Pollinator conservation in human-dominated landscapes

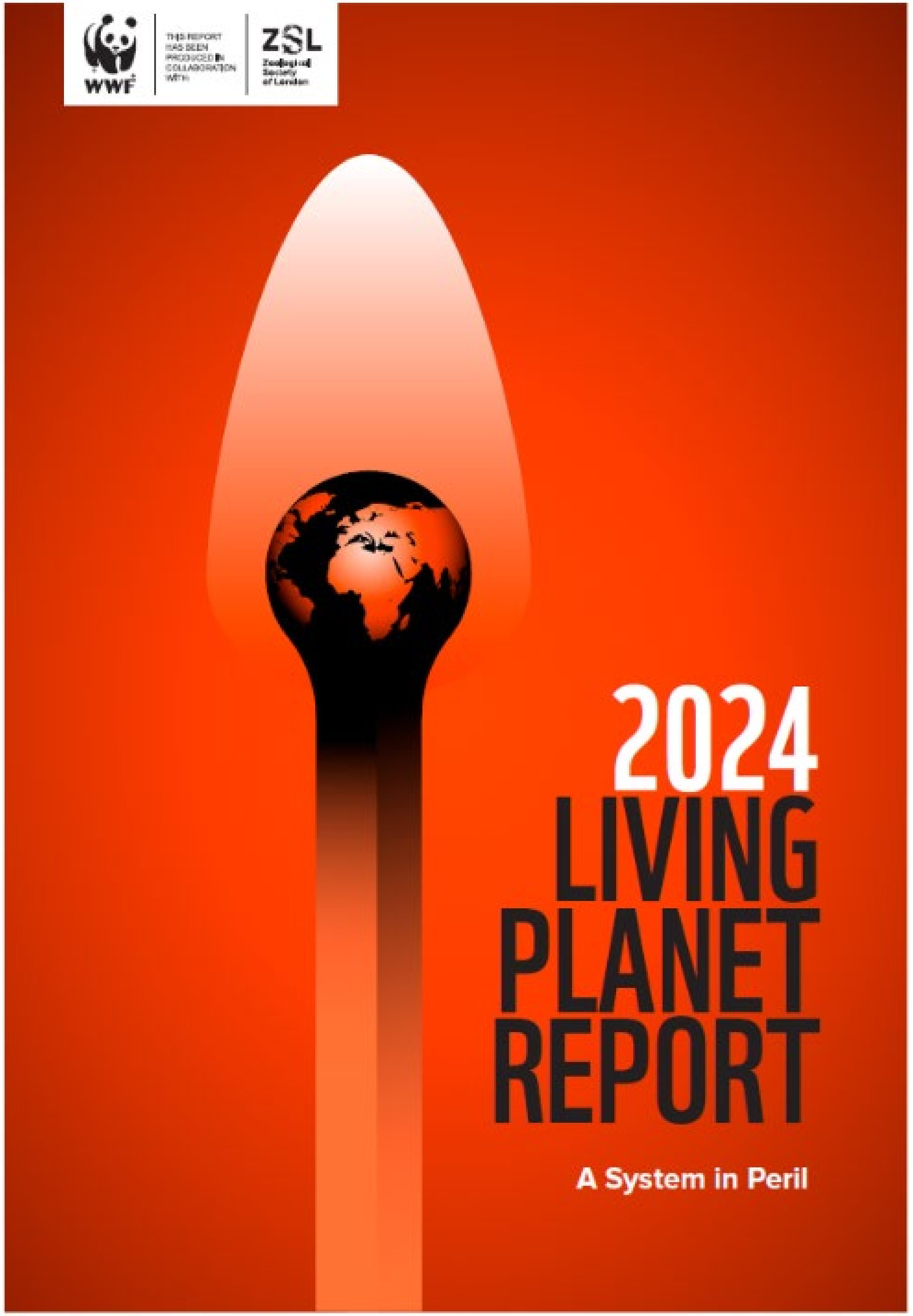


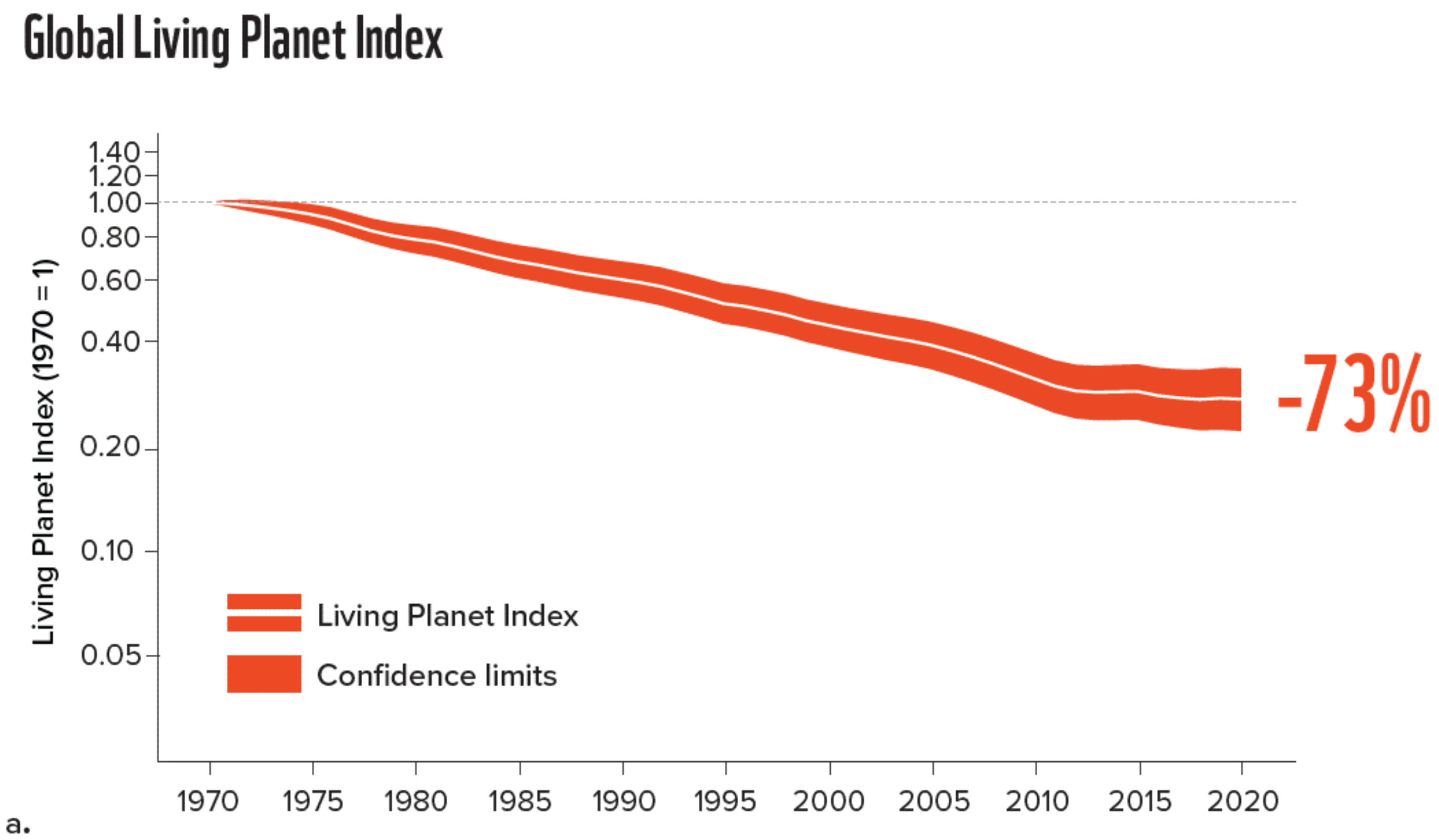

Jaret C. Daniels & Adam G. Dale

FLORIDA MUSEUM

UF | IFAS UNIVERSITY of FLORIDA

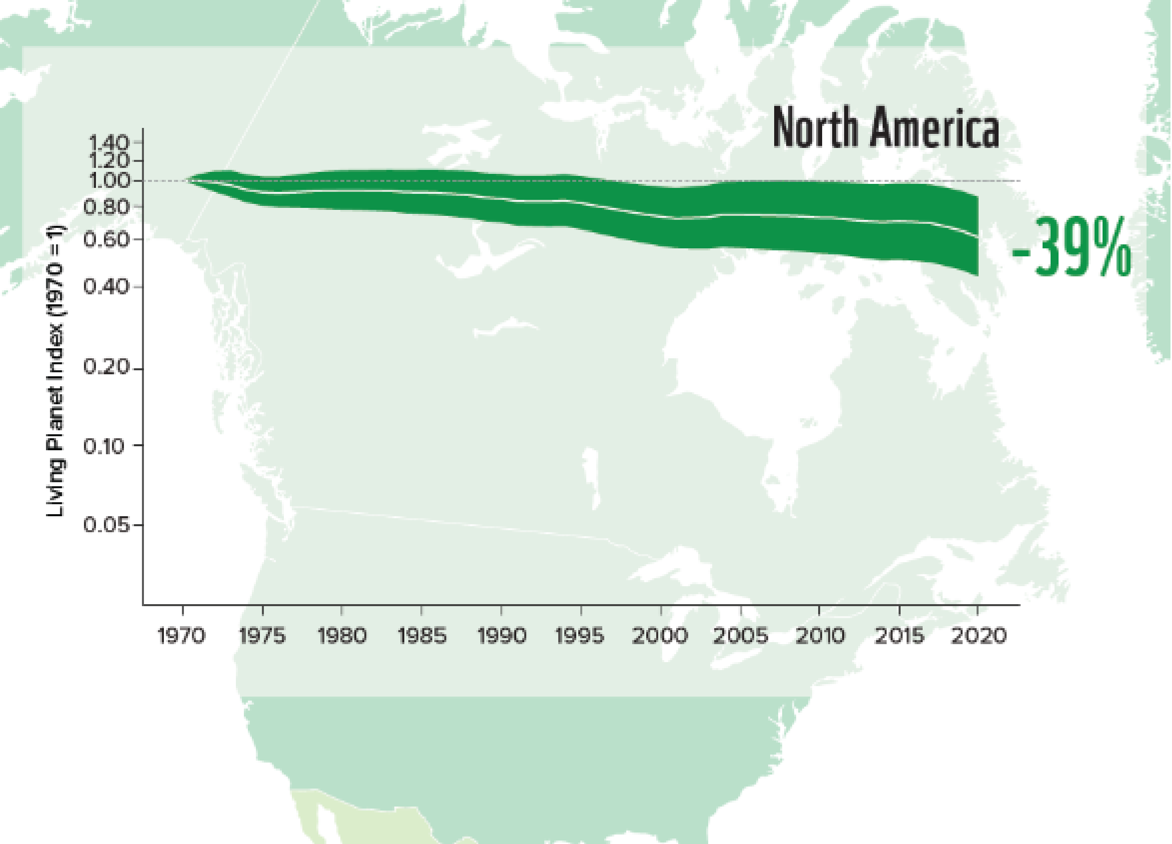
ENTOMOLOGY & NEMATOLOGY Department

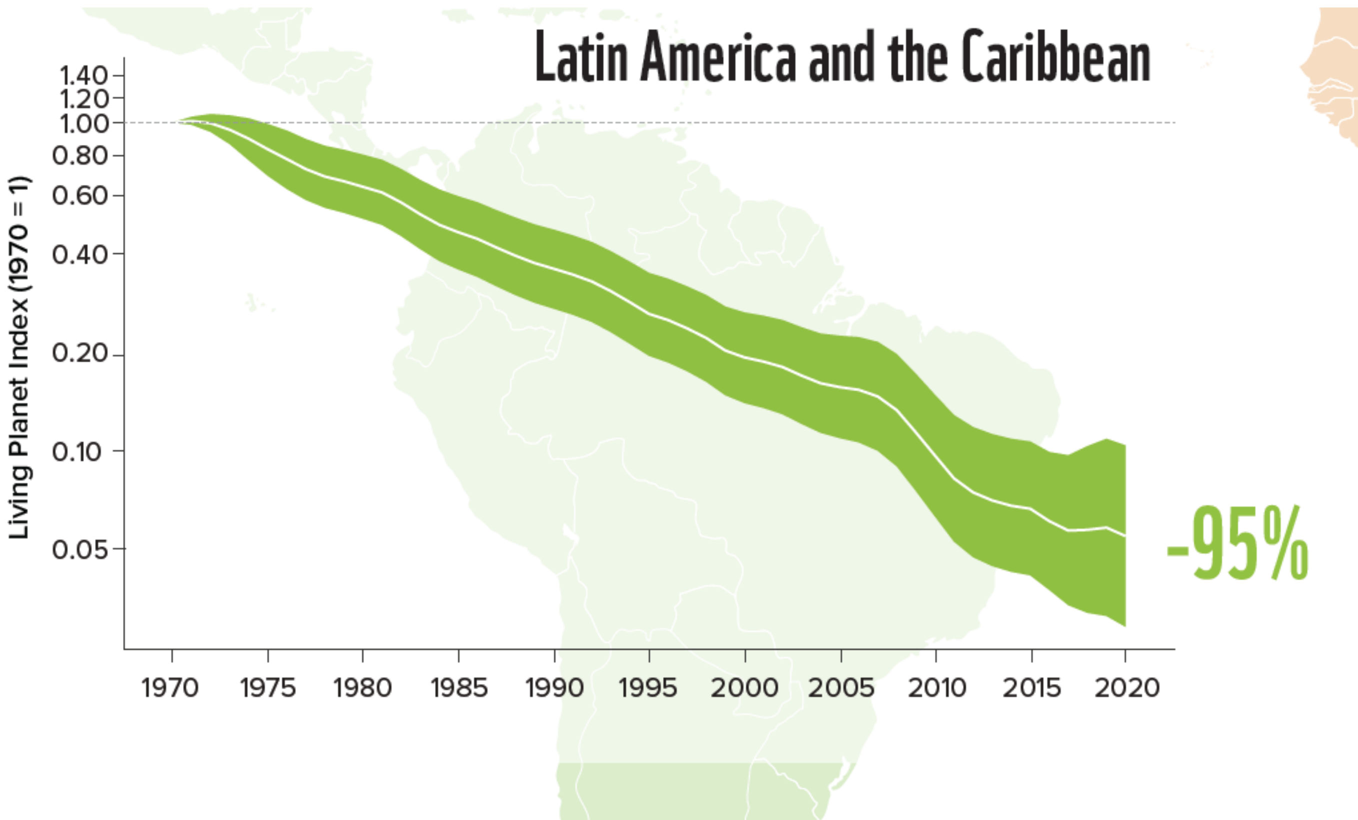




Catastrophic 73% decline in the average size of monitored wildlife populations over just 50 years

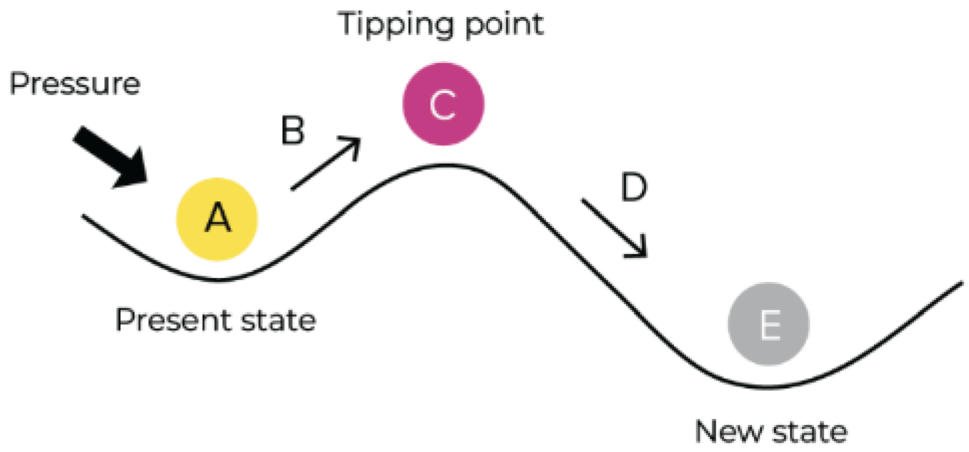
WWF (2024) Living Planet Report 2024 – A System in Peril. WWF, Gland, Switzerland.





