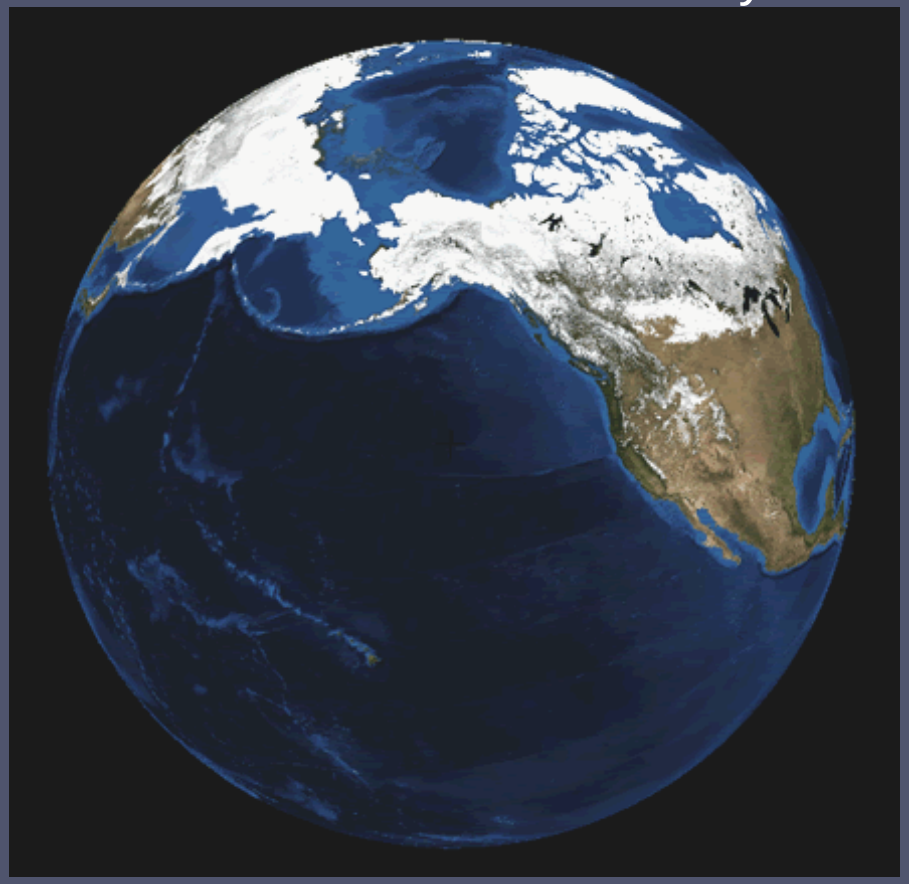
ECOSYSTEM CONSIDERATIONS 2015

Status of Alaska's Marine Ecosystems



Stephani Zador
North Pacific Fisheries Management Council meeting
December 2015

One-slide summary

2014

Physical indicators:

- Big shifts
- Newly warm conditions

⇨

Biological indicators:

- Mostly productive

2015

Physical indicators:

- Continuation of warm

⇨

Biological indicators:

- Average to low productivity

2015 Report Summary

Report Cards

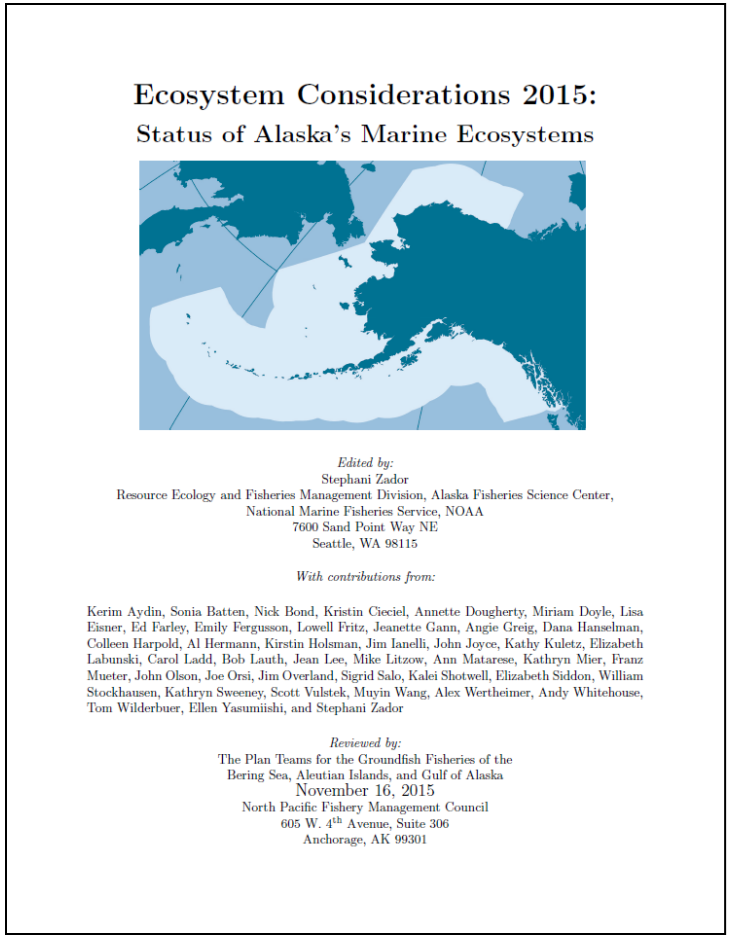
- EBS
- AI
- GOA (new)

Ecosystem Assessments

- Hot Topics – 6
- Arctic
- EBS
- AI
- GOA

Ecosystem Indicator Contributions

- New - 7
- Updated - 51



Ecosystem Considerations 2015:

Status of Alaska's Marine Ecosystems

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Reviewed by:
The Plan Teams for the Groundfish Fisheries of the
Bering Sea, Aleutian Islands, and Gulf of Alaska
November 16, 2015
North Pacific Fishery Management Council
605 W. 4th Avenue, Suite 306
Anchorage, AK 99301

Updated and New Indicators

Ecosystem

Status

- Physical - 13
- Habitat - 2
- ~~Primary production~~ - 0
- Zooplankton – 5 (2 new)
- Jellyfish – 4 (1 new)
- Ichthyoplankton - 1
- ~~Forage Fish~~ - 0
- Herring - 2
- Salmon – 4 (1 new)
- Groundfish – 9 (2 new)
- Benthic & Non-targets - 3
- Seabirds - 1
- ~~Marine Mammals~~ - 0
- Ecosystem/Community – 4 (1)
- Disease Ecology – 2 (1 new)

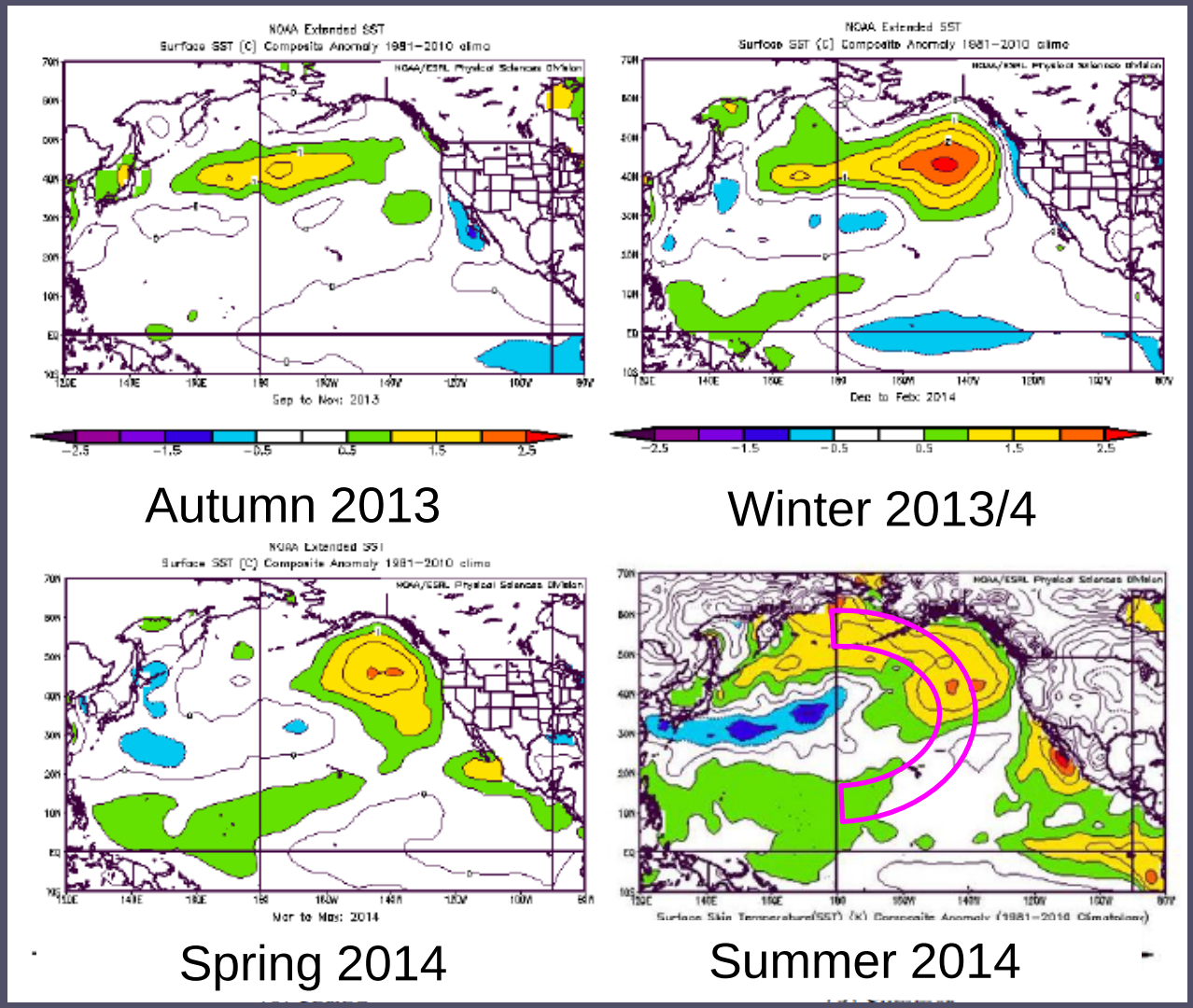
Ecosystem-based Management

- Discards and Non-targets - 3
- Habitat - 3
- Sustainability - 1
- Humans - 1

OUTLINE

1. North Pacific
2. EBS
   - Past – 2014
   - Present – Report card
   - Future – Forecasts and predictions
3. AI
   - Report Card
4. GOA
   - New Report Card
   - Assessment and hot topics

2014 Sea Surface Temperature Anomalies (Bond)

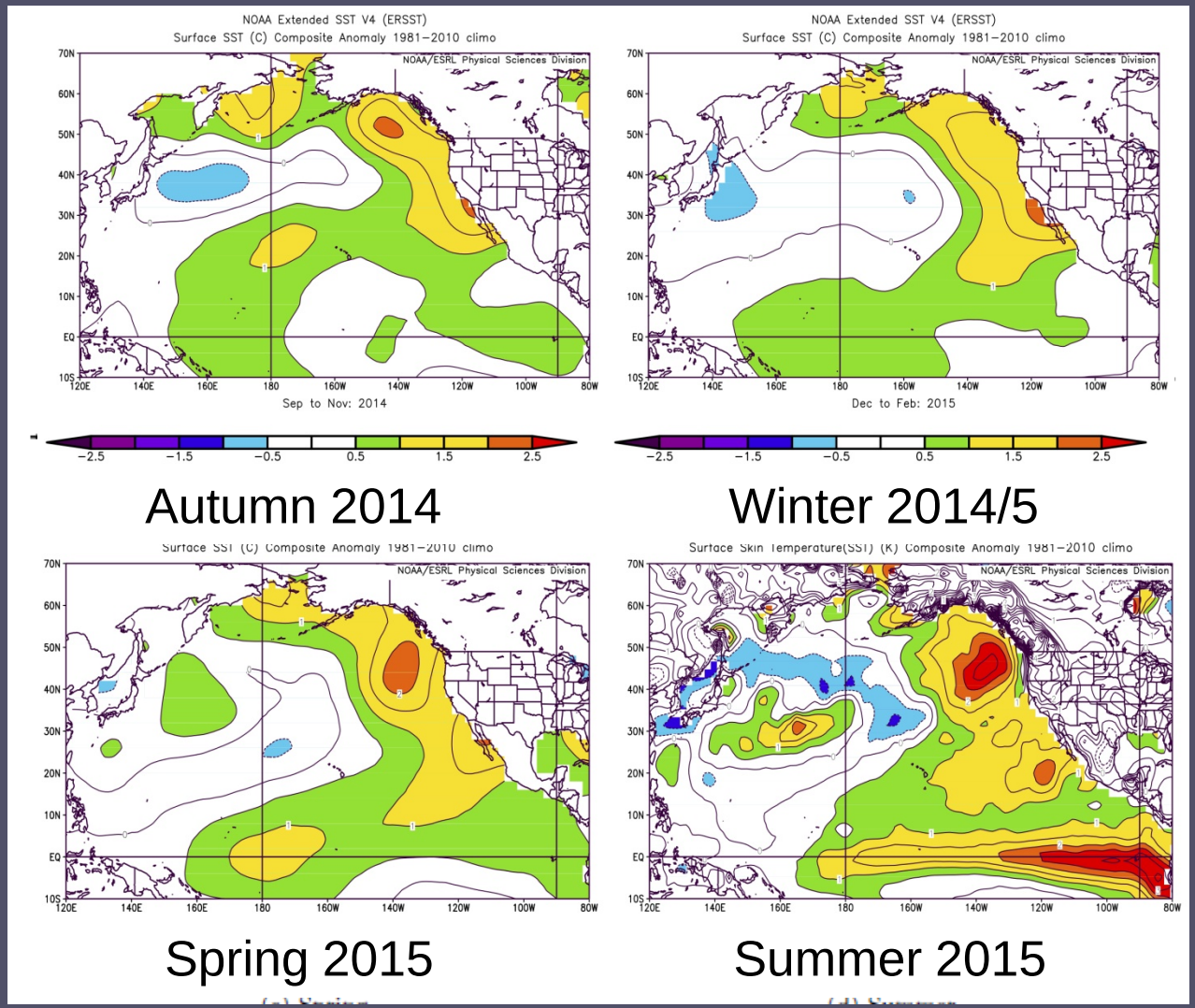


Appearance of The Blob
>2.5ºC warm anomalies

Widespread warm conditions by summer, in positive PDO pattern

From NOAA's Extended Reconstructed SST analysis

2015 Sea Surface Temperature Anomalies (Bond)

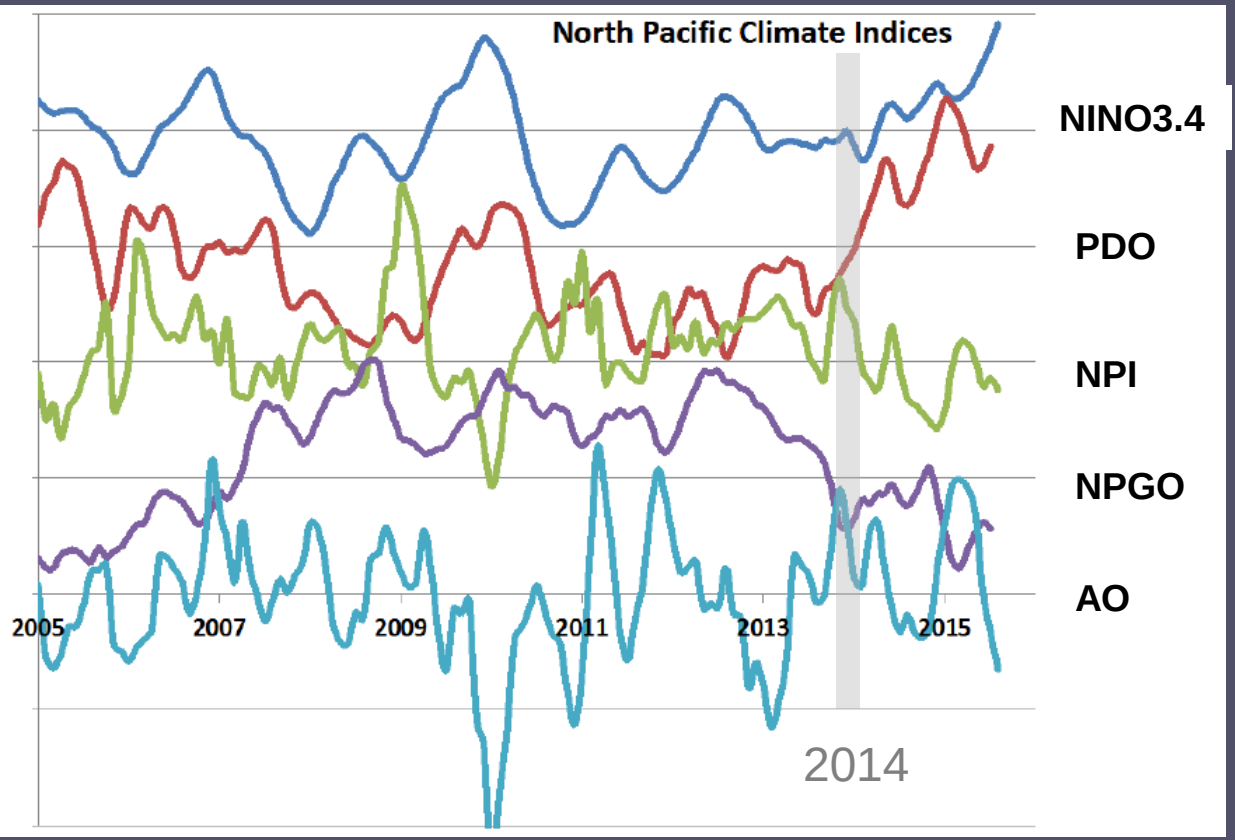


Continuance of widespread warm conditions. Fewer, weaker cold air outbreaks

Warm, typical storminess. El Nino develpment

From NOAA's Extended Reconstructed SST analysis

Climate Indices (Bond)



Strongly positive ENSO

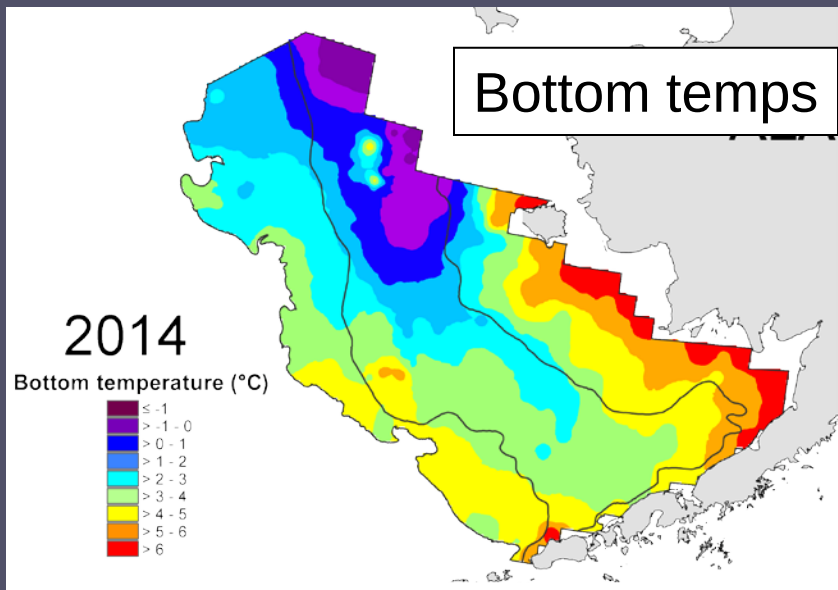
PDO in Dec 2014 largest winter value since 1900, leading ENSO recently

NPGO relates to chemical and biological properties in GOA and CalCOFI area. Negative→ reduced flows in Alaska and CA currents

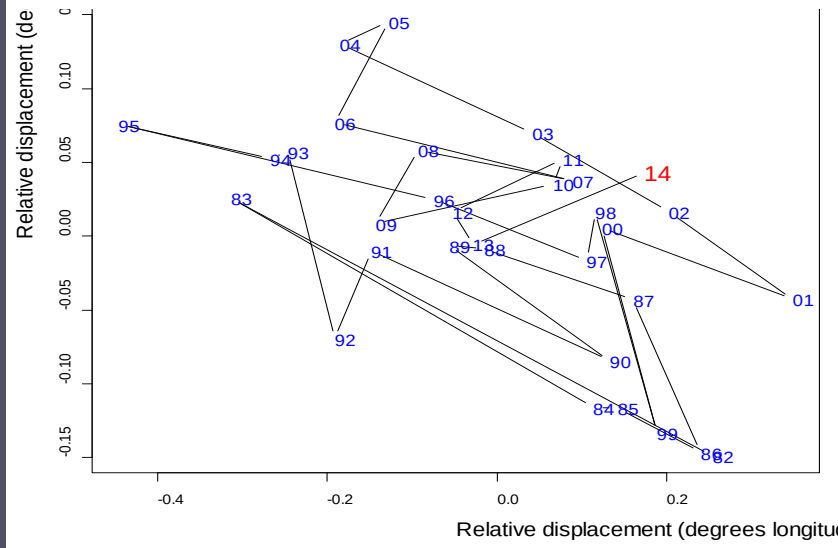
.

