Managed relocation

Definitions, historical precedence & literature review

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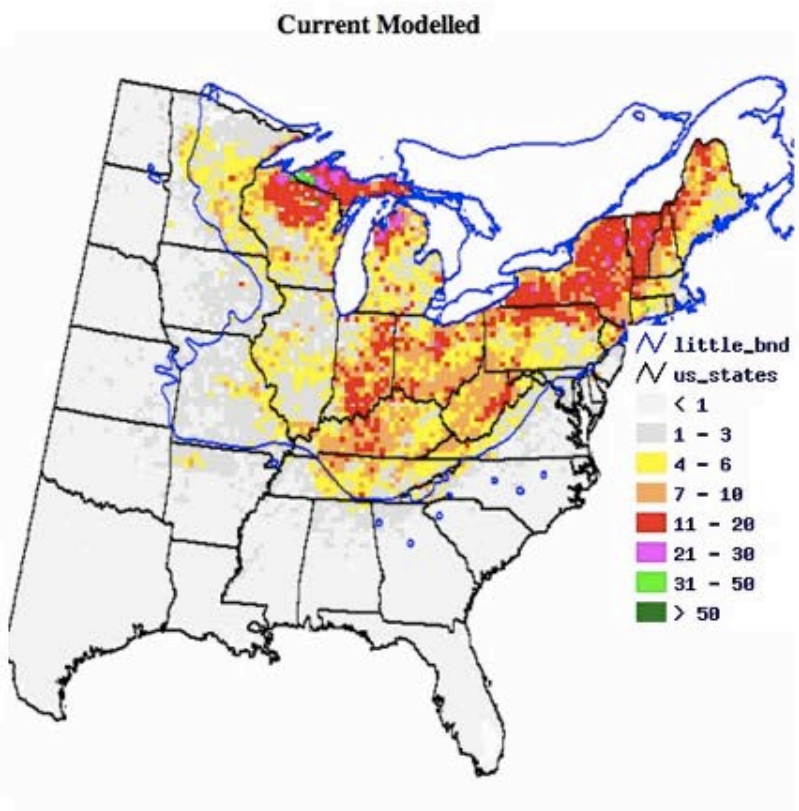
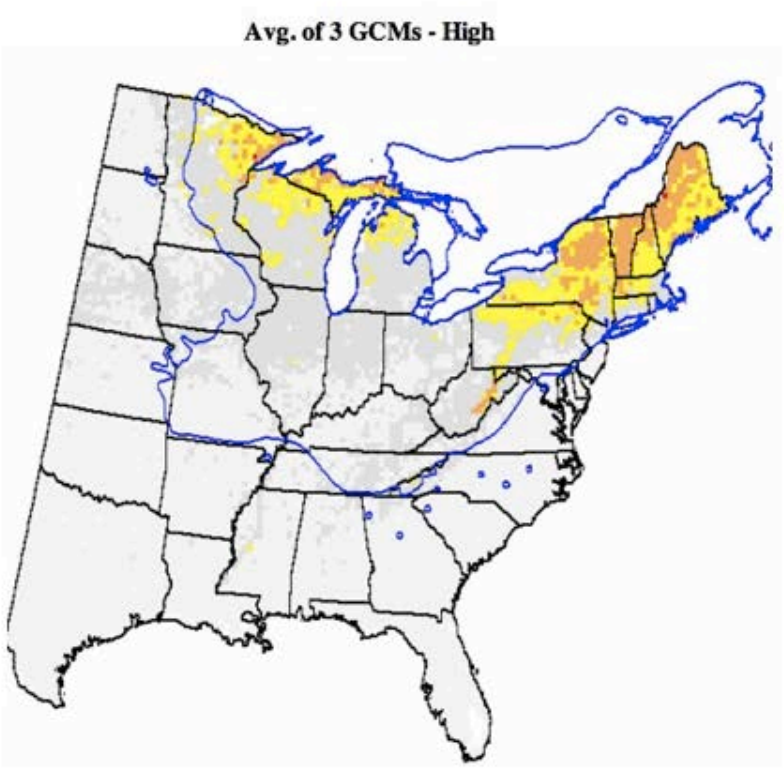
BROWN

