Department of the Environment

Stressor Identification

The First Step in Addressing MD's Non-tidal Biological Impairments

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Stressor Identification Section

Prepared for

Association of Mid-Atlantic Aquatic Biologists Workshop

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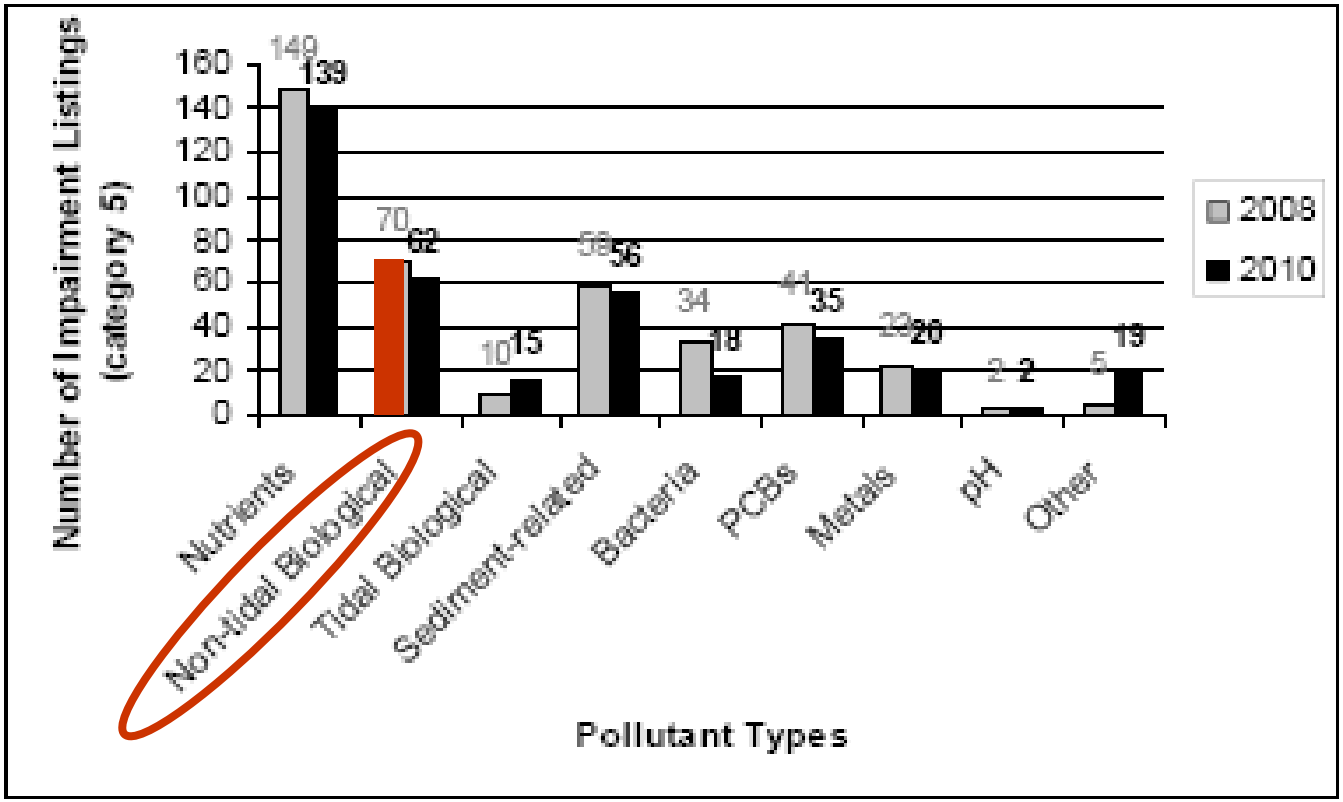
Allison O'Hanlon & John Holt
Presenters

