Progress On the CBP Stream Health Outcome

Presentation to the Chesapeake Bay Commission

Virginia Museum of History and Culture
Richmond, VA

November 9, 2023

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and Rikke Jepsen
Interstate Commission on the Potomac River Basin (ICPRB)

Mike Mallonee
ICPRB/Chesapeake Bay Program Office

Teamwork

15 years in the making
Many talented, dedicated people

Index Development

Claire Buchanan, *ICPRB*
Rikke Jepsen, *ICPRB*
Mike Mallonee, *ICPRB/CBPO*
Zachary Smith, *New York DEC*
Andrea Nagel, *ICPRB*
Katherine Foreman, *EPA HQ*
Adam Griggs, *EPA HQ*
Jacqueline Johnson, *formerly NOAA*

Data Collection/Sample Counting

The field crews and managers of 24 monitoring programs in the Chesapeake Bay watershed

Advisory Committees and Workshop Participants

State and regional macroinvertebrate experts (2011, 2017, 2018)
especially Greg Pond (EPA), Dustin Shull (PADEP), Scott Stranko (MDDNR), Jason Hill (VADEQ), A. J. Smith (NYDEC), Michael Whitman (WVDEP), Ellen Dickey (DEREC), Ellyn Campbell (SRBC), Karen Blocksom (EPA), and Kelly Maloney (USGS)

Chesapeake Bay Program

CBP Non-Tidal Workgroup and Stream Health Workgroup
especially Peter Tango (USGS), Scott Phillips (formerly USGS), Neely Law (Fairfax Co.) and Jennifer Greiner (FWS)

CBP Data Center staff
especially Jacqueline Johnson and presentation co-author Mike Mallonee

Funding

EPA Clean Water Act Sec.117 grants, ICPRB internal funds

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Stream Health Outcome(s)

2009 Chesapeake Bay Executive Order 13508

Improve the **health of streams** so that **70 percent** of sampled streams throughout the Chesapeake watershed are in **fair, good or excellent** condition as measured by the **Index of Biotic Integrity** by **2025**

2014 Chesapeake Bay Agreement

Continually improve **stream health** and function throughout the watershed. Improve health and function of **ten percent of stream miles above the 2008 baseline** for the Chesapeake Bay watershed

How to Measure Stream Health?

Developing a Watershed-wide Indicator

Progress Meeting CBP Stream Health Outcome

What Are We Doing That Works?

Use Index to Adapt Management

How to Measure Stream Health?

- **Stream Health**
  – the condition of all biotic and abiotic (habitat, water quality) parts of a stream ecosystem

- **Aquatic life**
  – the definitive indicator of a waterbody's health

- **Macroinvertebrates**
  - the only stream community measured with consistent methods across entire Chesapeake watershed

D-net sampling method for macroinvertebrates
Photo: West Virginia Dept of Environmental Protection (WVDEP)

Macroinvertebrates

- Benthic
- Diverse taxa
- Relatively short-lived
- Respond to environmental gradients
- Several feeding groups
- Several habits
- Collected by all states, some counties and federal agencies, and citizen groups
- Standard collection & counting methods (EPA Rapid Bioassessment Protocols)
- Inconsistent state assessment methods

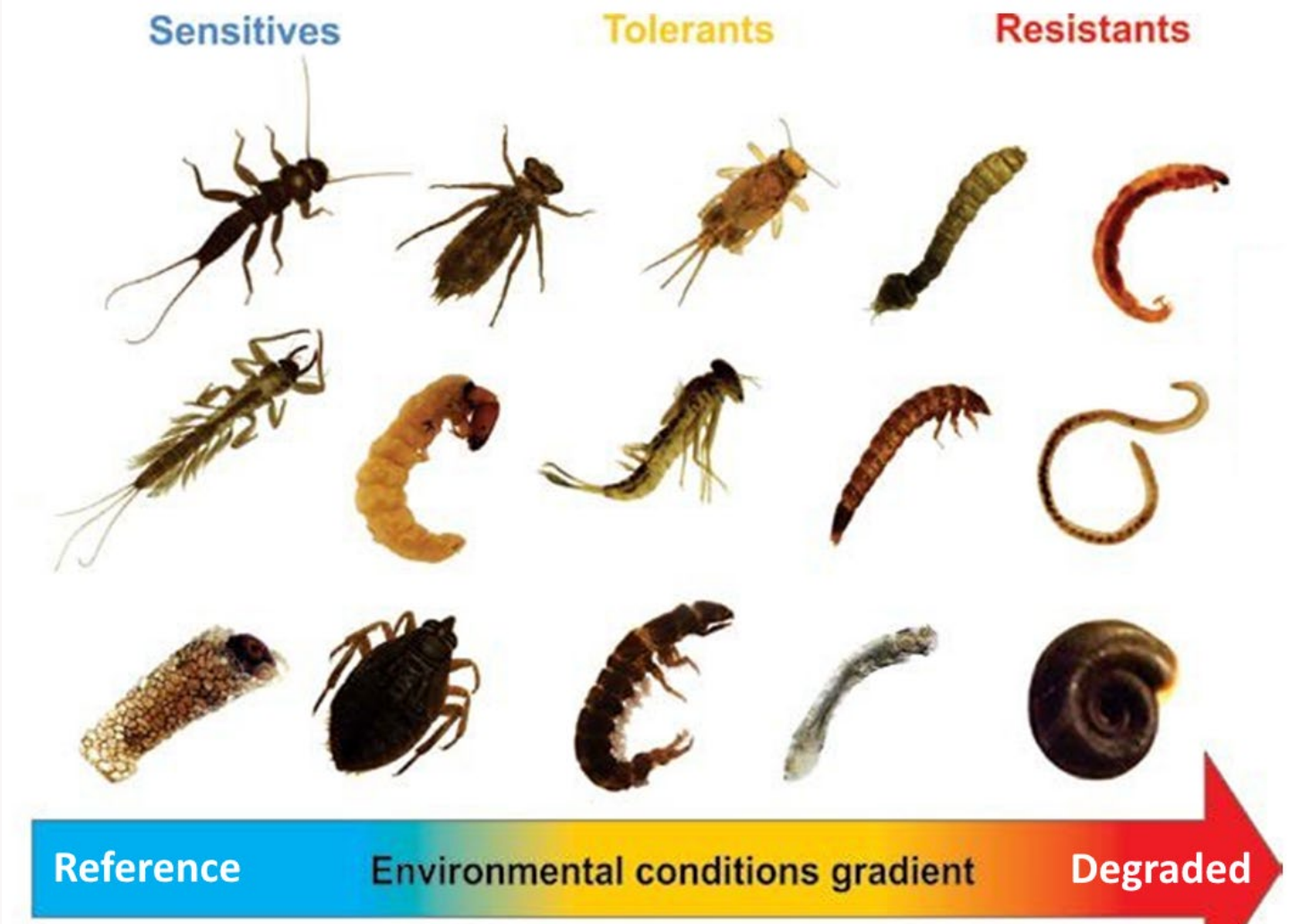
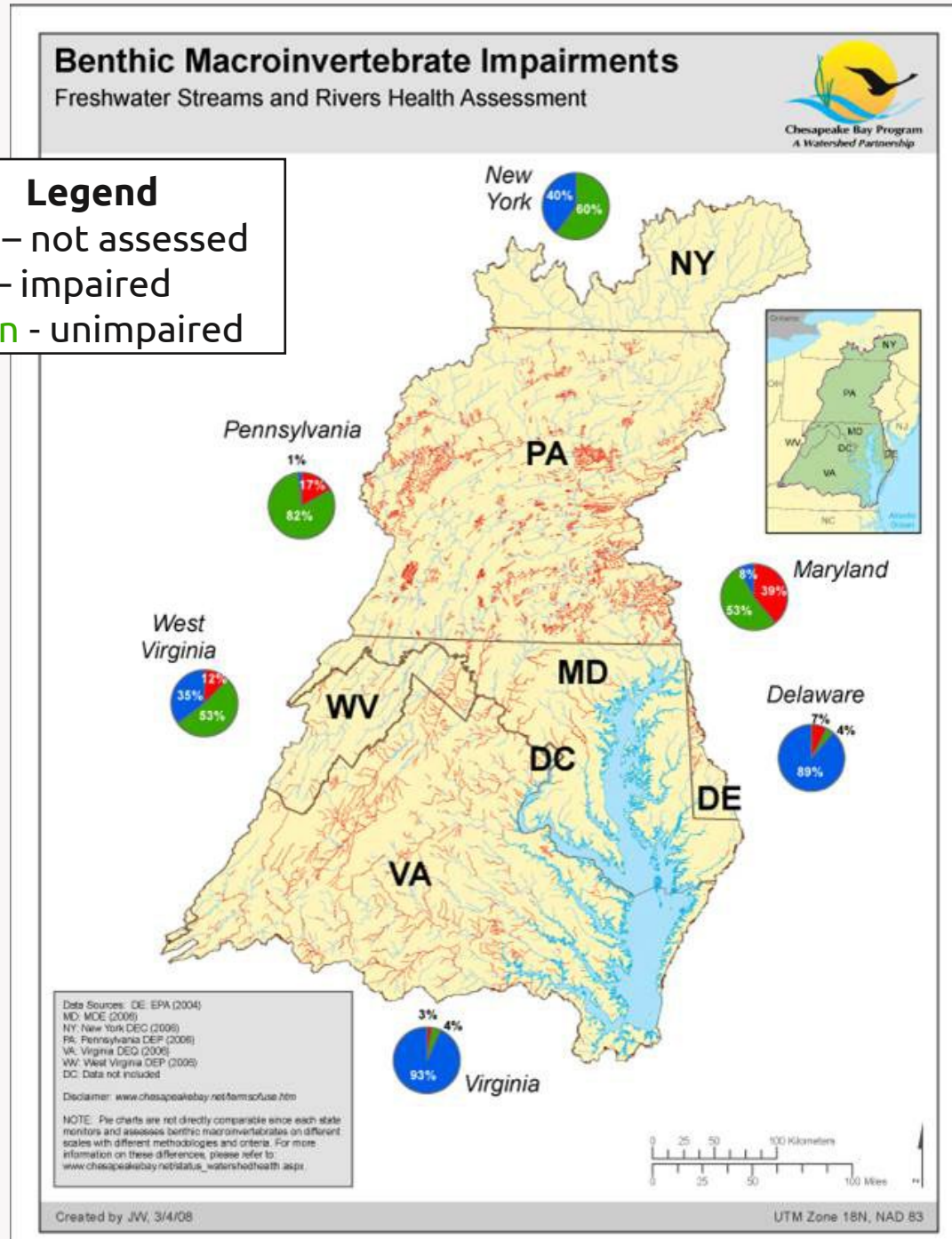


Figure: Diego Castro

State impairment assessments

…are not directly comparable and cannot be used by the Chesapeake Bay Program to measure progress towards meeting basin-wide goals.

CBP Non-Tidal Workgroup, 2008

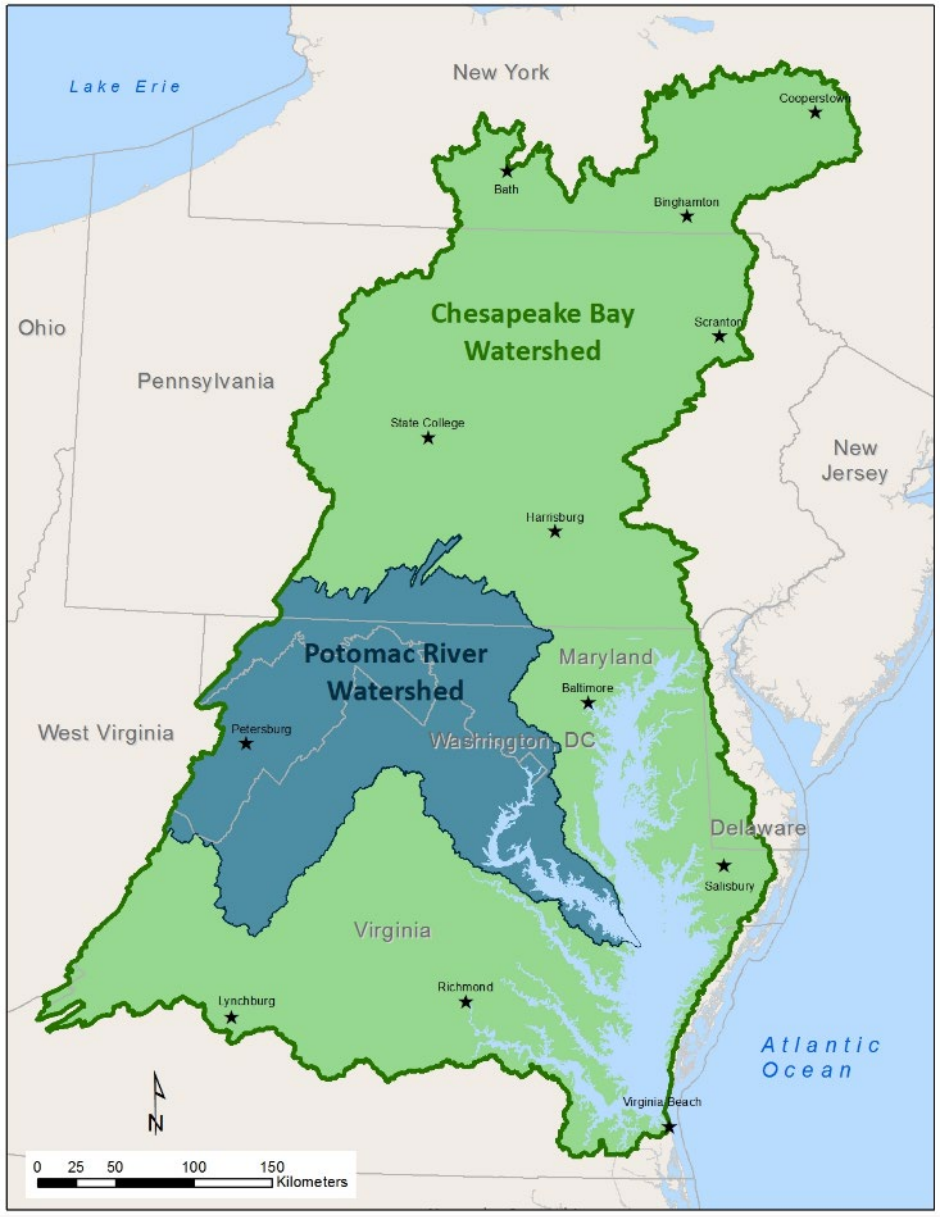


Developing a Watershed-wide Indicator

Metric – a measurement of something (e.g., percent of shredder taxa in sample)

Index – the value of several metrics combined

Indicator – a metric or index that has a threshold of significance (e.g., distinguishes “good” from “bad”) and can show trends



Early Efforts to Go Watershed-wide

- 2006/2007 - Potomac Basin-wide Index of Biotic Integrity

  Astin, L. E. (ICPRB) 2006, 2007
  Others (side-by-side comparisons)

