

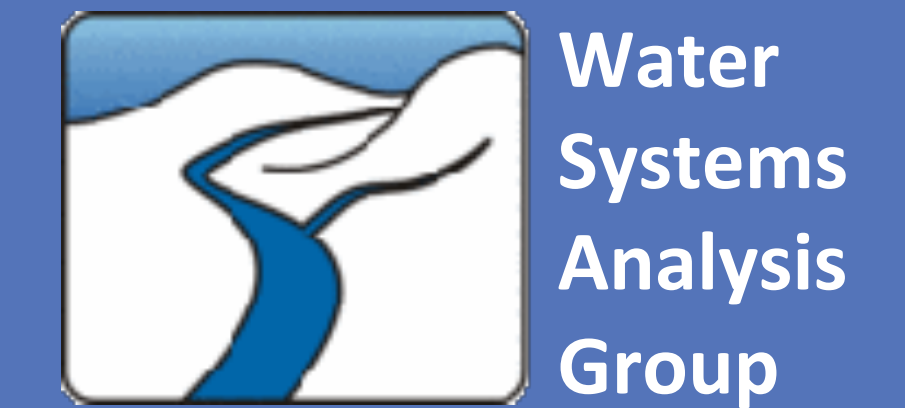
Why do We Need Healthy Rivers?

Understanding Fecal Coliform Removal by River Networks

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INTRODUCTION

Outbreak of waterborne disease is a worldwide water quality issue because waterborne diseases cause health, social, and economic problems.

The application of dynamic hydrologic models to simulate the fecal coliform loads and removal in varied aquatic ecosystems is still limited.

Rationale:

Human development has a significant impact on water quality, and quantifying this impact is critical.

Dynamic watershed-scale models are needed to understand the sources, transport and fate of fecal coliform and the consequences for water quality at broad regional scales and how they vary over time.

Research questions:

Are river networks important regulators of fecal coliform transfer from source areas to critical water bodies?

Hypothesis:

River networks play an important role of the fate and transport of fecal coliform. The varied hydrologic conditions cause the difference of fecal coliform decay and lead to the variations of fecal coliform removal among aquatic ecosystems.

OBJECTIVES

To address the overarching question we will use a spatially distributed modeling approach that accounts for the location of sources, routing, and in-stream transformations.

