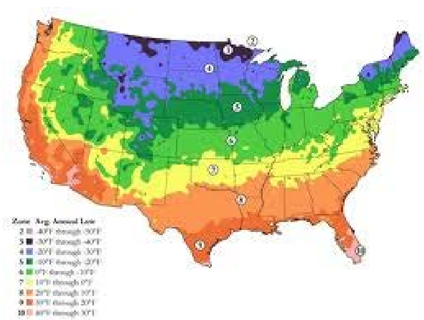
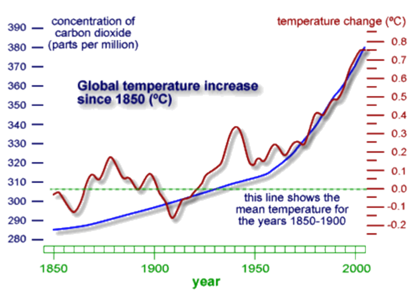
Preparing Wisconsin Invasive Species Policy for Future Climate Change

(or) how climate suitability models can support proactive management

Outline





- Wisconsin's proactive invasive species rule
  - NR40
  - Lit reviews/risk assessment
- Climate suitability model
- Predict future climate suitability
- Climate change and policy

The Chapter NR 40 rule creates a comprehensive, science-based system with criteria to classify invasive species into two categories: "prohibited" and "restricted."

2001 – Work toward a rule to identify, classify, control invasive species

Regulated Aquatic Invasive Plants in WI

Please report any **prohibited** species (as indicated by the red frame box) to the WDNR.

Report by email to: Invasive.Species@wi.gov or **by phone at: (608) 266-6437**

OR to find out more information, for information on reporting restricted species and whom to contact go to:

http://dnr.wi.gov/invasives/aquatic/whattodo/

Flowering rush
(Butomus umbellatus)

Purple loosestrife
(Lythrum salicaria)

Curly-leaf pondweed
(Potamogeton crispus)

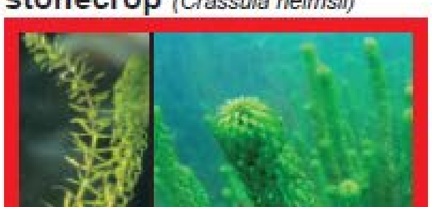
Eurasian water milfoil
(Myriophyllum spicatum)

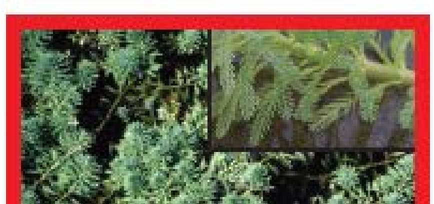
Australian swamp stonecrop *(Crassula helmsii)*

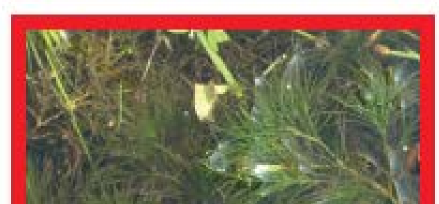
Brazilian waterweed
(Egeria densa)

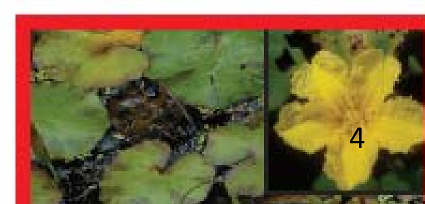
Hydrilla
(Hydrilla verticillata)

European frog-bit
(Hydrocharis morsus-ranae)









How do we decide which species to list?

An exotic species must be

likely to establish a population

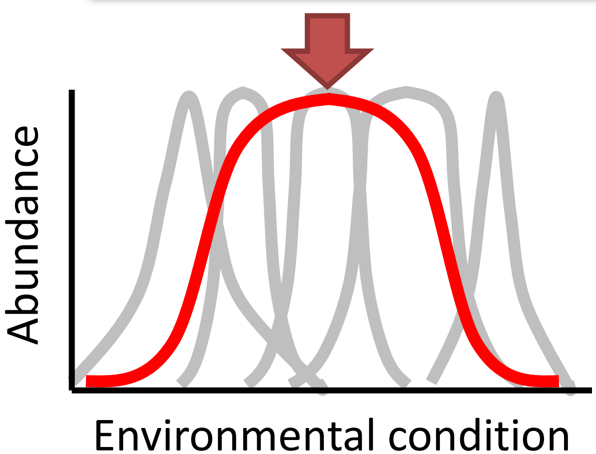
and pose high risk to

Wisconsin ecosystems or economy

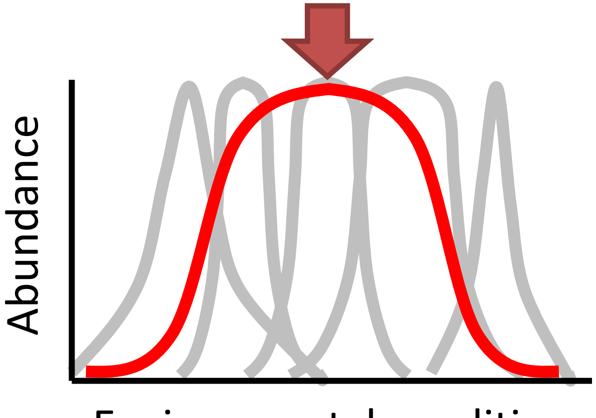
A high-risk invader:

A high-risk invader:

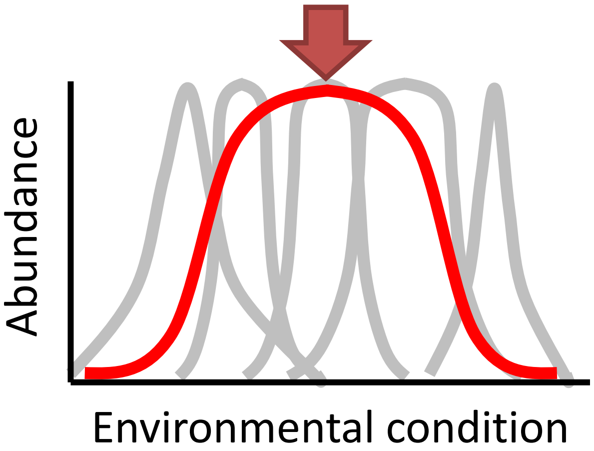
A high-risk invader:

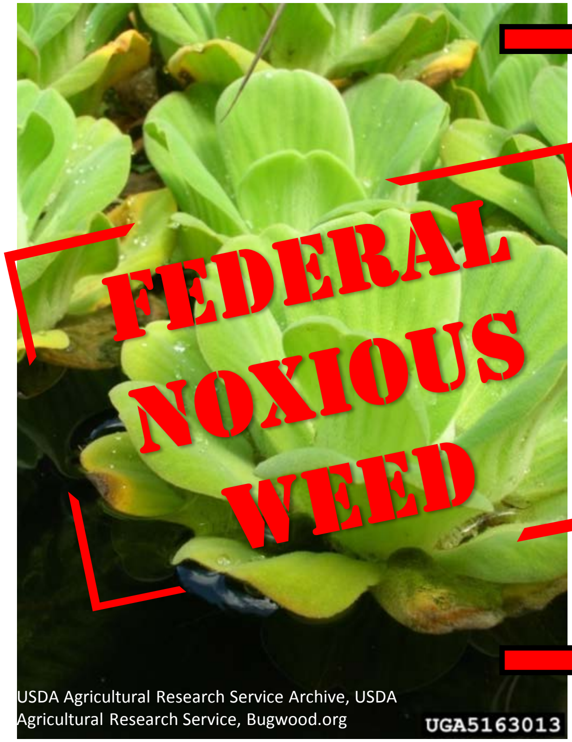


A high-risk invader:



A high-risk invader:

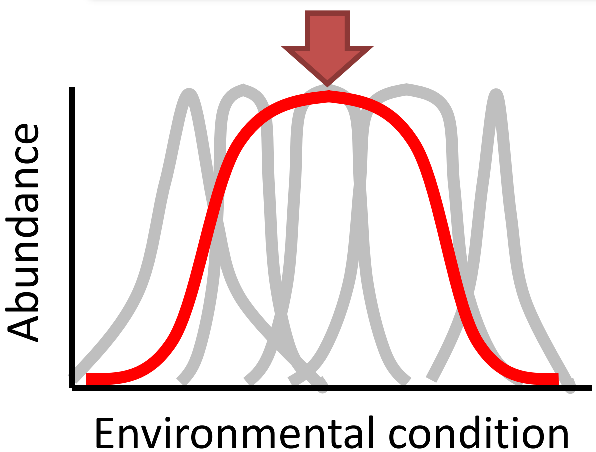


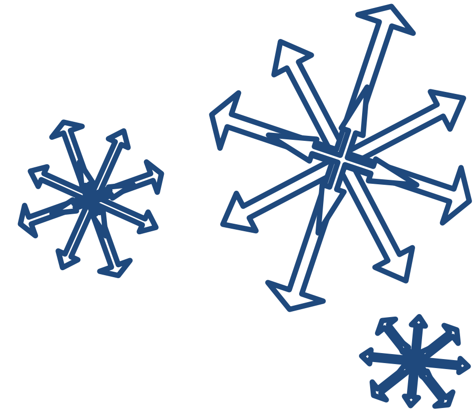


USDA Agricultural Research Service Archive, USDA Agricultural Research Service, Bugwood.org

Forest and Kim Starr, Starr Environmental, Bugwood.org

A high-risk invader:





“I can’t get this species to overwinter in my pond”

“I’ve never seen this species survive a Wisconsin winter”

Water Lettuce (unregulated)

Water Lettuce (unregulated)

Climate change is likely to favor many invasive species

- We want PROACTIVE policies
  - that regulate species BEFORE they arrive

BUT:

- We haven't quantified *current* climate suitability
- It is difficult to anticipate future changes in suitability

Dukes and Mooney 1999; Wrona et al. 2006

Supporting proactive policy

- We must better understand climate tolerances of aquatic invasive species
- We must anticipate species range expansions and/or shift under climate change

Supporting proactive policy

- We must better understand climate tolerances of aquatic invasive species
- We must anticipate species range expansions and/or shift under climate change

How?