If species are limited by climate, they will “want” to move…

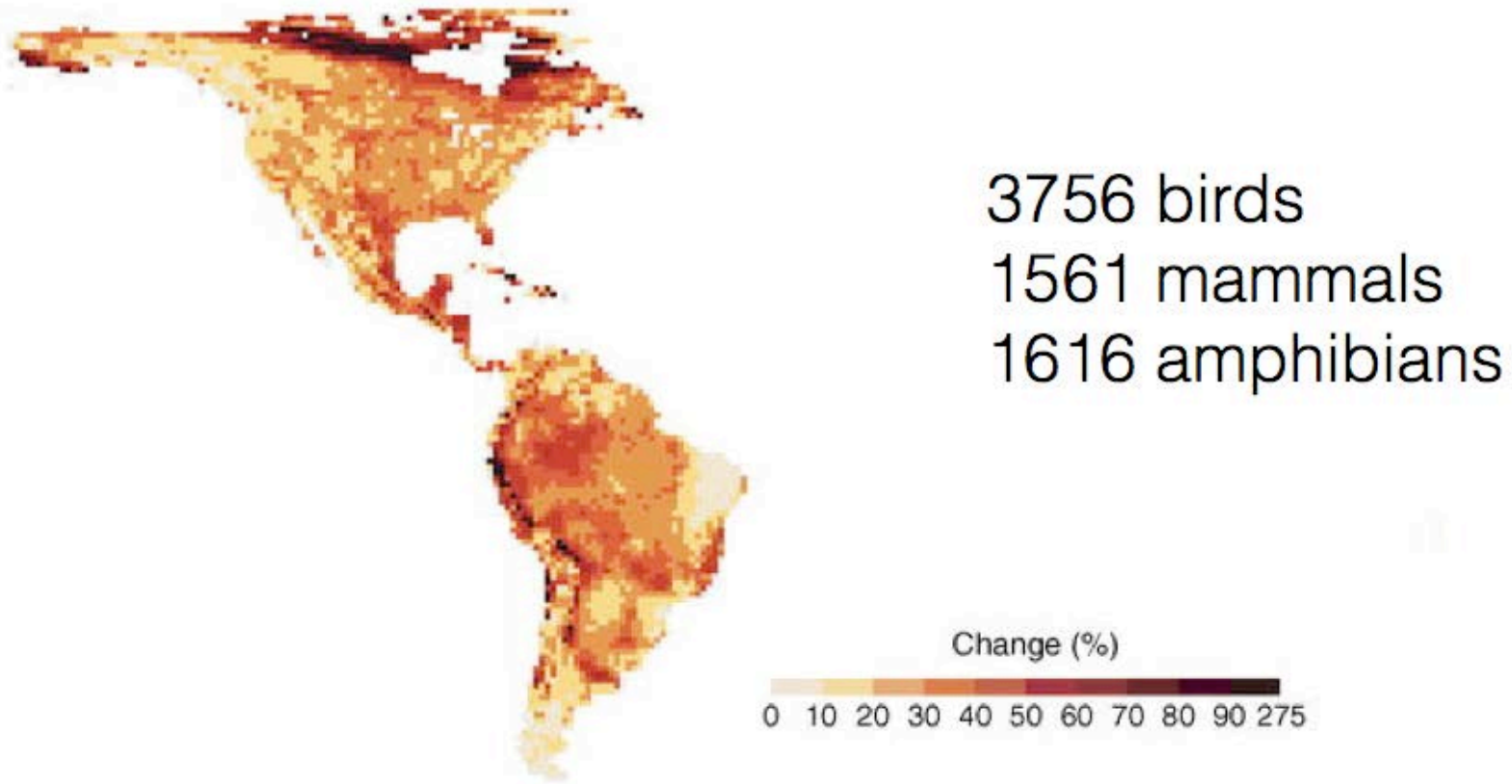




Sugar maple

Iverson et al. 2008
http://www.nrs.fs.fed.us/atlas/

… and that will cause major biological turnover



Lawler et al. 2009

What if species don't move?

