Climate Change and Ecological Forecasting in the Chesapeake Bay

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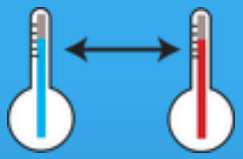
Ecological Factors to Consider

Climate Related Management Needs

Management Strategy	Baseline	Factor Influencing Success	Current Efforts & Gaps	Management Approach	Cross-Outcome Collaboration and Mutual Benefit	Adaptive Mgmt. & Monitoring Progress	No Mention	Rating
Water Quality		x		x	x	x		4
Black Duck		x	x	x		x		4
Brook Trout		x	x	x		x		4
Wetlands		x	x	x				3
Protected Lands		x	x	x				3
Public Access		x		x				2
Healthy Watersheds		x		x				2
Urban Tree Canopy			x	x				2
Blue Crab		x			x			2
Oyster Restoration		x			x			2
Fish Habitat		x			x			2
SAV		x						1
Diversity				x				1
Local Leadership		x						1
Fish Passage		x						1
Forage Fish		x						1
Toxics Research	x							1
Stream Health							x	0
Land Use Methods and Metrics							x	0
Land Use Options Evalations							x	0
Citizen Stewardship							x	0
Environmental Literacy							x	0
Toxics Prevention and Policy							x	0
Forest Buffer							x	0

Management Needs: Ecological Context



Temperature

Precipitation

Forage fish

Blue Crab

Oyster Restoration (etc.)

Fish Habitat

SAV

Wetlands/Marsh

pH

NaCl

Salinity

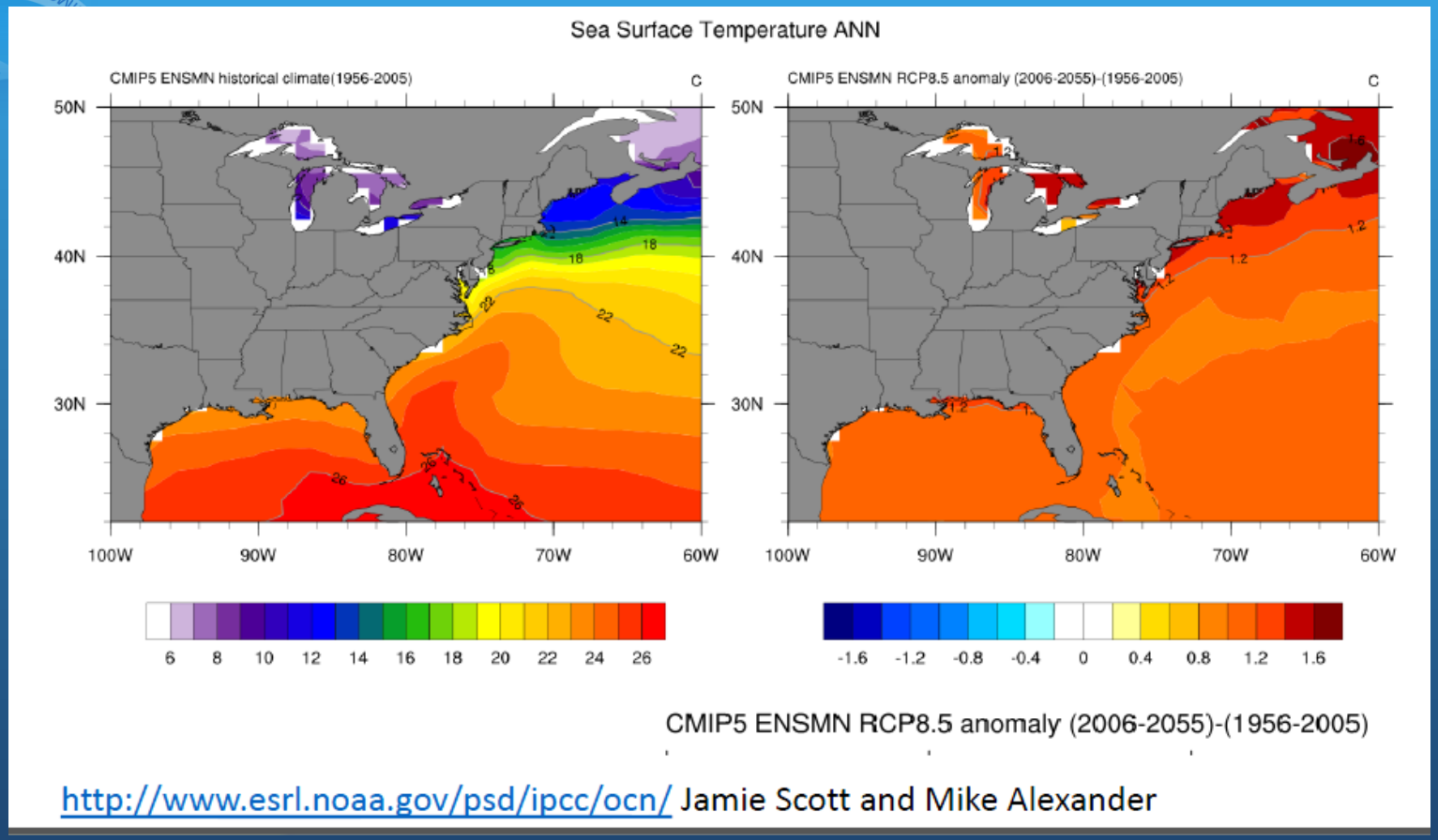
Primary Productivity

Climate-related management questions

- How will sea level rise influence marshes and the crabs and forage that depend on them?
- Will increased precipitation (resulting in increased sediments) and acidification impact oyster restoration?
- Will some living resources be less able to tolerate shifts in physical environment (temp, salinity, etc)?
- Will changes in temperature and salinity effect timing of the spring bloom and in turn impact overall fisheries productivity?

