RED FLAGS OR RED HERRINGS REVISITED

Using ecosystem indicators to track ecosystem status in the Gulf of Alaska

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Outline

- Marine ecosystem indicators in Alaska
- What ecosystem indicators *indicated* about the Gulf of Alaska ecosystem in 2011
- Have predictions of poor year classes held up?

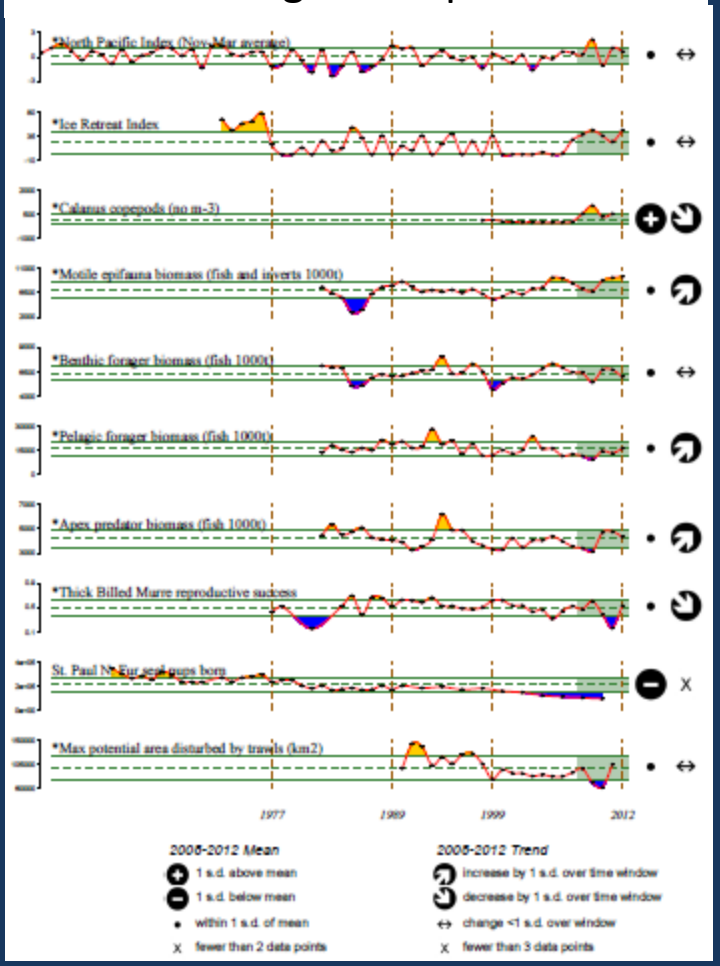




Ecosystem Indicators for Fisheries Managers

- Indicator = time-series that measures an ecosystem component
- NOAA follows 100's of ecosystem indicators that are evaluated annually to inform fisheries managers
- Developed by NOAA and other researchers
- Trends monitored for early signs of ecosystem change that may have management implications
- Ecosystem-Based Fisheries Management

Eastern Bering Sea Report Card



Why a Suite of Indicators?

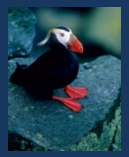
Synthesis – more than the sum of its parts

1. Provide stronger links between ecosystem research and management
2. Spur new understanding of connections between ecosystem components

Goal

Present the status of ecosystem indicators that cumulatively suggest anomalous conditions occurred in 2011

Red Flag #1: Seabirds



Widespread Reproductive Failure

N

Middleton:
Fail: Tufted puffin
Ok: Black-legged kittiwake
Ok: Rhinoceros auklet

Barrens:
Fail:
Black-legged kittiwake

St. Lazaria:
Ok: Common murre
Ok: Thick-billed murre

Chowiet:
Fail: Black-legged kittiwake
Fail: Tufted puffin
Fail: Parakeet auklet
Poor: Common murre
Poor: Thick-billed murre

