



A Warmer and Weedier Future?

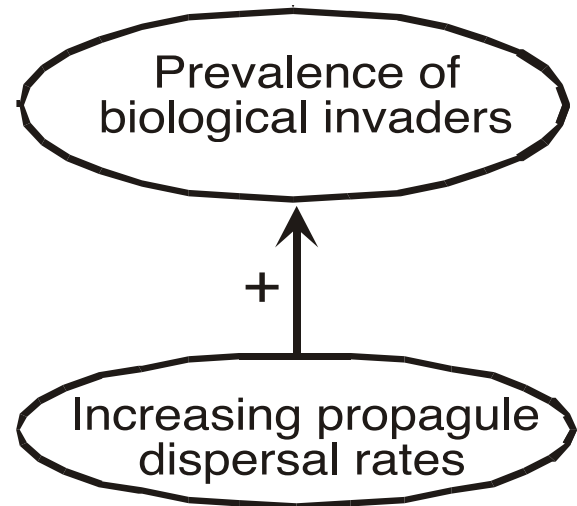
Challenges and new opportunities in a changing world

Jeffrey S. Dukes

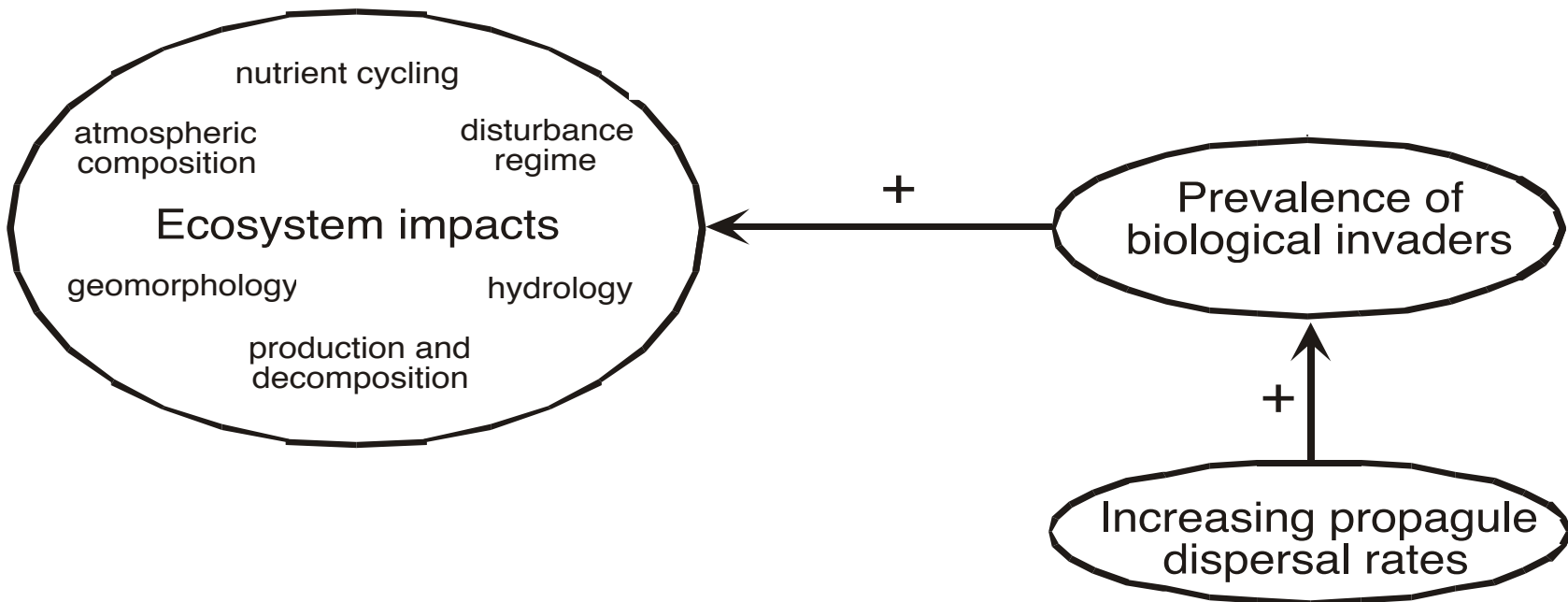


Purdue University
jsdukes@purdue.edu
[@DukesJeff](#)

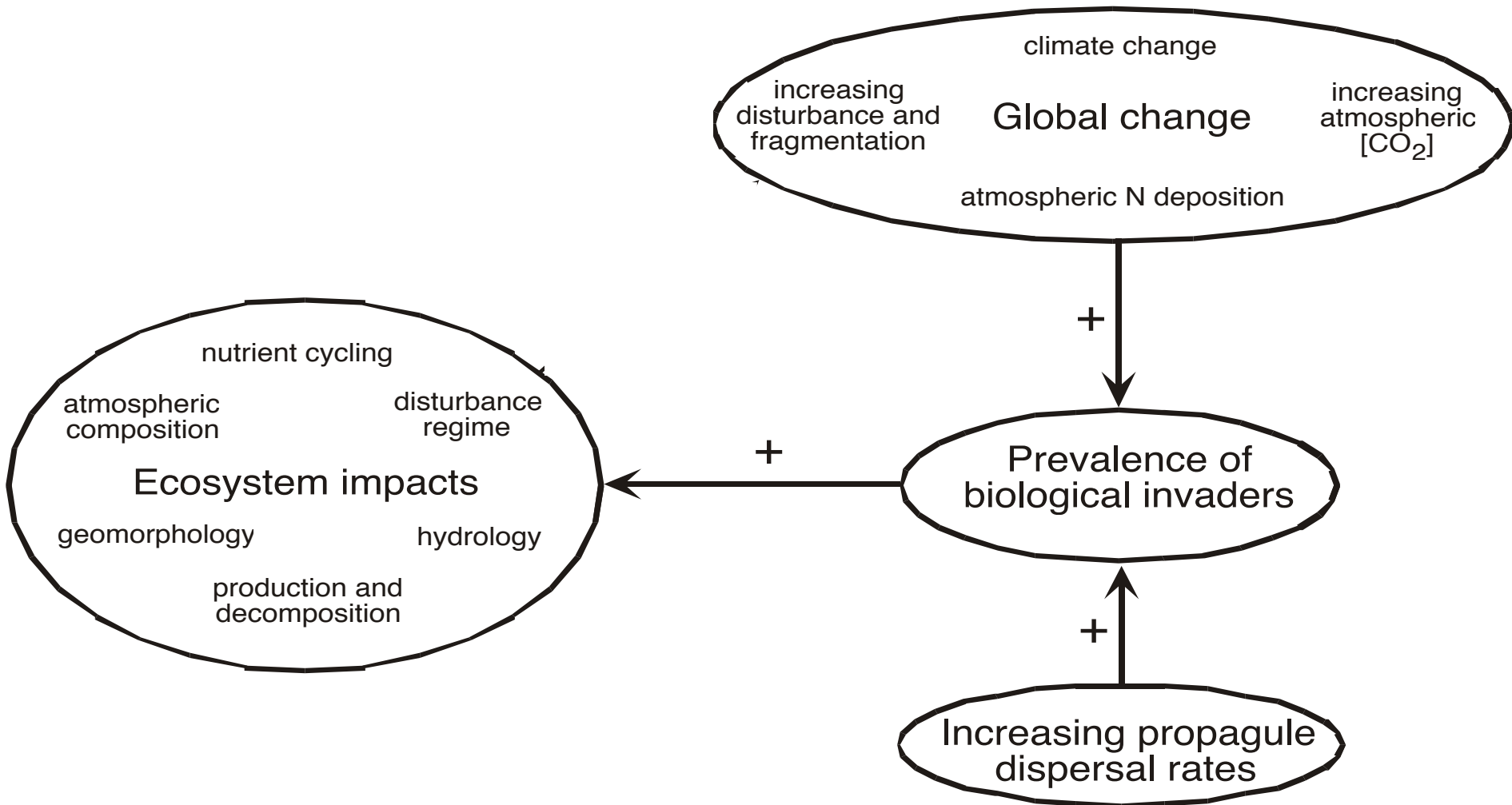
Increasing propagule transport is main cause of biological invasions



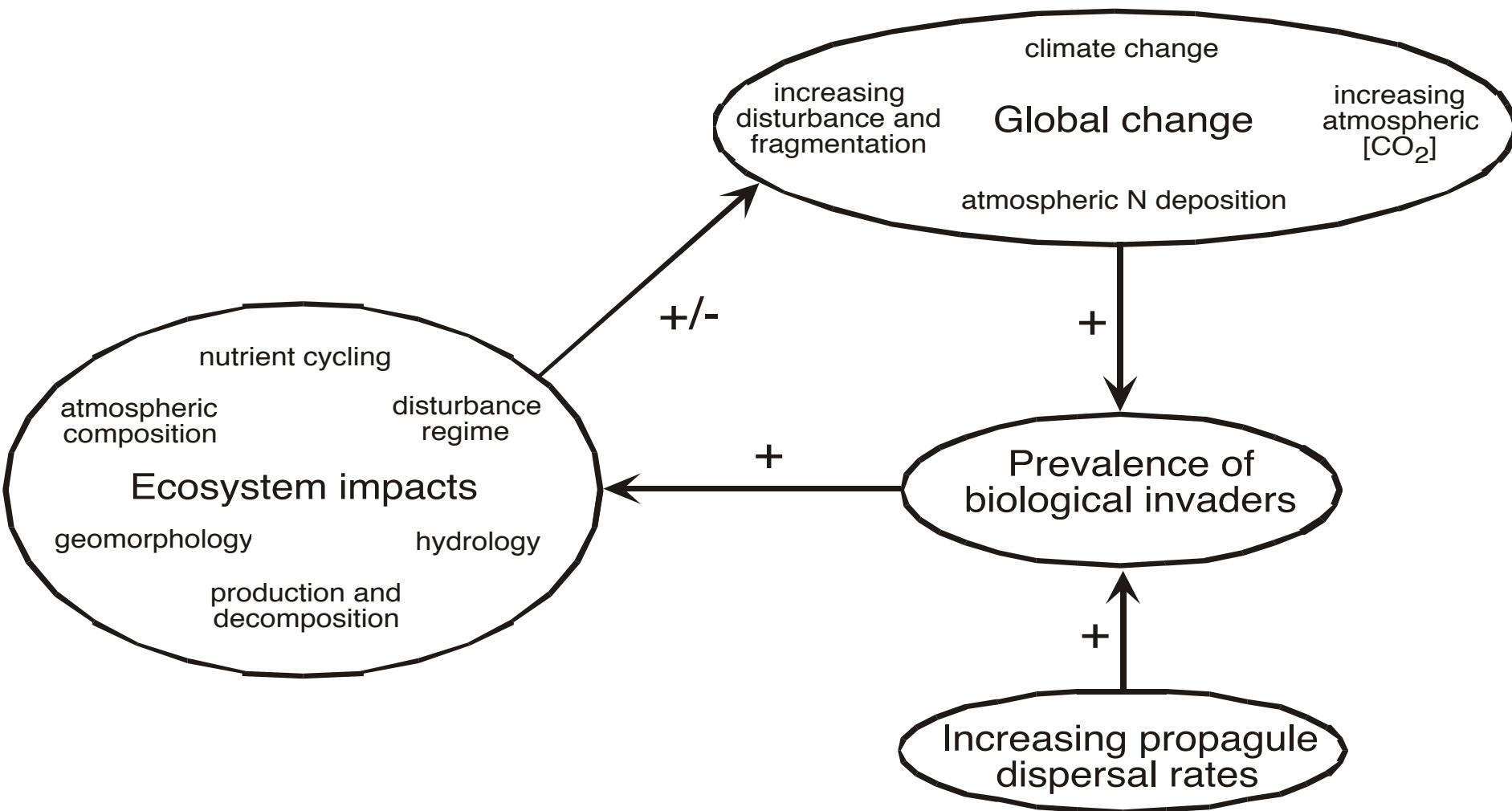
Invasive species affect ecosystem-level properties and processes



