



# Evaluating the risk of aquatic invasive species range expansions in a changing climate in Pennsylvania

**Sara N. Stahlman**  
**Pennsylvania Sea Grant**  
**sng121@psu.edu**



# Acknowledgements

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# Aquatic Invasive Species (AIS) Management in Pennsylvania



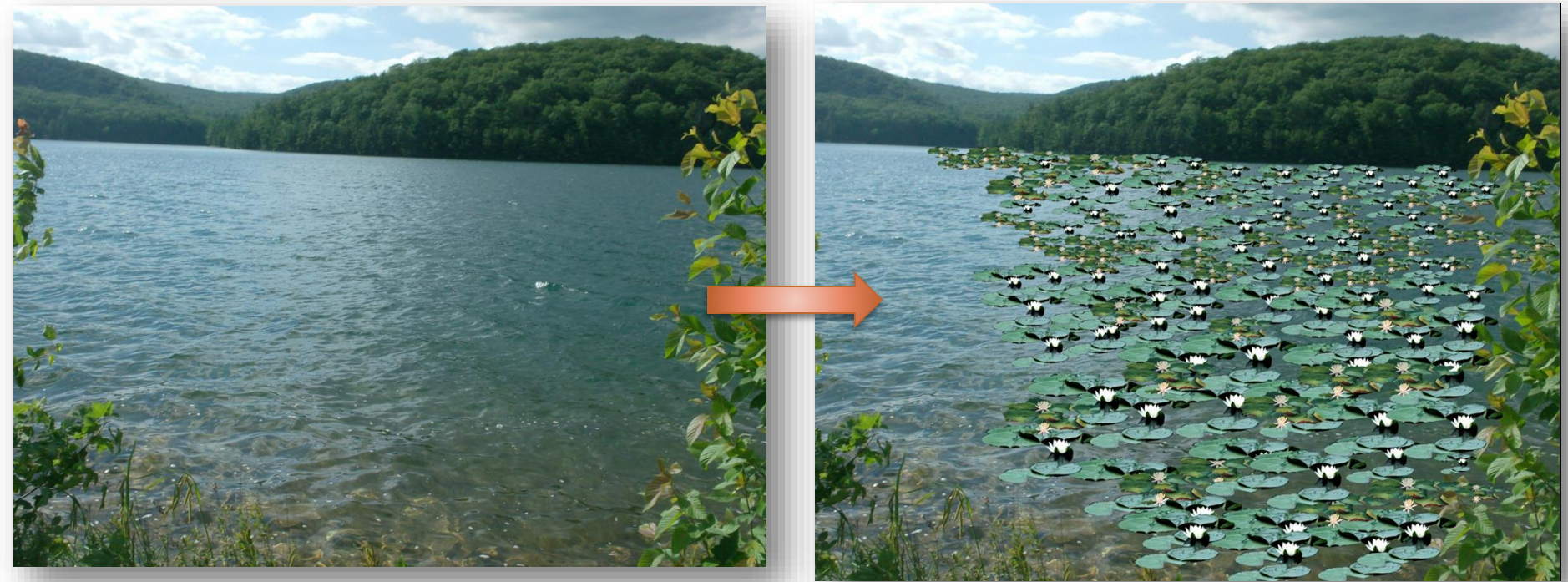
UGA1299199

Commonwealth of Pennsylvania  
Pennsylvania Invasive Species Council  
Aquatic Invasive Species Management Plan

October 2006



Will climate suitability in Pennsylvania increase for the establishment of non-native species that could move northward as the climate warms?



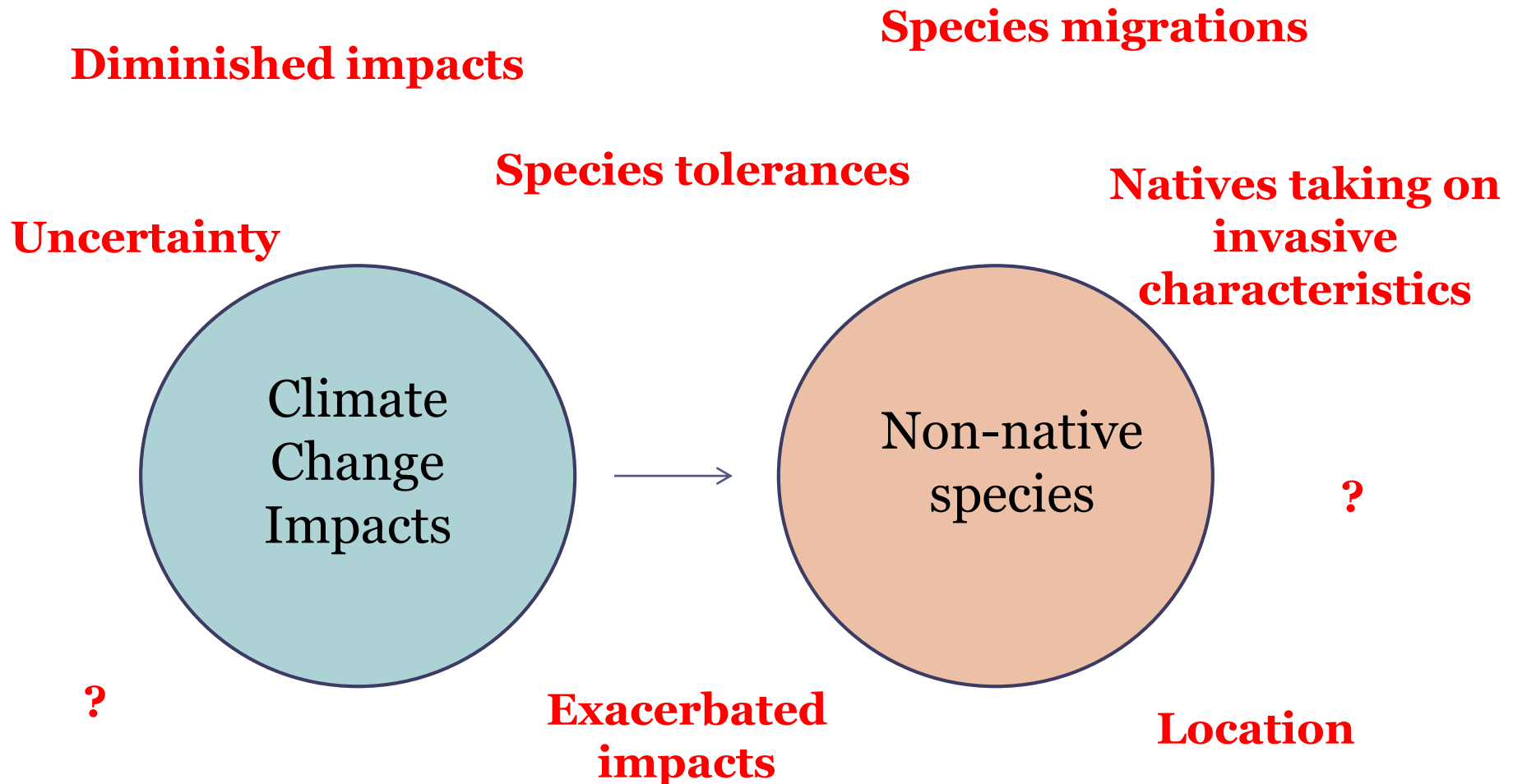
Which species should be considered high risk for future invasion into Pennsylvania under various climate scenarios?












