

Ecosystem Considerations

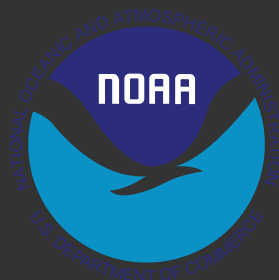
Eastern Bering Sea



North Pacific Fisheries Management Council

Crab Plan Team meeting

September 15, 2014



Ecosystem Considerations Report

Major Sections

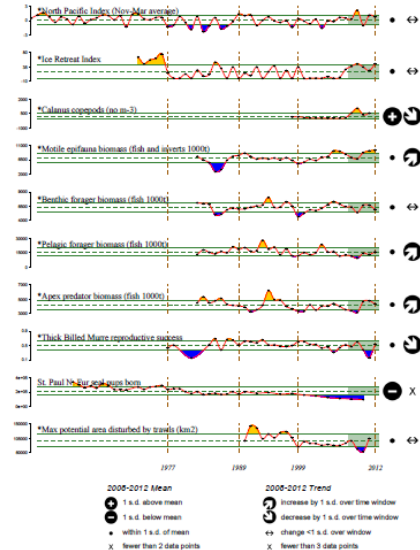
- Report Cards
- Executive Summary
- Ecosystem Assessments
- Ecosystem Status and Management Indicators

Arctic, EBS, AI, GOA

Eastern Bering Sea 2012 Report Card

- The North Pacific atmosphere-ocean system reflected a combination of a response to La Niña and intrinsic variability. The combination of the neutral to weak El Niño expected this winter and a continuation of reduced ice cover in the central Arctic should yield a lighter ice year for the Bering in 2013.
- Ocean temperatures remained cold and sea ice remained extensive, similar to 2008 and 2010. Ice retreat this year (and 2009) was the latest recorded since 1985. Summer was calm and cool, but had the most extensive cold pool area of the recent decade.
- The summer *Calanus* copepod time series showed an increase in abundance in 2011 relative to 2010, but remained below the 2009 peak. 2011 was the fourth year that concentrations remained well above average, following patterns also seen in fall zooplankton abundances during cold years. This suggests that prey availability for planktivorous fish, seabirds, and mammals continued to be high during the summer of 2011.
- Jellyfish remain abundant, although peak abundances observed in fall 2010 and summer 2011 declined by fall 2011 and summer 2012.
- While commercial crab stocks are relatively low, overall motile epifauna biomass remains stable or increasing since the late 1980s. Higher levels since 2003 are driven by increases in brittle stars and echinoderms, although these series show high within-year variances in the survey.
- Biomass of benthic foragers has remained stable since 1982, with interannual variability driven by short-term fluctuations in yellowfin and rock sole abundances.
- Biomass of pelagic foragers has increased to nearly average from record survey lows in 2009. While pollock has increased from low levels, the overall increase is additionally driven by increases in capelin seen in 2010-2012.
- Fish apex predator biomass has increased appreciably in the last few years, driven primarily by the increase in Pacific cod from lows in 2007-2009 to higher levels in 2010-2012. Arrowtooth flounder biomass has decreased from all-time survey highs during 2004-2005, though it remains high relative to pre-1980 levels.
- Thick-billed murres reproductive success on St. George Island was near average in 2012, a substantial increase from the record low in 2011. This suggests that foraging conditions were favorable for piscivorous seabirds.
- Northern fur seal pup production for St. Paul Island has declined over the long term. The most recent pup production estimates for St. Paul and St. George Islands in 2010 were 8.8% and 1.0% less than the 2008 estimates.
- The maximum potential area of sealiferous habitat disturbed by trawl gear increased in 2011 to the highest level since 1998. The cause of this increase is currently unknown.

Hot topic In September the Department of Commerce declared commercial king salmon fisheries in the Yukon and Kuskokwim rivers failures after extremely low returns over the summer. The two leading hypotheses for the reduced runs are climate change and fishing.



Executive Summary of Recent Trends

Physical and Environmental Trends

- The state of the North Pacific atmosphere-ocean system during 2012-2013 reflected the combination of mostly near-neutral ENSO conditions and intrinsic variability (p. 21).
- Cooler than normal upper ocean temperatures prevailed in the eastern portion of the North Pacific (p. 21,22).
- The Pacific Decadal Oscillation (PDO) has remained in a largely negative state since the latter part of 2007, and the North Pacific Gyre Oscillation has remained in a positive state during the same time period (p. 26).
- Models indicate a greater likelihood of near-neutral versus either El Niño or La Niña conditions for the winter of 2013-14 (p. 28).

Arctic

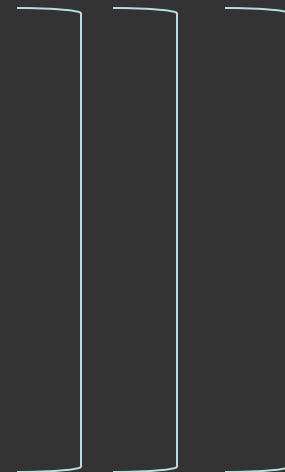
- There is reduced sea ice cover in the Arctic during the summer of 2013 compared to seasonal norms, but not to the extent that occurred in 2011 and 2012 (p. 21).
- Ice concentrations in the Chukchi Sea have been observed to be greater during the summer of 2013 than in 2012 (p. 21).

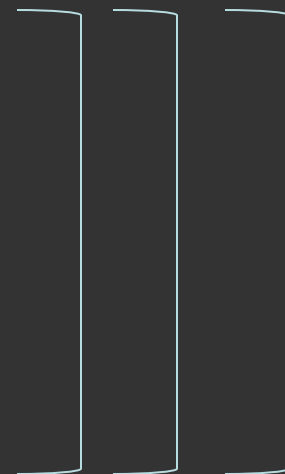
Eastern Bering Sea

- The eastern Bering Sea shelf experienced less storminess than normal in fall 2012 and spring 2013. On the other hand, the weather during fall and winter was cold, which resulted in another relatively heavy ice year (p. 21).
- Oceanographic surveys of regions within the northern EBS between 2002-2012 have documented spatial variations in oceanographic characteristics (salinity, temperature, and zooplankton abundance). Norton Sound stands out as most distinct from other regions because of high surface and bottom temperatures, low surface and bottom salinities, and lower than average light transmission (p. 31)

Alaska Peninsula and Aleutian Islands

- Easterly wind anomalies prevailed in this region during the fall of 2012 and spring of 2013. Anomalies in this sense tend to enhance the northward transport through Unimak Pass and perhaps also the Aleutian North Slope Current (p. 21).





Ecosystem Status and Management Indicators



- **Updated Sept 2013**
 - **Physical (8)**
 - **Zooplankton (3)**
 - **Forage fish (2)**
 - **Herring (1)**
 - **Salmon (2)**
 - **Groundfish (2)**
 - **Benthic Communities and Non-Targets (1)**
 - **Seabirds (1)**
 - **Ecosystem or Community Indicators (1)**
 - **Ecosystem-Based Management (12)**

Outline

- North Pacific Climate
- Eastern Bering Sea
 - Report Card
 - Physical and environmental trends
 - Ecosystem trends
- Alaska-wide Ecosystem indicators
- Fishing and Fisheries Trends

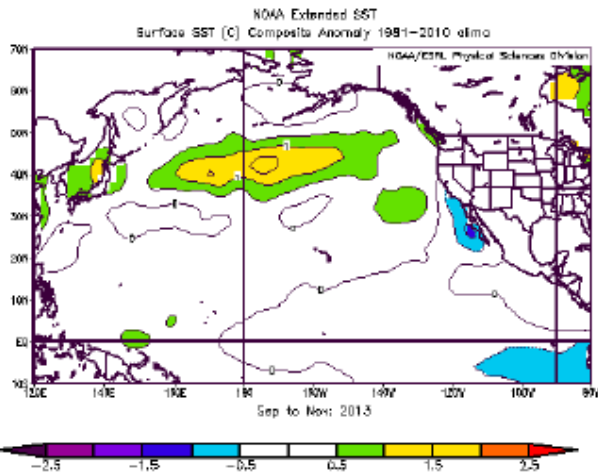


North Pacific Climate Overview (Bond)

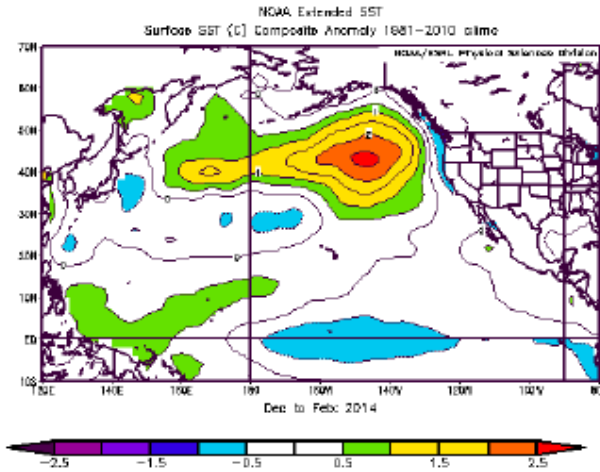
- 2013-2014: development of strongly positive SST south of Alaska
- Aleutian Low weak last winter
- Abnormally high SLP (reduced seasonal cooling)
- PDO transitioned to positive
- ENSO forecasts indicating *weak-moderate* El Niño state 2014-2015



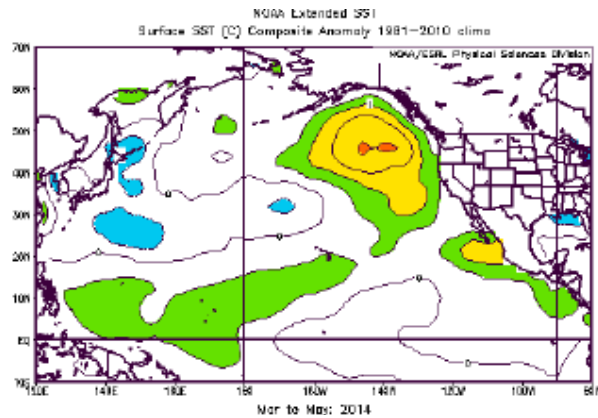
Sea Surface Temperature Anomalies (Bond)



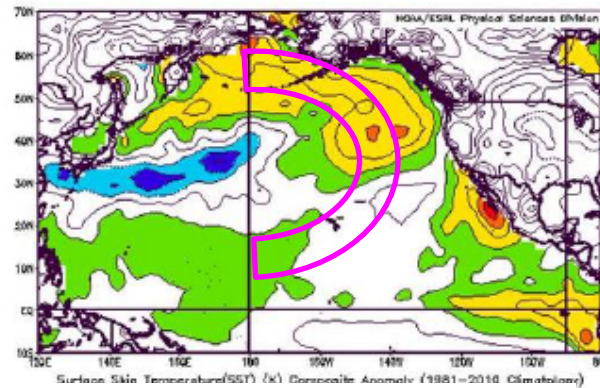
Autumn 2013



Winter 2013/4



Spring 2014



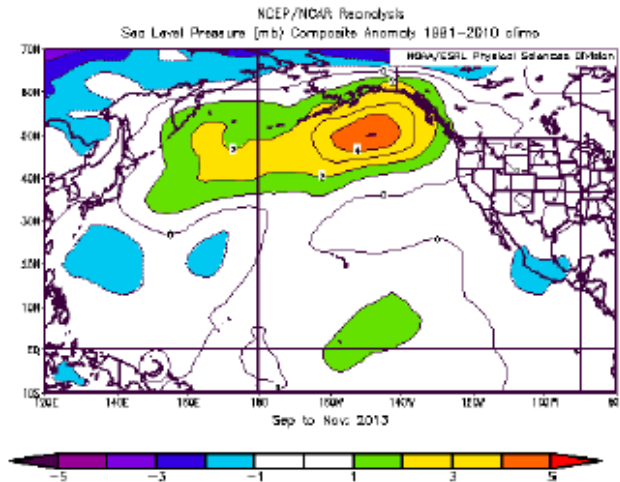
Summer 2014

>2.5°C warm anomalies during winter

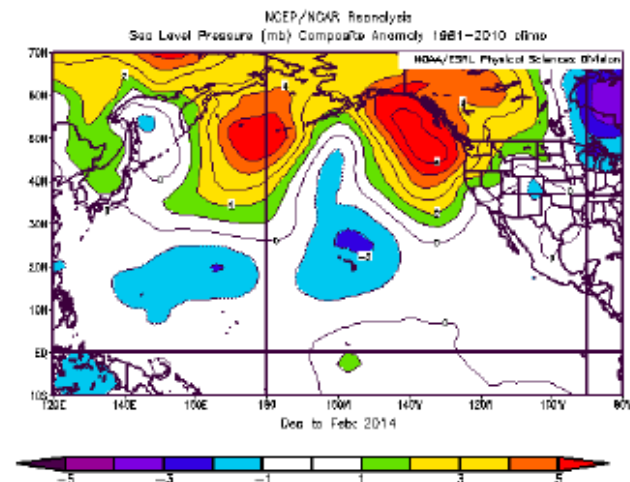
Warm anomalies across northern basin in summer, in positive PDO pattern

Sea Level Pressure Anomalies (Bond)

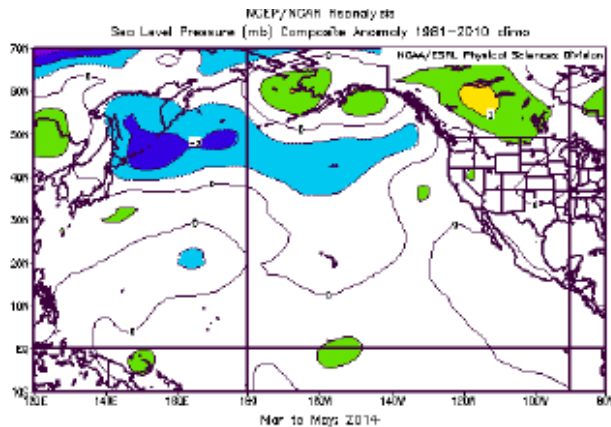
Upwelling favorable



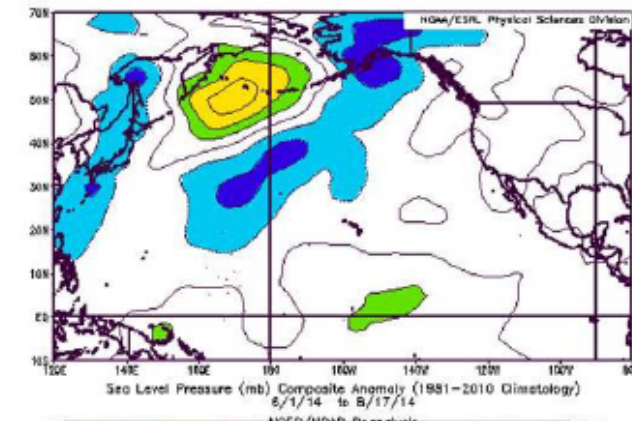
Autumn 2012



Winter 2012/3



Spring 2013

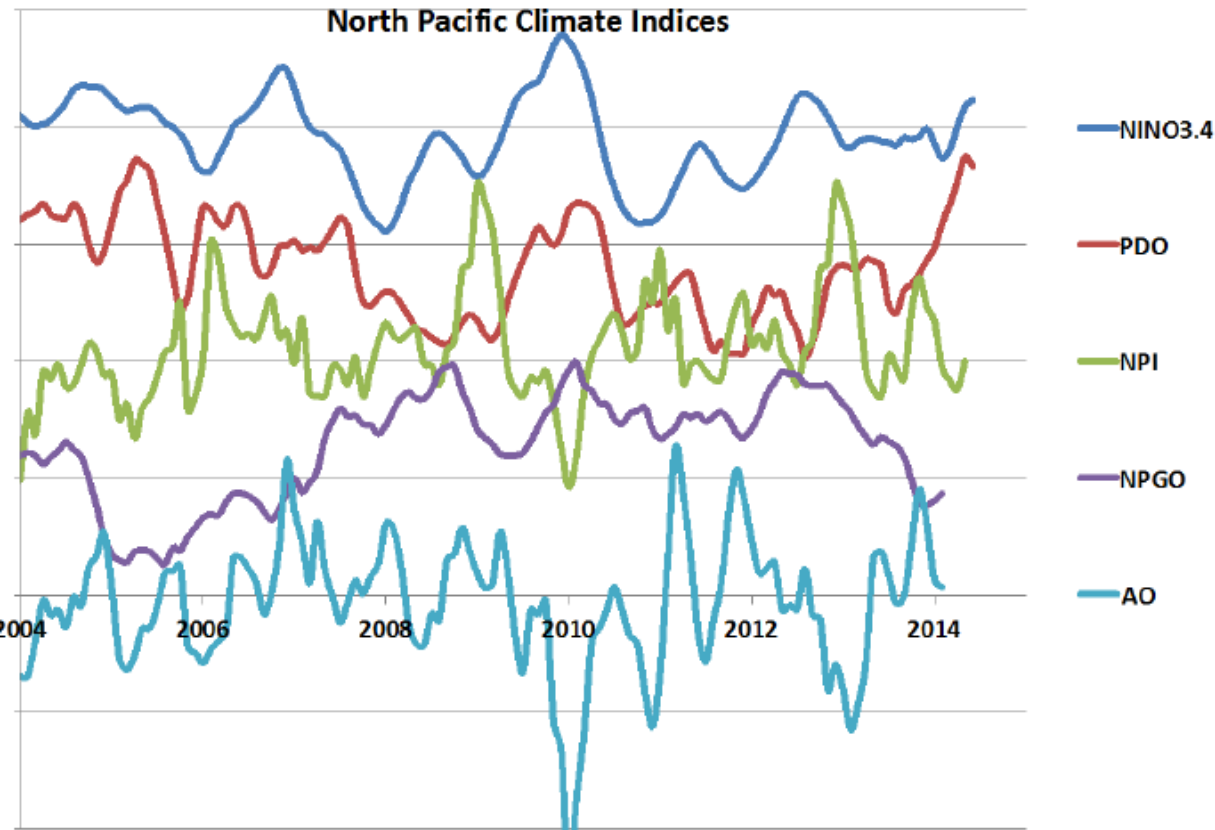


Summer 2013

Persistent "block"; low heat loss, less mixing

Dipole in western AI; weak winds

Climate Indices (Bond)