Use global records of species occurrences to map suitable climate


Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
5448243

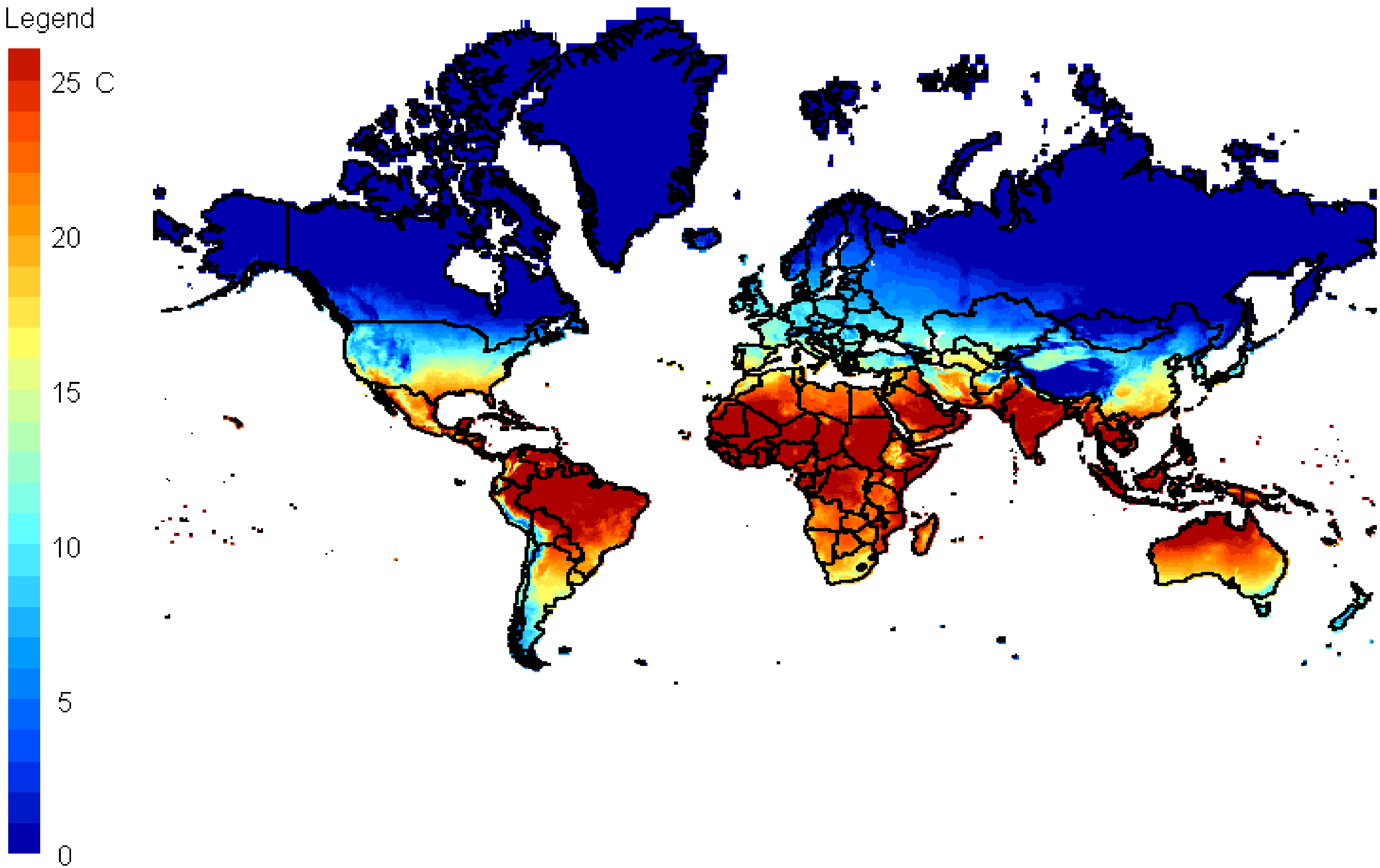
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

“Lilac Devil”

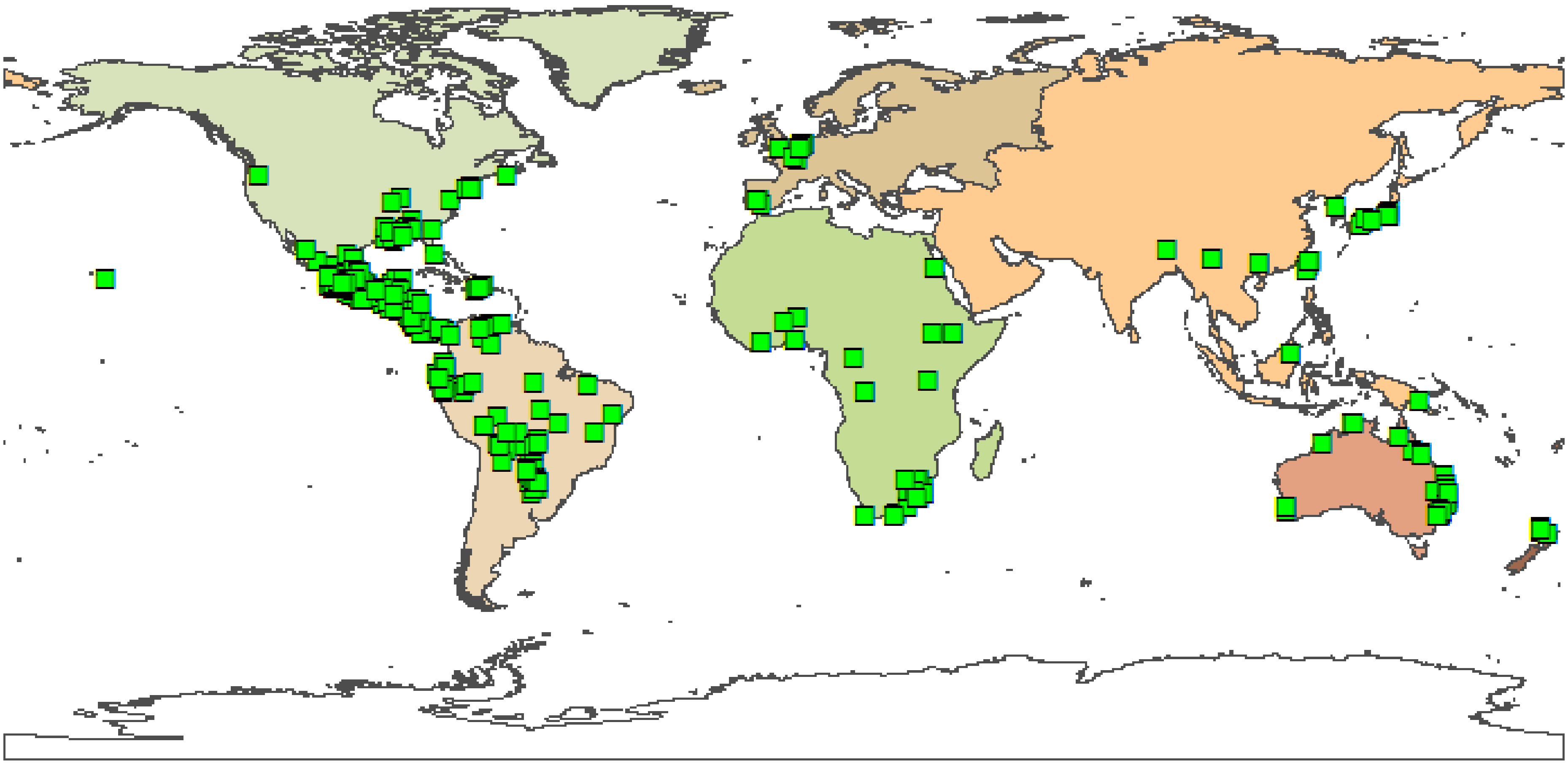
Highest growth rate of ANY vascular plant


Pedro Tenorio-Lezama, Bugwood.org
UGA5204015

Average annual temp, 1951-2002



Water hyacinth – Global occurrences, past 60 years (N = 930)



