Implications of Climate Change for Invasive Species in the Northeast

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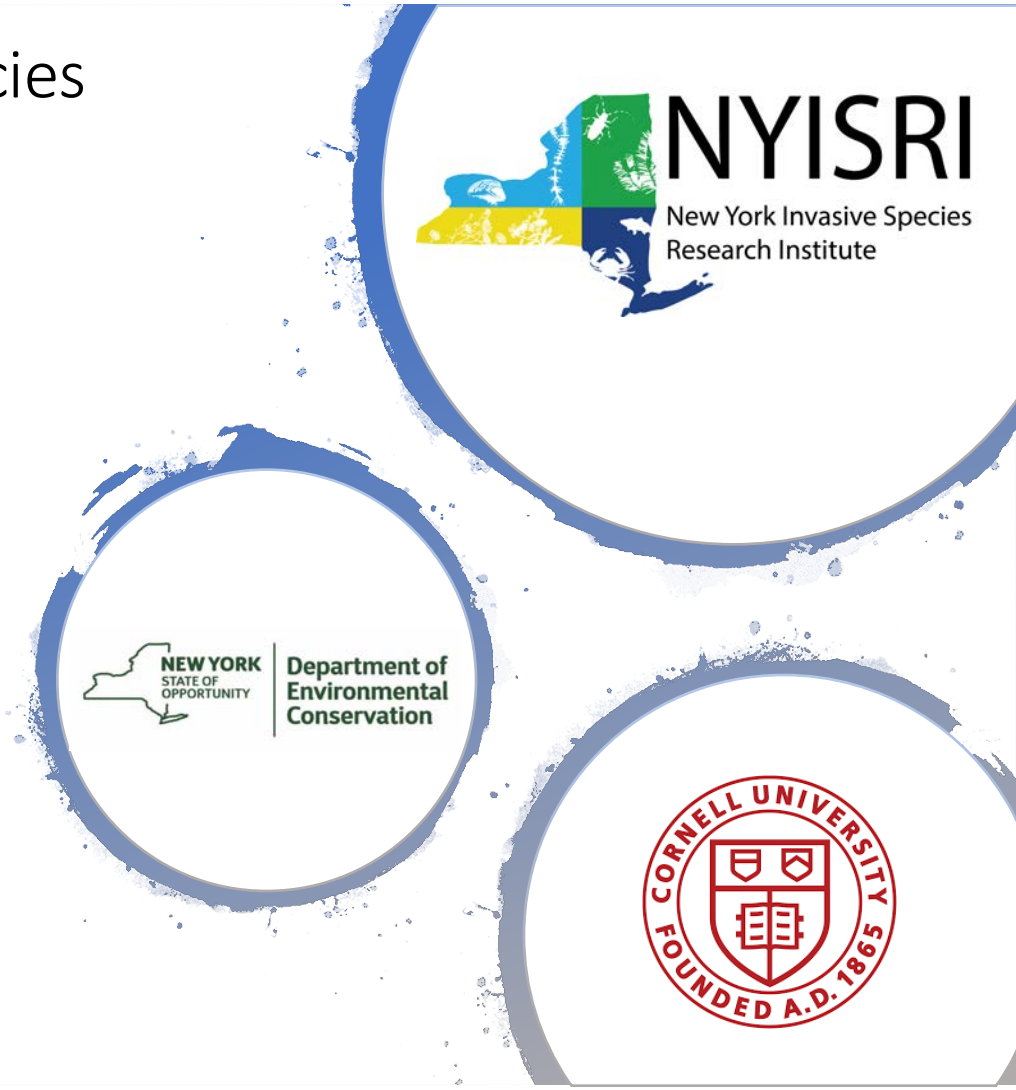
Northeast RISCC Management
Regional Invasive Species & Climate Change

UMass Amherst
USGS science for a changing world
NYISRI New York Invasive Species Research Institute
Cornell University
NECASC Northeast Climate Adaptation Science Center

The New York Invasive Species Research Institute

Established in 2008 to work at the interface of research and management with the mission:

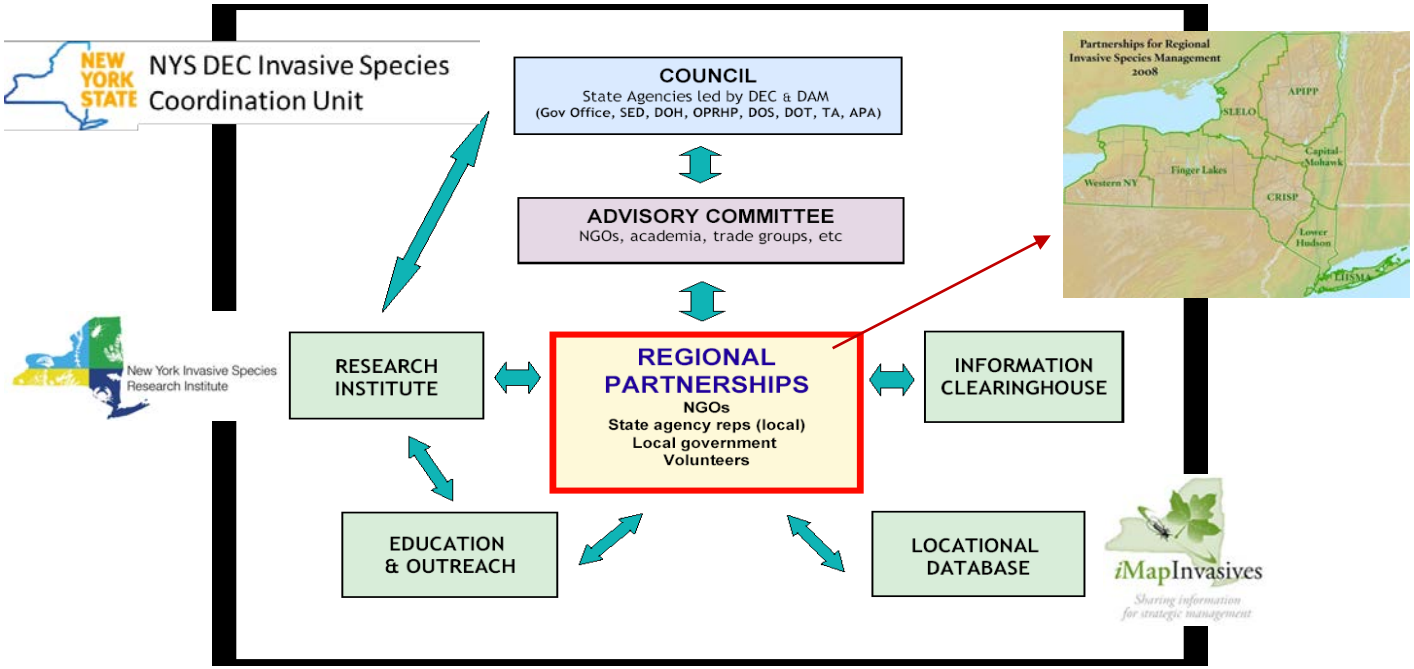
*"to coordinate invasive species **research** to help prevent and manage the **impact** of invasive species in New York State and beyond"*



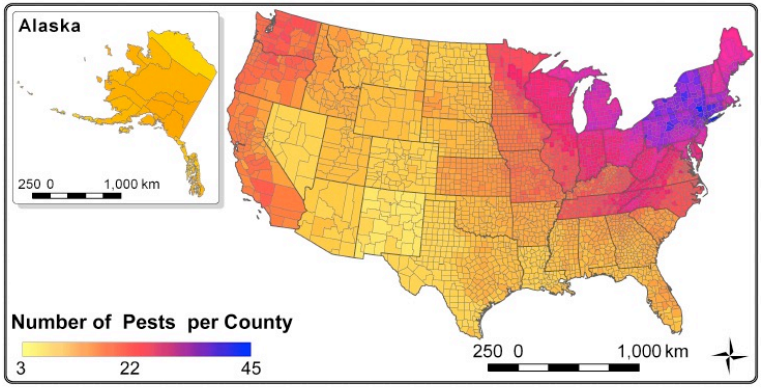
Working with PRISMs, iMapInvasives, NYS Invasive Species Council, NYS Invasive Species Advisory Committee, NYS DEC ISCU, CCE and others

PI: Dr. Bernd Blossey, Cornell University

NYS Strategic System



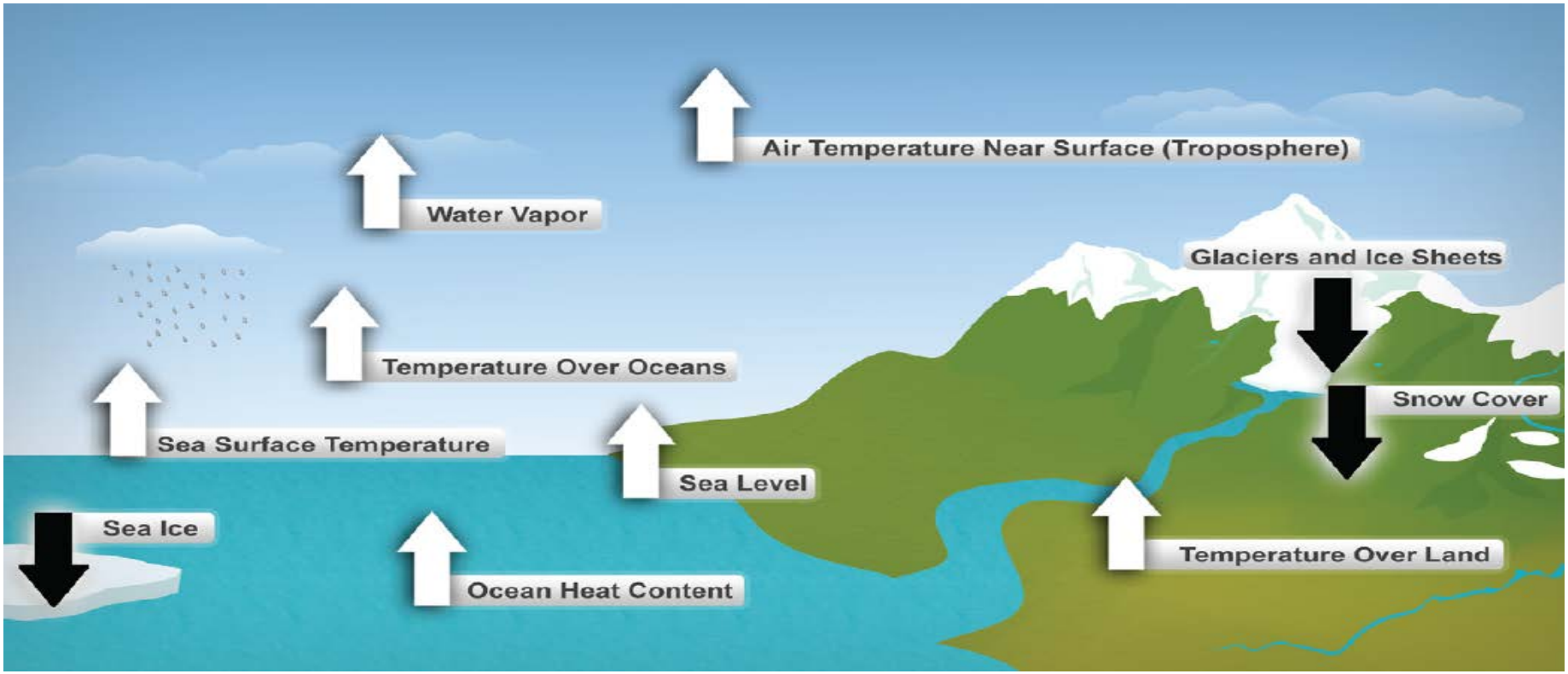
Role of NYISRI to connect IS network with relevant research to improve the scientific basis of invasive species prevention and management and solicit research needs


Alaska
250 0 1,000 km
Number of Pests per County
3
22
45
250 0 1,000 km

Today's talk

- Climate Change 101– what changes are occurring?
- Invasive species responses to these changes and the implications for invasive species management
- How can we increase knowledge and tools to incorporate climate change considerations into invasive species management decisions?

The climate is changing…..



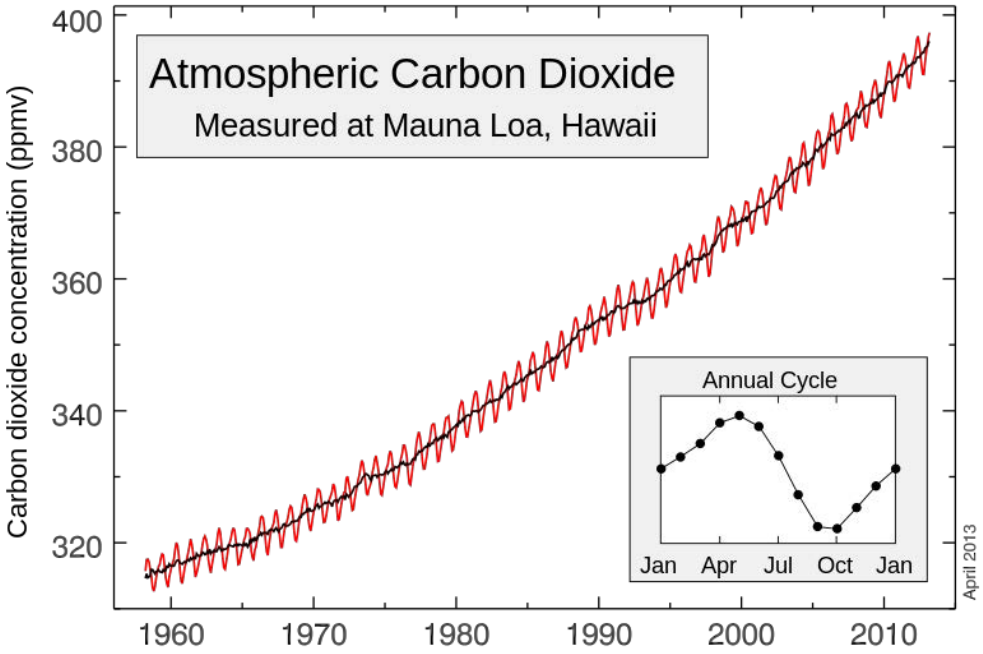
Decreasing trend Increasing trend

Figure source: NOAA National Climate Data Center

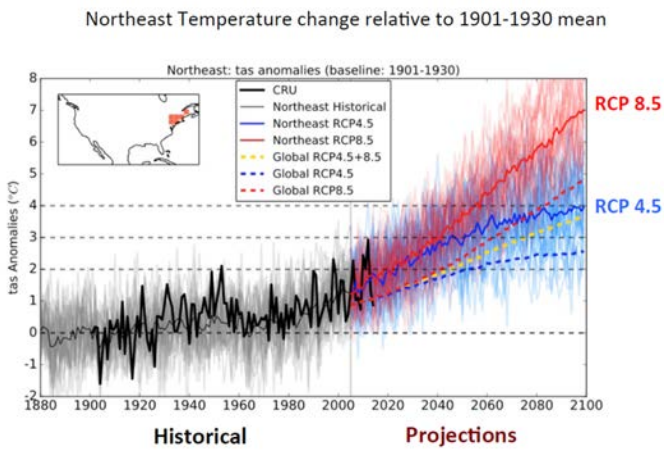
Rising CO_2

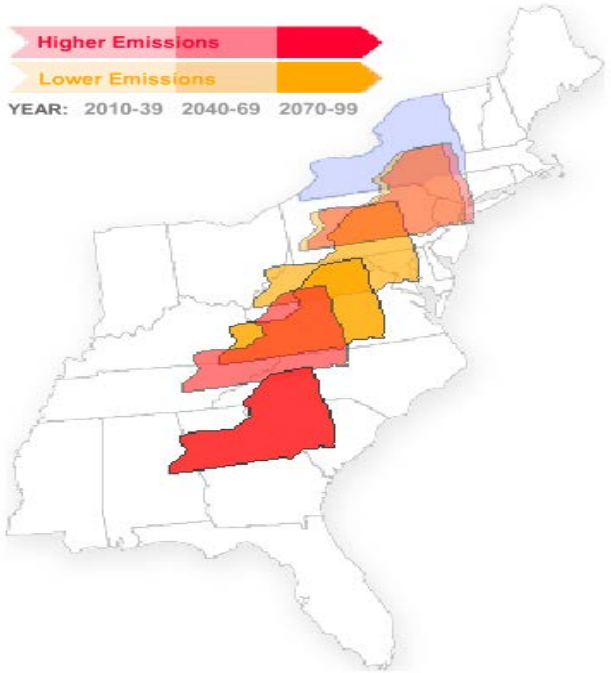
Atmospheric CO_2

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



Northeast average temperature rise



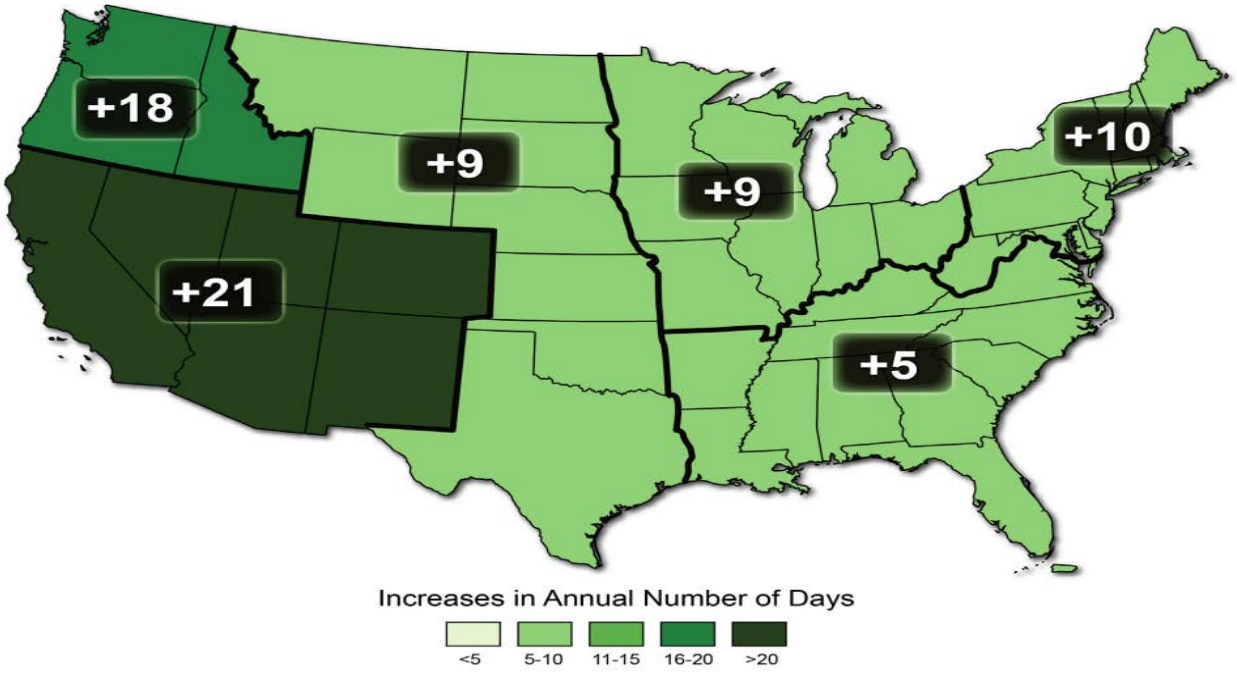


http://www.ucsusa.org/global_warming/science_and_impacts/impacts/global-warming-northeast-migrating-states.html

UCS USA

"Milder winters"

Observed changes in frost-free season (1991-2012)



- Frost free and growing seasons have increased nationally since 1980s
- Largest increases in west, continued lengthening is projected
- Earlier spring snow melt, less snow overall
- Lake ice forms later, melts earlier

2014 NCA report

Figure source: NOAA National Climate Data Center

Increasing frequency of temperature and precipitation extremes

and also extreme weather

Red River flood near Fargo, ND

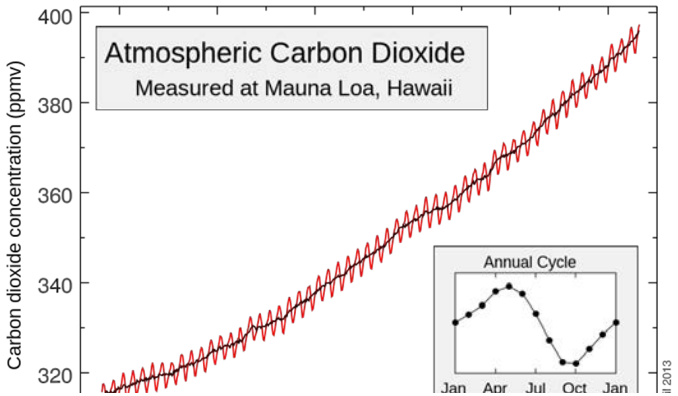
Hurricane Sandy damage in Newark Watershed

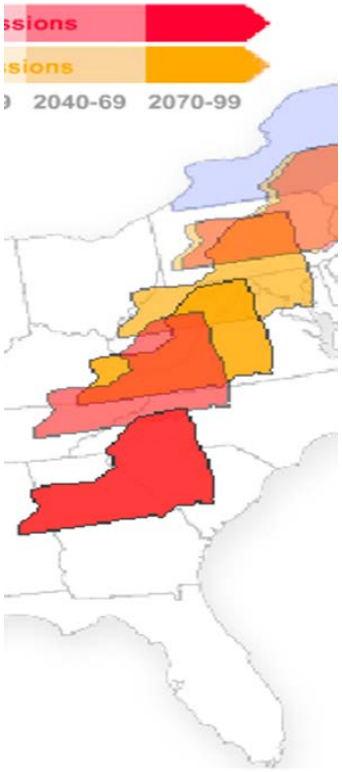
Heat waves/droughts cause fires in the West

Today's talk

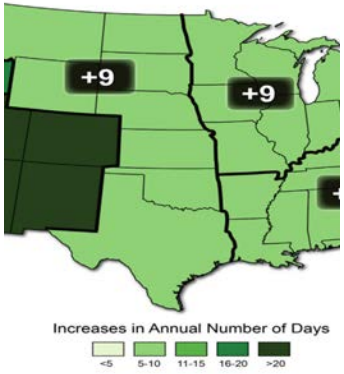
- Climate Change – what changes are occurring?

