

The Response of Fish Habitat to Environmental Stressors in the Albemarle-Pamlico Watershed

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ABSTRACT

The provision of habitat for fish is an important service provided by rivers. Future land development and climate change will likely alter several aspects of habitat. We have used multiple logistic models to predict the presence of 25 fish species within the Albemarle-Pamlico basin, using predictors of flow, velocity, temperature, land use, and environmental setting from the USGS NHDPlus dataset. The most parsimonious models for these species typically included positive responses to either flow or velocity and peaked responses to temperature. These models are incorporated into the FRAMES framework to take input from hydrologic models and feed into a fish community bioaccumulation model. This framework can serve as a tool for the assessment of effects of multiple stressors and alternative future scenarios on valued fish habitat and productivity endpoints.

BACKGROUND

- Wadeable streams provide a valuable service of aquatic habitat for fish and other species
- Physical habitat alteration is one of the greatest stressors in streams and rivers
- Objective: Identify habitat relationships for fish species in this region to support more complex framework-based assessments

METHODS

FISH DATA

Taken from NCDENR (2006), dropped multiple visits (N=191), included species occurring at >20% of sites



PHYSICAL DATA



<http://www.horizon-systems.com/nhdplus/>

- Flow (cfs)
- Slope (m/m)
- Velocity (fps)
- NLCD Land use (%)
- Temperature (C*10)
- Level III Ecoregion
- Elevation (m)

STATISTICAL ANALYSIS AND MODELING

Predictive habitat models were developed using multiple logistic regression (Guisan and Zimmermann 2000) with model selection based on AIC (Burnham and Anderson 2002)

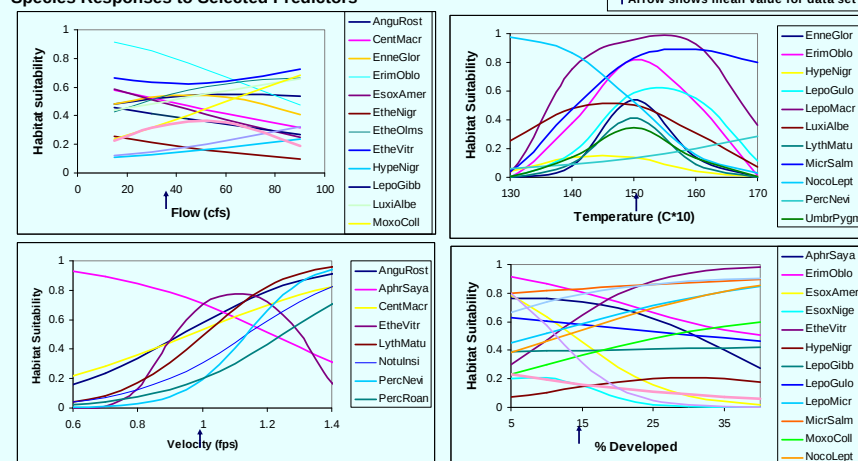
We examined species responses to selected stressors while other stressors were held constant at their mean values

Statistical models are incorporated in the FRAMES framework <http://www.epa.gov/ATHENS/research/modeling/3mra.html>-similar models will be used in the MIMES (<http://www.uvm.edu/giee/mimes/>) framework

Response of 25 Fish Species to Stressors (*Intolerant)

	Fish spp.	Flow	Velocity	Temp	Slope	Elev	Natural	Developed	Crops	% Correct
Eel	AnguRost									81
Pirate perch	AphrSaya									86
Pickrel	EsoxAmer									82
	EsoxNige									77
Darters	EtheVitr									83
	EtheNigr									81
	PercNevi*									76
	PercRoan*									76
	EtheOlms									73
Sunfish	LepoMacr									85
	EnneGlor									85
	LepoMicr									76
	CentMacr									74
	MicrSalm									63
	LepoGulo									61
	LepoGibb									60
Minnows	LuxiAlbe									78
	LythMatu*									77
	NocoLept									85
	NotrProc									74
Suckers	MoxoColl									81
	ErimOblo									76
	HypeNigr									75
Madtom	Notulnsi									71
Mudminnow	UmbrPygm									82

Species Responses to Selected Predictors



RESULTS AND DISCUSSION

- Good model fits (>75% Correct for 18/25 models) can be developed with a few predictors that are available nationally and remotely (NHDPlus)
- Worst fits were for some sunfish
- This approach lacks measures for substrate and cover

- Species showed a mixed response to FLOW; most species had a positive response to VELOCITY

- The three intolerant species (LythMatu, PercNevi, PercRoan) all showed positive responses to velocity

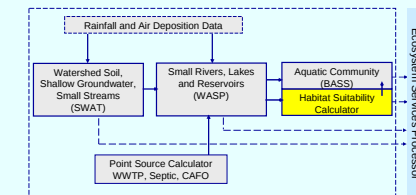
- Several species had peaked responses to TEMPERATURE – near their optimum in this system
- May be quite sensitive to climate/temperature shifts

- Some species showed a positive response to DEVELOPMENT

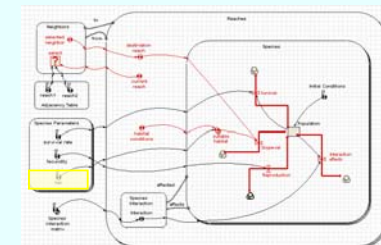
- Fish species may be more tolerant in this region
- Development in blackwater Coastal Plain may provide better habitat (more oxygen, more flow) (Ruhl et al., 1996)

APPLICATIONS IN ASSESSMENT

Habitat models support fish community/bioaccumulation modeling in headwater streams in the Albemarle Pamlico watershed in FRAMES



Habitat models contributing to spatial models of fish communities in stream networks in eastern Oregon within the MIMES framework



REFERENCES

- Burnham, K. P., and D. R. Anderson. 2002. Model selection and inference: a practical information-theoretic approach, 2nd. Springer, New York.
- Guisan, A., and N. E. Zimmermann. 2000. Predictive habitat distribution models in ecology. Ecological Modelling 135:147-186.
- North Carolina Department of Environment and Natural Resources (NCDENR), 2006. Standard Operating Procedure: Biological monitoring – stream fish community assessment program. Raleigh, NC.
- Ruhl, P. M., Angermeier, P. L., and Smogor, Roy, 1996. Relations between fish assemblages and environmental conditions in small Coastal Plain streams in the Albemarle-Pamlico Drainage Basin, North Carolina. [abs.] Annual meeting of the American Fisheries Society, August 1997, Monterey, California.