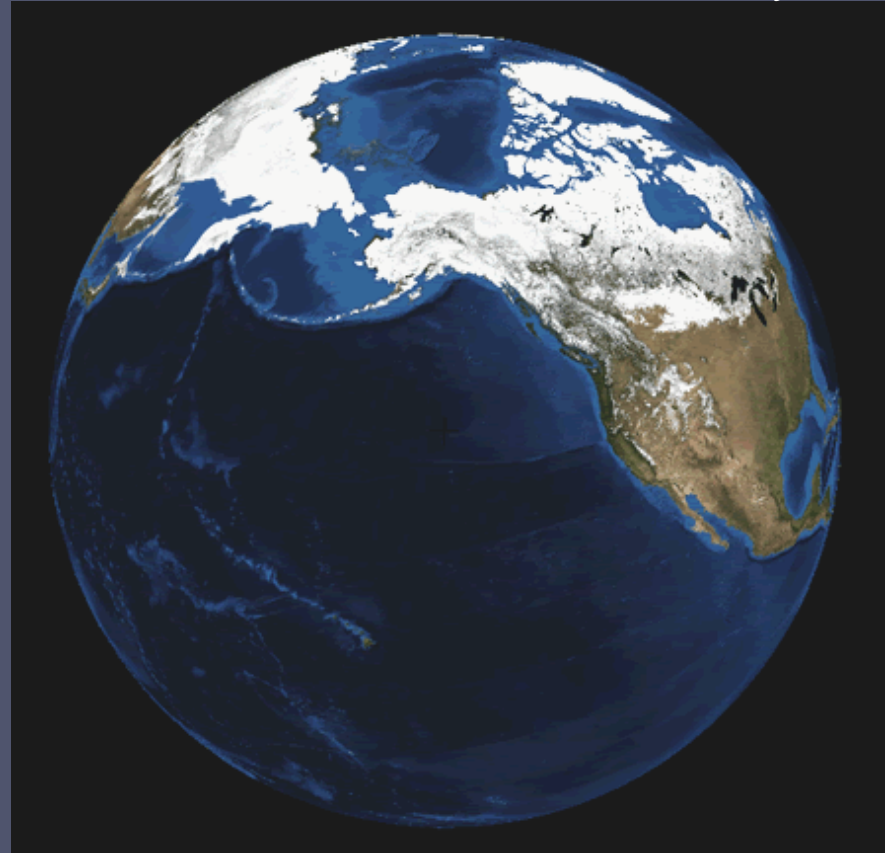


ECOSYSTEM CONSIDERATIONS

Status of the Gulf of Alaska Marine Ecosystem

Stephani Zador
Ellen Yasumiishi

GOA Groundfish Plan Team meeting
Nov 14, 2016



OUTLINE

1. Gulf of Alaska Report Cards (mostly 2015)
2. Hot Topic
3. Other indicators



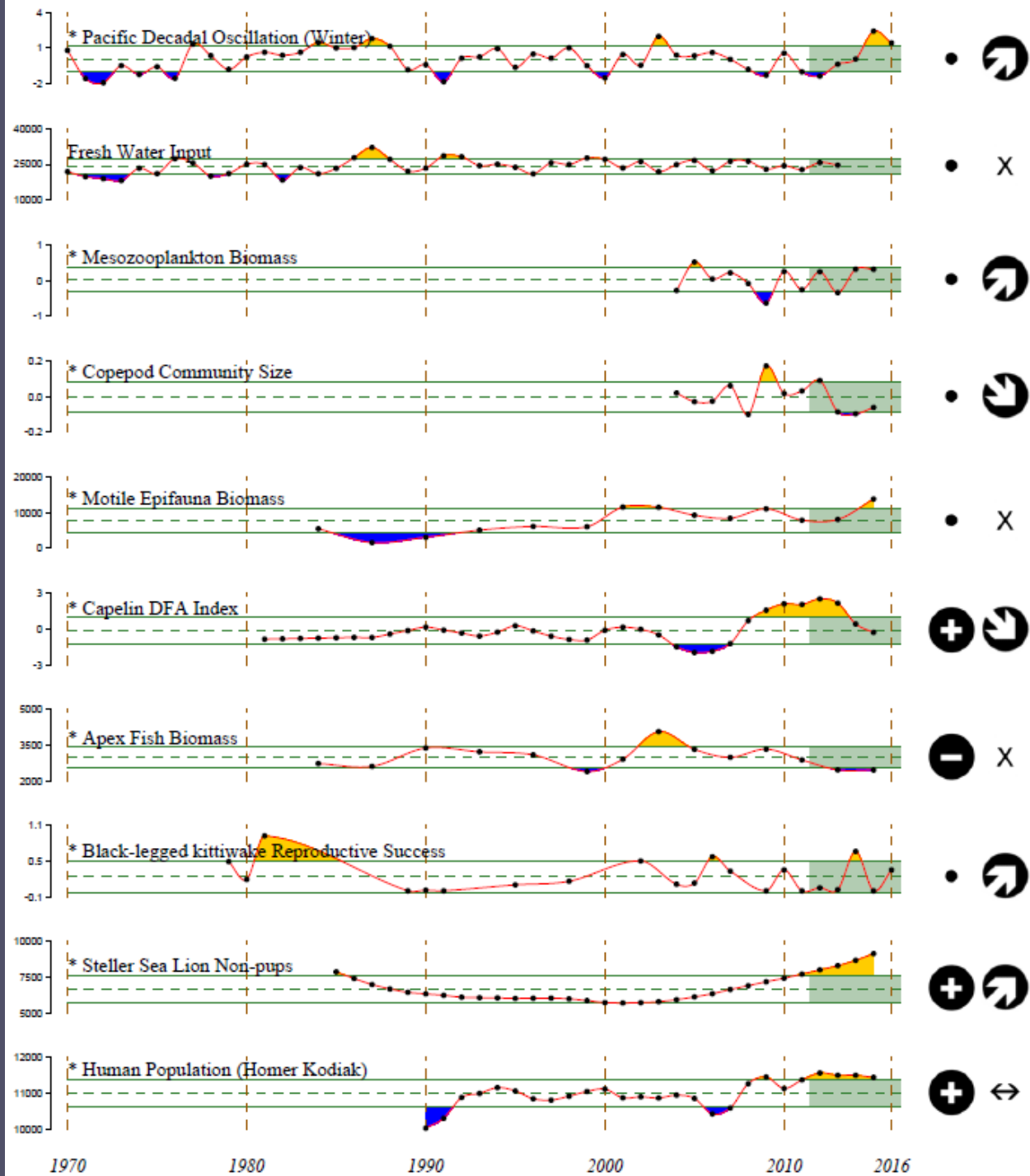
Gulf of Alaska Report Card



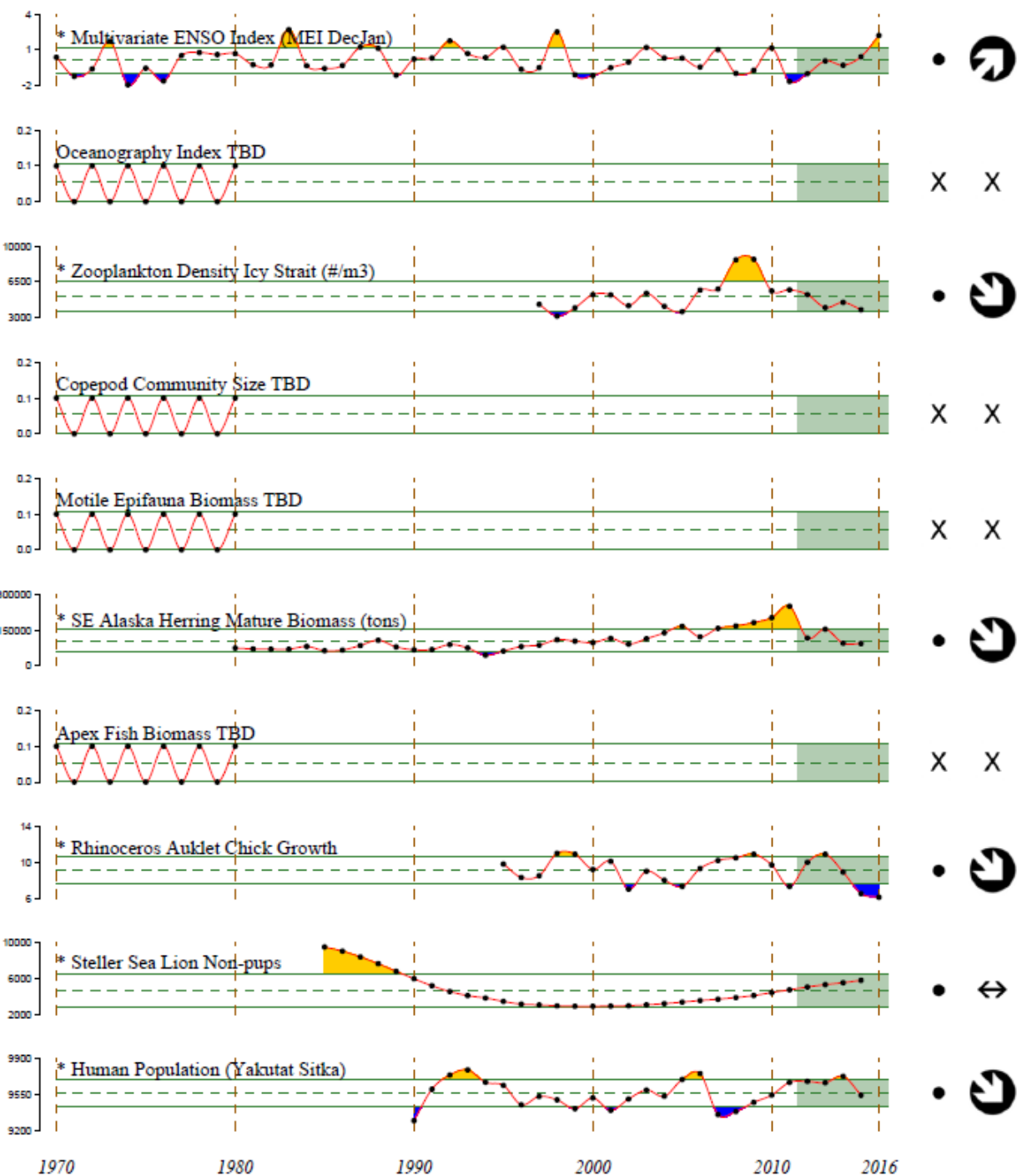
Now West and East

2016 Western Gulf of Alaska Report Card

1. PDO
2. Fresh Water Input
3. Mesozooplankton
4. Copepod Size
5. Motile Epifauna Biomass
6. Capelin
7. Apex Fish Biomass
8. Kittiwake Reproductive Success
9. Steller Sea Lions
10. Human Population



