Relative Confidence Index: Modeling Localized Impacts of Management Practices

Chesapeake Bay Program 6-year Cooperative Agreement
Objective 3: BMP Planning and Reporting

Relative Confidence Index

- RCI is a modeling effort to implement new site-level spatial modeling routines in combination with existing Chesapeake Bay modeling output and algorithms (e.g., established regional loading rates, BMP reduction coefficients, BMP reduction algorithms, etc.) in order to better estimate potential load reductions that might be achieved with “site-level” BMP implementation.
- The goal is to highlight projects that meet/exceed the modeled average to influence project planning towards higher performing projects and locations

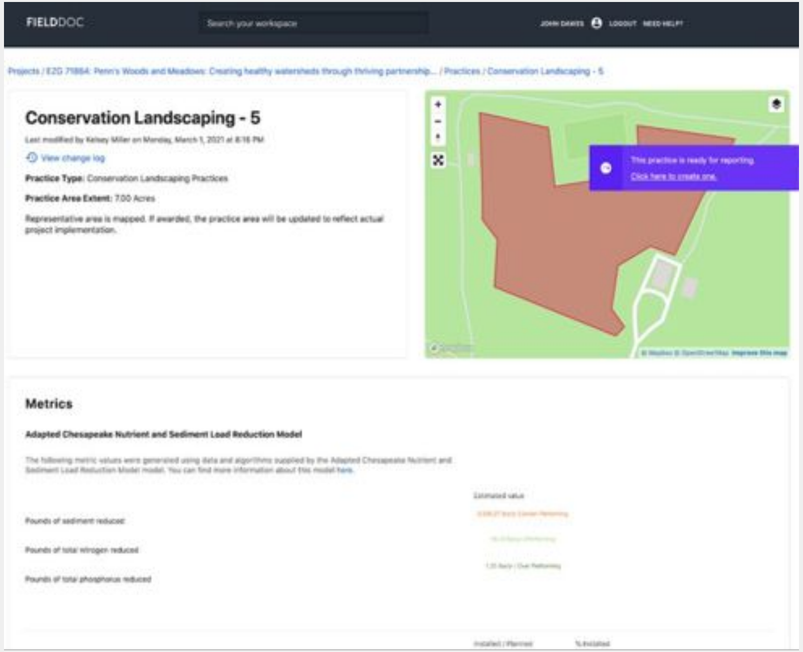
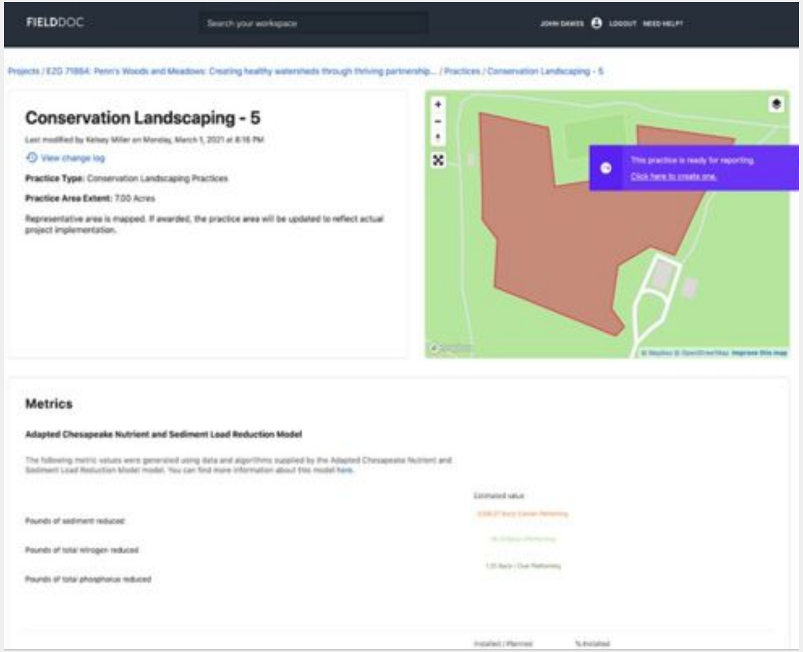


Image source from FieldDoc (The Commons)

Relative Confidence Index

- RCI is deployed as a feature in FieldDoc to inform the user of the likelihood that a practice will achieve or exceed a CAST-based average load reduction for the land-river segment where the practice footprint is located.
- Practices included in first phase:
  - Riparian Forest Buffer
  - Riparian Forest Buffer with streamside exclusion fencing
  - Grass Buffer
  - Forest Buffer - narrow



