Wisconsin's changing climate and forecasting invasive species spread.

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Climate change and invasives – Impacts, future invaders, and adaptation approaches

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Major topics

- Future climate scenarios for Wisconsin from WICCI
  - *How will Wisconsin resemble other states?*
- Selecting species for analysis
  - *Which species are found in other states or important lists?*
- Using Risk Assessment Mapping Program (RAMP) for climate match scores
  - *How will those species predicted to respond using models?*
- Identifying species patterns for current and future threats
  - *Do we have it now, is it close to Wisconsin?*

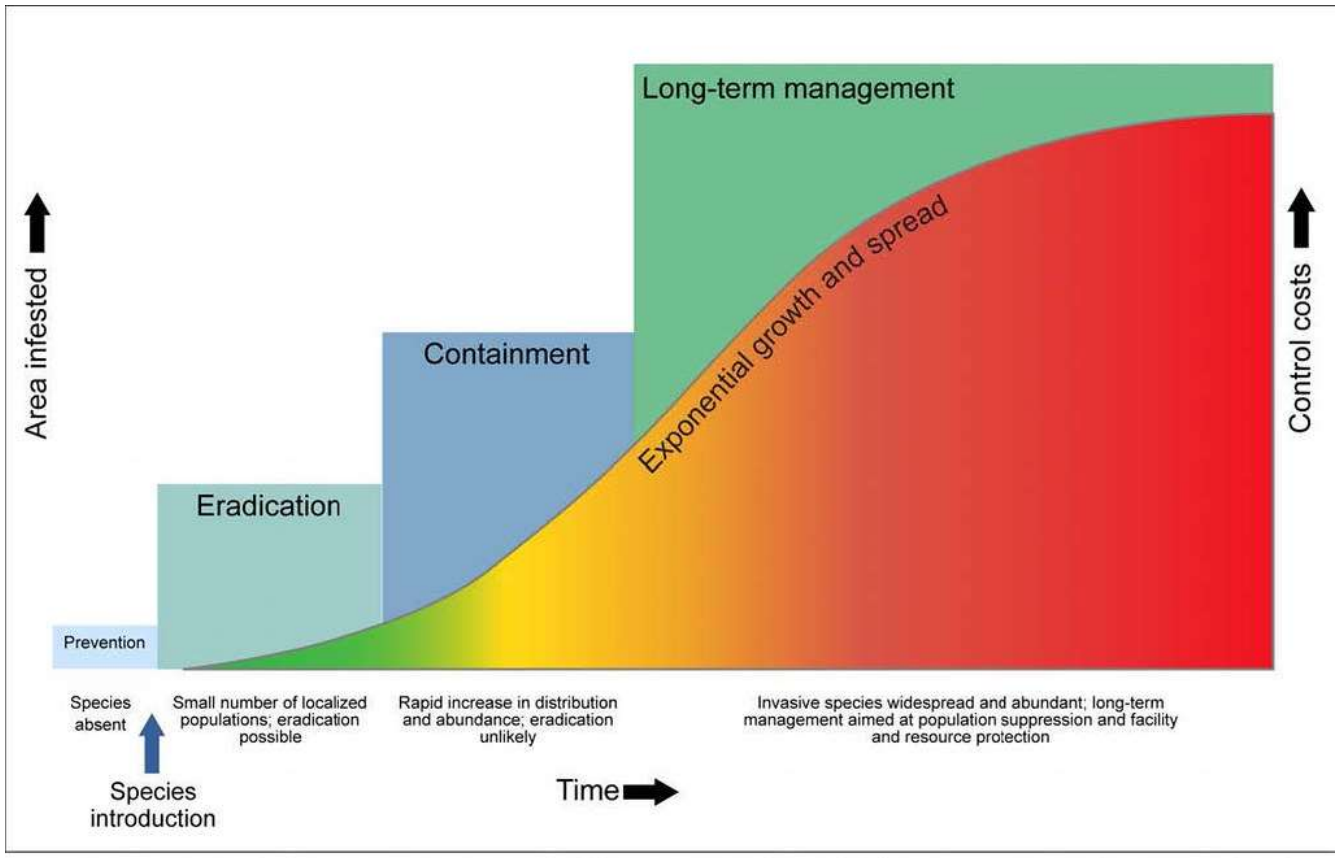
Impacts of Climate Change on Invasive Species

- Climate change is expected to:
  - Create extended spring season which benefits invasives colonization and competition over native species
  - Changes in flowering schedules, which invasives can adapt to better over native species
  - Increased CO2 can hinder native ecosystem recovery, invasives can use increased productivity to deny natives of resources
  - Nitrogen deposition favors fast growing plants

Climate change and pro-active planning

With climate change, can we assess current threats and predict future threats before they arrive?

We can by using climate scenarios.