STUDY AREA

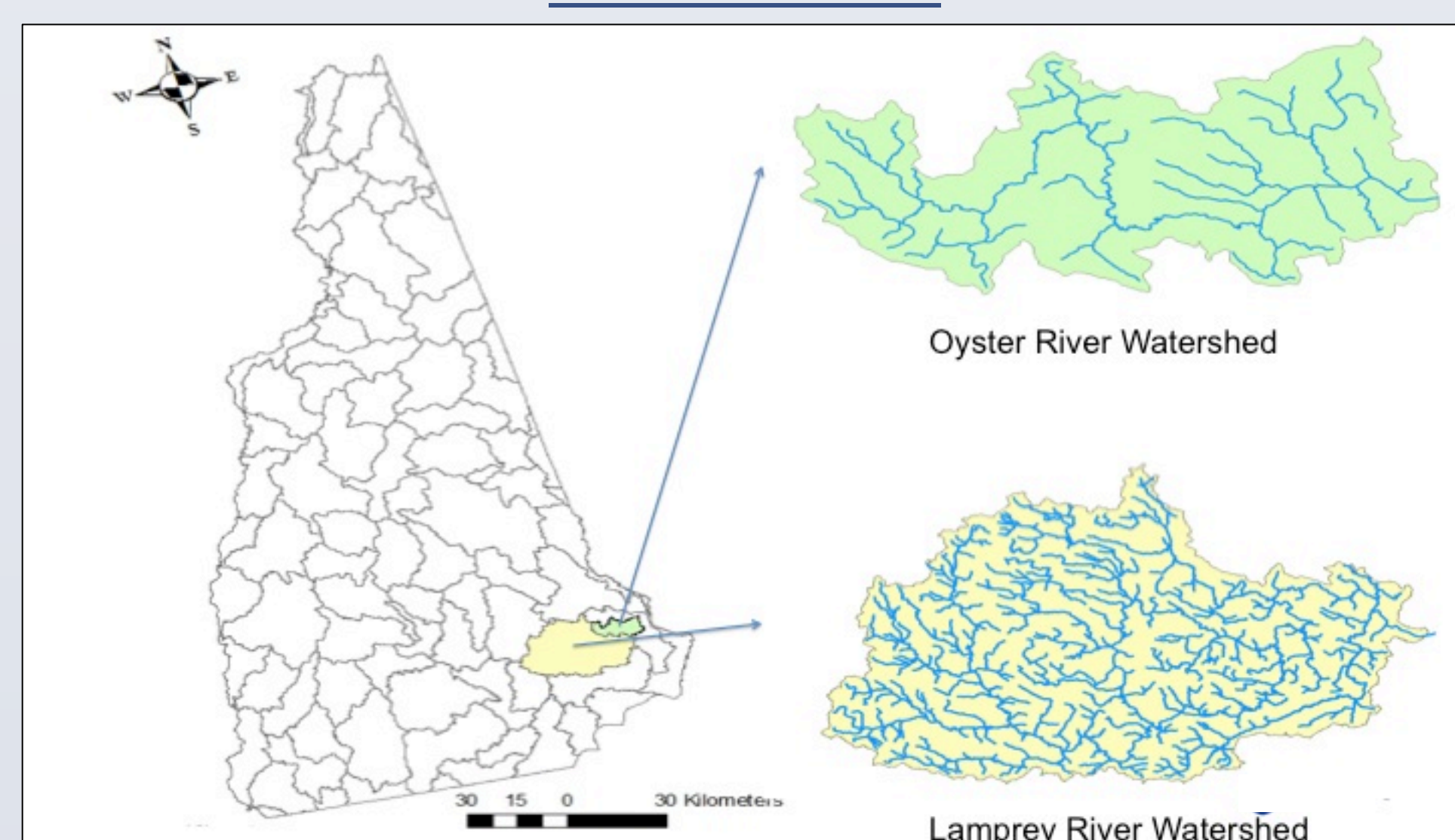


Fig 1. Locations of study watersheds

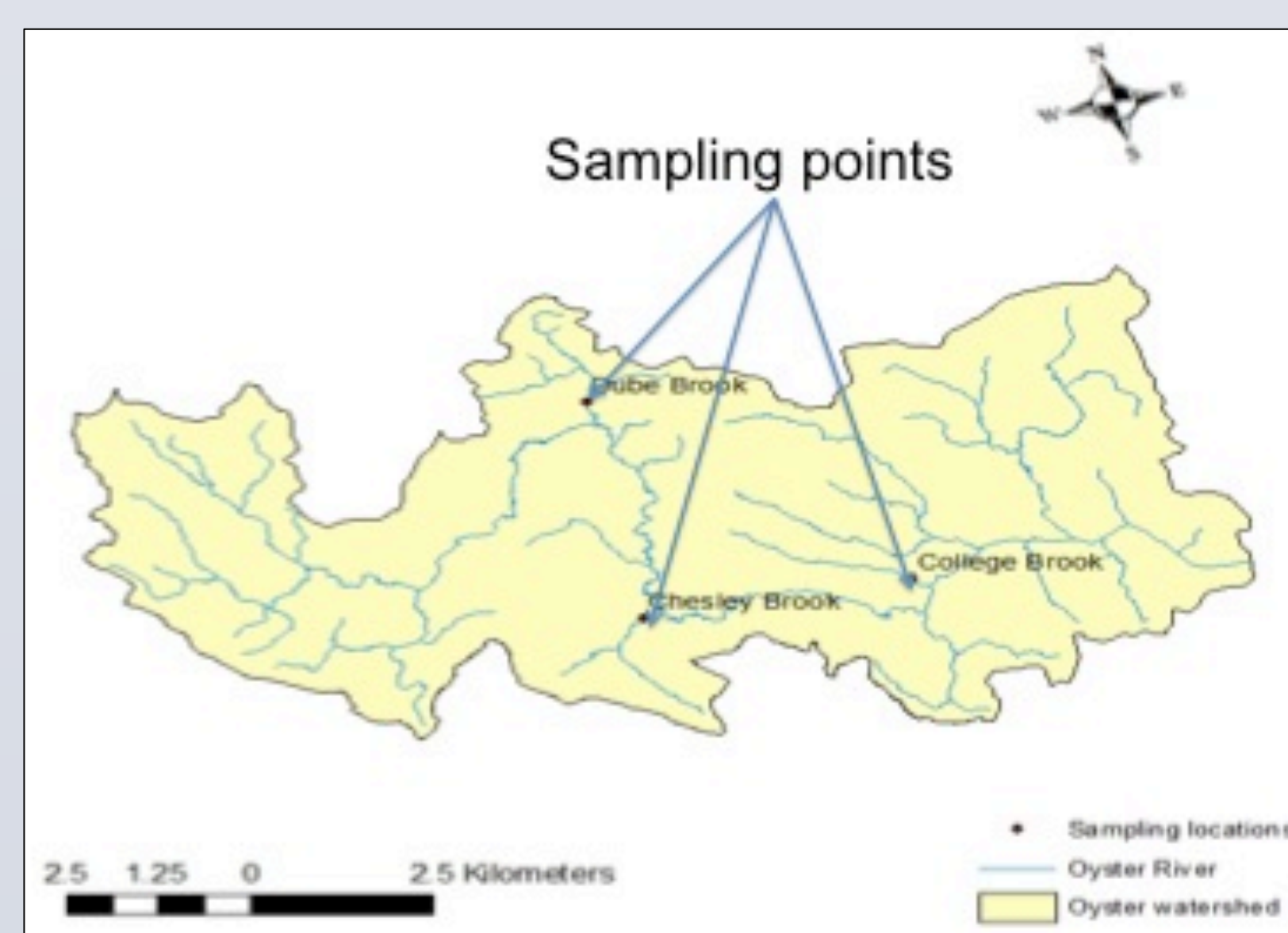


Fig 2. Locations of field sampling locations

Watershed characteristics

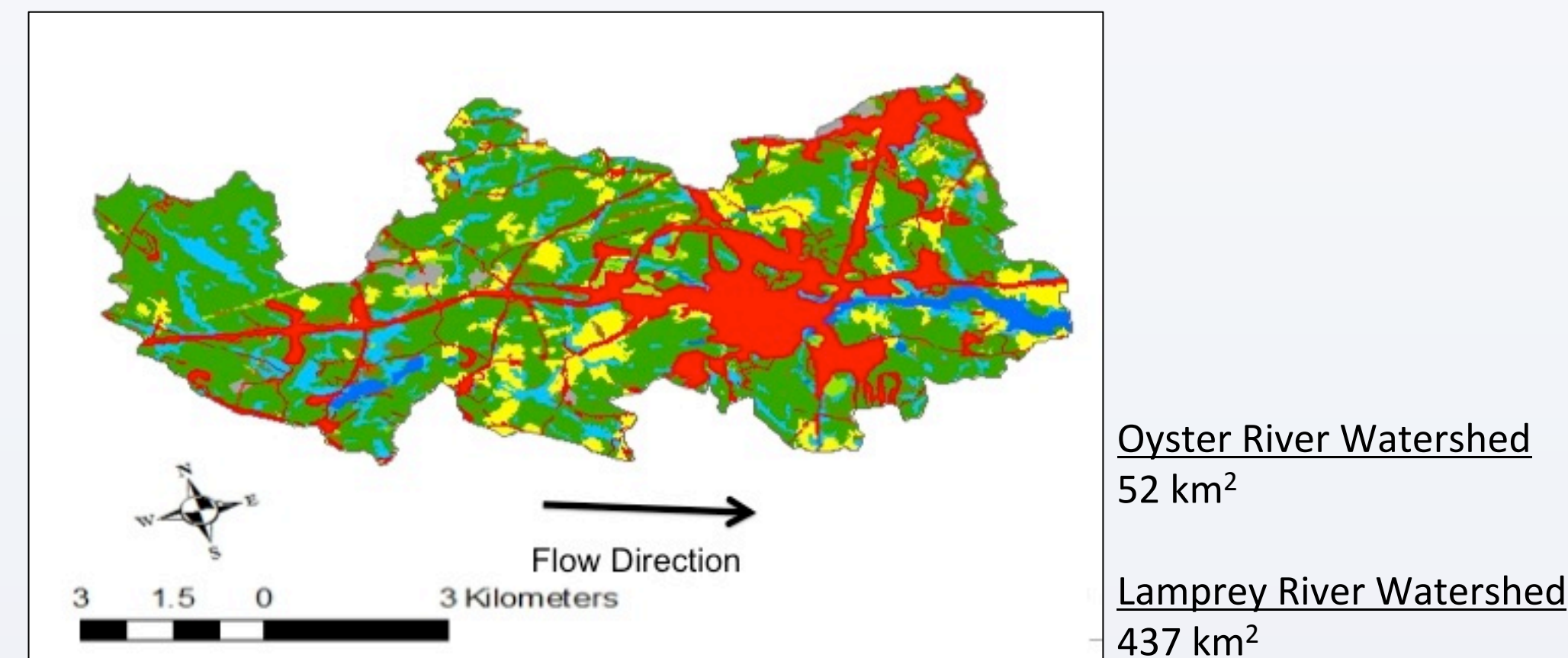


Fig 3. Land use of Oyster River Watershed

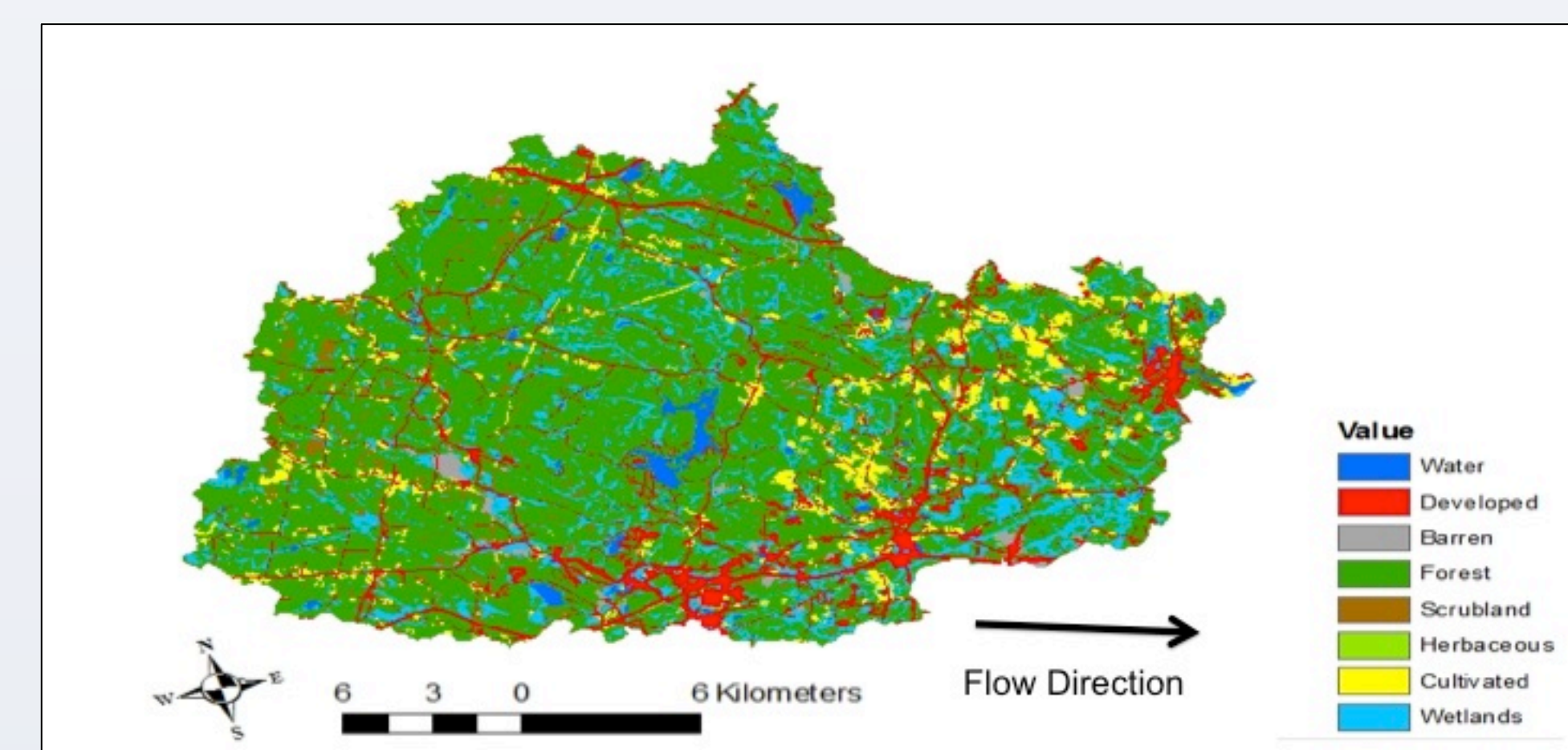


Fig 4. Land use of Lamprey River Watershed

METHODS

