City of Boise
8/22/12

Nutrient Target Development

Approach for the Lower Boise River

Large River Nutrient Criteria Approaches:

EPA identified nutrients as a major national water quality problem and encouraged states to develop numeric nutrient criteria in 1998. EPA subsequently provided regional nutrient criteria development guidance to the States in 2000.

In 2002, EPA published ecoregional background data for nutrients and response variables. Additionally, many states initiated action to develop numeric nutrient criteria for lakes, rivers, and estuaries using various statistical approaches to protect numeric endpoints/response variables. However, few States have developed or adopted numeric nutrient criteria for lakes (7 states to date) or rivers (4 to date) as concentration is not a good indicator of trophic or water quality status.

Researchers have identified shortcomings of using ambient nutrient concentrations within a waterbody alone to predict eutrophication, particularly in streams. Ambient concentration data frequently are not effective in assessing eutrophication and the subsequent impact on water use because algal productivity depends on multiple additional factors including morphology, light availability, flooding frequency, seasonality, and biological community structure.

The few States that have adopted or proposed numeric nutrient criteria for Phosphorus and/or Nitrogen have included biological verification where exceedance of numeric thresholds occurs as a necessary step in the process of determining nutrient impairment (e.g. Florida, New Jersey).

In many cases, periphytic algal biomass (usually measured as chlorophyll a per unit area) or nutrient levels needed to prevent nuisance algal species (blue-green, filamentous) are used as a numeric interpretation of narrative nuisance aquatic growth water quality standards. States have also incorporated sliding scales for algal biomass depending on the type and level of modification of the waterbody (e.g. lower targets for natural oligotrophic waters and higher targets for smaller, manmade, and warmer waters).

Numerous nuisance aquatic growth thresholds for large rivers have been published in the literature. The literature generally measure the threshold as mg/m2 Cl-a and generally place the threshold in the 100-200 mg/m2 range, with 150 mg/m2 being identified as the large river threshold in the state of Montana. Colorado recently also proposed use of a 150 mg/m2 threshold for rivers.

In addition to algal measures, streams must also meet established numeric criteria for other factors that may be related to nutrient response, including DO, pH, and ammonia toxicity for aquatic life support and nitrate concentrations for municipal supply use. .

States have used site specific mechanistic modeling to develop numeric nutrient targets for use in TMDLs for large rivers for a number of reasons, including: (1) a lack of large river reference conditions/minimal human influence, (2) variable physical characteristics of large rivers (e.g.

velocity, temperature, light limitation...), and (3) poor correlations between nutrient concentration and eutrophication response reported in the scientific literature.

Mechanistic models are deterministic and use well-described mathematical relationships among nutrients, light availability, algal uptake, growth, and nutrient recycling, they can be used to manage and understand the physical environment. Models also are good in translating between nutrient concentrations and existing water quality standards (e.g., dissolved oxygen, pH, ammonia, narrative/numeric algal biomass thresholds...). The challenge with models is the time, data and expense involved in collection of the data and model development.

Potential nutrient criteria development approaches and advantages/disadvantages are shown below.

Approach	Example	Advantage	Disadvantage	Comment
Reference Conditions	EPA Ecoregional TN and TP Criteria (2002)	Easy	Targets unrelated to impairment Regulates N and P when only one maybe controlling Lacks causal/limiting nutrient elements	No states using this approach
Gold Book or Literature Value	100 ug/l Gold Book Flowing Water TP level	Easy	Lacks causal link Lacks consideration important site specific factors (temperature, velocity, light, habitat, limiting nutrient)	
Empirical Approach	EPA 2009 Guidance (statistical approaches to relate N or P to response variable)	Relatively Easy	SAB review found weaknesses and recommended modification plus weight of evidence approach + confirmation of projected effects	States have tried and most have found methods not descriptive of observed relationships
Mechanistic Model	EPA's AQUATOX or modified-QUAL2K	Based on site specific data	Data and expertise needed	Many TMDLs and some numeric nutrient criteria development processes use this approach

Lower Boise River Nutrient Target Approach

The Lower Boise River has the advantage of a long chemical, physical and biological data set and recent EPA funded nutrient related modeling.

Because empirical and literature based approaches have significant weaknesses, a weight of evidence approach recommended by EPA's Science Advisory Board (2010) plus use/updating of recent modeling appears to be the preferred approach for determination of the LBR nutrient target. Three key science and policy question need to be answered during the nutrient target development, including:

1. Is there nutrient related Impairment?
   a. Is LBR nutrient impairment the result of violation of numeric water quality standards (e.g. pH, DO…) or narrative water quality impairment (nuisance aquatic growth)?
   b. If nutrient impairment is nuisance aquatic growth related, what is the threshold that needs to be met (e.g. mg/m2 periphyton; phytoplankton concentration…)?

2. What is the limiting nutrient in the lower Boise River?
   a. Is the impairment caused by excess P or excess N and P (e.g. does the recent modeling show co or nitrogen limitation?)

