The background of the slide is a photograph of a dense clam bed underwater. The clams are tightly packed together, their shells showing various shades of brown, tan, and grey. The water is clear, and the lighting is bright, creating a slightly hazy or ethereal atmosphere. The clams are oriented in various directions, some showing their flat tops and others their rounded sides.

An ecosystem-based modeling approach: The Chesapeake Atlantis Model (CAM)

Tom Ihde
Versar, Inc., NOAA Chesapeake Bay Office
and
Howard Townsend
NOAA Chesapeake Bay Office

Situs

Insulae Atlantidis, à
Mori olim absorptæ ex
mente Egyptianum et
Platonis descriptis.

The Commonwealth Scientific and Industrial Research Organisation

Africa.

Atlantis

Oceanus

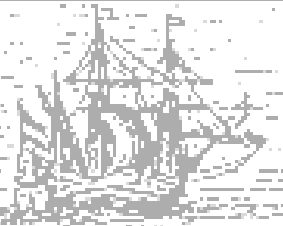
Atlantici.

America.

Hispania.



Beth Fulton



The Chesapeake Atlantis Model (CAM)

A Holistic Ecosystem Model

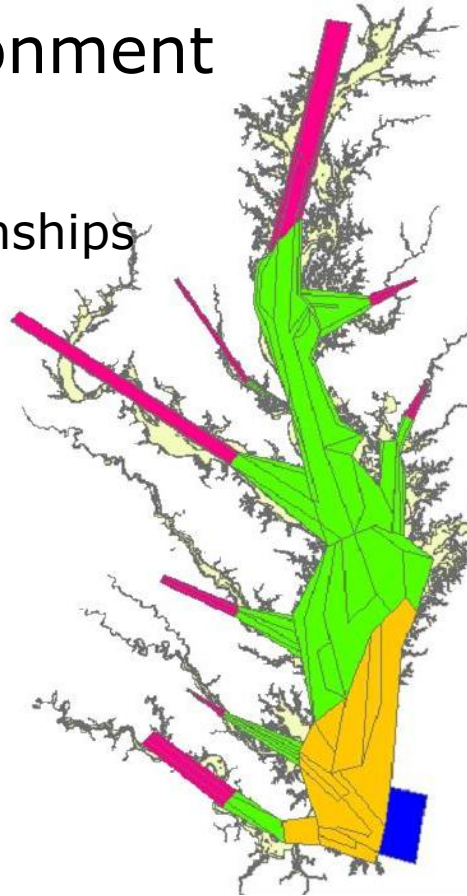
Incorporating:

Biological environment

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

Fisheries

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



Physical environment

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

Nutrient Inputs

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



The Chesapeake Atlantis Model (CAM)