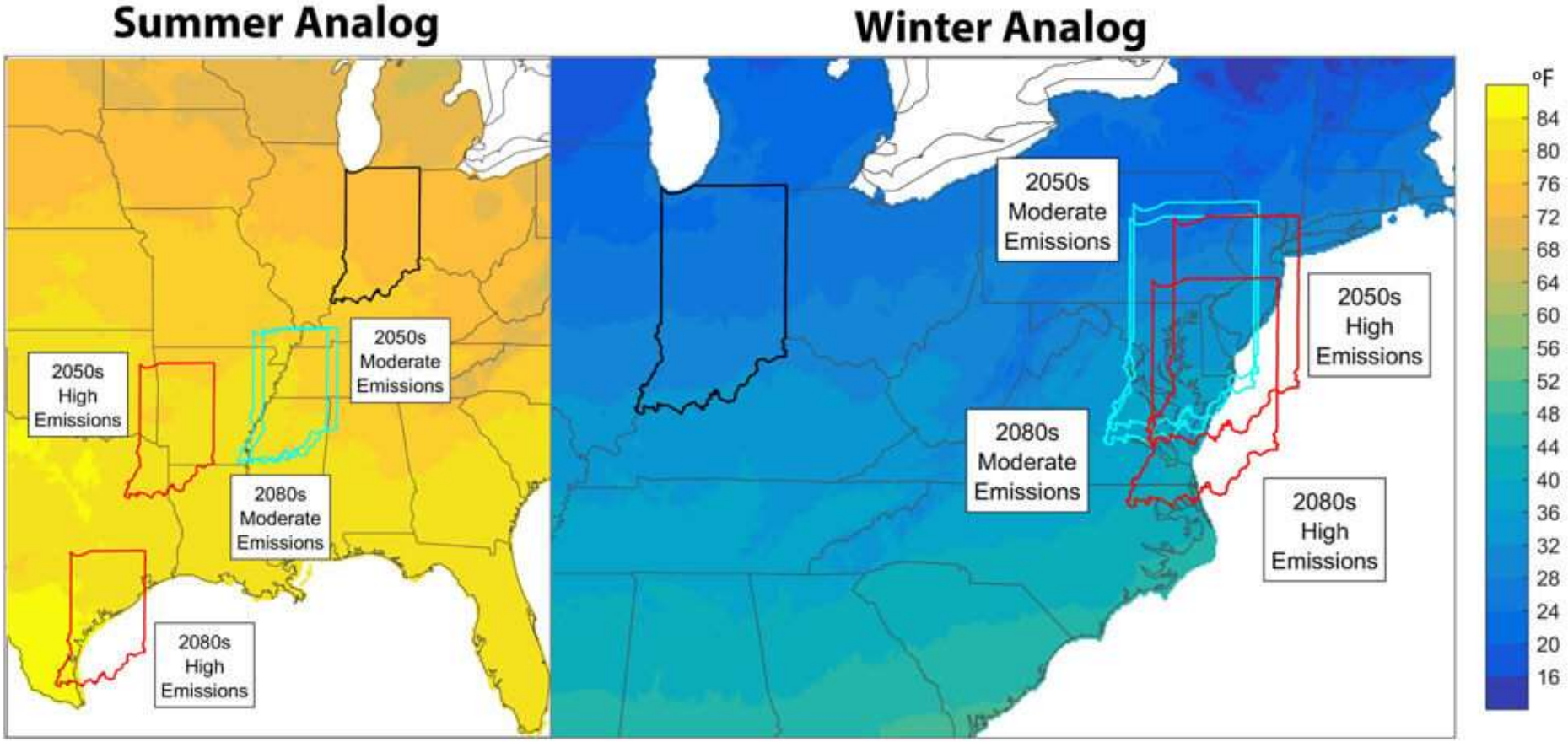


Sources: National Invasive Species Council; U.S. Department of Agriculture; National Park Service; U.S. Fish and Wildlife Service; Rodgers, L, South Florida Water Management District; Department of Primary Industries, State of Victoria, Australia; and GAO. | GAO-16-49

Future climate scenarios

- In coming decades Wisconsin's climate is expected to shift with changes in precipitation and temperature.
- Areas of Wisconsin are expected to resemble adjacent states. Known as "climate analogues".
- If we know which species are found in Wisconsin's climate analogues, they may colonize it in the future.

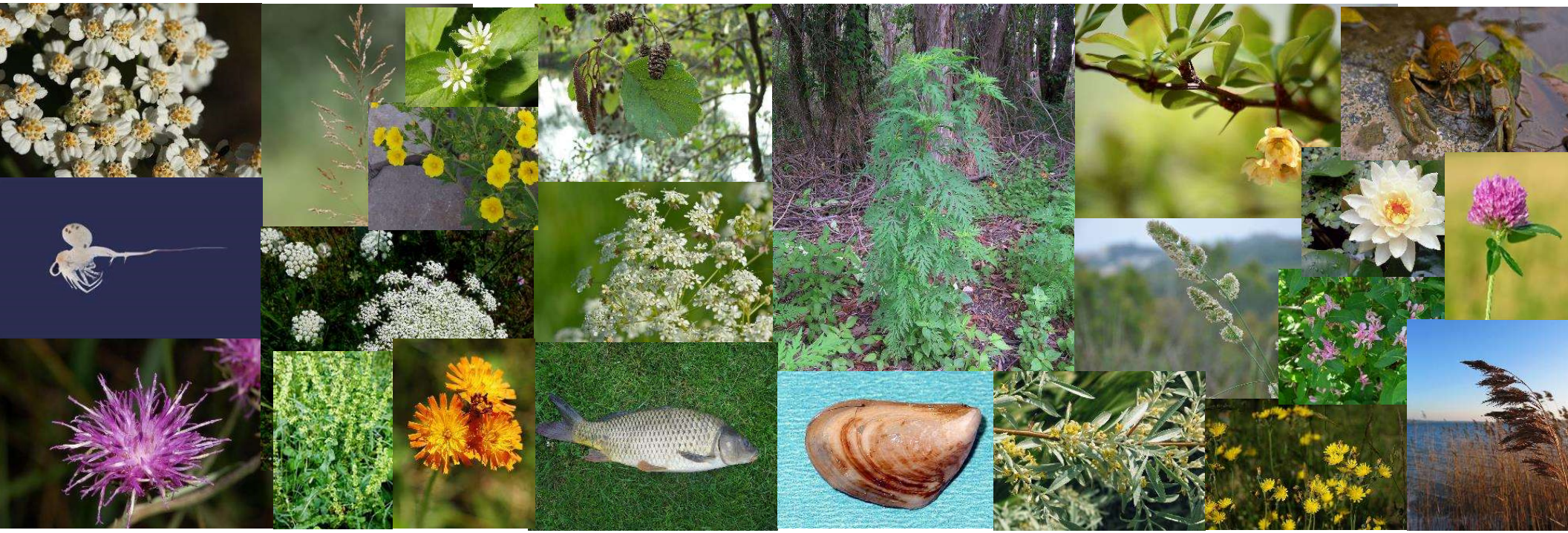
Climate analogues



https://ag.purdue.edu/indianaclimate/indiana-climate-report/

Predicting how species respond in the future

Since there are thousands of species, how do we select the targets for analysis? See what species are found in climate analogue states.

