



# Development of Climate Change Indicators and Metrics

Project Summary  
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## Today's Goals

1. Summarize the project goals and methods.
2. Share the results: a proposed suite of indicator topics.
3. Review the scoring and prioritization process that led to these results.
4. Discuss considerations relative to fish and fisheries.
5. Discuss how indicators will be developed and deployed.
6. Provide an opportunity for questions and answers.

## Project Background

- Project spearheaded by Climate Resiliency Workgroup
- FY'17 GIT funding awarded to Eastern Research Group, Inc. (ERG)
- Goal: develop a suite of indicators to track progress toward the “climate resiliency” goal and outcomes in the Watershed Agreement
  - Analogous to existing indicators on Chesapeake Progress website for other Watershed Agreement goals and outcomes
- Focus on selecting indicator topics
  - Full development of selected indicators as project resources allow
- Recognize connections to other goals and outcomes

## Specific Objectives

Track progress toward the climate resiliency goal and outcomes in the 2014 Watershed Agreement:

- **Goal:** Increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure, and communities, to withstand adverse impacts from changing environmental and climate conditions.
- **Monitoring and Assessment outcome:** Continually monitor and assess the trends and likely impacts of changing climatic and sea level conditions on the Chesapeake Bay ecosystem, including the effectiveness of restoration and protection policies, programs and projects.
- **Adaptation outcome:** Continually pursue, design, and construct restoration and protection projects to enhance the resiliency of Bay and aquatic ecosystems from the impacts of coastal erosion, coastal flooding, more intense and more frequent storms and sea-level rise.

# Three “Bins”

Look for three types of indicators:

Physical climate trends



Ecological and societal impact

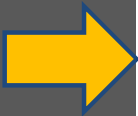


Programmatic progress towards resilience

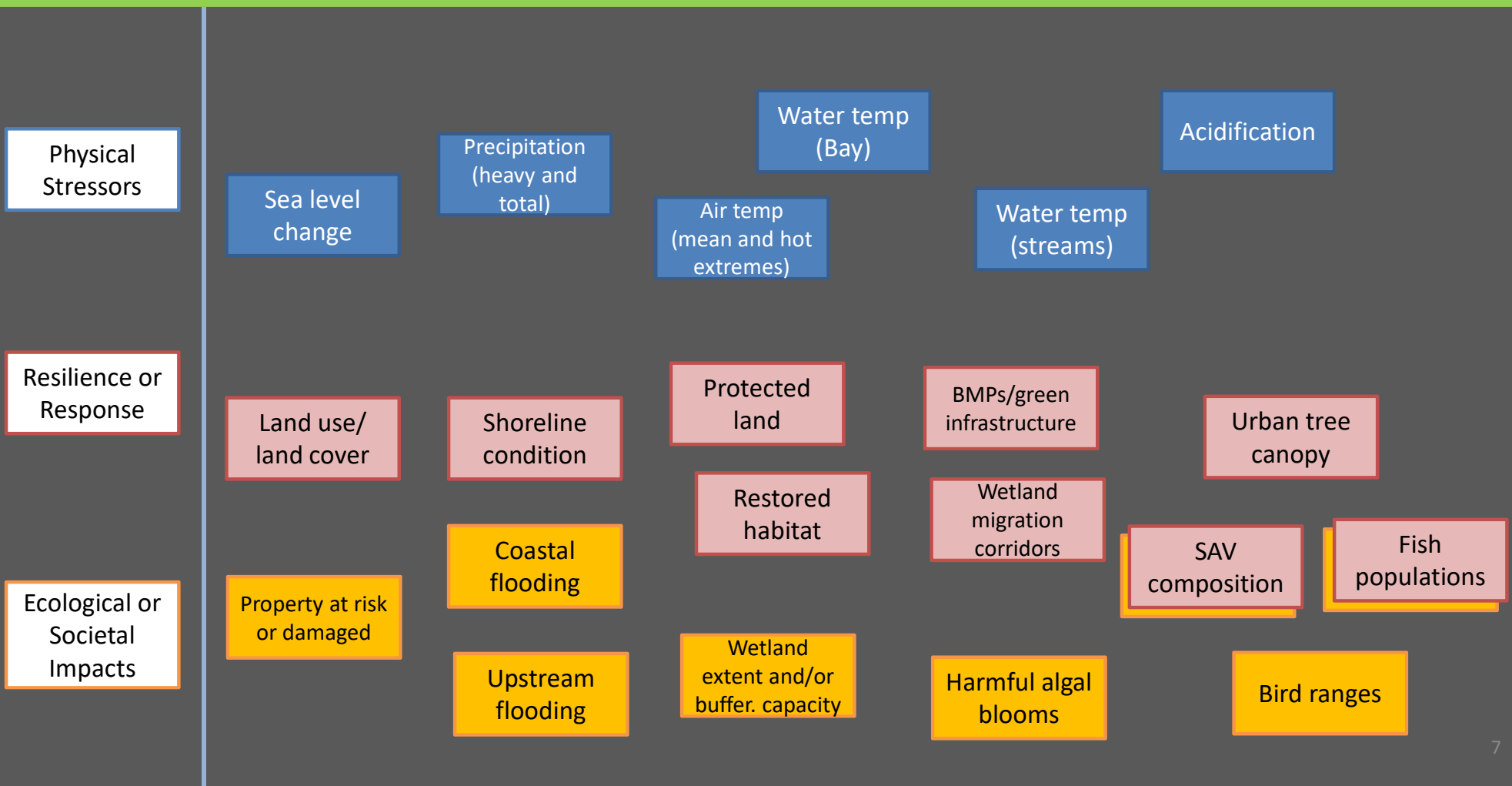


## Process and Timeline

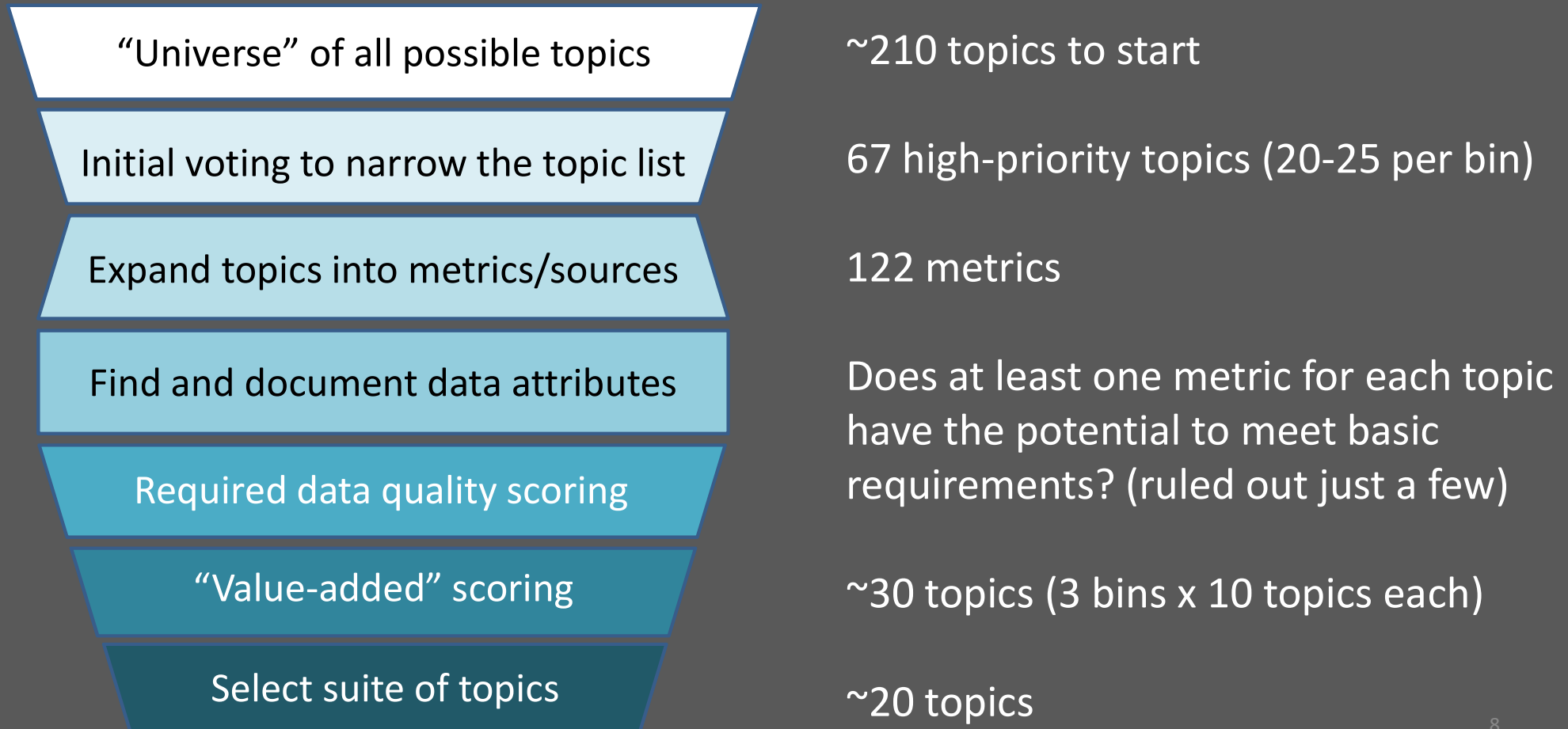
Step	Timeframe
Establish framework (categories, definitions, criteria)	May 2017
Compile lists of potential topics and data sources	May-June 2017
Evaluate candidate topics against the criteria	June-October 2017
Gather feedback and prioritize candidate topics	October-Nov. 2017
Flesh out sources and specific metrics for indicator topics; develop implementation plan	Dec. 2017-January 2018
Develop three to six indicators	Spring 2018
Compile final results	Summer 2018



