



A conceptual model for determining oil fate and effects on habitat and wildlife in the Arctic

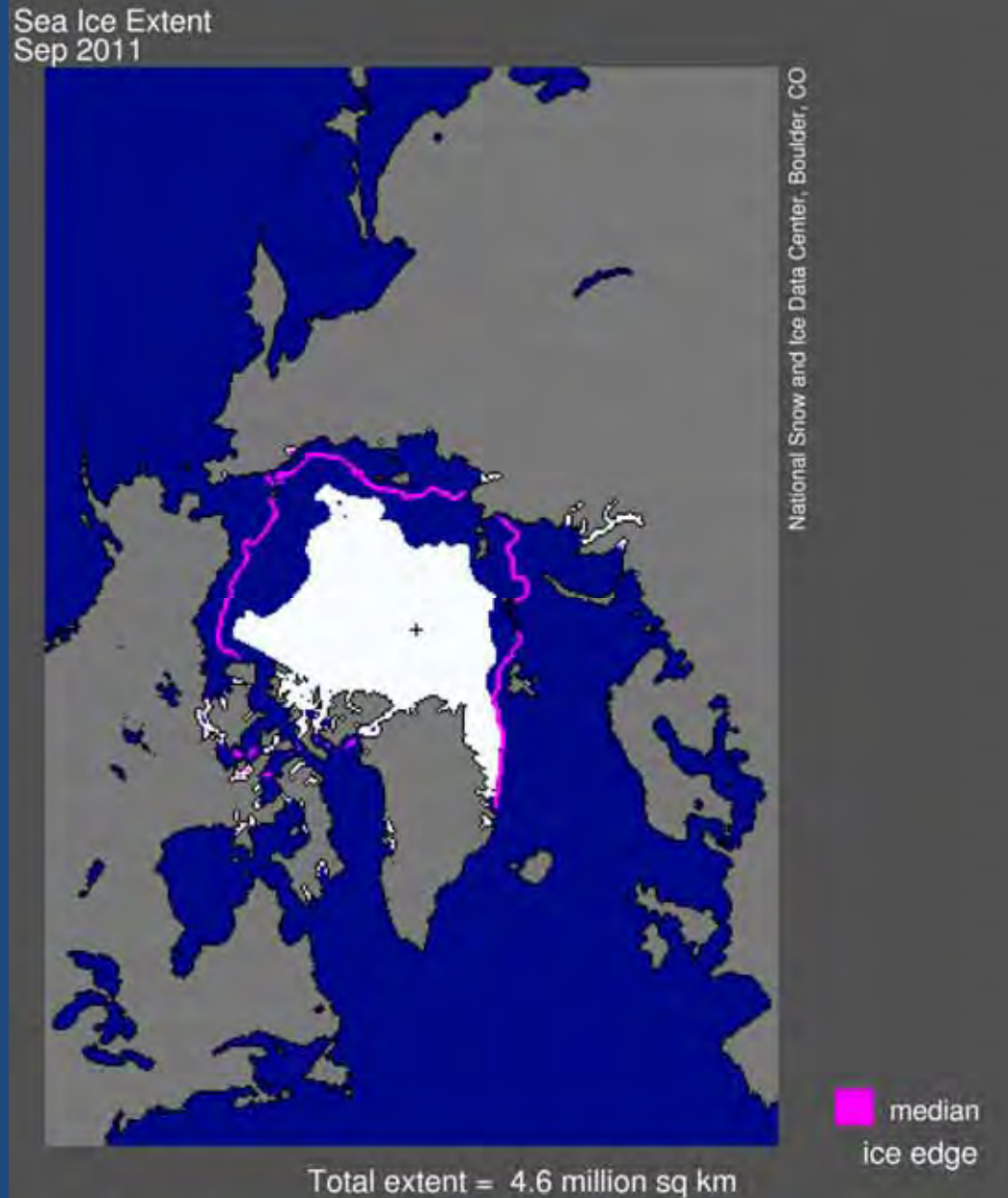
