



Abstract: Once nitrogen from wastewater treatment plants and septic systems enters aquatic ecosystems, it is difficult to distinguish it from other sources contributing to degradation. The Monie Bay sub-estuary of Chesapeake Bay, just south of Wicomico River, is situated within the Chesapeake Bay (Maryland) National Estuarine Research Reserve and provides a 'natural laboratory' useful to test whether or not waste nitrogen sources can be identified by analyzing $\delta^{15}\text{N}$ in oyster (*Crassostrea virginica*) tissues. Monie Bay receives freshwater inputs from three creeks varying in watershed size and land use: residential septic systems (Monie Creek), crop fertilizer (Little Monie Creek), and wetlands/forest (Little Creek). Differences in oyster $\delta^{15}\text{N}$ suggested oysters were suitable to identify waste nitrogen sources. Furthermore, in conjunction with a Water Quality Index score (0.36 ± 0.04), waste nitrogen was interpreted to be derived from septic and manure sources which entered Monie Bay from both within (35 poultry houses) and outside its watershed (sewage/septic). Sewage/septic/manure sources likely arrived from the adjacent Wicomico River, with a watershed encompassing wastewater facilities servicing ~29,500 people and an additional ~7,000 septic systems and from the poultry industry, with ~4,630 poultry houses across Delmarva Peninsula. To improve water quality and reduce nutrient inputs, nitrogen sources outside Monie Bay's topographically defined watershed need to be considered.