Near neutral ENSO

PDO significantly positive

NPI positive (usually with La Niña)

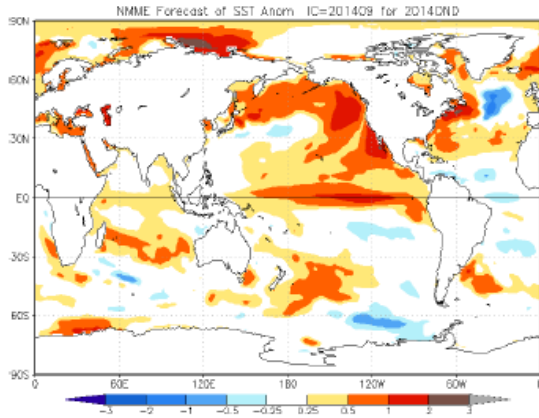
NPGO relates to chemical and biological properties in GOA and CalCOFI area.

Negative → reduced flows in Alaska and CA currents

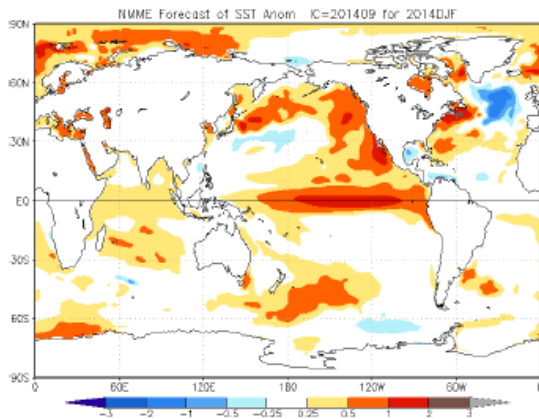
AO measures strength of polar vortex. Positive = low pressure over Arctic, high over Pacific (45°). Not strongly related to AK conditions recently.

Big changes, not ENSO related

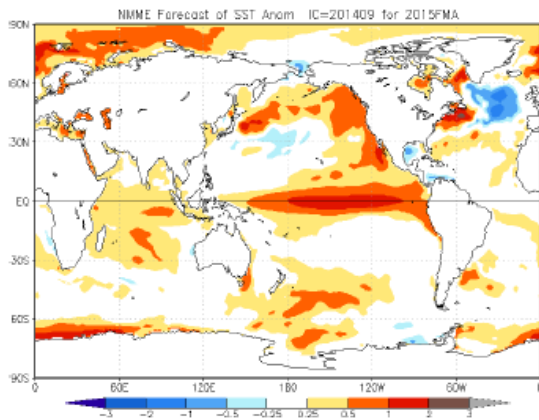
Seasonal Projections from the National Multi-Model Ensemble (NMME) (Bond)



(a) Months OND



(b) Months DJF



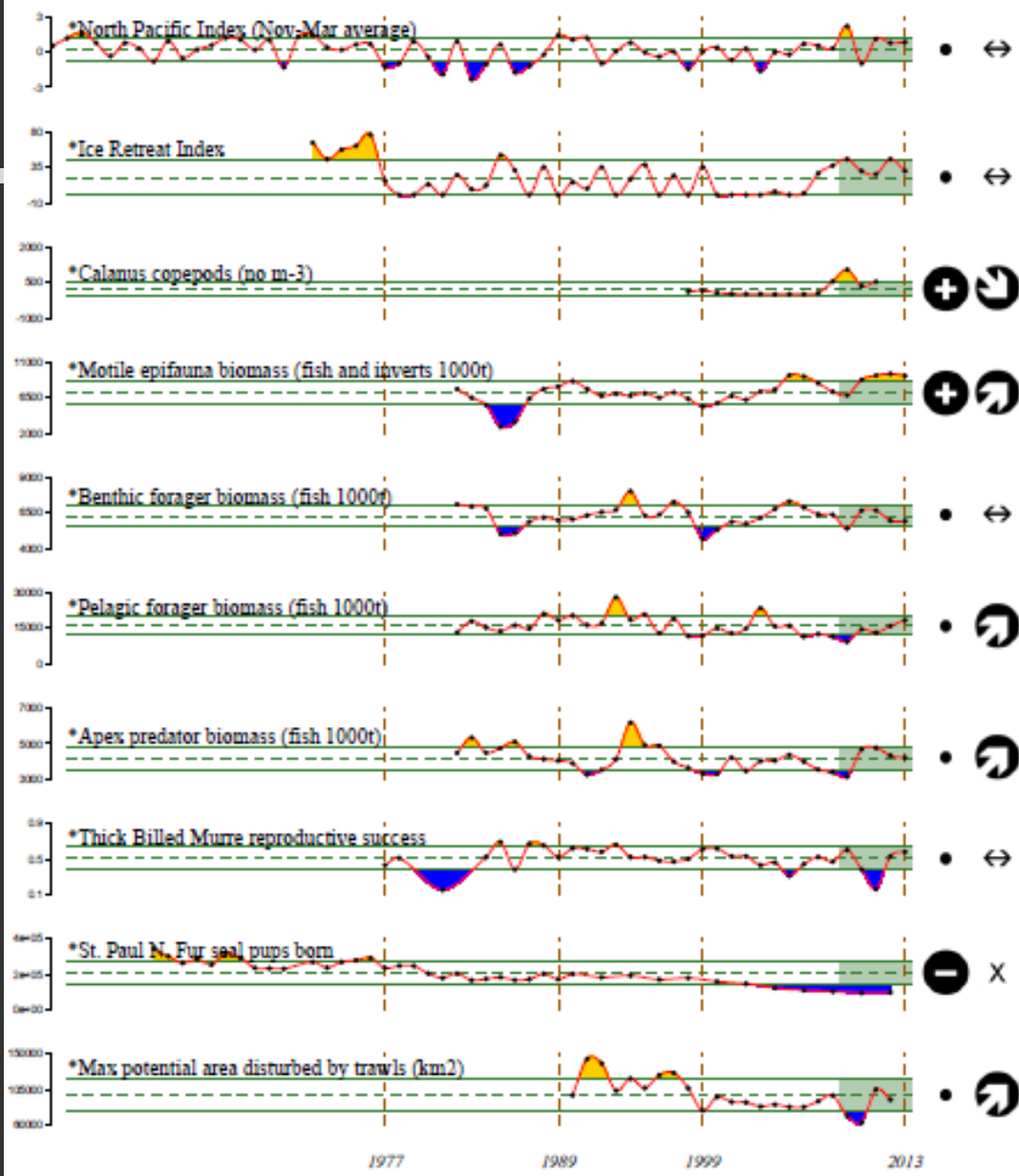
(c) Months FMA

- SST projections
- NMME is average of 6 models
- Indicate continued warming
- Development of weak-moderate El Niño 80%
- Projection skill limited

Eastern Bering Sea

2013 Report Card

1. North Pacific Index
2. Eastern Bering Sea ice retreat
3. Calanus copepods
4. Motile epifauna aggregate biomass
5. Benthic foragers aggregate biomass
6. Pelagic foragers aggregate biomass
7. Fish apex predators aggregate biomass
8. Thick-billed murre reproductive success on St. George Island
9. St. Paul Island fur seal pup production
10. Maximum potential trawl area disturbed



| 2009-2013 Mean | | 2009-2013 Trend | |
|----------------|--------------------------|-----------------|-------------------------------------|
| ⊕ | 1 s.d. above mean | ↷ | Increase by 1 s.d. over time window |
| ⊖ | 1 s.d. below mean | ↶ | decrease by 1 s.d. over time window |
| • | within 1 s.d. of mean | ↔ | change <1 s.d. over window |
| X | fewer than 2 data points | X | fewer than 3 data points |

Report Card

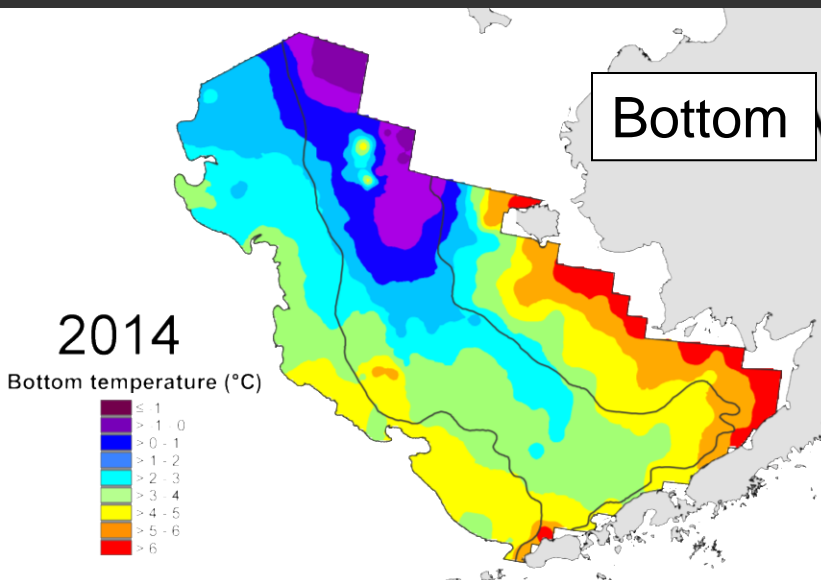
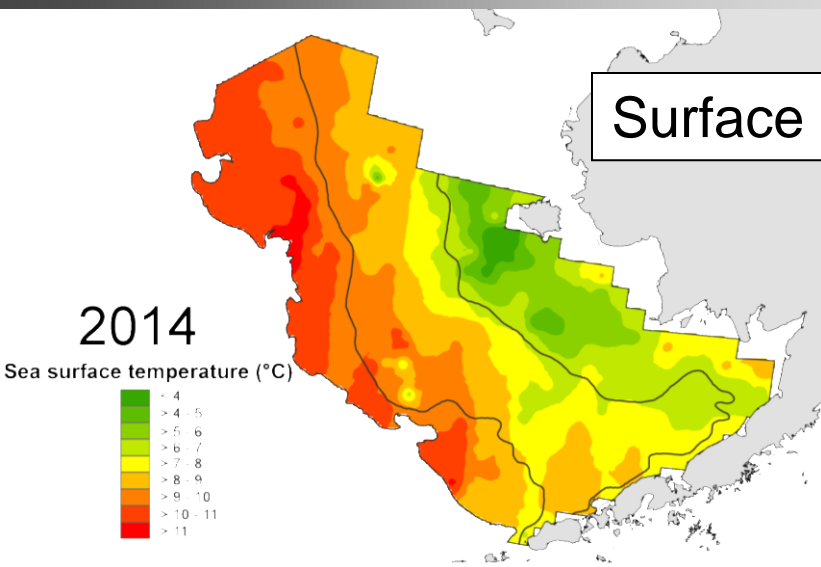
Eastern Bering Sea 2013 Report Card

- The North Pacific atmosphere-ocean system during 2012-2013 reflected a combination of a **mostly near-neutral ENSO and intrinsic variability**. **Neutral ENSO is expected again this winter.**
- **Ocean temperatures remained cool and sea ice remained extensive**. Dates of sea ice retreat, summer surface and bottom temperatures, and the extent of the cold pool were very similar to those **during 2007**.
- The summer ***Calanus* copepod time series showed an increase in abundance** in 2011 relative to 2010, but remained below the 2009 peak. 2011 was **the fourth year that concentrations remained well above average**, following patterns also seen in fall zooplankton abundance during **cold years**.
- **Jellyfish remained abundant** during summer, following a new peak fall biomass recorded in 2012.
- **Survey biomass of motile epifauna has been above its long-term mean** since 2010 and fairly stable since the early 1990s. However, the trend of the last 30 years shows a **decrease in crustaceans** (especially commercial crabs) and a **long-term increase in echinoderms**, including brittle stars, sea stars, and sea urchins. It is not known the extent to which this reflects changes in survey methodology rather than actual trends.
- **Survey biomass of benthic foragers has remained stable** since 1982, with interannual variability driven by short-term fluctuations in yellowfin and rock sole abundance.
- **Survey biomass of pelagic foragers has increased steadily** since 2009 and is currently above its 30-year mean. While this is primarily driven by the **increase in walleye pollock** from its historical low in the survey in 2009, it is also a result of **increases in capelin from 2009-2013**, perhaps due to cold conditions prevalent in recent years.
- **Fish apex predator survey biomass is currently near its 30-year mean**. **The increase since 2009** back towards the mean is driven primarily by the increase in Pacific cod from low levels in the early 2000s. **Arrowtooth flounder**, while still above its long-term mean, **has declined nearly 50% in the survey from early 2000s** highs, although this may be due to a distributional shift in response to colder water over the last few years, rather than a population decline.
- **Thick-billed murre reproductive success on St. George Island was above average** in 2013, suggesting that **foraging conditions were favorable for piscivorous seabirds**.
- **Northern fur seal pup production for St. Paul Island increased from the previous count in 2010, but overall numbers remain low**. 2012 was the first year that pup production has not declined since 1998.
- The maximum potential **area of seafloor habitat disturbed by trawl gear in 2012 decreased slightly** from 2011, which was the highest level since 1998. The cause of the increase may be due to increased search time for pollock and/or avoidance of salmon bycatch.

