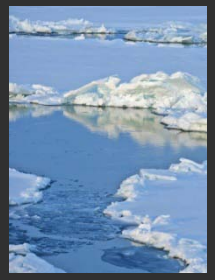
Ecosystem Considerations

for 2014





North Pacific Fisheries Management Council

December 2013

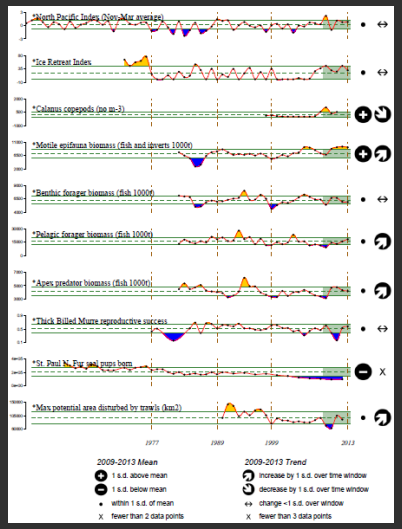
Ecosystem Considerations Report

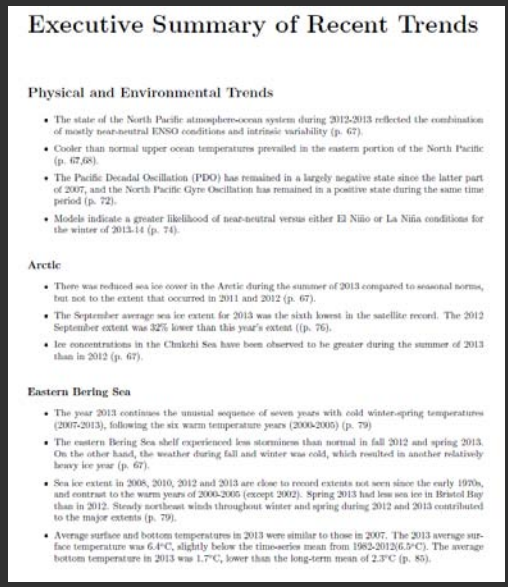
Major Sections

- Report Cards
  - Actionable trends/alert
- Executive Summary
- Ecosystem Assessments
  - Regional synthesis
  - GOA 2014 planned
- Ecosystem Status and Management Indicators
  - **52** updated and new contributions

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 know 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.





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. 67).
- Cooler than normal upper ocean temperatures prevailed in the eastern portion of the North Pacific (p. 67,68).
- 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. 72).
- Models indicate a greater likelihood of near-neutral versus either El Niño or La Niña conditions for the winter of 2013-14 (p. 74).

Arctic

- There was 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. 67).
- The September average sea ice extent for 2013 was the sixth lowest in the satellite record. The 2012 September extent was 32% lower than this year's extent ((p. 76).
- Ice concentrations in the Chukchi Sea have been observed to be greater during the summer of 2013 than in 2012 (p. 67).

Eastern Bering Sea

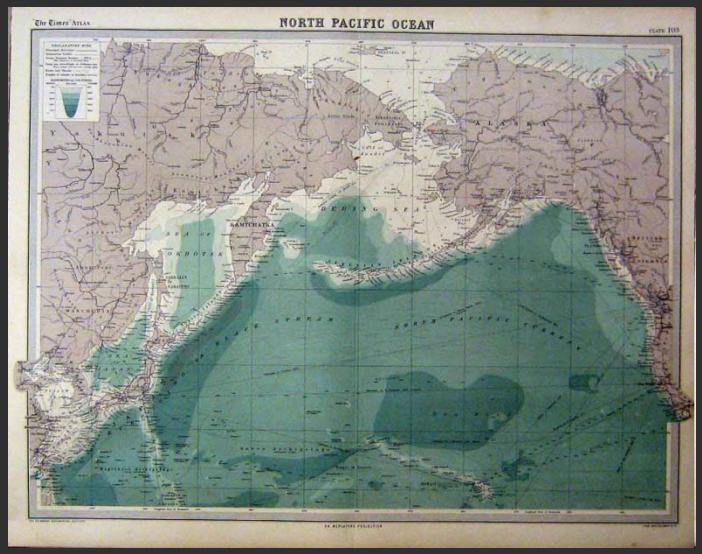
- The year 2013 continues the unusual sequence of seven years with cold winter-spring temperatures (2007-2013), following the six warm temperature years (2000-2005) (p. 79)
- The eastern Bering Sea shelf experienced less storminess than normal in fall 2012 and spring 2013. On the other hand, the weather during fall and winter was cold, which resulted in another relatively heavy ice year (p. 67).
- Sea ice extent in 2008, 2010, 2012 and 2013 are close to record extents not seen since the early 1970s, and contrast to the warm years of 2000-2005 (except 2002). Spring 2013 had less sea ice in Bristol Bay than in 2012. Steady northeast winds throughout winter and spring during 2012 and 2013 contributed to the major extents (p. 79).
- Average surface and bottom temperatures in 2013 were similar to those in 2007. The 2013 average surface temperature was 6.4°C, slightly below the time-series mean from 1982-2012(6.5°C). The average bottom temperature in 2013 was 1.7°C, lower than the long-term mean of 2.3°C (p. 85).

Outline

- North Pacific Climate
- Arctic
- Eastern Bering Sea
  - Report Card
  - Ecosystem Assessment (2012 summary)
  - 2013 indicators
- Aleutian Islands
  - Report Card
- Gulf of Alaska
  - Hot Topics
  - 2012 and 2013 Indicators
- Alaska-wide Indicators

North Pacific Climate Overview (Bond)

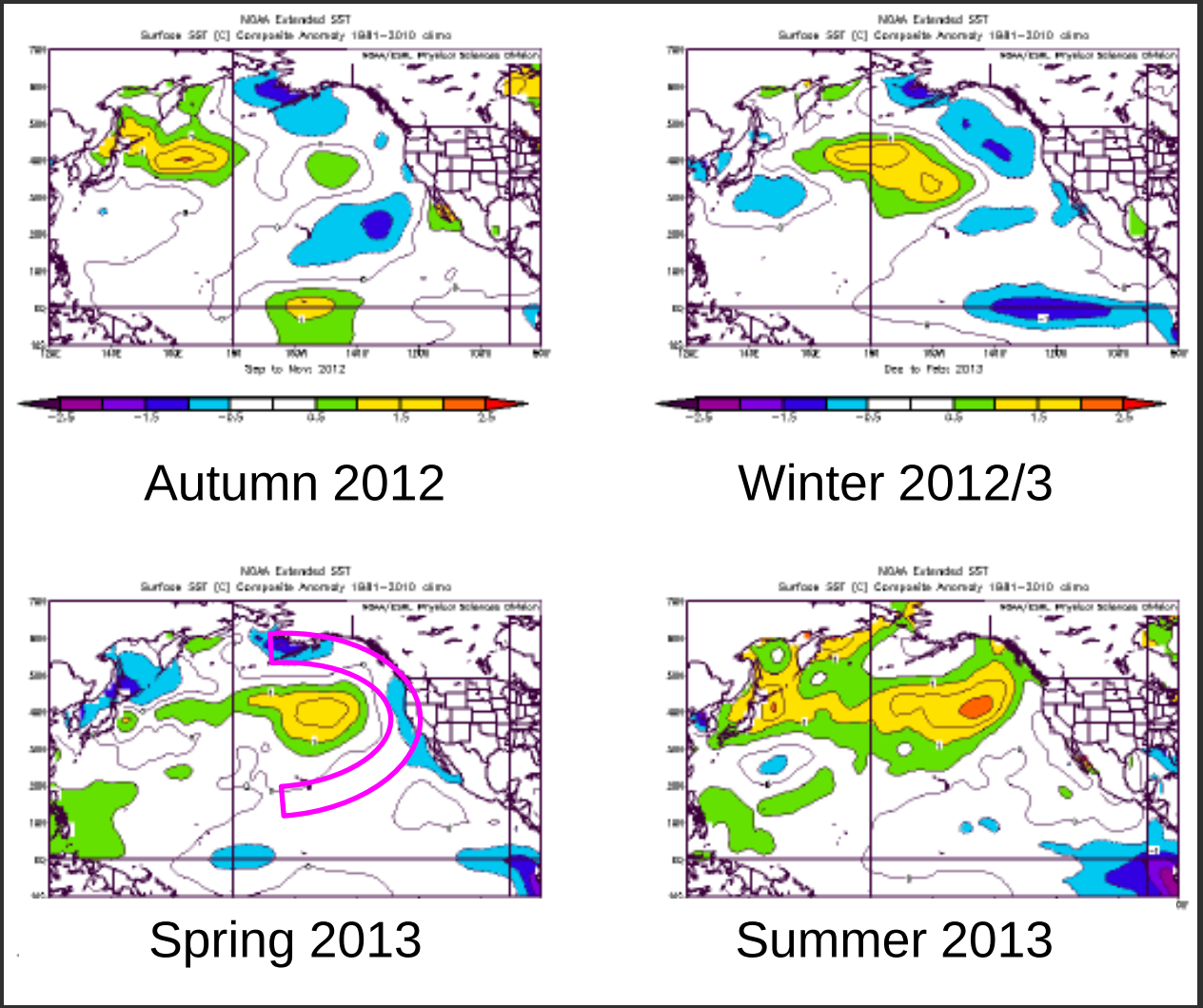
- 2012/2013 reflected a combination of response to mostly *near-neutral* El Niño and intrinsic variability
- Aleutian Low weak last winter
- Continuation of negative PDO
- Eastern NP showed cooler than normal upper ocean temperatures
- ENSO forecasts indicating *near-neutral* El Niño state 2013-2014



Sea Surface Temperature Anomalies
(Bond)

Weak El Niño?

Continued cool.



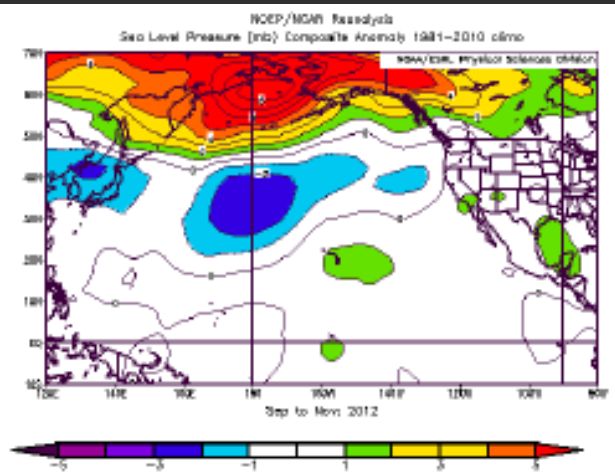
Weak negative PDO pattern by summer (horseshoe).

Warmed to normal in EBS

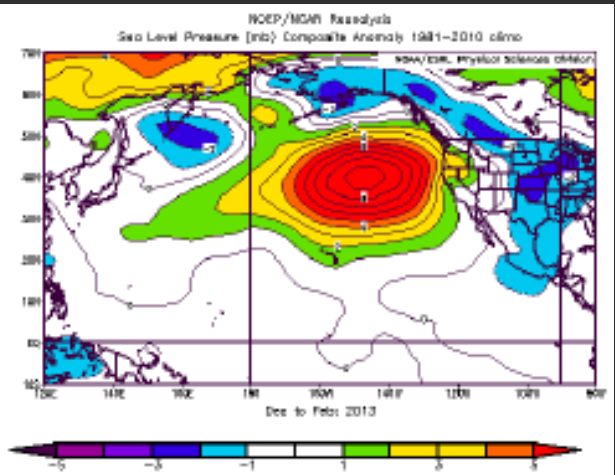
From NOAA's Extended Reconstructed SST analysis

Sea Level Pressure Anomalies
(Bond)

Easterly winds (opposite to 2011)



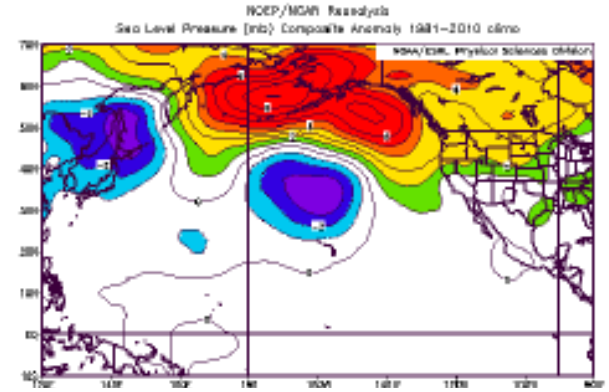
Autumn 2012



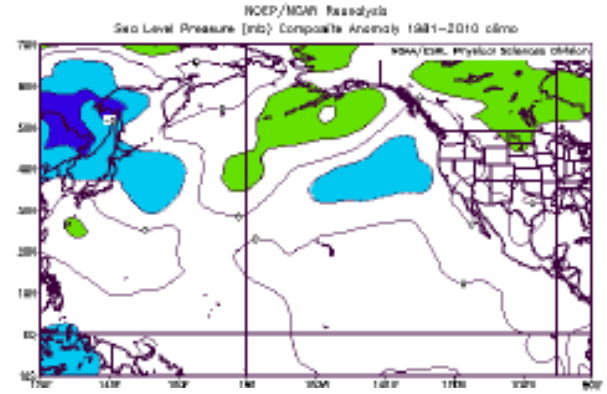
Winter 2012/3

Westerly winds. Siberian air to AK

Suppressed storminess in AK



Spring 2013

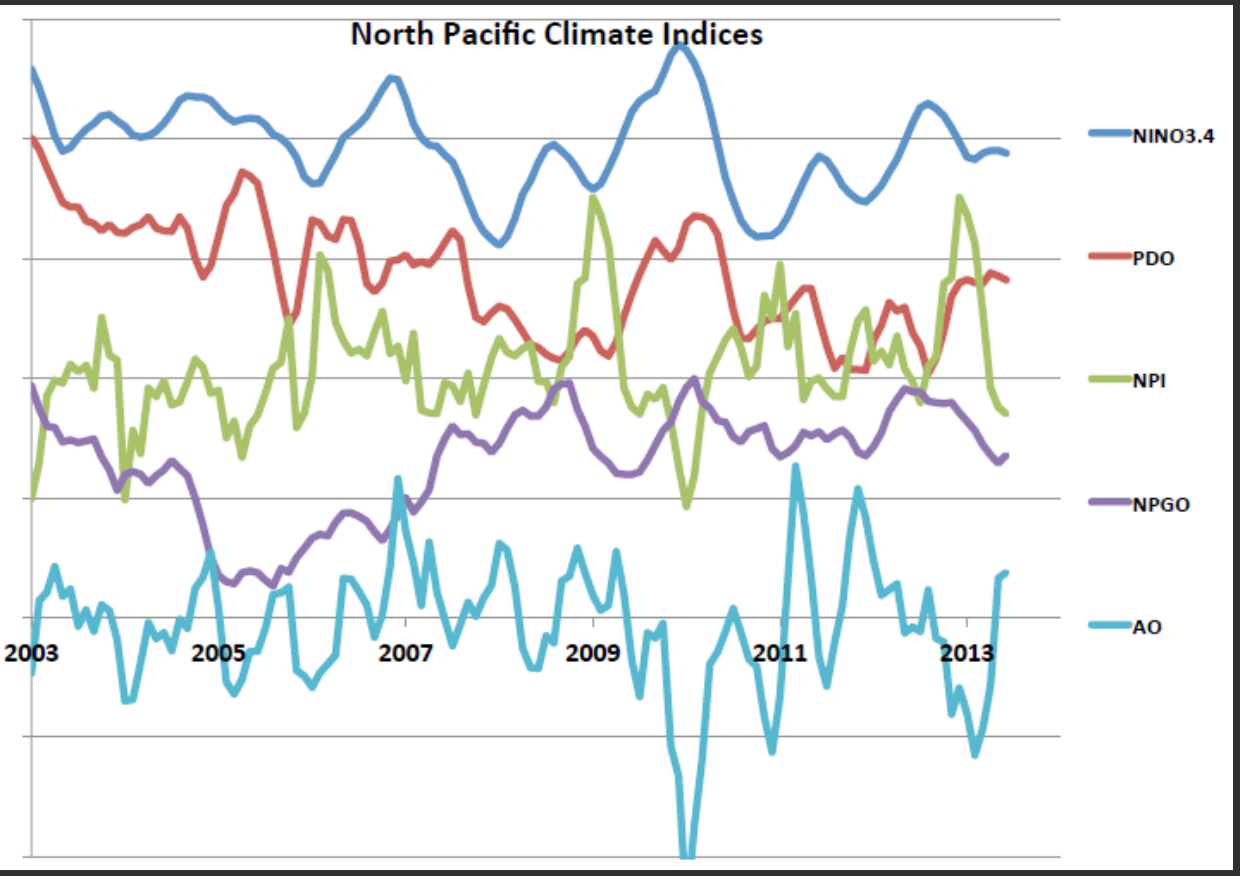


Summer 2013

Higher upwelling in GOA

From the NCEP/NCAR Reanalysis project

Climate Indices
(Bond)



Near neutral ENSO

PDO trending positive. Continuation?

