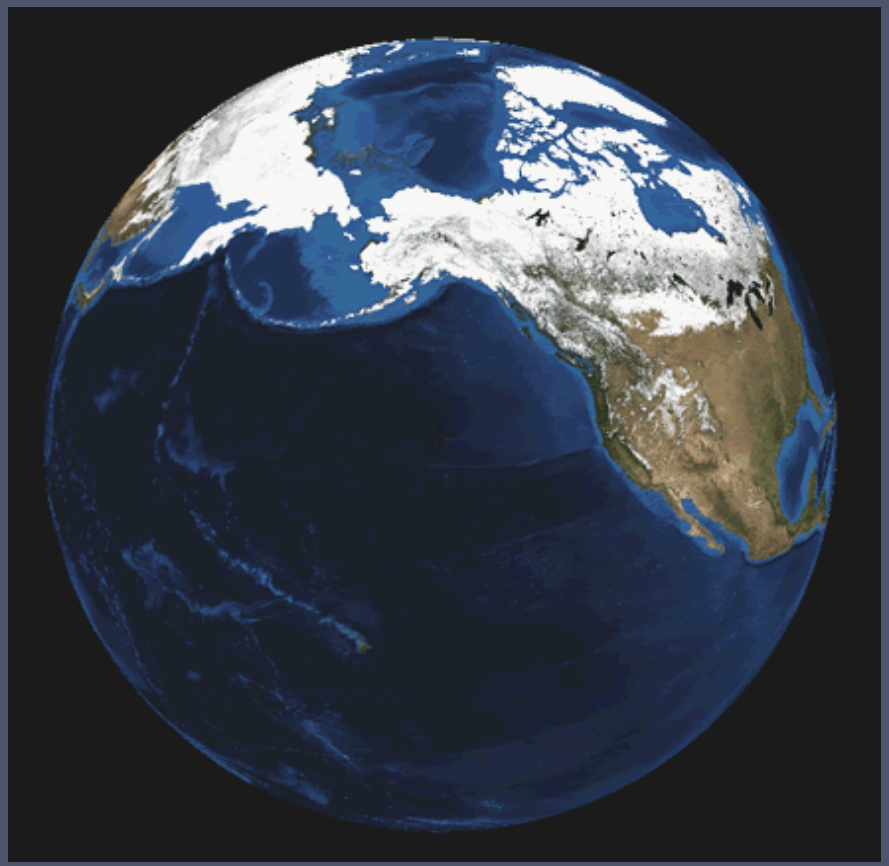
ECOSYSTEM CONSIDERATIONS

For the Eastern Bering Sea and Aleutian Islands



Stephani Zador

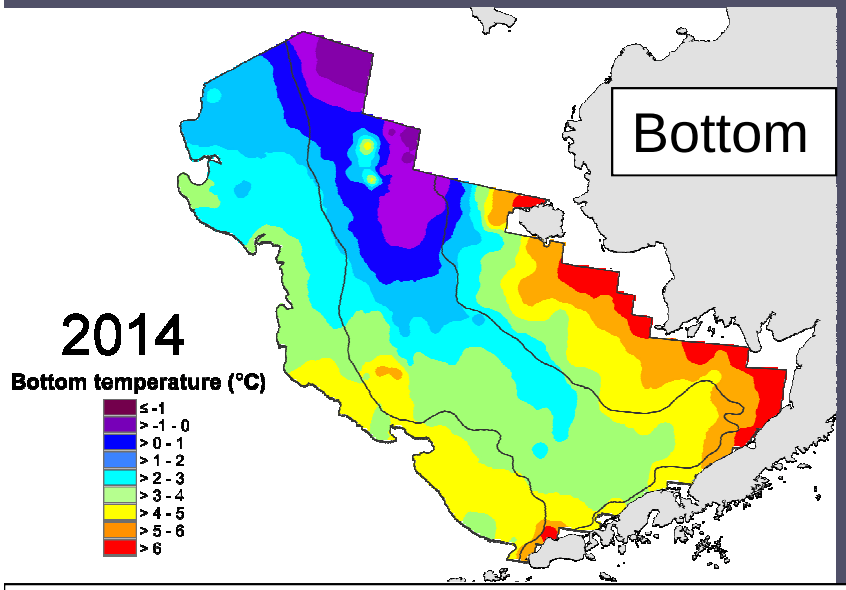
BSAI Groundfish Plan Team meeting

Sept 23, 2015

OUTLINE

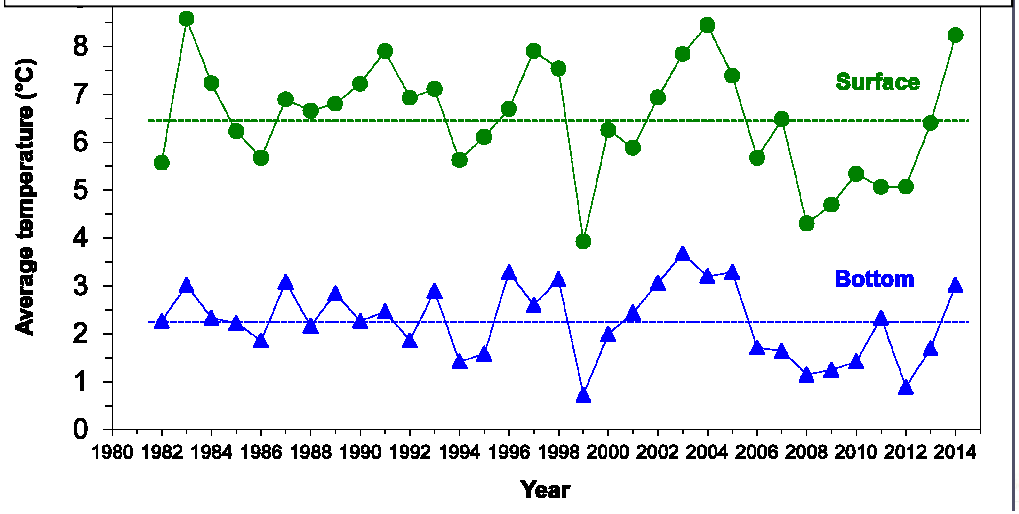
1. New 2014 (mostly) ecosystem indicator updates
2. Physical conditions
3. CEATTLE model (Kerim)
4. Full 2015 updates, assessments, report cards in November

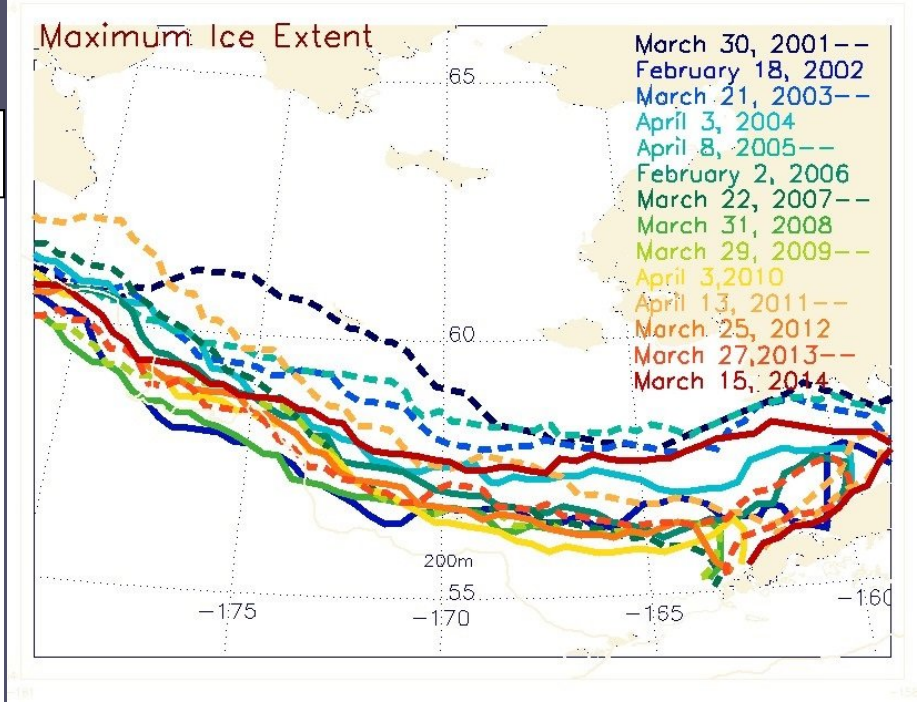
Back to 2014



- *WARM, and different*
- *Overall high productivity*
- *Similar to burst of productivity after multiple cold years in 2003?*

Average surface (top), bottom temps



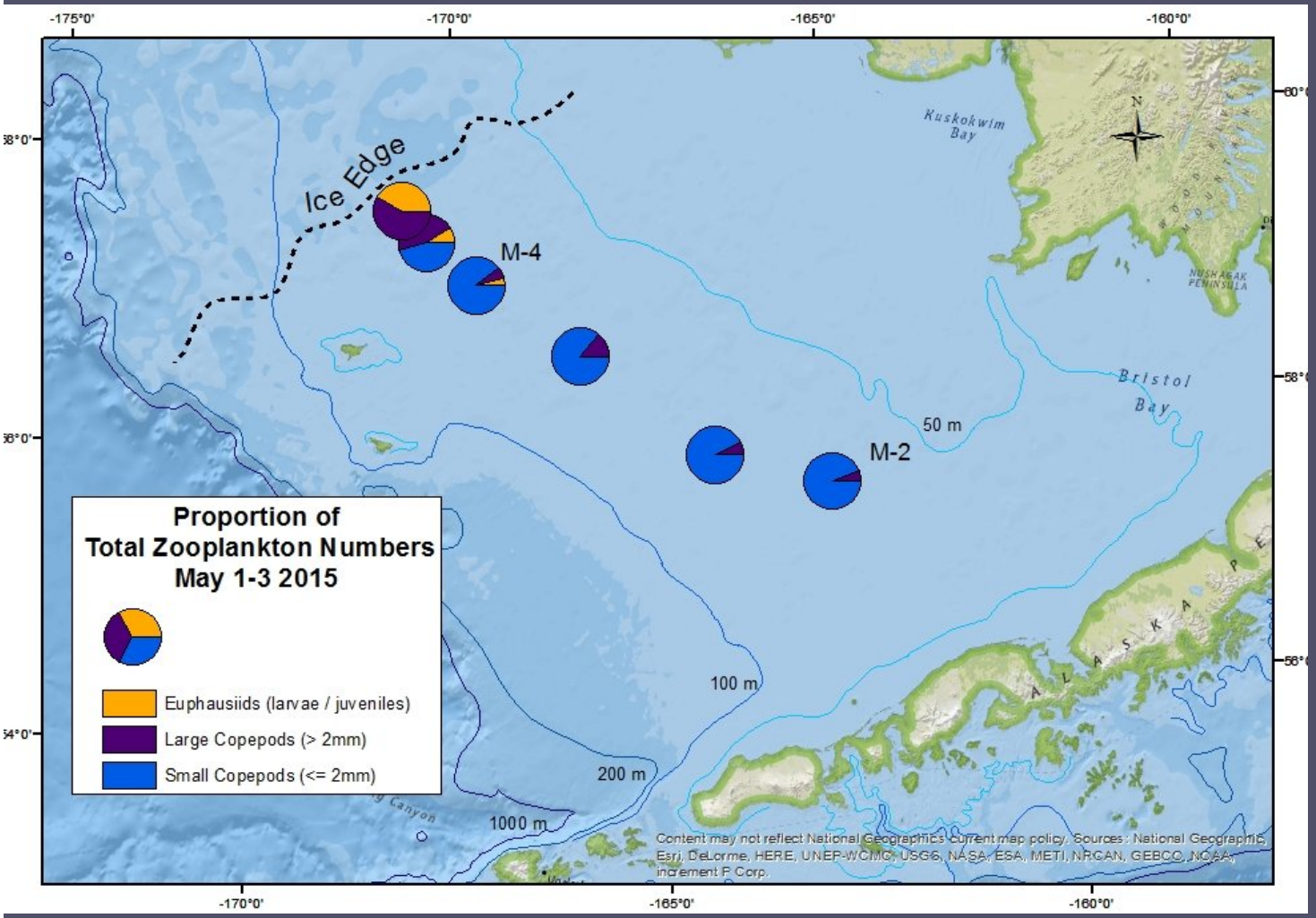


NEW 2014 ECOSYSTEM STATUS INDICATORS

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

NEW Spring EBS Zooplankton Rapid Assessment

(Harpold, ecoFOCI)