MDE

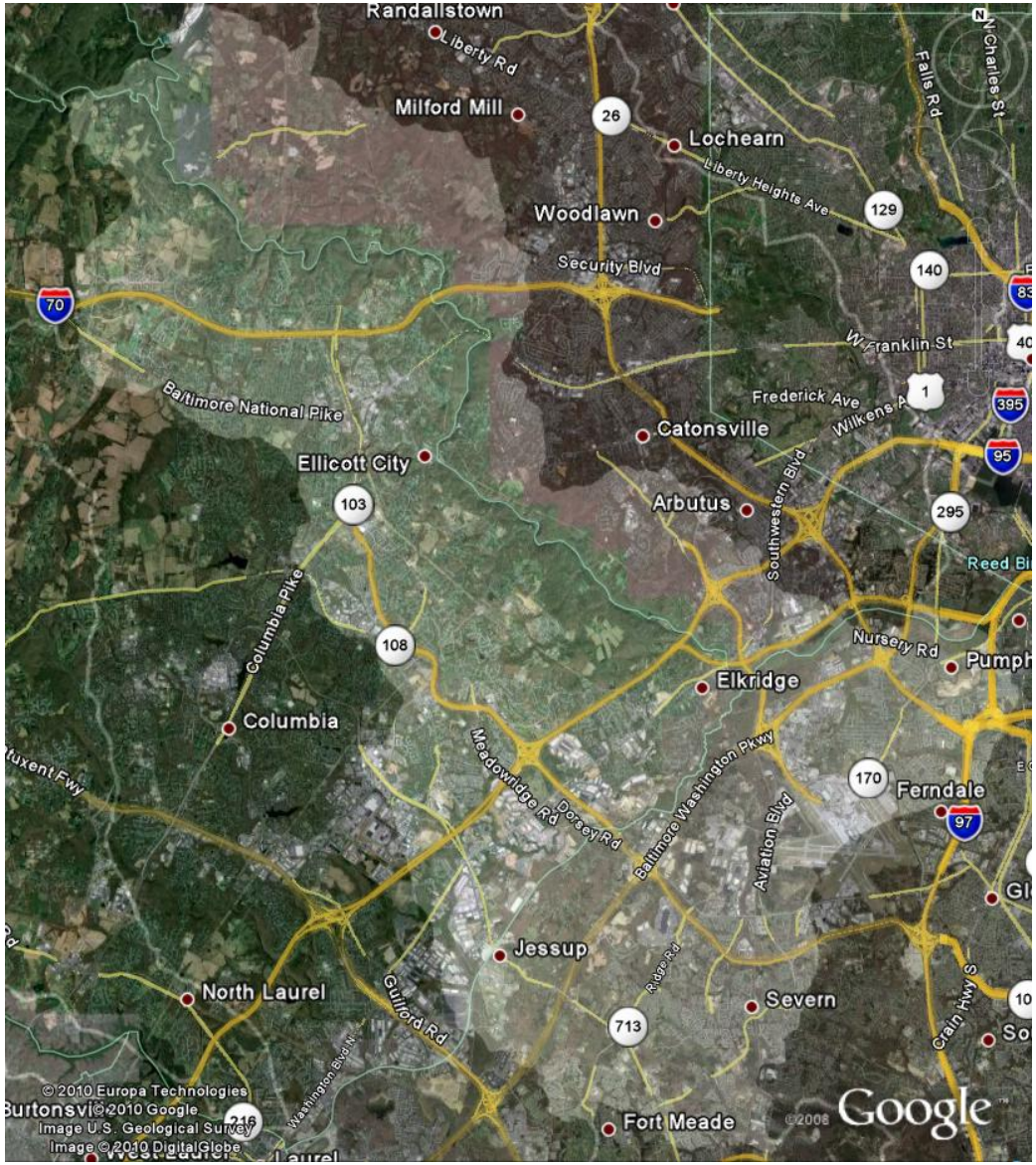
Number of Impairments



Impaired?... Cause?

Impaired?... Cause?

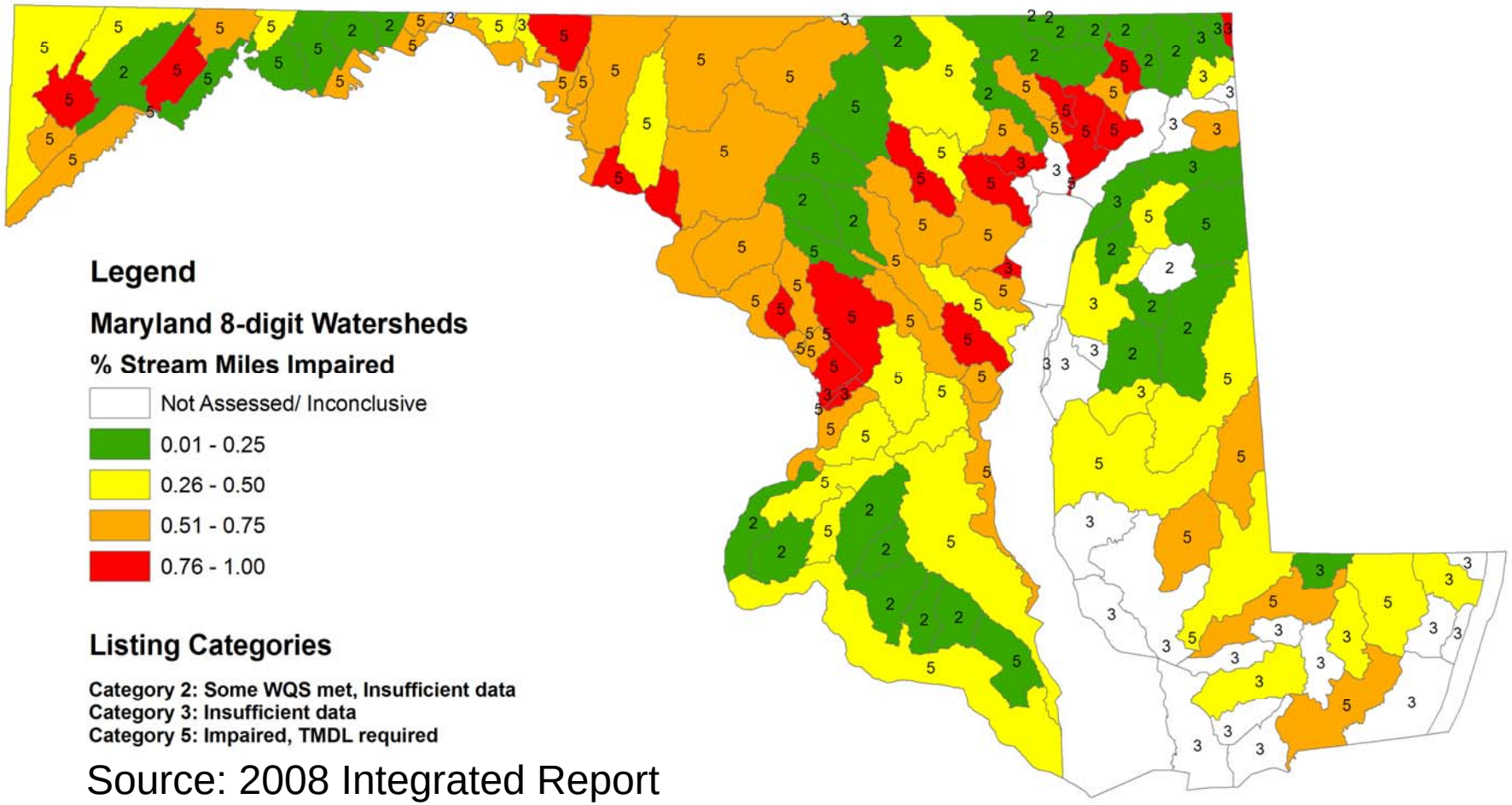
Assessment scale: 8-digit watersheds



Acknowledgements

- MDE Stressor Identification Section
- MD DNR MBSS
- EPA ORD
- University Of MD
- Versar