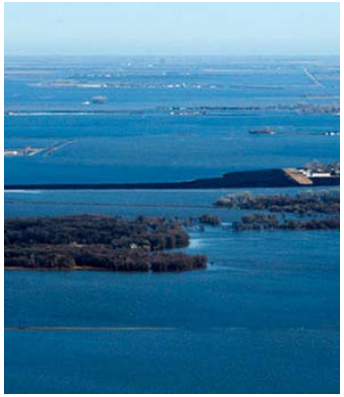
- Invasive species responses to these changes and the implications for invasive species management



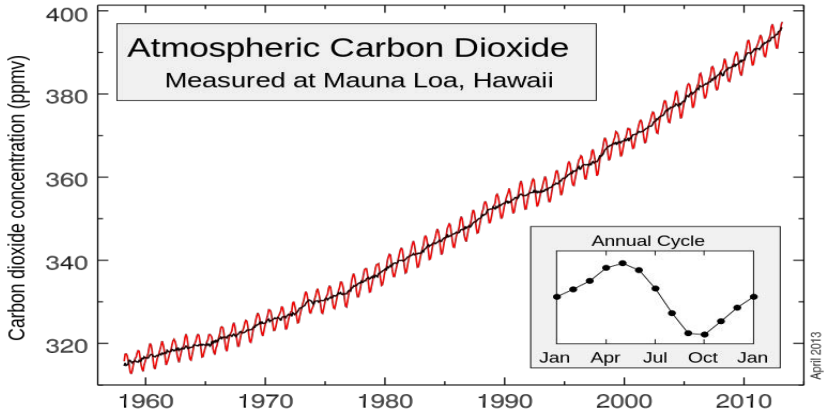


Under these conditions, many invasive species are given a competitive edge:

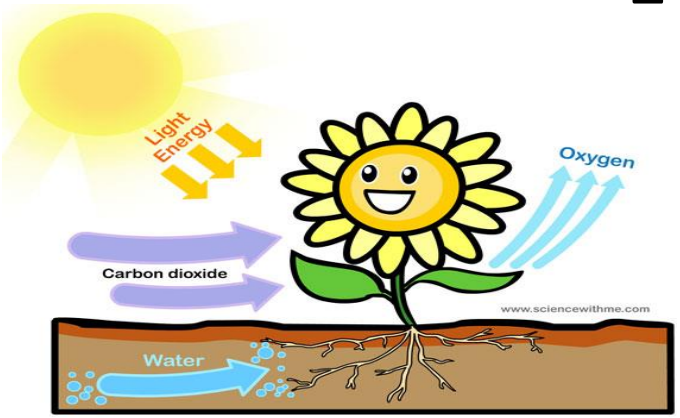




Rising CO_2

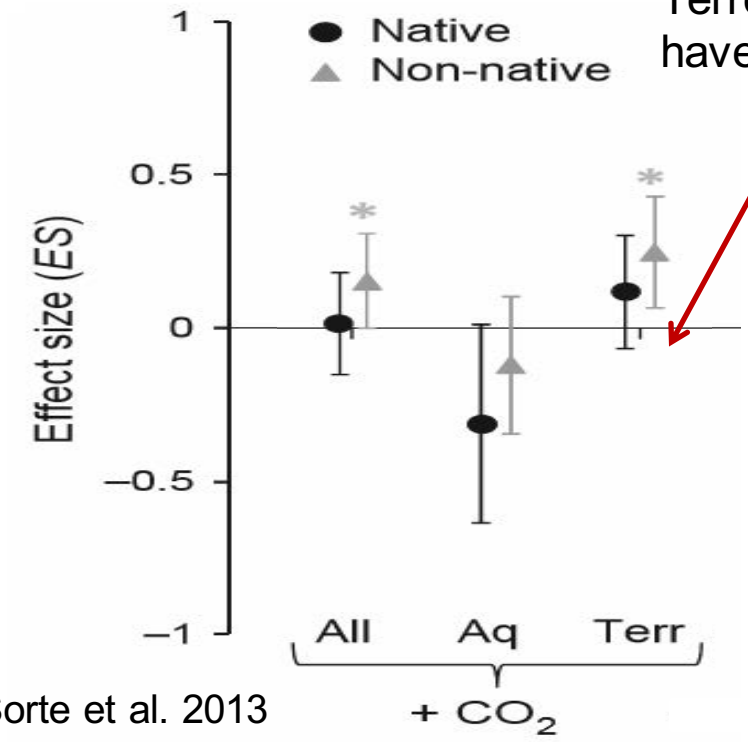


Plants ❤ CO_2



Rising CO_2

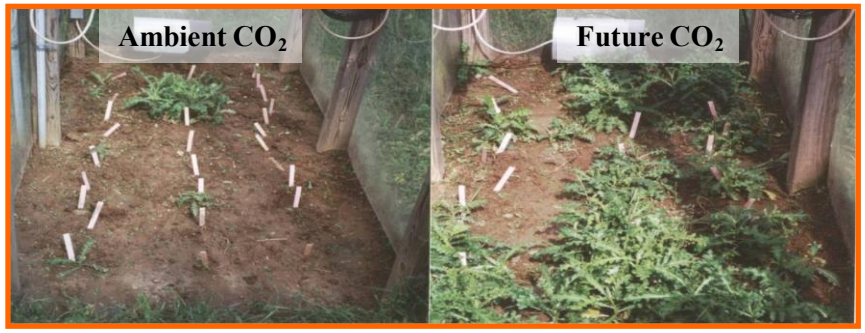
Invasive plants do better still



Sorte et al. 2013

Terrestrial <u>invasive</u> plants have a larger <u>advantage</u>

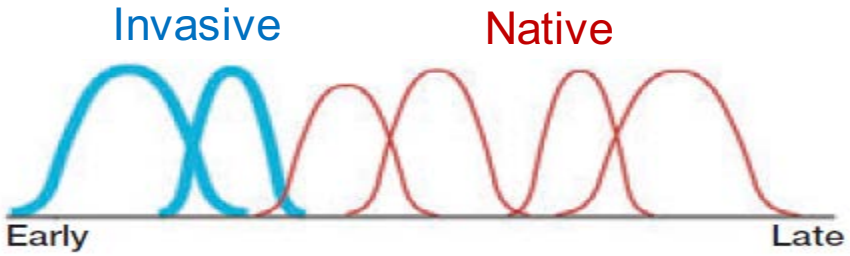
Bigger…… and harder to kill



Differential efficacy of the herbicide glyphosate to control the aggressive perennial weed, Canada thistle, at ambient and future CO2 concentrations. Credit: Ziska et al. 2004.

Warming temperatures

Milder winters and Priority Effects:
Some invasive plants show earlier spring green-up



Wolkovich & Cleland 2011

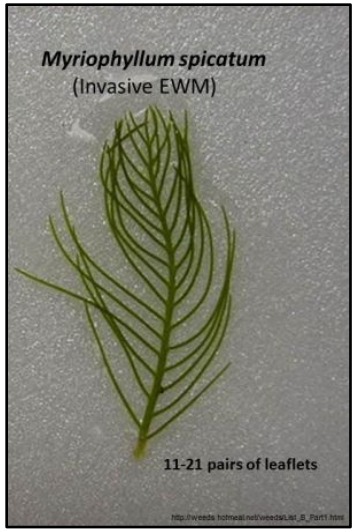

Barberry (*B. thunbergii*)


Garlic mustard (*A. petiolata*)


Honeysuckle (*L. maackii*)


Buckthorn (*R. cathartica*)

Warming temperature

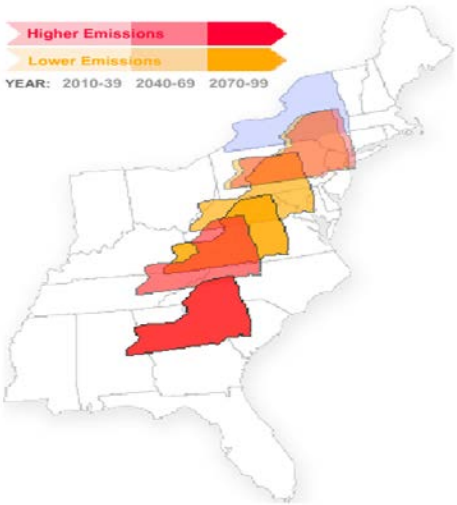


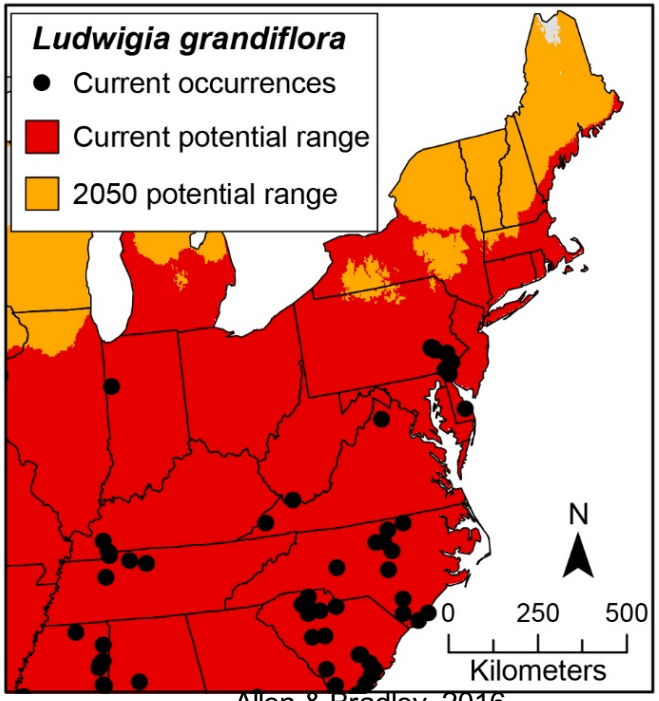
va s

competitive advantage for some invasives, results in growth and longer growing season

Warming temperature

(Invasive) species respond by shifting their ranges

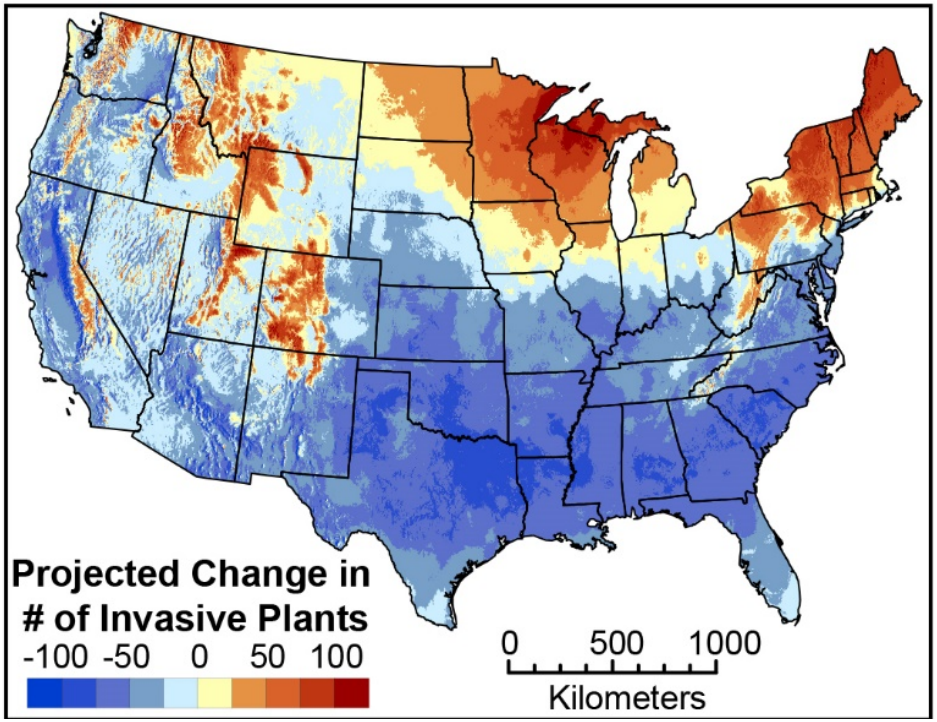




Allen & Bradley, 2016

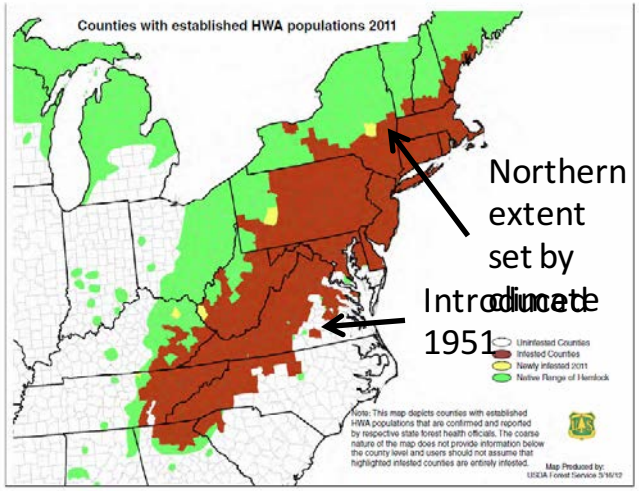
Photo: Alain Dutartre

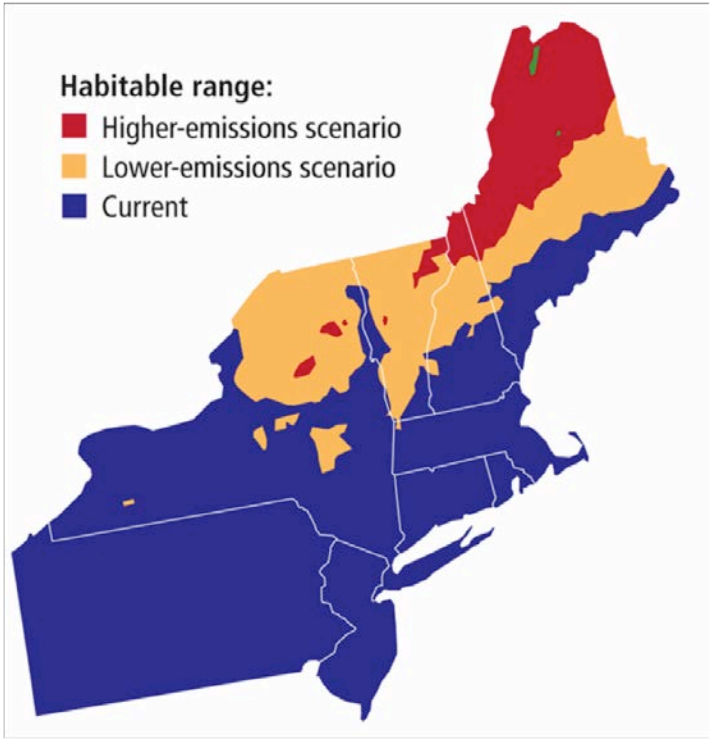
The northeast is a hotspot of future invasion



Allen & Bradley, 2016

Forest pests such as Hemlock Woolly Adelgid will continue to spread Northward as the climate warms

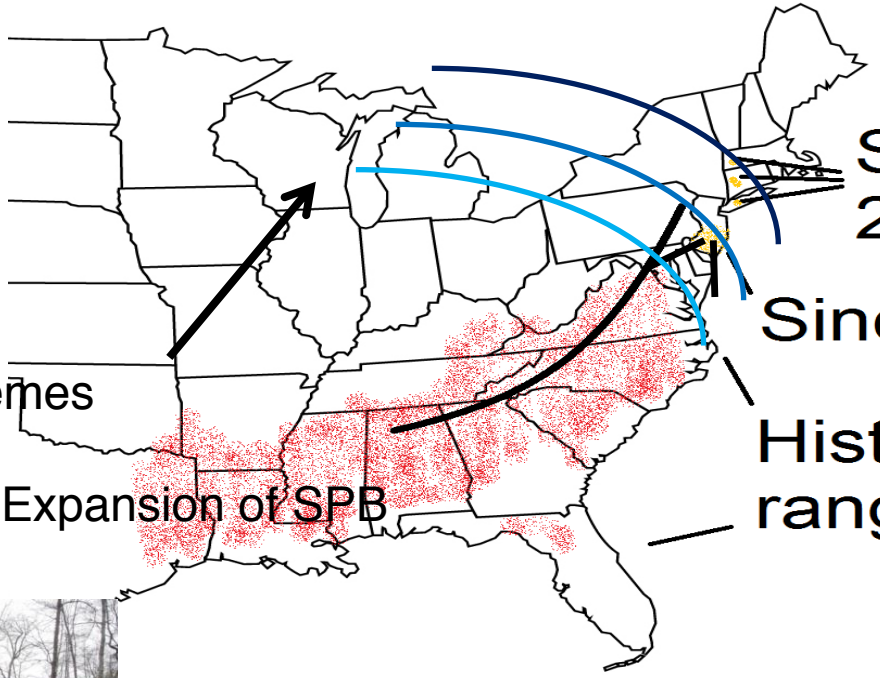


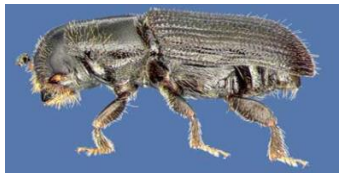


Source: Northeast Climate Impact Assessment, 2006
Slide by G. Lovett

Area habitable by HWA in 2100 under different CO_2 emissions scenarios

Southern Pine Beetle expansion with warmer winters





The New York Times

Long Island Confronts Destructive Southern Pine Beetles

By TATIANA SCHLOSSBERG OCT. 28, 2014

Robin Donohue, a wildlife biologist, inspected a pitch pine at the Wertheim National Wildlife Refuge in Shirley, N.Y., this week. Gordon M. Grant for The New York Times