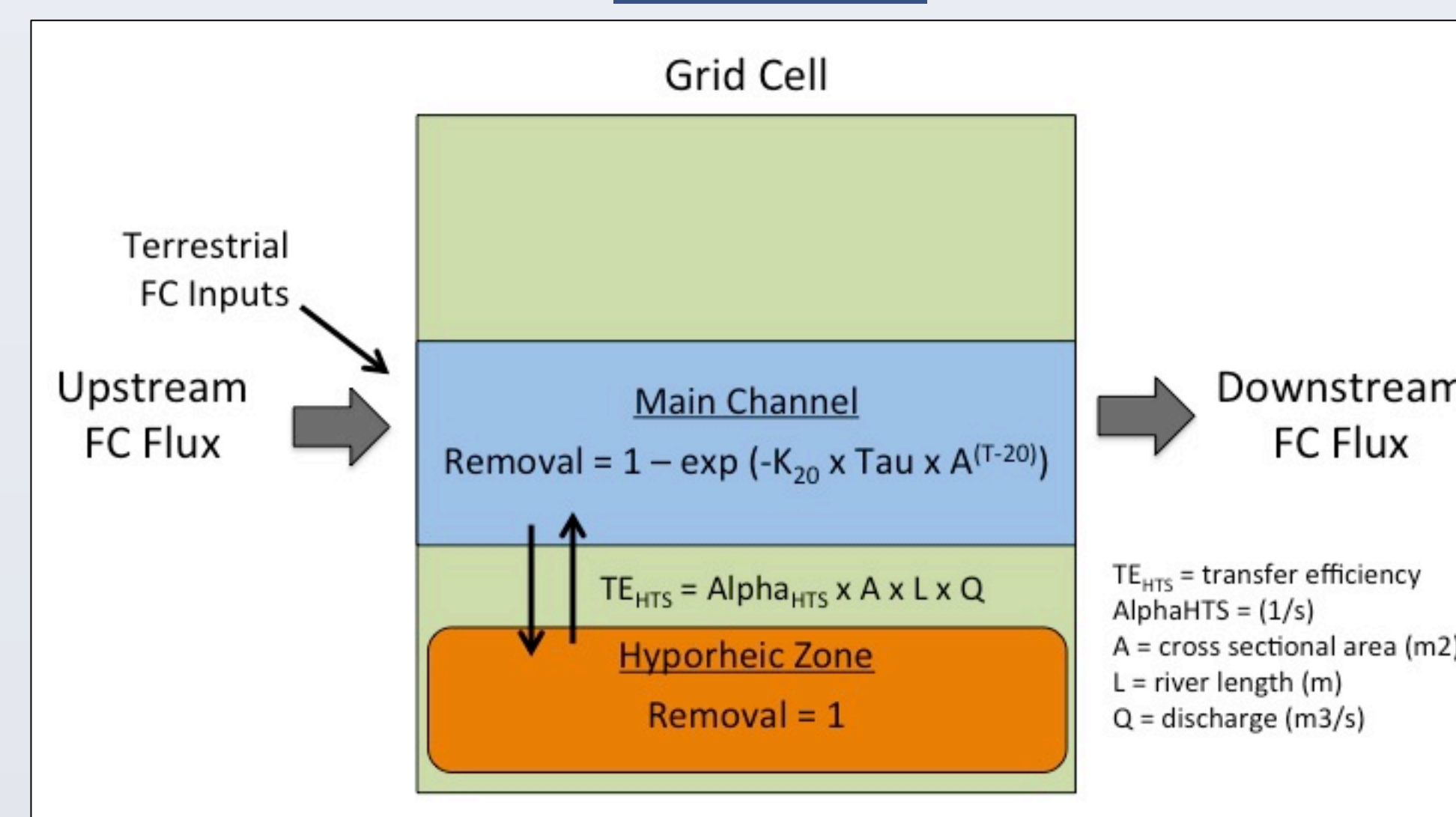


Fig 5. Model framework

E. Coli is used as an indicator organism for fecal contamination because its presence in water in defined amounts indicates that sewage may also be present.

We developed a fecal coliform (FC) module in the Framework for Aquatic Modeling in the Earth System (FrAMES) model, an existing spatially distributed river network model that accounts for storm runoff, routing, water temperature, land use effects, and serial processing in the river network.

Main channel removal was calculated by the first-order decay function. In this study, we assumed all the fecal coliform entering hyporheic zone is removed because mixing of river water with shallow groundwater across the porous sediment (hyporheic exchange) retains fecal coliform.