IR Biological Assessment

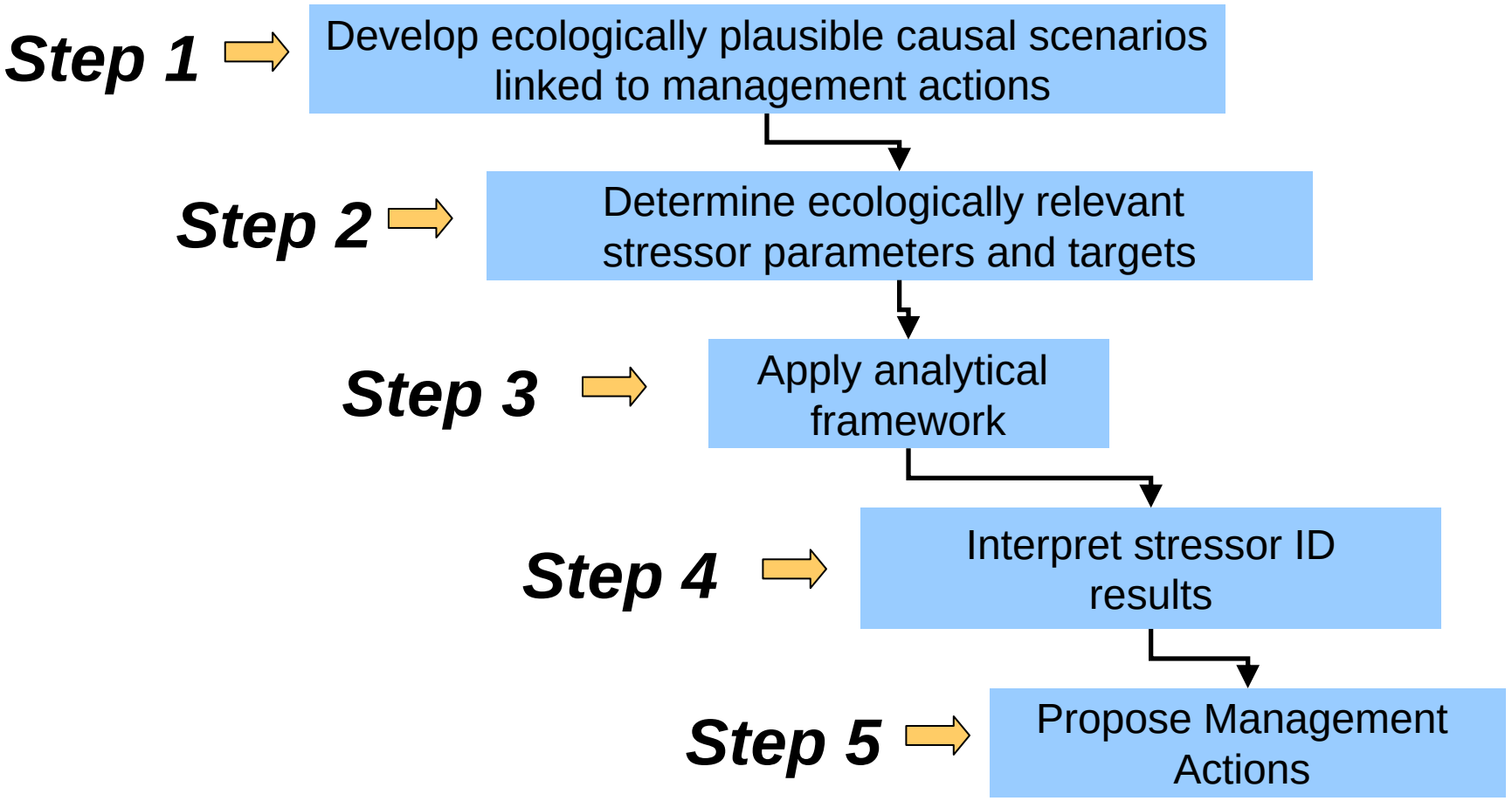


Source: 2008 Integrated Report

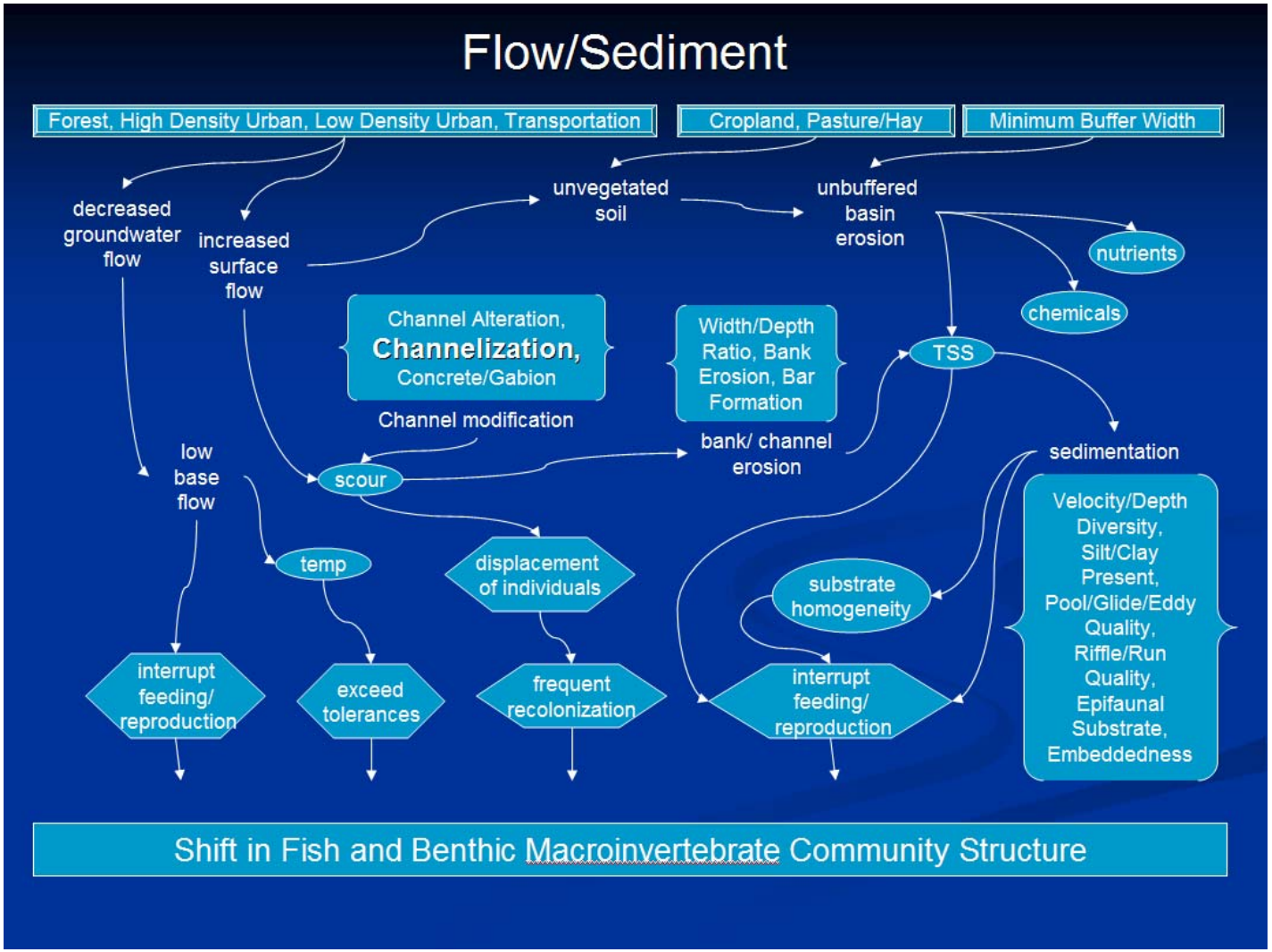
Refining the Stressor ID Approach

- Build on previous efforts
- Use concepts from the field of epidemiology
- Hill's Postulates (1965)

Stressor Identification Procedure



Causal Scenarios



Relevant Parameters

- MBSS Round 2 Dataset
  - Paired with IBI
  - Most Comprehensive
  - Consistent
  - Probabilistic
- Parameter Groups
  - Sediment
  - Habitat
  - Water Chemistry
  - Land Use/ Other sources

Parameter Targets

- Determine stressor presence/absence
- Allow for multiple data types
  - Water quality Standards (e.g. Dissolved Oxygen)
  - Presence/absence (e.g. Channelization)
  - Categorical - optimal, sub-optimal, marginal, or poor (e.g. Instream Habitat)
  - Biological gradient (e.g. Imperviousness, embeddedness)

Parameter Target Examples