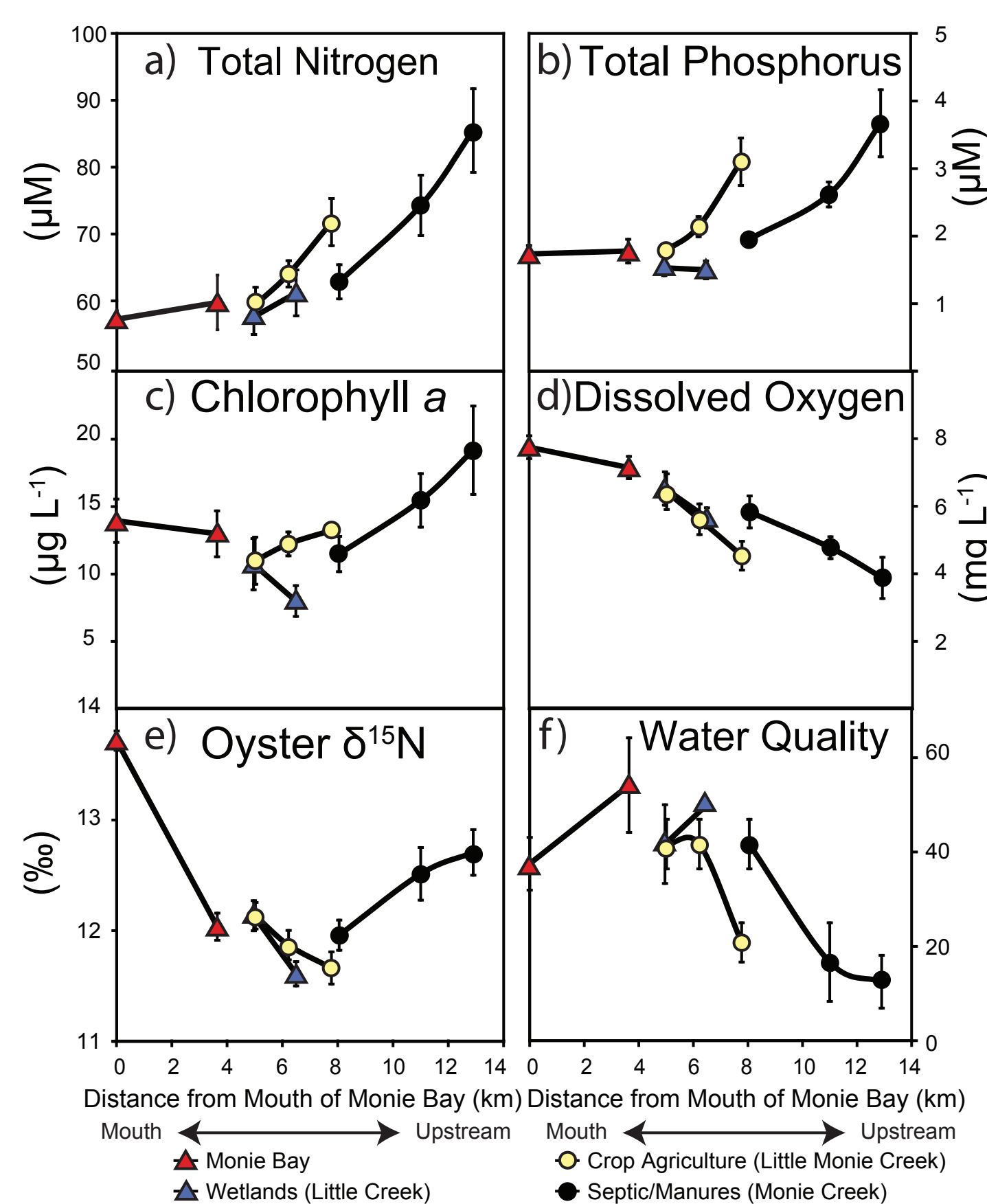
Introduction

In many NERES estuaries, excess anthropogenic nitrogen contributes to eutrophication. In conjunction with water quality monitoring, $\delta^{15}\text{N}$ from biological indicators can distinguish sources of nitrogen in estuaries.