NPI strongly positive (usually with La Niña)

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

AO measures strength of polar vortex. Positive = low pressure over Arctic, high over Pacific (45^{o})

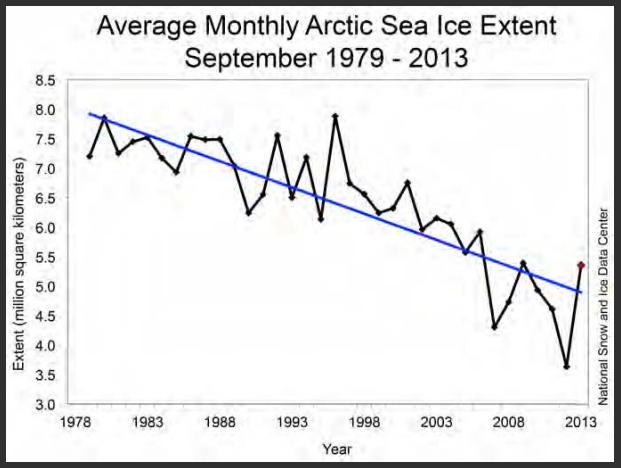

Arctic

Preliminary Assessment and Arctic Ice
(Whitehouse and Zador; Zador)

2013 Assessment Update

- Potential indicators:
  - Climate
    - Arctic Oscillation Index
    - Sept sea ice index
  - Plankton
    - Primary production
    - Zooplankton sp comp and biomass
  - Fish
    - Biomass or abundance index
  - Seabirds
    - Black guillemot reproductive success; food habits
  - Marine Mammals
    - Body condition; abundance/biomass
  - Humans
    - Subsistence hunting index

6th lowest average Sept sea ice extent



Sept 2013 ice extent v. 1981-2010 median

Eastern Bering Sea

Report Card

Eastern Bering Sea 2013 Report Card

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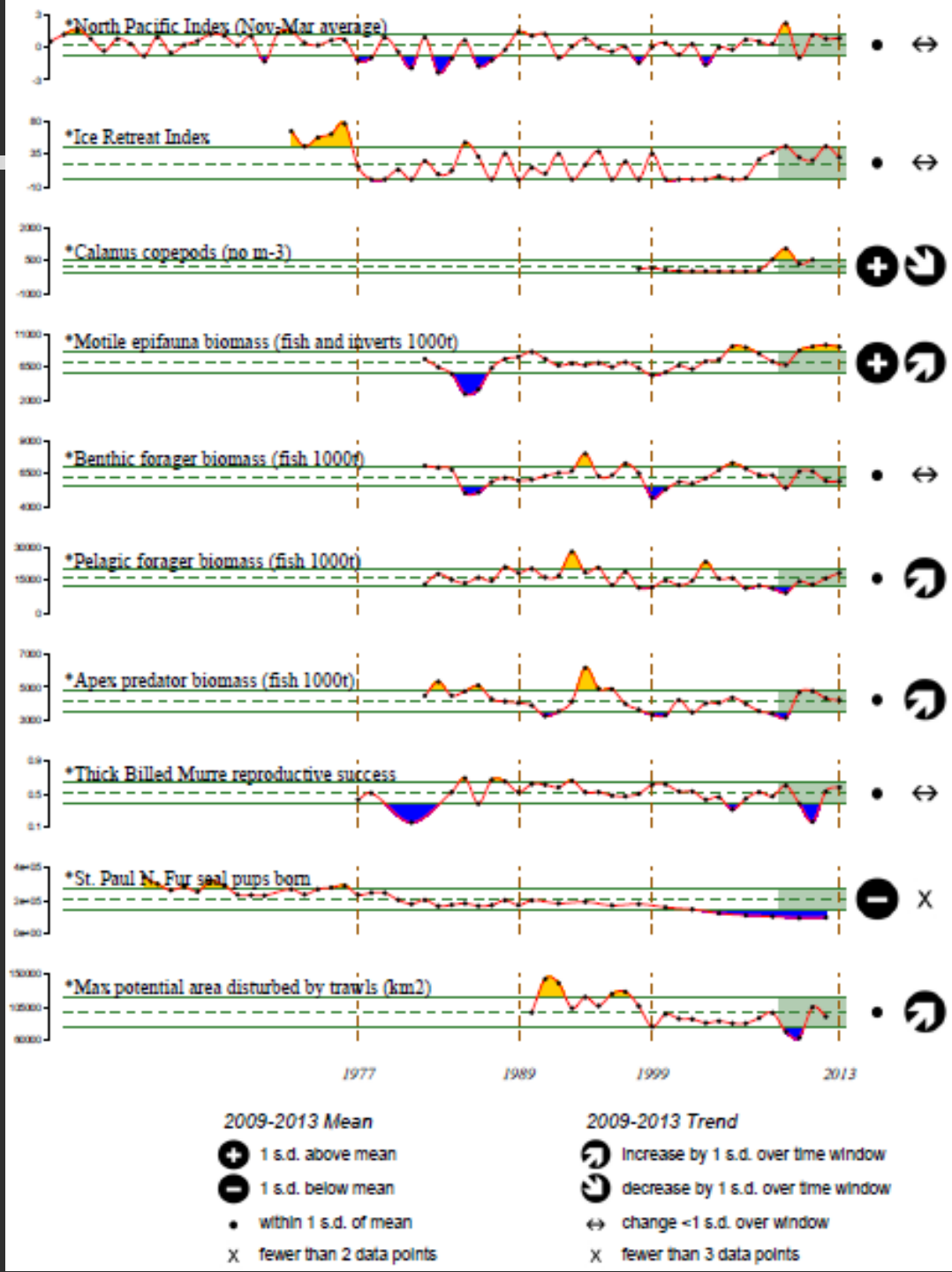
- The maximum potential **area of seafloor habitat disturbed by trawl gear in 2012 decreased slightly** from 2011, which was the highest level since 1998. The cause of the increase may be due to increased search time for pollock and/or avoidance of salmon bycatch.

Report Card

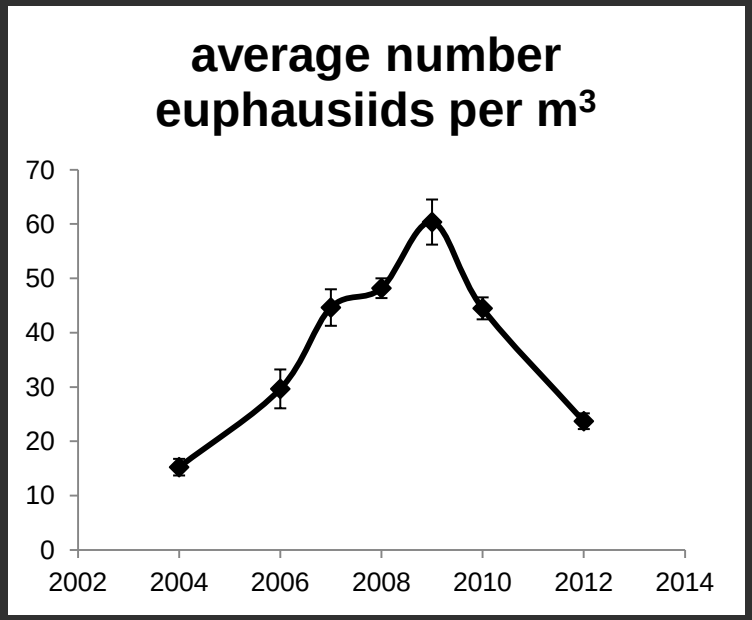
1. North Pacific Index
2. Eastern Bering Sea ice retreat
3. Calanus copepods
4. Motile epifauna aggregate biomass
5. Benthic foragers aggregate biomass
6. Pelagic foragers aggregate biomass
7. Fish apex predators aggregate biomass
8. Thick-billed murre reproductive success on St. George Island
9. St.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



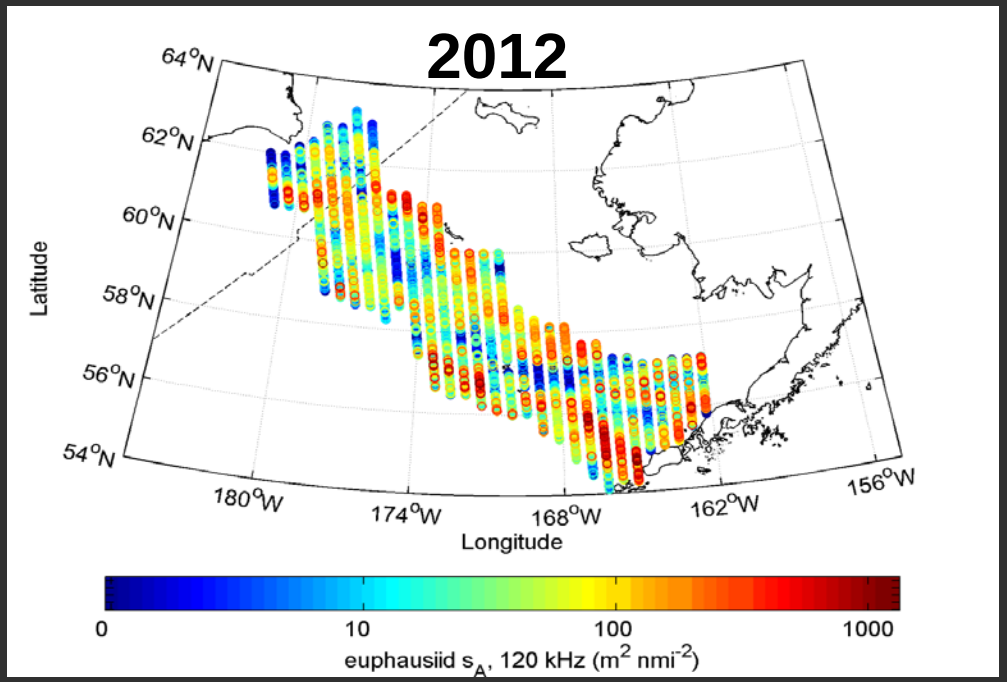
EBS Assessment

- 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

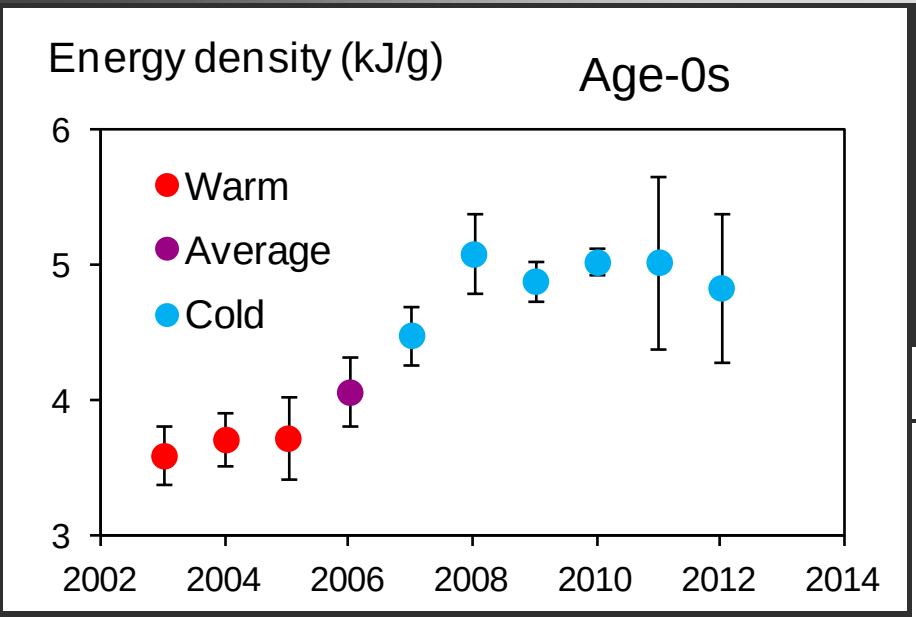
EBS Euphausiids (Ressler et al.)



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



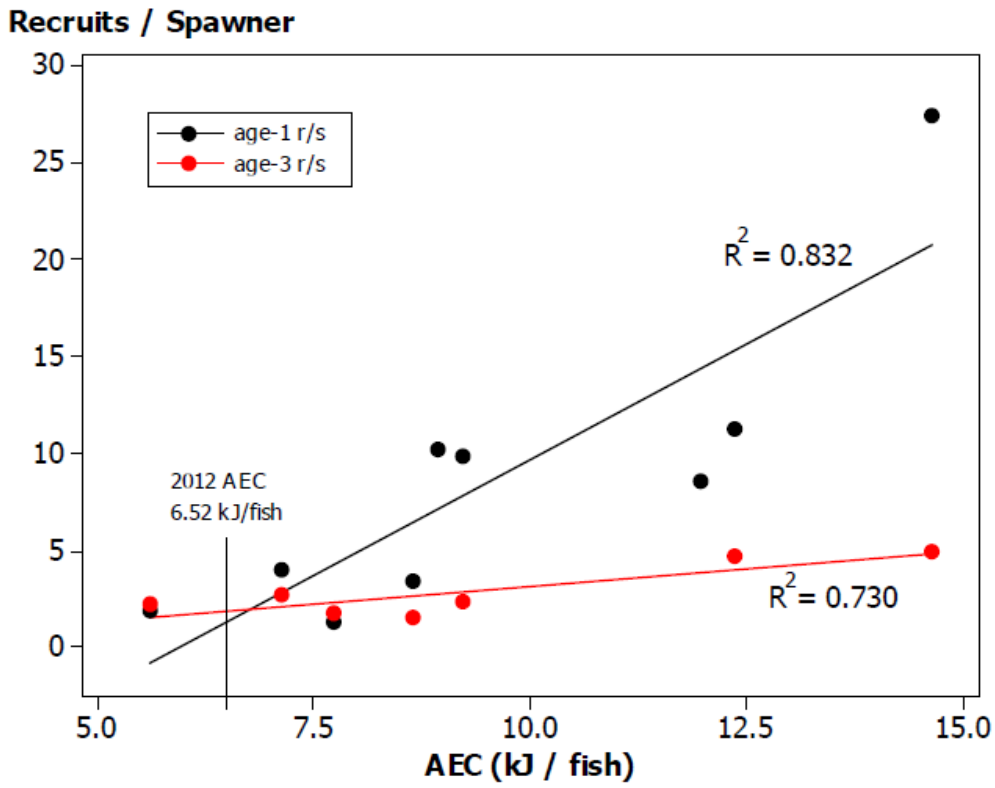
Fall Condition of YOY Predicts Recruitment of Age-1 Pollock (Heintz et al.)



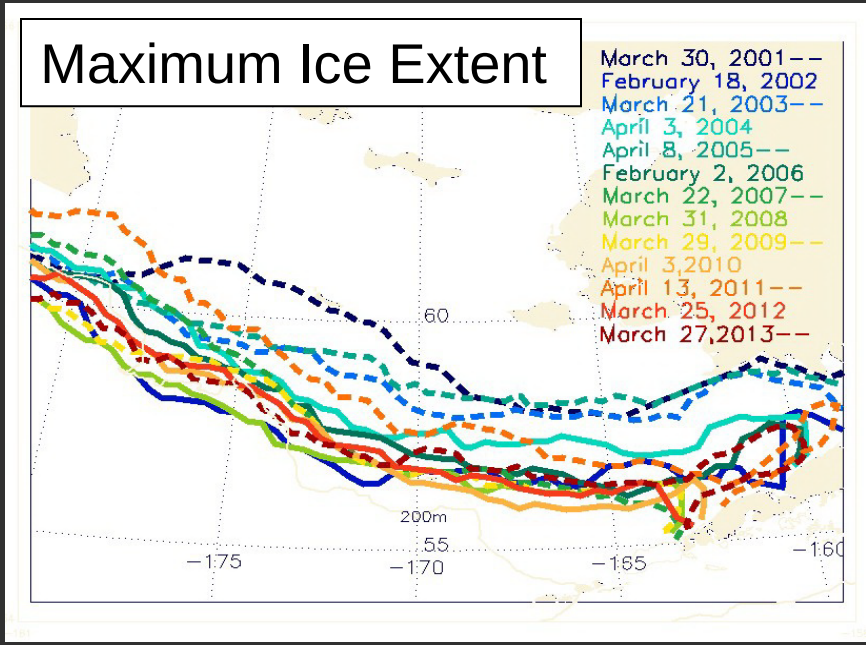
- Energy density influence by thermal regime; fish size has not
- 2012 too cold for good survival (smallest size in time series)

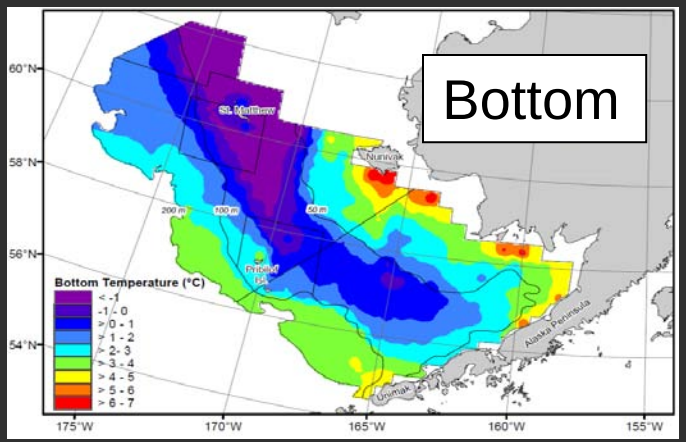
- Average energy content of YOY pollock accounted for 83% of the variation in number of age-1 and 73% of age-3 recruits per spawner .
- 2012 AEC indicates age-1 will be below median in 2013 (and age-3 in 2015)

