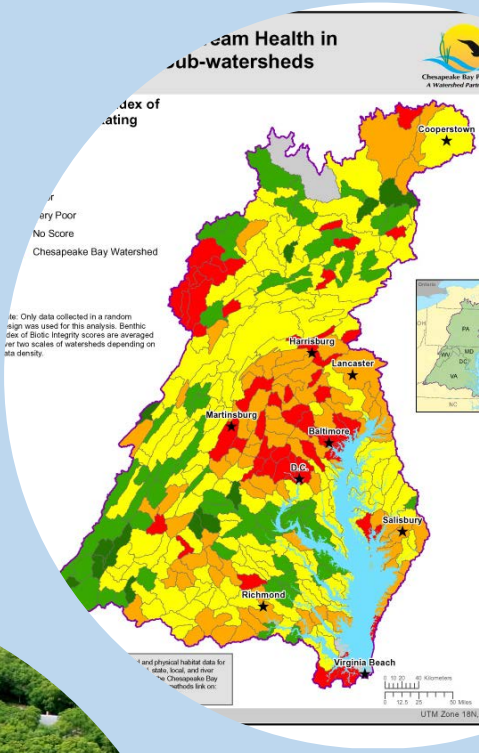
Indicators: Characteristics, Qualities and Options



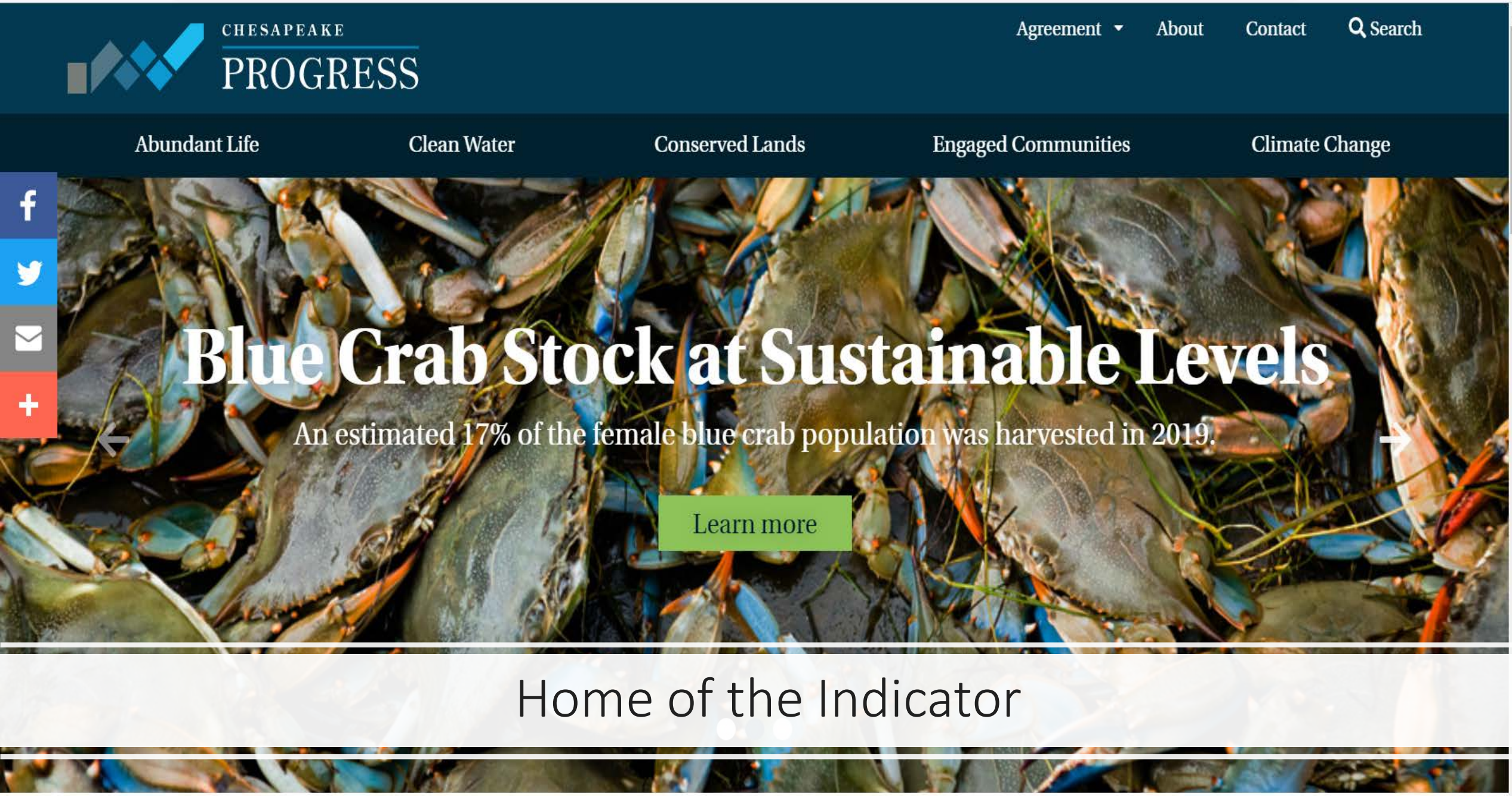
- Peter Tango
- USGS@CBPO
- STAR Co-Coordinator
- Status and Trends Workgroup Meeting
- December 1, 2020

A path to ecosystem recovery: Goals and Outcomes

Chesapeake Bay Agreement

Overview

- Schedule and Process
- Agreement /Participatory Sections
  - Preamble
  - Mission
  - Vision
  - Principles and Operational Commitments
- Goals (10)
- Outcomes (31)



Home of the Indicator

https://www.chesapeakeprogress.com/#carousel-home

What is an **Indicator**?

Indicators: *A summary measure that provides information on the state of (i.e., status), or change in (i.e., trend), the system that is being measured.*

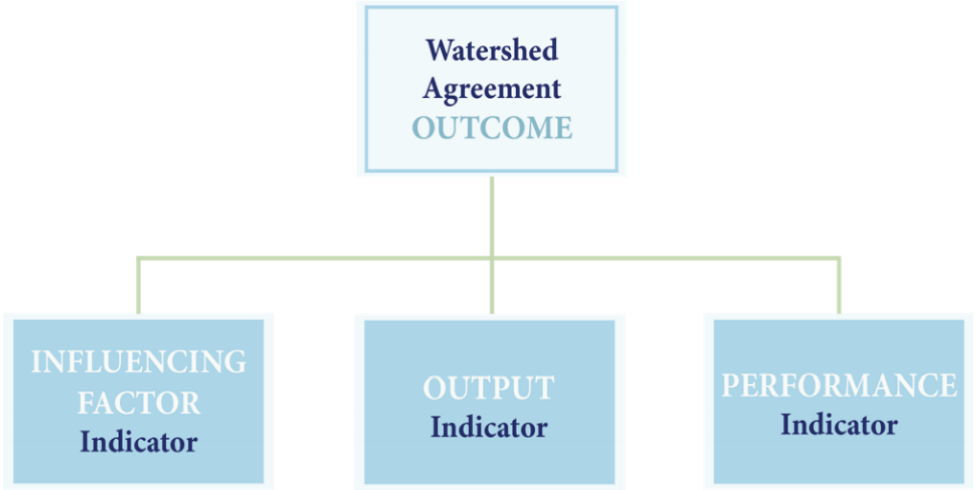
Reasons for Using Environmental Indicators

EVALUATE STATUS AGAINST ENVIRONMENTAL OBJECTIVES,

TO COMMUNICATE THE STATE OF THE ENVIRONMENT TO THE GENERAL PUBLIC AND DECISION MAKERS, AND

AS A DIAGNOSTIC TOOL THROUGH DETECTING TRENDS IN THE ENVIRONMENT.