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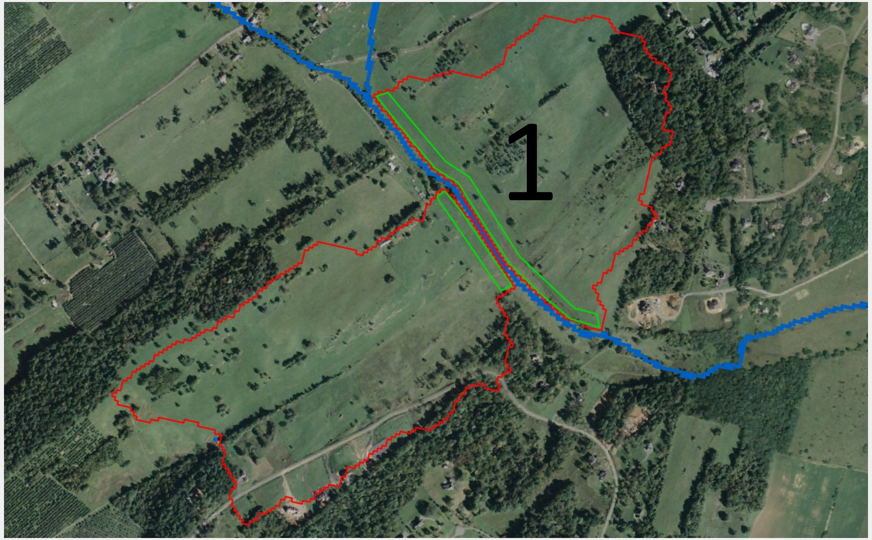
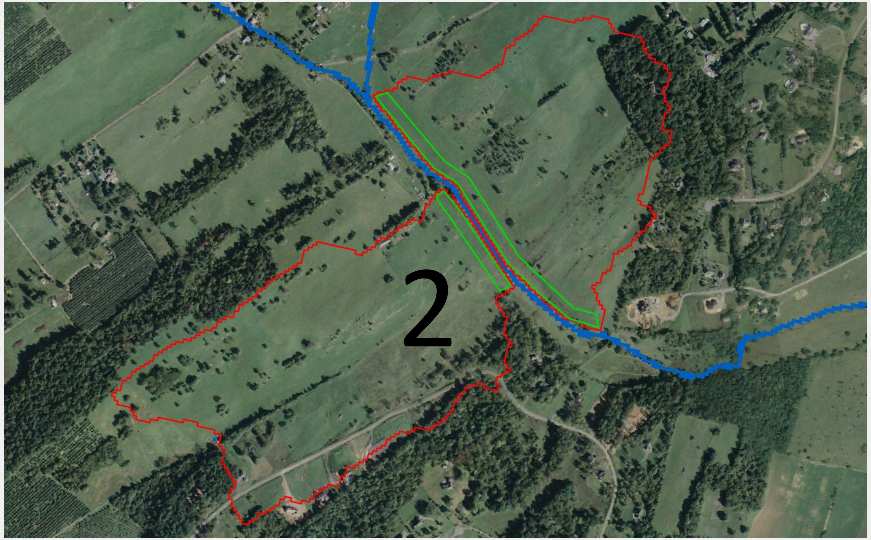
Who is the intended user audience?

- Overall intention to support local, state, and regional efforts to improve water quality throughout the watershed.
  - RCI is integrated into Commons’ FieldDoc platform as a planning feature for users
    - Initial roll-out to grant program managers in FieldDoc (e.g. NFWF, MDNR, VEE)
    - Goal is to share to all FieldDoc users through a BMP planning sandbox environment after testing and feedback from initial roll-out

Example: Testing Two Riparian Buffers

- Two riparian buffers, 100 ft wide each
- Buffer 1 is roughly 0.5 miles long, while buffer 2 is roughly 0.2 miles long





Relative Confidence Index

Method

- Create a ratio of the CAST ISO Reduction Estimate over the Practice Specific Reduction Estimate
- The ratio is scaled from 0 to 2, with any over-performing practice being capped at 2, and any under-performing practice measured as a percentage.
- This would be visualized with a gradient color bar for any practices receiving a ratio score of:

0 = potentially underperforming

1 = potentially performing as expected

2 = potentially performing better than expected

Confidence Index =
CAST Isolation Reduction /
Spatially Explicit Reduction

BMP Load Reduction API Origins

- Delaware River Watershed Initiative
- Developed specifically to assess project impact of NFWF Delaware River Restoration Fund capital investments
  - Ag BMPs
  - Urban Stormwater Management
- FieldDoc used for project planning and implementation tracking