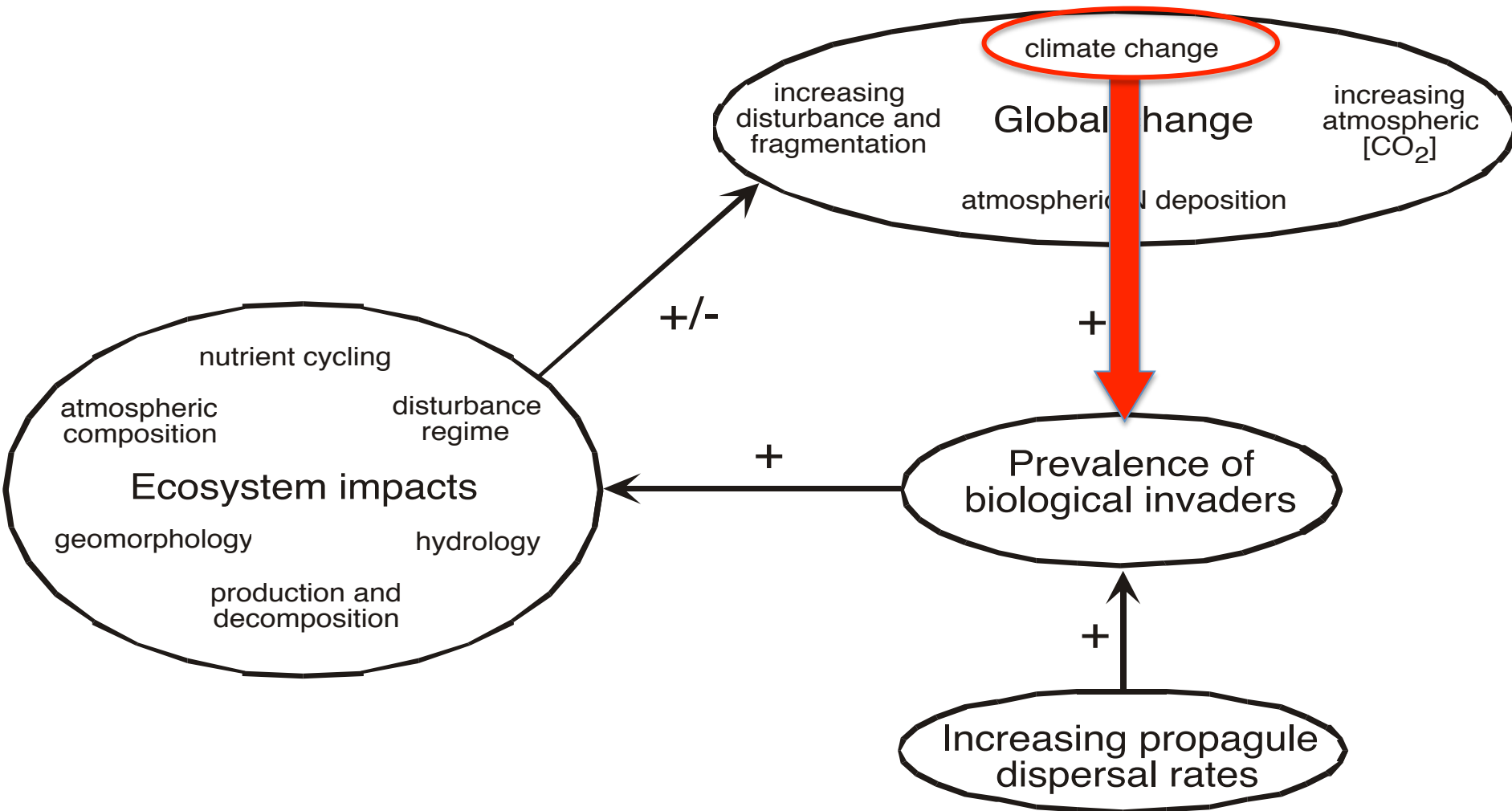
Global changes may increase success of invasive species



Invasive species may affect rates of some global changes

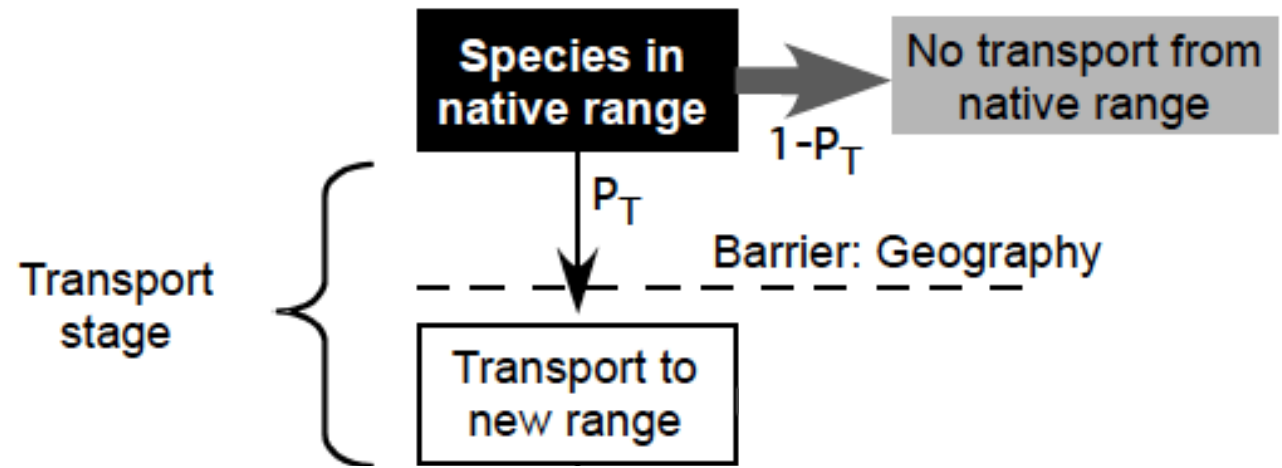


Today: climate and invasions

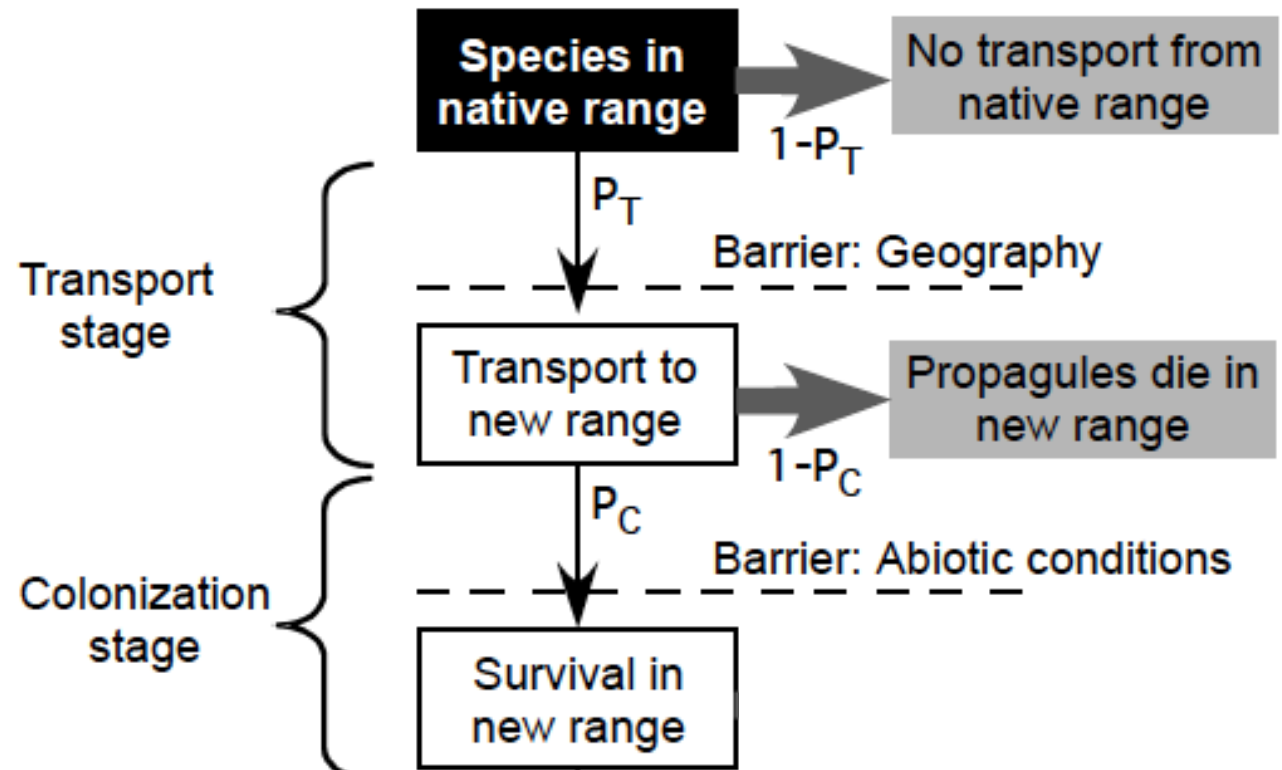


What worst-case scenario concerns
you most?

