The Stream Nutrient Assessment Procedure
A Weight of Evidence Water Quality Standard

Technical Assistance Presentation for The Conservation Foundation

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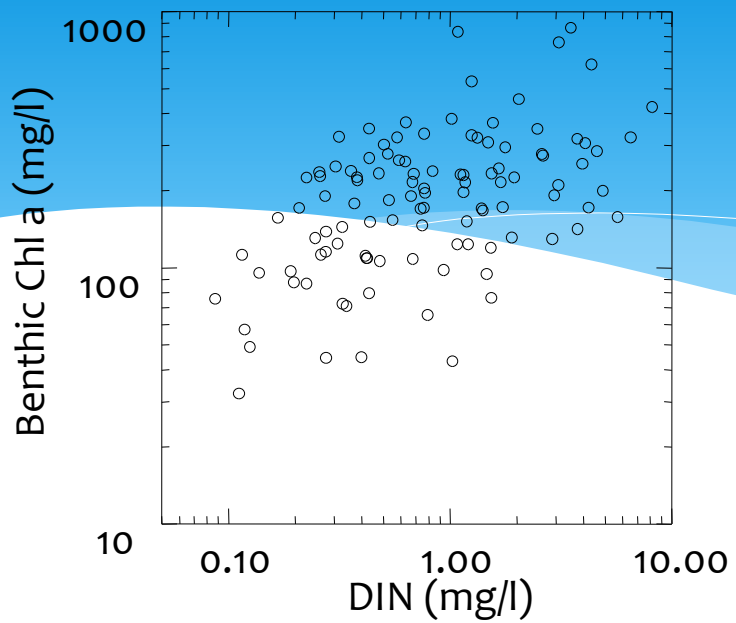
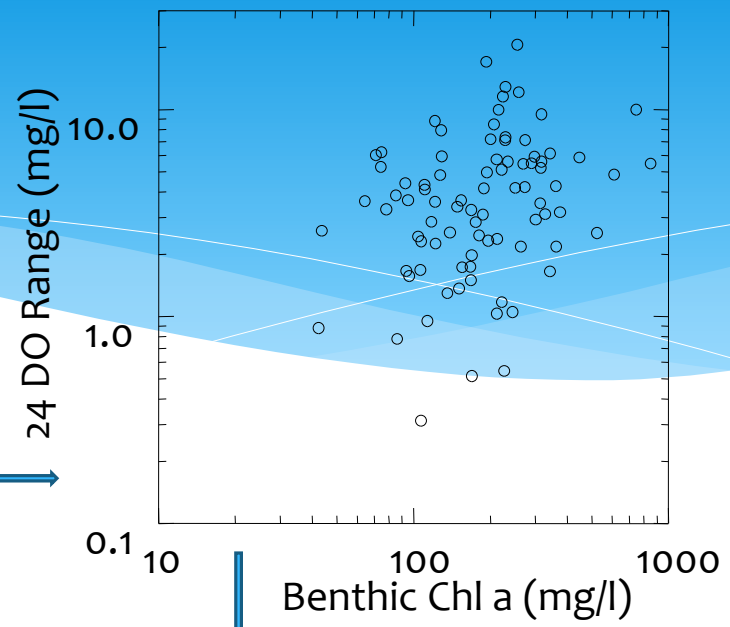
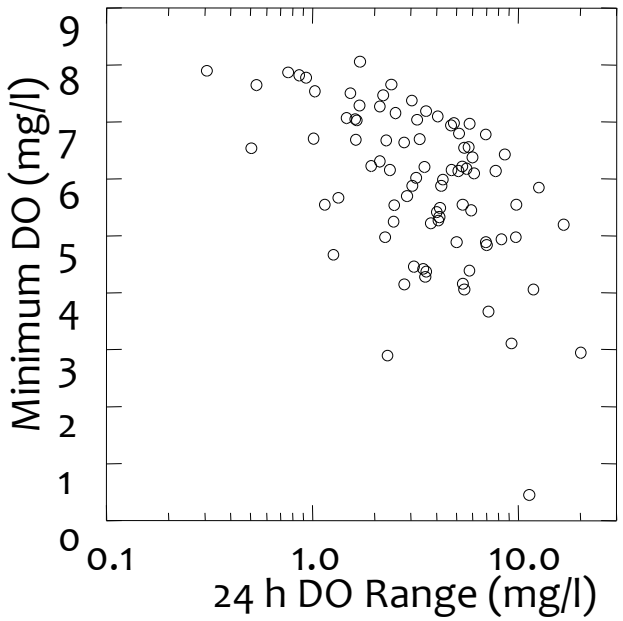
The SNAP in a Nutshell

