ECOSYSTEM CONSIDERATIONS

Status of the Eastern Bering Sea Marine Ecosystem

Elizabeth (Ebett) Siddon
Stephani Zador

BSAI Groundfish Plan Team meeting
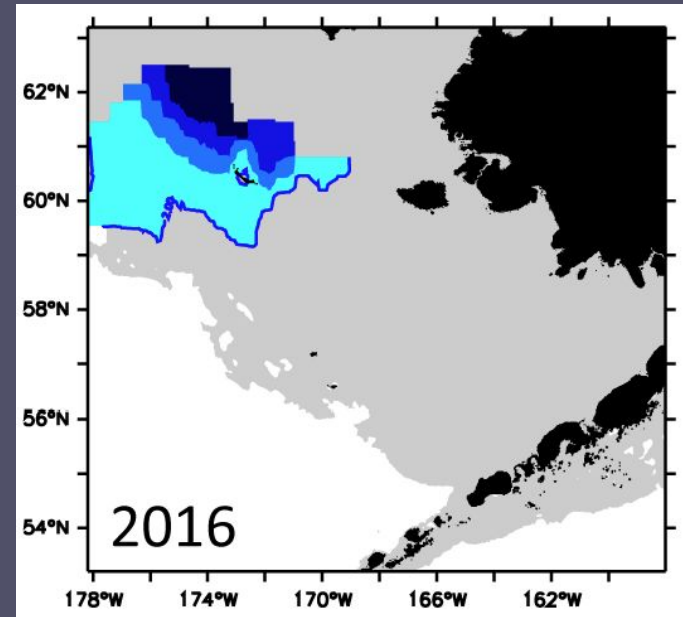November 14, 2017

Outline

- Past - 2016
- Present - 2017
  - Report Card
  - Ecosystem highlights and Hot Topics
- Future – Forecasts and predictions
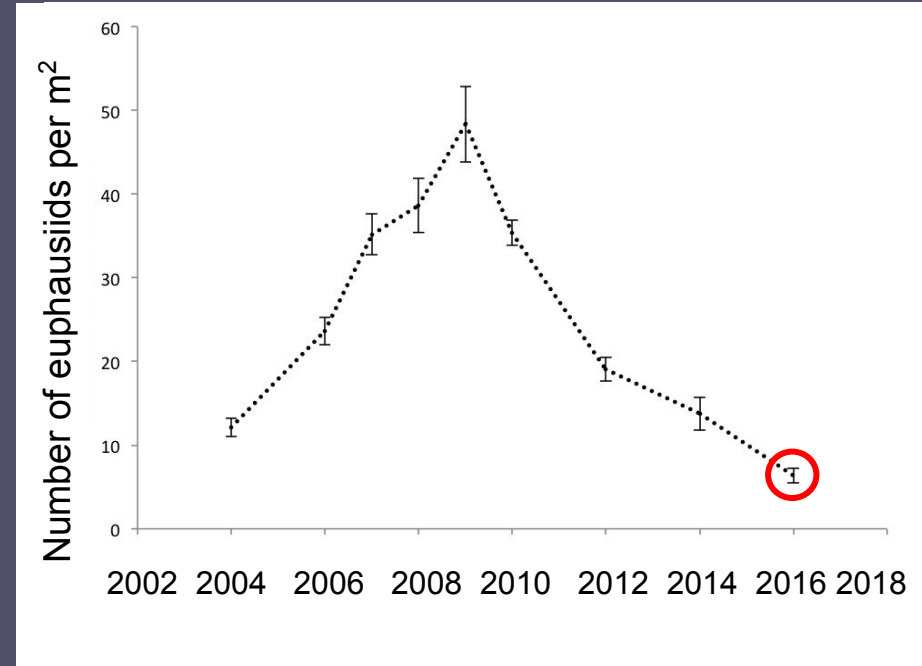
Complete recap of 2016

- WARM!!

Cold 'puddle'

Overland et al.

- WARM!!

- Small copepods predominant

- WARM!!

- Small copepods predominant

- Euphausiids were rare
  - lowest abundance in the time series

Complete recap of 2016

- WARM!!

- Small copepods predominant

- Euphausiids were rare

- Jellyfish declined from peak
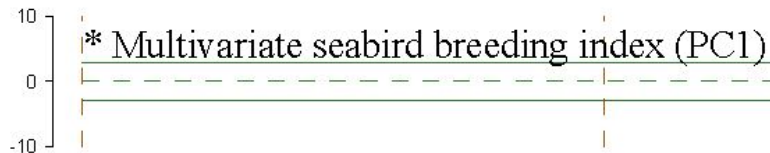
Complete recap of 2016

- WARM!!

- Small copepods predominant

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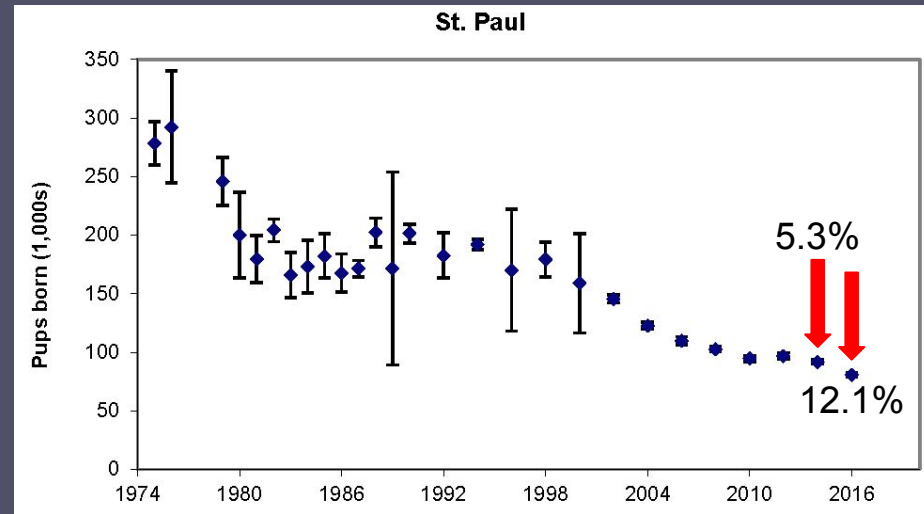- Aggregated CPUE in the bottom trawl survey remained high

Complete recap of 2016

- WARM!!