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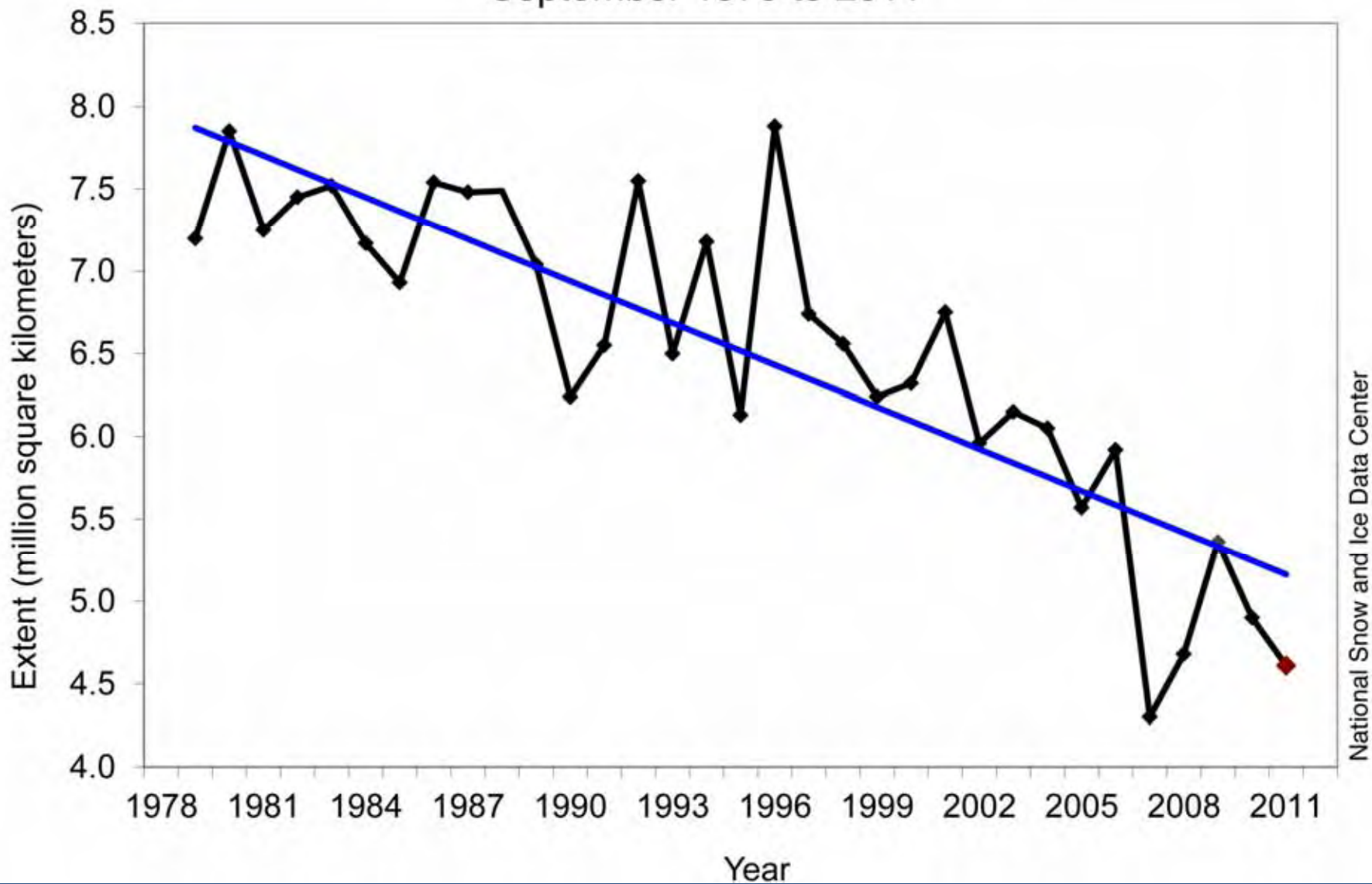
²Office of Response and Restoration, National Ocean Service, NOAA, Seattle, WA, USA.