Complete recap of 2014

- WARM, and different
- Mostly high productivity
- Average energy content age-0 pollock
- High total CPUE in BT survey
- Mostly positive groundfish condition
- High seabird productivity
- Early warning indicators suggest recovered resilience
- Fur seal pup counts remain low



Average north-south and east-west displacement



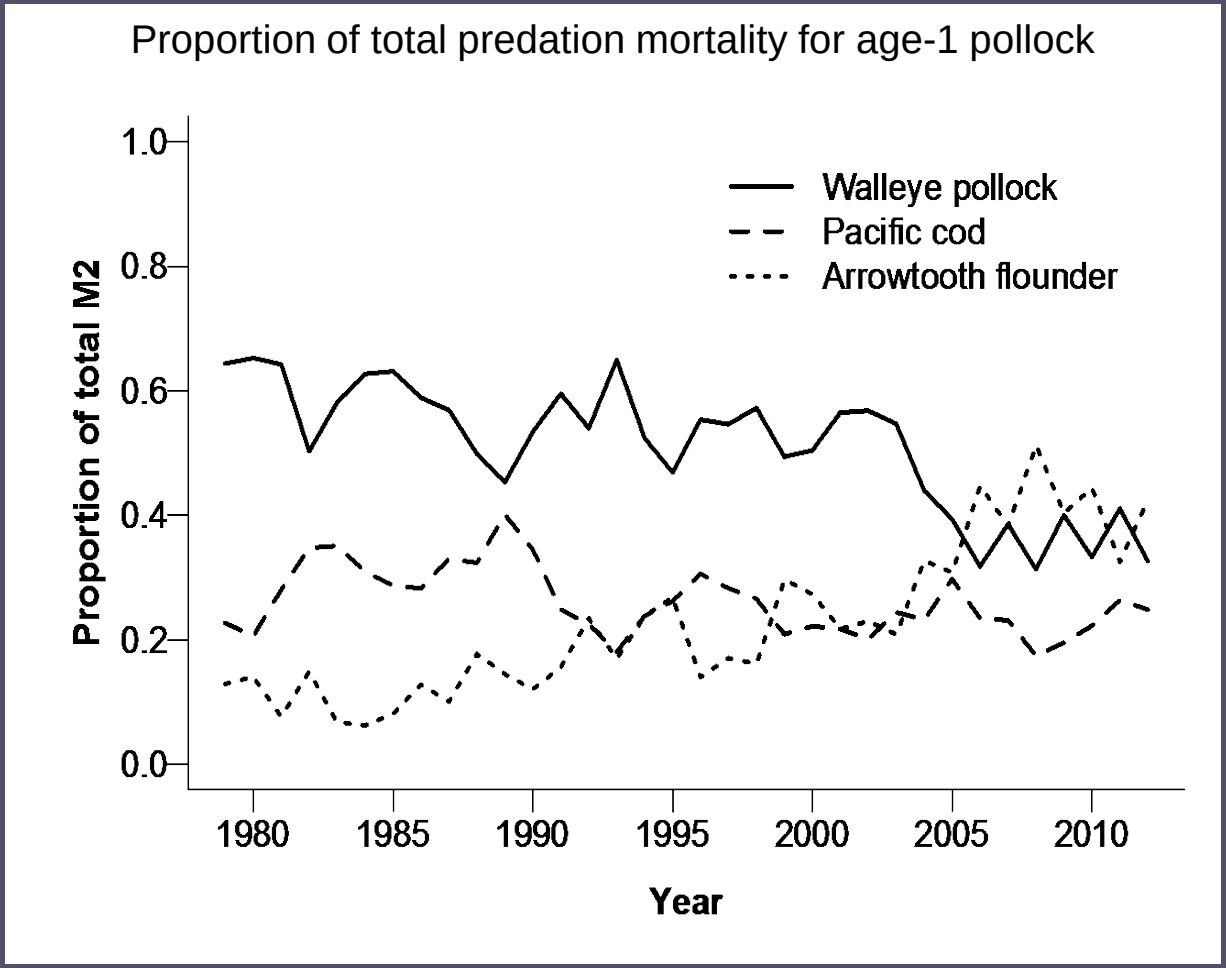
Updated 2014 ECOSYSTEM STATUS INDICATORS

Zooplankton, salmon, pollock recruitment, groundfish natural mortality, early warning

NEW Multispecies model estimates of time-varying natural mortality

(Holsman, Aydin, Ianelli)

- CEATTLE model
- Predation by ATF exceeded cannibalism since 2007
- Increased ATF could negatively impact pollock, esp during warm years

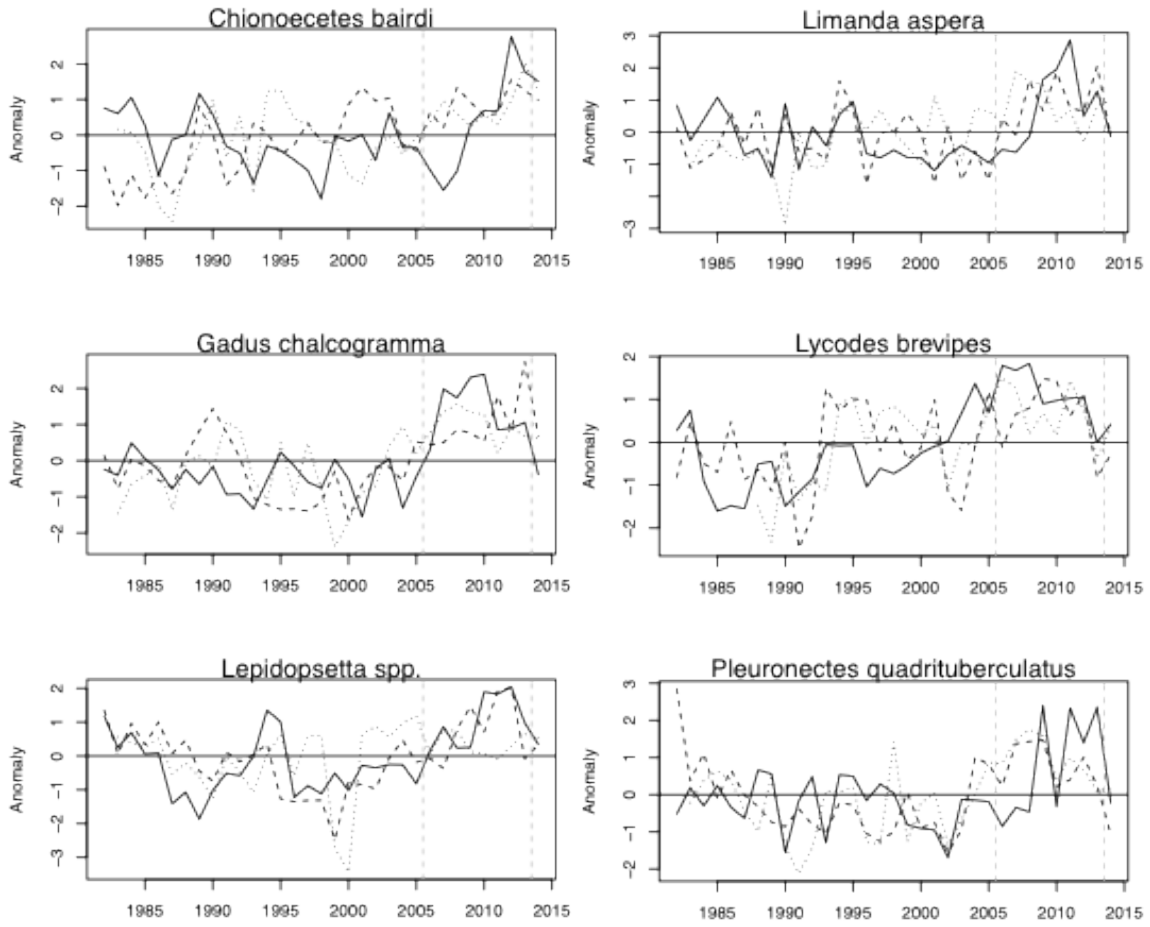


NEW Early Warning Indicators

C2 Ecosystem Chapter Report
December 2015

(Litzow and Lauth)

Early warning indicator time series for EBS taxa showing significant increases in ≥ 2 indicators

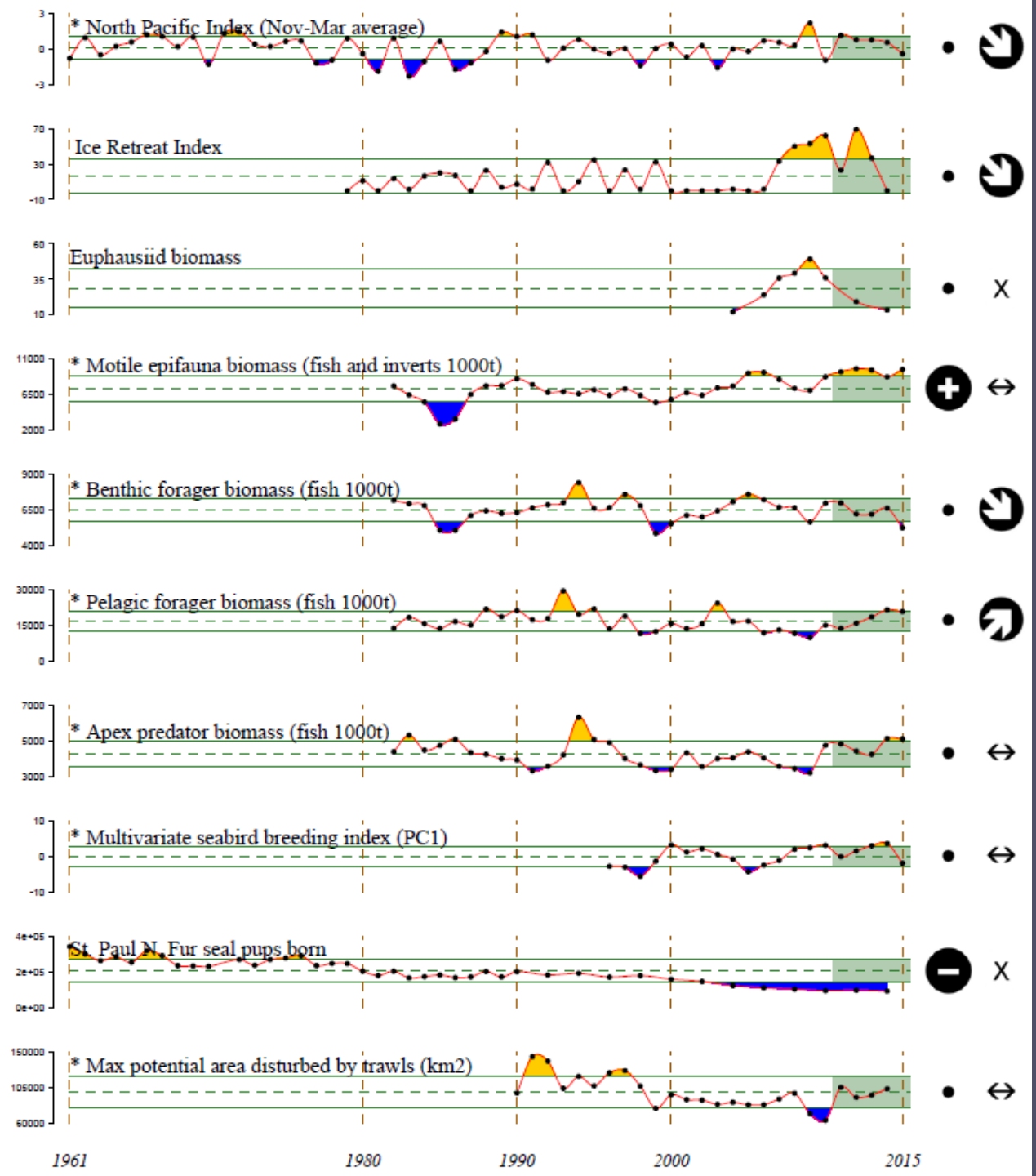


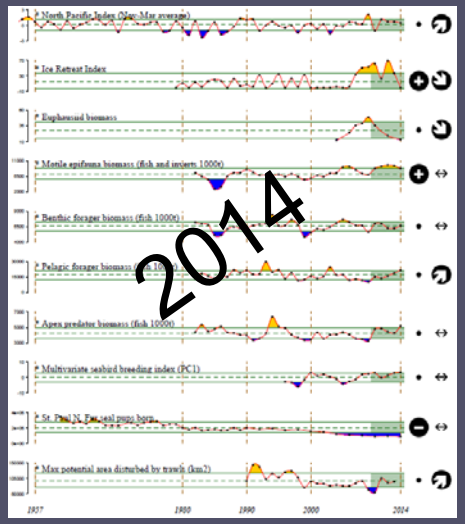
- Impending ecosystem shift?

Declining community resilience during the cold period, and recovered resilience with warming in 2014

C2 Ecosystem Chapter Report
December 2015

2015 EBS Report Card





2011-2015 Mean

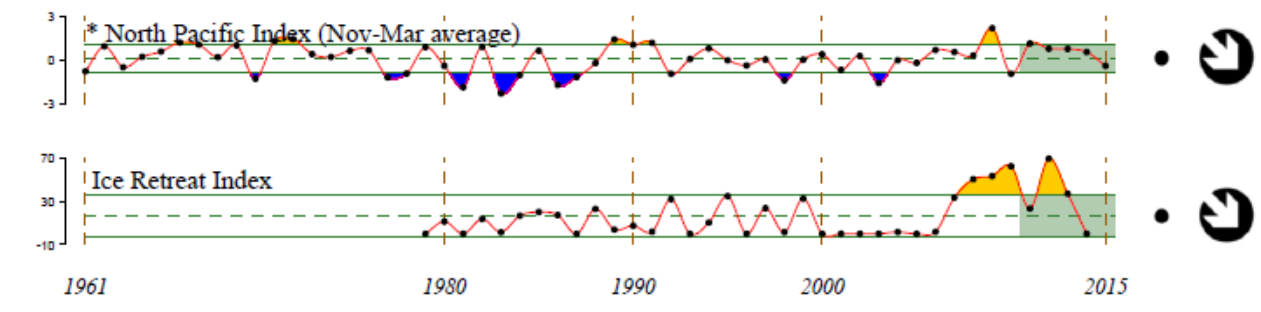
- 1 s.d. above mean
- 1 s.d. below mean
- within 1 s.d. of mean
- X fewer than 2 data points

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
- X fewer than 3 data points

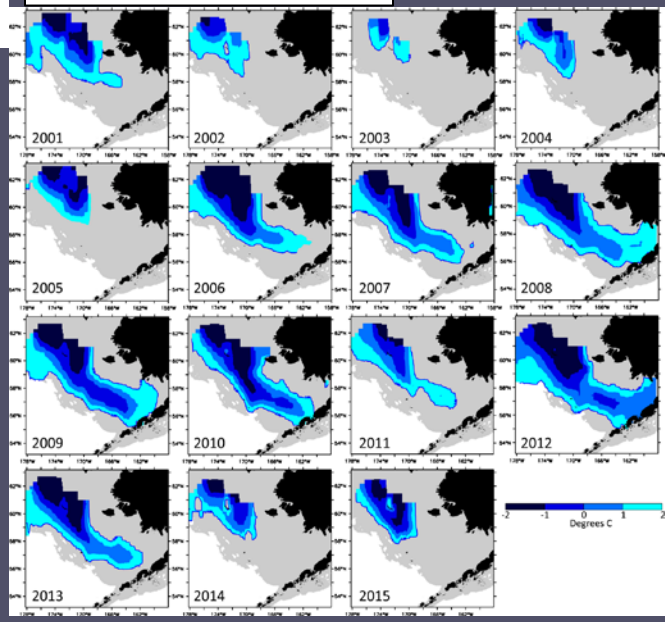
2015 EBS Physical Conditions

C2 Ecosystem Chapter Report
December 2015

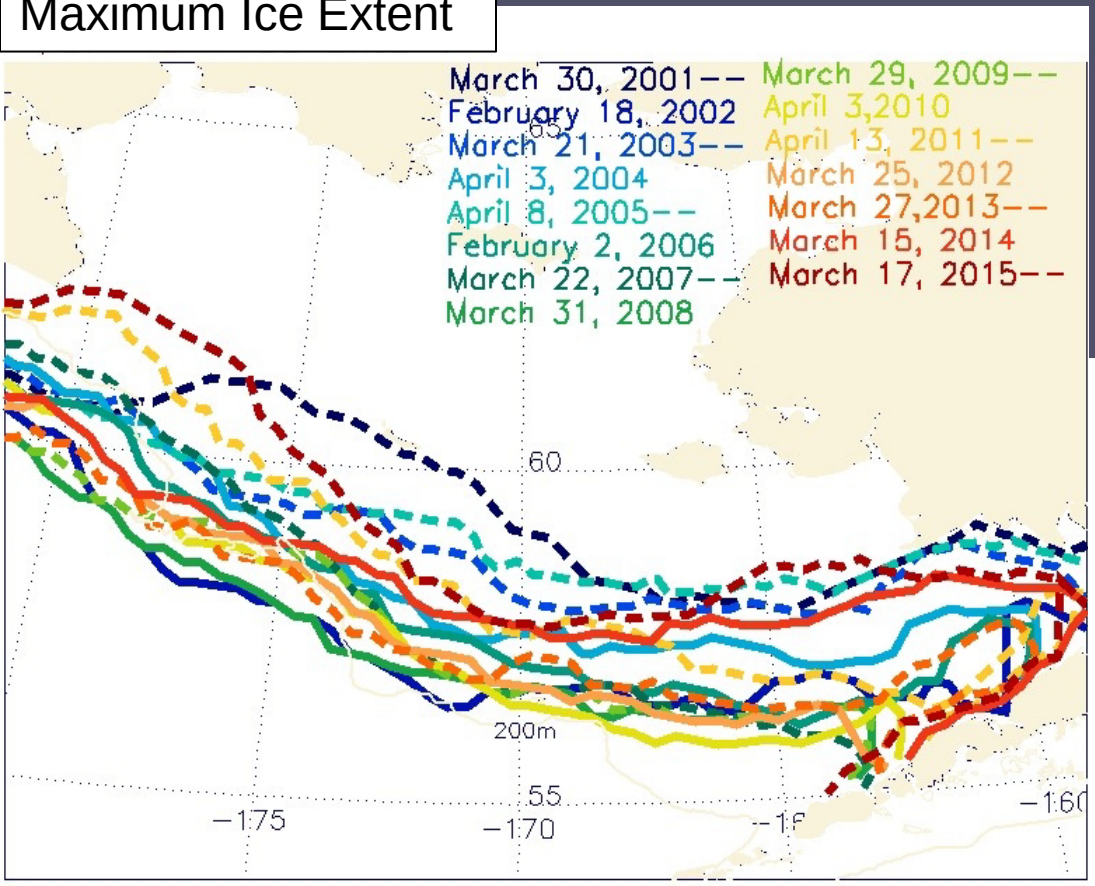


Warm, typical storminess

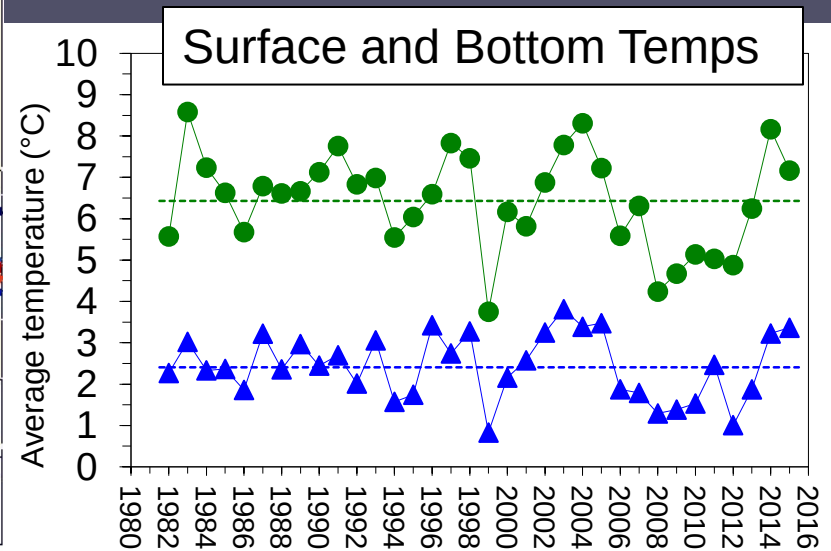
Cold Pool Size



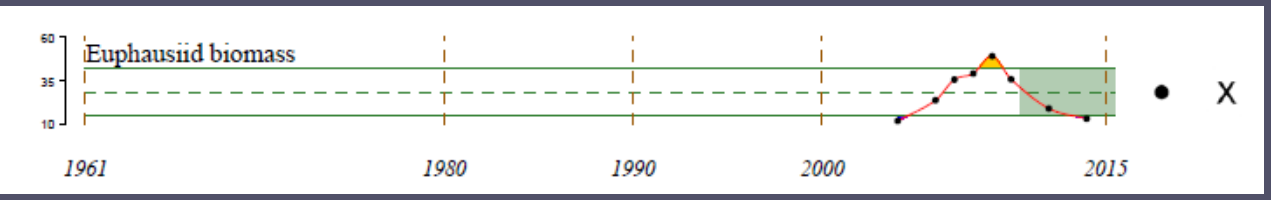
Maximum Ice Extent



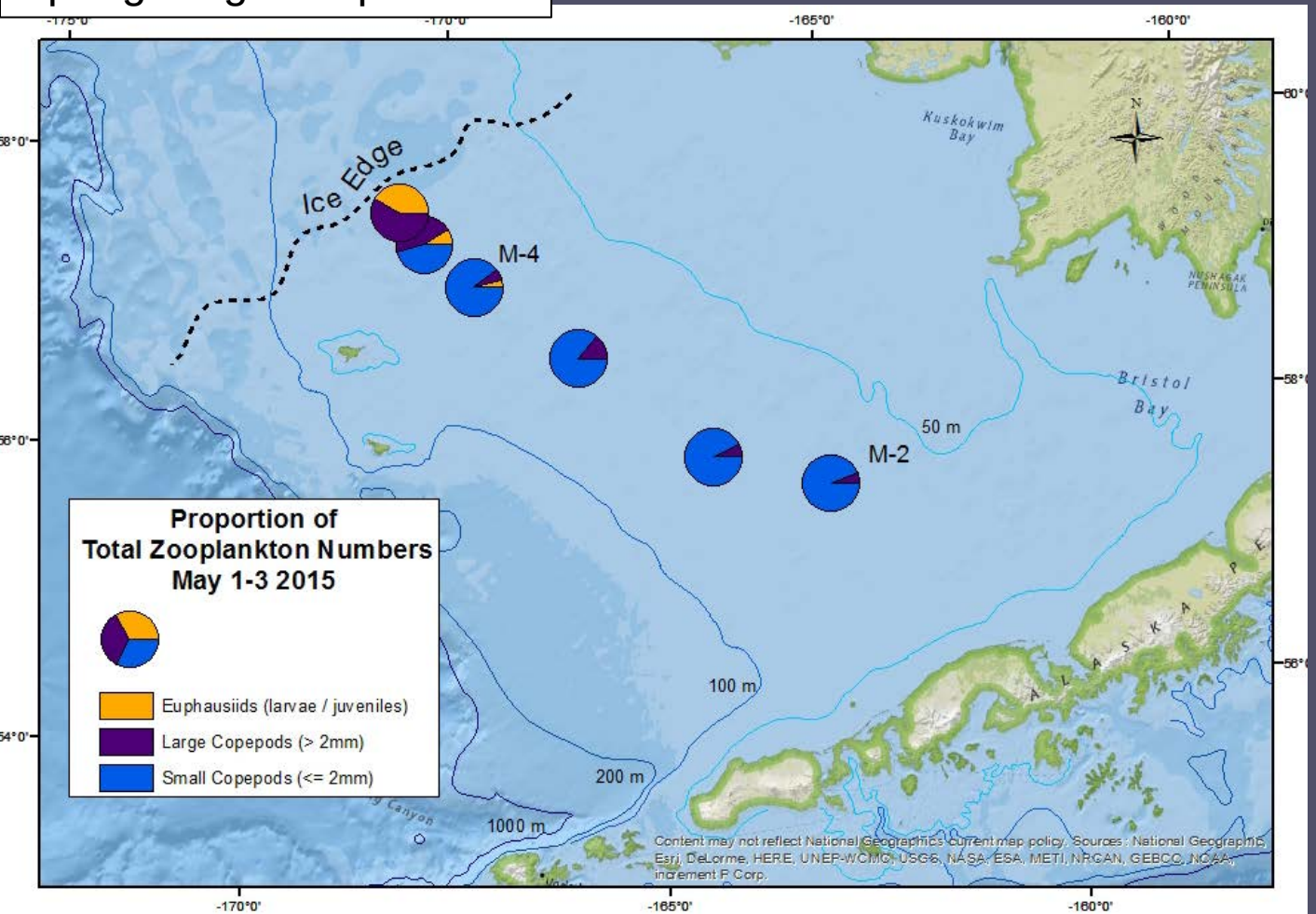
Surface and Bottom Temps



2015 EBS Zooplankton



Spring rough zoop counts



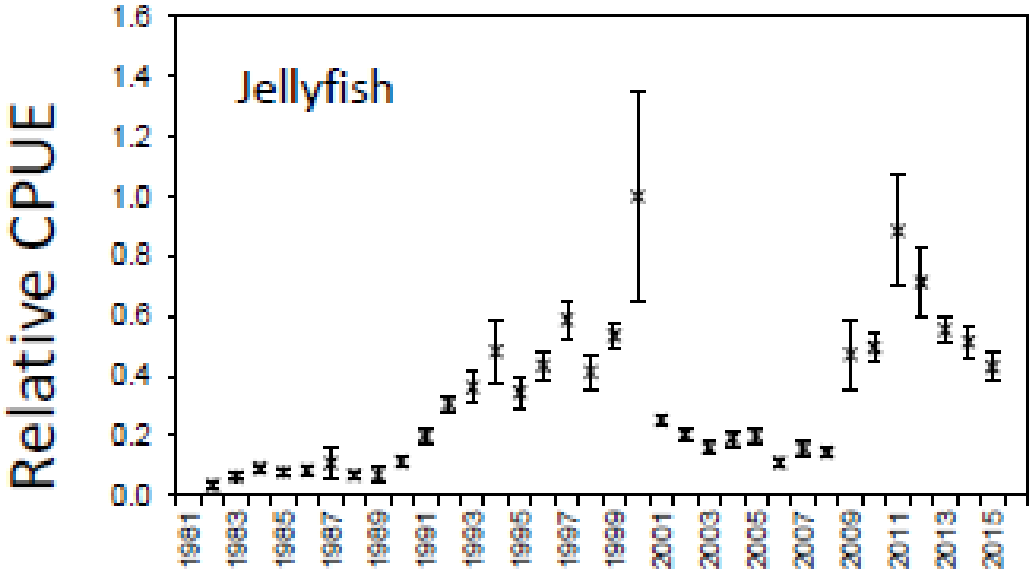
- No acoustic survey of euphausiids
- Small copepods more prevalent than lipid-rich large copepods or euphausiids

Jellyfish

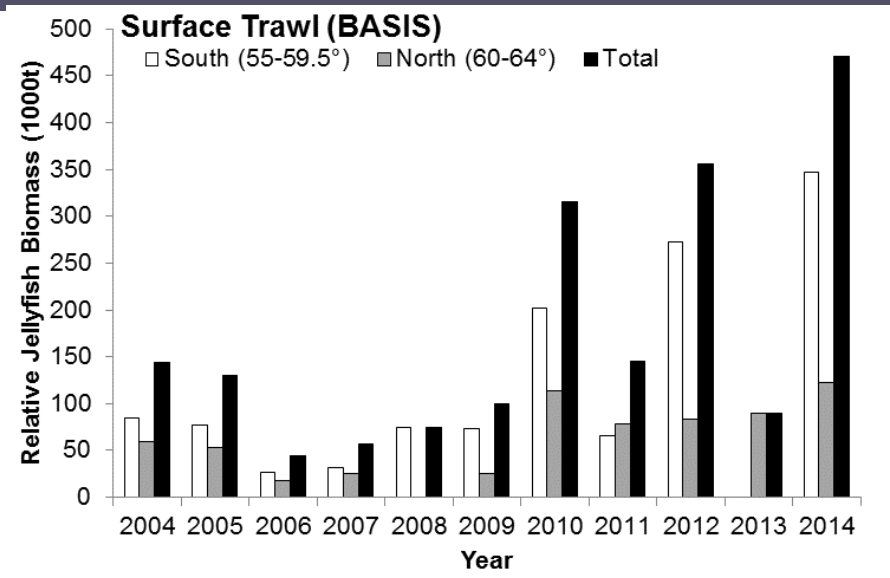
(Lauth and Hoff; Cieciel et al.)

