Ecosystems Assessments as used in Alaska Stock Assessments

Kerim Aydin
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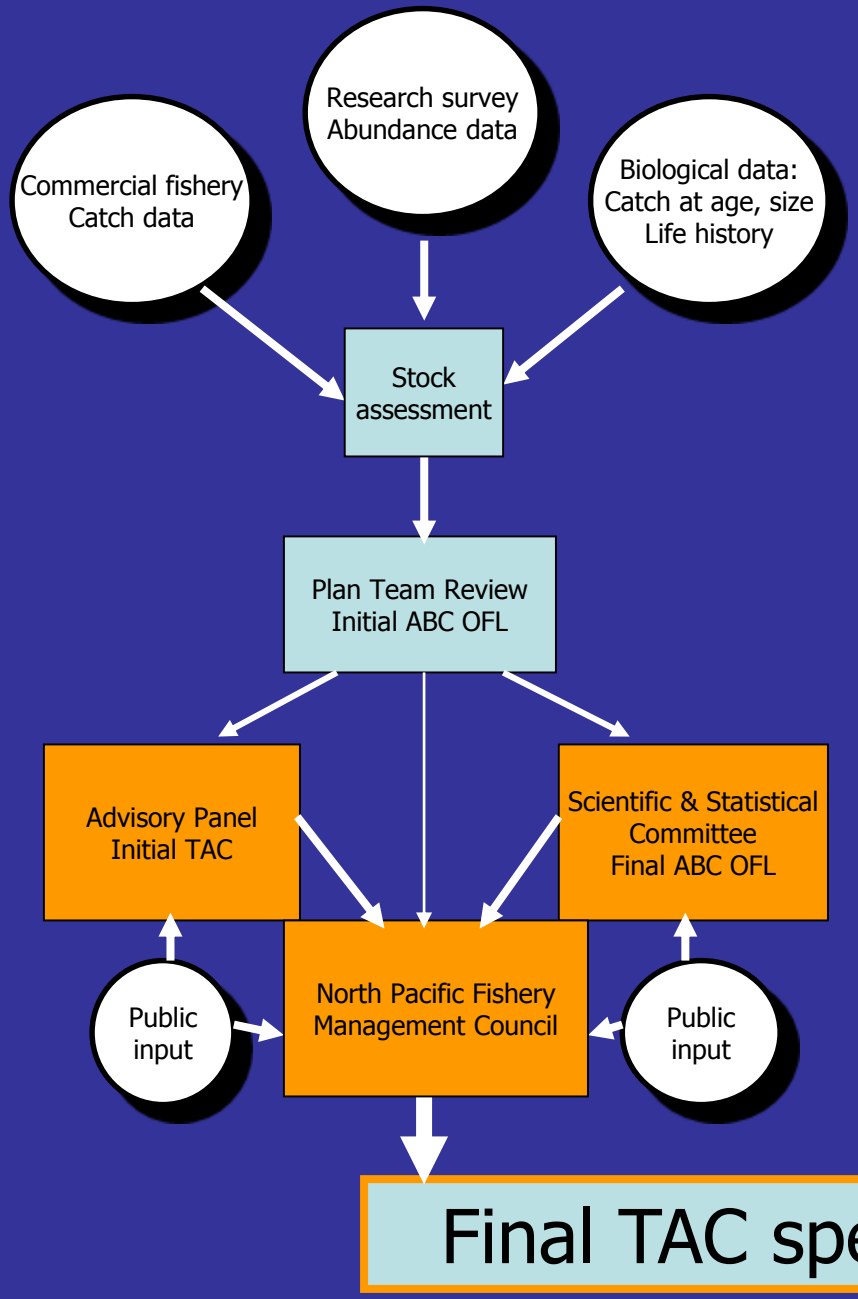
Resource Ecology and Ecosystem Modeling Program
AFSC

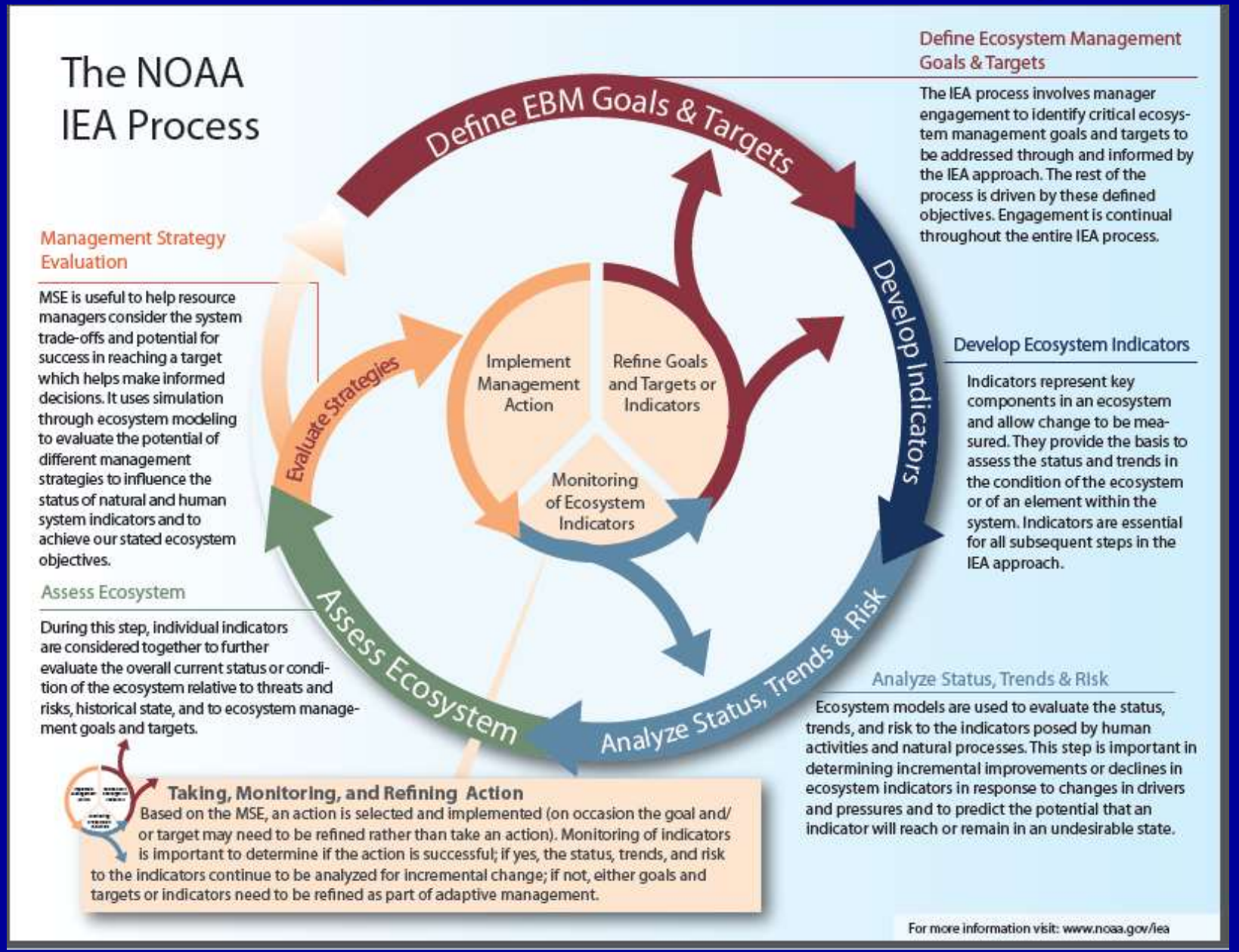
Fishery management: annual process



Ecosystem Stuff ????

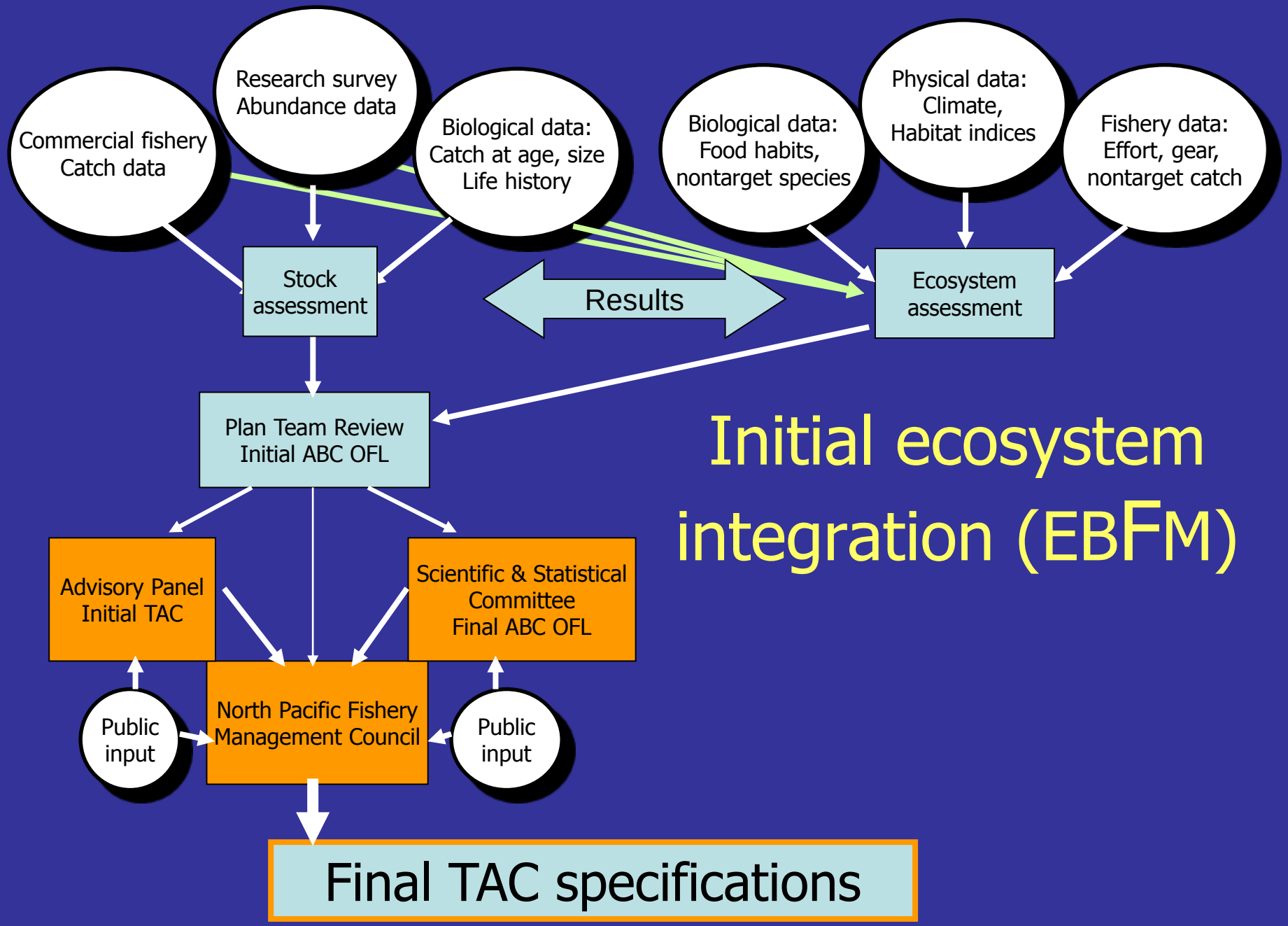
NOAA Integrated Ecosystem Assessment Program

http://www.noaa.gov/iea/ (note: EBM vs. EBFM)



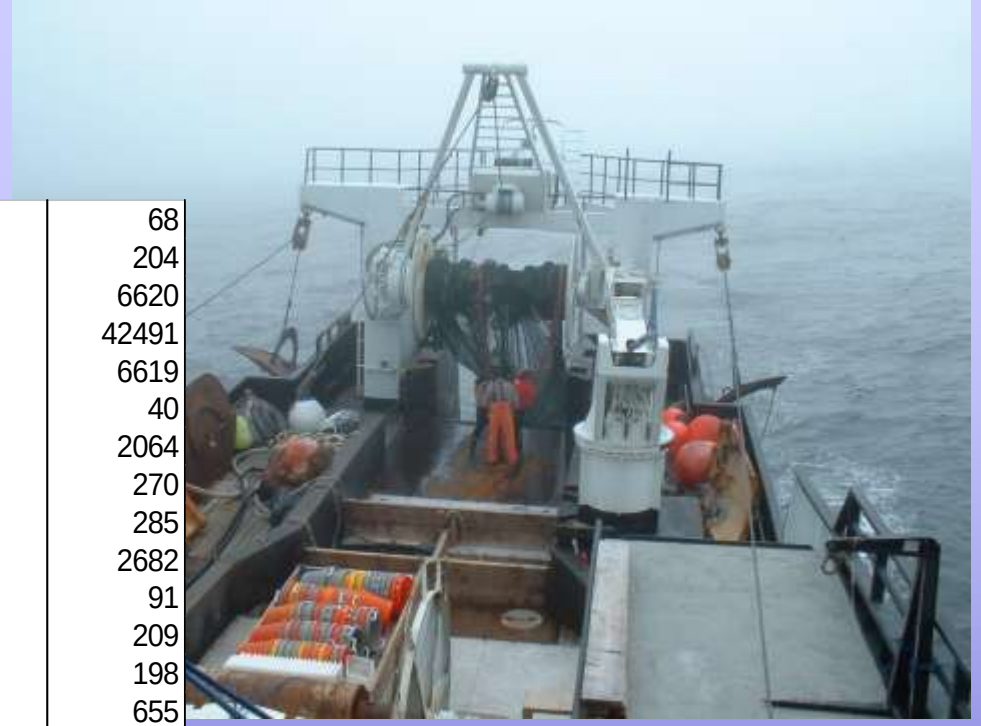
GOALS –
Resource Ecology and Ecosystem Modeling Program

- Collect, or work with others to collect and maintain “ecosystem” data and databases from existing or developing platforms.
- Incorporate environmental indicators into stock assessments.
- Provide Ecosystem Context (Report Cards) for quota-setting, during quota-setting process.
- Synthesize broad ecosystem effects (cumulative or individual) into Ecosystem Assessments, and for other regulatory documents (NEPA, Protected species).
- Determine and evaluate ecosystem-level thresholds and management limits (OYs, limits on perturbing particular ecosystem functions.
- Develop and maintain suite of multispecies and ecosystem models in service of above goals.



