pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Clean Water

Large River Semi-wadeable Multimetric Index (SWMMI)

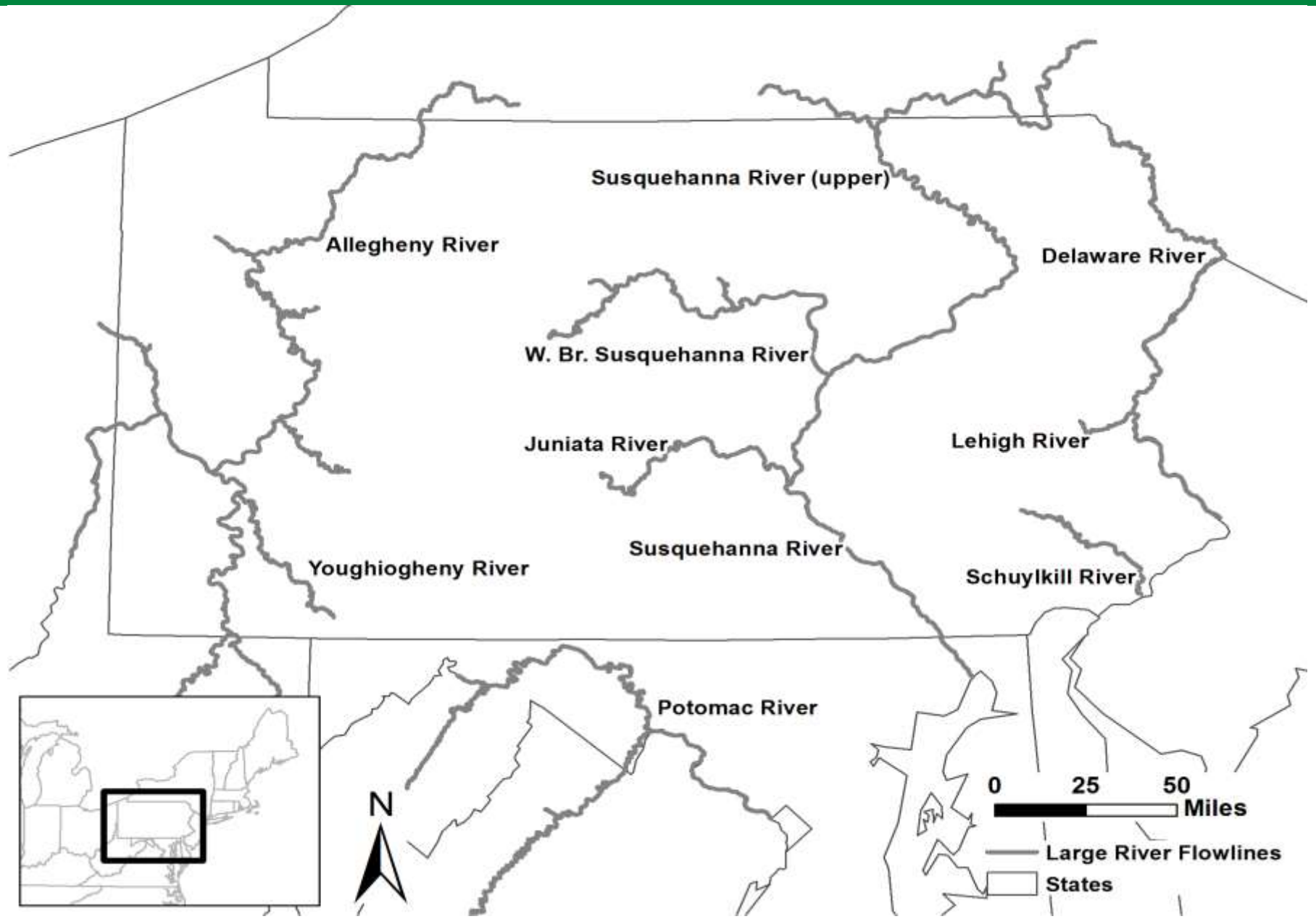
Dustin Shull

2020 National

CWA 303(d) Training Workshop

May 28th, 2020

Large Rivers



Complex Systems

Large Rivers

Semi-wadeable Rivers

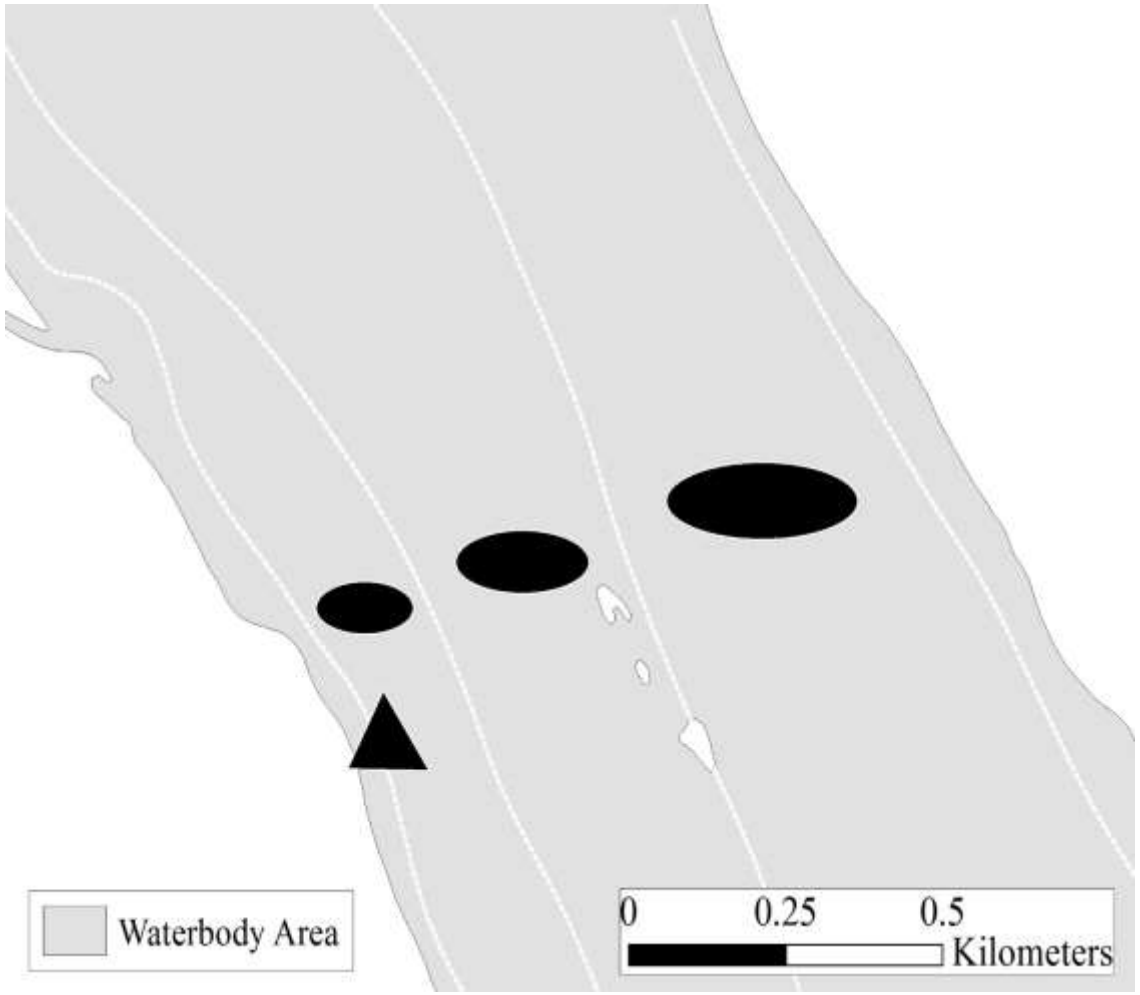
Example: Susquehanna River at Sunbury, PA where major influences do not mix for up to 65 miles

