Cost-Effective Spatial Data Interpolation

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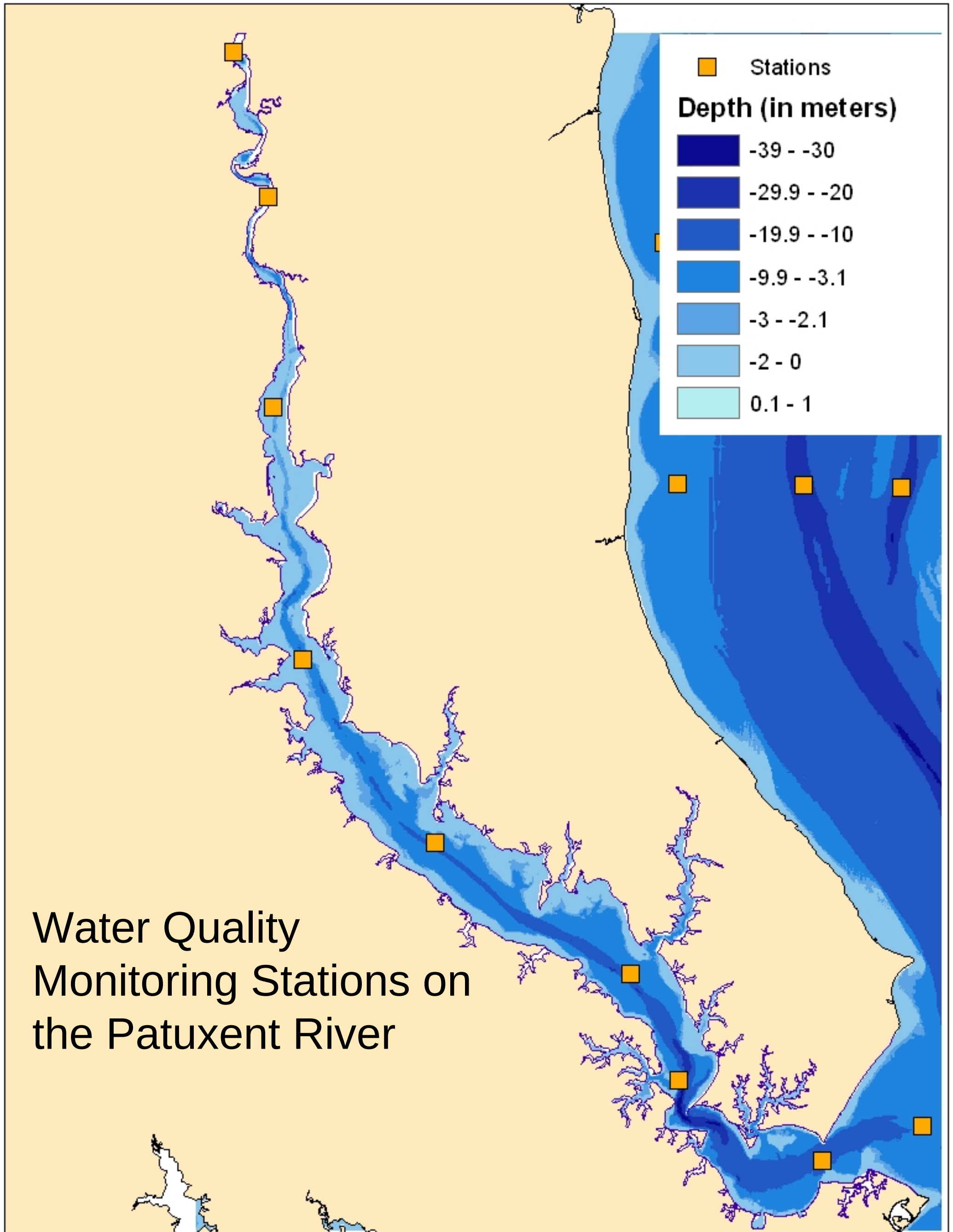
Questions to Discuss

1. What is the cost-effective level of effort in conducting interpolation?
2. Can we adequately capture weather, time-of-day & tidal signals to inform choices for interpolation methods?
3. How might other data sets or dynamic models enrich the interpretation and analysis of a single day's data?
4. Can spatially-rich data be used to leverage long-term observations of water quality to detect trends ?
5. How might we improve data sampling methods to provide the most representative data for interpolation while still offering a practical approach for the field crew?

