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# The Future of Stock Assessment Improvements Theme VII

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# Opportunities

see supporting documentation

- ✓ Annual assessment cycle provides time for research.
- ✓ Regular reviews and full assessments identify issues or concerns as they emerge.
- ✓ Research outlets of program members are diverse providing opportunity for new synergies.
- ✓ NMFS- Sea Grant Population and Ecosystem Dynamics Fellowship provides opportunities for graduate students, Hollings scholarships provides opportunities for undergraduate students.
- ✓ NPFMC SSC and Plan Teams annually rank research priorities for NPRB. Aligns research with pressing needs.
- ✓ Funding and travel ceilings have, so far, have allowed most scientists to attend at least one professional meeting.
- ✓ Service as external reviewers exposes analysts to the strengths and weaknesses of alternative assessment approaches.



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## Track Record on Types of Models Explored

- ✓ Catch only
- ✓ Time series
- ✓ Statistical catch-at age models (including State-Space models)
- ✓ Integrated Analysis models with length-structured population dynamics
- ✓ Integrated age – structured population dynamics (special case = environmentally enhanced assessment models, EEMs)
- ✓ Minimally Realistic Models, Models of Intermediate Complexity for Ecosystem Assessments, Multispecies models.



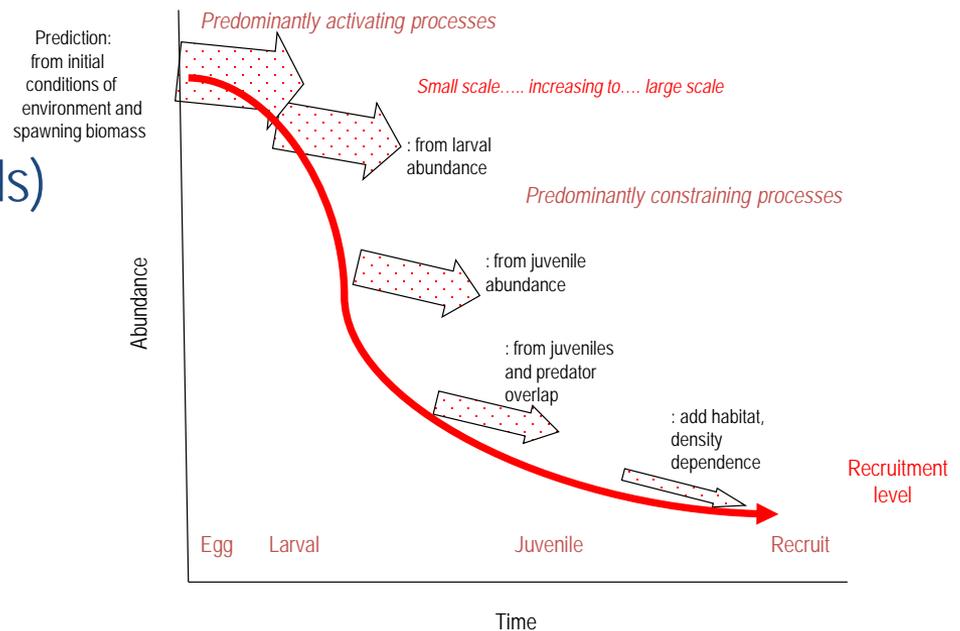
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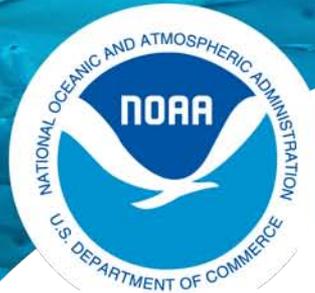
- ✓ Growth – bio-energetics
- ✓ Recruitment
- ✓ Catchability (non-trawlable grounds)
- ✓ Selectivity
- ✓ Natural mortality
- ✓ Bio-economic (fishers choice)
- ✓ Stock structure
- ✓ Maturity studies

