



Cranberry agriculture's role in watershed nutrient management

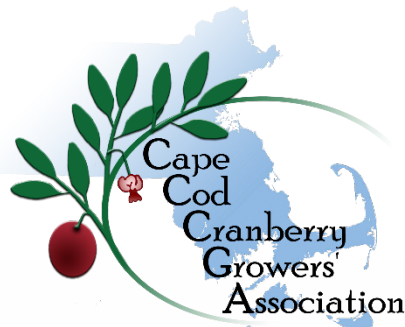


Photo: Lindsay Scott

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Acknowledgements

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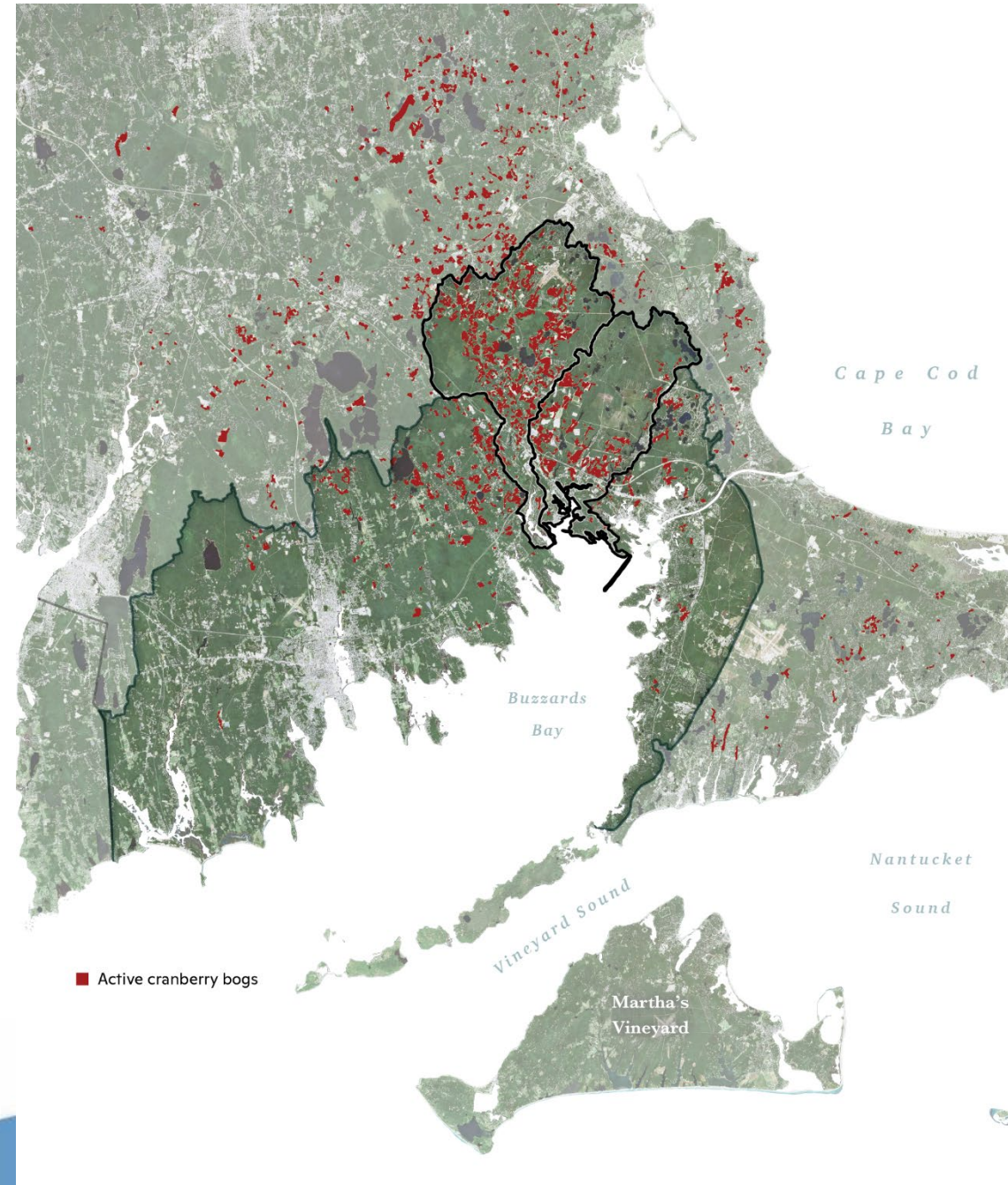
Background