# How will climate change impact invasive species?



# Determine risky species

Images	Group	Family	Scientific Name	Common Name	More info	Native Habitat	Exotic / Native Transplant
	Fishes	Chaetodontidae	<i>Heniochus diphreutes</i>	schooling bannerfish	<a href="#">Collection info</a> <a href="#">HUC maps</a> <a href="#">Point maps</a> <a href="#">Factsheet</a>	Marine	Exotic
	Fishes	Gobiidae	<i>Acanthogobius flavimanus</i>	yellowfin goby	<a href="#">Collection info</a> <a href="#">HUC maps</a> <a href="#">Point maps</a> <a href="#">Factsheet</a>	Marine	Exotic
	Fishes	Acanthuridae	<i>Acanthurus guttatus</i>	whitespotted surgeonfish	<a href="#">Collection info</a> <a href="#">HUC maps</a> <a href="#">Point maps</a> <a href="#">Factsheet</a>	Marine	Exotic
	Fishes	Acanthuridae	<i>Acanthurus sohal</i>	Red Sea surgeonfish	<a href="#">Collection info</a> <a href="#">HUC maps</a> <a href="#">Point maps</a> <a href="#">Factsheet</a>	Marine	Exotic
	Fishes	Acipenseridae	<i>Acipenser transmontanus</i>	white sturgeon	<a href="#">Collection info</a> <a href="#">HUC maps</a> <a href="#">Point maps</a> <a href="#">Factsheet</a>	Freshwater	Native
	Fishes	Acipenseridae	<i>Acipenser</i> or <i>Scaphirhynchus</i> sp.	sturgeon (eastern species)	<a href="#">Collection info</a> <a href="#">HUC maps</a> <a href="#">Point maps</a> <a href="#">Factsheet</a>	Freshwater	Native

United States Geological  
Survey (USGS) Non-  
Indigenous Aquatic Species  
Database (NAS)



128 species met the criteria

Giant  
Snakehead



Australian water-clover



Black Sea jellyfish



European physa



# CLIMATCH matches the climate of the species current geographic range, to an area of interest



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Source Region





Target Region

### Select Stations

Map Navigation





Select Stations





latlon +

Deselect Stations



Data Set

World Stations



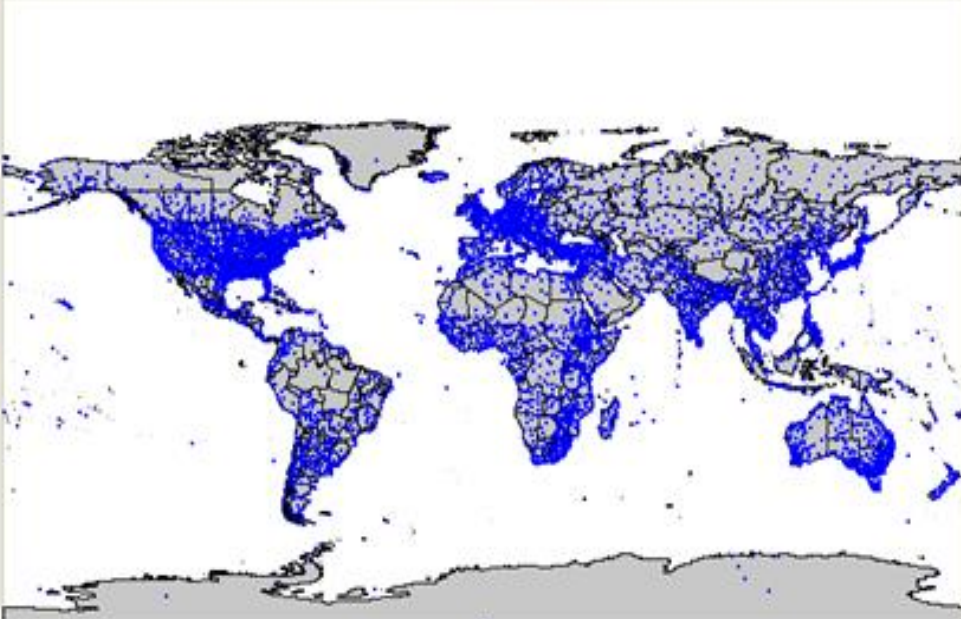
Station Selection: Rectangle

> Drag a rectangle to select a group of points


> Left click to select a single point

> Right click to deselect a single point

## Source Map






Climatch v1.0  
Invasive Animals CRC  
Bureau of Rural Sciences 2008






[Go to tutorial](#)

Use the ZOOM and PAN buttons to focus on the area of the map that you are interested in.



The RECTANGLE and POLYGON tools allow you to select (and deselect) stations to be used in a match.




Source Region


Target Region

You can select stations to define both a SOURCE and a TARGET region. The default target region is Australia.

Once you have defined source and target regions, click on the **RUN MATCH** button to compare the regions.



You can change the match settings if you wish.




Selected Stations

Source: 0

Target: 2785

Followed the procedures outlined in Britton, et al. 2010, and downscaled climate data to use CLIMATCH predictively



*Freshwater Biology*

[Explore this journal >](#)


### Non-native fishes and climate change: predicting species responses to warming temperatures in a temperate region


J. R. BRITTON, J. CUCHEROUSSET, G. D. DAVIES, M. J. GODARD, G. H. COPP

First published: 13 April 2010 [Full publication history](#)

DOI: 10.1111/j.1365-2427.2010.02396.x [View/save citation](#)

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Volume 55, Issue 5  
May 2010  
Pages 1130–1141

