University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

CBT Forage Indicator Development: Project kickoff meeting

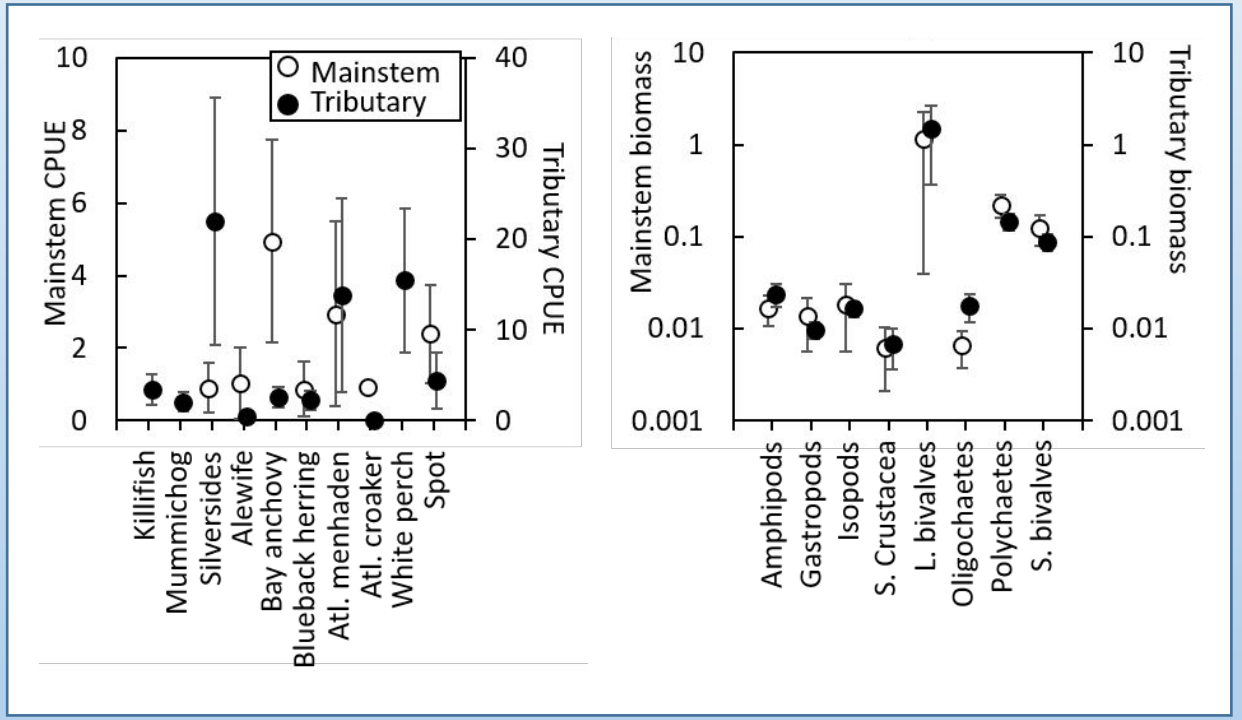
UMCES Team: Ryan Woodland, Edward Houde, Vyacheslav (Slava) Lyubchich

6/22/2021

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Ecosystem-Based Fisheries Management (EBFM)

- Forage a key component of EBFM
- Recent Chesapeake Bay research:
  - Key forage include invertebrates and small fishes
  - Taxon-specific patterns in abundance/biomass
  - Forage-environment relationships shared across taxa



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Project Goals

- Address stated needs of Chesapeake Bay Program
  - Calculate and provide updated forage population indices
  - Explore new variants of the forage population indices
  - Relate forage population indices to forage climate indices

- Focal forage taxa
  - Bay Anchovy (*Anchoa mitchilli*)
  - Polychaetes (marine annelids)

Images: https://www.inaturalist.org/guide_taxa/829795, https://en.wikipedia.org/wiki/Nereididae

