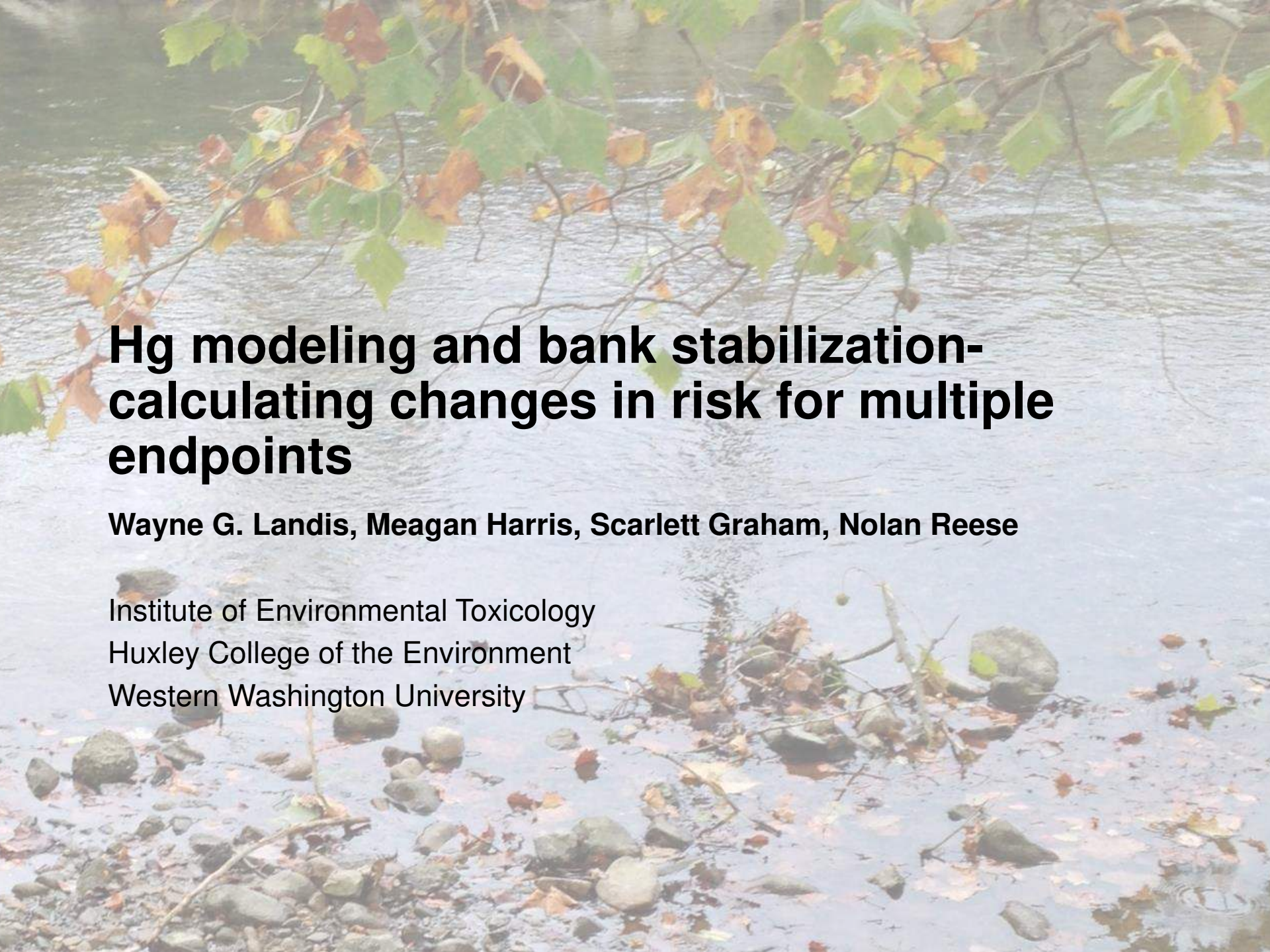


The background of the slide is a photograph of a riverbank. In the foreground, there are several dark, smooth rocks in the shallow water. The water is a light, milky blue-grey color. On the left side, there are branches with green and yellowing leaves hanging over the water. On the right side, there are more branches with yellow and orange leaves. The overall scene is a natural, somewhat overcast riverbank in autumn.

Hg modeling and bank stabilization- calculating changes in risk for multiple endpoints

Wayne G. Landis, Meagan Harris, Scarlett Graham, Nolan Reese

Institute of Environmental Toxicology
Huxley College of the Environment
Western Washington University

Objectives:

- Use bank stabilization mercury modeling output to update risk assessment
- Compare risk results for each bank Hg reduction scenario (25%, 50%, 75%, 100%)
- Compare risk results that consider changes in a single stressor (Hg) or multiple stressors

Ecological Risk Assessment

Relative Risk Model

4 biotic endpoints

- Smallmouth bass
- White sucker
- Carolina Wren
- Belted Kingfisher

4 abiotic endpoints

- Water quality Standards
- Fishing River Use
- Swimming River Use
- Boating River Use

For more information, see:

https://s3.amazonaws.com/abi_web_files/southriverscienceteam.org/document-library/2014/10/BriefingPaper_IntegratedRegionalRiskAssessment.pdf

5 endpoints affected by changes in Hg due to bank stabilization.

Endpoint	Mercury related variable
Belted Kingfisher	Bird blood Hg
Carolina Wren	Bird blood Hg
Smallmouth bass	Fish tissue Hg
White sucker	Fish tissue Hg
Fishing River Use	Fish tissue Hg

3 of the 5 endpoints can be updated using the Hg modeling output.

Endpoint	Mercury related variable
Belted Kingfisher	Bird blood Hg
Carolina Wren	Bird blood Hg
Smallmouth bass	Fish tissue Hg
White sucker	Fish tissue Hg
Fishing River Use	Fish tissue Hg

Ecological Risk Assessment

Relative Risk Model

4 biotic endpoints

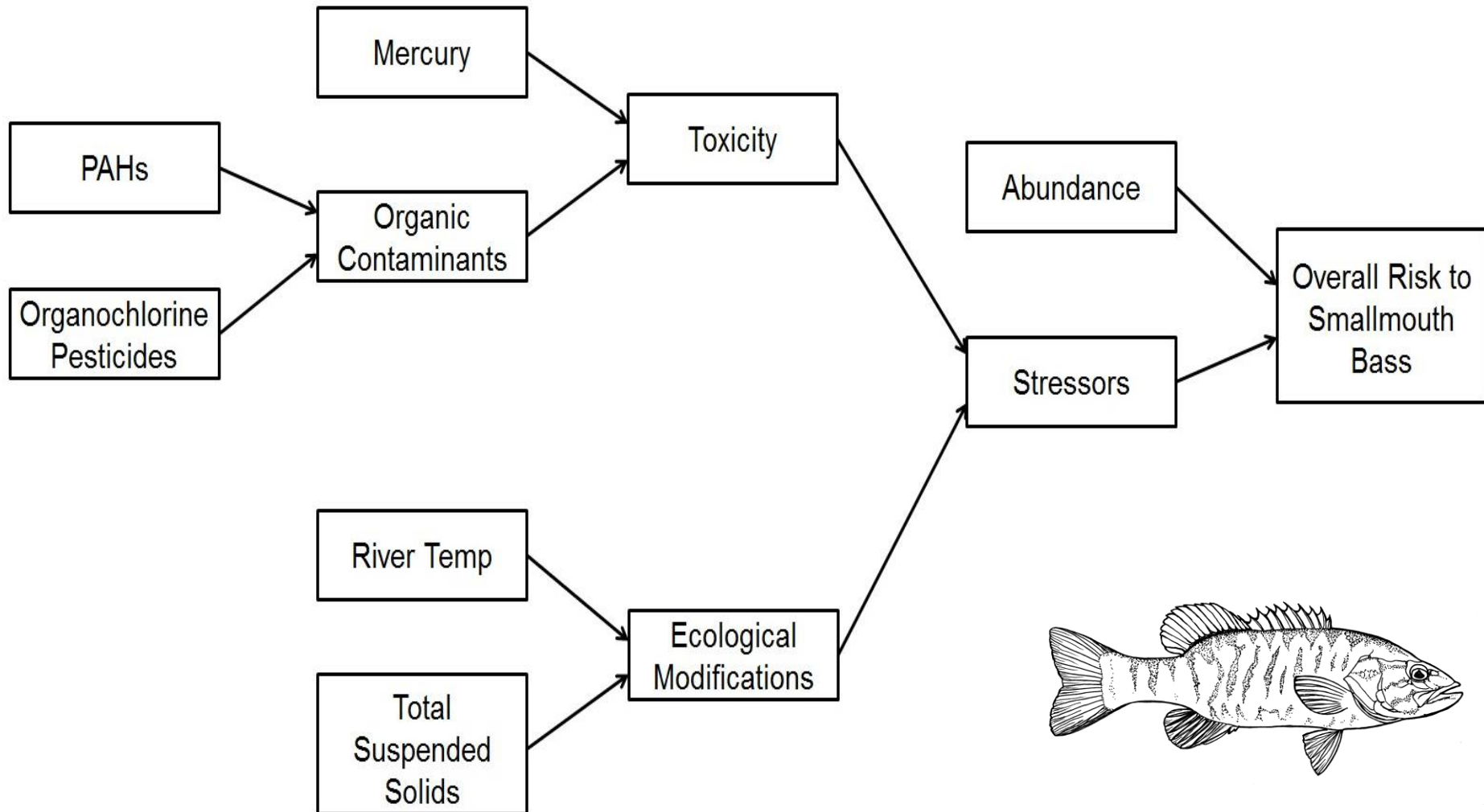
- Smallmouth bass
- White sucker
- Carolina Wren
- Belted Kingfisher