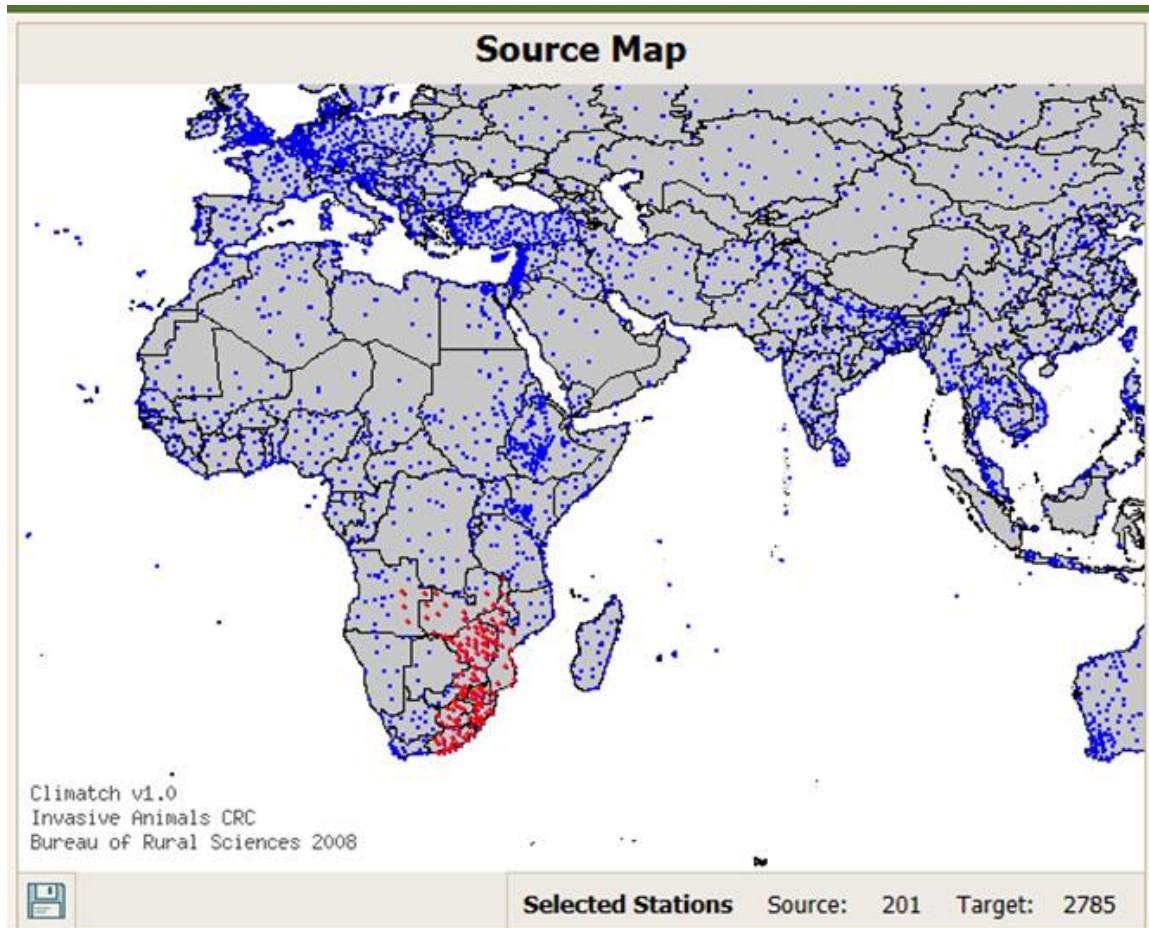
✉ Rob Britton, Centre for Conservation and Environmental Change, School of Conservation Sciences, Bournemouth University, Poole, Dorset, BH12 5BB, U.K. E-mail: [rbritton@bournemouth.ac.uk](mailto:rbritton@bournemouth.ac.uk)

#### Summary

1. Temperate regions with fish communities dominated by cold-water species (physiological optima <20 °C) are vulnerable to the effects of warming temperatures caused by climate change, including displacement by non-native cool-water (physiological optima 20–28 °C) and warm-water fishes

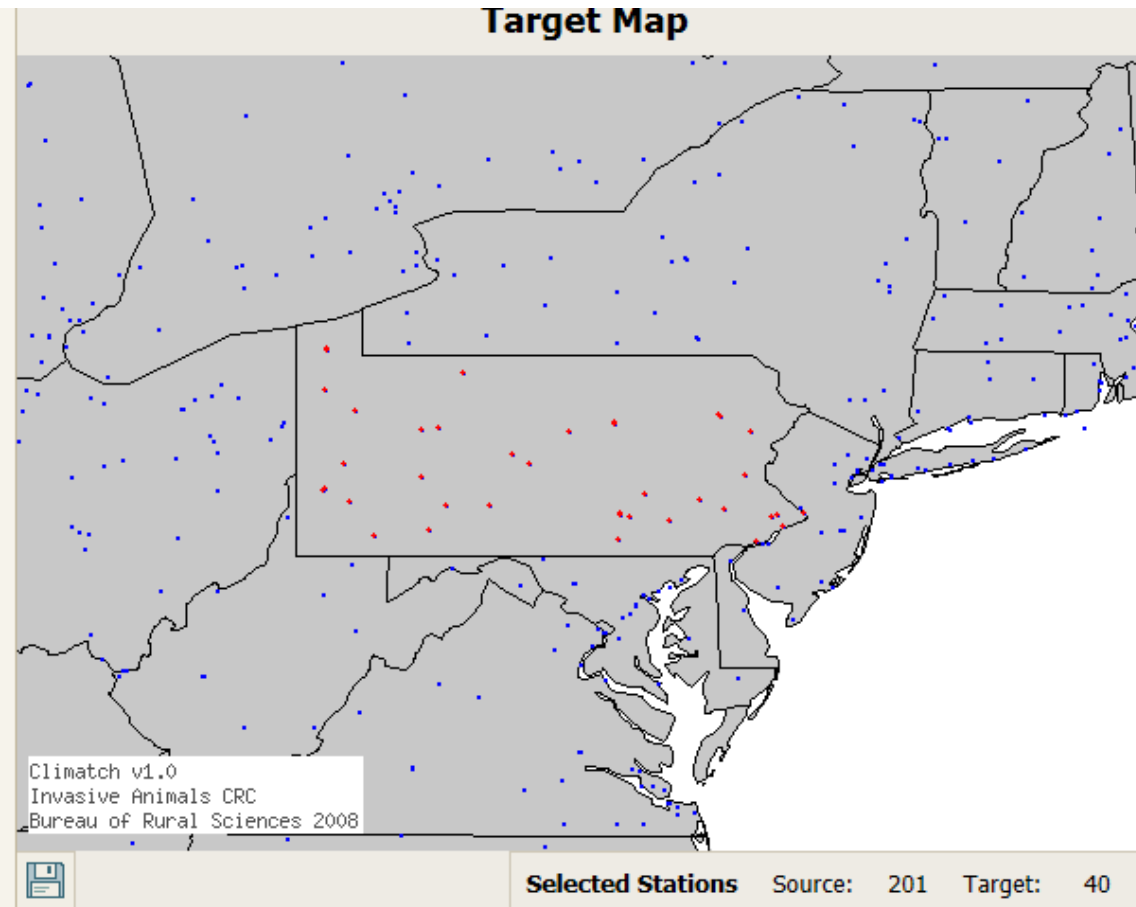


## Define “Source” region



Ex: Mozambique tilapia

# Define “Target” region



Baseline (2010)

# METHODS- Determine Pennsylvania's future climate

- Downscaled climate projection models in degrees Celsius

Time Period	B1	A2
Historical : 1970-1999	9.23	9.23
Mid-future: 2050-2059	11.22	11.66
Distant Future: 2090-2099	11.94	13.85

Increase of 2.7°C

Increase of 4.6°C





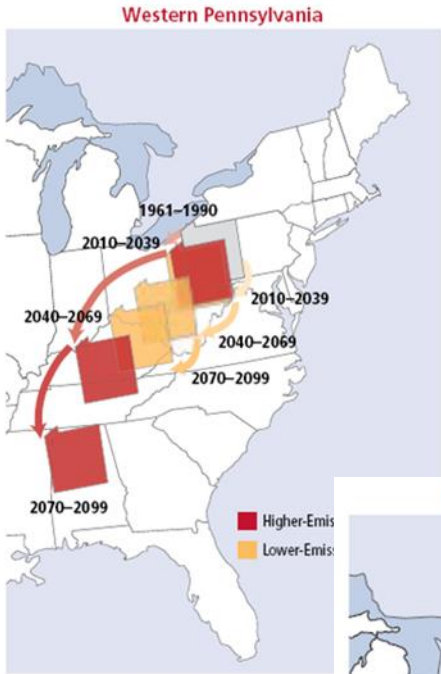
# METHODS- Determine which states climates will most closely resemble Pennsylvania's future climate

