



**NOAA  
FISHERIES**

# Ichthyoplankton as an Approach to Tiered Fishery Management across Large Marine Ecosystems

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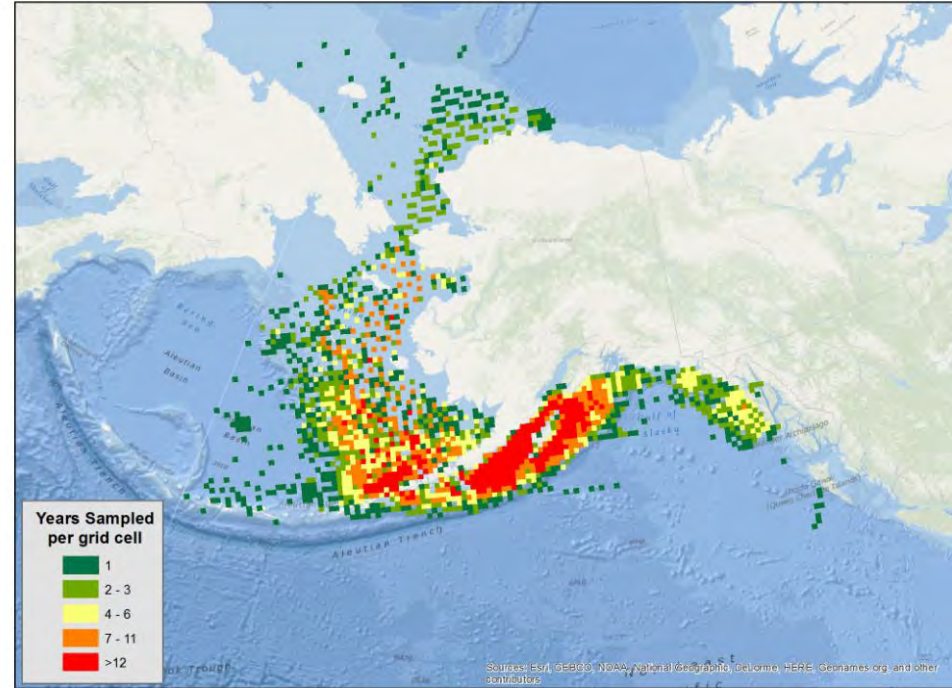
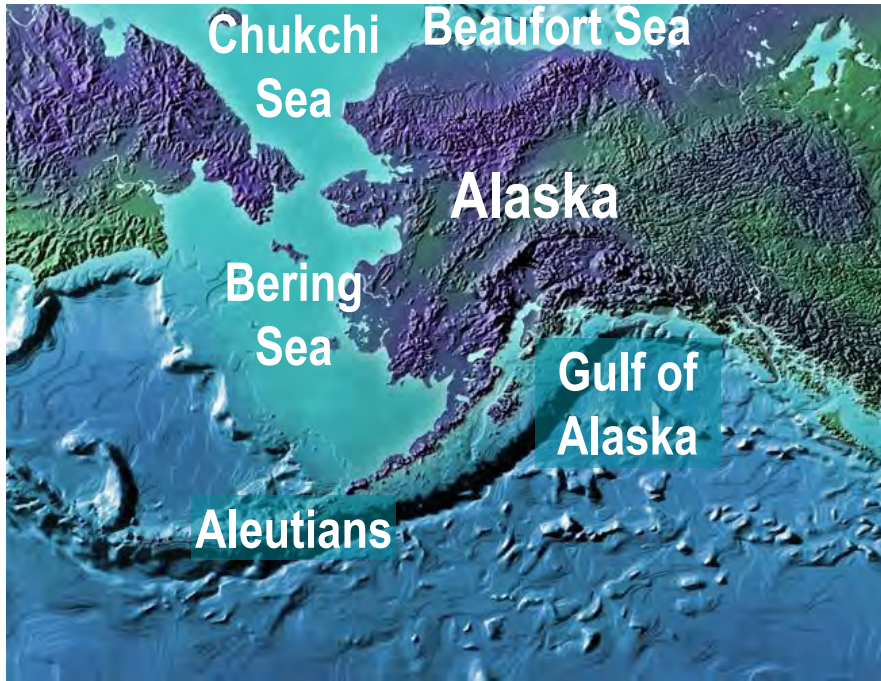
# Management Goal: maintain sustainability of marine fisheries, their habitats, interactions, and ecosystems





What input is sought?

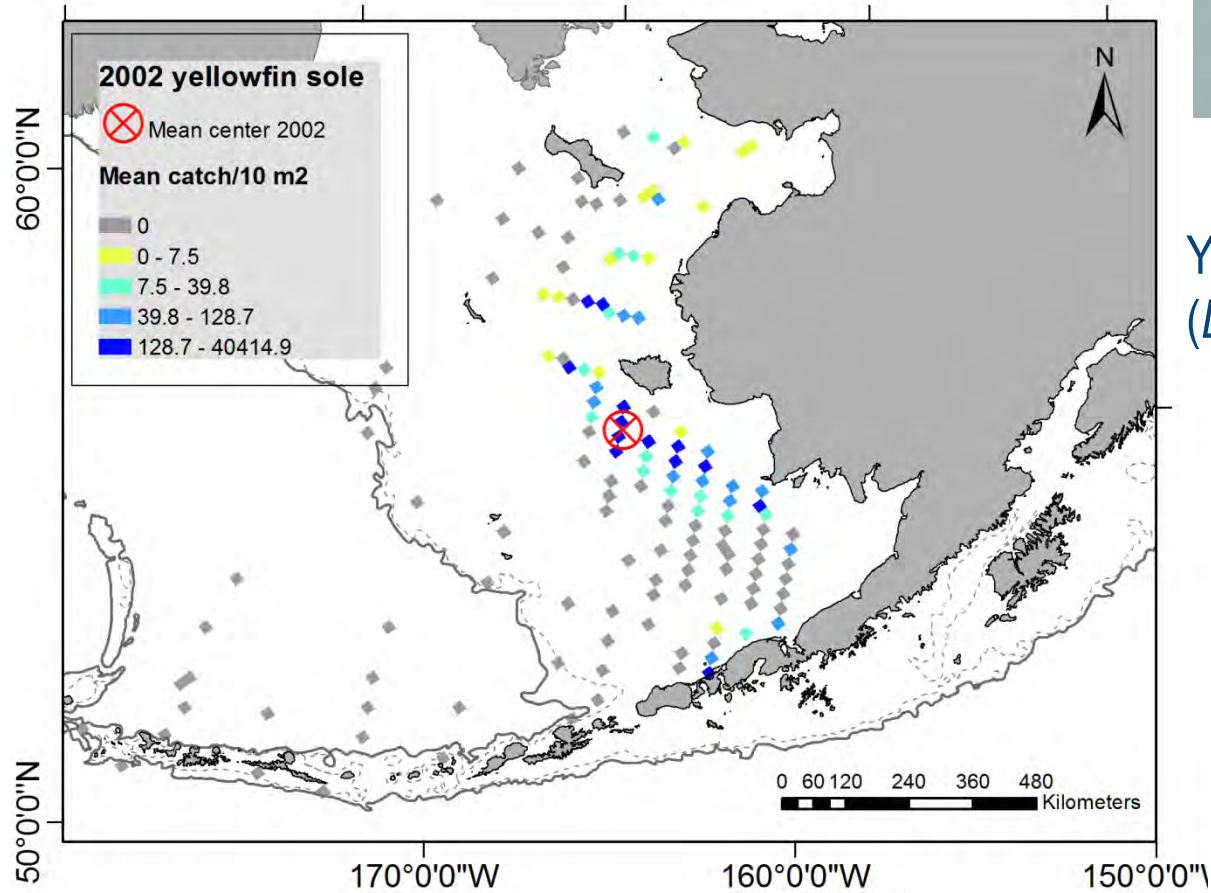
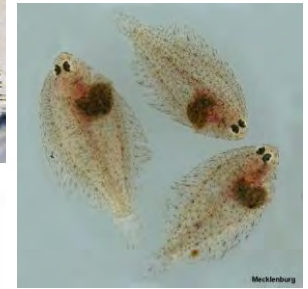
1. Stock status
2. Spawning biomass
3. Phenology
4. Spatial shifts

