# Harpeth River – TMDL Endpoint Discussion

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# Overview

- Life of a TMDL Developer
  - Listing for Nutrients
    - Got Listed . . . .
    - What is the Standard ?
      - Total Nitrogen
      - Total Phosphorus
      - Chlorophyll a
      - Dissolved Oxygen
  - What do you  mean a narrative criteria
    - Imbalance, huh?
    - Free From . . . .
    - I need a number!

# Developing a TMDL Target

- Is a TMDL Target the Same as WQS?
  - No, it is an interpretation of a narrative
    - Imbalance of flora and fauna
    - Free from . . .
  - May not consider all aquatic life use support
  - May not consider downstream protection
- TMDL is not a Standards Setting Action

# Expert Solicitation

**Pro's**

- Expert Solicitation
  - Local knowledge
  - Could be historical Condition
- Could build consensus with stakeholders for endpoints
- May bring key scientific information about the system

**Con's**

- Does not determine assimilative capacity
- May not consider all stressors
- May not consider all aquatic life use support
- May not consider downstream uses

# Statistical – Regional/EcoRegion

**Pro's**

- Make use of large availability of data
  - Accounts for spatial variability
  - Represents range of nutrient conditions
- Can be easily done
  - Percentile Ranking

**Con's**

- Data availability
  - Certain regions
- Does not take into account local conditions
  - Light
  - Nutrient species
- Differentiate between endpoints
  - Chl a
  - Benthic Algae
  - Dissolved Oxygen

# Statistical – Reference Conditions

**Pro's**

- Relatively easy to do
- Uses stream conditions from surrounding area
  - Least Impacted
  - No anthropogenic sources
  - Not impaired
- Could take into account local conditions
  - Hydrology
  - Environmental

**Con's**

- Like waterbody might not be impaired
- May not consider all ALUS
- May not consider downstream uses
- Difficult to define reference stream
- Limited by data

# Statistical -- Regression

**Pro's**

- Easily done
- Links stressors to response variables
- Uses site specific data for the waterbody

**Con's**

- May not account for all response variables
- Constrained by the data availability
- Confidence in the statistical fit
- Difficult to extrapolate to other conditions
- May not protect downstream

# Mechanistic Modeling

**Pro's**

- Linkage between stressors and response variables
  - Chlorophyll a (algae, benthic algae, macrophytes)
  - Light
  - Dissolved Oxygen
- Can extrapolate
  - Environmental Conditions
  - Current vs. WQS Condition
  - Response in Time
  - Duration and Frequency

**Con's**

- Time consuming
- Costly
- Can be misapplied

# Utility of Mechanistic Models

- Simplistic Representation of Reality
  - Cannot Simulate “Everything”
  - All Models are Wrong . . . .
- Interpolate
  - Known and Unknown
- Provides Linkage between
  - Loads and Response Variables
- Can Determine Important Processes
  - Nutrients/DO/Algae/Light
  - Management Strategies
- Determine Load Reductions to meet WQS
  - Never to Exceed
  - X% Exceedence
  - Duration, Frequency and Magnitude
- Evaluate Best Management Practices

