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science for a changing world

Climate and Land-use/Land Cover Change Effects on Stream Fishes and Instream Habitat in the Chesapeake Bay Watershed

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U.S. Geological Survey

Outline

- Priority Ecosystems Studies (PES) Large Landscape Research Funding: *Thresholds in fluvial fish vulnerability to climate change-induced flow alteration*
- Climate and Land-use/Land-cover Change (LULC) vulnerability assessment for Chesapeake Watershed Stream Fishes
  - Discussion & feedback

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Upcoming research!

- Priority Ecosystems Studies (PES) Large Landscape Research Funding: *Thresholds in fluvial fish vulnerability to climate change-induced flow alteration*
- FY2023-2025 project
- Large collaborative team:

PIs: Taylor Woods,

Kelly Maloney

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WFRC

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WMA

James McKenna Jr.
GLSC

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LMG WSC

Daniel Wieferich
CSS

Tanja Williamson
OH-KY-IN WSC

Bob Zuellig
CO WSC

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Priority Ecosystem Studies landscapes
Puget Sound
a
Columbia basin
Cold
dry, warm summer
no dry season, cold summer
Great Lakes
c
Cold
no dry season,
warm summer
Chesapeake Bay
d
Cold - Temperate
no dry season, hot summer
Desert Southwest
b
Upper Colorado basin
Arid
steppe
desert
Gulf of Mexico
e
Mobile basin
Temperate
no dry season,
hot summer