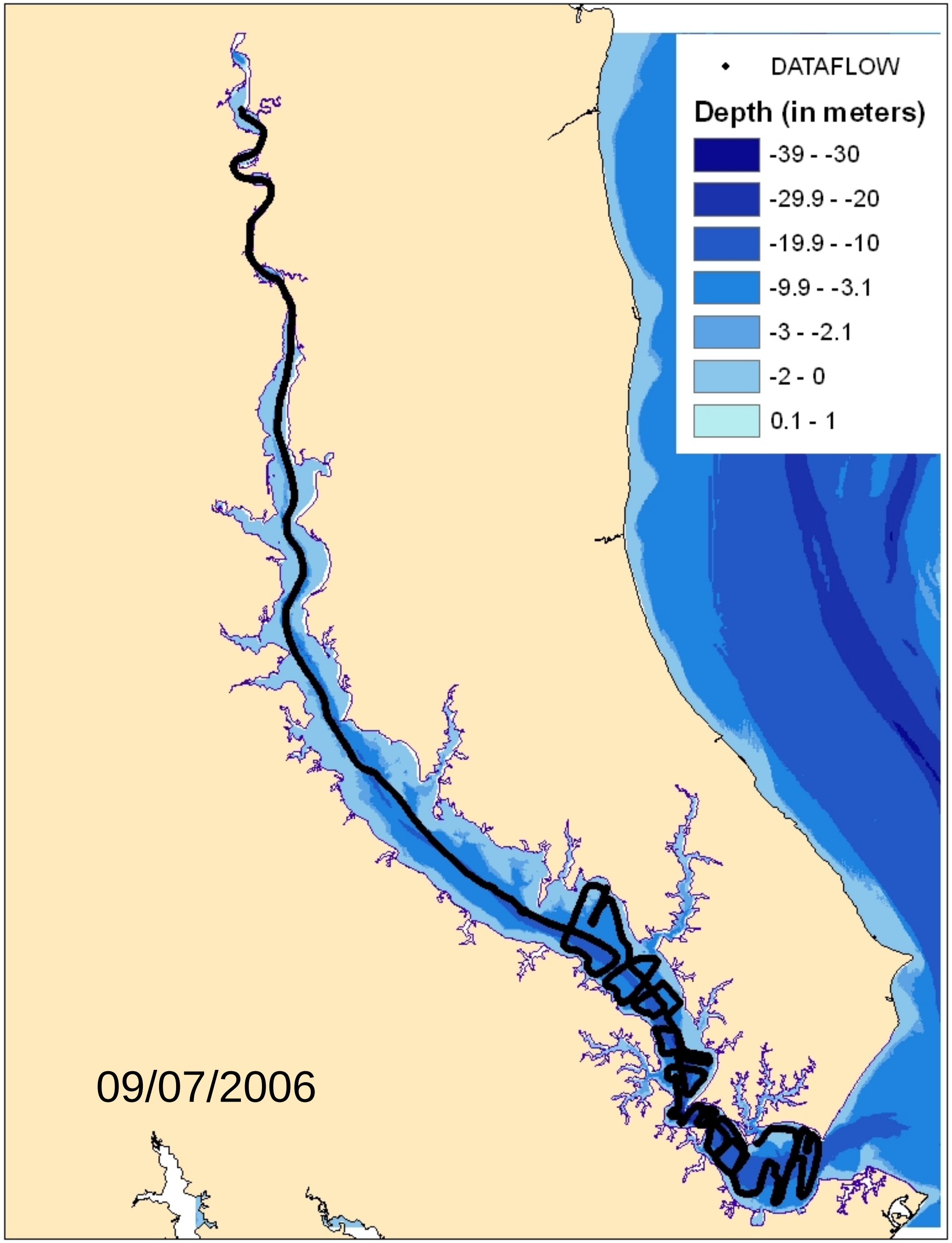
Data and analysis options



Water Quality Monitoring Stations on the Patuxent River

Sparse sampling network used for routine water quality monitoring

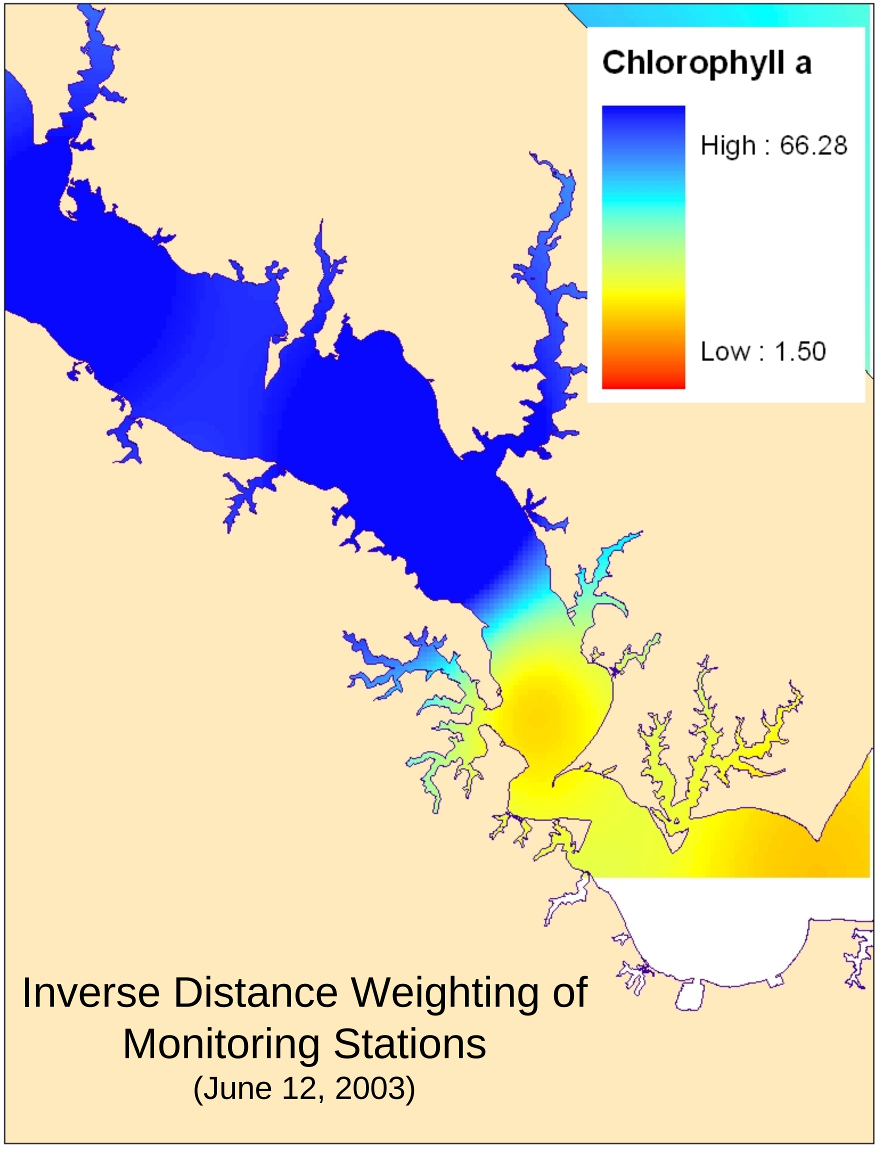
Data collected 12-20 times per year



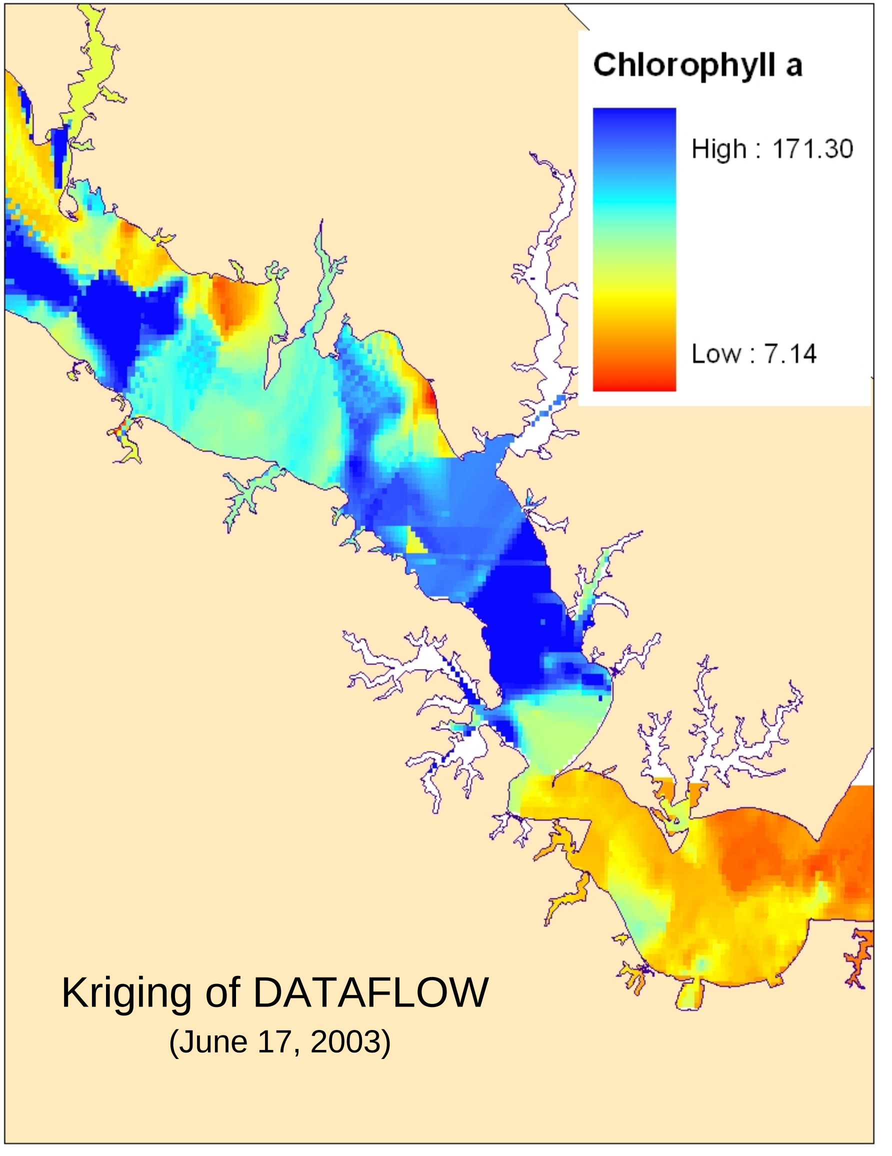
DATAFLOW sampling (boat-mounted sensors) provide more detailed spatial coverage than long-term monitoring stations

Data collected 7-13 times per year

Spatially detailed data (DATAFLOW) provide additional information for spatial interpolation of water quality



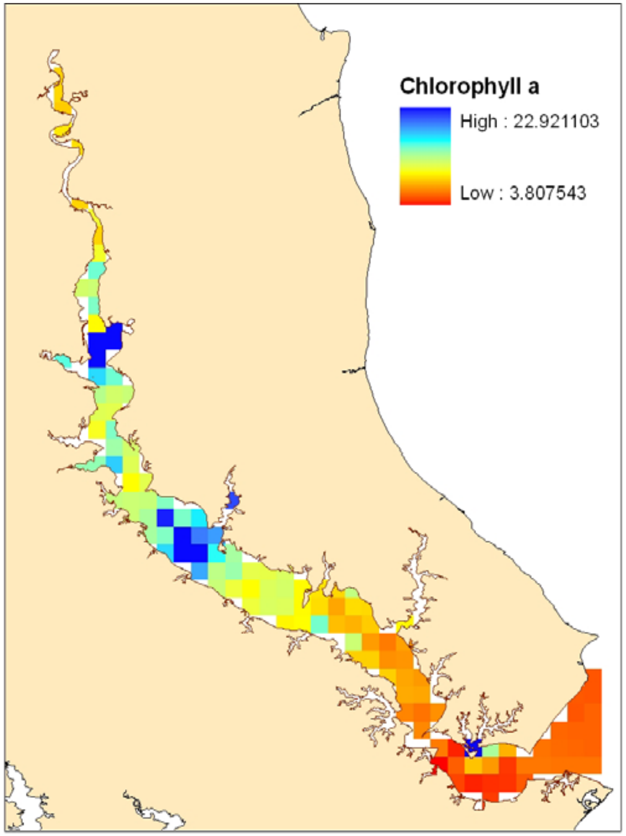
Inverse Distance Weighting of Monitoring Stations
(June 12, 2003)