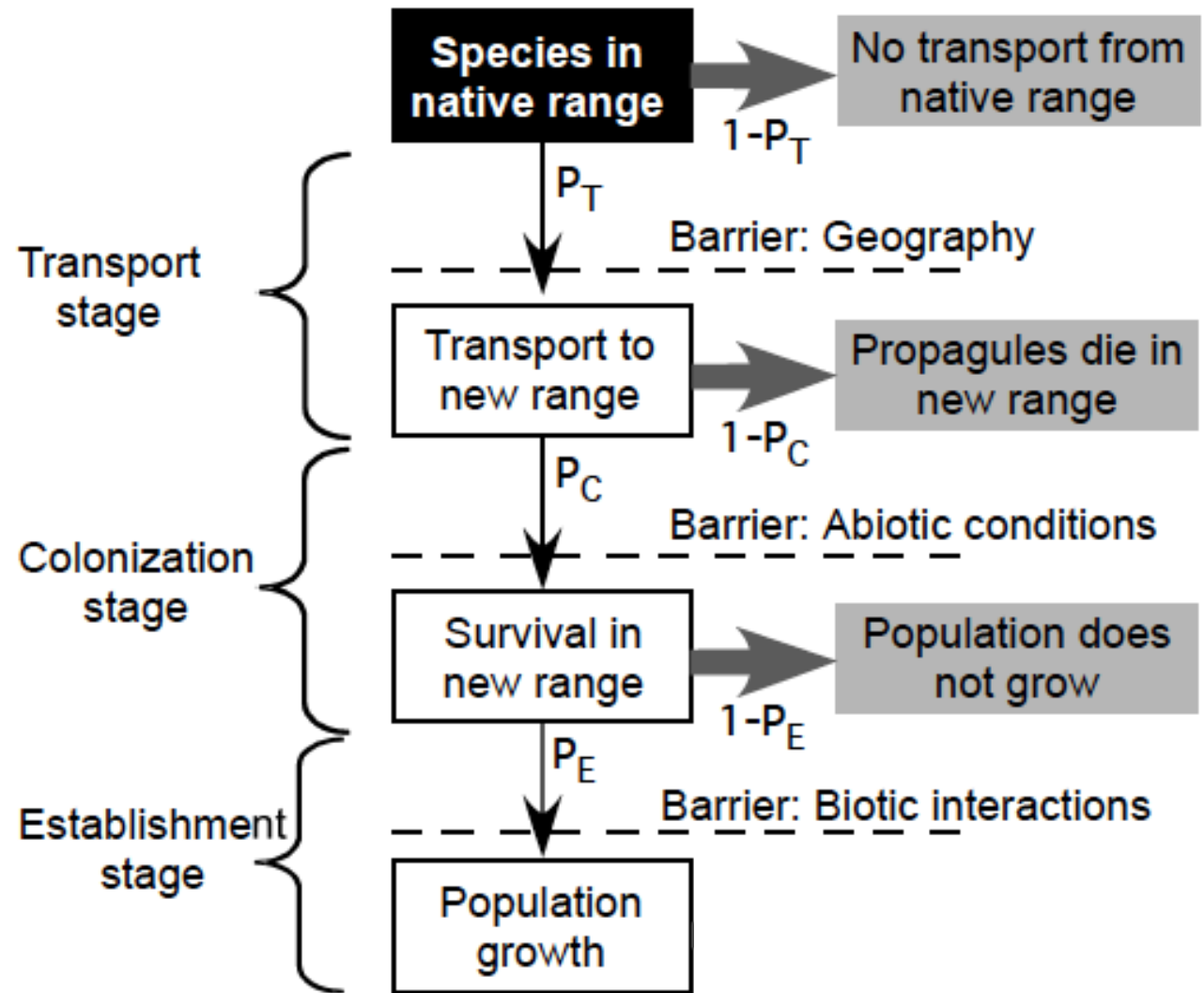
Stages of invasion



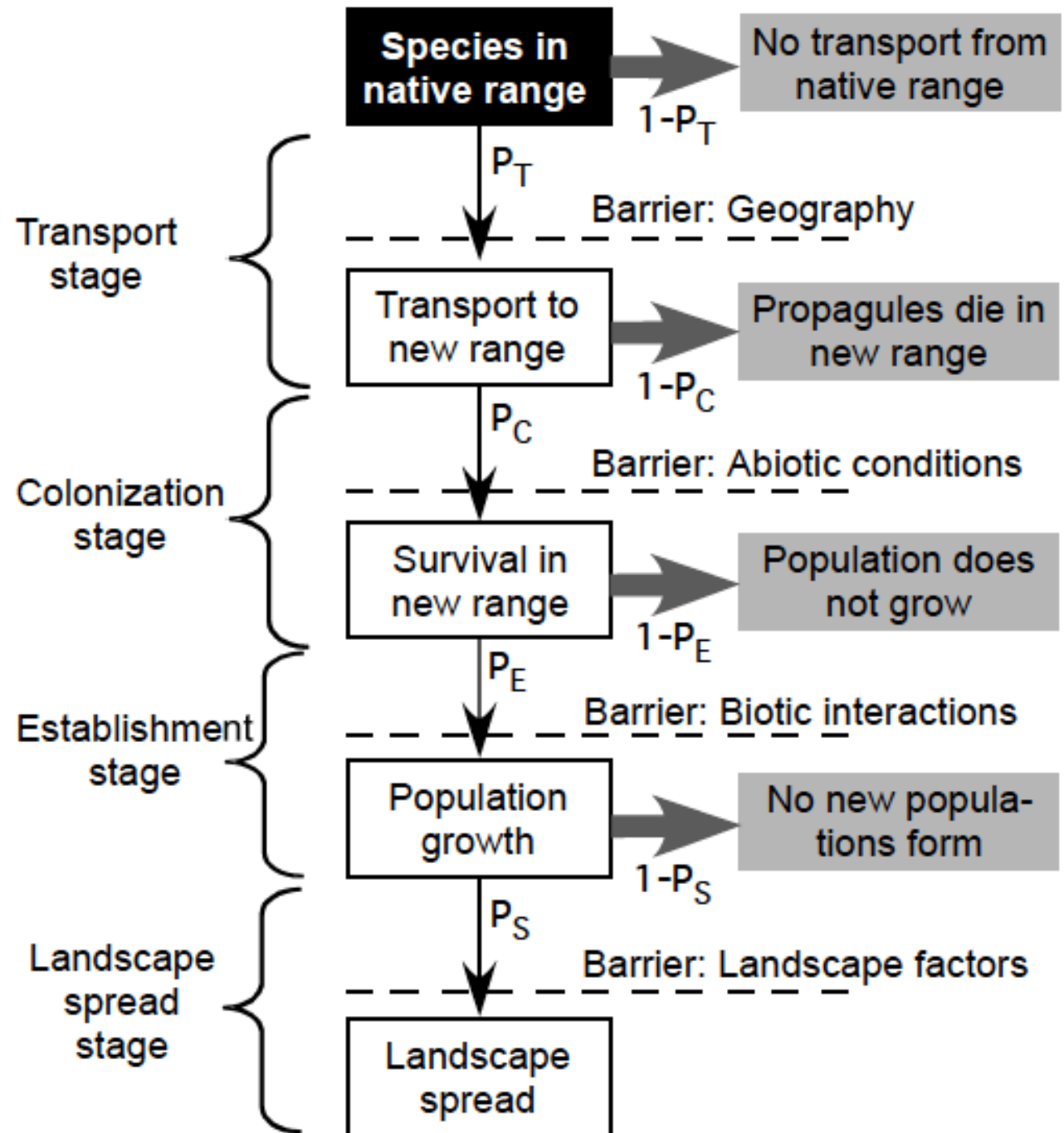
Stages of invasion



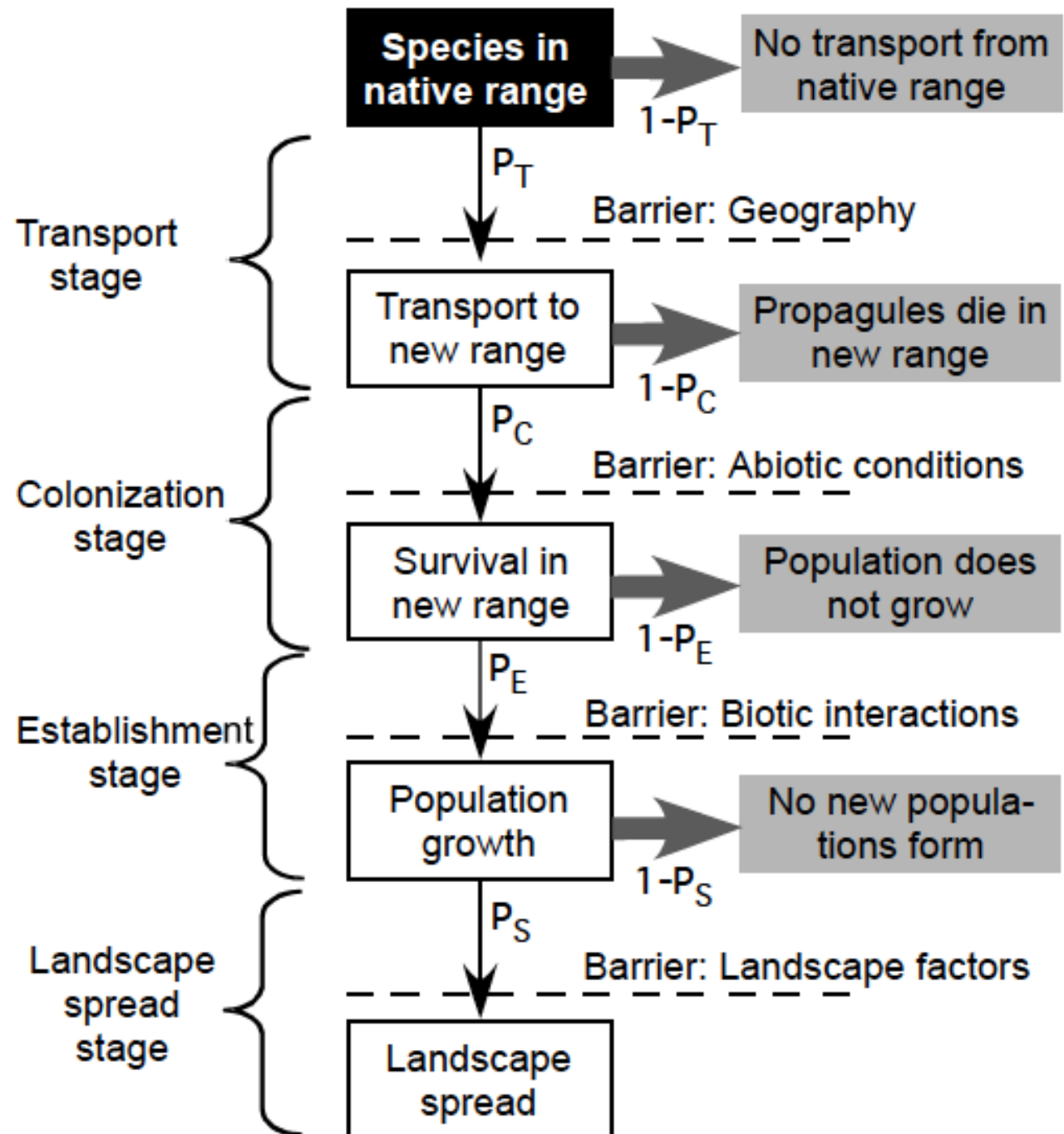
Stages of invasion



Stages of invasion



Climate change could affect each of the barriers to invasion

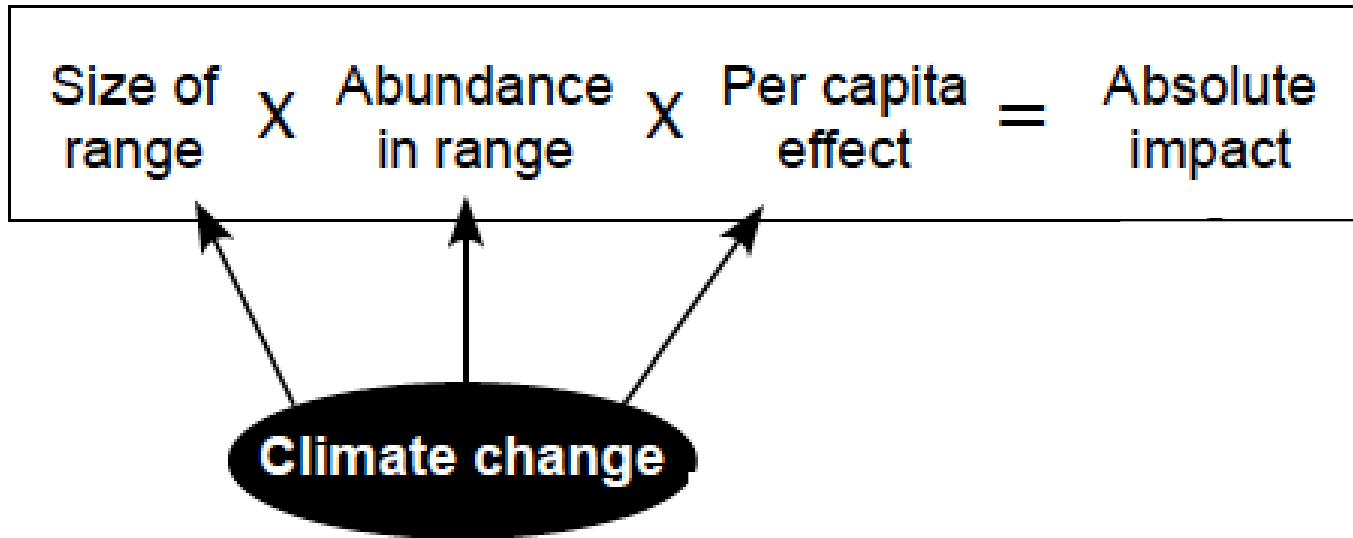


Each invader may be affected at
different stages and scales...

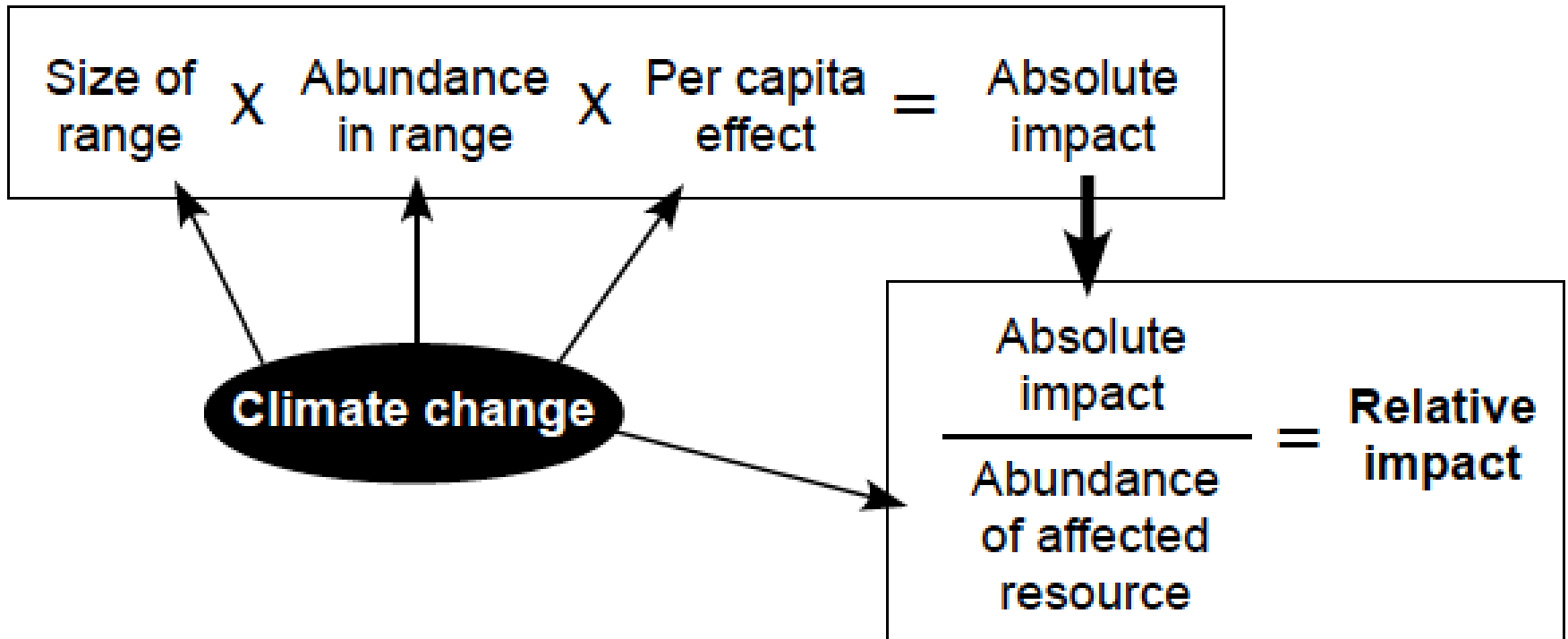
Climate change will alter some impacts

