USING ECOSYSTEM MODELS TO UNDERSTAND COMPLEX ESTUARINE INTERACTIONS

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Estuaries are complex ecosystems
Ecosystem based management

An integrated approach that considers:

• the interaction between ecosystem components
• the cumulative impacts of a full range of management activities
Ecopath with Ecosim

No fish is an island
Ecopath – A Balancing Act

Ecopath inputs
- Biomass
- Production
- Consumption
- Ecotrophic Efficiency
- Diet
- Catches
  - commercial
  - recreational

Within group production

Within group consumption
EcoPath Model Inputs

For each species/taxa group we need:

- Biomass \( \text{t/km}^2 \)
- Production/Biomass (PB) \( \text{yr}^{-1} \)
- Consumption / Biomass (Q/B) \( \text{yr}^{-1} \)
- Other mortality (EE) proportion
- Diet information proportions
- Catches \( \text{t/km}^2/\text{yr} \)
Ecopath results – Barnegat Bay 1981

Benthic: Benthic algae, Benthic infauna/epifauna
Pelagic: Piscivorous seabirds, Summer flounder, Atlantic silversides, Atlantic croaker, Bluefish, Striped bass
Both: Non-piscivorous seabirds, Winter flounder, Blue crabs, Ctenophores, Detritus, River herring, Bay anchovy, Copepods, Microzooplankton
Ecosim simulation – Barnegat Bay 1981-2013

Forcing the model
• Commercial and recreational catches (t/km²)
• Effort by gear type
• Environmental factors

Fitting the model
• Fishery-independent survey data
• Long-term research efforts
• Routine monitoring
Ecosim model fit

Species
- Atlantic croaker
- Blue crab
- Hard Clam
- Summer flounder
EwE scenario modeling
% change in biomass

- Piscivorous seabirds
- Weakfish
- Summer flounder
- Bluefish
- Winter flounder
- Atlantic silversides
- Atlantic Croaker
- Atlantic Menhaden
- River herring
- Mummichog
- Bay anchovy
- Amphipods
- Blue crabs
- Hard clams
- Oyster
- Copepods
- Microzooplankton
- Ctenophores
- Benthic algae
- Phytoplankton
- SAV
- Detritus
Ecopath with Ecosim Take Home

• Non-fishing impacts can be creatively incorporated into a trophic model
• Indirect effects mediated through trophic interactions can be very different than expected from a single species approach
• The outcomes of management scenarios are only as reliable as the data used to construct them.
• They are data intensive.
Conclusions

Even with “imperfect” data, ecosystem models are useful for testing our assumptions about ecosystem functioning.

The modeling process points out data needs and areas of uncertainty.

These are still very much strategic, not tactical tools.
Questions?
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OCNGS

- 732 MGD
- 662 MGD
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<th>Taxa Included in the EwE Model</th>
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<td>Non-piscivorous*</td>
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EcoPath Major Data Sources

Biomass
- Studies, Ecopath balancing, literature, other models

P/B & Q/B
- Empirical formulas, literature, stock assessments, other models

Diet information
- 1970s diet study (fish), literature, other models

Catches
- Federal (fish) / state (crabs) landings data

OCNGS
Ecosim time series “forcing” data

Forced Catches
- Federal recreational fishing data – Ocean County, inshore only
- Federal commercial fishing data – subset to hand gear, fyke and hoop nets, pots and traps, and weirs

Forced Effort By Gear
- State blue crab landings – 1995-2013
- OCNGS – intake rate of the cooling and dilution flow

Forced Biomass
- Sea Nettles – calculated a 2013 biomass using Monmouth data; then created a time series using LEK from Young et al.
Ecosim time series “fitting” data

Relative Biomass

• State Coastal otter trawl – inshore stations (<10m) along NJ coast
• RUMFS otter trawl – LEH (1981-2013) and BB-LEH (2012-2013)
• Rutgers Amphipods & Benthic infauna/epifauna sampling – 100 locations in July 2012/2013
• State Phytoplankton – Aircraft remote sensing data. March-October, 2008 - 2013