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



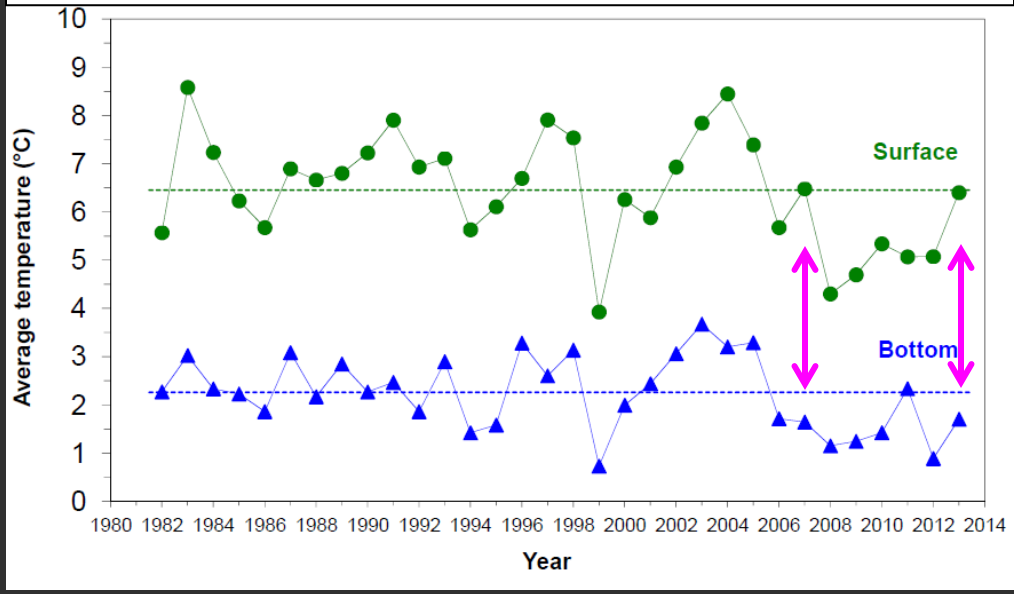
2013 Eastern Bering Sea Climate (Overland et al.; Lauth)



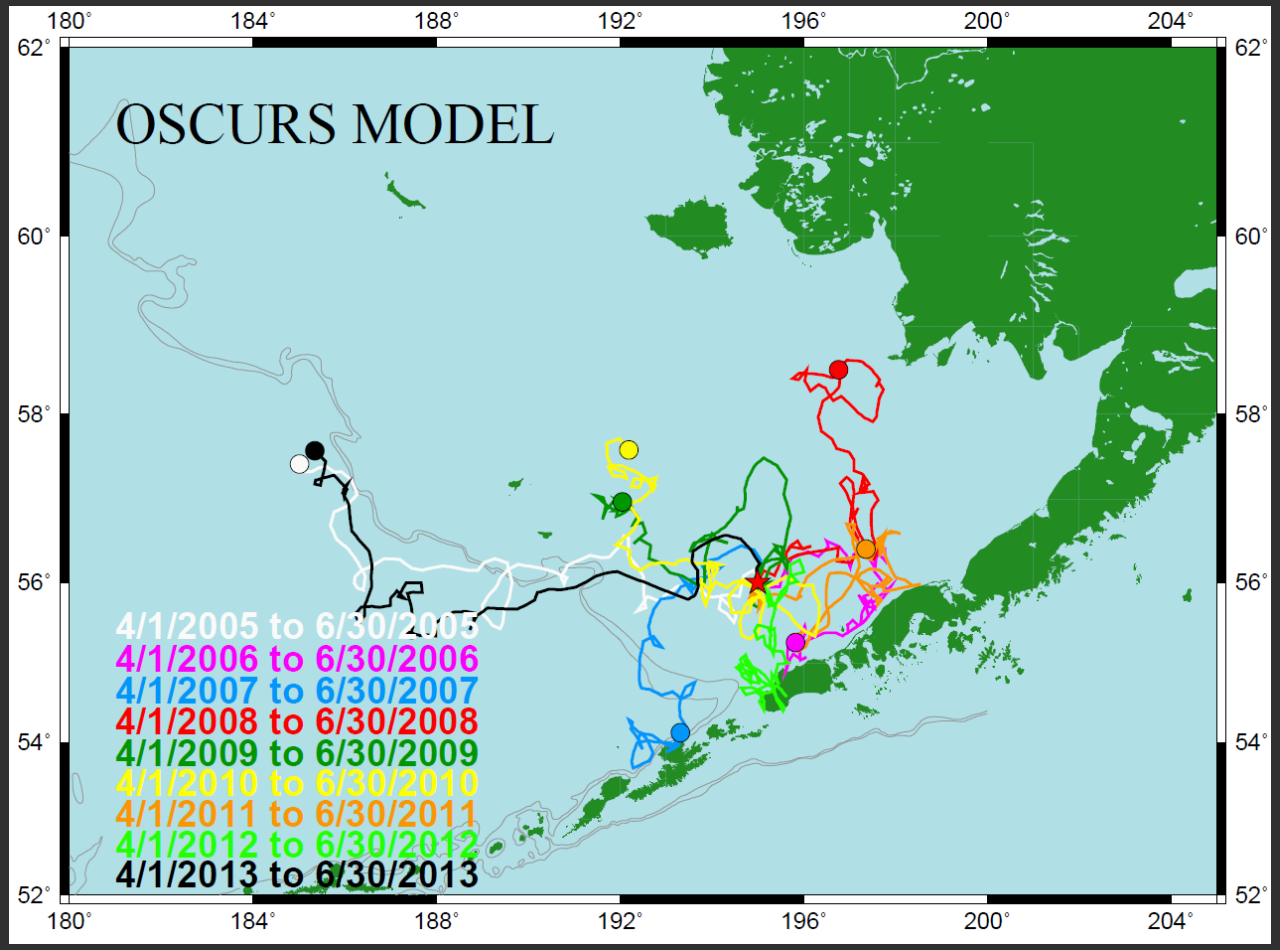


- 2013: another cold year
- Summer: near normal conditions
- Extensive sea ice (except Bristol Bay) due to steady northeast winds (due to high spring SLP)
- Average 2013 temps similar to 2007

Average surface (top), bottom temps

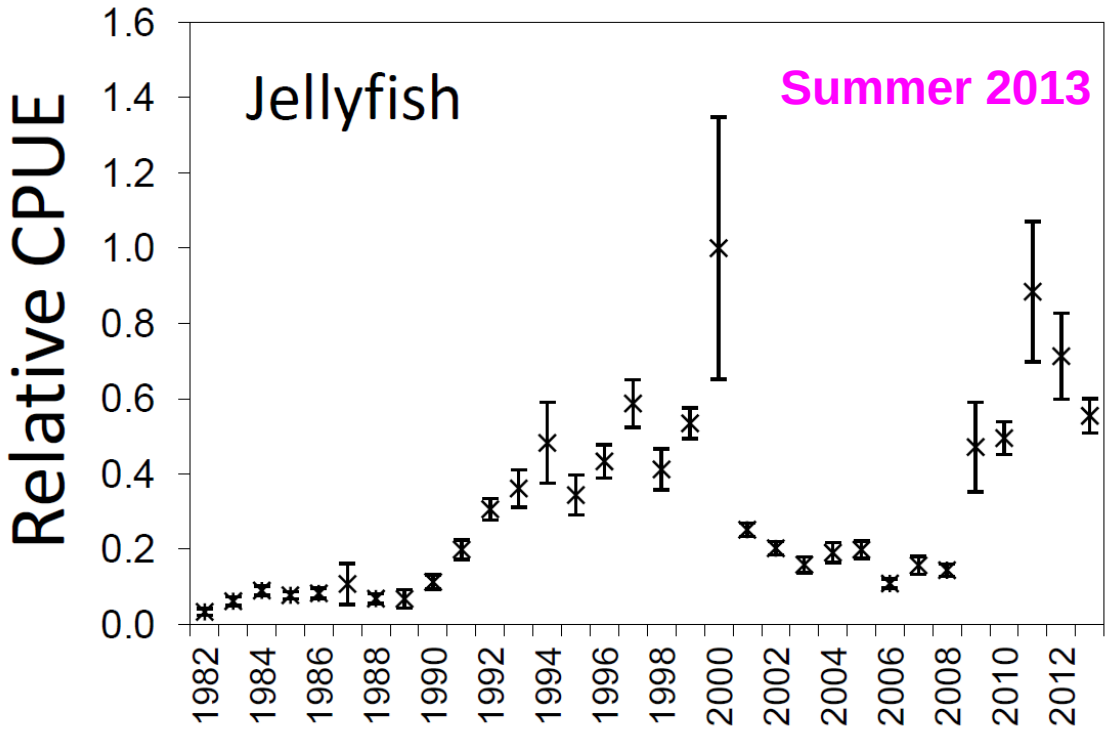


EBS Wind Forcing and Winter Spawning Flatfish Recruitment (Wilderbuer)

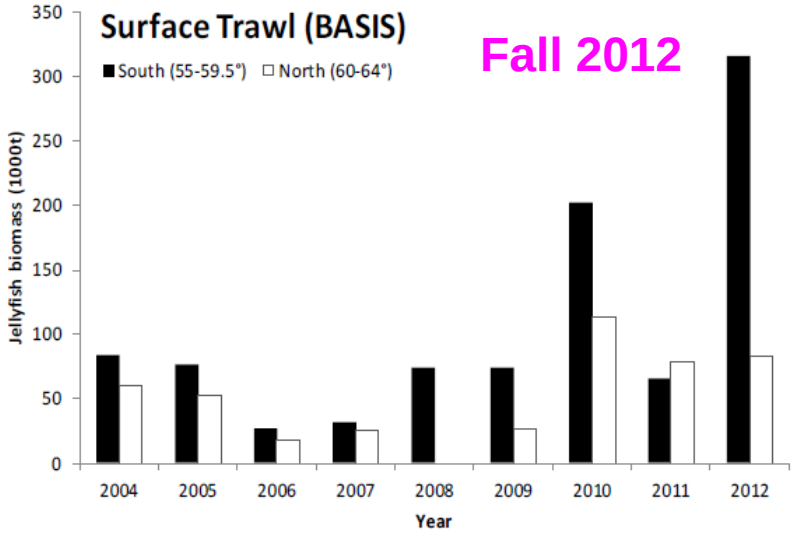


- Direction of wind-forcing during spring linked to flatfish recruitment (northern rock sole)
- Inshore advection to favorable nursery grounds in 2006, 2008, 2011
- 2013 not favorable

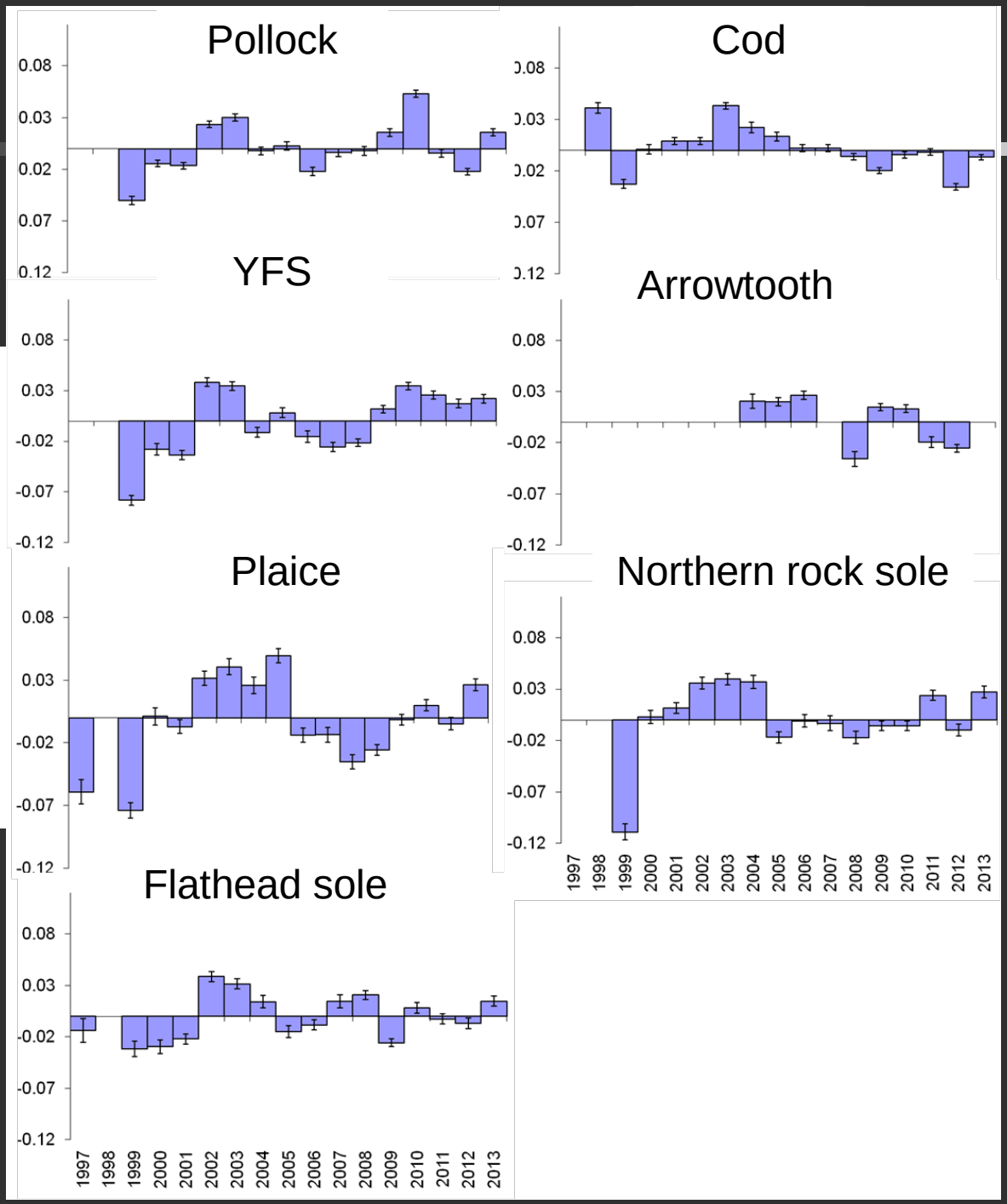
Jellyfish (Lauth and Hoff; Cieciel)



- 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

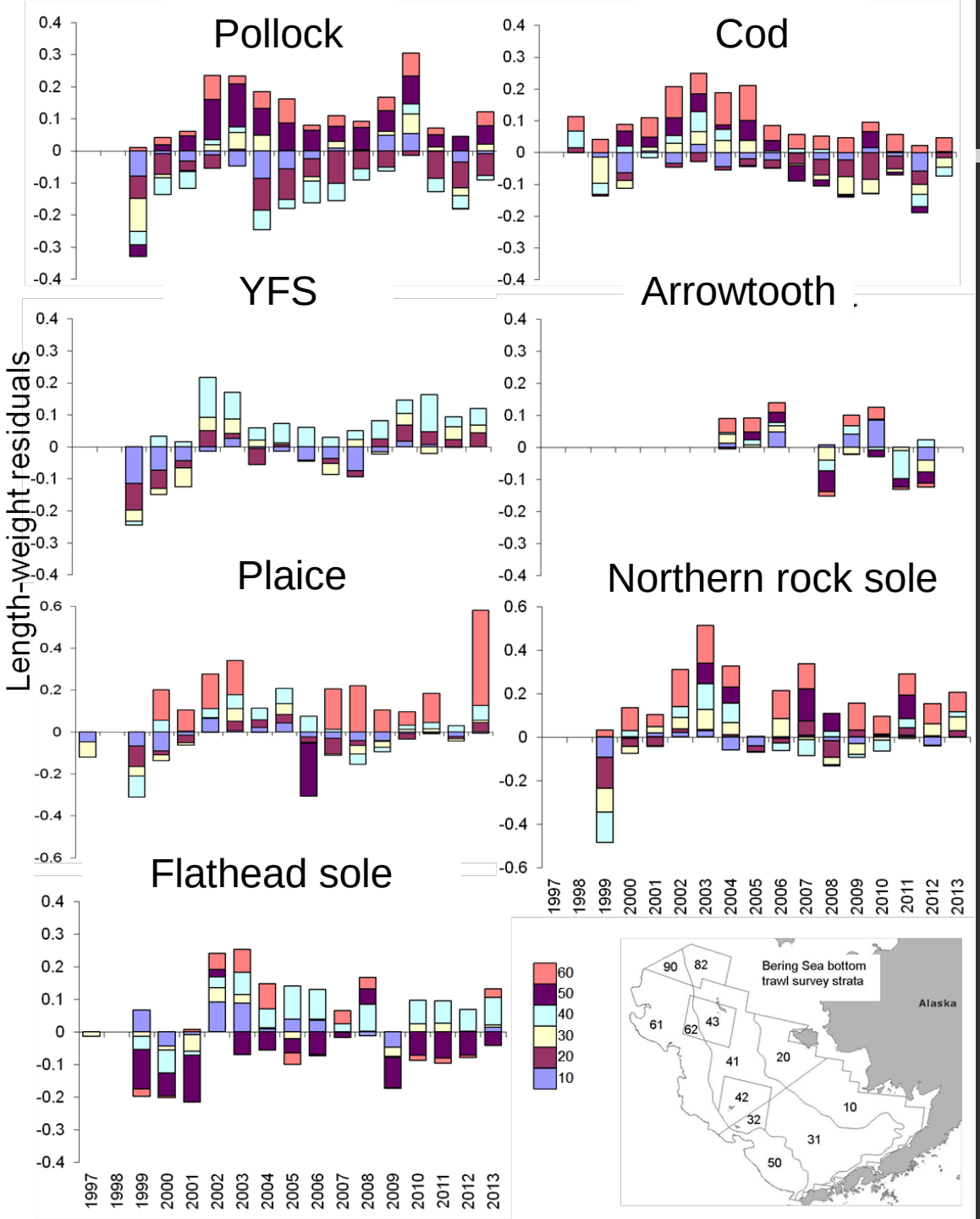


2013 Groundfish Condition (Boldt et al)



- Length-weight residuals from survey
- Pollock and yellow-fin 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.