Aiktak:
Fail: Common murre
Fail: Thick-billed murre
Ok: Tufted puffin

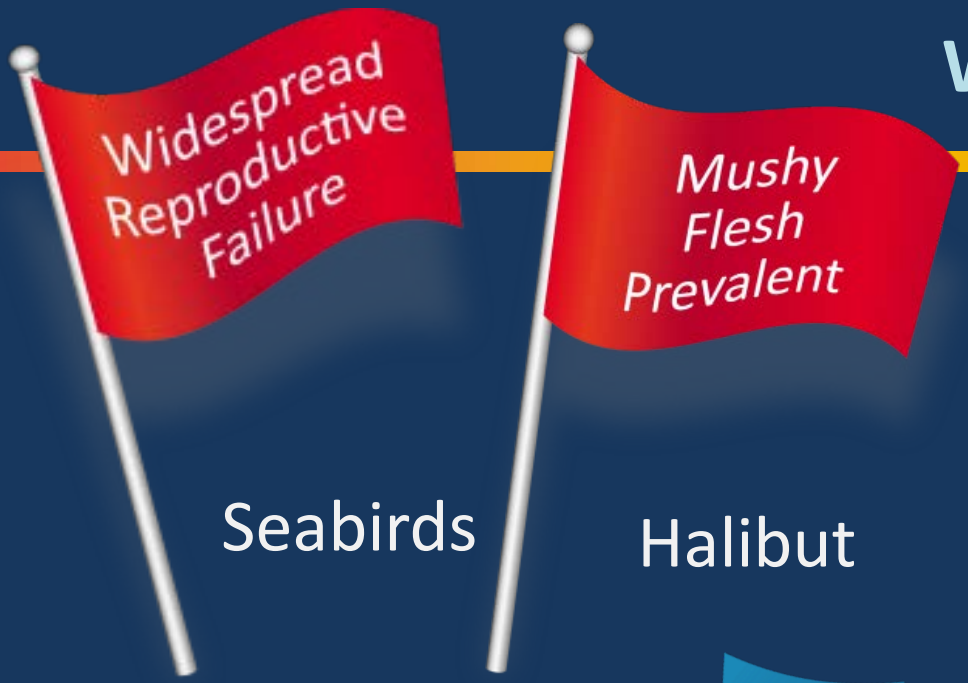
Gulf of Alaska

Red Flag #2: Halibut

Reoccurrence of "Mushy" Halibut Syndrome

- First detected in GOA in 1998
- Also seen 2005 and 2012
- Hypothesized nutritional deficiency
- Stomachs contain crab rather than forage fish

What Do They Indicate?