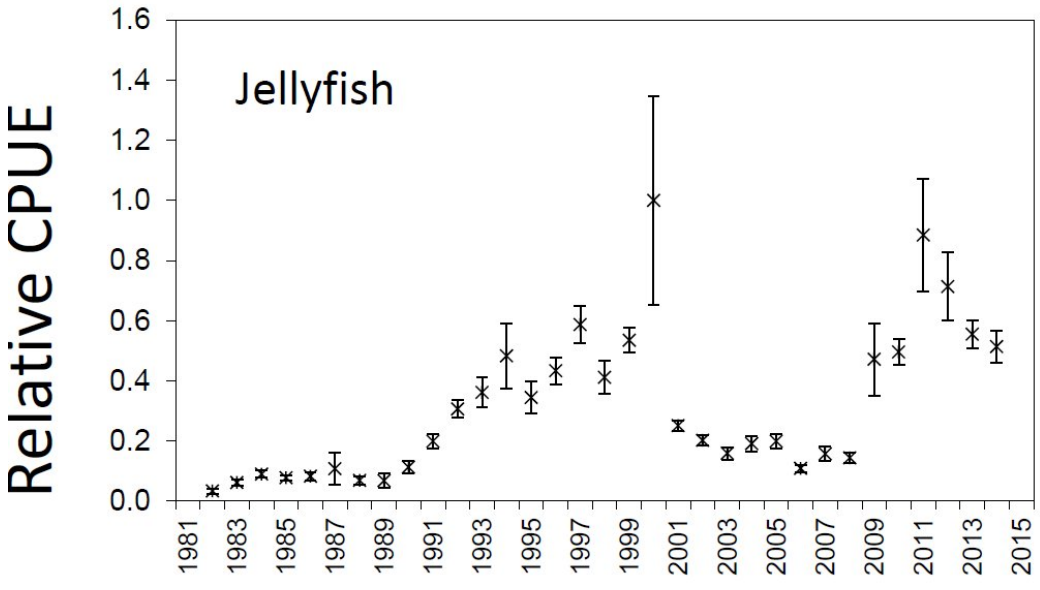
- Rough count, preliminary estimate
- Small copepods most common (warm year expectation)
- Large copepods and euphausiids close to ice edge (secondary bloom, more lipid-rich)
- Supports OCH

Jellyfish

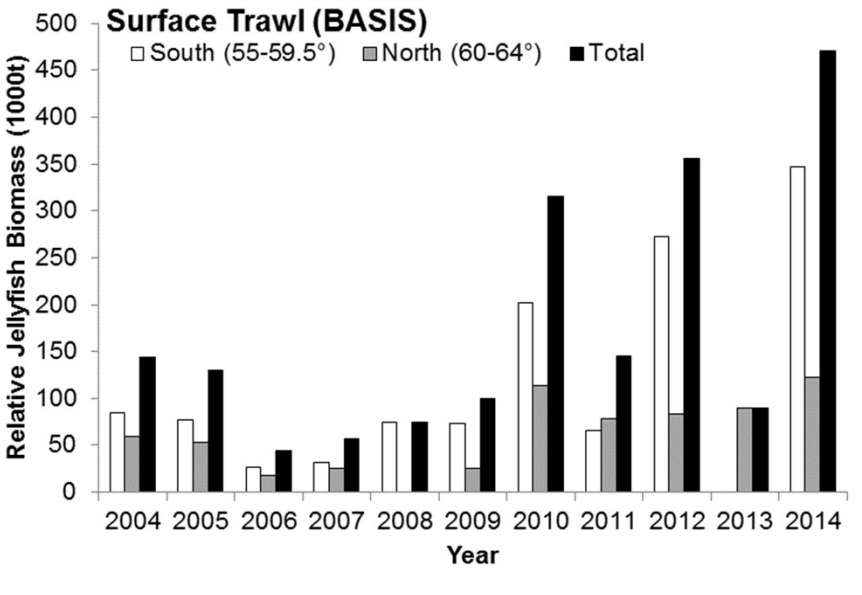
(Lauth and Hoff; Cieciel et al.)

- Summer 2014 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 2014



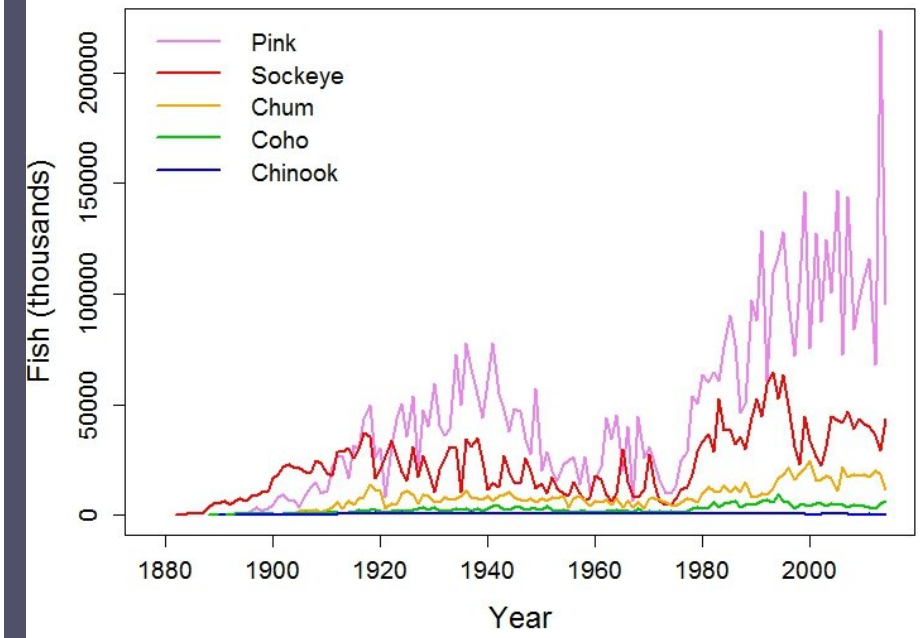
Fall 2014



Historical and current salmon trends

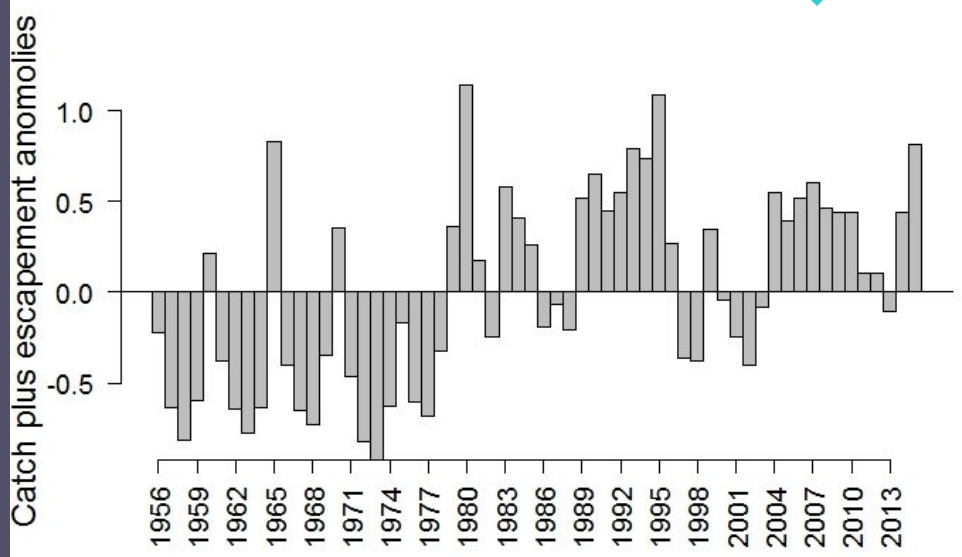
(Whitehouse)

Alaska commercial catch



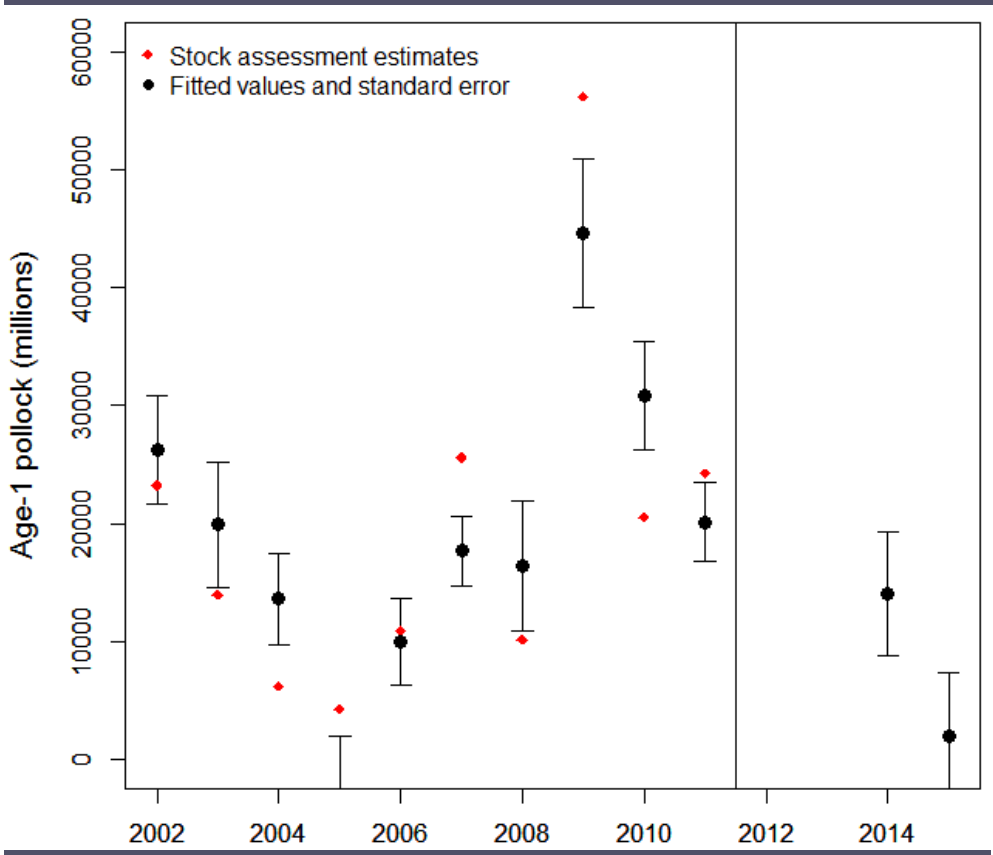
Returns	2014
Chinook	Below
Coho	Above
Chum	Mixed
Sockeye	Above

Bristol Bay sockeye



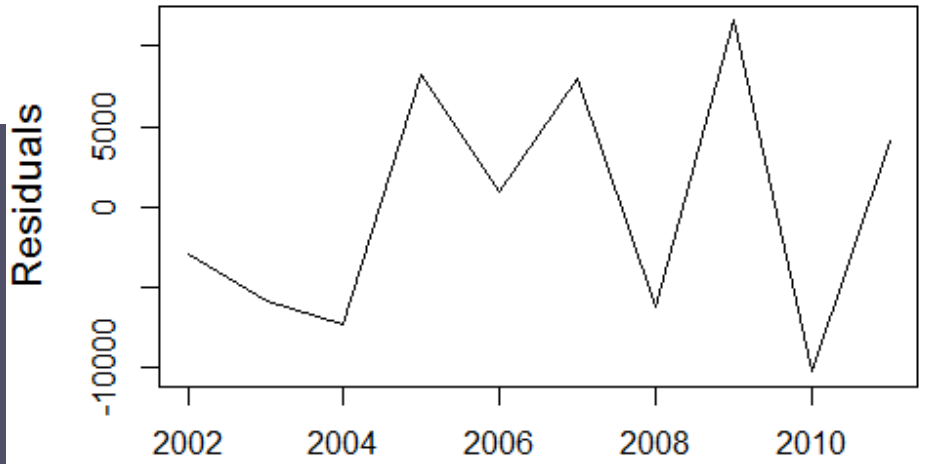
Salmon, Sea Temperature, and the recruitment of age-1 Bering Sea pollock

(Yasumiishi and Kondzela)



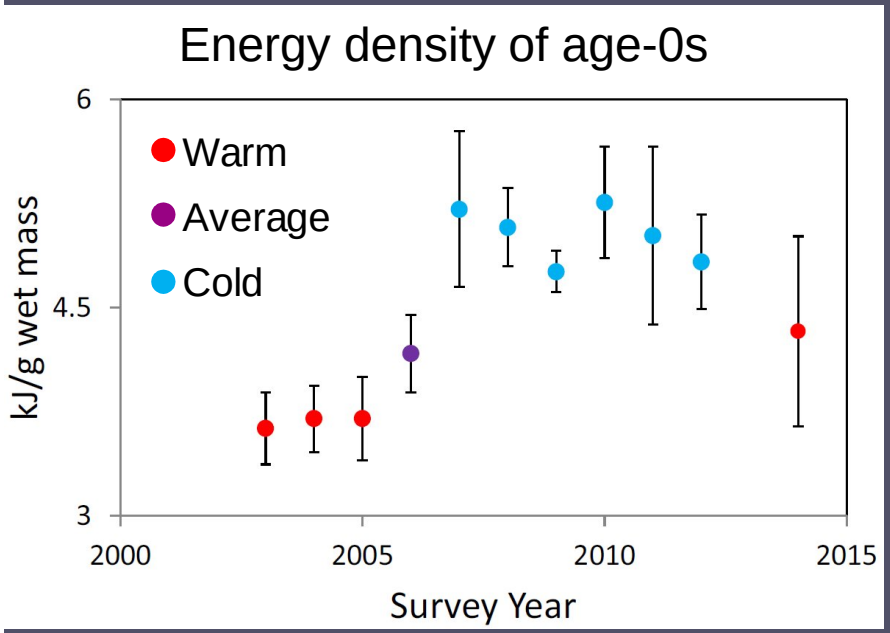
- Chum growth as proxy for ocean productivity for age-0s
- Age-1 recruitment ~ f(chum, spring temp)
- Used model to forecast
- Predicted below average recruitment to age-1 in 2015