Indicator Framework – Types of helpful indicators



Information Support

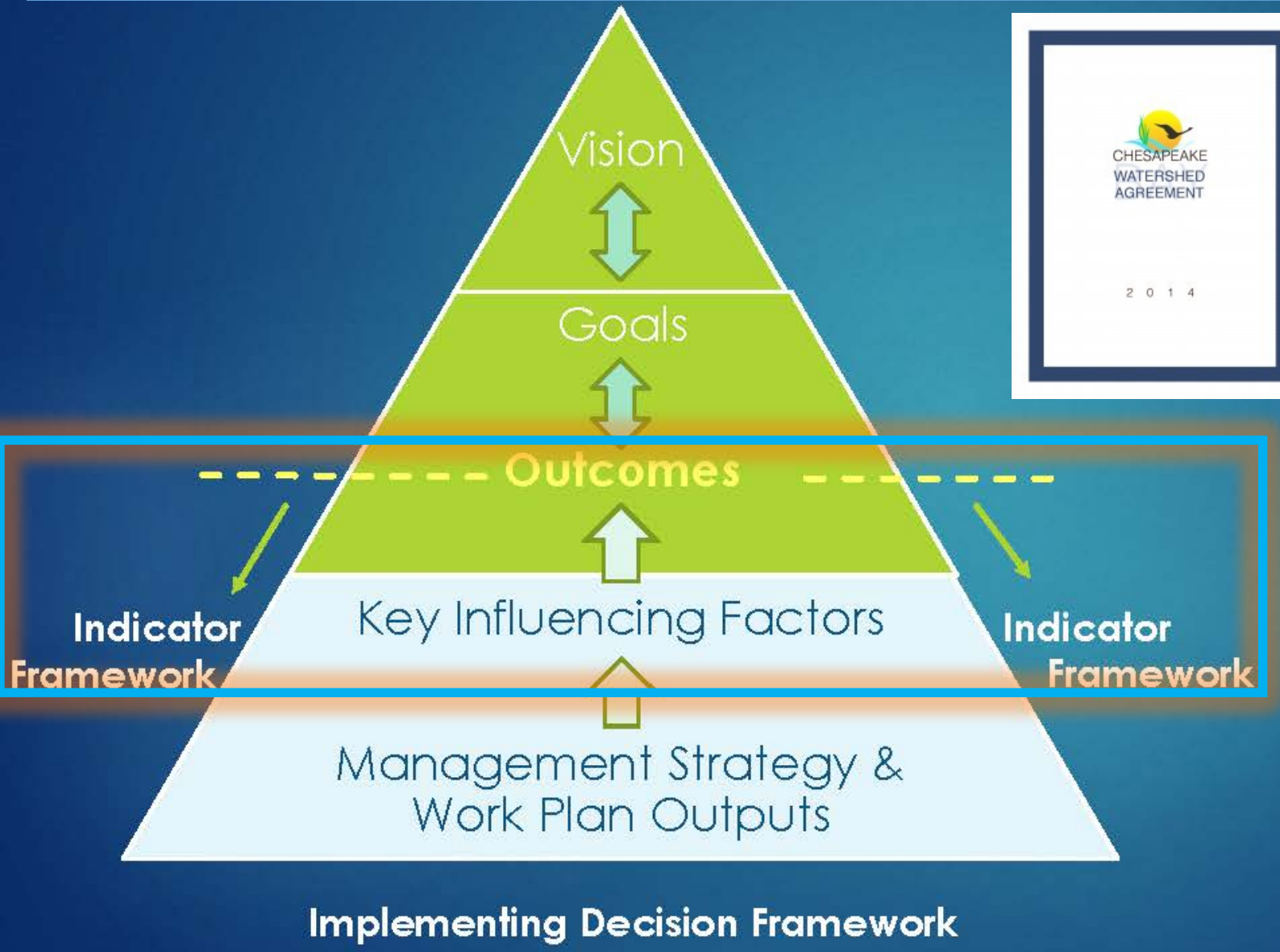
Three information types are needed to support adaptive management and communication needs.

Influencing Factors – What KEY influencing factors are impacting the achievement of an outcome?

Outputs – Are we doing what we said we would do in our work plans and management strategies?

Performance – Are we achieving the outcome?

Aligning the Indicators Framework with the 2014 Watershed Agreement



FINDING: The NEW Indicators Framework is **ALIGNED** with the Agreement at the Outcome level.

Agreement GOALS that support achieving the **VISION** flow from the Vision and are aligned with the mission of the CBP.

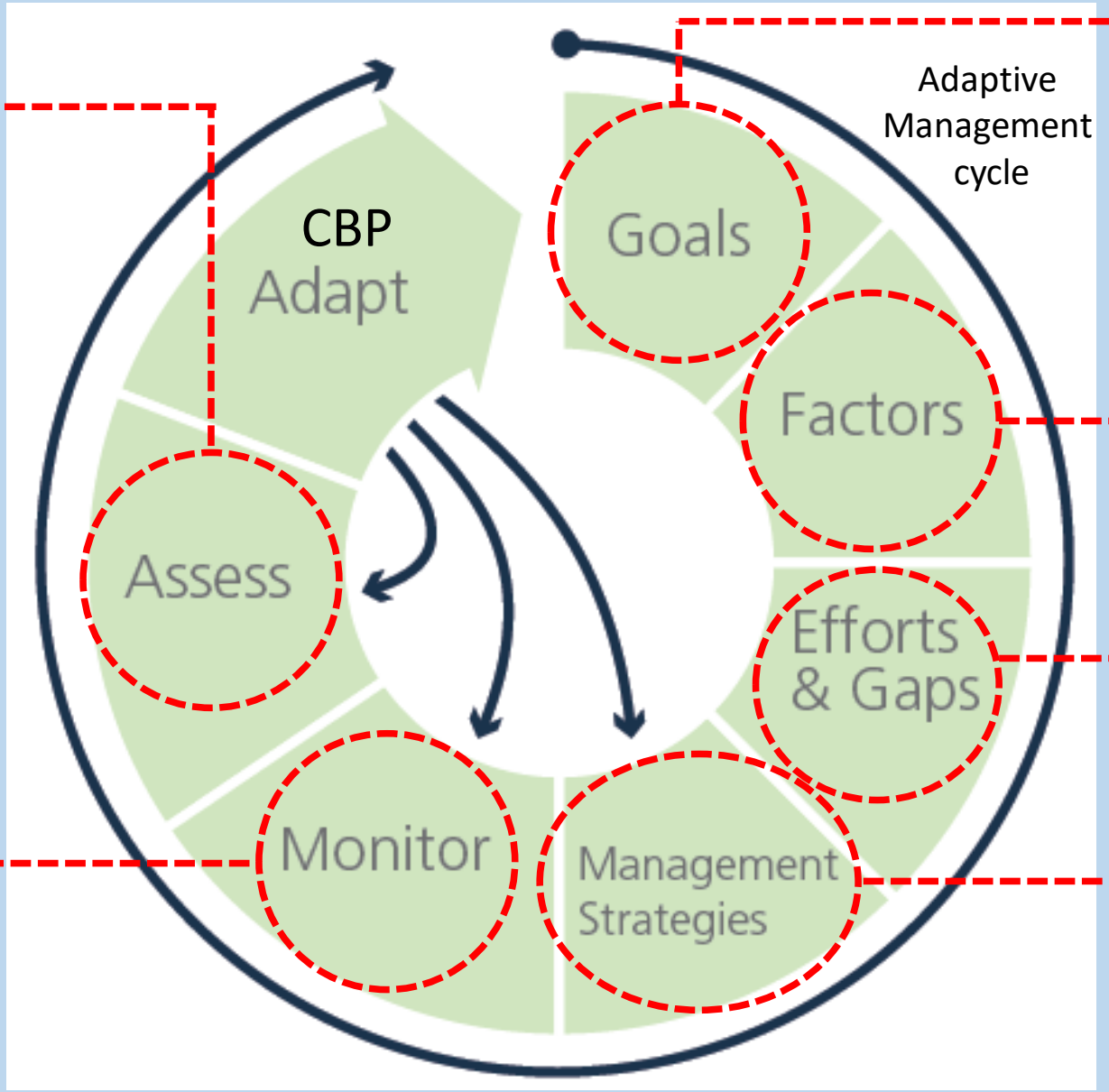
Agreement OUTCOMES are those aligned with the CBP mission, programs and resources and support achieving the Goal.

Outcomes are achieved through implementing the Decision Framework.

Status and Trends Workgroup works with STAC and STAR to support the GITs on Indicator choice and development.

STAC

Performance Assessment. Effectiveness of Management Actions.



STAC

What are the Current Conditions? Identify need for progress.

STAC

Identify the Impacts of stressors.

STAR

Monitoring Network Design to Support Adaptive management.

STAR

How do we fill Monitoring, Research, and Assessment Gaps? Implementation.

L. Rubin et al. BEI Report

Important Indicator Qualities: Top 10!

1. **Simple and easy to understand**
2. Be scientifically well-founded
3. Have a reference or threshold value of significance
4. Be responsive to changes in the environment
5. Show trends over time
6. Feasible to measure and report (reasonable cost/benefit ratio)
7. Updated regularly with reliable procedures (timely with support of a monitoring program)
8. Adequately documented, known data quality
9. Be useable by the community
10. Policy relevant

Additional indicator qualities to potentially keep in mind

- **Clear in value:** no uncertainty about which direction is good and which is bad.
- **Clear in content:** easily understandable, with units that make sense.
- **Compelling:** interesting, exciting, suggestive of effective action.
- **Policy relevant:** for all stakeholders in the system.
- **Feasible:** measurable at reasonable cost.
- **Sufficient:** not too much or too little information.
- **Timely:** compliable without long delays.
- **Appropriate in scale:** neither over- nor under-aggregated.
- **Democratically** chosen and accessible.
- **Supplementary:** include what people cannot measure for themselves.
- **Participatory:** make use of what people can measure for themselves and compile it to provide geographic or time overviews.

