



# Context and tools for Ecosystem-Based Fisheries Management in Alaska



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Science Center

*NPFMC Ecosystem  
Research Workshop  
November 8, 2017*



## Timeline of ecosystem-based fisheries management science

### 1980s: Proactive ecosystem measures in Alaska

Ecosystem models, 2M MT cap, forage fish ban

### 1990s: What is ecosystem-based management?

Academic panel reports (nationwide), development of Alaska Ecosystem Status Report (*“Ecosystem Considerations”*)

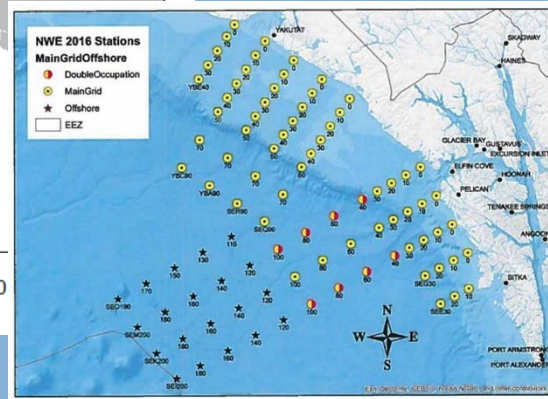
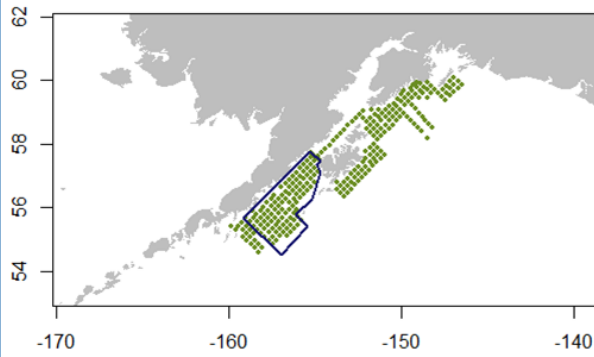
### 2000s: Product and tool development

Models, analysis tools, observations (IERPs), conceptual models

### 2010s: Development of formalized programs

National and Local Roadmaps, Integrated Ecosystem Assessments

# Increased integration of fieldwork and management advice



## Alaska Marine Ecosystem Considerations

Home Report Assessments Report Cards Hot Topics Links

The Ecosystem Considerations report is produced annually to compile and summarize information about the status of the Alaska Marine Ecosystem for the [North Pacific Fisheries Management Council](#), the scientific community and the public. The report includes ecosystem report cards, ecosystem assessments, and ecosystem and ecosystem-based management indicators for the Eastern Bering Sea (EBS), Aleutian Islands (AI), the Gulf of Alaska (GOA), and Arctic ecosystems.

### Eastern Bering Sea

- Assessment
- Report Card
- Hot Topics
  - Chum Salmon
  - Bird Sightings

### Aleutian Islands

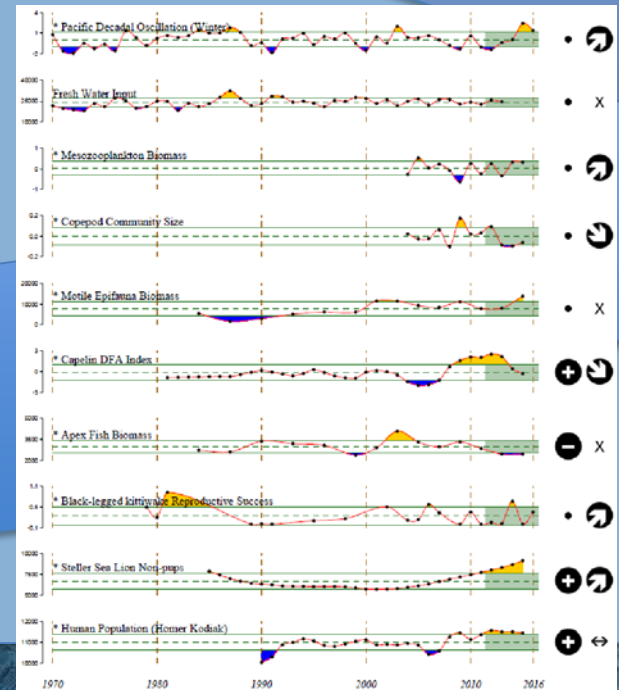
- Assessment
- Report Card

### Gulf of Alaska

- Assessment
- Report Card
- Hot Topics
  - Too Warm?
  - Age-0 Pollock
  - Marine Mammals

