



Proposed Nutrient Rule (Chapter 583)

Tom Danielson, Ph.D.
December 11, 2020

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

Protecting Maine's Air, Land and Water

Proposed Nutrient Rule (Chapter 583)

1. Nutrient criteria for all fresh surface waters except for lakes
2. Decision framework to determine attainment of nutrient criteria
3. Process for setting site-specific criteria
4. Guidelines for listing waterbodies that do not attain nutrient criteria



Lake Management



- Class GPA lakes must have stable or decreasing trophic state
- Lakes must be free of culturally induced algal blooms
- Phosphorus mitigation measures in stormwater management plans



Nutrients

- Nutrients are essential ecosystem components
 - Primarily phosphorus and nitrogen
- But too much of a good thing can have negative ecological impacts
 - Algal blooms
 - Altered habitat for fish and aquatic life
 - Not enough or too much oxygen in water
 - pH gets too high or too low
 - Fish kills and harm to aquatic life



Nutrient Criteria Will Help the Department Manage Water Quality



U.S. EPA Preliminary Criteria

- In 2001, U.S. EPA proposed criteria based on total phosphorus (TP) concentrations
- Divided country into nutrient regions
- Set criteria at 25th percentile of available data
- Included few data points from Maine
- Used the “one size fits all” approach



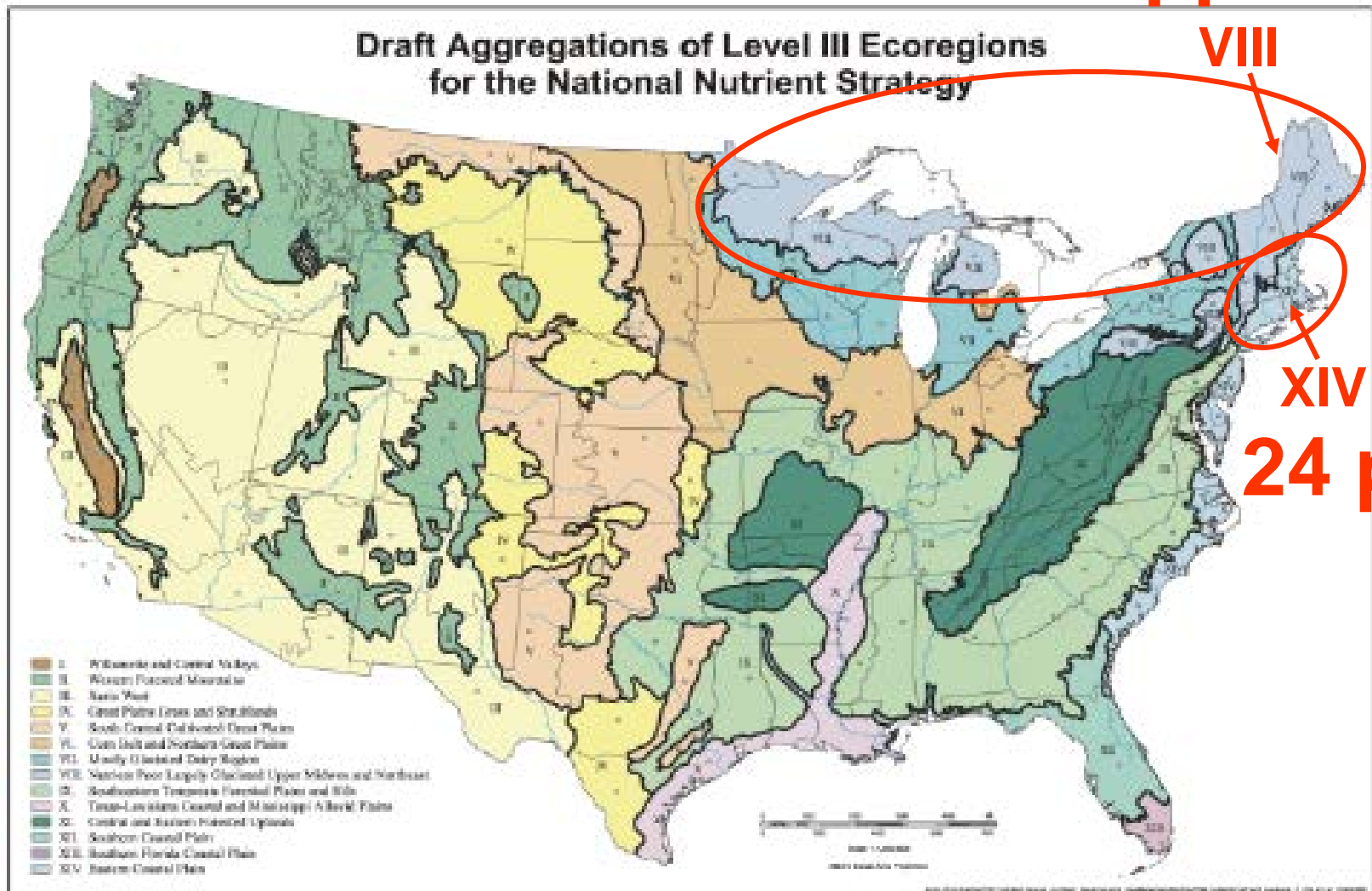
U.S. EPA Interim TP Criteria for Streams and Rivers

10 ppb

VIII

XIV

24 ppb

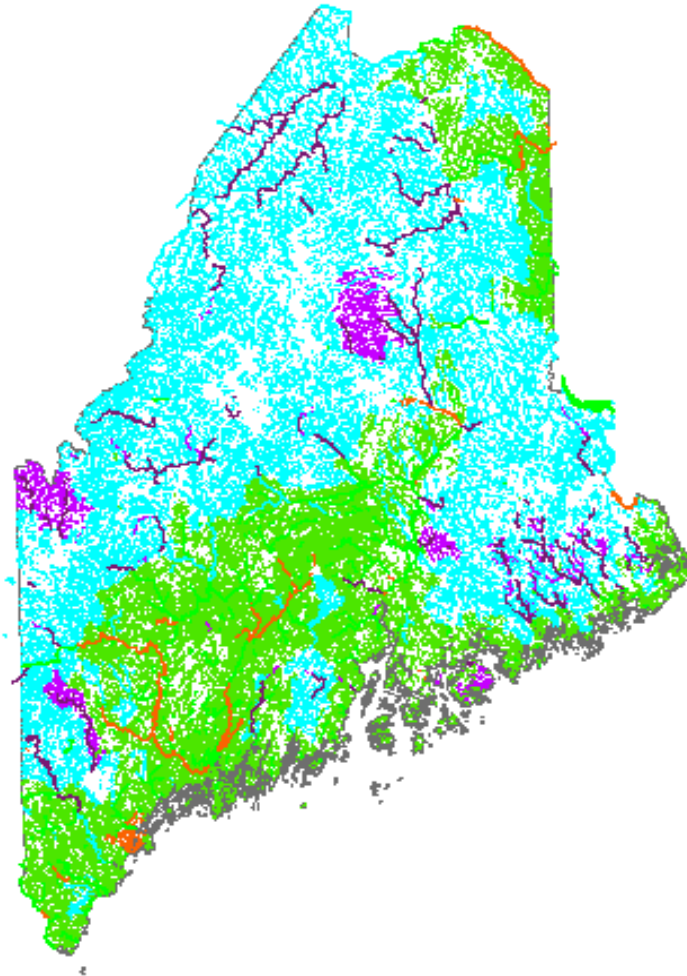


History of Nutrient Rule

- 2001– Started collecting data and writing the rule
- 2009 – First rulemaking attempt
 - stakeholders asked for more public meetings
- 2010 – Second rulemaking attempt
 - EPA concern over independent applicability
- 2011 – Negotiations with EPA
- 2012 – Third rulemaking attempt
 - Reasonable potential analysis



Fresh Surface Waters of Maine (not including lakes)



% OF LINEAR MILES OF
STATUTORY
CLASSIFICATIONS OF
STREAMS AND RIVERS

Class AA = 6.3%

Class A = 47.2%

Class B = 45.3%

Class C = 1.2%



Disturbance/Resource Supply/Grazer Control of Algal Biomass

HIGH BIOMASS



RESOURCES

- **Nutrients**
- Light
- Temperature



DISTURBANCE

- substratum instability
- velocity
- suspended solids

GRAZING

- fish
- macroinvertebrates

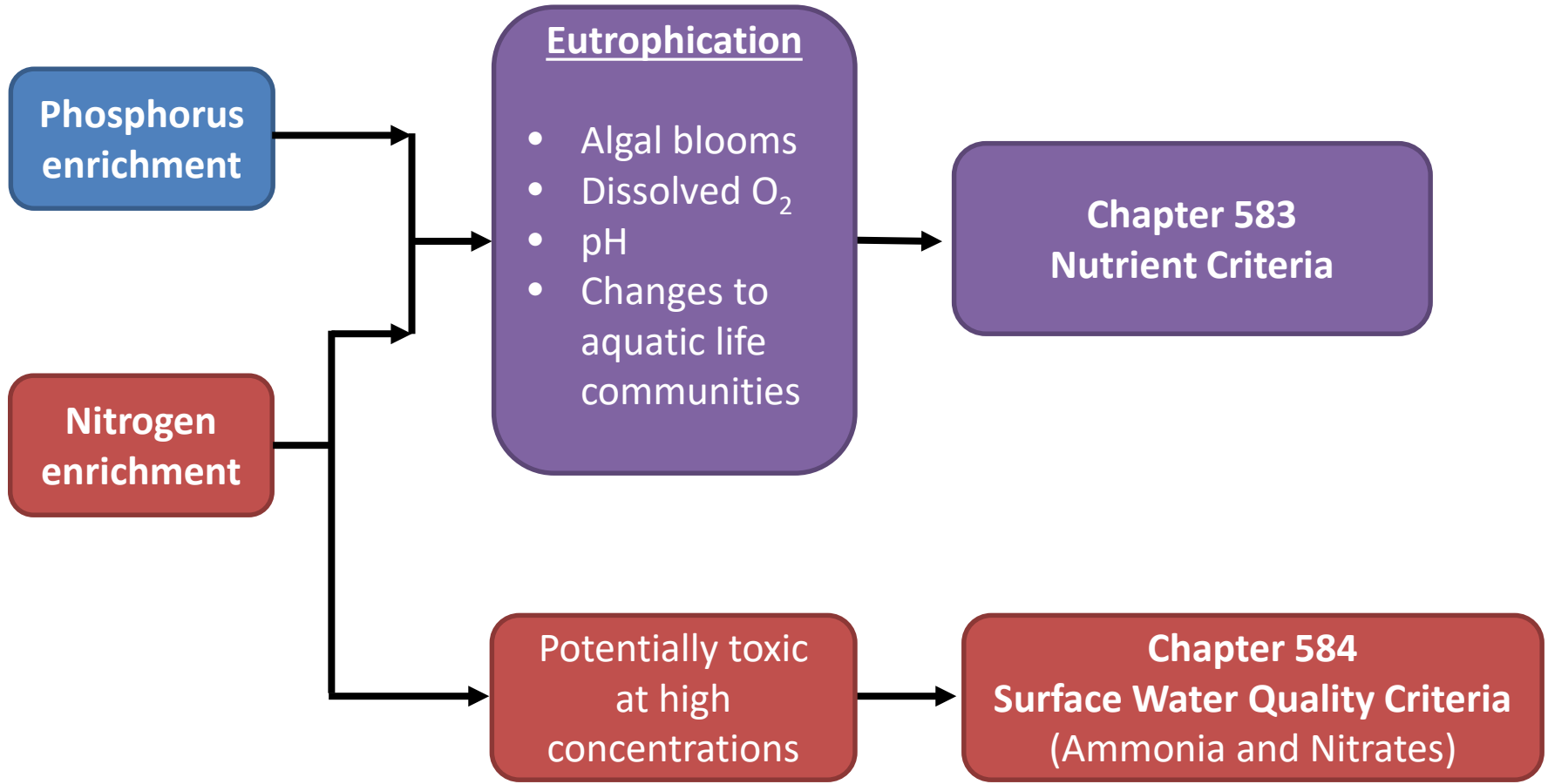


LOW BIOMASS





Biggs (1996)