Selected from a report to the Balaton Group by the Sustainability Institute: "Indicators and information systems of sustainable development"

Indicator Support at the CBP includes your A&M Documentation

Chesapeake Bay Program | Indicator Analysis and Methods Document

Water Quality Standards Achievement | *Updated 8/2/2016*

Note: This document is currently under review and should be considered draft at this time.

Indicator Title: Water Quality Standards Achievement

Relevant Outcome(s): Water Quality Standards Attainment and Monitoring

Relevant Goal(s): Water Quality

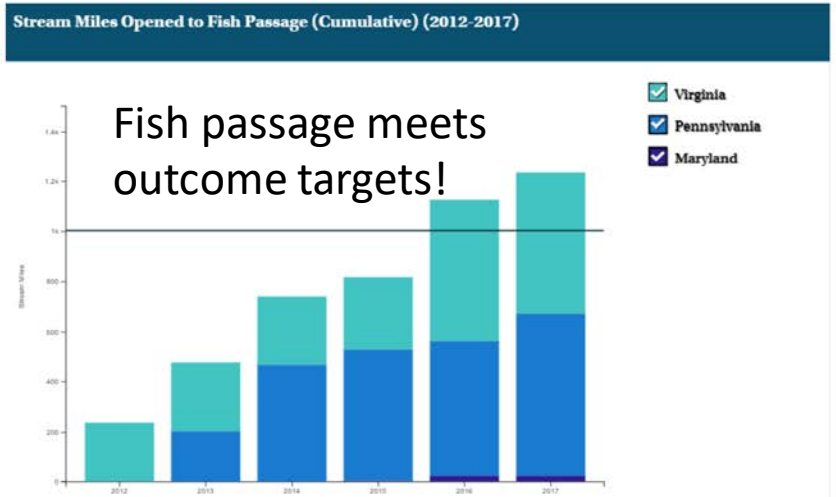
Location within Framework (i.e., Influencing Factor, Output or Performance): Performance

Chesapeake Progress: Our "Analytical & Methods" documentation with each indicator reflects good indicator characteristics.

- **A. Data Set and Source**
- **B. Temporal Considerations**
- **C. Spatial Considerations**
- **D. Communicating the Data**
- **E. Adaptive Management**
- **F. Analysis and Interpretation**
- **G. Quality**
- **H. Additional Information (*Optional)***

Reminder: A Good Indicator

- reflects the current state of environmental problems
- is scientifically grounded
- is measurable with a simple measurement unit
- Is comparable to current and past measures;
- long term;
- policy-relevant;

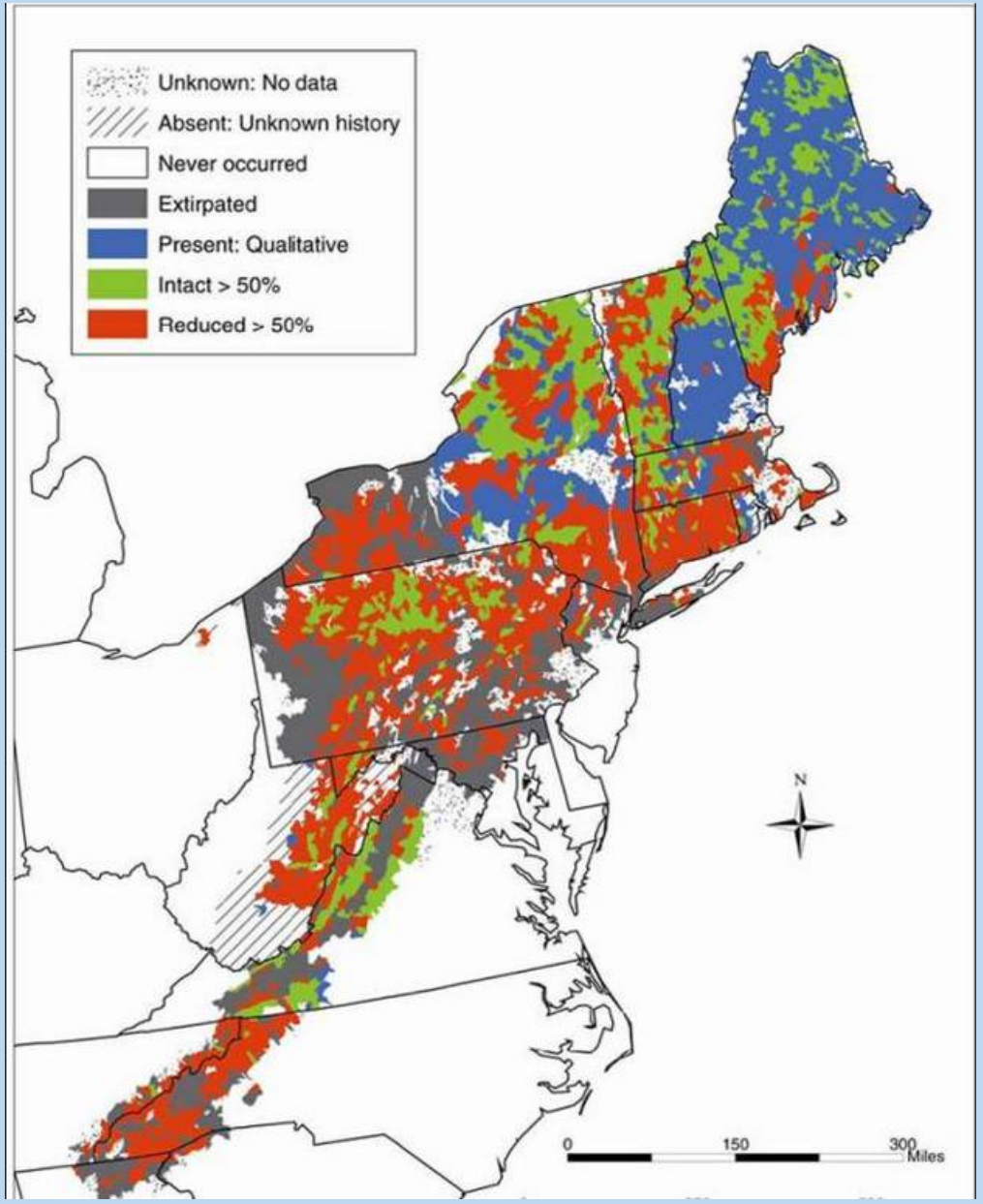


Practical example for Indicator development: Options and Approaches for a Brook Trout Indicator

- Direct measure
- Direct estimate
- Indirect estimate

Brook Trout Indicators

- **Direct measure**:
  - Census the entire Chesapeake watershed and indicate if brook trout were present or absent in each “patch” of available habitat.



Hudy et al. 2008

What is a census?

