



Seeding ecosystems of the future

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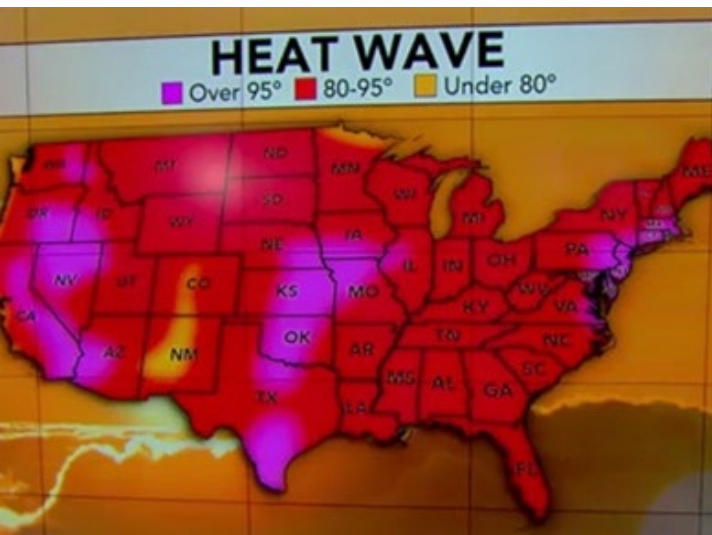
NECASC
Northeast Climate Adaptation Science Center



High Meadows
Environmental
Institute

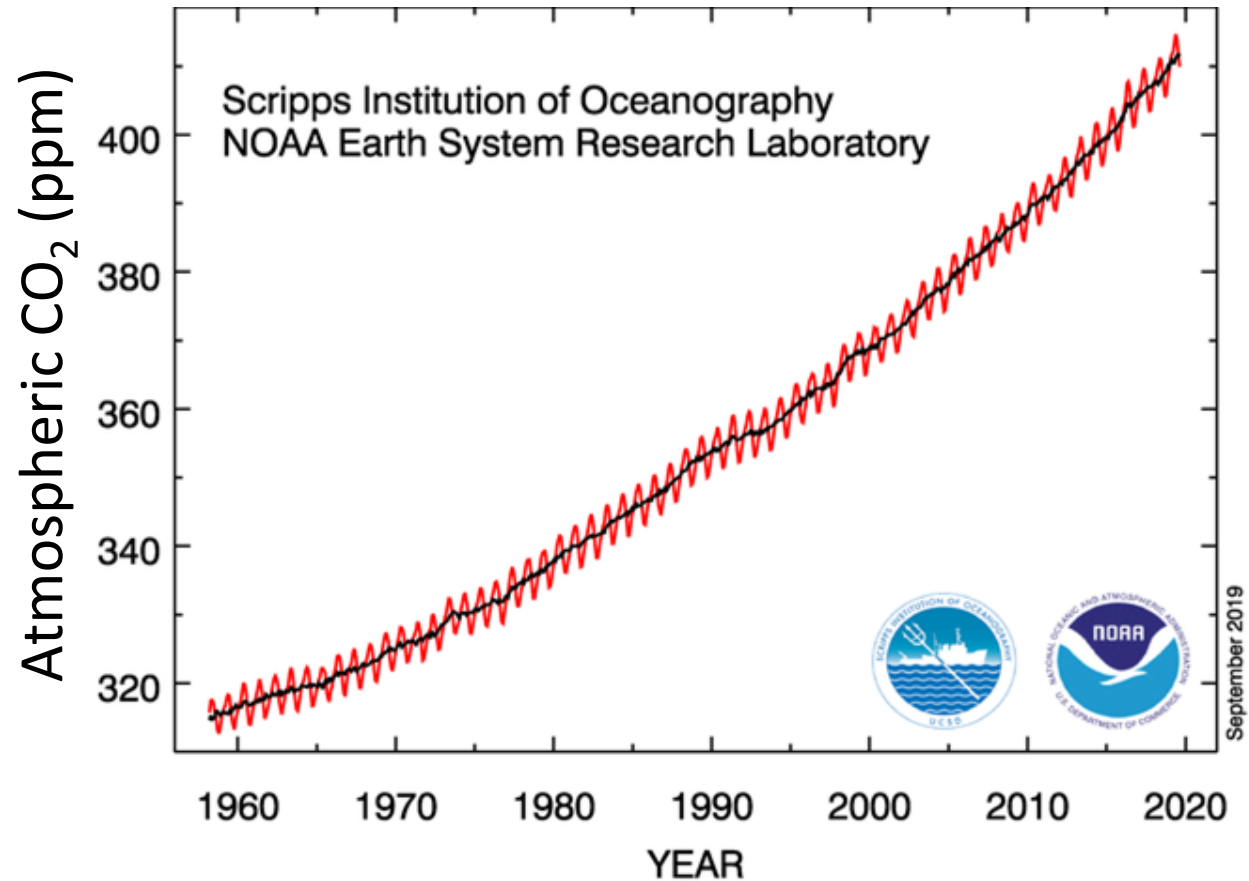
Outline

1. Brief overview of climate change
2. Impact on species
3. Gardens to support native biodiversity
4. Gardens as a pathway for invasion



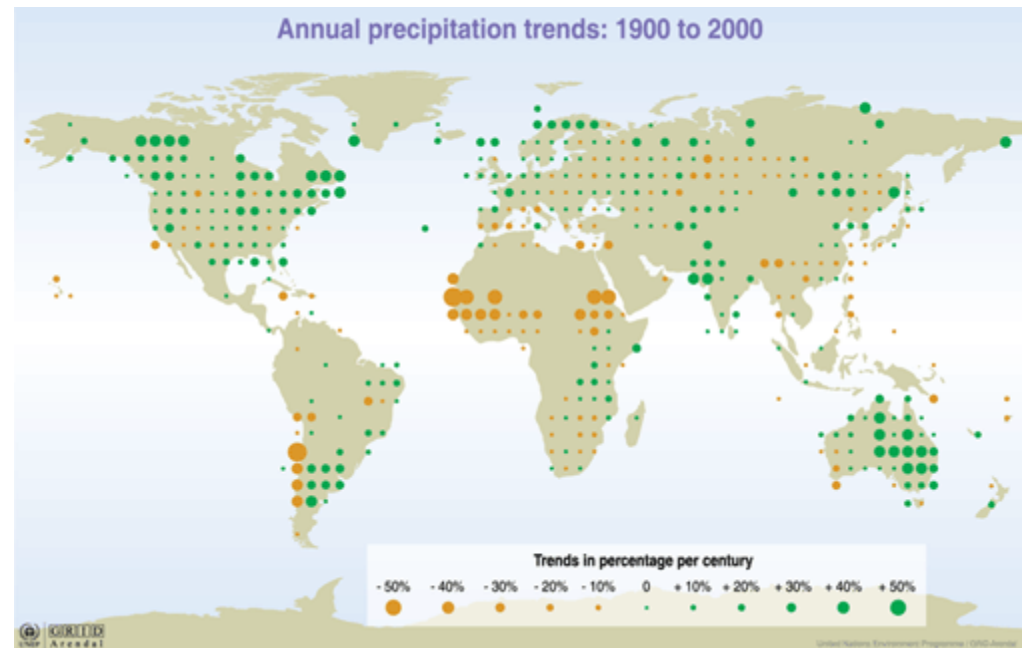
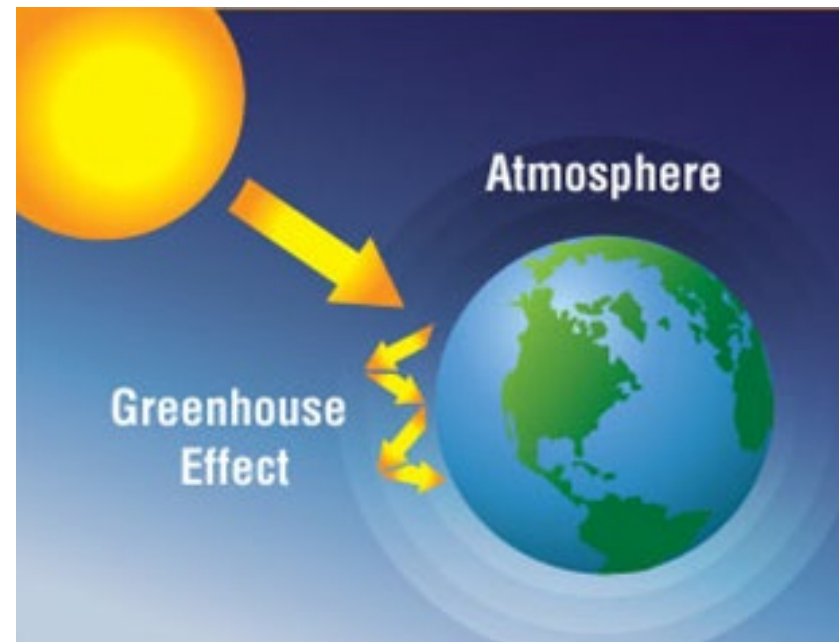
Rising CO₂: Not normal

- Risen from 280 pre-industrial
- Over 400ppm today



What does rising CO₂ mean for climate?

1. Rising temperatures (stronger greenhouse effect)
2. Altered precipitation (varies by region)

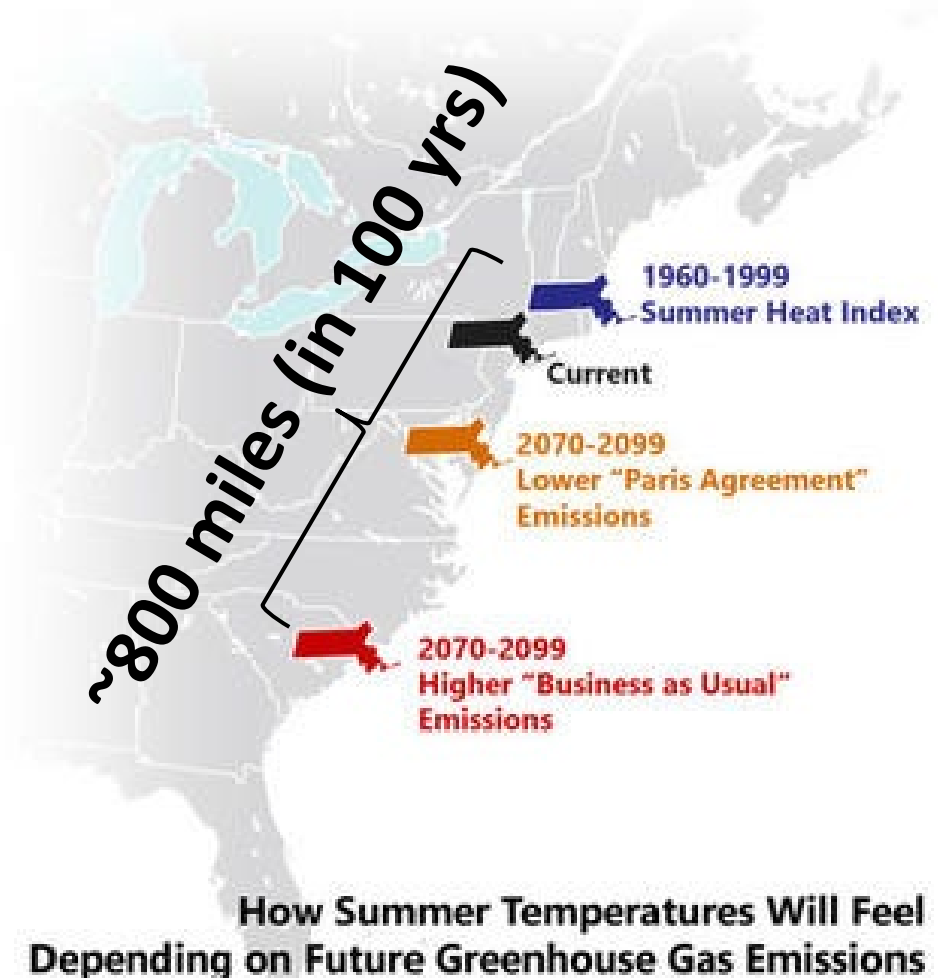


Temperatures are warming

Warming of 1°C (~2°F)
has already occurred

Goal is to limit
warming to 2°C (Paris
Agreement)

Longer growing
seasons are *'virtually
certain'* (IPCC, 2013)



Temperatures are warming



FOURTH NATIONAL CLIMATE ASSESSMENT
CHAPTER 18: NORTHEAST

By 2035, and under both lower and higher scenarios (RCP4.5 and RCP8.5), the Northeast is projected to be more than 3.6°F (2°C) warmer on average than during the preindustrial era. This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone.³⁶



Also changing – more extreme extremes

WARMING

RUTGERS | NJ Climate Change Resource Center


Heat Wave: Is This Scorcher ‘the New Normal’ for NJ?