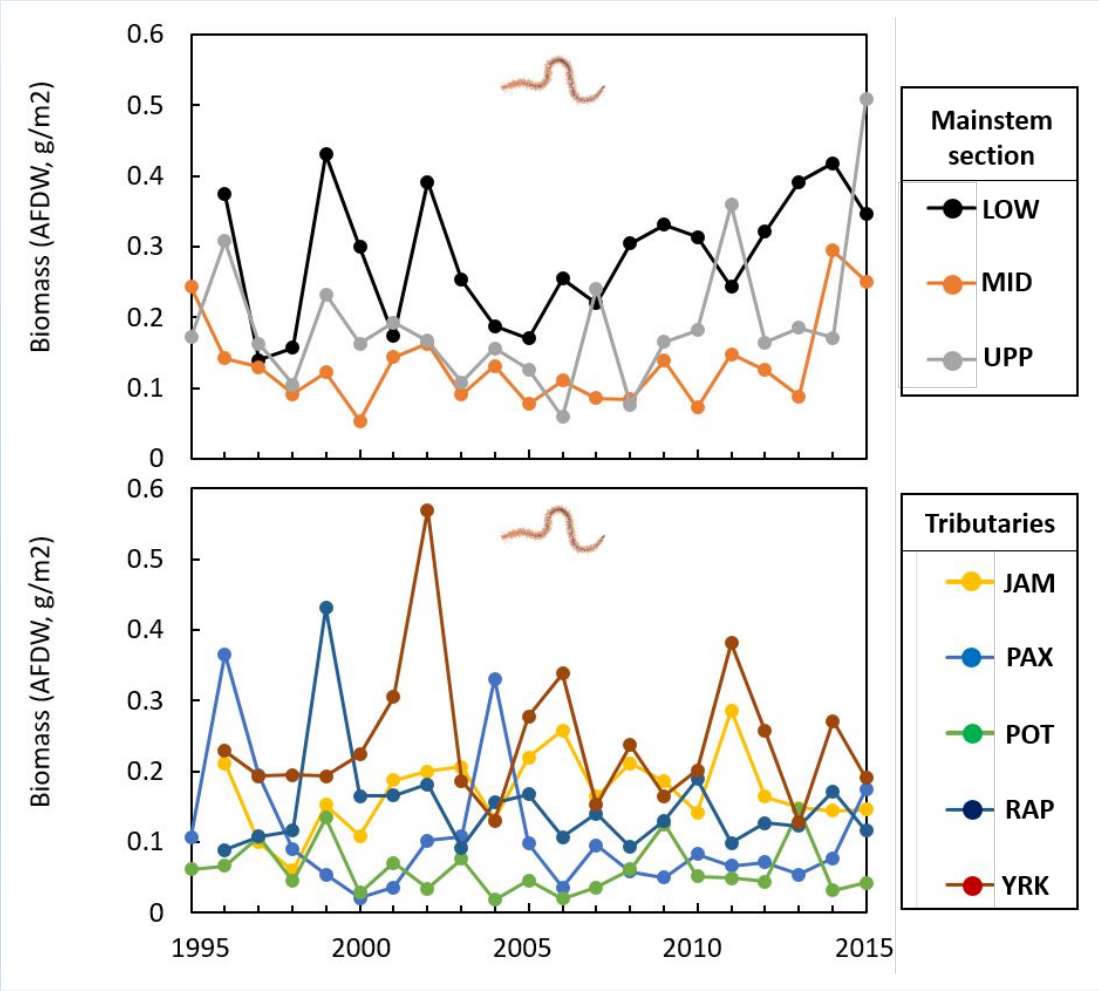
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