- 2008 – Proof of Concept for a Chesapeake Index

  Foreman et al. 2008

- 2011 – Prototype index for Chesapeake Bay watershed

  Buchanan et al. 2011

- 2015 – Prototype selected as indicator for Stream Health Outcome (2014 Bay Agreement)

  Stream Health Outcome Management Strategy,
  (2015 – 2025, v. 1)

- 2016/2017 – Refine and improve prototype
  Chesapeake Basin-wide Index of Biotic Integrity
  ("Chessie BIBI")

  Smith et al. 2017

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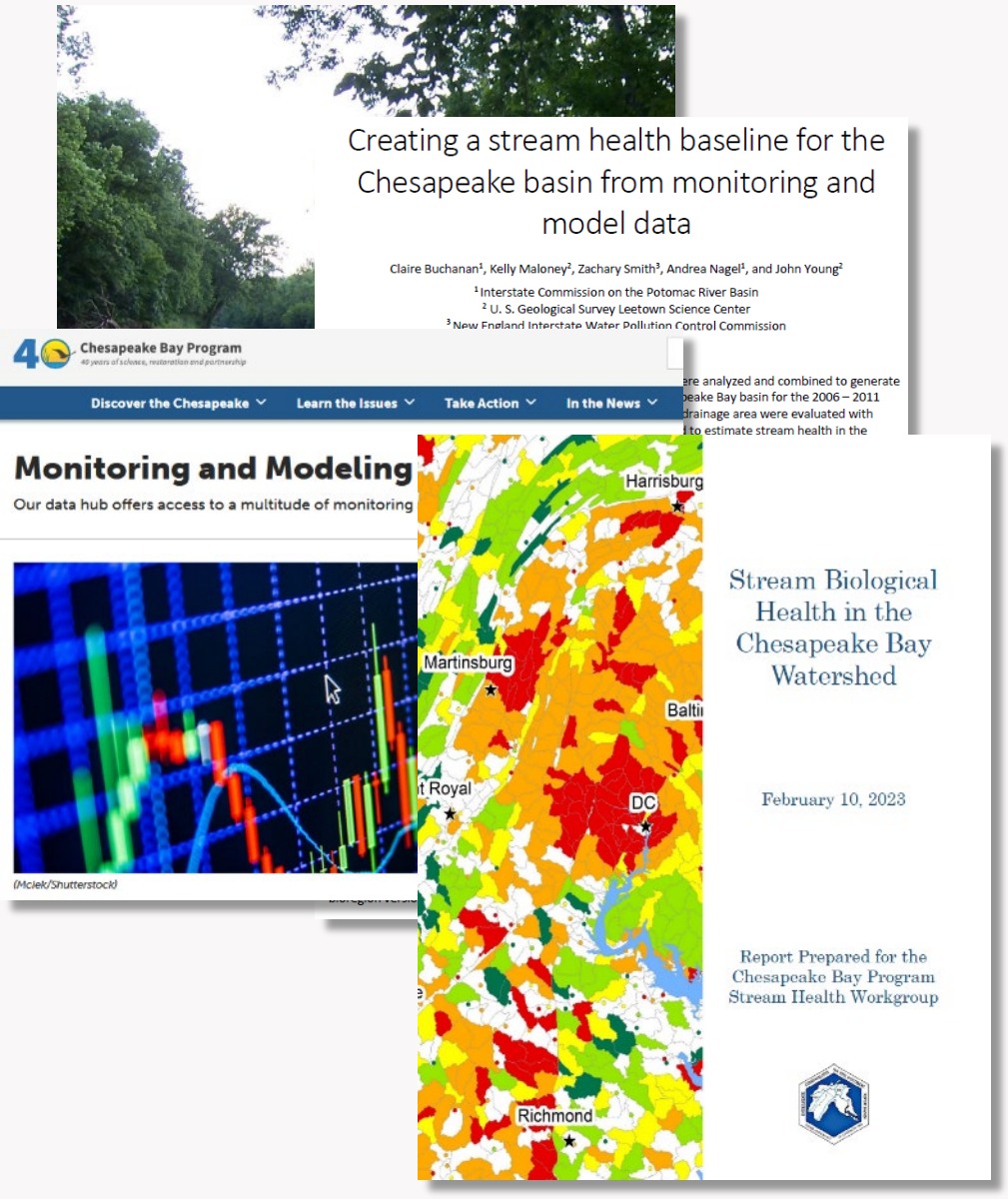
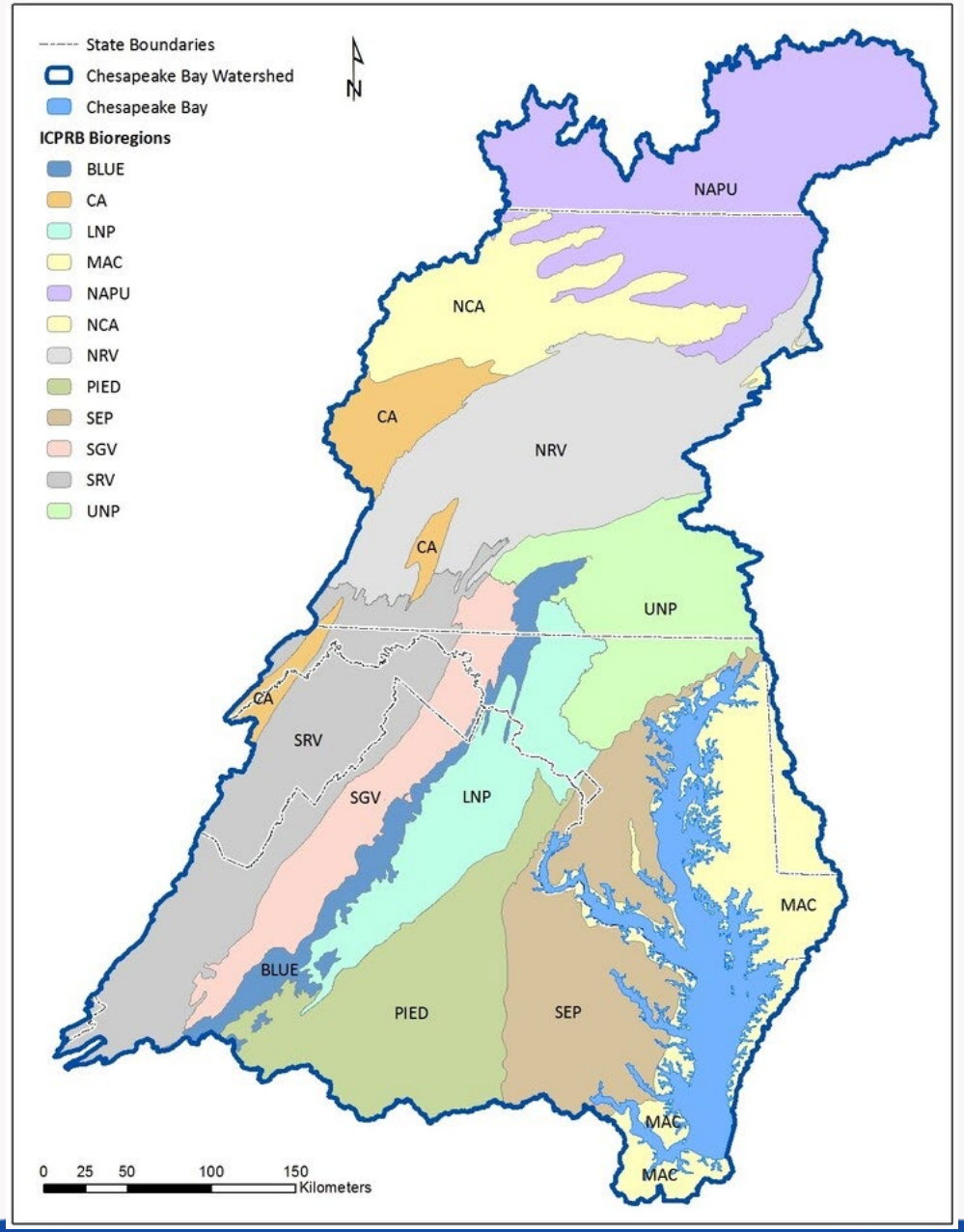


What, Where, How, When

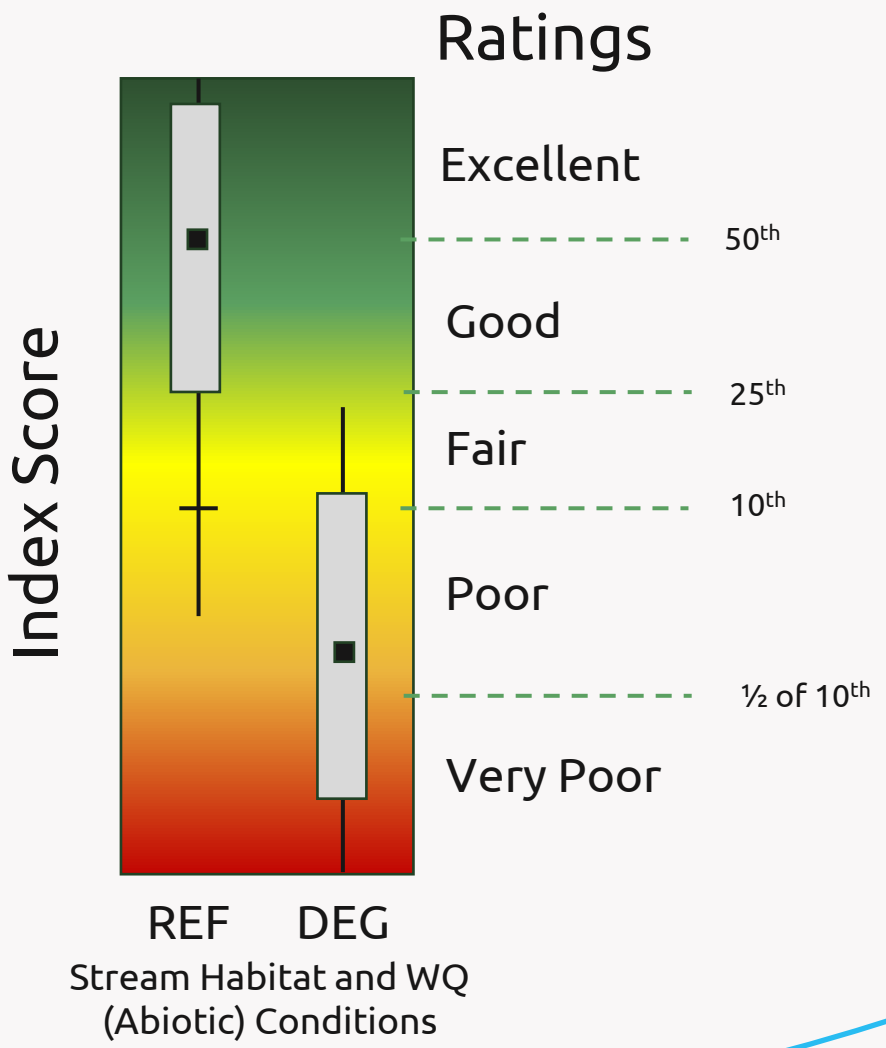
- 2018 – "2008 Baseline" Workshop ICPRB 2018
  - Chessie BIBI is CBP indicator of stream health
  - 2006 – 2011 is the baseline period
  - Statistical analysis methodology is proposed
  - Report due every 6 years
- 2019 – Methodology Tested Buchanan et al. 2019
- 2021 – Data Incorporated into Chesapeake Environmental Data Repository (CEDR) (link)
- 2021 – Computer Programs to Calculate Index (link)
- 2023 – First Progress Report Buchanan et al. 2023
  - 26,752 samples (~72% collected by the six states and D.C.)
- 2024 – Data Call
- 2025 – Second Progress Report (2018 – 2023)



The Index

The index accounts for natural differences in stream macroinvertebrate communities caused by differences in geology, elevation, climate, rainfall and soils (**bioregions**)

The Index



Populations found in undisturbed, high-quality (Reference) streams are considered **healthy**

Reference population scores are used in a consistent manner to create the five ratings in each bioregion

Index correctly distinguishes undisturbed, high-quality (REF) streams from degraded streams (DEG) about 80% of the time

Progress Meeting the CBP Stream Health Outcome

Progress Meeting the CBP Stream Health Outcome

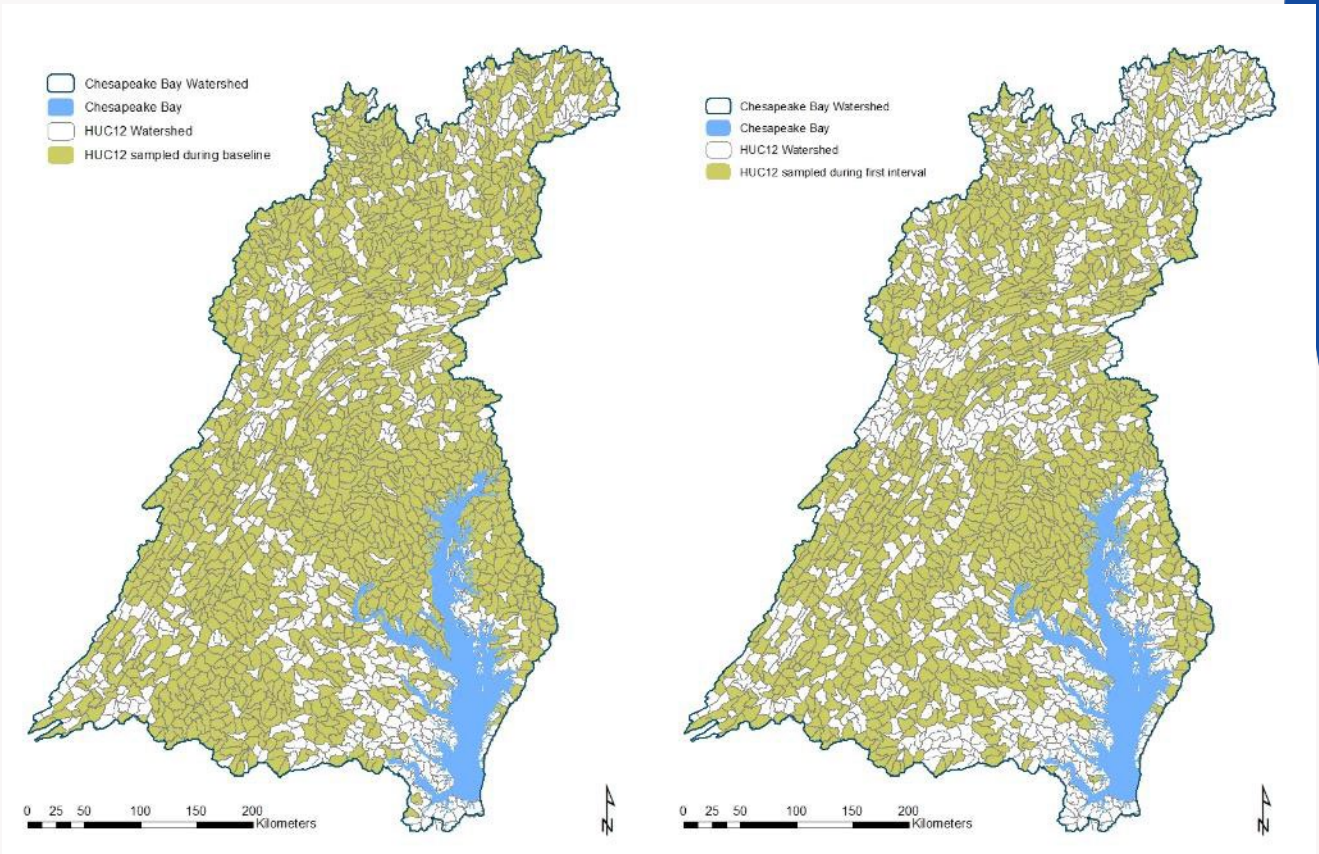
Statistical methods used to rate

~145,000 stream miles in the Chesapeake Bay watershed (1:24,000 scale) …

See report for details

2006 – 2011 “Baseline”

2012 – 2017 “First Interval”



Sampled HUC12 Subwatersheds

Progress Meeting the CBP Stream Health Outcome

"Improve health and function of ten percent of stream miles above the 2008 baseline."