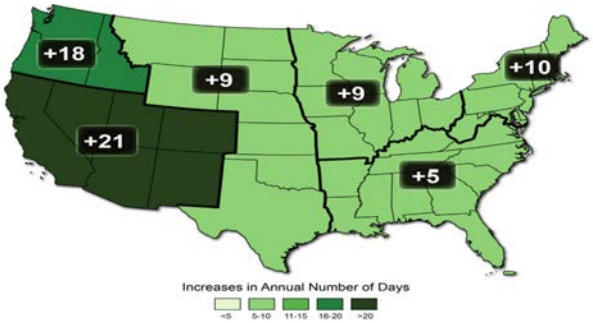
Range expansion of temperature-limited aquatic species

Water Hyacinth

Asian Clam

Changes in disturbance regime favors invasive species

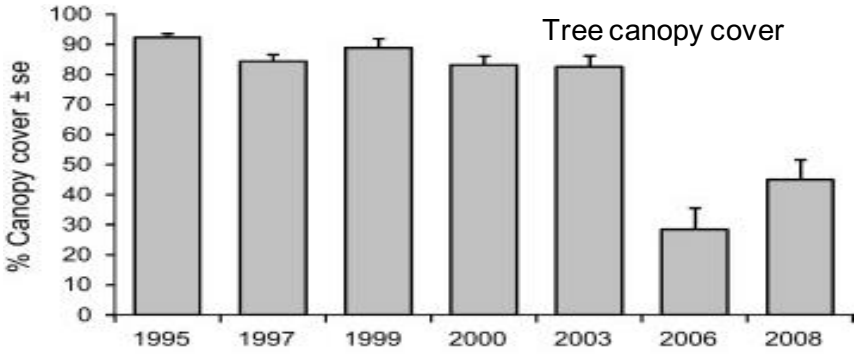
ex: ice scouring effect removed

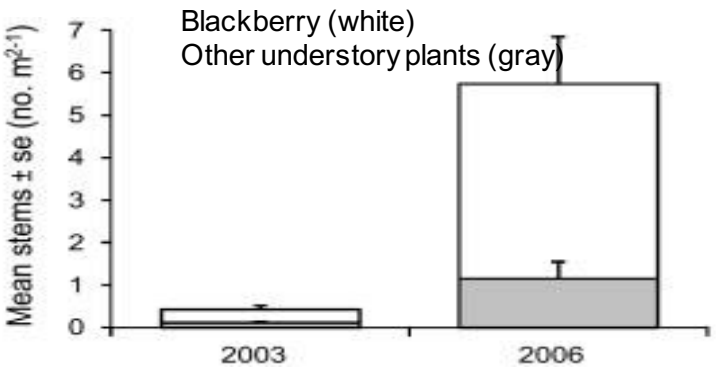


Increased extreme events

Extreme events cause native species mortality and allow invasive species to move in

Understory (invasive) plants thrive following disturbance from Hurricane Katrina. Duration of effect unknown.



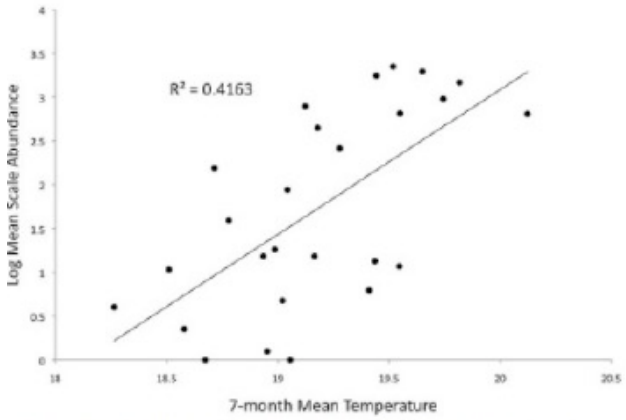


Brown et al. 2011

Warmer climate + drought= more stressed trees and more abundant pests

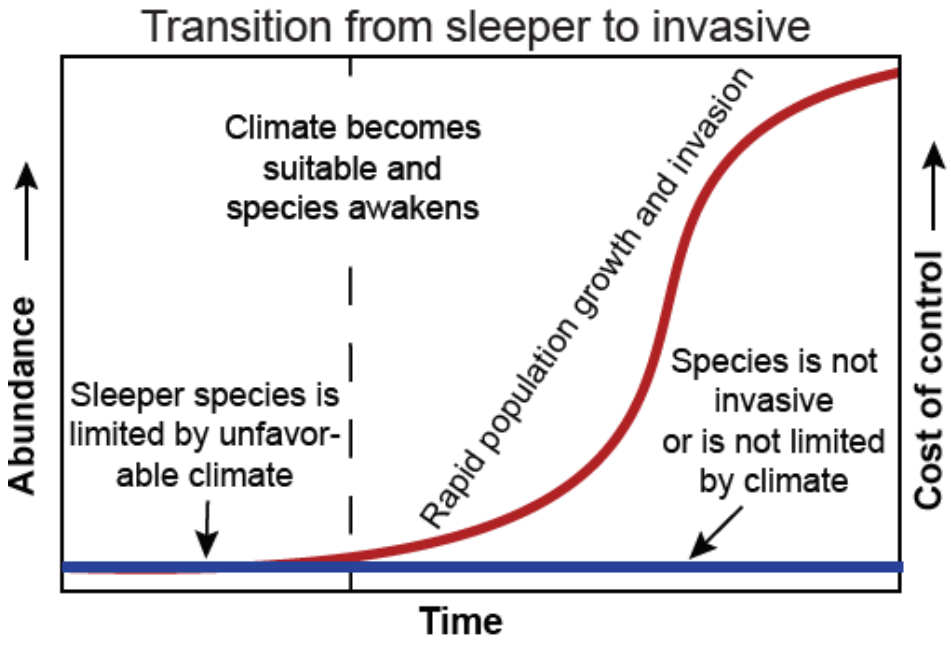
- Gloomy scale insects, *Melanaspis tenebricosa and red maples*
- Warmer, more drought-stressed trees harbored more successful pests than cooler, less drought-stressed trees.
- As cities and natural habitats become hotter and drier, damaging scale insects will become more abundant.

Adam Dale (UF) and Steven Frank (NCSU)



Linear regression of seven-month mean temperature and log mean scale abundance per 0.6 m of maple twig (log(y) = 229.95+1.65x).

“Unknown” future invaders: “Sleeper Species”



Bradley, Bethany A.; Beaury, Evelyn; Fusco, Emily J.; Laginhas, Brittany; Morelli, Toni Lyn; and Pasquarella, Valerie, "Regional Invasive Species & Climate Change Management Challenge: Preparing for sleeper species" (2018). *Environmental Conservation Educational Materials*. 2.
https://doi.org/10.7275/R5F18WXT

- Non-native species that are present but not invasive because growth is limited by biotic or abiotic conditions
- Often climate is the limiting factor and if climate becomes suitable, the species will proliferate

Examples of sleeper species

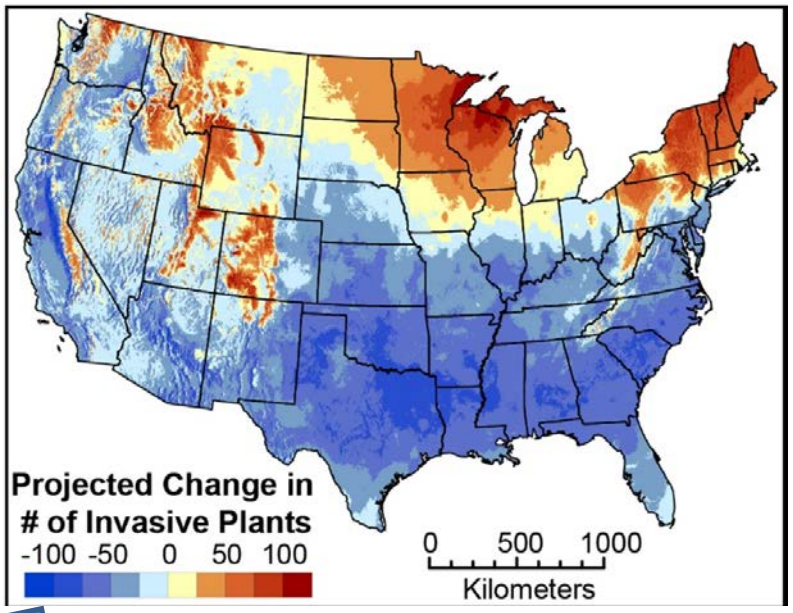
A Sleeper species

B Suspected sleeper

C Suspected sleeper

A) Acorn barnacle (*Austrominius modestus*), a cold-intolerant species first introduced around 1955 off the U.K. coast, did not become invasive until 50 years later after a series of mild winters. **B)** Mayweed chamomile (*Anthemis cotula*) was introduced to Massachusetts over a century ago. Its ability to respond quickly to climate change may give the plant a competitive advantage, shifting it from naturalized to invasive. **C)** First discovered in New York in 2004, Sirex woodwasp (*Sirex noctilio*) currently impacts stressed pines. Increasingly frequent disturbance events due to climate change may lead to greater damage from this forest pest.

Climate change does not always benefit invasive species



Responses are species and context specific!

Climate Change's 'Opportunities' for Invasive Species

- Increased growth and density of invasives due to higher CO_2
- "Hardier" invasives under higher CO2 show resistance to herbicide treatment
- Potential reduced effectiveness of biocontrols if phenology is mismatched
- Earlier green-up (via priority effects or greater plasticity) for invasives and other competitive advantages
- Northward shifts for invasives due to warmer temperatures and milder winters
- Increased new establishment due to increased disturbance
- Waking up "sleeper" invasive species

How could this research knowledge translate to management decisions?

Extend boat washing stations beyond traditional Memorial day to Labor day

Plant native to avoid introducing potential sleeper species

Seek additional management tools in preparation for hardier invasives under increased CO2

Proactively consider regulating invasive species from Southern states

Including IS in planning for extreme events response

Adjusting treatment timing to address earlier phenology

Look to neighbors to the south for species on the move

Today's talk

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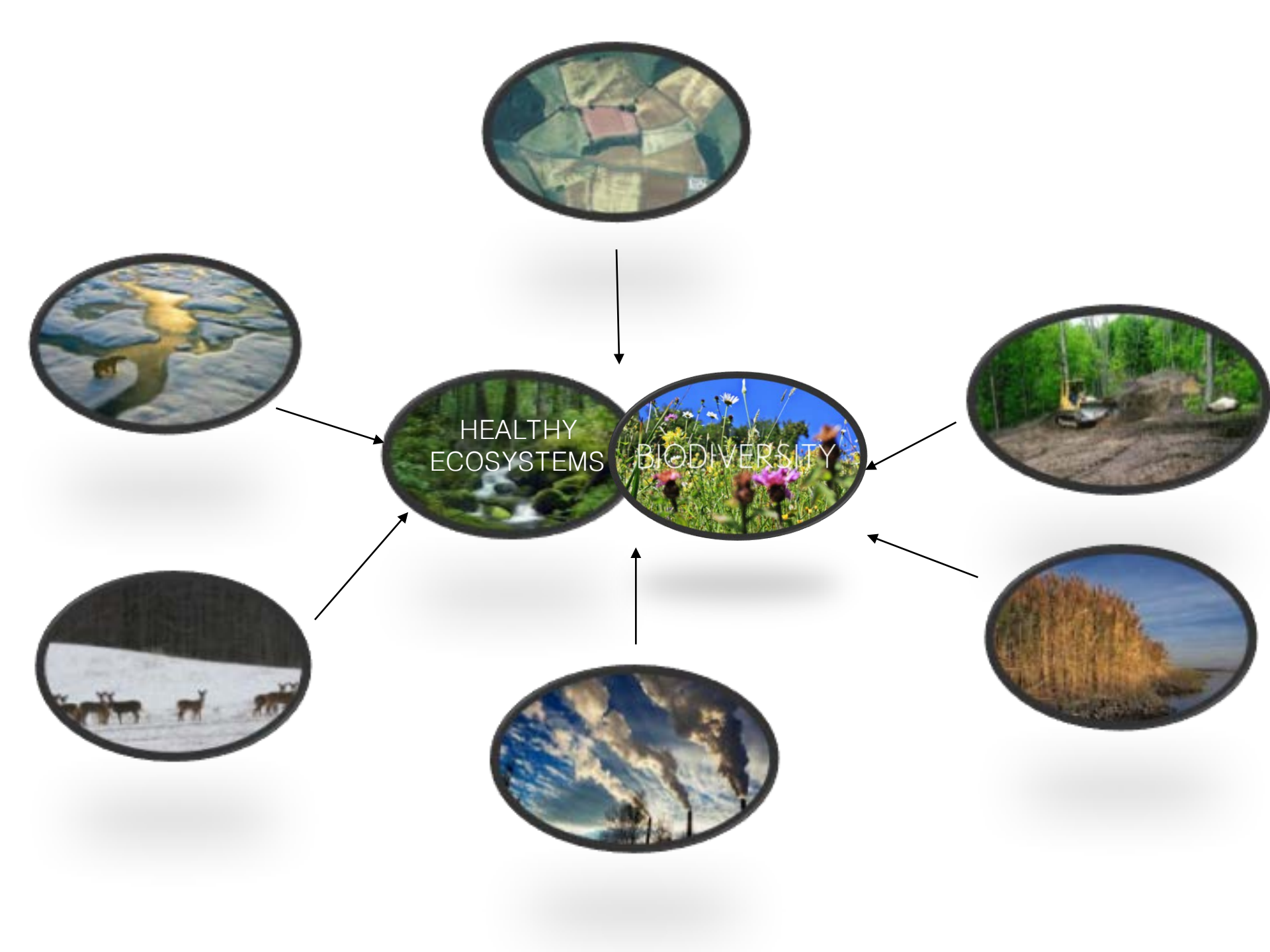

HEALTHY
ECOSYSTEMS
BIODIVERSITY

The White House

Office of the Press Secretary

For Immediate Release December 05, 2016

Executive Order -- Safeguarding the Nation from the Impacts of Invasive Species

EXECUTIVE ORDER

"consider opportunities to apply innovative science and technology….."

"We Can Do This……"

The man who has the time, the discrimination, and the sagacity to collect and comprehend the principal facts and the man who must act upon them must draw near to one another and feel that they are engaged in a common enterprise. (Woodrow Wilson, 1856–1924.)

Increasing research on invasive species

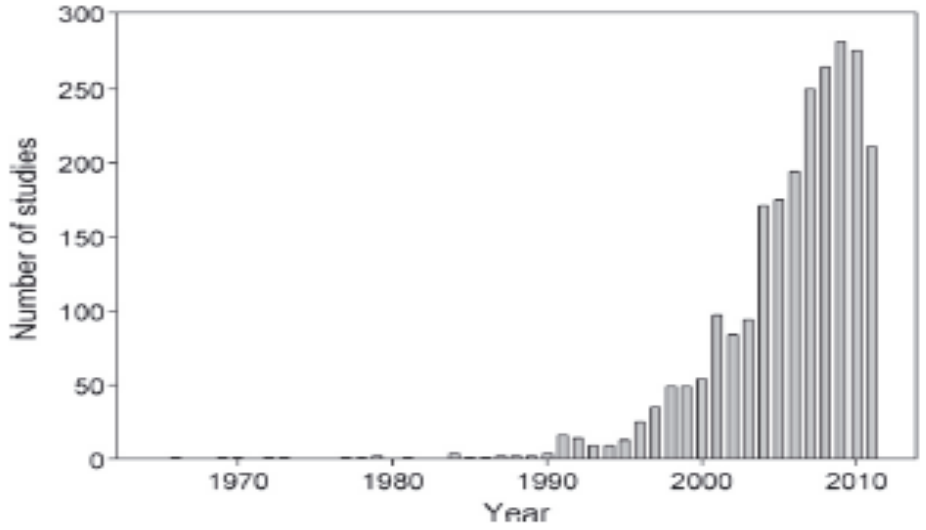


Figure 3. The number of studies published per year included in the field synopsis. The most recent year (2011) only included records included in the database through September (journals published at different dates in September will vary in their inclusion in the database) and indexed on the Web of Science as of September 2011.

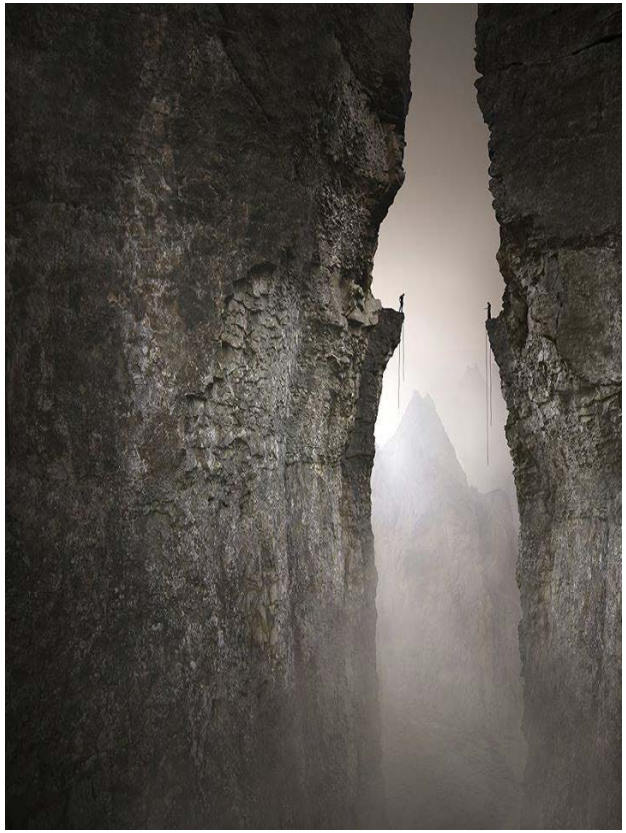
Biological invasions: a field synopsis, systematic review, and database of the literature

Edward Lowry[1], Emily J. Rollinson[1], Adam J. Laybourn[1], Tracy E. Scott[1,2], Matthew E. Aiello-Lammens[1], Sarah M. Gray[1,3], James Mickley[1,4] & Jessica Gurevitch[1]

The “Knowing- Doing Gap” in IS Management and Research

“There is a gap between research and practice, so that scientific information accumulates, but is not incorporated into management actions.”

