

Developing scientifically defensible nutrient standards: challenges and opportunities

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Topics

- Expectations for nutrient standards
- The issue of “scientifically defensible”
- What are the challenges?
- What are the opportunities?

Throughout, I will draw heavily on my work in Illinois

Are nutrient standards a solution in search of a problem?

At a continental scale, nutrient loading is a serious problem



At a local scale, nutrient loading is one of many stressors



Photo: T.V. Royer

Nutrient loading is clearly an issue deserving attention

But – nutrient standards are not a silver bullet that will fix all water quality problems!

Standards and TMDLs are unlikely to affect Gulf hypoxia

Environ. Sci. Technol. 2006, 40, 4126–4131

Timing of Riverine Export of Nitrate and Phosphorus from Agricultural Watersheds in Illinois: Implications for Reducing Nutrient Loading to the Mississippi River

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numeric standards, and total maximum daily loads (TMDLs) for nutrient-impaired streams and rivers. A TMDL represents the maximum load (kg d^{-1}) of a nutrient that a stream can receive and still maintain water quality sufficient to meet its designated uses. Determination of the TMDL is based on the assimilative capacity of the stream for that nutrient, natural or background sources, point and nonpoint inputs, and a specified margin of safety (2). Because the assimilative capacity, discharge, and magnitude of inputs can vary throughout a year, the approach allows for seasonal variation in the TMDL. In streams of the midwestern United States, the effects of eutrophication are most pronounced during periods of low discharge and warm water temperatures in summer and autumn. Nutrient TMDLs tend to focus on critical periods of summer low discharge, while allowing increased nutrient loads during times of high discharge. For example, the Stillwater River drains an agricultural watershed in western Ohio and the approved TMDL for $\text{NO}_2^- + \text{NO}_3^-$ increases from 3122 kg N d^{-1} in October and November to $>6700 \text{ kg N d}^{-1}$ for December through June (2). The highest

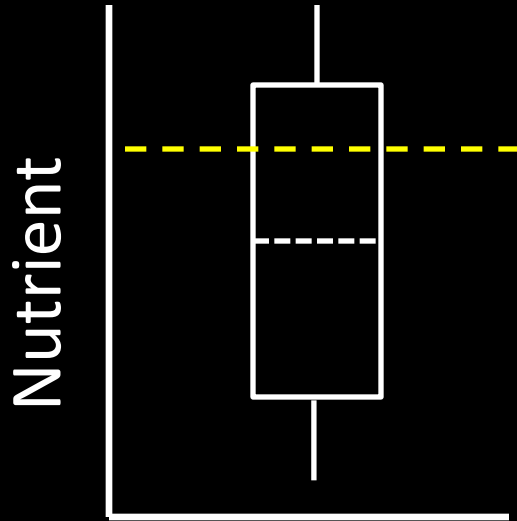
The issue of “scientifically defensible”

Is “scientifically defensible” = “legally defensible”?

What makes a standard, or the approach that developed the standard, scientifically defensible?