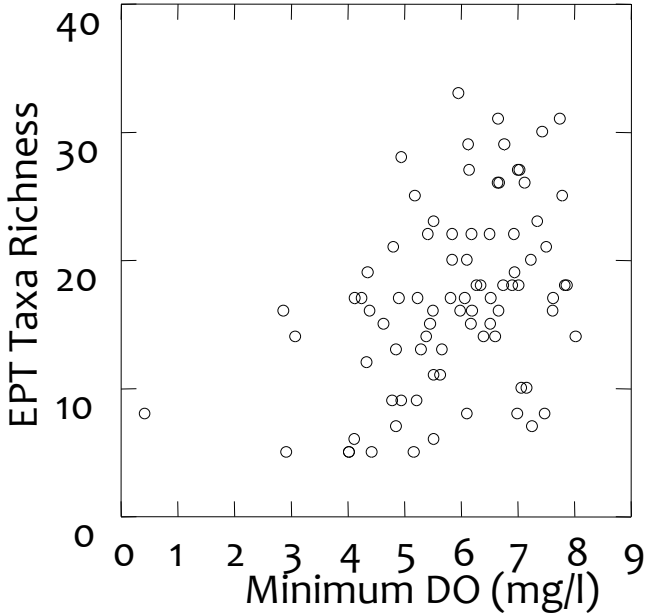
- A method to accurately ascribe nutrient over-enrichment as a cause of impairment to rivers and streams
- benchmarks from multiple measures are arrayed in a box model
  - fish and macroinvertebrates
  - dissolved oxygen
  - benthic chlorophyll
- further analysis is guided by decision trees to arrive at appropriate management action