Aleutian Islands

NOAA

Aleutian Islands Report Card

Aleutian Islands 2013 Report Card

Region-wide

- In 2012/2013, the winter North Pacific Index was strongly positive implying a **weak Aleutian Low pressure system and suppressed storminess** in the region. **Easterly wind anomalies prevailed** in this region for much of the past year, which may have **enhanced northward transport through Unimak Pass and perhaps also the Aleutian North Slope Current.**
- **Biomass of pelagic forager and apex fish predator foraging guilds decreased across the region** between the 2010 and 2012 surveys, although patterns varied among species. The overall decline **may indicate an underlying environmental shift, lower catchability due to cold water or reflect high variances commonly observed in estimated biomass among survey years.**
- Several species show longitudinal trends in the fish pelagic foragers foraging guild: the **biomass of walleye pollock increase towards the east**, whereas that of **northern rockfish and Pacific ocean perch increase towards the west.**
- **Fishing patterns have recently changed throughout the system**, largely in response to increased protection for Steller sea lions, although the final impacts to individual fishing sectors are currently unknown.
- The amount of **area with observed trawling has declined overall**, likely reflecting less fishing effort, particularly in the western ecoregion.
- In general, **schools in the Aleutian Islands have shown no recent trends in enrollment**, possibly indicating that communities with year-round residents that experience direct interactions with the ecosystem through residential and subsistence activites are stable.

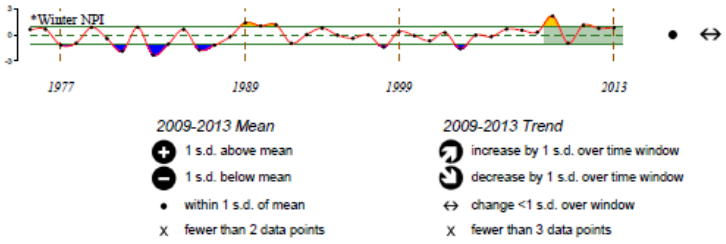
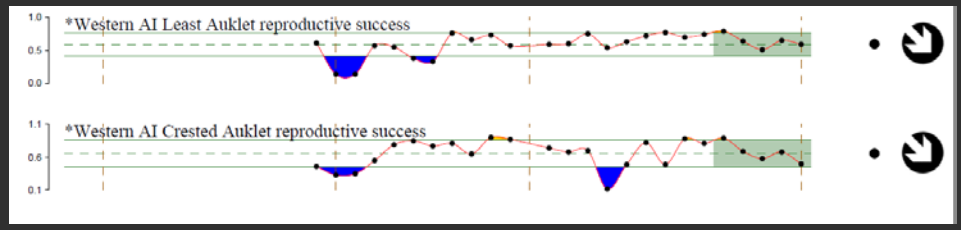
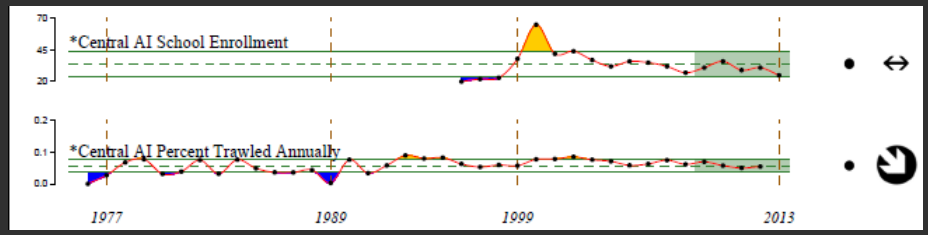


Figure 2: The winter North Pacific Index time series. * indicates time series updated in 2013.

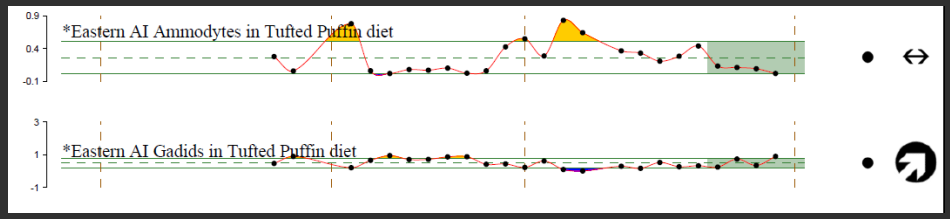
Western Ecoregion - zooplankton



Central Ecoregion - humans



Eastern Ecoregion – forage fish



Gulf of Alaska

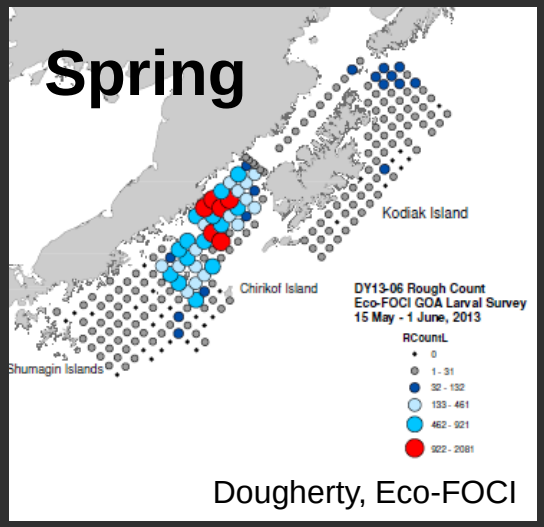
NOAA

Hot Topics - Gulf of Alaska 2013

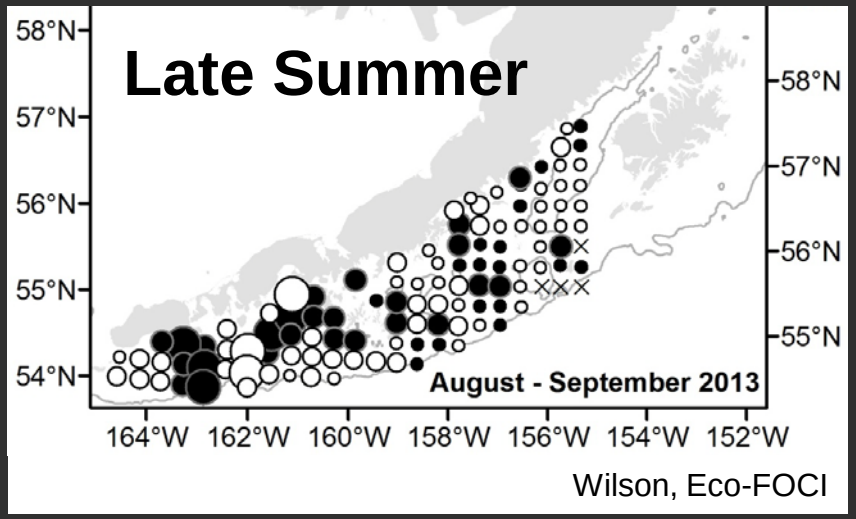
1. No* mushy halibut reported → better foraging conditions?
   - Prevalent in 1998, 2005, 2011, 2012

* “few” reports as of Sept 4

2. Large pulse of larval/age-0 pollock → strong year class?



Dougherty, Eco-FOCI



Wilson, Eco-FOCI

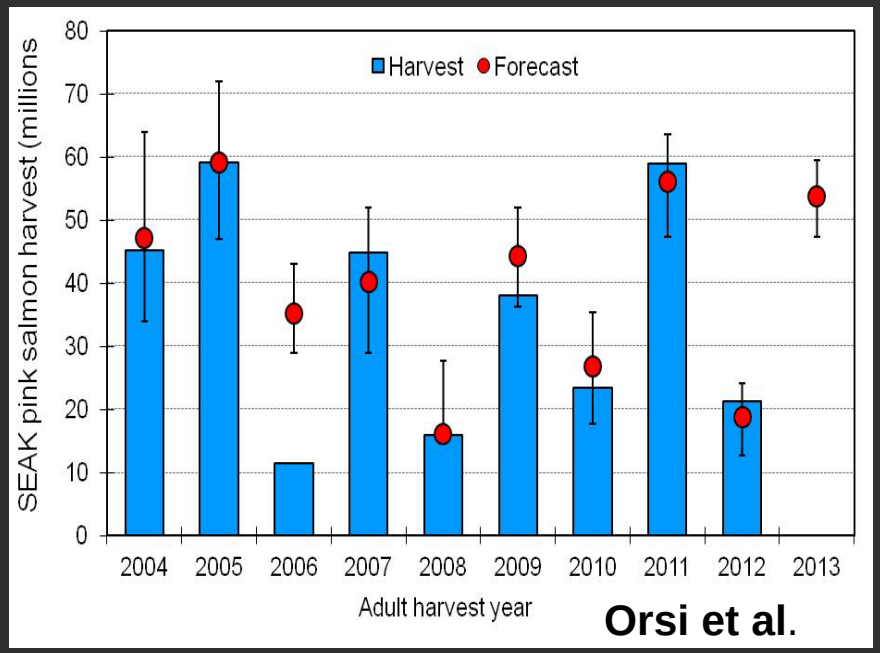
?

Recruitment

- Predation
- Transported out
- Other?

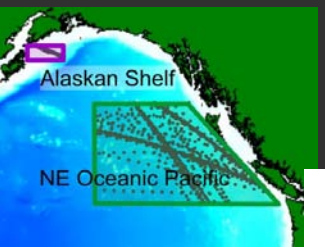
Hot Topic – Huge pink salmon harvest

3. Record Alaska 2013 salmon season
   - 219 M pinks caught
   - 89.4 M in SE (54 M predicted; Orsi et. al)
   - Favorable environmental conditions past 2 yr?



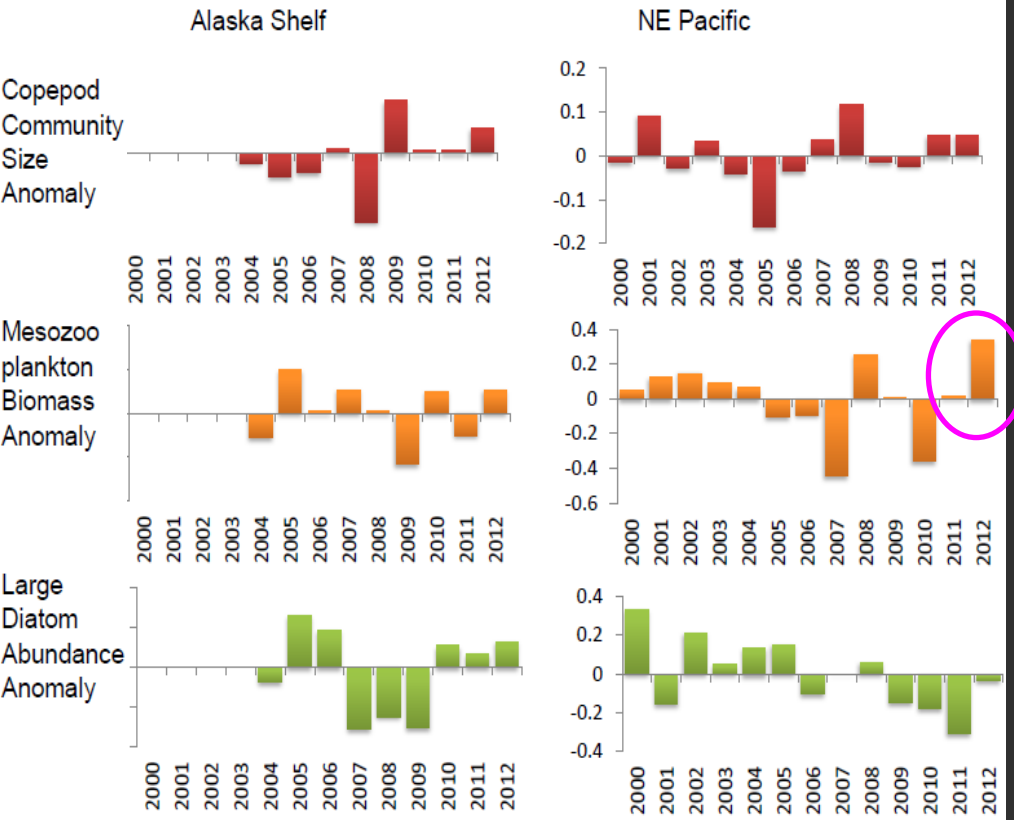
- 2012 peak juvenile CPUE 4th highest on record.
- Also, high ocean catch rates of juveniles, GOAIERP

Gulf of Alaska Zooplankton (Batten; Sturdevant)

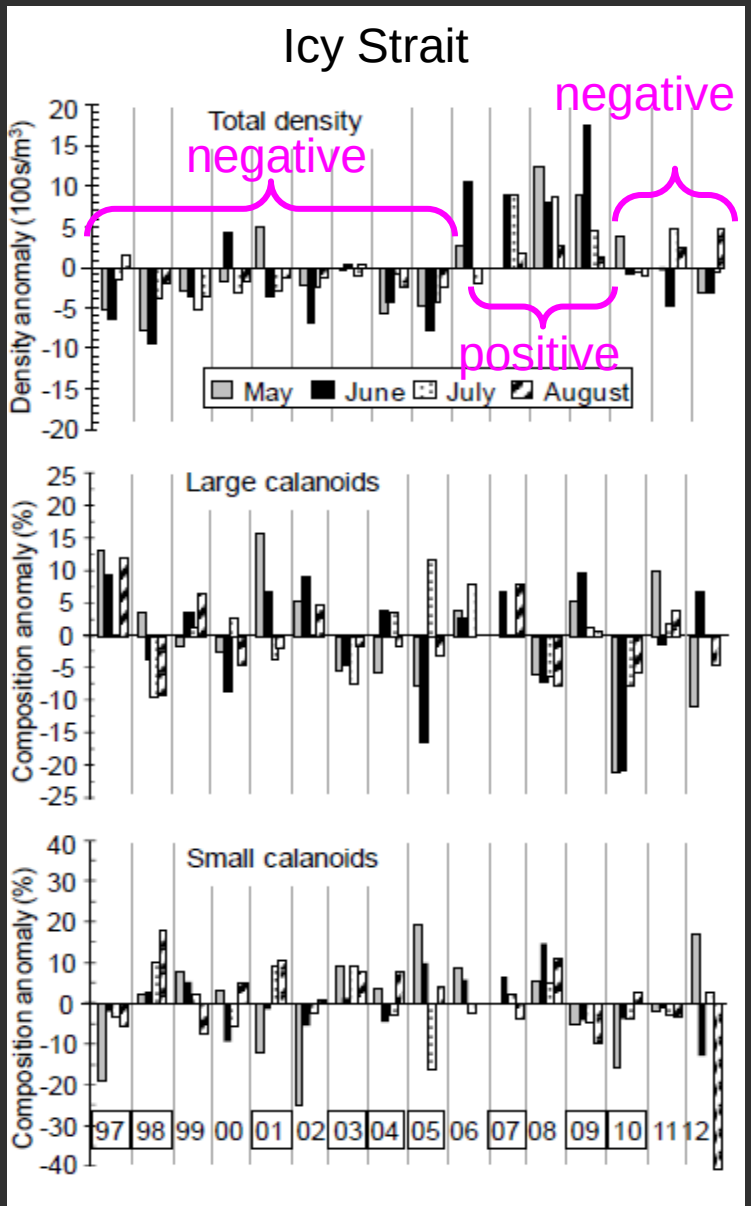


- Increases seen off shore; not in Icy Strait.

