USGS efforts and tools to document the status, trend, and overall condition of streams in the Chesapeake Bay Watershed

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U.S. Geological Survey

SHWG, 16 June 2023

USGS

Outline

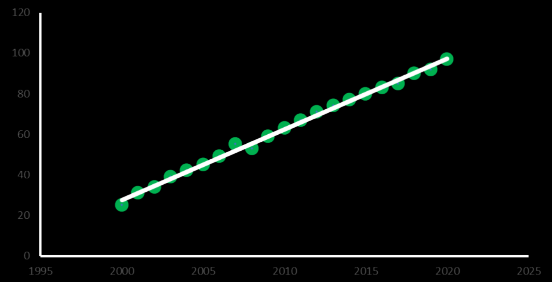
Computation and communication of status and trends for stream health, fish habitat, and aquatic conditions

Regional (watershed-wide) assessments of stream condition

Presentation of a preliminary web-based geonarrative on the regional assessments work

Status and Trends

Objective



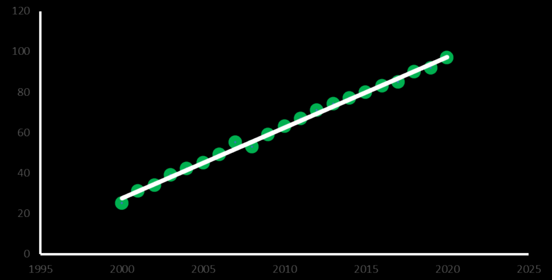
Computation and communication of status and trends for stream health, fish habitat, and aquatic conditions

Topic areas:

Aquatic communities
Physical habitat and geomorphology
Flow and ecological flows
Water temperature
Water Quality – Nutrients and SS
Conductivity and associated ions
Toxics

Objective

Status and Trends



Computation and communication of status and trends for stream health, fish habitat, and aquatic conditions

Topic areas:

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Identifying suitable stations

1) Use existing available data (benthic macroinvertebrates).

2) A current repeatedly sampled station.

3) Station must have at least 7 individual years of samples collected in the same season.

4) Station must have at least 5 yearly samples collected on or after 2008.

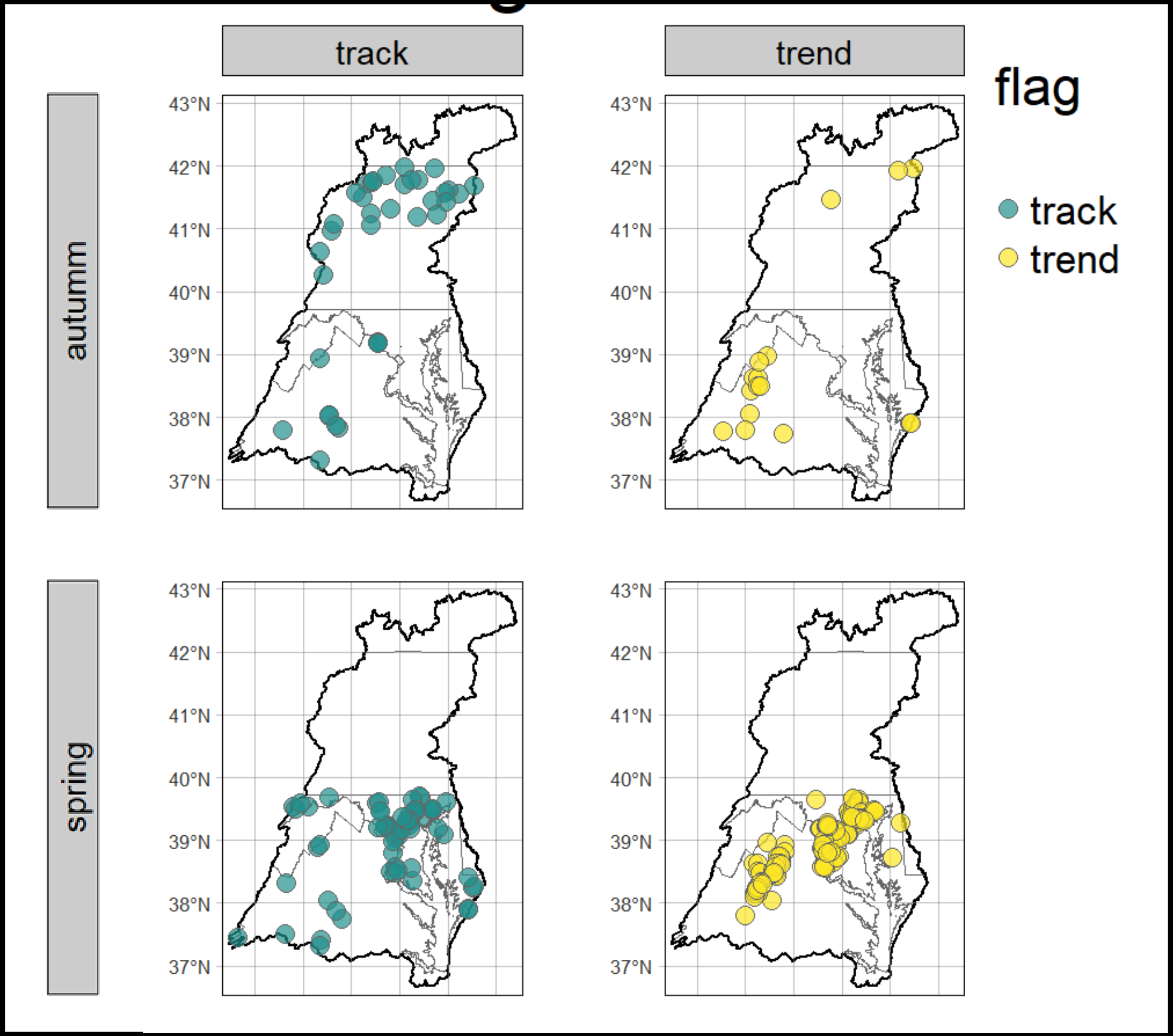
Status and Trends

Results

Benthic Macroinvertebrates (Boyle)

190 Trend sites – ≥7 yearly samples, at least five samples ≥2008.

102 Track sites – Not enough samples yet, but likely to qualify in next data collection round.



Preliminary data, not for citation or distribution

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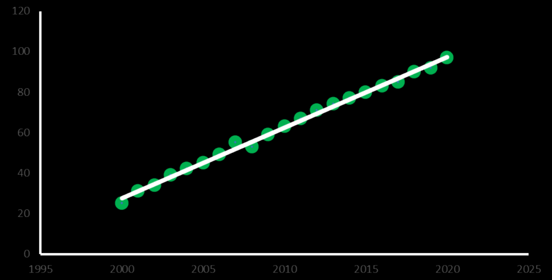
Status and Trends



Next Steps

Identify appropriate analytic approaches to quantify trends.

Identify reason for station being sampled long-term (need help here).

Identify any other long term data sets (need help here).

Identify factors behind trends?