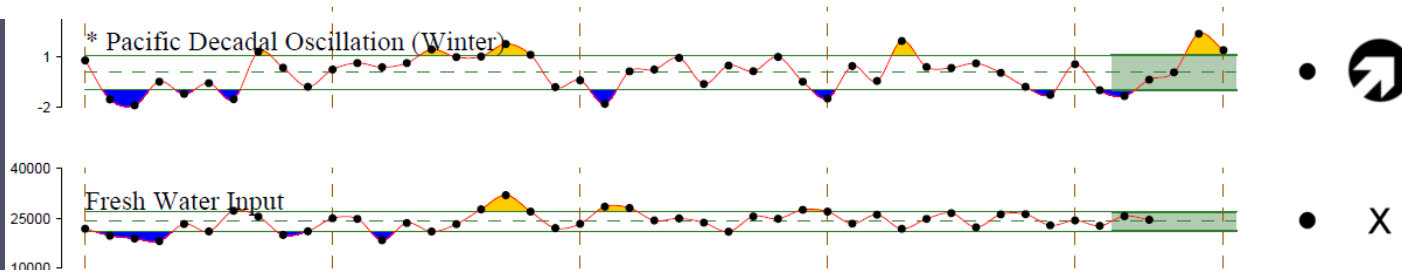
2016 Eastern Gulf of Alaska Report Card



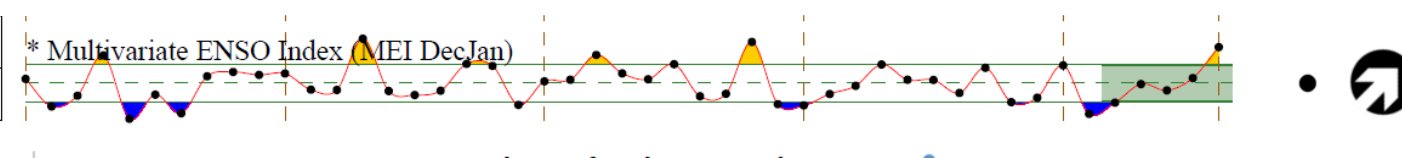
1. MEI
2. (Oceanography)
3. Zooplankton density
4. (Copepod Size)
5. (Motile Epifauna Biomass_
6. SE AK Herring
7. (Apex Fish Biomass)
8. Rhinoceros auklet chick growth
9. Steller Sea Lions
10. Human Population

2016 GOA Physical Conditions

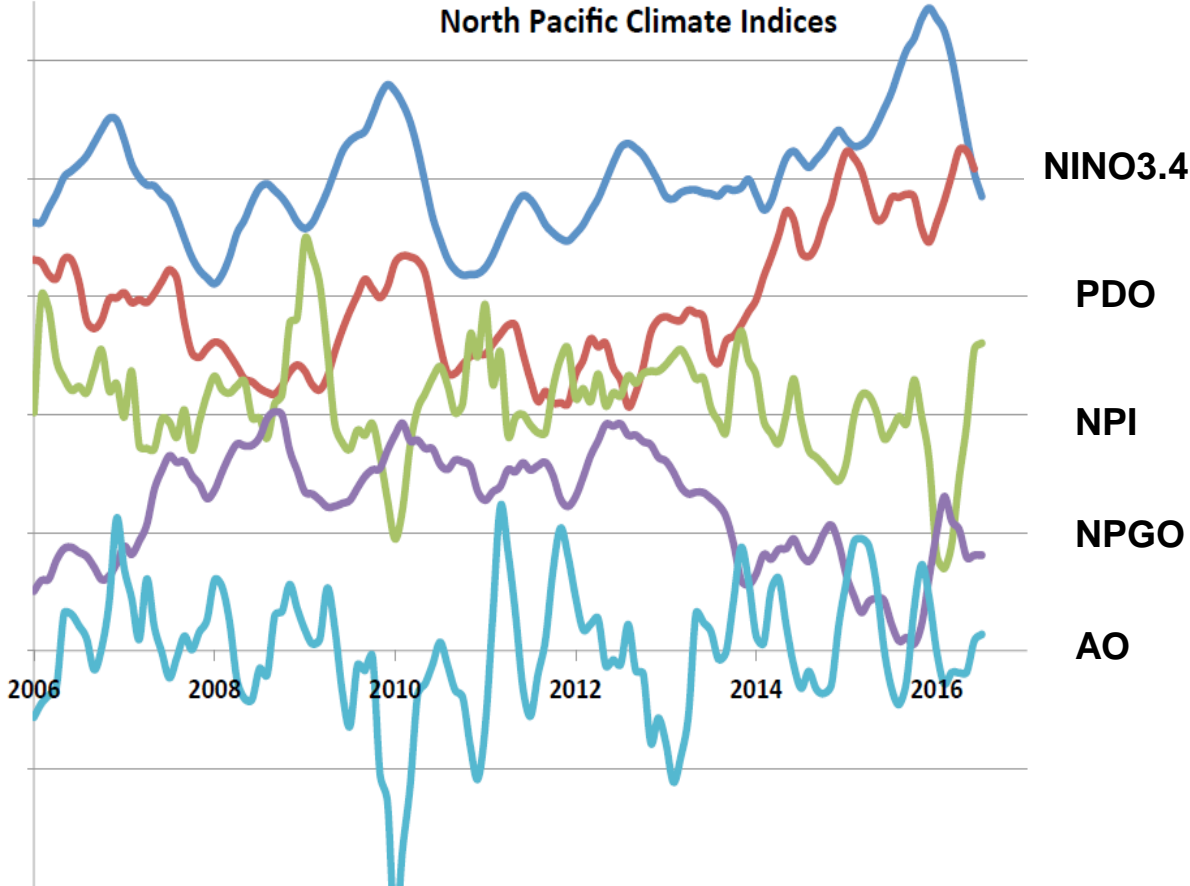
West



East



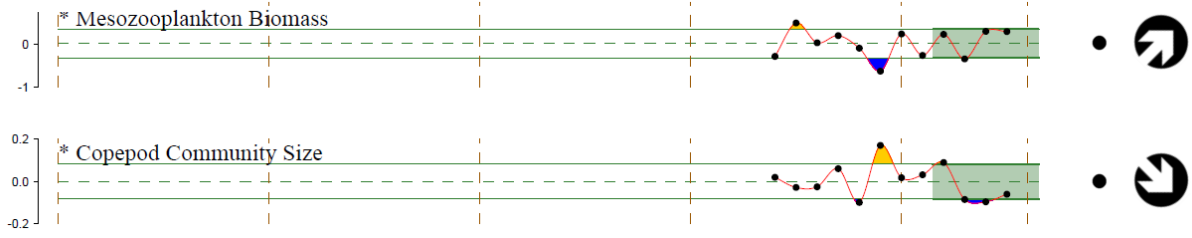
North Pacific Climate Indices



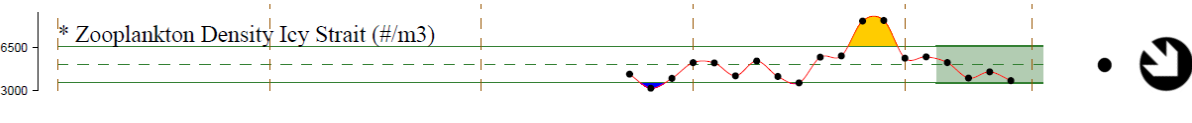
- Weak La Niña
- PDO still positive

Zooplankton

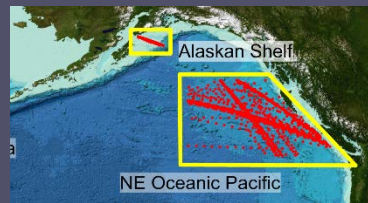
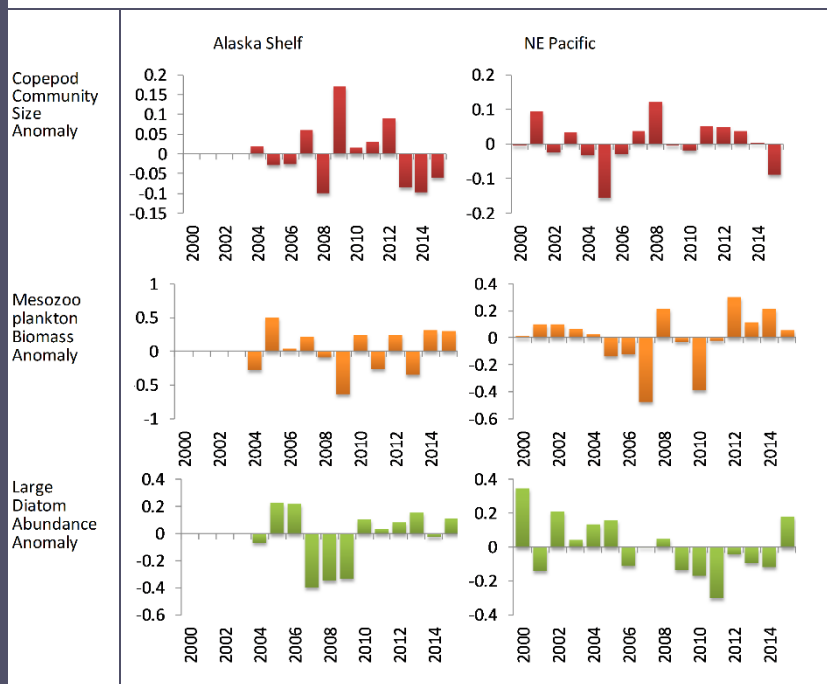
West



East



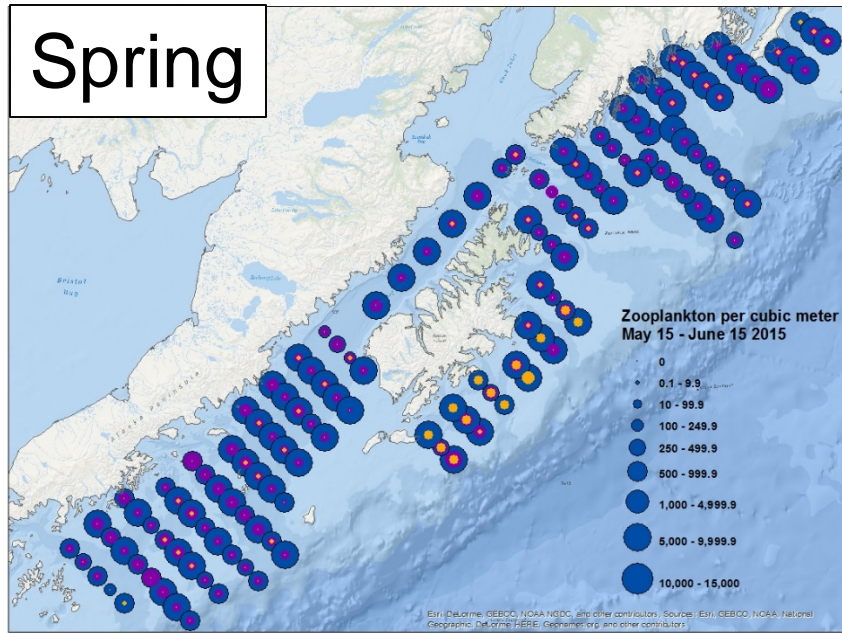
Continuous Plankton Recorder



2011-2015 Trend

- ↗ increase by 1 s.d. over time window
- ↘ decrease by 1 s.d. over time window
- ↔ change <1 s.d. over window
- ✕ fewer than 3 data points

