# Applications of NASA CMS Data

# A Maryland Perspective on Carbon Monitoring for Wetlands, Streams, and Forests

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# Introduction: Who are We?

- **Versar** is a publically-traded environmental and construction management firm (http://www.versar.com)

- Scientists working at the Columbia, MD office of Versar's **Environmental Services Group** have provided environmental consulting services to Maryland's Power Plant Research Program (PPRP) since its inception in the early 1970s.

- **PPRP** was created by the Maryland legislature to ensure that Maryland meets its electricity demands at reasonable costs while protecting the state's valuable natural resources. (http://dnr.maryland.gov/pprp)

# Introduction: What do we do?

PPRP conducts a broad program of research on direct and indirect impacts of power facilities and power generation on environmental resources, including:

- identifying potential impacts,
- exploring avoidance and mitigation approaches,
- and evaluating monitoring tools.

Versar's elements of the program include:

- Wetlands
- Streams
- Forests
- Carbon Offsets/Biological Carbon Sequestration
- Advanced Technology

PPRP has participated in several carbon research/ management programs….MRCSP, RGGI, VCS, CMS

# Wetlands and Carbon

- Wetlands are a critical environmental resource that are prized and heavily protected in Maryland for water quality services, wildlife habitat, fisheries spawning areas, etc.

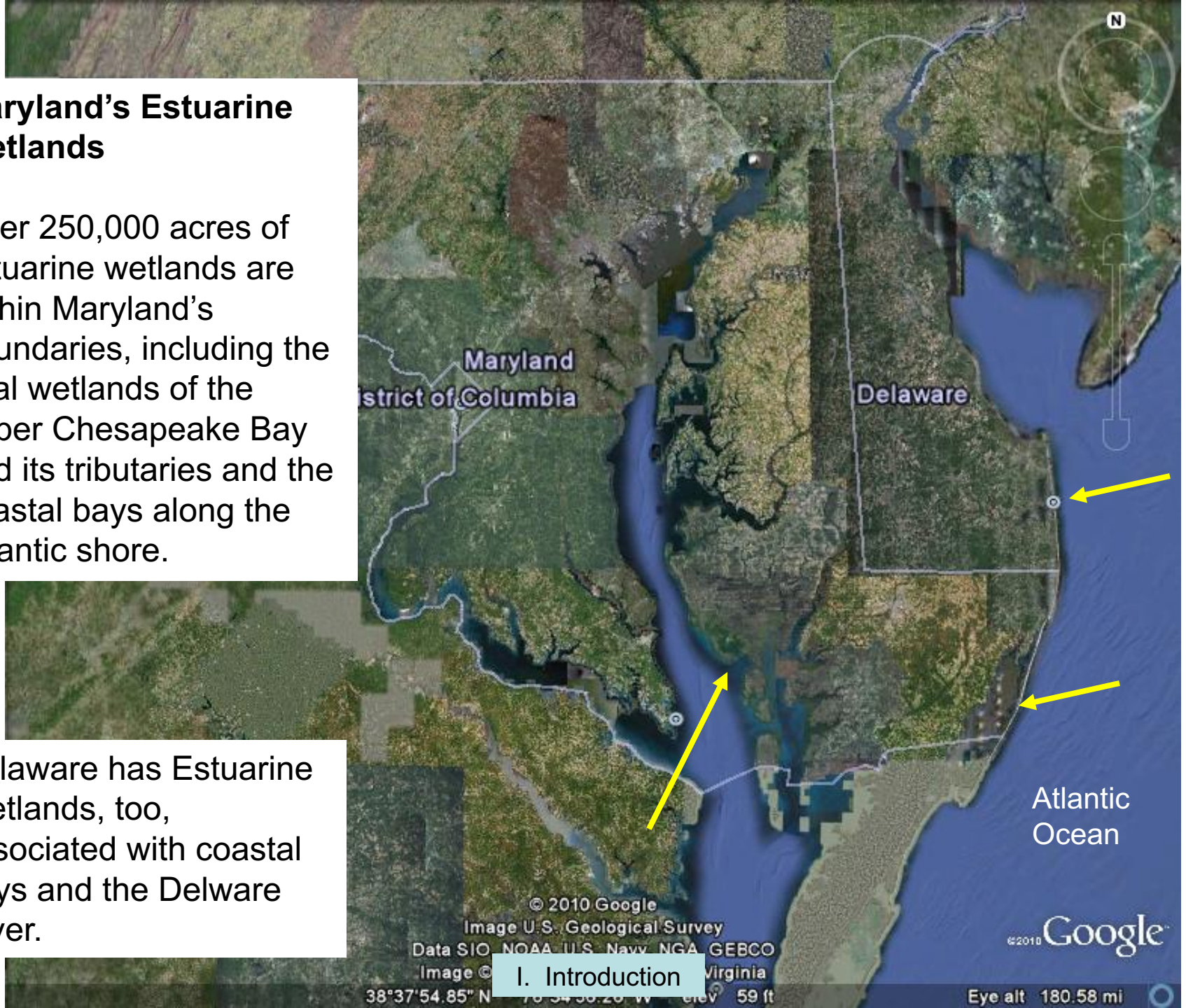
- Wetlands are also potential carbon sinks, with high rates of removing carbon from the atmosphere, coupled with rapid burial and slow decay of organic matter.

- Methane production and release from wetlands, however, can reduce their effectiveness as a carbon sink.

Research Focus: Are wetlands a net source or sink in Maryland, and should they be protected and restored as a means of lowering the state's carbon footprint?

