Using Network & Agglomeration Effects in Ecosystem Service Benefits Assessment

Case study of incentives to cost-effectively address climate change risks

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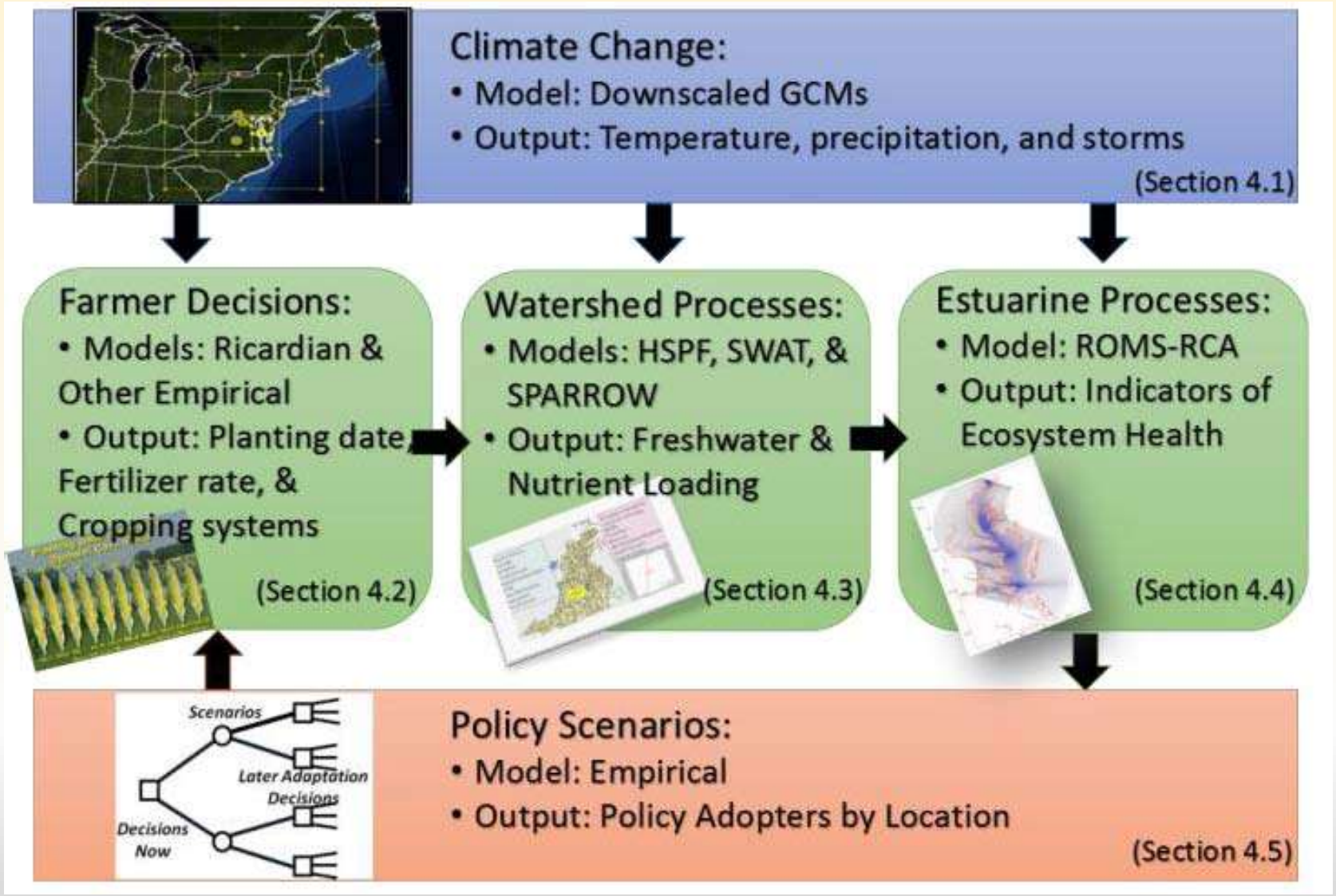
Project Overview