Continuous Plankton Recorder



Icy Strait



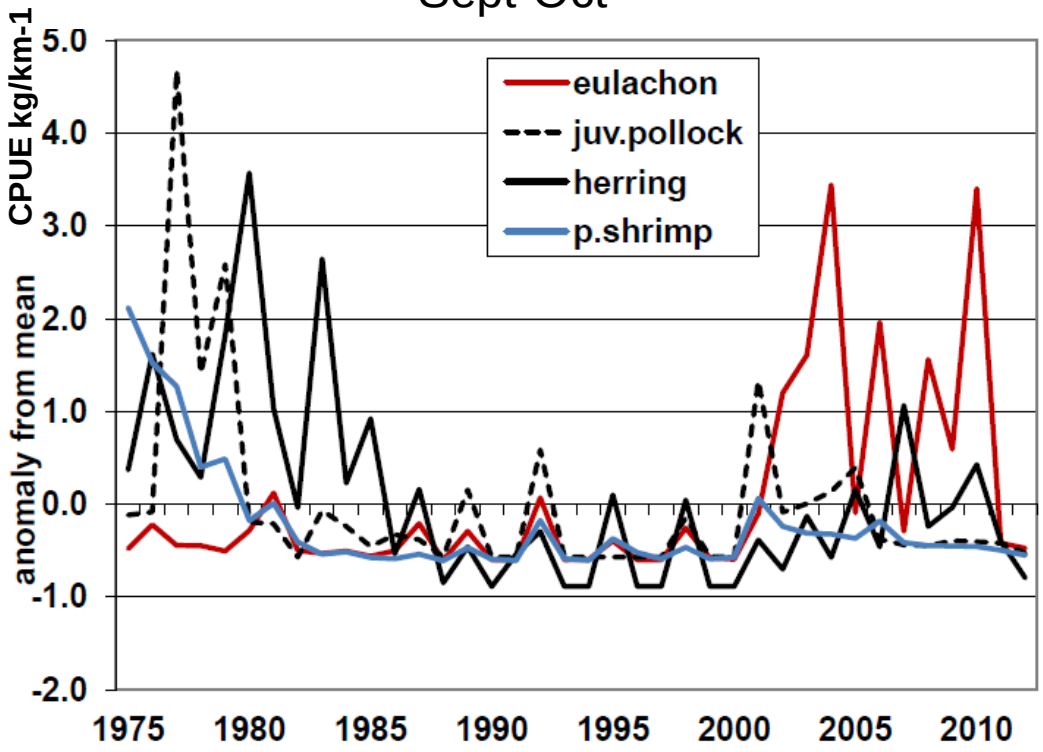
2012

Gulf of Alaska Forage Fish (Urban; Hebert and Dressel)

- Western GOA forage catch remains low, including eulachon
- Catch varied widely among and within bays
- Decrease in SEAK herring spawning biomass

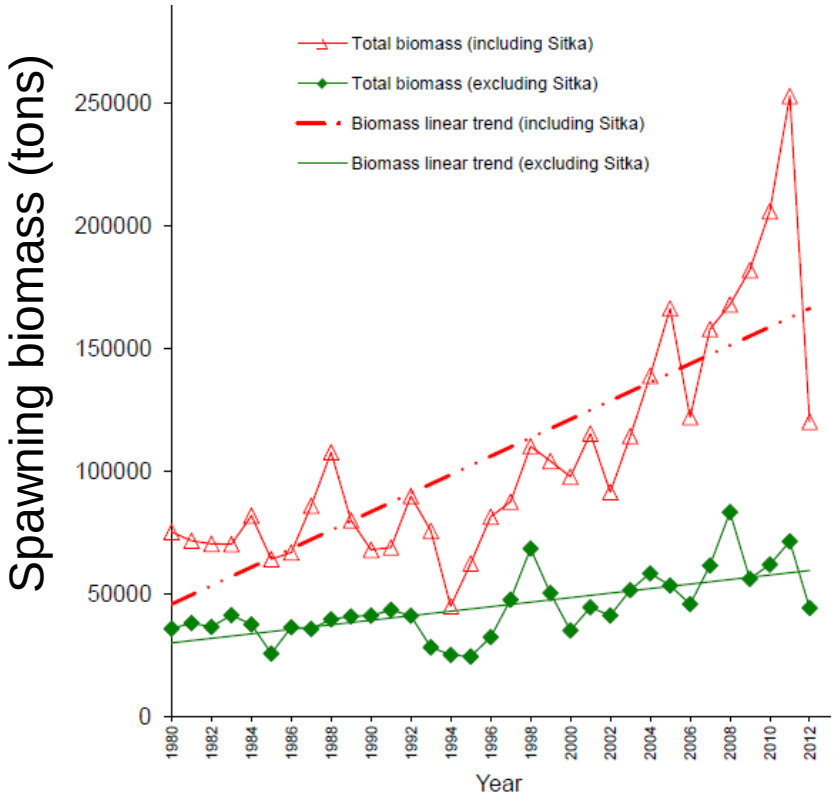
Small mesh surveys, western GOA

Sept-Oct



Southeast AK herring

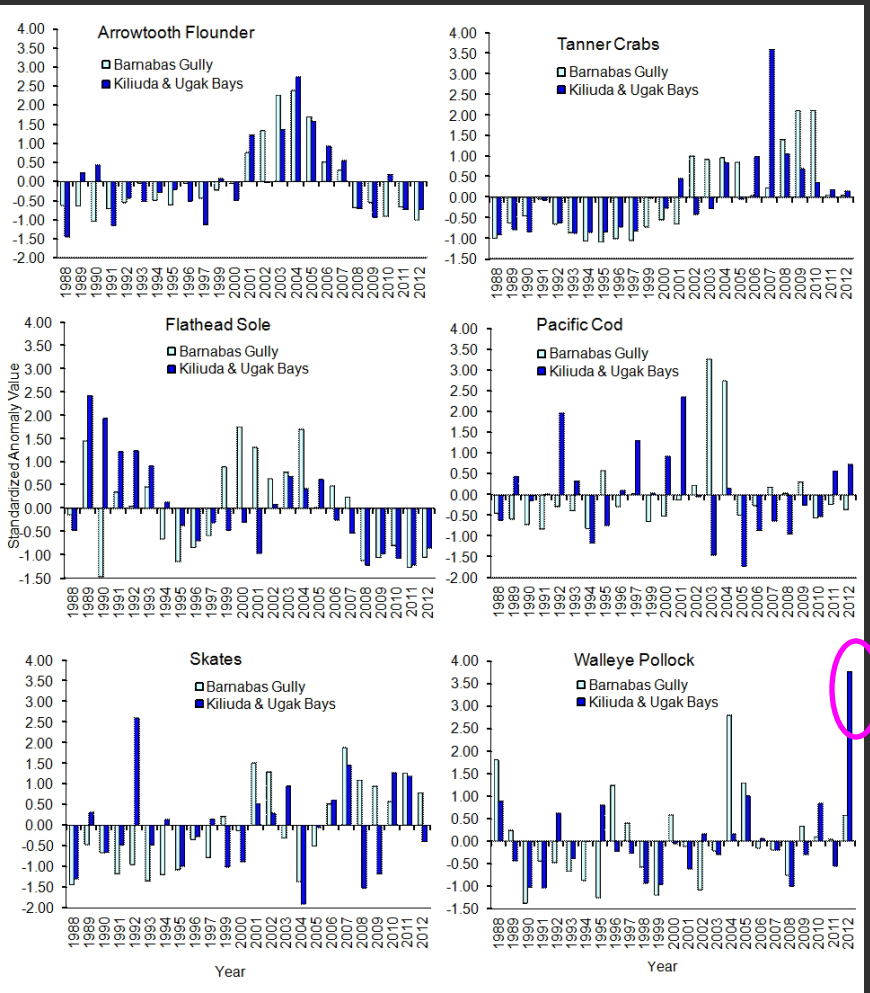
Red = including Sitka; Green = without

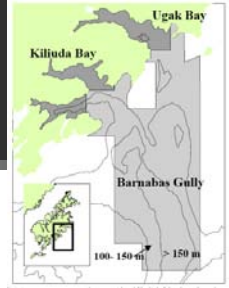


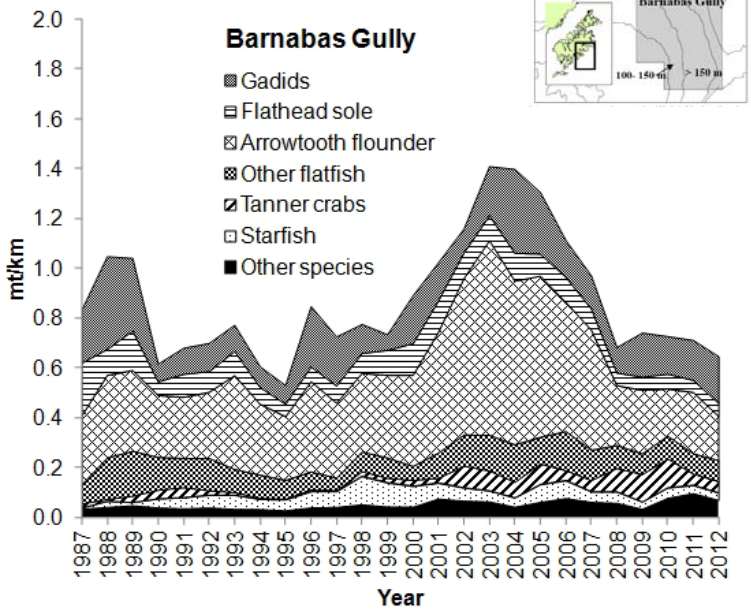
2012

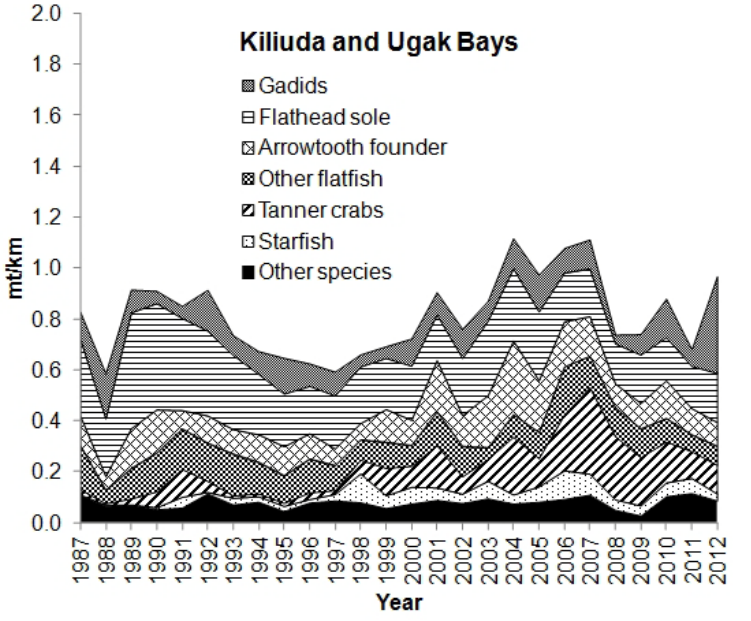
ADF&G Gulf of Alaska Trawl Survey (Worton)

- Decrease in overall biomass; gadids and flatfish continue to dominate catch
- In 2012, gadid catches slightly decreased offshore, but increased inshore; flathead sole/ATF below.

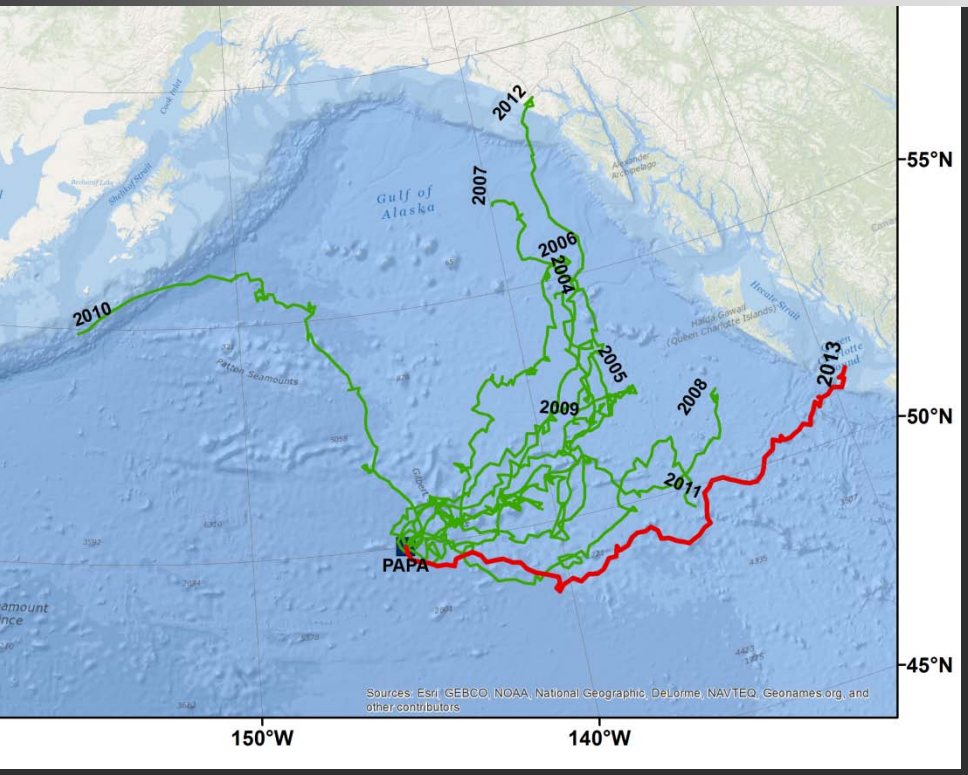




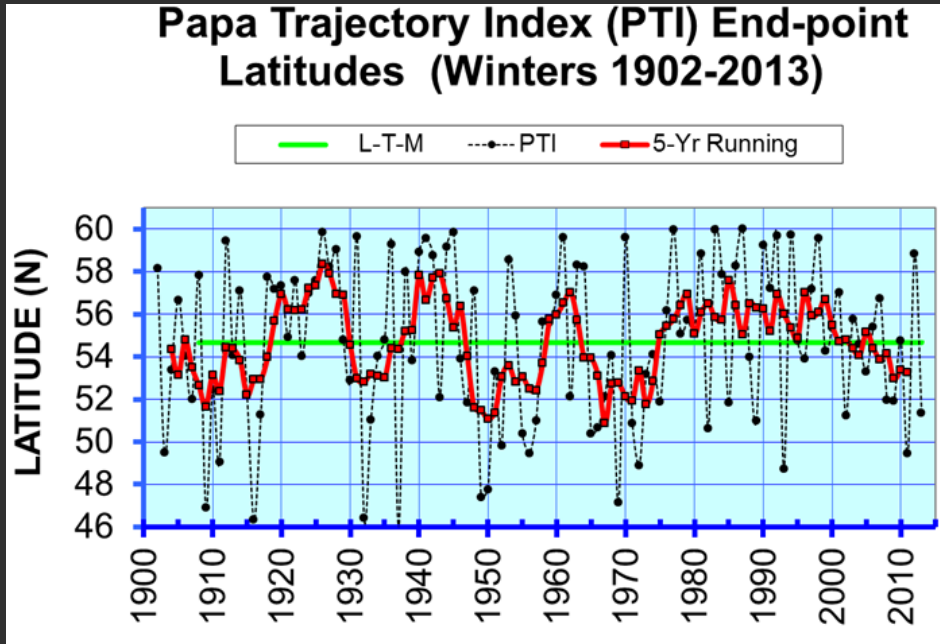




2013 Ocean Surface Currents – PAPA Trajectory Index
(Stockhausen and Ingraham)

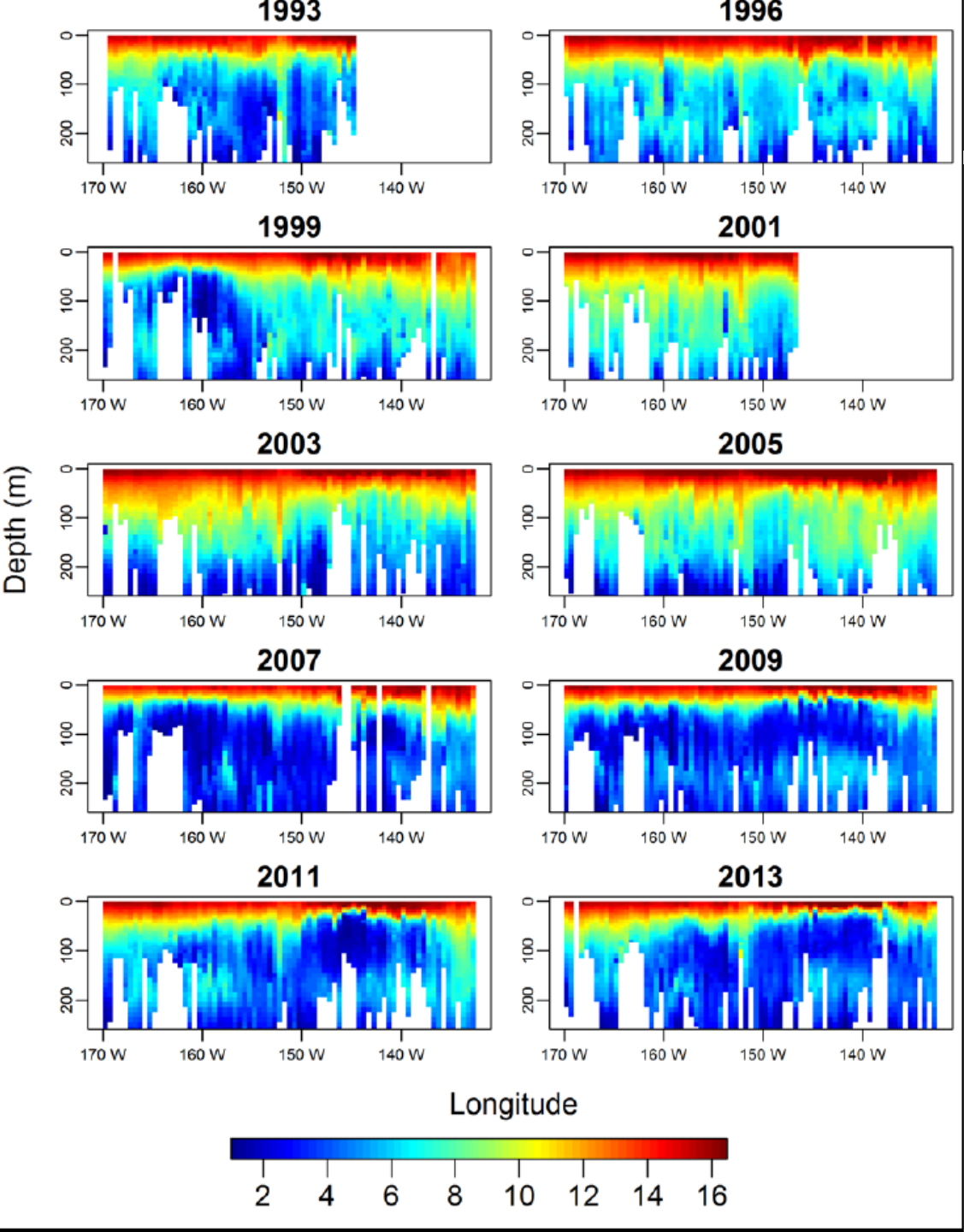


- Simulated surface drifter released from Ocean Station PAPA Dec 1 90 days
- 2012/13 trajectory: farthest east in recent years (westerly wind anomalies)
- Potential influx of lower trophic open ocean organisms to SE AK