EBS Assessment

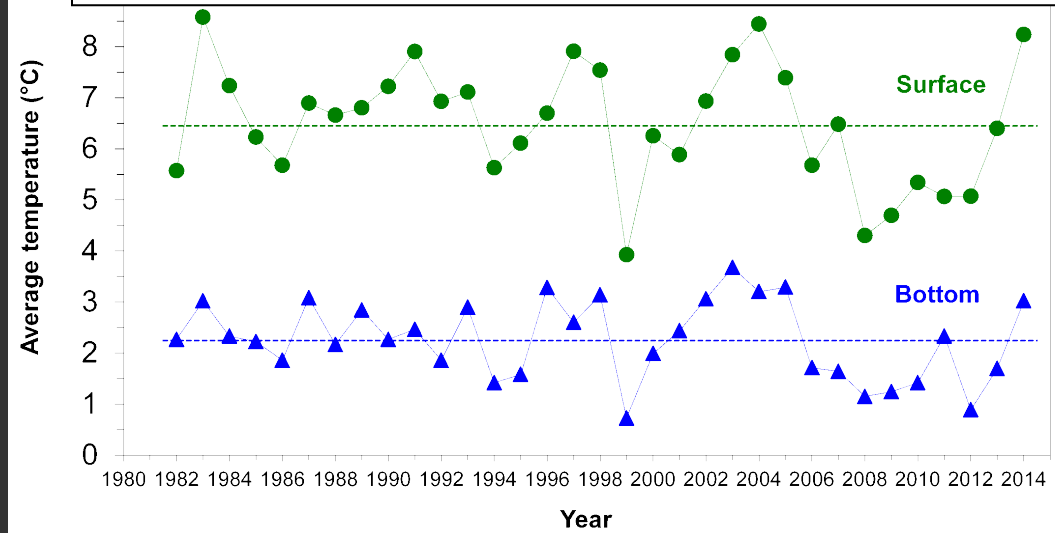
- Recap of 2012 ecosystem state - complete
 - *COLD*
 - Too cold for age-0 pollock? (Heintz)
 - Zooplankton less abundant (Ressler)
 - Abundant jellyfish (Lauth, Cieciel)
 - Biomass of foraging guilds increasing or stable
 - Groundfish condition generally negative (Rooper)
 - Seabird reproduction good; bycatch rates low (Zador, Fitzgerald)
 - Fur seal pup production increased
- Current conditions

2014 EBS Summer Bottom and Surface Temperatures (Lauth)



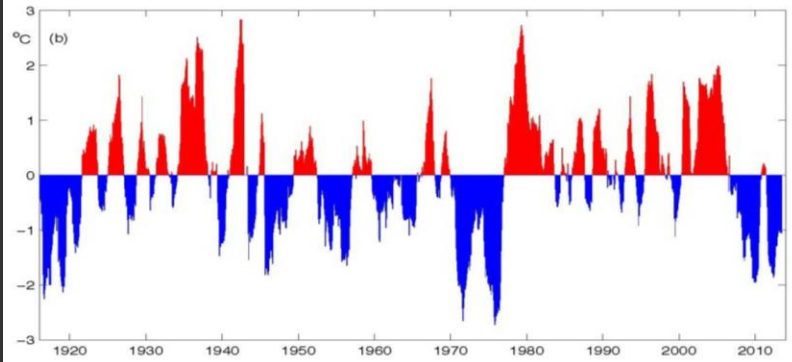
- Surface temps very warm
- Bottom temps warm

Average surface (top), bottom temps



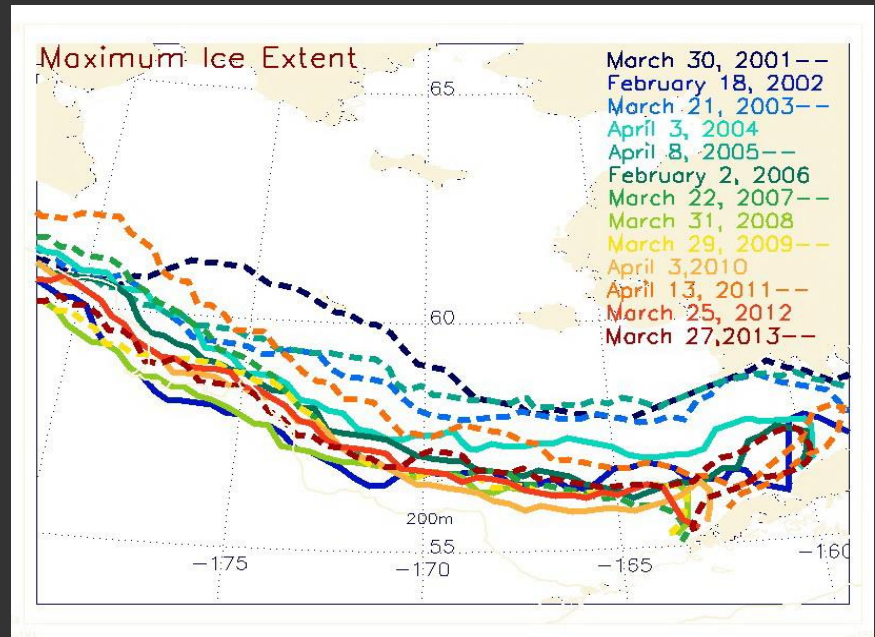
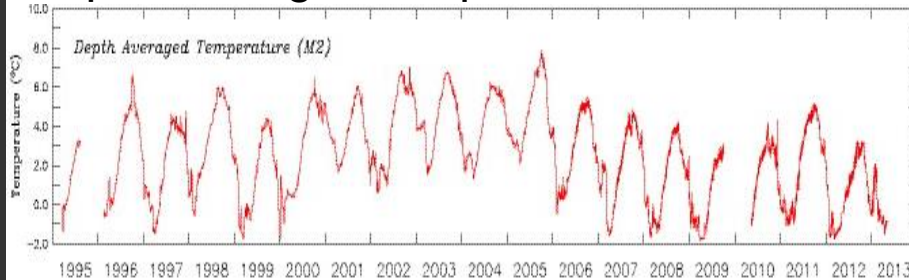
2013 Eastern Bering Sea Climate – FOCI (Overland et al.)

Surface air temperature – St Paul

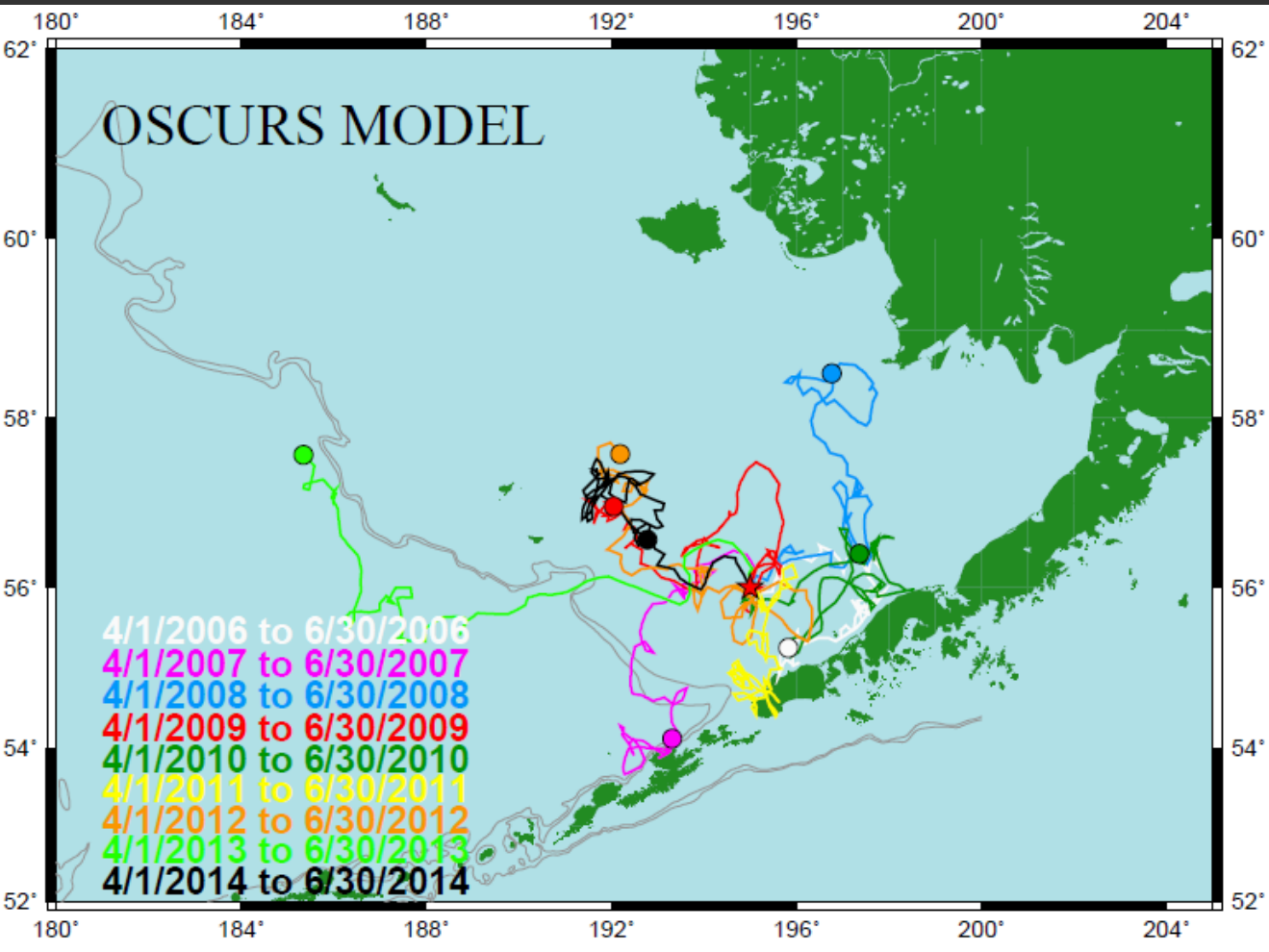


- 2013: another cold year
- Summer: near normal conditions
- Extensive sea ice (except Bristol Bay) due to steady northeast winds (due to high spring SLP)

Depth averaged temperature – M2



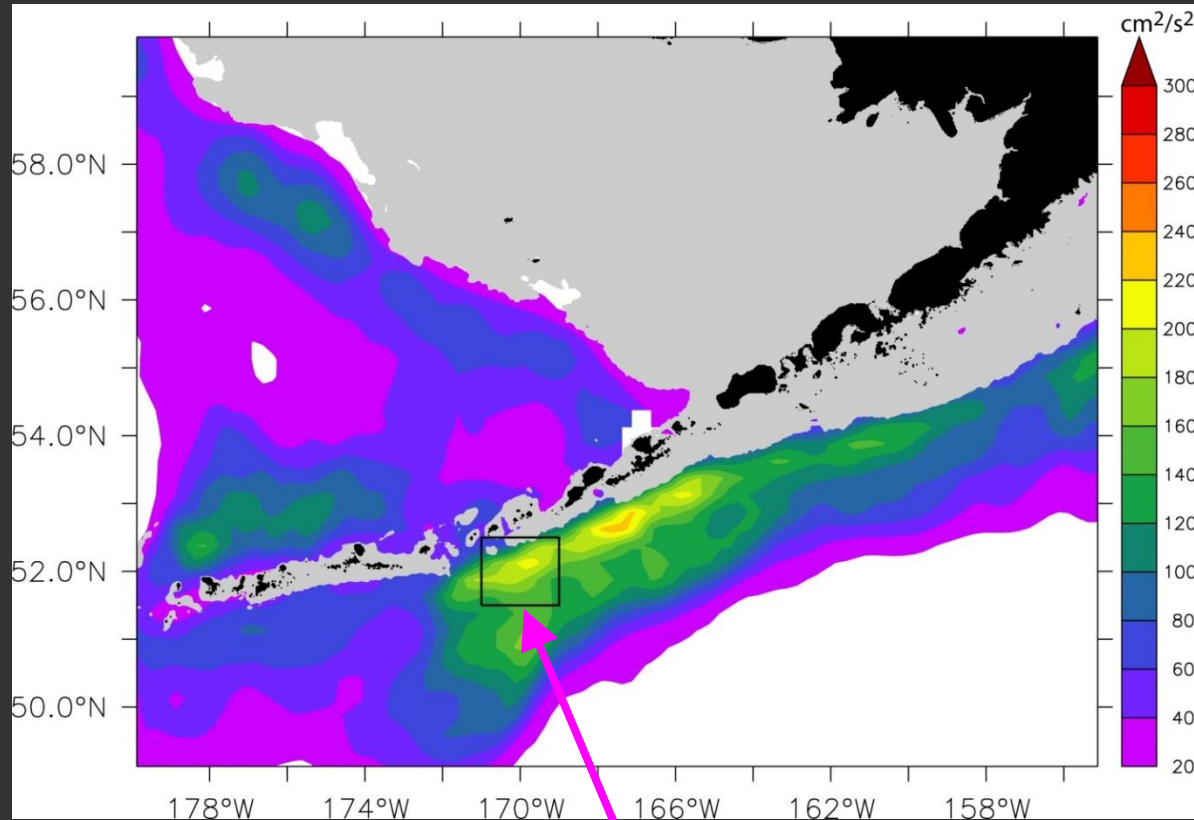
2014 EBS Wind Forcing and Winter Spawning Flatfish Recruitment (Wilderbuer)



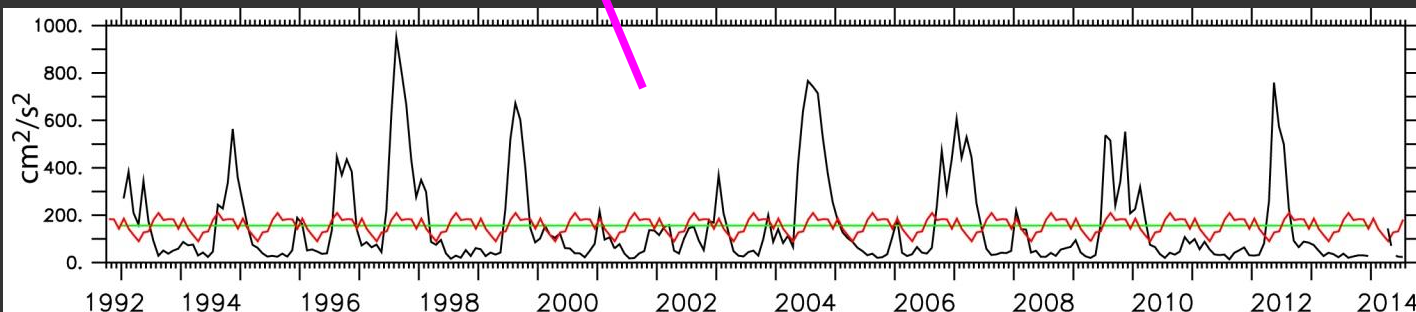
- Direction of wind-forcing during spring linked to flatfish recruitment (northern rock sole)
- Inshore advection to favorable nursery grounds in 2006, 2008, 2011
- 2012-2014 not favorable

2014 Eddies in the Aleutian Islands (Ladd)

Average Eddy Kinetic Energy Oct 1993 - 2013

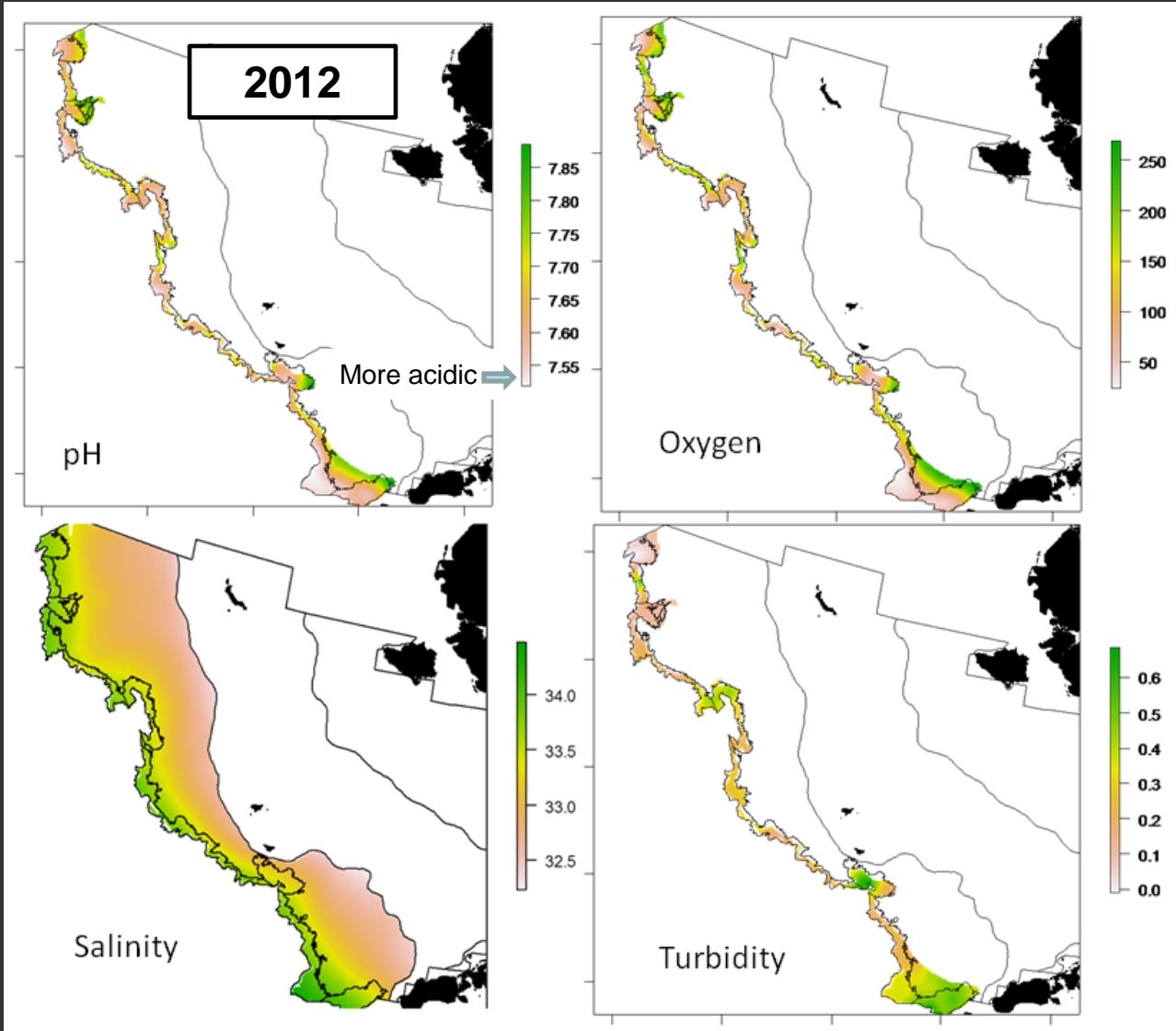


- EKE low fall 2012 – early 2014
- Higher than average volume, heat, salt, nutrient fluxes to BS through Amukta Pass summer 2012, low since



