Ecosystem-based fisheries management in the Alaska Region

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Examples of Ecosystem-based Management Actions

- OY cap on total groundfish yield
- No target fisheries on forage - designation of ecosystem component stocks
- Minimum biomass threshold in harvest control rule for sea lion prey species
- Trawl closures, bottom trawling restrictions
- Single species FMPs converted to place based or multispecies based FMPs or FEPs

CAP on TOTAL TARGET CATCH
Total yield < 2 million tonnes
NOAA Integrated Ecosystem Assessment Program
http://www.noaa.gov/iea/ (note: EBM vs. EBFM)

The NOAA IEA Process

Define EBM Goals & Targets

Implement Management Action

Refine Goals and Targets or Indicators

Monitoring of Ecosystem Indicators

Assess Ecosystem

Analyze Status, Trends & Risk

Develop Indicators

Ecosystem models are used to evaluate the status, trends, and risk to the ecosystem relative to threats and risks, historical state, and to ecosystem management goals and targets.

Ecosystem-based fishery management - Strategic planning

www.fakr.noaa.gov/npfmc/current_issues/ecosystem/AIFEP12_07.pdf
www.fakr.noaa.gov/npfmc/current_issues/Arctic/arctic.htm
alaskafisheries.noaa.gov/habitat/efh.htm
Council Research Priorities

- The Council would also like to highlight several current Council initiatives that are of high priority, and notes the research priorities that specifically relate to these initiatives:

- Build Integrated Ecosystem Management capabilities (related research priorities: 110, 125, 142, 194, 198, 200, 203, 204, 205, 216, and 217).
Methods of Using Ecosystem Information in an ACL context

- **Tactical**
  - Quantitative incorporation into a single species assessment model: M2, environmental or habitat variable
  - Qualitative evaluation of ecosystem factors in annual ACL process: suites of variables that may impact production

- **Strategic**
  - Management strategy evaluations (MSEs) to examine robustness of harvest strategies
  - Quantitative suites of ecosystem indicators and aggregate indices
Including ecosystem considerations in each stock assessment (Lowe et al. 2007)

Regional Examples: Tactical

- EBS yellowfin sole temperature dependent survey Q
- GOA walleye pollock B20 threshold for Steller sea lions
- Natural mortality from predation estimates of octopus, crab
An “operational ensemble” of models be developed and kept up-to-date to address pressing ecosystem-based management concerns in a timely fashion
- Endangered species issues
- Bycatch impacts
- Ocean acidification
- Oil and gas development

**Developing and maintaining Operational Readiness**

Multispecies Bycatch Model (Ianelli)

Forage and Euphausiid Abundance in Space and Time (FEAST); Aydin et al. North Pacific Research Board

Ecopath/Ecosim and Ecosense (Aydin et al.)

**http://access.afsc.noaa.gov/reem/ecoweb/index.cfm**

- Current and archived versions available
- Ongoing support from the FATE program
Raw materials for the assessment
Ecosystem Assessments at the Alaska Fisheries Science Center

- Goal: to provide a synthesis of current and relevant scientific advice for fisheries managers
- New indicator-based assessments:
  - Eastern Bering Sea (2010)
  - Aleutian Islands (2011)

Same method → Different product

Ecosystem comparison

<table>
<thead>
<tr>
<th></th>
<th>Eastern Bering Sea</th>
<th>Aleutian Islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</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>Team members:</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>NOAA</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Academia</td>
<td>1 (3)</td>
<td>1</td>
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<tr>
<td>Management</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Other Fed</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Non Profit</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Research sponsor</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Structuring theme</td>
<td>Production</td>
<td>Variability</td>
</tr>
<tr>
<td>Indicator focus</td>
<td>Broad, community-level, indicators of ecosystem-wide productivity, and those most informative for managers</td>
<td>Characterize global attributes with local behavior</td>
</tr>
</tbody>
</table>
Results

- 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

<table>
<thead>
<tr>
<th>Indicators</th>
<th>North Pacific Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Auklet reproductive success</td>
</tr>
<tr>
<td>Zooplankton</td>
<td>Tufted puffin chick diets</td>
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<tr>
<td>Forage fish</td>
<td>Pelagic foragers biomass</td>
</tr>
<tr>
<td>Fish biomass</td>
<td>Fish apex predator biomass</td>
</tr>
<tr>
<td>Marine Mammals</td>
<td>Sea otters</td>
</tr>
<tr>
<td>Seabirds</td>
<td>Steller sea lion non-pups</td>
</tr>
<tr>
<td>Humans</td>
<td>Area trawled</td>
</tr>
<tr>
<td></td>
<td>K-12 enrollment</td>
</tr>
</tbody>
</table>