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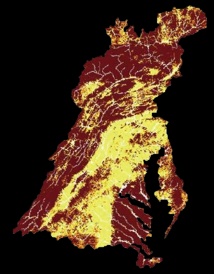
Regional Assessments



Objective

Computation and communication of a multivariate assessment of stream conditions

1:100,000 map scale 2023

1:24,000 map scale 2025

Topic areas:

Aquatic communities (bugs and fish)
Physical habitat and geomorphology
Flow and ecological flows

Water temperature*
Conductivity

Regional Assessments

Methods

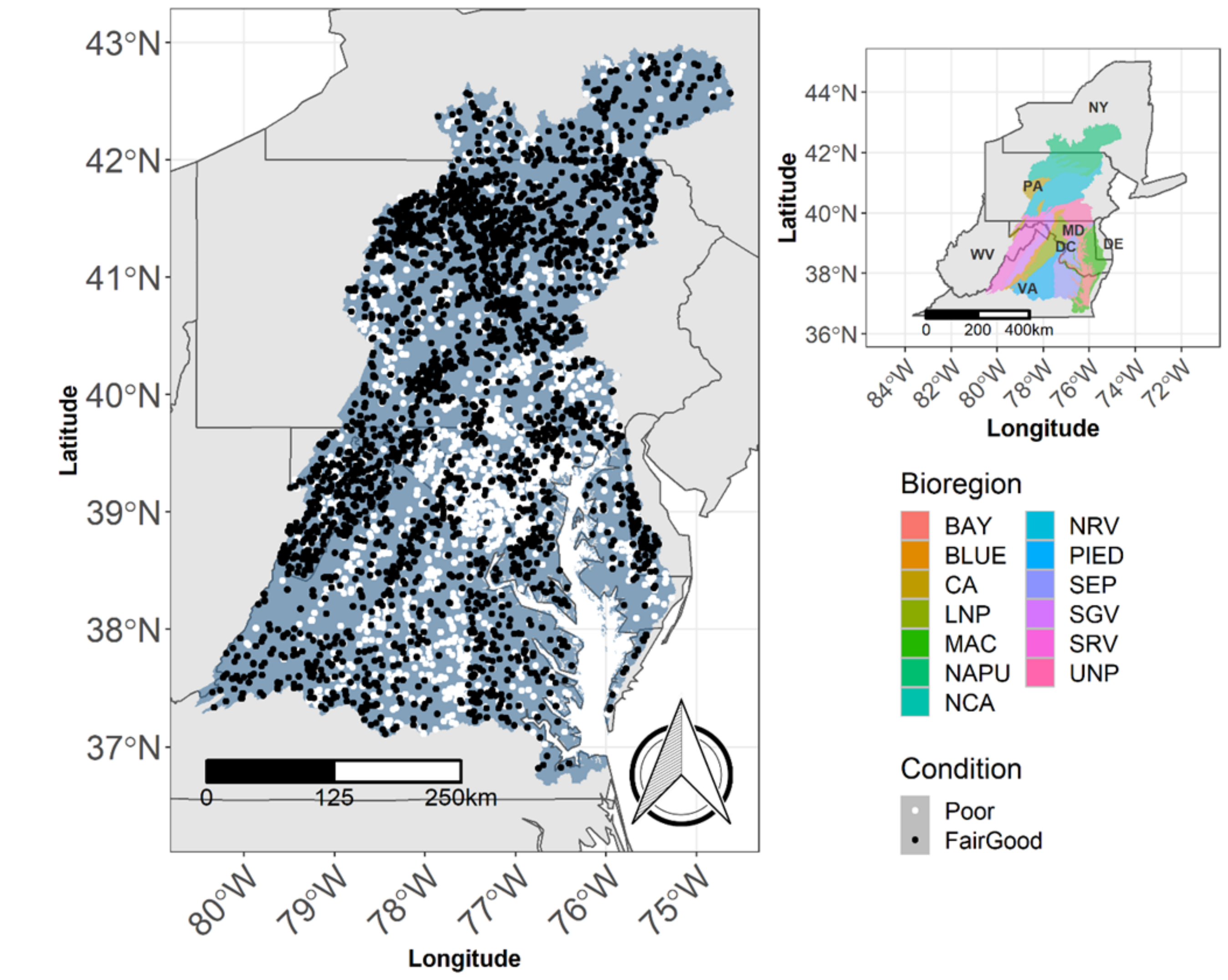
Benthic Macroinvertebrates (Maloney)

Chessie BIBI as response (n = 4,605 independent stations)

Ecosheds 1:24,000 network as base layer, ≤200 km^2 drainage area

19 landscape predictors

Analysis: Random forest Machine Learning; predictions for each NLCD year



https://doi.org/10.1016/j.jenvman.2022.116068

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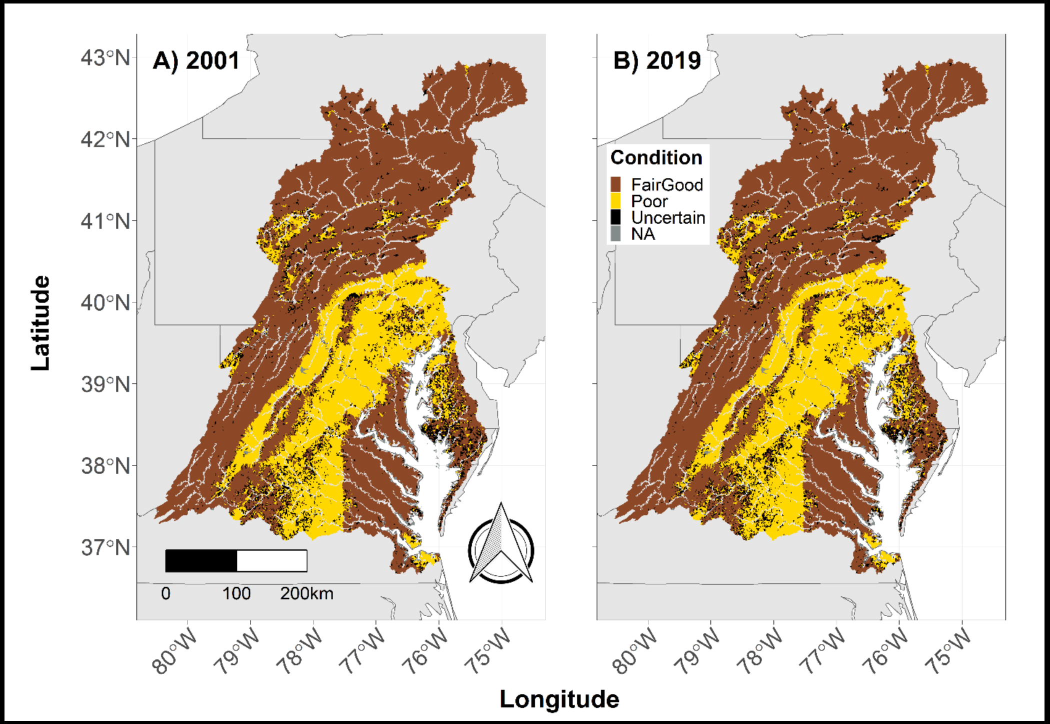
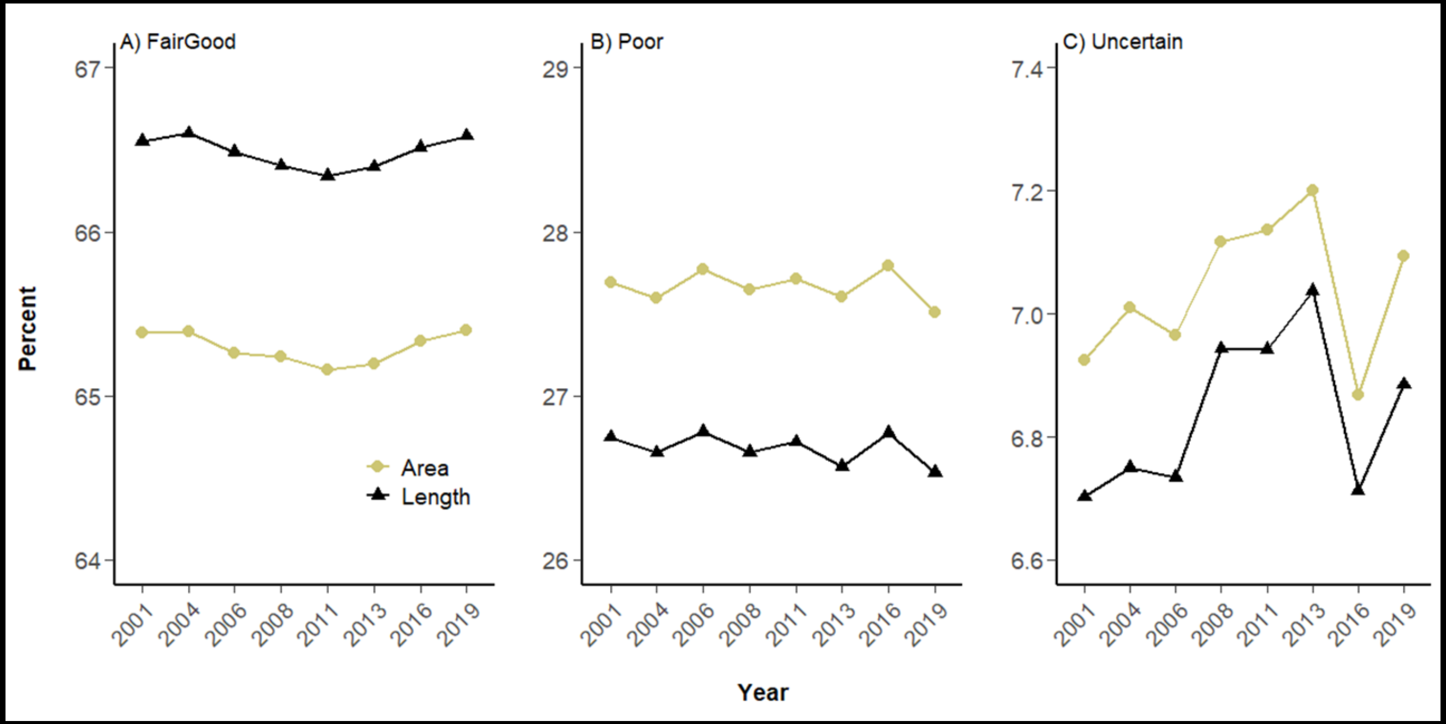
Regional Assessments