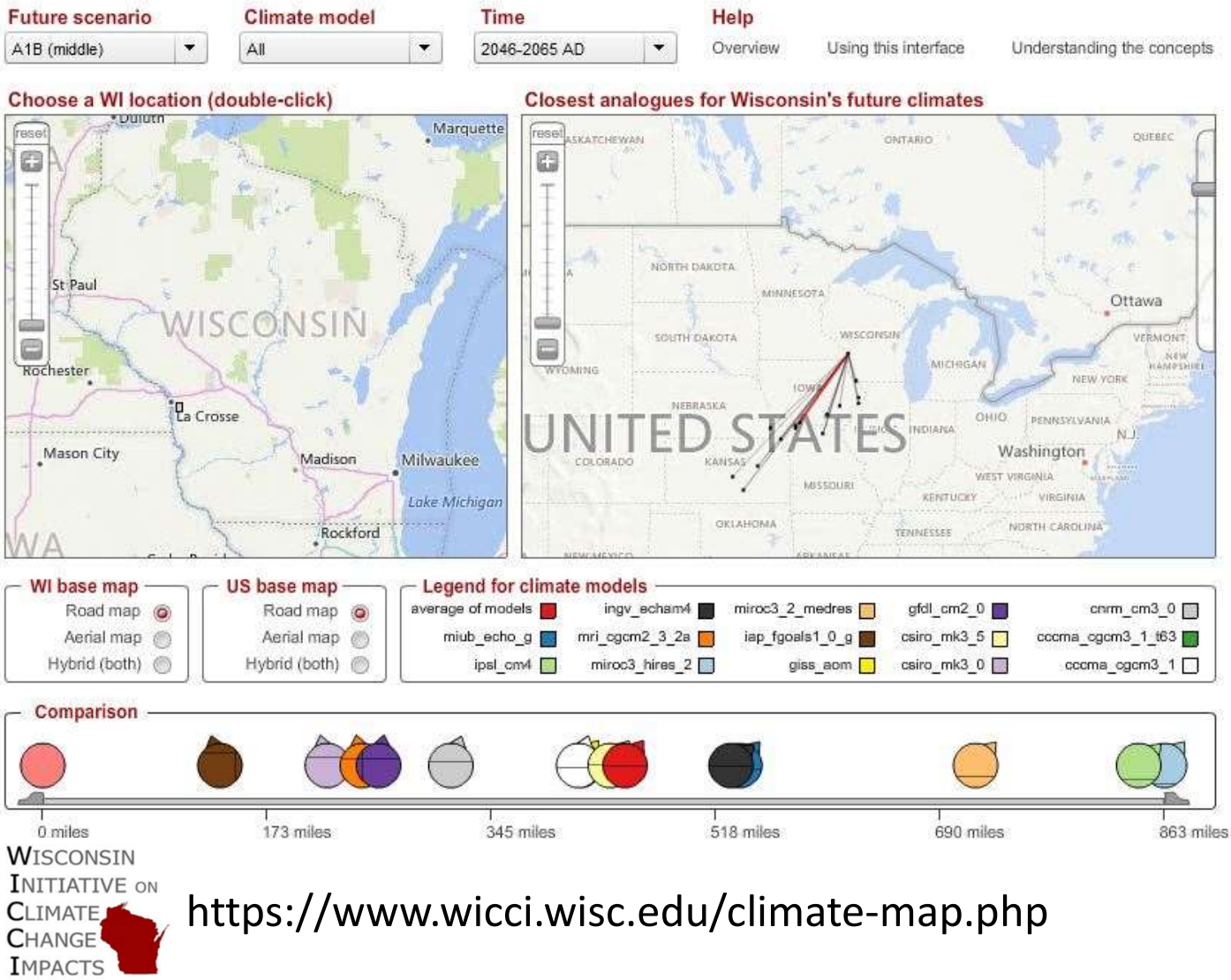


WICCI Interactive Mapping Tool

WICCI has a climate analogue match tool.

Predicts how the target area may appear under future climate scenarios.

Analogue states include: Wisconsin, Illinois, Indiana, Iowa, Kansas, Minnesota, Nebraska, Ohio, Michigan, & Virginia



WISCONSIN INITIATIVE ON CLIMATE CHANGE IMPACTS

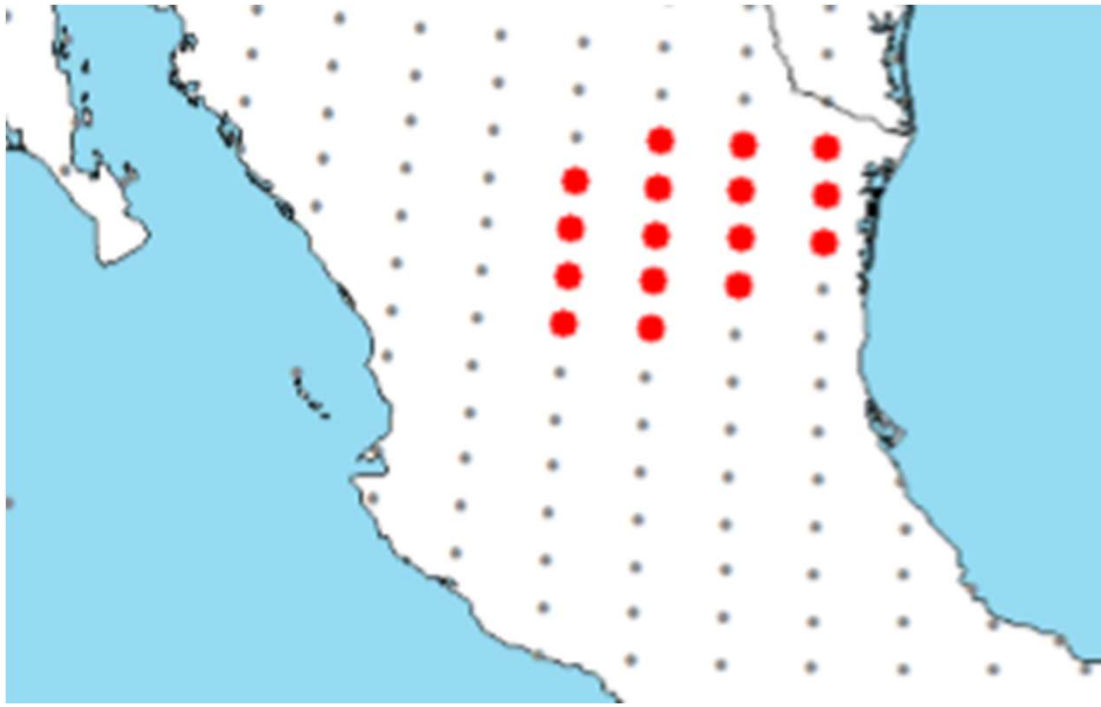
https://www.wicci.wisc.edu/climate-map.php

Species Lists

- Lists include:
  - EDDMapS records from WICCI analogue states.
  - Wisconsin's NR40: Invasive Species Rule
  - Midwest Invasive Plant Network (MIPN) – Invasive Plant list
  - USFWS Ecological Risk Screening Summaries (High risk species)
- 436 species found for aquatic, wetland & terrestrial habitats.
- Species are then analyzed using USFWS' Risk Assessment Mapping Program (RAMP)

USFWS Risk Assessment Mapping Program (RAMP)

- USFWS uses RAMP for ecological risk screening summaries.
- RAMP looks at similarities between selected global climate stations and matches them to climate stations within North America.
  - Looks at where target species is found now then compares where it could be using 16 climate variables.
- Has current and future climate matching at mid- and end-century.