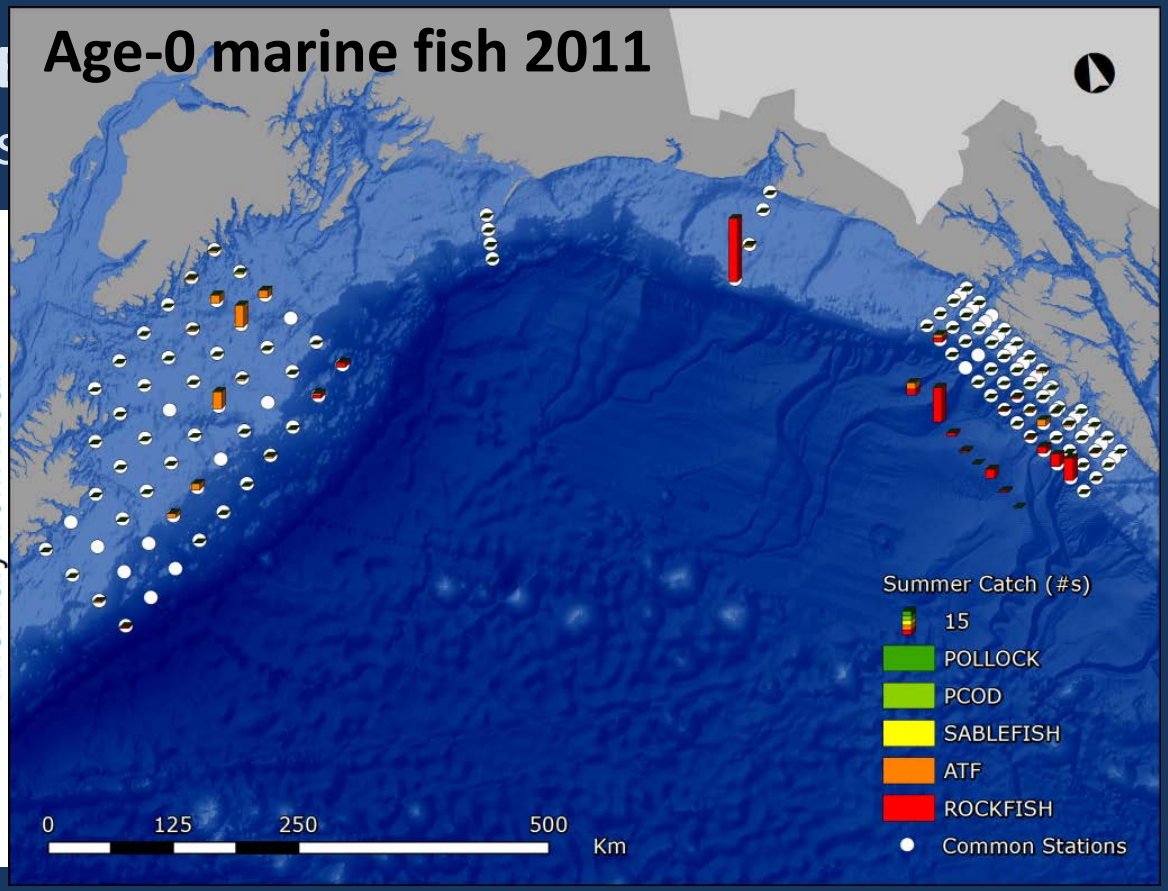
Seabirds

Halibut

- Both are attributed to poor foraging conditions

Forage Fish?

Forage Fish



Anomaly from mean

- Consistent with other GOA surveys (Moss et al., 2012)
- Winter age-1 pollock (2011 year class) survey estimates low
- Percent juvenile pink salmon catch rates in SE Alaska 2nd lowest in 15 years (Orsi et al. 2012)

