A photograph of a sunset over a body of water, likely a lake or wide river. The sun is a bright white circle in the upper center, partially obscured by a thin layer of clouds. The sky is a pale, hazy blue. The water is calm, reflecting the light from the sun. In the foreground, there is a wide, sandy beach with some sparse, low-lying vegetation. The overall scene is peaceful and serene.

**Predicted effects of water
temperature increases on the
distribution of warmwater fishes in
Wisconsin streams and rivers**

John Lyons

Wisconsin Department of Natural Resources

Effects of climate change on fish

Most studies on coldwater species such as trout



Major losses projected

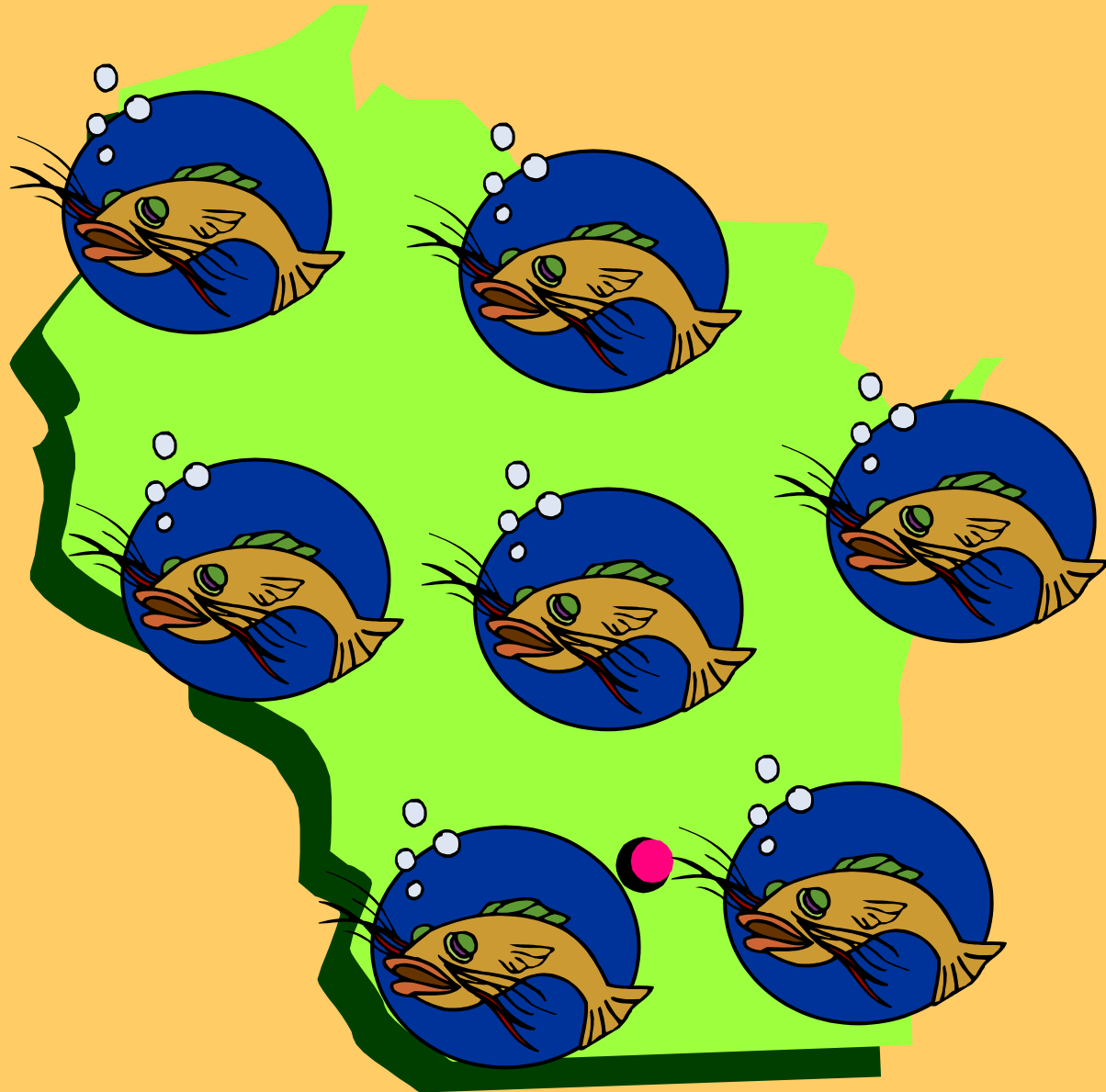
Effects of climate change on fish

Fewer studies on warmwater species such as sunfish or catfish



Major expansions forecasted

Will catfish really take over Wisconsin?