### Arctic

- Assessment
- Hot Topics
  - Polar Bears





# Development of national policy documents and programs

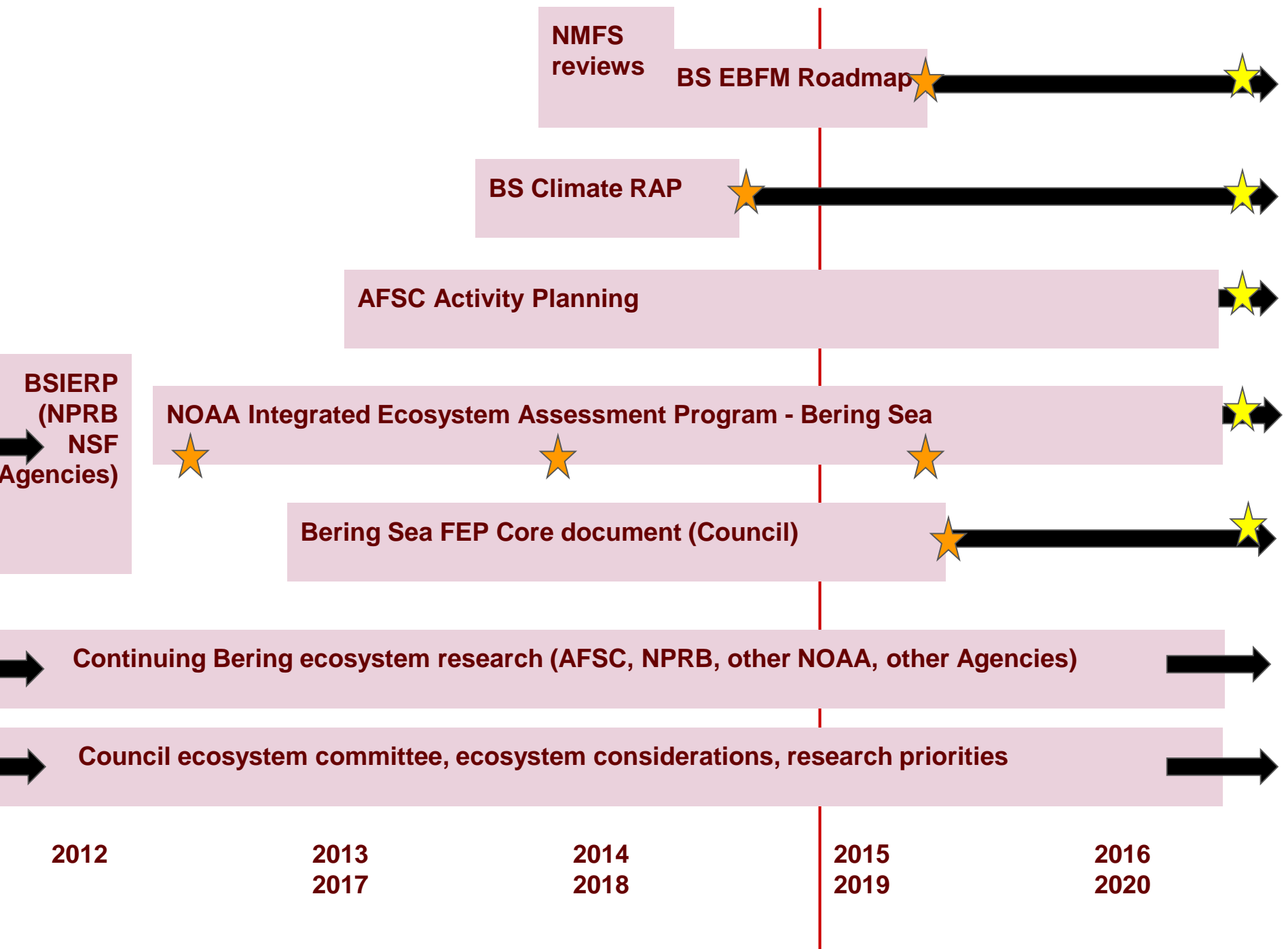
Levels	Scientific Advice	Management Framework
<b>EBM</b> Ecosystem Based Management	Fisheries                        Development                        Energy                        Eco Tourism                        Oil & Gas	Regional Ocean Plans
	Conservation                        Marine                        Sanctuaries                        Aquaculture                        Etc	
<b>EBFM</b> Ecosystem Based Fisheries Management	Fisheries                        Climate                        Habitat                        Predator	Fisheries Ecosystem Plan
<b>EAFM</b> Ecosystem Approach to Fisheries Management	Fisheries                        Climate                        Habitat                        Predator	Fishery Management Plan
<b>SS</b> Single Species	Fish	Fishery Management Plan



## NMFS EBFM Roadmap



## NOAA Integrated Ecosystem Assessment (IEA) Program





## What is an Integrated Ecosystem Assessment?



- A. It's a set of **best practices** and principles for EBM.
  - B. It's a **process** for delivering advice to management.
  - C. It's a **product**: “we have conducted an Integrated Ecosystem Assessment for the Bering Sea.”
  - D. It's a NOAA **program** with a budget and deliverables.
- A. All of the above.*



## PLACE-BASED

FOUR Large Marine Ecosystems -  
FOUR Integrated Ecosystem Assessment Programs

Eastern Bering  
Sea (EBS)



High Arctic



Aleutian Islands  
(AI)



Gulf of Alaska  
(GOA)





## B: It's a Process

### The NOAA IEA Process

#### Management Strategy Evaluation

MSE is useful to help resource managers consider the system trade-offs and potential for success in reaching a target which helps make informed decisions. It uses simulation through ecosystem modelling to evaluate the potential of different management strategies to influence the status of natural and human system indicators and to achieve our stated ecosystem objectives.