- Approximately 20% of the nation's cranberry crop is produced in MA
- Half of MA's cranberry crop is grown in Buzzards Bay watershed
- Cranberry cultivation is intimately associated with water – natural streams, rivers, and ponds used as reservoirs for:
 - Harvest floods
 - Winter frost-protection
 - Irrigation
 - Used as discharge points for water



Watershed Impacts

- Weweantic and Wareham River watersheds contain >9,000 acres of cranberry bogs
- Cranberry agriculture is estimated to account for up to 30% of the nitrogen pollution
- Both the Weweantic and Wareham Rivers have impaired water quality due to excess nitrogen



Potential Impact of Bogs on Watershed Nutrients

- Research Areas
 - Quantifying nutrient releases from bogs
 - Modeling how bogs impact overall watershed nutrients
 - Modeling the potential water quality benefits of restoring bogs



Photo: Adam Soule

Types of bogs

- Flow-through – where stream channel runs through bog complex
- Wetland – created from former wetlands, often former forested swamps
- Upland – bog created in non-wetland area such as pitch pine woods

Quantifying nutrient releases - methods

- Previous work was limited and focused on a flow-through bog.
- At wetland type bogs, both grab samples and automated samplers used to quantify N and P coming into and leaving the bogs in surface and groundwater at different times of year.



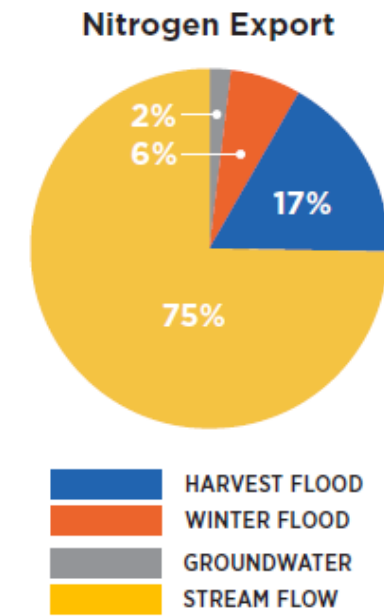
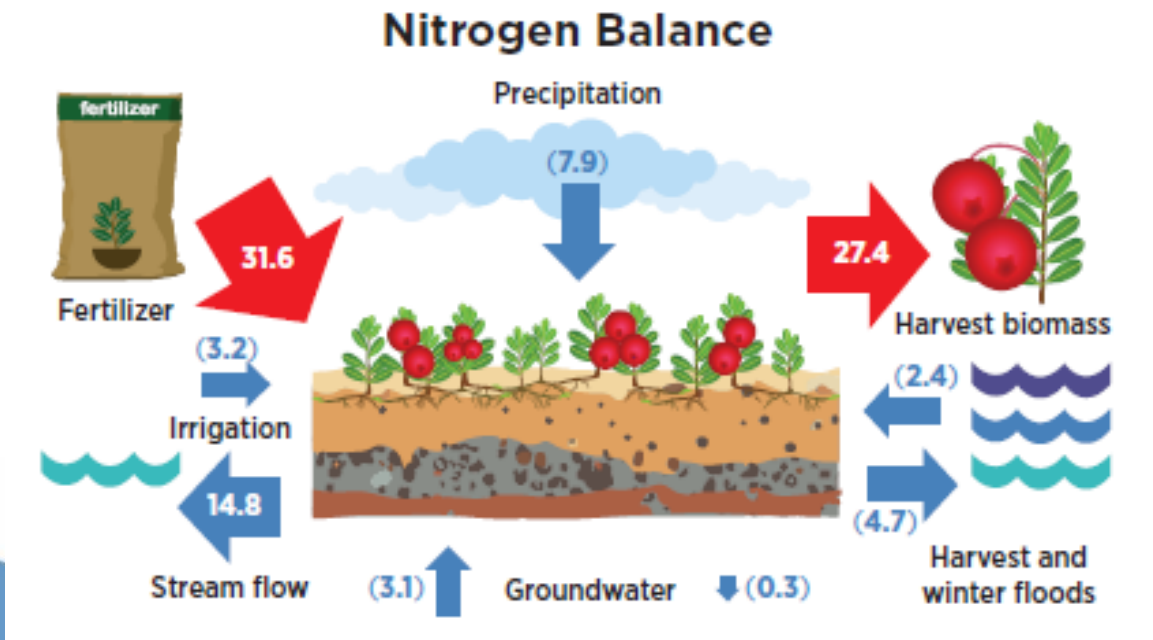
Photo: Buzzards Bay Coalition