- Matzek et al. 2014.Conservation Letters



Where do invasive plant managers get the information that directs their management decisions? *(Matzek et al. 2014)*

Informal conversations and learning from own experiments

Written material synthesized in books, newsletters, or Web sites

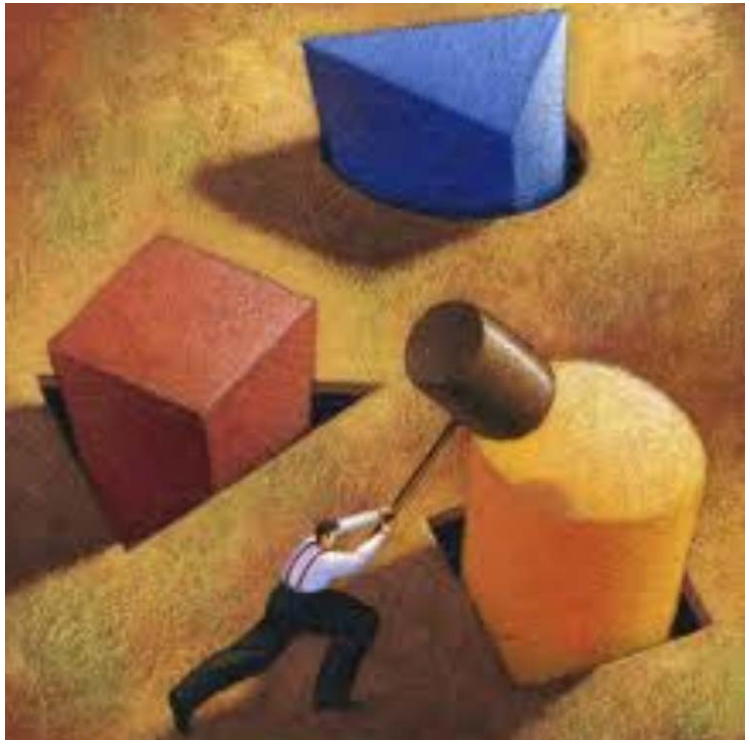
Conference/ symposium attendance

Peer review journals

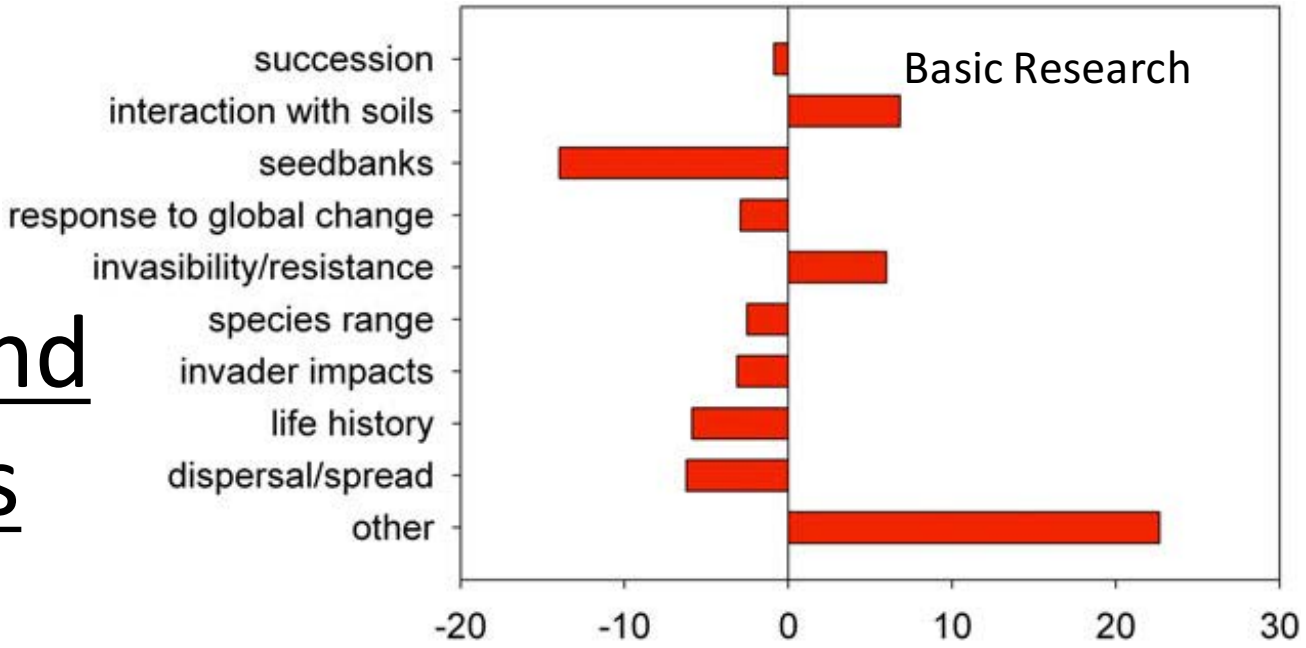
Ranked Highest

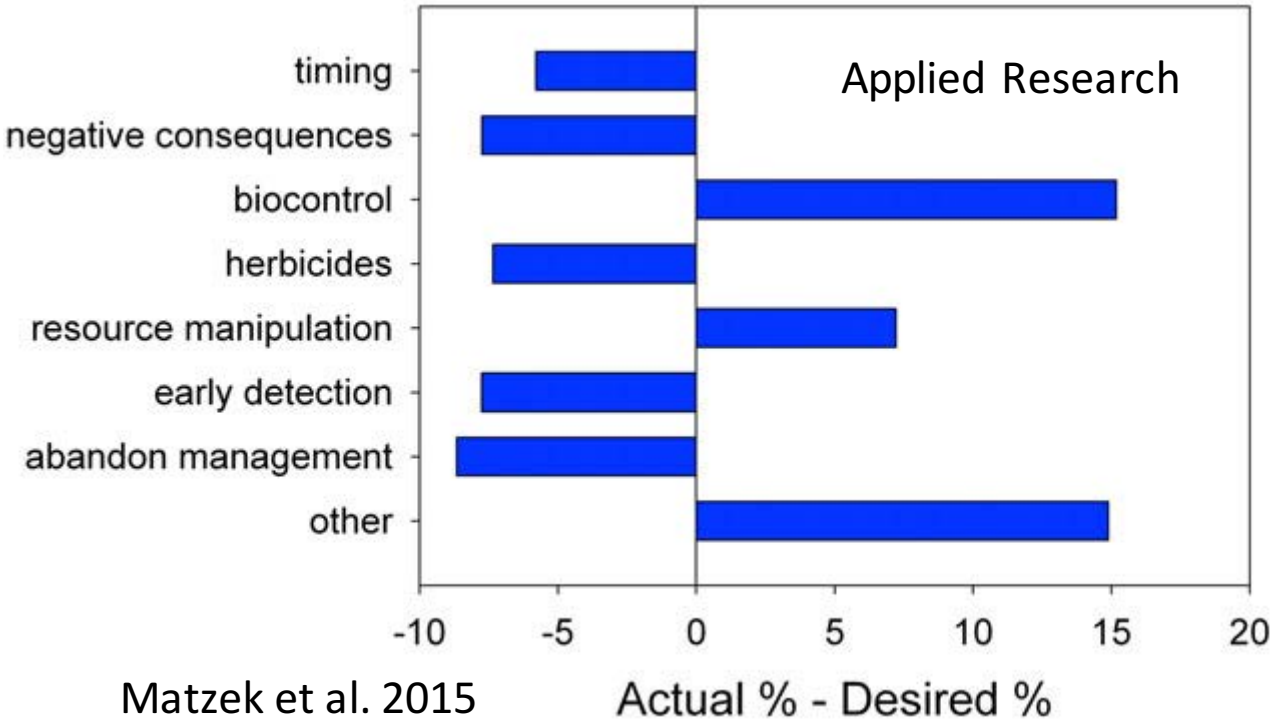
Ranked Lowest

Often the information doesn't exist or research doesn't address the specific question



Mismatch between researchers and stakeholders

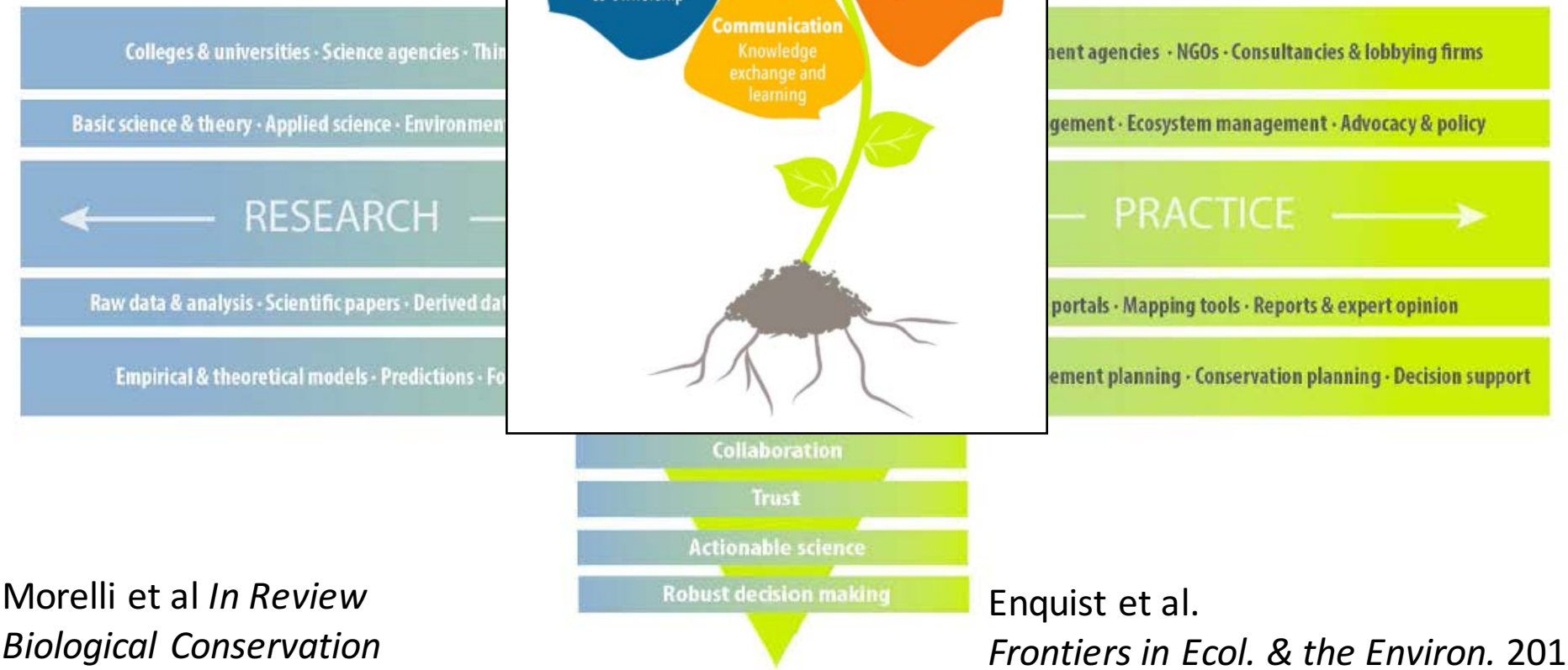




Matzek et al. 2015

Translational Invasion Ecology

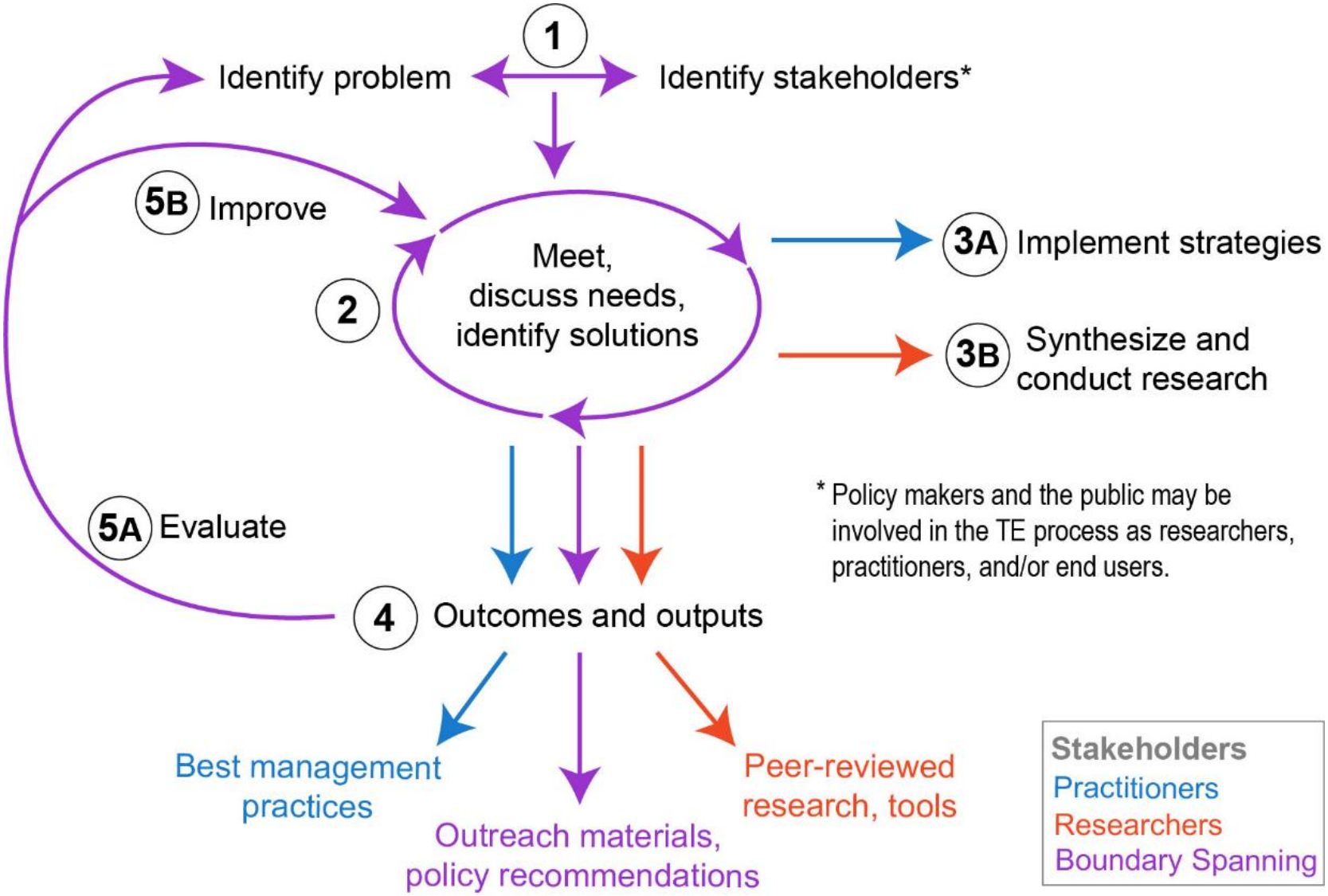
An approach that em and inclusive process in which researche nd decision makers collaborate to dev research via joint consideration of th gical, economic, and political contexts of t e species.



Morelli et al *In Review Biological Conservation*

Enquist et al. *Frontiers in Ecol. & the Environ.* 2017

Translational Invasion Ecology



Morelli et al *In Review*
Biological Conservation

NYISRI
New York Invasive Species Research Institute

Annual Solicitation for IS Research Needs

IS Managers asking:

How can we manage for upcoming biological invasions in the light of climate change?

Northeast RISCC Regional Invasive Species & Climate Change Management

Founded in 2016 to address the question

"How can we manage biological invasions in light of climate change?"

UMass Amherst USGS science for a changing world NYISRI New York Invasive Species Research Institute Cornell University NECASC Northeast Climate Adaptation Science Center

Northeast RISCC Management
Regional Invasive Species & Climate Change

Mission Statement:

The Northeast Regional Invasive Species & Climate Change (RISCC) Management Network aims to reduce the compounding effects of invasive species and climate change by **synthesizing** relevant science, **communicating** the needs of managers to researchers, **building** stronger scientist-manager communities, and **conducting** priority **research**.

Northeast RISCC Management
Regional Invasive Species & Climate Change

Leadership team:

Supports a network of ~450 invasive species researchers abd managers

Leadership team + our favorite invasives

Understanding manager needs

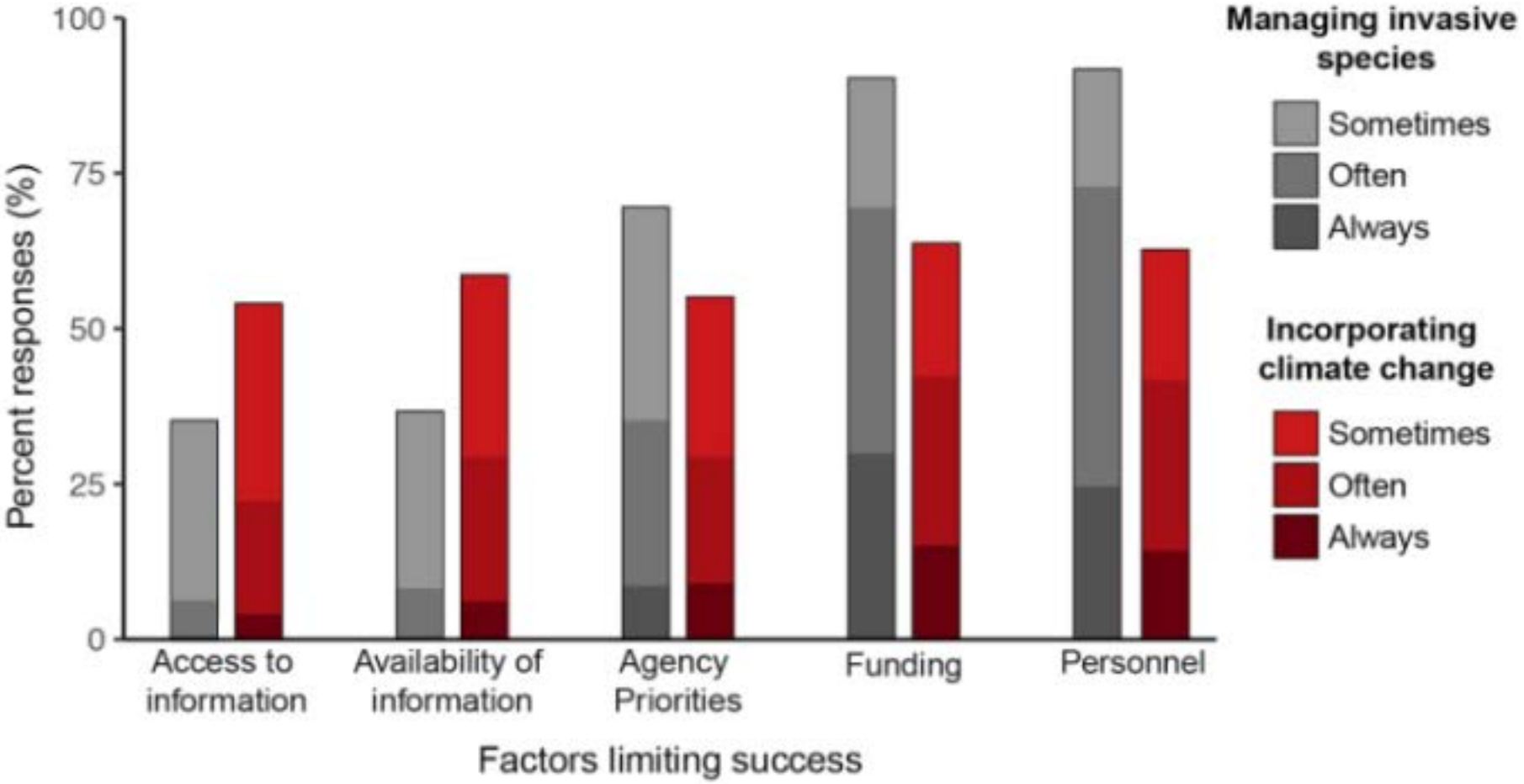
Biol Invasions
https://doi.org/10.1007/s10530-019-02087-6

ORIGINAL PAPER

Incorporating climate change into invasive species management: insights from managers

Evelyn M. Beaury · Emily J. Fusco · Michelle R. Jackson · Brittany B. Laginhas · Toni Lyn Morelli · Jenica M. Allen · Valerie J. Pasquarella · Bethany A. Bradley

Lack of information is a barrier to including climate change in management actions



Meeting manager needs

Summaries of relevant scientific papers

Research Summary: Shifty species - assessing range shifting neonatives Inbox ×

Northeast RISCC Management Network <riscc... Wed, May 27, 9:30 AM (6 days ago)

to ne_riscc-l

This week's research summary is a recent publication from some of the RISCC leadership team and colleagues that highlights the potential threat of nuisance neonatives – keep an eye out for more papers and a Management Challenge on this topic over the next few weeks!