Design

Chesapeake Atlantis Model

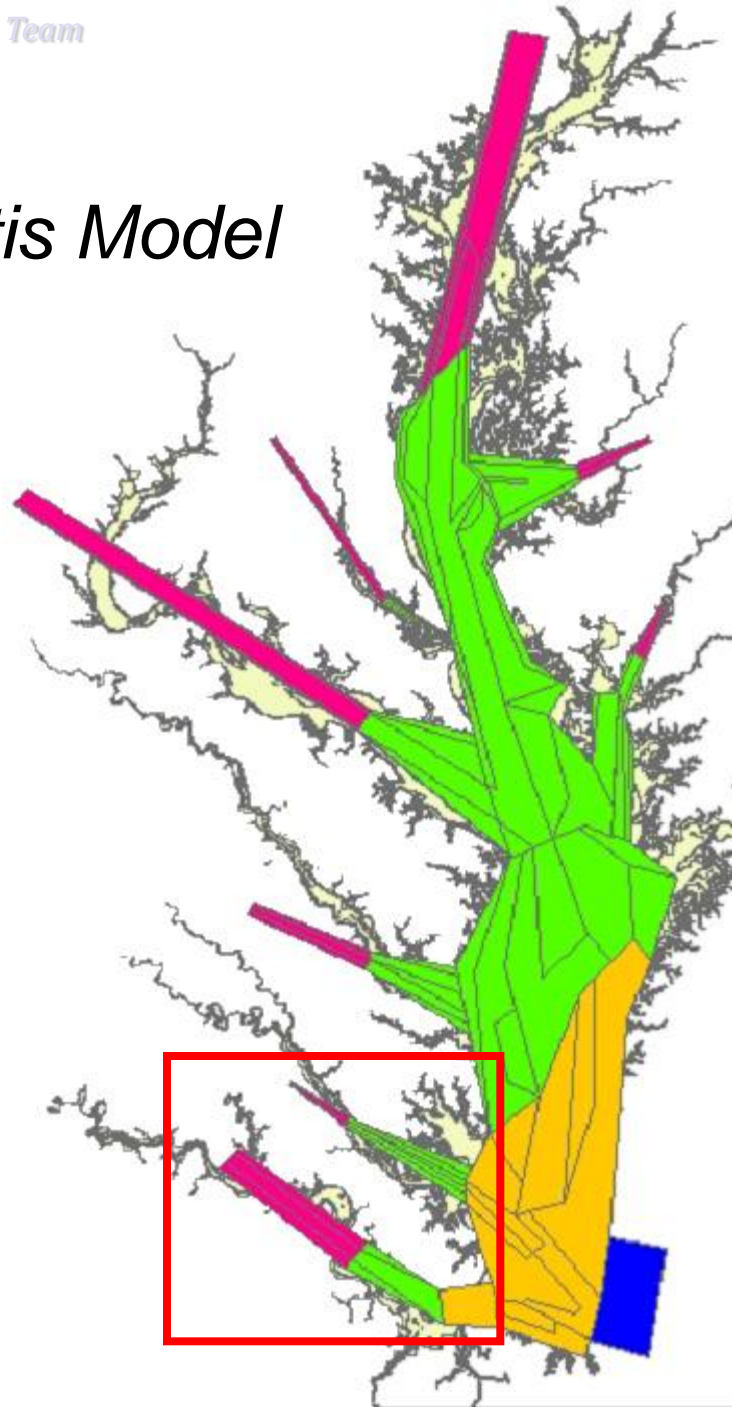
Salinity



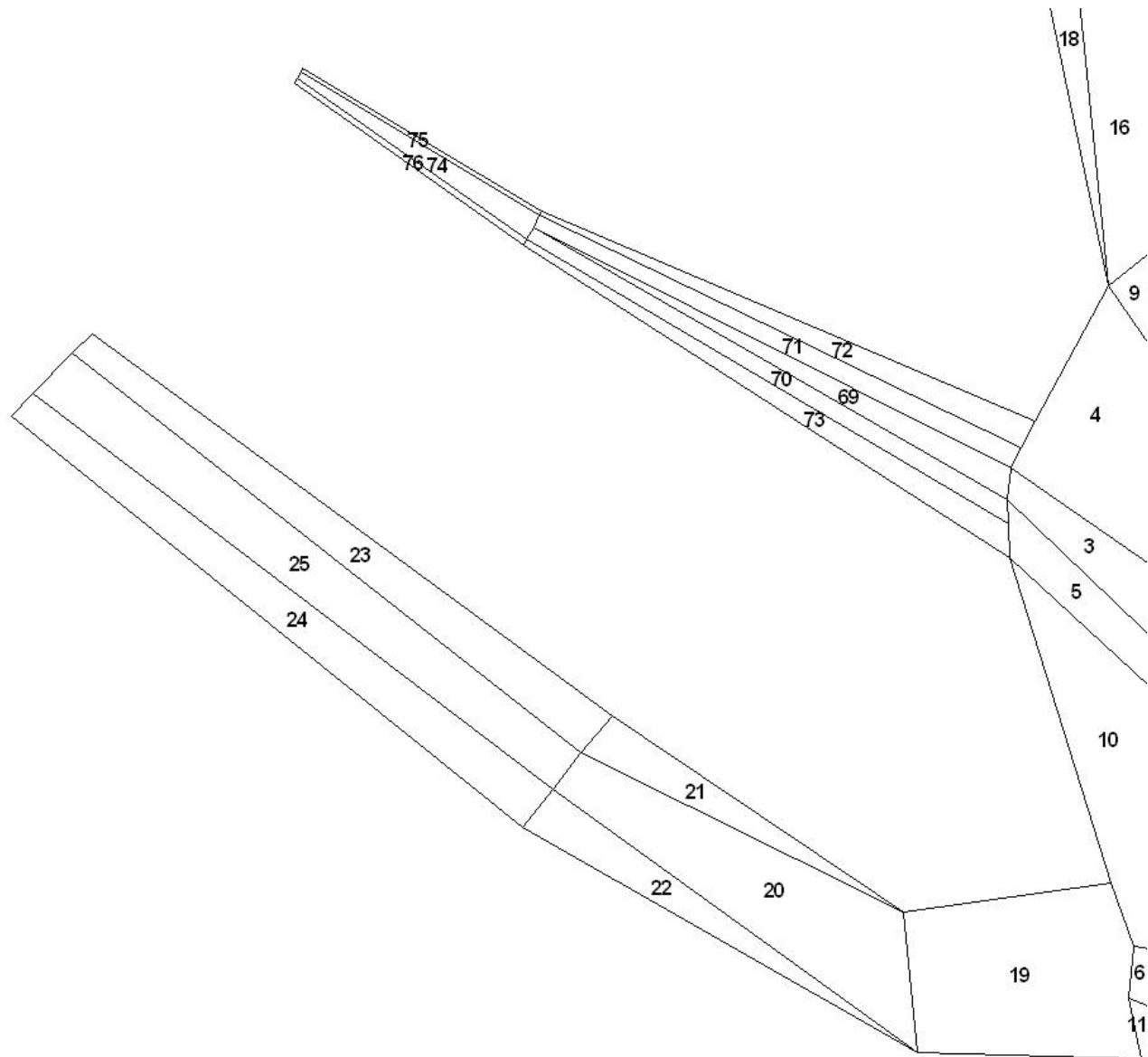
1-10

10-18

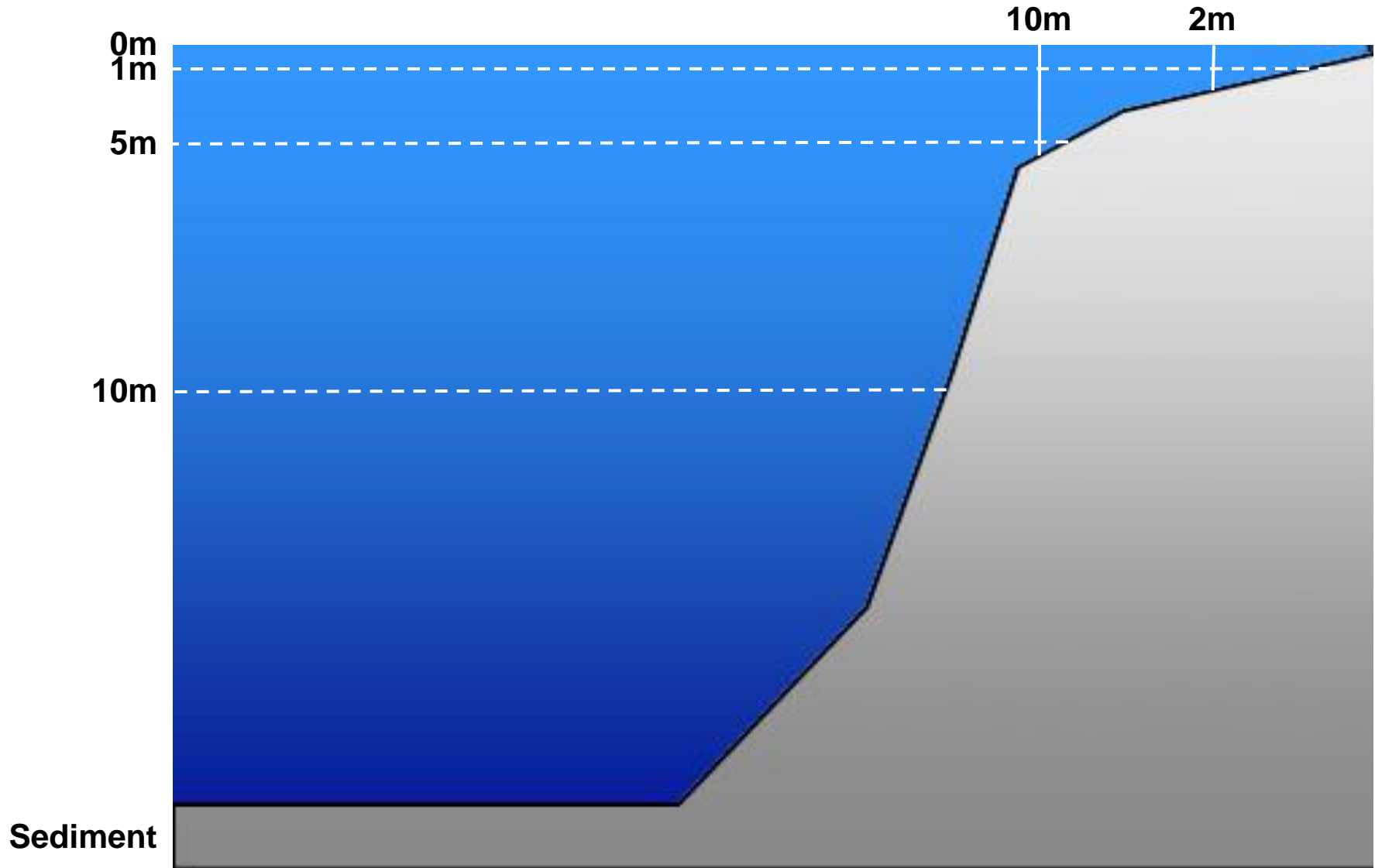
18-30



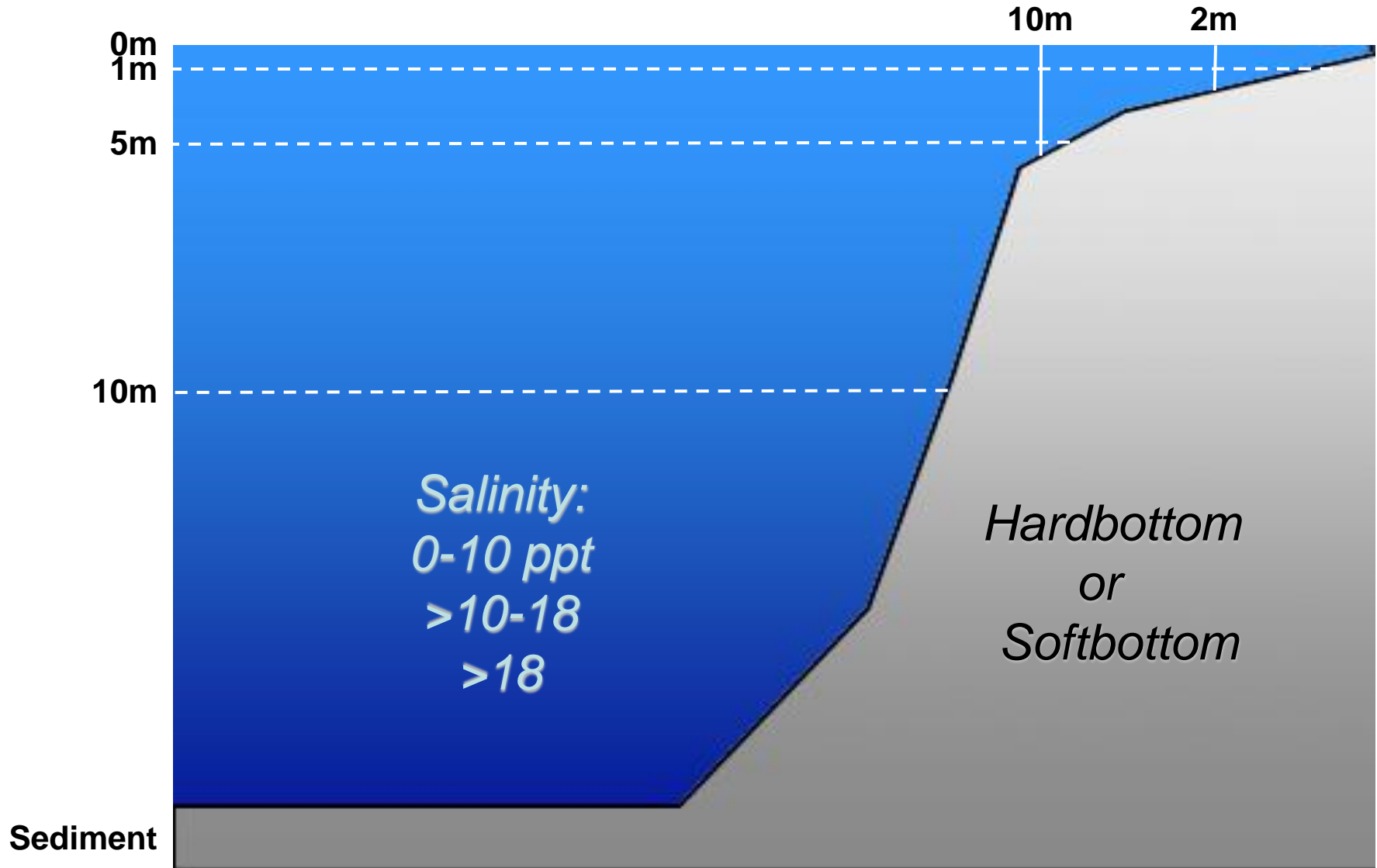
CAM: River Box Structure



3-dimensional structure of model:



3-dimensional structure of model:



Ecological Groups in CAM

Finfish

- Alosines (Amer.Shad, Hickory Shad, Alewife & Herring)
- Atlantic Croaker
- Bay anchovy
- Black drum
- Bluefish
- Butterfish, harvestfish ("Jellivores")
- Catfish
- Gizzard shad
- Littoral forage fish: silversides, mummichog
- Menhaden
- Striped bass
- Summer flounder
- Other flatfish (hogchoker, tonguefish, window pane, winter flounder)
- Panfish:
 - Euryhaline: Spot, silver perch; FW to 10ppt: yellow perch, bluegill
- Reef assoc. fish: spadefish, tautog, black seabass, toadfish
- Spotted hake, lizard fish, northern searobin
- Weakfish
- White perch

Elasmobranchs

- Cownose ray
- Dogfish, smooth
- Dogfish, spiny
- Sandbar shark

Birds

- Bald Eagle