**NOAA
FISHERIES
SERVICE**

Arctic and Climate Change



Average Monthly Arctic Sea Ice Extent September 1979 to 2011



National Snow and Ice Data Center

Increased Human Activity in the Arctic

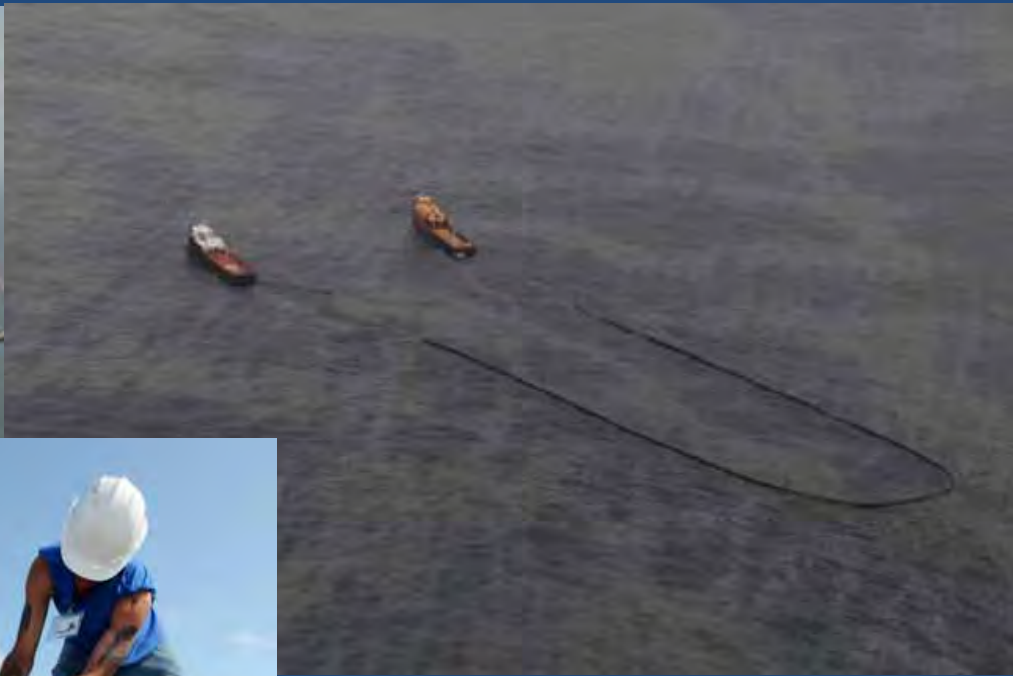
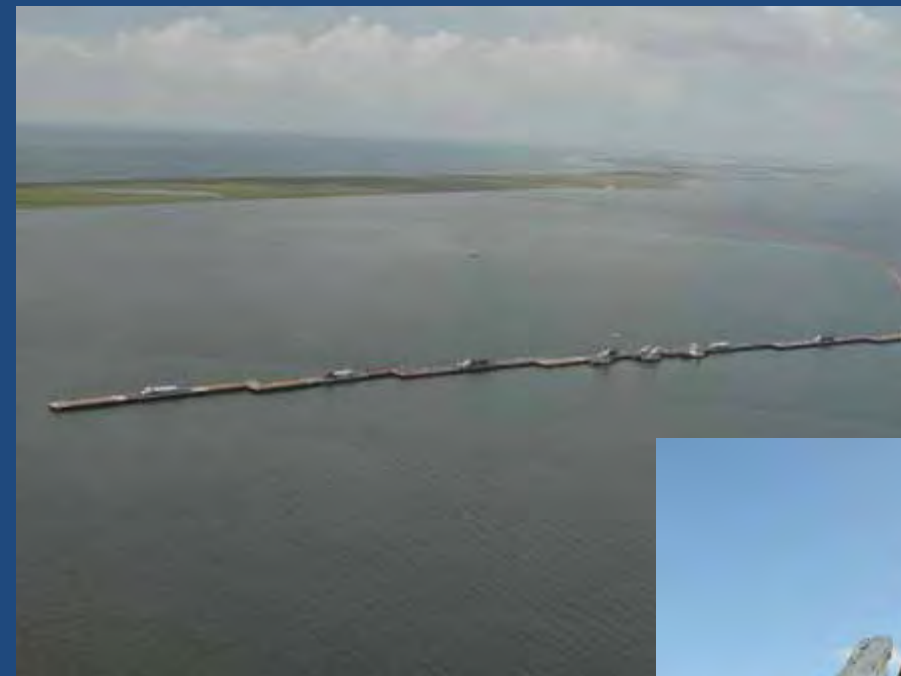
- Shipping, fishing, tourism and oil, gas, and mineral exploration.
- Arctic contains a potential 90 billion barrels of oil and 1,700 trillion cubic feet of natural gas
- 84% of the undiscovered oil and gas occurs offshore*