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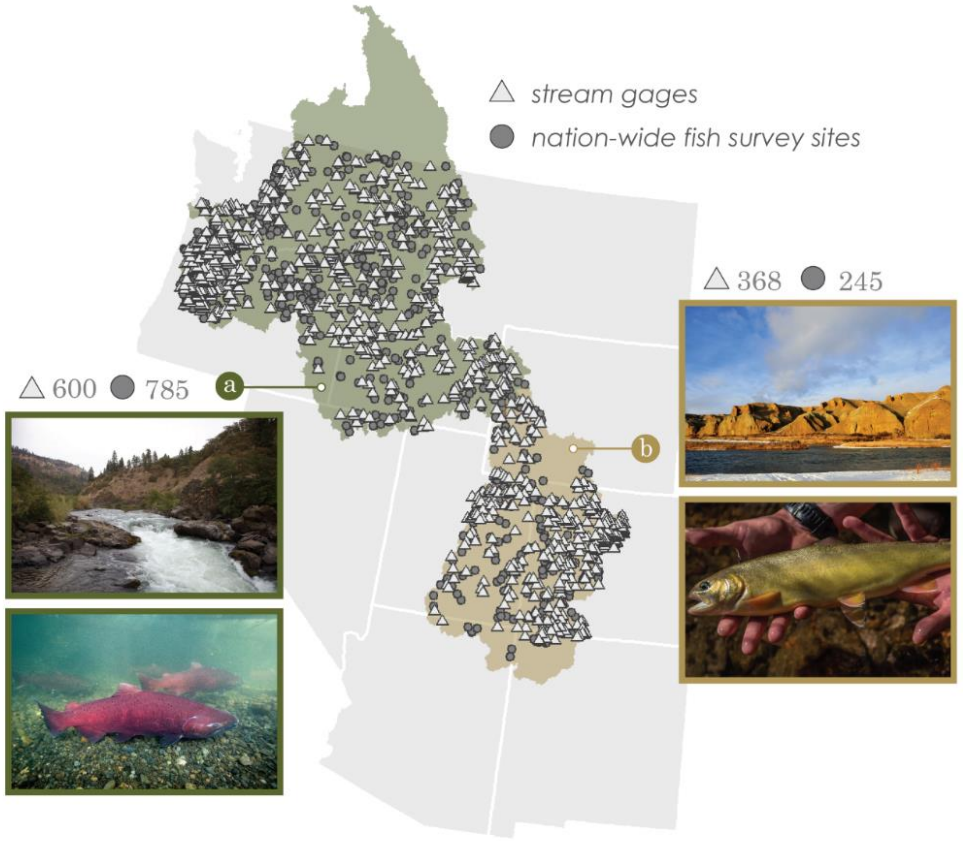
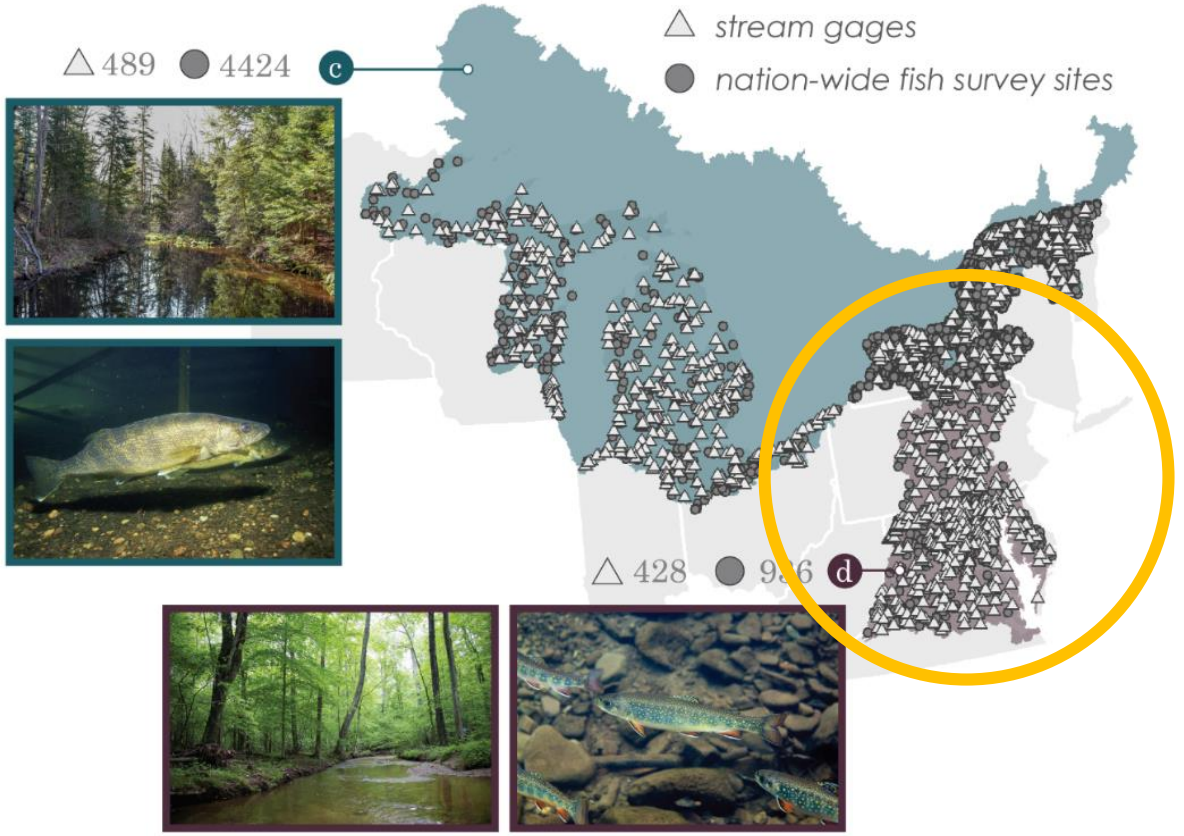
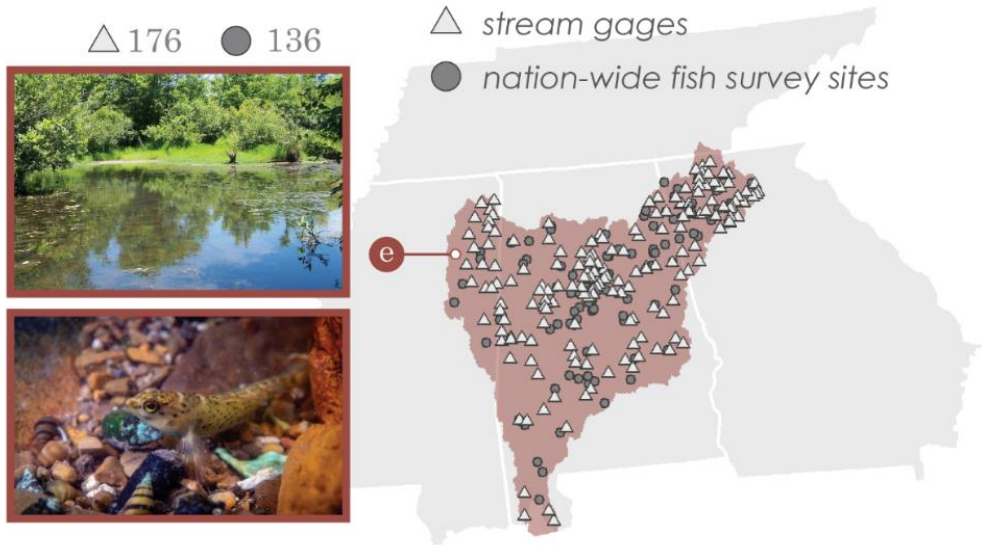

stream gages
nation-wide fish survey sites
△ 600 ● 785
a
△ 368 ● 245
b


stream gages
nation-wide fish survey sites
△ 489 ● 4424
c
△ 428 ● 936
d


△ 176 ● 136
stream gages
nation-wide fish survey sites
e

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PES LL project aims

- Predict streamflow alteration at all streams within 5 focal regions in contemporary periods & in future
  - Models based on climate, land-use/land-cover, & water use predictors
- Streamflow metrics include: high flow (flood) and low flow (drought) magnitude, duration, frequency, and timing
- Relate streamflow alteration to fish species & community characteristics (e.g., traits) of interest