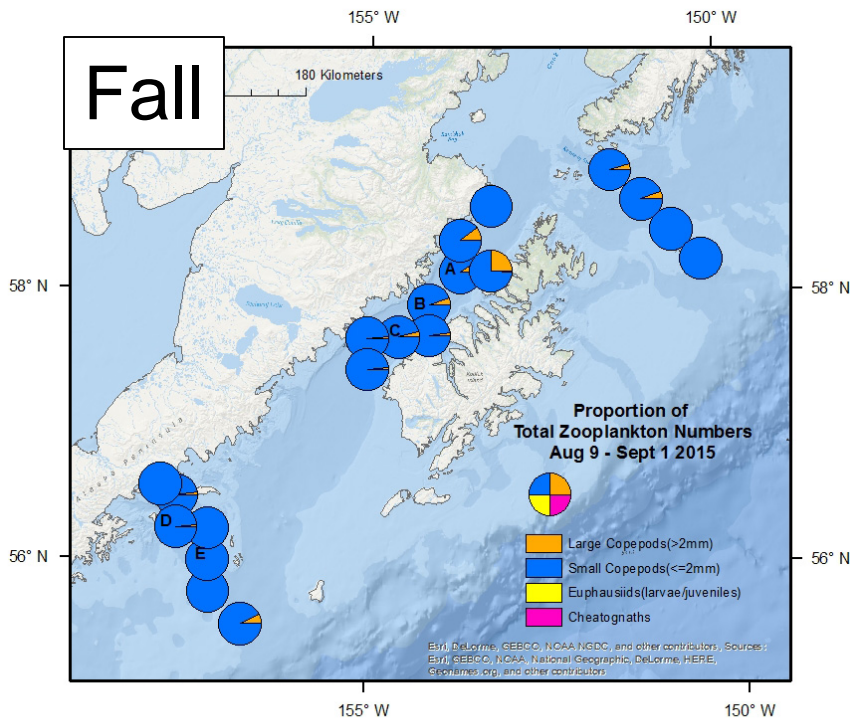
Spring



2015 Zooplankton Rapid Assessment Kimmeel

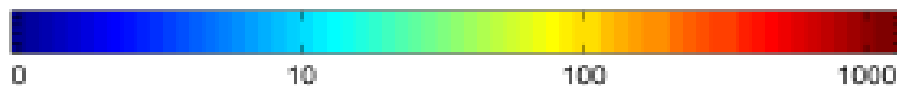
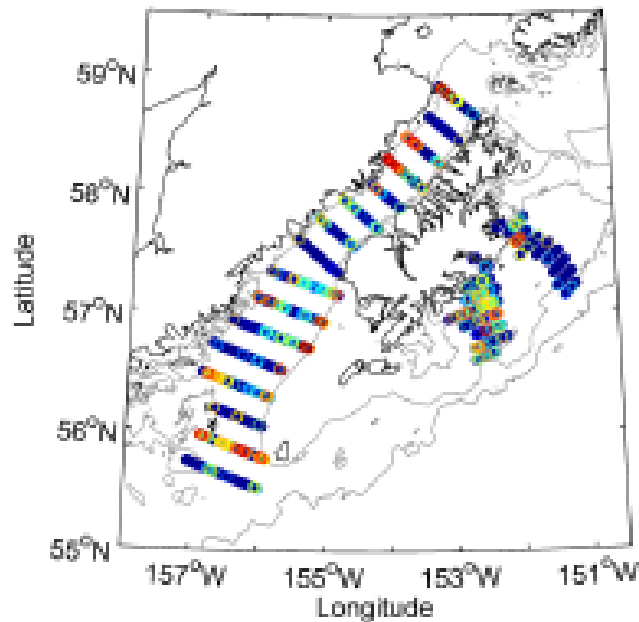
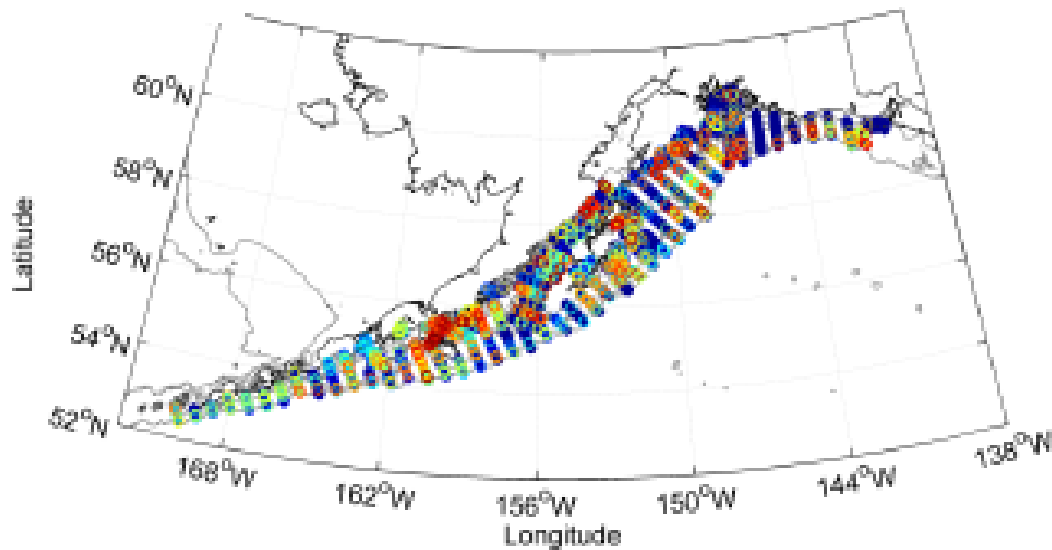
- Small copepods dominated and increased from spring to fall

Fall



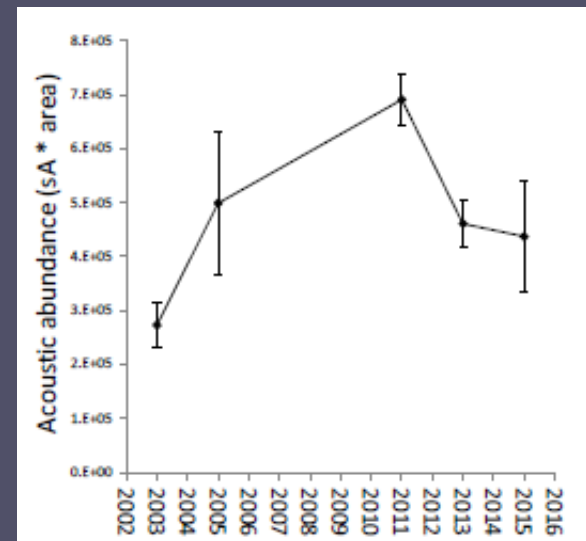
	Δ proportion
Large copepods	-4.1
Small copepods	+8.9
Euphausiids	+0.1
Chaetognaths	-7.8

2015



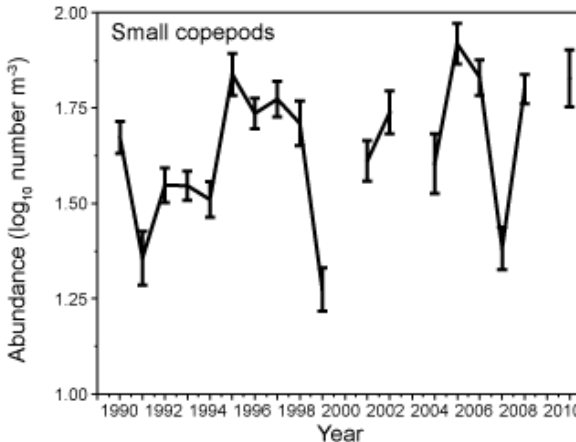
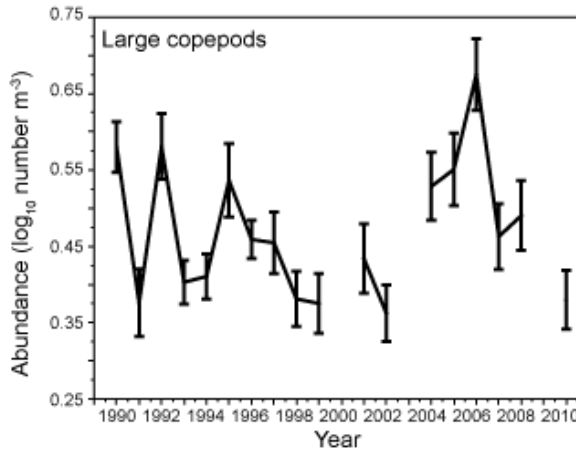
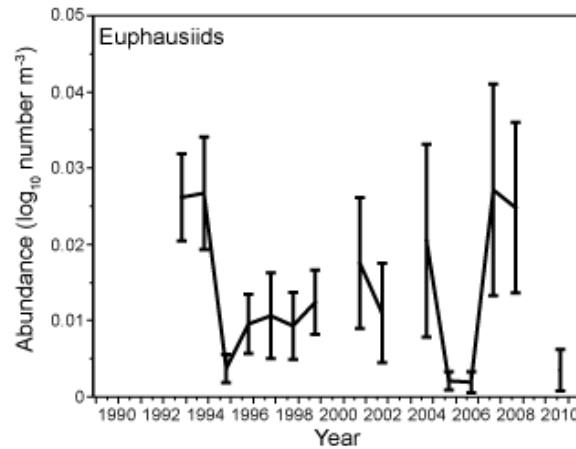
Gulf of Alaska euphausiids – “krill” (Ressler and Simonsen)

- Acoustically backscatter
- Highest abundance in 2011
- Lowest in 2003
- Small decline relative to 2013

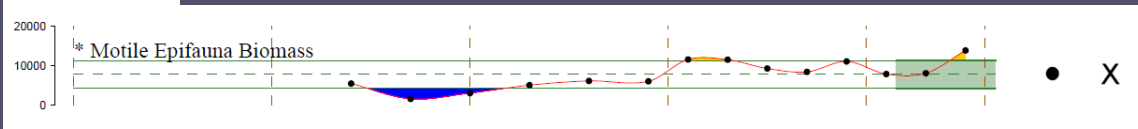


Zooplankton Rapid Assessment Hindcast

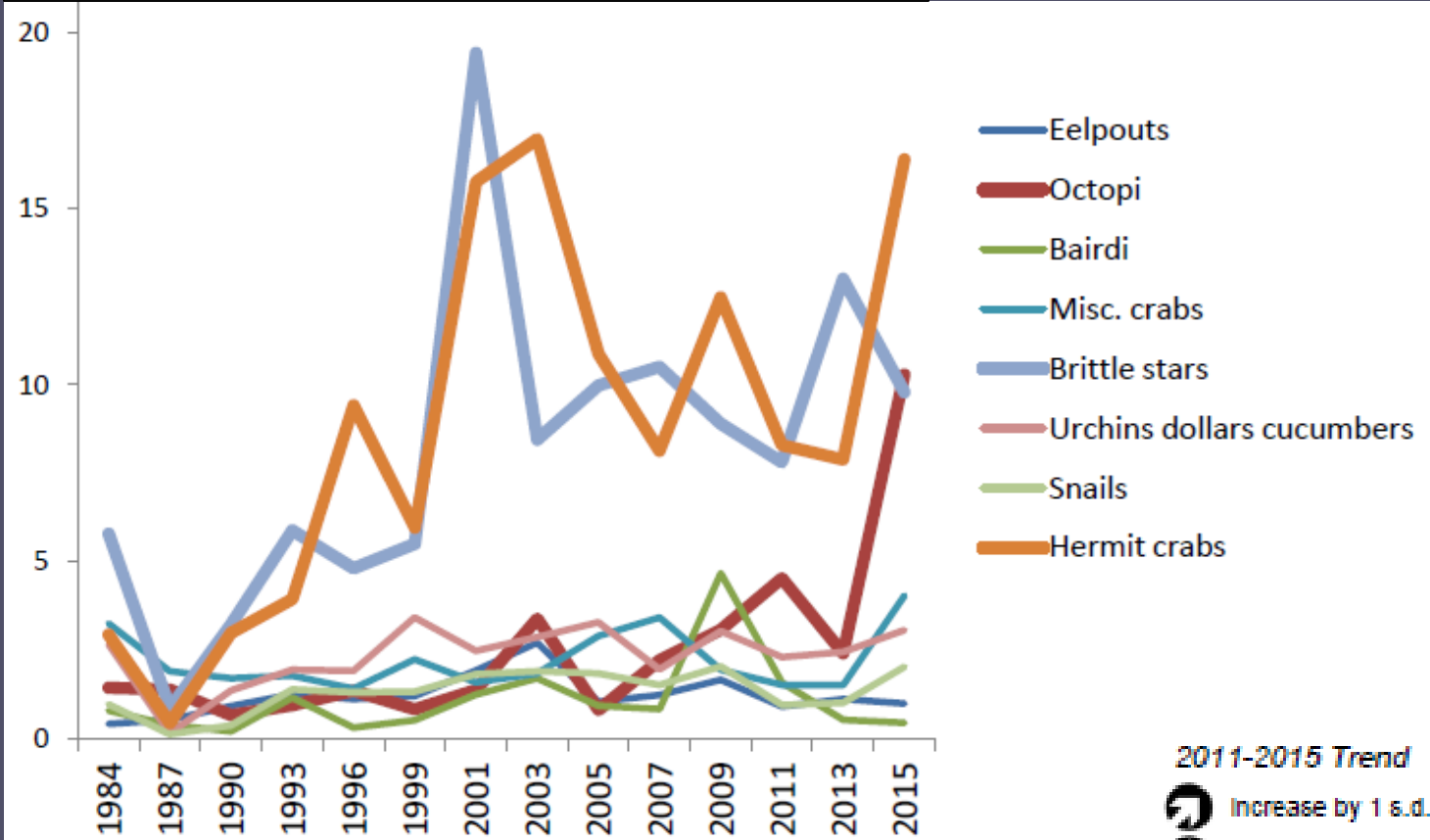
Kimmel







- Shelikof Strait, Line 8
- 1990-2012
- Can be compared with within-year rapid assessments
- Trends appear related to PDO cycles