Initial ecosystem integration (EBFM)

The data



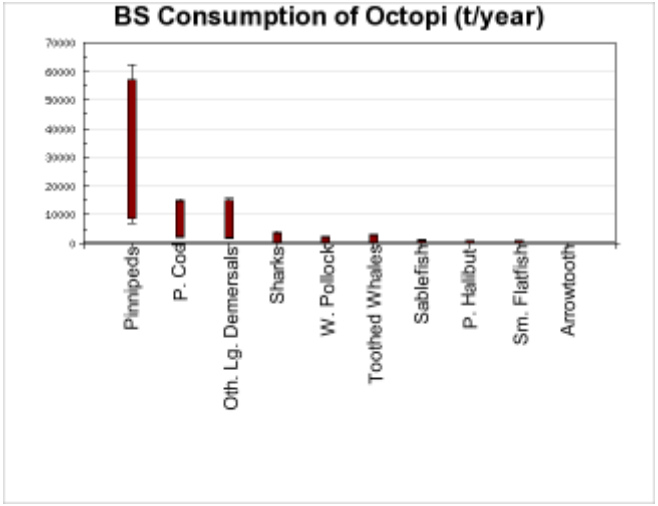
AK Plaice	4695
AK Skate	2043
Aleutian Skate	83
Arrowtooth	18657
Atka	2264
Bathylagidae	61
Bering Skate	44
Big Skate	8
Black Skate	4
Bocaccio	1
Canary Rock	63
Capelin	1
Dogfish	1
Dover Sole	905
Eelpout	490
Eulachon	53
FH Sole	12421
Giant Grenadier	209
Gr. Turbot	3098
Greenlings	24
Hake	16504
Herring	380
Kamchat fl	1412
Lg Sculpin	3107
Longsp Thorny	328
Mud Skate	68
Myctophidae	204
N Rock Sole	6620
P. Cod	42491
P. Halibut	6619
Pacific Grenadier	40
POP	2064
Rex sole	270
S Rock Sole	285
Sablefish	2682
Salmon	91
Sculpin	209
Sebastes	198
Sharp North Dusky	655
Short Rough Rocks	1054
Shortsp Thorny	1255
Sleeper Shark	13
Squid	66
Unid Bathyraja	297
Unid Rajidae	655
W. Pollock	82161
WhtBlotch Skate	33
Widow Rock	18
Yellowtail Rock	202
YF Sole	21525
Grand Total	236631

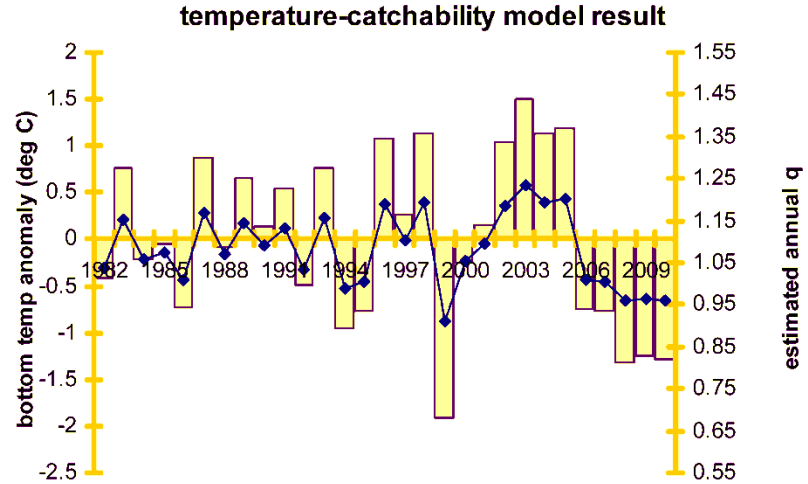
Food habits data collected on surveys and by observers 1982-2008

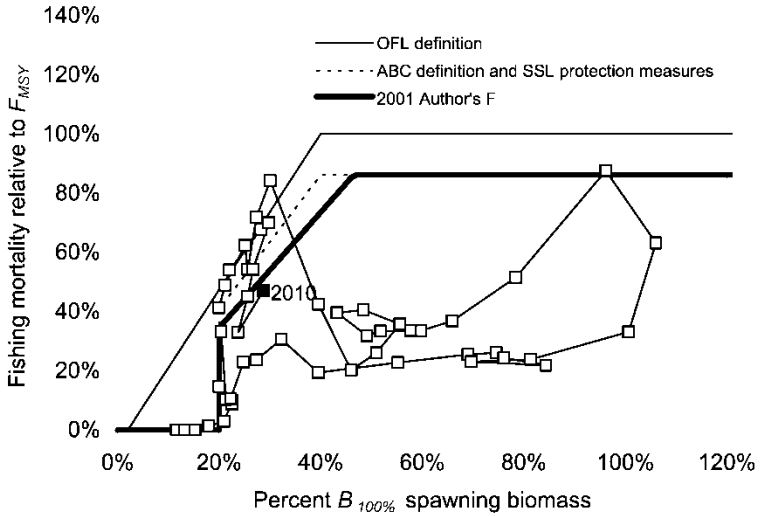
Fisheries observer-collected data is primary source for many critical seasons (e.g. winter).
10cm+ fish (not larval).
Largest sample sizes are for fishery-sized animals.

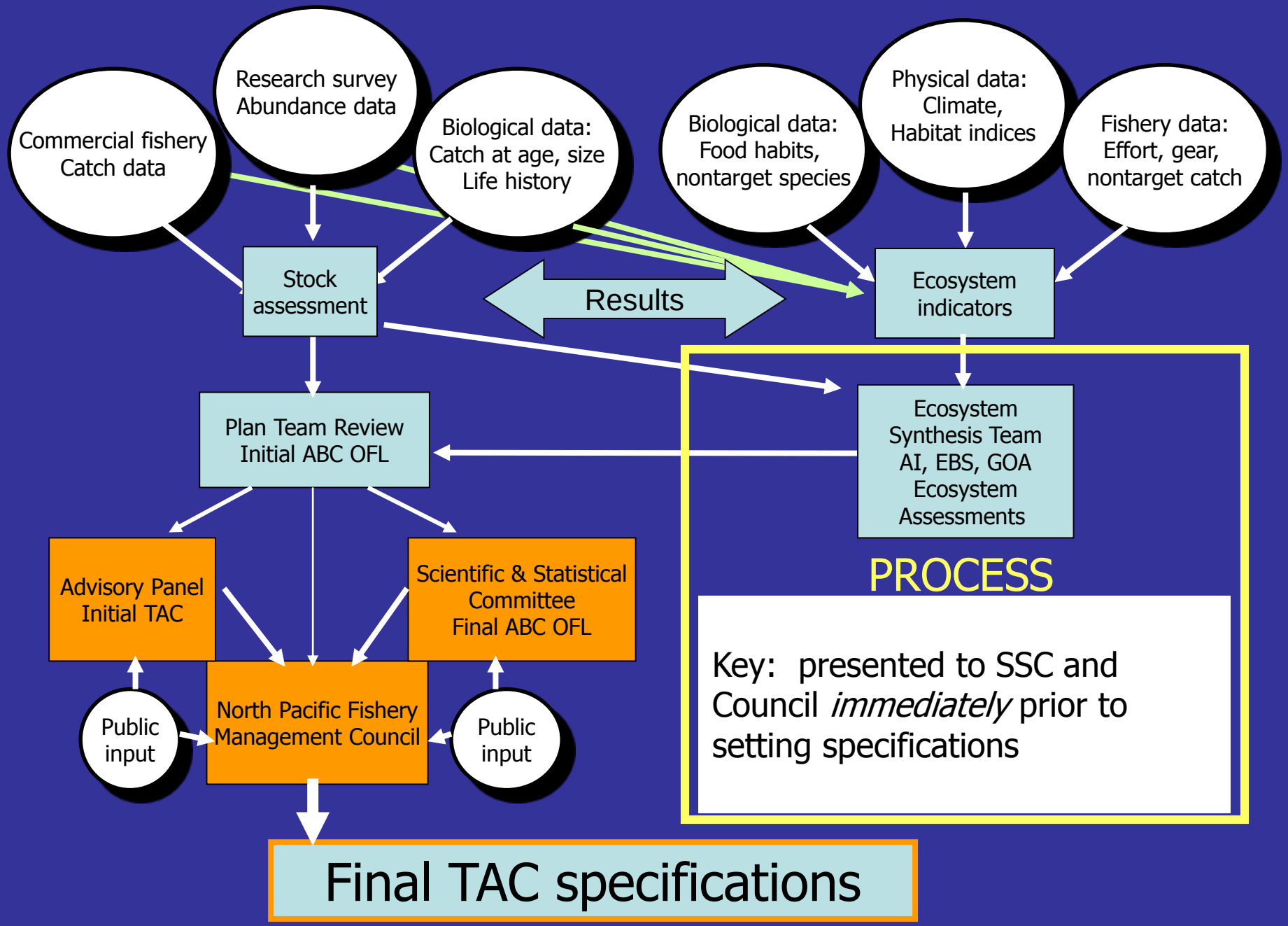
Regional Examples: Tactical

- EBS yellowfin sole temperature dependent survey Q
- GOA walleye pollock B20 threshold for Steller sea lions
- Natural mortality from predation estimates of octopus, crab