(2014 Chesapeake Watershed Agreement)

Period	Years	% Healthy Stream Miles
Before Baseline	(2000 – 2005)	57.1%
"2008 Baseline"	(2006 – 2011)	61.7%
First Interval	(2012 – 2017)	67.8%

+6.1%

+10.7%

Nearly 70%

"Improve the health of streams so that 70 percent of sampled streams …are in fair, good or excellent condition as measured by the Index of Biotic Integrity by 2025."

(2009 Executive Order 13508)

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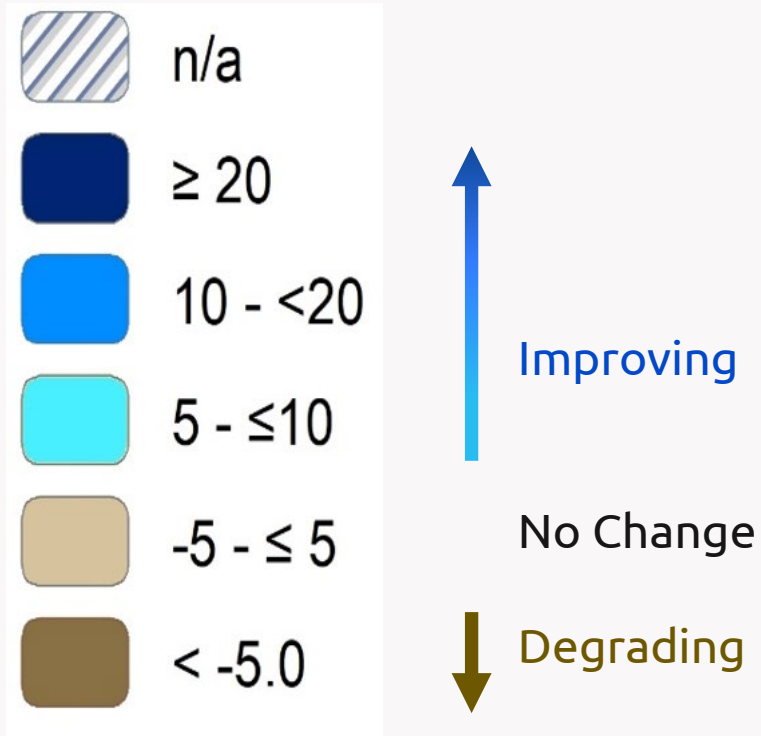
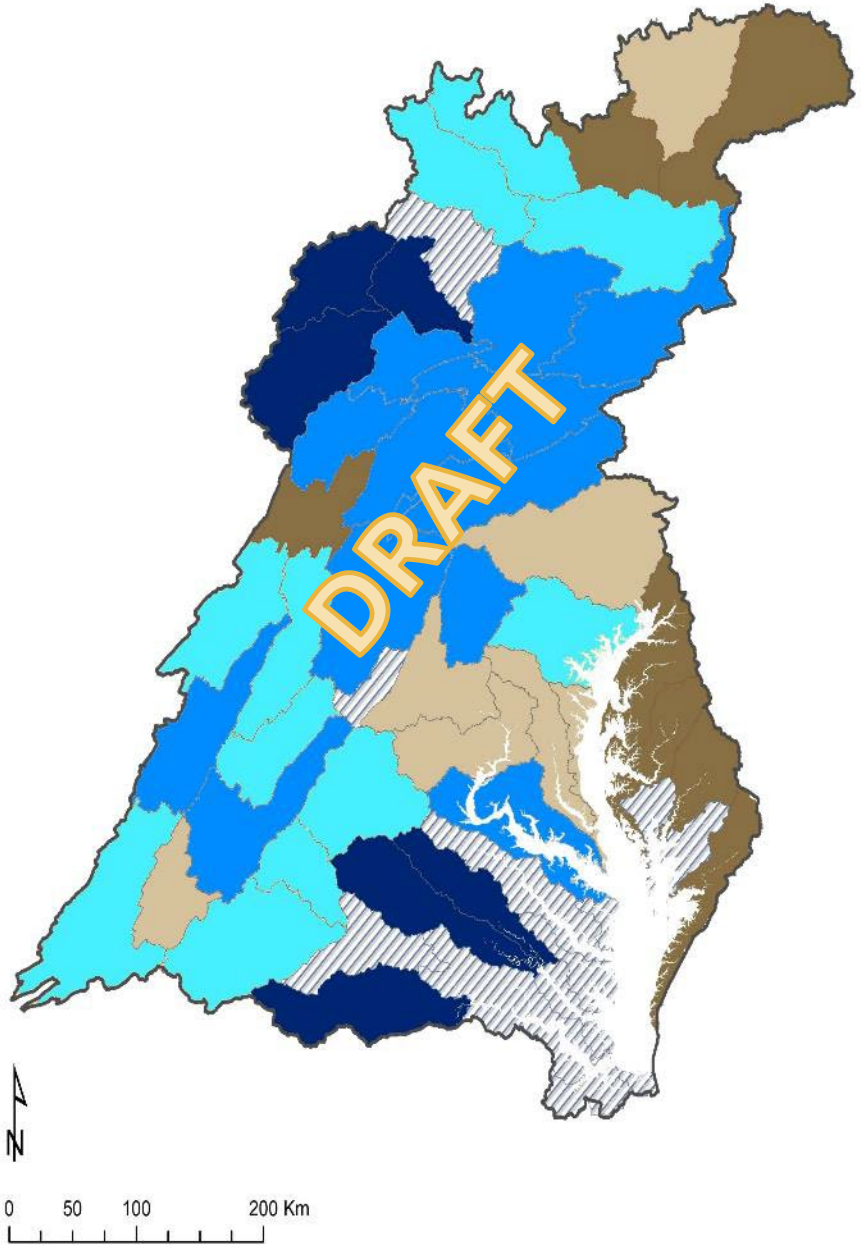
Progress Meeting the CBP Stream Health Outcome

Change, by HUC8 Watershed

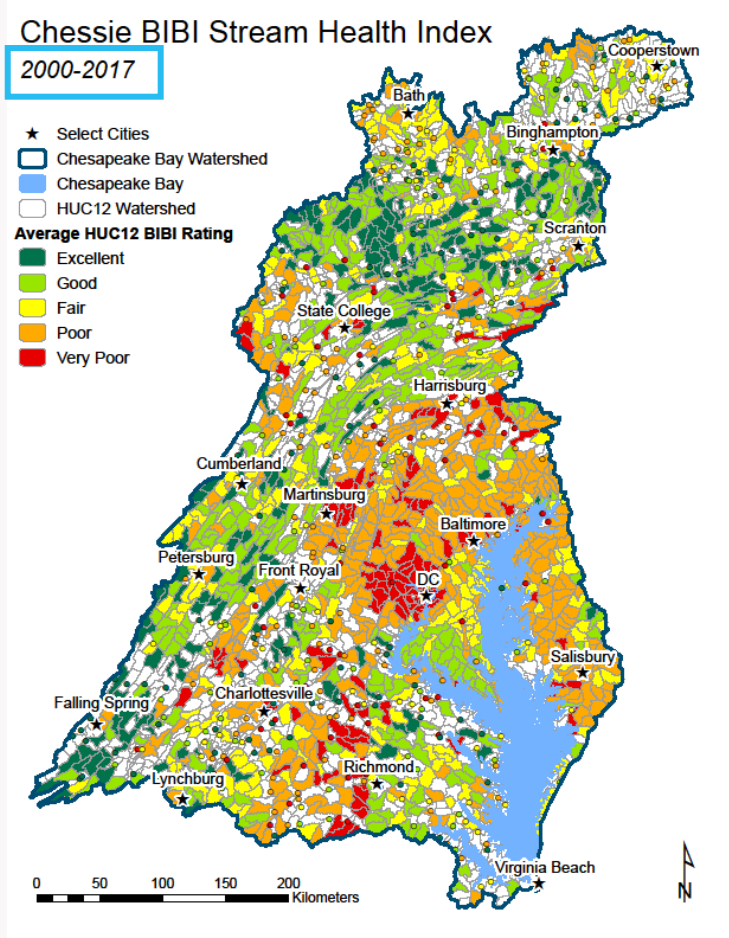
Pre-baseline (2000-2005) → First Interval (2012-2017)

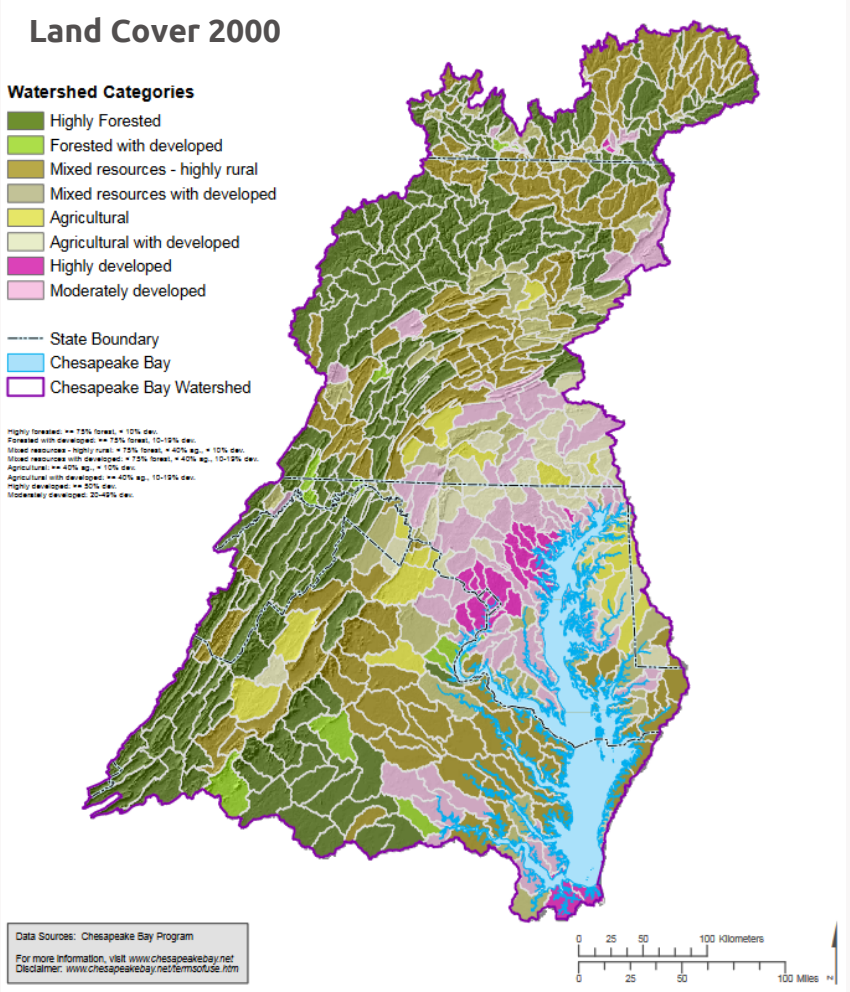




Progress Meeting the CBP Stream Health Outcome

Distribution of index ratings echoes land cover categories …





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Progress Meeting the CBP Stream Health Outcome

We don't know exactly why aquatic life is improving overall…

…we think the **collective impact of environmental stressors on streams is slowly lessening**, at least in parts of the Chesapeake watershed.

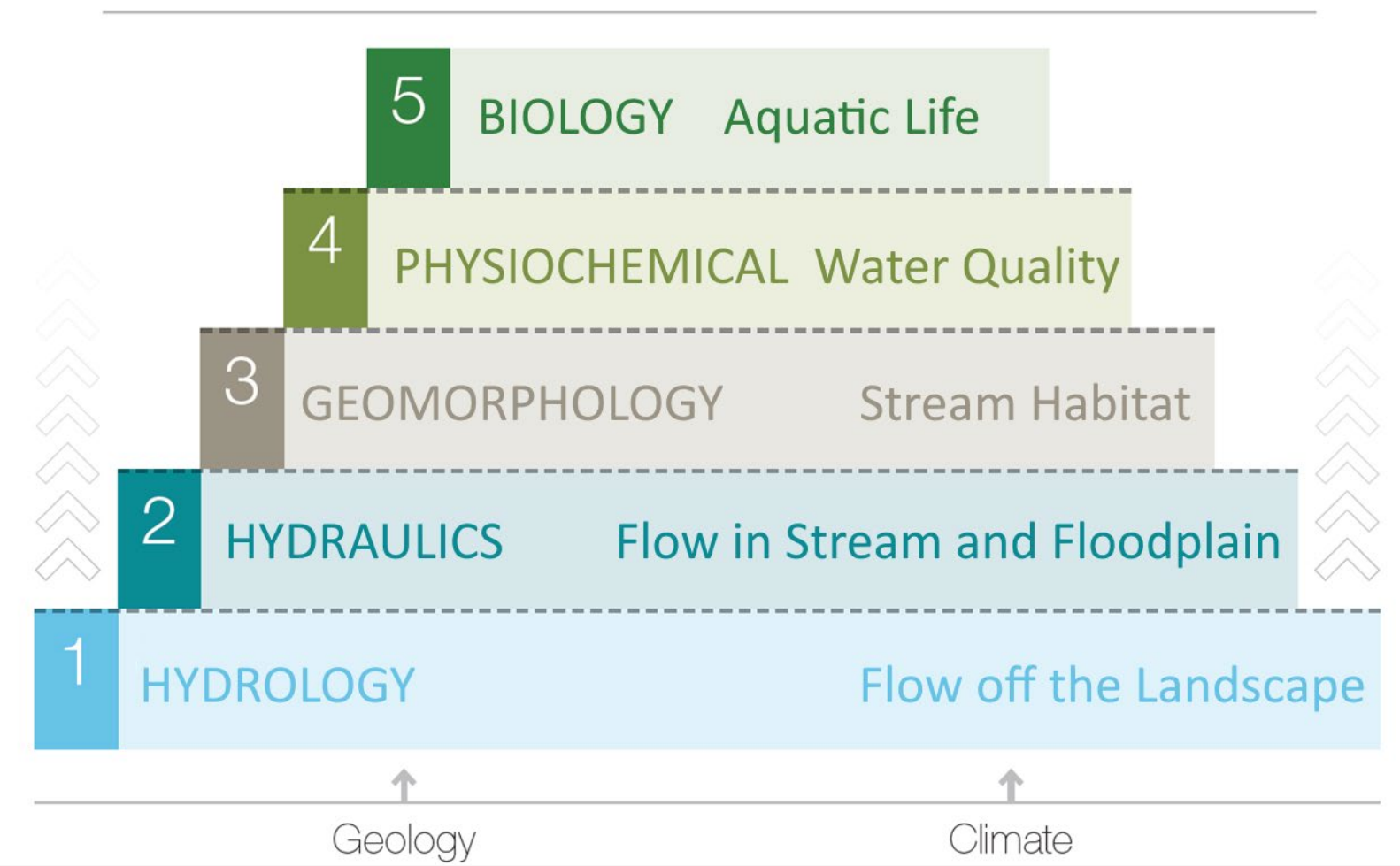
We also don't know **if** the improving trend will continue in the next 6-year interval (2018 – 2023).