Results-Benthic Macroinvertebrates

FairGood were predicted in mountainous and coastal plains regions; Poor conditions were predicted in Piedmont regions.

Total stream length and catchment area predicted in FairGood conditions decreased then increased over 19-years (length/area: 66.6/65.4% in 2001, 66.3/65.2% in 2011, and 66.6/65.4% in 2019).





https://doi.org/10.1016/j.jenvman.2022.116068

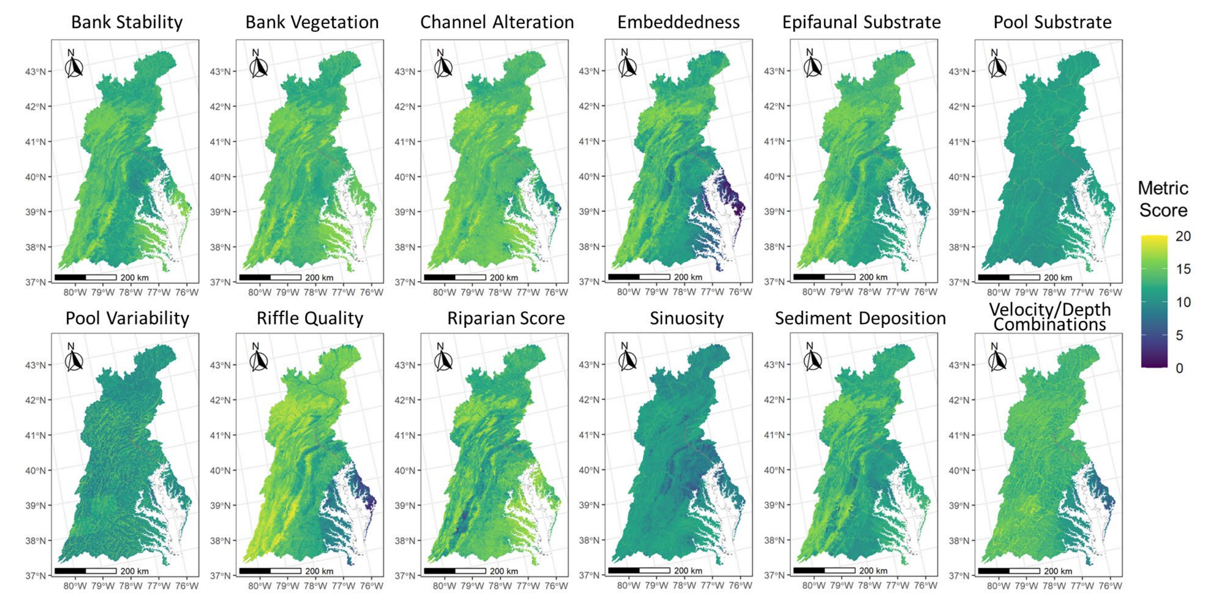
Results

Hydrogeomorphology (Cashman)

Using habitat data collected with EPA Rapid Habitat Protocols contained in CBP DataHub