e.g., Sediment group parameters

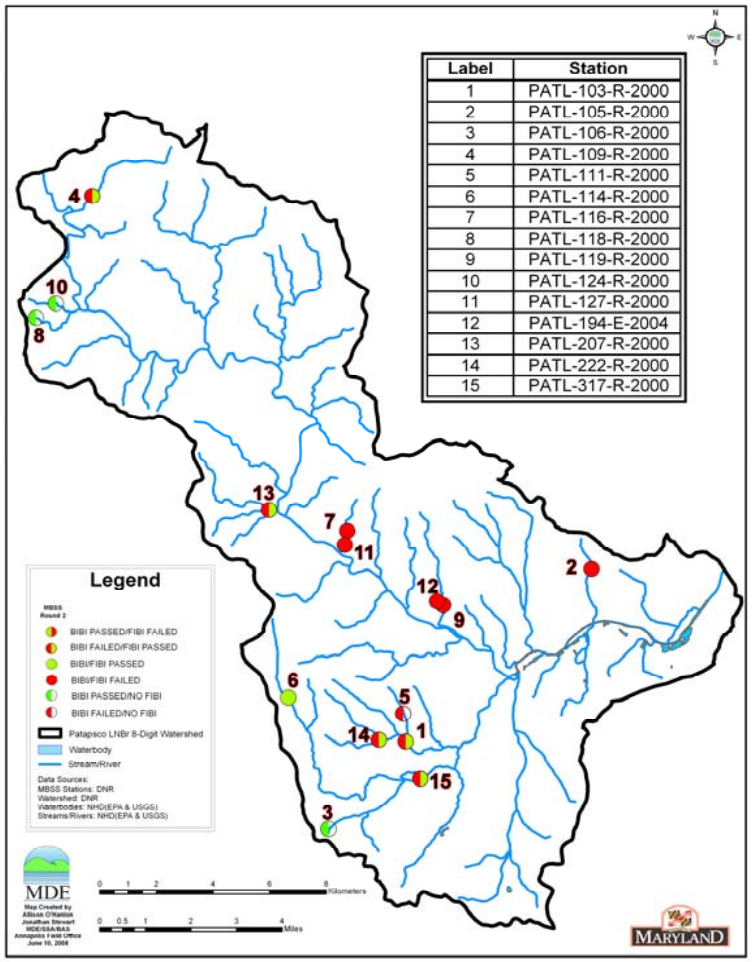
Parameter	Data Type	Target
Channelization	Presence/ Absence	Present
Instream Habitat	Categorical	6 (Poor) and 11 (Marginal)
Pool/eddy/glide Quality	Categorical	6 (Poor) and 11 (Marginal)
Riffle/run Quality	Categorical	6 (Poor) and 11 (Marginal)
Velocity/ Depth Diversity	Categorical	6 (Poor) and 11 (Marginal)
Concrete/Gabion	Presence/ Absence	Present
Beaver Pond	Presence/ Absence	Present
Riparian Buffer	Continuous (Gradient)	<1 meter
Low Shading	Proportion (Gradient)	<50%

Analytical Framework

Analysis Terms:

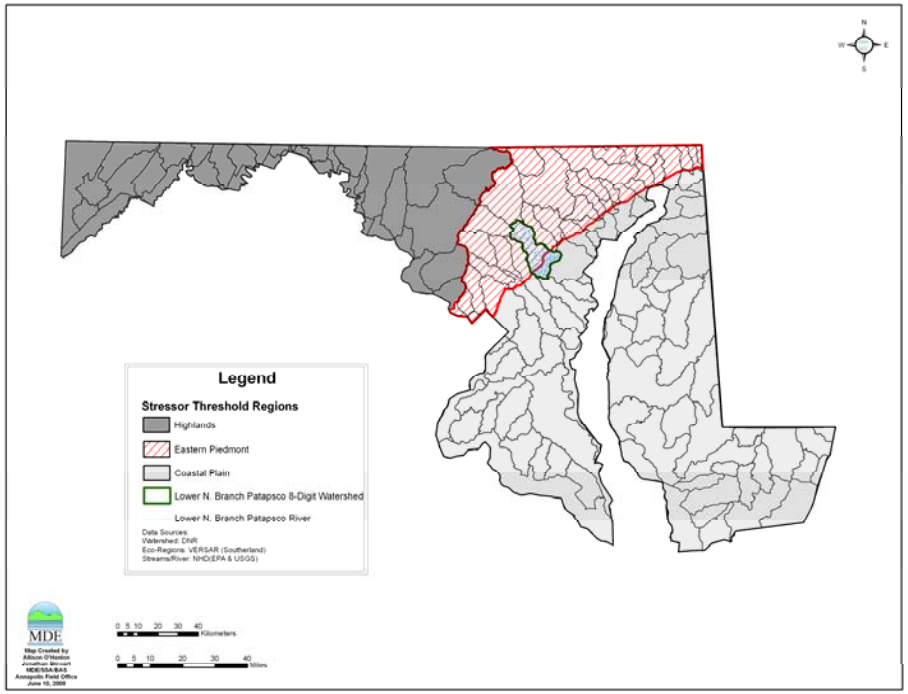
- Odds Ratio (Similar to Relative Risk)
  - Simple or Stratified Calculation
  - Confidence intervals (common or exact)
- Attributable Risk
  - Estimate of % degraded sites in a watershed that are associated with a stressor
  - Also calculated for stressor groups

