

# Floyds Fork Nutrient TMDL Targets

Presentation to:

**Floyds Fork Nutrient TMDL TAC**

**May 20, 2013**

**Department for Environmental Protection  
Environmental & Public Protection Cabinet**



*To Protect and Enhance Kentucky's Environment*

**Kentucky**  
UNBRIDLED SPIRIT™

# Water Quality Standards

## 401 KAR 10:31. Surface water standards.

Section 1. Nutrient Limits. In lakes and reservoirs and their tributaries, and other surface waters where **eutrophication problems** may exist, nitrogen, phosphorus, carbon, and contributing trace element discharges shall be limited in accordance with:

- (1) The scope of the problem;
- (2) The geography of the affected area; and
- (3) Relative contributions from existing and proposed sources.

# Water Quality Standards

## Section 2. Minimum Criteria Applicable to All Surface Waters.

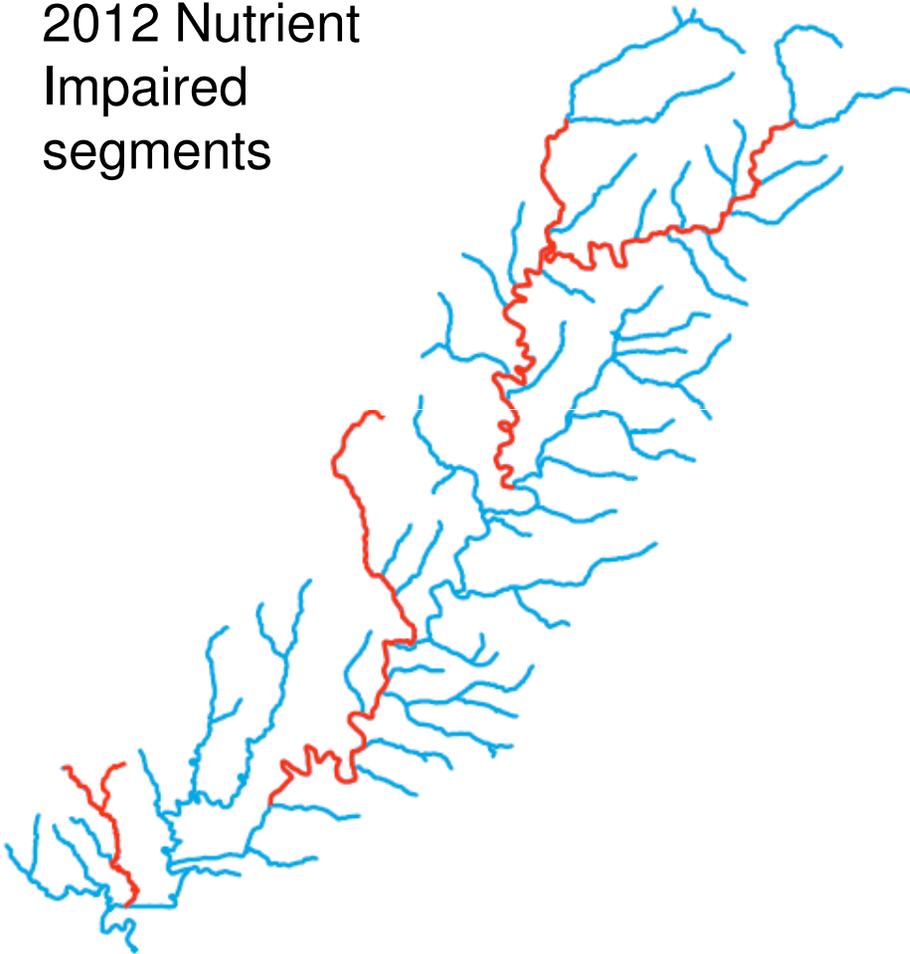
(1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that

...