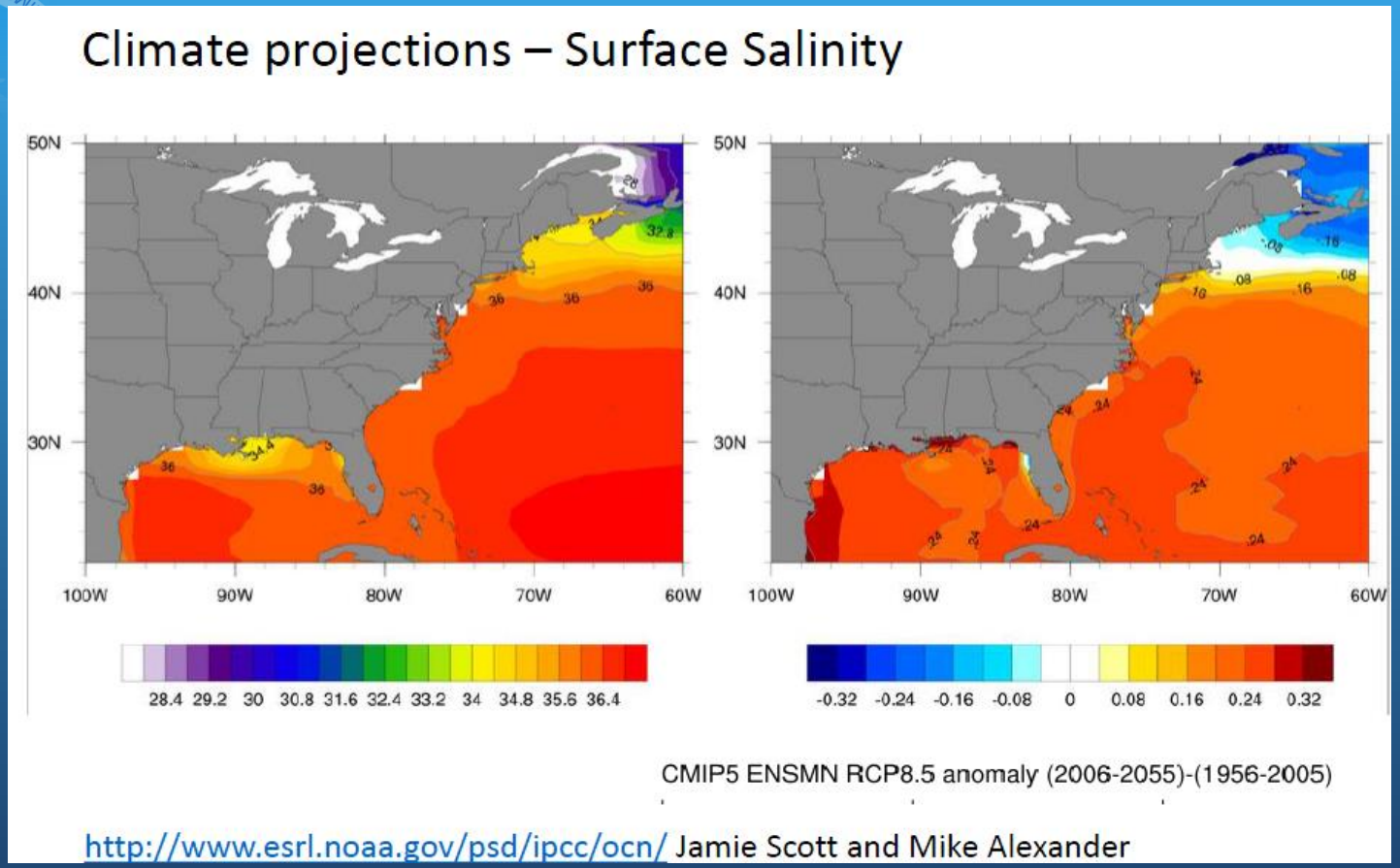
Climate Factors to Consider: Data and Trends