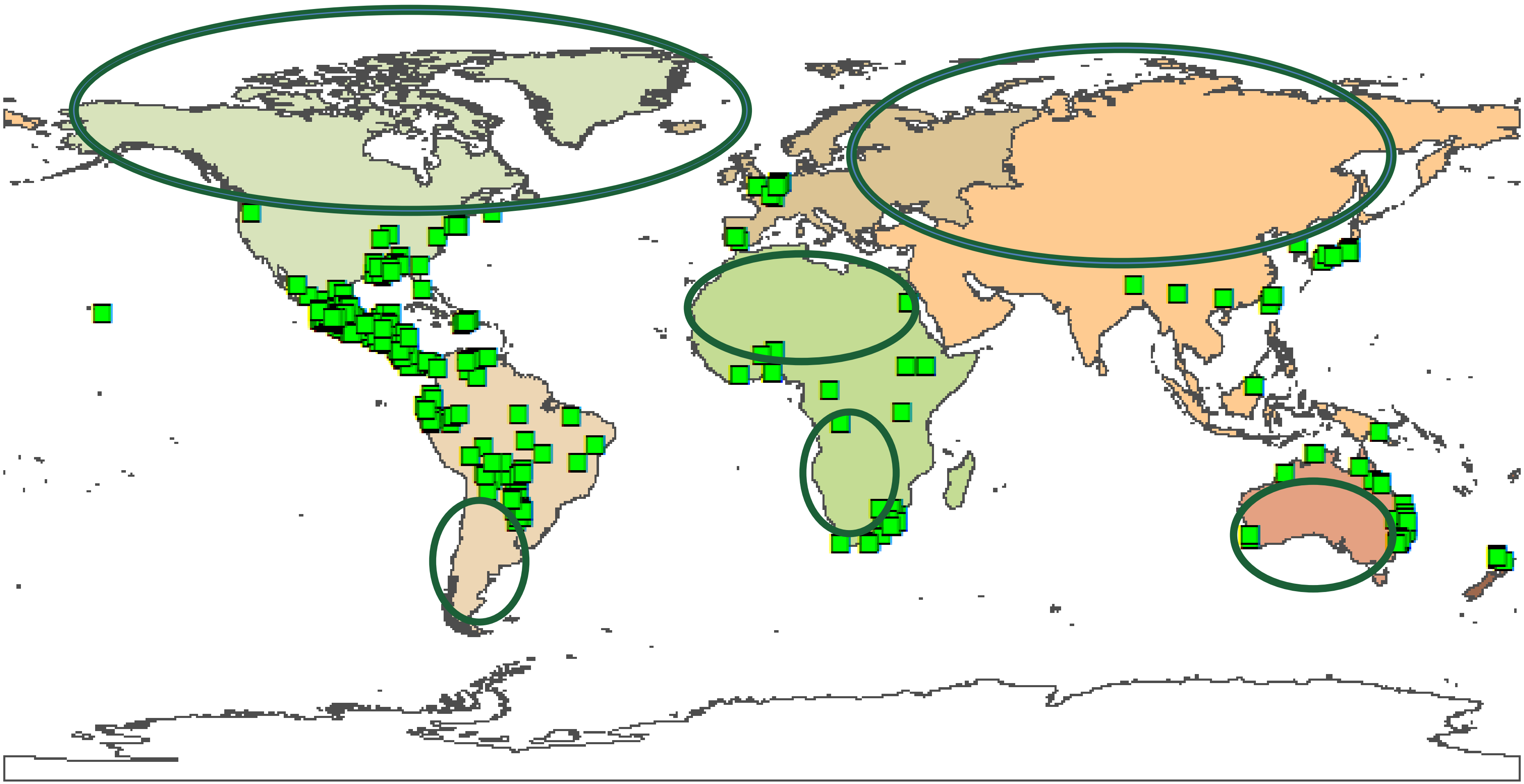
Compare climate conditions in locations with the species
To background conditions that exist elsewhere

Where is climate suitable for water hyacinth?

- Compare climate patterns in occurrence sites
- To climate patterns in background sites

- Extrapolate using gridded climate data to create a continuous suitability surface

Water hyacinth – Global occurrences – BIASED RECORDS (?)



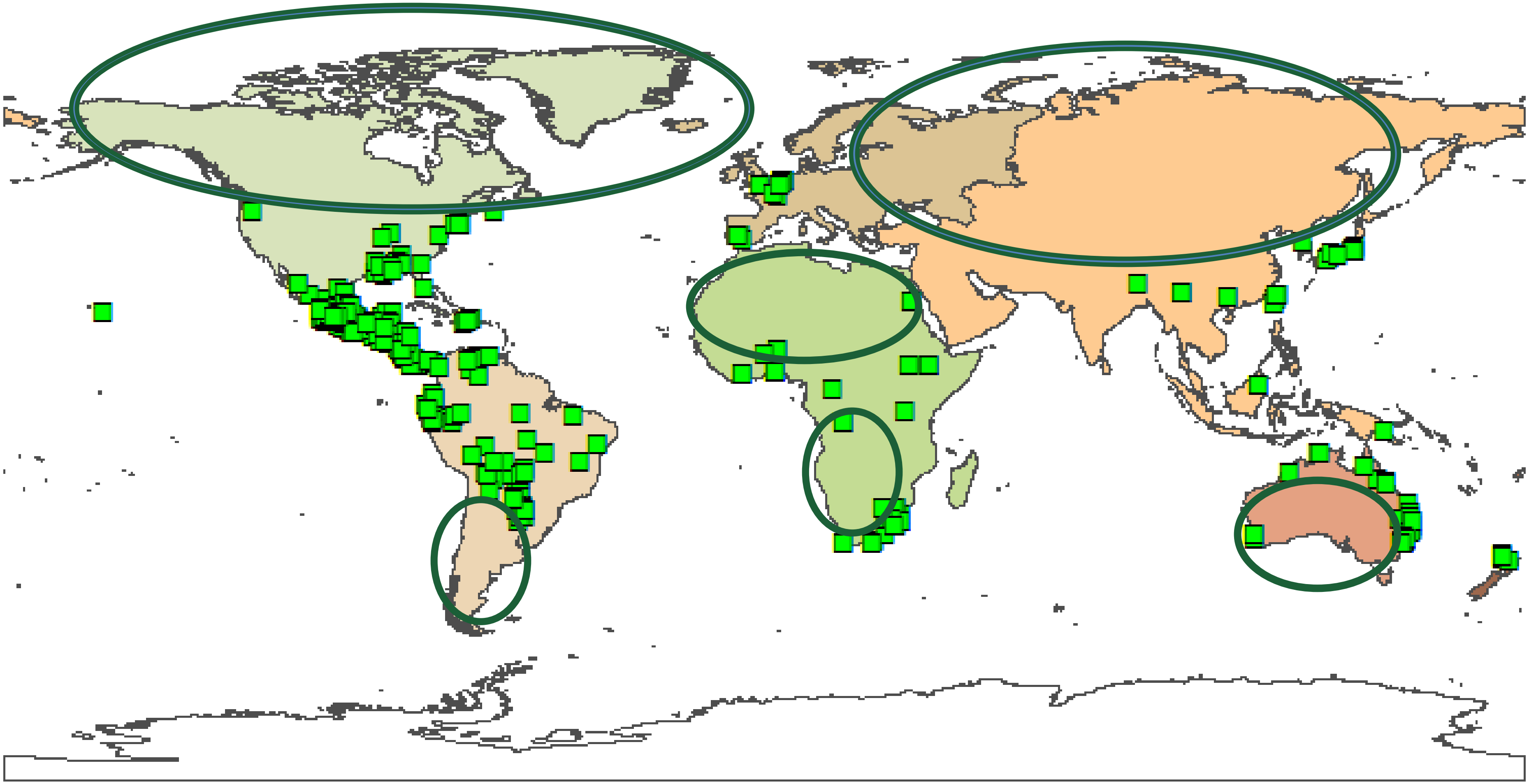
Compare climate conditions in locations with the species
To background conditions that exist elsewhere

Removing sampling bias: Cosmopolitan Species

Graves Lovell, Alabama Department of Conservation and Natural Resources, Bugwood.org

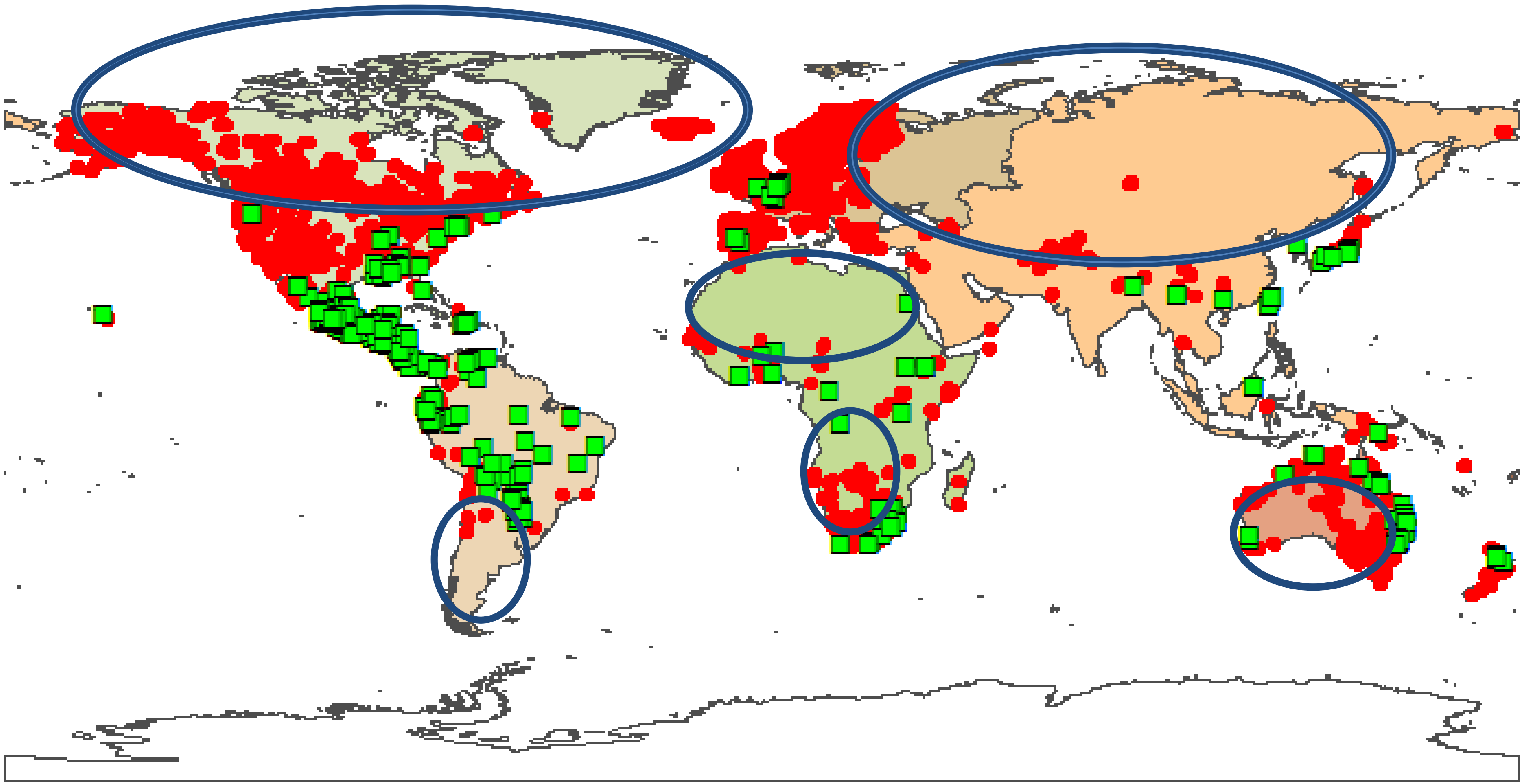
Species	Occurrences
Bolboschoenus maritimus	37061
Ceratophyllum demersum	47865
Cladium mariscus	12402
Eleocharis acicularis	15266
Eleocharis palustris	85739
Lemna gibba	23840
Lemna minor	100744
Lemna perpusilla	322
Lemna trisulca	54365
Najas marina	3763
Phragmites australis	243000
Potamogeton crispus	23144
Ruppia cirrhosa	2375
Schoenoplectus lacustris	33145
Spirodela polyrhiza	53986
Stuckenia pectinata	3756
Typha angustifolia	23181
Typha latifolia	78460
Vallisneria spiralis	152
Wolffia arrhiza	7995
Zannichellia palustris	27352
Total	**877913**