- Summer 2015 down slightly, fall 2014 record catch
- Jellyfish biomass influences: Ice cover, spring/summer SST, wind mixing
- Large blooms can have predatory impact on juvenile and forage fishes

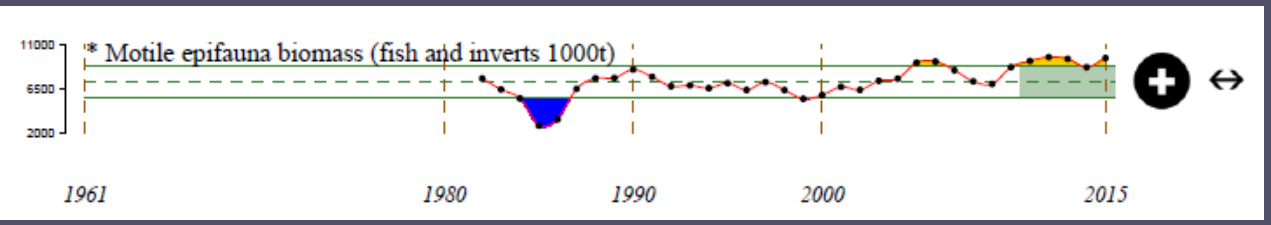
Summer 2015

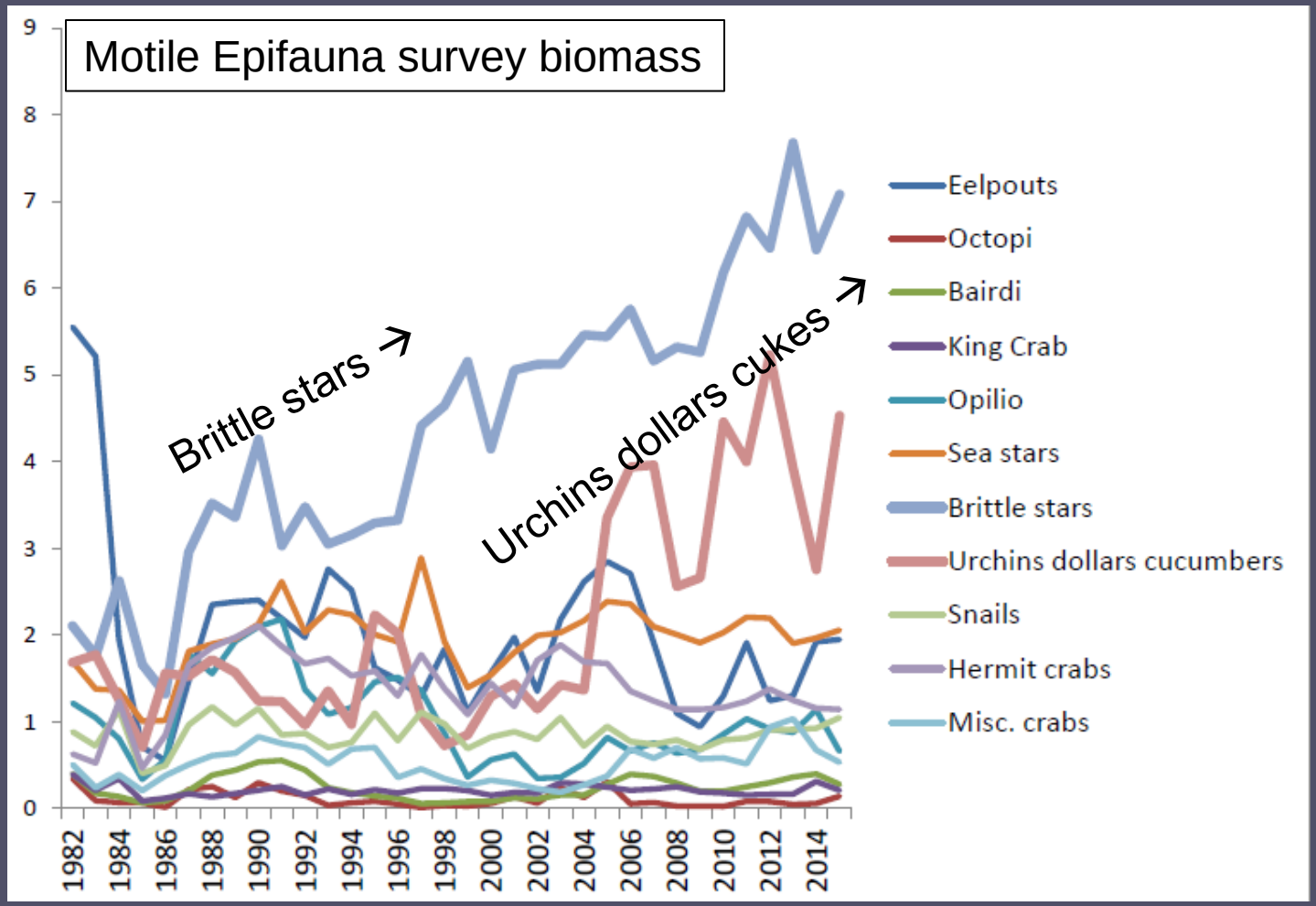


Fall 2014

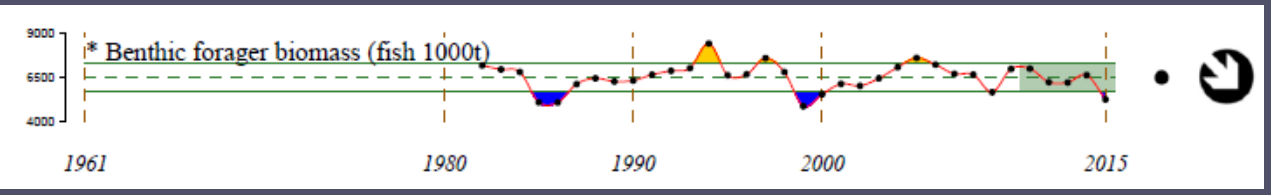


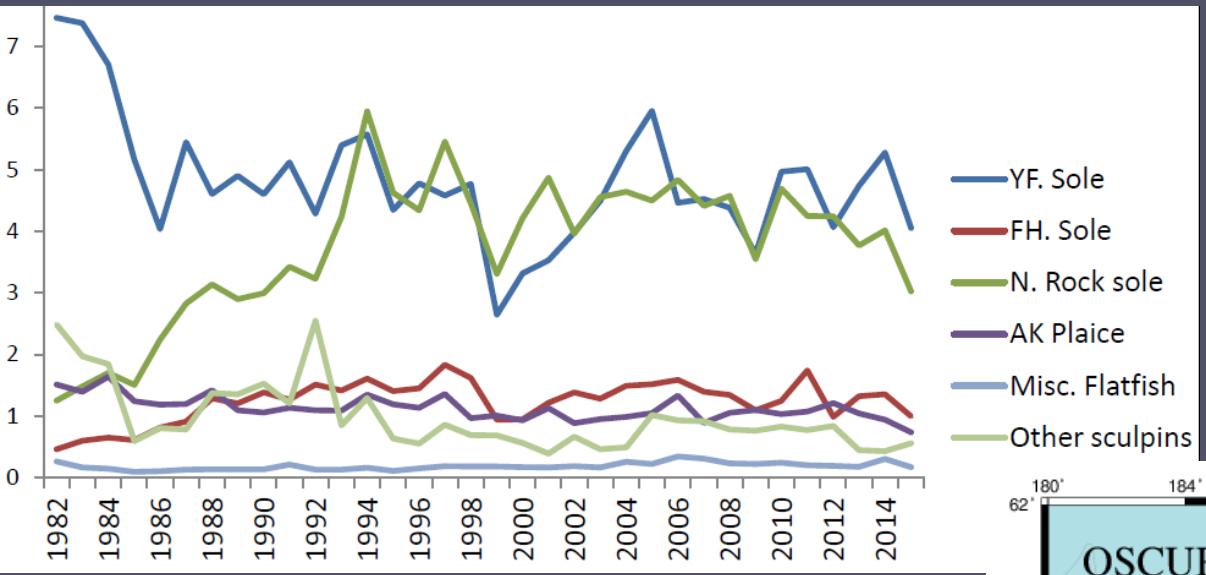
2015 EBS Motile Epifauna



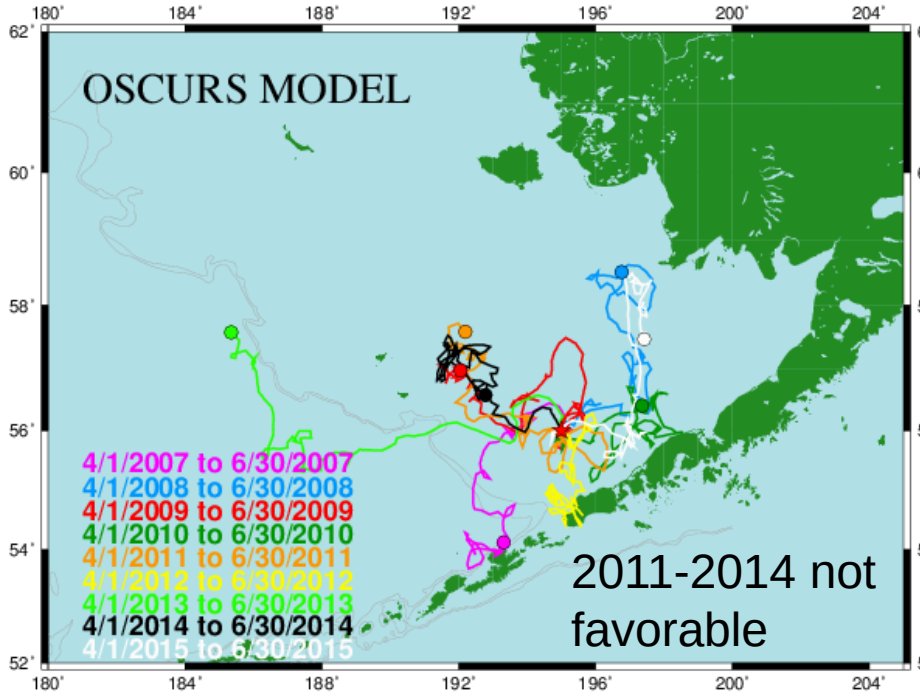


2015 EBS Benthic foragers

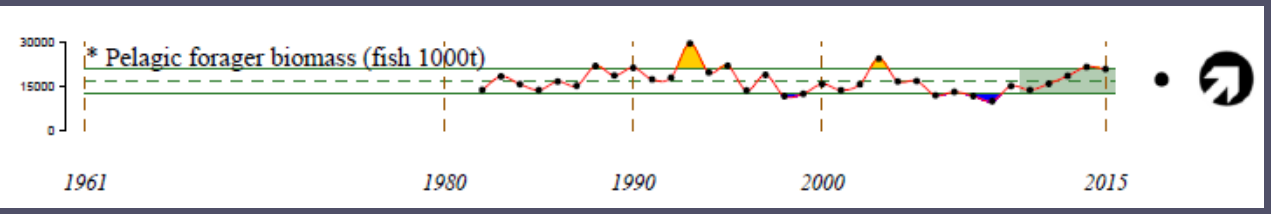


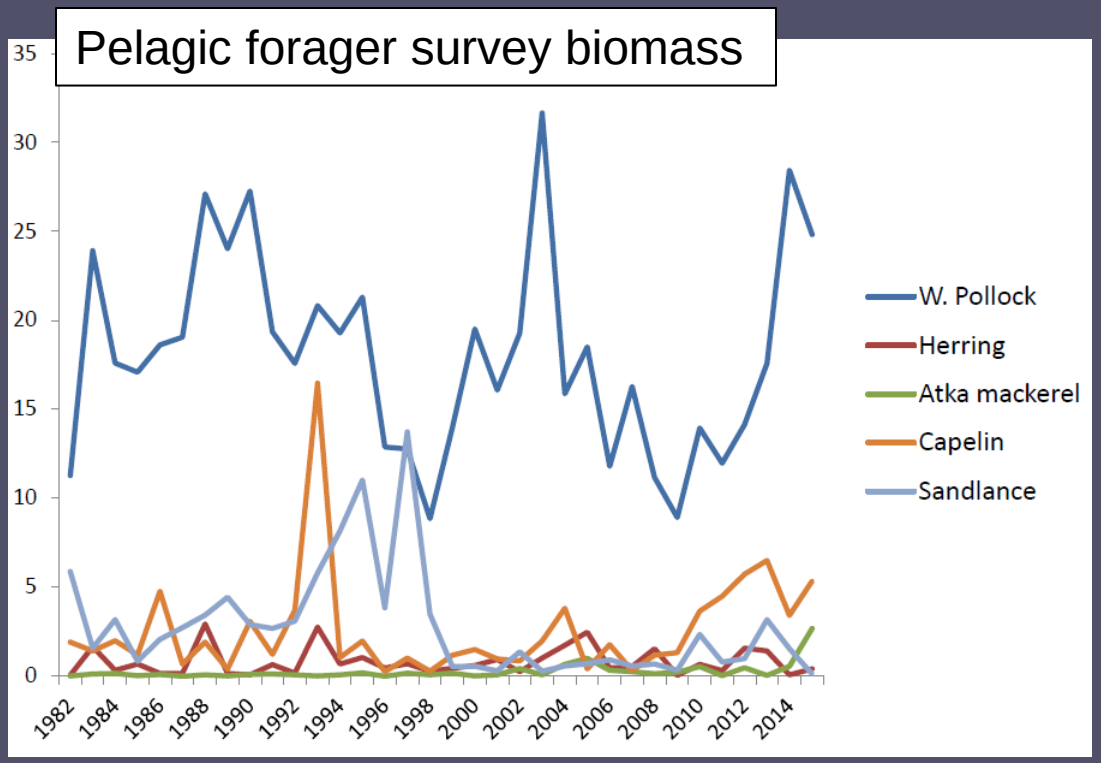


- Survey biomass decreased
- Recent trend is now negative
- Related to poor recent springtime drift patterns?? Or distribution or catchability…



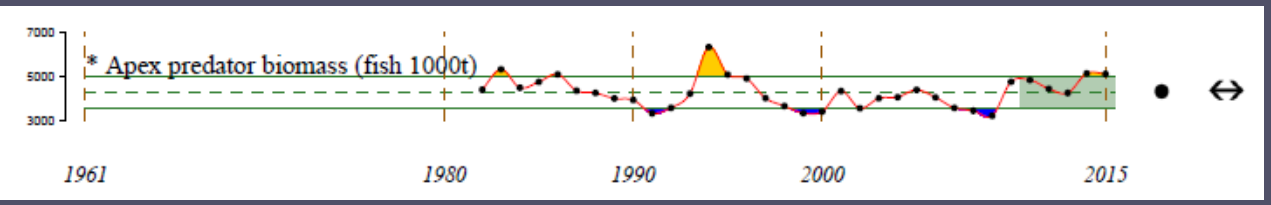
2015 EBS Pelagic foragers

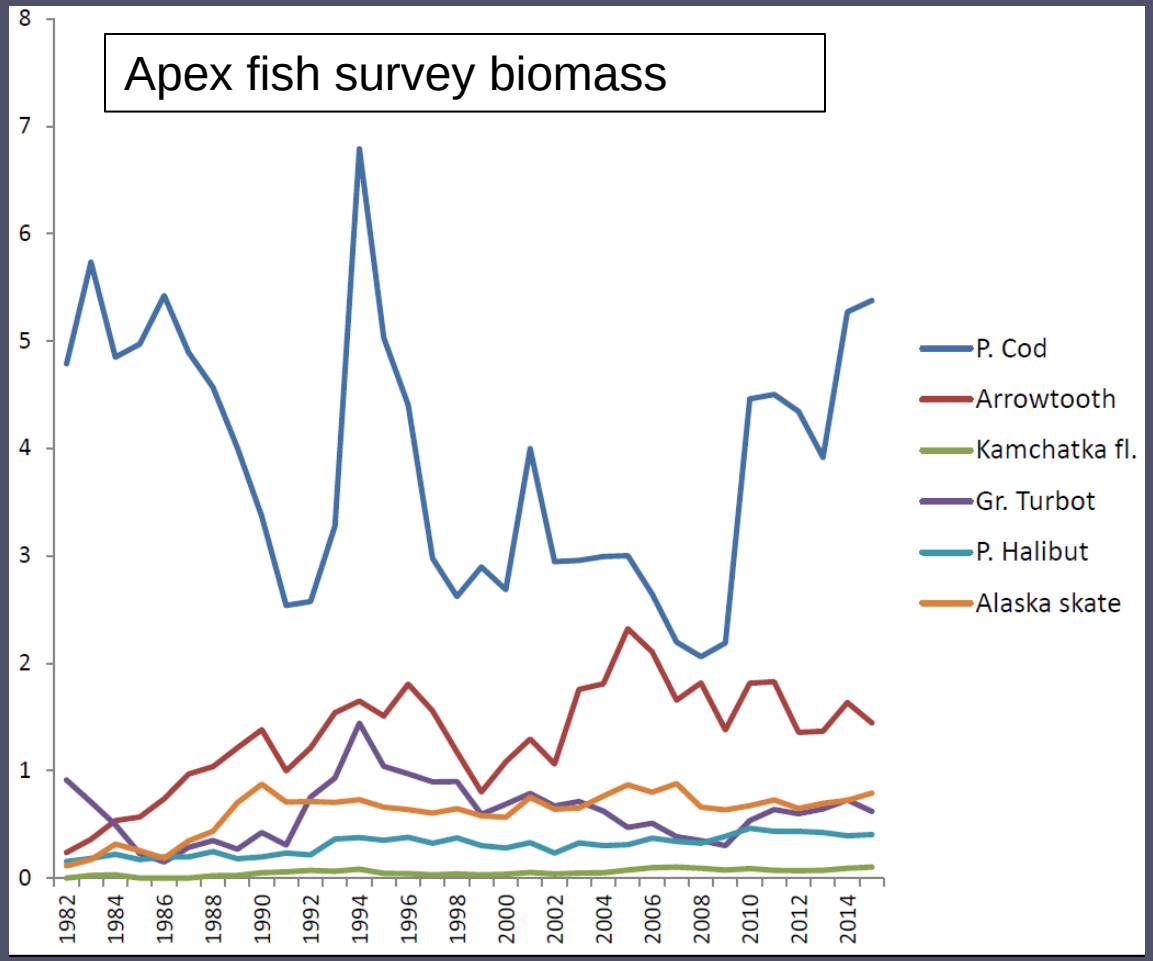




- Above 30 year mean
- Due to pollock
- And to capelin, which has remained high during past 2 warm years

2015 EBS Apex predators



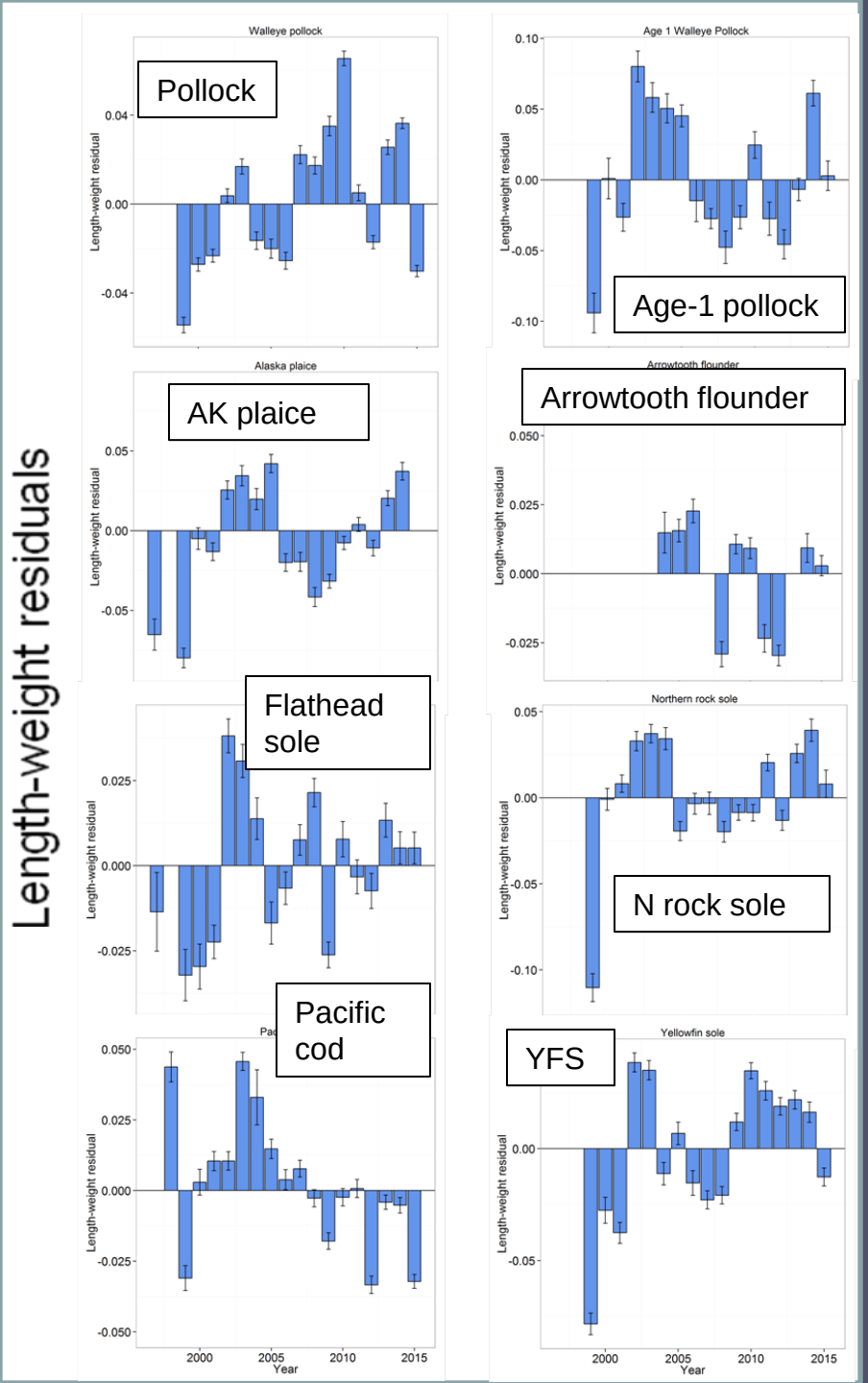


- Above 30 year mean
- Trend has leveled
- Increase from 2009 driven by P cod

2015 Groundfish Condition

C2 Ecosystem Chapter Report
December 2015

(Boldt, Rooper et al)