4 abiotic endpoints

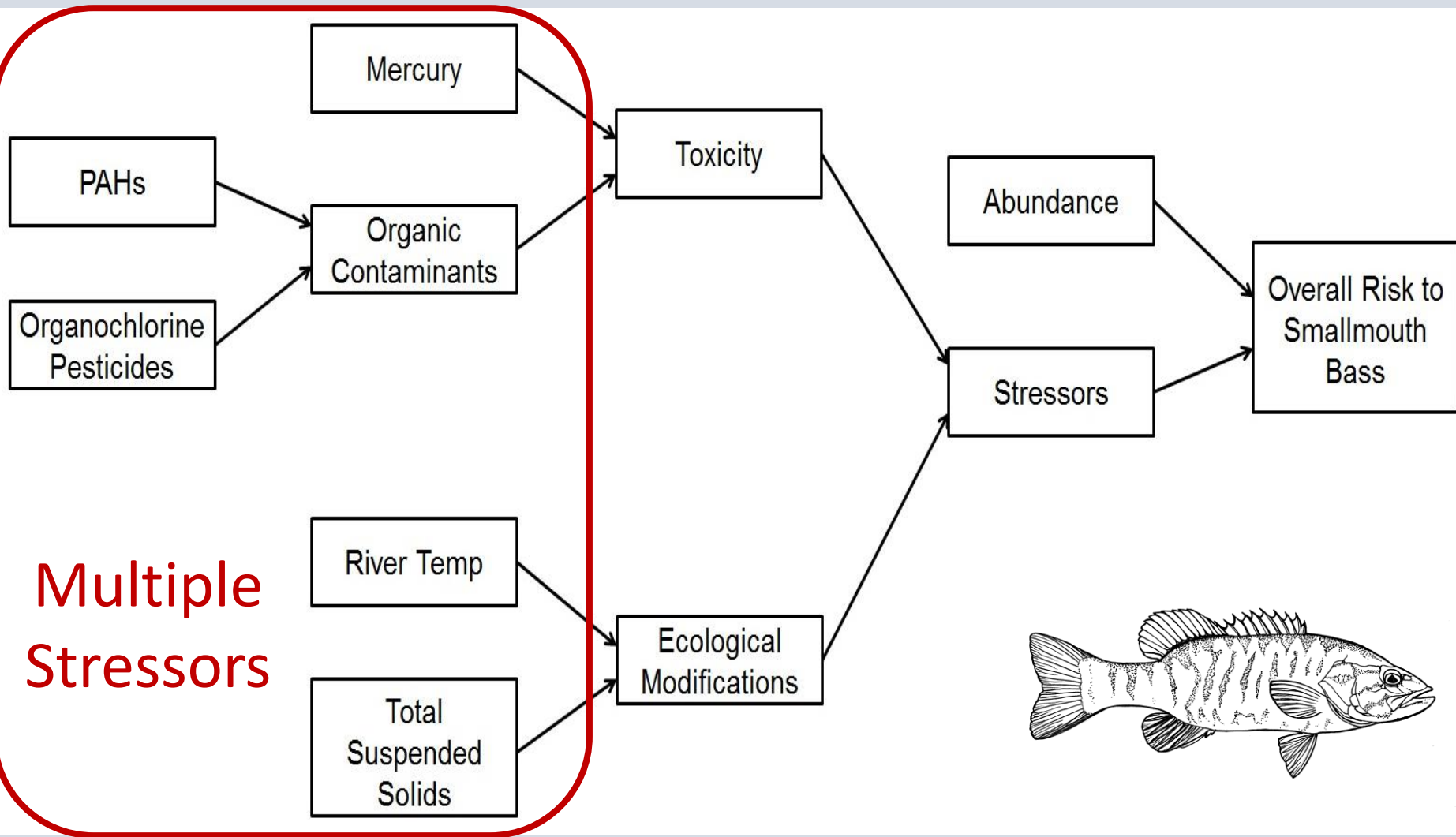
- Water quality Standards
- Fishing River Use
- Swimming River Use
- Boating River Use

How does mercury fit into the
conceptual models for these
endpoints?