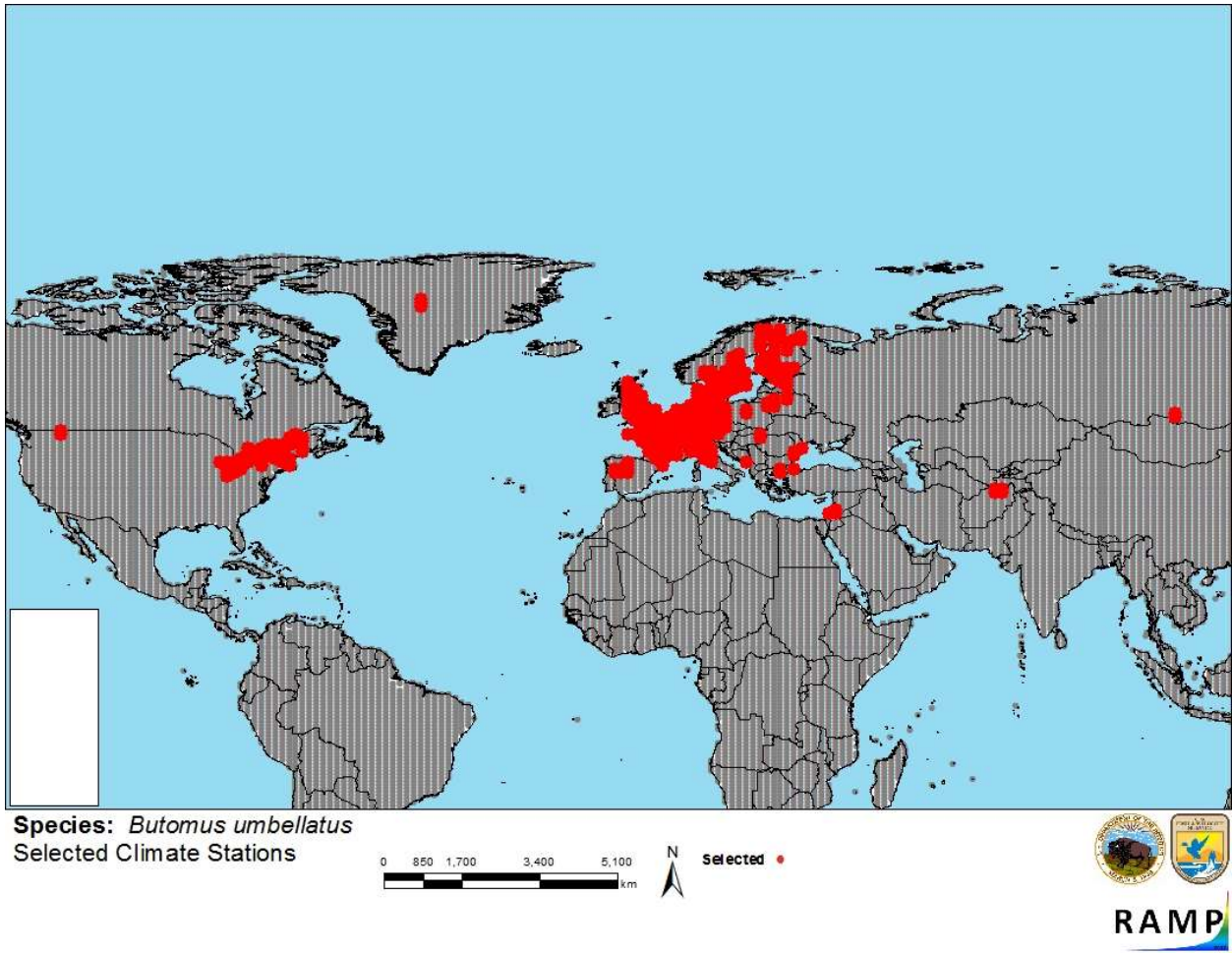
USFWS Risk Assessment Mapping Program (RAMP)

- 16 Climate Variables used in RAMP
- Divided into two major categories:

Temperature Variables	Precipitation Variables
Average Mean Temperature	Annual Precipitation
Max Temperature of Warmest Month	Precipitation of Wettest Month
Min Temperature of Coldest Month	Precipitation of Driest Month
Temperature Annual Range	Precipitation of Seasonality
Mean Temperature of Wettest Quarter	Precipitation of Wettest Quarter
Mean Temperature of Driest Quarter	Precipitation of Driest Quarter
Mean Temperature of Warmest Quarter	Precipitation of Warmest Quarter
Mean Temperature of Coldest Quarter	Precipitation of Coldest Quarter

Running RAMP…

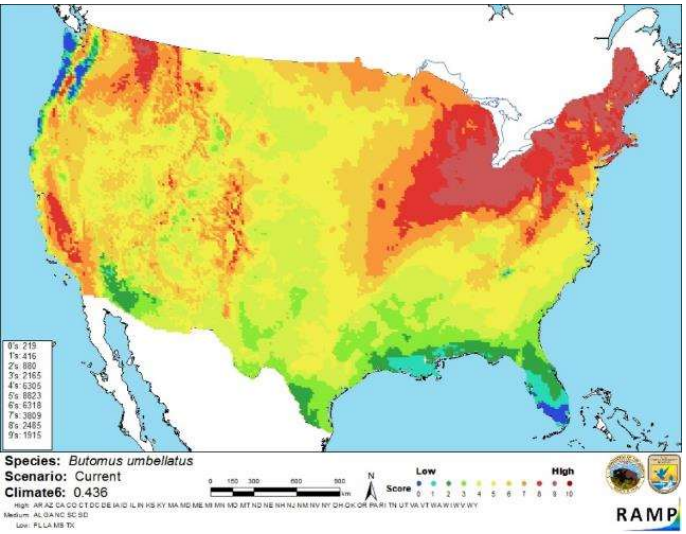
- Script gets records from Global Biodiversity Information Facility (GBIF). It has 987,000,000+ species records.
- Obtains a subsample of records and joins them to climate stations.
- Records expanded to include local verified records.