Analysis scale



Cases

e.g., Lower North Branch Patapsco



Controls

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Calculating Analysis Terms

	Cases (Very Poor to Poor)	Controls (Fair to Good)
Channelization Present	6	9
Channelization Absent	6	81
Total	12	90
% w/ Stressor Present	50%	9%

Odds Ratio = $\frac{6/6}{9/81} \approx 9$

Attributable risk = $50\% - 9\% \approx 41\%$

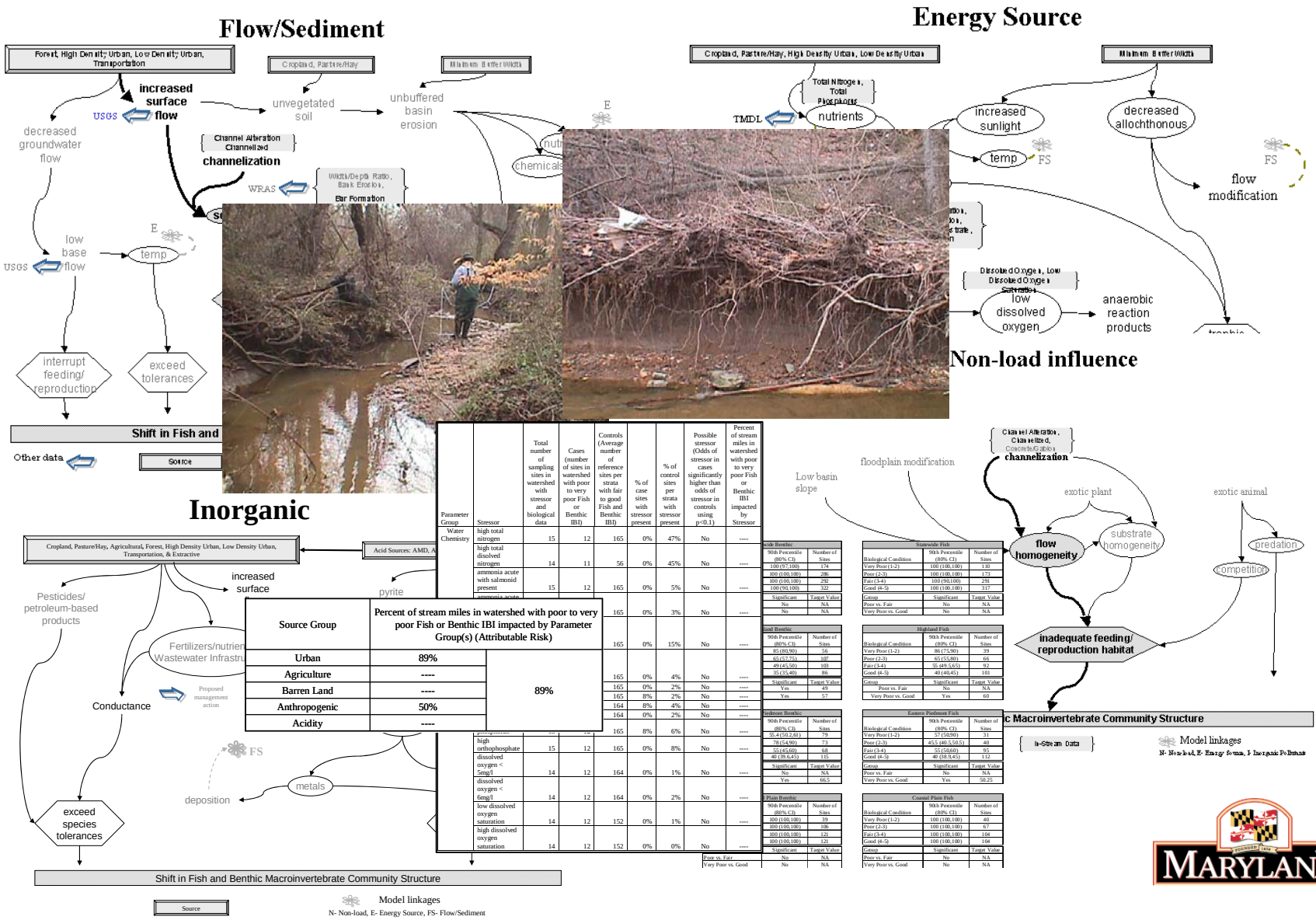
e.g., Lower North Branch Patapsco

Model Output: Stressor/Source Summary

Group	Stressor/ Source	Attributable Risk		
CHEMISTRY	high chlorides	78%	87%	95%
	high sulfates	79%		
	high conductivity	86%		
HABITAT	channelization present	41%	41%	
SEDIMENT	extensive bar formation present	28%	70%	
	channel alteration poor	29%		
	moderate bar formation present	58%		
	channel alteration marginal to poor	59%		
SOURCE	low % of forest in watershed	25%	89%	
	high % of transportation in watershed	41%		
	low % of forest in 60m buffer	50%		
	high % of low intensity urban in watershed	61%		
	high % of transportation in 60m buffer	61%		
	high % of high intensity urban in watershed	67%		
	high % of high intensity urban in 60m buffer	71%		
	high % of low intensity urban in 60m buffer	77%		
	high impervious surface in watershed	80%		

