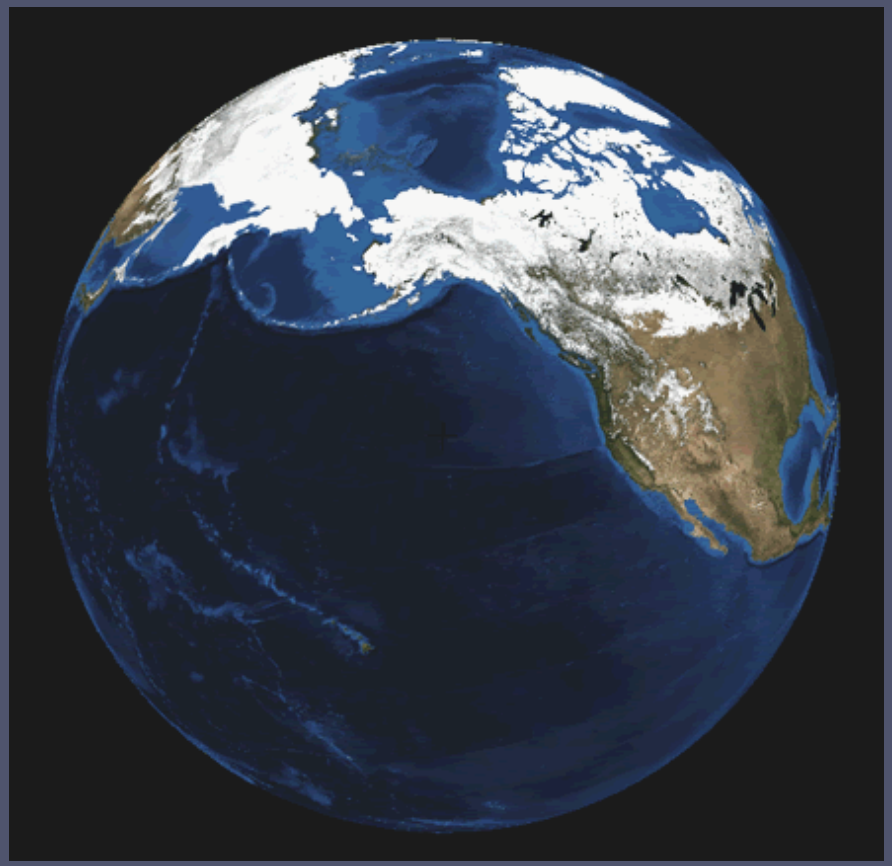
ECOSYSTEM OVERVIEW

September Update

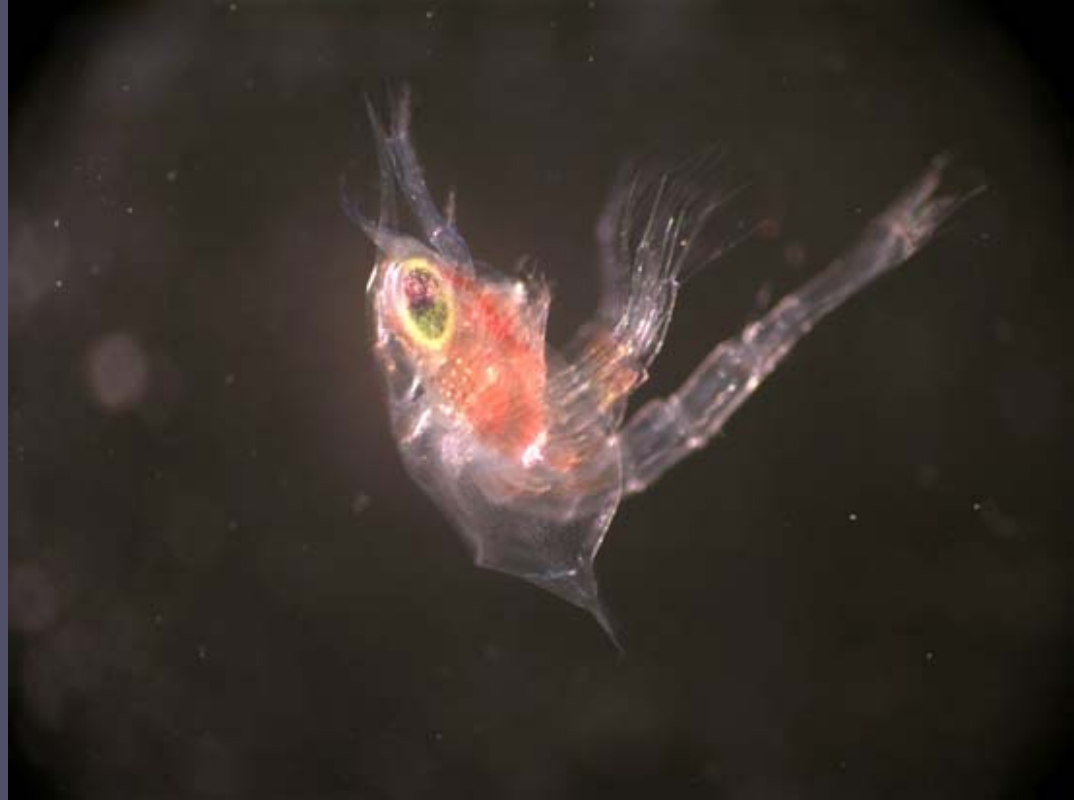
Status of the Eastern Bering Sea Ecosystem



Stephani Zador
Ellen Yasumiishi

Crab Plan Team meeting
Sept 20, 2016

OUTLINE

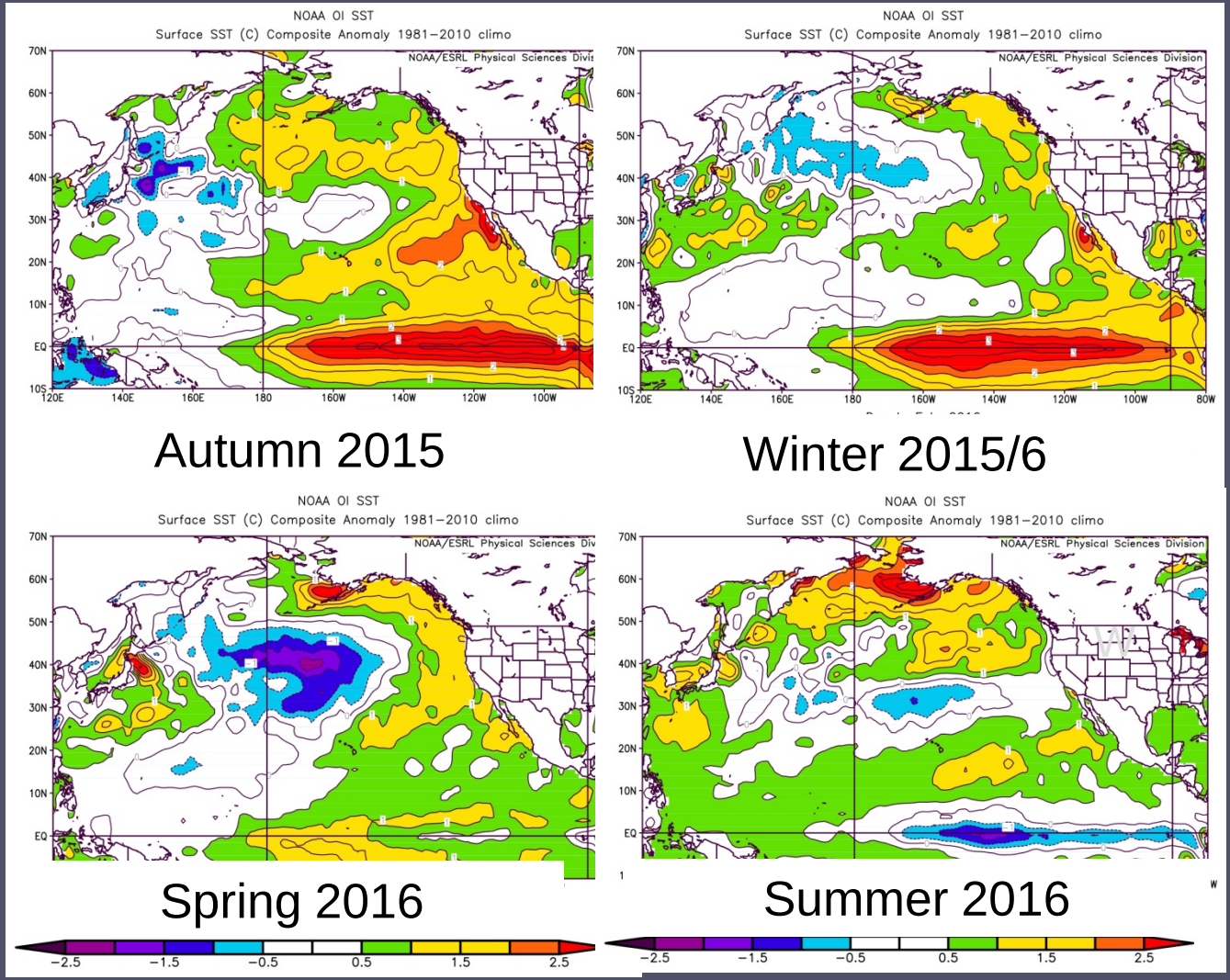


1. Climate and Oceanography
2. Ecosystem Surveys

PHYSICAL CONDITIONS

Climate and oceanography

Sea Surface Temperature Anomalies (Bond)