Anticipating and Adapting to Phenologic Changes in the Chesapeake Water System



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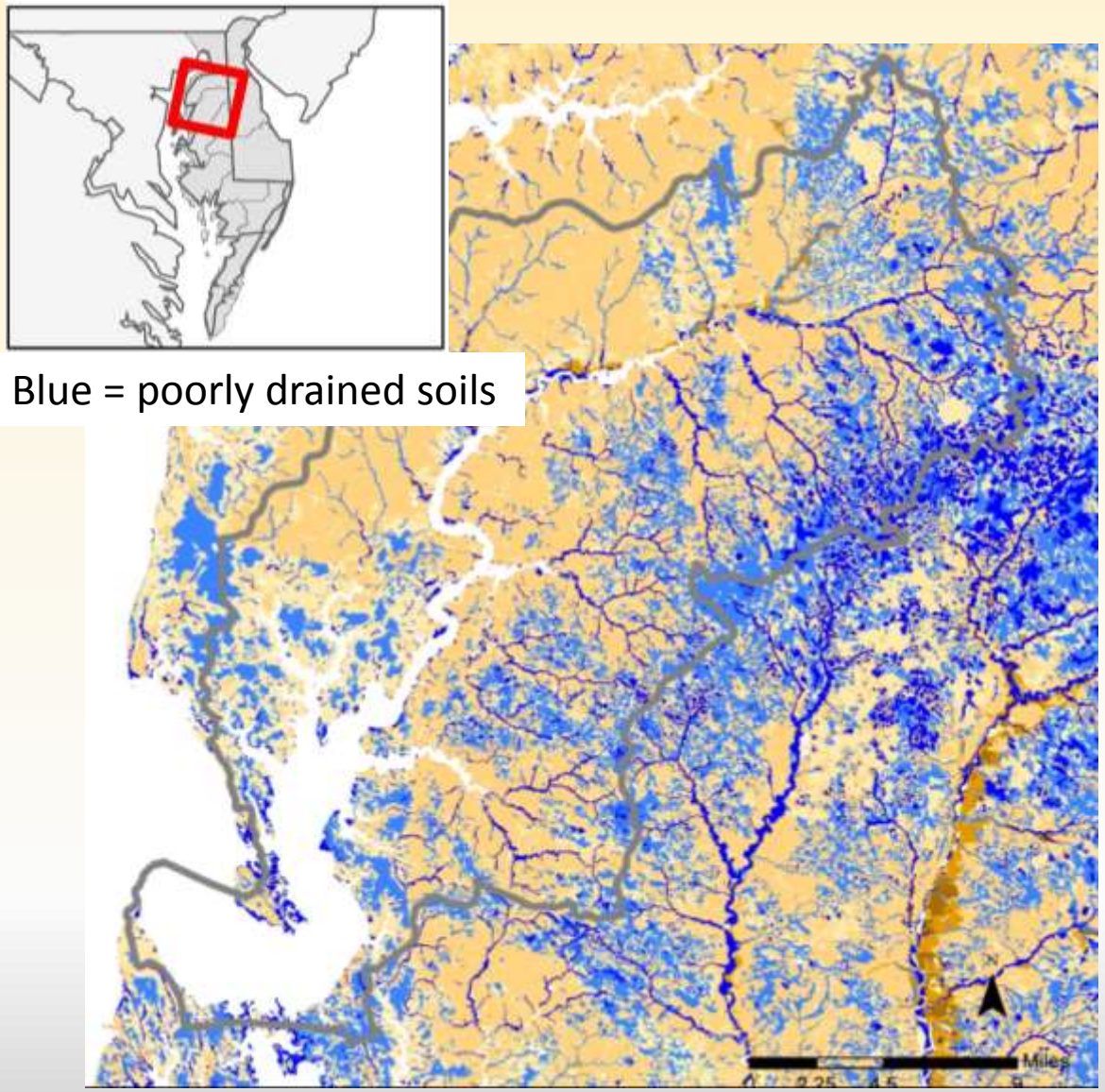
Questions being addressed in policy analysis