Excessive heat warnings and heat advisories are in place across the state

Coastal flooding expected to worsen at the Jersey Shore

By [Trish Hartman](#) and Sharifa Jackson via 

Tuesday, October 4, 2022 4:30AM

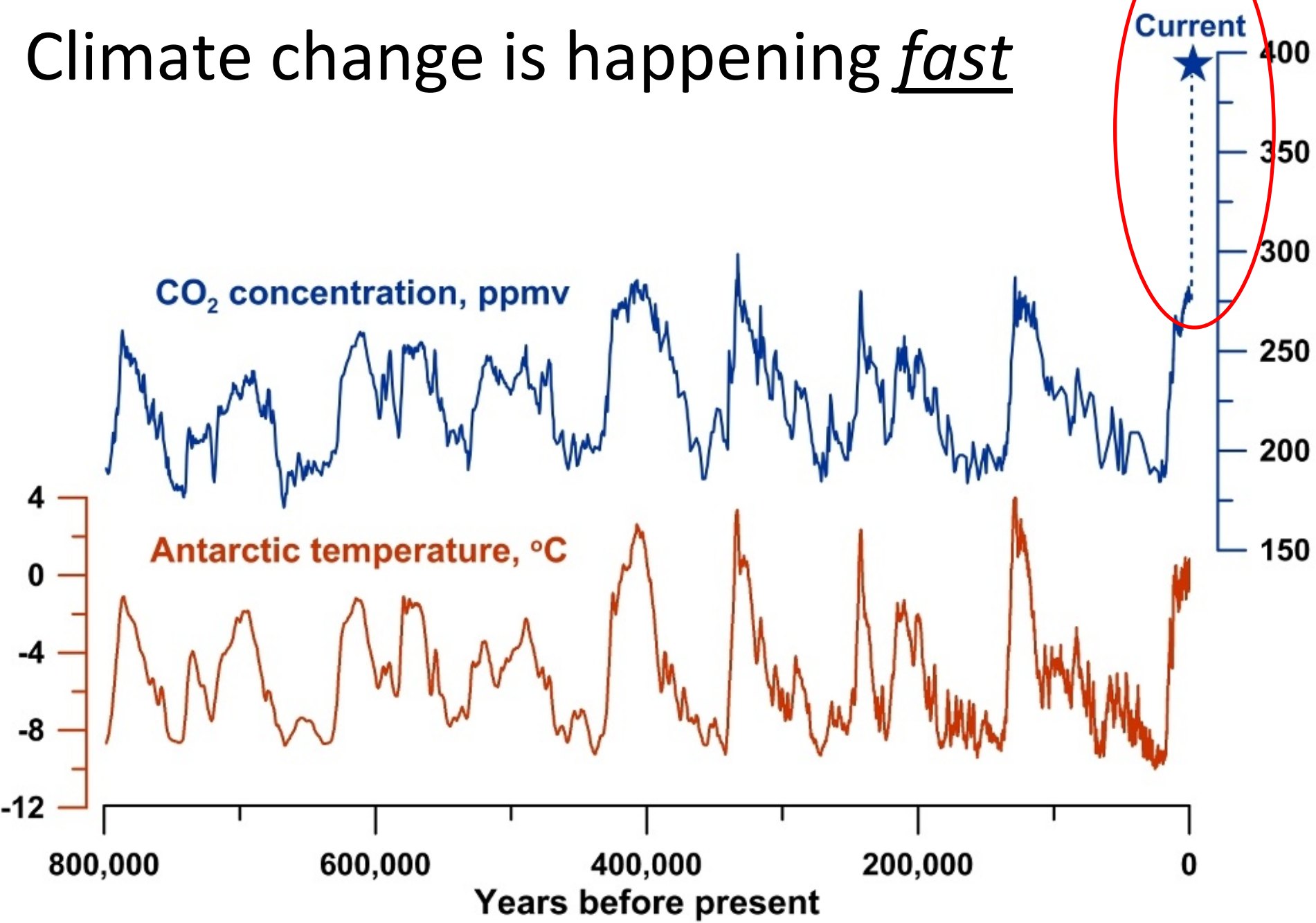
Ida’s Fierce Toll: 10 Dead, Massive Flooding, Thousands Forced from Homes

September 5, 2021

BRENDA FLANAGAN / NJ SPOTLIGHT NEWS

[Read More »](#)

Climate change is happening *fast*

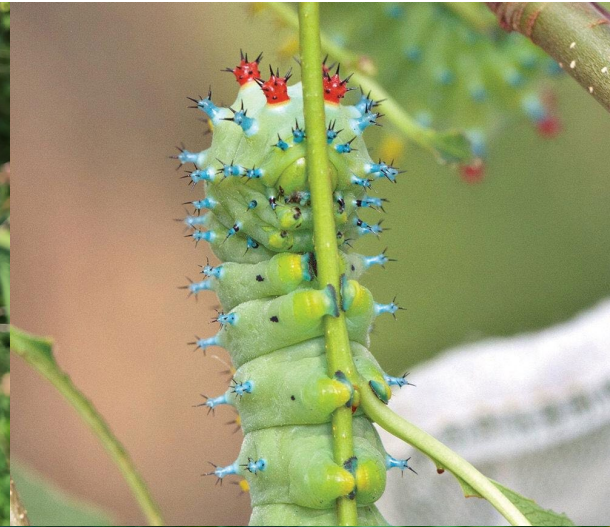


Take home point:

- Temperatures are rising. Droughts, floods, and hurricanes are becoming more extreme.
- “The Northeast has seen a greater recent increase in extreme precipitation than any other region in the United States”.
- Things are changing fast



2. Impact of climate change on our ecosystems



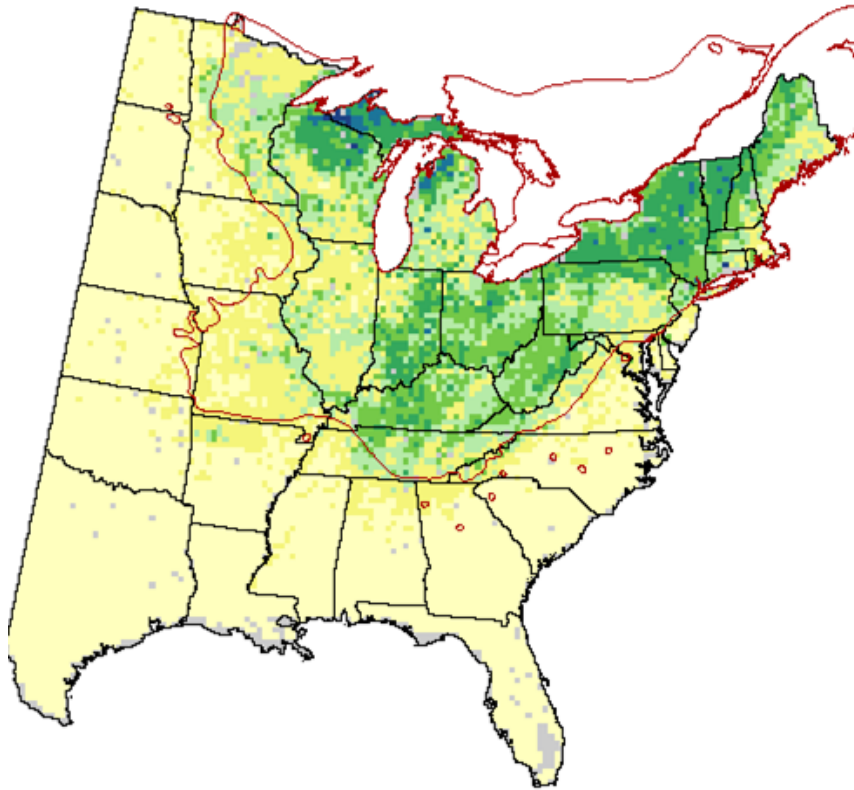
Species are shifting their ranges



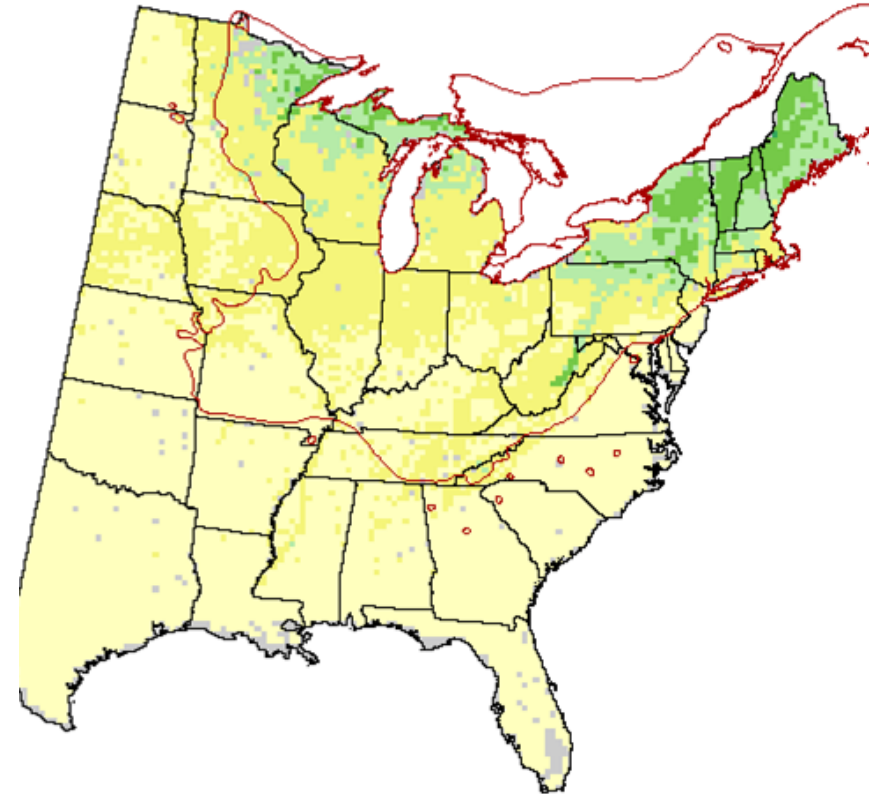
- White-tailed deer are expanding northward
- In southern part of range, moose experience greater parasitism
- Moose expanding northward replacing caribou

Species are shifting their ranges

Sugar maple is moving north



Current suitable habitat



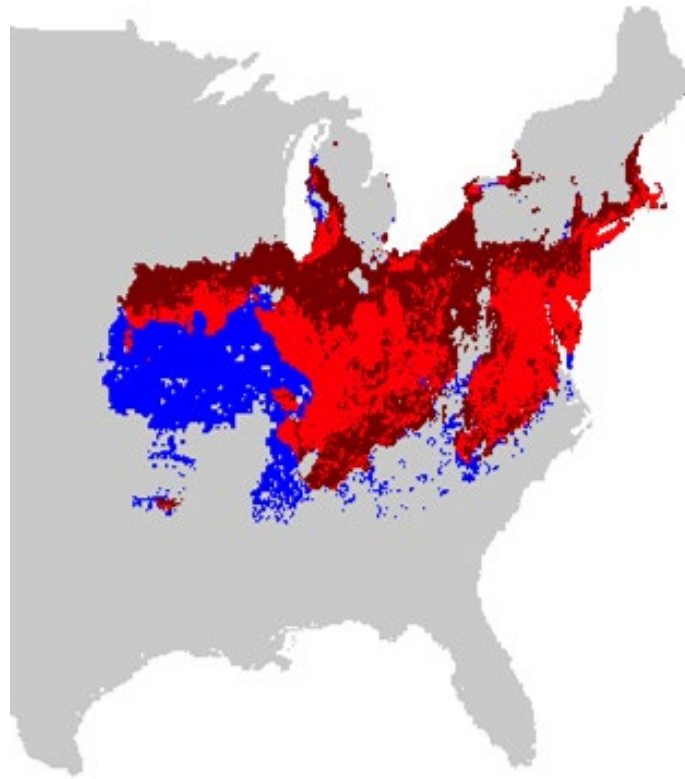
Future suitable habitat

Species are shifting their ranges

Invasive species are also on the move

Suitability for invasion under climate change:

- Decreasing
- Unchanged
- Increasing



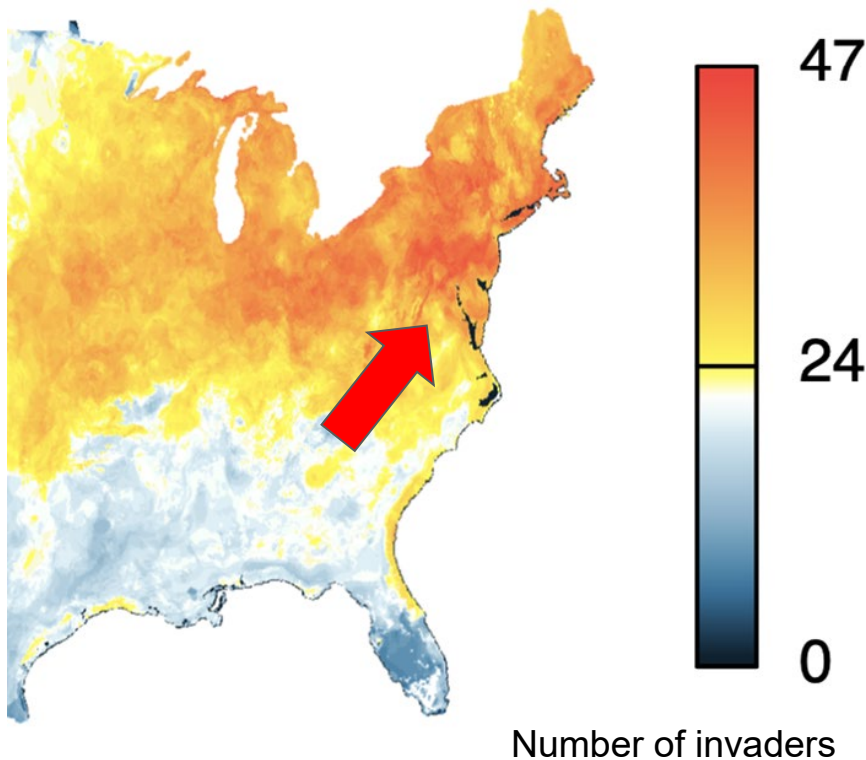
N = 144 east coast invaders

97% of invaders will have suitable habitat for invasion in new areas

Rubus phoenicolasius, invasive wineberry

Species are shifting their ranges

Invasive species are also on the move

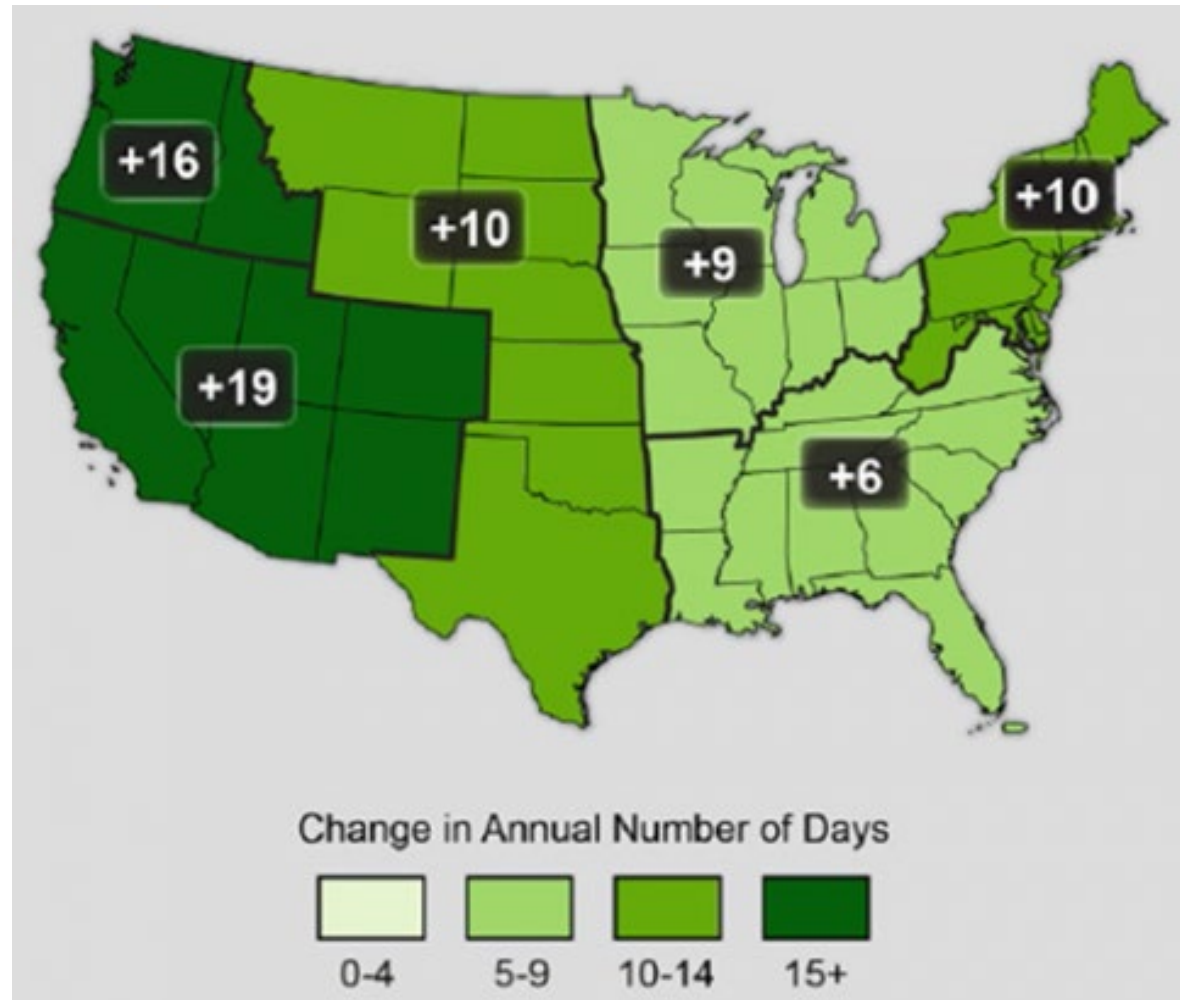


N = 144 east coast invaders

97% of invaders will have suitable habitat for invasion in new areas

Also seeing shifts in time – longer growing season

- Increase in growing degree days relative to mid-1900s
- Shorter winters, longer summers



Also seeing shifts in time – longer growing season

- Increase in growing degree days relative to mid-1900s
- Shorter winters, longer summers

Shifting seasons promote invasions

- Milder winters increase pest survival.
- Invasive plants are more likely to shift the timing of green-up and brown-down in response to longer growing seasons, giving them a competitive advantage.

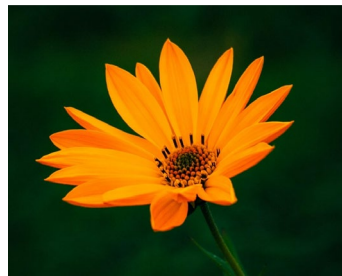


Eurasian millfoil



hemlock woolly adelgid

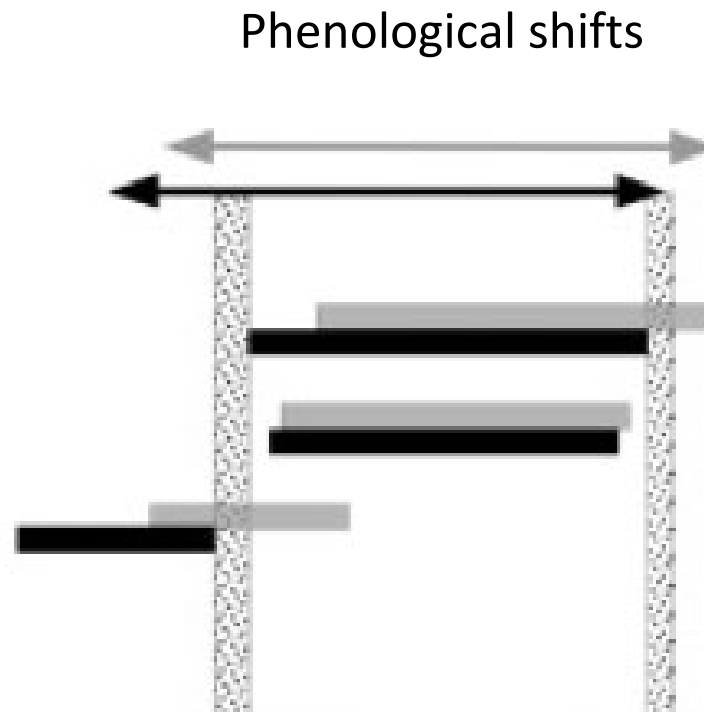
Also seeing shifts in time – mismatched life history



Plant species 1

Plant species 2

Plant species 3



Pollinator



Time of year

Take home point:

- Climate change driving changes across space (range shifts) and over time (life history)
- Not all species will keep pace with change



How do species respond to change?

- Move (range shifts)
- Adapt in place
- Die



3. Gardening as an ecological tool



Planting for Pollinators

From moths to bees, pollinators make it possible. Bees, wasps, bees, bats, butterflies, flies, moths, butterflies and the wind are all on the pollination team. We can play a part by planting gardens rich with food and homes for essential pollinators.

Native species work best. In their own right, native plants are well adapted to local conditions and are more likely to provide the food and shelter that native pollinators need. They are also more likely to be resistant to pests and diseases.

Planting native species to cover as much of your garden as you can from May to September is the best way to provide food for native pollinators. Native species are more likely to be resistant to pests and diseases.

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With the garden path Use native plants to create a path through your garden. This will help pollinators find their way through the garden and provide them with a safe place to rest and shelter.

What Can You Do?

- Reduce water usage.** Plant native and drought-tolerant plants that are adapted to your local climate. This will help you save water and reduce your water bill.
- Reduce lawn area.** Lawns are not a good source of food for pollinators. Instead, plant native species that provide food and shelter for native pollinators.
- Reduce chemical usage.** Chemicals can harm pollinators. Instead, use natural pest control methods.
- Provide nesting sites.** Many pollinators need places to lay their eggs. Provide nesting sites for native pollinators.

Utah State University

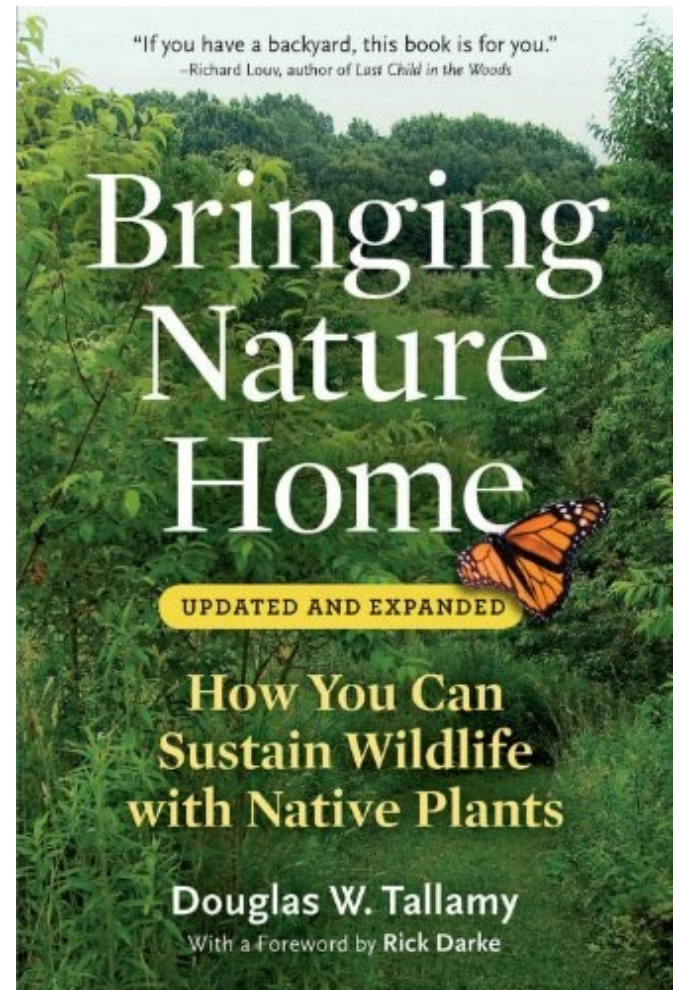


What Pollinator Plants are Blooming Now



3. Gardening as an ecological tool

“Chances are, you have never thought of **your garden**—indeed, of all of the space on your property—as a **wildlife preserve that represents the last chance we have for sustaining plants and animals that were once common throughout the U.S.** But that is exactly the role our suburban landscapes are now playing and will play even more in the near future.” - Doug Tallamy



Growing popularity of pollinator gardens



What Pollinator Plants
are Blooming *Now*



Gardens as 'stepping stones'

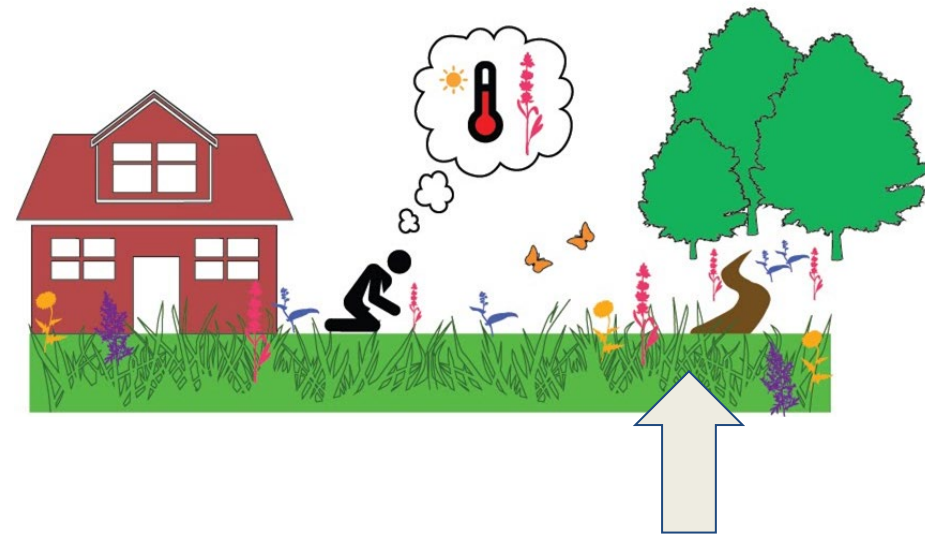
Landscaping that promotes native flora and fauna:

Ecological landscaping reduces the risk of introducing invasive species and supports wildlife.