Aleutians cooled to normal

Increased anomaly in EBS and W GOA

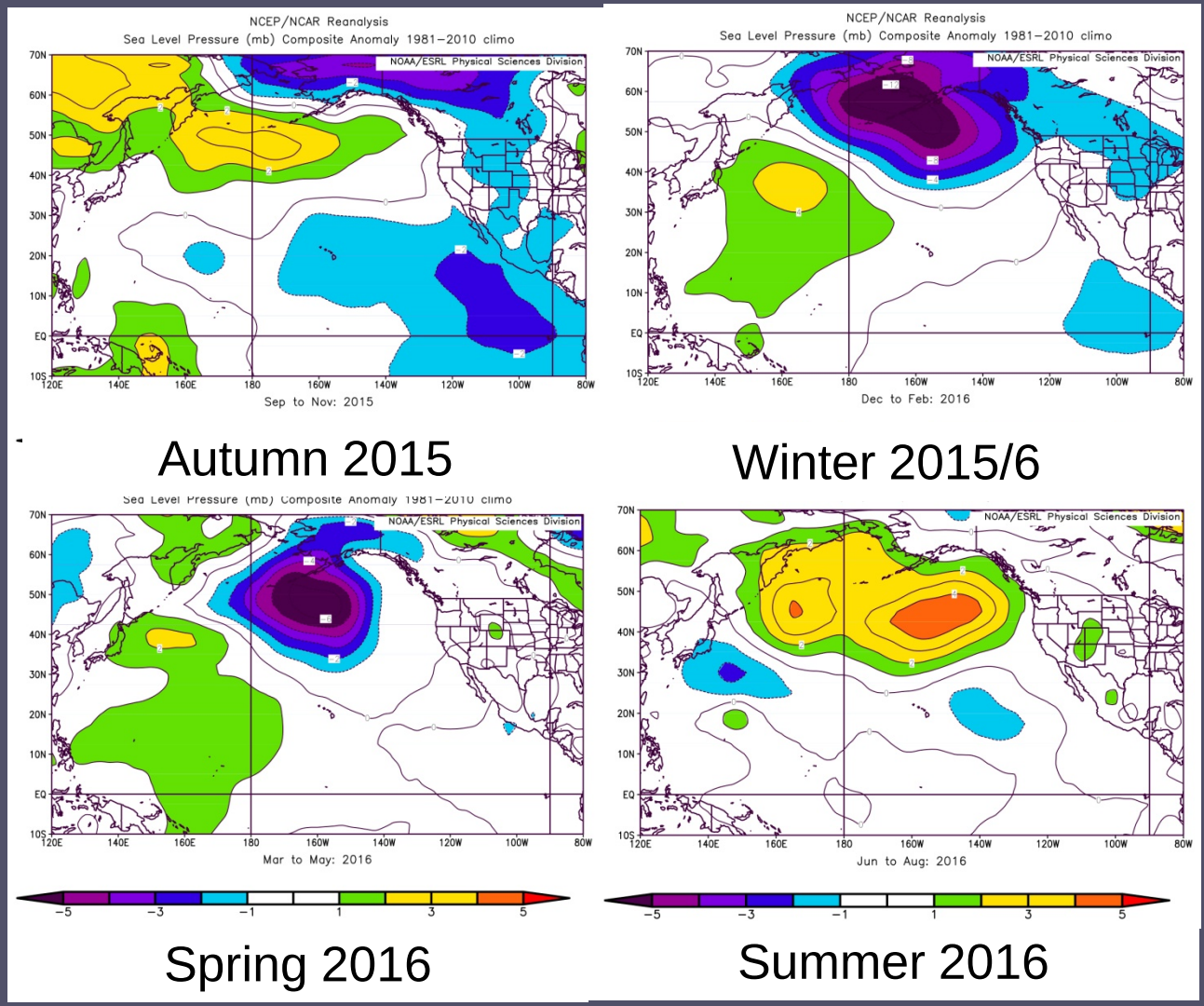
>3°C pos anomaly in EBS

Development of La Niña?

From NOAA's Optimum Interpolation SST analysis

Sea Level Pressure Anomalies (Bond)

Pattern implies anomalous westerly winds and upwelling in GOA



Lowest low since 1949

Warm wind to E GOA

Suppressed storminess

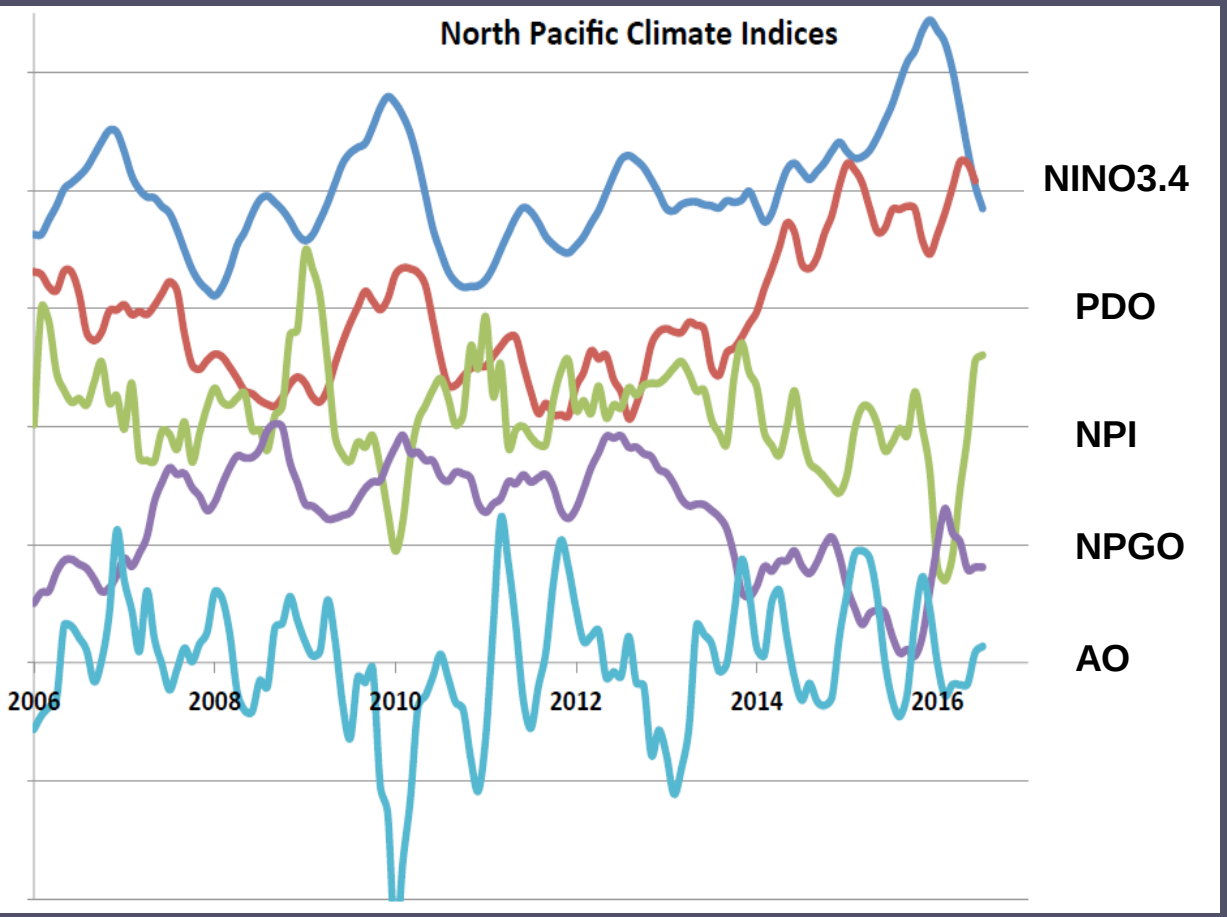
Little mixing, hence warm surface temp

From the NCEP/NCAR Reanalysis project

Climate Indices

(Bond)

North Pacific atmosphere-ocean climate system “highly perturbed”



ENSO declining

PDO has been positive; did not track with recent El Niño

NPI implies deep Aleutian Low; contributed to EBS warmth

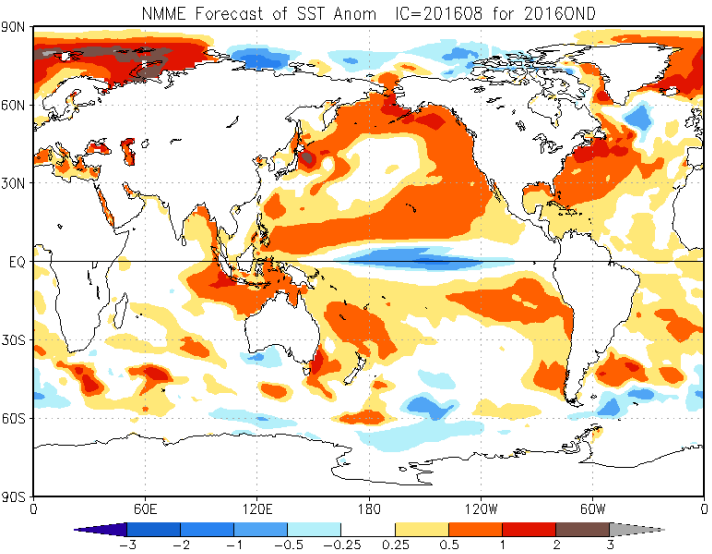
NPGO relates to chemical and biological properties in GOA and CalCOFI area. Negative→ reduced flows in Alaska and CA currents

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

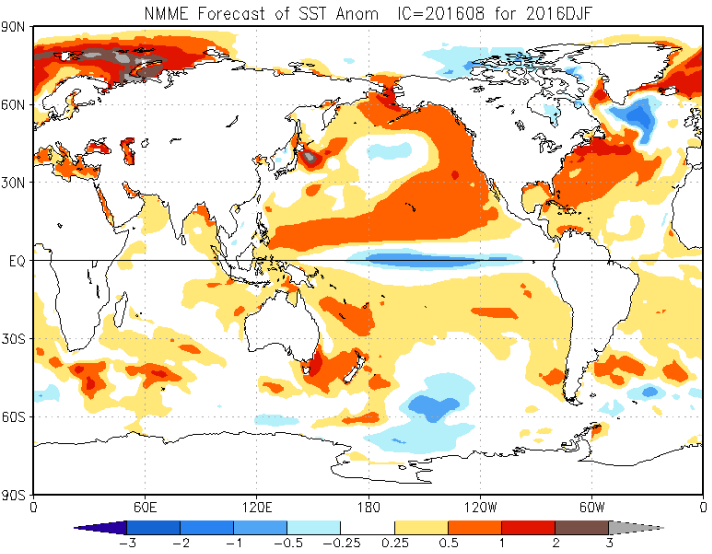
Seasonal Projections from the National Multi-Model Ensemble (NMME)

(Bond)

