ASSESSING IMPACTS OF NUTRIENT LOADING ON CULTURABLE E. COLI IN RE-CREATED NATURAL STREAM MESOCOSMS

LUCAS GREGORY

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“IN WINE THERE IS WISDOM, IN BEER THERE IS STRENGTH, IN WATER THERE IS BACTERIA”
Inhabitants of bird and mammal large intestines are presumed to represent recent fecal contamination when found in secondary environments. These indicator bacteria signify an increased likelihood that fecal pathogens are present.
Quality standards for recreational waters are based on fecal indicator bacteria levels demonstrated to correlate with gastrointestinal illness.

Cause of 14.5% of water quality impairments nationally and 51.4% in Texas.

12,209 Pathogen TMDLs developed since Oct. 1995 across the U.S.
Behavior outside of host not clear

Extended survival in secondary environments observed

Numerous environmental factors influence their fate and transport

It is a living organism...not a contaminant with defined decay rate
LACK OF COMPLETE UNDERSTANDING

- Has likely:
  - Caused inappropriate impairment listings
  - Made bacteria pollution source identification more difficult, complex and costly
  - Hindered proper management planning
  - Led to recommendations of ill-advised management approaches
  - Stakeholder and manager uncertainty
What are the real sources of bacteria observed in environmental samples?

How do you reduce levels of ‘background,’ or ‘indigenous’ bacteria?

If bacteria are naturalized in the system, do they signify a real risk to humans recreating in these waters?

Are applied standards:

- appropriate for multiple waterbody types?
- effectively or overly protective of human health?
NEED FOR & BASIS OF WORK

- Continue to develop the understanding of impacts that ambient conditions have on bacteria fate
  - Improve bacteria fate and transport modeling capability
  - Prescribe more appropriate management measures

- Considerable work previously completed
  - Individual, or small number of parameters
  - Unnatural conditions
    - Sterilized lab environments
    - Limited influential factors
    - Non-wild type bacteria
PLANNED APPROACH

- Monitor culturable *E. coli* response to nutrient amendments in re-created natural stream mesocosms

Hypothesis:
- Addition of nutrients to system will significantly affect culturable *E. coli* growth and persistence in re-created stream mesocosms
**EXPERIMENTAL DESIGN**

- Test effects of “low” and “high” nutrient dose on *E. coli* growth and persistence relative to ambient nutrient load in control

- Lab based set up prevents addition of *E. coli* and other uncontrolled factors from impacting the system

Old algae raceways
**SAMPLING SCHEME**

- Initial sample from each raceway when filled
  - Establish baseline *E. coli* and nutrient levels
  - Initial nutrient levels used to develop ‘low’ and ‘high’ nutrient doses (~25% and 100% increases respectively)

- Nutrient dose applied at Day 1

- Sample daily until *E. coli* no longer culturable

- Each sample analyzed for:
  - *E. coli* (mTEC) (EPA 1603)
  - pH
  - DO
  - Conductivity
  - Water Temp
  - Turbidity
  - Nitrate
  - Ammonium
  - Total Nitrogen
  - Dissolved Organic Nitrogen
  - Dissolved Organic Carbon
  - Orthophosphate
No treatments applied

Natural *E. coli* attenuation vs. change in nutrient suite observed

Didn’t quantify total heterotrophic community activity
  - Will add for later trials
COMBINATION OF FEATURES

- Natural creek water medium

- No alterations to pre-existing microbial community
  - Allows competition and predation

- Suite of nutrients represented in two-level treatments that mimic small and large storm event influences
LIMITATIONS

- Not repeatable research
  - Natural instream conditions can’t be duplicated

- Does not truly represent real-instream conditions
  - Mesocosms kept indoors so temperature and UV are not accounted for; no influx of additional pollution
  - Does not incorporate stream sediment and its interactions with the water column

- No assessment of non-culturable *E. coli* included
Response in microbial activity as a result of nutrient doses
- *E. coli* or heterotrophic community
- Diminished *E. coli* decay rates

Provide insight into instream *E. coli* response to nutrient loading during rain events

Improve ability to model *E. coli* fate & transport

Improve management planning
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QUESTIONS?

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