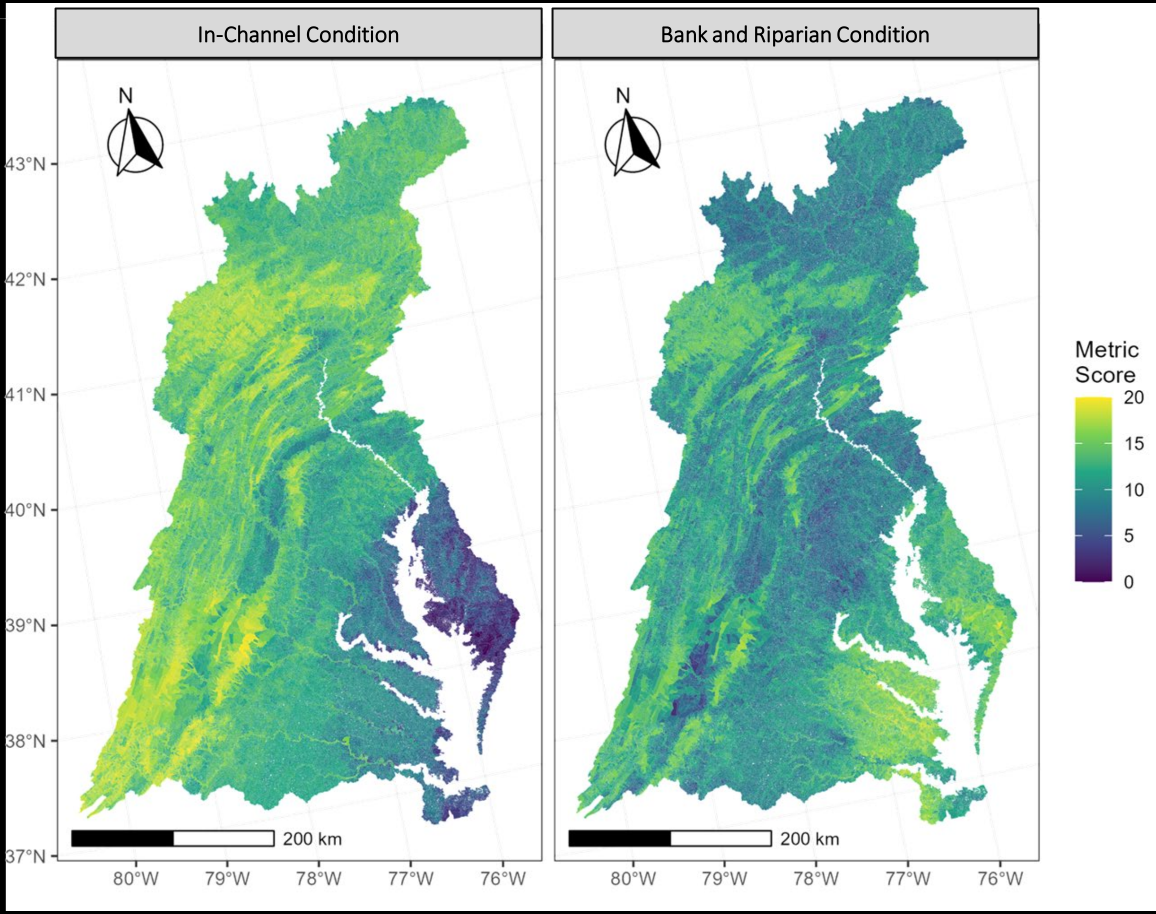
~1,500 – 14,000 observations per metric

Random forest and landscape models similar to other assessments at 1:100k NHDPlus



12 Predicted RBP Scores

Regional Assessments



2 summary scores

Preliminary data, not for citation or distribution

Results

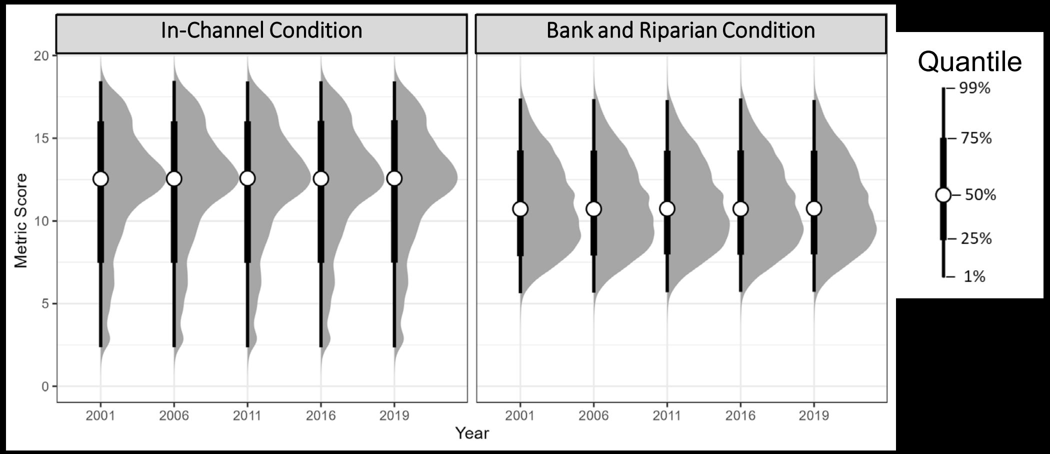
Hydrogeomorphology (Cashman)

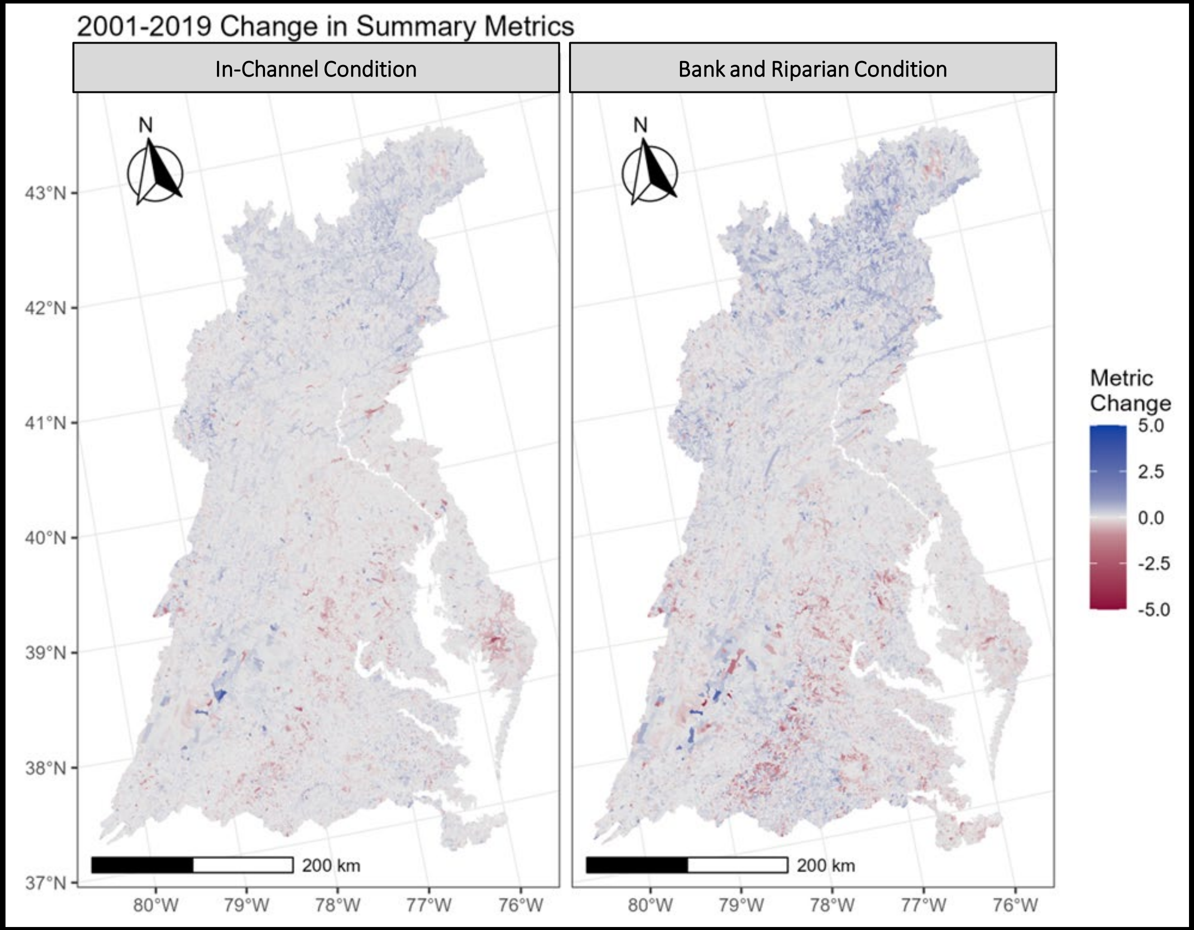
Regional Assessments

We predict change in condition from 2001-2019

There are clear clusters of improvement and deterioration across Chesapeake Watershed

These areas roughly balance out on average, for negligible overall change





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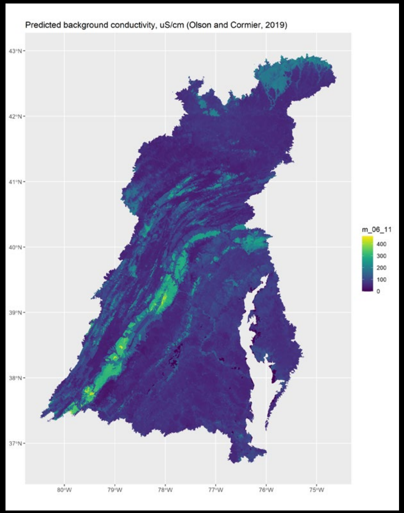
Methods

