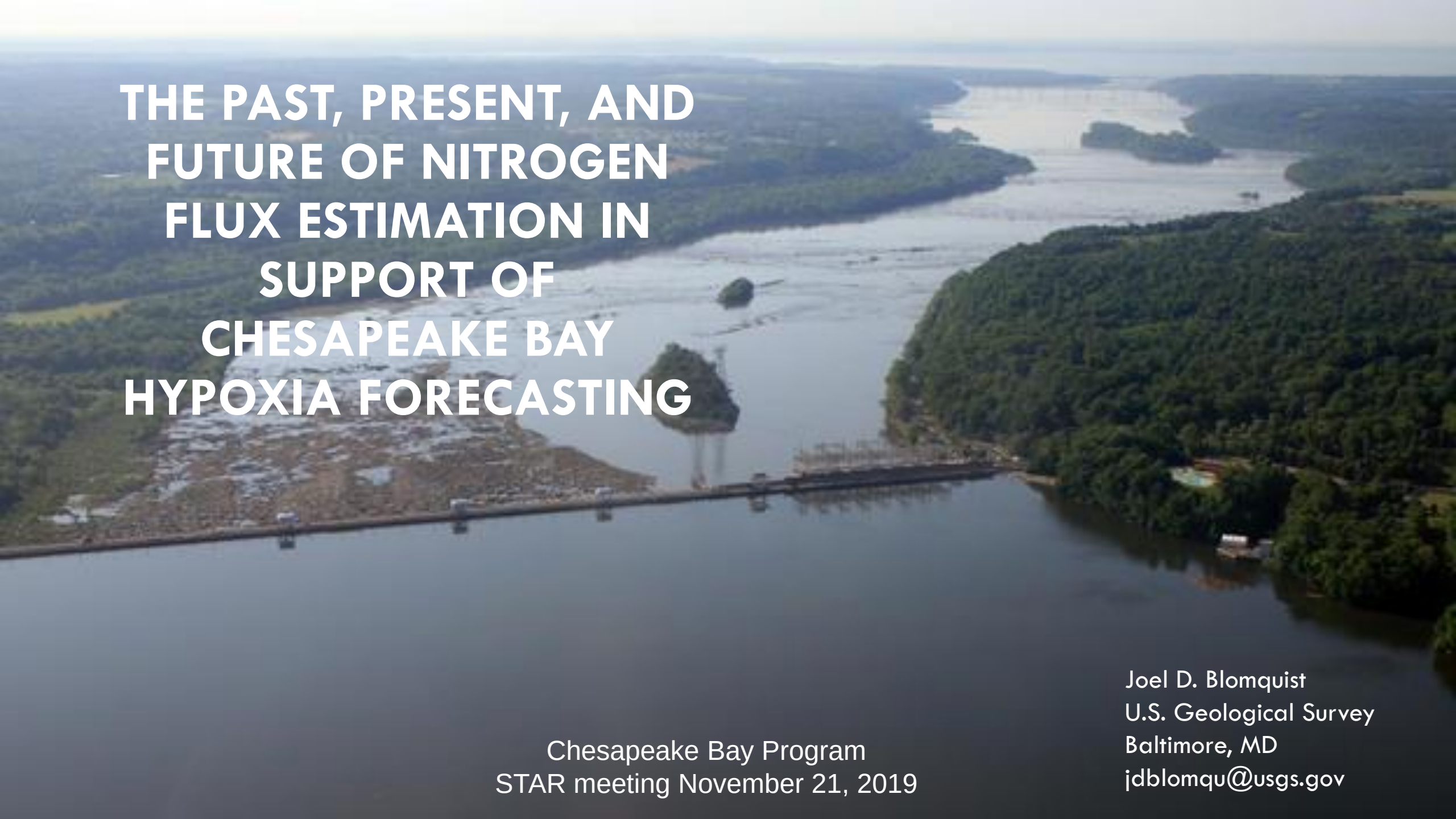

THE PAST, PRESENT, AND FUTURE OF NITROGEN FLUX ESTIMATION IN SUPPORT OF