2016 Oct-Nov-Dec



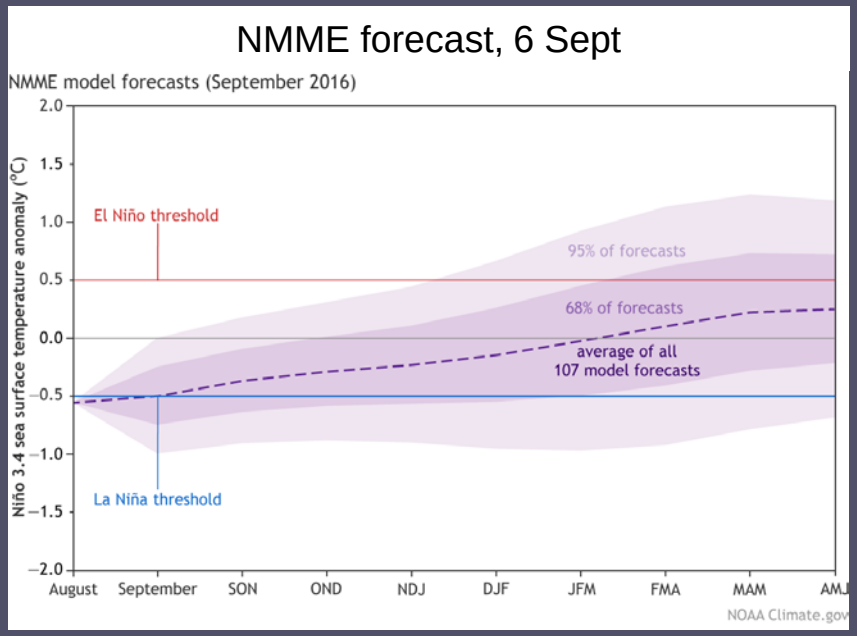
2016 Dec-Jan-Feb



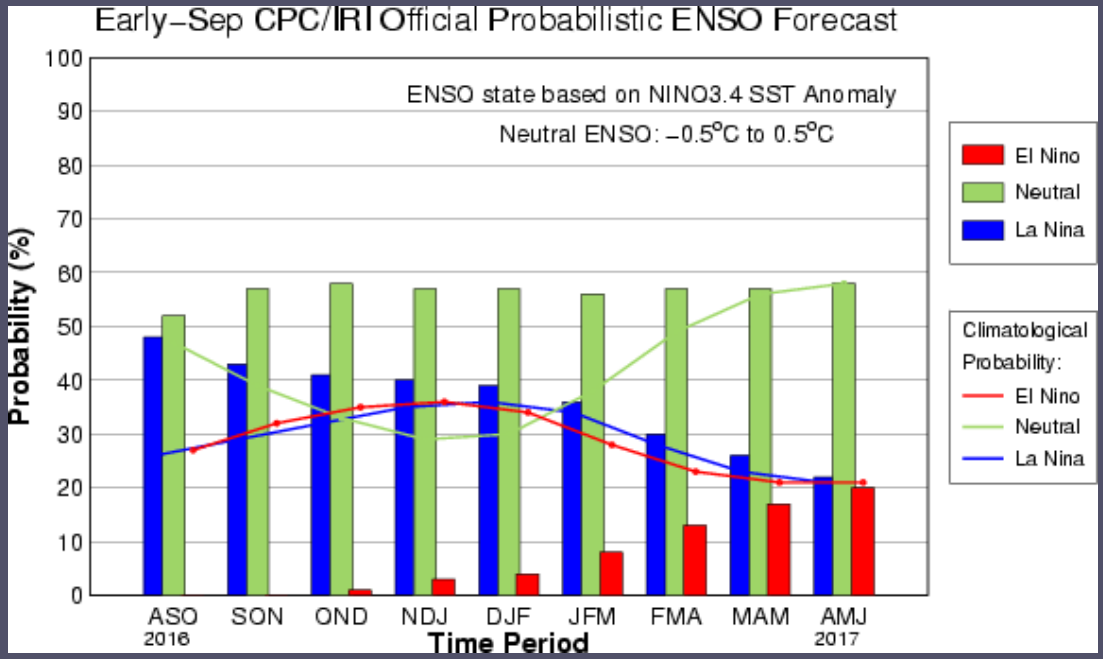
- SST projections
- NMME is average of 6 models
- Continuation of warm
- Strongest positive anomalies in EBS and GOA
- Maintenance of positive PDO conditions with La Niña could reflect extra heat in system, *however…*

Latest La Niña forecast

NMME forecast, 6 Sept



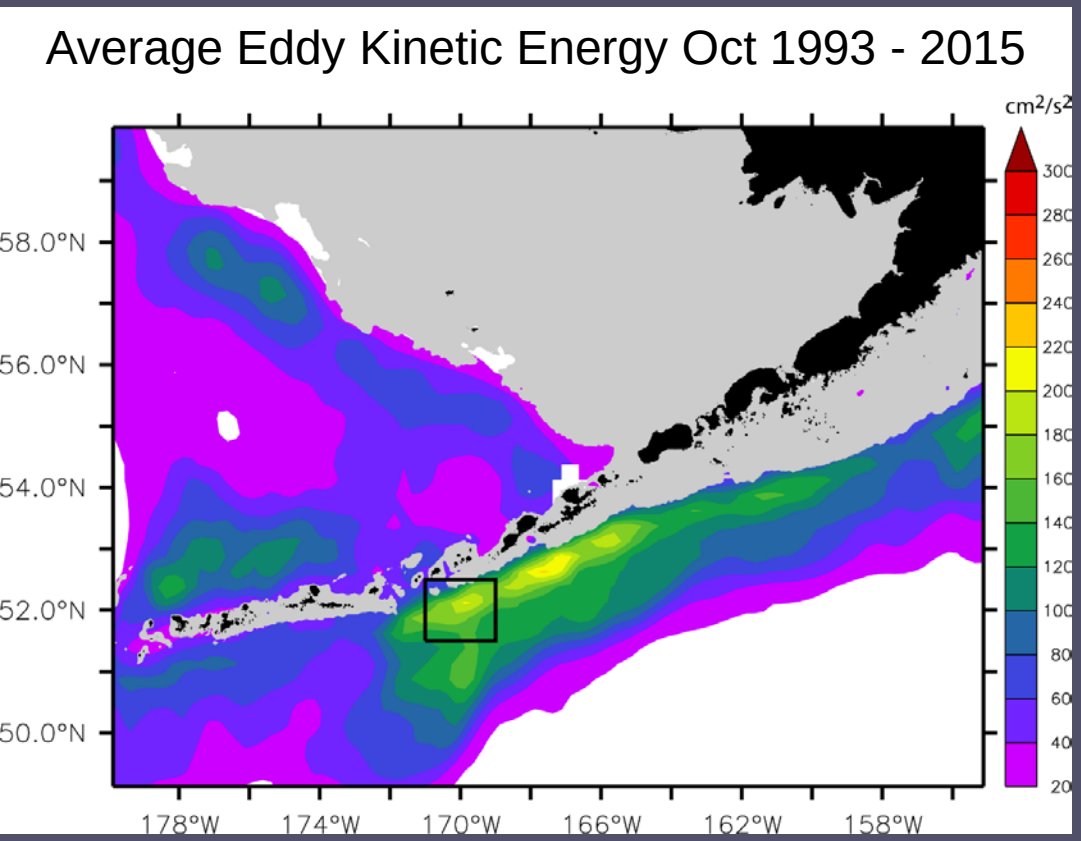
ENSO-Neutral conditions 55-60% likely for upcoming fall, winter



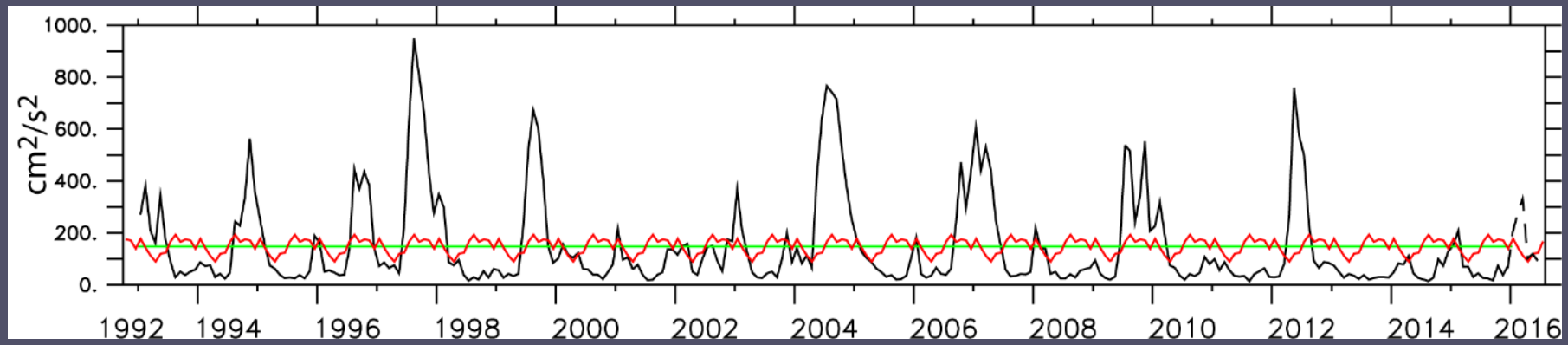
From NOAA's climate prediction center

Eddies in the Aleutians

(Ladd)

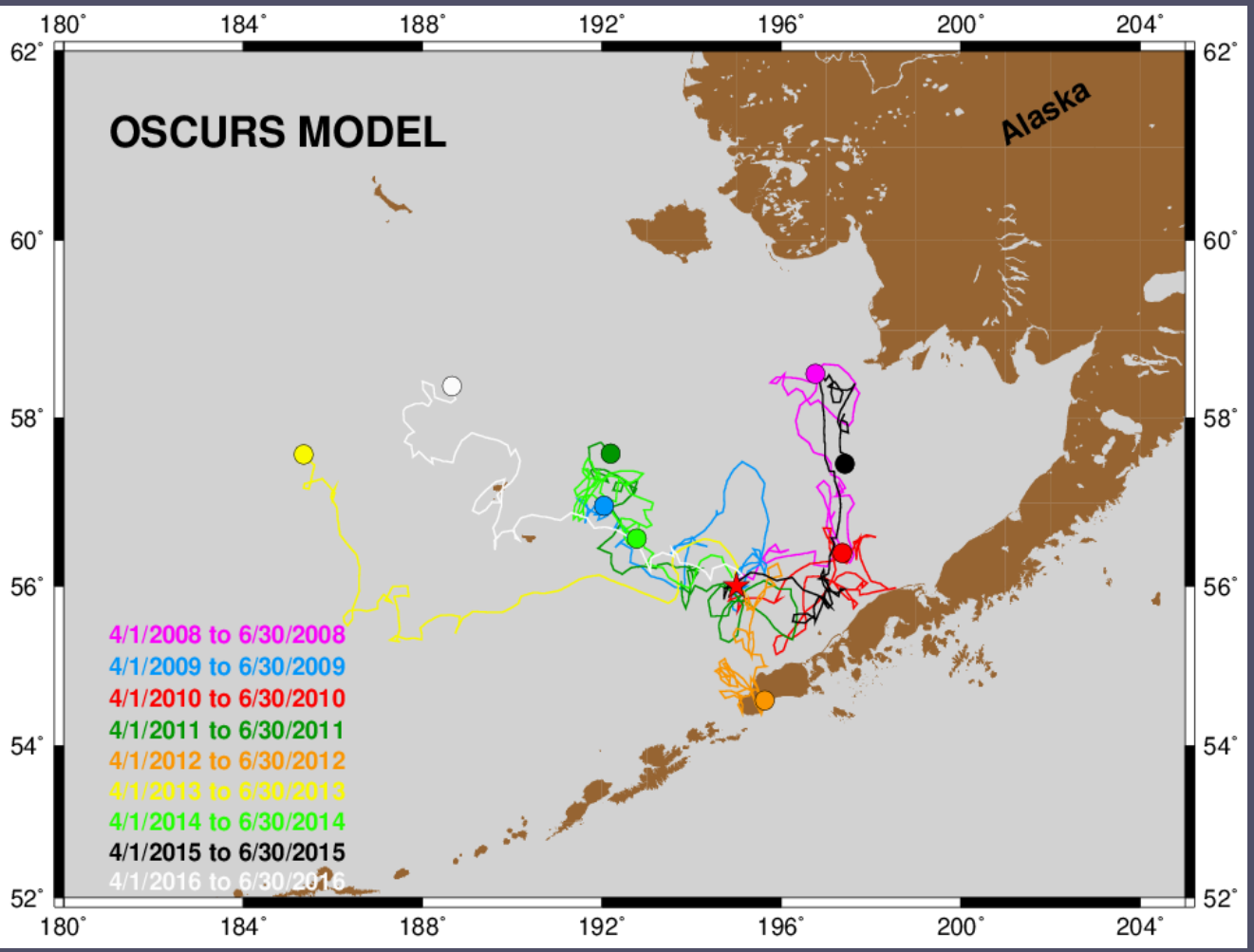


- EKE low fall 2012 –2015
- Small eddy in early 2016
- Lower than average volume, heat, salt, nutrient fluxes to BS through Amukta Pass since summer 2012; possibly enhanced 2016