# AFSC Research Aligned to Support Integrated Analysis Models (EEMs)

## Recruitment Processes Alliance

Scheme of Continuous Refinement of Recruitment Forecast





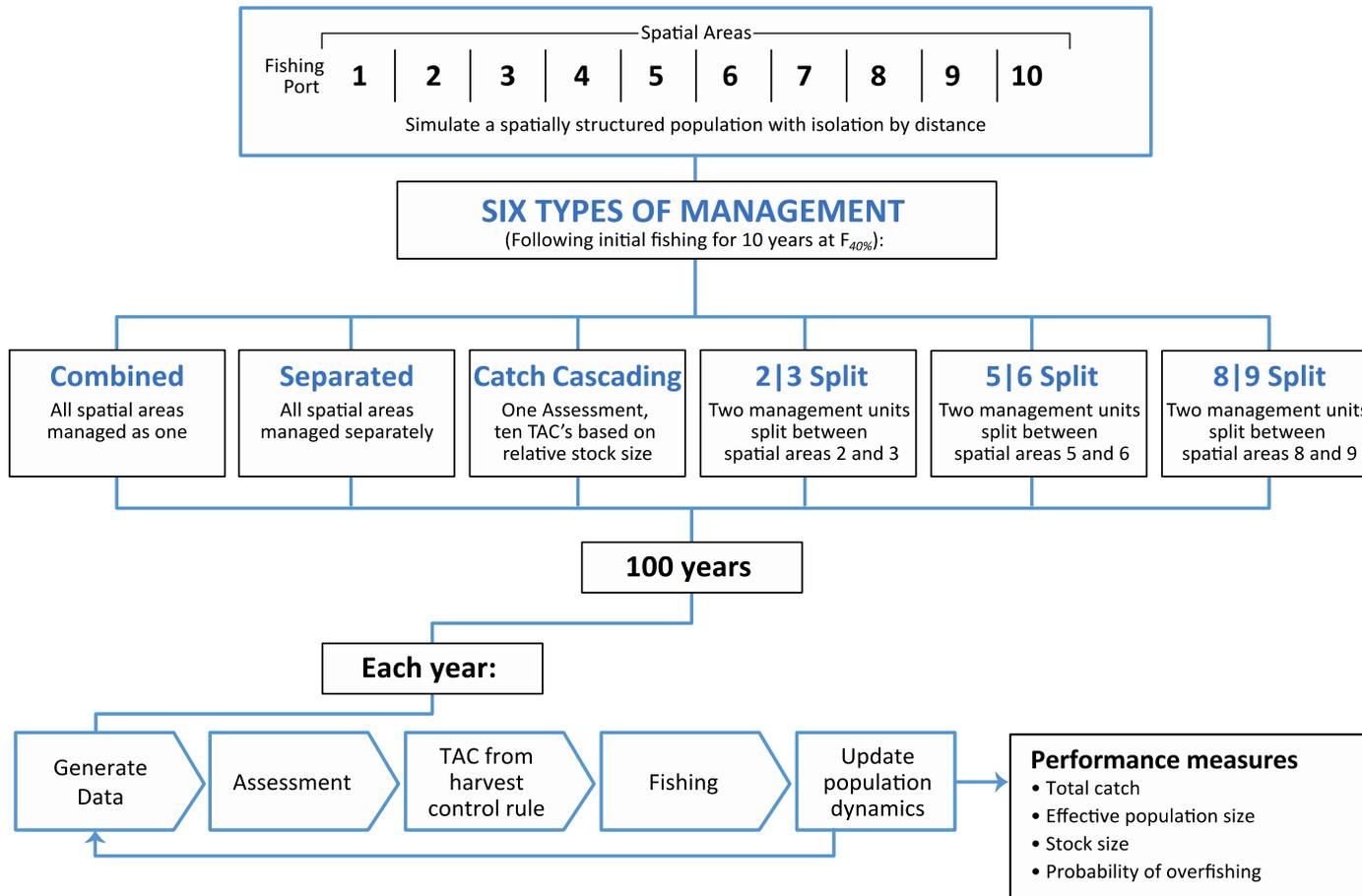
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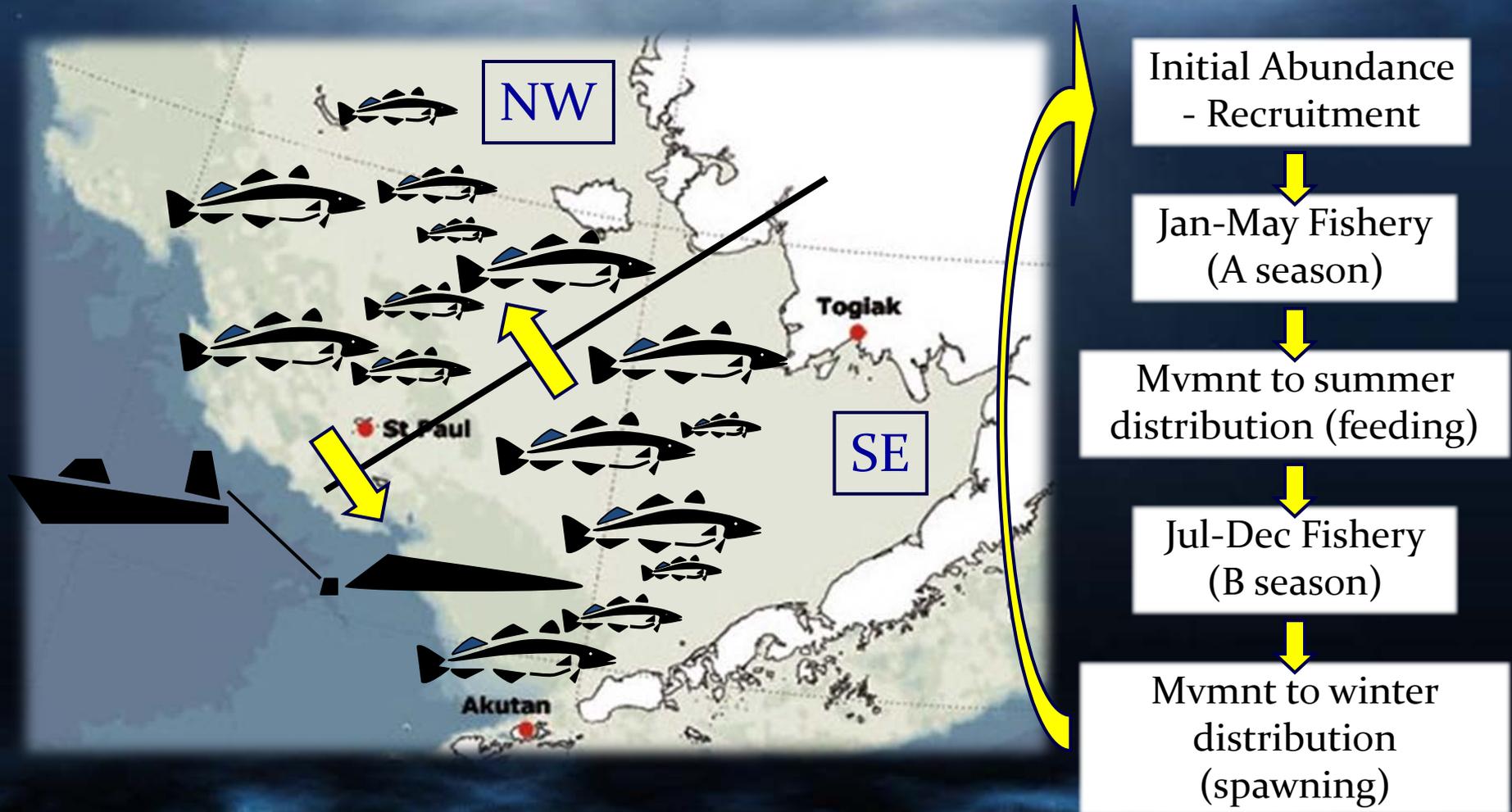
# Existing or Emerging Challenges

- Benchmarks for stock structure (Spies, Spencer)
- Understanding interactions with protected resources (Logerwell – FIT, Barbeaux)
- Multispecies benchmarks (Moffitt, Dorn)
- Prohibited species time/area/gear modifications (Ianelli)
- Bio-economic (fishers choice and demand) (Haynie)
- Comprehensive strategies for more efficient management (McGilliard, Ianelli, Punt, Hollowed, Thompson)
- Spatially explicit models for EBS (Hulson et al)
- Comprehensive strategies for adaptation to climate change (A'mar, Ianelli, Wilderbuer, Hollowed, Szuwalski and Turnock)
- Preparing for Arctic fisheries (Ormseth, Logerwell)

# Framework for simulation including the operating model, selection of management units, stock assessment, harvest control rule and performance measures (Spies Dissertation)

