Working to Improve Fisheries Production Modeling by Applying Satellite data to an Ecosystem Modeling Approach

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NOAA Chesapeake Bay Office

Ocean Color Users and New Applications, 27 August

The Atlantis Model

A Whole Ecosystem Modeling Approach

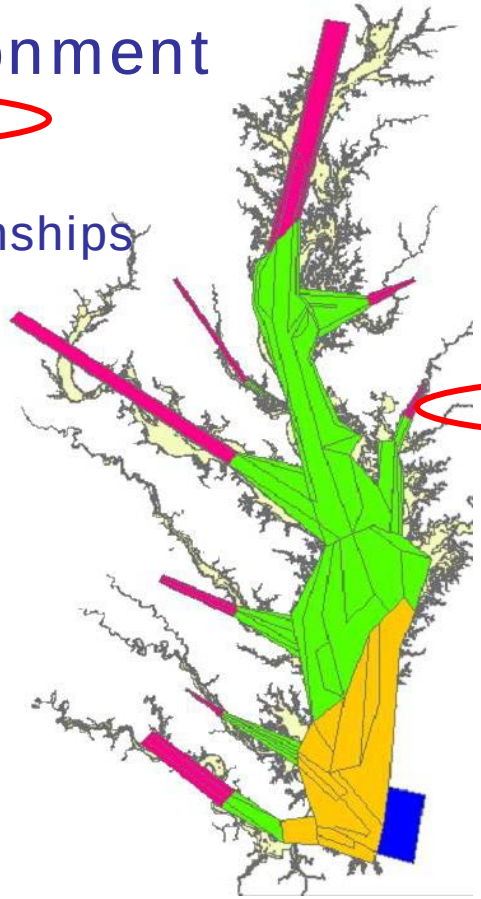
Incorporating:

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

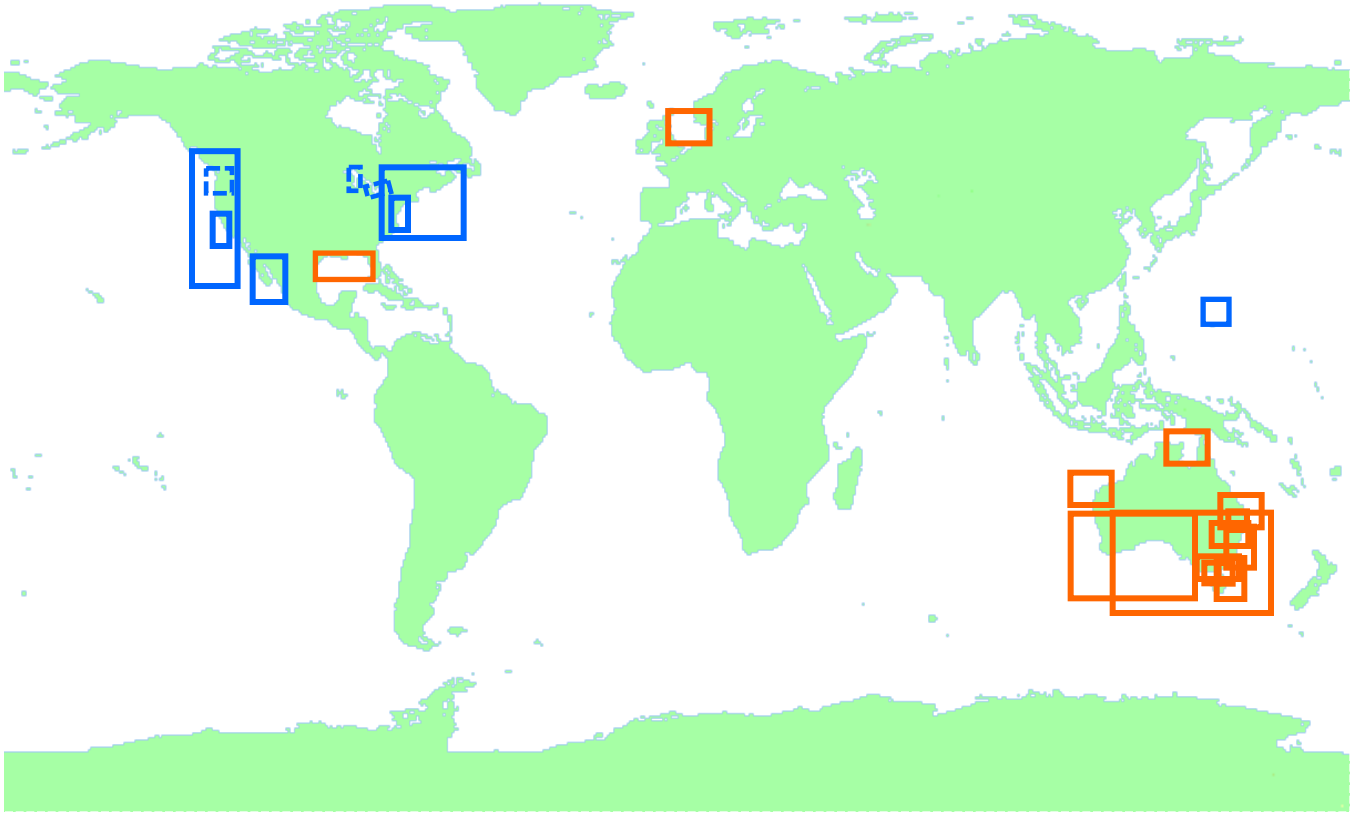
Nutrient Inputs

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

How Model is Used

- Provides integrated system information on trade-offs to decision makers (Integrated Ecosystem Assessment approach)
  - Levels the playing field for system stressors
- Management strategies – Socioeconomic effects:
  - Gear choice effects
  - Marine Protected Area (MPA) design
  - Catch Shares
- Ecological effects of expected system changes:
  - Climate impacts
    - Temperature, Salinity,
    - Storms – frequency, intensity (turbidity & circulation, respectively)
    - Habitat Loss
    - Ocean Acidification
  - Nutrient effects
  - Ecosystem health indicators/metrics
  - Inshore production (forage species & habitat) effects on offshore fisheries production
  - Harvest impacts

Implementations



~25 systems established simulations

New NOAA models begun

Benefits of NESDIS data for science questions addressed in the Chesapeake Atlantis Model

- Verify/tune current model
- Develop new improved model:

✓ Test effects of vastly improved spatial & temporal resolution of Chl_a & TSS data on model predictions

✓ Capture/ model system effects of episodic events

o Take advantage of high temporal resolution data to better understand effects of storms, etc.