- Small copepods predominant

- Euphausiids were rare

- Jellyfish declined from peak

- Aggregated CPUE in BT survey remained high

- Groundfish condition improved for all, except Arrowtooth

- WARM!!

- Small copepods predominant

- Euphausiids were rare

- Jellyfish declined from peak

- Aggregated CPUE in BT survey remained high

- Groundfish condition improved

- Poor seabird productivity, die-off, and high bycatch rates
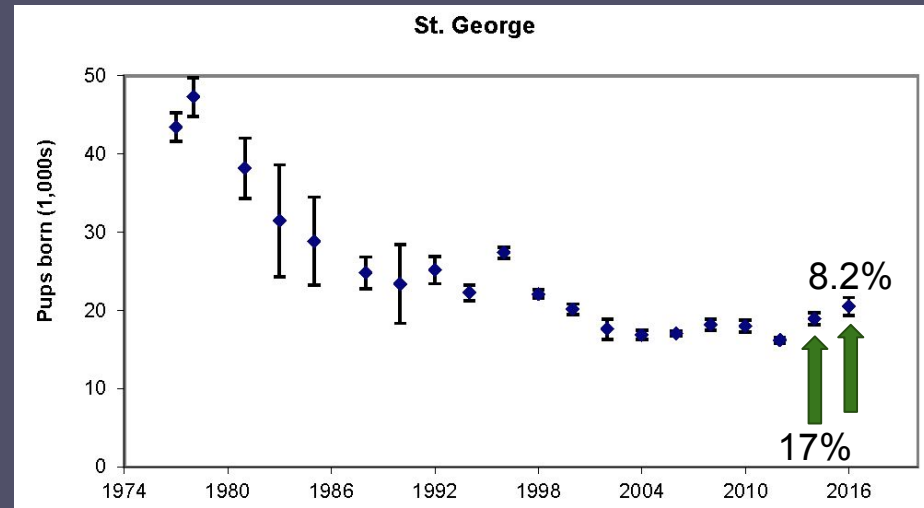

*Multivariate seabird breeding index (PC1)

Complete recap of 2016

- WARM!!
- Small copepods predominant
- Euphausiids were rare
- Jellyfish declined from peak
- Aggregated CPUE in BT survey remained high
- Groundfish condition improved
- Poor seabird productivity, die-off, and high bycatch rates
- Northern fur seal pup production mixed

St. Paul

5.3%

12.1%

Pups born (1,000s)

1974 1980 1986 1992 1998 2004 2010 2016

Towell et al.

Complete recap of 2016

- WARM!!

- Small copepods predominant

- Euphausiids were rare

- Jellyfish declined from peak

- Aggregated CPUE in BT survey remained high

- Groundfish condition improved

- Poor seabird productivity, die-off, and high bycatch rates

- Northern fur seal pup production mixed

St. George

8.2%

17%

Towell et al.

New human dimensions indicators included in the 2017 Report (reflect 2016 patterns):

Seafood Production (Fissel et al., Wise and Sparks)

Profits (Fissel et al.)

Recreation (D. Lew and J. Lee)
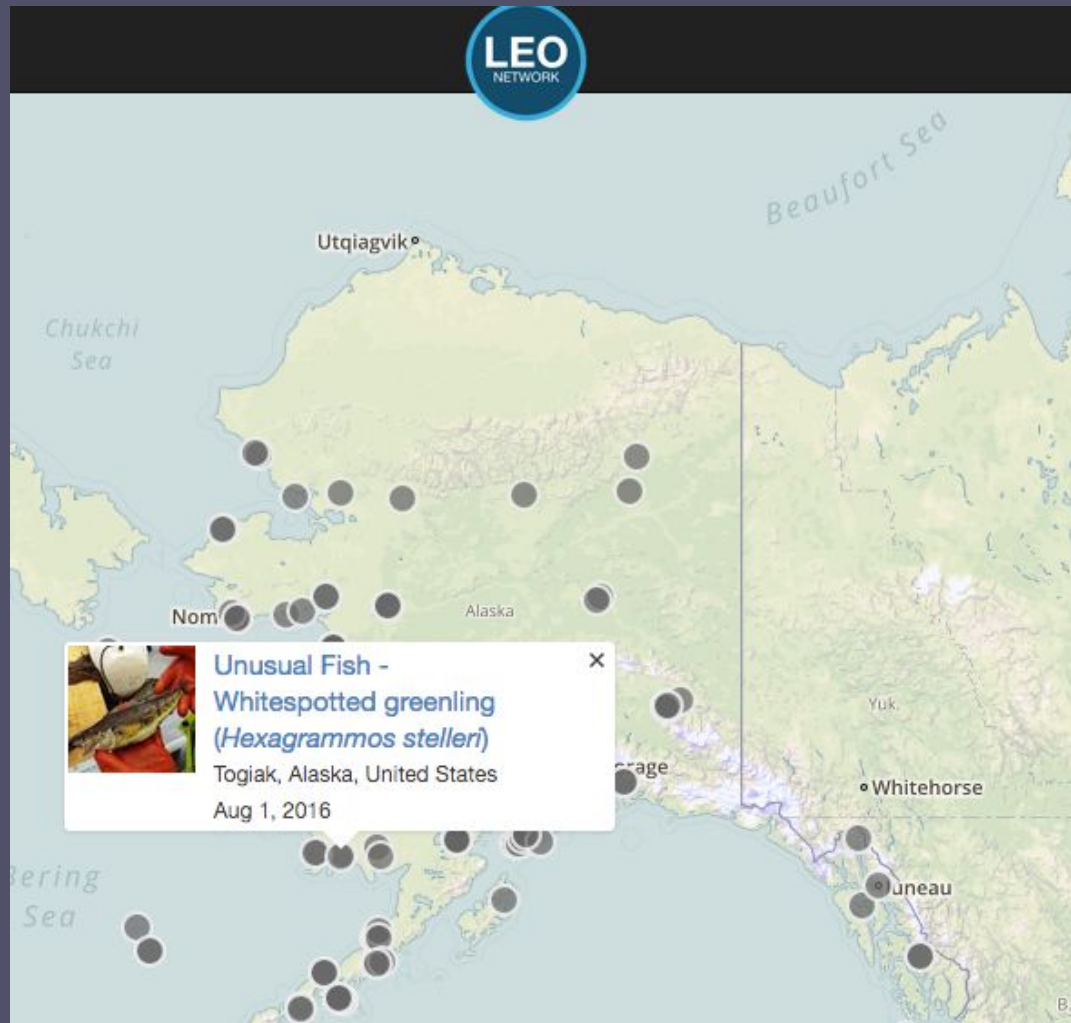
Employment (EBS and NBS; A. Lavoie)