Wallingford, P. D./Morelli, T. L., Allen, J. M., Beaury, E. M., Blumenthal, D. M., Bradley, B. A., Dukes, J. S., Early, R., Fusco, E. J., Goldberg, D. E., Ibáñez , I., Laginhas, B. B., Vilà, M., Sorte, C. J. B. (2020). Adjusting the lens of invasion biology to focus on the impacts of climate-driven range shifts. Nature Climate Change, 10, 398–405.

Summary:

Climate change is causing species to shift their distributions in order to track their preferred temperature and precipitation regimes. A primary conservation goal in the current era is to aid these climate-driven range shifts by protecting and creating landscape corridors, or even encouraging shifts by moving southern species. However, as species move into new areas

Meeting manager needs

One-pagers on key topics

Northeast RISCC Management — Regional Invasive Species & Climate Change

Management Challenge

Preparing for sleeper species

Climate change could awaken some naturalized species

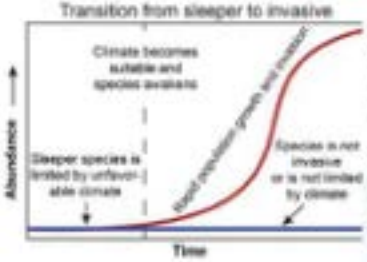
Summary

Many naturalized non-native species never become inva
limited resources. However, climate change could enhan
invasive. Therefore, we need to reassess the current pool
of 'sleeper' species.

What are sleeper species?

Sleeper species are naturalized in a region, potentially inv
or abiotic conditions. Many naturalized species remain at
are constrained by unfavorable climate conditions. Climate
ized species limited by climate, enabling them to 'awaken'

Transition from sleeper to invasive



Examples of sleeper species

A) Acorn barnacle (Austrominius modestus), a cold-intolera
not become invasive until 50 years later after a series of rele
duced to Massachusetts over a century ago. Its ability to reg
advantage, shifting it from naturalized to invasive. C) First d
currently impacts stressed pines. Increasingly frequent dis
damage from this forest pest.

Northeast RISCC Management — Regional Invasive Species & Climate Change

Management Challenge

Warming Waters: Implications for Invasive Species in the Northeast

SUMMARY: Climate change is warming northeastern
tions that structure aquatic communities, preventing
of these ecosystems. The altered physical, chemical, a
may benefit or harm native species while providing n
expand. Here, we summarize how increasing water tem
size the growing body of scientific evidence on this t
drafting management plans, creating species watch li

Changing Aquatic Ecosystems

In the Northeast, water temperatures and ice-out dates correlate
In long-term studies, stream and lake temperatures have been i
and fall freezing later[1,2]. Stream flows are also more extreme, incr

How Does Temperature Affect Aquatic

Temperature is a key variable that influences the physical,
chemical, and biological properties of aquatic ecosystems.
Warmer waters:

1. Alter solubility of gases and compounds, importantly, warmer water can hold less dissolved oxygen.
2. Increase the sensitivity of organisms to toxins, such as copper and lead.
3. Increase metabolic rates of fish and other ectotherms, requiring increased feeding to meet energy needs. This could increase predation rates as well as competition for food.
4. Cause physiological stress, which can lead to negative health outcomes (including mortality) for organisms if certain temperature thresholds are crossed.
5. Alter historic temperature seasonality, an important cue for breeding in some fish, which can reduce reproductive success.

Evidence & Examples of Invasive Speci

1. Increased Growth Rates and Competitive Adva

Several studies have shown invasive species have a compet
growth rates of the invasive plant curly pondweed (*Potamo*
growth rates increased in warmer waters relative to native
brown trout was an increasingly better competitor against
logs are not consistent across studies and species. Other inv
aquatic plants to warmed temperatures, or no difference in

Additionally, warmer late season temperatures may positiv
ation to setting seed, as in a study of *Myriophyllum* species[7].

Northeast RISCC Management — Regional Invasive Species & Climate Change

Management Challenge

Why Native?

Benefits of planting native species in a changing climate

Summary

Yards host a variety of native and non-native plants. It is easy to assume all plants play a similar role in supporting wildlife, but native plants dramatically increase the diversity of bees, butterflies, birds and other native animals. Additionally, non-native plants can become invasive or support invasive pests. Native plants increase biodiversity and reduce risks associated with invasive species, which supports resilient ecosystems in the face of climate change.

Native plants support native wildlife

Landscaping with native plants offers a unique opportunity to promote healthy, resilient ecosystems. Native plants support a diverse food web due to a long history of interacting and evolving with other native wildlife. Most native insects evolved to be specialists on native plants. An example specialist is the monarch butterfly caterpillar, which only eats milkweed. Native plants support a more complex food web of both specialist and generalist insects, resulting in a higher diversity and abundance of native birds, butterflies, and pollinators (Figure 1).

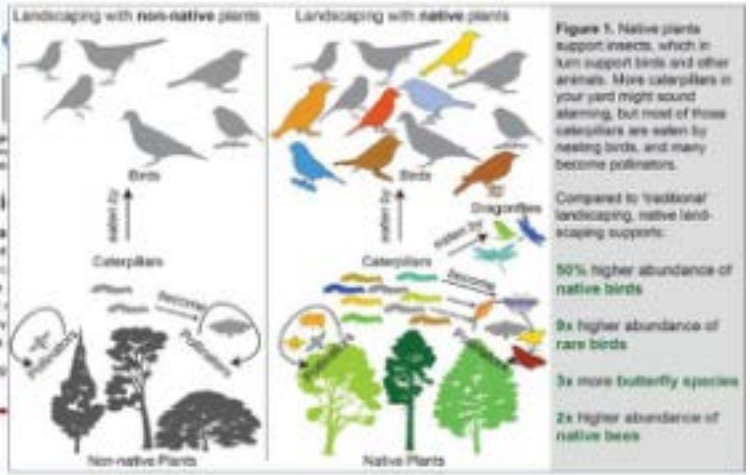


Figure 1. Native plants support insects, which in turn support birds and other animals. More caterpillars in your yard might sound alarming, but most of those caterpillars are eaten by nesting birds, and many become pollinators.

Compared to 'traditional' landscaping, native landscaping supports:

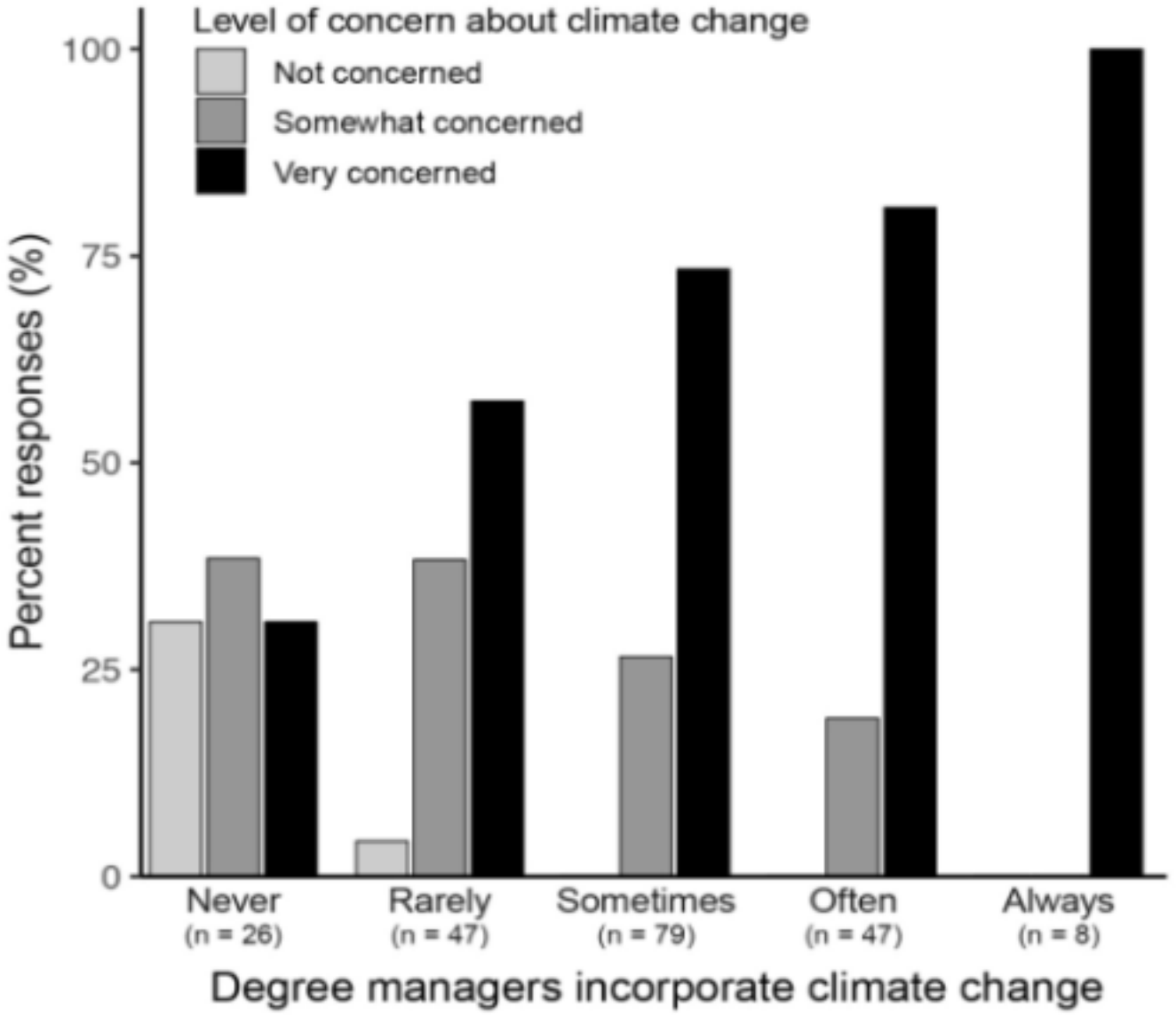
- 50% higher abundance of native birds
- 9x higher abundance of rare birds
- 3x more butterfly species
- 2x higher abundance of native bees

Definitions

Non-native: A species unlikely to have — Traditional landscaping: Predomi — Generalist: Uses a variety of

www.risccnetwork.org/

Managers more concerned about climate change incorporate proactive solutions



What are some climate-smart management options?

Survey + workshop at NAISMA to learn about climate-smart actions invasive species managers are already taking

Northeast RISCC Management

Regional Invasive Species & Climate Change

Management Challenge

Taking Action:
Managing invasive species in the context of climate change

Summary

Climate change is likely to alter the timing and effect of invasive species management, as well as the suite of species we are managing. Despite concern about the effects of climate change, lack of information about how and when to take action is a barrier to climate-smart invasive species management. Here, we outline strategies for incorporating climate change into management along with examples of tools that can inform proactive decision-making.

Motivations for incorporating climate change into management

1. Invasives may emerge earlier and persist longer in response to longer growing seasons
2. Warming causes invasives to shift their ranges into new ecosystems
3. Invasives are introduced via new shipping pathways due to sea ice melt
4. Extreme weather events and sea level rise cause disturbance that creates new opportunities for invasion
5. Herbicides may be less effective with higher atmospheric CO_2
6. Invasives become more competitive with warming and higher atmospheric CO_2

Strategic Planning

Recommendations:

- Prioritize land conservation and management action based on vulnerability to climate change and invasion.
- Increase restoration, management, and early detection & rapid response in areas vulnerable to disturbance caused by extreme weather events.
- Advocate for invasive species management funding to be included in climate change adaptation and response plans.

Example: Mount Grace Land Trust protected lands identified as resilient to climate change (Fig. 1) using TNC's resilient land tool. These lands are high priority for preventative invasive species management and monitoring.

South Athol Pond, MA

Fig 1. Site prioritized by TNC's resilient land tool (maps.tnc.org/resilientland).

Preventative Management

Recommendations:

- Plant species native to Eastern North America that are resistant to climate change (e.g., drought-tolerant, broad hardiness zones; Fig. 2).
- Develop watch lists and proactive management plans for invasive species predicted to shift into your region.
- Prioritize treatment of existing invasive species predicted to spread or increase in abundance with climate change.
- Monitor non-natives for increases in populations ('sleeper species').

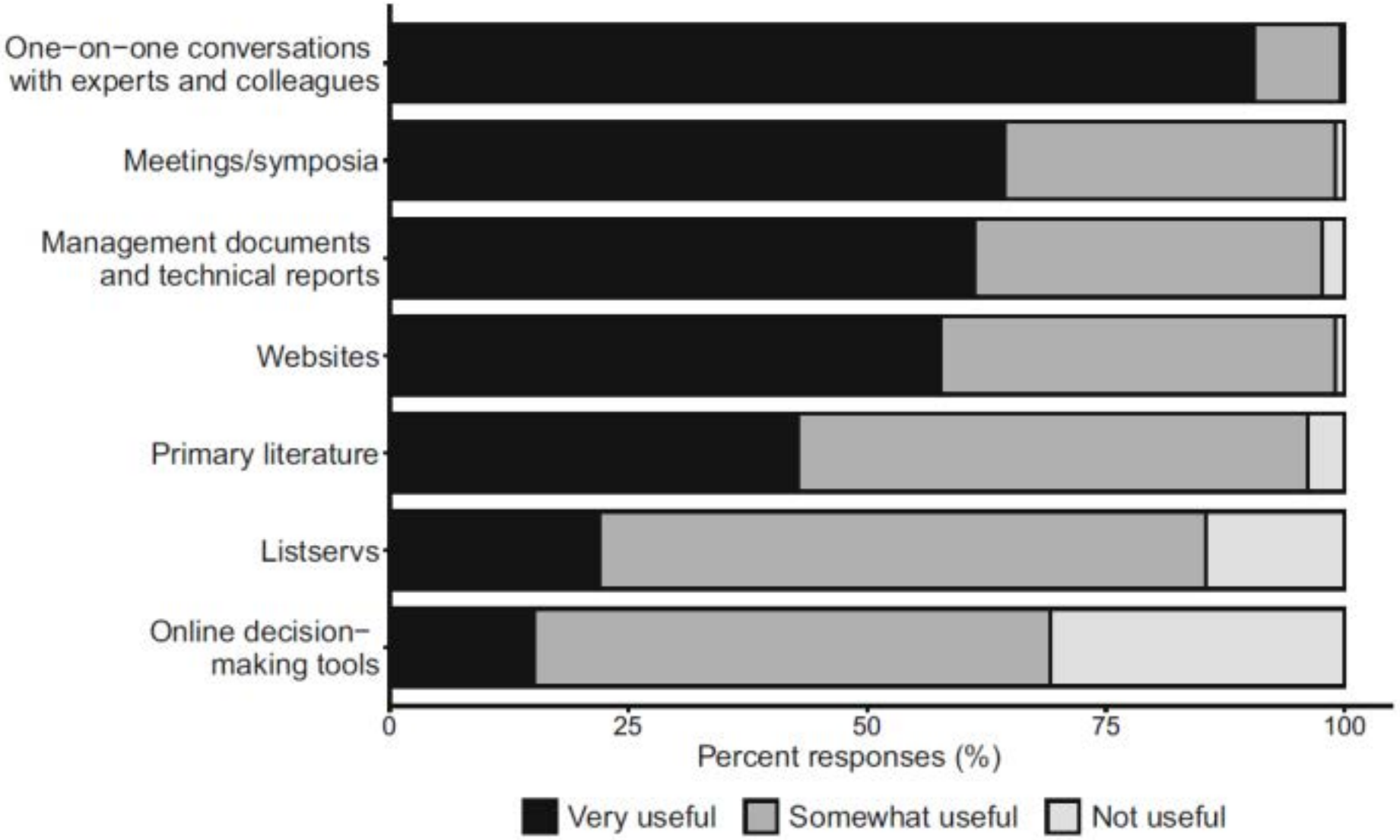
Example: Tug Hill State Forest in NY planted native, warm-adapted trees to reduce future disturbance and resist invasions with climate change.

Projected Plant Hardiness Zones (2040-2059)

Fig 2. Climate Voyager maps future hardiness zones (climate.ncsu.edu/voyager).