# Proposed Suite of Climate Indicators



# How We Got There





## Summary of Scoring Steps

Scoring Step	Who Votes	Use
1. Initial value voting	Workgroups and other stakeholders	Narrow the list of topics to research and score in more detail; consider connections to other goal teams
2. Required data quality criteria	ERG data team	Eliminate topics that do not have a viable present or future indicator
3. Value-added scoring	Workgroups, other stakeholders, CBPO project team, ERG	Select topics that are strong contenders for the final suite
4. Suite criteria	CBPO project team, ERG	Select a cohesive final suite of topics
5. Desirable data quality criteria	ERG data team	Select the best data source(s) for each of the selected topics, if more than one option is available

## “Value-Added” Criteria

- Rate of change
- Significance of consequences
- Significant advancement in our understanding of climate
- Known new need
- Relevance to CBP management actions
- Relevance to climate resiliency goal and outcomes (“climate relevance”)

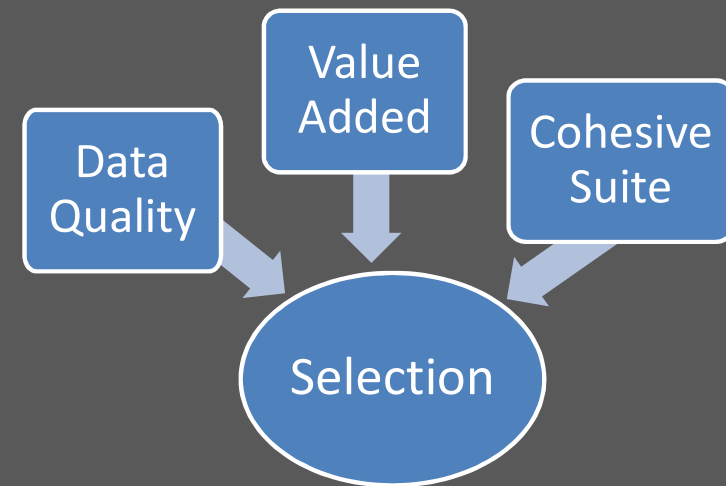
## Suite Selection Criteria

- Balance across bins
- Balance of tidal and nontidal/watershed-wide
- Balance of ecological and societal/human concerns
- Balance between breadth (diversity) and depth (causal relationships or “threads” among indicators)

## The Desired End Result

A suite of indicators that...