Delmarva Case Study

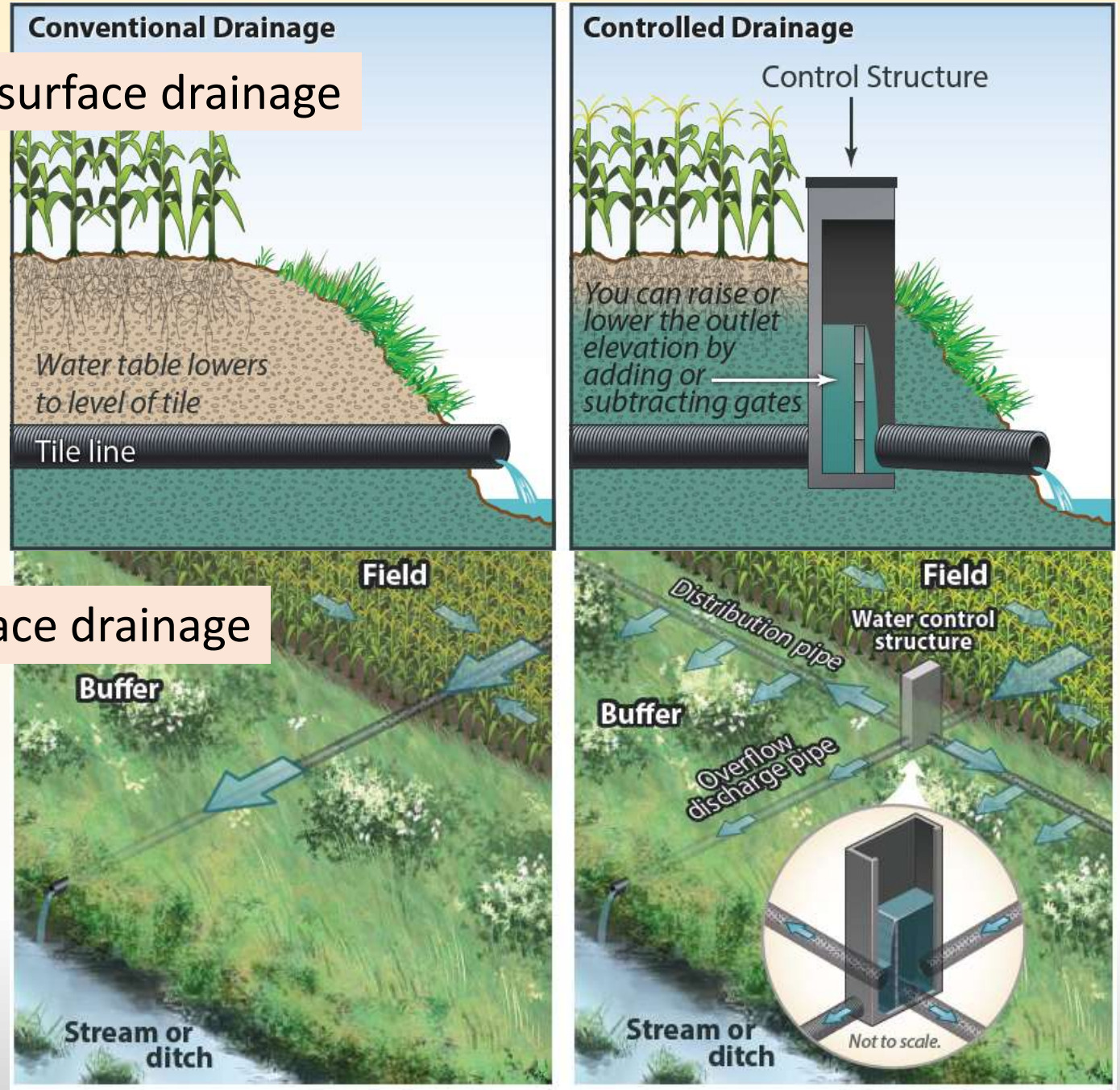
1. What is the capacity for farmland to provide a “rapid-response” option for managing environmental harms of extreme weather?
2. What policy incentives are most cost-effective?
3. Does spatial targeting improve cost-effectiveness?
   - Are there agglomeration and/or network effects that influence benefits?
   - How do more complex policies affect adoption likelihood?