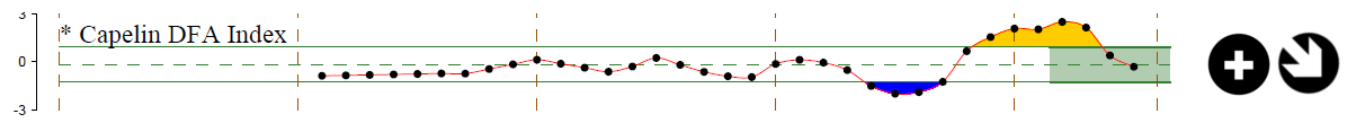


Aggregated biomass from the BT survey



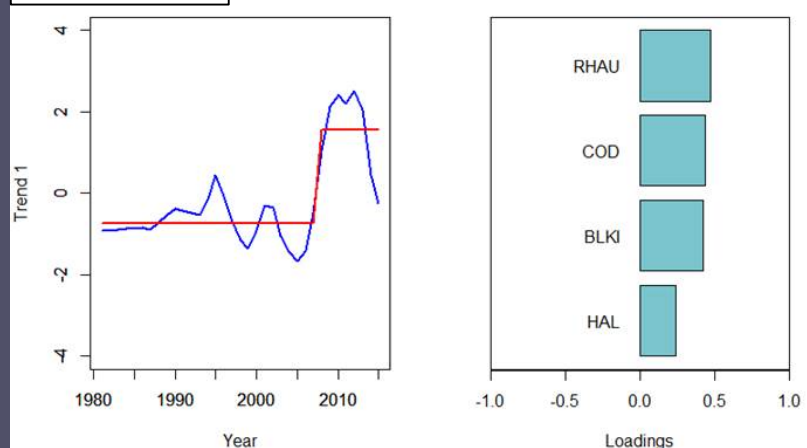
2011-2015 Trend

-  Increase by 1 s.d. over time window
-  decrease by 1 s.d. over time window
-  change <1 s.d. over window
-  fewer than 3 data points



Capelin

New indicator

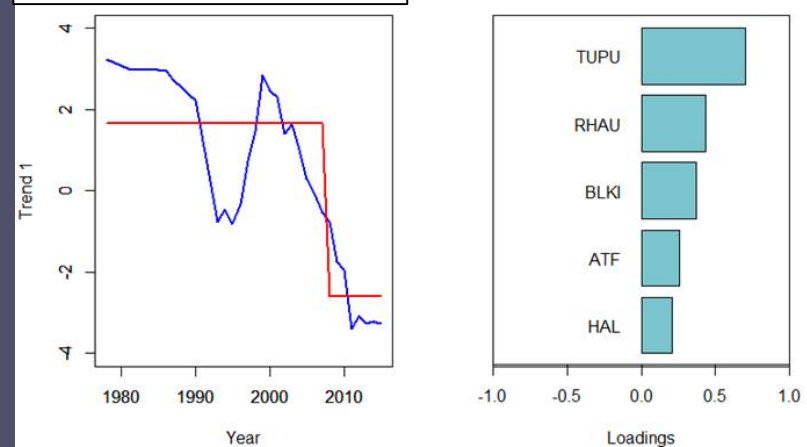


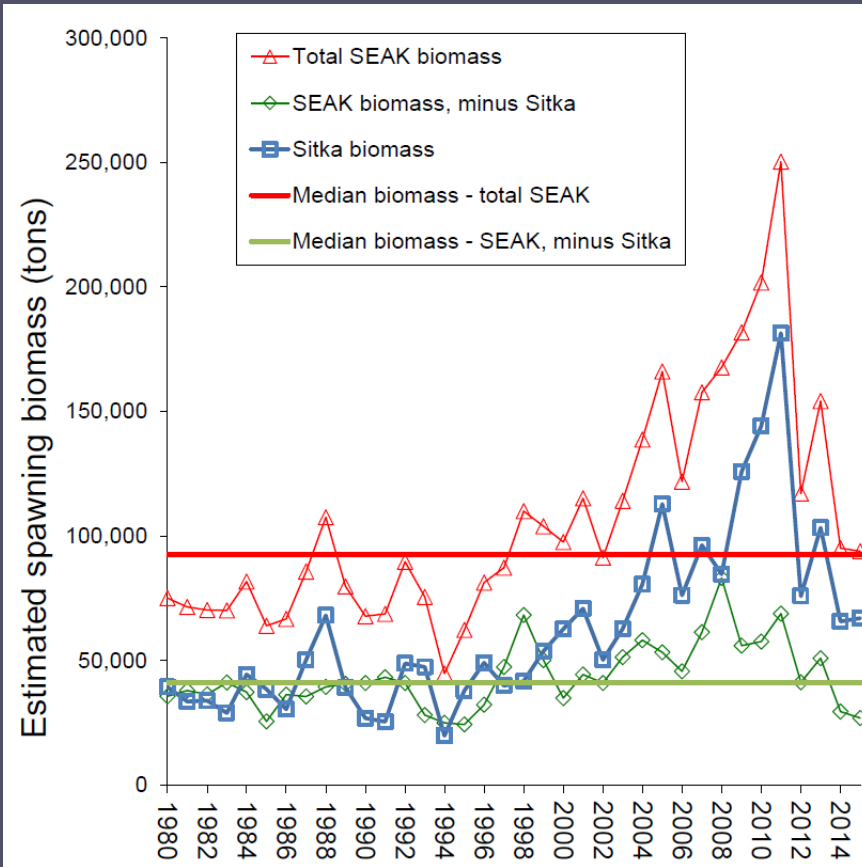
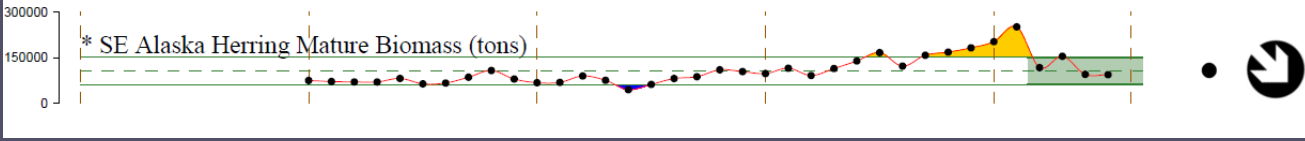
Capelin and Sand Lance Trends

Zador

- Groundfish and seabird used as “samplers” with diverse foraging strategies.
- ~1980-2015
- Dynamic Factor Analysis with SRSD (regime shift detection, Rodionov)
- Single trend best fit model for both
- Regime shifts detected in 2008

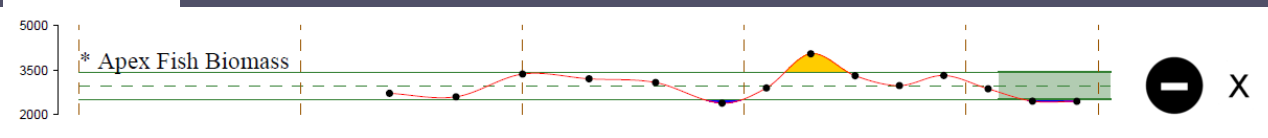
Sand lance



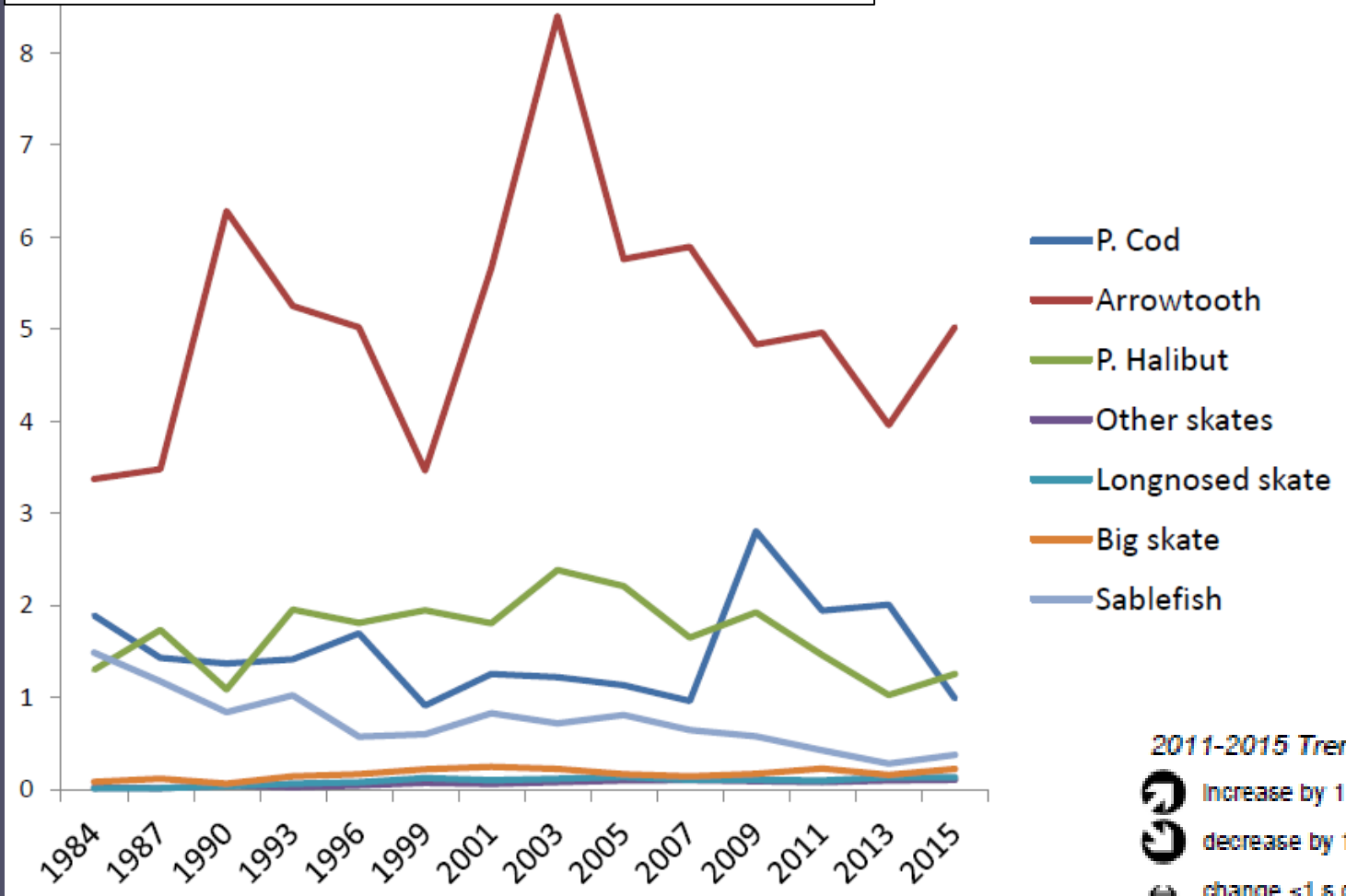


Southeast Alaska Herring (Hebert and Dressel)

