

Attribute data sources and approach to developing flow-ecology relationships (MI example).

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In 1987 we began compiling all available river-related datasets into a spatially-explicit data system (GIS). This was originally pretty elementary but the idea of bringing together state coverages of data on landscapes, flows, temperature, chemistry, channels, riparian vegetation, fishes, and invertebrates has paid off greatly.

Today we continue to build and refine this system via an “Inland Waters Atlas” GIS project.

Statewide stream flow data:

Statewide, Michigan has about 140 USGS sites with long-term stream flow gaging records, with somewhat biased placement; not all of these continue to operate. Developed statewide regression models (quite good ones) and estimated synthetic flows per ecological segment (or reach).

Now available for many states from USGS Streamstats program. Can extrapolate summary stats; or can extrapolate daily flows and then summarize.

Next-generation, network-intelligent spatial data models are being implemented by USGS in the GL region. Will incorporate misc. flow measures and diversions/returns.

Statewide gaging design is being re-assessed per the Fisheries Classification map.

Statewide stream temperature data:

One parameter that is sensitive to water withdrawals, and critical to fish distributions.

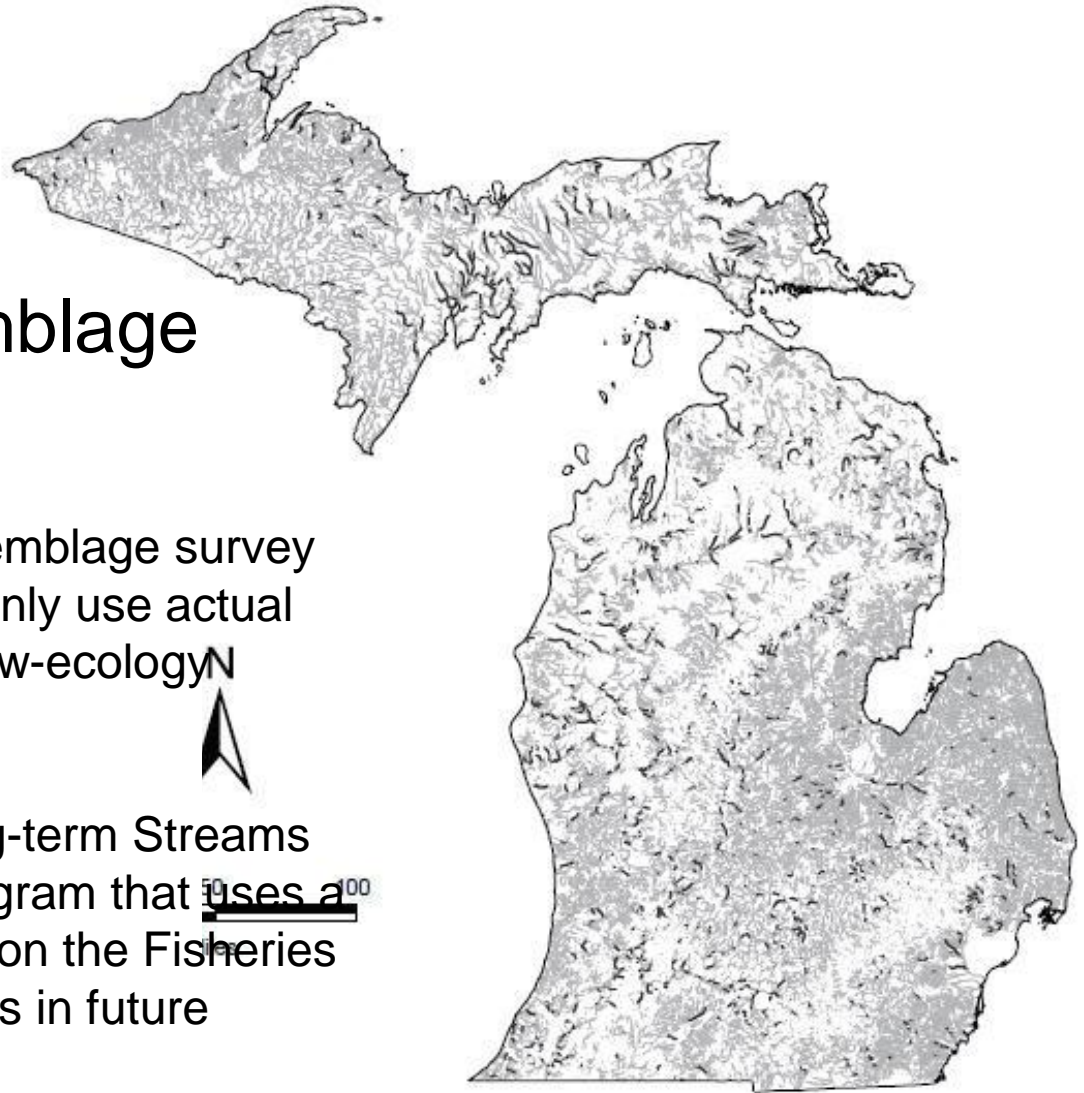
We have about 1000 stream sites with temperature data. These are distributed across the state but with some bias. We have developed good statistical models but estimates are $\pm 1-2$ °C and in many transitional waters this is not good enough. So we only use actual thermal data when examining fish responses.