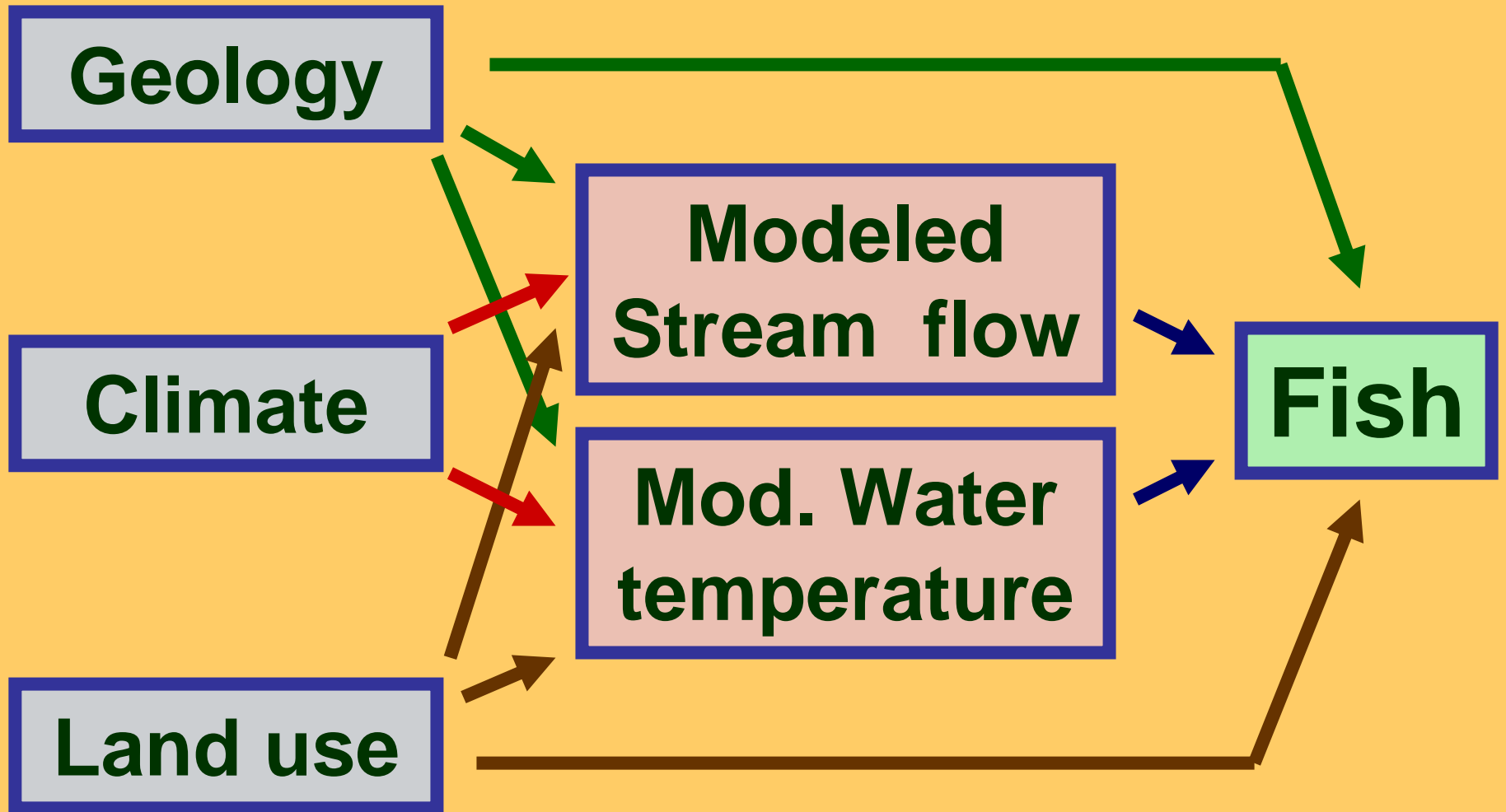


The Stream Model

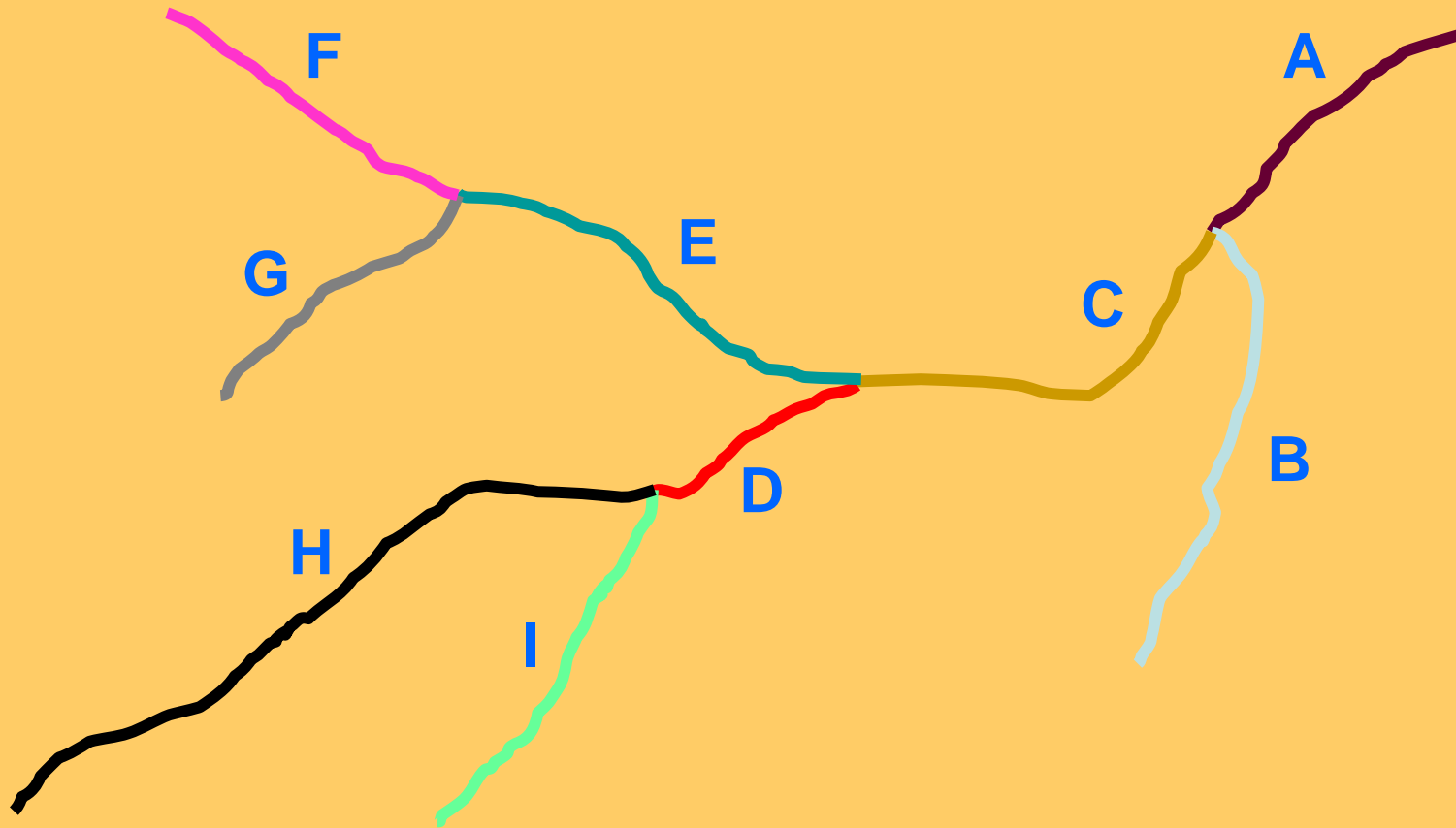


**A new GIS-based statewide watershed model
to evaluate human impacts on streams**

Stream model - Conceptual



Stream model - reaches



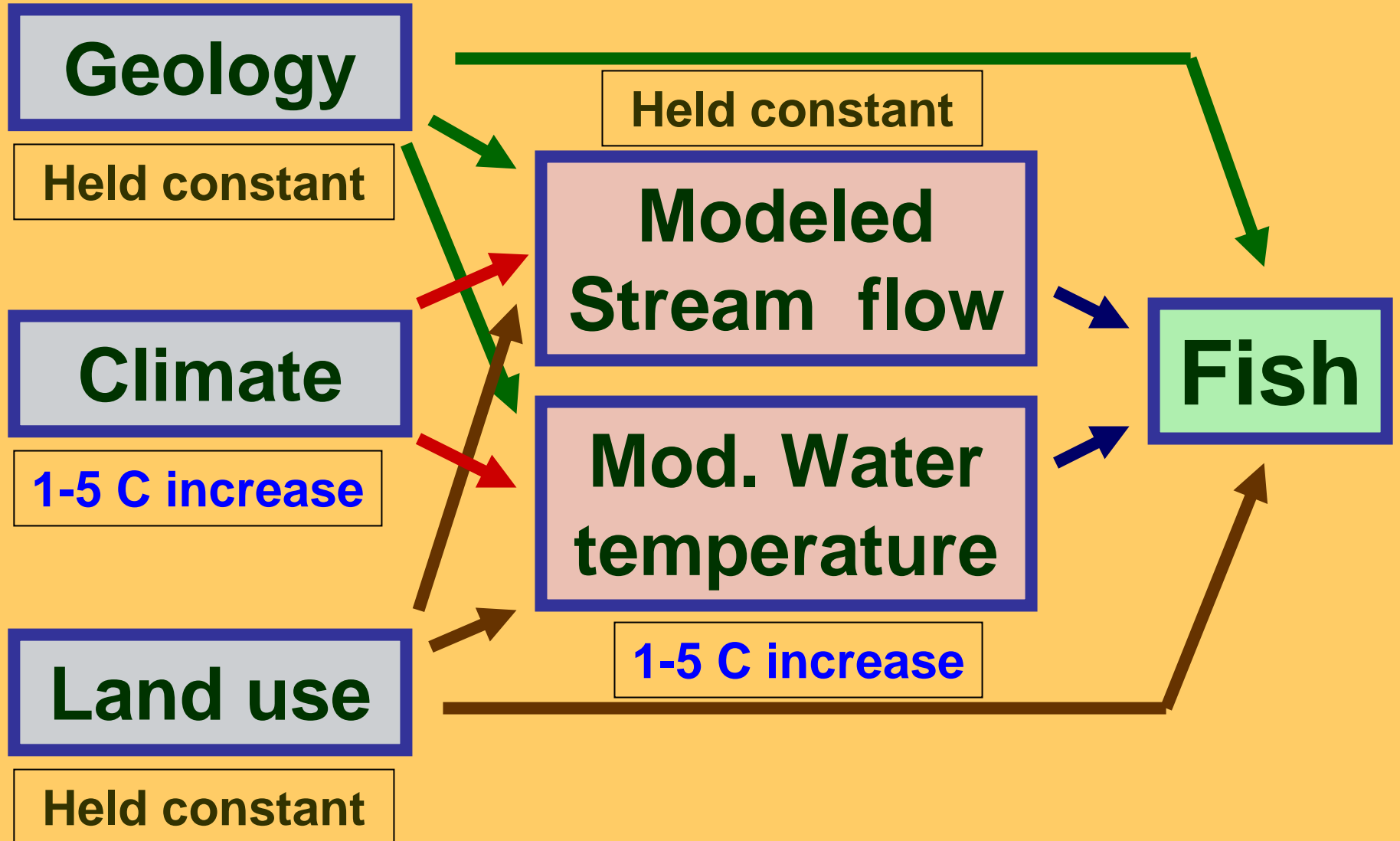
Each reach (“A”, “B”, etc.) is modeled independently; ~125,000 reaches in the state!