Two distinct approaches have been proposed

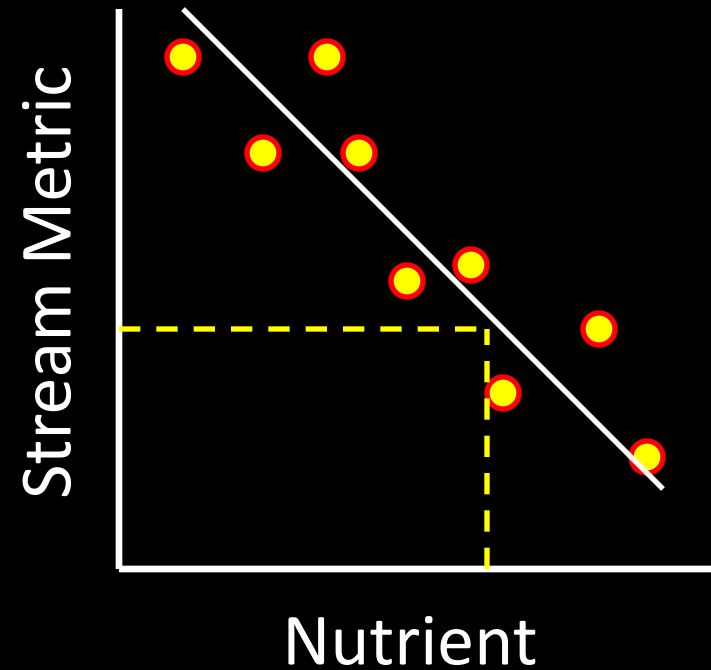
Statistical/Distributional



Simple
Requires nutrient data only

Arbitrary

Effects based



Rigorous and Intuitive

Requires great deal of data
Sophisticated analyses

(both can be combined with a reference condition approach)

What makes a standard, or the approach that developed the standard, scientifically defensible?

- Rigorously collected data (QA/QC)
- Appropriate data analyses
- Based on a hypothetico-deductive model

Approach is based on testable hypotheses regarding the dependent (*stream condition*) and independent (*nutrients*) variables

Challenges

- Lack of hypothetico-deductive data collection
- For streams, excessive nutrients are rarely, if ever, the sole cause of impairment
- Clean Water Act provides few options for non-point sources

It is a common misconception that generators of non-point source inputs can be regulated; no such authority in the CWA

Lack of hypothetico-deductive data collection

Monitoring data provide context and describe conditions, but often are inappropriate for effects based models

Agencies are forced to “shoe-horn” existing data into a model; can result in statistical acrobatics (e.g., conditional probability)

Probabilistic data collection is not necessarily hypothetico-deductive data collection

For streams, excessive nutrients are rarely, if ever, the sole cause of impairment

TECHNICAL REPORTS: SURFACE WATER QUALITY

Assessment of Chlorophyll-*a* as a Criterion for Establishing Nutrient Standards in the Streams and Rivers of Illinois

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TECHNICAL REPORTS: SURFACE WATER QUALITY

Relationships between Water Quality, Habitat Quality, and Macroinvertebrate Assemblages in Illinois Streams

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Relationships among Nutrients, Chlorophyll-*a*, and Dissolved Oxygen in Agricultural Streams in Illinois

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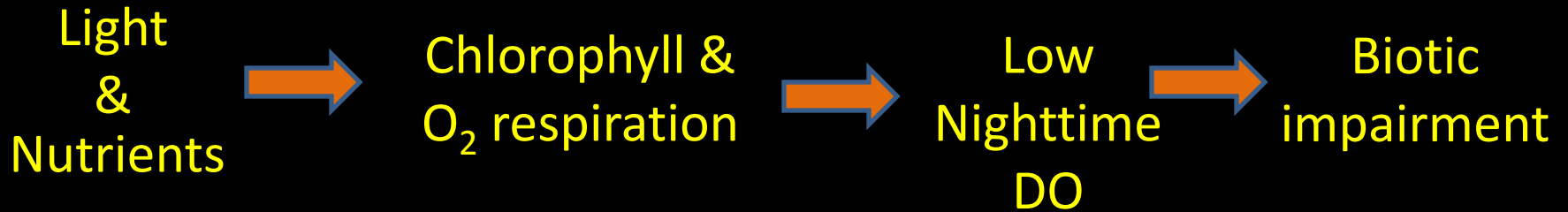
ABSTRACT

A better understanding of the controls on algae and dissolved O₂ in agricultural streams of Illinois is needed to aid in development of nutrient standards. We investigated the relationships between dis-

tion, with some moderate diurnal fluctuation caused by temperature and metabolism (Walling and Webb, 1992).

In freshwater systems, increased inputs of P are of particular concern because it commonly is the limiting

Initial Model for Illinois Streams



How strong is this relationship in Illinois streams?

Can we relate nutrients and algae (chl-*a*) across Illinois?

Does O₂ respond as expected?