## Maryland's Estuarine Wetlands

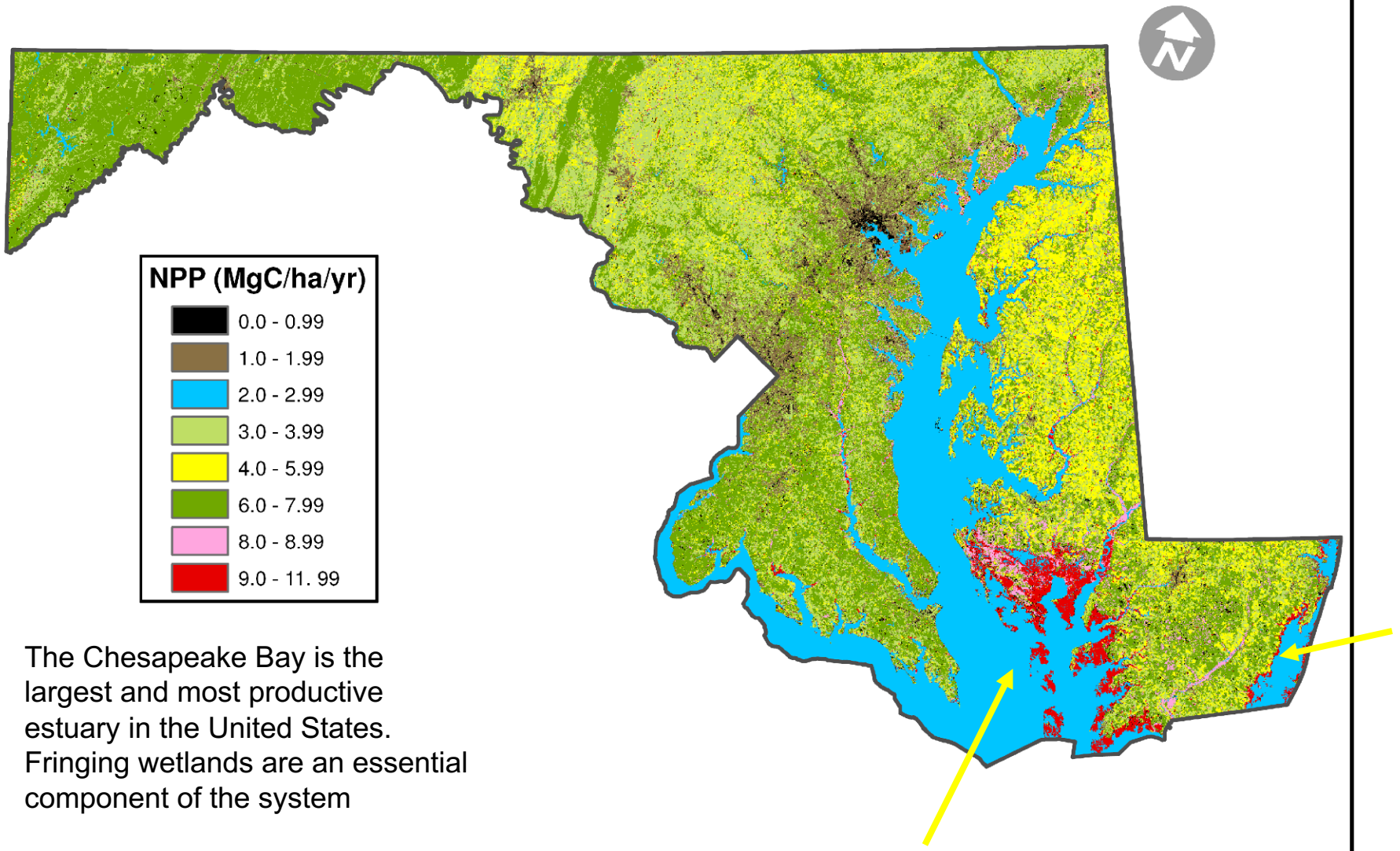
Over 250,000 acres of estuarine wetlands are within Maryland's boundaries, including the tidal wetlands of the upper Chesapeake Bay and its tributaries and the coastal bays along the Atlantic shore.




Delaware has Estuarine Wetlands, too, associated with coastal bays and the Delware River.

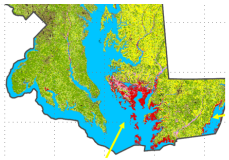
# Wetland Productivity

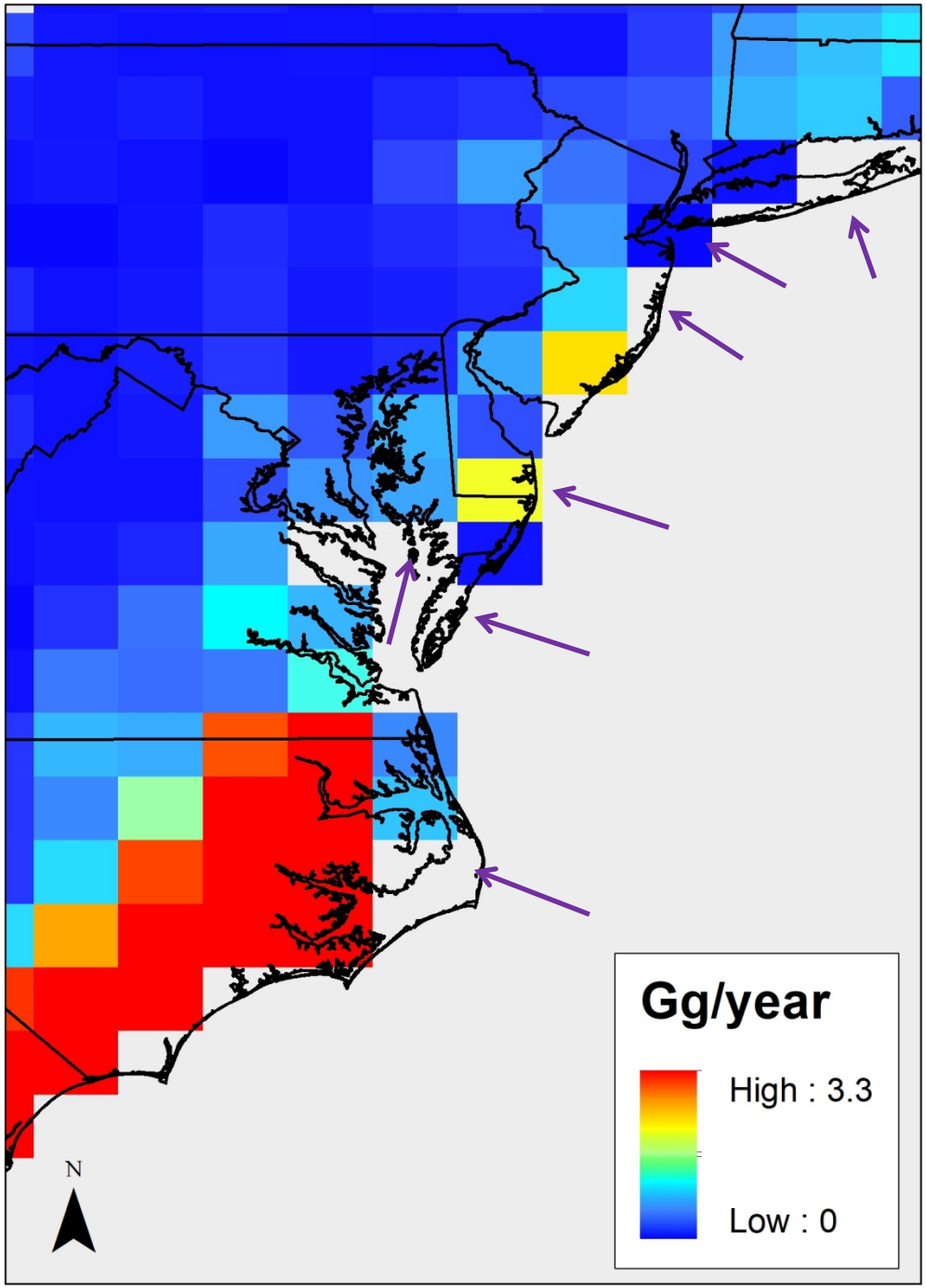
Maryland Net Primary Productivity estimates based on land use class and literature values.