Sea Surface Temperature



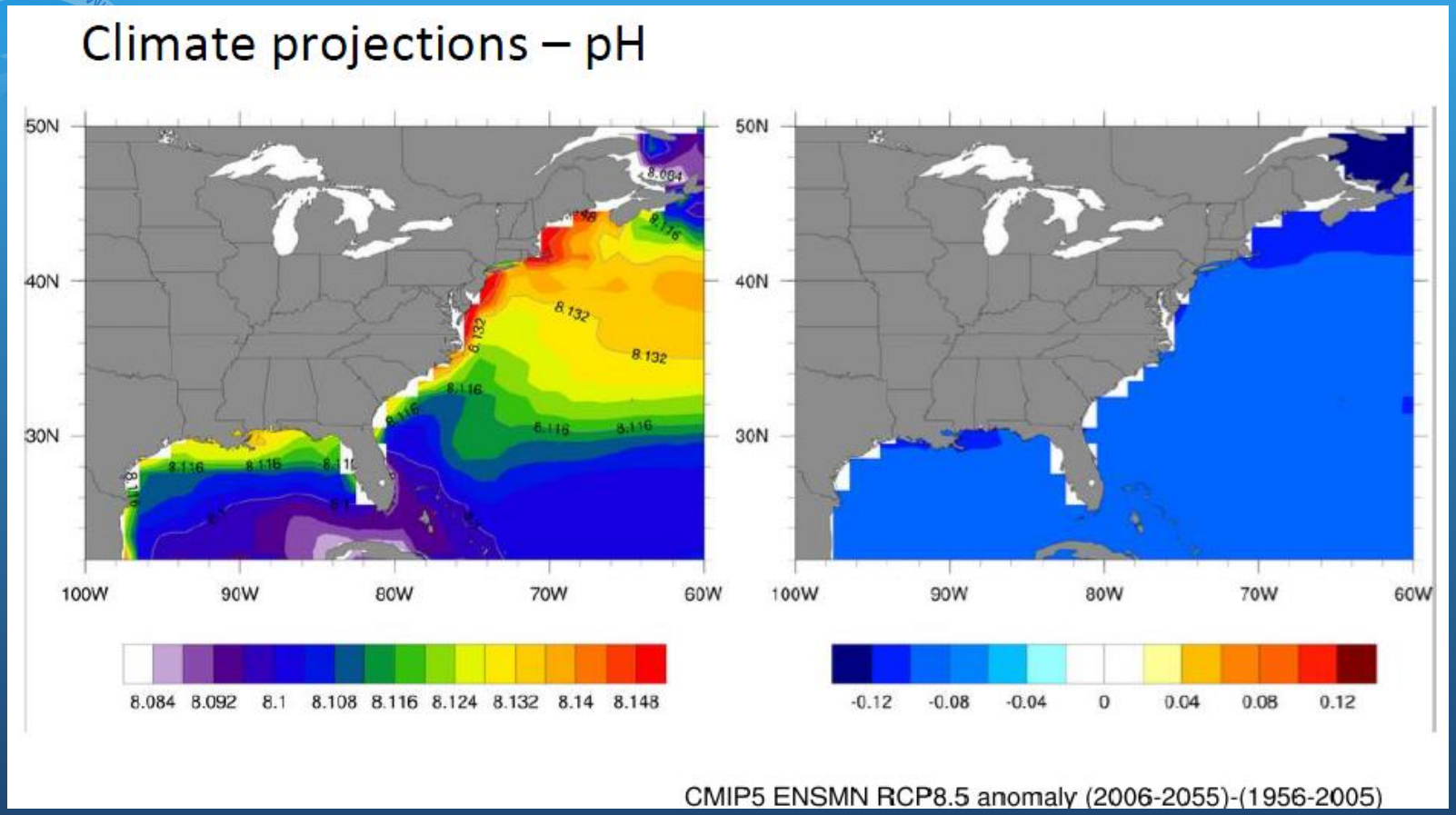
Source: J. Hare, NMFS 2015

Surface Salinity



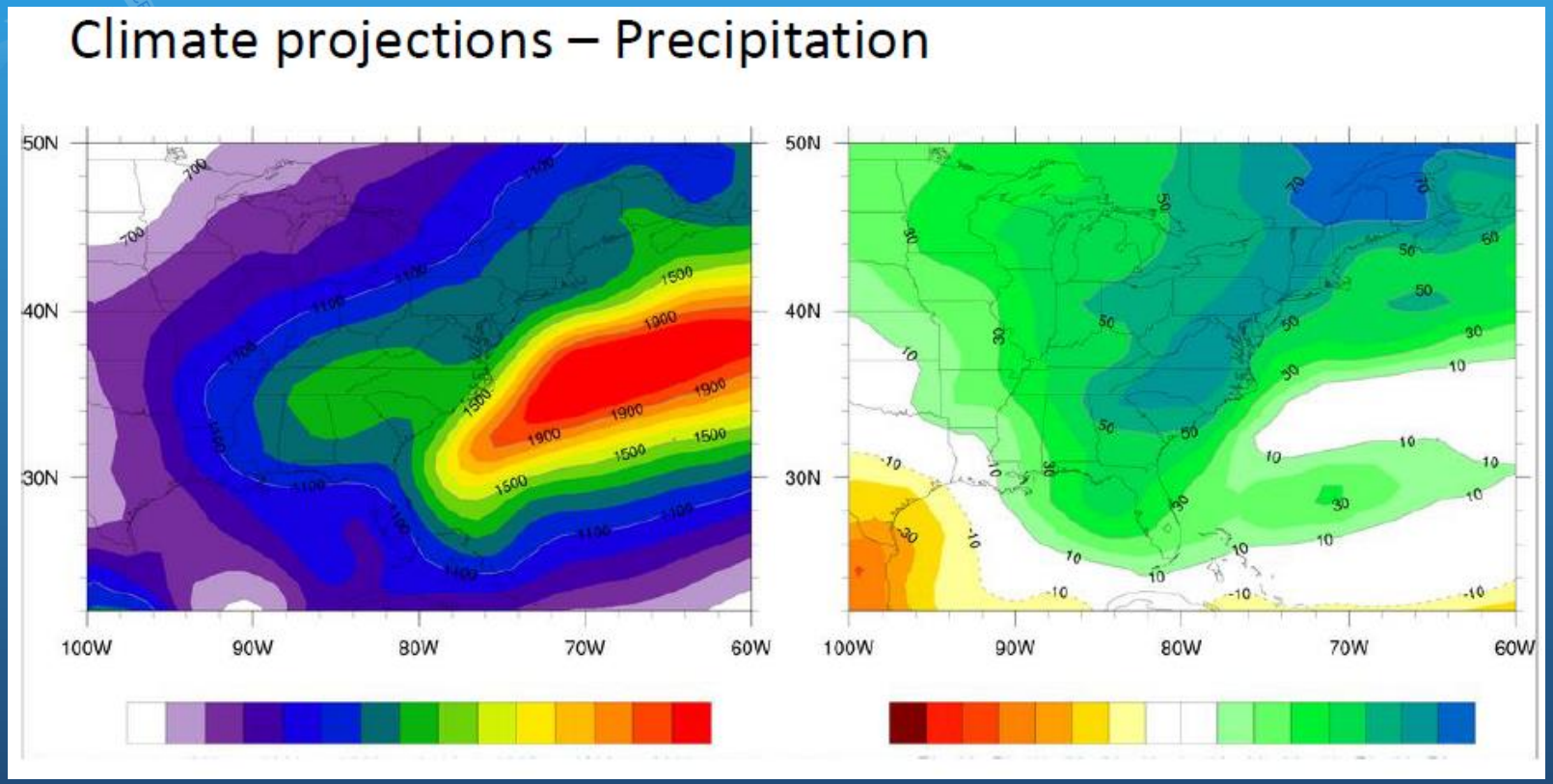
Source: J. Hare, NMFS 2015

pH



Source: J. Hare, NMFS 2015

Precipitation



Source: J. Hare, NMFS 2015

Primary Productivity

Peak

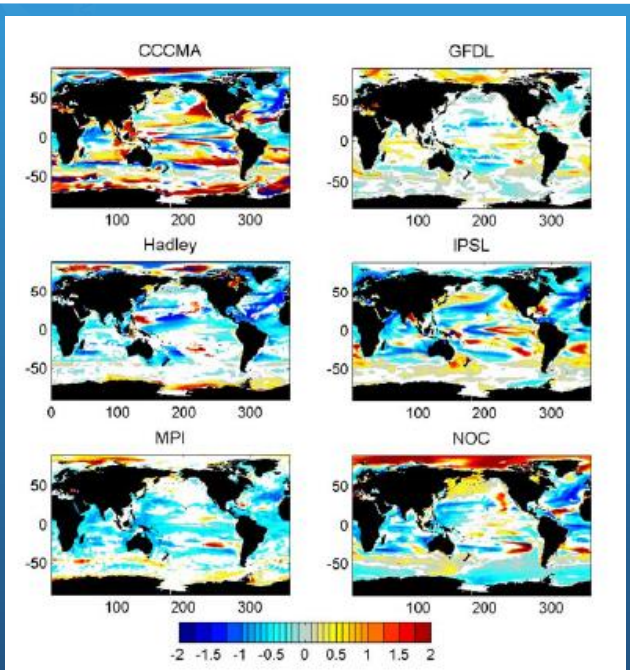


Fig. 3. Trends in PP seasonal amplitude for 2006–2100 (expressed as average % change per year) for 6 models forced with IPCC AR5 scenario RCP8.5. Only points where the trend is statistically significant at the 95 % level are plotted.