Once ecosystems are damaged and degraded, they can become more vulnerable to tipping points.

That's when pressures such as habitat loss, land-use change, or climate change push ecosystems beyond a critical threshold, resulting in substantial and potentially irreversible change.



WWF (2024) Living Planet Report 2024 – A System in Peril. WWF, Gland, Switzerland.

- Insects and other arthropods create the biological foundation for all terrestrial ecosystems
- Insects are the most diverse group in the animal kingdom, with an estimated 5.5 million species
- At any time, it is estimated that there are some 10 quintillion (10,000,000,000,000,000,000) individual insects alive

May, R. M. 1988. How many species are there on earth? Science, Volume 241: 441-1449.

Beneficials

Functional biodiversity = range of ecological services that organisms contribute to communities and ecosystems

- Pollination
- Natural Pest Control
- Nutrient Recycling
- Decomposition
- Food for Wildlife

Is of high ecological importance because it influences ecosystem dynamics, productivity and stability

Photo by Lyle J. Buss

Photo by Richard Orr

https://birdwatchinghq.com/flowers-for-bees/

https://www.mccallservice.com/blog/what-is-an-earwig/

Insect Pollination

- Animals are responsible for the pollination of 87.5% of all flowering plants on Earth, the bulk of this service is delivered by insects.

https://www.ncsl.org/research/health/pharmaceuticals.aspx

Mark Sulc

https://www.earth.com/news/restoring-americas-prairies/

Alex Westner

https://davesgarden.com/guides/articles/the-buzz-about-bumblebees

https://extension.illinois.edu/blogs/extensions-greatest-hits/2014-09-26-hover-flies-may-look-bees-are-beneficial-flies

https://bugguide.net/node/view/402024

Photo Credit: Beverly Meekins

https://www.bluecrossanimalhospital.ca/pet-hazards/beeswasps-stings-and-your-pet/

https://www.scfbins.com/articles/limiting-unintended-exposure-and-harm-pesticide-use

Sustainability and Resilience

PNAS

Non-bee insects are important contributors to global crop pollination

Romina Rader, Ignasi Bartomeus, Lucas A. Garibaldi, Michael P. D. Garratt, Brad G. Howlett, Rachael Winfree, Saul A. Cunningham, Margaret M. Mayfield, Anthony D. Arthur, Georg K. S. Andersson, Riccardo Bommarco, Claire Brittain, Luisa G. Carvalheiro, Natacha P. Chacoff, Martin H. Entling, Benjamin Foully, Breno M. Freitas, Barbara Gemmill-Herren, Jaboury Ghazoul, Sean R. Griffin, Caroline L. Gross, Lina Herbertsson, Felix Herzog, Juliana Hipólito, Sue Jaggar, Frank Jauker, Alexandra-Maria Klein, David Kleijn, Smitha Krishnan, Camila Q. Lemos, Sandra A. M. Lindström, Yael Mandelik, Victor M. Monteiro, Warrick Nelson, Lovisa Nilsson, David E. Pattemore, Natália de O. Pereira, Gideon Pisanty, Simon G. Potts, Menno Reemer, Maj Rundlöf, Cory S. Sheffield, Jeroen Scheper, Christof Schüepp, Henrik G. Smith, Dara A. Stanley, Jane C. Stout, Hajnalka Szentgyörgyi, Hisatomo Taki, Carlos H. Vergara, Blandina F. Viana, and Michal Woyciechowski

https://www.audubon.org/news/global-study-reveals-extent-habitat-fragmentation

Contents lists available at ScienceDirect
Agriculture, Ecosystems and Environment
journal homepage: www.elsevier.com/locate/agee

Wild pollinators improve production, uniformity, and timing of blueberry crops

Charles C. Nicholson[a,b,1], Taylor H. Ricketts[a,b,c,1]

OPEN ACCESS Freely available online
PLOS ONE

Bee Species Diversity Enhances Productivity and Stability in a Perennial Crop

Shelley R. Rogers*, David R. Tarpy, Hannah J. Burrack

Contents lists available at ScienceDirect
Agriculture, Ecosystems and Environment
journal homepage: www.elsevier.com/locate/agee

Hummingbirds, honeybees, and wild insect pollinators affect yield and berry quality of blueberries depending on cultivar and farm's spatial context

Andrés F. Ramírez Mejía[a,*], Silvia Lomáscolo[a], Pedro G. Blendinger[a,b]

Contents lists available at ScienceDirect
Agriculture, Ecosystems and Environment
journal homepage: www.elsevier.com/locate/agee

Optimal pollination thresholds to maximize blueberry production

Andrés F. Ramírez Mejía[a,*], Natacha P. Chacoff[a,b], Silvia B. Lomáscolo[a], Ben A. Woodcock[c], Reto Schmucki[c], Pedro G. Blendinger[a,b]

Received: 10 February 2023 | Accepted: 14 September 2023
DOI: 10.1111/1365-2664.14536
Journal of Applied Ecology

REVIEW

Synthesis of highbush blueberry pollination research reveals region-specific differences in the contributions of honeybees and wild bees

Maxime Eeraerts[1,2,3] | Lisa W. DeVetter[2] | Péter Batáry[4] | John J. Ternest[5] | Rachel Mallinger[5] | Matthew Arrington[6] | Faye E. Benjamin[7] | Brett R. Blaauw[8] | Joshua W. Campbell[9] | Pablo Cavigliasso[10] | Jaret C. Daniels[11] | G. Arjen de Groot[12] | James D. Ellis[5] | Jason Gibbs[13] | Lauren Goldstein[1] | George D. Hoffman[14] | David Kleijn[15] | Andony Melathopoulos[16] | Sharron Z. Miller[1] | Ana Montero-Castaño[17] | Shiala M. Naranjo[5] | Charlie C. Nicholson[18] | Jacquelyn A. Perkins[1] | Sujaya Rao[19] | Nigel E. Raine[17] | James R. Reilly[20] | Taylor H. Ricketts[21] | Emma Rogers[2] | Rufus Isaacs[1]

Enhanced insect pollination services increases blueberry fruit set, berry weight, seed set, and ripening time

https://www.backyardecology.net/southeastern-blueberry-bee/

https://blogs.ifas.ufl.edu/duvalco/2023/05/22/growing-blueberries-in-your-jacksonville-backyard/

Globally, over half of GDP (55%) – or an estimated US$58 trillion – is moderately or highly dependent on nature and its services.

Between US$235 billion and US$577 billion worth of annual global food production relies on direct contributions by pollinators

Estimated value of those insect services is nearly $60 billion a year in the United States, which is only a fraction of the value for all the services insects provide

Edible insect market will exceed $710 million globally by 2024

Illa J, Yuguero O. An Analysis of the Ethical, Economic, and Environmental Aspects of Entomophagy. Cureus. 2022 Jul 14;14(7):e26863

Economic Value of Ecological Services Provided by Insects. BioScience. (2006)

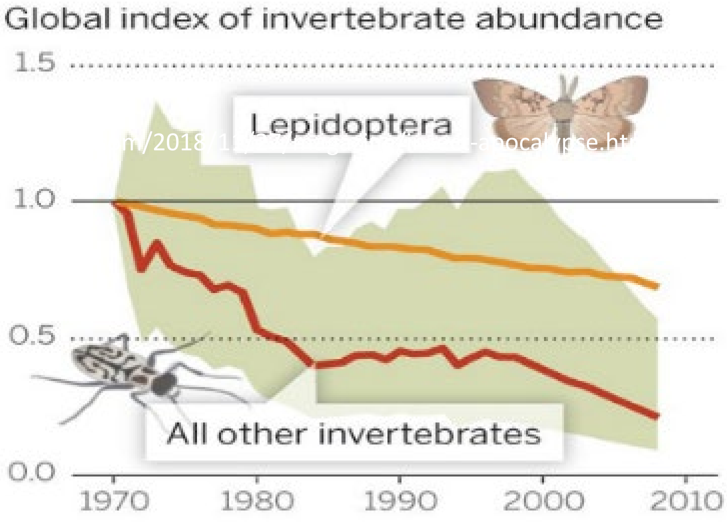
IPBES (2016). The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production. S.G. Potts, V. L. Imperatriz-Fonseca, and H. T. Ngo (eds).

Evison W, Low LP, O’Brien D. Managing Nature Risks: From Understanding to Action. PWC, 2023.

FEATURE

The Insect Apocalypse Is Here

What does it mean for the rest of life on Earth?



Conservation

Robust evidence of insect declines

William E. Kunin

Data are mounting that document widespread insect losses. A long-term research project now provides the strongest evidence of this so far, and demonstrates the value of standardized monitoring programmes. See p.671

Insect Declines in the Anthropocene

Annual Review of Entomology
Vol. 65:457-480 (Volume publication date January 2020)
First published as a Review in Advance on October 14, 2019
https://doi.org/10.1146/annurev-ento-011019-025151

David L. Wagner
Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut 06269, USA; email: david.wagner@uconn.edu

frontiers in Ecology and Evolution
PERSPECTIVE
published: 03 July 2019
doi: 10.3389/fevo.2019.00258

Western Monarch Population Plummets: Status, Probable Causes, and Recommended Conservation Actions

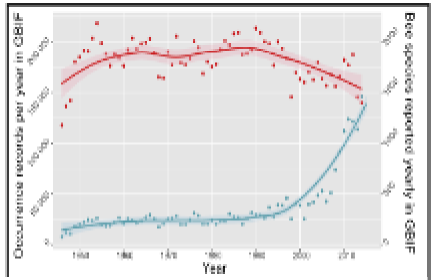
Emma M. Pelton[1], Cheryl B. Schultz[2], Sarina J. Jepsen[1], Scott Hoffman Black[1] and Elizabeth E. Crone[3]*

Article

One Earth

Worldwide occurrence records suggest a global decline in bee species richness

Graphical abstract



Authors
Eduardo E. Zattara, Marcelo A. Aizen

Correspondence
ezattara@comahue-conicet.gob.ar

In brief
Wild bees are key to pollination of wild and crop plants, and local and regional reports of their decline are cause for concern. Since there are no global long-term datasets of bee diversity, we analyzed historical occurrence data from collections and observations gathered by the Global Biodiversity Information Facility and found that the number of bee species worldwide has been steadily decreasing since the 1990s as a result of either concerted changes in data-gathering strategies or, most likely, an actual global decline in bee diversity.

RESEARCH

INSECT POPULATIONS

Meta-analysis reveals declines in terrestrial but increases in freshwater insect abundances

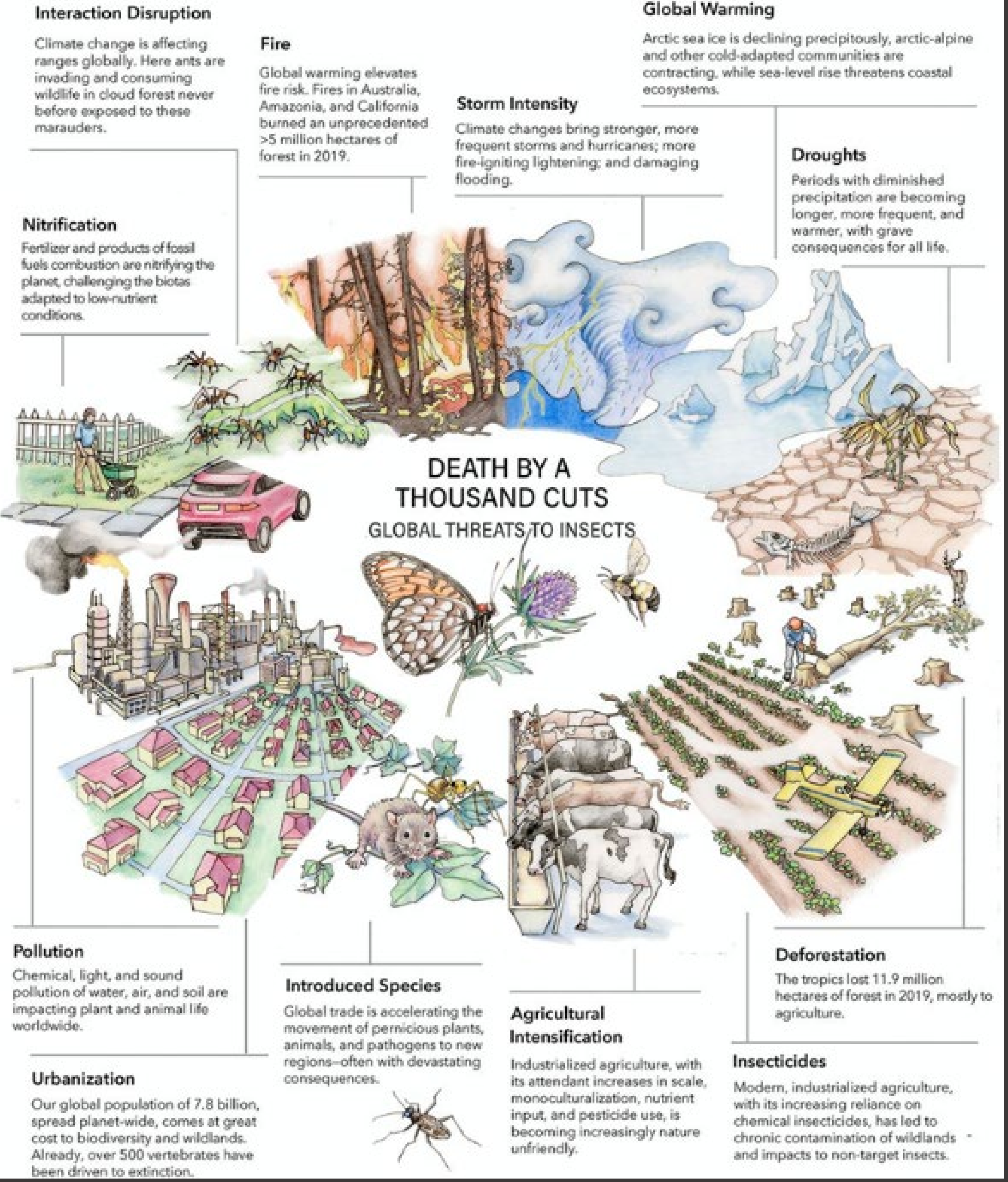
Roel van Klink[1,2,3]*, Diana E. Bowler[1,4,5], Konstantin B. Gongalsky[6,7], Ann B. Swengel[8], Alessandro Gentile[1], Jonathan M. Chase[1,9]