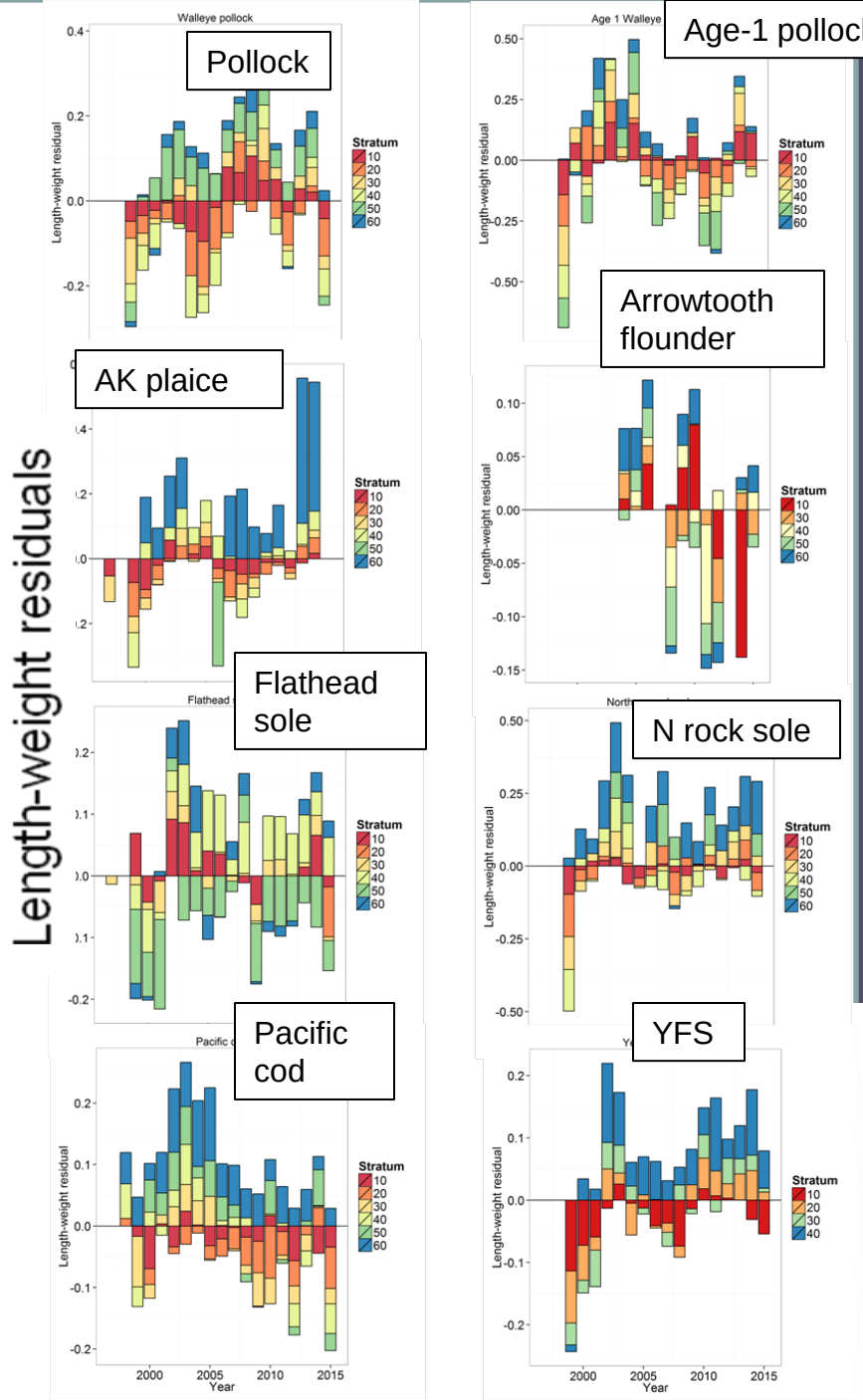


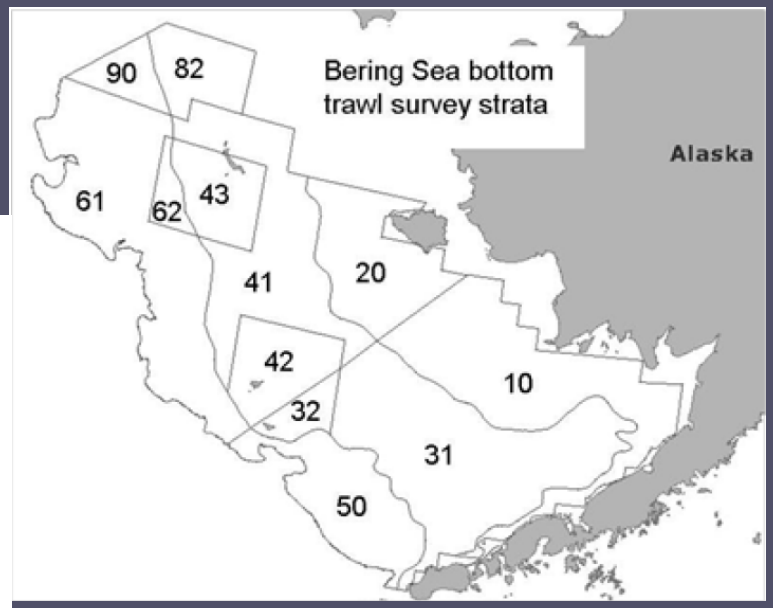
- Length-weight residuals from survey
- Negative trend in cod since 2003
- Residuals negative for pollock, cod, and yellowfin sole
- Age-1 and age-2+ pollock not well correlated

2015 Groundfish Condition

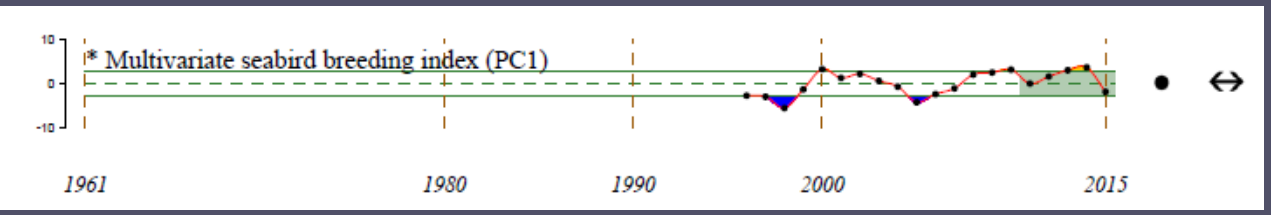
(Boldt et al)

- Usually positive on outer, especially northern outer, shelf
- Influential factors: temperature, survey timing, fish migration.





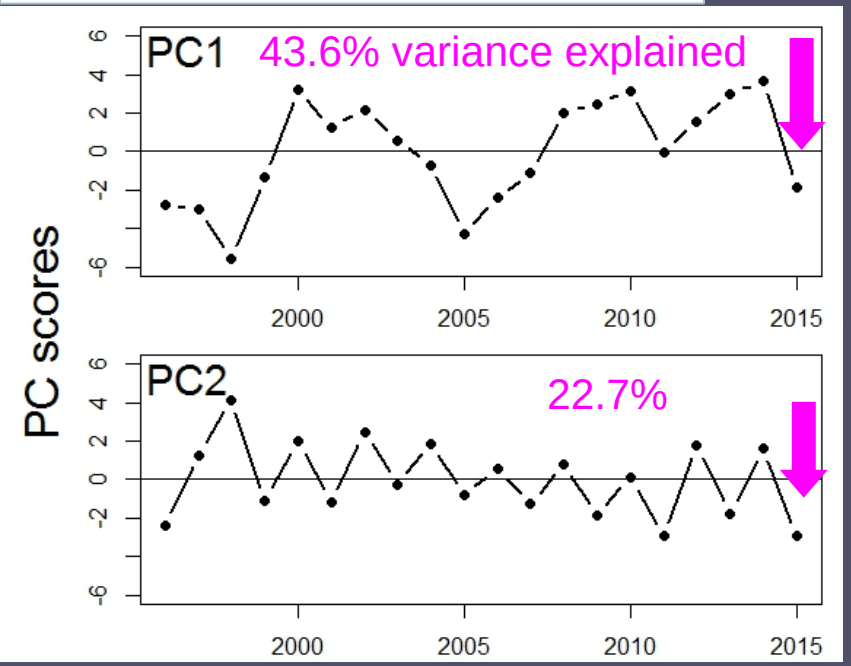
2015 EBS Seabirds



Poor breeding success and dead birds at sea

Year	Dead birds obs
< 2014	1-2 per year
2014	51
2015	19 (8 in bloom)

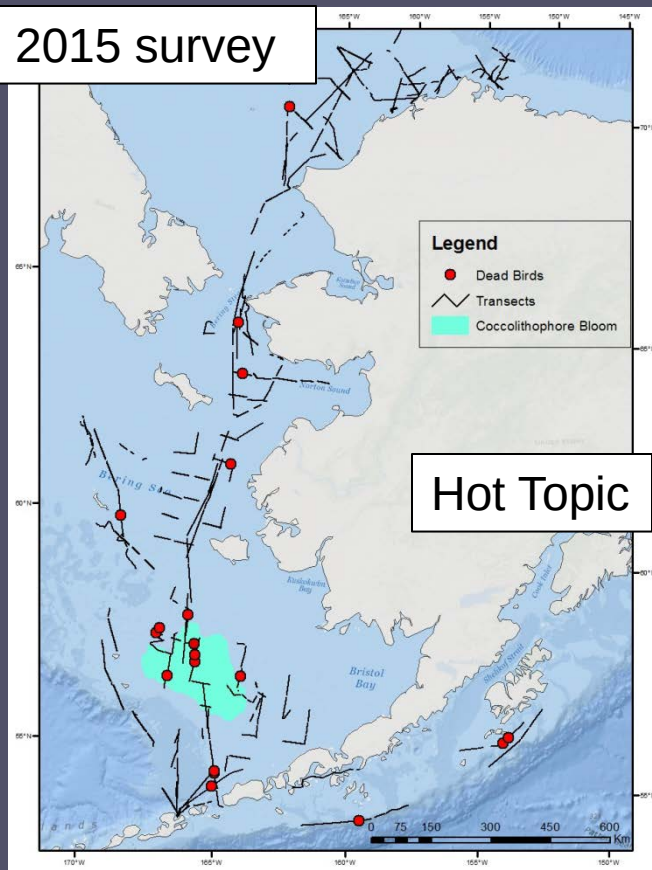
Pribilof seabird breeding index



Lower murre and cormorant productivity. Later seabird hatch dates

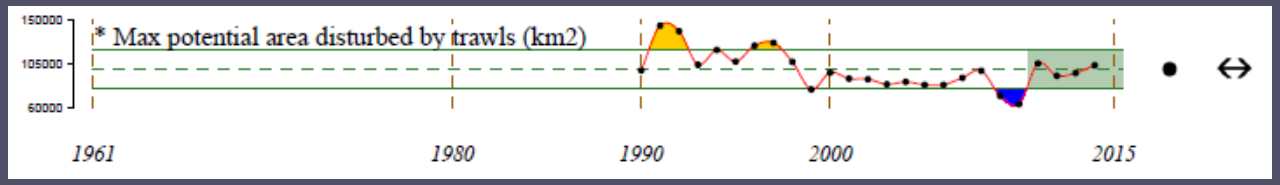
Lower kittiwake productivity

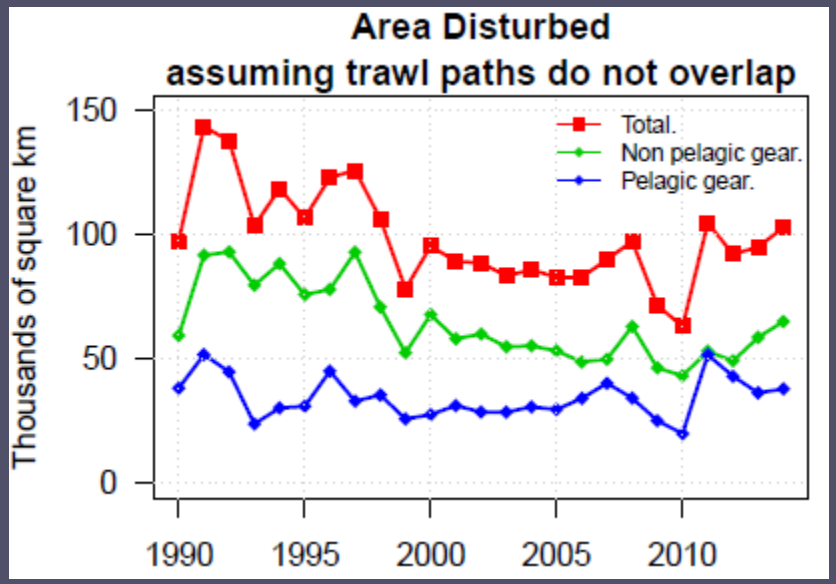
2015 survey



Hot Topic

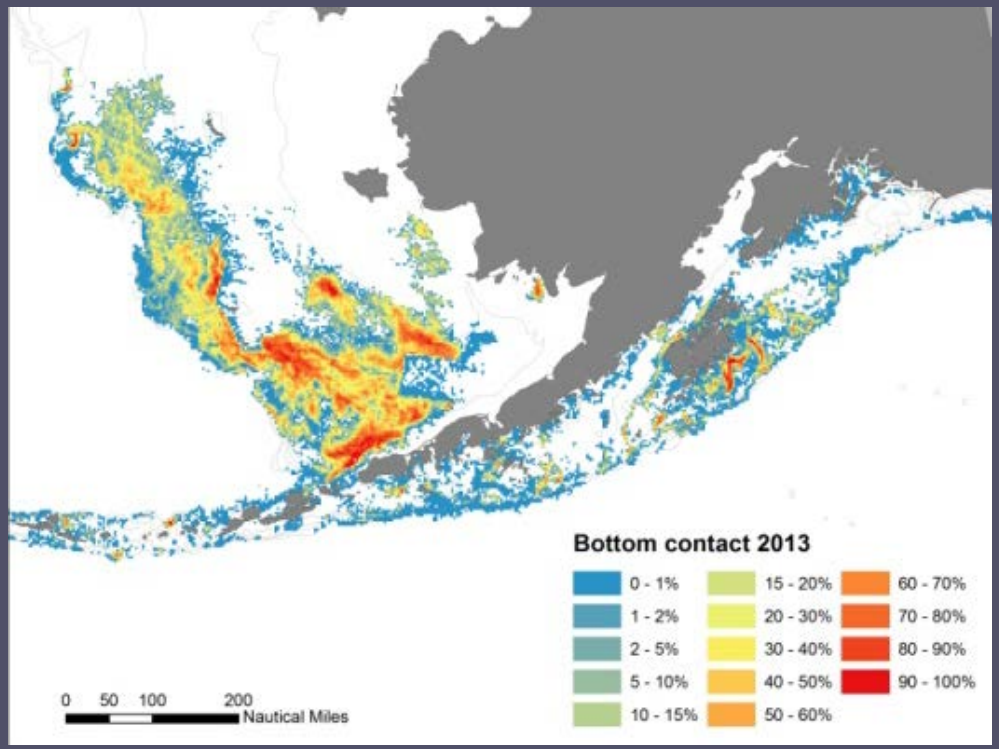
(2014) EBS Fishing impacts





Area disturbed by trawls stable since 2011

New indicator in development for next year
(Lewis, Olsen, Harris)



Chum salmon distribution, diet, and bycatch (Jim Murphy)

2004 – 2006 (warm years)

- High chum bycatch in pollock trawl fishery
- Higher surface densities of age-0 pollock (BASIS)
- High (90%) proportion of age-0 pollock in juv chum diets

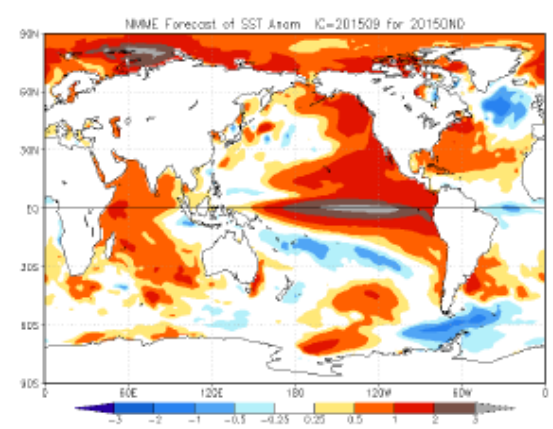
Chum bycatch correlated with surface trawl catches of age-0 pollock
($r = 0.83$, $p < 0.01$)

Implications:

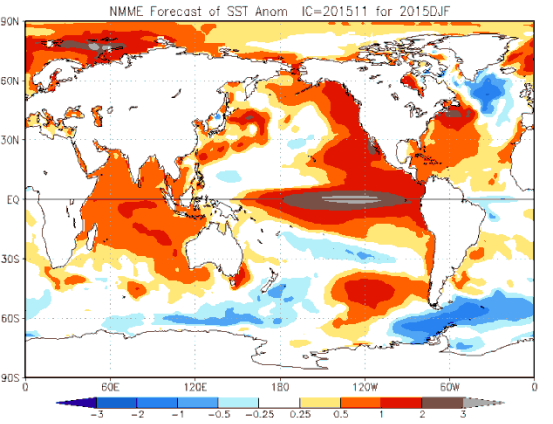
Chum foraging behavior (on age-0 pollock) is an important component to understanding bycatch

2015 Forecasts and Predictions

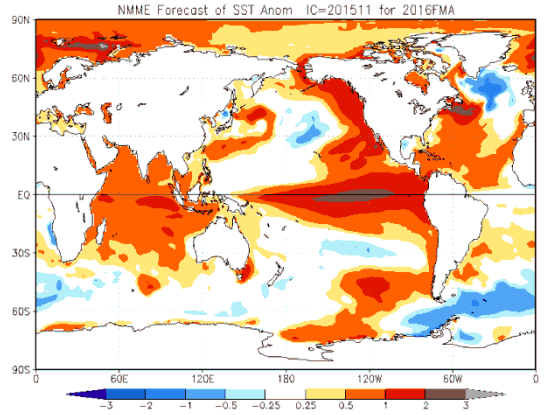
Seasonal Projections from the National Multi-Model Ensemble (NMME) (Bond)



(a) Months OND



(b) Months DJF



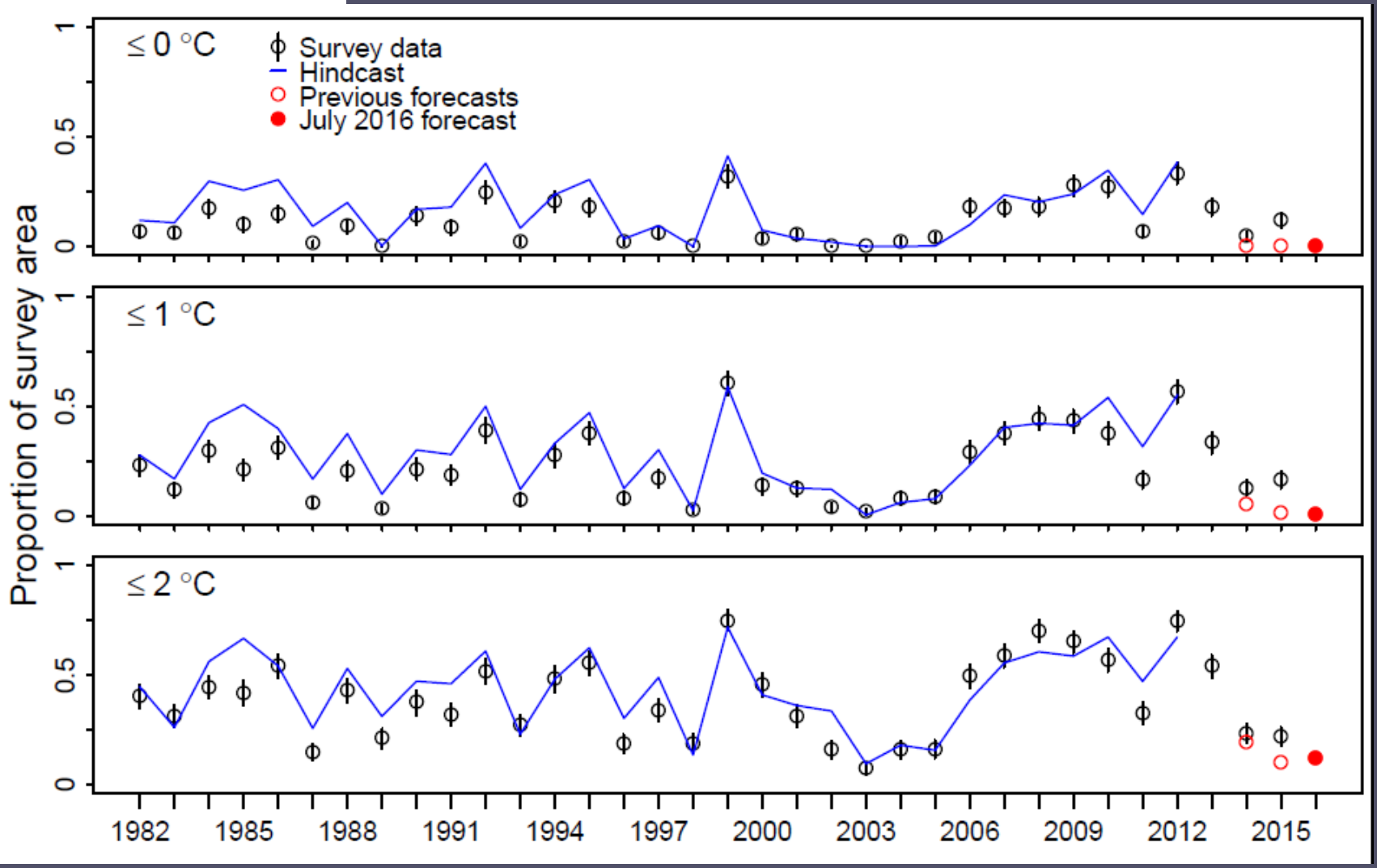
(c) Months FMA

- SST projections
- NMME is average of 6 models
- Moderate-strong El Nino likely to strengthen
- Likely to have teleconnections to North Pacific, deeper than normal Aleutian Low
- (even) Warmer than normal SSTs until spring 2016

EBS 9 month forecast

(Aydin and Hermann)

Cold Pool



A collection of pollock recruitment predictions

2015

- Age-1 pollock predicted to have below average recruitment (Indicator: chum salmon, SST; Yasumiishi)
- Age-3 pollock (2012 year class) predicted to be weak based on low energy content and small size (Heintz et al)
- Age-3 pollock predicted to be slightly above average abundance (Yasumiishi)

