Expanding the Chesapeake Bay Watershed report card to include social, economic and environmental justice indices

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Integration and Application Network
University of Maryland Center for Environmental Science

STAR Meeting

26 July 2023

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Began using report cards in Southeast Queensland in the 1990s

MarineBotany
The University of Queensland

HEALTHY WATERWAYS

Because we're all in the same boat

SECTION 6

A report card for the whole Moreton Bay catchment

Test Site 1 – Bramble Bay	F
Test Site 2 – Southern Deception Bay	C→D
Test Site 3 – Northern Deception Bay & Pumicestone Passage	C→D
Test Site 4 – Waterloo Bay	C
Test Site 5 – Caboolture River	C
Test Site 6 – Bromer River	F
Test Site 7 – Southern Moreton Bay	C→B
Test Site 8 – Eastern Moreton Bay	A
Whole of Moreton Bay catchment	B

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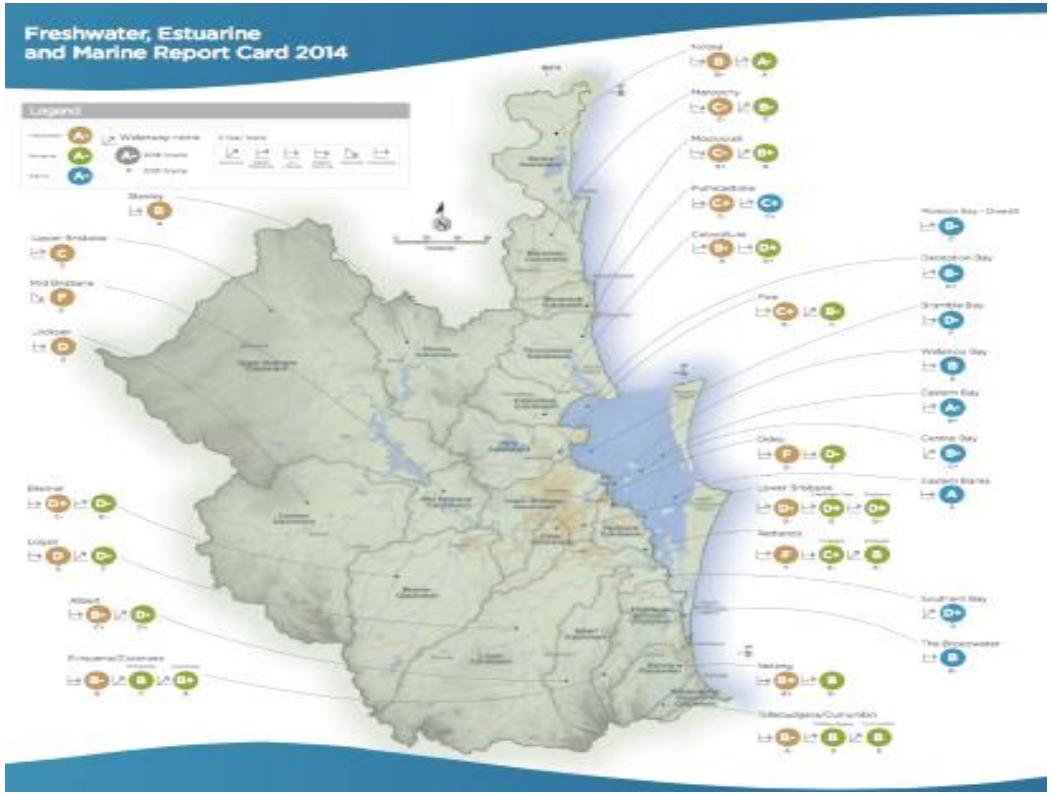
Report cards generated media attention

Report cards expanded throughout Australia



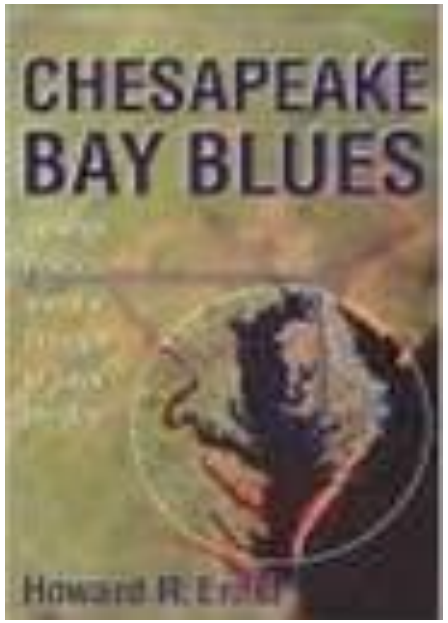
Chesapeake Bay had data, but no synthesis

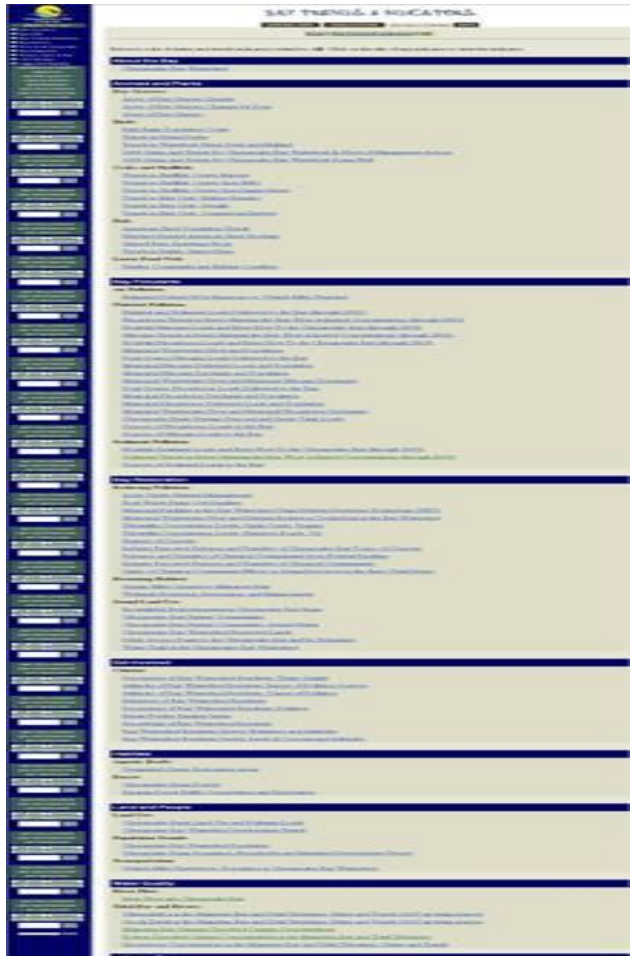

Hamilton Leads Els by One in British Open

The Washington Post

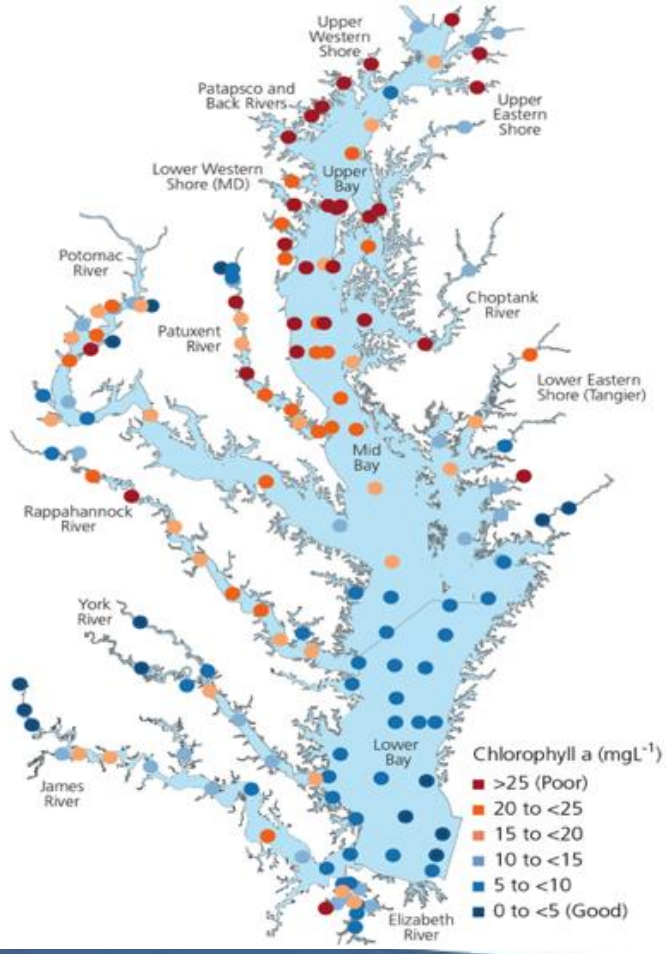
Bay Pollution Progress Overstated

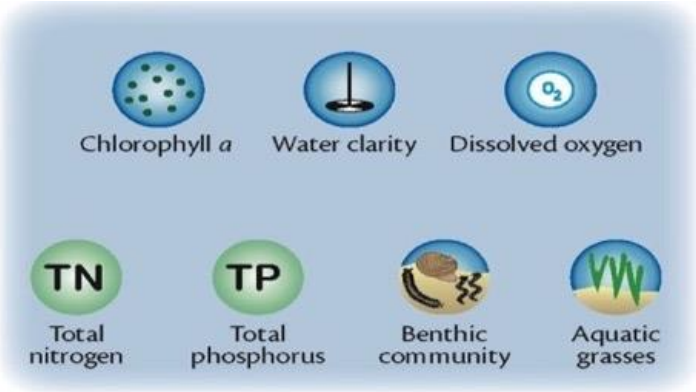
Government Program's Computer Model Proved Too Optimistic

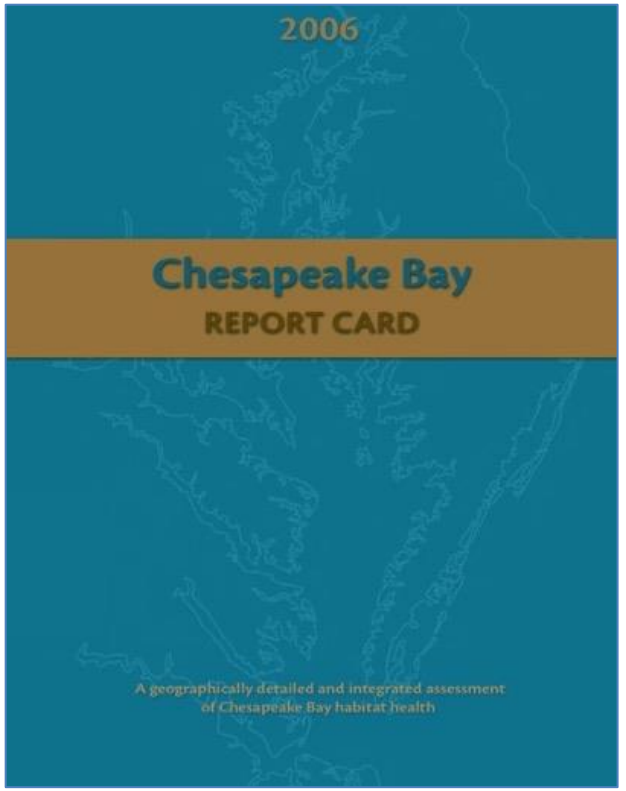




Initial Chesapeake Bay report card produced

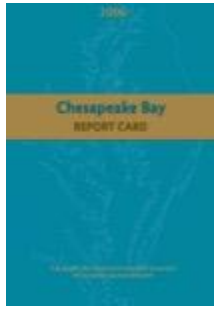


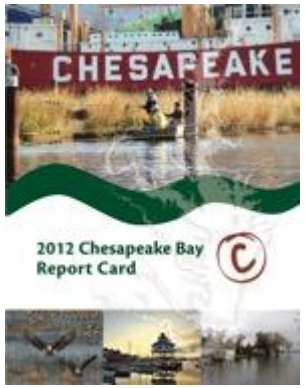


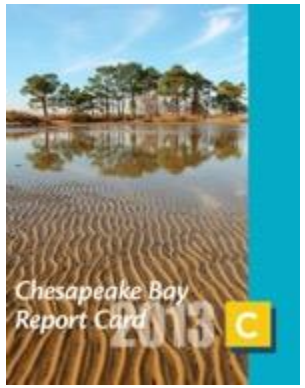


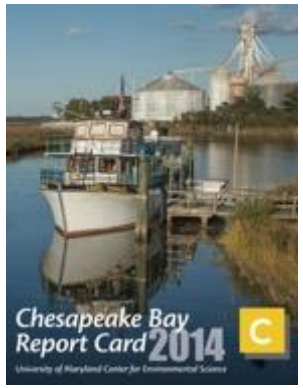
Initial Chesapeake Bay report card

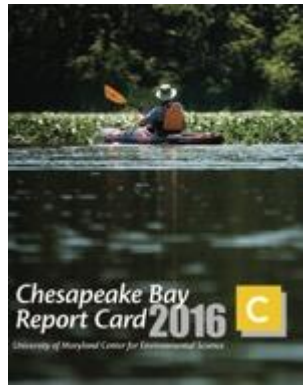
IAN-UMCES has been producing the Chesapeake Bay report card annually since 2007

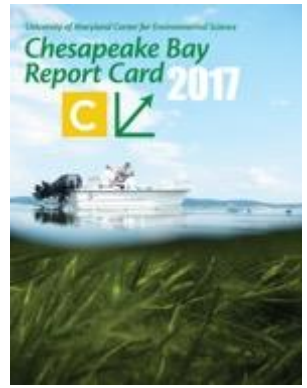




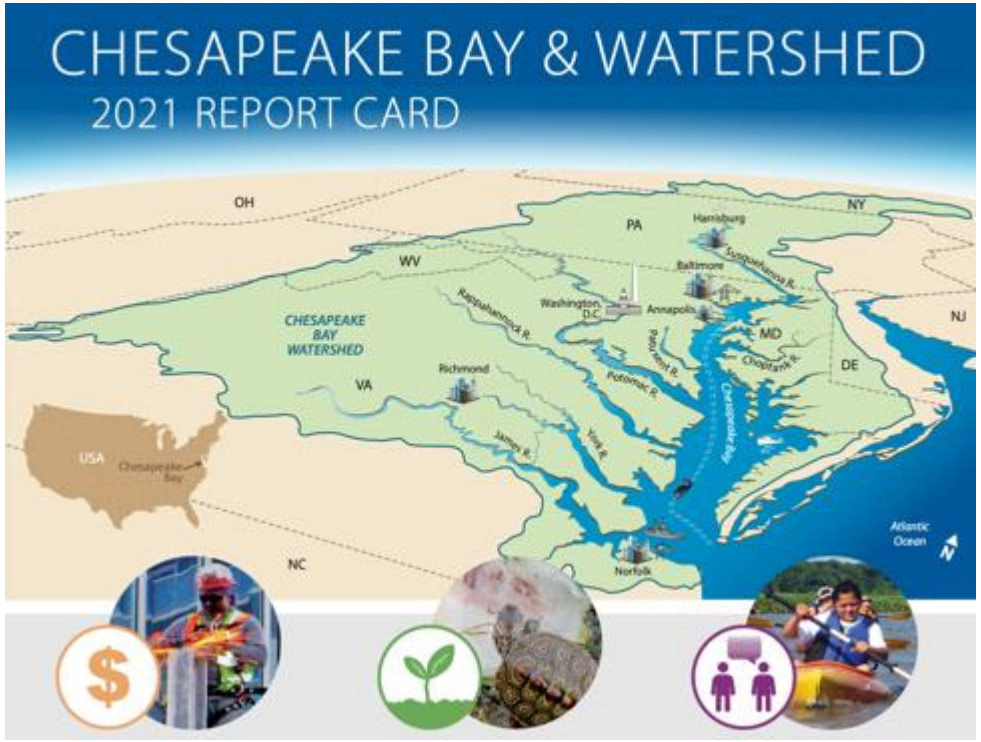








Chesapeake Bay Watershed report card since 2019



Chesapeake Bay & Watershed Report Card 2022

Bay Indicators

Total phosphorus measures the amount of phosphorus in bay waters.