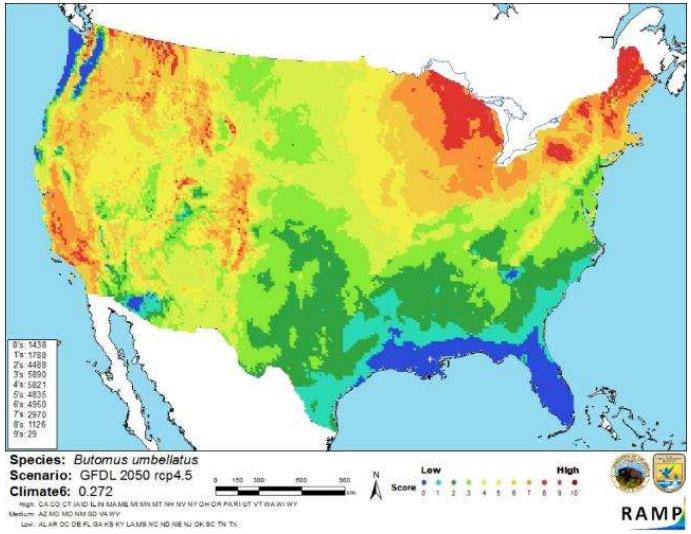
Example of GBIF records linked to climate stations

Climate match output:
National map for each species

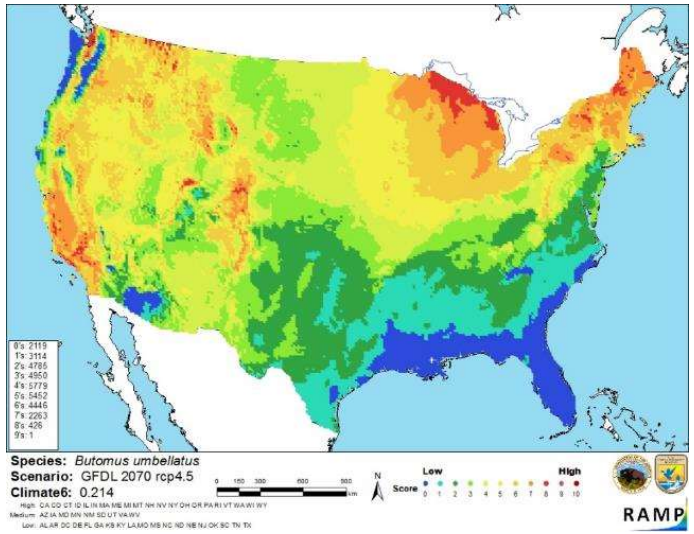
Example: Flowering rush (*Butomus umbellatus*)



Current emissions scenario



2050 scenario



2070 scenario

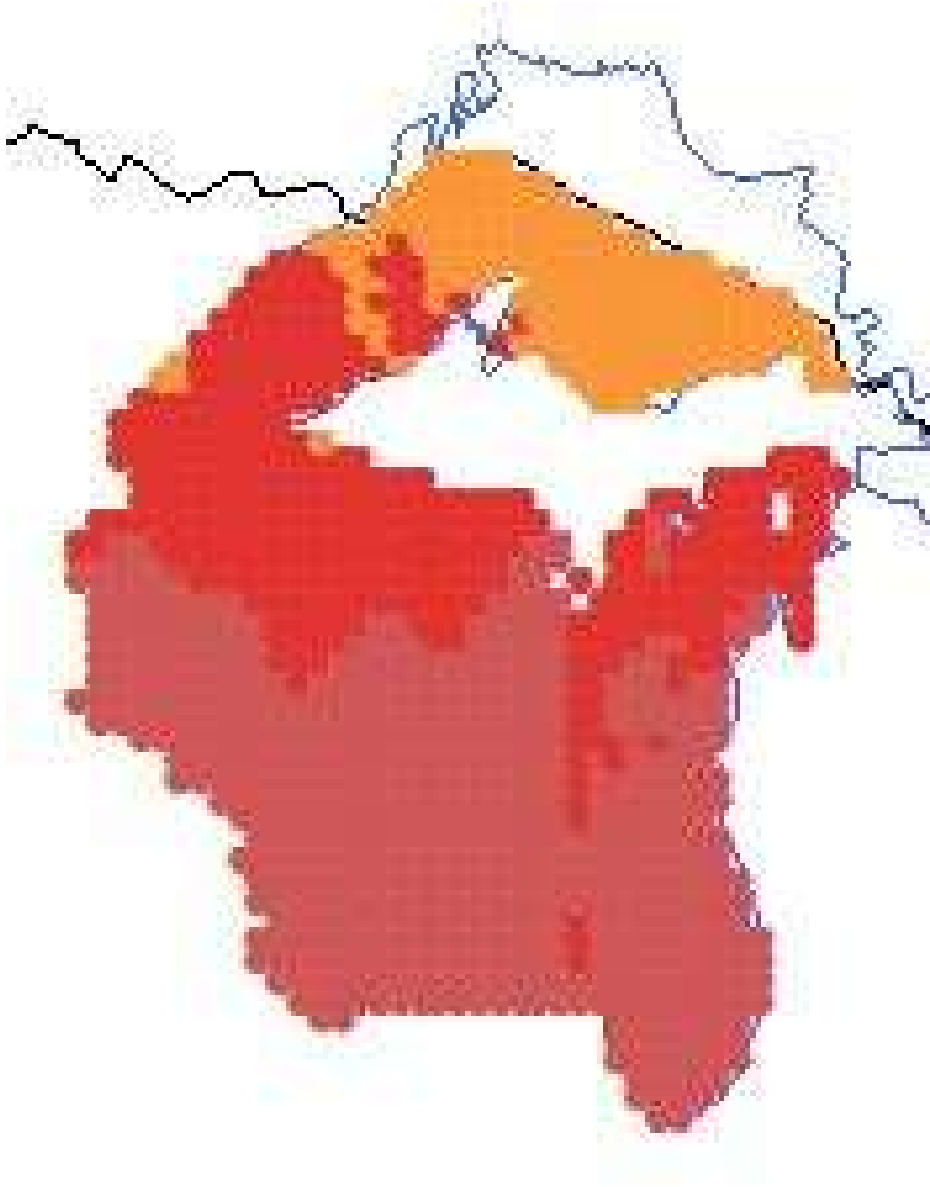
Values range from **0 (Blue)** **to** **5 (Yellow)** **to** **10 (Red)**. The warmer the colors, the better the climate match & suitability. Scores 6+, climate matches.

RAMP output in Wisconsin

<u>How suitable is this species to Wisconsin?</u>
National scores clipped to Wisconsin, southern Lake Superior and Lake Michigan.

Scores interpreted using Score Average.

If the species' average is greater than 6, then the climate is suitable for the species at some point during its life history.



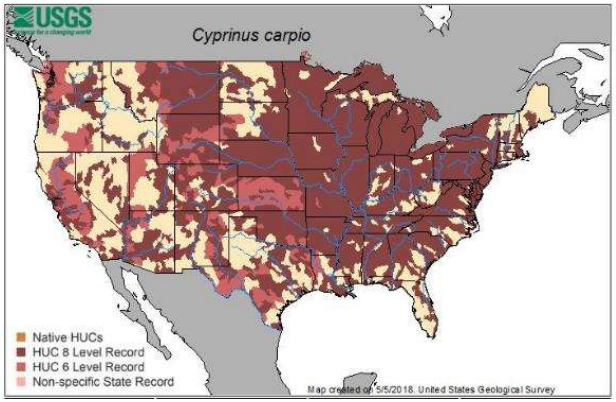
Species referenced for presence/absence.
Is it in Wisconsin?