Photo: Lindsay Scott

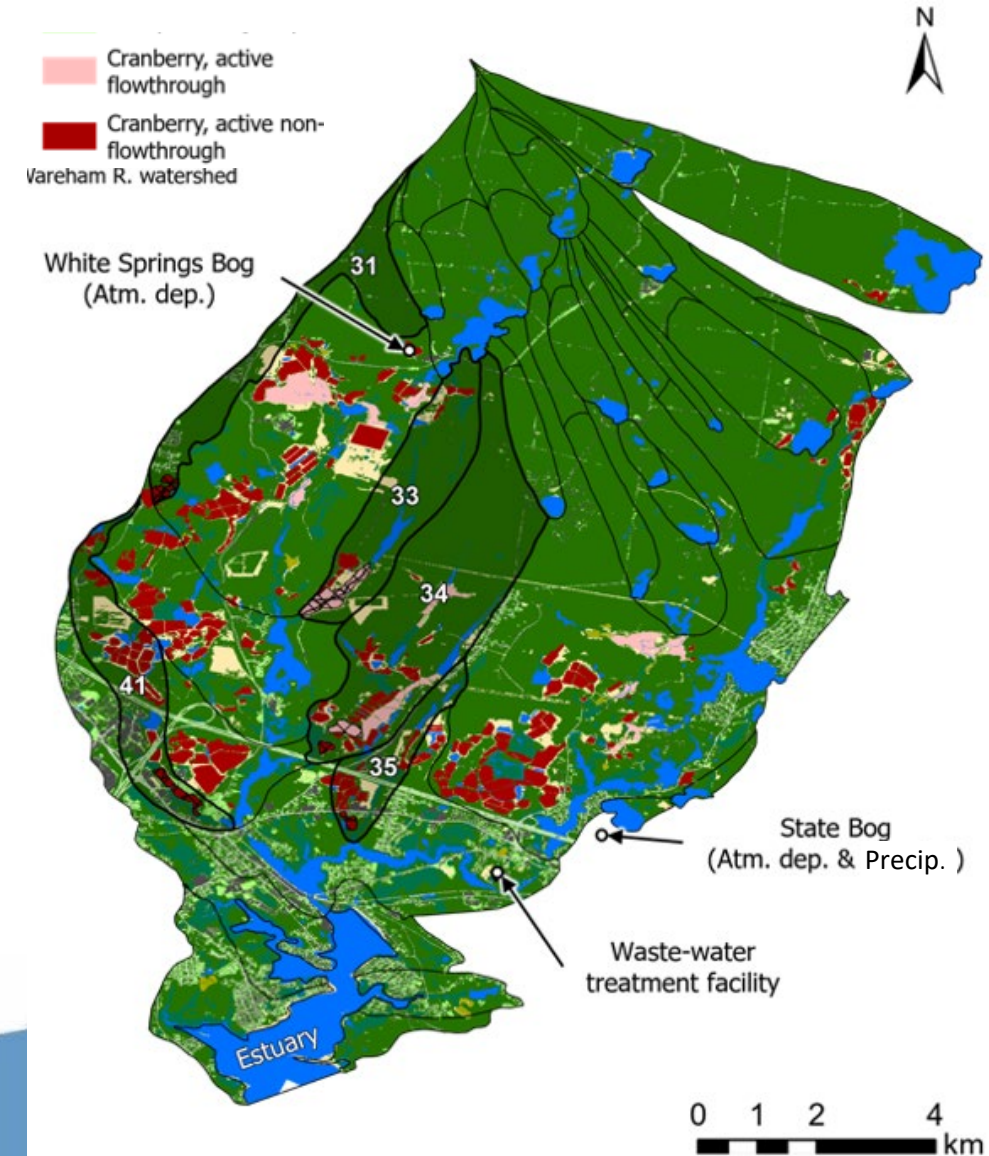
Quantifying nutrient releases - results

- Nitrogen releases were influenced more by nitrogen sources in the watershed and how much water flows through a bog than by farm management
- The small, steady trickle of water leaving bogs during non-flooding times accounts for the majority of water flowing downstream



Modeling bogs watershed impact - methods

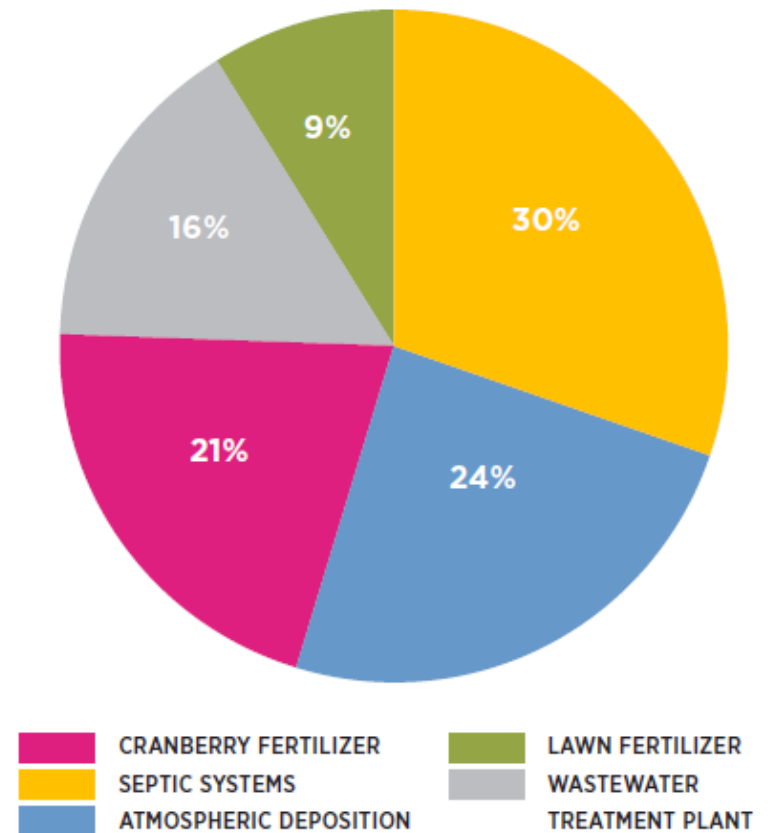
- Nutrient Loading Model (NLM, Valiela et al. 1997) paired with a stream channel model (Wollheim et al. 2006) to track nitrogen as it moves from bogs to progressively larger streams to the estuary
- Analyzed samples to refine atmospheric deposition



Modeling bogs watershed impact - results

- Cranberry bogs account for 21% of the nitrogen flowing into the Wareham River
- 2/3 of the nitrogen from bogs is taken up by plants and bacteria as the water moves through the watershed
- Flow-through bogs and those closest to the estuary have the largest impact on estuarine water quality

Nitrogen Sources to the Wareham River



Modeling restoration WQ benefits - methods

- Flow of surface water and groundwater through bogs and watersheds estimated using a combination of USGS MODFLOW, surface LiDAR, and national hydrography dataset
- Nitrogen load to cranberry farms estimated using two methods (discharge * concentration; MEP loading rate * contributing area) for 24 watersheds
- Developed potential scenarios for bog restoration (all farms; the farm in a watershed with highest N reduction potential)
- Modeled how watershed nitrogen load changed under each scenario