- Meet basic criteria for indicator quality
- Use the best available data
- Add value in achieving the project objectives (**based on diverse input**)
- Achieve synergies together (**whole is greater than sum of parts**)

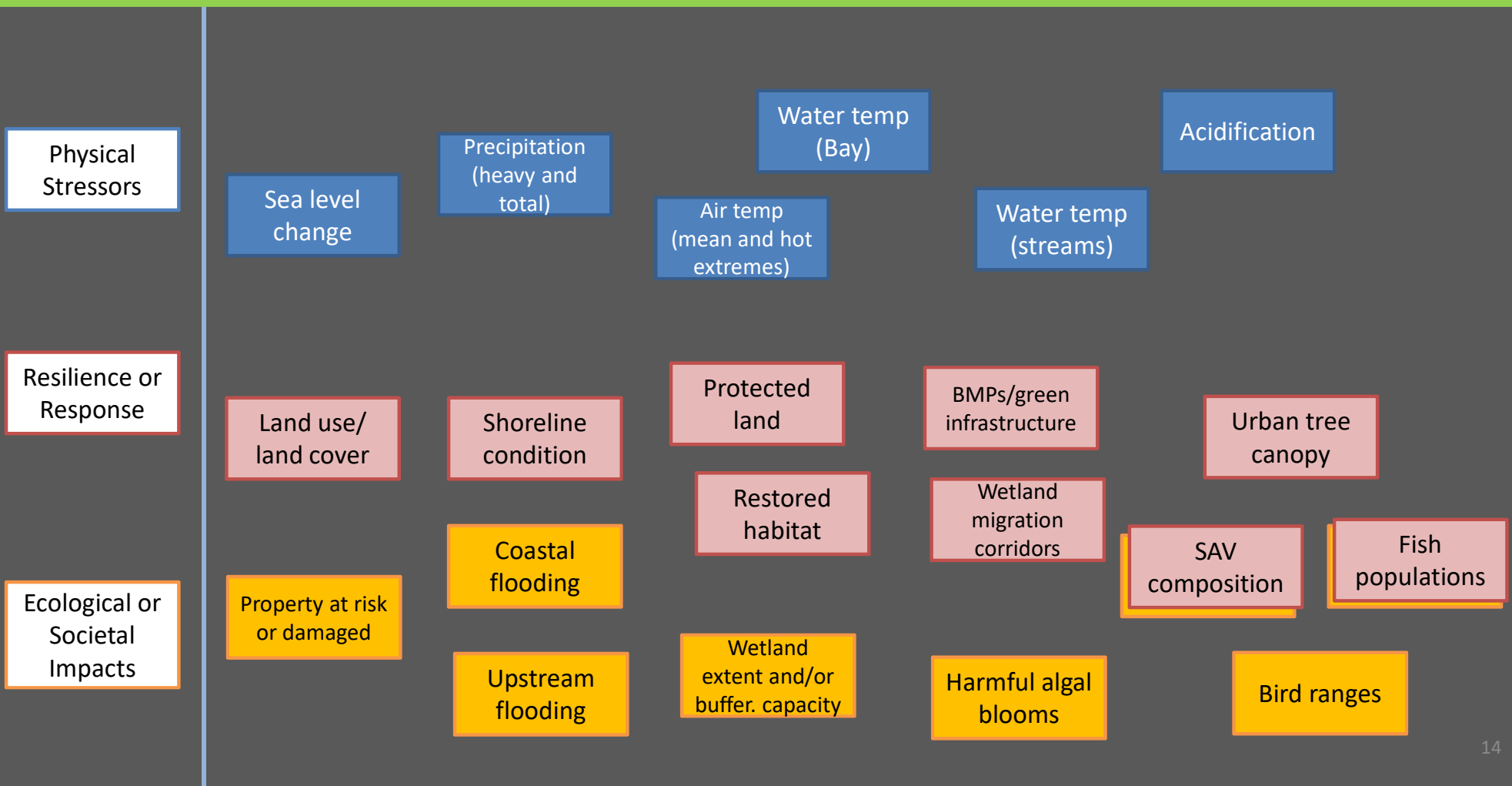


## The Desired End Result (continued)

- All indicators in the suite must at least be feasible, but...
- Suite selection is independent of:
  - Current status (existing vs. proposed indicator)
  - Level of effort to construct
- Resource requirements will be considered in the implementation plan