- Get in touch:
- Taylor Woods tewoods@usgs.gov
- Kelly Maloney kmaloney@usgs.gov

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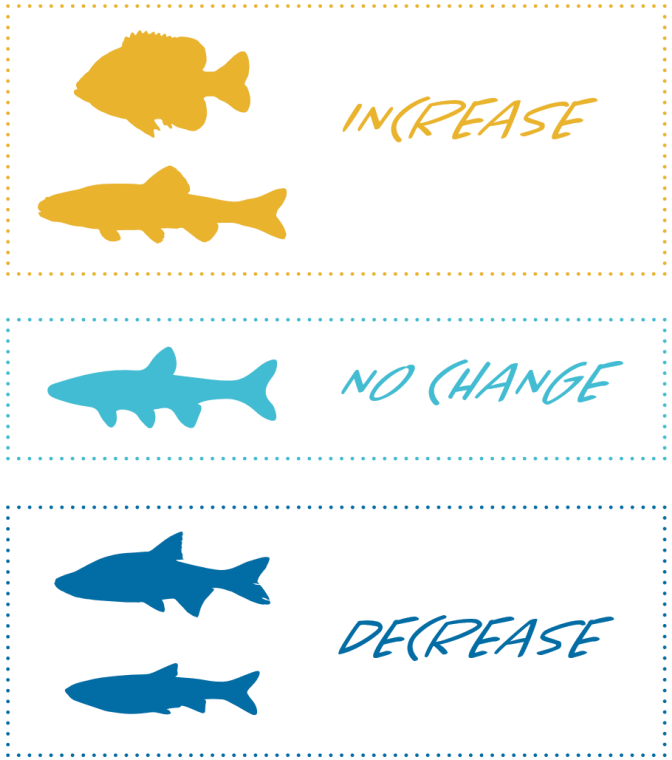
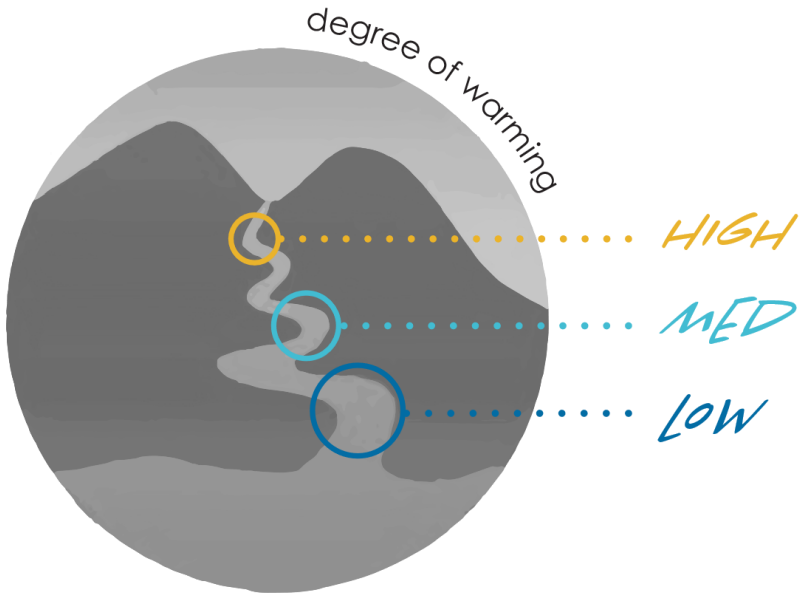
Climate and LULC change vulnerability assessment for Chesapeake Bay Watershed Stream Fishes

variable responses among species





variable effects among habitats

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Woods, Taylor, Mary C. Freeman, Kevin P. Krause, and Kelly O. Maloney. "Observed and projected functional reorganization of riverine fish assemblages from global change." *Global Change Biology* (2023).

Main questions

What **species** are most vulnerable to global change?

What **regions & habitats** are most vulnerable to global change?

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What **species** are most vulnerable to global change?