3. What concentration of nutrient(s) is necessary for the river to be free from nuisance aquatic growth?
   a. Water quality criteria include three components, magnitude, duration, and frequency.
      a. Magnitude:
         i. What nutrient concentration(s) is necessary to meet numeric or narrative water quality standards?

      b. Duration:
         i. Is the LBR impairment year round or seasonal (e.g. are nutrient controls needed seasonally or continuously?)
      c. Frequency:
         i. Choose criteria exceedance frequency appropriate for nutrients (EPA approved Wisconsin nutrient and toxics exceedance frequency is once in three years)

Lower Boise Nutrient Target Strawman

Approach:

Weight of Evidence + Mechanistic model (existing or modified AQUATOX)

Nutrient Impairment Target:

150-200 mg/m2 periphyton Chla target

Limiting Nutrient

P only based on existing AQUATOX results and SR-HC TMDL

Seasonality

Use temperature, light, and flow limitation thresholds to evaluate necessary timeframe for nutrient controls.

Lower Yellowstone River Nutrient Criteria (2011, p. 3-4) findings based on all Montana rivers are:

- Temperature Limitation: April-October
- Light limitation: July-October
- Critical limiting period: August-October

Lower Boise River critical periods are anticipated to be similar

References: (need to fill in details)

CH2MHill, Eco Modeling, Warren Pinnacle Consulting and Boise City Public Works, 2008, Application of the AQUATOX Model to the Lower Boise River

EPA, 1986, Gold book

EPA, 1998, Nutrient Criteria memo

EPA, 2000, Nutrient Criteria Guidance

EPA, 2002, Ecoregional nutrients

EPA, 2008 Empirical nutrient criteria approach

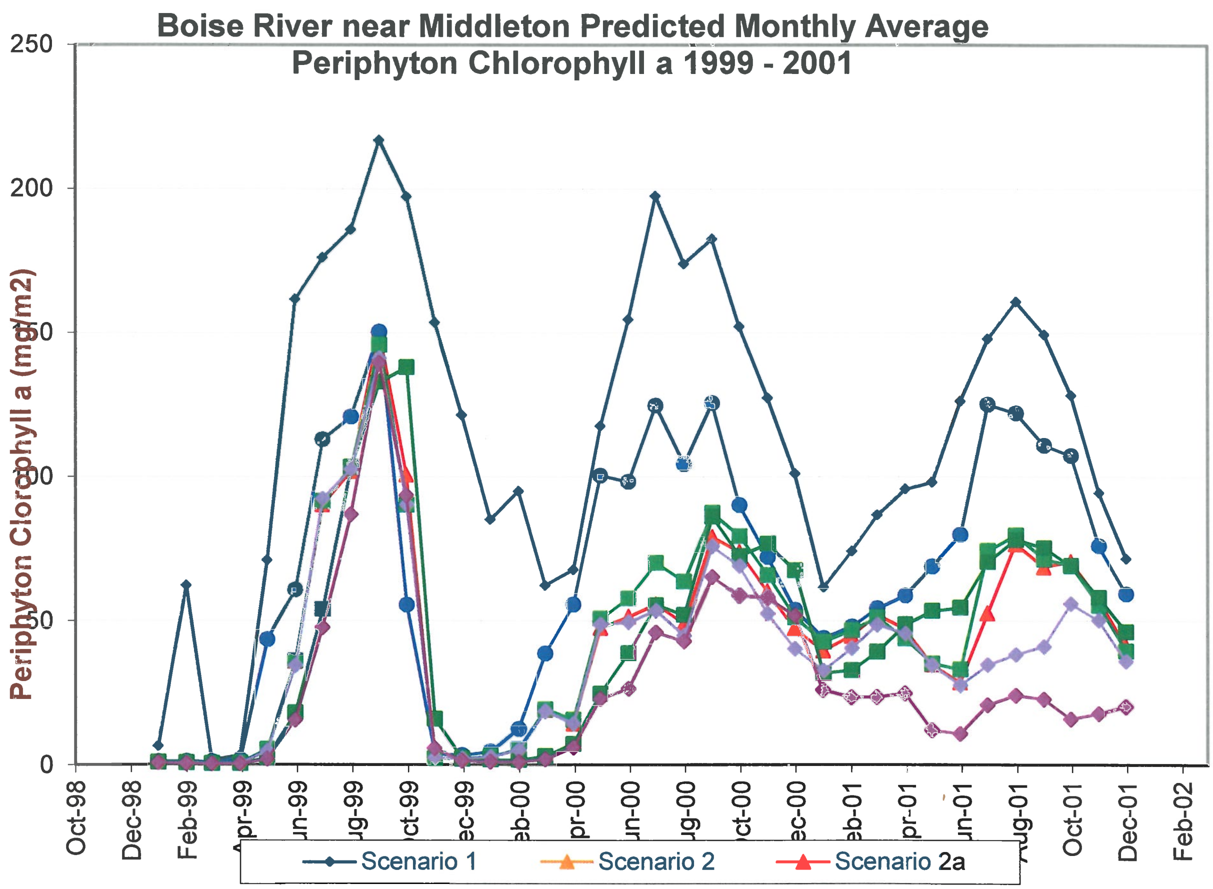
EPA 2010, SAB Review of empirical approach