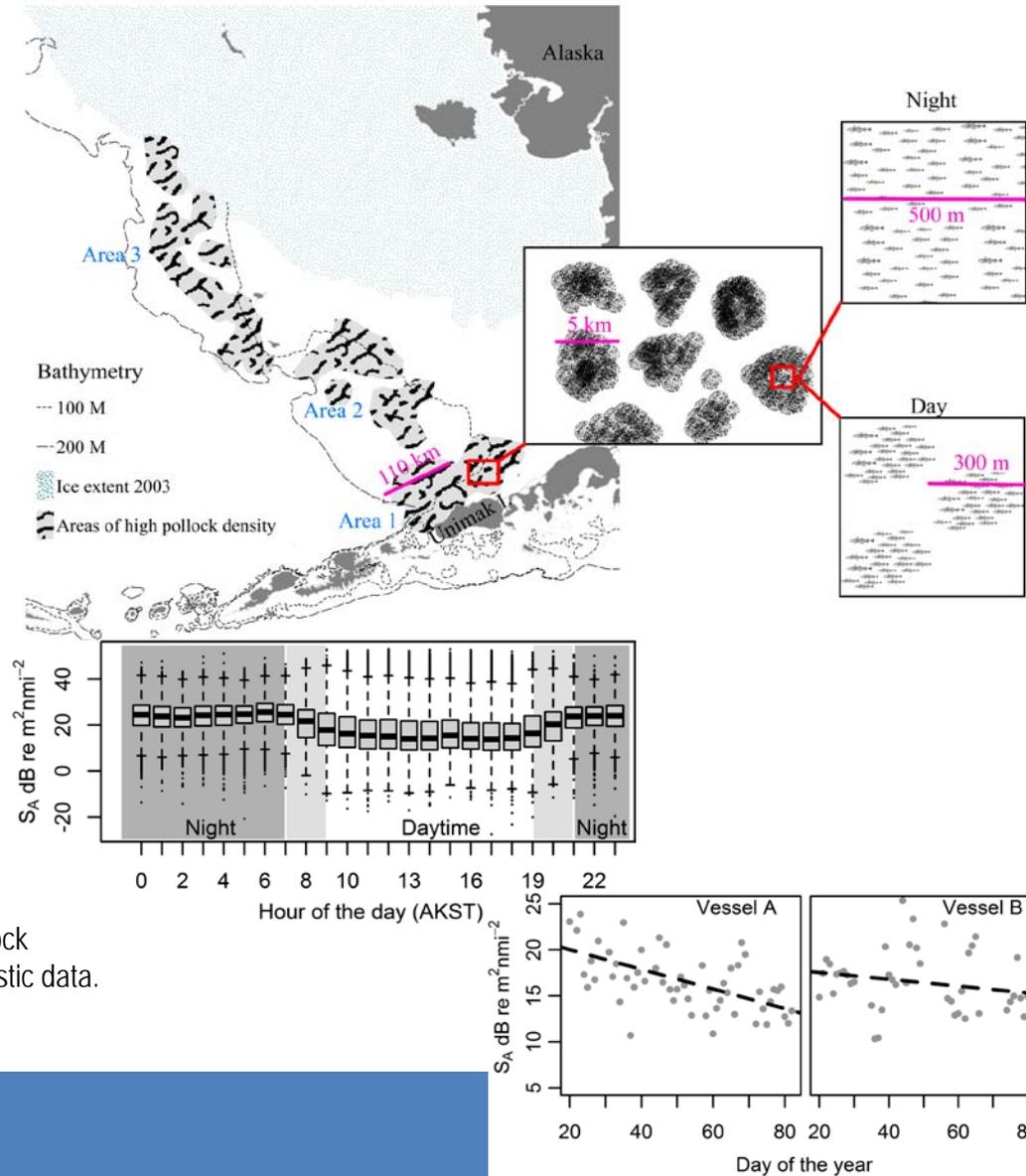


# Operating Model: 2 region – 2 season movement



# Evaluating spatial and temporal distributional trends in pollock aggregations\*

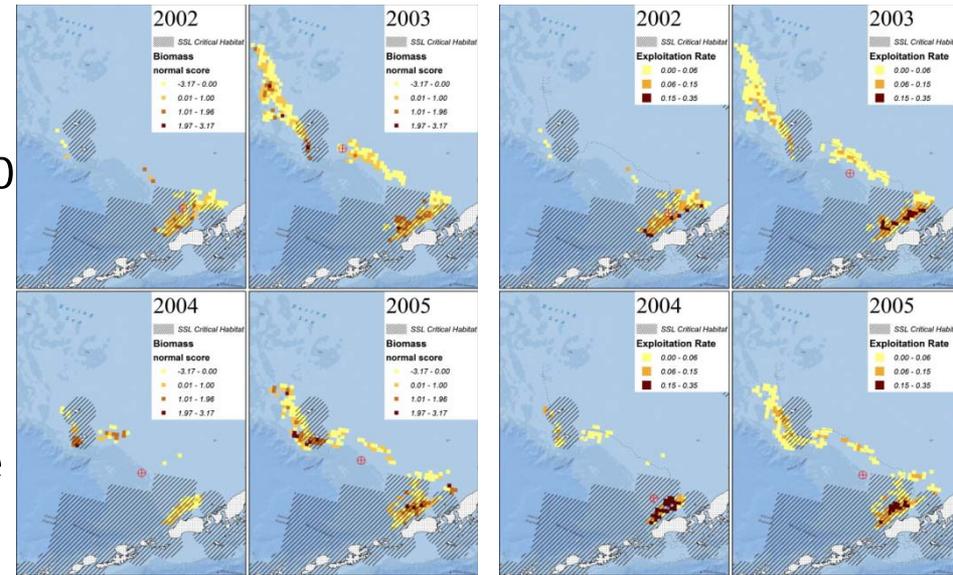
- Acoustic data collected from commercial fishing vessels were used to explore pollock spatial and temporal dynamics.
- Aggregations were found to have complex spatial structure with at least three levels of organization.
- Day and night distributions differed at small scales potentially masking fishing effects.
- A seasonal decline in pollock density was detected.



\*Barbeaux, S., J. Horne, and M. Dorn. 2013. Characterizing walleye pollock (*Theragra chalcogramma*) winter distribution from opportunistic acoustic data. ICES Journal of Marine Science. 70:1162-1173

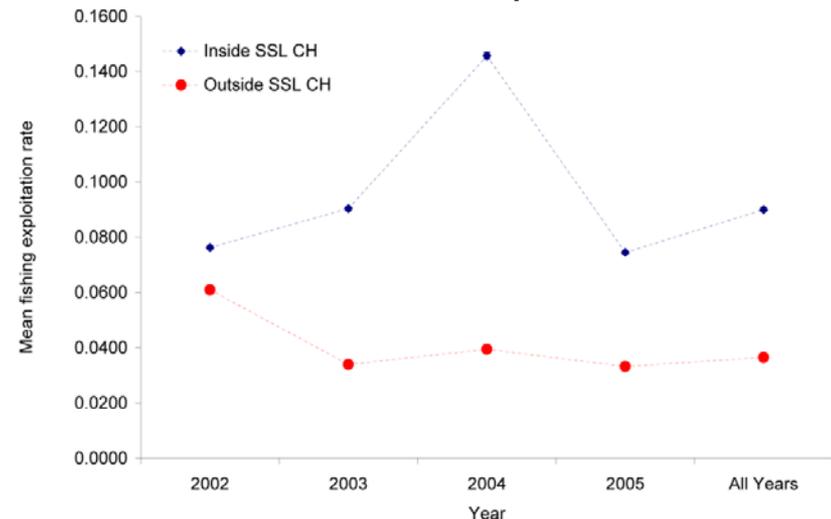
# Estimating location and scale specific fishing exploitation rates in the pollock fishery\*

- Depletion models fit to opportunistic acoustic and catch data were used to estimate pollock biomass across a range of spatial scales.
- At large scales exploitation rates were consistent with population-wide targets but at smaller scales rates varied relative to the target.
- In 2002 through 2005, exploitation rates within identified Steller sea lion (*Eumetopias jubatus*) critical habitat areas exceeded rates outside.



