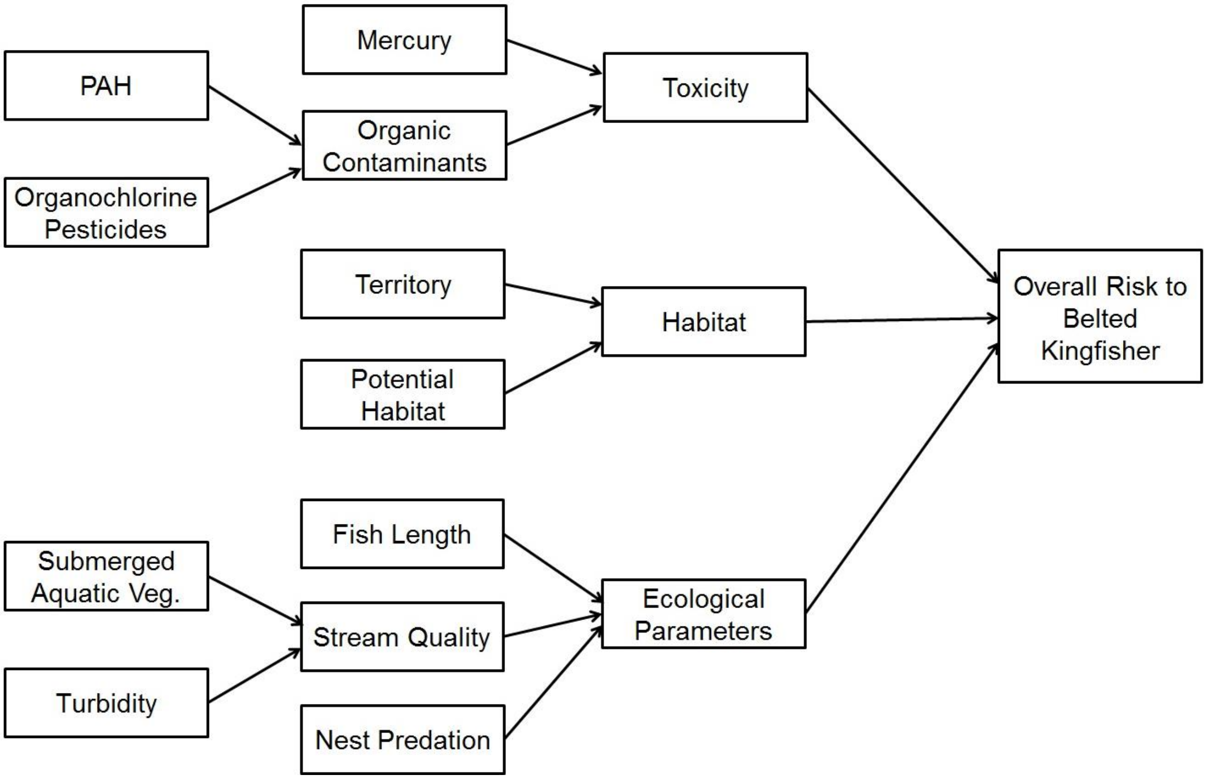
Results for the Integrated Regional Risk Assessment for the South River and Upper Shenandoah River, Virginia

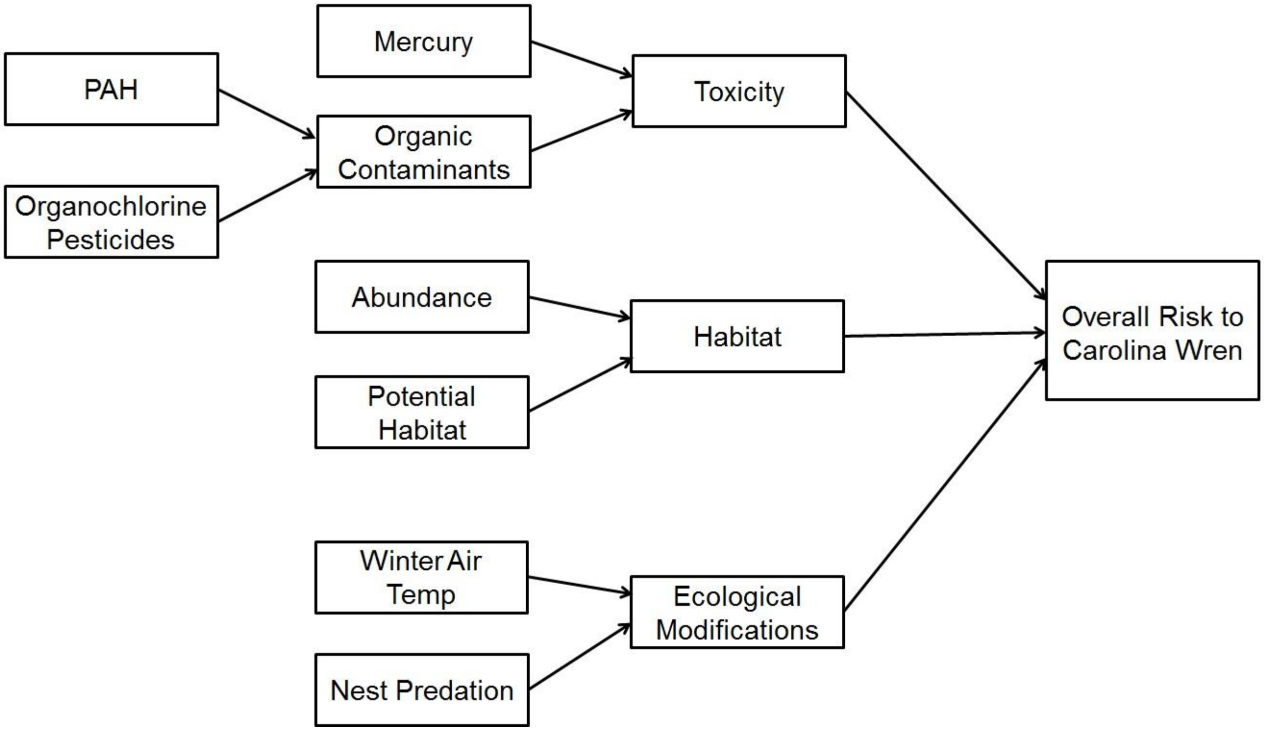
APPENDIX

List of Appendices

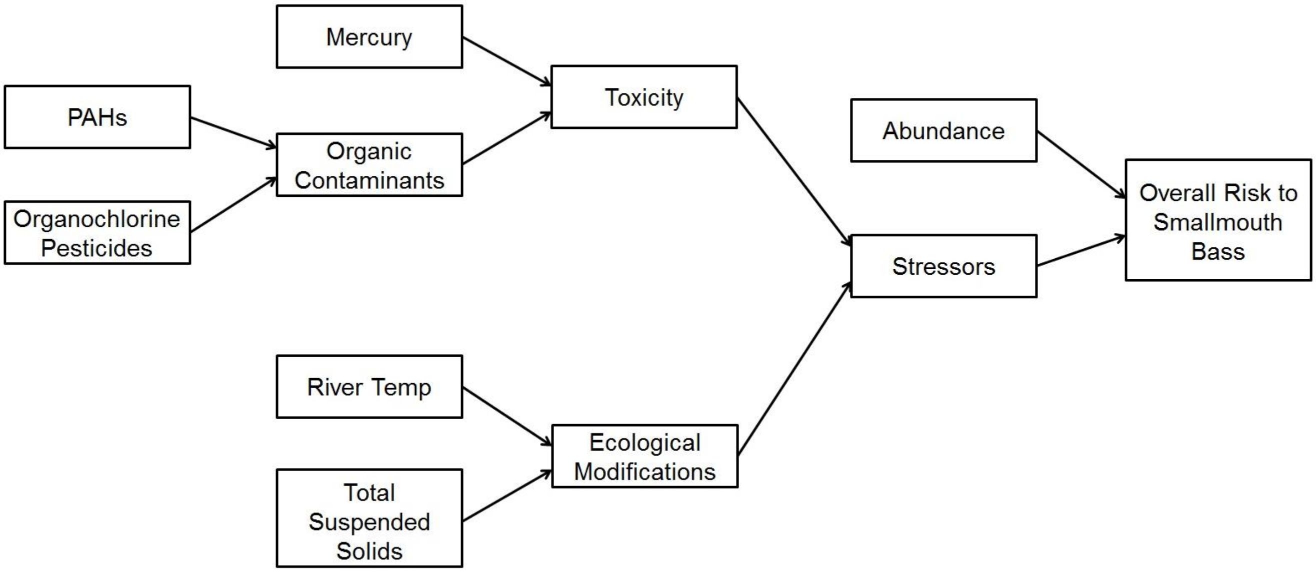
Appendix 1. Conceptual models for the biotic and water quality endpoints.



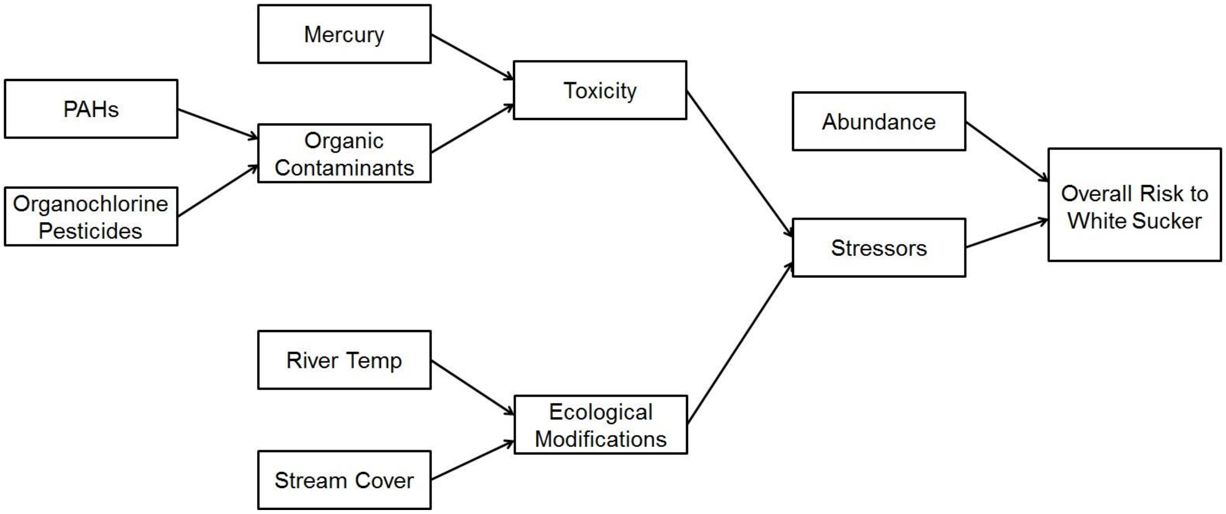
A1- 1. Belted Kingfisher conceptual model.



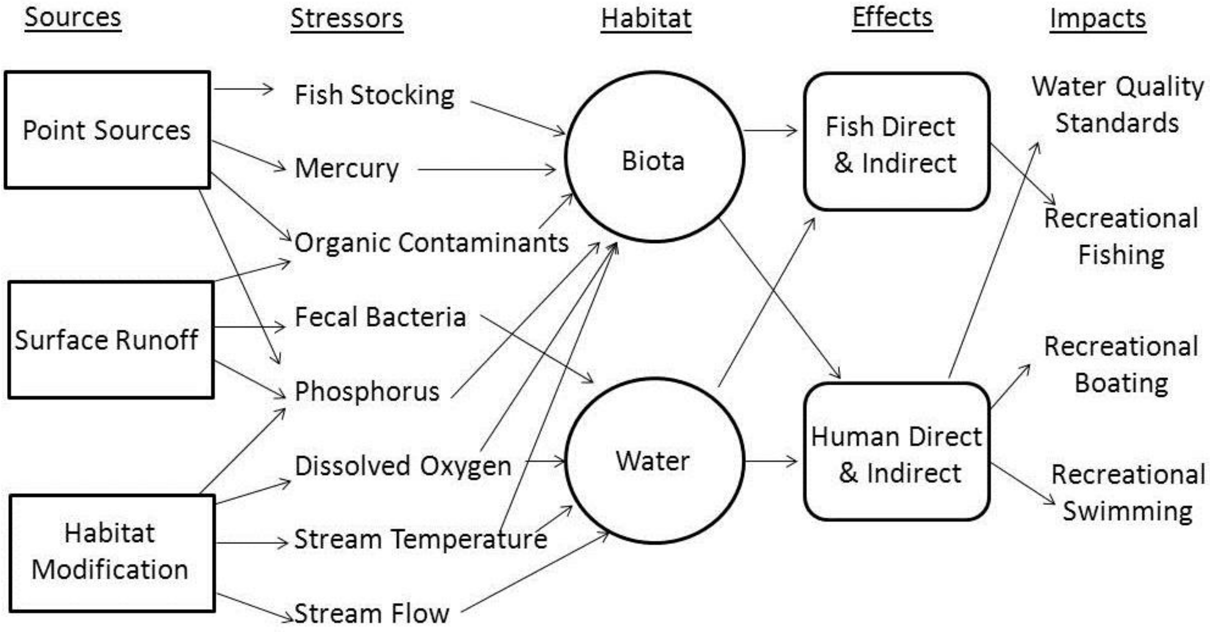
A1- 2. Carolina Wren conceptual model.



A1- 3. Smallmouth bass conceptual model.



A1- 4. White sucker conceptual model.



A1- 5. Water Quality and Recreational River Use Conceptual Model

Appendix 2. Data Sources

A2 1. Summary of data used for prior probabilities (input parameters) for all models including years and source of data.

Endpoint	Input node	Data Variable	Years	Source of Data
Belted Kingfisher	Mercury	Mercury bird blood concentration (ppm)	2005-2007	South River Science Team (SRST) (SRST/URS, pers. comm., 3 January 2014)
	PAHs (ug/kg)	Acenaphthene Acenaphthylene Anthracene Benz[a]anthracene Benzo[a]pyrene Benzo[e]pyrene Benzo[b]fluoranthene Benzo[ghi]perylene Benzo[k]fluoranthene Chrysene Dibenz[a,h]anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene	2003 – 2010 Sediment Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Organochlorine Pesticides (ug/kg)	Aldrin Chlordane Dieldrin Endrin Heptachlor Methoxychlor Heptachlor epoxide	2003 – 2007 Water Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Territory	Nests per length of river section (m)	2006	SRST (SRST/URS, pers. comm., 3 January 2014)
	Potential Habitat	Land Use Type (%)	2006	SRST (SRST/URS, pers. comm., 3 January 2014)

	Fish Length	Length of Sample Fish in River (cm)	2006 Fish Community Survey 2005-2011 Fish Fillet Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Submerged Aquatic Vegetation	Percent SAV Cover (%)	2006 – 2007	SRST (SRST/URS, pers. comm., 3 January 2014)
	Turbidity	Seechi depth (cm)—converted from NTU Equation: (244.13*NTU)^-0.662	1994-2009 Water Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Nest Predation	Nests predated (%)	----	Jackson et al. 2011*a*
Carolina Wren	Mercury	Mercury bird blood concentration (ppm)	2005 – 2008	SRST (SRST/URS, pers. comm., 3 January 2014)
	PAHs	*Same as PAHs for Belted Kingfisher*	2003 – 2010 Sediment Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Organochlorine Pesticides	*Same as Pesticides for Belted Kingfisher*	2003 – 2007 Water Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Abundance	Relative Abundance	2005-2008	SRST (SRST/URS, pers. comm., 3 January 2014)
	Potential Habitat	Land Use Type (%)	2006	SRST (SRST/URS, pers. comm., 3 January 2014)
	Winter Air Temperature	Winter Air Temperature, December – February (°C)	2005 – 2014	NOAA
	Nest Predation	Nests predated (%)	----	Jackson et al. 2011*a* – data linked to nest abandonment
Smallmouth Bass	Mercury	Fish Fillet Mercury Concentration (mg/kg)	2003 – 2011	SRST (SRST/URS, pers. comm., 3 January 2014)
	PAHs	*Same as PAHs for Belted Kingfisher*	2003 – 2010 Sediment Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Organochlorine Pesticides	*Same as Pesticides for Belted Kingfisher*	2003 – 2007 Water Data	SRST (SRST/URS, pers. comm., 3 January 2014,)
	River Temperature	River Temperature (°C)	2006 – 2007 (Region 4 only)	USGS *a,b,c,d*

			2010 – 2011	
	Total Suspended Solids	Suspended Solids (mg/L)	*2005 – 2013*	SRST (SRST/URS, pers. comm., 3 January 2014)
	Abundance	Smallmouth Bass Abundance in each risk region relative to entire site (%)	2006 Fish Community Survey	SRST (SRST/URS, pers. comm., 3 January 2014)
White Sucker	Mercury	Fish Fillet Mercury Concentration (mg/kg)	2005 – 2007	SRST (SRST/URS, pers. comm., 3 January 2014)
	PAHs	*Same as PAHs for Belted Kingfisher*	2003 – 2010 Sediment Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	Organochlorine Pesticides	*Same as Pesticides for Belted Kingfisher*	2003 – 2007 Water Data	SRST (SRST/URS, pers. comm., 3 January 2014)
	River Temperature	River Temperature (°C)	2006 – 2007 (Region 4 only) 2010 – 2011	USGS *a,b,c,d*
	Stream Cover	Submerged Aquatic Vegetation Cover (%)	2006 – 2007	SRST (SRST/URS, pers. comm., 3 January 2014)
	Abundance	White Sucker Abundance in each Risk Region relative to entire site (%)	2006 Fish Community Survey	SRST (SRST/URS, pers. comm., 3 January 2014)
Water Quality	Total Phosphorus (mg/l)	Total Phosphorus, Total Phosphorus as P	2006-2007 (Region 6); 2006-2007 & 2010-2013 (Region 2-5)	SRST (SRST/URS, pers. comm., 3 January 2014)
	Bacteria Indicators	*E. coli*	2005 – 2010	SRST (SRST/URS, pers. comm., 3 January 2014)
	Summer Dissolved O2	Summer Dissolved Oxygen, April-September (mg/L)	2006 – 2008	SRST (SRST/URS, pers. comm., 3 January 2014)
	Winter Dissolved O2	Winter Dissolved Oxygen, October-March (mg/L)	2006 – 2008	SRST (SRST/URS, pers. comm., 3 January 2014)
	MeHg Body Burden Fish	Fish Fillet Methylmercury Concentration (mg/kg)	2003 – 2013	SRST (SRST/URS, pers. comm., 3 January 2014)

	Deviation from LT Summer Temperatures	Deviation from 30-Year average for Summer river temperature, April-September (°C)	2010 – 2011 No data for Region 4	USGS *a,b,c,d*
	Deviation from LT Winter Temperature	Deviation from 30-Year average for Winter river temperature, October-March (°C)	2010 – 2011 No data for Region 4	USGS *a,b,c,d*
	Deviation from LT Summer Discharge	Deviation from 30-Year average for Summer Discharge, April-September (%)	2010 – 2013 No data for Region 4	USGS *a,b,c,d*
	Deviation from LT Winter Discharge	Deviation from 30-Year average for Winter Discharge, October- March (%)	2010 – 2013 No data for Region 4	USGS *a,b,c,d*
	Fish Stocking	Presence or absence of fish stocking	2011	Bugas 2011 Virginia Department of Game and Inland Fisheries

Appendix 3. Biotic model parameterization tables describing input parameters, ranking schemes, justification, and data sources or references.

A3- 1. Summary explanation of input parameters for Belted Kingfisher initial risk estimates. This includes parameter and parameter definition; states and associated ranges, and justification for ranges with corresponding references.

Input parameter	State	Value	Justification	Reference
Mercury Probability of mercury bird blood concentration (ppm)	Zero	0.00-0.40 ppm	Adverse effects estimated from Evers et al. 2004	Evers et al. 2004 Lane et al. 2004; White 2007
	Low	0.41-1.00 ppm		
	Med	1.01-2.00 ppm		
	High	>2.01 ppm		
PAHs Probability of PAH concentration (ug/kg)	Under NOAA’s LEL for sediment	≤4,000 (µg/kg)	Comparison with the NOAA's Low Effects Limit (LEL) Screening Reference Value	Buchman 2008
	Over NOAA’s LEL for sediment	4,000-8,000 (µg/kg)		
Organochlorine Pesticides Probability of Organochlorine pesticide concentration (µg/kg)	Lower than NOAA’s Chronic Level for water	*pesticide specific (µg/kg)	Comparison with the NOAA's Chronic Toxicological Effects Level	Buchman 2008
	Higher than NOAA’s Chronic Level for water	*pesticide specific (µg/kg)		
Potential Habitat Probability of each land use type (%)	Zero	Pasture/Hay, Developed Open Space, Developed Low Intensity, Open Water	>1 nest present in land use for entire risk region	Bent 1940; Prose 1985; White 2007
	Low	Deciduous Forest, Cultivated Crops	One nest present in land use for entire risk region; directly adjacent to land use with containing nests	
	Medium	Evergreen Forest, Mixed Forest	Adjacent to land use containing nests, but with no nests present	
	High	Developed Medium Intensity, Developed High Intensity	No nests present nearby	
Submerged Aquatic Vegetation (SAV) Probability of percent SAV cover (%)	Zero	0-20%	Linear relationship between suitability Index and % water surface obstruction	Prose 1985
	Low	20-40%		
	Med	40-70%		
	High	70-100%		
Turbidity Probability of Secchi depth (cm)	Zero	> 60 cm	Linear relationship between suitability Index and turbidity measure by Secchi depth	Prose 1985
	Low	30-60 cm		
	Med	15-30 cm		
	High	<15 cm		

Fish Length Length of sample fish in river (cm)	Acceptable Unacceptable	<17 cm >18 cm	Generally eat fish <10 cm; will feed young fish as large as 17 cm Outside of the range of fish sizes normally found in kingfishers	Slayer and Lagler 1949 Davis 1982 Imhof 1962
Nest predation Nests predated (%)	Not effected Effected	Site specific nest predation data	Site-specific Carolina Wren predation rates of 14.5% +/- 6.1% for the contaminated South River and 19.6% +/- 7.8% for upstream of the contaminated site.	Jackson et al. 2001
Territory Length of river section (m)	Ideal Acceptable Unacceptable	0-2340 meters 2340-4800 m >4800 m	Home range when food is plentiful Medium home range size Maximum measured home range	Davis 1982; Brooks and Davis 1987

*SQuiRTs tables for chronic levels of pesticides can be found here: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

A3- 2. Summary explanation of input parameters for Carolina Wren initial risk estimates. This includes parameter and parameter definition; states and associated ranges, and justification for ranges with corresponding references.