A2 Emission Scenario

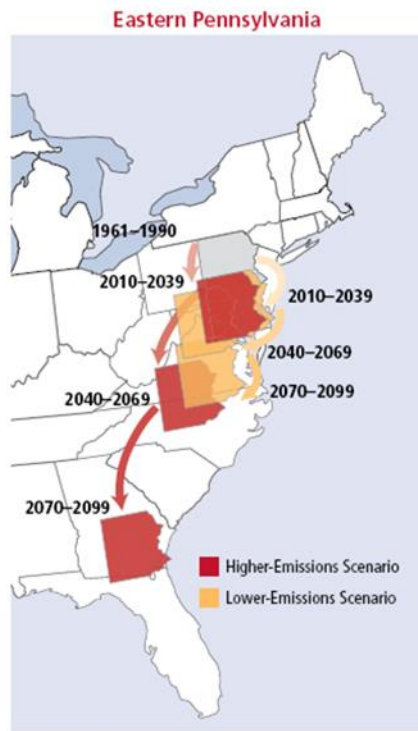
2050-2059	2090-2099
New Jersey	Tennessee
Maryland	Kentucky
Illinois	Delaware
Kansas	Virginia
West Virginia	North Carolina

B1 Emission Scenario

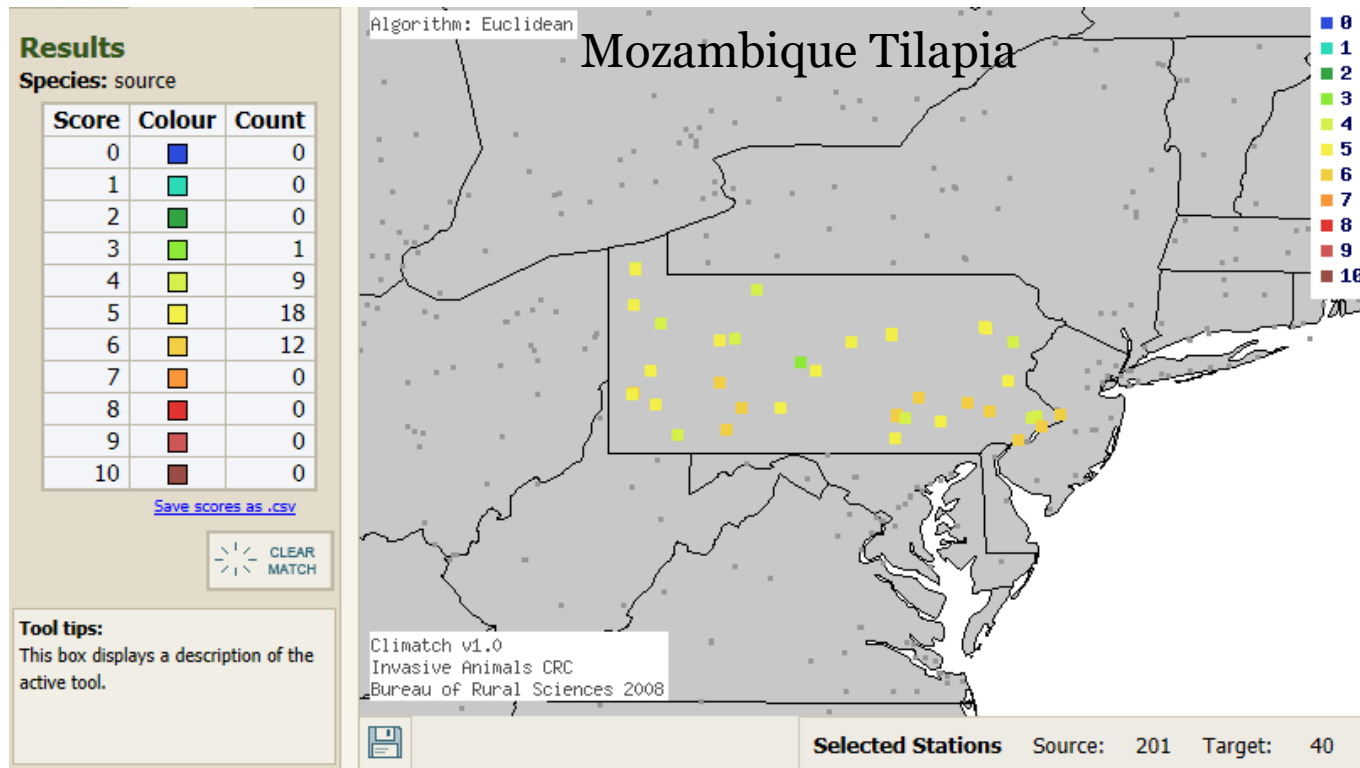
2050-2059	2090-2099
New Jersey	Maryland
Illinois	Kansas
West Virginia	New Jersey
Indiana	Missouri
Ohio	Virginia



Union of Concerned Scientists



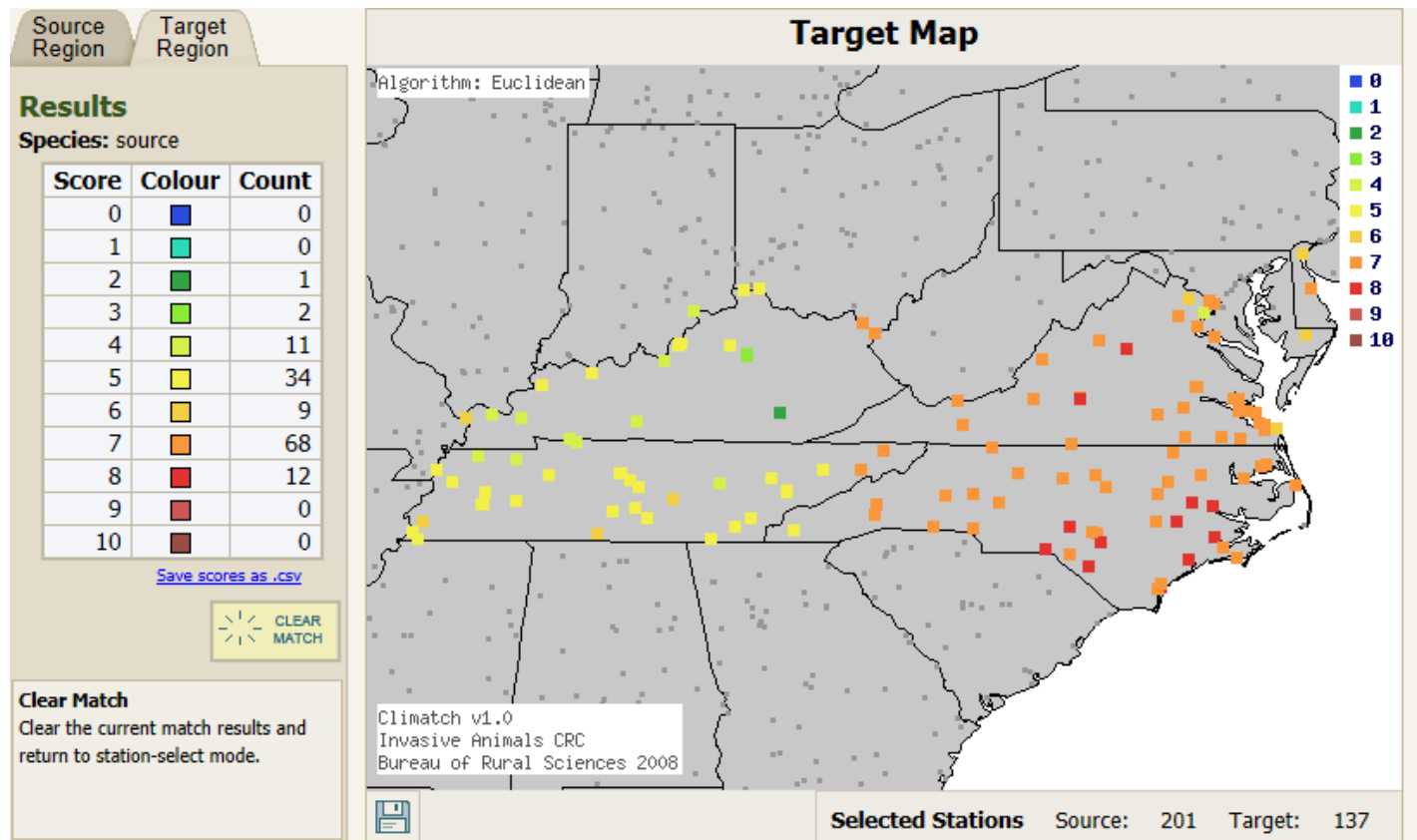
Run the Climate Match on the baseline and determine outputs score from 0-10