Total nitrogen measures the amount of nitrogen in bay waters.

Dissolved oxygen is critical to the survival of aquatic life.

Benthic community measures the condition of organisms living in or on the bottom areas of the bay.

Water clarity is a measure of how much light penetrates through the water column.

Chlorophyll *a* is used as a measure of phytoplankton (microalgae) biomass.

Aquatic grasses, or submerged aquatic vegetation, are one of the most important habitats in the bay.

Fisheries index is made of up striped bass, bay anchovy, and blue crab. It is not included in the Bay Health score.

Watershed Indicators

Economic

Median household income is a traditional measure of economic vitality and uses data from the U.S. Census.

Jobs growth measures the percentage of jobs gained or lost (net) per capita from the past four years.

Income inequality uses the Gini coefficient that measures the inequality in income distribution.

Housing affordability measures how much housing is available at a cost that people can afford based on their income.

Ecological

Water quality indicators include total phosphorus and total nitrogen.

Stream benthic community measures the condition of the organisms living on the bottom of streams.

Protected lands measures the amount of all lands protected in the watershed.

Fish community, an index developed by the EPA, examines river health in categories including native species and pollution tolerance.

Societal

Stewardship index examines citizen stewardship in categories of behavior, volunteerism, and civic engagement.

Heat vulnerability index indicates climate-safe neighborhoods and includes metrics for tree canopy, impervious surface, land surface temperature, and households in poverty.

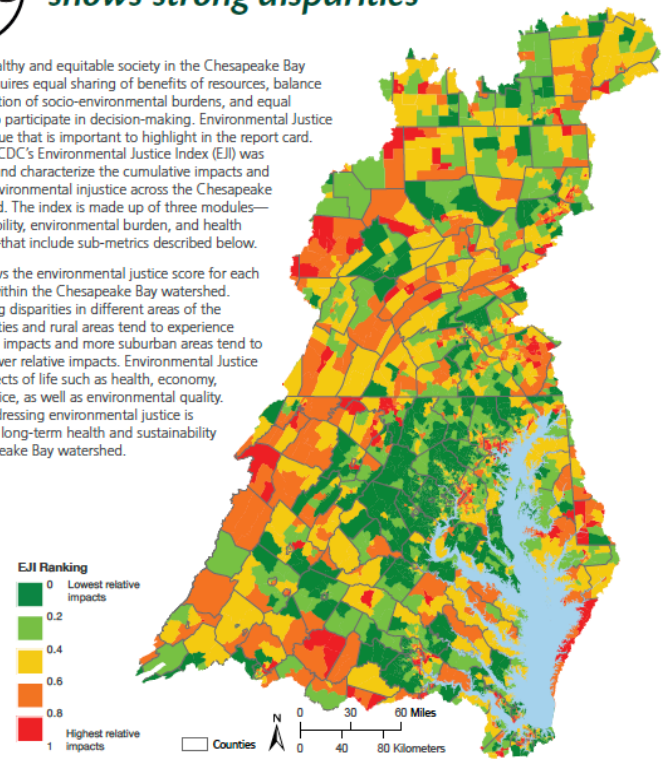
Social index uses data about social vulnerability from the U.S. Census and measures how a community can respond to hazardous events.

Walkability measures how many people can walk to a park in 10 minutes and includes metrics for the total population and for diverse groups.

New environmental justice index shows strong disparities

Creating a healthy and equitable society in the Chesapeake Bay watershed requires equal sharing of benefits of resources, balance in the distribution of socio-environmental burdens, and equal opportunity to participate in decision-making. Environmental Justice is a priority issue that is important to highlight in the report card. This year, the CDC's Environmental Justice Index (EJI) was used to map and characterize the cumulative impacts and patterns of environmental injustice across the Chesapeake Bay Watershed. The index is made up of three modules—social vulnerability, environmental burden, and health vulnerability—that include sub-metrics described below.

The map shows the environmental justice score for each census tract within the Chesapeake Bay watershed. It shows strong disparities in different areas of the watershed. Cities and rural areas tend to experience higher relative impacts and more suburban areas tend to experience lower relative impacts. Environmental Justice considers aspects of life such as health, economy, and social justice, as well as environmental quality. Therefore, addressing environmental justice is crucial for the long-term health and sustainability of the Chesapeake Bay watershed.



Social Vulnerability

- Racial/Ethnic Minority Status
- Socioeconomic Status
- Household Characteristics
- Housing Type

Environmental Burden

- Air Pollution
- Potentially Hazardous & Toxic Sites
- Built Environment
- Transportation Infrastructure
- Water Pollution

Health Vulnerability

- Pre-existing Chronic Disease Burden

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Chesapeake Bay and Watershed Report Card 2022 release event

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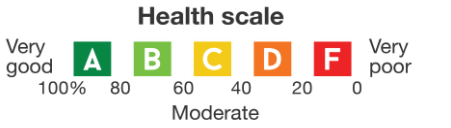
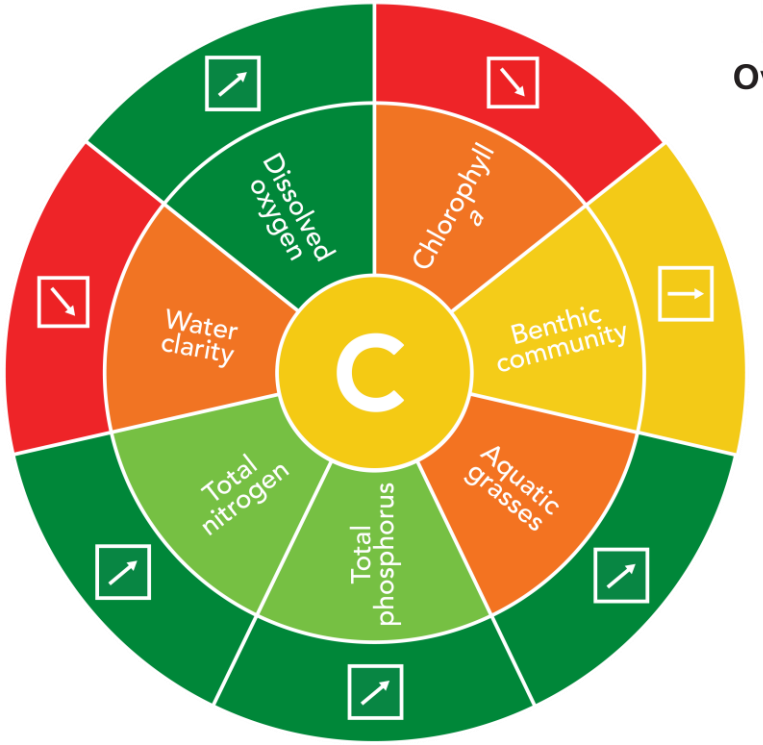
Chesapeake Bay and Watershed Report Card 2022 release event

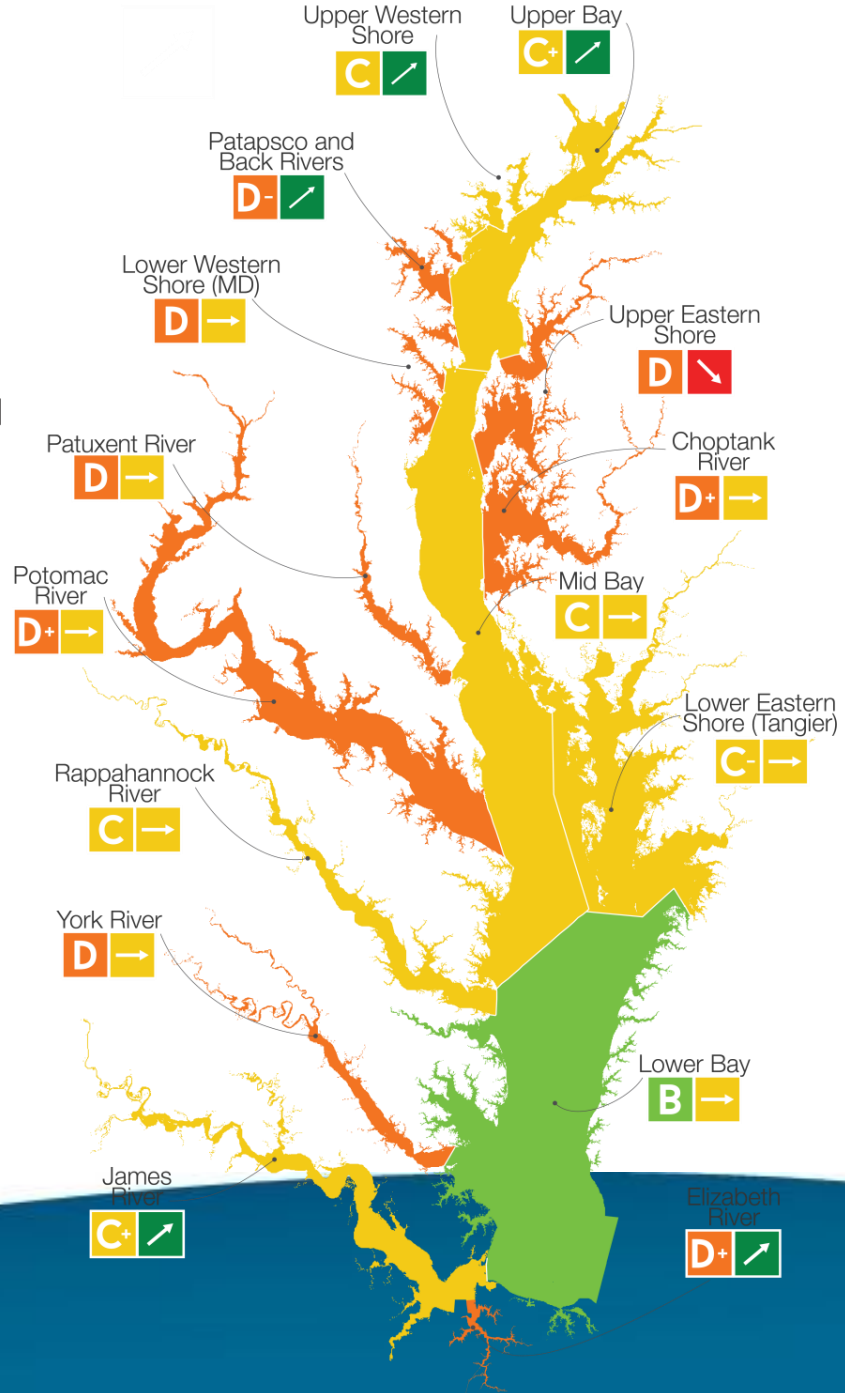
- **About 500 million media impression, highest ever**

Overall Bay score improving but most tributaries scored poorly





Overall Trend



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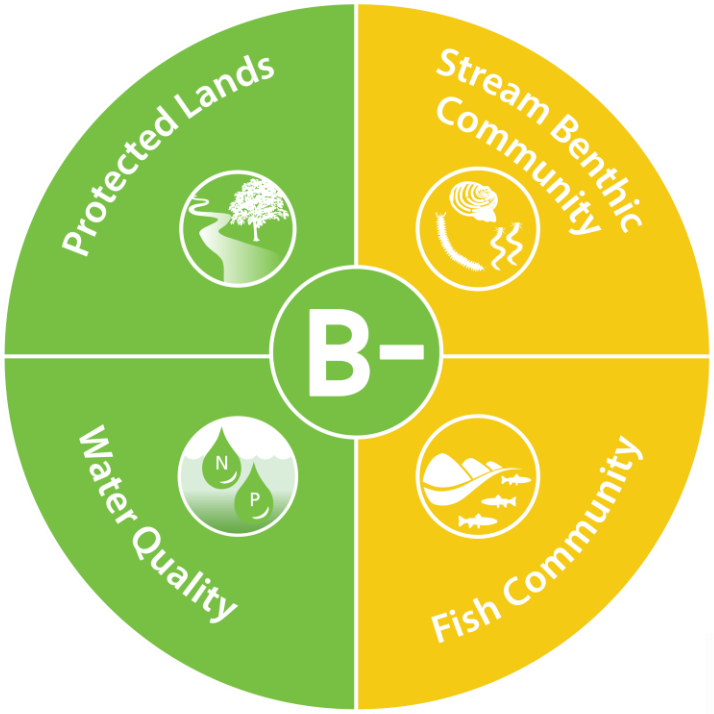
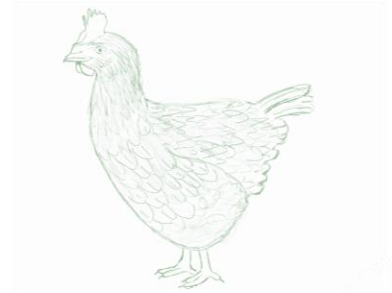
Overall good ecological conditions in the watershed