# Alaska marine ecosystems as a model



Levels	Scientific Advice	Management Framework
	<p>Abundance estimates of larvae provide key indicators of spawning stock health and production of young</p> <p>Production hotspots, identifying spawning grounds that may need protection</p> <p>Colonization and range shifts</p>	
<p><b>SS</b> Single Species</p>		

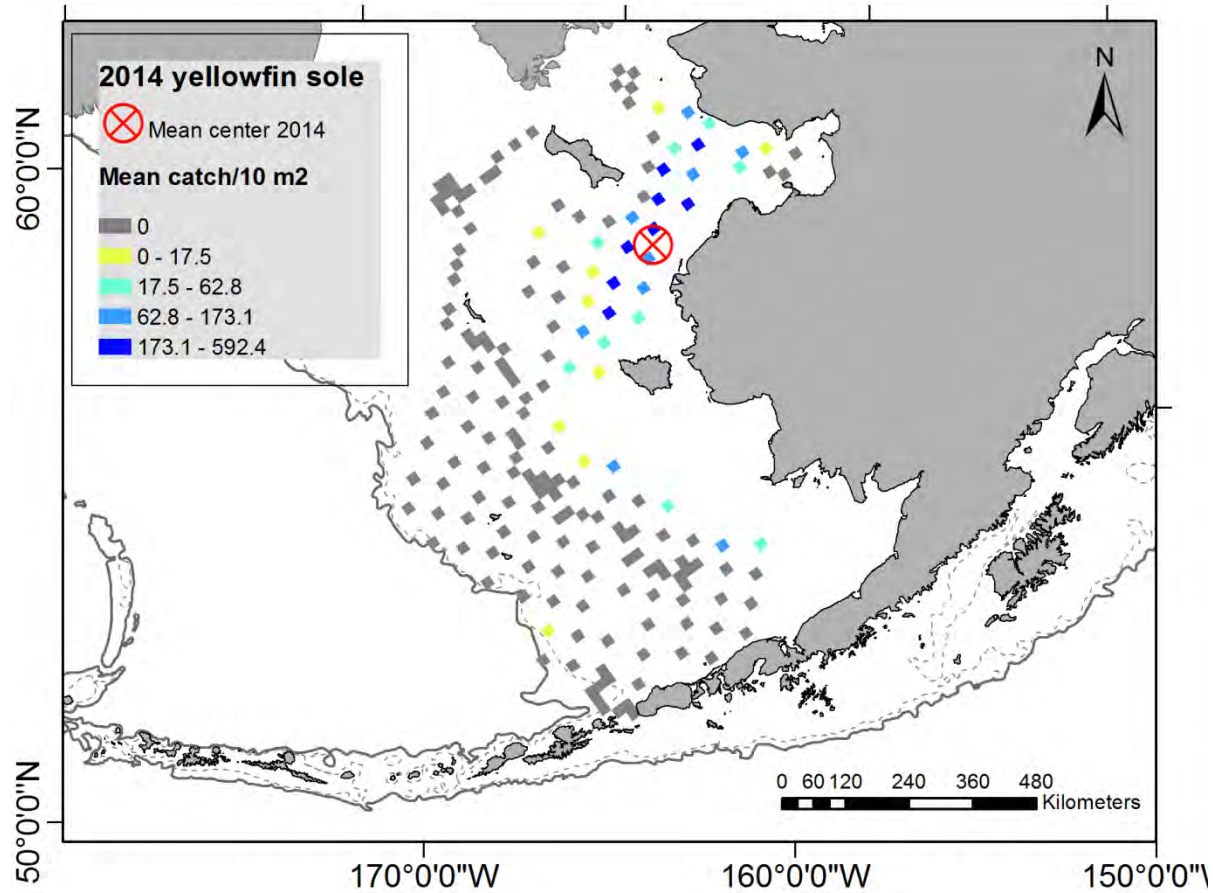
# Single species



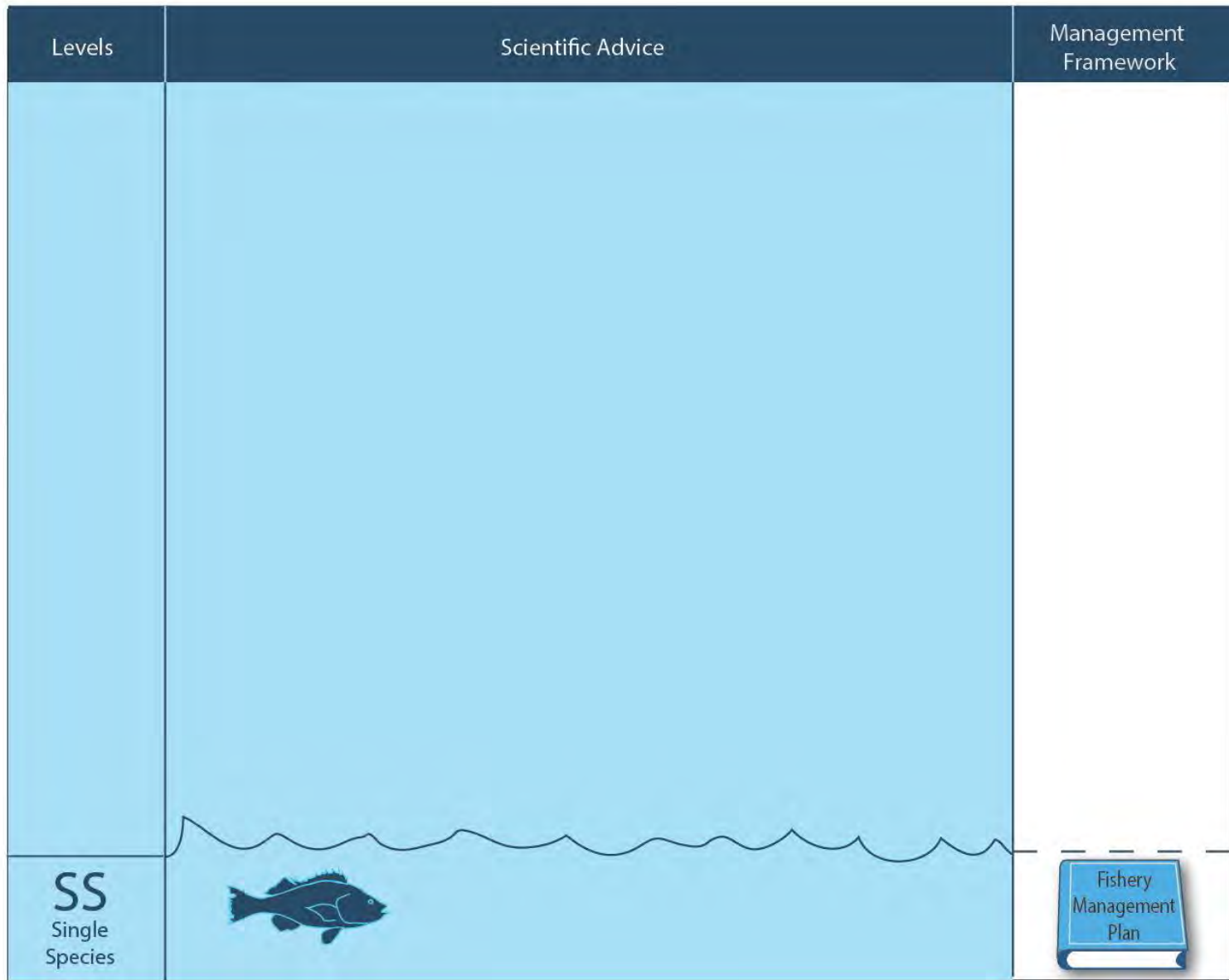
Yellowfin sole  
(*Limanda aspera*)





Goldstein et al. in progress

# Single species



Goldstein et al. in progress

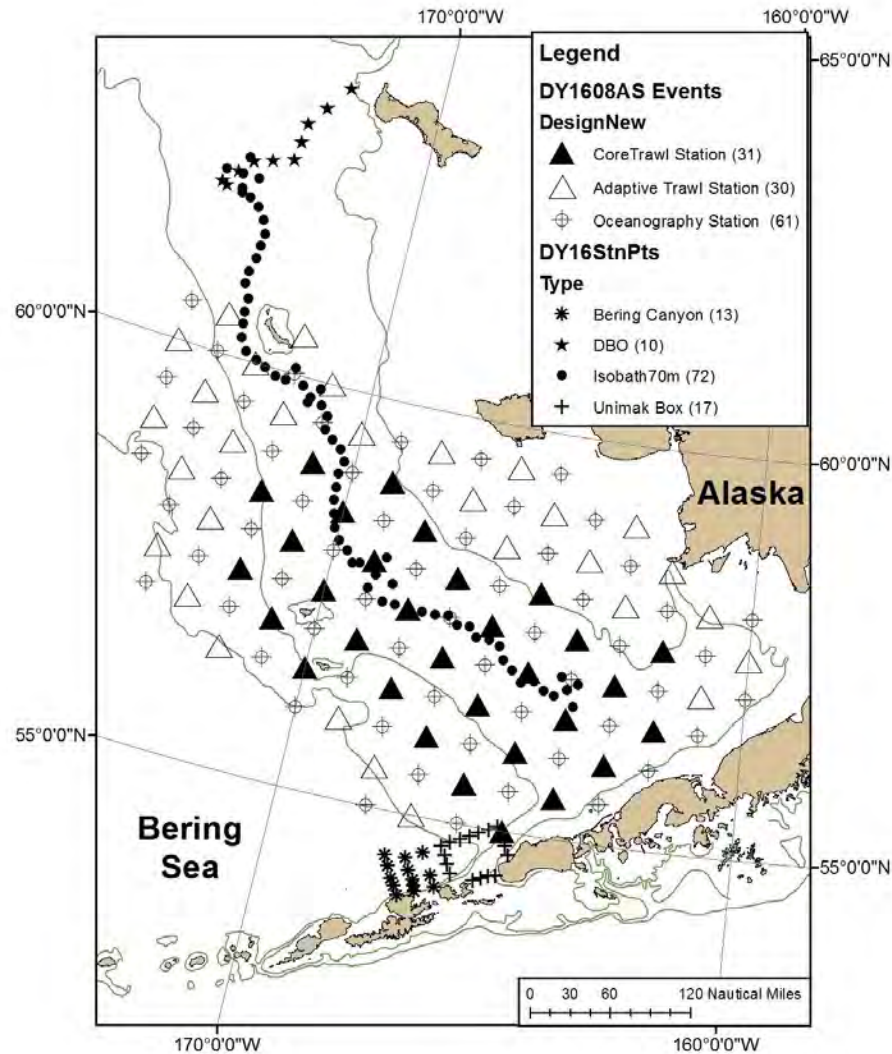


Levels	Scientific Advice	Management Framework
<p>Production of young in response to environmental variability</p> <p>Trophic interactions and trade offs</p> <p>Improved recruitment forecasting in response to regime shifts</p>		
<p><b>EAFM</b> Ecosystem Approach to Fisheries Management</p>	 <p>The diagram illustrates the Ecosystem Approach to Fisheries Management (EAFM) with four circular icons: a fish, a sun and cloud representing climate, a fish in a tank with seaweed representing habitat, and a predator fish.</p>	 <p>Fishery Management Plan</p>
<p><b>SS</b> Single Species</p>	 <p>The diagram illustrates the Single Species (SS) approach with a single fish icon.</p>	 <p>Fishery Management Plan</p>