Specific Conductance (Fanelli)

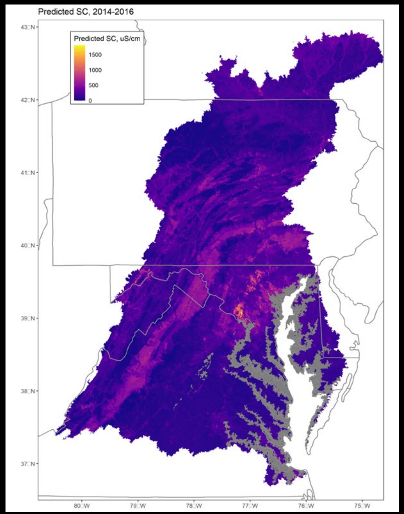
- Input datasets
  - Observed SC (Water Quality Portal)
  - Modeled background SC *(Olson and Cormier 2019; ES&T)*
  - Watershed characteristics (land use, climate, geology, point sources)
- Modeling
  - Grouped observations into four time periods to center around major NLCD years (2001, 2006, 2011, 2016)
  - Used random forests regression models to predict median annual SC for four time periods
  - Applied background SC (or equivalent) to determine departures from background SC

Regional Assessments

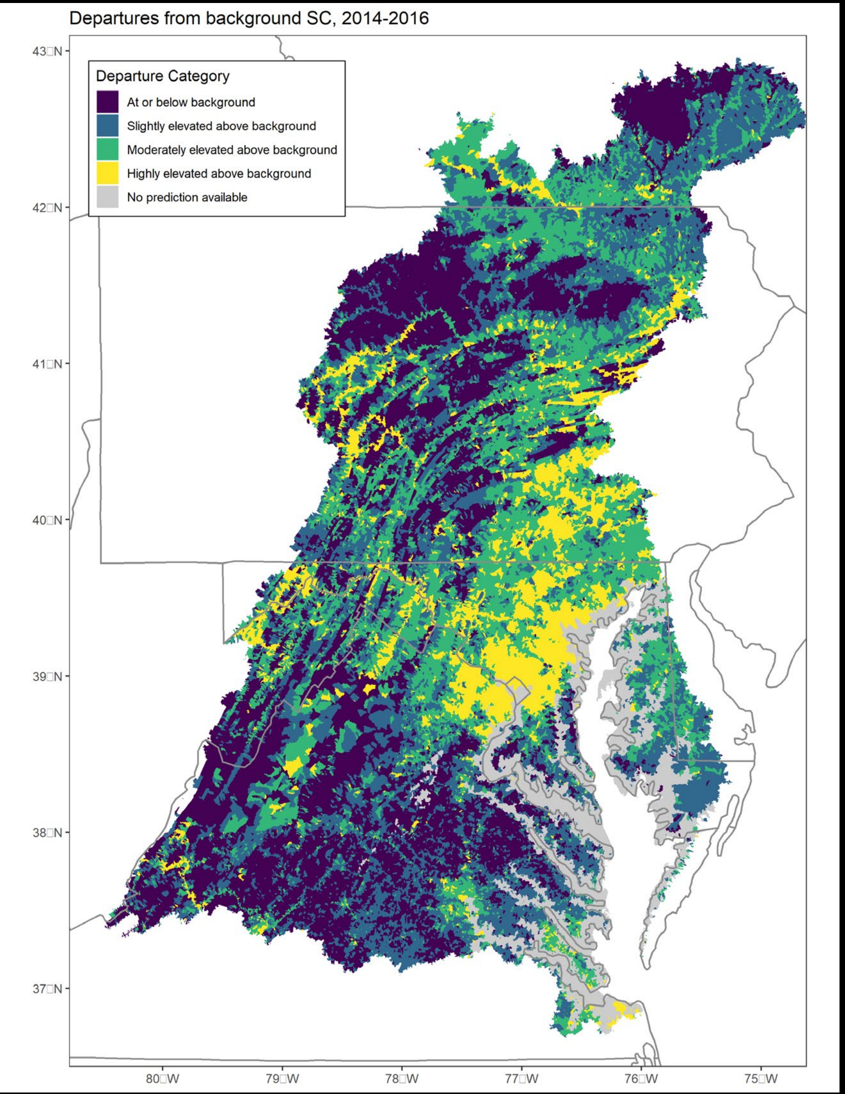
Modeled background SC