- Piscivorous birds (osprey, great blue heron, brown pelican, cormorant)
- Benthic predators (diving ducks)
- Herbivorous seabirds (mallard, redhead, Canada goose, & swans)

Mammals

- Bottlenose dolphin

Reptiles

- Diamond-back Terrapin
- Seaturtles

Invertebrates

- Benthic feeders: (B-IBI "CO"+"IN") ...,
- Benthic predators: (B-IBI "P") ...,
- Benthic suspension feeders: (B-IBI "SU")
- Blue crab YOY
- Blue crab adult
- Brief squid
- Macoma clams: (B-IBI)
- Meiofauna: copepods, nematodes, ...,
- Oysters

Primary Producers

- Benthic microalgae ("microphytobenthos" benthic diatoms, benthic cyanobacteria, & flagellates)
- "Grasses:"
 - SAV – type varies with salinity
- Marsh grass
- Phytoplankton – Large: diatoms & silicoflagellates (2-200um)
- Phytoplankton – Small: nanoplankton, ultraplankton, aka "picoplankton" or "picoalgae" (0.2-2um), cyanobacteria included (2um)
- Dinoflagellates (mixotrophs) (5-2,000um)

ZooPlankton

- Ctenophores
- Sea nettles
- Microzooplankton (.02-.2mm): rotifers, ciliates, copepod nauplii
- Mesozooplankton (.2-20mm): copepods, etc.