20 yrs after retirement — many pitch pines

Photo: C. Hatch/Living Observatory



5 yrs after restoration — variety of wetland plants

Photo: A. Hackman/Living Observatory

Modeling restoration WQ benefits - results

- Bog location and type have an important impact on the potential nitrogen removal
 - For most watersheds, more than half of the N load that flowed through cranberry farms was intercepted by a single farm
 - In 7 watersheds, a single farm intercepted >20% of the watershed N load
- Of watersheds studied, restoration of all bogs would equate to N watershed reductions of:
 - Less than 3% in 9 watersheds
 - Between 3 and 10% in 7 watersheds
 - Between 10 and 30% in 8 watersheds

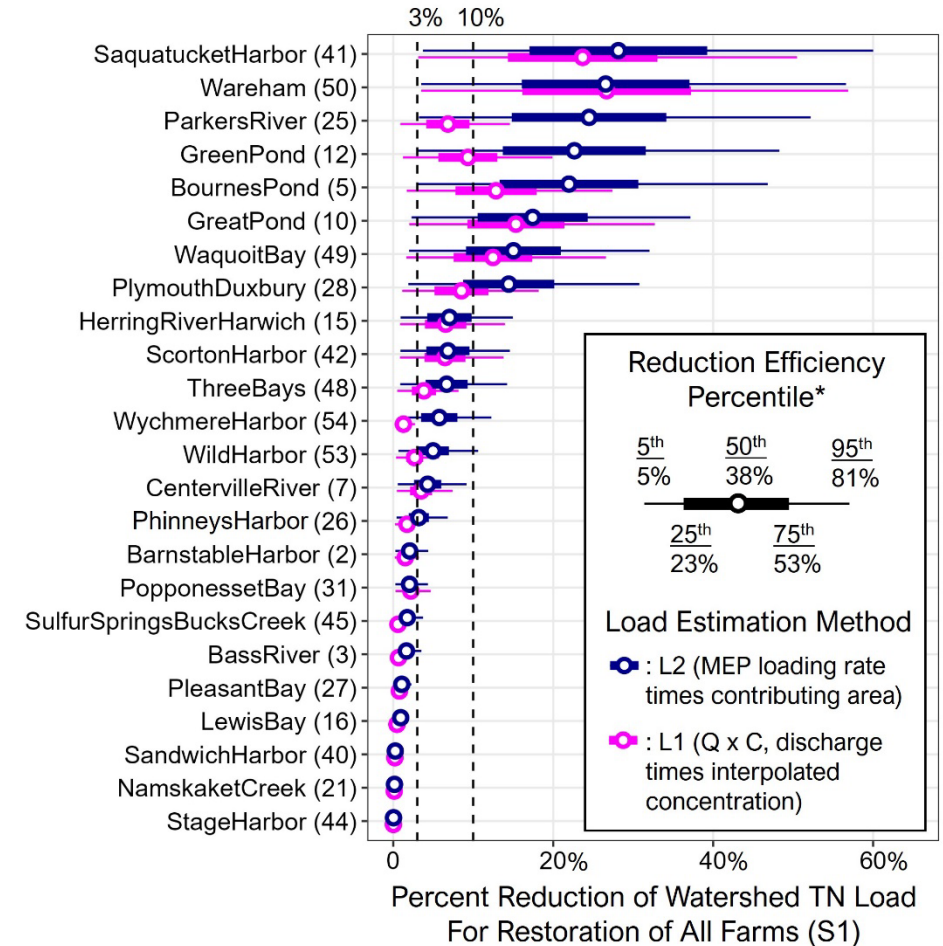


Figure: Wiegman et al., in prep.