What Are We Doing That Works?

… what environmental stressors degrade streams?

… what actions seem to be improving stream health?

A Unifying Framework to Evaluate Stressors



Stream Functions Pyramid

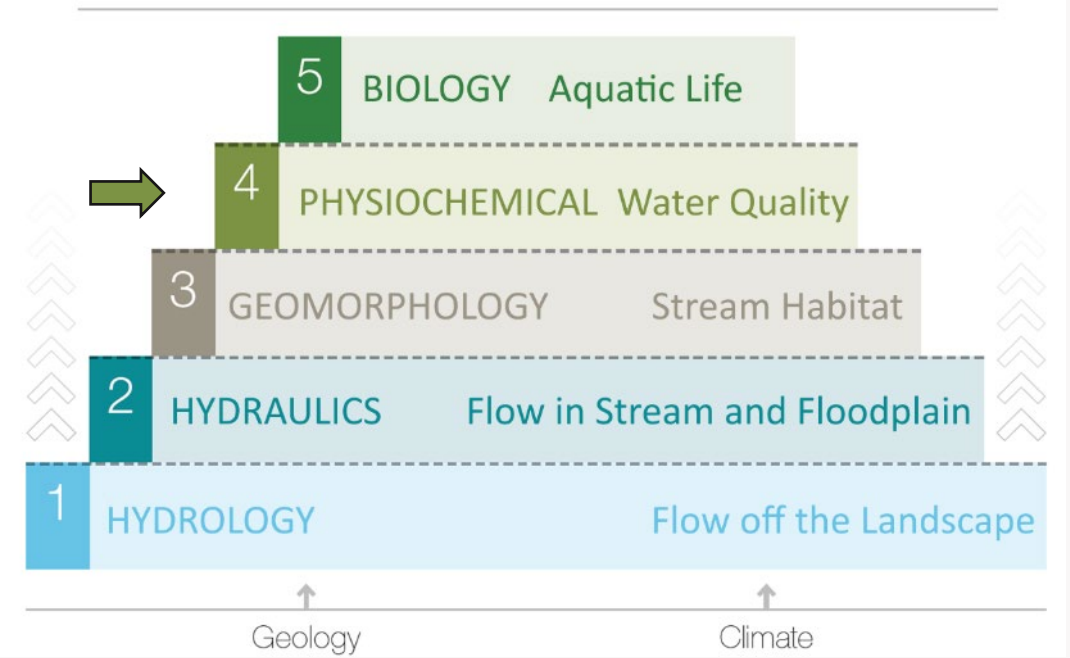
Harman, W., et al. 2012. A function-based framework for stream assessment and restoration projects.

Stressors That Negatively Affect Biology

5	**Biology**	Diseases, parasites, invasive species Harmful algal bloom (HABs) Fish stocking
4	**Physiochemical**	High nutrient (N, P)* and sediment levels Low dissolved oxygen (DO) More acid (low pH) More contaminants (salt, others)
3	**Geomorphology**	Degraded physical instream habitat conditions* (e.g., bank erosion, embeddedness, riparian buffers, sediment particle sizes)
2	**Hydraulic**	In-stream features that alter natural flow patterns* (e.g., dams, culverts, hardened banks, straightened channels, withdrawals, discharges)
1	**Hydrologic**	Changes in land cover* that alter transport of water over land and in the ground (e.g., %forest, %imperviousness, %agriculture)

* Shown in ICPRB studies using the Chessie BIBI index

4 Physiochemical



Excess Nutrients (N, P) and Sediments

- Runoff (urban, agricultural)
- Wastewater discharges
- Atmospheric deposition (contains nitrogen)
- Legacy sediments and groundwater

ICPRB photo

1985 – 2017 Trends (USGS)

USGS publication
Zhang et al. 2021. Progress in reducing nutrient and sediment loads to Chesapeake Bay: Three decades of monitoring data and implications for restoring complex ecosystems. DOI:10.1002/wat.1671

Flow-Normalized* Loads Are Declining

Nitrogen (N)	-19.0%
Phosphorus (P)	-2.5%
Sediment	-1.5%

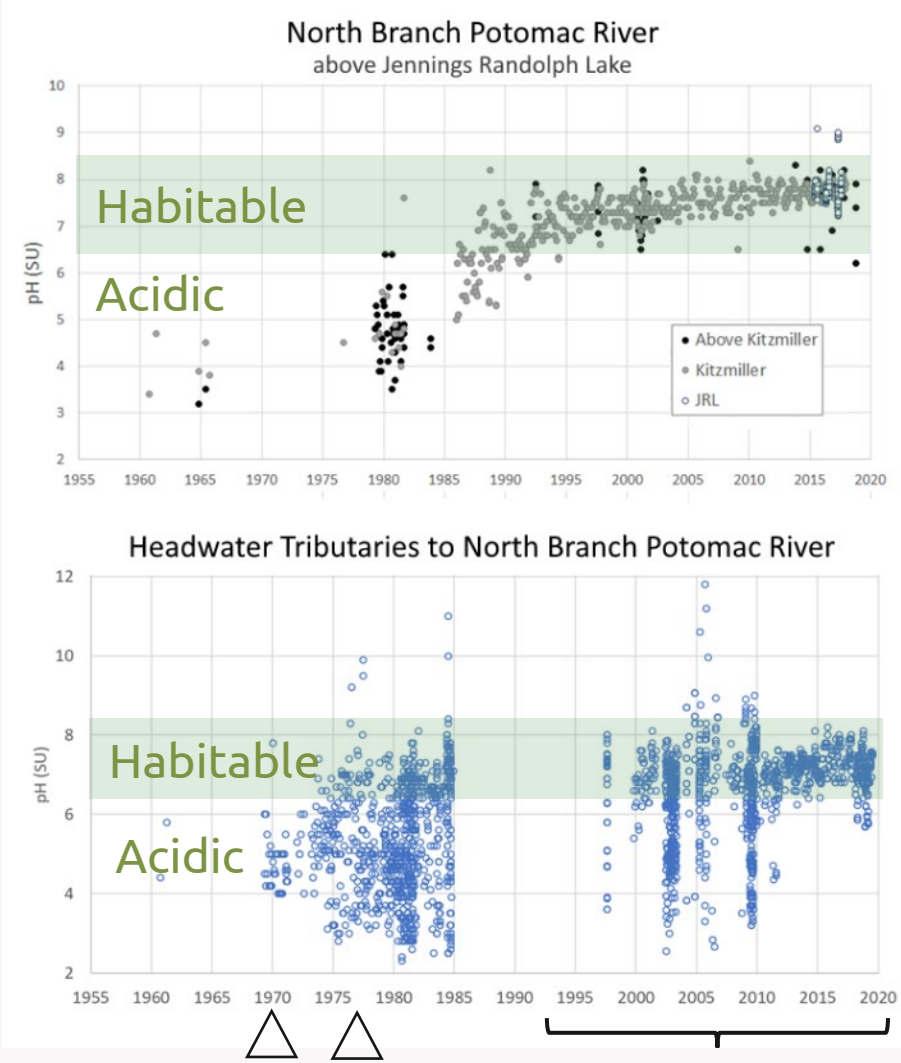
* Reflects effect of management after the influence of flow is accounted for.

Acidity

- Acid mine drainage (AMD)
- Atmospheric deposition (“acid rain”)

AMD entering McDonald Cr in North Branch Potomac River watershed

ICPRB photo

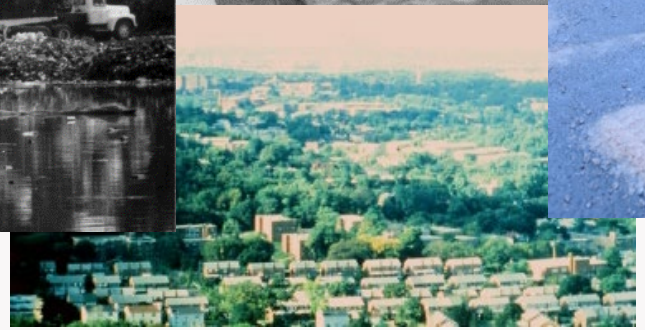


Report link

Contaminants

- Residential (runoff, road salt, waste)
- Agricultural (pesticides, herbicides, salination)
- Fracking (slurry mixture)
- Industrial (PCBs, PFAS, plastics, etc.)
- Energy (emissions)

AP file photo

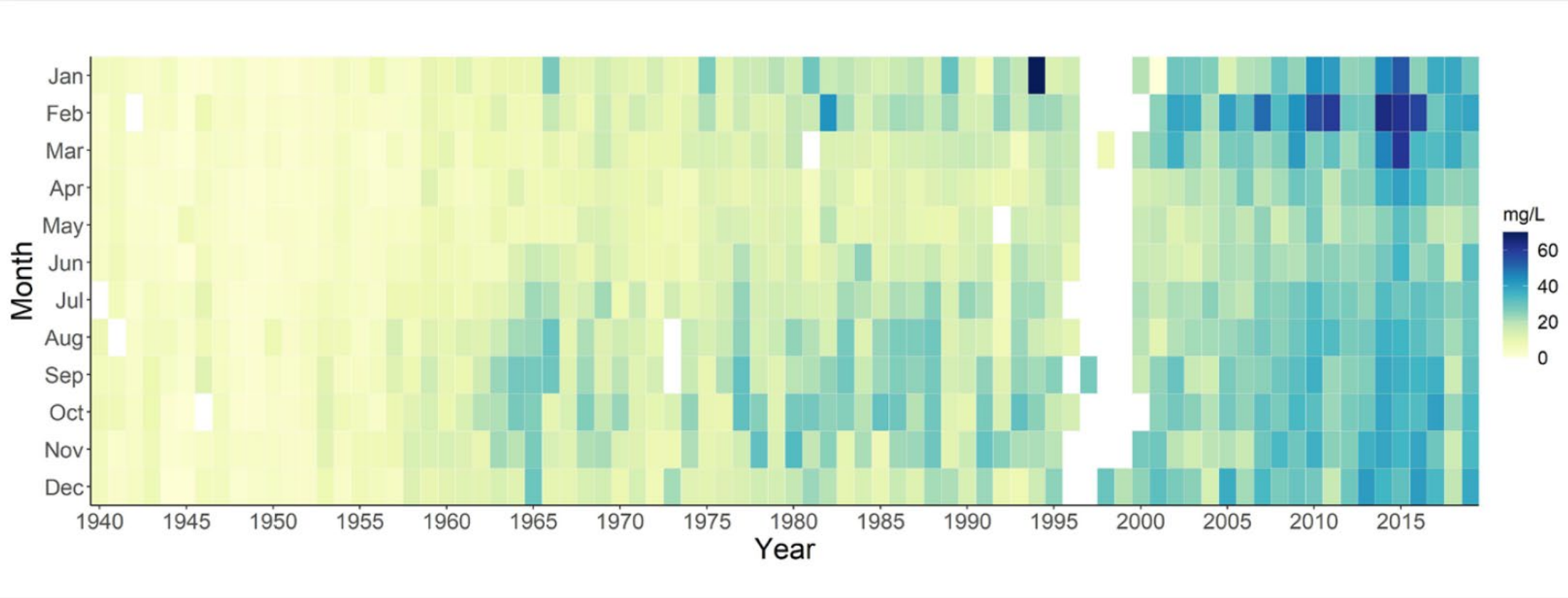


ICPRB photos

Contaminants

Chloride as in Salts such as Sodium Chloride (NaCl)

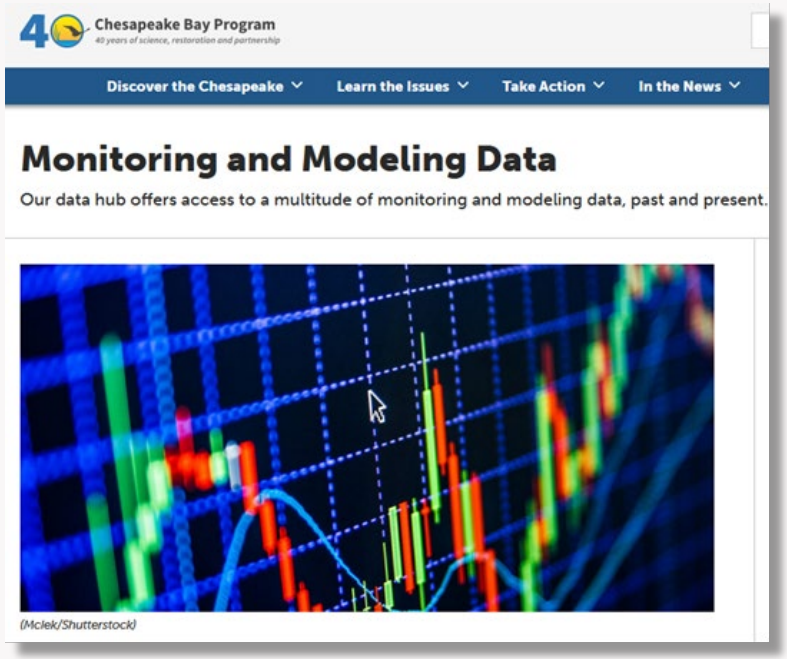
Report Link



Potomac River at Little Falls

(Army Corps of Engineers, Washington Aqueduct raw water data,1940 -2019)

Actions



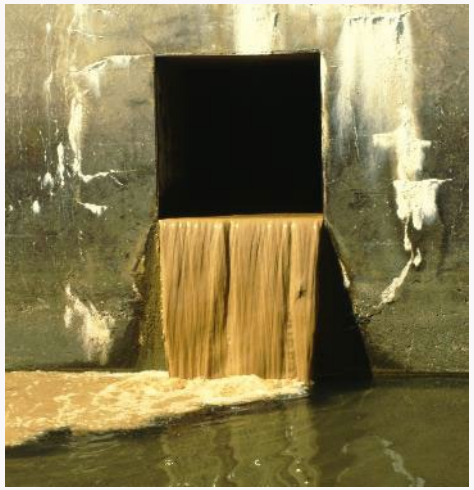
Water quality information

Phosphate detergent ban
Article by Sen. G. Winegrad, Capital Gazette Feb 20, 2021