Detritus

- Carrion
- Carrion (sediment)
- Labile
- Labile (sediment)
- Refractory
- Refractory (sediment)

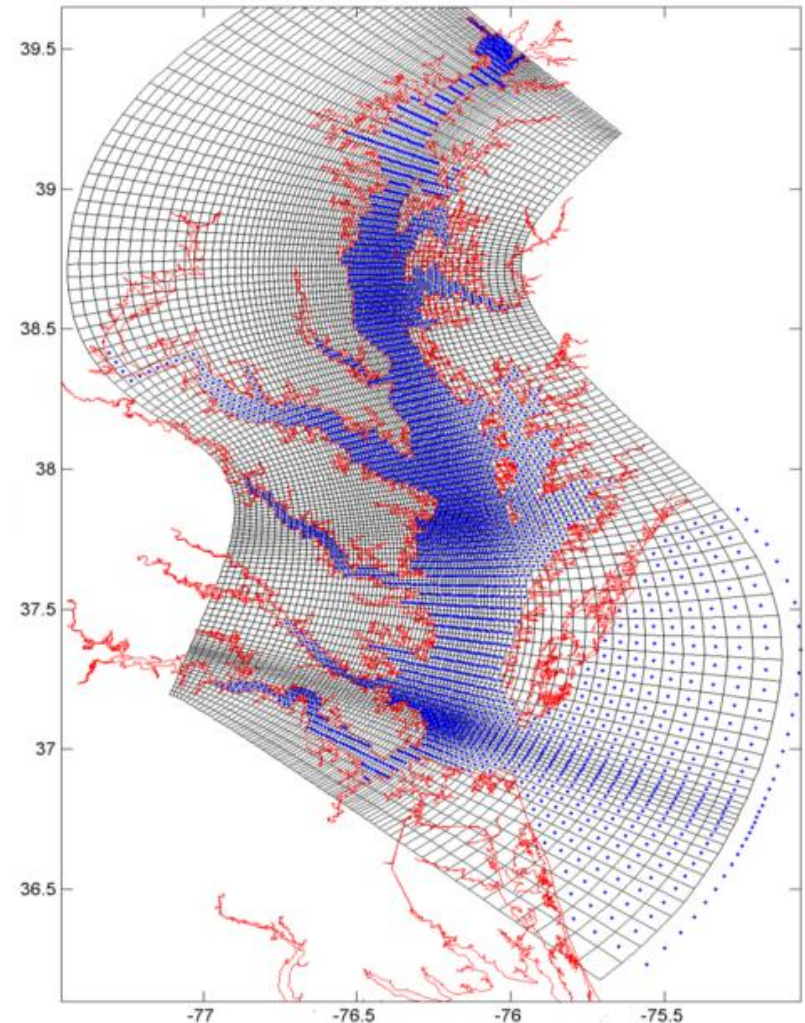
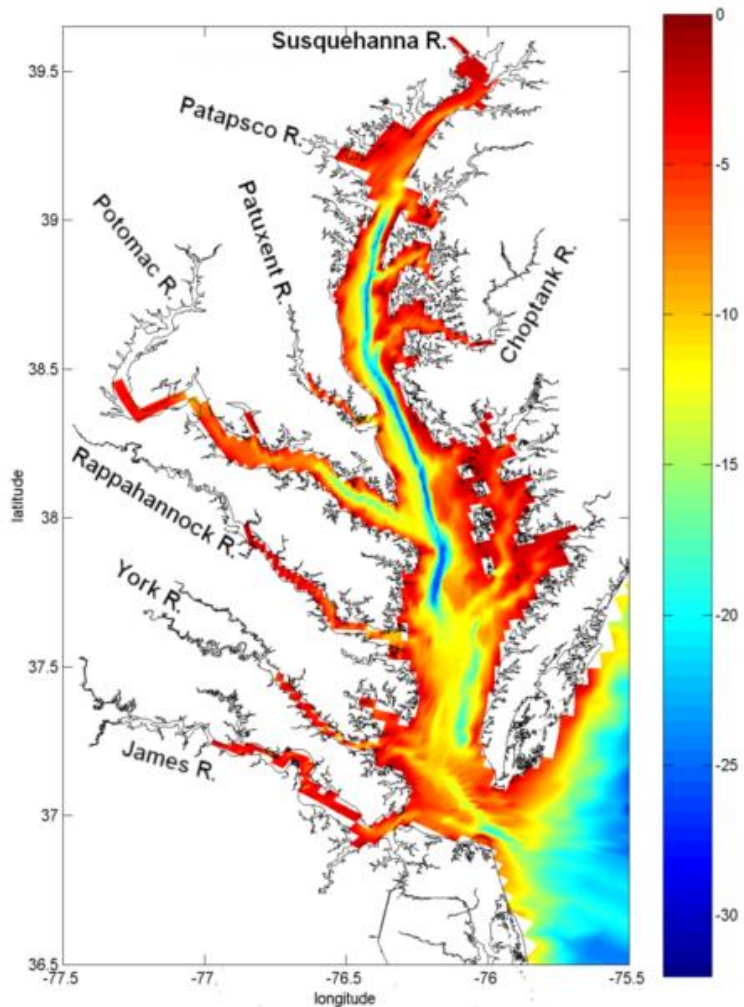
Bacteria (.2-2 um [.002 mm] - feed microzooplankton food chain)

- Benthic Bacteria (sediment)
- Pelagic Bacteria: (free-living)

A large colony of brown birds, possibly terns, is gathered on a rocky shore. The birds are densely packed in the foreground and middle ground, with some individuals showing lighter-colored heads. In the background, the ocean is visible with several fish swimming near the surface. The text "In Progress" is overlaid on the lower-left portion of the image.

In Progress

Daily oceanographic fluxes (water, heat, salt) into and out of each box are controlled by a ROMS (*Regional Ocean Modeling System*) oceanographic model by Raleigh Hood, UMCES-HPL/



A photograph showing a vast colony of brown birds, likely frigatebirds, gathered on a rocky or pebbly shoreline. The birds are densely packed in the foreground and middle ground, extending towards the water. The water is a pale blue, and several small fish are visible swimming in the upper portion of the frame. The text "EXTRA SLIDES" is superimposed in bold black letters on the lower-left side of the image.