50 warmwater species models developed

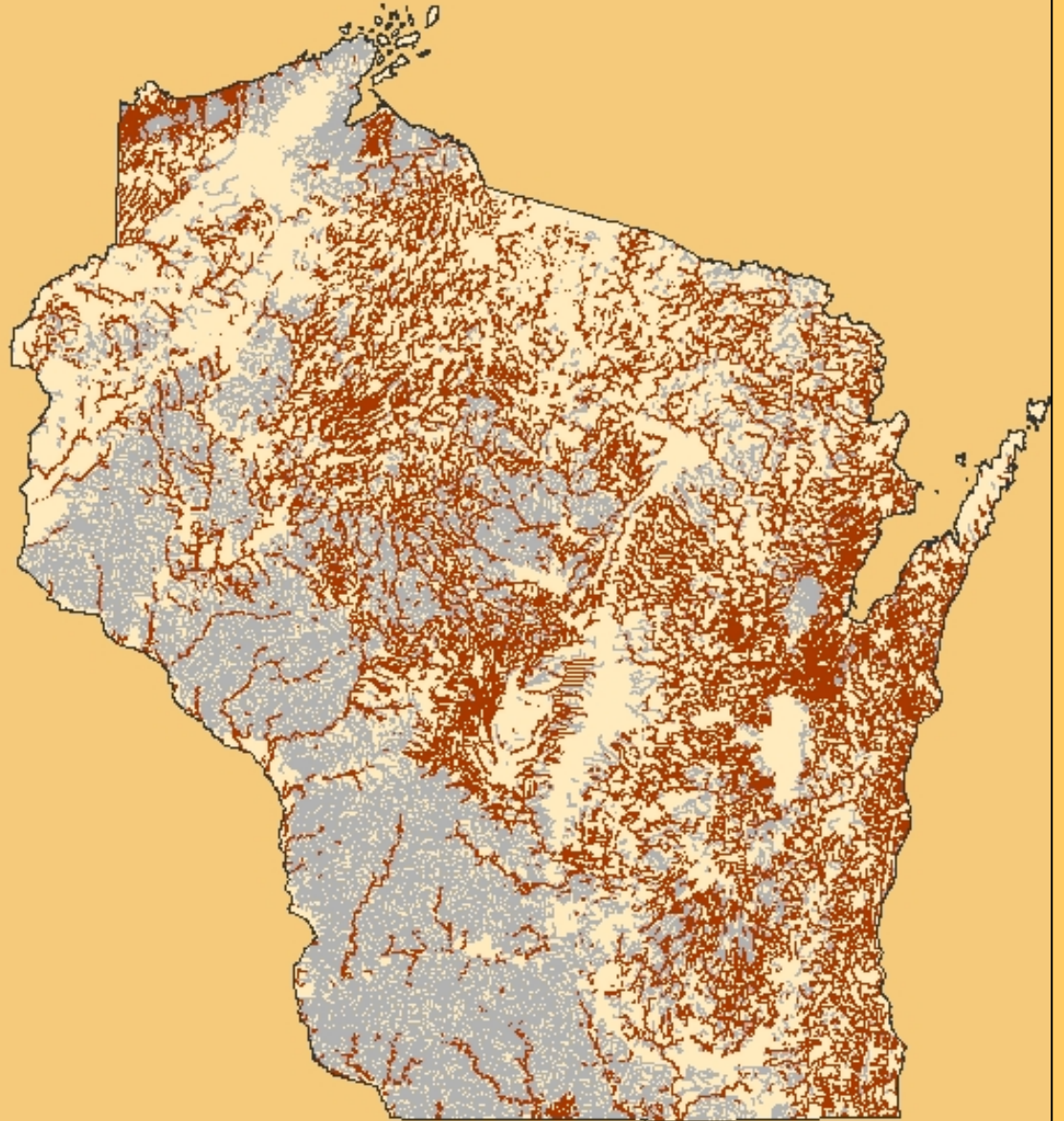


Models 65-90% accurate in independent tests

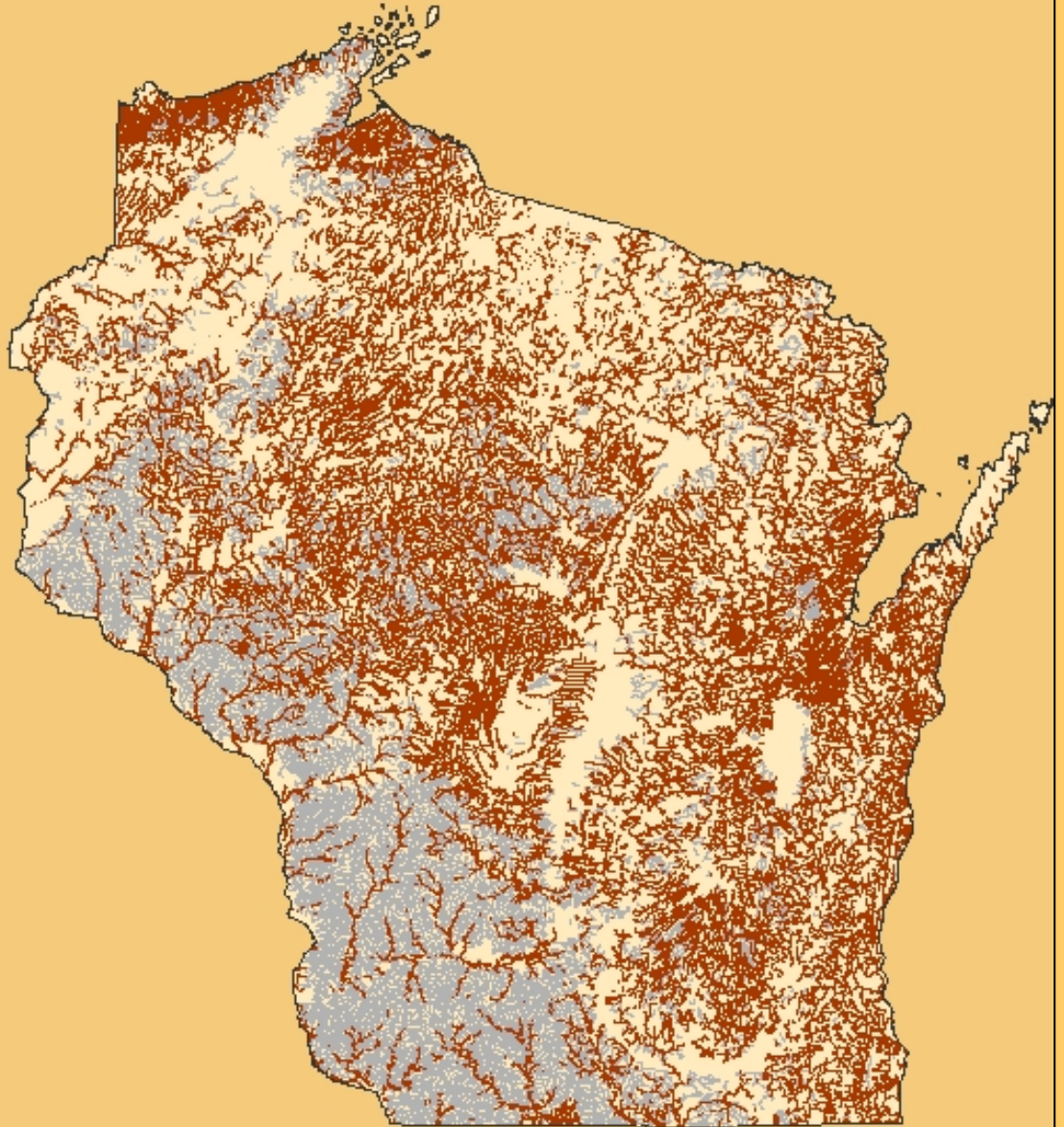
Stream model - Conceptual



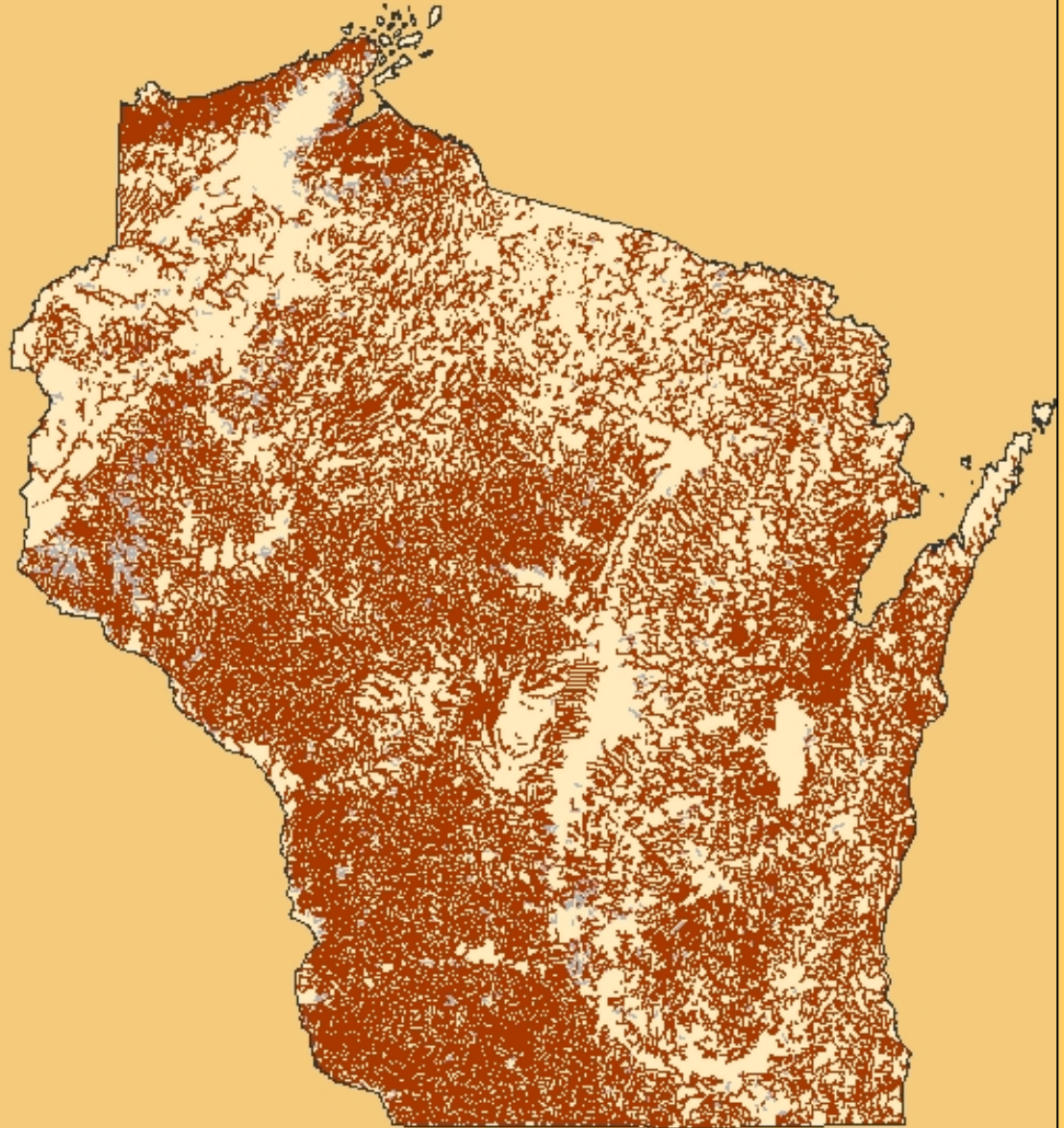
**Warmwater
habitat:
Current
climate**



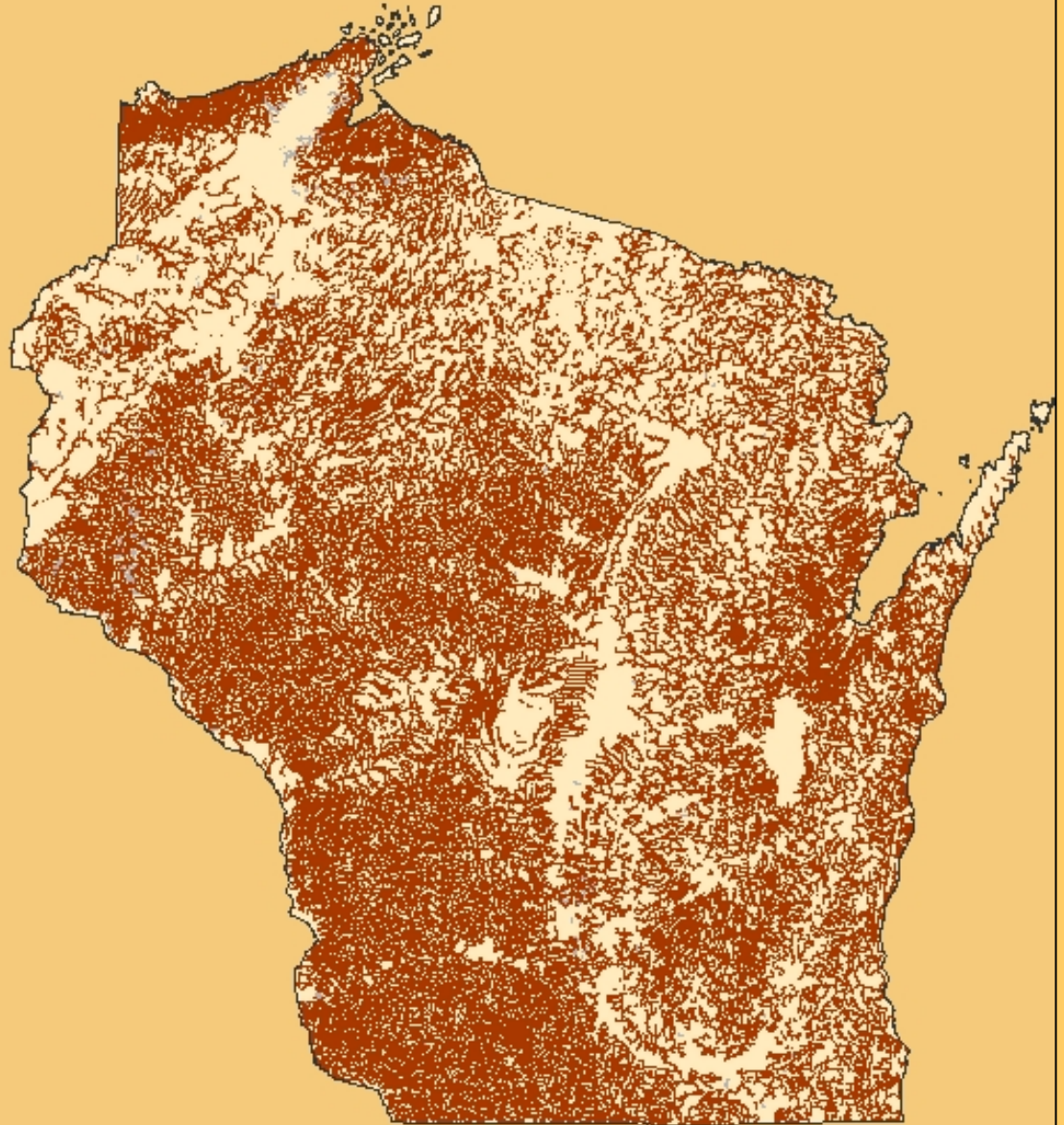
**Warmwater
habitat:
+1 C increase
air and water**