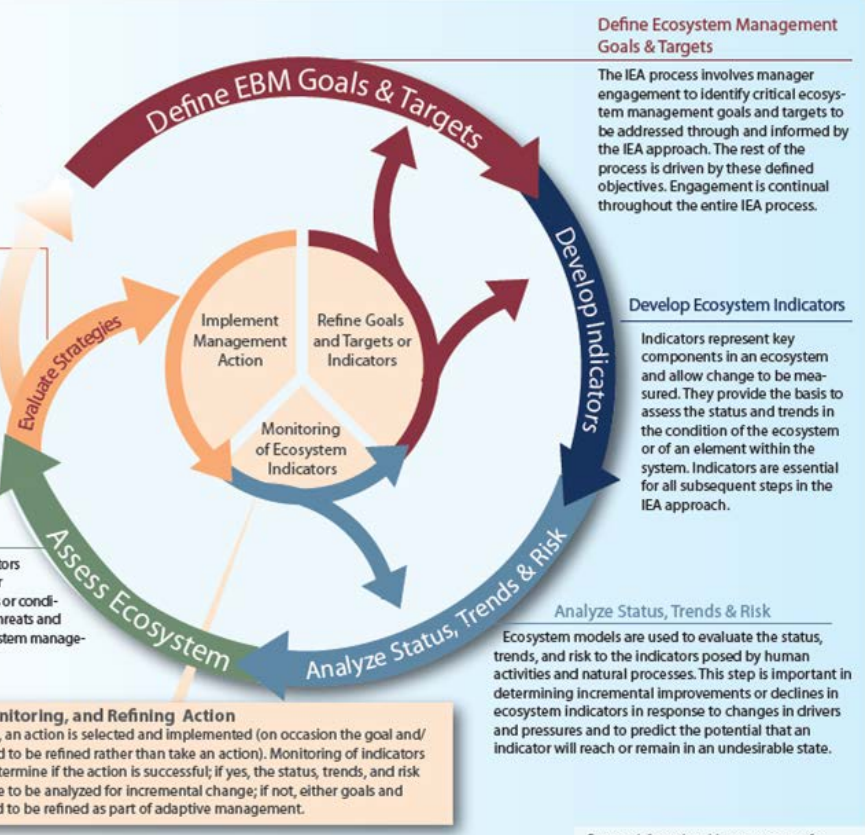
#### Assess Ecosystem

During this step, individual indicators are considered together to further evaluate the overall current status or condition of the ecosystem relative to threats and risks, historical state, and to ecosystem management goals and targets.



#### Taking, Monitoring, and Refining Action

Based on the MSE, an action is selected and implemented (on occasion the goal and/or target may need to be refined rather than take an action). Monitoring of indicators is important to determine if the action is successful; if yes, the status, trends, and risk to the indicators continue to be analyzed for incremental change; if not, either goals and targets or indicators need to be refined as part of adaptive management.



#### Define Ecosystem Management Goals & Targets

The IEA process involves manager engagement to identify critical ecosystem management goals and targets to be addressed through and informed by the IEA approach. The rest of the process is driven by these defined objectives. Engagement is continual throughout the entire IEA process.

#### Develop Ecosystem Indicators

Indicators represent key components in an ecosystem and allow change to be measured. They provide the basis to assess the status and trends in the condition of the ecosystem or of an element within the system. Indicators are essential for all subsequent steps in the IEA approach.

#### Analyze Status, Trends & Risk

Ecosystem models are used to evaluate the status, trends, and risk to the indicators posed by human activities and natural processes. This step is important in determining incremental improvements or declines in ecosystem indicators in response to changes in drivers and pressures and to predict the potential that an indicator will reach or remain in an undesirable state.

For more information visit: [www.noaa.gov/iea](http://www.noaa.gov/iea)

- Stock assessment**
- Goal:** Max. sustainable yield
- Indicators:** Stock biomass
- Status:** Surveys, reference points
- Assess:** Stock assessment
- Evaluate:** Adaptive management