Predicted SC



Departures from background SC

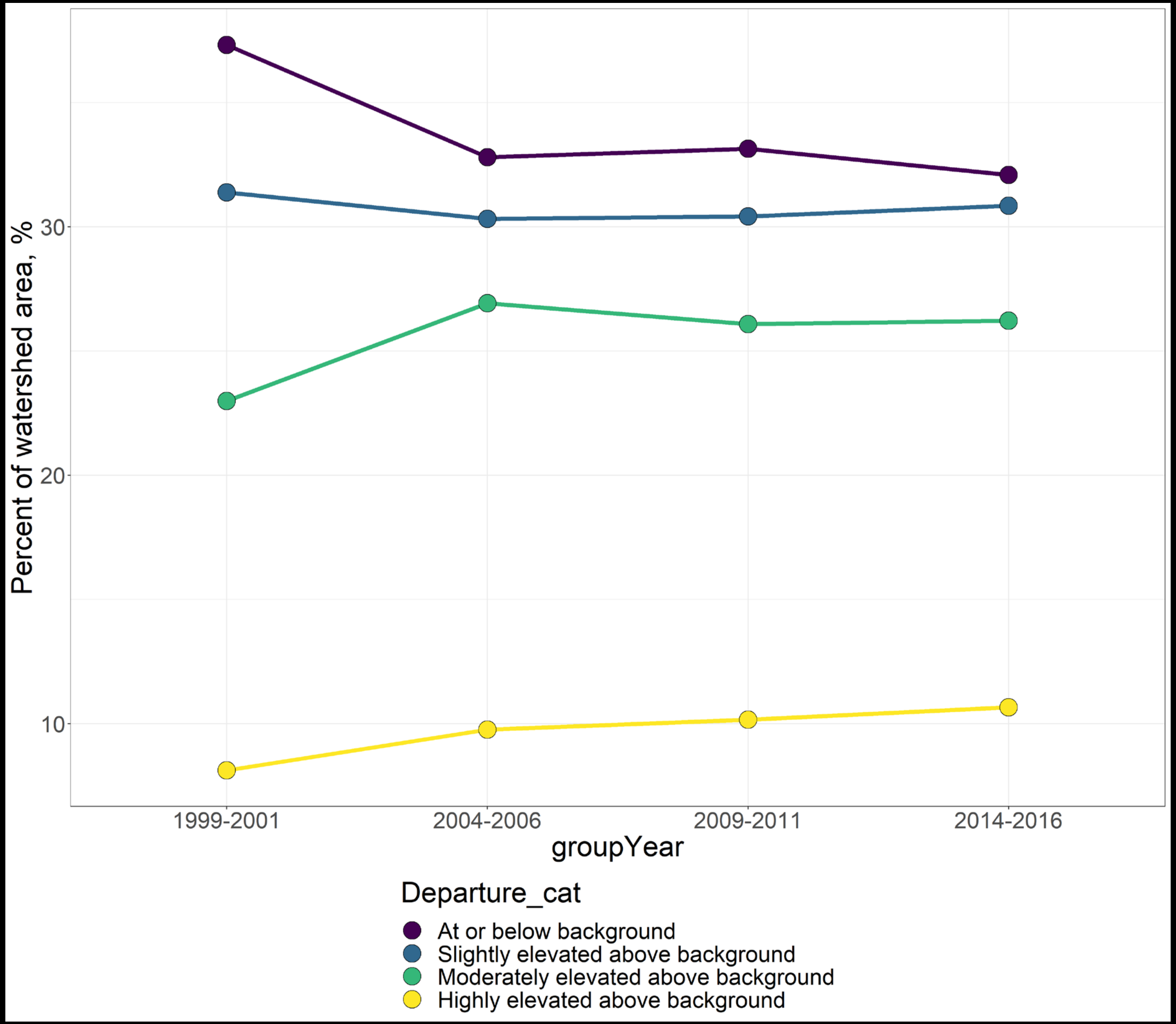


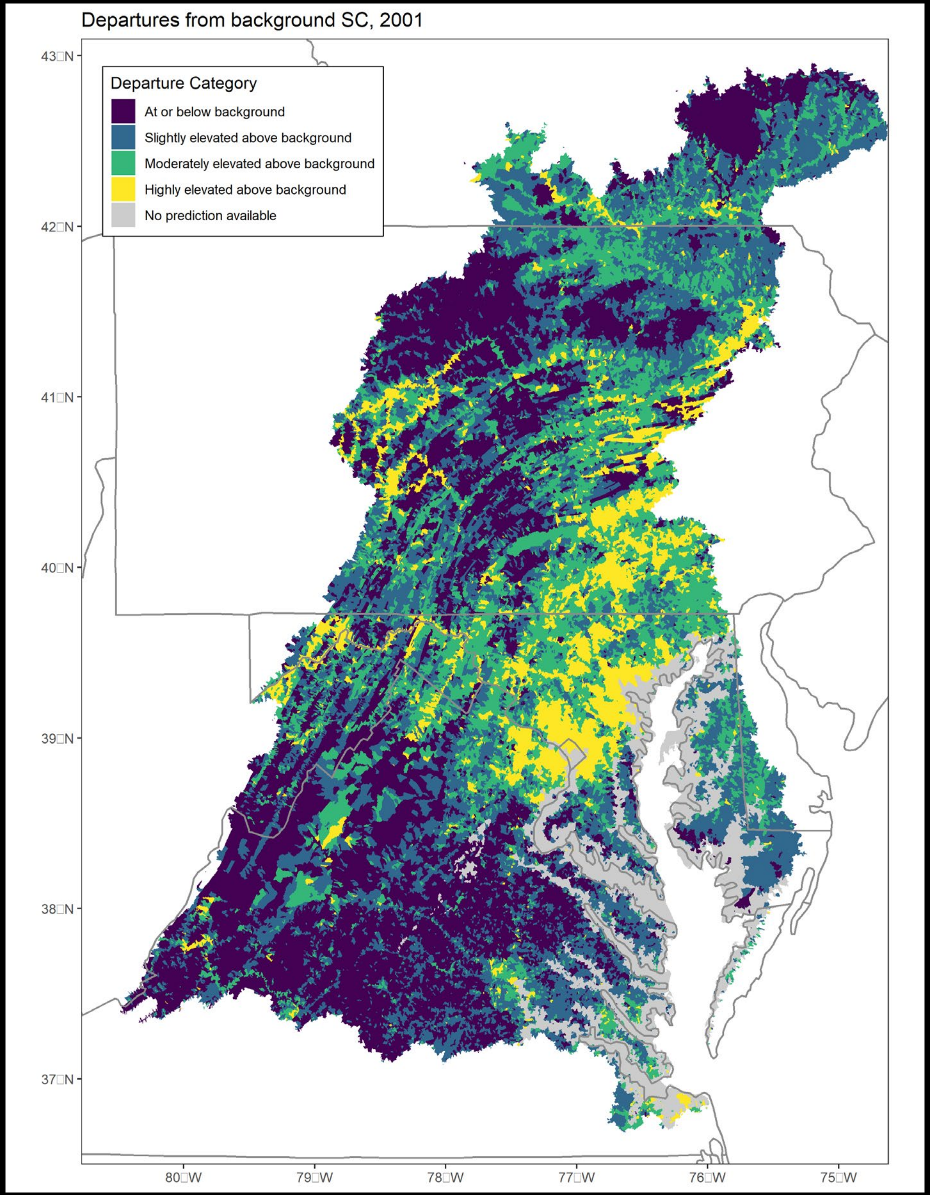
Results

Regional Assessments

Specific Conductance (Fanelli)

Departures have worsened over time





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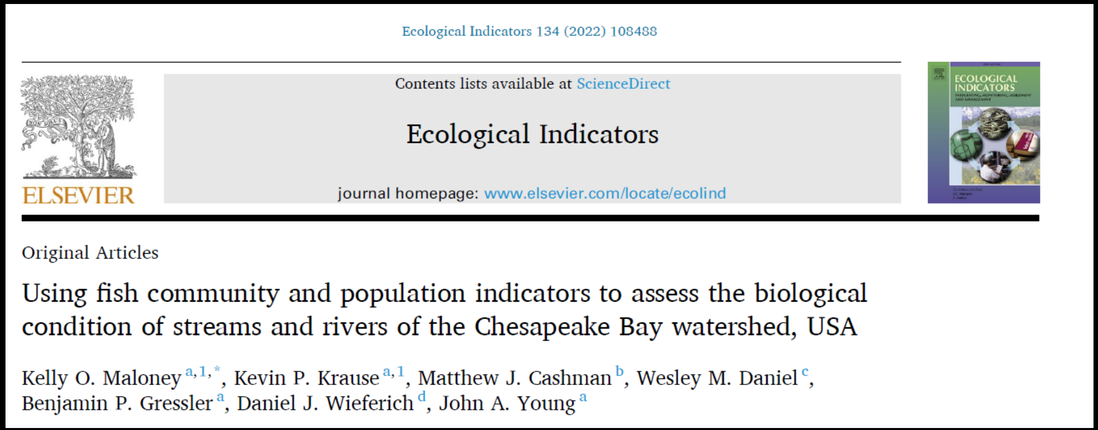
Methods

Fish (Maloney)

- Unable to use reference sites and develop MMI
- Developed a decile approach based on multiple metrics (measures like %intolerant) of assemblage
- Mean of decile scores across suitable metrics used as condition indicator
- Higher mean decile infers less altered system

For details see:


Ecological Indicators 134 (2022) 108488

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

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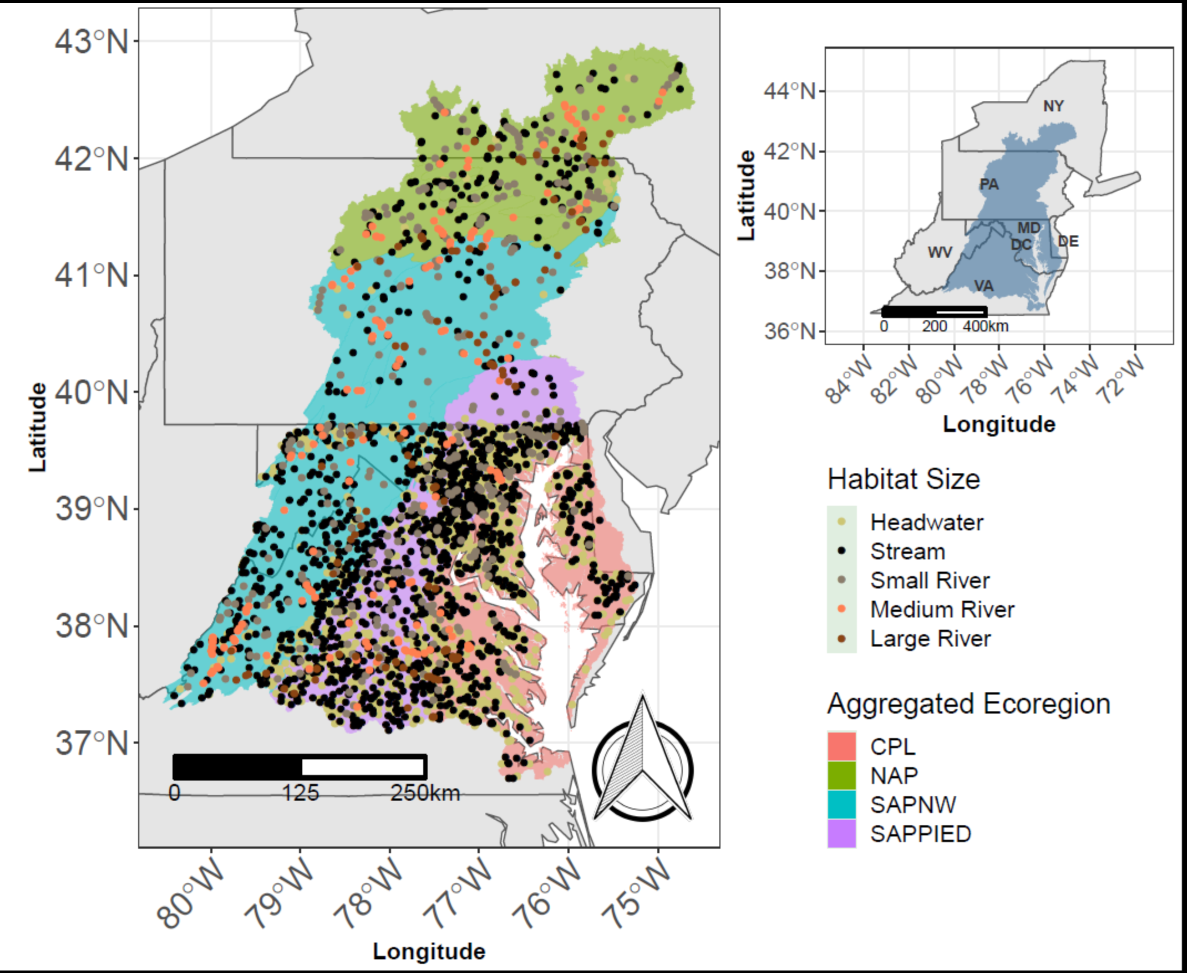
ECOLOGICAL INDICATORS

Original Articles

Using fish community and population indicators to assess the biological condition of streams and rivers of the Chesapeake Bay watershed, USA

Kelly O. Maloney [a,1,*], Kevin P. Krause [a,1], Matthew J. Cashman [b], Wesley M. Daniel [c], Benjamin P. Gressler [a], Daniel J. Wieferich [d], John A. Young [a]

Regional Assessments



https://doi.org/10.1016/j.ecolind.2021.108488

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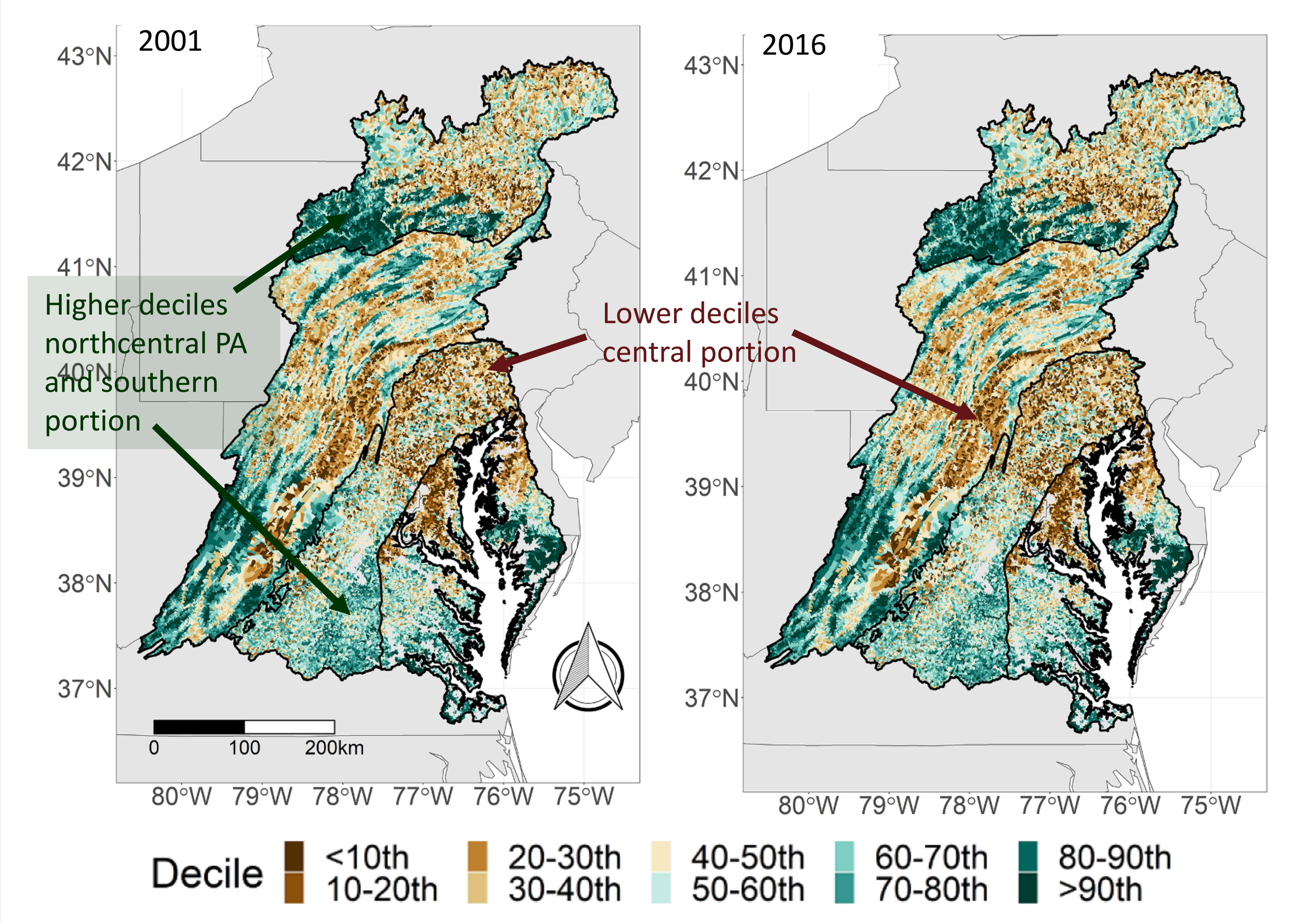
Results- Fish (Maloney)

Regional Assessments

Higher deciles infer less altered system.