Seabirds

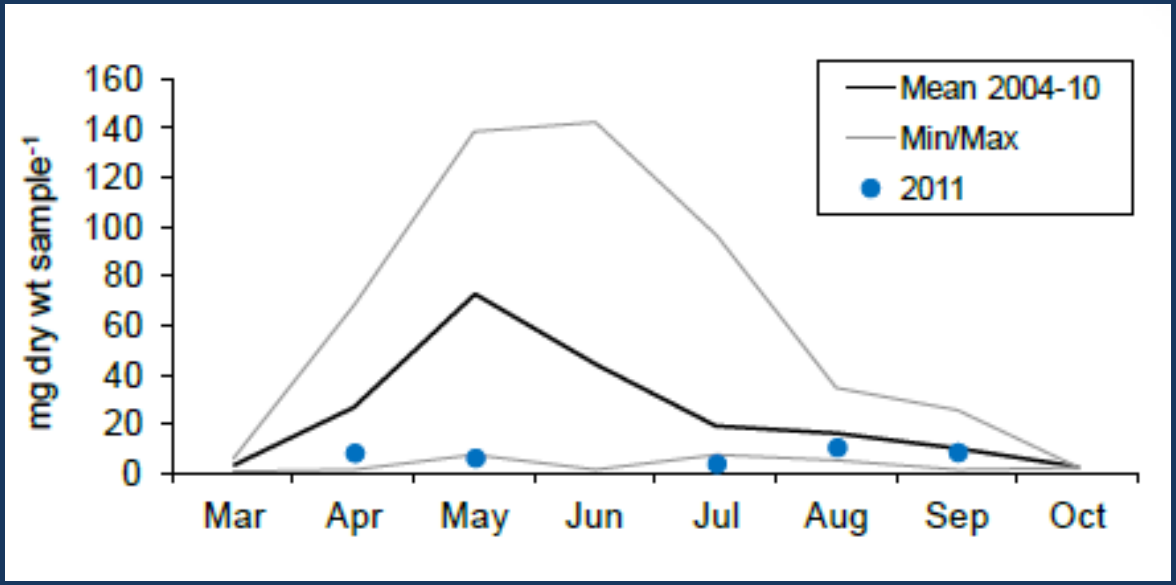
Halibut

Forage fish

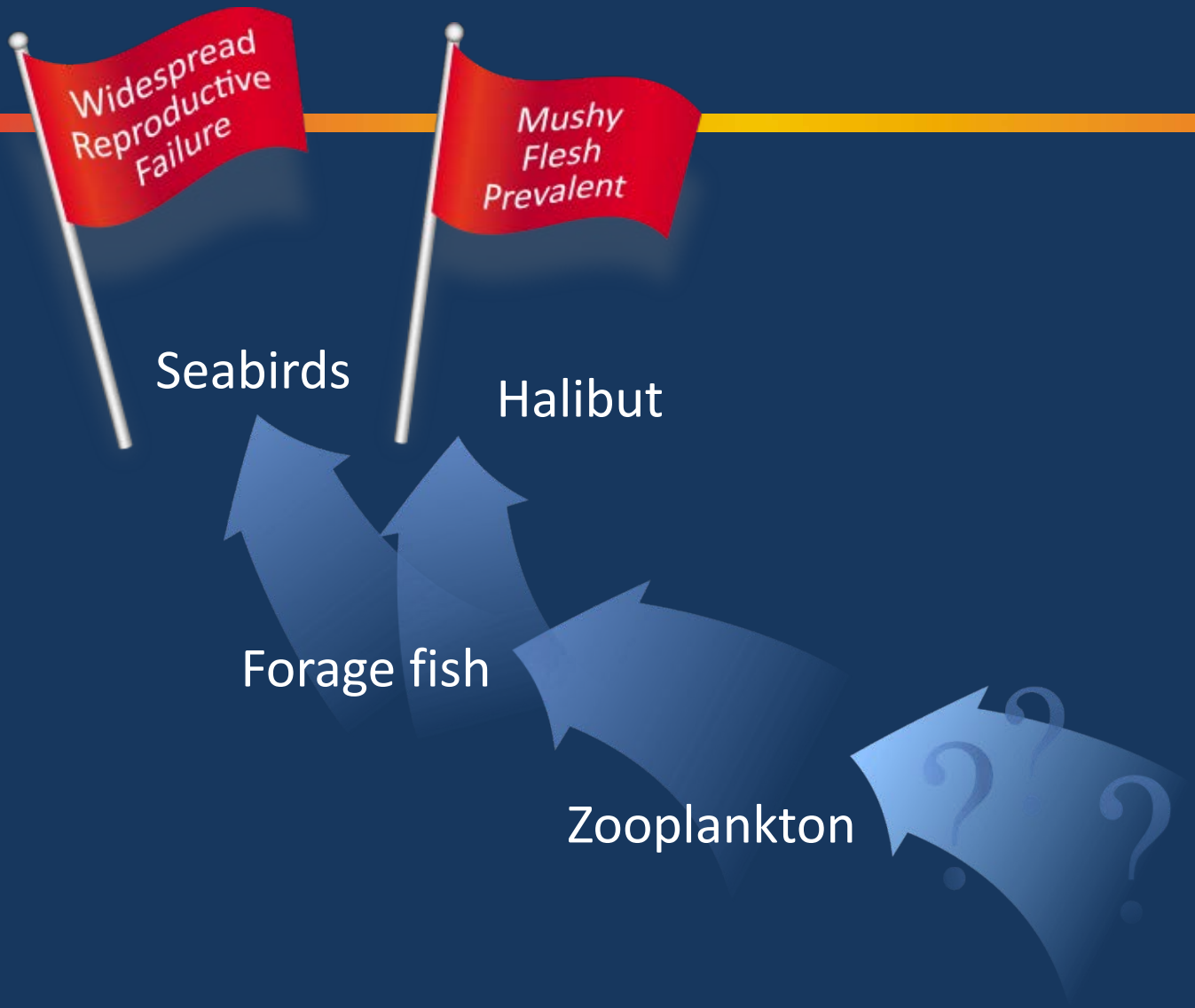
Zooplankton?