Non-wadeable Rivers

Example: Ohio River at Pittsburg, PA where major influences “mix” in about 1 mile

Macroinvertebrate Collection Method

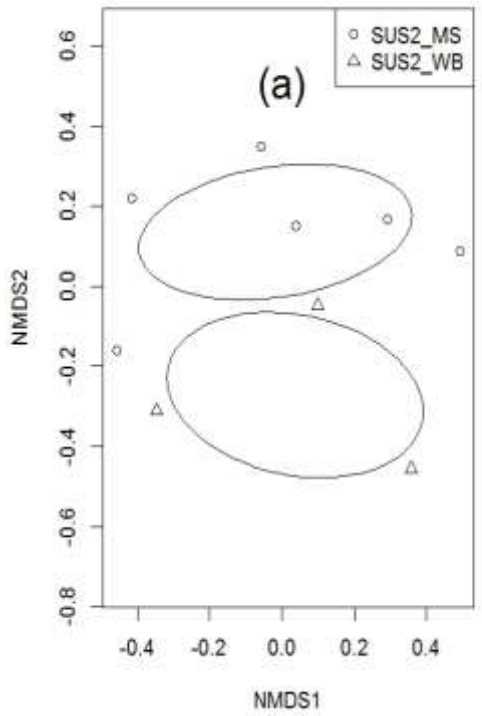
- Two approaches
  - Wadeable method: ▲
    - Standard method for PADEP/WQN
    - Problematic in large rivers
  - Transect Method: ●
    - Multiple samples taken based on water quality
    - Addresses major water influence differences



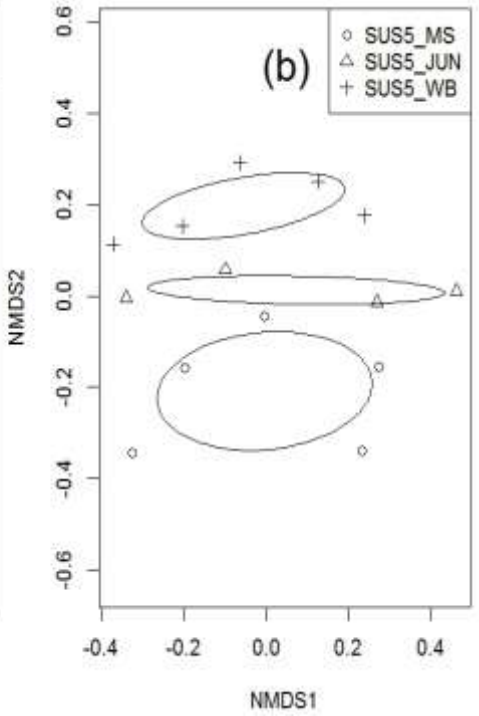
pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Method Test