BMP Load Reduction API - Data Sources & Models

Chesapeake Bay Watershed (CBW)

- USGS NHD+ High Resolution (10m)
- Digital Elevation Model (DEM)
- Flow Direction Raster (FDR)
- CBW High Resolution Land Cover (2013) (10m re-sample)
- Chesapeake Bay Watershed Model
- Chesapeake Assessment Scenario Tool (CAST) BMP Efficiency Coefficients
- Phase 6 BMP Methods Documentation

Delaware River Basin (DRB)

- USGS NHD+ High Resolution (10m)
- Digital Elevation Model (DEM)
- Flow Direction Raster (FDR)
- National Land Cover Dataset (NLCD, 2011)
- Generalized Watershed Loading Function – Enhanced (GWLF-E)
- CB Program and PADEP BMP Efficiency Coefficients

Best Management Practice (BMP) Load Reduction API

Models reductions in TN, TP, and TSS for each practice in FieldDoc

- Currently 8 BMPs modeled in the Chesapeake River basin within 2 archetypes
- Modeling approach for each BMP was established
  - Met with CBP modelers
  - BMPs were grouped into archetypes that all have similar methodology

- Agricultural Animal
- Stream Restoration
- Land Use Change
- Agricultural Land
- Urban Stormwater Management
- Polygon Drainage
- Exclusion Buffer

7 Major Archetypes

Models reductions in TN, TP, and TSS for each practice in FieldDoc

- Agricultural Animal
- Stream Restoration
- Land Use Change
- Agricultural Land
- Urban Stormwater Management
- **Polygon Drainage**
- Exclusion Buffer

Use "polygon drainage" routine to calculate acres of different land cover types to the feature (buffer or wetland), apply upland loading rates to estimate the total loads, and then reduce these loads using fixed reduction coefficients

7 Major Archetypes

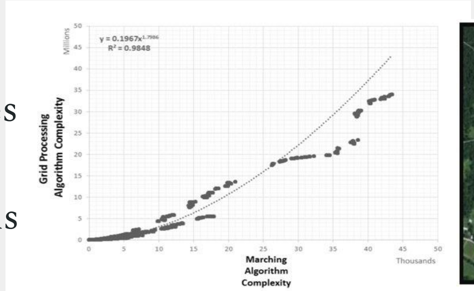
Models reductions in TN, TP, and TSS for each practice in FieldDoc

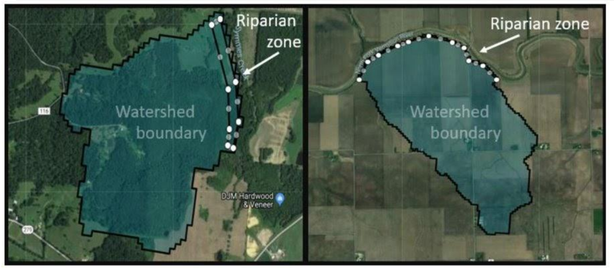
- Agricultural Animal
- Stream Restoration
- Land Use Change
- Agricultural Land
- Urban Stormwater Management
- Polygon Drainage
- **Exclusion Buffer**

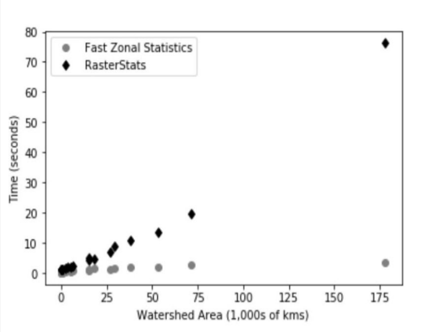
Use the approach that combines reductions from both buffers (based on area drained) and reduced streambank erosion. (i.e. needs a LineString geometry submitted and watershed boundary computed)

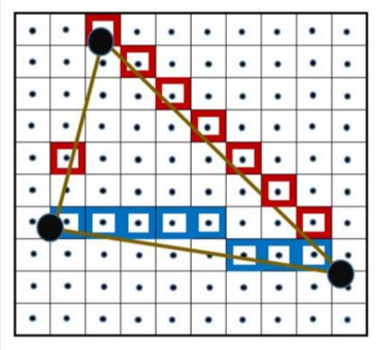
Drexel Microservice APIs

- Watershed delineation
  - Uses marching algorithm that scales with perimeter
  - Works for points, lines and polygons
  - Working on D-inf watershed delineation using internal watershed skeleton
- Fast Zonal Statistics
  - Based on Green's Theorem
  - Also scales with perimeter

