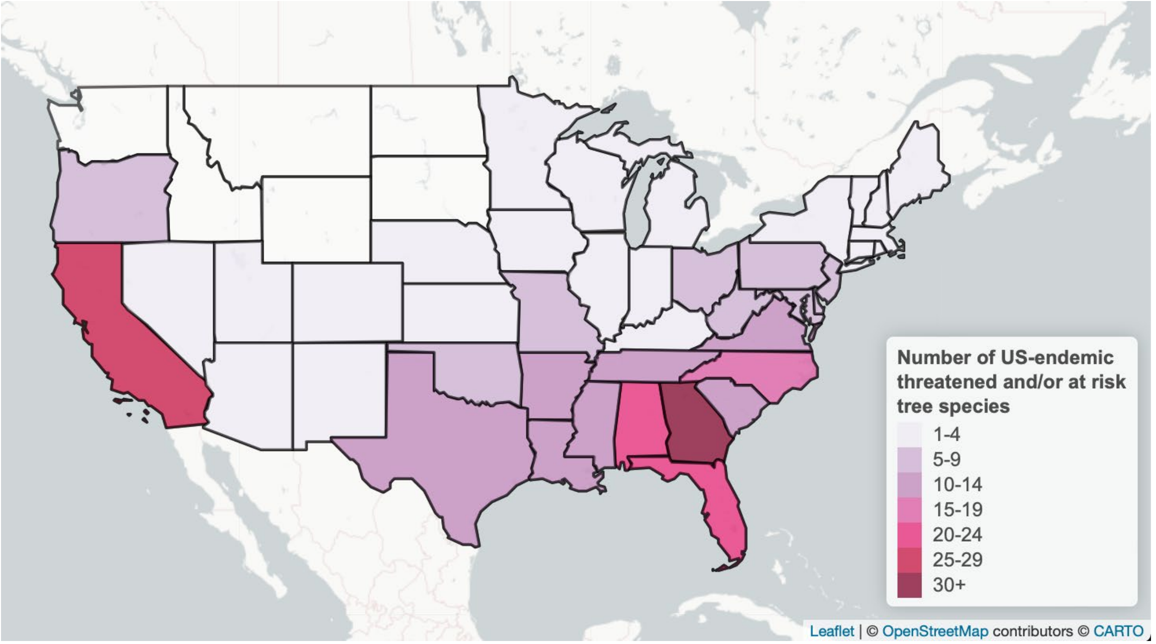
Carrero et al., 2022. *Plants, People, Planet*

Threatened tree hotspots

Native threatened trees



Endemic threatened trees



Carrero et al., 2022. *Plants, People, Planet*

How can urban forestry save threatened trees in the wild?

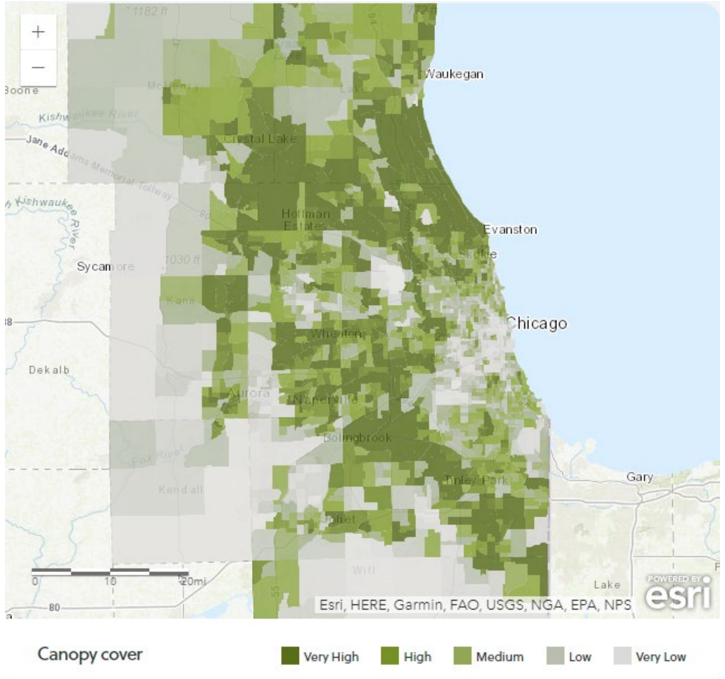
Healthy urban forests benefit *all* trees