Managing Nutrient Enrichment







Limiting Nutrients

Phosphorus	Low	Low	High	High
Nitrogen	Low	High	Low	High
Amount of Nuisance Algae	Very little 	Small amount 	Small amount 	A lot 




Limiting Nutrients

Phosphorus	Low	Low	High	High
Nitrogen	Low	High	Low	High
Amount of Nuisance Algae	Very little 	Small Amount 	Small Amount 	A lot 



Forms of Phosphorus

Form of Phosphorus	Availability to Algae and Plants	Orthophosphate (O-PO ₄)	Total Phosphorus (TP)	
Dissolved Inorganic	Easily obtained	✓	✓	
Dissolved Organic			✓	
Organic Solids			✓	
Inorganic Solids		Difficult to obtain		✓



Maine's Approach

- Combination of TP and Response Indicators
- Provision for site-specific criteria for another nutrient, such as nitrogen, as needed
- Tiered use approach with different expectations for classes
 - AA/A, B, and C



Used as a Model for Other States

- Vermont adopted nutrient criteria with a similar approach
- New York is preparing to start rulemaking in 2021
- U.S. EPA Bioconfirmation Approach

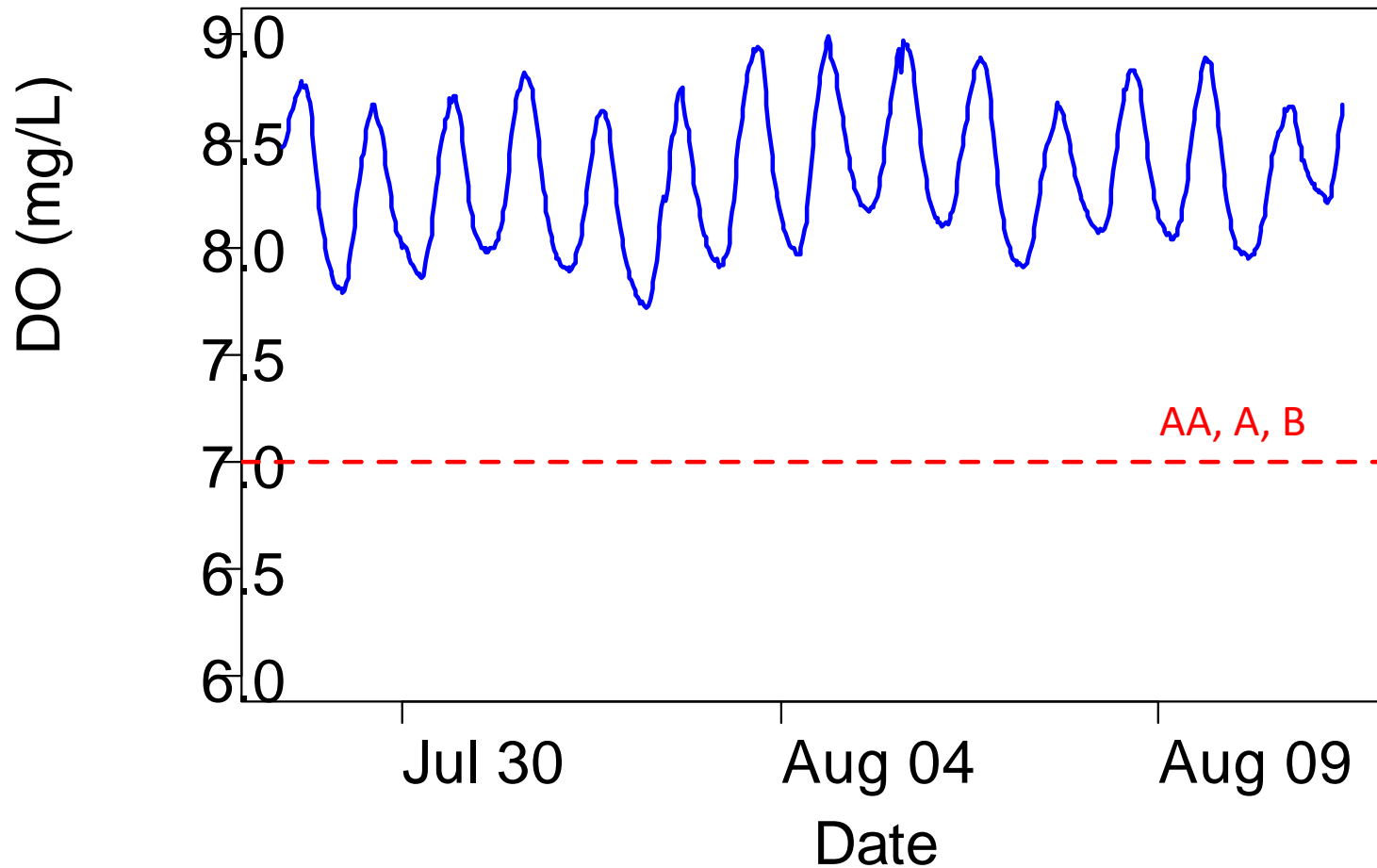


Section 3: Nutrient Response Indicators

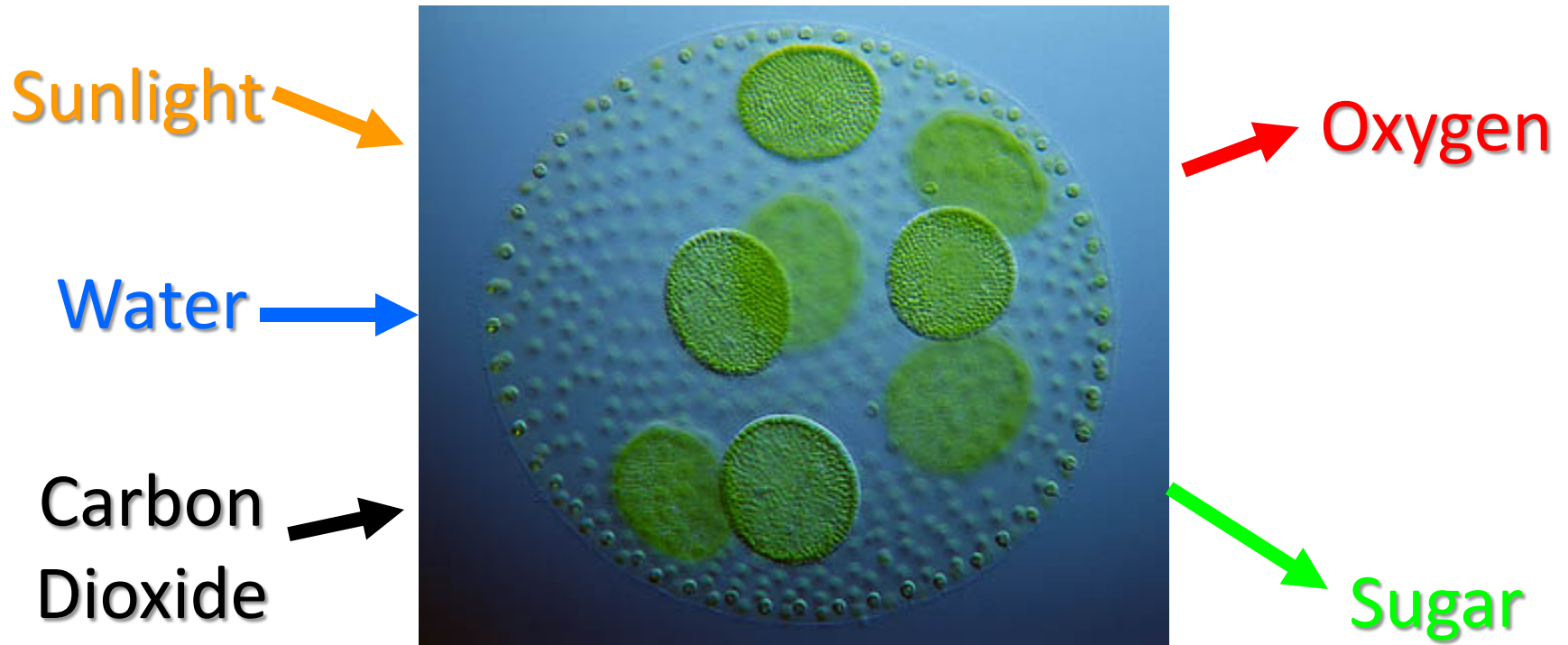
- Seven nutrient response indicators
- Protect designated uses and relate to narrative criteria already in water quality standards
 - Habitat for fish and aquatic life
 - Aquatic life criteria (aka, biological criteria)
 - Recreation



Dissolved Oxygen (DO) in a Healthy Stream



Photosynthesis (Daytime)