Spatial patterns in near-bottom oceanographic variables during bottom trawl slope surveys (Rooper and Hoff)

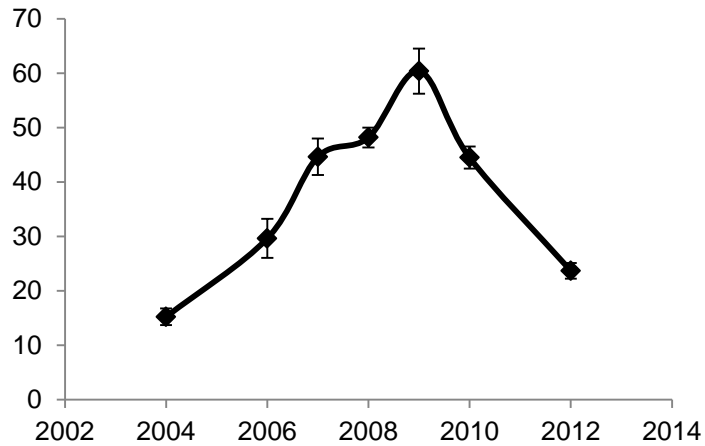
New



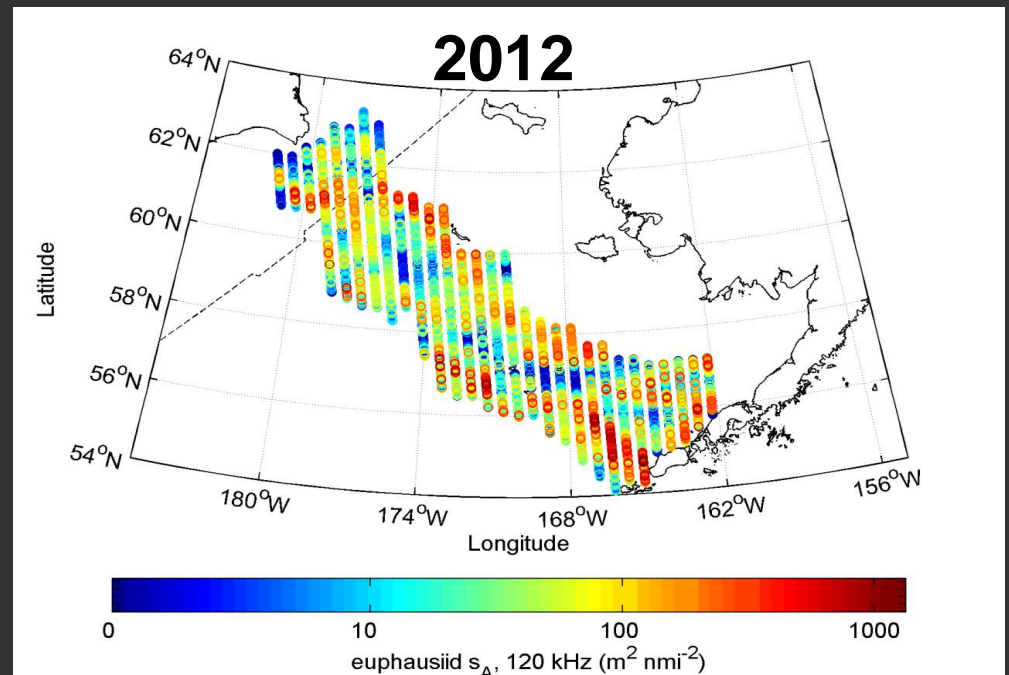
- New SeaGuard CTDs
- No time series yet
- Low oxygen in Pribilof and Zhemchug canyons
- Salinity mirrored depth
- Turbidity higher in south and canyons
- Patterns likely influenced by depth, 1° prod, oceanography

2012 EBS Euphausiids (Ressler et al.)

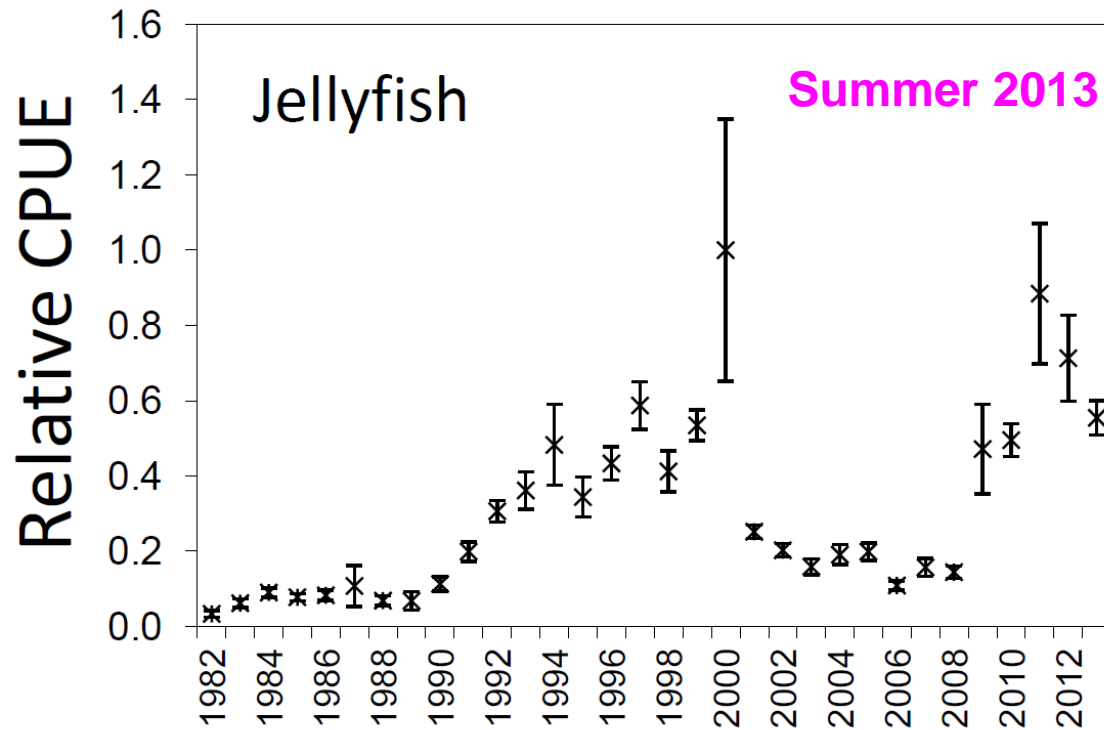
average number euphausiids per m³



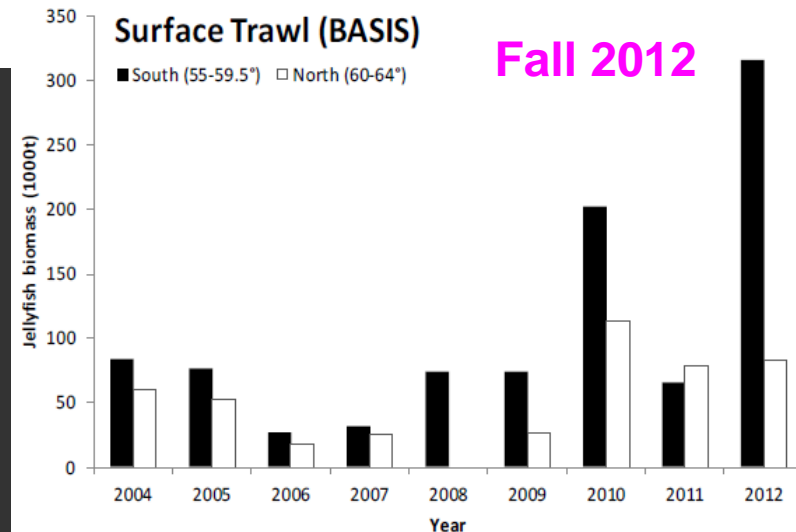
- Acoustically-determined
- Euphausiid abundance is better predicted by water temperature during summer than pollock abundance (Ressler et al., in prep)



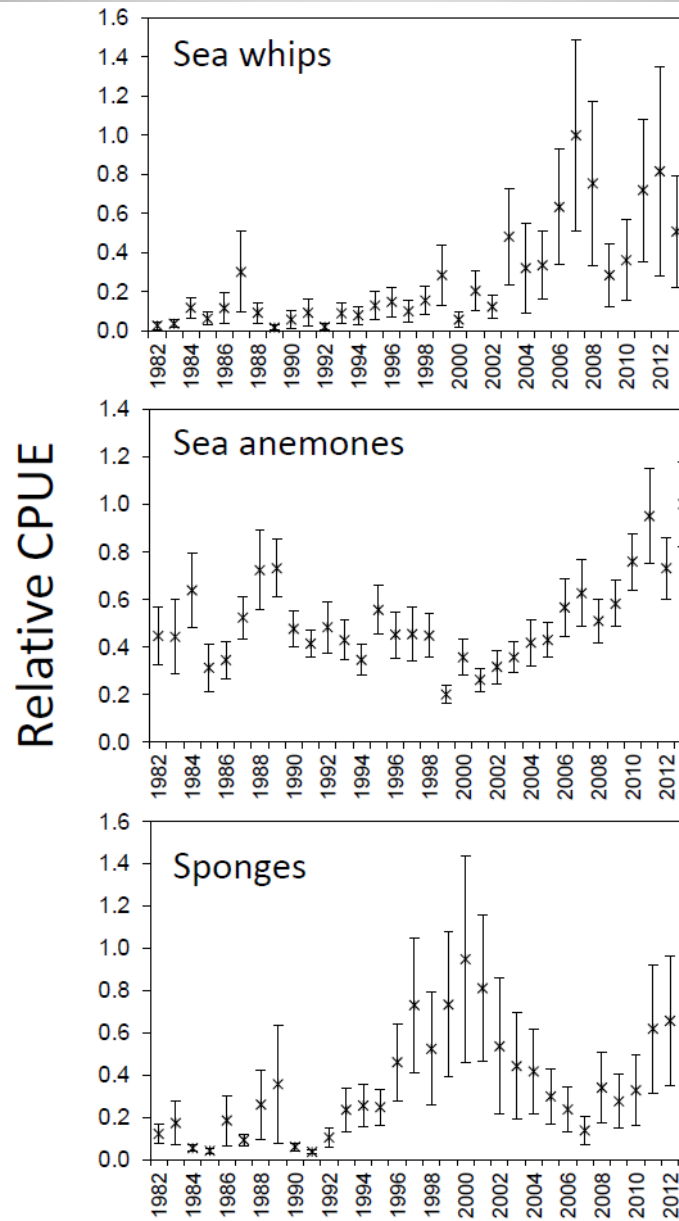
Jellyfish (Lauth and Hoff; Cieciel)



- Recent summer high abundances also seen during fall.
- Jellyfish biomass influences: Ice cover, spring/summer SST, wind mixing
- Large blooms can have predatory impact on juvenile and forage fishes

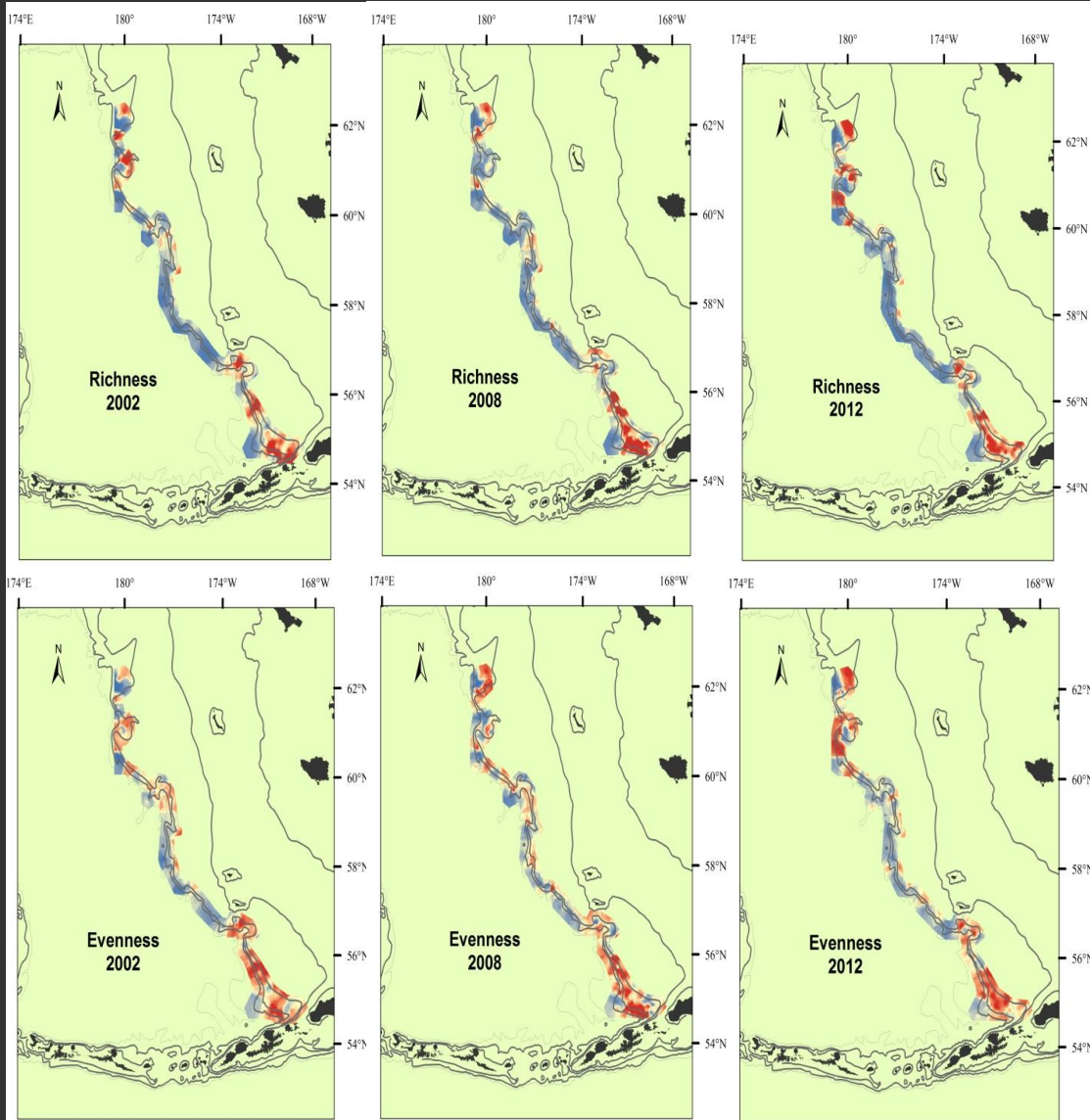


2013 Structural epifauna (HAPC biota) – survey (Lauth and Hoff)

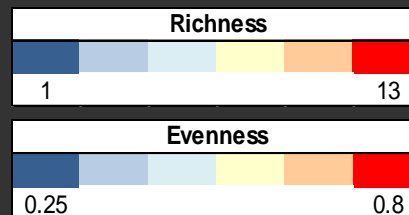


- Difficult to detect trends due to taxonomic uncertainty within groups
- May represent changes in habitat or variable field ID