Taking action

- Trees are a nature based solution to combat climate change
  - Higher canopy cover → cooler temps, mitigates runoff
  - Trees are a carbon sink
- A diverse urban canopy is more resilient to new pests/diseases
- Create forest preserves and connect habitat with corridors
- Engage and support private landowners to plant trees
- Partner with local gardens and arboreta to join conservation efforts and share knowledge and best practices
- Ensure threatened tree species are included in habitat restoration and reforestation efforts ("near situ" conservation)
- Advocate for and build awareness of the importance of trees
- Help reduce "plant blindness" so trees aren't taken for granted

Case Study: Chicago Region Trees Initiative at The Morton Arboretum

CRTI is a partnership of communities, individuals, organizations, green industry, businesses, and governments working together to develop and implement strategies for a healthier, more diverse, more equitable urban forest



Case Study:
City of Columbia, MO - Stephen's Lake Park Arboretum
Maple leafed oak conservation

- A city that is an accredited arboretum is actively working to conserve the endangered species *Quercus acerifolia*
- Establishing at least four urban "conservation grove" sites
- Planting both seed-derived groves and grafted trees that represent the four known sites where this species exists in Arkansas.
- Goal: to develop a complete collection of Q. *acerifolia*, by capturing the maximum amount of genetic variability across the species as possible, while also planting the urban forest.

Become an Accredited Arboretum

- Arboreta come in all shapes and sizes!
- Take your urban and community forestry efforts to the next level, recognizing the educational and conservation value of the trees in your care.
- Be recognized for achievement of specified levels of professional practice.
- Earn distinction in your community, university, or government agency.
- Leverage funding.
- Identify opportunities for collaboration with other arboreta for scientific, collections, or conservation activities.

ArbNet
THE INTERACTIVE COMMUNITY of ARBORETA

City Arboretum Toolkit

The Morton Arboretum | THE CHAMPION of TREES

Thank you

Murphy Westwood, PhD | The Morton Arboretum

Other information

mwestwood@ mortonarb.org

www.mortonarb.org

www.chicagorti.org

U.S. trees paper:

Food and Agriculture Organization of the United Nations · Arbor Day Foundation · d. · POLITECNICO MILANO 1863 · SISEF · ISA · Smithsonian · Forest Service U.S. Department of Agriculture

2nd World Forum on Urban Forests

2023

World Forum on Urban Forests

2nd World Forum on
Urban Forests

Washington DC, 2023

From Hardscape to Welcoming Greenscape:

Grass and Diverse Trees Transform a Highway in Nairobi, Inspiring Replication

CIFOR 30 YEARS

World Agroforestry

CORNELL UNIVERSITY FOUNDED A.D. 1865

Presented by

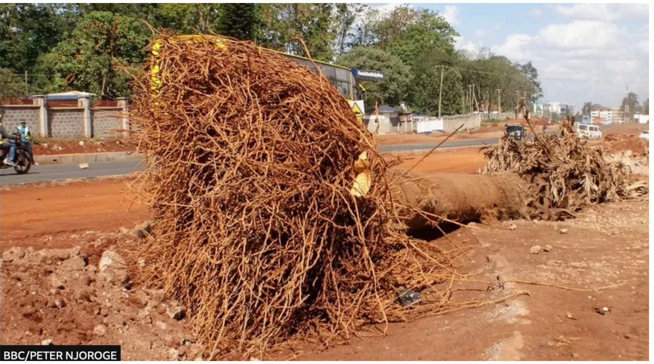
Kate Chesebrough
Landscape Architect (NYS)
Urban Forestry Research Fellow, CIFOR-ICRAF

Cornell University Masters of Landscape Architecture ‘24

A Watershed Moment for Trees in Nairobi

- **Link Road Trees Case Study**
  – Led by Catharine Watson, CIFOR-ICRAF
- **CIFOR- ICRAF Urban Forestry Research Fellows**
- **Always in collaboration with Kenyan youth and scientists**

Link Road Trees Case Study: Why Here, Why Now?