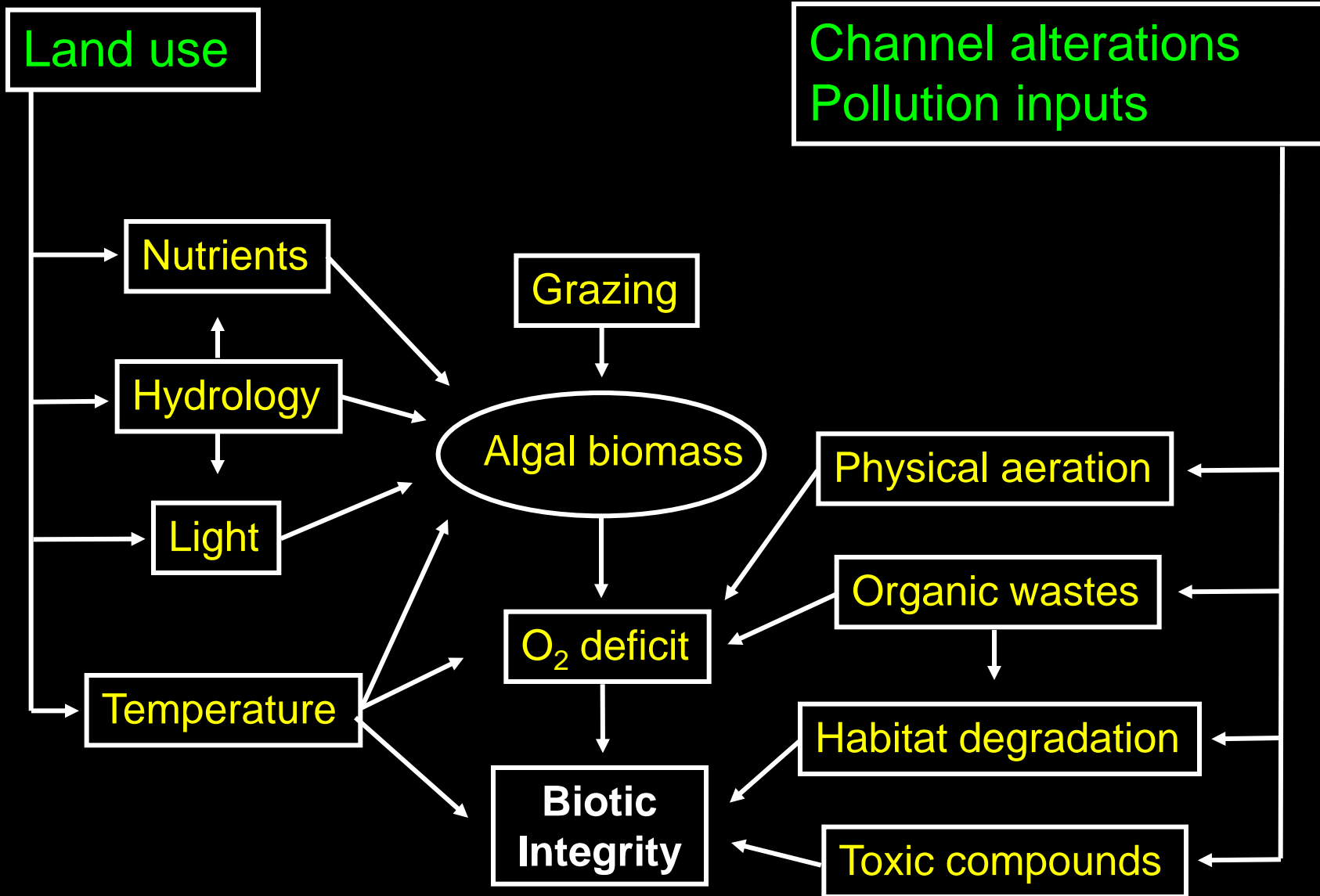
Results from our work in Illinois

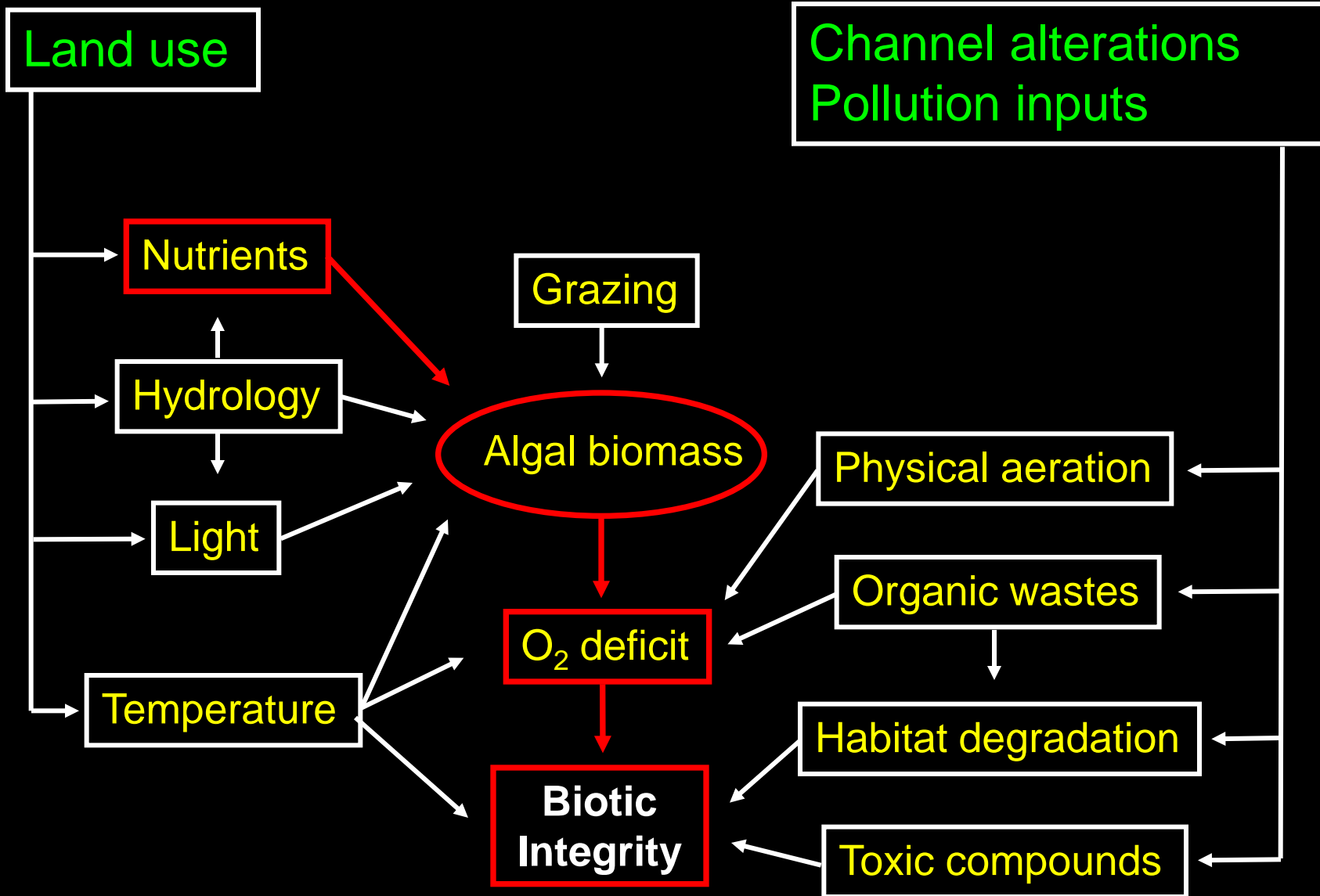
At a statewide scale, we did not observe strong nutrient-chlorophyll relationships

Nutrients are not the limiting factor for algal biomass in most Illinois streams and rivers

Substrate conditions and water clarity (light penetration) are at least as important as nutrients in determining algal abundance

Elevated nutrients did not consistently cause low O₂





We rejected our initial model (hypothesis) and formulated a new hypothesis:

Nutrient standards are unlikely to have a large effect on biotic integrity without concurrent improvements in stream habitat



Opportunities

- Outreach and engagement with stakeholders
- Educate public about water resources and the Clean Water Act
- Improve state and national monitoring programs
- Implementation of nutrient standards could be a “grand experiment”