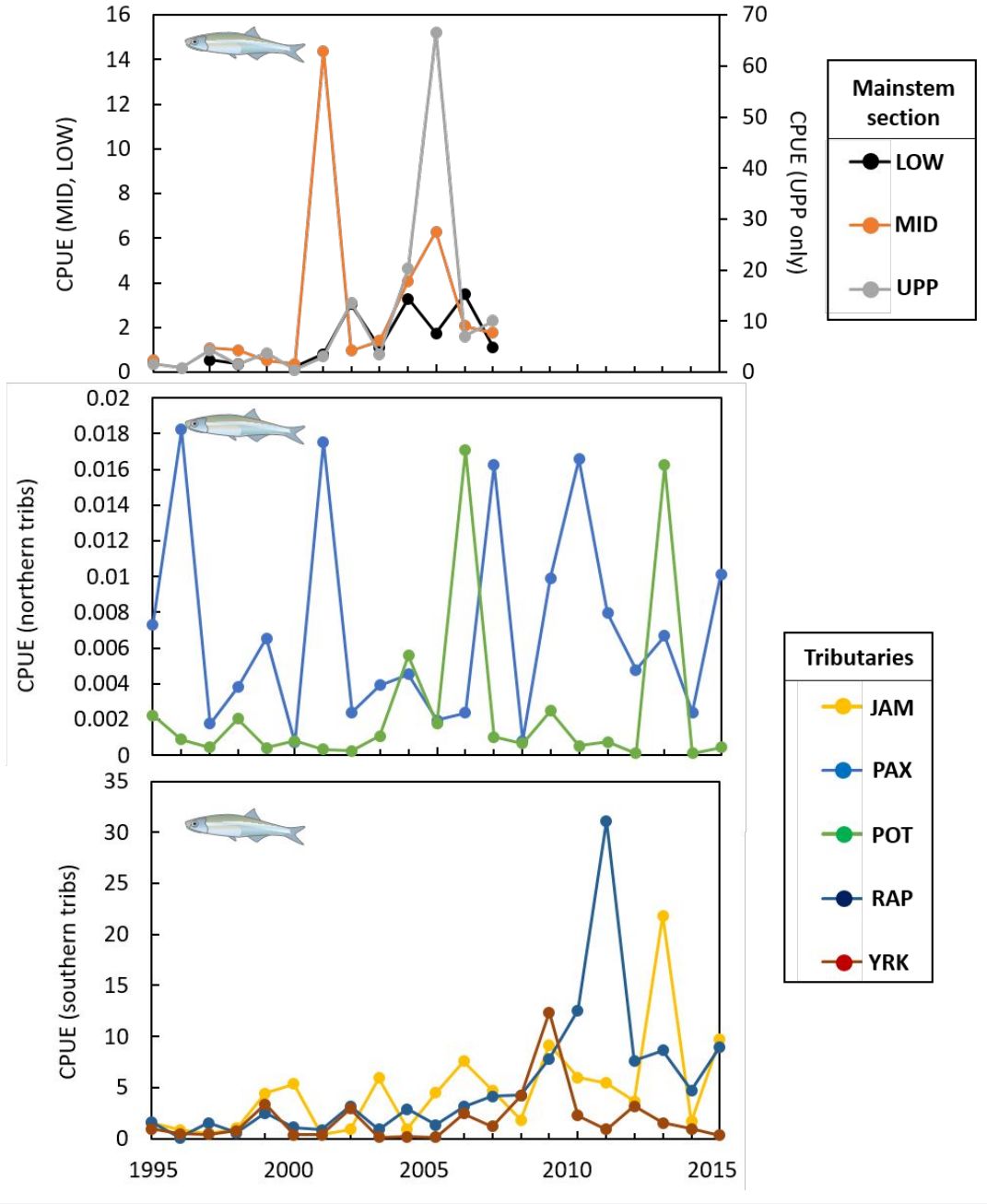
Proposed Methods: Forage indices

- Biota data sources
  - Chesapeake Bay Program
  - TIES/ChesFIMS
  - MD DNR/VIMS Seine survey
  - VIMS Juvenile Fish and Blue Crab Trawl survey
- Environmental data sources
  - Chesapeake Bay Program
  - NOAA National Data Buoy Center
  - NOAA Physical Sciences Laboratory
- Taxon index variants
  - Bay Anchovy
    - Age-1+ spawning stock index (Spring-ES)
    - Age-0 recruit index (LS-Autumn)
    - Total (annual index)
  - Polychaetes
    - Nereididae
    - Total (all taxa)