Water hyacinth – Global occurrences

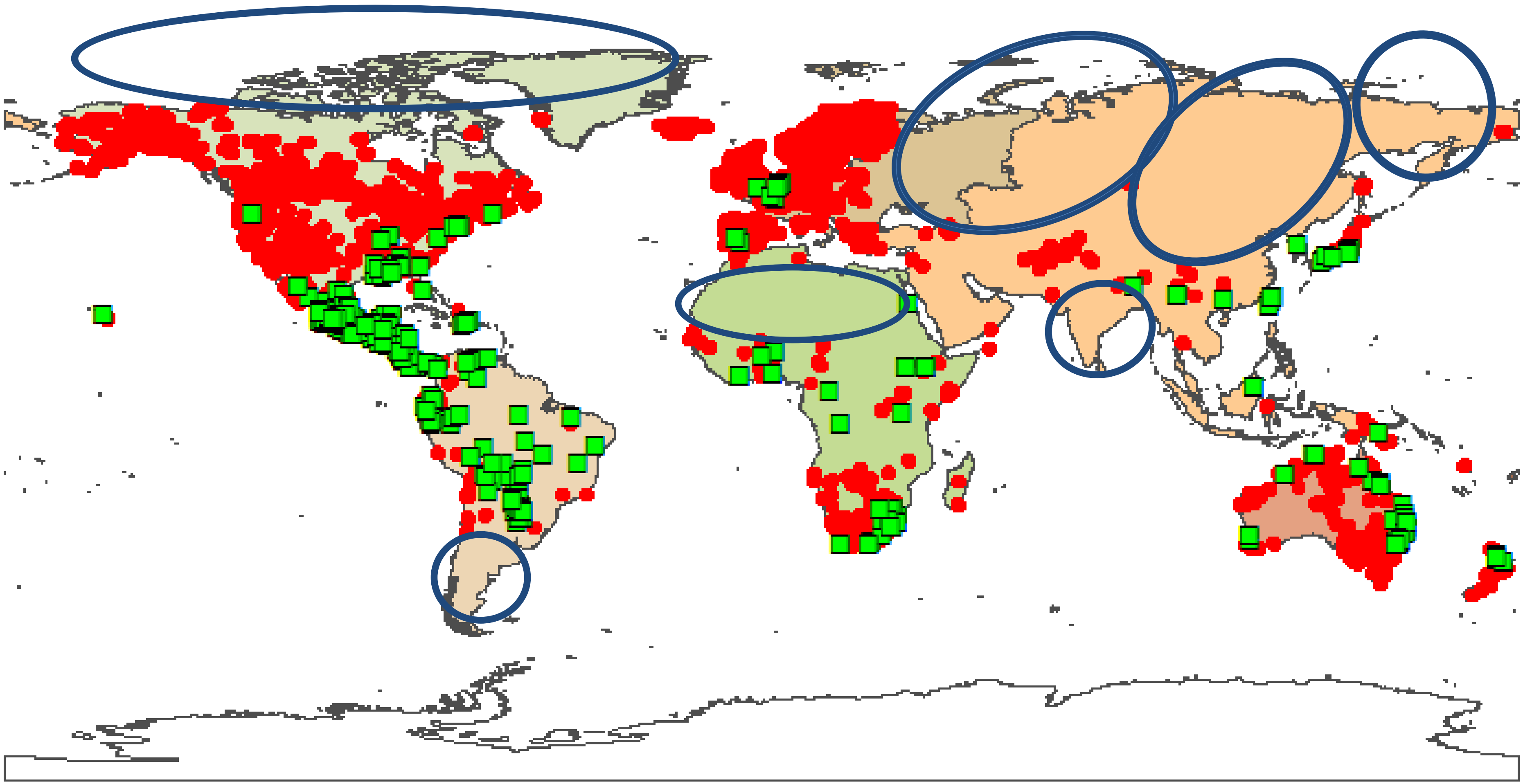


Compare climate conditions in locations with the species
To background conditions that exist elsewhere

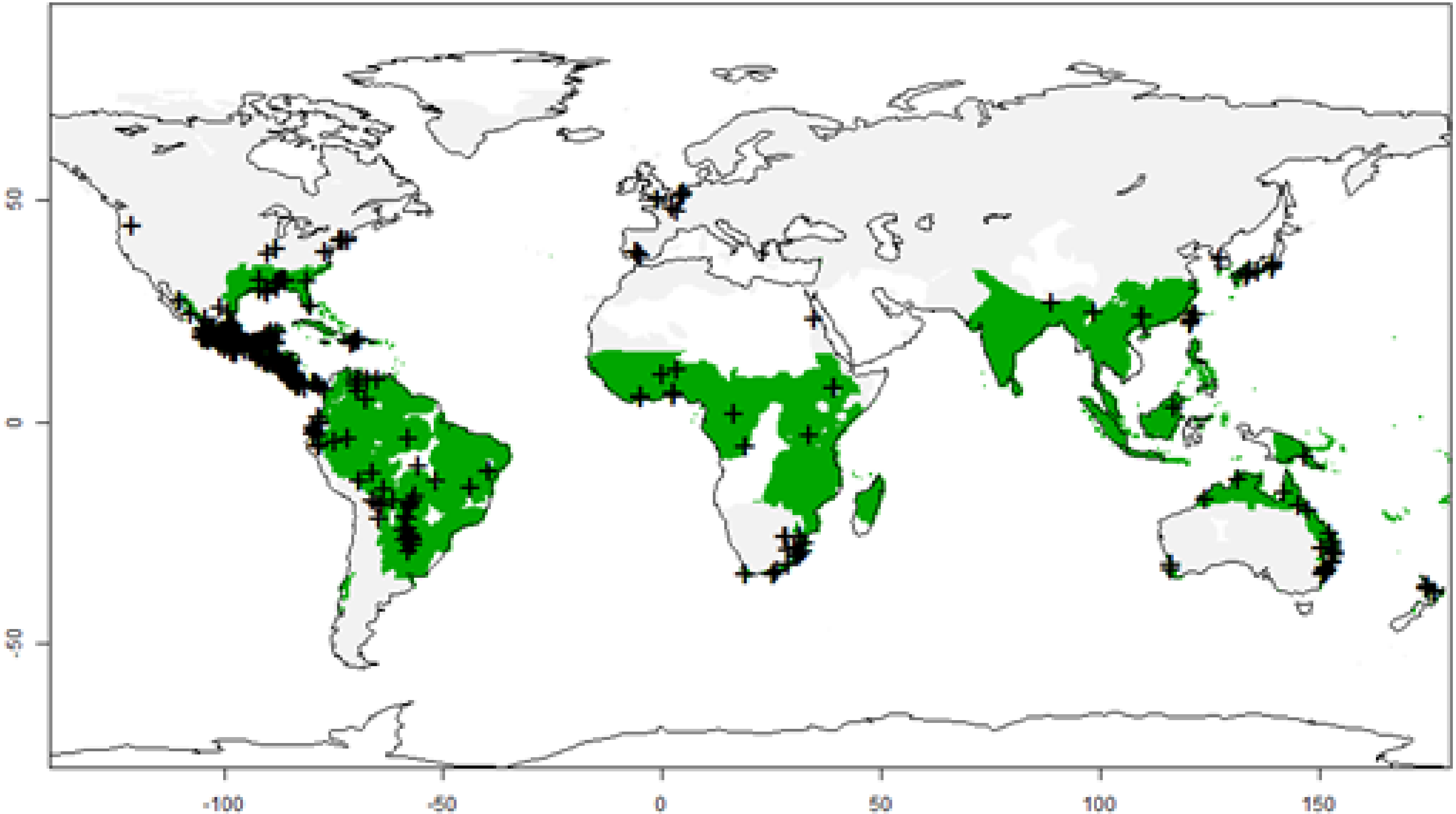
Global occurrences + Cosmopolitan species