0% suitable climate (0/40 stations greater than 7)

A score above 7 is considered “suitable”  
(Britton, et al. 2010)

# Run the Climate Match on target states and determine outputs score from 0-10



58.4% suitability between all five states (80/137 stations greater than 7)



Species with the highest increases in suitable habitat

SPECIES OF GREATEST CONCERN:	PERCENT CHANGE
<u>Fish</u>	
Redeye bass	70.51
Rosy barb	62.88
Highscale shiner	62.77
Mozambique tilapia	58.39
Saffron shiner	55.51
Red piranha	54.74
Snubnose darter	52.59
<u>Plants</u>	
Australian water-clover	83.94
Banana water-lily	83.43
Water-spangles	62.46
<u>Invertebrates</u>	
Ditch-fencing crayfish	62.17
Longnose crayfish	52.59
Channeled applesnail	37.96

## Invasiveness scoring kits

- 49 question survey
  - Biogeography/historical
  - Undesirable attributes
  - Life history
- Level of confidence
- Final score
  - <0 Low Risk
  - 1-19 Medium risk (Fish)
  - 1-16 Medium risk (Invertebrate)
  - >19 High risk (Fish)
  - >16 High risk (Invertebrates)



Common Name	Scientific Name	FISK Score	Risk Level	Designation
<b>Invertebrates</b>				
Longnose crayfish	<i>C. longirostris</i>	9	Medium	Evaluate
Channeled applesnail	<i>P. canaliculata</i>	29	High	Reject
<b>Fish</b>				
Snubnose darter	<i>E. simoterum</i>	2	Medium	Evaluate
Redeye bass	<i>M. coosae</i>	15	Medium	Evaluate
Highschale shiner	<i>N. hypsilepis</i>	-6	Low	Accept
Saffron shiner	<i>N. rubricroceus</i>	0	Medium	Evaluate
Mozambique tilapia	<i>O. mossambicus</i>	26	High	Reject
Rosy barb	<i>P. conchoni</i>	7	Medium	Evaluate
Red piranha	<i>P. nattereri</i>	19	High	Reject

Plants were evaluated based on their inclusion on a noxious weed list



\*Of the three plants, only the banana water-lily holds a position on a state noxious weed list



## Mozambique tilapia

*Oreochromis mossambicus*

**One of the World's 100 Worst!**

### **Fisk Score: 26**

- CLIMATCH baseline-o
- CLIMATCH A2 2099 - 60% climate suitability
- Hardy; Adaptable; reproduce frequently; opportunistic feeders; potential lack of predators; intentionally stocks; high rates of establishment in other areas



## Red piranha

*Pygocentrus nattereri*

### **Fisk Score:** 19

- CLIMATCH  
baseline- 0%
- CLIMATCH A2 2099  
-54.7%
- Aggressive; lack of  
predators; popular in  
the aquarium trade;  
threat to native  
organisms and  
recreation



## Banana water-lily

### *Nymphaea mexicana*

- CLIMATCH  
baseline - 10%  
CLIMATCH A2  
2099–83.4%  
climate suitability
- Highly tolerant and adaptable;  
reproduces sexually and asexually;  
shades out other plants; used in the aquarium and water garden trade;  
successful introductions around the world



## Channeled applesnail

*Pomacea canaliculata*

### **FI-ISK Score:** 29

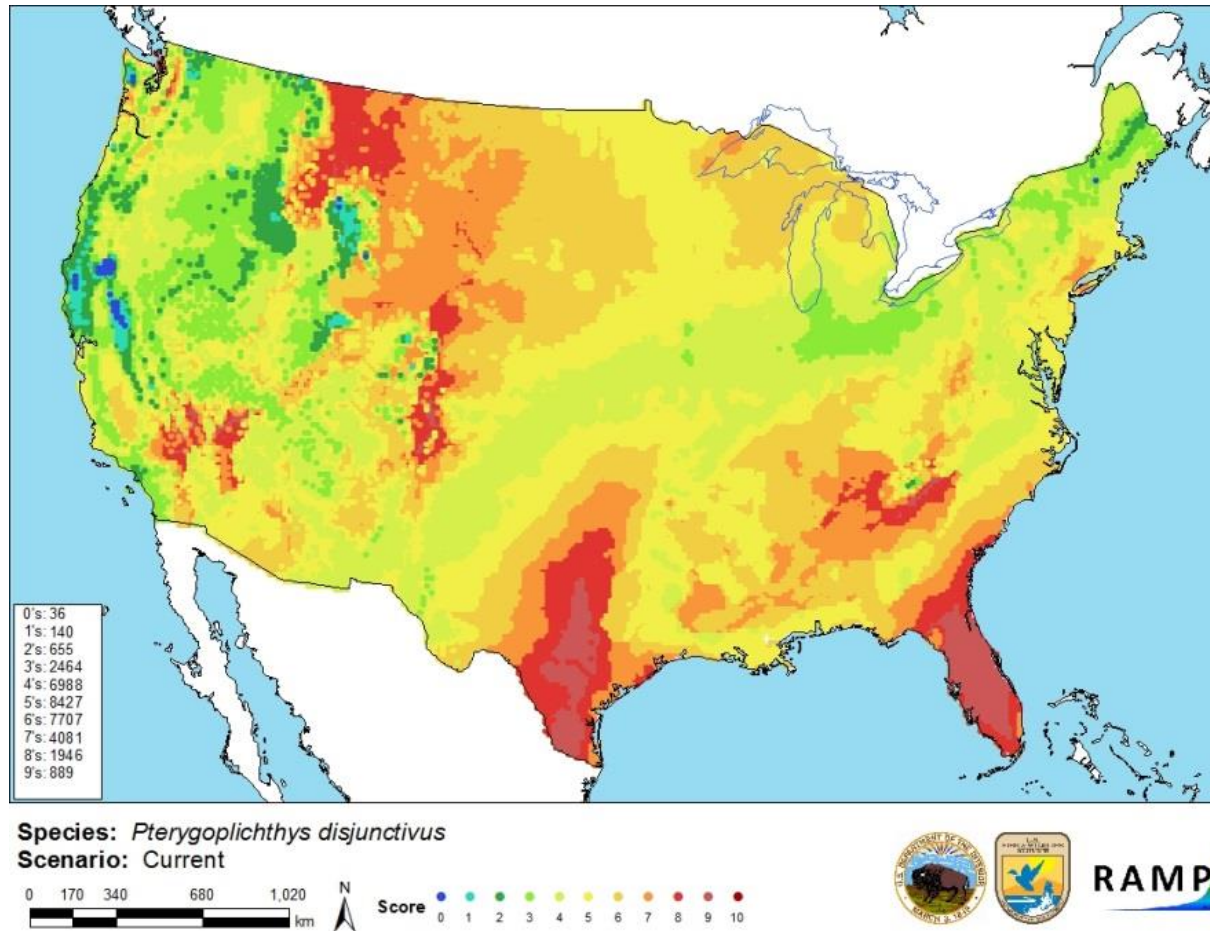
- CLIMATCH baseline-0%
- CLIMATCH A2 2099-38% climate suitability
- Highly adaptable; continual reproduction; survives in and out of water; used in aquarium trade and aquaculture; damage to aquatic habitats, ornamental plants, and crops