## C: Products

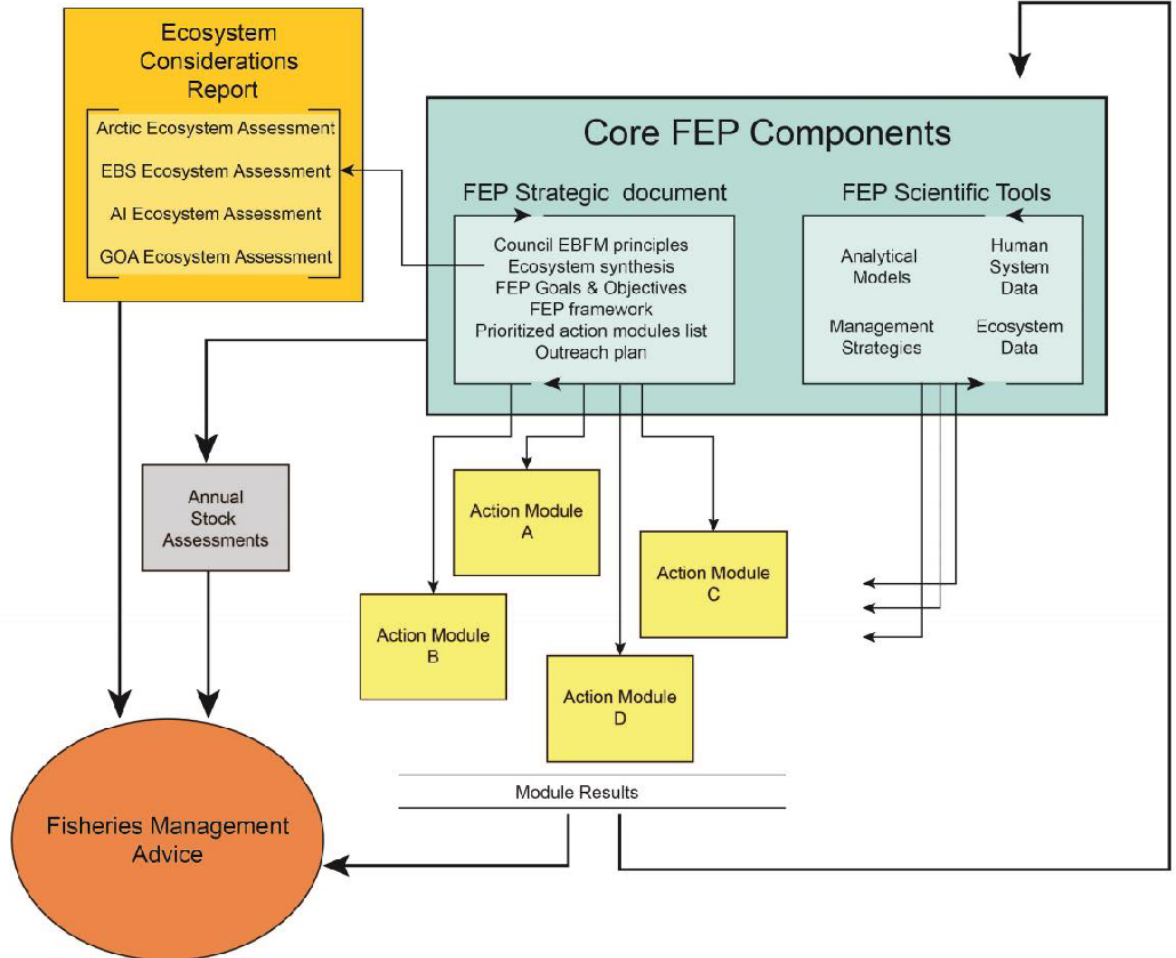
- **Fisheries Ecosystem Plans (FEPs)**
- Conceptual Models
- Ecosystem Models
- Ecosystem Indicators
- Ecosystem Assessment
- Risk Assessments
- Management Strategy Evaluations

# Eastern Bering Sea

Fisheries Ecosystem Plan  
(completion ~Summer 2018)



## Fisheries Action Plan Process



- Developed by multi-agency team
- Transparent council processes for including ecosystem information in management
- Outreach
- Action modules integrate climate, EFH, human sectors, local/traditional knowledge
- Ecological framework of conceptual models
- Research and success tracking (“did we get there?”)