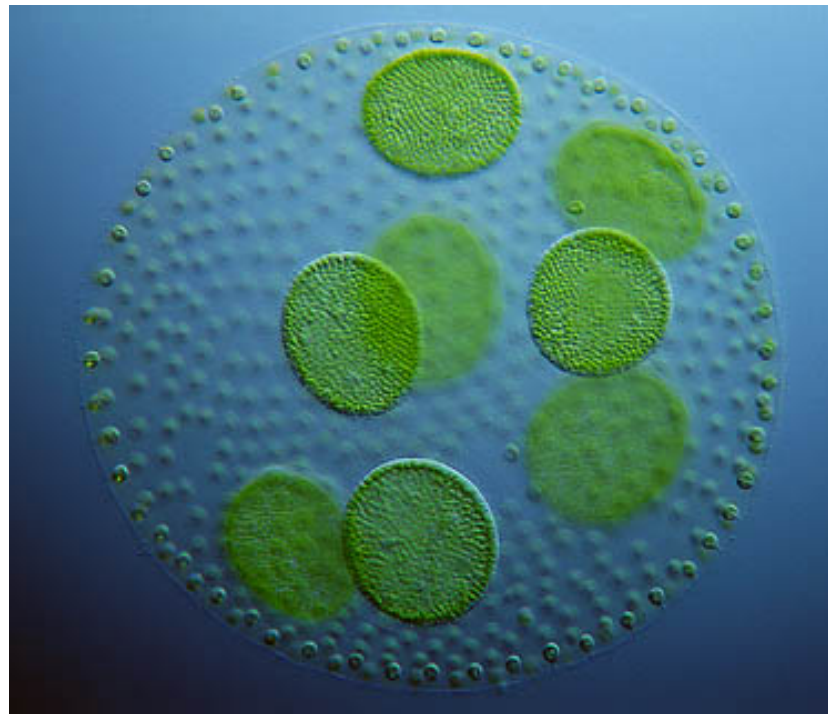


Respiration (Day & Night)

Energy ←

Water ←

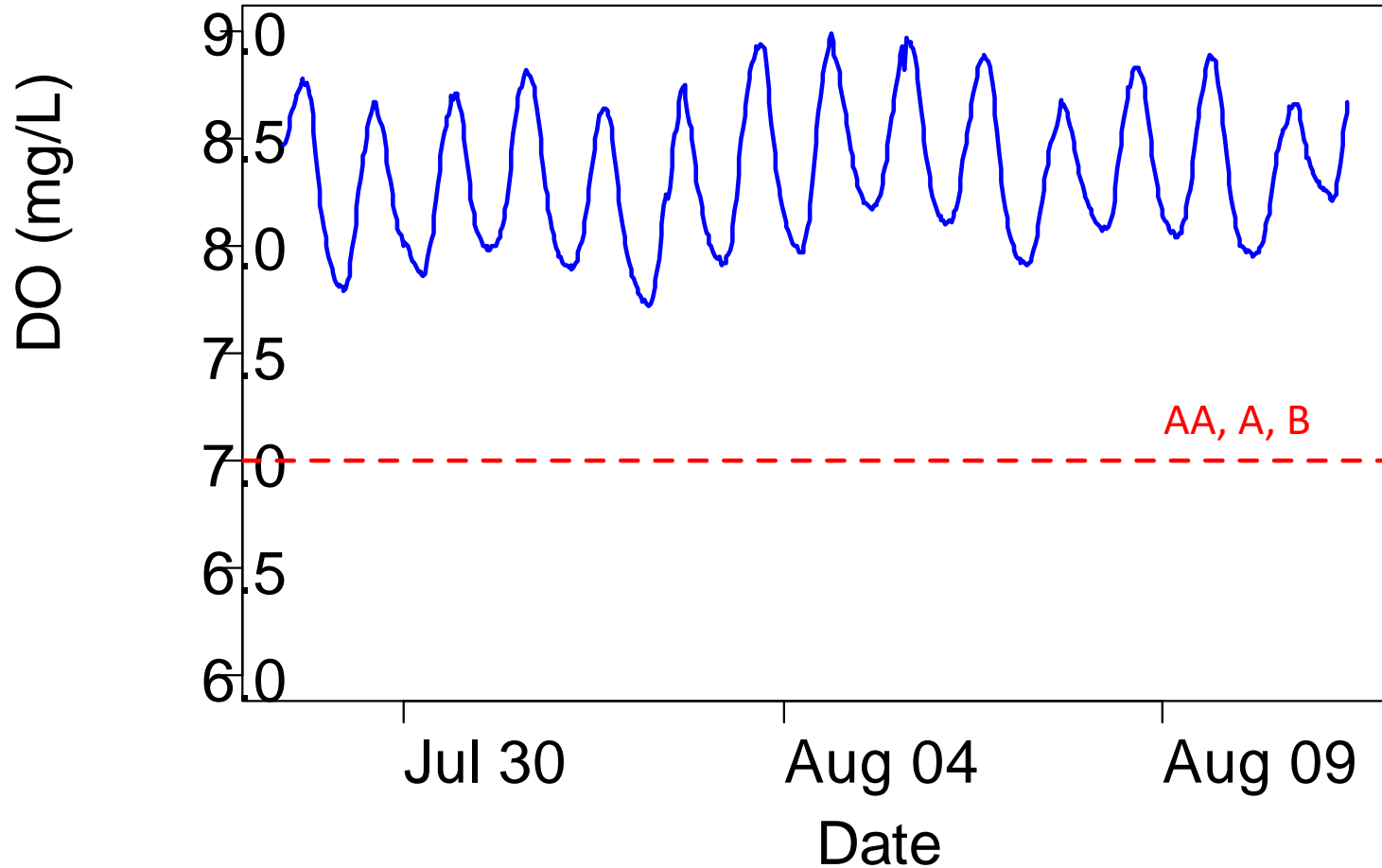
Carbon
Dioxide ←



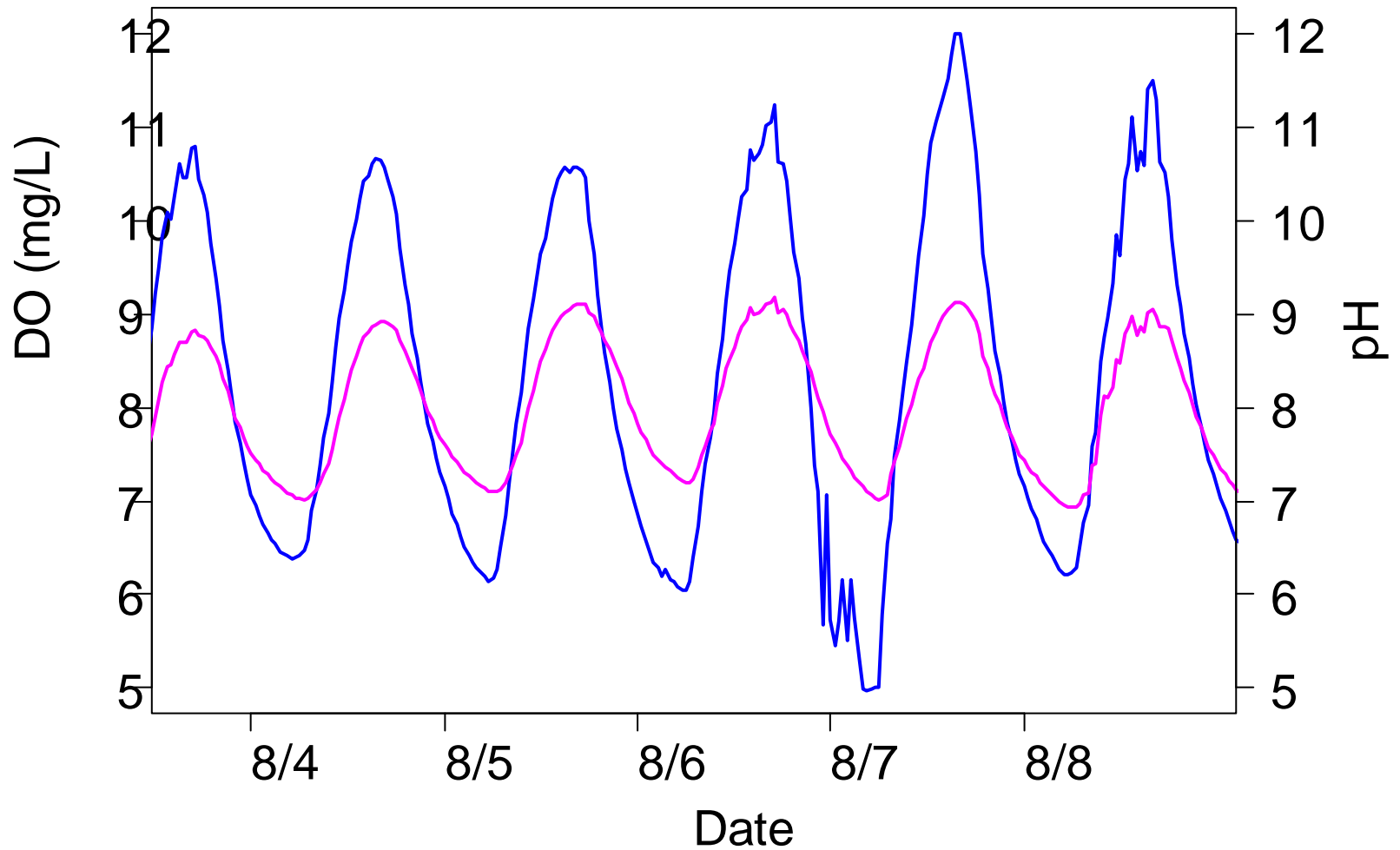
← Oxygen

← Sugar

Dissolved Oxygen (DO) in a Healthy Stream



Dissolve Oxygen (DO) and pH



Nutrient Response Indicators



Secchi-disk Transparency



Chlorophyll *a*



Percent Nuisance
Algal Cover



Patches of Bacteria
"Sewage Fungus"