- Species extinction
- Loss of genetic diversity/population extinction
- Reduced ecosystem services from reduced abundance or fitness
- Expansion or increases in harmful species

Adaptation for nature

Any strategy to reduce the negative effects of climate change for species, biodiversity, ecosystems, & their services

- Traditional conservation biology
- Strategic resistance
- Corridors
- Ex situ conservation
- Managed relocation

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definitions

Assisted colonization

Assisted migration

Managed relocation

Translocation

Managed relocation

intervention technique aimed at reducing negative effects of climate change on biological units, involving the intentional movement of these units from areas of current occupancy to locations where the probability of future persistence if predicted to be higher.

- Richardson et al. 2009 PNAS 106: 9721
- Schwartz et al. 2012 BioScience 62: 732

Boston Globe 2008

New York Times Tues., Nov. 10, 2009

A Hunt for Seeds to Save Species, Perhaps by Helping Them Move

By ANNE RAVER

CHICAGO — Pitcher's thistle, whose fuzzy leaves and creamy pink puffs once thrived in the sand dunes along several of the Great Lakes, was driven by development, drought and weevils into virtual extinction from the shores of Lake Michigan decades ago.

But in the 1990s, seeds collected from different parts of the thistle's range were grown at the Chicago Botanic Garden and planted with the help of the Morton Arboretum along the lake, in Illinois State Beach Park, north of Chicago near the Wisconsin state line. The plants from Indiana's dunes to the south are doing well; the plants that had come from the north are failing.

With those mixed results in mind, scientists from the botanic garden are sending teams out across the Midwest and West to the Rocky Mountains and Great Basin to collect seeds from different populations of 1,500 prairie species by 2010, and from 3,000 species by 2020. The goal is to preserve the species and, depending on changes in climate, perhaps even help species that generally grow near one another to migrate to a new range.

"In 50 to 100 years, because habitats or climates are so altered, we might end up trying to move species in a restoration context, in assemblages of species," said Pati Vitt, a conservation scientist and curator of the Dixon National Tallgrass Prairie Seed Bank at the botanic garden.

The garden is seeking permits to test the concept with the thistle, by pushing it into new, colder territory along the shores of Lake Ontario. "It may be the best test case for moving an individual species outside its range," Dr. Vitt said.

But assisted migration, as it is called, is a hotly debated issue. On one side are those like the botanic garden scientists, who argue that the risks are better than doing nothing.

"We recognize that climate change is likely to be very rapid and that seeds only disperse a few hundred yards, half a mile at most, naturally," said Kayri Havens, the botanic garden's director of plant science and conservation. "They'll need our help if we want to keep those species alive."

Other scientists argue that tinkering with the complexity of habitats is court-

SALLY RYAN FOR THE NEW YORK TIMES

FLOWERING Native plants like black-eyed Susans are growing in what had been a vacant Chicago lot.

change."

The American beech, for example, was so rare during the ice age that it is rarely found in fossils. "It may have been one of those rare and unusual species we think about saving with approaches like assisted migration," Dr. McLachlan said. Now, the beech is so abundant in Eastern forests, he said, it is shading out "almost all other species."

Dr. McLachlan and other scientists have formed a working group on managed relocation, financed by the National Science Foundation and the Cedar Tree Foundation, to open up the discussion to citizens, economists, natural resource managers and policy makers.

While the debate proceeds, scientists at the botanic garden are building the seed collection and assessing the adapt-

of September, they moved collections of 800 Midwestern species — some made up of 300,000 seeds — from their old home in four large freezers, hardly different from the kind a large family might use to store home-grown produce and a side of beef.

"The first time I walked in here, I started to cry," Dr. Vitt said. "I know what having this will allow us to do in the

Is it wise or foolish to assist with the migration of plants?

future. It's the most important conservation work the garden can be doing."

The prairie effort is part of the Bureau

Seeds of Success, started in 2001 in response to a Congressional mandate to plant native seed in restoring public lands destroyed by wildfire, began its far more ambitious initiative in June 2008.

A consortium of botanic gardens and other institutions have sent 65 teams across the country, which so far have collected groupings of 3,200 species.

"We hope to collect 20 populations across the species' range so we can get 95 percent of the genetic diversity of the species," said Peggy Orwell, the plant conservation program manager at the bureau. "Because frankly, we don't know what it is we're going to need when we're talking restoration in light of climate change. It's going to be one big experiment."