Input parameter	State	Value	Justification	Reference
Mercury Probability of mercury bird blood concentration (ppm)	Zero Low Med High	0-1.2 ppm 1.2-2.1 ppm 2.1-2.9 ppm 2.9- 10 ppm	0-20% reduction in nest success 20-40% reduction in nest success 40-60% reduction in nest success >60% reduction in nest success	Jackson et al. 2011a Cristol et al. 2008
PAHs Probability of PAH concentration (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (µg/kg) 4,000-8,000 (µg/kg)	Comparison with the NOAA's Low Effects Limit (LEL) Screening Reference Value	Buchman 2008
Organochlorine Pesticides Probability of Organochlorine pesticide concentration (µg/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (µg/kg) *pesticide specific (µg/kg)	Comparison with the NOAA's Chronic Toxicological Effects Level	Buchman 2008

Potential Habitat Probability of each land use type (%)	Zero	Deciduous forest, evergreen forest, mixed forest, pasture/hay, cultivated crops	>1 nest present in land use for entire risk region	Bent 1940 Prose 1985 White 2007
	Low	Open water, developed open space, developed low intensity	One nest present in land use for entire risk region; directly adjacent to land use with containing nests	
	Medium	Developed medium intensity	Adjacent to land use containing nests, but with no nests present	
	High	Developed high intensity, barren land, woody wetlands, emergent herbaceous wetlands	No nests present nearby	
Winter Air Temperature Probability of winter air temperature during December-February (°C)	Zero	>2.7 °C	Based on seasonal trends and extreme weather events as described in Haggerty (1995)	Haggerty et al. 1995 NOAA National Climatic Data
	Low	-12 to 2.7 °C		
	Med	-20.83 to -12 °C		
	High	-27 to -20.83 °C		
Abundance Probability of relative abundance (%)	Zero	<10% of site abundance	Site-specific relative abundance. The percentage of total birds sampled that are in a given risk region was calculated. A ranking scheme was created to evenly distribute regions into 4 states.	Jackson et al. 2011a
	Low	11-22% site abundance		
	Medium	23-35% site abundance		
	High	> 36% of the total of all regions		
Nest Predation Probability of Carolina Wren nest predation (%)	No predation	Site specific predation data	Site-specific Carolina Wren predation rates of 14.5% +/- 6.1% for the contaminated South River and 19.6% +/- 7.8% for upstream of the contaminated site (Region 1 and part of Region 2).	Jackson et al. 2011a Cristol et al. 2008
	Predation			

*SQuiRTs tables for chronic levels of pesticides can be found here: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

A3- 3. Summary explanation of input parameters for smallmouth bass initial risk estimates. This includes parameter and parameter definition; states and associated ranges, and justification for ranges with corresponding references.

Input parameter	Parameter states	Range	Justification	References
Mercury Probability of fish fillet methylmercury concentration (mg/kg)	Zero	<0.2 mg/kg	< 5% lethality or equivalent endpoints	Dillon et al. 2010; USEPA 2009c
	Low	0.21-1.1 mg/kg	5 - 24% lethality or equivalent	
	Med	1.2-2.8 mg/kg	24 - 50% lethality or equivalent	
	High	>2.9 mg/kg	> 50% lethality or equivalent	
PAHs Probability of PAH concentration (ug/kg)	Under NOAA's LEL for sediment	≤4,000 (ug/kg)	Comparison with the NOAA's Low Effects Limit (LEL) Screening Reference Value	Buchman 2008
	Over NOAA's LEL for sediment	4,000-8,000 (ug/kg)		
Organochlorine Pesticides Probability of Organochlorine pesticide concentration (ug/kg)	Lower than NOAA's Chronic Level for water	*pesticide specific (ug/kg)	Comparison with the NOAA's Chronic Toxicological Effects Level	Buchman 2008
	Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg)		
River Temperature Probability of river temperature (°C)	Zero	20-26 °C	Ideal temps for spawning & growth; Temp optimum for juvenile growth & fry survival; Preferred adult temp range	Horning and Pearson 1973, Shuter et al. 1980, Armour 1993
	Low	17-19.9 or 26.1-29 °C	Spawning occurs at lower temp range, however we have reached upper temp limit for spawning (27°C); Positive growth rates for juvenile & fry (upper temps)	Kerr 1966, Horning and Pearson 1973, Shuter et al. 1980
	Med	15-16.9 or 29.1-31.9 °C	Reaching min. spawning temps, survival rates of egg/fry start to decrease; Nearing the upper avoidance temps by SMB (31°C); 100% mortality of egg/fry at upper temps (>30°C)	Kerr 1966, Cherry et al. 1975, Stauffer et al. 1976, Shuter et al. 1980
	High	≤14.9 or ≥32 °C	Below 15°C spawning likely won't occur; Egg survival decreases; Nest abandonment by male fish leads to increased predation; Colder waters (10-12°C) are associated with a fungus that causes egg/fry mortality; Avoidance temps for adults & juvenile fish; Upper thermal limits for fry & fingerlings ~33°C	Kerr 1966, Horning and Pearson 1973, Cherry et al. 1975 and 1977, Shuter et al. 1980, Armour 1993

Total Suspended Solids Probability of suspended solids (mg/L)	Zero	<25 mg/L	Preferential habitats ≤ 25 mg/L	Hubert and Lackey 1980; Carter et al. 2010 USEPA 2003
	Low	25-80 mg/L	Prey consumption decreases > 20 mg/L	
	Med	80-200 mg/L	Avoidance behavior; non-lethal effects	
	High	>200 mg/L	Onset of gill tissue damage in adult trout (no information on smallmouth bass)	
Abundance Probability of smallmouth bass abundance in each risk region relative to entire site (%)	Zero	<5%	Site-specific relative abundance. The percentage of total SMB sampled that are in a given risk region was calculated. A ranking scheme was created to evenly distribute regions into 4 states.	URS Fish Community Survey 2006
	Low	5-10%		
	Med	10-50%		
	High	>50%		

*SQuiRTs tables for chronic levels of pesticides can be found here: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

A3- 4. Summary explanation of input parameters for white sucker initial risk estimates. This includes parameter and parameter definition; states and associated ranges, and justification for ranges with corresponding references.

Input parameter	Parameter states	Range	Justification	References
Mercury Probability of fish fillet methylmercury concentration (mg/kg)	Zero	<0.2 mg/kg	< 5% lethality or equivalent endpoints	Dillon et al. 2010; USEPA 2009c
	Low	0.21-1.1 mg/kg	5 - 24% lethality or equivalent	
	Med	1.2-2.8 mg/kg	24 - 50% lethality or equivalent	
	High	>2.9 mg/kg	> 50% lethality or equivalent	
PAHs Probability of PAH concentration (ug/kg)	Under NOAA's LEL for sediment	≤4,000 (ug/kg)	Comparison with the NOAA's Low Effects Limit (LEL) Screening Reference Value	Buchman 2008
	Over NOAA's LEL for sediment	4,000-8,000 (ug/kg)		
Organochlorine Pesticides Probability of Organochlorine pesticide concentration (ug/kg)	Lower than NOAA's Chronic Level for water	*pesticide specific (ug/kg)	Comparison with the NOAA's Chronic Toxicological Effects Level	Buchman 2008
	Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg)		
River Temperature	Zero	14-19 °C	Maximum hatching success	McCormick et al. 1977

Probability of river temperature (degrees Celsius)	Low	11-14 or 19-22 °C	Preferred temp. range for adult white sucker (Horak and Tanner 1964)	Horak and Tanner 1964
	Med	9-11 or 22-29 °C	Preferred temp. range for juvenile	Marcy 1976 Brett 1944; Carlander 1969
	High	<9 or >29 °C	Upper lethal temp. limit for juvenile; decreased hatching success	Twomey et al. 1984
Stream Cover Probability of percent submerged aquatic vegetation cover (%)	Zero	25-85%	Derived from Habitat Suitability Index models and in stream flow suitability curves. Submerged aquatic vegetation was used as a metric for stream cover.	Twomey et al. 1984. Dence 1948; Probst 1982b
	Low	15-25% or 85-100%		
	Med	5-15%		
	High	<5%		
Abundance Probability of white sucker abundance in each risk region relative to entire site (%)	Zero	<5%	Site-specific relative abundance. The percentage of total WS sampled that are in a given risk region was calculated. A ranking scheme was created to evenly distribute regions into 4 states.	URS Fish Community Survey 2006
	Low	5-10%		
	Med	10-50%		
	High	>50%		

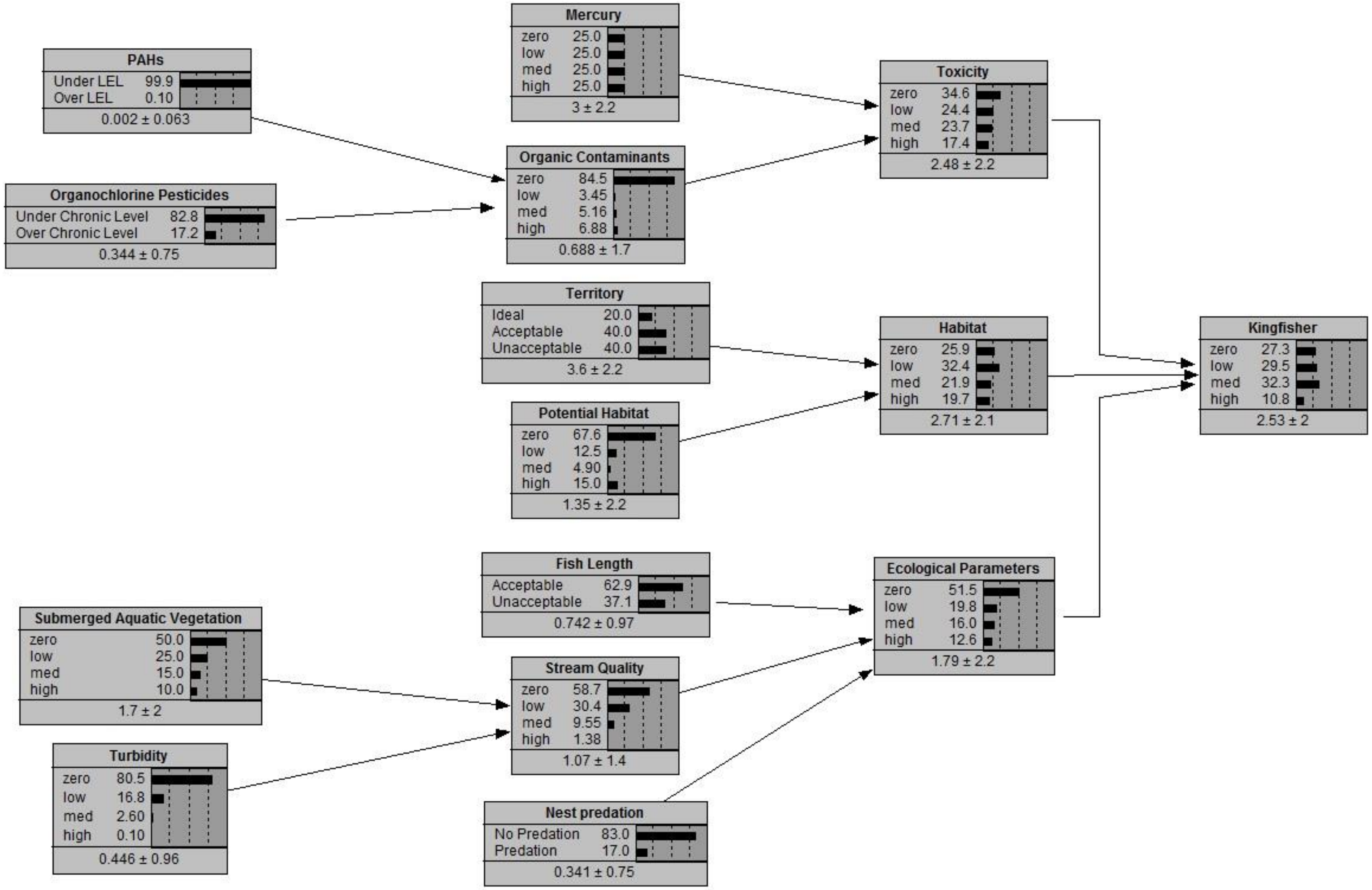
*SQuiRTs tables for chronic levels of pesticides can be found here: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

Appendix 4. WQ model parameterization tables describing input parameters, ranking schemes, justification, and data sources or references.

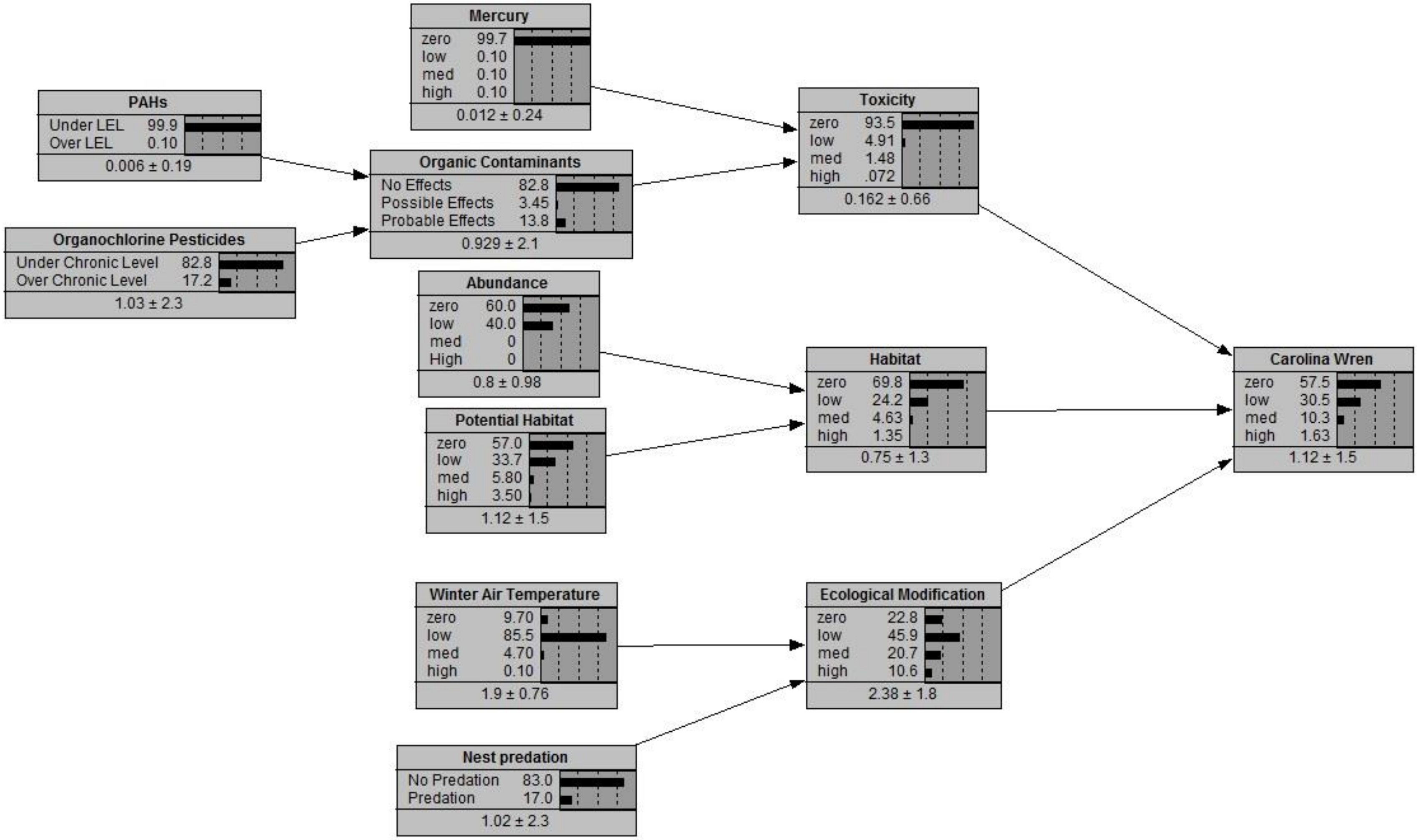
Input parameter	Parameter states	Range	Justification	Sources
Total Phosphorus Probability of total phosphorus (mg/L)	Zero Low Med High	<0.1 mg/L 0.1-0.3 mg/L 0.31-0.5 mg/L >0.51 mg/L	Below 0.1 no nuisance algal blooms EPA desired goal =0.1 mg/L 01-0.3 mg/L few surface waters are contaminated by algal booms Algal growth decreases water clarity and interferes with fishing, swimming and boating (Nat'l WQ Assessment)	Black et al. 2010, USEPA 2006 (Wadeable Streams Assessment) Sprague 2009
Bacteria indicators Probability of fecal bacteria (CFU/100mL)	Zero Moderate High	<200 CFU/100 mL 200-1000 CFU/100 mL >1000 CFU/100 mL	Categorical definitions based on VA DEQ bacteria standards	VDEQ 2009
Summer Dissolved O_2 Probability of dissolved oxygen levels April-September (mg/L)	Zero Moderate High	>9 mg/L 5-9 mg/L <5 mg/L	Categorical states were defined following the methodology of a similar water quality risk analysis (Pollino et al. 2007).	Pollino et al. 2007 30-year seasonal averages from USGS *(a,b,c,d)*
Winter Dissolved O_2 Probability of dissolved oxygen levels October-March (mg/L)	Zero Moderate High	>9 mg/L 5-9 mg/L 5 mg/L	Categorical states were defined following the methodology of a similar water quality risk analysis (Pollino et al. 2007)	Pollino et al. 2007 30-year seasonal averages from USGS *(a,b,c,d)*
MeHg Body Burden Fish Probability of fish fillet methylmercury concentration (mg/kg)	Zero Low Med High	<0.2 mg/kg 0.21-1.1 mg/kg 1.2-2.8 mg/kg >2.9 mg/kg	Criteria were the same used for the SMB mercury assessment.	Dillon et al. 2010 EPA fish study www.epa.gov/waterscience/fishstudy
Deviation from LT summer temp Probability of deviation from 30-year seasonal average for river temp from April-September (°C)	No change Moderate High	0-2 °C deviation 2-4 °C deviation >4 °C deviation	Categorical states were defined following the methodology of a similar water quality risk analysis (Pollino et al. 2007).	Pollino et al. 2007 30-year seasonal averages from USGS *(a,b,c,d)*

Deviation from LT winter temp Probability of deviation from 30-year seasonal average for river temp from October-March (°C)	No change Moderate High	0-2 °C deviation 2-4 °C deviation >4 °C deviation	Categorical states were defined following the methodology of a similar water quality risk analysis (Pollino et al. 2007).	Pollino et al. 2007 30-year seasonal averages from USGS *(a,b,c,d)*
Deviation from LT summer discharge Probability of deviation from 30-year seasonal average for discharge from April-September (%)	No change Increase Decrease	76-125% deviation 126-175% deviation 25-75% deviation	Categorical states were defined following the methodology of a similar water quality risk analysis (Pollino et al. 2007).	Pollino et al. 2007 30-year seasonal averages from USGS *(a,b,c,d)*
Deviation from LT winter discharge Probability of deviation from 30-year seasonal average for discharge from October-March (%)	No change Increase Decrease	76-125% deviation 126-175% deviation 25-75% deviation	Categorical states were defined following the methodology of a similar water quality risk analysis (Pollino et al. 2007).	Pollino et al. 2007 30-year seasonal averages from USGS *(a,b,c,d)*
Fish Stocking Presence or absence of fish stocking	Yes No	Fish stocking occurs in risk region No fish stocking in risk region	Presence or absence of fish stocking within a risk region.	Bugas 2011 (VDGIF Angler Survey)

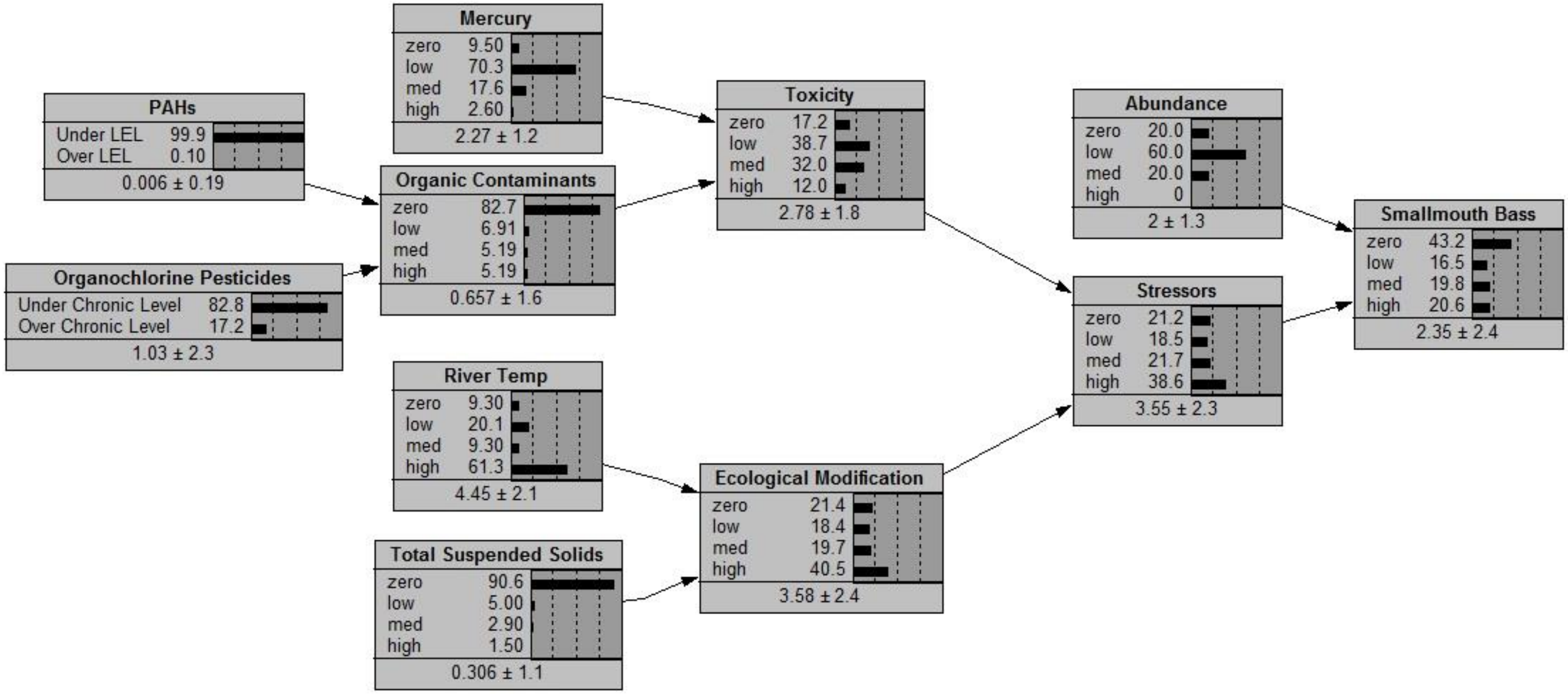
Appendix 5. Diagrams of Bayesian networks for all biotic endpoints for Region 2. The specific Netica models will be provided with the Appendix. For a given endpoint, the structure of the model is the same except for the inputs specific to that region.