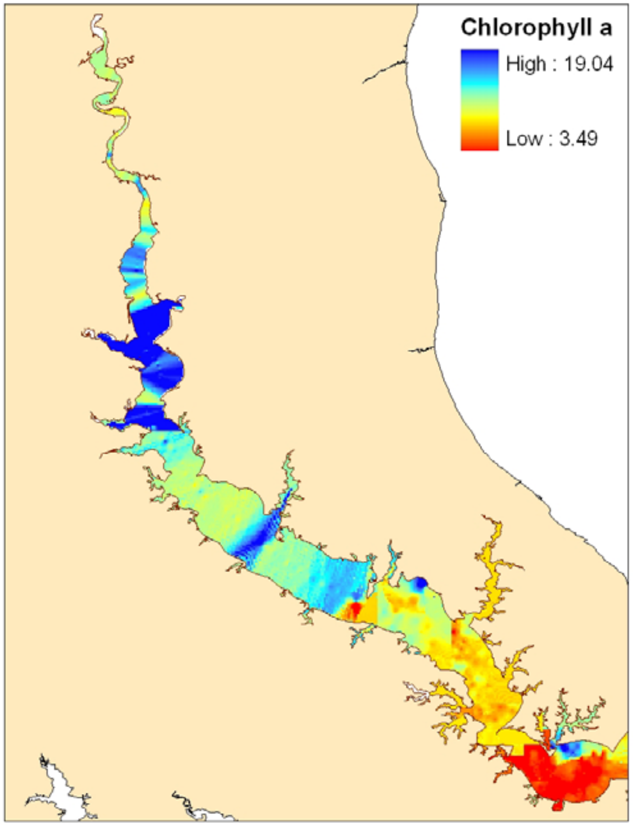
Kriging of DATAFLOW
(June 17, 2003)

Different Methods of Interpolation of DATAFLOW

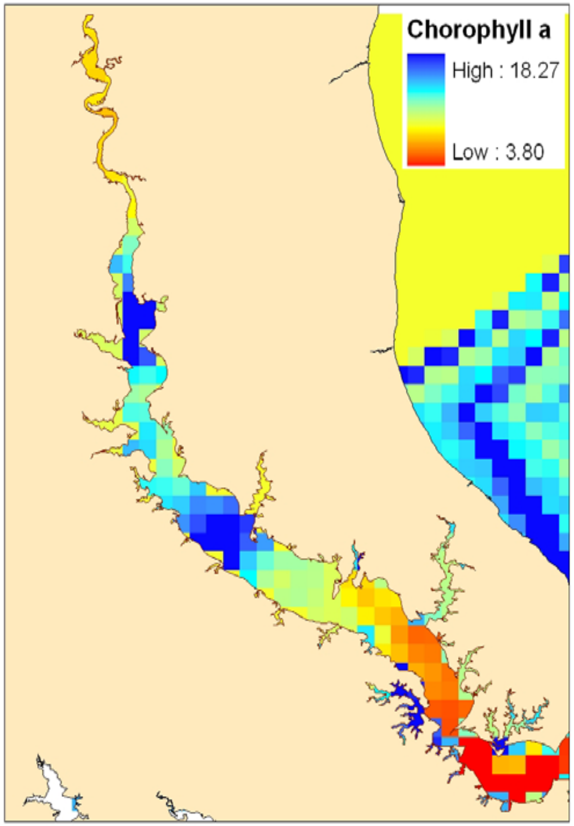
Inverse Distance Weighting of the River (all points included)



Kriged Pieces of the River (all points included)

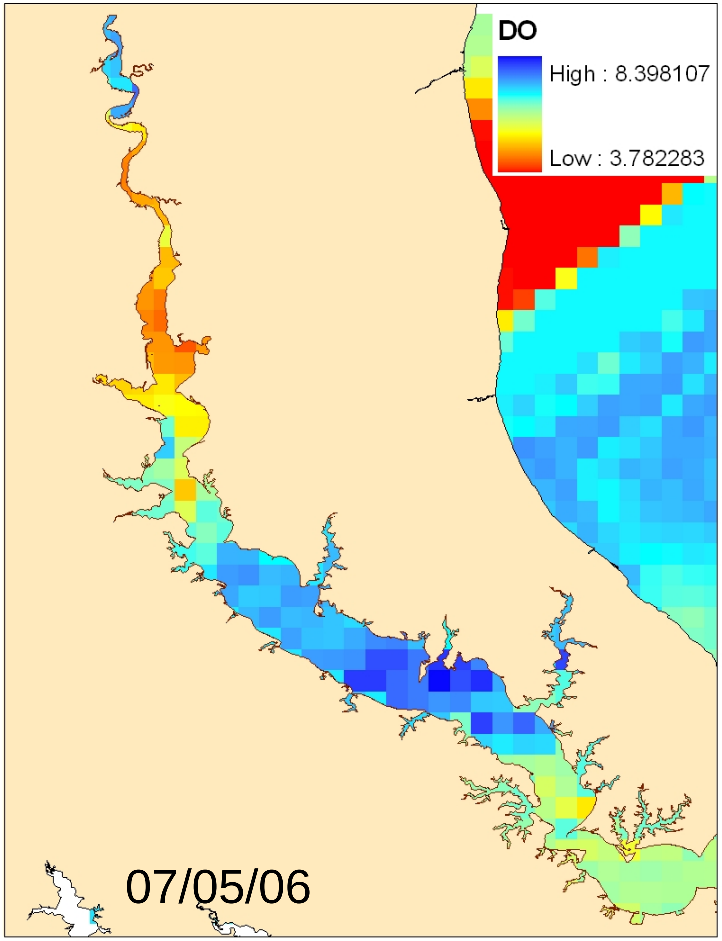


Whole River Kriged (data points removed)