Timing

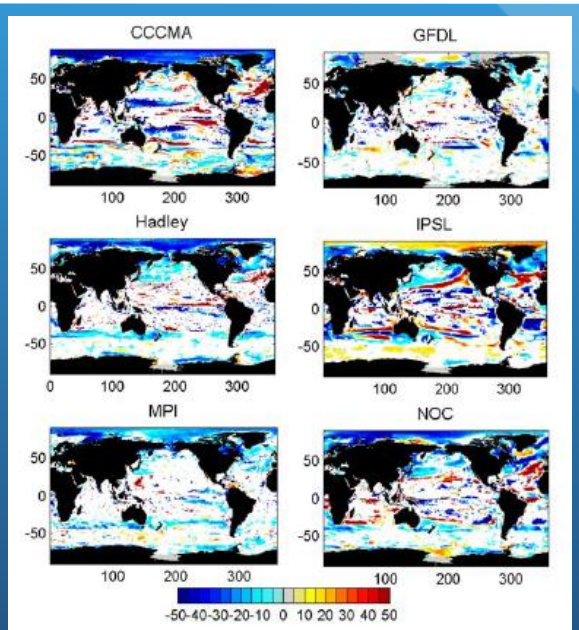
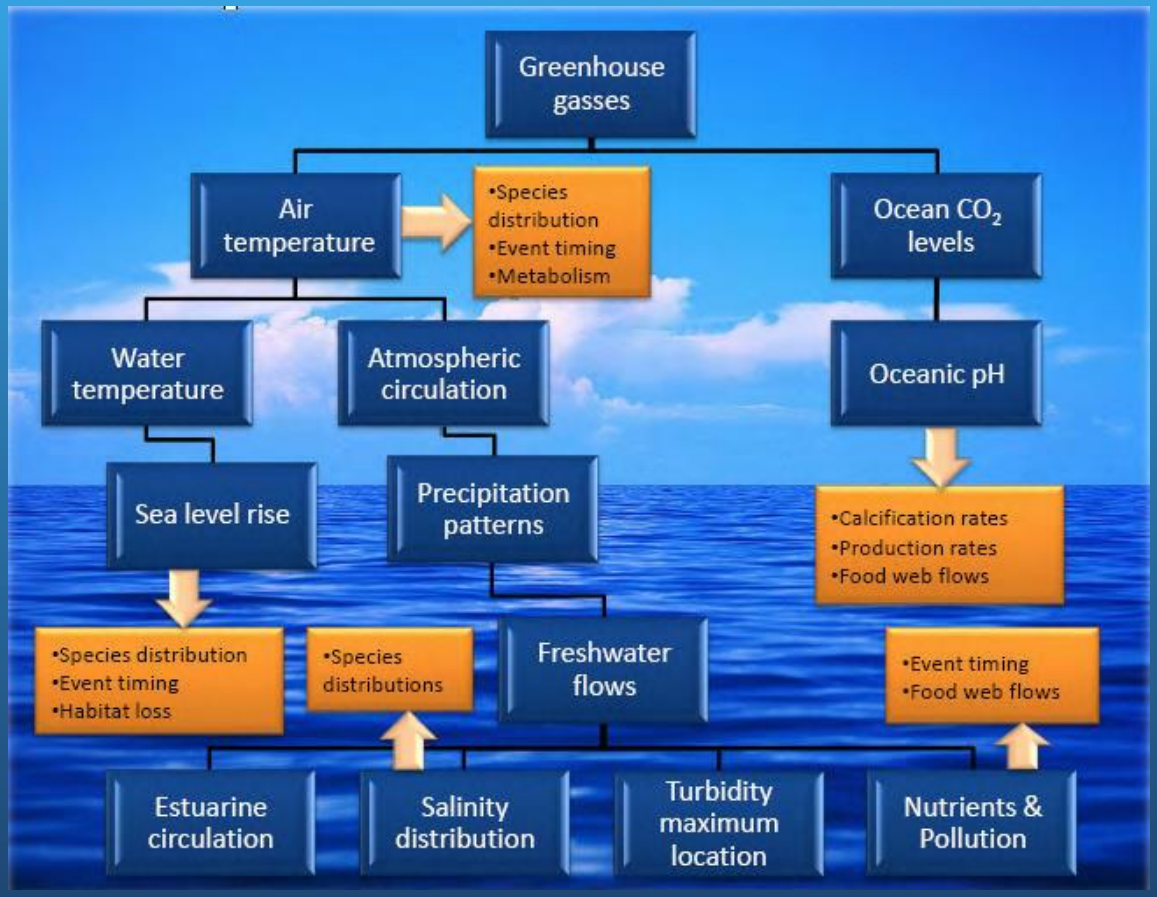


Fig. 4. Difference in timing of peak PP between the period 2006–2026 and 2081–2100 (where negative values indicate earlier peak timing). Only points where a 1-way ANOVA analysis showed no significant difference in the means of the 2 periods (significance at 5 % level) are plotted.

Source: Henson et al 2013, doi:10.5194/bg-10-4357-2013

Estuarine Habitats



Source: http://ccrm.vims.edu/coastal_zone/climate_change/

Approaches for Climate Assessments of Ecosystems

- Chesapeake Atlantis Model
- Ecological Forecasting
- Climate Sensitivity Assessment

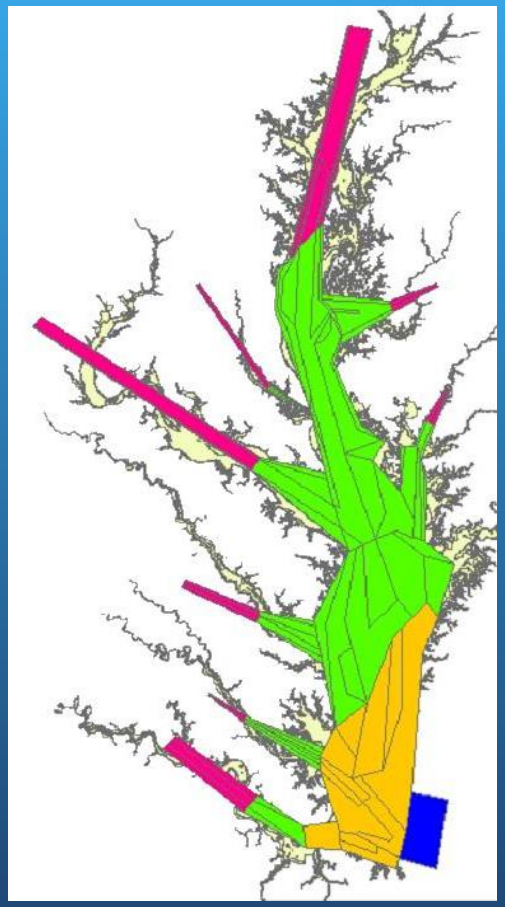
Chesapeake Atlantis Model

Biological environment

- ✓Primary production
- ✓Trophic interactions
- ✓Recruitment
- ✓Age structure
- ✓Size structure
- ✓Life History