$$\text{Size of range} \times \text{Abundance in range} \times \text{Per capita effect} = \text{Absolute impact}$$

Climate change will alter some impacts



Climate change will alter some impacts



Can you think of an example?

Climate can indirectly affect impact

- *Tamarix* is thought to use more water than natives
- Decreasing regional precipitation would increase economic impact (Zavaleta 2000)



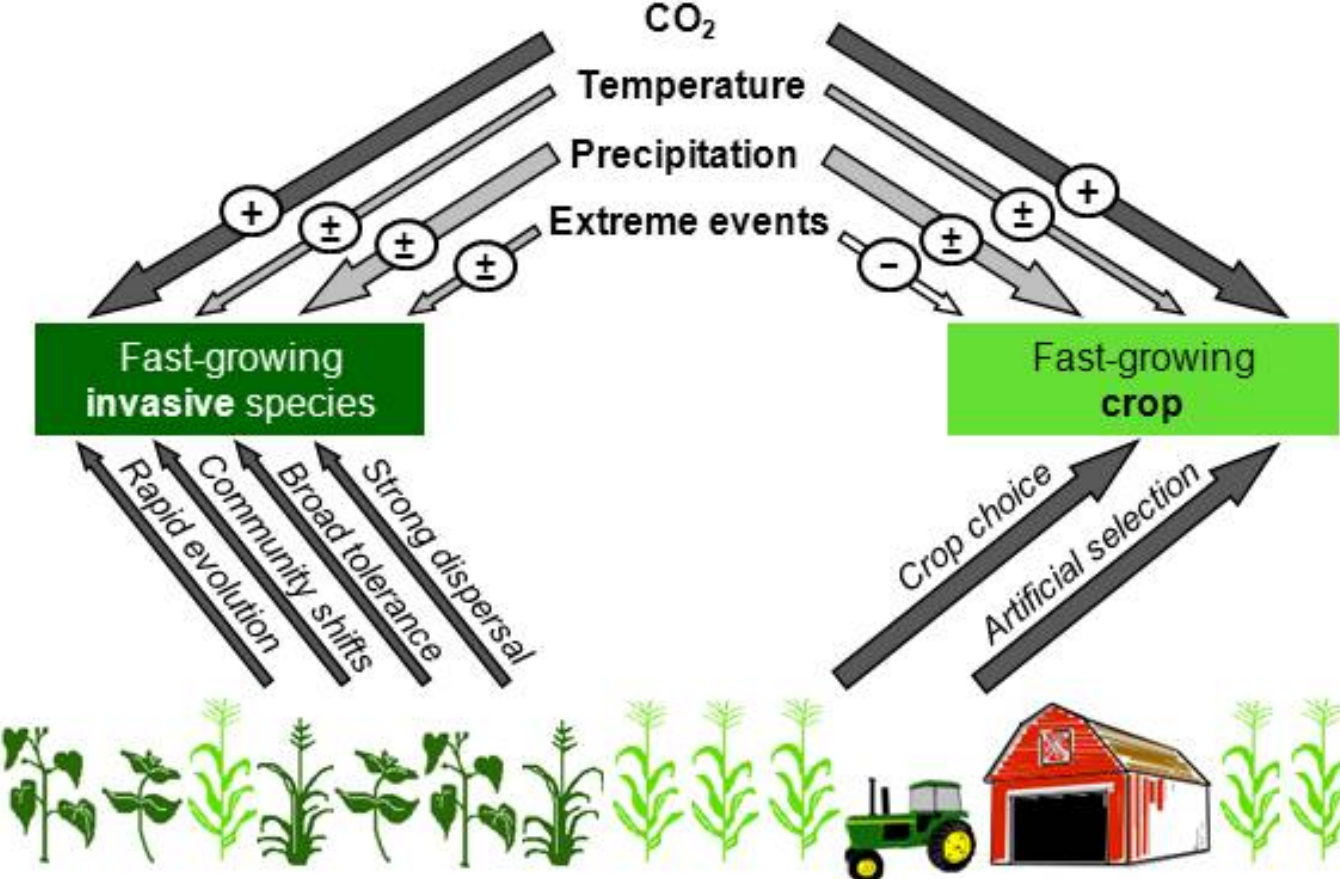
Will global changes favor invasive species?