Methods

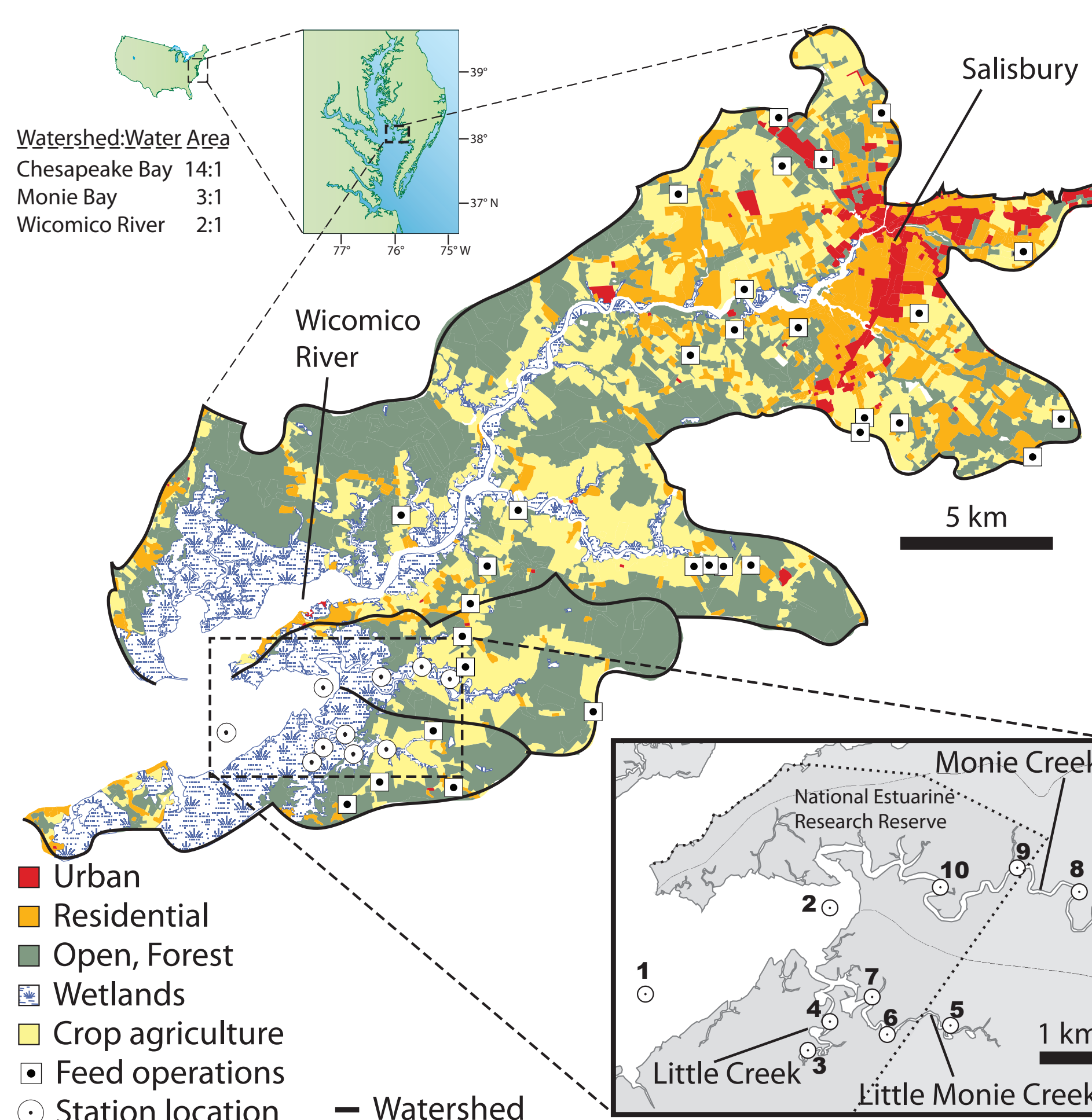
- Fortnightly water quality monitoring (TN, TP, chl *a*, DO)
- Water Quality Index indicates proportion of sites attaining threshold values
- Deploy oysters at 10 stations Jun - Oct, analyze $\delta^{15}\text{N}$ in adductor muscle