EBS Wind Forcing and Winter Spawning Flatfish Recruitment

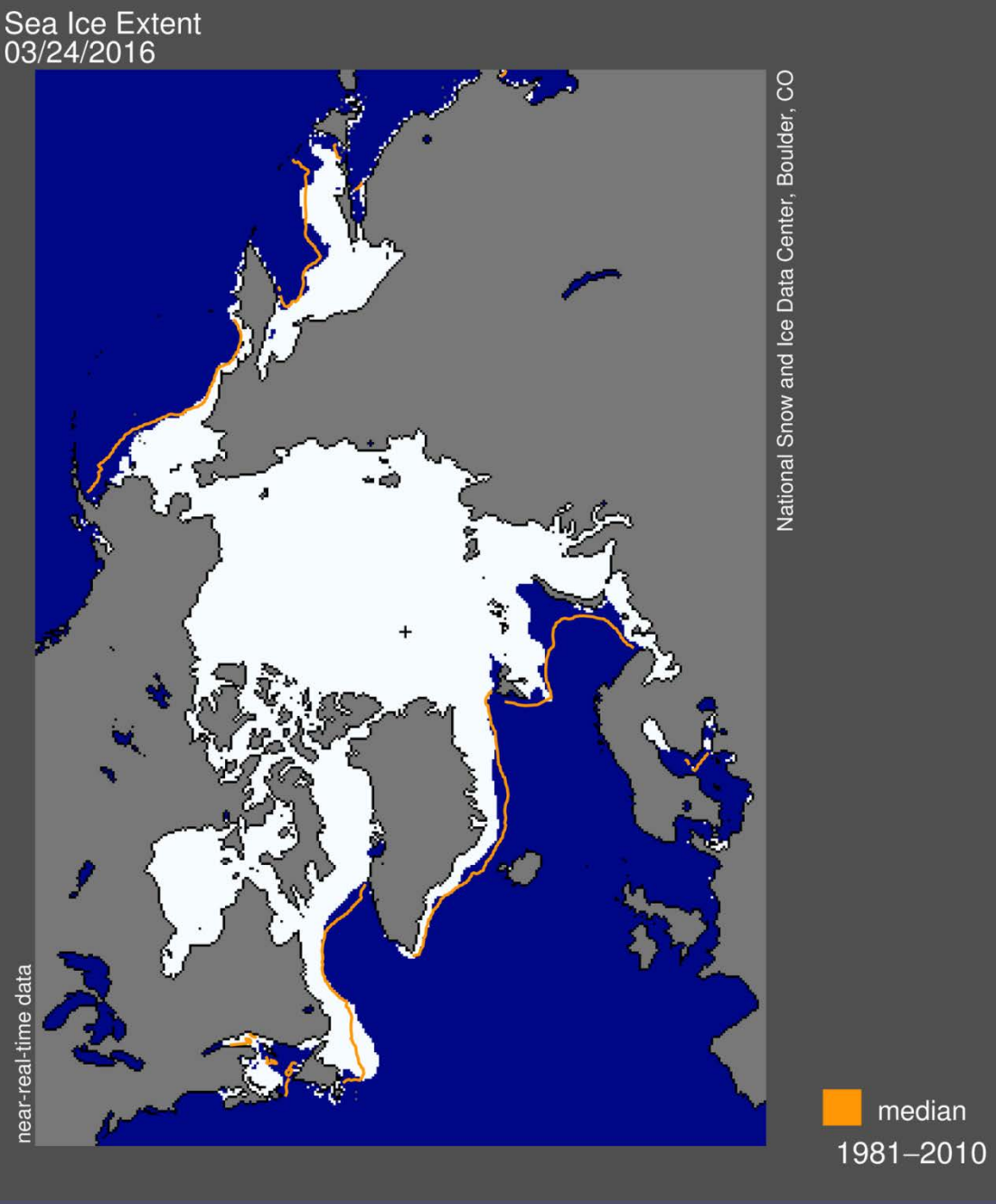
(Wilderbuer)

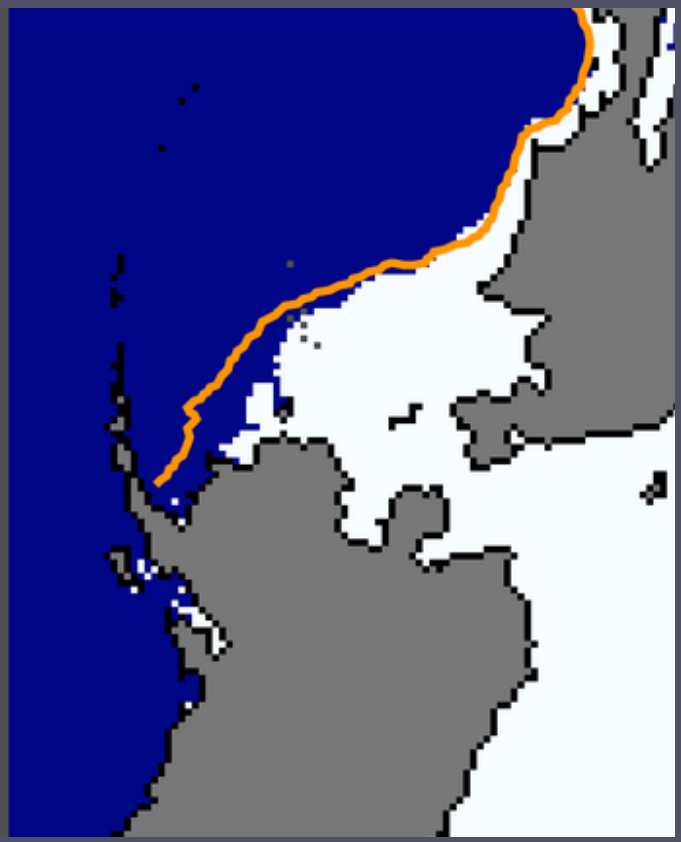


- Direction of wind-forcing during spring linked to flatfish recruitment (northern rock sole)
- Inshore advection to favorable nursery grounds in 2008 and 2015
- 2016 not favorable

EBS sea ice extent
(Overland et al.)

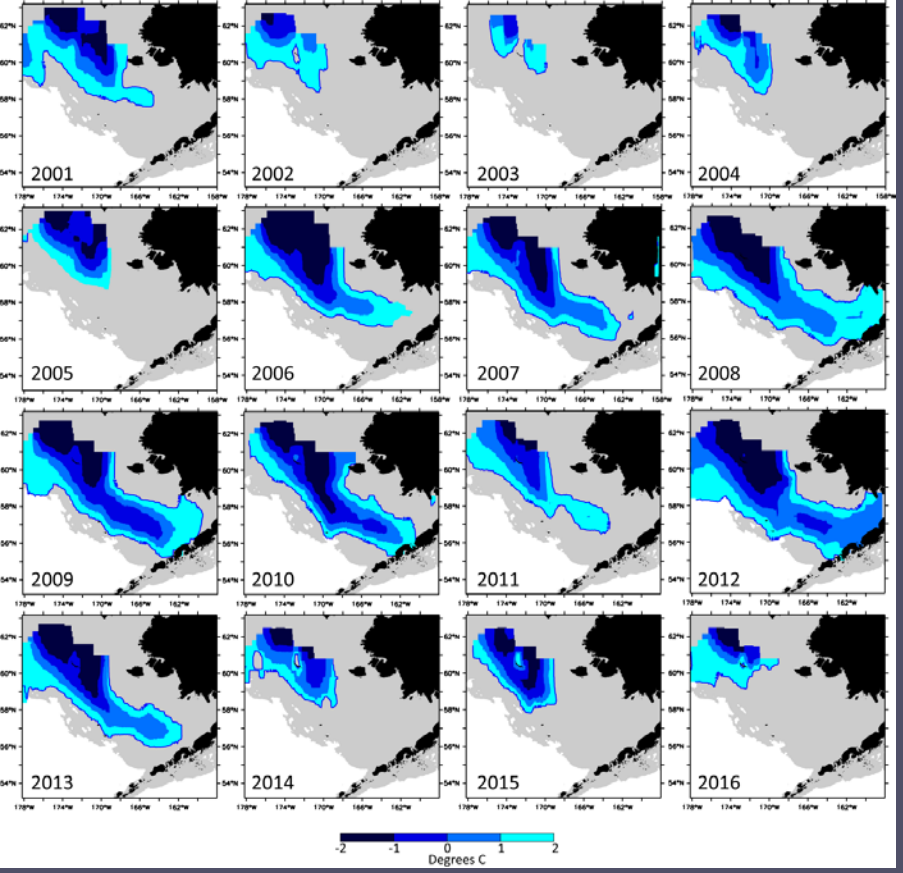
- Record low maximum ice extent, March 24
- EBS-specific TBD



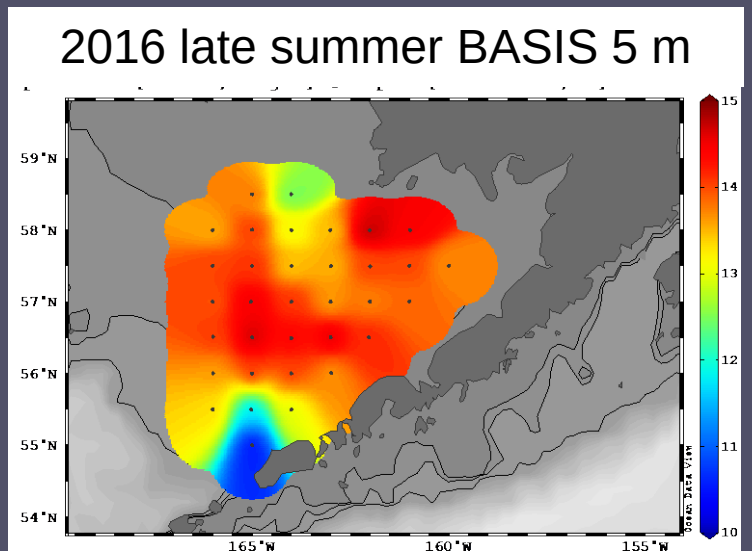


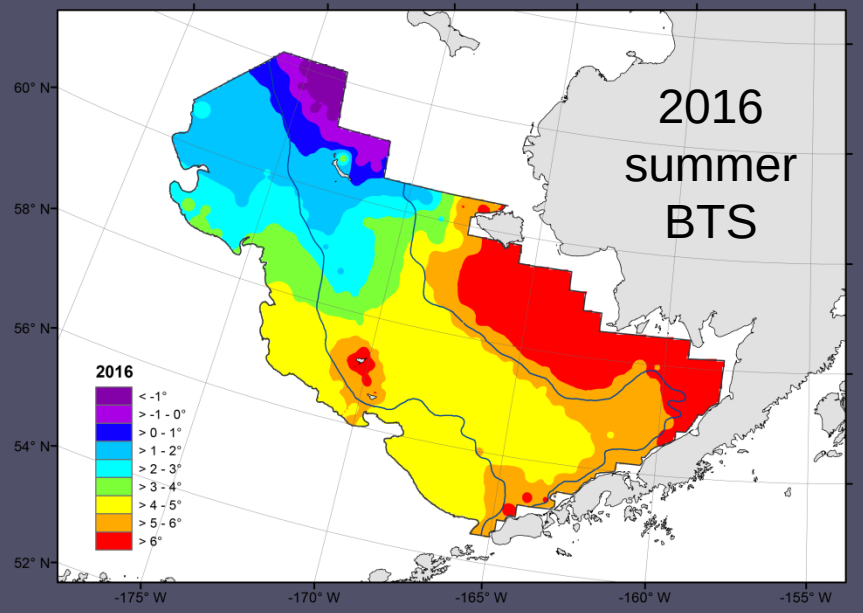
EBS cold pool

(Overland, Lauth, et al.)