e.g., Lower North Branch Patapsco

Putting it all together…



Parameter Group	Stressor	Total number of sampling sites in watershed with stressor and biological data	Cases (number of sites in watershed with poor to very poor Fish or Benthic IBI)	Controls (Average number of reference sites per strata with fair to good Fish and Benthic IBI)	% of case sites with stressor present	% of control sites per strata with stressor present	Possible stressor (Odds of stressor in cases significantly higher than odds of stressor in controls using p<0.1)	Percent of stream miles in watershed with poor to very poor Fish or Benthic IBI impacted by Stressor
Water Chemistry	high total nitrogen	15	12	165	0%	47%	No	----
	high total dissolved nitrogen	14	11	56	0%	45%	No	----
	ammonia acute with salmonid present	15	12	165	0%	5%	No	----
				165	0%	3%	No	----
				165	0%	15%	No	----
				165	0%	4%	No	----
				165	0%	2%	No	----
				165	8%	2%	No	----
				164	8%	4%	No	----
				164	0%	2%	No	----
				165	8%	6%	No	----
	high orthophosphate	15	12	165	0%	8%	No	----
	dissolved oxygen < 5mg/l	14	12	164	0%	1%	No	----
	dissolved oxygen < 6mg/l	14	12	164	0%	2%	No	----
	low dissolved oxygen saturation	14	12	152	0%	1%	No	----
	high dissolved oxygen saturation	14	12	152	0%	0%	No	----

Source Group	Percent of stream miles in watershed with poor to very poor Fish or Benthic IBI impacted by Parameter Group(s) (Attributable Risk)	
Urban	89%	89%
Agriculture	----	
Barren Land	----	
Anthropogenic	50%	
Acidity	----	

Statewide Benthic	
90th Percentile (80% CI)	Number of Sites
100 (97,100)	174
100 (100,100)	286
100 (100,100)	292
100 (90,100)	322
Significant	Target Value
No	NA
No	NA

Statewide Fish		
Biological Condition	90th Percentile (80% CI)	Number of Sites
Very Poor (1-2)	100 (100,100)	110
Poor (2-3)	100 (100,100)	173
Fair (3-4)	100 (90,100)	291
Good (4-5)	100 (100,100)	317
Group	Significant	Target Value
Poor vs. Fair	No	NA
Very Poor vs. Good	No	NA

Highland Benthic	
90th Percentile (80% CI)	Number of Sites
85 (80,90)	56
65 (52,75)	107
49 (45,50)	103
35 (35,40)	86
Significant	Target Value
Yes	49
Yes	57

Highland Fish		
Biological Condition	90th Percentile (80% CI)	Number of Sites
Very Poor (1-2)	86 (75,90)	39
Poor (2-3)	65 (55,80)	66
Fair (3-4)	55 (49,5,65)	92
Good (4-5)	40 (40,45)	101
Group	Significant	Target Value
Poor vs. Fair	No	NA
Very Poor vs. Good	Yes	60

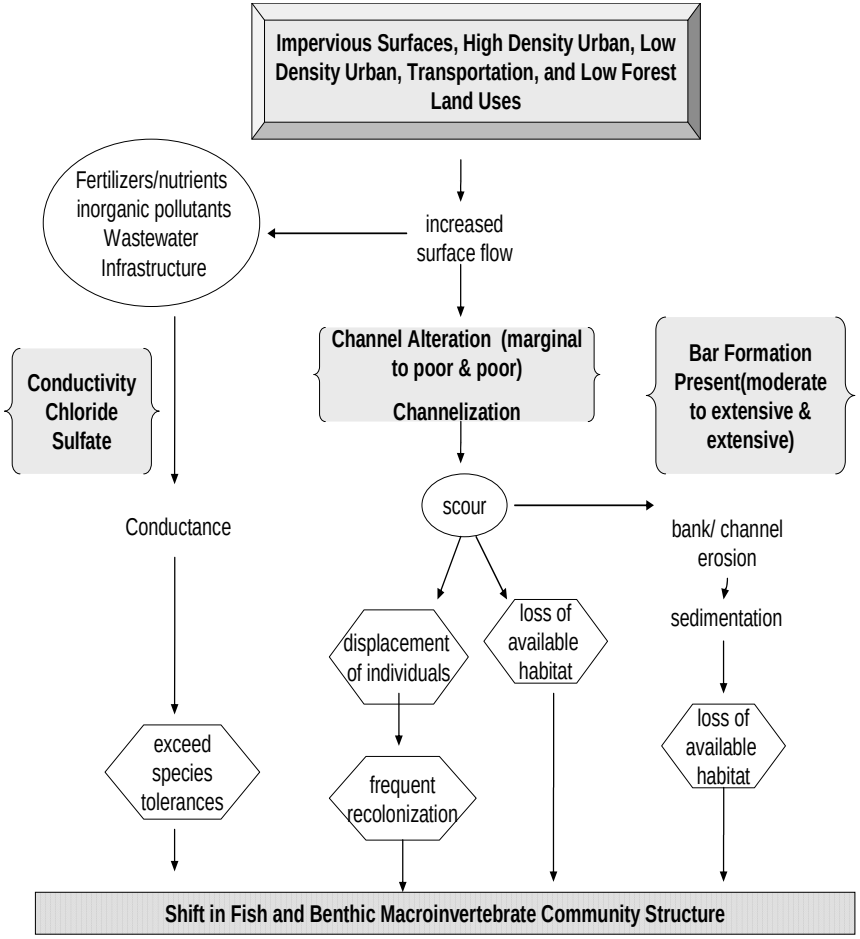
Piedmont Benthic	
90th Percentile (80% CI)	Number of Sites
55.4 (50.2,61)	79
78 (54,90)	73
55 (45,60)	68
40 (39.6,45)	115
Significant	Target Value
No	NA
Yes	66.5