*<http://geology.com/usgs/arctic-oil-and-gas-report.shtml>

Deepwater Horizon Oil Spill April 22, 2010



Response



Damage assessment



Conceptual model for oil fate and effects in the Arctic

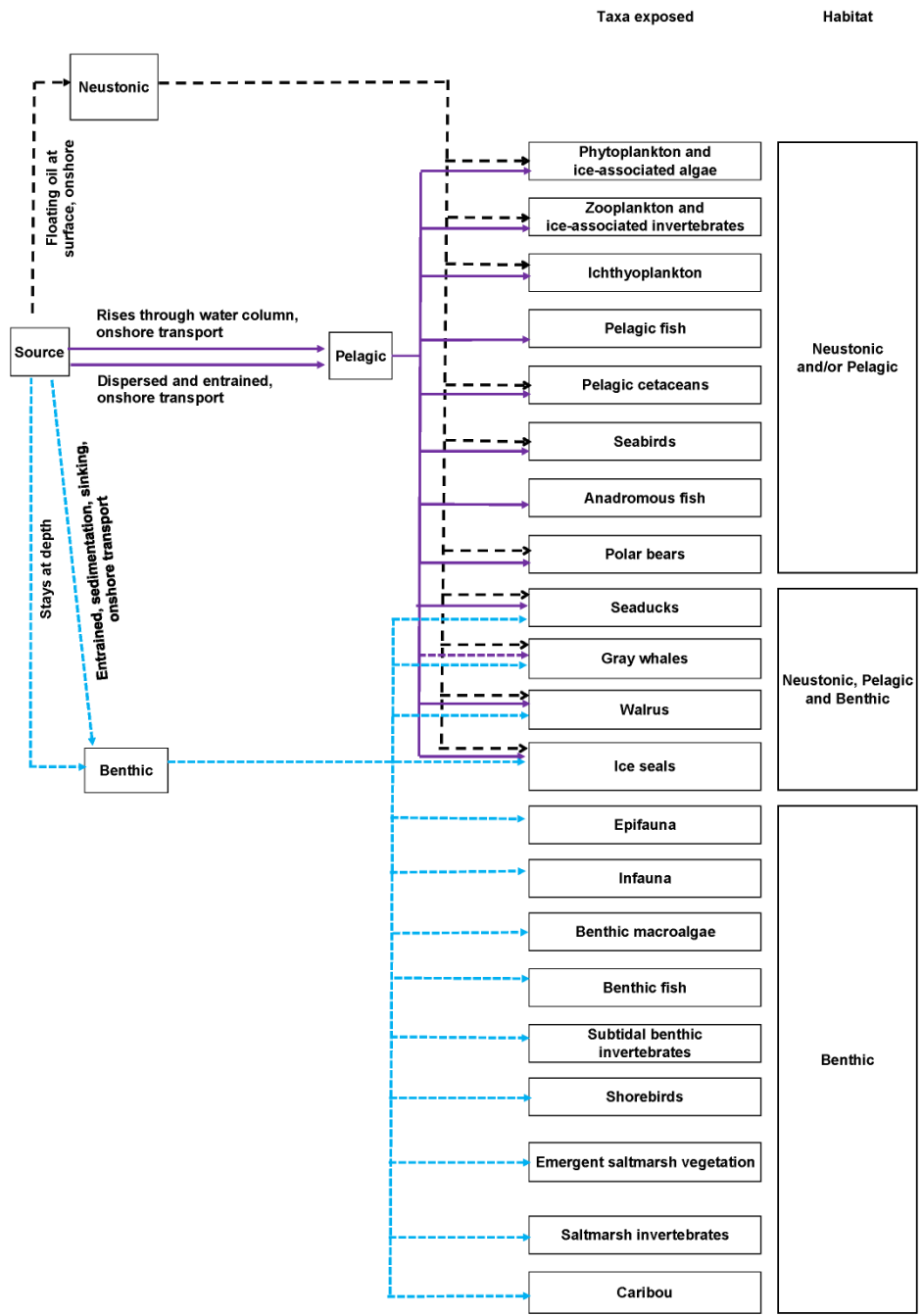
- Tool to prioritize damage assessment studies and restoration projects
- Pathways for oil to reach habitat and wildlife
- Taxa and habitat exposed
- For each taxa
 - Exposure mechanisms
 - Individual impacts
 - Population impacts
 - Ecosystem impacts