- (c) **Produce objectionable color, odor, taste, or turbidity;**
- (d) **Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;**
- (e) **Produce undesirable aquatic life or result in the dominance of nuisance species;**

# The Problem

2012 Nutrient  
Impaired  
segments



- Several impaired streams, more suspected
- Excessive algae and reduced biological integrity, attributable in part, to excess nitrogen and phosphorus
- TMDL required for these waters

# The fundamental task

- What levels of nitrogen and phosphorus will ensure the attainment and maintenance of Water Quality Standards in these streams?
- Required element of the TMDL

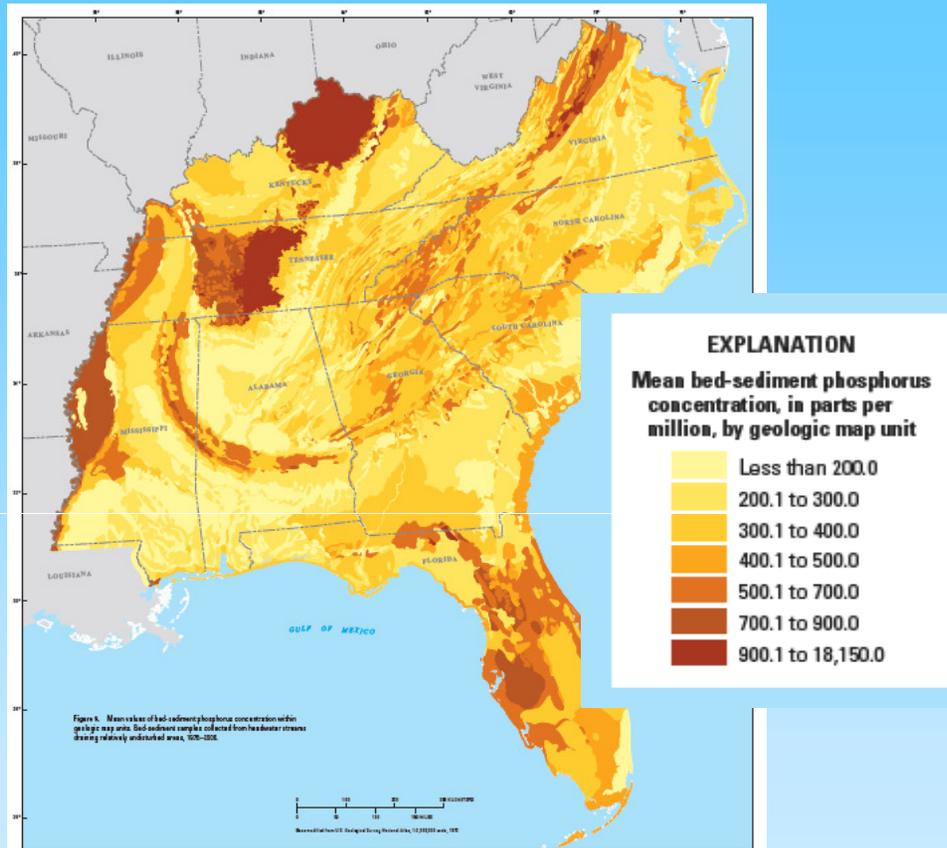
# The general approach

- How do biological integrity and/or the severity of benthic algae problems vary with nutrient levels?
- What are typical nutrient levels in streams that have acceptable biological integrity?
- What literature guidelines and thresholds might be relevant in judging risk of impairment at varying nutrient levels?

# The considerations

- Geographic setting
- Variability within watershed
- Data/information availability

# The considerations



**Figure 5.** Mean values of bed-sediment phosphorus concentration within geologic map units. Bed-sediment samples collected from headwater streams draining relatively undisturbed areas, 1976–2006.