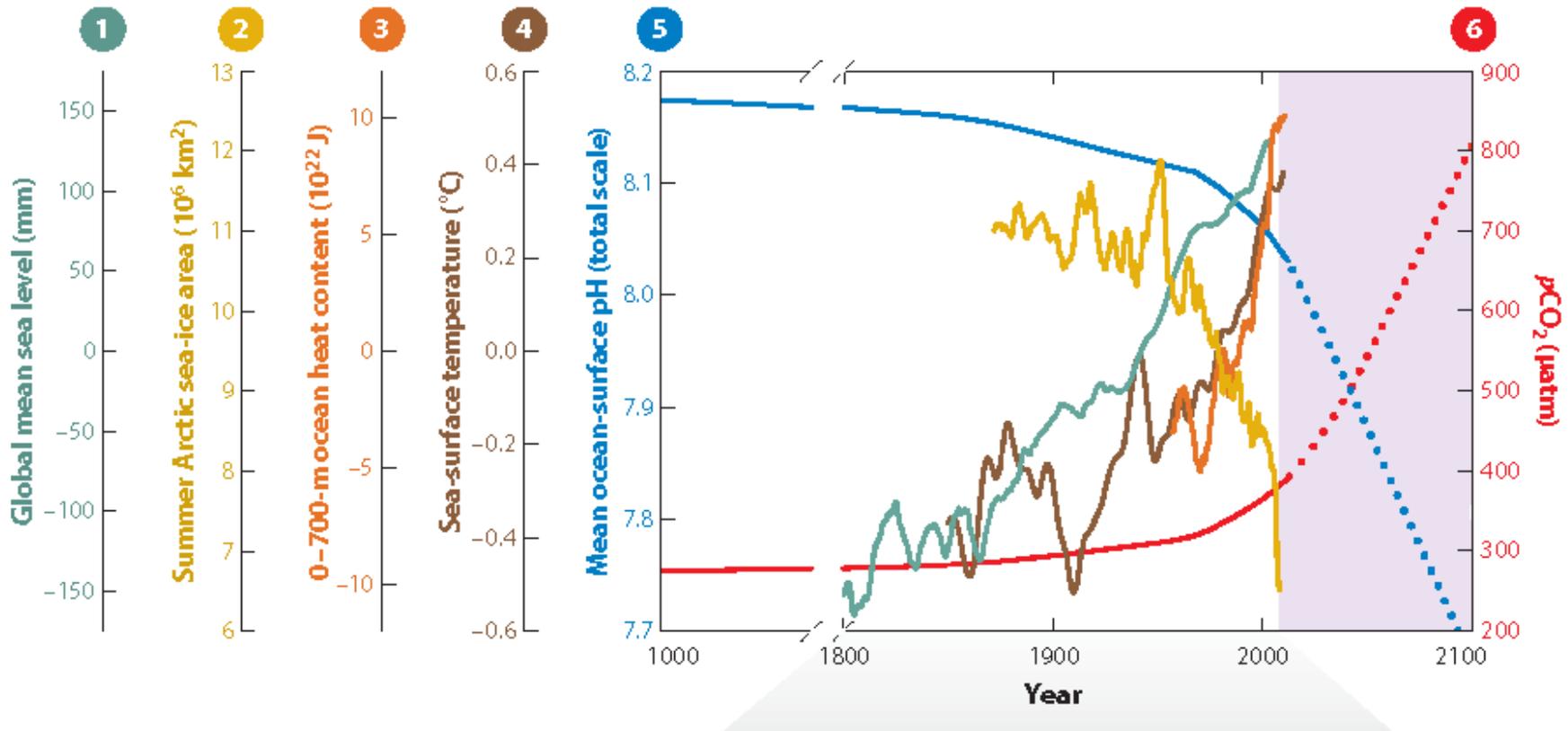
Biomass

Exploitation Rate



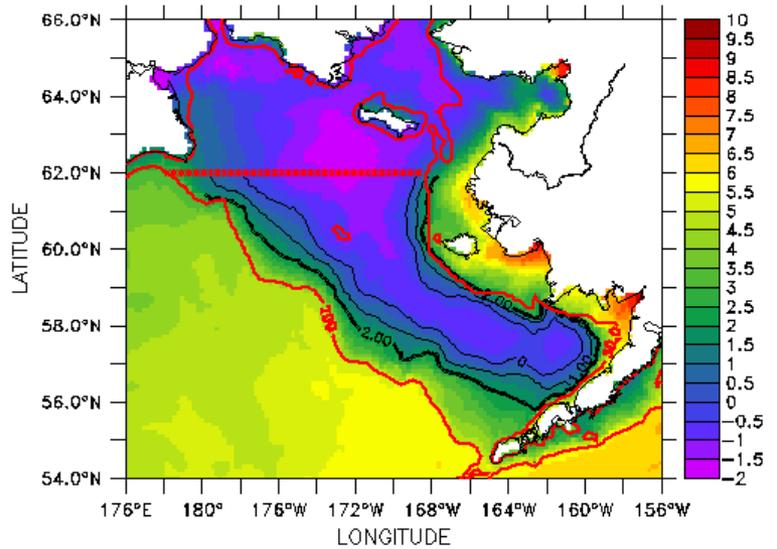
\*Barbeaux, S., J. Horne, and J. Ianelli. 2014. A novel approach for estimating location and scale specific fishing exploitation rates of eastern Bering Sea walleye pollock (*Theragra chalcogramma*). *Fisheries Research*. 153:69-82

# Physical Changes: Observations and projections

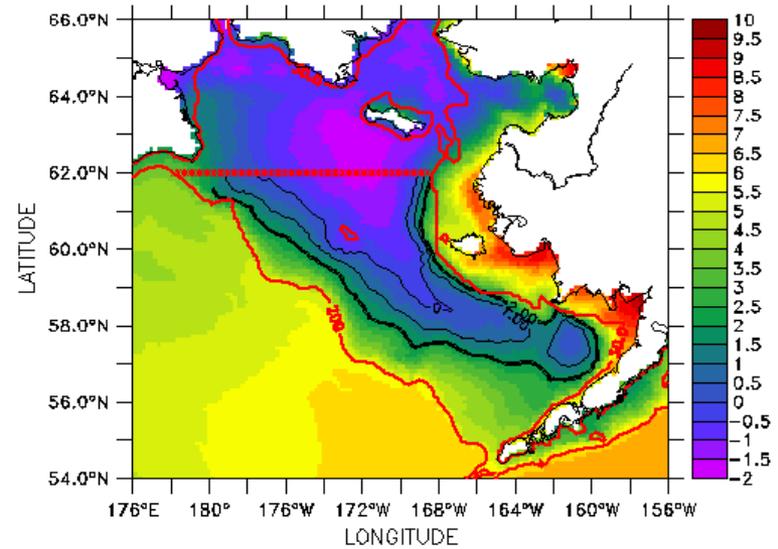


Changes in global mean sea level (teal line; Jevrejeva et al. 2008), summer Arctic sea-ice area (yellow line; Walsh & Chapman 2001), 0-700-m ocean heat content (orange line; Levitus et al. 2009), sea-surface temperature (brown line; Rayner et al. 2006), mean ocean-surface pH (blue line; Natl. Res. Council. 2010), and  $p\text{CO}_2$  (red line; Petit et al. 1999). Light purple shaded region denotes projected changes in pH and  $p\text{CO}_2$  consistent with the Intergovernmental Panel on Climate Change's twenty-first-century A2 emissions scenario with rapid population growth.