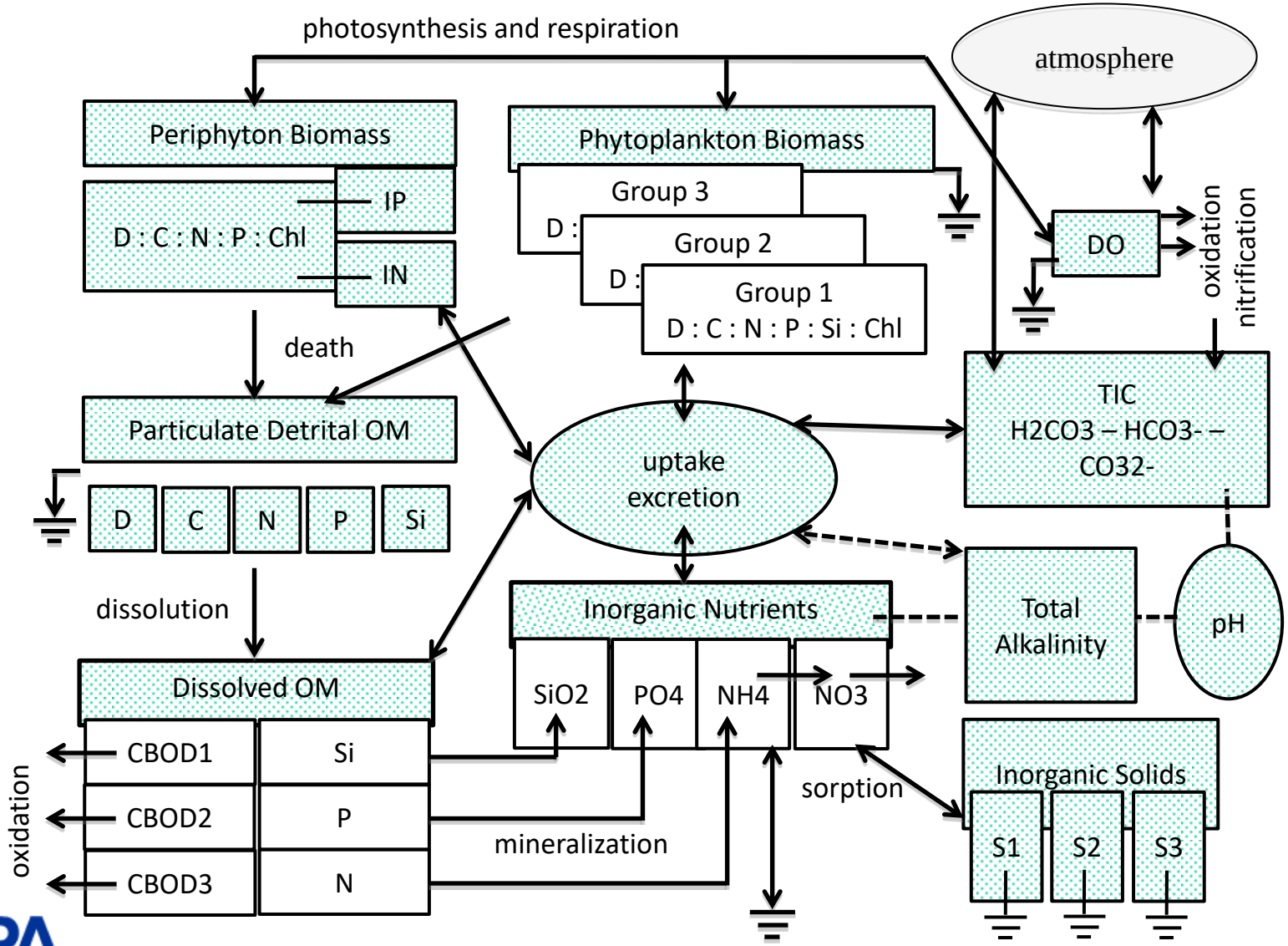
# Conventional Water Quality

- Important Processes
  - Nutrient Dynamics
    - Nitrogen (Ammonia, Nitrate, DON, PON)
    - Phosphorus (Orthophosphate, DOP, POP)
    - Silica (Dissolved, Particulate)
  - Algal Dynamics
    - Multiple Algal Groups (Green, Blue Green, Diatoms)
    - Light (Algal Self Shading, DOC, TSS)
  - Dissolved Oxygen Dynamics
    - Multiple BOD (Slow, Med, Fast or Biotic, Watershed, WWTP)
    - Reaeration (Wind, Hydraulic)
    - Sediment Diagenesis (Oxygen Consumption, Nutrient Fluxes)
  - pH/TDS/Temperature