- Reduced cold pool (“puddle”)
- Extended warm spell?
- Surface temp 10-15°C and especially warm over the middle domain

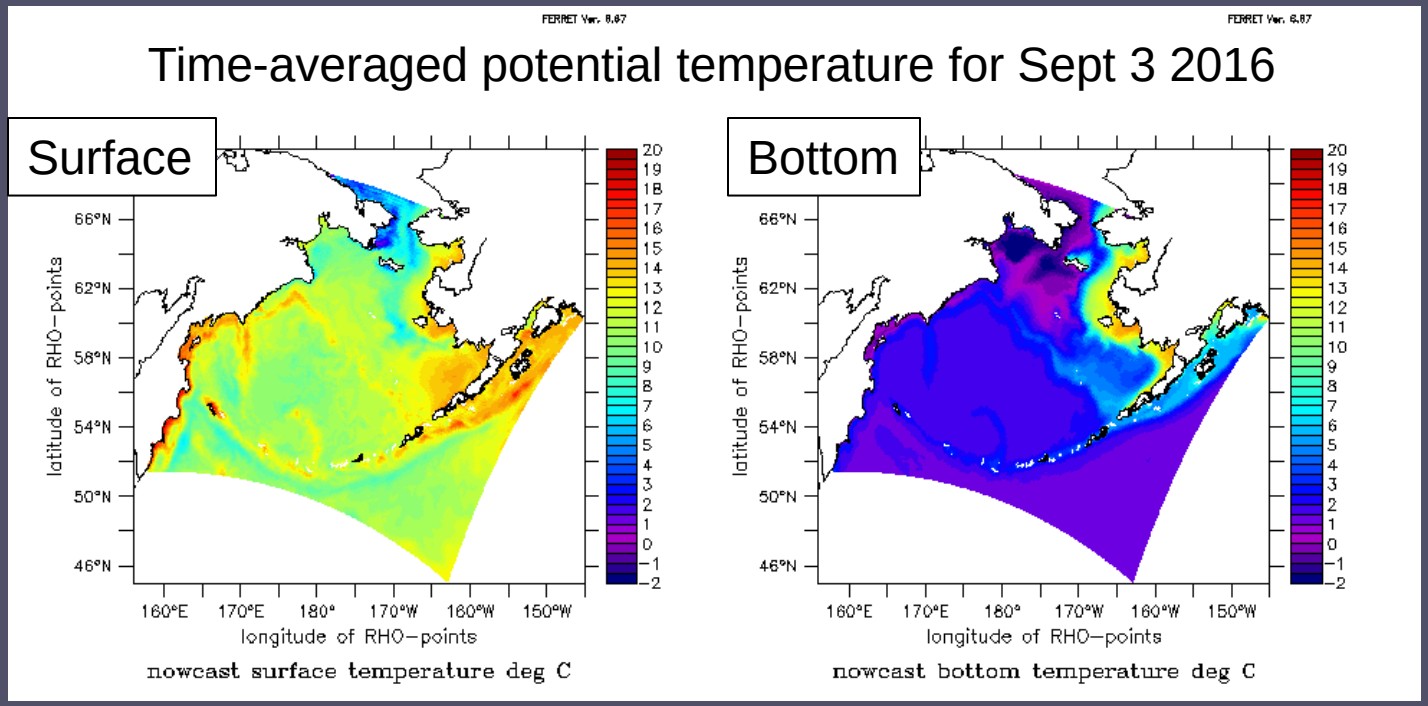




J. Cross, D. Strausz, P. Stabeno (PMEL)

First “nowcast” done (BEST-NPZ)

(Hermann, Aydin, et al.)



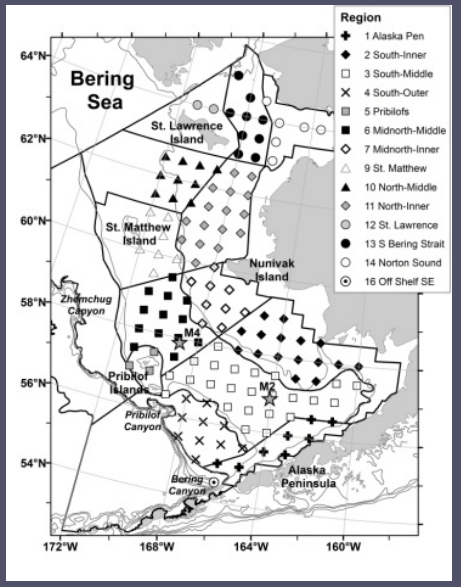
- Surface temps pattern similar to satellite data
- Model can fill in data gap for bottom temps

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

Temperatures below MLD

B)

Domain	Region Name and No.		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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		6.3	7.3
	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		6.1	7.2
	North	11	7.3	7.7	9.0	7.0	6.7	7.1		6.4	6.1	6.8	6.3	5.2	8.8	
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		7.2	7.9
	South	3	4.9	5.2	5.2	5.9	4.1	2.9	2.9	2.6	2.2	3.9	2.0		4.8	5.3
	Pribilofs	5	4.1		7.6	7.5	5.5	4.2		4.2		5.0	3.6		5.9	
	Mid-north	6		5.7	4.3	5.5	2.2	2.9	1.9	3.4	1.9	3.5	2.2		3.4	3.9
	St Matthew	9	3.5	6.0	3.8	4.0	1.5	0.8		0.7	0.7	1.9	1.0		2.5	
	North	10	4.6		3.2	1.3	1.4	1.0		1.3	1.4	0.9		0.6	2.1	
Outer	South	4	6.9	6.8	6.1	6.3	6.0	5.4		5.6	5.0	5.3	5.3		5.5	6.3
> 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	5.5	
	Norton Sound	14	7.3	10.2	11.4		8.1	10.3		8.0	8.6	7.5	6.8	8.2	8.9	
Offshore	southeast	16	5.7	6.7	5.5	6.1	6.0				5.3	5.2			4.5	



Salinity below MLD

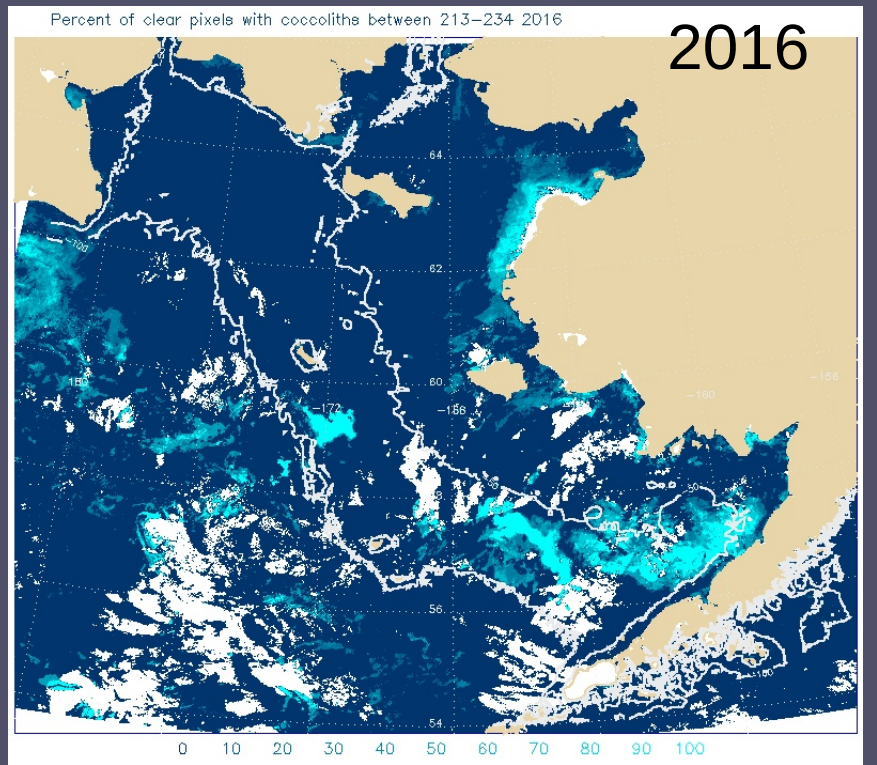
D)

Domain	Region Name and No.		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Inner	South	2	31.40	31.25	31.05	31.17	30.96	31.30	31.18	31.07	31.26	30.90	31.30		31.90	31.82
	Mid-north	7	31.48	31.25	31.20	31.20	30.88	30.99	31.21	31.28	31.29	31.06	31.12		31.67	31.96
	North	11	30.54	30.65	30.68	31.04	30.66	30.77		30.91	30.77	30.91	30.93	30.74	30.17	
Middle	AK Penn	1	32.12	31.94	32.02	32.08	32.01	32.18	31.89	32.05	31.99	32.21	32.16		32.15	32.24
	South	3	32.07	31.88	31.96	32.08	31.88	31.81	31.91	31.77	31.73	31.94	31.81		32.08	31.93
	Pribilofs	5	33.14		32.07	32.09	32.07	31.91		32.24		32.08	32.09		32.21	
	Mid-north	6		32.06	31.97	32.07	31.83	31.64	31.74	31.61	31.53	31.63	31.72		32.03	32.07
	St Matthew	9	31.64	31.57	31.57	32.04	31.38	31.52		31.54	31.15	31.24	31.49		31.25	
	North	10	31.68		31.13	31.60	31.37	31.75		31.45	31.77	31.39		31.61	31.31	
Outer	South	4	32.76	32.61	32.48	32.49	32.53	32.59		32.66	32.51	32.64	32.61		32.64	32.45
> 63°N	St Lawrence	12	32.22	31.72	32.12		31.99	31.80		31.90	31.68	32.22	31.80	31.59		
	S Bering Strait	13	31.46	31.49	31.24	31.21	31.62	31.68		31.68	31.56	31.75	32.00	31.69	31.77	
	Norton Sound	14	29.11	27.95	29.80		29.69	29.15		29.98	29.80	29.51	29.71	29.92	29.66	
Offshore	southeast	16	33.17	32.74	33.09	33.22	32.74				32.91	33.02			33.47	