Fisheries

- ✓Multiple sectors
- ✓Gears
- ✓Seasons
- ✓Spatially explicit



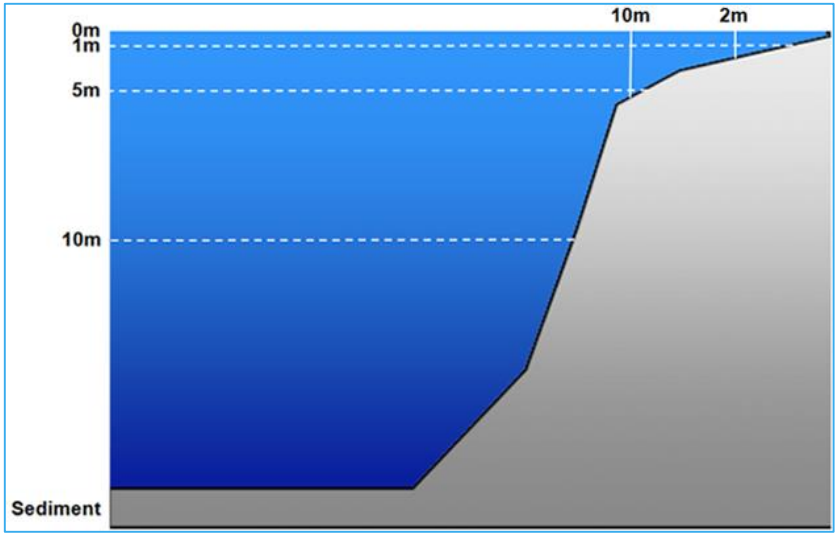
Physical environment

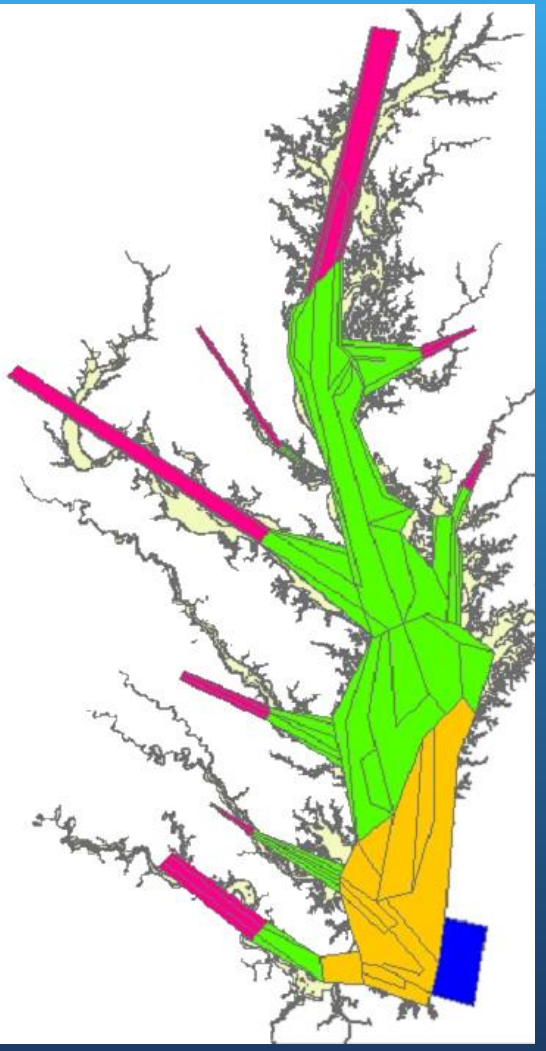
- ✓Geology
- ✓Chemistry
- ✓Circulation & currents
- ✓Temperature
- ✓Salinity
- ✓Water clarity (TSS)
- ✓Climate variability

Nutrient Inputs

- ✓Currency is Nitrogen
- ✓Oxygen
- ✓Silica
- ✓3 Detrital forms
- ✓Bacteria-mediated recycling