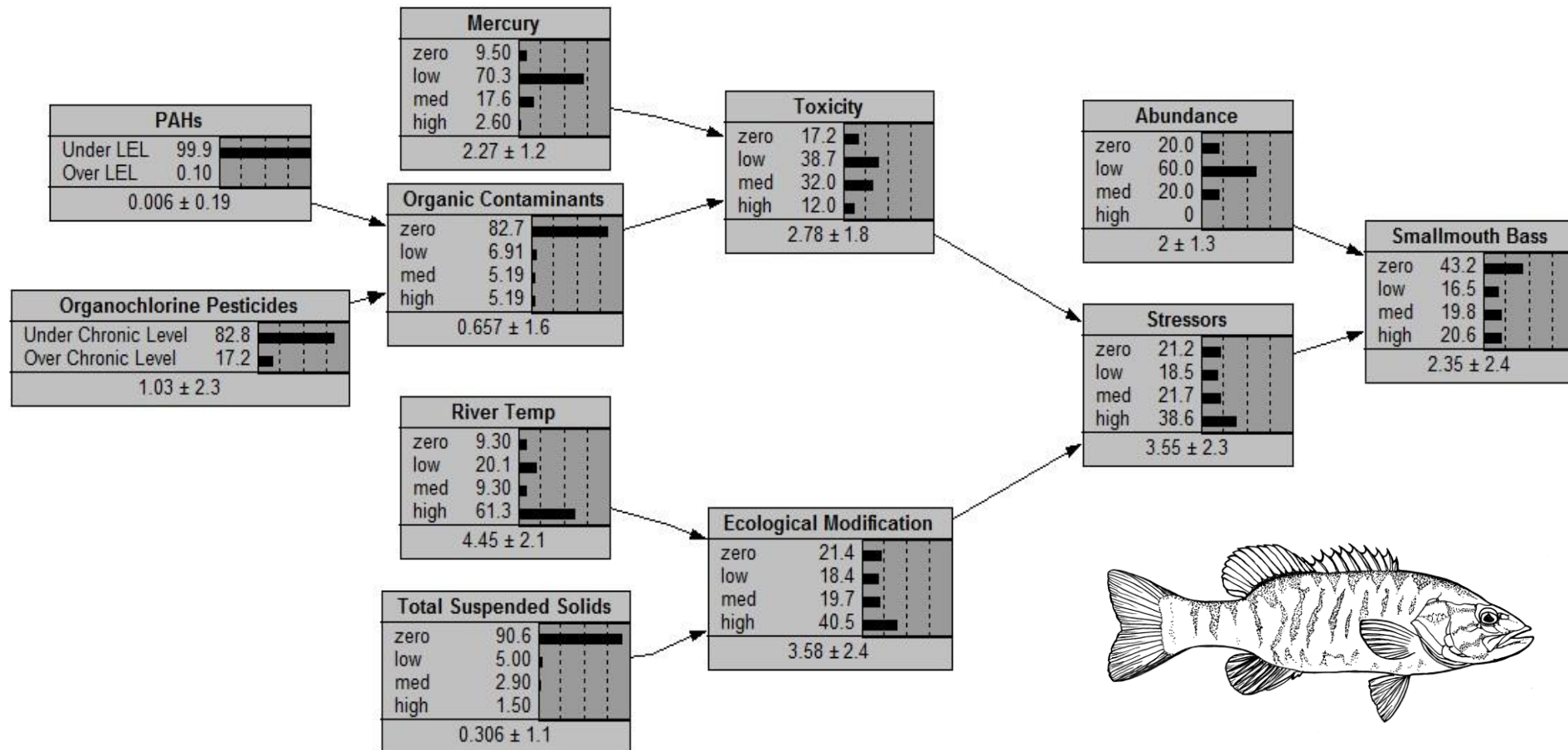
Smallmouth bass- conceptual model



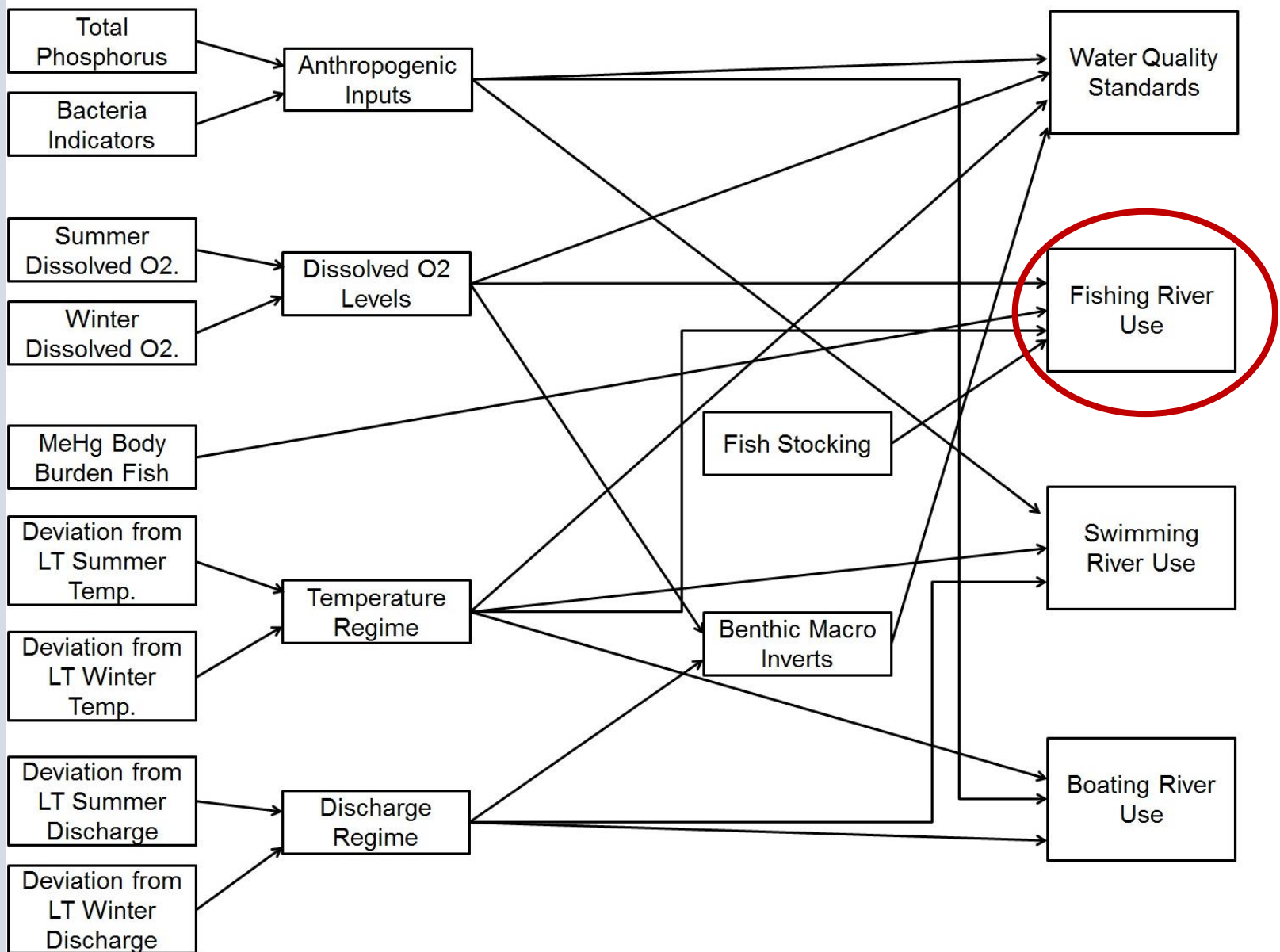
Smallmouth bass- conceptual model



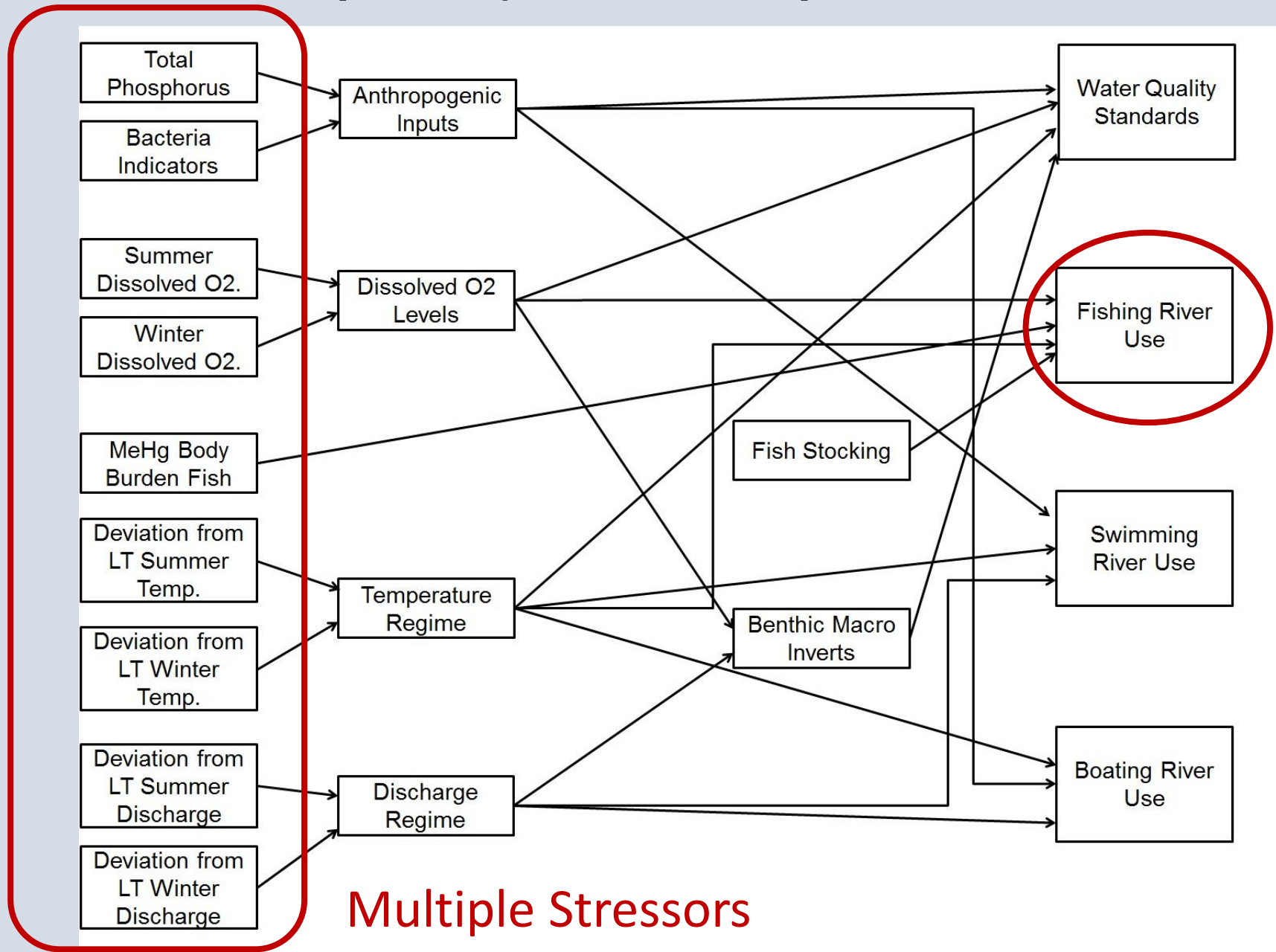
Smallmouth bass- Bayesian network



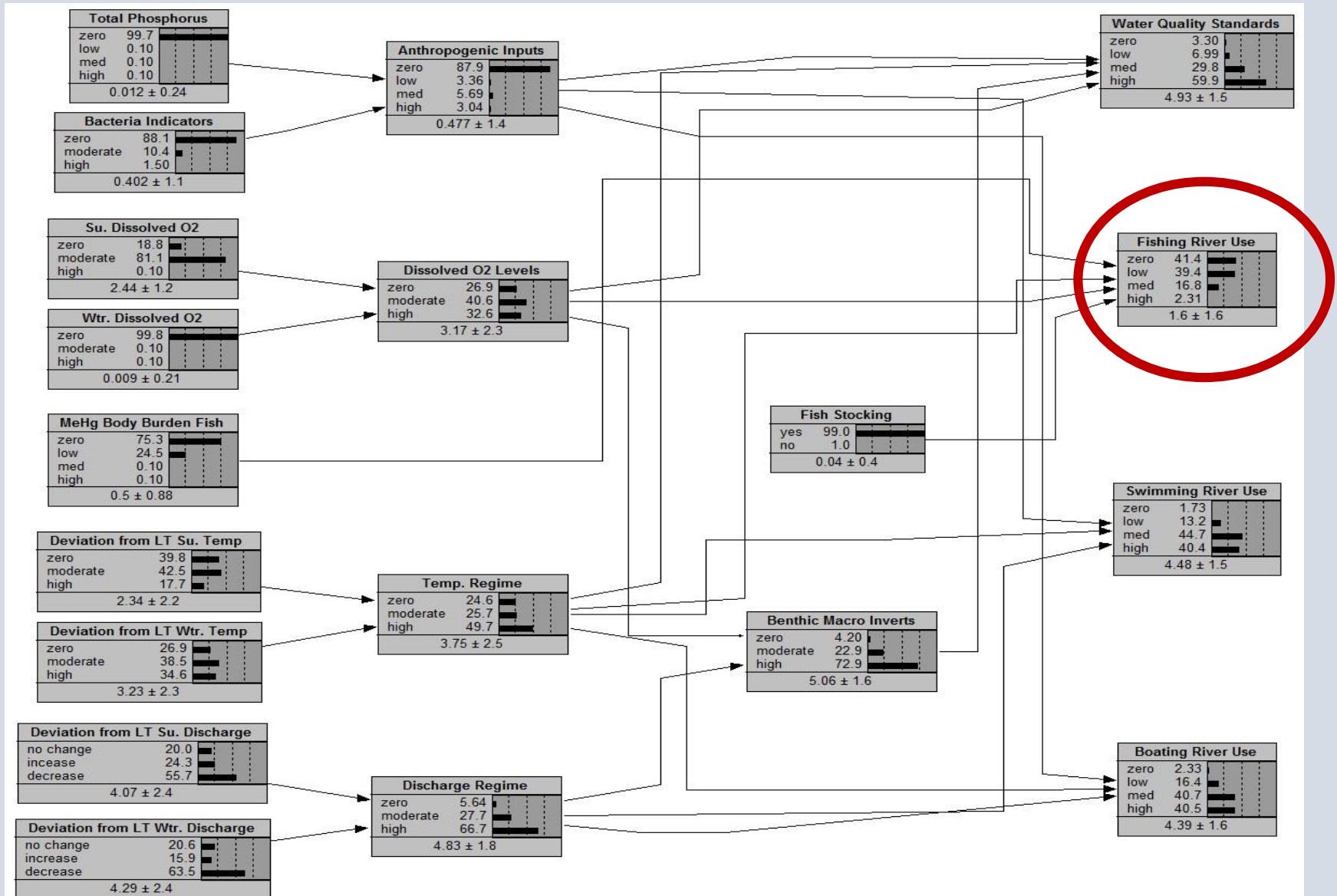
Water quality- conceptual model



Water quality- conceptual model



Water quality- Bayesian network



Updating the model inputs

We can update a single input node

Mercury

Mercury	
zero	9.50
low	70.3
med	17.6
high	2.60
2.27 ± 1.2	

PAHs	
Under LEL	99.9