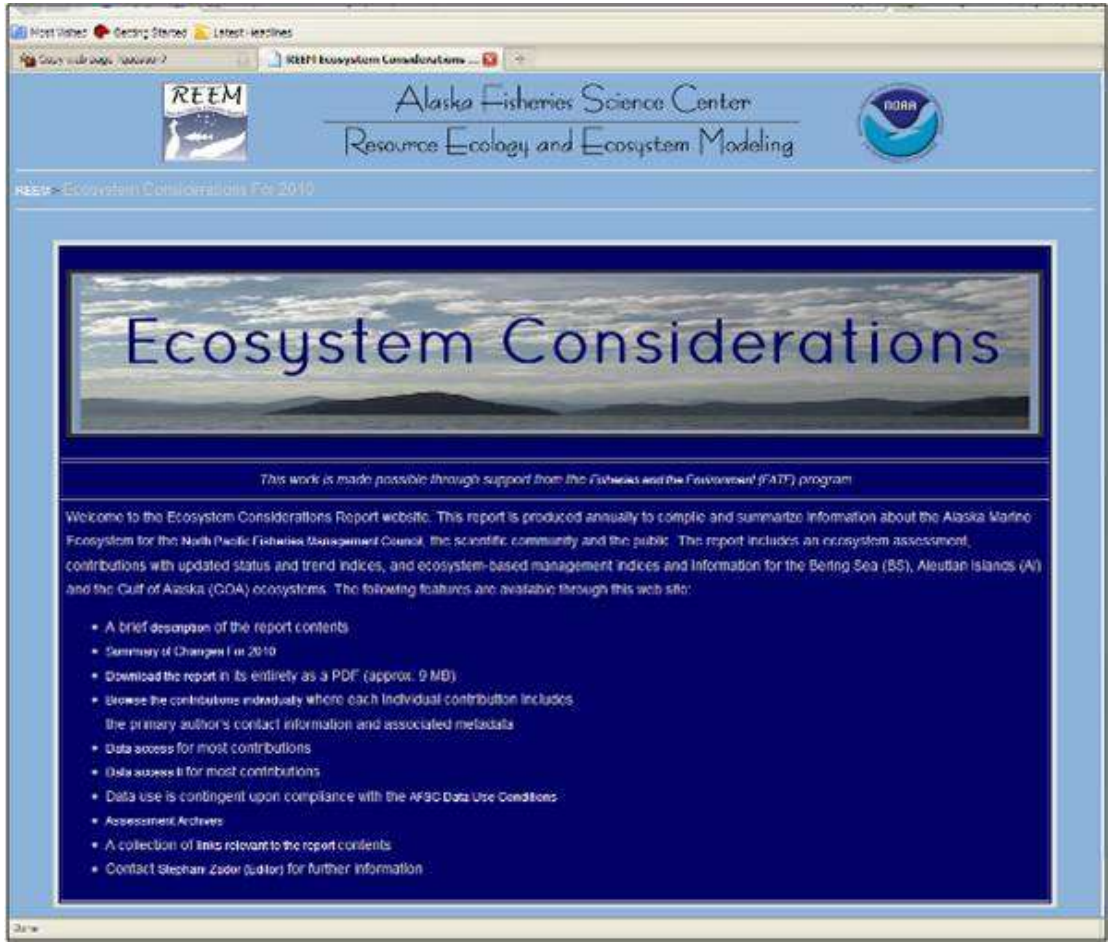




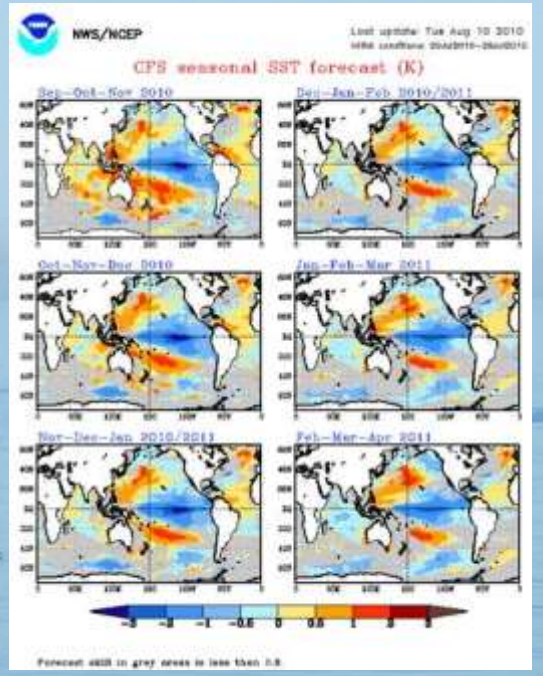


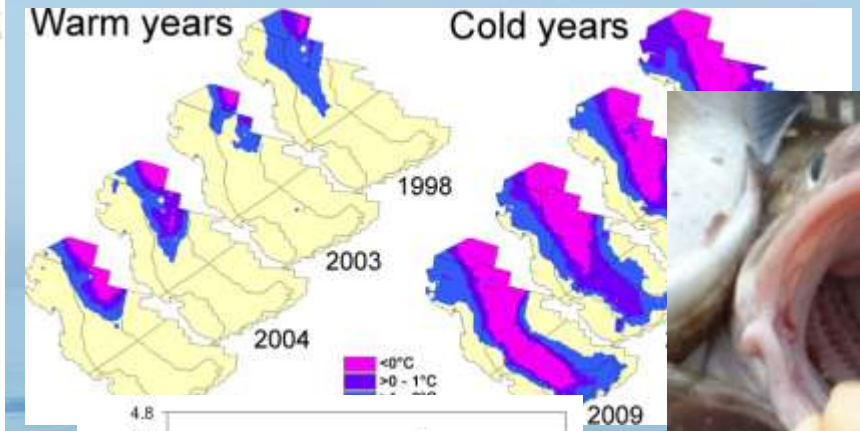

Commercial fishery
Catch data
Research survey
Abundance data
Biological data:
Catch at age, size
Life history
Biological data:
Food habits,
nontarget species
Physical data:
Climate,
Habitat indices
Fishery data:
Effort, gear,
nontarget catch
Stock
assessment
Results
Ecosystem
indicators
Plan Team Review
Initial ABC OFL
Ecosystem
Synthesis Team
AI, EBS, GOA
Ecosystem
Assessments
PROCESS
Advisory Panel
Initial TAC
Scientific & Statistical
Committee
Final ABC OFL
Public
input
North Pacific Fishery
Management Council
Public
input
Key: presented to SSC and
Council *immediately* prior to
setting specifications
Final TAC specifications

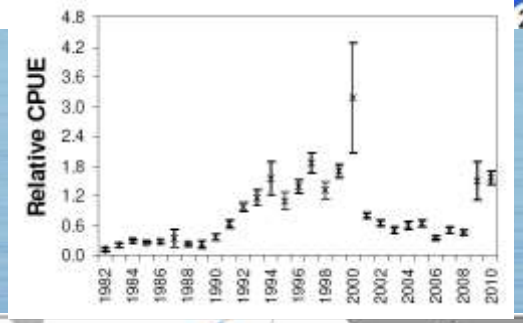
http://access.afsc.noaa.gov/reem/ecoweb/index.cfm



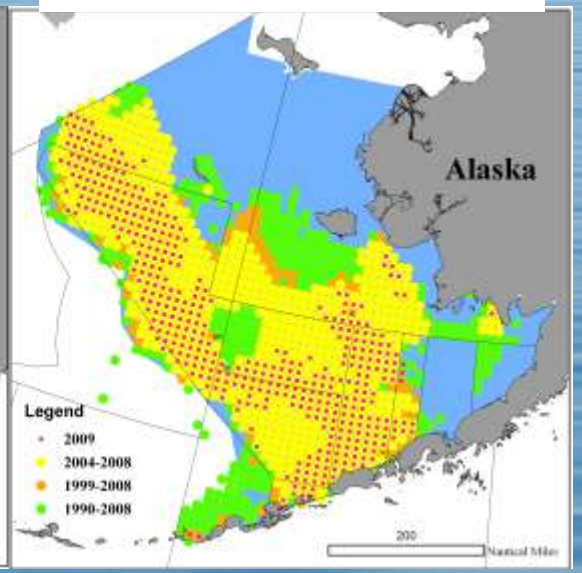
- **Current and archived versions available**
- **Ongoing support from the FATE program**

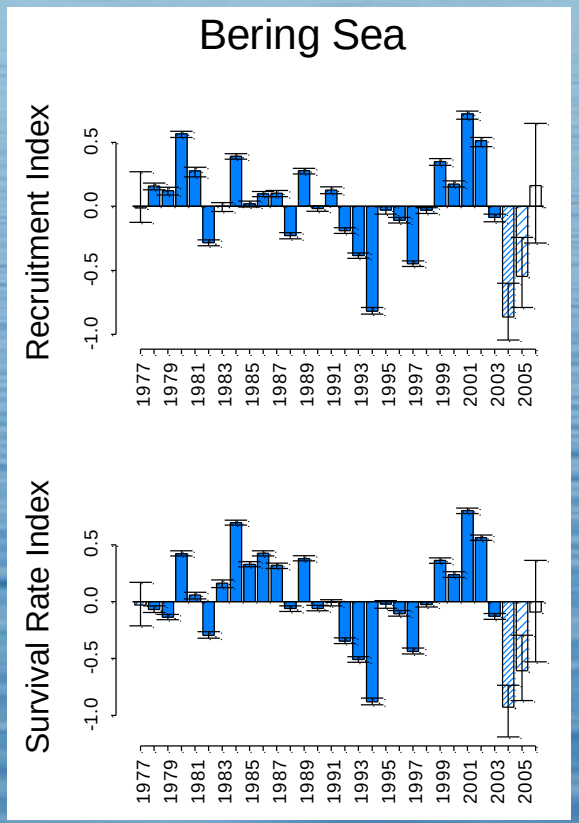

NWS/NCEP
CFS seasonal SST forecast (K)


Warm years
Cold years
1998
2003
2004
2009
<0°C
>0 - 1°C


Relative CPUE

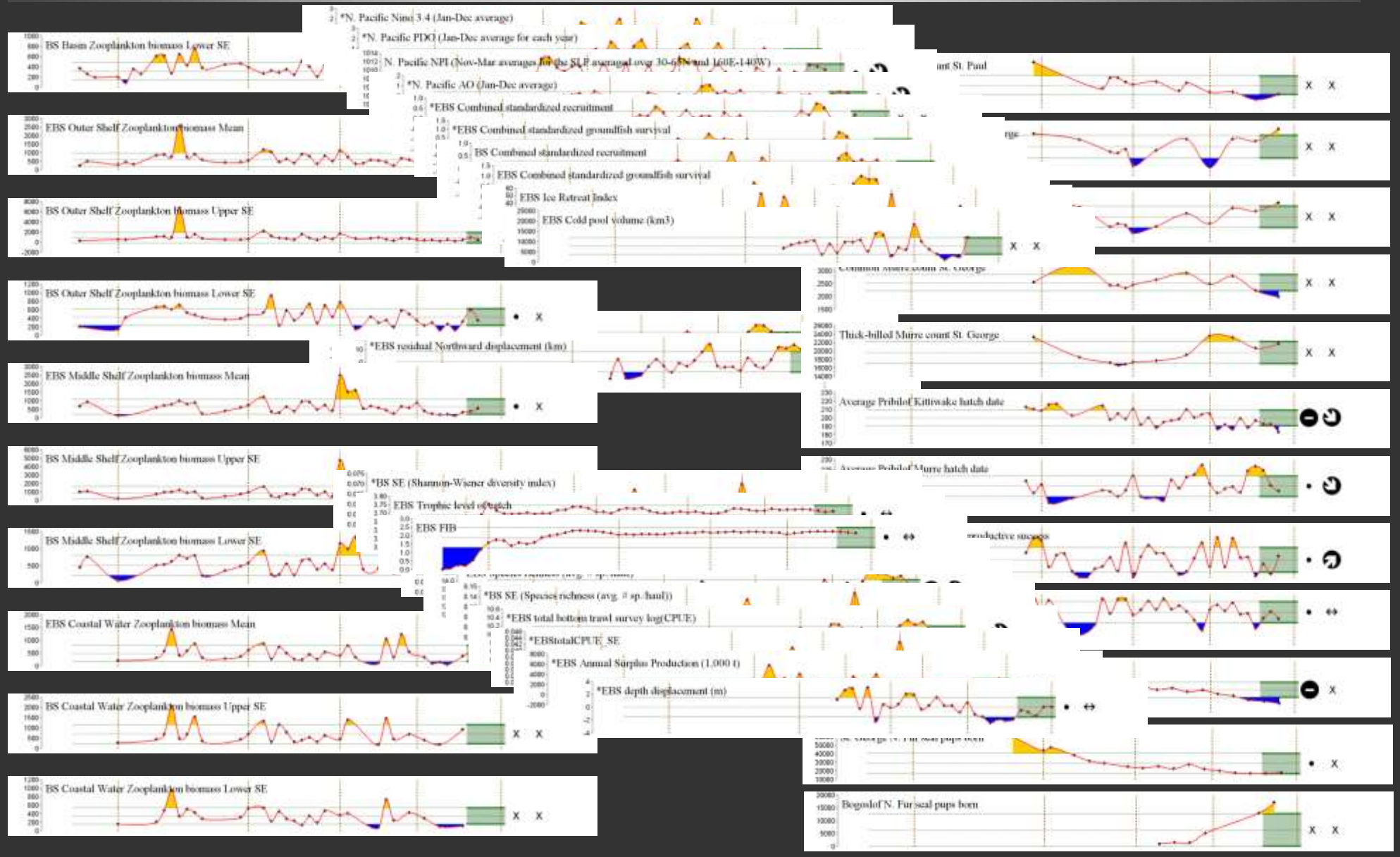

Alaska
Legend
Reporting Areas
Area Considered
200
Nautical Miles


Alaska
Legend
2009
2004-2008
1999-2008
1990-2008
200
Nautical Miles


Bering Sea
Recruitment Index
Survival Rate Index

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



	Eastern Bering Sea	Aleutian Islands
Habitat	Broad, flat, muddy shelf. Valuable fisheries ->>br>Lots of fish-related research.	Extensive rocky island chain, deep trenches, oceanic basins. Smaller-scale fisheries (and research)
Team members: NOAA Academia Management Commercial Other Fed Non Profit Research sponsor	 17 2 1 (3)	 10 4 1 1 2 1 1
Structuring theme	Production	Variability
Indicator focus	Broad, community-level, indicators of ecosystem-wide productivity, and those most informative for managers	Characterize global attributes with local behavior

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

Indicators
Climate
Zooplankton
Forage fish
Fish biomass
Marine Mammals
Seabirds
Humans