2012 Biodiversity (Evenness) of the groundfish and invertebrate community on the EBS slope (Hoff)



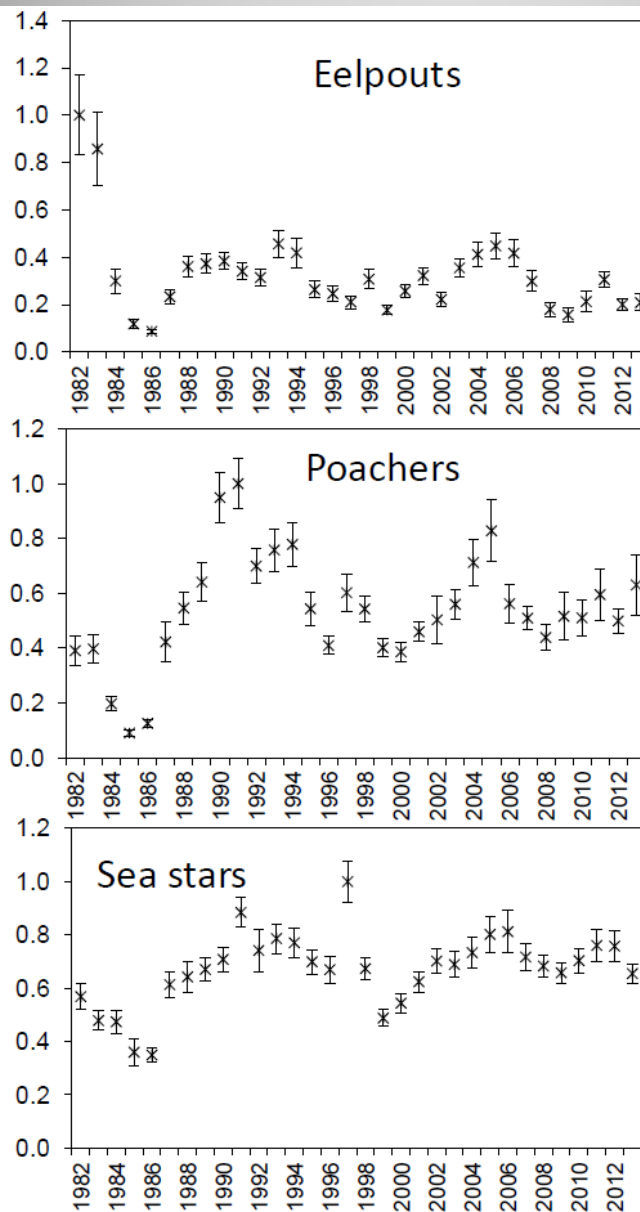
- Indicators of ecosystem stability
- Biennial from 2002-2012 (except 2006)
- Mostly stable over time
- Higher diversity in south and north near canyons (but not central near Zhemchug)



2013 Miscellaneous species – EBS survey (Lauth and Hoff)

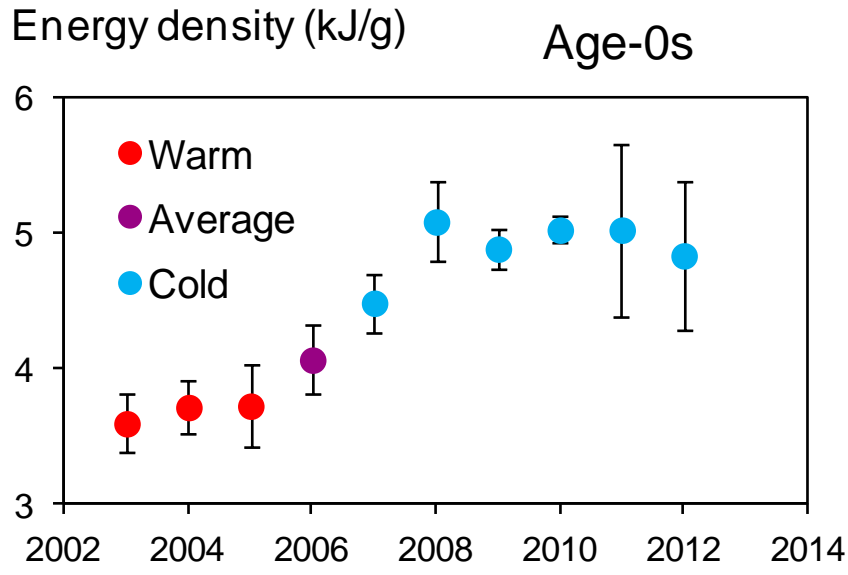


Relative CPUE



- Trends are similar among groups
- Unknown whether trends reflect response to environment or sampling artifact
- Eelpouts are common arrowtooth prey

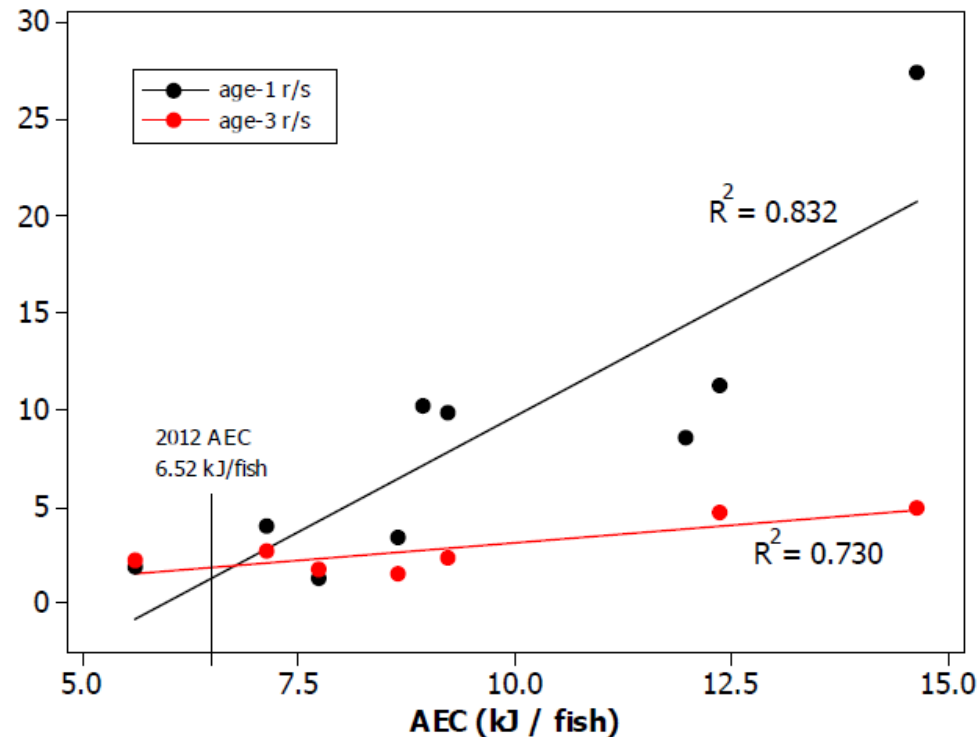
Fall Condition of YOY Predicts Recruitment of Age-1 Pollock (Heintz et al.)



- Energy density influence by thermal regime; fish size has not
- 2012 too cold for good survival (smallest size in time series)

Energy density in fall v. age-1 R/S

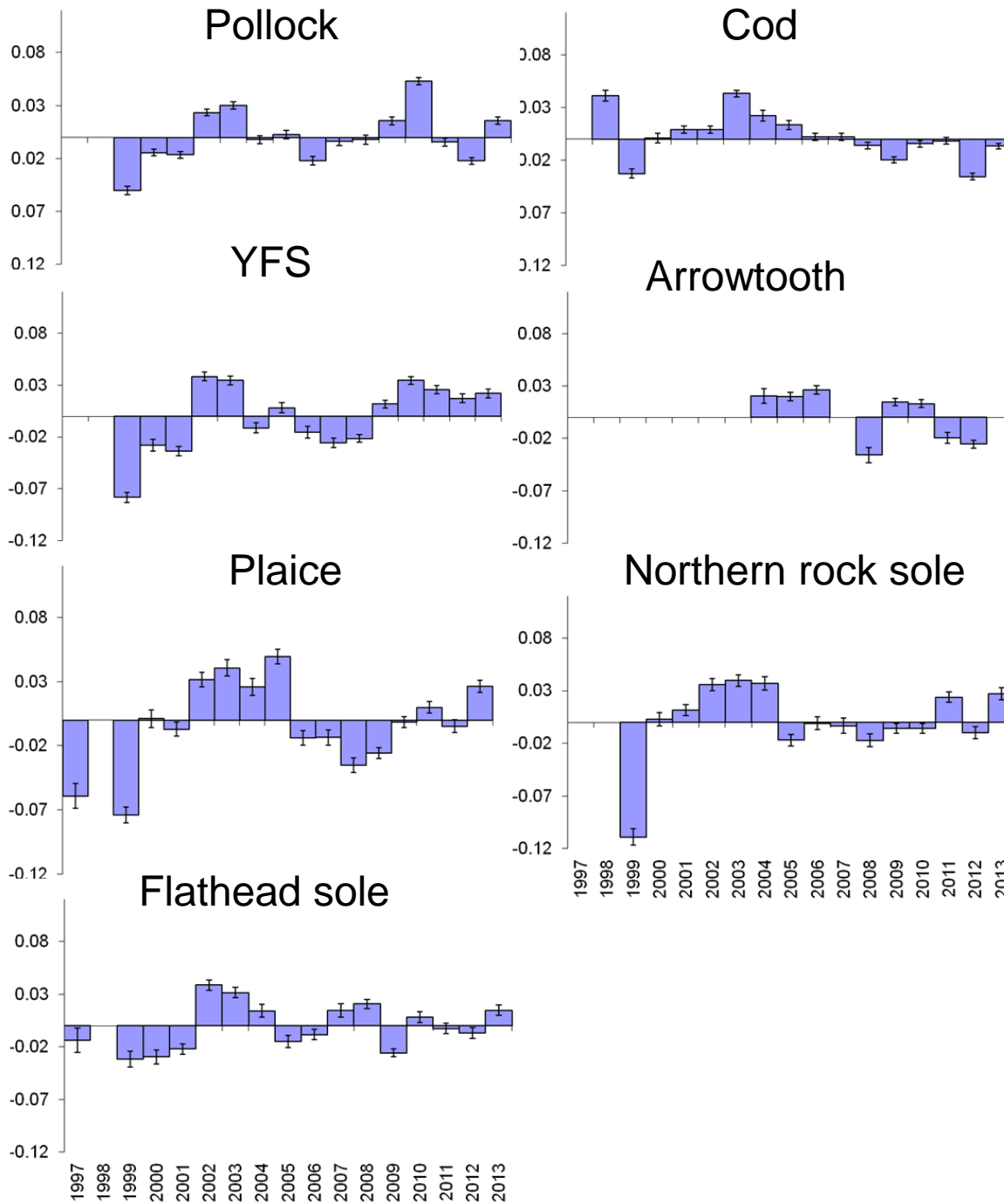
Recruits / Spawner



- Average energy content of YOY pollock accounted for 83% of the variation in number of age-1 and 73% of age-3 recruits per spawner .
- 2012 AEC indicates age-1 will be below median in 2013 (and age-3 in 2015)

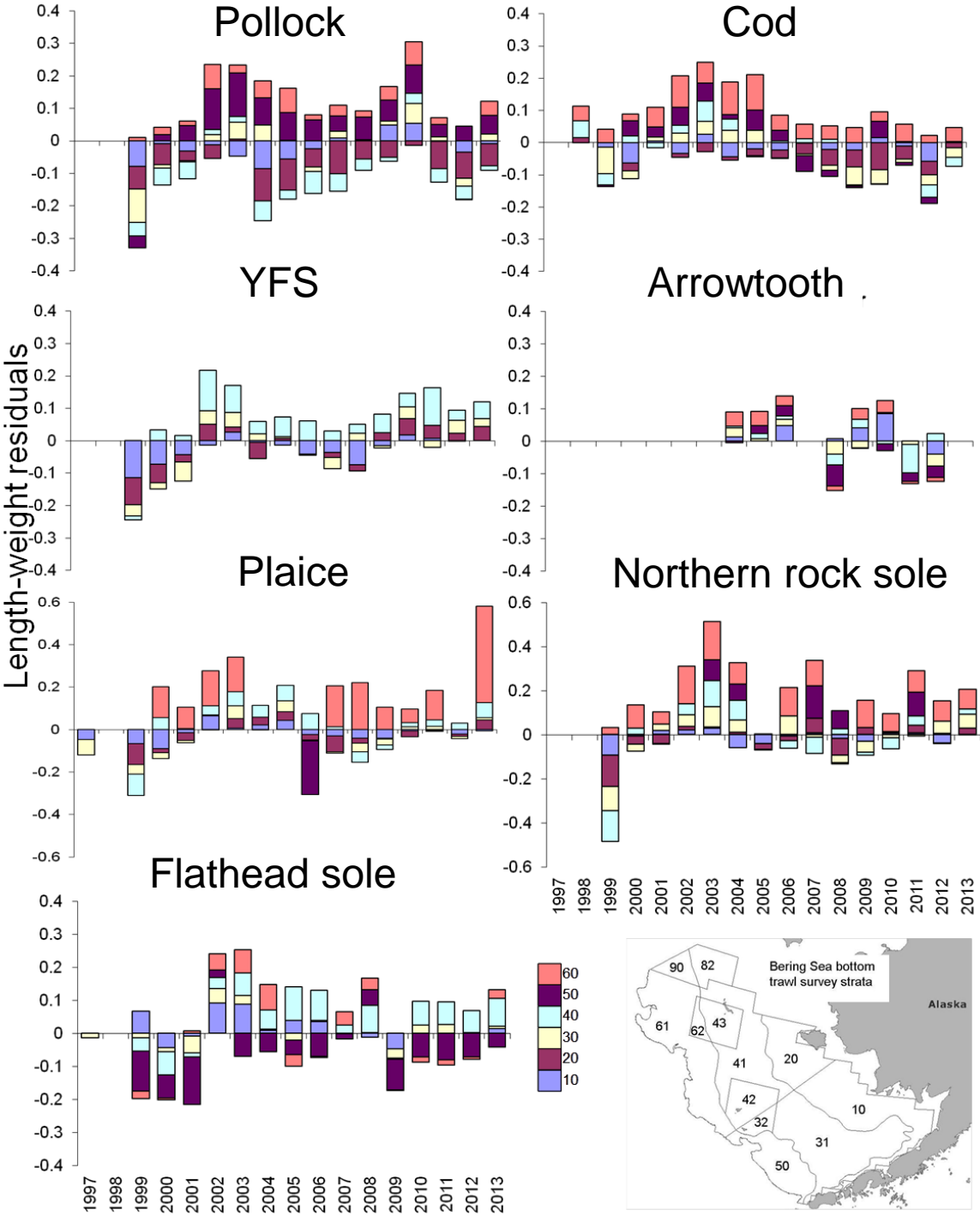
2013 Groundfish Condition (Boldt et al)

Length-weight residuals



- Length-weight residuals from survey
- Pollock and yellowfin sole correlated
- Negative trend in cod since 2003

2013 Groundfish Condition (Boldt et al)

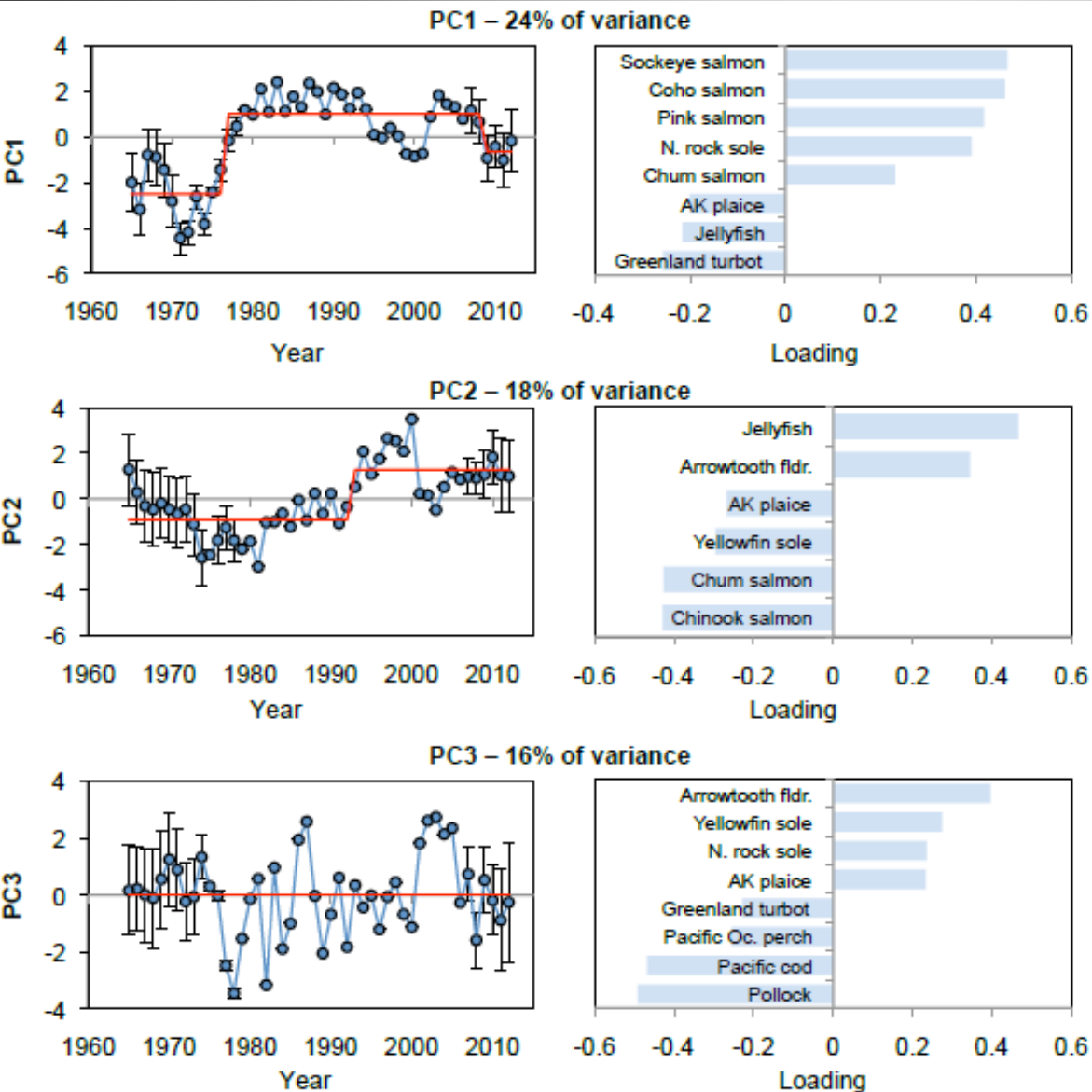


- Almost always positive on outer, especially northern outer, shelf
- Gadids tend to be negative on inner shelf
- Influential factors: temperature, survey timing, fish migration.