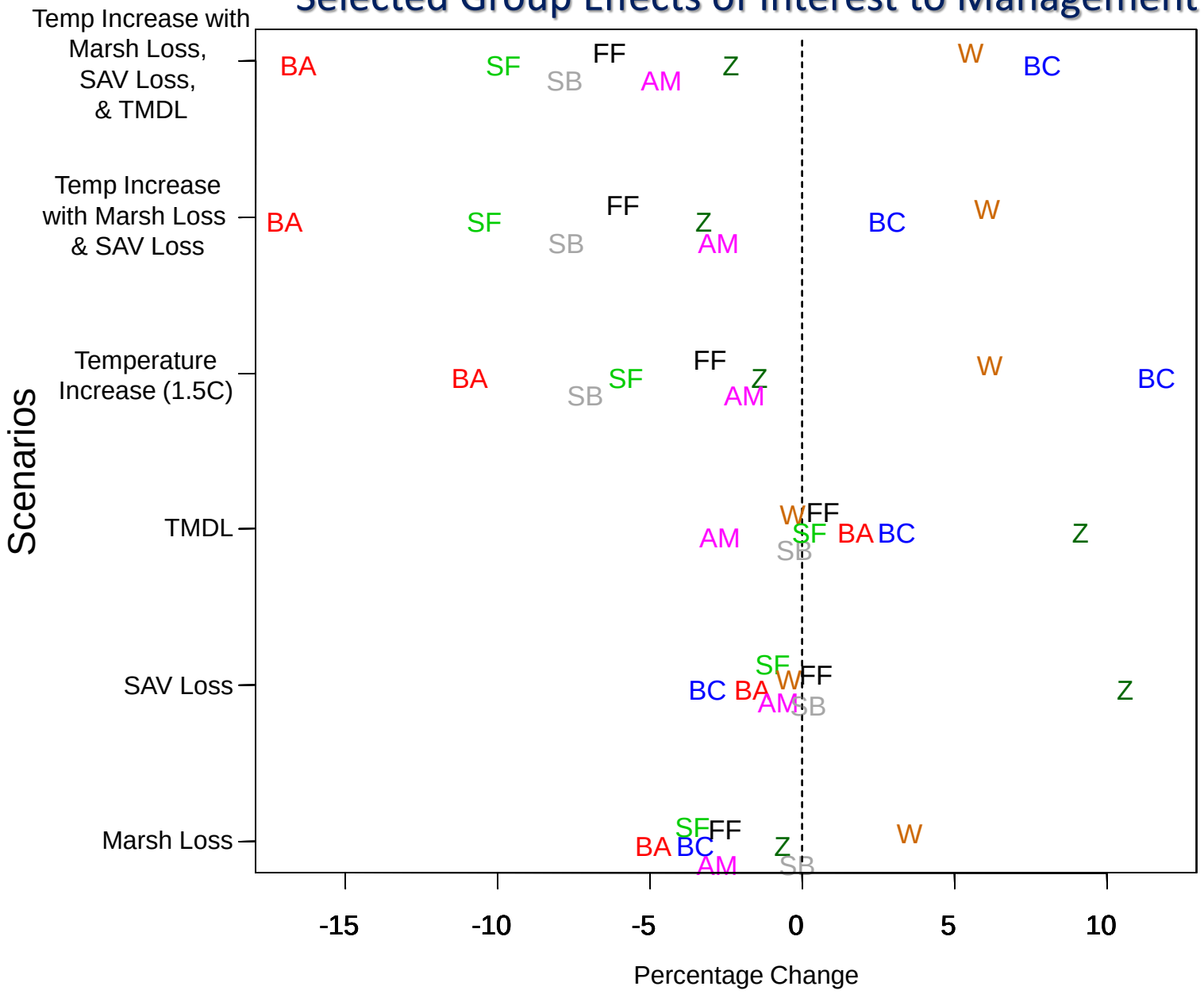
Chesapeake Atlantis Model





Sensitivity To Climate Change

Selected Group Effects of Interest to Management

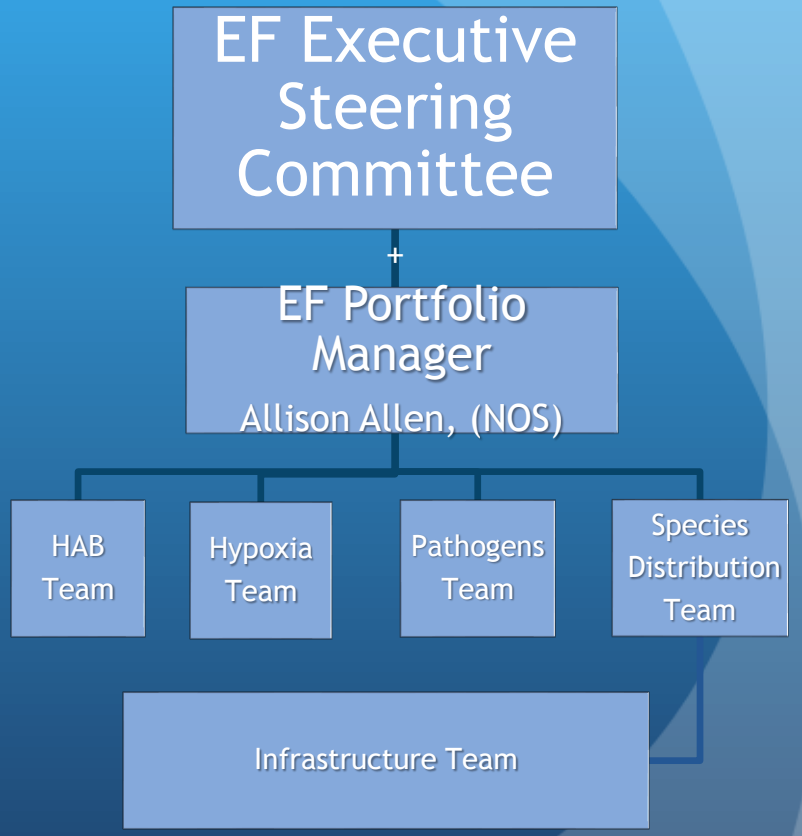


NOAA Ecological Forecasting Roadmap Structure and Priorities

Focus Areas:

HABs, Hypoxia, Pathogens, Habitat/Species Distribution

- Selected based on
  - relative maturity and potential readiness to transition to operations
  - Nation-wide applicability to NOAA's core missions
  - well-identified needs with strong, interested constituencies



NOAA Ecological Forecasting:

Vibrio Guidance Model

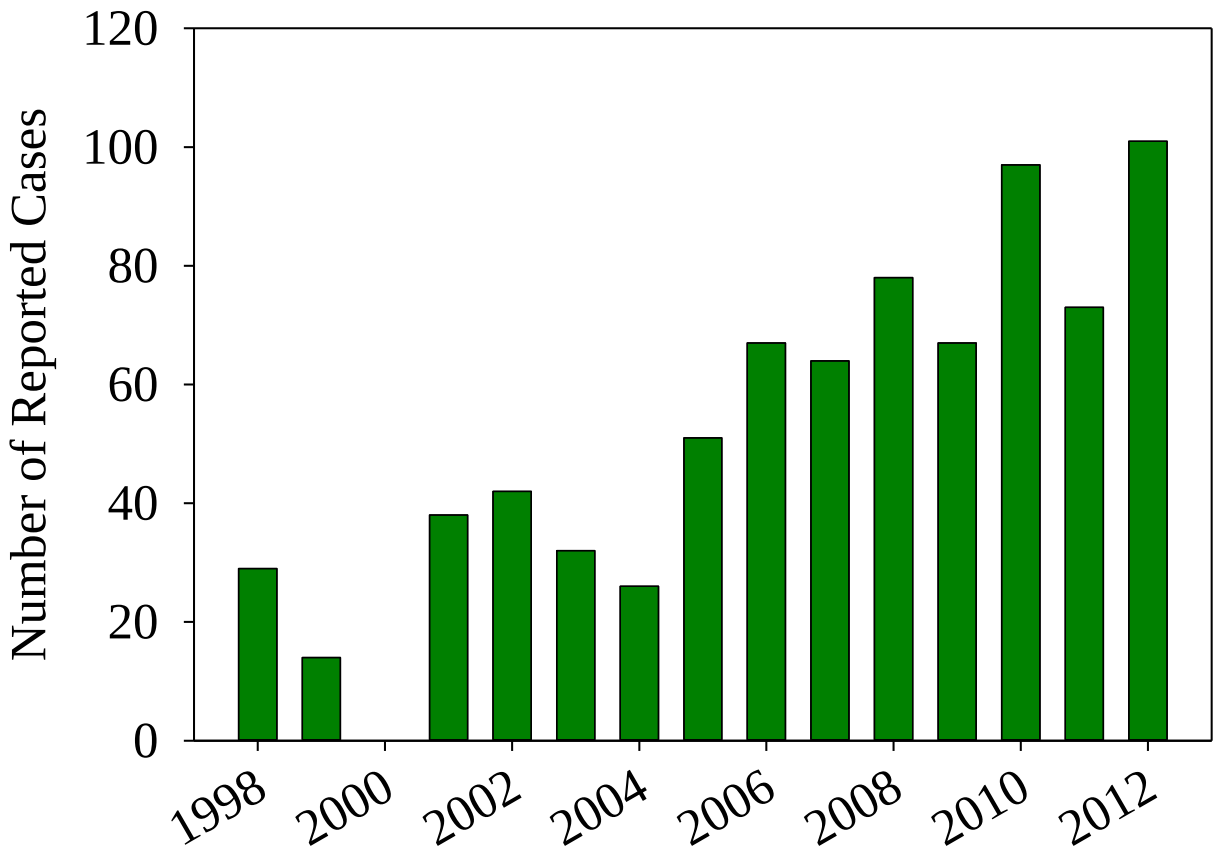
Vibrios: Naturally Occurring Harmful Bacteria

Vibrio cholerae

Vibrio parahaemolyticus (Vp)
Vibrio vulnificus (Vv)

- Naturally occurring bacteria in coastal waters
- Vv responsible for 95% of all seafood related mortality
- Vp estimated at 80,000 cases per year
- Over $300 million annually in health care costs alone.

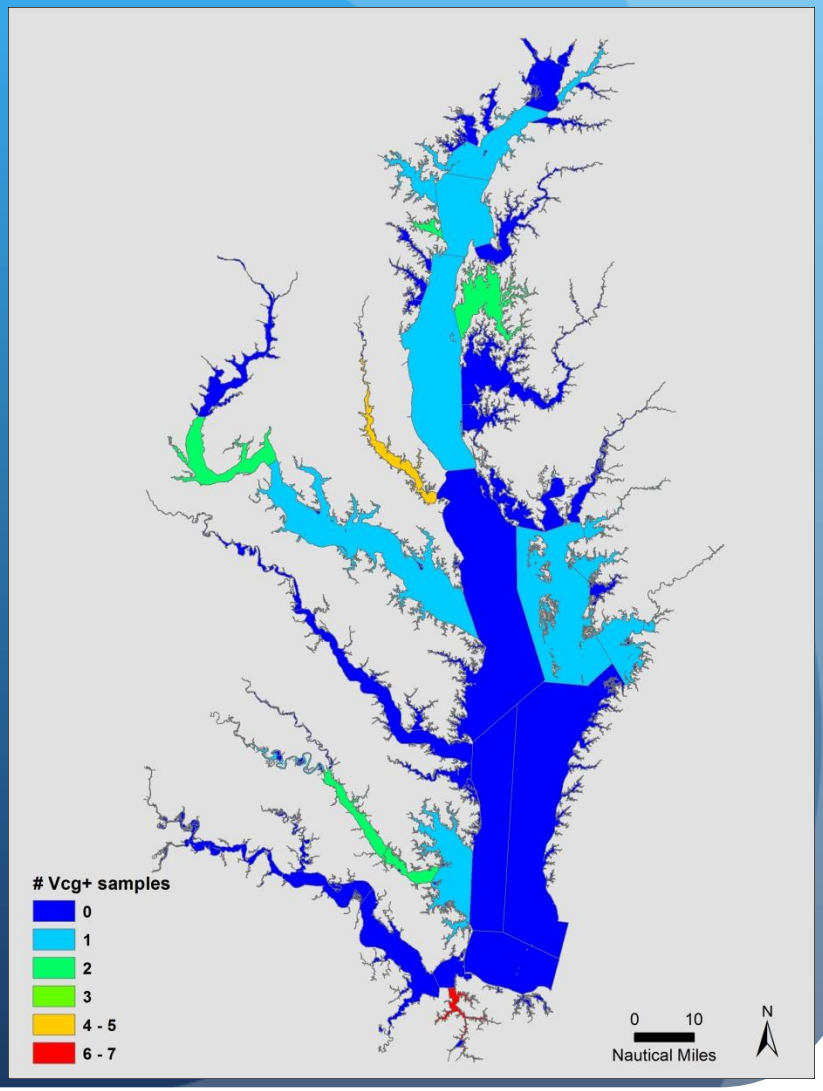
Chesapeake Region Vibrio Infections



CDC, COVIS Surveillance Program (MD, VA, PA)

Virulence correlated gene (*vcgC*)

- ~10% of samples positive.
- Initial presence/absence model – 81% concordance.
- Temperature, salinity, phosphate, and ChlA drivers.