Population trends (EBS and NBS; A. Lavoie)

School enrollment (Wise and Sparks)

These indicators do not depict any red flags (generally), but detailed patterns need further investigation.
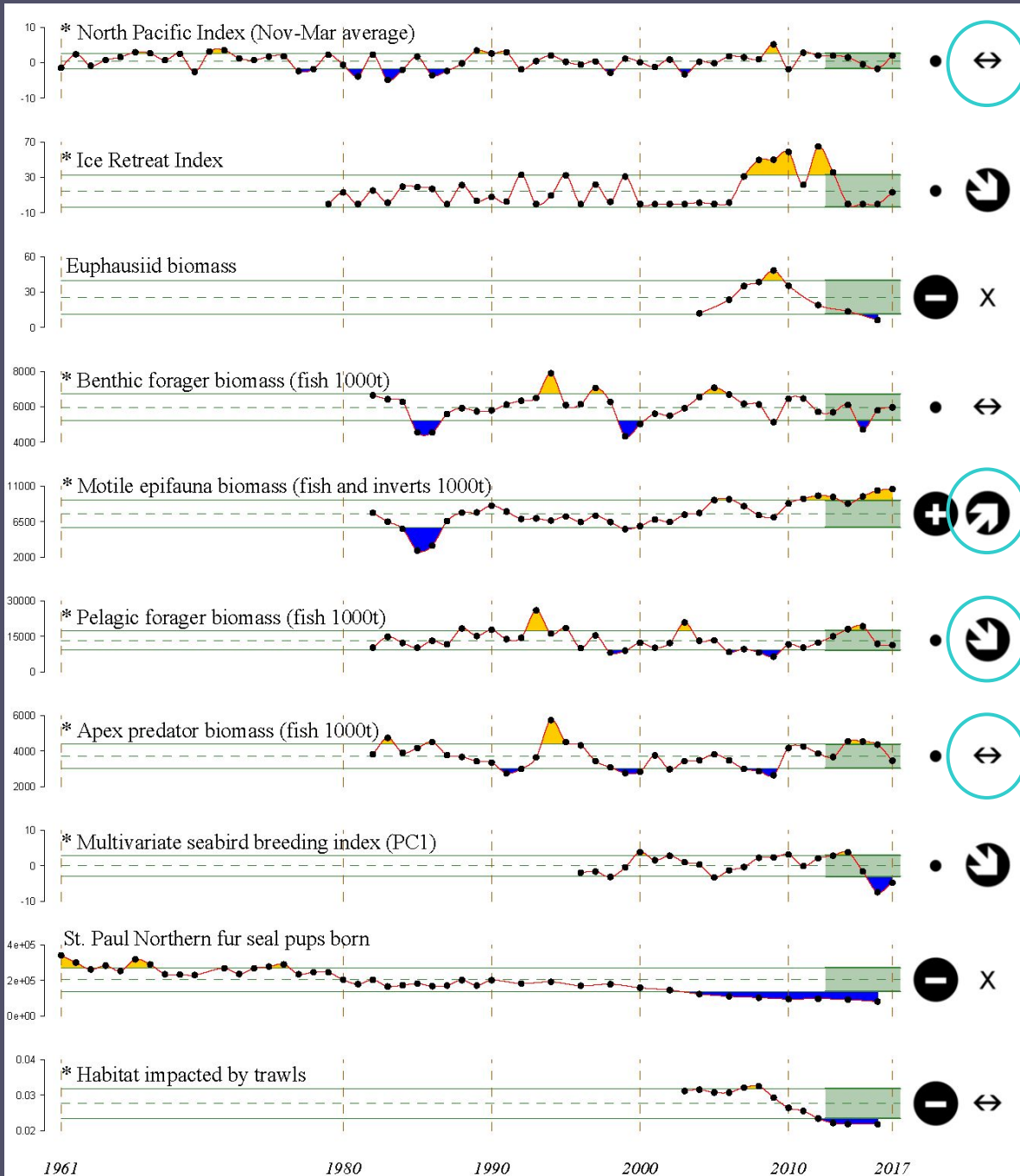
Hot Topic:
Local Environmental Observer (LEO) Network
(M. Szymkowiak)

- Citizen science observations

- Launched in 2012

- Unusual/notable environmental events

- Classified by relevant category

- Avenue for community engagement in fisheries management process
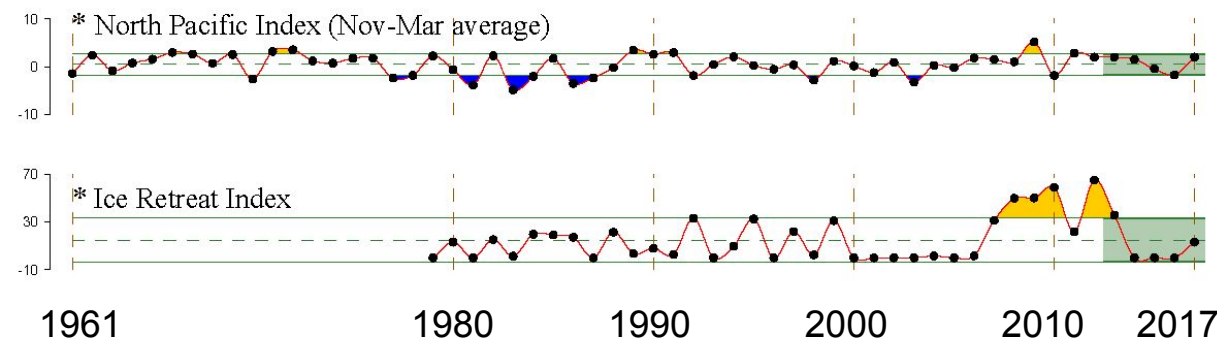
- Seeking feedback