Climate-smart native gardening:

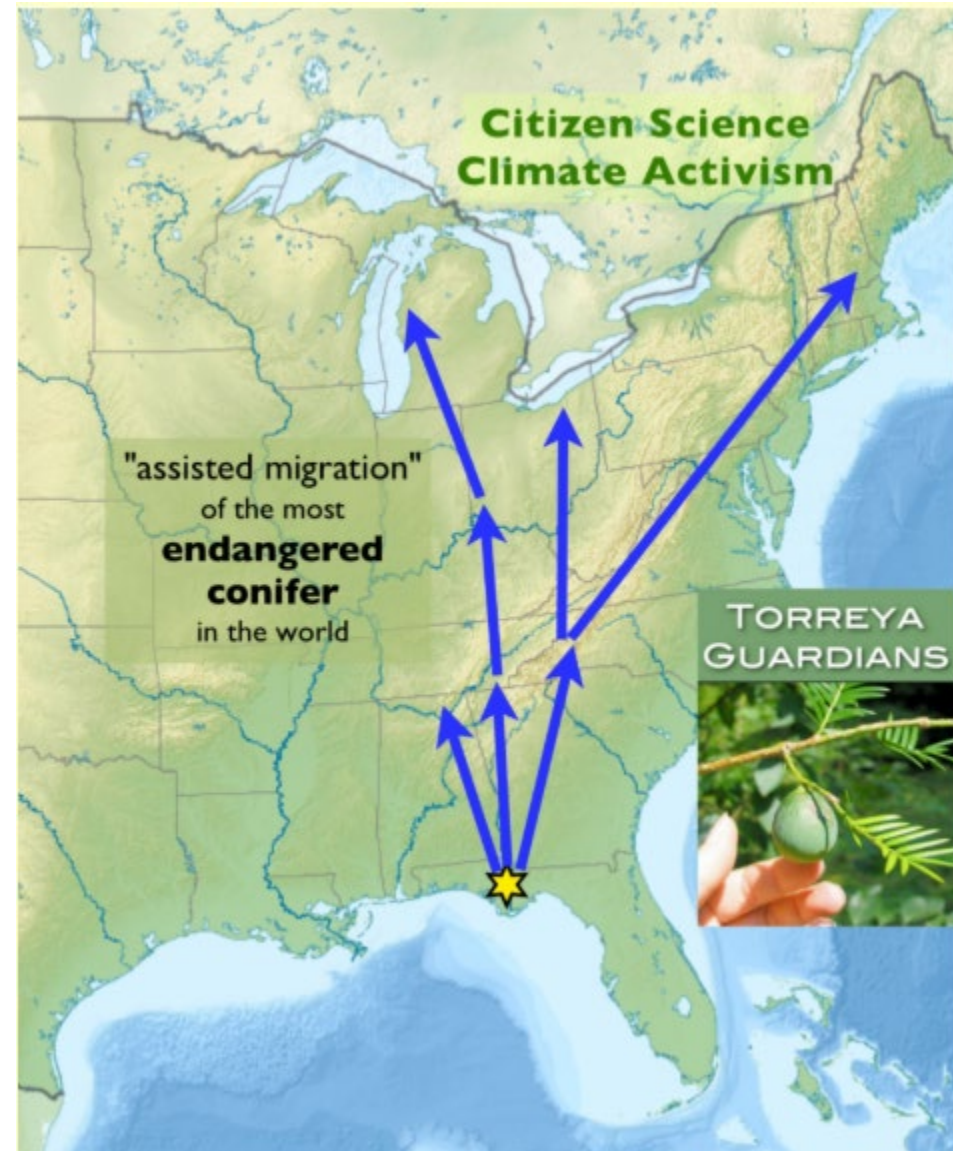
Assisting the range shifts of native plants helps flora and fauna 'keep up' with climate change.



Tool for assisted migration with climate change

Assisted migration

- The intentional introduction of species outside of their historic ranges into more climatically favorable regions



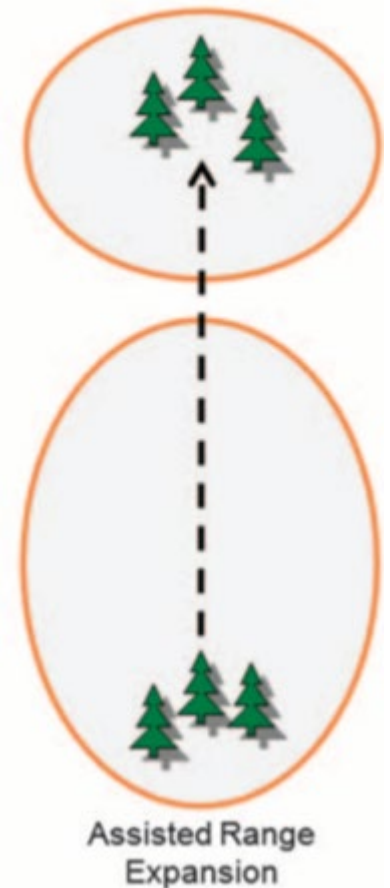
Assisted migration could refer to several different strategies

- Introducing warm-adapted populations to northern range margins



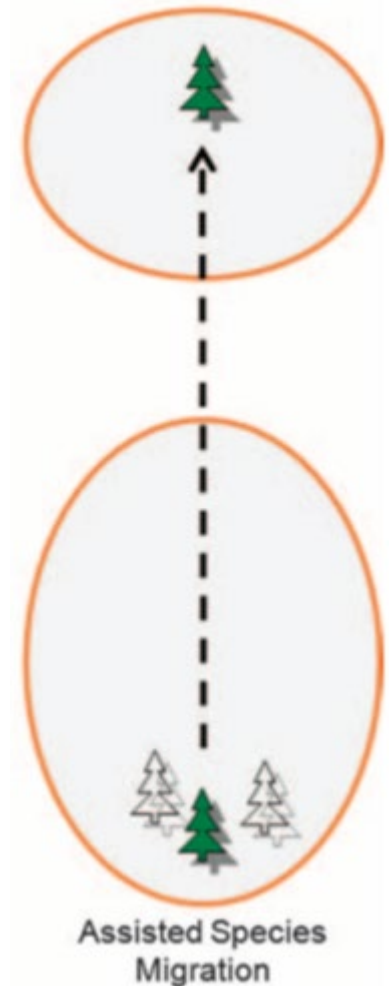
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- Introducing warm-adapted populations to northern range margins
- Expanding ecological communities outside their current ranges

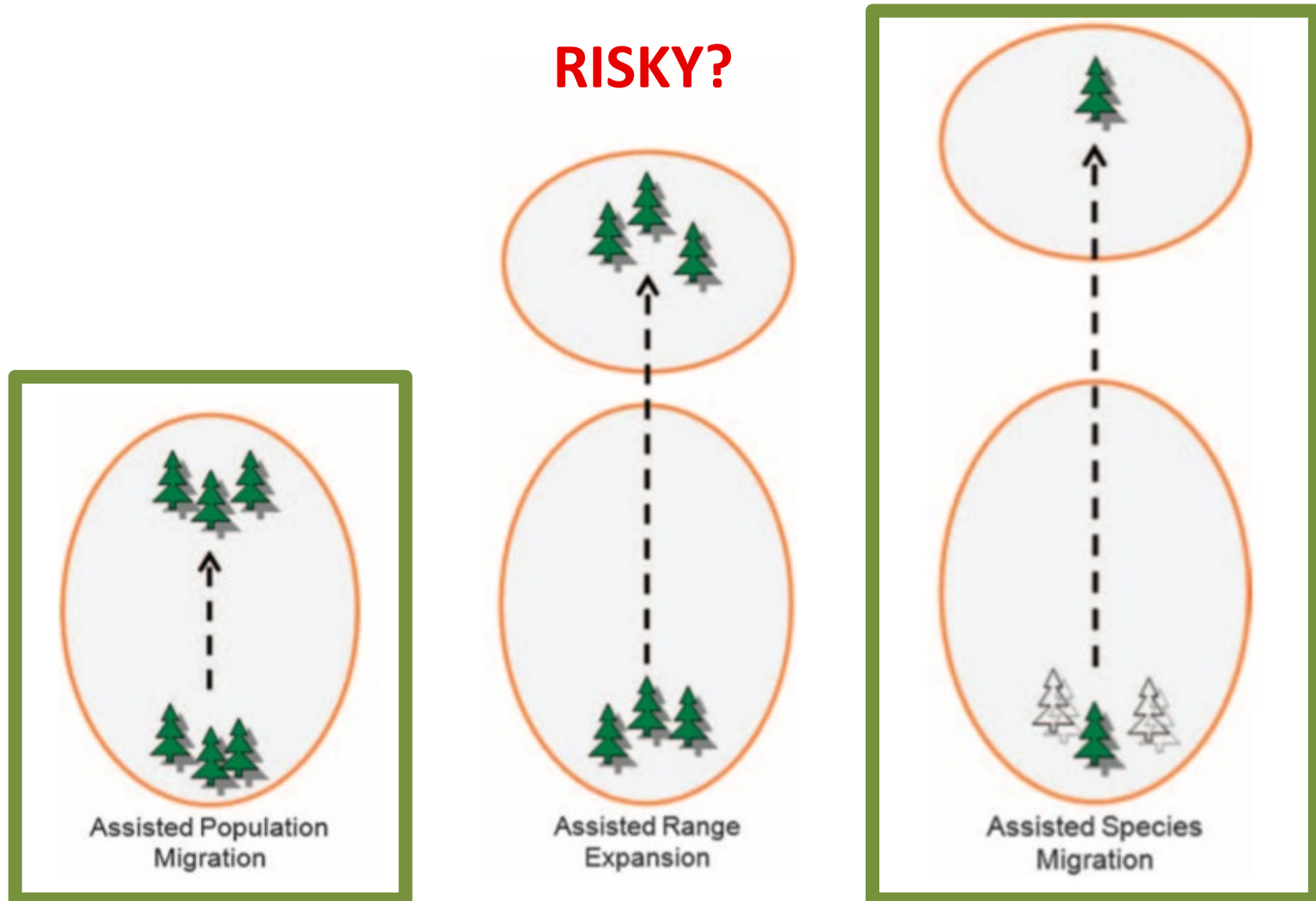


Assisted migration could refer to several different strategies

- Introducing warm-adapted populations to northern range margins
- Expanding ecological communities outside their current ranges
- Introducing single rare/endangered species outside their current ranges



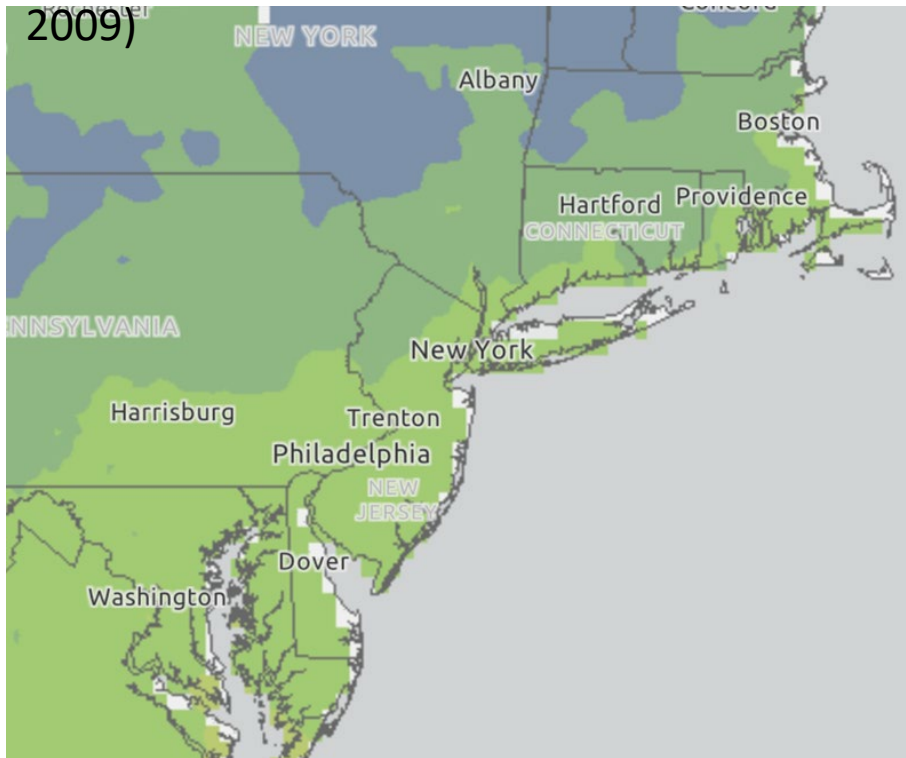
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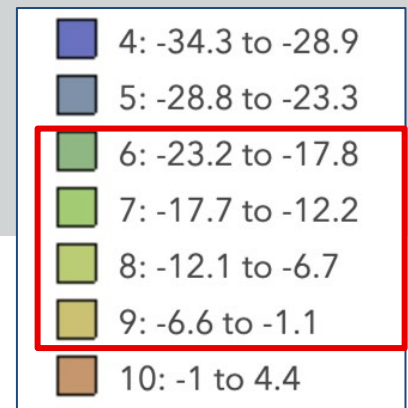
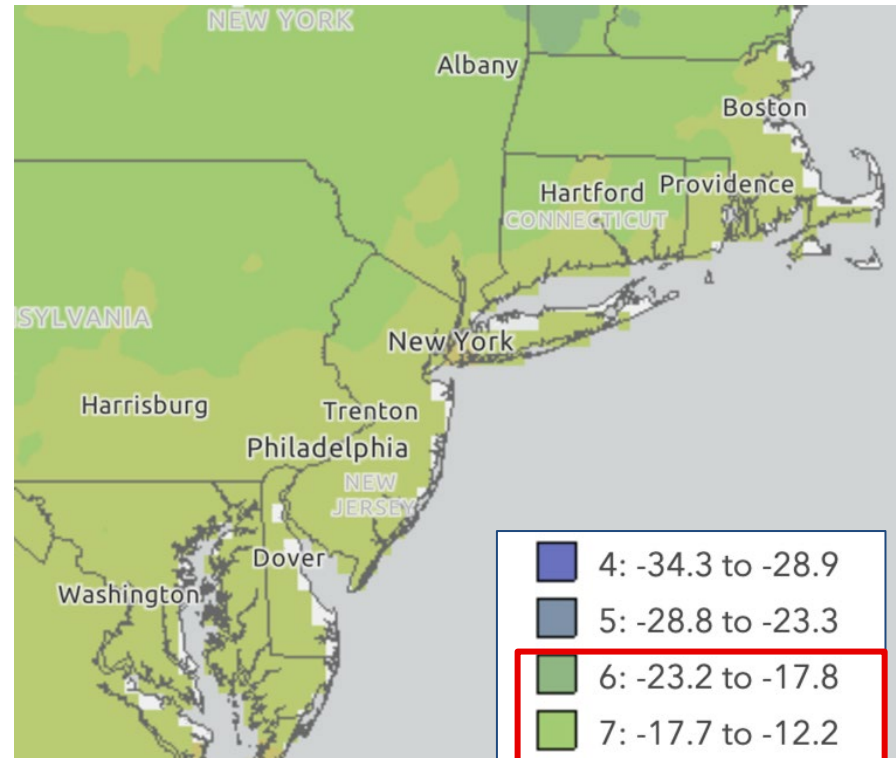
Gardens and assisted migration