# Example FEP task: Formalize ecosystem warnings (while maintaining flexibility)

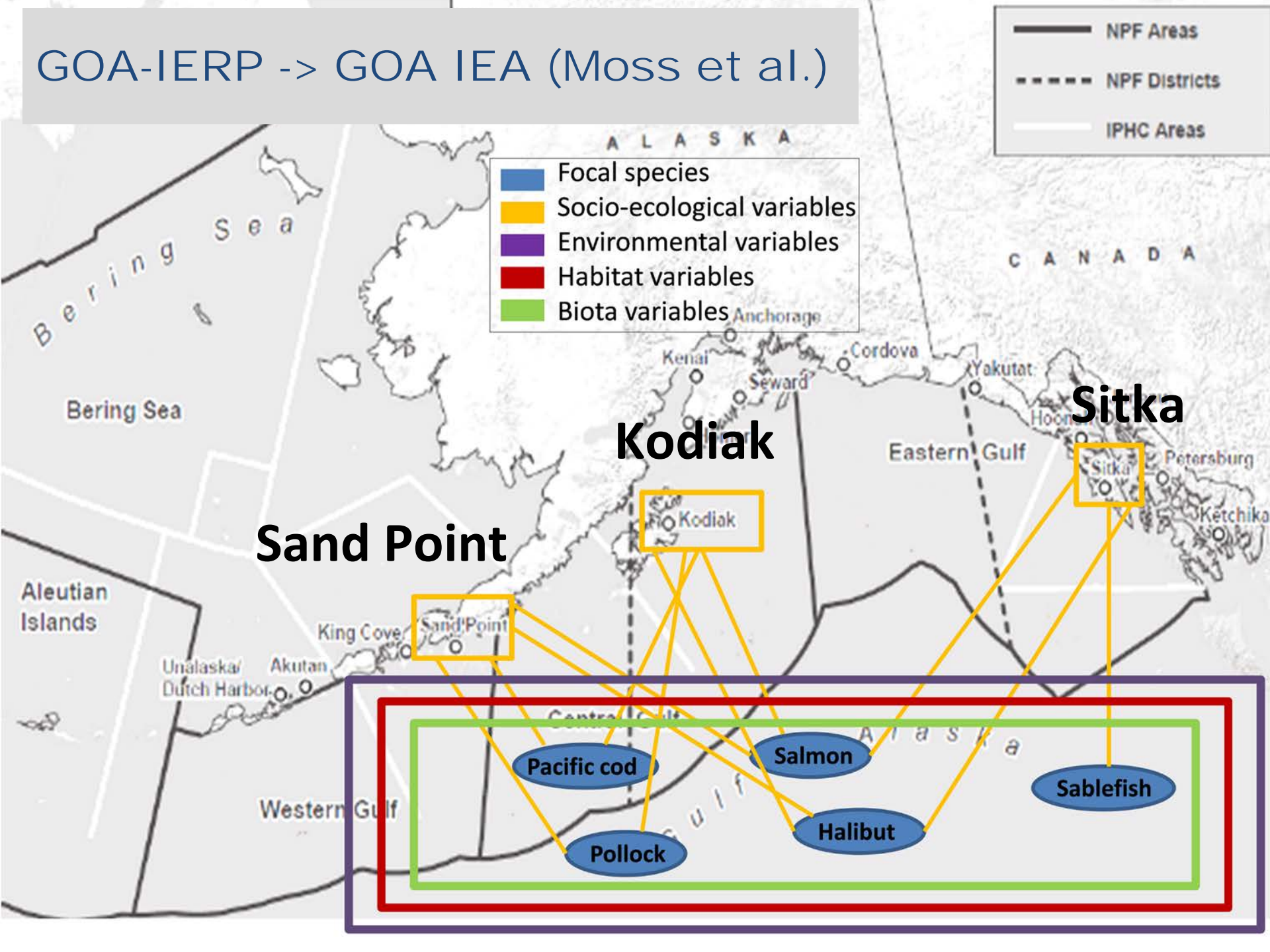
		Stock Assessment information	
		Not okay	Okay
Ecosystem Status Report information	Not Okay	2006 EBS pollock 2017 GOA cod	2016 EBS Pollock
	Okay	"No red flags were indicated."	EBS Yellowfin sole



## C: Products

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- **Conceptual Models**
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# GOA-IERP -> GOA IEA (Moss et al.)





## C: Products

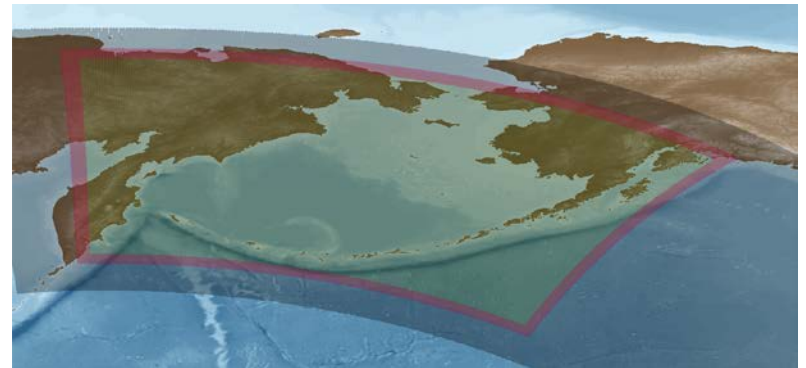
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## Bering ROMS/NPZ

(Regional Oceanographic model with nutrients and plankton dynamics)

- Developed with NSF/North Pacific Research Board
- Ongoing IEA partnership (AFSC/PMEL)
- Significant advances in ice modeling, ice plankton
- Products
  - 46-year hindcast (1971-2017)
  - Nowcasts (annual)
  - 9-month forecast (annual)
  - Forecasts to 2100 with IPCC outputs
  - Rapid Climate Assessment
  - EFH predictive maps