Trait	Values
Substrate preference	SS (soft sediment – muck, clay, silt), LTH (lithophilic – gravel, rock, cobble), VG (vegetation or vegetated debris)
Reproductive strategy	CC [spawns over clean, coarse (lithophilic) substrate], GD (nest guarder), O (other)
Temperature preference	WM (warm), CL (cool-water), CD (cold-water)
Velocity preference	RH (rheophilic; fast-flowing), PL (pool; sluggish), O (other)
Trophic guild	CRN (carnivore; invertebrates and fishes), HRB (herbivore), INV (invertivore), O (omnivore)

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	bluegill	creek chub	rosyside dace	golden shiner	blacknose dace
					
	Lepomis macrochirus	*Semotilus atromaculatus*	*Clinostomus funduloides*	*Notemigonus crysoleucas*	*Rhinichthys atratulus*
substrate	vegetation	veg., muck, gravel	gravel	vegetation	veg., muck, gravel
reproduction	guarder	lithophil	lithophil	other	lithophil
temperature	warm	cool	warm	warm	cool
velocity	pool	other	other	other	rheophilic
trophic	invertivore	omnivore	invertivore	omnivore	omnivore

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bluegill

creek chub

rosyside dace

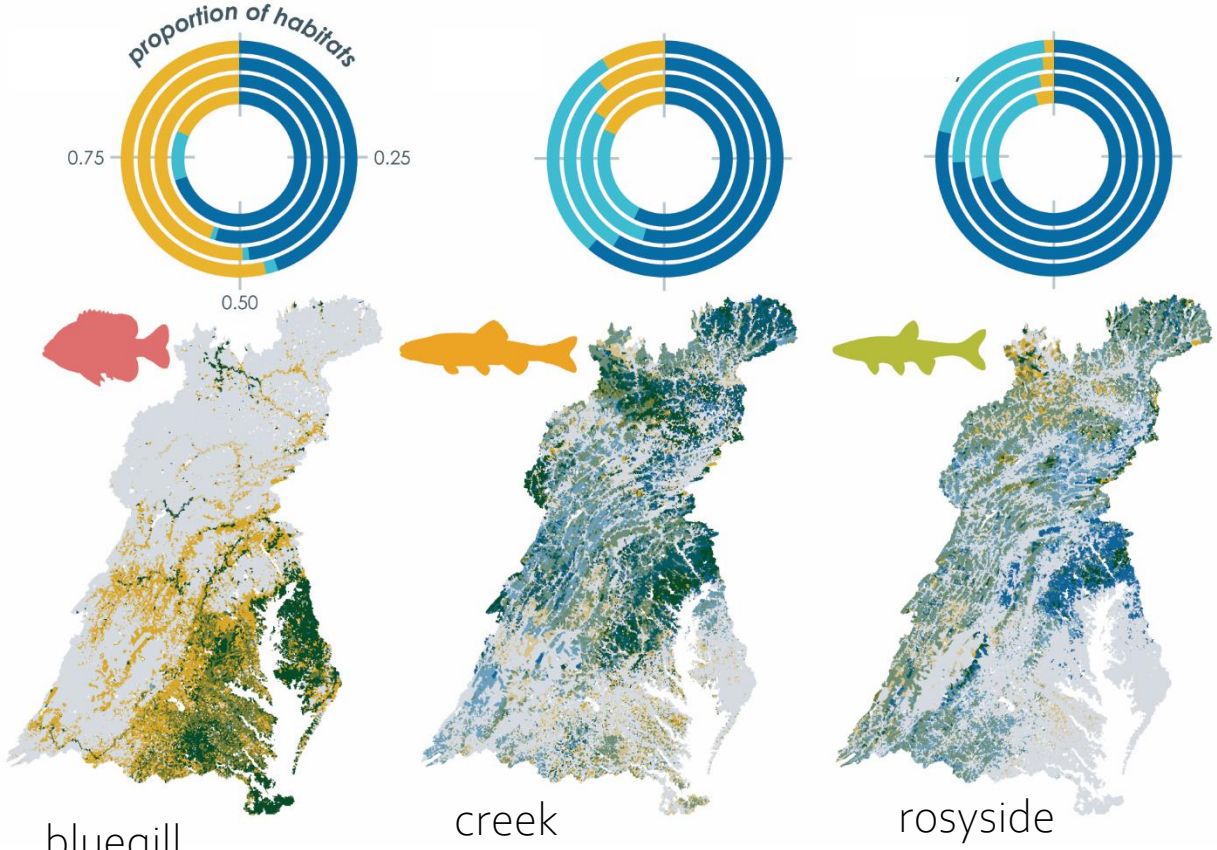
golden shiner

blacknose dace

low, medium, high

abundance ~ predictors

Climate, LULC



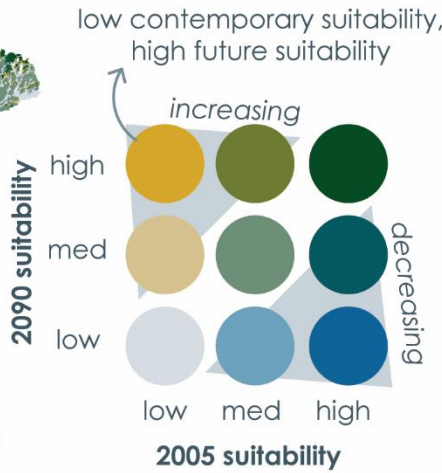
bluegill

creek chub

rosyside dace

golden shiner

blacknose dace



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What **species** are most vulnerable to global change?