https://doi.org/10.1016/j.jenvman.2022.116068

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Results-Fish Population

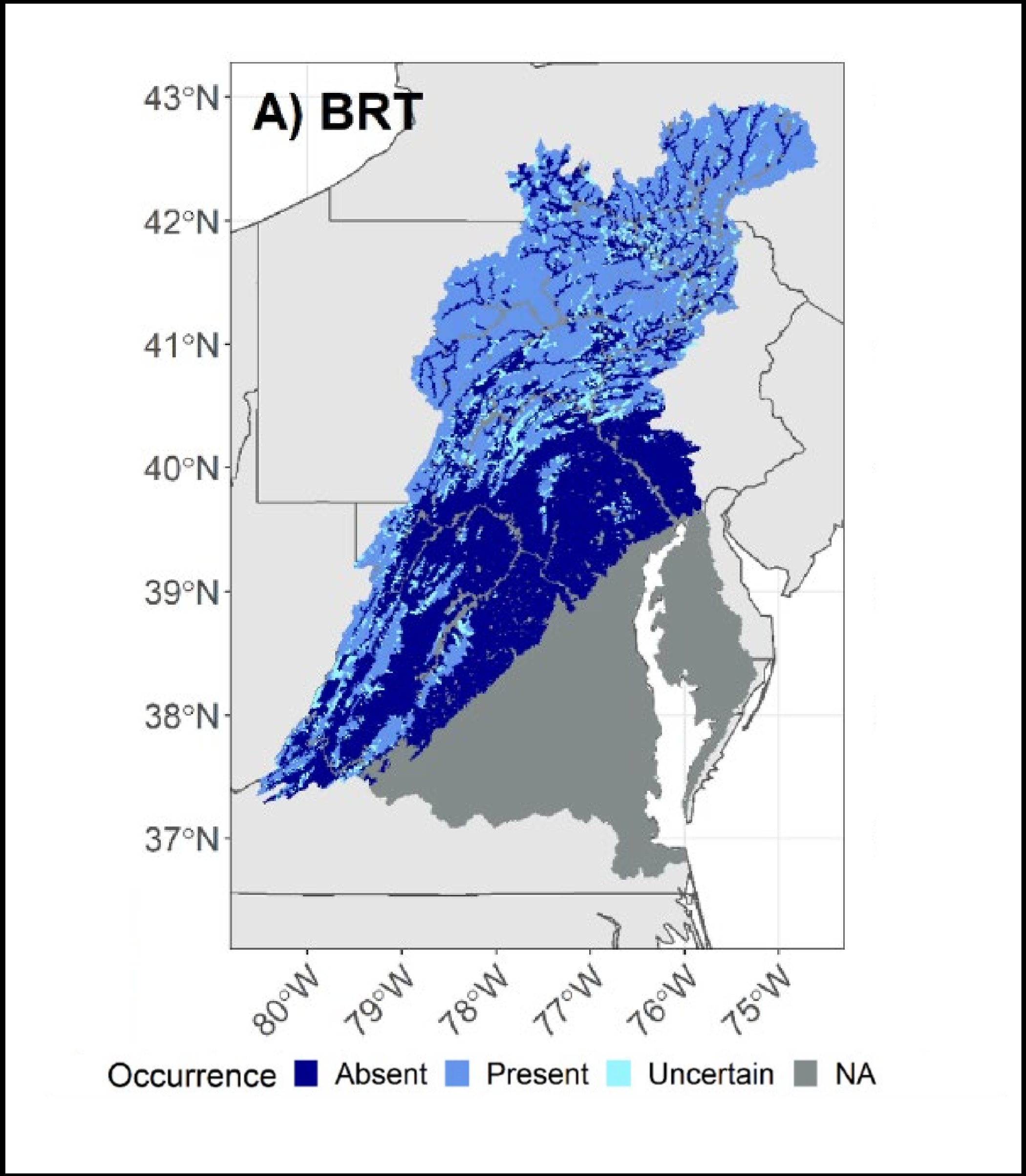
Regional Assessments

4 species (Brook Trout, Smallmouth Bass, Torrent Sucker, N. Hog Sucker)

Species occurrence, with presence indicating suitable habitat.

Example shows presence, absence and uncertain predictions for Brook Trout.

https://doi.org/10.1016/j.jenvman.2022.116068



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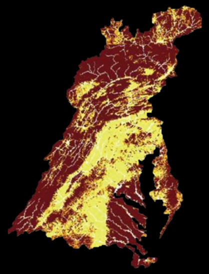
Regional Assessments



Next Steps

Incorporate additional indicators (e.g., other measures of the biological community, water temperature, etc.)

Move all assessments to the NHDPlus High Resolution (1:24,000) framework.

Include higher resolution data (e.g., 1m LULC).

Utilize causal inference approaches.

Thank you!

Status and Trends Fact Sheet: https://doi.org/10.3133/fs20233003

Manuscripts:

Woods et al. 2023 Global change and riverine fish: https://doi.org/10.1111/gcb.16707
Maloney et al. 2022 latest Chessie BIBI modeling effort: https://doi.org/10.1016/j.jenvman.2022.116068
Maloney et al. 2022 latest fish habitat assessment effort: https://doi.org/10.1016/j.ecolind.2021.108488
Maloney et al. 2021 eflow effort: https://doi.org/10.1007/s00267-021-01450-5
Maloney et al. 2020 global change and Chessie BIBI: https://doi.org/10.1111/gcb.14961

Data releases:

Fish and Chessie BIBI linked to NHDPlus V2.1: https://www.sciencebase.gov/catalog/item/60677b1cd34edc0435c09d82
Model predictions latest Chessie BIBI effort: https://www.sciencebase.gov/catalog/item/622f9e7cd34ec9f19eeaa61c
Model predictions latest fish habitat assessment: https://www.sciencebase.gov/catalog/item/61533111d34e0df5fb9c5bc5
Community metrics Chesapeake compiled fish dataset: https://www.sciencebase.gov/catalog/item/606cdef4d34e670a7d5cfff1

Contact Information

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Toxics: Trevor Needham (tneedham@usgs.gov) or Emily Majcher (emajcher@usgs.gov)

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Flow: Sam Austin (saustin@usgs.gov), Kelly Maloney (kmaloney@usgs.gov) and Taylor Woods (tewoods@usgs.gov)
Water temperature: John Clune (jclune@usgs.gov), Kelly Maloney (kmaloney@usgs.gov) and Taylor Woods (tewoods@usgs.gov)
Conductivity : Rosemary Fanelli (rfanelli@usgs.gov)

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Geonarrative

USGS Assessments of Stream Health Condition in the Chesapeake Bay Watershed

Assessing Freshwater Habitats in the Chesapeake | General Assessment Trends | Detailed Results | About

Understanding Habitat Condition

In order to provide science for the environmental management of stream health, fish habitat, fish health, and water quality, the USGS and Chesapeake Bay Program partners are conducting multiple habitat assessment efforts throughout the Chesapeake Bay Watershed. The goal of this work is focused on understanding and modeling aquatic communities, physical conditions, water quality, and toxic contaminants in the streams and rivers throughout the Watershed.

These assessments rely on collected and modeled data to build estimates of condition, and localized information generated with these models allows managers to focus restoration and protection efforts in Chesapeake Bay watershed.

Each section (below) in this geonarrative describes the data inventory/generation and modeling steps undertaken for a given Assessment:

- Aquatic Communities
  - Fish
  - Benthic
- Physical Conditions
  - Hydrogeomorphology
  - Specific Conductance
  - Stream Temperature
  - Freshwater Flows
- Additional Assessments
  - Toxic Contaminants
  - Water Quality

All results are incorporated into an interactive dashboard, as to inform healthy watershed, fish habitat and health decision-making. General trends in regional assessments can be found on the Detailed Time Series tab. For links to all journal articles, data releases, and contact information, see the About page.

Allison Sussman and Stephanie Gordon