- Shift in mid 2000s to predominantly southerly flow after 20+ years of opposite
- Indicates return to surface drift conditions similar to <1977 regime shift

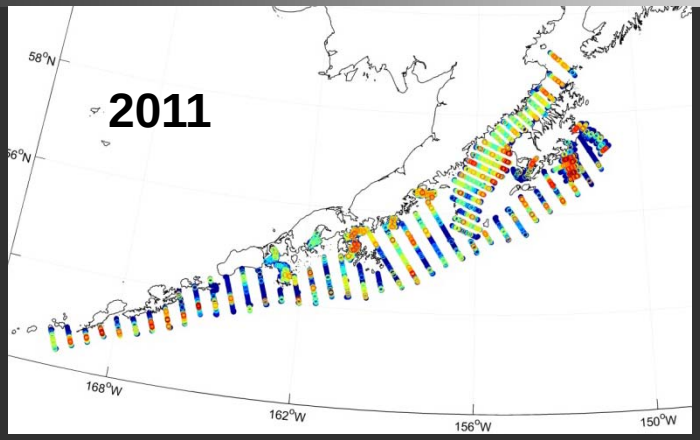
2013 GOA survey water temps (Laman)

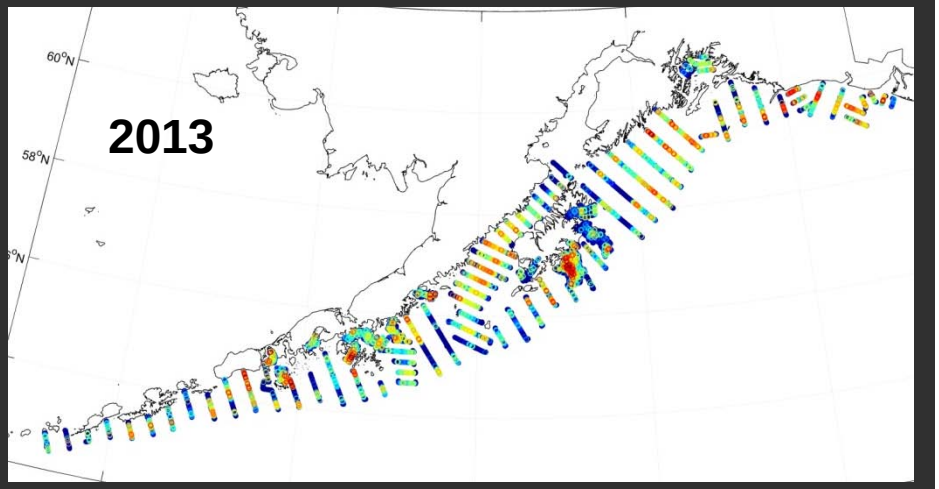


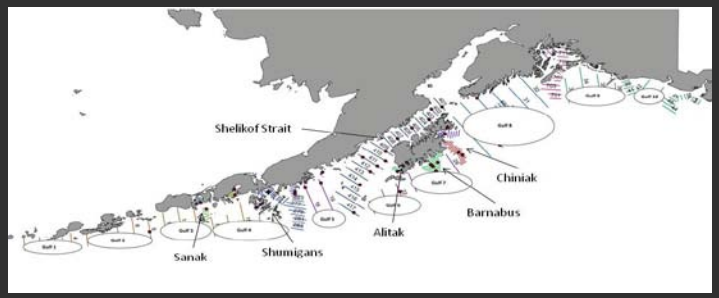
- Overall, continued cool pattern seen since 2007
- Thermocline depth somewhat deeper in 11/13 compared to 07/09
- 2013 similar to 2011
- Except… W surface water slightly cooler and >50m in east slightly cooler.
- Caveats
  - Snapshot of survey temps
  - Temps can be affected by storms, eddies, current, etc.

Spatial and temporal distribution of euphausiids in the GOA, summers 2011 and 2013 (Simonsen and Ressler)

New



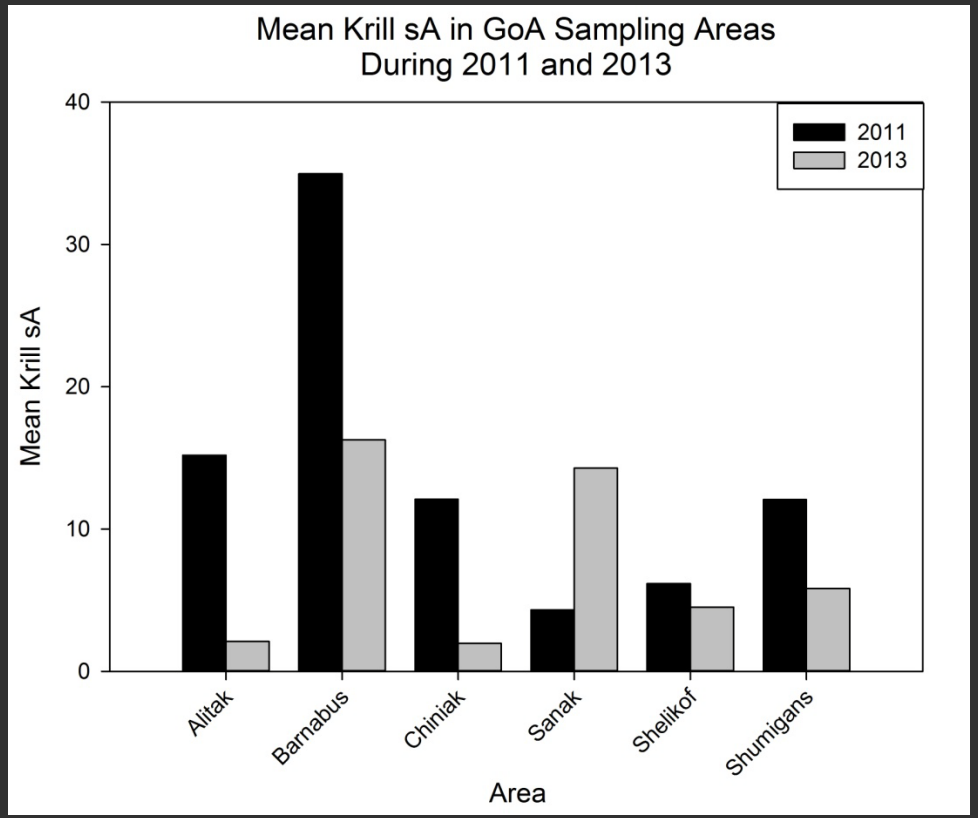




Goal: develop an index of abundance and distribution of euphausiids

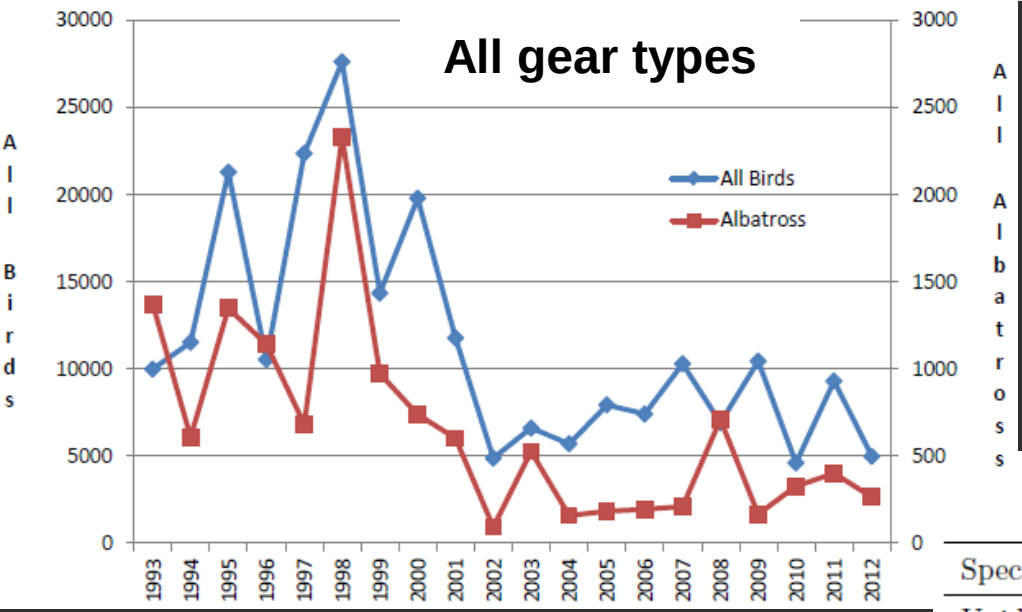
Potential indicator of prey availability, lower trophic biomass

2003 and 2005 will be added



Alaska-wide

Seabird Bycatch Estimates for Alaskan Groundfish Fisheries 1993-2012 (Fitzgerald)



- 2012 numbers are 40% *below* 07-11 average

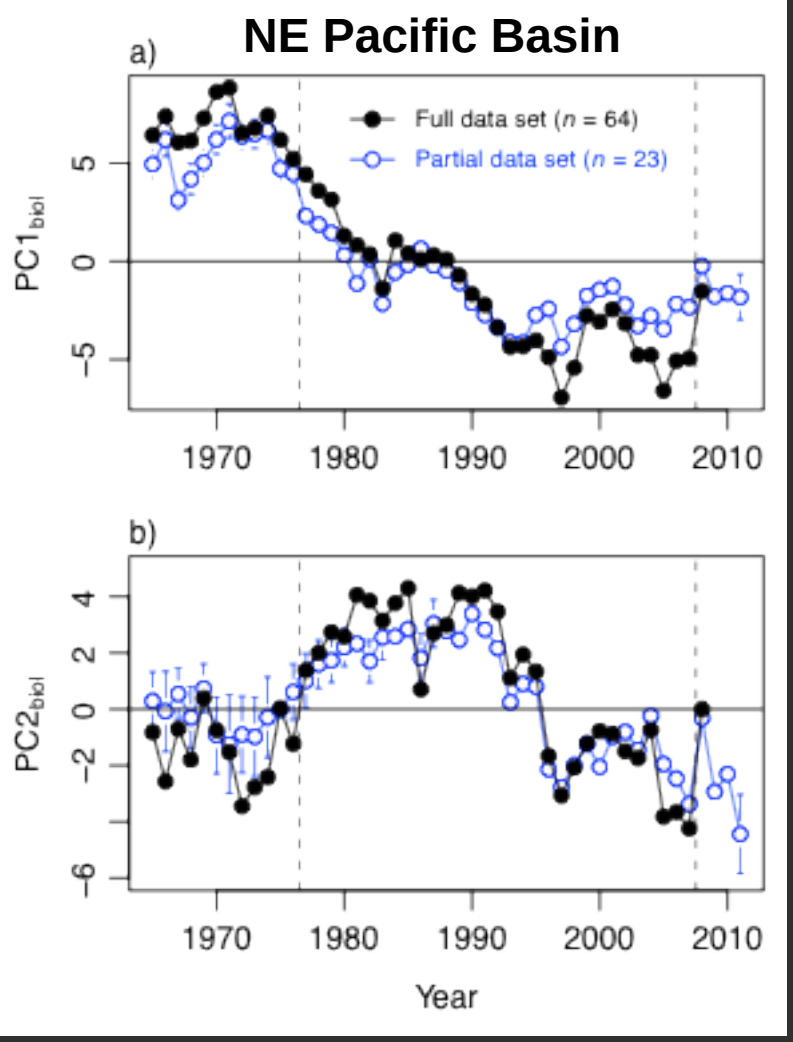
- Notable decreases in Laysan albatross, fulmar, and gull
- No observed short-tailed albatross takes in 2012
- Higher bycatch in years with poor food supply?

Estimated numbers of seabird bycatch

Species/Species Group	2007	2008	2009	2010	2011	2012
Unidentified Albatross	16	0	0	0	0	0
Short-tailed Albatross	0	0	0	15	5	0
Laysan Albatross	17	420	114	267	189	128
Black-footed Albatross	176	290	52	44	206	136
Northern Fulmar	4,581	3,426	7,921	2,357	6,214	3,016
Shearwater	3,602	1,214	622	647	199	510
Storm Petrel	1	44	0	0	0	0
Gull	1,309	1,472	1,296	1,141	2,208	885
Kittiwake	10	0	16	0	6	5
Murre	7	5	13	102	14	6
Puffin	0	0	0	5	0	0
Auklet	0	3	0	0	0	7
Other Alcid	0	0	105	0	0	0
Other Bird	0	0	136	0	0	0
Unidentified	509	40	166	18	259	284
Total	10,228	6,914	10,441	4,596	9,298	4,997

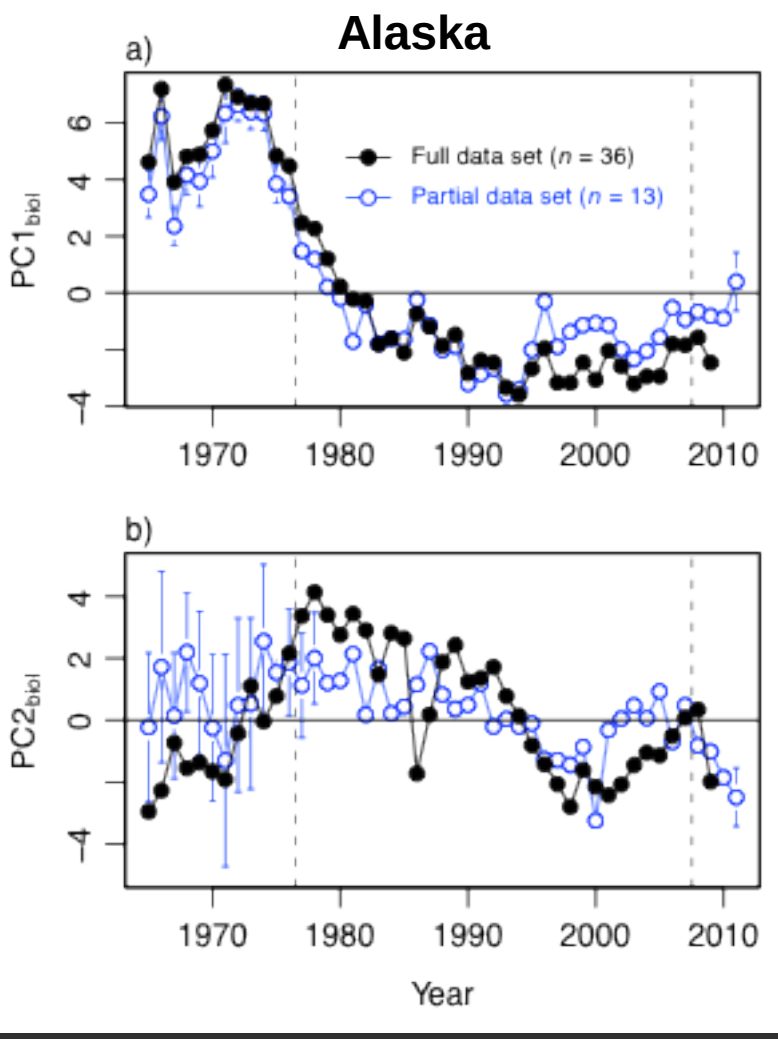
Indicators of Basin-scale and Alaska-wide Community Regime Shift (Litzow and Mueter)

NE Pacific Basin



- Was there a regime shift in 2008?
- PCA of 64 biological time series (Basin), 36 (Alaska)
- Includes groundfish recruitment, salmon catch, invert cpue, etc.