	Lepomis macrochirus	*Semotilus atromaculatus*	*Clinostomus funduloides*	*Notemigonus crysoleucas*	*Rhinichthys atratulus*
substrate	vegetation	veg., muck, gravel	gravel	vegetation	veg., muck, gravel
reproduction	guarder	lithophil	lithophil	other	lithophil
temperature	warm	cool	warm	warm	cool
velocity	pool	other	other	other	rheophilic
trophic	invertivore	omnivore	invertivore	omnivore	omnivore

‘winner’ traits: generalist, warm-water, fine substrate, slow-water

‘loser’ traits: cold-water, clean substrate, fast-water

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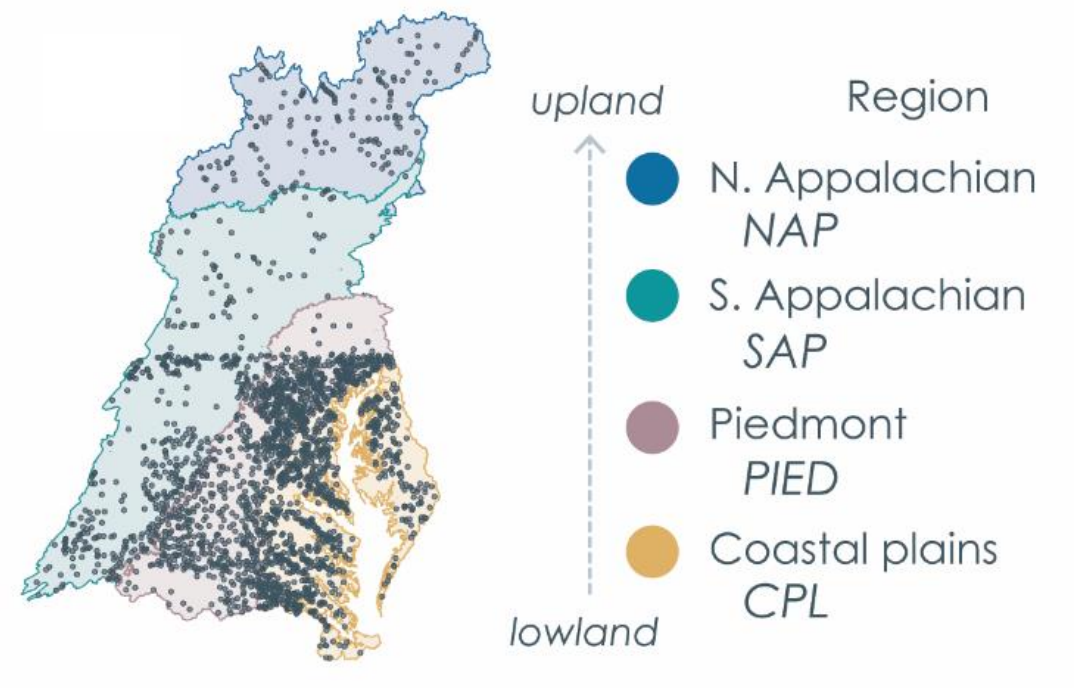
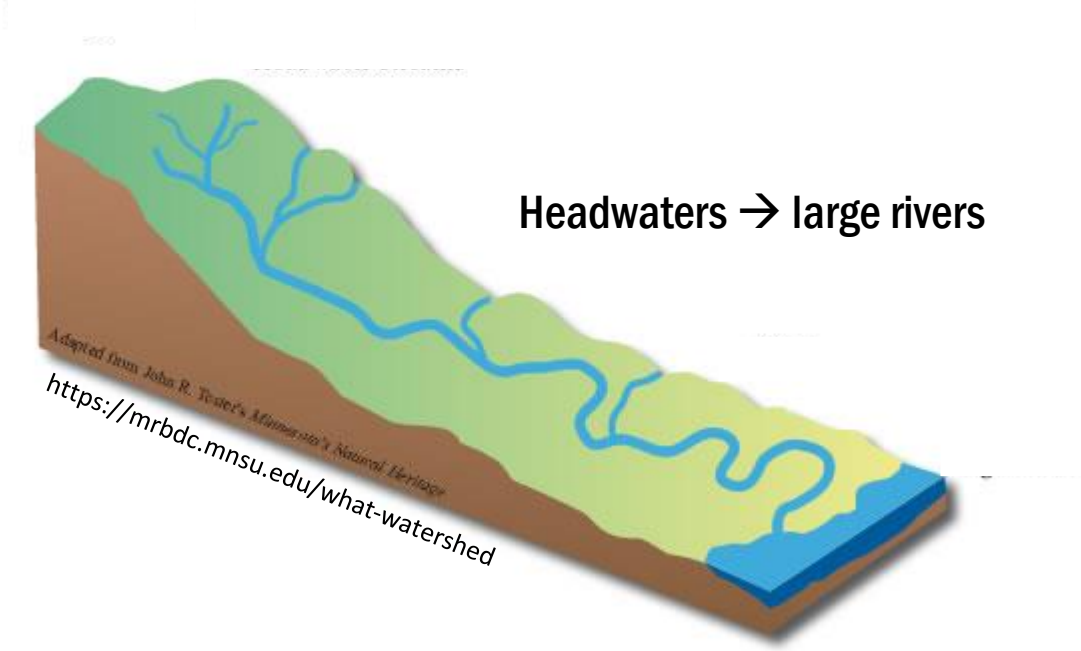
What **regions & habitats** are most vulnerable to global change?