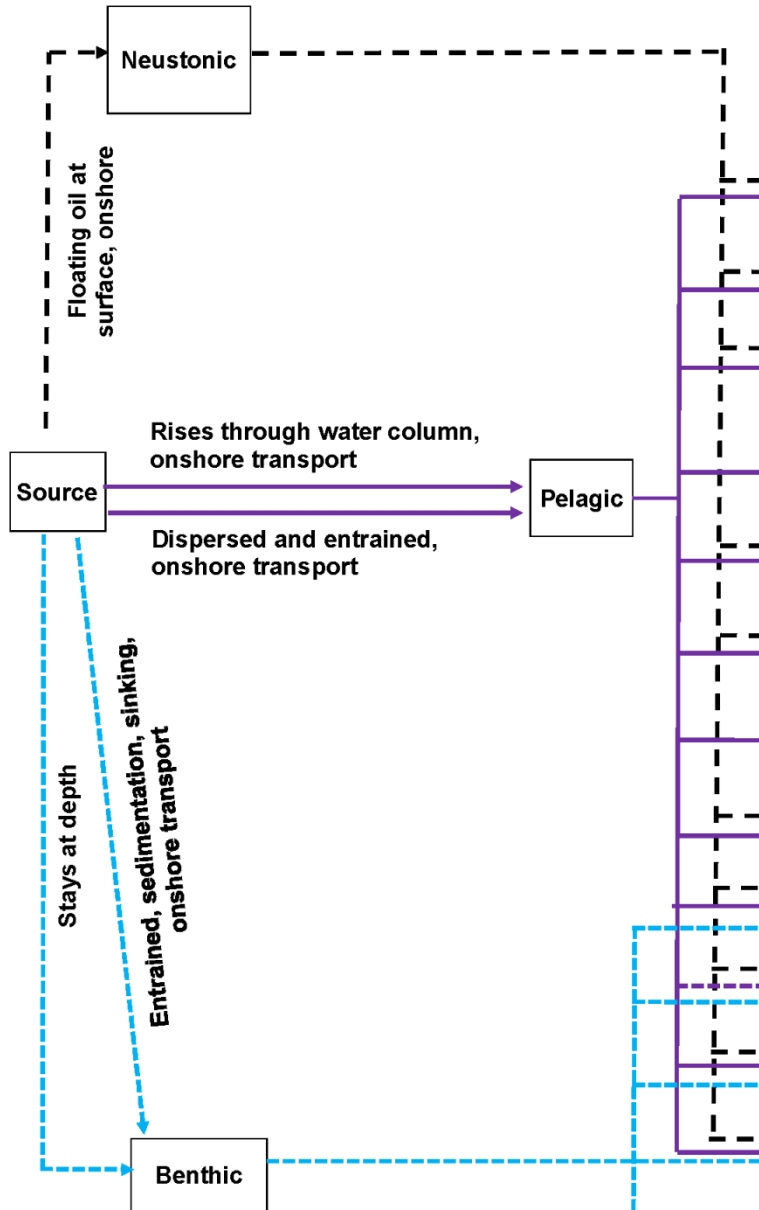
Outline of talk

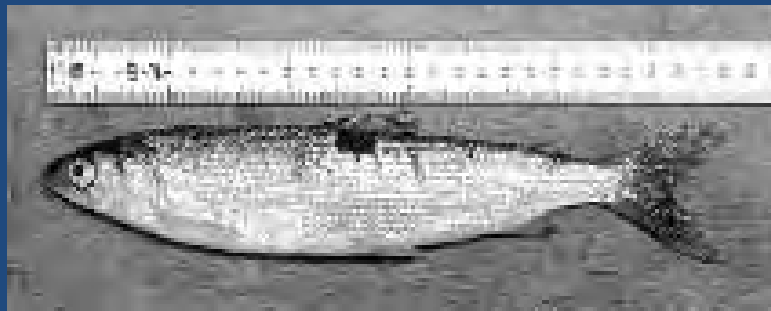
- Describe overall model
 - Oil pathways
 - Taxa and habitat exposed
- Detailed (hypothetical) example
 - Oil tanker or barge
 - Oil spill at the surface of the ocean
 - April to September
 - Impacts on Arctic cod eggs and larvae
- Research recommendations

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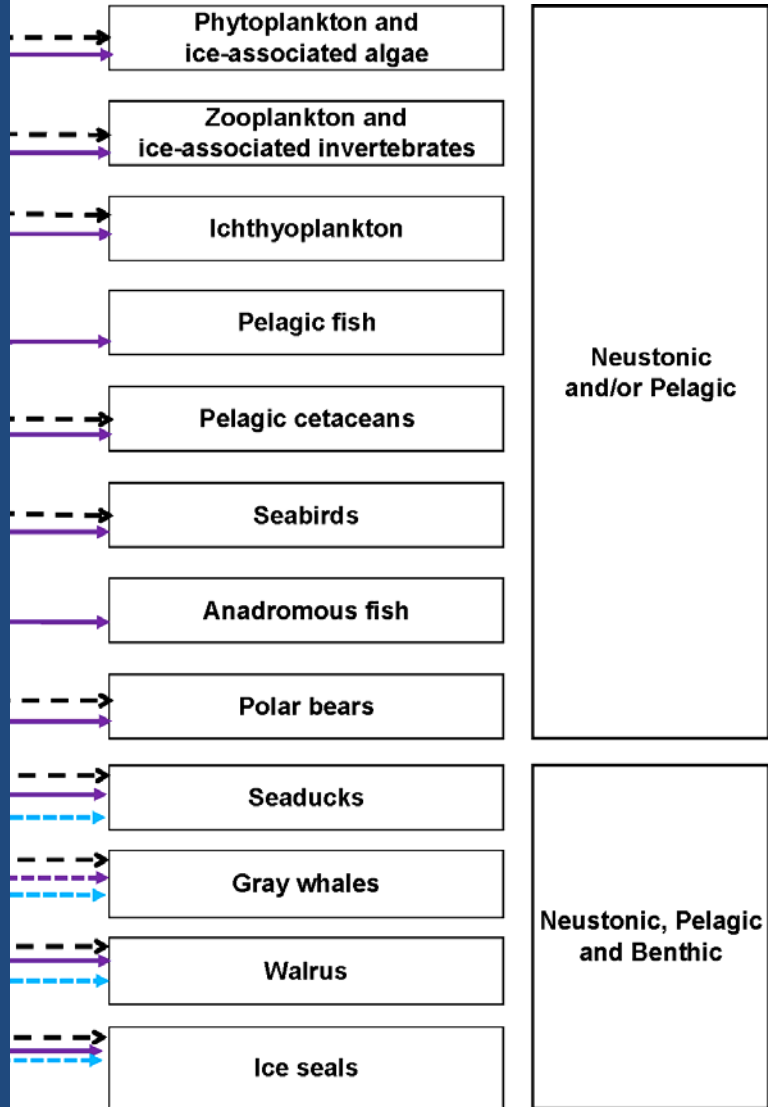