BIOLOGICAL CONSERVATION 132 (2006) 279–291
available at www.sciencedirect.com
SCIENCE DIRECT
journal homepage: www.elsevier.com/locate/biocon
ELSEVIER

Rapid declines of common, widespread British moths provide evidence of an insect biodiversity crisis

Kelvin F. Conrad[a,*], Martin S. Warren[b], Richard Fox[b], Mark S. Parsons[a], Ian P. Woiwod[a]

Every Landscape Counts



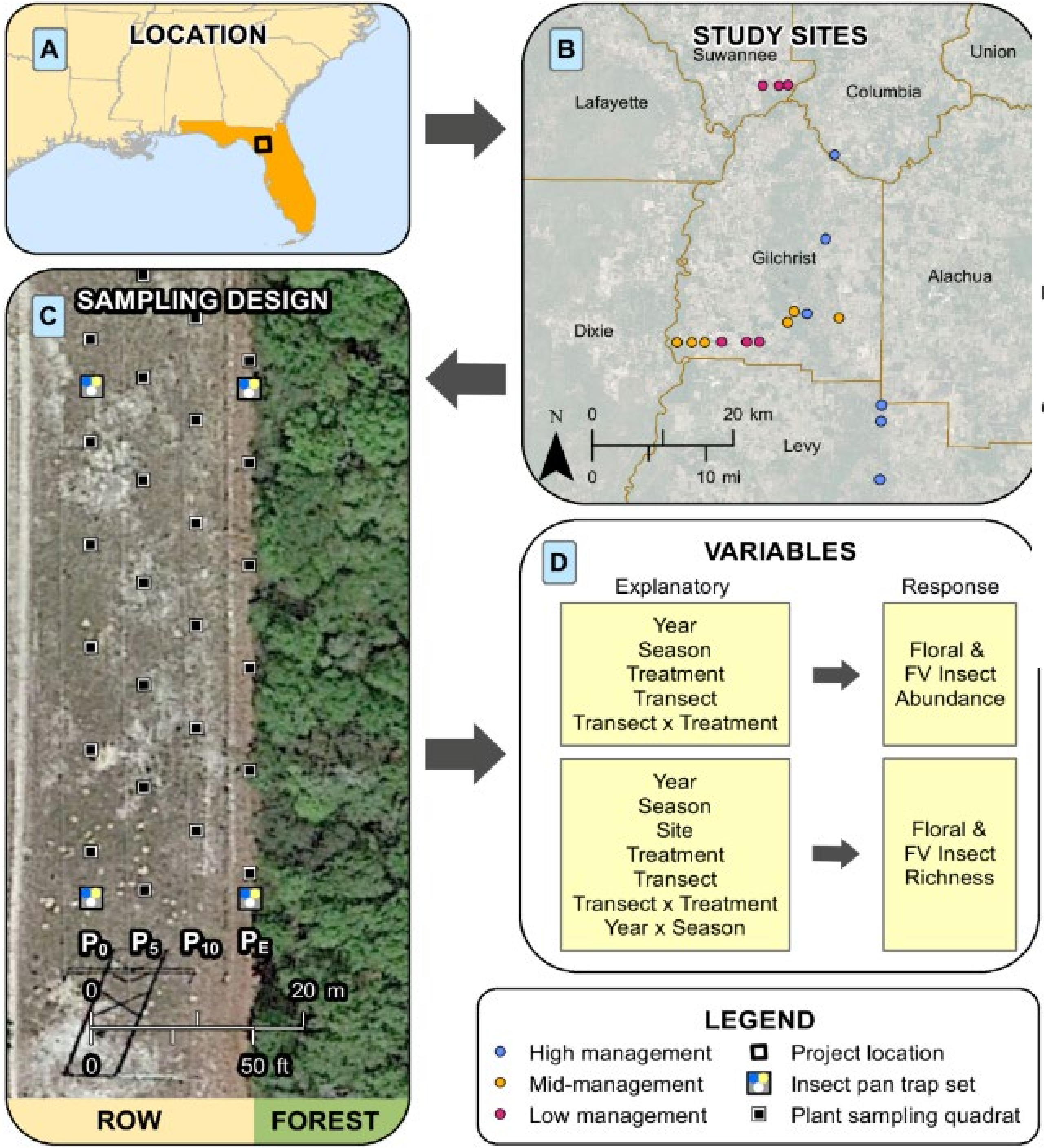
David L. Wagner et al. PNAS 2021;118:2:e2023989118

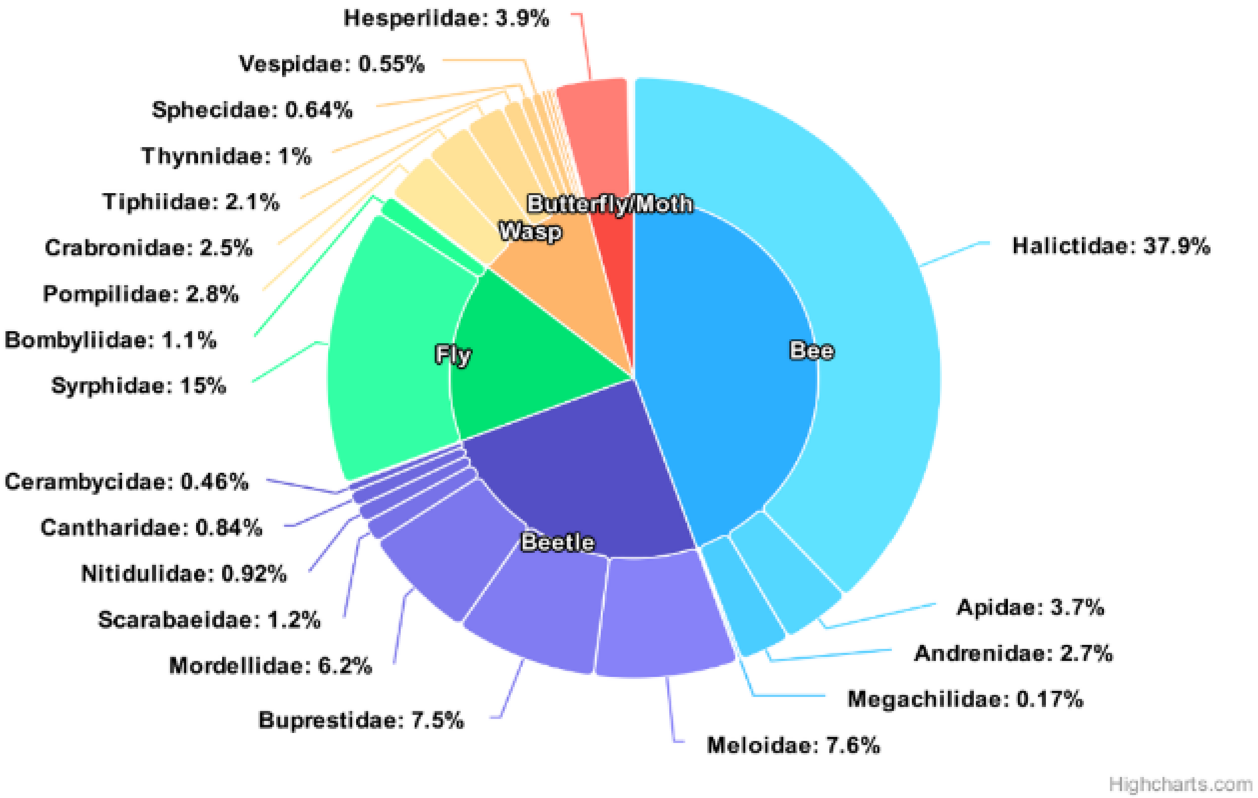
PLOS ONE

RESEARCH ARTICLE

Integrated vegetation management within electrical transmission landscapes promotes floral resource and flower-visiting insect diversity

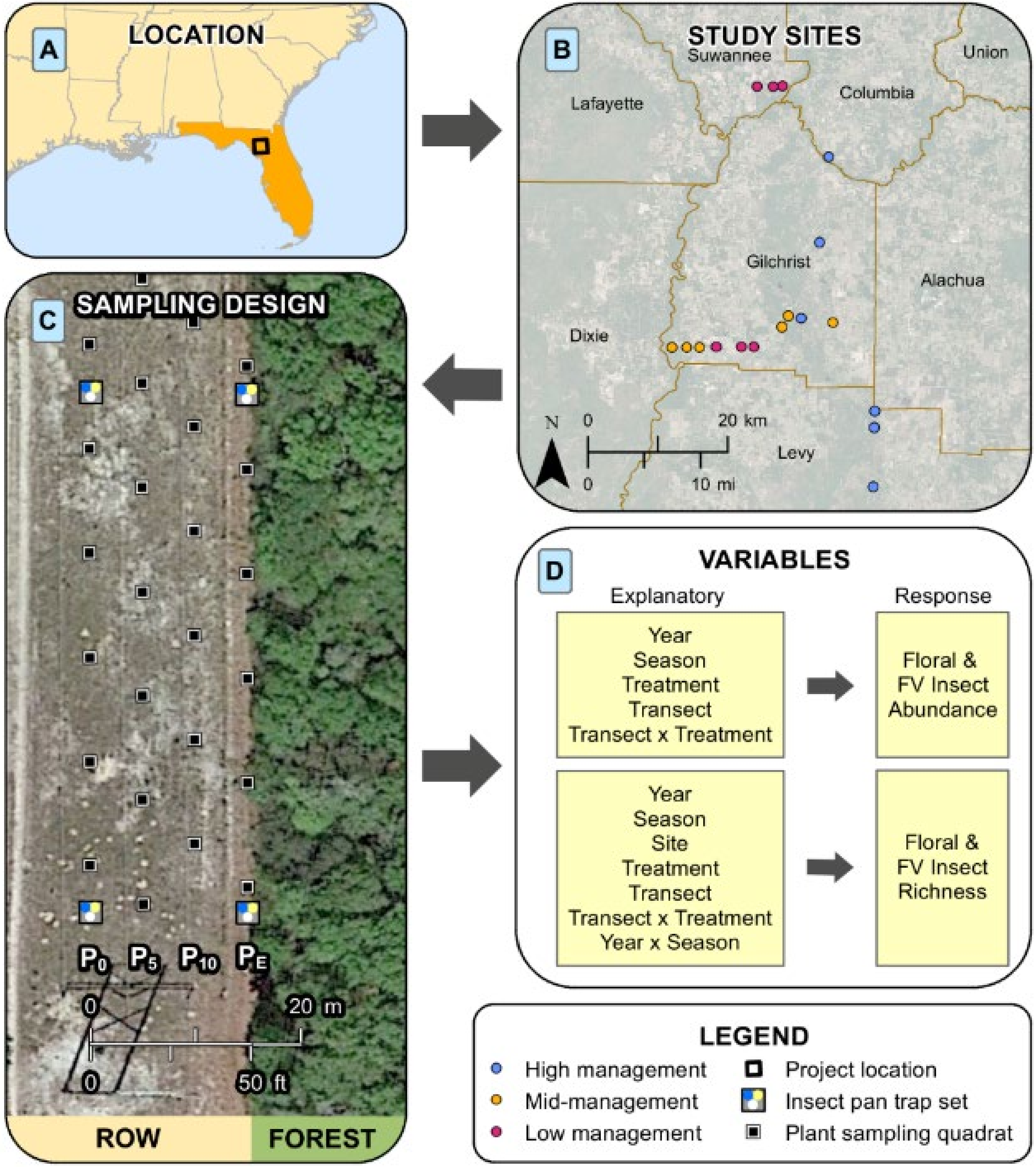
Chase B. Kimmel[1*], Ivone de Bem Oliveira[1], Joshua W. Campbell[1,2], Emily Khazan[1], Jonathan S. Bremer[1,3], Kristin Rossetti[1], Matthew Standridge[1], Tyler J. Shaw[1], Samm Epstein[1], Alexandra Tsalickis[1,4], Jaret C. Daniels[1,5]



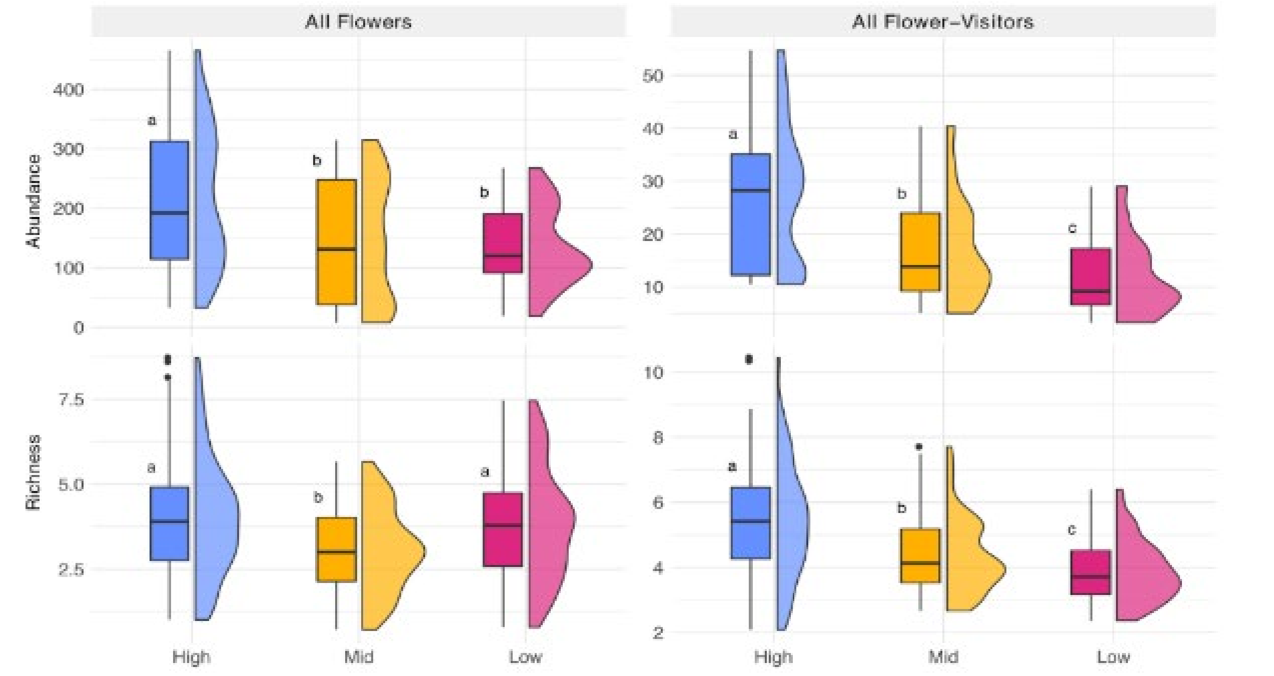


We identified 76541 flowers/inflorescences across 456 transects, including 188 species in 56 plant families.