- Peak biomass in 2011
- 2012, 2014, large declines
- Little change in 2015



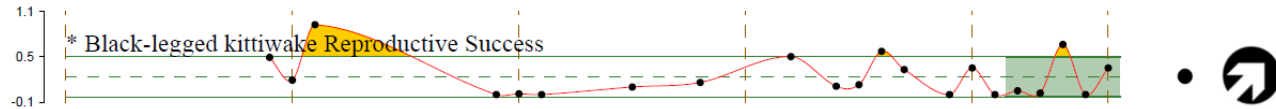
Aggregated biomass from the BT survey



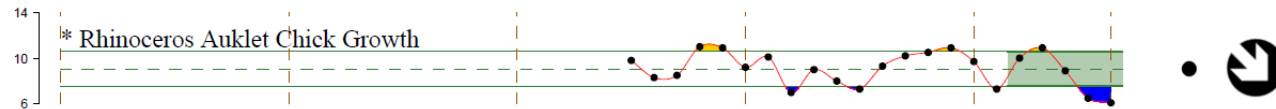
- 2011-2015 Trend**
- increase by 1 s.d. over time window
 - decrease by 1 s.d. over time window
 - change <1 s.d. over window
 - fewer than 3 data points

GOA Seabirds

West



East

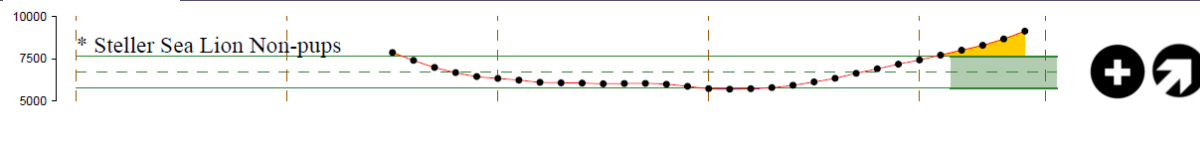


- Common surface-foraging, piscivorous seabirds
- Black-legged kittiwakes: proportion of nest sites with chicks that fledged
- Rhinoceros auklets: chick growth rates
- Replace with multivariate seabird indicators in the future?

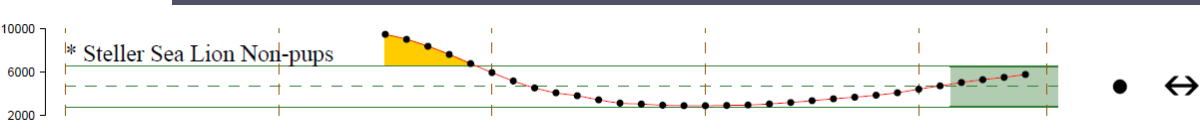


Steller sea lions

West



East



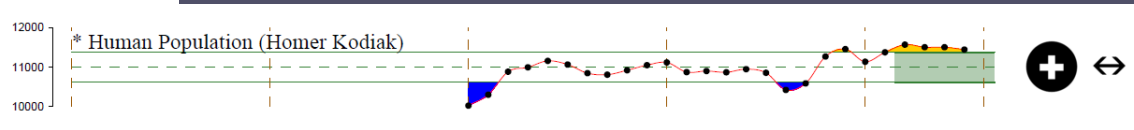
- Marine Mammal indicator
- AgTrend model
- Abundance estimates of non-pups



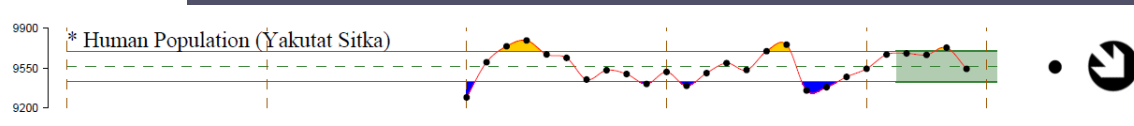
2011-2015 Trend

- ↗ increase by 1 s.d. over time window
- ↘ decrease by 1 s.d. over time window
- ↔ change <1 s.d. over window
- ✕ fewer than 3 data points

West



East



Human populations

- Human Impact Indicator
- Combined populations of Homer and Kodiak (West); Sitka and Yakutat (East)
- Closely associated with the marine ecosystem
- Data from the Alaska State Labor Statistics
- Refine to better represent human population directly influenced by fishing and/or ecosystem state?

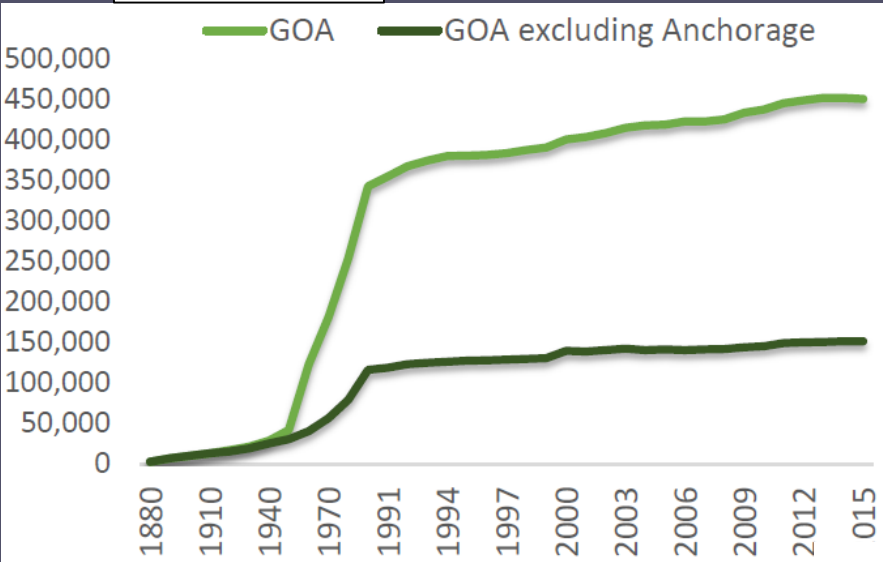
2011-2015 Mean

- ⊕ 1 s.d. above mean
- ⊖ 1 s.d. below mean
- within 1 s.d. of mean
- χ fewer than 2 data points

Human Population and Unemployment

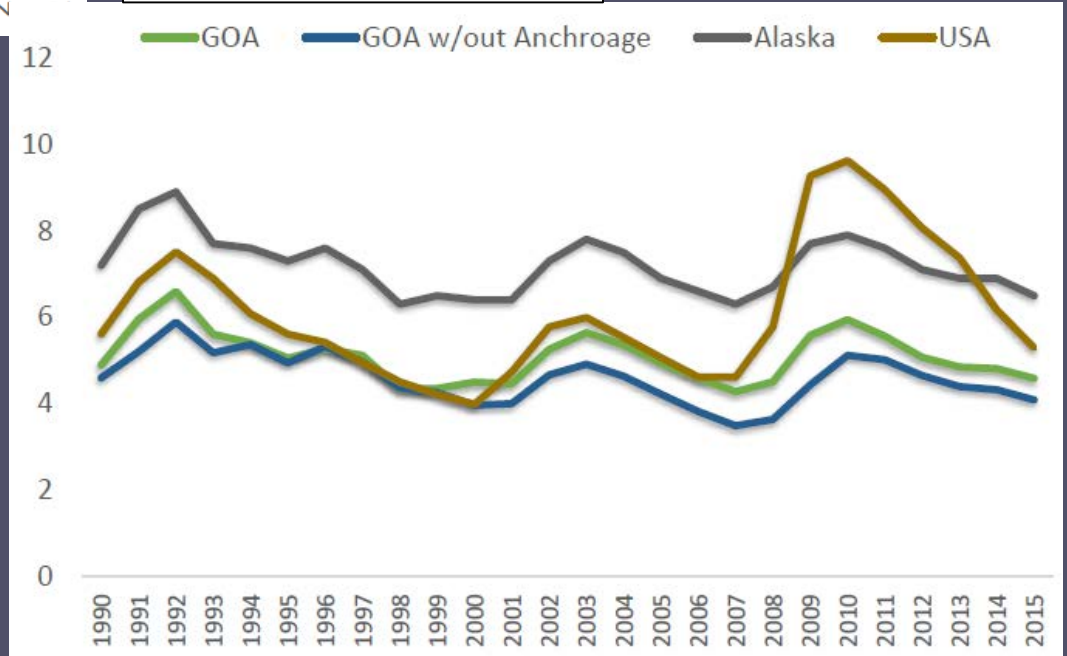
Santos

Population



- Potential to replace current human indicators?
- Communities within 25 miles of coast or historical fishing involvement
- Unemployment data aggregated and weighted across boroughs

Unemployment rate



Hot Topic

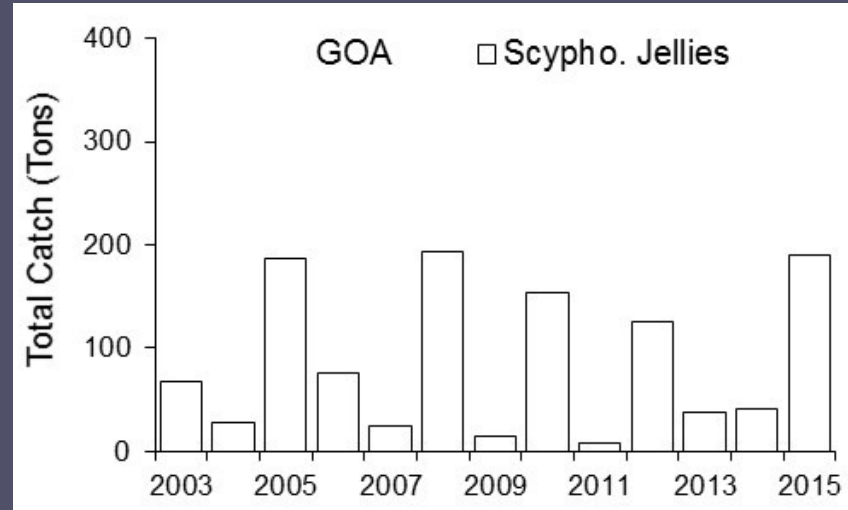
Newly observed pteropod and re-occurrence of high salp abundance during 2016 surveys (Moss and Strasburger)



- High abundance in 2011 and 2016
- High water filtration rate contributed to low chlorophyll a in 2011
- Preliminary observations indicate same pattern in 2016
- Indicator of poor productivity?
- *Corolla ovata*
- Inside waters, over shelf and offshore