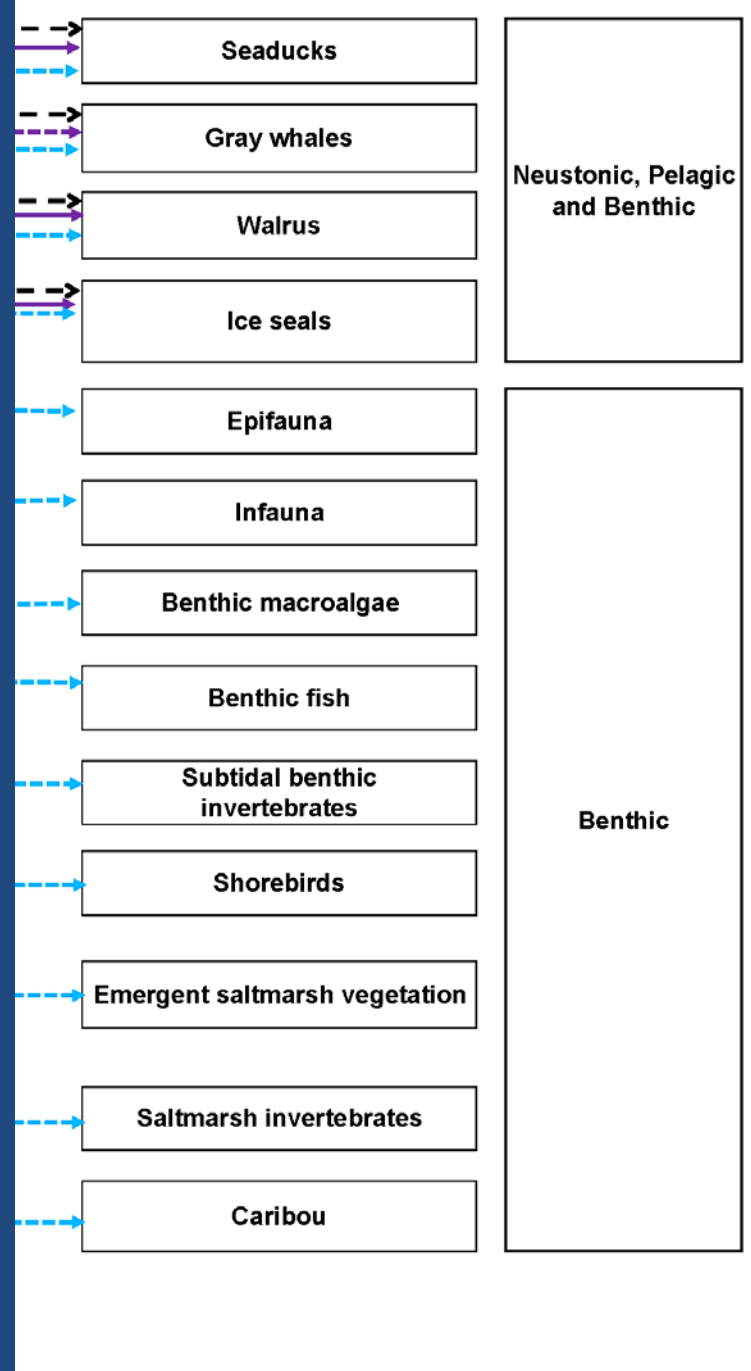




Taxa exposed

Habitat

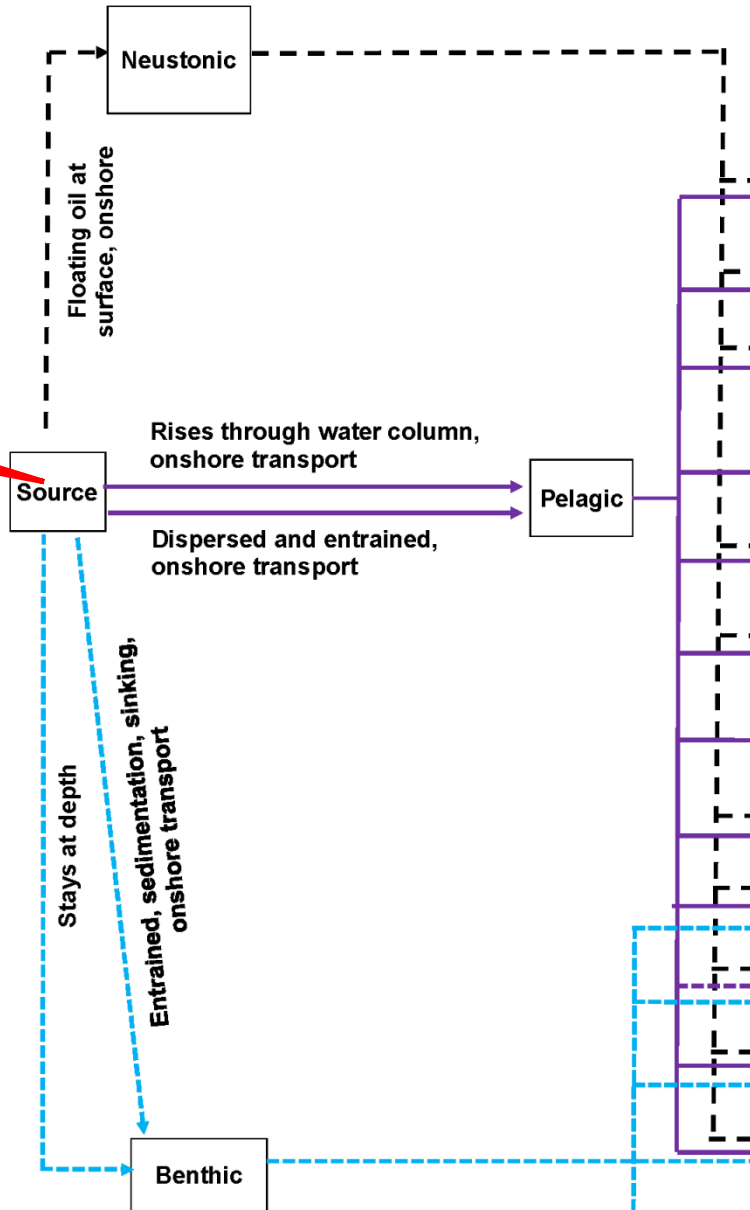


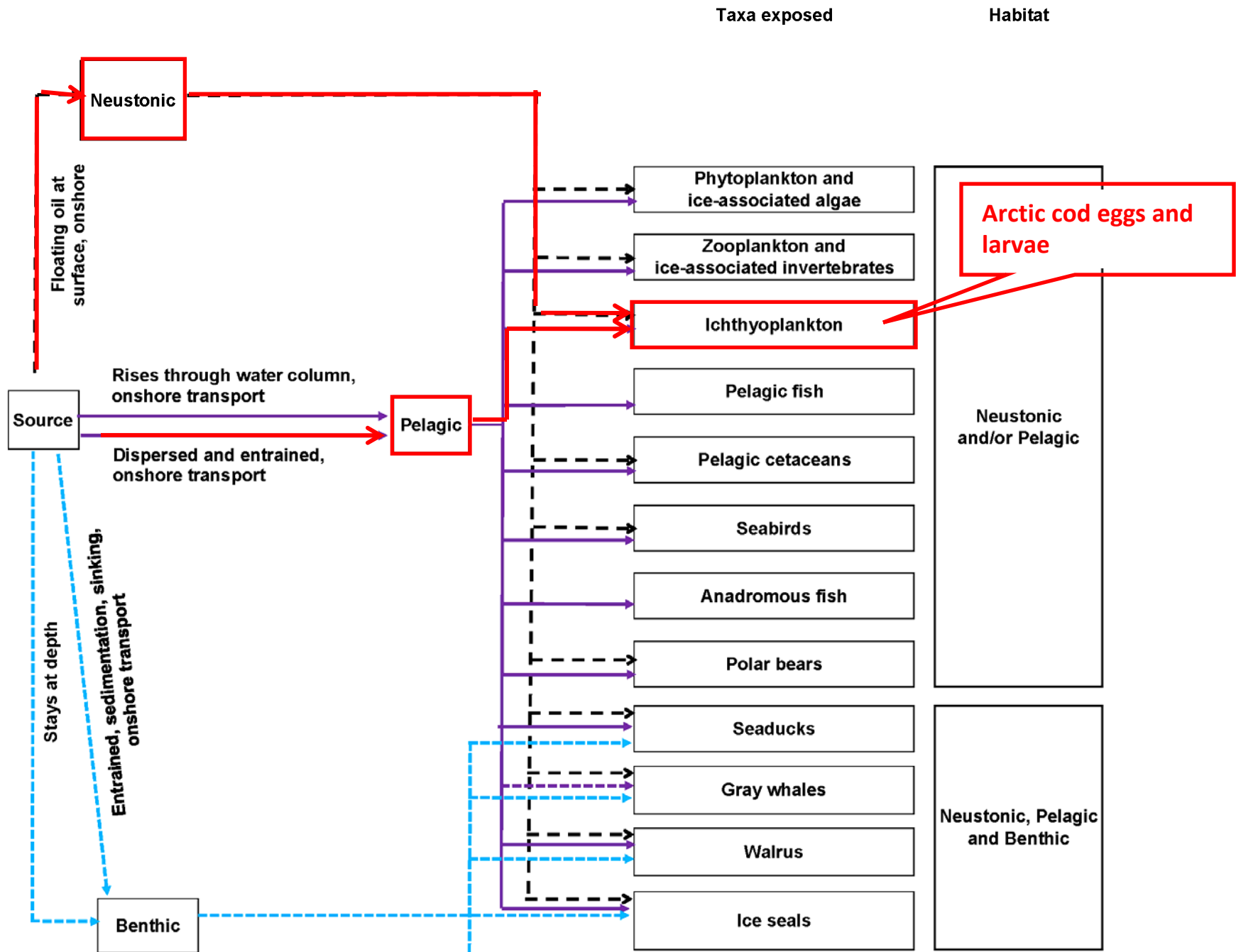


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Oil tanker or barge





Why Arctic cod (*Boreogadus saida*) ?

- Central in Arctic foodwebs
- Distributed across broad range of habitats in benthic and pelagic waters
- Eggs and larvae are in surface waters nearshore
- Disclaimer: No studies on effects of oil of Arctic cod eggs and larvae. Extensive literature on Pacific herring used to develop model.