Evaluating effectiveness of incentives for drainage management

Sub-surface drainage

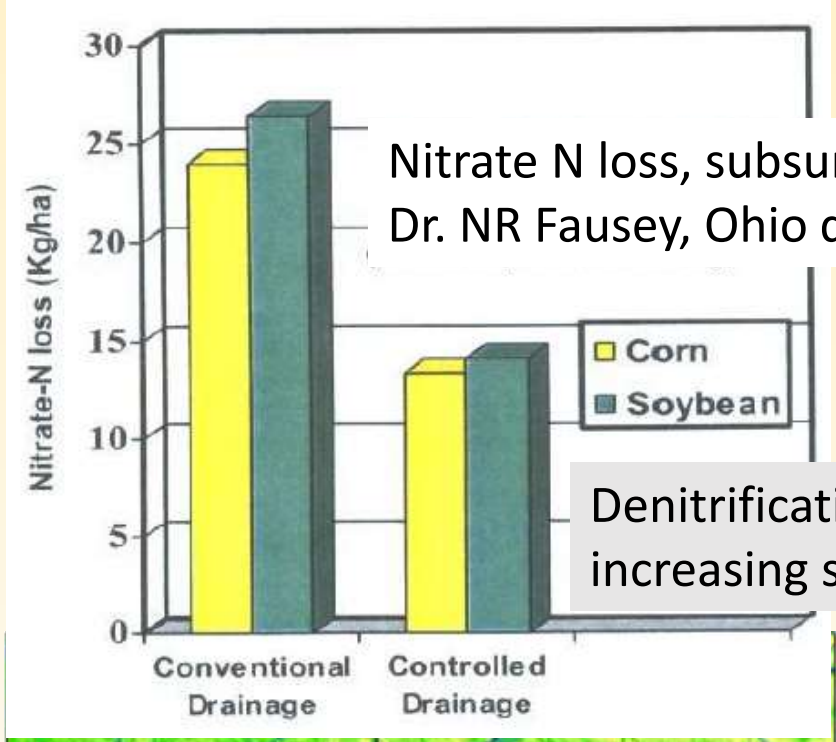
Surface drainage



Ecosystem effects

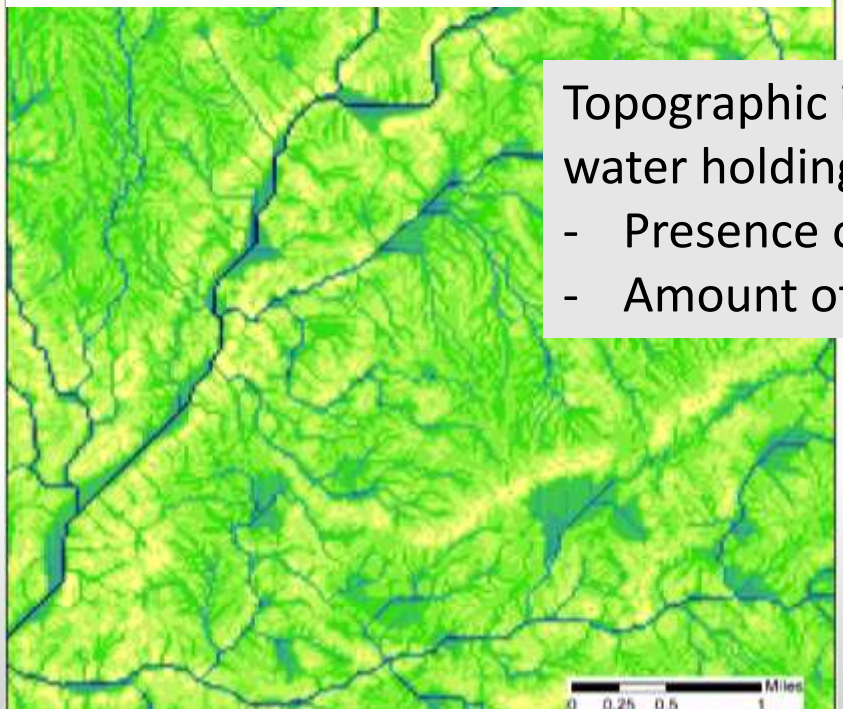
Drainage management affects

- Denitrification
  - Function of topographic index and soil type
- Flood peak attenuation
  - Function of storage capacity and downstream network length



Nitrate N loss, subsurface
Dr. NR Fausey, Ohio data

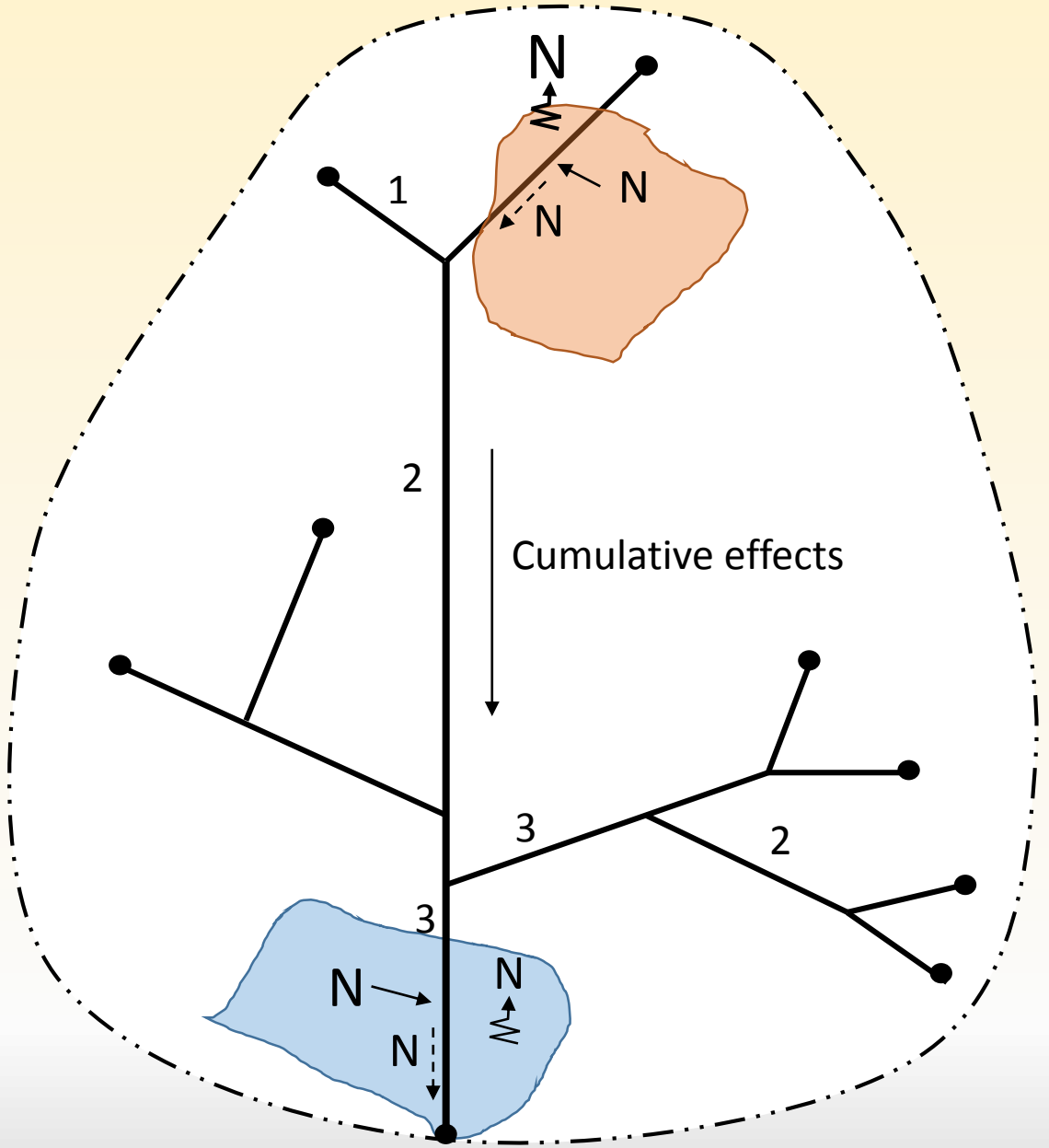
Denitrification from increasing saturated area