CHESAPEAKE BAY HYPOXIA FORECASTING

Chesapeake Bay Program
STAR meeting November 21, 2019

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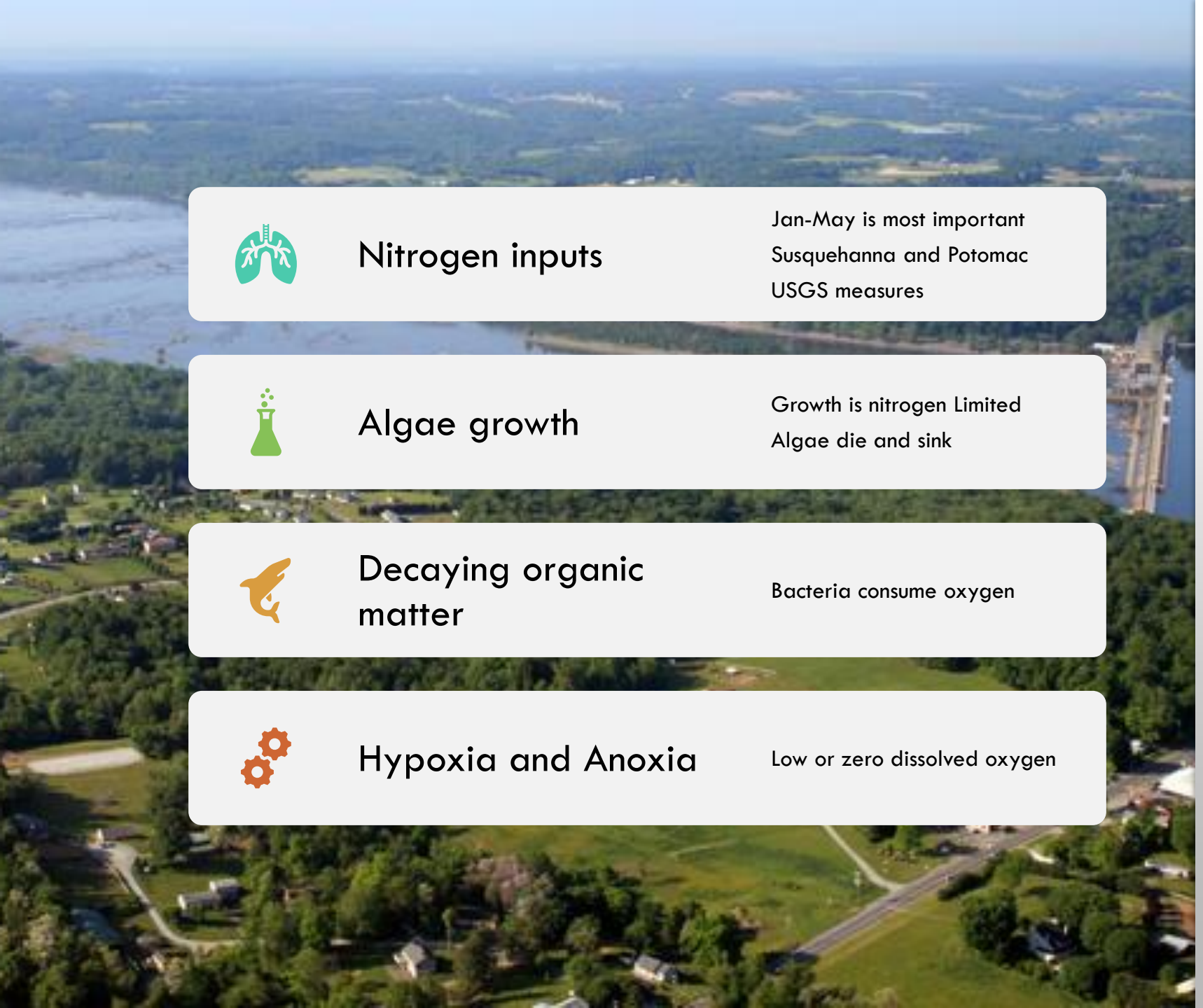
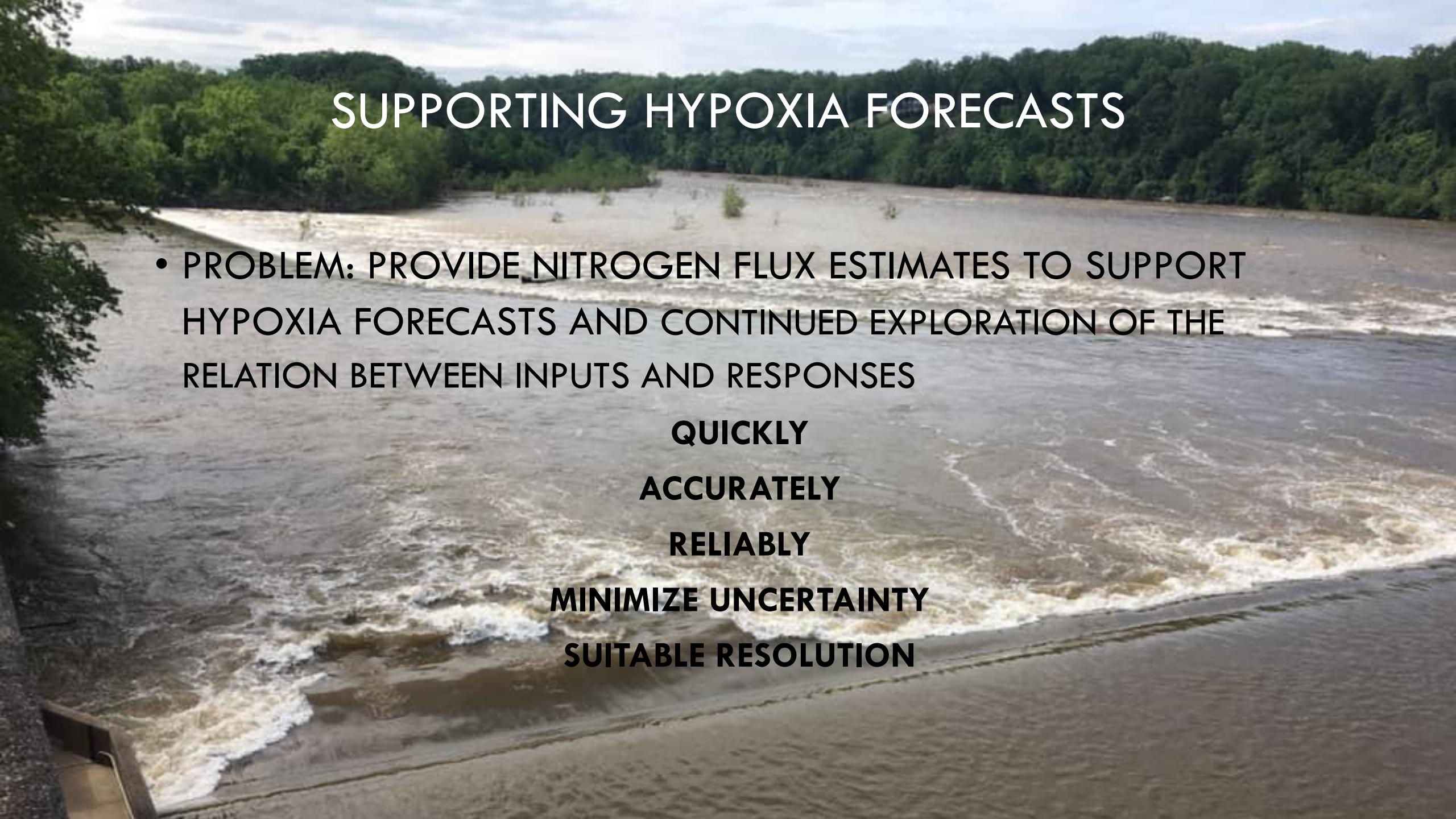