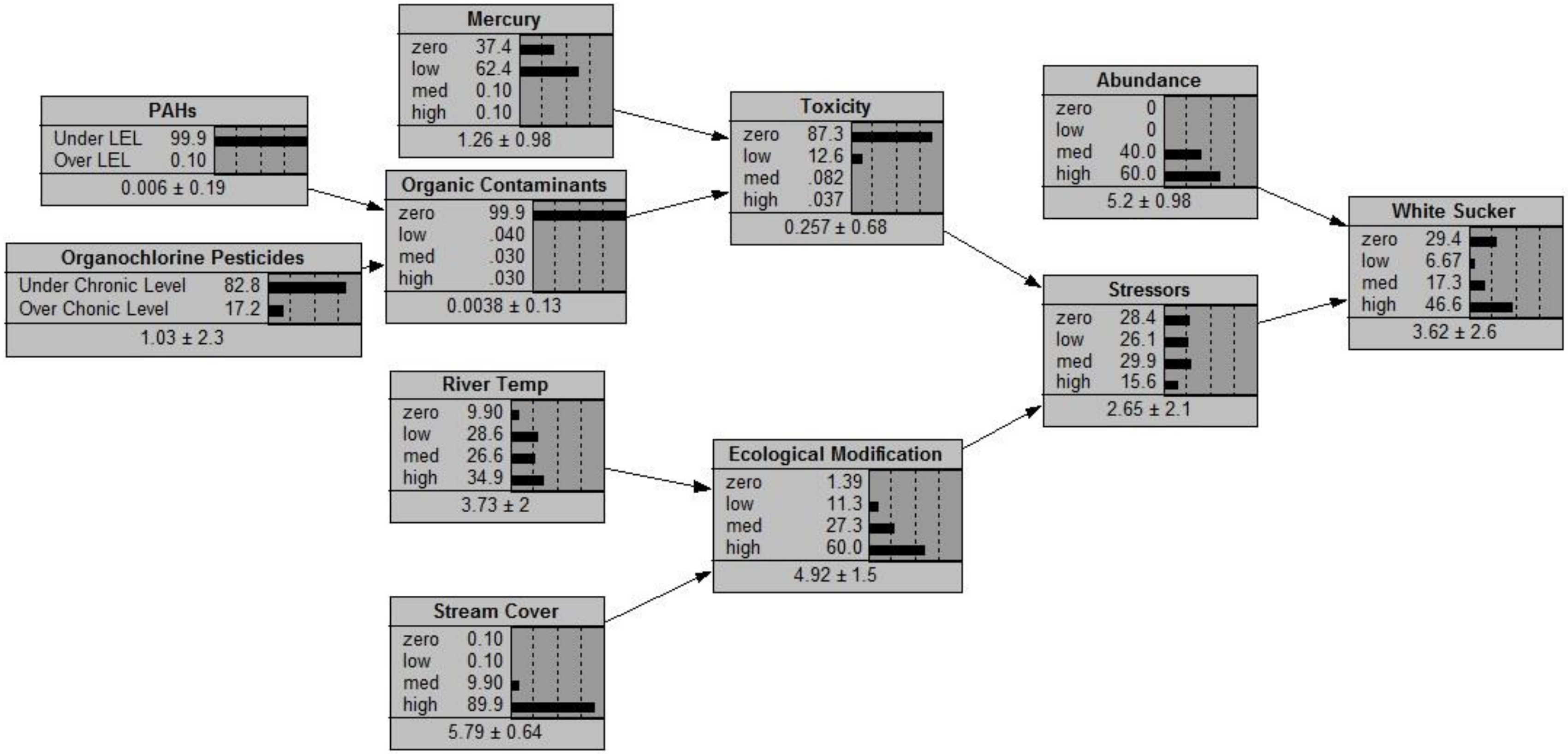
A5-1. Bayesian network for Belted Kingfisher, Region 2.



A5-2. Bayesian network for Carolina Wren, Region 2.

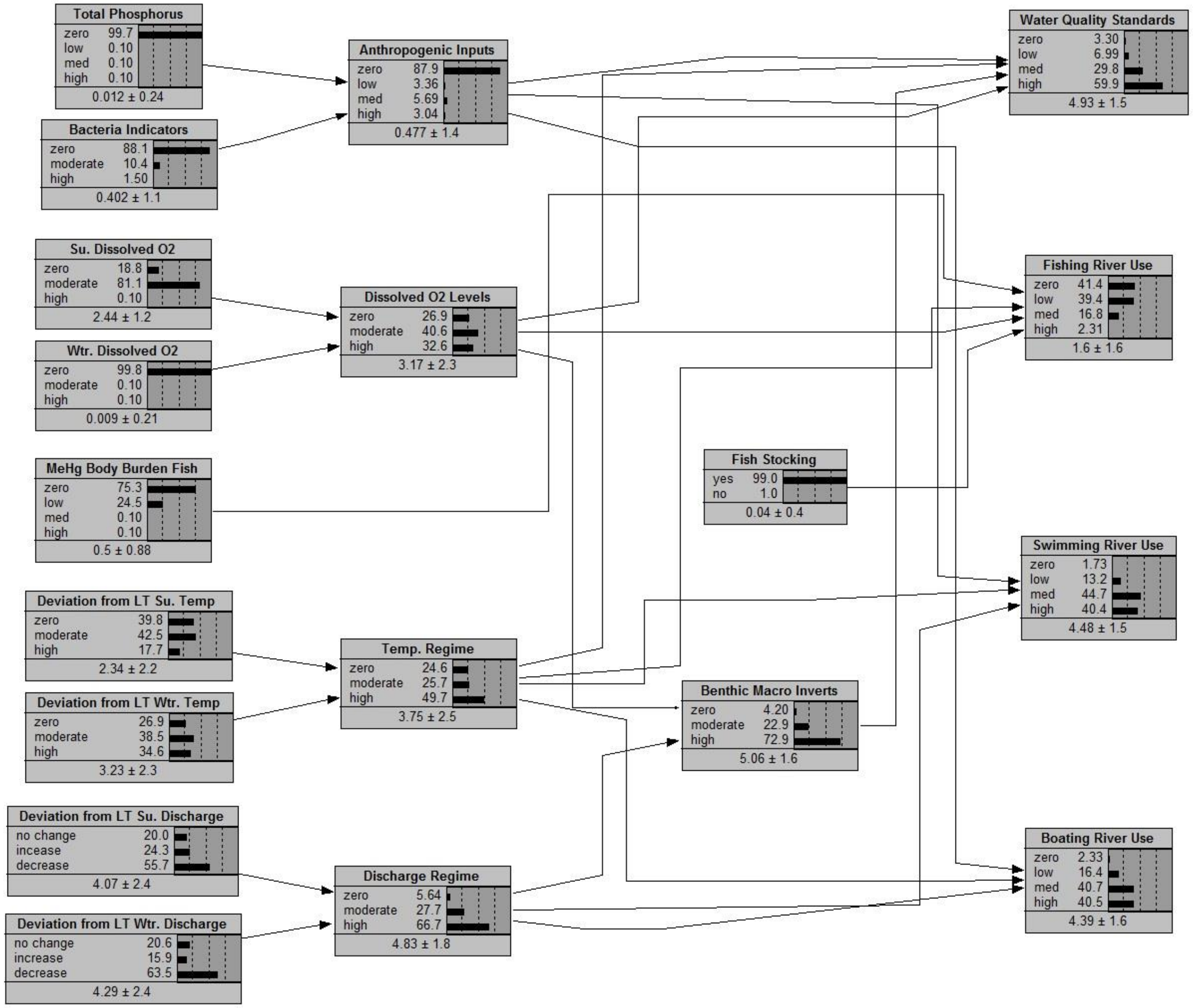


A5-3. Bayesian network for Smallmouth Bass, Region 2.



A5-4. Bayesian network for White Sucker, Region 2.

Appendix 6. Bayesian networks for water quality endpoints using Region 2 as an example. Each model is available as a Netica file as part of the electronic appendix.



A6-1. Bayesian network for Water Quality, Region 2.

Appendix 7. Sensitivity Analysis: entropy reduction results for the initial biotic and water quality models.

The following table displays the top 3 input parameters (chemical and ecological stressors) and their degree of entropy reduction on each of the endpoints in every region.

Only input parameters (parent nodes) were included in the lists. For example, Discharge Regime could not be on the list because site-specific data were lacking. As such, only Deviation from Summer Discharge or Deviation from Winter Discharge could be used. Inherently, nodes that have the least number of connections to the endpoint are more likely to have greater influence over the final entropy reduction value of the endpoint. Management may choose to target Discharge Regime as a whole, but it is important to know what component of the Discharge Regime is driving the risk. This can only be understood by looking at the influence of input parameters on the endpoints.

	Input Parameter	**Entropy Reduction**
Belted Kingfisher		
Region 2	Mercury	0.1475
	Fish Length	0.0704
	Potential Habitat	0.0433
Region 3	Mercury	0.1563
	Fish Length	0.0946
	Potential Habitat	0.0399
Region 4	Mercury	0.1929
	Fish Length	0.0759
	Territory	0.0250
Region 5	Mercury	0.2242
	Fish Length	0.0781
	Territory	0.0229
Region 6	Fish Length	0.0981
	Mercury	0.0449
	Territory	0.0428
Carolina Wren		
Region 2	Nest Predation	0.0617
	Potential Habitat	0.0587
	Winter Air Temperature	0.0195
Region 3	Mercury	0.1082
	Nest Predation	0.0581
	Winter Air Temperature	0.0181
Region 4	Mercury	0.0953
	Nest Predation	0.0335
	Winter Air Temperature	0.0122
Region 5	Mercury	0.1081
	Nest Predation	0.0363

	Potential Habitat	0.0121
Region 6	Mercury	0.0893
	Nest Predation	0.0426
	Winter Air Temperature	0.0136
Smallmouth Bass		
Region 2	River Temp	0.0273
	Mercury	0.0174
	Total Suspended Solids	0.0011
Region 3	River Temp	0.0143
	Mercury	0.0059
	Organochlorine Pesticide	0.0029
Region 4	River Temp	0.0326
	Mercury	0.0150
	Organochlorine Pesticide	0.0070
Region 5	River Temp	0.0517
	Mercury	0.0413
	Total Suspended Solids	0.0040
Region 6	River Temp	0.0488
	Mercury	0.0149
	Organochlorine Pesticide	0.0035
White Sucker		
Region 2	River Temp	0.0777
	Stream Cover	0.0078
	Mercury	0.0007
Region 3	River Temp	0.0564
	Stream Cover	0.0396
	PAHs	0.0003
Region 4	River Temp	0.0998
	Stream Cover	0.0156
	Mercury	0.0065
Region 5	River Temp	0.0498
	Stream Cover	0.0138
	Mercury	0.0042
Region 6	River Temp	0.0416
	Stream Cover	0.0183
	Mercury	0.0031
Water Quality Standards		
Region 2	Summer Dissolved O_2	0.0927
	Deviation from Winter Temp	0.0122
	Bacterial Indicators	0.0103
Region 3	Summer Dissolved O_2	0.1081
	Bacterial Indicators	0.0393
	Deviation from Winter Discharge	0.0147
Region 4	Summer Dissolved O_2	0.1673

	Deviation from Winter Discharge	0.0209
	Deviation from Summer Discharge	0.0200
Region 5	Summer Dissolved O_2	0.1104
	Bacterial Indicators	0.0348
	Deviation from Winter Discharge	0.0106
Region 6	Summer Dissolved O_2	0.1120
	Deviation from Winter Discharge	0.0215
	Deviation from Summer Discharge	0.0168
Fishing River Use		
Region 2	Summer Dissolved O_2	0.1019
	Deviation from Winter Temp	0.0199
	Deviation from Summer Temp	0.0145
Region 3	MeHg Body Burden Fish	0.1184
	Summer Dissolved O_2	0.1385
	Deviation from Winter Temp	0.0259
Region 4	MeHg Body Burden Fish	0.1804
	Summer Dissolved O_2	0.1071
	Deviation from Winter Temp & Deviation from Summer Temp	0.0233
Region 5	MeHg Body Burden Fish	0.1399
	Summer Dissolved O_2	0.0967
	Deviation from Winter Temp	0.0153
Region 6	Summer Dissolved O_2	0.2395
	Deviation from Winter Temp	0.0132
	Deviation from Summer Temp	0.0132
Swimming River Use		
Region 2	Deviation from Winter Temp	0.0384
	Deviation from Summer Temp	0.0310
	Bacterial Indicators	0.0250
Region 3	Bacterial Indicators	0.0548
	Deviation from Winter Temp	0.0349
	Deviation from Summer Temp	0.0257
Region 4	Deviation from Summer Discharge	0.0481
	Deviation from Winter Discharge	0.0428
	Deviation from Winter Temp & Deviation from Summer Temp	0.0386
Region 5	Bacterial Indicators	0.0568
	Deviation from Winter Temp	0.0306
	Deviation from Summer Temp	0.0289
Region 6	Deviation from Winter Temp	0.0327
	Deviation from Summer Temp	0.0327
	Bacterial Indicators	0.0202
Boating River Use		
Region 2	Deviation from Winter Temp	0.0567

	Deviation from Summer Temp	0.0429
	Bacterial Indicators	0.0224
Region 3	Deviation from Winter Temp	0.0538
	Bacterial Indicators	0.0505
	Deviation from Summer Temp	0.0391
Region 4	Deviation from Winter Temp	0.0530
	Deviation from Summer Temp	0.0530
	Deviation from Summer Discharge	0.0274
Region 5	Bacterial Indicators	0.0577
	Deviation from Winter Temp	0.0403
	Deviation from Summer Temp	0.0356
Region 6	Deviation from Winter Temp	0.0414
	Deviation from Summer Temp	0.0414
	Bacterial Indicators	0.0198

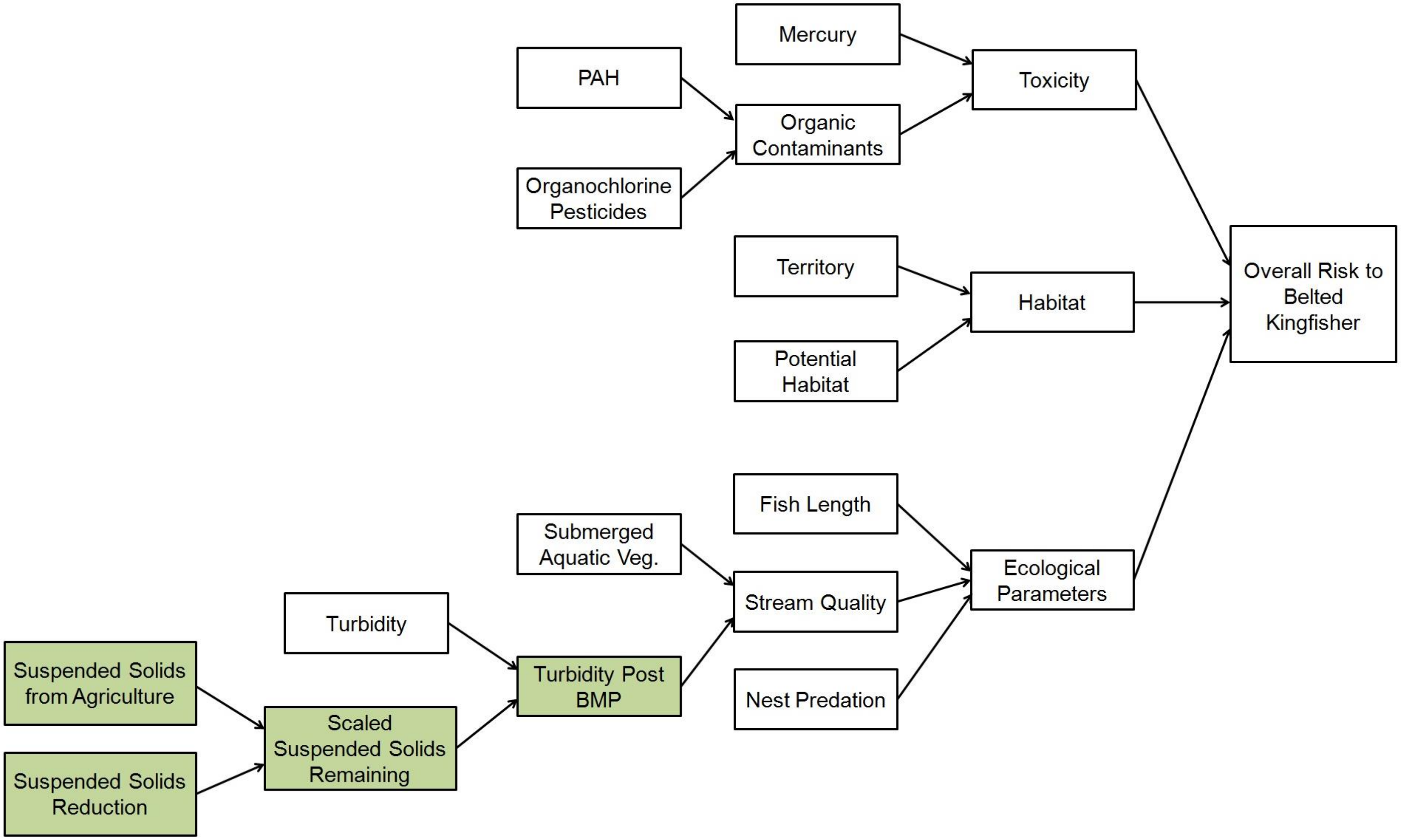
Appendix 8. Percent reduction of risk when top entropy parameters were set to 100% for the lowest state (e.g. Zero or Under LEL).

	Altered Input Parameter	Current risk	Risk with input parameter at 100% probability zero risk state	% change in risk
Belted Kingfisher				
Region 2	Mercury	2.53 ± 2.0	1.52 ±1.9	-39.9
	Fish Length		2.07 ±1.9	-18.2
	Potential Habitat		2.26 ±1.9	-10.7
Region 3	Mercury	1.47 ± 1.8	0.881 ±1.5	-40.1
	Fish Length		0.958 ±1.5	-34.8
	Potential Habitat		1.20 ±1.7	-18.4
Region 4	Mercury	2.14 ± 2.0	1.24 ±1.7	-42.1
	Fish Length		1.67 ±1.9	-22.0
	Territory		1.86 ±2.0	-13.1
Region 5	Mercury	2.18 ±2.1	1.29 ±1.8	-40.8
	Fish Length		1.73 ±1.9	-20.6
	Territory		1.64 ±2.0	-24.8
Region 6	Fish Length	1.51 ±1.8	1.04 ±1.6	-31.1
	Mercury		1.38 ±1.8	-8.6
	Territory		1.11 ±1.6	-26.5
Carolina Wren				
Region 2	Nest Predation	1.12 ±1.5	0.917 ±1.3	-18.1
	Potential Habitat		0.838 ±1.3	-25.2
	Winter Air Temperature		0.537 ±1.2	-52.1
Region 3	Mercury	1.91 ±1.8	1.29 ±1.5	-32.5
	Nest Predation		1.66 ±1.6	-13.1
	Winter Air Temperature		1.23 ±1.7	-35.6
Region 4	Mercury	3.00 ±1.9	2.41 ±1.8	-19.7
	Nest Predation		2.81 ±1.8	-6.3
	Winter Air Temperature		2.36 ±2.0	-21.3
Region 5	Mercury	2.85 ±1.8	1.94 ±1.8	-6.7
	Nest Predation		2.66 ±1.8	-3.2
	Potential Habitat		2.76 ±1.9	-3.2
Region 6	Mercury	2.45 ±1.9	1.61 ±1.8	-34.3
	Nest Predation		2.23 ±1.8	-9.0
	Winter Air Temperature		1.80 ±1.9	-26.5
Smallmouth Bass				
Region 2	River Temp	2.35 ±2.4	1.54 ±2.2	-34.5
	Mercury		1.43 ±2.1	-39.1
	Total Suspended Solids		2.33 ±2.4	-0.9
Region 3	River Temp	2.69 ±2.4	2.16 ±2.4	-19.7
	Mercury		1.34 ±2.1	-50.2
	Organochlorine Pesticide		2.62 ±2.4	-2.6
Region 4	River Temp	4.31 ±2.2	3.57 ±2.1	-17.2
	Mercury		2.25 ±2.5	-47.8

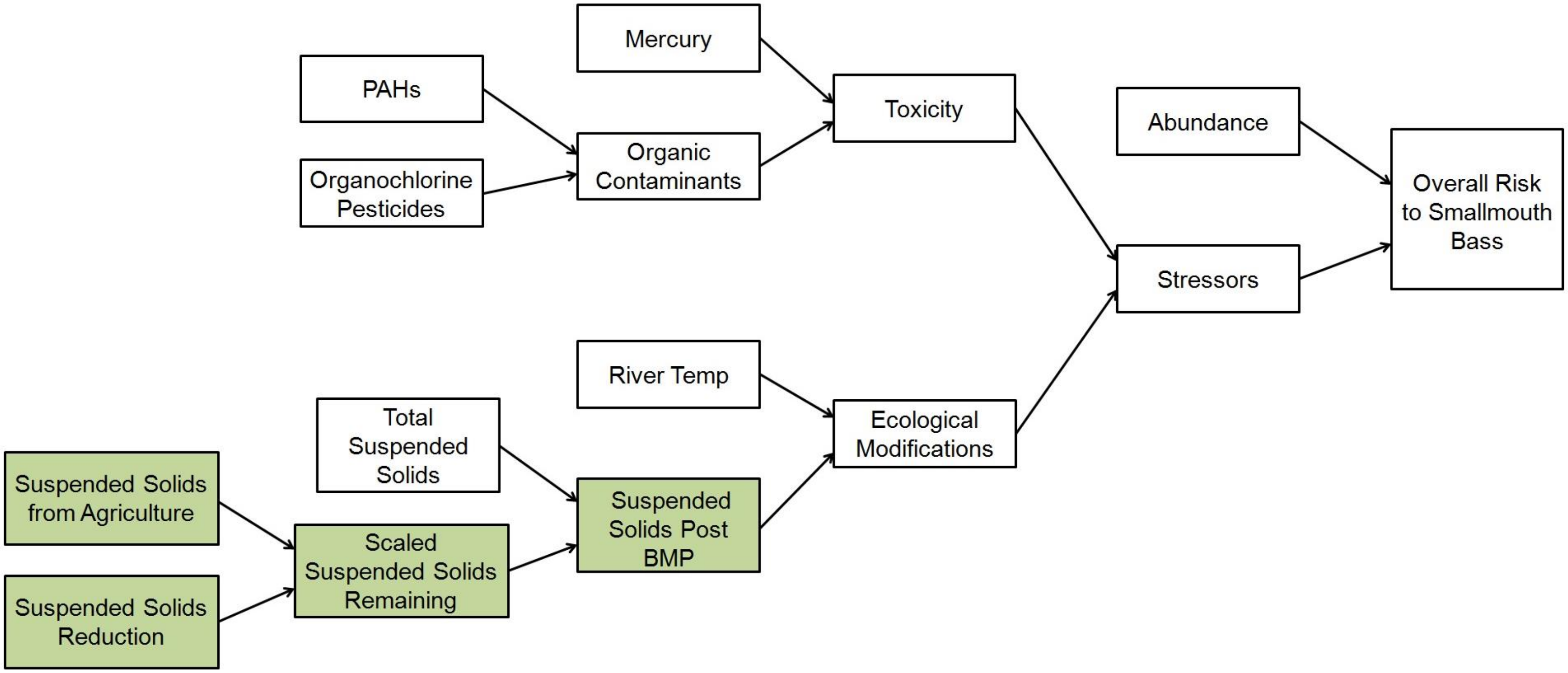
	Organochlorine Pesticide		4.22 ±2.2	-2.1
Region 5	River Temp	4.48 ±2.4	3.77 ±2.7	-15.8
	Mercury		1.79 ±2.6	-60.0
	Total Suspended Solids		4.42 ±2.4	-1.3
Region 6	River Temp	3.30 ±2.4	2.53 ±2.5	-23.3
	Mercury		1.63 ±2.2	-50.6
	Organochlorine Pesticide		3.22 ±2.4	-2.4
White Sucker				
Region 2	River Temp	3.62 ±2.6	2.77 ±2.7	-23.5
	Stream Cover		2.14 ±2.6	-40.9
	Mercury		3.53 ±2.6	-2.5
Region 3	River Temp	3.11 ±2.5	2.05 ±2.5	-34.1
	Stream Cover		2.49 ±2.6	-19.9
	PAHs		3.11 ±2.5	0.0
Region 4	River Temp	2.41 ±2.6	1.07 ±2.1	-55.6
	Stream Cover		2.22 ±2.5	-7.9
	Mercury		1.85 ±2.4	-23.2
Region 5	River Temp	1.33 ±2.0	0.505 ±1.4	-62.0
	Stream Cover		1.19 ±1.9	-10.5
	Mercury		1.11 ±1.9	-16.5
Region 6	River Temp	1.70 ±2.2	0.914 ±1.8	-46.2
	Stream Cover		1.41 ±2.1	-17.1
	Mercury		1.48 ±2.1	-12.9
Water Quality Standards				
Region 2	Summer Dissolved O_2	4.93 ±1.5	3.72 ±2.0	-24.5
	Deviation from Winter Temp		4.64 ±1.6	-5.9
	Bacterial Indicators		4.86 ±1.6	-1.4
Region 3	Summer Dissolved O_2	4.54 ±1.8	3.98 ±1.9	-12.3
	Bacterial Indicators		4.30 ±1.9	-5.3
	Deviation from Winter Discharge		4.13 ±2.1	-9.0
Region 4	Summer Dissolved O_2	4.48 ±1.9	3.29 ±2.1	-26.6
	Deviation from Winter Discharge		4.14 ±2.2	-7.6
	Deviation from Summer Discharge		4.14 ±2.2	-7.6
Region 5	Summer Dissolved O_2	4.84 ±1.6	4.07 ±1.9	-15.9
	Bacterial Indicators		4.66 ±1.7	-3.7
	Deviation from Winter Discharge		4.52 ±1.9	-6.6
Region 6	Summer Dissolved O_2	4.31 ±1.9	3.83 ±2.0	-11.1
	Deviation from Winter Discharge		3.73 ±2.2	-13.5
	Deviation from Summer Discharge		3.87 ±2.2	-10.2
Fishing River Use				
Region 2	Summer Dissolved O_2	1.60 ±1.6	0.515 ±0.89	-67.8
	Deviation from Winter Temp		1.20 ±1.4	-25.0
	Deviation from Summer Temp		1.33 ±1.5	-16.9
Region 3	MeHg Body Burden Fish	1.54 ±1.8	1.24 ±1.5	-19.5
	Summer Dissolved O_2		0.924 ±1.4	-40.0
	Deviation from Winter Temp		1.10 ±1.5	-28.6