Element of global change	Prevalence of plant invaders^a
Increased atmospheric CO ₂	+
Rising temperature	±
Changing precipitation regime	±
Changing land use or land cover	+
Increased N deposition	+
Increased global commerce	+

^a+ Likely to increase invasion risk for many plant species; ± Might increase or decrease invasion risk

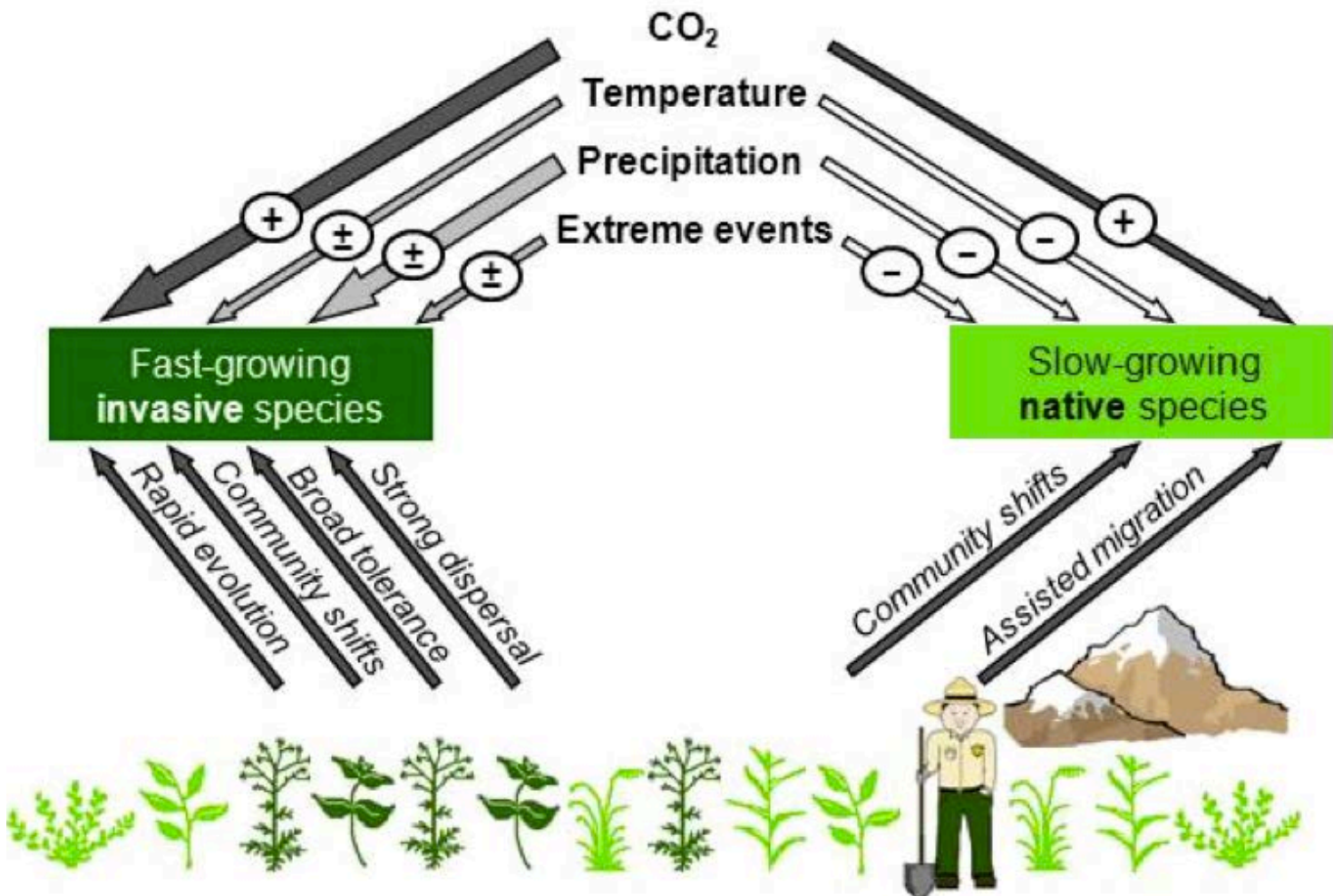
Management options may determine outcome in different systems

Ag system



Management options may determine outcome in different systems

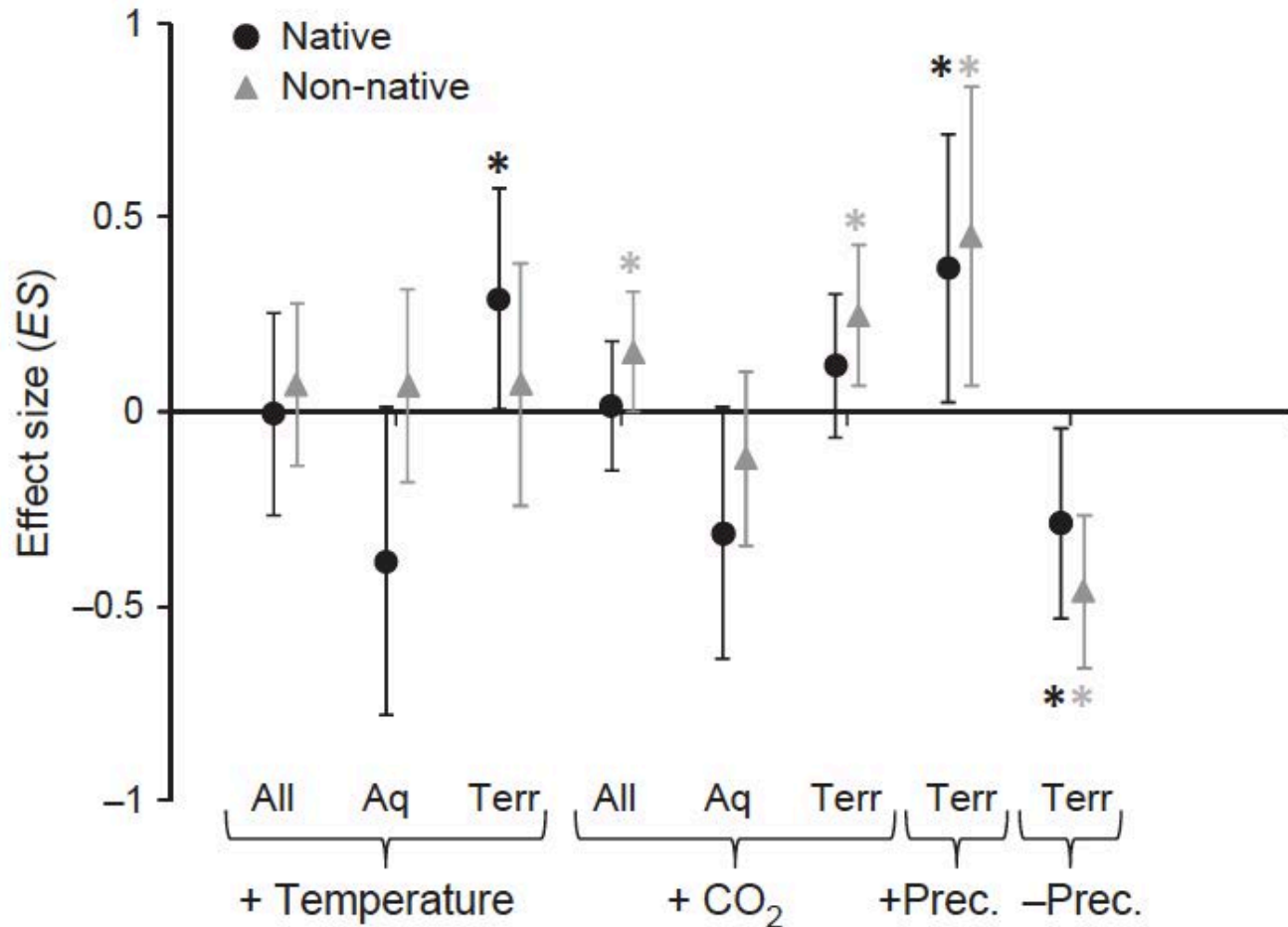
Natural system



Some working hypotheses:

General responses of invasives
(or non-natives) vs. natives

Do non-native species respond more strongly than natives to global change?



Some native systems would seem to be poorly adapted to a *changing* climate...

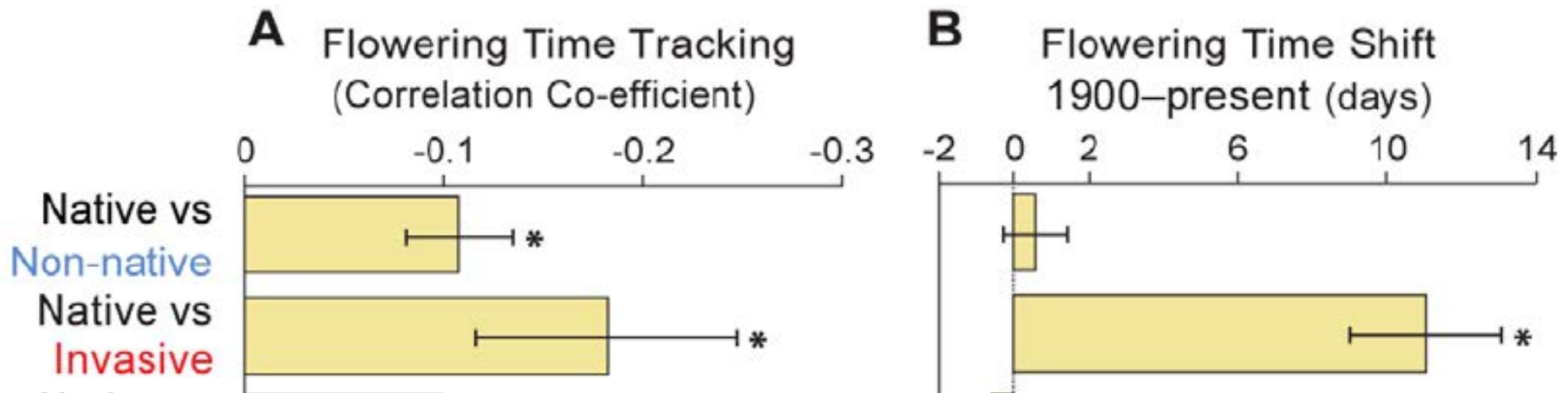
- Traits that preclude rapid range shifts or rapid adaptation
 - Long juvenile period
 - Long lifespan
 - Little dispersal
- ...if biotic resistance erodes, these systems may be more easily invaded in the future

Many invasives are well adapted to a *changing* climate

- Traits that allow rapid range shifts
 - Short juvenile period
 - Long-distance dispersal

Invasive plants track climate change better

- In New England, invasives shifted flowering times to match climate faster than natives
 - Now flowering 11 days earlier than natives