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

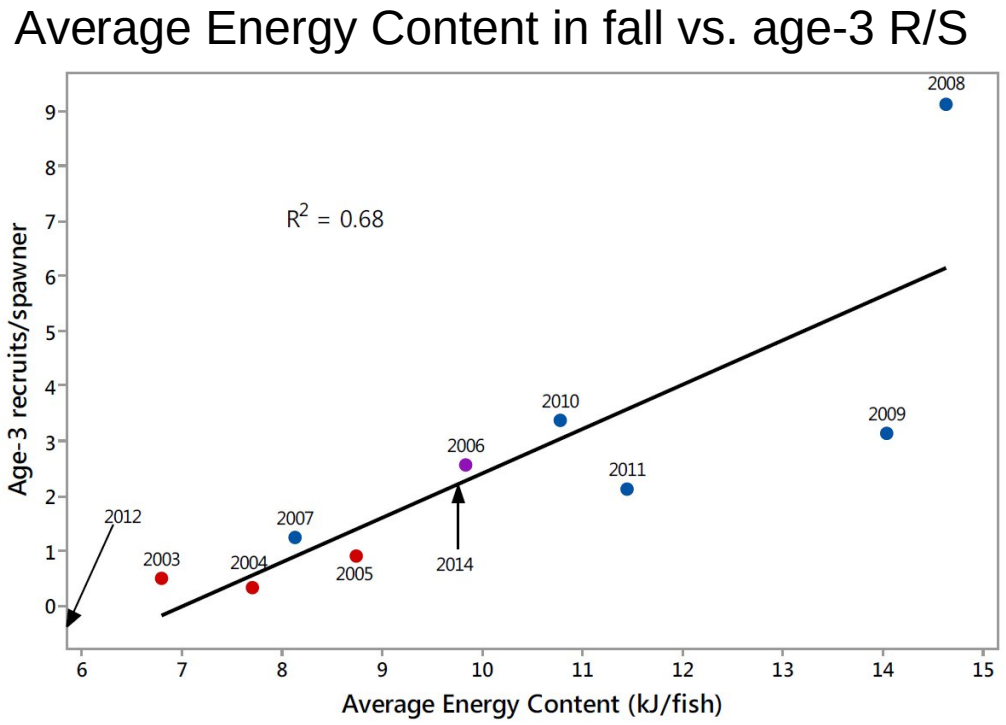
(Heintz, Siddon, Farley)



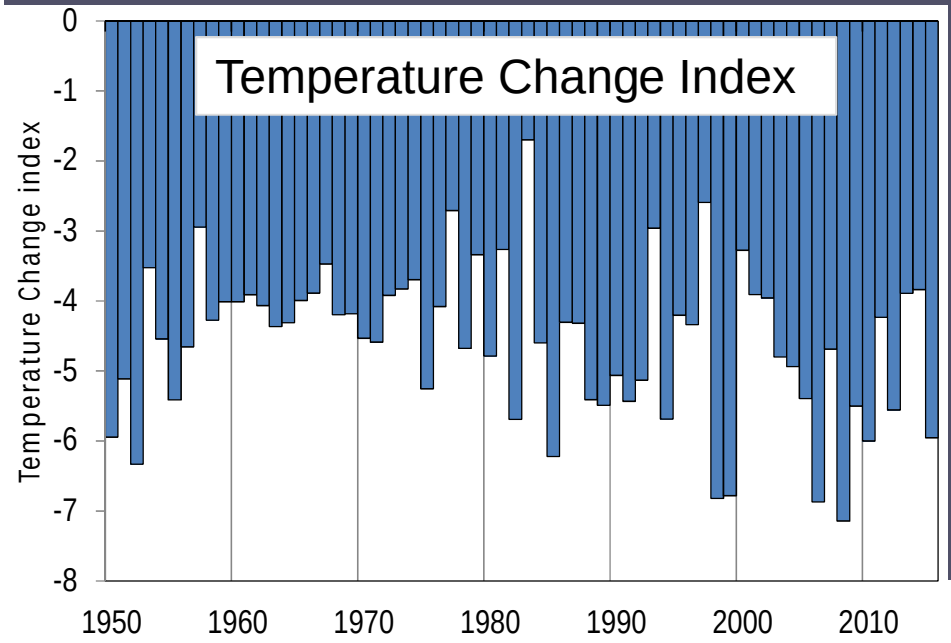
- Energy density influence by thermal regime; fish size less so

	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



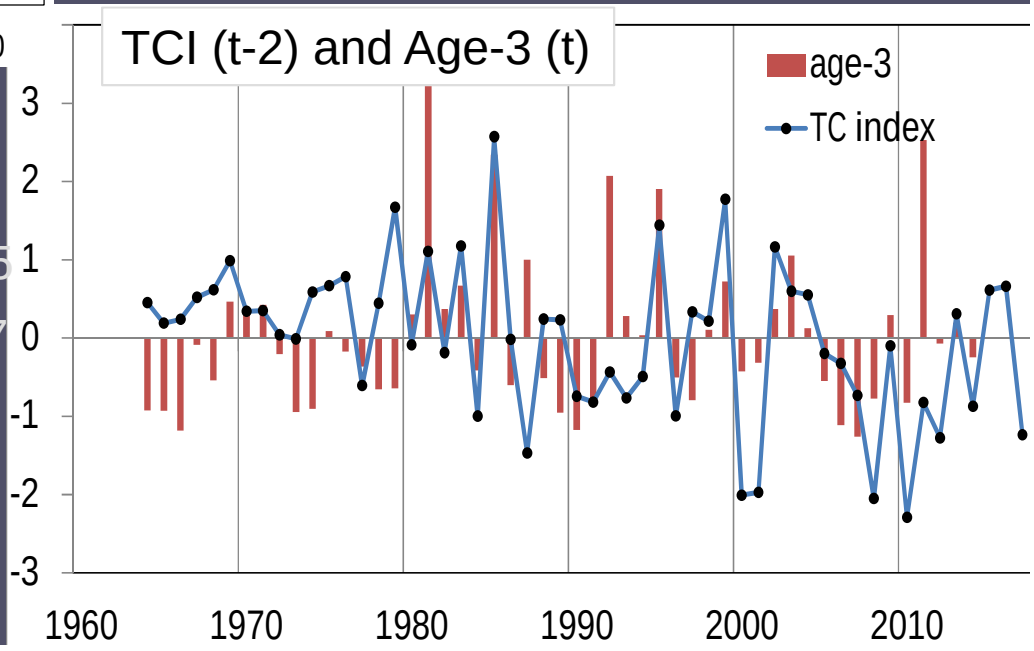
Pre- and Post-Winter Temperature Change Index and the Recruitment of Bering Sea Pollock (Yasumiishi)



- 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

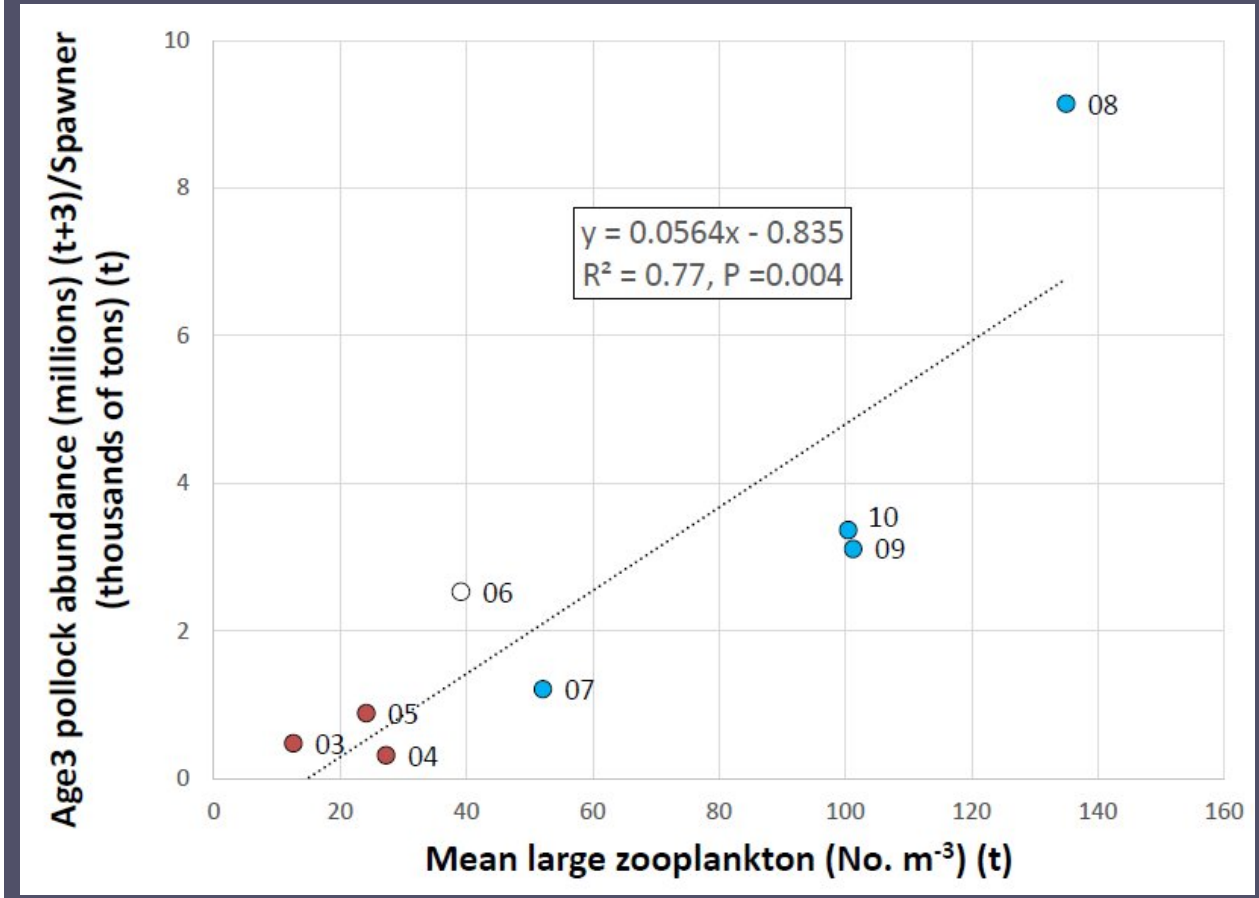
TCI predictions of age-3:

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



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

(Eisner and Yasumiishi)



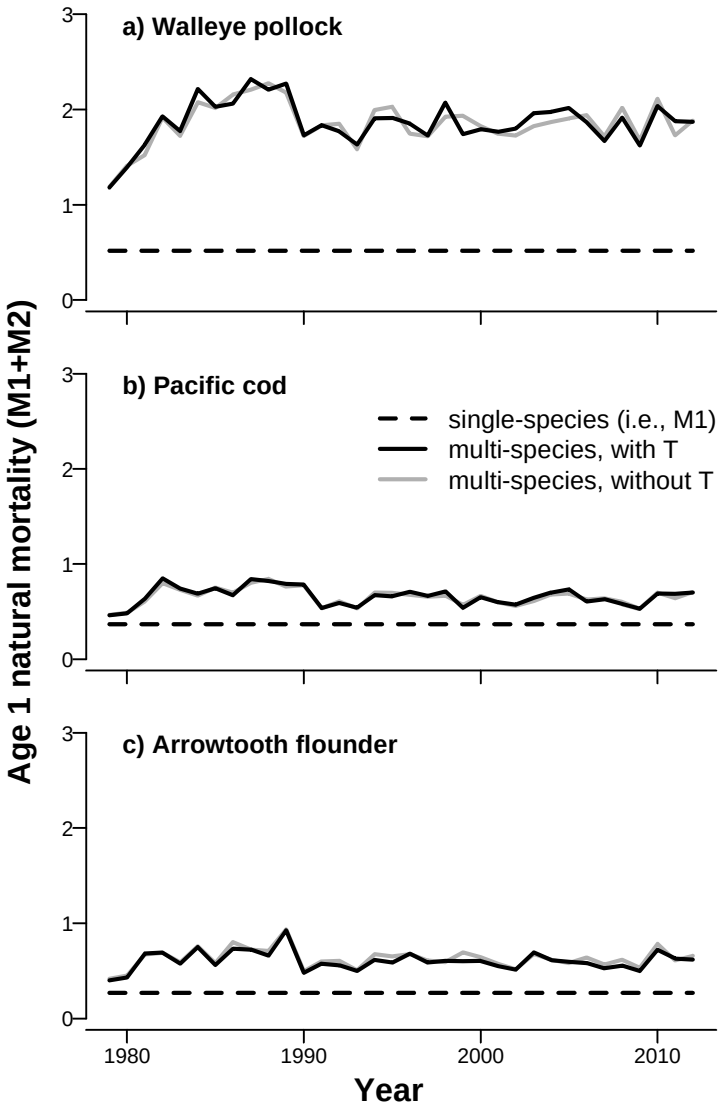
- Assessment age-3 ~f(Fall large zoop abundance (no euphausiids))
- If relationship remains robust, could be leading indicator of age-3 recruitment
- Supports OCH