# Using Mechanistic Models for TMDL

- Critical Conditions (Steady State)
  - Typically used for criteria development
- Nutrients
  - Usually not a critical condition
  - Seasonal Variation
  - Need to consider varying meteorological conditions
    - Low/Ave/High Flow years
    - Long-term Continuous Simulation
    - Should allow perturbations

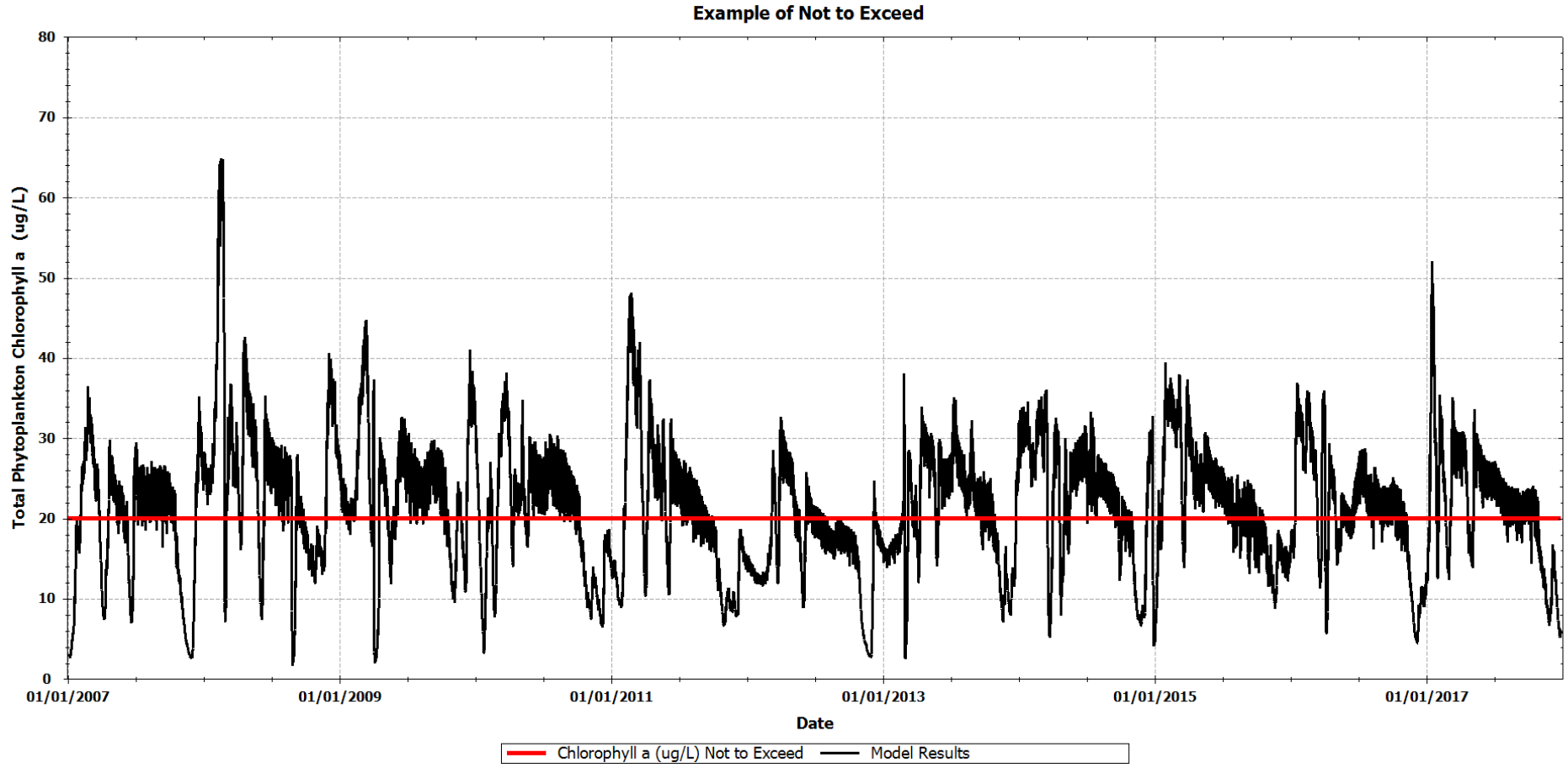
# Stressor/Response Relationship

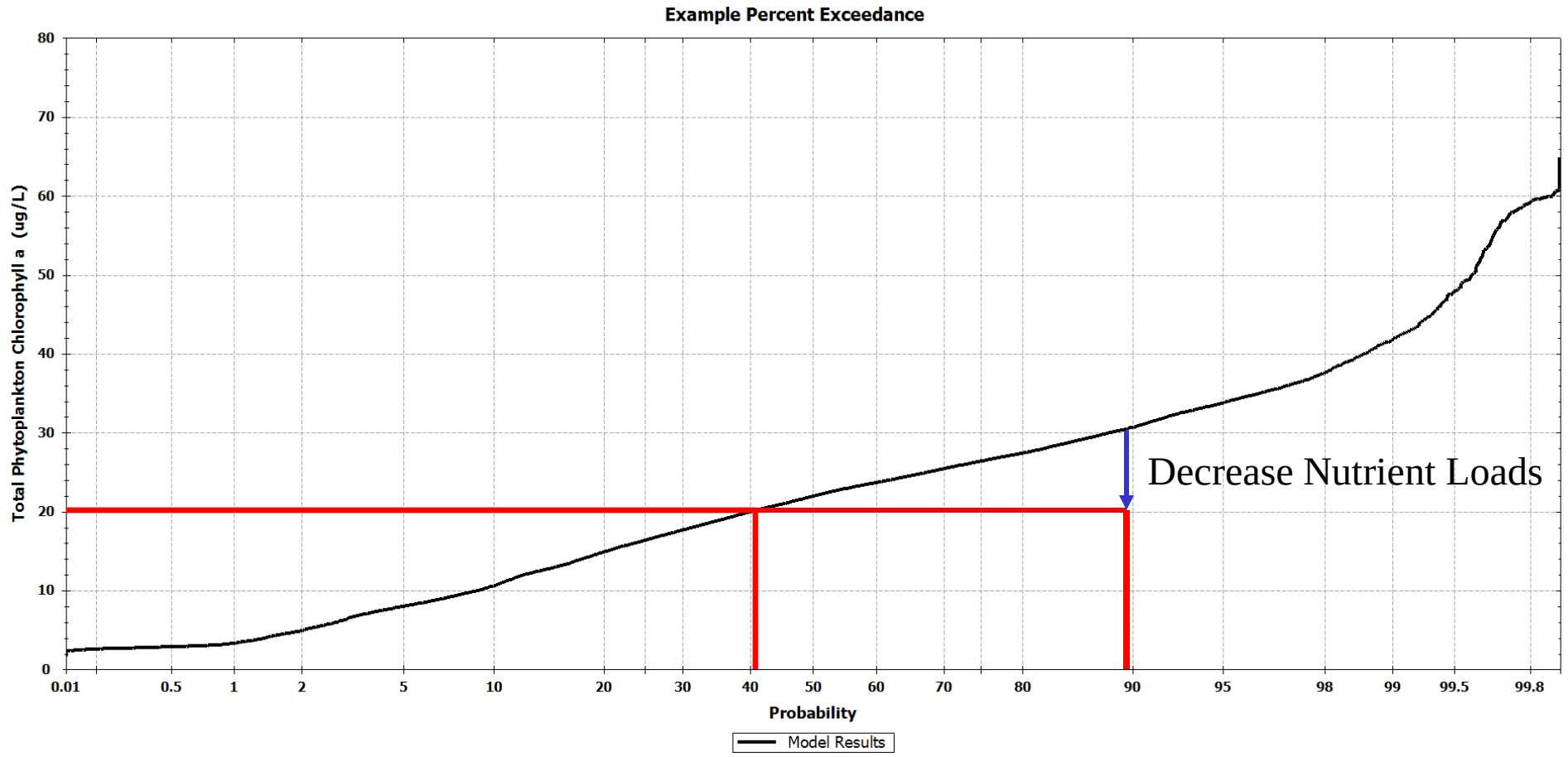


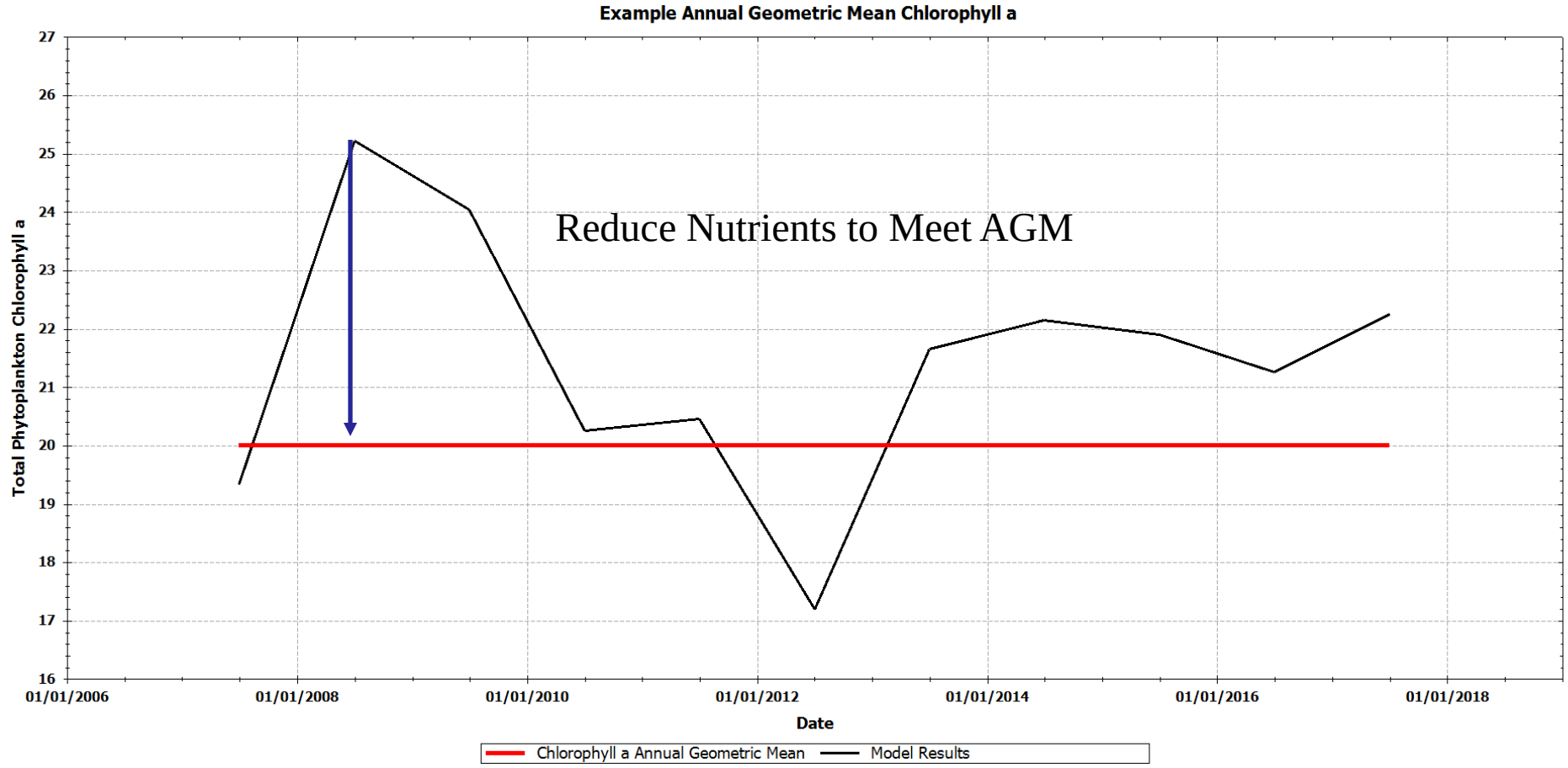