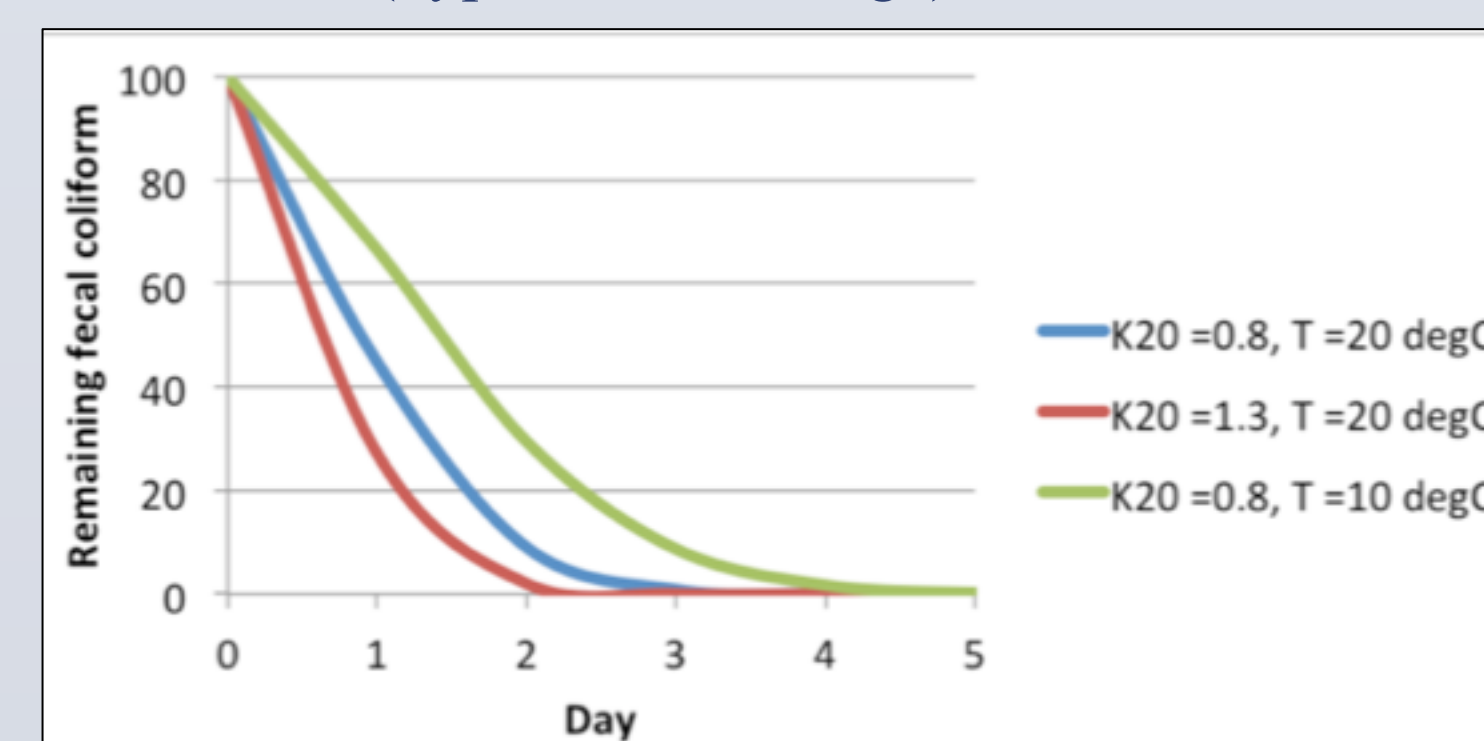


Fig 6. First-order decay process in main channel

RESULTS

In this section, both field data and simulated results are presented.

Fecal coliform and storm events

Most storm runoff enter aquatic ecosystems as untreated discharge.

Heavy rainfall can lead to overflow of storm drains that may be combined with the sewage system.

High level of fecal coliform usually observed after storms.