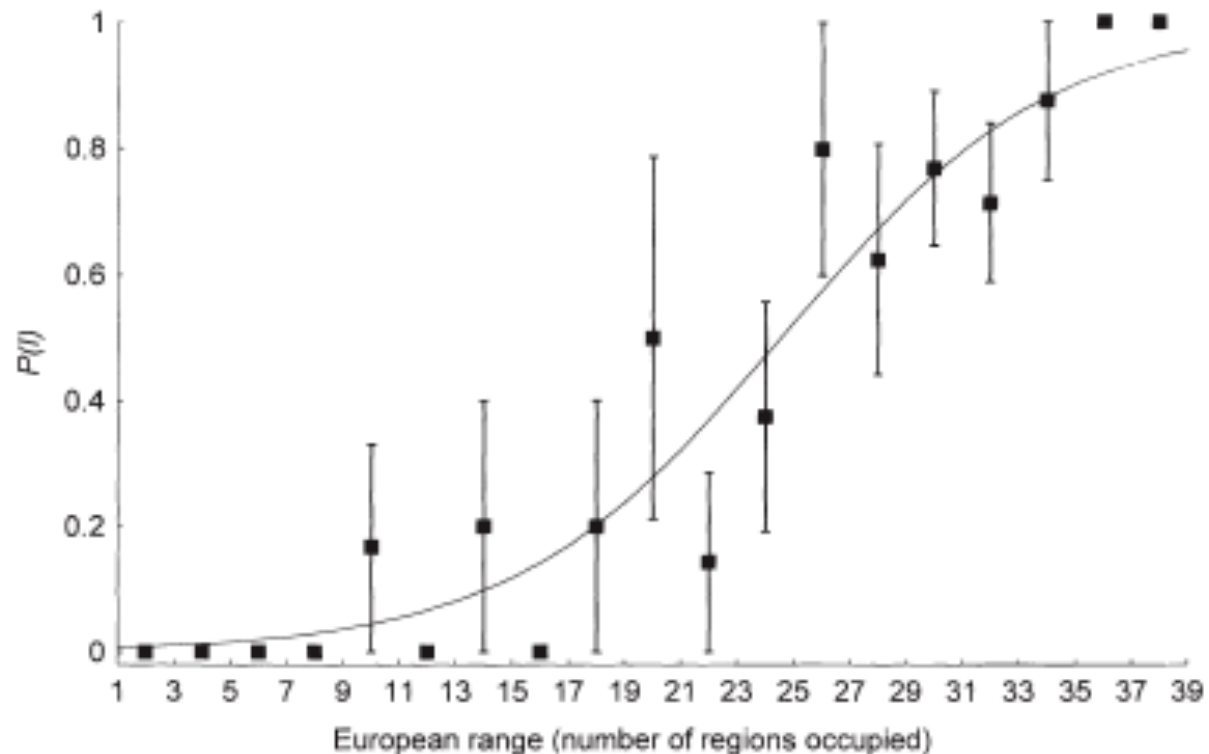


Invasives are often more climate-tolerant than non-invasives

- In some families, invasives span greater latitudes in native ranges (Rejmánek 1995)

Probability of plant species being invasive increases with breadth of native range

(Goodwin et al. 1999)



Invasives are often more climate-tolerant than non-invasives

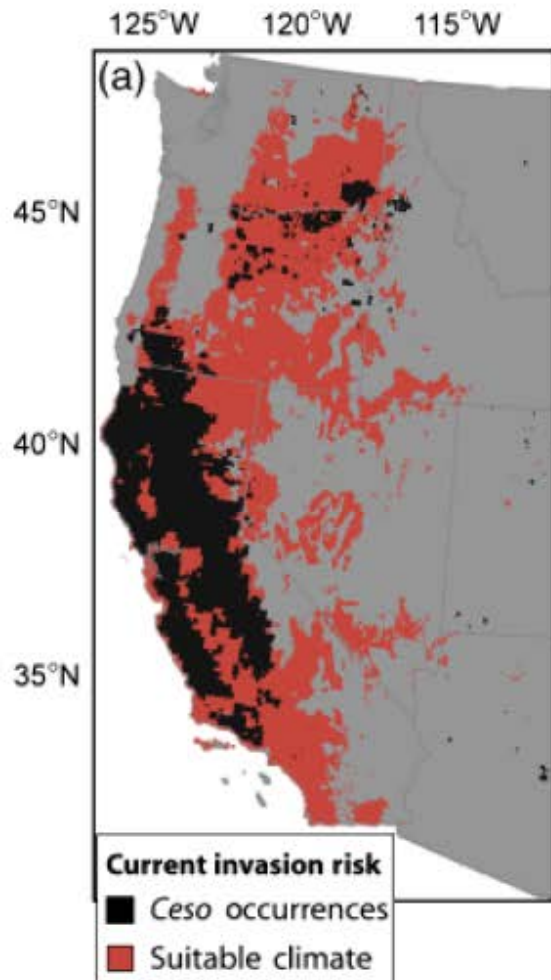
- Disruption of mutualistic relationships
 - Invasive plant species unlikely to need specialist pollinators



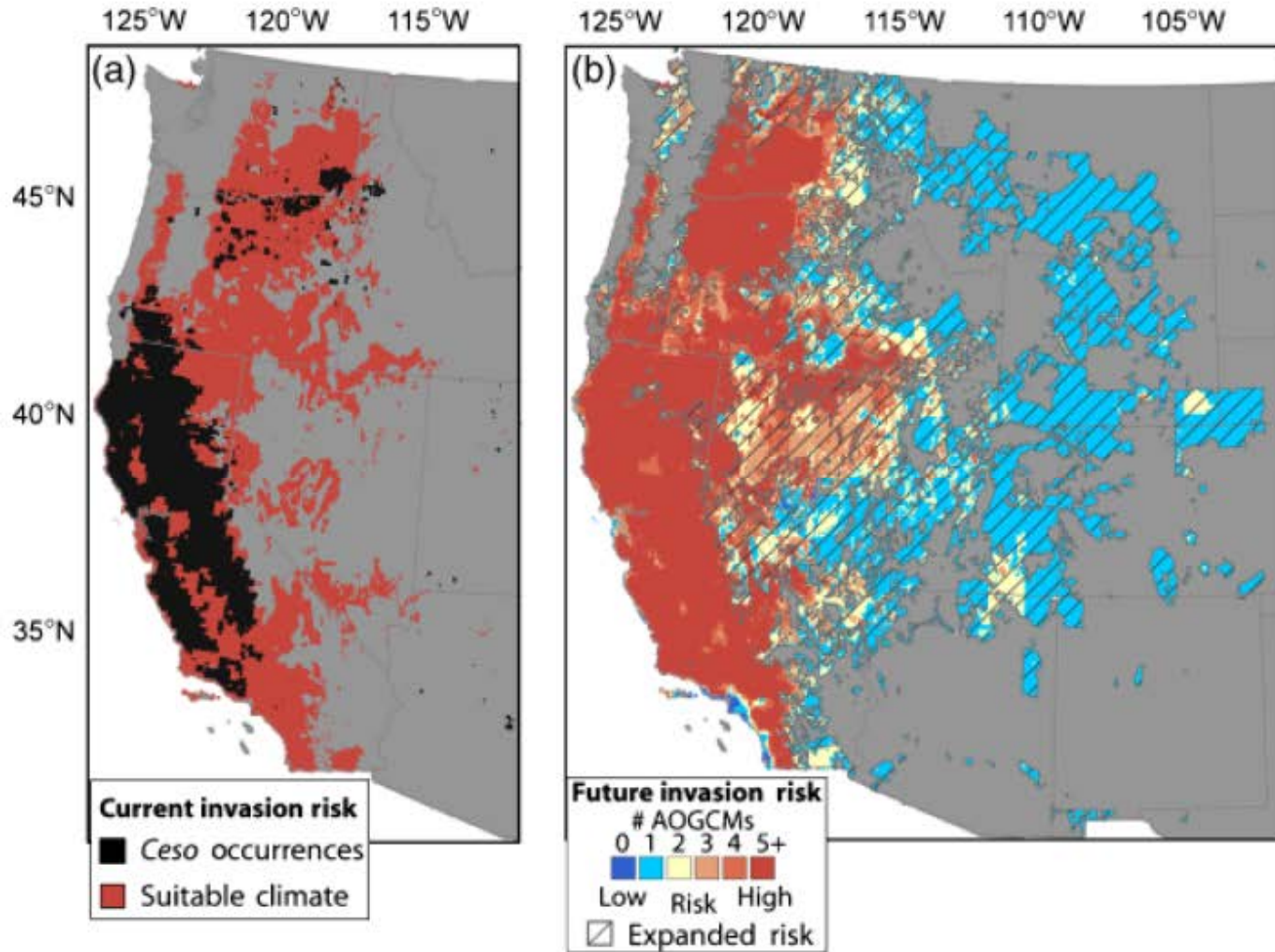
Ok, but... Give us specific predictions!

- How will ranges shift?
 - Some invasives might be expected to benefit as suitable area increases
 - Potential ranges of other invasives might contract
- One tool for predicting range shifts: "niche-based" or "species distribution" models