The Chesapeake Bay is the largest and most productive estuary in the United States. Fringing wetlands are an essential component of the system

# CMS Wetland Methane Product






The CMS Methane product is a set of maps of 50x50 km pixels with annual emissions estimates, by source. The values have been derived from model-based inversion of the remote sensing data at a relatively small number of sample points, coupled with a spatial interpolation to fill out the map.

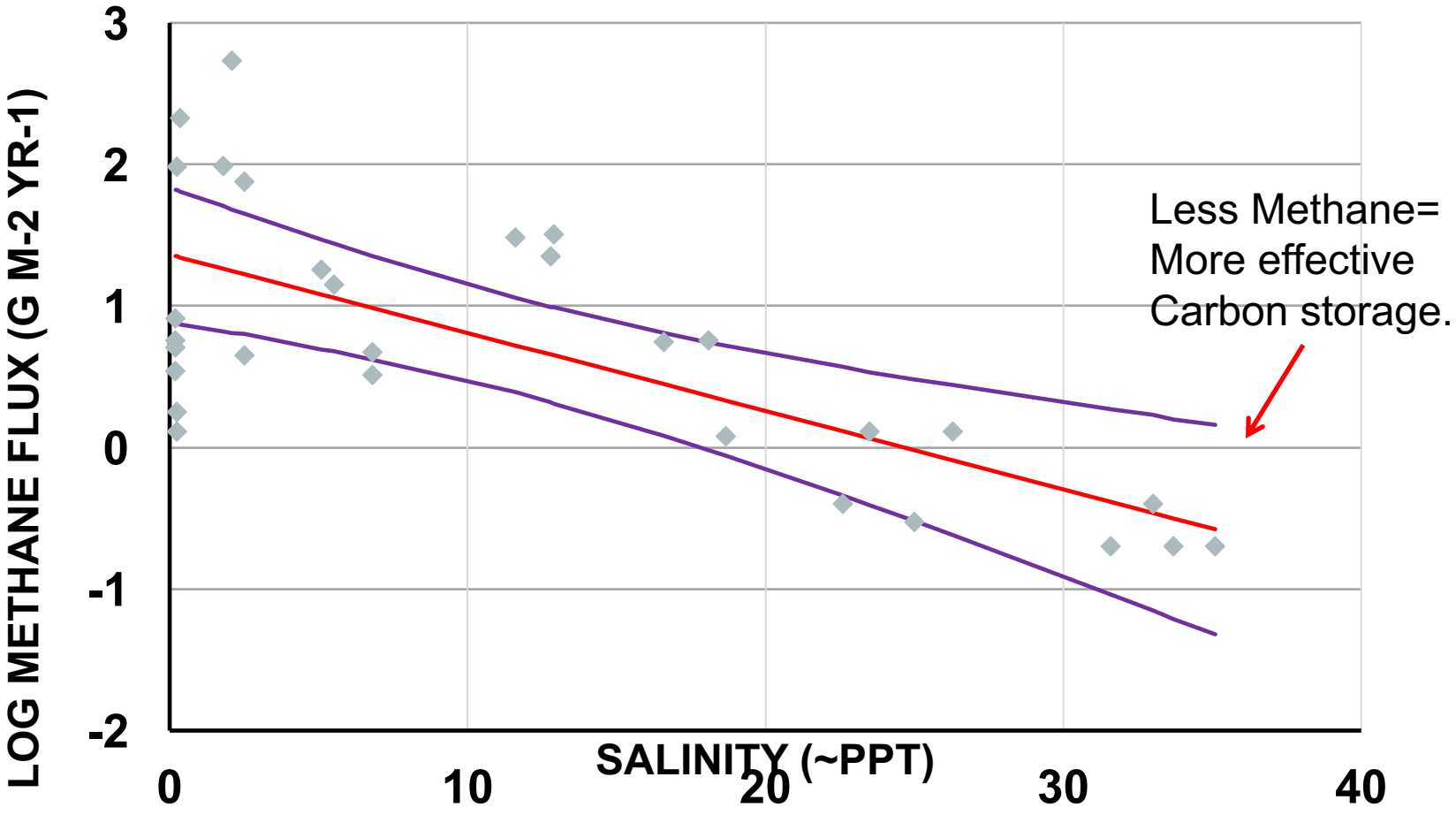
## Challenges presented by the CMS Methane Data set for wetland analysis

The large pixels of this product only crudely follow the coastline of North America. Major estuarine wetlands areas along the East Coast are excluded, including:

- the Long Island shoreline,
- the New Jersey coastal bays,
- the Delmarva Peninsula,
- the entire lower half of the Chesapeake Bay,
- most of Pamlico Sound.

While high salinity areas are known to have lower methane emissions, defining the methane emissions gradient is critical to understanding and accounting for methane production from coastal estuarine wetlands. A much higher-resolution product is required for this purpose.

**Salinity Influence on Methane Emissions from Tidal Marshes**
Wetlands, Vol. 31, No. 5, pp. 831-842
H. J. Poffenbarger, B. A. Needelman, J. P. Megonigal.
October 1, 2011.



## Is an Improved Methane Data Product Possible?

- Newer technology (e.g. GHGSAT) has demonstrated direct measurement of column methane at 50m pixel resolution
- Direct measurements at this scale over spatially extensive wetlands would reduce the reliance on apportioning the column methane to sources using reporting inventories (anthropogenic sources) and estimates (natural sources)
- Regionally specific calibration and methane production models could be introduced – the current product relies on data collected in boreal wetlands and is not adjusted for salinity.