Introducing warm-adapted populations to northern range margins

Historical hardiness zones (1980-2009)



Predicted shift 2040+



Gardens and assisted migration

Introducing warm-adapted populations to northern range margins

Gardening with climate-smart native plants in the Northeast



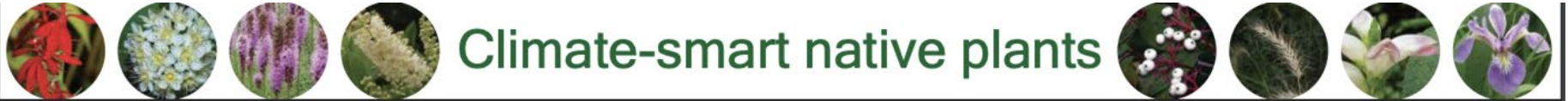
 Northeast Regional Invasive Species & Climate Management
 NECASC
 NYISRI

Climate-smart native plants

	Species	Growth Form	Hardiness Zones	Planting Conditions	Benefits
Native Grasses	Big blue stem (<i>Andropogon gerardii</i>)	Grass	4-9	☀️ 💧	☒ ☒
	Canada wild rye (<i>Elymus canadensis</i>)	Grass	3-8	☀️ 💧	🦋 ☒
	Indian grass (<i>Sorghastrum nutans</i>)	Grass	4-9	☀️ 💧	🦋
	Little bluestem (<i>Schizachyrium scoparium</i>)	Grass	3-9	☀️ 💧	☒ ☒
	Sideoats grama (<i>Bouteloua curtipendula</i>)	Grass	4-9	☀️ 💧	🌸 🦋 ☒
Native Flowering Herbs	Beardtongue (<i>Penstemon digitalis</i>)	Herb	3-8	☀️ 💧	🌸 🦋 🦋 ☒ ☒
	Blazing star (<i>Liatris spicata</i>)	Herb	3-8	☀️ 💧	🌸 🦋 🦋 ☒
	Blue false indigo (<i>Baptisia australis</i>)	Herb	3-9	☀️ ☀️ 💧	🌸 🍎 🦋 ☒ ☒
	Blue flag iris (<i>Iris versicolor</i>)	Herb	3-9	☀️ ☀️ 💧	🌸 ☒ ☒
	Blue lobelia (<i>Lobelia siphilitica</i>)	Herb	4-9	☀️ ☀️ 💧	🌸 ☒ ☒
	Butterfly weed (<i>Asclepias tuberosa</i>)	Herb	3-9	☀️ 💧	🌸 🦋 ☒ ☒
	Cardinal flower (<i>Lobelia cardinalis</i>)	Herb	3-9	☀️ ☀️ 💧	🌸 🦋 🦋 ☒ ☒
	Foam flower (<i>Tiarella cordifolia</i>)	Herb	4-9	☀️ ☀️ 💧	🌸 ☒ ☒
	Ironweed (<i>Vernonia noveboracensis</i>)	Herb	5-9	☀️ 💧	🌸 🦋 ☒ ☒
	Joe pye weed (<i>Eutrochium fistulosum</i>)	Herb	4-8	☀️ ☀️ 💧	🌸 🦋 ☒ ☒
	Lance leaf coreopsis (<i>Coreopsis lanceolata</i>)	Herb	4-9	☀️ 💧	🌸 🦋 ☒
	Monkey flower (<i>Mimulus ringens</i>)	Herb	4-9	☀️ ☀️ 💧	🌸 ☒ ☒
	New England aster (<i>Symphotrichum novae-angliae</i>)	Herb	4-8	☀️ 💧	🌸 🦋 🦋
	Obedient plant (<i>Physostegia virginiana</i>)	Herb	3-9	☀️ 💧	🌸 🦋 ☒
	White turtlehead (<i>Chelone glabra</i>)	Herb	3-8	☀️ 💧	🌸 🦋 ☒

Gardens and assisted migration

Introducing warm-adapted populations to northern range margins



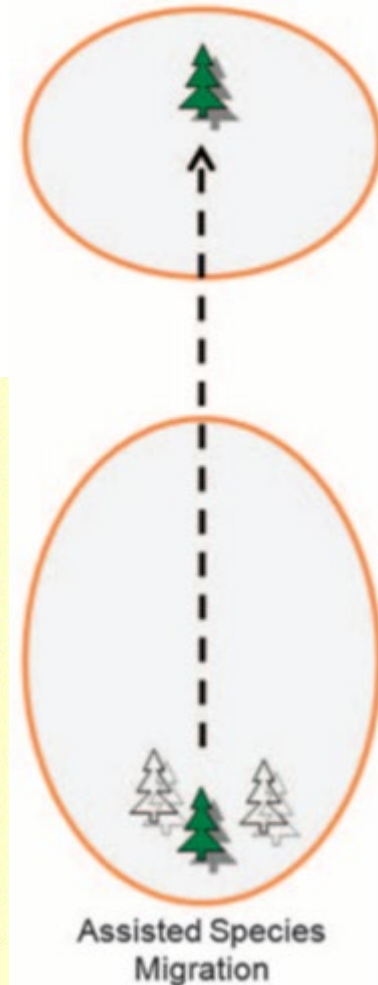
Climate-smart native plants

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	Sideoats grama (<i>Bouteloua curtipendula</i>)	Grass	4-9	☀️ 💧/💧	🌸 🌱🐦 🚫🔪
Herbs	Beardtongue (<i>Penstemon digitalis</i>)	Herb	3-8	☀️ 💧/💧	🌸 🐦🐦 🌱🐦 🚫🐴
	Blazing star (<i>Liatris spicata</i>)	Herb	3-8	☀️ 💧/💧	🌸 🐦🐦 🌱🐦 🚫🔪
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Introducing single rare/endangered species outside their current ranges

Scrappy Group of Citizen Scientists Rallies Around One of World's Rarest Trees

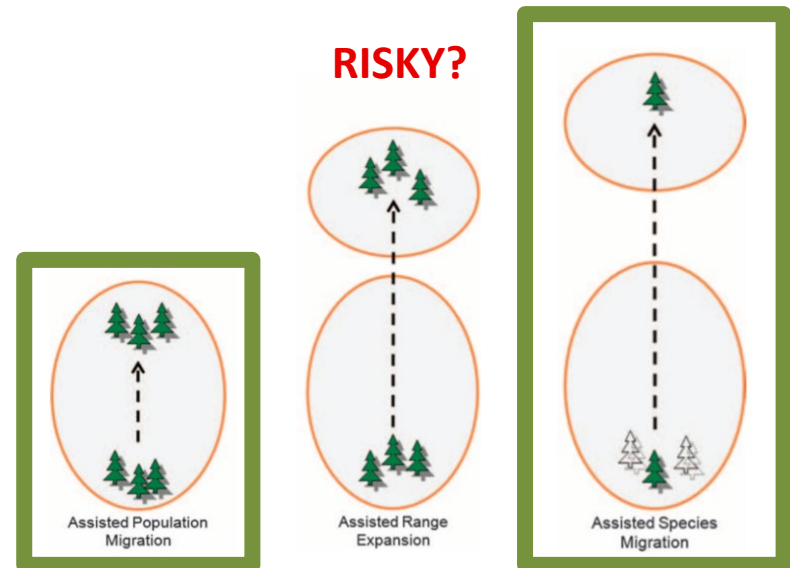


LEFT: A fleshy sarcotesta surrounds the single large seed of *T. tax*

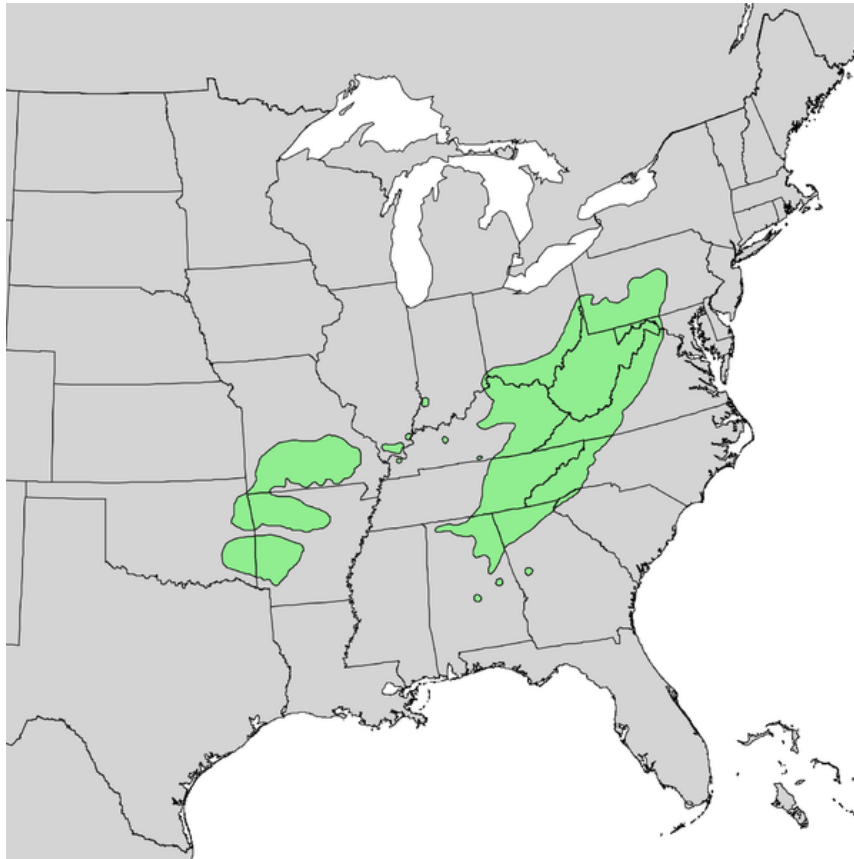
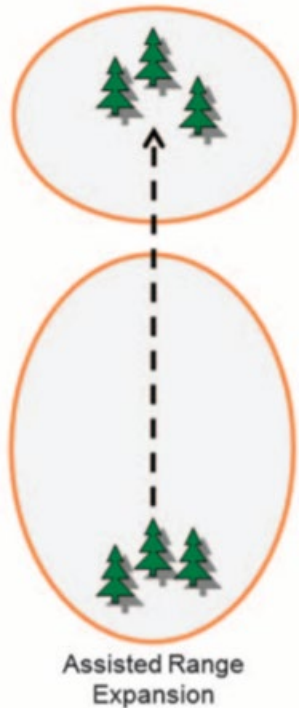
RIGHT: Connie Barlow with **STATE CHAMPION** *Torreya californica* near Santa Cruz CA, 2005.