Region 4	MeHg Body Burden Fish	2.14 ±2.0	1.59 ±1.7	-25.7
	Summer Dissolved O_2		1.24 ±1.7	-42.1
	Deviation from Winter Temp & Deviation from Summer Temp		1.68 ±1.8	-21.5
Region 5	MeHg Body Burden Fish	1.88 ±1.8	1.42 ±1.6	-24.5
	Summer Dissolved O_2		1.15 ±1.6	-38.8
	Deviation from Winter Temp		1.47 ±1.7	-21.8
Region 6	Summer Dissolved O_2	1.19 ±1.5	0.649 ±0.95	-45.5
	Deviation from Winter Temp		0.876 ±1.3	-26.4
	Deviation from Summer Temp		0.876 ±1.3	-26.4
Swimming River Use				
Region 2	Deviation from Winter Temp	4.48 ±1.5	3.98 ±1.6	-11.2
	Deviation from Summer Temp		4.13 ±1.6	-7.8
	Bacterial Indicators		4.38 ±1.5	-2.2
Region 3	Bacterial Indicators	4.64 ±1.4	4.41 ±1.5	-5.0
	Deviation from Winter Temp		4.23 ±1.6	-8.8
	Deviation from Summer Temp		4.34 ±1.6	-6.5
Region 4	Deviation from Summer Discharge	4.28 ±1.6	3.79 ±1.9	-11.4
	Deviation from Winter Discharge		3.81 ±1.9	-11.0
	Deviation from Winter Temp & Deviation from Summer Temp		3.80 ±1.8	-11.2
Region 5	Bacterial Indicators	4.79 ±1.4	4.60 ±1.4	-4.0
	Deviation from Winter Temp		4.36 ±1.5	-9.0
	Deviation from Summer Temp		4.43 ±1.5	-7.5
Region 6	Deviation from Winter Temp	4.63 ±1.4	4.16 ±1.6	-10.2
	Deviation from Summer Temp		4.16 ±1.6	-10.2
	Bacterial Indicators		4.55 ±1.4	-1.7
Boating River Use				
Region 2	Deviation from Winter Temp	4.39 ±1.6	3.74 ±1.8	-14.8
	Deviation from Summer Temp		3.97 ±1.7	-9.6
	Bacterial Indicators		4.29 ±1.6	-2.3
Region 3	Deviation from Winter Temp	4.55 ±1.6	4.01 ±1.8	-11.9
	Bacterial Indicators		4.31 ±1.6	-5.3
	Deviation from Summer Temp		4.15 ±1.7	-8.8
Region 4	Deviation from Winter Temp	4.18 ±1.7	3.63 ±1.9	-13.2
	Deviation from Summer Temp		3.63 ±1.9	-13.2
	Deviation from Summer Discharge		3.8 ±1.8	-9.1
Region 5	Bacterial Indicators	4.70 ±1.5	4.49 ±1.5	-4.5
	Deviation from Winter Temp		4.20 ±1.7	-10.6
	Deviation from Summer Temp		4.29 ±1.7	-8.7
Region 6	Deviation from Winter Temp	4.54 ±1.5	4.02 ±1.7	-11.5
	Deviation from Summer Temp		4.02 ±1.7	-11.5
	Bacterial Indicators		4.47 ±1.5	-1.5

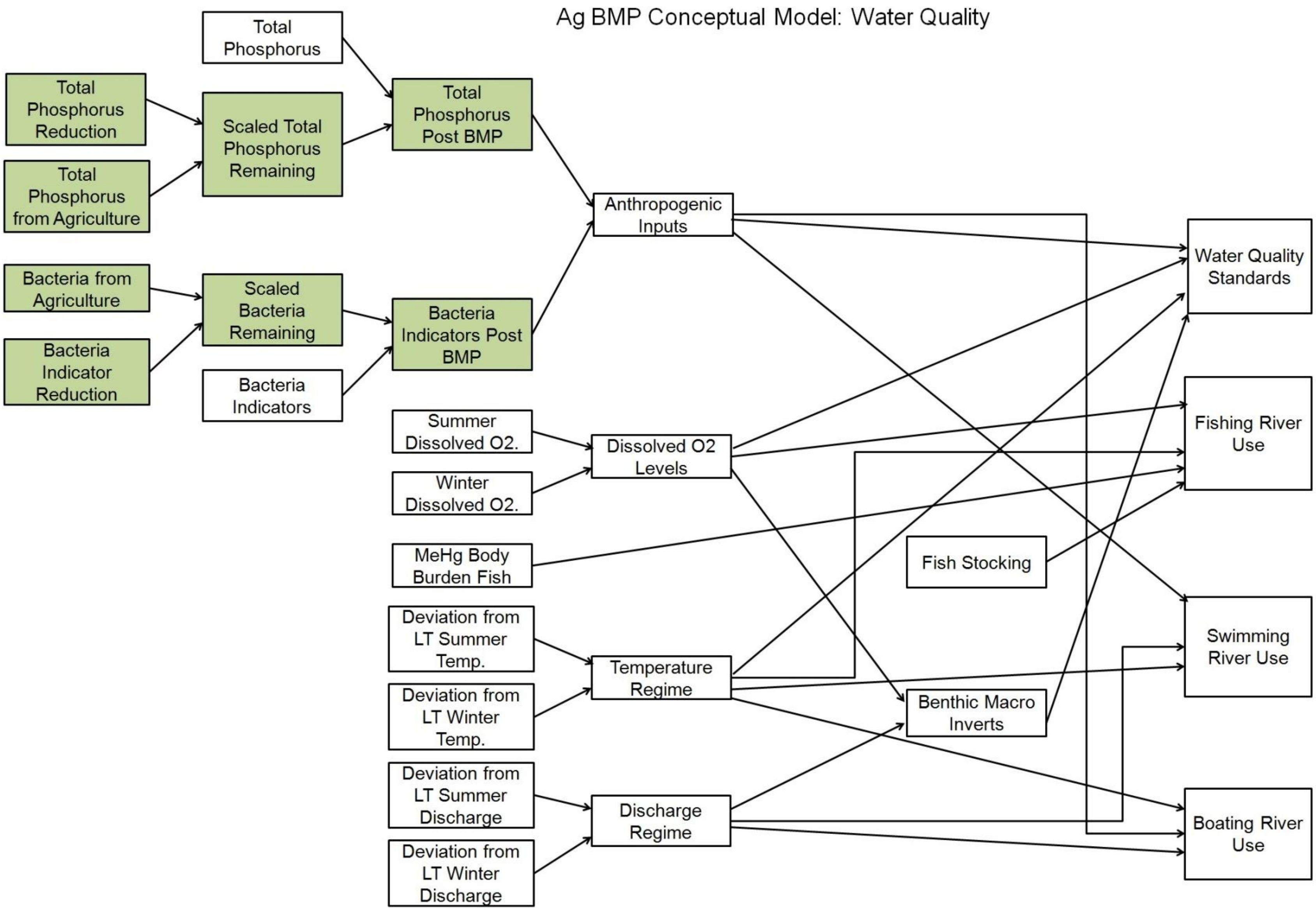
Appendix 9. Conceptual models for the Agriculture Best Management Practices (Ag BMPs) management scenario. Management nodes for the Ag BMPs are shaded green.



A9-1. Ag BMP conceptual model for Belted Kingfisher.

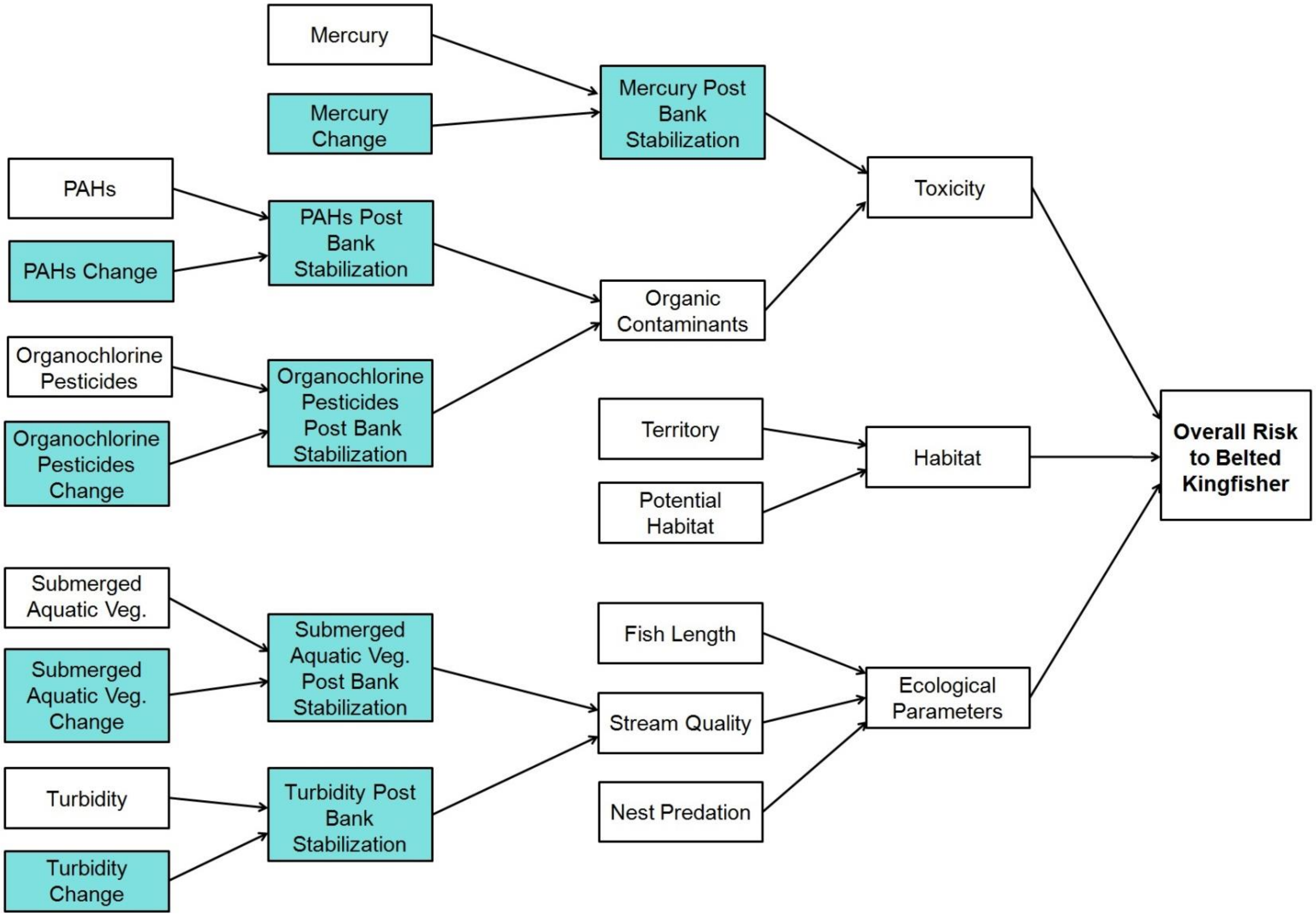


A9-2. Ag BMP conceptual model for smallmouth bass.

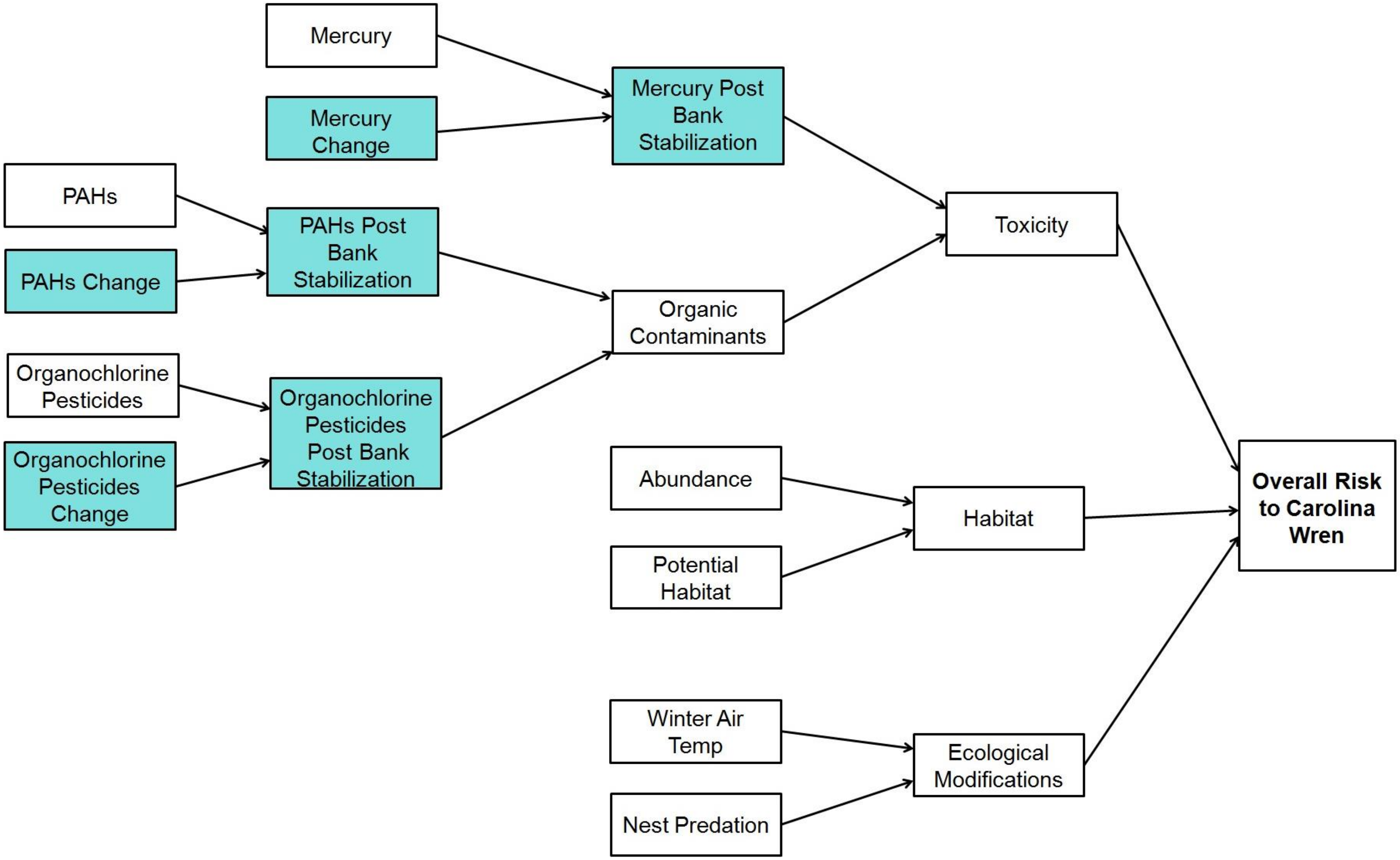


A9-3. Ag BMP conceptual model for water quality endpoints.

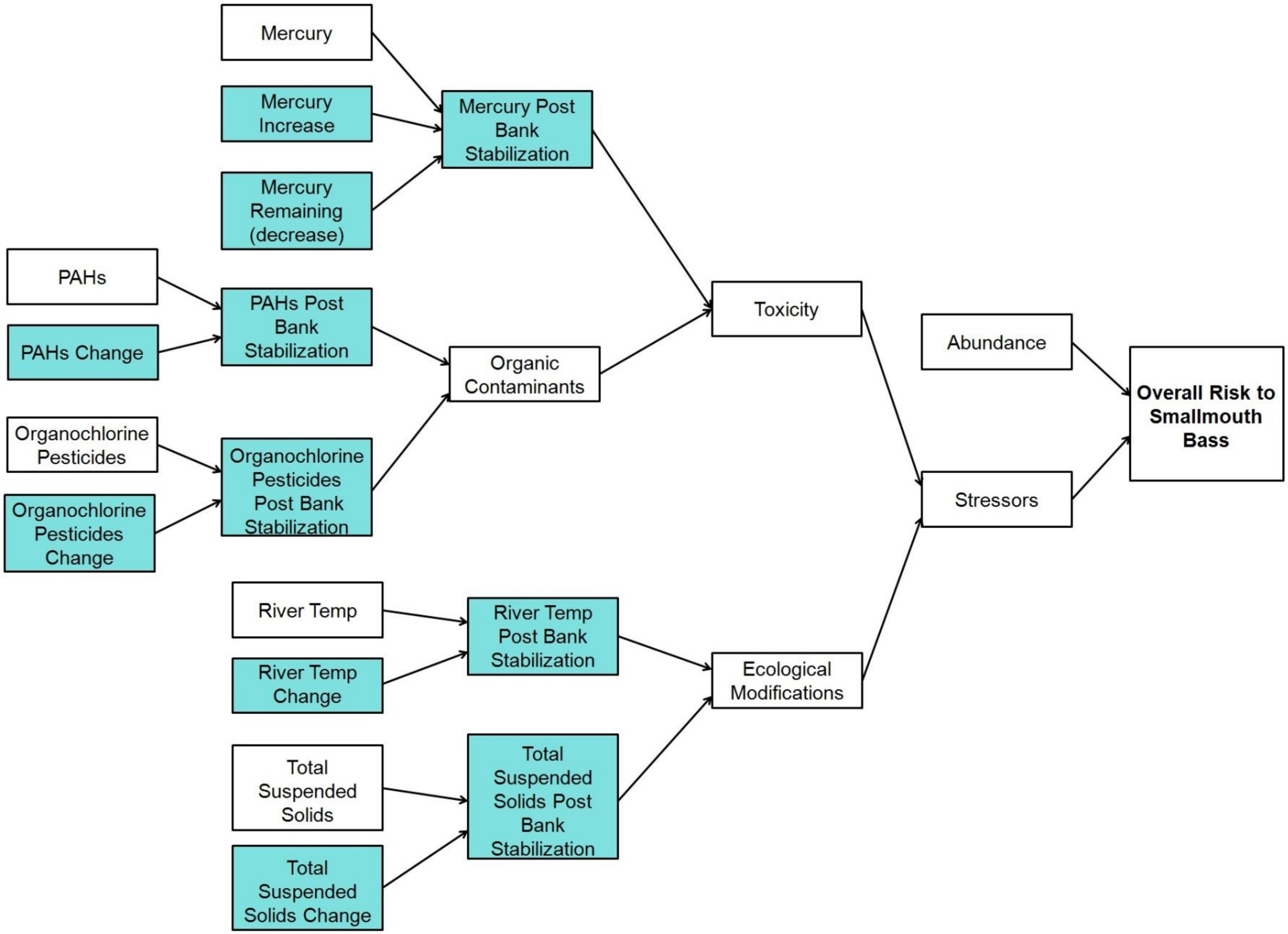
Appendix 10. Conceptual models for the Bank Stabilization management scenario. Management nodes for the bank stabilization are shaded blue.



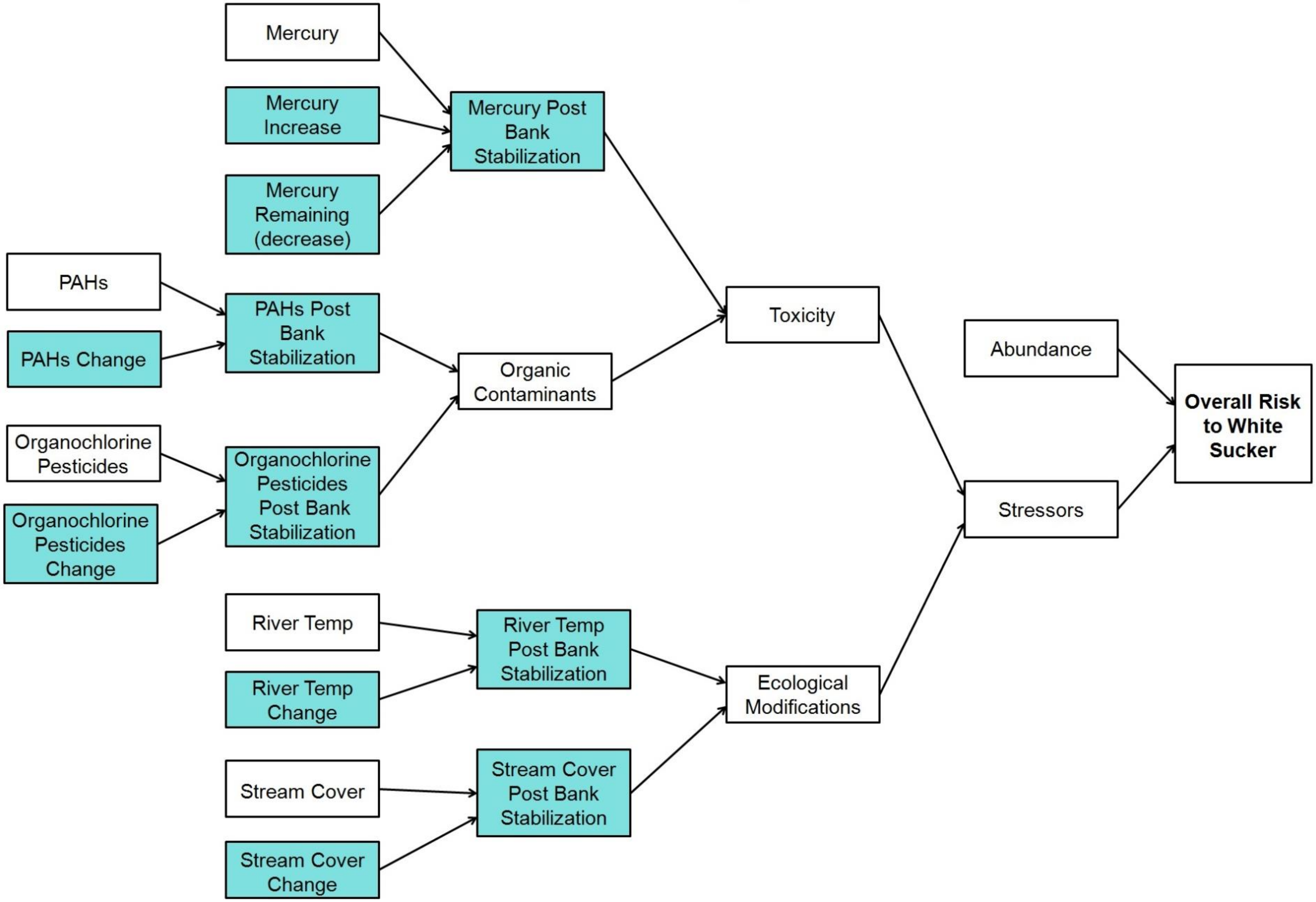
A10-1. Bank stabilization conceptual model for Belted Kingfisher.