# Ecosystem Approach to Fisheries Management

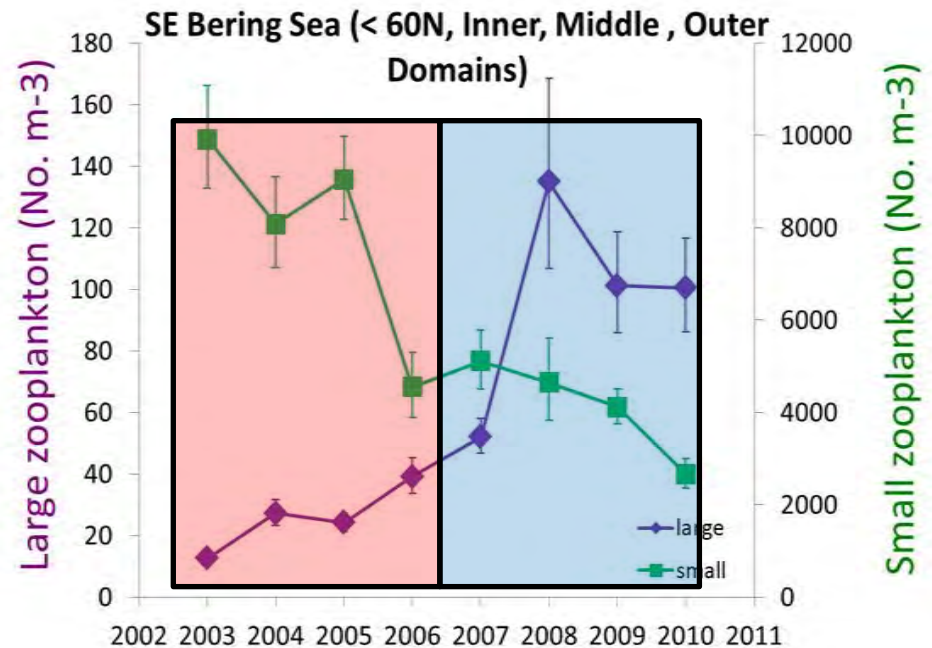
Walleye pollock (*Gadus c*)



# Ecosystem Approach to Fisheries Management

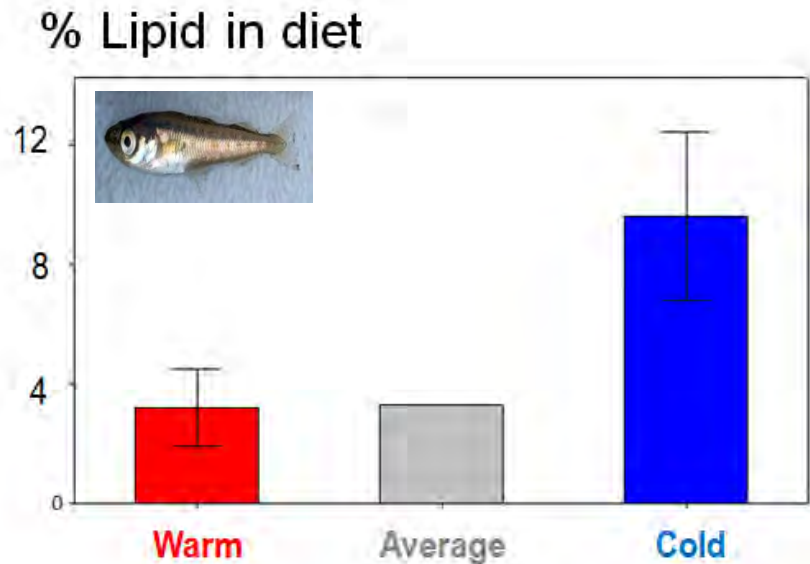


SeaWiFS

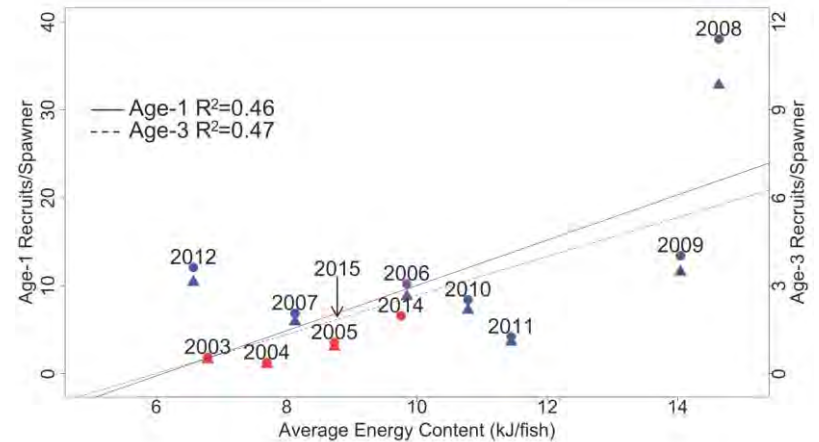
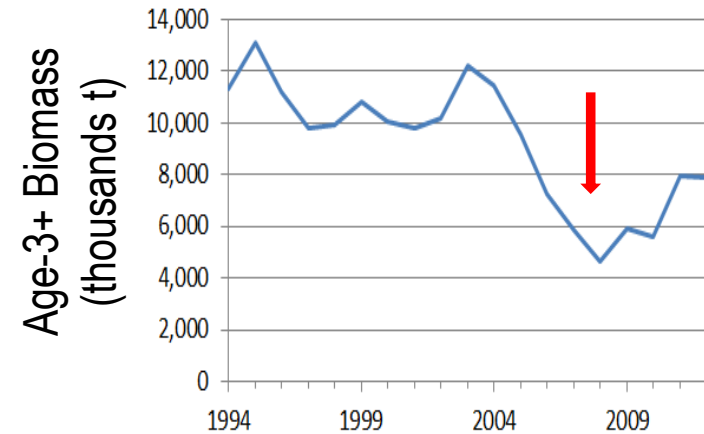