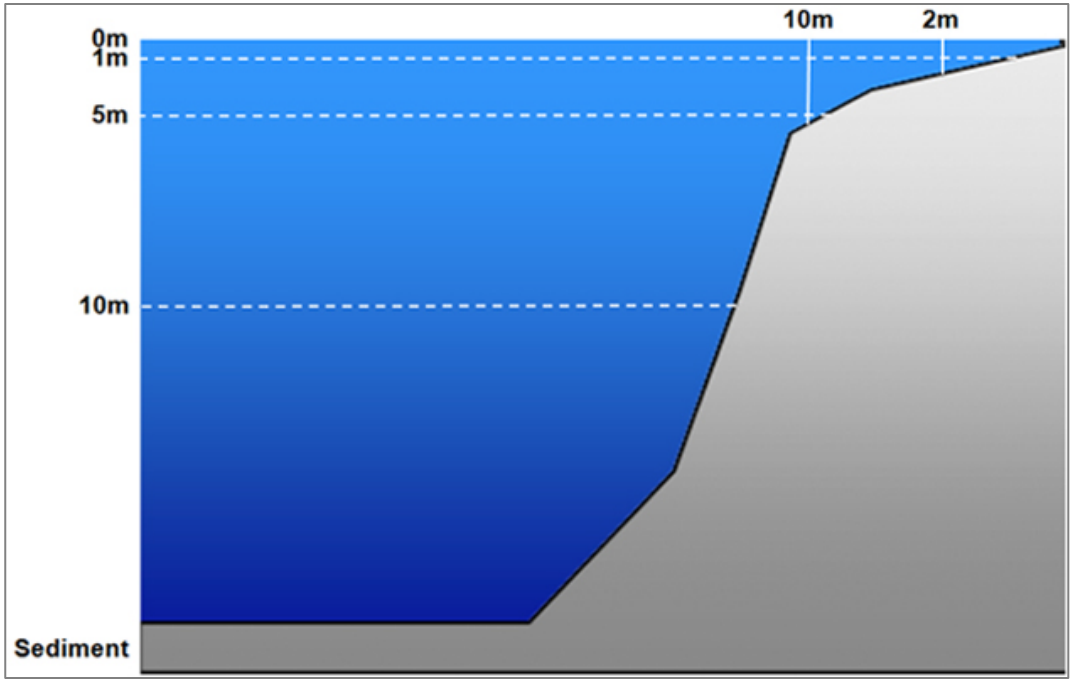
✓ Minimize lower trophic-level errors & consequently, limit error propagation

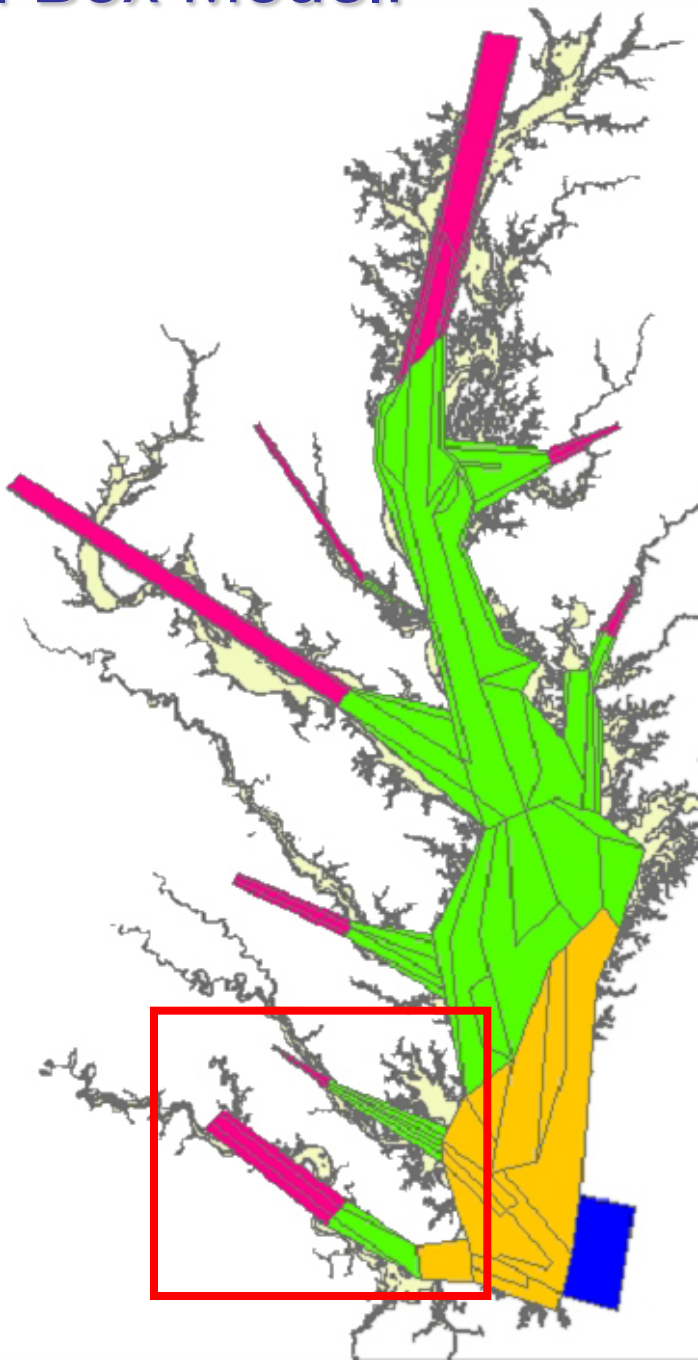
The Chesapeake Atlantis Model

(CAM)