Take home point:

- Approaches to assisted migration vary in risk
- But, doing nothing is also doing harm
- Using gardens to facilitate warm-adapted populations and rare/endangered species



But there are risks to expanding: A translocated species becomes invasive

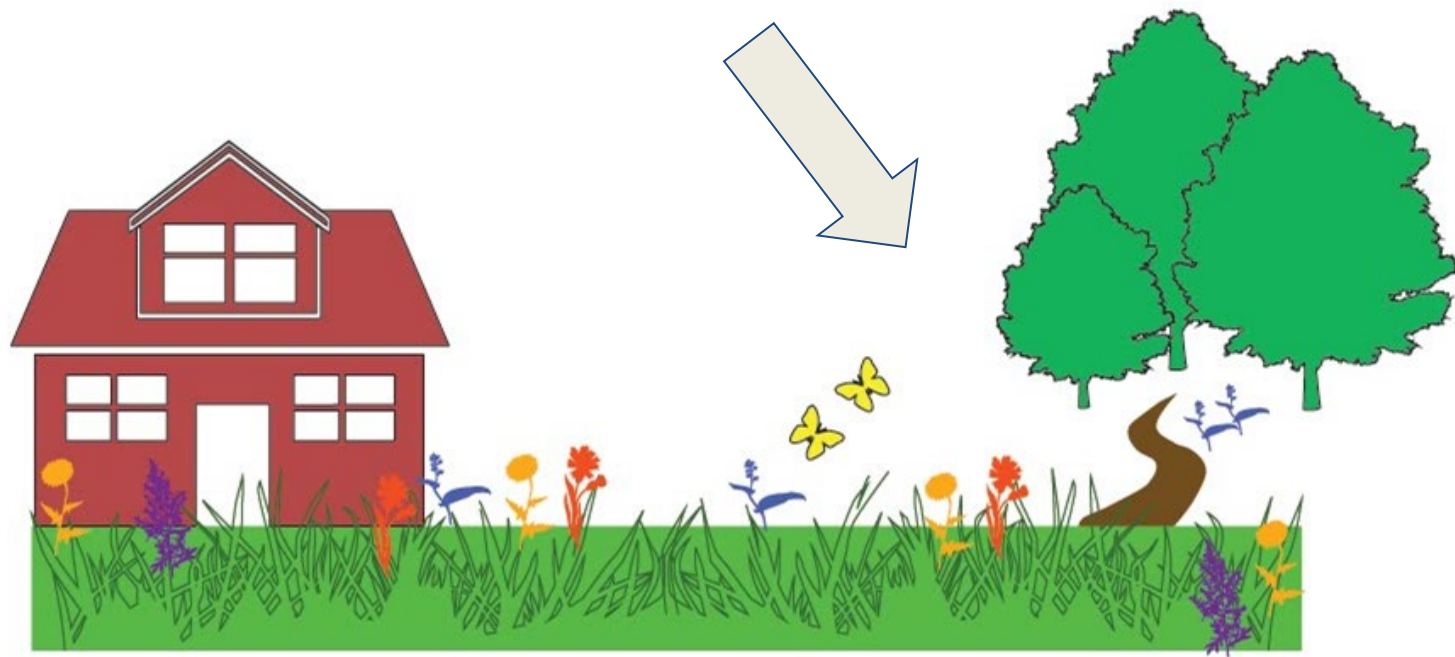


Native range in green



Black locust – now considered invasive

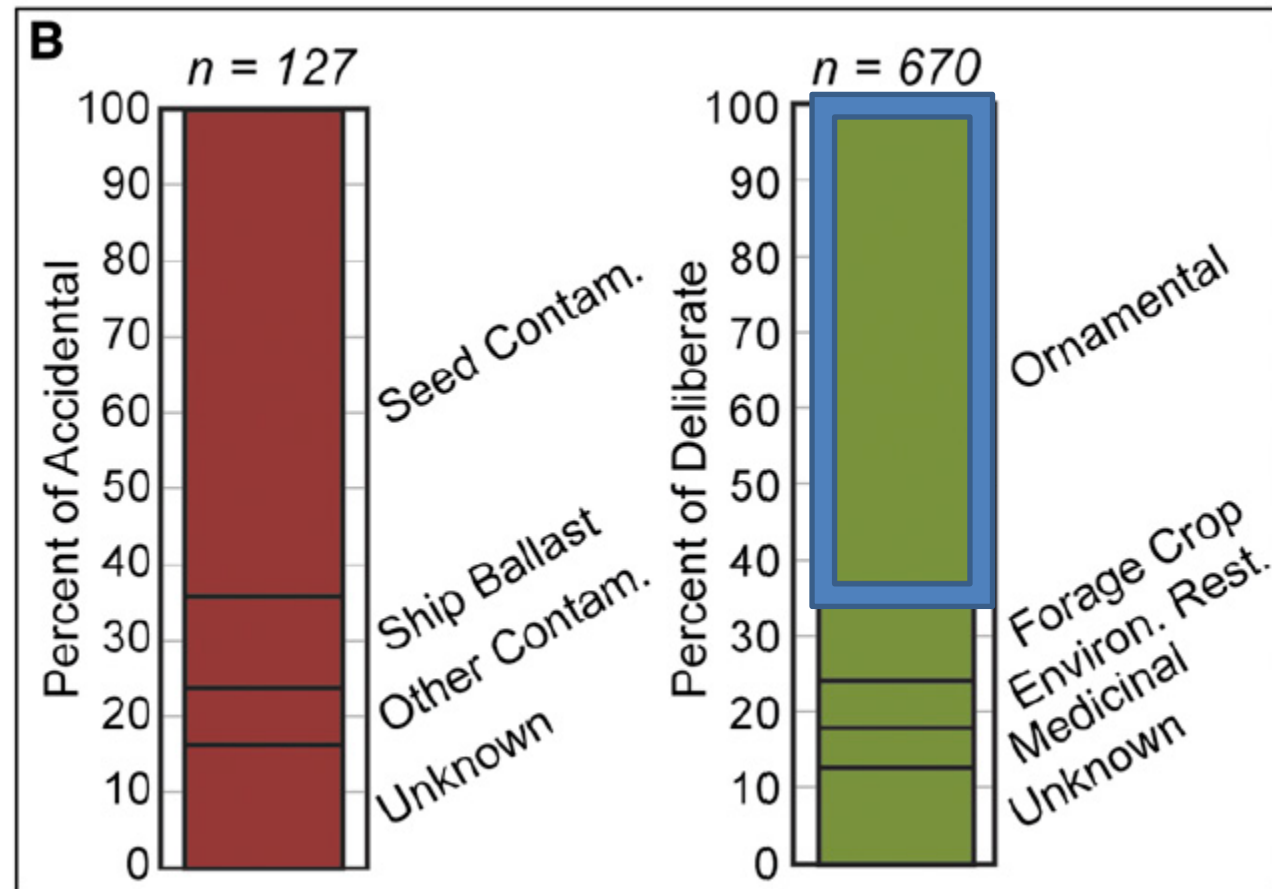
But there are risks to expanding:
A translocated species becomes invasive



Gardens as a pathway for invasions

Nursery imports are the primary introduction pathway of invasive plants

53% of invasive plants introduced as ornamentals



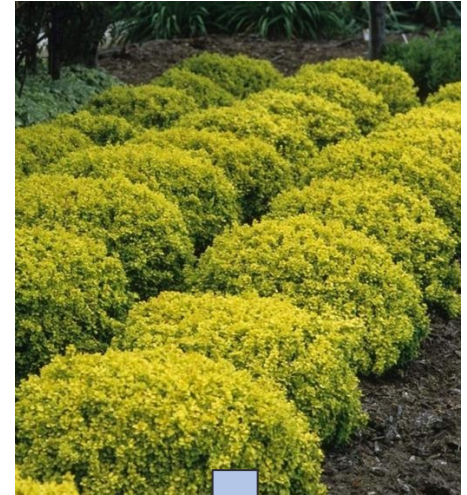
Gardens as a pathway for invasions



Purple loosestrife, *Lythrum salicaria*



Chinese silvergrass, *Miscanthus sinensis*

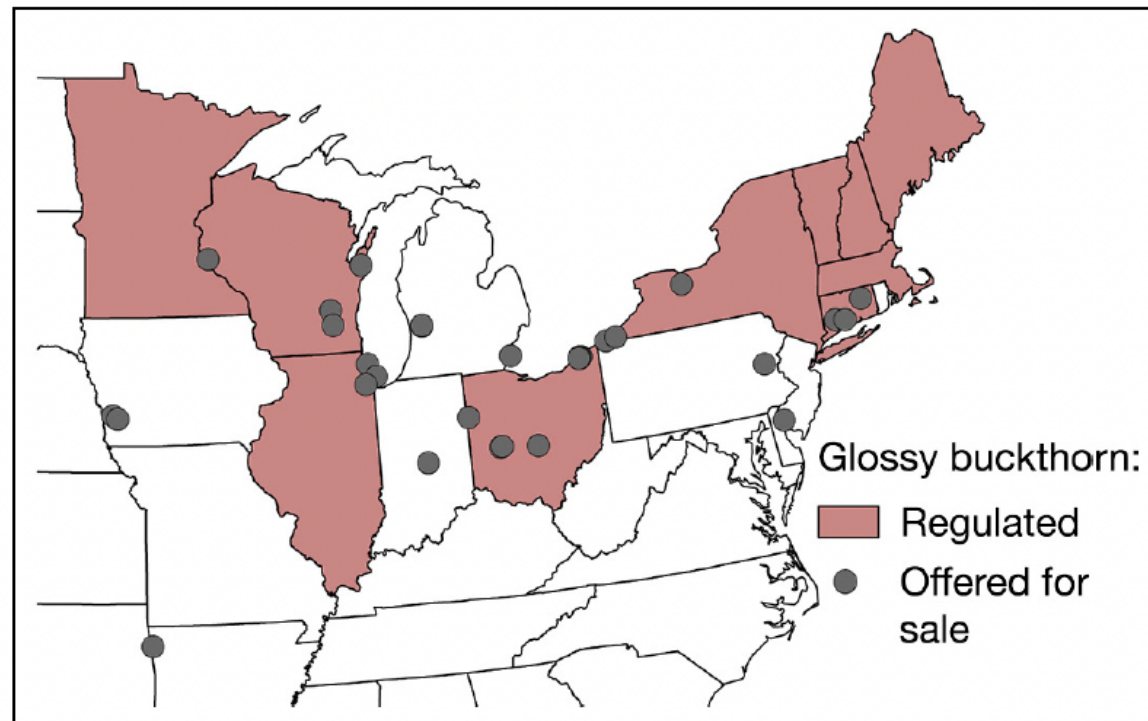


Japanese barberry, *Berberis thunbergii*

Gardens as a pathway for invasions

61% of ~1300 U.S. invasive plants are still marketed as ornamentals

Including federal noxious weeds and state prohibited plants



Gardens as a pathway for invasions

Sudden oak death



70% of non-native forest pests in the U.S. arrived as contaminants on nursery plant imports.

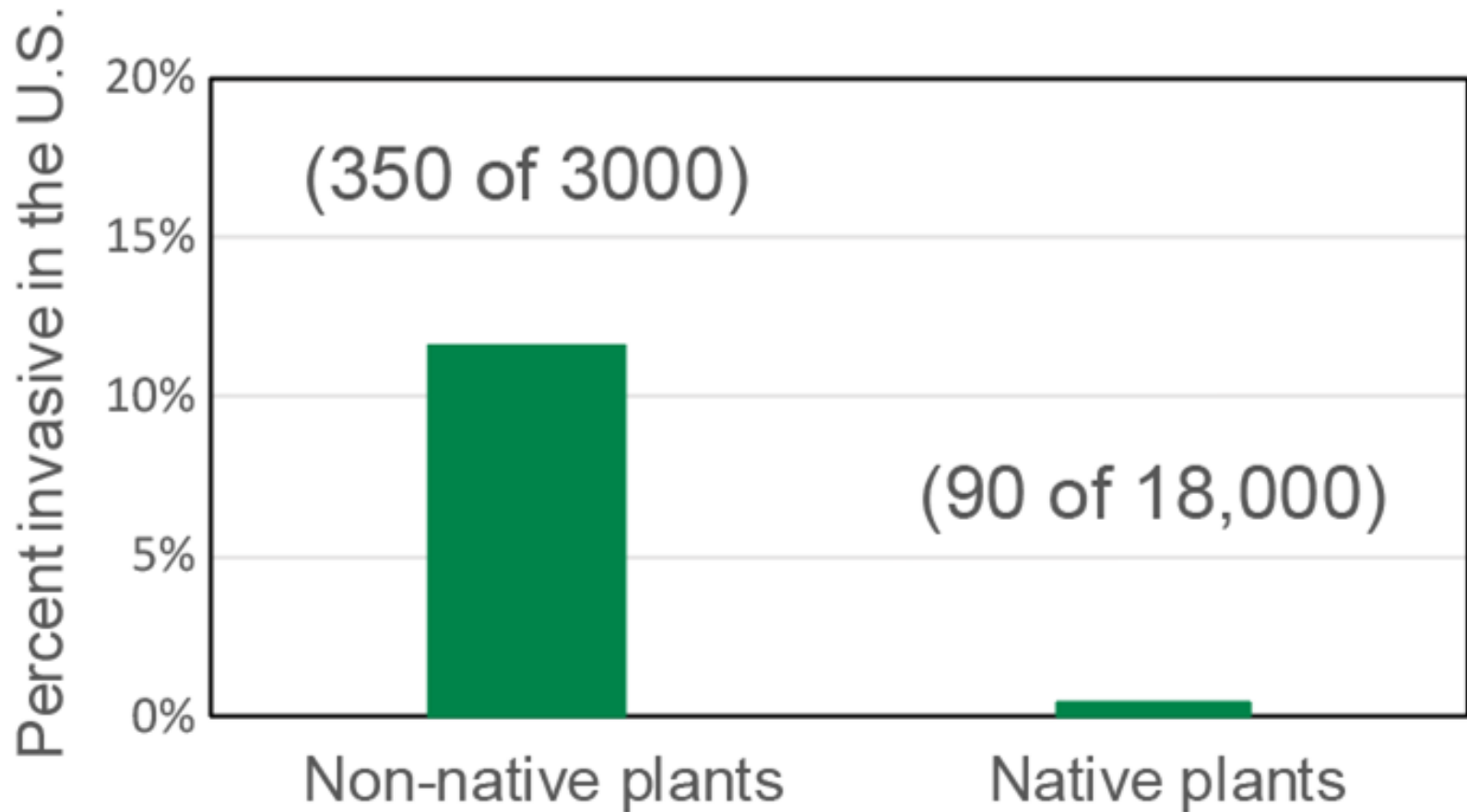


Hemlock wooly adelgid

60% of nursery plants are non-native to the U.S.