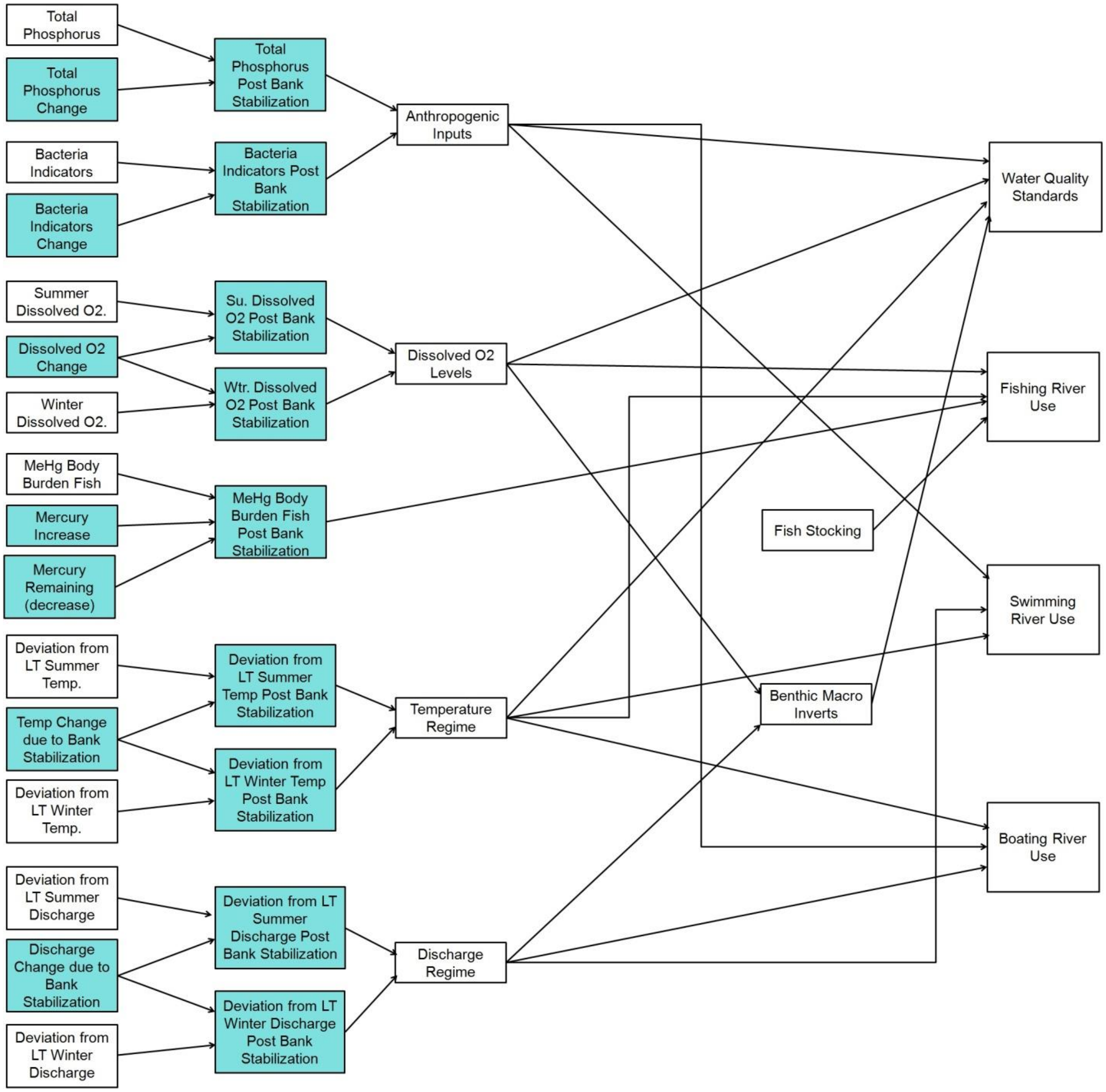
A10-2. Bank stabilization conceptual model for Carolina Wren.



A10-3. Bank stabilization conceptual model for smallmouth bass.



A10-4. Bank stabilization conceptual model for white sucker.



A10-5. Bank stabilization conceptual model for water quality endpoints.

Appendix 11. Model parameterization tables for Ag BMPs management scenario**.** Any variables that were carried over from the initial model without modifications are not included in the table, and it can be assumed the ranking scheme remains unchanged. Model parameterization for the initial model can be found in **Appendix 3.**

A11-1. Summary explanation of additional input parameters for Ag BMPs management BNs for Belted Kingfisher. This includes parameters and definitions; states and associated ranges, and justification with corresponding references.

Parameter	States	Range	Justification	References
Suspended solids from Agriculture Probability of percent suspended solids from agricultural land (%)	Zero Low Med High	0-25% 26-50% 51-75% 76-100%	Estimates of percent cover and TSS from agricultural lands from USEPA 2010	USEPA 2010 Engineering Concepts, Inc. 2009
Suspended solids reduction Probability of percent suspended solids reduction via Ag BMP (%)	Zero Low Med High	0-15% 16-31% 32-47% 48-100%	Cullum et al. (2006)- 58% reduction in TSS (cultural BMP only) Sheffield et al. (1997)- 90% reduction, flow-weighted study	Cullum et al. 2006 Sheffield et al. 1997 USEPA 2010 Engineering Concepts, Inc. 2009
Scaled suspended solids remaining Probability of percent of suspended solids remaining (%)	Zero Low Med High	0-52% 53-68% 69-84% 85-100%	Determined by CPT via two parent nodes (Land-use and suspended solids reduction)	Engineering Concepts, Inc. 2009
Turbidity Probability of Secchi depth (cm)	Zero Low Med High	60-70 cm 30-60 cm 15-30 cm <15 cm	Same ranking from initial BK model (see Appendix 3)	Prose 1985 Rankings from Summers 2012
Turbidity post BMP Probability of Secchi depth level after Ag BMPs are implemented (cm)	Zero Low Med High	>60 cm 30-60 cm 15-30 cm <15 cm	Same ranking from initial SMB model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012

A11-2. Summary explanation of input parameters in Ag BMPs management BNs for smallmouth bass. This includes parameter and parameter definition; states and associated ranges, and justification for ranges with corresponding references.

Parameter	States	Range	Justification	References
Suspended solids from Agriculture Probability of percent suspended solids from agricultural land (%)	Zero Low Med High	0-25% 26-50% 51-75% 76-100%	Estimates of percent cover and TSS from agricultural lands from USEPA 2010	USEPA 2010 Engineering Concepts, Inc. 2009
Suspended solids reduction Probability of percent suspended solids reduction via Ag BMP (%)	Zero Low Med High	0-15% 16-31% 32-47% 48-100%	Cullum et al. (2006)- 58% reduction in TSS (cultural BMP only) Sheffield et al. (1997)- 90% reduction, flow-weighted study	Cullum et al. 2006 Sheffield et al. 1997 USEPA 2010 Engineering Concepts, Inc. 2009
Scaled suspended solids remaining Probability of percent of suspended solids remaining (%)	Zero Low Med High	0-52% 53-68% 69-84% 85-100%	Determined by CPT via two parent nodes (Land-use and suspended solids reduction)	Engineering Concepts, Inc. 2009
Total Suspended Solids Probability of suspended solids (mg/L)	Zero Low Med High	0-25 mg/L 25-80 mg/L 80-200 mg/L 200-650 mg/L	Same ranking from initial SMB model (see Appendix 3)	Hubert and Lackey 1980; Carter et al. 2010 USEPA 2003 Rankings from Summers 2012
Suspended Solids post BMP Probability of suspended solids level after Ag BMPs are implemented (mg/L)	Zero Low Med High	0-25 mg/L 25-80 mg/L 80-200 mg/L 200-650 (mg/L)	Same ranking from initial SMB model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012

A11-3. Summary explanation of input parameters in Ag BMPs management BNs for water quality endpoints (Water Quality Standards, and Fishing, Swimming, and Boating River Use). This includes parameters and definition; states and associated ranges, and justification with corresponding references.

Parameter	States	Range	Justification	References
Total Phosphorus from Agriculture Probability of percent total phosphorus from agricultural land (%)	Zero	0-25%	TMDL study estimates 58% total phosphorus comes from agriculture	Engineering Concepts, Inc. 2009
	Low	26-50%		
	Med	51-75%		
	High	76-100%		
Total Phosphorus reduction Probability of percent total phosphorus reduction via Ag BMP (%)	Zero	0-15%	Cullum et al (2006) reports 32% reduction in total phosphorus	Cullum et al. 2006 Sheffield et al. 1997 Engineering Concepts, Inc. 2009 USEPA 2010
	Low	16-43%		
	Med	44-69%		
	High	70-100%		
Scaled total Phosphorus remaining Probability of percent of total phosphorus remaining (%)	Zero	0-30%	TMDL study estimates a ≥70% reduction (or ≤30% remaining) in total phosphorus from agricultural land use is necessary to meet TMDL requirements	Engineering Concepts, Inc. 2009
	Low	31-56%		
	Med	57-84%		
	High	85-100%		
Total Phosphorus Probability of total phosphorus (mg/L)	Zero	<0.1 mg/L	Same ranking from initial WQ model (see Appendix 4)	Black et al. 2010 USEPA 2006 Sprague 2009 National Water Quality Assessment Program, USGS
	Low	0.1-0.3 mg/L		
	Med	0.31-0.5 mg/L		
	High	0.51-5.0 mg/L		
Total Phosphorus post BMP Probability of total phosphorus level after Ag BMPs were implemented (mg/L)	Zero	<0.1 mg/L	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1
	Low	0.1-0.3 mg/L		
	Med	0.31-0.5 mg/L		
	High	0.51-5.0 mg/L		
Bacteria indicators from Agricultural land Probability of percent bacteria indicators from agricultural land (%)	Zero	0-25%	TMDL study estimates 89.6% E.coli comes from agriculture	Engineering Concepts, Inc. 2009 USEPA 2010
	Low	26-50%		
	Med	51-75%		
	High	76-100%		

Bacteria indicator reduction Probability of percent bacteria indicator reduction via Ag BMP (%)	Zero Low Med High	0-15% 16-55% 56-94% 95-100%	Sheffield et al (1997) reported 51% reduction fecal coliform and 77% reduction fecal streptococci	Cullum et al. 2006 Sheffield et al. 1997 Engineering Concepts, Inc. 2009 USEPA 2010
Scaled Bacteria indicators remaining Probability of percent bacteria remaining (%)	Zero Low Med High	0-5% 6-44% 45-84% 85-100%	TMDL study estimates ≥95% reduction (or ≤5% remaining) in *E.coli* from ag. land use is necessary to meet TMDL requirements 85-100% remaining considered "high"	Engineering Concepts, Inc. 2009
Bacteria indicators Probability of fecal bacteria (CFU/100mL)	Zero Moderate High	0-200 CFU/100 mL 200-1000 CFU/100 mL 1000-2000 CFU/100 mL	Same ranking from initial WQ model (see Appendix 4)	VDEQ 2009 Rankings from Ayre et al. Report 2013-1
Bacteria indicators post BMP Probability of fecal bacteria level after Ag BMPs were implemented (CFU/100mL)	Zero Moderate High	0-200 CFU/100 mL 200-1000 CFU/100 mL >1000 CFU/100 mL	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1

Appendix 12. Example of a Conditional Probability Table (CPT) calculation for the management nodes. This example is from the bank stabilization management option for the Carolina Wren and specifically relates to a CPT calculation in the Mercury Post Bank Stabilization node.

Hg States
zero: 0.0 -1.2 mg/kg
low: 1.2-2.1 mg/kg
med: 2.1-2.9 mg/kg
high: 2.9-10 mg/kg

Hg Change
Increase: 5.1 to 50%
No Change: -5 to 5%
Decrease: -5.1 to -50%

*Lets calculate the CPT line for the combination of Low Hg and Increase (from the Hg States and Hg Change above – blue text).

Lower Bound

[(1.2 mg/kg)*0.051] + 1.2 = **1.2612 mg/kg**

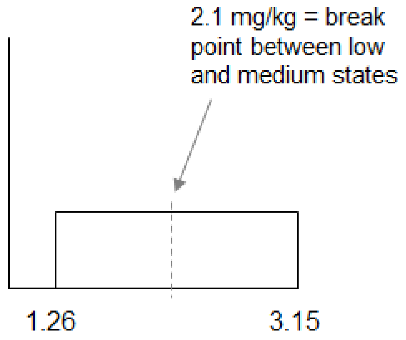
This represents the smallest increase in mercury concentration with this combination

Upper Bound

[(2.1 mg/kg)*0.5] + 2.1 = **3.15 mg/kg**

This represents the highest concentration possible with this combination

*Now we need to calculate the probability of each state in the child node. We will assume a uniform distribution between the upper and lower bound.



Distributions for Mercury Post Bank Stabilization node, CPT combination: low Hg & Increase Hg Change)

zero: 0% - lowest concentration is 1.2612 mg/kg
low: 48%
med: 52%
high: 0% - highest concentration is only 3.15 mg/kg

Area: 3.15 – 1.26 = 1.8

% med risk state: 3.15 – 2.1 = 1.05

$$\frac{1.05}{1.8} = 0.52 * 100 = \mathbf{52\%}$$

% low risk state: 100% – 52% = **48%**

Appendix 13. Model parameterization for Bank Stabilization management scenario. Any variables that were carried over from the initial model without modifications are not included in the table, and it can be assumed the ranking scheme remains unchanged. Model parameterization for the initial model can be found in **Appendix 3.**

A13-1. Summary explanation of input parameters specific to bank stabilization management BNs for Belted Kingfisher. This includes parameters and definitions; states and associated ranges, and justification with corresponding references.

Parameter	States	Range	Justification	References
Mercury Probability of mercury bird blood concentration (ppm)	Zero Low Med High	0.00-0.40 ppm 0.41-1.00 ppm 1.01-2.00 ppm 2.01-10 ppm	Same ranking from initial BK model (see Appendix 3)	Evers et al. 2004 Lane et al. 2004; White 2007 Rankings from Summers 2012
Mercury change Probability of change in mercury concentration due to bank stabilization (%)	Increase No change Decrease	5.1 to 25% 5 to - 5% -5.1 to -25%	5% change in bird blood mercury considered within natural variation 25% used as lower or upper bound of variation due to bank stabilization	Anchor QEA LLC et al. (2013)
Mercury post Bank Stabilization Probability of mercury bird blood concentration after bank stabilization is implemented (ppm)	Zero Low Med High	0.00-0.40 ppm 0.41-1.00 ppm 1.01-2.00 ppm >2.01 ppm	Same ranking from initial BK model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
PAHs Probability of PAH concentration (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (ug/kg) 4,000-8,000 (ug/kg)	Same ranking from initial BK model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
PAH change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in PAH considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
PAH post Bank Stabilization Probability of PAH concentration after bank stabilization is implemented (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (ug/kg) >4,000 (ug/kg)	Same ranking from initial BK model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Buchman 2008 Rankings from Summers 2012

Organochlorine Pesticides Probability of Organochlorine pesticide concentration (ug/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg) *pesticide specific (ug/kg)	Same ranking from initial BK model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
Organochlorine Pesticides change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in organochlorine pesticides considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Organochlorine Pesticides post Bank Stabilization Probability of Organochlorine Pesticides concentration after bank stabilization is implemented (ug/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg) *pesticide specific (ug/kg)	Same ranking from initial BK model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Buchman 2008 Rankings from Summers 2012
Submerged Aquatic Vegetation (SAV) Probability of percent SAV cover (%)	Zero Low Med High	0-20% 20-40% 40-70% 70-100%	Same ranking from initial BK model (see Appendix 3)	Prose 1985 Rankings from Summers 2012
Submerged Aquatic Vegetation (SAV) change Probability of change in SAV due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in SAV considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Submerged Aquatic Vegetation (SAV) post Bank Stabilization Probability of SAV cover after bank stabilization is implemented (%)	Zero Low Med High	0-20% 20-40% 40-70% 70-100%	Same ranking from initial BK model (see Appendix 3)	Prose 1985 Rankings from Summers 2012
Turbidity Probability of secchi depth (cm)	Zero Low Med High	60-70 cm 30-60 cm 15-30 cm 0-15 cm	Same ranking from initial BK model (see Appendix 3)	Prose 1985 Rankings from Summers 2012

Turbidity change Probability of change in turbidity due to bank stabilization (%)	Increase	5 to 50%	5% change turbidity considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	5 to -5 %		
	Decrease	-5 to -50%		
Turbidity post Bank Stabilization Probability turbidity Secchi depth after bank stabilization is implemented (cm)	Zero	>60 cm	Same ranking from initial BK model (see Appendix 3)	Prose 1985 Rankings from Summers 2012
	Low	30-60 cm		
	Med	15-30 cm		
	High	<15 cm		

A13-2. Summary explanation of input parameters in bank stabilization management BNs for Carolina Wren. This includes parameters and definitions; states and associated ranges, and justification with corresponding references.

Parameter	States	Range	Justification	References
Mercury Probability of mercury bird blood concentration (ppm)	Zero	0-1.2 ppm	Same ranking from initial CW model (see Appendix 3)	Jackson et al. 2011a Cristol et al. 2008 Rankings from Summers 2012
	Low	1.2-2.1 ppm		
	Med	2.1-2.9 ppm		
	High	>2.9 ppm		
Mercury change Probability of change in mercury concentration due to bank stabilization (%)	Increase	5.1 to 25%	5% change in bird blood mercury considered within natural variation 25% used as lower or upper bound of variation due to bank stabilization	Anchor QEA LLC et al. (2013)
	No change	5 to -5%		
	Decrease	-5.1 to -25%		
Mercury post Bank Stabilization Probability of mercury bird blood concentration after bank stabilization is implemented (ppm)	Zero	0-1.2 ppm	Same ranking from initial CW model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
	Low	1.2-2.1 ppm		
	Med	2.1-2.9 ppm		
	High	>2.9 ppm		
PAHs Probability of PAH concentration (ug/kg)	Under NOAA’s LEL for sediment	≤4,000 (ug/kg)	Same ranking from initial CW model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
	Over NOAA’s LEL for sediment	4,000-8,000 (ug/kg)		

PAH change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in PAH considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
PAH post Bank Stabilization Probability of PAH concentration after bank stabilization is implemented (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (ug/kg) >4,000 (ug/kg)	Same ranking from initial CW model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Buchman 2008 Rankings from Summers 2012
Organochlorine Pesticides Probability of Organochlorine pesticide concentration (ug/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg) *pesticide specific (ug/kg)	Same ranking from initial CW model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
Organochlorine Pesticides change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in organochlorine pesticides considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Organochlorine Pesticides post Bank Stabilization Probability of Organochlorine Pesticides concentration after bank stabilization is implemented (ug/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg) *pesticide specific (ug/kg)	Same ranking from initial CW model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Buchman 2008 Rankings from Summers 2012

A13-3. Summary explanation of input parameters specific to bank stabilization management BNs for smallmouth bass. This includes parameters and definitions; states and associated ranges, and justification with corresponding references.

Parameter	States	Range	Justification	Data sources
Mercury Probability of fish fillet MeHg concentration (mg/kg)	Zero Low Med High	<0.2 mg/kg 0.21-1.1 mg/kg 1.2-2.8 mg/kg >2.9 mg/kg	Same ranking from initial SMB model (see Appendix 3)	Dillon et al. 2010 Rankings from Summers 2012
Mercury increase Probability of increase in MeHg concentration due to bank stabilization (%)	Zero Low Med High	0-162.5% 162.6-325% 325.1-487.5% 487.6-650%	Based on pore water Hg monitoring values from bank stabilization pilot study	Anchor QEA LLC et al. (2013)
Mercury remaining (decrease) Probability of decrease in MeHg concentration due to bank stabilization (%)	Zero Low Med High	0-10% (remaining) 11-40% 41-70% 71-100%	Based on porewater Hg monitoring values from bank stabilization pilot study	Anchor QEA LLC et al. (2013)
Mercury post Bank Stabilization Probability of MeHg fish fillet concentration after bank stabilization is implemented (mg/kg)	Zero Low Med High	<0.2 mg/kg 0.21-1.1 mg/kg 1.2-2.8 mg/kg >2.9 mg/kg	Same ranking from initial SMB model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
PAHs Probability of PAH concentration (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (ug/kg) 4,000-8,000 (ug/kg)	Same ranking from initial SMB model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
PAH change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in PAH considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
PAH post Bank Stabilization	Under NOAA's LEL for sediment	≤4,000 (ug/kg)	Same ranking from initial SMB model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes

Probability of PAH concentration after bank stabilization is implemented (ug/kg)	Over NOAA's LEL for sediment	>4,000 (ug/kg)		Rankings from Summers 2012
Organochlorine Pesticides Probability of Organochlorine pesticide concentration (ug/kg)	Lower than NOAA's Chronic Level for water	*pesticide specific (ug/kg)	Same ranking from initial SMB model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
	Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg)		
Organochlorine Pesticides change Probability of change in PAH concentration due to bank stabilization (%)	Increase	5 to 50%	5% change in organochlorine pesticides considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	5 to -5 %		
	Decrease	-5 to -50%		
Organochlorine Pesticides post Bank Stabilization Probability of Organochlorine Pesticides concentration after bank stabilization is implemented (ug/kg)	Lower than NOAA's Chronic Level for water	*pesticide specific (ug/kg)	Same ranking from initial SMB model (see Appendix 3)	Frequencies determined by CPT via parent nodes Rankings from Summers 2012
	Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg)		
River Temperature Probability of river temperature (°C)	Zero	20-26 °C	Same ranking from initial SMB model (see Appendix 3)	Horning and Pearson 1973, Shutter et al. 1980, Amour 1993, Kerr 1966, Stauffer et al. 1976, Cherry et al. 1975, 1977 Rankings from Ayre et al. Report 2013-1
	Low	17-19.9 or 26.1-29 °C		
	Med	15-16.9 or 29.1-31.9 °C		
	High	≤14.9 or ≥32 °C		
River Temperature change Probability of change in river temp due to bank stabilization (%)	Increase	5 to 50%	5% change in river temp considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	5 to -5 %		
	Decrease	-5 to -50%		
River Temperature post Bank Stabilization Probability of river temp bank stabilization is implemented (°C)	Zero	20-26 °C	Same ranking from initial SMB model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
	Low	17-19.9 or 26.1-29 °C		
	Med	15-16.9 or 29.1-31.9 °C		
	High	≤14.9 or ≥32 °C		
Total Suspended Solids	Zero	0-25 mg/L	Same ranking from initial SMB model (see Appendix 3)	Hubert and Lackey 1980; Carter et al. 2010
	Low	25-80 mg/L		

Probability of suspended solids (mg/L)	Med	80-200 mg/L		USEPA 2003 Rankings from Summers 2012
	High	>200 mg/L		
Total Suspended Solids change Probability of change in total suspended solids due to bank stabilization (%)	Increase	5 to 50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	5 to -5 %		
	Decrease	-5 to -50%		
Suspended solids post Bank Stabilization Probability of total suspended solids bank stabilization is implemented (mg/L)	Zero	0-25 mg/L	Same ranking from initial SMB model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
	Low	25-80 mg/L		
	Med	80-200 mg/L		
	High	>200 mg/L		

A13-4. Summary explanation of input parameters in the bank stabilization management BNs for white sucker. This includes parameters and definitions; states and associated ranges, and justification with corresponding references.