- Regions



- Habitat sizes



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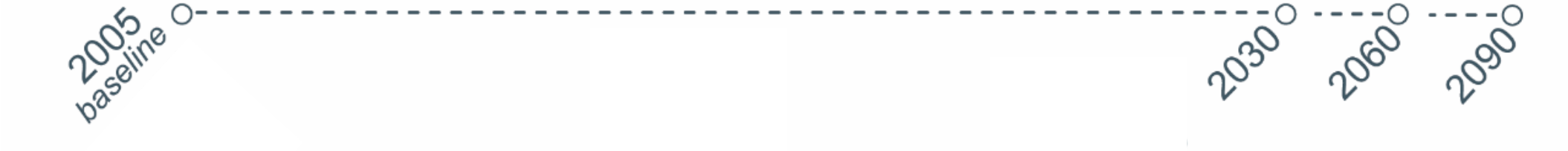
Metric	Description
CARNPIND	Percentage of carnivorous individuals
COLDPIND	Percentage of cold-water individuals
LITHPIND	Percentage of coarse (lithophilic) spawners
RHEOPIND	Percentage of rheophilic individuals

metrics ~ predictors

Climate, LULC



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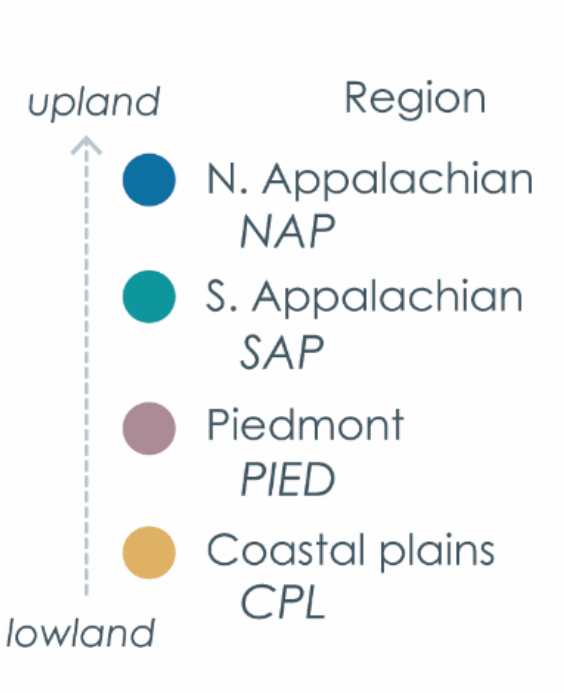
- Summarize model output:



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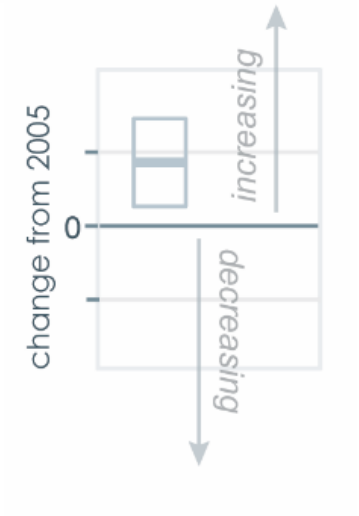