Global occurrences + Cosmopolitan species = sample mask

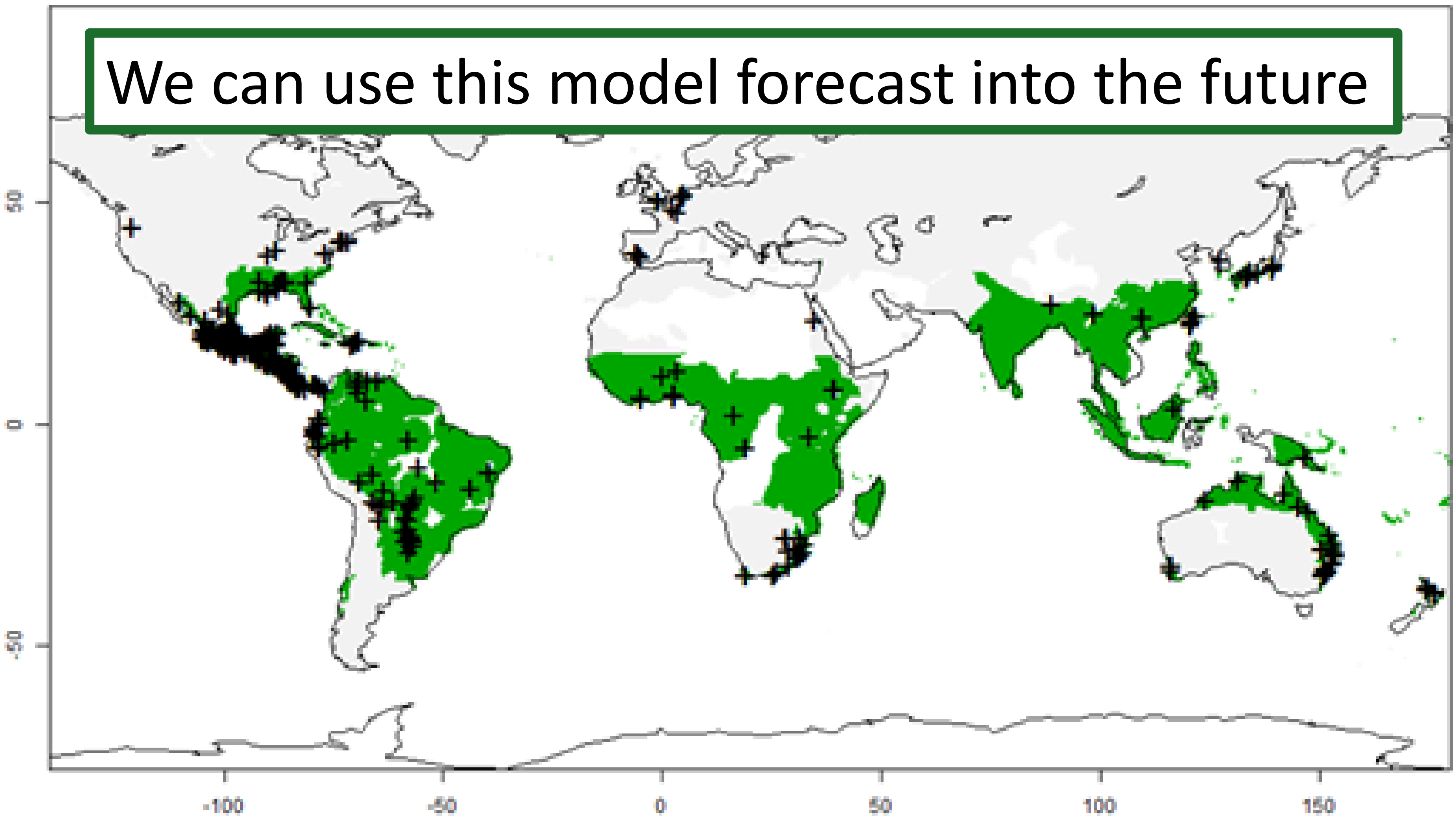


Modelled Range (current)



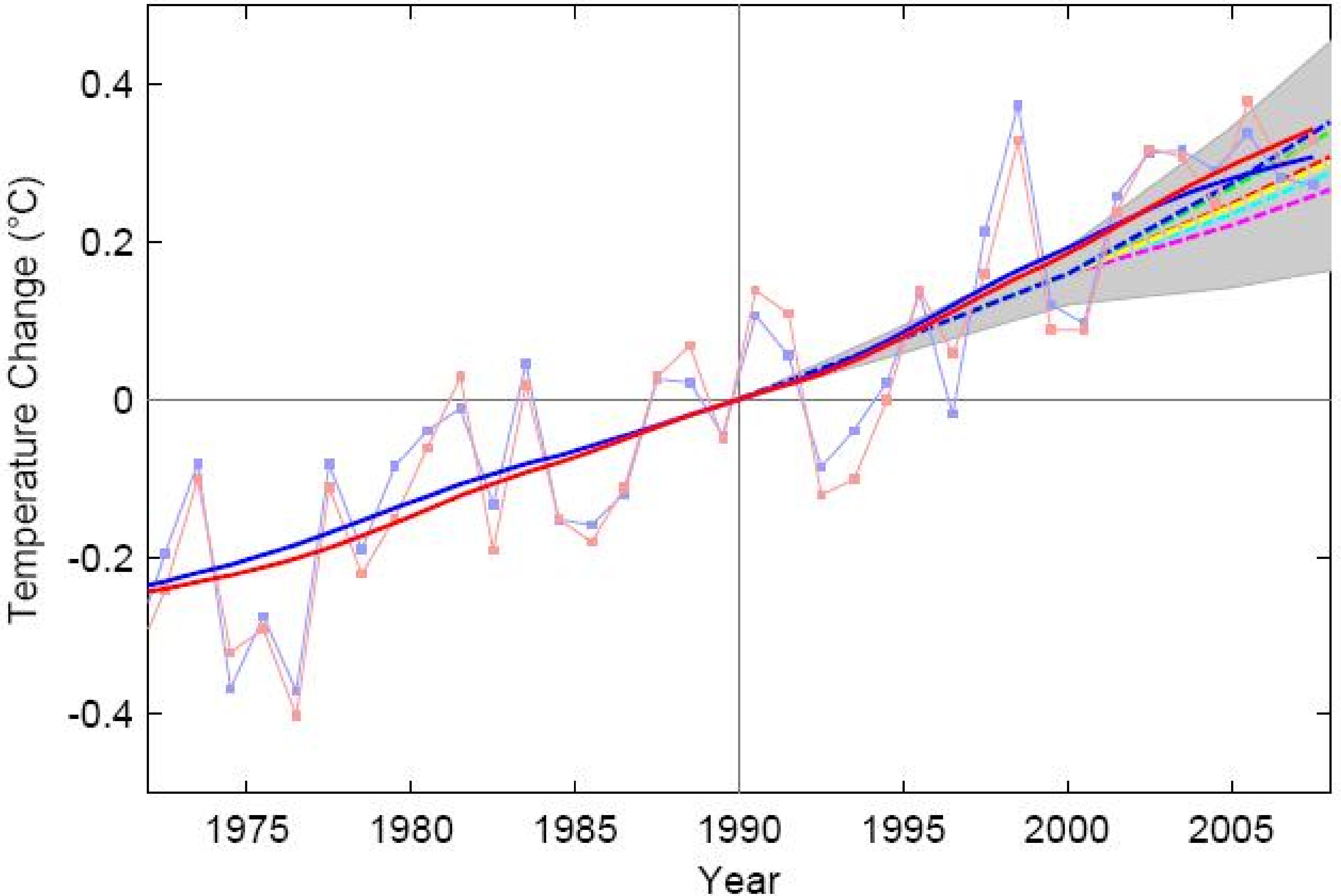
AUC = 0.92 (strong predictive power)

Modelled Range (current)



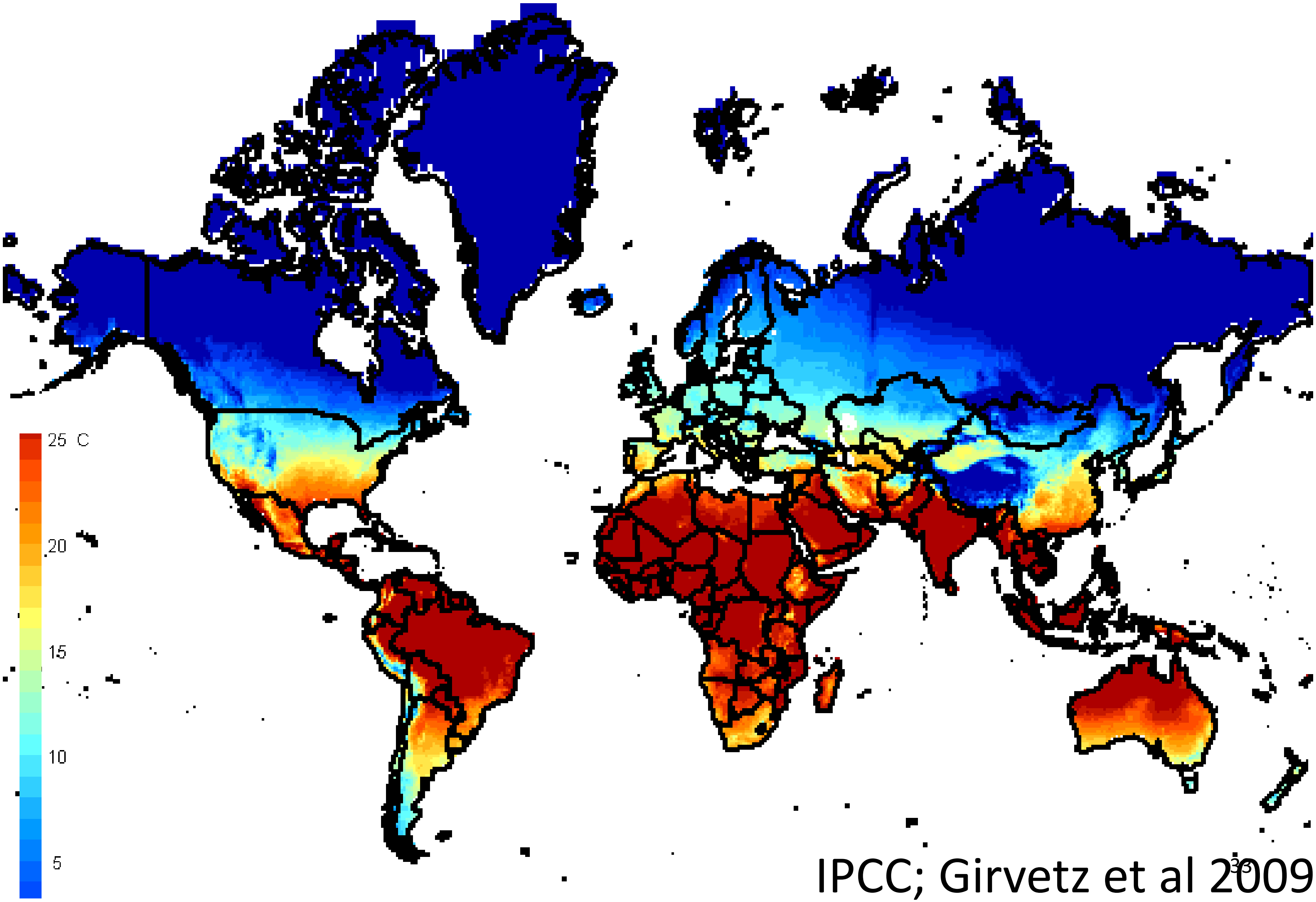
We can use this model forecast into the future