GENERAL PRINCIPALS OF BAY HYPOXIA

Nitrogen inputs	Jan-May is most important Susquehanna and Potomac USGS measures
Algae growth	Growth is nitrogen Limited Algae die and sink
Decaying organic matter	Bacteria consume oxygen
Hypoxia and Anoxia	Low or zero dissolved oxygen



SUPPORTING HYPOXIA FORECASTS

- PROBLEM: PROVIDE NITROGEN FLUX ESTIMATES TO SUPPORT HYPOXIA FORECASTS AND CONTINUED EXPLORATION OF THE RELATION BETWEEN INPUTS AND RESPONSES

QUICKLY

ACCURATELY

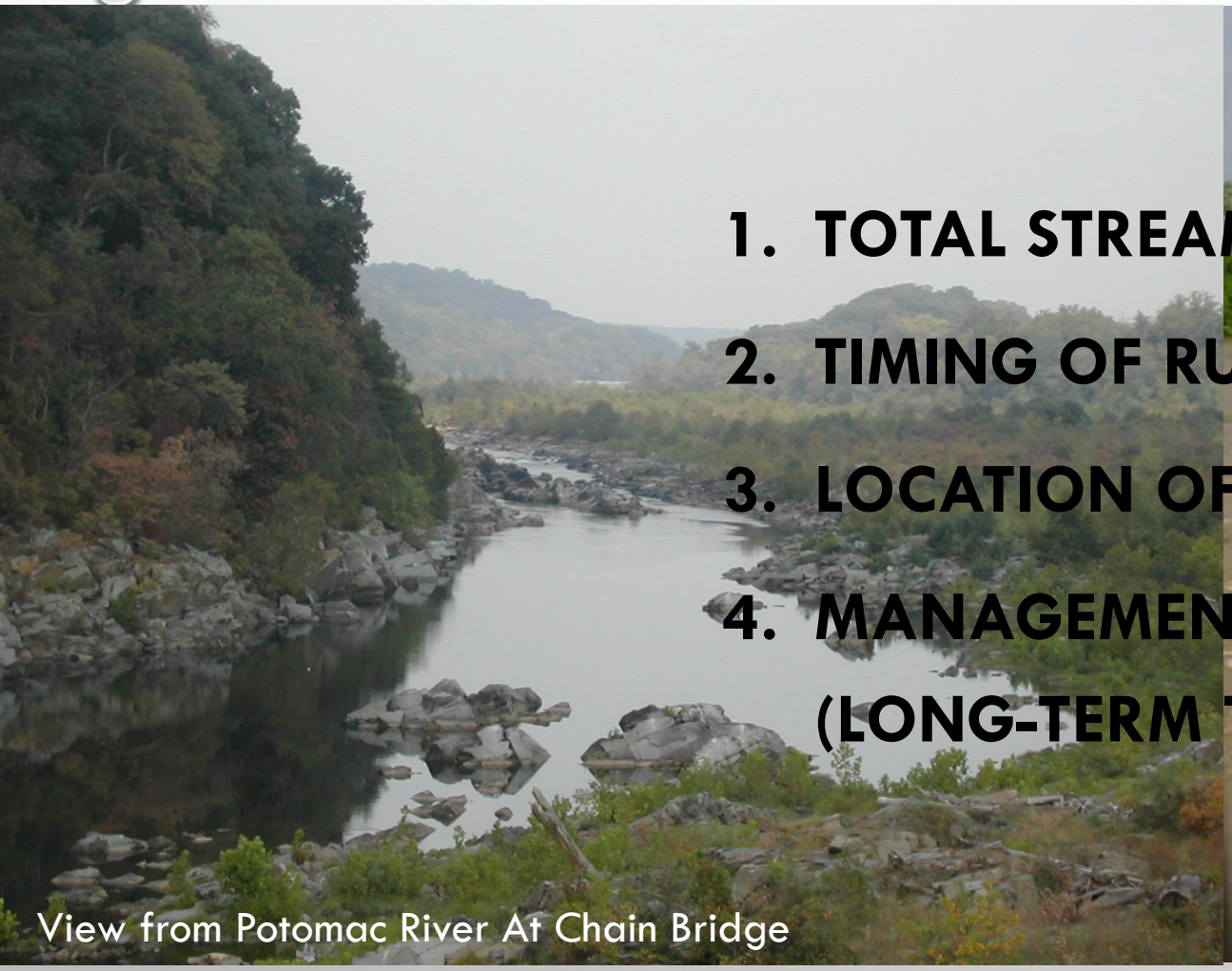
RELIABLY

MINIMIZE UNCERTAINTY

SUITABLE RESOLUTION

THINGS THAT CONTROL TRIBUTARY NITOGEN FLUX IN ANY GIVEN YEAR

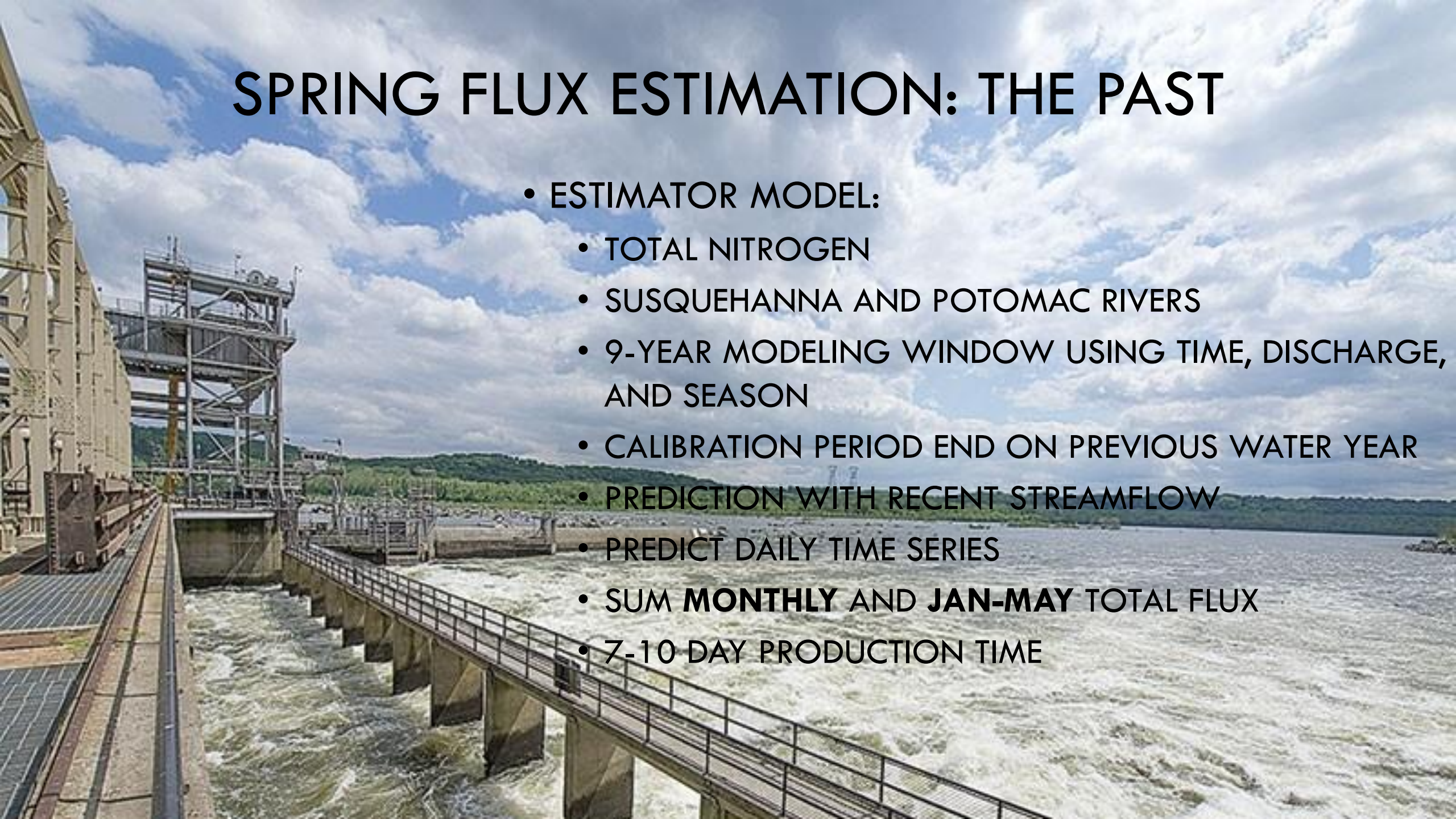
1. **TOTAL STREAMFLOW**
2. **TIMING OF RUNOFF EVENTS**
3. **LOCATION OF EVENTS**
4. **MANAGEMENT ACTIONS (LONG-TERM TRENDS)**