Understanding manager needs

Sources of information



Meeting manager needs

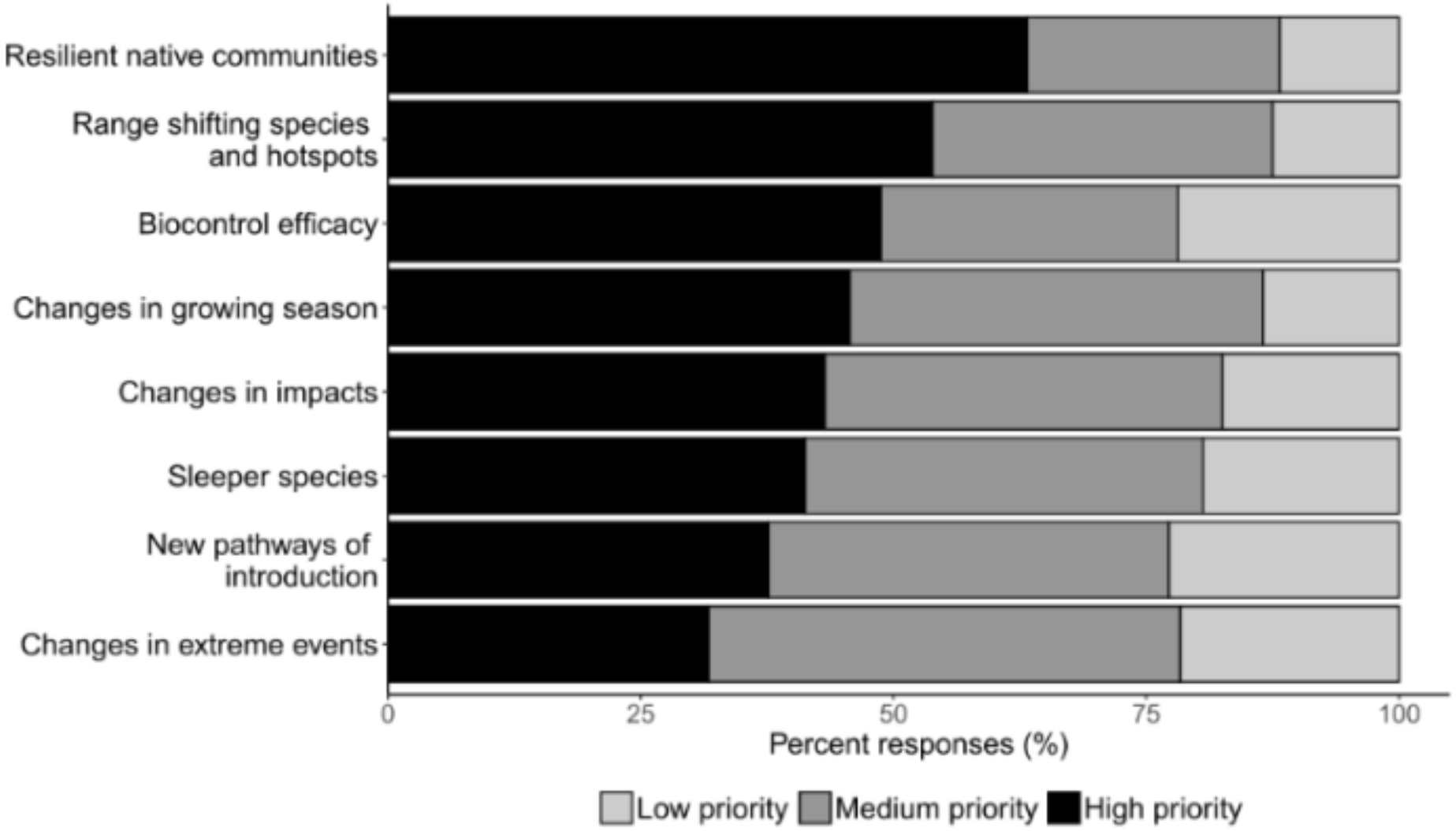
Networking Building

Symposia + workshops

- 2017 & 2018 at UMass
- 2019 at NAISMA
- Jan 2021- virtual

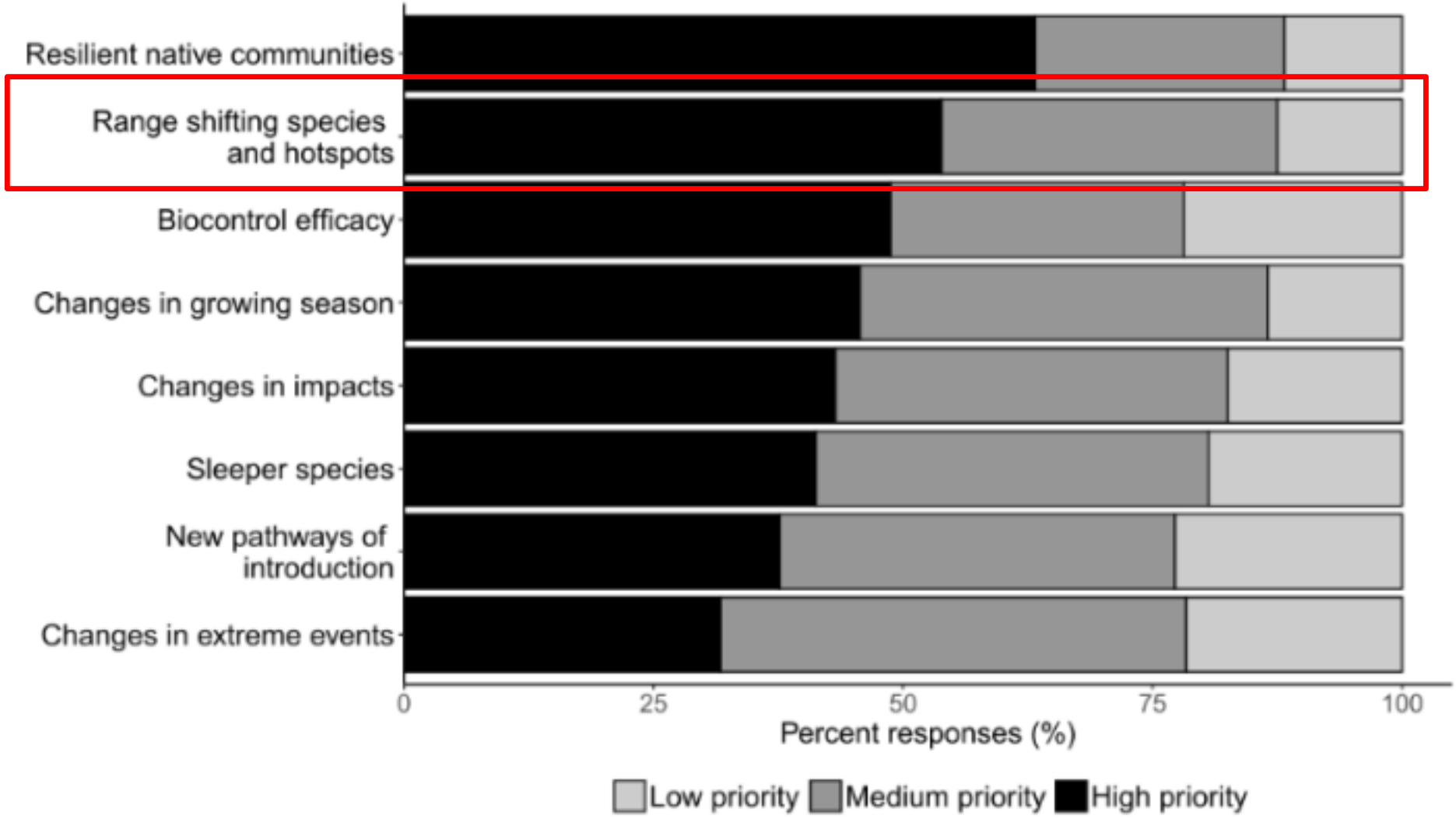
Understanding manager needs

Research priorities

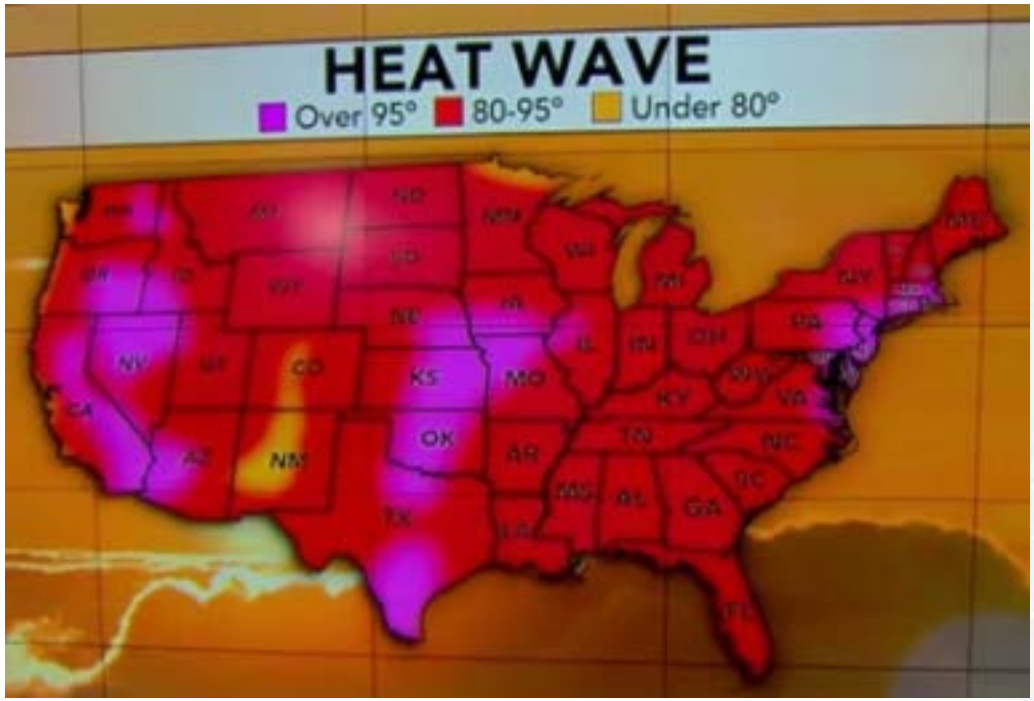


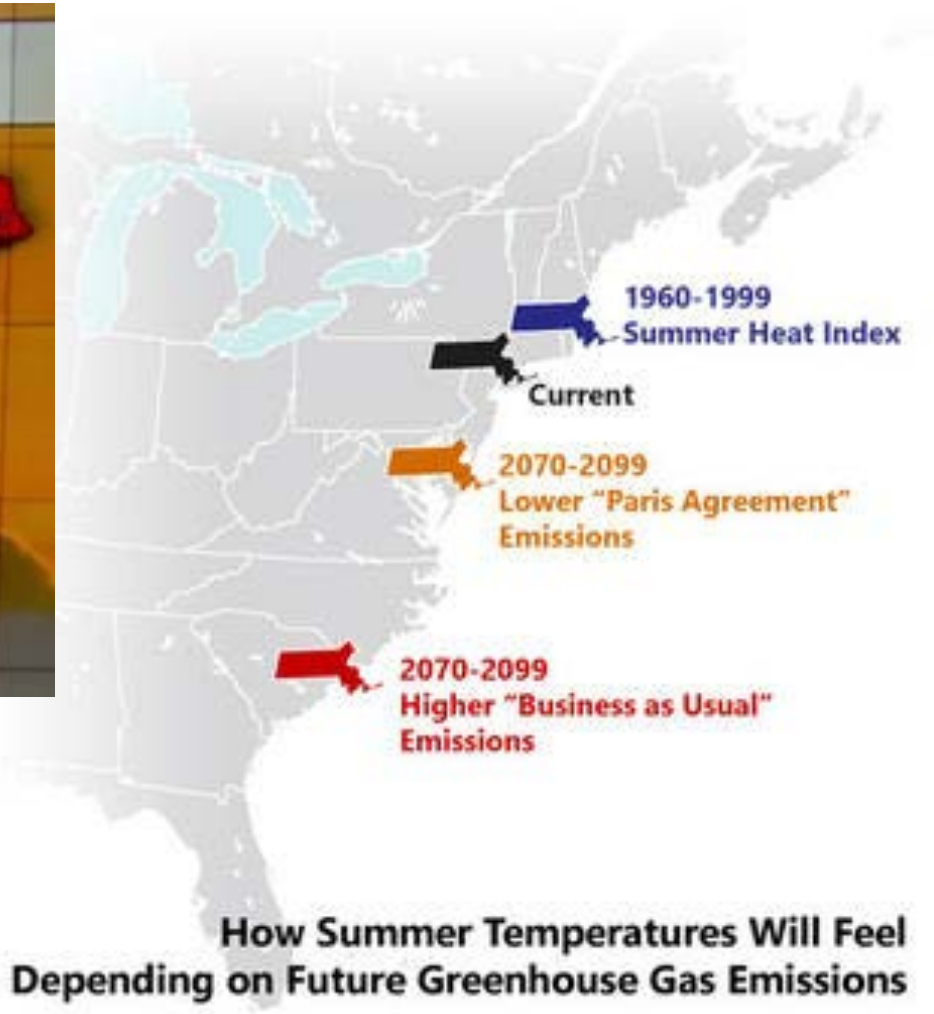
Understanding manager needs

Research priorities

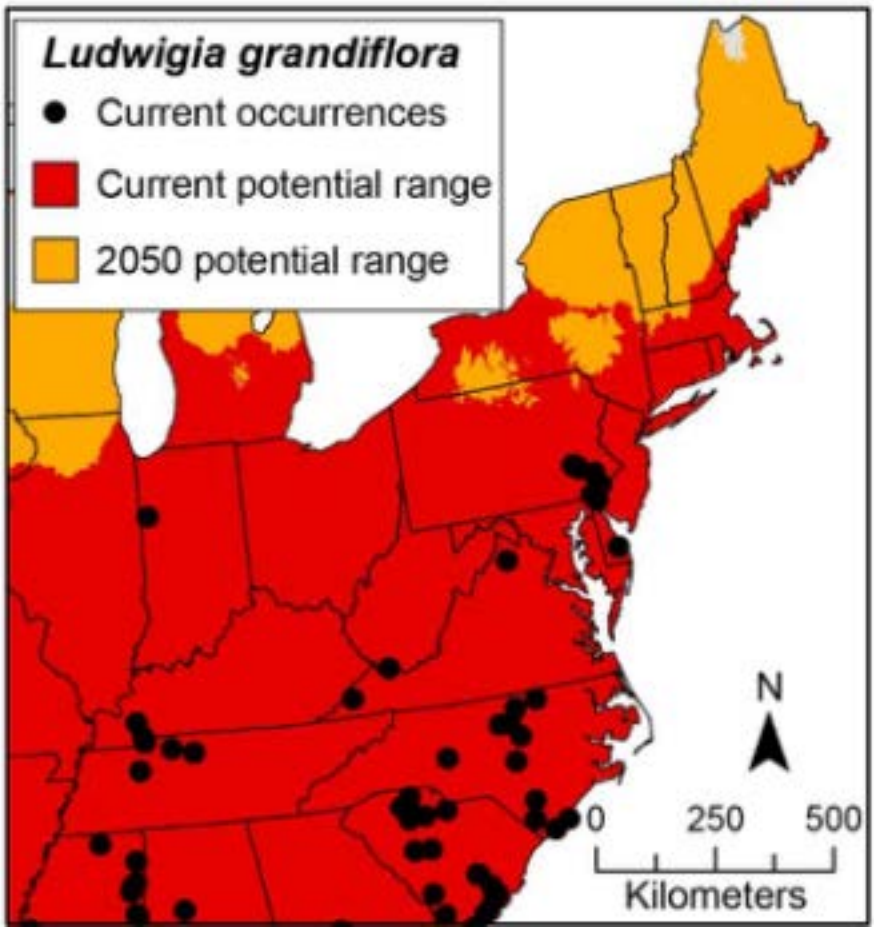


Changing climate, new ecosystems





(Invasive) species respond by shifting their ranges

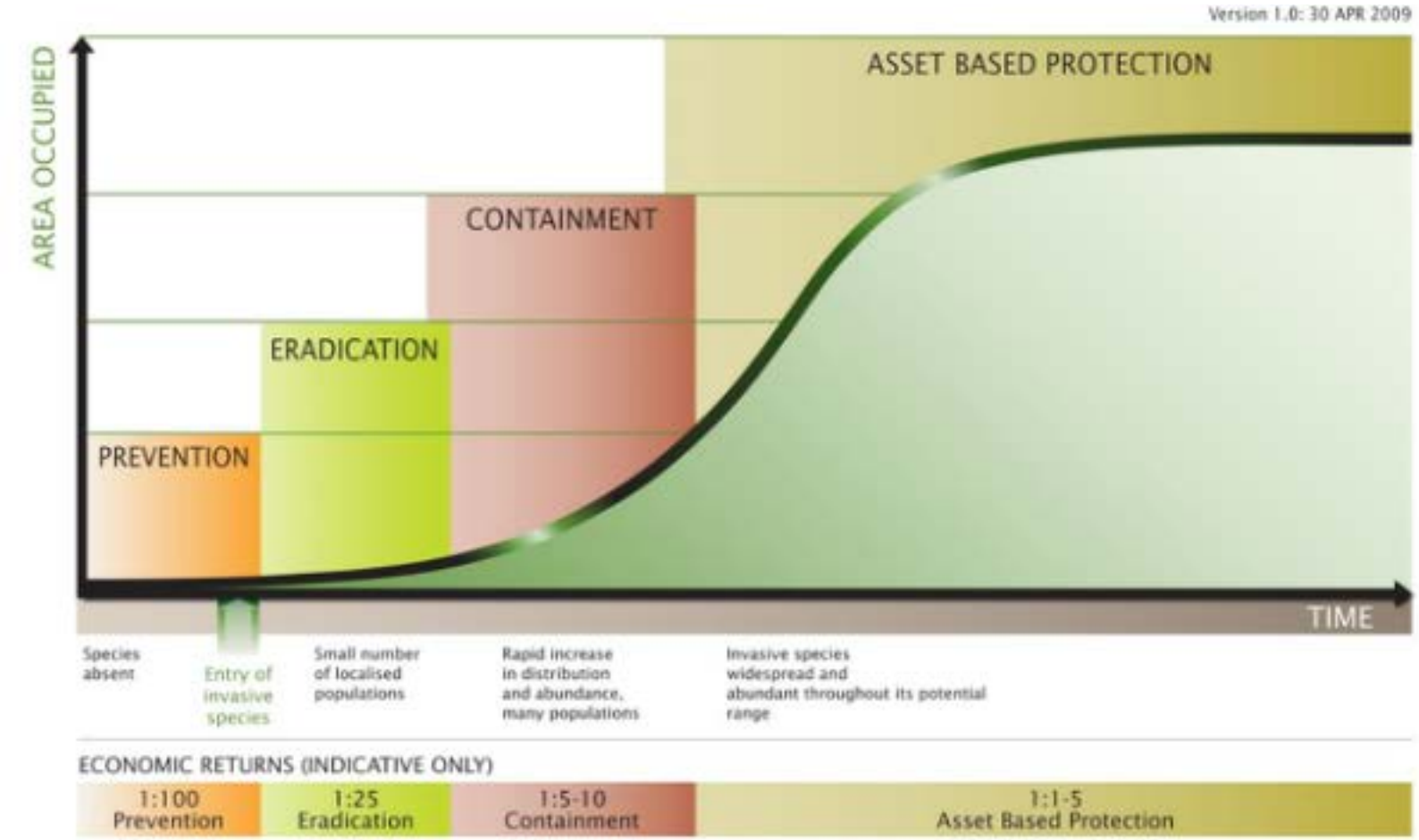


Allen & Bradley, 2016

Photo: Alain Dutartre

Range-shifting invasives

Definitely a concern, but also an opportunity



giant reed

***Arundo donax* L.**

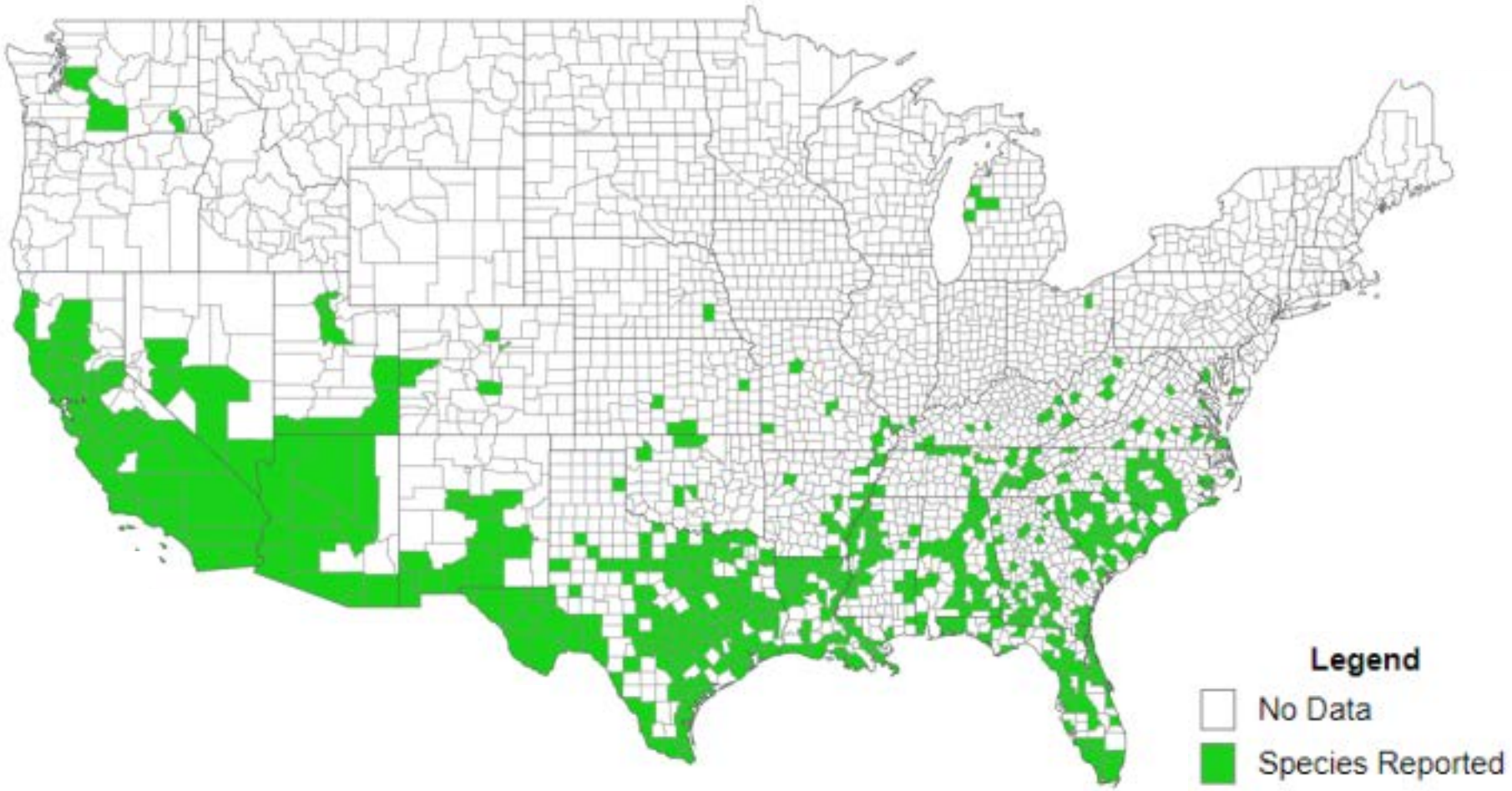
This species is Introduced in the United States

EDDMapS find · map · track

States | Counties | Points | List | Species Info

Distribution | Record Density | Literature vs Observation | Future Range | Future Certainty

Current Distribution



Where are invasive plants likely to move?