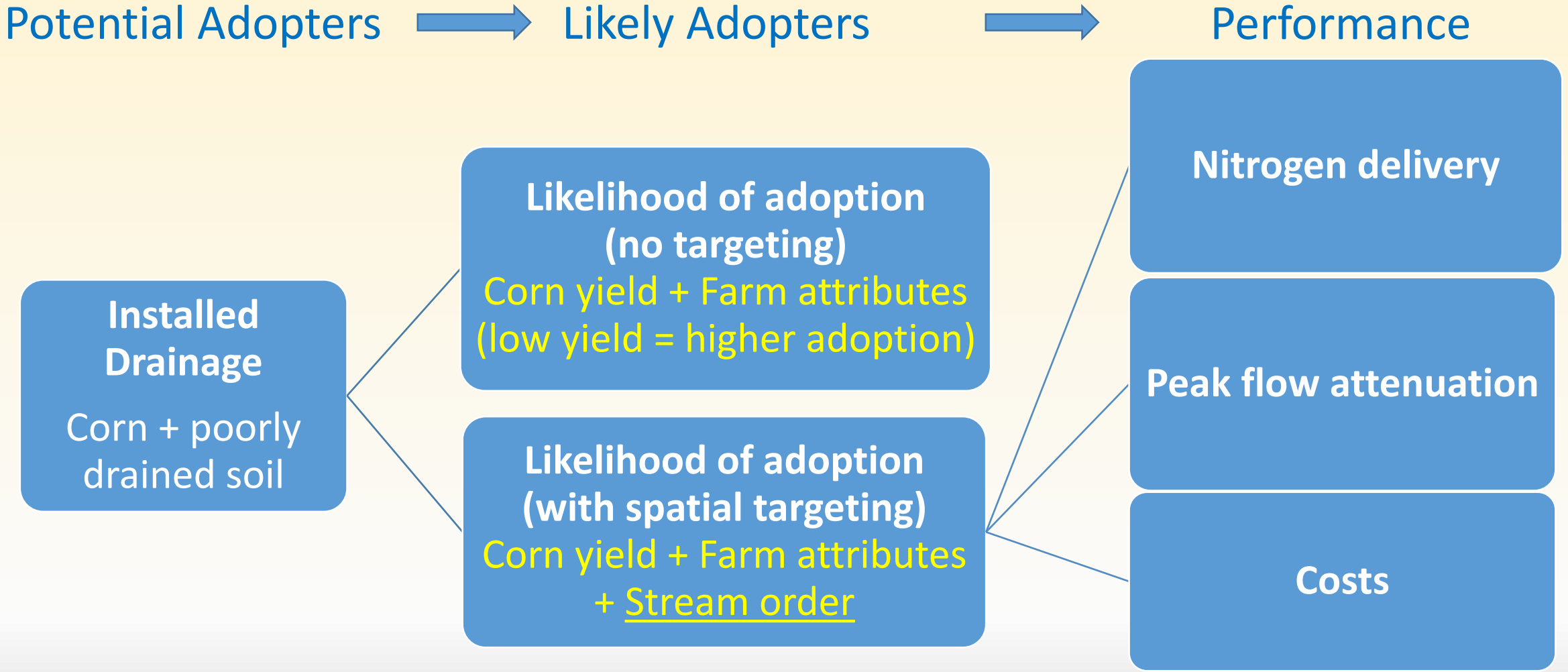
Topographic index reflects water holding capacity
- Presence of depressions
- Amount of upslope area

Spatial variables influence ecosystem service benefits

- Headwaters tend to have greater potential (relative to downstream areas) for:
  - Denitrification
  - Flood peak attenuation
- Benefits accumulate along stream network
  - Larger portion of stream improved
  - More land protected from floods
- A competing effect – Total downstream *delivered* N load may be more cost-effectively reduced low in the network