# Linear Features: Streams and Transmission Lines

Sub-pixel sized linear features have always been a remote sensing problem – they usually don't line up with pixels and their effects can be swamped by the surroundings.

Maryland is interested in monitoring and improving the condition of its streams, and interesting in monitoring and minimizing the impact of other linear features such as transmission lines.  Forested areas are thought to be key to both goals.

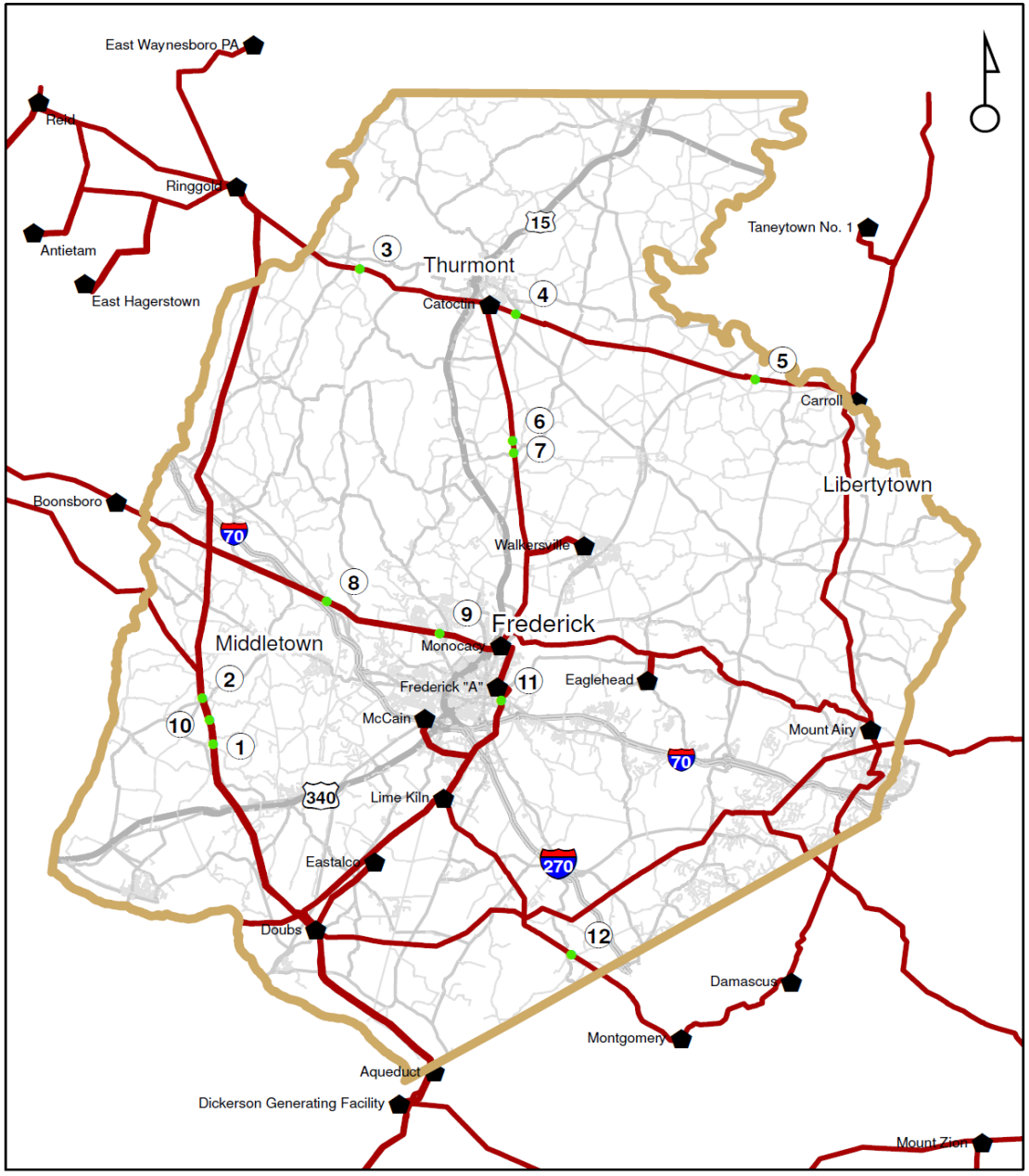
Can landscape-scale LiDAR products at high resolution overcome some of these limitations while providing a spatially-extensive monitoring tool that amplifies ground sampling resutls?

# A Transmission Line Right of Way in Frederick County, MD

Frederick County Transmission Lines

Data: Transmission line surroundings were classified by land-use type and survey sites were placed in each.

12 sites (numbered green points)