Parameters	States	Range	Justification	Data sources
Mercury Probability of fish fillet MeHg concentration (mg/kg)	Zero Low Med High	<0.2 mg/kg 0.21-1.1 mg/kg 1.2-2.8 mg/kg >2.9 mg/kg	Same ranking from initial WS model (see Appendix 3)	Dillon et al. 2010 Rankings from Summers 2012
Mercury increase Probability of increase in MeHg concentration due to bank stabilization (%)	Zero Low Med High	0-162.5% 162.6-325% 325.1-487.5% 487.6-650%	Based on pore water Hg monitoring values from bank stabilization pilot study	Anchor QEA LLC et al. (2013)
Mercury remaining (decrease) Probability of decrease in MeHg concentration due to bank stabilization (%)	Zero Low Med High	0-10% (remaining) 11-40% 41-70% 71-100%	Based on porewater Hg monitoring values from bank stabilization pilot study	Anchor QEA LLC et al. (2013)
Mercury post Bank Stabilization Probability of MeHg fish fillet concentration after bank stabilization is implemented (mg/kg)	Zero Low Med High	<0.2 mg/kg 0.21-1.1 mg/kg 1.2-2.8 mg/kg >2.9 mg/kg	Same ranking from initial WS model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
PAHs Probability of PAH concentration (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (ug/kg) 4,000-8,000 (ug/kg)	Same ranking from initial WS model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
PAH change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in PAH considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
PAH post Bank Stabilization Probability of PAH concentration after bank stabilization is implemented (ug/kg)	Under NOAA's LEL for sediment Over NOAA's LEL for sediment	≤4,000 (ug/kg) >4,000 (ug/kg)	Same ranking from initial WS model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012

Organochlorine Pesticides Probability of Organochlorine pesticide concentration (ug/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg) *pesticide specific (ug/kg)	Same ranking from initial WS model (see Appendix 3)	Buchman 2008 Rankings from Summers 2012
Organochlorine Pesticides change Probability of change in PAH concentration due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in organochlorine pesticides considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Organochlorine Pesticides post Bank Stabilization Probability of Organochlorine Pesticides concentration after bank stabilization is implemented (ug/kg)	Lower than NOAA's Chronic Level for water Higher than NOAA's Chronic Level for water	*pesticide specific (ug/kg) *pesticide specific (ug/kg)	Same ranking from initial WS model (see Appendix 3)	Frequencies determined by CPT via parent nodes Rankings from Summers 2012
River Temperature Probability of river temp (°C)	Zero Low Med High	14-19 °C 11-14 and 19-22 °C 9-11 and 22-29 °C <9 and >29 °C	Same ranking from initial WS model (see Appendix 3)	McCormick et al. 1977, Horak and Tanner 1964, Marcy 1976, Brett 1944, Carlander 1969, Twomey et al. 1984 Rankings from Summers 2012
River Temperature change Probability of change in river temp due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in river temp. considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
River Temperature post Bank Stabilization Probability of river temp bank stabilization is implemented (°C)	Zero Low Med High	14-19 °C 11-14 and 19-22 °C 9-11 and 22-29 °C <9 and >29 °C	Same ranking from initial WS model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
Stream Cover Probability of percent submerged aquatic vegetation cover (%)	Zero Low Med High	25-85% 15-25% or 85-100% 5-15% <5%	Same ranking from initial WS model (see Appendix 3)	Twomey et al. 1984, Dence 1948, Probst 1982b Rankings from Summers 2012

Stream Cover Change Probability of change in submerged aquatic vegetation due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Stream Cover post Bank Stabilization Probability of submerged aquatic vegetation cover after bank stabilization is implemented (%)	Zero Low Med High	25-85% 15-25% or 85-100% 5-15% <5%	Same ranking from initial model (see Appendix 3)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012

A13-5. Summary explanation of input parameters specific to bank stabilization management BNs for water quality endpoints (Water Quality Standards, and Fishing, Swimming, and Boating River Use). This includes parameters and definitions; states and associated ranges, and justification with corresponding references. Any variables that were carried over from the initial model without modifications are not included in the table, and it can be assumed the ranking scheme remains unchanged. Model parameterization for the initial WQ model can be found in **Appendix 4.**

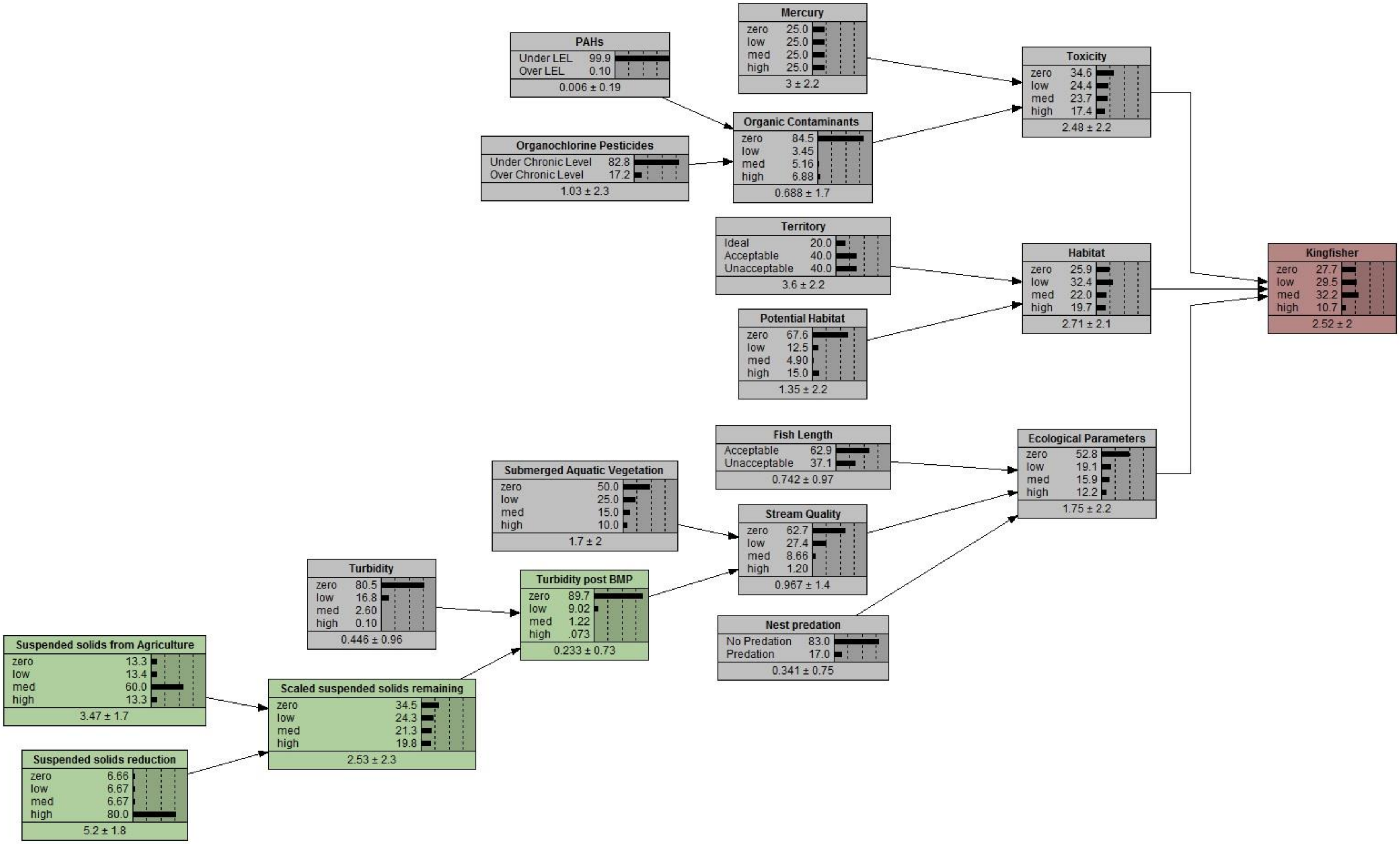
Parameters	States	Range	Justification	Data sources
Total Phosphorus Probability of total phosphorus (mg/L)	Zero Low Med High	<0.1 mg/L 0.1-0.3 mg/L 0.31-0.5 mg/L 0.51-5.0 mg/L	Same ranking from initial WQ model (see Appendix 4)	Black et al. 2010 USEPA 2006 National Water Quality Assessment Program, USGS Rankings from Ayre et al. Report 2013-1
Total Phosphorus change Probability of change in total phosphorus due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Total Phosphorus post Bank Stabilization Probability of total phosphorus after bank stabilization is implemented (mg/L)	Zero Low Med High	<0.1 mg/L 0.1-0.3 mg/L 0.31-0.5 mg/L >0.51 mg/L	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1
Bacteria indicators Probability of fecal bacteria (CFU/100mL)	Zero Moderate High	0-200 CFU/100 mL 200-1000 CFU/100 mL 1000-2000 CFU/100 mL	Same ranking from initial WQ model (see Appendix 4)	VDEQ 2009 Rankings from Ayre et al. Report 2013-1
Bacteria indicators change Probability of change in bacteria indicators due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Bacteria indicators post Bank Stabilization Probability of bacteria indicators after bank stabilization is implemented (mg/L)	Zero Moderate High	0-200 CFU/100 mL 200-1000 CFU/100 mL >1000 CFU/100 mL	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1

Summer Dissolved O_2 Probability of dissolved oxygen levels April-September (mg/L)	Zero	9-15 mg/L	Same ranking from initial WQ model (see Appendix 4)	Pollino et al. 2007 USGS *(a,b,c,d)* NHD database Rankings from Ayre et al. Report 2013-1
	Moderate	5-9 mg/L		
	High	0-5 mg/L		
Summer Dissolved O_2 change Probability of change in summer dissolved oxygen due to bank stabilization (%)	Increase	5 to 50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	5 to -5 %		
	Decrease	-5 to -50%		
Summer Dissolved O_2 post Bank Stabilization Probability of summer dissolved oxygen levels after bank stabilization is implemented (mg/L)	Zero	>9 mg/L	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1
	Moderate	5-9 mg/L		
	High	<5 mg/L		
Winter Dissolved O_2 Probability of dissolved oxygen levels October-March (mg/L)	Zero	9-22 mg/L	Same ranking from initial WQ model (see Appendix 4)	Pollino et al. 2007 USGS *(a,b,c,d)* NHD database Rankings from Ayre et al. Report 2013-1
	Moderate	5-9 mg/L		
	High	0-5 mg/L		
Winter Dissolved O_2 change Probability of change in winter dissolved oxygen due to bank stabilization (%)	Increase	5 to 50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	5 to -5 %		
	Decrease	-5 to -50%		
Winter Dissolved O_2 post Bank Stabilization Probability of winter dissolved oxygen levels after bank stabilization is implemented (mg/L)	Zero	>9 mg/L	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1
	Moderate	5-9 mg/L		
	High	<5 mg/L		
MeHg Body Burden Fish Probability of fish fillet MeHg concentration (mg/kg)	Zero	<0.2 mg/kg	Same ranking from initial WQ model (see Appendix 4)	Dillon et al. 2010 Rankings from summers 2012, Ayre et al. Report 2013-1
	Low	0.21-1.1 mg/kg		
	Med	1.2-2.8 mg/kg		
	High	>2.9 mg/kg		
Mercury Increase Probability of increase in MeHg fish fillet concentration due to bank stabilization (%)	Zero	0-162.5%	Based on porewater Hg monitoring values from bank stabilization pilot study	Anchor QEA LLC et al. (2013)
	Low	162.6-325%		
	Med	325.1-487.5%		
	High	487.6-650%		
	Zero	0-10% (remaining)		Anchor QEA LLC et al. (2013)

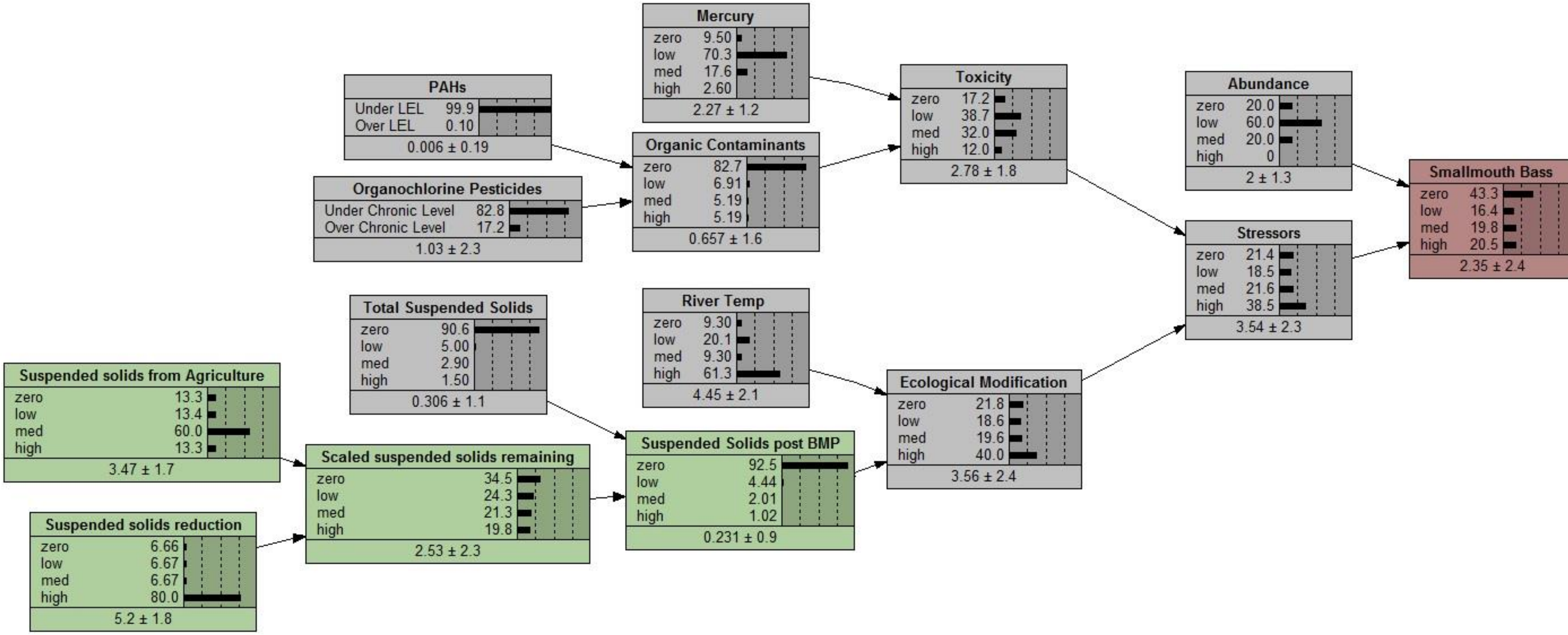
Mercury Remaining (decrease) Probability of decrease in MeHg fish fillet concentration due to bank stabilization (%)	Low Med High	11-40% 41-70% 71-100%	Based on porewater Hg monitoring values from bank stabilization pilot study	
MeHg Body Burden Fish post Bank Stabilization Probability of MeHg fish fillet concentration after bank stabilization is implemented (mg/kg)	Zero Low Med High	<0.3 mg/kg 0.3-1.0 mg/kg 1.1-3.0 mg/kg >3.0 mg/kg	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012.
Deviation from LT summer temp Probability of deviation from 30-year seasonal average for river temp from April-September (°C)	No change Moderate High	0-2 °C deviation 2-4 °C deviation 4-6 °C deviation	Same ranking from initial WQ model (see Appendix 4)	Pollino et al. 2007 USGS *(a,b,c,d)* NHD database Rankings from Ayre et al. Report 2013-1
Deviation from LT summer temp due to Bank Stabilization Probability of summer temp deviation due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA.
Deviation from LT summer temp post Bank Stabilization Probability of deviation from summer temp after bank stabilization is implemented (°C)	No change Moderate High	0-2 °C deviation 2-4 °C deviation >4 °C deviation	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012
Deviation from LT winter temp Probability of deviation from 30-year seasonal average for river temp from Oct-March (°C)	No change Moderate High	0-2 °C deviation 2-4 °C deviation 4-6 °C deviation	Same ranking from initial WQ model (see Appendix 4)	Pollino et al. 2007 USGS *(a,b,c,d)* NHD database Rankings from Ayre et al. Report 2013-1
Deviation from LT winter temp due to Bank Stabilization Probability of winter temp deviation due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
	No change	0-2 °C deviation	Same ranking from initial WQ model	

Deviation from LT winter temp post Bank Stabilization Probability of deviation from winter temp after bank stabilization is implemented (°C)	Moderate High	2-4 °C deviation >4 °C deviation	(see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012.
Deviation from LT summer discharge Probability of deviation from 30-year seasonal average for discharge from April-Sept (%)	No change Increase Decrease	76-125% deviation 126-175% deviation 25-75% deviation	Same ranking from initial WQ model (see Appendix 4)	Pollino et al. 2007 USGS *(a,b,c,d)* NHD database Rankings from Ayre et al. Report 2013-1
Deviation from LT summer discharge due to Bank Stabilization Probability of summer discharge deviation due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Deviation from LT summer discharge post Bank Stabilization Probability of deviation from summer discharge after bank stabilization is implemented (%)	No change Increase Decrease	76-125% deviation 126-175% deviation 25-75% deviation	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Ayre et al. Report 2013-1
Deviation from LT winter discharge Probability of deviation from 30-year seasonal average for discharge from Oct-March (%)	No change Increase Decrease	76-125% deviation 126-175% deviation 25-75% deviation	Same ranking from initial WQ model (see Appendix 4)	Pollino et al. 2007 USGS *(a,b,c,d)* NHD database Rankings from Ayre et al. Report 2013-1
Deviation from LT winter discharge due to Bank Stabilization Probability of deviation from winter discharge due to bank stabilization (%)	Increase No change Decrease	5 to 50% 5 to -5 % -5 to -50%	5% change in TSS considered within natural variation Frequencies from expert elicitation survey scenarios	Expert elicitation, Anchor QEA
Deviation from LT winter discharge post Bank Stabilization Probability of deviation from winter discharge after bank stabilization is implemented (%)	No change Increase Decrease	76-125% deviation 126-175% deviation 25-75% deviation	Same ranking from initial WQ model (see Appendix 4)	Prior probabilities determined by CPT via parent nodes Rankings from Summers 2012

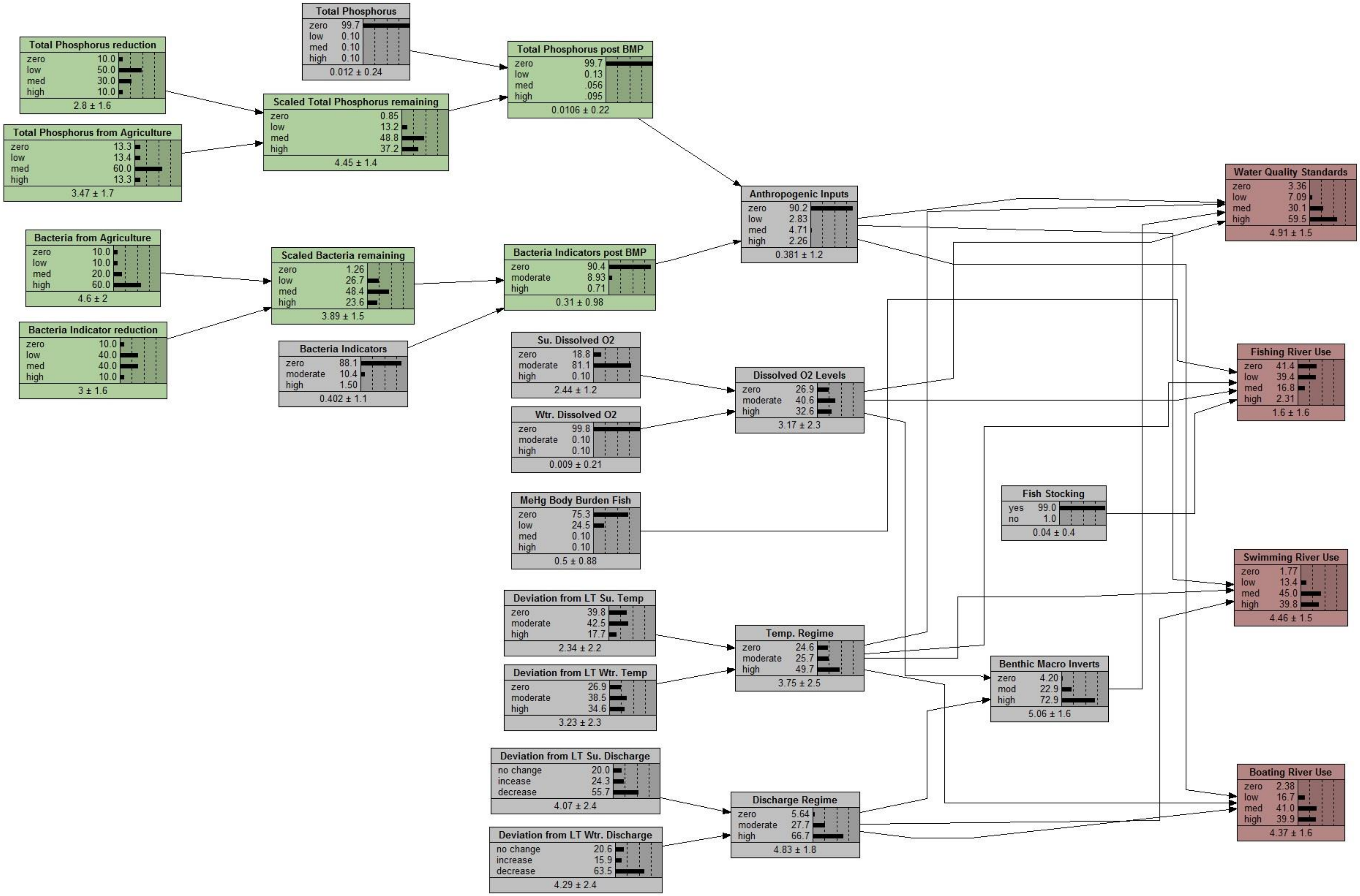
Appendix 14. Example of Bayesian networks for the Ag-BMP management scenario for Region 2.