Over LEL	0.10
0.006 ± 0.19	

Organic Contaminants	
zero	82.7
low	6.91
med	5.19
high	5.19
0.657 ± 1.6	

Toxicity	
zero	17.2
low	38.7
med	32.0
high	12.0
2.78 ± 1.8	

Abundance	
zero	20.0
low	60.0
med	20.0
high	0
2 ± 1.3	

Smallmouth Bass	
zero	43.2
low	16.5
med	19.8
high	20.6
2.35 ± 2.4	

Organochlorine Pesticides	
Under Chronic Level	82.8
Over Chronic Level	17.2
1.03 ± 2.3	

River Temp	
zero	9.30
low	20.1
med	9.30
high	61.3
4.45 ± 2.1	

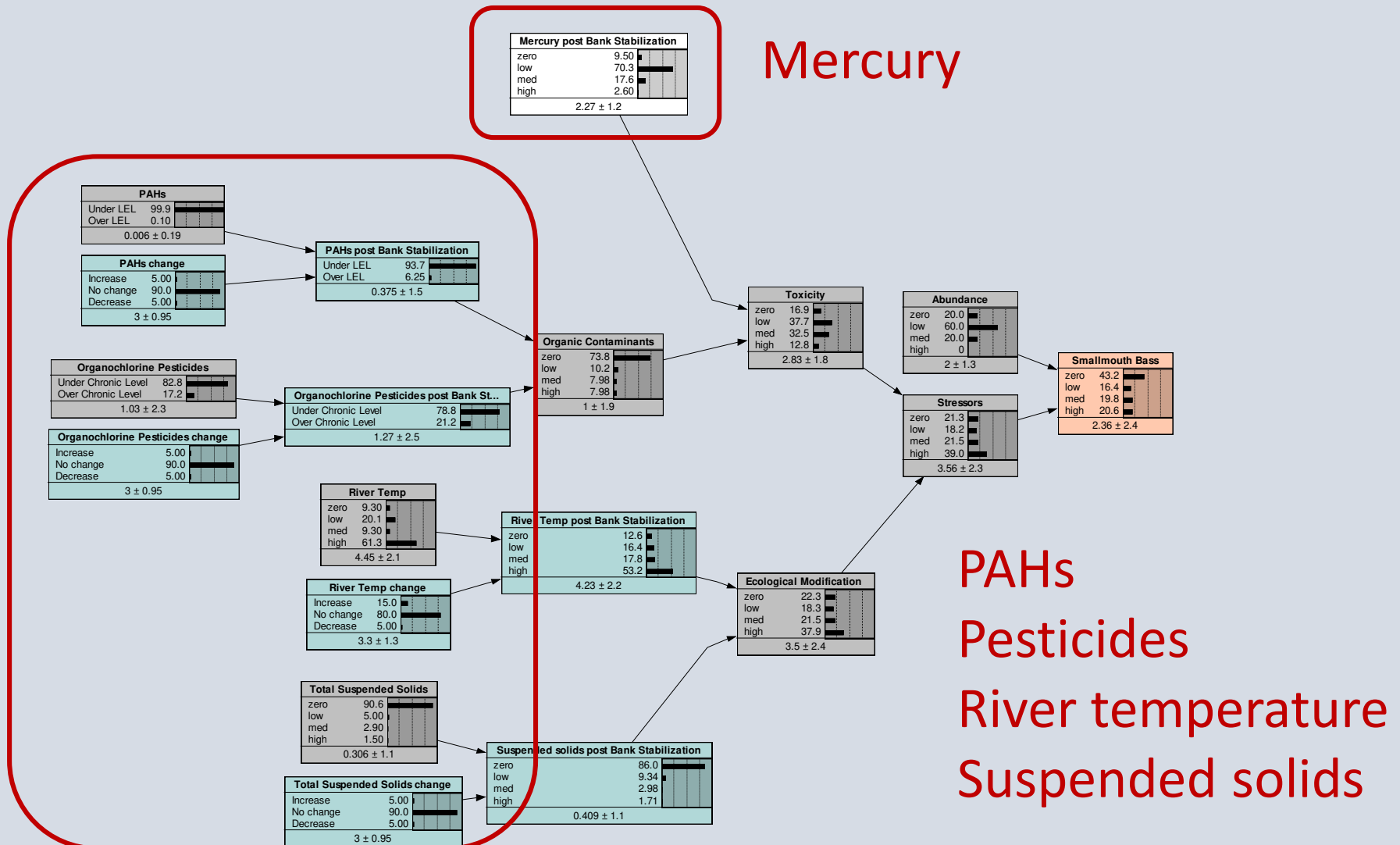
Stressors	
zero	21.2
low	18.5
med	21.7
high	38.6
3.55 ± 2.3	