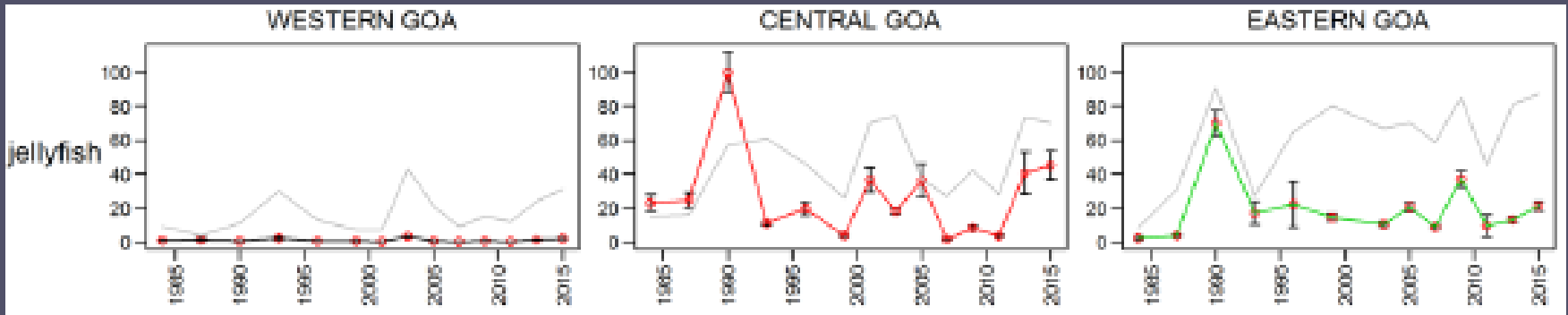
Jellyfish Non-target catch in commercial fisheries

Whitehouse



Generally highest in Central and Eastern
Recently very high in Central

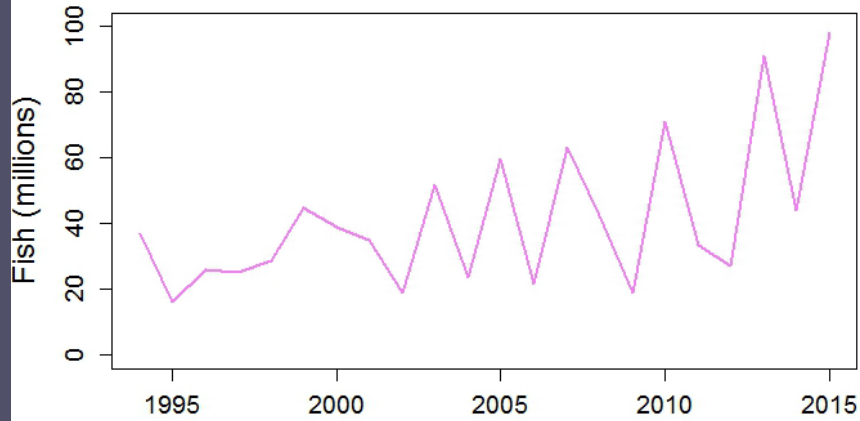
Jellyfish Bottom Trawl Survey (Rooper)



GOA Pink Salmon

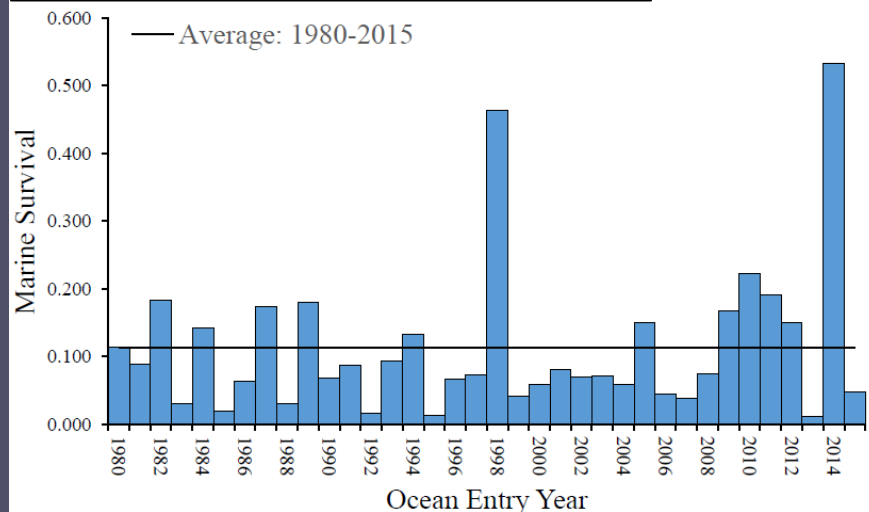
Whitehouse, Vulstek, Orsi et al

PWS pink harvest

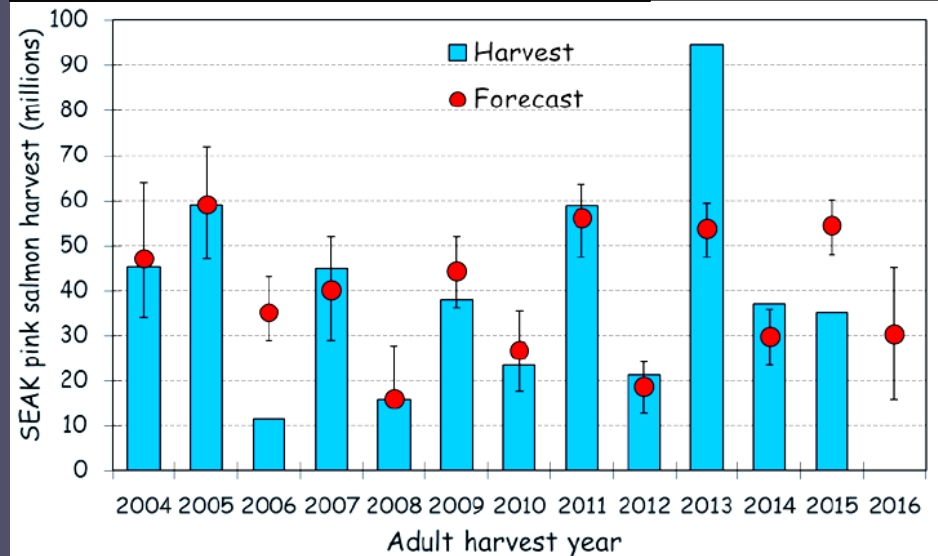


- Large 2015 return in north, but less than expected in South
- 2016 return low: 18 M in SE, 13 M in PWS
- Many juvenile pinks observed in 2016

Auke Creek marine survival



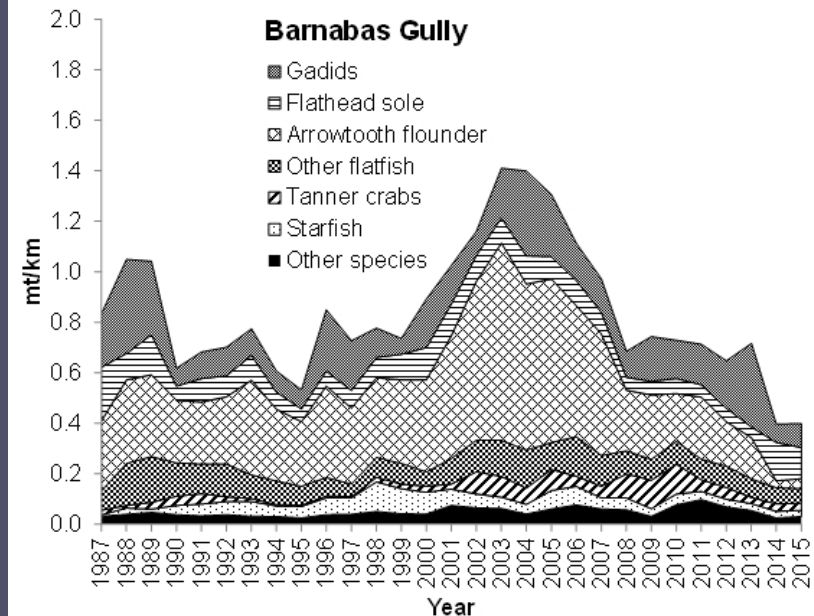
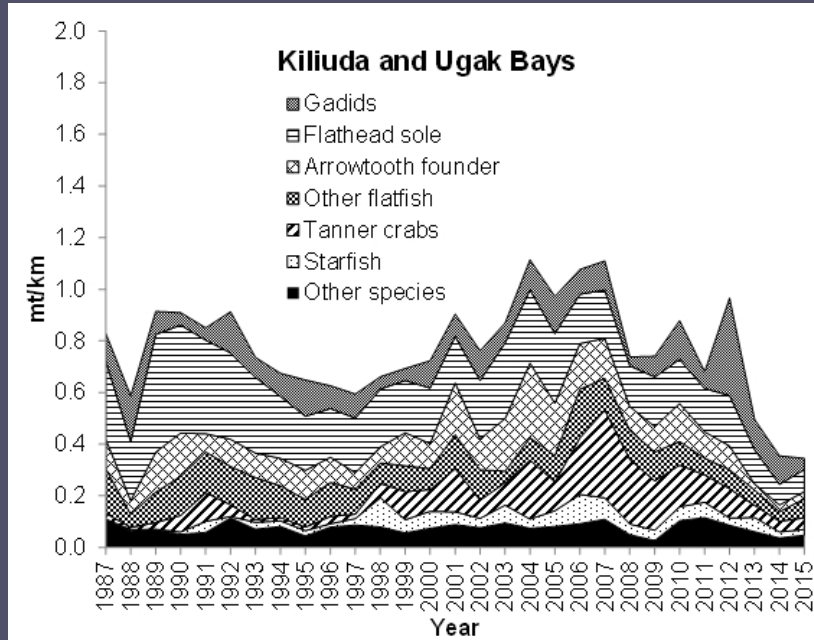
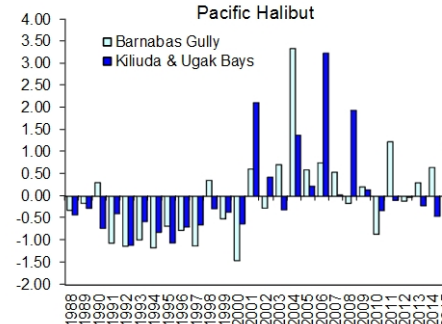
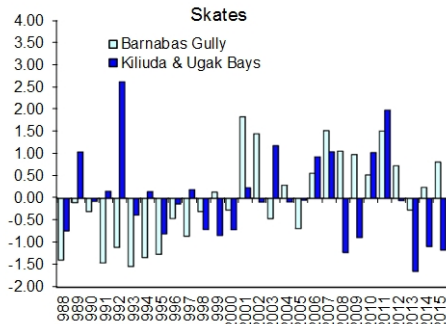
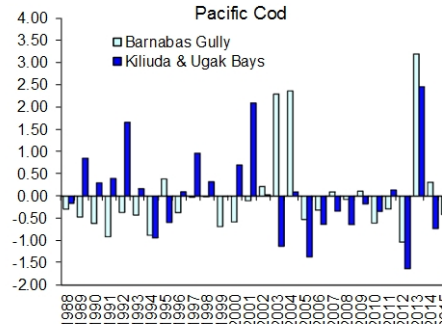
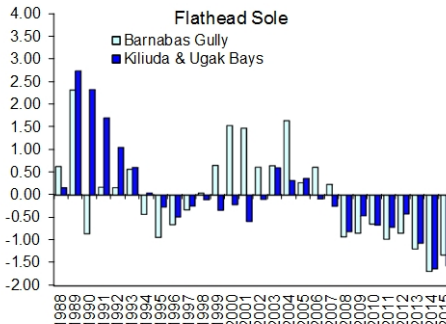
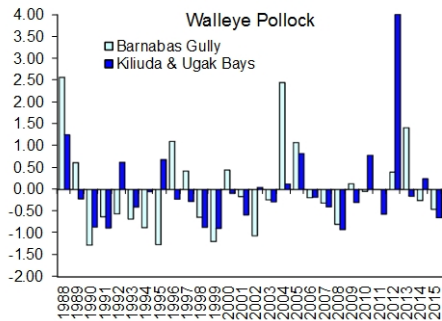
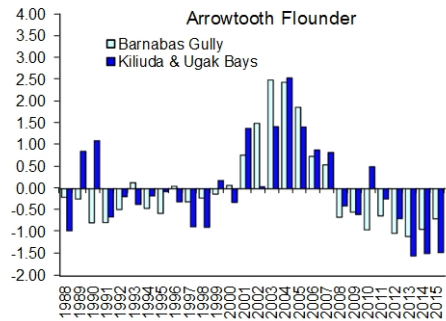
SEAK harvest forecast