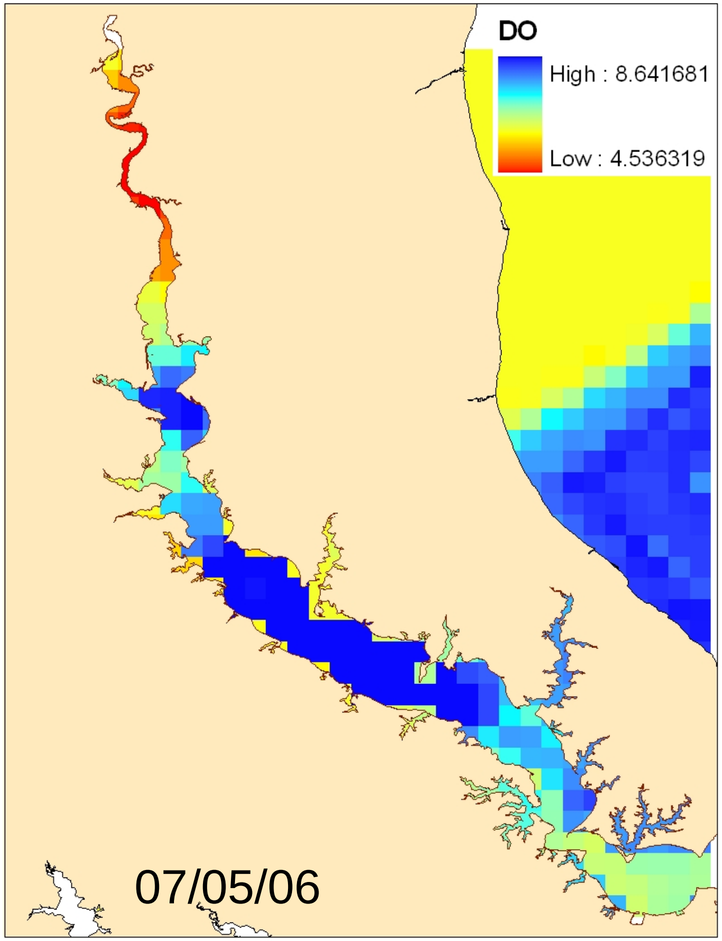


Detrending vs. No Detrending

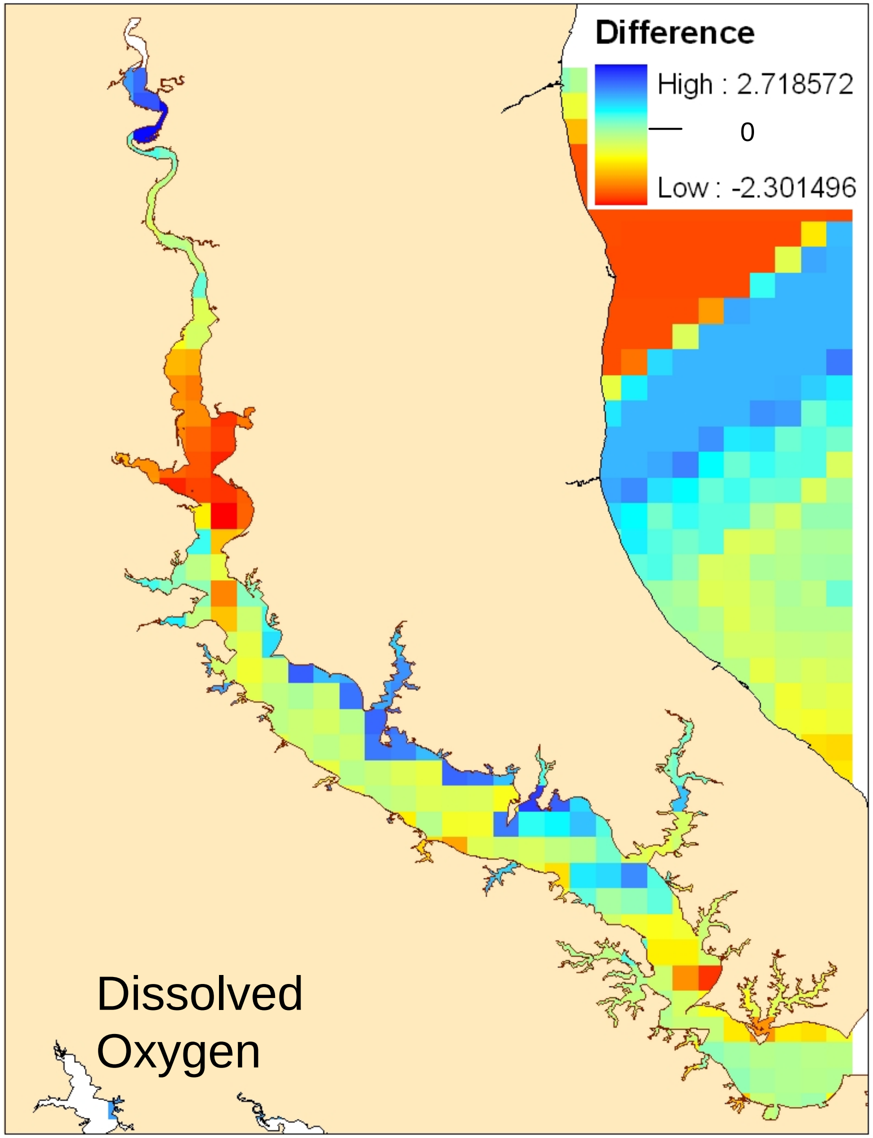
Kriging DO with Detrending
DO = *f* (distance from mouth)



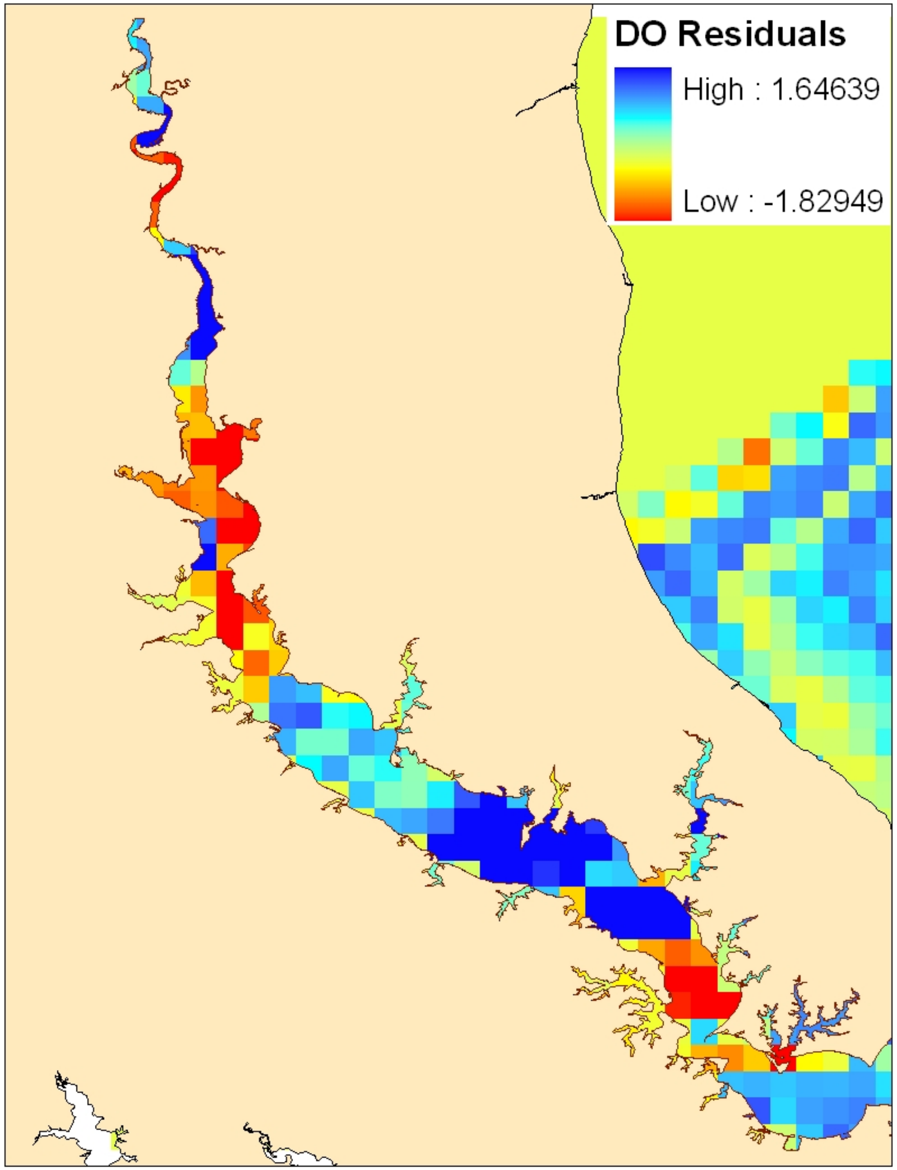
Kriging DO with No Detrending
(ordinary kriging)



Difference between Detrended and Ordinary Kriging Results



Detrending = Challenges



- Goal of developing uniform techniques for detrending multiple data sets seem limited