- I checked for the presence of any verified and vouchered records of the species
  - Herbaria
  - Museums
  - DNR sources & databases

FLORA of WISCONSIN
Consortium of
Wisconsin Herbaria

NAS


Open Interactive Map



Wisconsin Department of Natural Resources
Surface Water Integrated Monitoring System (SWIMS)

Outputs: General patterns for all species

Current Climate: 78% target species are compatible.

2050 Climate: 76% target species are compatible.

2070 Climate: 74% target species are compatible.

Range expansion = “Winners”: 28 species increase from unsuitable in current climate to suitable in future climate.

Range retraction = “Losers”: 33 species decrease from suitable in current climate to unsuitable in future climate.

Top Ranking Species: Wetland Plants in Wisconsin

Agrostis gigantea	redtop	*Ambrosia artemisiifolia*	annual ragweed
Alnus glutinosa	European alder	*Veronica officinalis*	common speedwell
Dactylis glomerata	orchardgrass	*Phleum pratense*	timothy
Morus alba	white mulberry	*Acorus calamus*	calamus
Phragmites australis	common reed	*Lonicera tatarica*	Tatarian honeysuckle
Rumex crispus	curly dock	*Berberis thunbergii*	Japanese barberry
Salix alba	white willow	*Achillea millefolium*	common yarrow
Trifolium pratense	red clover	*Elaeagnus angustifolia*	Russian olive
Phalaris arundinacea	Reed canarygrass	*Stellaria media*	common chickweed
Solanum dulcamara	climbing nightshade	*Ranunculus acris*	tall buttercup

Top Ranking Species:
Wetland Plants *not* in Wisconsin yet…

Eichhornia crassipes	common water hyacinth*	*Polygonum caespitosum*	Oriental Lady's thumb
Lonicera sempervirens	trumpet honeysuckle	*Rubus phoenicolasius*	wine raspberry
		Marsilea quadrifolia	European waterclover
Jacobaea vulgaris	stinking willie	*Microstegium vimineum*	Nepalese browntop
Ligustrum sinense	Chinese privet	*Schoenoplectiella mucronate*	bog bulrush
Persicaria perfoliata	Asiatic tearthumb	*Saccharum ravennae*	ravennagrass
Bothriochloa bladhii	Caucasian bluestem	*Epilobium parviflorum*	mallflower hairy willowherb
Juncus inflexus	European meadowrush	*Kummerowia striata*	Japanese clover
Buddleja davidii	orange eye butterflybush	*Arundo donax*	giant reed
Carex acutiformis	lesser pond sedge	*Mentha pulegium*	pennyroyal

* Site in Wisconsin has been controlled.

Top Ranking Species:
Wetland Plants *not* in Wisconsin yet…

Eichhornia crassipes
common water hyacinth
**some sites controlled.*

Lonicera sempervirens
trumpet honeysuckle

Jacobaea vulgaris
stinking willie

Persicaria perfoliata
Asiatic tearthumb

Bothriochloa bladhii
Caucasian bluestem

Juncus inflexus
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Top Ranking Species:
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Polygonum caespitosum
Oriental Lady's thumb

Rubus phoenicolasius
wine raspberry

Marsilea quadrifolia
European waterclover

Microstegium vimineum
Nepalese browntop / Japanese stiltgrass

Schoenoplectiella mucronate
bog bulrush

Saccharum ravennae
ravennagrass

Epilobium parviflorum
mallflower hairy willowherb

Kummerowia striata
Japanese clover

Top Ranking Species:
Aquatic Plants in Wisconsin

- *Nasturtium officinale* watercress
- *Potamogeton crispus* curly pondweed
- *Hydrilla verticillata* waterthyme
- *Najas minor* brittle waternymph
- *Myriophyllum spicatum* Eurasian watermilfoil
- *Nitellopsis obtuse* starry stonewort
- *Nymphoides peltata* yellow floatingheart
- *Nelumbo nucifera* sacred lotus

Top Ranking Species:
Aquatic Plants not in Wisconsin yet…

- *Eichhornia crassipes* common water hyacinth
- *Egeria densa* Brazilian waterweed
- *Marsilea quadrifolia* European waterclover
- *Trapa natans* water chestnut

Top Ranking Species:
Aquatic Plants not in Wisconsin yet…

Eichhornia crassipes
common water hyacinth
**some sites controlled.*

Egeria densa
Brazilian waterweed

Marsilea quadrifolia
European waterclover

Trapa natans
water chestnut

Top Ranking Species:
Aquatic Animals in Wisconsin

• *Dreissena polymorpha*	zebra mussel
• *Cyprinus carpio*	common carp
• *Orconectes rusticus*	rusty crayfish
• *Bythotrephes longimanus*	spiny waterflea
• *Dreissena bugensis*	quagga mussel
• *Neogobius melanostomus*	Round goby
• *Cipangopaludina chinensis*	Chinese mystery snail
• *Morone americana*	White perch
• *Alosa pseudoharengus*	Alewife
• *Bosmina coregoni*	a waterflea
• *Oncorhynchus tshawytscha*	Chinook salmon

Top Ranking Species:
Aquatic Animals *not* in Wisconsin yet…

- *Ameiurus catus* White catfish
- *Pterygoplichthys pardalis* Amazon sailfin catfish
- *Tilapia zillii* redbelly tilapia
- *Perccottus glenii* Chinese sleeper
- *Oreochromis niloticus* Nile tilapia
- *Silurus glanis* wels catfish
- *Rhodeus sericeus* Amur bitterling
- *Hypomesus nipponensis* Wakasagi
- *Oreochromis mossambicus* Moazambique tilapia
- *Pseudorasbora parva* stone moroko

Top Ranking Species:
Aquatic Animals *not* in Wisconsin yet…

Ameiurus catus
White catfish

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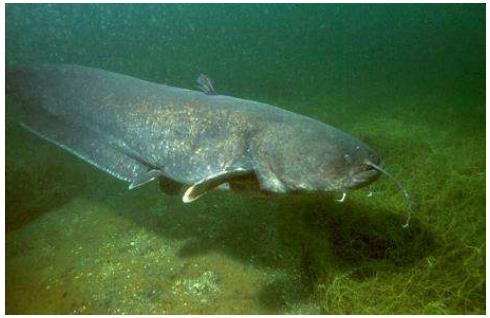