Seeds of Success sends one collection

The Dixon seed bank at the Chicago Botanic Garden houses not only species from the tallgrass prairie, but also natives of the bogs, dunes and other ecosystems in the prairie region. It also includes the working collections of species singled out for restoration.

"In the Midwest, we have about 200 that are going to be very important," Dr. Havens said. "These are the matrix species, the bread-and-butter species that can be used in restorations after disturbance to really stabilize the community."

Climate models all show temperatures rising, but they do not agree on the prairie's future climate.

"Some models show us with more Virginia-like ecosystem, some say more like Texas," Dr. Havens said.

In a paper to be published in the journal Biology Conservation and available now online, Dr. Vitt, Dr. Havens and three other scientists at the botanic garden outline a framework for assisted migration, calling first for a globally unified seed banking strategy, which involves collecting genetically diverse populations of each species, accompanied by provenance data like GPS coordinates, soil type and the structure of the surrounding plant community.

They also propose how to predict where species can be relocated. The scientists are just beginning to test their theories in seven climate change gardens planted this fall across the country. Each contains genetically identical clones of plants grown from seed collected in four hardiness zones (4, 5, 6 and 7). Three sites are in the Chicago area, with the others in Boston; Chapel Hill, N.C.; Seattle; and Washington.

Students and volunteers will collect data on the species, and can compare their gardens with others through a webcam system. "If plants grown from seed collected in Zone 4, 5 or 6 can't withstand Texas conditions," Dr. Havens said, "that's a good sign they're going to become extinct here, if there's no way for them to migrate on their own or human-assisted."

Collecting all the native species in the United States, as well as developing restoration techniques and growing huge amounts of seed will take about 10 years and cost about $500 million, Dr. Havens said — a cost that she argues is well worth it.

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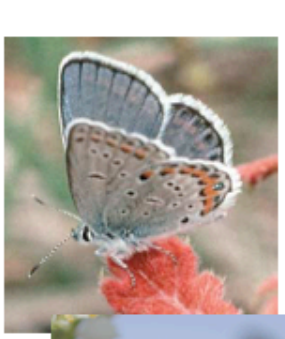
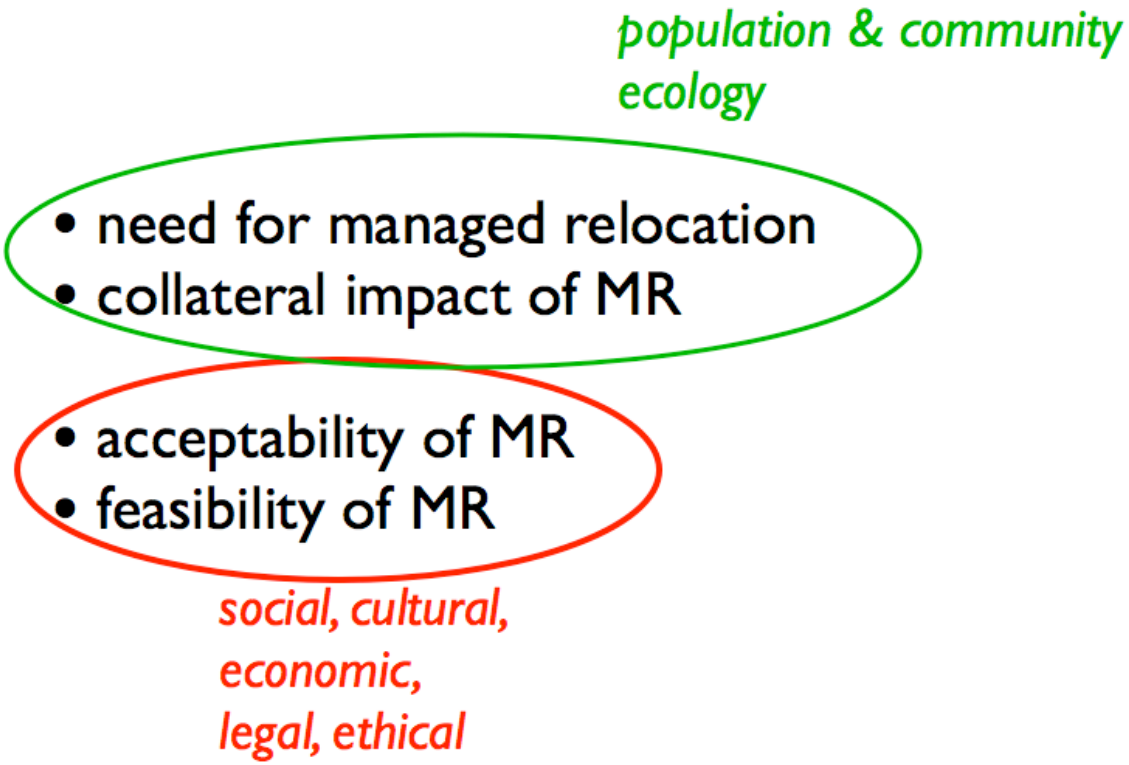
Species-level conservation