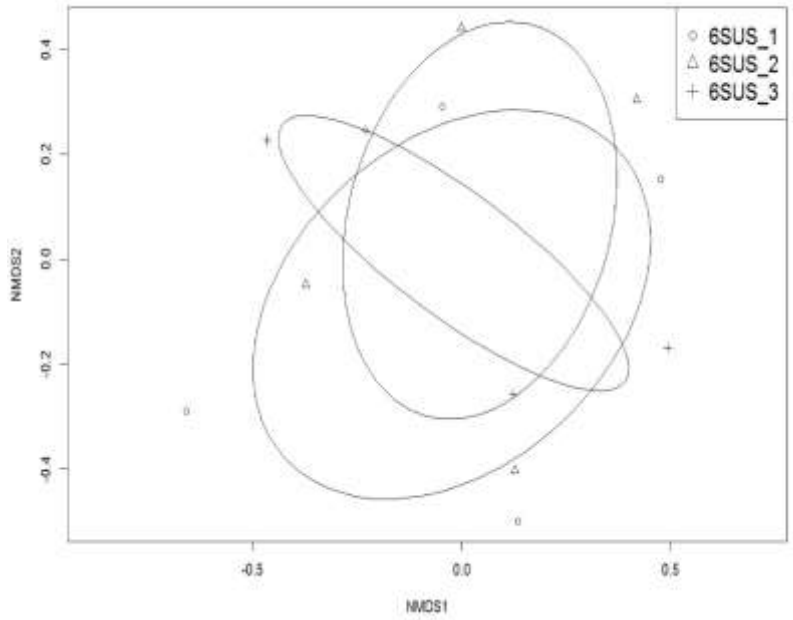
Sunbury, PA



Rockville, PA



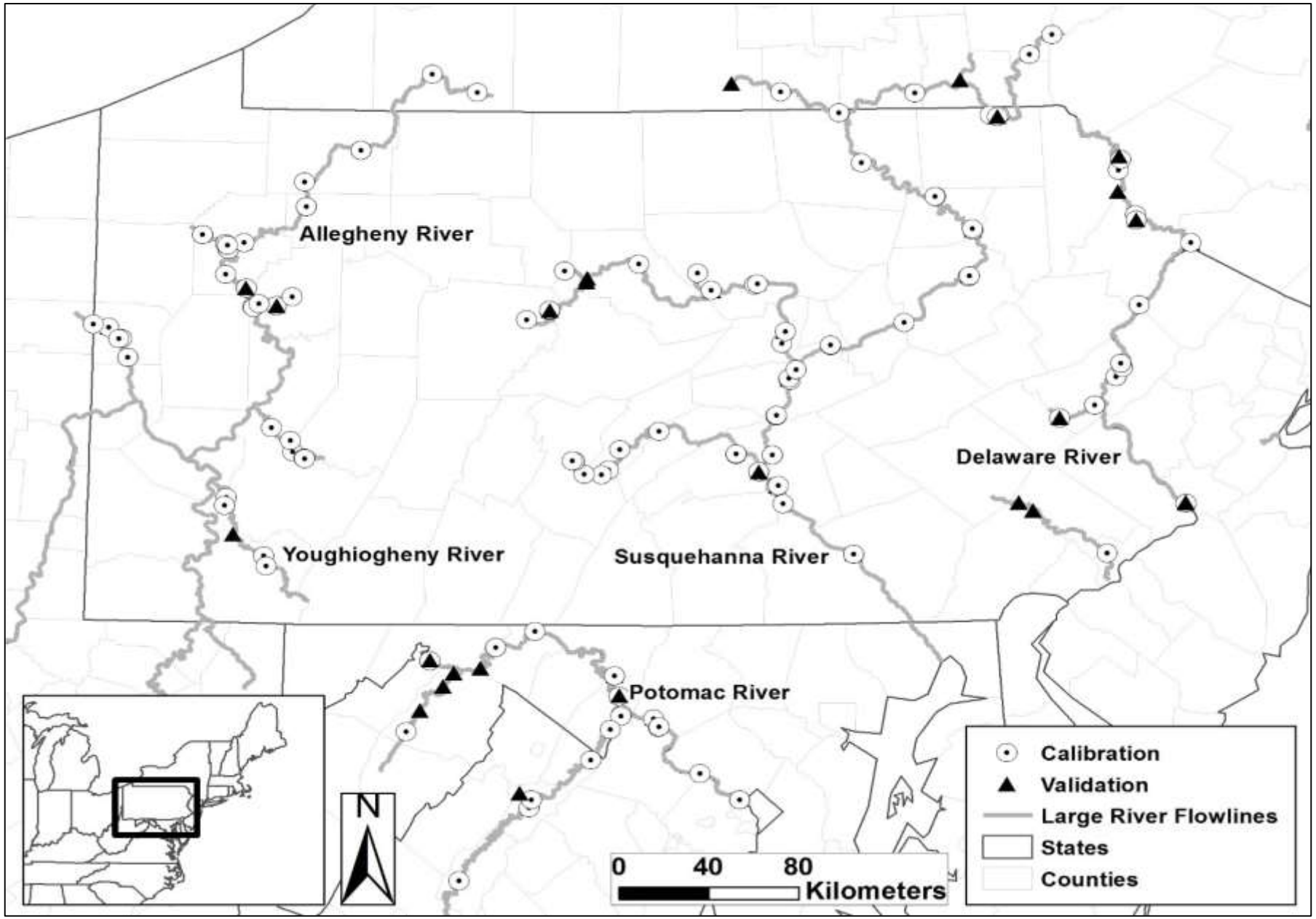
Marietta, PA



Shull, D. R., & Lookenbill, M. J. (2017). Assessing the expansion of wadeable benthic macroinvertebrate collection methods in large semiwadeable rivers. Freshwater Science 36(3):683–691. https://doi.org/10.1086/692942

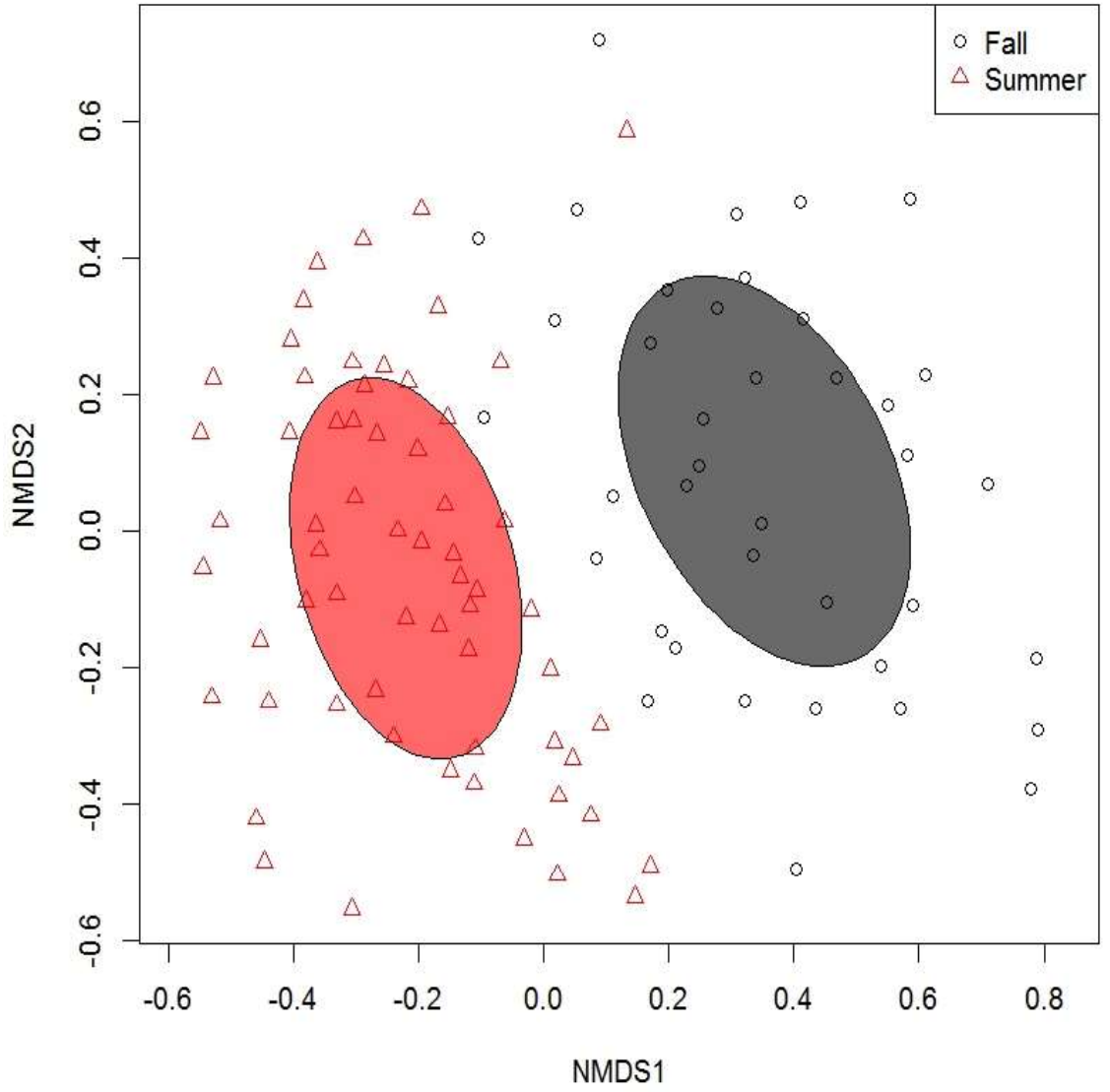
pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