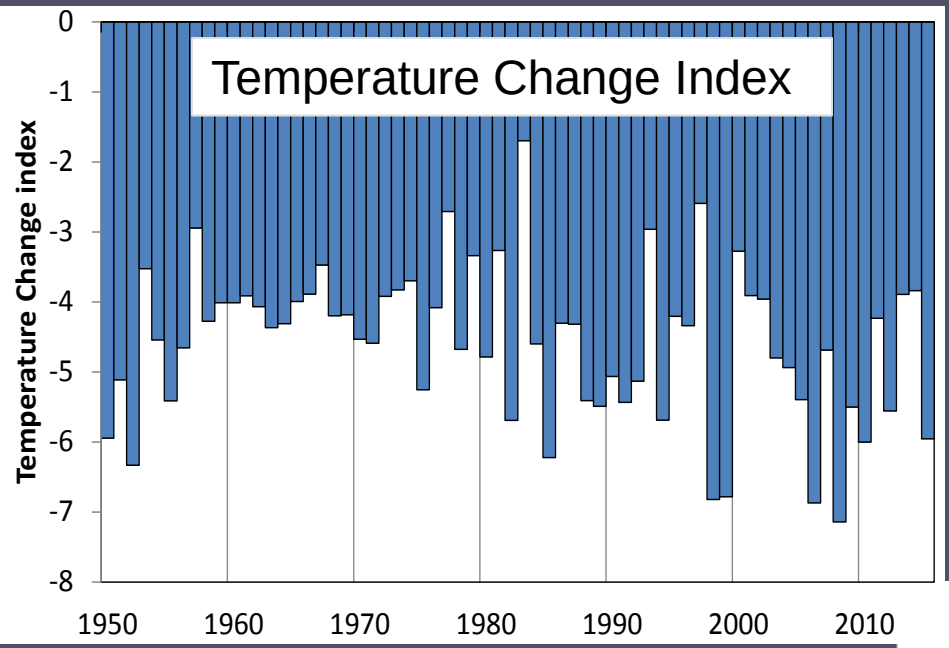
2017

- Age-3 pollock (2014 year class) predicted to have intermediate recruitment (Heintz et al)
- Age-3 pollock to have below average abundance based on current temperature change index (Yasumiishi)

2018

- Poor 2015 year class?? Based on small size of zooplankton this year (Eisner, Yasumiishi)

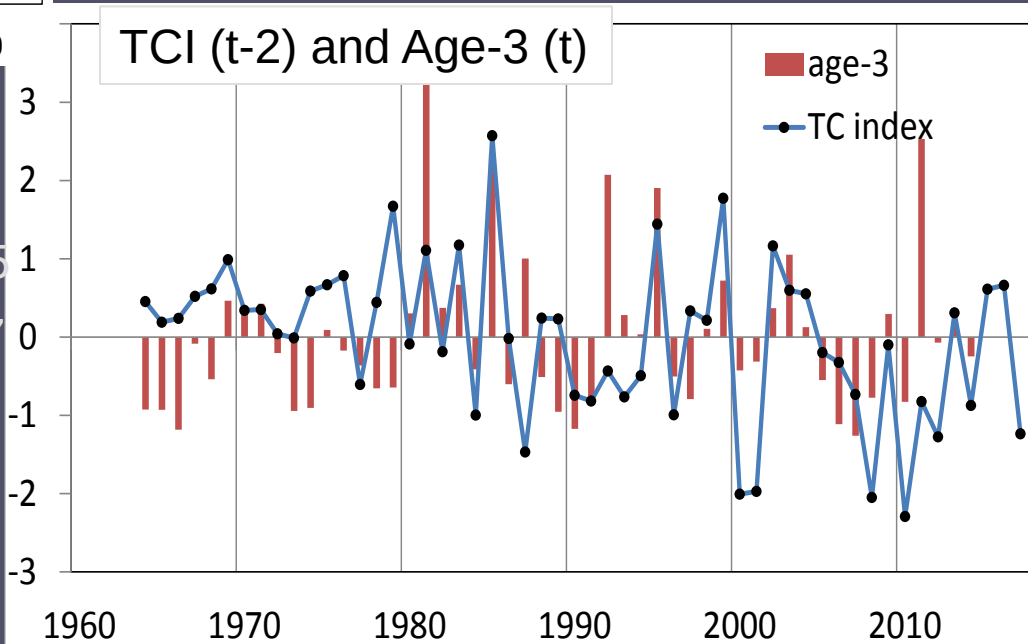
Pre- and Post-Winter Temperature Change Index and the Recruitment of Bering Sea Pollock (Yasumiishi)



- Index = June SST_t – Aug SST_{t-1}
- More negative → warm late summer followed by warm spring
- Positively correlated with subsequent age-1 through age-6 abundance

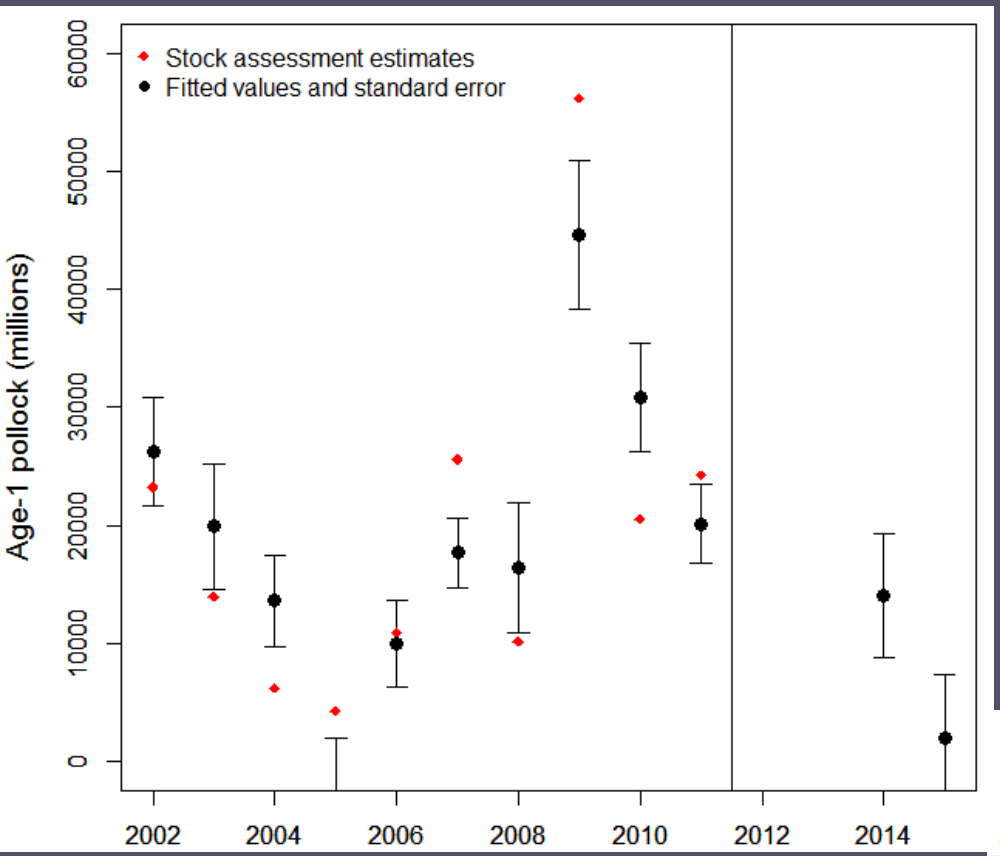
TCI predictions of age-3:

- 2013 (2012 yr cl) → above average in 2015
- 2015 (2014 yr cl) → below average in 2017



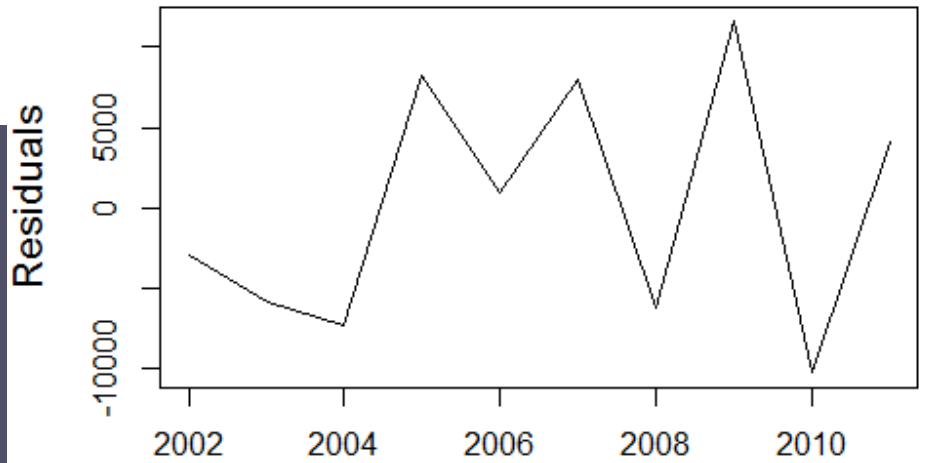
Salmon, Sea Temperature, and the recruitment of age-1 Bering Sea pollock

(Yasumiishi and Kondzela)



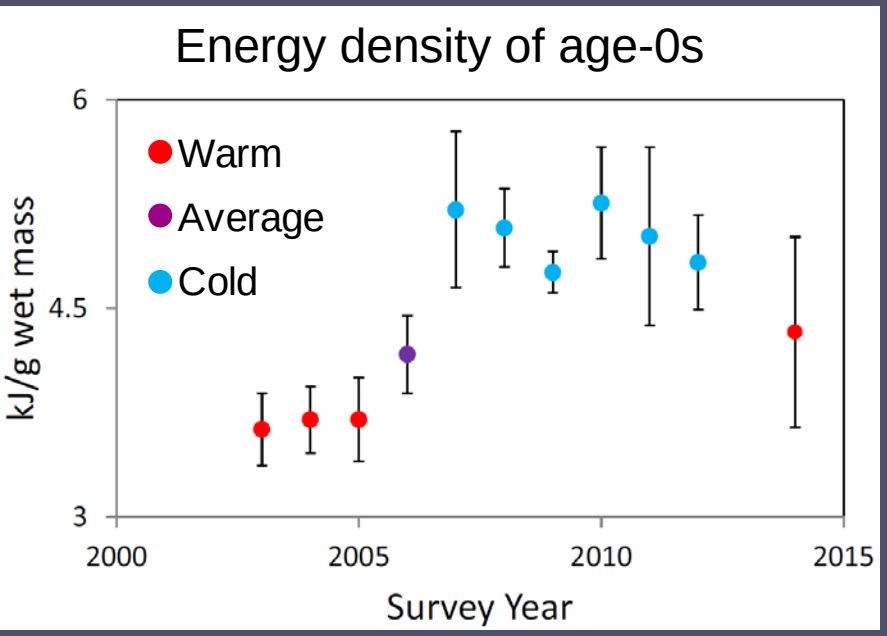
- Chum growth as proxy for ocean productivity for age-0s
- Age-1 recruitment ~ f(chum, spring temp)
- Used model to forecast
- Predicted below average recruitment to age-1 in 2015

Alternating residual pattern: fewer adult pink salmon (a predator and competitor) in even-years as age-0s or as a predator buffer in odd-years during the early spring age-1 stage of pollock.



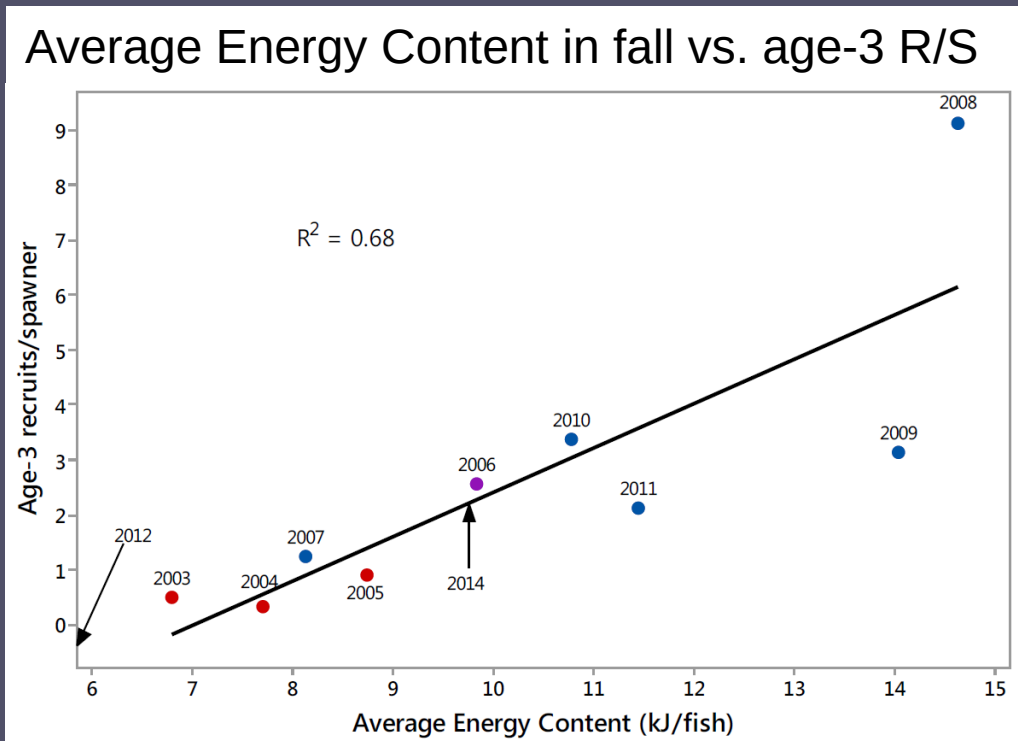
Fall condition of YOY predicts recruitment of age-3 pollock

(Heintz, Siddon, Farley)



- Energy density influence by thermal regime; fish size less so

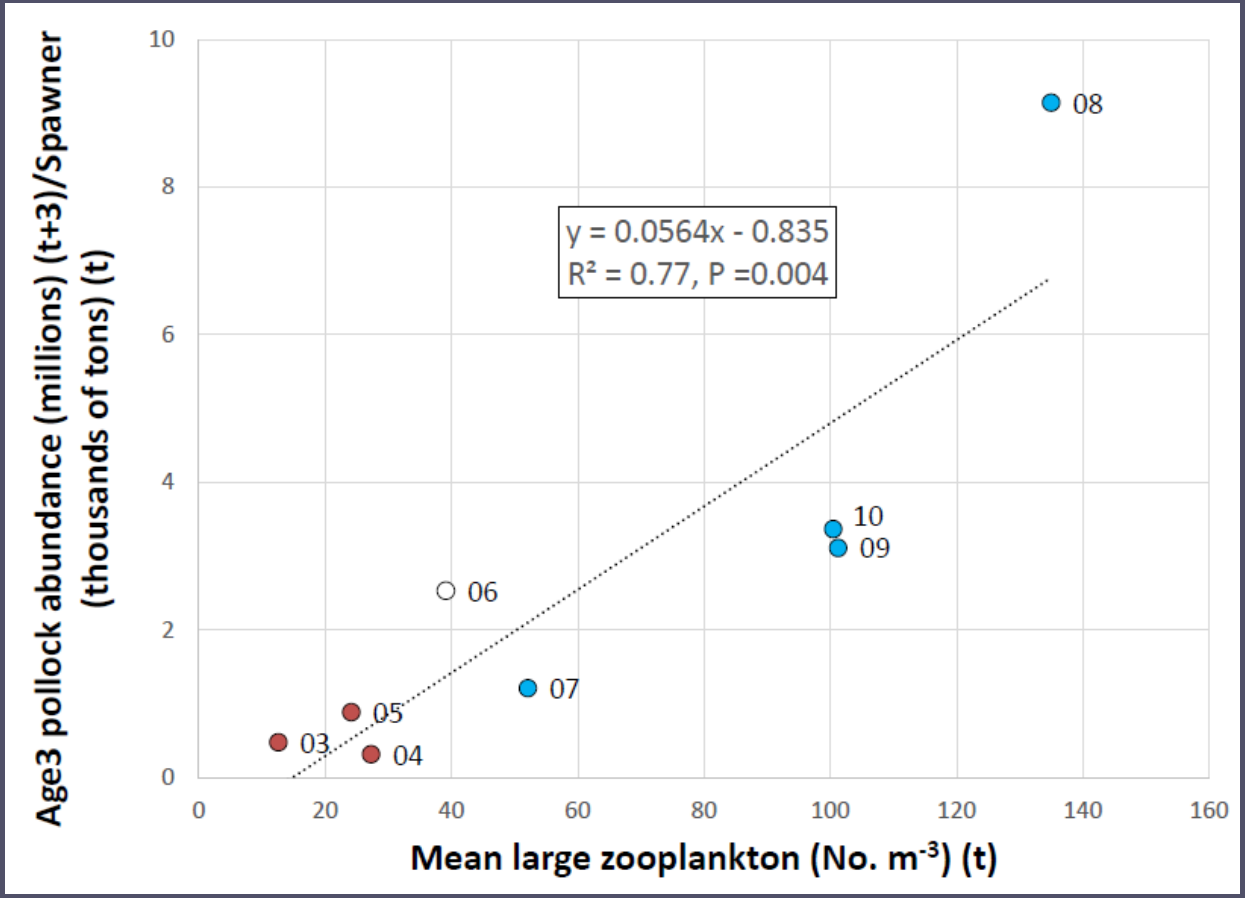
	warm	cool
mass	2.15 g	2.18 g
length	72.6 mm	67.6 mm



- Average energy content of YOY pollock accounted for 68% of the variation in number of age-3 recruits per spawner
- 2014 AEC indicates age-3 will be intermediate in 2017

NEW Large zooplankton abundance as an indicator of pollock recruitment to age-3 in the southeastern Bering Sea

(Eisner and Yasumiishi)



- Assessment age-3 ~f(Fall large zoop abundance (no euphausiids))
- If relationship remains robust, could be leading indicator of age-3 recruitment
- Supports OCH

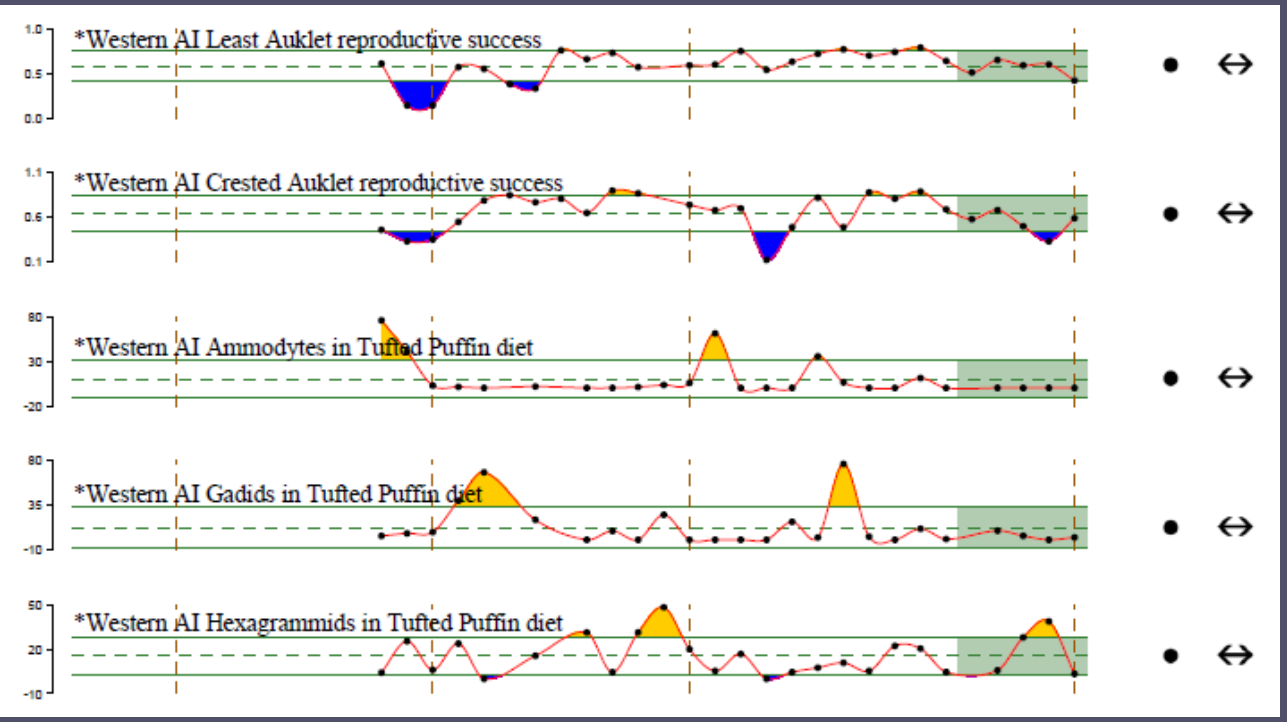
Similar relationship with age-3 abundance

Aleutian Islands

C2 Ecosystem Chapter Report
December 2015

2015 Aleutian Islands Report Card

Western Ecoregion

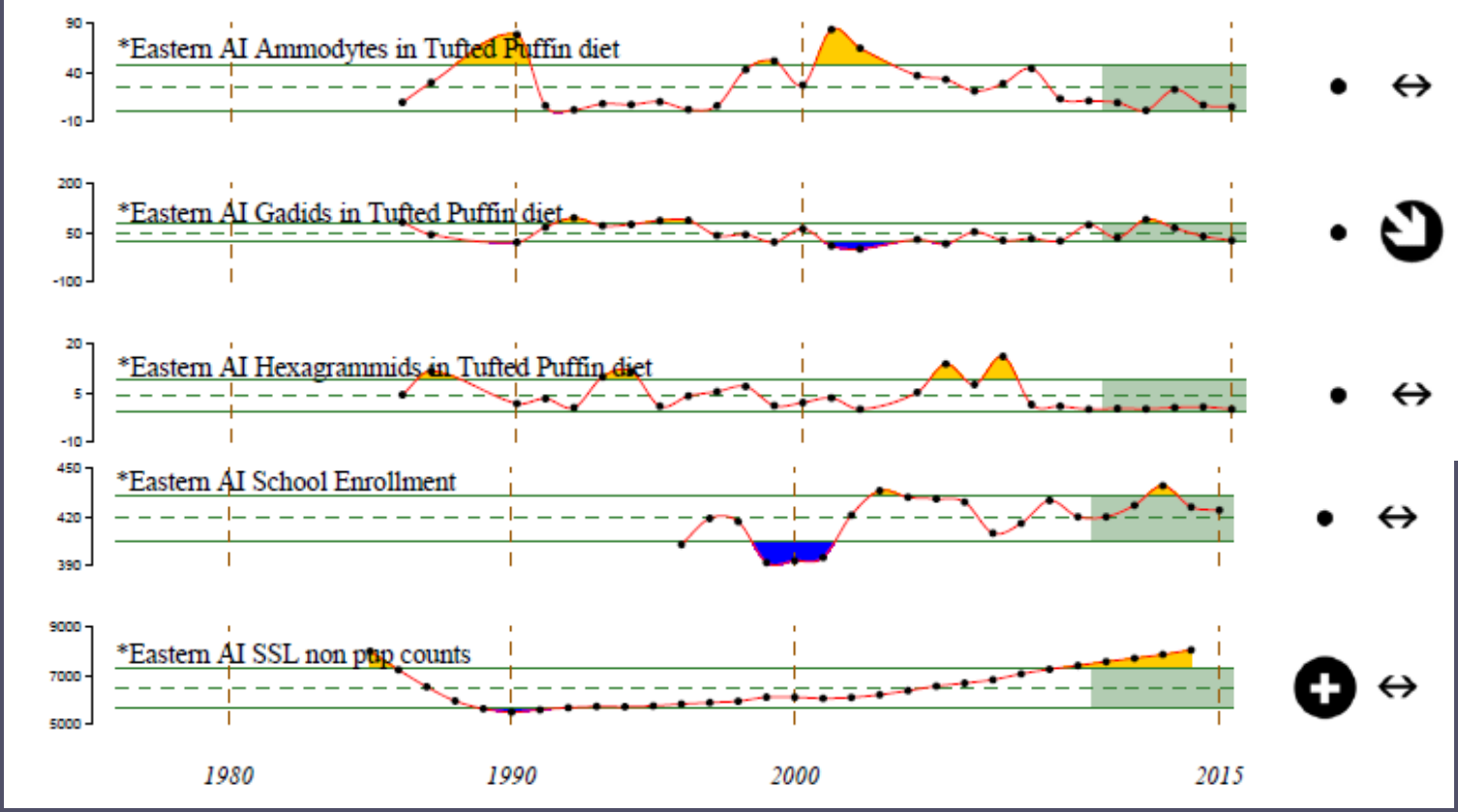


- Planktivorous auklets had average to low breeding success
- Very few forage fish in puffin diets (squid)
- Low sea lion estimates (2014)