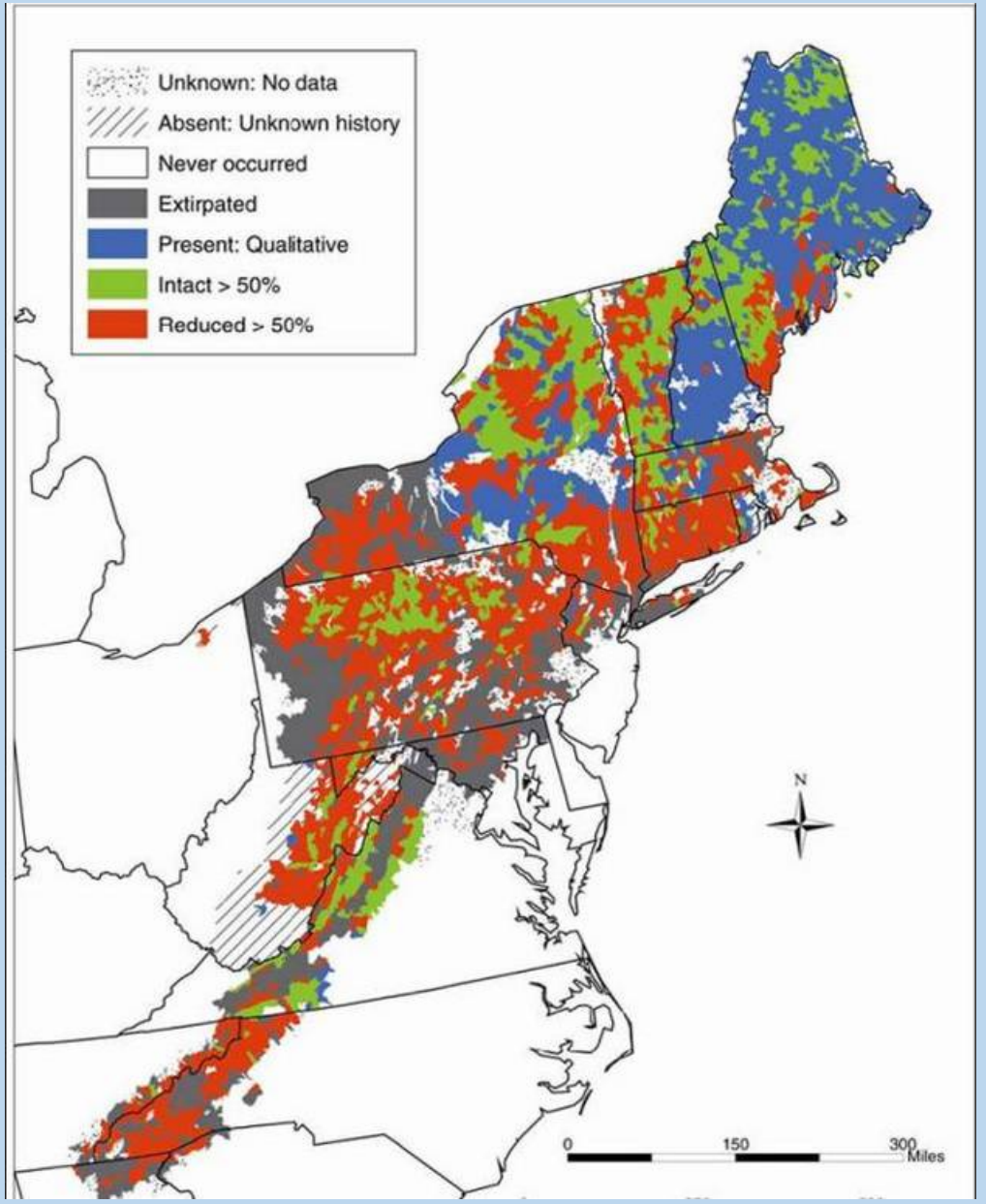
- Legal Definition of census: a **usually complete count of a population.**

Brook Trout Indicators

- **Direct measure approach**:
  - Census the entire Chesapeake watershed and indicate if brook trout were present or absent.
  - Acres of occupied habitat/total acres available *100 = % occupied.

  - This is the answer for % occupancy. We don't need to estimate the measure of interest because we are sampling every catchment each sampling period.

A census of this scale is time and resource intensive, expensive, difficult to use as a monitoring program.



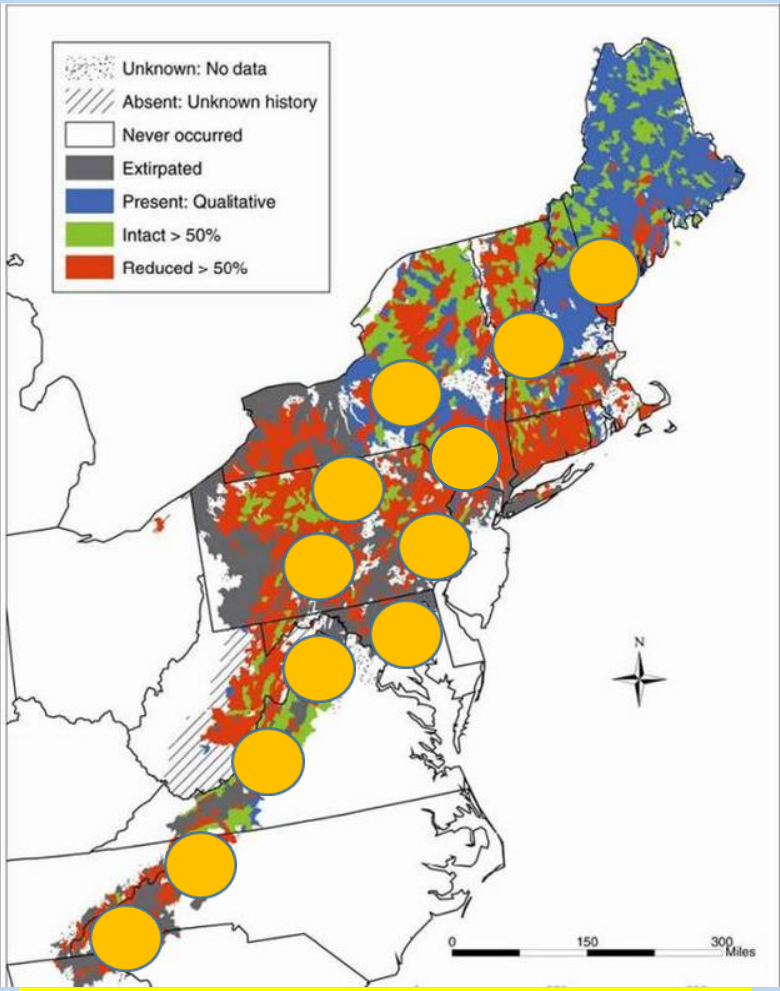
Hudy et al. 2008

Brook Trout Indicators

- Could we estimate occupied patches reliably?
  - Use sampling theory methods to estimate area occupied (probability sampling).

- **<u>Direct *estimate approach*</u>**

- There are over 3000 habitat patches available in the Chesapeake Bay watershed.
- Randomly sample a subset of the patches –
  - Fictitious example: 400 patches are sampled, 272 have brook trout. 272/400=68%. Let's say there are 4000 patches, how many patches out of 4000 have brook trout? With 95% Confidence, we can say it is 63% to 72%. As you resample year after year you can track change over time in the proportion. (.63 x 4000 = 2520, .72x4000=2880)

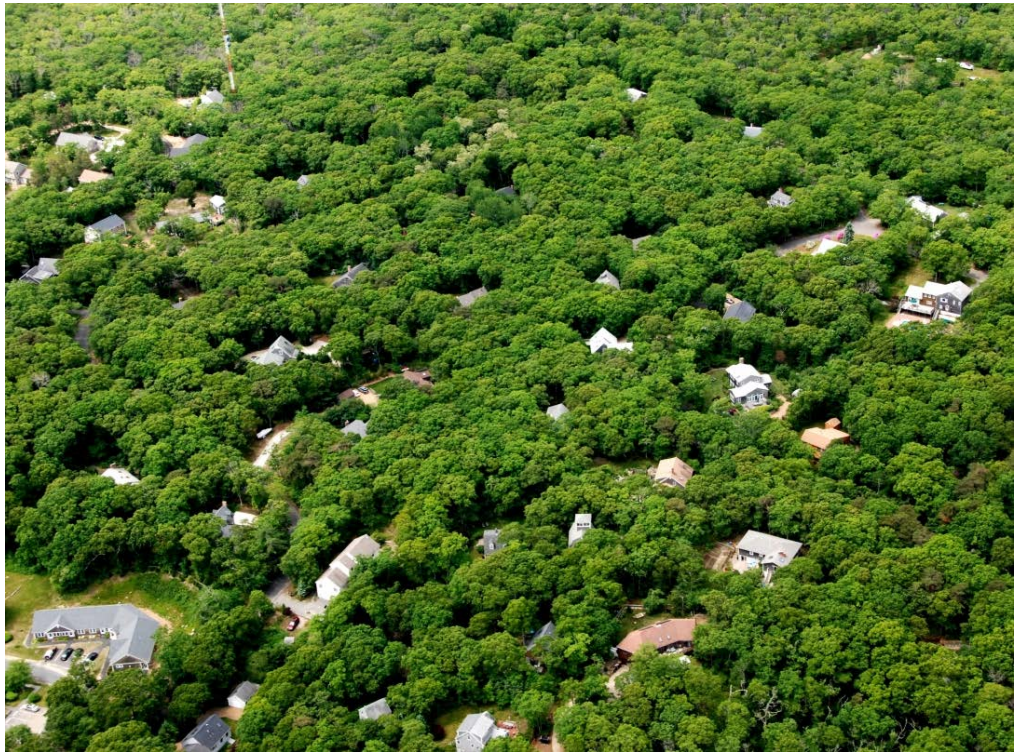


"Monitoring changes in patch metrics …in a monitoring design combining fixed annual "sentinel" patches and a rotating panel design for other patches has potential to be a cost-effective tool for managers to detect trends in wild brook trout populations."

Hudy et al 2013.

Brook Trout Indicators

- **Indirect estimate approach** – model the response of brook trout survival and extirpation to something else in the environment.