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Proposed Methods: Spatial and temporal extent

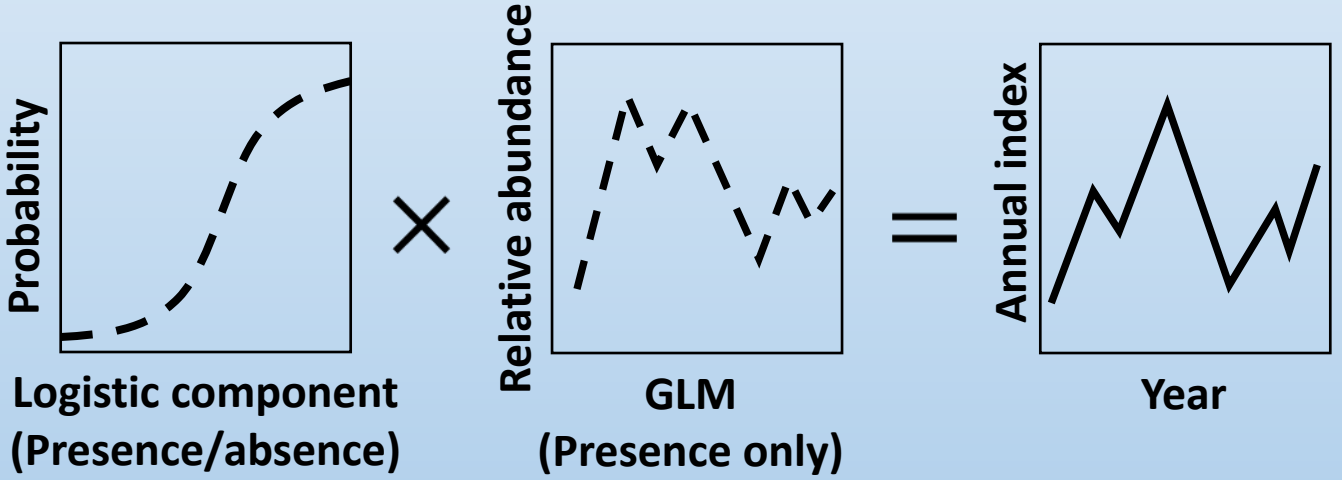




University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Proposed Methods: Calculating forage indices

Annual indices: delta-generalized linear models (Delta-GLMs)