Wastewater treatment plant upgrades *Photo: Harrisburg WWTP*

Tree plantings
ICPRB Photo

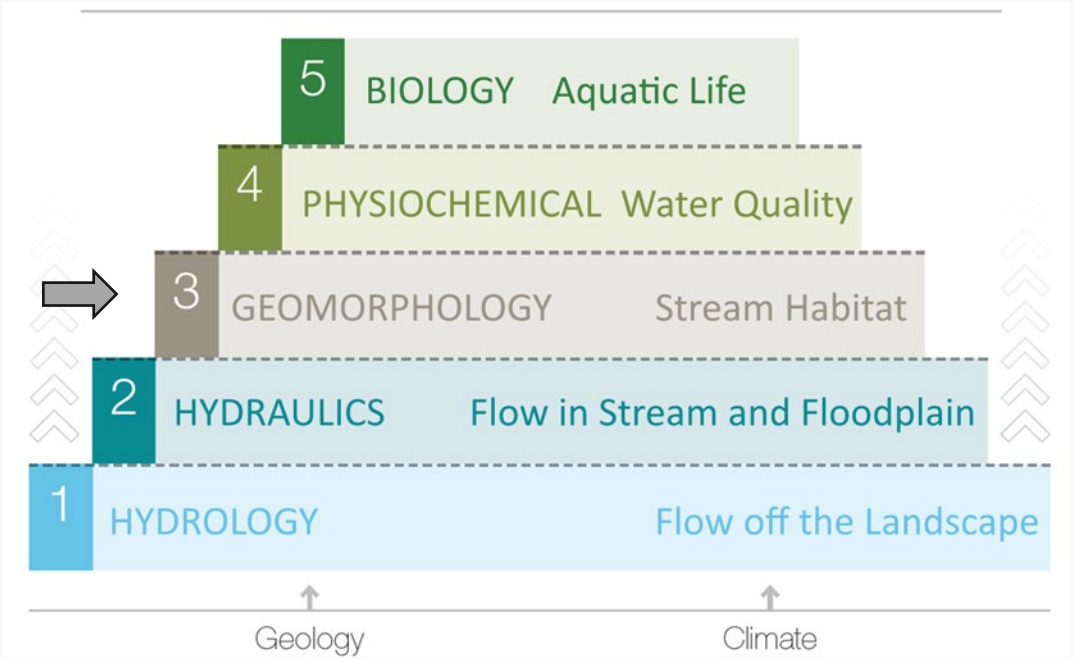
Emission controls *EPA photo*



Combined sewer outfalls redirected *ICPRB photo*

Lime dosers
ICPRB photo

3 Geomorphology

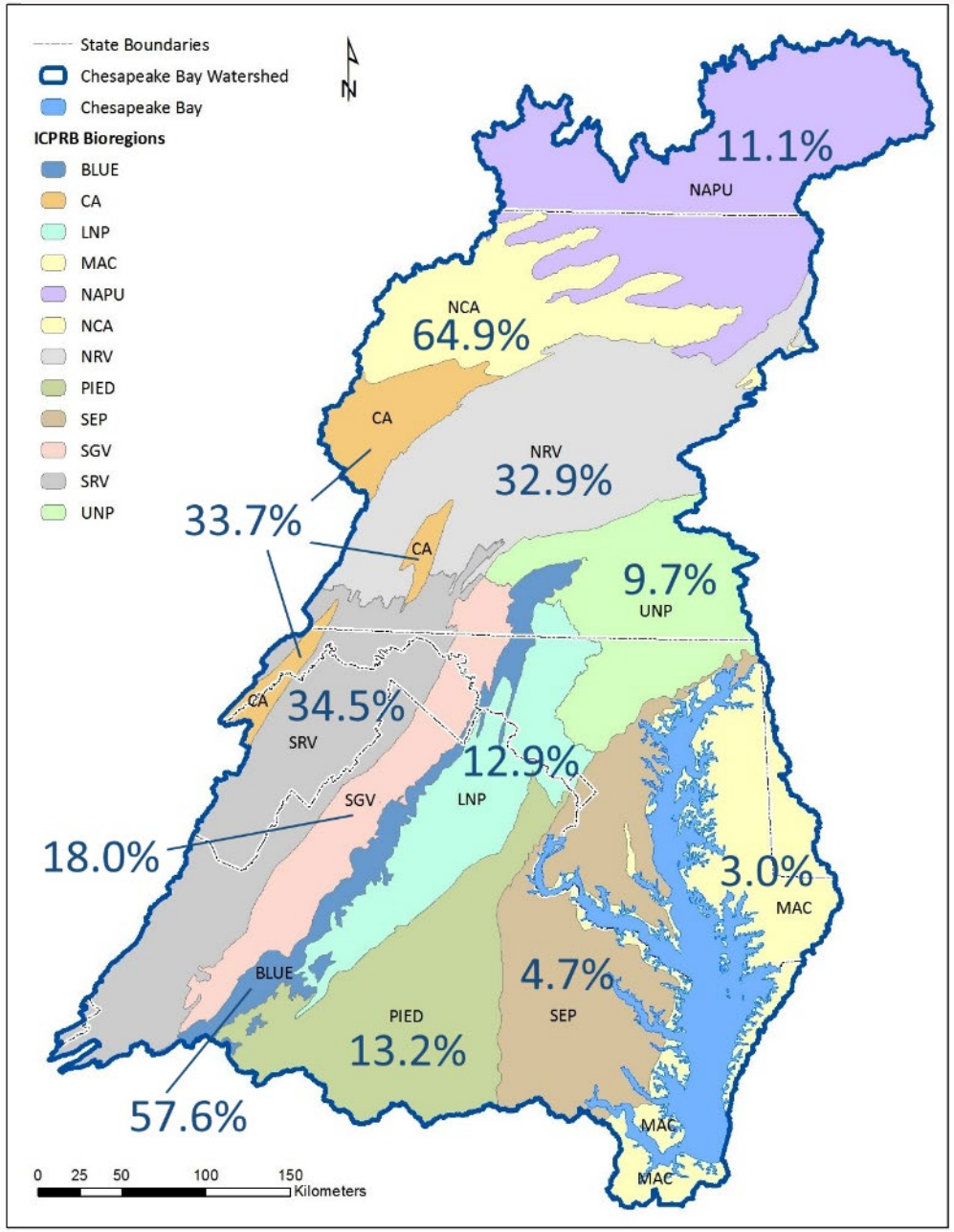


Degraded Stream Habitat

- Rapid, erosive stream flows
- Intentional changes (dams, culverts, hardened banks, buried streams, riparian loss, ditching…)
- Legacy sediments

Photo: Maryland DNR (2001) Stream Corridor Assessment Survey

Current percent of **highest quality ("reference")** sampling sites



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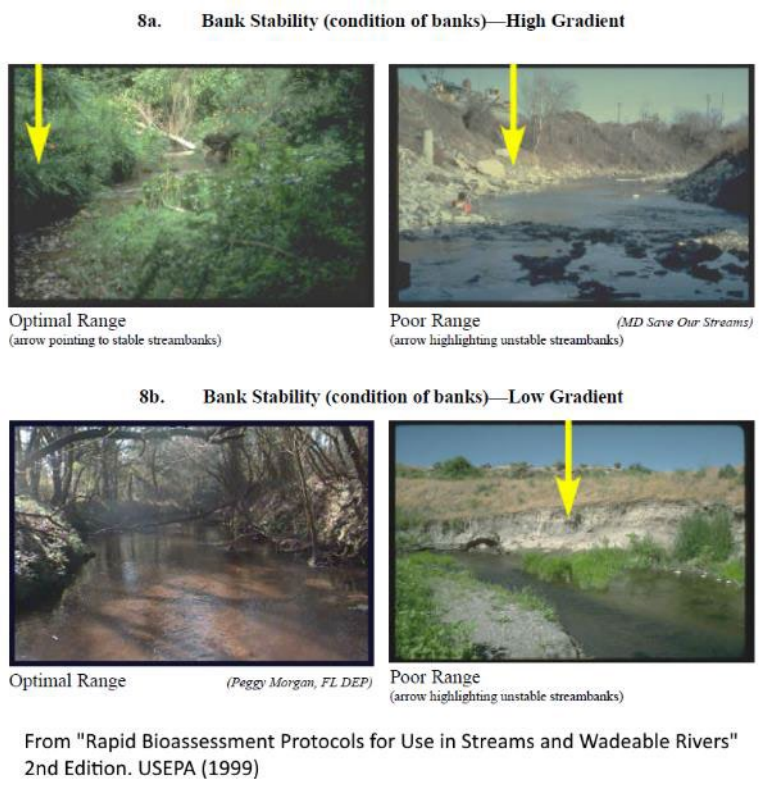
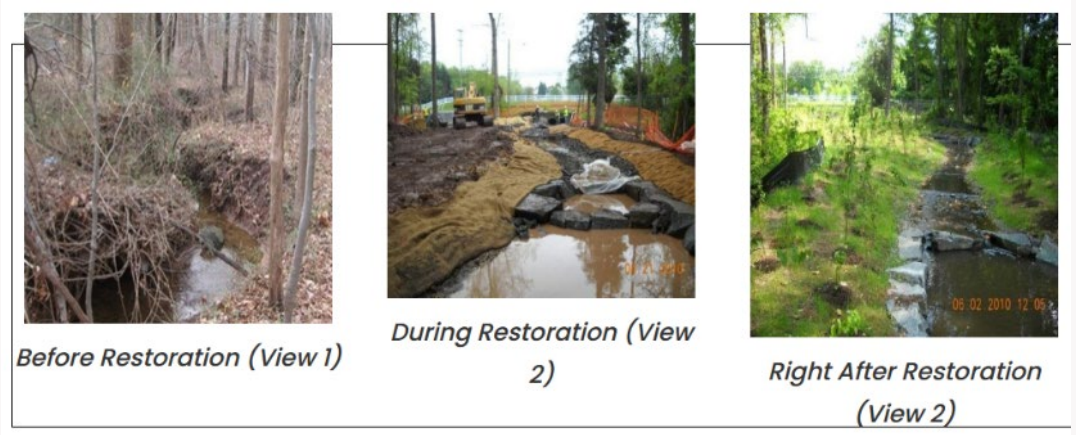


Stream habitat information

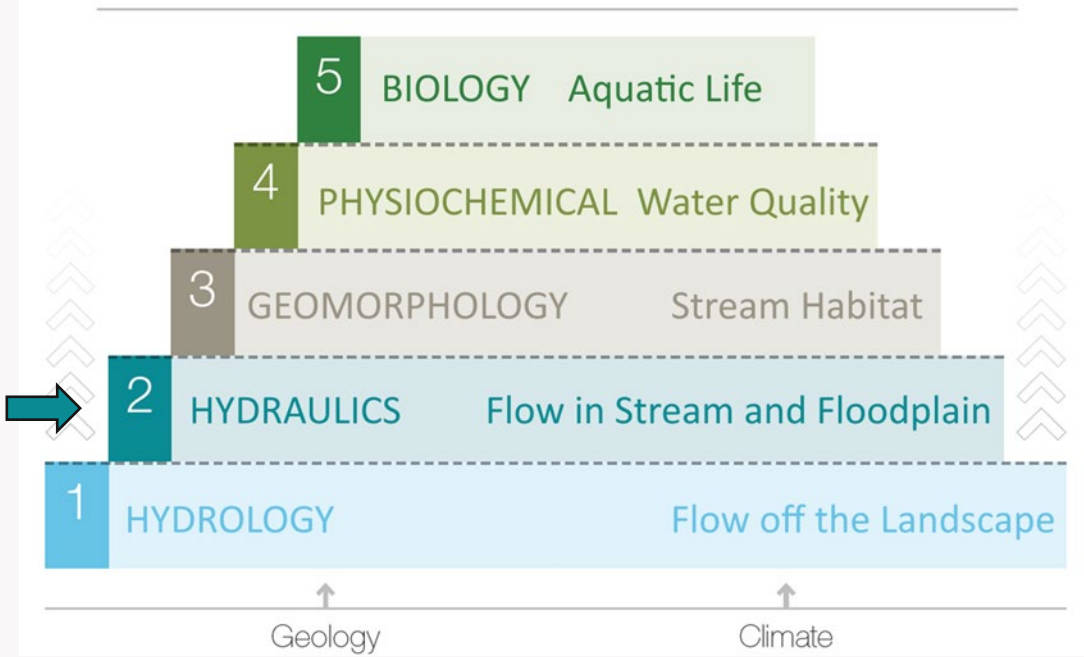
Riparian buffers *Friends of the Rappahannock*



Stream restoration projects

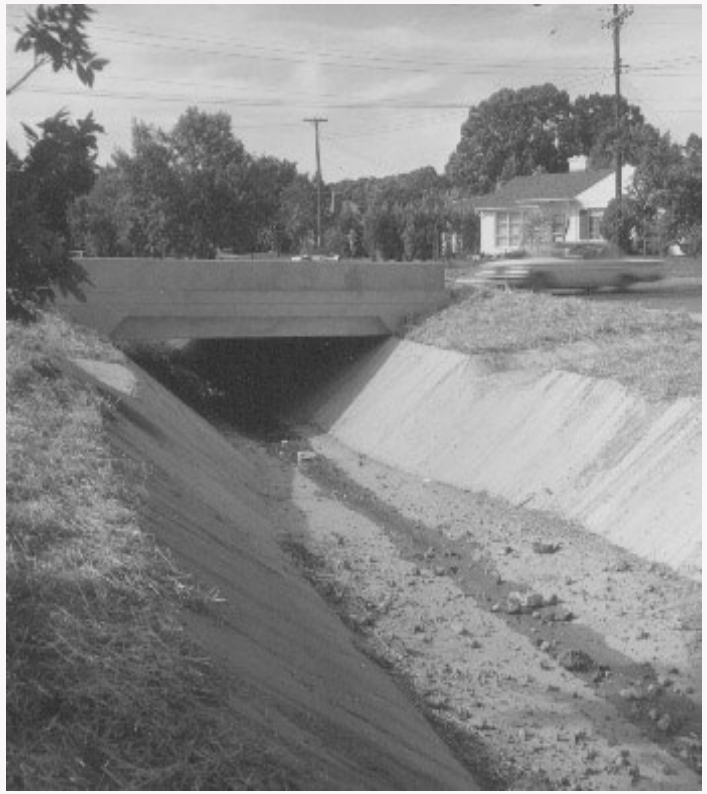
Fairfax Co. VA Stormwater Planning Division