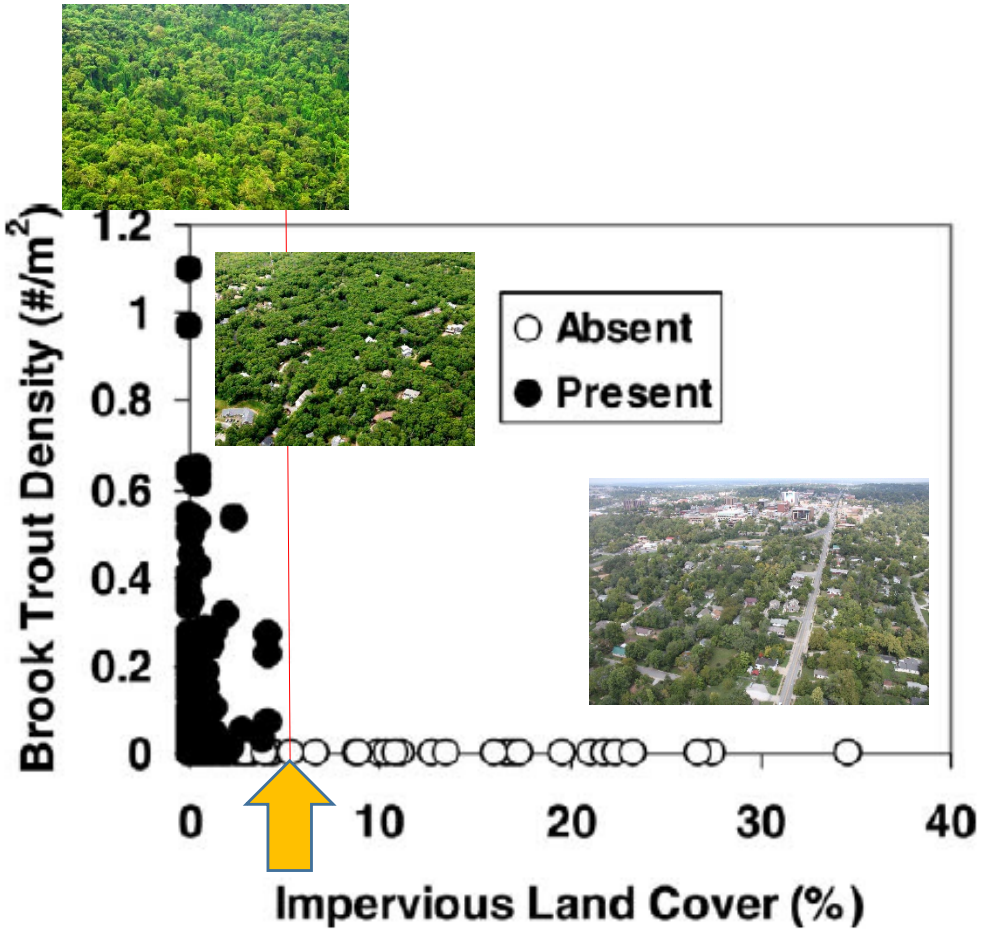
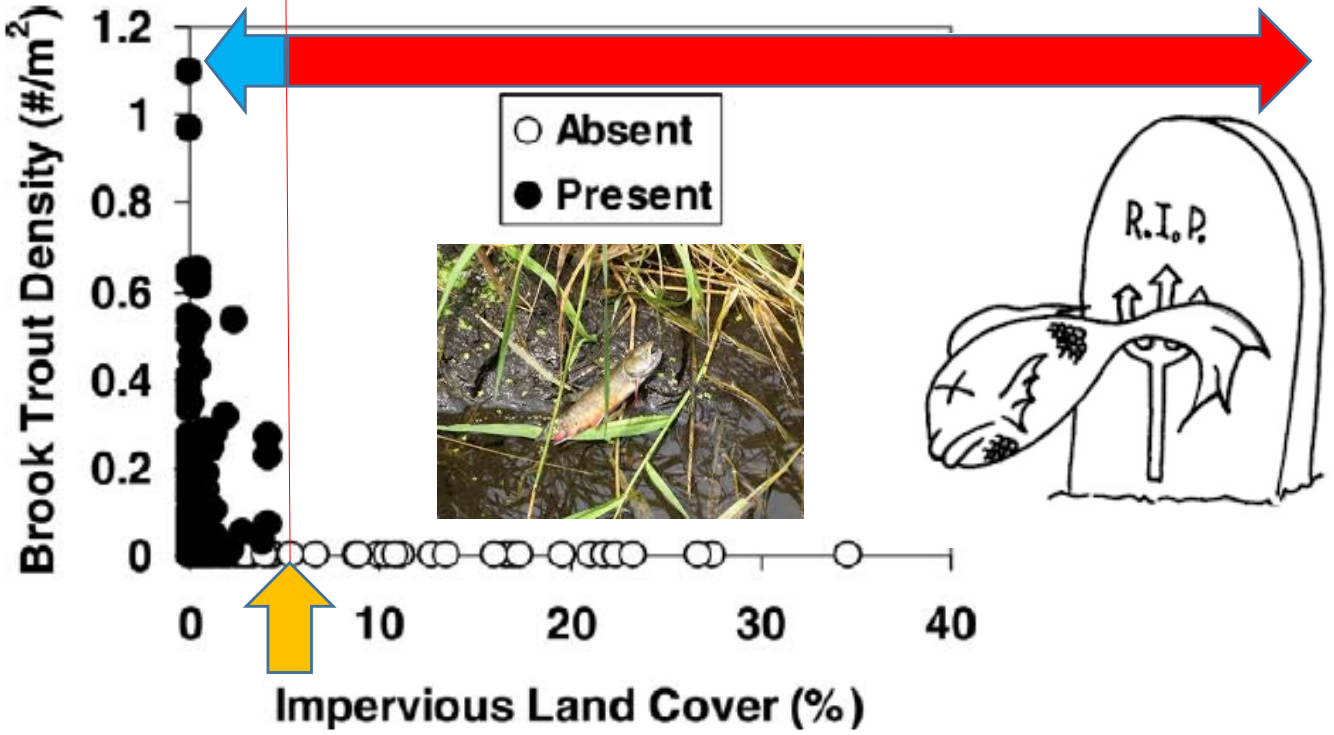


FIGURE 3.—Relationship between brook trout density (fish/m^2) and percentage of impervious land cover in Maryland stream catchments where the species was present and sites where the species was expected but absent.

Spatial assessment of brook trout presence absence with landcover.

Threshold Response of Brook Trout to impervious cover.

- Policy-relevant for land managers
- Social and economic relevance
- Supported by science
- Feasible to measure
- Simple to understand



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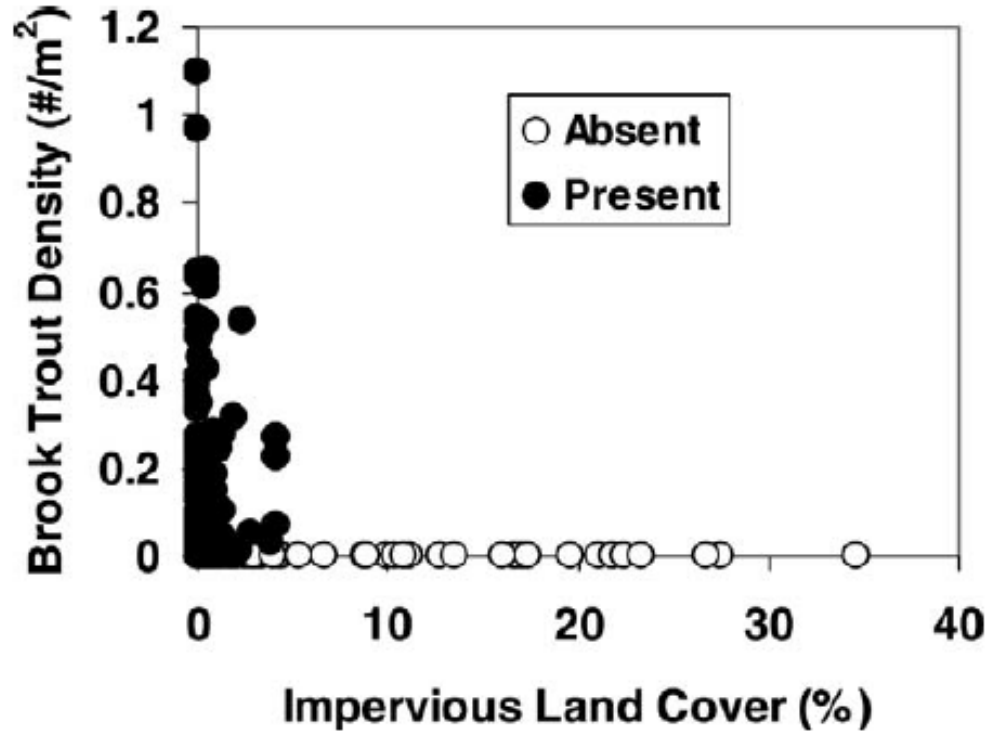