- The Bluegrass as a whole has substantial and varied inputs of phosphorus from geologic sources
- There is considerable variation within and among the ecoregions that must be considered in setting expectations

# The considerations

## Stream sizes



Ashers Run  
2.8 mi<sup>2</sup>



Chenoweth Run  
17 mi<sup>2</sup>



Floyds Fork @ Seatonville  
172 mi<sup>2</sup>

- depth
- canopy width
- flow regime
- substrate
- biota
- stream function

# The considerations

- Available data and information
  - stream biological monitoring data on similar streams (wadeable/headwaters)
  - long term water chemistry monitoring data on Floyds Fork mainstem near mouth
  - literature guidelines and thresholds (generic)

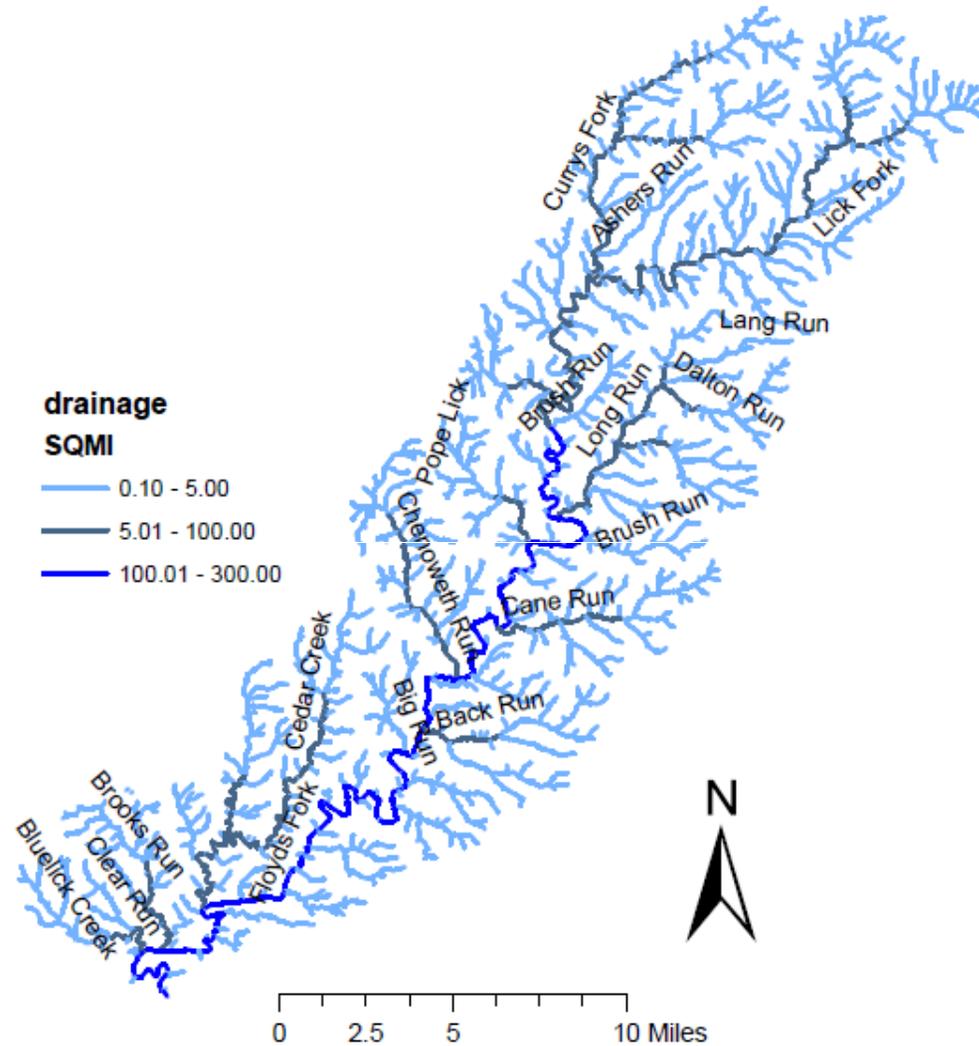
# Stratification by Stream Size

| Size Category               | Catchment Area        | Description   |
|-----------------------------|-----------------------|---|
| Headwater                   | <5 sq mi <sup>2</sup> | Low or no summer-fall flow; distinct size category for biological indices; bioassessments in March-May          |
| Wadeable*                   | 5-100 mi <sup>2</sup> | Year-round flow; biological assessments May-September   |
| Transitional/<br>Boatable** | >100 mi <sup>2</sup>  | Long, slow, sunny pools during growing season; boating recreation important; biological assessments May-October |