EXTRA SLIDES

Atlantis Architecture

Modular Components:

- Biogeophysical
- Fisheries (harvest)
- Assessment/ Management triggers
- Socioeconomics

Program Code

- C++
- NetCDF

The background of the slide is a photograph of a vast oyster reef. The reef is composed of numerous oyster shells, some of which are open, creating a textured, brownish-grey surface. The reef extends from the foreground into the distance, where it meets a clear blue sky. The water is a light blue color, and the overall scene is bright and clear.

The Chesapeake Atlantis Model (CAM)

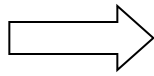
Benefits

Atlantis

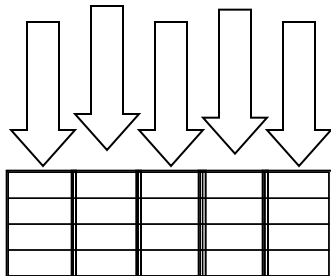
Management Strategy Evaluation (MSE)

Manager Roles

DEFINE
OBJECTIVES



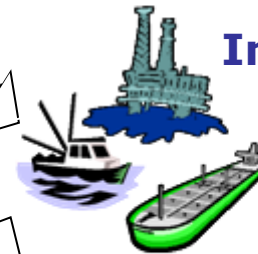
PERFORMANCE
MEASURES



Simulation Cycle



Biophysical



Industry

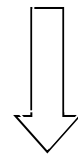


Implementation

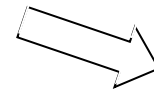
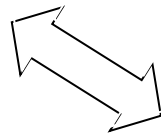
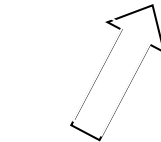
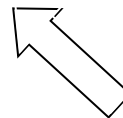
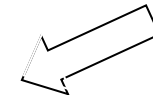


Management

Monitoring



Assessment

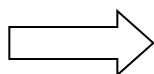


Atlantis

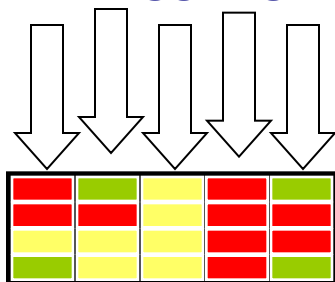
Management Strategy Evaluation (MSE)