MMI Development



Natural Classification

- Season was the strongest driver of natural variation
- Moved forward with:
  - 2 classifications based on seasonality
  - 2 semi-wadeable MMIs, one for summer, one for fall.



MMI Development

- Calibration Dataset
  - 275 samples from 126 sites
    - Summer 155 samples from 114 sites
    - Fall 120 samples from 93 sites
- Validation Dataset
  - 106 samples from 42 sites
    - Summer 63 samples from 42 sites
    - Fall 43 samples from 32 sites
- 167 metrics analyzed

Shull, D. R., Z. M. Smith, and G. M. Selckmann. 2019. Development of a benthic macroinvertebrate multimetric index for large semiwadeable rivers in the Mid-Atlantic region of the USA. Environmental Monitoring and Assessment 191(22). https://doi.org/10.1007/s10661-018-7153-x

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

MMI Development

Summer Metrics

Metric Code	Metric Name	Metric Type	RTD	Min	Median	Max	Range	DE	MR	SOI	SGC (PC 1)	Selected
BCGpct456	Percent Tolerant/Invasive Individuals (BCG 4-6)	Tolerance	POS	37.7	61.4	81.5	43.9	92.1	0.78	1.3	0.55	
BCGpct5	Percent Tolerant Individuals (BCG 5)	Tolerance	POS	21.1	41.7	65.0	43.9	92.1	0.81	1.1	0.54	X
PTVpct03	Percent Sensitive Individuals (PTV 0-3)	Tolerance	NEG	12.2	33.2	59.4	47.2	92.1	0.80	0.4	-0.62	X
BCGindex2	Hilsenhoff Index (BCG attributes)	Tolerance	POS	3.7	4.1	4.6	1.0	89.5	0.81	0.7	0.60	X
pctEbcg13	Percent Ephemeroptera (BCG 1-3)	Composition	NEG	5.6	24.0	51.0	45.5	86.8	0.73	0.5	-0.41	X
pctDOM	Percent Dominant Taxon	Dominance	POS	12.7	19.2	34.2	21.5	84.2	0.37	0.7	0.41	X
PTVbeck3	Beck Index (PTV 0-3)	Tolerance	NEG	3	10	18	15	81.6	0.47	0.7	-0.59	
richEPTbcg	EPT Richness (BCG 1-3)	Richness	NEG	4	8	13	9	76.3	0.78	0.3	-0.62	X