**One of the World's 100 Worst!**



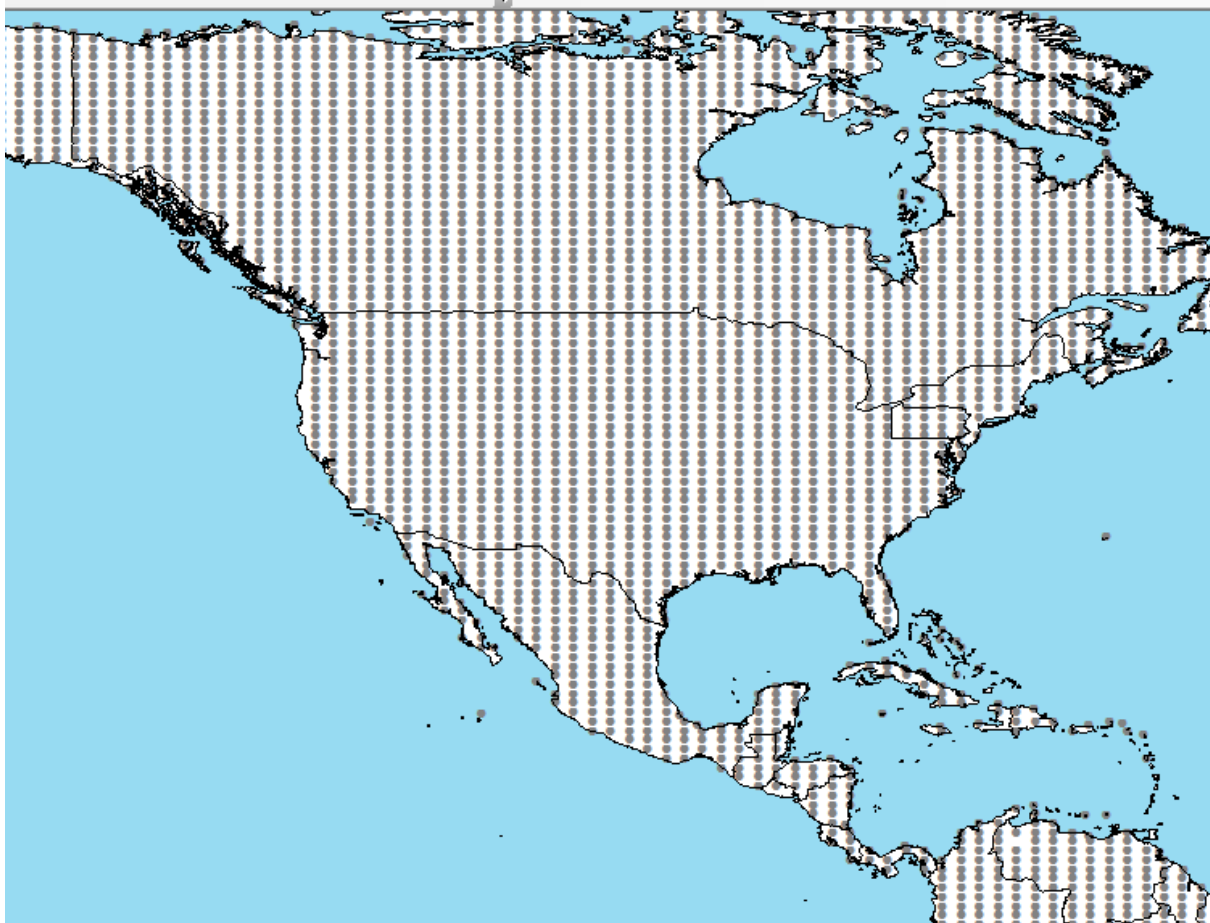


## NEXT STEPS: RAMP

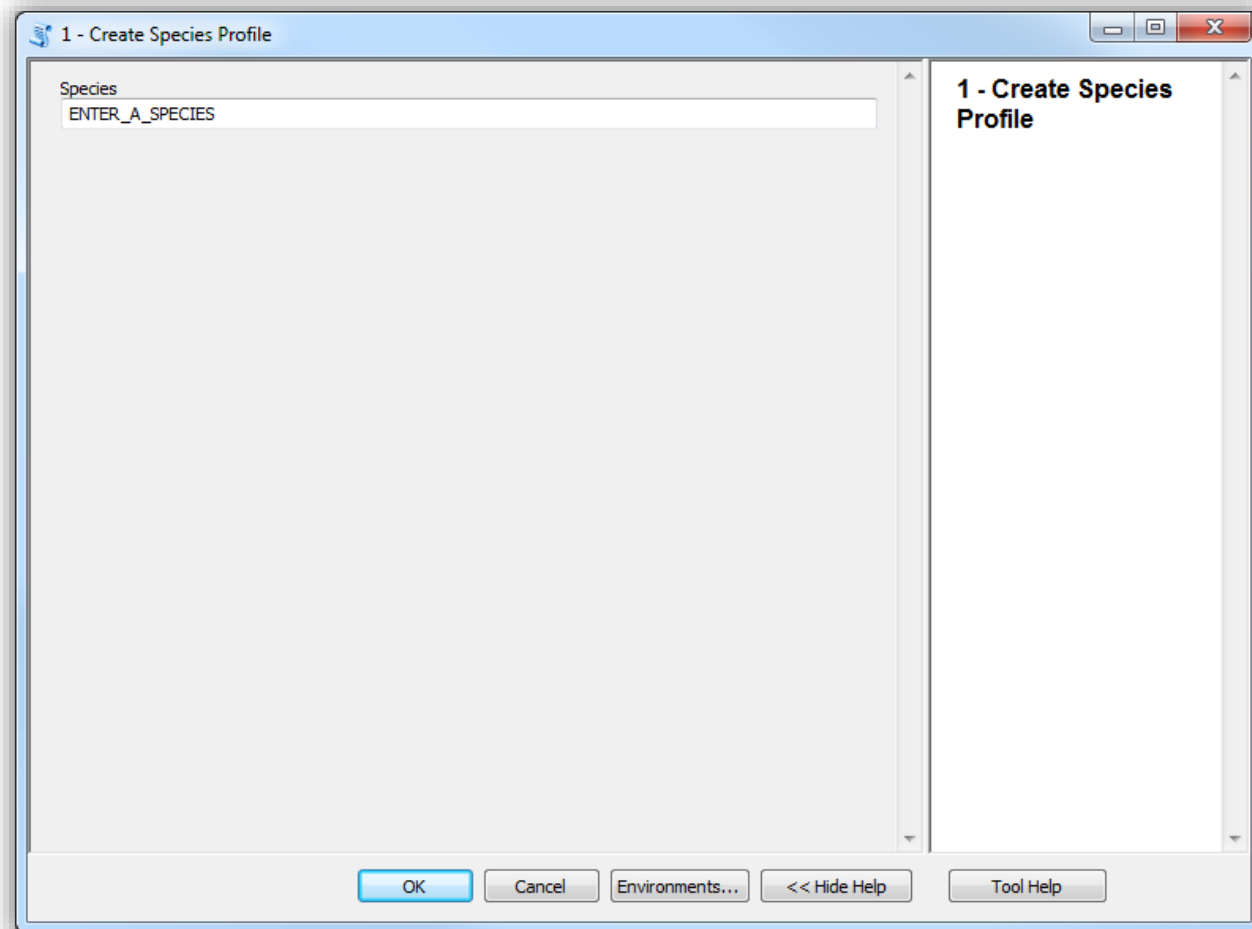


- Follow up study- U.S. Fish and Wildlife Service climate match program