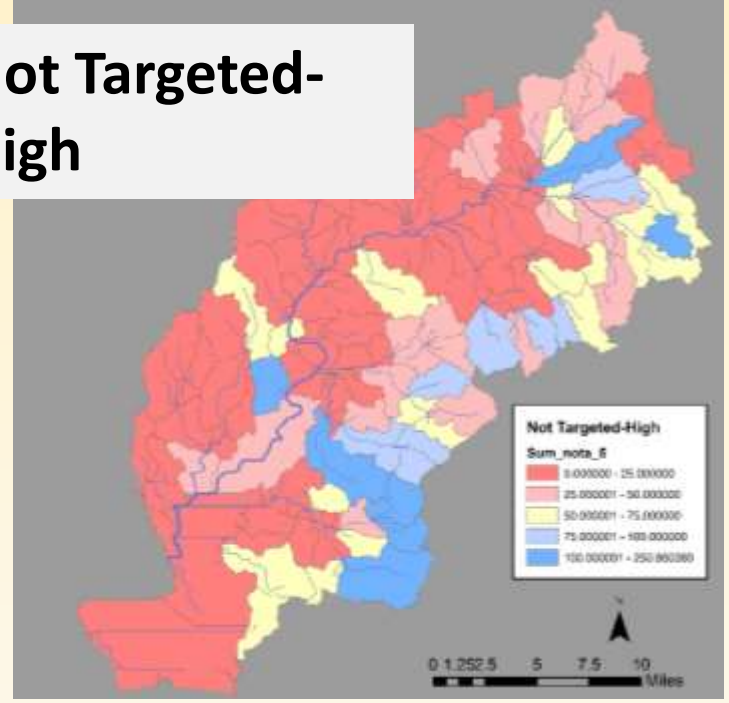
Methods for proof of concept analysis



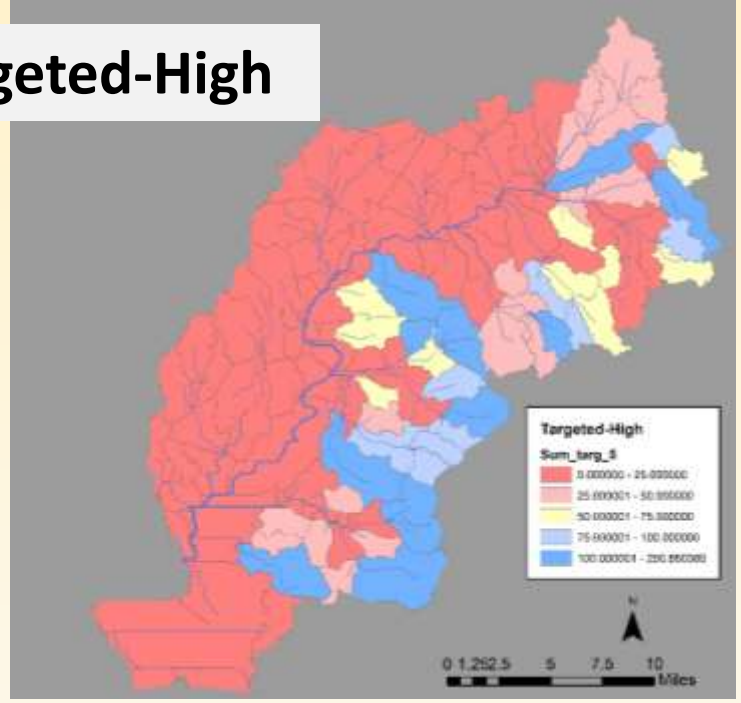
Results

Area & Distribution of Adopting Parcels by sub-watershed

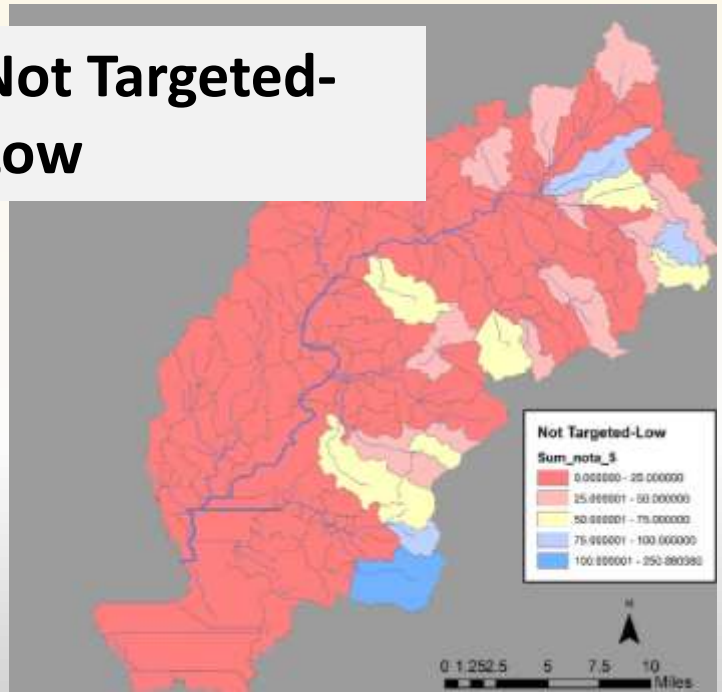