A14-1. Bayesian network for Ag BMPs for Belted Kingfisher, Region 2.

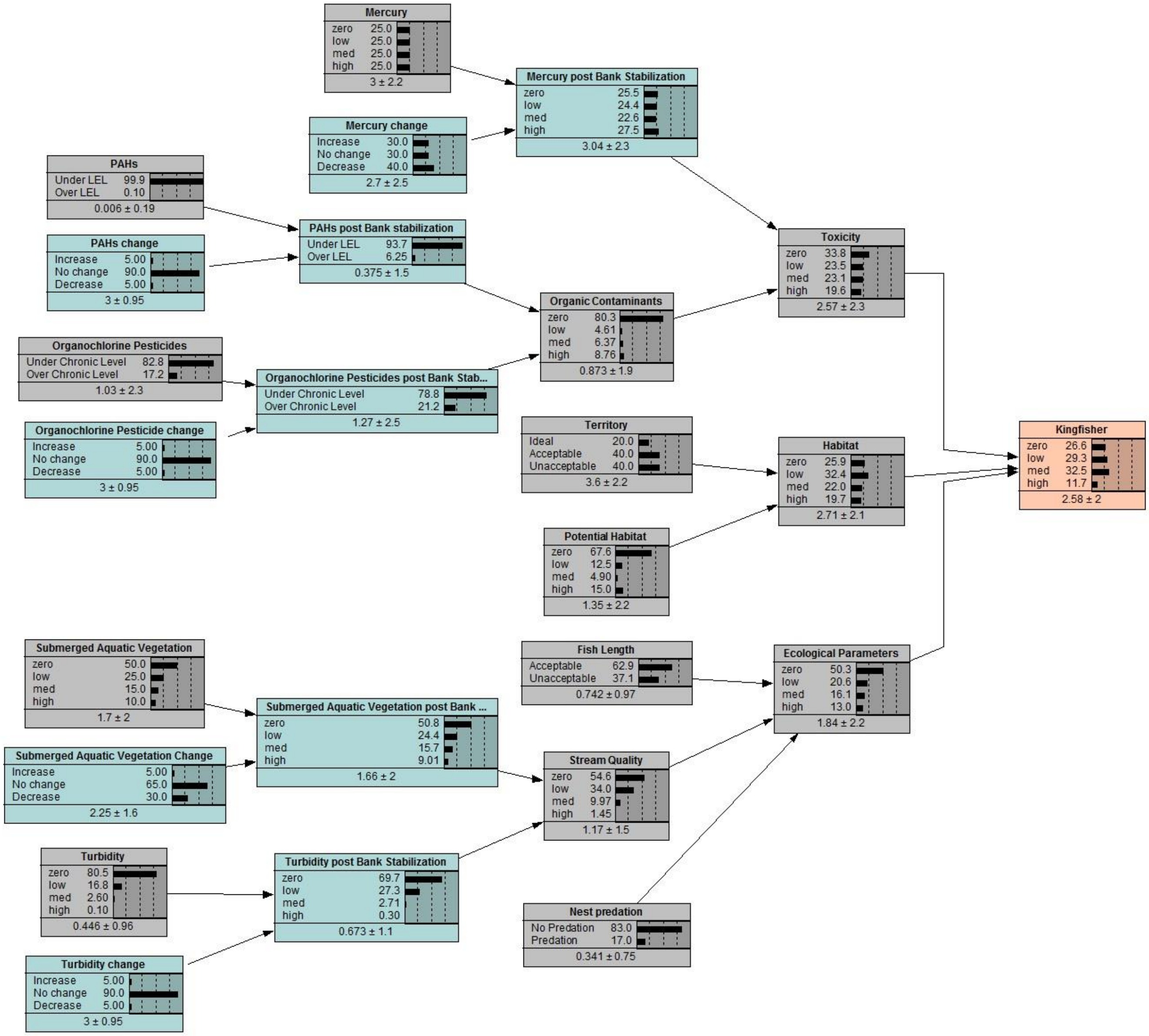


A14-6. Bayesian network for Ag BMPs for smallmouth bass, Region 2.

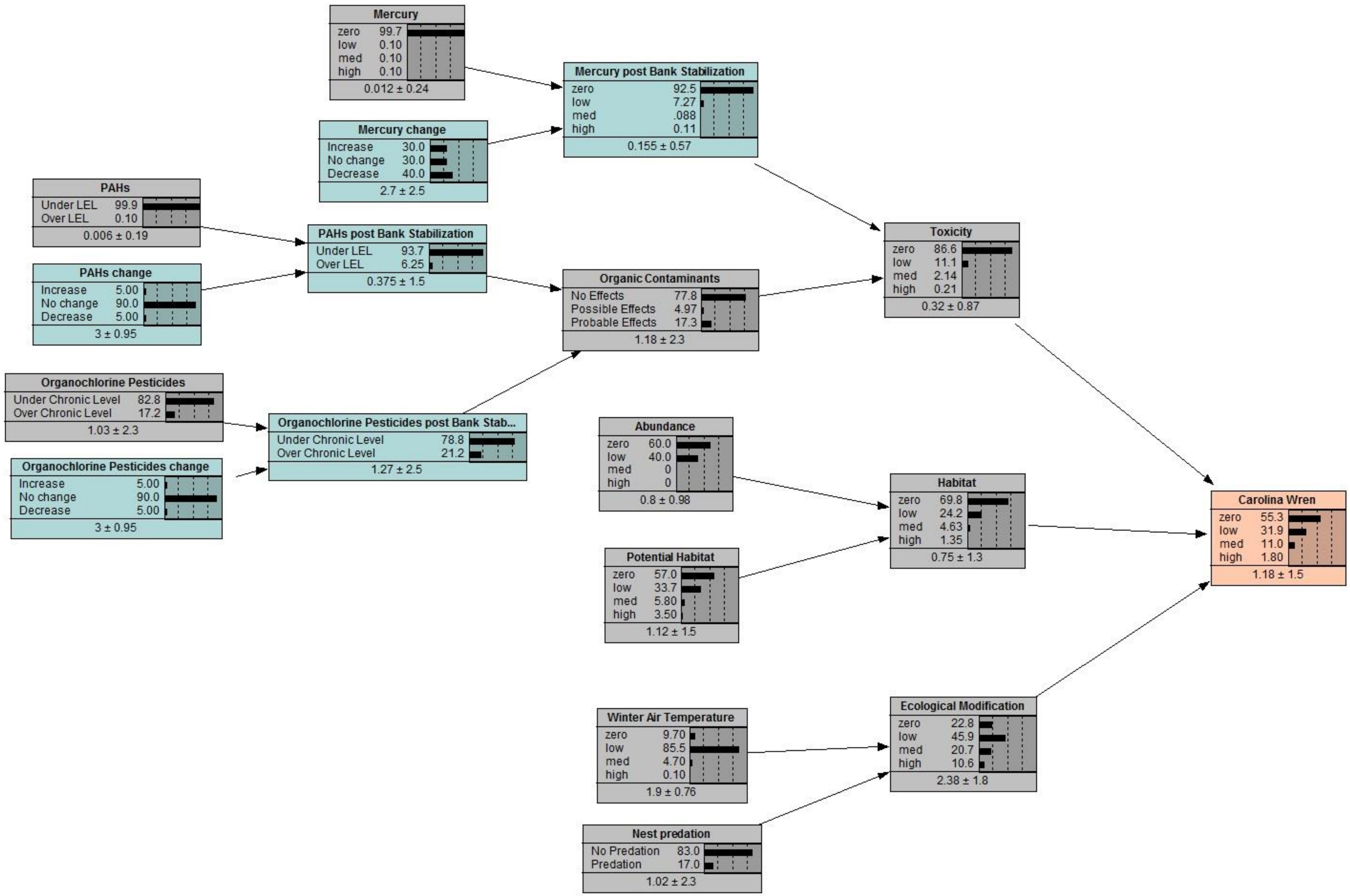


A14-11. Bayesian network for Ag BMPs for water quality endpoints, Region 2.

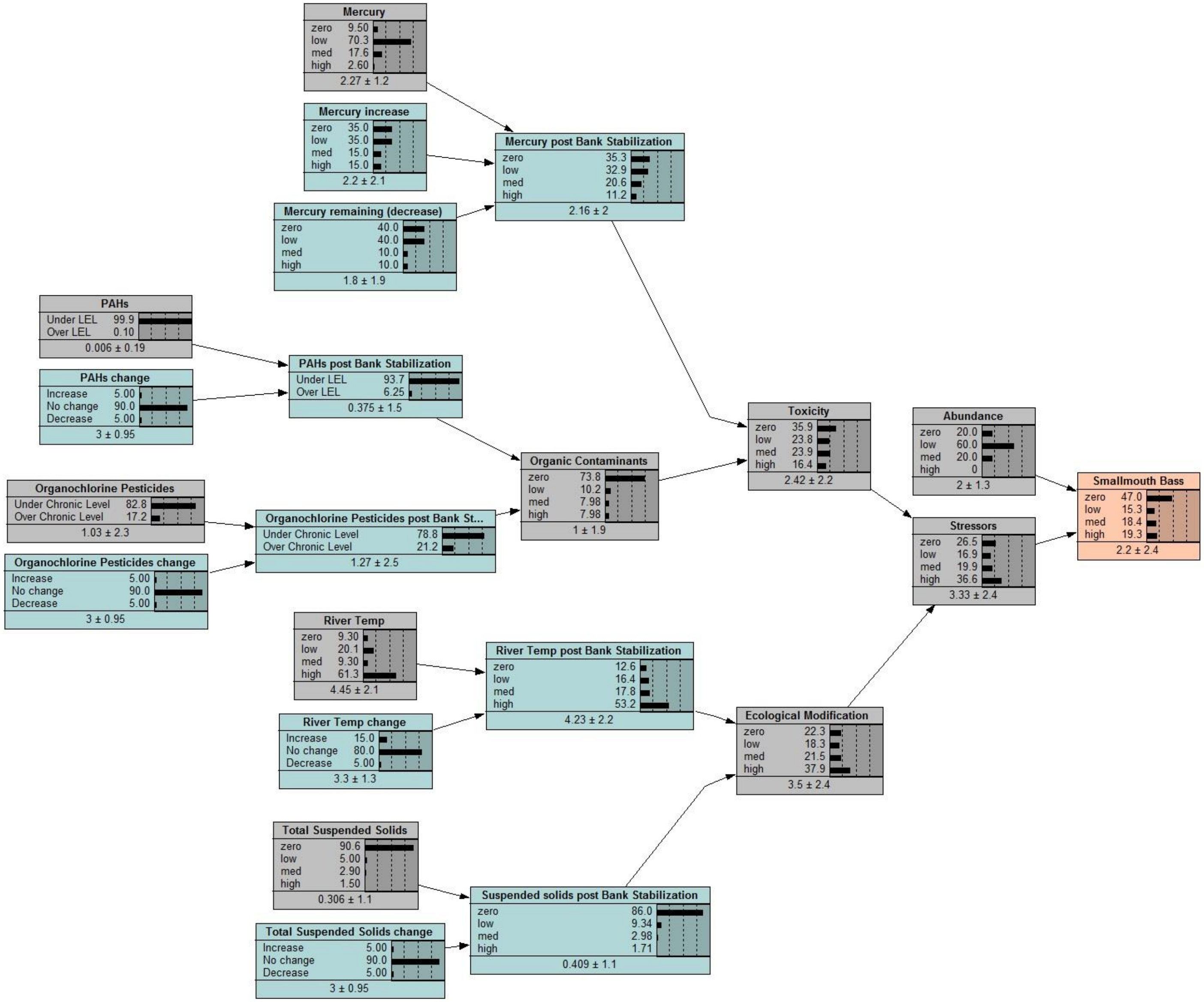
Appendix 15. Bayesian networks for the Bank Stabilization management scenario for affected endpoints for Region 2.



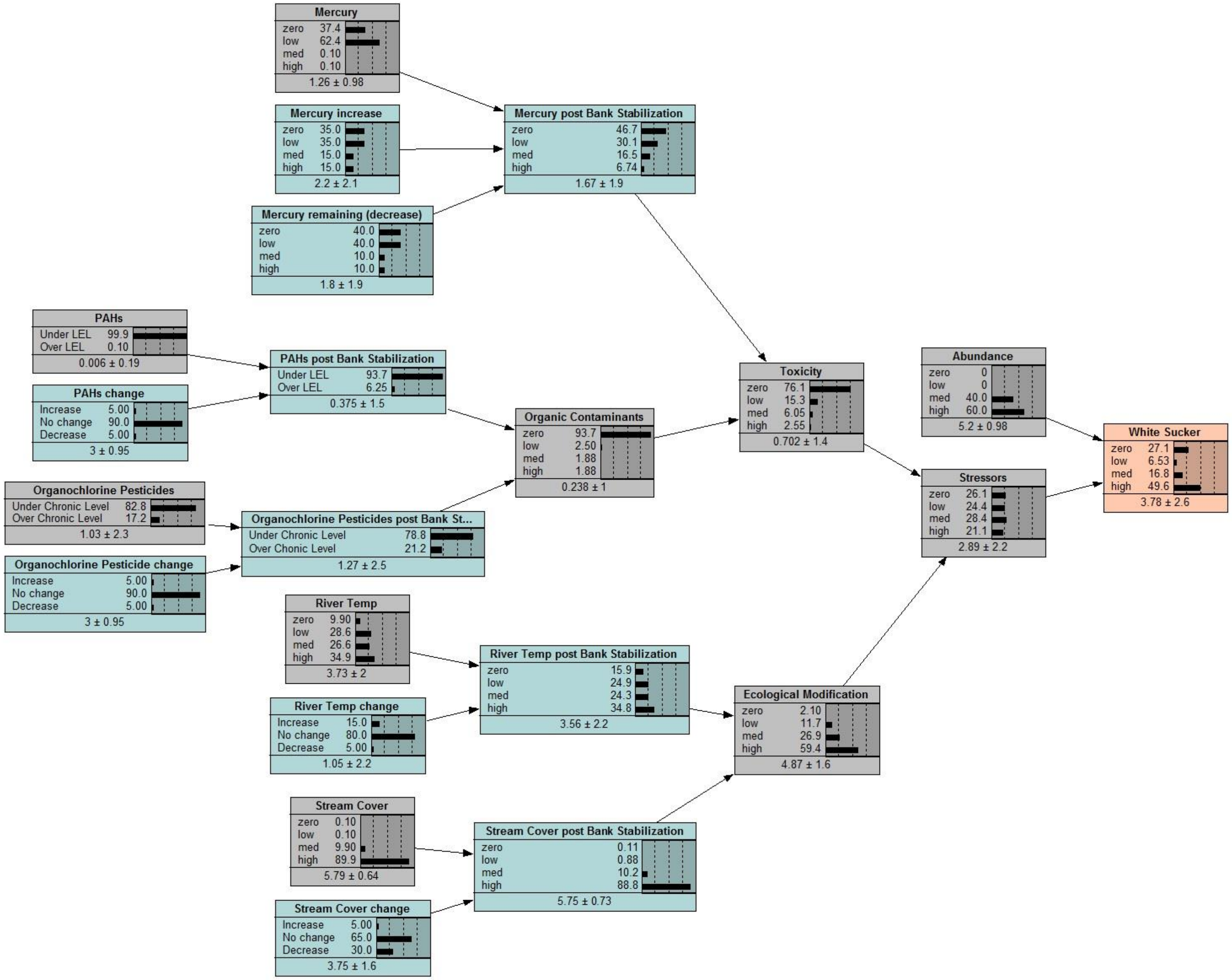
A15-1. Bayesian network for Bank Stabilization for Belted Kingfisher, Region 2



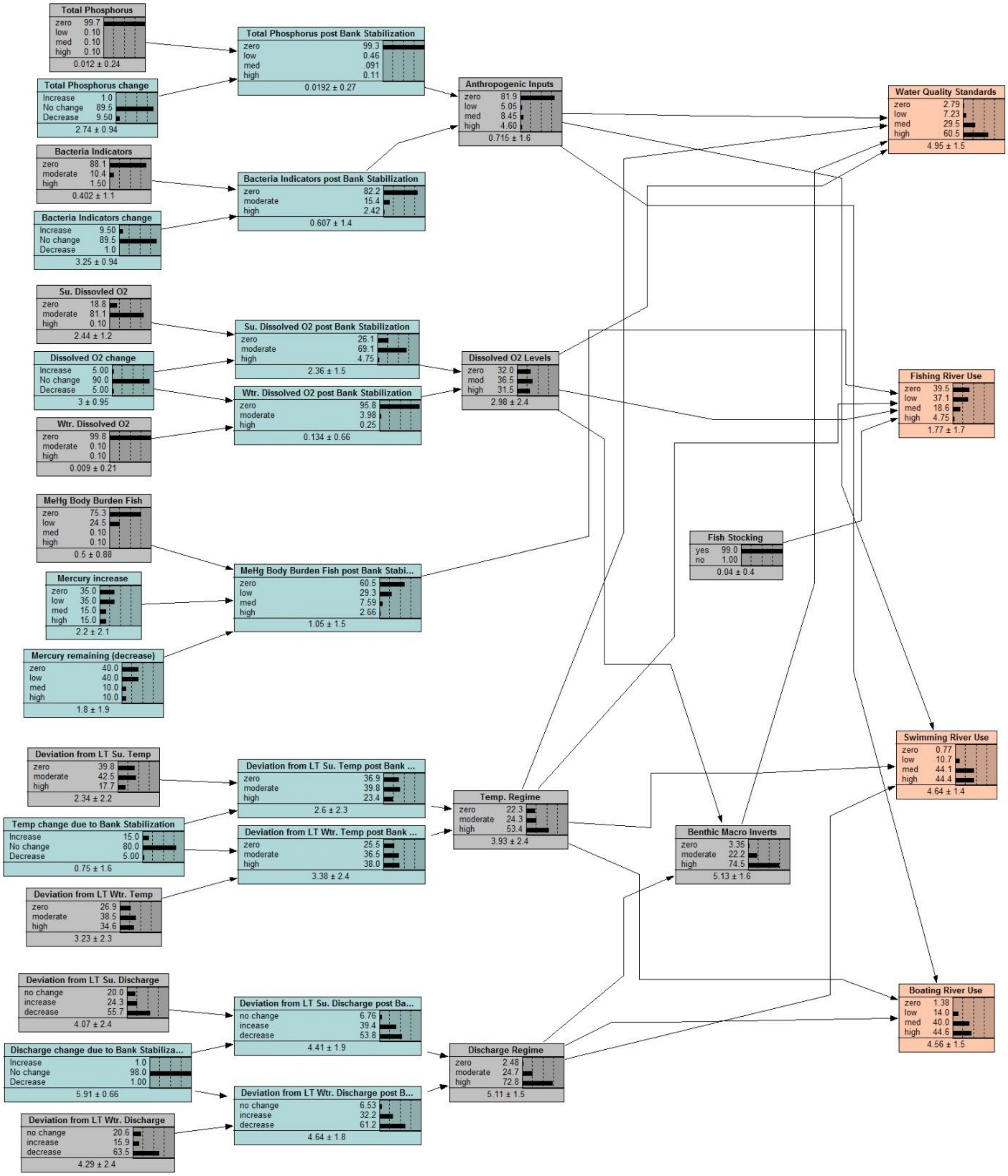
A15-2. Bayesian network for Bank Stabilization for Carolina Wren, Region 2.



A15-3. Bayesian network for Bank Stabilization for smallmouth bass, Region 2.



A15-4. Bayesian network for Bank Stabilization for white sucker, Region 2.



A15-5. Bayesian network for Bank Stabilization for water quality endpoints, Region 2.

Appendix 16. Bank stabilization management scenarios.

In addition to the risk that was predicted from the bank stabilization management option, we also conducted additional scenarios. These scenarios represent the Best Case and Worst Case Scenarios of possible risk with the implementation of this management option. For the Worst Case Scenario, we set all of the bank stabilization nodes to the high risk level with a risk value of 6 and calculated the change in risk between the initial risk estimates and the new risk estimates. The same process was completed for the Best Case Scenario except the nodes were set to a risk value of 0. For a more detailed description of this process, see Section 3.5.3.

A16-1. Change in likelihood of risk states to endpoints with the Worst Case Scenario. This scenario represents the upper bound of risk for the bank stabilization management option.

Belted Kingfisher	Zero	Low	Med	High	**Carolina Wren**	Zero	Low	Med	High
Region 2	-7.3	-0.8	3.5	4.5	R-2	-5.5	2.9	2.0	0.6
R-3	-10.8	3.3	5.2	2.2	R-3	-4.7	-0.5	3.7	1.6
R-4	-9.1	1.2	4.5	3.4	R-4	-2.2	-0.1	0.4	1.9
R-5	-8.2	2.7	2.7	2.9	R-5	-2.5	-0.5	0.7	2.2
R-6	-11.5	3.8	5.7	2.0	R-6	-4.1	-1.3	2.6	2.8
Smallmouth Bass	Zero	Low	Med	High	**White Sucker**	Zero	Low	Med	High
R-2	-11	0.9	2.8	7.3	R-2	-9.3	-0.3	-1.1	10.6
R-3	-15.2	1.0	3.8	10.4	R-3	-13.9	0.7	1.6	11.7
R-4	-17.9	0.2	1.0	16.6	R-4	-18.6	1.7	3.2	13.6
R-5	-23.5	-0.2	-1.2	24.8	R-5	-13.0	1.9	3.8	7.3
R-6	-19.8	1.7	4.4	13.7	R-6	-10.9	1.2	3.0	6.9
WQ-Standards	Zero	Low	Med	High	**WQ-Fishing**	Zero	Low	Med	High
R-2	-2.2	-5.1	-9.6	16.9	R-2	-17.0	-1.1	11.3	6.9
R-3	-3.1	-7.1	-10.3	20.6	R-3	-23.5	-6.7	12.0	18.2
R-4	-3.2	-6.7	-10.0	19.9	R-4	-21.0	-9.2	10.0	20.1
R-5	-2.2	-5.3	-9.2	16.7	R-5	-20.5	-7.1	11.2	16.5
R-6	-3.5	-7.7	-9.2	20.5	R-6	-19.2	-6.4	8.4	17.3
WQ-Swimming	Zero	Low	Med	High	**WQ-Boating**	Zero	Low	Med	High
R-2	-0.6	-5.7	-7.7	13.9	R-2	-1.0	-7.5	-4.0	12.5
R-3	-0.5	-5.2	-8.6	14.2	R-3	-0.9	-7.5	-4.9	13.2
R-4	-0.6	-6.0	-7.9	14.4	R-4	-1.1	-8.1	-3.9	13.1
R-5	-0.3	-3.5	-7.0	10.8	R-5	-0.6	-5.1	-4.8	10.4
R-6	-0.3	-3.6	-6.7	10.6	R-6	-0.6	-5.0	-4.6	10.3

A16-2. Change in likelihood of risk state to endpoints with Best Case Scenario. This scenario represents the lower risk bound for the bank stabilization management scenario.