AUC = 0.92 (strong predictive power)



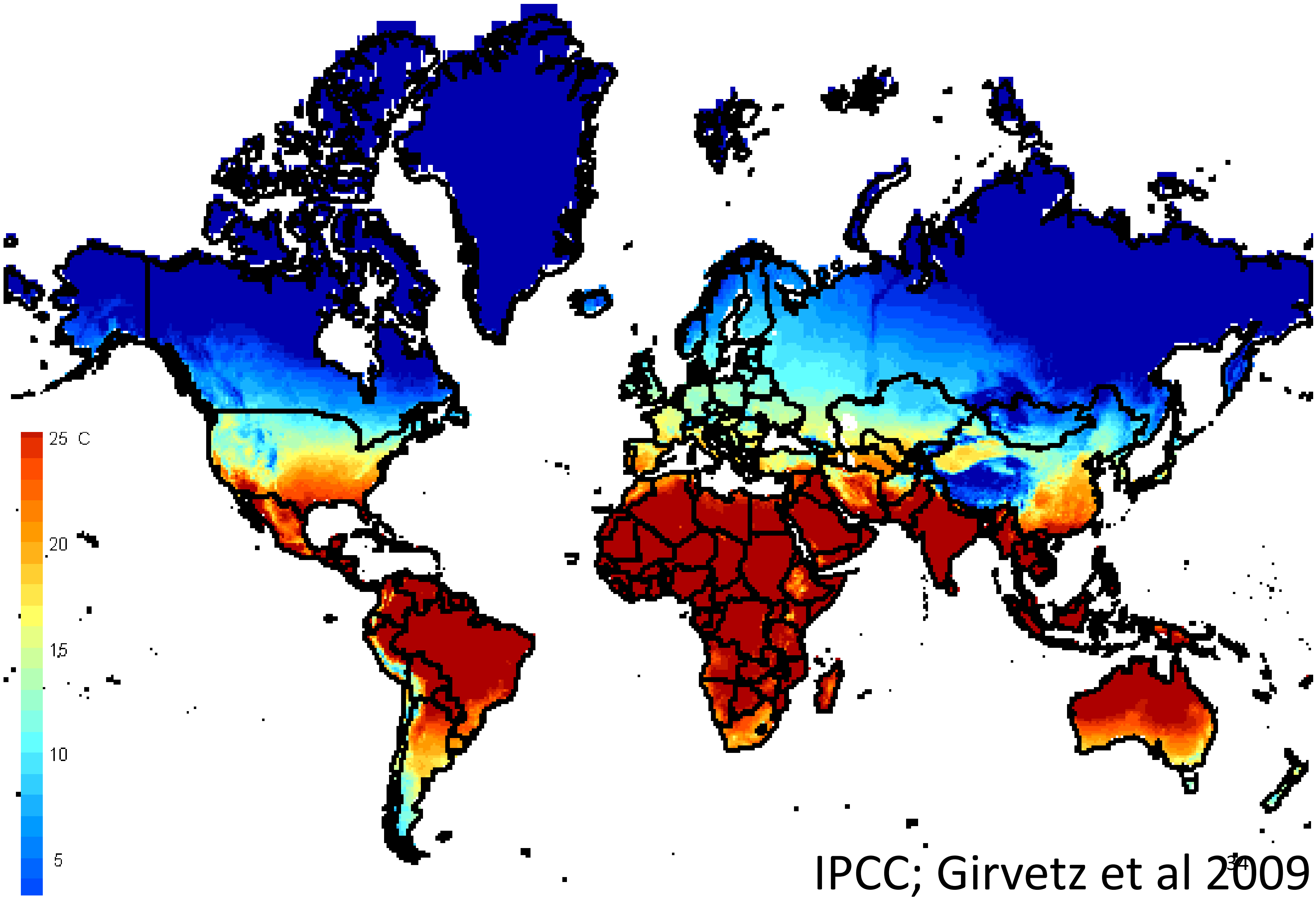
Rahmstorff et al. 2007

Projected annual mean temp, 2040-2069



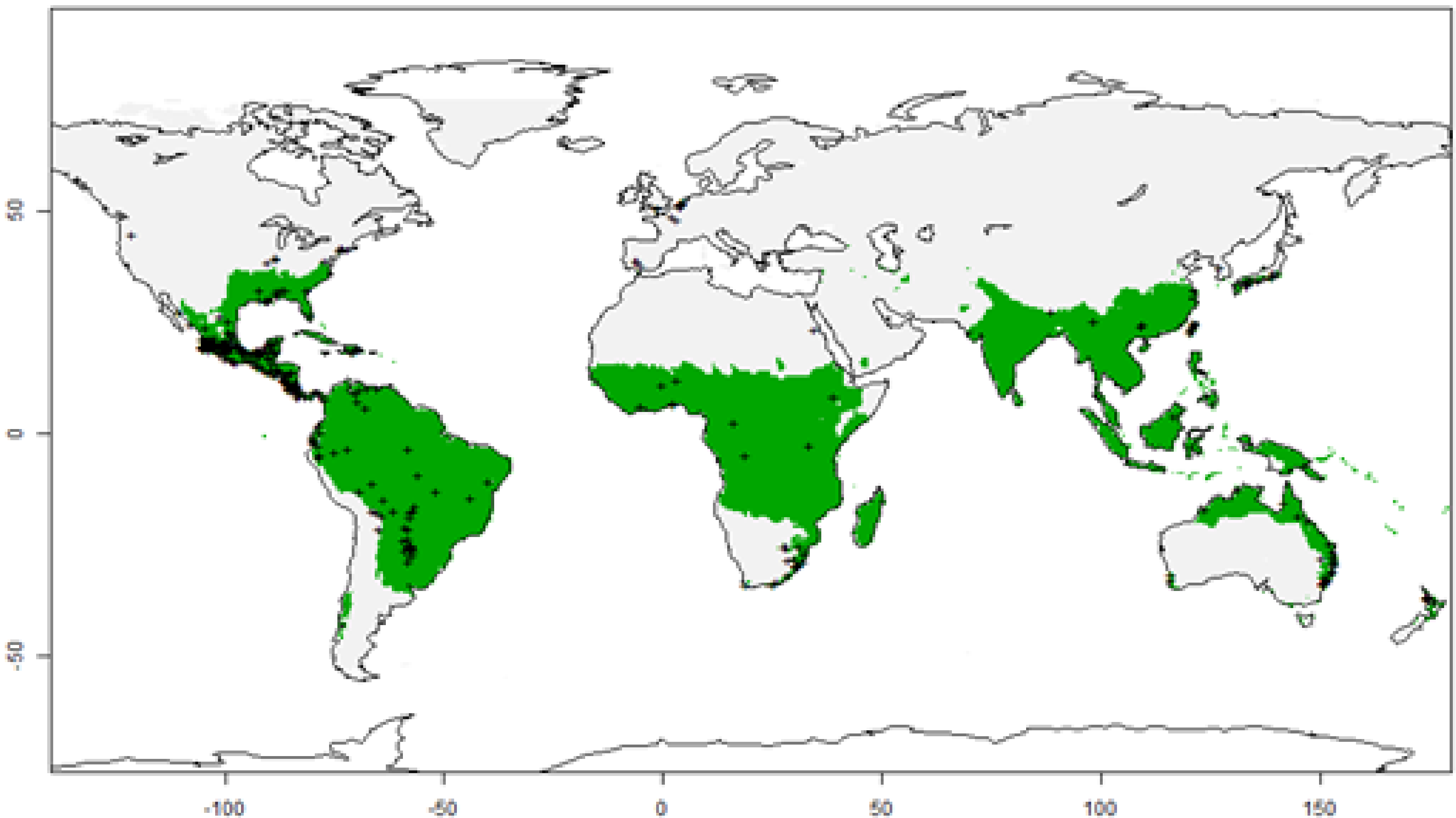
IPCC; Girvetz et al 2009

Projected annual mean temp, 2070-2099