Silurus glanis
wels catfish

Rhodeus sericeus
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Top Ranking Species:
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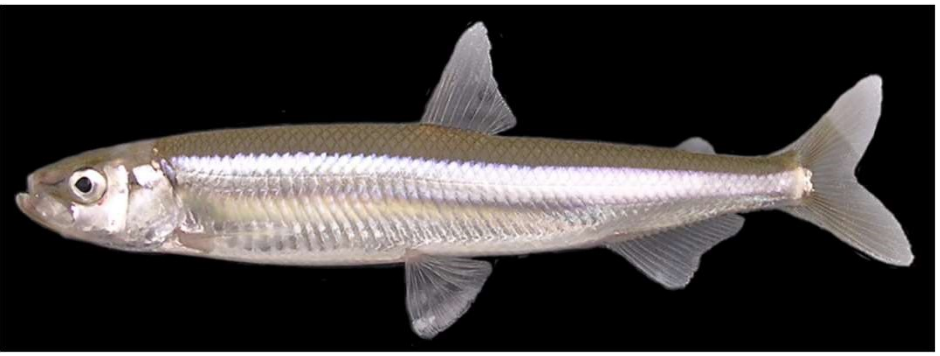


Hypomesus nipponensis
Wakasagi

Oreochromis mossambicus
Moazambique tilapia

Pseudorasbora parva
stone moroko

Limitations

- Species has to be designated as invasive in a list. If there are no reports, then it isn't considered.
- This approach doesn't consider native species in other areas becoming problems in WI
- GBIF subsampling doesn't keep all the information. No easy way to QA/QC records.
- RAMP is a single model; multiple models are better
- If a species is under-surveilled, it can have poor RAMP fitting
  - Graceful cattail (*Typha laxmanii*) has a RAMP score of 5, but is a new threat in Wisconsin.

When assessing new threats with RAMP

- Use RAMP scores with literature reviews:
  - Potential environmental, economic, or human health impacts
  - Life history traits
  - Reproductive rates
  - Abundance and distribution; *are there many populations near Wisconsin?*
  - Vulnerable habitats or species-specific habitat needs
  - Methods of control
  - Ability to naturalize with native ecosystems.
- RAMP scores are coarse-grained and not useful for small scale planning at state scale.
- RAMP scores do not imply competitive advantage of one species over another.

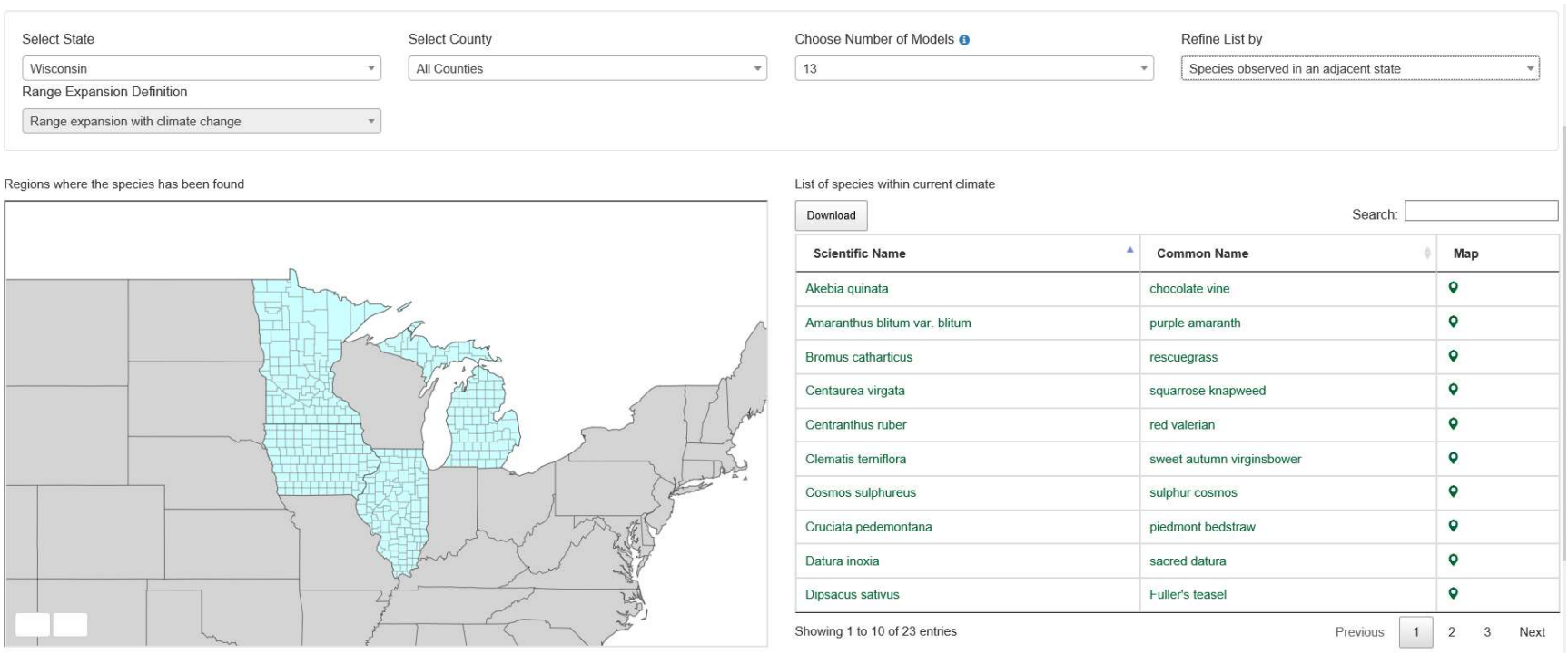
New Tool: Range shift maps from EDDMapS!

EDDMapS
Early Detection & Distribution Mapping System

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

Tool developed by Dr. Jenica Allen of Mount Holyoke College

Uses 13 models for species predictions



chocolate vine

***Akebia quinata* (Houtt.) Dcne.**

This species is Introduced in the United States

USDA PLANTS Symbol:AKQU
Invasive Plant Atlas
Species Information

CSV KML Shapefile

States | Counties | Points | List

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

chocolate vine (*Akebia quinata*)