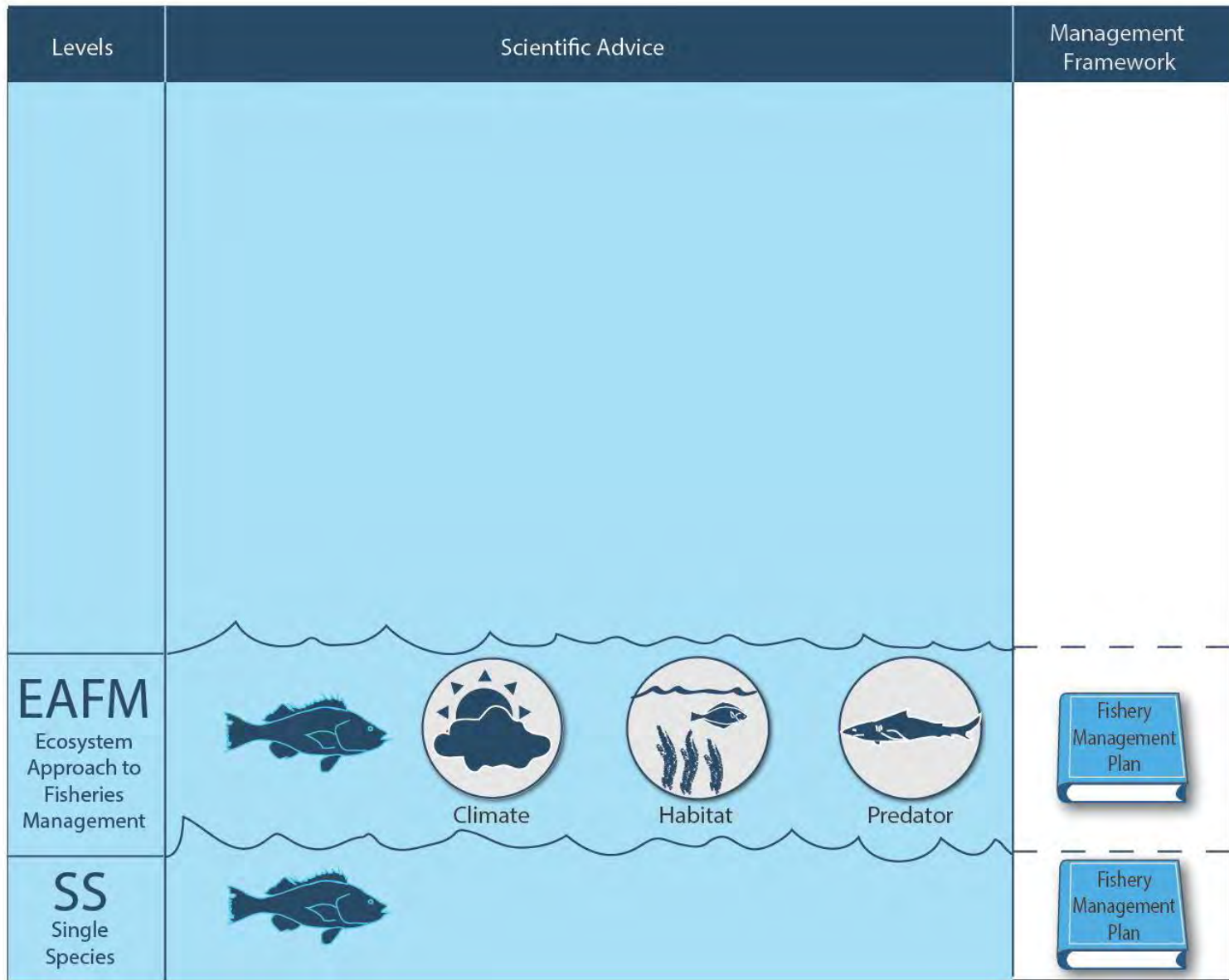
Eisner et al. 2014


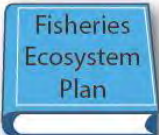




# Ecosystem Approach to Fisheries Management



Heintz et al 2013

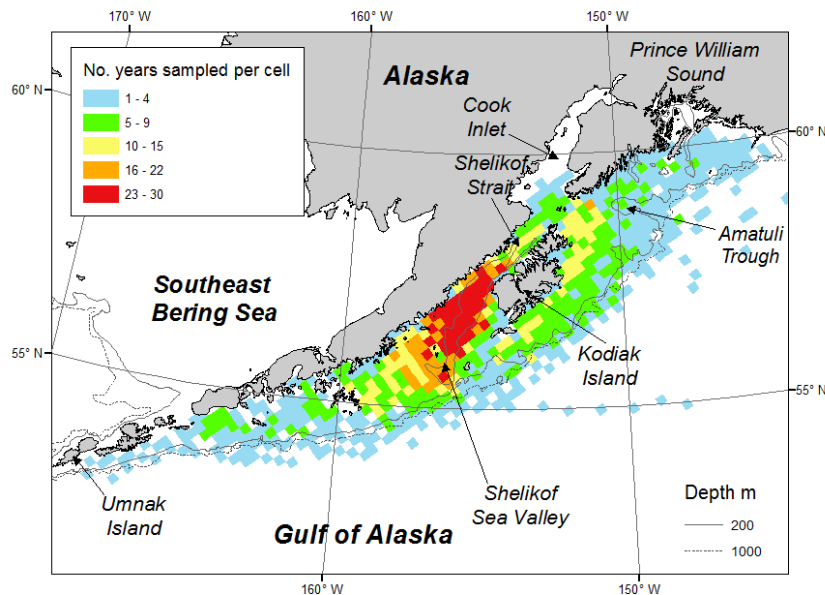




Levels	Scientific Advice	Management Framework
<p>Community responses to environmental variability</p> <p>Diversity, stability – ecosystem sustainability and resilience</p> <p>Identify weaknesses, thresholds, tipping points</p>		
<p><b>EBFM</b> Ecosystem Based Fisheries Management</p>	 <p>Climate      Habitat      Predator</p>	
<p><b>EAFM</b> Ecosystem Approach to Fisheries Management</p>	 <p>Climate      Habitat      Predator</p>	
<p><b>SS</b> Single Species</p>		