In other words, the suite represents the **indicators we want**.  
Resources will determine the **indicators we get**.

# Proposed Suite of Climate Indicators



# Indicator Development and Deployment

- Implementation plan
  - Identifies potential sources, next steps, and anticipated costs and timelines
- ERG to develop “low-hanging fruit” (up to six of 21 indicators)
- Future development of other indicators will be driven by CRWG priorities and resources

## Indicators Grouped by Feasibility

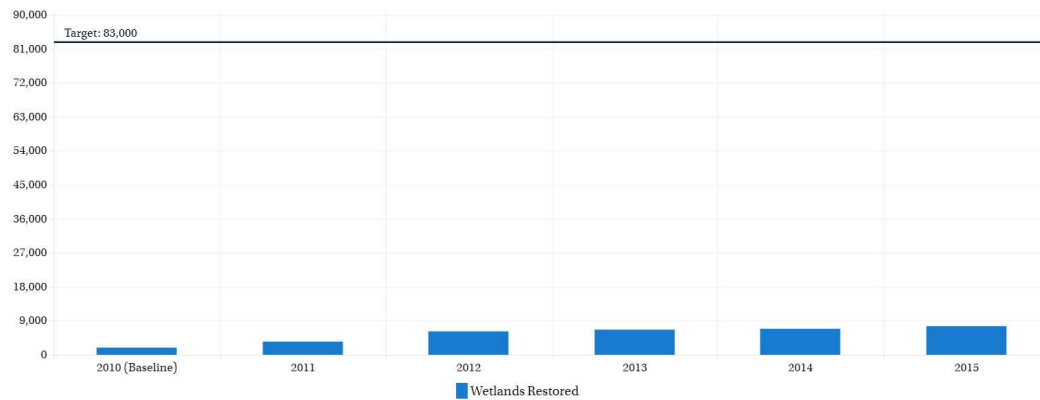
Group	# of indicators	Status
A	2	Chesapeake indicator already exists
B	6	National indicator; just needs to be clipped or cropped
C	6	Indicator defined, but need to process data and develop indicator
D	5	Data likely exist, but need to define and develop indicator
E	2	Could require new data collection program, TBD



# Group A Example: Restored Habitat

## Metric: Wetlands restored

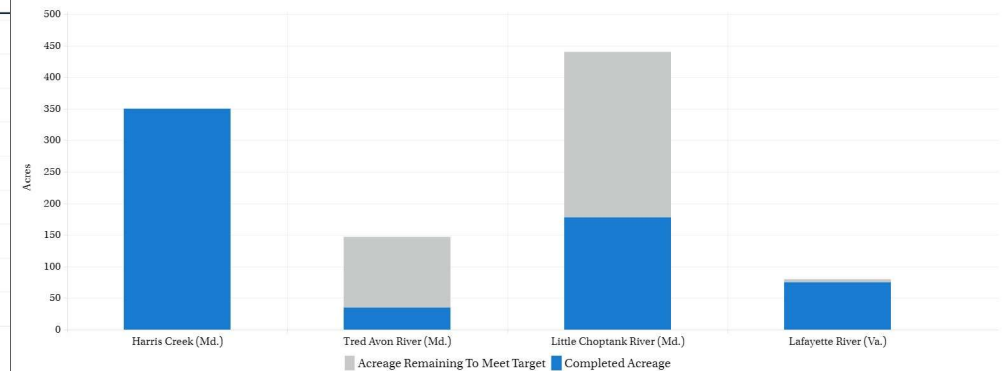
Wetlands Restored on Agricultural Lands (Cumulative) (2010-2015)