2 Hydraulic


5
BIOLOGY Aquatic Life
4
PHYSIOCHEMICAL Water Quality
3
GEOMORPHOLOGY Stream Habitat
2
HYDRAULICS Flow in Stream and Floodplain
1
HYDROLOGY Flow off the Landscape
Geology
Climate

Altered Streamflow

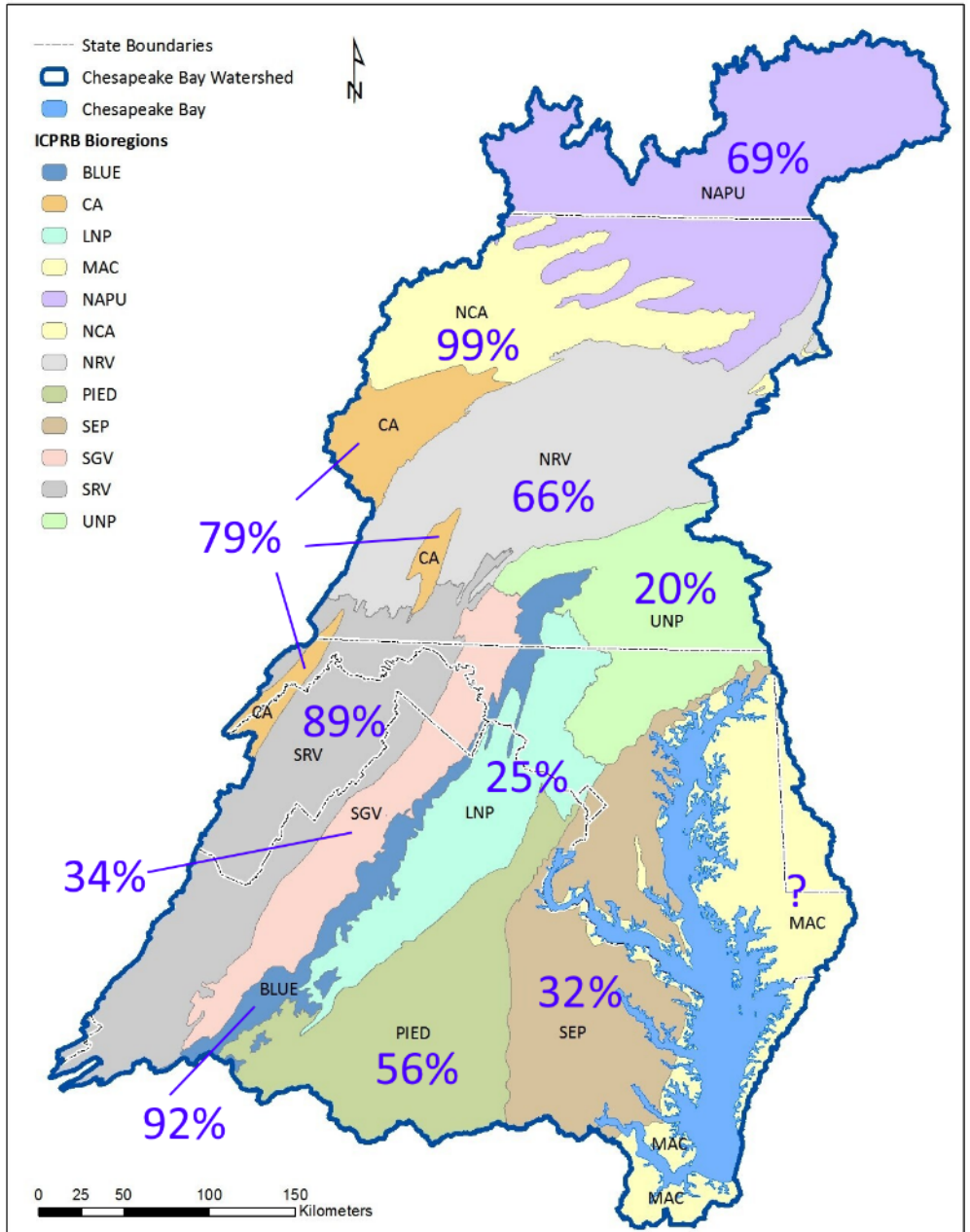
- Rapid surface runoff
- Large withdrawals and discharges
- Stream channelization and dams



Stream hardening/channeling

ICPRB photo, Washington DC

Current percent of catchments with **natural (unaltered)** streamflow



Actions

Streamflow information

Photo: USGS and Church stream gage, USGS

Flood prevention coupled with summer cold-water releases in places

Jennings Randolph lake and dam on the North Branch Potomac River. Operated by the ACOE. *Photo: Robyn Phillips Photography*

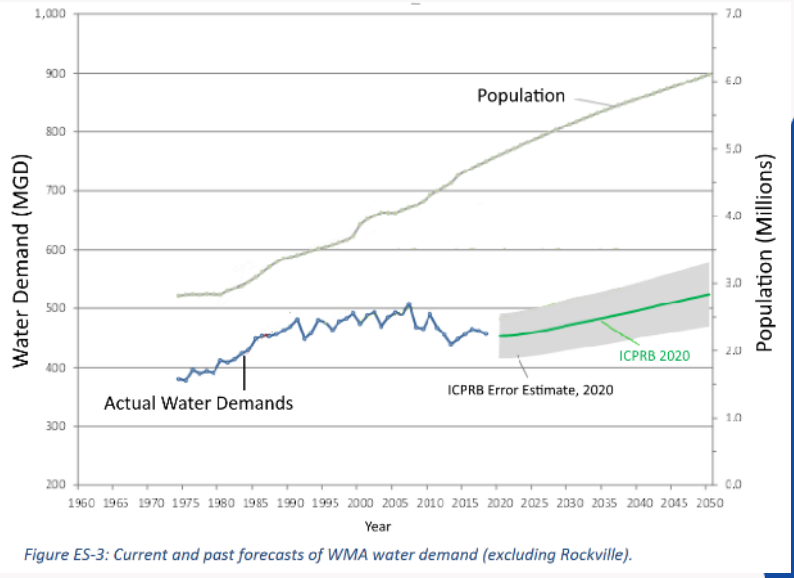


Figure ES-3: Current and past forecasts of WMA water demand (excluding Rockville).

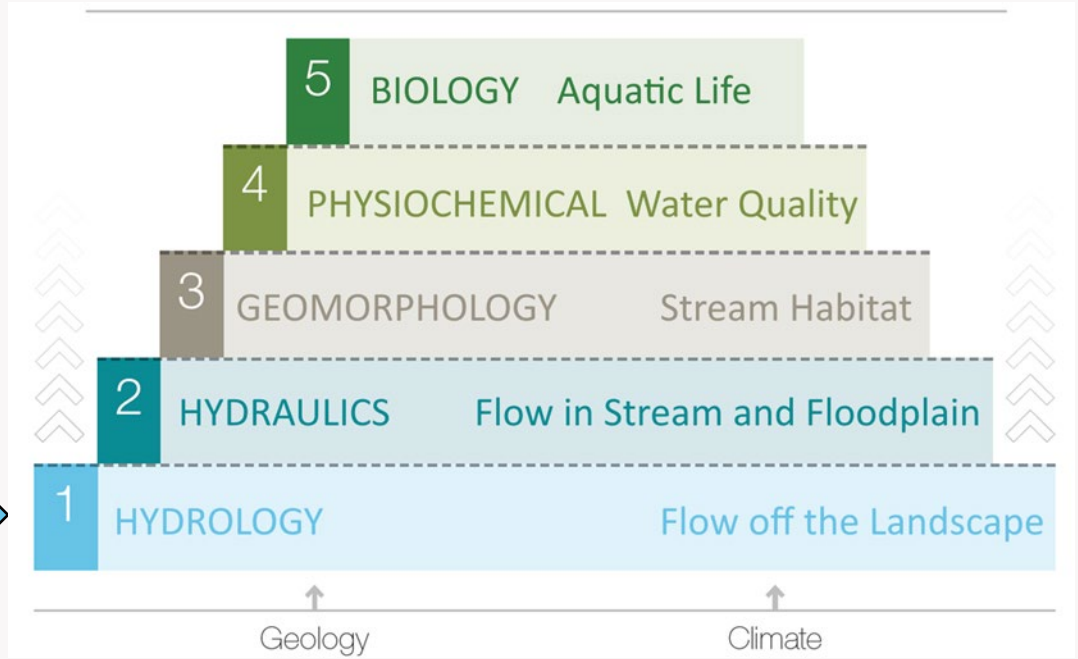
Water use per capita leveling off in many urban areas, including in the Washington Metropolitan Area (WMA)

ICPRB 2020 WMA water demand study

Reconnected floodplains reduce flooding

American Rivers

1 Hydrology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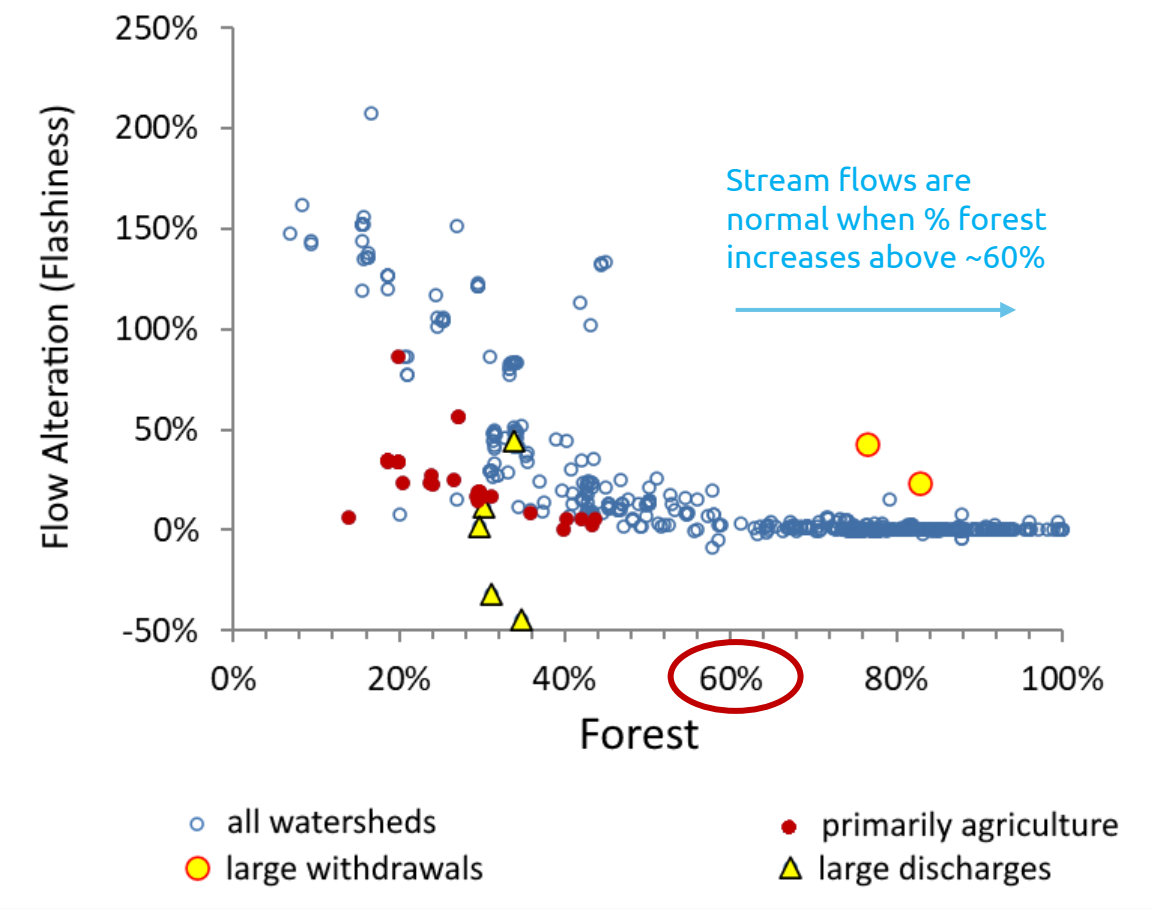
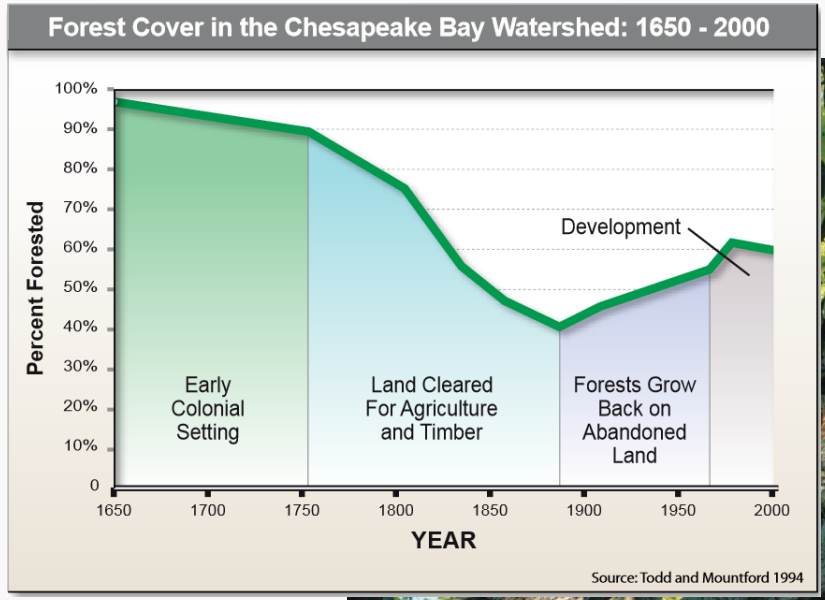
Forest Landcover

- Logging, agriculture, development, acid rain, fragmentation, diseases, climate change, poor soils