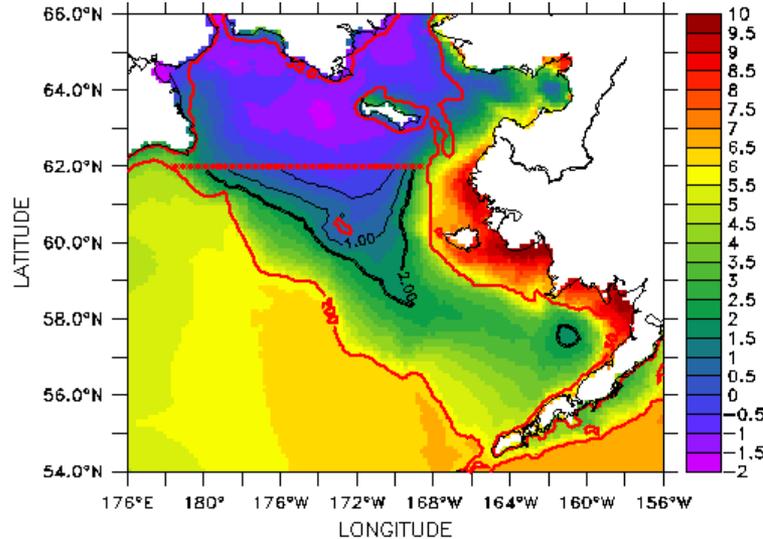
# Projected EBS July bottom temperatures in SE Bering Sea (Al Hermann JISA0)



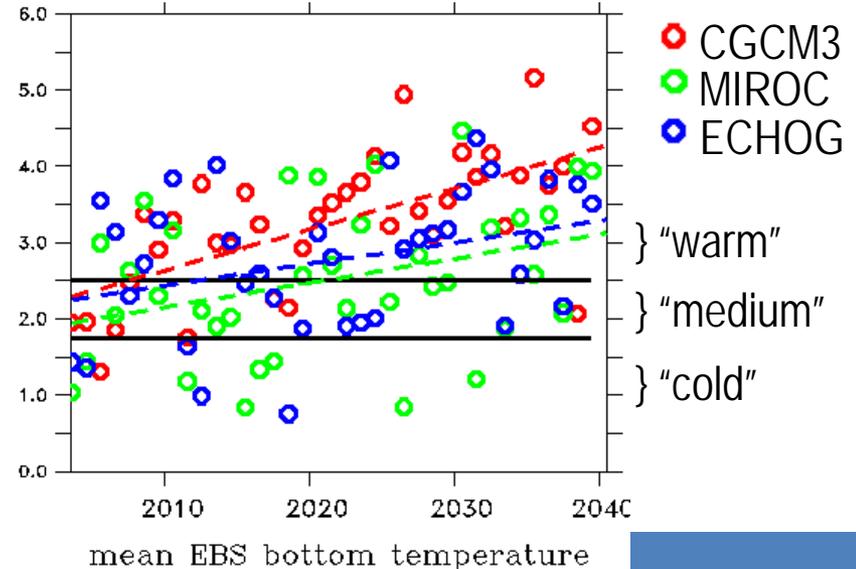
ensemble ave cold year



ensemble ave medium year



ensemble ave warm year



# Detecting temporal trends and environmentally-driven changes in the spatial distribution of bottom fishes and crabs on the eastern Bering Sea shelf.

Stan Kotwicki and Robert R. Lauth  
2013, DSR II 94:231-243

Data: Eastern Bering Sea (EBS) bottom trawl survey 1982 – 2011

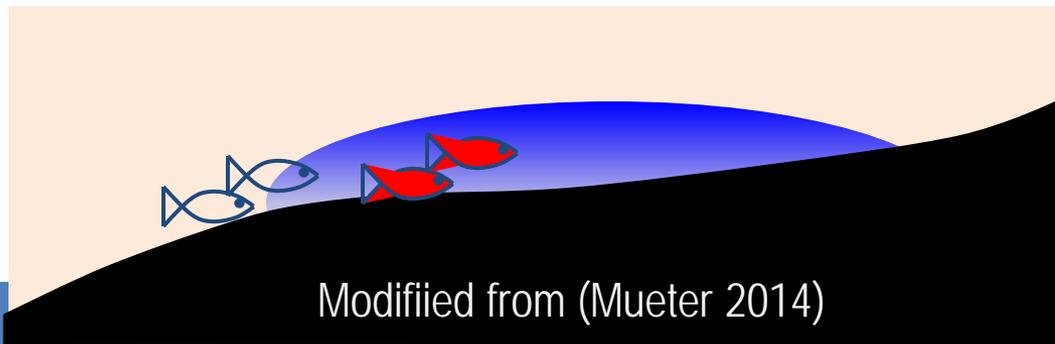
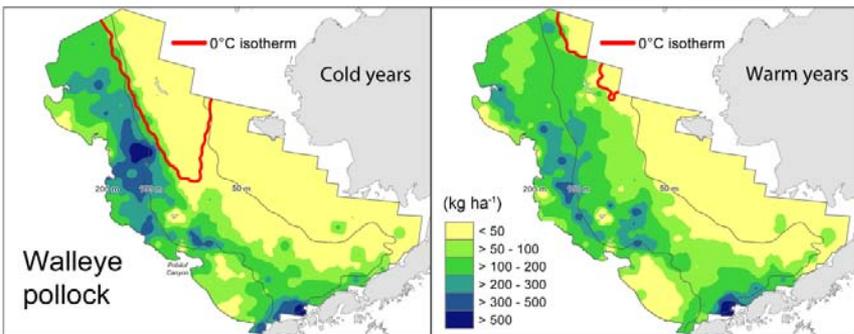
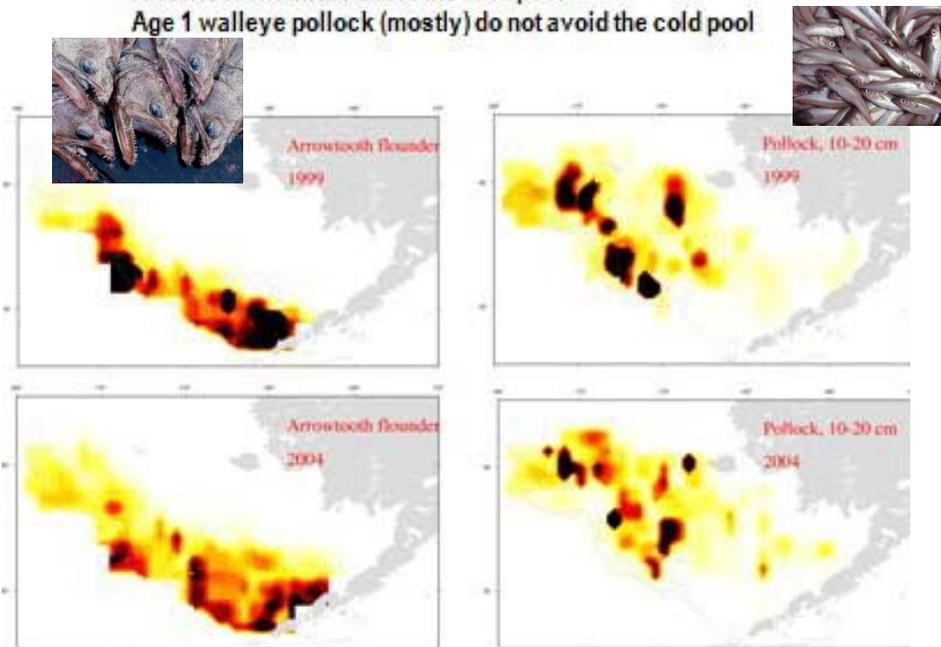
Tested effects of time lag, population abundance and cold pool area using three isothermal boundaries - 0°, 1°, and 2°C.