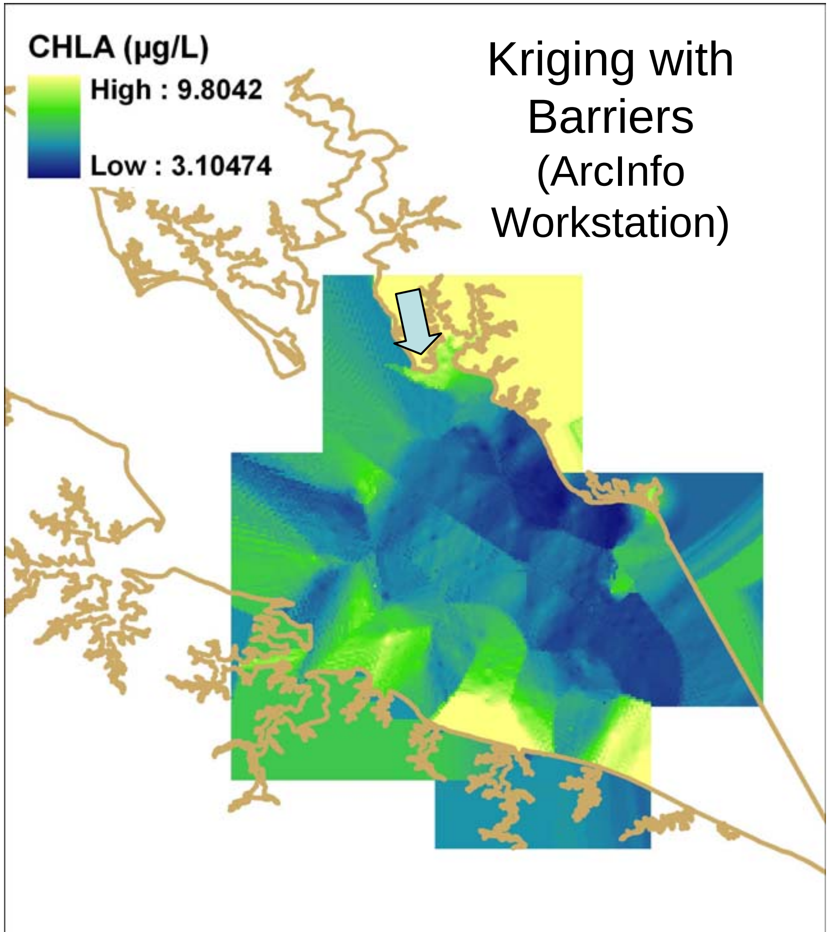
- Trends were highly inconsistent between months

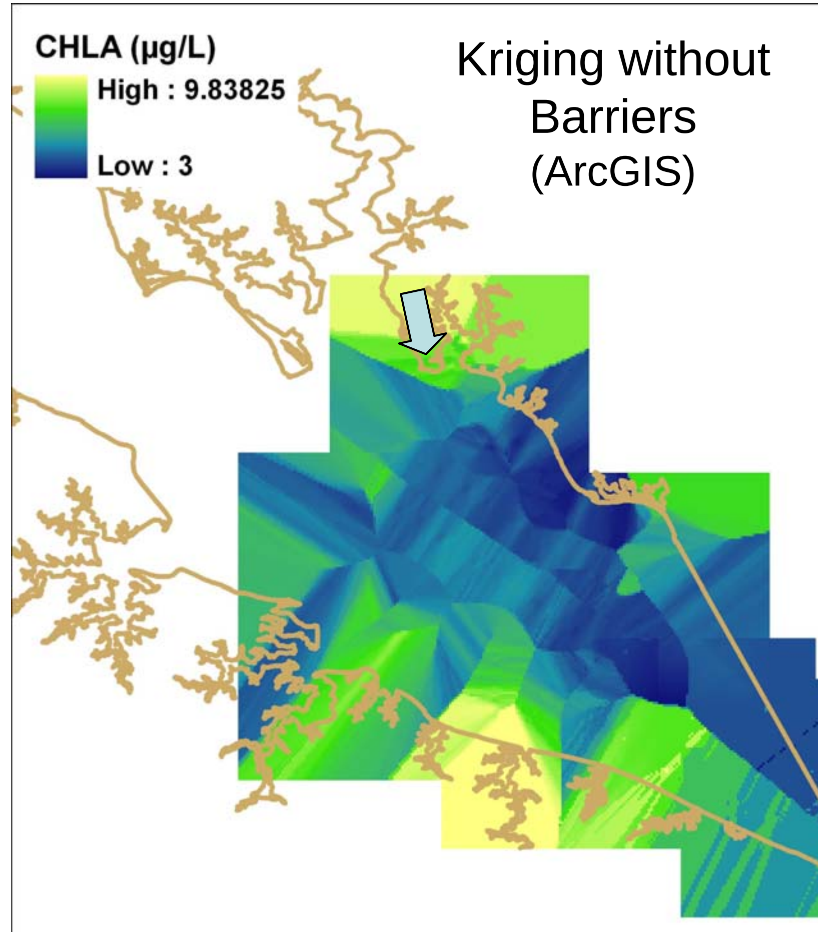
- Detrending did not improve interpolation in our test

- Can we use other sources of variables in detrending (e.g., model data)?

- Yet residuals are highly useful for evaluating excursions from expected values

Comparison of Kriging with & without Barriers

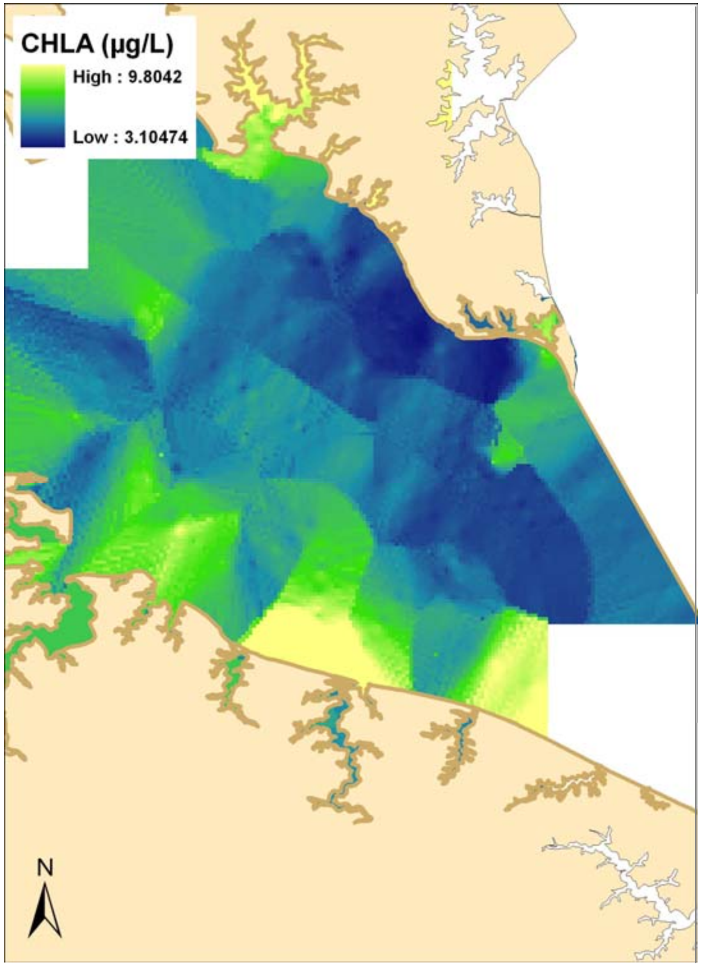




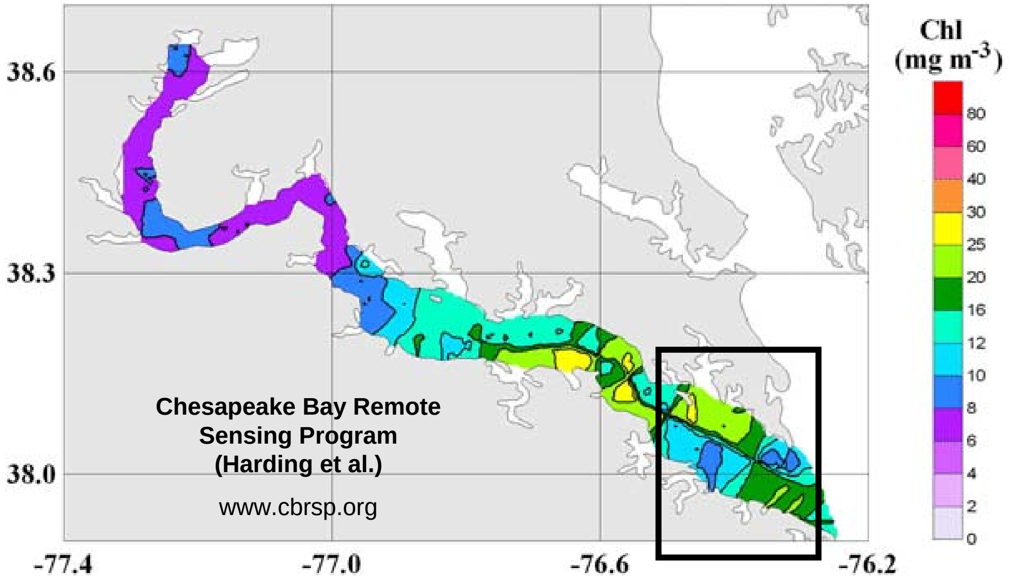
Lower Potomac River - April 2007 Estimation of Chlorophyll a