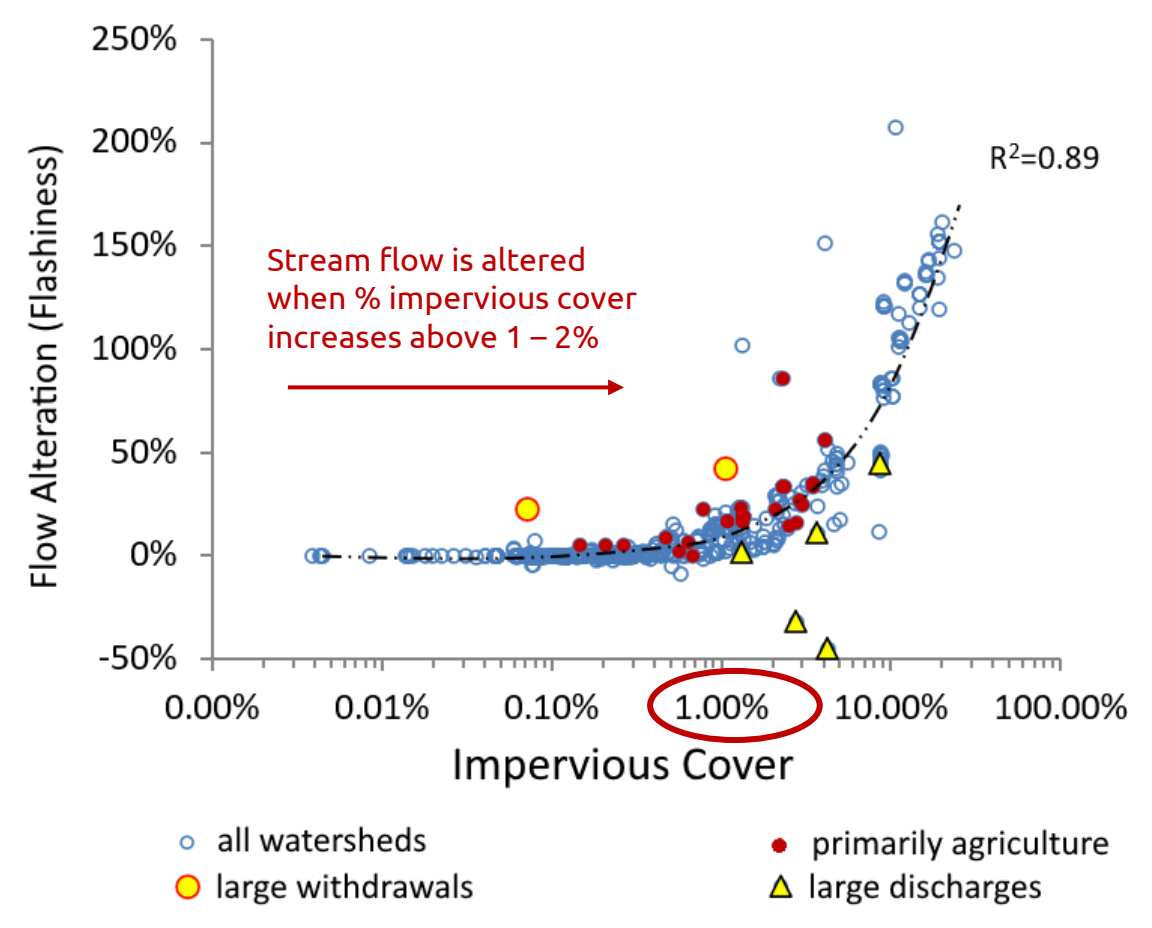
ICPRB Middle Potomac River Watershed Assessment (2014)



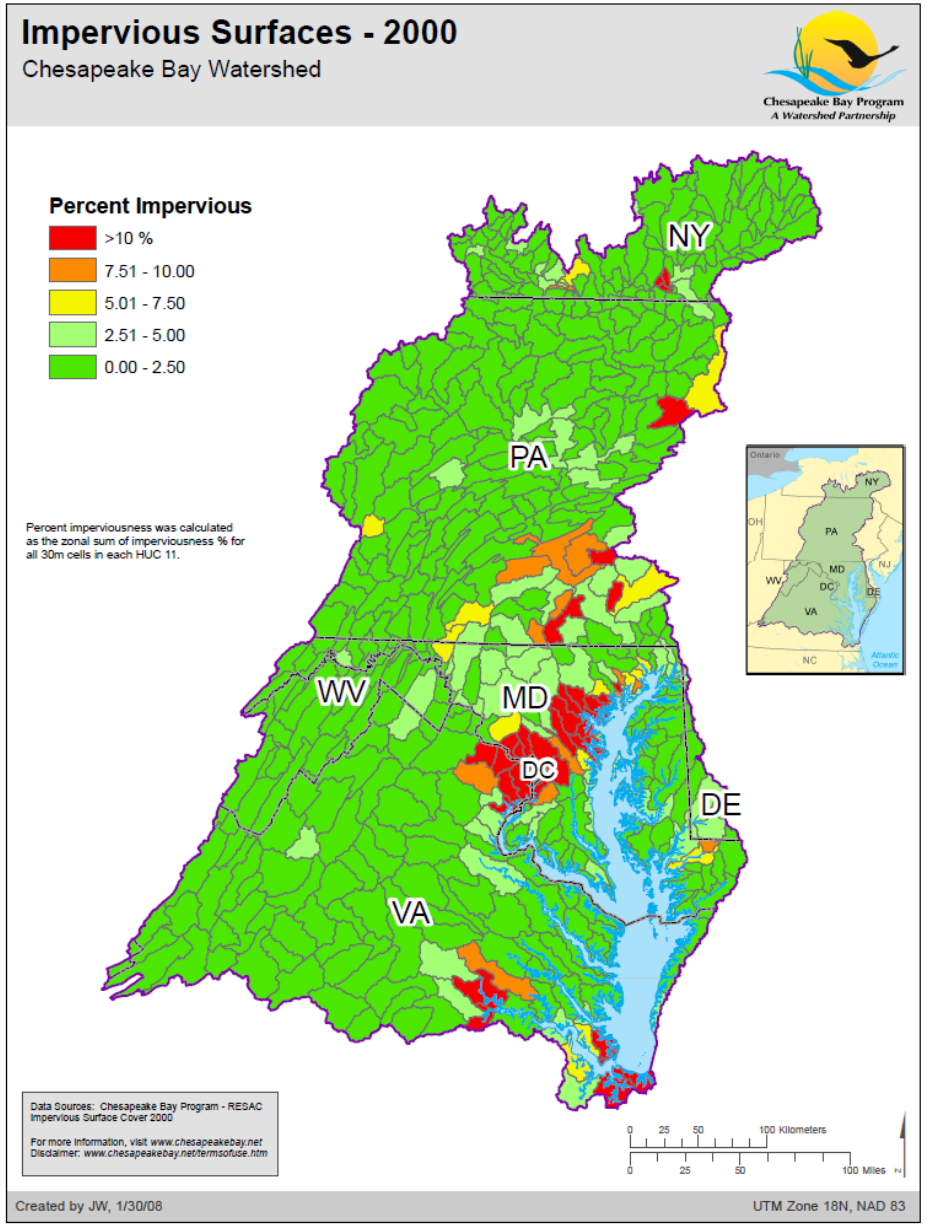
Report (2006)

Impervious Surface

- Development



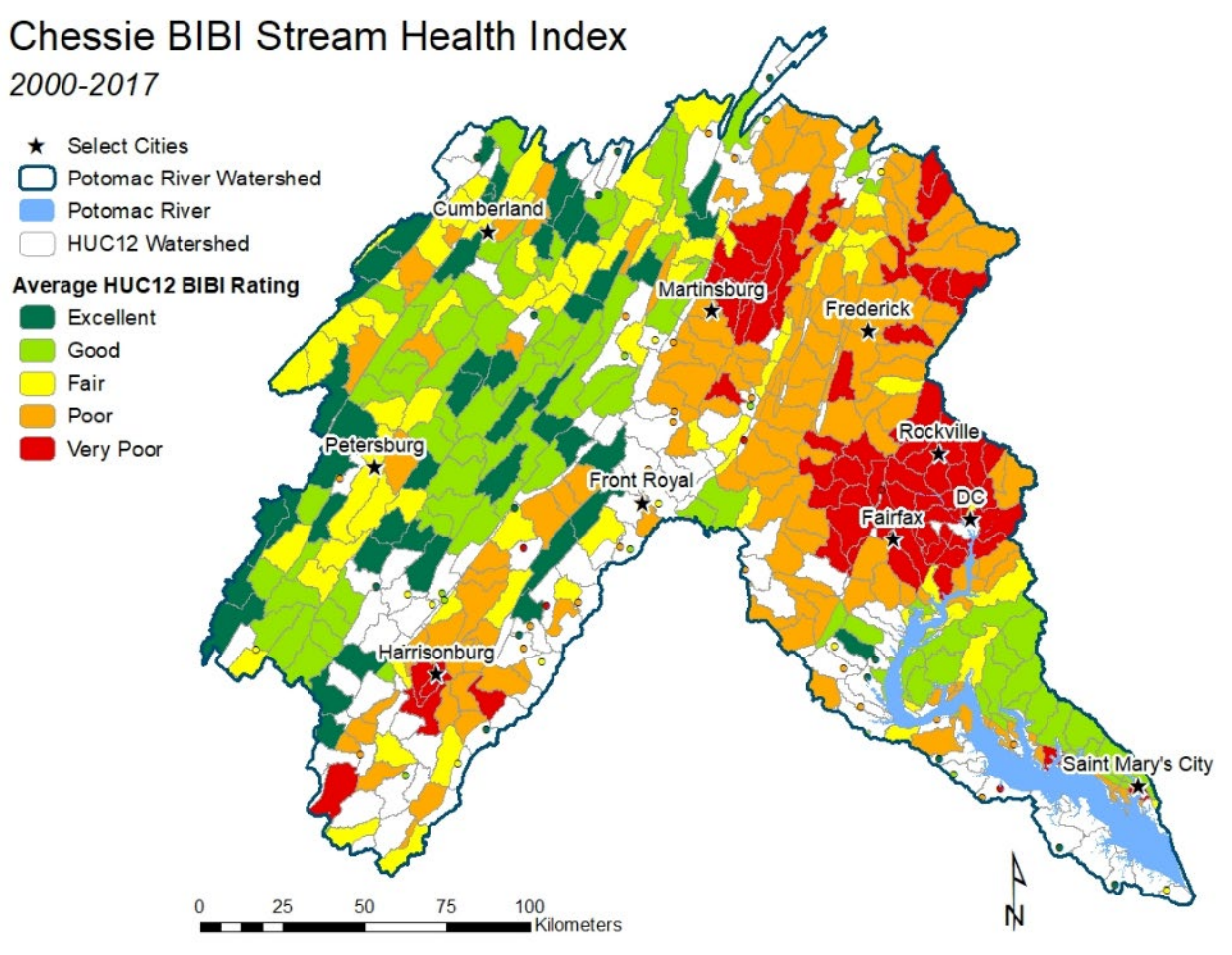
ICPRB Middle Potomac River Watershed Assessment (2014)



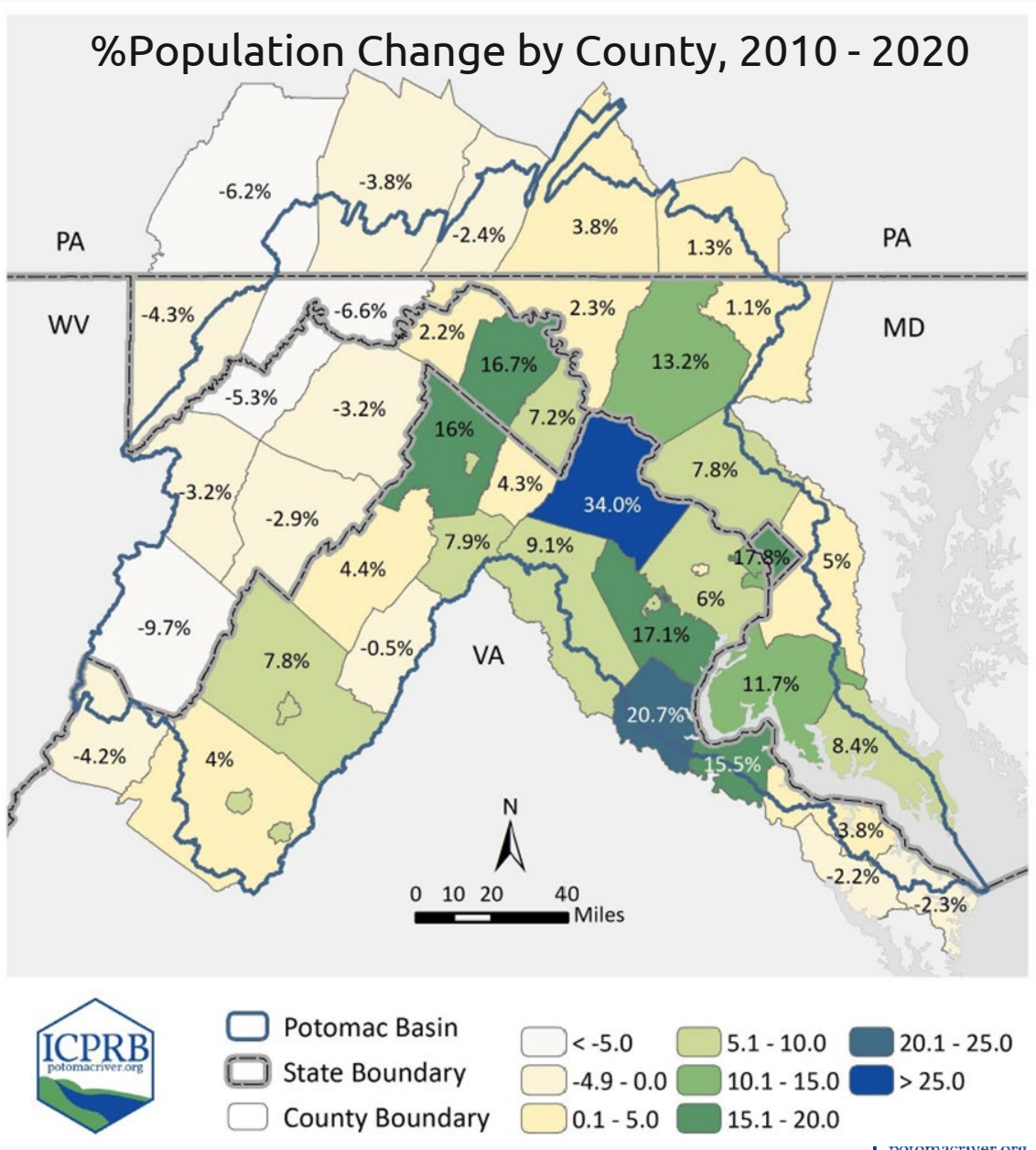
2013/2014 → 2017/2018 (4 years)
Increased 79.1 square miles (+0.12%)

Very-High Resolution Land Use/Land Cover and Change Data

Population Shifts



e.g., Potomac River Basin



Potomac River Basin Comprehensive Plan
(2023 update) *ICPRB* www.potomacriver.org