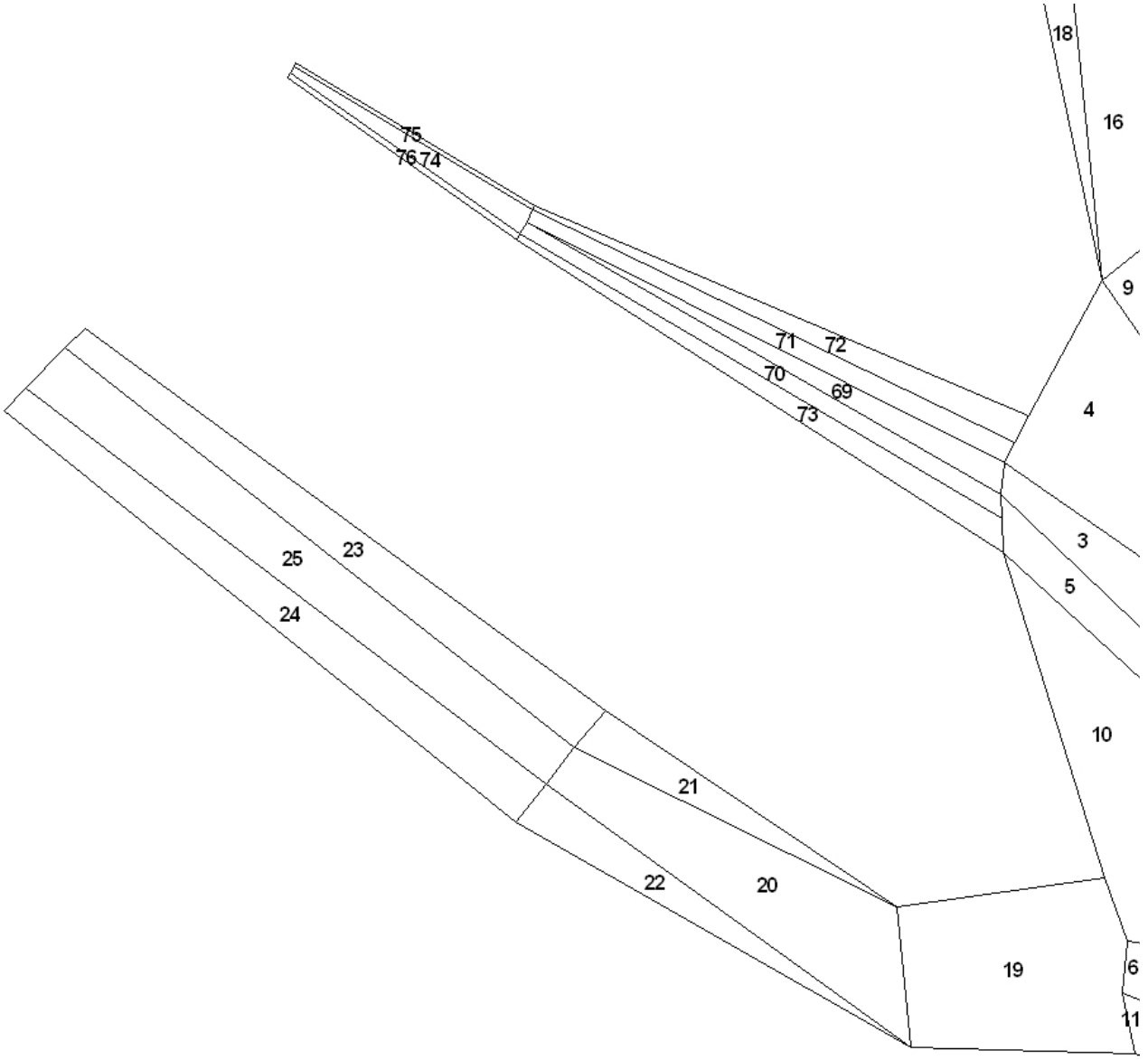
Design

CAM Design: 3-Dimensional Box Model:





CAM: River Box Structure



Ecological Groups: Federal fisheries, Forage, Protected, Habitat

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: nannoplankton, 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)

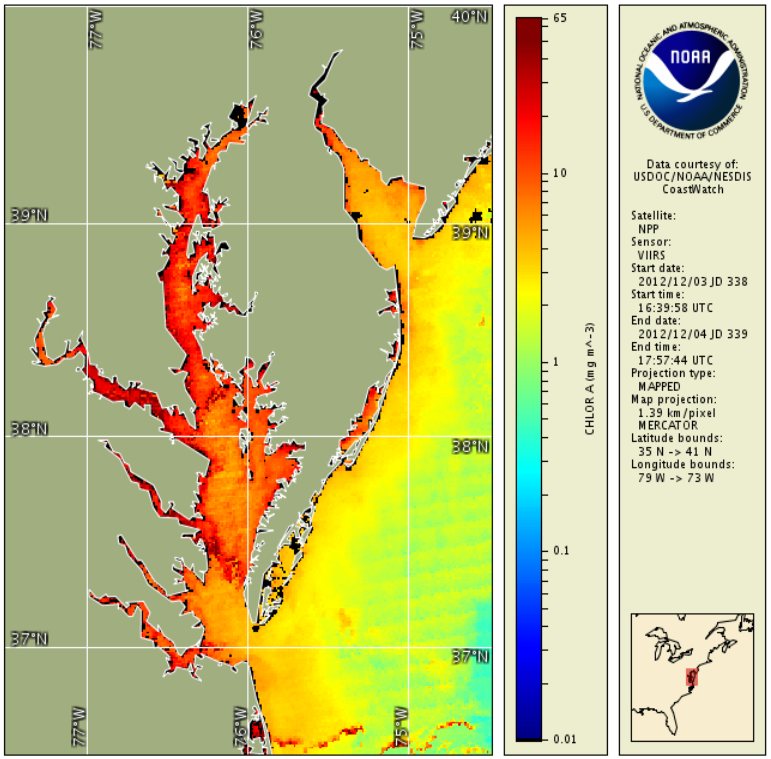
Images courtesy of ian.umces.edu/imagelibrary/

Collaborative Progress To Date

- Format data for Atlantis
- Compare results for various Chl_a data sources:
  - EPA – base model
  - MODIS (std)
  - MODIS (tunedCB)
  - SeaWiFS (2002)
  - VIIRS (IDPS algorithm 1st year, now MSL12 algorithm)
- Outputs
  - Run length
  - Biomass
- Future Directions