Alaska-wide

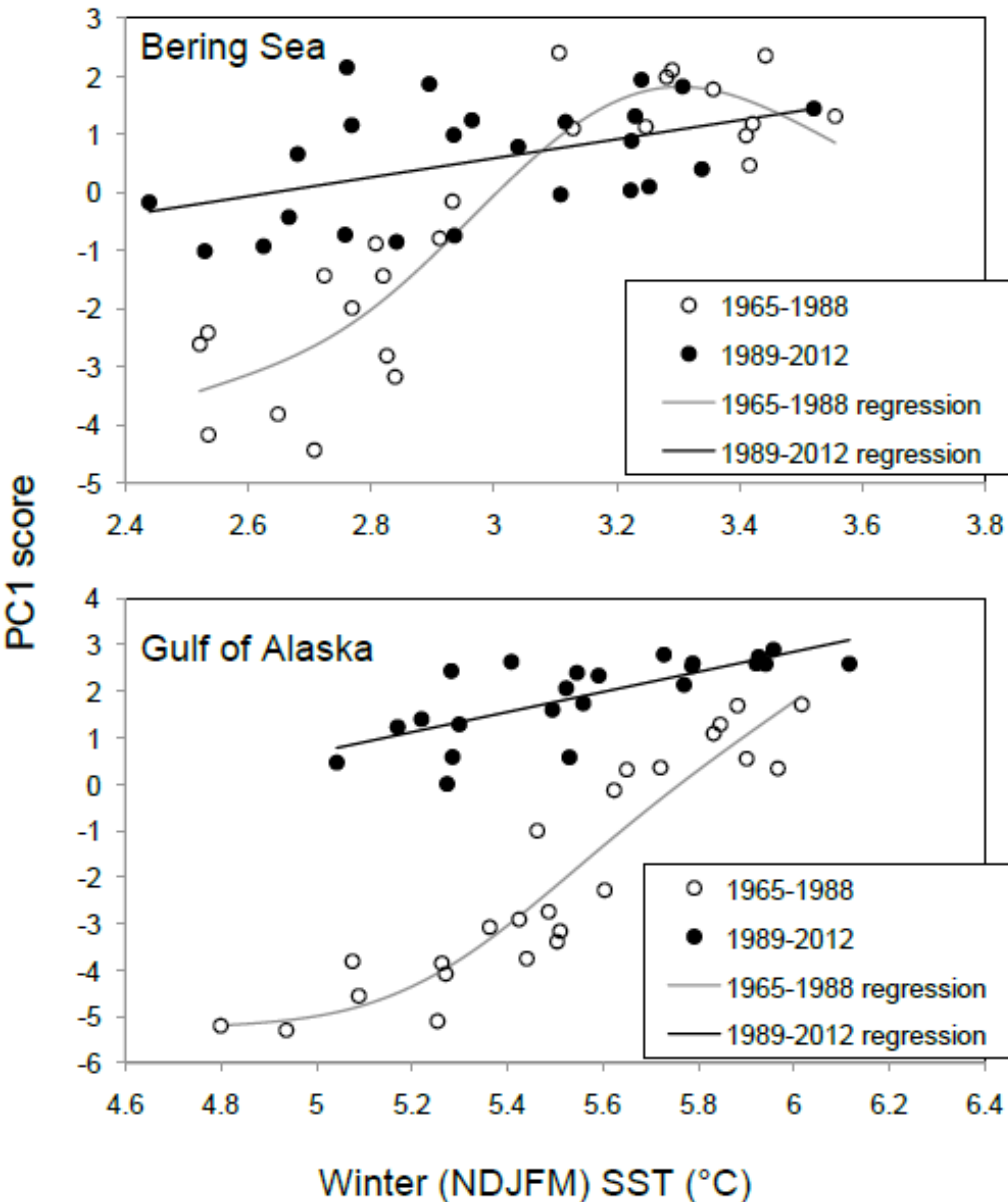


Regime Shift Indicators for the EBS and GOA (Litzow and Mueter) - I



- Extending Hare and Mantua – EBS only
- PCA of 16 EBS biological time series (5 salmon, 10 groundfish, jellies)
- PC1 transitioned to negative 2009

Regime Shift Indicators for the EBS and GOA (Litzow and Mueter) - II



- PC1 variability related to climate variability and change.
- Relationship to SST appears to follow time-dependent functions
- Response around 2006 of smaller magnitude than around 76/77

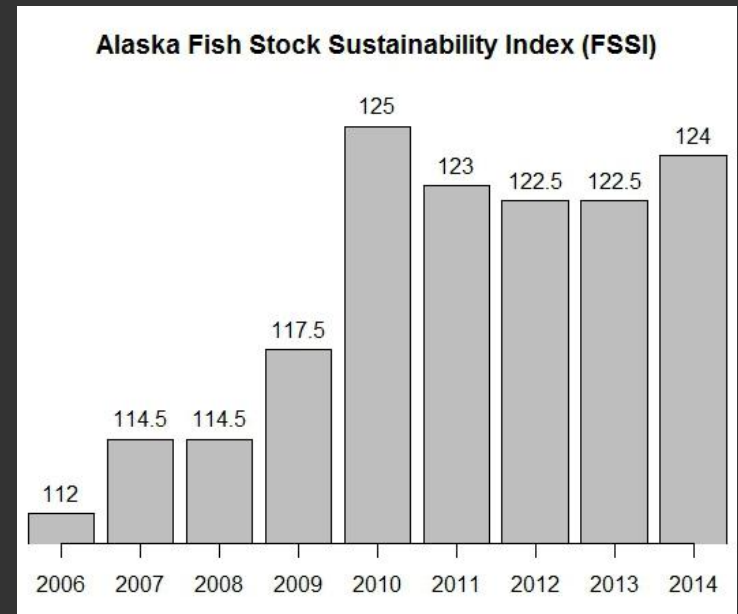
Fishing and Fisheries Trends



2014 Fish Stock Sustainability Index (Whitehouse)

- Performance measure for sustainability of stocks selected for importance to commercial and recreational fishing

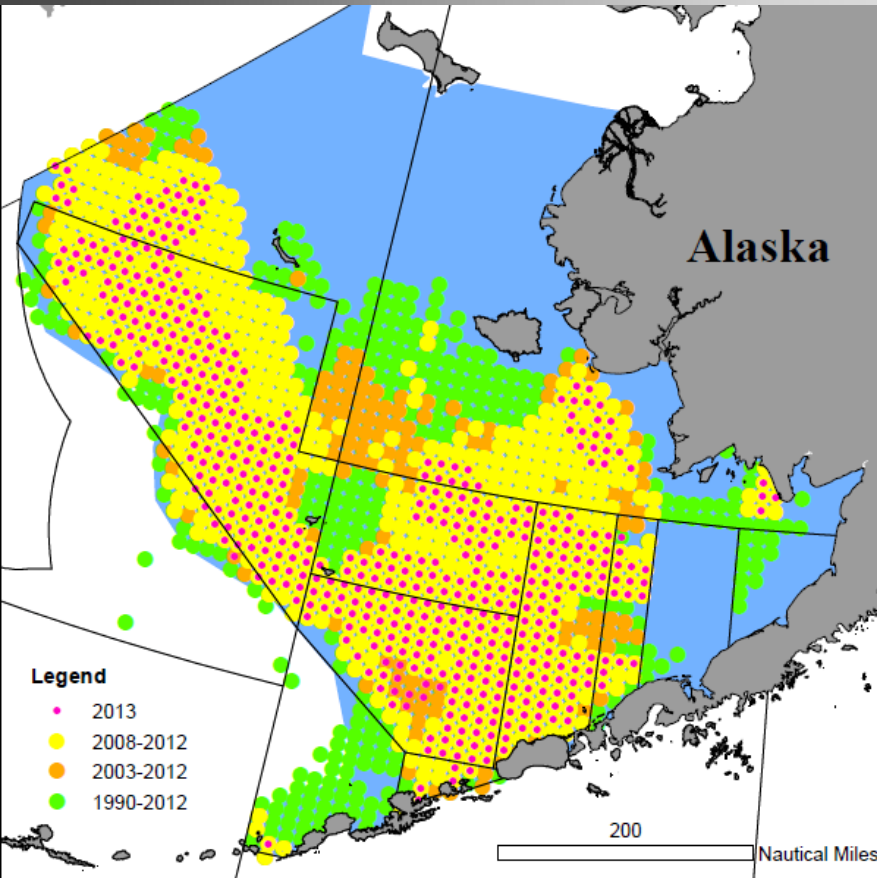
- No *groundfish* stock or stock complexes are overfished or subject to overfishing
- Overfished: Pribilof Island blue king crab



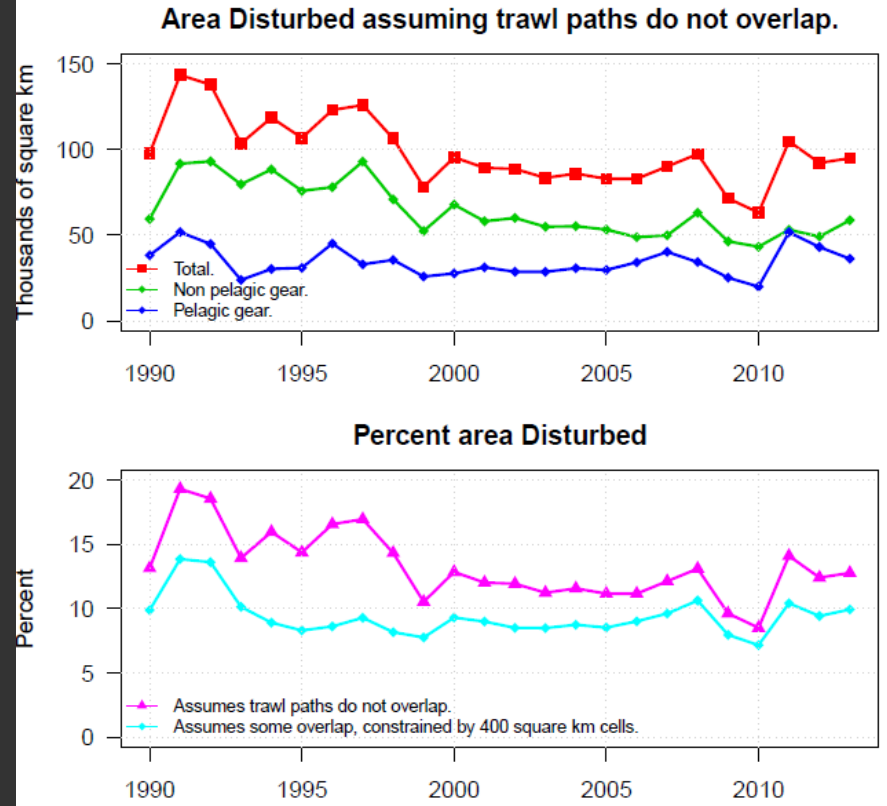
| Jurisdiction | Stock Group | Number of Stocks | Overfishing | | | | Overfished | | | | Approaching Overfished Condition |
|--------------|-------------|------------------|-------------|----|-----|-------|------------|----|-----|-------|----------------------------------|
| | | | Yes | No | Unk | Undef | Yes | No | Unk | Undef | |
| NPFMC | FSSI | 35 | 0 | 35 | 0 | 0 | 1 | 30 | 4 | 0 | 0 |
| NPFMC | NonFSSI | 30 | 0 | 29 | 1 | 0 | 0 | 5 | 25 | 0 | 0 |
| | Total | 65 | 0 | 64 | 1 | 0 | 1 | 35 | 29 | 0 | 0 |

- Total possible score = 140
- BSAI = 81/92
- BSAI groundfish = 54/56
- BSAI king and tanner = 27/36