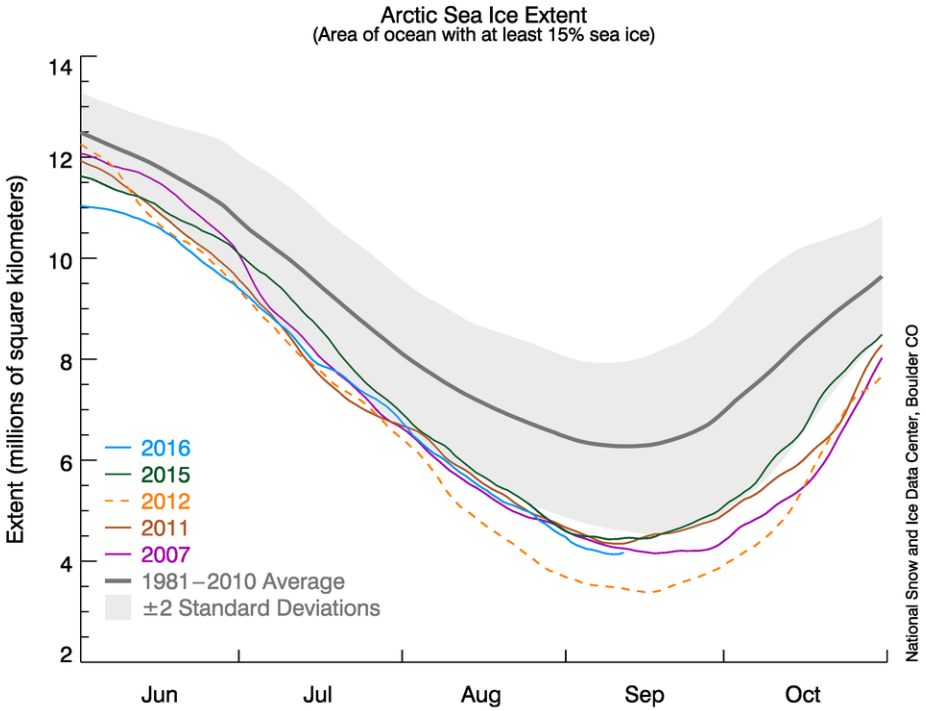
- Temps and salinity above and below mixed layer depth
- Below better reflects longer term climatic shifts
- Above influenced by episodic mixing events

Coccolithophores
(Ladd and Eisner)

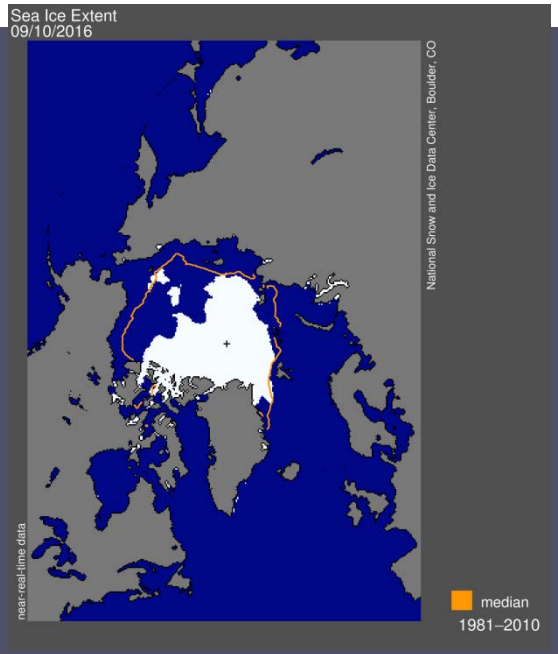
- Preliminary data suggests bloom this year
- Trophic implications – smaller than diatoms -> longer chains; less desirable for microzooplankton
- Neg impacts on visual foragers

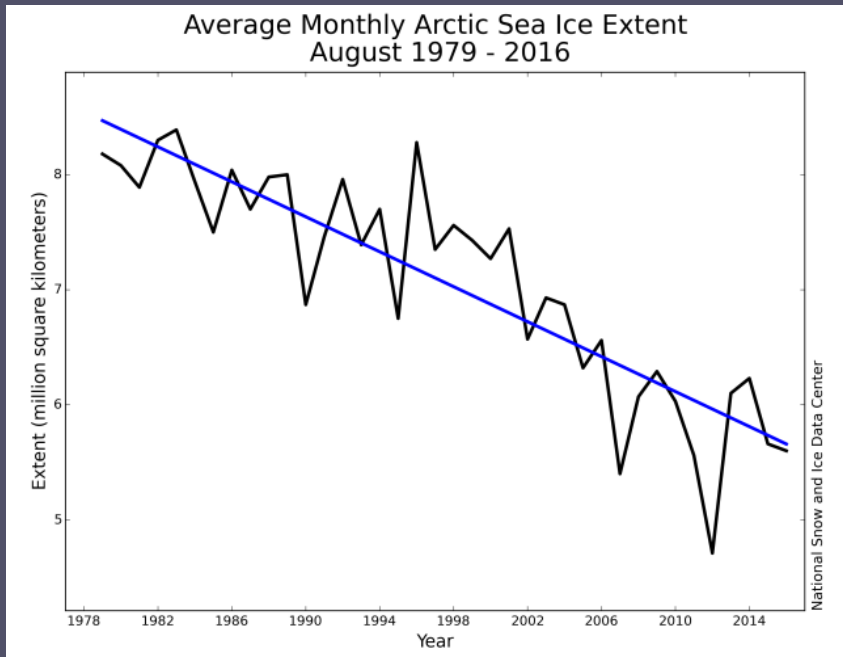


Arctic Sea Ice Extent

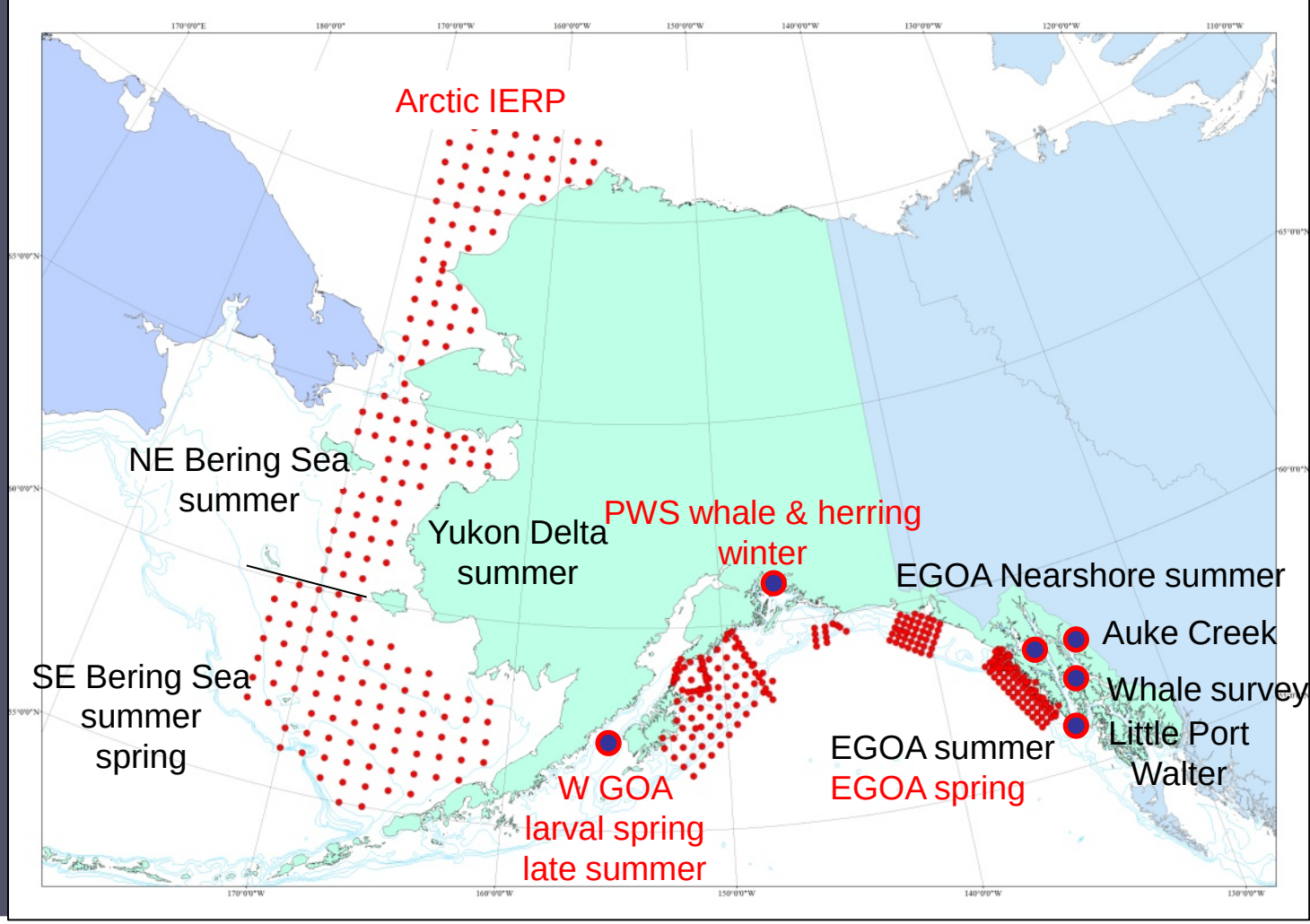


- 2016 ties with 2007 for second lowest ice minimum
- 4th lowest August extent
- 10.4% decline per decade





AFSC



2016 Ecosystem Surveys & Observations

Courtesy: Farley

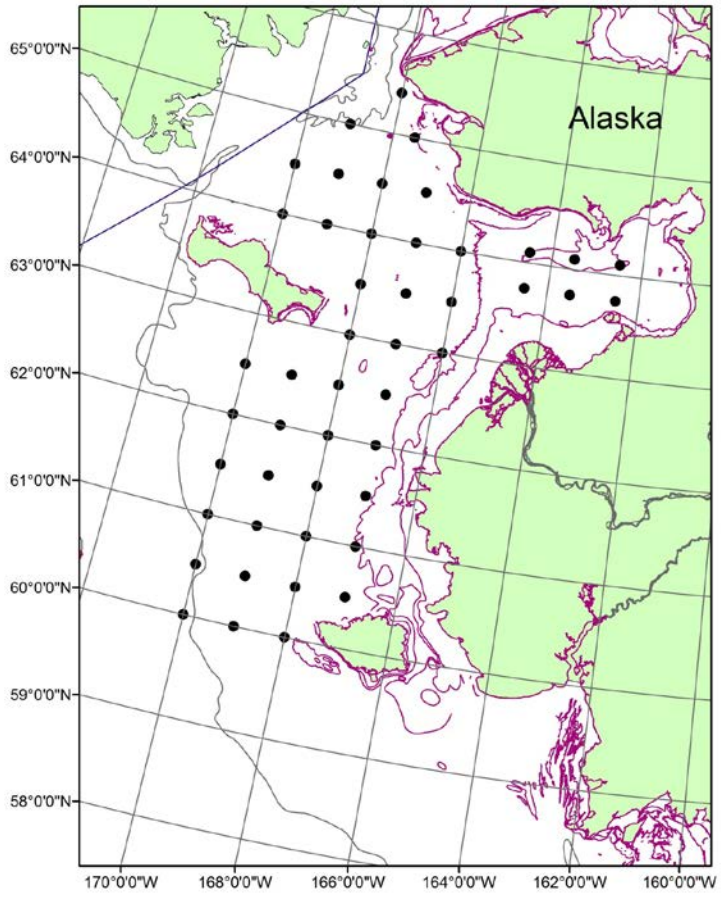
Northern Bering Sea Surveys

- Provide FEAST model input
- Assessing the impacts of the loss of sea ice on marine species