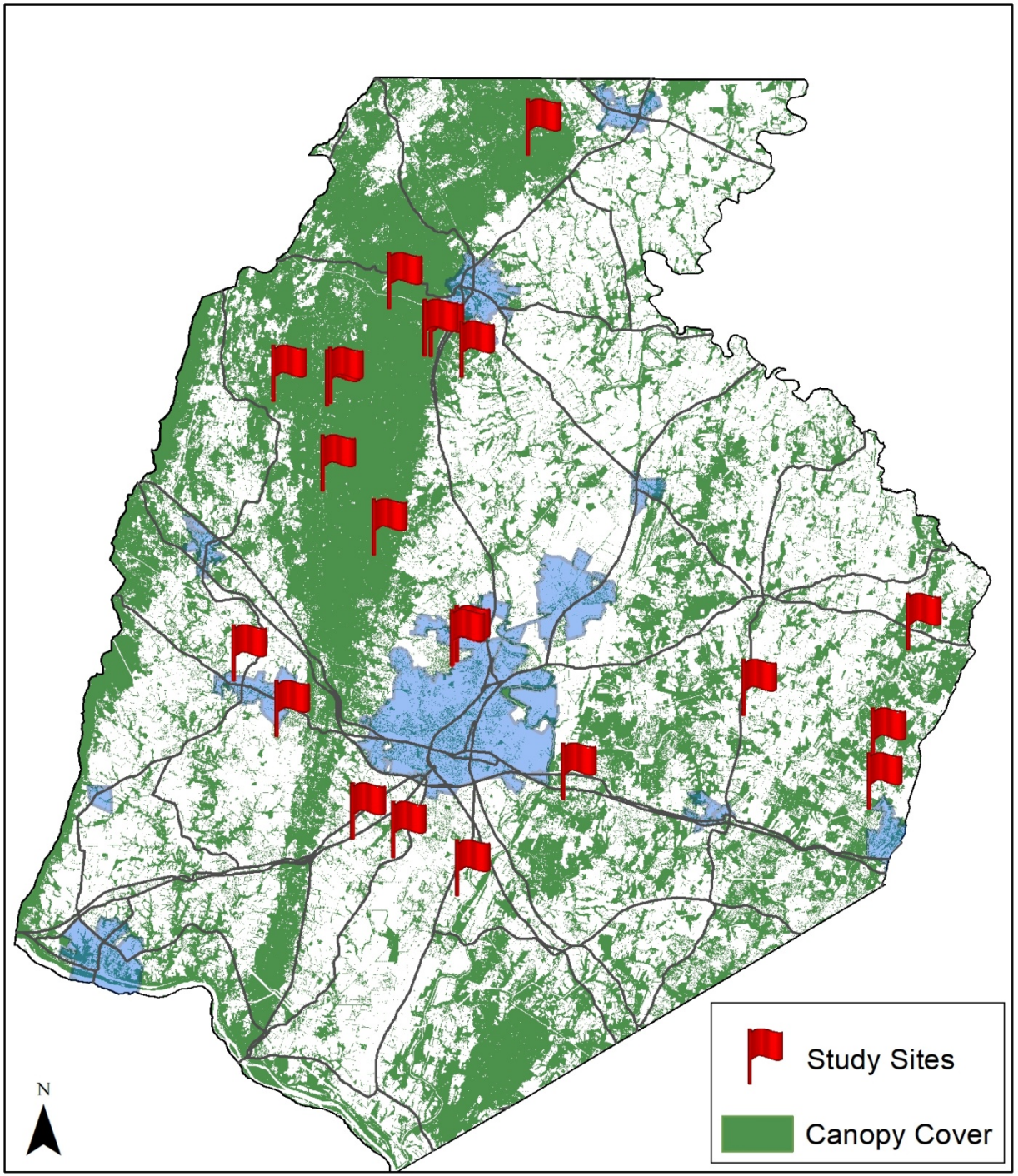

**Frederick County Pilot Survey Sites: revised January 2009**

Pilot survey sites | Substations | Transmission lines | Roads

0 10 Miles

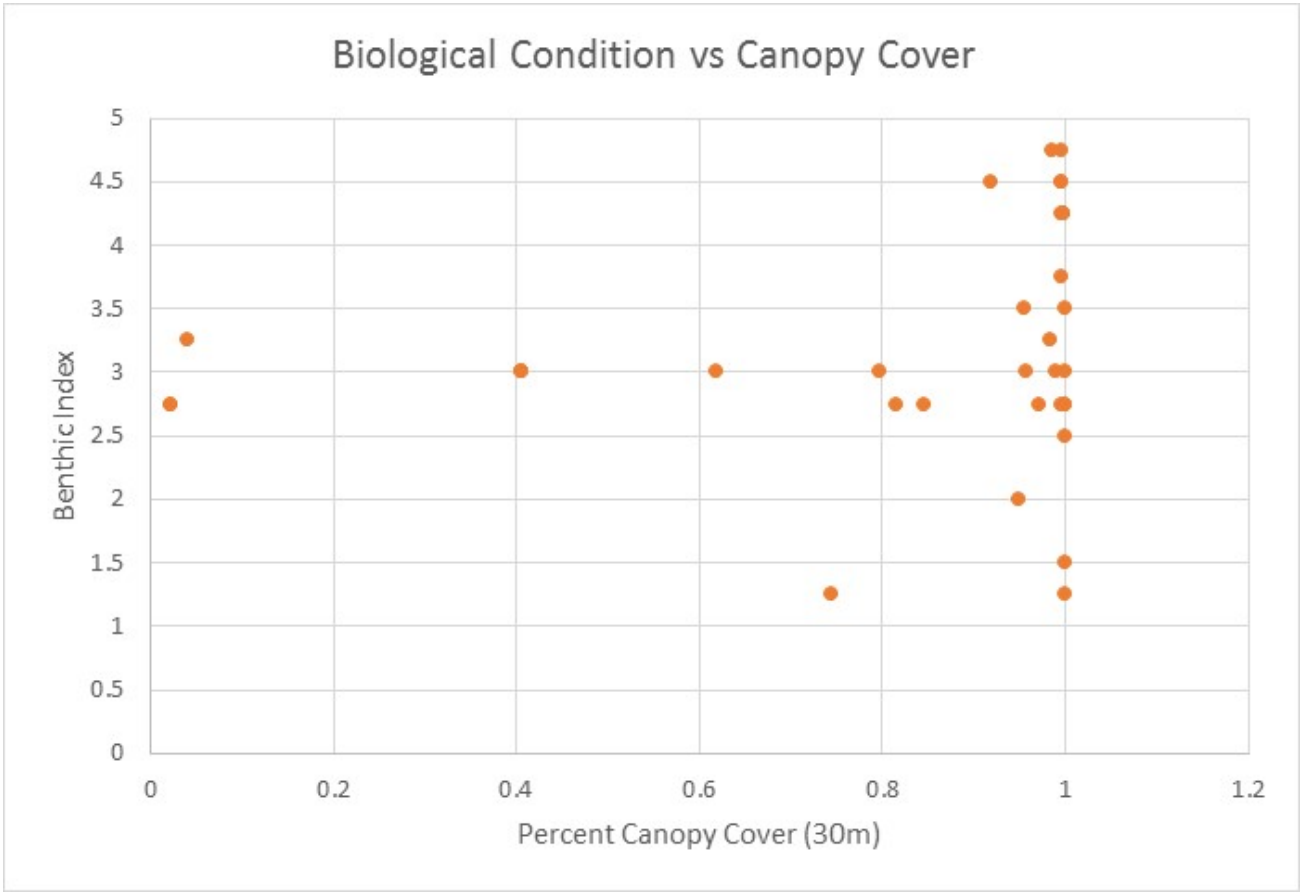
Frederick County Test Sites

Data: Stream sites are available from the Maryland Biological Stream Survey (MBSS)



# Stream Condition and Canopy Cover

A closed tree canopy is thought to support good stream biological conditions (as measured by benthic invertebrates and fish). Are CMS percent canopy cover and biological condition correlated?