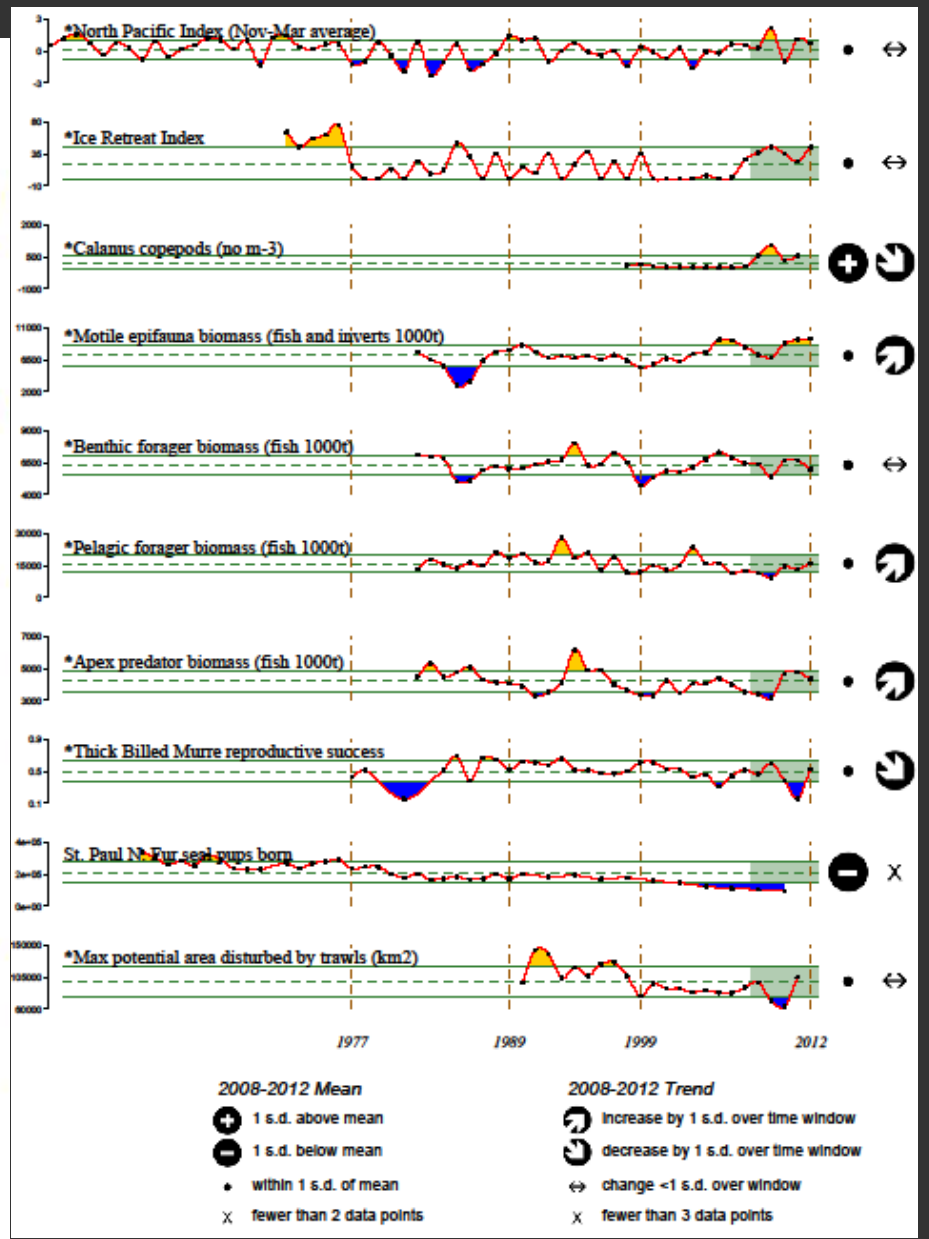
- North Pacific Index
- Auklet reproductive success
- Tufted puffin chick diets
- Pelagic foragers biomass
- Fish apex predator biomass
- Sea otters
- Steller sea lion non-pups
- Area trawled
- K-12 enrollment

Report Card

Eastern Bering Sea 2012 Report Card

- The North Pacific atmosphere-ocean system reflected a combination of a **response to La Niña and intrisic variability**. The combination of the **neutral to weak El Niño expected this winter** and a continuation of reduced ice cover in the central Arctic should yield **a lighter ice year for the Bering in 2013**.
- **Ocean temperatures remained cold and sea ice remained extensive**, similar to 2008 and 2010. Ice retreat this year (and 2009) was the latest recorded since 1985. Summer was calm and cool, but had the **most extensive cold pool area of the recent decade**.
- The summer ***Calanus* copepod time series showed an increase in abundance** in 2011 relative to 2010, but remained below the 2009 peak. 2011 was **the fourth year that concentrations remained well above average**, following patterns also seen in fall zooplankton abundance during cold years. This suggests that prey availability for planktivorous fish, seabirds, and mammals continued to be high during the summer of 2011.
- **Jellyfish remain abundant**, although peak abundances observed in fall 2010 and summer 2011 declined by fall 2011 and summer 2012.
- **While commercial crab stocks are relatively low**, overall **motile epifauna biomass remains stable or increasing** since the late 1980s. Higher levels since 2003 are driven by increases in brittle stars and echinoderms, although these series show high within-year variances in the survey.
- **Biomass of benthic foragers has remained stable** since 1982, with interannual variability driven by short-term fluctuations in yellowfin and rock sole abundance.
- **Biomass of pelagic foragers has increased to nearly average** from record survey lows in 2009. While pollock has increased from low levels, this is additionally driven by increases in capelin seen in 2010-2012.
- **Fish apex predator biomass has increased appreciably in the last few years**, driven primarily by the increase in Pacific cod from lows in 2007-2009 to higher levels in 2010-2012. Arrowtooth flounder biomass has decreased from all-time survey highs during 2004-2005, though it remains high relative to pre-1989 levels.
- **Thick-billed murre reproductive success on St. George Island was near average** in 2012, a substantial increase from the record low in 2011. This suggests that **foraging conditions were favorable for piscivorous seabirds**.
- **Northern fur seal pup production for St. Paul Island has declined over the long term.** The most recent pup production estimates for St. Paul and St. George Islands in 2010 were 8.8% and 1.0% less than the 2008 estimates.
- The maximum potential **area of seafloor habitat disturbed by trawl gear increased in 2011** to the highest level since 1998. The cause of this increase is currently unknown.

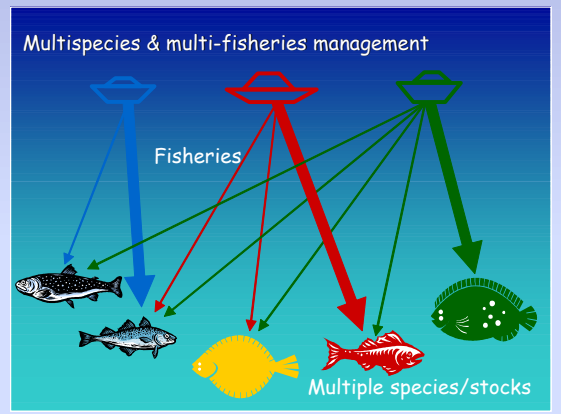
Hot topic In September the Department of Commerce declared commercial king salmon fisheries in the Yukon and Kuskokwim rivers failures after extrememly low returns over the summer. The two leading hypotheses for the reduced runs are climate change and fishing.



Developing and maintaining **Operational Readiness**

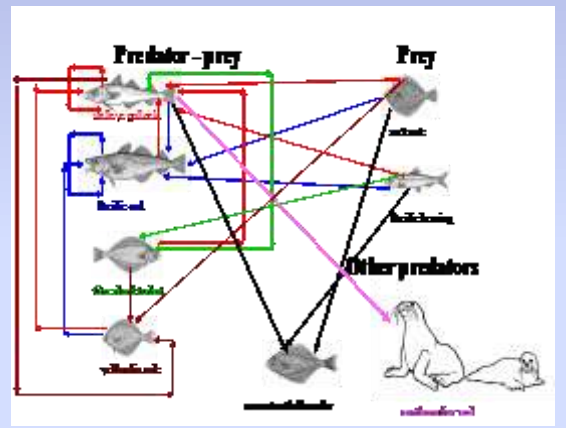
An "operational ensemble" of models be developed and kept up-to-date to address pressing ecosystem-based management concerns in a timely fashion

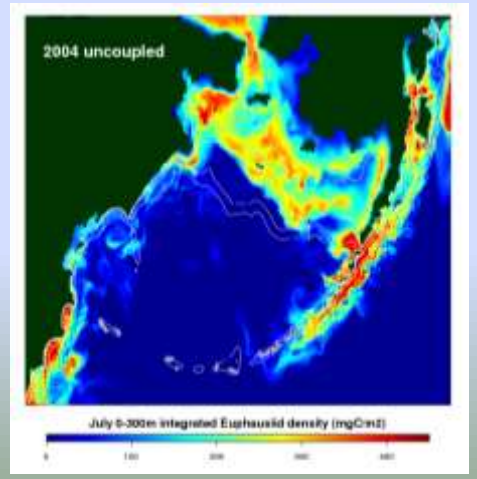
- Endangered species issues
- Bycatch impacts
- Ocean acidification
- Oil and gas development



Multispecies Bycatch Model (Ianelli)

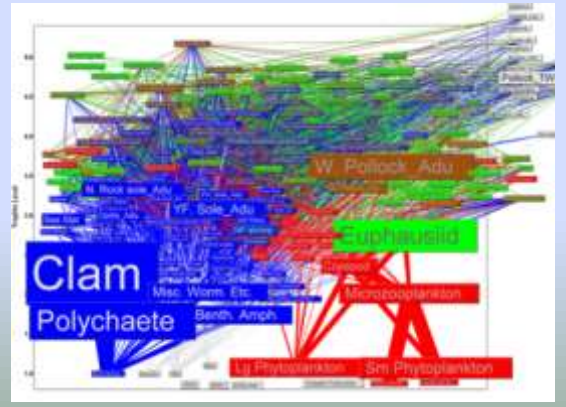
MSVPA/ Multispecies Statistical Model (Jurado-Molina et al.)





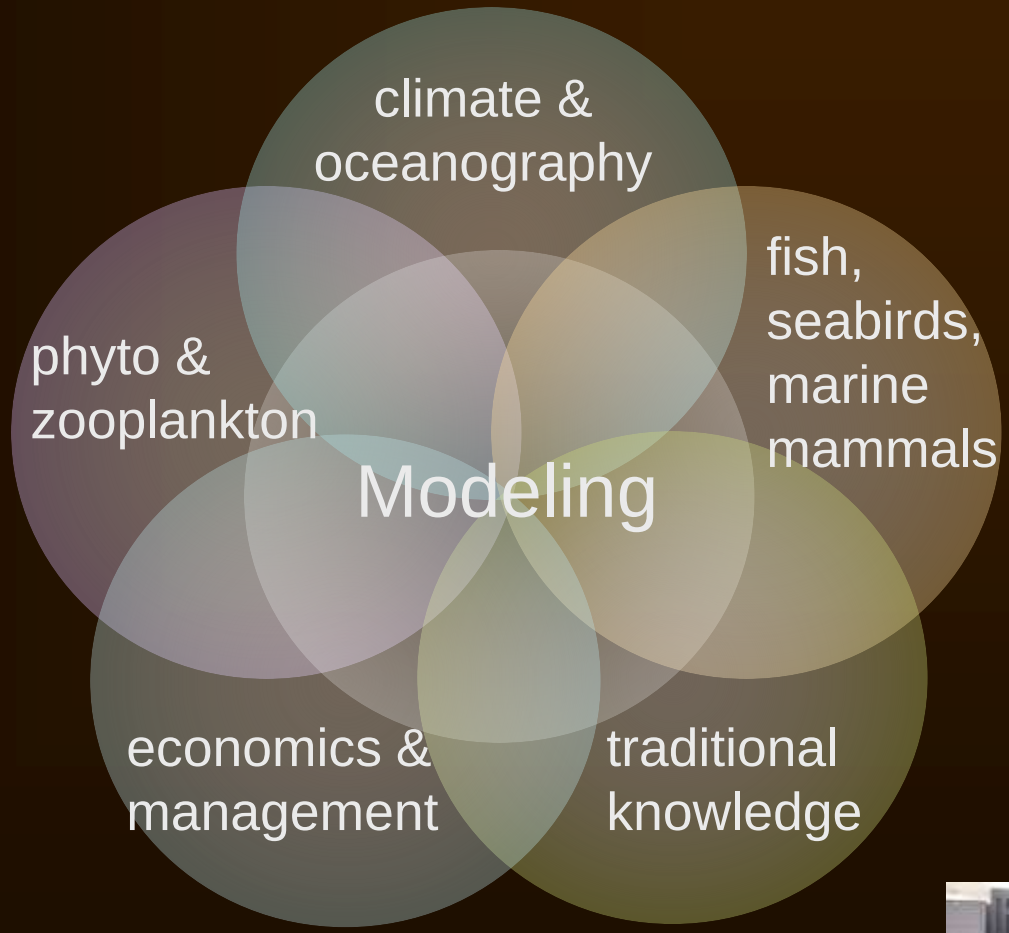
Forage and Euphausiid Abundance in Space and Time (FEAST); Aydin et al. North Pacific Research Board