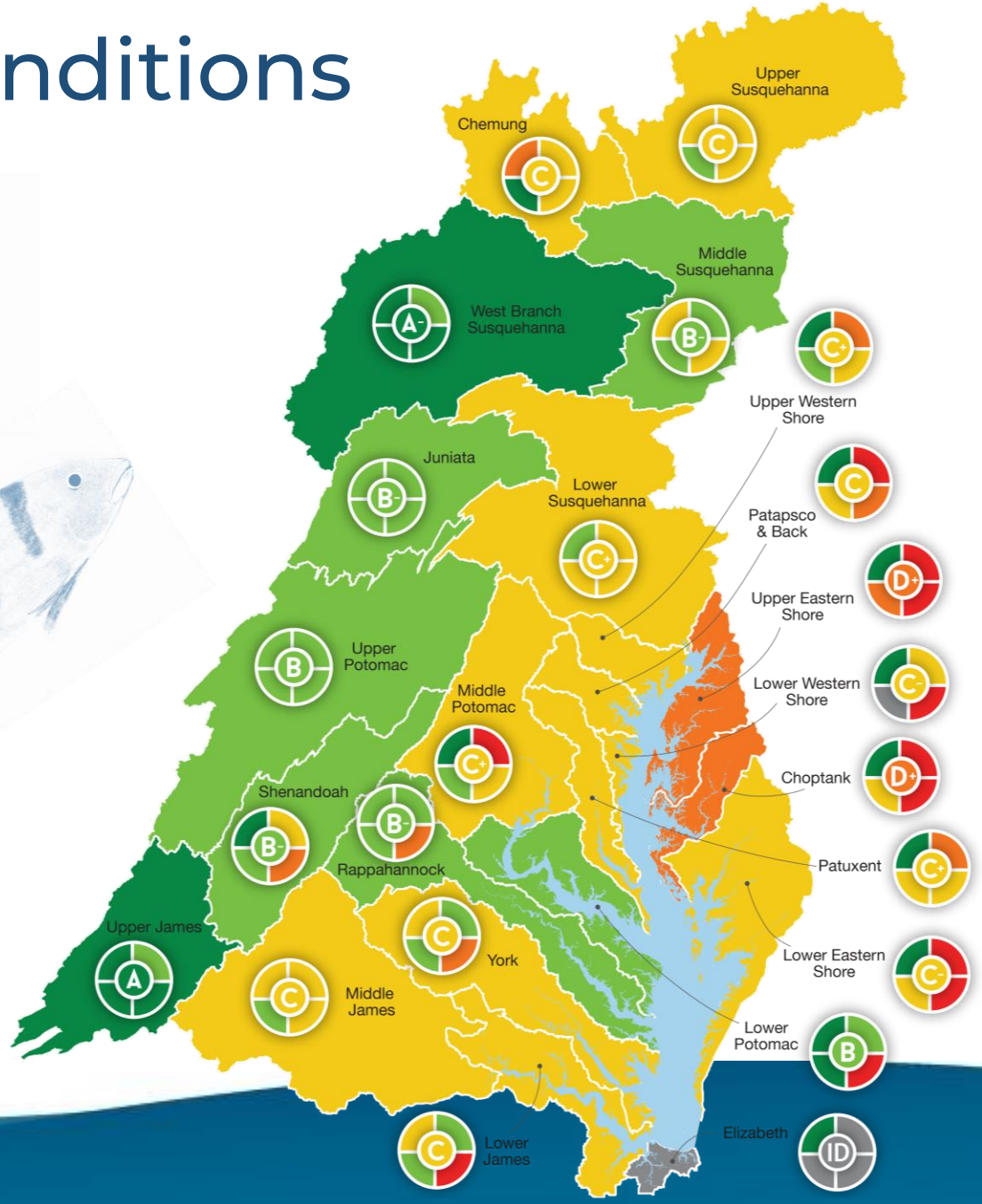
Health scale

Very good — A — B — C — D — F — Very poor — ID*

100% 80 60 40 20 0

Moderate

*insufficient data



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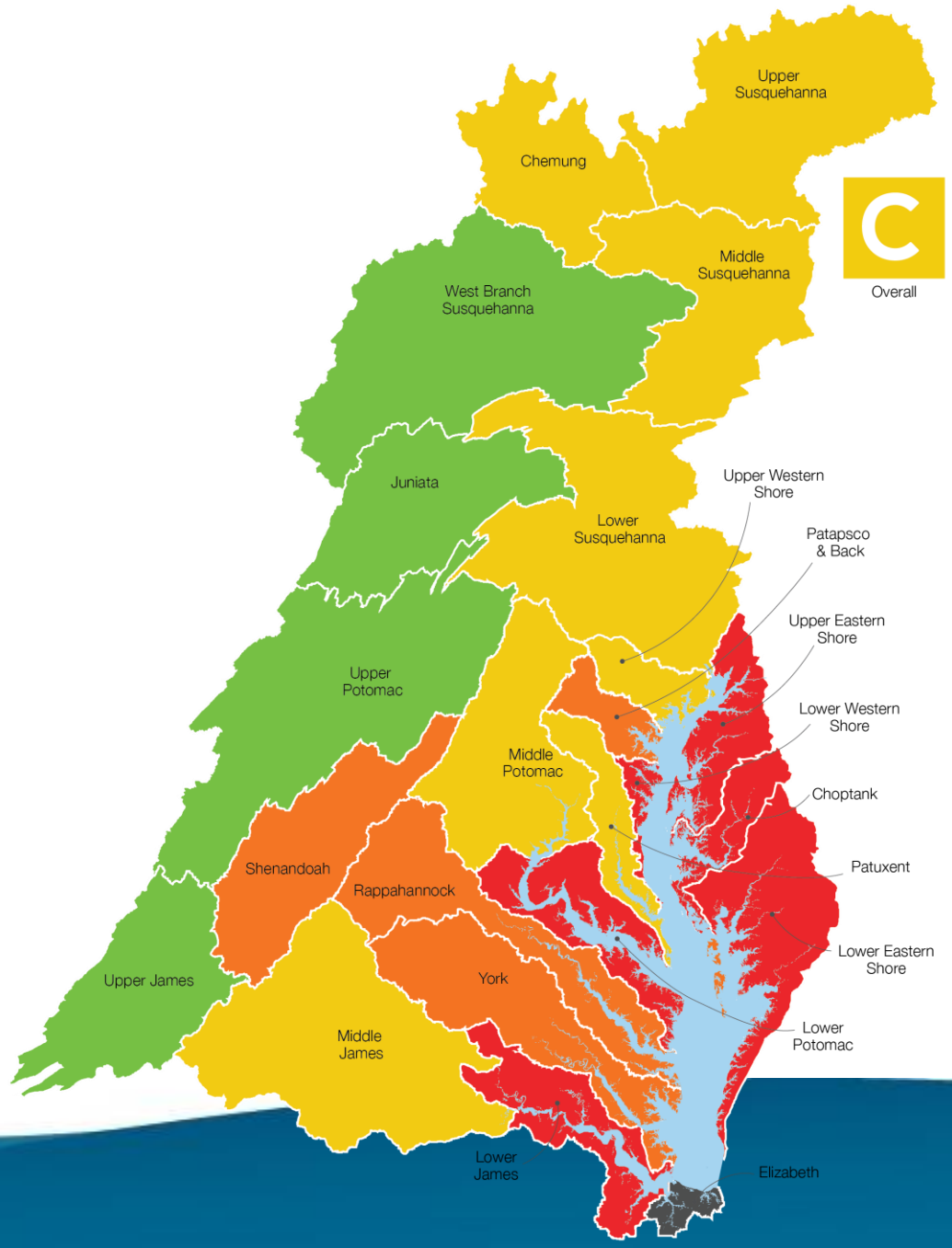
New for 2022: Fish Community Index

Fish community

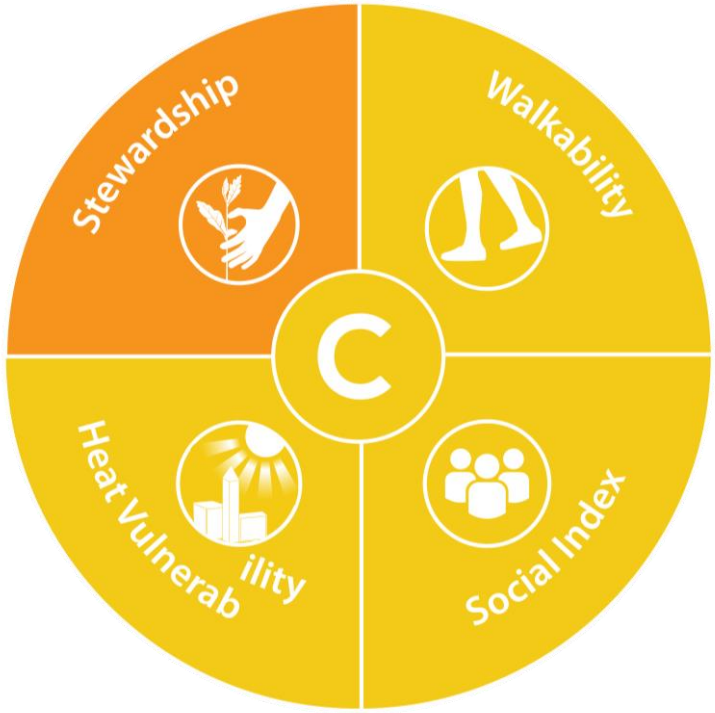
Fish Community measures the condition of freshwater fish communities in the watershed, including taxonomic richness and composition, percent migratory taxa, native species, pollution tolerance, etc. This index is based on the fish multi-metric index developed by the EPA. Calculations for the Chesapeake Bay watershed is done by the USGS.

How is it measured?

Fish community for 2022 was assessed using the most recent five years of data from each reporting region. Values for good, fair, and poor conditions were determined for each of the three ecoregions in the watershed. Samples were scored based on the threshold of the ecoregion they fell within, then averaged at the HUC12 level. These scores are area-weighted to the region scores.



Moderate societal conditions in the watershed need improvement



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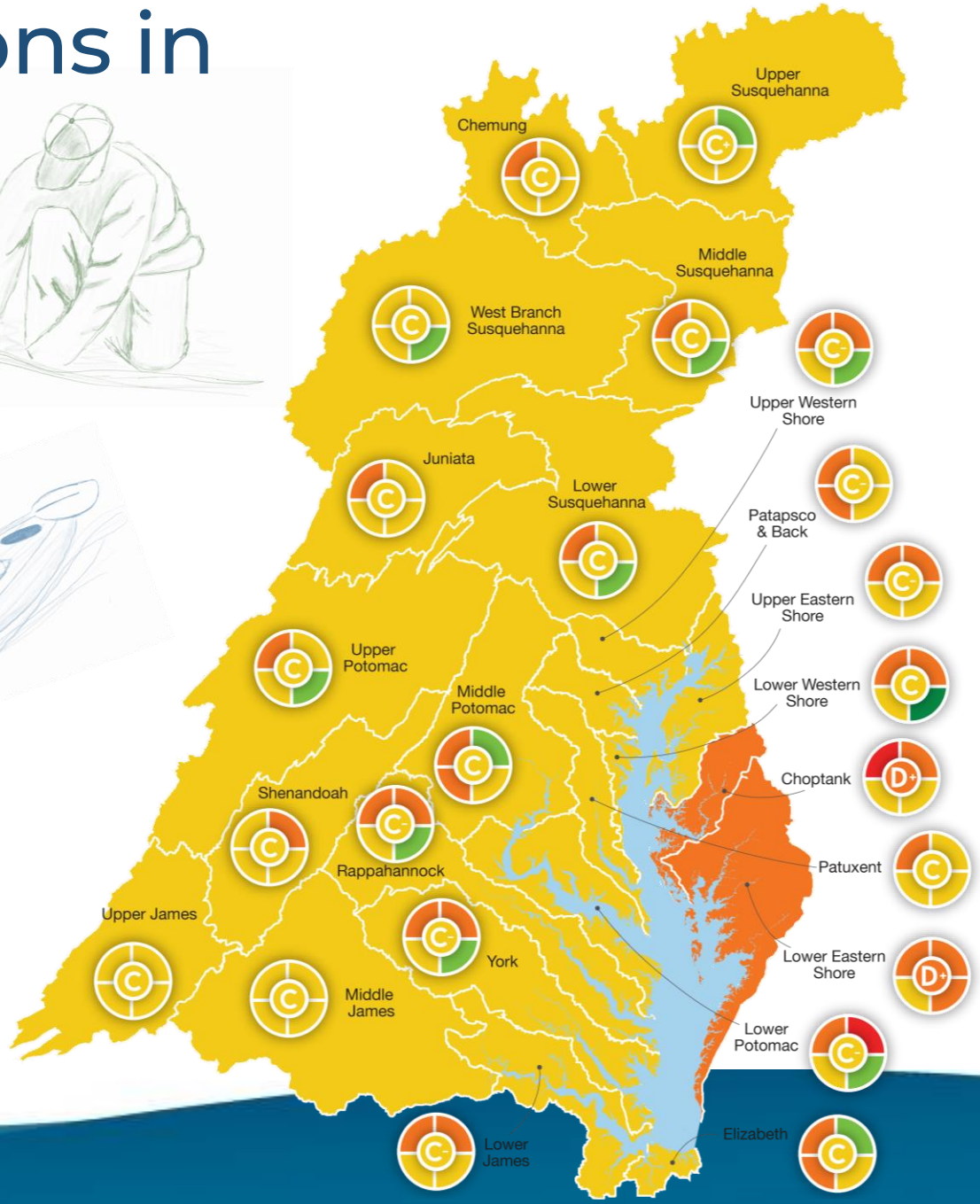

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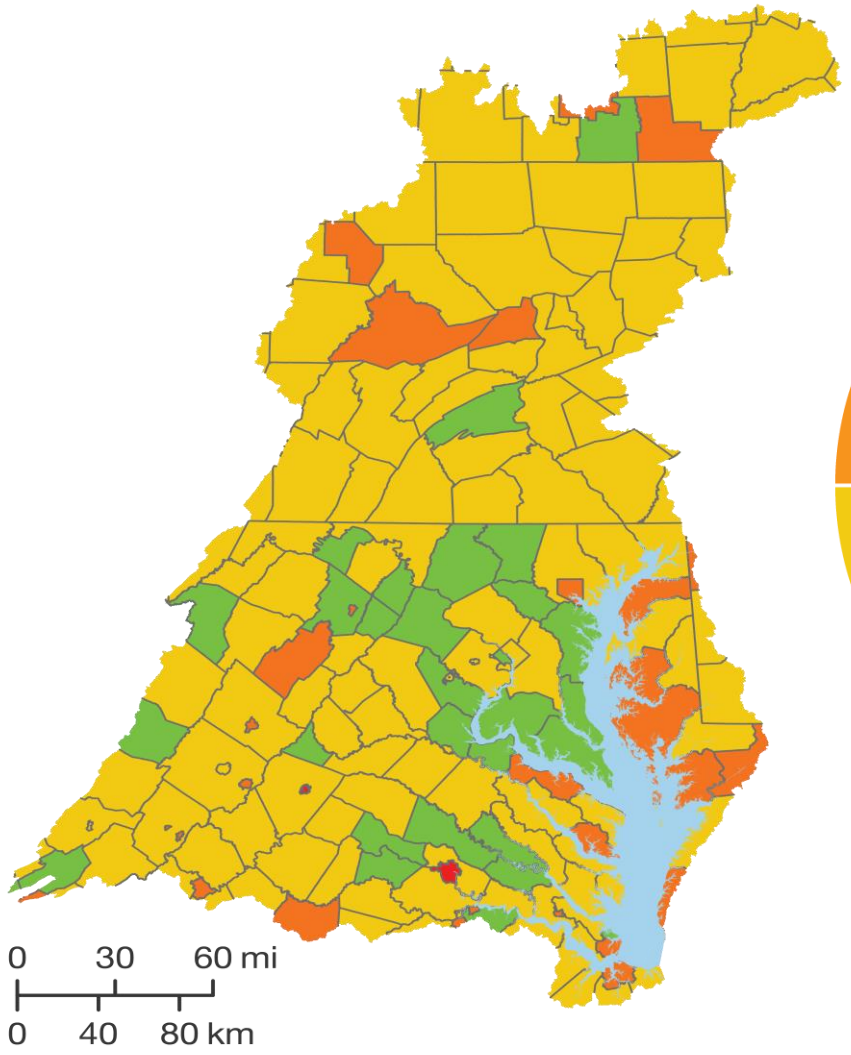
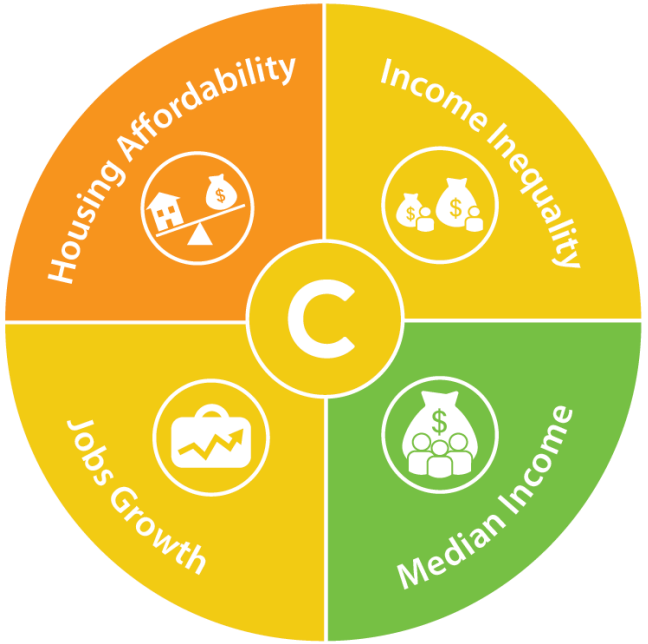
Economic conditions are moderate, but disparities exist at the county level