Similar relationship with age-3 abundance

NEW Multispecies model estimates of time-varying natural mortality

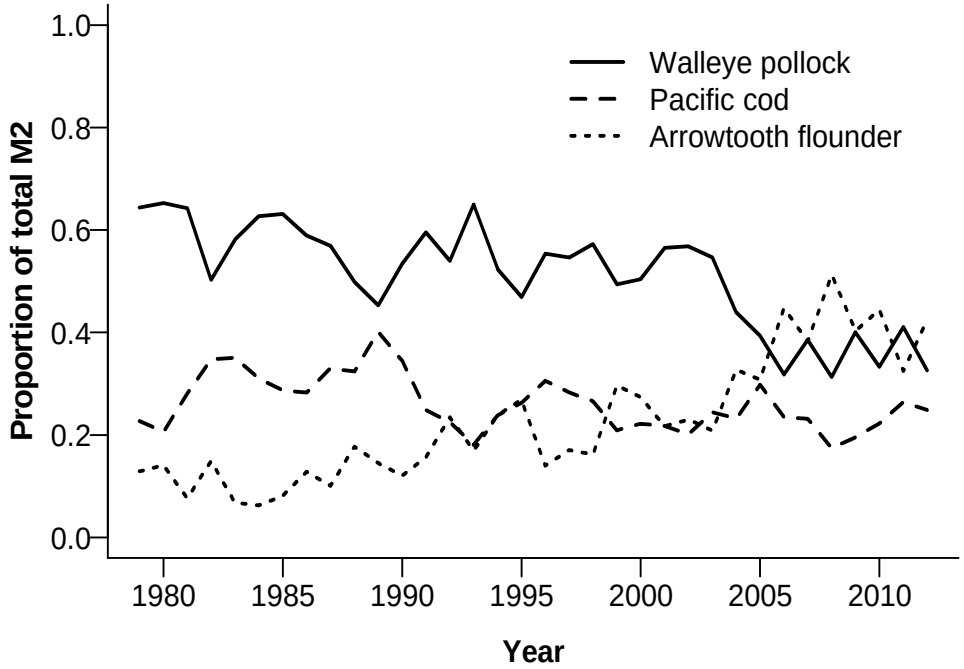
(Holsman, Aydin, Ianelli)

Annual variation in total mortality (M1 + M2) for age 1 pollock



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

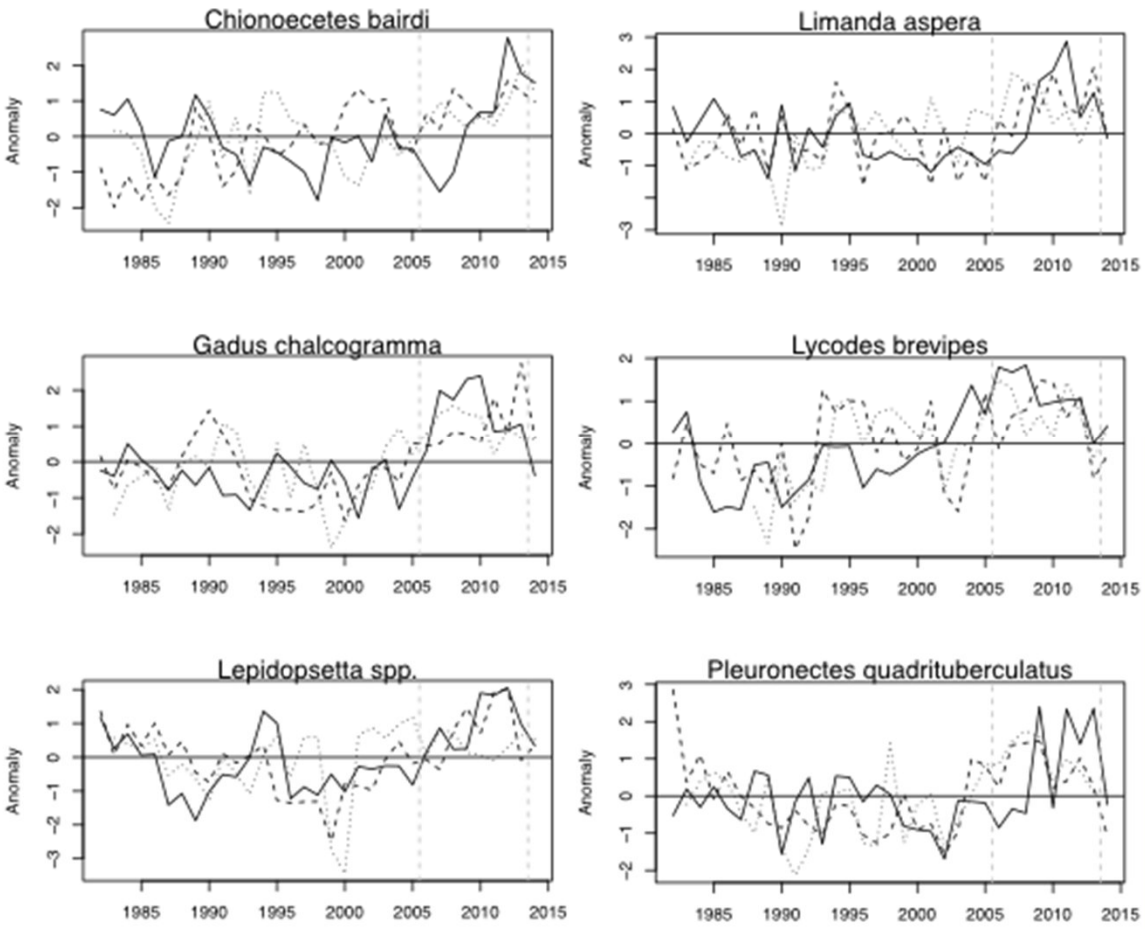
Proportion of total predation mortality for age-1 pollock



NEW Early Warning Indicators

(Litzow and Lauth)

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



- Solid lines = spatial variability in CPUE (SD of log-transformed data)
- Dashed lines = spatial correlation in CPUE (Moran's I)
- Dotted lines = temporal autocorrelation in CPUE (AR1)

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

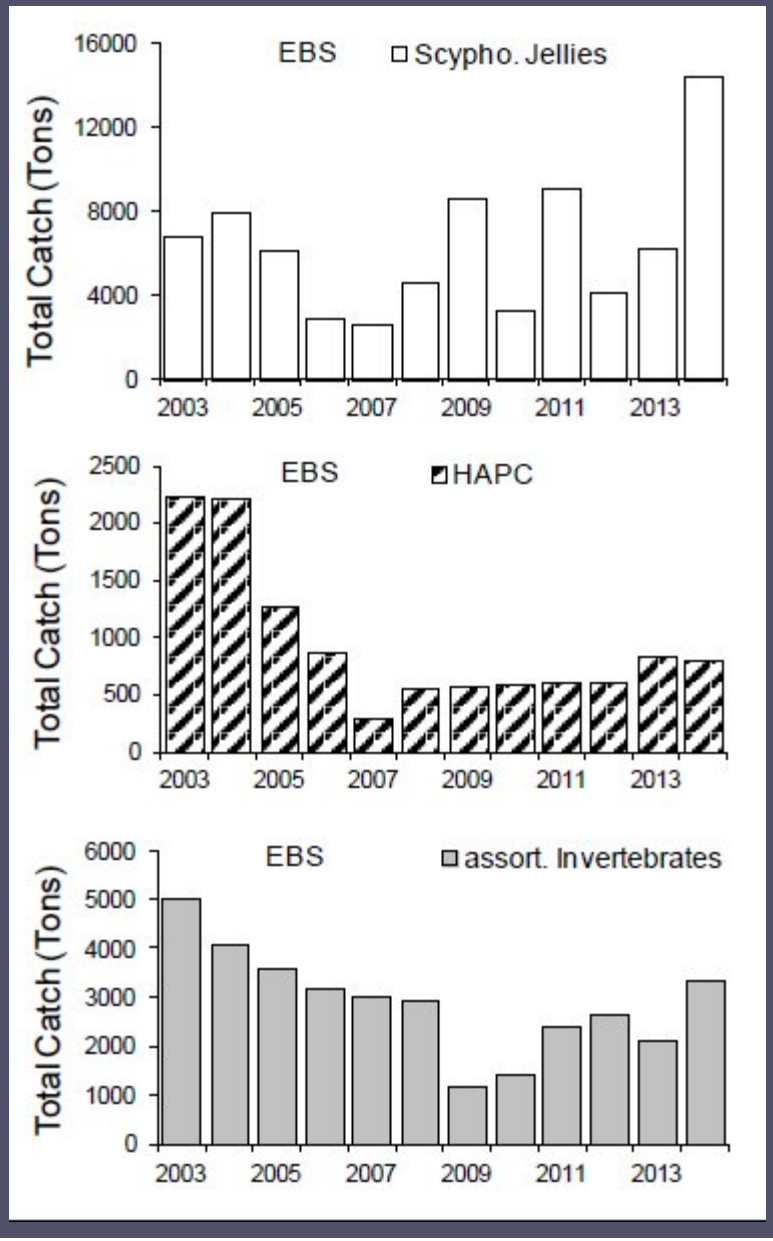
NEW 2014

EBFM INDICATORS

Non-targets, discards, habitat disturbance

Time Trends in Non-Target Catch

(Whitehouse)



Jellyfish: caught in EBS pollock

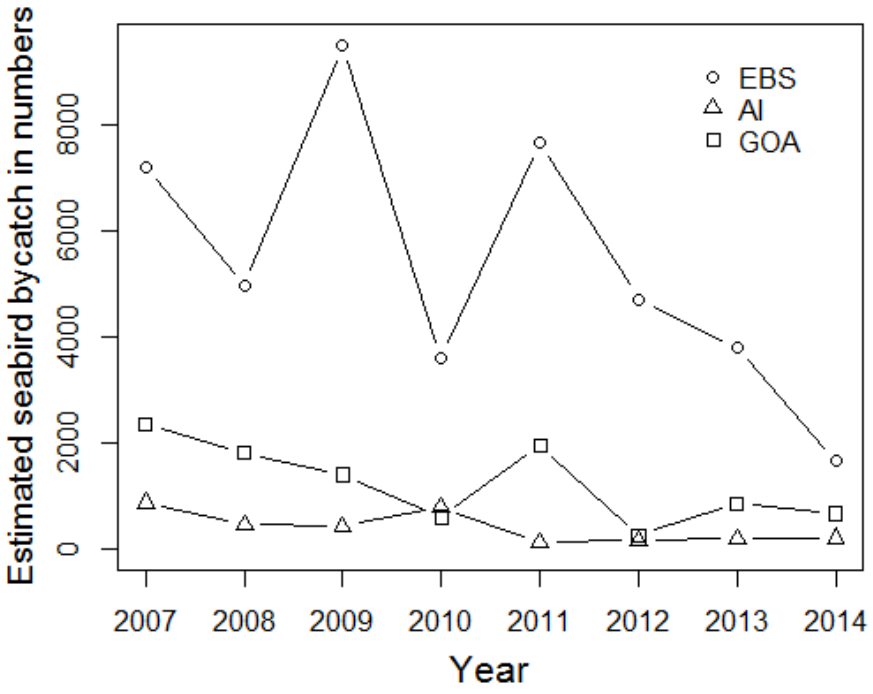
HAPC: benthic urochordata (EBS flatfish)

Other Inverts: sea stars (EBS flatfish)

Seabird bycatch, 2007-2014

(Zador, Fitzgerald, Mondragon)

Total estimated bycatch, all gear types



- 2014 lowest number of birds bycaught in EBS
- Decline seen in fulmars and shearwaters
- Short-tailed albatross caught

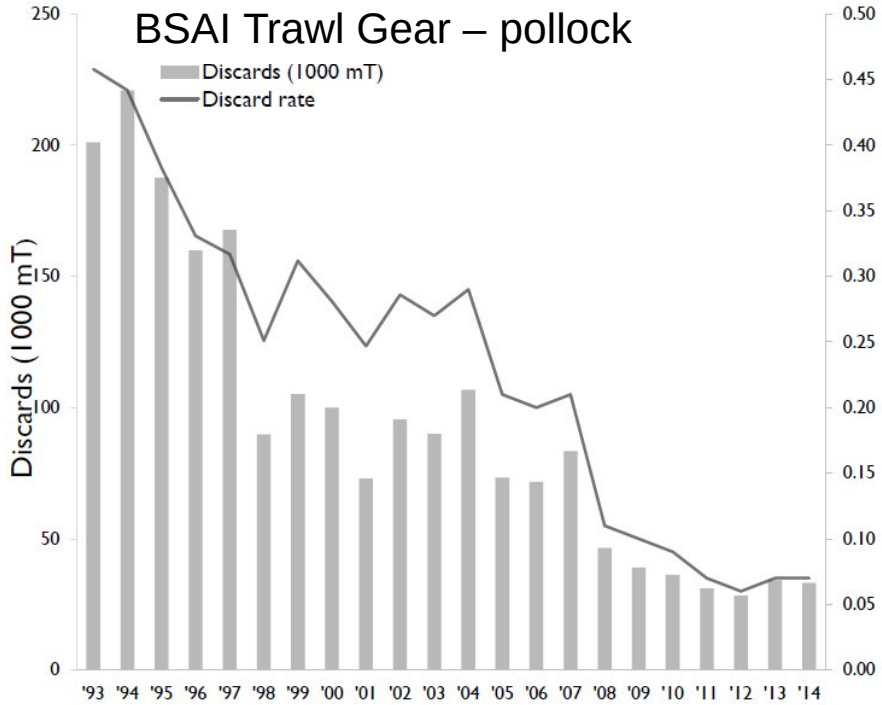
Estimated numbers of birds caught in EBS