# Ecosystem Based Fisheries Management

Larval  
community



Understand multispecies response to environmental drivers

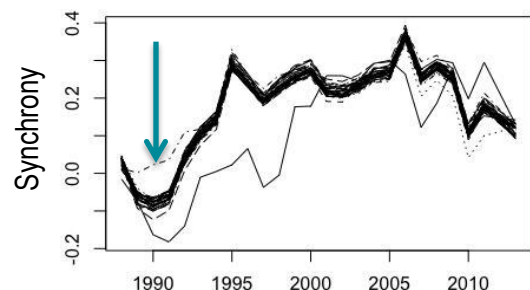
Sentinel species/species groups

Long term changes across communities

# Ecosystem Based Fisheries Management

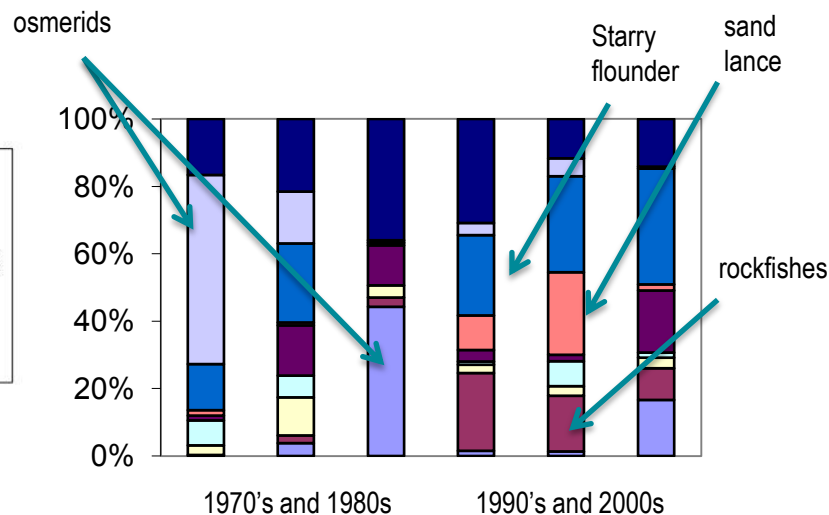


AFSC Kodiak, AK



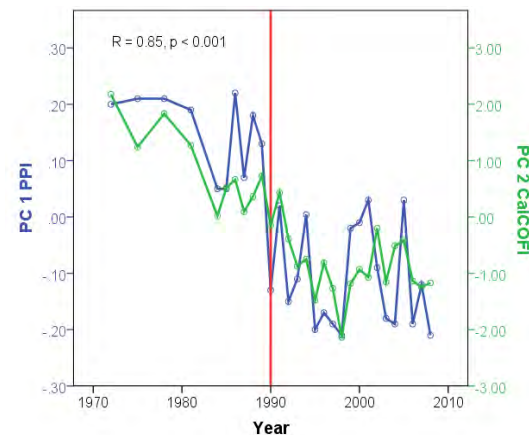
Marshall et al in progress

NWFSC Newport, OR




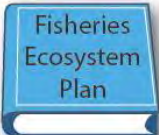




Auth et al. (2011) Fish. Ocean.