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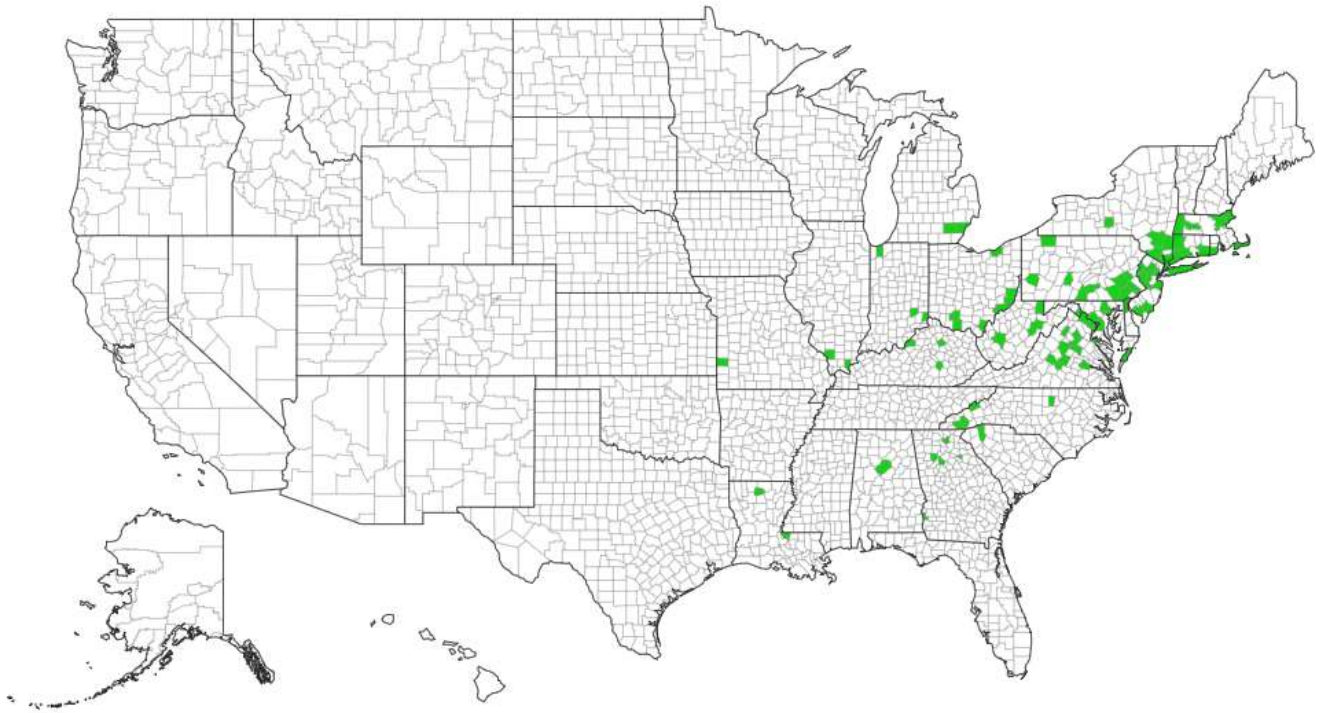


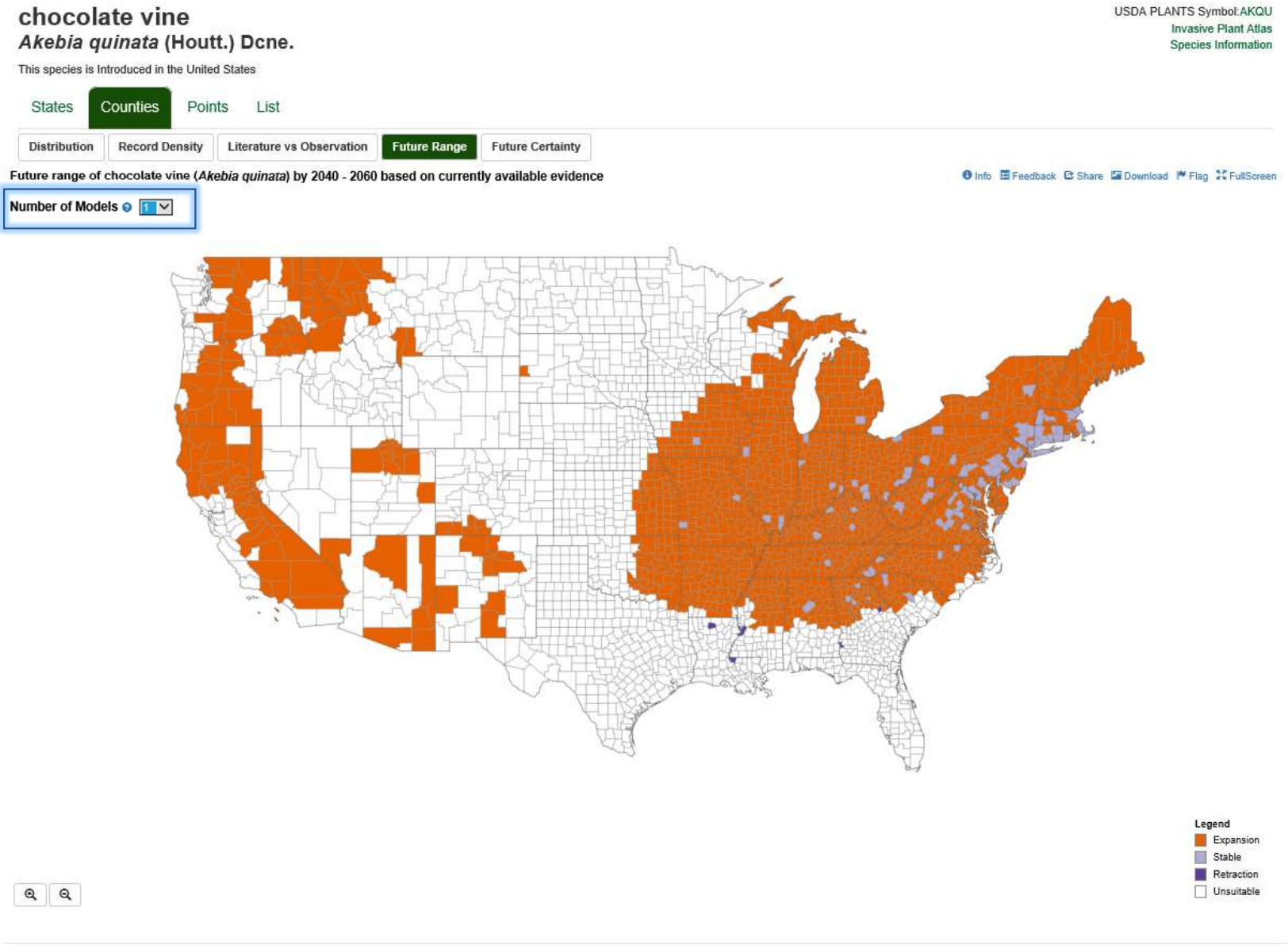
Legend
No Data
Species Reported

EDDMapS has 13 models. Users can set the sensitivity.

Does at least 1 model suggest change?

or

Do multiple models needs to suggest change?



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Future certainty of chocolate vine (*Akebia quinata*) by 2040 - 2060 based on currently available evidence

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