2004 JUN

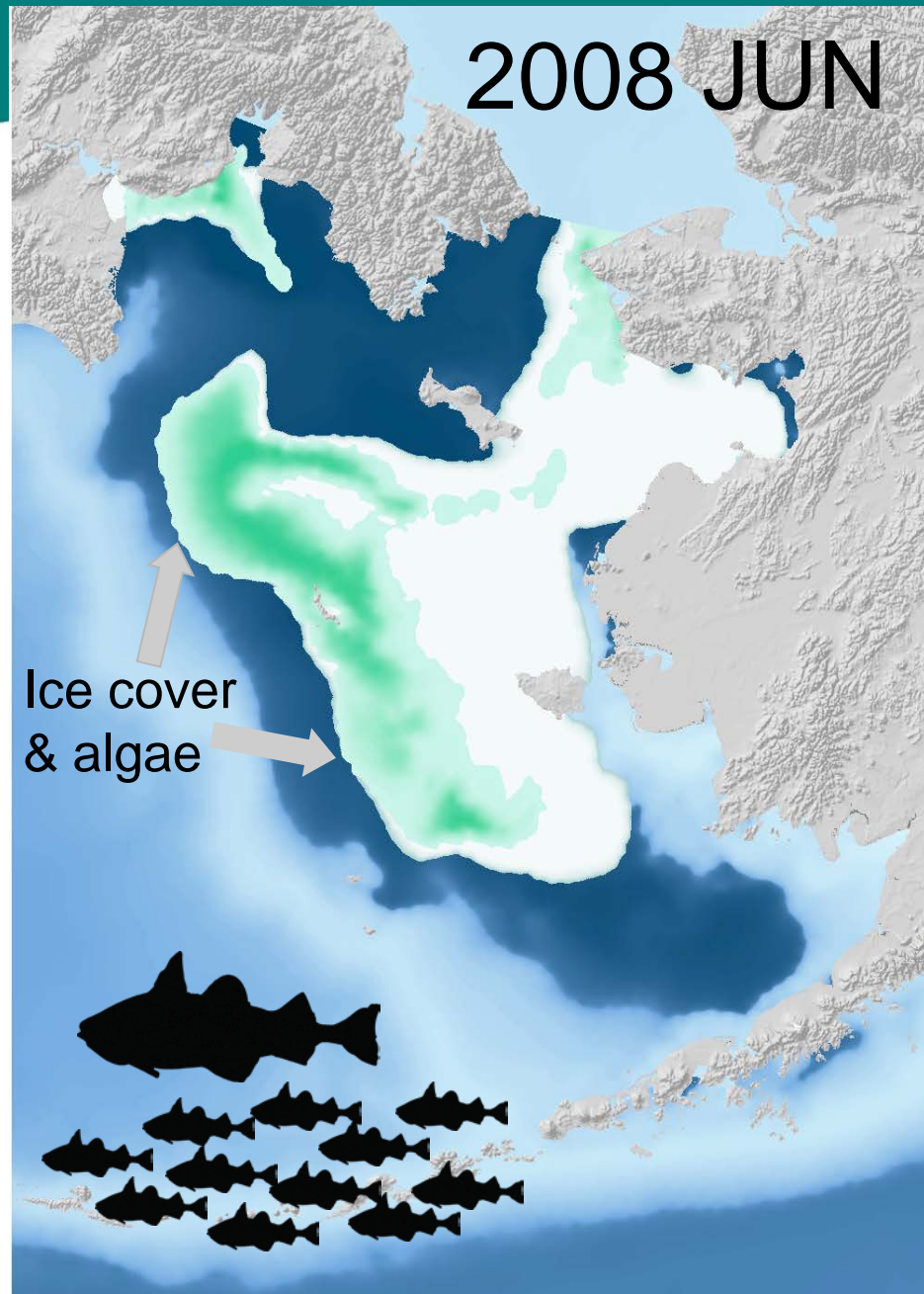
Ice cover  
& algae

cold  
pool



2008 JUN

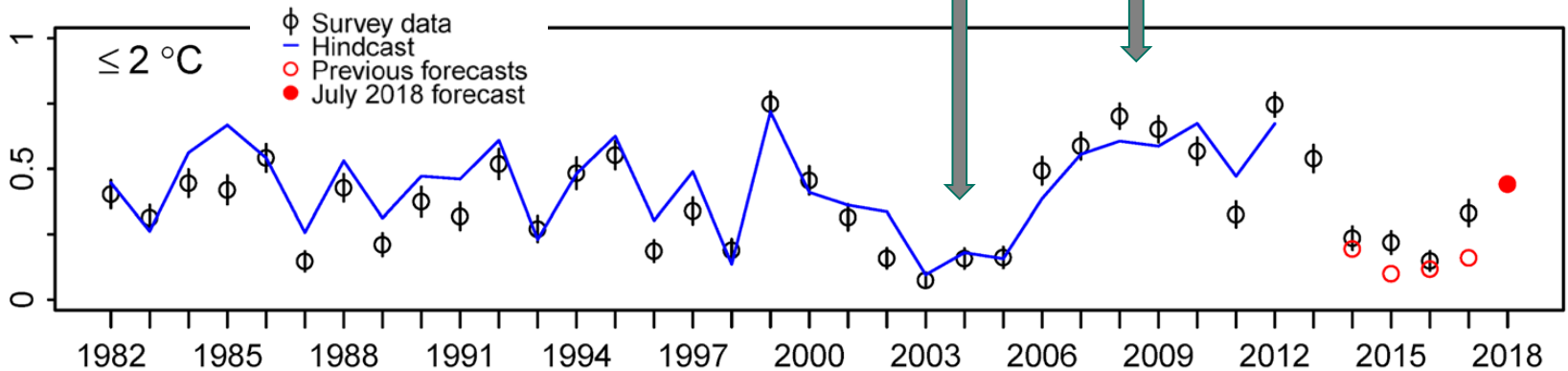
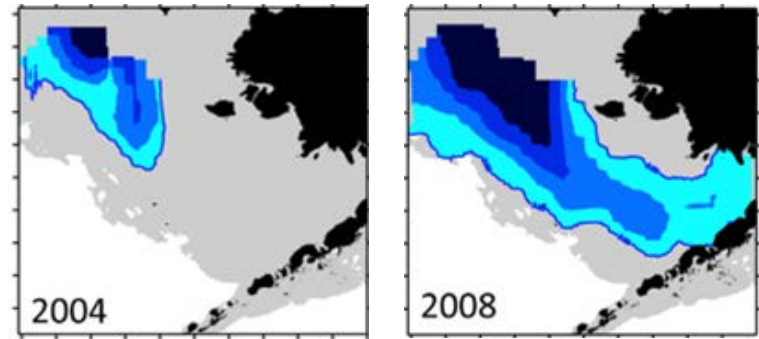
Ice cover  
& algae