Maine DEP Biomonitoring

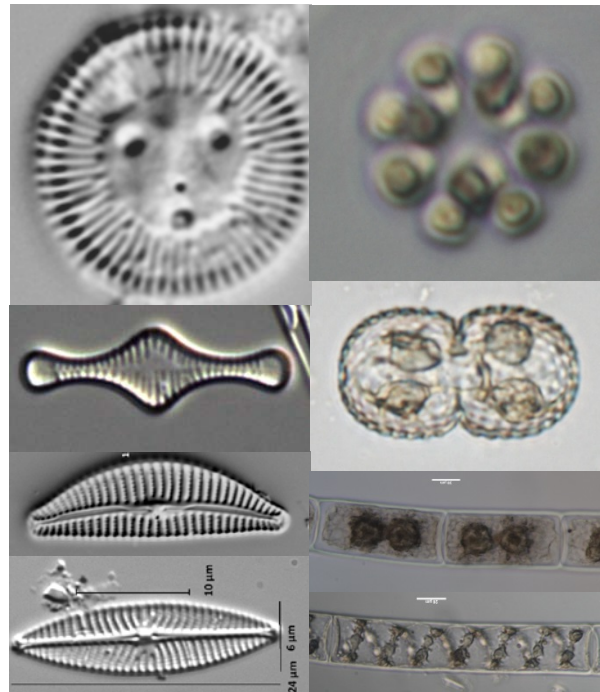
Macroinvertebrates

Algae

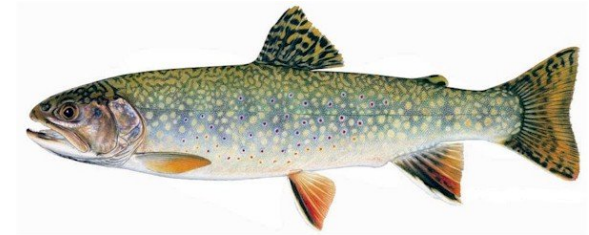
Fish



Tom Murray



Maine DEP



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Tolerant Macroinvertebrates

Isopods



nwnature.net

Aquatic Earthworms



ANEBO

Leeches



Aphotofauna

Amphipods



Biodiversity Institute of Ontario

Midges



Tom Murray



Mardon Erbland

Class AA/A Stream



Babel Brook, T5 R9 NWP

Stoneflies

Dragonflies &
Damselflies

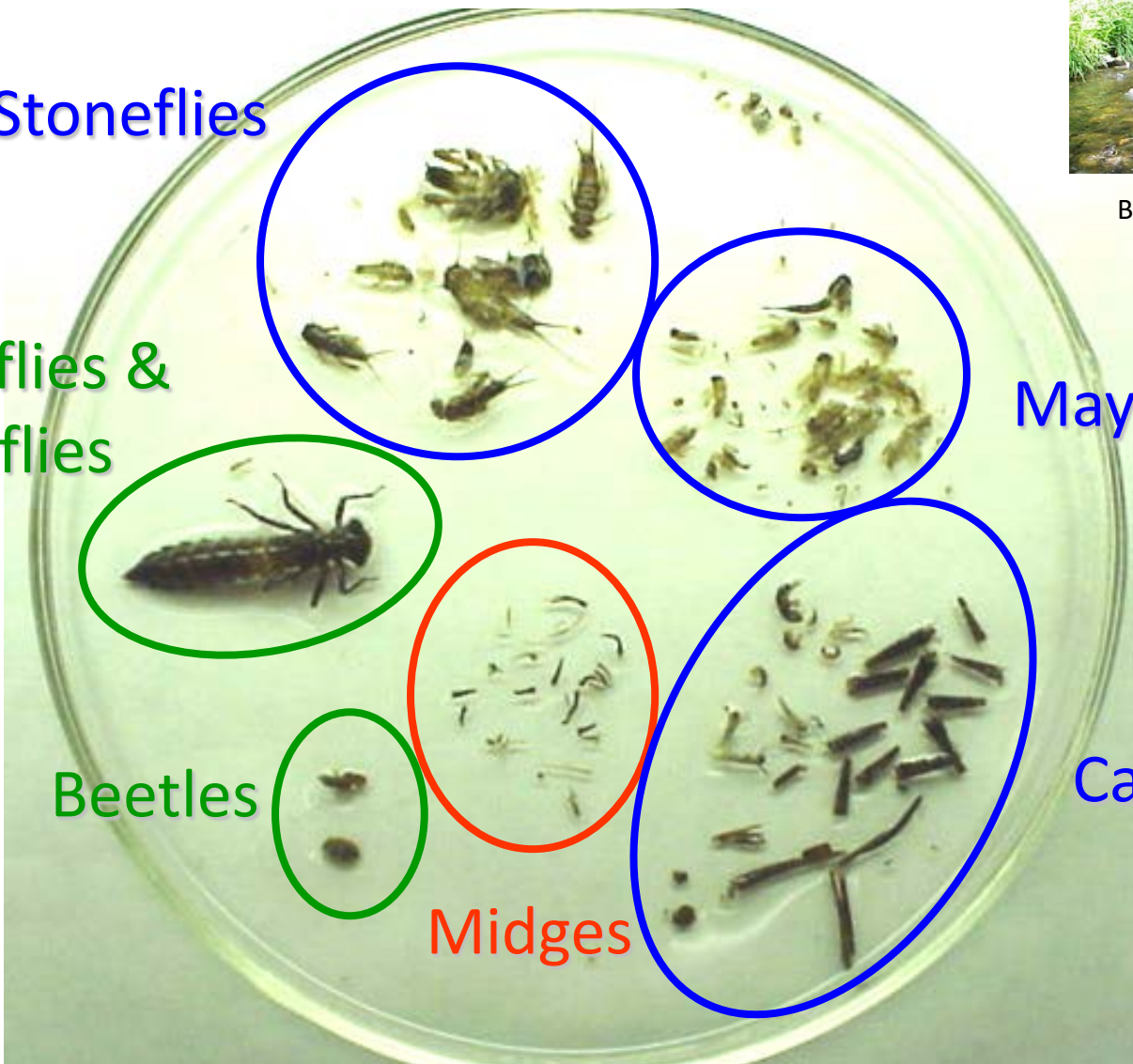
Mayflies

Beetles

Midges

Caddisflies

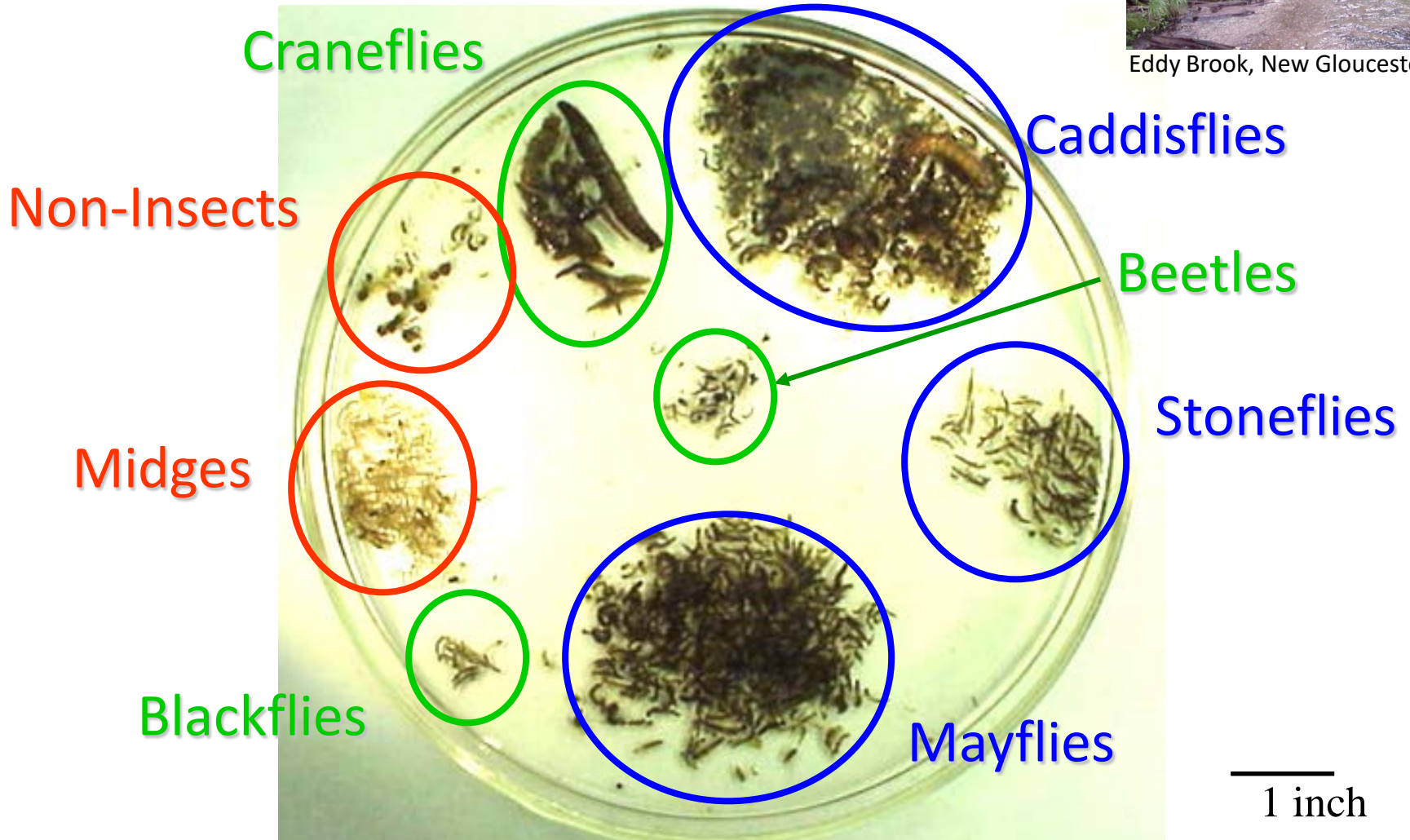
1 inch



Class B Stream



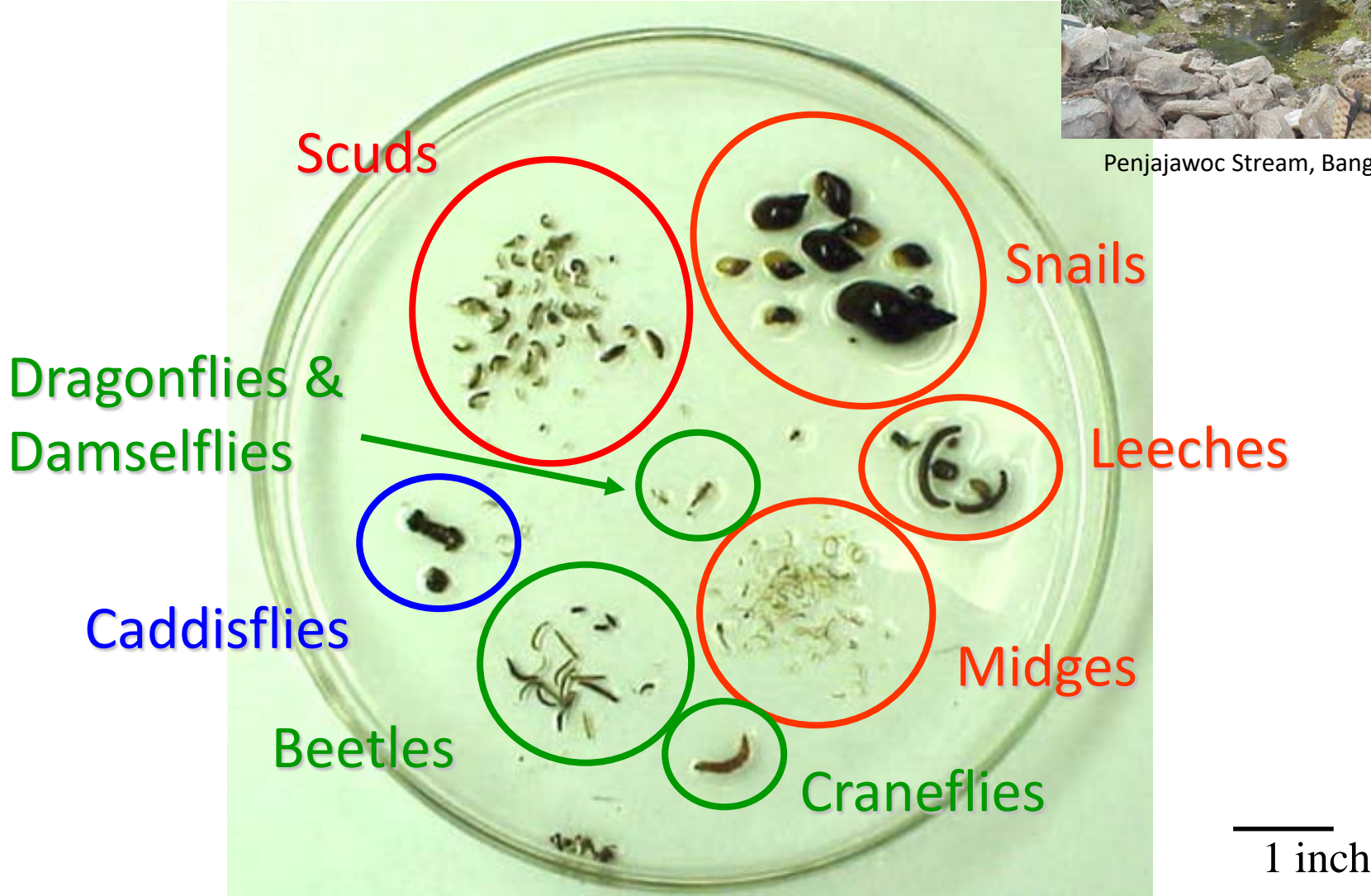
Eddy Brook, New Gloucester



Non-Attainment Stream

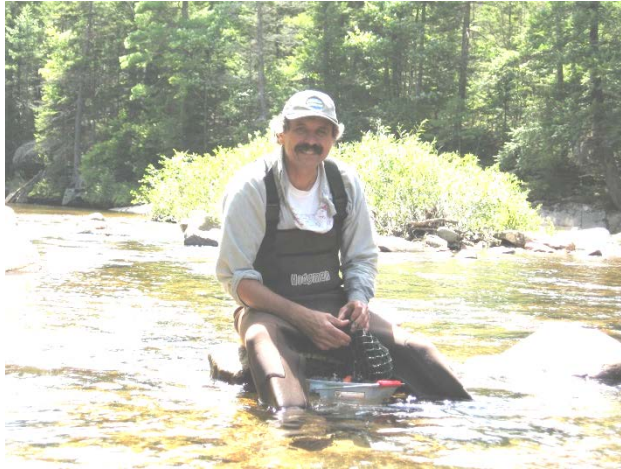


Penjawoc Stream, Bangor



1 inch

Sampling



Macroinvertebrate Sample



Taxa List

<i>Pteronarcys</i>	2
<i>Acroneuria</i>	7
<i>Epeorus</i>	23
<i>Baetis</i>	14
<i>Leucrocuta</i>	10
<i>Chimarra</i>	25
<i>Psilotreta</i>	8
others . . .	



Compute Metrics

such as
**Taxa Richness,
EPT Richness,
and
Hilsenhoff Biotic
Index**

Statistical Model

**Predicts
probabilities of a
sample attaining
Class AA/A,
Class B, Class C,
or Non-
Attainment (NA)**

Biological Assessments

	Rocky Streams	Sandy Streams	Deep Rivers	Wetlands
Macroinvertebrates 	In Rule (Chapter 579)	In Rule (Chapter 579)	In Rule (Chapter 579)	Add to Chapter 579 in 2021
Algae 	Add to Chapter 579 in 2021	Developing		Testing
Fish 	Developing	Developing	U.S EPA funded model for New England rivers	



Class AA, A, B, and C Waters



Rocky streams



Sandy Streams



Deep Rivers



Impoundments



Ponds & Marshes



	Shallow, rocky stream	Deep river	River impoundment	Marsh or Pond
Dissolved O ₂	✓	✓	✓	✓
pH	✓	✓	✓	✓
Aquatic life (Biocriteria)	✓	✓*	✓*	✓
“Sewage fungus”	✓	✓	✓	✓
Secchi disk transparency	--	✓*	✓	✓
Chlorophyll <i>a</i>	--	✓	✓	✓
% cover of nuisance algae	✓	--	--	--

* if conditions such as depth and current velocity are suitable for DEP methods



Section 4: Nutrient Criteria

Nutrient criteria	Statutory Class		
	AA & A	B	C
		$\leq 18.0 \mu\text{g/L (ppb) TP}^a$ <i>and</i> if the waterbody has a site-specific value for another nutrient, the mean concentration of that nutrient is less than or equal to the site-specific value <i>and</i> all applicable response indicator ^b values in this column OR all applicable response indicator ^b values in this column	$\leq 30.0 \mu\text{g/L (ppb) TP}^a$ <i>and</i> if the waterbody has a site-specific value for another nutrient, the mean concentration of that nutrient is less than or equal to the site-specific value <i>and</i> all applicable response indicator ^b values in this column OR all applicable response indicator ^b values in this column
Percent Nuisance Algal Cover	≤ 18.0	≤ 24.0	≤ 35.0