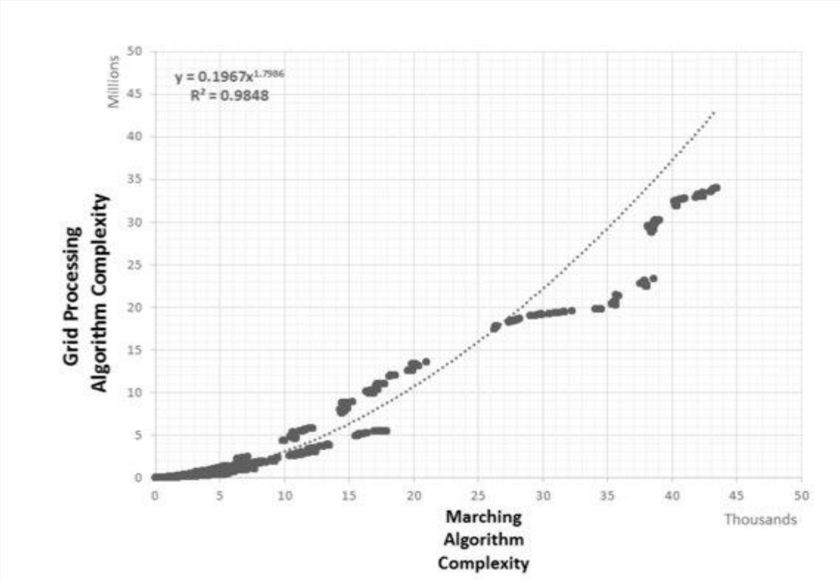


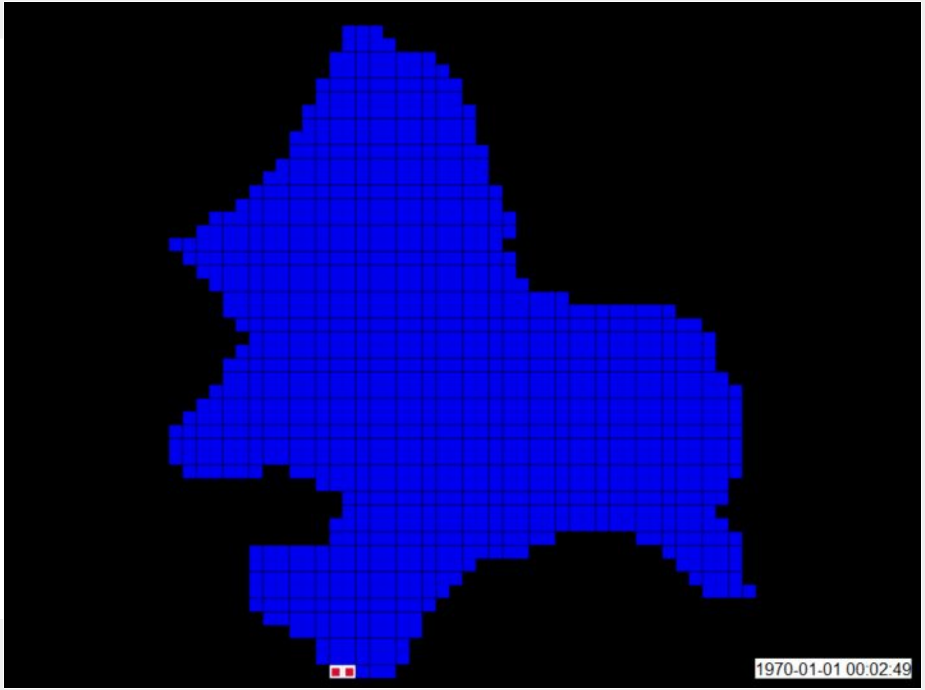






WMA vs Watershed Delineation Methods



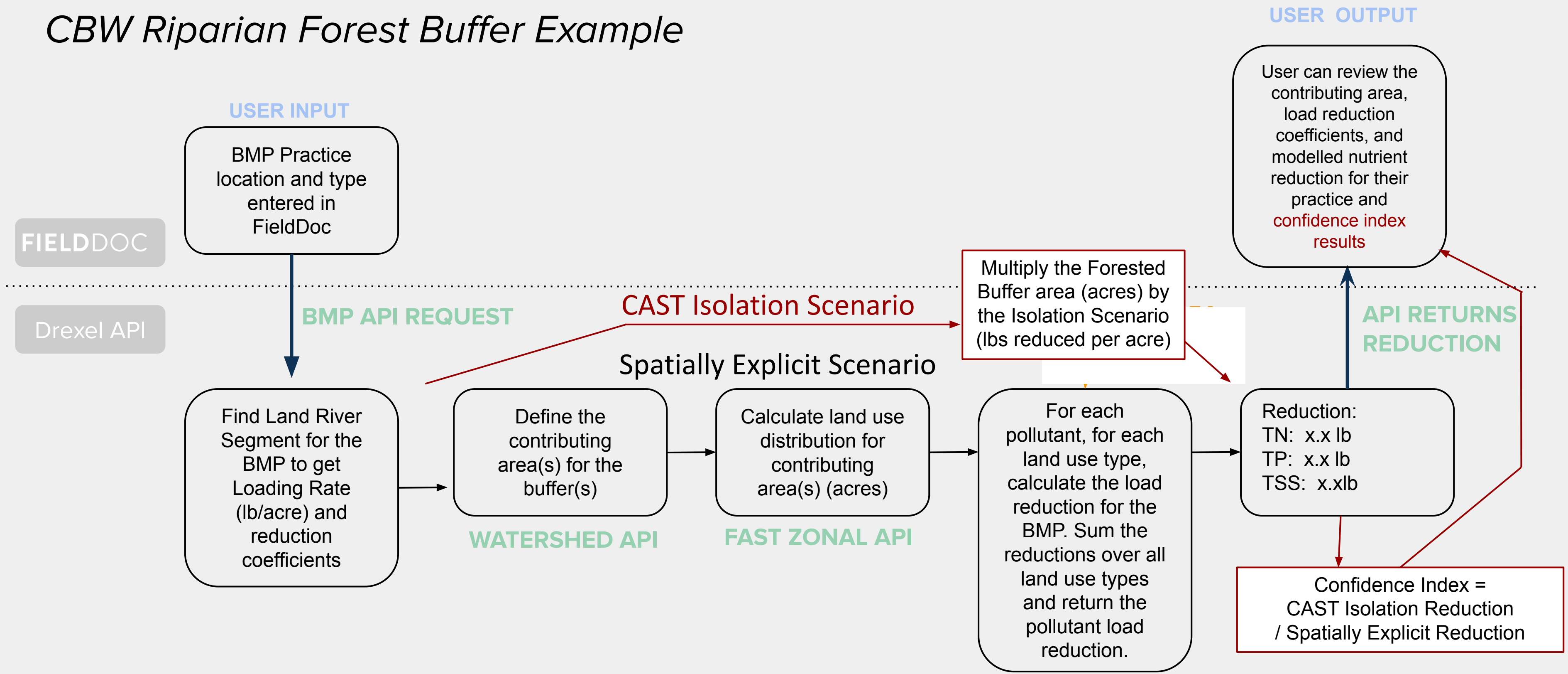


Progress to Date

- Eight BMPs have been implemented thus far:
    1. Forest Buffer
    2. Grass Buffers
    3. Forest Buffer-Streamside with Exclusion Fencing
    4. Forest Buffer – Narrow
    5. Forest Buffer-Narrow with Exclusion Fencing
    6. Grass Buffer - Narrow
    7. Grass Buffer-Streamside with Exclusion Fencing
    8. Grass Buffer-Narrow with Exclusion Fencing
- Tested high resolution watershed delineation and land cover (1m)