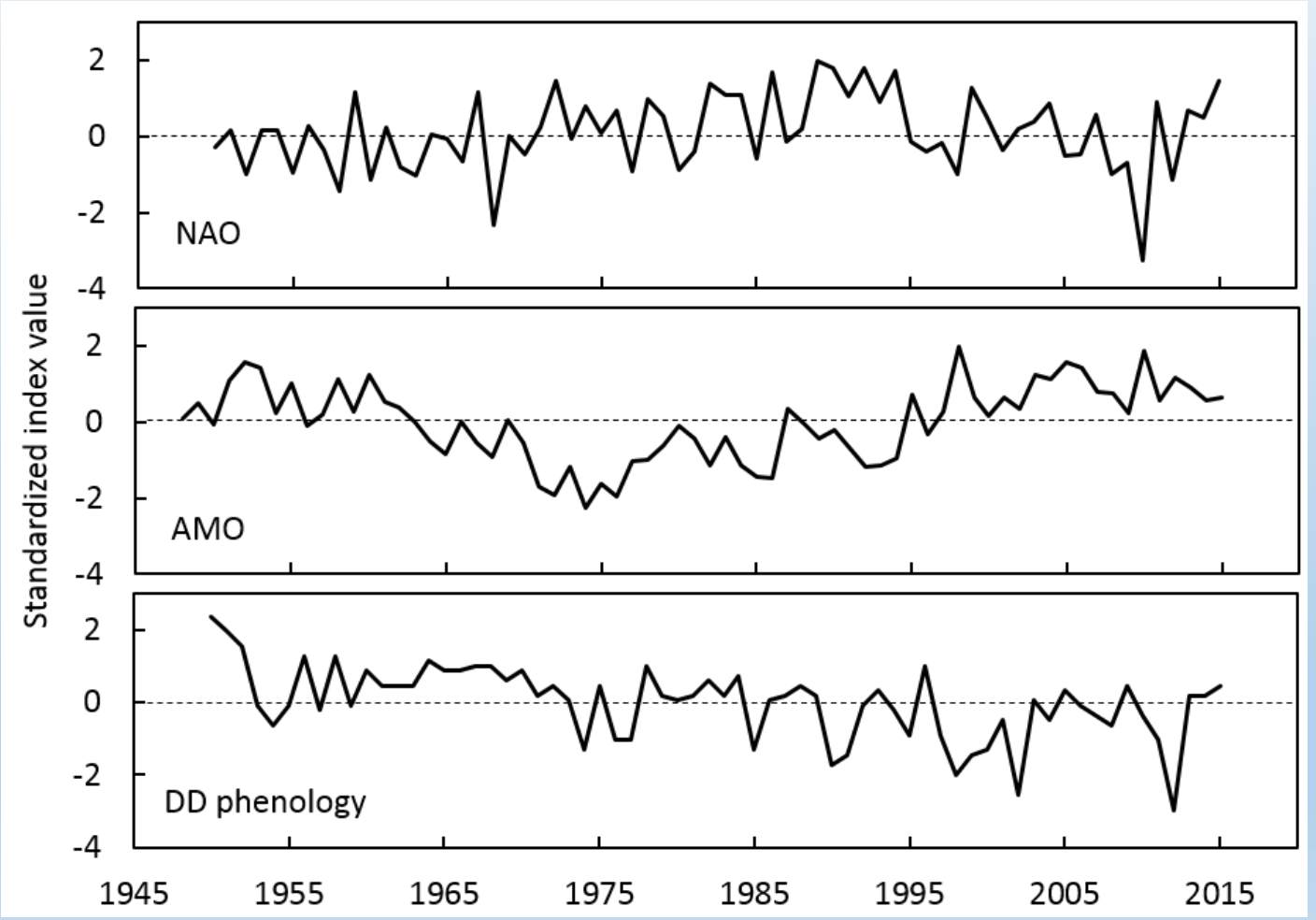
Additional model variables: Year, Section*, Depth

** 'Section' represents the spatial unit for a given calculation*

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Proposed Methods: Climate indices

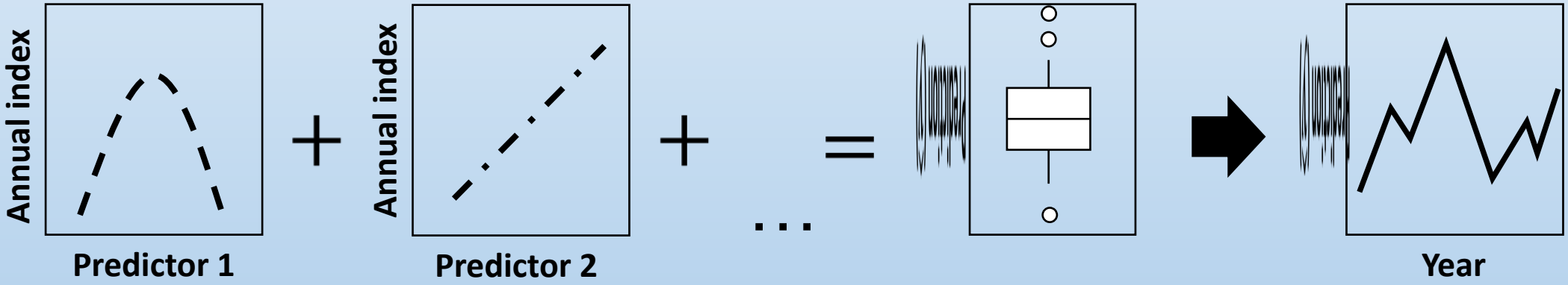
- Focus on two climate indices
  - Atlantic Multidecadal Oscillation (AMO)
  - 5 °C Degree-Day Index (DD)
    - Mean daily water temperature for 1950-present
    - Integer day each year at which the cumulative threshold of 500 5°C DD is achieved