Contact: Kristin Cieciel and Katharine Miller

Northern Bering Sea survey

Station locations



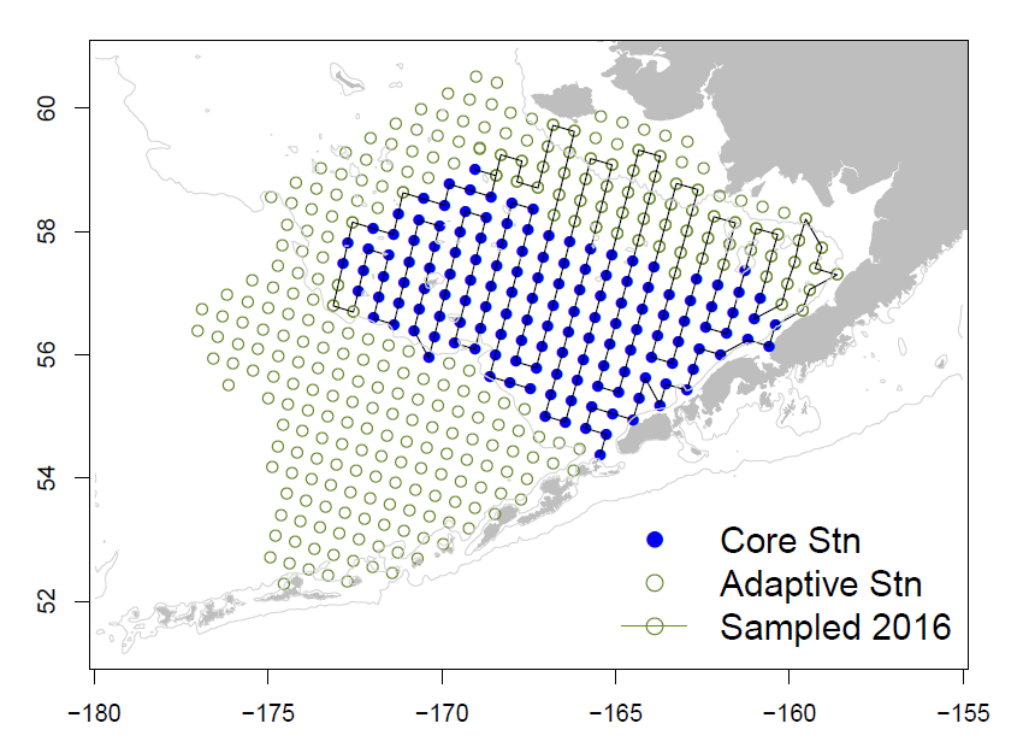
- 2003-2016 late summer
- Surface trawl and oceanography
- Pollock, salmon, forage fish, jellyfish
- Large catches of age-0 pollock
- Large catches of juvenile chum
- Juvenile Chinook salmon abundance index predict returns to the upper Yukon River (Murphy).
- In cold years, volume of river discharge predicts the abundance of juvenile Chinook salmon (Gann in prep.)

Contact: Kristin Ciecie

Southern Bering Sea Surveys

- Studying mechanisms driving the variability in pollock recruitment
- Provide information on warm/cold years and zooplankton communities that influence recruitment and overwintering success of pollock
- Implications for predicting summer bycatch of chum salmon

2016 Spring egg & larval survey



Survey redesign

Core stations, stations farther apart, and adaptive sampling based on pollock abundance

Eggs and larvae of groundfish (esp. pollock, flatfishes)

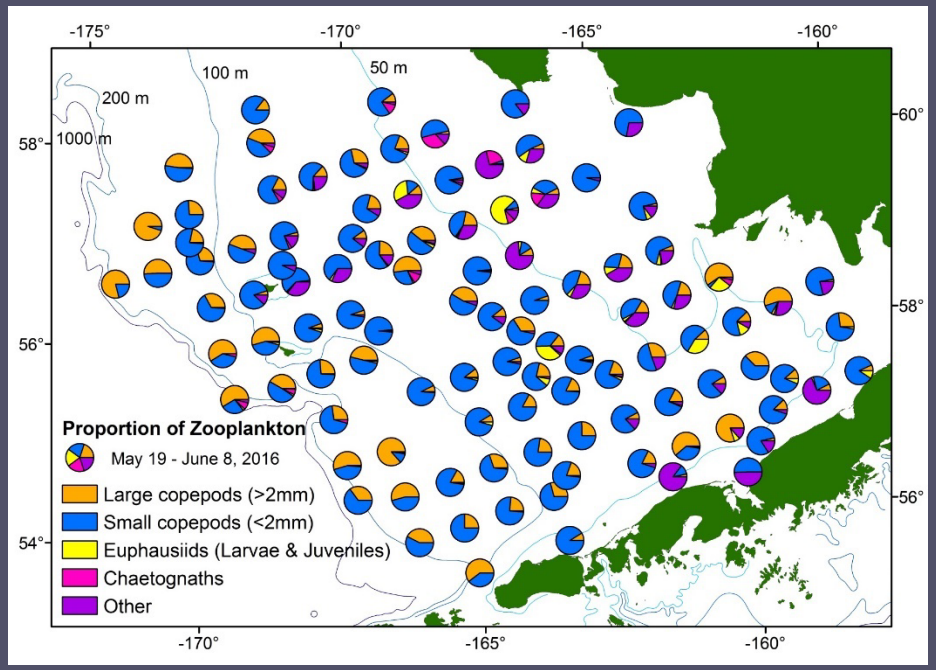
Abundance, size, condition
Zooplankton community
Temperature, salinity

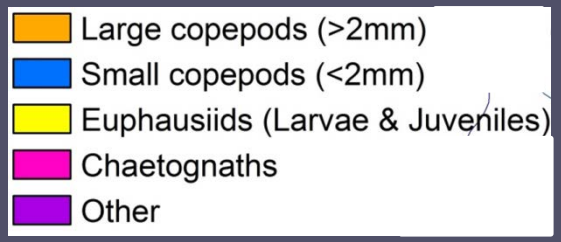
Rapid assessments at sea

Zooplankton species composition
Larval pollock abundance
Larval Pollock distribution

Contact: Janet Duffy-Andersen

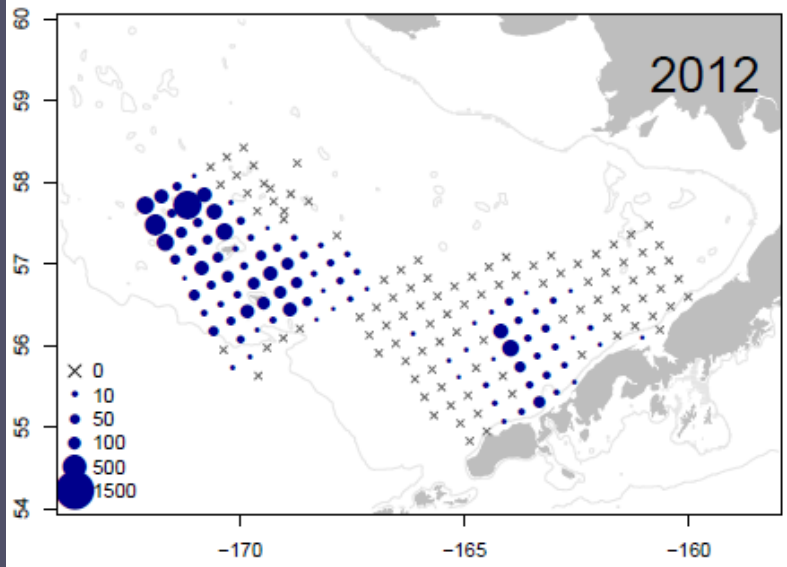
Rapid assessment spring zooplankton community

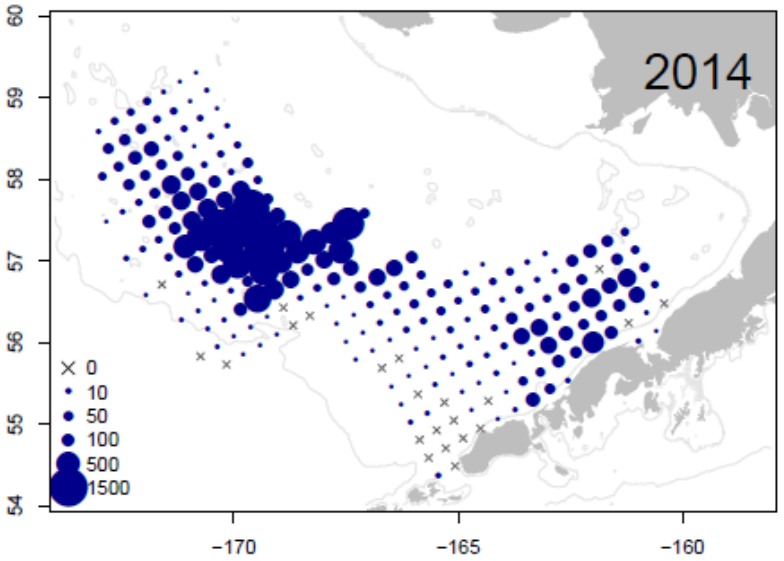


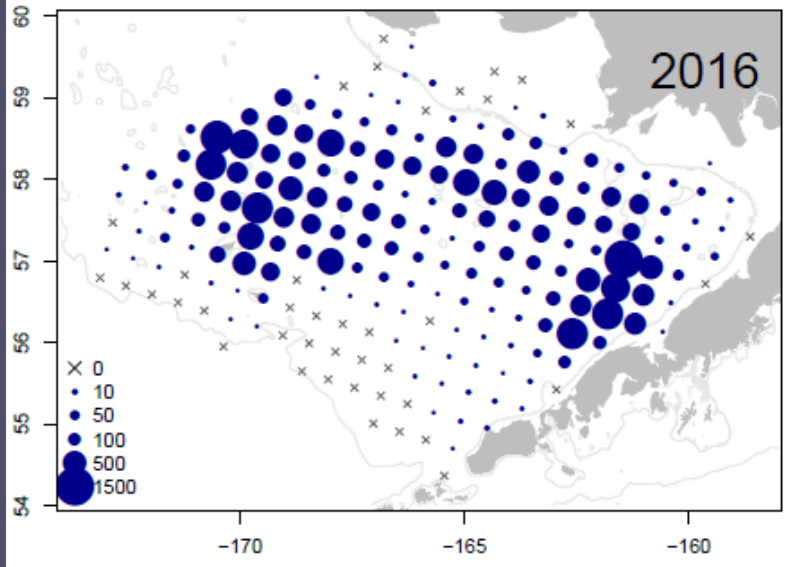


- 2016 dominated by small copepods, as expected with warmer conditions
- Smaller copepods are less energy-rich prey for pollock
- Few large copepods in the inner and middle domains, where the majority of pollock larvae were found