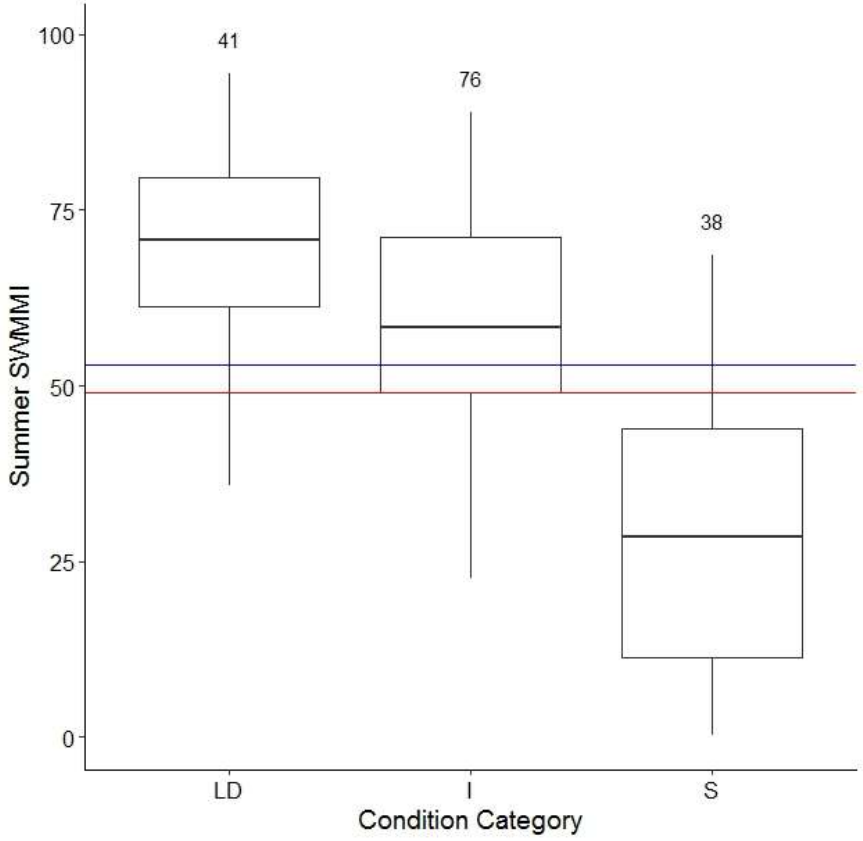
MMI Development

Fall Metrics

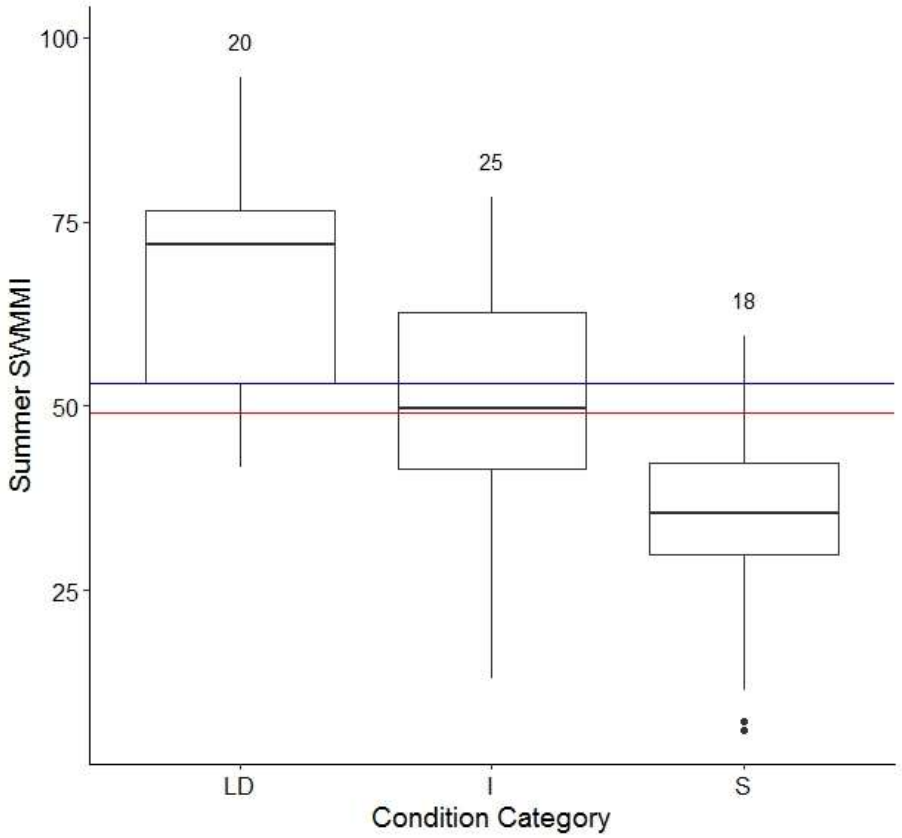
Metric Code	Metric Name	Metric Type	RTD	Min	Median	Max	Range	DE	MR	SOI	SGC (PC 1)	Selected
PTVbeck3	**Beck Index (PTV 0-3)**	**Tolerance**	**NEG**	**3.0**	**11.0**	**24.0**	**21.0**	**97.0**	**0.70**	**0.6**	**-0.64**	**X**
richEPTptv	**EPT Richness (PTV 0-4)**	**Richness**	**NEG**	**7.0**	**12.5**	**18.0**	**11.0**	**90.9**	**0.74**	**0.3**	**-0.62**	**X**
PTVpct03	**Percent Sensitive Individuals (PTV 0-3)**	**Tolerance**	**NEG**	**23.6**	**46.6**	**69.1**	**45.5**	**84.8**	**0.69**	**0.8**	**-0.63**	**X**
PTVrich05	Richness (PTV 0-5)	Richness	NEG	14.0	18.0	23.0	9.0	81.8	0.70	0.2	-0.55	
pctEbcg13	**Percent Sensitive Ephemeroptera (BCG 1-3)**	**Composition**	**NEG**	**11.4**	**34.1**	**58.5**	**47.0**	**78.8**	**0.69**	**0.7**	**-0.47**	**X**
PTVpct02	Percent Sensitive Individuals (PTV 0-2)	Tolerance	NEG	7.3	21.8	46.8	39.5	78.8	0.60	1.9	-0.58	
Richness	**Total Richness**	**Richness**	**NEG**	**18.0**	**24.0**	**32.0**	**14.0**	**78.8**	**0.70**	**0.2**	**-0.48**	**X**
BCGpct5	Percent Tolerant Individuals (BCG 5)	Tolerance	POS	13.5	33.7	64.0	50.5	75.8	0.53	0.6	0.41	
BCGpct3	Percent Sensitive Individuals (BCG 3)	Tolerance	NEG	14.8	29.9	67.6	52.8	72.7	0.53	0.9	-0.36	
BCGrich2	Richness (BCG 2)	Richness	NEG	1.0	2.5	6.0	5.0	72.7	0.60	0.5	-0.52	
FFGrichSC	**Scraper Richness**	**Functional**	**NEG**	**5.0**	**8.0**	**11.0**	**6.0**	**72.7**	**0.51**	**0.3**	**-0.45**	**X**
pctEPHMRLA	Percent Ephemerella	Composition	NEG	0.0	7.1	25.6	25.6	72.7	0.60	19.6	-0.43	
richEbcg13	Ephemeroptera Richness (BCG 1-3)	Richness	NEG	3.0	5.0	8.0	5.0	72.7	0.61	0.2	-0.54	-