Alaska



- Some evidence, but did not persist
- Weak evidence in PC2

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
- Non-FSSI: BSAI octopus subject to overfishing

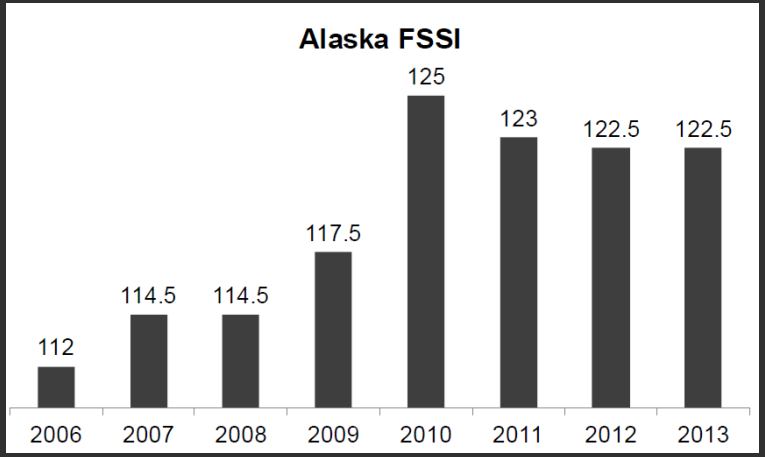


Table 8: Summary of status for FSSI and non-FSSI stocks managed under federal fishery management plans off Alaska, 2012.

Jurisdiction	Stock Group	Number of Stocks	Overfishing					Overfished				Approaching Overfished Condition
			Yes	No	Unk	Undef	NA	Yes	No	Unk	Undef	
NPFMC	FSSI	35	0	35	0	0	0	1	29	5	0	0
NPFMC	NonFSSI	29	1	28	0	0	0	0	4	25	0	0
	Total	64	1	63	0	0	0	1	33	30	0	0

Total possible score = 140

Points **lost** due to:
BSAI greenland halibut, BS/RE rockfish, PI red king crab <80% Bmsy;

Points **gained** due to:
BS southern tanner crab

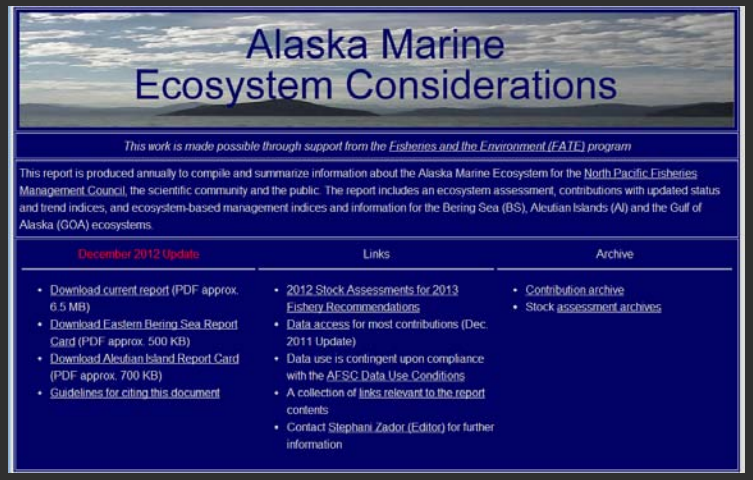
Acknowledgements

With contributions from:

Kerim Aydin, Steve Barbeaux, Sonia Batten, Jennifer Boldt, Nick Bond, Greg Buck, Kristin Cieciel, Miriam Doyle, Sherrie Dressel, Lisa Eisner, Ed Farley, Emily Fergusson, Shannon Fitzgerald, Jeanette Gann, Angie Greig, Kyle Hebert, Ron Heintz, Amber Himes-Cornell, Jerry Hoff, Carol Ladd, Ned Laman, Jean Lee, Mike Litzow, Ellen Martinson, Kate Mier, Franz Mueter, John Olson, Joe Orsi, James Overland, John Piatt, Heather Renner, Marc Romano, Chris Rooper, Sigrid Salo, Elizabeth Siddon, Phyllis Stabeno, William Stockhausen, Molly Sturdevant, Muyin Wang, Alex Wertheimer, Andy Whitehouse, Tom Wilderbuer, Matt Wilson, Carrie Worton, and Stephani Zador.

Website

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



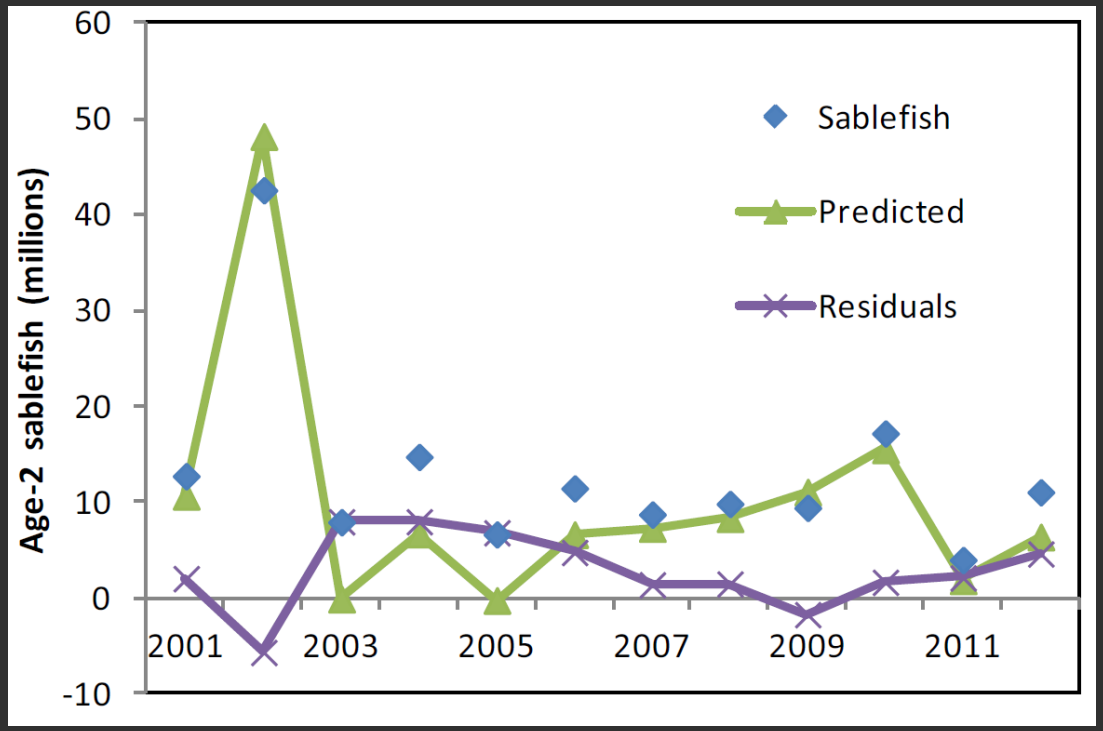
Gulf of Alaska – 2012 summary

- Varying zooplankton densities: high offshore, low inshore (Batten, Sturdevant)
- Low abundances of forage fish and herring in nearshore waters (Urban, Hebert and Dressel)
- High numbers of juvenile pink salmon (Orsi)
- Decrease in adult gadids and flatfish overall, except pollock inshore (Worton)
- Seabird reproduction poor – average (USFWS)

2012

New

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



Icy Strait

Data: temperature, chla

Provides: rearing habitat for sablefish

Age-2 (t) ~ lm(Sea temp (t-2), Chl (t-2), Age-2(t))

Recruitment appears to be a function of sea temp and chl during age-0 stage and age-2 recruitment in previous year.

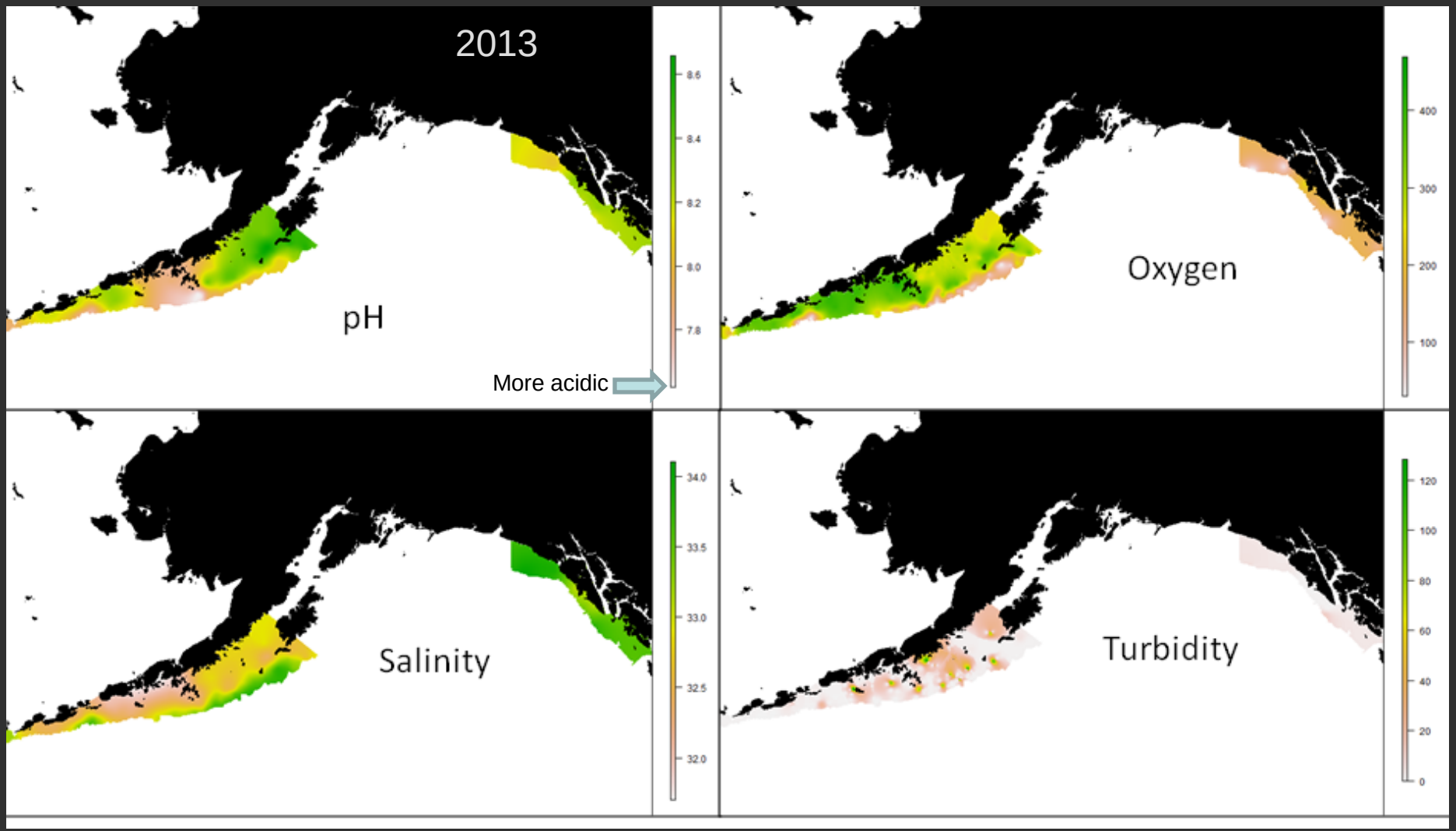
Chl R^2 = 0.77

Prediction: above-average age-2 recruitment in 2013

based on high chl and warm temps in 2011.

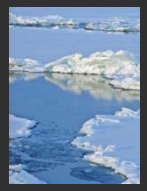
New

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



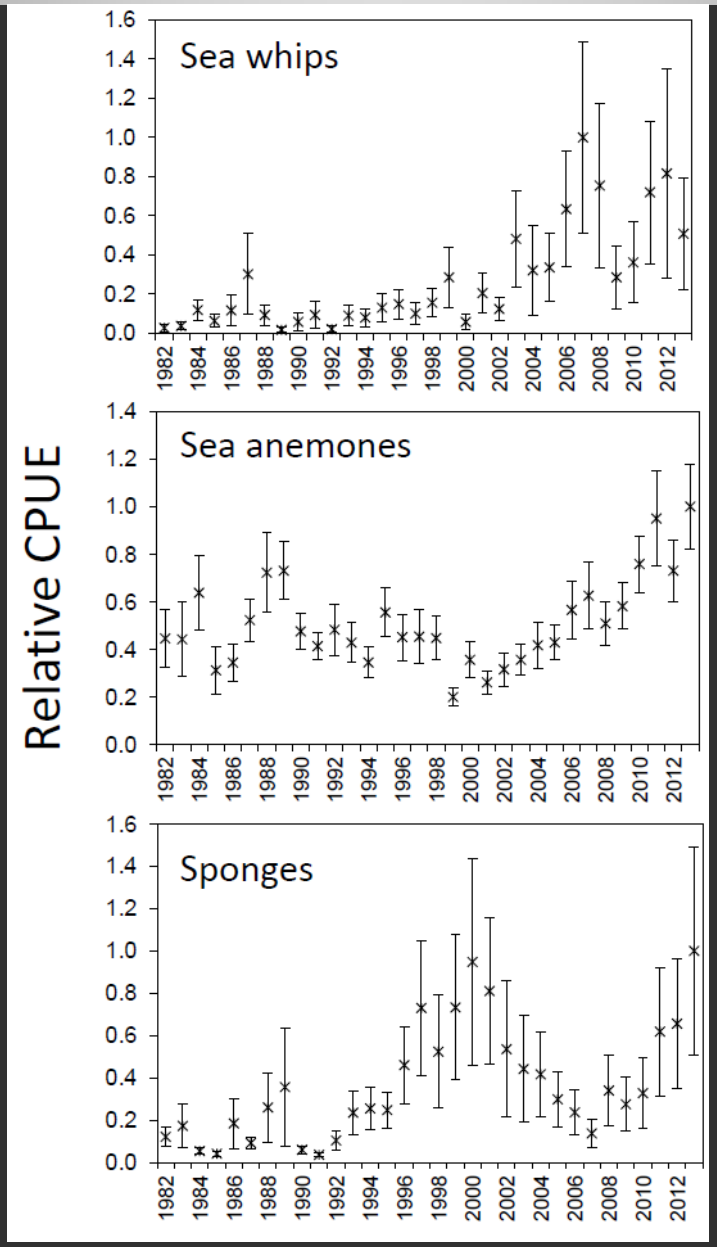
- No time series yet
- Not corrected for date
- High turbidity spots from individual trawls
- Influenced by FW runoff, 1^{o} prod, oceanography

Ecosystem Status and Management Indicators



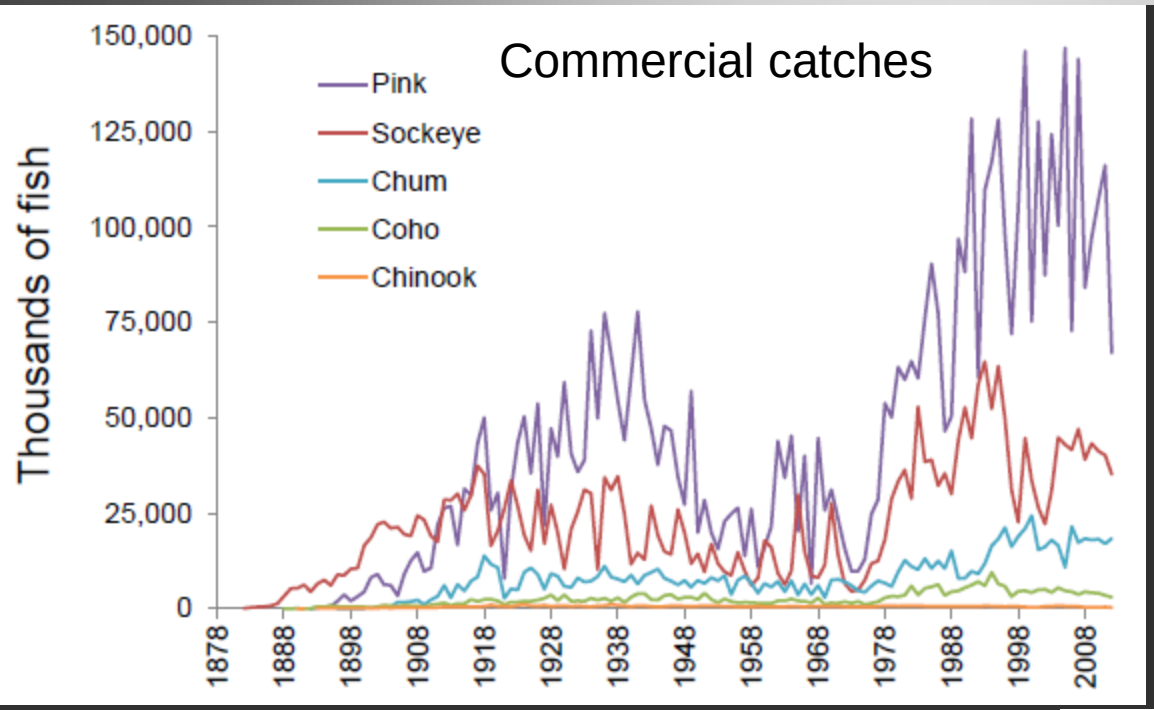
- Updated
  - Physical (12 + 2 new)
  - Habitat (2)
  - Zooplankton (5)
  - Forage fish (2)
  - Herring (2)
  - Salmon (2)
  - Groundfish (5 + 1 new)
  - Benthic Communities and Non-Targets (3)
  - Seabirds (1)
  - Ecosystem or Community (2)
  - Ecosystem-Based Management (12)