We obtained data on 11361 flower-visiting insects representing 33 families



High management intensity of electrical transmission ROW has a significant positive impact on flowering plants and flower-visiting insect abundance and richness, mutually supporting positive outcomes for the transmission of energy and for pollinator conservation.

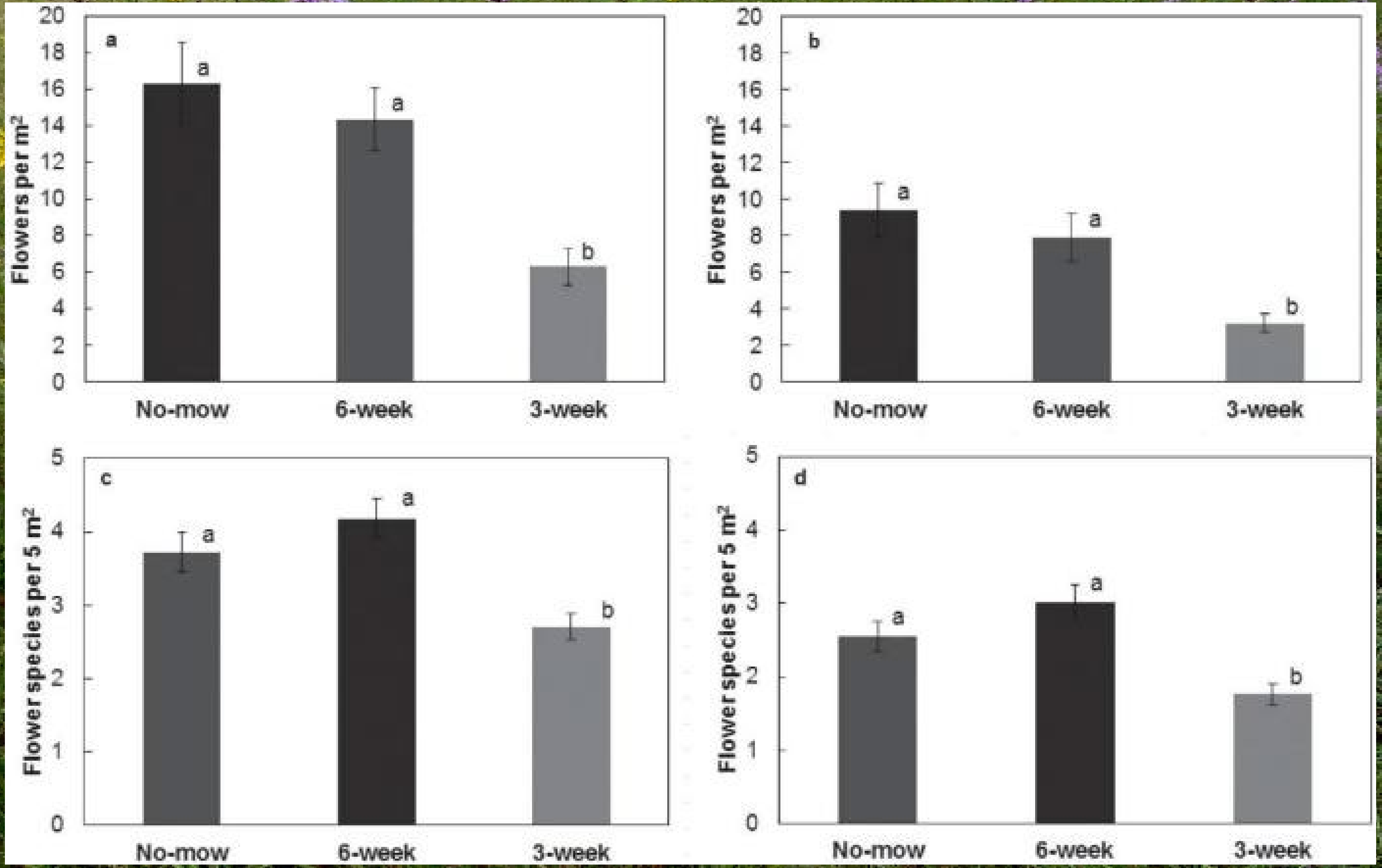


Reducing mowing frequency increases floral resource and butterfly (Lepidoptera: Hesperioidea and Papilionoidea) abundance in managed roadside margins

Dale A. Halbritter[1,], Jaret C. Daniels[2], Douglas C. Whitaker[3], and Lei Huang[4]*

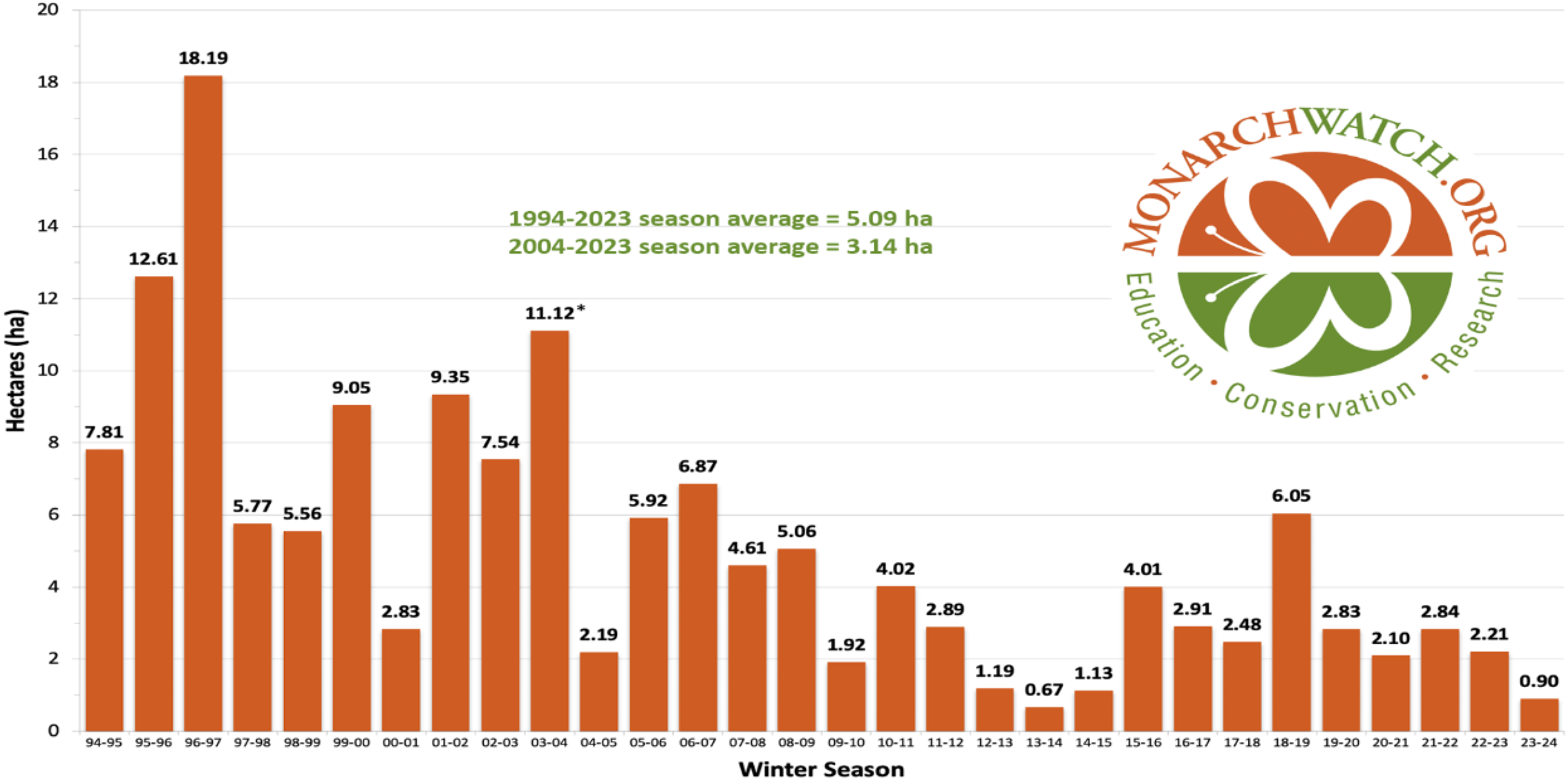
133 herbaceous flowering plant species in 42 families

11 orders and 147 families



https://www.flawildflowers.org/roadsides/

Total Area Occupied by Monarch Colonies at Overwintering Sites in Mexico



1994-2003 data collected by personnel of the Monarch Butterfly Biosphere Reserve (MBBR) of the National Commission of Natural Protected Areas (CONANP) in Mexico. 2004-2023 data collected by World Wildlife Fund Mexico in collaboration with the National Commission of Natural Protected Areas (CONANP), the National Autonomous University of Mexico (UNAM), and the MBBR. * Represents colony sizes measured in November of 2003 before the colonies consolidated. Measures obtained in January 2004 indicated the population was much smaller, possibly 8-9 hectares. CT

Kristin Grace

The declines over the last 20 to 30 years led to a formal petition in 2014 to list the species as threatened or endangered under the US Endangered Species Act (ESA) and a recommendation in 2016 for listing as endangered under the Canadian Species at Risk act (SARA).


insects
MDPI
Article
Better Understanding the Potential Importance of Florida Roadside Breeding Habitat for the Monarch
Jaret Daniels [1,2,*], Chase Kimmel [1,2], Simon McClung [1], Samm Epstein [1], Jonathan Bremer [1]
and Kristin Rossetti [1]