We have focused on summer mean monthly temperatures as a useful index of fish suitabilities. However we believe that other dimensions of the thermal regime, e.g., cumulative growing degree days, might be more biologically meaningful.

Statewide fish assemblage survey data:

1,700 stream sites with fish assemblage survey data. Some location bias. We only use actual survey data when developing flow-ecology relationships.

MI has instituted (10 yrs?) a long-term Streams Status and Trends sampling program that uses a stratified random design (based on the Fisheries Classification map) to lessen bias in future sampling.



Reference flows

River types

Degree of flow alteration

Ecological response curves

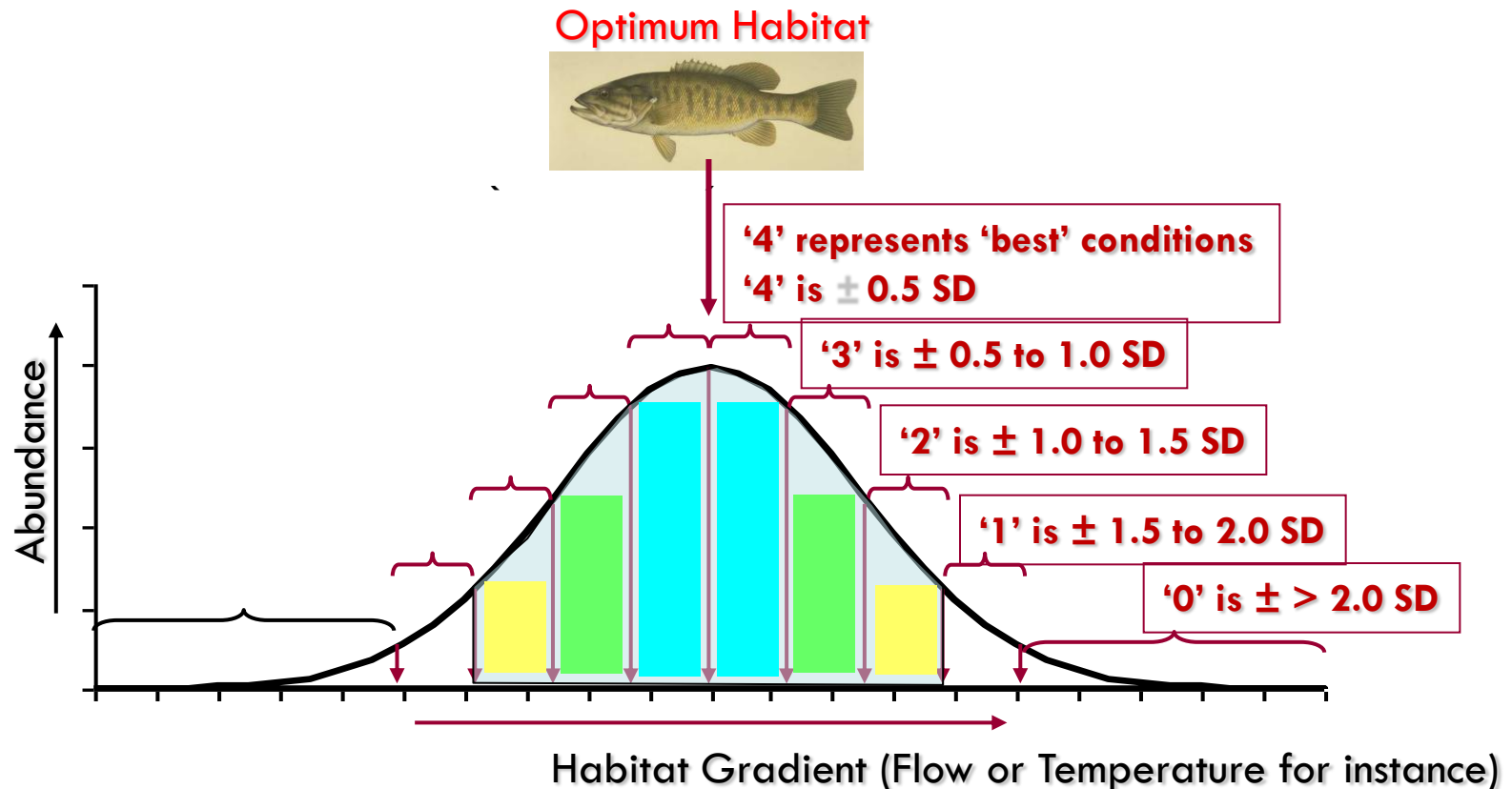
Ecological targets

Enviro. flow targets

Implement program

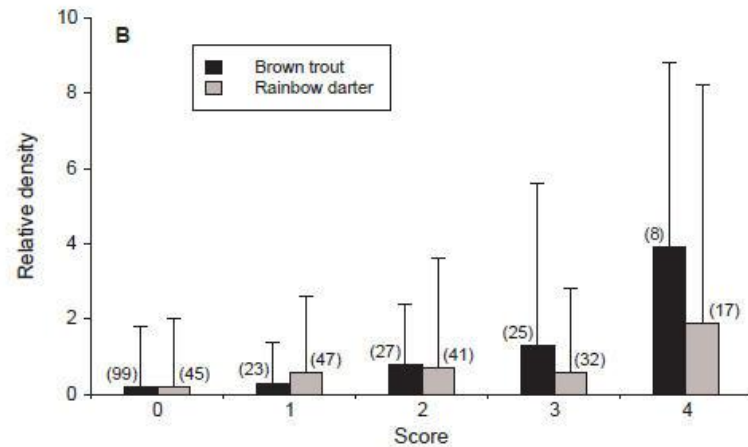
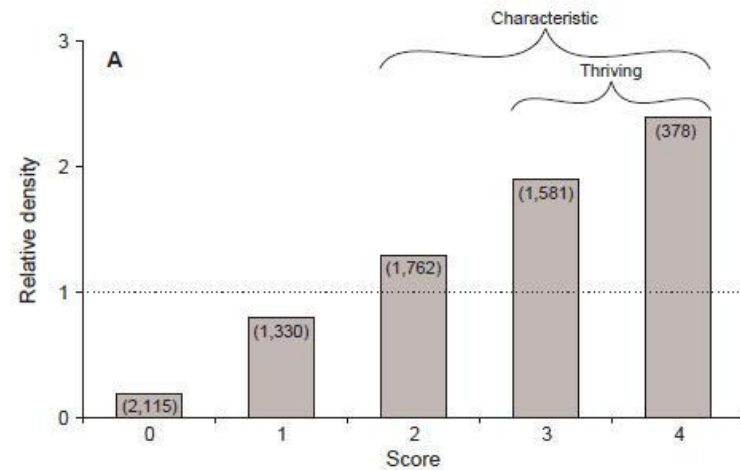
Statewide habitat suitability info: flow and temperature)

Rank scores per normal distribution; 60+ species



Overall, fish species defined as “Thriving” or “Characteristic” were found at densities above their species’ state average (N= 7,000 comparisons).

The pattern was not as strong in all species (e.g., rainbow darter).



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For representative sites per river type:

Considered initial “characteristic” species

Ran withdrawal simulations and followed scores

	Percent flow reduction						
	0	10	20	30	40	50	60
common shiner	4	4	4	3	3	3	2
white sucker	4	3	3	3	2	2	2
longnose dace	3	3	2	2	2	0	0
rainbow darter	2	2	1	0	0	0	0

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We didn't really have "Percent flow reduction", i.e., at a particular site; i.e., an experiment. Instead we substituted lower flows from other sites that were likely "reference quality" sites. So our response were potentially not sensitive enough.