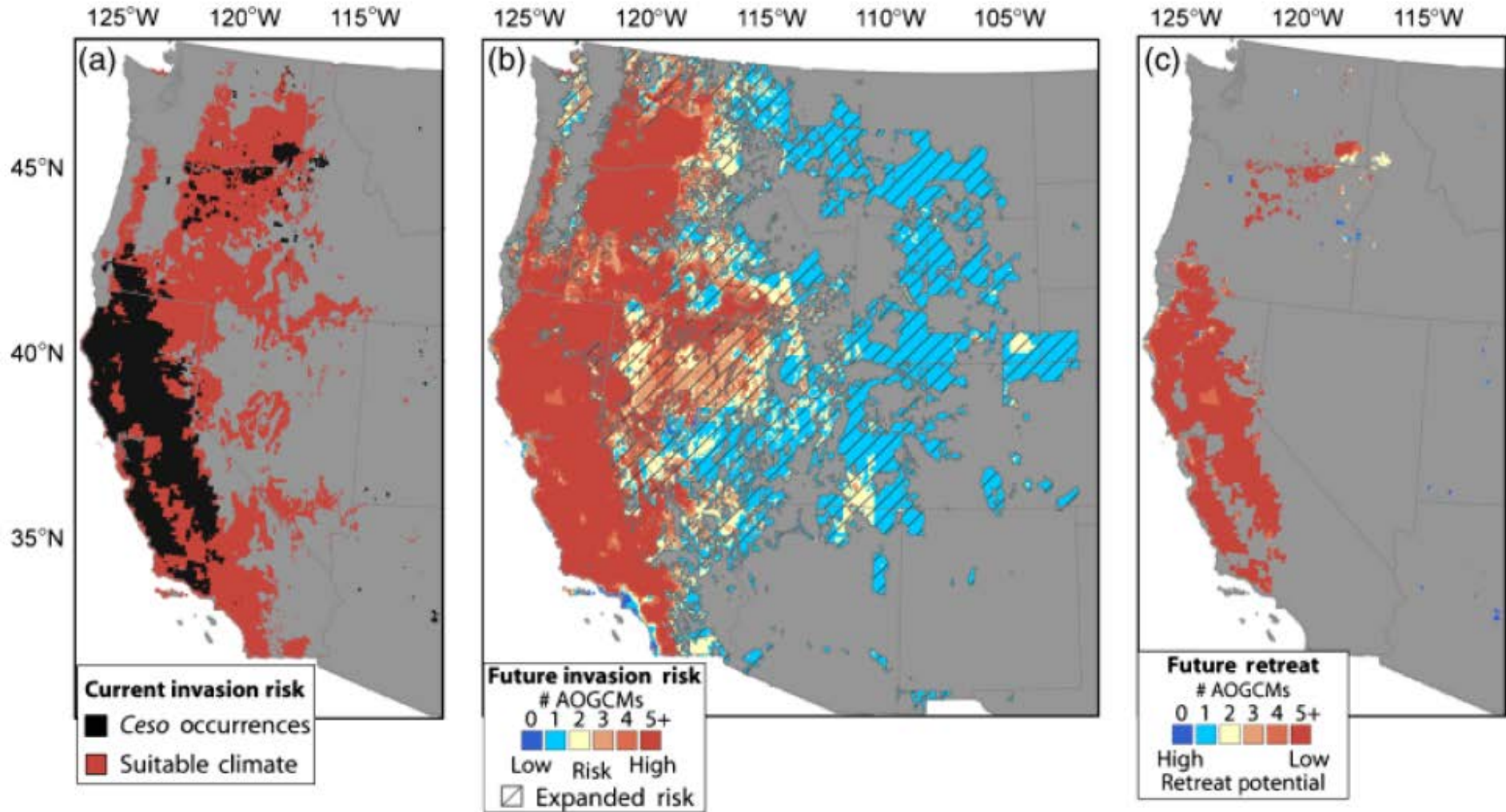
Suitable climate for yellow starthistle



Suitable climate for yellow starthistle



Suitable climate for yellow starthistle



Drawbacks of niche-based models

- Often ignore soil type (plants)
- Too coarse in spatial scale; omit topography, microclimates
- Ignore effects of CO₂, etc. (plants)
- Competition not explicitly in models
- Biocontrol ranges not in models

But niche-based models have many advantages! So...

- Can we bring together modelers and experimentalists to improve them?
- Can we improve them by collecting more detailed, widespread, and standardized data on invasive species' ranges?

How well prepared are we for new invasion threats?

ARTICLE

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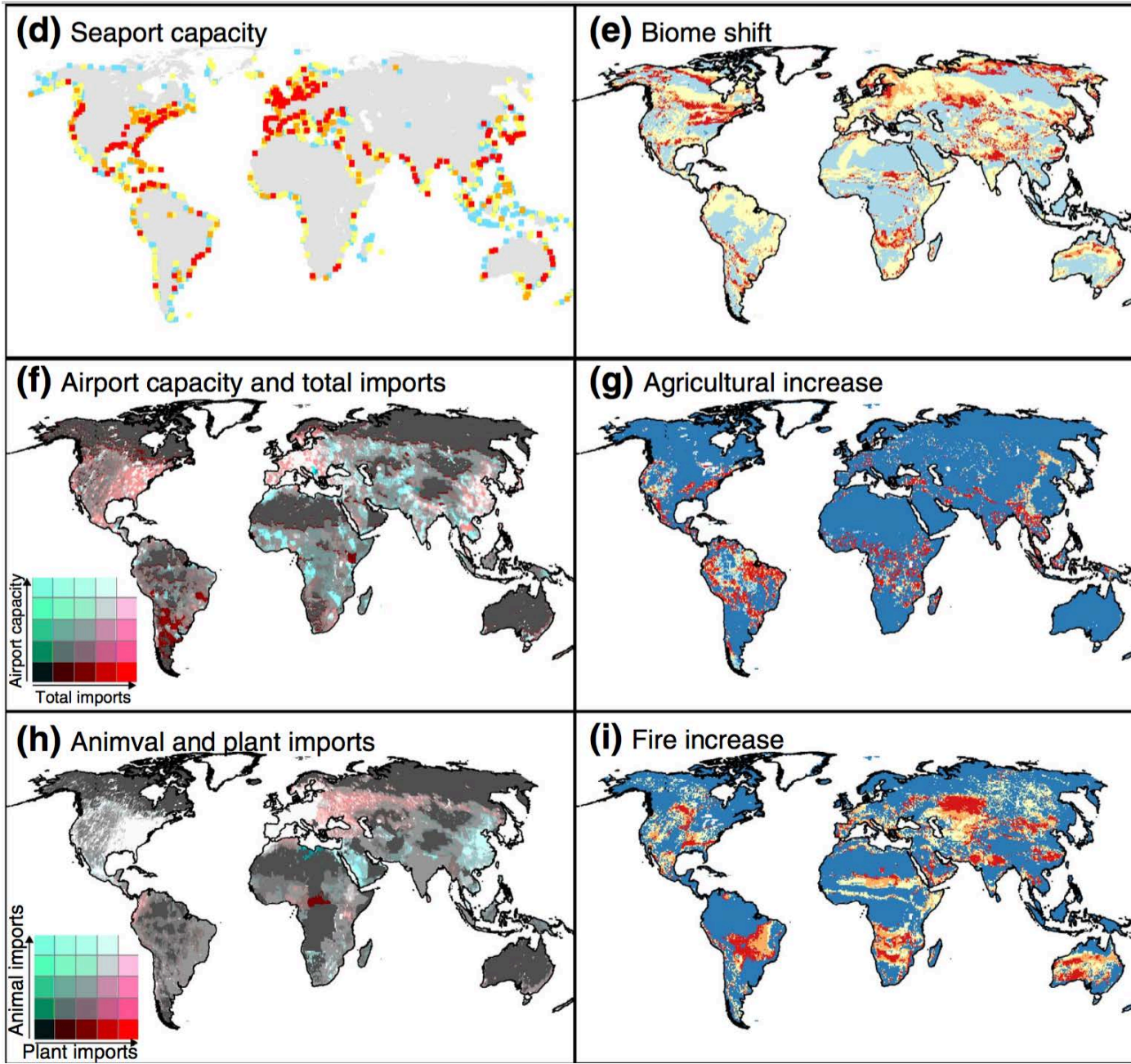
DOI: [10.1038/ncomms12485](https://doi.org/10.1038/ncomms12485)

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Global threats from invasive alien species in the twenty-first century and national response capacities

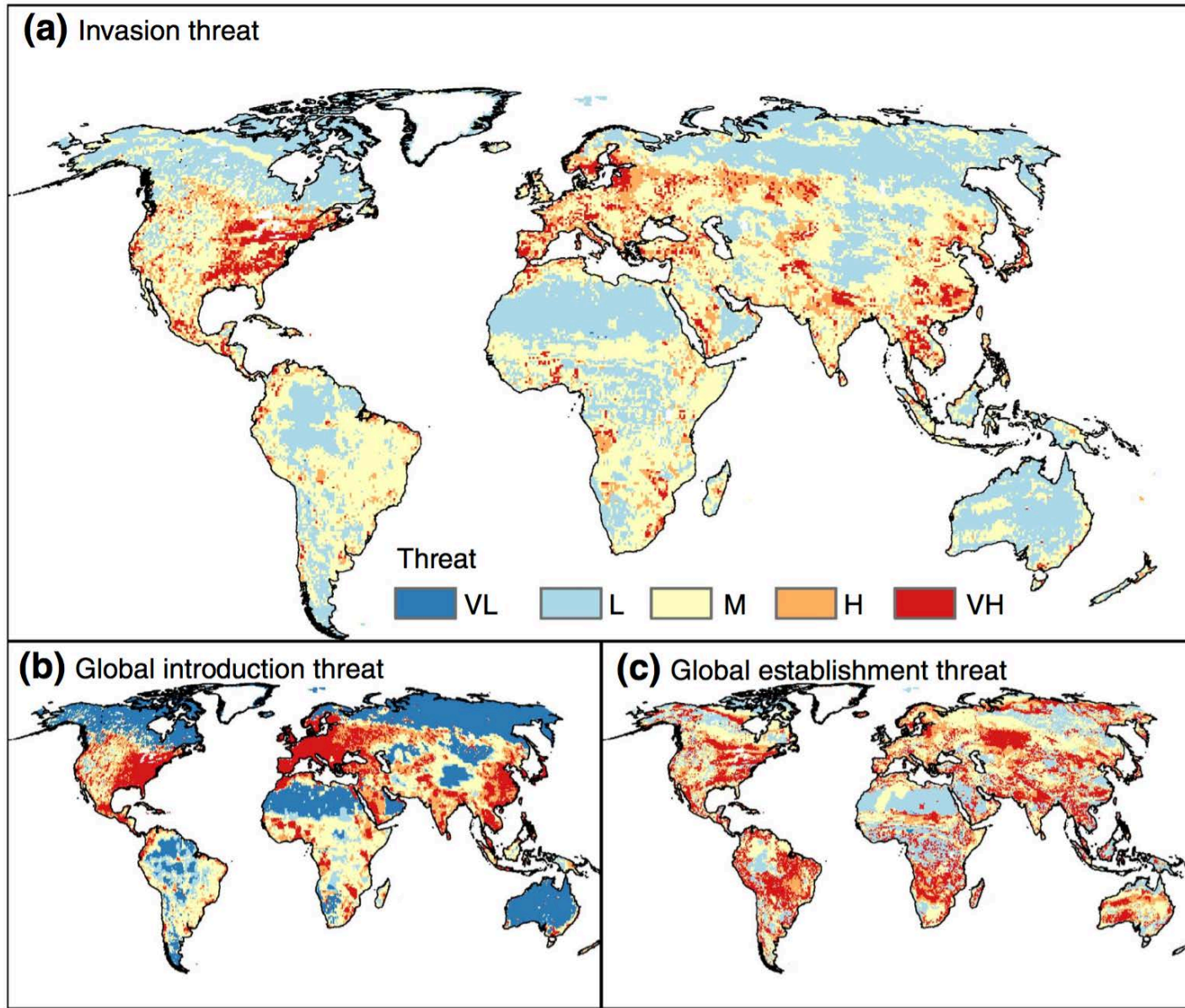
Regan Early¹, Bethany A. Bradley², Jeffrey S. Dukes^{3,4}, Joshua J. Lawler⁵, Julian D. Olden⁶, Dana M. Blumenthal⁷, Patrick Gonzalez^{8,9}, Edwin D. Grosholz¹⁰, Ines Ibañez¹¹, Luke P. Miller¹², Cascade J.B. Sorte¹³
& Andrew J. Tatem^{14,15,16}