- Updated API architecture from Django to Flask
    - More lightweight, more easily containerized

API Workflow

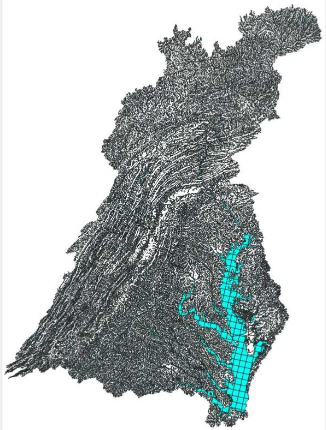
CBW Riparian Forest Buffer Example

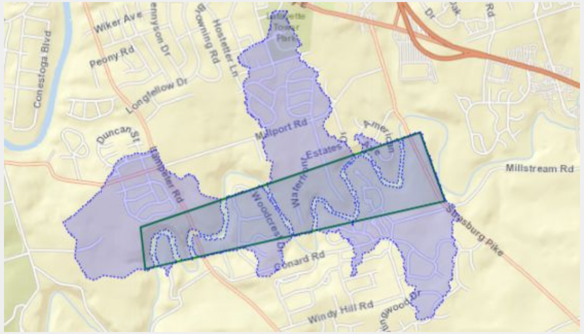


Progress - Continued

Erase Surface Water Network from BMP

- Download NHDplus HR network for each HUC04 in the Chesapeake Bay
- Polygonalize the Network and Buffer by 10 meters
- Run through a fishnet to take advantage of spatial indices
- Create function that erases the SW network from the BMP before watershed delineation