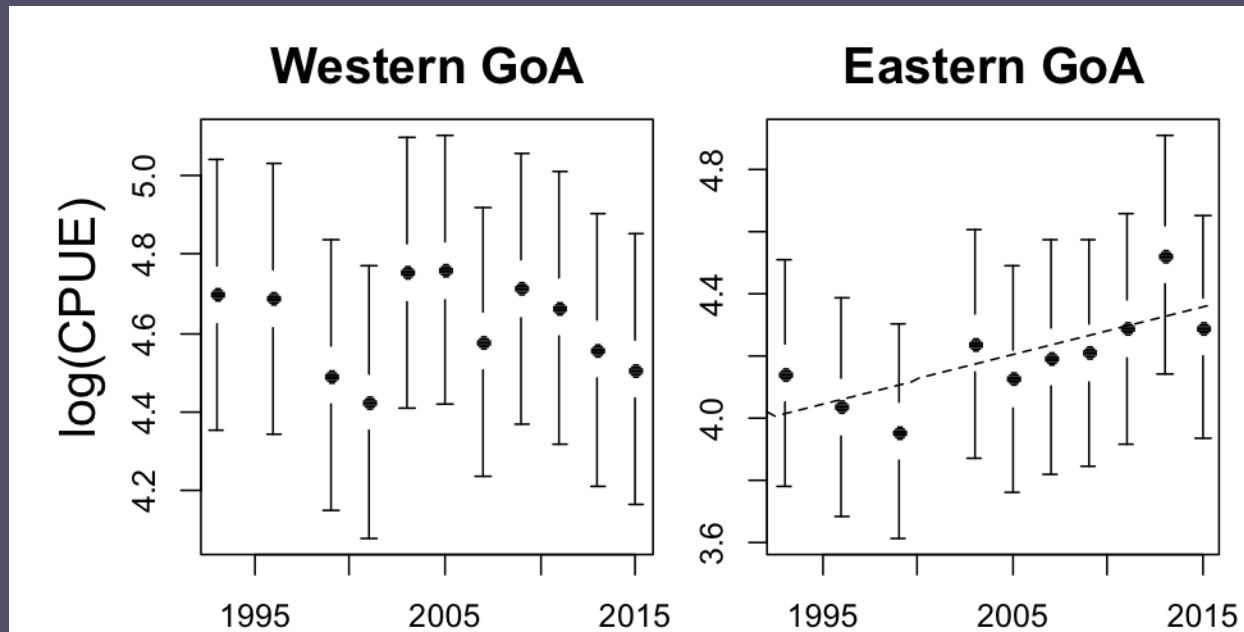


2015

ADF&G Gulf of Alaska Trawl Survey (Worton)

- Decrease in overall biomass since 2007; flatfish continue to dominate catch
- In 2015, halibut increased; flathead sole, ATF, cod, pollock all below; lower skates inshore.

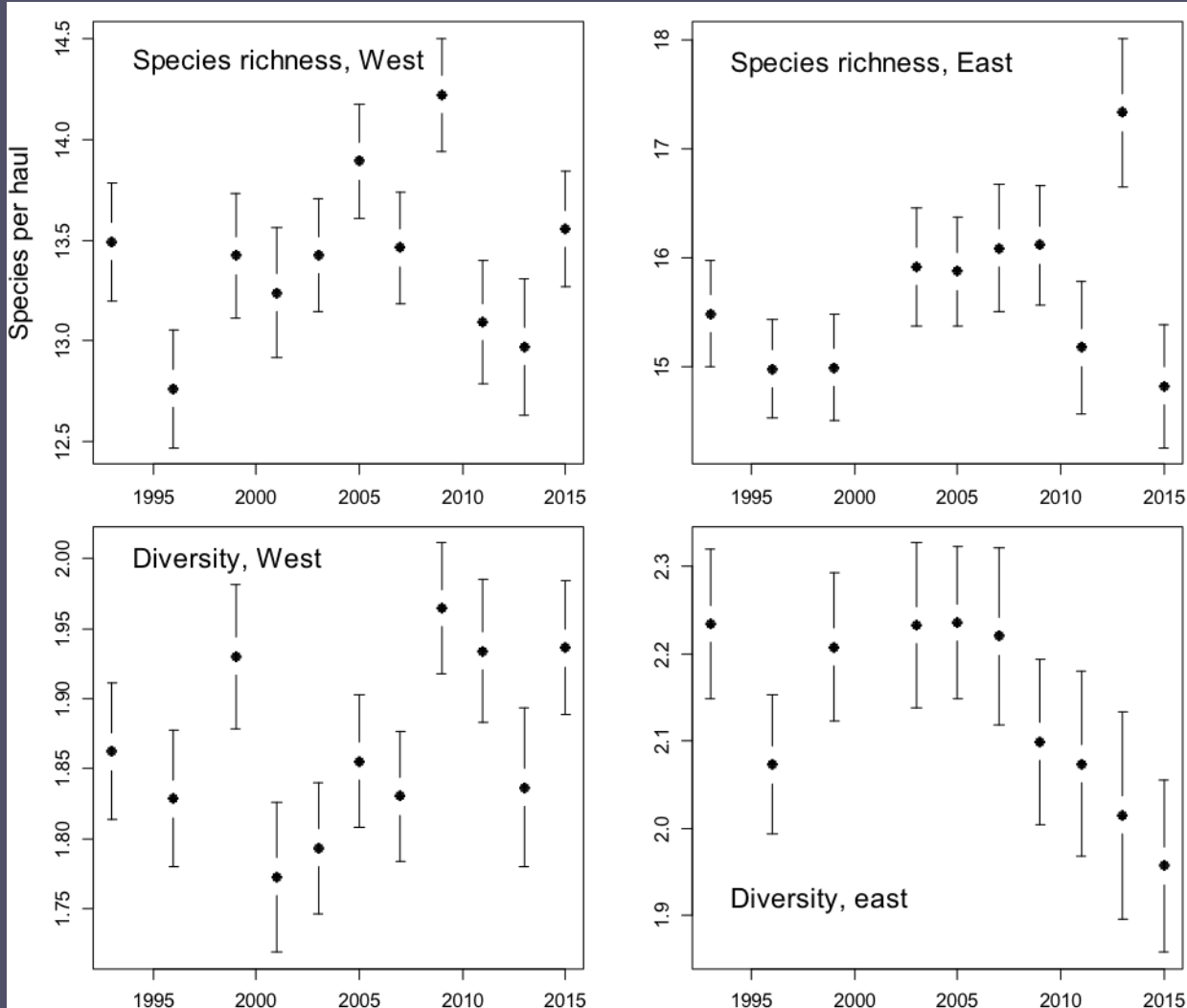




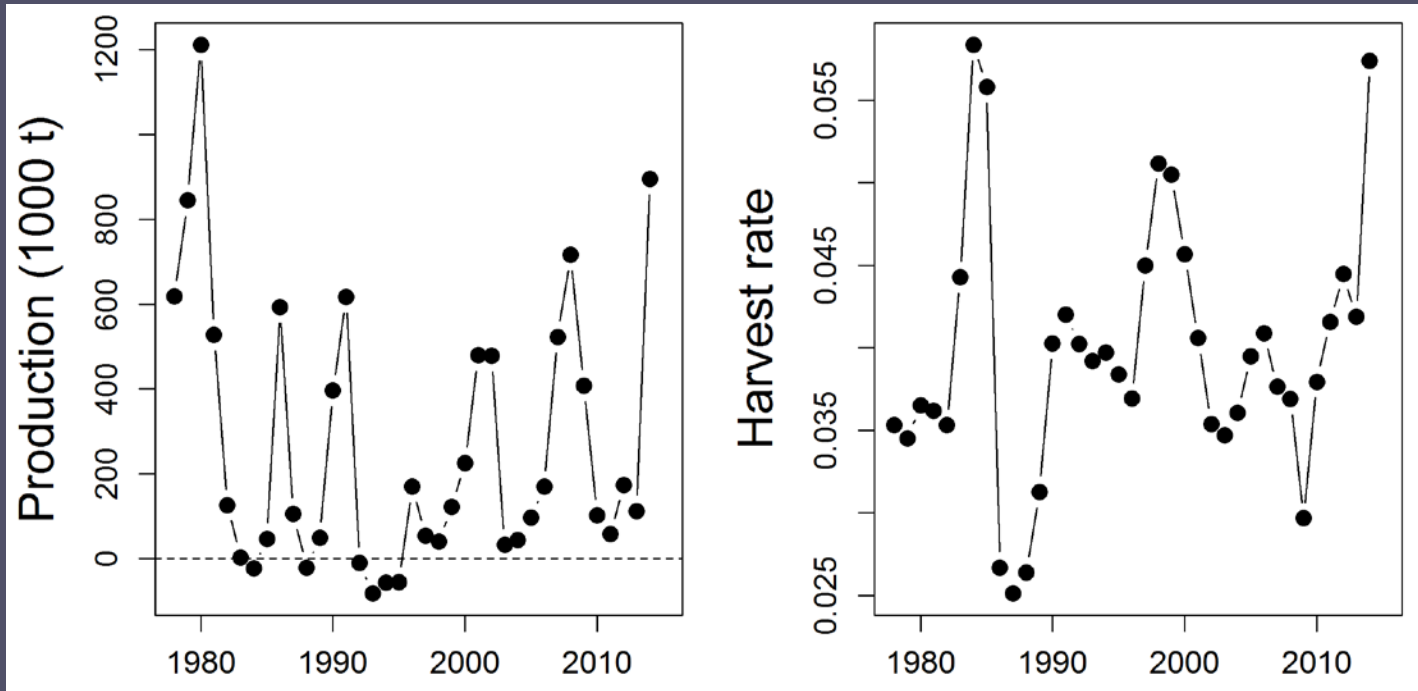
- Aggregated CPUE of fish and invertebrates in bottom trawl survey
- No overall trend in W GOA, though appears to decline in recent past
- Significant increasing trend in E GOA ($t = 3.102$, $p = 0.0146$)
- Suggests prey base has remained stable or increasing

Species Richness and Diversity

Meuter



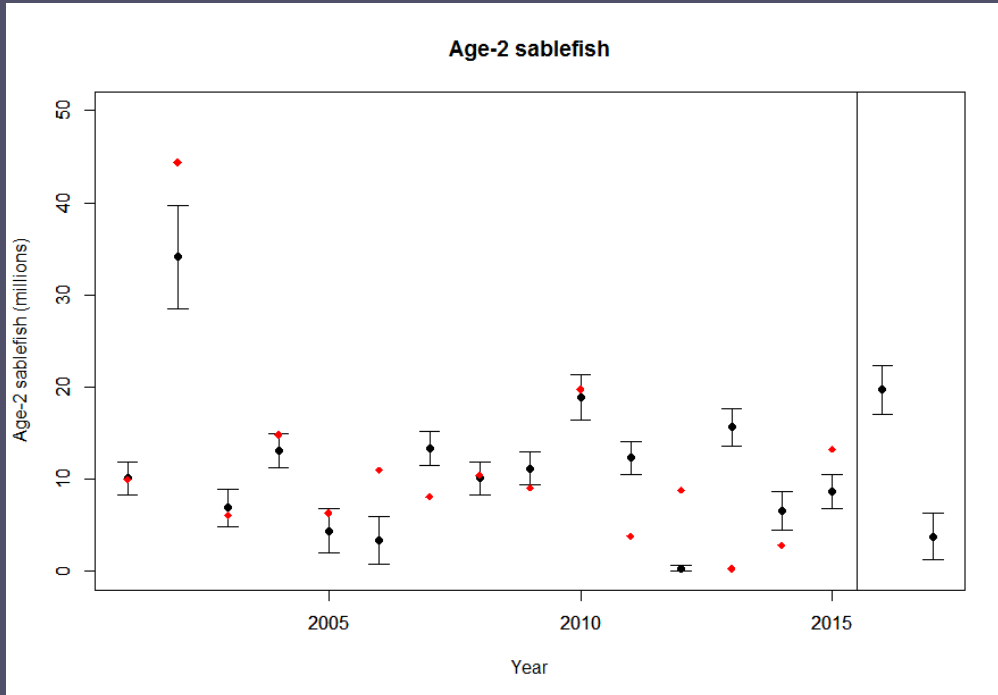
- Richness and diversity tend to be higher in E GOA (not so much recently)
- Diversity decreasing in E GOA since 2007