View from Potomac River At Chain Bridge

View from Potomac River At Chain Bridge

SPRING FLUX ESTIMATION: THE PAST

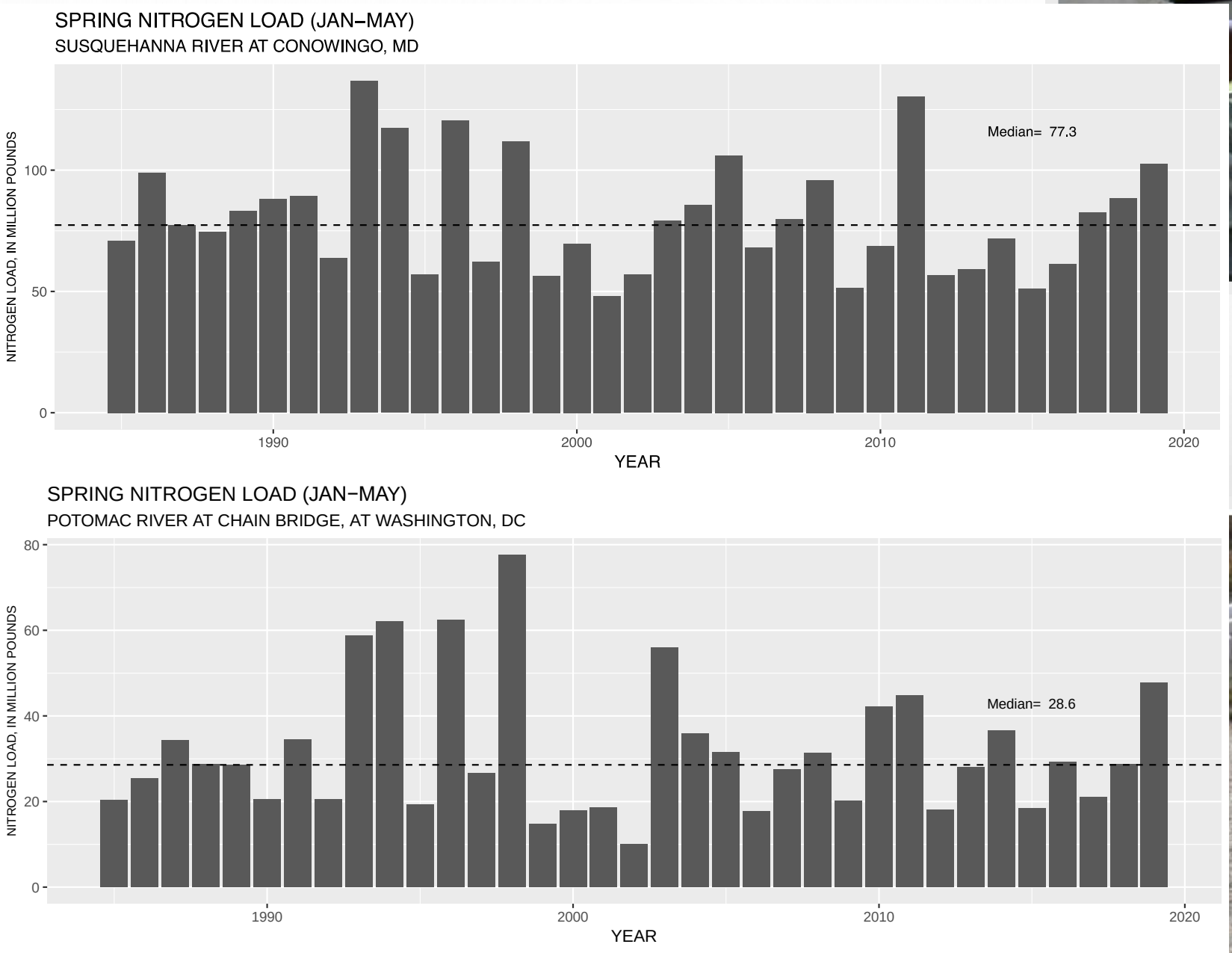


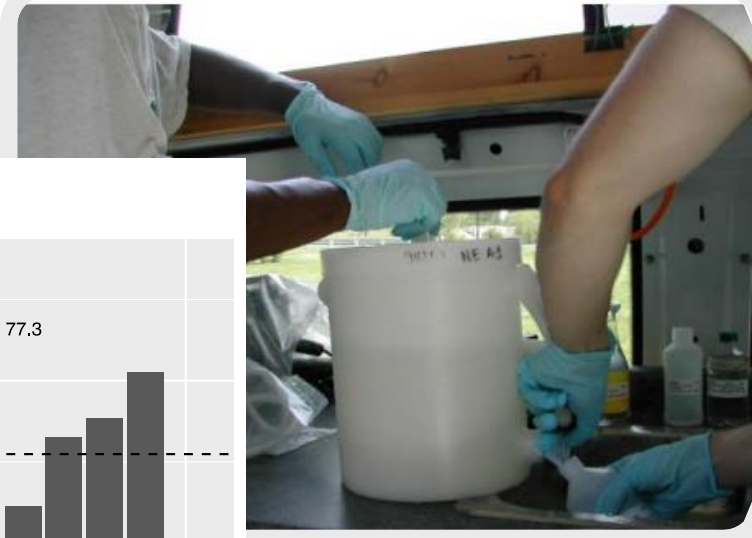
- ESTIMATOR MODEL:
  - TOTAL NITROGEN
  - SUSQUEHANNA AND POTOMAC RIVERS
  - 9-YEAR MODELING WINDOW USING TIME, DISCHARGE, AND SEASON
  - CALIBRATION PERIOD END ON PREVIOUS WATER YEAR
  - PREDICTION WITH RECENT STREAMFLOW
  - PREDICT DAILY TIME SERIES
  - SUM **MONTHLY** AND **JAN-MAY** TOTAL FLUX
  - 7-10 DAY PRODUCTION TIME

SPRING FLUX ESTIMATION: **THE PRESENT**

- WRTDS MODEL
  - LOCALLY WEIGHTED ON TIME DISCHARGE AND SEASON
  - CALIBRATION ON RECENT OBSERVATIONS (APRIL)
  - PREDICT DAILY TIME SERIES
  - 1-DAY PRODUCTION TIME
- ADVANTAGES
  - IMPROVED ACCURACY
  - TAKES ADVANTAGE OF RECENT SAMPLE DATA
  - IMPROVED AUTOMATION
  - QUICKER TURN AROUND