2013 Area Disturbed by Trawl Fishing Gear in the EBS (Greig)

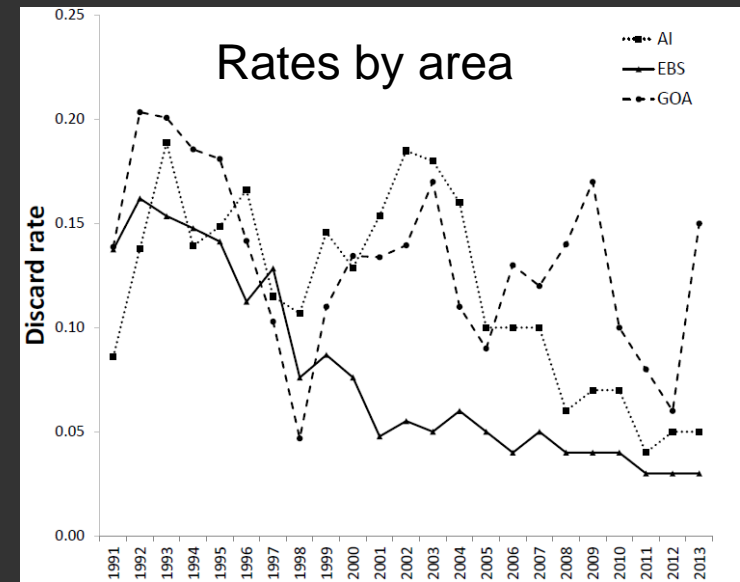
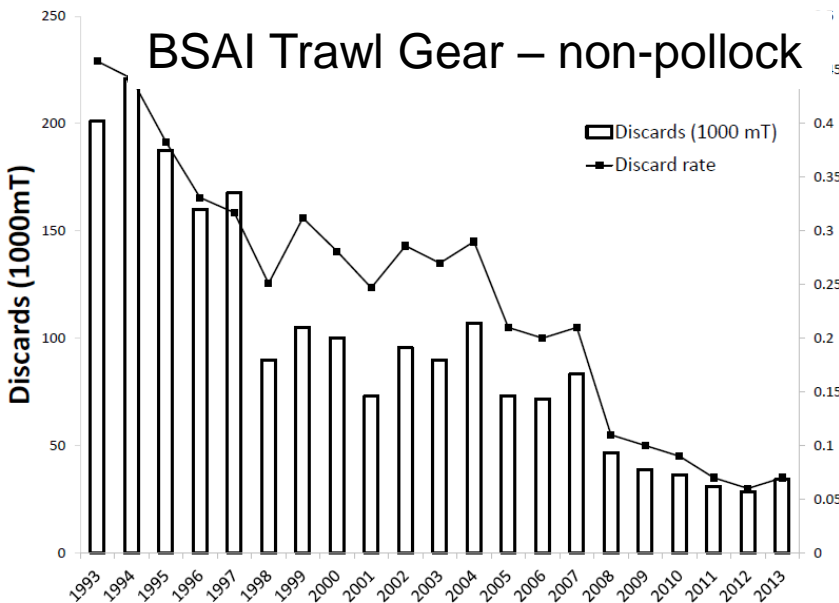
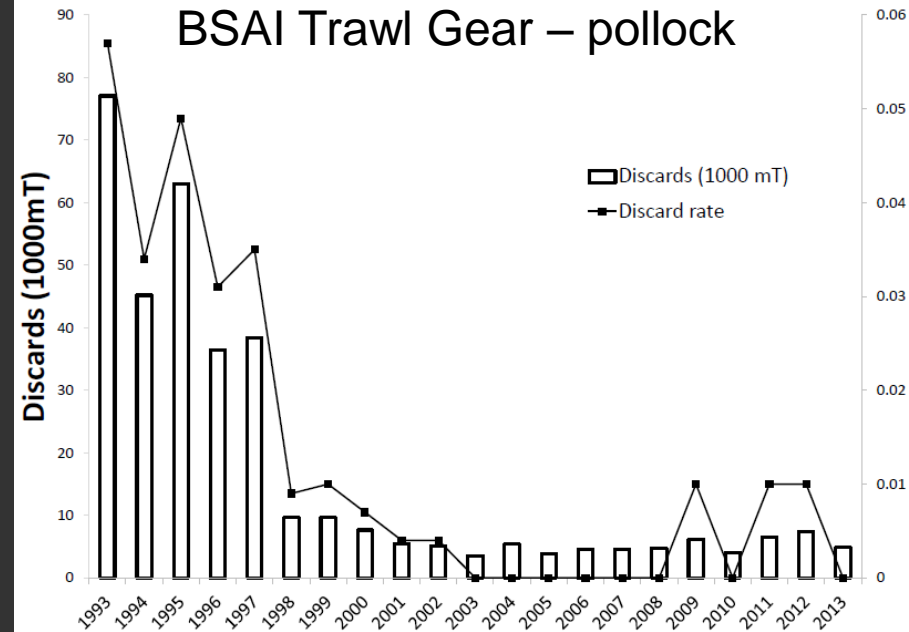
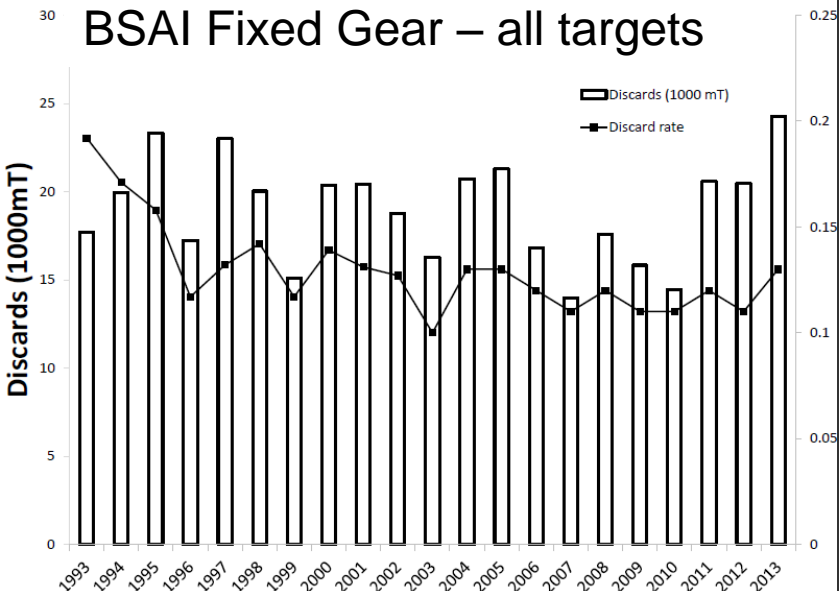


- 400 sq km cells with some trawling in cumulative time periods
- Green = last trawled 1990-2012

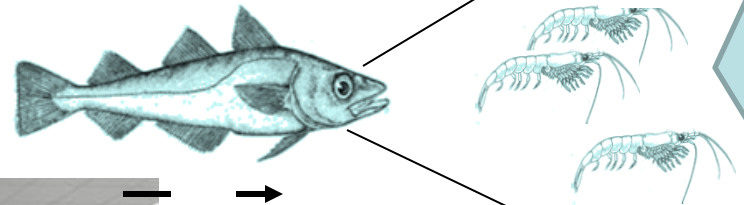
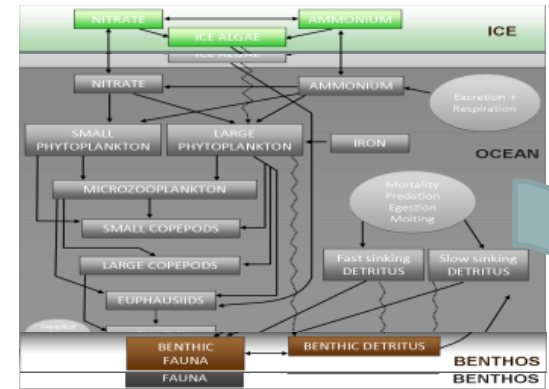
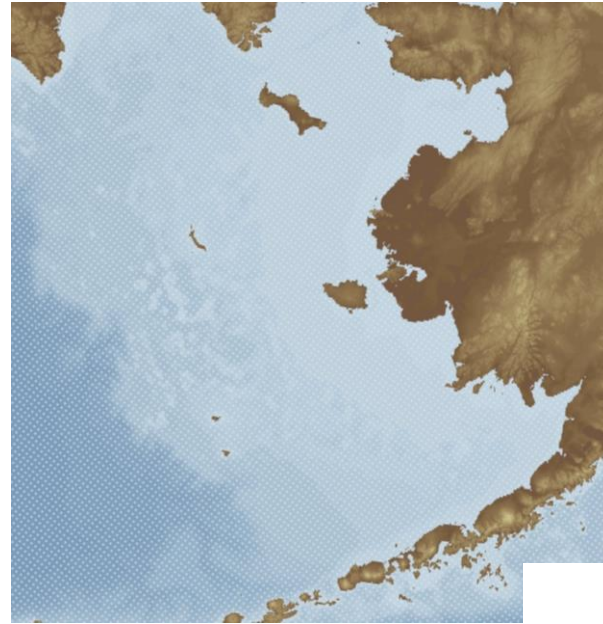
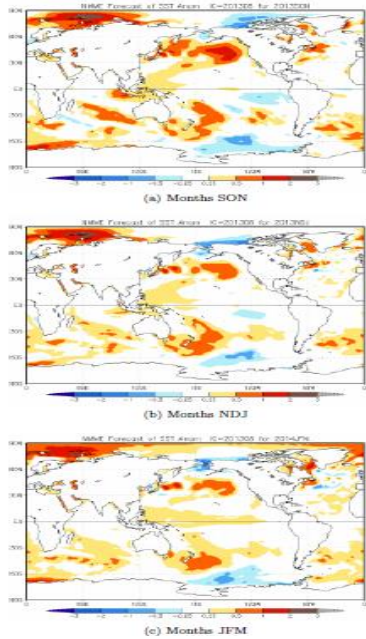


- Decrease during 2000s indicates greater fishing efficiency
- Uptick in 2011 may be due to low pollock and/or new salmon bycatch caps?
- 1993-1999 effort more concentrated → greater difference between upper and lower estimates of area disturbed

2013 Time Trends in Groundfish Discards (Lee)



Moving to 9-month Ecological Forecasts



v

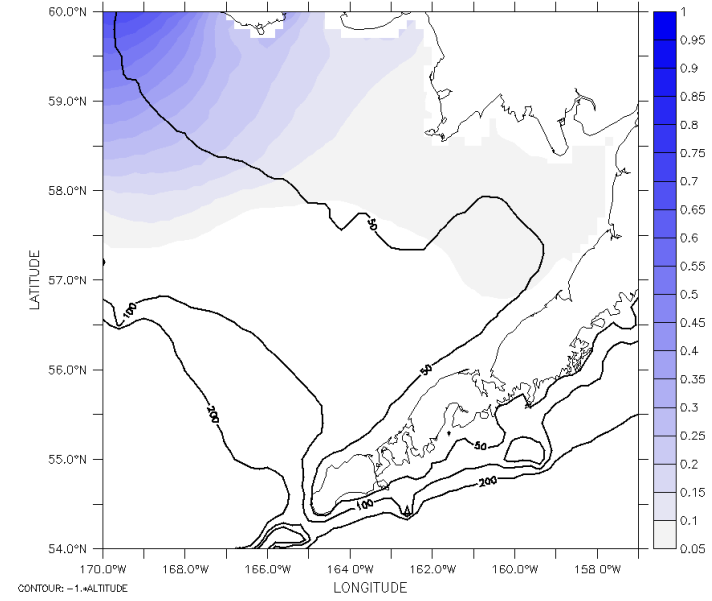
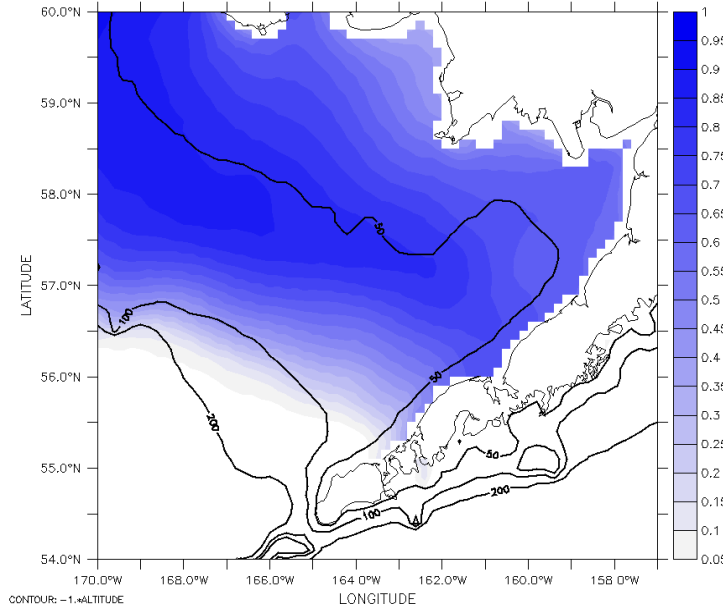
Encounter rate



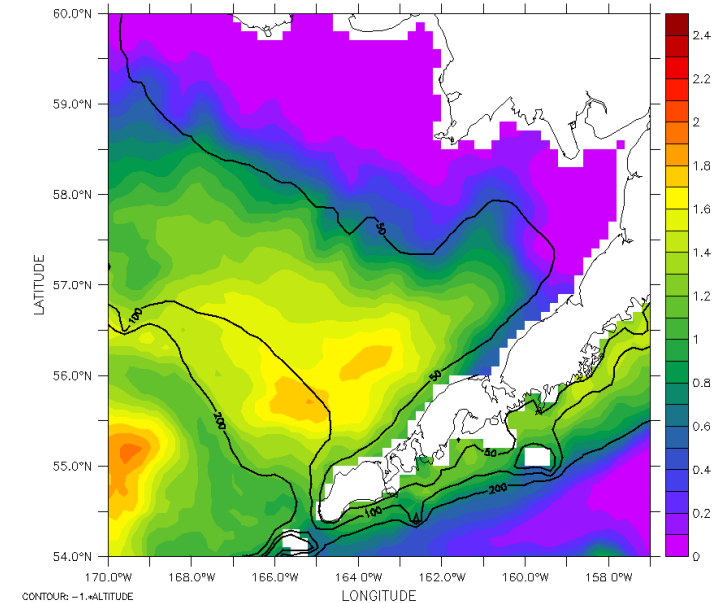
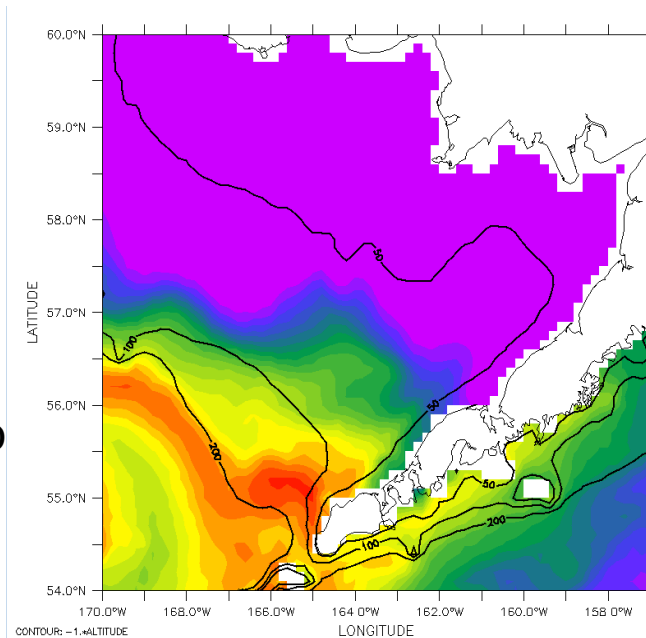
2012 hindcast

2014 **sample** forecast

Spring
(Mar-May)
Ice Cover



Spring
(Mar-May)
Crust.
Zooplankto
n



Website

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



Alaska Marine Ecosystem Considerations

This work is made possible through support from the Fisheries and the Environment (FATE) program

This report is produced annually to compile and summarize information about the Alaska Marine Ecosystem for the North Pacific Fisheries Management Council, the scientific community and the public. The report includes an ecosystem assessment, contributions with updated status and trend indices, and ecosystem-based management indices and information for the Bering Sea (BS), Aleutian Islands (AI) and the Gulf of Alaska (GOA) ecosystems.