Water Column Chl <i>a</i> ($\mu\text{g/L, ppb}$)	≤ 3.5 (≤ 5.0 for low gradient streams with velocity $< 2.0 \text{ cm/sec}$ or impoundments)	≤ 8.0 (impoundments must have spatial mean ≤ 8.0 and no value > 10.0)	≤ 8.0 (impoundments must have spatial mean ≤ 8.0 and no value > 10.0)
Secchi Disk Transparency (m)	≥ 2.0		
Patches of Bacteria and Fungi	None observed		
pH	6.5 – 9.0		
Dissolved Oxygen (mg/L, ppm)	In accordance with 38 M.R.S. § 465 (2020) ^c		
Aquatic Life	In accordance with 38 M.R.S. §§ 464 and 465 (2020) ^c , and where applicable <i>Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams</i> , 06-096 C.M.R. ch. 579 (effective May 27, 2003)		

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TP values

Class	TP Value	Rationale
AA/A	18 ppb	Most minimally disturbed streams have TP concentrations <18 ppb
B	30 ppb	Most streams that attain Class B aquatic life criteria (based on macroinvertebrates) have TP concentrations less than 30 ppb
C	40 ppb	Protect recreation and aquatic life



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	AA & A	B	C
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Response Indicator	Class AA & A	Class B	Class C
Percent Nuisance Algal Cover	≤ 18.0	≤ 24.0	≤ 35.0
Water Column Chl a (µg/L, ppb)	≤ 3.5 (≤ 5.0 for low gradient streams with velocity < 2.0 cm/sec or impoundments)	≤ 8.0 (impoundments must have spatial mean ≤ 8.0 and no value > 10.0)	≤ 8.0 (impoundments must have spatial mean ≤ 8.0 and no value > 10.0)
Secchi Disk Transparency (m)	≥ 2.0		
Patches of Bacteria and Fungi	None observed		
pH	6.5 – 9.0		
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Section 5: Decision Framework

	<p>Mean TP \leq the default value for the class or a site-specific value</p> <p>AND</p> <p>If there is a site-specific value for another nutrient, then the mean concentration of that nutrient is \leq the site-specific value</p>	<p>Mean TP $>$ the default value for the class or a site-specific value</p> <p>OR</p> <p>If there is a site-specific value for another nutrient, then the mean concentration of that nutrient is $>$ the site-specific value</p>
All applicable response indicators meet the values in Table 1		
One or more response indicators do not meet the values in Table 1		



Section 5: Decision Framework

	Mean TP \leq the default value for the class*	Mean TP $>$ the default value for the class *
All applicable response indicators meet the values in Table 1		
One or more response indicators do not meet the values in Table 1		

* Any site-specific criteria for TP or another nutrient would be included in the decision



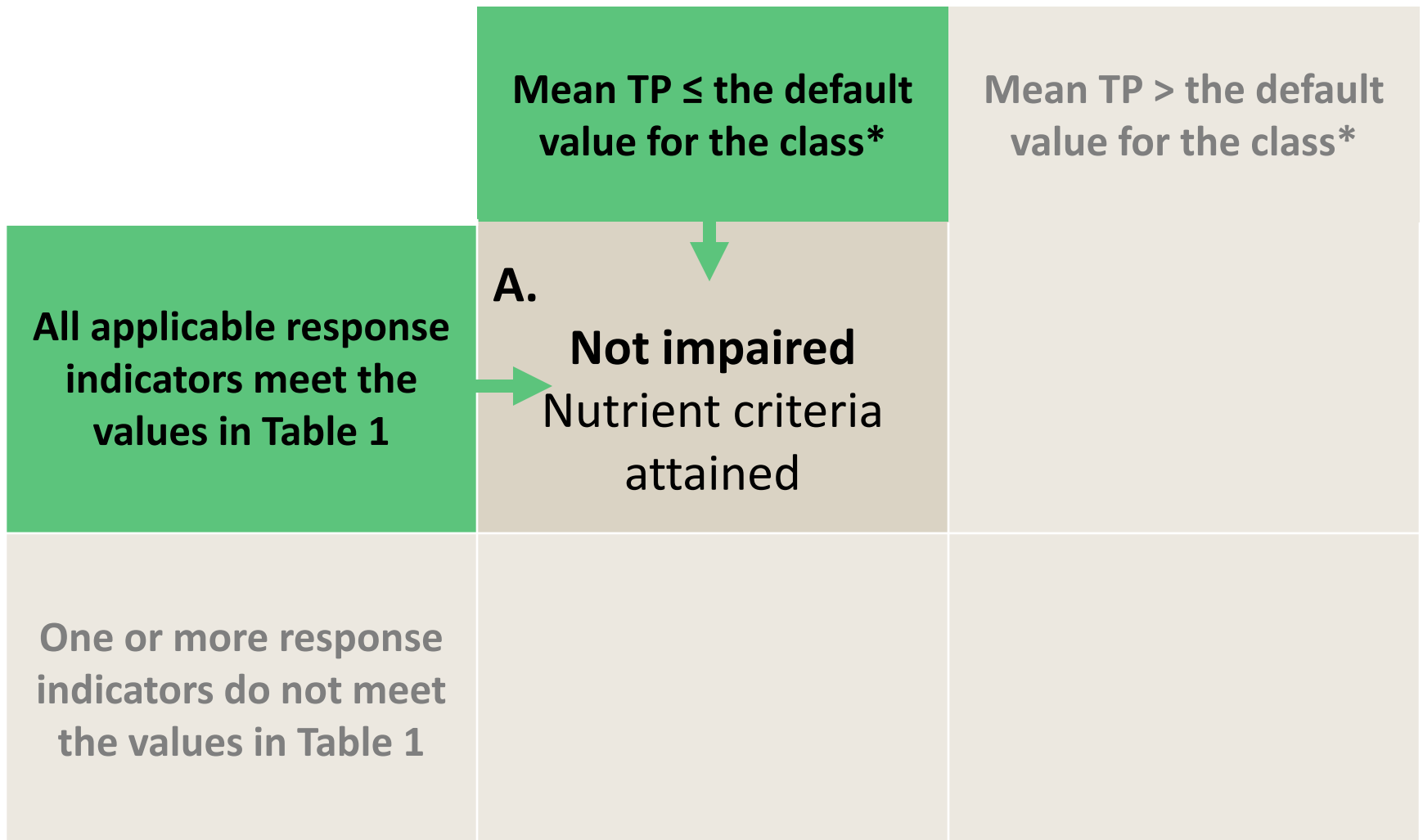
Section 5: Decision Framework

	Mean TP \leq the default value for the class*	Mean TP $>$ the default value for the class *
All applicable response indicators meet the values in Table 1	A. Not impaired Nutrient criteria attained	B. Not impaired Nutrient criteria attained
One or more response indicators do not meet the values in Table 1	C. Impaired Determine cause of impairment	D. Impaired Nutrient criteria not attained