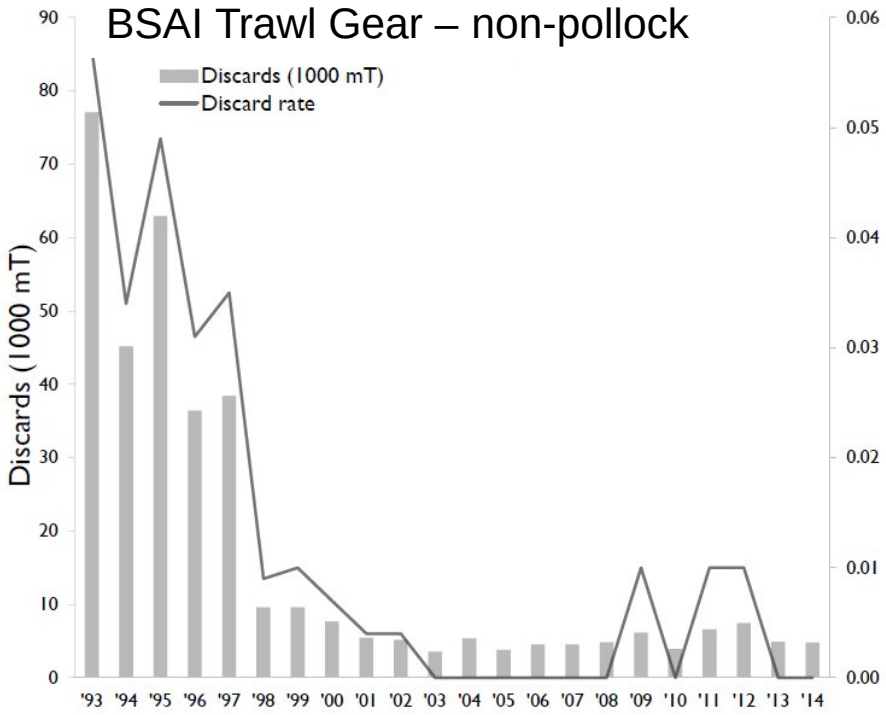
Species/Species Group	2007	2008	2009	2010	2011	2012	2013	2014
Unidentified Albatross	0	0	0	0	0	0	0	11
Short-tailed Albatross	0	0	0	15	5	0	0	9
Black-footed Albatross	18	7	5	9	2	0	1	10
Laysan Albatross	5	7	14	16	29	48	20	17
Northern Fulmar	2821	1185	571	569	160	512	196	117
Shearwaters	3157	2132	7215	1923	5405	2992	2883	701
Storm Petrels	1	0	0	0	0	0	0	0
Gull	718	1348	911	703	1650	835	416	572
Kittiwake	10	0	16	0	6	5	3	9
Murre	6	6	13	102	14	6	3	47
Puffin	0	0	0	9	0	0	0	0
Auklets	0	3	0	0	0	7	4	105
Other Alcid	0	0	105	0	0	0	0	0
Other	0	0	136	0	0	0	0	0
Unidentified	461	267	501	253	378	308	278	76
Grand Total	7196	4955	9487	3600	7649	4713	3803	1675

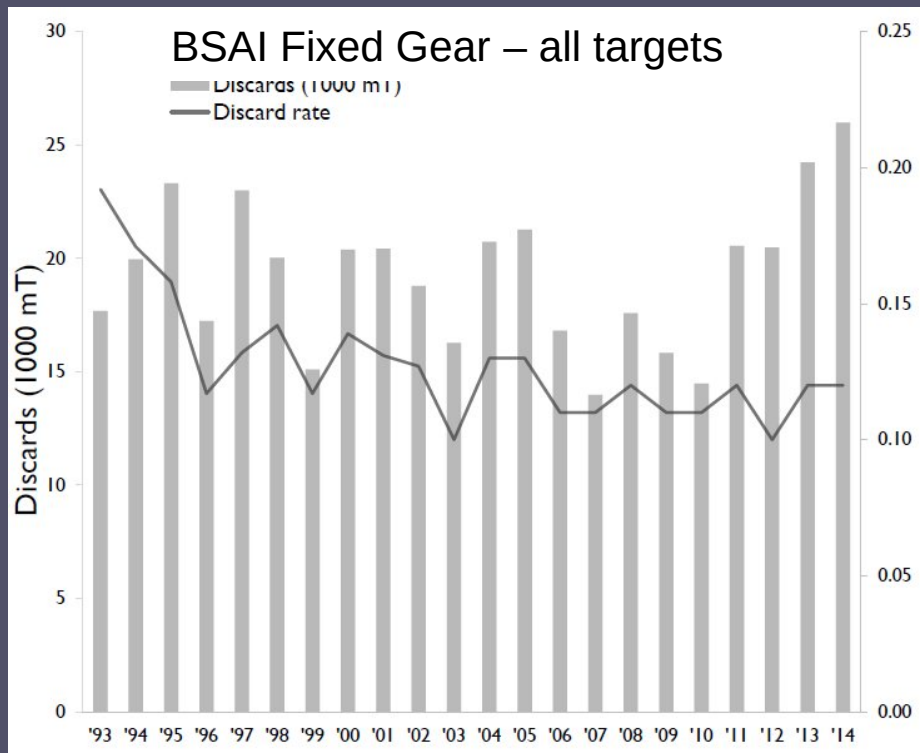
2014 Time Trends in Groundfish Discards

(Lee)

Beginning in 2013, includes estimates from fixed gear halibut, so 2013-2014 not comparable to earlier years



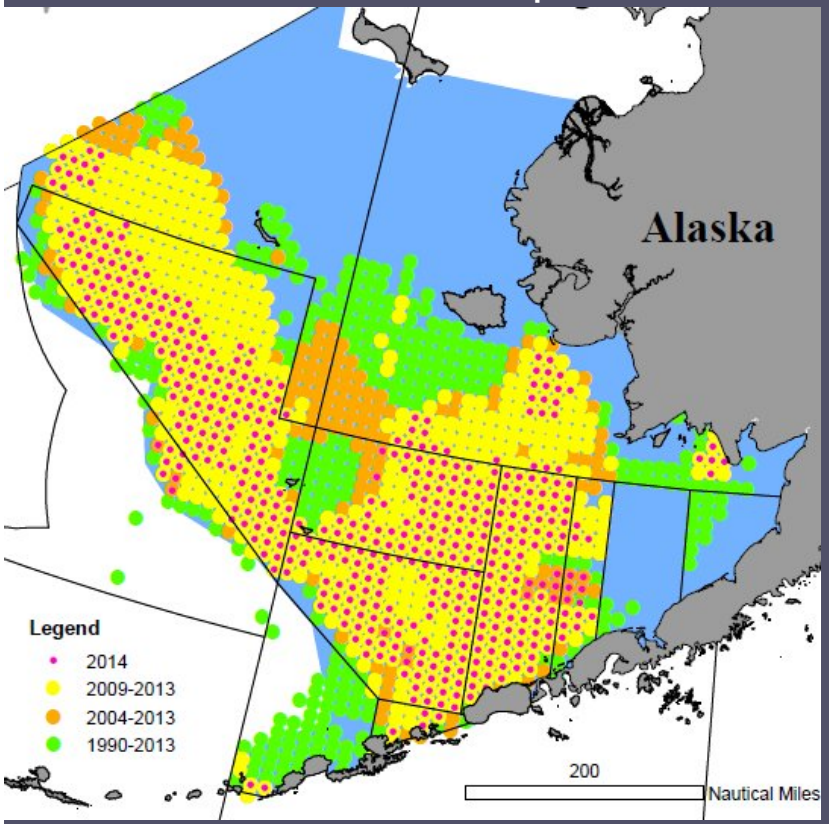




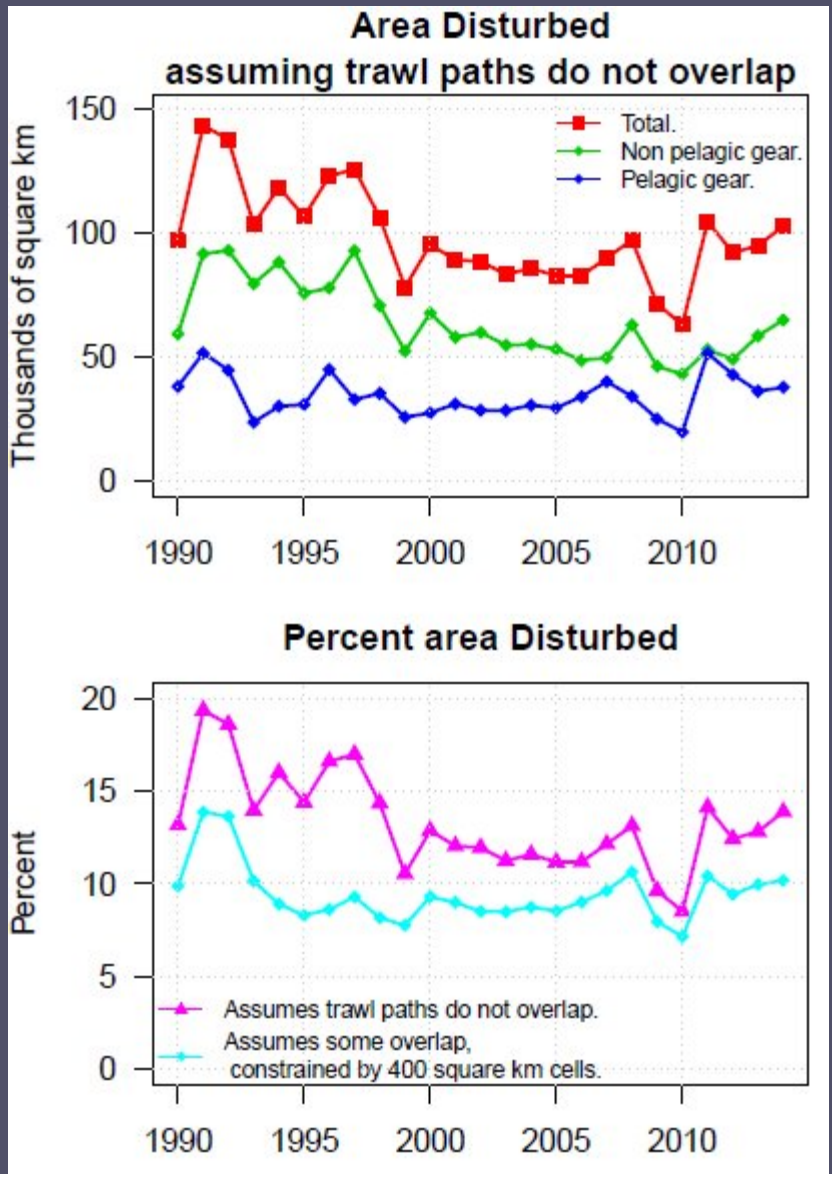
2014 Area Disturbed by Trawl Fishing Gear in the EBS

Greig and Zador

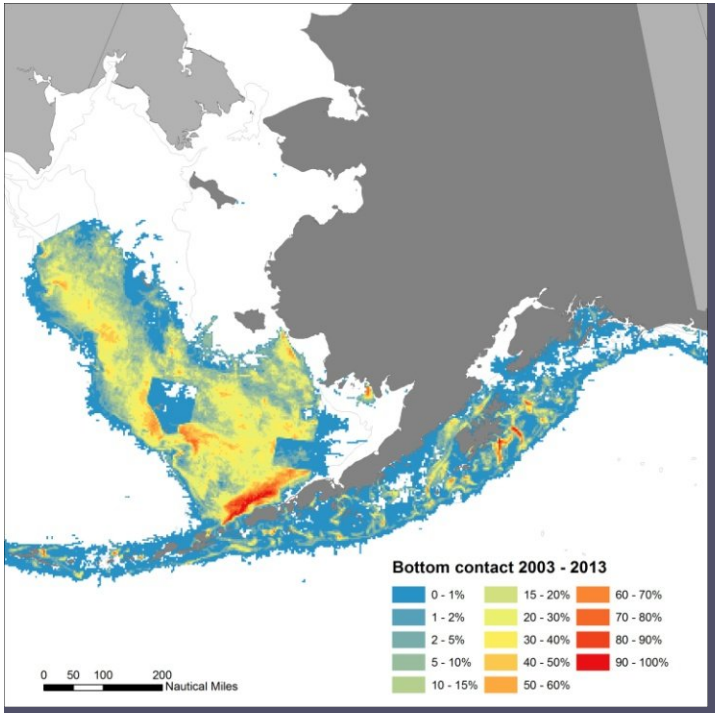
400 sq km cells with some trawling in cumulative time periods