December 2012 Update

- [Download current report](#) (PDF approx. 6.5 MB)
- [Download Eastern Bering Sea Report Card](#) (PDF approx. 500 KB)
- [Download Aleutian Island Report Card](#) (PDF approx. 700 KB)
- [Guidelines for citing this document](#)

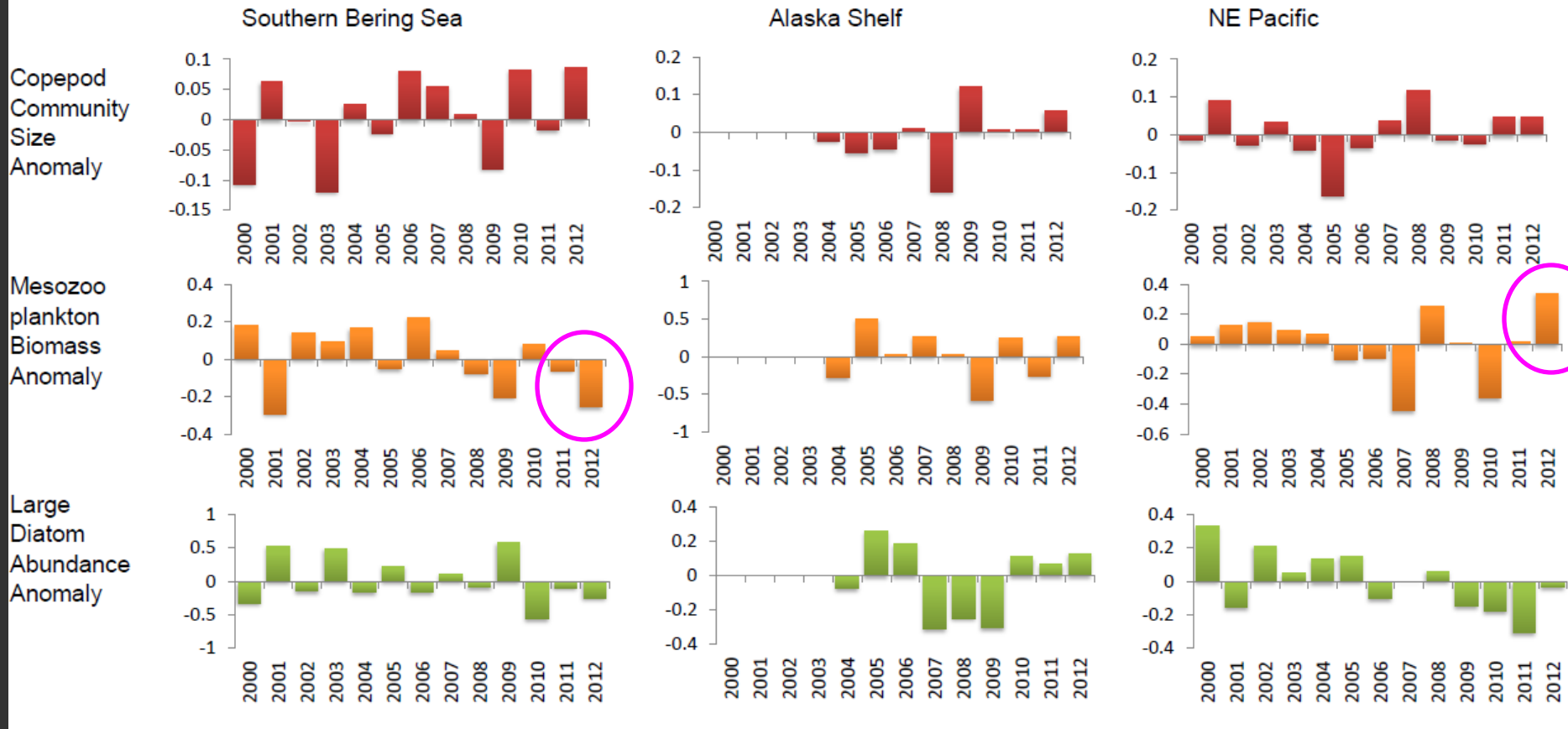
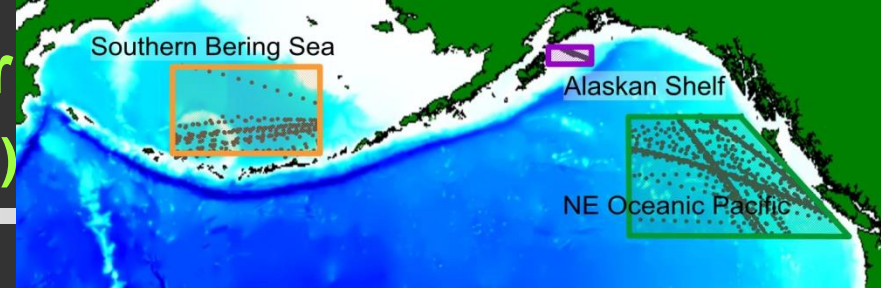
Links

- [2012 Stock Assessments for 2013 Fishery Recommendations](#)
- [Data access](#) for most contributions (Dec. 2011 Update)
- Data use is contingent upon compliance with the [AFSC Data Use Conditions](#)
- A collection of [links relevant to the report](#) contents
- Contact [Stephani Zador \(Editor\)](#) for further information

Archive

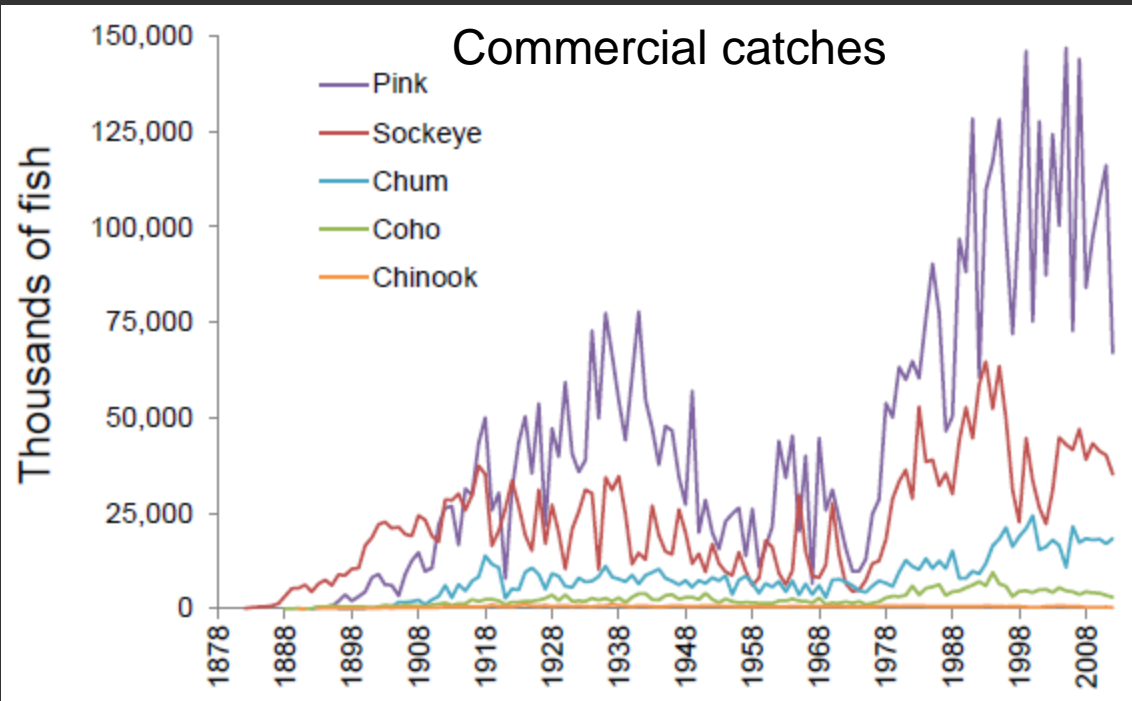
- [Contribution archive](#)
- [Stock assessment archives](#)

Continuous Plankton Recorder Data from the NE Pacific (Batten)



- 2012:
- S Bering Sea → low biomass, but large size
 - NE Pacific → highest biomass anomaly

Historical and Current Alaska Salmon Trends (Whitehouse)

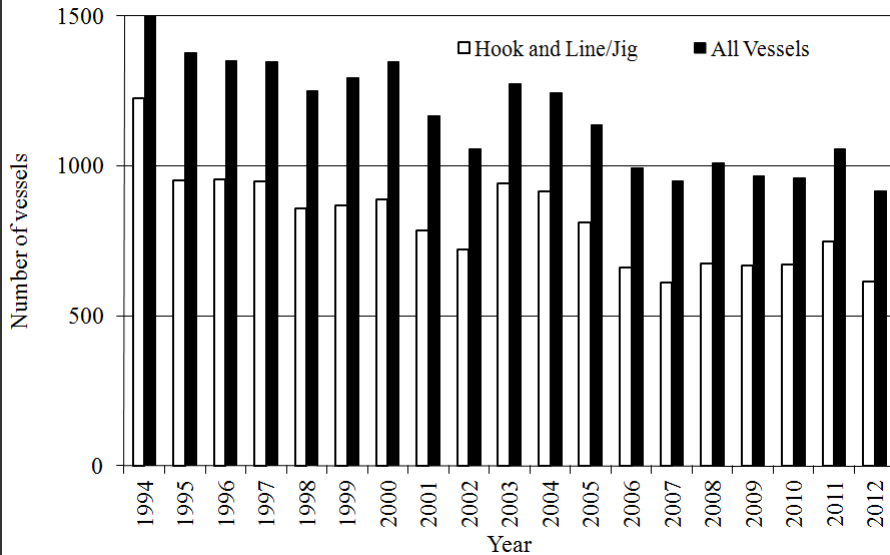


2012 harvest < 2011 harvest

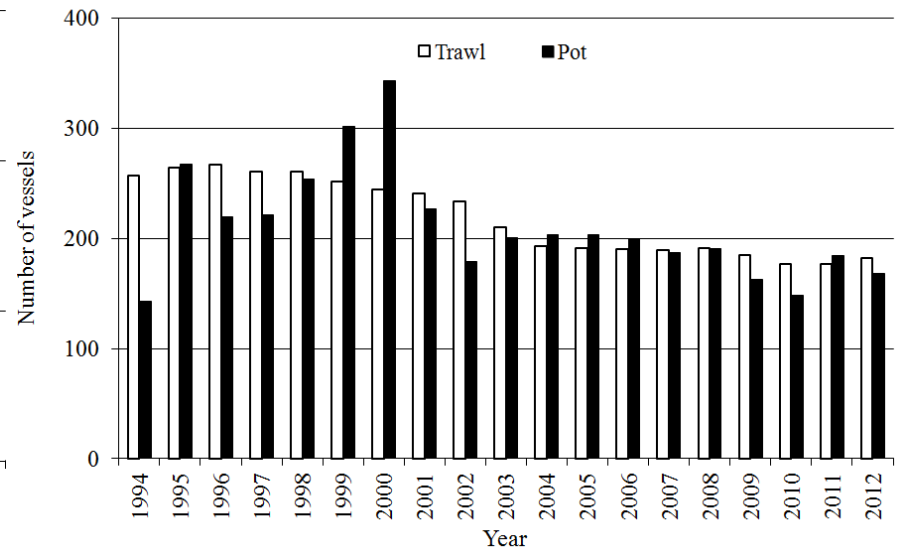
EBS 2012: Chinook and chum down; sockeye, average, coho above 20-yr average

Groundfish Fleet Composition (Lee)

Longline/Jig and All Vessels (black)

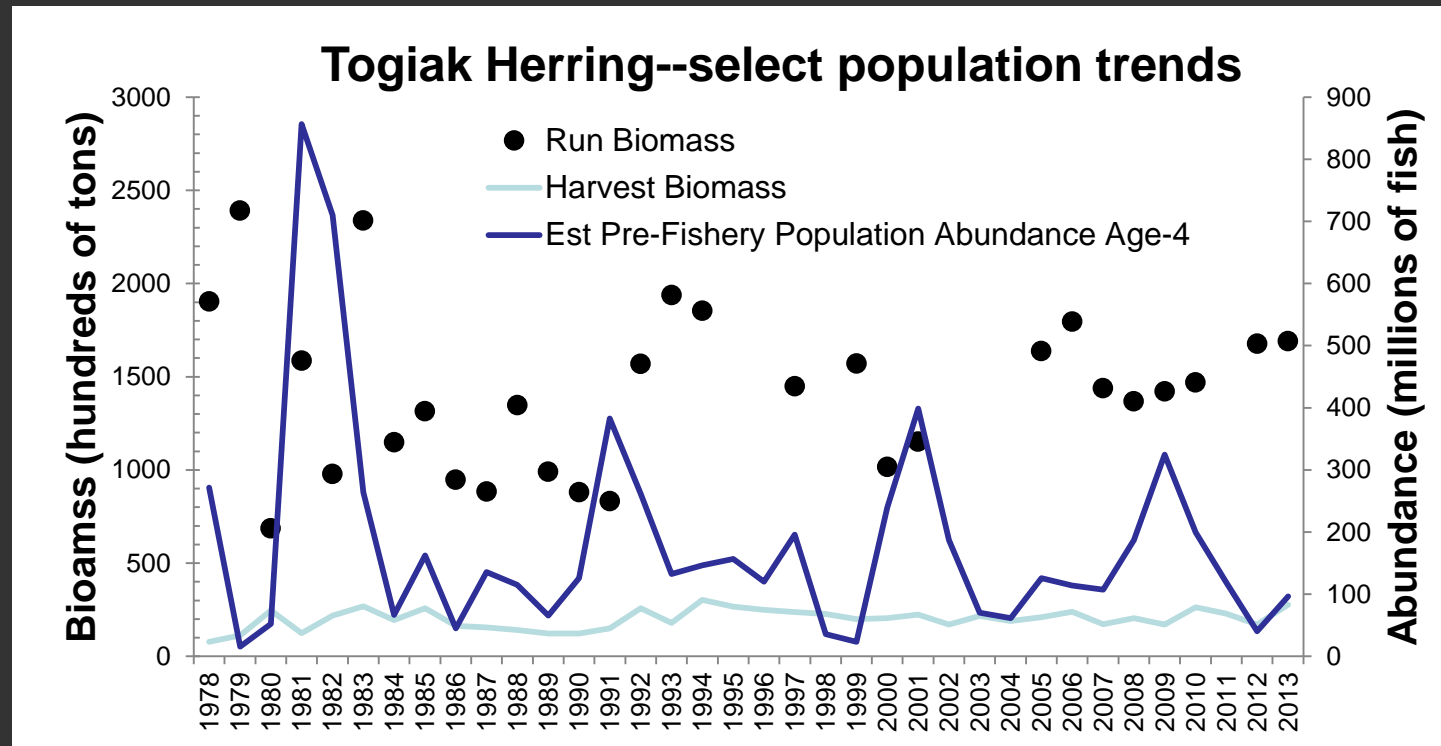


Trawl (white) and Pot (black)



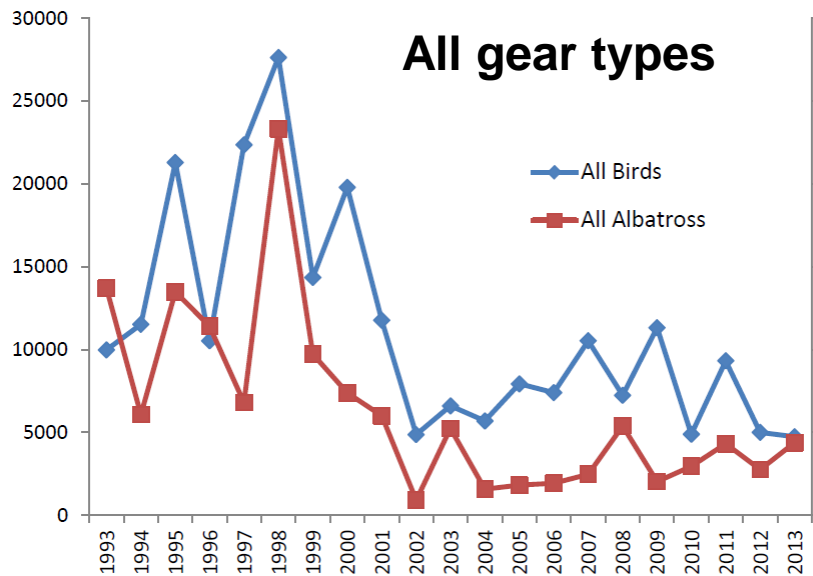
- Patterns of change similar since 1994, except pot, which peaked in 2000
- 2003 increase in longline/jig and pot due to shift to CAS
- 2011 total increase due to new jig-gear vessels targeting cod

2013 Togiak herring (Buck)



- 2013 abundance (169K tons) is 113% of recent 10-yr average
- Sac roe fishery (27.6K tons) is 134% of recent 10-yr average
- Cyclic recruitment every 8-10 years
- Considered healthy and sustainably harvested

Seabird Bycatch Estimates for Alaskan Groundfish Fisheries 1993-2013 (Fitzgerald)



- 2013 numbers lowest in time series (began 1993)

Estimated numbers of seabird bycatch

| Species/Species Group | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------------------------|--------------|-------------|--------------|-------------|-------------|-------------|-------------|
| Unidentified Albatross | 23 | 0 | 0 | 0 | 0 | 0 | 0 |
| Short-tailed Albatross | 0 | 0 | 0 | 15 | 5 | 0 | 0 |
| Black-footed Albatross | 208 | 314 | 56 | 48 | 221 | 141 | 249 |
| Laysan Albatross | 17 | 226 | 148 | 233 | 206 | 135 | 189 |
| Northern Fulmar | 4806 | 3334 | 8200 | 2452 | 6214 | 3022 | 3277 |
| Shearwaters | 3587 | 1224 | 620 | 653 | 194 | 514 | 191 |
| Storm Petrels | 1 | 44 | 0 | 0 | 0 | 0 | 0 |
| Gull | 1360 | 1551 | 1335 | 1145 | 2158 | 890 | 556 |
| Kittiwake | 10 | 0 | 16 | 0 | 6 | 5 | 3 |
| Murre | 6 | 6 | 13 | 102 | 14 | 6 | 3 |
| Puffin | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Auklets | 0 | 3 | 0 | 0 | 0 | 7 | 4 |
| Other Alcid | 0 | 0 | 105 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 136 | 0 | 0 | 0 | 0 |
| Unidentified | 522 | 541 | 696 | 240 | 306 | 285 | 267 |
| Grand Total | 10540 | 7243 | 11325 | 4894 | 9324 | 5005 | 4740 |

- Notable decreases in shearwaters and gulls
- More albatrosses than in 2012
- No observed short-tailed albatross takes in 2013

2013 Multivariate seabird index (Zador)