## Metric: Oyster reefs restored

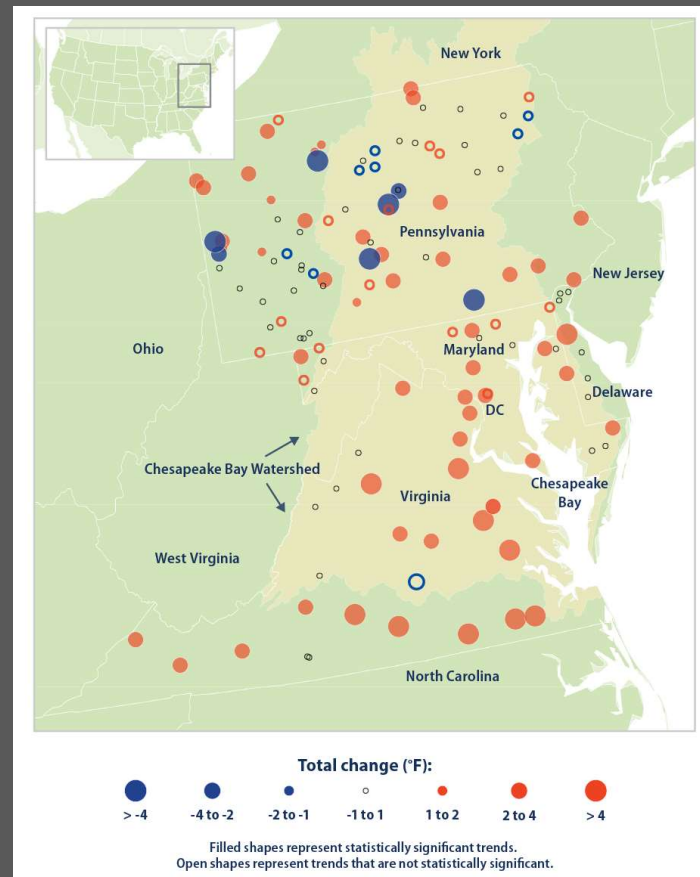
Oyster Reef Restoration (2017)

Individual acreage targets are based on a tributary's historic oyster habitat and currently restorable area. The Great Wicomico, Lower York, Lynnhaven and Piankatank rivers will be added to this chart once their target acreages are established.



# Group B Example: Stream Water Temperature

Metric: Annual mean temperature



## All Indicators Grouped by Feasibility

### Group A:

- Protected lands
- Restored habitat

### Group B:

- Air temperatures
- Coastal flooding
- Precipitation
- Sea level change
- Stream water temperature
- Upstream flooding

### Group C:

- Acidification
- Bay water temperature
- Harmful algal blooms
- Property at risk
- Urban tree canopy
- Wetland extent or physical buffering capacity

### Group D:

- Bird species ranges
- BMPs and green infrastructure
- Land use/land cover
- Shoreline condition
- Wetland migration corridors

### Group E:

- Fish population distribution
- Submerged aquatic vegetation composition

# Indicators of Particular Relevance to Fish and Fisheries

- Physical measures
- Habitat-related measures and activities
  - Shoreline condition metric development under another project
  - TBD: focus on extent of hardening? “living” shoreline? natural?
- Fish populations
  - Integrative index as proposed by Wainger et al. (2017):
    - Consider spatial distribution as a measure of resilience against locally variable stressors
    - Colonization of “edge” habitat facilitates adaptation

Water temp  
(Bay)

Water temp  
(streams)

Acidification

Shoreline  
condition

Restored  
habitat

Fish  
populations

## Fish Indicator

- Suggestion to track a suite of species that cover a range of habitats and trophic levels
- Other considerations:
  - Data source(s)
  - Metric(s) to characterize population distribution
  - Possibly proxy measures?
  - How (if at all) to isolate effects of climate; time of year?
- Suggestions from the group?
- Can you envision other uses for this type of indicator?

**Questions?**



Thank you!