* Any site-specific criteria for TP or another nutrient would be included in the decision



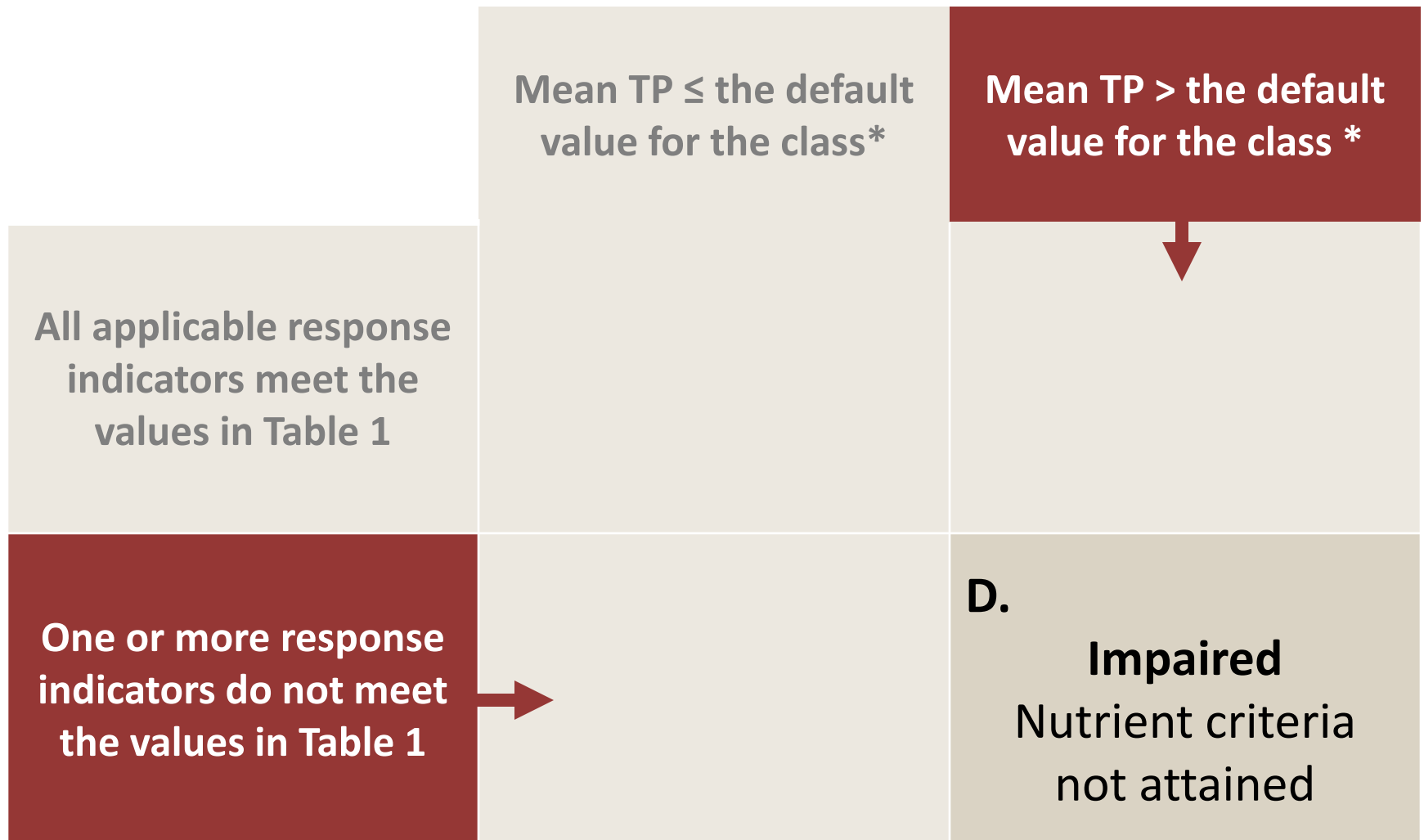
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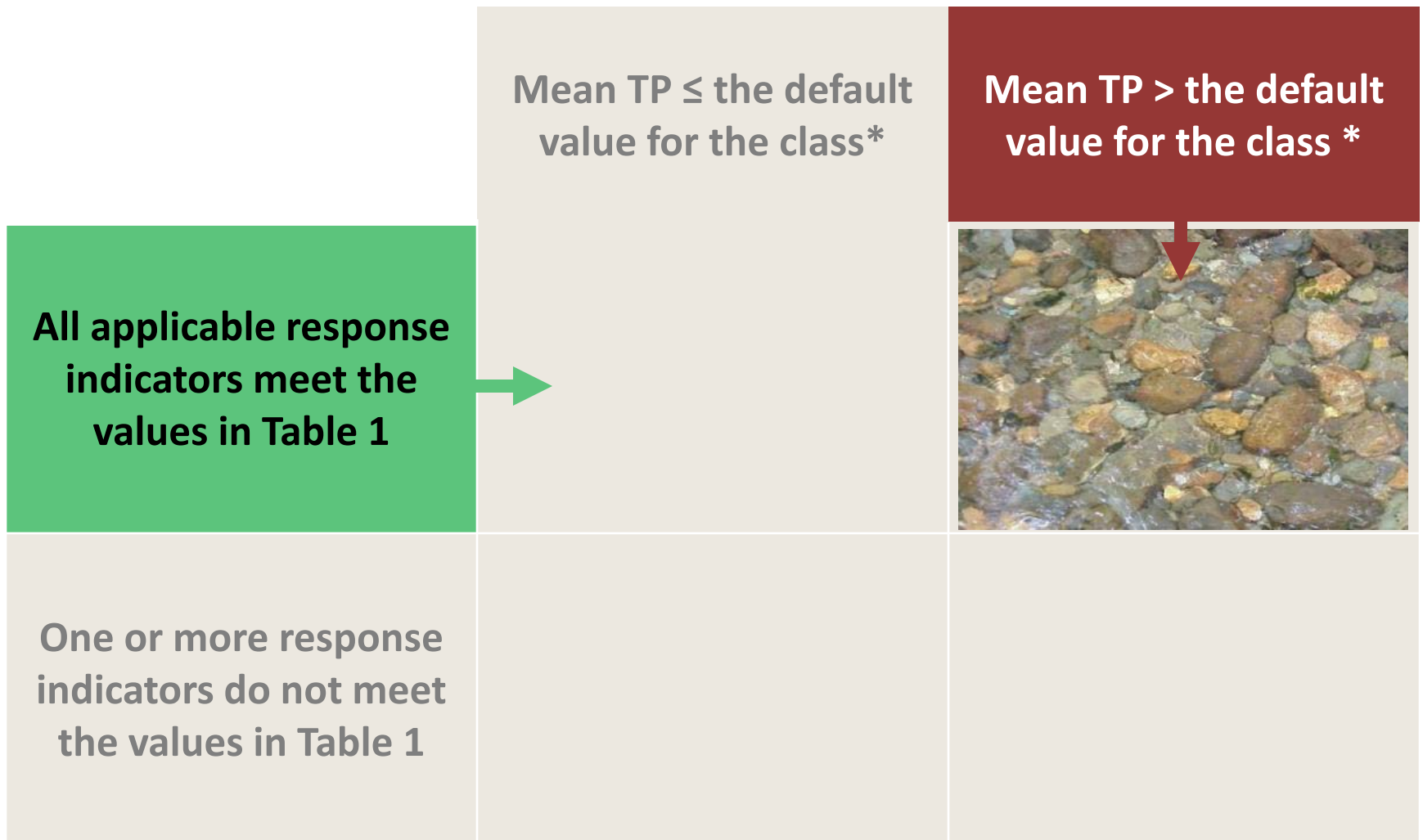
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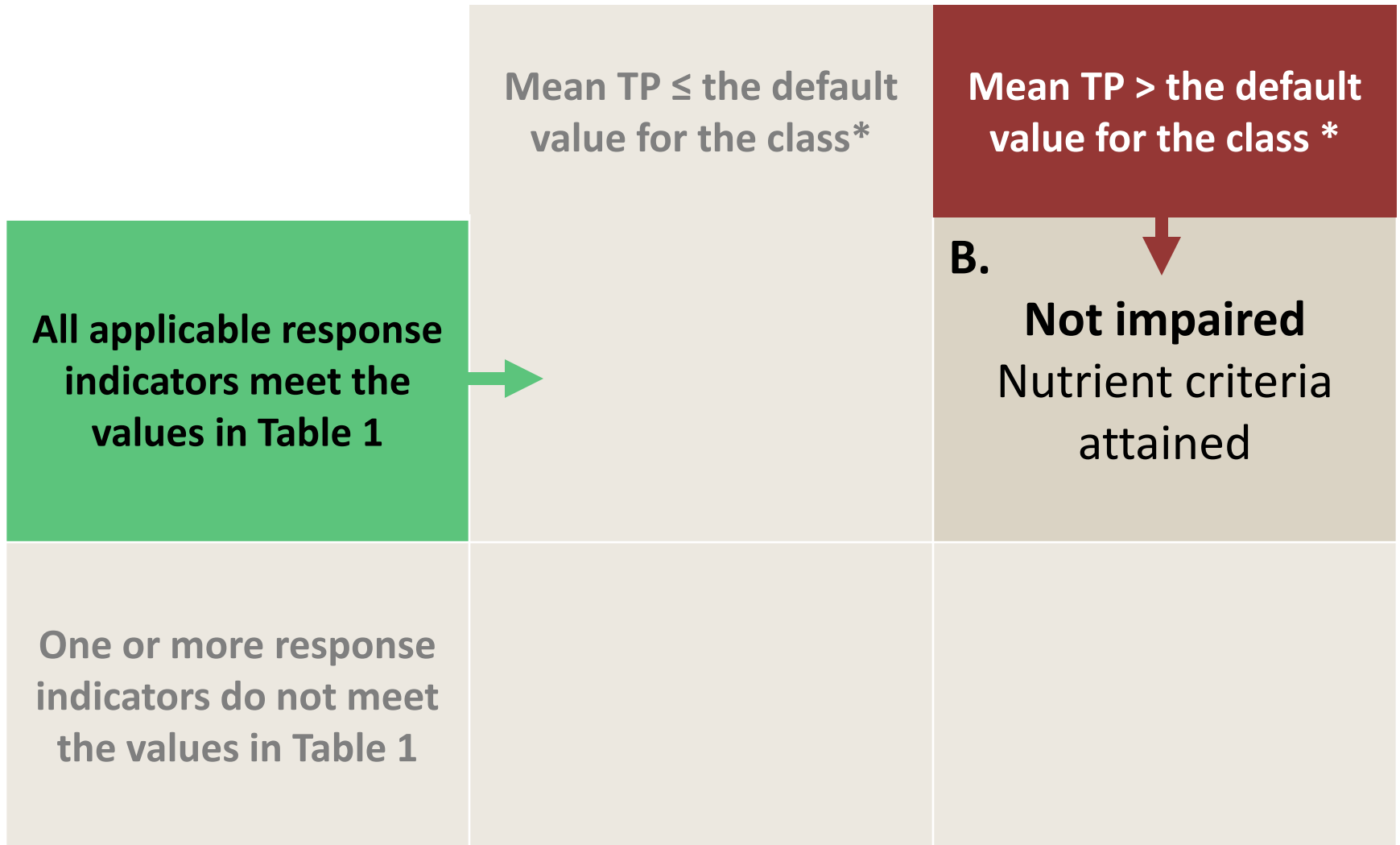