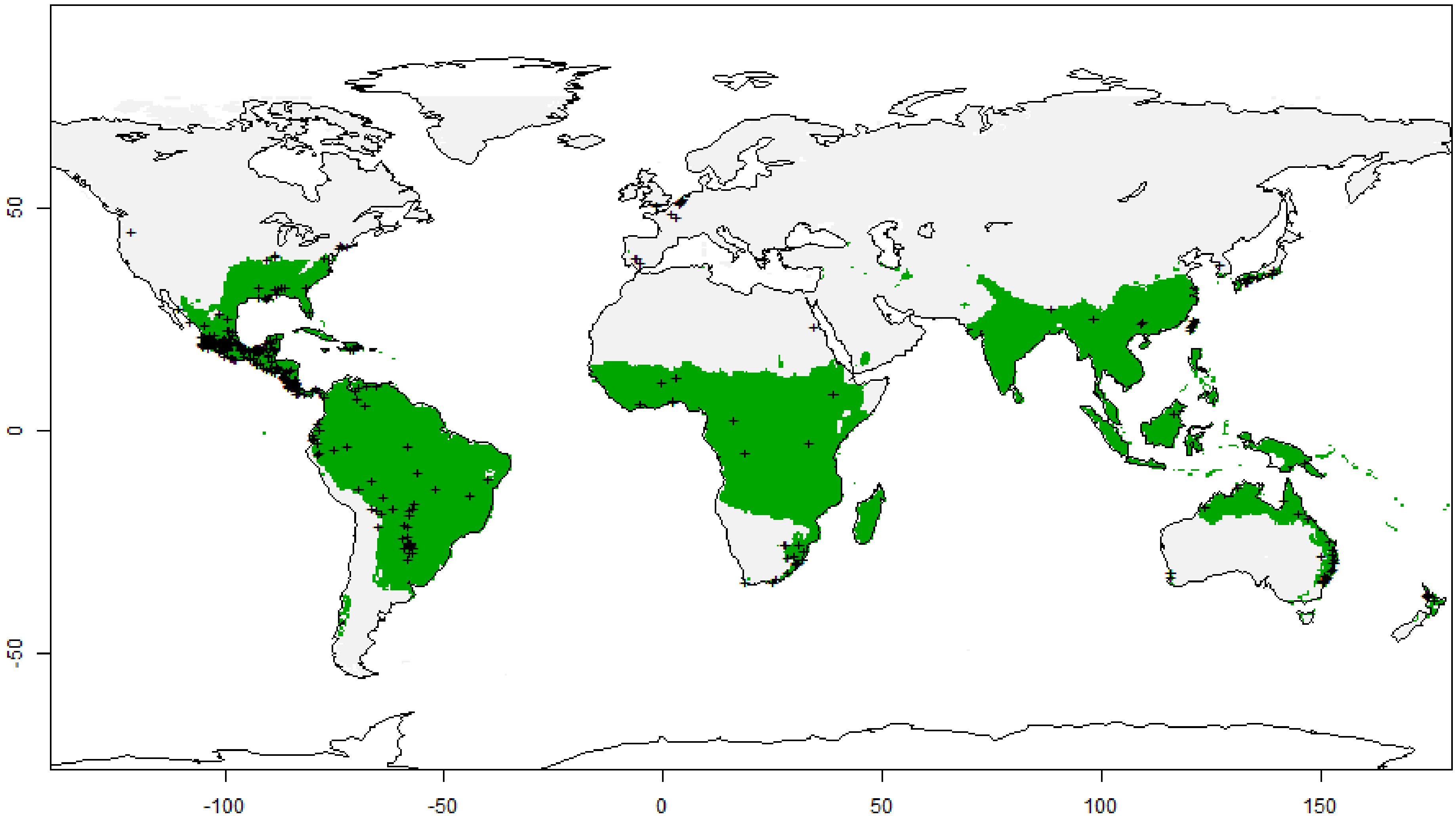


IPCC; Girvetz et al 2009

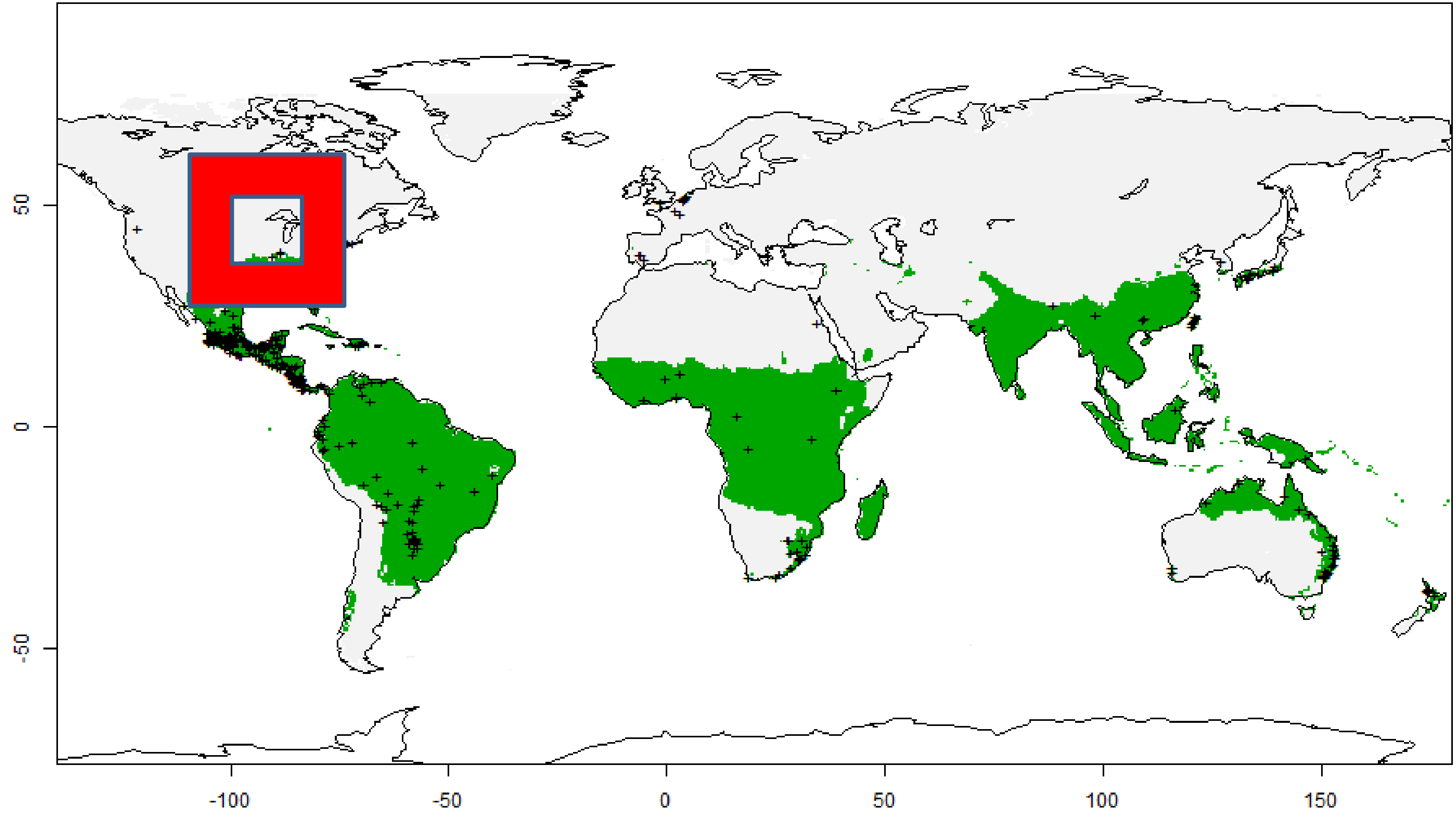
Modelled Suitable Climate (2040-2069)



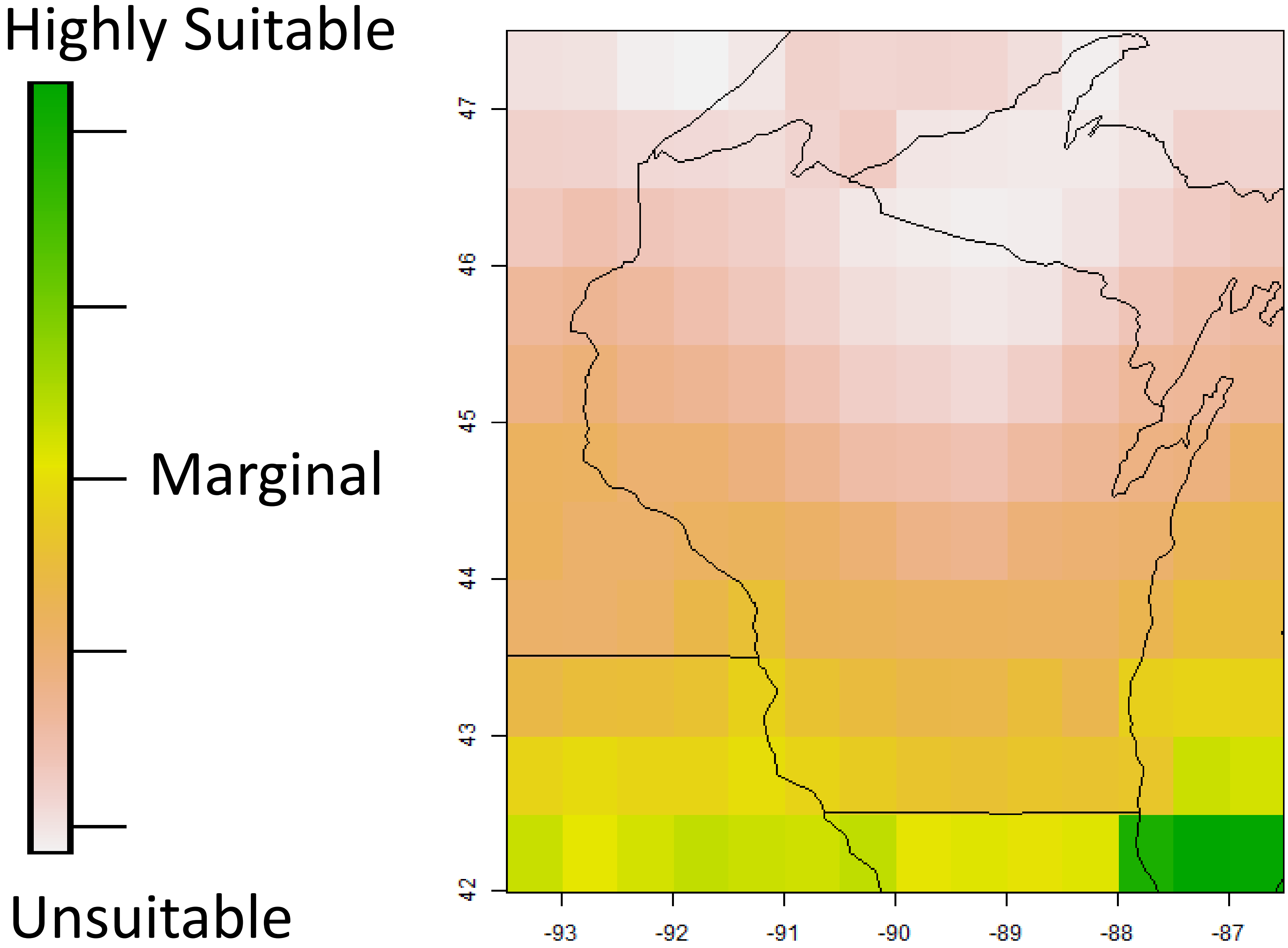
Modelled Suitable Climate (2070-2099)