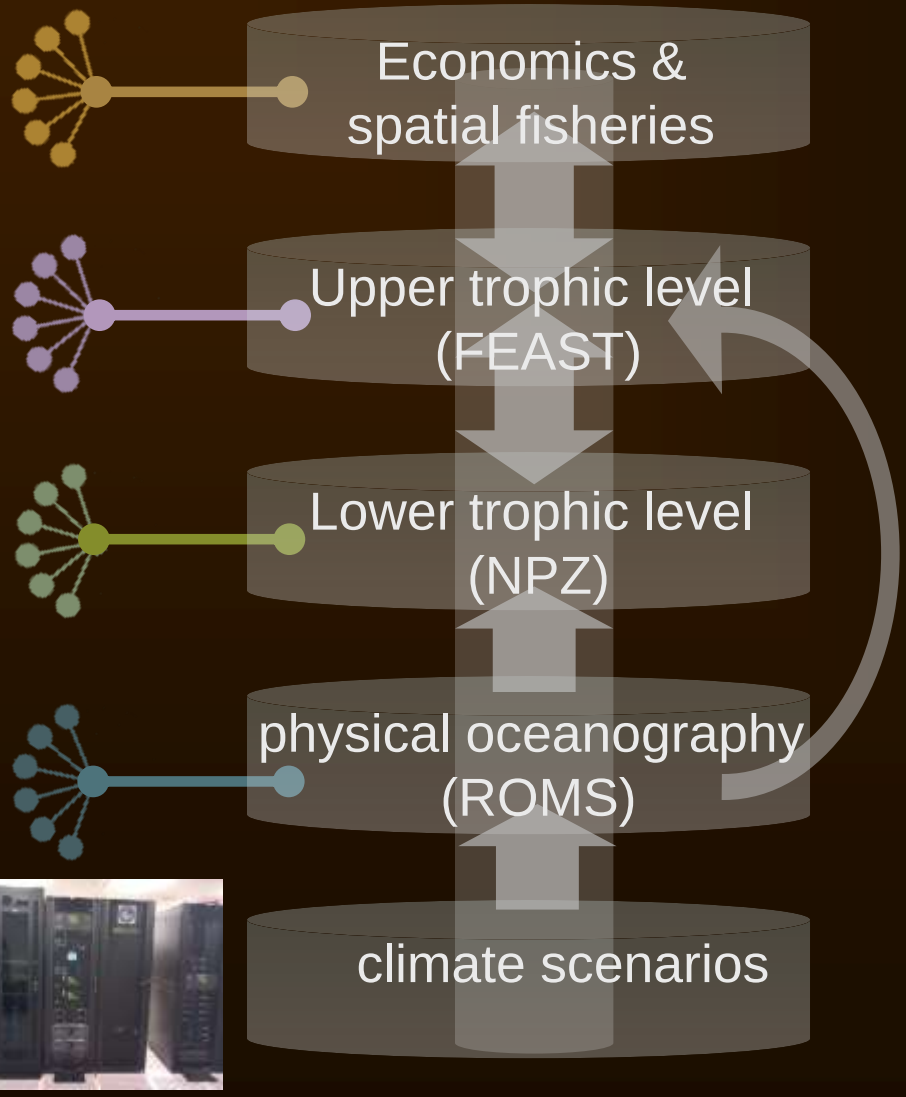
Ecopath/Ecosim and Ecosense (Aydin et al.)



The Bering Sea Project

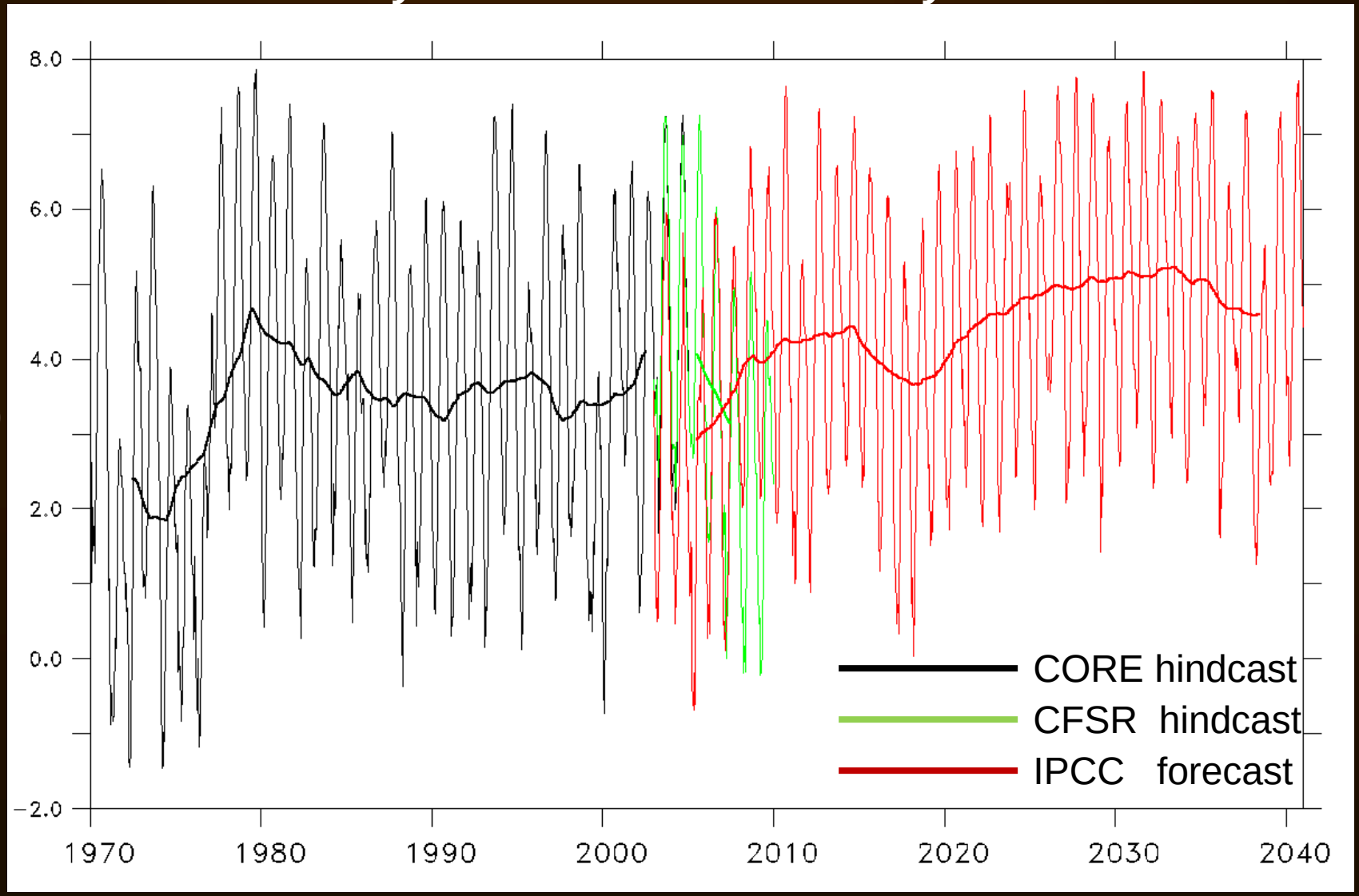
BEST/BSIERP Research Program



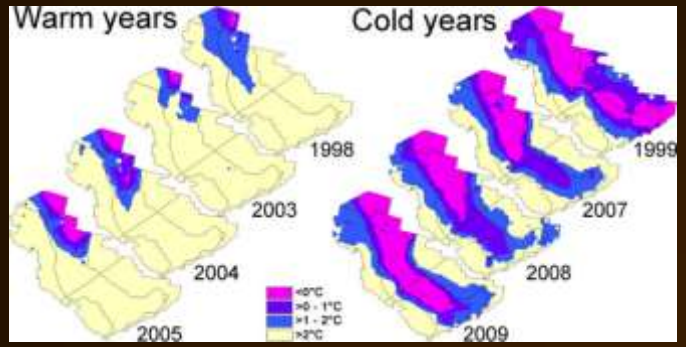


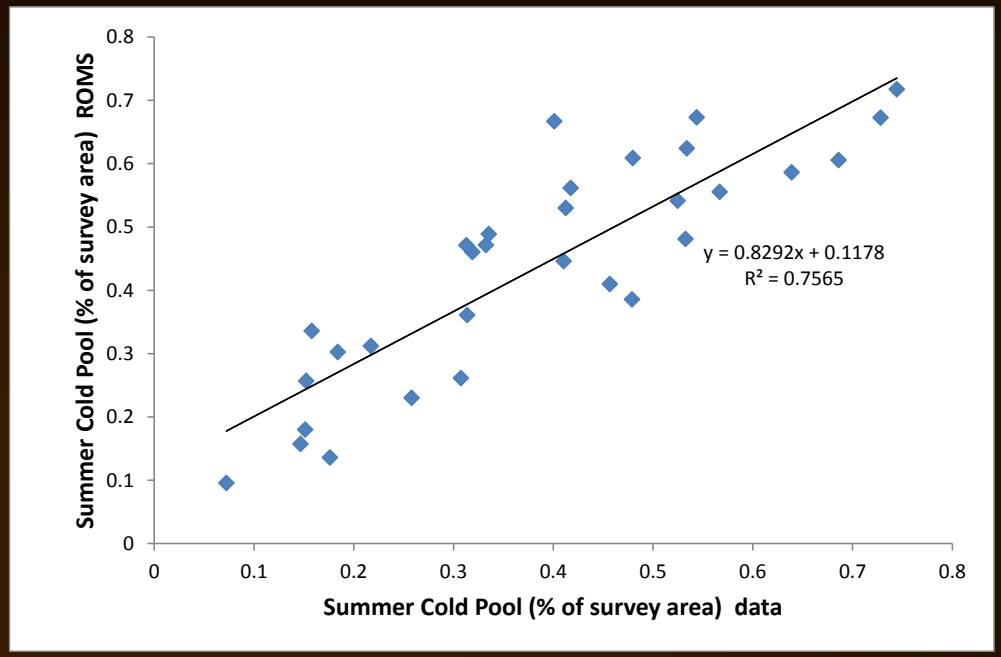
Southeast Bering depth-averaged temperature

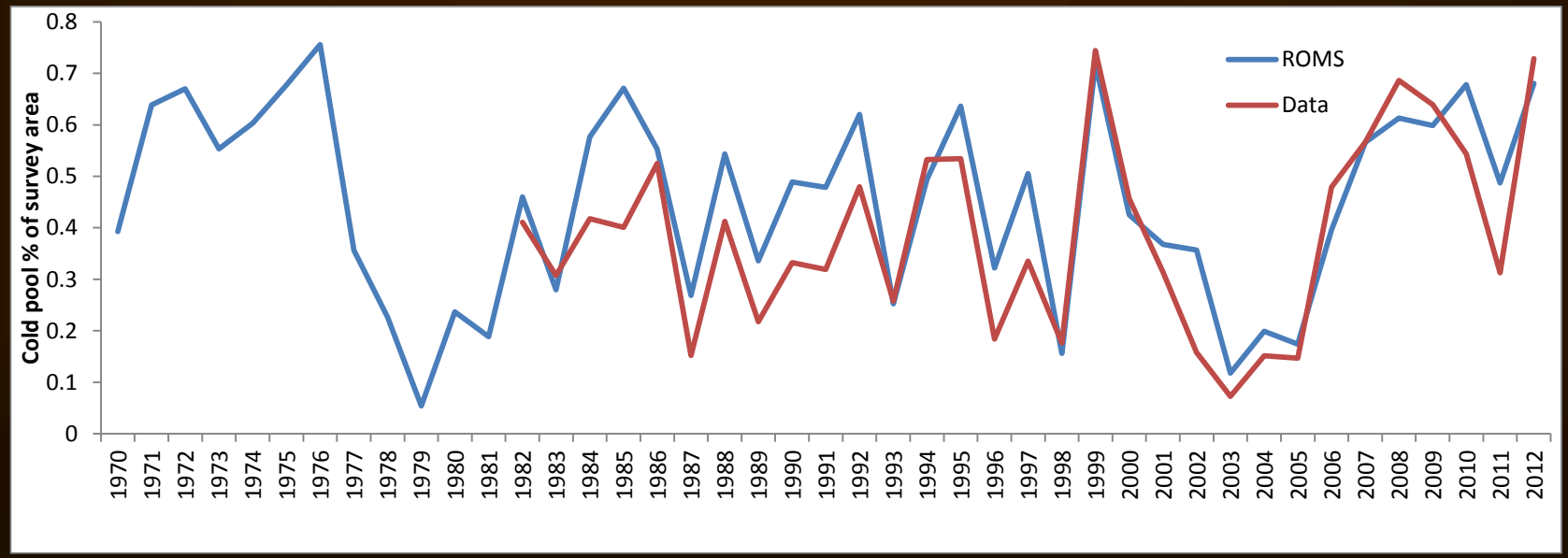
thin line = weekly ave; thick line = 5-year smoothed



Focus on dynamic habitat (e.g. Barbeaux, Spencer et al.)