2015 Aleutian Islands Report Card

Eastern Ecoregion

Below average sandlance and age-0 pollock in puffin chick diets



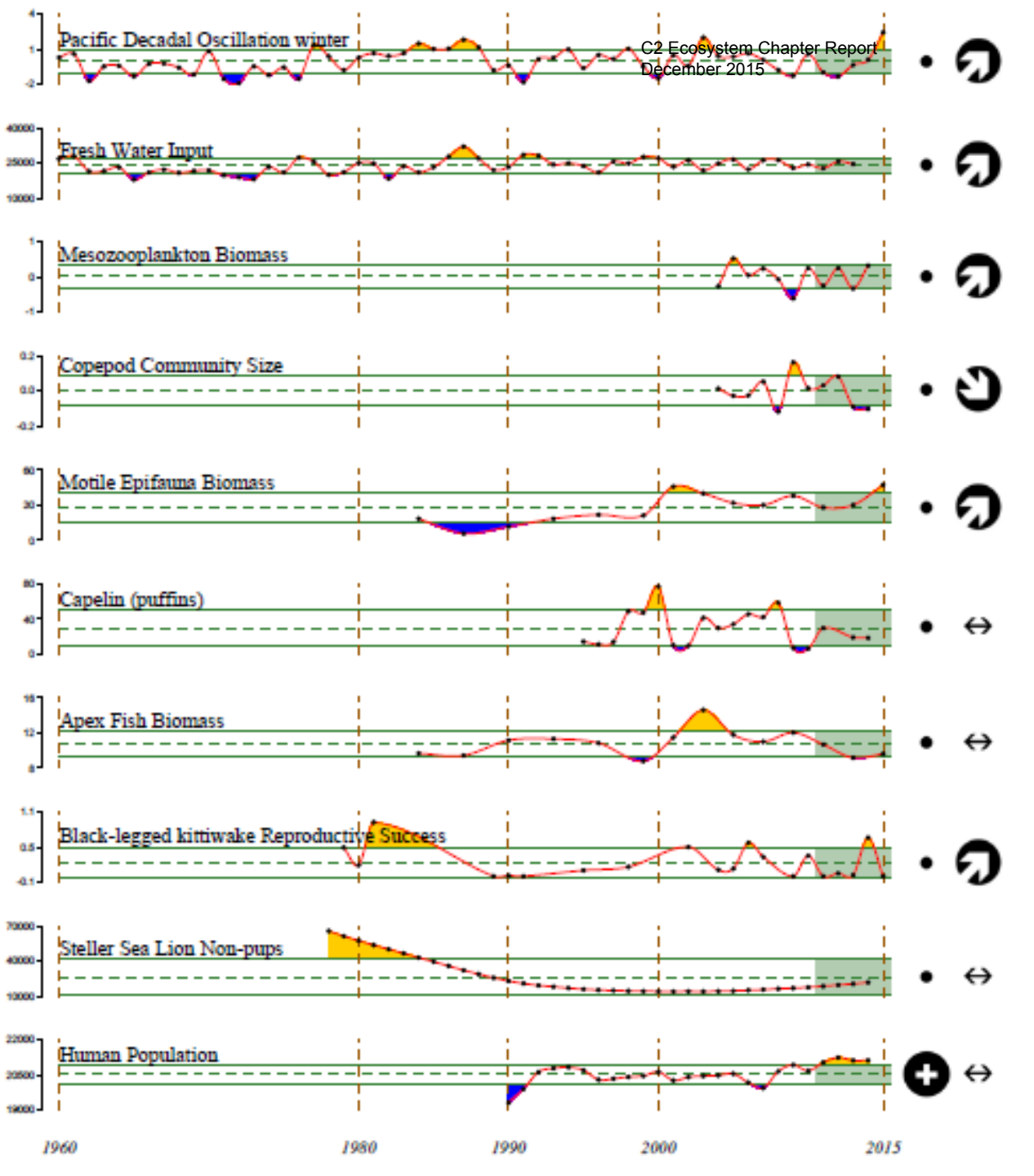
Gulf of Alaska Report Card

Goal

- Select “top” 8-10 indicators that best represent the complexity of the GOA ecosystem (as in the EBS, AI)
- Team of experts voted via online survey (to broaden expertise)
- 44 experts participated
- Paperwork Reduction Act

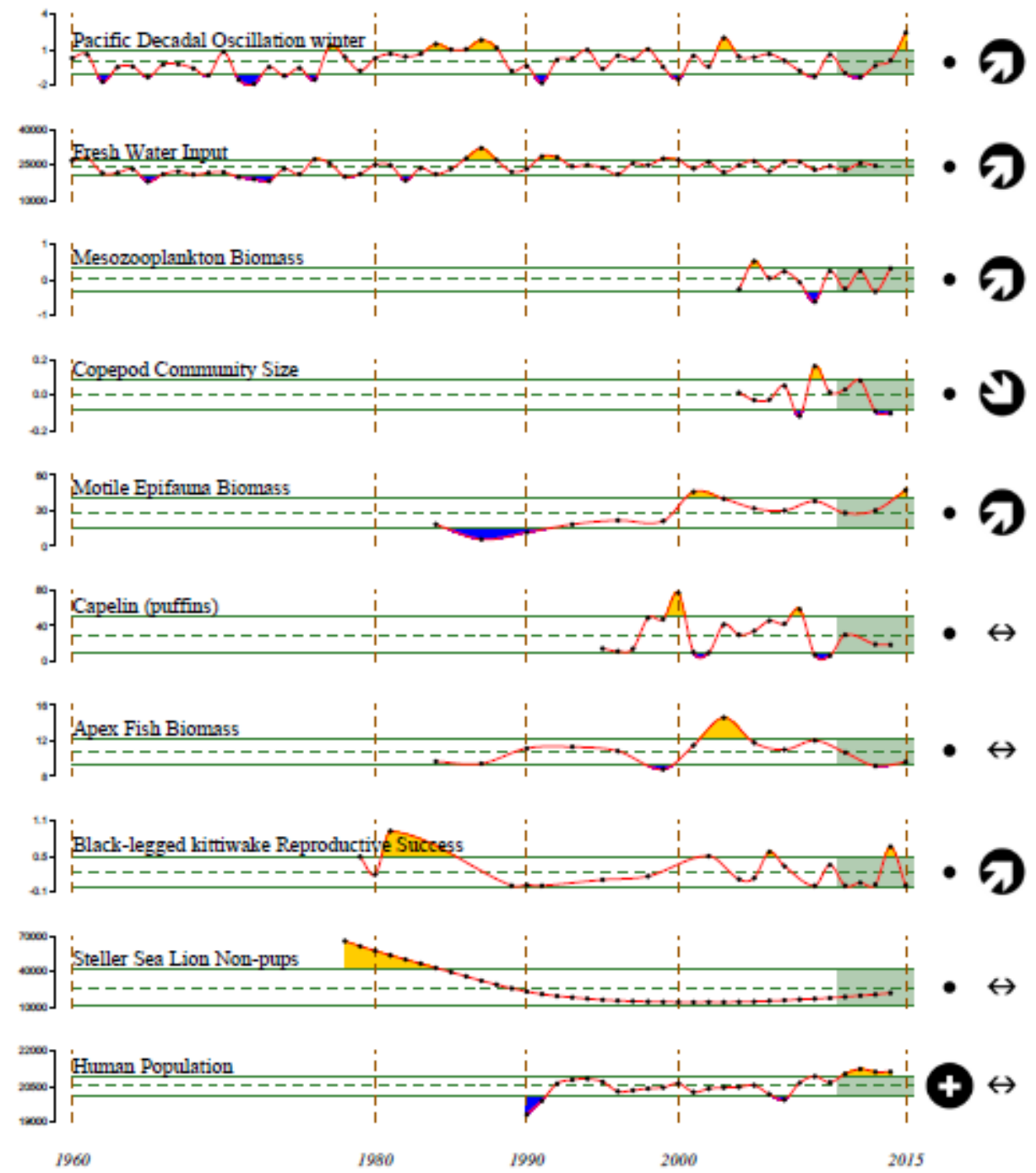
2015 Gulf of Alaska Report Card

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



C2 Ecosystem Chapter Report
December 2015

2015 Gulf of Alaska Report Card



2011-2015 Mean

- 1 s.d. above mean
- 1 s.d. below mean
- within 1 s.d. of mean
- X fewer than 2 data points

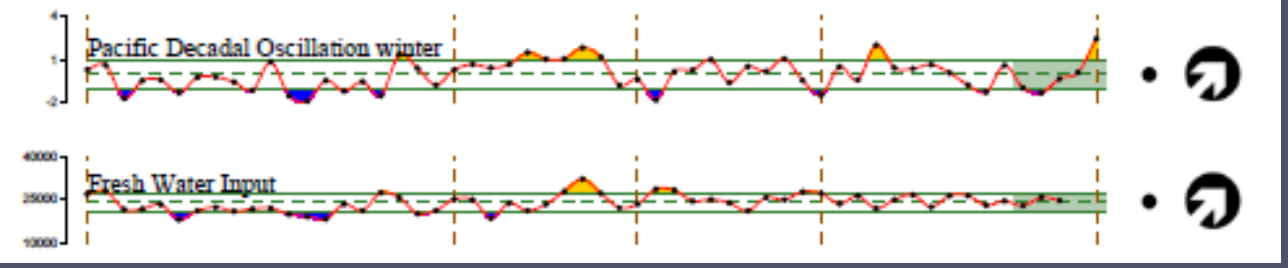
2011-2015 Trend

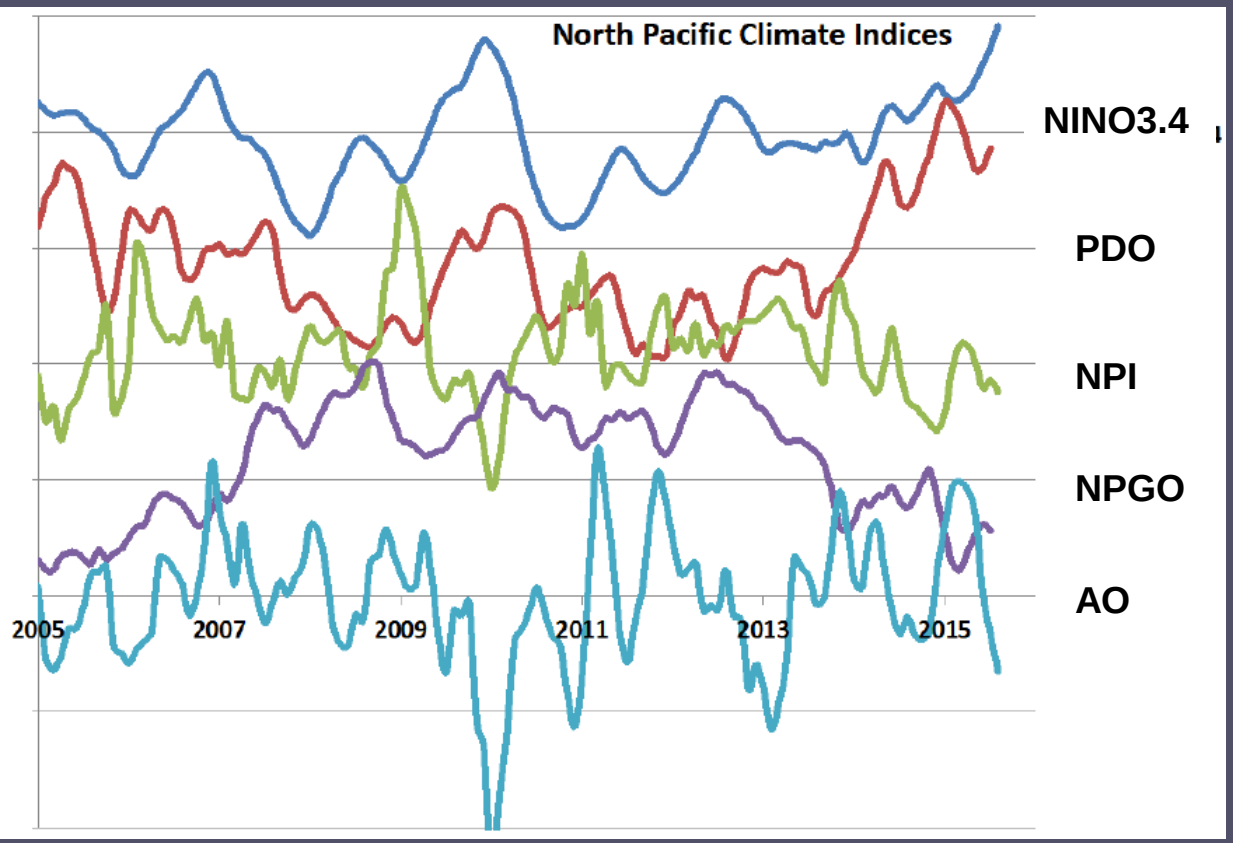
- increase by 1 s.d. over time window
- decrease by 1 s.d. over time window
- ↔ change <1 s.d. over window
- X fewer than 3 data points

Gulf of Alaska 2015 Report Card

- **The Gulf of Alaska in 2015 was characterized by warm conditions** that were first seen in 2014, and continued through the winter, during which **the PDO reached the highest winter value seen** in the record extending back to 1900.
- **Fresh water input as estimated at the GAK1 station has been variable** over the long time series. The most recent data indicate an increasing trend.
- **Mesozooplankton biomass measured by the continuous plankton recorder has shown a biennial trend since 2009**, with higher biomass recorded during even-number years. Biomass trends can be influenced by ecosystem conditions and mean size of the community. This suggests that prey availability for planktivorous fish, seabirds, and mammals has been variable recently. **The biennial patterns suggests a possible link with biennially varying planktivorous pink salmon abundance.**
- **Copepod community size has been declining in recent years.** The prevalence of small copepods during 2014 fits predictions of warm conditions favoring small copepods. This suggests that **less lipid-rich prey were available to planktivorous predators.**
- **Survey biomass of motile epifauna** has been **above its long-term mean** since 2001. The increase from 1987 to 2001 was driven by hermit crabs and brittle stars, which dominate the biomass. Since 2001 their biomass has been stable. Record catches of octopus influenced the increased estimate in 2015.
- **Trends in capelin captured by tufted puffins at the Barren Islands have been variable** in the 20 year time series. **Capelin comprised the majority of chick diets in 2000 and were generally abundant from 2003 - 2008, but have been at or below the mean since that time.** It is unknown whether these trends reflect capelin abundance or prey preferences of the puffins.
- **Fish apex predator survey biomass is currently below its 30-year mean**, although the declining trend seen in recent years has leveled off. **The trend is driven primarily by arrowtooth flounder** which, along with halibut, had been declining since 2005. Both increased slightly in 2015. It is unknown whether these increases were due to distributional shifts in the warm water. **Pacific cod has declined from a peak survey biomass in 2009.**
- With the exception of 2014, **black-legged kittiwake reproductive success has been poor** in the Semedi Islands, indicating that conditions were not favorable for these surface-foraging piscivorous seabirds. This may reflect poor conditions prior to the breeding season, during, or both.
- Modelled estimates of total Gulf of Alaska **Steller sea lion non-pups counts are approaching the long term mean.** This slowly increasing pattern since 2000 reflects the combination of increasing trends in the eastern population with declining trends in the western popoulation.
- **Human populations in the Gulf of Alaska coastal towns of Homer, Kodiak, Sitka, and Yakutat are above the 25 year mean.** Homer is the sole town with a steadily increasing trend. Kodiak saw declines until 2006 and has recovered slightly since then.

2015 GOA Physical Conditions





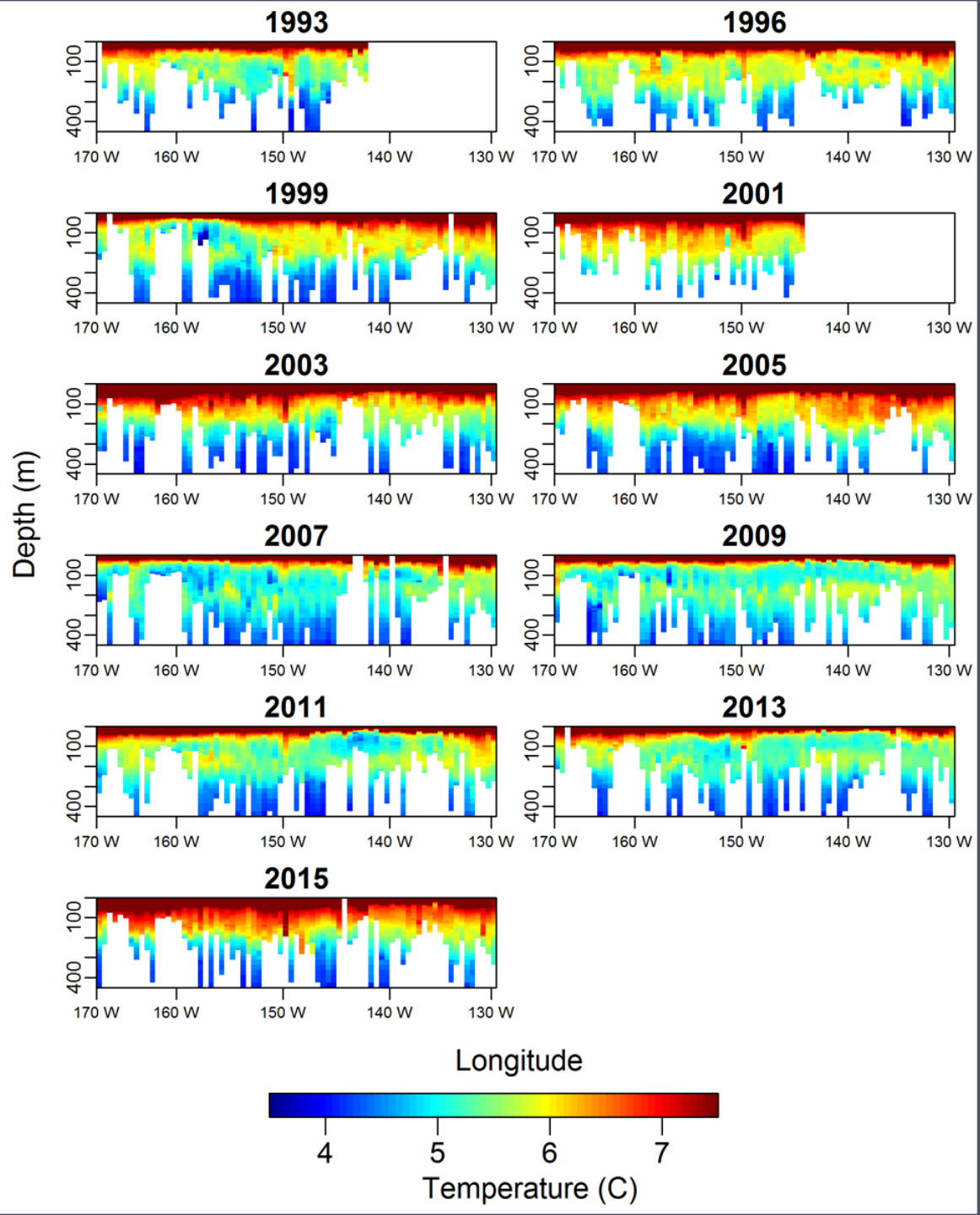
Strongly positive ENSO

PDO in Dec 2014 largest winter value since 1900, leading ENSO recently

FW discharge indicator

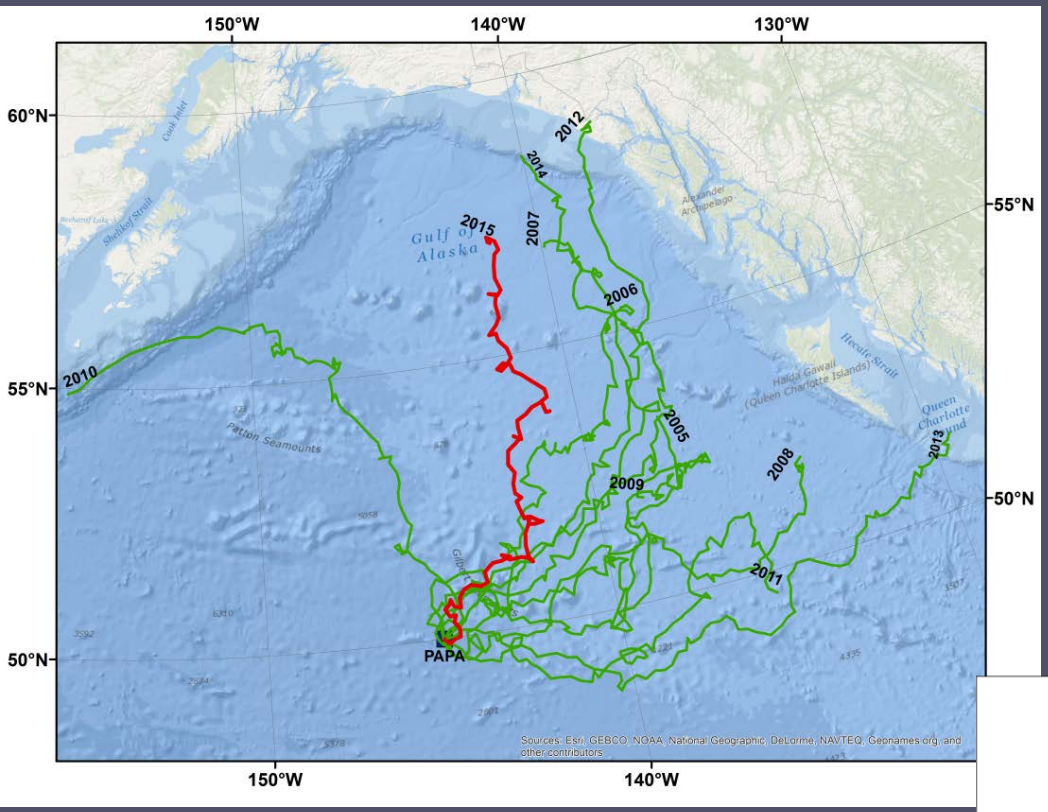
Low resolution model of air temp, precip and lags.
New high resolution model (Hill) to replace in future

GOA survey water temps (Laman)

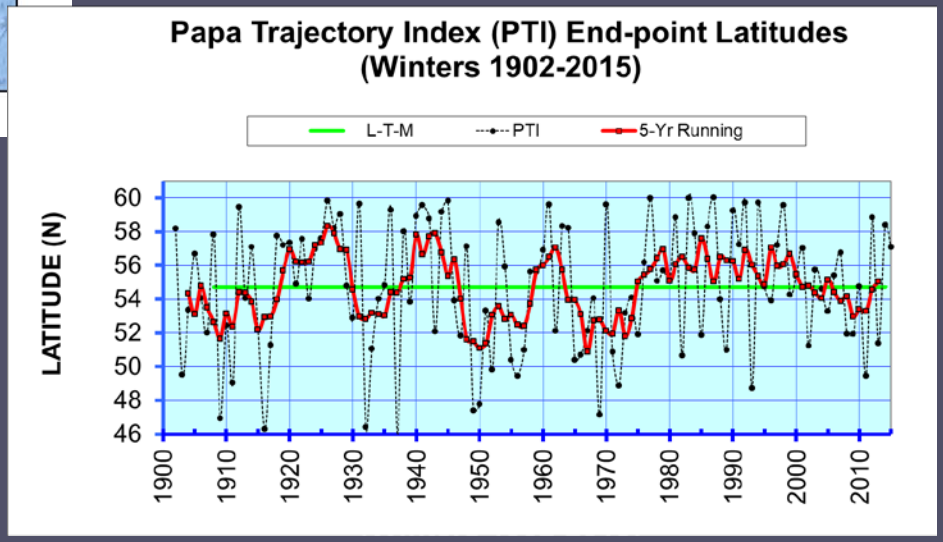


- Overall, 2015 similar to 2005
- Stratification and thermocline depth deeper than 2007-2013
- Caveats
  - Snapshot of survey temps
  - Temps can be affected by storms, eddies, current, etc.