Arctic cod eggs and larvae

Exposure mechanisms			
Ingestion		Adsorption	Fouling
X		X	

Individual Impacts					
Death	Photosynthesis	Respiration	Growth	Reproduction	Behavior
X		X	X		X

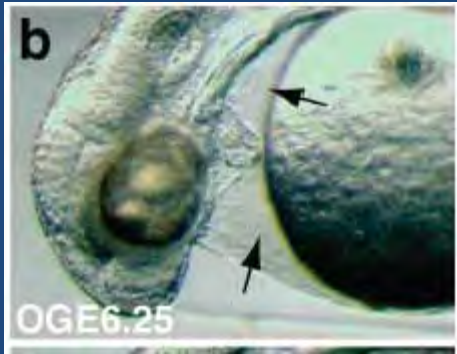
Population Impacts			
Mortality	Recruitment	Production	Habitat use or Distribution
X	X		

Ecosystem Impacts		
Alterations in community structure	Prey availability	Human subsistence
X	X	X



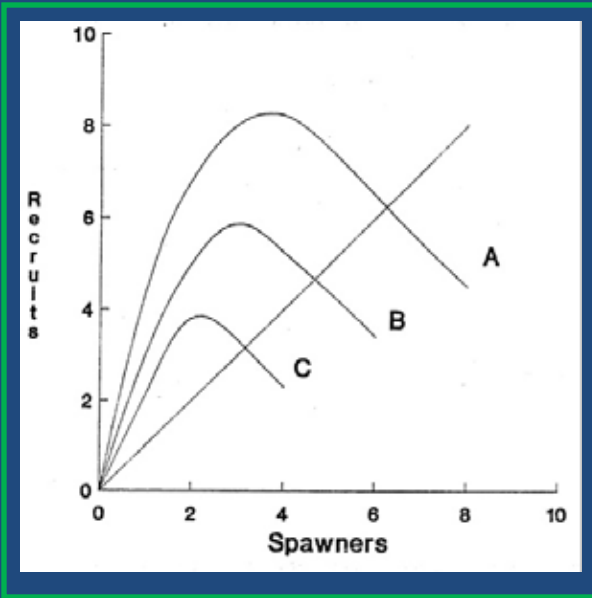
Arctic cod eggs and larvae

Exposure mechanisms			
Ingestion	Inhalation	Adsorption	Fouling
X		X	

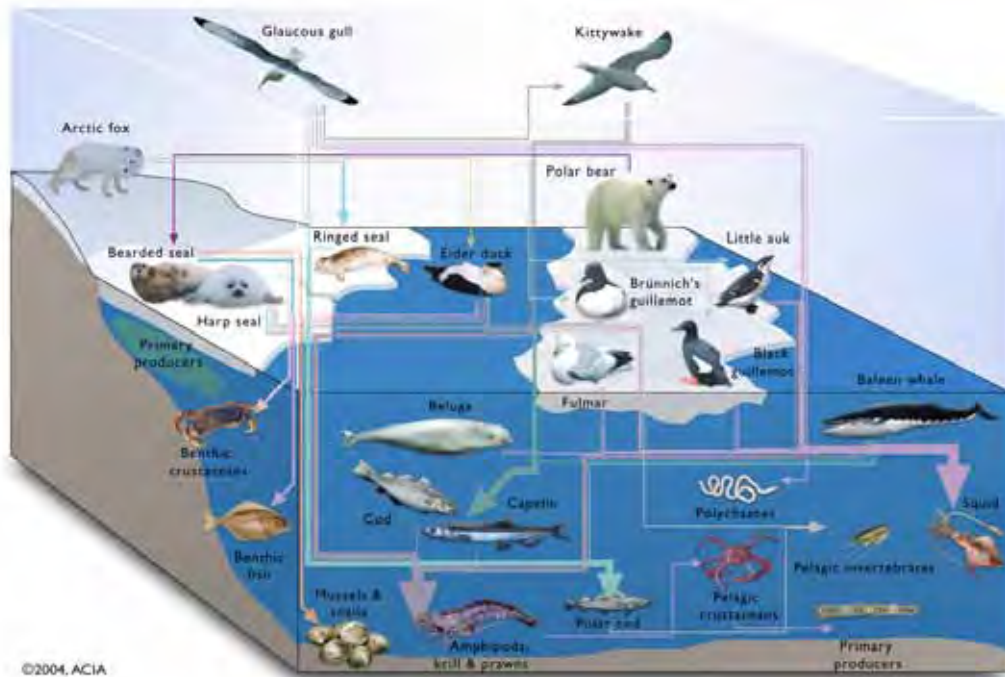


Incardona et al. 2009

Individual Impacts					
Death	Photosynthesis	Respiration	Growth	Reproduction	Behavior
X		X	X		X



Population Impacts			
Mortality	Recruitment	Production	Habitat use or Distribution
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Ecosystem Impacts		
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Arctic cod eggs and larvae

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Ecosystem Impacts		
Alterations in community structure	Prey availability	Human subsistence
X	X	X

Research Recommendations

- Baseline data on distribution and abundance of several taxa
- Laboratory research on the toxic effects of oil on Arctic cod eggs and larvae
- Modeling to translate individual impacts to population and ecosystem impacts