Manager Roles

DEFINE
OBJECTIVES



PERFORMANCE
MEASURES



Simulation Cycle



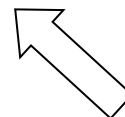
Biophysical



Industry



Implementation



Management



Monitoring

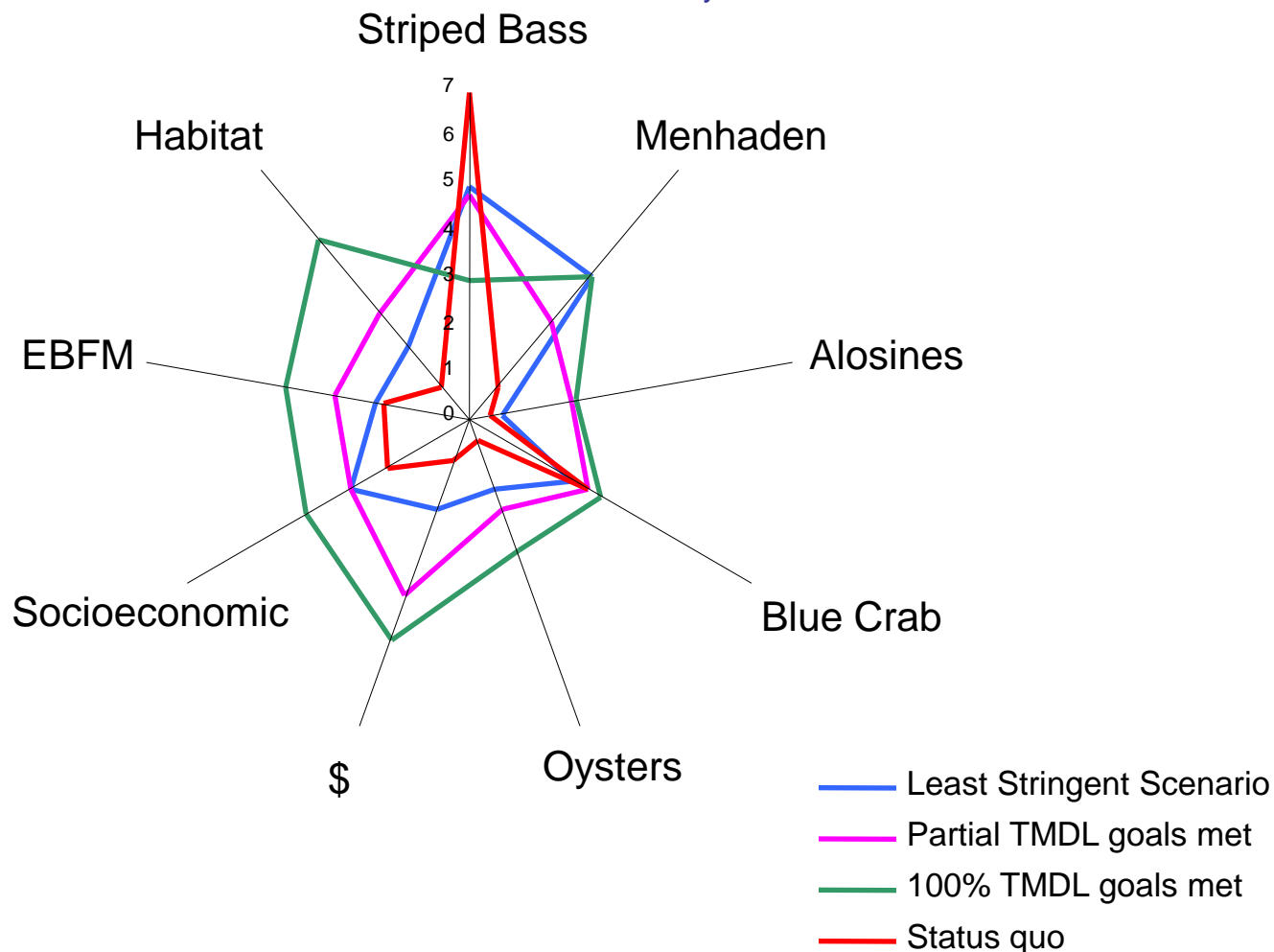


Assessment

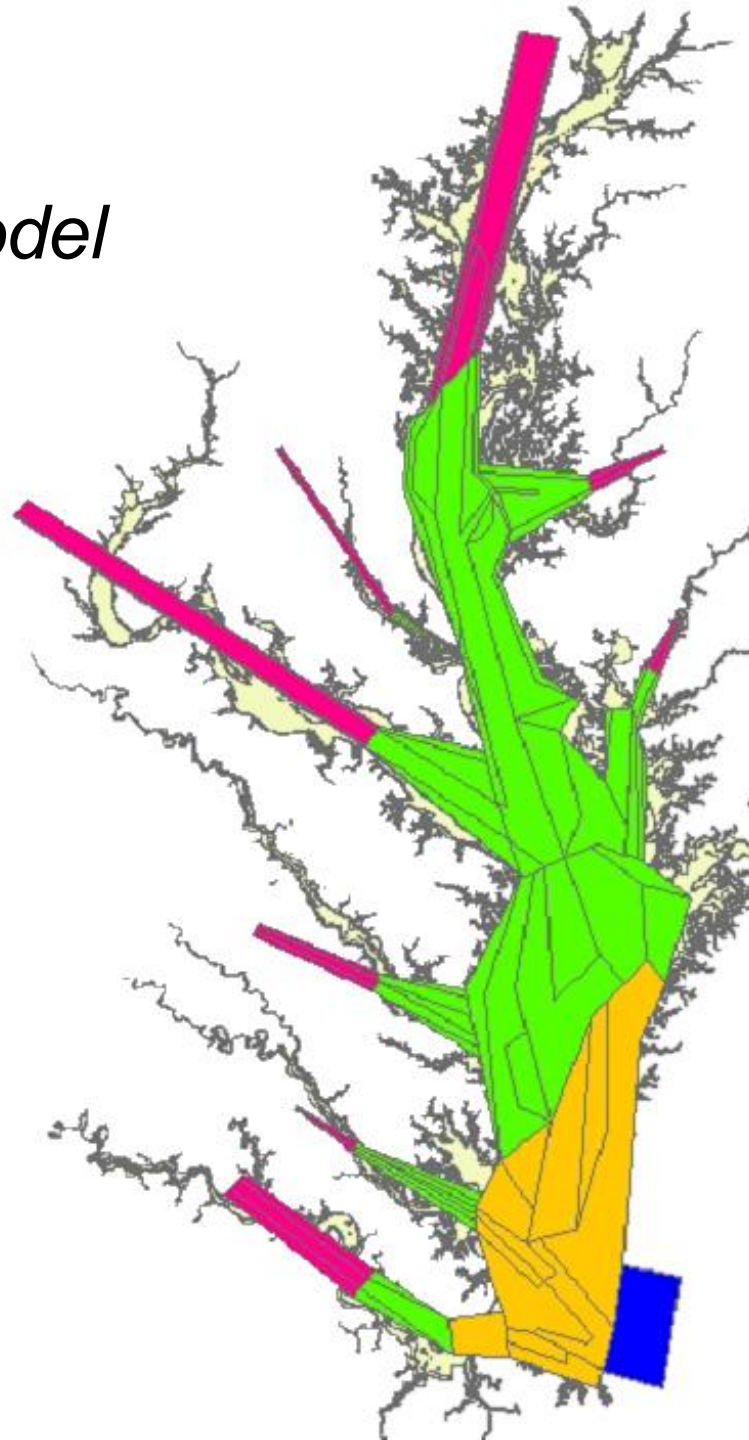
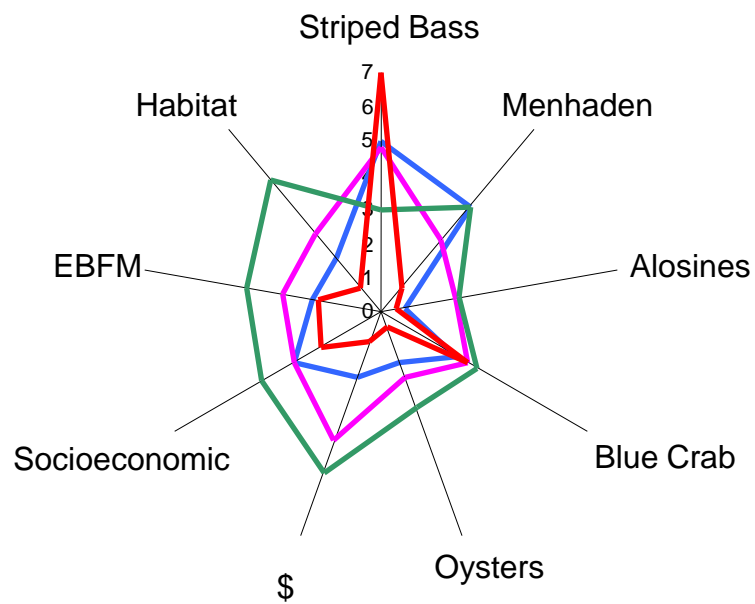