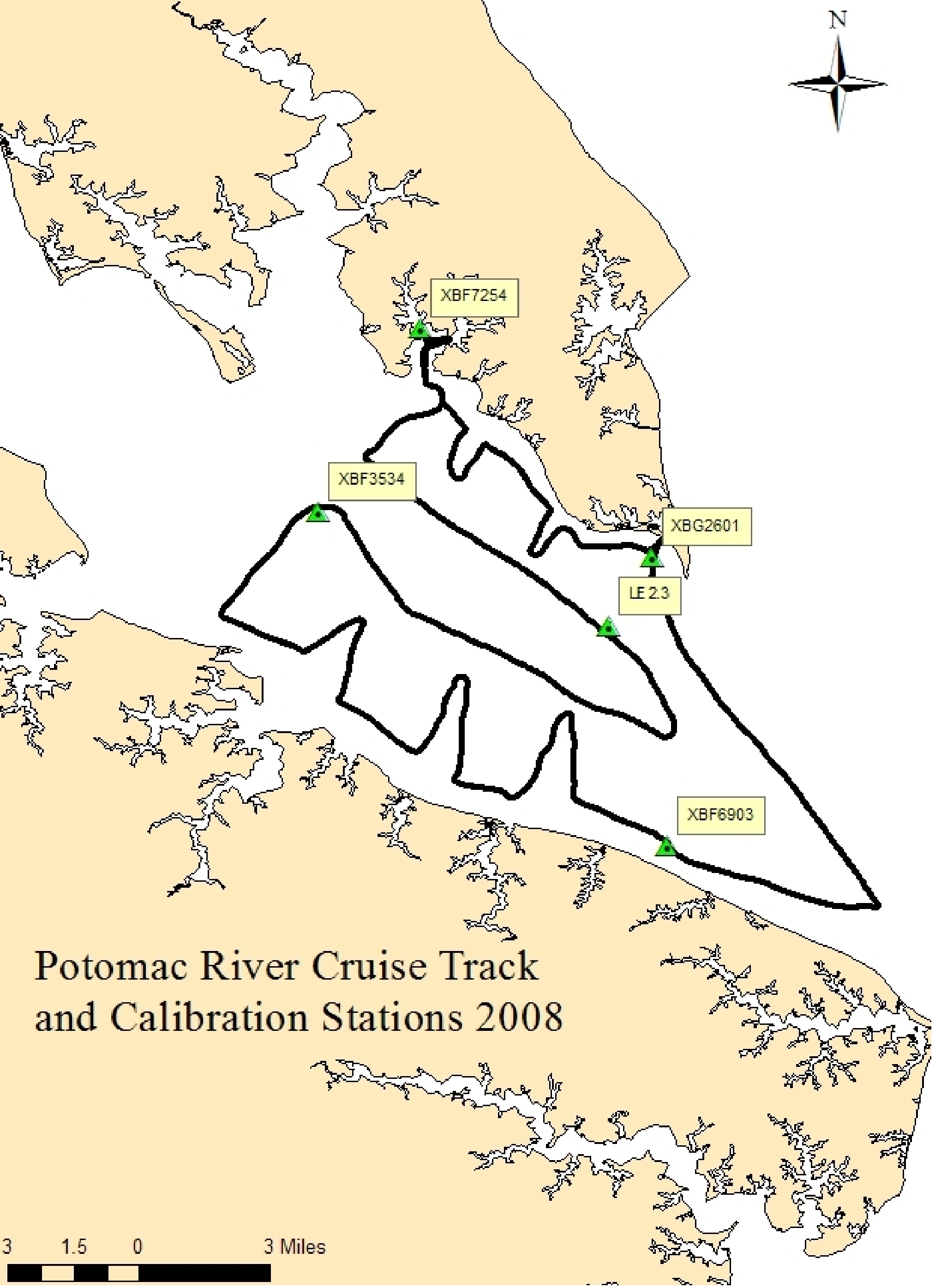
COMPARISON OF DATAFLOW AND REMOTE SENSING RESULTS