Non-native plants are 40x more likely to be invasive than native plants



Non-native plants provide fewer ecological benefits

Benefits of Native Plants



50% higher abundance of **native birds**



9x higher abundance of **rare birds**

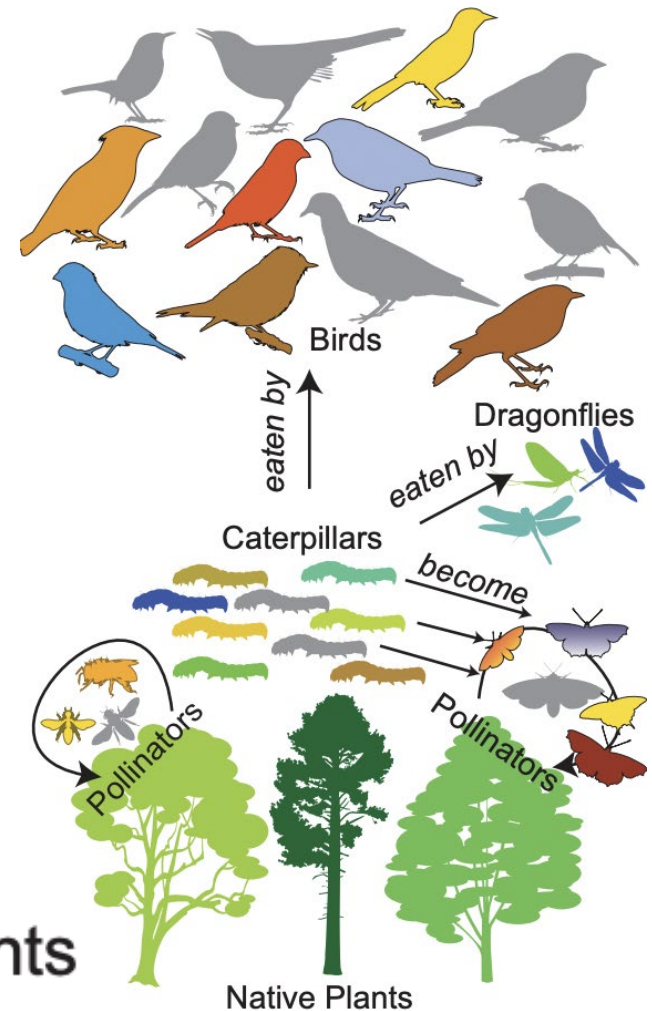


3x more **butterfly species**



2x higher abundance of **native bees**

Landscaping with **native** plants

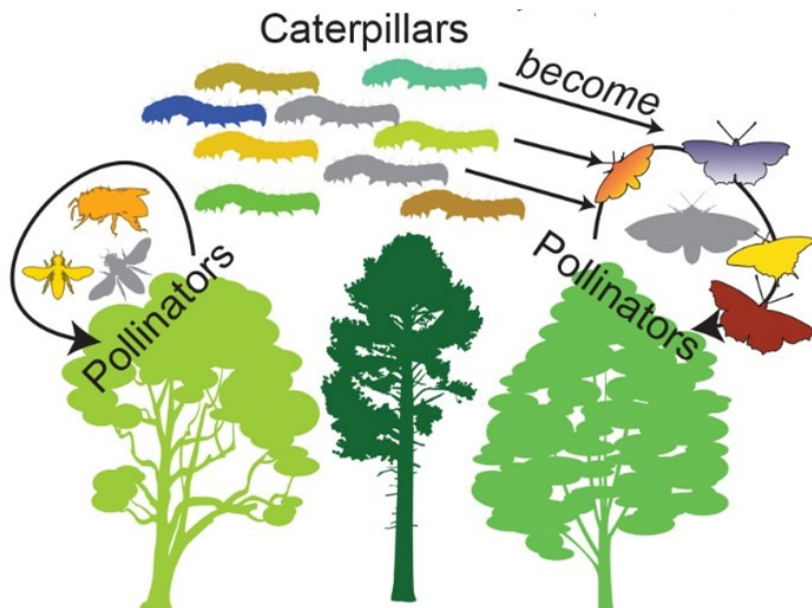


Aim for **less than 30%** non-native plants

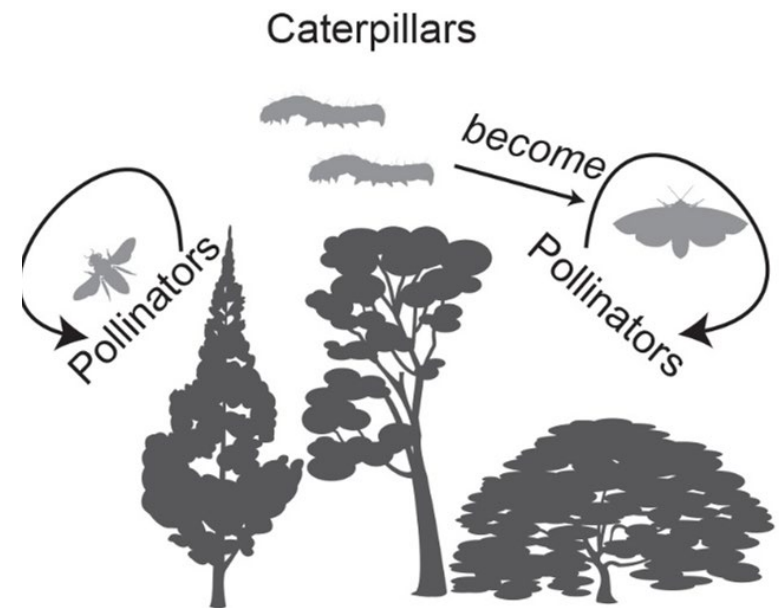
Why are non-natives so much more likely to become invasive?

- Release from natural enemies

Native plants are eaten by many native insects



Non-native plants are not



Why are non-natives so much more likely to become invasive?

- Lack of co-evolution creates unfair advantages



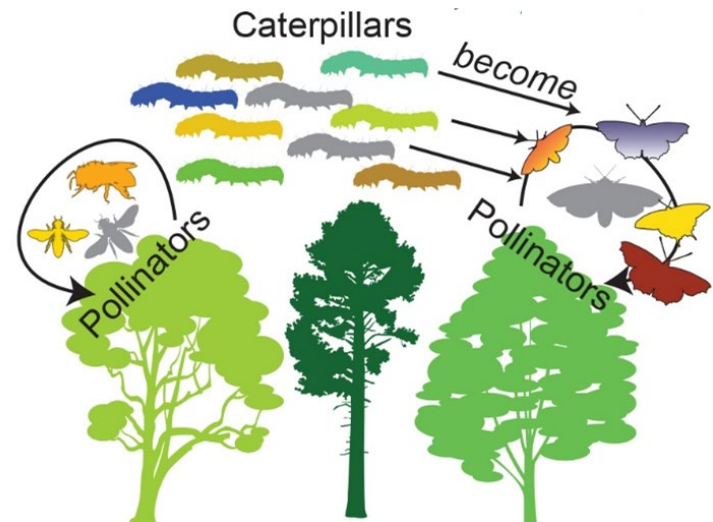
Japanese chestnut
Blight resistant



American chestnut
Susceptible to blight

Take home point #1:

- Gardens can help species move, but moving some species is riskier than others
- Non-native species are more likely to become invasive + provide fewer ecological benefits



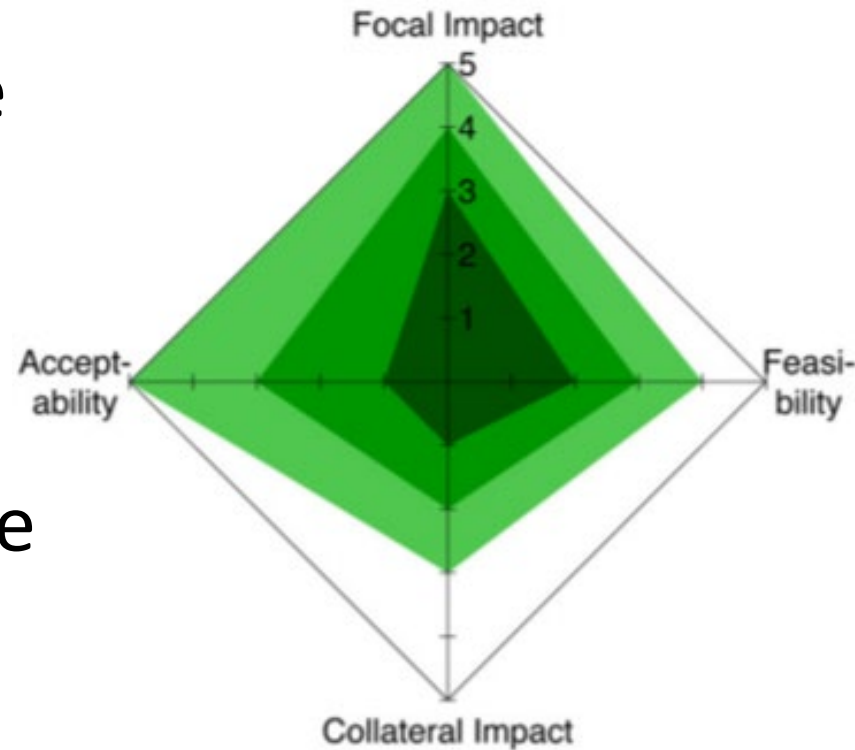
Risks vs. benefits of assisted migration

Focal Impact: Will it help the target species?

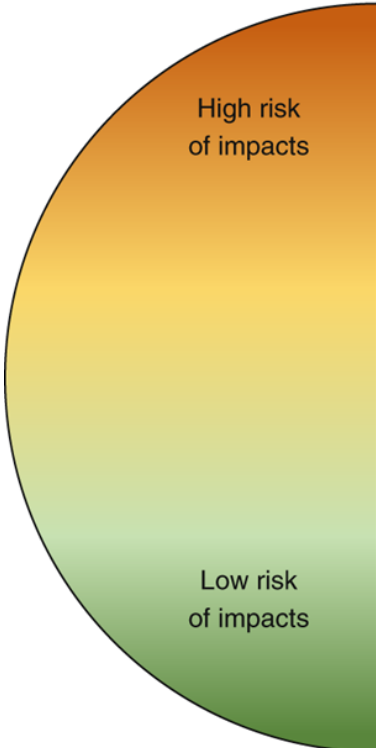
Feasibility: Can we even grow/translocate it?

Collateral Impact: What's the risk for the recipient ecosystem?

Acceptability: Will people support this action?



Predicting collateral impact using traits associated with invasion



	Propagule or dispersal pressure (species)	Abiotic effects (community)	Biotic characteristics	
			Species	Community
High risk of impacts	High fecundity	History of disturbance	Invasive elsewhere	Rare community
	Wide dispersal	Increasing environmental stress	Abundant in home range	Naïve prey
	Continuous propagules	Breach of biogeographic barriers	Fast growth	Enemy release
	High genetic diversity		Generalists	
			Foundation species or ecosystem engineers	
			Pathogen carriers	
Low risk of impacts	Low fecundity	Resilient or resistant to disturbance	Threatened or endangered	Shared evolutionary history
	Limited dispersal	Similar environmental conditions	Endemic	Biotic resistance
			Obligate mutualist Specialists	