\* includes tributaries in that size range and Floyds Fork mainstem above (Upper) Chenoweth Run

\*\* includes mainstem of Floyds Fork downstream of (Upper) Chenoweth Run

# Stratification by Stream Size



# The general approach

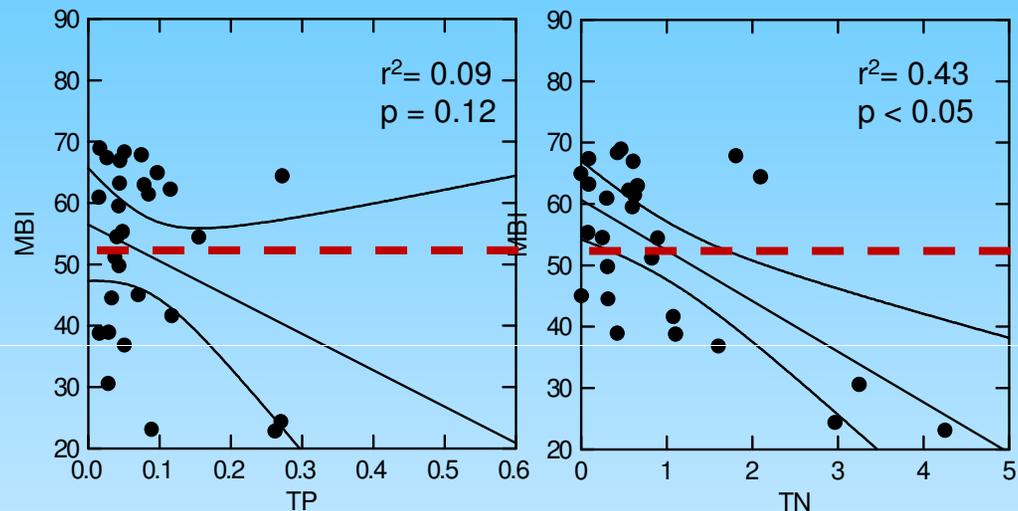
- How do biological integrity and/or the severity of benthic algae problems vary with nutrient levels?
- What are typical nutrient levels in streams that have acceptable biological integrity?
- What literature guidelines and thresholds might be relevant in judging risk of impairment at varying nutrient levels?

# Target Components

- Magnitude
  - specific to size class due to expectation of different effects
- Duration (averaging method and period)
  - represented as annual (headwaters) or growing season geometric means
- Frequency – 2 components
  - allow for infrequent excursions – once per 3 year period widely used as a general guideline to allow for ecosystem recovery (EPA 1994)
  - ceiling (max) to prevent infrequent but large excursions that may have unpredictable/long-term impact

# Headwater Streams

- Bluegrass region monitoring data
- Weak association with TP, but indications of biological integrity reduced below acceptable levels in the range around 1 mg/L TN



Relationship of Macroinvertebrate Bioassessment Index (MBI) scores with TN and TP, headwater Bluegrass streams; 90% confidence intervals on linear smoother. Red line is the boundary of Good-Excellent vs. Fair-Poor scores