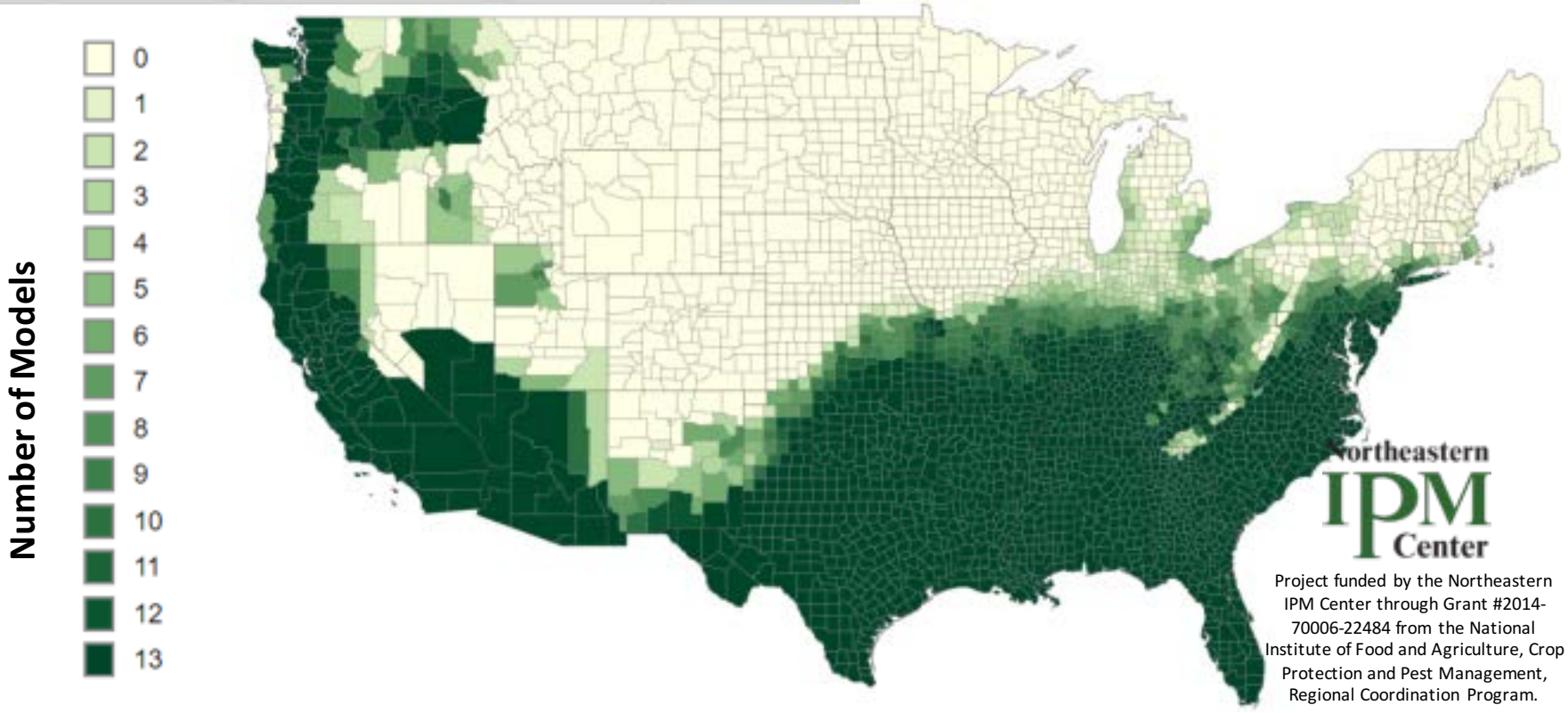
Work led by Jenica Allen

EDDMapS
find • map • track

giant reed
***Arundo donax* L.**
This species is Introduced in the United States

States | Counties | Points | List | Species Info

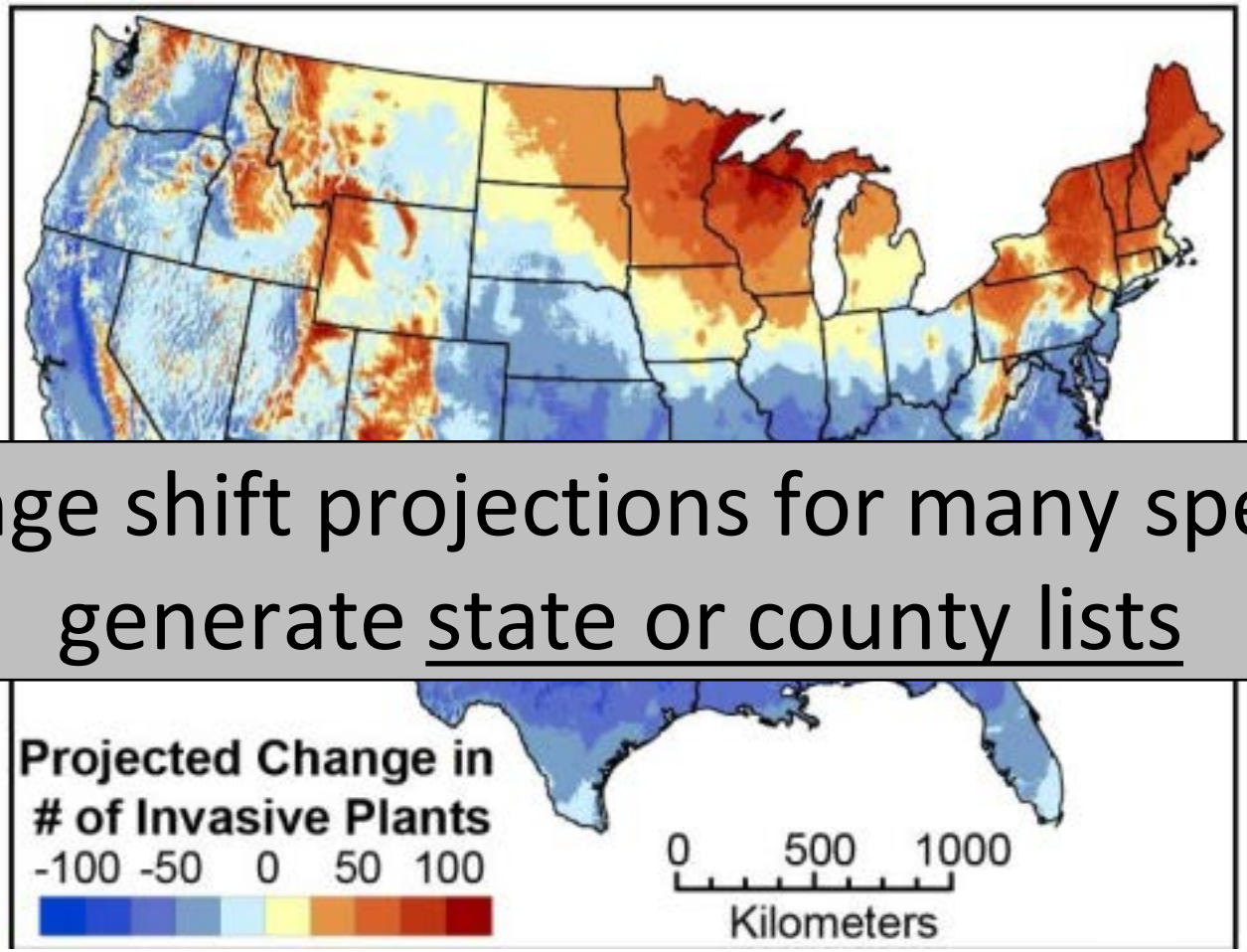
Distribution | Record Density | Literature vs Observation | Future Range | Future Certainty



Northeastern IPM Center

Project funded by the Northeastern IPM Center through Grant #2014-70006-22484 from the National Institute of Food and Agriculture, Crop Protection and Pest Management, Regional Coordination Program.

Range shifts can occur for many species



Use range shift projections for many species to generate state or county lists

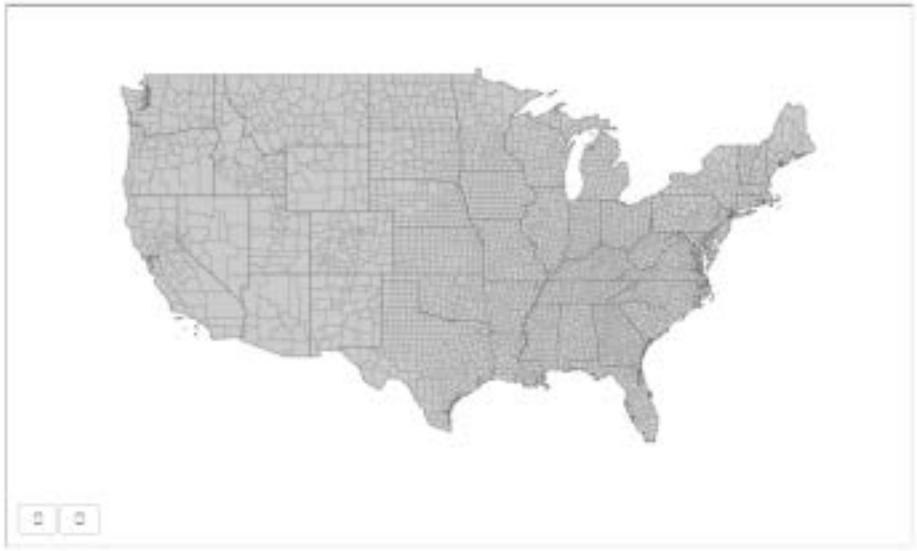
Allen & Bradley, 2016

Range Shift Listing Tool:

https://www.eddmaps.org/rangeshiftlisting/

Select State: Pennsylvania
Refine List by: Species observed within the country
Select County: All Counties
Range Expansion Definition: Range expansion with climate change
Choose Number of Models: 11

REGIONS WHERE THE SPECIES HAS BEEN FOUNDLIST OF SPECIES WITHIN CURRENT CLIMATE



Download | Search:

Scientific Name	Common Name	Map
Araujia sericifera	white bladderflower	
Ardisia elliptica	shoebutton ardisia	
Arundo donax	giant reed	
Asclepias curassavica	bloodflower milkweed	
Bellardia trixago	bellardia	
Buddleja lindleyana	Lindley's butterflybush	
Canna indica	Indian shot	
Cenchrus setaceus	crimson fountaingrass	
Centaurea melitensis	Malta starthistle	
Cestrum diurnum	day jessamine	

Showing 1 to 10 of 35 entries | Previous 1 2 3 4 Next

In collaboration with EDDMapS find · map · track

Northeastern IPM Center

Project funded by the Northeastern IPM Center through Grant #2014-70006-22484 from the National Institute of Food and Agriculture, Crop Protection and Pest Management, Regional Coordination Program.

Select State	Select County	Choose Number of Models
Pennsylvania	All Counties	11

Refine List by	Range Expansion Definition
Species observed in an adjacent state	Range expansion with climate change

Download

Search:

Scientific Name	Common Name
Arundo donax	giant reed
Cenchrus setaceus	crimson fountaingrass
Centaurea melitensis	Malta starthistle
Conyza bonariensis	hairy fleabane
Digitaria violascens	violet crabgrass
Firmiana simplex	Chinese parasoltree
Genista monspessulana	French broom
Hypericum calycinum	Aaron's beard
Lagerstroemia indica	crapemyrtle
Ligustrum japonicum	Japanese privet

Showing 1 to 10 of 18 entries Previous 1 2 Next

This tool was funded by the Northeastern IPM Center through Grant #2014-70006-22484 and supported by Southern IPM Center throught Grant #2018-70006-28884 from the USDA National Institute of Food and Agriculture, Crop Protection and Pest Management, Regional Coordination Program.Read modeling details in the scientific publication here

Example watch list for New York + Southern New England

Could establish currently, expand ranges by 2050

Achyranthes japonica	*Ceratocephala testiculata*	*Ludwigia grandiflora*	*Sacciolepis indica*
Aegilops ovata	*Clerodendrum chinense*	*Lythrum virgatum*	*Schedonorus pratensis*
Alhagi maurorum	*Cruciata pedemontana*	*Mahonia bealei*	*Sinapis arvensis*
Alyssum murale	*Cunninghamia lanceolata*	*Murdannia keisak*	*Spartium junceum*
Ambrosia artemisiifolia	*Cytisus striatus*	*Oplismenus hirtellus*	*Stachys arvensis*
Anchusa arvensis	*Daphne laureola*	*Petrorhagia dubia*	*Stellaria media*
Anthriscus caucalis	*Elaeagnus pungens*	*Pinus pinaster*	*Tamarix africana*
Arum italicum	*Euphorbia oblongata*	*Poncirus trifoliata*	*Thymelaea passerina*
Avena sterilis	*Euphorbia esula*	*Prunus laurocerasus*	*Trifolium hirtum*
Cardaria chalepensis	*Festuca brevipila*	*Pseudelephantopus spicatus*	
Cardaria pubescens	*Gastridium phleoides*	*Pseudognaphalium luteoalbum*	*Tripleurospermum perforatum*
Centaurea iberica	*Hedera hibernica*	*Quercus acutissima*	*Ventenata dubia*
Centaurea macrocephala	*Hypericum calycinum*	*Rubus macrophyllus*	*Vitex agnus-castus*
Centaurea melitensis	*Kniphofia uvaria*	*Rubus ulmifolius*	*Vitis vinifera*
Centaurea virgata	*Leontodon taraxacoides*	*Rubus vestitus*	*Youngia japonica*
Centranthus ruber	*Lotus pedunculatus*	*Rumex stenophyllus*	

Could establish by 2050

Allium paniculatum	*Conyza bonariensis*	*Jasminum multiflorum*	*Phyllanthus tenellus*
Ardisia elliptica	*Cortaderia selloana*	*Lagerstroemia indica*	*Phyllostachys aurea*
Arundo donax	*Crotalaria spectabilis*	*Ligustrum japonicum*	*Prunus lusitanica*
Avena barbata	*Dalbergia sissoo*	*Liriope spicata*	*Senna occidentalis*
Bellardia trixago	*Ehrharta erecta*	*Mosla dianthera*	*Sesbania punicea*
Brachypodium distachyon	*Firmiana simplex*	*Nandina domestica*	*Tamarix aphylla*
Buddleja lindleyana	*Hedera helix*	*Peganum harmala*	*Urochloa distachya*
Carduus tenuiflorus	*Hemarthria altissima*	*Persea americana*	

But, which species do we manage?

Could establish currently, expand ranges by 2050

Achyranthes japonica	*Ceratocephala testiculata*	*Ludwigia grandiflora*	*Sacciolepis indica*
Aegilops ovata	*Clerodendrum chinense*	*Lythrum virgatum*	*Schedonorus pratensis*
Alhagi maurorum	*Cruciata pedemontana*	*Mahonia bealei*	*Sinapis arvensis*
Alyssum murale	*Cunninghamia lanceolata*	*Murdannia keisa*	*Spartium junceum*
Ambrosia artemisiifolia	*Cytisus striatus*	*Oplismenus h*	*Stachys arvensis*
Anchusa arvensis	*Daphne laureola*	*Petrorhac*	*Stellaria media*
Anthriscus caucalis	*Elaeagnus pungens*	*Pinus*	*Tamarix africana*
Arum italicum	*Euphorbia oblongata*	*Po*	*Thymelaea passerina*
Avena sterilis	*Euphorbia esula*		*Trifolium hirtum*
Cardaria chalepensis	*Festuca brevipila*	*pus spicatus*	
Cardaria pubescens	*Gastridium phleoide*	*alium*	*Tripleurospermum perforatum*
Centaurea iberica	*Hedera hiberni*	*us acutissima*	*Ventenata dubia*
Centaurea macrocephala	*Hypericum*	*ous macrophyllus*	*Vitex agnus-castus*
Centaurea melitensis	*Kniphof*	*Rubus ulmifolius*	*Vitis vinifera*
Centaurea virgata	*Leo*	*Rubus vestitus*	*Youngia japonica*
Centranthus ruber		*Rumex stenophyllus*	

100 species!!

establish by 2050

Allium paniculatum	*nariensis*	*Jasminum multiflorum*	*Phyllanthus tenellus*
Ardisia elliptica	*Co ria selloana*	*Lagerstroemia indica*	*Phyllostachys aurea*
Arundo donax	*Crotalaria spectabilis*	*Ligustrum japonicum*	*Prunus lusitanica*
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Carduus tenuiflorus	*Hemarthria altissima*	*Persea americana*	

Meeting manager needs

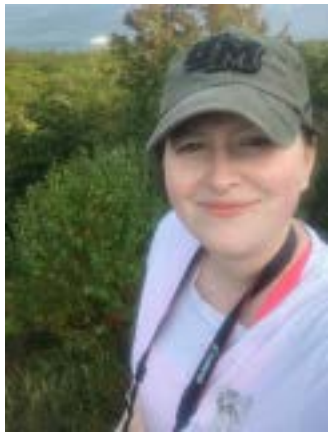
New tools to identify & prioritize range-shifting invasive plants

- Read titles & abstracts of all peer-reviewed papers for the species of interest
- Identify all papers that measure impacts

Framework and guidelines for implementing the proposed IUCN Environmental Impact Classification for Alien Taxa (EICAT)

Charlotte L. Hawkins[1], Sven Bacher[2], Franz Essl[3], Philip E. Hulme[4], Jonathan M. Jeschke[5,6], Ingolf Kühn[7,8], Sabrina Kumschick[9,10], Wolfgang Nentwig[11], Jan Pergl[12], Petr Pyšek[12,13], Wolfgang Rabitsch[14], David M. Richardson[9], Montserrat Vilà[15], John R. U. Wilson[9,10], Piero Genovesi[16] and Tim M. Blackburn[1,17,18,*]

Mei Rockwell-Postel



Bridget Griffin

Will Coville

Example outcome:

Use models to identify species-level range shifts with climate change

Genus	species	Common Name
Araujia	sericifera	White bladderflower
Ardisia	elliptica	Shoebutton
Arundo	donax	Giant reed
Asclepias	curassavica	Bloodflower
Avena	barbata	Slender oat
Bellardia	trixago	Mediterranean linseed
Brachypodium	distachyon	Purple false brome
Buddleja	lindleyana	Lindley's butterflybush
Canna	indica	Indian shot
Carthamus	lanatus	Woolly distaff thistle
Cestrum	diurnum	Day jessamine
Conyza	bonariensis	Asthmaweed
Cortaderia	selloana	Uraguayan pampas grass
Crotalaria	spectabilis	Showy rattlebox
Ehrharta	erecta	Panic veldtgrass
Firmiana	simplex	Chinese parasoltree
Hedera	helix	Algerian ivy
Hemarthria	altissima	Limpograss
Hibiscus	tiliaceus	Sea hibiscus
Jasminum	multiflorum	Star jasmine
Lagerstroemia	indica	Crapemyrtl
Ligustrum	japonicum	Japanese privet
Liriope	spicata	Creeping liriope
Mosla	dianthera	Miniature beefsteak plant
Nandina	domestica	Sacred bamboo
Nerium	oleander	Oleander
Paspalum	urvillei	Vasey's grass
Peganum	harmala	Harmal peganum
Persea	americana	Avocado
Phyllanthus	tenellus	Mascarene island leaf-flower
Polypogon	viridis	Beardless rabbitsfoot
Sesbania	punicea	Rattlebox
Tamarix	aphylla	Athel tamarisk
Tamarix	chinensis	Five-stamen tamarisk

NEW YORK

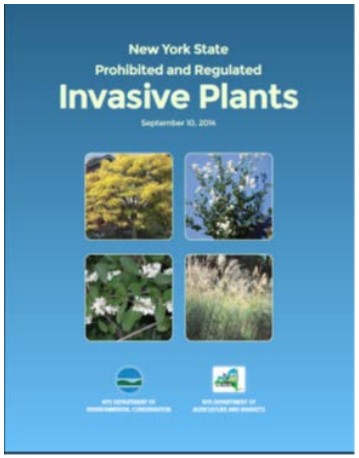
NON-NATIVE PLANT INVASIVENESS RANKING FORM FOR NATURAL / MINIMALLY MANAGED AREAS

Scientific name: USDA Plants Code:
Common names:
Native distribution:
Date assessed:
Assessors:
Reviewers:
Date Approved: Form version date: 28 November 2012

New York Invasiveness Rank:

Distribution and Invasiveness Rank (*Obtain from PRISM invasiveness ranking form*)

	Status of this species in each PRISM:	Current Distribution	PRISM Invasiveness Rank
1	Adirondack Park Invasive Program		
2	Capital/Mohawk		
3	Catskill Regional Invasive Species Partnership		



Identified five ‘major’ impact species likely to affect Northeast ecosystems

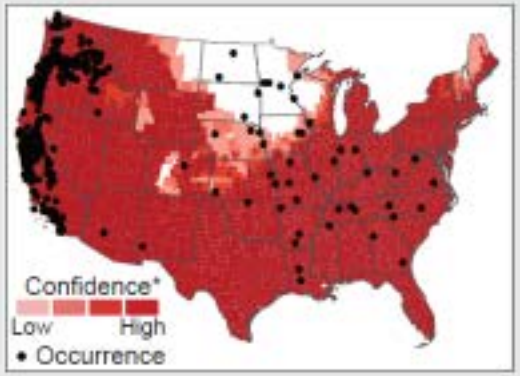
<u>High risk for southern NY/New England</u>:

Anthriscus caucalis (bur chervil); *Arundo donax* (giant reed); *Avena barbata* (slender oat); *Ludwigia grandiflora* (water primrose); *Rubus ulmifolius* (elmleaf blackberry)

Anthriscus caucalis (bur chervil)

HIGH Impact: Outcompetes native plants in grasslands and forest edges. Closely related to wild chervil (*Anthriscus sylvestris*).