Health scale

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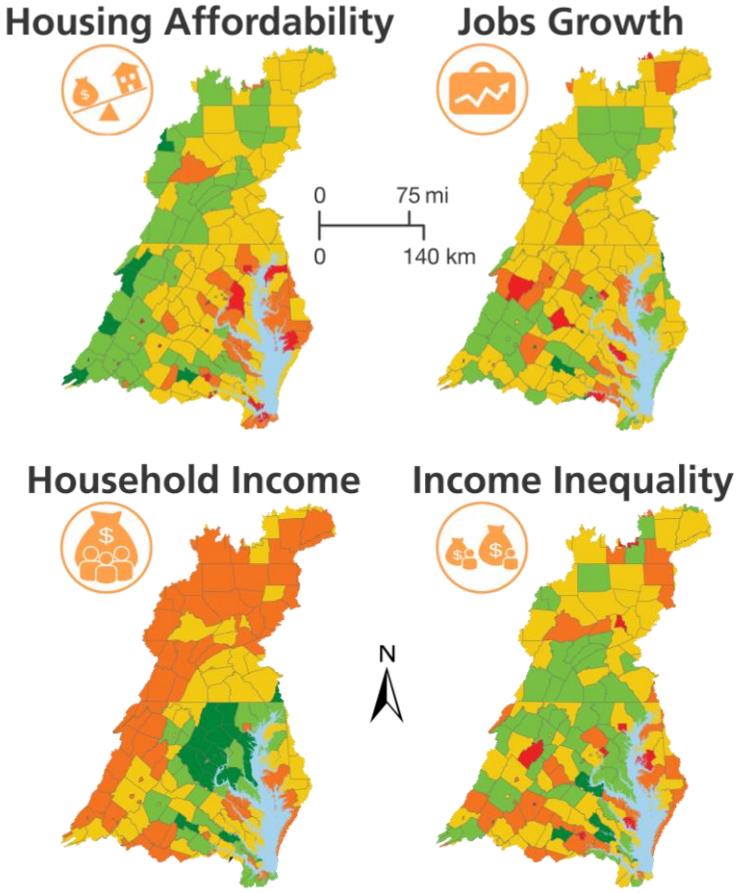
Moderate



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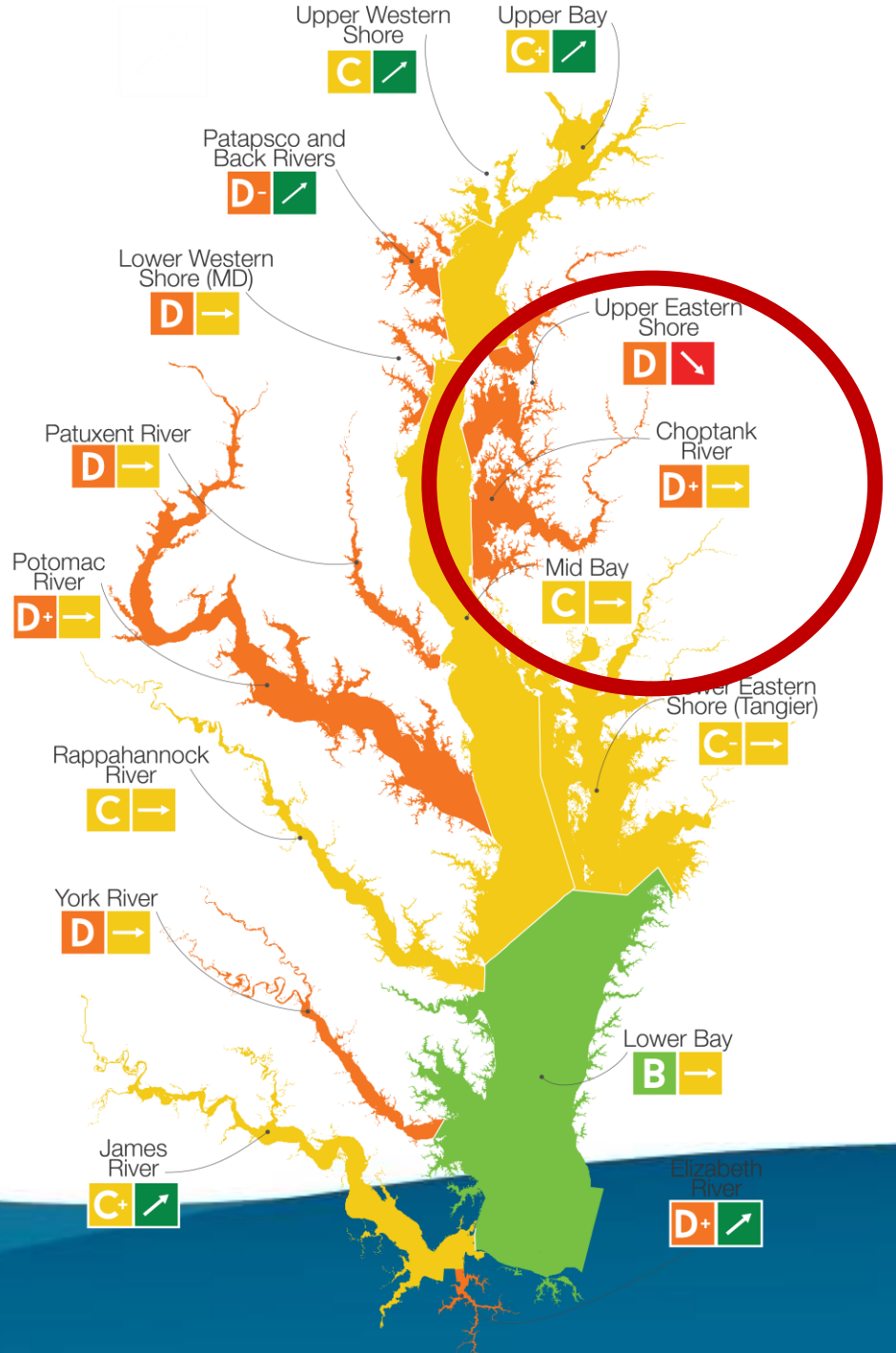
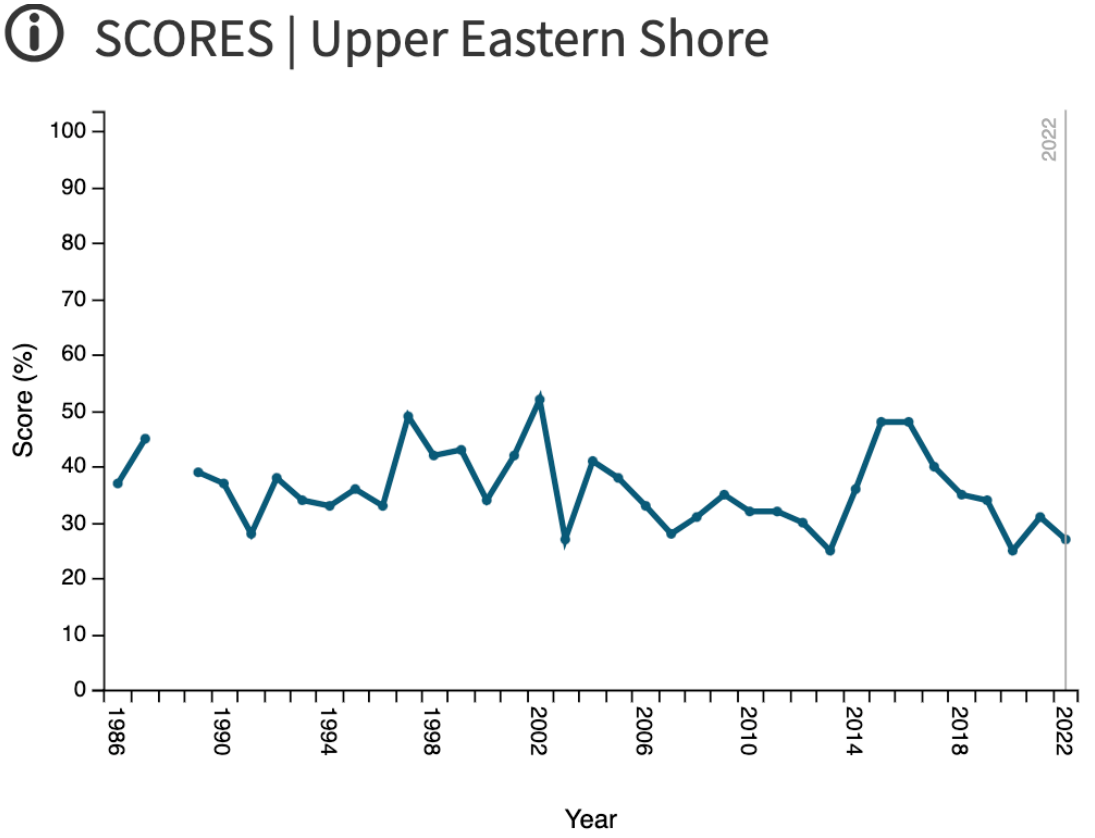
Why are the tributary scores, particularly in the Eastern Shore, declining?



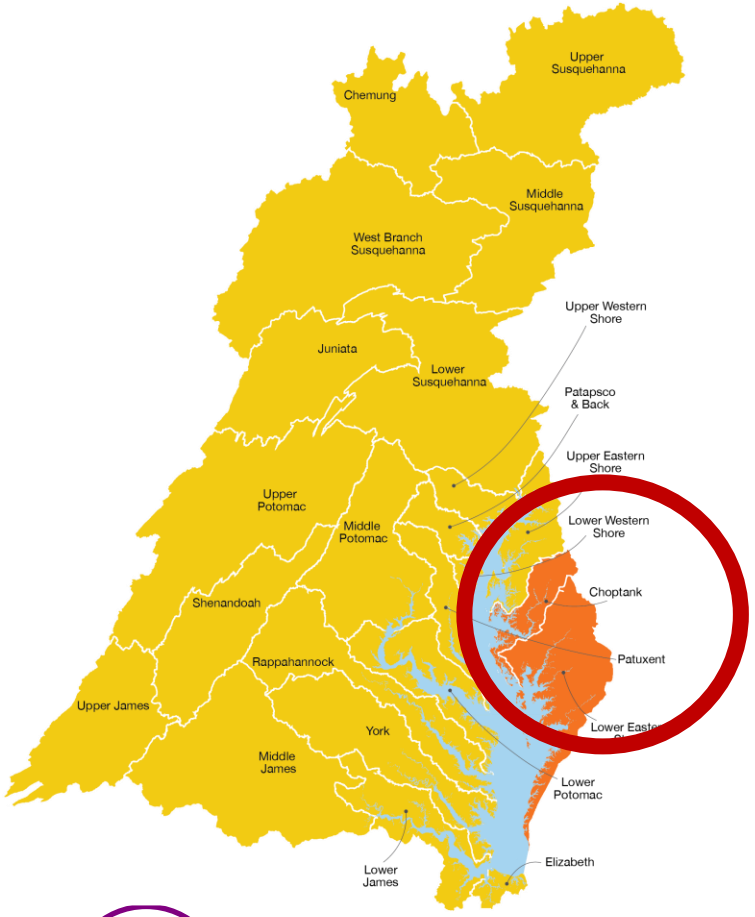
Upper Eastern Shore has a history of poor scores and declining trend

- In 2013 (D) and 2014 (D+), a significantly declining trend was reported
- From 2015 (C) to 2020 (D), no trend was observed but grades went down from C to D over the years
- Slightly negative trend was reported in 2021 (D) and turned significantly negative trend in 2022 (D)

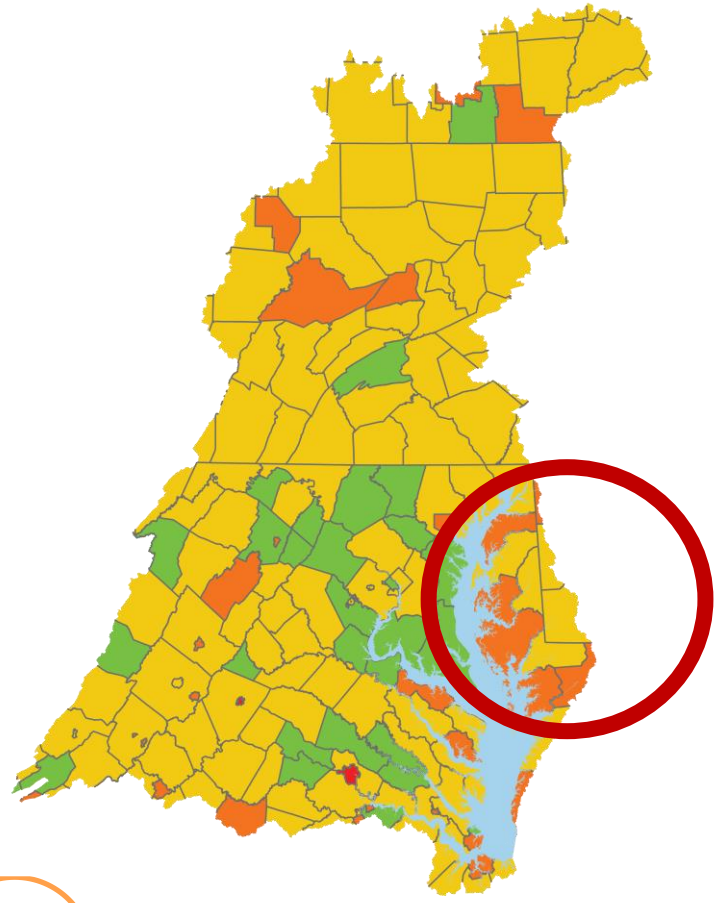


Poor conditions are also seen in the watershed

Ecological



Social



Economic

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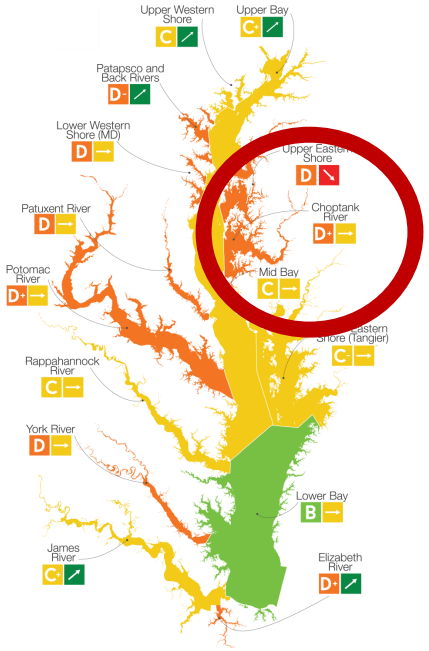
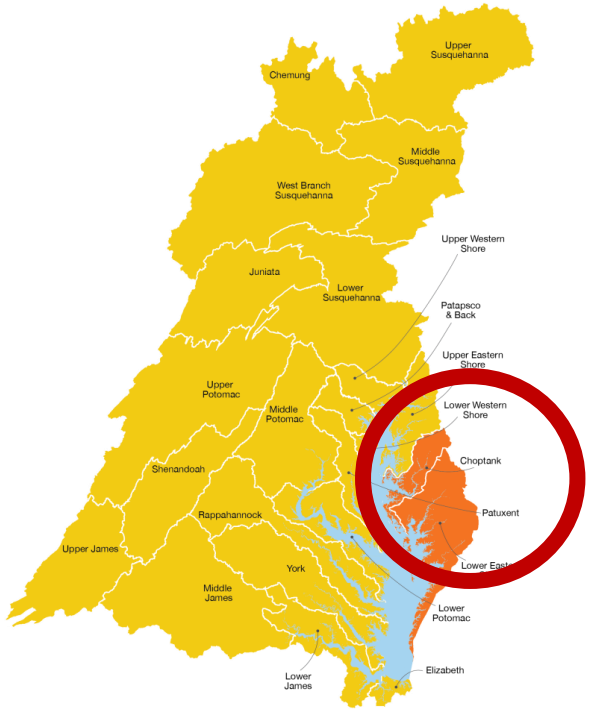
We need healthy communities to have a healthy Bay