# Headwater Streams

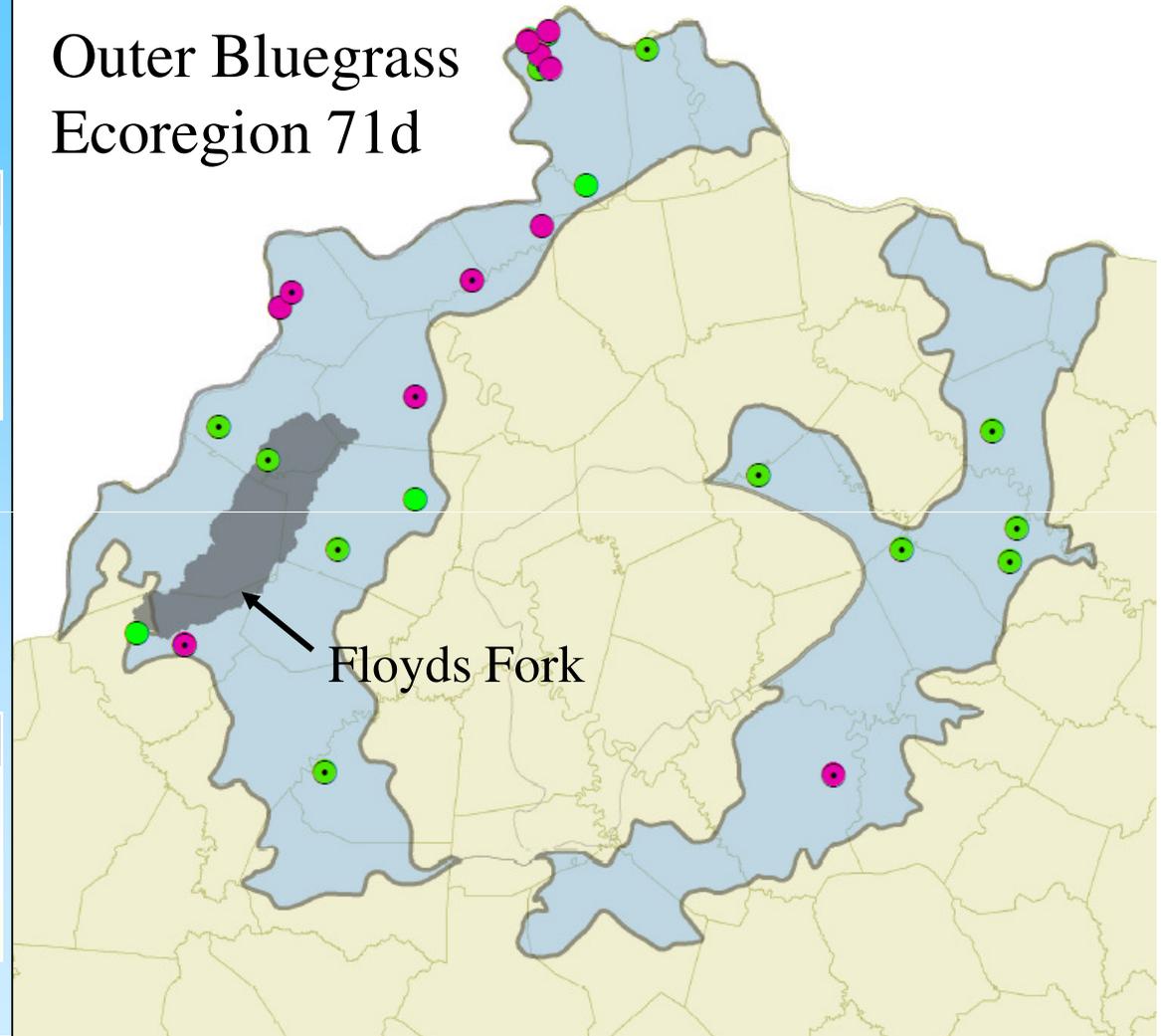
- Reference Reaches
- Pink dotted-circles

|                             | TP mg/L | TN mg/L |
|-----------------------------|---------|---------|
| N                           | 19      | 19      |
| maximum                     | 0.116   | 0.972   |
| 75 <sup>th</sup> percentile | 0.079   | 0.600   |

- All MBI “passing” sites
- Green dotted-circles

|                             | TP mg/L | TN mg/L |
|-----------------------------|---------|---------|
| N                           | 8       | 8       |
| maximum                     | 0.157   | 0.909   |
| 75 <sup>th</sup> percentile | 0.085   | 0.638   |

Outer Bluegrass  
Ecoregion 71d



# Literature Guidelines

- TP 0.100 mg/L widely cited as level necessary to prevent nuisance algae (EPA1986)
- Trophic classification (Dodds et al 1998)

| Trophic Category Boundary | TP mg/L | TN mg/L |
|---------------------------|---------|---------|
| Oligotrophic              | 0.025   | 0.700   |
| Mesotrophic               | 0.075   | 1.5     |