Ohio Nutrient Study - Bivariate Representation

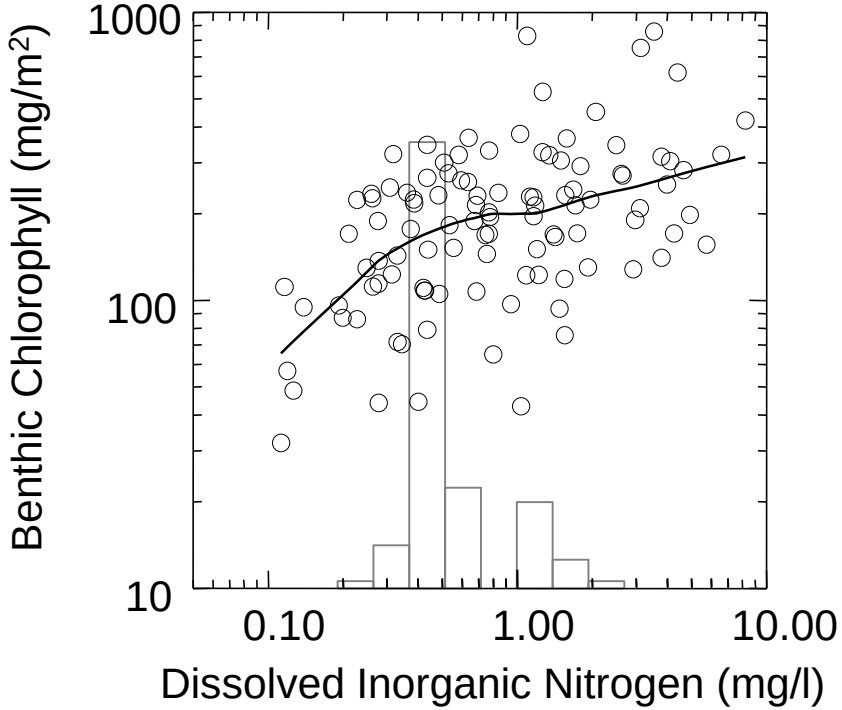


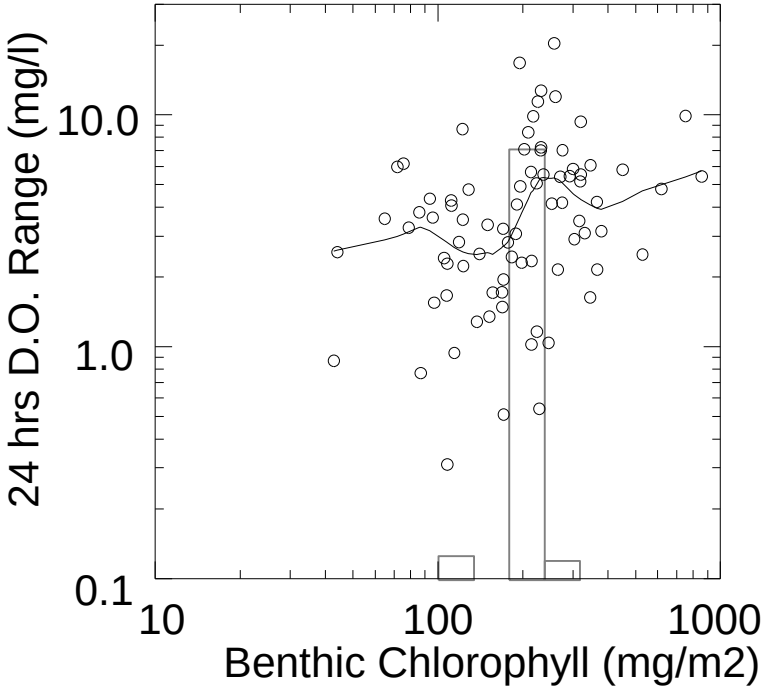






Change Point Analysis



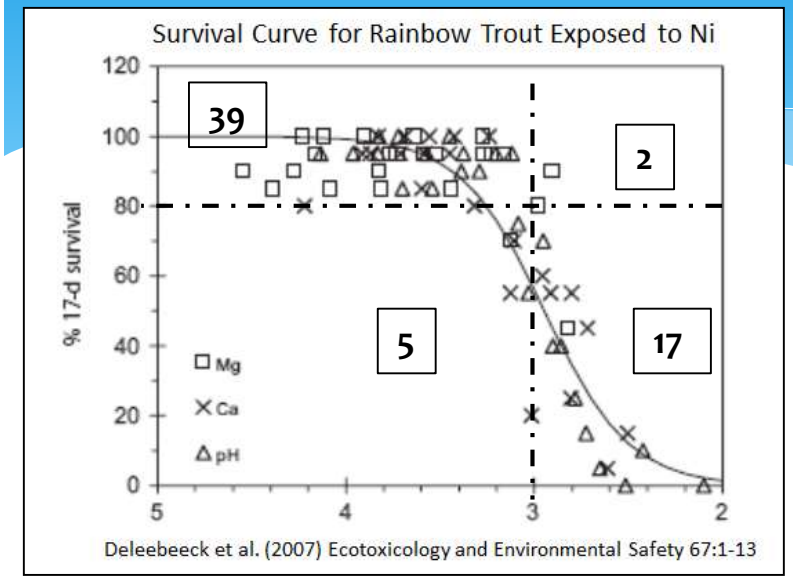


Change Points

Parameter	Change Points	Affects
TP	0.04 mg/l	Chlorophyll
DIN	0.44 mg/l	Chlorophyll
Benthic Chlorophyll	200 mg/m^2	D.O. & Macros
24-Hour D.O. Max - Min	6.5 mg/l	Fish & Macros