## 9-month (seasonal) forecast - cold pool



- Included in annual Bering Sea ecosystem status report (November prediction for following summer)
- Validation funded under NOAA MAPP Program - focus on ice prediction



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# Ecosystem Considerations Reports

<http://access.afsc.noaa.gov/reem/ecoweb/>

Contact: [Stephani.Zador@noaa.gov](mailto:Stephani.Zador@noaa.gov)

Alaska Marine Ecosystem Considerations



[Home](#)

[Report](#)

[Assessments](#)

[Report Cards](#)

[Hot Topics](#)

[Links](#)

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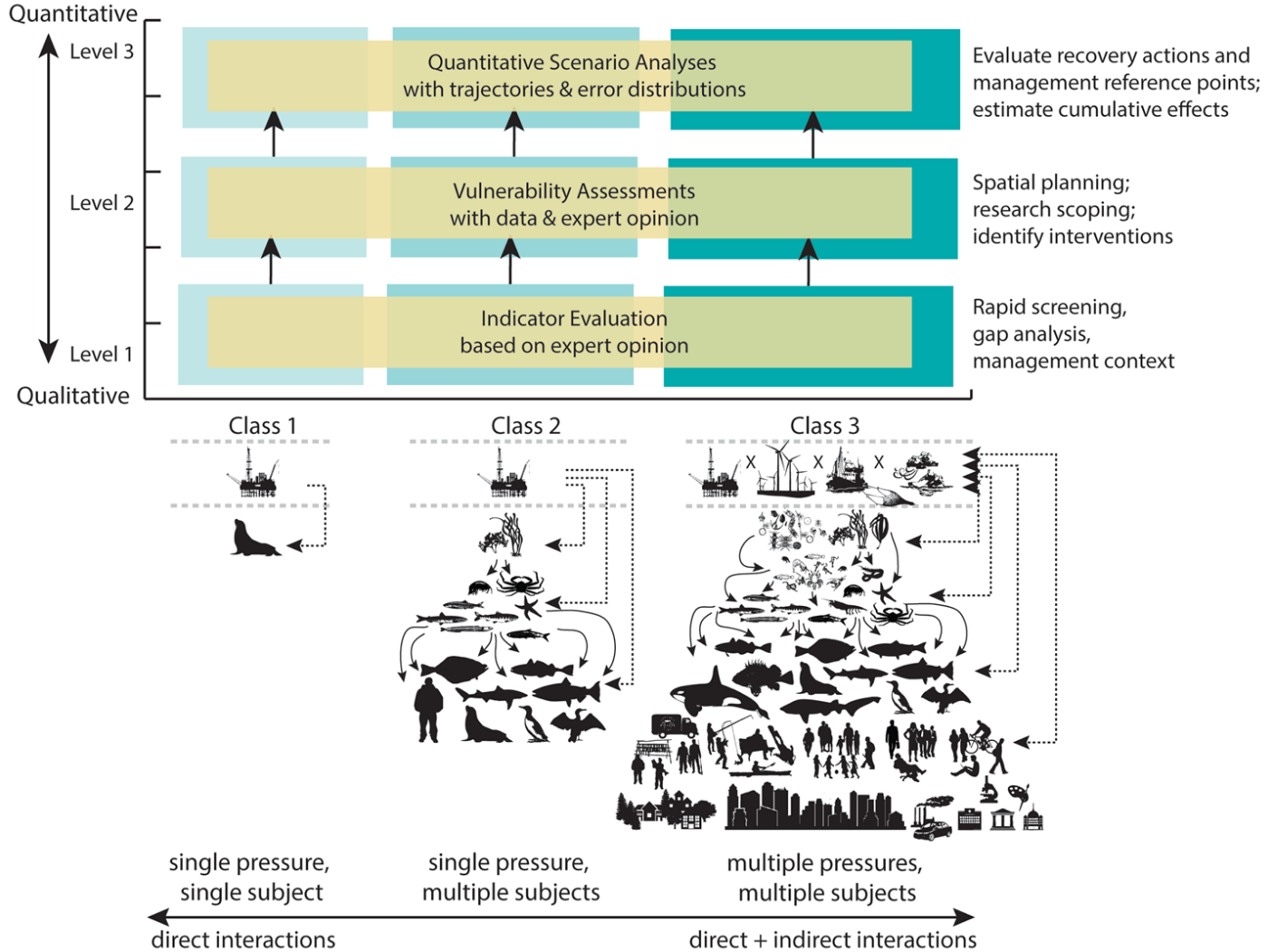
- LME-scale assessments
- Targeted for managers
- Linked with stock assessments
- Provides context for EBFM



