Integrated Ecosystem Assessments for NW Atlantic Ecosystems

How might conceptual models help address interactions?
Integrated Ecosystem Assessment is a *Process*

- **Scoping**
  Identify goals of EBM and threats to achieving goals

- **Develop ecosystem indicators and targets**

- **Risk Analysis**

- **Assessment of ecosystem status relative to EBM goals**

- **Management Strategy Evaluation**

---

**Monitoring of Ecosystem Indicators and Management Effectiveness**

**Adaptive Management and Monitoring**

**Implementation of Management Action**
California Current Example

INTEGRATED SOCIO-ECOLOGICAL SYSTEM OF THE CALIFORNIA CURRENT

FOCAL ECOSYSTEM COMPONENTS
- Ecological Integrity
  Diversity, Seabirds, Marine mammals, Salmon, Forage species, Groundfish, Species interactions

HUMAN WELLBEING
- Conditions, Connections, Capabilities
  (e.g., safety, community, livelihood)

MEDIATING COMPONENTS
- Habitat
  Marine, Estuarine, Freshwater

HUMAN ACTIVITIES
- (e.g., fishing, farming, mining, recreation, research, education, activism, restoration, management)

LOCAL SOCIAL SYSTEMS
- (e.g., laws, policies, economies, institutions, social networks, hierarchies, cultural values, built environment)

DRIVERS AND PRESSURES
- Climate & Ocean Drivers
  (e.g., climate, ocean upwelling)

SOCIAL DRIVERS
- (e.g., population growth and settlement patterns, national and global economic and political systems, historical legacies, dominant cultural values, and class systems)

NOAA FISHERIES
Northwest & Southwest Fisheries Science Centers
Overview and detailed models

“Overview” model outlines links between species and key ecosystem drivers, components, and goals

Environmental Drivers

Next-tier models flesh out key details

Human Activities

Ecological Interactions
Conceptual model Example: Salmon Overview
Conceptual model Example
Salmon and Environmental Drivers

Ocean drivers are largely dependent on basin-scale forcing such as PDO state. Specifically, PDO, MEI and such represent the forces that ultimately result in local production. There is also a need to consider regional drivers such as local upwelling and wind dynamics and they translate to water column characteristics and forage dynamics. Freshwater habitat and the factors related to it relate to the production of salmon entering the ocean.
Salmon and Ecological Interactions

Salmon rely on krill and forage fish to survive the first year. Krill are eaten by salmon but they also indirectly impact salmon through their interaction with forage fish. Conditions conducive to more prey typically lead to more salmon. Larger marine mammals and seabirds prey on salmon.
Conceptual model Example
Salmon and Human Activities
First draft IEA Conceptual Model: Georges Bank Gulf of Maine

<table>
<thead>
<tr>
<th>Large scale drivers:</th>
<th>Focal ecosystem components:</th>
<th>Human activities:</th>
<th>Human well being:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (surface &amp; bottom)</td>
<td>Healthy Biomass</td>
<td>Commercial Fishing</td>
<td>Optimize food</td>
</tr>
<tr>
<td>Stratification</td>
<td>Healthy Production</td>
<td>Recreational Fishing</td>
<td>Optimize fun</td>
</tr>
<tr>
<td>salinity</td>
<td>Healthy Trophic structure</td>
<td>Subsistence</td>
<td>Optimize profitability</td>
</tr>
<tr>
<td>Fresh water input</td>
<td></td>
<td>Energy Development (tidal in ME, wind, gas? Pipelines?)</td>
<td>Optimize employment</td>
</tr>
<tr>
<td>Social drivers</td>
<td>Mediating components:</td>
<td></td>
<td>Optimize stability</td>
</tr>
<tr>
<td>Global economic drivers</td>
<td>Local social systems</td>
<td>Tourism, other recreation</td>
<td>Cultural &amp; spiritual services</td>
</tr>
<tr>
<td></td>
<td>Healthy habitat</td>
<td>Shipping</td>
<td></td>
</tr>
</tbody>
</table>

**KEY**
- **Category**
- **Driver or Human activity (2014)**
- **Objective within category (pre 2015)**
- **Driver, Activity or Benefit not considered yet**
- **Focal component**
First draft Conceptual model linking large scale drivers to ecosystem component: forage fish
Chesapeake Bay example

Tradeoffs!
Ecosystem-based approaches

- Ecosystem-based approaches include mortality as an explicit, dynamic feature of the ecosystem.
- Recognize dependencies among species.
- Focus on trade-offs among objectives.

Ecosystem model of the Northwest Atlantic Coastal Shelf Ecosystem – Buchheister and Miller (in prep)
Tradeoffs in Chesapeake Bay – fishing menhaden at MSY

- Natural ecosystems are not Lake Wobegon,
- There are winners and losers, (but winners and losers can be difficult to predict)
- Limits to production
- Species are affected whether fished, managed or not

Miller et al. (in prep)
Ecosystem level Management Strategy Evaluation

Identifying thresholds and tradeoffs on the Northeast US shelf
Full system responses to climate and fishing

- Energy flow indicators most sensitive to fishing
- Diversity most sensitive to SST and precipitation
- Potential ecosystem level thresholds related to climate and fishing
Sensitivity of thresholds to climate impact

- Reduction in groundfish growth rate.

- Thresholds of response to fishing can be dependent on other system drivers.

**Indicator**

- TotBio
- pPel
- pPred
- MTLcat

**Landings threshold (t)**

Slide courtesy Gavin Fay
What aspects are most important to MAFMC?

Start with a conceptual model?
Mid Atlantic—connecting key interactions for management

Next-tier models flesh out key details

Environmental Drivers

Human Activities

Ecological Interactions

“Overview” model outlines links between species and key ecosystem drivers, components, and goals
Hobday et al. 2007. ERA for the effects of fishing
Climate risks vary at the regional scale

Gaichas, Link, and Hare 2014 ICES JMS
Conceptual model: What does the MAFMC want in here?

Large scale drivers:
- Temperature
- Stratification
- Salinity
- Fresh water input
- Others??

Social drivers
- Global economic drivers

Global economic drivers

Mediating components:
- Healthy habitat
- Local social systems

Focal ecosystem components:
- Healthy Biomass
- Healthy Production
- Healthy Trophic structure
- Others ??

Focal ecosystem components:
- Healthy Biomass
- Healthy Production
- Healthy Trophic structure
- Others ??

Human activities:
- Commercial Fishing
- Recreational Fishing
- Subsistence
- Others??

Human activities:
- Commercial Fishing
- Recreational Fishing
- Subsistence
- Others??

Energy Development
- Tourism, other recreation
- Shipping

Energy Development
- Tourism, other recreation
- Shipping

Human components:
- Optimize food
- Optimize fun
- Optimize profitability
- Optimize employment
- Optimize stability
- Others?

Human components:
- Optimize food
- Optimize fun
- Optimize profitability
- Optimize employment
- Optimize stability
- Others?

Others: ?

Others: ?

FMP species: Dogfish
- Bluefish
- Monkfish
- Tilefish
- Summer Fl. Bl. Sea Bass
- Scup
- Mackerel
- Squid
- Butterfish
- Surfclam
- O Quahog

FMP species: Dogfish
- Bluefish
- Monkfish
- Tilefish
- Summer Fl. Bl. Sea Bass
- Scup
- Mackerel
- Squid
- Butterfish
- Surfclam
- O Quahog

Others: ?

Others: ?