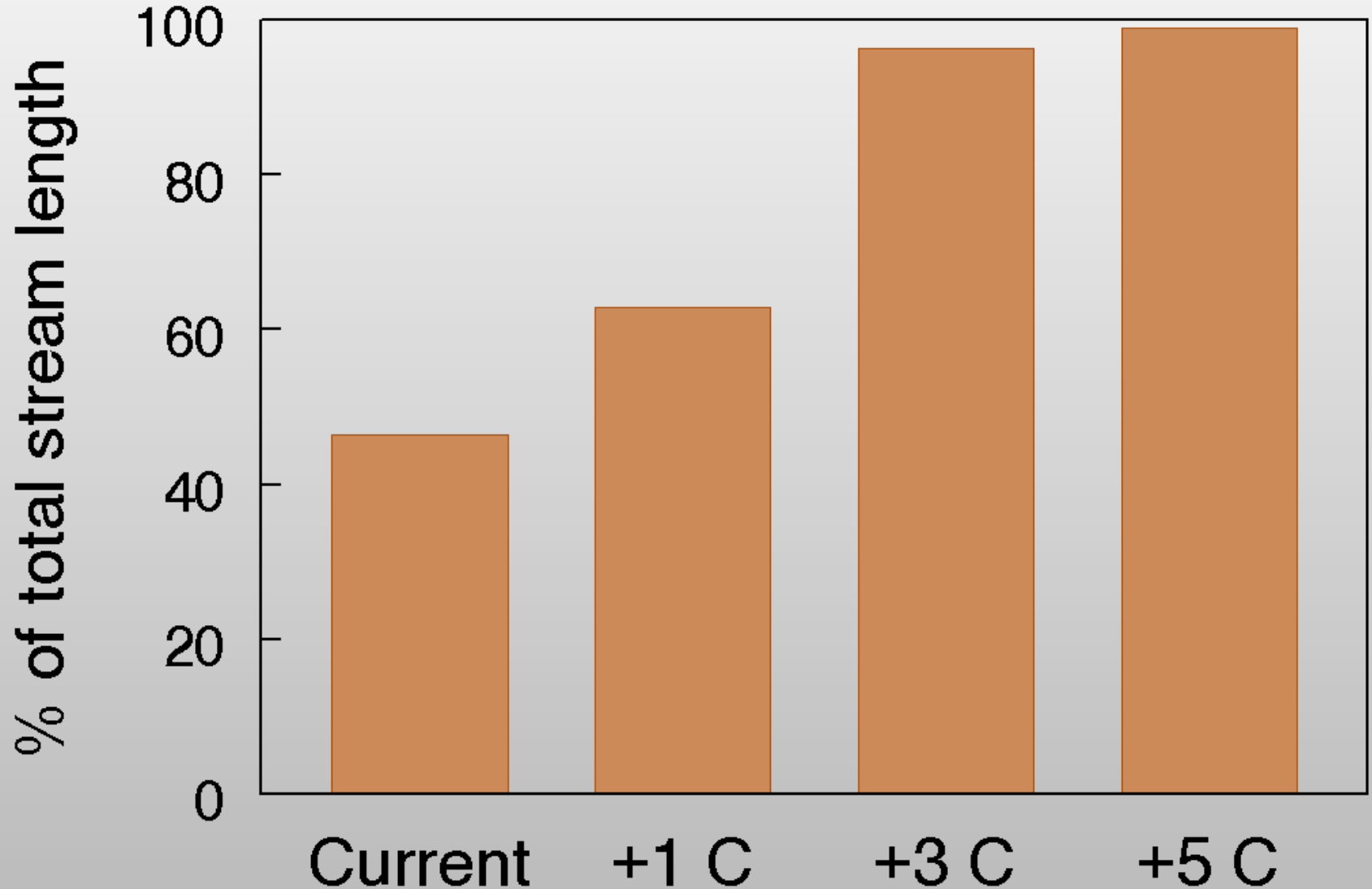
**Warmwater
habitat:
+3 C increase
air and water**



**Warmwater
habitat:
+5 C increase
air and water**



Warmwater habitat gains with temperature



Channel catfish

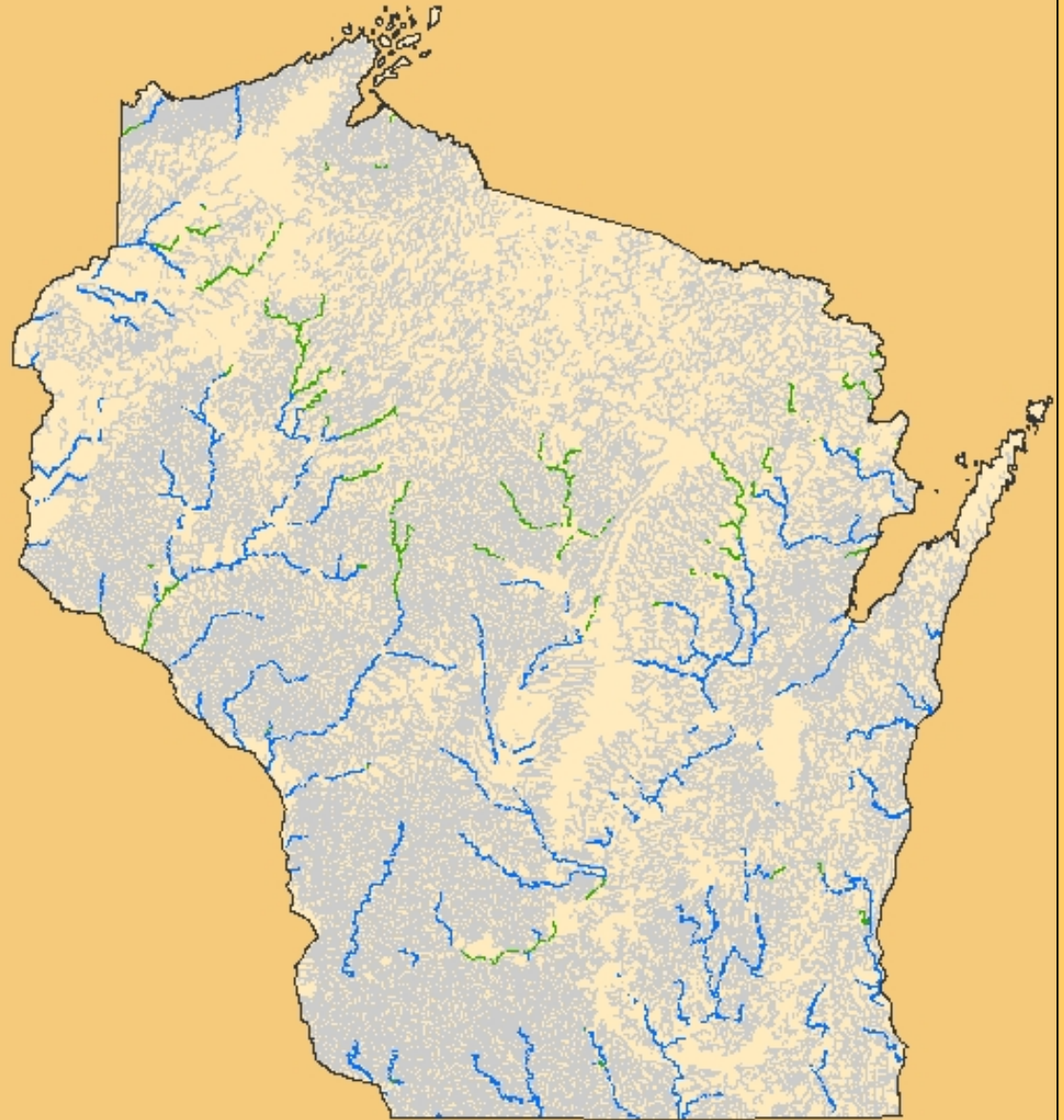


**Channel
catfish:
Current
climate**



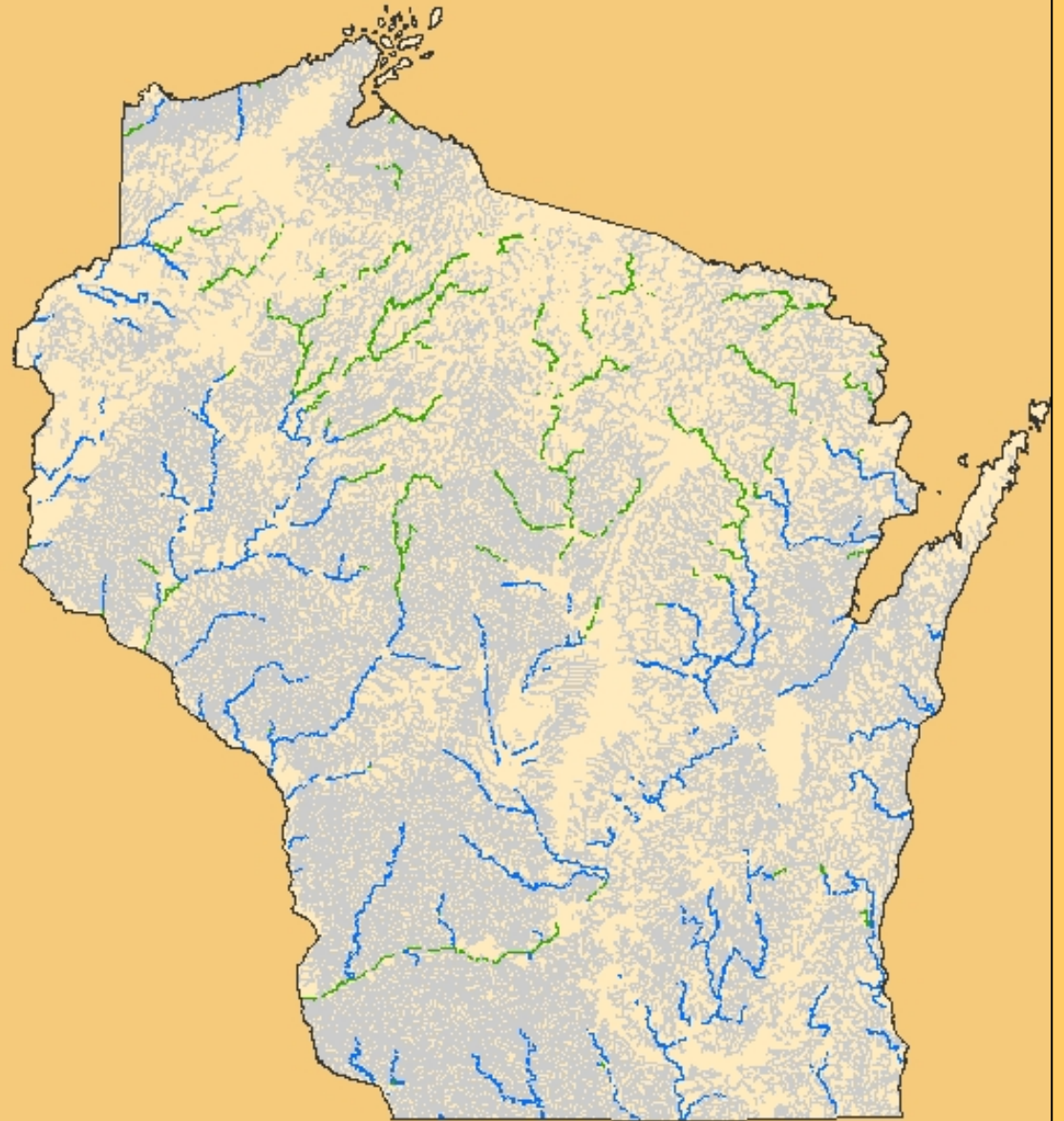
Channel catfish:

**+1 C increase
air and water**



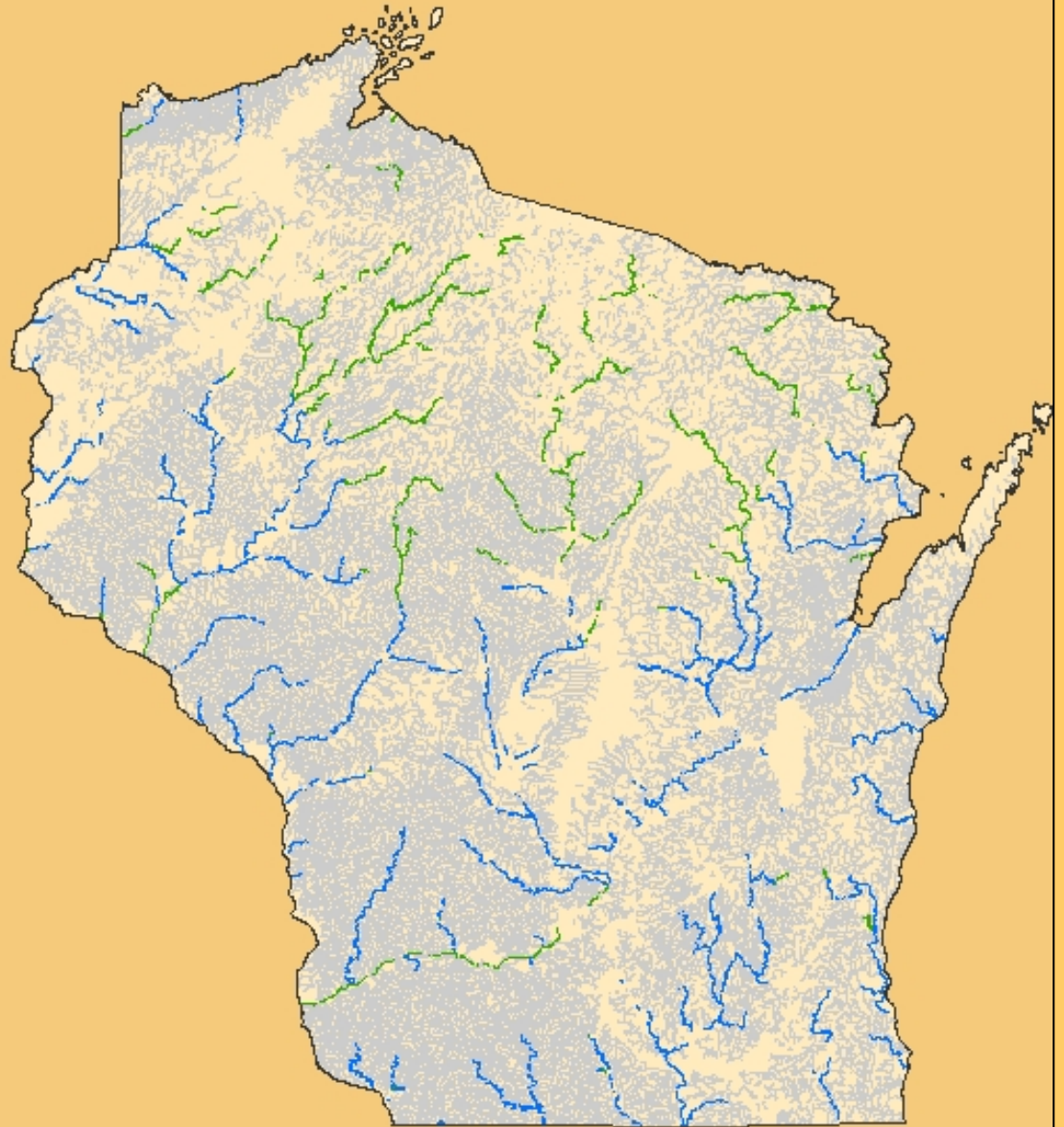
Channel catfish:

**+3 C increase
air and water**

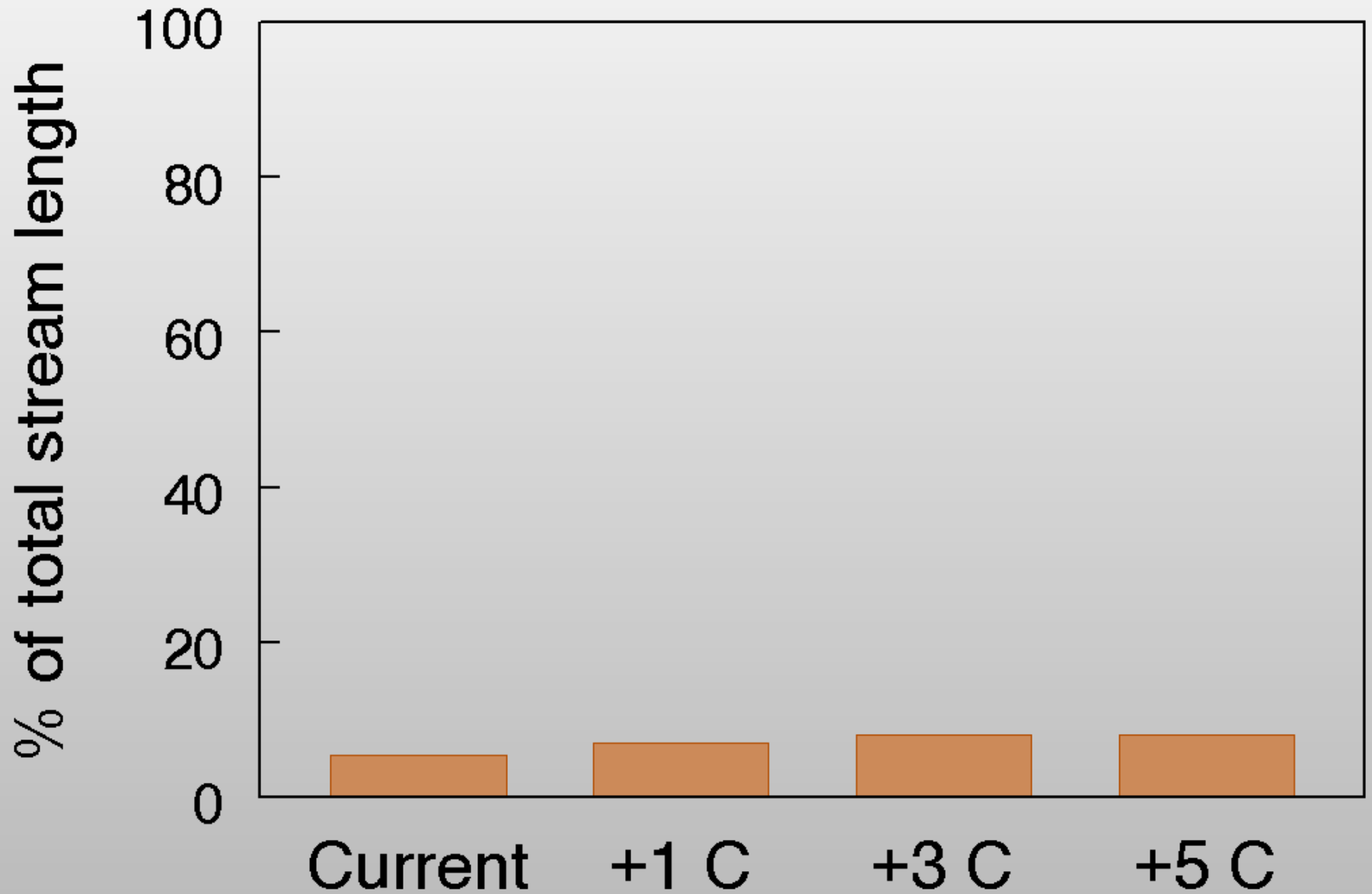


Channel catfish:

**+5 C increase
air and water**



Channel catfish habitat gains w/ temperature



Channel catfish limited by stream size



Black crappie



**Black
crappie:
Current
climate**

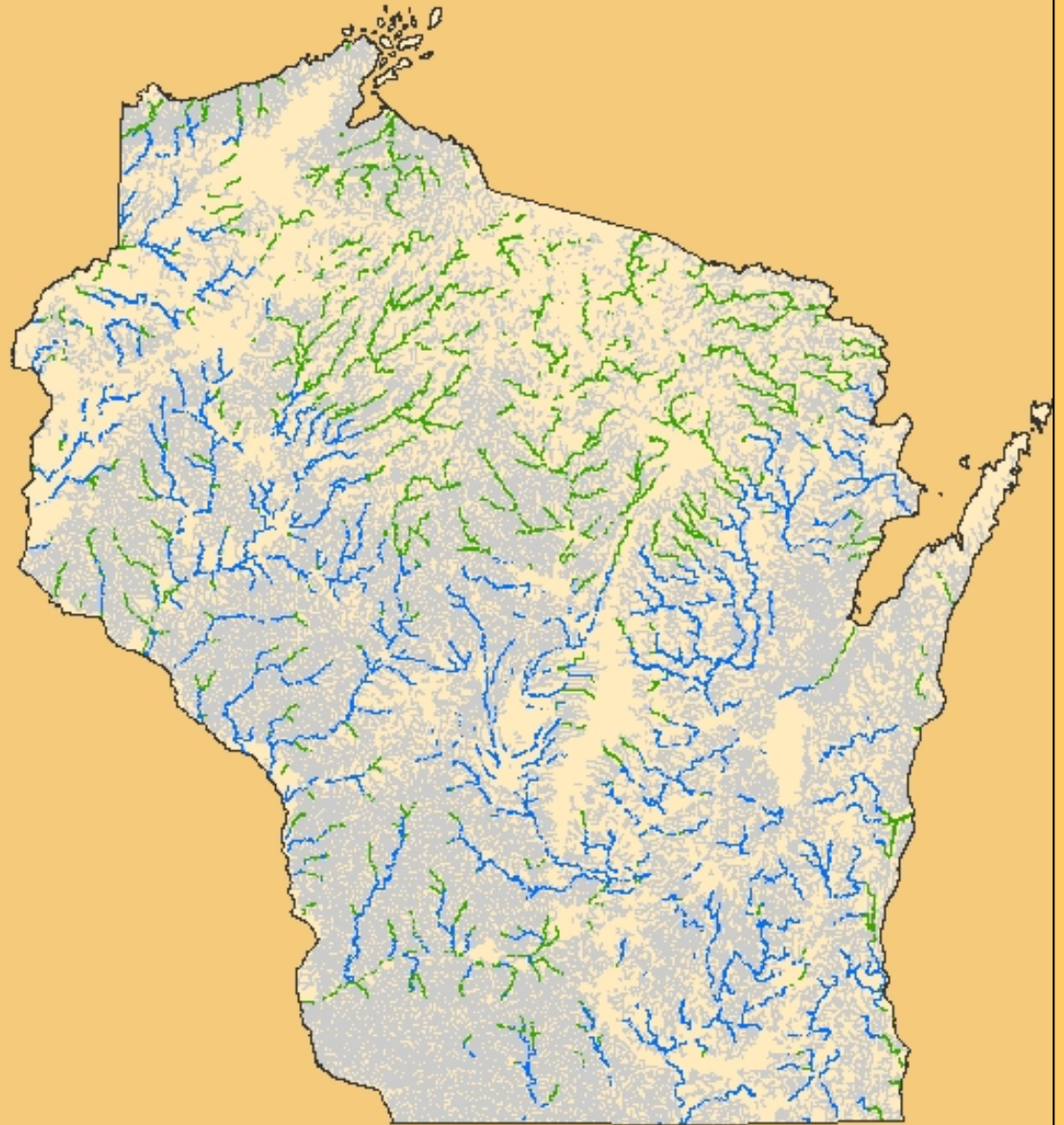


**Black
crappie:
+1 C increase
air and water**

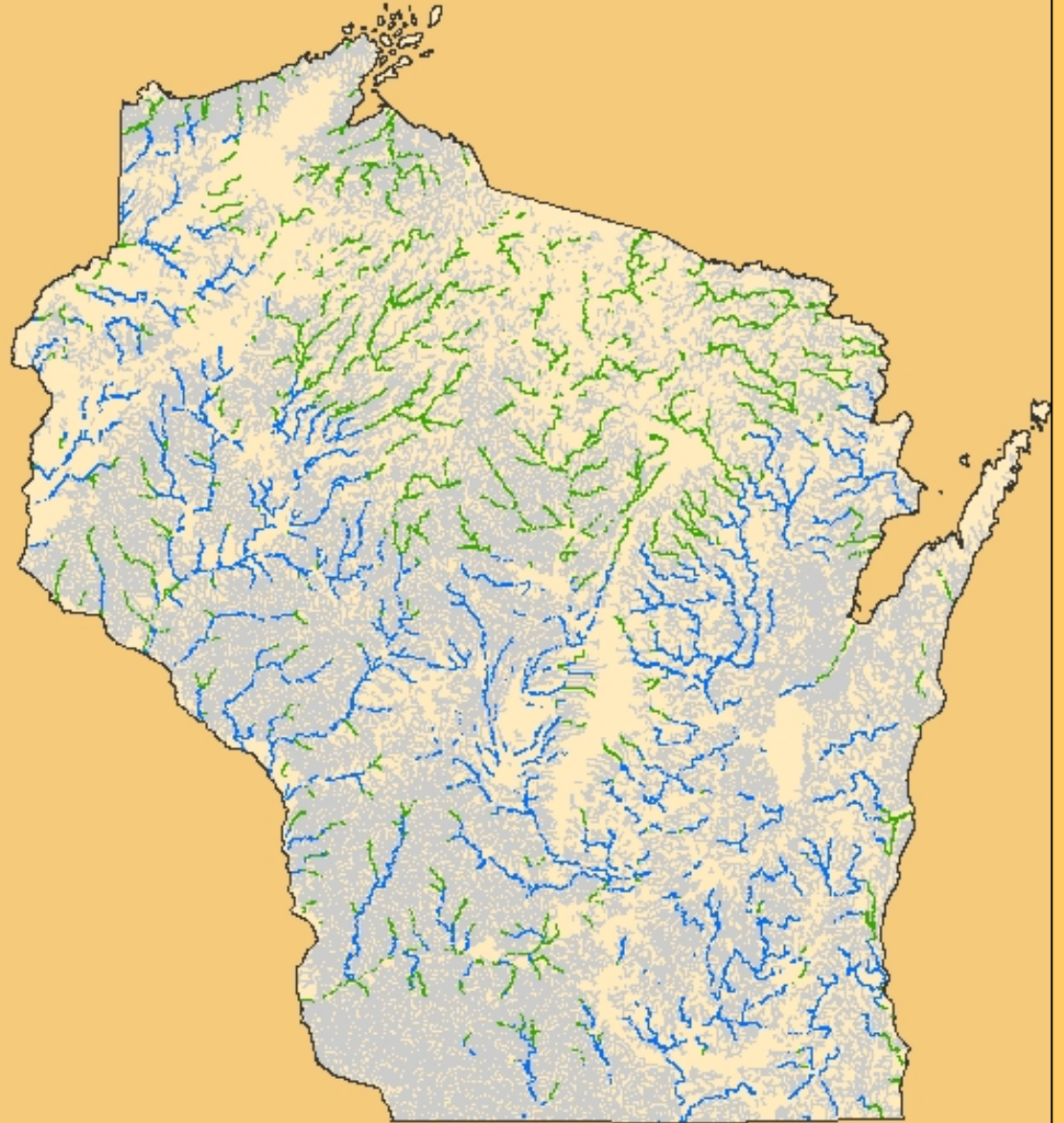


**Black
crappie:**

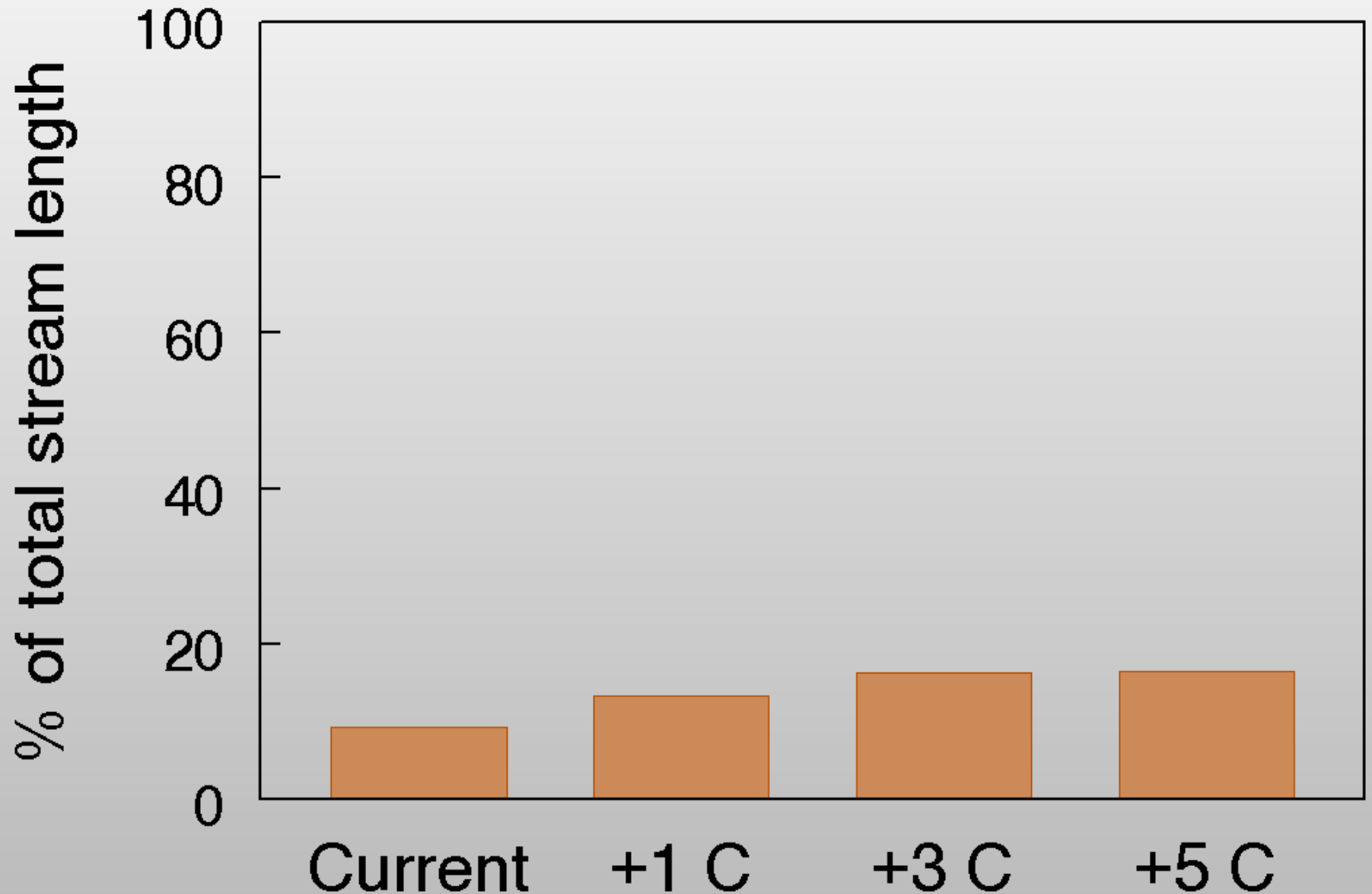
**+3 C increase
air and water**



**Black
crappie:
+5 C increase
air and water**



Black crappie habitat gains with temperature



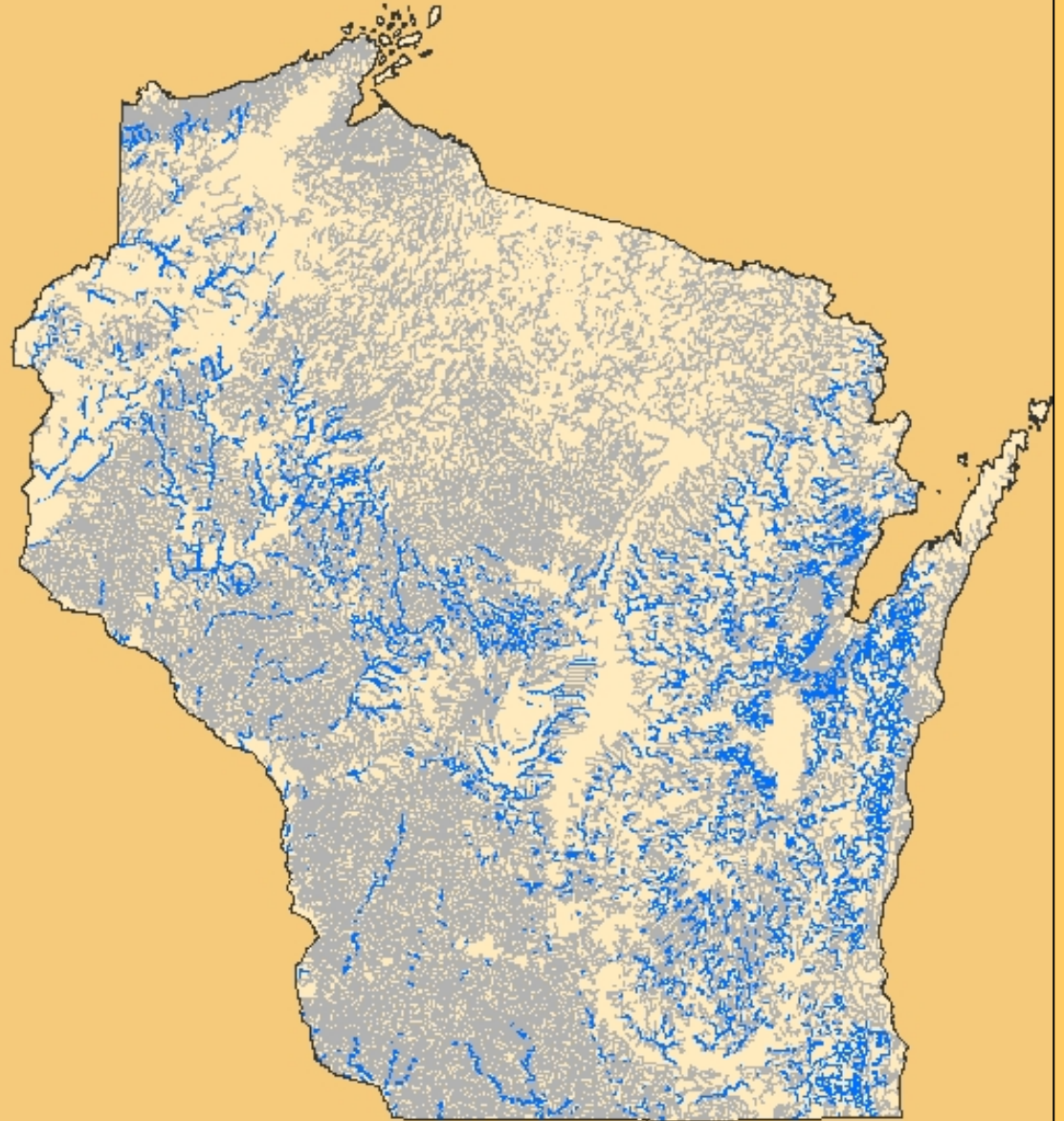
Black crappie limited by stream gradient, size