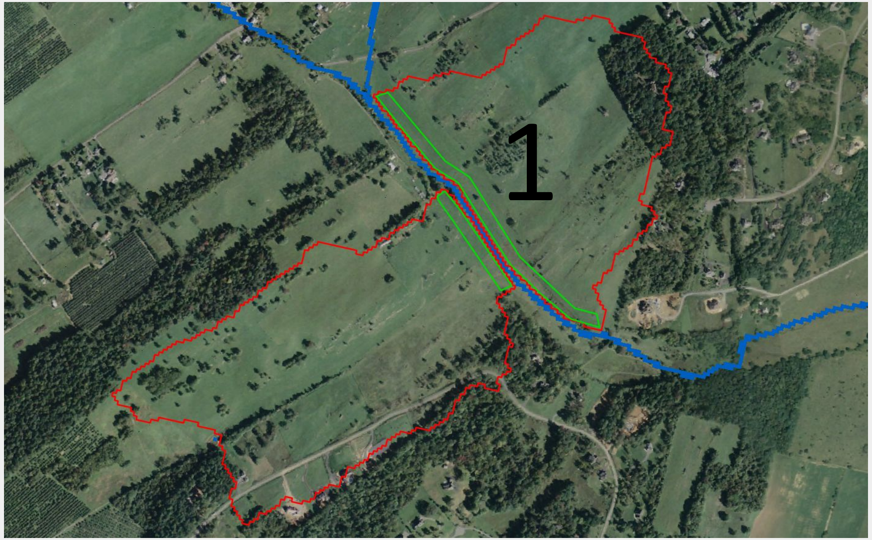




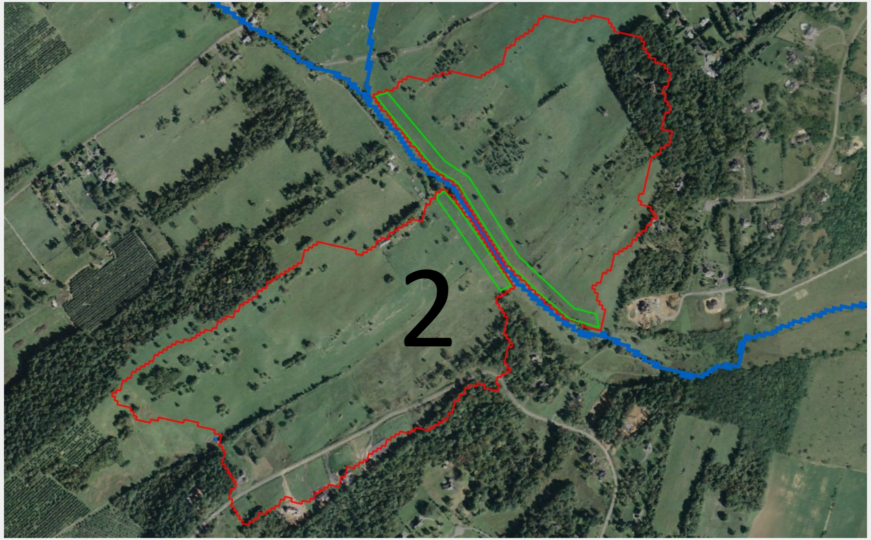
Example: Testing Two Riparian Buffers

- Two riparian buffers, 100 ft wide each
- Buffer 1 is roughly 0.5 miles long, while buffer 2 is roughly 0.2 miles long