Ocean Surface Currents – PAPA Trajectory Index (Stockhausen and Ingraham)

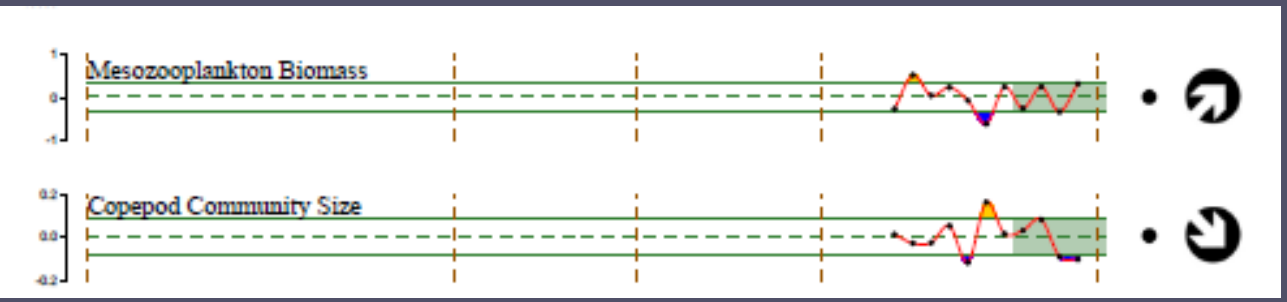


- Simulated surface drifter released from Ocean Station PAPA Dec 1 90 days
- 2014/15 trajectory: similar to 2013/14 (S wind anomalies -> "Blob")
- N-ward shift in "boundary" between sub-arctic and sub-tropical species; absence of open ocean LT organisms in SE AK

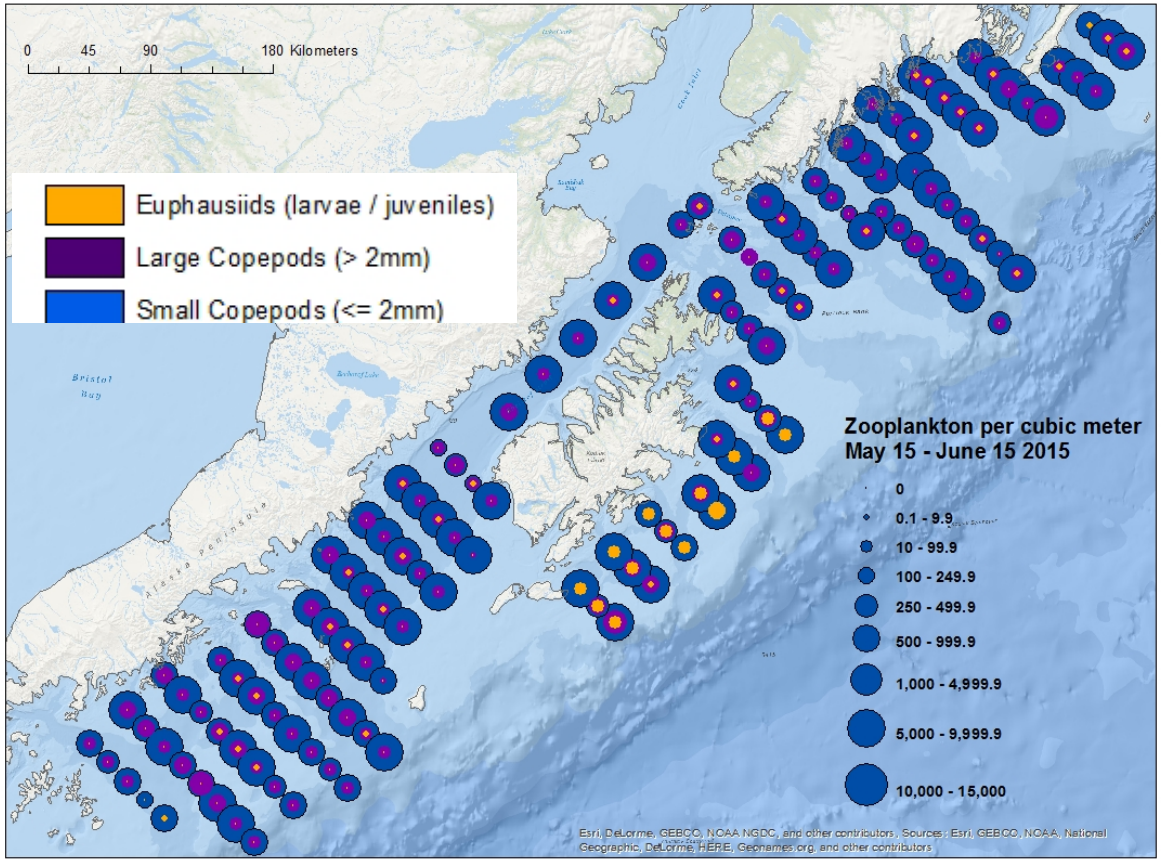


- Changed little from last year - rare
- Recent period of mostly southerly flow is shortest in time-series
- Does **not** indicate return to surface drift conditions similar to <1977 regime shift

2015 GOA Zooplankton



NEW Spring EBS Zooplankton Rapid Assessment

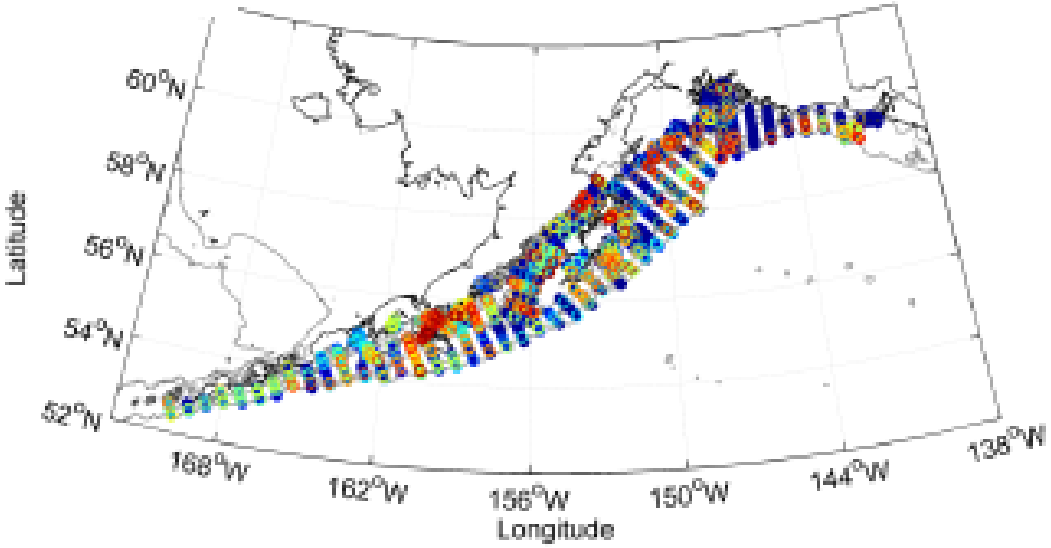


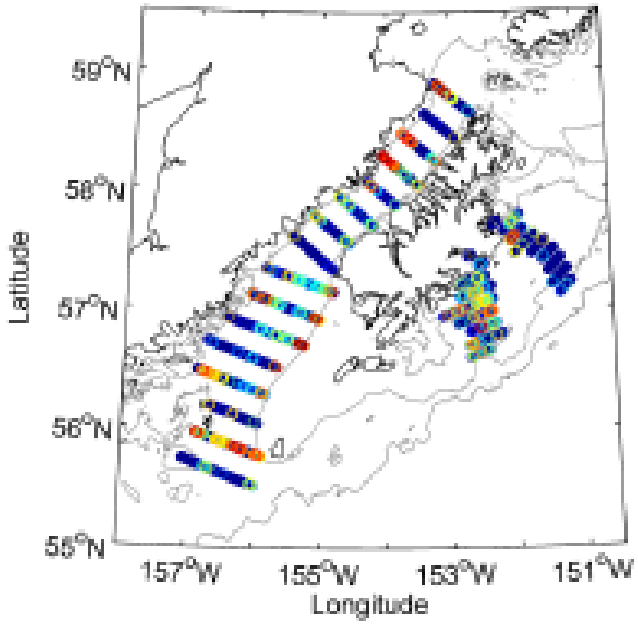
- Rough count, preliminary estimate (ecoFOCI)
- Small copepods most common (warm conditions)
- Euphausiids highest SE of Kodiak
- Temps cooler SW of Kodiak, higher large zoop abundances

2015

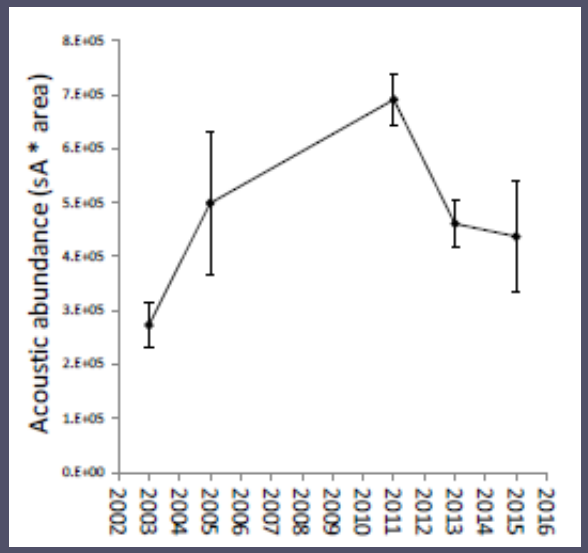
Gulf of Alaska euphausiids – "krill"

(Ressler and Simonsen)

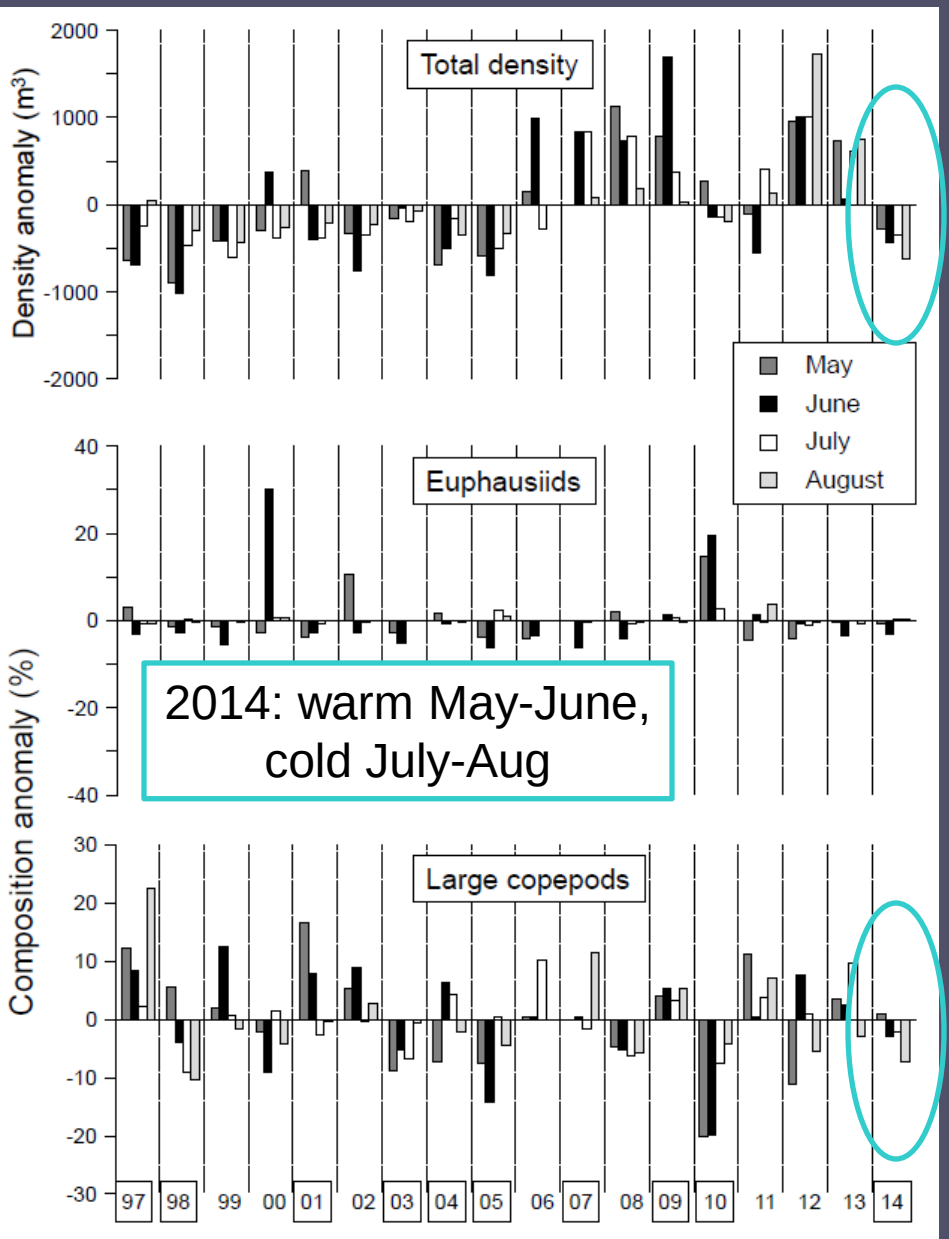


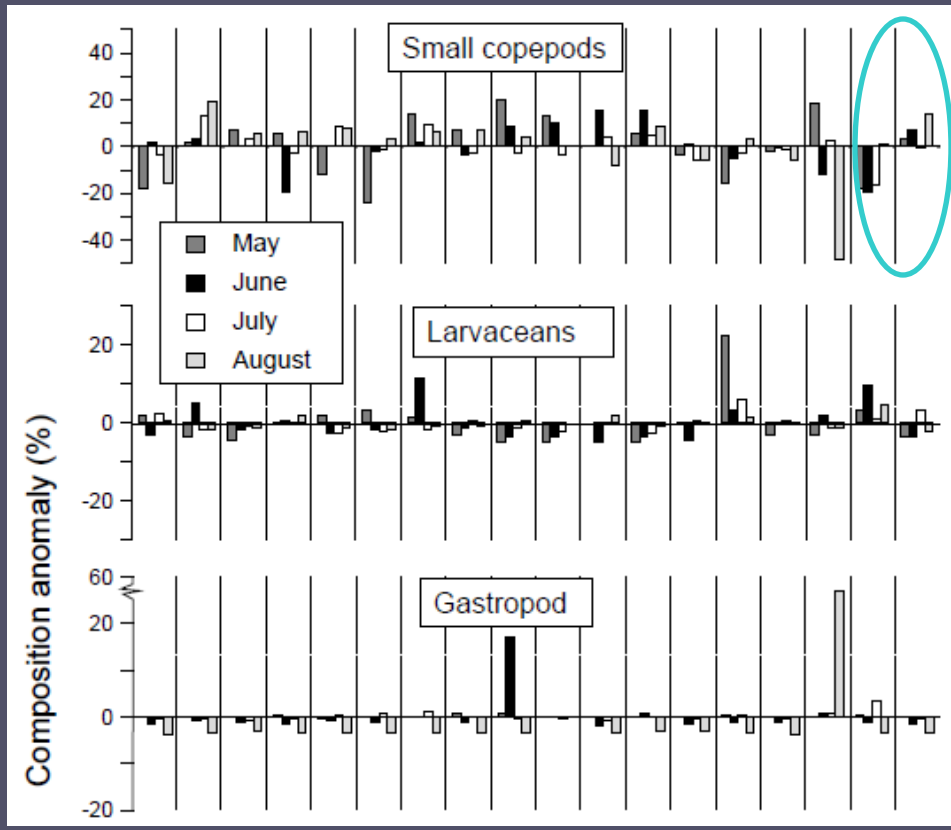


- Acoustically backscatter
- Highest abundance in 2011
- Lowest in 2003
- Small decline relative to 2013



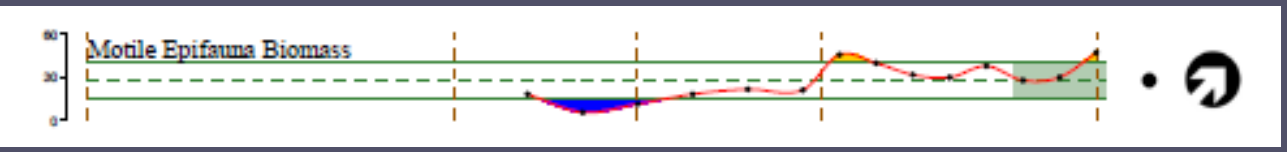
2014 Zooplankton in Icy Strait (Fergusson et al)



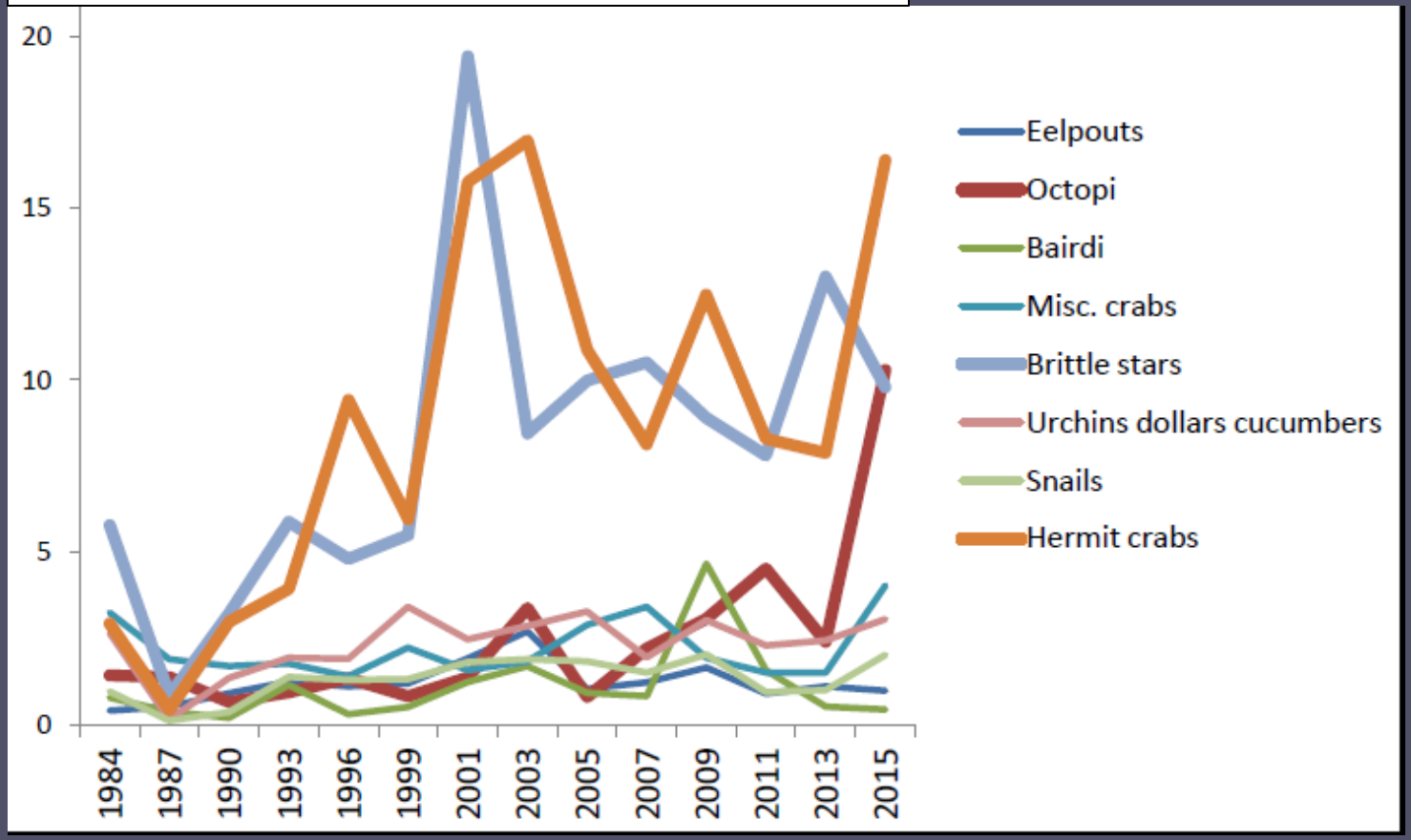


Small copepods more prevalent than large

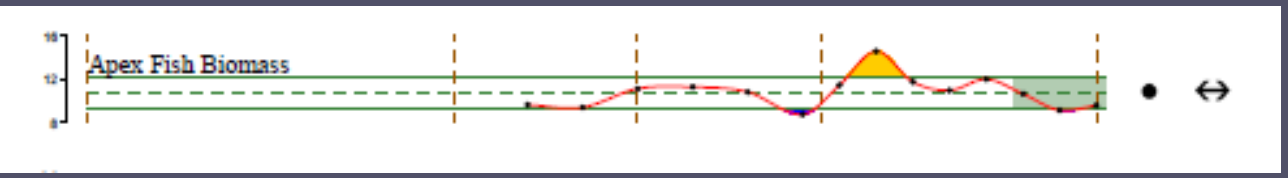
2015 GOA Motile Epifauna



Aggregated biomass from the BT survey



2015 GOA Apex Fish



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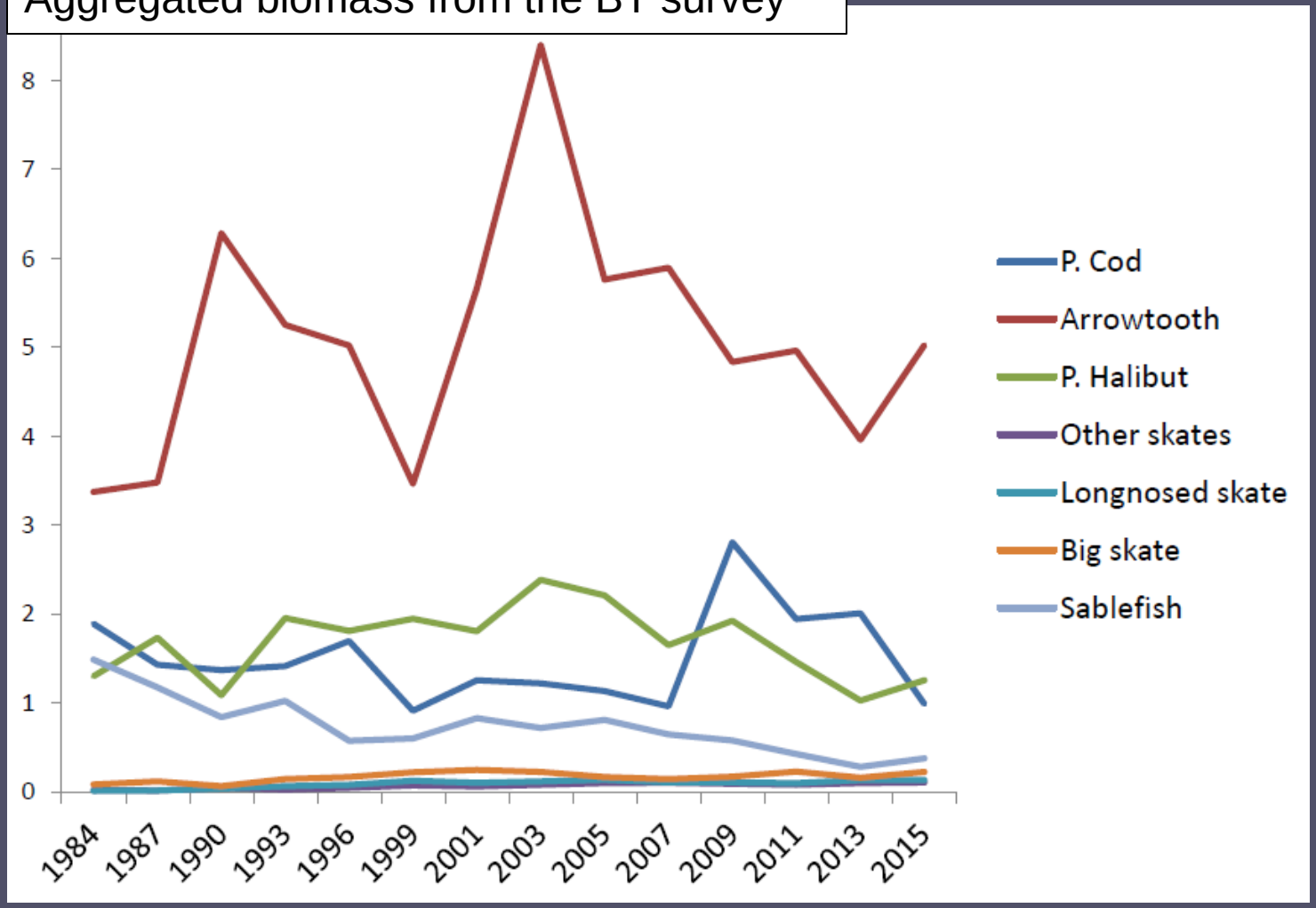