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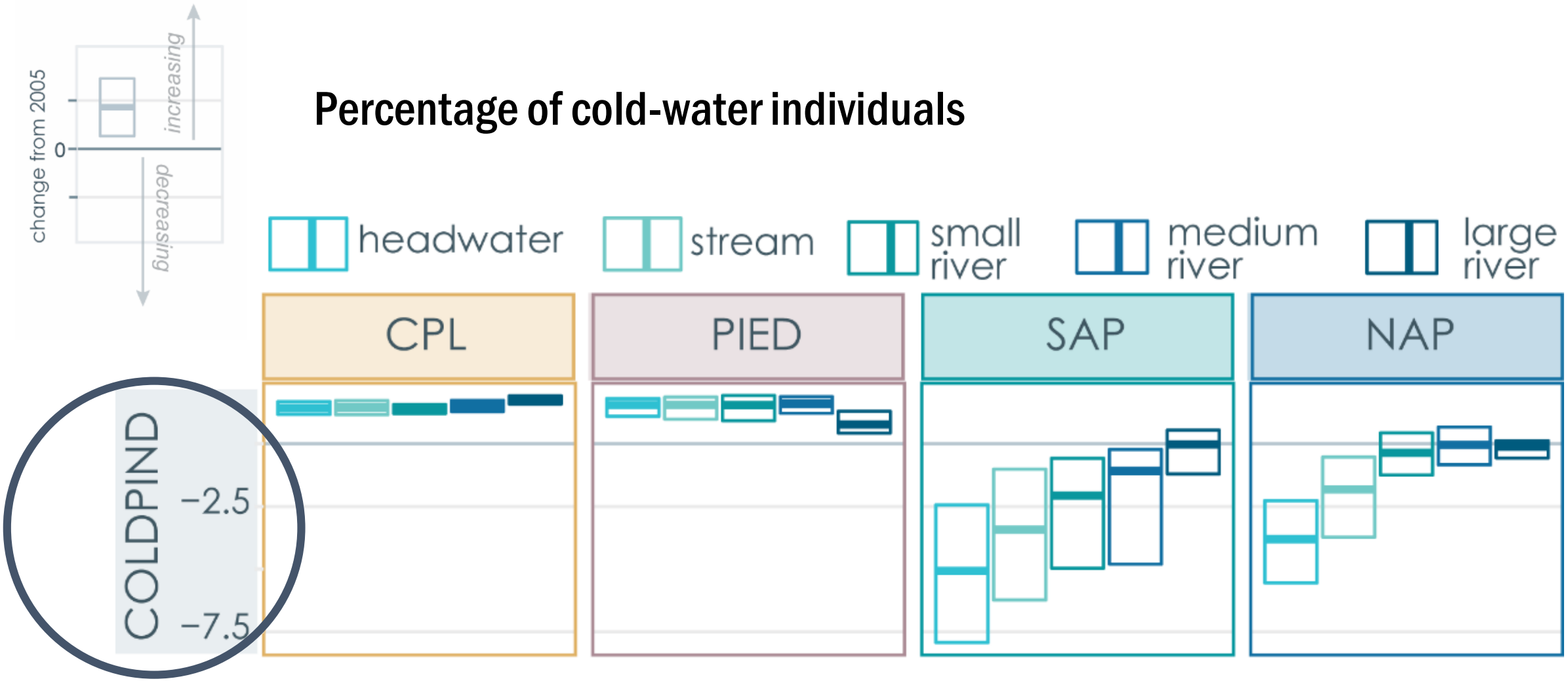