Juvenile and Adult Pollock

Spencer, Bond, Holsman and Hollowed

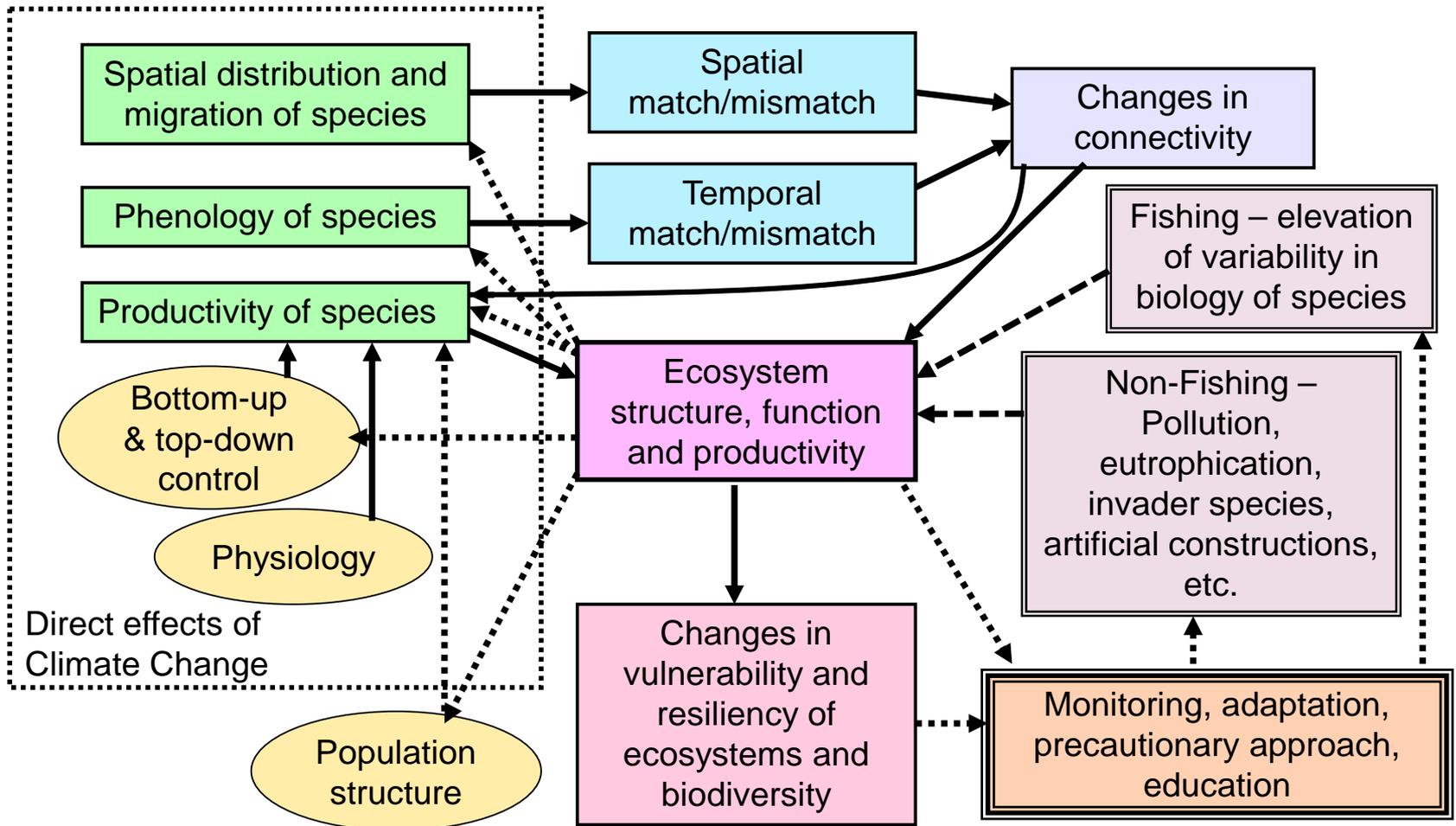
Arrowtooth flounder avoid the cold pool  
Age 1 walleye pollock (mostly) do not avoid the cold pool



Modified from (Mueter 2014)

**EAM challenges NMFS to disentangle the effects of fishing, climate, environmental variability, and anthropogenic stress to build sustainable fisheries.**

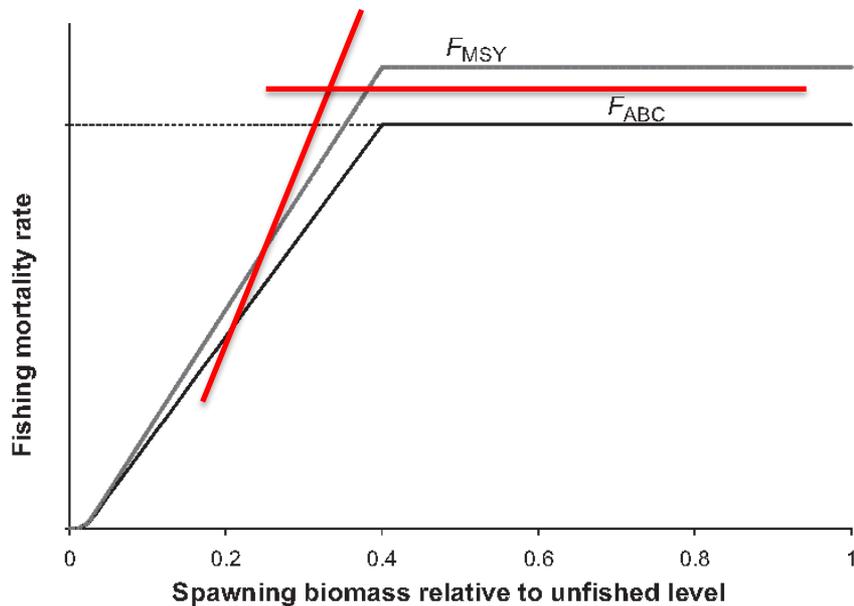
Conceptual pathways of direct and indirect effect of climate on marine ecosystems and their implication to adaptation and management