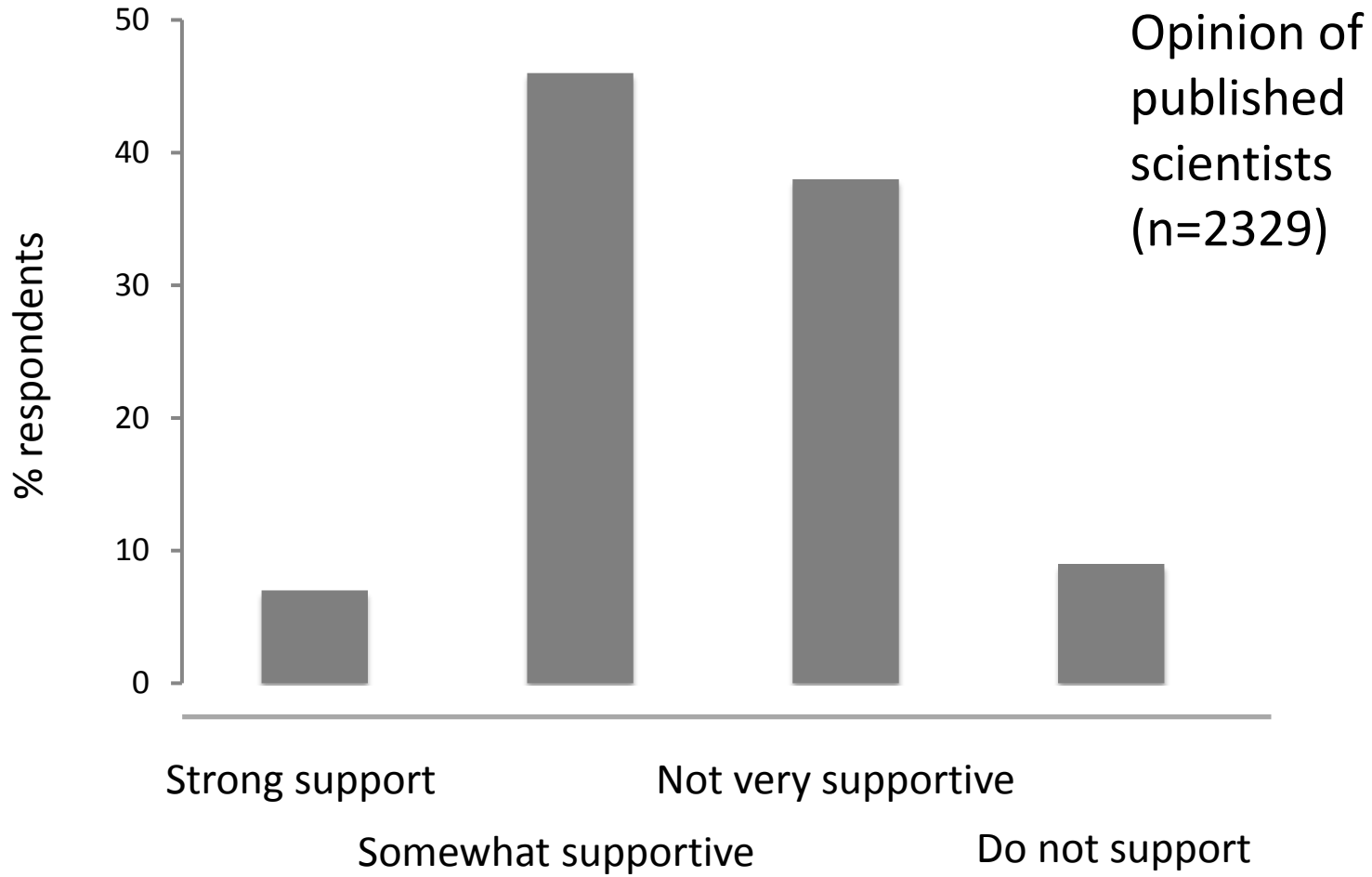


Deliberating MR



Richardson et al. 2009 PNAS

Deliberating MR



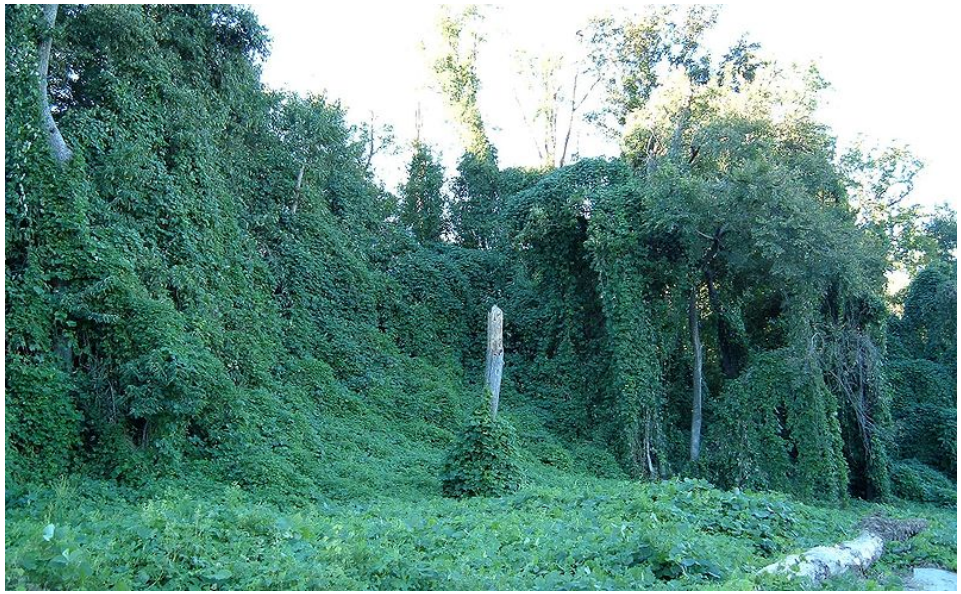
Javeline et al. In review

Historical precedent for managed relocation

Stone 2010, *Science*

Major unanswered questions about MR:

- **Risk to target species** – is it a technically viable conservation strategy? How likely is successful establishment?
- **Risk to recipient ecosystem** – how likely are collateral impacts if the species becomes "too successful"?



Kudzu in Atlanta, GA

How can we inform MR from past species translocations?

- Draw inferences from:
  - Native reintroductions
  - Non-native introductions
  - Range-limit experiments

Credit: J. Michael Lockhart/USFWS

DEFINITION

Translocation is the intentional movement of living organisms from one area to another (Seddon 2010). Includes both **reintroductions** into previously-occupied regions as well as **introductions** into exotic regions.

Reintroductions & introductions

Species- and release-specific correlates of success:

Native reintroductions	**Non-native introductions**
Wild propagules	Non-migratory species
Herbivores	Herbivores
Early breeders	Sexual monomorphism, short juvenile periods, short lifespans, small body size, vegetative reproduction
Multiple source populations	
Release into core of range	Climate match
Release into protected site	Release onto island
Propagule pressure	Propagule pressure

Griffith et al. 1989; Dodd & Siegel 1991; Wolf et al. 1996; Wolf et al. 1998; Fischer & Lindenmayer 2000; Germano & Bishop 2008; Jule et al. 2008; Godefroid et al. 2011; Dalrymple et al. 2012