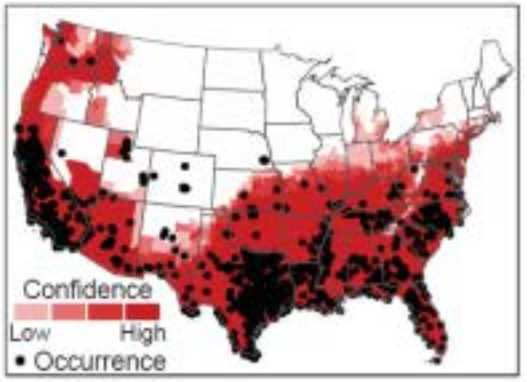
HIGH Vulnerability: Invades disturbed areas across the U.S. and Canada, but more prevalent in the Western U.S. Easily spreads on animals and equipment.



Arundo donax (giant reed)

HIGH Impact: Outcompetes native wetland plants, alters wetland structure, increases fire frequency, acts as a host for crop pests and pathogens.

HIGH Vulnerability: Invades rivers, streams, wetlands, and coastal areas. Widely introduced as a biofuel crop, so introduction could be fast. Difficult to control and spreads by rhizomes along waterways.



Publication and summary for managers available at risccnetwork.org

Biol Invasions
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ORIGINAL PAPER

Supporting proactive management in the context of climate change: prioritizing range-shifting invasive plants based on impact

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Abstract Non-native, invasive plants are projected to shift their ranges with climate change, creating hotspots of risk where a multitude of novel species may soon establish and spread. The Northeast U.S. is one such hotspot. However, because monitoring for novel species is costly, these range-shifting invasive plants need to be prioritized. Preventing negative impacts is a key goal of management, thus, comparing the potential impacts of range-shifting invasive species could inform this prioritization. Here, we adapted the environmental impacts classification for alien taxa protocol to evaluate potential impacts of 100 Science for each species and identified paper ing ecological, economic, human health, or tural impacts. We scored ecological impacts ('minimal concern') to 4 ('major') and socio ical impacts as present or absent. We evalu impact studies and categorized 20 species impact, 36 as medium-impact, and 26 as low We further refined high-impact invasive speci on whether major impacts affect ecosystems Northeast U.S. and identified five high species: *Anthriscus caucalis*, *Arundo donax barbata*, *Ludwigia grandiflora*, and *Rubus ul*

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 emerging 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 priority, 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 856 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 by 2050

Range-shifting invasive plants assessed for impacts

We assessed all non-native, invasive plants that are rare or absent in Connecticut, Massachusetts, New York, or Rhode Island but projected to expand into the region by 2050. Based on the scientific literature through 2018, red species have 'major' impacts on native community diversity, orange species have 'moderate' impacts on single-species populations, blue species have 'minor' impacts that don't affect species populations.
Note: understudied species may have higher impacts than currently reported.

Anthriscus caucalis	*Achnatherum japonicum*	*Lilium pensylvanicum*	*Acer tataricum*
Ambrosia artemisiifolia	*Alyssum murale*	*Lythrum virgatum*	*Avena sterilis*
Arundo donax	*Artemisia verlotiorum*	*Mahonia bealei*	*Buddleja lindleyana*
Avena barbata	*Asclepias curassavica*	*Nandina domestica*	*Carduus tenuiflorus*
Centaurea cheiranthifolia #	*Bellardia trixago*	*Ophiopogon hetrelia*	*Centaurea diluta*
Centaurea tenuifolia #	*Brachypodium distachyon*	*Paspalum urvillei*	*Centaurea melitensis*
Cortaderia selloana	*Cardaria pubescens*	*Pennisetum hermaphroditum*	*Crotalaria spectabilis*
Cynoglossum borbasicola #	*Centranthus ruber*	*Persea americana*	*Elaeagnus pungens*
Ehrharta erecta	*Cestrum diurnum*	*Prunus laurocerasus*	*Firmiana simplex*
Hemarthria altissima	*Conringia orientalis*	*Quercus acutissima*	*Hibiscus tiliaceus*
Ludwigia grandiflora	*Conyza bonariensis*	*Senna occidentalis*	*Leonotis nepetifolia*
Pinus pinaster	*Cytisus striatus*	*Sesbania punicea*	*Phyllostachys aurea*
Rubus ulmifolius	*Delairea odorata*	*Sinarundinaria nitida*	*Pinus nigra*
Rubus ventitus #	*Daphne laureola*	*Spartium junceum*	*Prunus subhirtella*
Tamarix aphylla	*Festuca brevipila*	*Stellaria media*	*Pseudosasa japonica*
Tamarix chinensis	*Hedera helix* ssp. *canariensis*	*Tamarix africana*	*Rumex stenophyllus*
Trifolium hirsutum #	*Hedera hibernica*		*Sacciolepis indica*
Ventenata dubia	*Hypericum calycinum*	*Alhagi maurorum*	*Stachys arvensis*
	Lagarosiphon indica	*Asphodelus cerasifer*	*Vitis vinifera*
	Ligustrum japonicum	*Avellinia michelii*	*Youngia japonica*

Low confidence that 'major' impacts are caused by the invasive plant (e.g., reported impacts are anecdotal)

Working on species for northern New England + New York

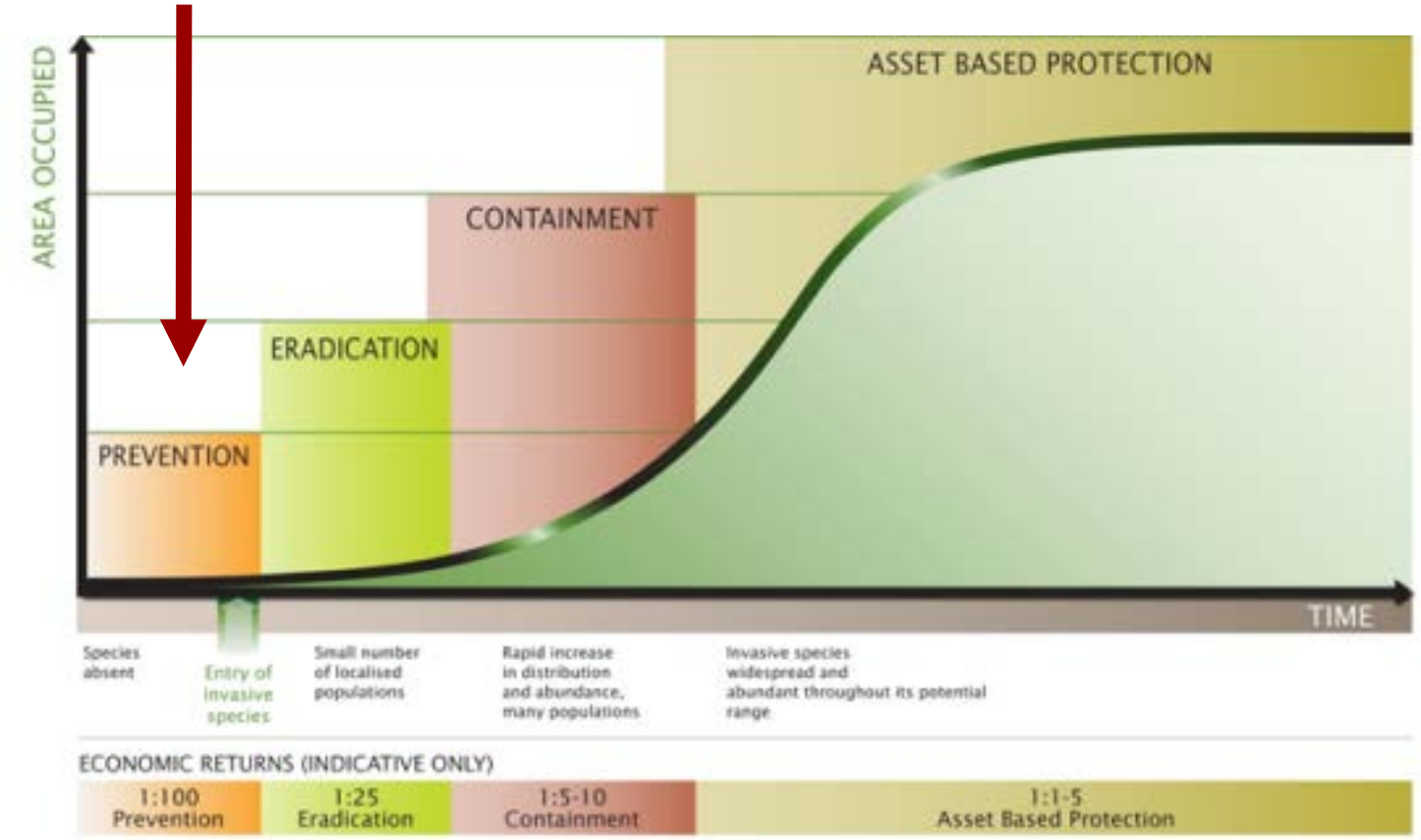
- 83 species to assess, 55 completed to date
- 20 species with ‘major’ impacts so far

Pueraria montana (kudzu)
Regulated in CT, MA, NH, NY

Euonymous fortunei (wintercreeper)
Regulated in MD

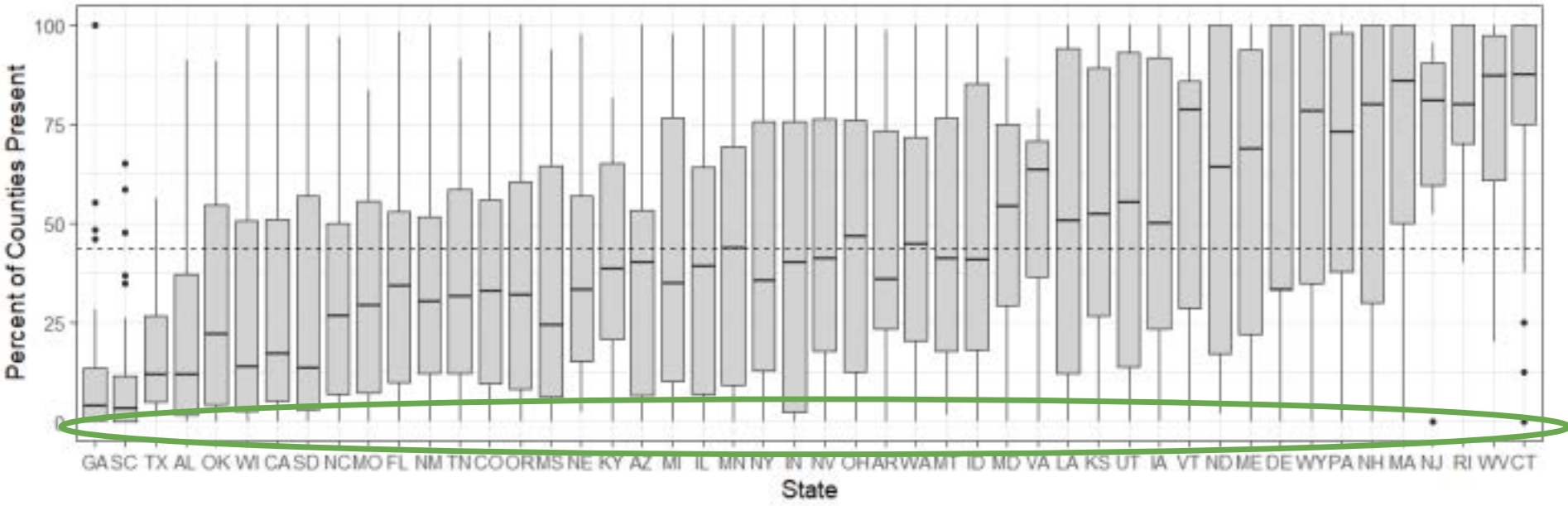
Climate change offers an opportunity to be proactive about invasive species management.

We are here.



How proactive are state regulated plants lists? Not very – we need to do better.

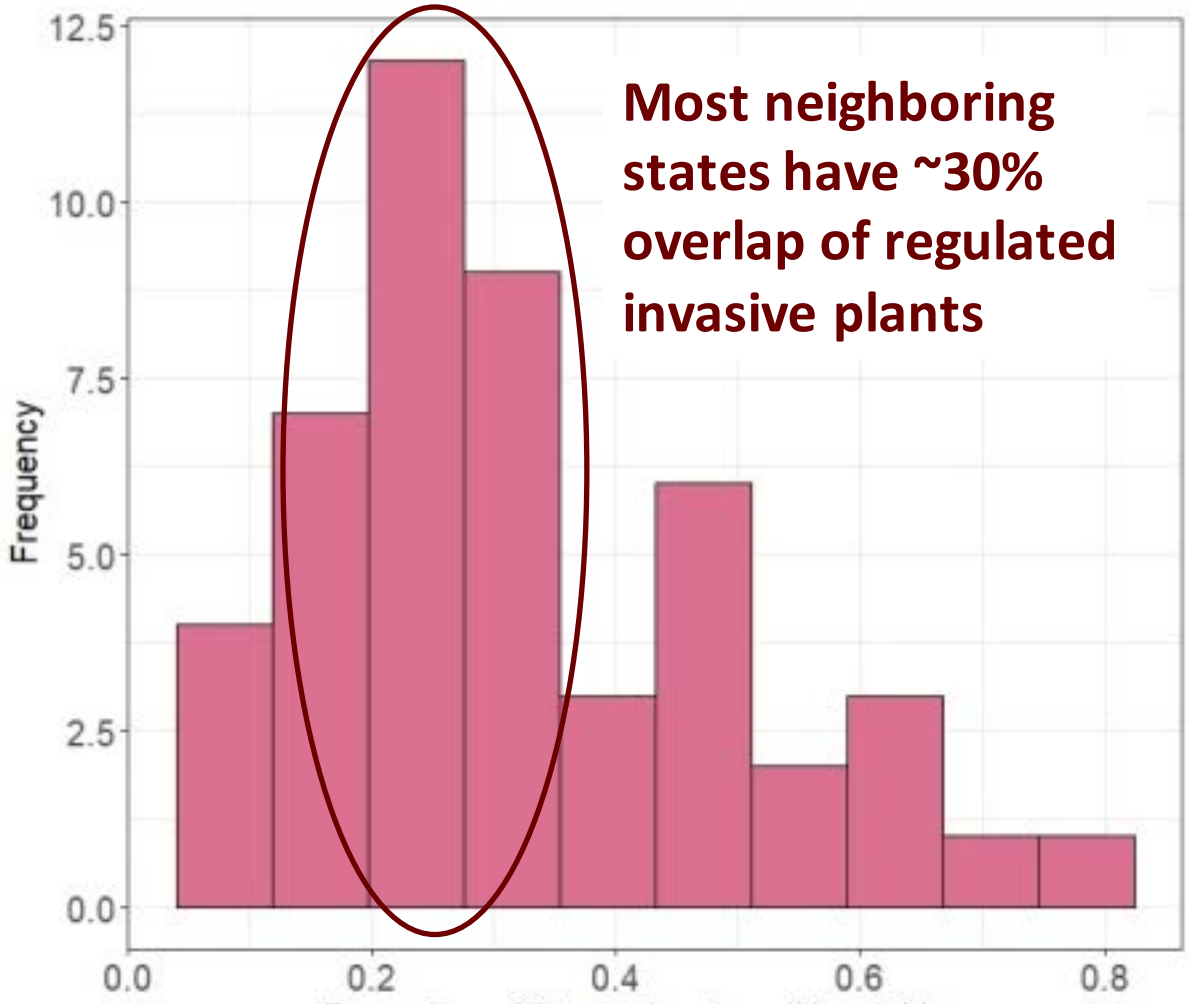
Reactive



Proactive

Most states have at least one species that is regulated proactively

We also need to coordinate with our neighbors



Proportion of regulated species list that overlaps with neighboring states

Northeast RISCC Regional Invasive Species & Climate Change Management

Getting regional discussion started in the Northeast:

Workshop of Invasive Plant Council members from seven Northeast states

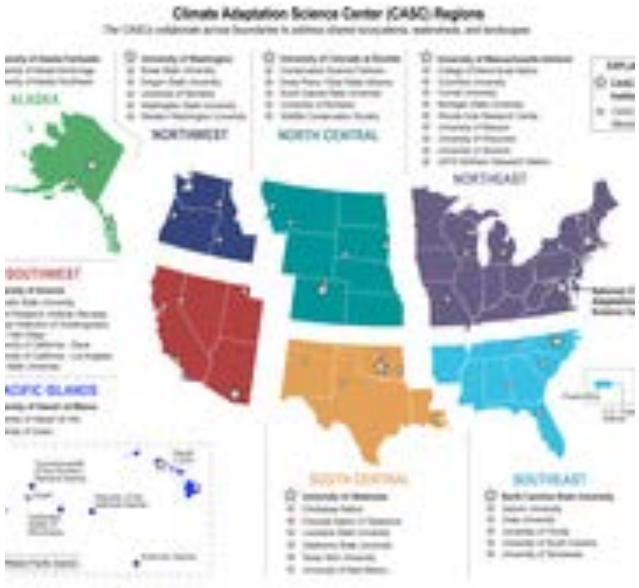
Northeast RISCC Regional Invasive Species & Climate Change Management

Conclusions:

- Climate change creates new risks from invasive species
- But, it also creates opportunities to work together and share knowledge
- Together, we can prevent future invasions and learn how to reduce the combined impacts of invasives species + climate change

Not just the Northeast…..

- Concerns, information needs, and science priorities are similar across regions



- North-Central RISCC, Pacific Islands RISCC and Northwest RISCC being initiated

Northeast RISCC Regional Invasive Species & Climate Change Management

Have a seat at our table!

Join us at:

risccnetwork.org

UMass Amherst

USGS science for a changing world

NYISRI New York Invasive Species Research Institute

Cornell University

NECASC Northeast Climate Adaptation Science Center