# Potential End Points with WASP

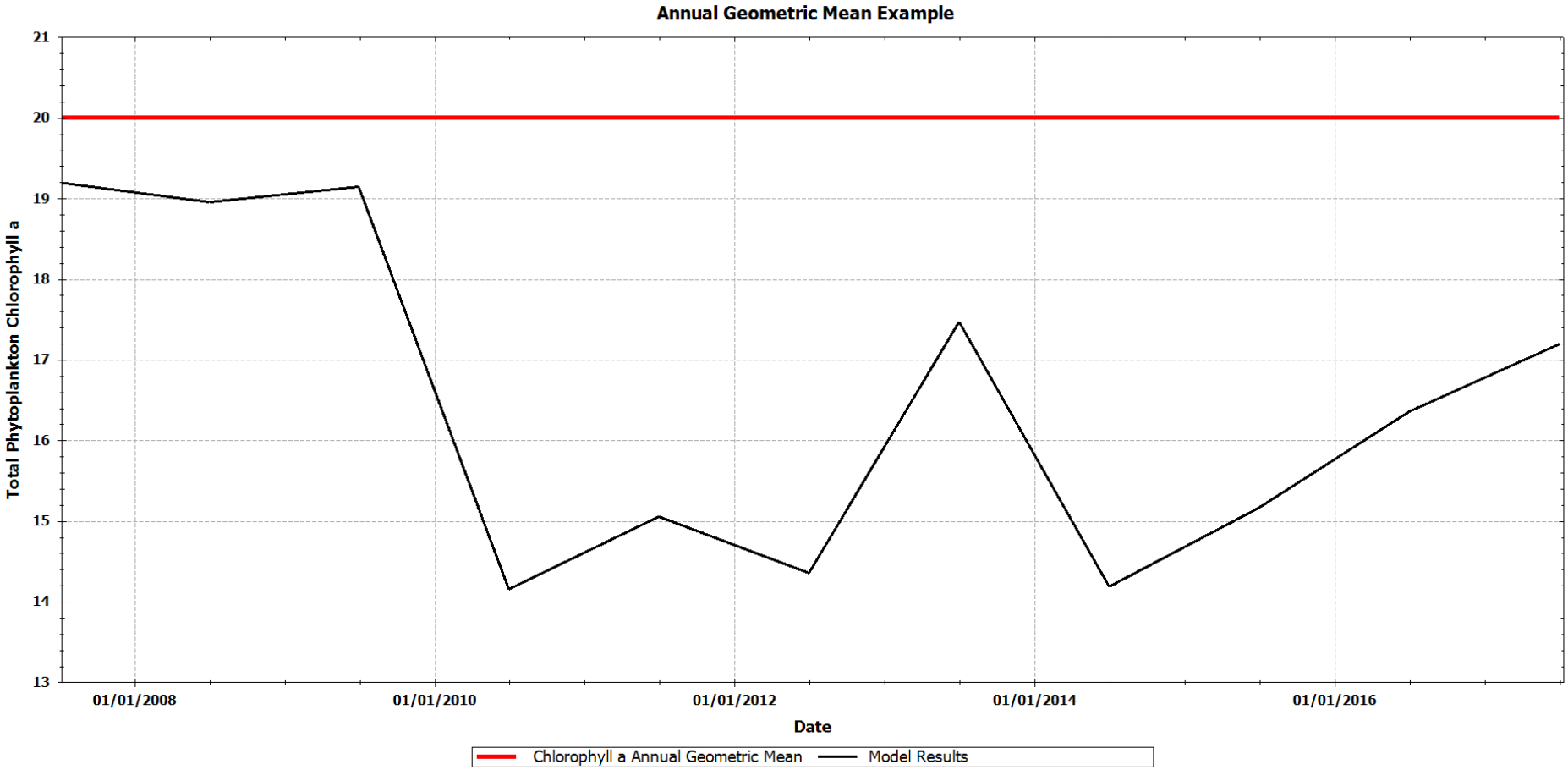
- Dissolved Oxygen/CBOD
- Nutrients (Nitrogen, Phosphorus, Silica)
- Biomass
  - Phytoplankton
  - Periphyton
- pH
- Light