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Credit: Melissa Carr

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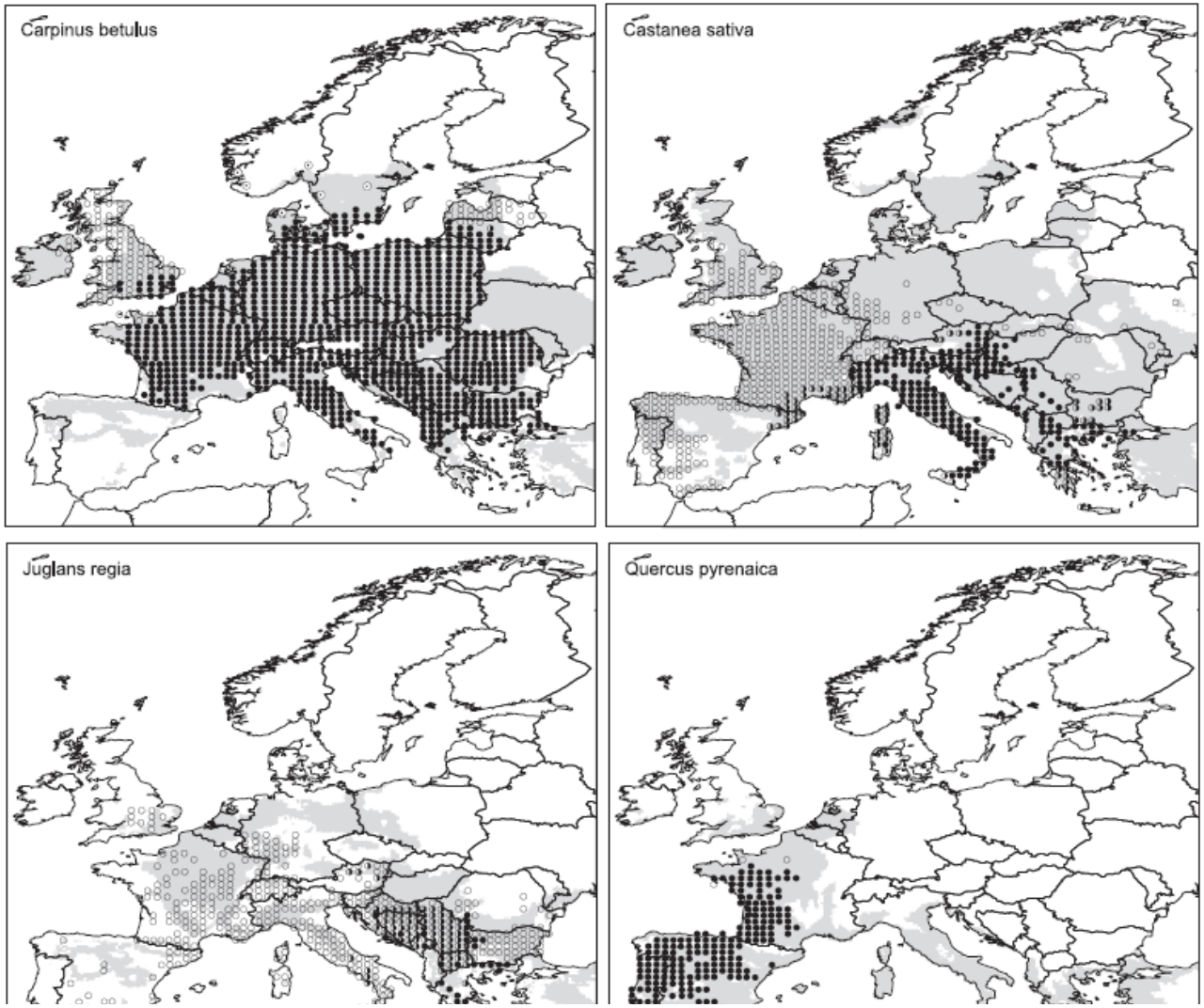
Credit: Melissa Carr

Range-limit experiments

- Species capable of surviving beyond existing range limit
- Dispersal ability limits ranges in certain cases

e.g. Van der Veken et al. 2007; Samis & Eckert 2009; Willis et al. 2009; Marsico & Hellman 2009; Van der Veken et al. 2012



Potential (gray), native (black circle), and naturalized (open circle) ranges of four tree species in Europe (Svenning & Skov 2004)

What about predicting risk to recipient habitat?