# Headwater Streams

## Summary of candidate targets

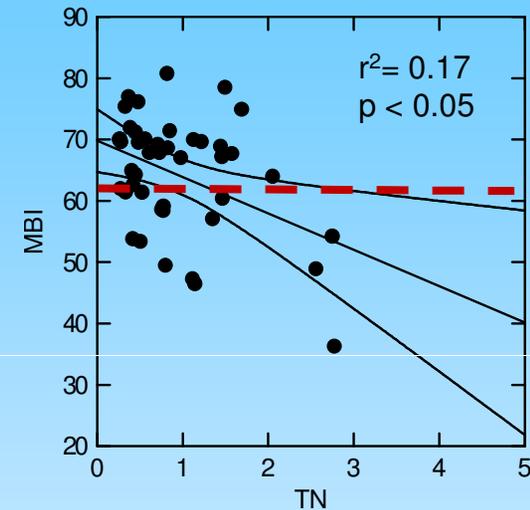
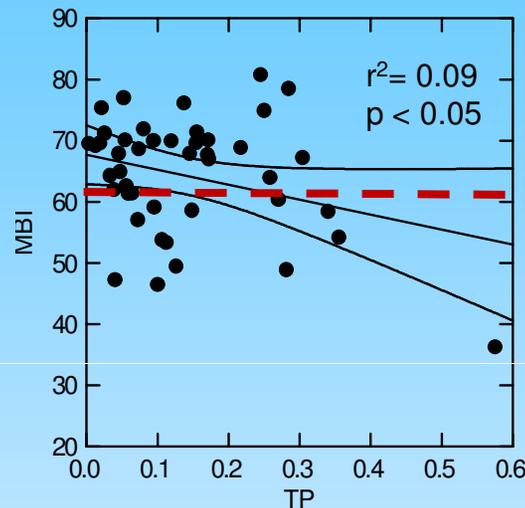
|   | TP mg/L | TN mg/L |
|---|---------|---------|
| Oligo-Mesotrophic Boundary                      | 0.025   | 0.70    |
| Meso-Eutrophic Boundary                         | 0.075   | 1.5     |
| Reference 75 <sup>th</sup> percentile (samples) | 0.079   | 0.600   |
| Reference Max (samples)                         | 0.116   | 0.972   |
| Healthy 75 <sup>th</sup> percentile (sites)     | 0.085   | 0.638   |
| Healthy Max (sites)                             | 0.157   | 0.909   |
| Literature nuisance algae protection            | 0.100   | --      |

## Final proposed targets

|         | TP mg/L | TN mg/L |
|---------|---------|---------|
| 3 year  | 0.09    | 0.70    |
| maximum | 0.12    | 1.0     |

# Wadeable Non-headwater Streams

- Bluegrass region monitoring data
- Considerable variability, but apparent decline below acceptable scores in the range 0.1 - 0.3 mg/L TP and 1 - 2 mg/L TN.



Relationship of Macroinvertebrate Bioassessment Index (MBI) scores with TN and TP, wadeable Bluegrass streams; 90% confidence intervals on linear smoother. Red line is the boundary of Good-Excellent vs. Fair-Poor scores