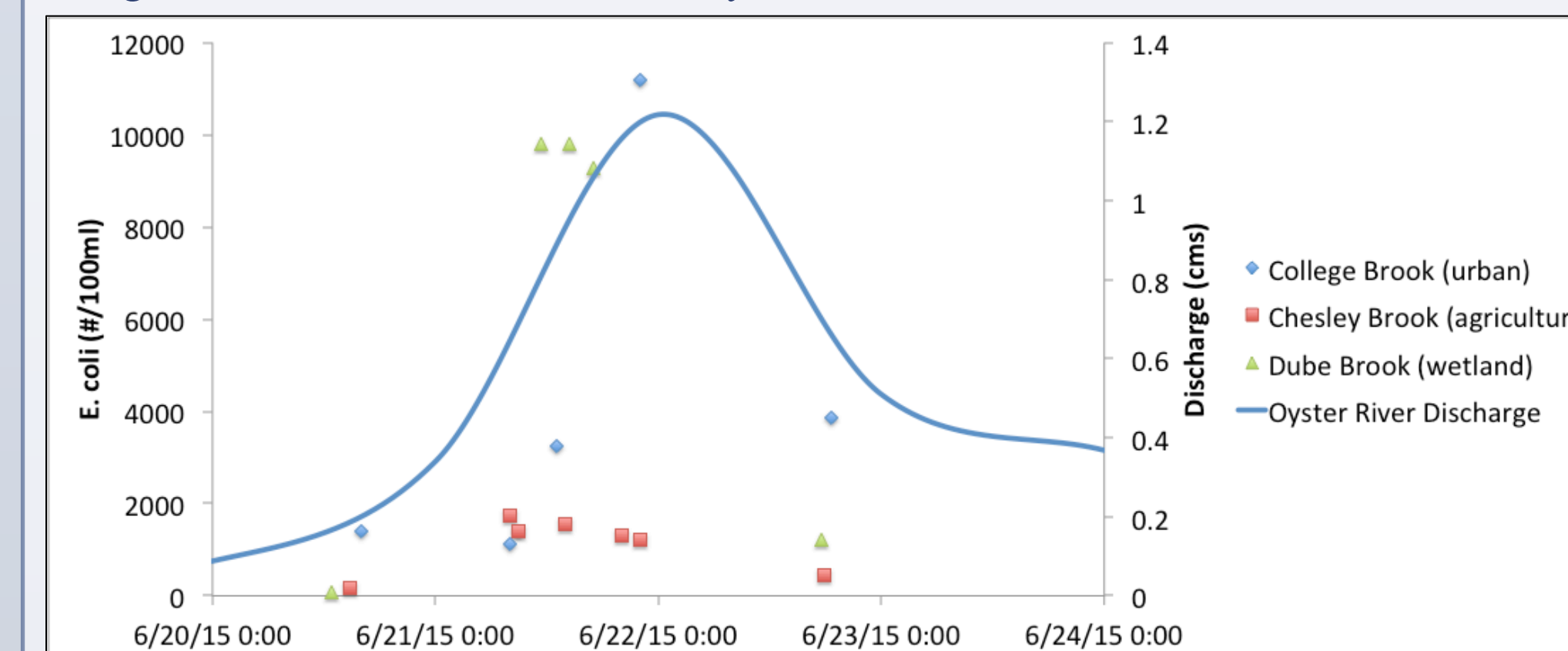


Fig 7. The breakthrough curve of a storm event

Effective discharge for fecal coliform

High flow is effective for fecal coliform load.

Effective discharges of fecal coliform input and removal occur in high flow conditions.

The capacity of river networks to remove fecal coliform inputs reduced in high flow conditions.

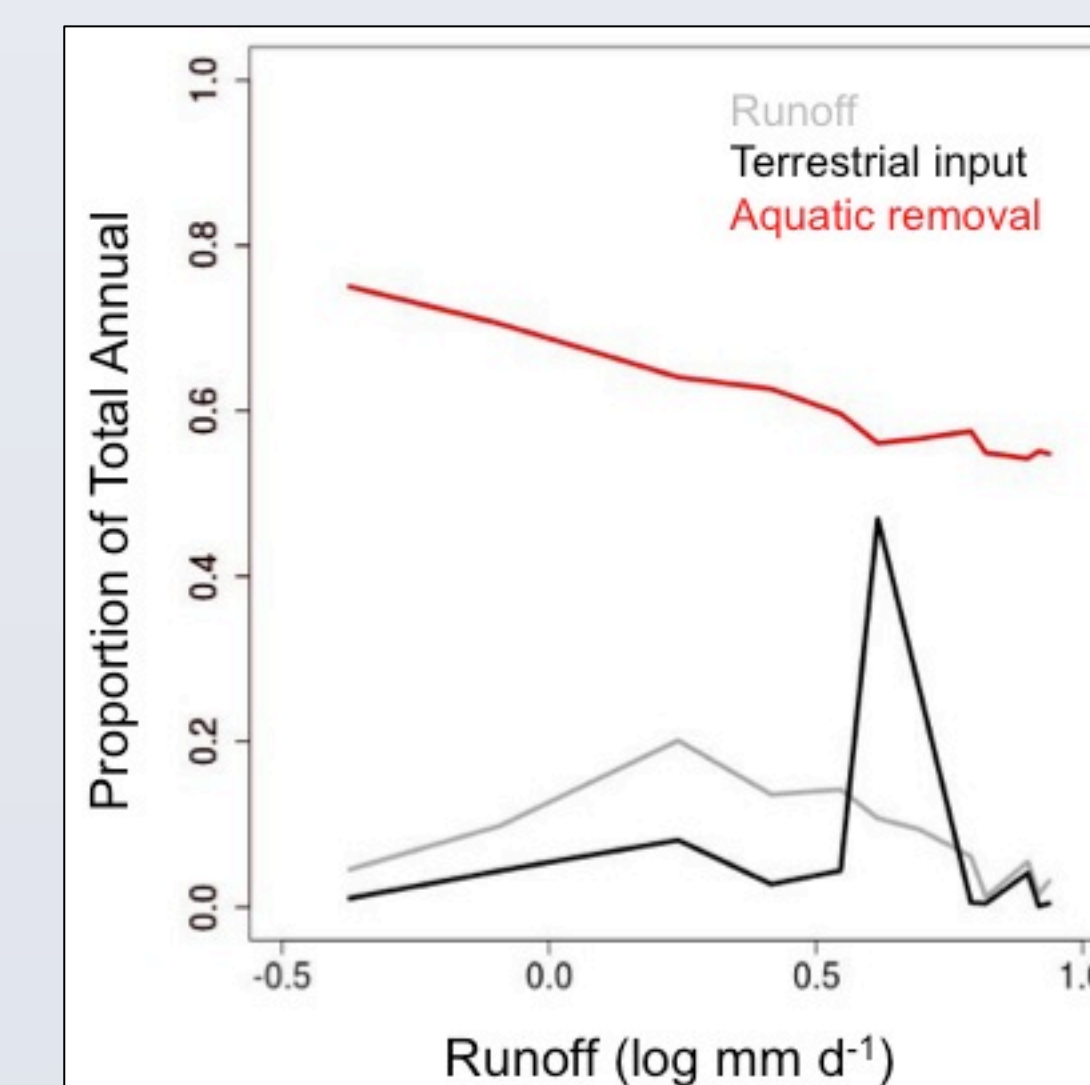


Fig 8. Aquatic removal across hydrologic conditions

Fecal coliform concentration along the river

Possible sources anthropogenic sources of fecal contamination include failing septic systems and storm runoff.

Fecal coliform was removed from upstream to downstream, and fecal coliform concentration in turn is reduced.