Characteristics of a Robust Numeric Criterion

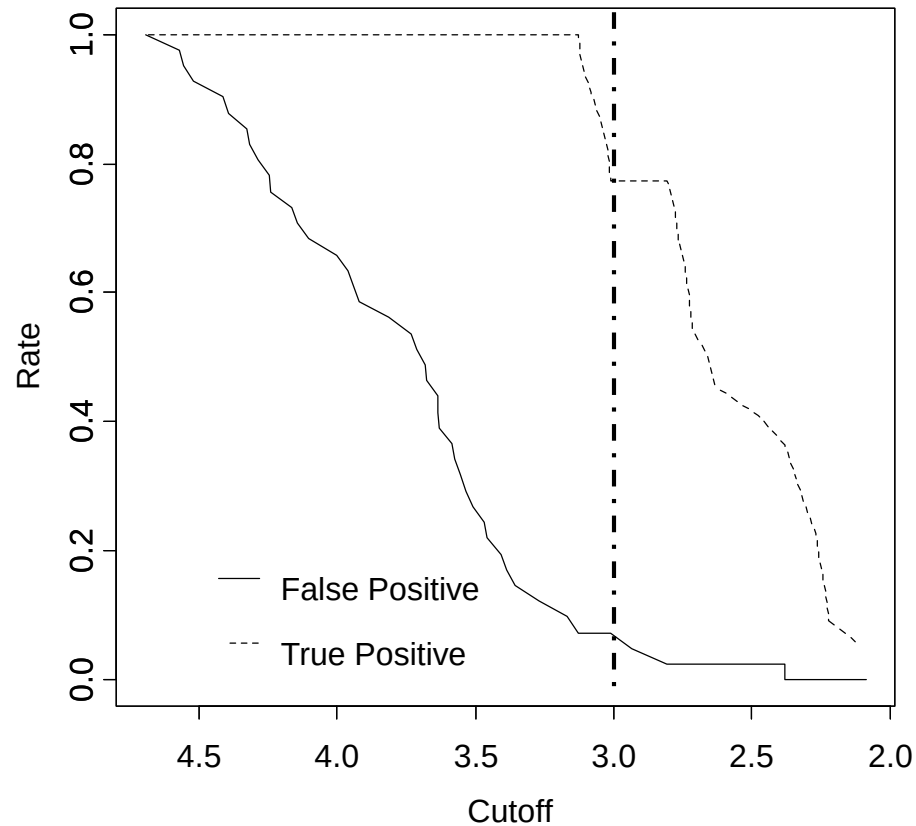
Balancing Error Rates



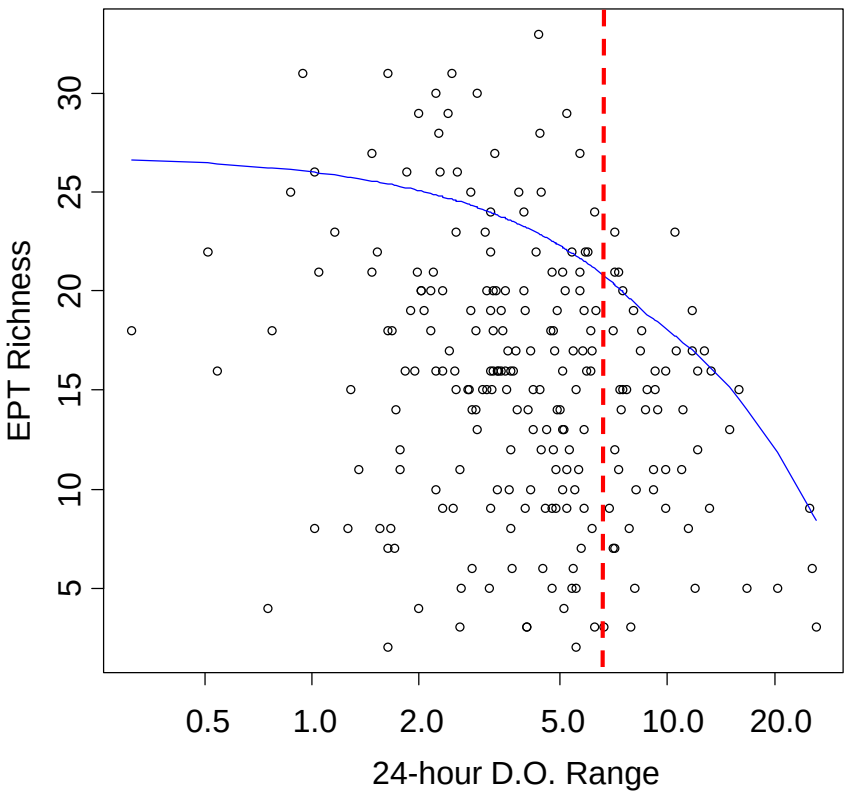
		% 17d Survival	
		1	0
Indicator	1	True Positive 17	False Positive 2
	0	False Negative 5	True Negative 39