Percent flow reduction

	0	10	20	30	40	50	60
common shiner	4	4	4	3	3	3	2
white sucker	4	3	3	3	2	2	2
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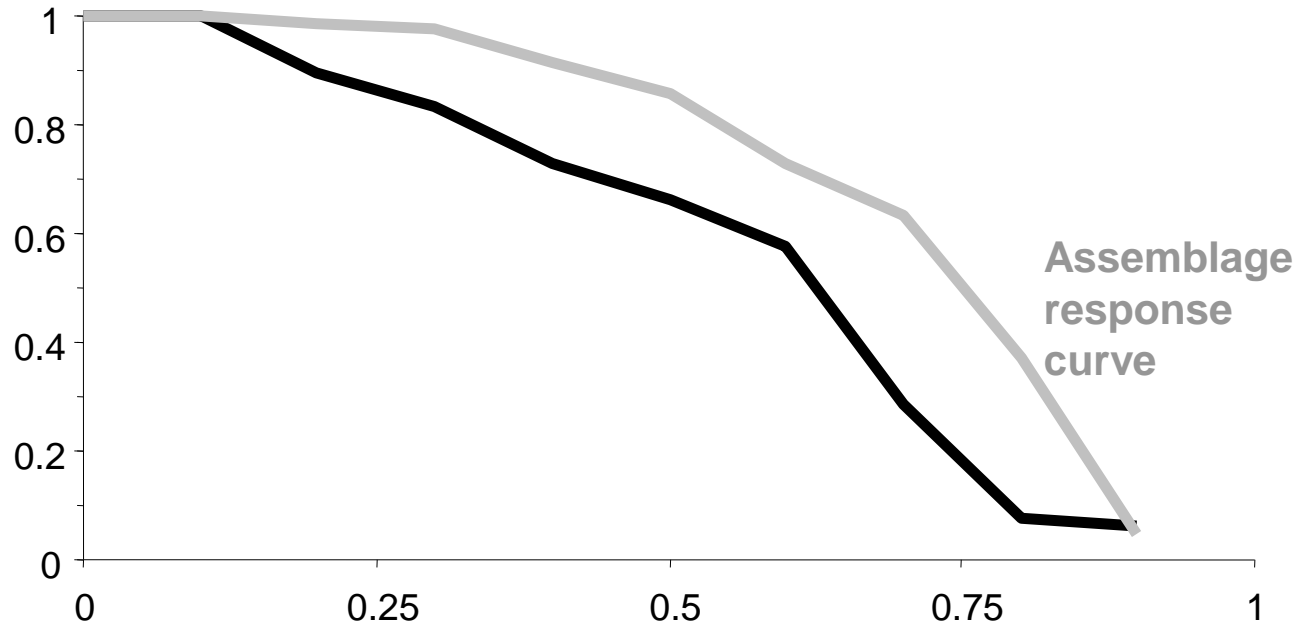
**Ecological
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Summaries of simulations create early warning and total impact curves (for assemblage)



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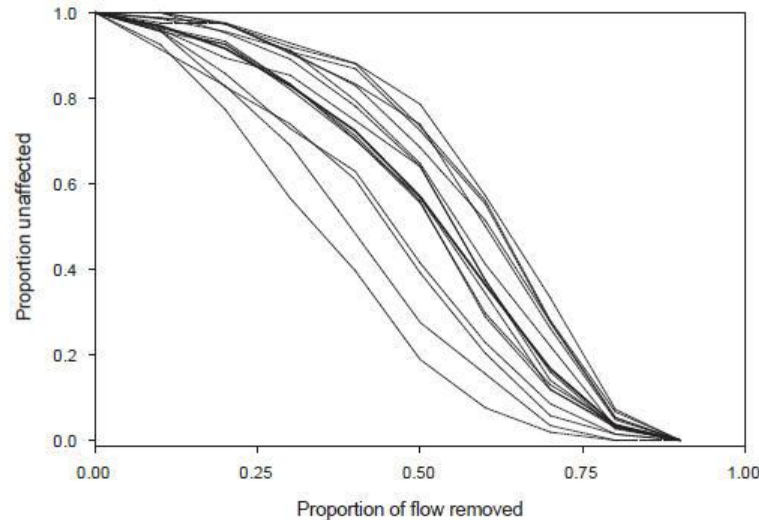
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Variation in fish assemblage response curves for each of 15 representative sites within one river type. The mean response (dark line) was used in the water management program, and policy safeguards were used in recognition of the degree of variation.

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Curves per each ecological river type. Geographies of biological response.