FEAST

11 ages/ 15 lengths
high detail

15 lengths
medium detail

biomass pools
low detail

NPZ

cod

arrowtooth

pollock

salmon

herring

myctophid

capelin

squids

eulachon

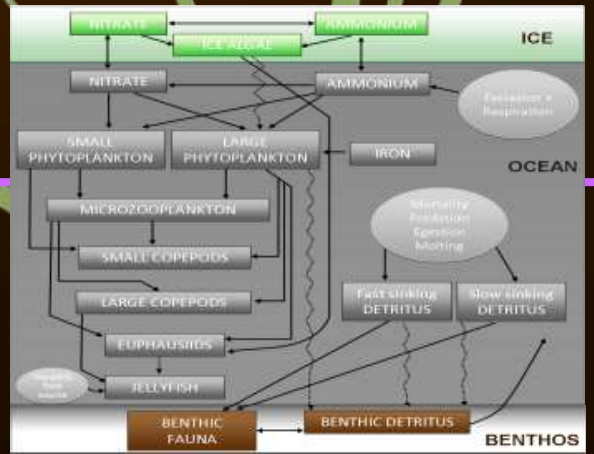
sandlance

crabs

shrimp

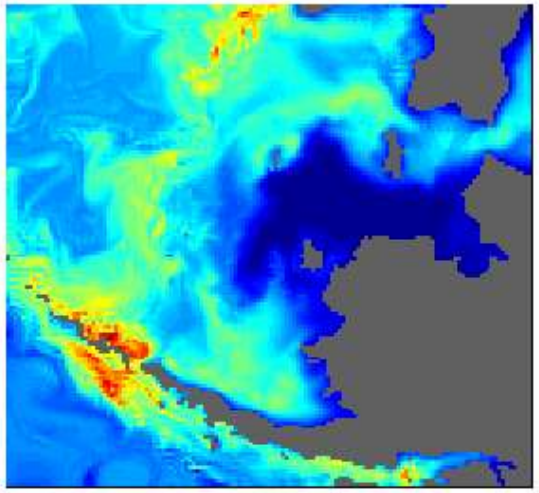
epifauna

benthos

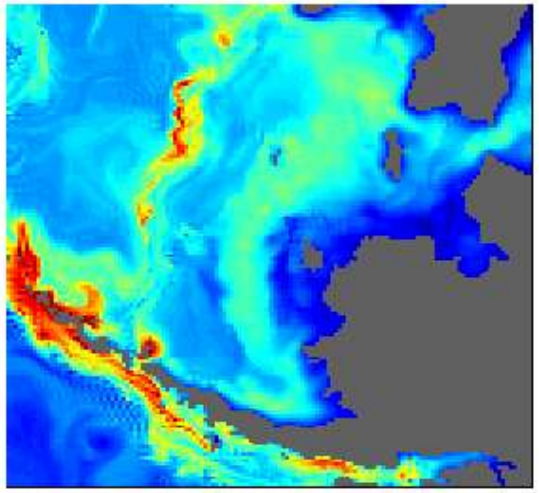


Prey Fields and temperature – foraging potential for an 8 cm (age 0) pollock

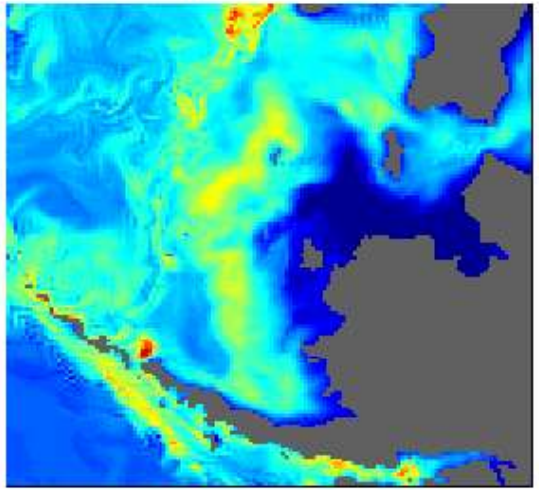
July 1975 (cold)



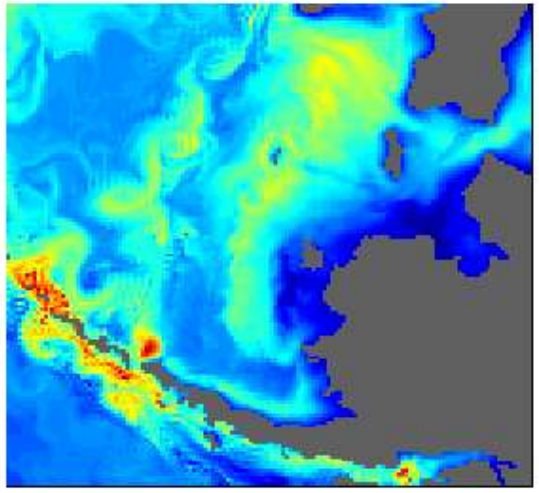
July 2004 (warm)



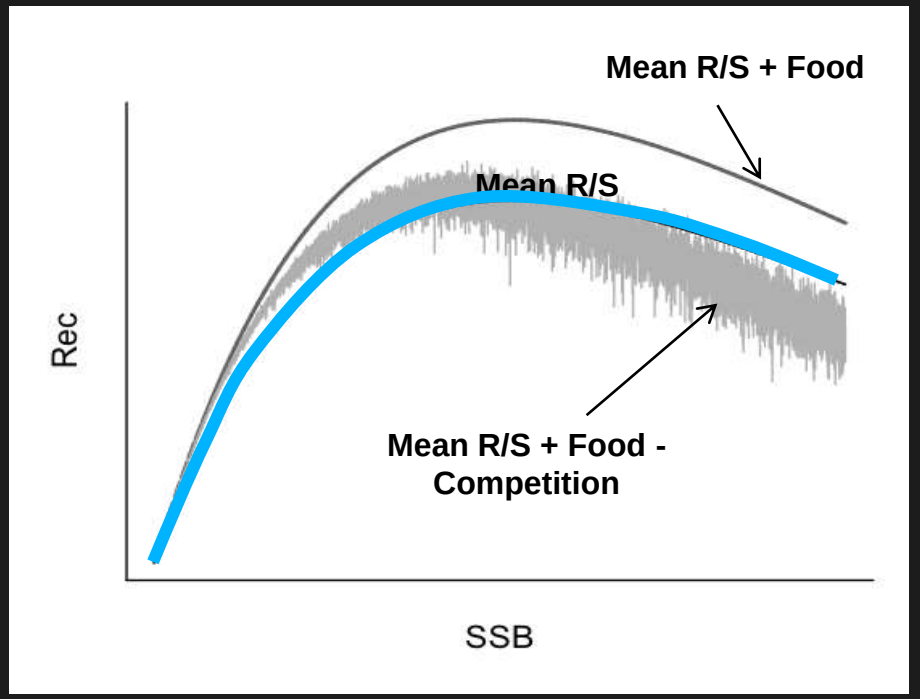
July 2008 (cold)



July 2040 (warm)



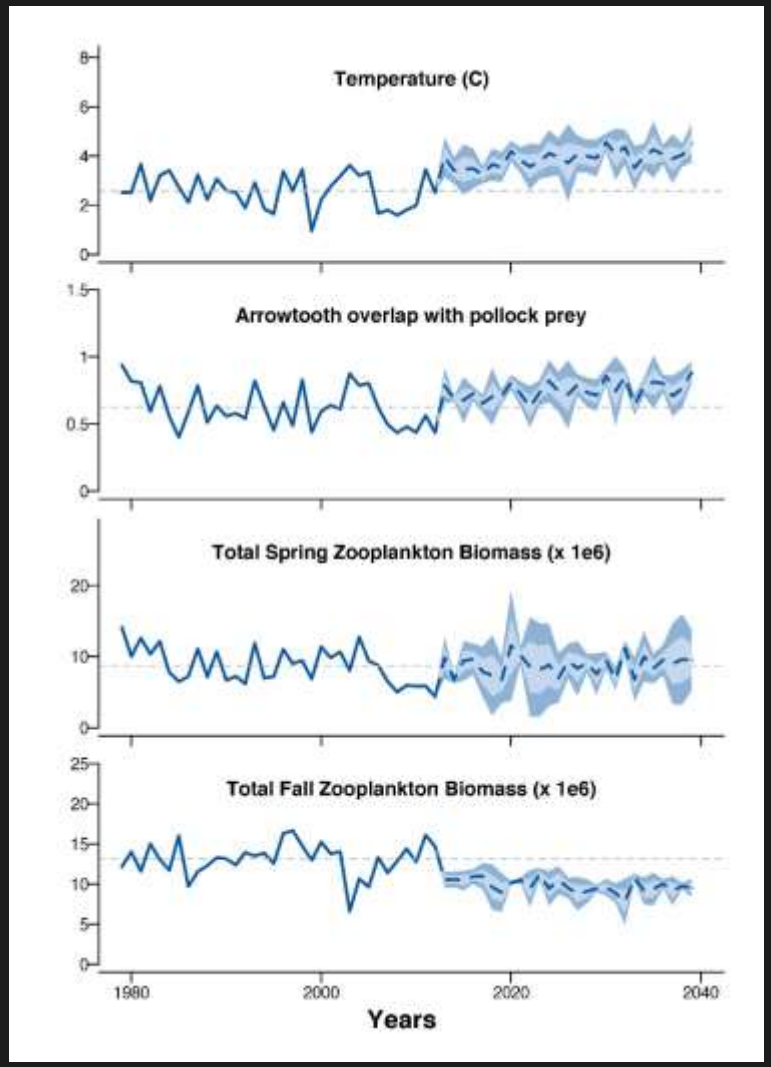
MSMt Projections



$$log\left(R_{p,v}^{fut}\right) = \log\left(\alpha_{R,p} \cdot SSB_{p,v-1}\right) - \beta_{R,p} \cdot SSB_{p,v-1} + \beta_{Z,p}^{spr} \cdot Z_v^{spr} - \beta_{Z,p}^{fall} \cdot \left(\delta_{p1,v}^{fut} / Z_v^{fall}\right)$$

Future recruitment

Environmental covariates



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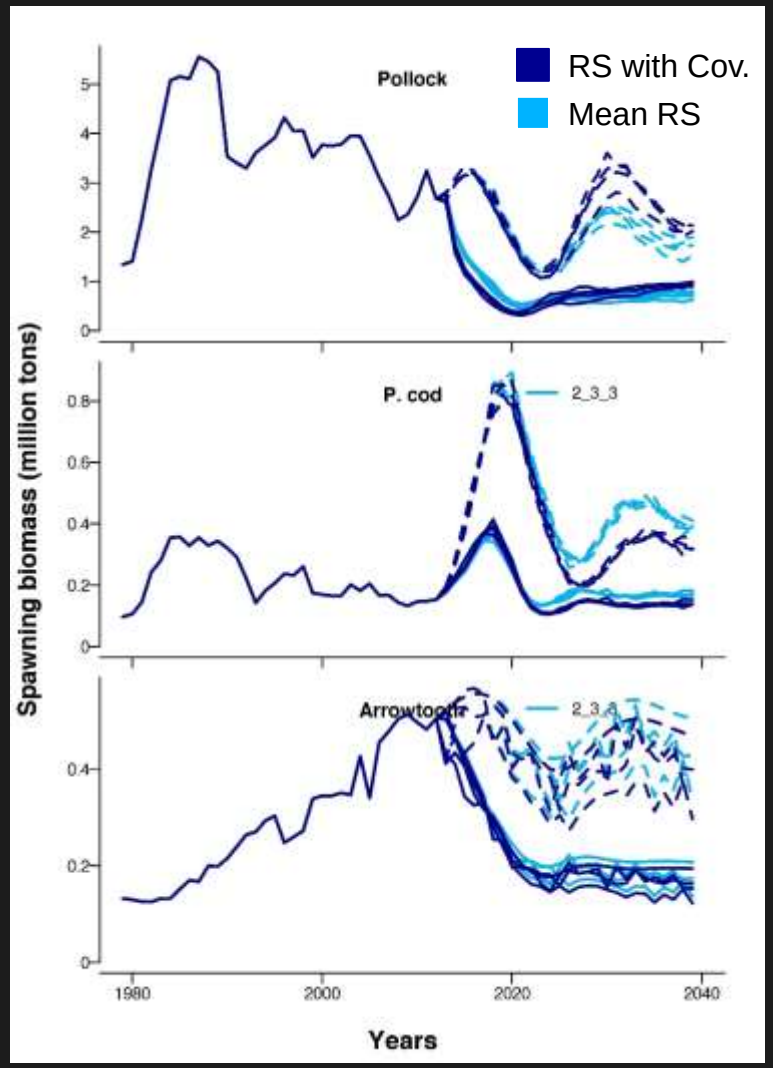
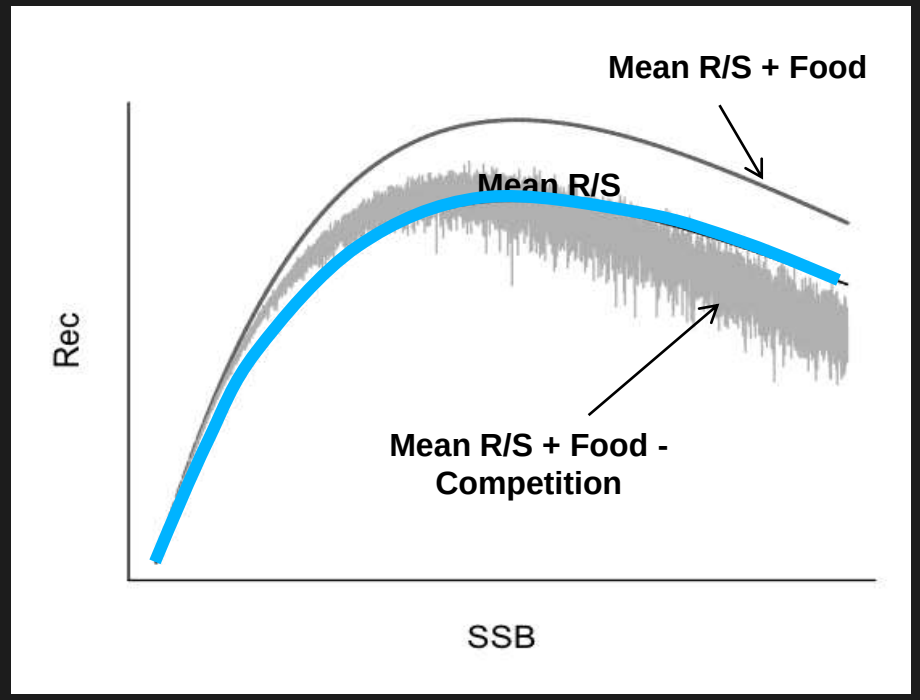
MSMt Projections