ANNUAL PRODUCTS



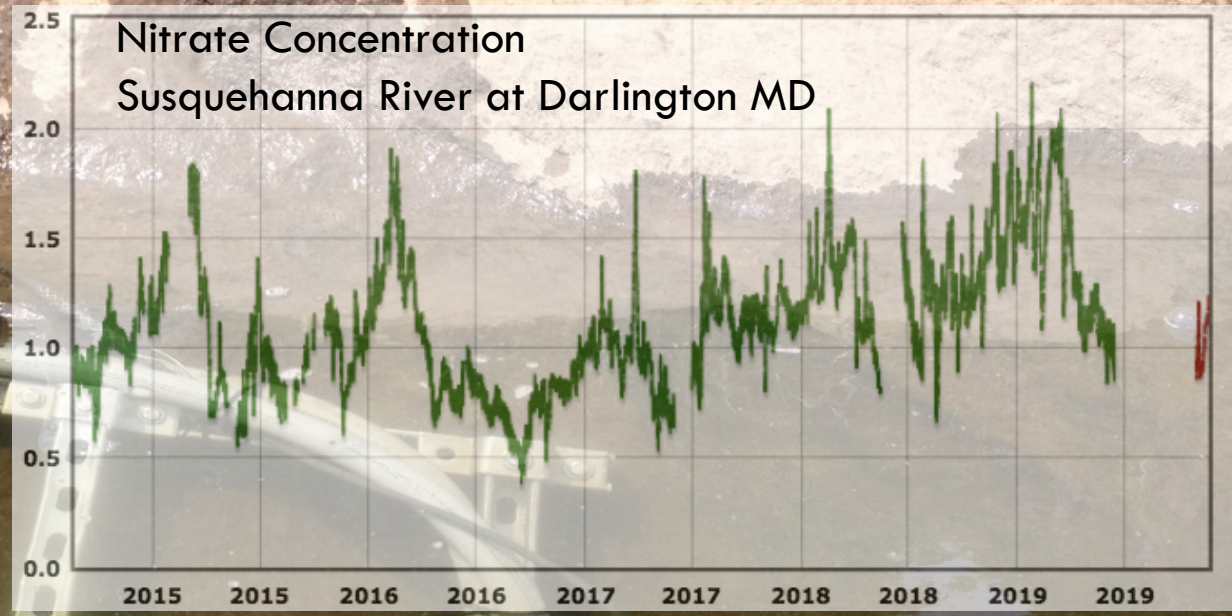


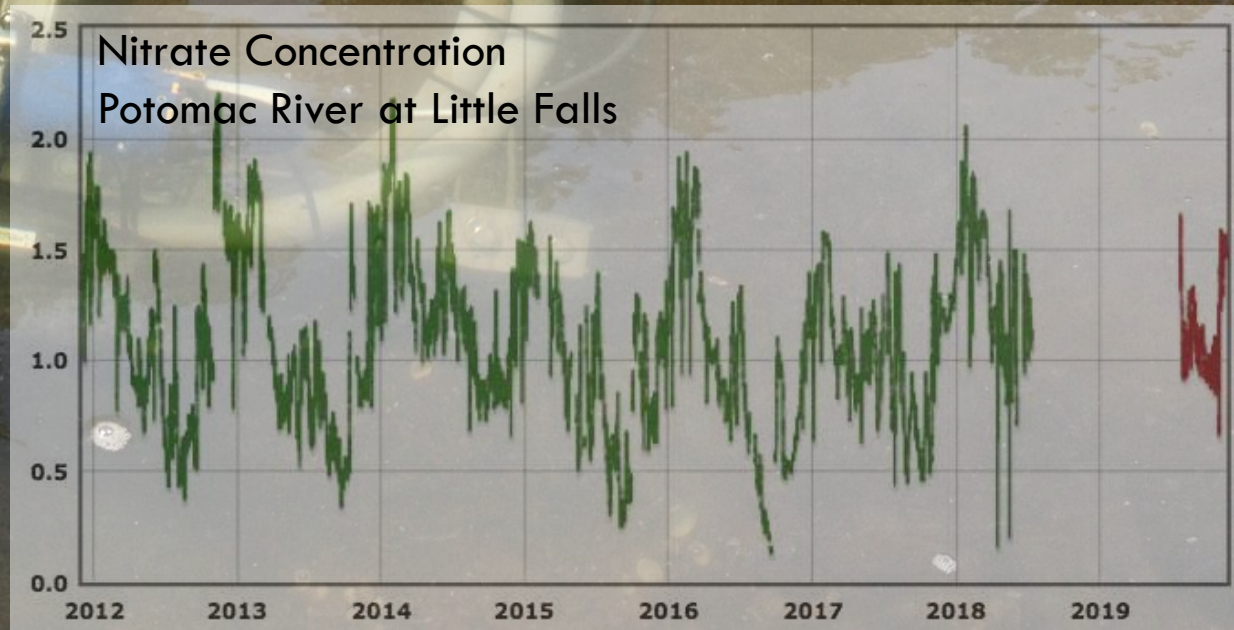
SPRING FLUX ESTIMATION: **THE FUTURE**

- DIRECT MEASUREMENT OF NITRATE FLUX:
  - SUSQUEHANNA 2014-PRESENT
  - POTOMAC 2012-PRESENT
- SURROGATE MODEL FOR TOTAL NITROGEN
  - TURBIDITY AND FLOW
- WRTDS HISTORICAL AND GAP FILLING

- ADVANTAGES
  - MUCH IMPROVED ACCURACY
  - HIGH RESOLUTION
  - IMMEDIATE AVAILABILITY (EVENTUALLY)
  - SOLVES UNCERTAINTY RELATED TO STORM TRACK

CONTINUOUS NITRATE DATA





FILLING IN THE GAPS (WHAT MORE COULD BE DONE)

- ADDITIONAL TRIBUTARIES (RIM)
- MODEL UNMONITORED AREAS
  - (ANNUALLY ADJUSTED SPARROW)
  - (ANNUALLY ADJUSTED WSM)
- INCORPORATE MAJOR WASTEWATER TIME SERIES