Actions

Forest management/preservation

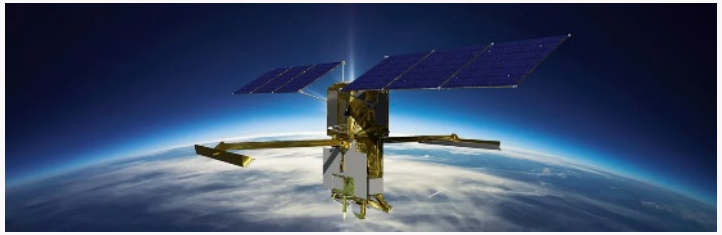
Catoctin Front, ICPRB photo

Agricultural reserves

Montgomery Co. MD, ICPRB photo

Green infrastructure

Photo: American Society of Landscape Architects, Washington DC



Land use/cover information

Surface Water and Ocean Topography satellite

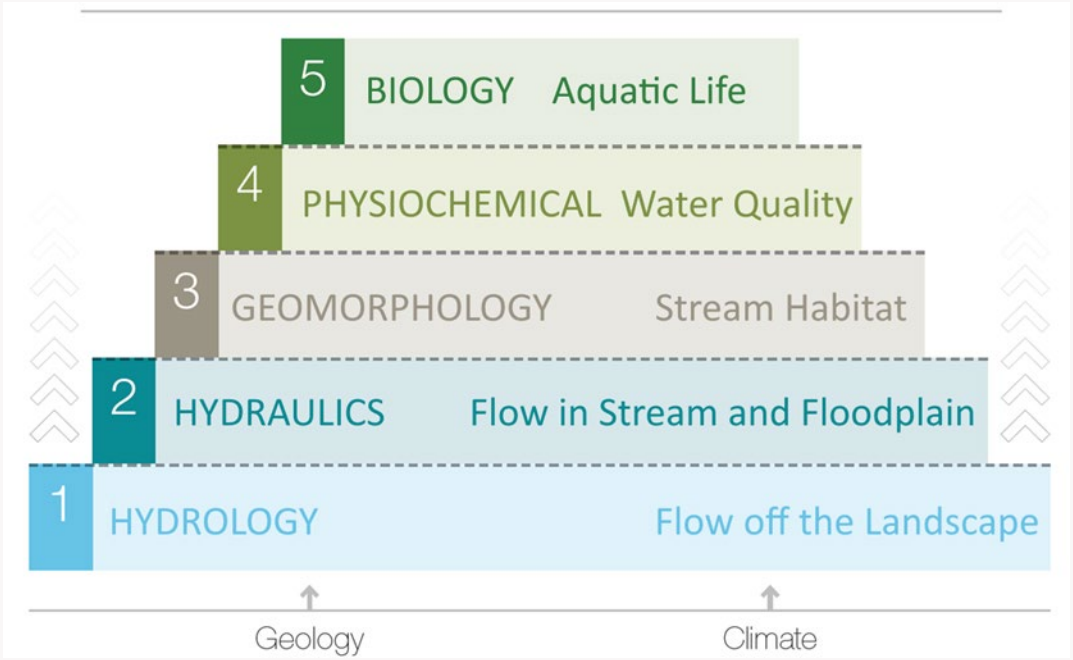
Stormwater ponds

Frederick Co. MD, ICPRB photo

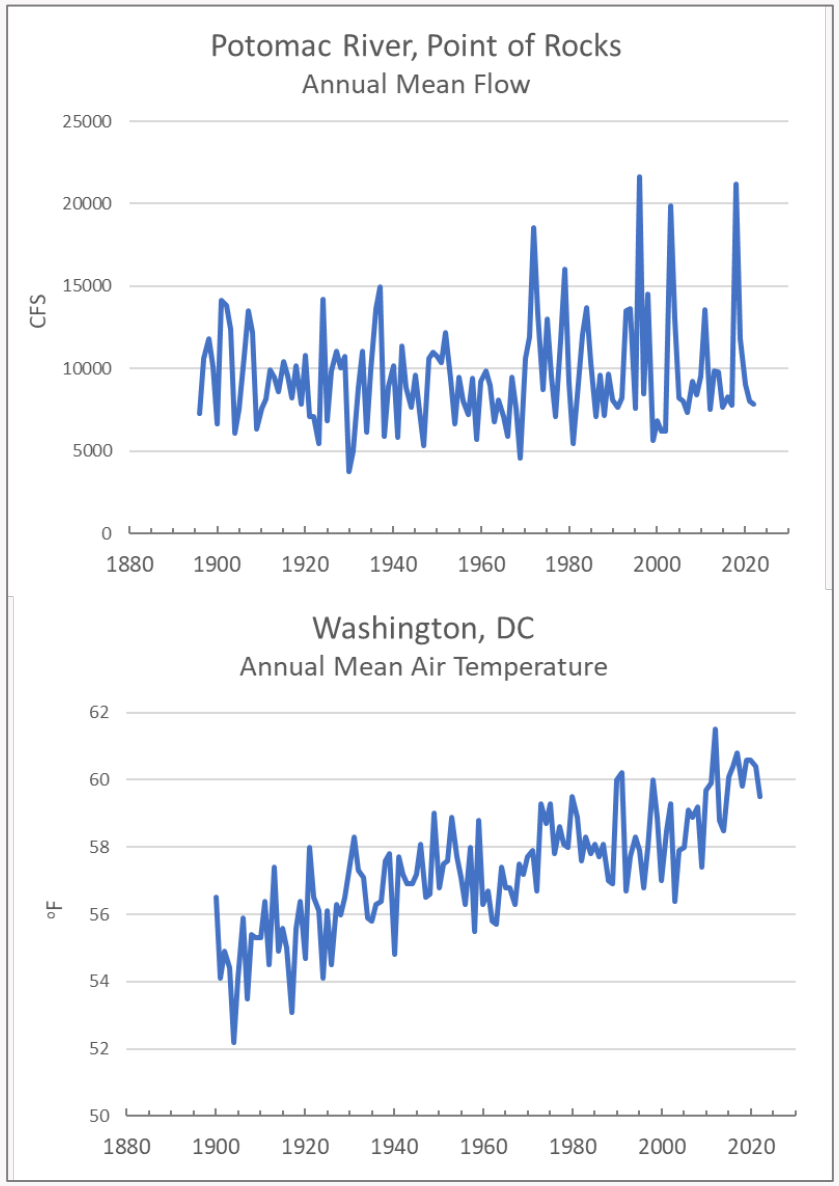
Wetland protection/creation

Photo: Anne Arundel Co. Soil Cons.

Geology and Climate



Climate Change



Population Growth

versus

Climate Change?

- **Future growth & development** will have a much **greater negative impact** on stream macroinvertebrates in the next decades **than climate-related precipitation and temperature changes**.
- It may take **improving 11% - 26.2%** of stream miles **to counter** the combined impacts of **future development *and* climate change** and sustain achievement of the 10% goal [for macroinvertebrates].

Maloney et al. (2020)

Some Governmental Policies Driving Improvement

- Federal Clean Air Act, EPA - air quality standards, emission regulation, emission control technology, enforcement
- Federal Clean Water Act, EPA – Sec. 106 funds, Pollutant Discharge Elimination System (NPDES), stormwater control (MS4), wastewater standards, Chesapeake and state TMDLs
- Federal Surface Mining Control and Reclamation Act (SMCRA) - Lime dosers, abandoned mine lands reclamation, active coal mine regulation
- Department of Agriculture, Forest Service – forest preservation, management, planting programs
- Department of Energy - appliance and equipment standards for conserving water and energy
- Federal incentive programs – tax credits
- CBP Agreement goals -
  - Riparian buffers
  - Fish passages
  - Wetland restoration
  - Stream restoration
  - Trash cleanups
  - Local leadership
- State water quality standards – Water quality criteria for aquatic life in non-tidal waters (turbidity, DO, chla, pH, SpCond, metals, bacteria), reporting requirements (Integrated Reports)
- State and local regulations and codes - Sewer and septic, sediment runoff prevention, forest conservation, phosphate detergent ban, etc.
- State Watershed Implementation Plans (WIPs)
- State mitigation programs – AMD, Salt Management Plans (NoVA, MD)
- State incentive programs – tax credits,
- County – MS4 stormwater controls

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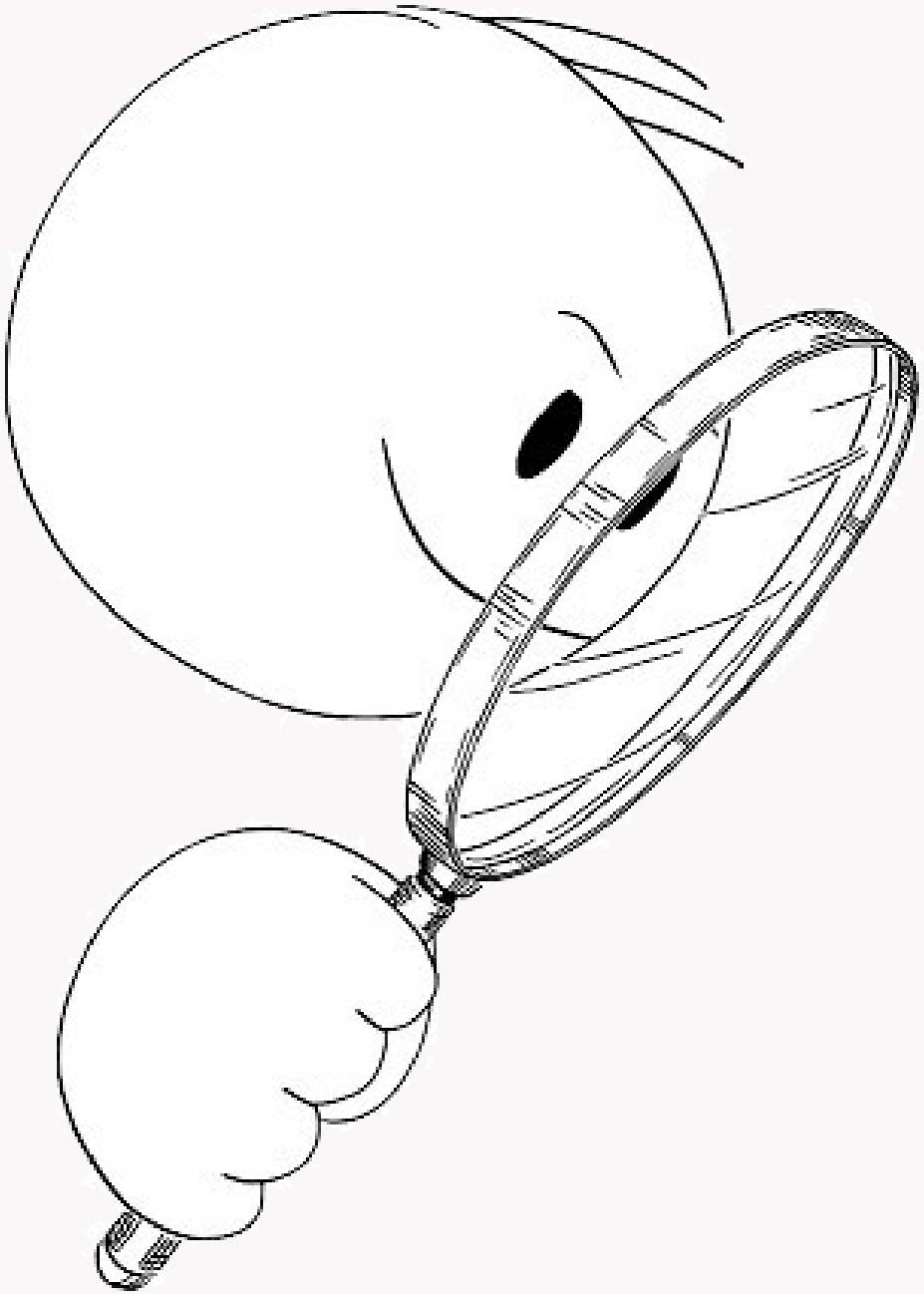
Use Index to Adapt Management



Stream macroinvertebrates are **<u>response</u>** indicators

1) “Trust but verify”

- Identify management approaches that truly restore and protect streams and actually improve **index** scores

2) Plan & implement strategically

- Use monitoring information to identify dominant stressors, then identify where restoration and protection can improve **index** scores (achieve “lift”)

3) Review often

- Were policies and restoration practices really implemented? Enforced? What should be done better? Did the **index** improve?

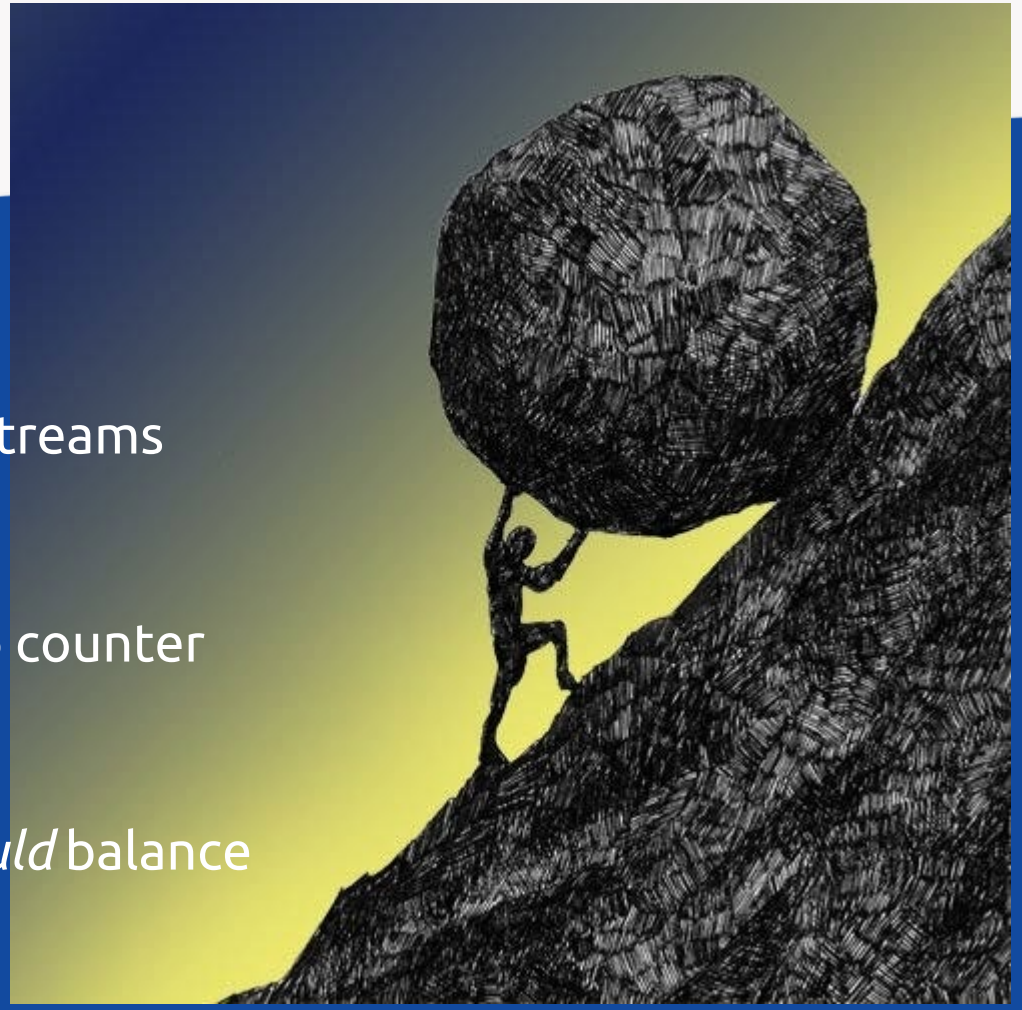
Sampling the Cacapon River, WV at dusk

Some closing thoughts…

The biological improvement seen in many headwater streams may be foreshadowing a Bay recovery

Population growth and climate change will continue to counter CBP restoration and protection efforts going forward

Committed, informed land and water management *could* balance these impacts and sustain resilient, desirable streams



More information: Website: bit.ly/chessiepage Interactive map: bit.ly/chessiemap

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