Multi-Species Model





$$log\left(R_{p,y}^{fut}\right) = \log\left(\alpha_{R,p} \cdot SSB_{p,y-1}\right) - \beta_{R,p} \cdot SSB_{p,y-1} + \beta_{Z,p}^{spr} \cdot Z_y^{spr} - \beta_{Z,p}^{fall} \cdot \left(\delta_{p1,y}^{fut} / Z_y^{fall}\right)$$

Future recruitment

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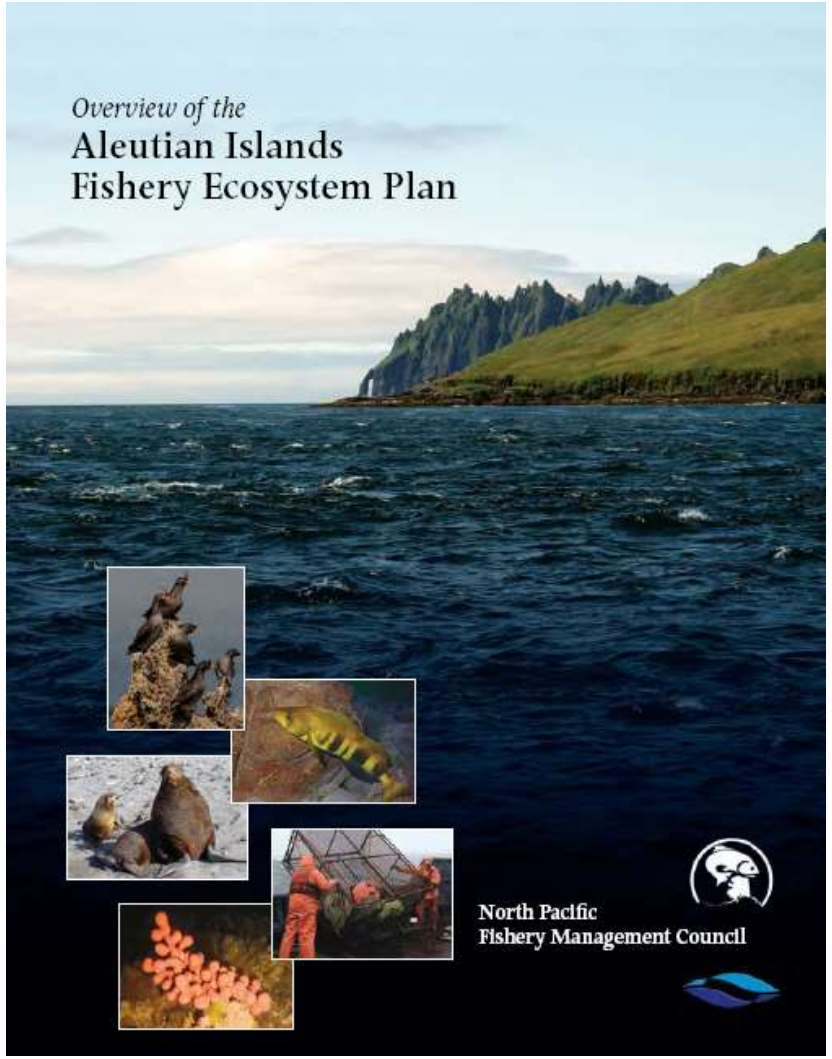
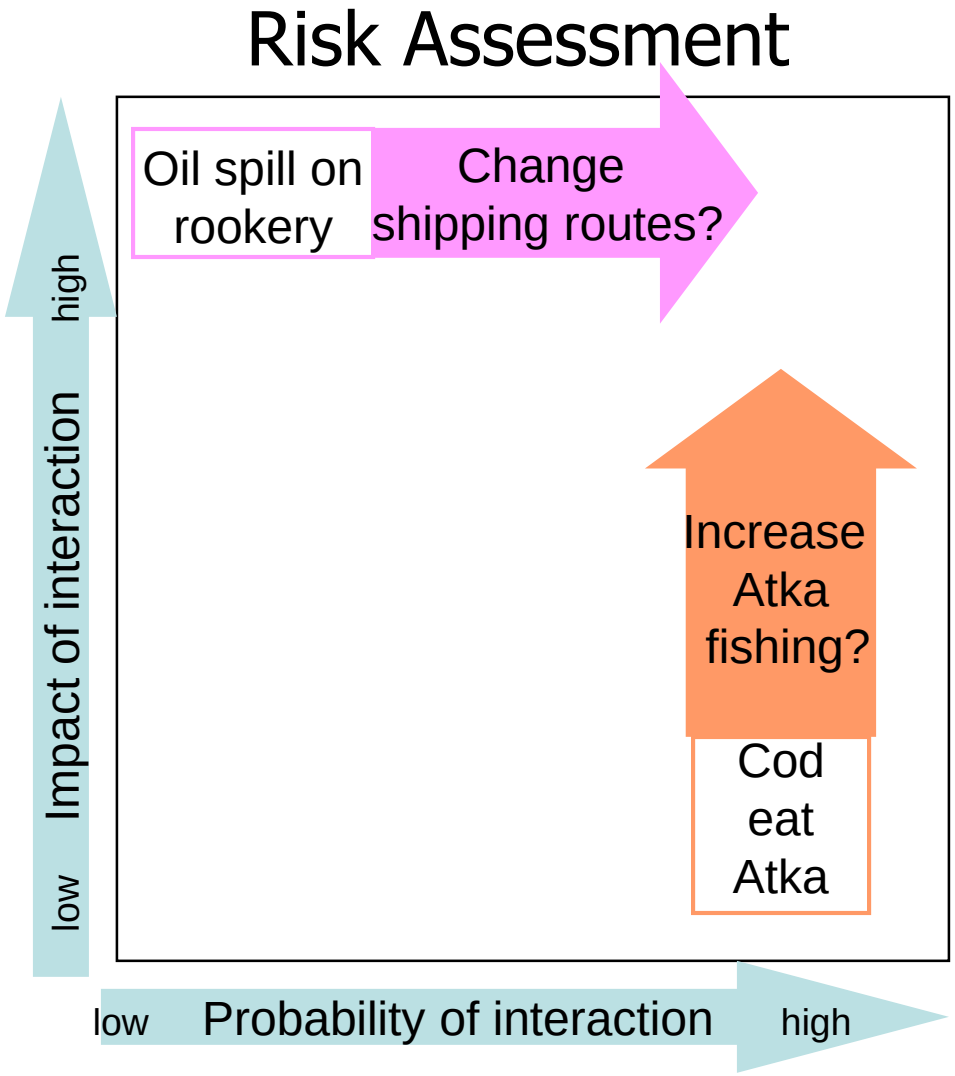
Interactions → Risk Assessment, EBFM to EBM





Risk Assessment

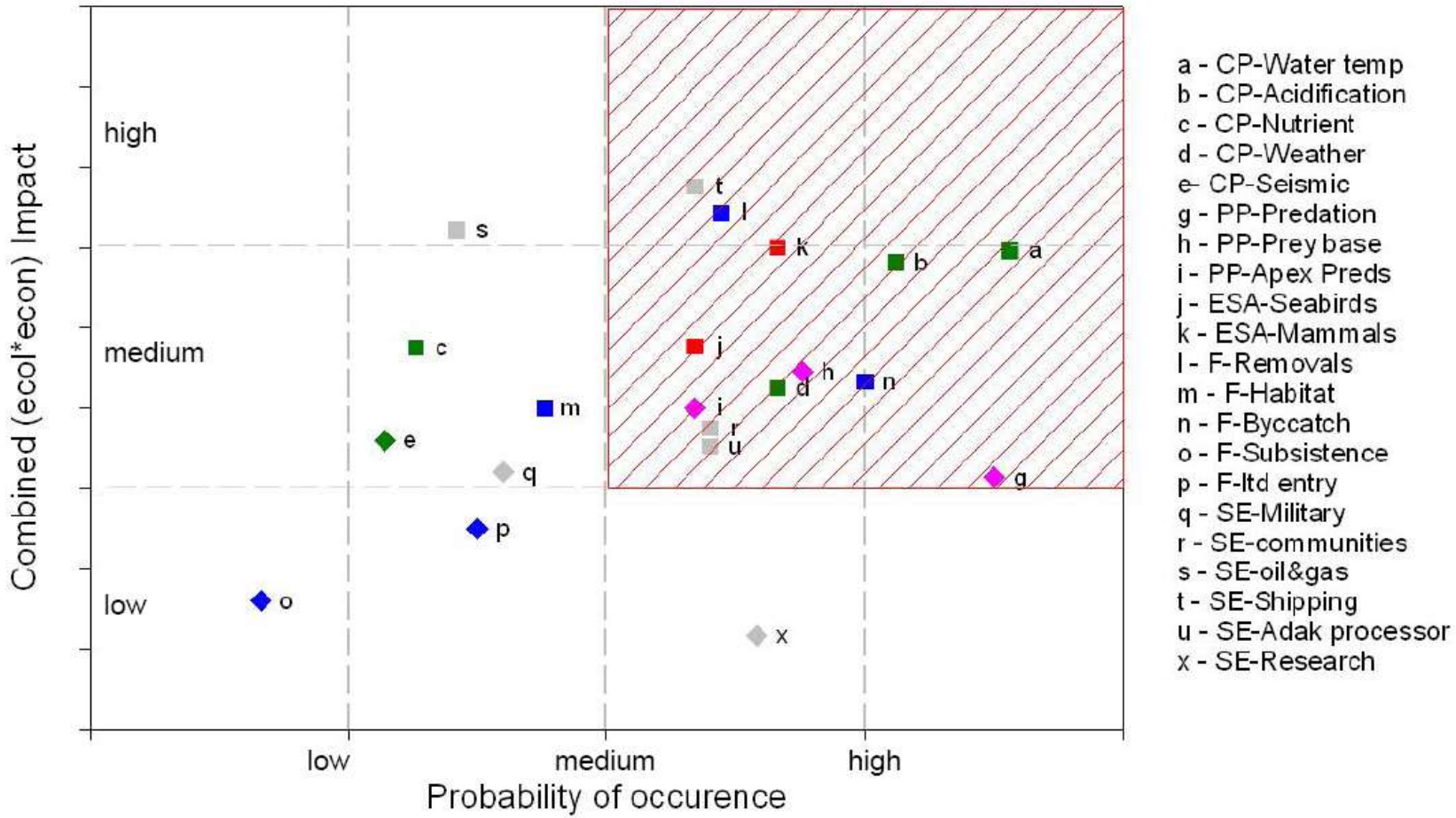
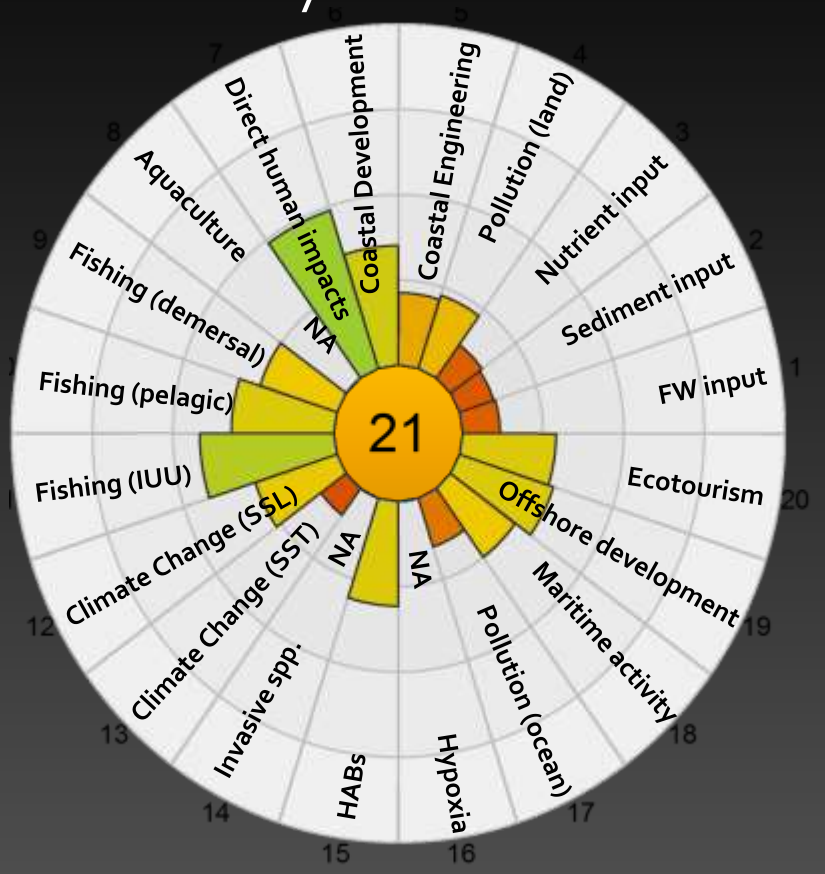