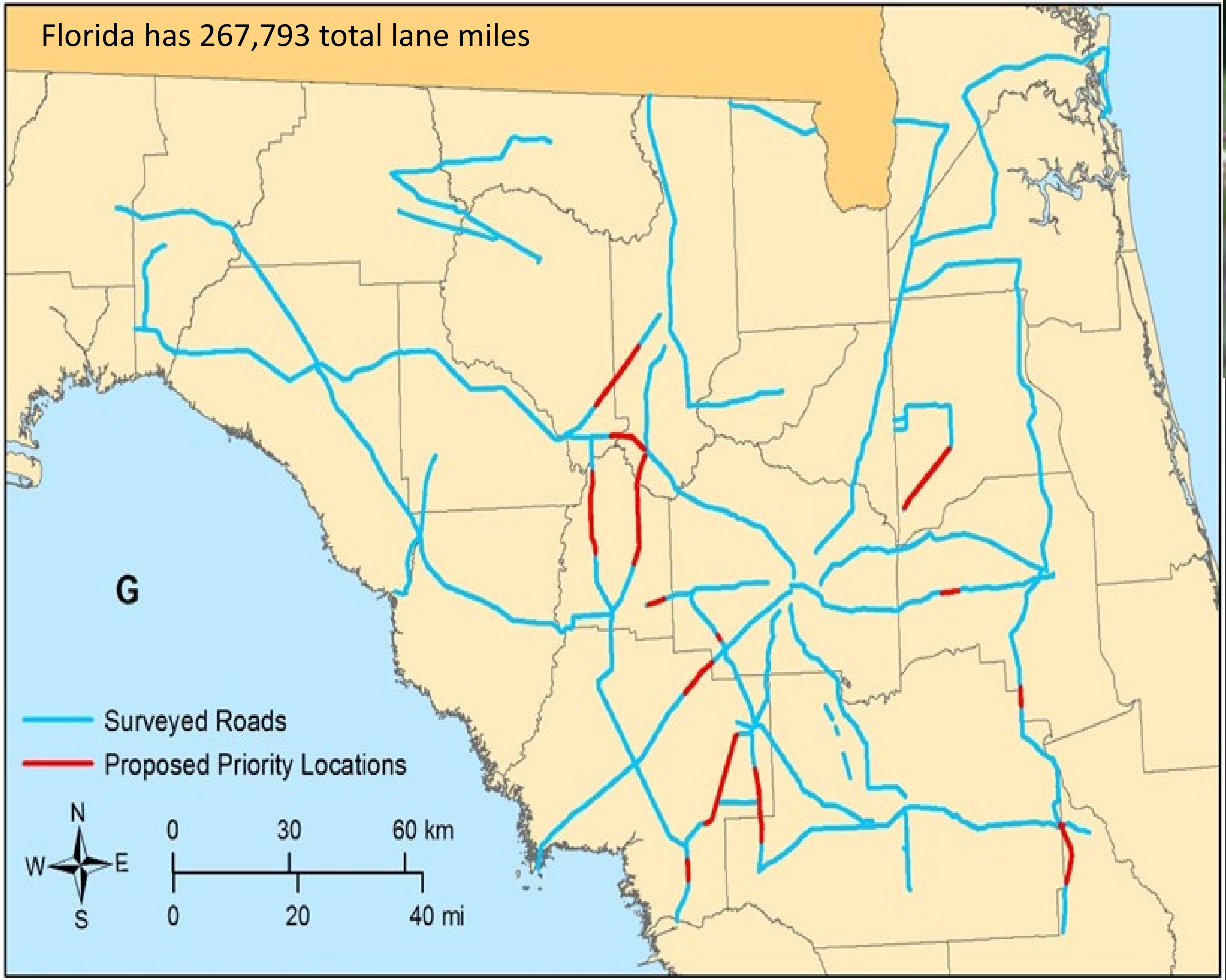


Photo: Eleanor Dietrich

UF Informatics

ARTIFICIAL INTELLIGENCE AT UNIVERSITY OF FLORIDA

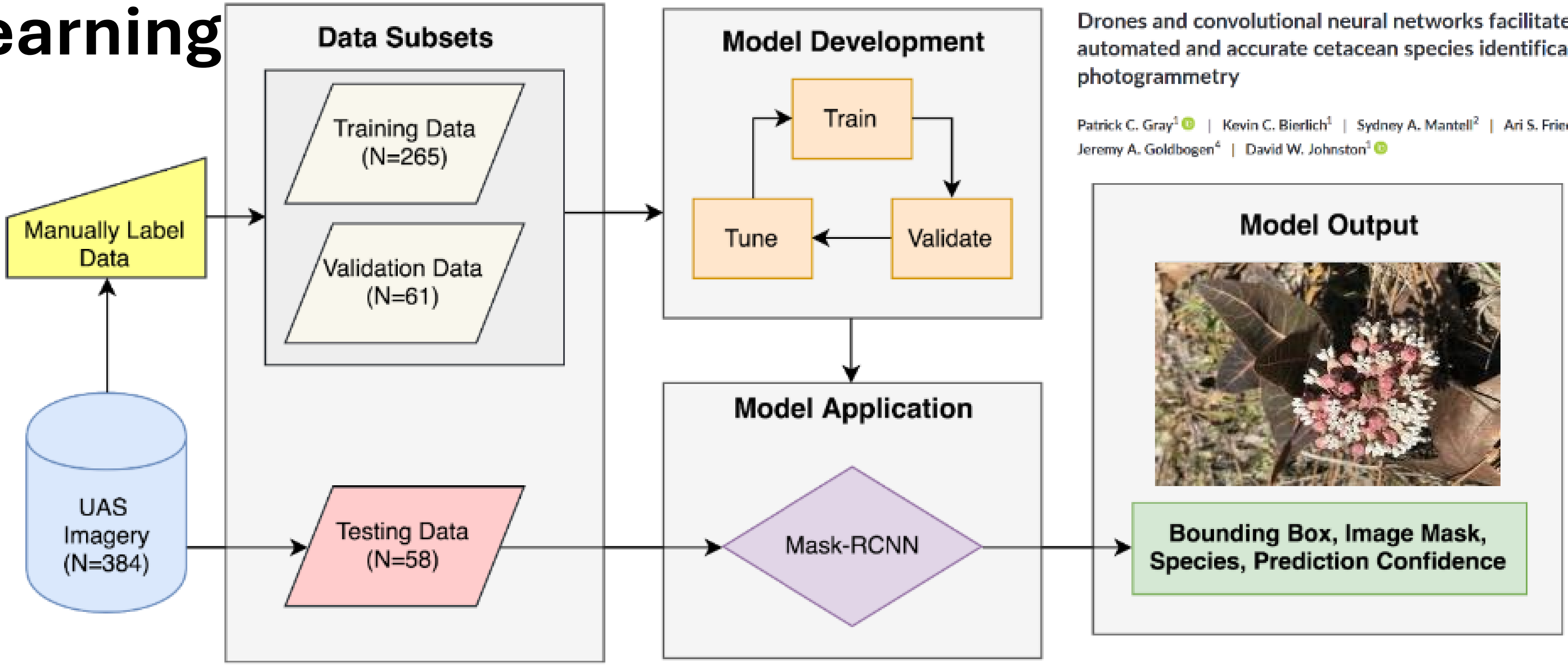
Deep Learning

RESEARCH ARTICLE

Methods in Ecology and Evolution

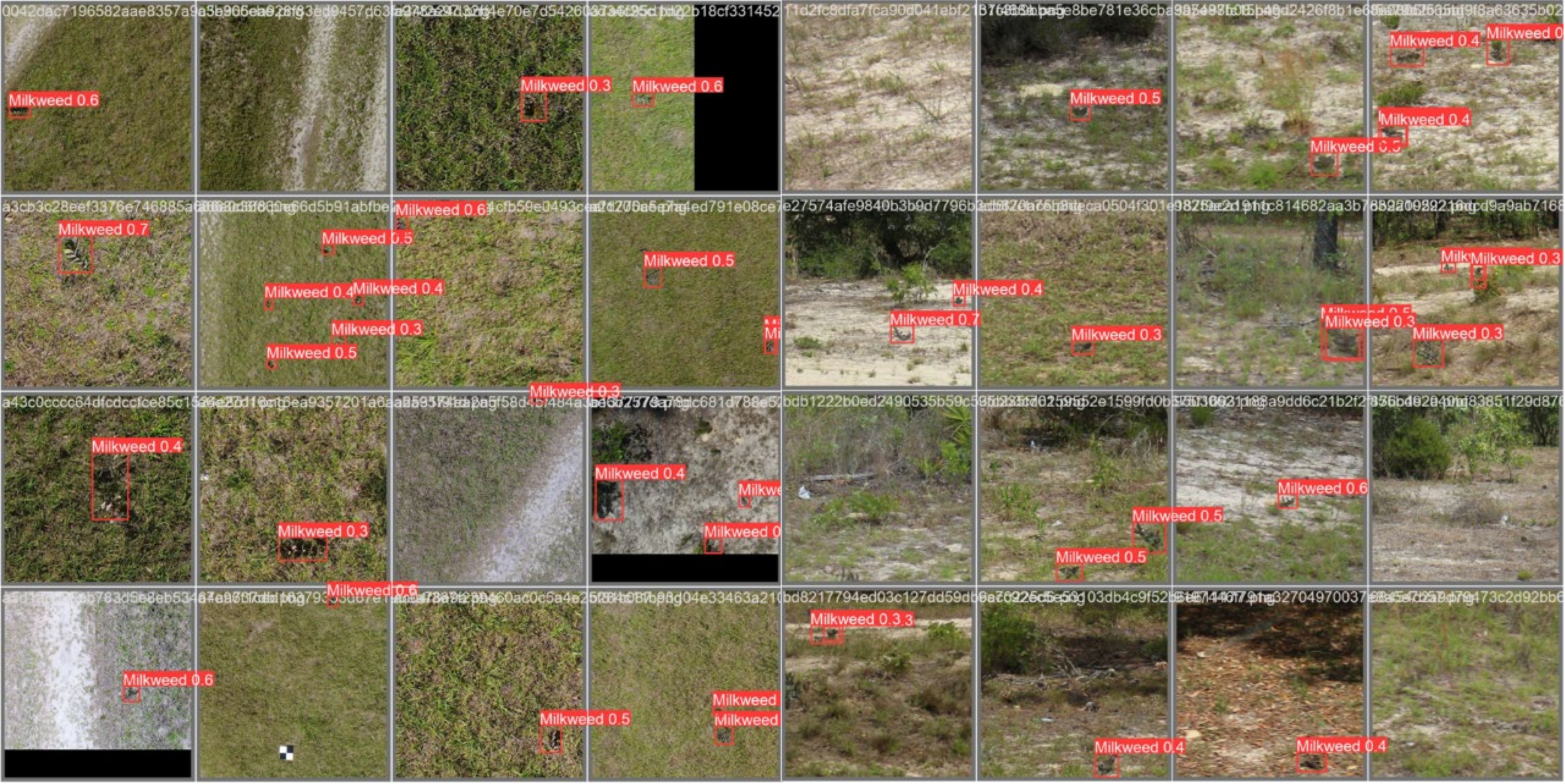
Drones and convolutional neural networks facilitate automated and accurate cetacean species identification and photogrammetry

Patrick C. Gray[1] | Kevin C. Bierlich[1] | Sydney A. Mantell[2] | Ari S. Friedlaender[3] | Jeremy A. Goldbogen[4] | David W. Johnston[1]



Example workflow – different models are useful for certain applications. We can use a system like AIDE (Annotation Interface for Data-driven Ecology) to help with the process of choosing a model and training it.

Deep learning is a subfield of ML that uses neural networks to automate feature extraction, permitting raw data to be input into a computer and creating high-level abstractions to inform decisions in classification, object detection, or other problems



Drones

Vehicle-Side

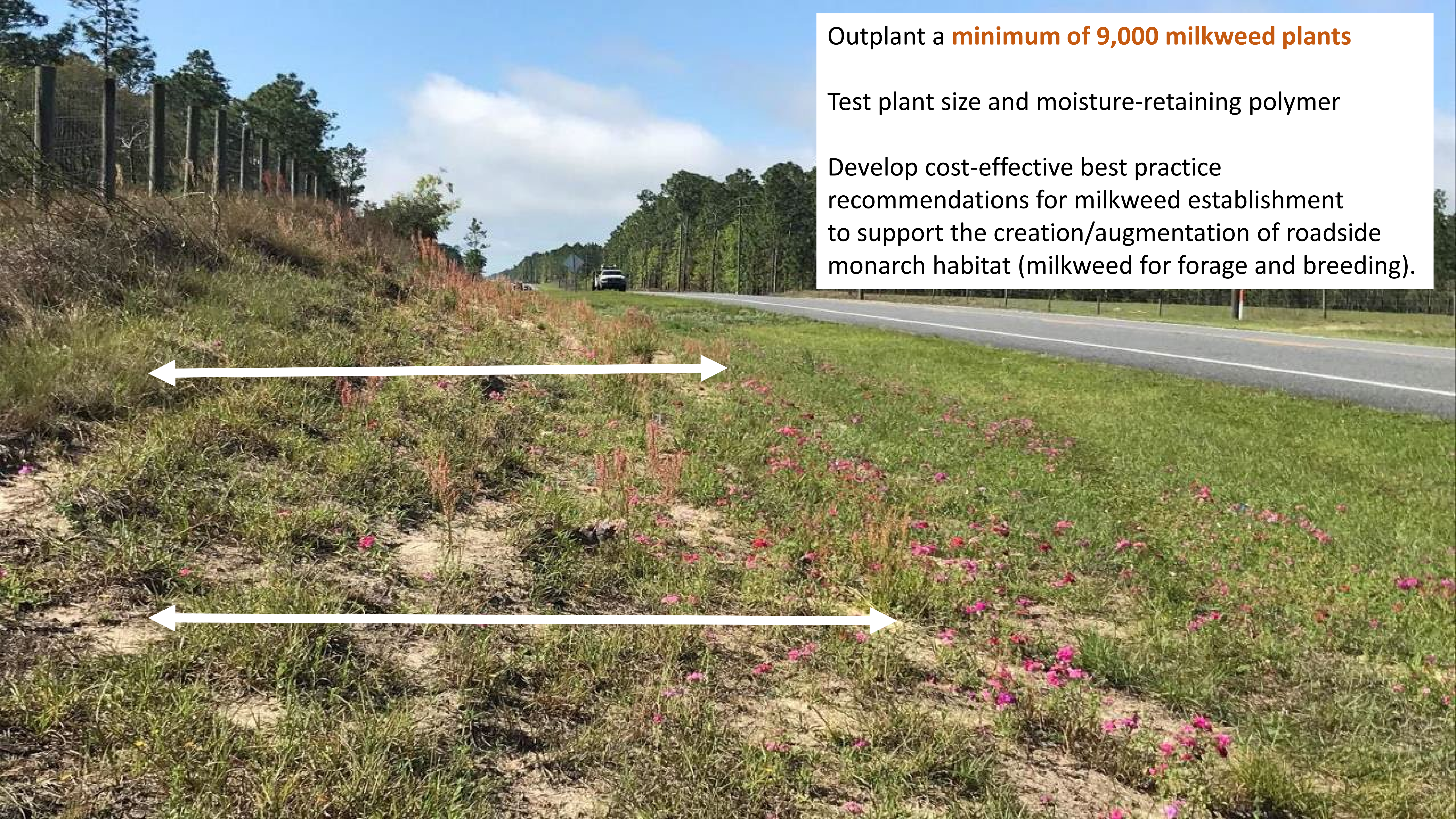
Nationwide CCAA for MONARCH BUTTERFLY

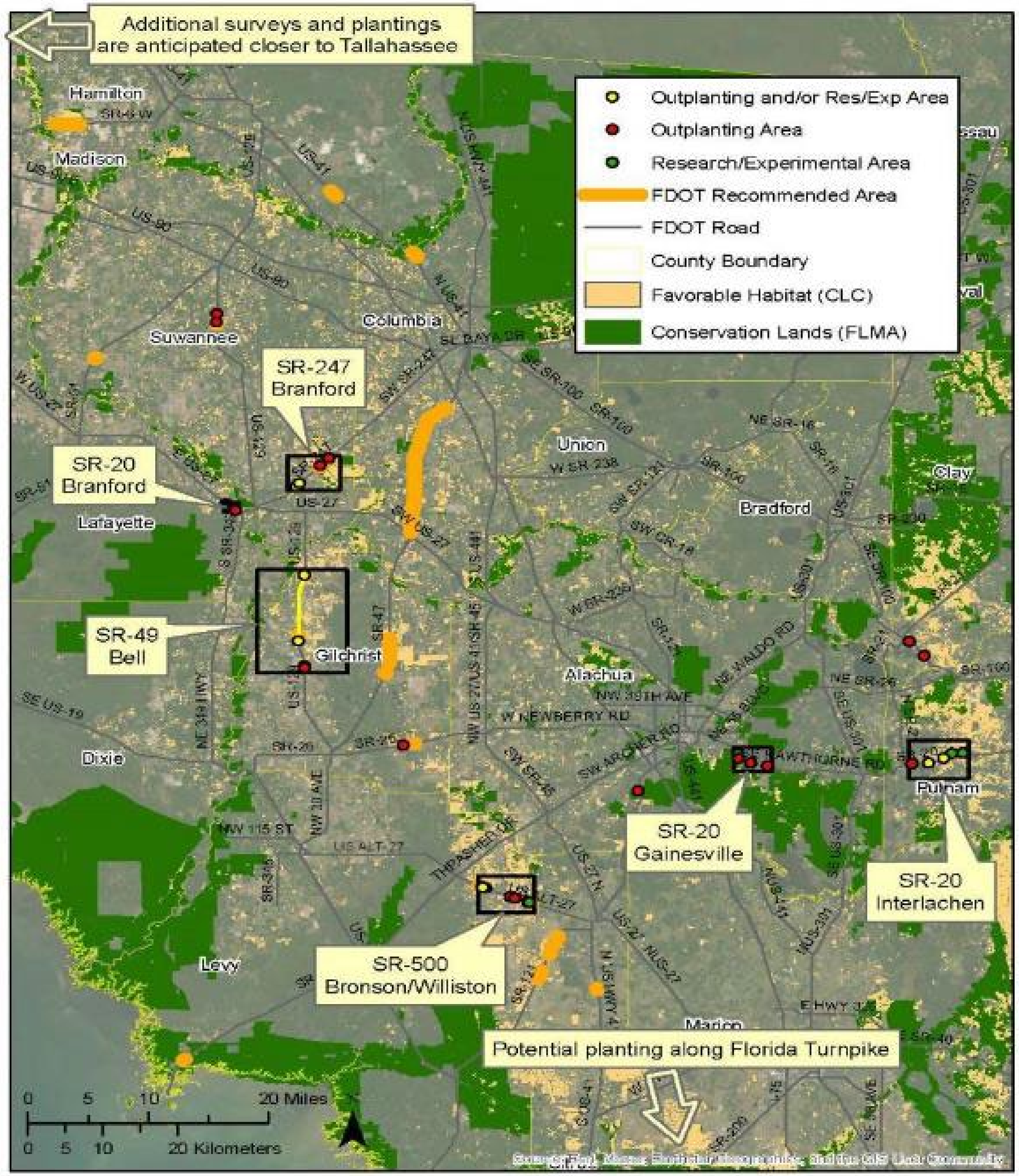
Management actions that benefit the monarch include brush removal, conservation-timed mowing, seeding or planting of native wildflowers, and pollinator-focused integrated vegetation management (IVM).