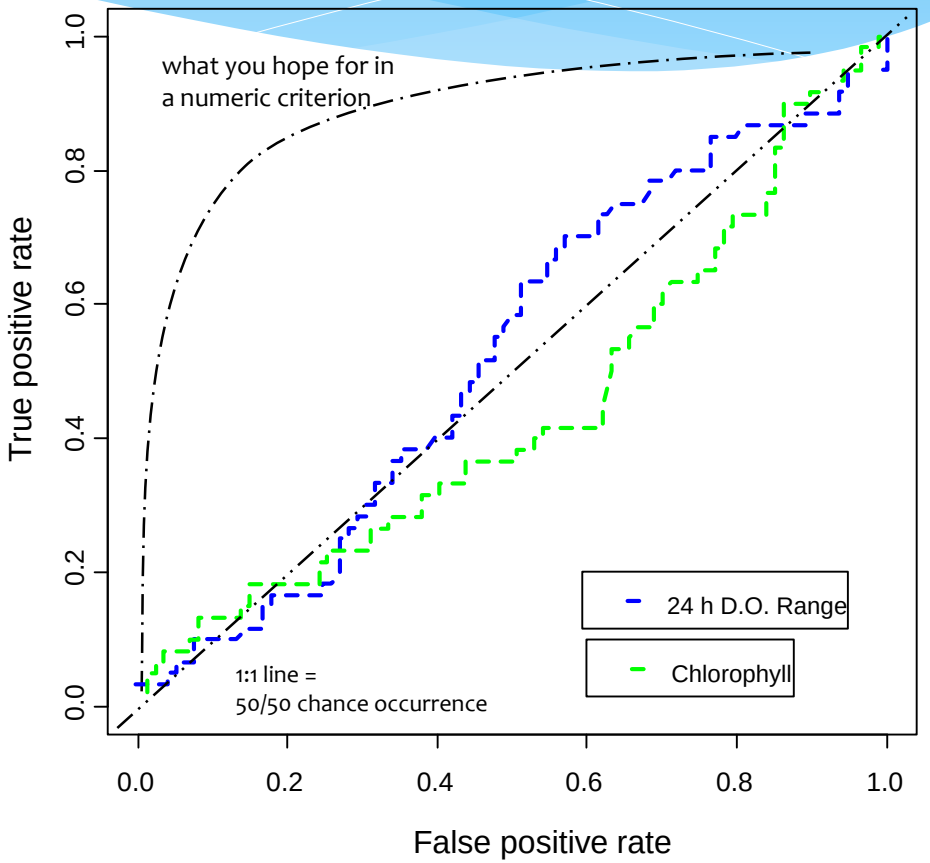
Assuming a cutoff value of 3
False positive rate = 2/39 = 0.05;
True positive rate = 17/22 = 0.77

Receiver Operating Characteristics



Indicator Performance Against Bio-indicator (IBI, ICI or EPT)