Oyster $\delta^{15}\text{N}$ distinguishes fertilizers from human/animal wastes



Monitoring data showed terrestrial inputs of nutrients increased chlorophyll *a* and decreased dissolved oxygen. Enriched oyster $\delta^{15}\text{N}$ at the mouth (red triangles) and in Monie Creek (black circles) suggested human/animal wastes. Water Quality Index was poor at the aquatic margins, which suggested multiple sources led to degradation.

Monie Bay receives waste nitrogen from multiple watersheds

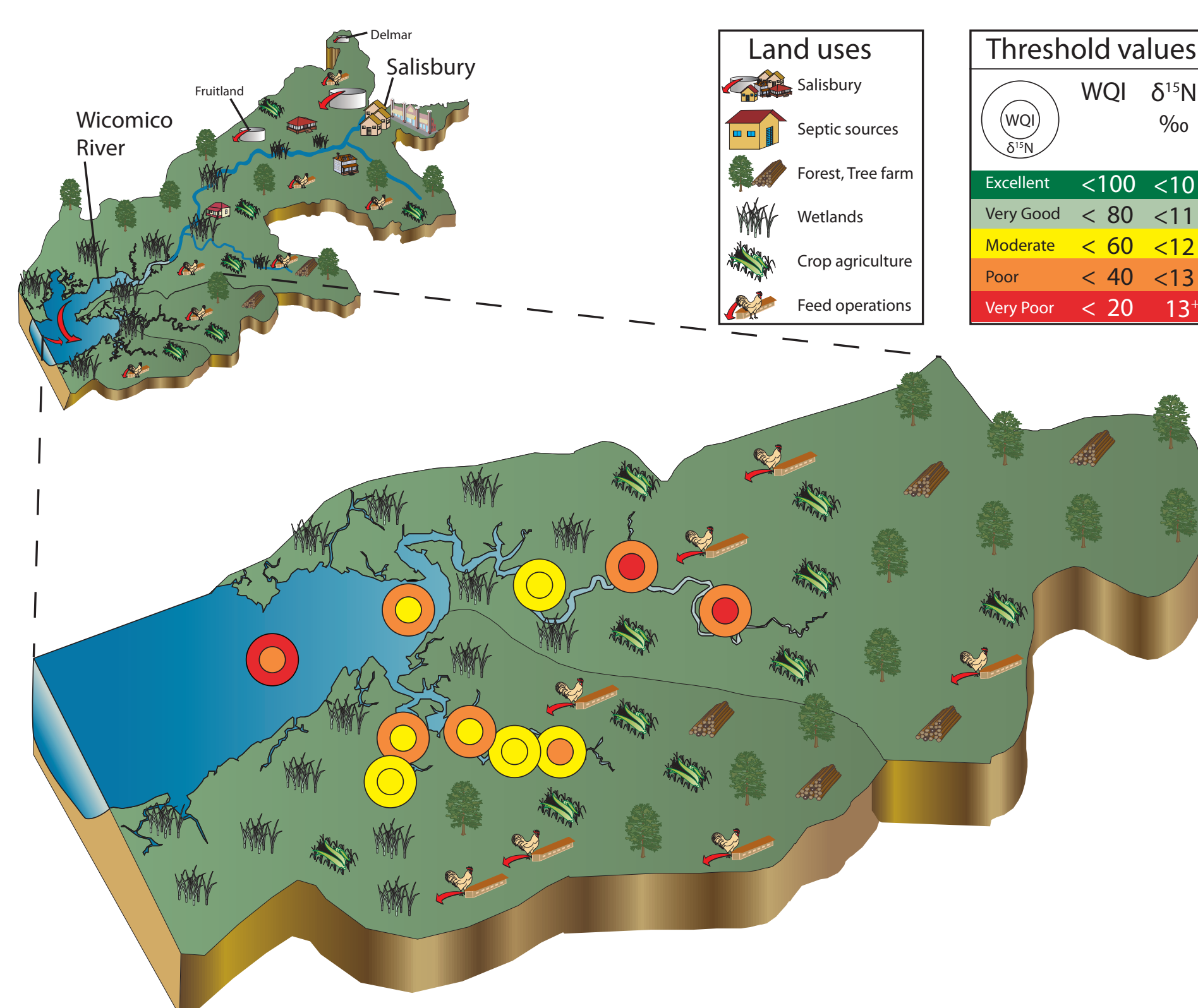


Land use adjacent to the creeks of Monie Bay:

- Poultry (Monie Creek)
- Crop agriculture (Little Monie Creek)
- Wetlands (Little Creek)