CalCOFI, La Jolla CA

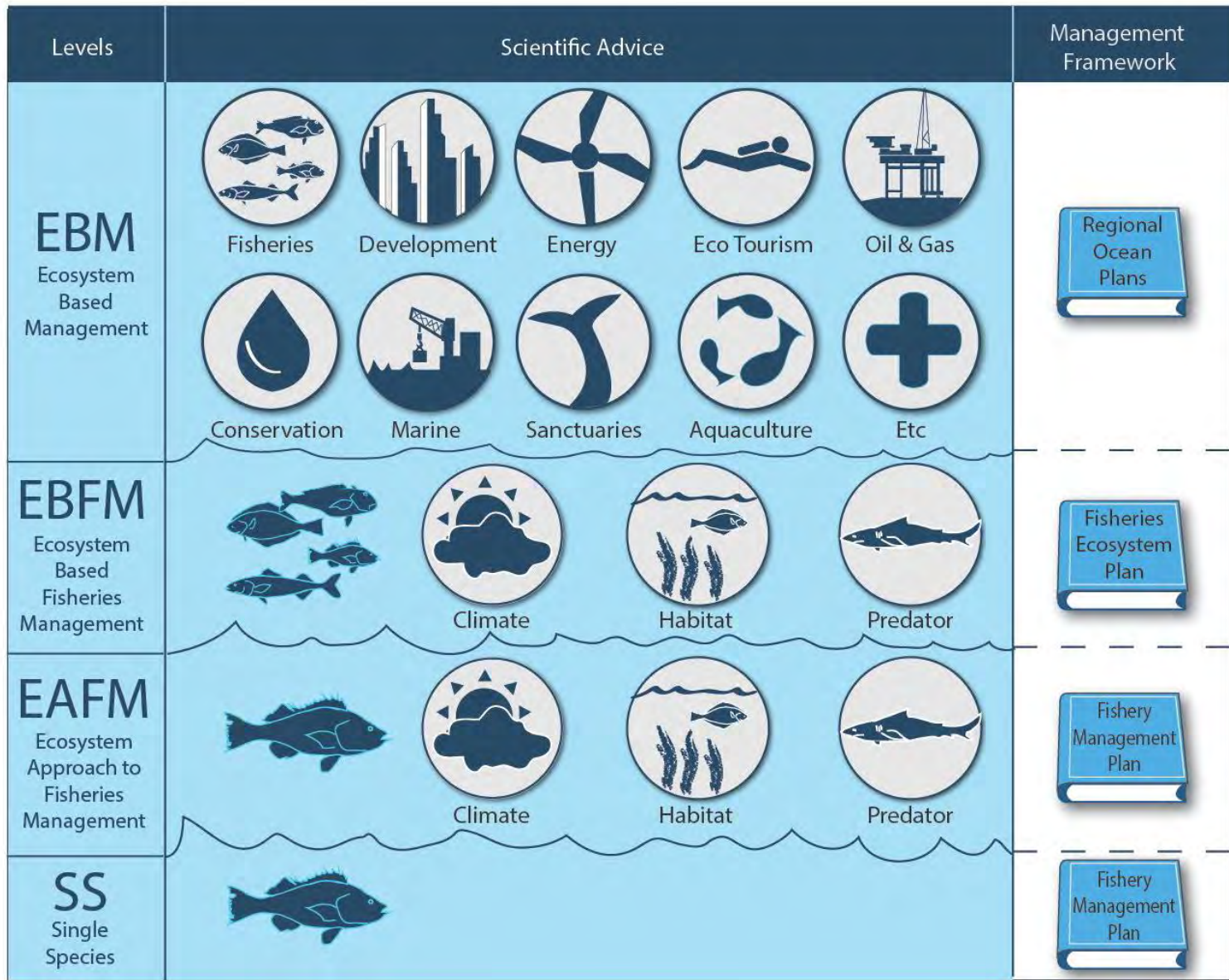


Koslow et al 2013

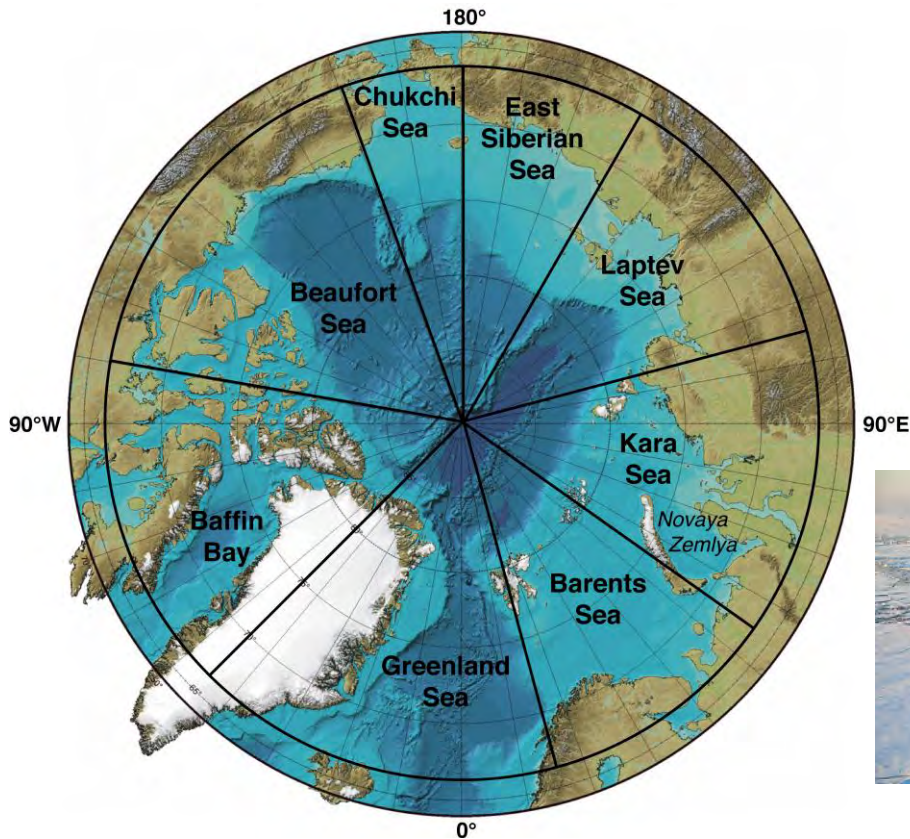
- Pacific hake, northern anchovy,
- rockfish (*Sebastes* spp.),
- Myctophid
- Bathylagid

Levels	Scientific Advice	Management Framework
<b>EBFM</b> Ecosystem Based Fisheries Management	 <p>Climate      Habitat      Predator</p>	 <p>Fisheries Ecosystem Plan</p>