Tradeoffs - *Hypothetical*

CAM Output
20 year Simulation

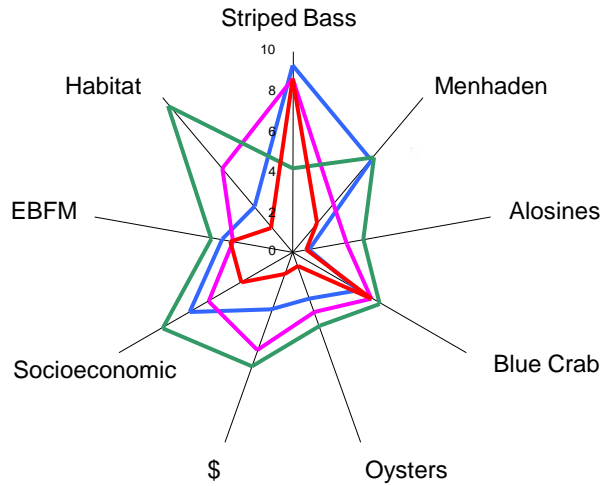


Chesapeake Atlantis Model



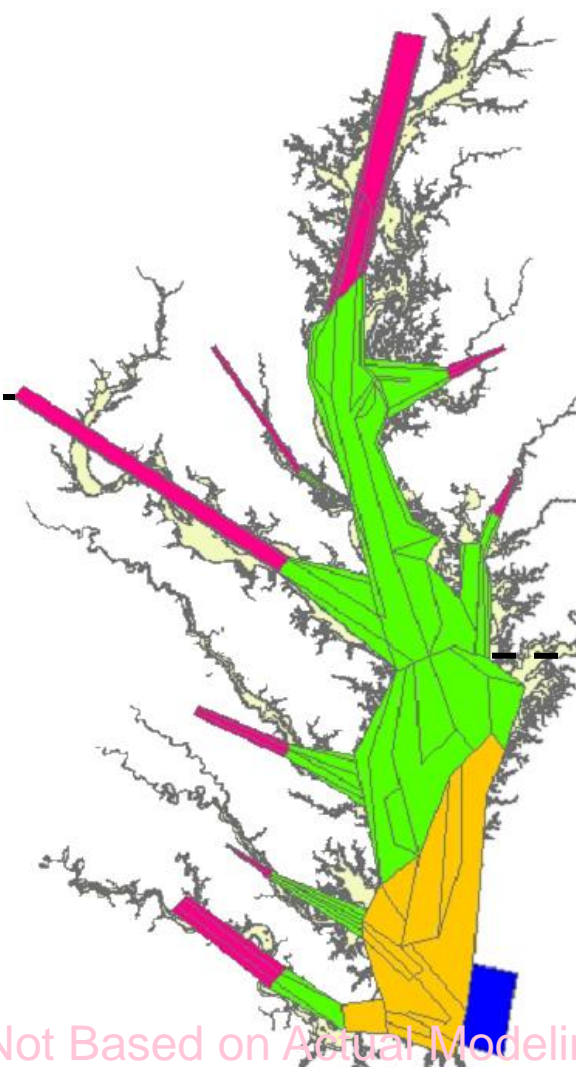
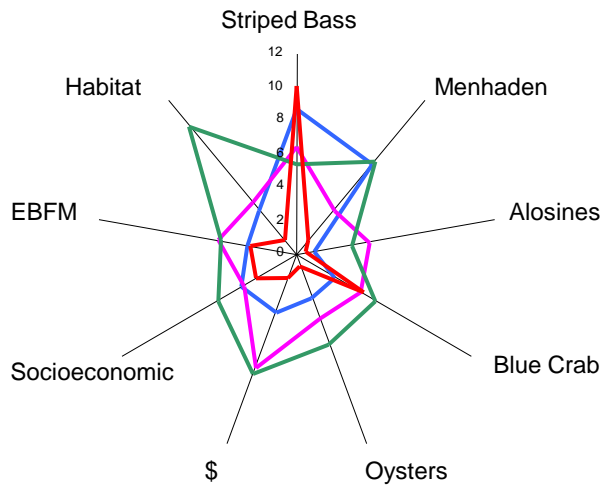
Tradeoffs

CAM Output
20 year Simulation



MD

VA

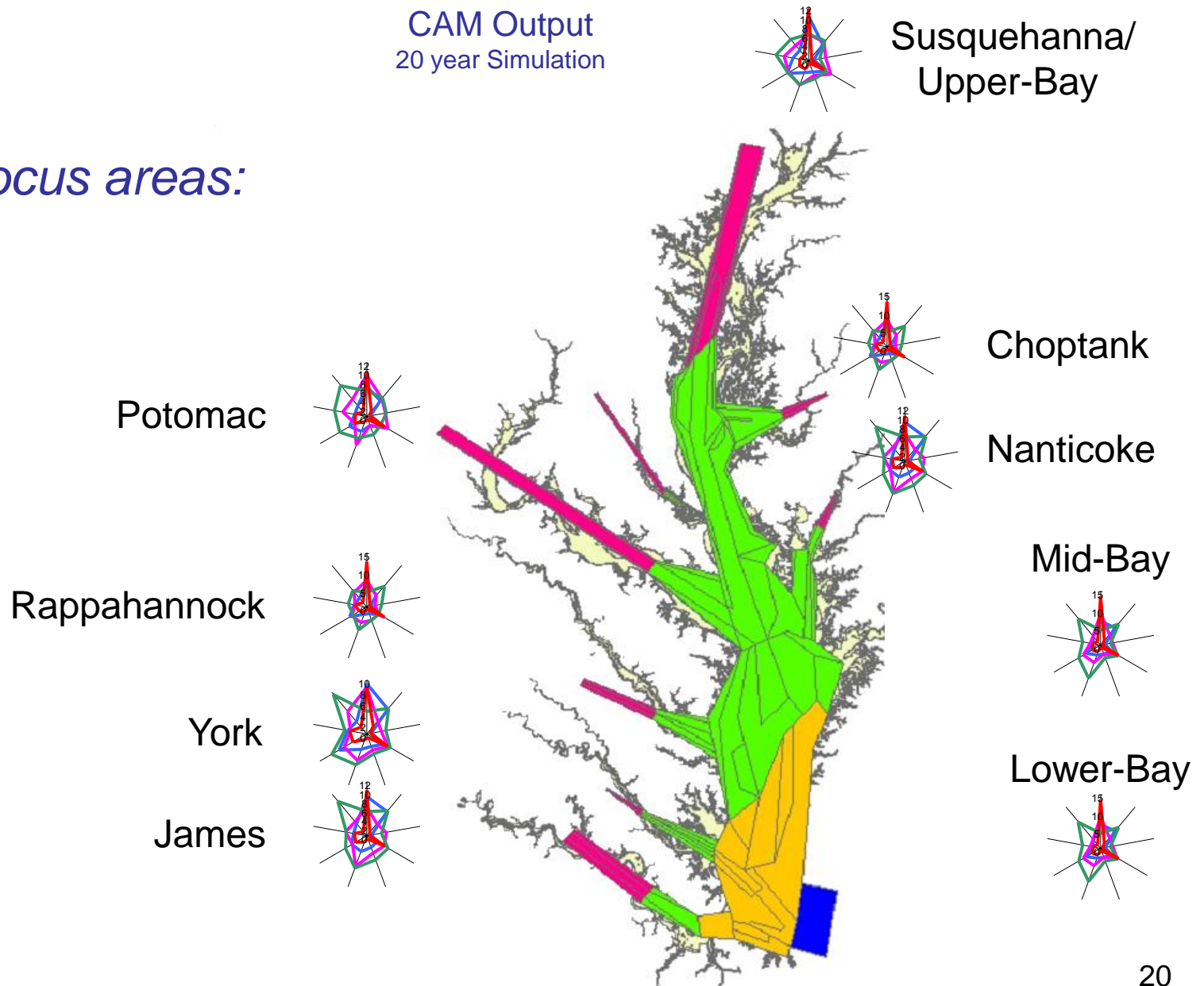


For Illustrative Purposes Only -- Not Based on Actual Modeling Results

Tradeoffs

CAM Output
20 year Simulation

Focus areas:



For Illustrative Purposes Only -- Not Based on Actual Modeling Results

Every 12 hours simulation-time...