- MR candidates unlikely to have life-history traits of good invaders
- Most invasives are intercontinental in origin
  - But: intracontinental species that do invade cause equally severe impacts

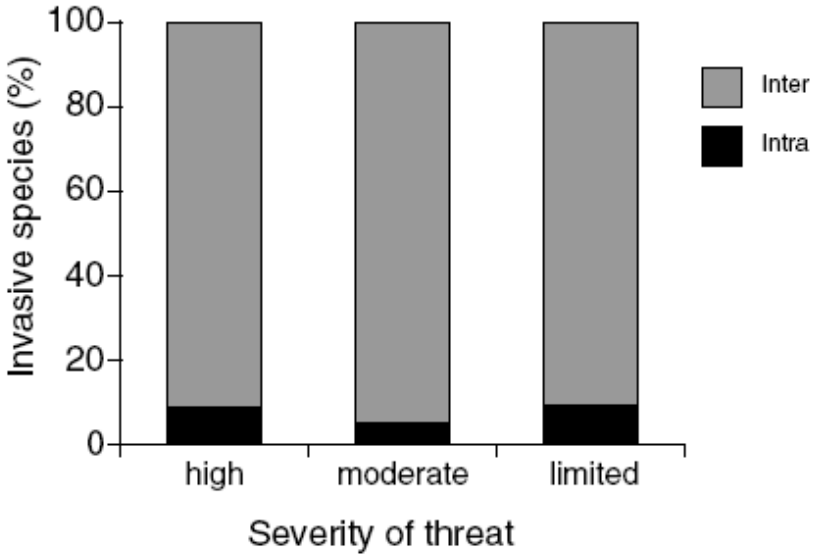


Figure 1. Percentage of invasive species that are intra- versus intercontinental in origin for 3 levels of threat severity. Correlation between continental origin and level of invasive severity is not significant ($p = 0.52$). Data are from 3 state invasive plant lists.

Mueller & Hellmann 2008

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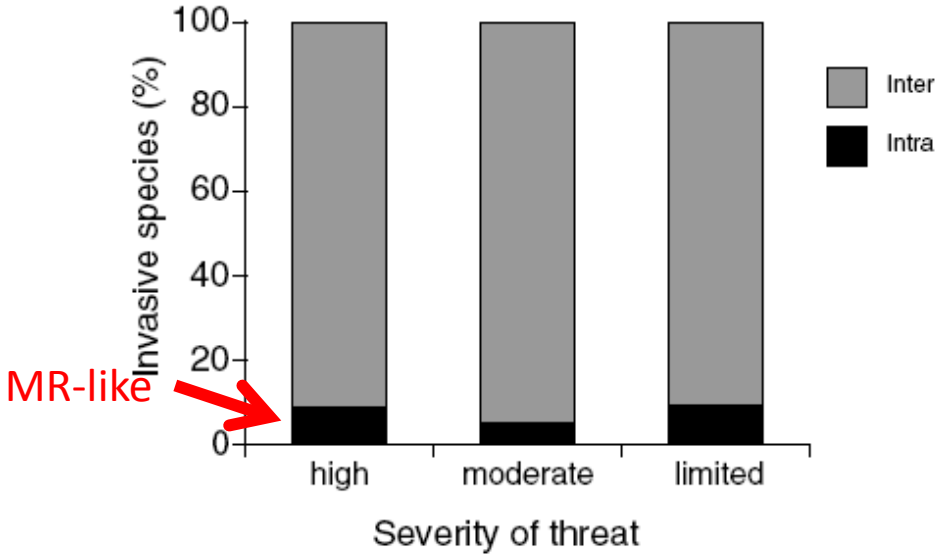

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Mueller & Hellmann 2008

Past species translocations suggest:

- **Risk to target species:** Steps can be taken to improve likelihood of success – but success is hard to predict
- **Risk to recipient ecosystem:** Most MR candidates probably won't invade – but those that do can still cause harm

Going forward

- Balance between establishing a self-sustaining population and minimizing negative effects
- Dealing with uncertainty: importance of contingency plans
- Broad management spectrum: when does MR seem appropriate? Not appropriate?