Bay Health

Ecological



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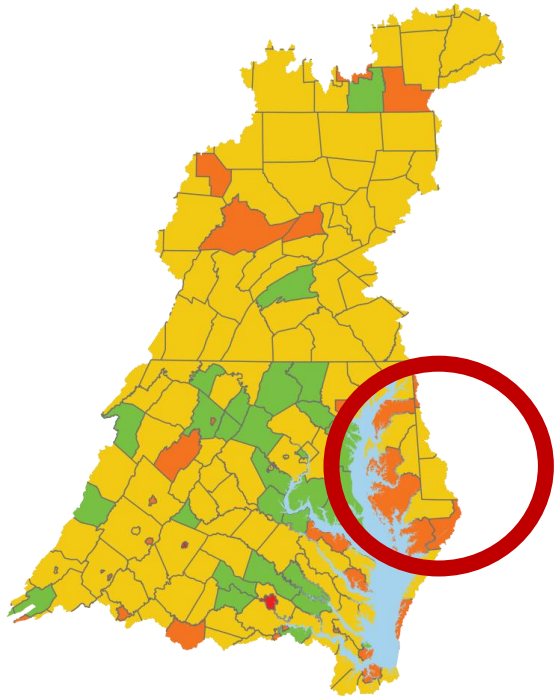

Economic

Graduate course to develop EJ Index was offered in 2021

Developing a framework for an Environmental Justice Index in the Chesapeake Bay Watershed

Recommended Next Steps

The graduate course that produced the ideas for this indicators was just the first step in a multi-phased approach for co-producing an Environmental Justice Index to be incorporated into future Chesapeake Bay Report Cards.

Phase 1: Representative Indicator Development

- Initial conversations with multiple stakeholders
- Survey dissemination
- EJ newsletter finalization and dissemination (multi-lingual)
- Communicate Phase 1 findings to partners in COAST Card project

Phase 2: Meaningful Stakeholder Engagement

- Continued MEES courses for developing EJ index
- Data collection through Semi-structured interviews, meet-ups, and listening sessions
- Co-production of EJ index with stakeholders
- Collaborative evaluation in monitoring, adapting and finalizing EJ index

Phase 3: Progressive Integrated Action

- Collaborative Action plan co-development with stakeholders
- Discussions with federal/ state agencies about reparations and support for communities
- Data calls for essential missing data
- Calls to universities, government, NGOs to support and conduct data collection

Acknowledgments

Course Instructors
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Course Participants
Imani Black, Haoyu Chen, Amber Fandel, Taylor Gedeon, Shakira Goffe, Sarah Jones, Katrina Kelly, Jehnae Linkins, Nylah McClain, Andrea Miralles-Barboza, Megan Murkacsy, Chelsea Richardson, Amanda Rockler, Ashley Silver, Isabel Sullivan, Faith Taylor, Imani Wilburn, and Olivia Wolford

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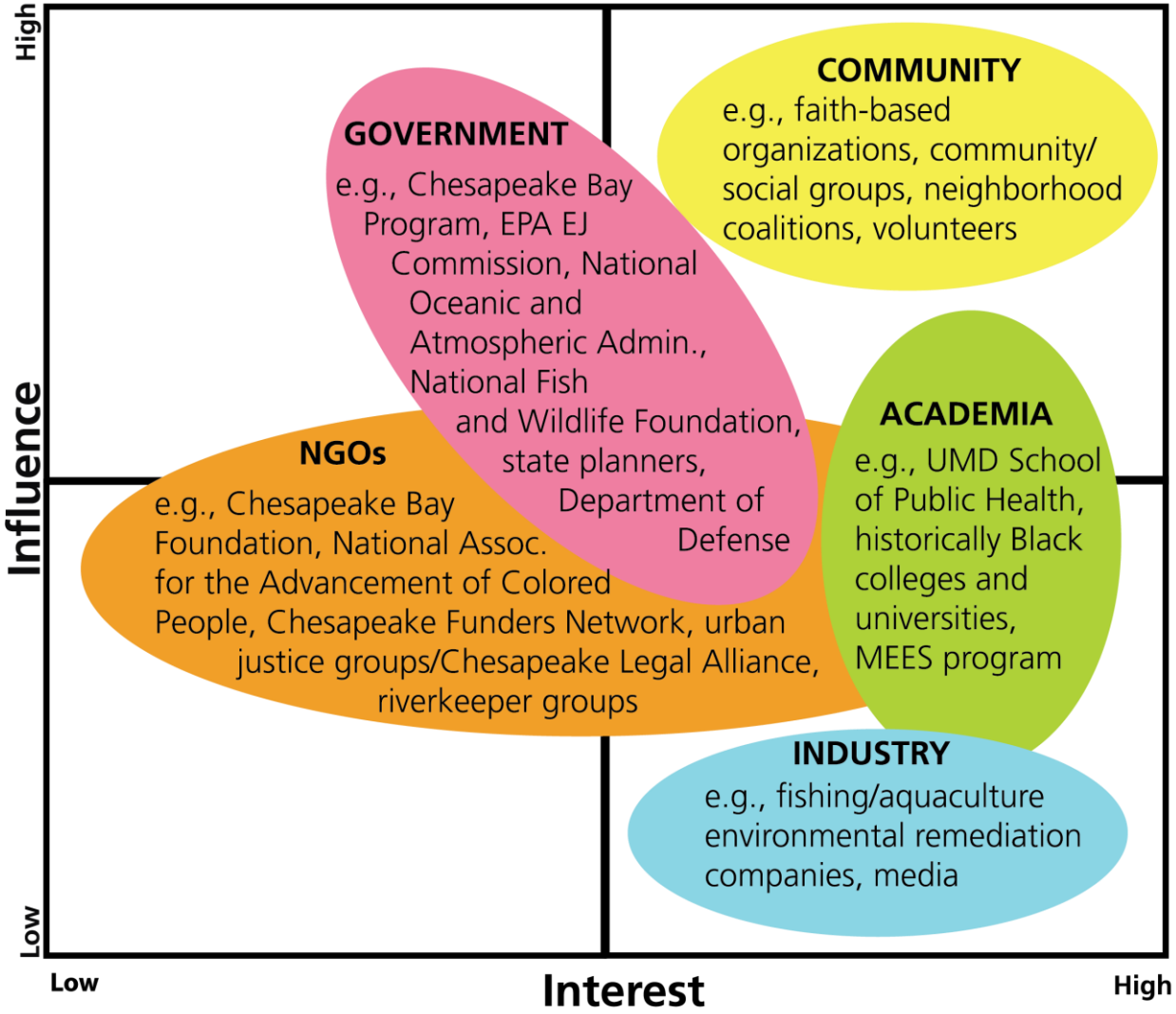
Developing an Environmental Justice Index

Environmental justice requires providing fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the environment. We are developing a framework for addressing environmental justice issues by using a suite of indicators.

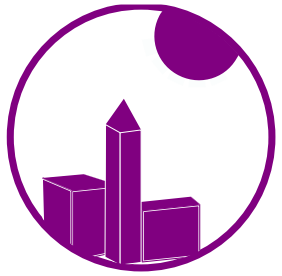
Four categories of environmental justice indicators (center) include a) proximity to hazards (top left), b) access to green space (top right), c) management and governance (bottom left), and d) environmental financing (bottom right).

Addressing Environmental Justice issues is important

Engaging with communities and incorporating diverse knowledge is critical



EJ-related indicators were incorporated in 2021 and 2022



Heat Vulnerability Index

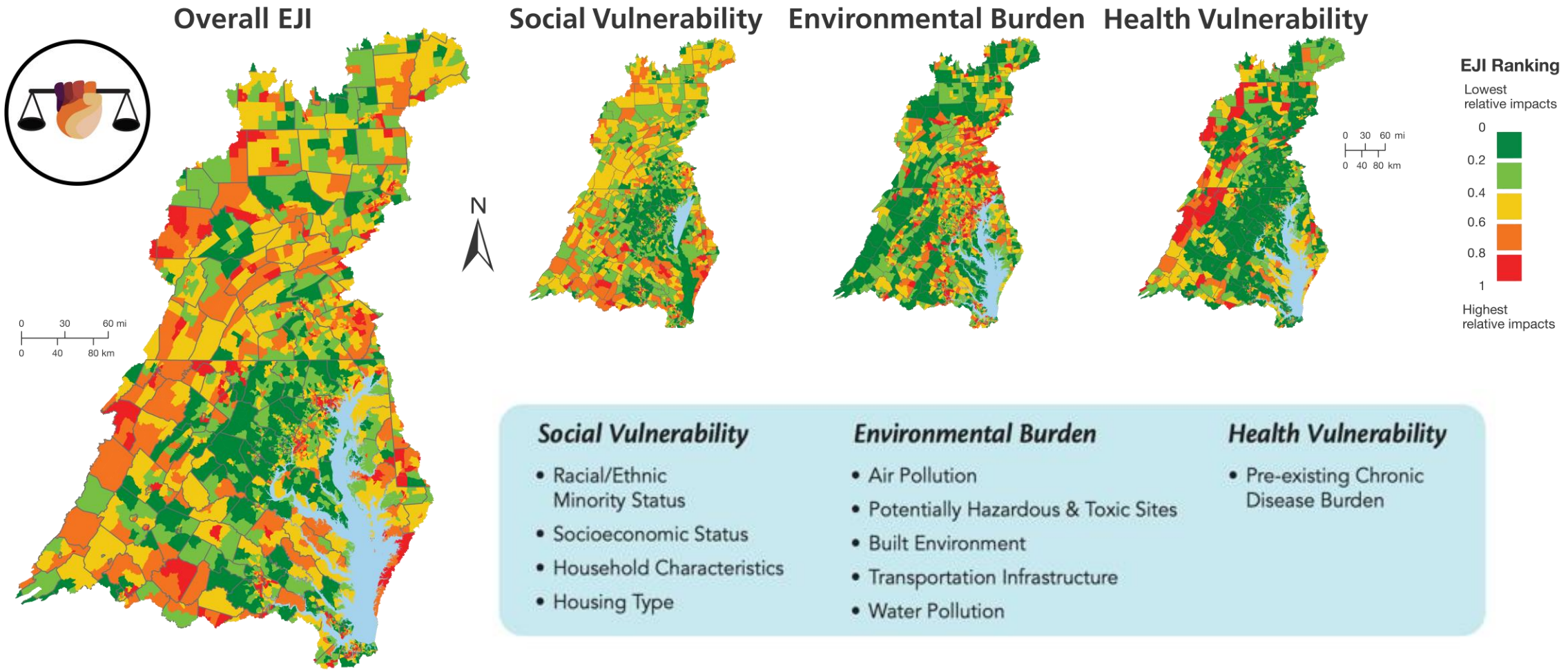
Social Vulnerability Index

Walkability

Housing Affordability

Income Inequality

EJ Index from the CDC incorporated in 2023



Social Vulnerability

- Racial/Ethnic Minority Status
- Socioeconomic Status
- Household Characteristics
- Housing Type

Environmental Burden

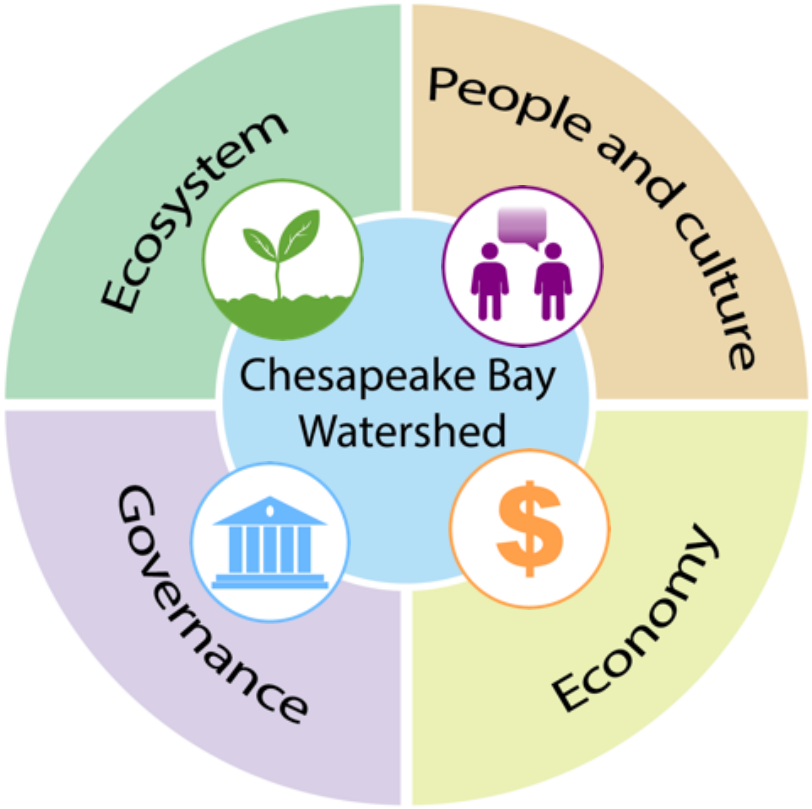
- Air Pollution
- Potentially Hazardous & Toxic Sites
- Built Environment
- Transportation Infrastructure
- Water Pollution