Lower Potomac River – 20 April 2007
Estimation of Chlorophyll a



Potomac River Chlorophyll a
29 April 2007



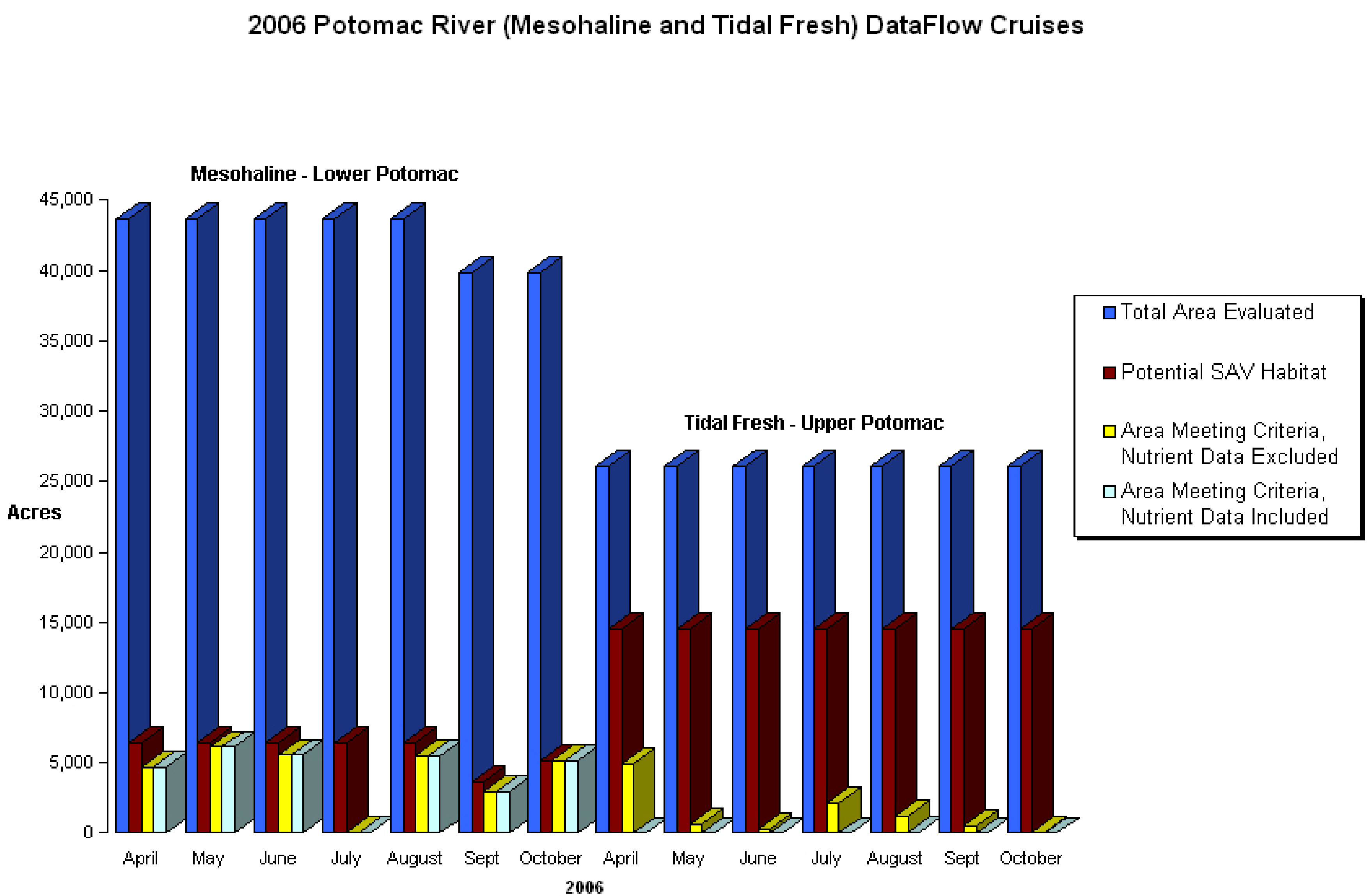


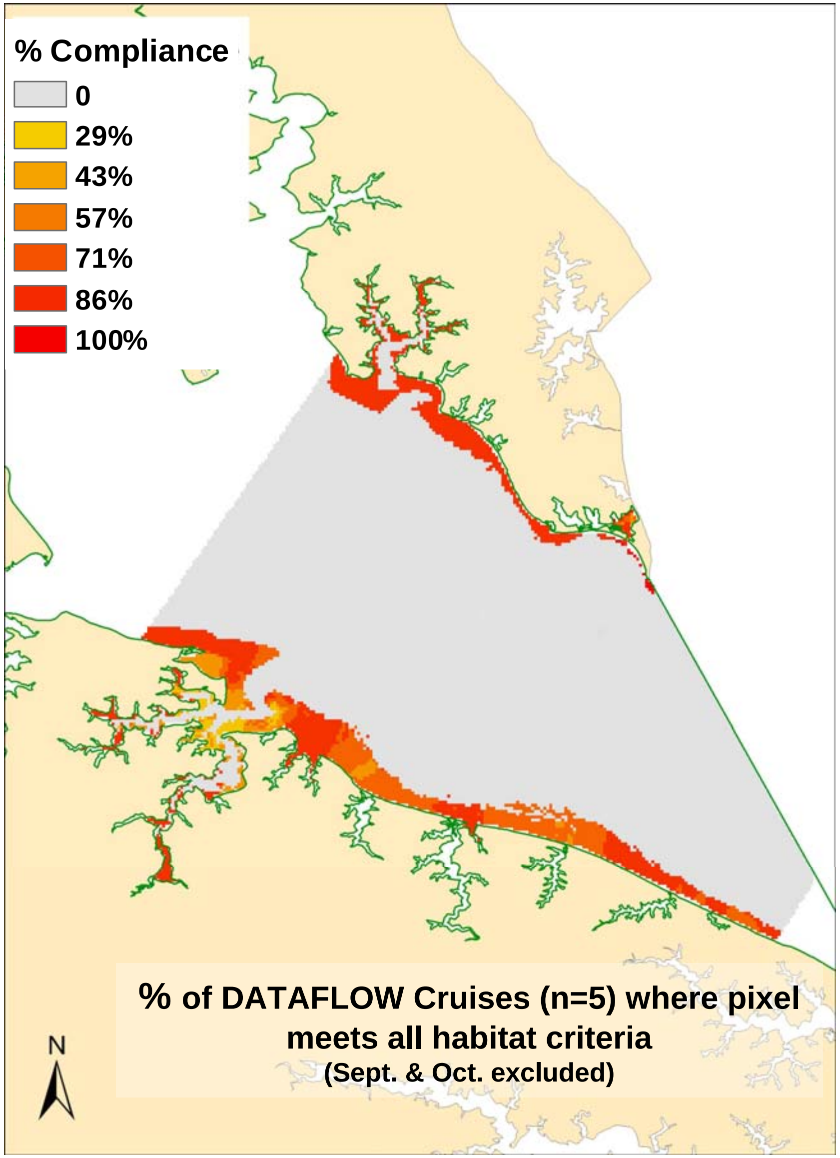
SAV Habitat Analysis of Potomac River

Goal: Understand SAV Habitat Quality & Restoration Potential

SAV Habitat Criteria

Potomac River	Water column light requirement (%) = *g*(turbidity, salinity, chla)	Chlorophyll a (μg/L)	Dissolved Inorganic Phosphorus (mg/L)	Dissolved Inorganic Nitrogen (mg/L)
Tidal Fresh	>13	<15	None*	None
Mesohaline	>22	<15	<0.01	<0.15


2006 Potomac River (Mesohaline and Tidal Fresh) DataFlow Cruises
Mesohaline - Lower Potomac
Tidal Fresh - Upper Potomac
Acres
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
April
May
June
July
August
Sept
October
April
May
June
July
August
Sept
October
2006
Total Area Evaluated
Potential SAV Habitat
Area Meeting Criteria, Nutrient Data Excluded
Area Meeting Criteria, Nutrient Data Included

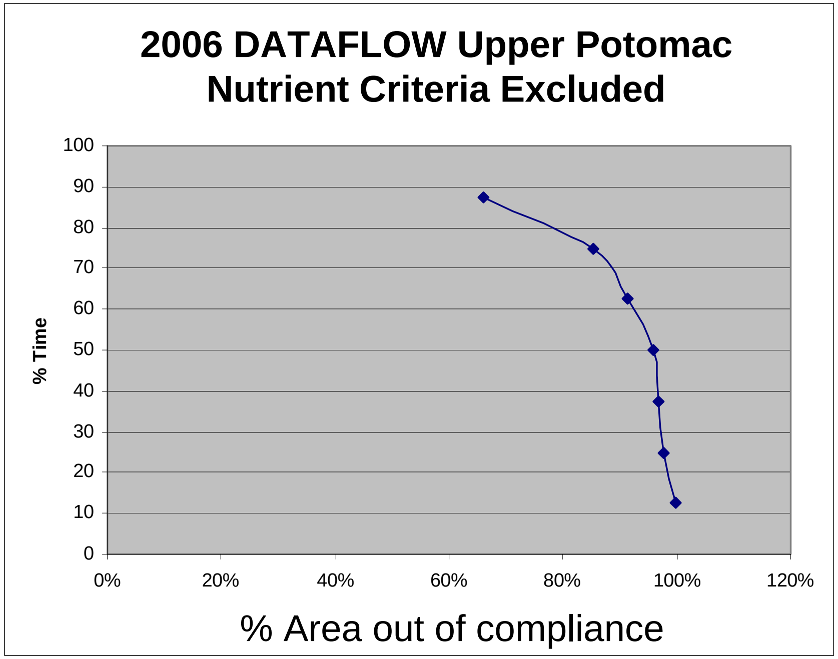


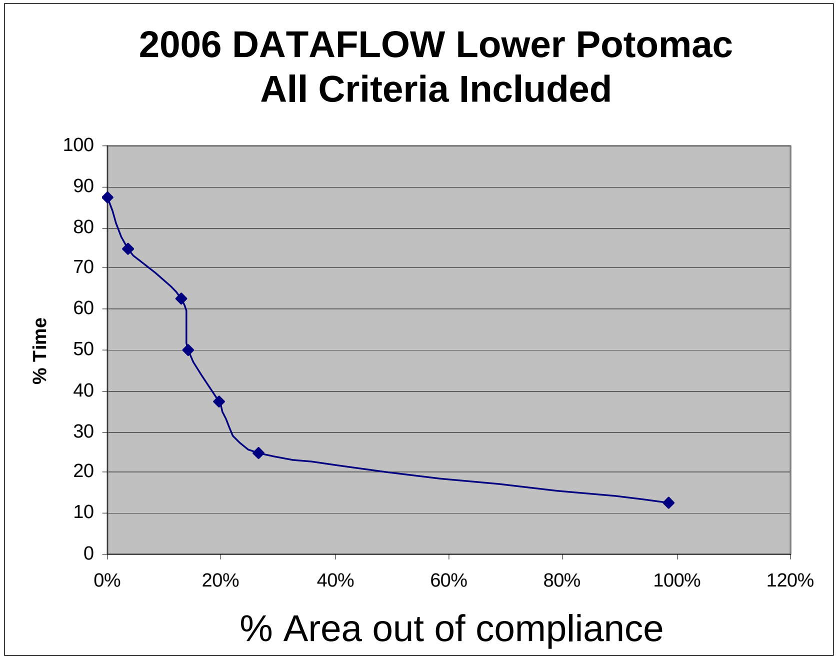
SAV Habitat Hotspots – Mesohaline Potomac