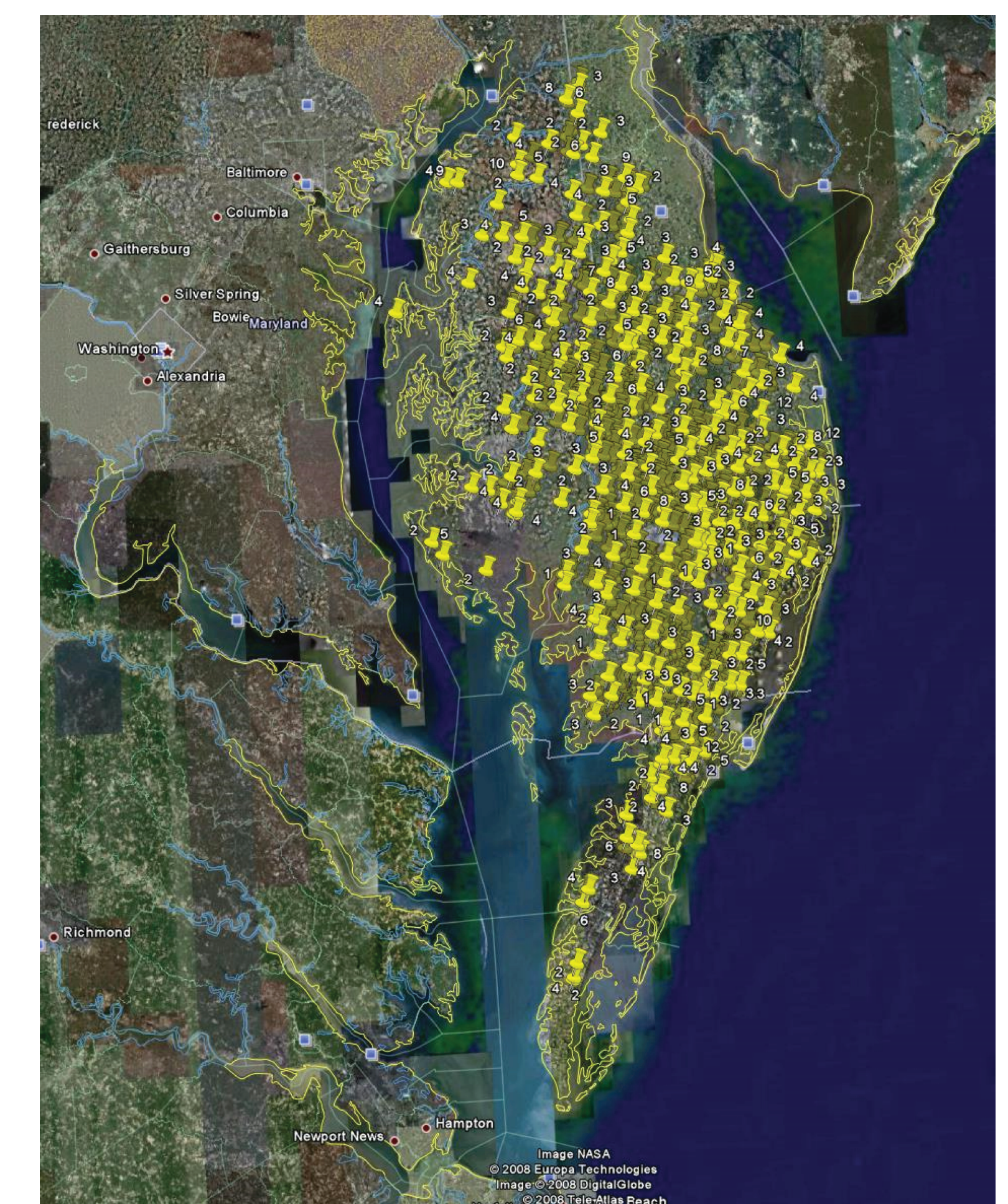
Wicomico River watershed

- ~7,000 septic systems
- ~29,500 people on wastewater treatment
- 82 poultry production houses