Total Suspended Solids	
zero	90.6
low	5.00
med	2.90
high	1.50
0.306 ± 1.1	

Ecological Modification	
zero	21.4
low	18.4
med	19.7
high	40.5
3.58 ± 2.4	

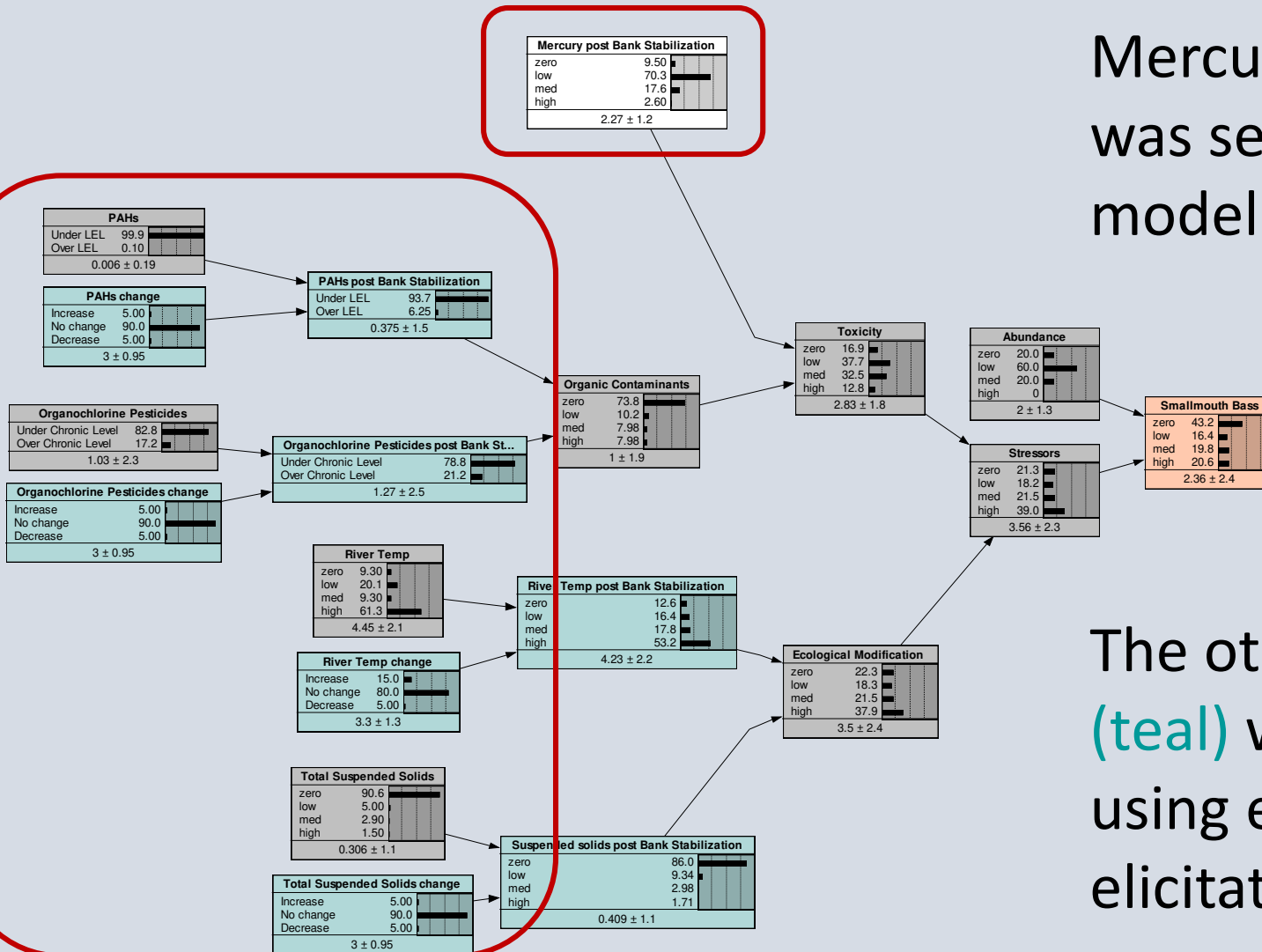
Smallmouth bass,
Region 2

or multiple input nodes.



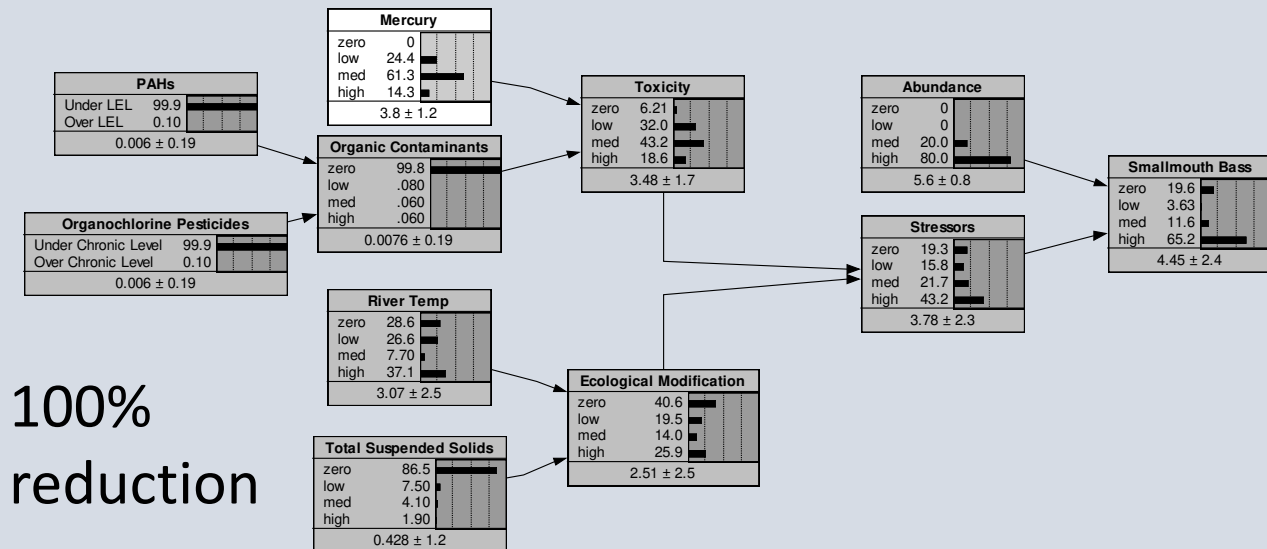
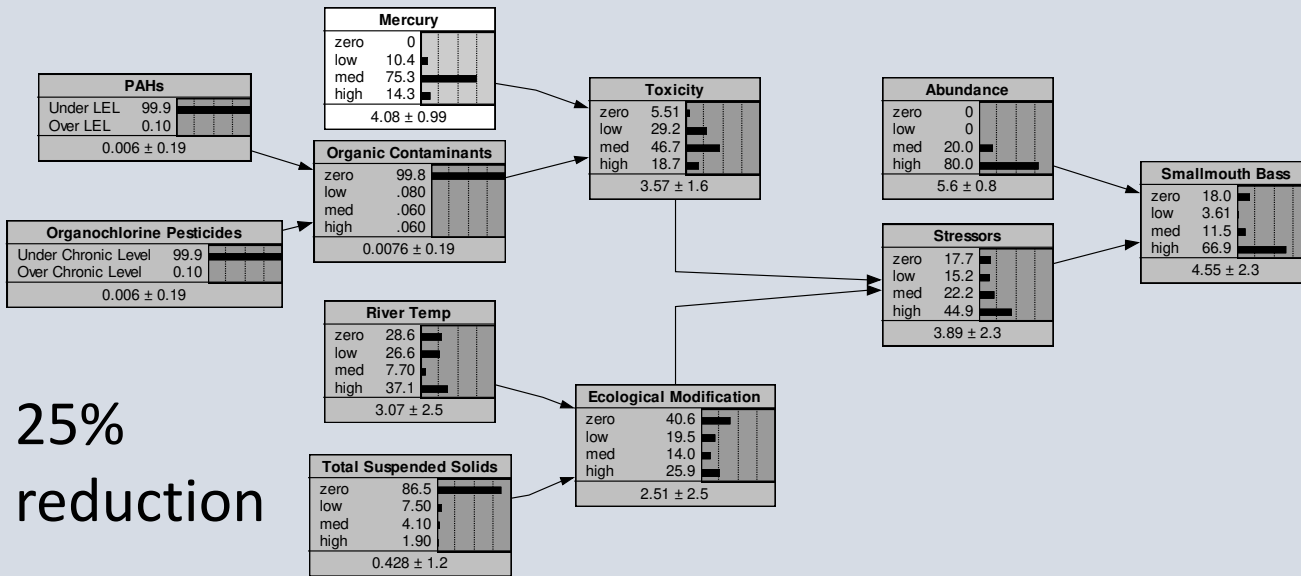
Nodes can be updated using different data sources or model outputs.

Mercury node was set using Hg model output.

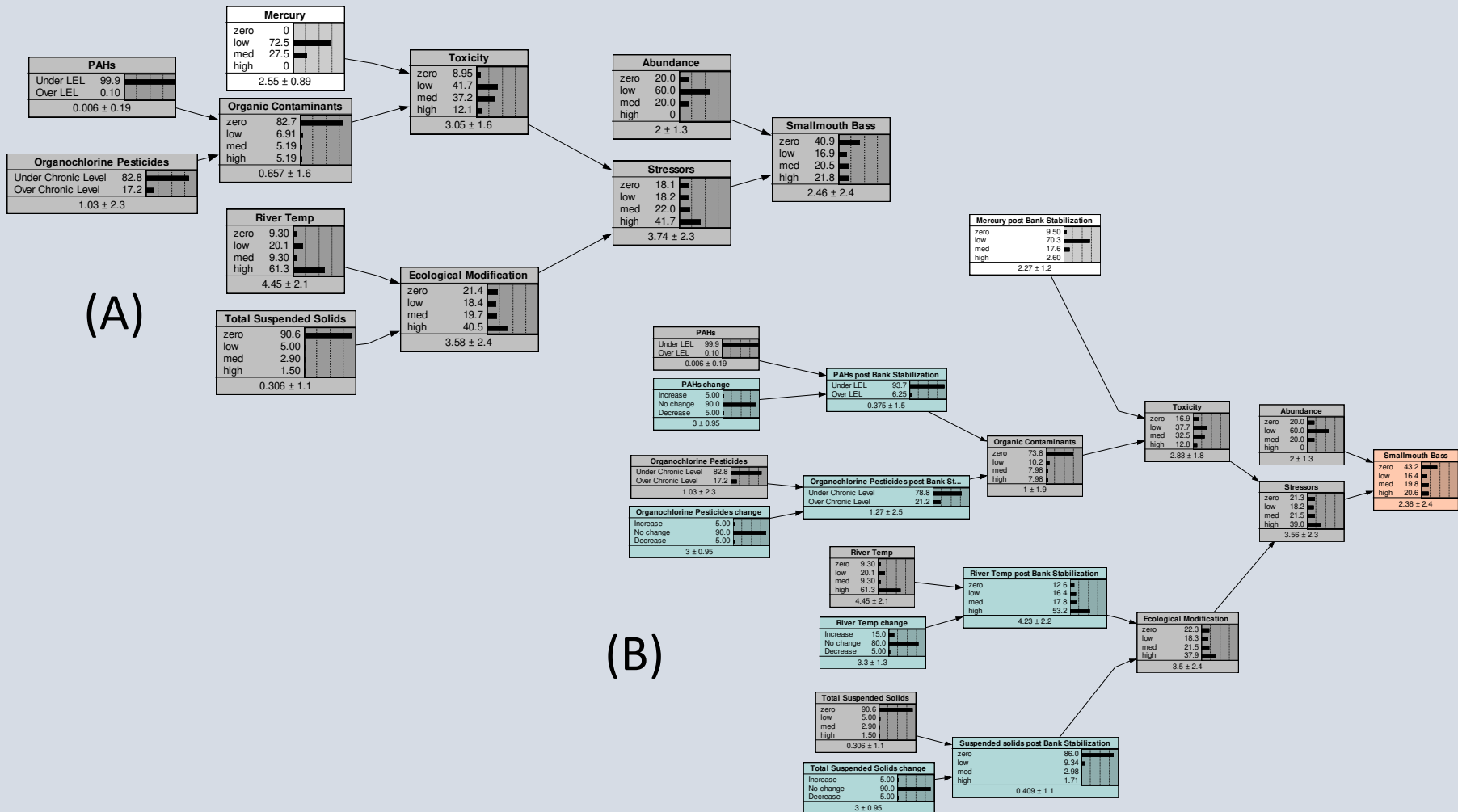


The other nodes (teal) were set using expert elicitation.