New work: Future invasion threats

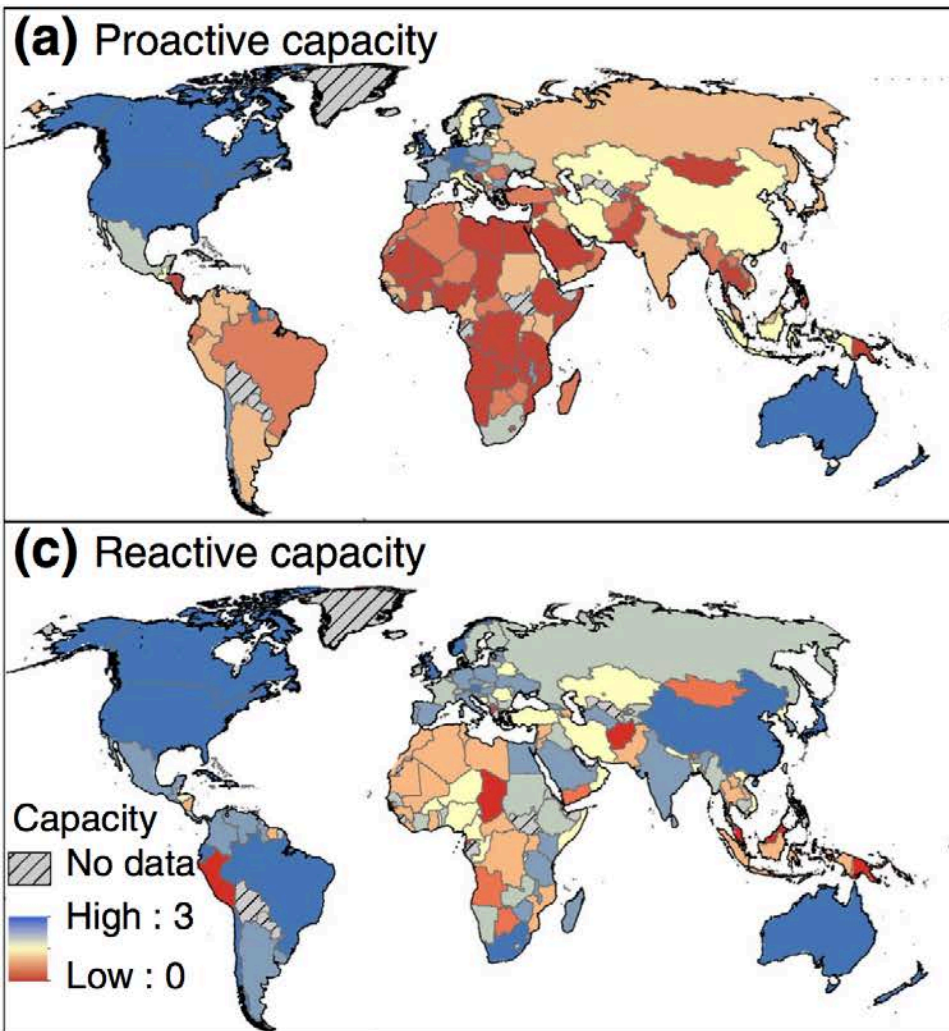


Early et al.
Nature Comm.
2016

New work: Future invasion threats



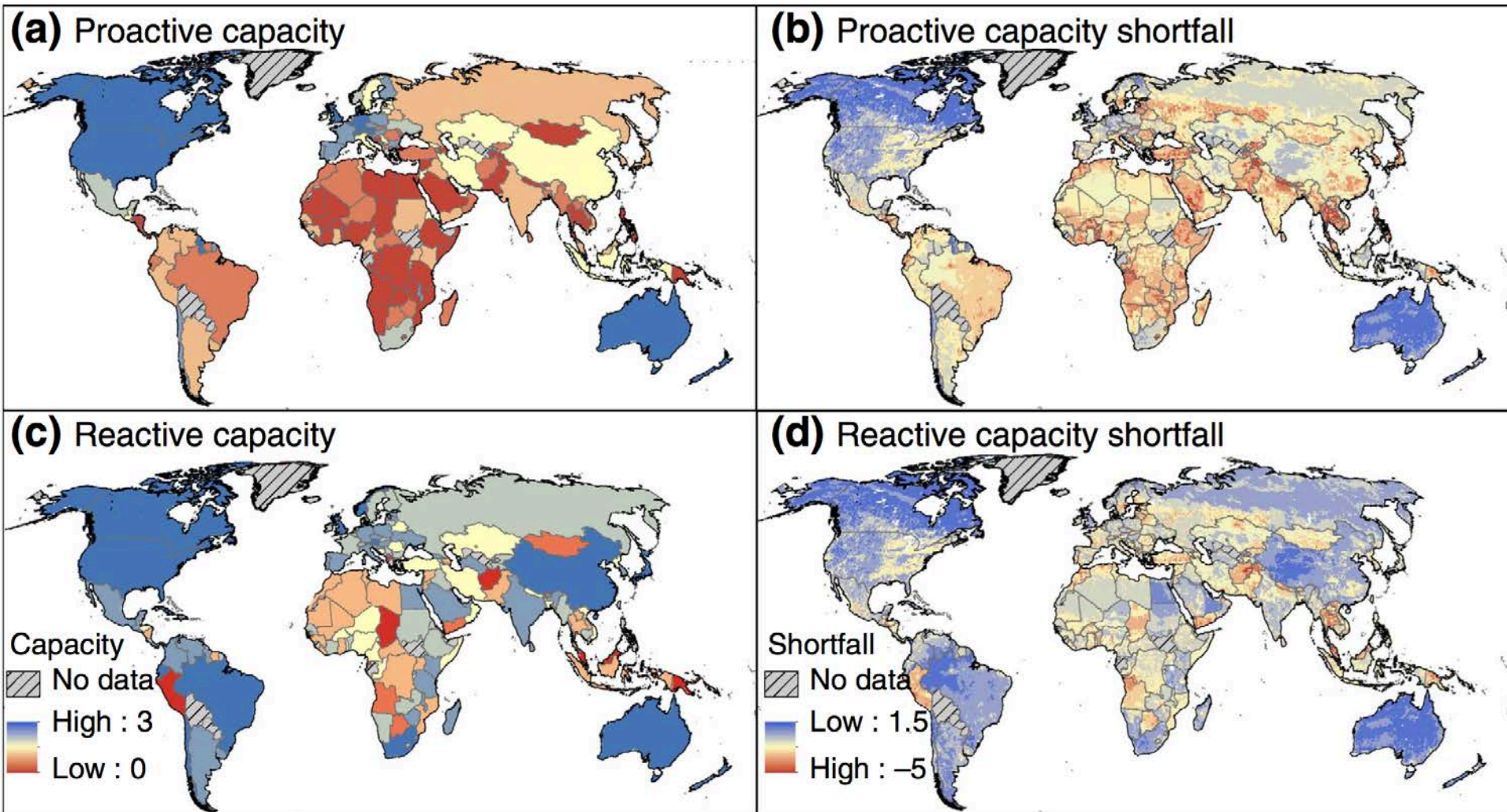
Readiness: Are countries prepared?



Based on 2014 reports to the (UN) Convention on Biological Diversity

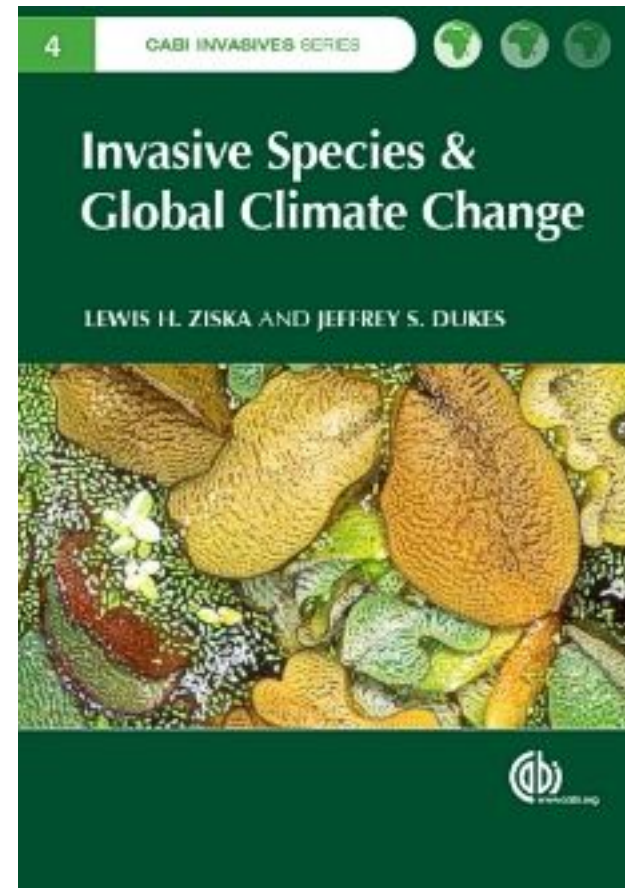
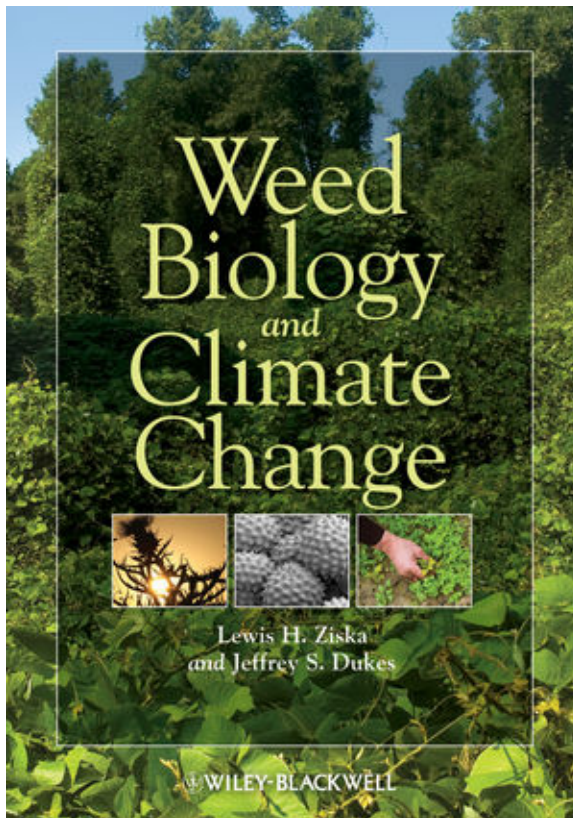
Early et al. *Nature Comm.* 2016

Threat vs. readiness



Can't get enough on invasive species and global change?

- Two books with Lew Ziska (2011, 2014)



Thank you!

jsdukes@purdue.edu
[@DukesJeff](#)



