Tools and Methods for FEP development

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Alaska Fisheries Science Center and University of Washington
Schedule 8:45 – 12:00

- Introduction (Kerim)
- Scoping (Kerim)
- Developing indicators (Stephani)
- Evaluating status and thresholds (Kerim)
- Spatial Modeling (Ivonne)
- Risk assessment & MSEs (Kirstin)
Fishery management: annual process

Ecosystem Stuff

Commercial fishery
Catch data

Research survey
Abundance data

Biological data:
Catch at age, size
Life history

Stock assessment

Plan Team Review
Initial ABC OFL

Advisory Panel
Initial TAC

Scientific & Statistical
Committee
Final ABC OFL

North Pacific Fishery
Management Council

Public input

Public input

Final TAC specifications
Initial ecosystem integration (EBFM)
Acronyms

- **The NOAA Integrated Ecosystem Assessment (IEA) Program** is an **ongoing science program** to develop and use EBM tools, and deliver results to management.

- **The IEA Process** is one method of formalizing steps recommended in EBFM and EFB literature.

- **An FEP is** (in part) a **specific implementation plan built with strong stakeholder input**.
  - A cohesive document that sets guidelines for capacity building and implementation of EBM within the Council/management, AND in view of marine uses from other sectors. It is a tool both to be used within the Council/management organizations and to be used by the Council when facing/addressing non-fisheries sectors.
Methods versus tools

- “Methods” such as Risk Assessment or Management Strategy Evaluation.

- “Tools” such as FEAST or single-species assessments.

- “Scenarios” (or “alternatives”) are developed by stakeholder process (e.g. FEP team).
Methods

Define goals and targets:

For some aspects, FEP may define goals and targets.

For some aspects, define how to define goals and targets.
Tools

Bering Sea Models

- CEATTLE
- ECOPATH
- FEAST

Single Species

Additive Pressures

Multiple Interacting (non-linear) Pressures

Non-linear Species Interactions; Non-linear Cumulative Effects

Estimation of Error/ multiple random iterations
Scoping
Geographical extent:

Primary management & regulatory areas

Note: BS versus BSAI?
Geographical extent:

Other Sectors: BOEM areas and prospective activities
Vessel traffic

Ports: AK Dept Transportation & Public Facilities + US Army Corps of Engineers

Proposed Routing: US Coast Guard

Particularly Sensitive Areas: Bering Strait & Unimak Pass (recommendation to) International Maritime Organization
Conceptual Models: Goals

Goals of conceptual model development:

• **Unifying framework**
  – Single construct that crosses disciplines
  – Clarifies system boundaries
  – Reveals gaps

• **Communication Tool**
  – Within group
  – To other scientists
  – To the public

• **Linking**
  – Indicators should consistently map back to elements of model
  – Integrates concepts across ecological component
Conceptual model Example 1.1
Overview: Socio-Ecological System

- Human Activities
- Institutions & Governance
- Human Well Being
- Focal Components of Ecological Integrity
  - Ecological Interactions
  - Fisheries
  - Protected Species
- Climate & Ocean Drivers
- Habitat

- Health and safety
- Autonomy & Self-sufficiency
- Social-cultural relationships
- Economic Conditions
INTEGRATED SOCIO-ECOLOGICAL SYSTEM OF THE CALIFORNIA CURRENT

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

MEDIATING COMPONENTS
- Habitat
  Marine, Estuarine, Freshwater

HUMAN ACTIVITIES
- Human Wellbeing
  Conditions, Connections, Capabilities (e.g., safety, community, livelihood)
- Human Activities (e.g., fishing, farming, mining, recreation, research, education, activism, restoration, management)

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

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

SOCIAL DRIVERS
- Social Drivers
  (e.g., population growth and settlement patterns, national and global economic and political systems, historical legacies, dominant cultural values, and class systems)
1. **[Ecological Interactions]:**
   What are the strongest food web interactions

2. **[Environmental Drivers]:**
   What are the acknowledged drivers of abundance and community composition?

3. **[Human Activities]:**
   What are the strongest known human interactions or human risks posed to this group?