Not Targeted-High



Targeted-High

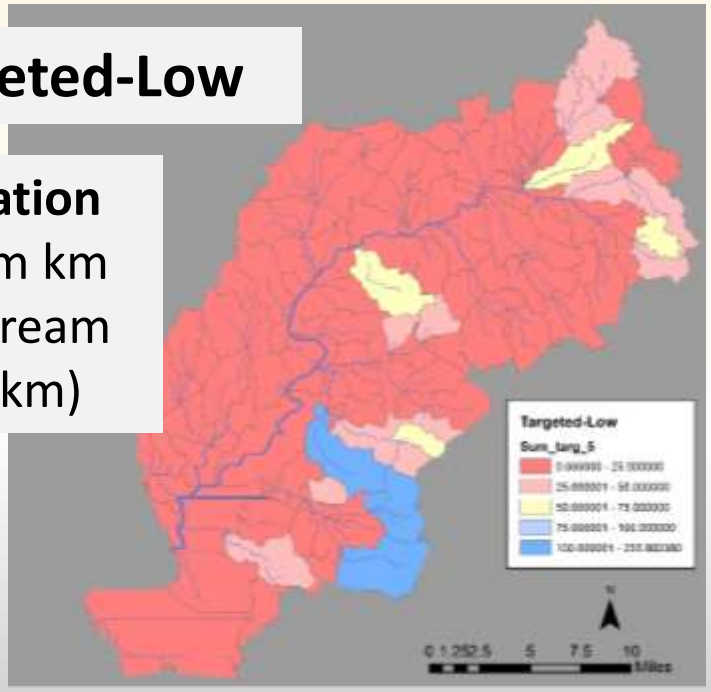


Not Targeted-Low



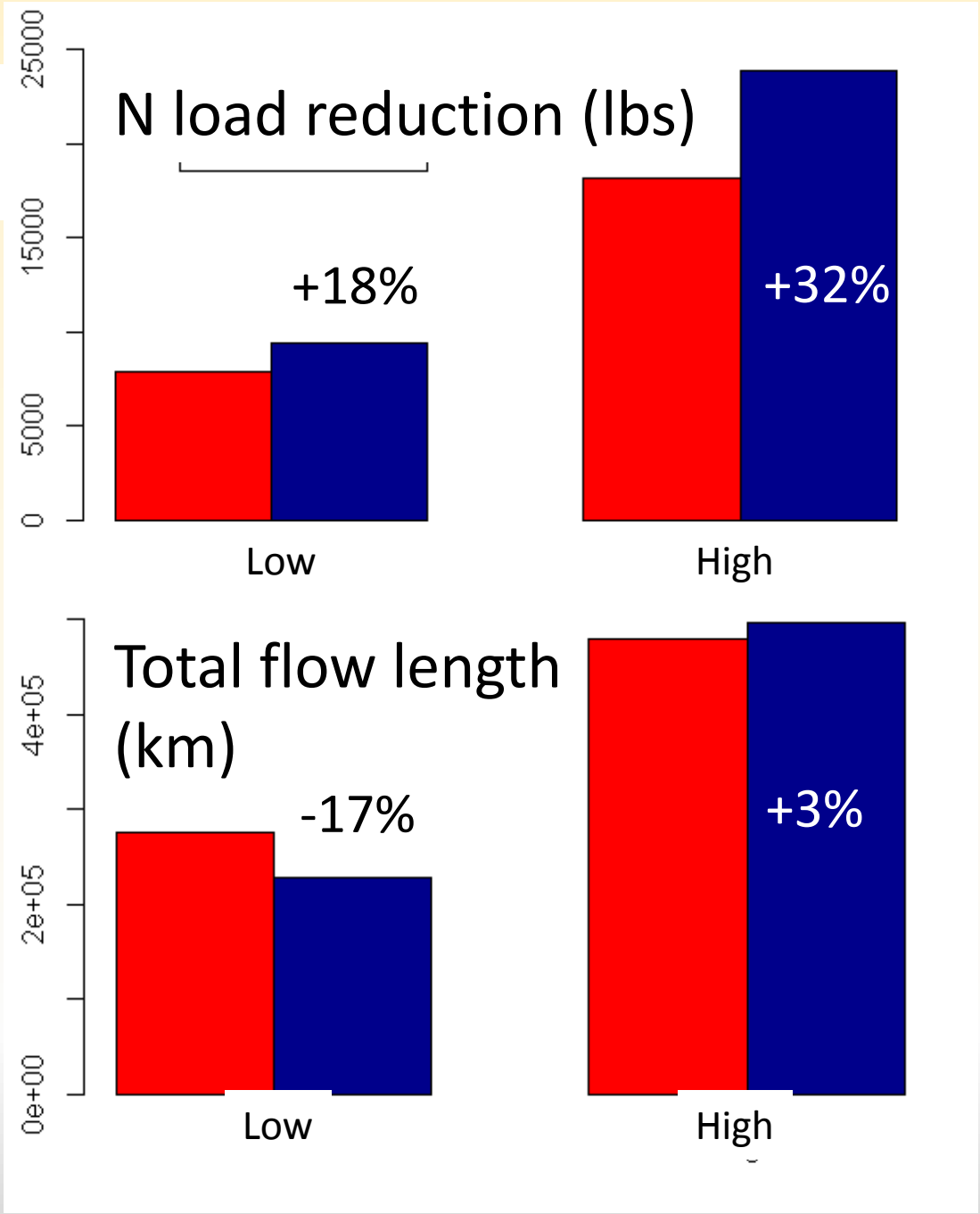
Targeted-Low

Agglomeration
+ 20 stream km
>10% upstream wetlands (km)