Conversion of VIIRS data to Atlantis Ecosystem Model Grid

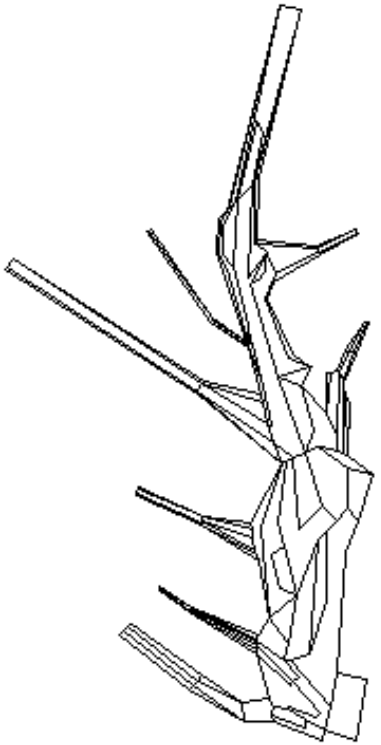
VIIRS satellite chlorophyll → **Georeferenced grid** → **Ecosystem model grid**



S-NPP VIIRS chlorophyll
CoastWatch 2-day avg (Dec 3-4, 2012)
Raster data: UTM coordinates



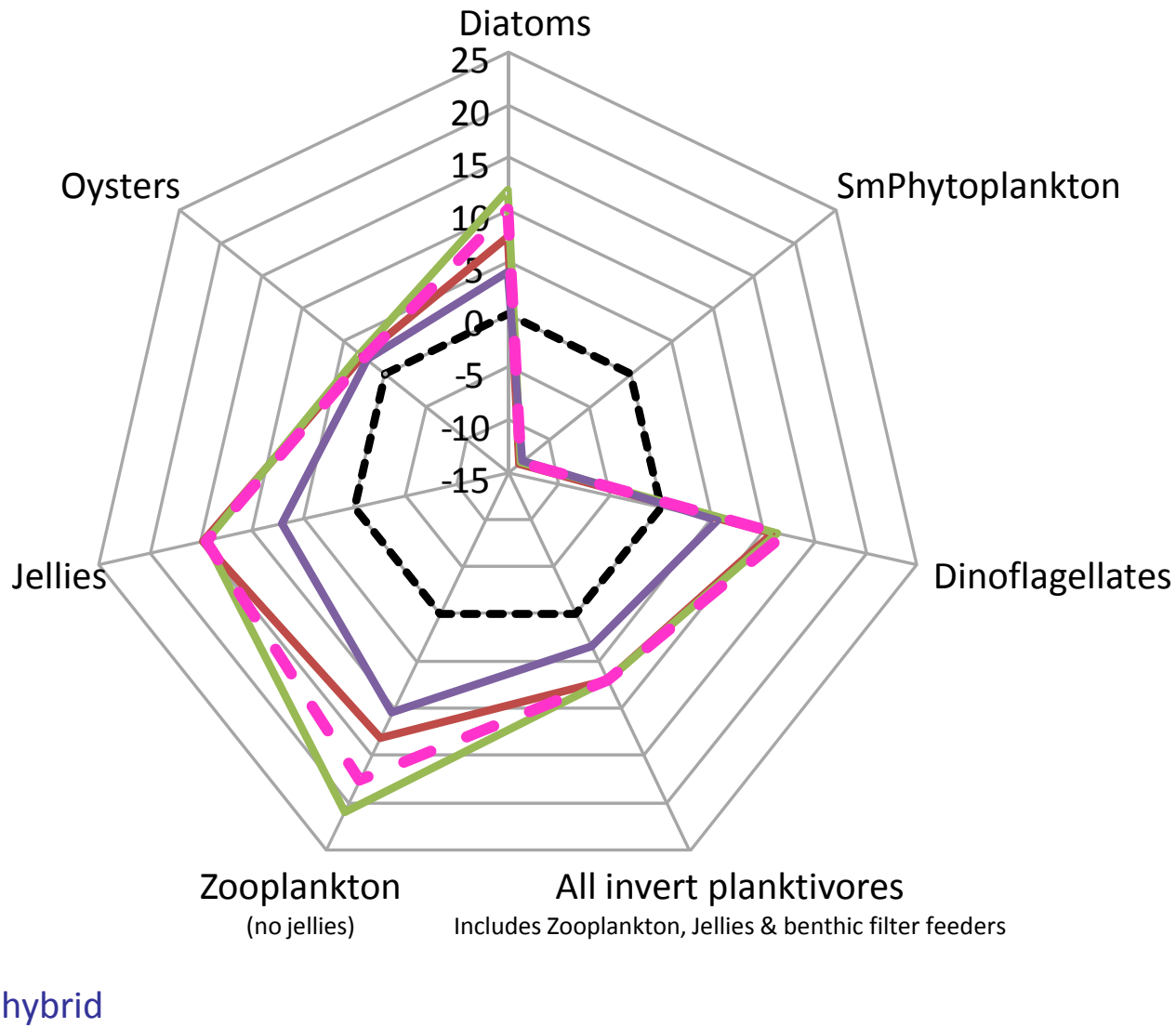
Chesapeake Bay Program
Georeferenced polygonal grid
8,282 polygons



NOAA/NMFS/NCBO
Atlantis Ecosystem Model
97 polygons
Aggregated from 8,282

EPA (base model) compared to Satellite Datasets

Percent difference from base run



Future Directions

- Continue to develop methods to verify model output (and assess accuracy)
- Assess model skill:
  EPA vs. Satellite vs. Hybrid
- Data assimilation
- Apply Satellite data to other Atlantis efforts

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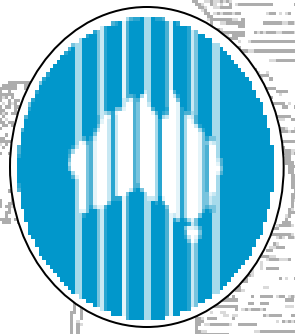