Outplant a **minimum of 9,000 milkweed plants**

Test plant size and moisture-retaining polymer

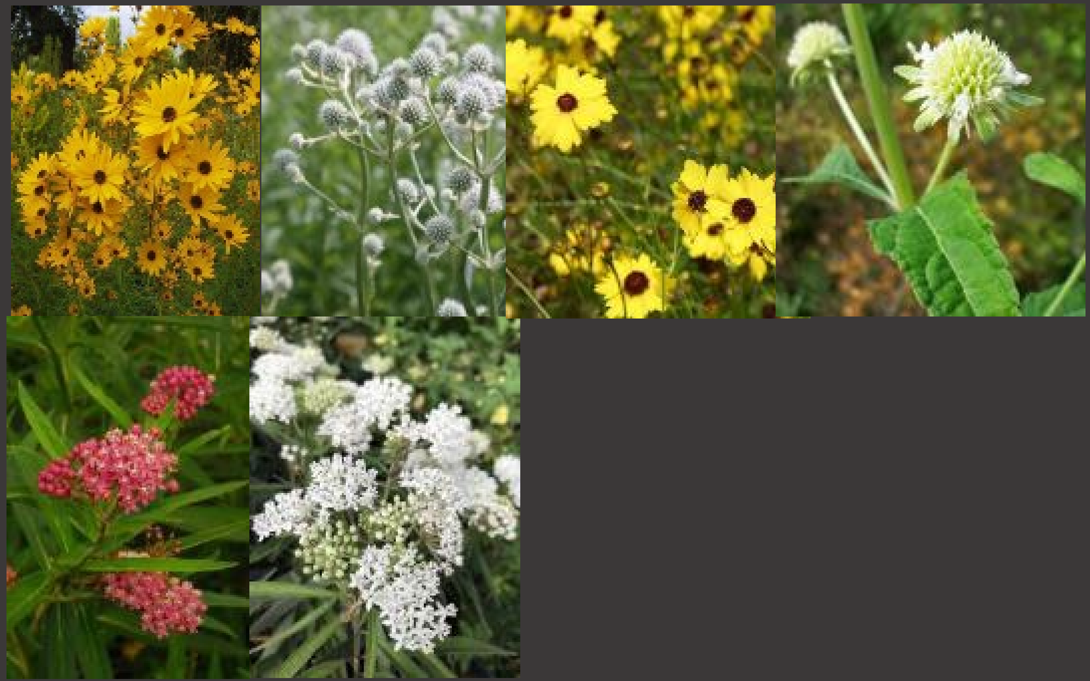
Develop cost-effective best practice recommendations for milkweed establishment to support the creation/augmentation of roadside monarch habitat (milkweed for forage and breeding).




Additional surveys and plantings are anticipated closer to Tallahassee
Outplanting and/or Res/Exp Area
Outplanting Area
Research/Experimental Area
FDOT Recommended Area
FDOT Road
County Boundary
Favorable Habitat (CLC)
Conservation Lands (FLMA)
Hamilton
Madison
Suwannee
Columbia
Union
Bradford
Clay
Lafayette
Gilchrist
Alachua
Dixie
Putnam
Levy
Marion
SR-247
Branford
SR-20
Branford
SR-49
Bell
SR-20
Gainesville
SR-20
Interlachen
SR-500
Bronson/Williston
Potential planting along Florida Turnpike
0 5 10 20 Miles
0 5 10 20 Kilometers



Jul 17, 2024 at 12:57:54 PM
+30.019288,-82.837283
Suwannee County
Milkweed Area
FDOT



- Treatments - Larger plants, plugs, seed
- Establishment
- Pollinator use/monarch butterfly colonization
- Cost analysis

Duke Energy Solar Site Pollinator Habitat Establishment Trials

What plant installation rates and techniques provide optimal floral resources for pollinators while maximizing cost effectiveness

- Seeds
- Plugs
- 1 Gal containers

- Season
- Augmentation
- Moisture-retaining polymer

https://fresh-energy.org/electric-cooperatives-connecting-pollinator-conservation-and-clean-energy/

https://www.choosechicago.com/meeting-planners/contact-us/

According to the U.S. Census, over 80% of Americans live in or near cities

https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/ua-facts.html

Conservation in urban and residential settings

Creating spaces that

- Support diverse, abundant, and active wildlife in human-dominated systems
- Require reduced chemical inputs to maintain because they leverage natural regulatory processes
- Sustain the aesthetic and functional traits that are desired in an urban or residential landscape

Fundamental concepts for urban biodiversity conservation

1. Right plant, right place
2. Sustained resource availability
3. Vegetation diversity and structure
4. Predominantly native species

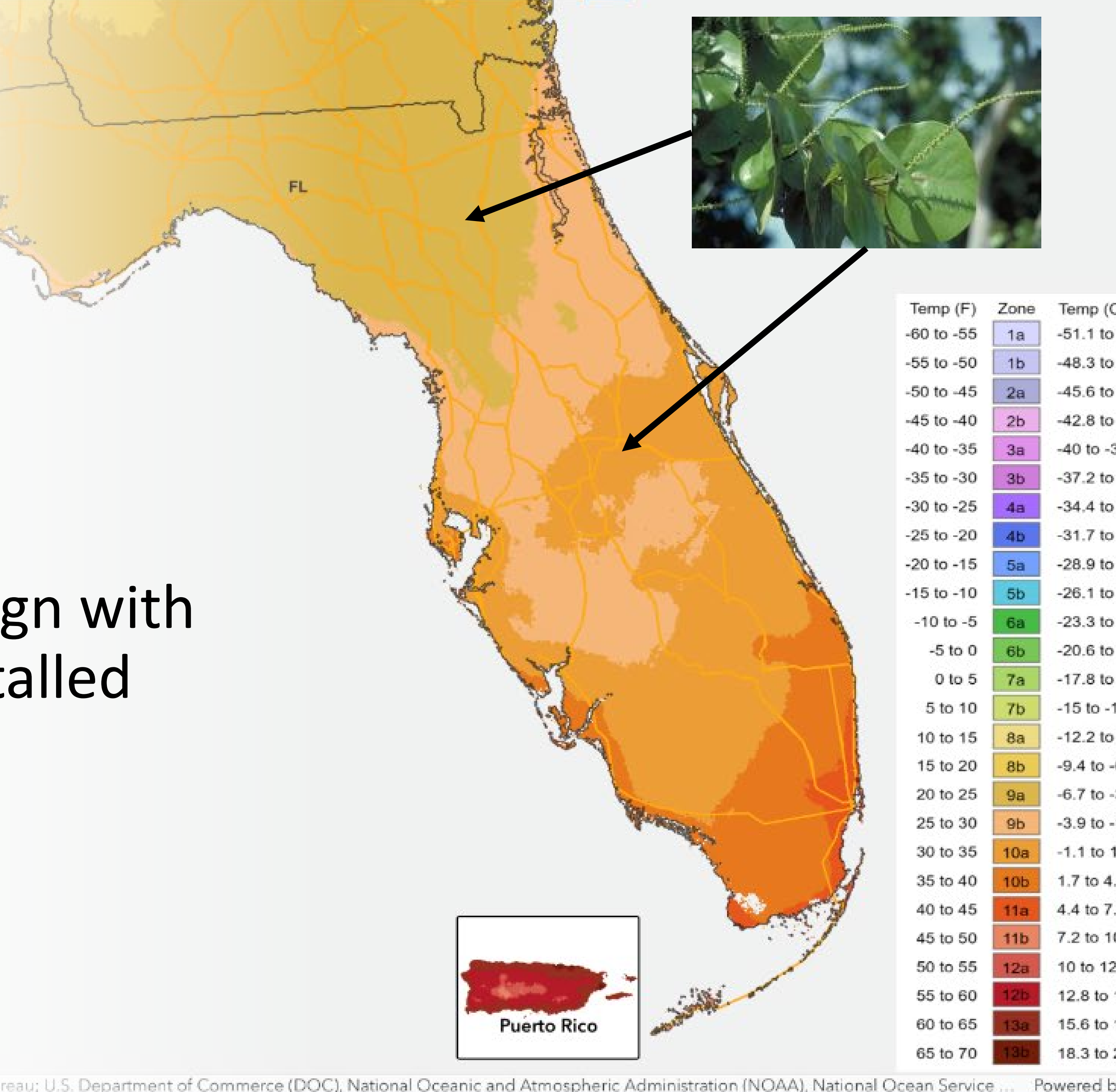
1. Right plant, right place

Consider factors that will determine a plant's long-term survival, condition, and ecological value

a. Landscape scale factors (Hardiness zone)
b. Local scale factors (planting site conditions)
c. External pressures (new pests or diseases)

a. Know your zone

- What zone are you in?
- Do your selected plants align with the zone they're being installed into?
- Has that changed??



b. Local landscape characteristics

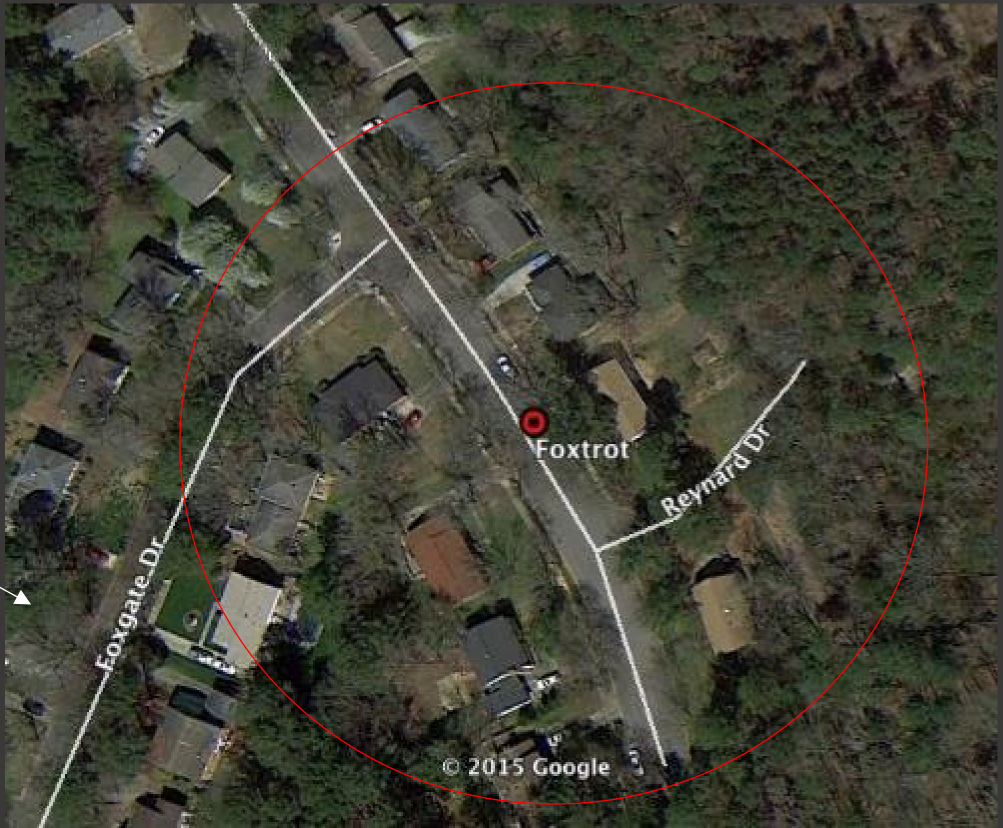
Local characteristics like impervious surface, root space, soil moisture, sun exposure, and many other factors influence

1. plant health
2. the insects that inhabit them

Both can influence a plant's conservation value

Hardscape
Vegetation
Temperature

3 miles apart



Dramatically different pest densities, tree health, and management needs

c. External pressures

Consider known risks in the landscape area/region like key pests and diseases that may inhibit your conservation goals

- Are your specified plant species susceptible to key pests present in the region?