University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

Proposed Methods: Relating forage to climate

Generalized additive (mixed) models



$$\hat{y} = s_1(\text{Predictor 1}) + s_2(\text{Predictor 2}) + \ldots$$

Potential additional model components: Predictor 1 × Predictor 2

Proposed Methods: Relating forage to climate

			Scale	
Tier	Variable	Indicator	Spatial	Temporal
1. Abundance	Bay Anchovy	Spawning stock	Mainstem	Spring-Early summer
		Recruits	Mainstem	Late summer-Fall
		Population	Mainstem/Tribs	Spring-Fall
	Polychaetes	Aggregate taxa	Mainstem/Tribs	Summer
		Family (Nereididae)	Mainstem/Tribs	Summer
2. Environmental Factors	5°C degree day (DD) spring warming index	$DD_{SpawningStock}$	Mainstem	Spring-Early summer
		$DD_{Recruits}$	Mainstem	Late summer-Fall
		$DD_{Population}$	Mainstem/Tribs	Spring-Fall
		$DD_{Polychaete}$	Mainstem/Tribs	Summer
		$DD_{Nereididae}$	Mainstem/Tribs	Summer
	Atlantic Multidecadal Oscillation (AMO)	$AMO_{SpawningStock}$	Mainstem	Spring-Early summer
		$AMO_{Recruits}$	Mainstem	Late summer-Fall
		$AMO_{Population}$	Mainstem/Tribs	Spring-Fall
		$AMO_{Polychaete}$	Mainstem/Tribs	Summer
		$AMO_{Nereididae}$	Mainstem/Tribs	Summer

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Proposed Methods: Indicator development