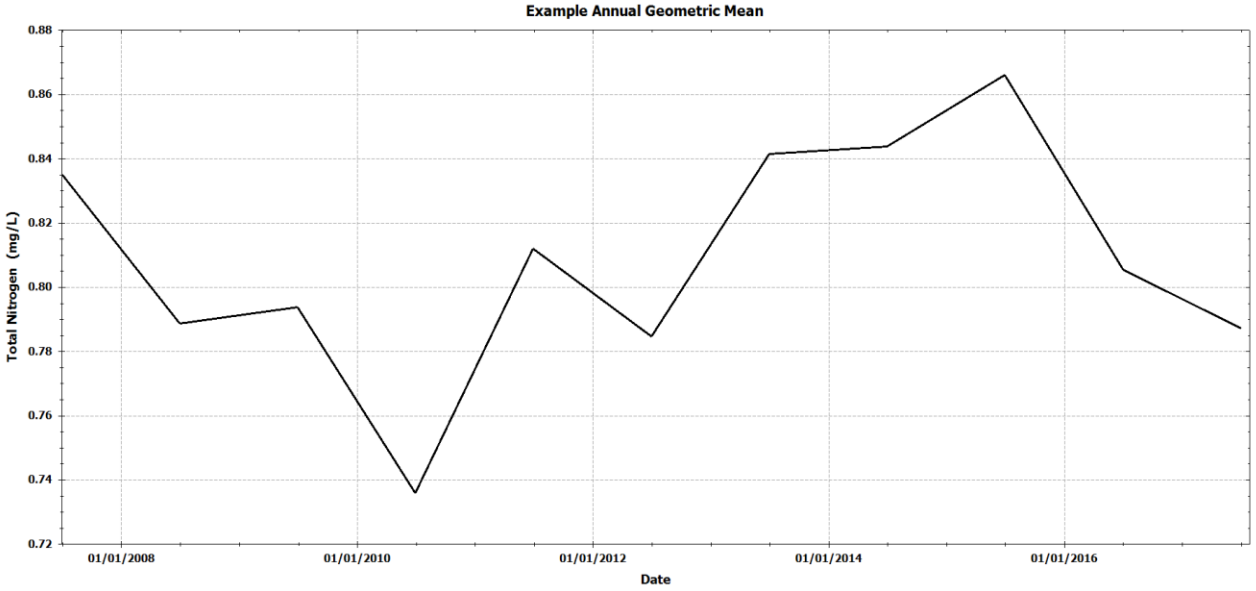
# Ways to Express End Points

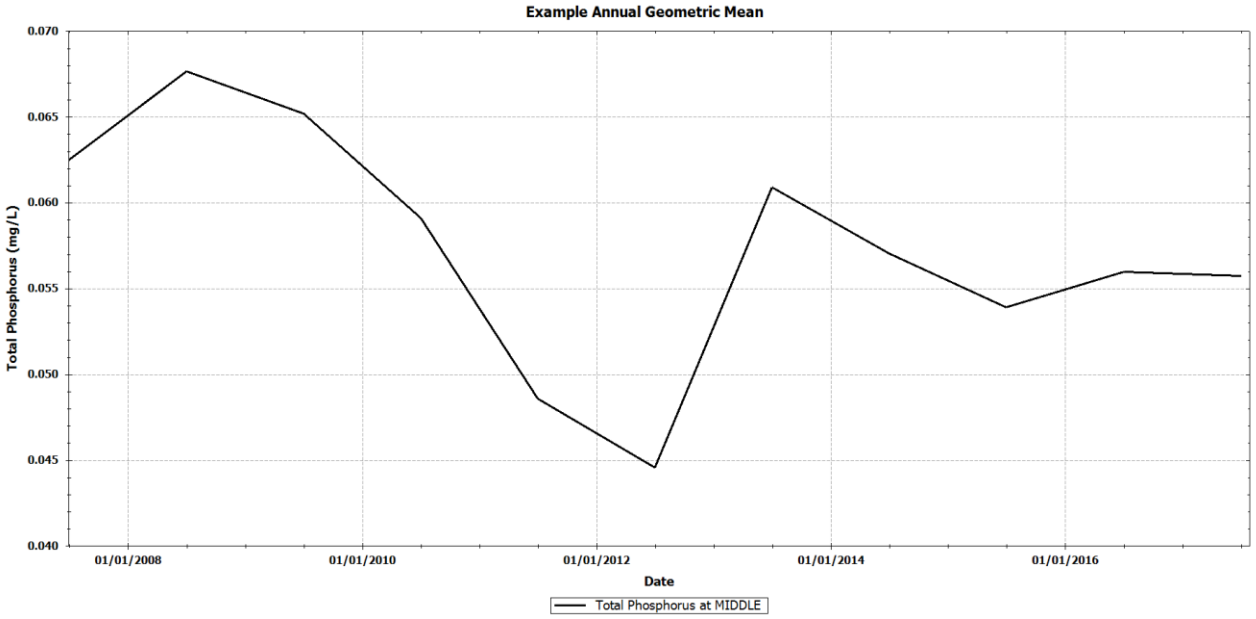

Example of Not to Exceed
Total Phytoplankton Chlorophyll a (ug/L)
80
70
60
50
40
30
20
10
0
01/01/2007
01/01/2009
01/01/2011
01/01/2013
01/01/2015
01/01/2017
Date
Chlorophyll a (ug/L) Not to Exceed
Model Results


Example Percent Exceedance
Total Phytoplankton Chlorophyll a (ug/L)
80
70
60
50
40
30
20
10
0
0.01
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
Probability
Decrease Nutrient Loads
Model Results


Example Annual Geometric Mean Chlorophyll a
Reduce Nutrients to Meet AGM
Total Phytoplankton Chlorophyll a
27
26
25
24
23
22
21
20
19
18
17
16
01/01/2006
01/01/2008
01/01/2010
01/01/2012
01/01/2014
01/01/2016
01/01/2018
Date
Chlorophyll a Annual Geometric Mean
Model Results


Annual Geometric Mean Example
Total Phytoplankton Chlorophyll a
21
20
19
18
17
16
15
14
13
01/01/2008
01/01/2010
01/01/2012
01/01/2014
01/01/2016
Date
Chlorophyll a Annual Geometric Mean
Model Results


Example Annual Geometric Mean
Total Nitrogen (mg/L)
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0.74
0.72
01/01/2008
01/01/2010
01/01/2012
01/01/2014
01/01/2016
Date


Example Annual Geometric Mean
Total Phosphorus (mg/L)
0.070
0.065
0.060
0.055
0.050
0.045
0.040
01/01/2008
01/01/2010
01/01/2012
01/01/2014
01/01/2016
Date
Total Phosphorus at MIDDLE

# Questions?