Health Vulnerability

- Pre-existing Chronic Disease Burden

Chesapeake Bay Watershed report card is continuously being updated

- Indicators being investigated:
  - Agricultural indicators
  - Flooding and Coastal Adaptation
  - Cultural Indicators
- Governance category to be included
- Current indicators are being evaluated
- Different ways of communication, roll-out of results, and engagement being explored



Chesapeake Bay report card serves as a model

COAST CARD

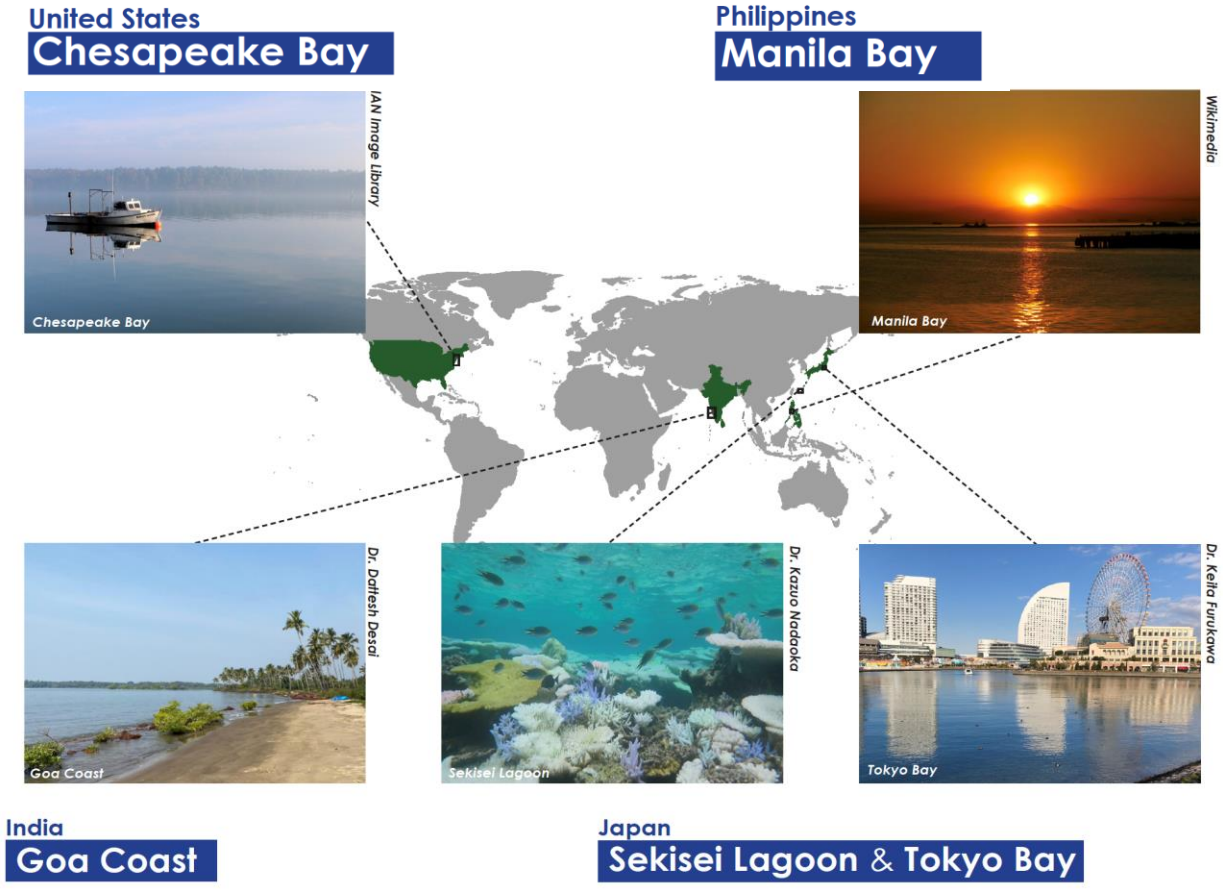
COAST Card is a new generation of report cards

COAST Card uses a three pronged approach to improve sustainability management practices:

Social-environmental Report Card

Social Network Analysis

Systems Dynamic Modeling



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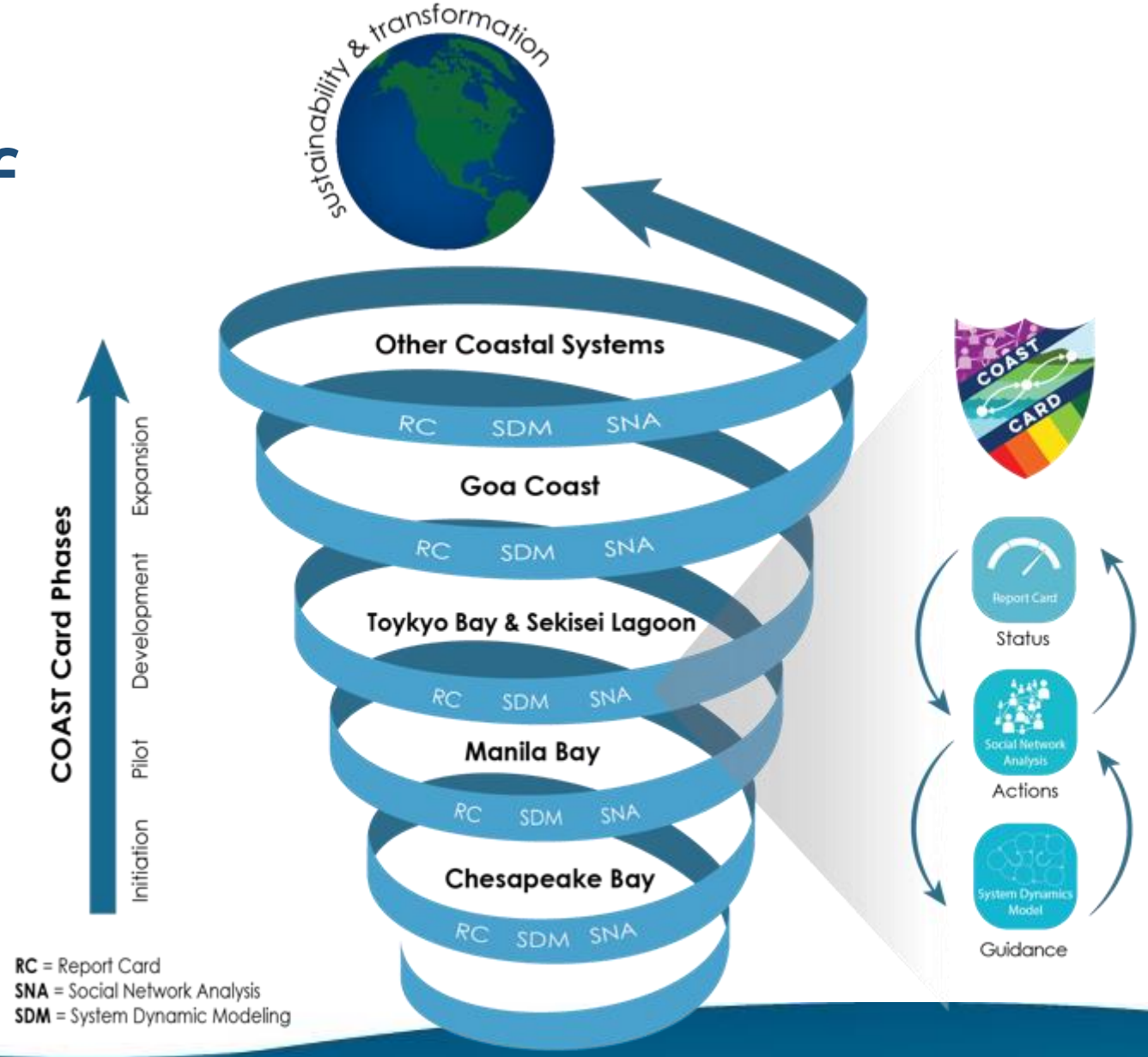
COAST Card is a new generation of report card

Inclusive and diverse Stakeholder Engagement is vital



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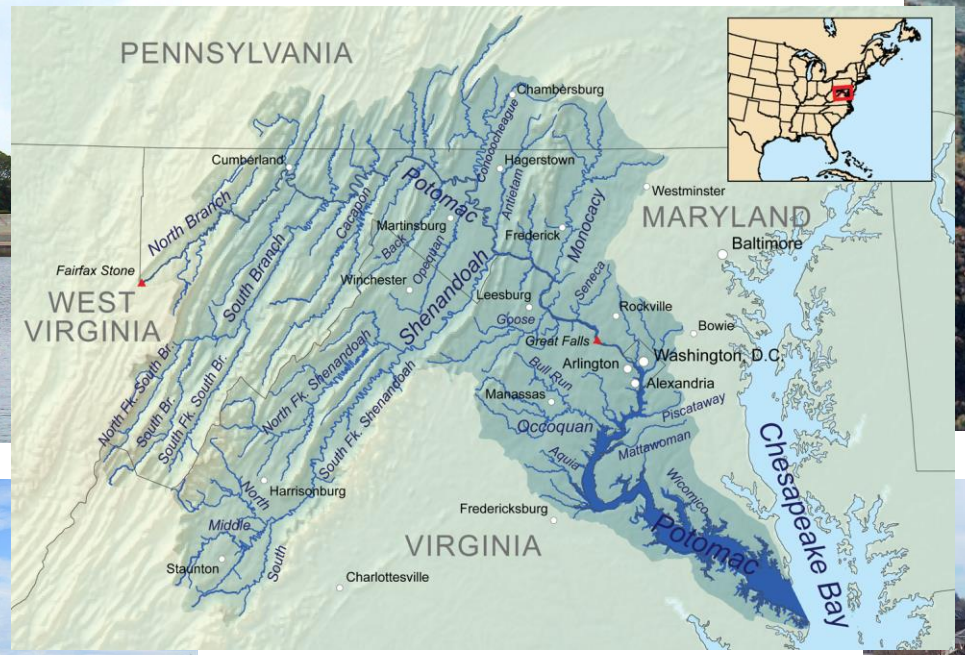
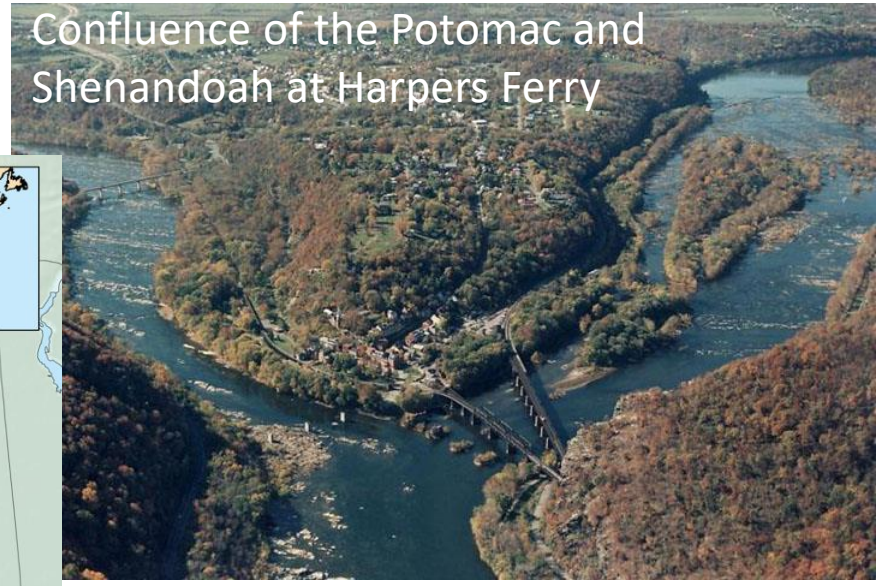
Developing the Potomac COAST Card

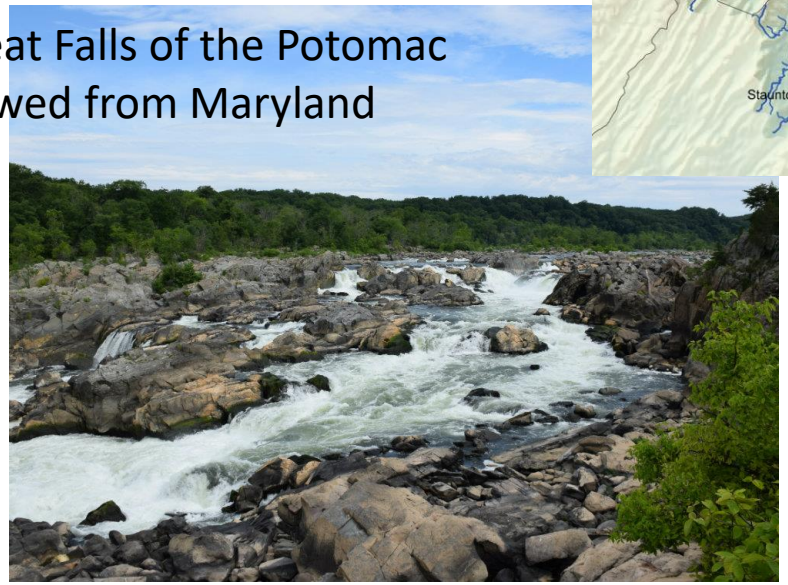
Jefferson Memorial in Washington, D.C., viewed from across the Tidal Basin of the Potomac



Confluence of the Potomac and Shenandoah at Harpers Ferry



Great Falls of the Potomac viewed from Maryland



Map showing the Potomac River drainage basin.

The North Branch between Cumberland, Maryland, and Ridgeley, West Virginia

Global Sustainability Scholars

Global Sustainability Scholars

The National Science Foundation

University of Maryland
Center for Environmental Science

Help Shape the Future of the Potomac Watershed!

People, land and water are all connected!

- Drop in to share your opinion of current conditions of the Potomac Watershed and what you hope it will look like in the future
- Help inform an assessment on the social, economic, and environmental aspects of the land and waterways in your area
- Participate in designing publically available materials for all users of the Potomac Watershed

Join us anytime between noon and 8:00pm on July 21st outside of Hood College's Whitaker Campus Center.

Food and beverages are available!

HOOD COLLEGE

Register Here!

*Due to current COVID-19 case numbers, this event will be held outdoors in a covered environment. In the event of rain, the event will be held inside the Whitaker Campus Center. We will provide masks and ask that you social distance while in attendance. Thank you!

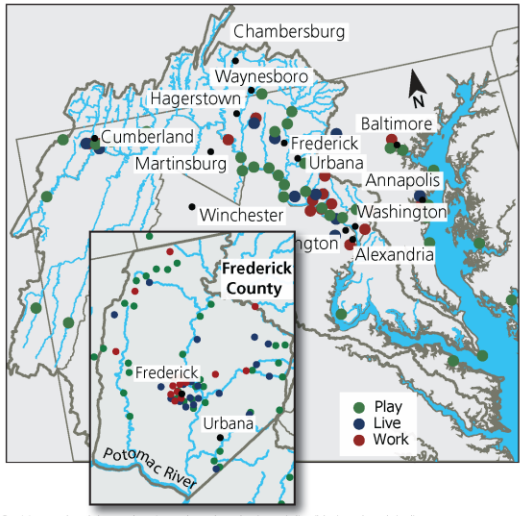
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Results of the Middle Potomac Listening Session

The Listening Session format provides a source for individualized conversation. Input from diverse stakeholders is needed to guide decision-making when it comes to managing natural spaces.