Summarize forage indicator values

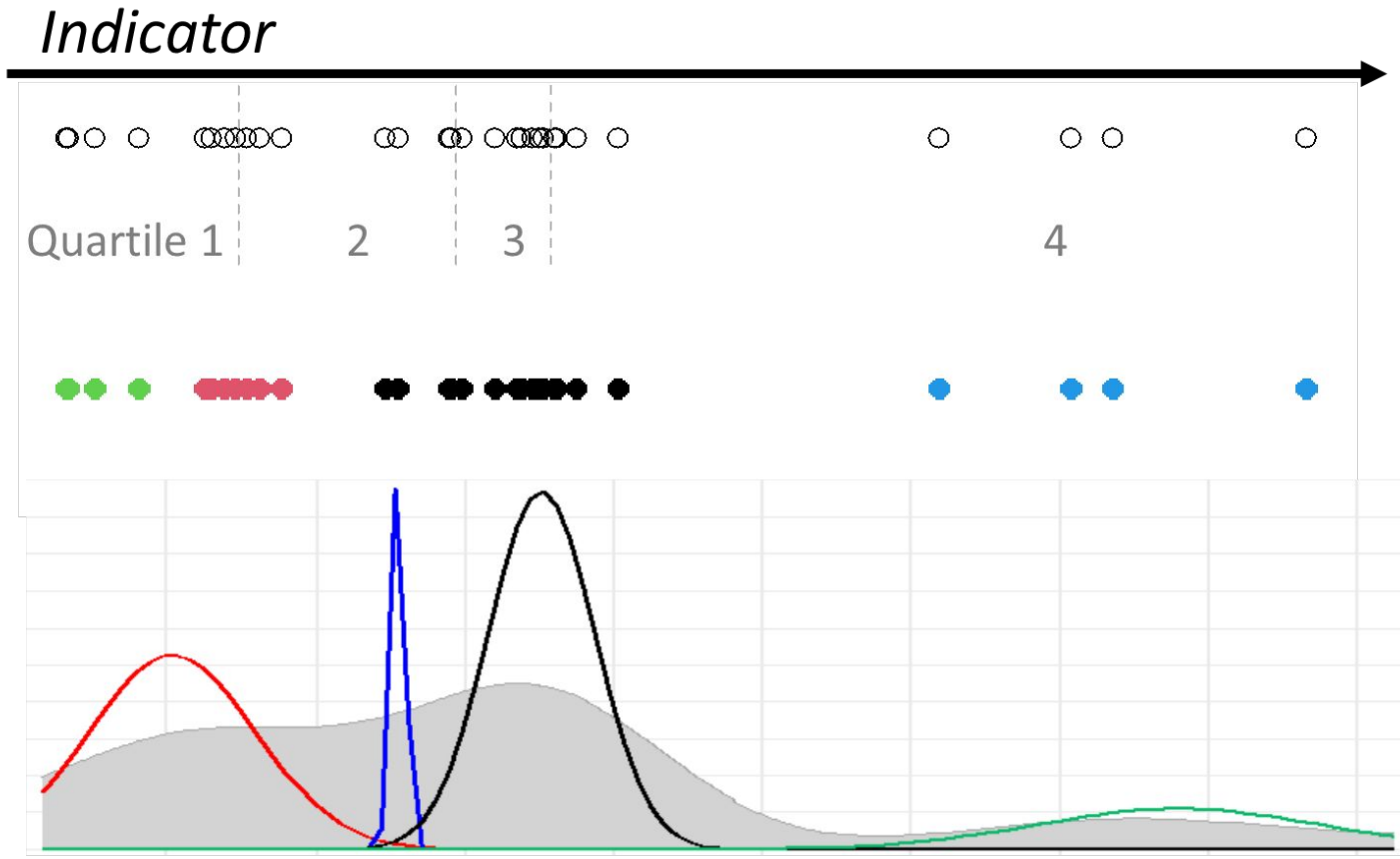
We will assess several methods and select one to group values of indicator into categories, then develop a colorimetric scheme.

Methods:

Quantiles

K-means
(K = 4)

Gaussian
mixture model
(K = 4)



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

Proposed Deliverables and Schedule

Report # and Reporting Period	Project Deliverables	Date of Delivery
QAPP deliverable (Reporting Period #1)	• Final (signed) QAPP in PDF format	**5/21/2021**
Report #1 (Reporting Period #1)	• Excel or Access database of all biological and environmental data and sources • Presentation and PDF of the proposed analytical framework • Progress report	**7/14/2021**
Report #2 (Reporting Period #2)	• R modeling/analysis script (code) and model outputs • Progress report	**10/14/2021**
Meeting deliverable (Reporting Period #3)	• Meet with the FAT and other CBP partners and stakeholders to discuss and coordinate indicator development options based on the results of the analyses	**10/15/2021-11/1/2021**
Report #3 (Reporting Period #3)	• R indicator script (code) and visualization outputs • Progress report	**1/14/2022**
Draft Report #4 (Reporting Period #4)	• Editable draft report, submitted to the GIT Lead and the FAT for review and feedback	**3/1/2021**
Report #4 (Reporting Period #4)	• Final report package, including editable database, the R files and PDFs of all R scripts and outputs for modeling/analysis and indicator development, and the final indicator graphics • Presentation of final project results	**4/14/2022**

Progress to date

- Signed and approved Quality Assurance Project Plan (QAPP)
- Data acquisition from survey websites
  - Web-crawling/manual download
  - Contacting survey data managers
- Collaboration with VIMS scientists (Mary Fabrizio, Troy Tuckey)
  - Juvenile Fish and Blue Crab Trawl Survey