Summer SWMMI

Calibration Dataset: DE = 97%



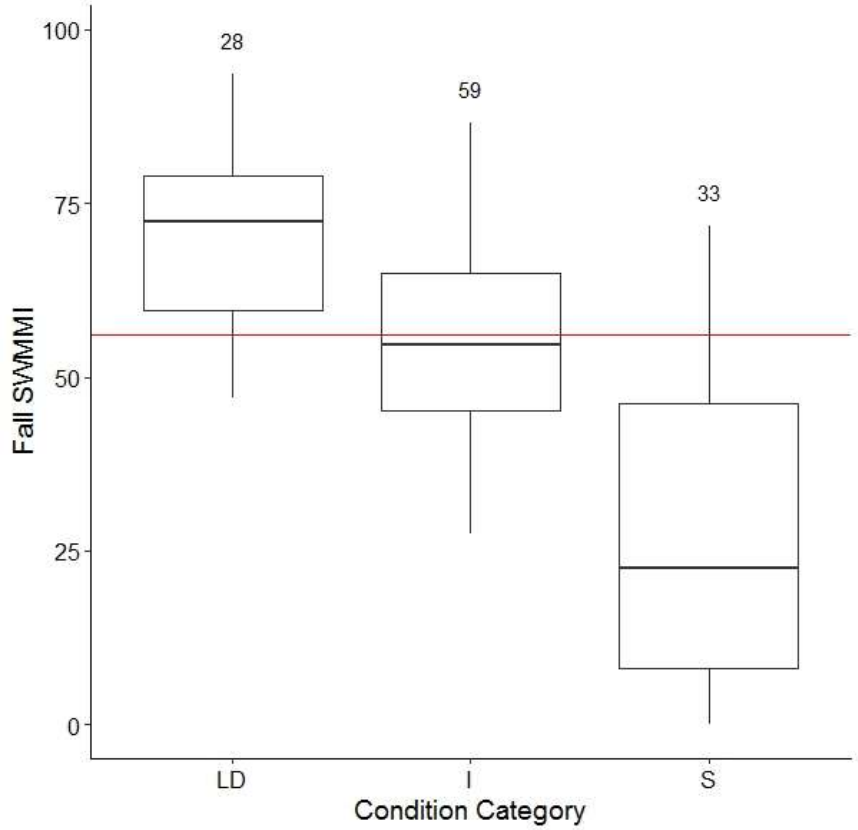
Validation Dataset: CE = 84%



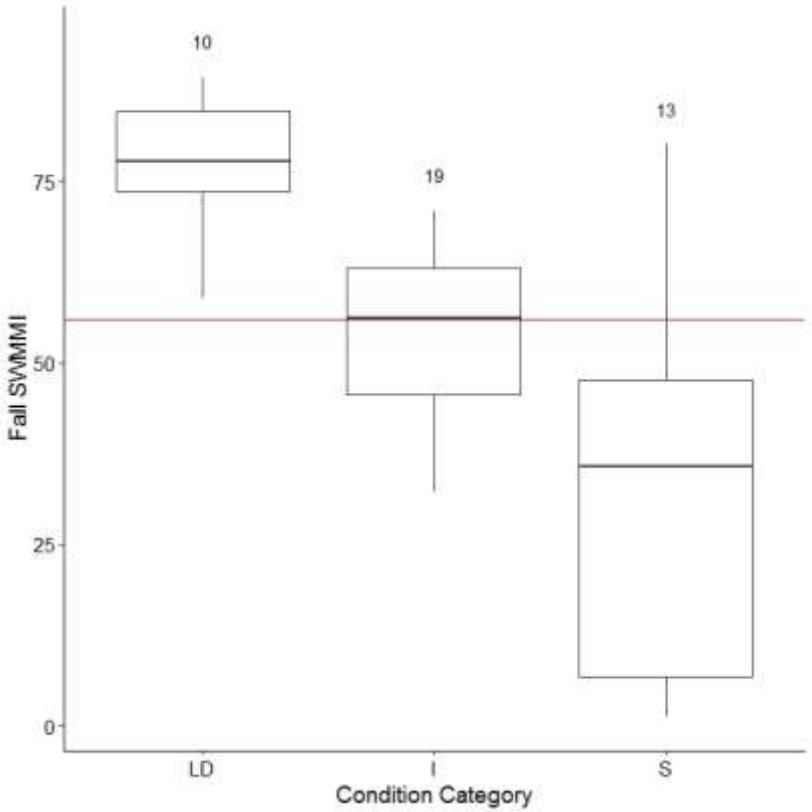
pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Fall SWMMI