Section 5: Decision Framework



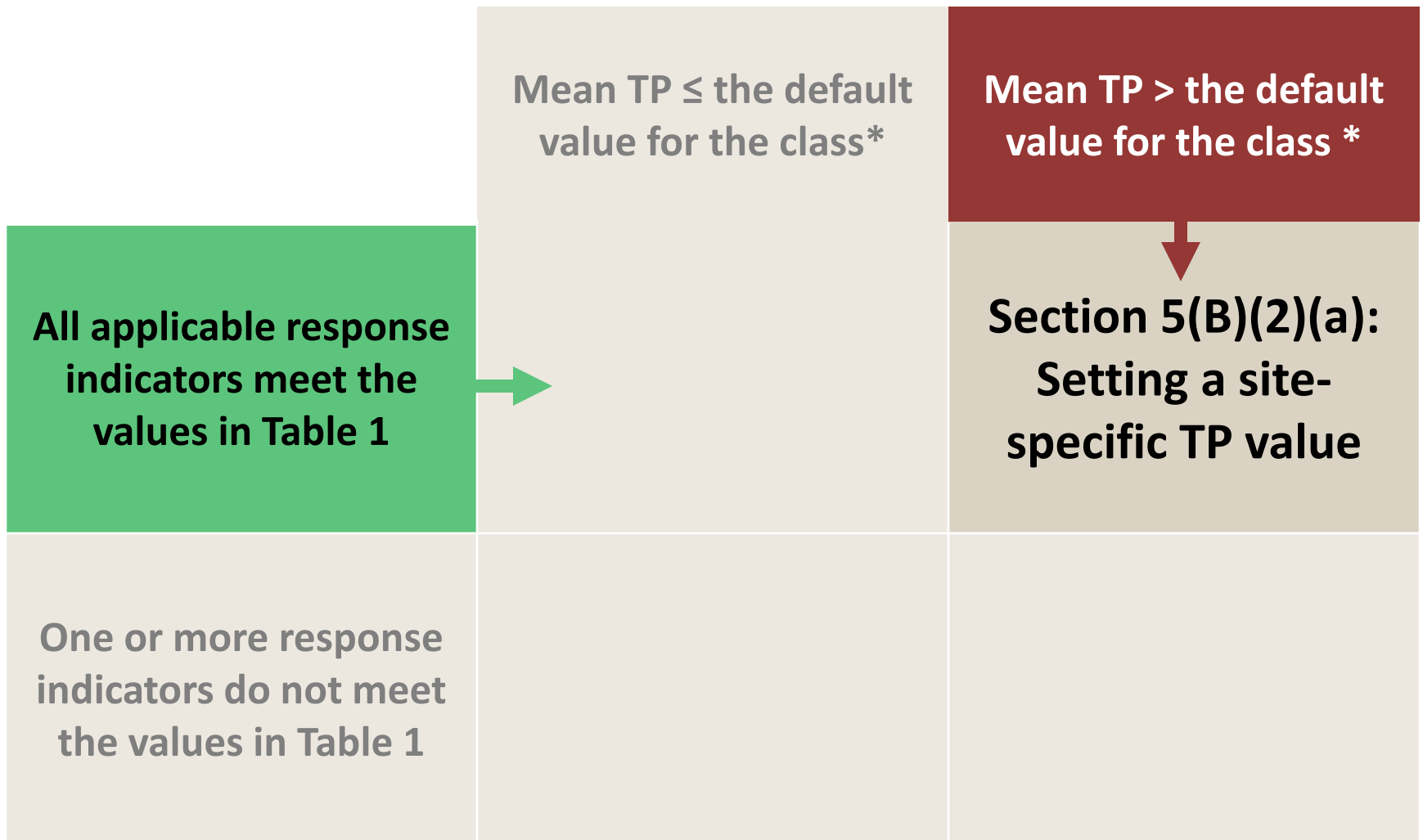
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Decision Framework



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Section 5: Decision Framework



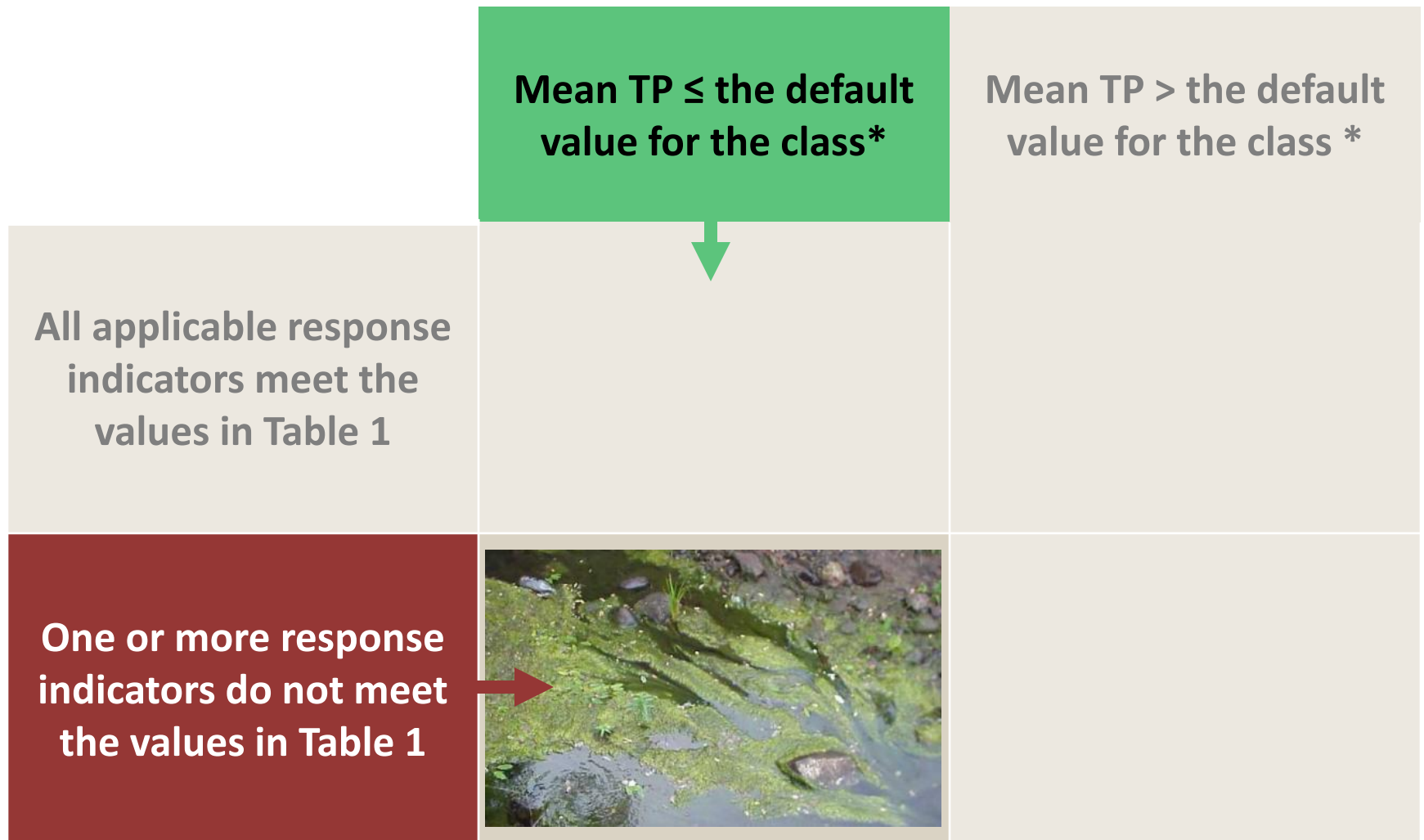
* Any site-specific criteria for TP or another nutrient would be included in the decision

Section 5(B)(2): Site-specific TP Value

- Multi-year study to determine if a site-specific TP value is warranted
- At least 3 years of data including at least 1 year with critical ambient conditions (*e.g.*, low flow, warm temperature)
- If nutrient response indicators are consistently good, then the Department could propose a site-specific TP value that is greater than the default value