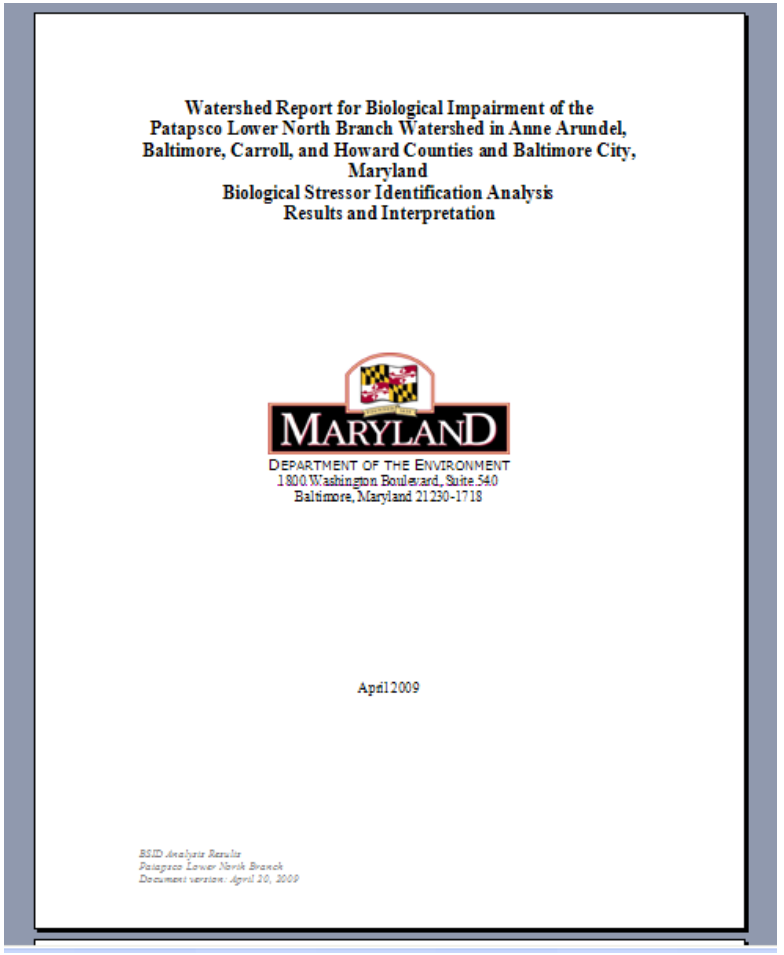
Eastern Piedmont Fish		
Biological Condition	90th Percentile (80% CI)	Number of Sites
Very Poor (1-2)	57 (50,90)	31
Poor (2-3)	45.5 (40.5,50.5)	40
Fair (3-4)	55 (50,60)	95
Good (4-5)	40 (39.9,45)	112
Group	Significant	Target Value
Poor vs. Fair	No	NA
Very Poor vs. Good	Yes	50.25

Coastal Plain Benthic	
90th Percentile (80% CI)	Number of Sites
100 (100,100)	39
100 (100,100)	106
100 (100,100)	121
100 (100,100)	121
Significant	Target Value
Poor vs. Fair	NA
Very Poor vs. Good	NA

Coastal Plain Fish		
Biological Condition	90th Percentile (80% CI)	Number of Sites
Very Poor (1-2)	100 (100,100)	40
Poor (2-3)	100 (100,100)	67
Fair (3-4)	100 (100,100)	104
Good (4-5)	100 (100,100)	104
Group	Significant	Target Value
Poor vs. Fair	No	NA
Very Poor vs. Good	No	NA

BSID Reporting





Watershed Report for Biological Impairment of the Patapsco Lower North Branch Watershed in Anne Arundel, Baltimore, Carroll, and Howard Counties and Baltimore City, Maryland
Biological Stressor Identification Analysis
Results and Interpretation

MARYLAND
DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard, Suite 540
Baltimore, Maryland 21230-1718

April 2009

BSID Analysis Results
Patapsco Lower North Branch
Document version: April 20, 2009

Watershed Specific

Patapsco LNB Conclusions & Actions

BSID Conclusions

- Probable cause: inorganic pollutants (i.e., chlorides, conductivity, sulfate).
- Probable cause: flow/sediment related stressors.
- No nutrient stressors