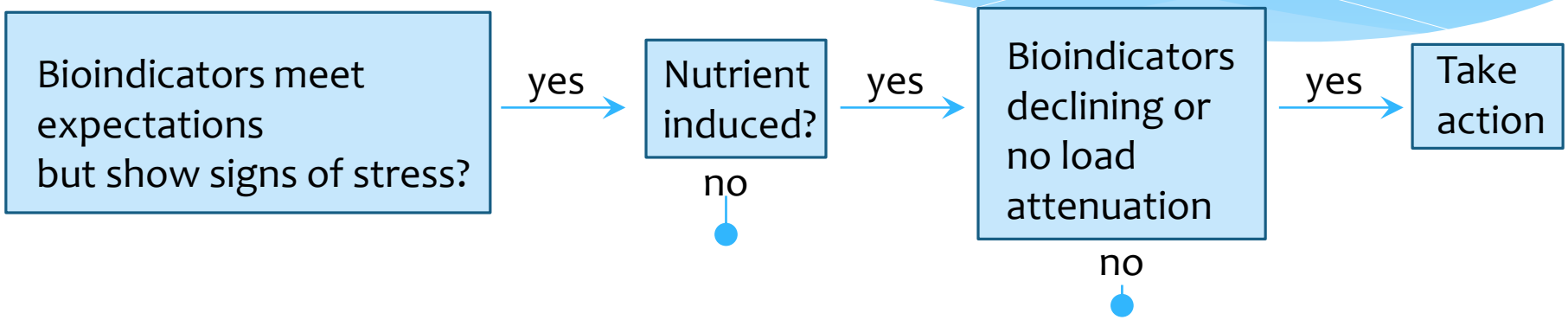
The Box Model

STEP 1	***STEP 2***	***STEP 3***	***STEP 4***	
Biological Criteria	**DO Swing** [2]	**Benthic Chlorophyll** [3]	**Preliminary Assessment: Trophic Condition Status of Evaluated Segment or Waterbody**	
All indices attaining or in non-significant departure[1]	Normal (≤6.5 mg/l)	Low to moderate (≤320 mg/m^2)	Attaining use / Not threatened	
		High (>320 mg/m^2)	Attaining use, but may be **threatened**	***See Flow Chart A***
	Wide (>6.5 mg/l)	Low to High		
Non-attaining (one or more indices below non-significant departure)	Normal or low swings (≤6.5 mg/l)	Low to moderate (≤320 mg/m^2)	Impaired, but cause(s) other than nutrients	***See Flow Chart B***
		High (>320 mg/m^2)	Impaired; likely nutrient over-enrichment	***See Flow Chart C***
	Wide swings (>6.5 mg/l)	Low to moderate		
		Moderate to High	Impaired; Nutrient over-enrichment	

When is a Waterbody Threatened by Enrichment? Flow Chart A

- Nutrient enrichment alters biological condition incrementally
  - small changes accrue along gradient of enrichment
  - predictable in general sense; unpredictable in specific cases
- Flow Chart A asks three broad questions:
  - is the biology stable/improving over time, or is it deteriorating?
    - deteriorating condition indicates present level of enrichment unsustainable
  - is the observed biological condition expected given conditions unrelated to nutrient enrichment?
    - habitat quality
    - landscape features
  - are nutrients assimilated and enrichment localized?

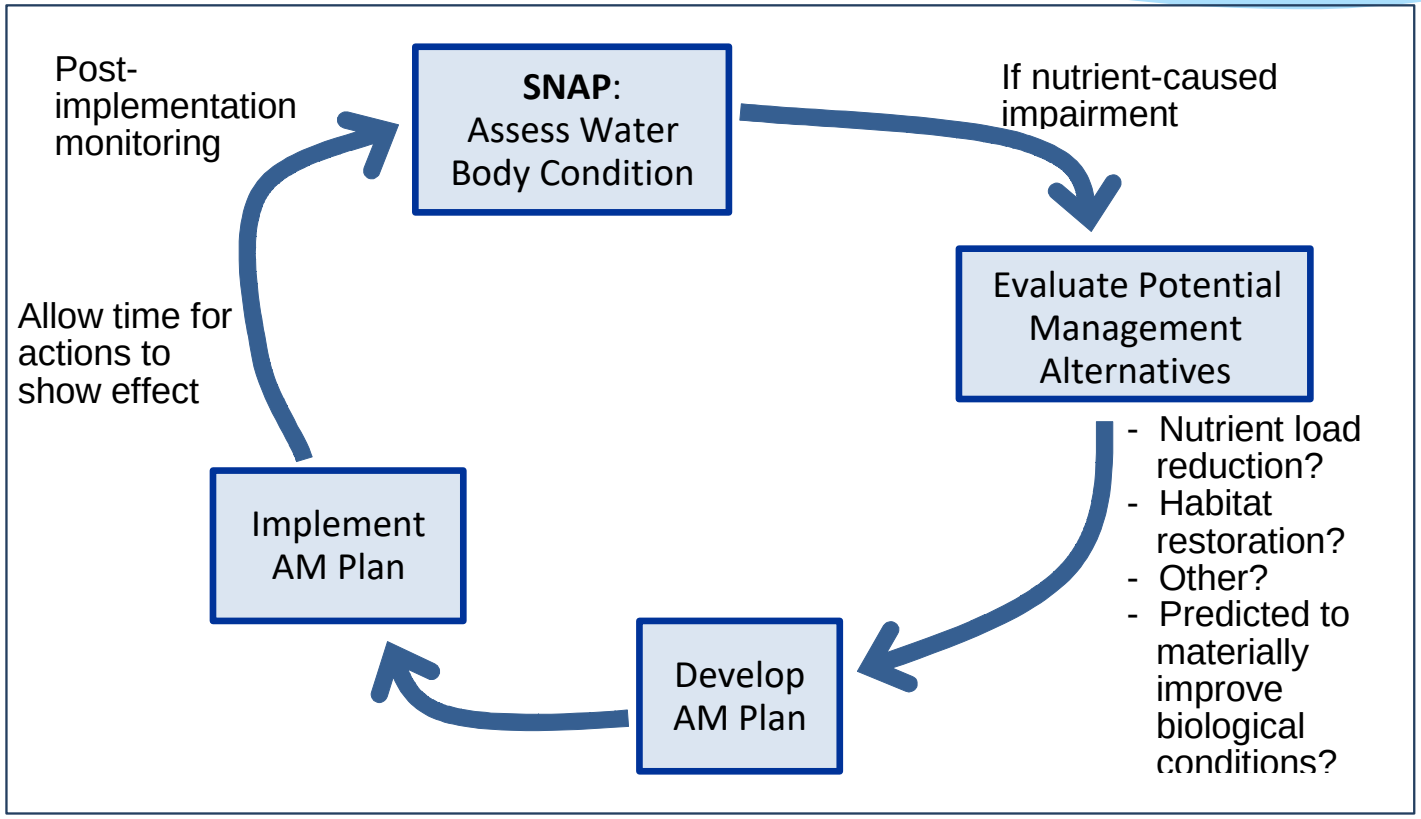
Flow Chart A
(Abbreviated Version)