Banded darter

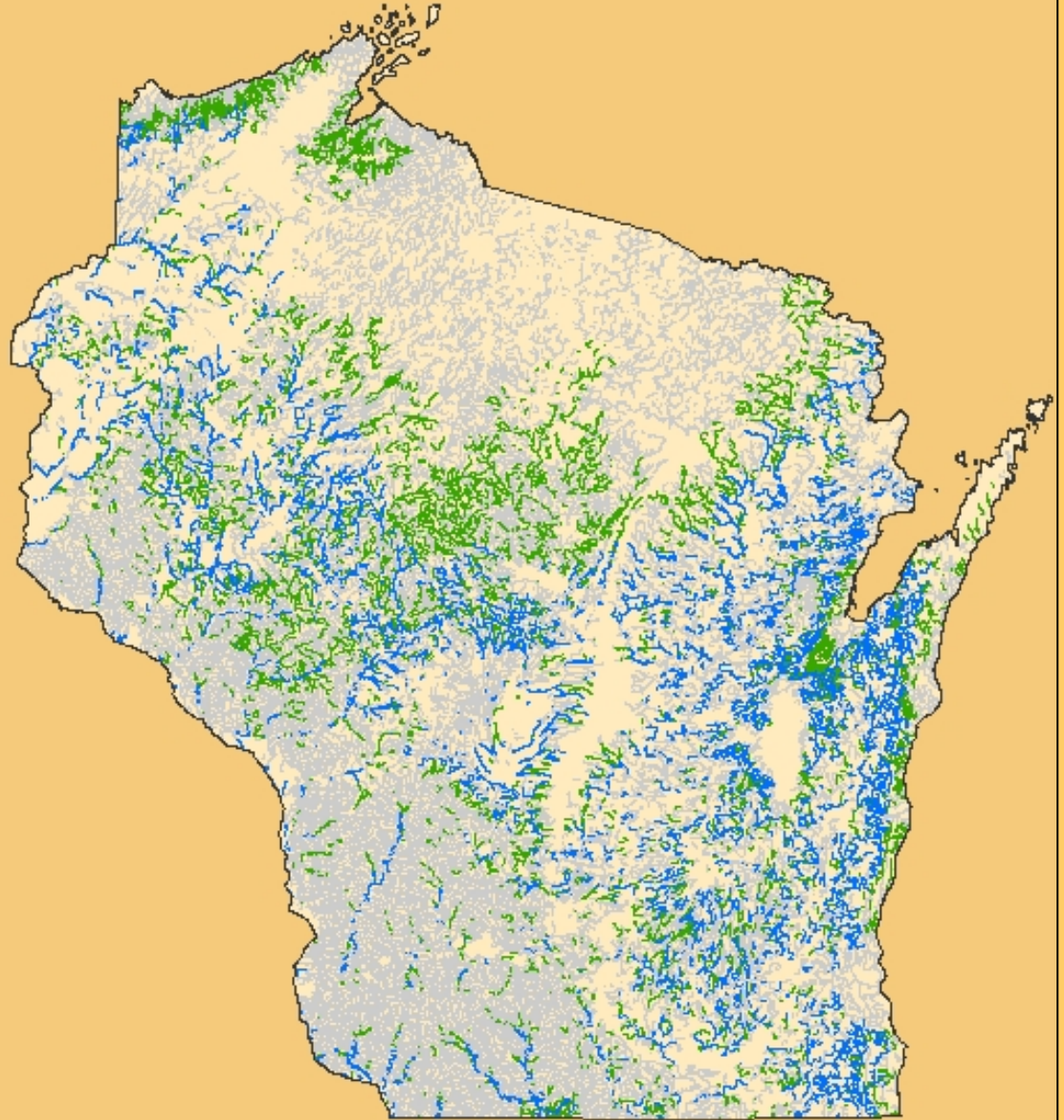


**Banded
darter:
Current
climate**



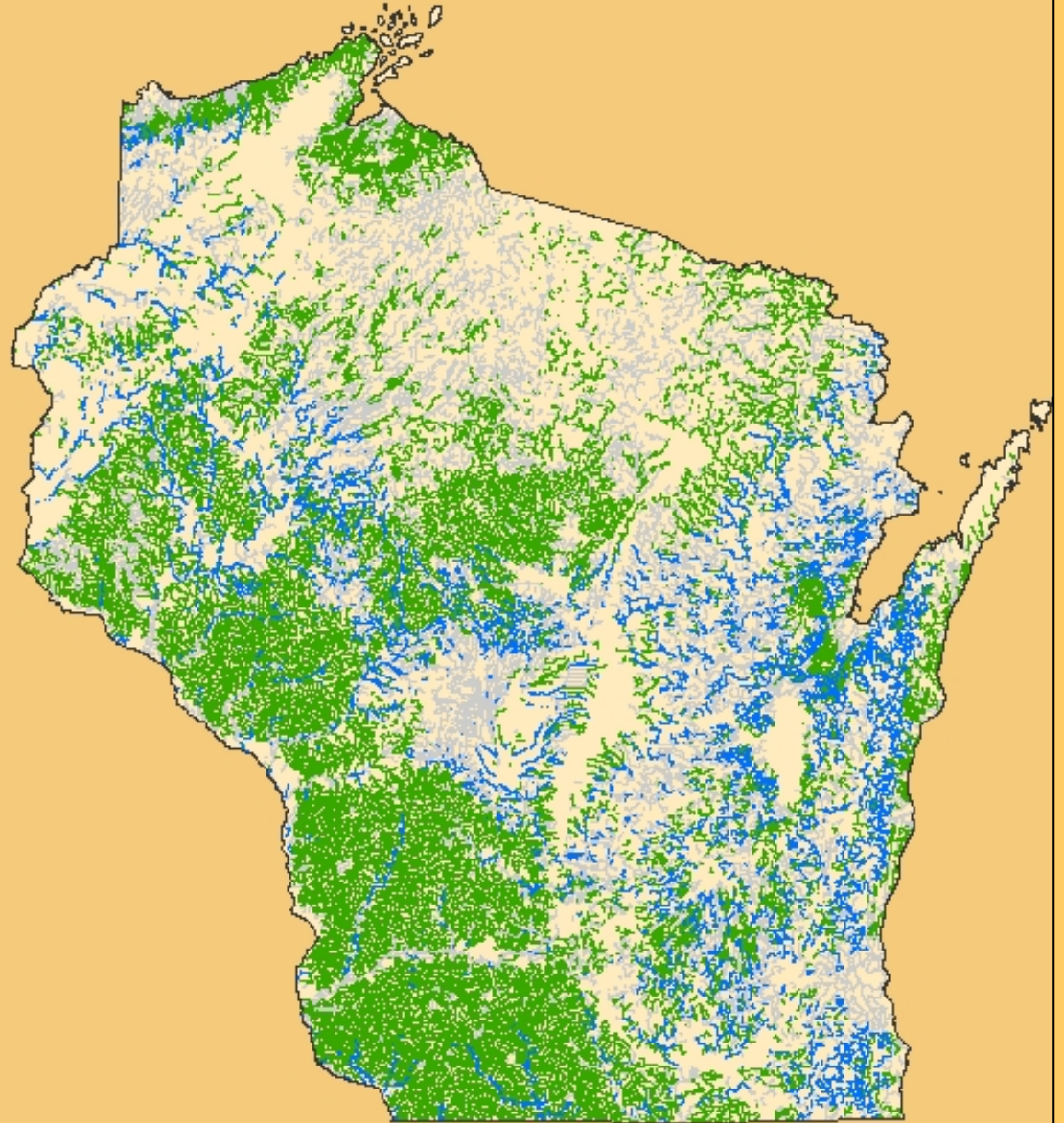
**Banded
darter:**

**+1 C increase
air and water**



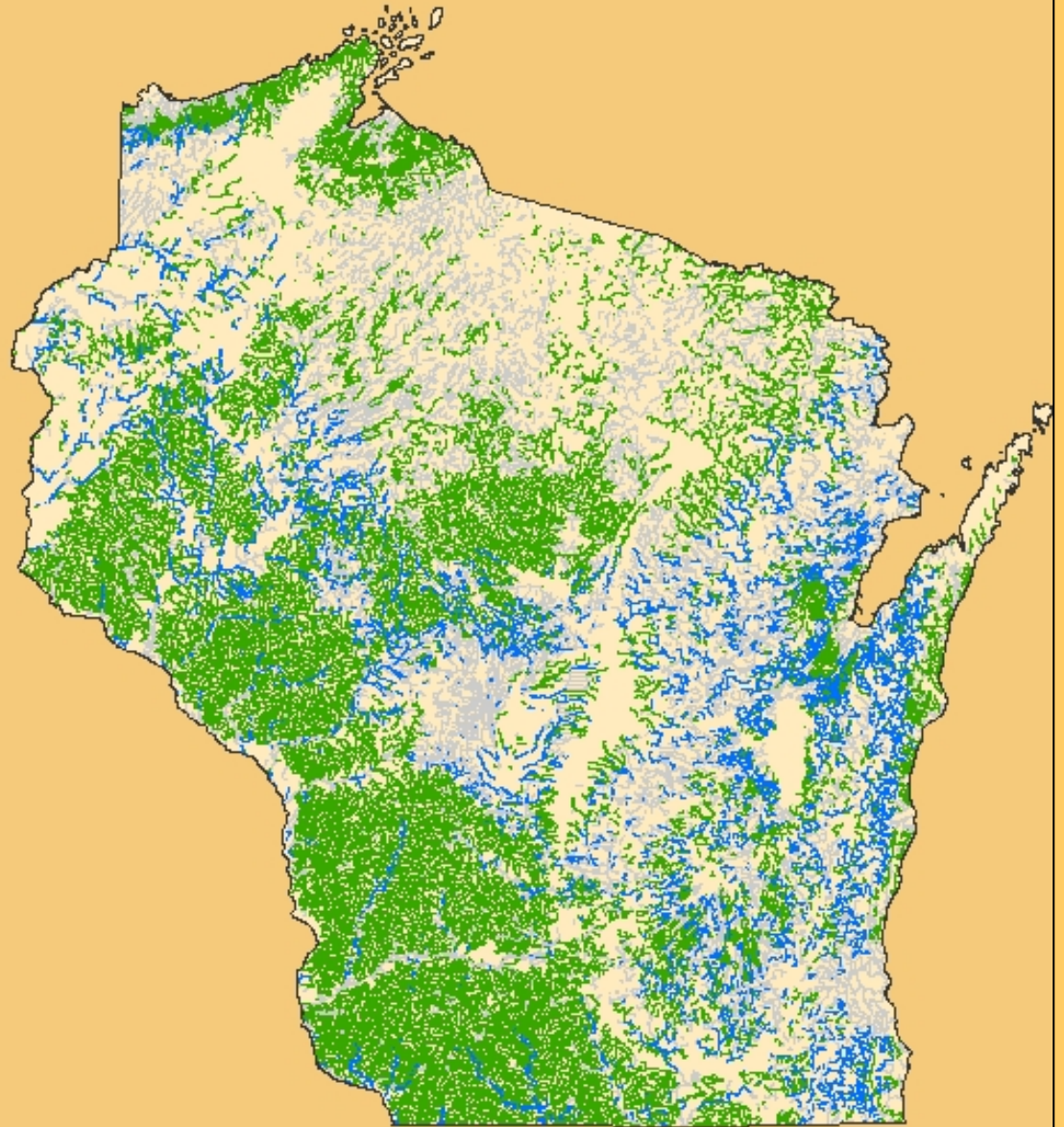
Banded darter:

**+3 C increase
air and water**

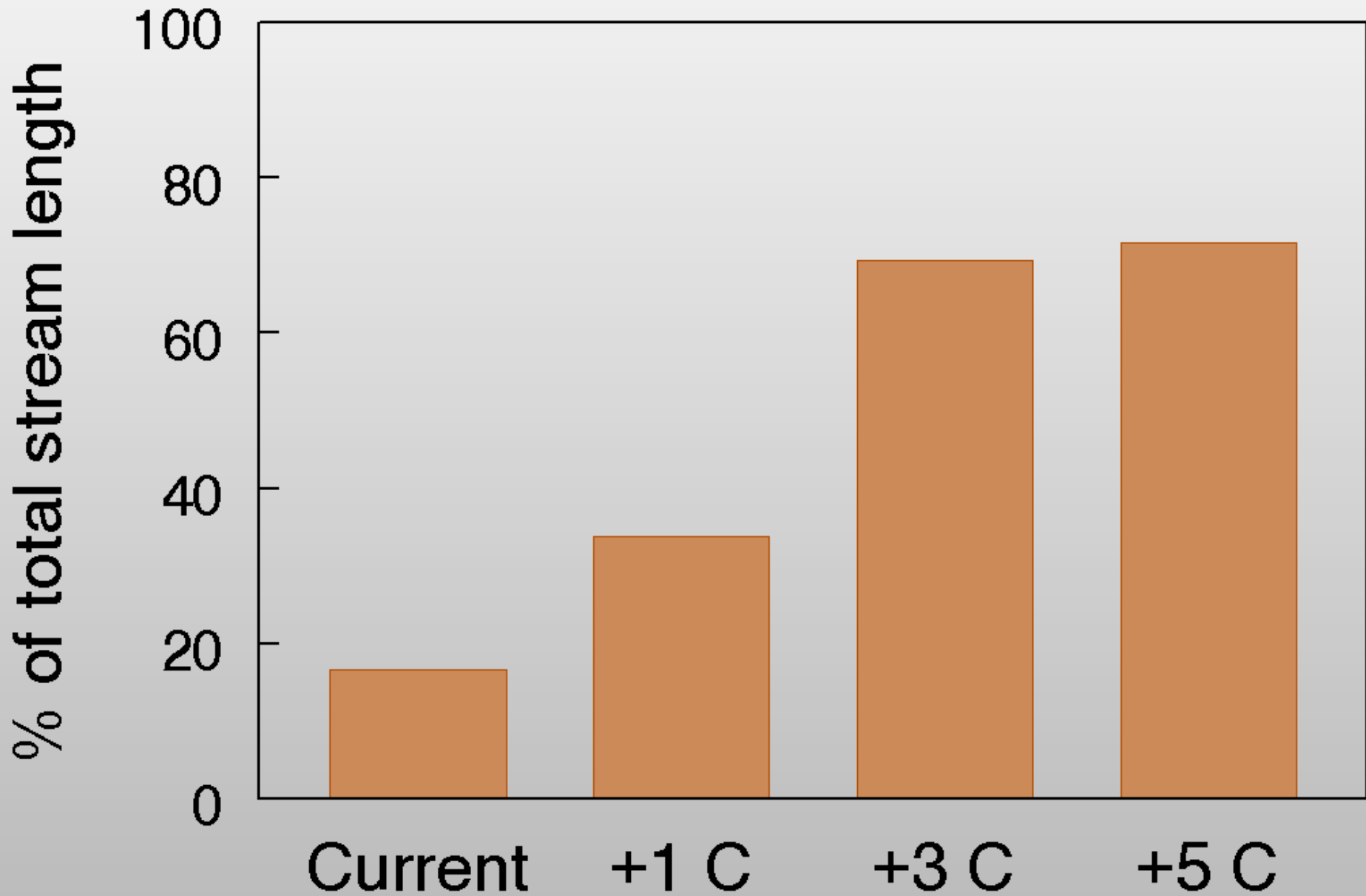


Banded darter:

**+5 C increase
air and water**



Banded darter habitat gains with temperature