2006 Spatially Intensive Shallow Water Quality Monitoring

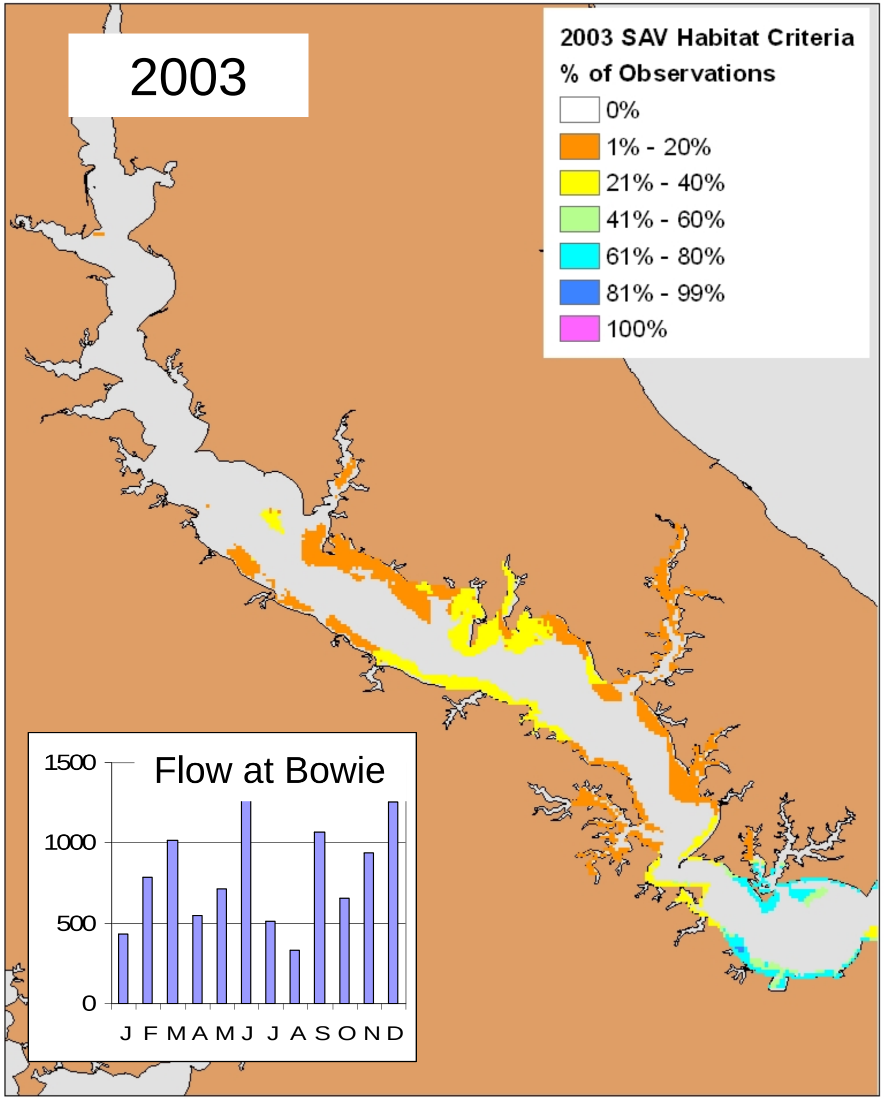
Cumulative Frequency Diagrams

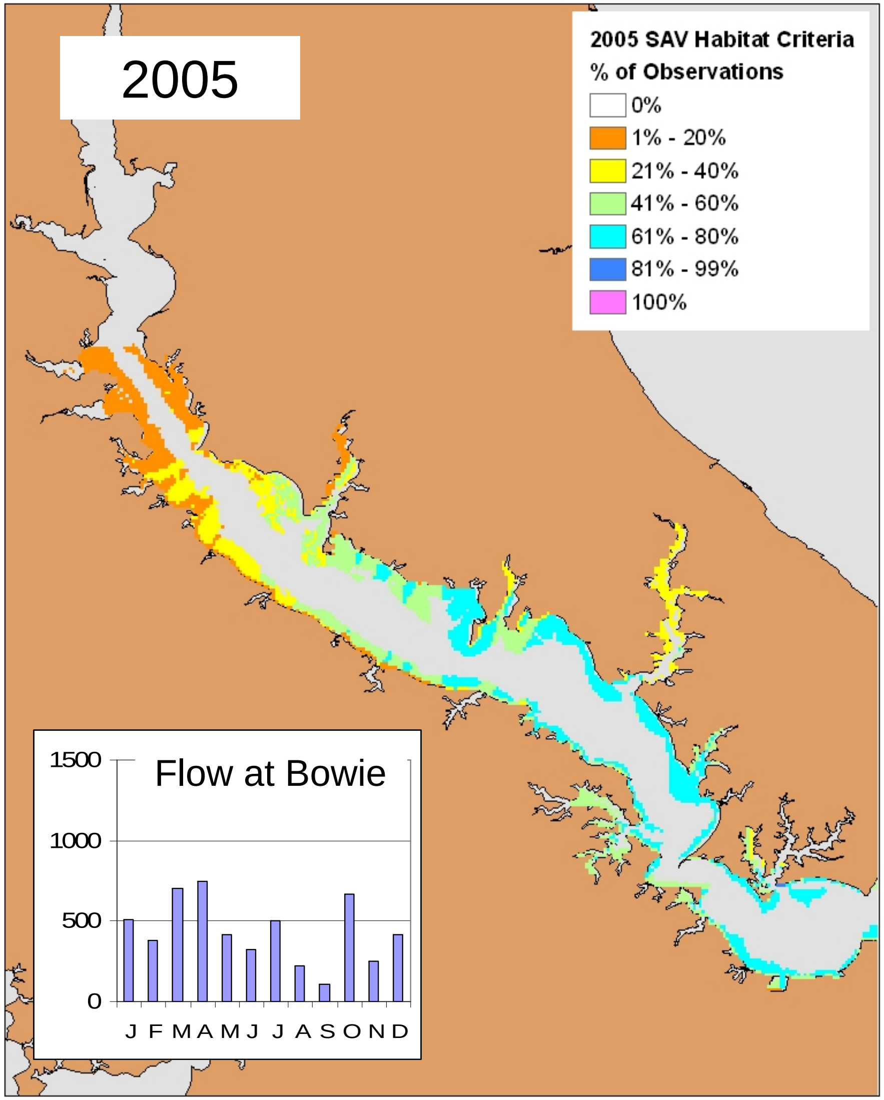
Spatially Intensive Shallow Water Quality Monitoring of the Potomac River





Patuxent River
% Observations Meeting SAV Habitat Criteria
(nutrient criteria excluded)





Conclusions and Recommendations

- Interpolation techniques that go beyond basic IDW, create significant time costs, even when tasks are automated with scripts.
- More complex spatial interpolation in some cases, but not others, appears to provide substantially improved information over simpler interpolation techniques.
- Expected use of interpolation results as well as time and budget constraints can inform the level of effort that is warranted or feasible.

- The use of barriers, detrending and other techniques, raises the risk of imposing conditions on data that may not represent physical reality.
- On the other hand, failing to account for barriers introduces localized misrepresentations of data (e.g., near peninsulas).
- Failure to detrend dissolved oxygen may create spatial gradients that represent time effects rather than spatial variability.
- Alternative sampling regimes could help to minimize time-of-day effects on data

- Model data output could be a useful addition to detrending functions to better establish “expected values” given time of year and antecedent rainfall conditions if concerns about error can be addressed.

Acknowledgements

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- Other major contributors:
  - Maria Ceballos
  - Eva Bailey