EXTRA SLIDES

The Commonwealth Scientific and Industrial Research Organisation

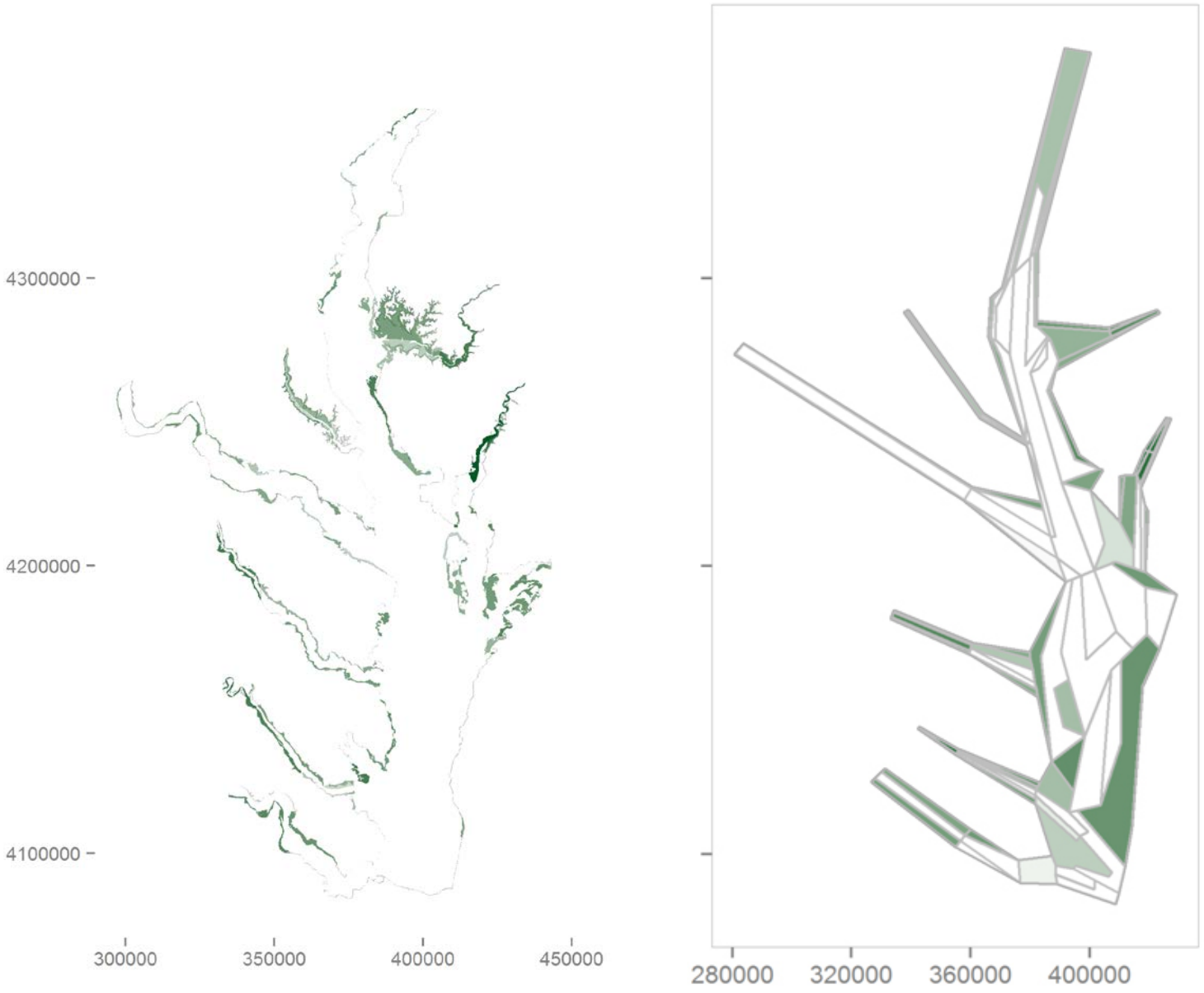
Atlantis



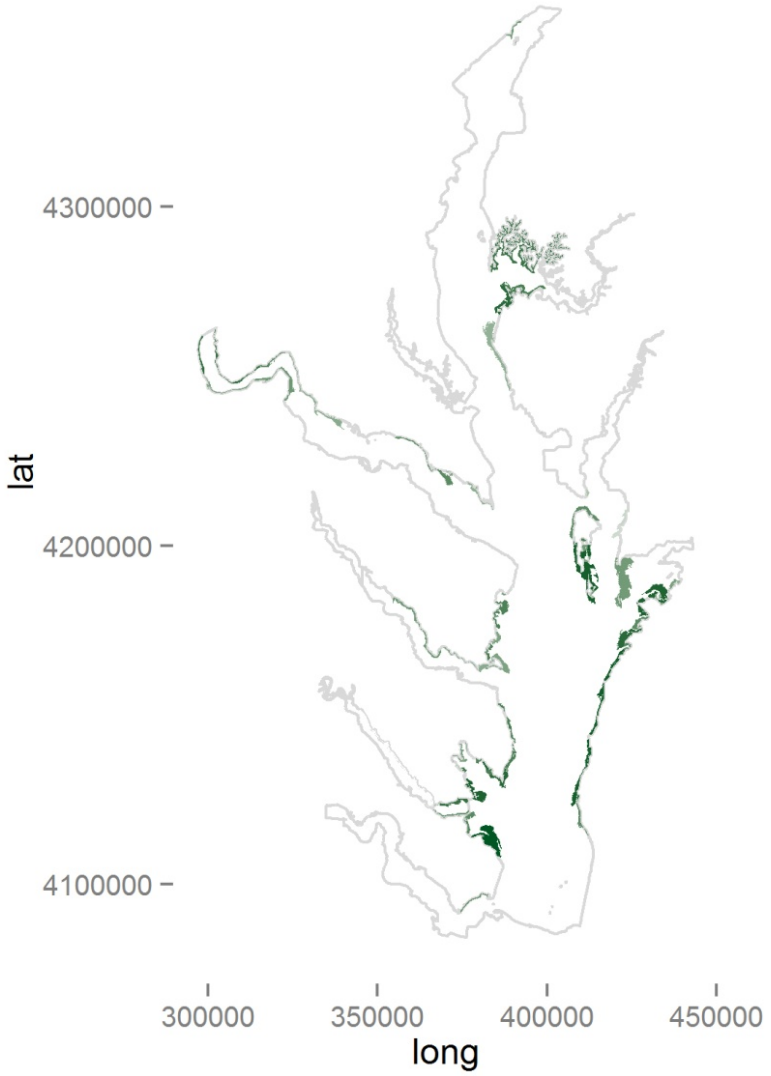


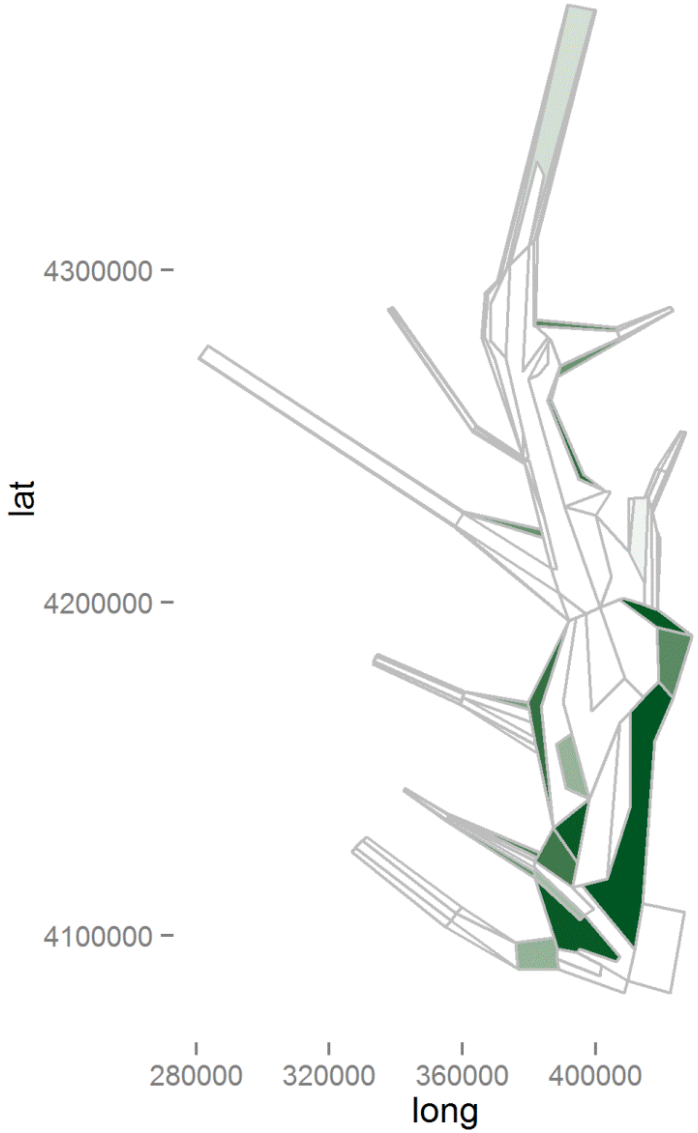
Beth Fulton

Habitat: SAV Modeled in CAM



Habitat: Marsh Modeled in CAM

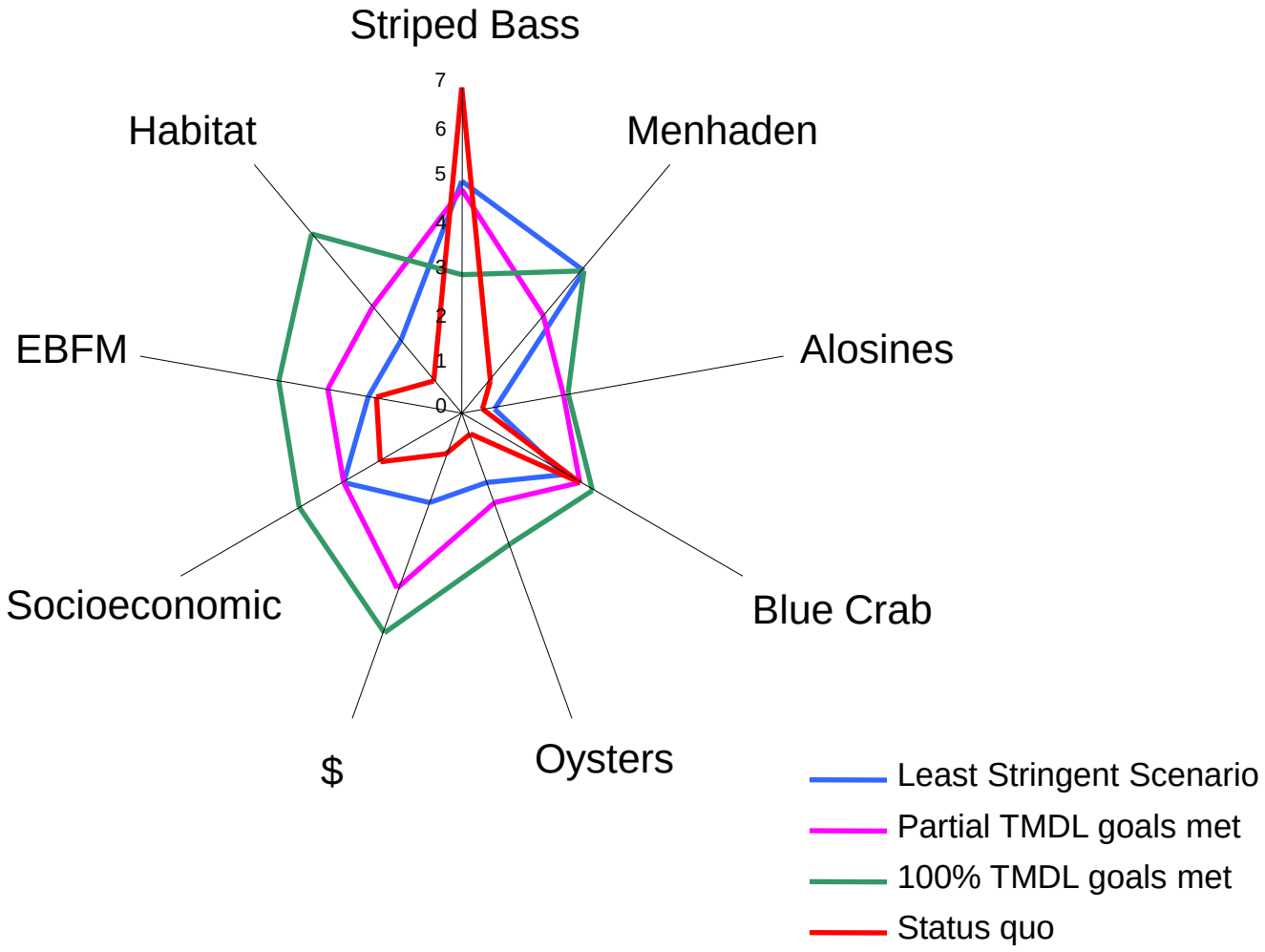




Tradeoffs - *Hypothetical*

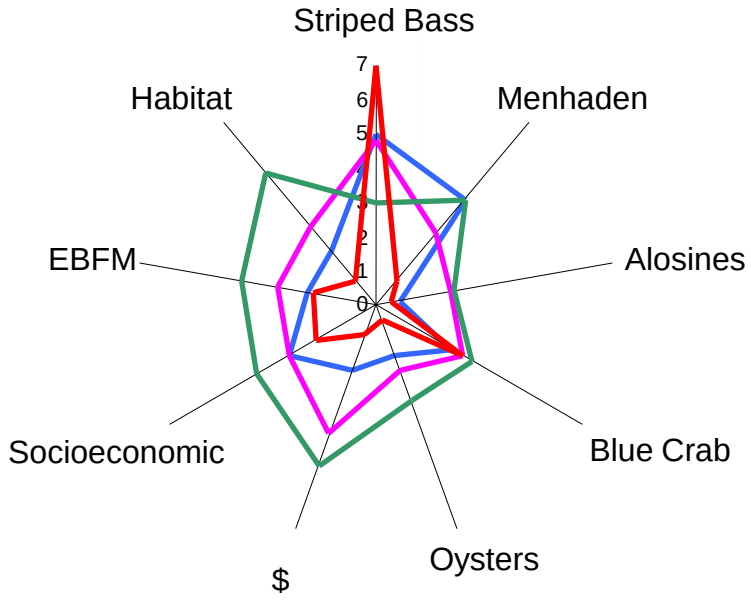
CAM Output

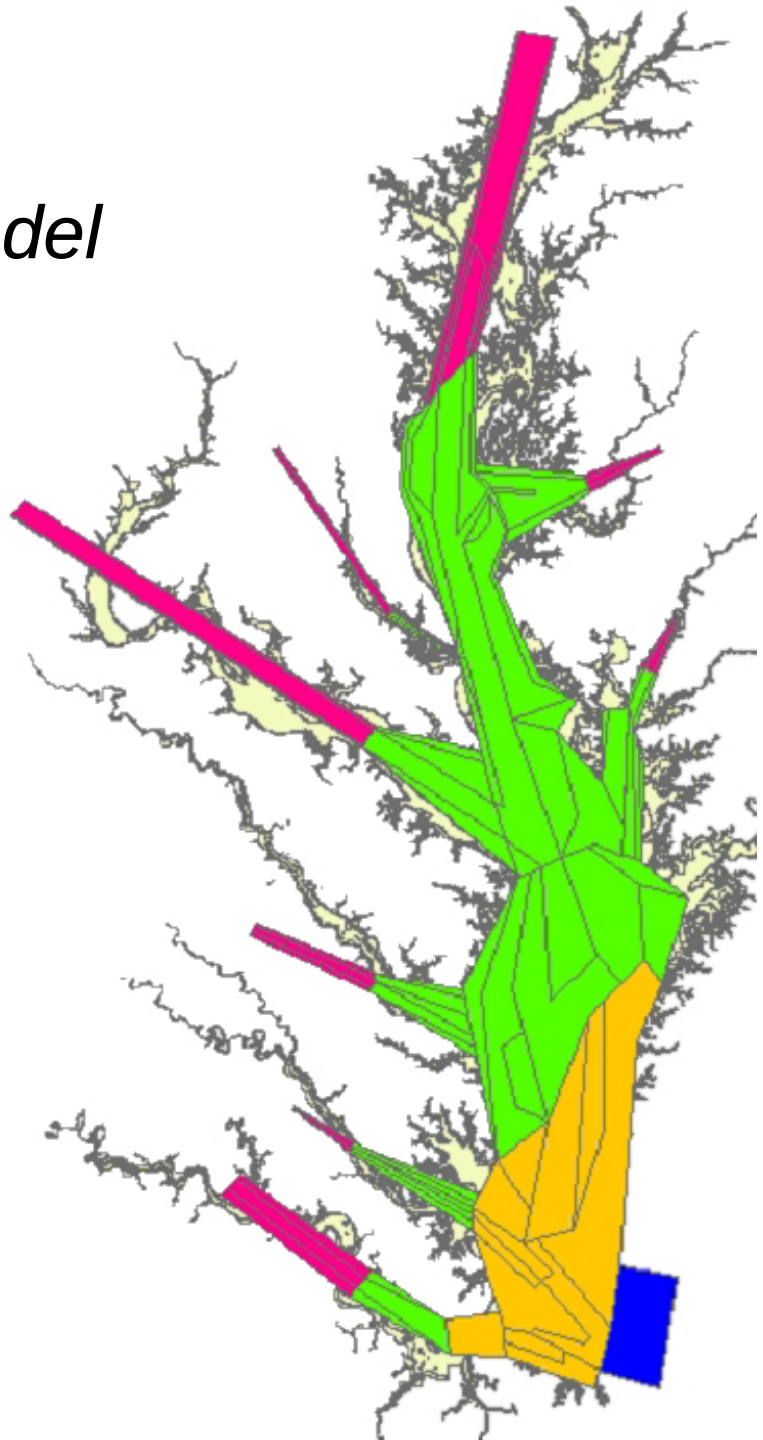
20 year Simulation



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