Loss of cold-water individuals: small streams in Appalachian regions

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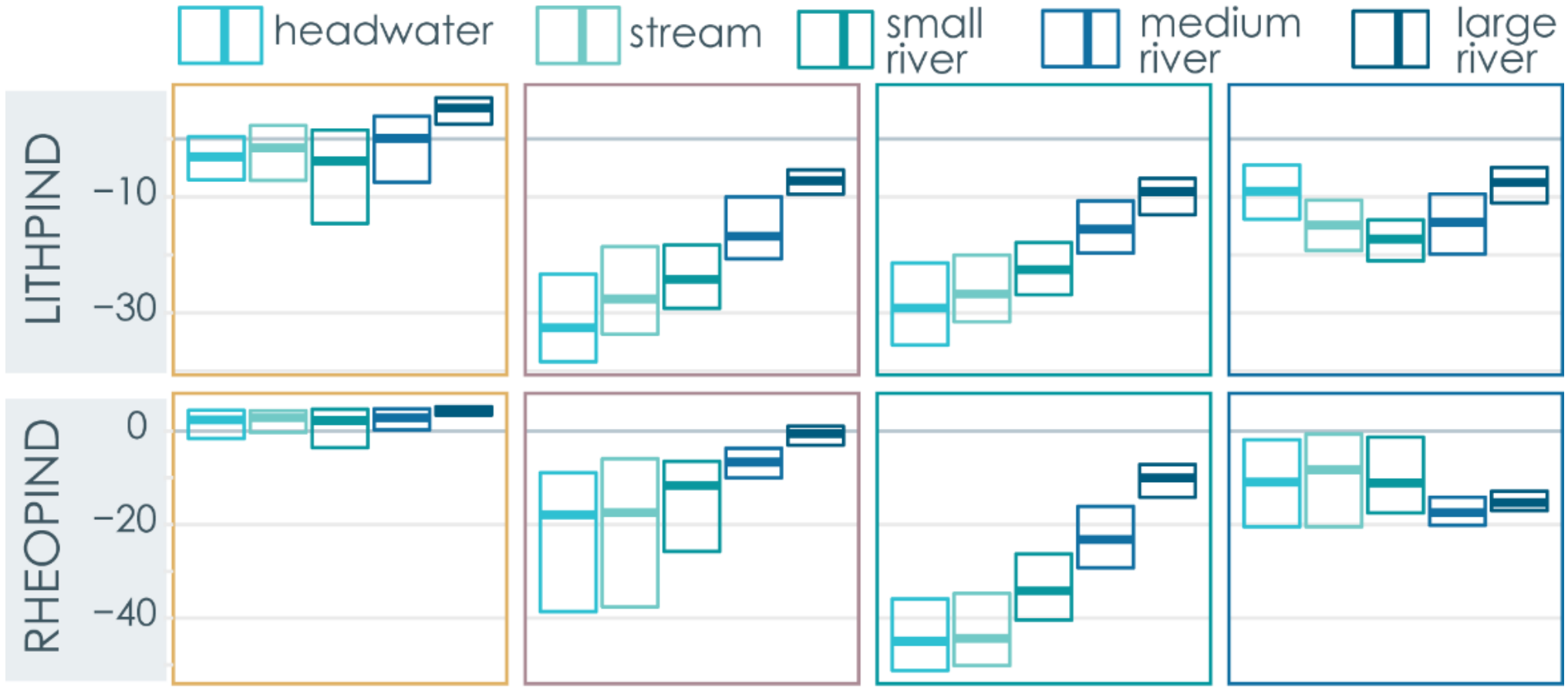
What **regions & habitats** are most vulnerable to global change?

Percentage of lithophilic, rheophilic individuals



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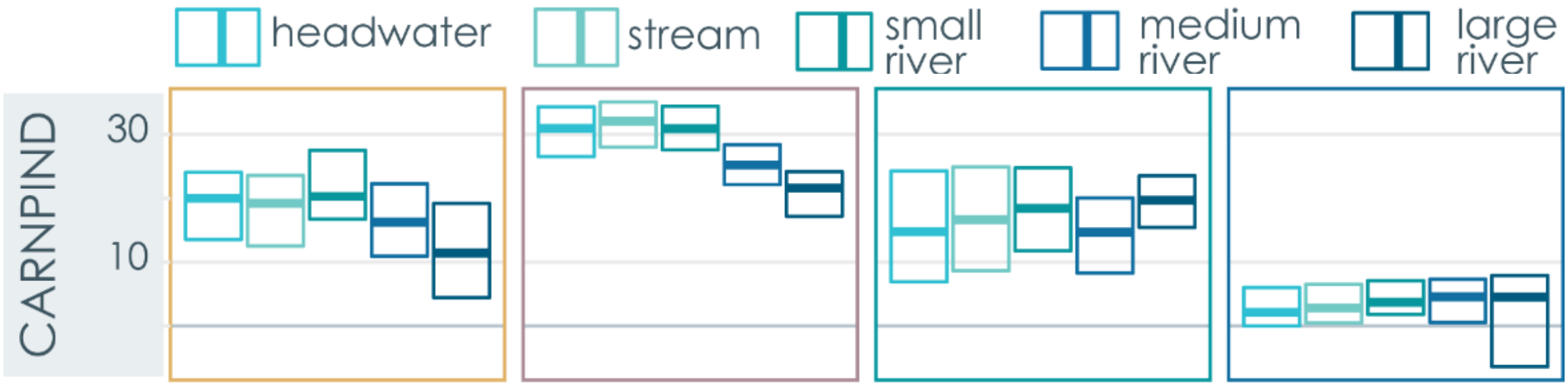
Small streams in Piedmont, S. Appalachian regions

What **regions & habitats** are most vulnerable to global change?

Percentage of carnivorous individuals



Increasing predators: small streams in Piedmont, coastal regions

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Take homes

- Not all species respond similarly to climate & land-use/land-cover change
- Habitat stressors (increasing temperature, developed land-use) vary spatially on the landscape
- Understanding trait-environment relationships may help generalize effects of global change on ecological communities
- Next steps: develop a web application

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Web application

- With help from the USGS Community for Data Integration, developing an R Shiny application to present results.
- What would be useful?
  - Downloading raw data (e.g., model inputs or outputs)?
  - Downloading summaries by ecoregion and or stream size?
  - Information on the functional grouping assignments for fishes?
  - Downloadable maps of model inputs and outputs?
  - What format graphics do you prefer: static vs. interactive?
  - What temporal results: 2005 (baseline), 2060, 2090?

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Thank you!

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