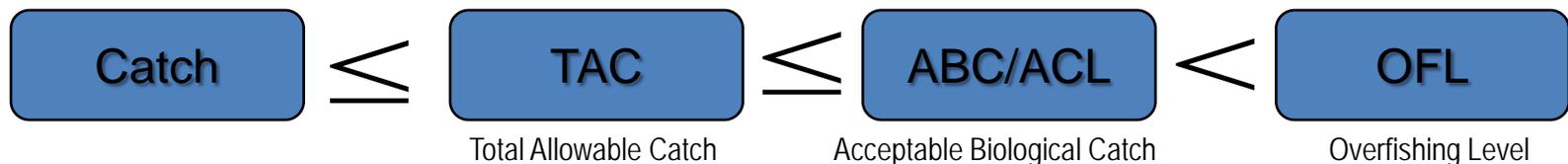
# Engineering Option: Change Fishing Strategy

*“modifying management strategies to include environmental factors seldom improves the ability to achieve management goals unless the system is well known.” Punt et al. 2013*

Schematic of Harvest Control Rule



- Atl. 1: Adjust control rules to maintain historical Bmsy
- Alt 2: Account for climate impact on growth, maturation schedule, M, fishery selectivity
- Alt 3: Adopt steeper control rule to create a larger no fishing buffer.
- Alt 4: Adopt larger buffer between OFL and ABC to account for increased uncertainty due to climate change



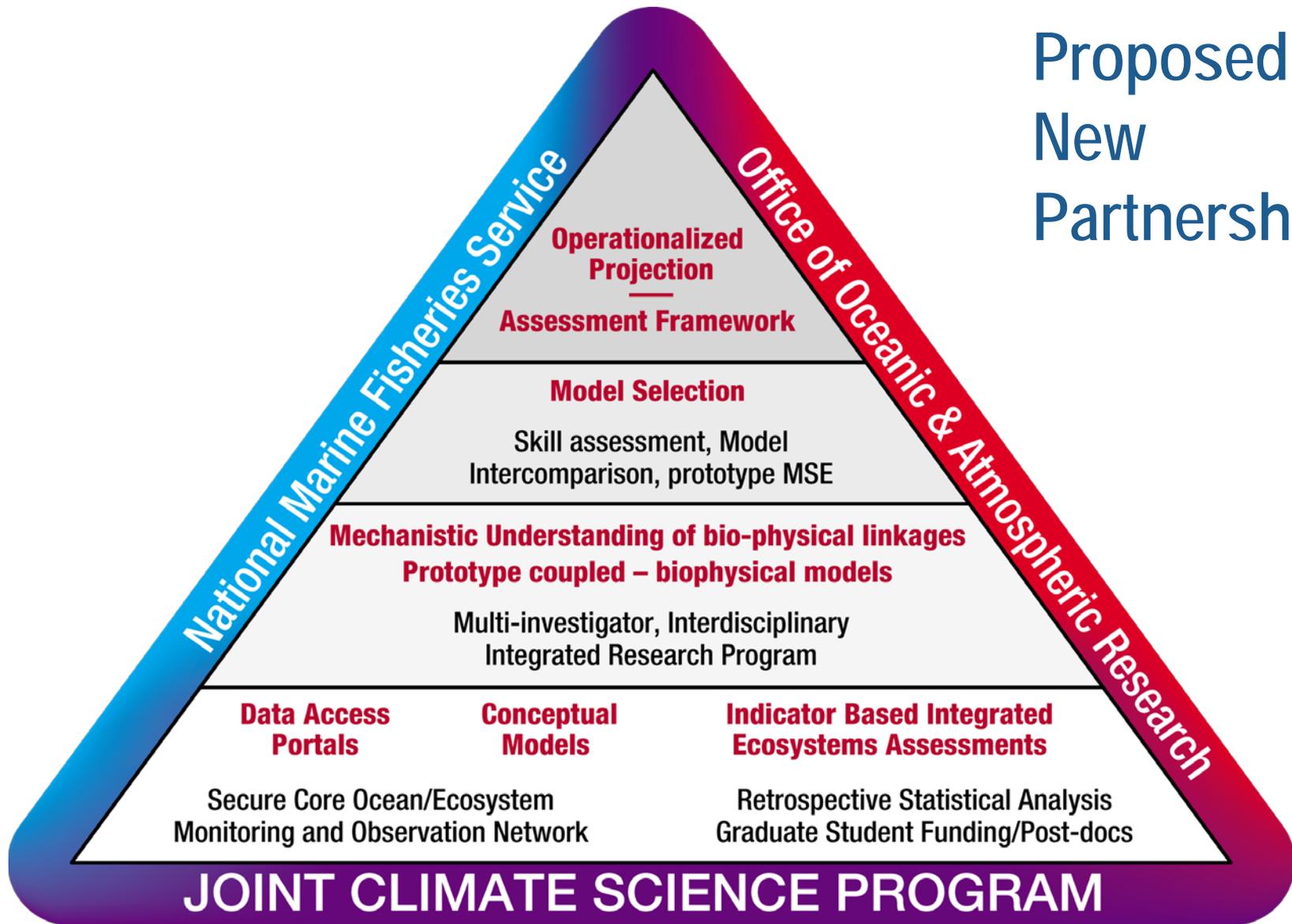


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# Are NPFMC's EAM Strategies Robust to Climate Change?

1. Shifts in distribution – catchability/selectivity adjustments required; marine spatial planning and agreements for transboundary stocks will be problematic
2. Shift in abundance – Current rules should work if effects on growth, maturation schedule, selectivity and stock structure known
3. Shifts in phenology – Fishing seasons could change, especially for roe fisheries
4. System level caps and allocation scheme will require major overhaul which will disrupt catch shares
5. Prohibited species caps – salmon, halibut and crab bycatch limits may become an issue
6. Protected resources – ST albatross and marine mammals ???