We can compare results for each bank Hg reduction scenario



and results that consider changes in a single stressor (A) or multiple stressors (B).



Methods

Mercury ranking scheme for fish tissue Hg

Input parameter	Parameter states	Range	Justification	References
Mercury Probability of fish tissue mercury concentration (mg/kg)	Zero	<0.2 mg/kg	< 5% lethality or equivalent endpoints	Dillon et al. 2010 USEPA 2009
	Low	0.2-1.1 mg/kg	5 - 24% lethality or equivalent	
	Med	1.1-2.8 mg/kg	24 - 50% lethality or equivalent	
	High	>2.8 mg/kg	> 50% lethality or equivalent	

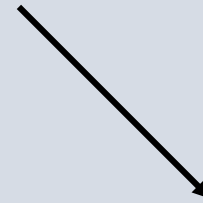
Data source: dose-response from Dillon et al. (2010) and USEPA (2009)

1. Use modeling output to derive input frequencies

Region 3			
		count	percent
Zero <0.2 mg/kg		8	1.5
Low 0.21-1.1 mg/kg		186	34.6
Med 1.2-2.8 mg/kg		235	43.8
High >2.9 mg/kg		108	20.1
	total	537	

1. Use modeling output to derive input frequencies

Region 3			
		count	percent
Zero <0.2 mg/kg		8	1.5
Low 0.21-1.1 mg/kg		186	34.6
Med 1.2-2.8 mg/kg		235	43.8
High >2.9 mg/kg		108	20.1
	total	537	



2. Enter new input frequencies into the BN

Node: fish_other

Apply

OK

Chance

% Probability

Reset

Close

zero	low	med	high
1.5	34.6	43.8	20.1

1. Use modeling output to derive input frequencies

Region 3			
		count	percent
Zero <0.2 mg/kg		8	1.5
Low 0.21-1.1 mg/kg		186	34.6
Med 1.2-2.8 mg/kg		235	43.8
High >2.9 mg/kg		108	20.1
	total	537	

2. Enter new input frequencies into the BN

Node: **fish_other**

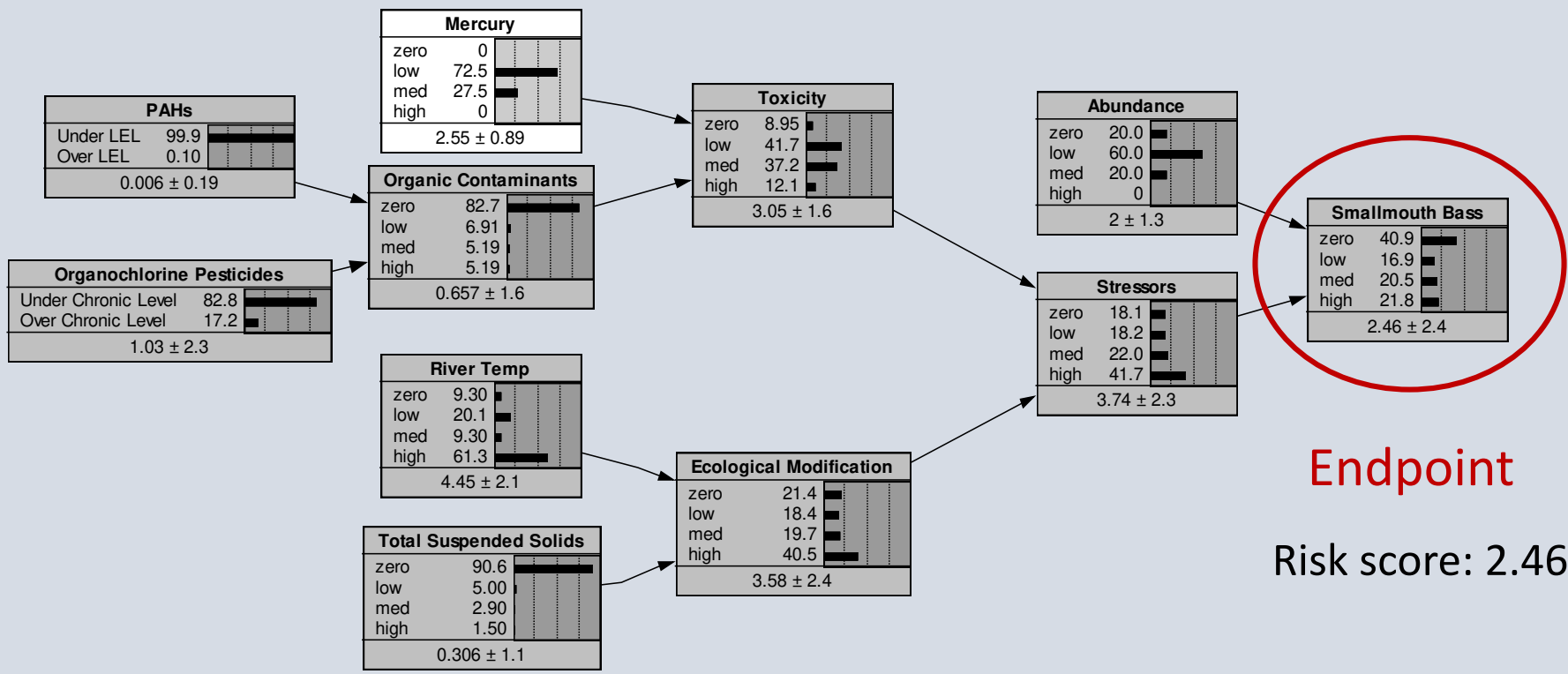
zero	low	med	high
1.5	34.6	43.8	20.1

3. The new node displays the updated frequencies

Fish Tissue Hg	
zero	1.50
low	34.6
med	43.8
high	20.1
3.65 ± 1.5	

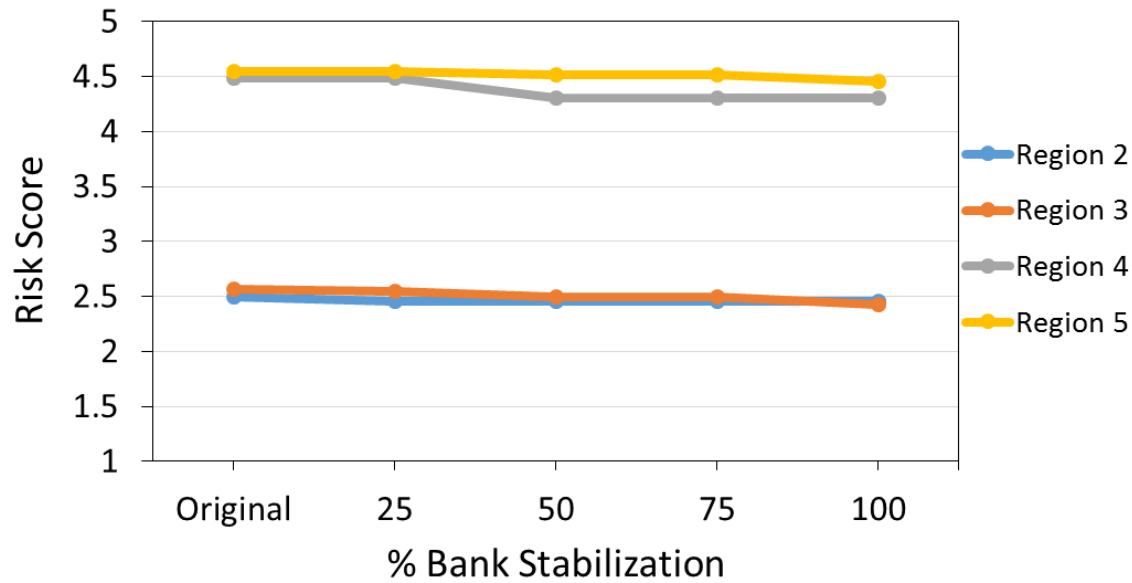
Run the model.

Netica calculates a new risk distribution and risk score.