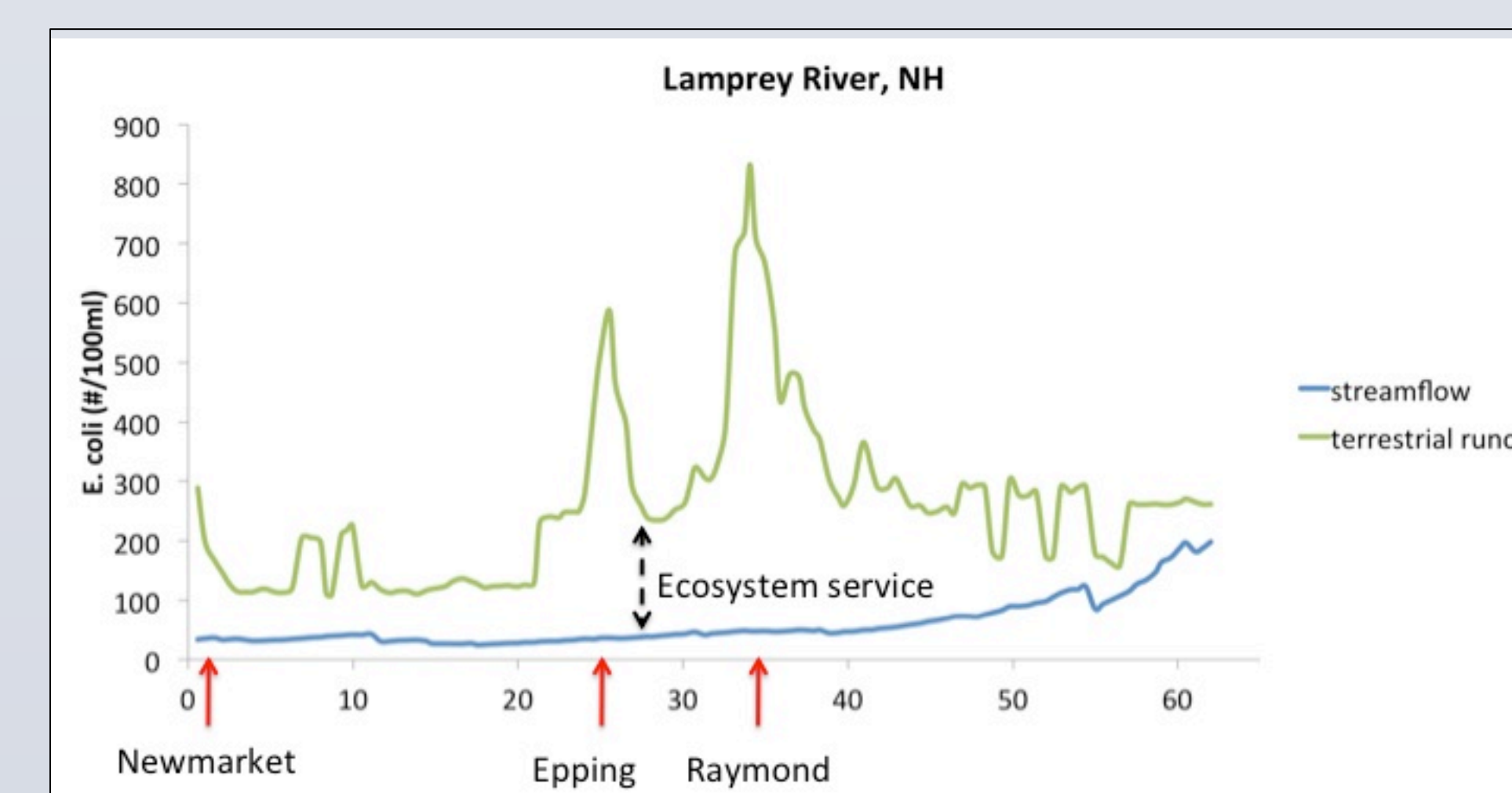


Fig 9. Basin profile

Fecal coliform removal across scales

Larger watersheds remove more fecal coliform.

In large watersheds, it takes longer traveling time for fecal coliform transport from sources to receiving water. Longer traveling time results in more removal.

Larger rivers have more benthic areas and hyporheic exchange. Slower velocity results in more sorption and sedimentation to remove fecal coliform.