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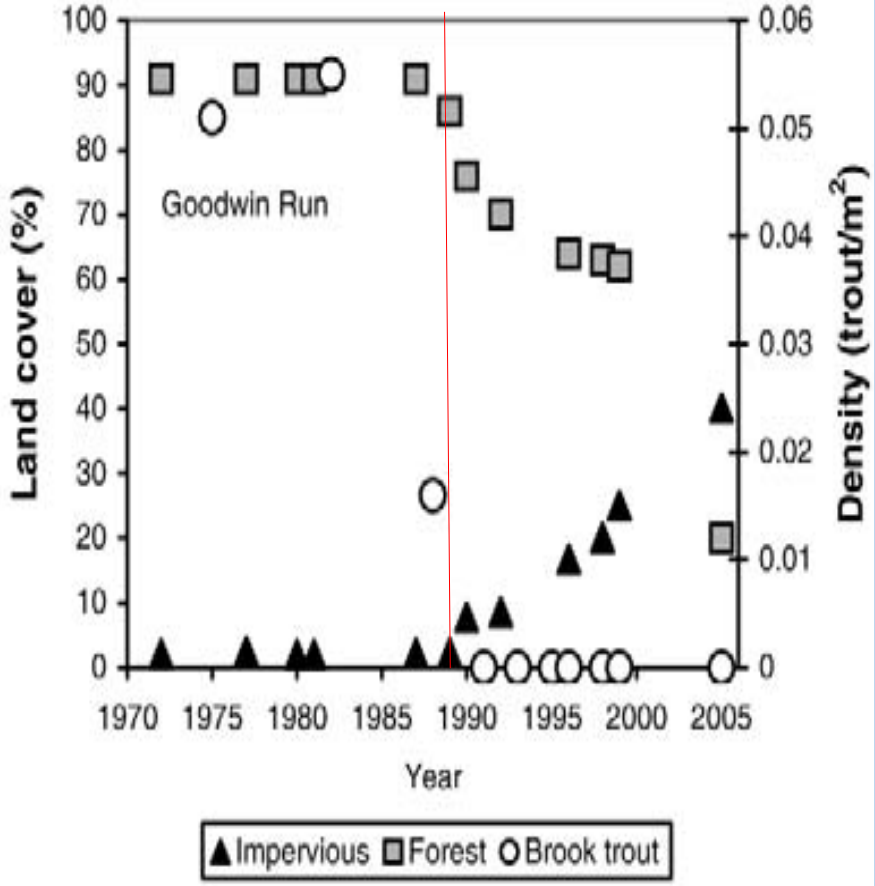
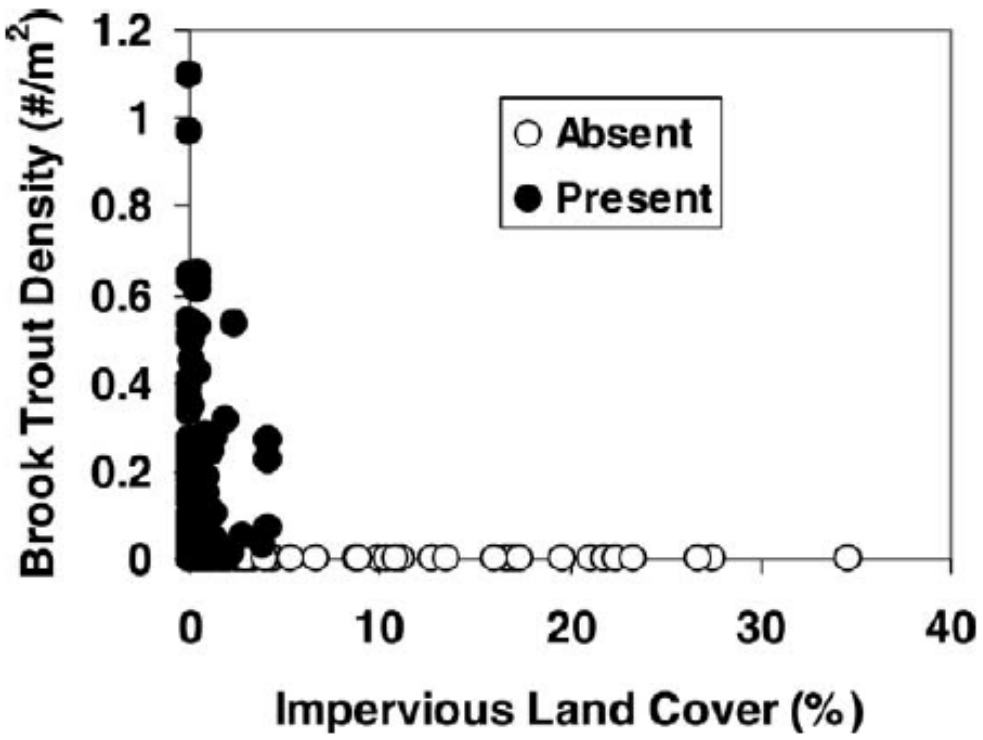


Temporal response of presence absence with landcover.



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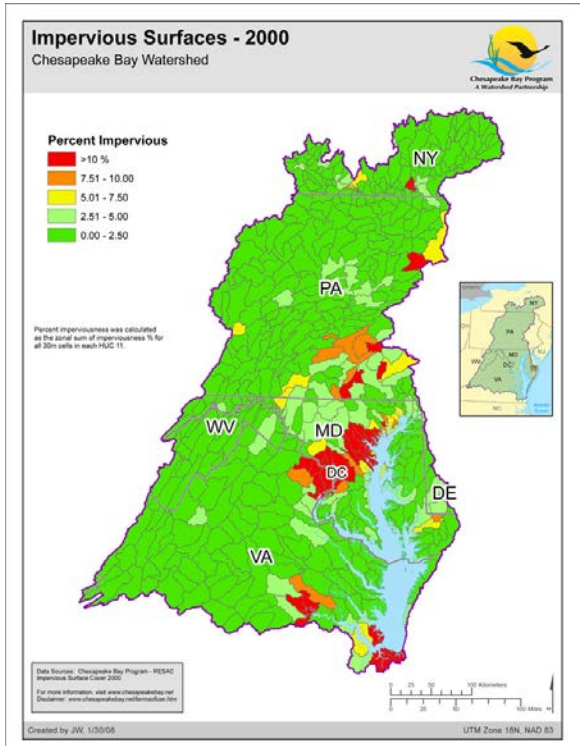
Spatial assessment of brook trout presence absence with landcover.

Indicator: LANDCOVER CHANGE TO >4% Imperviousness = Patch loss. <4% impervious = Patch maintained.

If the impervious landcover changes from below 4% to above 4% You can pretty much kiss that population good bye!



Example: Brook Trout Indicators

- Direct measure approach – time and resource intensive
- Direct estimate approach – cost effective option, field monitoring needs
- Indirect estimate approach – cost effective, GIS based analysis

- **With widely different levels of resources, with completely different information flows, we could effectively estimate brook trout patch area change over time.**

Summary

Checklist of good indicator qualities is a reference to keep in mind as we consider developing any indicator.

Our A-and-D documentation for *Chesapeake Progress* focuses indicator development for needed support material to defend it.

There are diverse approach options across a wide range of resource investments that are feasible to implement effective tracking indicators.

Investigate existing tools and resources to support efficient application of indicators and monitoring programs.

EXTRA SLIDES FOR REFERENCE

A Good Indicator is:

- simple and easy to understand by both experienced users and the general public;
- representative, reflecting the current state of environmental problems;
- scientifically grounded, based on a well-developed scientific platform (appropriate geographic area and/or an appropriate interval of time) and flexible;
- measurable (in the case of quantitative indicators) with a simple measurement unit;
- comparable to current and past measures;
- long term, taking into account possible future environmental changes;
- policy-relevant;
- timely, leaving opportunity for action; and
- results-oriented, focusing on measuring achievements.

Good Indicators (Lowell Center for Sustainable Development)

- address carrying capacity;
- are relevant to the community;
- are understandable by the community;
- are useable by the community;
- provide a long-term view; and
- show linkages.

A good indicator should be policy relevant and useful, analytically sound and measurable:

- provide a representative picture of environmental conditions, pressures on the environment and society's responses;
- be simple and easy to interpret and show trends over time;
- be responsive to changes in the environment and related human activities;
- provide a basis for international comparisons;
- be either national in scope or applicable to regional environmental issues of national significance; and
- have a threshold or reference value against which it can be compared so that users can assess the significance of the values associated with it.
- be theoretically well-founded in technical and scientific terms;
- be based on international standards and international consensus regarding its validity; and
- lend itself to being linked to economic models, forecasting and information systems.
- readily available or made available at a reasonable cost/benefit ratio;
- adequately documented and of known quality; and
- updated at regular intervals in accordance with reliable procedures.