2017 EBS Report Card

* North Pacific Index (Nov-Mar average)

* Ice Retreat Index

Euphausiid biomass

* Benthic forager biomass (fish 1000t)

* Motile epifauna biomass (fish and inverts 1000t)

* Pelagic forager biomass (fish 1000t)

* Apex predator biomass (fish 1000t)

* Multivariate seabird breeding index (PC1)

St. Paul Northern fur seal pups born

* Habitat impacted by trawls

1961   1980   1990   2000   2010   2017

2013-2017 Mean
+ 1 s.d. above mean
− 1 s.d. below mean
• within 1 s.d. of mean
x fewer than 2 data points

2013-2017 Trend
↱ increase by 1 s.d. over time window
↴ decrease by 1 s.d. over time window
↔ change <1 s.d. over window
x fewer than 3 data points

2017 EBS Physical Conditions

* North Pacific Index (Nov-Mar average)

* Ice Retreat Index

1961   1980   1990   2000   2010   2017

Maximum Ice Extent

March 30, 2001 --
February 18, 2002
March 21, 2003 --
April 3, 2004
April 8, 2005 --
February 2, 2006
March 22, 2007 --
March 31, 2008

March 29, 2009 --
April 3, 2010
April 13, 2011 --
March 25, 2012
March 27, 2013 --
March 15, 2014
March 17, 2015 --
April 9, 2016
March 30, 2017 --
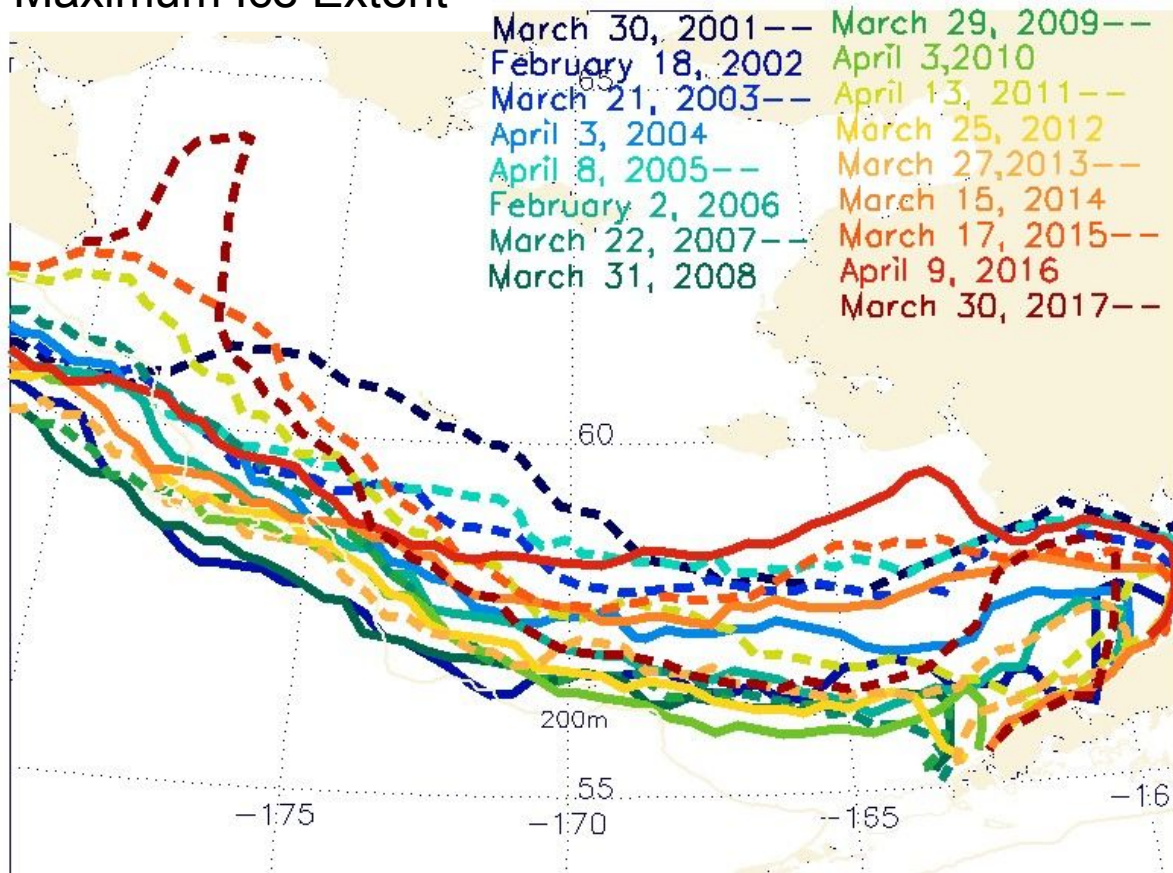
Unusual sea ice extent pattern