# Proposed New Partnership



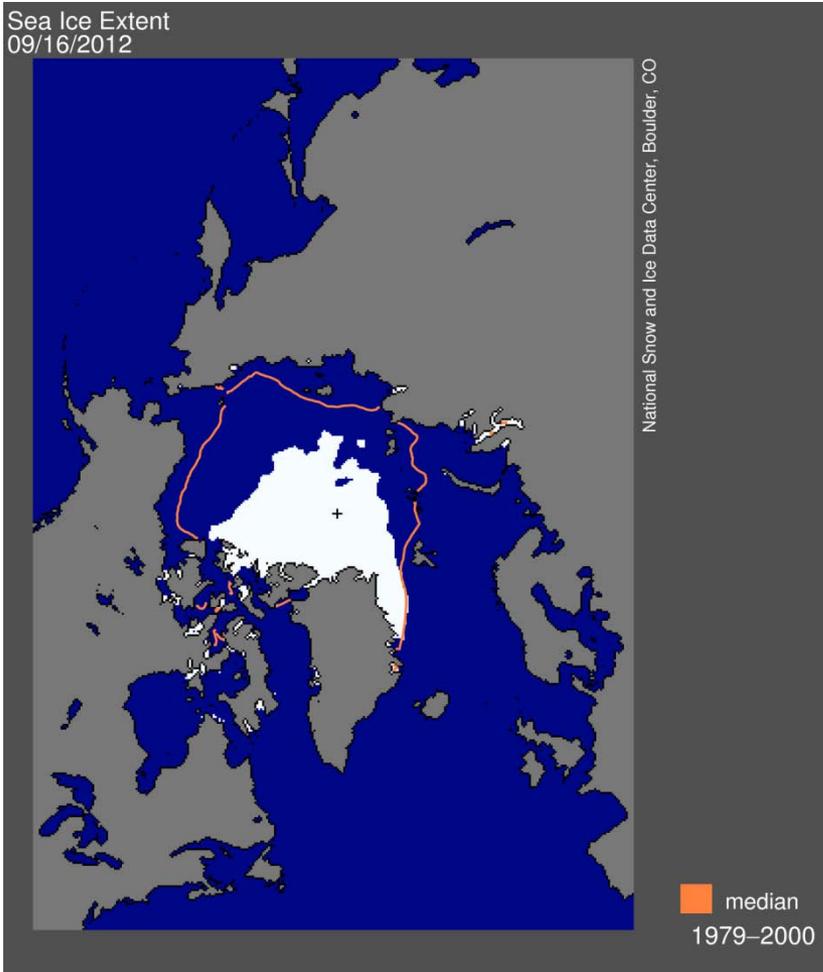
Deliverables listed in **RED**

Funding request listed in **BLACK**



# Record Low Sea Ice Extent in September, 2012

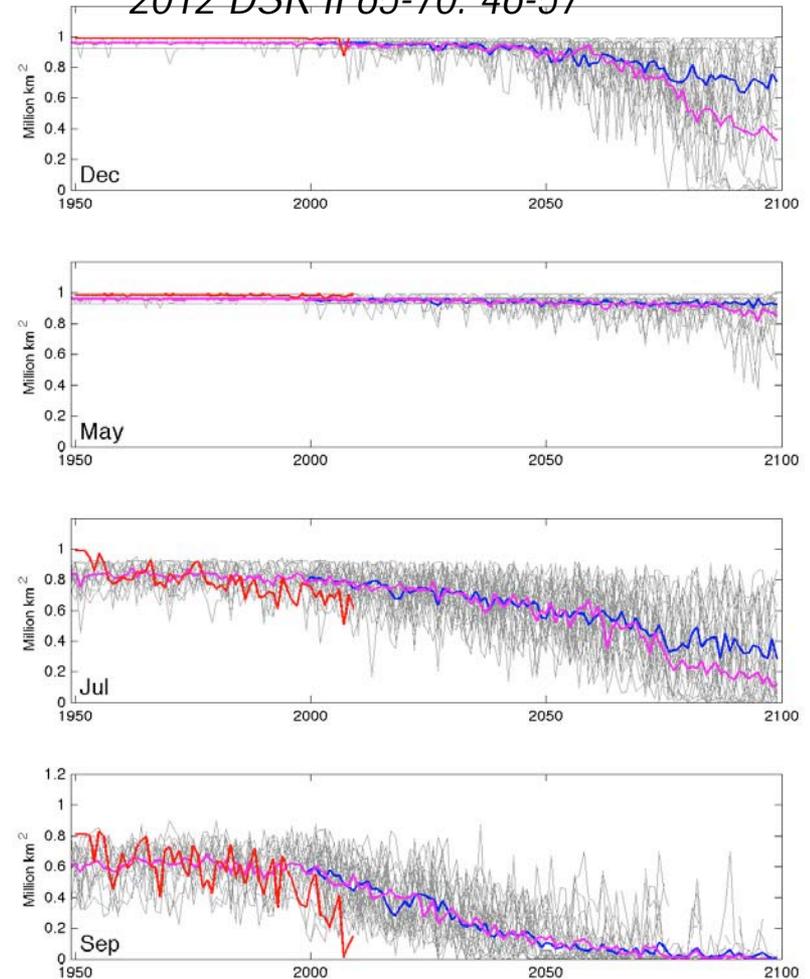
Source: National Snow and Ice Data Center,



From <http://nsidc.org/>

## Projected Seasonal – Sea Ice Extent Over Chukchi Sea

Wang, Overland and Stabeno  
2012 DSR II 65-70: 46-57



Red – Observed; Blue – Ensemble means under A1B scenario  
Pink – Ensemble mean under A2 scenario  
Gray curve – one realization of one model

# AFSC's Loss of Sea Ice Program

- MSE for OA impacts on crab, pollock, shellfish (Dalton, Foy and Turnock)
- Vulnerability Analysis (Hollowed, Spencer)
- Protected species Biological Review Teams (Logerwell)
- Baseline Census (BOEM) (Logerwell)
- International Arctic Fisheries Science (Hollowed, Logerwell)
- NPFMC FMP (Ormseth)



# Strengths

- Staff are aware of, and utilize, diverse modeling approaches.
- Research leads to innovation and publications.
- Stock assessment scientists are well integrated into planning and implementation of process oriented research.
- AFSC supports fisheries oceanography and food habits programs to understand impacts of fishing and environment on adult, juvenile and early life stages.
- Stock assessment scientists have a strong track record of mentoring students.
- NPFMC and AFSC scientists collaborate in applied science planning (field and laboratory research).
- NPRB provides opportunities for applied science.
- NMFS- Sea Grant Population and Ecosystem Dynamics Fellowship provides opportunities for students.
- NOAA science programs (FATE, AMWG, ASTWG and Cooperative Research) align academic scientists with stock assessment scientists.



# Challenges

- Only soft money available for studies of catchability, selectivity, growth, maturity, and life history.
- Funding for large integrated research programs provides insights but NOAA can seldom maintain core observations after program is completed.
- Impact analyses require reasonable suite of future management actions. Industry response horizons are uncertain.
- Funding for NSAW disappeared – new focus targets narrow subject matter which limits participation.
- Funding for internal graduate student stipends and interns has been reduced or eliminated.
- Climate change modeling will require development of modeling platforms that extend beyond current LMES. This will require coordination between regions.
- Estimating equilibrium states for use in setting biological reference point be difficult in a changing climate.



# Solutions

- Restore funding for NSAW – or hold annual meeting of funded AMWG PIs (as FATE does).
- Establish funding for OAR-NMFS partnership to maintain observations.
- Restore stock assessment stipends.
- Establish dedicated maturity laboratory and initiate on-going observation and analysis program.
- Conduct stock assessment surveys in the High Arctic, in response to specific requests from BOEM, the North Pacific Fishery Management Council, or NOAA HQ to support future Arctic stock assessment, and vulnerability analyses to inform management in future.
- Establish sabbaticals for core scientists.
- Fund annual applied research retreat.
- Establish international modeling networks to align research with IPCC