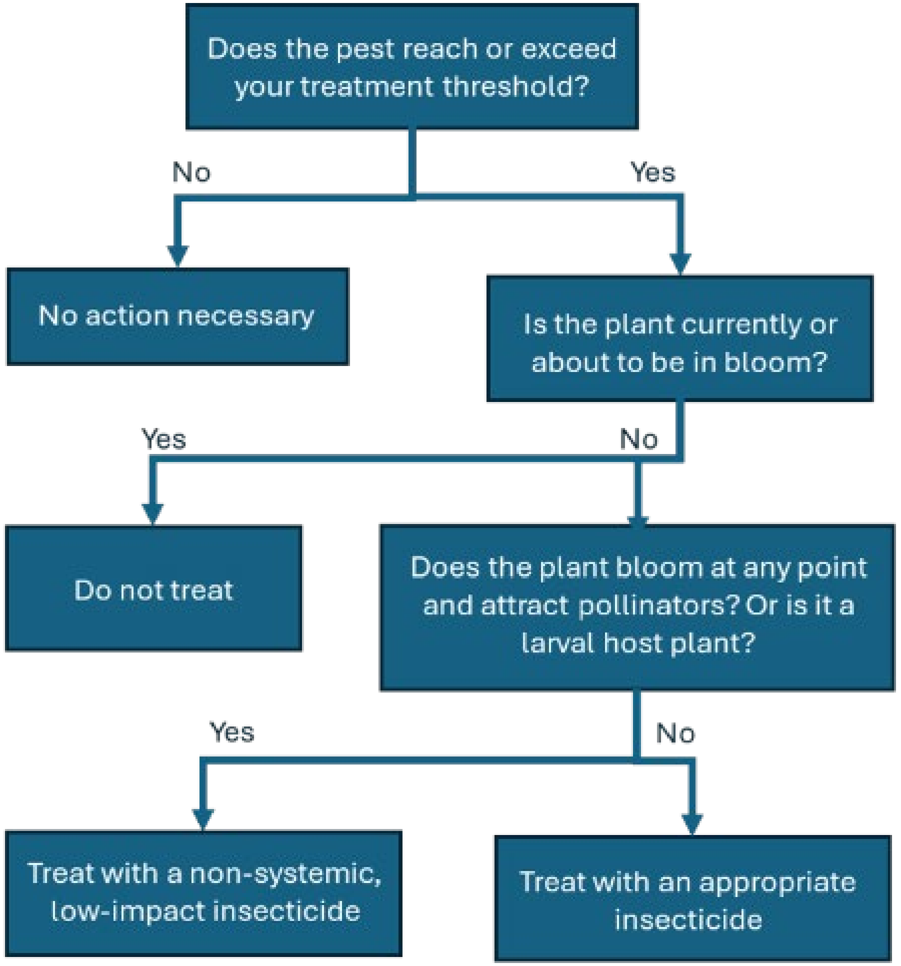
Crape myrtle, *Lagerstroemia indica*

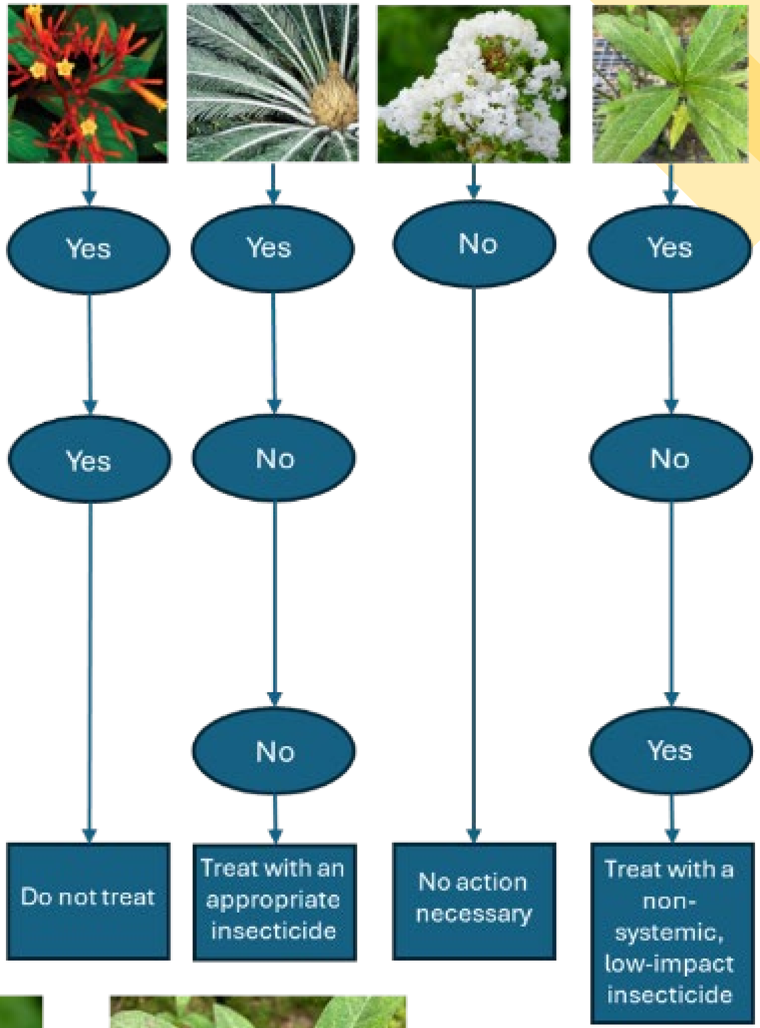
- Most common urban tree in the Southeast



Pest management can conflict with conservation goals

- Systemic insecticides are the most cost-effective and relied upon form of pest management
- There are downstream, non-target effects of insecticide use





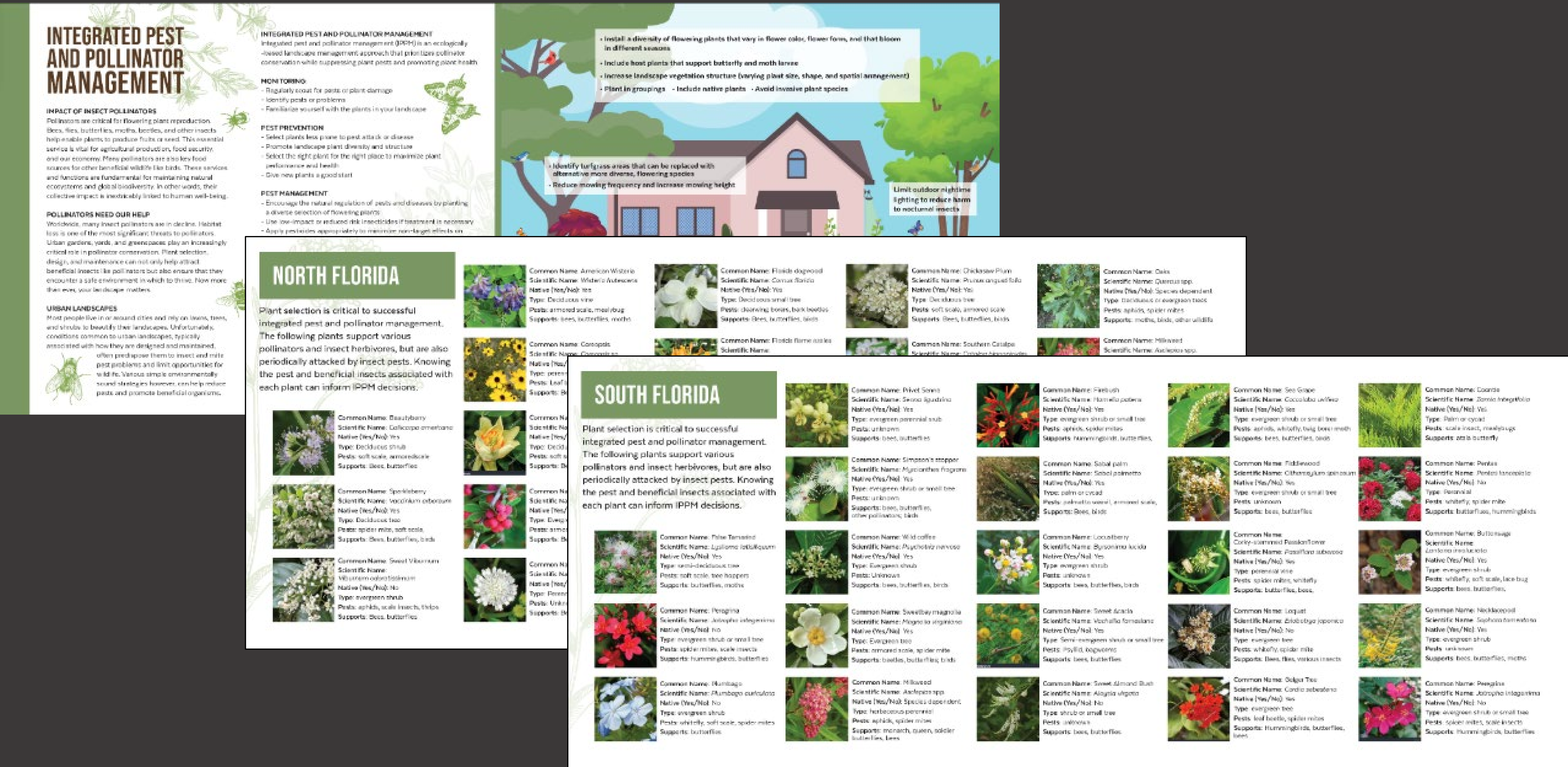

Firebush in bloom, heavily infested with aphids


Sago palm with significant scale infestation


Crape myrtle in bloom with minor aphid damage and honeydew


Milkweed not in bloom, heavily infested with spider mites

Recent IFAS Publications



Fundamental concepts for urban biodiversity conservation

1. Right plant, right place

2. Sustained resource availability

3. Vegetation diversity and structure

4. Predominantly native species

2. Sustained resource availability

What is a resource?

- A substance or object that facilitates an organism’s development, survival, and/or reproduction

Can generally categorize these into

- Food
- Habitat

Floral resources

- Flowering plants provide multiple benefits for wildlife in urbanized landscapes
- Support an incredible diversity of bees, butterflies, flies, moths, beetles, birds, and other organisms
- Consider the plant to be sure its flowers are attractive to wildlife

UF | IFAS Extension
UNIVERSITY of FLORIDA

ENY2042

Attracting Native Bees to Your Florida Landscape [1]

Rachel E. Mallinger, Wayne Hobbs, Anne Yasalonis, and Gary Knox[2]

Are the flowers attractive to pollinators?

Common flowering plants with low pollinator conservation value:

- Bougainvillea
- Society garlic
- Roses
- Camellias (multiple whorled varieties)
- African irises
- Petunia
- Black-eyed Susan

UF | IFAS Extension
UNIVERSITY of FLORIDA

ENY2042

Attracting Native Bees to Your Florida Landscape [1]

Rachel E. Mallinger, Wayne Hobbs, Anne Yasalonis, and Gary Knox[2]

Select plant pallets that bloom throughout the growing season

- Provide a continuous resource for flower-visiting insects

High Diversity Mix	Color	Annual/ Perennial	Season in Bloom: Spring		Summer		Fall		Winter	
Linaria canadensis	Purple	Annual/Biennial	Purple							Purple
Coreopsis lanceolata	Yellow	Perennial	Yellow	Yellow						
Coreopsis basalis	Yellow	Annual		Yellow	Yellow					
Gaillardia pulchella	Red	Perennial		Red	Red	Red	Red			
Mondarda punctata	Purple	Perennial				Purple	Purple	Purple		
Conoclinium coelestinum	Blue	Perennial				Blue	Blue			
Spermacoce verticillata	White	Perennial			White	White	White	White		
Liatris gracilis	Purple	Perennial				Purple	Purple	Purple		
Solidago stricta	Yellow	Perennial				Yellow	Yellow	Yellow		

Nestle et al. 2021

Provide nesting habitat

- Create "bee hotels"
- Install plants that produce hollow stems
- Provide areas of pesticide-free ground nesting habitat

Red and black mason wasp
Pachodynerus erynnis

https://news.wttw.com/2017/10/04/guests-welcome-lincoln-park-zoo-s-new-insect-hotel

Dale et al. 2020. Urban Ecosystems

https://entnemdept.ufl.edu/creatures/MISC/WASPS/Pachodynerus_erynnis.html

Fundamental concepts for urban biodiversity conservation

1. Right plant, right place
2. Sustained resource availability
3. Vegetation diversity and structure
4. Predominantly native species

3. Vegetation diversity and structure

Provide a variety of resources for a variety of organisms

- More plant species = more animal species that can/will use them
- More different plant traits (e.g., flowers, foliage, refuge) = more animal species

Floral diversity & structural habitat

Turfgrass

Low diversity flowers

High diversity flowers

Pollinators are more than bees and butterflies

Compared to managed turfgrass, diverse flowering plantings supported:

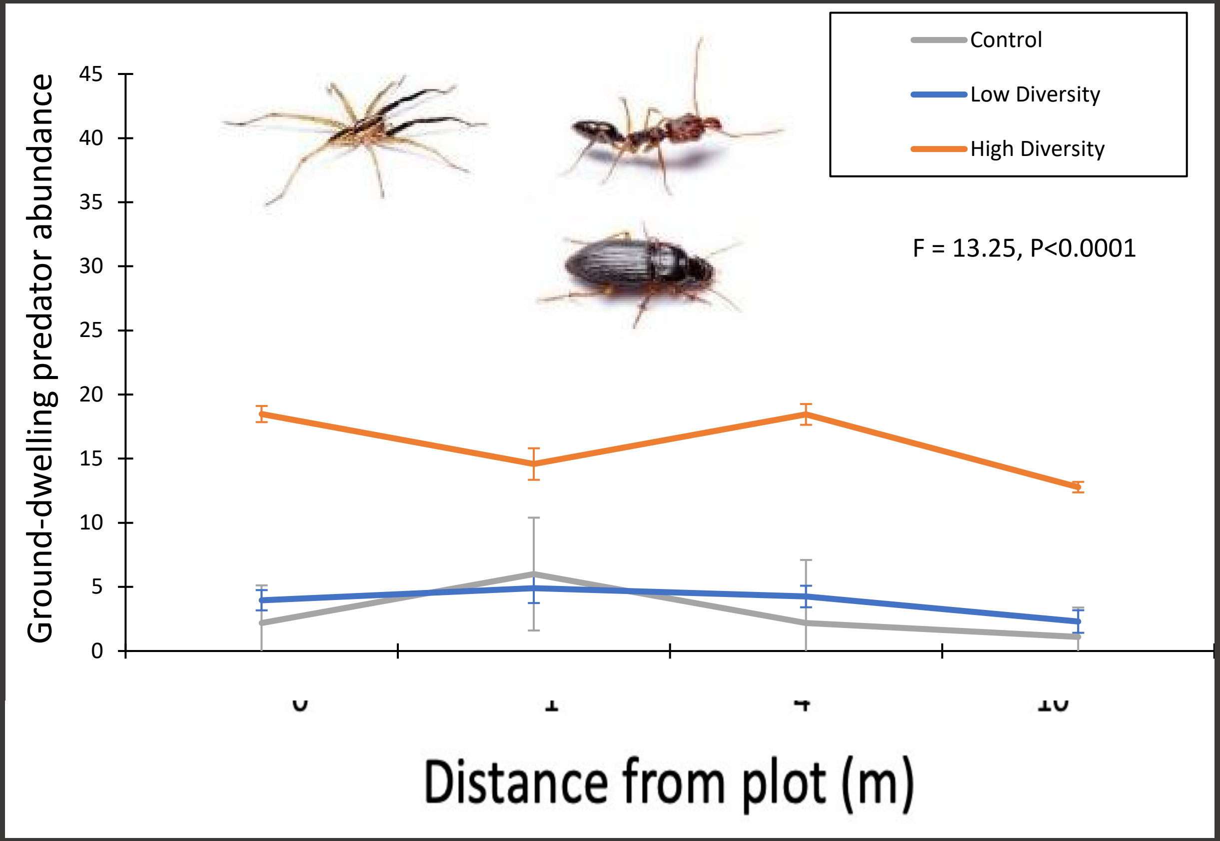
- Over 4X as many native bees
- Six-fold increase in predatory and parasitic wasp abundance
- Biological control of turfgrass caterpillar pests increased by nearly 50% when adjacent to wildflowers

Urban Ecosystems (2020) 23:55–66
https://doi.org/10.1007/s11252-019-00907-0

Floral abundance and richness drive beneficial arthropod conservation and biological control on golf courses

Adam G. Dale[1] · Rebecca L. Perry[1] · Grace C. Cope[1] · Nicole Benda[1]

Flying insects aren't everything



Ground-dwelling predators are more abundant within 30ft of diverse flower plantings than areas next to turfgrass or single flower species plantings

Strategic plant selection and landscape design

Increasing functional diversity by providing an assortment of plant traits in the landscape

- Can some conventionally-turfgrass areas be composed of turfgrass alternatives that provide additional traits?