"confidence_index": {"tn": 1.74, "tp": 1.56, "tss": 0.062}



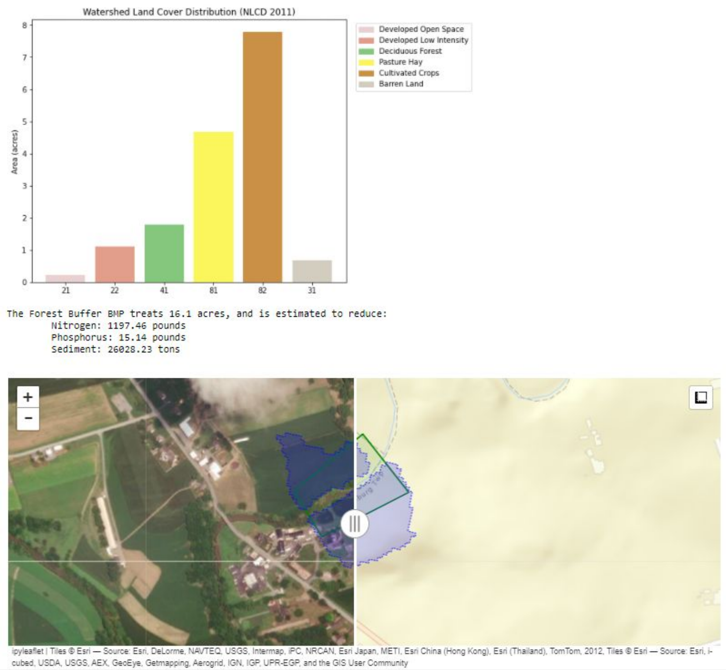
"confidence_index": {"tn": 2.0, "tp": 2.0, "tss": 1.76}



Jupyter Notebook Demonstration

- We use Jupyter Notebooks for testing and documentation for our APIs as well as Swagger

- Useful for testing projects against one another
  - Twice as big does not always mean twice as effective



Next Step Objectives

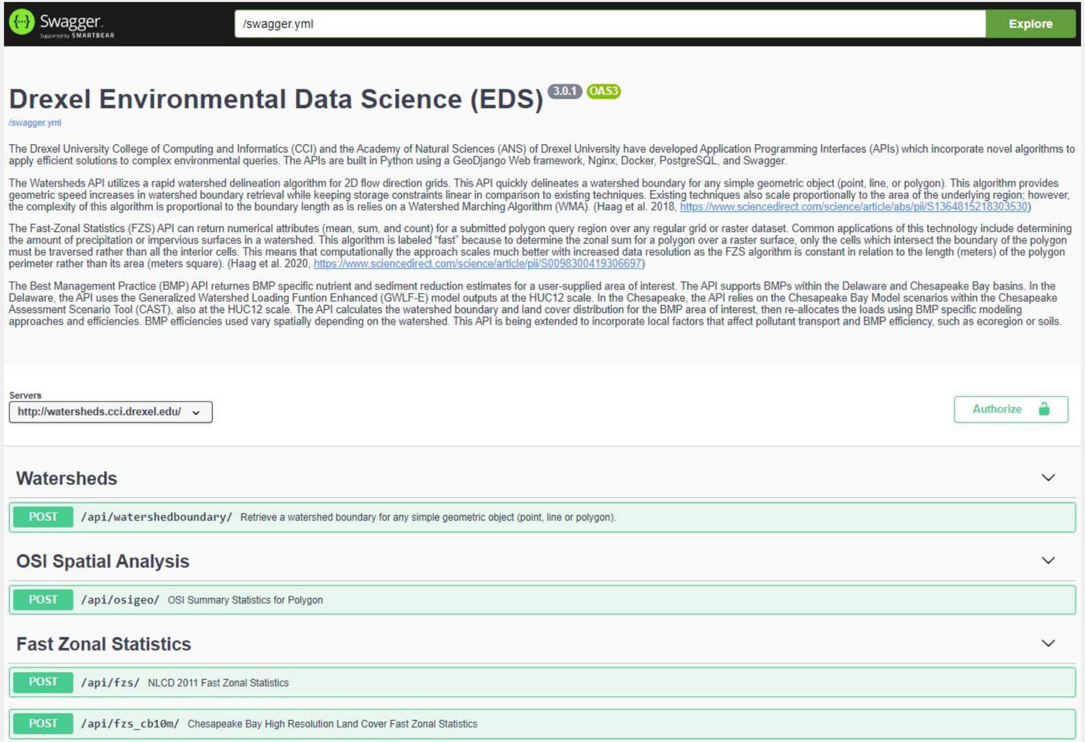
- Urban Stormwater Management
  - Prioritization / placement of low-impact development control (LID) BMPs
  - We have tested and implemented on high resolution raster datasets (1m)
  - Would need R&D and outreach, current method would need data for engineered environments, i.e. subsurface infrastructure that is not widely available