Calibration Dataset: DE = 88%

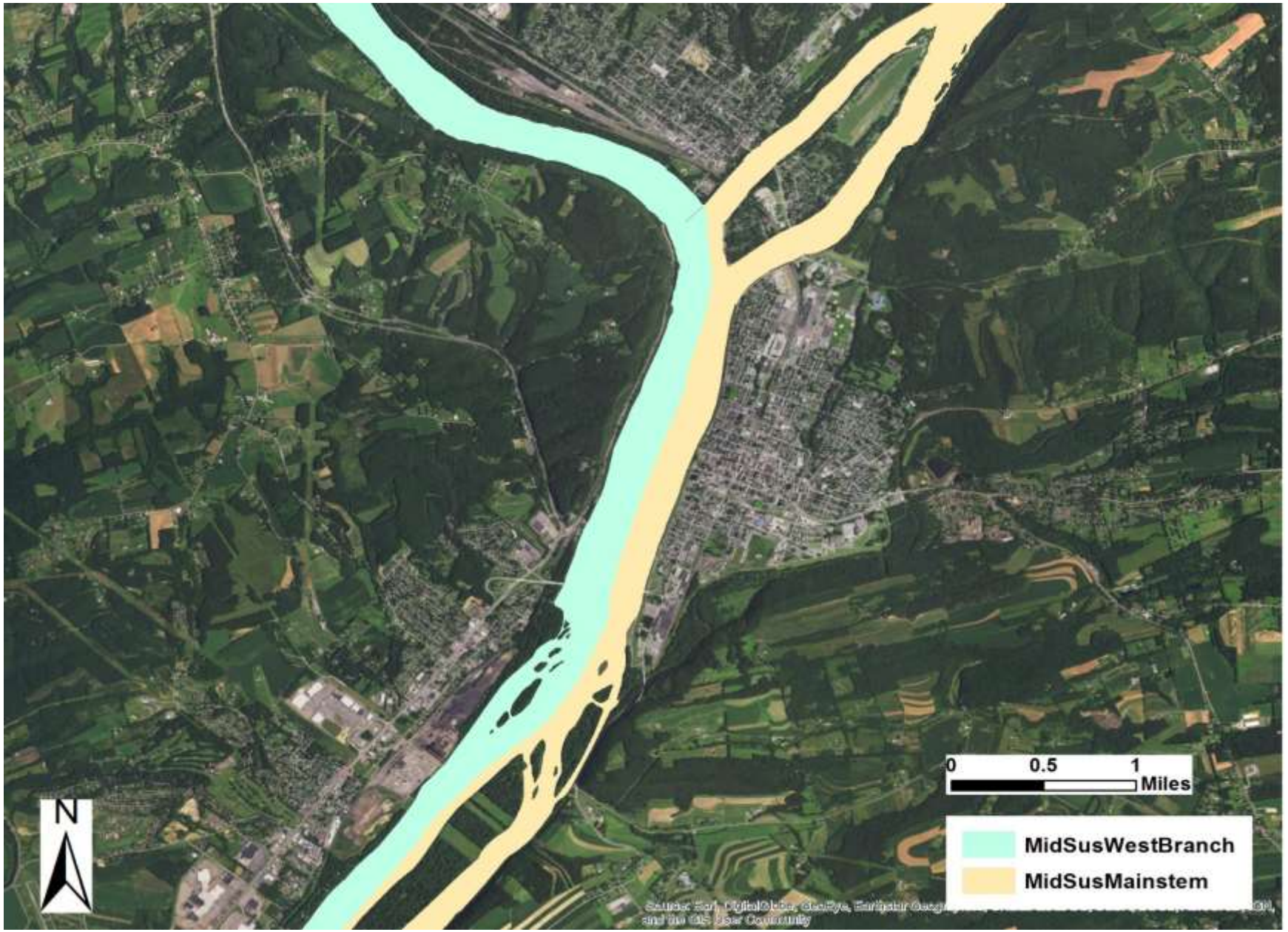


Validation Dataset: CE = 87%

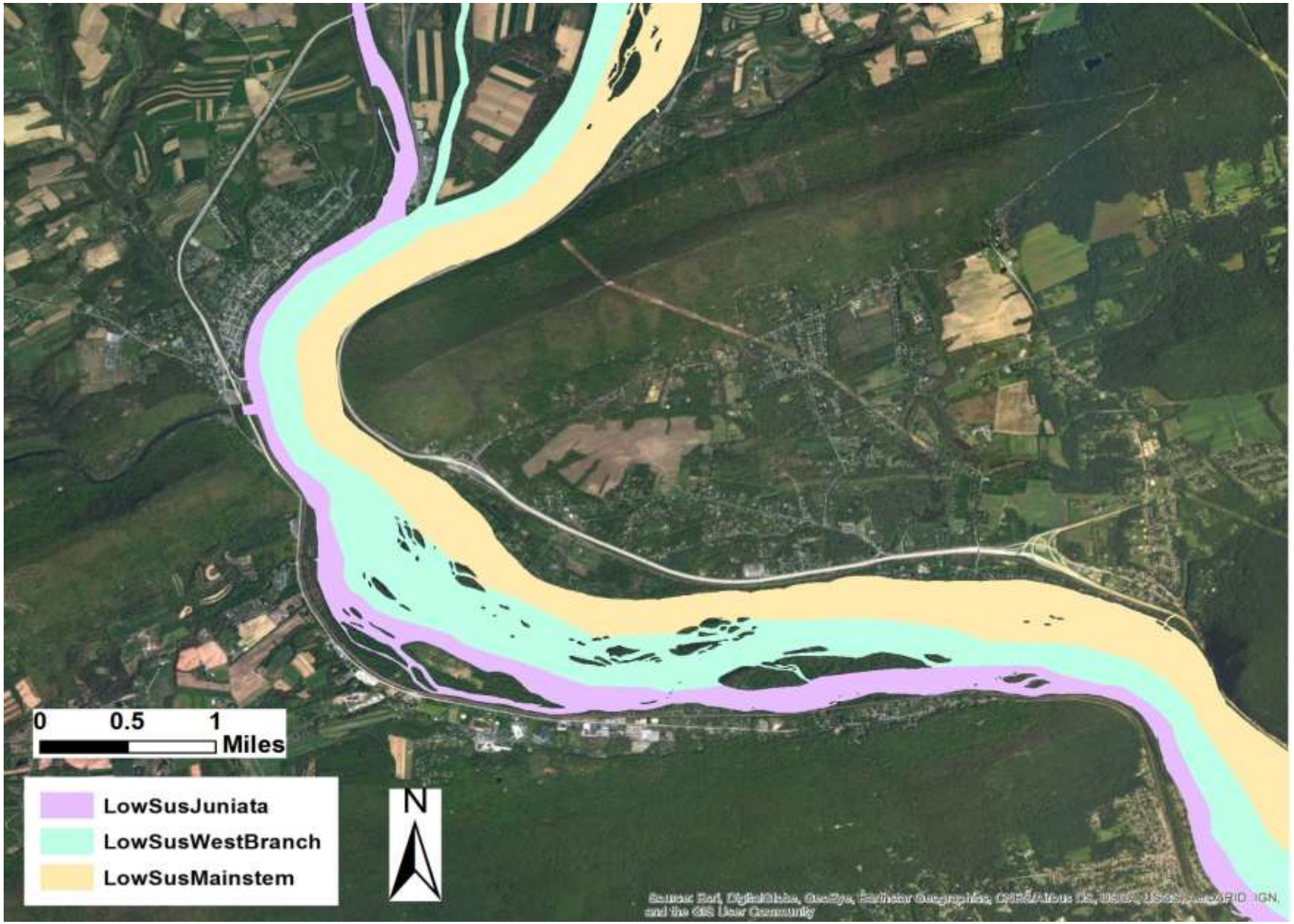


pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Implementation

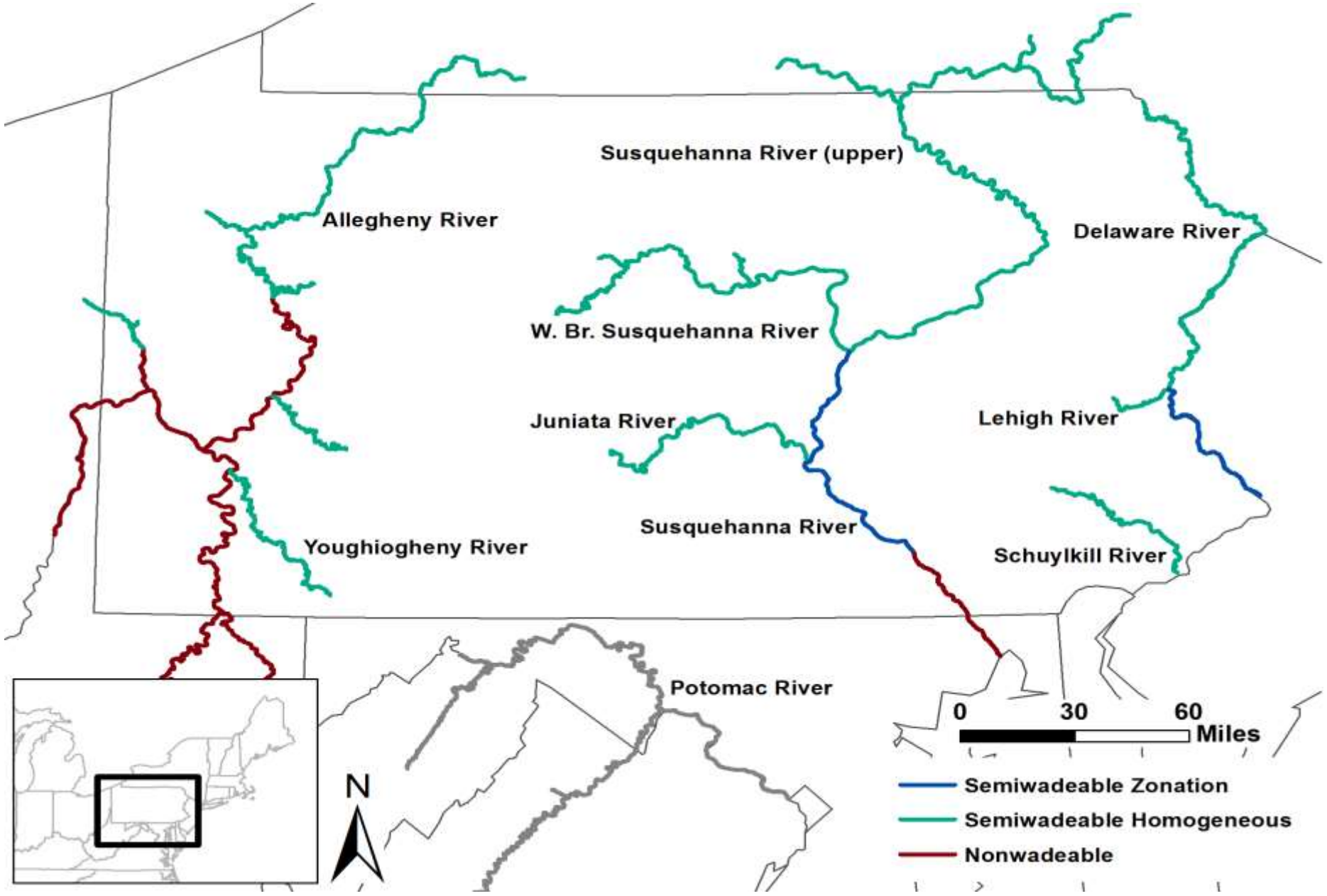