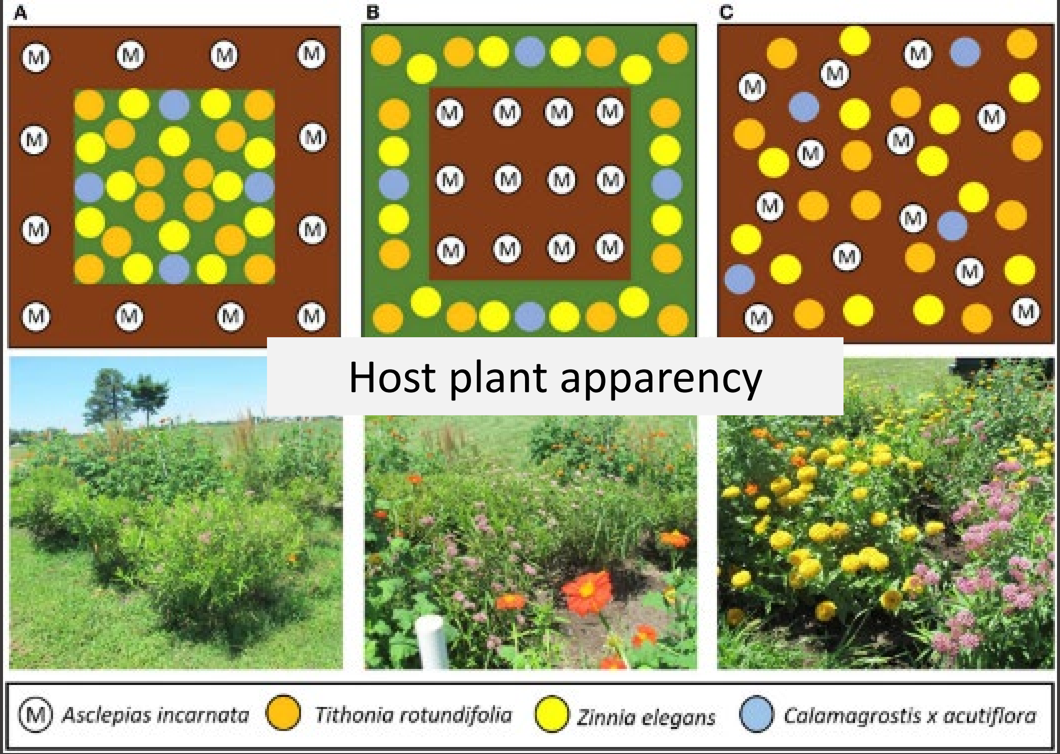
Zoysia japonica

Mimosa strigillosa

Phyla nodiflora

Trifolium repens

Strategic pollinator garden design



insects MDPI

Article

Mixed-Species Gardens Increase Monarch Oviposition without Increasing Top-Down Predation

Rebecca Nestle [1], Jaret C. Daniels [1,2] and Adam G. Dale [1,*]

- Create diverse gardens
- Make larval hosts visible and readily found by butterflies

Configuration and Location of Small Urban Gardens Affect Colonization by Monarch Butterflies

*Adam M. Baker and Daniel A. Potter**

Baker & Potter 2019. *Frontiers in Ecology and Evolution*


Less Even
More Even
Braatz et al. 2021. PeerJ

Simple vegetation structure

Increasingly complex landscape

Vegetation structure provides habitat and opportunity for different organisms to live there

Fundamental concepts for urban biodiversity conservation

1. Right plant, right place

2. Sustained resource availability

3. Vegetation diversity and structure

4. Predominantly native species

4. Predominantly native species

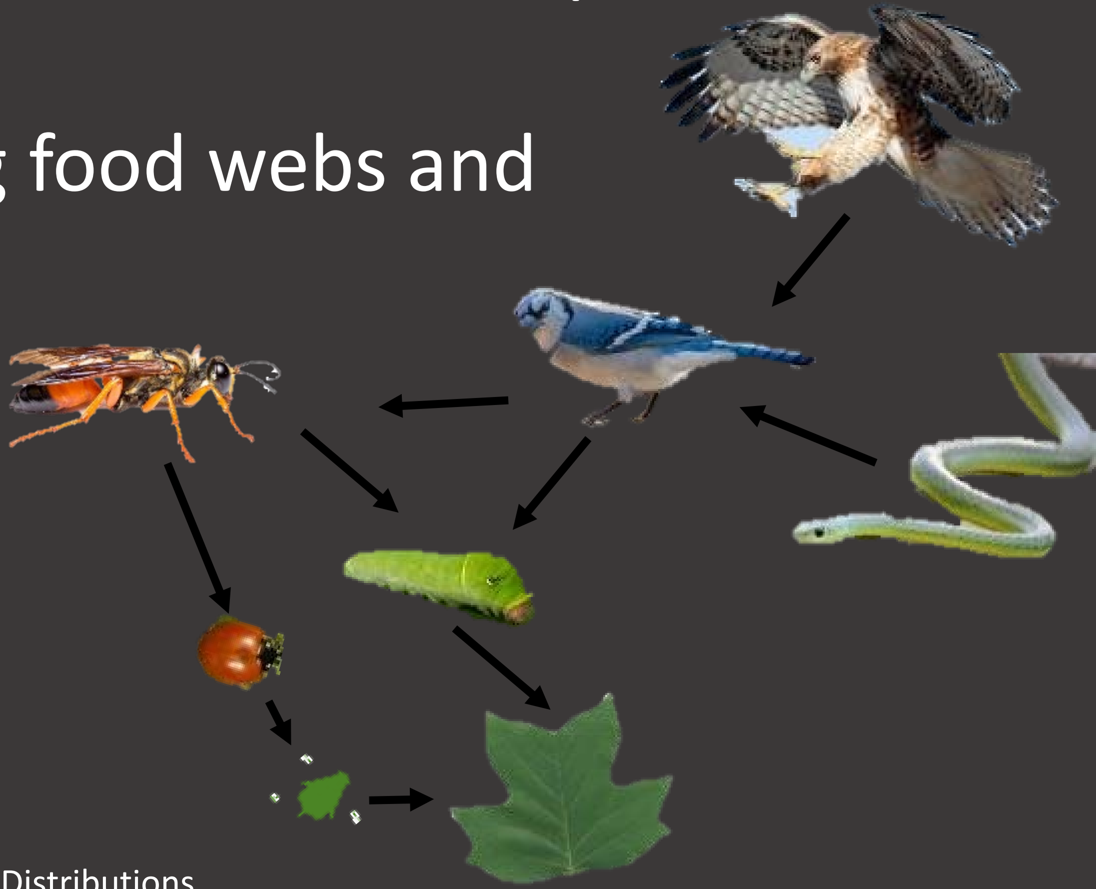
Plant origin can influence plant performance and ecological value

Why??

1. Environmental adaptations
2. The organisms that use it as a resource

Value of native plants

Native plants support more herbivores than non-native plants



Herbivores play vital roles in supporting food webs and ecosystems

- <1% of herbivores are plant pests

Burghardt & Tallamy. 2013. Diversity & Distributions
Wilson & Frank. 2022. Environmental Entomology

No plants originated in an urban ecosystem

- Native plants should be the majority of a designed urban landscape planting, **but** non-native species can have value

- What can that value be?
  - Not susceptible to known pests
  - Pollinator-attractive flowers
  - Resilience to stressful urban conditions

We plant natives to attract and support native insects…

- Some native insects behave like invasive species in urban environments and become pests
- Non-native congeners may fulfill a similar function without the pest outbreaks

Red maple vs. Trident maple

Willow oak vs. Sawtooth oak

Frank et al. 2019. PeerJ

Scientific name	Common name	Bloom Period				Flower color	Region			Native (Y = yes, N = no)	Florida hardiness zone
		Winter	Spring	Summer	Fall		North	Central	South		
Acacia vachella	Sweet acacia	X	X	X	X	Yellow	-	X	X	Y	9–11
Acer rubrum	Red maple	X	X	-	-	Red-pink	X	X	X	Y	8–10
Adonidia merrillii	Christmas palm	X (south FL)	-	-	-	White	-	-	X	N	10–11
Aloysia virgata	Sweet almond	-	-	X	X	White	X	X	X	N	8–11
Symphyotrichu-m carolinianum	Climbing aster	-	-	-	X	White-purple	X	X	X	Y	8–10b
Bursera simaruba	Gumbo limbo	-	X	-	-	Yellow-green	-	-	X	Y	10b–11
Callicarpa americana	Beautyberry	-	X	X	X	Lavender-pink	X	X	X	Y	8–11
Callistemon spp.	Bottlebrush	X	X	X	X	Red	X	X	X	N	8b–11
Cercis canadensis	Eastern redbud	X	X	-	-	Pink-purple	X	X	-	Y	8–9a
Chionanthus virginicus	Fringe	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	-	Y	8–9
Chrysobalanus icaco	Cocop	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	X	Y	10–11
Citharexylum spinosum	Fiddle	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	X	Y	10–11
Clethra alnifolia	Sweet	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	-	Y	8–9
Coccoloba diversifolia	Pigeo	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	X	Y	10a–11
Coccoloba uvifera	Seagr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	X	Y	9–11
Cornus foemina	Swamp dogwood	-	X	-	-	White	X	X	X	Y	8–10
Duranta erecta	Golden dewdrop	X (south FL)	X	X	X	Purple	-	X	X	N	9b–11
Forestiera segregata	Florida privet	X	X	-	-	Yellow	X	X	X	Y	8b–11
Gamolepis chrysanthemo-ides	Bush daisy	X (south FL)	X	X	X	Yellow	X	X	X	N	8b–11
Halesia carolina	Carolina silverbell	-	X	-	-	White	X	-	-	Y	8
Hibiscus spp.	Hibiscus	-	X	X	X	Variable	X	X	X	Some	8–11
Ilex glabra	Inkberry	X	X	-	-	White	X	X	X	Y	8–10

UF IFAS Extension UNIVERSITY of FLORIDA
ENY2042

Attracting Native Bees to Your Florida Landscape [1]

Rachel E. Mallinger, Wayne Hobbs, Anne Yasalonis, and Gary Knox[2]

Resilience to urban conditions

- Can you use non-native plants to increase the diversity, structure, and resource availability of a landscape?
- Non-native plant diversity and structure conservation can offset a lack of native plants

Persian ironwood
Parrotia persica

Crape myrtle
Lagerstroemia indica

Trident maple
Acer buergerianum

Chinese pistache
Pistacia chinensis

DO NOT plant invasive species

- Invasive plants are non-native species that were introduced by humans and cause ecological and/or economic harm (Iannone et al. 2020. Journal of Extension)

- The most common route for non-native plant invasion is the ornamental plant trade
- Always confirm that specified plants are not invasive in the region

UF IFAS Assessment of non-native plants - https://assessment.ifas.ufl.edu

Summary: Urban biodiversity conservation

- Strategic, evidence-based, biodiverse landscapes provide more ecosystem functions and services
- Consider factors from the soil to flowers to tree canopy
- There is a wealth of research-based information available to help inform more ecologically friendly landscape design

1. Right plant, right place
2. Sustained resource availability
3. Vegetation diversity and structure
4. Predominantly native species

Wildlife-Friendly Landscape Management

Extension Online Learning
In development

A cohort-based online curriculum focused on pollinator ecology, integrated pest and pollinator management, social dimensions of wildlife-friendly landscape management, and applications in landscape design, installation, and management.

URBAN LANDSCAPE ENTOMOLOGY

Entomology & Nematology | University of Florida

THE DALE LAB / BLOG / EXTENSION / RESEARCH / PUBLICATIONS / TEACHING / PEOPLE

@adamGdale
http://dalelab.org
agdale@ufl.edu

Thank you!

Relevant Extension publications:

- Balancing
- Wildlife-friendly landscaping: Connecting professionals and the public
- Creating wildflower habitats in golf course out-of-play areas

http://ifasbooks.ifas.ufl.edu/p-153-helpful-harmful-harmless.aspx

Southern IPM Center

FNGLA
FLORIDA NURSERY, GROWERS AND LANDSCAPE ASSOCIATION
Leading Florida's Green Industry

UF | IFAS
UNIVERSITY of FLORIDA

Thank You

Daniels Lab (@JCDanielsLab)

https://www.floridamuseum.ufl.edu/daniels-lab/

jdaniels@flmnh.ufl.edu

Kristen Grace

FDOT

SAFE SAVING ANIMALS FROM EXTINCTION

Disney CONSERVATION FUND

FLORIDA WILDFLOWER FOUNDATION

DUKE ENERGY

UF UNIVERSITY of FLORIDA

FLORIDA MUSEUM