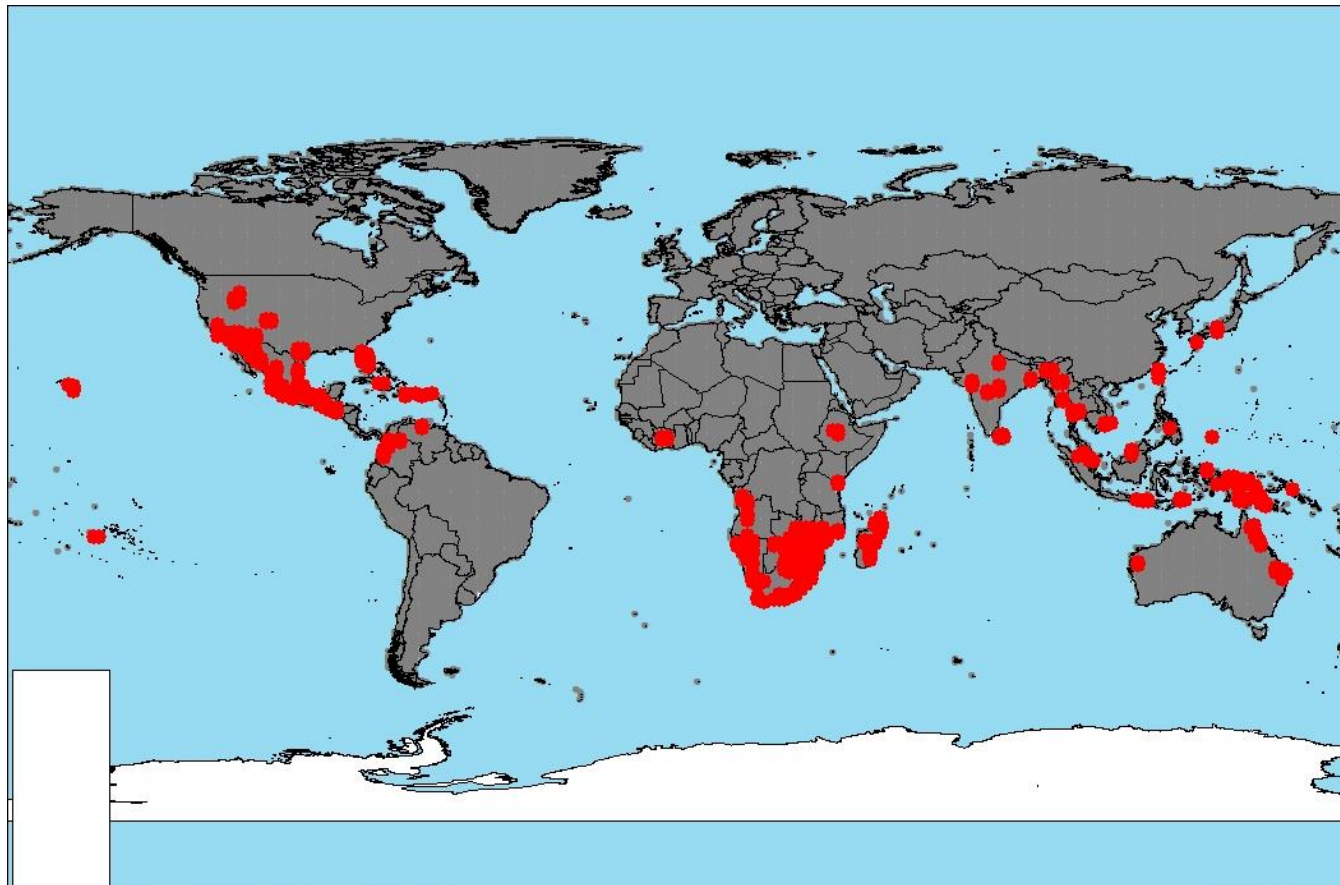
Increased from 1,960 U.S. points to 42,638 points



RAMP creates a species profile by directly downloading species information from GBIF.org