Agricultural runoff is the largest source of stream pollution in Pennsylvania and the Bay, and the least expensive overall to reduce. Acid mine drainage is the second leading source of stream impairment here. Urban/suburban runoff is the third leading source.

http://pecpa.org/pec-blog/clean-water-efforts-benefit-pennsylvania-and-the-chesapeake-bay/

Acid Mine Drainage to the Chesapeake Bay Watershed - Literature Synthesis

Published: July 01, 1998

Land use activities in the Chesapeake Bay watershed are diverse and contribute significantly to water quality. Because of the long history of coal mining in the upper reaches of the Chesapeake Bay watershed, much concern has been generated regarding the impact of acid drainage from active and abandoned coal mines. The U.S. Environmental Protection Agency has singled out acid drainage from abandoned coal mines as the number one water quality problem in Appalachia. Acid mine drainage from abandoned coal mines is the most severe and extensive water pollution problem in western Maryland, West Virginia, and northern, central and western Pennsylvania. Within the Chesapeake Bay Basin, drainage from abandoned coals mines poses a significant threat to water quality in the Susquehanna. West Branch Susquehanna, and Juniata River basins in Pennsylvania, as well as North Branch Potomac River and its tributaries in West Virginia and Maryland.

Baseline:
Acid mine drainage has devastated at least 1,100 miles of streams in the Bay watershed,

Restoration:
The fish in Babb Creek, a northern Pennsylvania stream, have enjoyed such a comeback. Not long ago, the creek was the victim of heavy mining operations, most of which closed a century ago.
"There were about 13 miles of the mainstem and four tributaries that were totally dead," said Bill Beacom of the Babb Creek Watershed Association. "There were no fish, no insect life, nothing. Most people said there's nothing you can do about it, it's such a big problem."
Aggressive cleanup efforts began in the 1990s. The first signs of reproducing trout appeared by 2000. Last year, Babb Creek was reclassified as a wild trout stream.
"People just can't believe it," Beacom said. "I fish there all the time. It's great."

http://www.bayjournal.com/article/mining_operations_legacy_a_mother_lode_of_acid_drainage

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1.2% of AMD Affected area

http://www.bayjournal.com/article/mining_operations_legacy_a_mother_lode_of_acid_drainage

Approximately 150 Pennsylvania community groups have made AMD their primary focus, helped by regional organizations such as the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation.

Good results are starting to show in Kettle Creek, too. Treating one AMD drainage site restored water quality in 2,500 feet of the stream. Brook trout and aquatic insects returned within a year.

Joe Mills, who works with the Maryland Bureau of Mines, offers direct testimony to the highs and lows of AMD restoration. For 15 years, he has studied, repaired and nurtured AMD streams feeding the North Branch of the Potomac.

An environmental project more likely to have been spearheaded by the U.S. Environmental Protection Agency than elementary school students led to Garrett County Public Schools in rural western Maryland receiving the National Civic Star Award for 2008. The project, known as Crellin Elementary Corps of Discovery, evolved after students at a 2003 science camp noticed orange water seeping from a playground area into a stream known as Snowy Creek near the school property - See more at: http://www.learningfirst.org/repairing-and-using-environment#sthash.xyQxzCl6.dpuf

http://www.learningfirst.org/repairing-and-using-environment

2015

Winebrenner Run Acid Mine Drainage Remediation project – Allegany County

A $251,948 Mining Remediation Program grant to the Allegany Soil Conservation District, in addition to a previous $273,052 grant from the same program, will help fund the Winebrenner Run Acid Mine Drainage Remediation project.The project will address the effects of acidic and metal-laden water draining from an abandoned mine along a coal outcrop in the community of Midlothian.The untreated acid mine drainage affects the water quality of Winebrenner Run and Georges Creek and drains onto the properties of several homes and the Midlothian Schoolhouse.The project includes the demolition of the Midlothain Schoolhouse and proper handling of and disposal of materials such as asbestos and lead paint.Impaired water will be treated by a lime doser downstream of the site. The project will reduce the effects of untreated acid mine drainage on the community and improve the quality of the two waterways.

http://news.maryland.gov/mde/2015/08/26/board-of-public-works-approves-funding-for-clean-water-and-the-chesapeake-bay-18/

Gov. Tom Wolf Wednesday announced the selection of 114 projects to receive $25,143,294 in funding from Department of Environmental Protection, for the protection of Pennsylvania's water resources.

The selected projects enhance watersheds, mitigate acid mine drainage, and support water pollution cleanup programs.

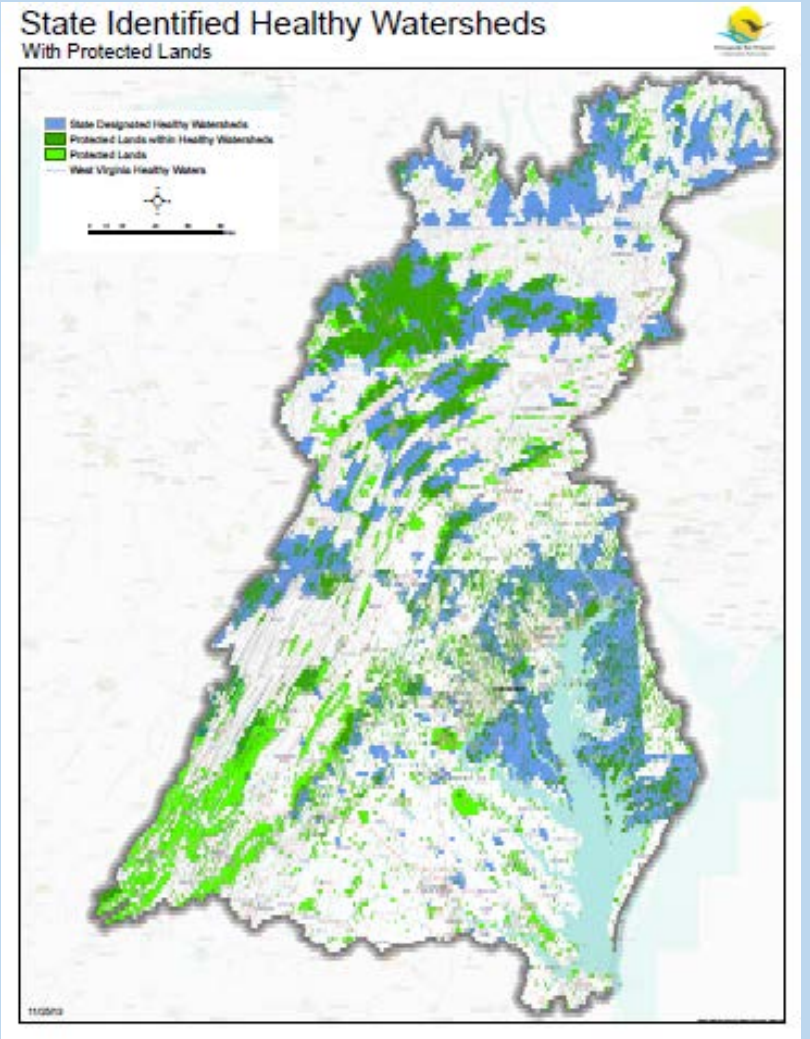
http://paenvironmentdaily.blogspot.com/2016/05/gov-wolf-awards-251-million-in-grants.html

Indicator Needs at CBP (Laura Free: Status and Trends WG)

Indicator in Development	Research in Progress	Need to Align with Agreement	No Indicator
• Environmental Literacy • Citizen Stewardship • Diversity • Oyster • Tree Canopy	• Forage Fish • Stream Health • Toxic Contaminants Policy and Prevention • Healthy Watersheds • Local Leadership • Climate Resiliency	• Black Duck • Brook Trout • Protected Lands	• Fish Passage • Forest Buffer • Wetlands