Similar to 2012, but retraction in Gulf of Anadyr and Bristol Bay

Surface and Bottom Temperatures: moderately warm
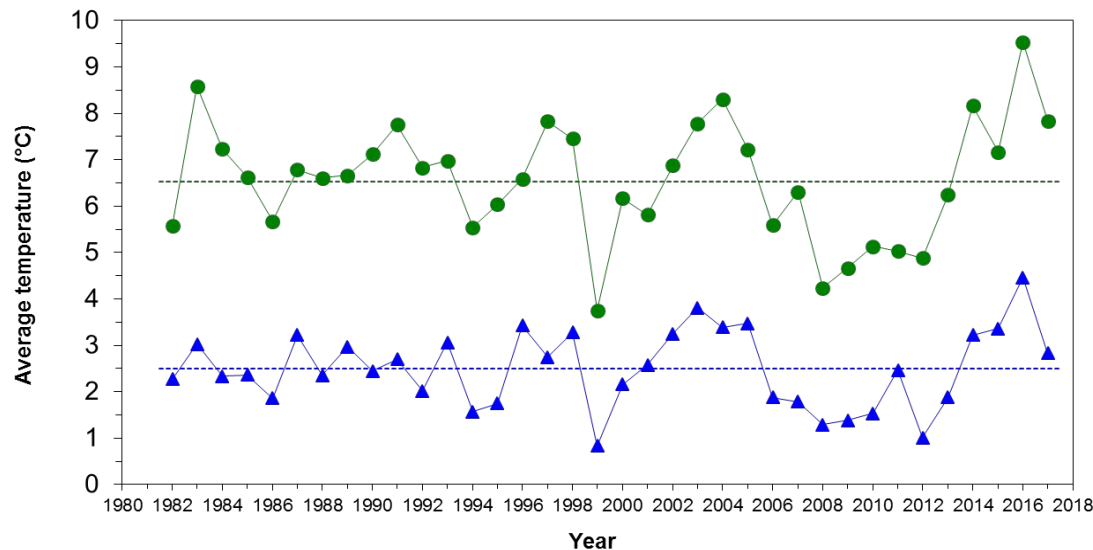
Cold Pool: extensive, but
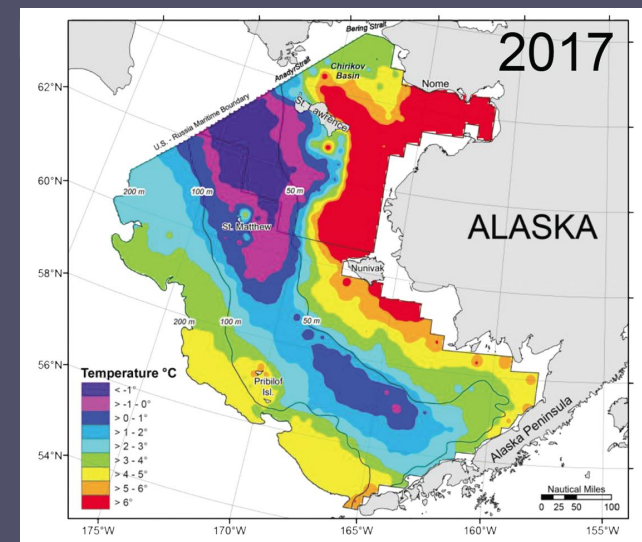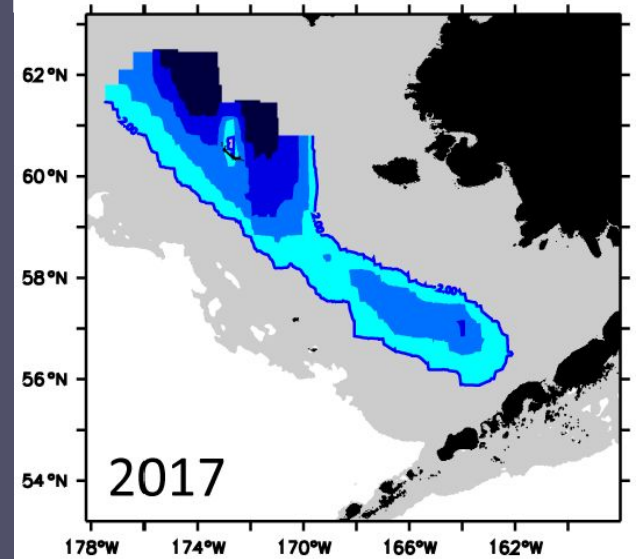
Hot Topic:
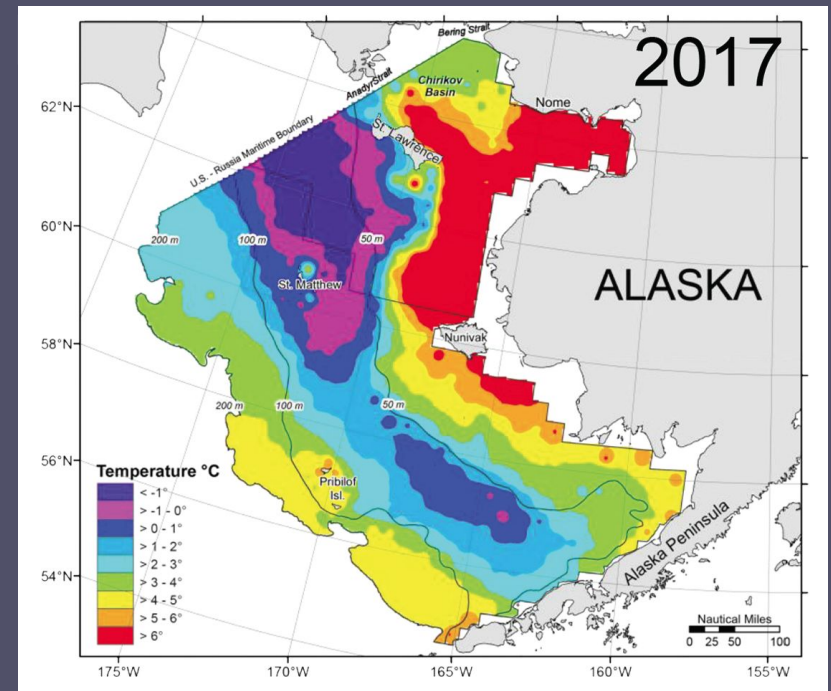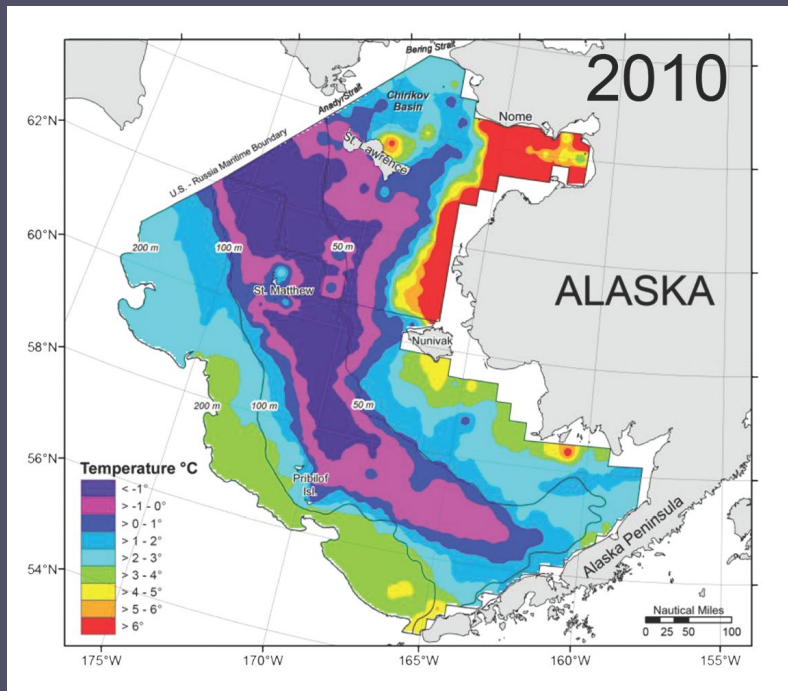## Thinking Outside the Survey Box
(B. Lauth and L. Britt)