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

Historical and Current Alaska Salmon Trends (Whitehouse)

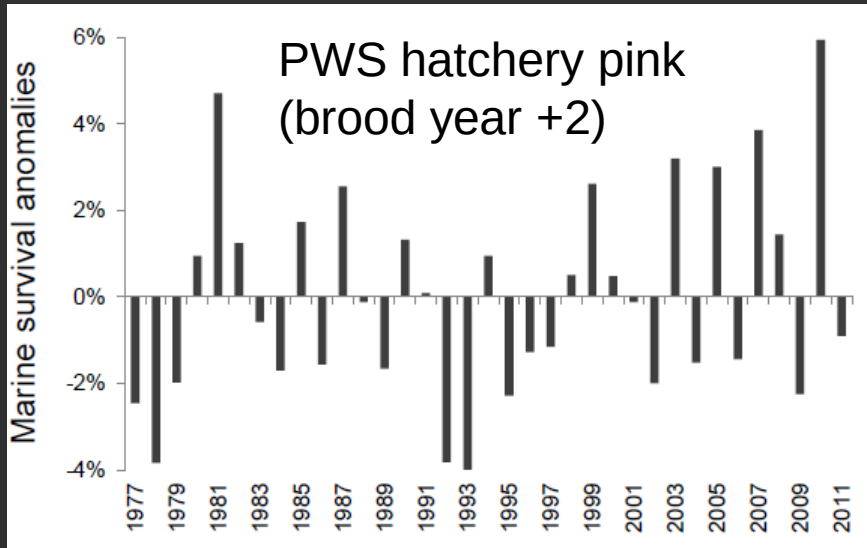


2012 harvest < 2011 harvest

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

GOA 2012: Pinks, chinook and coho down; chum, above average

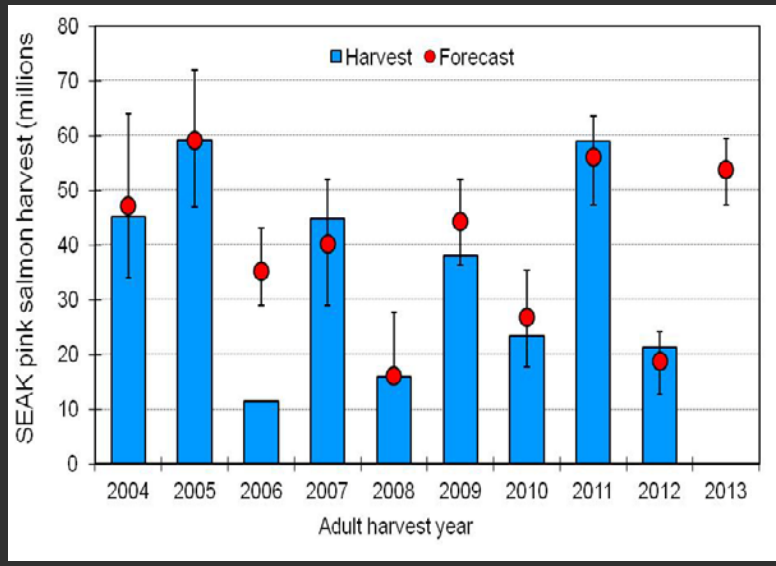
- Marine survival in 2010 (2008 brood year) is highest (11%) since 1977
- Survival dropped to 4% in 2011 (2009 brood year)



Forecasting Pink Salmon in Southeast Alaska (Orsi et al)

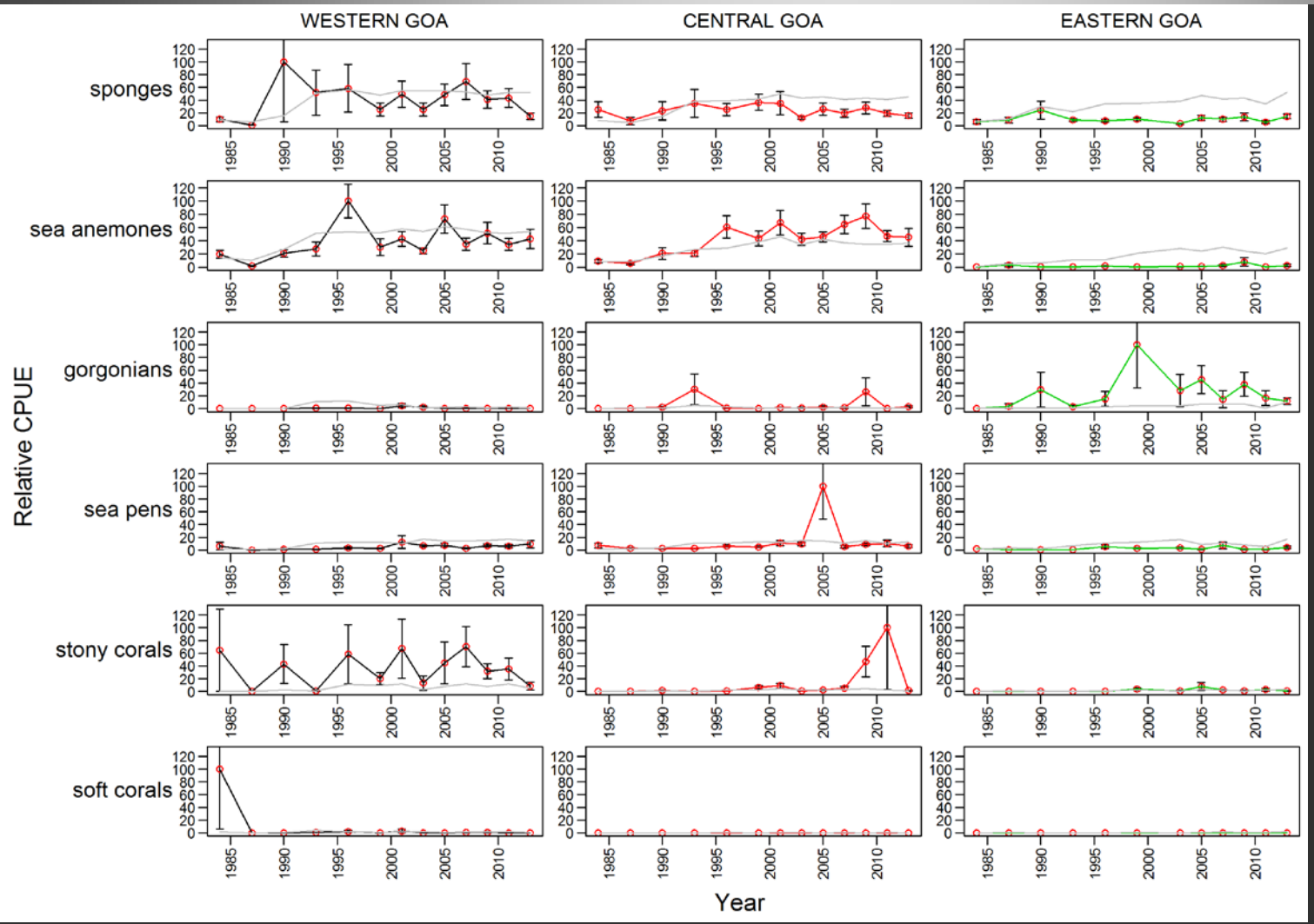
Brood year (BY)			BY +1						BY		BY +1		BY +1
Adult pink salmon return year	SE pink harvest (response variable)		Ocean entry year	Juvenile peak pink CPUE June or July	Peak seaward migration month	North Pacific Index (June, July, Aug)	% pink in trawl hauls average June-July		Adult pink escapement index for SEAK		Auke Creek fry outmigration (1,000s) Lat 58 ° N		Upper 1-20 m avg. Icy Strait temp. "IST" May-Aug
	ADFG		$SECM_{year}$	NOAA	NOAA	CGD	NOAA		ADFG		NOAA		NOAA
1998	42.5		1997	2.5	July	15.6	12%		18.1		31.1		9.5
1999	77.8		1998	5.6	June	18.1	57%		14.8		60.8		9.6
2000	20.2		1999	1.6	July	15.8	8%		14.3		53.5		9.0
2001	67.0		2000	3.7	July	16.9	18%		27.3		132.1		9.0
2002	45.3		2001	2.9	July	16.8	19%		10.8		61.5		9.4
2003	52.5		2002	2.8	July	15.6	14%		18.6		150.1		8.6
2004	45.3		2003	3.1	July	16.1	24%		16.6		95.1		9.8
2005	59.1		2004	3.9	June	15.1	29%		20.0		169.6		9.7
2006	11.6		2005	2.0	Aug	15.5	19%		15.7		87.9		10.3
2007	44.8		2006	2.6	June	17.0	30%		19.9		65.9		8.9
2008	15.9		2007	1.2	Aug	15.7	9%		10.2		81.9		9.3
2009	38.0		2008	2.5	Aug	16.1	14%		17.6		117.6		8.3
2010	23.4		2009	2.1	Aug	15.1	22%		9.5		34.8		9.6
2011	58.5		2010	3.7	June	17.6	66%		12.7		121.6		9.6
2012	20.7		2011	1.4	Aug	15.7	21%		11.2		30.9		8.9
2013	53.8?		2012	3.2	July	16.7	40%		14.3		61.8		8.7
Pearson correlation "*r*"				0.93	-0.78	0.65	0.59		0.52		0.46		-0.06
P-value (*= significant @ <0.05)				0.00*	0.00*	0.01*	0.02*		0.05*		0.09		0.84

- Monthly oceanography/surface trawls May – Aug in Icy Strait
- Forecast 7% average deviation from harvest (except in 2006)
- 2013 forecast is 54 M (46-58)



- 2012 peak juvenile CPUE 4th highest on record.
- Also, high ocean catch rates of juveniles, GOAIERP

Structural epifauna (HAPC biota) – GOA survey (Rooper)



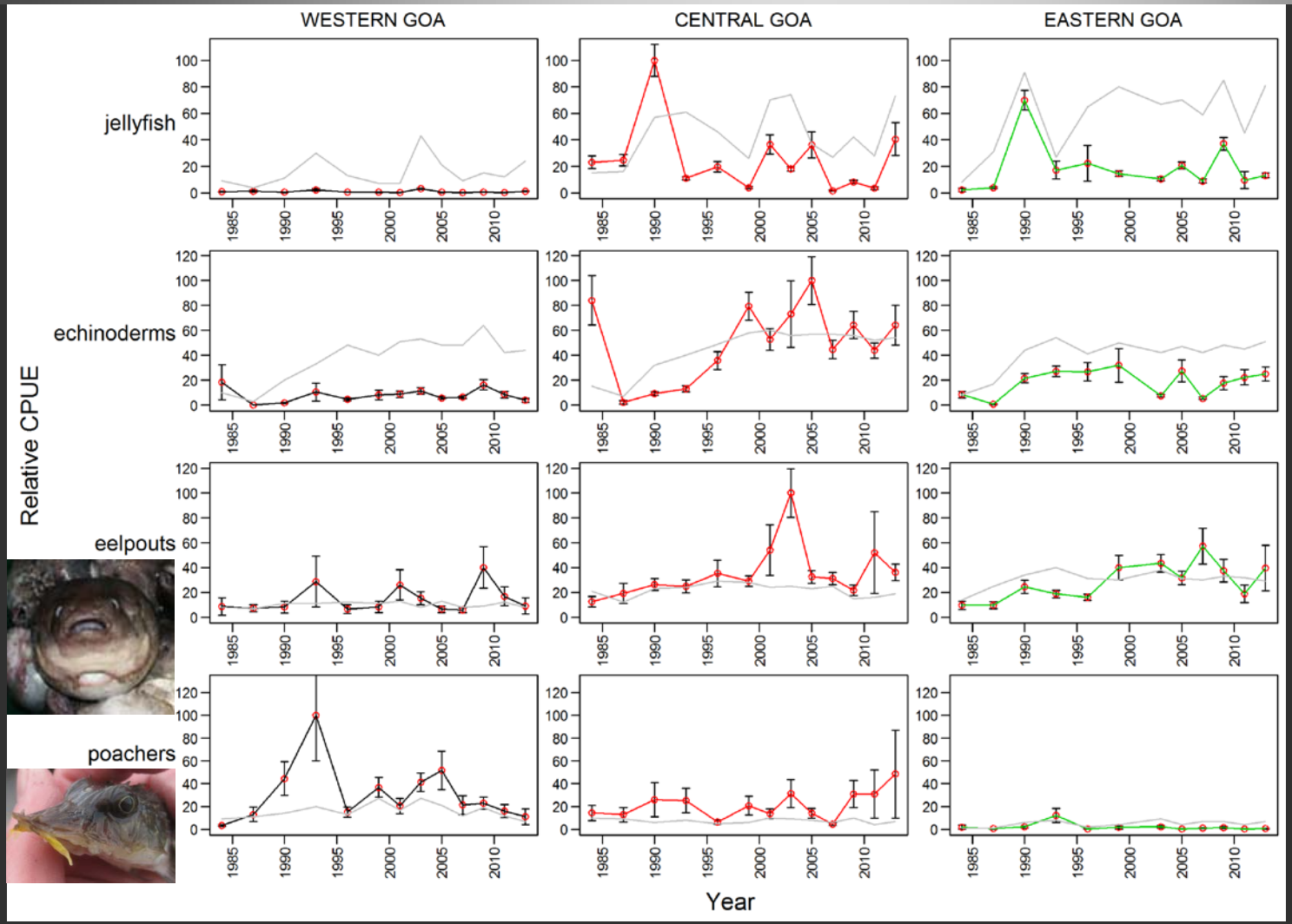
Sponges, anemones decrease W → E (but caught in 50% of tows throughout)

Gorgonian (sea whip/fan) increase in E (but uncommon)

Recent years reflect more effort to identify and classify these groups

Line is % non-zero catch

Miscellaneous species – GOA survey (Rooper)



High but variable in C and E

Consistently captured in ~50% trawls in all areas

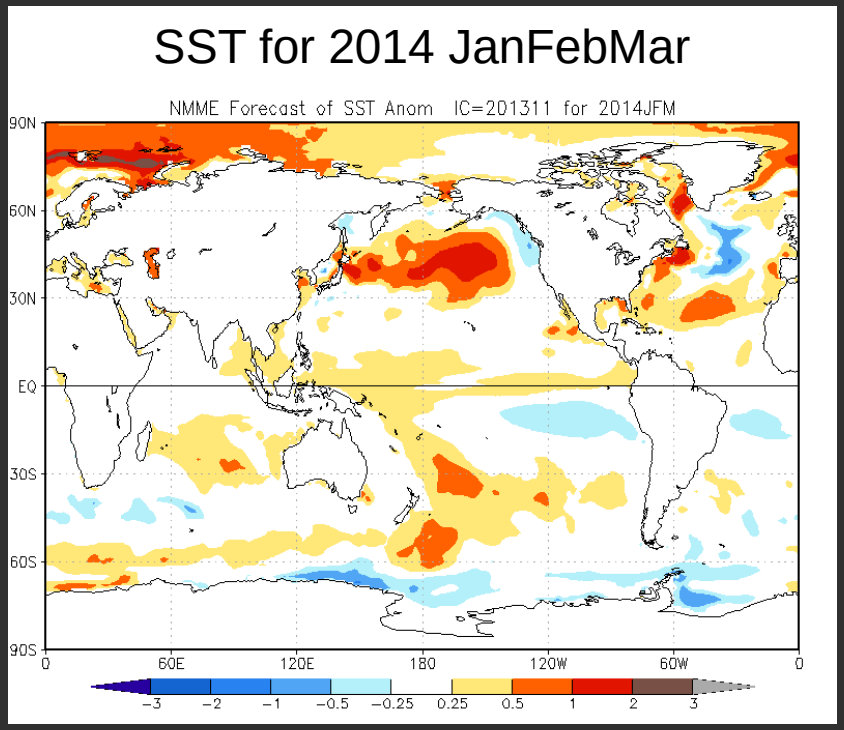
Peak years vary among areas

Uniformly low in E

Different gear <1990.

Line is % non-zero catch

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



* Updated Dec 6

- NMME is average of 6 models
- Warming in central North Pacific; normal in EBS
- Neutral ENSO
- Projection skill limited
- Likely warming of AK waters next 2-3 seasons