4. **[Human Wellbeing]:**
   Human dimension; context
Salmon

Habitat: Direct links to HWB

Salmon: Direct links to HWB (e.g., harvest, cultural, existence)

Ecological Interactions: Direct links to HWB

Salmon: Indirect links to HWB (e.g., marine mammal prey, carcasses)

Pressures: Direct link to HWB

Human Well-Being

Human activities

Environmental Drivers
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.
Human Activities

- Hatchery fish
- Harvest
- Marine Habitat
- Environmental Drivers

Salmon

Ecological Interactions

Human Well-Being

- FW Habitat
- Hydropower
- Water Diversions
- Land Use Practices

Environmental Drivers

- Marine Habitat

Human Activities

- Hatchery fish
- Harvest

Marine Habitat

- Hatchery fish
- Harvest

Ecological Interactions

- FW Habitat
- Hydropower
- Water Diversions
- Land Use Practices

Human Well-Being

- FW Habitat
- Hydropower
- Water Diversions
- Land Use Practices
Ecological Interactions: Salmon rely on krill production and forage fish production to survive the first year. Krill are directly eaten by salmon but they also have an impact of salmon through the interaction of krill and forage fish. So condition conducive to more prey lead to more salmon typically. Salmon are also prey to larger marine mammals and seabirds.
CONCEPTUAL MODEL EXAMPLE 2.2
SALMON
Seabirds rely on forage fish, squid, juvenile salmon, juvenile rockfish, and krill production. They compete with other seabird species and with adult salmon through their reliance on forage fish. Seabirds fall prey to raptors (bald eagle, peregrine falcon, great horned owl) and introduced mammals on their terrestrial breeding colonies.
Conceptual Models

Strengths

• Simple, elegant, engaging; good communication tool
• Readily adaptable
• Help us identify gaps, inconsistencies, biases
• Organize suites of indicators or predictors
• Good reminders from time to time

• Major development theme/product of an FEP?
AK differences from other regions:

High number of native Alaskan communities

Very limited Coastal development

Limited marine uses other than fishing (vs CA: oil, mining, alternative energy, military)

No Coastal Management

Management scope (salmon, crab)
Develop Indicators
Developing Indicators: Report Cards

Eastern Bering Sea 2014 Report Card

- The North Pacific atmosphere-ocean system during 2013-2014 featured the development of strongly positive SST anomalies south of Alaska. This warming was caused by unusually quiet weather conditions during the winter of 2013-14 in association with a weak Aleutian low (positive NPI), and abnormally high SLP off the coast of the Pacific Northwest.

- The eastern Bering Sea experienced warmer air temperatures and less sea ice that were related to the broader North Pacific conditions. Dates of sea ice retreat, summer surface and bottom temperatures, and the extent of the cold pool were similar to those of the warm years of 2003-2005.

- The summer acoustically-determined time series of euphausiids continues to decrease from its peak in 2009. This suggests that prey availability for planktivorous fish, seabirds, and mammals was low in 2014.

- Survey biomass of motile epifauna has been above its long-term mean since 2010, although the trend has stabilized. However, the trend of the last 30 years shows a decrease in crustaceans (especially commercial crabs) and a long-term increase in echinoderms, including brittle stars, sea stars, and sea urchins. It is not known to the extent to which this reflects changes in survey methodology rather than actual trends.

- Survey biomass of benthic foragers has remained stable since 1982, with interannual variability driven by short-term fluctuations in yellowfin and rock sole abundance.

- Survey biomass of pelagic foragers has increased steadily since 2009 and is currently above its 30-year mean. While this is primarily driven by the increase in walleye pollock from its historical low in the survey in 2009, it is also a result of increases in capelin from 2009-2013, perhaps due to cold conditions prevalent in recent years.

- Fish apex predator survey biomass is currently above its 30-year mean, although the increasing trend seen in recent years has leveled off. The increase since 2009 back towards the mean is driven primarily by the increase in Pacific cod from low levels in the early 2000s. Arrowtooth flounder, while still above its long-term mean, has declined nearly 50% in the survey from early 2000s highs, although this may be due to a distributional shift in response to colder water over the last few years, rather than a population decline.

- The multivariate seabird breeding index is above the long term mean, indicating that seabirds bred earlier and more successfully in 2014. This suggests that foraging conditions were favorable for piscivorous seabirds.

- Northern fur seal pup production for St. Paul Island remained low in 2014, with fewer pups produced than the last survey in 2012.
“Team-based Synthesis Approach”

- Created Ecosystem Assessment
- Synthesis teams: regional scientific experts, fisheries managers, others
- Met 1-2 times
- Chose structuring themes to guide indicator selection
- Developed list of 8-10 indicators:
  - “vital signs”
  - updatable
# Ecosystem comparison

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Eastern Bering Sea</th>
<th>Aleutian Islands</th>
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<tbody>
<tr>
<td>Habitat</td>
<td>Broad, flat, muddy shelf. Valuable fisheries. Fish-related research.</td>
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<tr>
<td>Team members:</td>
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<td>NOAA</td>
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<td>Academia</td>
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<td>Management</td>
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<td>Commercial</td>
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<td>Other Fed</td>
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<td>Non Profit</td>
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<td>Research sponsor</td>
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<tr>
<td>Structuring theme</td>
<td>Production</td>
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<tr>
<td>Indicator focus</td>
<td>Broad, community-level, indicators of ecosystem-wide productivity, and those most informative for managers</td>
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## Results