In 2017, the bottom trawl survey extended northward to study the impacts of diminished sea ice on the ecosystem.
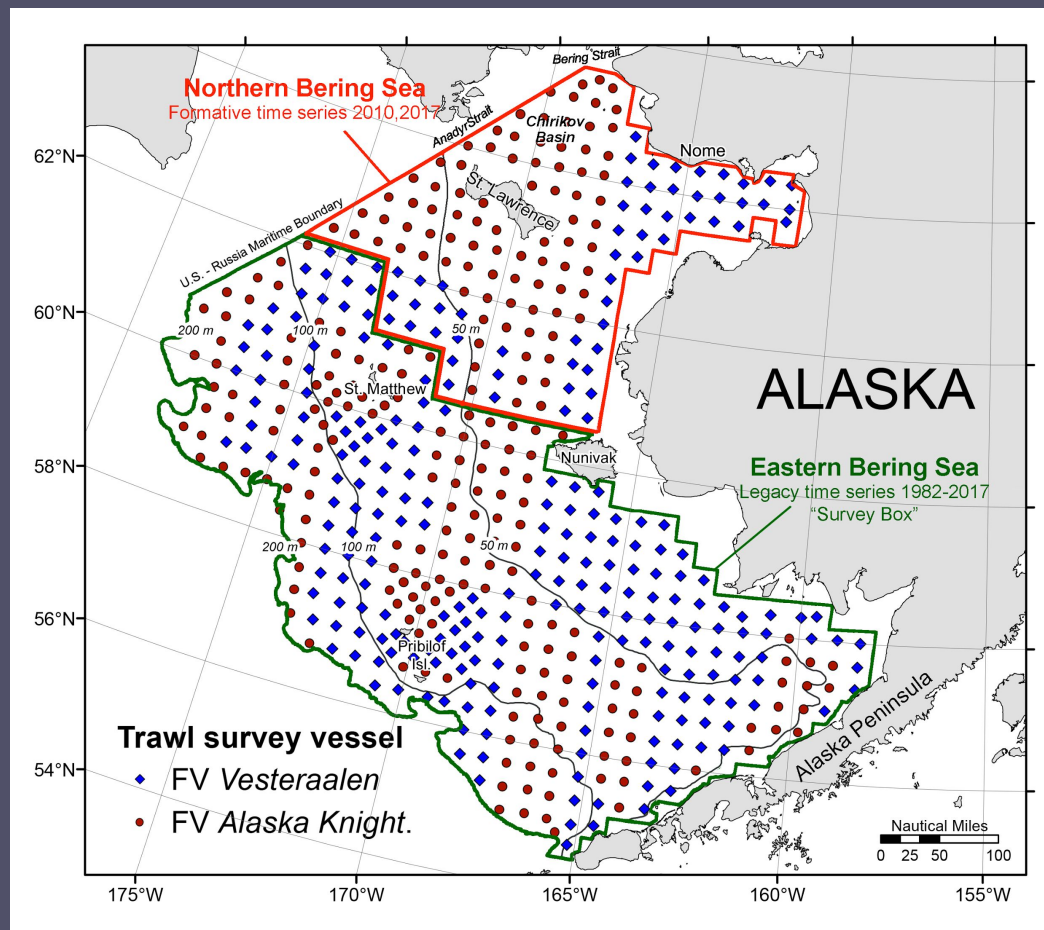
Hot Topic:
Thinking Outside the Survey Box
(B. Lauth and L. Britt)

The inner domain of the northern Bering Sea experienced very warm conditions while the southern shelf, especially the middle domain, was cooler.