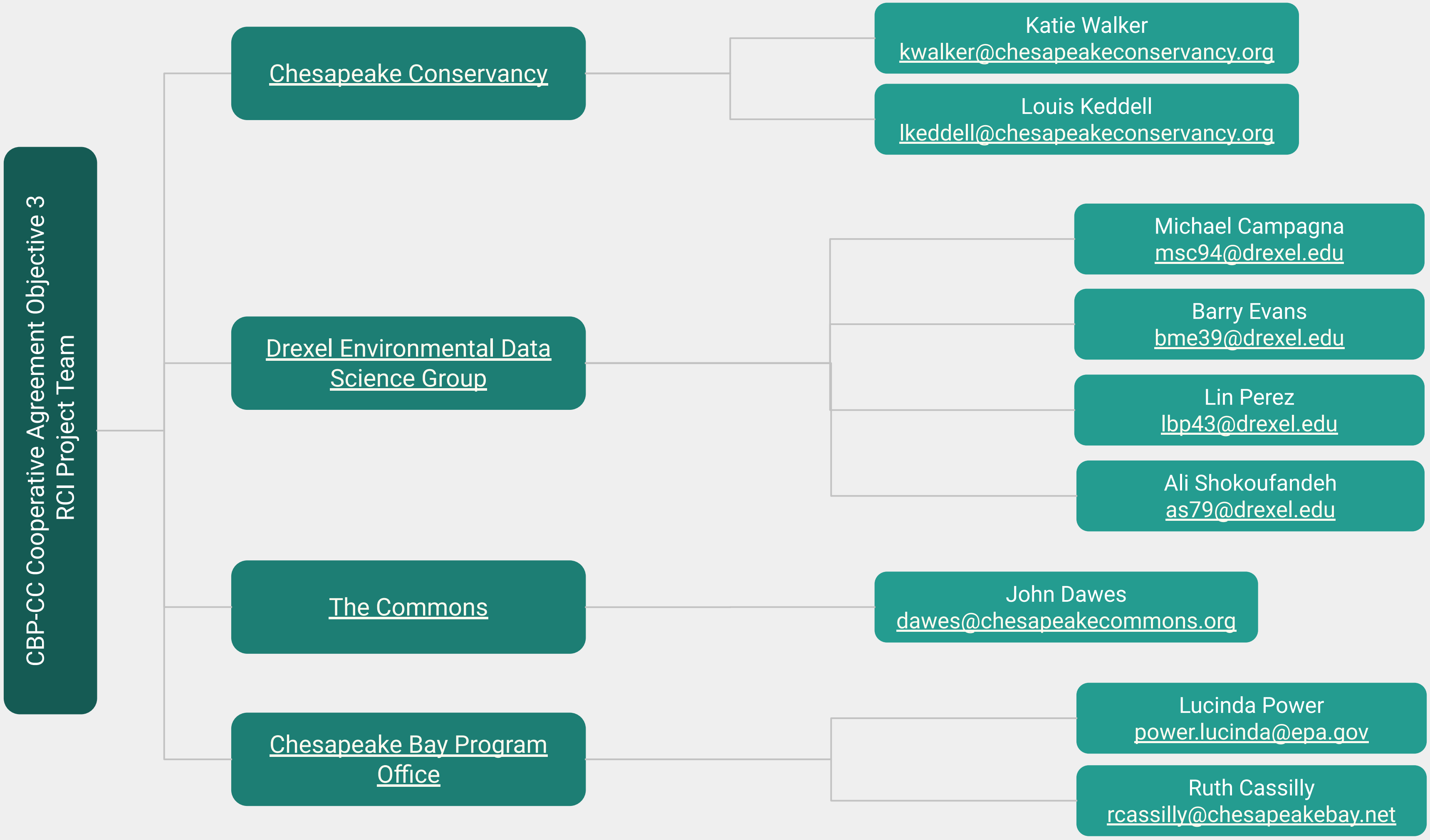
- Potential Investigations
  - Wetlands BMPs methodology
  - Remove Concentrated Flow Paths from Contributing Area for Buffers
    - Was of interest to Bay modelers, need more feedback before implementation
    - Pilot scale test using dataset available for the lower Susquehanna River

Technical Documentation

API Documentation:
http://watersheds.cci.drexel.edu/docs

API Demo Jupyter Notebooks:
https://github.com/TheAcademyofNaturalSciences/Jupyter_Notebooks





CBP-CC Cooperative Agreement Objective 3
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