Report Card

Eastern Bering Sea 2012 Report Card

- The North Pacific atmosphere-sea surface reflects a continuation of a response to La Nina and La Nina variability. The combination of the neutral to weak El Nino expected this winter and a continuation of reduced ice cover in the central Arctic should provide a lighter ice cover for the Northwest Arctic.
- Ocean temperatures remained cold and sea ice continued extensive, similar to 2008 and 2010. However, the year 2009 was the latest recorded since 1995. Summer sea ice was cool, but had the most extensive cold pool area of the recent decade.
- The eastern Chukchi Sea ecosystem showed in the area in attendance in 2011 relative to 2010, not recorded before 2009 peak. 2011 was the fourth year that concentrations remained above 1.20m. This suggests that prey availability to planktonic fishes, whales, and mammals continued to be high during the summer of 2011.
- AdLibits reveals abatement, although peak abundance observed in fall 2009 and summer 2011 declined by fall 2011 and winter 2012.
- While marine bird counts are relatively low, overall marine epipelic biomass remain stable, especially since the late 1990s. Higher levels since 2003 are driven, in increase in benthic and epifauna, although these states show high within-year variability in the survey.
- Biomass of benthic foragers has remained stable since 1992, with interspecific variability driven by seasonal fluctuations in jellyfish and insect plankton.
- Biomass of pelagic foragers has increased to nearly average levels seen in 1998.
- While polar bear increased in the last few years, diversely driven by the increase in Pacific ice cover, levels in 2009-2010 were lower. However, wintering season high relative to previous levels.
- Thick-billed nina reproductive success on St. George Island was near average in 2012, a substantial increase from the record low in 2011. This suggests that bringing seabirds were favorable for persistent conditions.
- Northern fur seal pup production for St. Paul Island has declined over the long terms. The most recent pup production estimates for St. Paul and St. George Islands in 2010 were 8,951 and 1,051, respectively.
- The northern ventilation of arctic basin disturbed by reduced sea ice. In 2011 to the late 1990s since 1995. The return of this increase community declines.
**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)**

- **Sustainability**
  - Biomass
  - Fishing intensity
  - Habitat size

- **Habitat**
  - Habitat damage
  - Discarded wastes
  - Habitat protection

- **Socio-Economics**
  - Employment
  - Average wage
  - Profit-per-vessel

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

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**Guild Catch and Exploitation Rates**

- **Pelagic foragers** aggregate biomass
- **Benthic foragers** aggregate biomass
- **Fish apex predators** aggregate biomass
- **Motile epifauna** aggregate biomass

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**2005-2010 (five-year) mean**
- • ± 1 s.d. above mean
- • ± 1 s.d. below mean
- • within 1 s.d. of mean
- • <2 data points

**2005-2010 (five-year) trend**
- ▲ Increases by >1 s.d. over five years
- ▼ Decreases by >1 s.d. over five years
- ± Change ±1 s.d. over five years
- X <1 s.d. over five years

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**2011-2012 SAFE Projection**

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Similar distributions across the guild, but partitioning within that space.
Interactions $\rightarrow$ Ecosystem Assessment

Risk Assessment

Oil spill on rookery
Change shipping routes?

Increase Atka fishing?
Cod eat Atka

Risk Assessment

Figure 4-4 Characterization of interactions in terms of probability of occurrence and a combined ecological multiplied by economic impact. Shaded area in upper right quadrant highlights those interactions with a medium to high probability of occurring and likely impact.
Challenge 1: Ecosystem Science

What Controls Trophic Interconnectivity in the eastern Bering Sea?

Bering Ecosystem Study (BEST) +
Bering Sea Integrated Ecosystem Research Program (BSIERP)

Alaska Marine Science Symposium
Anchorage, Alaska
January 23rd, 2013

Michael Lomas (Bigelow Lab) & Phyllis Stabeno (PMEL)
(on behalf of the larger program)

http://bsierp.nprb.org/
The Project is an ‘End-to-End Ecosystem Study’

- Humpback and fin whales
- Commercial/subsistence fish: Pollock, cod, arrowtooth flounder
- Kittiwakes and murres, fur seals, walrus
- Forage species: juvenile pollock, capelin, myctophids
- NPZ: Ichthyoplankton, euphausiids, copepods, phytoplankton
- Fauna: Bivalves, gastropods, polychaetes
- Atmosphere/ocean

**Climate Scenarios**

Importance of Seasonal Sea Ice:
Ice algae: Importance to early reproduction in copepods

Both *Calanus* spp. and *T. raschii* have higher ingestion when feeding on ice algae (green) than when feeding on ambient water column phytoplankton (blue)

*Campbell, Lessard, Ashjian*
Large Zooplankton Increase in Cold Years:

Cold years favor the increases in abundance of large zooplankton at the expense of small zooplankton.