Hot Topic:
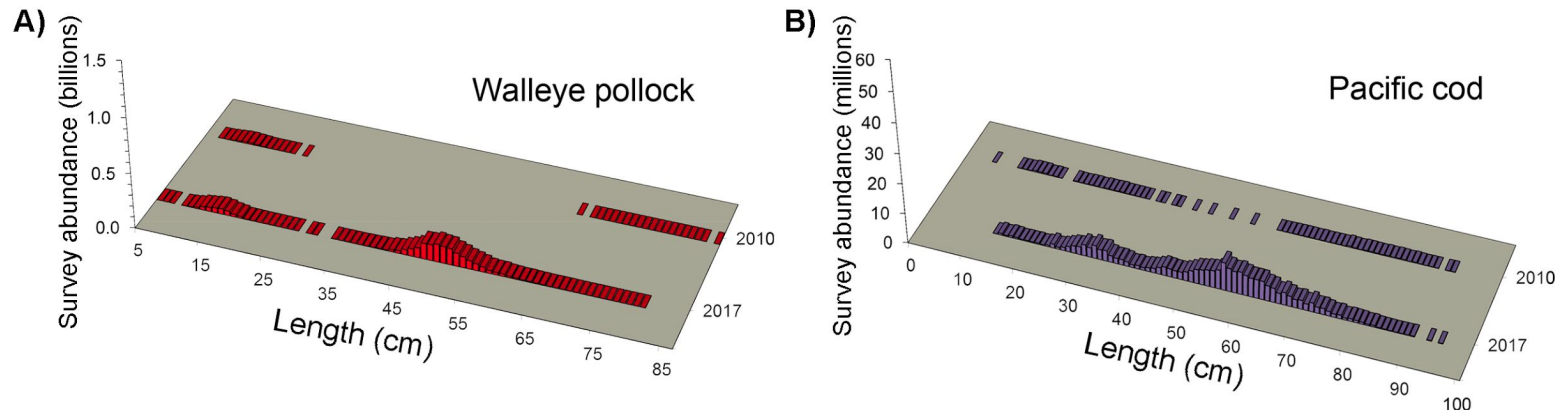# Thinking Outside the Survey Box
(B. Lauth and L. Britt)

Common name	Taxon	Biomass (mt)		
		2010	2017	Change
Walleye pollock	*Gadus chalcogrammus*	20,977	1,312,620	6,157%
Pacific cod	*Gadus macrocephalus*	28,425	286,310	907%
Jellfishes	Scyphozoa	13,112	66,166	405%
Poachers	Agonidae	422	2,040	384%
Green sea urchin	*Strongylocentrotus* sp.	49,263	164,277	233%
Blue king crab	*Paralithodes platypus*	1,940	5,795	199%
Shorthorn (=warty) sculpin	*Myoxocephalus scorpius*	38,172	108,753	185%
Bryozoans	Bryozoa	2,747	7,463	172%
Northern rock sole	*Lepidopsetta polyxystra*	21,379	56,093	162%
Other flatfishes	Pleuronectidae	3,549	8,715	146%
Pricklebacks	Stichaeidae	1,553	3,609	132%
Sea anenomes	Actinaria	9,381	21,330	127%
Clams	Bivalvia	2,531	5,374	112%
Starry flounder	*Platichthys stellatus*	15,319	31,103	103%
Other snails	Gastropoda	27,102	54,963	103%
Pacific herring	*Clupea pallasii*	22,289	35,365	59%
Bering flounder	*Hippoglossoides robustus*	12,661	20,022	58%
Neptune whelk	*Neptunea heros*	115,325	178,443	55%
Snailfishes	Liparidae	3,316	4,842	46%
Plain sculpin	*Myoxocephalus jaok*	28,338	36,819	30%
Hermit crabs	Paguridae	134,417	162,475	21%
Purple-orange sea star	*Asterias amurensis*	298,087	353,314	19%
All shrimps		3,777	4,462	18%

Hot Topic:
Thinking Outside the Survey Box
(B. Lauth and L. Britt)

"...the inner shelf was certainly an open corridor for north-south movement...."
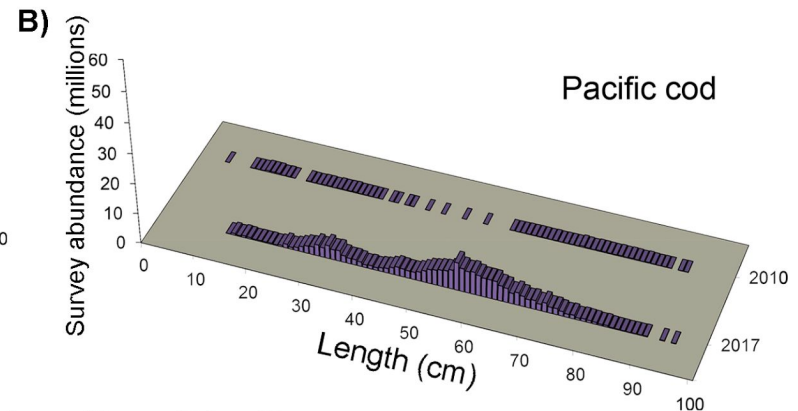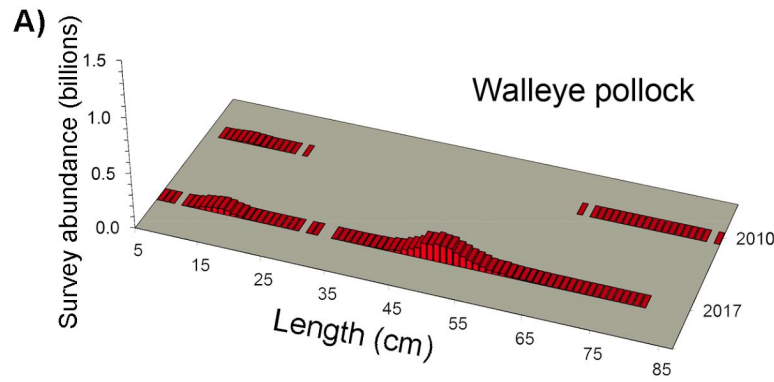
Hot Topic:
Thinking Outside the Survey Box
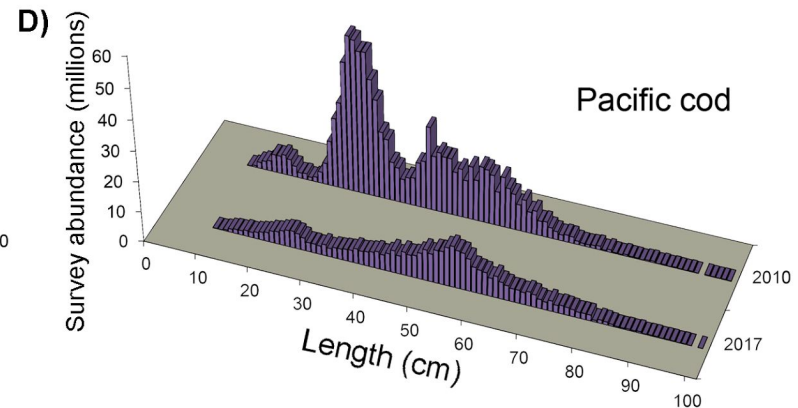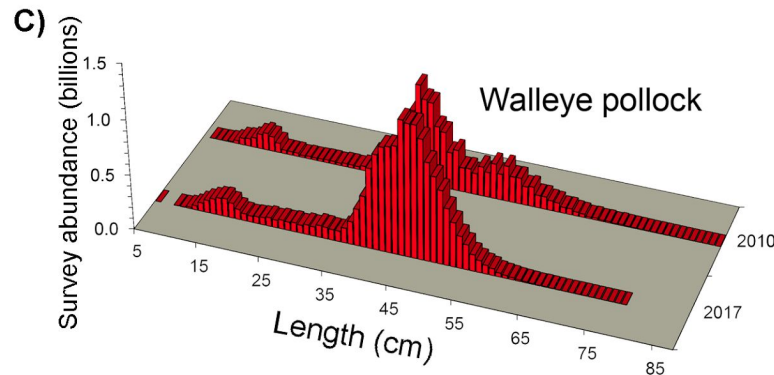(B. Lauth and L. Britt)