Expressway construction caused much tree removal, and preservation of a large ficus

- Room for new ideas about native trees, in contrast to exotics planted earlier in history
- 3,500+ trees removed by expressway – widespread disappointment, sparked activism
- Much attention to tree planting nationwide
- An opportunity– KURA approached for help improving environment in otherwise vacant road reserves
- Intended to promote and demonstrate effectiveness of native trees
- Tangible expertise, collaboration

Kenyan President Ruto announced plans to plant 15 billion trees by 2032

Peter Greensmith, Nairobi Parks Superintendent 1947-1965, pictured here with the Queen Mother

Link Road Trees: How it Started

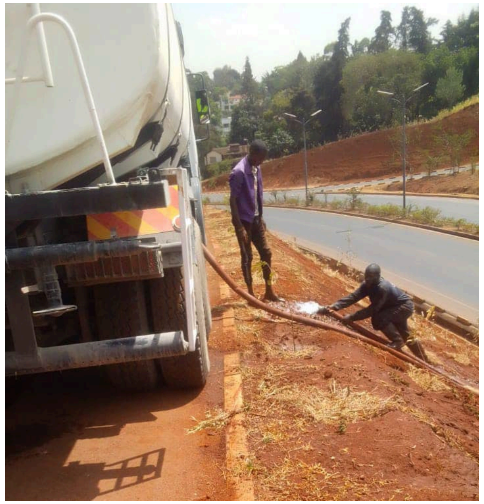
- Eroding bare soil on very steep slopes
- Employed people from nearby informal settlements – energy poverty
- Site preparation
- Taken on as personal project

Link Road Trees: How it's Going

- 50+ species of native trees
- A park-like, attractive environment
- Dense plantings create canopy closure reducing pressure from weeds

Link Road Trees: Commitment to Care

- Maintenance is key to success
- Over 75% of funds toward labor
- Drought during 2021-2023
- Unofficial motto: *Grow slower, better*



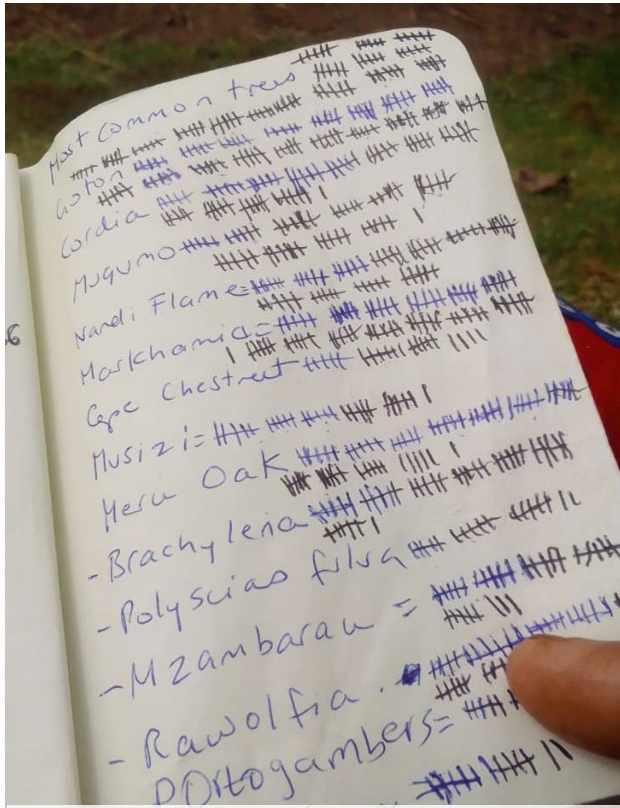
Dr. Wanja Kinuthia (Museums of Kenya) wuth Dr. Katherine Baldock and Dr. Michael Poind from Northumbria University

Bernard Onkware, assistant to Muhammad Ahmad in the Geospatial Division at CIFOR-ICRAF, helps test the Regreening Africa app at the site

Link Road Trees: Growing Knowledge

- Tree count and identification: Staff become tree experts
- Pedestrian footfall throughout day counted by staff
- Beneficial insects identified by local and visiting entomologists
- Testing the Regreening Africa phone app in urban setting reveals new potential use
- Road reserves can be less contested than other urban spaces

The highway reserve has become home for forest species



Tree species inventory by staff after 3 years of growing

Scaling Up?