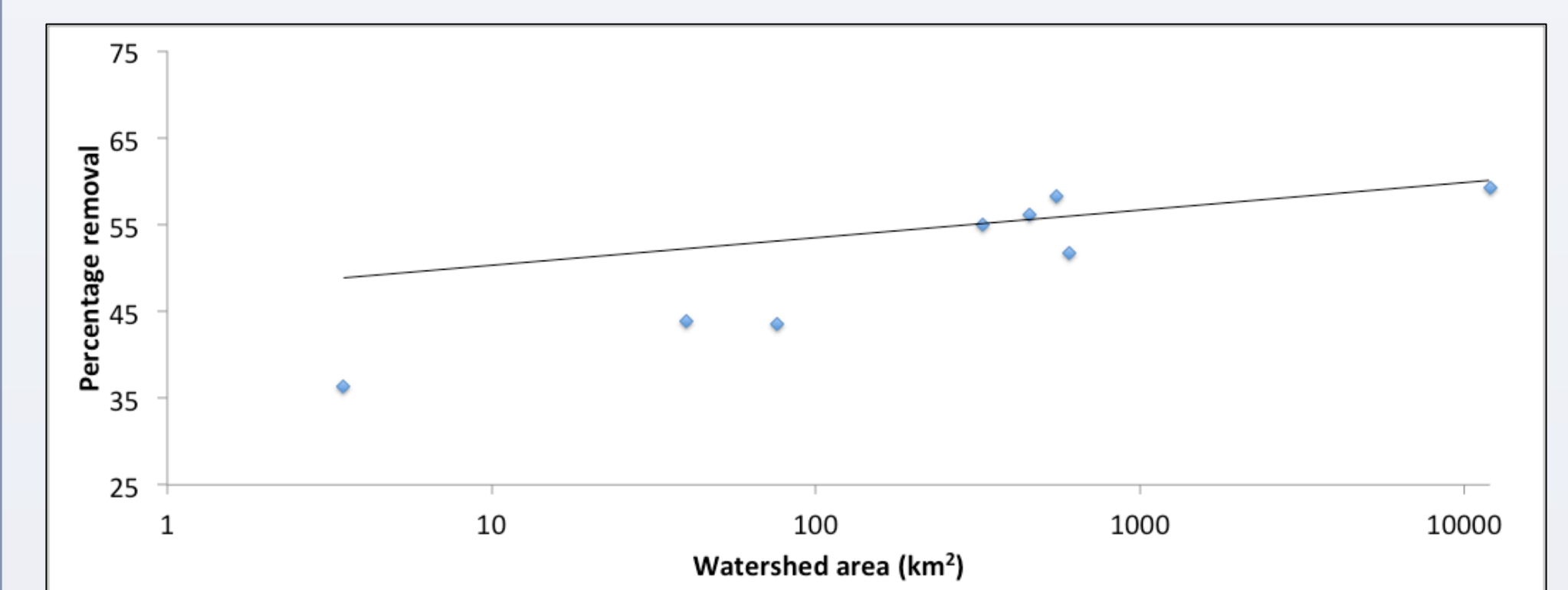


Fig 10. Fecal coliform removal vs. watershed size

IMPLEMENTATION

The accepted level of E. coli is 126 (#/100mL).

The ecosystem service of fecal coliform removal prevents water from exceeding water quality standard.

Storm would cause more impairment if the ecosystem service of fecal coliform removal is lost.

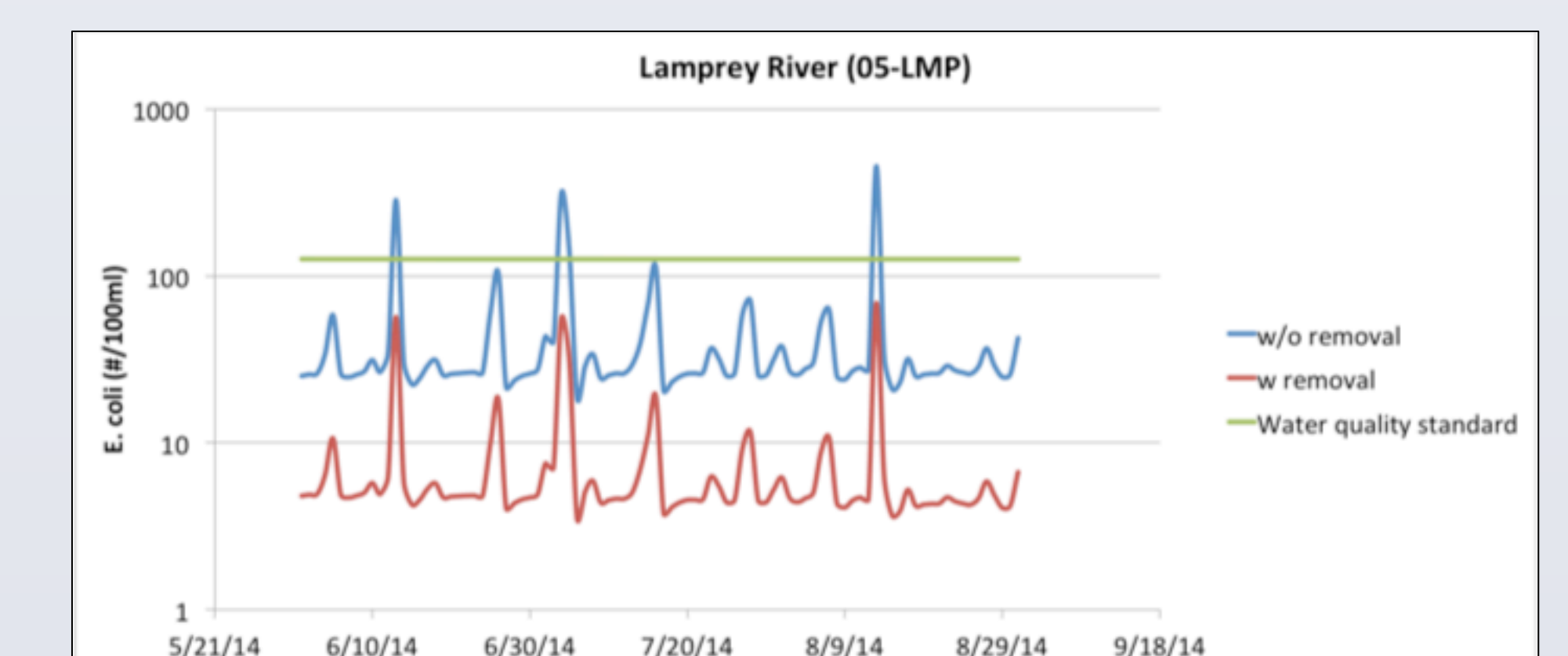


Fig 11. Fecal coliform level and the water quality standard

SUMMARY

River networks have the ability to remove fecal coliform and improve water quality.

The capacity of river networks to remove fecal coliform inputs reduced in high flow conditions.

Large rivers remove more fecal coliform.

CONTACT INFORMATION

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