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<td>Climate</td>
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<td>Zooplankton</td>
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<tr>
<td>Forage fish</td>
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<td>Fish biomass</td>
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<td>Humans</td>
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Results

EASTERN BERING SEA

- North Pacific Index
- Ice Retreat Index
- Euphausiids/Copepods
- Motile epifauna biomass
- Benthic foragers biomass
- Pelagic foragers biomass
- Fish apex predator biomass
- St Paul fur seal pups
- St George thick-billed murre reproductive success
- Area trawled

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Multivariate seabird index
## Ecosystem comparison

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<tbody>
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<td><strong>Habitat</strong></td>
<td>Broad, flat, muddy shelf. Valuable fisheries -&gt; Lots of fish-related research.</td>
<td>Extensive rocky island chain, deep trenches, oceanic basins. Smaller-scale fisheries (and research)</td>
</tr>
<tr>
<td><strong>Team members:</strong></td>
<td><strong>NOAA</strong> 17&lt;br&gt;Academia 2&lt;br&gt;Management 1 (3)&lt;br&gt;Commercial 1&lt;br&gt;Other Fed 2&lt;br&gt;Non Profit 1&lt;br&gt;Research sponsor 1</td>
<td><strong>Fed</strong> 10&lt;br&gt;Non Profit 4&lt;br&gt;Commercial 1&lt;br&gt;Other Fed 1&lt;br&gt;Management 2&lt;br&gt;Academia 1&lt;br&gt;Research sponsor 1</td>
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<tr>
<td><strong>Structuring theme</strong></td>
<td><strong>Production</strong></td>
<td><strong>Variability</strong></td>
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<td>Characterize global attributes with local behavior</td>
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Indicator Selection: Conclusions

1. Indicator selection influenced by:
   - Physical and biological nature of ecosystem
   - Extent of regional scientific knowledge
   - Expertise and interests of Team members

2. Assessment development should be iterative process with frequent review by managers

   Original plan: Revisit and revise assessments periodically (~ 3-5 yrs) – time to revisit the EBS!
Next steps

- Progress towards the inclusion of ecosystem data directly into stock assessments and resulting management recommendations
Report Cards for different conceptual model components

Indicators to be selected for each pathway and trophic level
Models for evaluating indicators?

• Qualitative
  • Synthesis

As we build modeling and predictive capacity, we will still need qualitative synthesis to:

- capture events outside the bounds of current models
- detect impacts of the unexpected

Gulf of Alaska SST anomalies

Gulf of Alaska normalized SST anomalies (160W–130W, 30–50N)
Models for evaluating indicators?

- Qualitative
  - Synthesis
- Qualitative/Quantitative
  - Recent 5 year mean relative to long-term mean
  - Recent 5 year trend
- Quantitative
  - Thresholds
Evaluate Status and Thresholds

APPENDIX C-1. EVALUATION OF INDICATORS FOR COASTAL PELAGIC AND FORAGE SPECIES USING THE BONNEVILLE POWER ADMINISTRATION DATA SET

James F. Samhouri¹, Gregory D. Williams³, Richard Brodeur¹, and Caren Barcelo²

1. NOAA FISHERIES, NORTHWEST FISHERIES SCIENCE CENTER
2. OREGON STATE UNIVERSITY, COLLEGE OF EARTH, OCEAN AND ATMOSPHERIC SCIENCE 104 CDEAS ADMINISTRATION BUILDING, CORVALLIS, OREGON 97331
**Goal**: formal ecosystem thresholds

- **Example**: 2 million MT cap on total removals from the Bering Sea.

- **Future development** (e.g. through the Fisheries and the Environment (FATE) program):
EBS trawl impacts modified from
Integrated Fisheries Risk Assessment for Method for Ecosystems (Zhang et al. 2009)

- Biomass
- Fishing intensity
- Habitat size

- Sustainability

- Habitat damage
- Discarded wastes
- Habitat protection

- Employment
- Average wage
- Profit-per-vessel

- Socio-Economics

- Discards
- Trophic level
- Diversity
- Integrity of functional group

- Biodiversity

- Habitat size

- Profit-per-vessel
Pelagic foragers aggregate biomass

Benthic foragers aggregate biomass

Fish apex predators aggregate biomass

Motile epifauna aggregate biomass
Similar distributions across the guild, but partitioning within that space.
Goal: formal ecosystem thresholds

- 2 million MT cap on total removals from the Bering Sea.

Tool: Ecopath food web/network models
Goal: formal ecosystem thresholds

• Example: 2 million MT cap on total removals from the BSAI.

• Scenarios and alternatives:
  – “Simple” (2MMT, fixed)
  – “Complex” (varies bases on productivity).
  – Guild limits: Forage fish, apex predators, etc.
  – System of indicators (IFRAME).
Spatial Models
Risk Assessment and MSE