Identifying the Importance of the Potomac Watershed

One of the first steps in the COAST Card framework developing a shared understanding with stakeholders and identifing their perspectives of current conditions, including values and threats facing the watershed. Individuals highlighted where they work, live, and play in the Potomac Watershed and in Frederick County, showing how both the land and the water are used and valued.

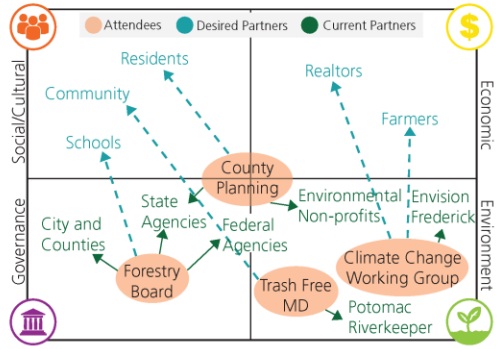


Participants placed dots on locations where they play (green), live (blue), and work (red).

Potomac Watershed residents value recreation, clean water, and natural resources. Overall, residents value continued use of their watershed as a well-maintained natural space.

Residents are concerned about unmanaged development, climate change, and pollution. Lack of education and engagement and poor resource management are also concerning.

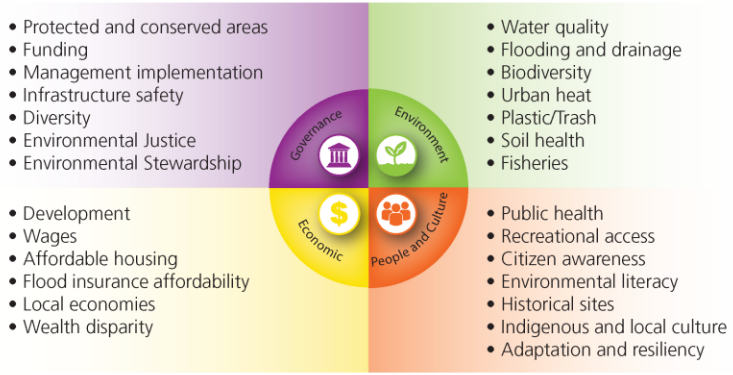
Understanding Connections



Participants identified current and desired partners.

Social Network Analysis allows decision makers to identify stakeholders already working on the problem and see who else should be involved. Most attendees work with organizations from the governance and environmental sectors but indicated their desire to work more with the social/cultural and economic sectors, including educational organizations.

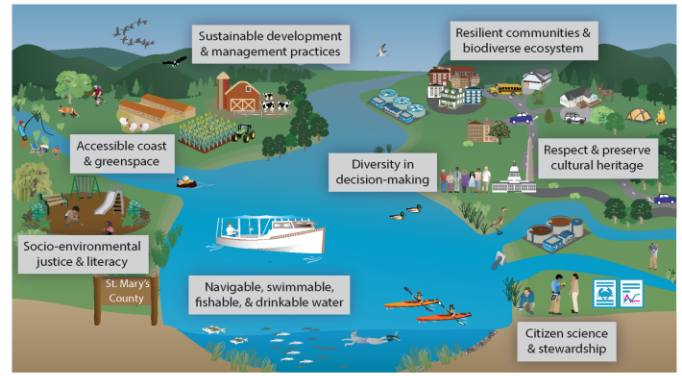
Buiding a Report Card



Participants developed indicators for assessment from four categories.

A socio-environmental report card incorporates social, cultural, economic, environmental, and governance indicators, in order to encompass watershed health through a variety of perspectives.

Developing a Shared Vision and Priority Actions



Eight vision statements were developed from participant responses. Six main actions were suggested to achieve these visions.

A shared vision ensures that the Potomac COAST Card will be useful to the community. Residents desire an accessible, swimmable, drinkable Potomac, with increased biodiversity, stable fisheries, less development, and more land conservation. To achieve these goals, residents suggest actions in Management, Education, Policy, and Engagement.

Engaging stakeholders through listening sessions

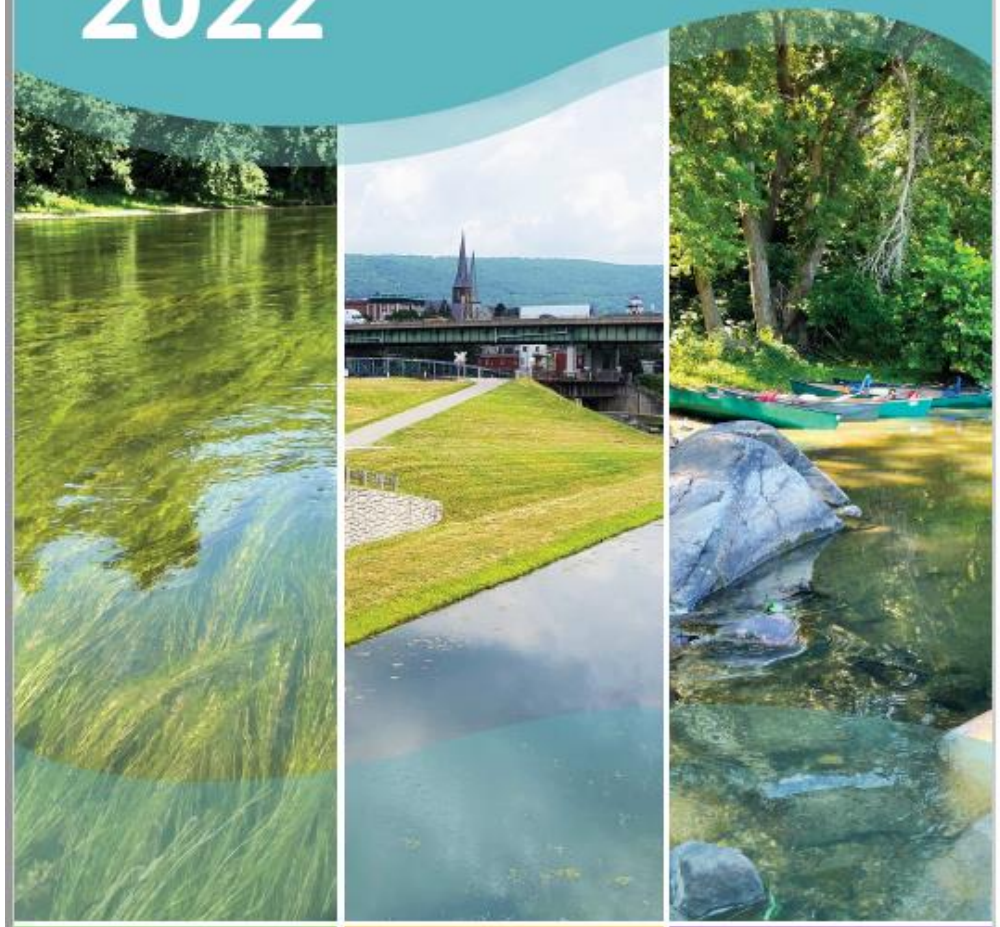
- **Chesapeake Biological Laboratory, Solomons, MD (Patuxent)**
- **Jug Bay Wetland Sanctuary, Lothian, MD (Patuxent)**
- **Horn Point Laboratory, Cambridge, MD (Choptank)**
- **Institute of Marine and Environmental Technology, Baltimore, MD (Patapsco)**

Values

Threats

Potomac River and Watershed Report Card

2022



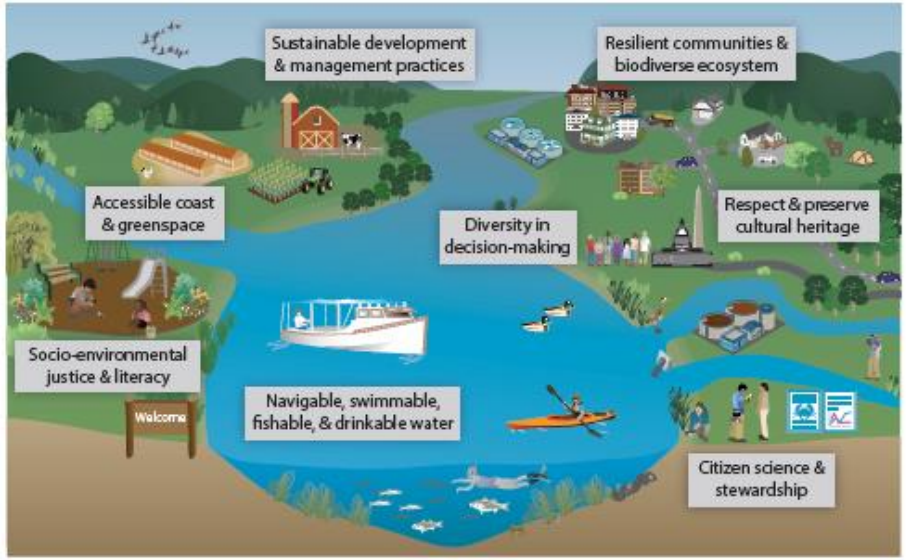
Developing a holistic vision of the watershed

The Potomac River watershed is an essential resource that holds interconnected and shared values. To ensure that informed decisions are made, adopting an inclusive and participatory approach allows for development of a comprehensive vision for the entire watershed. One such approach is the COAST Card or Coastal Ocean Assessment for Sustainability and Transformation framework.

The Potomac River is home to the nation's capital.

COAST Card builds on the Chesapeake Bay and Watershed Report Card produced by the University of Maryland Center for Environmental Science (UMCES) and is being introduced in the Potomac watershed, covering the Lower Potomac, Middle Potomac, Upper Potomac, and Shenandoah regions. This framework can bridge the gap between qualitative and quantitative information, allowing stakeholders to make informed management or policy decisions.

The 2022 Potomac River and Watershed Report Card is one of the foundations of the Potomac COAST Card that will be further developed in the coming years.



A conceptualized vision of a sustainable Potomac co-developed with stakeholders during a Listening Session at Hood College in Frederick, MD on July 21, 2022. The vision will be further honed with future sessions.

Engaging stakeholders is a pivotal first step

The first step in the COAST Card framework was to engage a diverse set of stakeholders to co-develop the Potomac COAST Card. The first event was at Hood College in July 2022. To achieve this, additional Stakeholder Listening Sessions will be held across the Potomac watershed to include local perspectives in answering the following questions:

Stakeholders participate in a social network analysis activity at the Listening Session held at Hood College.

Why should you care?

Establishing a shared understanding with stakeholders and identifying their perspectives on current conditions, including values and threats facing the watershed is important for the COAST Card framework.

What do we measure?

After taking stakeholder's perspectives into account, the next step in the framework is identifying social, cultural, economic, and governance indicators in order to create an inclusive socio-environmental report card.

Where do we go?

Developing a shared vision and path forward for the watershed is necessary to ensure that the Potomac COAST card will be useful to the community.

What can be done?

Using system dynamics modeling, actions are ranked by quantifying indicator relationships, assessing management scenarios, and making recommendations for better outcomes.

Who should be involved?

Identifying stakeholders involved in Potomac watershed issues and determining who else should be included to improve collaborations through social network analysis.

Watershed indicators

Ecological

Water quality indicators include total phosphorus and total nitrogen.

Stream benthic community measures the condition of the benthic organisms living in streams.

Protected lands measures the amount of valuable lands that are protected in the watershed.

Fish community is an index developed by the EPA* that examines river health in categories including native species and pollution tolerance.

Economic

Median household income is a measure of economic vitality and uses data from the U.S. Census.

Income inequality uses the Gini Coefficient that measures the inequality in income distribution.

Jobs growth measures the percentage of jobs gained or lost (net) per capita from the past four years.

Housing affordability measures the percentage of households that spend 30 percent or more of their income on housing costs.

Societal

Social Index measures how a community can respond to hazardous events using CDC's** social vulnerability index.

Stewardship Index examines citizen's stewardship behavior, volunteerism, and civic engagement.

Walkability measures how many people (for total population and for diverse groups) can walk to a park in 10 minutes.

Heat Vulnerability Index indicates climate-safe neighborhoods using metrics for tree canopy, impervious surface, land surface temperature, and households in poverty.

River indicators

Total nitrogen measures the amount of nitrogen in river waters.

Total phosphorus measures the amount of phosphorus in river waters.

Dissolved oxygen is critical to the survival of the river's aquatic life.

Chlorophyll *a* is used as a measure of phytoplankton (microalgae) biomass.

Water clarity is a measure of how much light penetrates through the water column.

Aquatic grasses, or submerged aquatic vegetation, are a critical river habitat.

Benthic community measures the condition of the organisms living on the bottom areas of the river.

** Environmental Protection Agency*
*** Centers for Disease Control and Prevention*

The Potomac River and Watershed is in moderate condition

Overall, the Potomac River watershed scored 46% (C), a combination of the Potomac watershed (55%) and the Potomac River (37%) scores.

Ecological, societal, and economic conditions in the watershed vary

The Potomac watershed scored 55% (C+) in 2022, based on the combined scores of the four Potomac regions in the UMCES Chesapeake Bay and Watershed Report Card. Overall, the Potomac watershed had a moderately good ecological score (64%, B-) and moderate economic (56%, C+) and societal (47%, C) scores. The highest-scoring indicators were protected lands (86%, A) and household income (81%, A-), while the lowest-scoring indicators were stewardship (33%, D) and housing affordability (38%, D+).

Upper Potomac

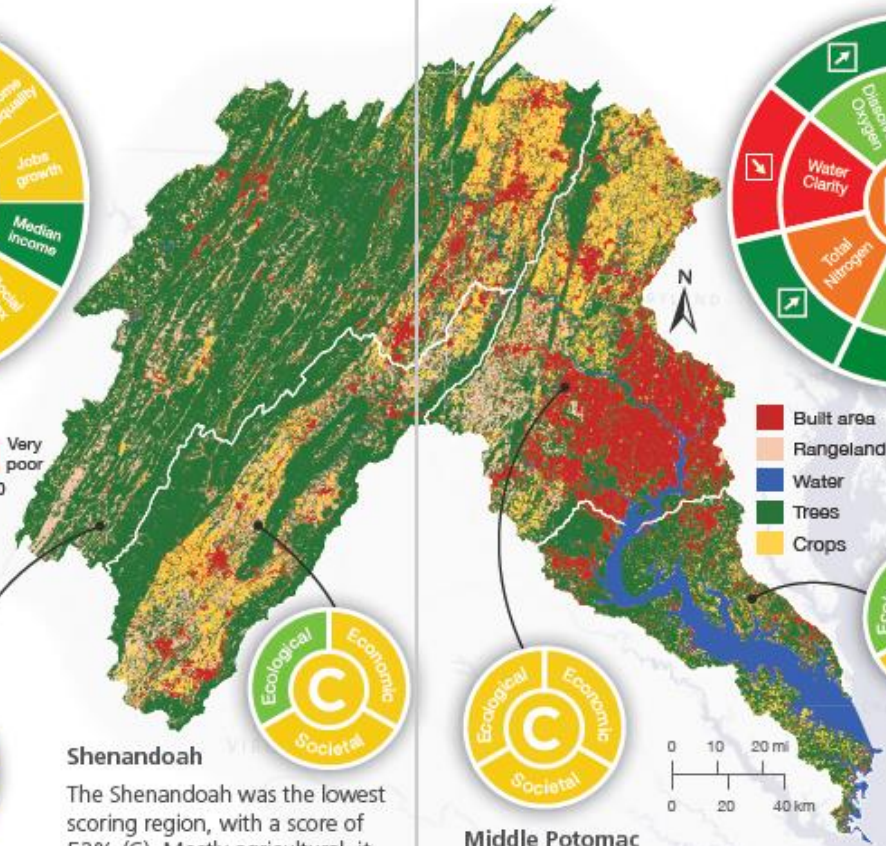
The Upper Potomac was the highest scoring region with a score of 58% (C+). It is mostly forested and received the highest score in the ecological category. It also had the highest score among the regions in the social index, fish community, housing affordability and jobs growth.