Zooplankton

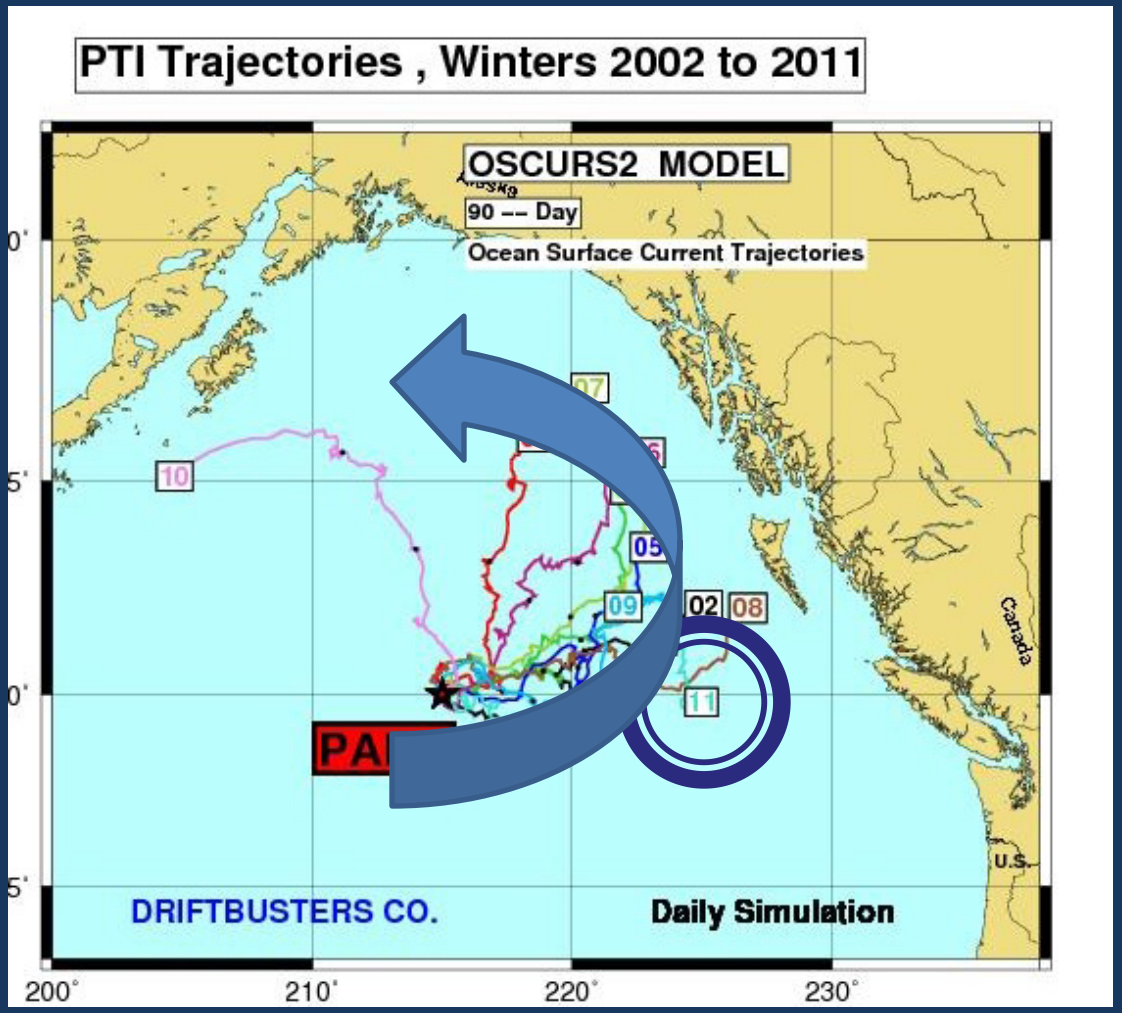
Very low zooplankton biomass sampled by Continuous Plankton Recorders (Batten 2012)