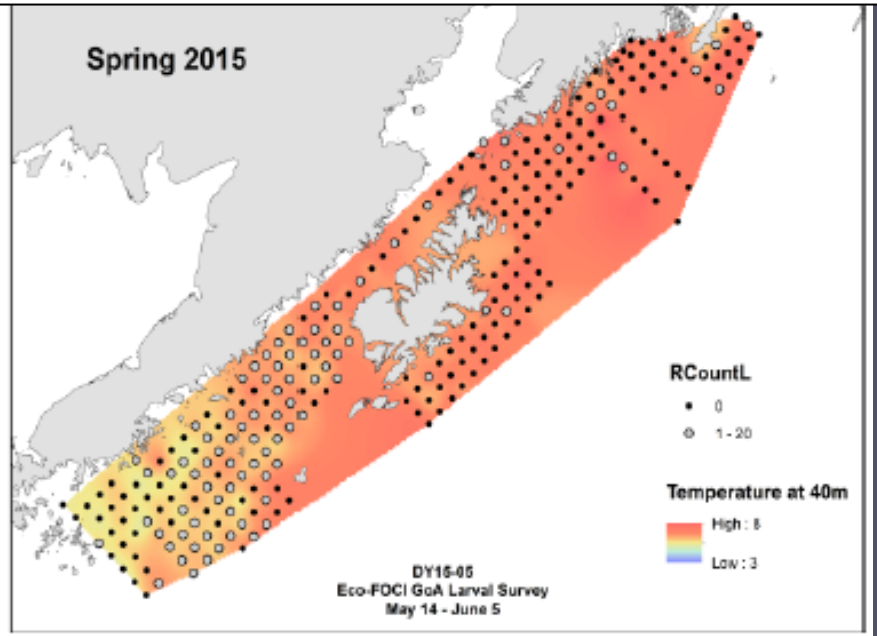
2015 GOA Capelin

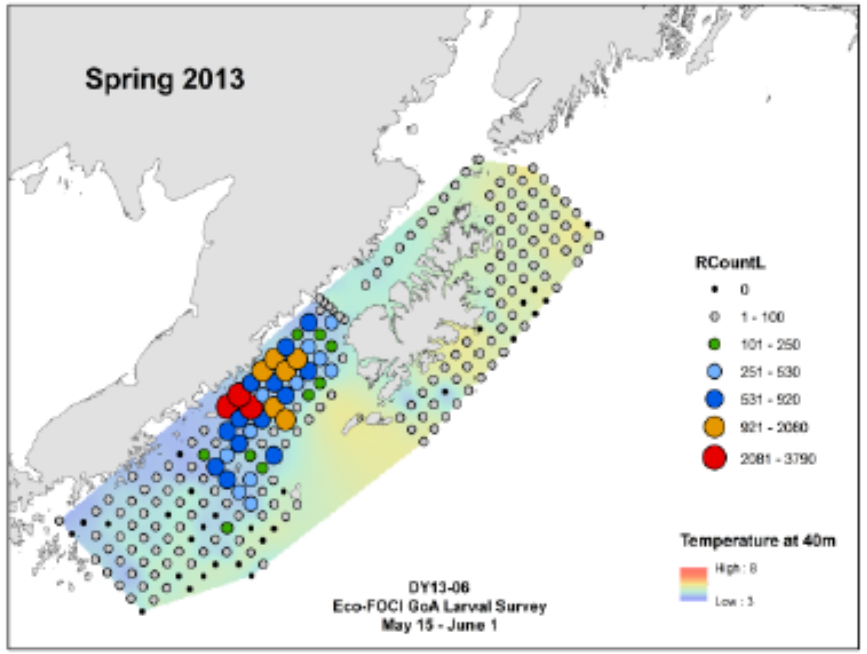
- Forage fish indicator species
- Percent composition that was capelin delivered to tufted puffin chicks at the Barren Islands
- Collected by USFWS screening burrows during summer
- Replace with multivariate forage fish indicator (multiple samplers?) in the future

Hot Topics

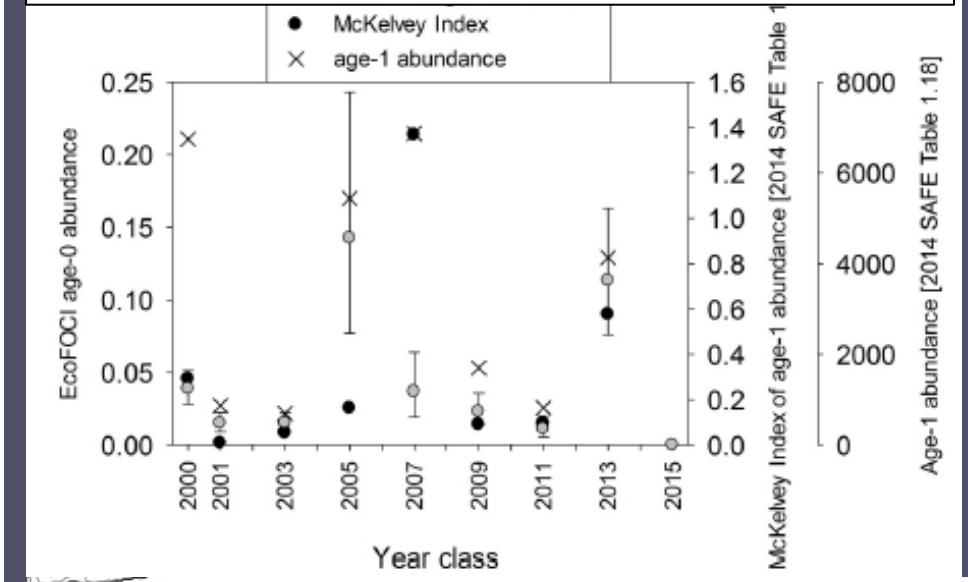
Too warm for age-0 pollock?

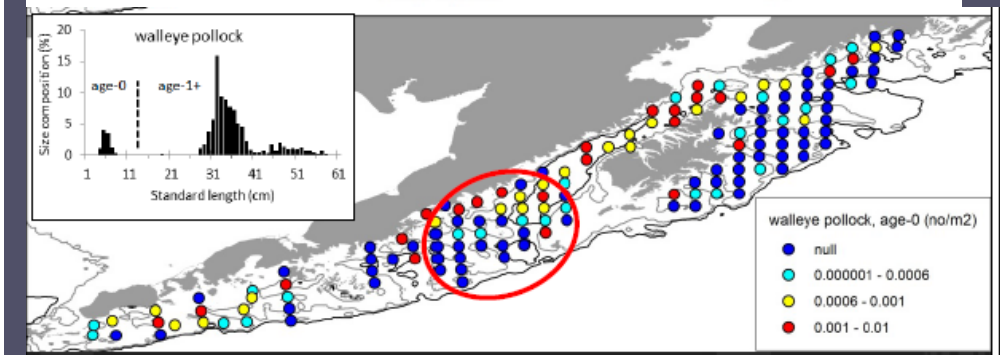
Spring: Bongo arrays, 10 m off bottom

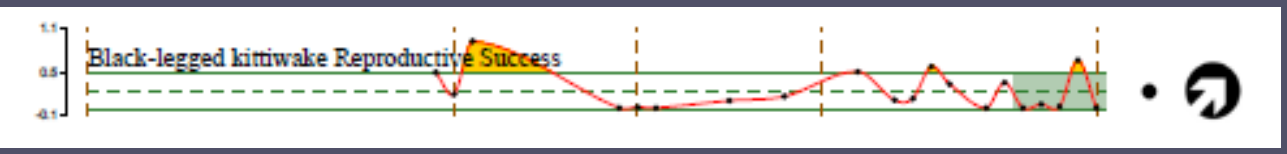




Late Summer: 70 fish/km^2, lowest on record, few age-1s



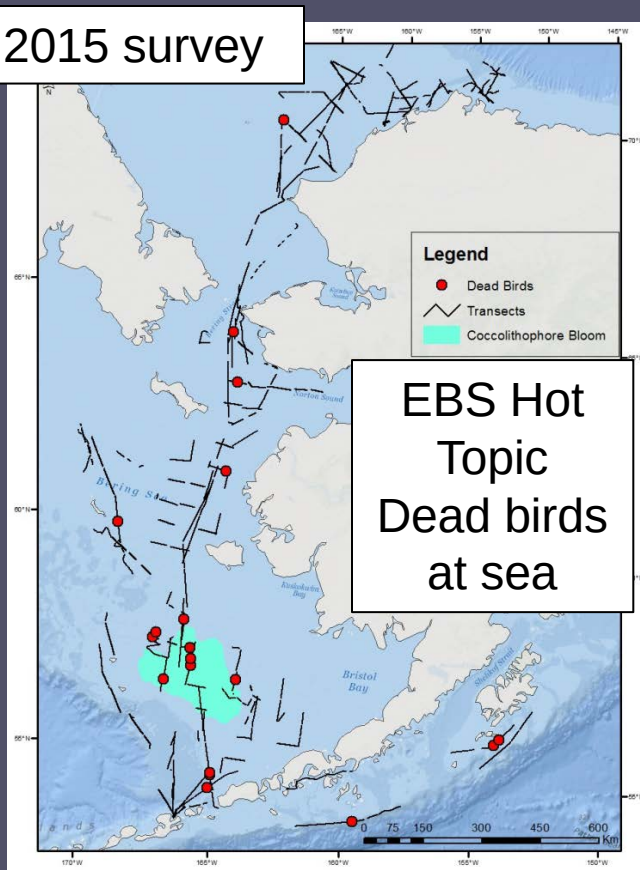




2015 GOA Kittiwake reproductive success

- Black-legged Kittiwakes
- Common surface-foraging, piscivorous seabird
- Conspicuous nester
- Proportion of nest sites with chicks that fledged
- Replace with multivariate seabird indicator in the future?

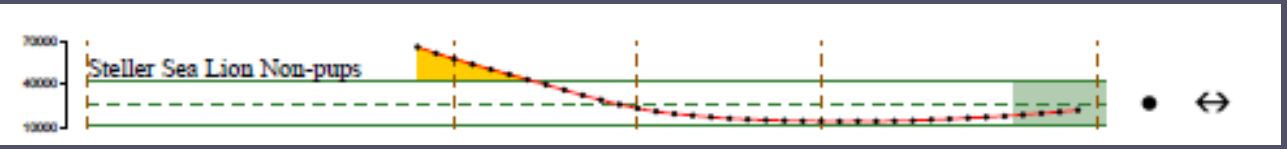
2015 survey



EBS Hot Topic
Dead birds at sea

Year	Dead birds obs
< 2014	1-2 per year
2014	51
2015	19 (8 in bloom)

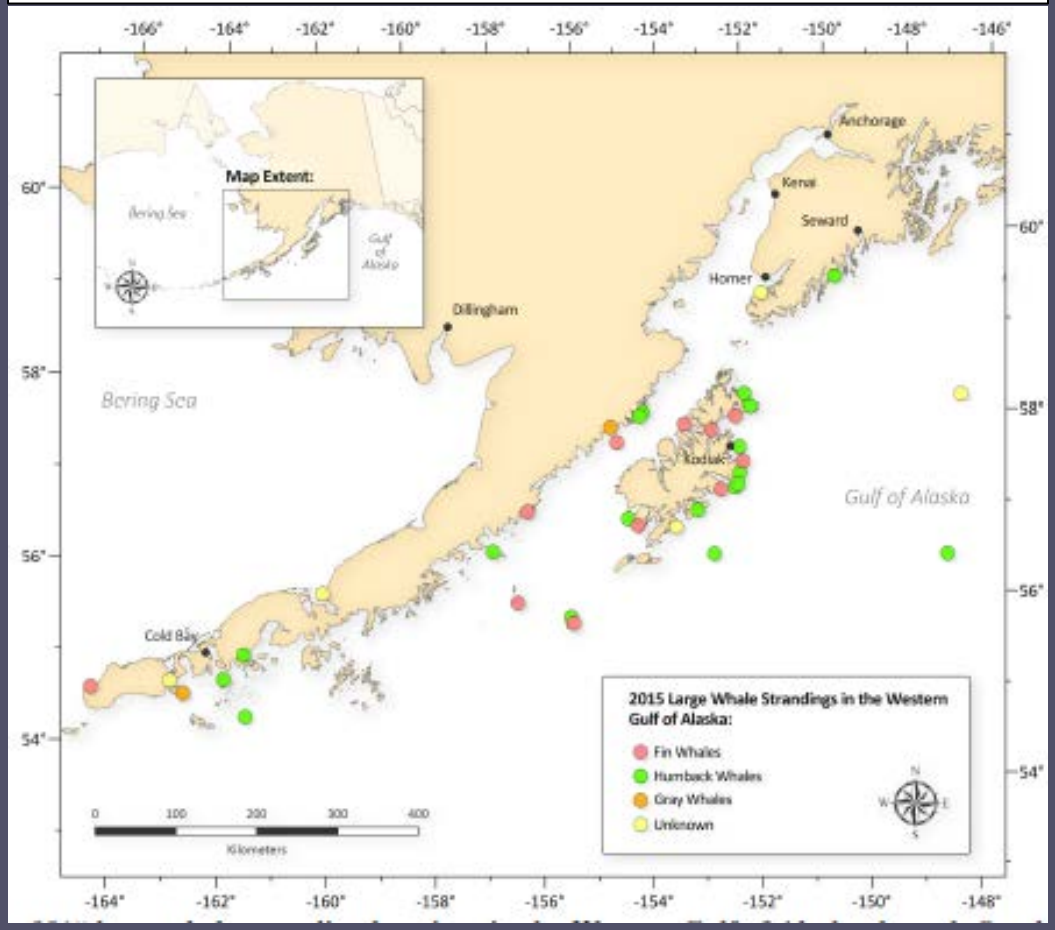
2015 GOA Steller sea lions



- Marine Mammal indicator
- AgTrend model
- Abundance estimates of non-pups
- Combines eastern and western distinct populations
- Split in future? Use only one?

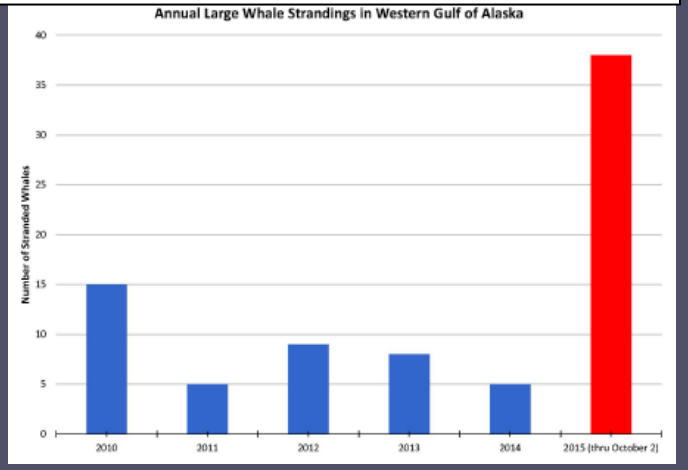
Hot Topic
Unusual Mortality Event

Species composition of whale strandings

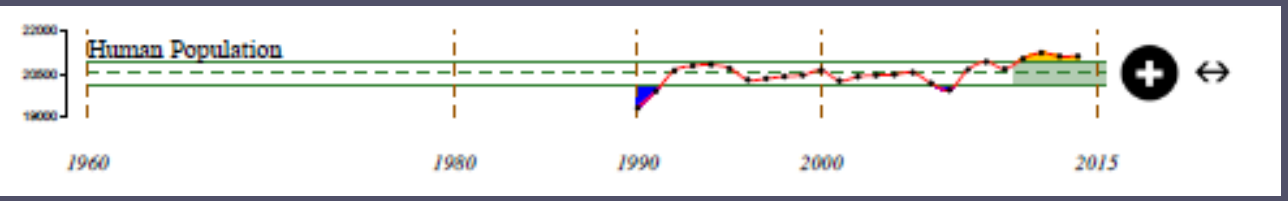


- Large whale mortalities
- Harmful algal bloom?

Annual large whale strandings



2015 GOA Human populations



- Human Impact Indicator
- Combined populations of Homer, Kodiak, Sitka, and Yakutat
- 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?

Gulf of Alaska Report Card

Next Steps

- Review with GOA IERP group in February 2016
- East vs West, similar to AI?

Gulf of Alaska 2015 Report Card

- **The Gulf of Alaska in 2015 was characterized by warm conditions** that were first seen in 2014, and continued through the winter, during which **the PDO reached the highest winter value seen** in the record extending back to 1900.
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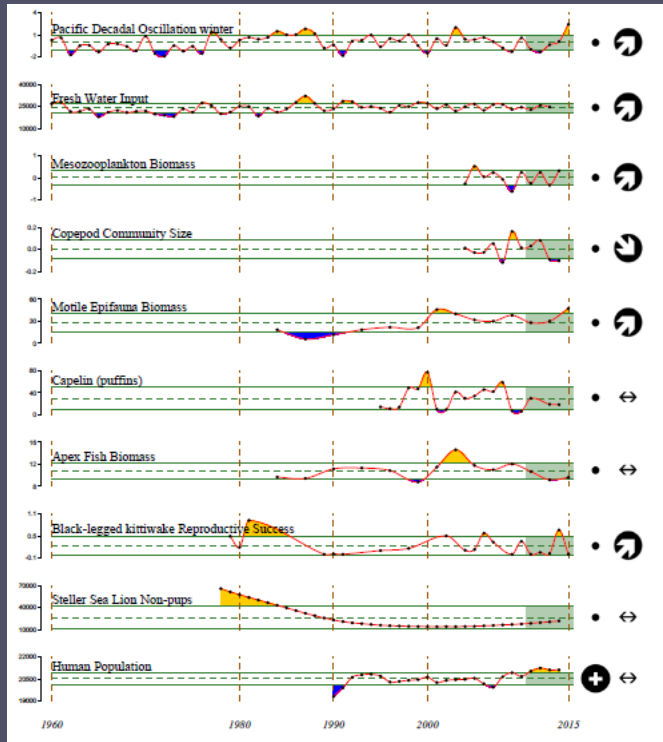
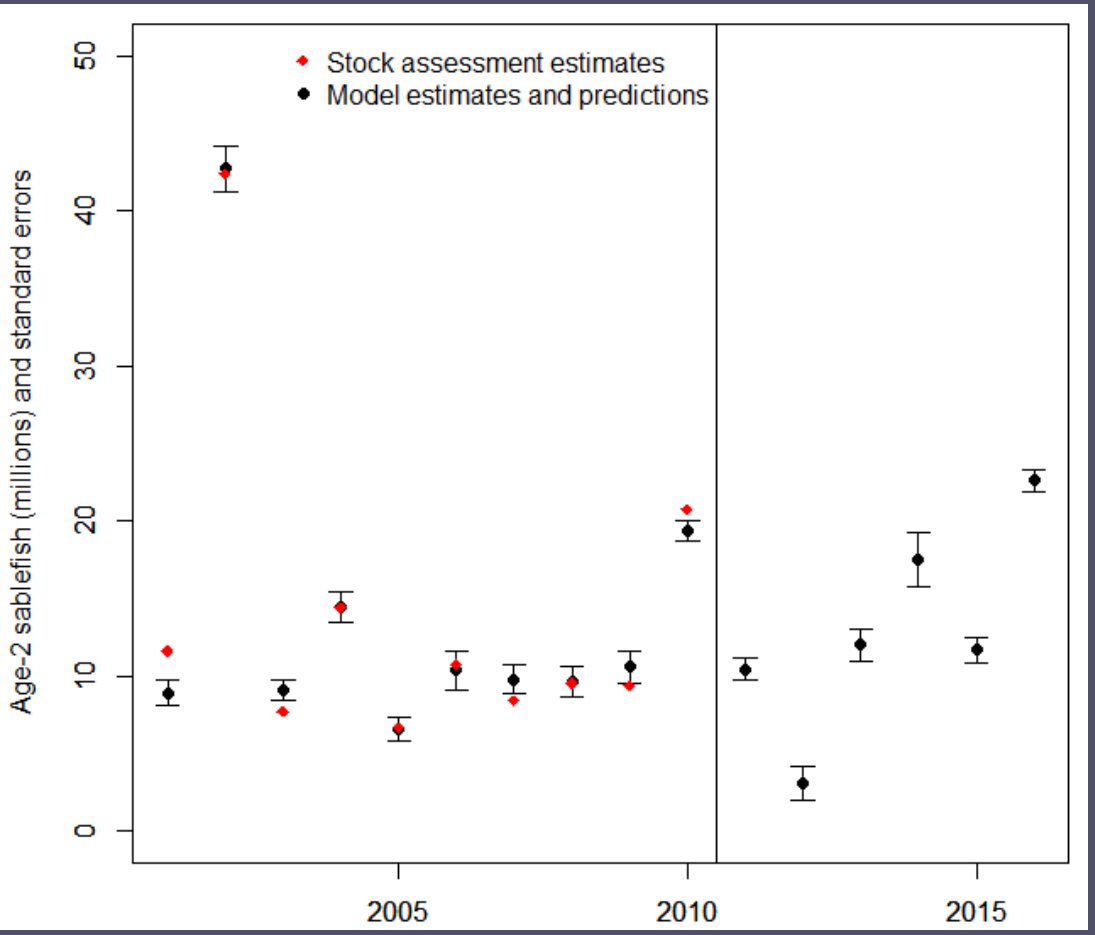


New Disease Ecology section as suggested by the SSC

- Ichthyophonus parasite
- Mushy halibut - reappearance in 2015

Southeast coastal monitoring survey indices and the recruitment of GOA sablefish **(Yasumiishi)**



Icy Strait

Data: temperature, chl a, pink salmon productivity

Provides: rearing habitat for sablefish

Higher recruitment appears to be a function of warmer SST and more chl a during age-0 stage and higher pink salmon productivity

Chl a R^2 = 0.88, temp and productivity explained 10%

Prediction: above-average age-2 recruitment in 2016.

Summary

2014

- Reversal to warm conditions. Mostly high productivity.

2015

- Continuation of warm conditions
- Average to poor productivity
- Small zooplankton
- “Mushy” halibut
- Poor groundfish condition
- Few forage fish
- Poor seabird reproduction
- Dead whales

Contributors

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Thank you!

Website

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