Implementation

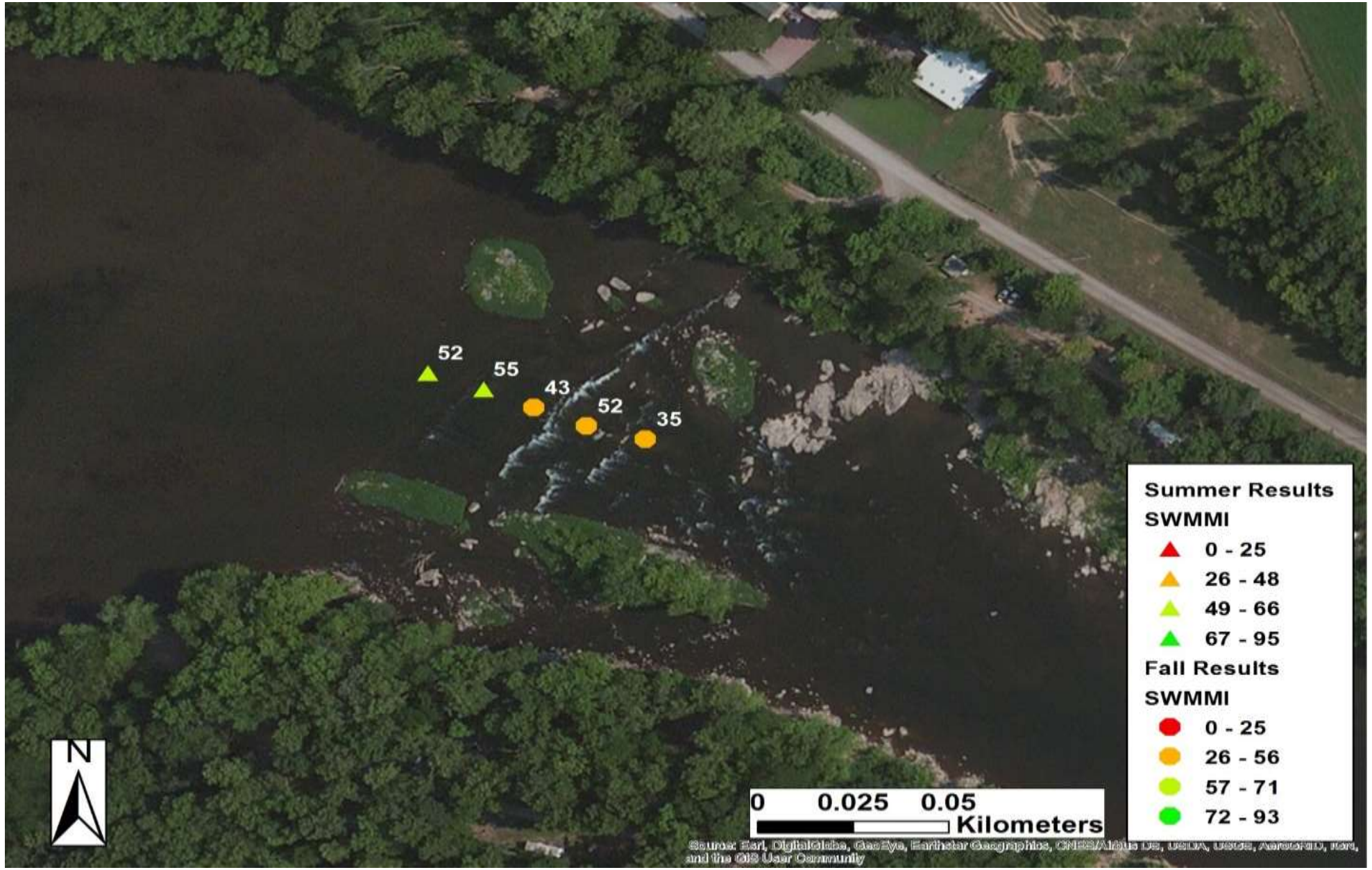


Implementation

Implementation



Independent Applicability



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Clean Water

Questions?

Dustin Shull
dushull@pa.gov