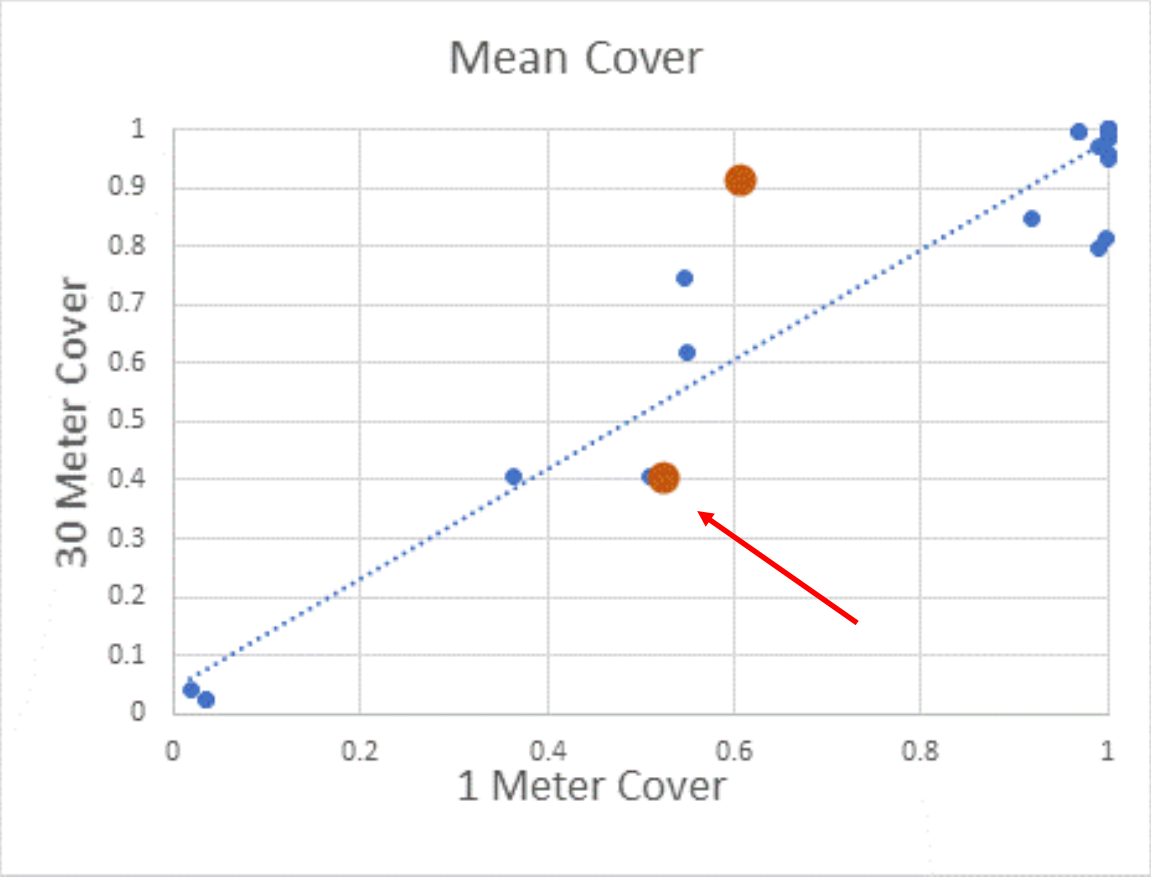



???? Canopy Cover is not the only factor!

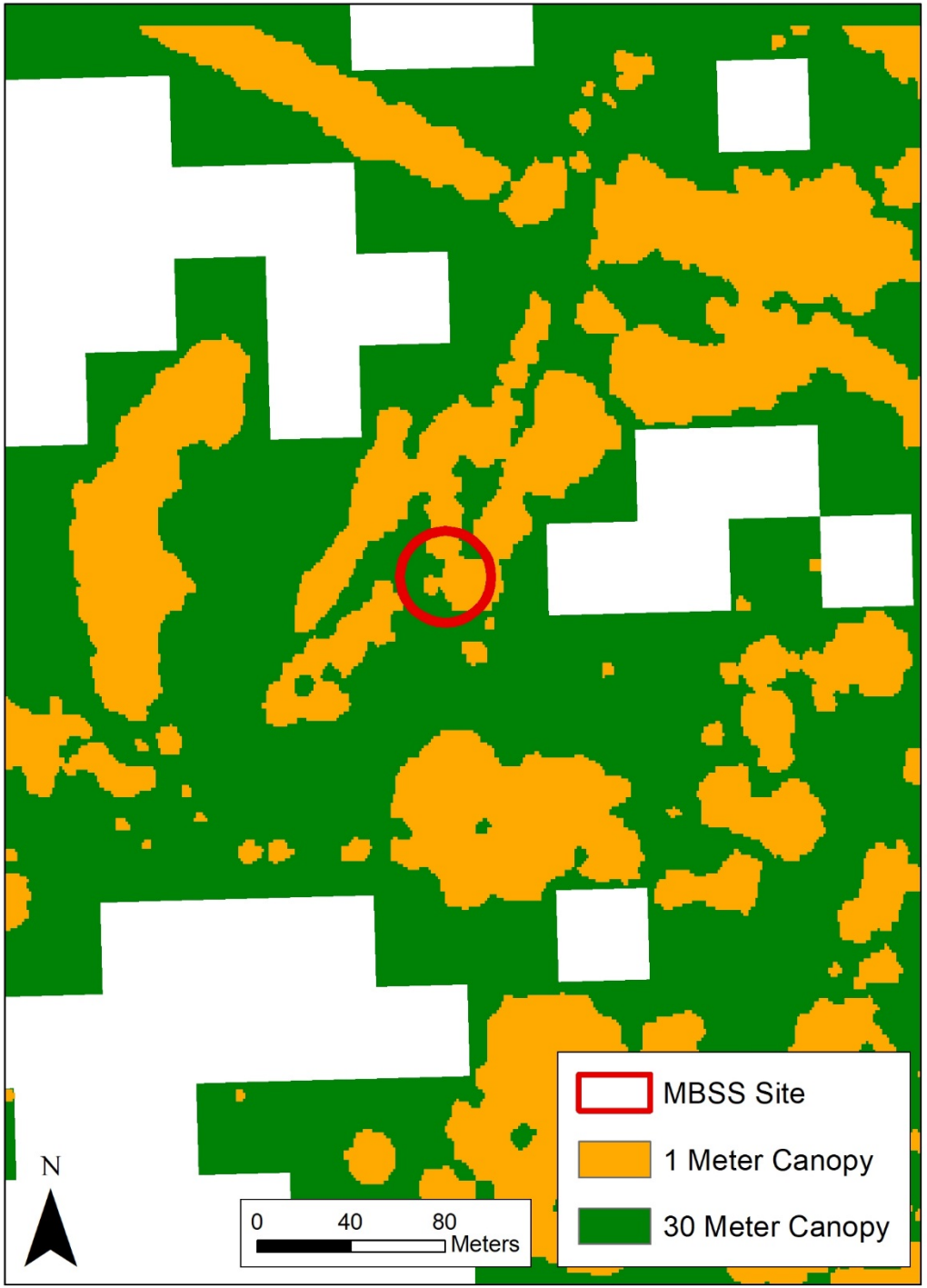
Will it help to be more precise than 30m?