## C: Products

- Fisheries Ecosystem Plans (FEPs)
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- Ecosystem Indicators
- Ecosystem Assessment
- Ecosystem Models
- **Risk Assessments**
- Management Strategy Evaluations

# Ecosystem Risk Assessment



*Holsman et al. 2017*



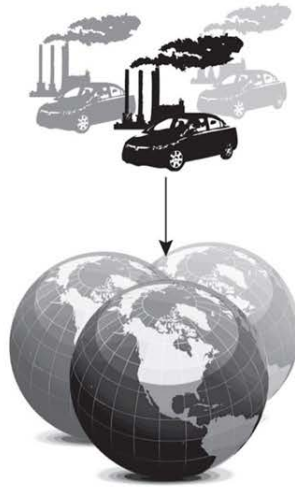
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- Fisheries Ecosystem Plans (FEPs)
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- Ecosystem Assessment
- Ecosystem Models
- Risk Assessments
- **Management Strategy Evaluations**

## Alaska CLIMate Project

Anne Hollowed (AFSC, SSMA/REFM)  
Kirstin Holzman (AFSC, REEM/REFM)  
Alan Haynie (AFSC ESSR/REFM)  
Stephen Kasperski (AFSC ESSR/REFM)  
Jim Ianelli (AFSC, SSMA/REFM)  
Kerim Aydin (AFSC, REEM/REFM)  
Trond Kristiansen (IMR, Norway)  
Al Hermann (UW JISAO/PMEL)  
Wei Cheng (UW JISAO/PMEL)  
André Punt (UW SAFS)

**FATE: Fisheries & the Environment**  
**SAAM: Stock Assessment Analytical Methods**  
**S&T: Climate Regimes & Ecosystem Productivity**



### IPCC Scenarios (x3)

AR4 A1B  
AR5 RCP6.0  
AR5 RCP8.5

### Global Climate Models (x 11)

ECHO-G (AR4 A1B)  
MIROC3.2 med res. (AR4 A1B)  
CGCM3-t47 (AR4 A1B)  
CCSM4-NCAR- PO (AR5 RCP 6.0 & 8.5)  
MIROCESM-C- PO (AR5 RCP 6.0 & 8.5)  
GFDL-ESM2M\*- PO (AR5 RCP 6.0 & 8.5)  
GFDL-ESM2M\*- PON (AR5 RCP 6.0 & 8.5)

## Future Climate Scenarios



## Climate-enhanced Biological Models



## Fishing Scenarios



### Bering Sea Models

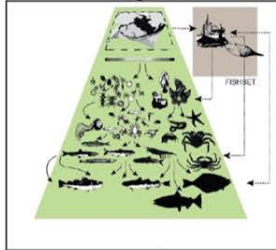
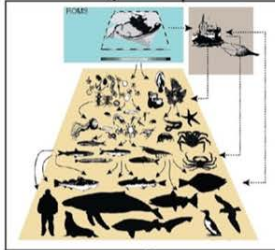
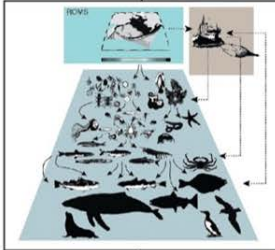
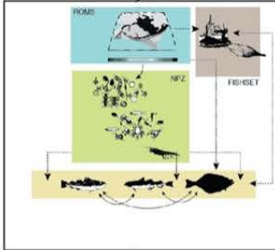
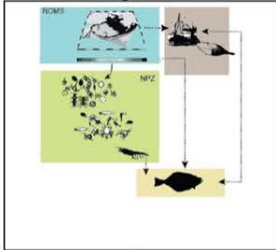
#### CE-SSM

#### CEATTLE

#### EwE

#### Size-Spectrum

#### FEAST



By-catch MSY

By-catch MSY

By-catch MSY

By-catch MSY

Fleet dynamics

Status quo MEY No fishing

Status quo MEY No fishing

Status quo MEY No fishing

Status quo MEY No fishing

Status quo No fishing

Harvest Control Rules (x5)

Harvest Control Rules (x5)

Harvest Control Rules (x5)

Harvest Control Rules (x5)

Harvest Control Rules (x3)

multiple non-linear pressures

multiple non-linear interacting pressures