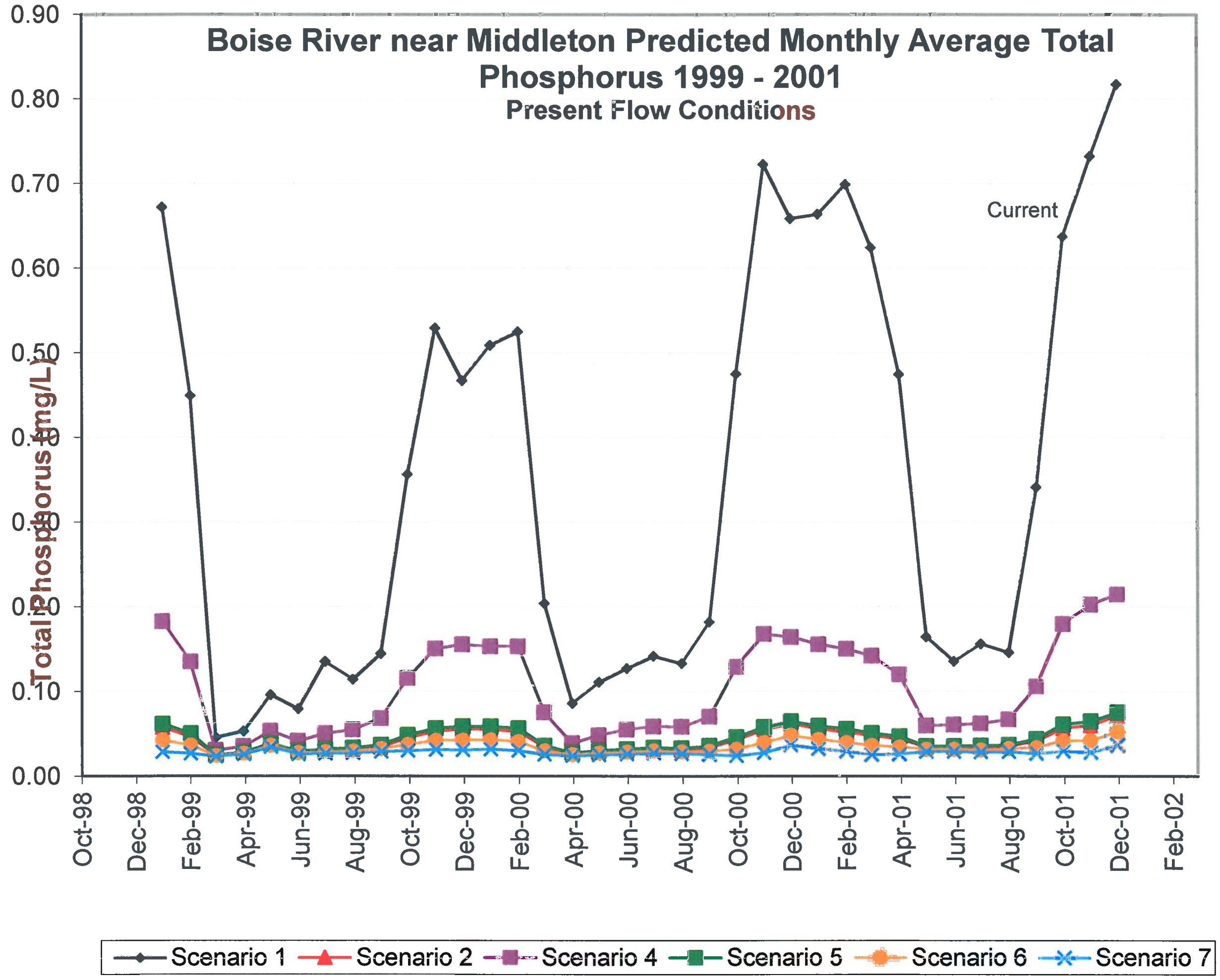
MDEQ, 2008, How Green is too Green public opinion survey 150 mg/m2 periphyton threshold for recreational use

MDEQ, 2011, Lower Yellowstone River Nutrient Criteria Model , http://deq.mt.gov/wqinfo/NutrientWorkGroup/draftyellowstonemodel.mcpx

Suplee, M. W., V. Watson, M. E. Teply, and H. McKee. 2009. How Green Is Too Green? Public opinion of What Constitutes Undesirable Algae Levels in Streams. 45(1): 123-140.

Background Materials





Boise River near Middleton Predicted Monthly Average Total Phosphorus 1999 - 2001
Present Flow Conditions
Total Phosphorus (mg/L)
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Current
Oct-98
Dec-98
Feb-99
Apr-99
Jun-99
Aug-99
Oct-99
Dec-99
Feb-00
Apr-00
Jun-00
Aug-00
Oct-00
Dec-00
Feb-01
Apr-01
Jun-01
Aug-01
Oct-01
Dec-01
Feb-02
Scenario 1
Scenario 2
Scenario 4
Scenario 5
Scenario 6
Scenario 7

Middleton
October-November
2001
f=y0+a*x/(b+x)