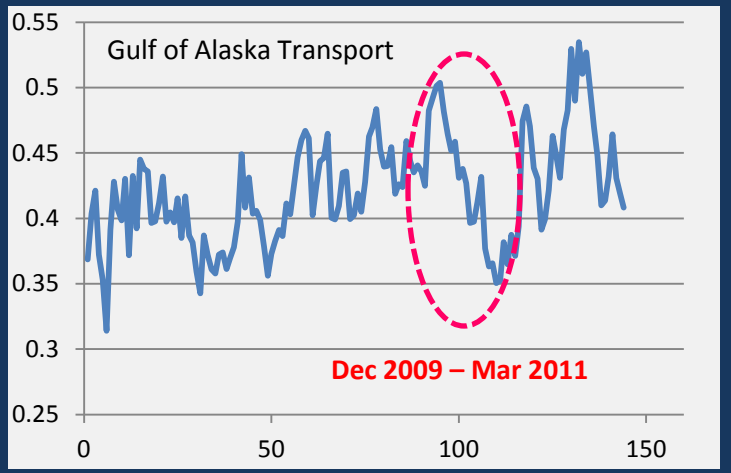
- Also, **high abundance of salps** in eastern GOA


Widespread Reproductive Failure
Mushy Flesh Prevalent
Seabirds
Halibut
Forage fish
Zooplankton
Climate?

Climate



- PAPA Trajectory Index unusually east and southernmost since 1993 (Stockhausen and Ingraham 2012)
- Decline in poleward branch of the Alaska Current (Bond 2012)



Has a similar pattern occurred in other years?

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	Seabirds	Halibut	Forage Fish	Pink Salmon	Zoops	Climate
1995	High		Med			Med
1996			Low			Med
1997			Low	Low		Med
1998	Low	Mushy	Low	High		High
1999			Low	Low		Med
2000			Low	Med		Med
2001			Med	Med		Med
2002	High		Med	Med		Low
2003			Med	Med		Med
2004	Med		Med	Med	Low	Med
2005	Med	Mushy	Low	Low	High	Med
2006	High		Med	Low	Med	Med
2007	Med		Low	Low	High	Med
2008			Med	Low	Med	Med
2009	Med		Low	Low	Low	Med
2010	HIgh		Med	Med	High	Med
2011	Low	Mushy	Low	Low	Low	Low
2012	HIgh	Mushy	Low	Med	High	High

Conclusions and a Prediction

- **Synthesis** of indicators' status across multiple trophic levels **can reveal broad-scale changes** in the environment that may have important biological and management implications.
- **Upper trophic organisms** such as seabirds and halibut serve as integrative indicators that **can provide near-real time cues** of environmental state.
- **Changes in bottom-up forcing factors** may have negatively influenced productivity during 2011.
- Thus, **2011 may be a poor year class for forage fish and forage-fish eating predators**.

Testing prediction

- Was **2011 a poor year class for forage fish and forage-fish eating predators**?

Forage fish:

- Sandlance, Herring, etc ??
- Pollock: poor (similar to record small year classes of 2001-2003; lowest since pre-1970)

Predators:

- Halibut: TBD 2017 (appear in survey at age 6-8)
- Arrowtooth: TBD 2014 (age-3 recruits)
- Birds:??

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FATE (Fisheries and the Environment)