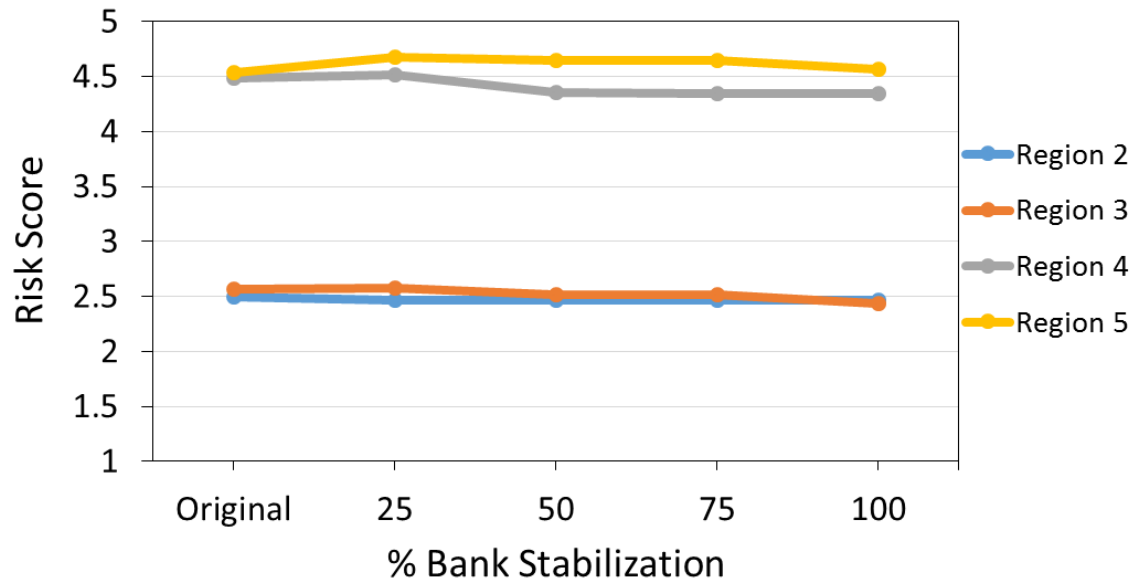


Results for Smallmouth bass,
White sucker, and
Fishing River Use

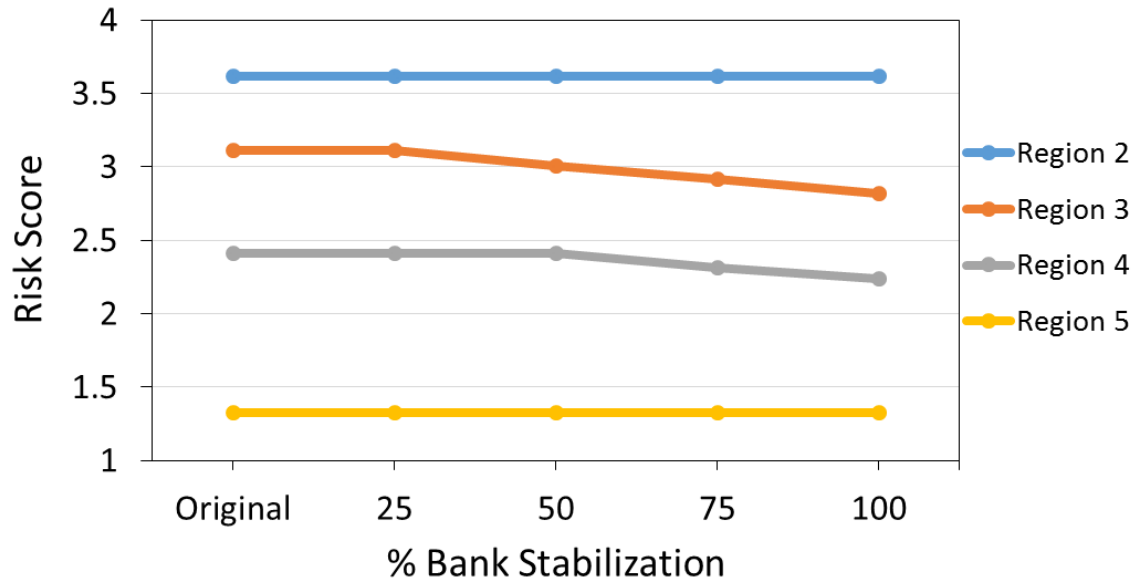
Smallmouth bass- HG Inputs Changed



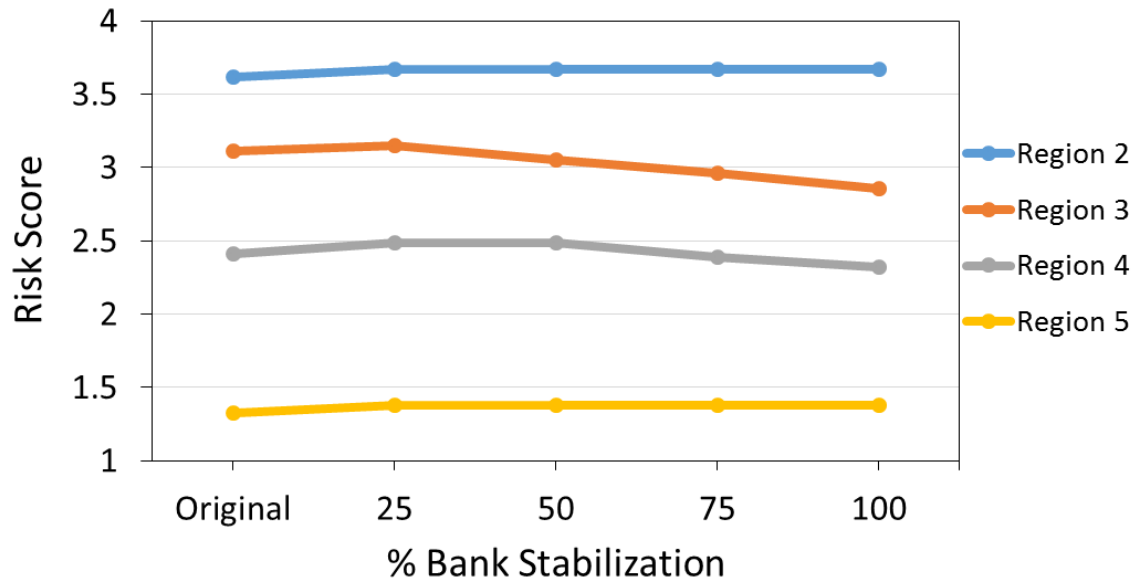
Smallmouth bass- All Inputs Changed



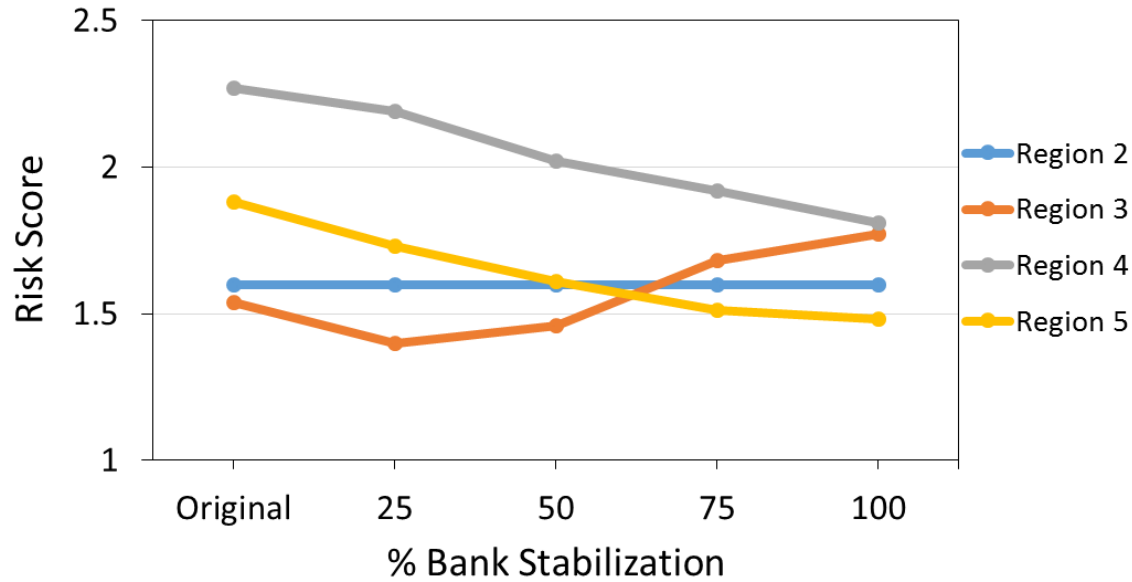
White sucker- HG Inputs Changed



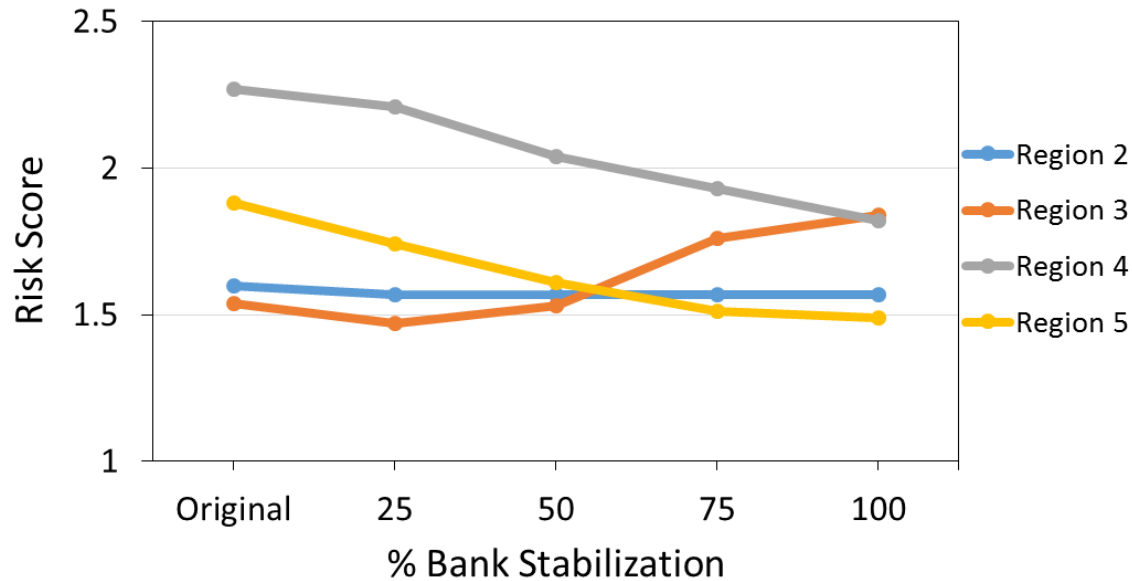
White sucker- All Inputs Changed



Fishing River Use- HG Inputs Changed

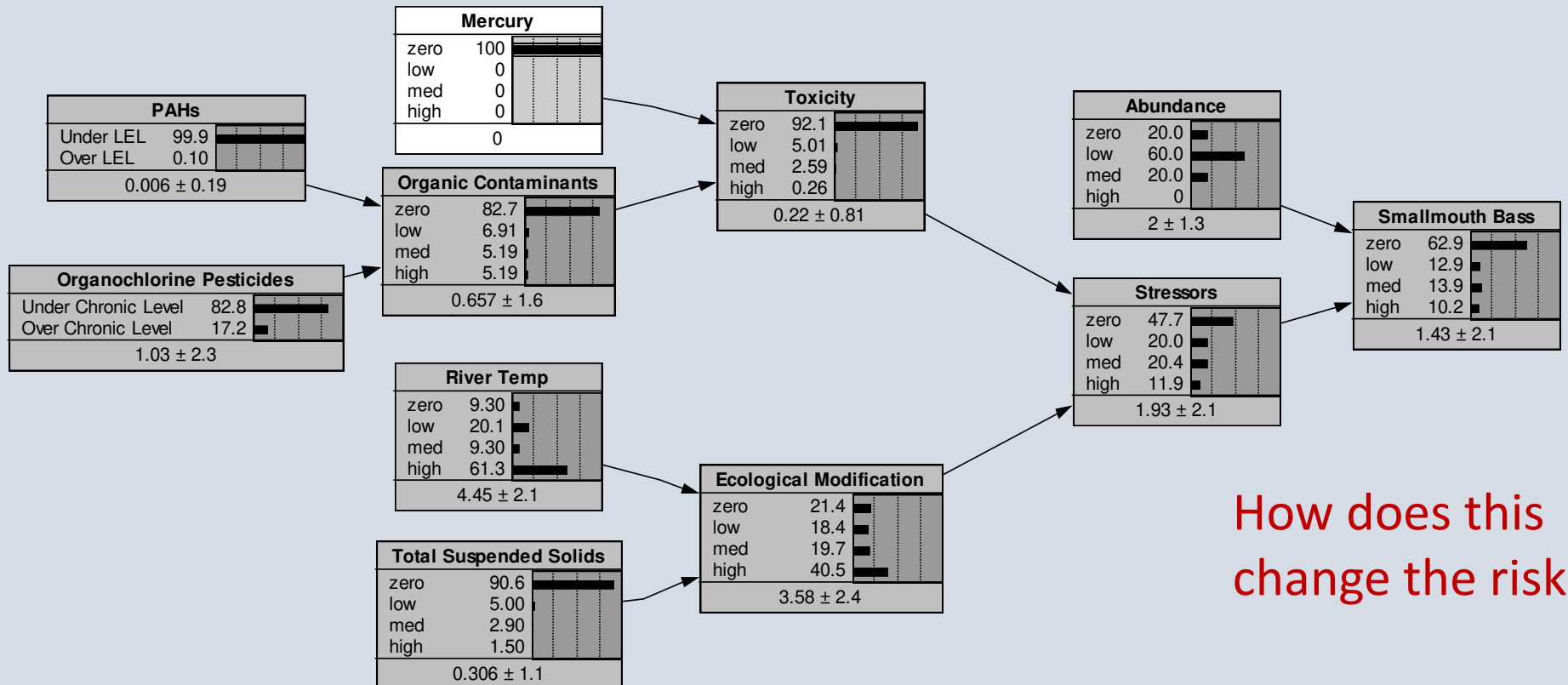


Fishing River Use- All Inputs Changed



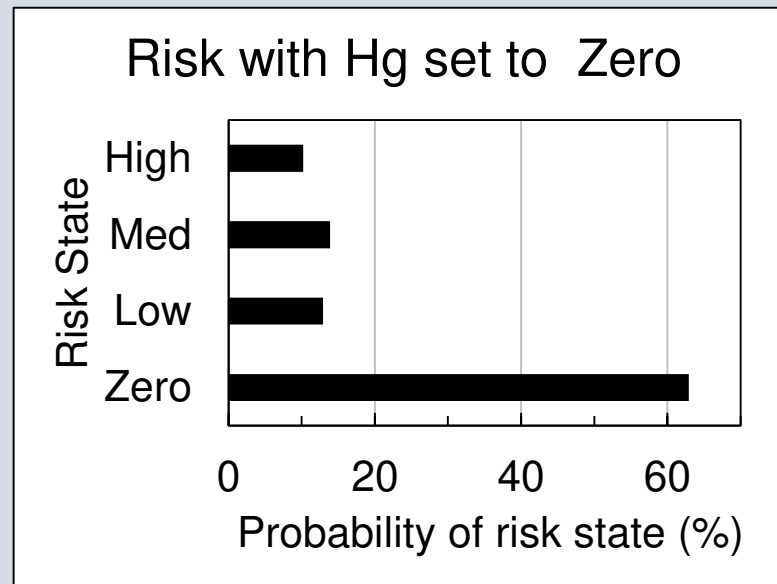