- Sum of new growth and recruitment minus natural mortality
- Should equal long term average catch, if no long-term trend in biomass
- Recent peak in 2014, which was first year of warmth.
- Fits overall ecosystem observations of high productivity following climate shift (Zador interpretation)

Southeast coastal monitoring survey indices and the recruitment of GOA sablefish

(Yasumiishi et al)



Icy Strait

Data: temperature, chl a, pink salmon productivity

Provides: rearing habitat for sablefish

Higher recruitment appears to be a function of more late August chl a during age-0 stage (BIC)

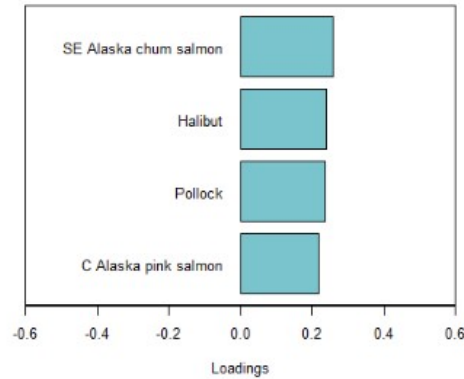
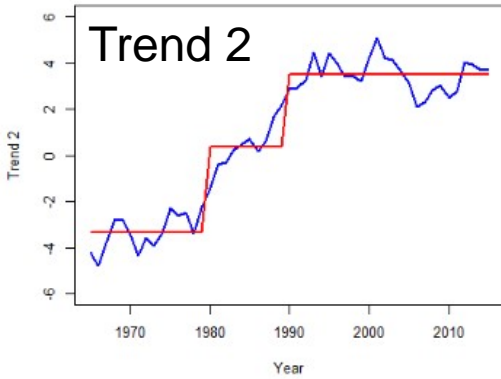
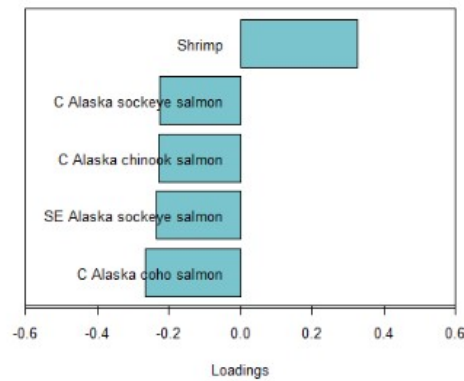
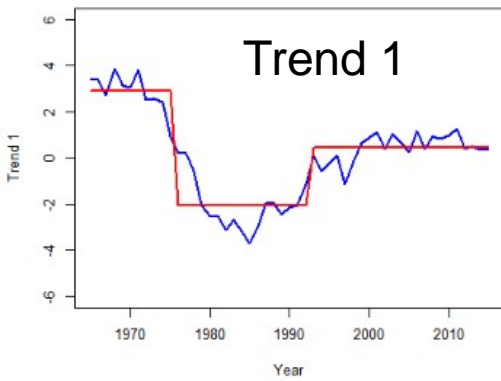
Chl a $R^2 = 0.59$, $p = 0.0008$

Prediction: below-average age-2 recruitment in 2017.



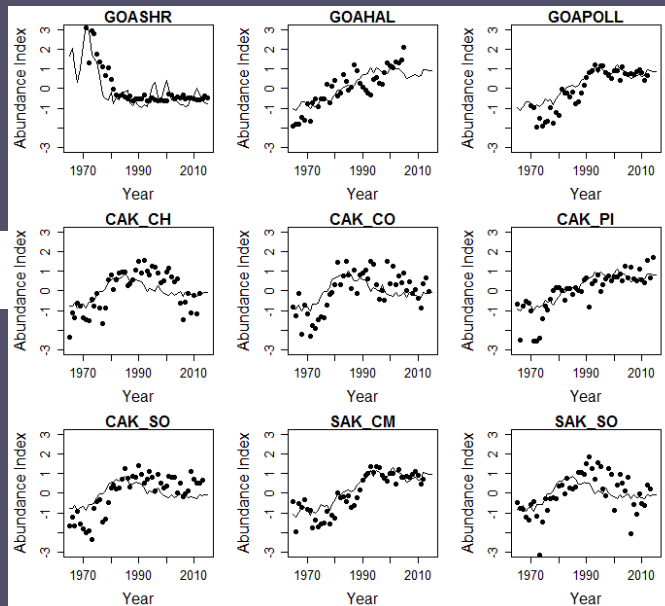
Regime Shift Indicator

Zador and Frandsen



- Update to Hare and Mantua; Litzow papers
- Changed PCA to DFA
- 2 trend model selected (PCA found only 1 with additional shift in mid-2000s)
- 2 regime shifts detected (Rodionov):
 - Late 70's: more salmon and groundfish, less shrimp
 - 89-92: more shrimp, groundfish, pink and chum, less other salmon

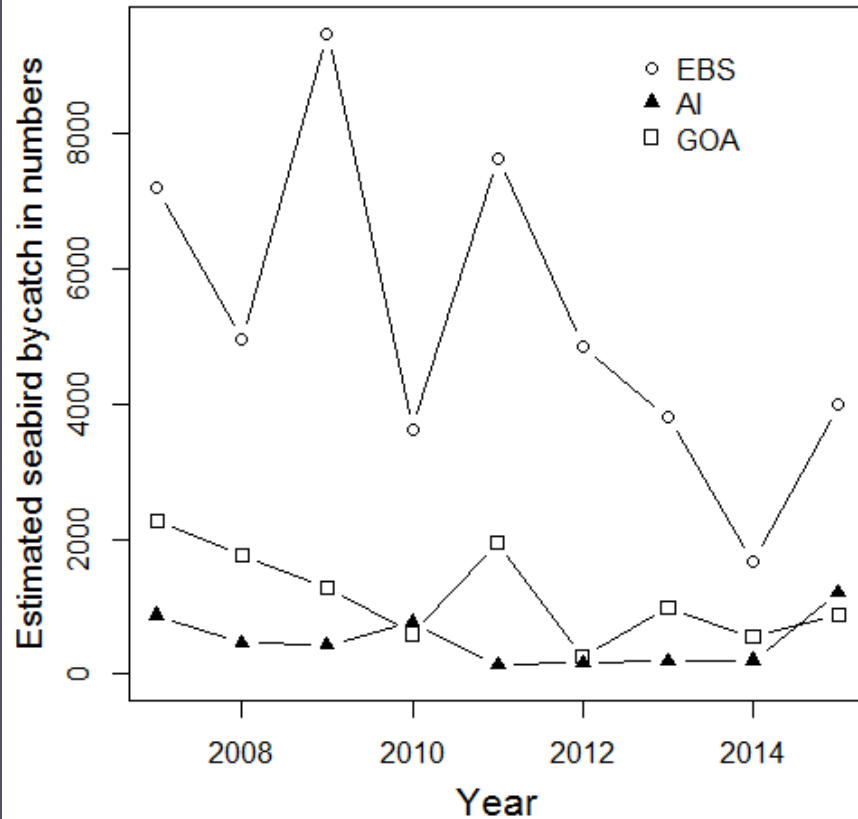
Fit to data



Seabird bycatch in commercial fisheries

(Zador et al)

Total estimated bycatch, all gear types



- Increase in birds bycaught in the GOA in 2015
- Increase in most commonly-caught species
- Indicative of poor “natural” food supply?

Estimated numbers of birds caught in GOA

Species Group	2007	2008	2009	2010	2011	2012	2013	2014	2015
Unidentified Albatross	17	0	0	0	10	0	28	0	0
Black-footed Albatross	180	273	49	62	215	141	432	269	350
Laysan Albatross	0	168	89	84	163	17	69	32	41
Northern Fulmar	1439	870	602	174	874	19	260	51	88
Shearwaters	31	0	0	0	61	0	56	0	5
Cormorant	0	0	0	0	0	0	0	0	28
Gull	560	182	366	279	615	50	136	157	287
Auklets	0	0	0	0	0	0	0	6	49
Other Alcid	0	0	0	0	0	0	0	39	0
Unidentified	48	266	187	0	9	33	7	0	34
Grand Total	2275	1759	1292	600	1946	260	988	553	883



Summary

2015

- Continuation of warm conditions
- Average to poor productivity
- Die-offs for birds and whales

2016

- Continuation of warm conditions
- Low zooplankton biomass and lower-lipid taxa in EGOA
- Reoccurrence of salps and mushy halibut syndrome
- High catches of juvenile pink and chum salmon in the EGOA
- Small age-3 pollock in winter, caught up over spring

Website

Contributors

Sonia Batten, Nick Bond, Kristin Cieciel, Sherri Dressel, Emily Fergusson, Nissa Fern, Shannon Fitzgerald, Madisyn Frandsen, Sarah Gaichas, Jeanette Gan, Andrew Gray, Dana Hanselman, Brad Harris, Kyle Hebert, John Joyce, David Kimmel, Carol Ladd, Robert Lauth, Jean Lee, Kathryn Miers, Jennifer Mondragon, Jamal Moss, Franz Mueter, John Olson, Joseph Orsi, Heather Renner, Lauren Rogers, Nora Rojek, Joshua Russell, Anna Santos, Kalei Shotwell, Leslie Slater, Wes Strasburger, Scott Vulstek, Alex Wertheimer, Andy Whitehouse, Carrie Worton, Ellen Yasumiishi, and Stephani Zador

Thank you!

<http://access.afsc.noaa.gov/reem/ecoweb/index.php>

Alaska Marine Ecosystem Considerations

Home Report Assessments Report Cards Hot Topics Links

The Ecosystem Considerations report is produced annually to compile and summarize information about the status of the Alaska Marine Ecosystem for the [North Pacific Fishery Management Council](#), the scientific community and the public. The report includes ecosystem report cards, ecosystem assessments, and ecosystem and ecosystem-based management indicators for the Eastern Bering Sea (EBS), Aleutian Islands (AI), the Gulf of Alaska (GOA), and Arctic ecosystems.

Eastern Bering Sea

- [Assessment](#)
- [Report Card](#)
- Hot Topics
 - [Chum Salmon](#)
 - [Bird Sightings](#)

Aleutian Islands

- [Assessment](#)
- [Report Card](#)

Gulf of Alaska

- [Assessment](#)
- [Report Card](#)
- Hot Topics
 - [Too Warm?](#)
 - [Age-0 Pollock](#)
 - [Marine Mammals](#)

Arctic

- [Assessment](#)
- Hot Topics
 - [Polar Bears](#)

Next Steps

2017

- Continue to refine GOA Report Cards
- Split indicators into West v East as possible
- Select indicators to fill gaps
- Aim for current year indicators
- Move towards past, present, future structure of EBS assessment