Shenandoah

The Shenandoah was the lowest scoring region, with a score of 52% (C). Mostly agricultural, it had the lowest economic score among the regions, having the lowest scores in household income, income inequality, and jobs growth.

Potomac River in poor health but some indicators are improving

The Potomac River scored 37% (D+), six points lower than in 2021. This decrease was due to lower dissolved oxygen, chlorophyll *a*, benthic community, and total phosphorus. The good news is that dissolved oxygen, total phosphorus, total nitrogen, and aquatic grasses scores all had improving trends. These scores are based on the UMCES Chesapeake Bay and Watershed report card.



Lower Potomac

The Lower Potomac had a score of 56% (C+), scoring highest in the economic category. It had the highest scores in water quality, heat vulnerability, and income inequality. It also had the lowest societal score, with poor scores in stewardship and walkability.

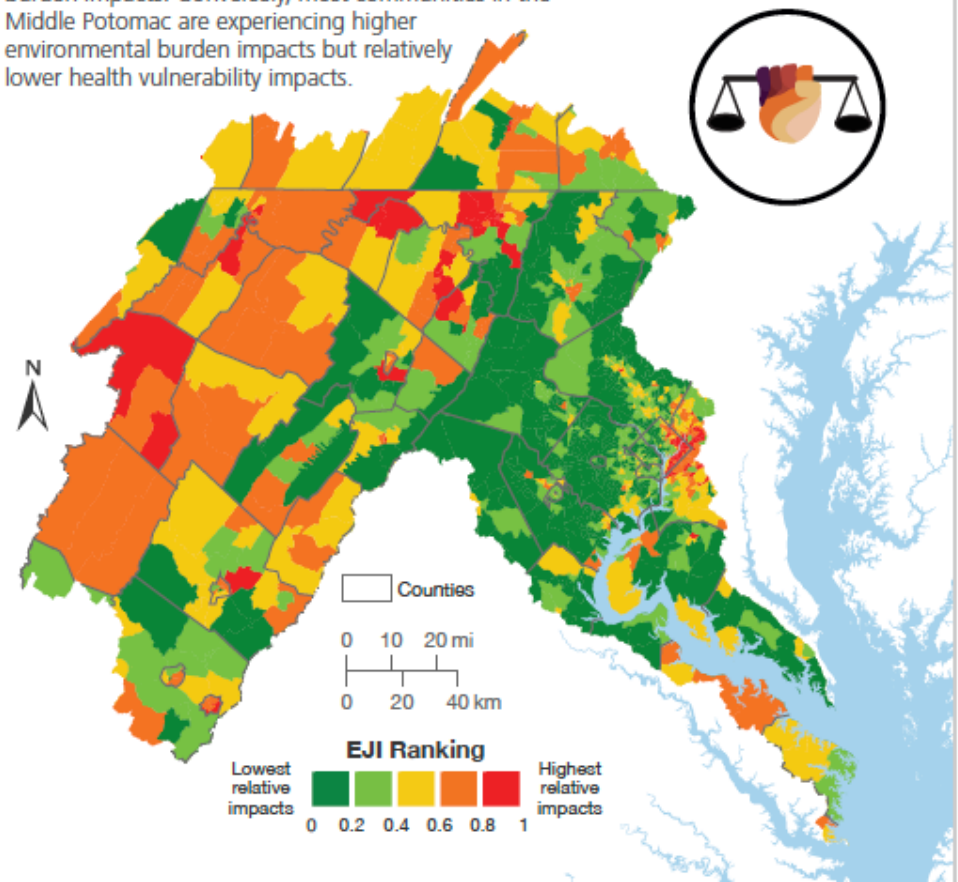
Middle Potomac

The Middle Potomac scored 53% (C). It is the most developed region with the lowest score in the social and heat vulnerability indexes, housing affordability, income inequality, water quality, and benthic community. Among the four regions, it scored the highest in the societal category but the lowest in the ecological category.

Addressing environmental justice is key

Ensuring that all communities in the Potomac River watershed have access to clean water and a healthy environment requires addressing environmental justice. The Centers for Disease Control and Prevention's Environmental Justice Index (EJI) measures and tracks environmental inequality, identifying areas that need action.

The map below displays the EJI score for each census tract in the Potomac watershed, highlighting significant disparities between them. These differences could be due to various factors, as the EJI considers social vulnerability, health vulnerability, and environmental burden indicators. For example, communities in the Upper Potomac region face higher health and social vulnerability impacts but lower environmental burden impacts. Conversely, most communities in the Middle Potomac are experiencing higher environmental burden impacts but relatively lower health vulnerability impacts.

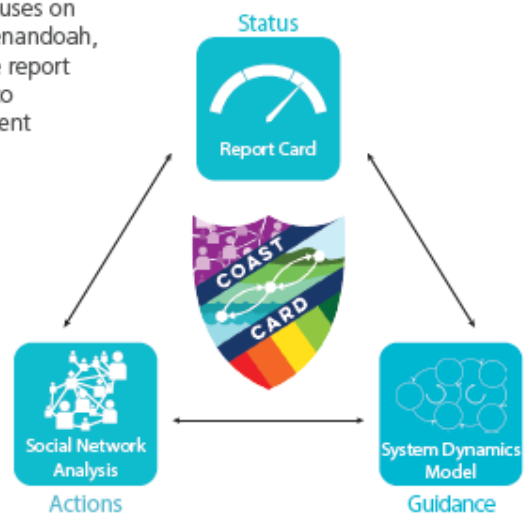


Co-producing the Potomac COAST Card

The COAST Card framework is a useful tool for communities to address socio-environmental challenges. By combining socio-environmental report cards, system dynamics modeling, and social network analysis, it provides a comprehensive understanding of the issues affecting the Potomac watershed.

Report cards offer an easily understandable overview of key indicators, while system dynamics modeling (SDM) helps to comprehend the interaction between variables over time. The Potomac SDM currently focuses on three counties in the watershed—Shenandoah, Frederick, and St. Mary's. It brings the report card to life by enabling stakeholders to analyze the dynamic patterns of nutrient pollution, assess best management practices, and test policy options.

Lastly, social network analysis helps identify key players in a system, develop strategies to engage with them, and highlights potential areas for coordinated actions. By working together, a more sustainable and equitable future can be created for all.



Acknowledgments

COAST Card Consortium: University of Maryland Center for Environmental Science Integration and Application Network (UMCES IAN), University of Bergen, Philippines National Academy of Science and Technology, Tokyo Institute of Technology, and Goa National Institute of Oceanography.

Funding Agencies: The Belmont Forum and the National Science Foundation (NSF)

Key Partners: Hood College, Livable Frederick Planning and Design Office, Sustainable Monocacy Commission, UMCES Appalachian Laboratory, Interstate Commission on the Potomac River Basin, and Metropolitan Washington Council of Governments, Frederick County, and the Potomac Riverkeeper Network.

Land use/land cover map data source: Impact Observatory, Microsoft, Esri (2022)

All photos courtesy of UMCES IAN

Lower Potomac
Leonardtown Park, MD

June 08, 2023

University of Maryland
Center for Environmental Science

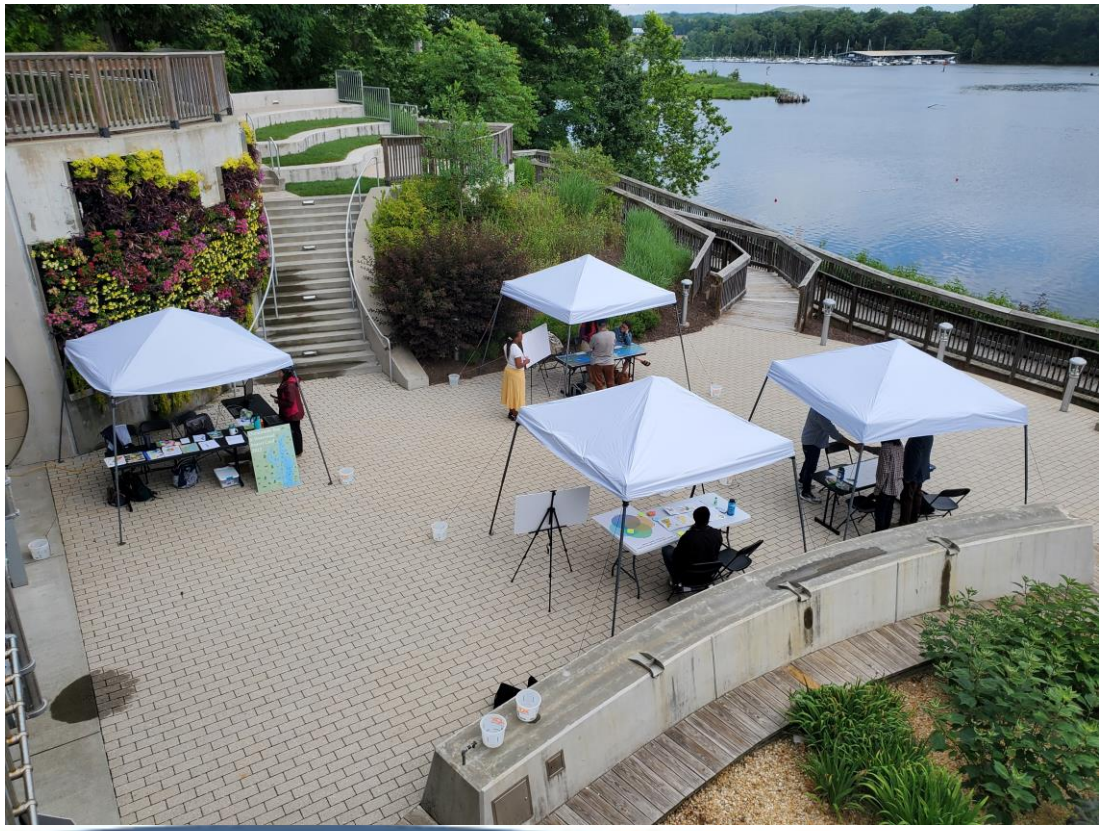
Middle Potomac
Washington Sailing Marina, VA
June 06, 2023

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Upper Potomac, Canal Place MD

June 22, 2023

Chesapeake Bay Scientific and Technical Experts
Potomac Science Center, VA
June 14, 2023



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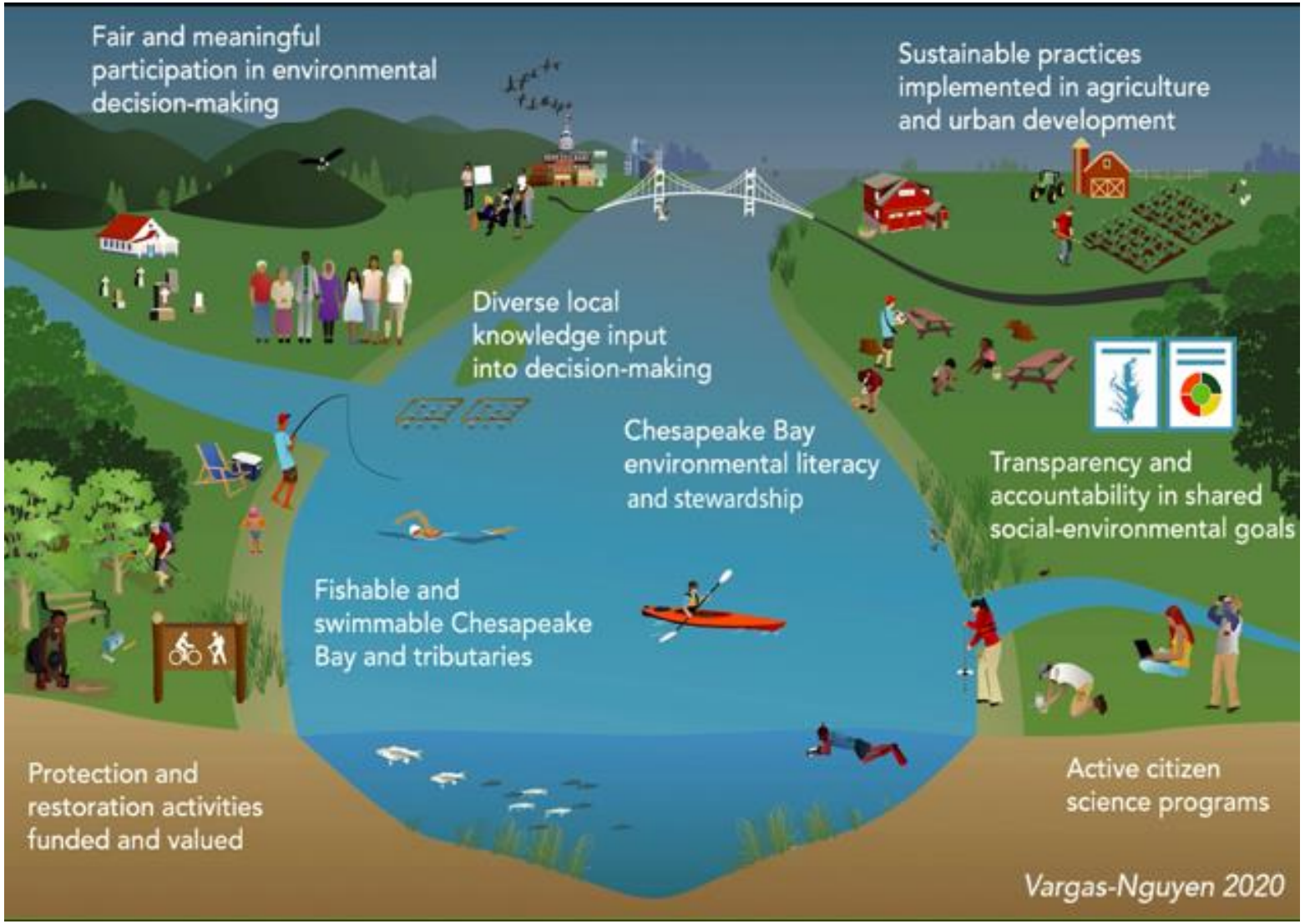
Capital Rivers Church
Wheaton High School, Silver Spring, MD
July 16, 2023

Co-developing a shared vision for the Chesapeake Bay Watershed



Empowering communities by developing capacity