# Wadeable Non-headwater Streams

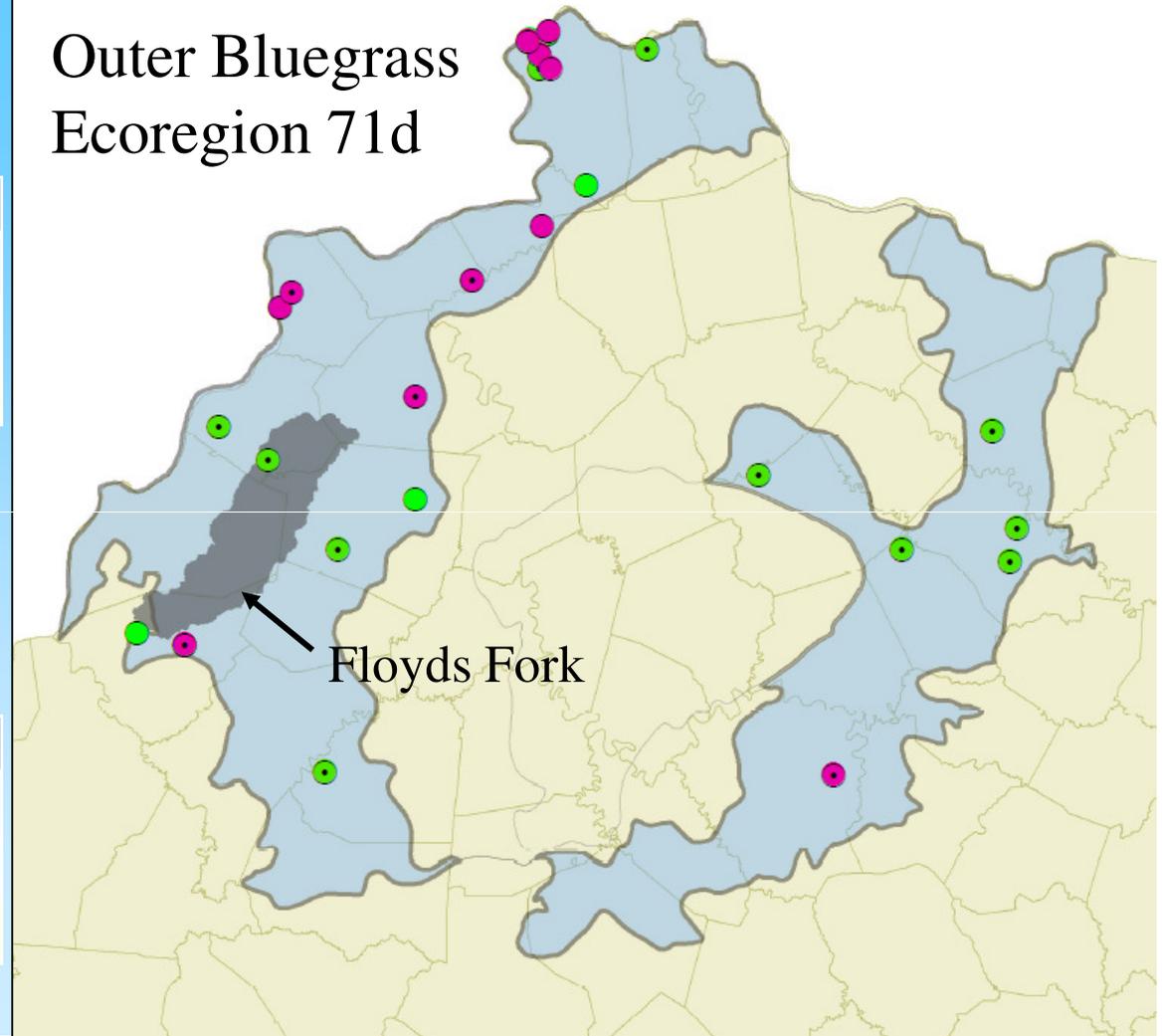
- Reference reaches
- Pink open circles

|                             | TP mg/L | TN mg/L |
|-----------------------------|---------|---------|
| N                           | 26      | 28      |
| maximum                     | 0.249   | 1.55    |
| 75 <sup>th</sup> percentile | 0.070   | 0.822   |

- All MBI “passing” sites
- Green open circles

|                             | TP mg/L | TN mg/L |
|-----------------------------|---------|---------|
| N                           | 13      | 13      |
| maximum                     | 0.219   | 1.59    |
| 75 <sup>th</sup> percentile | 0.147   | 1.14    |

Outer Bluegrass  
Ecoregion 71d



# Wadeable Non-headwater Streams

## Summary of candidate targets

|   | TP mg/L | TN mg/L |
|---|---------|---------|
| Oligo-Mesotrophic Boundary                      | 0.025   | 0.70    |
| Meso-Eutrophic Boundary                         | 0.075   | 1.5     |
| Reference 75 <sup>th</sup> percentile (samples) | 0.070   | 0.822   |
| Reference Max (samples)                         | 0.249   | 1.55    |
| Healthy 75 <sup>th</sup> percentile (sites)     | 0.147   | 1.14    |
| Healthy Max (sites)                             | 0.219   | 1.59    |
| Literature nuisance algae protection            | 0.100   | --      |