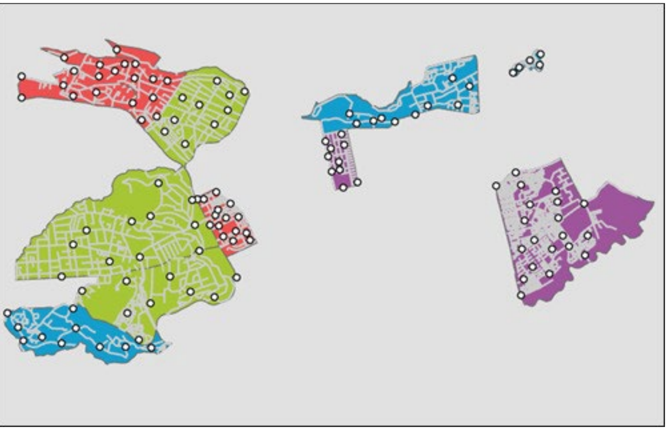
- KURA road reserves throughout country include over 19,000ha of potential urban forestation – of which Nairobi appx. 7,000ha
- Forested roadways as multi-functional, dynamic infrastructure
- Corridors for habitat, biodiversity, pedestrian connectivity
- Meets definition of UN Habitat 2022 Public Space Inventory as 'linear public space'
- Attractive and appreciated

Urban Forestry Research Fellows

At CIFOR-ICRAF after urban forestry seminar, with Bolurin Adepipe (MIT M.Arch), myself, Cathy, Sam Dindi (Mazingera Yetu Environmental Magazine), Alice, Lawrence Wachira (KURA), José Chong (UNHabitat Public Space)

- First-ever at CIFOR-ICRAF
- **Kate Chesebrough**
  - Master of Landscape Architecture ’24, Cornell University College of Agriculture and Life Sciences
- **Alice Gerow**
  - Master of Forestry ’24, Yale University School of the Environment
- Summer 2023 in-person in Nairobi
- Hosted urban forestry seminar at CIFOR-ICRAF with outside guests
- A new direction – open to collaboration

Urban Forestry Research Fellows



- **Alice Gerow**
  - Studying street tree distribution in Nairobi
  - Examines socioeconomic and spatial inequalities in distribution of urban greenspace
  - Investigates differences in street tree abundance, size structure, species diversity, and composition between selected residential neighborhoods
  - Study rests on a ground-based inventory of nearly 2,000 street trees in 12 neighborhoods.
  - Objective: to characterize the distribution of street trees and address a knowledge gap on a critical layer of Nairobi's urban forest to inform formal and informal urban greening initiatives.