Example: Healthy Watersheds Indicator

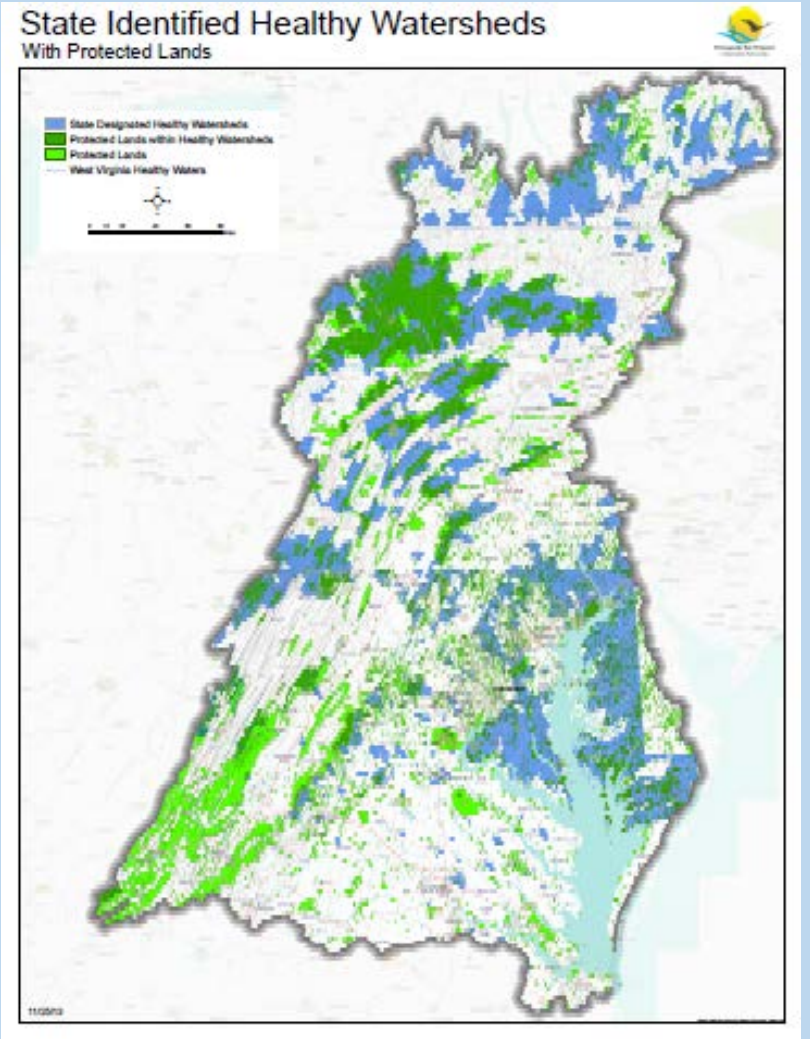
- ***Healthy Watersheds Outcome*** 100 percent of state-identified currently healthy waters and watersheds remain healthy.



Healthy Watersheds Indicator

- ***Healthy Watersheds Outcome*** 100 percent of state-identified currently healthy waters and watersheds remain healthy.

- By default – the decision rule comes down to whether any single criterion that defined a healthy watershed fails, the watershed fails.

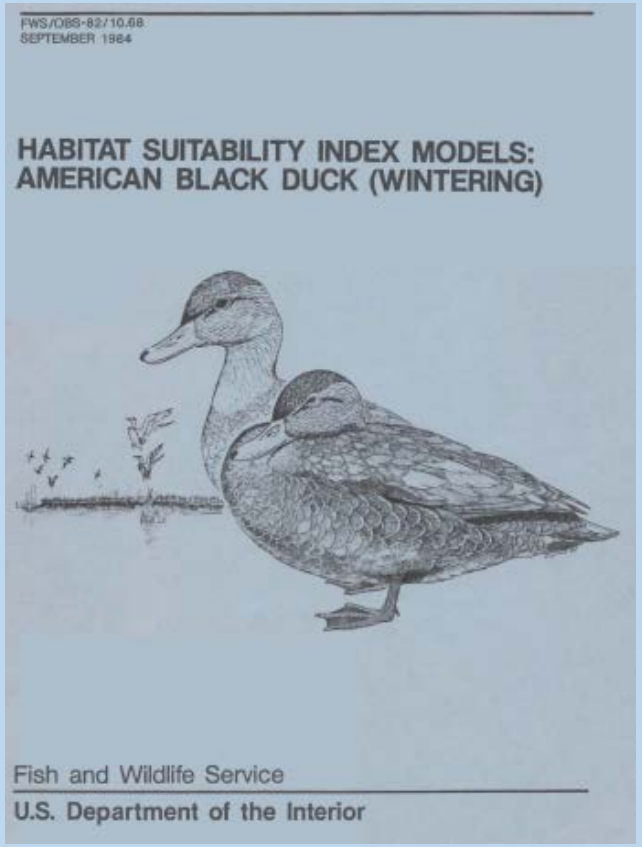


Black Duck Wintering Habitat

- Indicator under development

Black Duck – using existing science

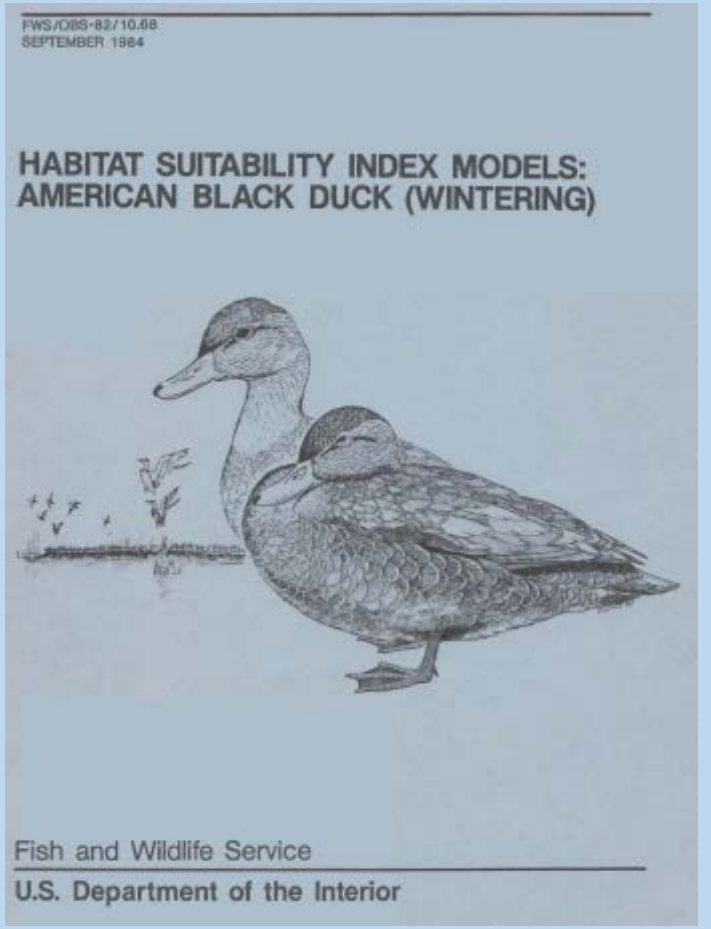
1984 USFWS published a wintering black duck Habitat suitability index



Black Duck – using existing science

1984 USFWS published a wintering black duck Habitat suitability index

Habitat	Equation
M and E open water north of Cape Cod, Massachusetts	$\left[\left(\frac{SI_{V_1} + SI_{V_2}}{2}\right)^2 \times SI_{V_4}\right]^{1/3}$
M and E open water south of Cape Cod, Massachusetts	$\left[\left(\frac{SI_{V_1} + SI_{V_2}}{2}\right)^2 \times \left(\frac{SI_{V_3} + SI_{V_4}}{2}\right)\right]^{1/3}$
E vegetated wetlands	$\frac{2\,SI_{V_5} + SI_{V_6} + SI_{V_7}}{4}$



Index of Community Waterbird Integrity (DeLuca et al.)

- The IWCI was used as a tool to gain insight into how human land use affects estuarine ecosystem integrity.
- 28 watershed study throughout Chesapeake Bay.
- The thresholds found by DeLuca et al. (2004) showed the marsh bird community is primarily vulnerable to disturbances at local scales.
- landscape stressors examined showed development near estuarine coastlines is the primary stressor to estuarine waterbird community integrity, and that estuarine ecosystem integrity may be impaired by even extremely low levels of coastal urbanization.

Index of Waterbird Community Integrity

- Pied-billed grebe (PBGR)
- Great blue heron (GBHE)
- Snowy egret (SNEG)
- Mute swan* (MUSW)
- Wood duck (WODU)
- Domestic duck* (DODU)
- Osprey (OSPR)
- Laughing gull (LAGU)
- Herring gull* (HEGU)
- Royal tern (ROTE)
- Forster's tern (FOTE)
- Belted kingfisher (BEKI)
- Double-crested Cormorant* (DCCO)
- Great egret (GREG)
- Green heron (GRHE)
- Canada goose* (CAGO)
- Mallard* (MALL)
- Bald eagle (BAEA)
- Spotted sandpiper
- Ring-billed gull* (RBGU)
- Great black-backed gull (GBGU)
- Common tern (COTE)
- Least tern (LETE)

*Site integrity scores reflect ecosystem integrity gradients for diagnostic assessments based on diverse criteria:

- Foraging niche breadth
- Nesting sensitivity
- Migratory status
- Breeding range
- State listing
- Native status

Index of Waterbird Communi

- Pied-billed grebe (PBGR) D
- Great blue heron (GB
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- Belted kingfisher (B

A Current Baywide Monitoring Plan exists!

WATERBIRDS OF THE CHESAPEAKE BAY

A Monitoring Plan

Edition 1.0

December 2013

By Bryan D. Watts

Center for Conservation Biology

College of William & Mary and Virginia Commonwealth University

nents

- ...tory status
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