# Resolution

LiDAR canopy cover data are available at 1m and 30m pixel sizes (Note: Oak Ridge only supplies the 30m percent canopy cover).



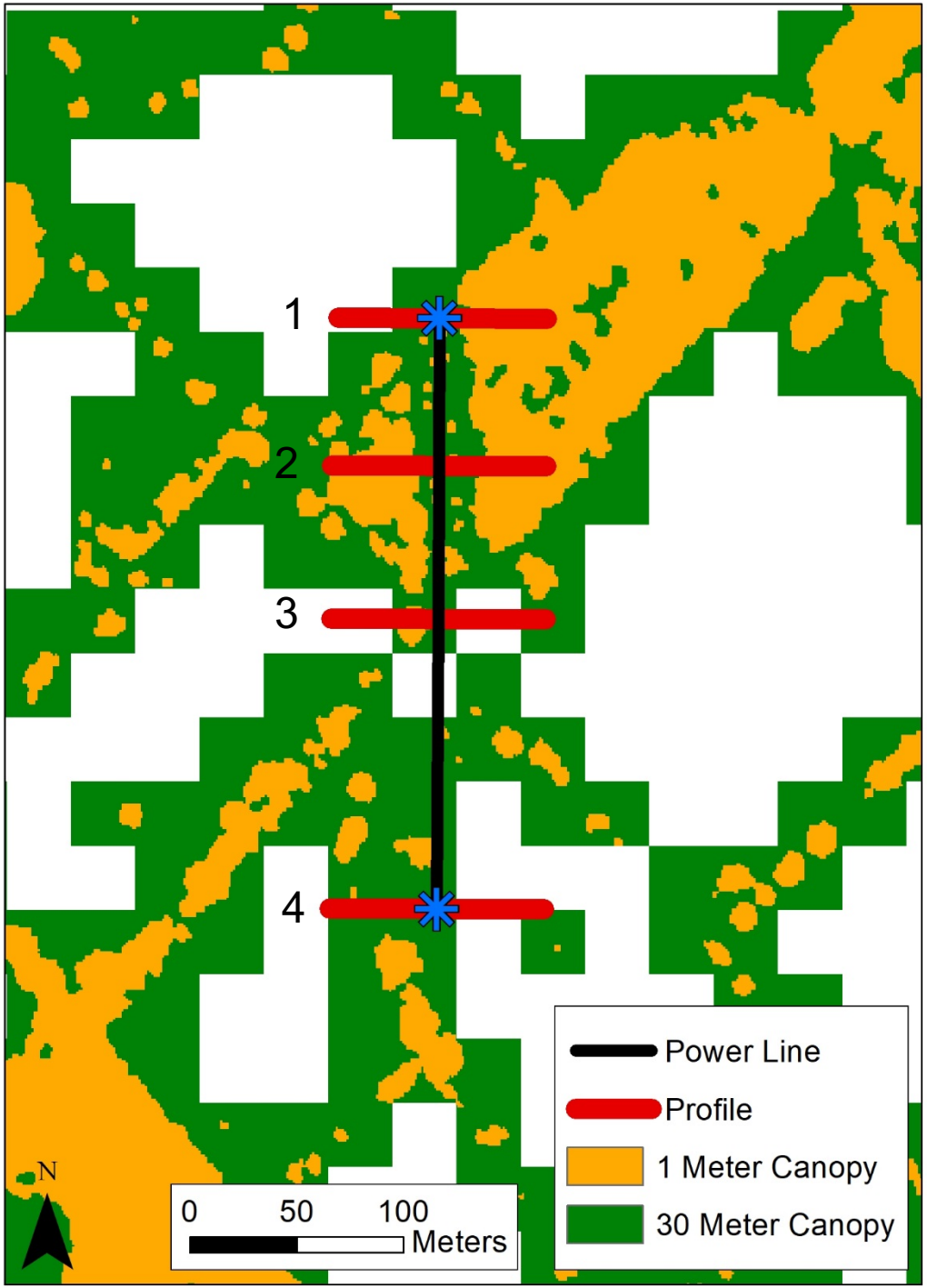

Means from 3x3, 30m window are generally correlated with means from a 10m radius, 1m window – but with significant outliers.




## Resolution and Stream Condition

Differences between 30m averages (green blocks) and 1m presence/absence (0/1 image - orange) are sometimes large at observation points.

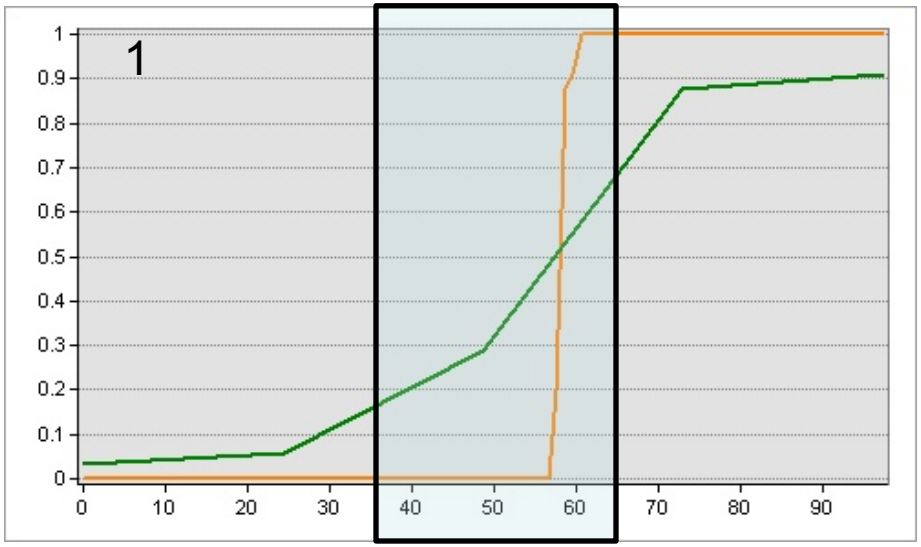
However, absence of trees does not mean there are no other buffering elements, e.g. wetland or meadow. Other data layers may need to be included.