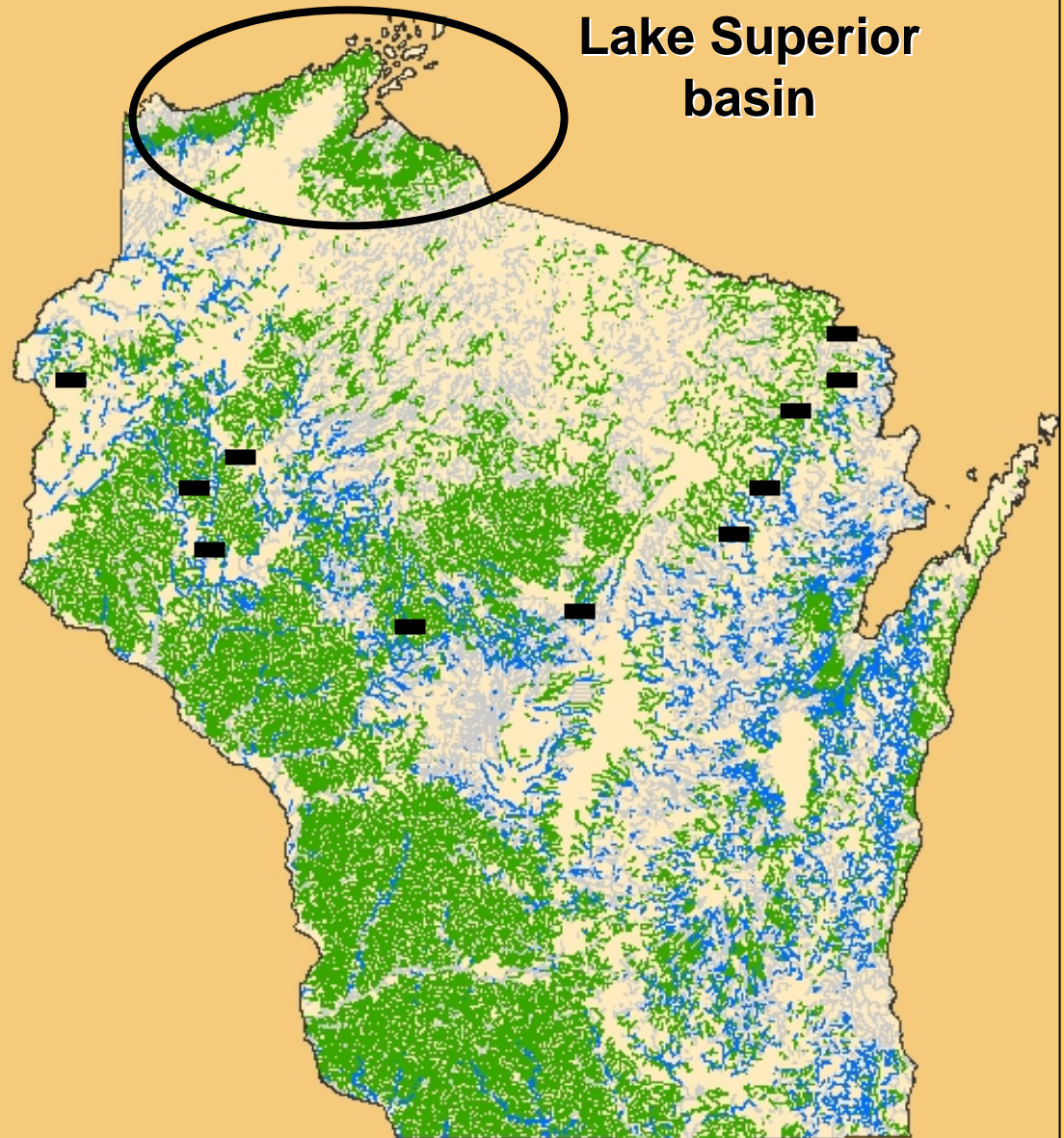
Banded darter limited by access



**Banded
darter:**

**+5 C increase
air and water**

**With key
barriers
shown**



Summary and conclusions

Climate warming will greatly increase warmwater habitat

Warmwater species will generally not increase as much as habitat because of:

Other limiting factors (e.g. stream size, gradient)

Lack of access to newly suitable habitats

Acknowledgments