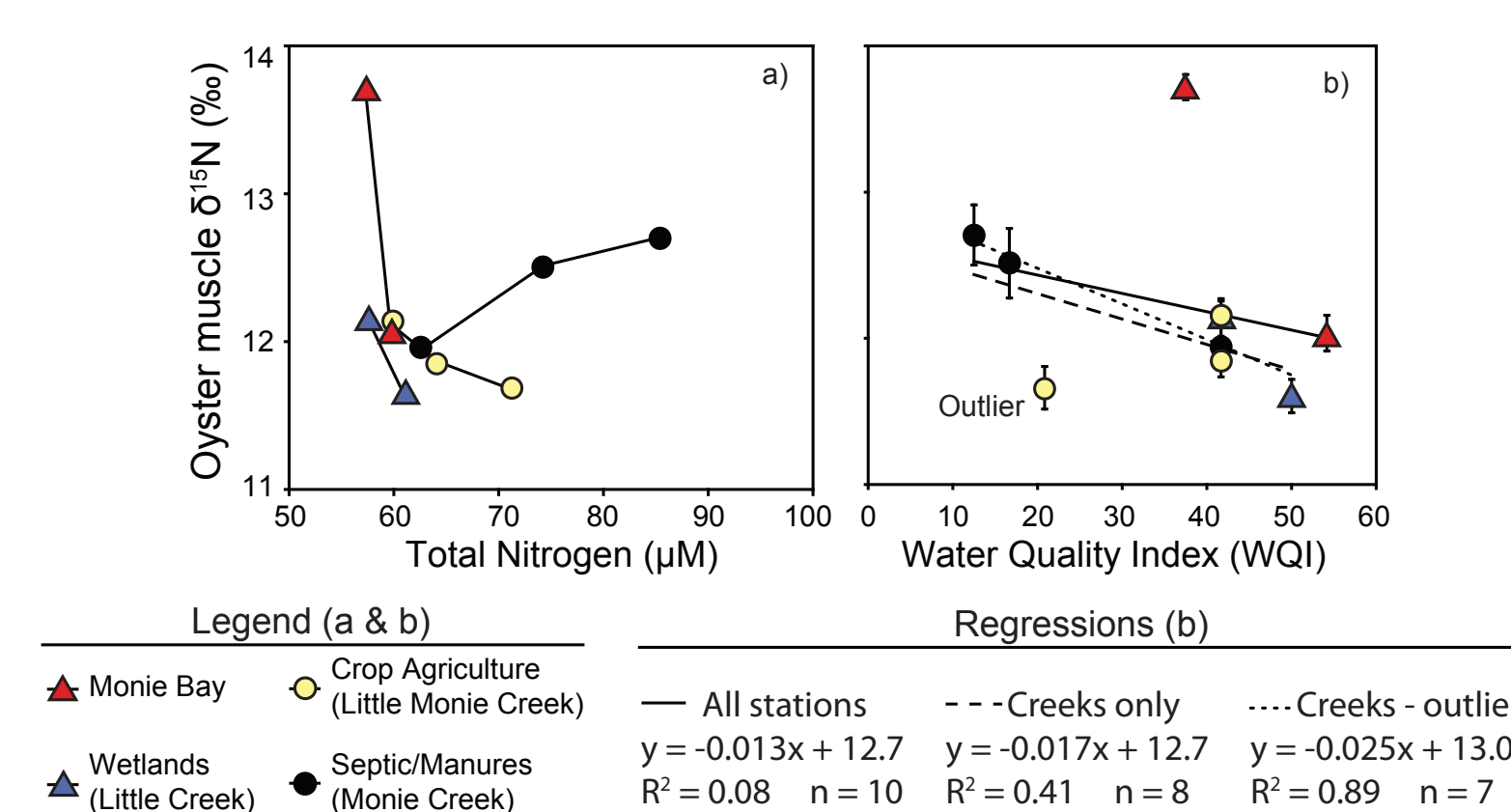


Water Quality Index and oyster $\delta^{15}\text{N}$ suggest that human/animal wastes enter Monie Creek from its watershed and Monie Bay from the adjacent Wicomico River watershed.

Poultry are an important nitrogen source across Delmarva Peninsula



Poultry production is a major economic driver across Delmarva Peninsula. The 4,630 poultry houses are pinpointed (Google Earth).



Oyster $\delta^{15}\text{N}$ was not directly related to TN, which meant they provided different information. Oyster $\delta^{15}\text{N}$ was inversely related to the Water Quality Index. Therefore, poor water quality was related to human/animal wastes. Low $\delta^{15}\text{N}$ and poor water quality in Little Monie Creek suggested fertilizer sources contributed to poor water quality at that site.