# Pre-selection of species current range



**Species:** *Oreochromis mossambicus*

Selected Climate Stations



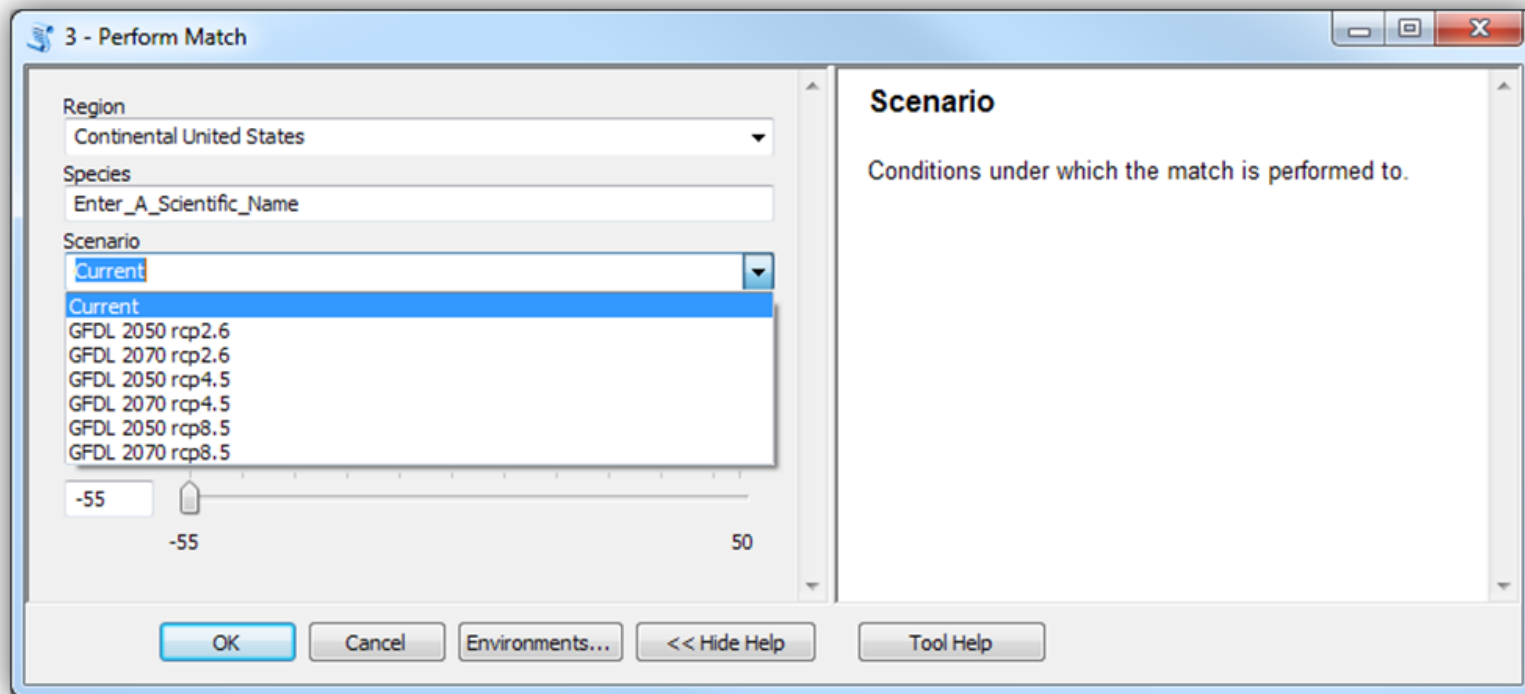
Selected •

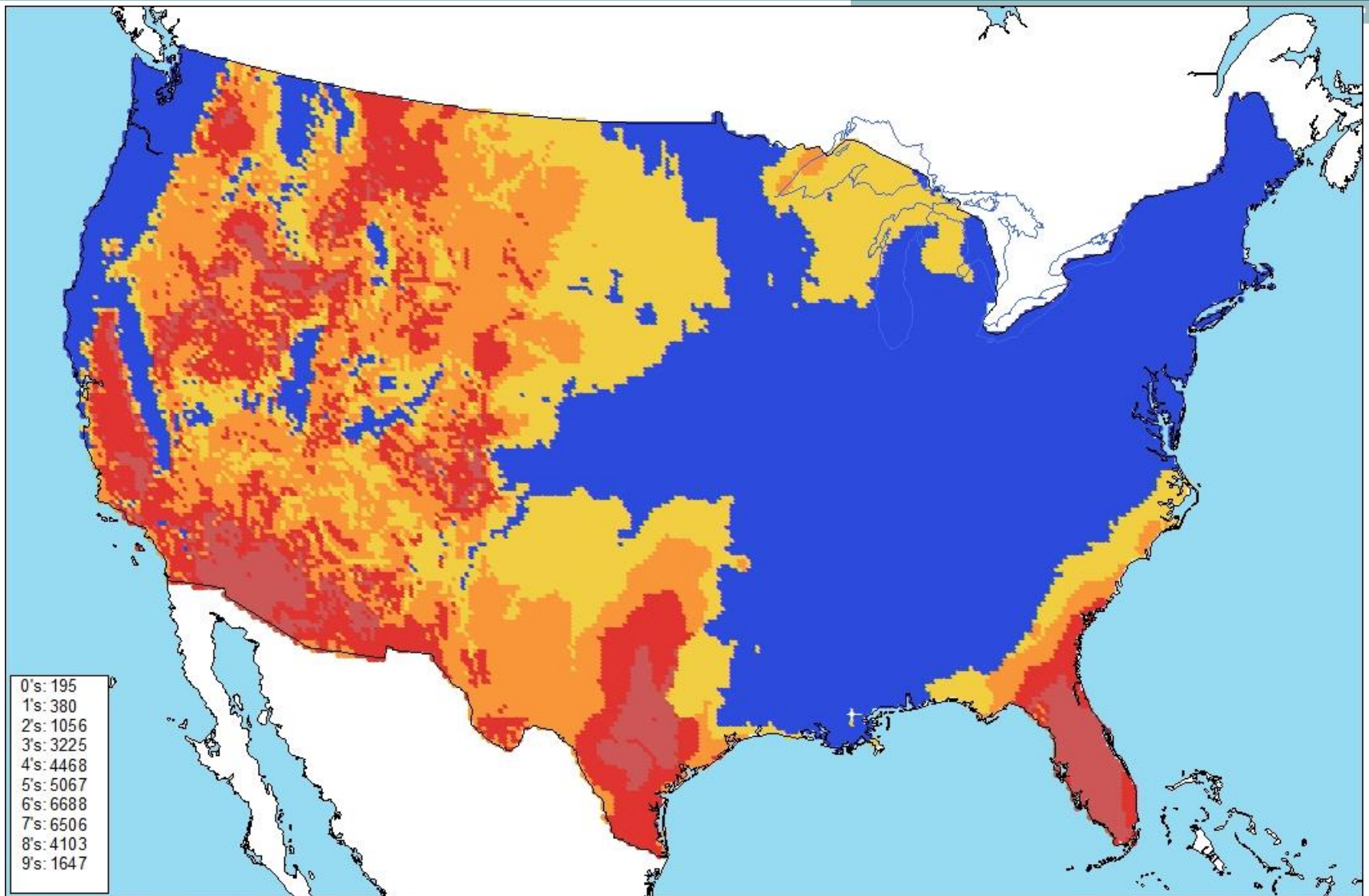


**RAMP**



Choose a target range, choose a scenario, and run the match!





**Species:** *Oreochromis mossambicus*

**Scenario:** Current

**Climate6:** 0.568

High: AZ CA CO FL GA ID MI MN MT NC ND NE NM NV OK OR SC SD TX UT WA WI WY

Medium: AL AR IA KS LA

Low: CT DC DE IL IN KY MA MD ME MO MS NH NJ NY OH PA RI TN VA VT WV



**RAMP**

# Questions?

Sara Stahlman  
301 Peninsula Drive  
Erie, PA 16505  
(814) 217-9011  
[sng121@psu.edu](mailto:sng121@psu.edu)  
[www.seagrants.psu.edu](http://www.seagrants.psu.edu)