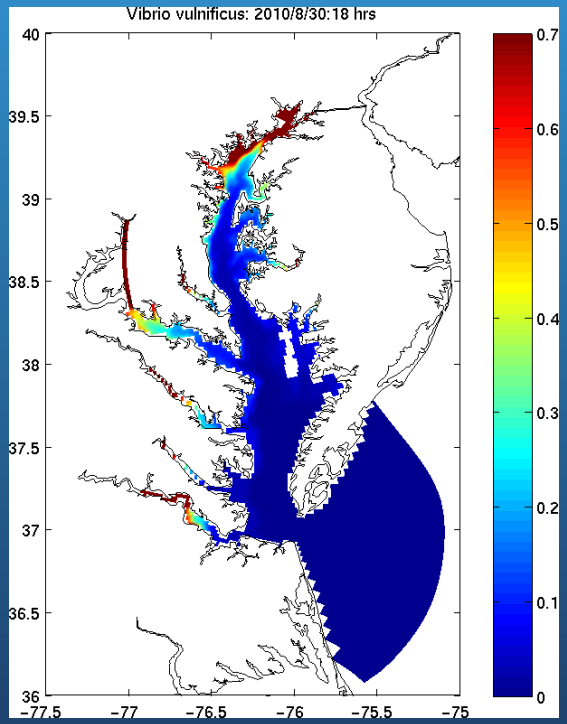


2007-2010 data

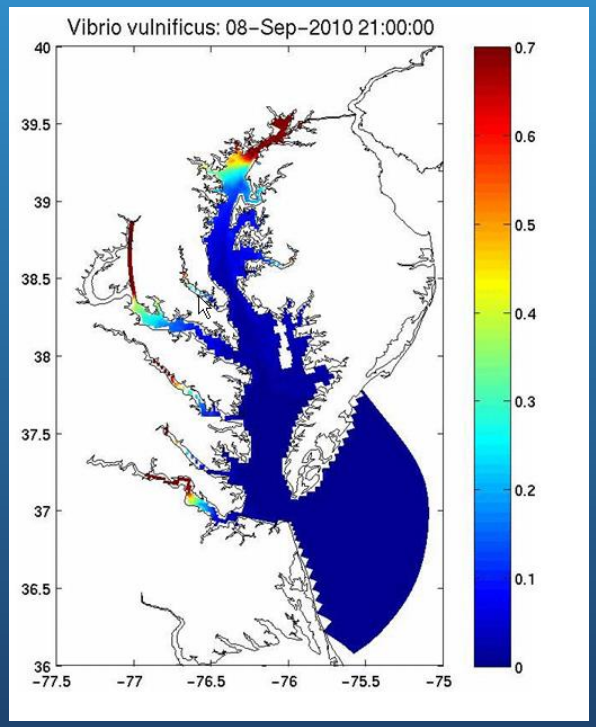
Forecasts and other Products

Current Experimental Products

- Nowcasts and 2-3 day forecast – UMCES and NOAA
- 14 and monthly forecasts - UMD ESSIC



14 day

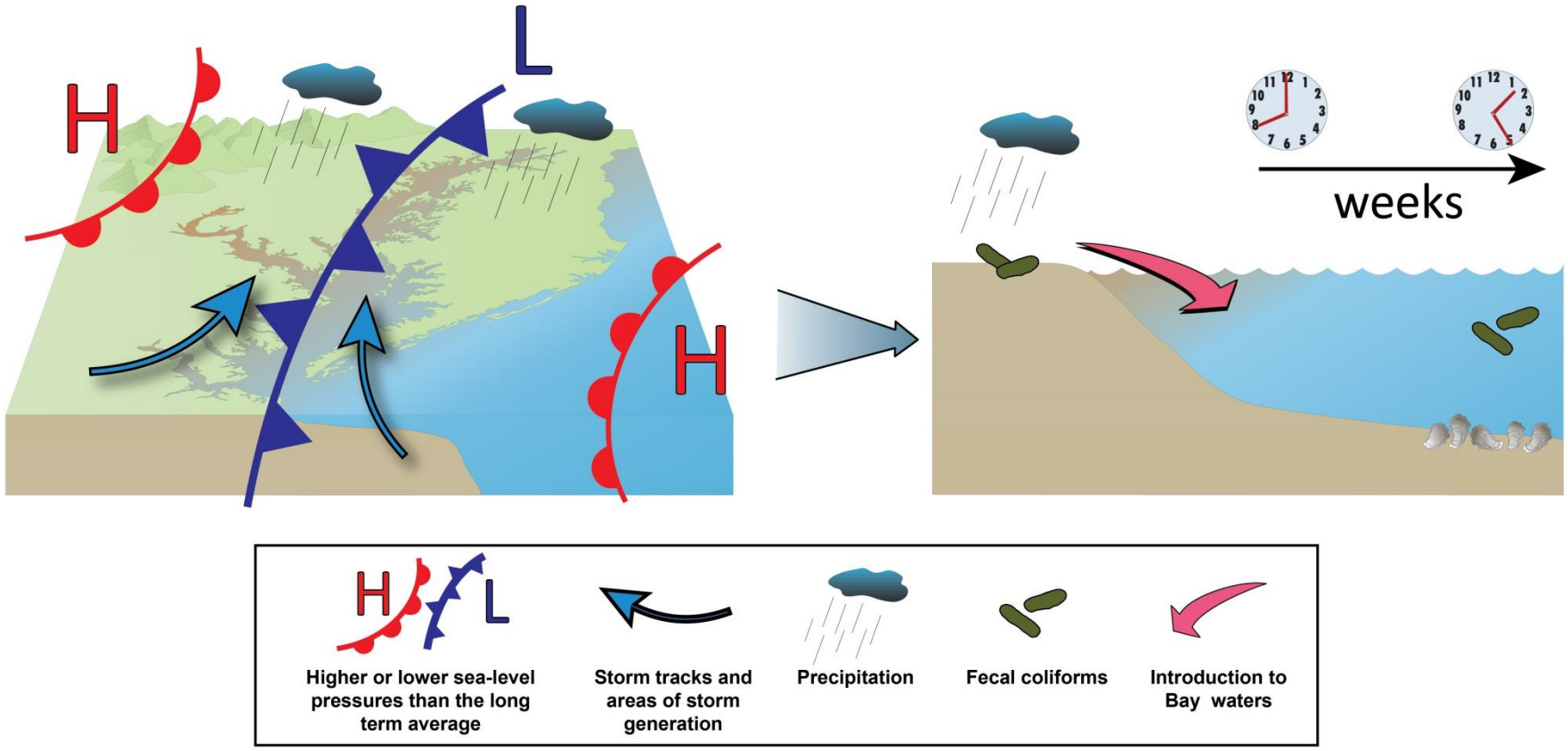


Monthly

Climate Sensitivity Assessment:

Vibrio Guidance Model

Climate variability and patterns drive bacterial pollution at shellfish harvest stations



Climate variability and pattern drive bacterial pollution at shellfish harvest stations

3 wettest years = 3 years with highest fecal coliform levels in Maryland waters

Distinct sea-level pressure patterns:

- Low pressure anomaly spanning the coastal mid-Atlantic
- Storm tracking and cyclogenesis
- Loosely related to Bermuda High