Belted Kingfisher	Zero	Low	Med	High	**Carolina Wren**	Zero	Low	Med	High
Region 2	4.0	0.1	-2.3	-1.9	R-2	2.8	-1.7	-0.9	-0.2
R-3	4.9	-1.7	-2.4	-0.8	R-3	3.0	-0.2	-2.1	-0.7
R-4	4.1	-1.0	-21.8	-1.2	R-4	1.2	-0.1	-0.4	-0.6
R-5	3.1	-1.1	-0.8	-1.1	R-5	1.0	0.0	-0.6	-0.5
R-6	5.6	-2.1	-2.7	-0.9	R-6	2.5	0.8	-2.0	-1.3
Smallmouth Bass	Zero	Low	Med	High	**White Sucker**	Zero	Low	Med	High
R-2	10.4	-1.8	-3.0	-5.5	R-2	8.1	-0.4	-0.9	-6.9
R-3	11.3	-2.1	-3.4	-5.9	R-3	7.9	-1.0	-1.8	-5.1
R-4	15.6	-1.4	-2.6	-11.7	R-4	7.9	-1.1	-1.8	-5.1
R-5	10.9	-0.1	-0.1	-10.7	R-5	6.4	-1.4	-2.1	-2.9
R-6	12.1	-1.9	-3.1	-7.1	R-6	6.4	-1.4	-2.0	-2.9
WQ-Standards	Zero	Low	Med	High	**WQ-Fishing**	Zero	Low	Med	High
R-2	9.7	8.0	1.5	-19.1	R-2	18.1	-5.4	-9.7	-3.0
R-3	9.7	6.7	0.0	-16.3	R-3	17.3	0.2	-10.8	-6.7
R-4	8.3	7.4	1.2	-16.8	R-4	19.6	1.3	-12.7	-8.2
R-5	8.6	7.0	1.6	-17.3	R-5	18.4	-0.3	-11.0	-7.0
R-6	10.3	6.0	-1.1	-15.3	R-6	16.2	2.8	-10.3	-8.7
WQ-Swimming	Zero	Low	Med	High	**WQ-Boating**	Zero	Low	Med	High
R-2	3.1	5.2	-1.4	-6.9	R-2	2.8	4.3	1.2	-8.3
R-3	3.0	5.7	-0.2	-8.5	R-3	2.8	4.3	2.3	-9.5
R-4	2.0	4.2	-0.7	-5.5	R-4	1.8	3.7	1.2	-6.8
R-5	0.4	1.6	1.8	-3.8	R-5	0.4	1.5	1.5	-3.6
R-6	2.5	5.7	-0.8	-7.5	R-6	2.1	4.4	2.4	-8.9

Appendix 17. Sensitivity Analysis: entropy reduction results for adaptive management.

Parent nodes were included in the lists. For example, Deviation from LT Summer Discharge or Deviation from LT Winter Discharge were used rather than Discharge Regime. Nodes that have the least number of connections to the endpoint are more likely to have greater influence over the final value of the endpoint. Management may choose to target Discharge Regime as a whole, but it is important to know what component of the Discharge Regime is driving the response.

A17-1. Entropy Reduction (mutual information) for Ag BMPs.

	Input Parameter	Entropy Reduction
Belted Kingfisher		
Region 2	Mercury	0.1484
	Fish Length	0.0707
	Potential Habitat	0.0434
Region 3	Mercury	0.1568
	Fish Length	0.0951
	Potential Habitat	0.0399
Region 4	Mercury	0.1934
	Fish Length	0.0760
	Territory	0.0250
Region 5	Mercury	0.2264
	Fish Length	0.0785
	Territory	0.0228
Region 6	Fish Length	0.1018
	Mercury	0.0456
	Territory	0.0431
Smallmouth Bass		
Region 2	River Temp	0.0277
	Mercury	0.0177
	Organochlorine Pesticides	0.0008
Region 3	River Temp	0.0146
	Mercury	0.0059
	Organochlorine Pesticides	0.0029
Region 4	River Temp	0.0330
	Mercury	0.0151
	Organochlorine Pesticides	0.0071
Region 5	River Temp	0.0525
	Mercury	0.0418
	Total Suspended Solids	0.0024
Region 6	River Temp	0.0493
	Mercury	0.0151
	Organochlorine Pesticides	0.0036

Water Quality Standards		
Region 2	Summer Dissolved O_2	0.0943
	Deviation from Winter Temp	0.0123
	Deviation from Summer Temp	0.0093
Region 3	Summer Dissolved O_2	0.1135
	Bacterial Indicators	0.0237
	Deviation from Winter Discharge	0.0156
Region 4	Summer Dissolved O_2	0.1675
	Deviation from Winter Discharge	0.0210
	Deviation from Summer Discharge	0.0201
Region 5	Summer Dissolved O_2	0.1153
	Bacteria Indicators	0.0212
	Deviation from Winter Discharge	0.0111
Region 6	Summer Dissolved O_2	0.1137
	Deviation from LT Winter Discharge	0.0219
	Deviation from LT Summer Discharge	0.0171
Swimming River Use		
Region 2	Deviation from Winter Temp	0.0391
	Deviation from Summer Temp	0.0316
	Deviation from Summer Discharge	0.0231
Region 3	Deviation from Winter Temp	0.0368
	Bacterial Indicators	0.0342
	Deviation from Summer Temp	0.0271
Region 4	Deviation from Summer Discharge	0.0483
	Deviation from Winter Discharge	0.0430
	Deviation from Summer Temperature & Deviation from Winter Temperature	0.0388
Region 5	Bacterial Indicators	0.0359
	Deviation from Winter Temp	0.0318
	Deviation from Summer Temp	0.0301
Region 6	Deviation from Summer Temp	0.0333
	Deviation from Winter Temp	0.0333
	Deviation from Winter Discharge	0.0198
Boating River Use		
Region 2	Deviation from Winter Temp	0.0577
	Deviation from Summer Temp	0.0436
	Bacterial Indicators	0.0136
Region 3	Deviation from Winter Temp	0.0566
	Deviation from Summer Temp	0.0411
	Bacterial Indicators	0.0306
Region 4	Deviation from Winter Temp	0.0532
	Deviation from Summer Temp	0.0532
	Deviation from Summer Discharge	0.0276
Region 5	Deviation from Winter Temp	0.0423

	Deviation from Summer Temp	0.0374
	Bacteria Indicators	0.0359
Region 6	Deviation from Summer Temp	0.0421
	Deviation from Winter Temp	0.0421
	Deviation from Winter Discharge	0.0135

Table A17-2. Entropy reduction (mutual information) for bank stabilization.

	Input Parameter	**Entropy Reduction**
Belted Kingfisher		
Region 2	Mercury	0.1287
	Fish Length	0.0693
	Potential Habitat	0.0425
Region 3	Mercury	0.1415
	Fish Length	0.0924
	Potential Habitat	0.0394
Region 4	Mercury	0.1780
	Fish Length	0.0742
	Territory	0.0250
Region 5	Mercury	0.2093
	Fish Length	0.0765
	Territory	0.0233
Region 6	Fish Length	0.0968
	Territory	0.0426
	Mercury	0.0390
Carolina Wren		
Region 2	Nest Predation	0.0635
	Potential Habitat	0.0554
	Winter Air Temperature	0.0200
Region 3	Mercury	0.0904
	Nest Predation	0.0553
	Potential Habitat	0.0181
Region 4	Mercury	0.0851
	Nest Predation	0.0336
	Winter Air Temperature	0.0121
Region 5	Mercury	0.0953
	Nest Predation	0.0367
	Potential Habitat	0.0122
Region 6	Mercury	0.0738
	Nest Predation	0.0416
	Winter Air Temperature	0.0135

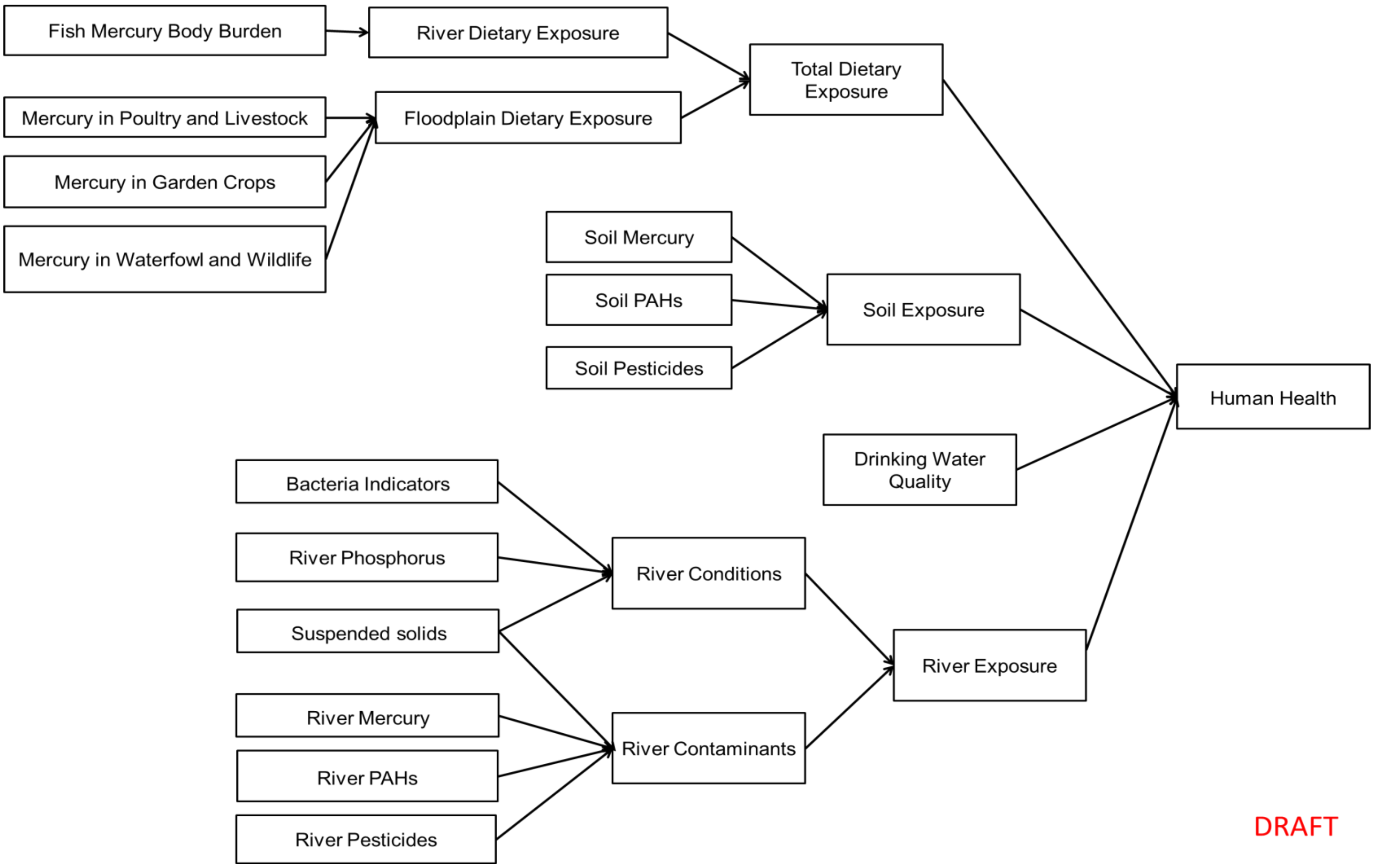
Smallmouth Bass		
Region 2	River Temp	0.0221
	Mercury remaining (decrease)	0.0053
	Mercury	0.0040
Region 3	River Temp	0.0252
	Mercury remaining (decrease)	0.0164
	Mercury	0.0026
Region 4	River Temp	0.0444
	Mercury remaining (decrease)	0.0340
	Mercury	0.0110
Region 5	River Temp	0.0570
	Mercury remaining (decrease)	0.0398
	Mercury	0.0139
Region 6	River Temp	0.0497
	Mercury remaining (decrease)	0.0205
	Organochlorine Pesticides	0.0026
White Sucker		
Region 2	River Temp	0.0458
	Stream Cover	0.0066
	Mercury	0.0014
Region 3	River Temp	0.0535
	Stream Cover	0.0529
	Mercury remaining (decrease)	0.0028
Region 4	River Temp	0.0769
	Stream Cover	0.0169
	Mercury remaining (decrease)	0.0028
Region 5	River Temp	0.0304
	Stream Cover	0.0124
	Mercury increase	0.0014
Region 6	River Temp	0.0303
	Stream Cover	0.0171
	PAHs Change	0.0009
Water Quality Standards		
Region 2	Summer Dissolved O_2	0.0481
	Bacterial Indicators	0.0101
	Deviation from Winter Temp	0.0089
Region 3	Summer Dissolved O_2	0.0587
	Bacterial Indicators	0.0344
	Deviation from Winter Temp	0.0091
Region 4	Summer Dissolved O_2	0.0753
	Deviation from Winter Temp	0.0083
	Deviation from Summer Temp	0.0083
Region 5	Summer Dissolved O_2	0.0600
	Bacterial Indicators	0.0315

	Deviation from Winter Temp	0.0068
Region 6	Summer Dissolved O_2	0.0606
	Bacterial Indicators	0.0139
	Deviation from Winter Temp & Deviation from Summer Temp	0.0071
Fishing River Use		
Region 2	Summer Dissolved O_2	0.0496
	MeHg Body Burden Fish	0.0285
	Deviation from Winter Temp	0.0135
Region 3	Summer Dissolved O_2	0.0628
	MeHg Body Burden Fish	0.0277
	Deviation from Winter Temp	0.0189
Region 4	Summer Dissolved O_2	0.0594
	MeHg Body Burden Fish	0.0176
	Mercury increase	0.0163
Region 5	Summer Dissolved O_2	0.0516
	Mercury increase	0.0212
	Deviation from Winter Temp	0.0118
Region 6	Summer Dissolved O_2	0.0509
	Mercury increase	0.0353
	Deviation from Winter Temp & Deviation from Summer Temp	0.0126
Swimming River Use		
Region 2	Deviation from Winter Temp	0.0280
	Bacteria Indicators	0.0232
	Deviation from Summer Temp	0.0226
Region 3	Bacteria Indicators	0.0498
	Deviation from Winter Temp	0.0259
	Deviation from Summer Temp	0.0194
Region 4	Deviation from Winter Temp	0.0293
	Deviation from Summer Temp	0.0293
	Temp Change due to Bank Stabilization	0.0030
Region 5	Bacteria Indicators	0.0518
	Deviation from Winter Temp	0.0240
	Deviation from Summer Temp	0.0231
Region 6	Deviation from Summer Temp	0.0253
	Deviation from Winter Temp	0.0253
	Bacterial Indicators	0.0189
Boating River Use		
Region 2	Deviation from Winter Temp	0.0421
	Deviation from Summer Temp	0.0312
	Bacteria Indicators	0.0202
Region 3	Bacterial Indicators	0.0449
	Deviation from Winter Temp	0.0401

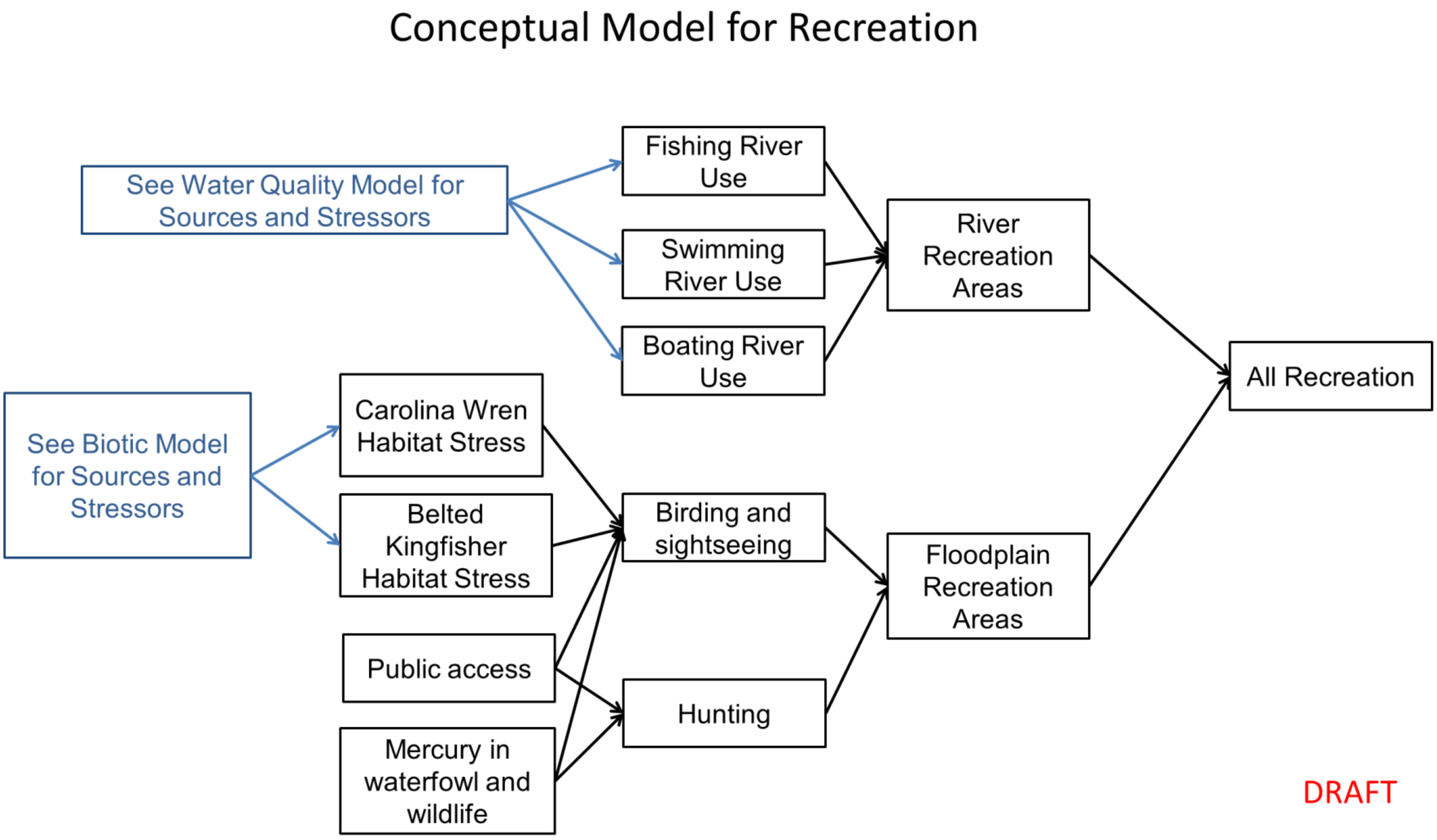
	Deviation from Summer Temp	0.0292
Region 4	Deviation from Winter Temp	0.0387
	Deviation from Summer Temp	0.0387
	Temp Change due to Bank Stabilization	0.0034
Region 5	Bacterial Indicators	0.0512
	Deviation from Winter Temp	0.0309
	Deviation from Summer Temp	0.0274
Region 6	Deviation from Summer Temp	0.0309
	Deviation from Winter Temp	0.0309
	Bacterial Indicators	0.0178

Appendix 18. Conceptual Models for the human health and recreation endpoints.

Conceptual Model for Human Health

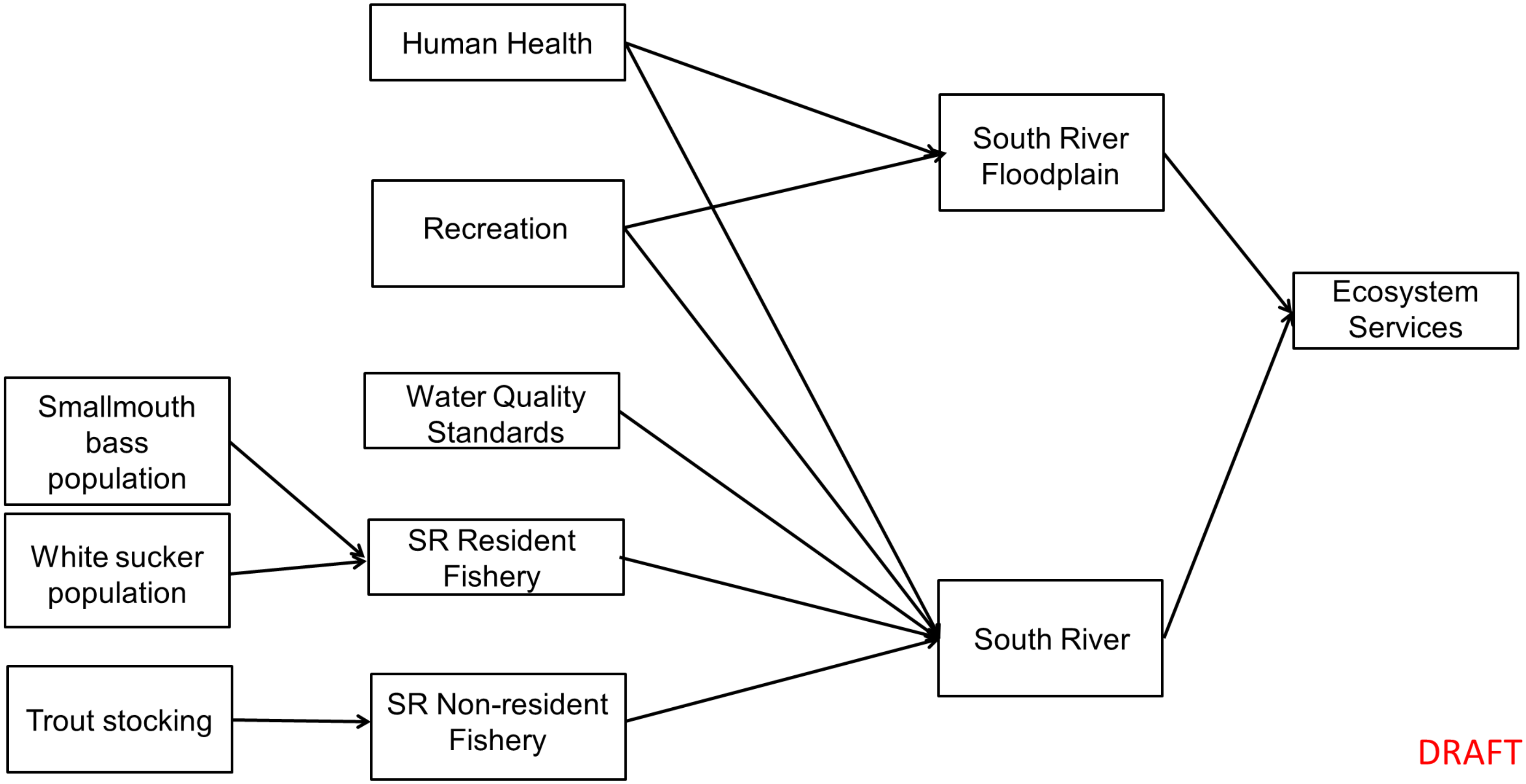


A18-1. Human Health Conceptual Model.



A18-2. Recreation Conceptual Model.

Conceptual Model for Human-Eco Integration - Ecosystem Services Model



A18-3. Ecosystem Services Conceptual Model.