Chesapeake Atlantis Model



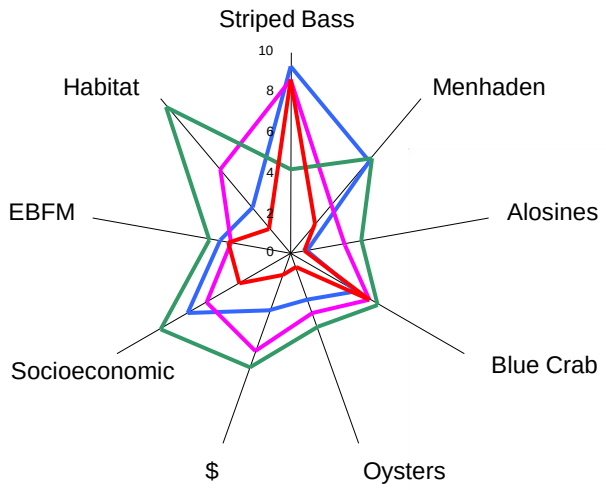


Tradeoffs

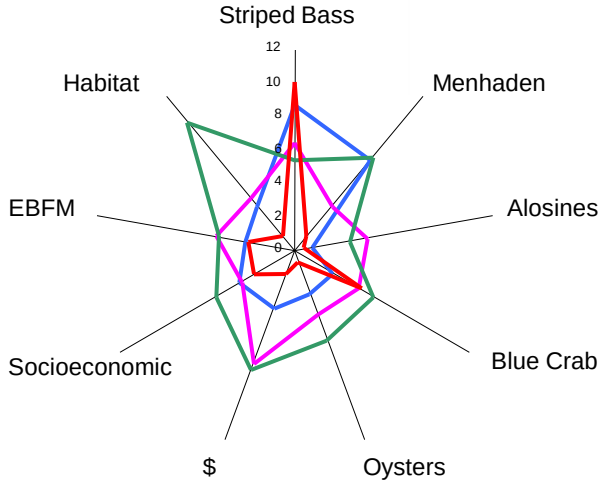
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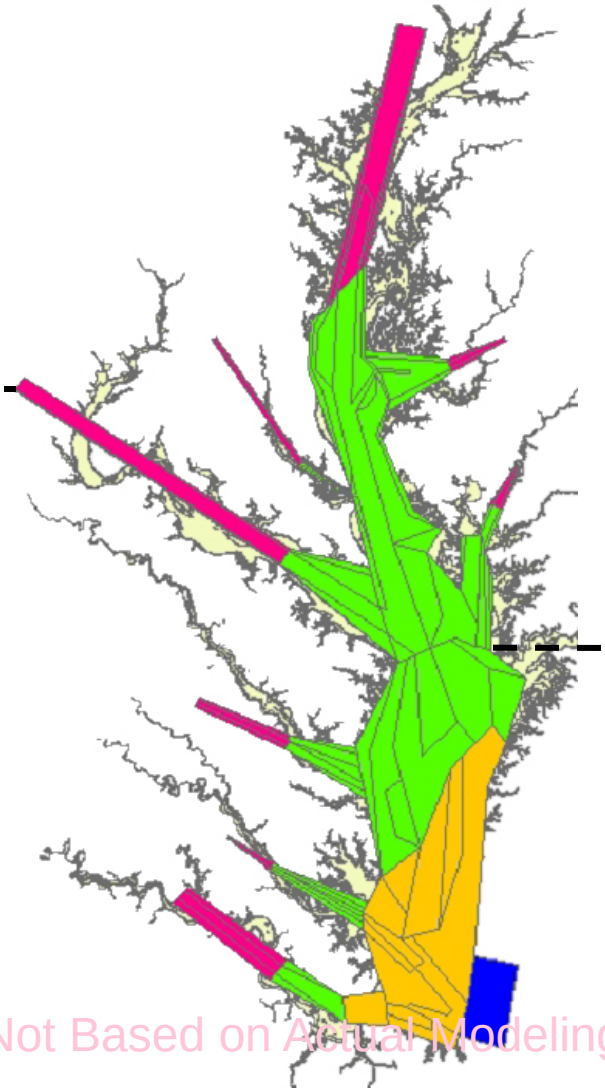
20 year Simulation

MD



VA





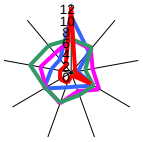
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Tradeoffs

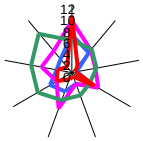
CAM Output

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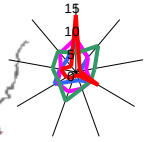
Focus areas:



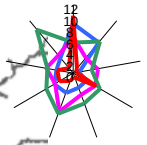
Susquehanna/
Upper-Bay



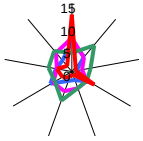
Potomac



Choptank

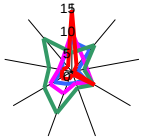


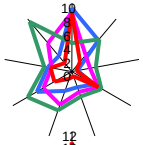
Nanticoke



Rappahannock

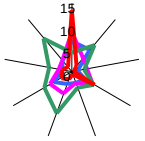
Mid-Bay

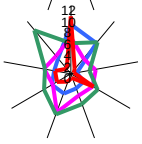




York

Lower-Bay





James

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Atlantis

Management Strategy Evaluation (MSE)

Manager Roles

DEFINE OBJECTIVES

PERFORMANCE MEASURES

Simulation Cycle



Biophysical



Industry

Monitoring





Implementation



Assessment



Management

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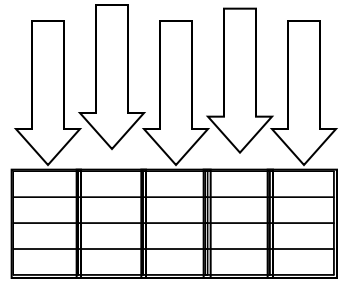
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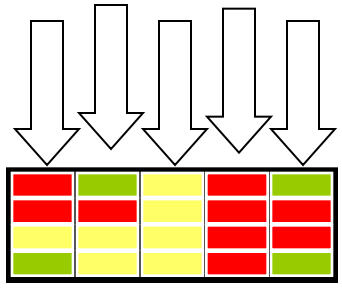
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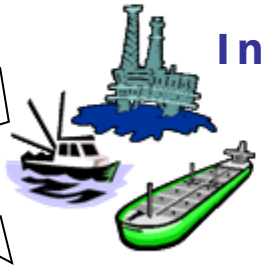
PERFORMANCE MEASURES



Simulation Cycle



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Assessment



Management

EPA Chlorophyll Inputs to Atlantis Model