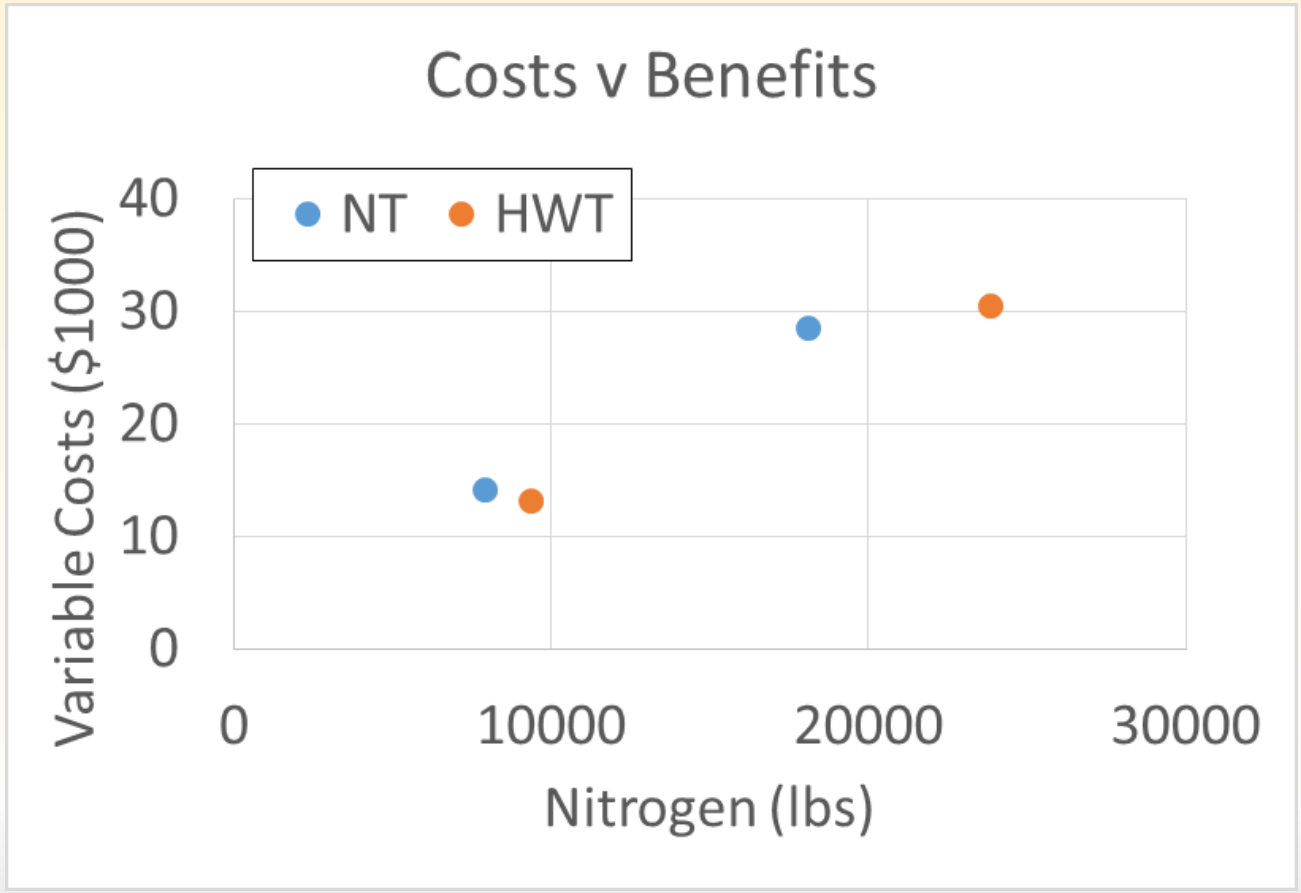
Results

- Targeting by stream order increased
  - N load reduction 18-32%
  - Stream length with improved water quality & flood protection -17-3%



Simple targeting improved cost-effectiveness for denitrification but not flood peak attenuation

- Nitrogen benefits improved modestly
  - No cumulative effects included
- Flood peak attenuation reduced at low adoption only
  - Removed the lowest performing parcels from the set
  - Appears that behavioral choices negated network effects at low adoption



Conclusions

- Performance of a policy instrument depends on behavioral responses and biophysical factors
  - The attractiveness of the policy to farmers
  - Site-specific conditions
  - Network effects
- In this initial case study:
  - Simple targeting rule appeared to improved N reduction /dollar but not peak flow attenuation
  - Opportunity costs of land were about the same across scenarios suggesting that targeting did not increase costs
  - Critical to consider how policy changes adoption
    - Yield potential was used, but further work needed