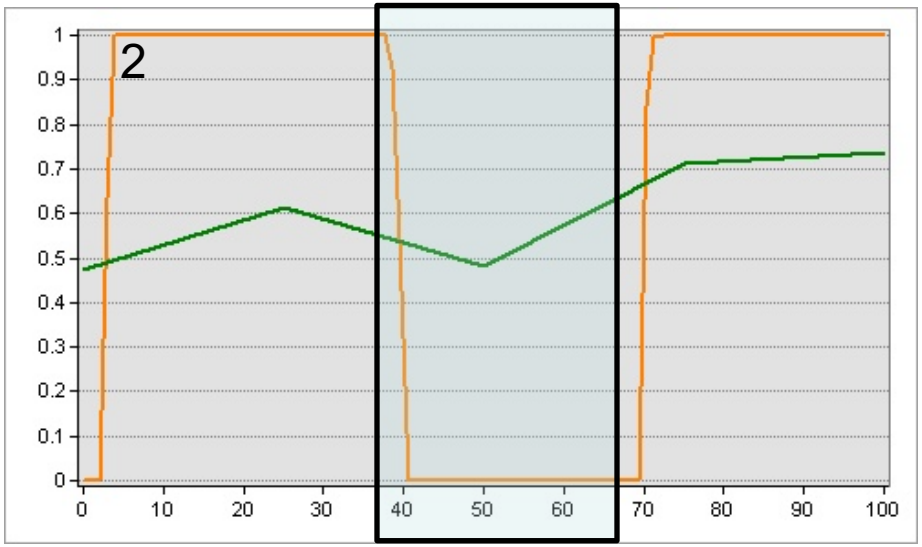


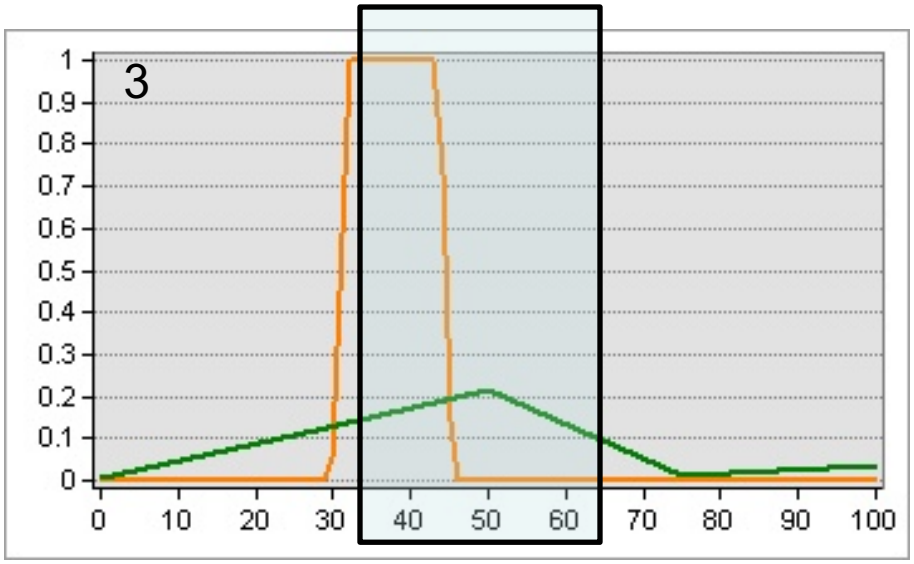

# Transmission Lines – Gaps in the Forest

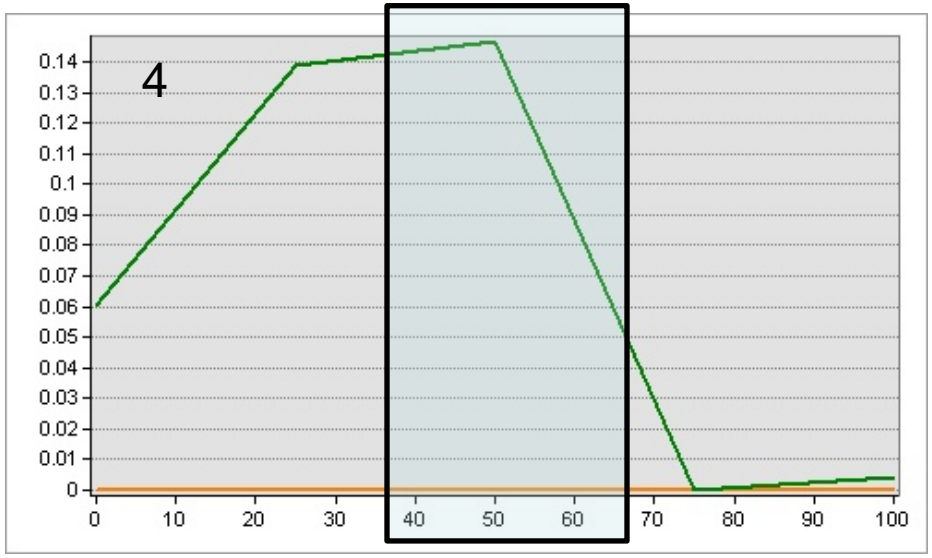
Transmission line ROWs must be maintained clear of tall trees and hence fragment forests through which they pass. Evaluation of the fragmentation effect on wildlife and forest interior species is based on the width of the ROW and the vegetation permitted to grow in it. Different pictures emerge from 30m and 1m LiDAR cover data.

# Profiles Across a Forest Gap



# Observations from Preliminary Work on using LiDAR products for linear features analysis

- Forest canopy may be a useful tool for stream monitoring, but so far correlations with stream biological condition are not high. We still lack the ability to detect in an integrated way high-value buffer areas that are not trees (e.g. wetlands, meadows, or shrub-scrub greenbelts)

- High resolution forest canopy is good for defining forest gaps, e.g. those associated with transmission lines. This may be useful for maintaining ROWs and minimizing impacts, but vegetation condition will require analysis in conjunction with additional data sets.

- In both cases, LiDAR data products provide the capability for change analysis – quantitative assessments based on direct physical measurements – vs. only change detection from reflectance imagery. This would be of value to monitoring programs.

Questions ?