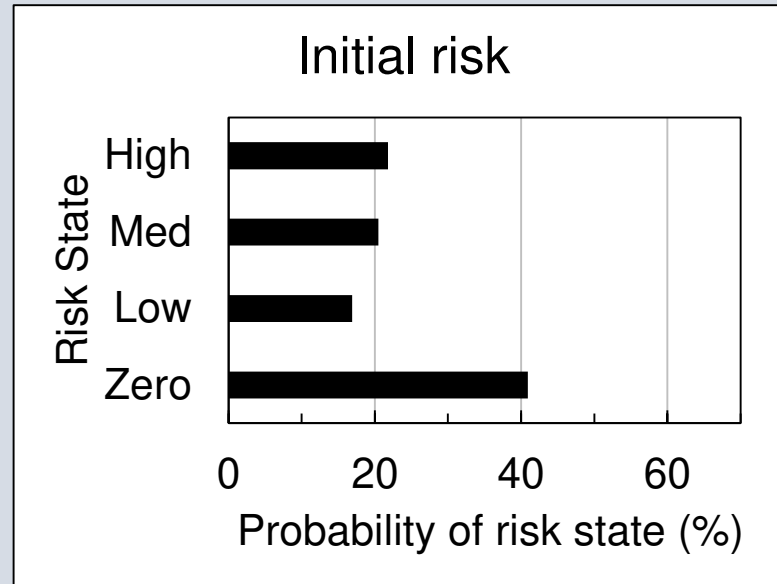
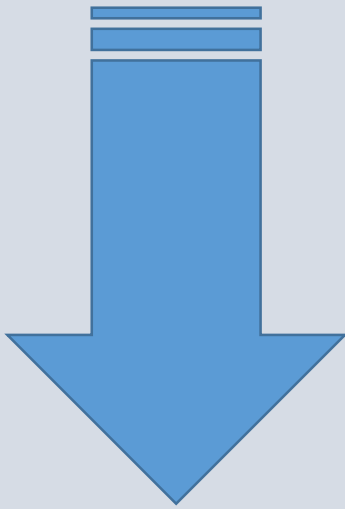
Influence Analysis

Set Hg node to 100% in Zero risk state



How does this
change the risk?

Risk to
smallmouth bass
decreases
(but not to zero)



Conclusions

- BNs are easily updatable with new data (or model output).
- Effects of bank stabilization can be considered for Hg and other stressors for multiple endpoints.

More conclusions

- Predicted reductions in Hg only slightly reduce the overall risk to the endpoints.
- Risk reductions are greatest downstream- largest reductions in risk in Region 4 (river miles 7-15).