Urban Forestry Research Fellows

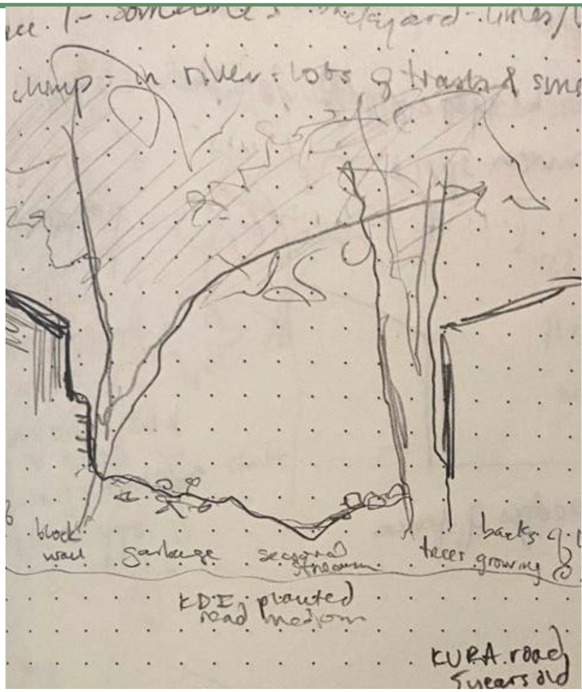
- **Kate Chesebrough**
  - Studying urban forestry through design with focus along riverways, roadways in selected informal settlements
  - Focus on care- <u>growing</u> trees, not planting
  - Image of city transformed
  - Shift from untended to cared for, safety, pride
  - Flood-prone areas and ongoing adaptation
  - Assembling palette of urban/climate-adapted tree species appropriate to site conditions
  - Knowledge-sharing and partnership-building
  - Objective: urban forestry approach that values maintenance, creates new collaborations for impactful climate adaptation for more livable cities

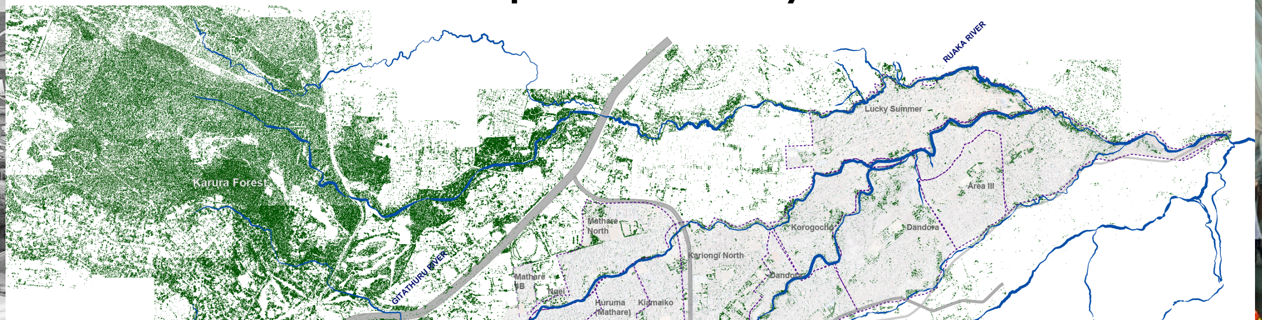
Informed by Networks

- Many organizations are stakeholders in urban forestry in Nairobi
  - Organizers and urban planners Slum Dwellers International, Muungano wa Wanavijiji
  - Youth groups in Mathare, Korogocho, Lucky Summer, Kibera, and Mukuru
  - Botanists at CIFOR-ICRAF, Kenya Forestry Research Institute, Darubini, Museums of Kenya
  - Policymakers at Nairobi City-County Sustainability, Parks & Recreation, and Planning Departments, as well as UN Habitat Public Space Programme
- Goal: help share knowledge between

Action-Oriented Design Research

- Illustrating trees to make them more visible
- Sketching live during all site visits
- Ongoing coordination for site- and neighborhood-specific plans
- Trees are about time - tenure, maintenance, long-term climate goals
- Preparing tree species matrix based on performances – food, timber, medicine, habitat, ornamental, etc.
- Potential workshops in January





Uniquely Nairobi, With Broad Themes

Large vendor stalls of traditional medicines for sale in the Mathare informal settlement, many of which are sourced from native tree bark, seeds, fruit, etc.

- Transferal of rural knowledge to urban settings due to population shift
- Medicinal use of trees – important to health of residents, few plans discuss
- Addressing plant blindness
- A shift in identity with native trees
- Health benefits of public green space
- Huge potential for collaboration
- Tangible green spaces maintained and loved by people bring climate goals to life


Transforming from dump sites to green spaces – tangible differences that require systemic change for the longer term

Thank you

Kate Chesebrough | Landscape Architect

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30 YEARS CIFOR

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Session 3.4: Some Like it Hot: Creating and sharing new knowledge and supporting education on the contribution of forests and trees to adaptation and mitigation to climate change

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