97 spatial polygons

×

5 vertical depth layers

×

56 ecological groups

×

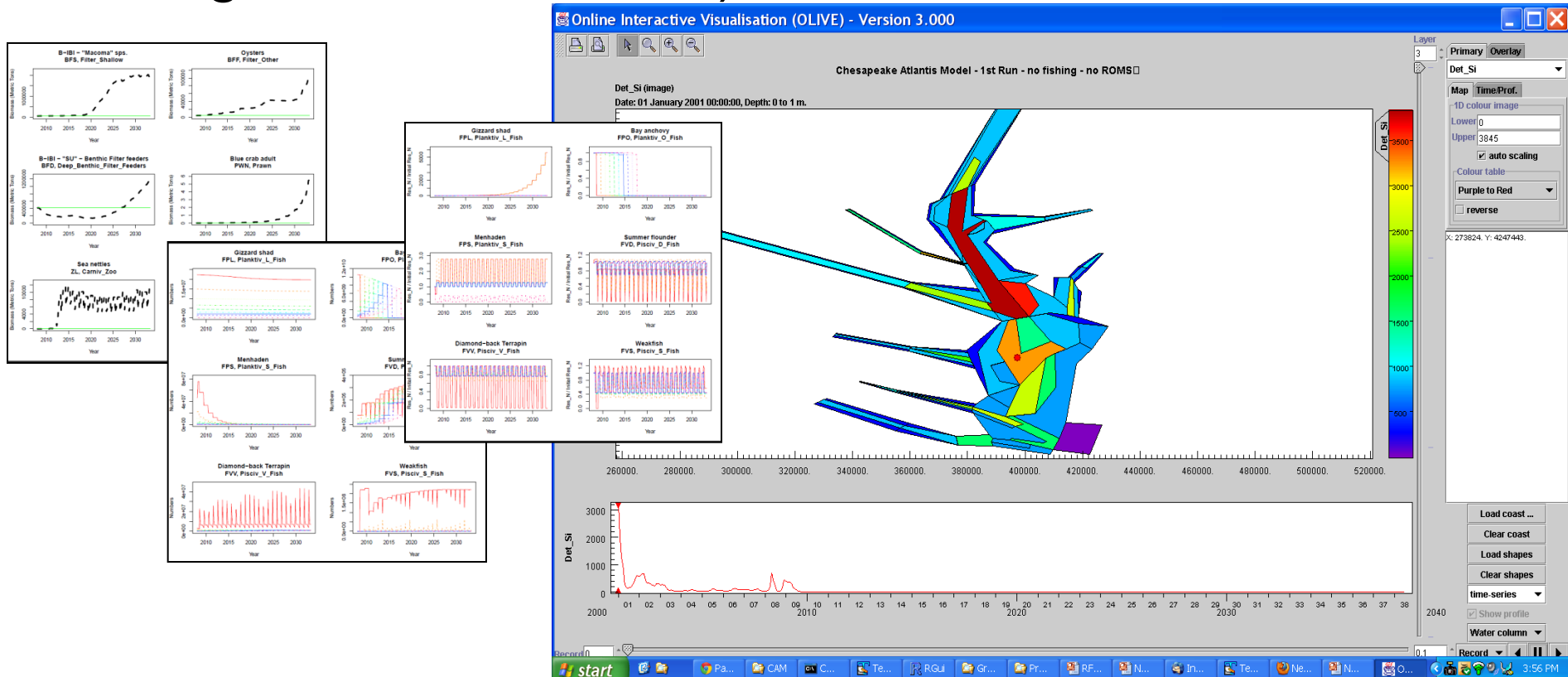
33 fisheries

= ~900,000 parameter estimates

Output

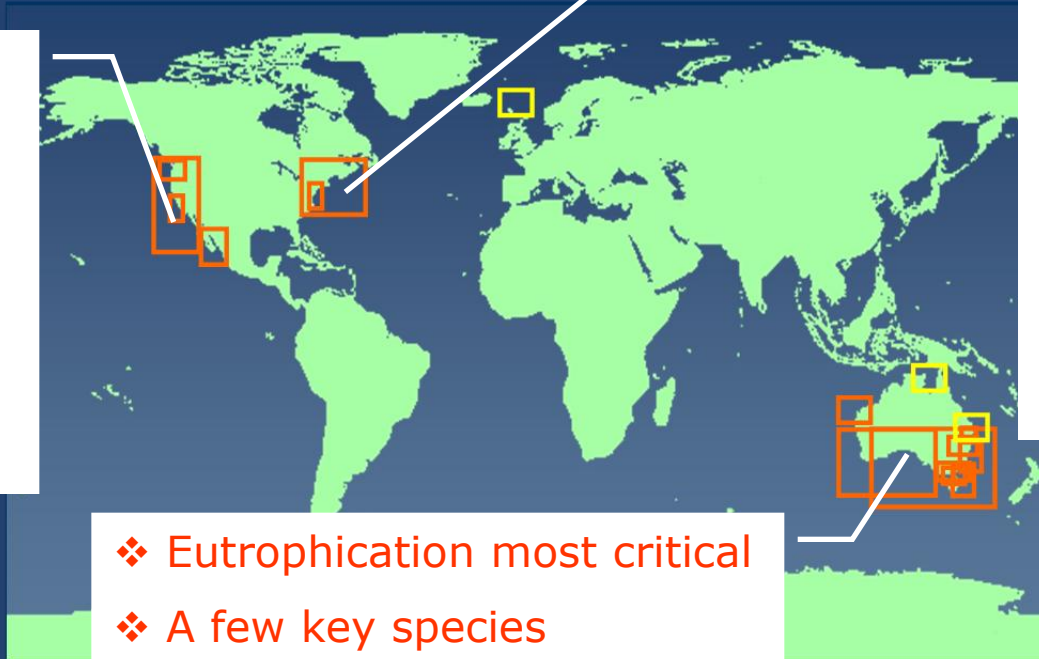
Scads of output:

- Though we try to limit, could potentially have >100 GB of output for a run (current runs generate ~ 3-5 GB)



Implementations

- ❖ MPA planning in E.S. context
- ❖ ITQ's/ "catch shares"
- ❖ Evaluate ecological indicators



Sustainability of fisheries in context of climate change:

- ❖ Evaluate economic pressures
- ❖ Effort allocation
- ❖ Gear choice

- ❖ Eutrophication most critical
- ❖ A few key species capture the major ecosystem impacts
- ❖ Ecosystem models identify impacts single-species models miss

Thanks to:



Marine and Atmospheric Research

Northeast Fisheries Science Center



Northwest Fisheries Science Center

NOAA Fisheries Service