Possible Actions

- Continue to work through management plan
- Evaluate fate and impact of load to downstream waters
- Increase monitoring frequency
- Permit limits or adaptive management plan
- List as threatened

Adaptive Management



Wide D.O. Swing Unrelated* to Nutrient Enrichment

Chlorophyll a = 113 mg/m2; D.O. range = 8.2 mg/l; D.O. minimum = 1.0 mg/l

TP = 0.028 mg/l; DIN = 0.090; N:P ~ 7.1

IBI = 40; MIWb = 7.24; EPT = 9; ICI = NA

* mostly

Modest Enrichment is Typical of Agricultural Landscapes

Chlorophyll a = 435 mg/m2; D.O. range = 4.0 mg/l; D.O. minimum = 6.8 mg/l

TP = 0.050 mg/l; DIN = 1.178; N:P ~ 52.1

IBI = 55; EPT = 32

What if Flow Chart A Evaluates to Threatened?

- Threatened evaluation ends at one of two management nodes
  - if the waterbody is being actively managed for nutrients, then continue to work iteratively through plan
    - e.g., Little Miami River
  - if no active management, then waterbody may be listed as threatened on 303d list
    - requires TMDL, NPDES action
    - NPDES
      - adaptive management (WWTP optimization, BNR)
      - alternative endpoints (D.O., benthic chlorophyll)
      - numeric limits (generous compliance schedule; stepwise)

Advantages & Disadvantages of SNAP

- Sets a high bar for attributing impairment to WWTPs
  - False positives expensive
- Applied during low-flow, critical condition
  - works within existing regulatory infrastructure
  - does not address low frequency, high magnitude load events
    - Nutrient Reduction Strategy
  - eutrophication from diffuse sources is often manifest during CC
    - over-application of manure or fertilizer
- Retains primacy of biocriteria for determining impairment
- Not a numeric criterion

Nutrient Targets
Box Model Evaluates to Impaired or Threatened

		Dissolved Inorganic Nitrogen				
		<0.44	0.44 < 1.1	1.1 < 3.6	3.6 < 6.7	>6.7
Total Phosphorus	<0.04					
	0.04 < 0.08					
	0.08 < 0.13					
	0.13 < 0.30					
	>0.30					

Reference or Ambient
Enriched
Atypical
Working Landscapes
Tile Drained or Manure
Effluent Dominated

Questions