Modelled Suitable Climate (2070-2099)

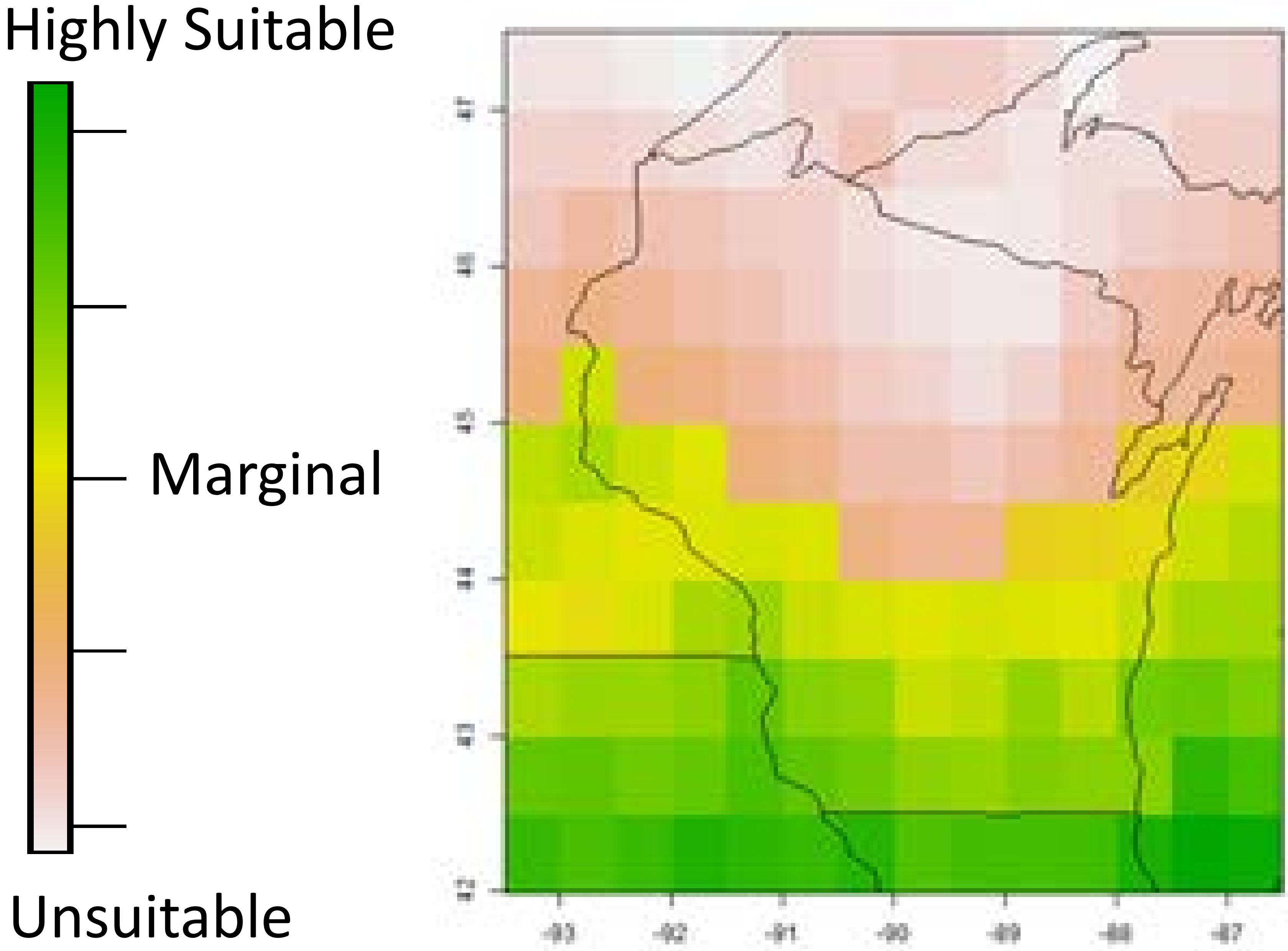


1950-2002

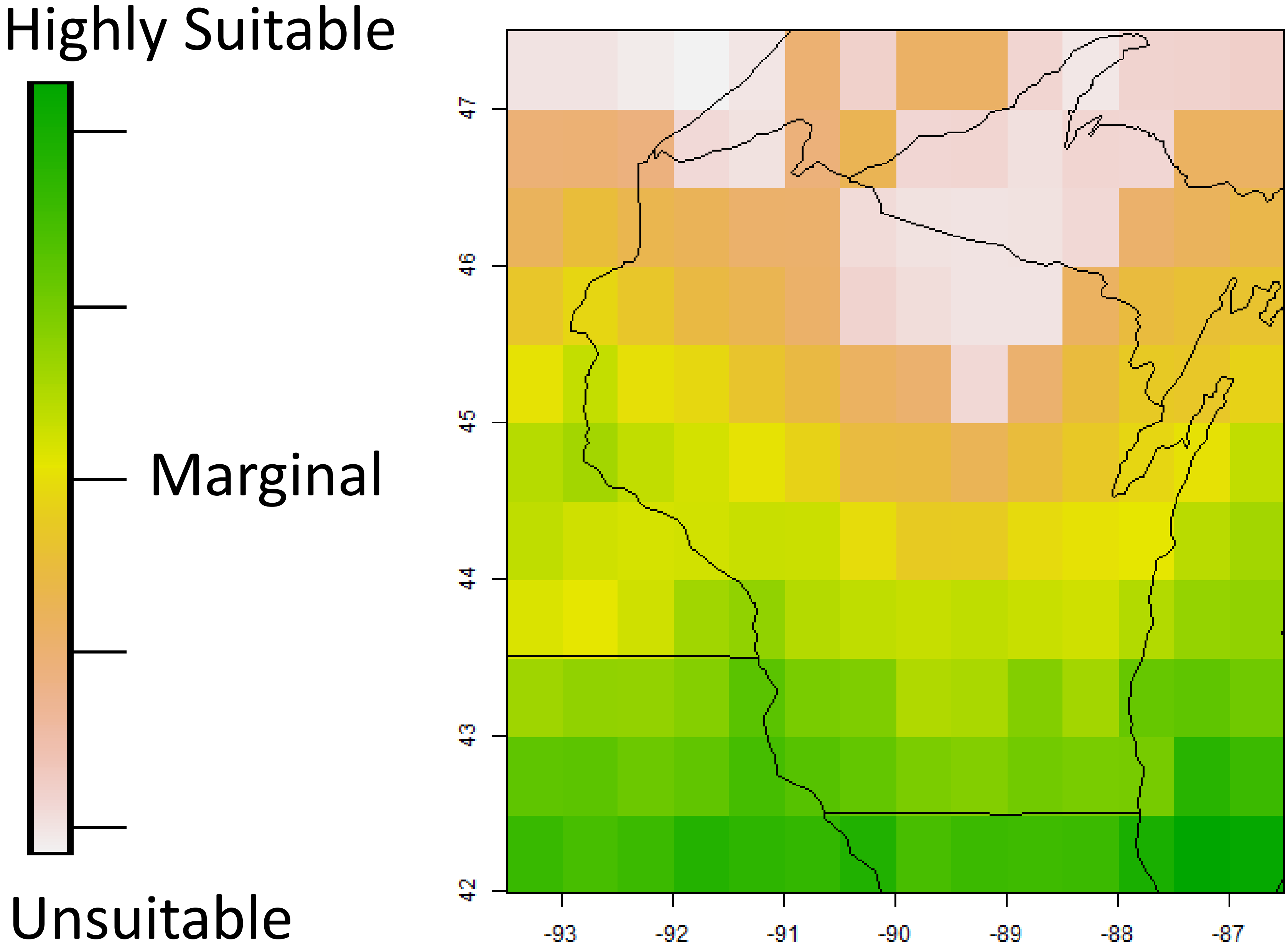


Highly Suitable
Marginal
Unsuitable
47
46
45
44
43
42
-93
-92
-91
-90
-89
-88
-87

2040-2069



2070-2099



Highly Suitable
Marginal
Unsuitable
47
46
45
44
43
42
-93
-92
-91
-90
-89
-88
-87

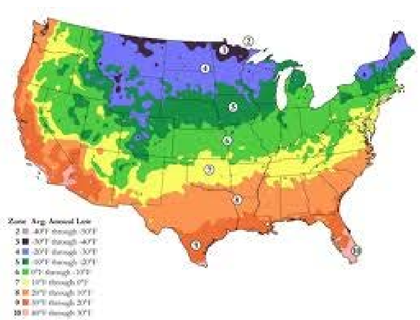
Summary

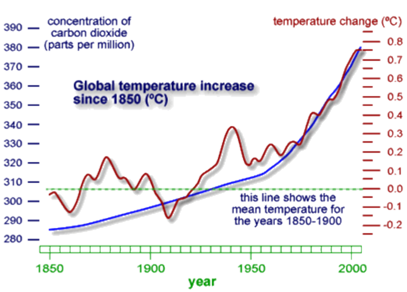
- We can use global species distributions to map climate suitability
- I think this approach will work
- It will help us better understand how climate change may impact the distribution of novel invaders
- 2 species tested:
  - Wisconsin climate was marginally suitable
  - Suitable climate likely to expand/shift northward
- We might want to consider regulation, soon.

Next Steps

- Assess climate suitability for more species
- Estimate uncertainty and range in predictions
- Quantify range expansions and shifts
- Identify invaders for which Wisconsin's climate is (or will be) suitable
- Plan accordingly.

Final Thoughts





- We must prepare invasive species policy for a changing climate
- Quantifying climate suitability will improve risk assessments
- Explicitly considering climate change in invasive species policy will better prepare us for the future

Acknowledgements

- Jennifer Hauxwell, Michelle Nault, Martha Barton, Kelly Wagner
- Jake Vander Zanden, Monica Turner, Steve Carpenter