Regulations as a mechanism for reducing invasion risk

Federal noxious weed list

- ~100 species
- Focus on national border
- Preventing interstate trade



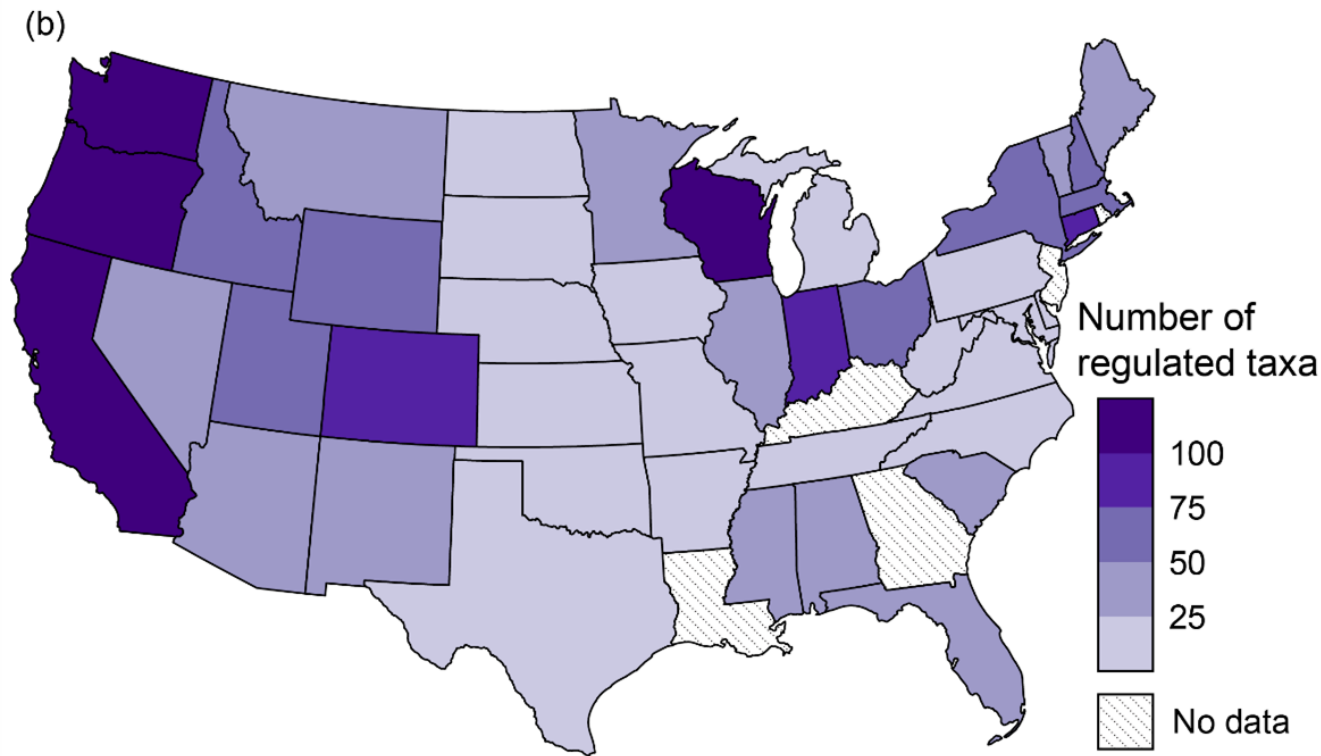
State prohibited plant lists

- ~600 species
- Focus on state borders
- Preventing within-state movement



Regulations as a mechanism for reducing invasion risk

But regulations are inconsistent



Neighboring states have
<20% overlap in
regulated species

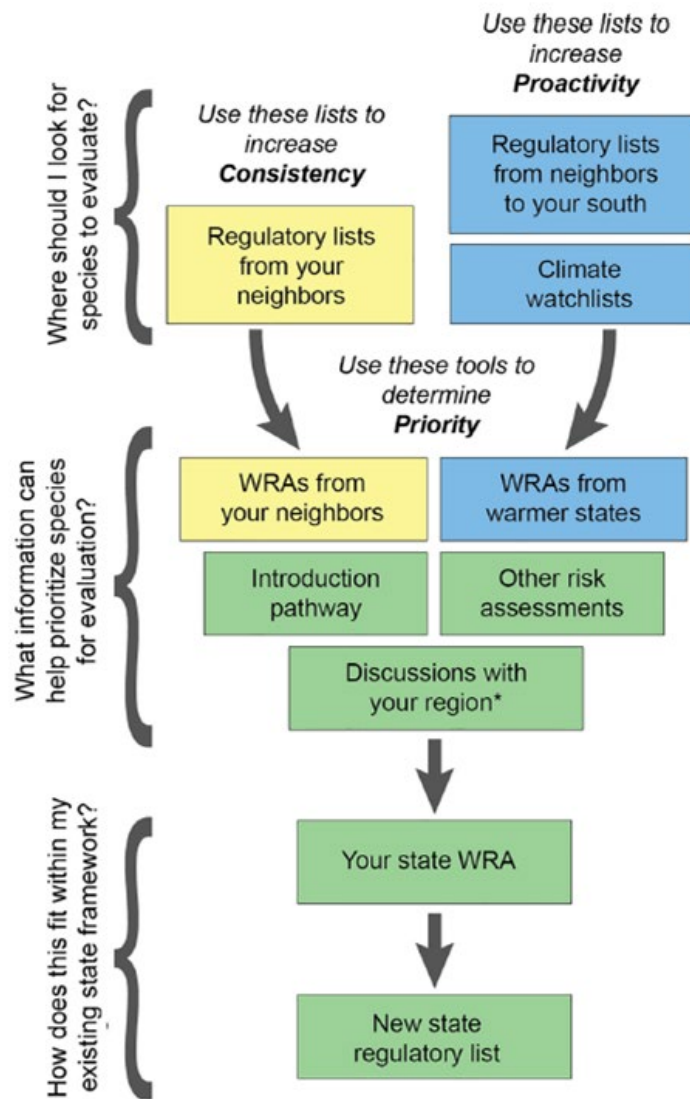
Several states still lack a
regulatory list

Regulations as a mechanism for reducing invasion risk

Increase consistency:

- Evaluating species on your neighbors lists
- Sharing completed weed risk assessments

Think about what plants are leaving your state and moving elsewhere!



Preventing species movement using watch lists

Northeast RISCC Management
Regional Invasive Species & Climate Change
Management Challenge

Prioritizing range-shifting invasive plants High-impact species coming to the Northeast

Summary

Prevention of new invasions is a cost-effective way to manage invasive species and is most effective when invaders are identified and prioritized before they arrive. Climate change is projected to bring nearly 100 new invasive plants to the Northeast. However, these plants are likely to have different types of impacts, making some a higher concern than others. Here, we summarize the results of original RISCC research that identifies high-impact range-shifting invasive plants based on their potential impacts.

Why is risk higher in the Northeast?

Because invasive plants are more prevalent in states to our south and many species are shifting their ranges poleward in response to climate warming, the Northeast is a hotspot of risk from range-shifting species (red areas in Figure 1). A study by Allen & Bradley (2016) modeled the current and potential ranges by 2050 for 896 invasive plants in the continental U.S. Up to 100 new invasive plants are likely to shift into Northeast states with climate change.

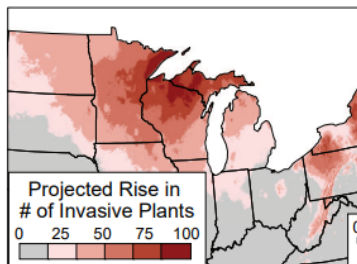


Fig 1. Projected number of new invasive plants

Northeast RISCC Management
Regional Invasive Species & Climate Change
Management Challenge

Do Not Sell! Ornamental invasive plants to avoid with climate change

Summary

Climate change is likely to bring dozens of new invasive plants to the Northeast. Despite their invasive tendencies, many of these species are sold as ornamental plants in slightly warmer climates, but are not yet a large part of nursery sales in the Northeast. By avoiding these species, we protect our native ecosystems from future invasive species impacts. We also present alternative native plants that provide similar aesthetics while also supporting biodiversity.

Ornamentals as Invasives

About 50% of invasive plants were introduced via horticultural trade, including the majority of Northeast invasive plants. The past is a good indicator of the future unless behaviors change.



Fig. 1. Northeastern invasive plants with ornamental origins.

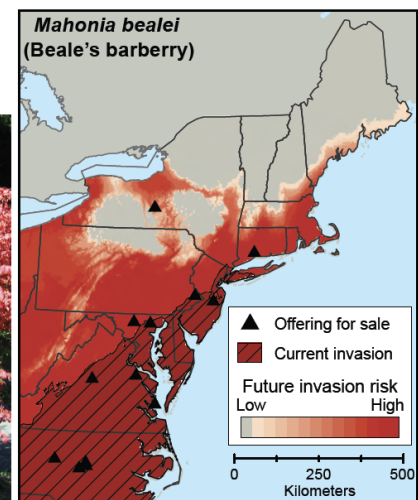
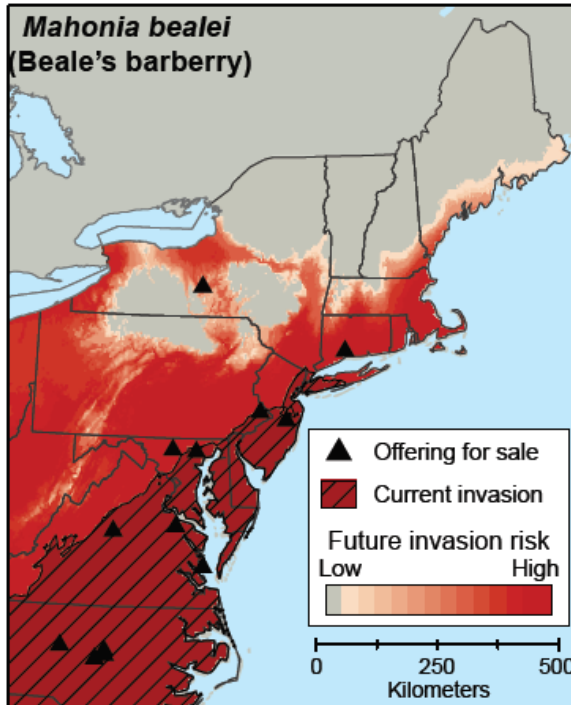


Fig. 2. Current and potential range map with

Preventing species movement using watch lists

Do Not Sell!

Ornamental invasive plants to avoid with climate change



Do Not Sell

Mahonia bealei (Beale's barberry)



Ecological Impacts: Spreads rapidly into natural areas. Similar characteristics to other invasive barberries (e.g., *Berberis thunbergii*).

Vulnerable Ecosystems: Forests.

Akebia quinata (chocolate vine)



Ecological Impacts: Crowds out native understory species as thick ground cover, can over top shrubs and trees.

Vulnerable Ecosystems: Forest edges, wetlands.

Native Alternative

Aronia melanocarpa (black chokeberry)



Zones
3 - 8

Lonicera sempervirens (coral honeysuckle)



Zones
4 - 9

Take home point #2:

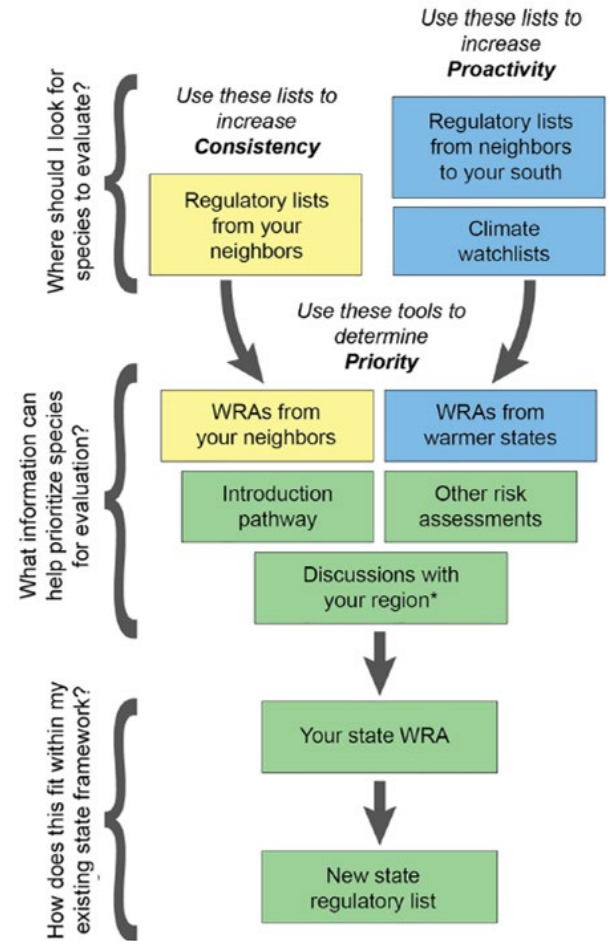
- We have tools for predicting potential risk
- Continuing to import non-native ornamental plants perpetuates invasion risk, especially under climate change
- Geographically informed watch lists can facilitate prevention

Gardens have the potential to seed ecosystems of the future



Facilitate climate-resilient native biodiversity
and minimize risk of introducing invasive species

Prohibited plant lists can be effective tools for prevention



Incorporating geography into watch lists

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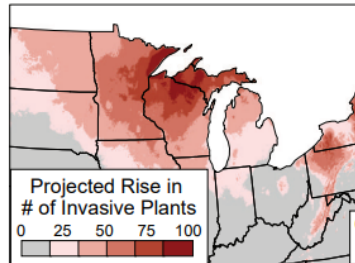


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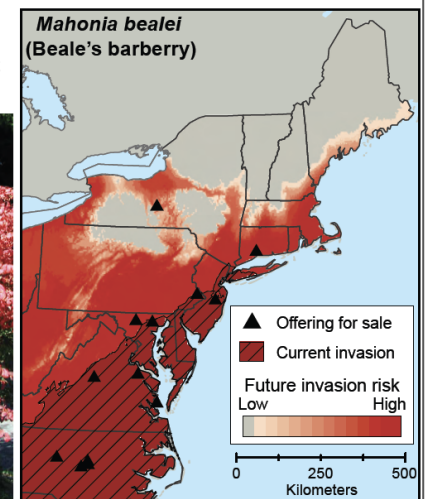


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Resources

Climate Change

Resilient MA: <https://resilientma.org>

- State level climate assessment/clearinghouse for information
- One stop shop for tools and information

Gardening in a Warmer World:

<https://climatechange.cornell.edu/gardening/>

Climate Change Response Framework:

<https://forestadaptation.org/>

Climate Explorer: https://crt-climate-explorer.nemac.org/variables/?id=days_tmax_it_32f&left=historical&leftyear=avg&right=rcp_85&rightyear=2050&extent=-75.2%2C-69.84%2C41.2%2C43.52&zoom=8

Invasive Species

Invasive species and climate change interactions: <https://www.risccnetwork.org/>

National Invasive Species Information:

<https://www.invasivespeciesinfo.gov/>

Planting Guides

Selecting Climate Resilient Urban Trees: <https://www.umass.edu/newsoffice/article/umass-amherst-scientists-create-urban-tree>

Climate Smart Gardening:

https://scholarworks.umass.edu/eco_ed_materials/8/

Native Plant Trust:

<http://www.nativeplanttrust.org/>

Climate Voyager for Hardiness Zone Maps:

<http://climate.ncsu.edu/voyager/>

Forest Resiliency:

<https://masswoods.org/sites/masswoods.net/files/Forest-Resiliency.pdf>

Grow Native Massachusetts

<https://www.grownativemass.org/>



Northeast

RISCC

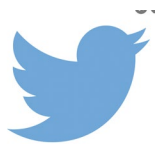
Management

Regional Invasive Species
& Climate Change



- **Want to know more about invasive species & climate change? Join the RISCC listserv!** Email "ne_riscc-l-request@cornell.edu" with the subject "join" to sign up.
- <https://www.risccnetwork.org/>

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