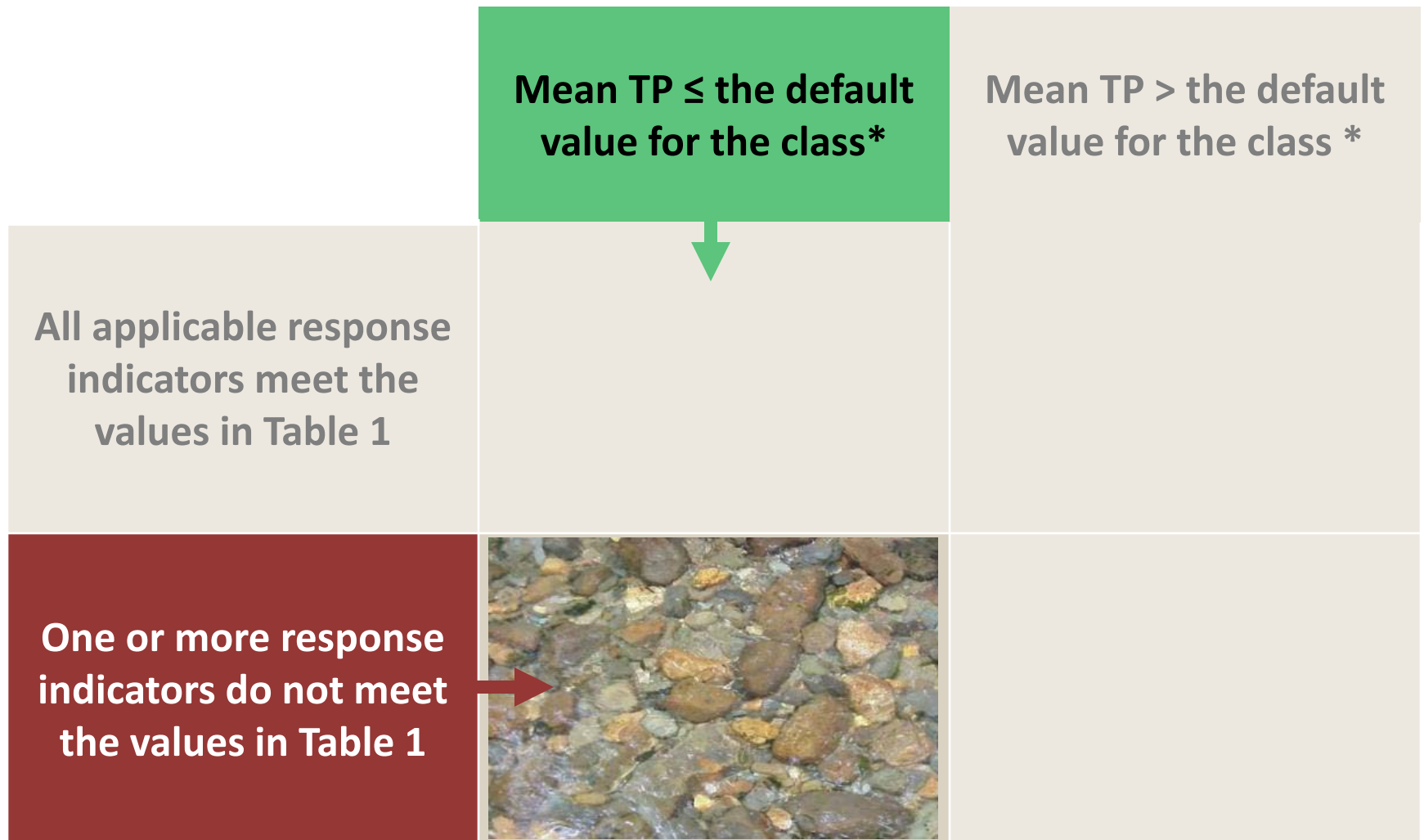
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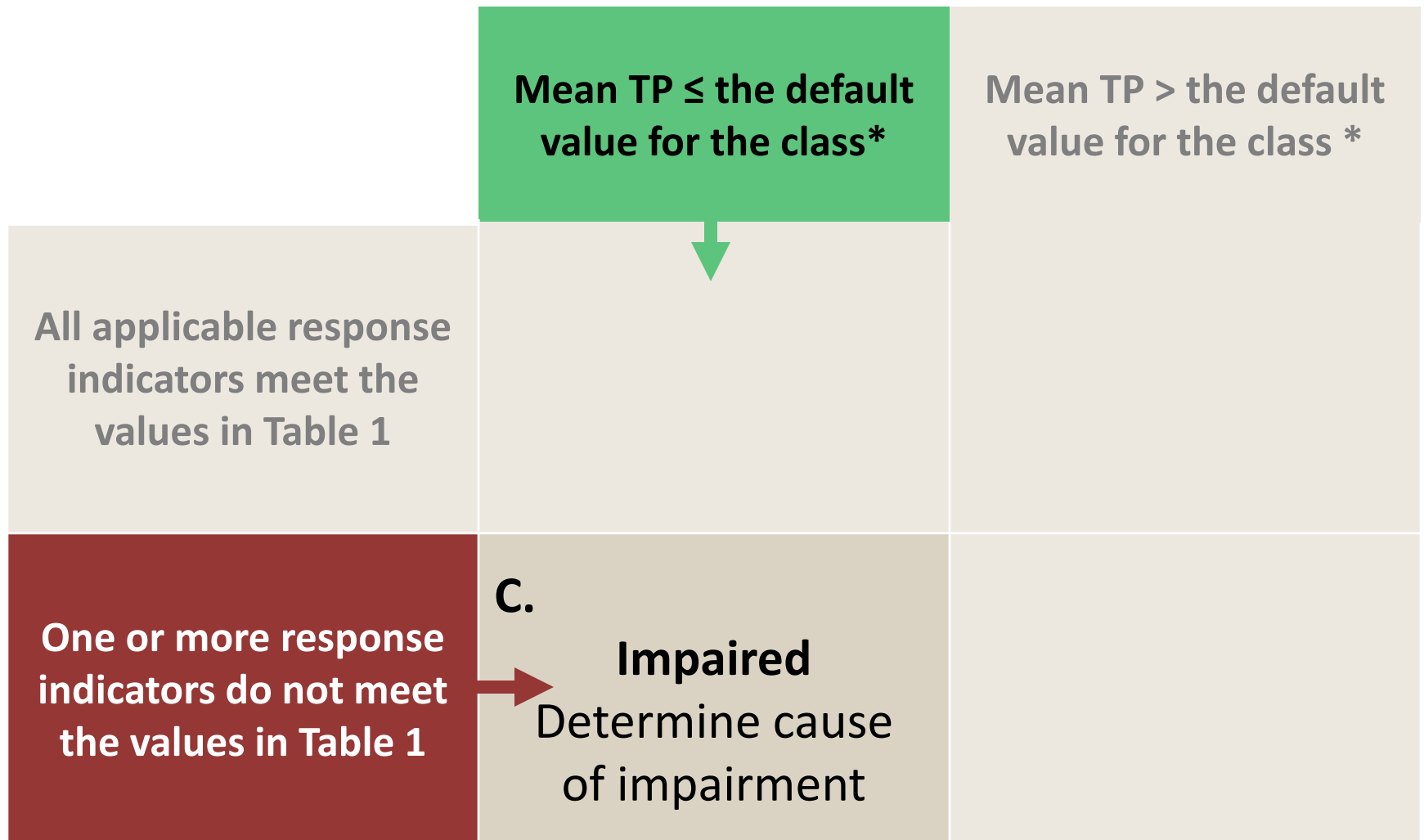
Section 5: Decision Framework



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Section 5: Decision Framework



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Section 5(C)(3): Determine Cause of Impairment

- Weight-of-evidence approach to determine cause of impairment

Cause of impairment	Nutrient Criteria
TP	Not attained
Another nutrient	Not attained
Non-nutrient cause	Attained (but waterbody may be listed as impaired for another reason)



Section 5: Decision Framework

	Mean TP \leq the default value for the class*	Mean TP $>$ the default value for the class *
All applicable response indicators meet the values in Table 1	A. Not impaired Nutrient criteria attained	B. Not impaired Nutrient criteria attained
One or more response indicators do not meet the values in Table 1	C. Impaired Determine cause of impairment	D. Impaired Nutrient criteria not attained

* Any site-specific criteria for TP or another nutrient would be included in the decision



Section 5(E): Natural Conditions

The Department may decide to not list a waterbody as impaired if natural conditions caused the non-attainment of nutrient criteria

- proximity to unimpaired wetlands
- downstream of unenriched lake outlets
- tidal areas
- naturally occurring concentrations of plants, fish, or wildlife



Section 6: Site-specific values

- No site-specific values are proposed at this time
- New site-specific values for TP or another nutrient would be added to Section 6 through a public rulemaking process



Proposed Nutrient Rule (Chapter 583)

1. Nutrient criteria for all fresh surface waters except for lakes
2. Decision framework to determine attainment of nutrient criteria
3. Process for setting site-specific criteria
4. Guidelines for listing waterbodies that do not attain nutrient criteria



Discharge Permits

- State and federal regulations require permit writers to assess the potential impact of direct discharges of effluent to downstream water quality
 - Maine Pollution Discharge Elimination System (MEPDES)
 - National Pollution Discharge Elimination System (NPDES)
- DEP staff evaluate potential impacts when issuing or renewing discharge licenses



Reasonable Potential (RP) Analysis

- RP determines if there is a reasonable potential of a waterbody failing to attain water quality standards under the following conditions:
 - Critical river flow
 - Maximum flow discharge allowed by the permit
 - Average facility phosphorus concentration
 - Maximum background phosphorus concentration



Nutrient Rule and RP

Chapter 583 Nutrient Criteria	Reasonable Potential Analysis
Does the river attain nutrient criteria at current conditions?	Could there be a problem under worst-case conditions?
Reactive management	Proactive management



RP Analysis



DISCHARGE

Flow ($Q_{\text{discharge}}$)

and

TP concentration ($TP_{\text{discharge}}$)

UPSTREAM

Flow (Q_{upstream})

and

TP concentration (TP_{upstream})

DOWNSTREAM

Flow ($Q_{\text{downstream}}$)

and

TP concentration ($TP_{\text{downstream}}$)



RP Calculations

$$\frac{Q_{\text{discharge}} TP_{\text{discharge}} + Q_{\text{upstream}} TP_{\text{upstream}}}{Q_{\text{discharge}} + Q_{\text{upstream}}} = TP_{\text{downstream}}$$

$Q_{\text{discharge}}$ = Maximum flow of the discharge allowed by permit

$TP_{\text{discharge}}$ = Average TP concentration of the discharge

Q_{upstream} = Background stream flow

TP_{upstream} = Maximum background in-stream TP concentration

$TP_{\text{downstream}}$ = Resultant downstream TP concentration



How will Chapter 583 change RP?

Component of RP Analysis	Before 2012	2012 – current	If Chapter 583 was adopted
TP threshold	35 ppb	100 ppb	18 ppb for AA/A 30 ppb for B 40 ppb for C
Critical Flow (cubic feet per second)	7Q10	7Q10	August median flow <i>(approximately 3-5 time more water than 7Q10)</i>



Example of RP for Class B River

TP Downstream	TP From rule	Response Indicators	Action
20 ppb	30 ppb	All are OK	Nothing or monitor TP
40 ppb	30 ppb	All are OK	Nothing or monitor TP Could consider a study to determine if a site-specific TP value is appropriate
40 ppb	30 ppb	One or more responses are bad or not measured	Permit must have an effluent limit for TP <ul style="list-style-type: none"> • Reduce maximum discharge • Adjust treatment process <ul style="list-style-type: none"> • Add P treatment





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