Applications of the Atlantis Model in the Gulf of Mexico

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Overview

- Atlantis model
- GOM implementation
  - Diet
  - Biomass
  - Other data
- Application 1: DWHOS
- Application 2: IEA
- Application 3: Hypoxia
Fisheries
Target, bycatch, habitat effects, ports, costs, compliance
Effort models: CPUE / cost based

Ecology sub-models
Consumption / production, waste production, migration, predation, reproduction & recruitment, habitat dependence and mortality

Nutrients (Si, N)

Oceanography sub-model

- Bacteria to apex predators ("end-to-end")
- Irregular polygons
- Fully age structured
- Larval transport
- Space limitation
- Biogenic & physical habitat
- Nutrient and waste cycling
- Detailed fisheries accounting
Food web analysis

C-IMAGE longline surveys
- 136 stomachs analyzed in lab
- 19 under-sampled species (bycatch/deep)

Other data
- 235 spp.
- 15 spp.
- 905 spp.

FWRI Diet database (B. McMichaels)

FishBase

SeaLifeBase

Gut content analysis

Morphometrics for gape-limited feeding
Methodological paper 1: Diet

Partial food web; showing 20% minimum connectance
Methodological paper 2: Biomass

- GAM predicts relative biomass distribution based on environmental predictors
- 2/3 data for model training, 1/3 for validation
- Neg. binomial w/ log link
- 1/12th degree resolution

Methodological paper 3: Larval dispersal

- Lagrangian passive drift model of larval transport
- Individual based model
- Driven by GoM HYCOM NCODA (Chassignet et al. 2007)
- Egg density calculated based on spawner biomass (from generalized additive model, Drexler and Ainsworth 2011)
- Source/destination matrix imported to Atlantis
- Provides connectivity for 46 spp.

Red grouper larvae

Provides connectivity
Application 1: Oil impacts

Oil impacts module for Atlantis
- Developed Nov 2013 for C-IMAGE
- Allows spatial forcing function for *mortality, growth and recruitment*
- Useful for oil, HABs and other spatial stressors

Oil concentrations from far field modeling (Clair Paris, UM)

Functional response from toxicology studies

Spatial impacts in Atlantis

CIMAGE Renewal
- Campeche Bay model for IXTOC comparison
- MOSSFA (marine snow) for DWHOS – includes hypoxia
Deep-C is funding Lindsey Dornberger to act as a liaison with CIMAGE.

Same oil forcing functions will be used in both models.

Similar data and structure.

Eventually, we may be able to feed boundary conditions into Deep-C model.

Focus: Mercury bioaccumulation.
Role of Atlantis in Integrated Ecosystem Assessment

• Evaluation of indicators
• Management Strategy Evaluation (MSE)

Ecology and fishing simulator (Atlantis)

Observations → Monitoring and indicators
1 year cycle
Assessments and parameter estimation
Management policies: quotas, TAC, MPAs

Implementation

• Ongoing Sea Grant project testing harvest control rules in the GOM under climate change
Application 3: Hypoxia

Relevant processes explicitly modeled in Atlantis

- Point-source terrigenic nutrient loading (e.g., Mississippi R.)
- Bottom-up trophic dynamics (e.g., plankton blooms)
- Bacterial growth and respiration
- DO depletion in water column and sediment
- Oxygen requirements by species
- Hydrodynamics from ROMS limited to short time series

Outputs

- Ecological indicators
  (biomass, numbers, age structure biodiversity, species ratios, condition factor)
- Biophysical indicators (DO, DON, Chl A)
- Fisheries economics
- Seasonal/daily outputs available
A nested suite of models

C-IMAGE / IEA

Doran Mason (GLERL) and post-doc Andrea Van Der Woude developing a TX-MS-LA shelf model to look at hypoxia effects (Dead zone)

CSCOR - NCCOS

- Doran Mason (GLERL) and post-doc Andrea Van Der Woude developing a TX-MS-LA shelf model to look at hypoxia effects (Dead zone)
- Center for Sponsored Coastal Ocean Research (NCCOS) sponsored research for reducing size of the hypoxic zone by the Gulf of Mexico/Mississippi River Watershed Nutrient Task Force.

Doran Mason
Andrea Vander Woude
NCCOS Model status

Model specs
- 4 water column depth layers plus sediment
- ~30 polygons
- 45 functional groups
- Diet, biomass, movement described
- Still tuning (stable to 180 days)
NCCOS Model status

- Input river values for Dissolved Organic Nitrogen, Ammonia and Silicate from the Atchafalaya and the Mississippi River to force hypoxic conditions.
- Incorporated the hydrodynamics from Rob Hetland and this was interpolated by the Atlantis developers to each grid cell and each layer.

![DON concentration Day 1](image1)
![DON concentration Day 178](image2)
![DO concentration Day 1](image3)
![DO concentration Day 178](image4)
Collaborators

University of South Florida (Ainsworth, Murawski)
SEFSC-NOAA (Schirripa, Kelble, Zimmerman)
NWFSC-NOAA (Levin, Kaplan)
University of Miami (RSMAS) (Die, Babcock)
Florida State University (Coleman, Gosnell)
FWRI (Mahmoudi, Chagaris)
CSIRO (Fulton)
NCDDC (Beard, Parsons, Carleton)
& many others