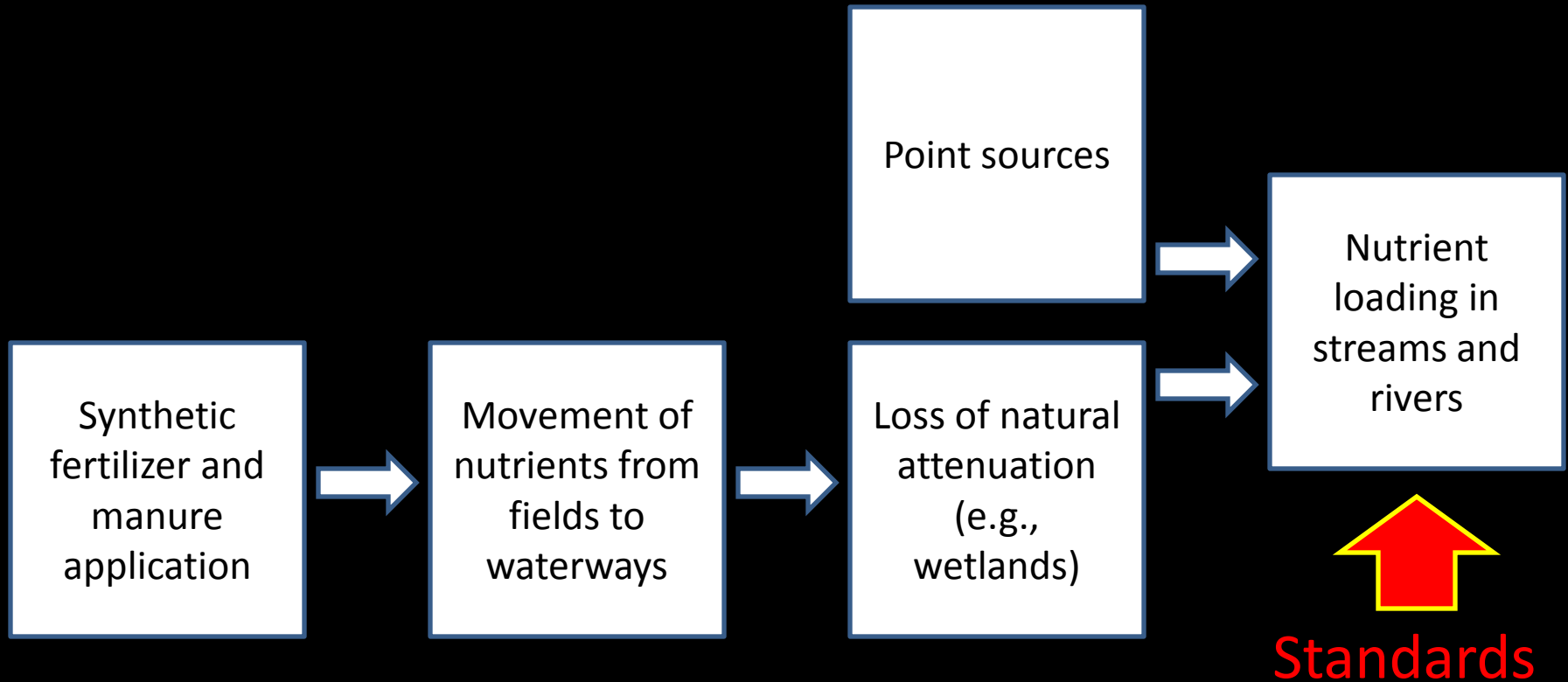
Illinois Nutrient Summit

The Illinois EPA has organized a 2 day nutrient summit on September 13-14 in Springfield.

Stakeholders who are invited include agriculture, municipal water treatment systems, environmental groups, academics, scientists, etc.

The goal is to have an overall discussion of how we can reduce nutrient losses to rivers and streams, with participation toward these goals from all segments of society.

Nutrient standards are “end of pipe”:



Will standards and TMDLs cause changes upstream?

Challenge and Opportunity

Ecological data and
conclusions



“the data suggest”

Statewide,
regulatory standard

“the law is”

Thank you!