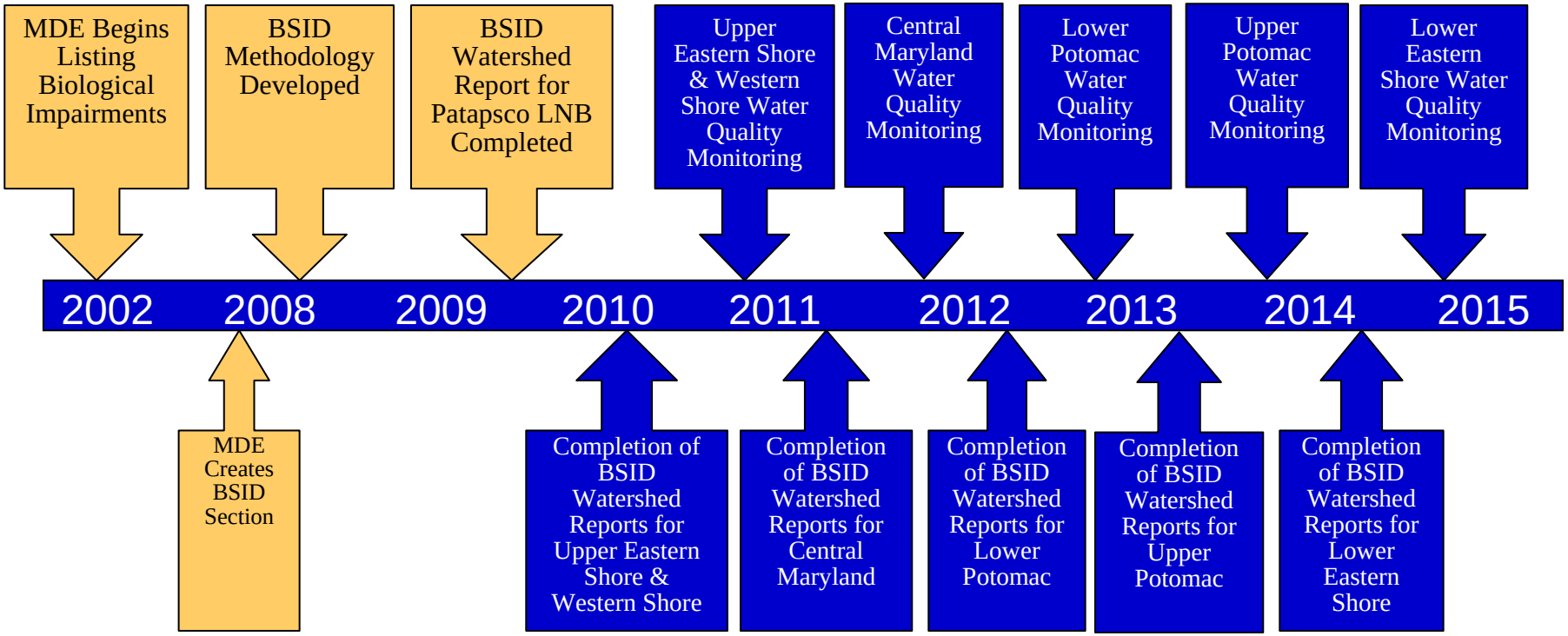
BSID Resulting Actions

- Inform monitoring: Additional monitoring of priority inorganic pollutants
- Direct reporting: Sulfates and Chlorides impairments added to 2010 IR
- Direct management: TSS impairment TMDL in review
- Direct management: Eutrophication WQA approved in Sept2009 by EPA

2009 Completed BSID Reports

WATERSHED	TMDLs SUPPORTED
Anteitam Creek	TSS, Phosphorus, TN
Cabin John Creek	TSS
Casselman River	pH
Evitts Creek	TSS
Gywnns Falls	TSS
Jones Falls	TSS
Little Patuxent River	TSS
Lower North Branch Patapsco	TSS
Seneca Creek	TSS
Town Creek	N/A
Wills Creek	TSS

BSID Timeline versus Monitoring



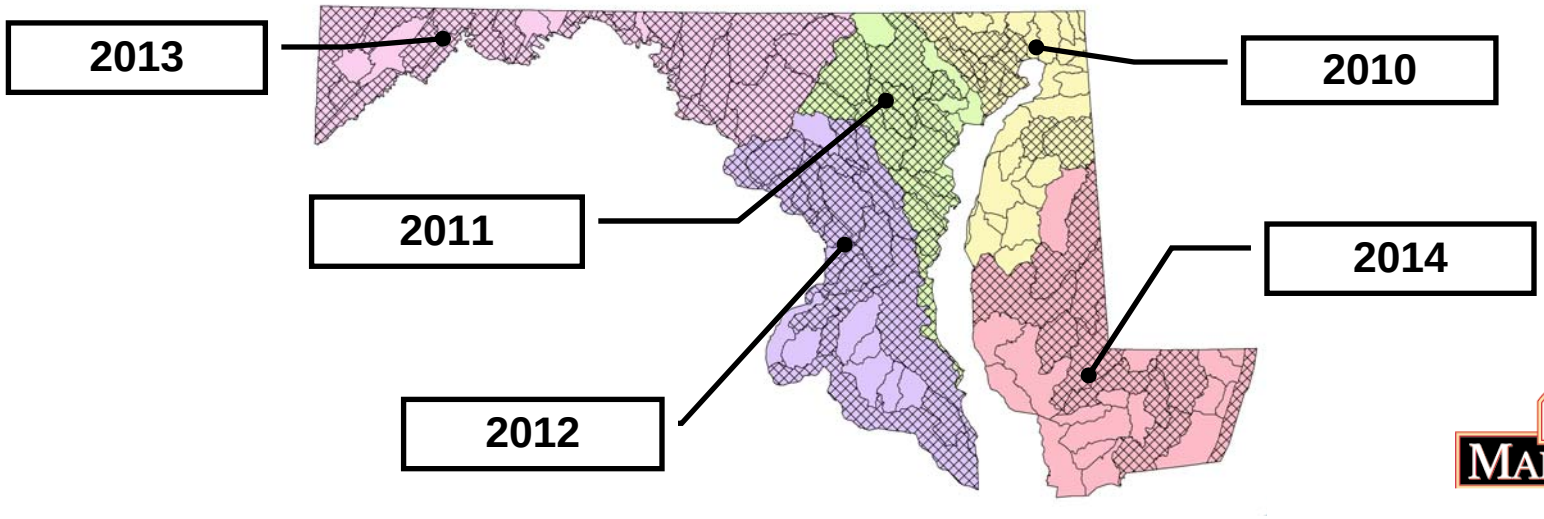
2010 Scheduled BSID Analyses

*Anacostia
*Catoctin Creek
*Deep Creek
*Double Pipe Creek
*Lower Monocacy River
*Middle Chester River
*Upper Monocacy River
*Upper North Branch Potomac
Aberdeen P.G.
*Bynum Run
*Liberty Reservoir
Licking Creek
Lower North Branch Potomac
*Lower Gunpowder Falls
Middle Patuxent River
*Patuxent River Upper
*Potomac River MO Cnty
*Potomac River WA Cnty
*Rock Creek
South Branch Patapsco
St. Mary's
*Upper Chester River
Upper Pocomke
West River
Atkisson Reservoir
Bush River
L Susquehanna River
Lower Winters Run
Swan Creek

*In Review

Watershed BSID Schedule

2011	2012	2013	2014
Back River	Mattawoman Creek	Conococheague Creek	Lower Choptank
Baltimore Harbor	Patuxent River lower	Georges Creek	Lower Pocomoke River
Loch Raven Reservoir	Patuxent River middle	Little Tonoloway Creek	Lower Wicomico River
Magothy River	Piscataway Creek	Little Youghiogheny R	Marshyhope Creek
Severn River	Port Tobacco River	Marsh Run	Nanticoke River
South River	Potomac River L tidal	Potomac River AL Cnty	Transquaking River
West Chesapeake Bay	Potomac River U tidal	Potomac River FR Cnty	Upper Choptank
Western Branch	Rocky Gorge Dam	Youghiogheny River	



Summary

- Challenges
  - Limited sample size
  - Scale
  - Uncertainty in targets
  - Accounting for “all” stressors
- However…
  - It provides a systematic process for moving forward with addressing non-tidal biological impairments

Maryland Department of the Environment

TMDL Development Program

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