Modeling restoration WQ benefits - results

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 - For most watersheds, more than half of the N load that flowed through cranberry farms was intercepted by a single farm
 - In 7 watersheds, a single farm intercepted >20% of the watershed N load
- Of watersheds studied, restoration of all bogs would equate to N watershed reductions of:
 - Less than 3% in 14 watersheds
 - Between 3 and 10% in 3 watersheds
 - Between 10 and 30% in 7 watersheds

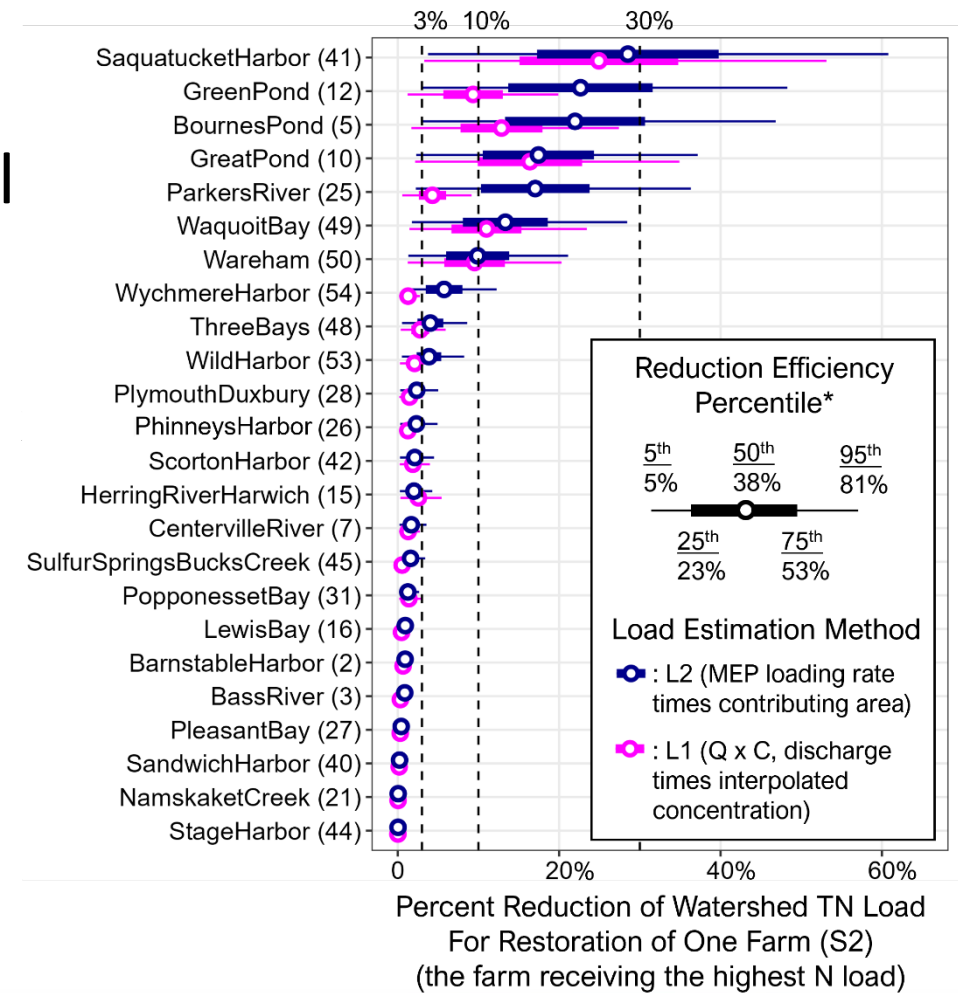


Figure: Wiegman et al., in prep.

Take home messages

- We have solid information on cranberry agriculture for the development of watershed nitrogen management plans
 - The slow steady flow coming out of bogs should be targeted for reducing nitrogen most efficiently
- Restoration of cranberry bogs has substantial potential to reduce watershed N loads in Southeastern MA
 - To maximize nitrogen removal, flow-through bogs, bogs closest to the estuary, and those that intercept high nitrogen water should be targeted for restoration

Take home messages

- We have solid information on cranberry agriculture for the development of watershed nitrogen management plans
NOTE – The cranberry industry is not static, so continued research on new cranberry varieties will be important
- Restoration of cranberry bogs has substantial potential to reduce watershed N loads in Southeastern MA

NOTE – Research and monitoring is needed to assess real-world nitrogen removal – this type of monitoring not typically funded for restoration projects.