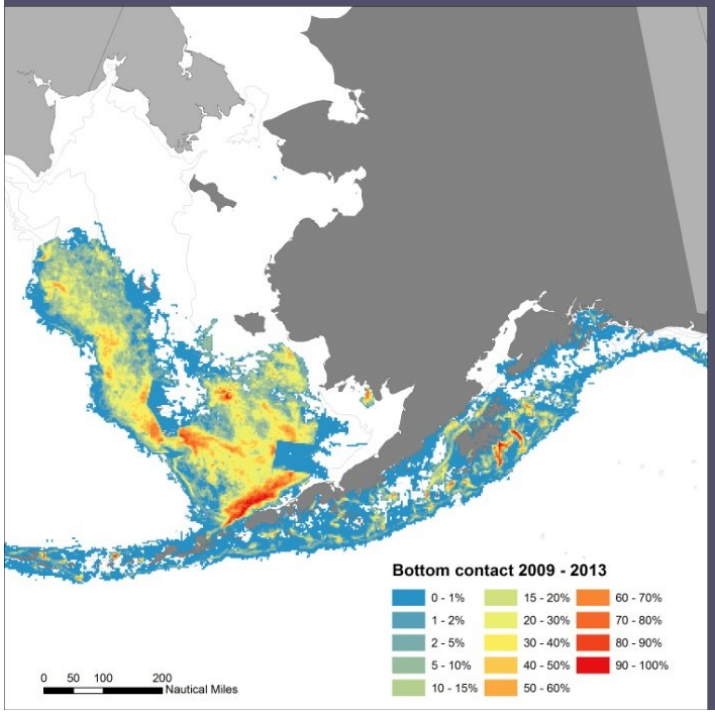


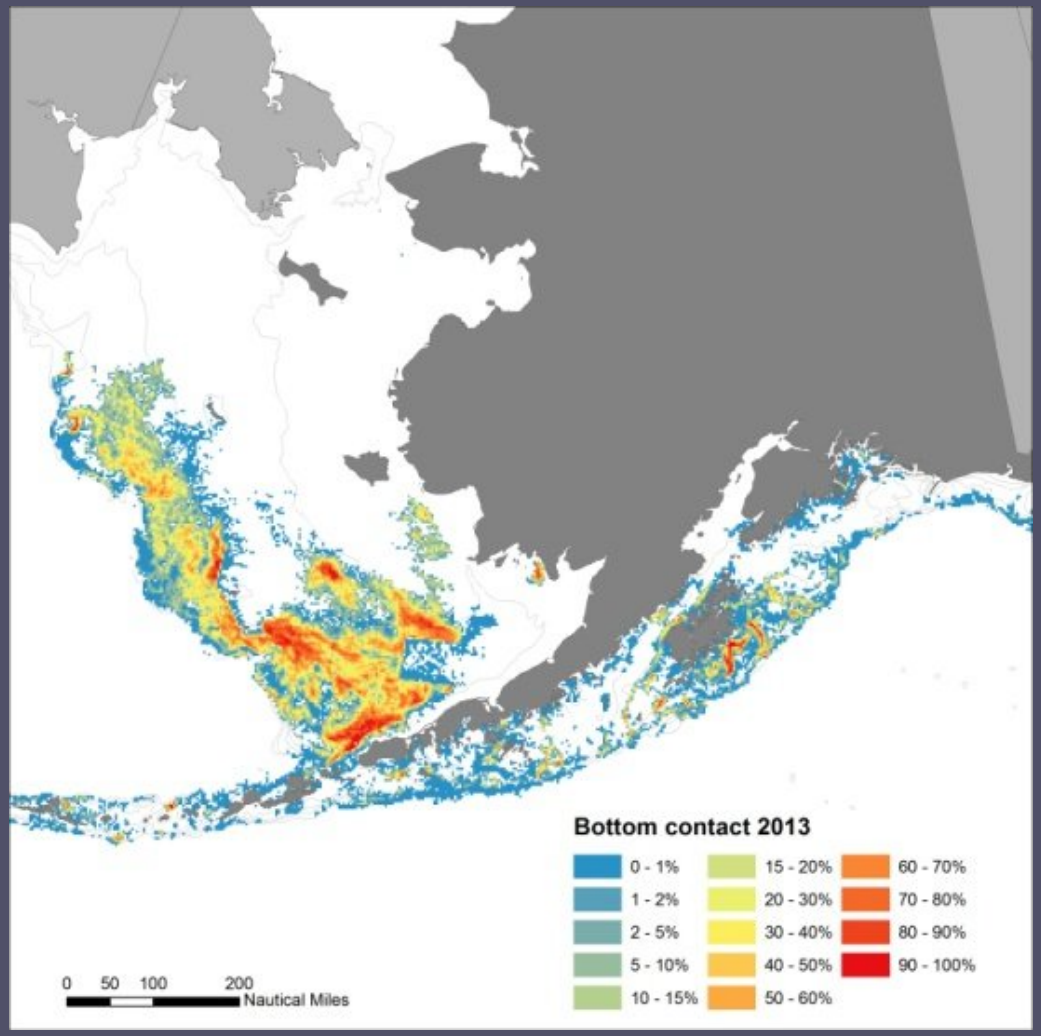
Green = last trawled 1990-2013



New habitat disturbance indicator in development
(Harris, Olson et al)





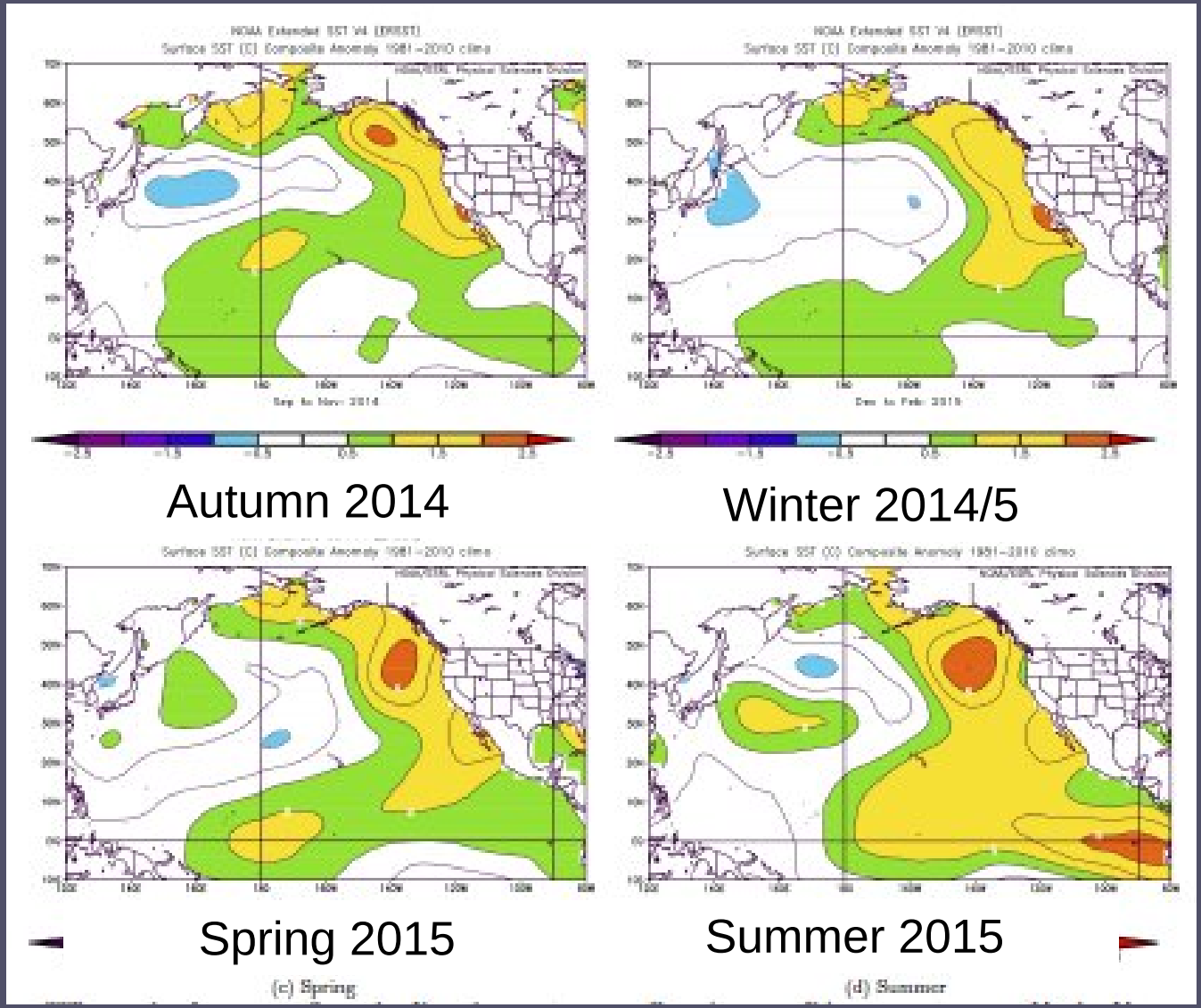


% of grid cell that was contacted over a 1, 5, and 10 year span with the actual dimensions of the gear

PHYSICAL CONDITIONS

Climate and oceanography

Sea Surface Temperature Anomalies (Bond)

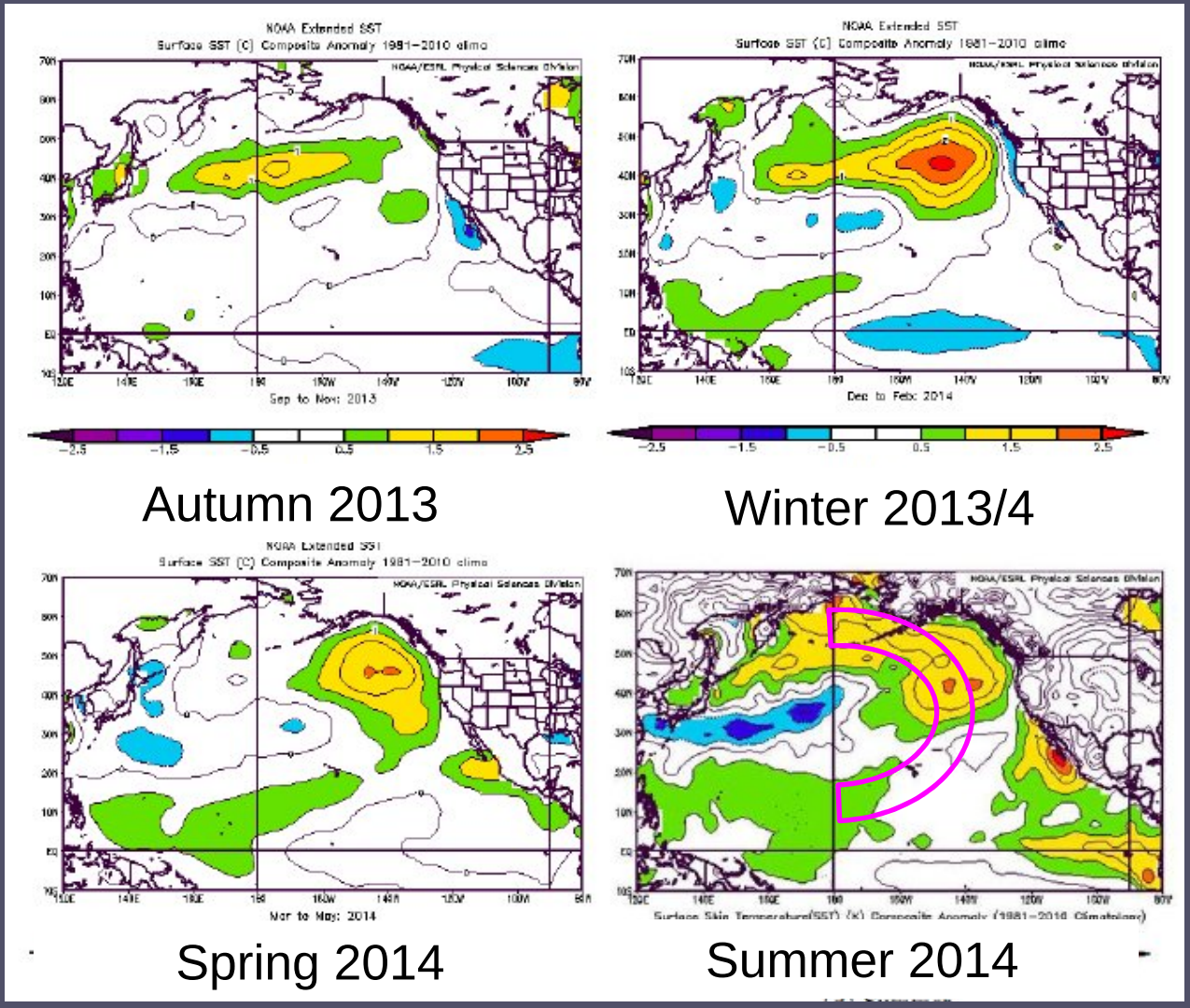


Fewer, weaker cold air outbreaks

Warm, typical storminess

From NOAA's Extended Reconstructed SST analysis

Sea Surface Temperature Anomalies (Bond)



>2.5°C warm anomalies during winter

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

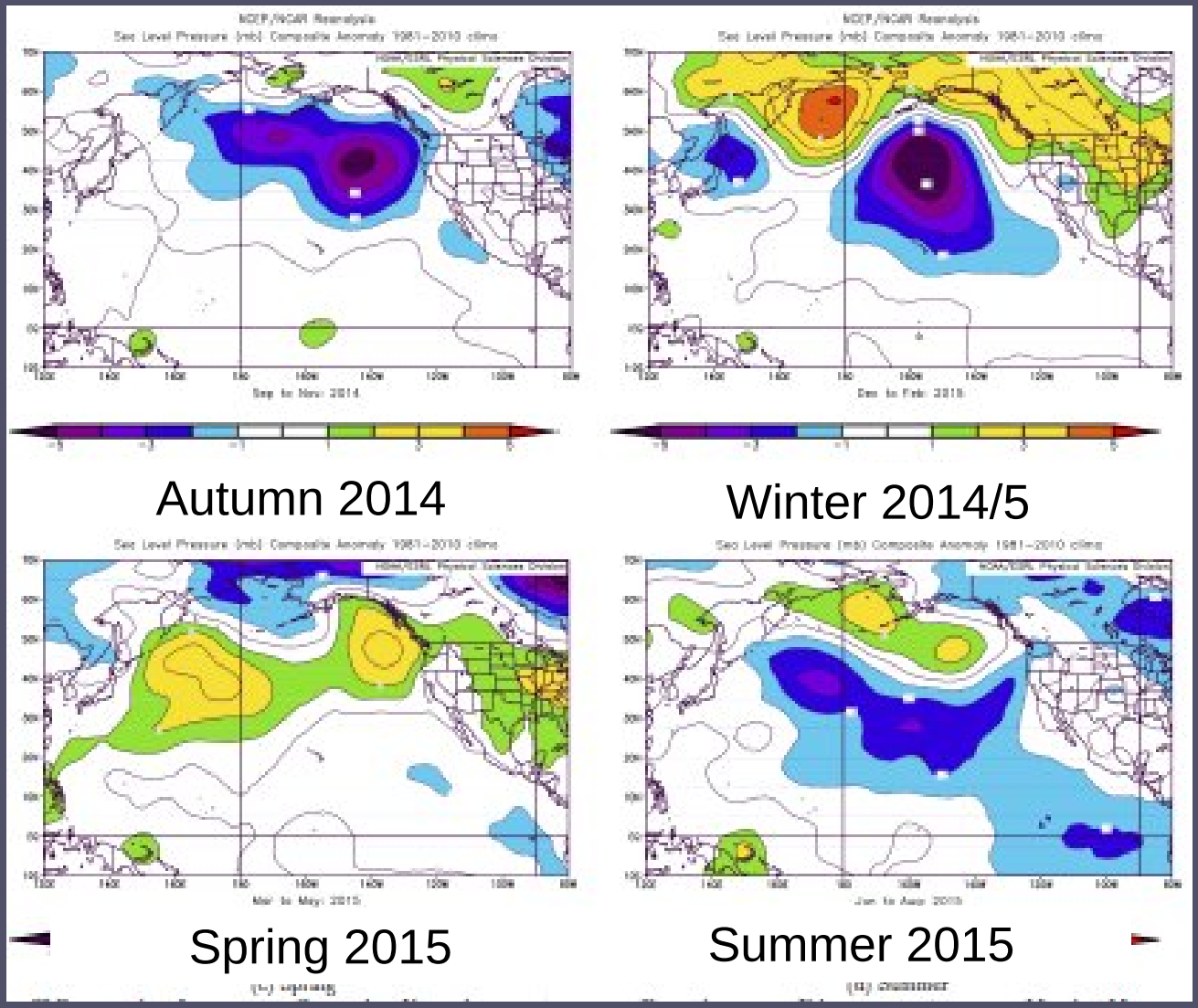
From NOAA's Extended Reconstructed SST analysis