Conclusions

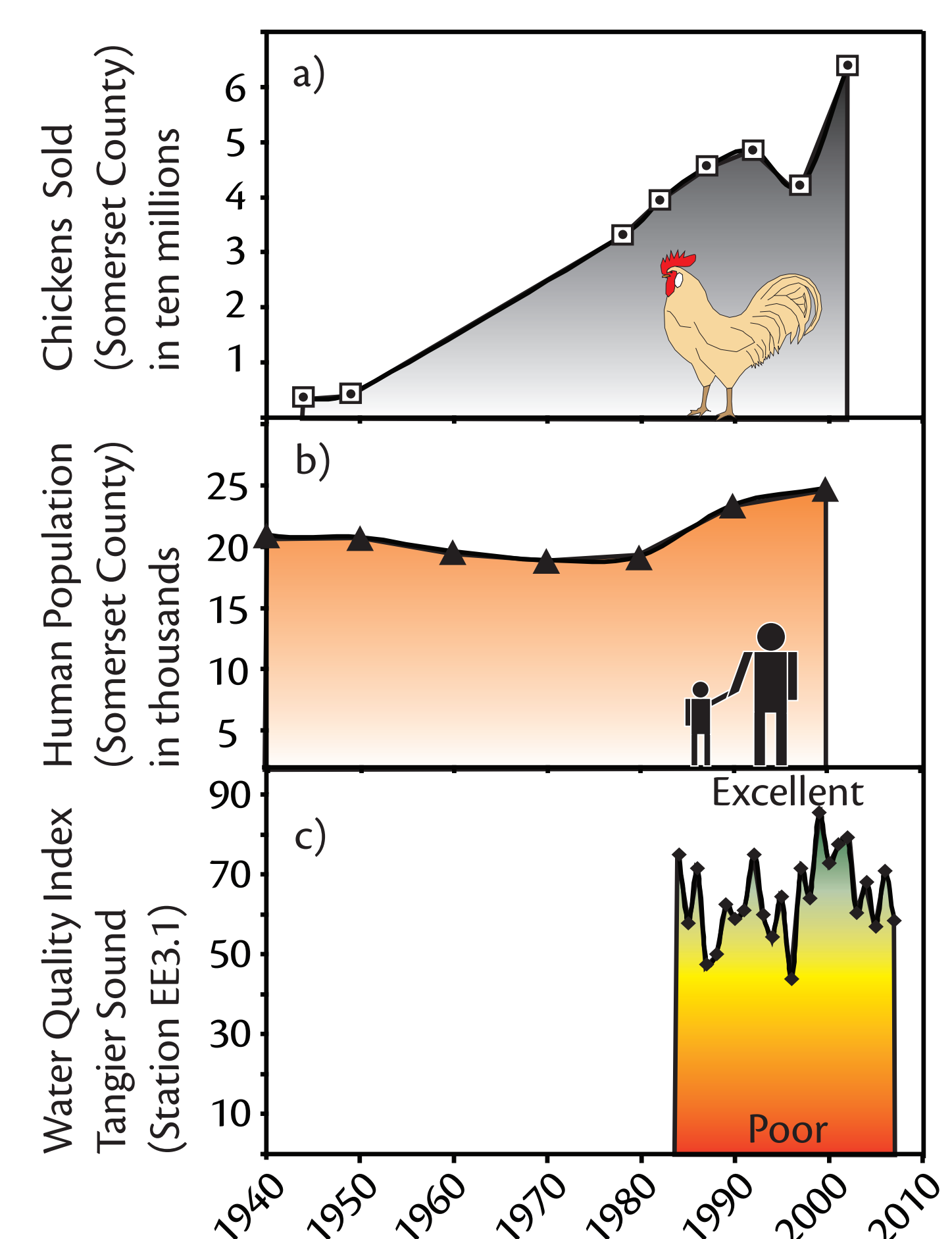
- Water quality is impacted in Monie Bay
- Oyster $\delta^{15}\text{N}$ indicates sewage/septic/manure nitrogen sources
- Nitrogen enters from multiple watersheds

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- UC Davis Stable Isotope Facility

References

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- U.S. Department of Agriculture. 2002. Census of Agriculture.



Historically, water quality in Tangier Sound declined after periods of poultry production increase and improved after decreases in production (USDA 2002, US Census 2000, CBP 2008).