<b>EAFM</b> Ecosystem Approach to Fisheries Management	 <p>Climate      Habitat      Predator</p>	 <p>Fishery Management Plan</p>
<b>SS</b> Single Species		 <p>Fishery Management Plan</p>



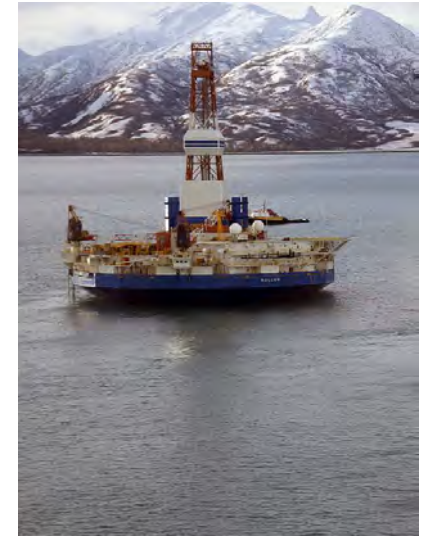


# Towards Ecosystem Based Management in the Arctic



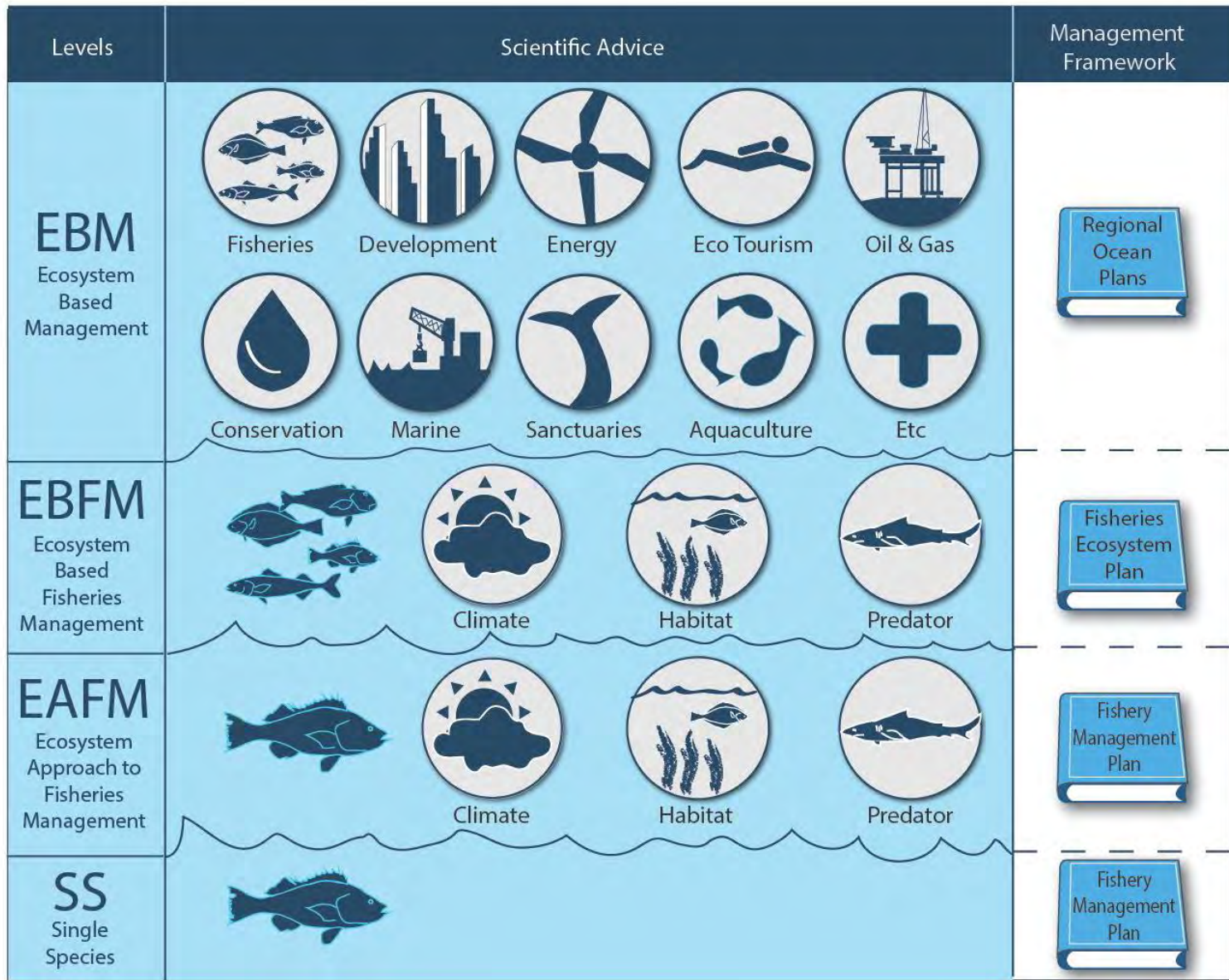
Management questions:

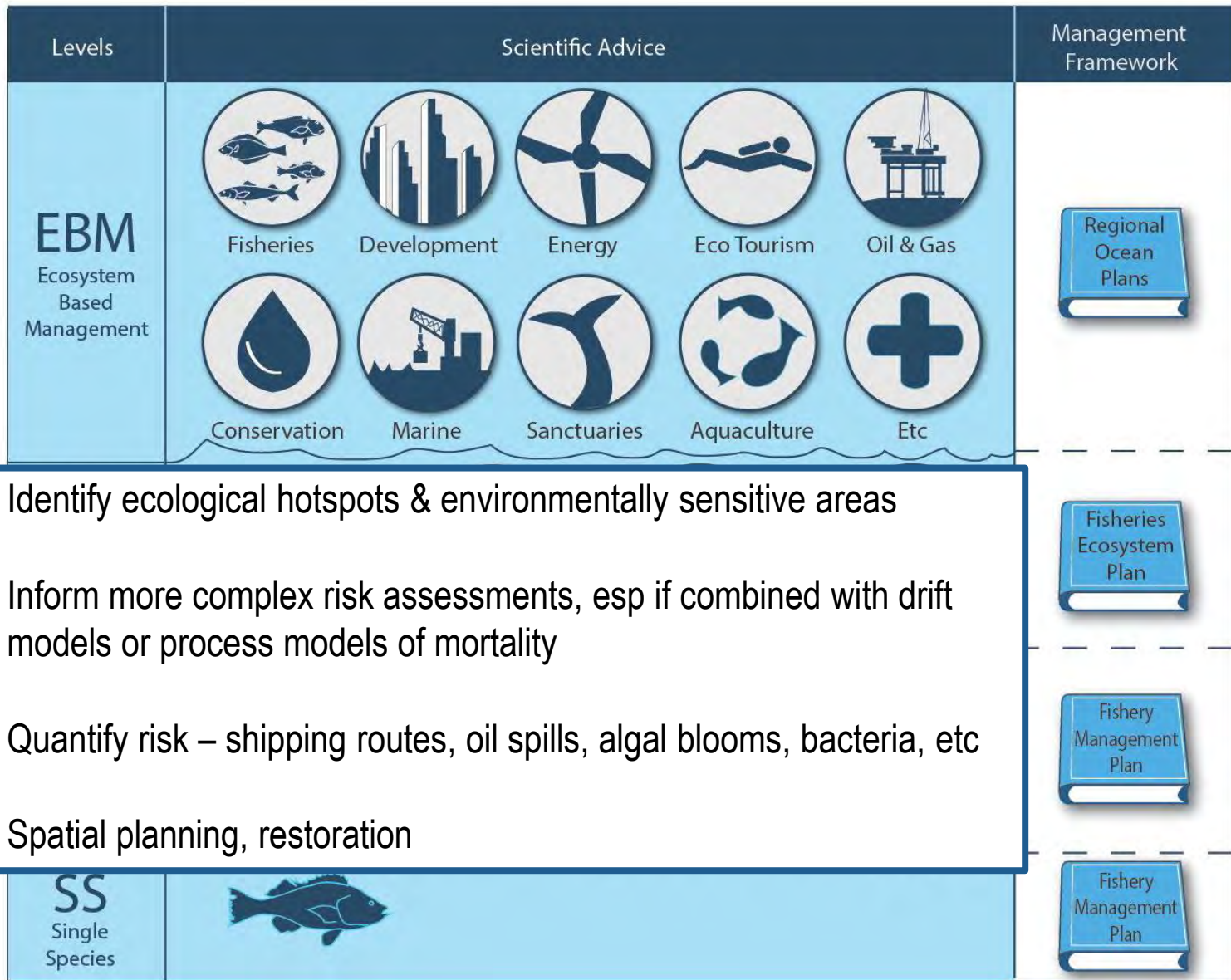
Where should oil and gas exploration be allowed so as to minimize impacts on critical species?



What risk does Arctic shipping pose to key species? To coastal communities? How can risks be minimized?

What are the critical production areas? How can they be preserved?



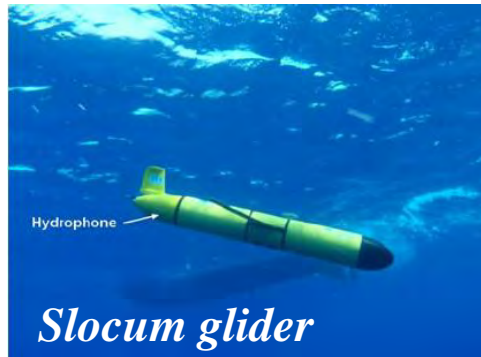


# Opportunities and Future Directions

- New Technologies



<https://vimeo.com/100145046>



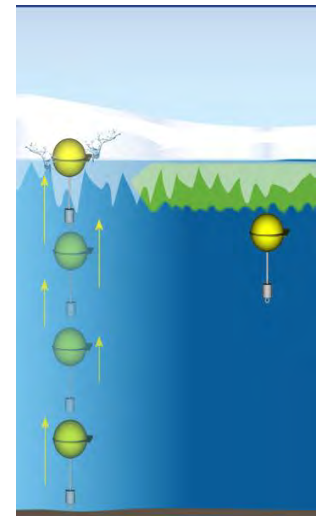
Hare, NWFSC



Bi, CBL



<http://www.pmel.noaa.gov/arctic/news-story/saildrones-monitor-bering-sea>



# Thank you

PICES

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