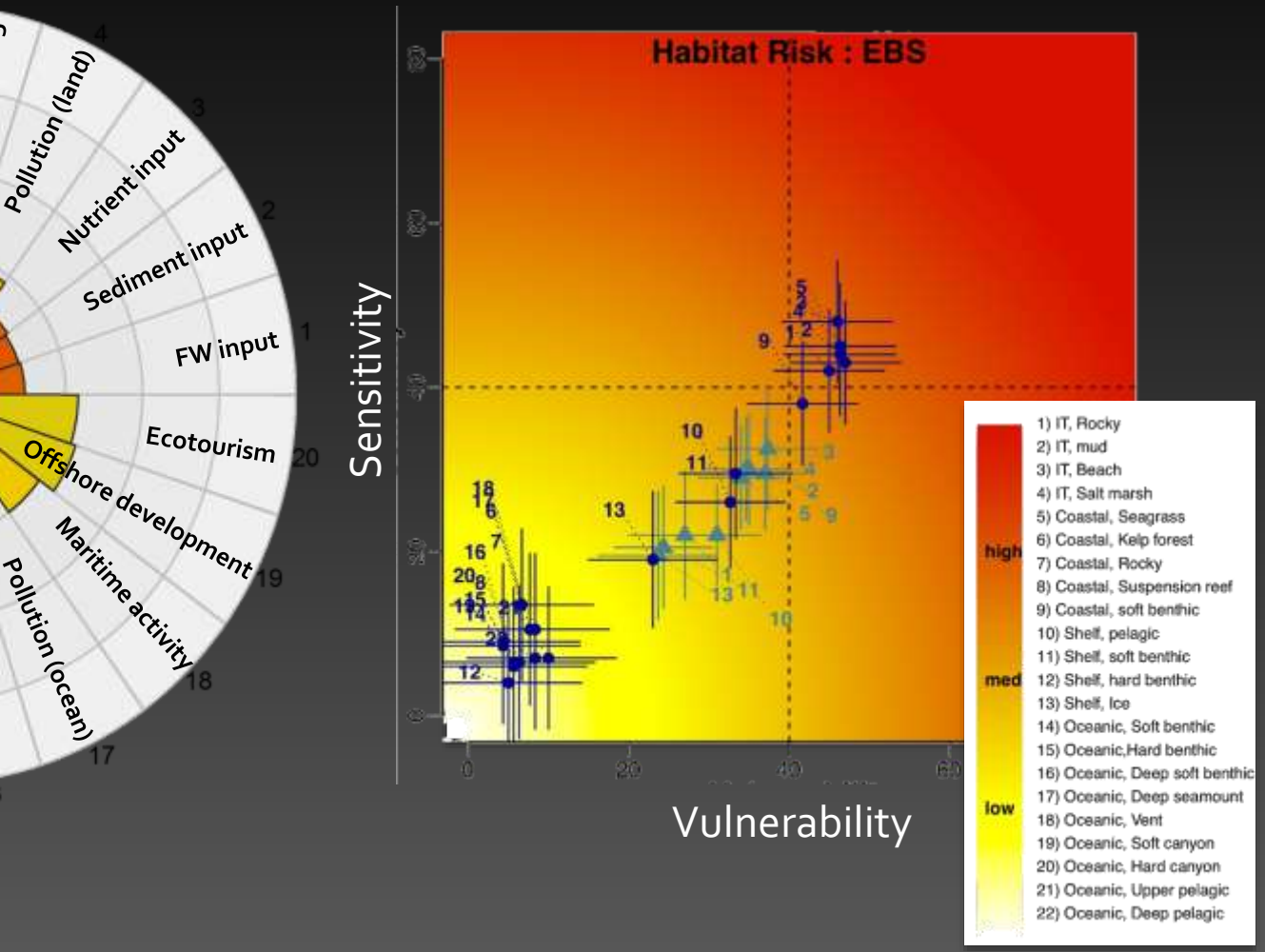
Figure 4-4 **Characterization of interactions in terms of probability of occurrence and a combined ecological multiplied by economic impact. Shaded area in upper right quadrant highlights those interactions with a medium to high probability of occurring and likely impact.**

Habitat

Ecosystem Index



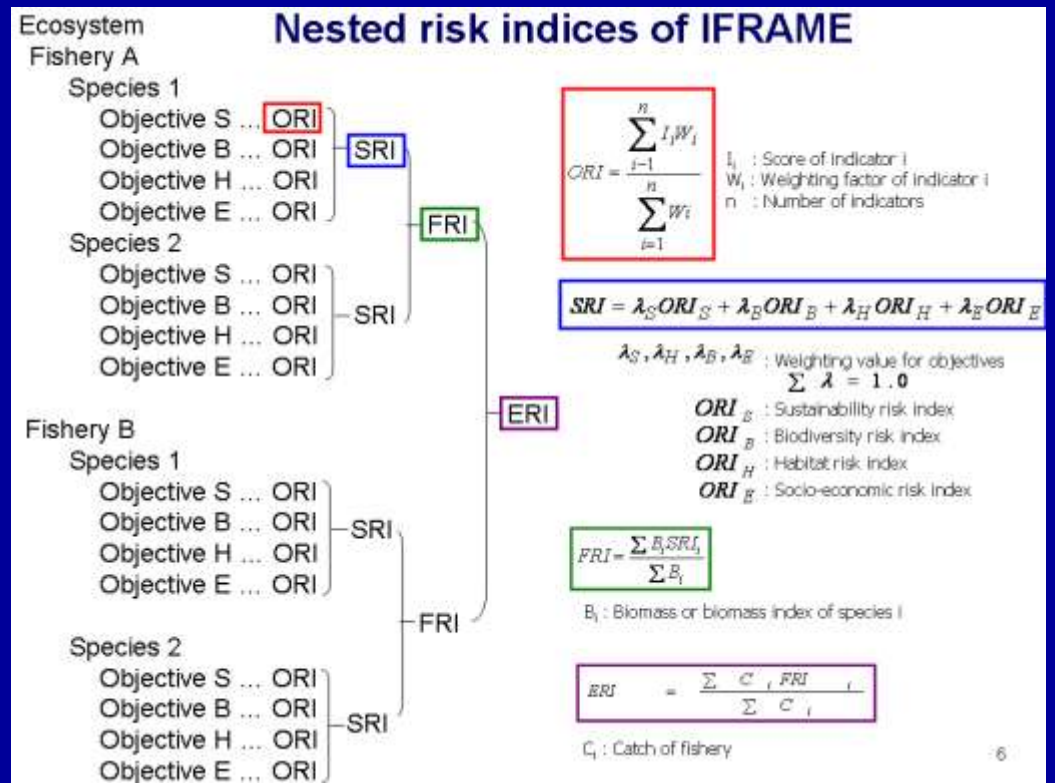
Habitat Risk



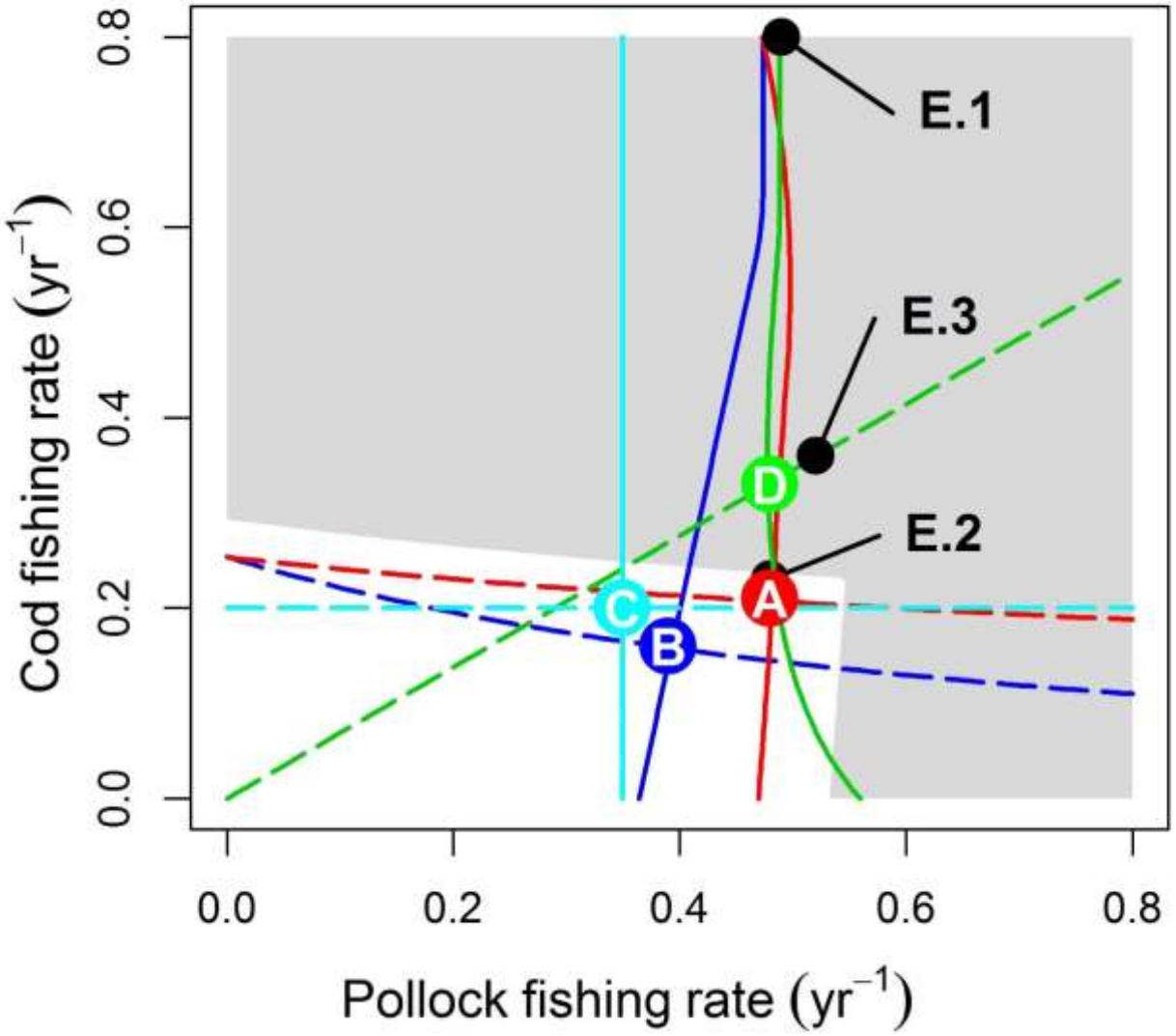
Goal: formal ecosystem thresholds

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

- Future development (e.g. through the Fisheries and the Environment (FATE) program):



Comparisons of reference points – management strategies



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).

- **STRENGTHS**
  - Tightly integrated with Council processes, strong relationship with stock assessments, bringing products by direct request to serve quota-setting and other agency analyses (NEPA, SSLs).

- **CHALLENGES**
  - Long-term funding stabilization (particularly for model upkeep)
  - Data limitations, especially in AI and Arctic
  - Thresholds require deeper ecosystem knowledge
  - Thresholds require substantial buy-in and mandates
  - EBFM versus EBM

- **SOLUTIONS**
  - IEA Program offers some possibilities of longer-term stabilization
  - Working especially with BASIS and FOCI programs to focus long-term collections based on specific analysis needs.
  - Particular emphasis on development testbeds (Management Strategy Analyses) and collaborative expert assessments (Ecosystem Assessment Process)
  - Maintaining strongly collaborative process with stakeholders via workshops, ongoing Council engagement, FEP process