Spring rapid assessment Larval pollock counts

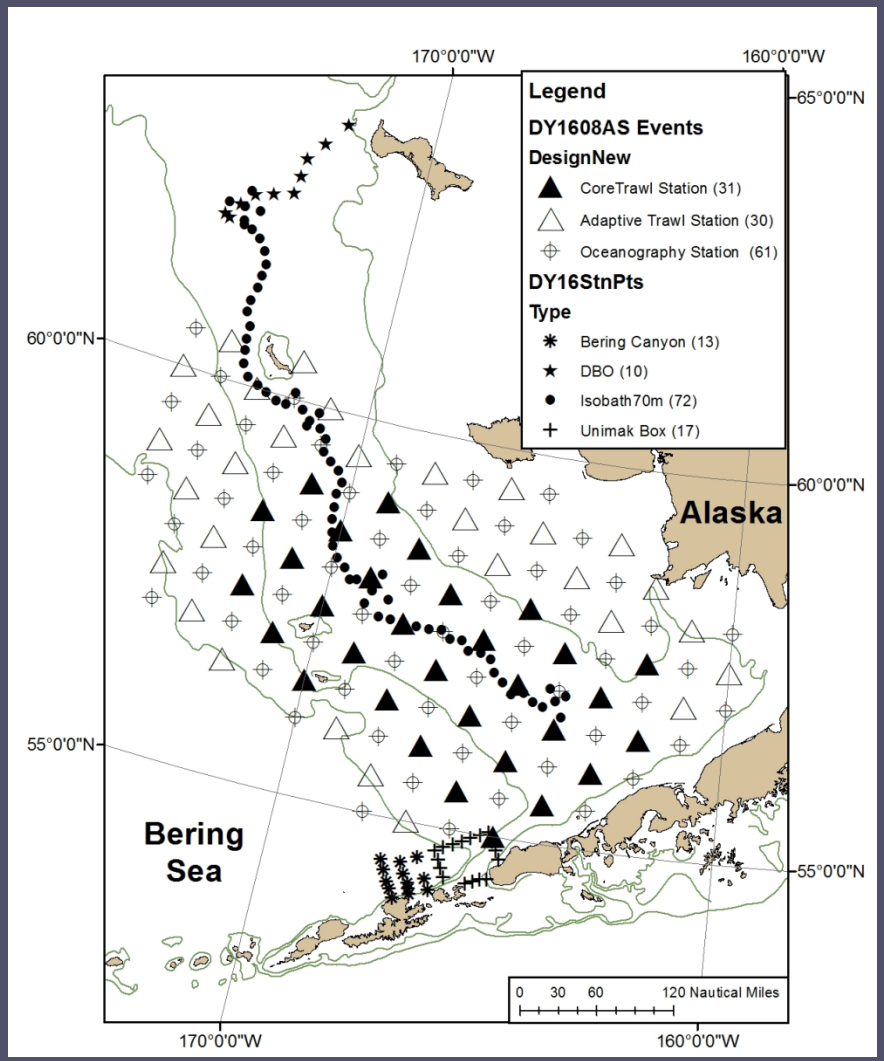






- High larval pollock counts in 2016
- Distributed on-shelf, consistent with warm-year observations
- Likely reflects changes in spawning location and currents (Petrik et al. 2014, Smart et al. 2012)
- Ongoing research: how does spatial overlap with prey affect condition, survival?

2016 late summer EBS survey



Survey redesign

Combined surface, mid-water trawls with acoustics in 2016.

Age-0 pollock, P. cod, capelin, herring, salmon, atka mackerel, sablefish, jellyfish

Energy density of age-0 pollock to predict over-wintering survival

Rapid assessments

Zooplankton
Age-0 Pollock abundance
Age-0 Pollock distribution

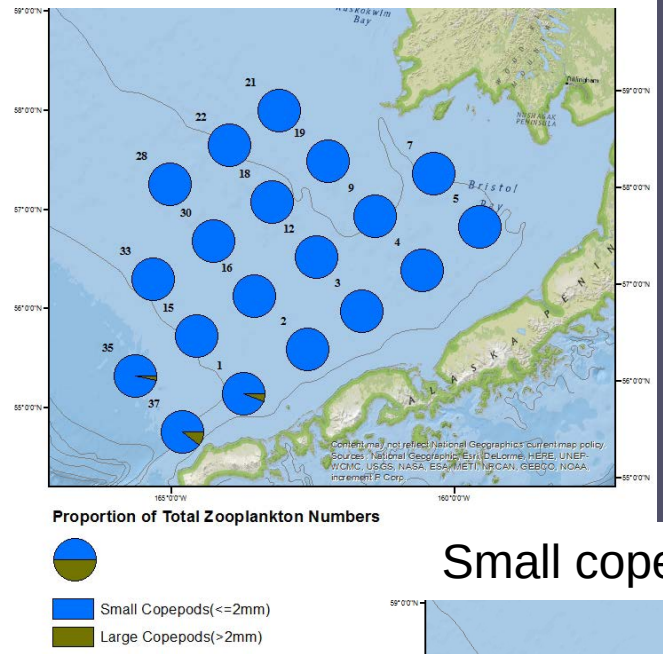
Contact: Elizabeth Siddon

Late summer zooplankton rapid assessment

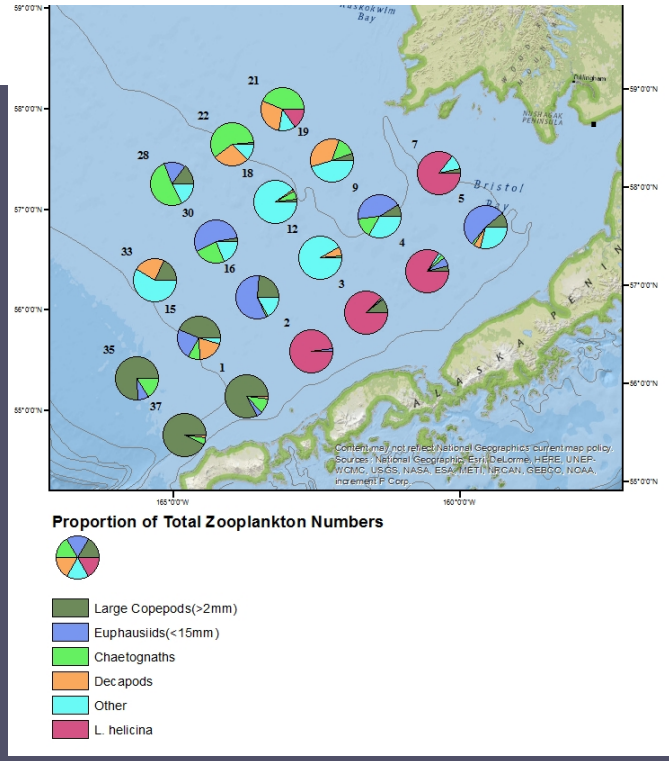
(Lamb, Spear, Siddon (RPA))

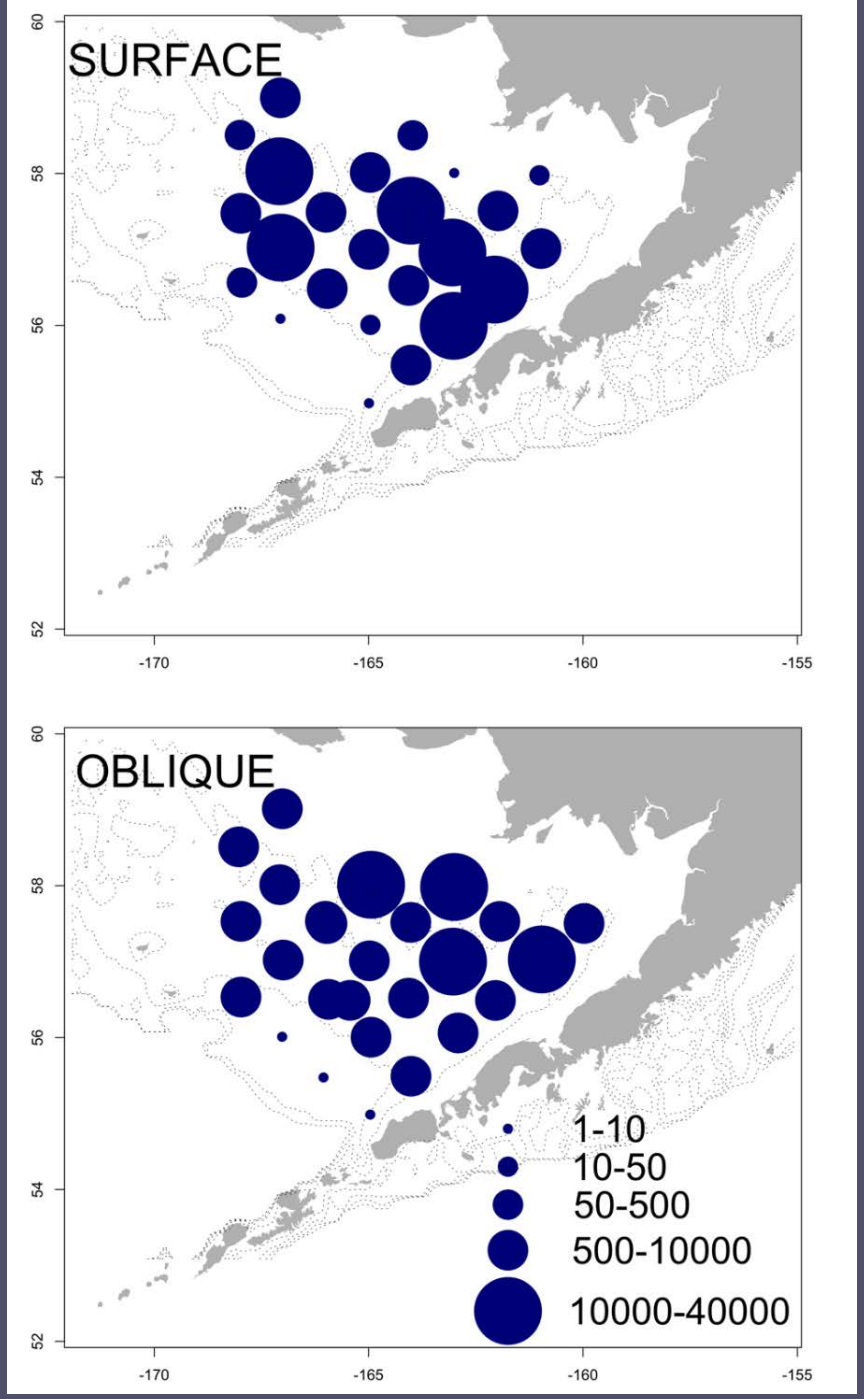
- Overall low zooplankton volume
- Small copepods dominated the rough count numbers, but *Pseudocalanus* spp. was rare
- Large copepods (i.e., *Calanus marshallae*) present in southwest.
- Euphausiids juveniles absent in northern middle to inner domains

Proportion total zooplankton



Small copepods removed





Late summer age-0 pollock

(Andrews, Siddon, Cooper (RPA))

- High catches of age-0 pollock in surface and oblique (midwater)
- Age-0 pollock distribution shifted eastward (middle and inner domains)
- Outer domain increase in zooplankton concurrent with drop in age-0 pollock biomass...spatial mismatch (Siddon)
- Age-0 pollock were the dominant prey of salmon, sandfish, rainbow smelt, age-1 & adult pollock

Summary of 2016 Observations

- Warm
- Low zooplankton biomass and lower-lipid taxa in EBS and EGOA
- High catches of larval & age-0 pollock in the EBS
  - Expect low overwintering survival
- High catches of juvenile chum salmon in the NEBS