L. Eisner et al., submitted.

Water Temperature, pollock and euphausiids:

- Cold years generally enhance survivorship

L. Eisner et al., submitted.
Modelled conditions for juvenile pollock survival are associated with moderate temperatures.

Meuter
Southeast Bering depth-averaged temperature
thin line = weekly ave; thick line = 5-year smoothed

Focus on dynamic habitat (e.g. Barbeaux, Spencer et al.)
Prey Fields and temperature – foraging potential for an 8 cm (age 0) pollock
Age 0 pollock seasonal Forage Potential (FP) and stock-assessment estimate of year-class strength

Colors show ranked stock-assessment year-class strength from weakest (blue) to strongest (red)

Gulf of Alaska IERP

Comparative approach
GOA breakpoints - oceanography

(SST, CHL, PAR maps showing oceanographic variables)

(Waite, Mueter)

GOA breakpoints – fishes – CPUE & diversity

(Graph showing CPUE and species diversity over distance, with breaks indicated)

(Waite, Mueter)
individual-based model (IBM): arrowtooth flounder (Buck Stockhausen)

• The Climate Forecast System (CFS) – a global coupled air/sea/land model – is used for boundary conditions and atmospheric forcing of an established ROMS-based regional model
CFS prediction of ENSO and PDO

Fig. 3. Time series of (a) the PDO index and (b) the Niño-3.4 SSI ensemble during 1988–2006. Black line denotes observation, and blue, green, and red lines denote CFS predictions in P, P, and 5 month lead, respectively.

Wen et al, 2012

May actually be better at predicting biology due to biological integration

Peterson NOAA/NWFSC
Recruitment Processes Alliance

• Goals
  o Improve walleye pollock stock assessment
  o Address salmon bycatch

• Alliance of major AFSC programs
  o Eco-Fisheries Oceanography Coordinated Investigations (with Pacific Marine Environmental Laboratory)
  o Ecosystem Monitoring and Assessment
  o Resource Ecology and Ecosystem Modeling

Balance of process studies and stock assessments

FD/FI Data

Stock Assessments

Process Studies
Data collections used in process studies

- Moorings
- Ichthyoplankton surveys
- Bottom trawl surveys
- Acoustic surveys
- Surface trawl/acoustic surveys (aka BASIS)
- Nearshore surveys
- Many of these surveys also conduct measurements of physical and biological (e.g., zooplankton) oceanography

Ongoing Projects

- Integrated Ecosystem Research Programs
- Recruitment Processes Alliance
- Spatially-explicit ecosystem models (FEAST)
- Management Strategy Evaluations (MSE)
- IPCC-scenario driven projections (e.g., Mueter et al 2011; Ianelli et al. 2011)
- Bioeconomic modeling of crab fisheries and ocean acidification
- *(Does not cover substantial socioeconomic work)*
Short Term Objectives for Improvement

- **Continue to address ecosystem terms of reference in stock assessments (M2, environmental drivers of recruitment and growth, habitat covariates)**
  - Develop regionally specific priorities for species and processes to be considered

- **Continue development of integrated ecosystem assessment frameworks**
  - Estimate and implement system level thresholds
  - Improve modeling capabilities (multispecies, ecosystem)
  - Improve integration of environmental data

- **More explicit rules or processes for defining where ecosystem considerations should play into ACL decisions for information not already captured in the current management process**
  - Work with Councils/SSCs/Regions and stock assessment review panels to develop structured process for considering ecosystem factors
  - Develop processes within Science Centers to bring scientists doing stock assessment, habitat science and ecosystem research together (improve data access)

- **Continued and enhanced funding for National programs that focus on ecosystem data collection and integration (FATE, IEA, Habitat, ESA)**
  - Improve ecosystem data collection
  - Continue integration into single species models
  - Improve integrated assessments at the regional level

Challenges:
IEA, EBFM versus EBM, PSEIS, mandates
Management Strategy Evaluation: Climate Impacts on Productivity

- Age-structured operating model
- Data
- TAC

Link to recruitment

Management Strategy

Years for defining the current regime

Climate Decision rule

Climate data