Sea Level Pressure Anomalies (Bond)

Winds from the east in EBS

Most intense storm on record for N Pacific (Nuri)

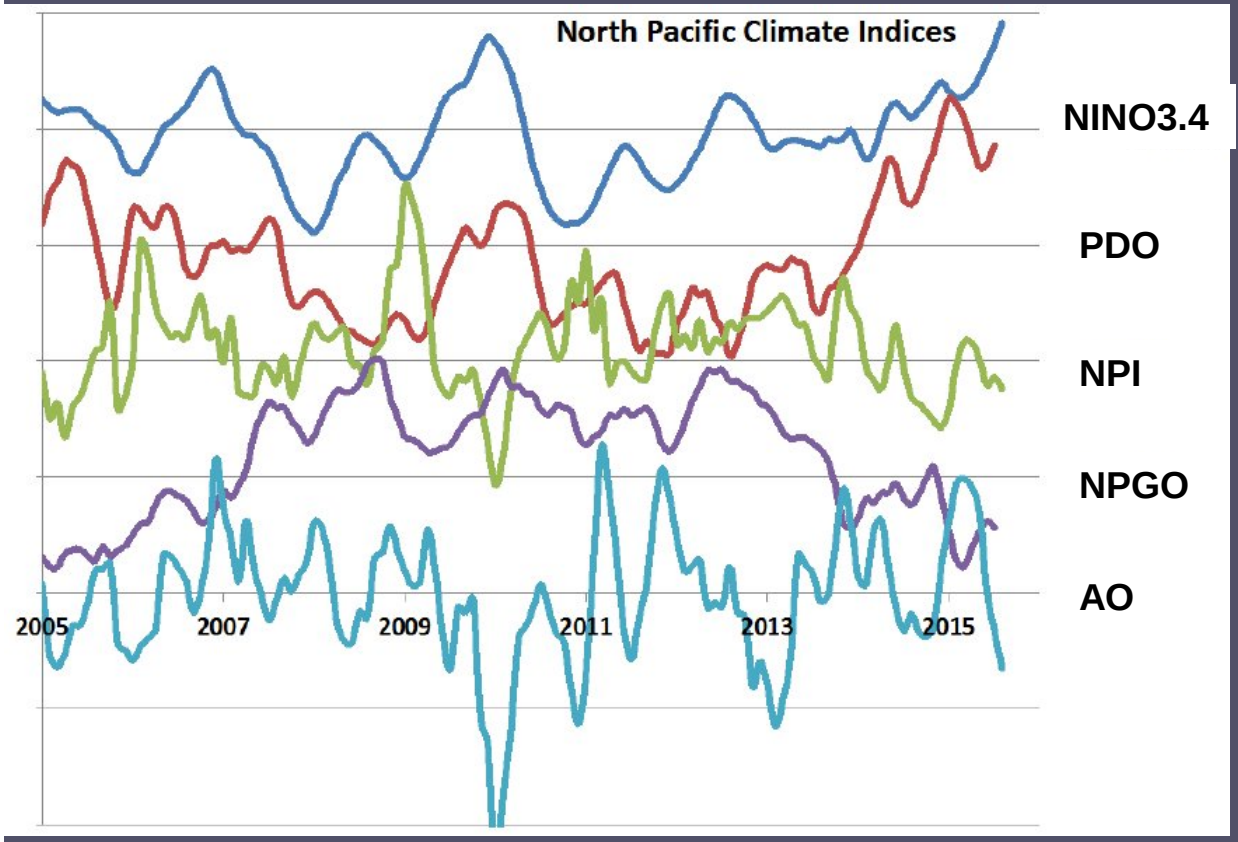
Typically cold weather pattern, but still warm due to ocean temp and low ice



Reduced storminess

From the NCEP/NCAR Reanalysis project

Climate Indices **(Bond)**



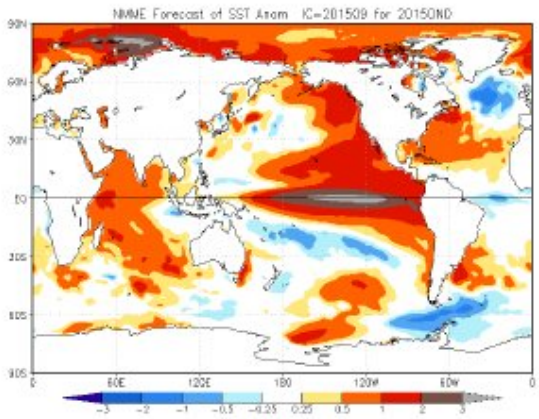
Strongly positive ENSO

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

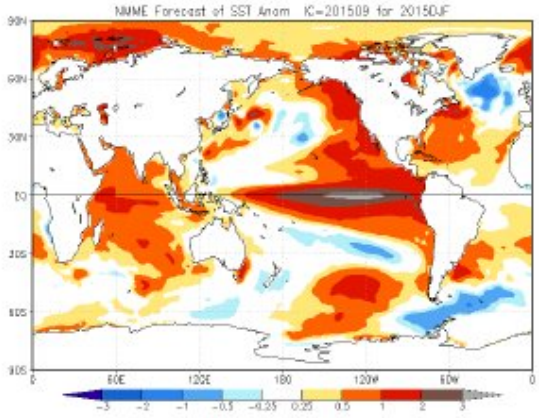
NPI implies strong Aleutian Low

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

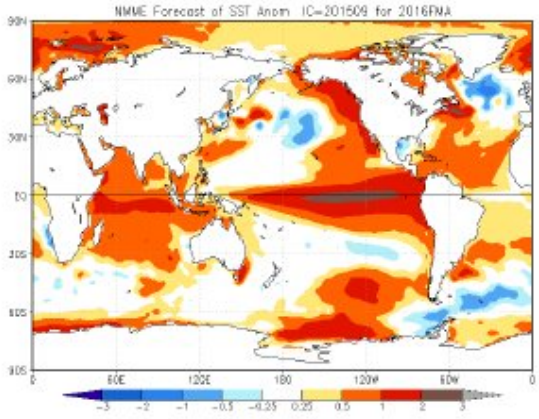
AO measures strength of polar vortex. Positive = low pressure over Arctic, high over Pacific (45º). Not strongly related to AK conditions recently.



(a) Months OND



(b) Months DJF

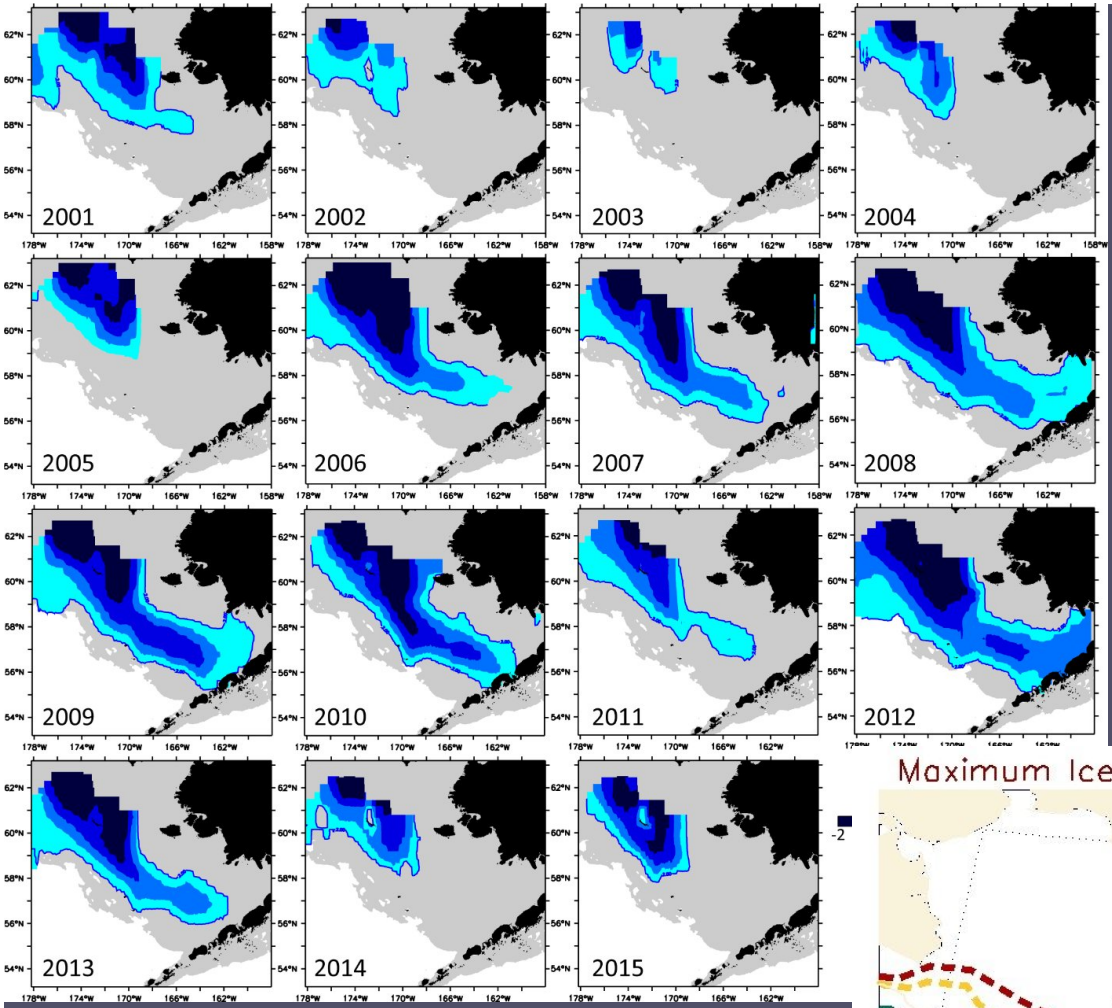


(c) Months FMA

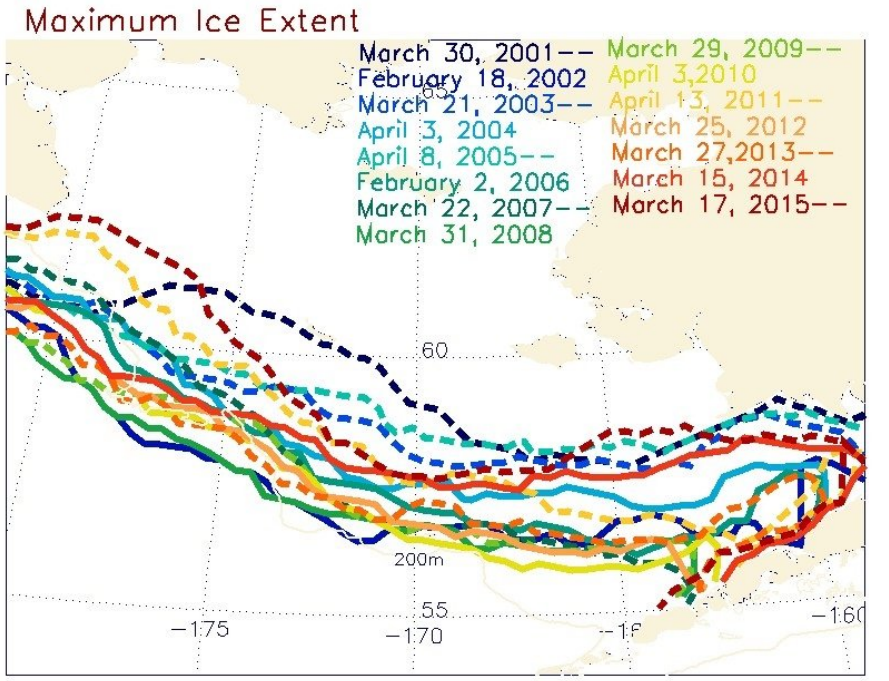
Seasonal Projections from the National Multi-Model Ensemble (NMME) (Bond)

- 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
- Warmer than normal SSTs until spring 2016

ESB cold pool and sea ice (Overland et al.)