## Final proposed targets

|         | TP mg/L | TN mg/L |
|---------|---------|---------|
| 3 year  | 0.15    | 1.1     |
| maximum | 0.25    | 1.6     |

# Transitional / Boatable Sections

**Floyds Fork @ KY1526: fully supporting WAH confirmed by biological sampling 2011**

Monthly/ bimonthly samples - Annual geometric means

| Year       | TP mg/L      | TN mg/L      |
|------------|--------------|--------------|
| 1999       | 0.159        | 1.359        |
| 2000       | 0.150        | 1.154        |
| 2001       | 0.133        | 1.194        |
| 2002       | 0.111        | 1.426        |
| 2003       | 0.185        | 1.434        |
| 2004       | 0.173        | 1.729        |
| 2005       | 0.158        | 2.191        |
| 2006       | 0.173        | 1.676        |
| 2007       | 0.198        | 1.848        |
| 2008       | 0.126        | 1.720        |
| 2009       | 0.174        | 1.768        |
|            |              |              |
| min        | 0.111        | 1.154        |
| <b>max</b> | <b>0.198</b> | <b>2.191</b> |



# Transitional / Boatable Sections

Two comparable WAH supporting large streams with frequent monitoring  
Monthly/ bimonthly samples - Annual geometric means 1999-2009



**Brashears Creek @ Taylorsville**

**Beech Fork @ Maud 436 mi<sup>2</sup>**

|     | <b>TP<br/>mg/L</b> | <b>TN<br/>mg/L</b> |
|-----|--------------------|--------------------|
| min | 0.089              | 0.401              |
| max | 0.329              | 1.445              |

**Brashears Creek @ Taylorsville 258 mi<sup>2</sup>**

|     | <b>TP<br/>mg/L</b> | <b>TN<br/>mg/L</b> |
|-----|--------------------|--------------------|
| min | 0.129              | 0.643              |
| max | 0.663              | 2.436              |

# Transitional / Boatable Sections

## Summary of candidate targets

|   | TP mg/L | TN mg/L |
|---|---------|---------|
| Oligo-Mesotrophic Boundary                                | 0.025   | 0.70    |
| Meso-Eutrophic Boundary                                   | 0.075   | 1.5     |
| Floyds Fork unimpaired section max growing season geomean | 0.197   | 2.19    |
| Beech Creek max growing season geomean                    | 0.329   | 1.45    |
| Beech Creek max growing season geomean                    | 0.663   | 2.44    |
| Literature nuisance algae protection                      | 0.100   | --      |

## Final proposed targets

|         | TP mg/L | TN mg/L |
|---------|---------|---------|
| 3 year  | 0.20    | 2.2     |
| maximum | 0.66    | 2.4     |

# Preliminary Targets

## TN and TP targets for model assessment points

| Size category                                   | TP<br>3yr | TP<br>max | TN<br>3yr | TN<br>max |
|---|-----------|-----------|-----------|-----------|
| Headwater (<5 sq mi <sup>2</sup> )              | 0.09      | 0.12      | 0.70      | 1.0       |
| Wadeable (5-100 mi <sup>2</sup> )*              | 0.15      | 0.25      | 1.1       | 1.6       |
| Transitional/Boatable (>100 mi <sup>2</sup> )** | 0.20      | 0.66      | 2.2       | 2.4       |

\* includes tributaries in that size range and Floyds Fork mainstem above Upper Chenoweth Run

\*\* includes mainstem of Floyds Fork downstream of Upper Chenoweth Run

**3yr:** not to exceed as an annual (headwater) or growing season geometric mean more than once in a three year period

**max:** never to exceed as an annual (headwater) or growing season geometric mean

# Next Steps

- Ground truth preliminary targets with findings from 2012-13 Floyds Fork biological monitoring
- Gather recent additions to regional bioassessment data
- Examine annual variation predicted by Floyds Fork water quality model