- Less sea ice cover
- Reduced cold pool
- Warm



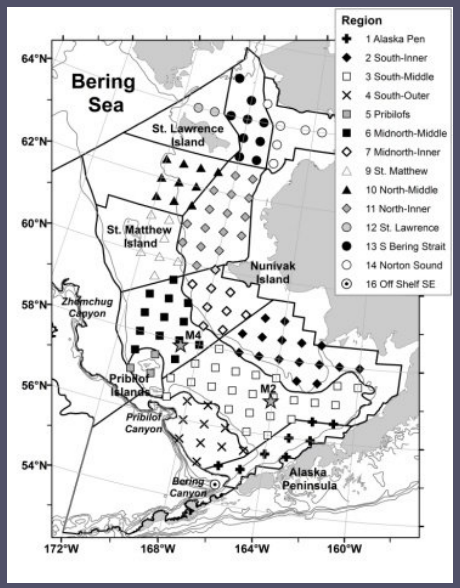
Variations in temp and salinity - BASIS (Eisner et al.)

Temperatures below MLD

Domain	Region Name and No.		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Inner	South	2	8.7	9.3	9.5	9.2	7.9	6.3	6.5	7.3	7.1	7.0	6.5		6.5
	Mid-north	7	9.5	9.9	9.9	8.4	7.6	7.9	6.1	7.6	7.3	7.2	6.5		6.2
	North	11	7.3	7.7	9.0	7.0	6.7	7.1		6.4	6.1	6.8	6.3	5.2	
Middle	AK Penn	1	7.7	7.8	7.8	7.8	7.9	5.3	6.8	7.0	6.0	6.9	5.4		7.3
	South	3	4.9	5.2	5.2	5.9	4.1	2.9	2.9	2.6	2.2	3.9	2.0		4.9
	Pribilofs	5	4.1		7.6	7.5	5.5	4.2		4.2		5.0	3.6		6.3
	Mid-north	6		5.7	4.3	5.5	2.2	2.9	1.9	3.4	1.9	3.5	2.2		3.7
	St Matthew	9	3.5	6.0	3.8	4.0	1.5	0.8		0.7	0.7	1.9	1.0		
	North	10	4.6		3.2	1.3	1.4	1.0		1.3	1.4	0.9		0.6	
Outer	South	4	6.9	6.8	6.1	6.3	6.0	5.4		5.6	5.0	5.3	5.3		5.7
> 63°N	St Lawrence	12	6.2	4.4	7.0		4.7	6.4		3.9	5.4	3.9	5.5	5.6	
	S Bering Strait	13	5.4	5.8	6.9	7.4	4.7	6.1		3.7	5.5	5.1	3.2	3.3	
	Norton Sound	14	7.3	10.2	11.4		8.1	10.3		8.0	8.6	7.5	6.8	8.2	
Offshore	southeast	16	5.7	6.7	5.5	6.1	6.0				5.3	5.2			4.6

Salinity below MLD

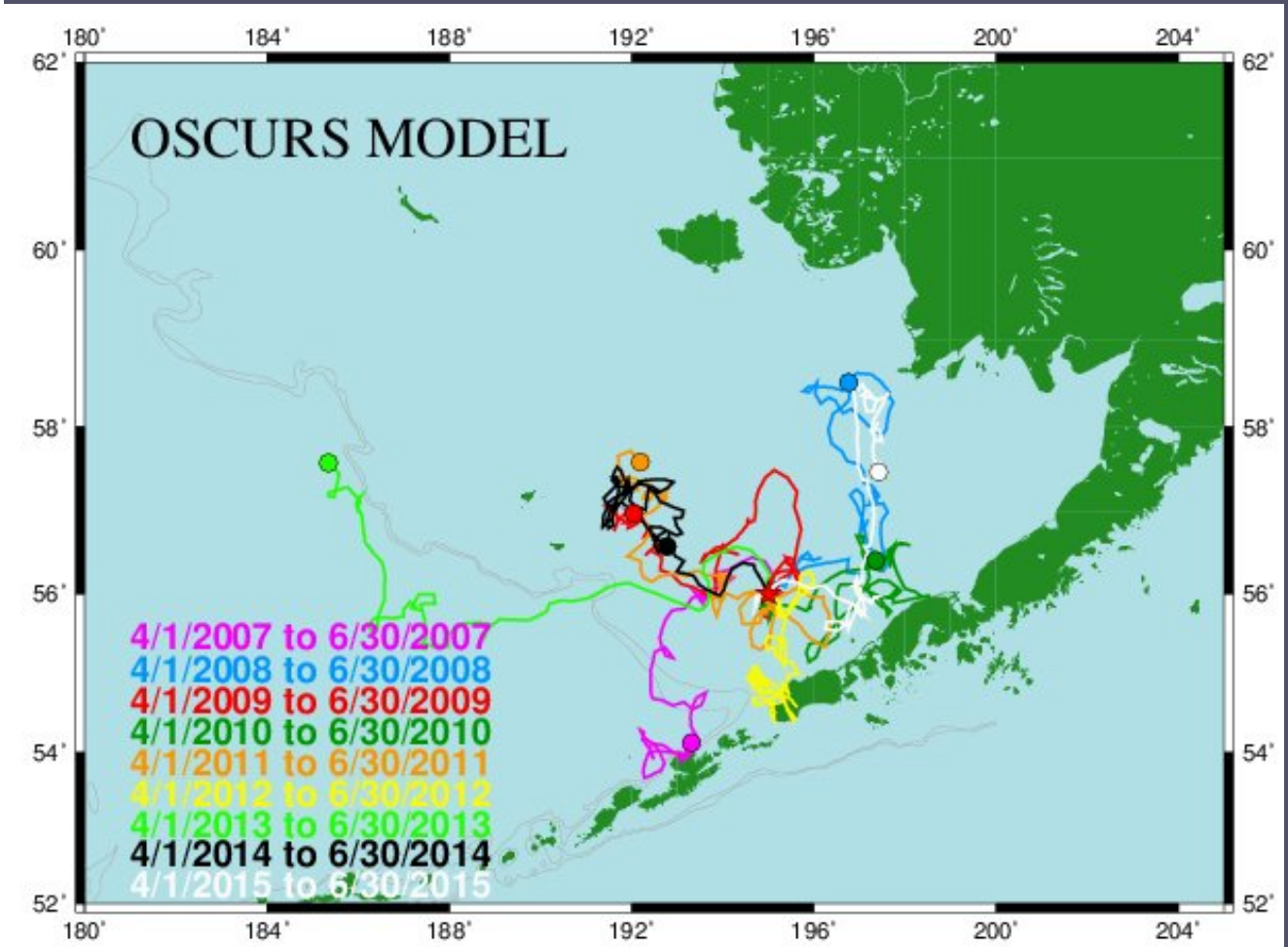
Domain	Region Name and No.		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Inner	South	2	31.4	31.2	31.0	31.2	31.0	31.3	31.2	31.1	31.3	30.9	31.3		31.9
	Mid-north	7	31.5	31.3	31.2	31.2	30.9	31.0	31.2	31.3	31.3	31.1	31.1		31.7
	North	11	30.5	30.7	30.7	31.0	30.7	30.8		30.9	30.8	30.9	30.9	30.7	
Middle	AK Penn	1	32.1	31.9	32.0	32.1	32.0	32.2	31.9	32.1	32.0	32.2	32.2		32.1
	South	3	32.1	31.9	32.0	32.1	31.9	31.8	31.9	31.8	31.7	31.9	31.8		32.1
	Pribilofs	5	33.1		32.1	32.1	32.1	31.9		32.2		32.1	32.1		32.2
	Mid-north	6		32.1	32.0	32.1	31.8	31.6	31.7	31.6	31.5	31.6	31.7		32.0
	St Matthew	9	31.6	31.6	31.6	32.0	31.4	31.5		31.5	31.1	31.2	31.5		
	North	10	31.7		31.1	31.6	31.4	31.8		31.5	31.8	31.4		31.6	
Outer	South	4	32.8	32.6	32.5	32.5	32.5	32.6		32.7	32.5	32.6	32.6		32.5
> 63°N	St Lawrence	12	32.2	31.7	32.1		32.0	31.8		31.9	31.7	32.2	31.8	31.6	
	S Bering Strait	13	31.5	31.5	31.2	31.2	31.6	31.7		31.7	31.6	31.8	32.0	31.7	
	Norton Sound	14	29.1	28.0	29.8		29.7	29.2		30.0	29.8	29.5	29.7	29.9	
Offshore	southeast	16	33.2	32.7	33.1	33.2	32.7				32.9	33.0			33.5



- Temps and salinity above and below mixed layer depth
- Below better reflects longer term climatic shifts
- Above influenced by episodic mixing events

EBS Wind Forcing and Winter Spawning Flatfish Recruitment

(Wilderbuer)

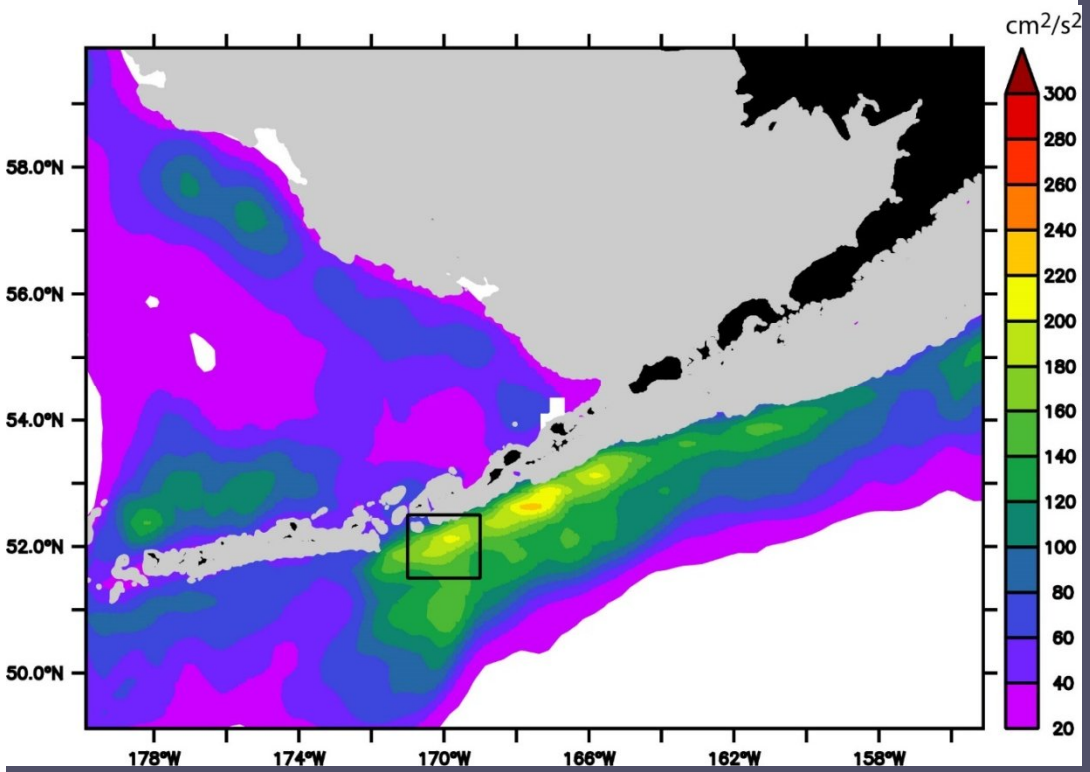


- Direction of wind-forcing during spring linked to flatfish recruitment (northern rock sole)
- Inshore advection to favorable nursery grounds in 2015
- 2012-2014 not favorable

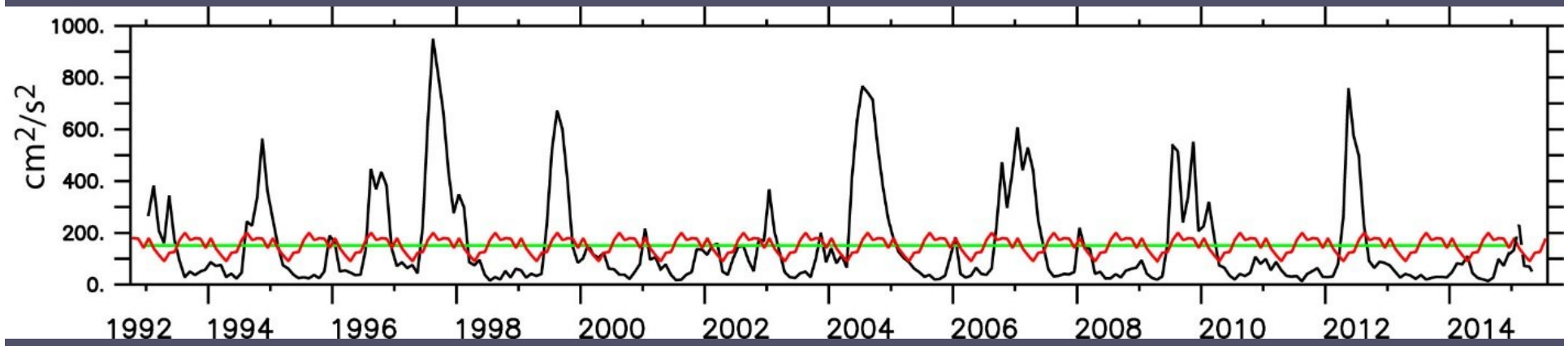
Eddies in the Aleutians

(Ladd)

Average Eddy Kinetic Energy Oct 1993 - 2014



- EKE low fall 2012 – early 2015
- Lower than average volume, heat, salt, nutrient fluxes to BS through Amukta Pass since summer 2012



Website

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