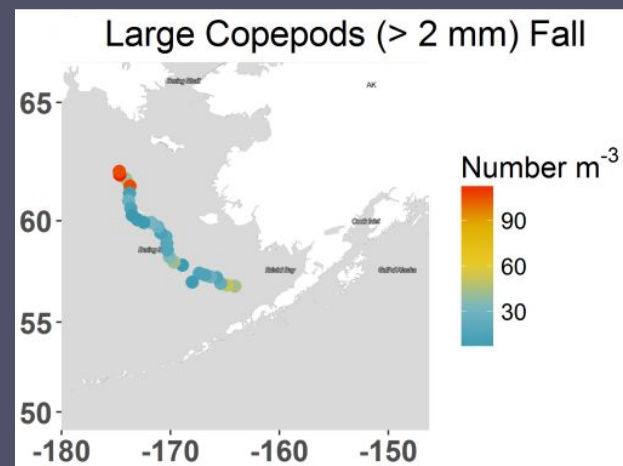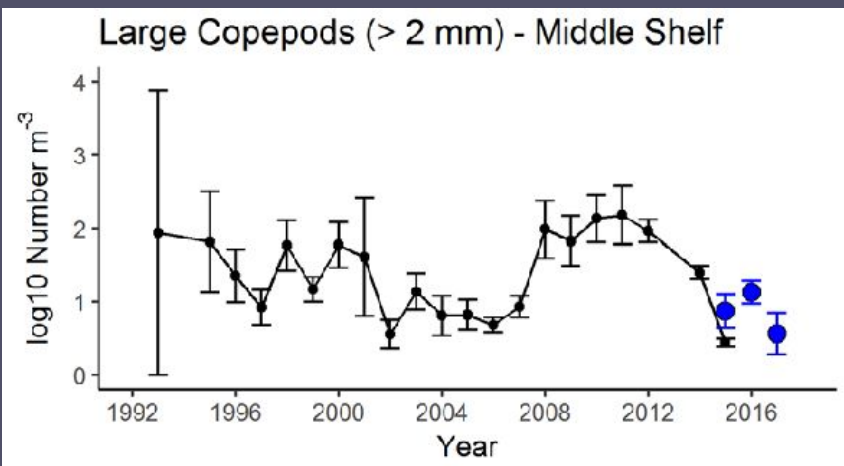"The similar size distributions between areas for both species suggests they could be from the same populations."
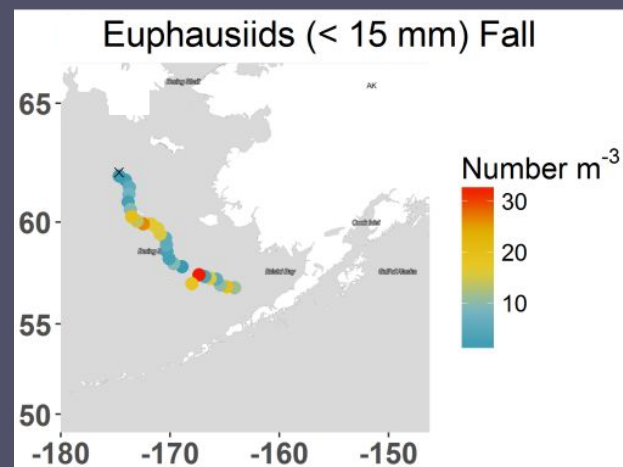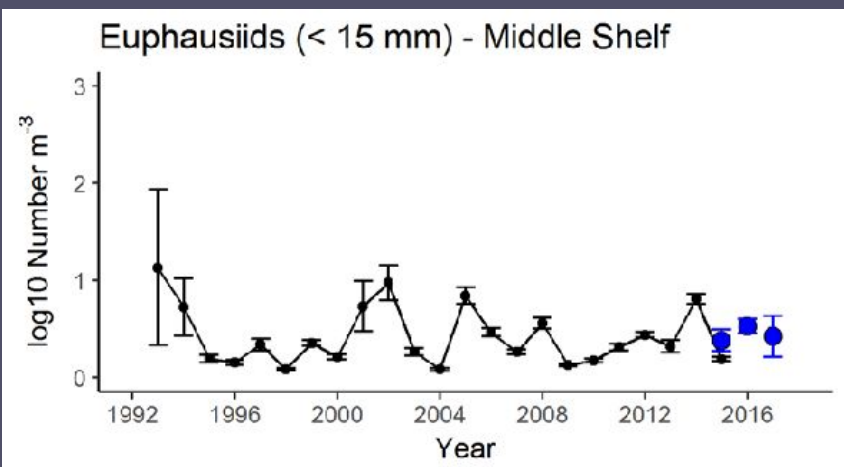
2017 EBS Zooplankton

- Large copepod abundance decreased over middle shelf
- Hot spot over NW shelf
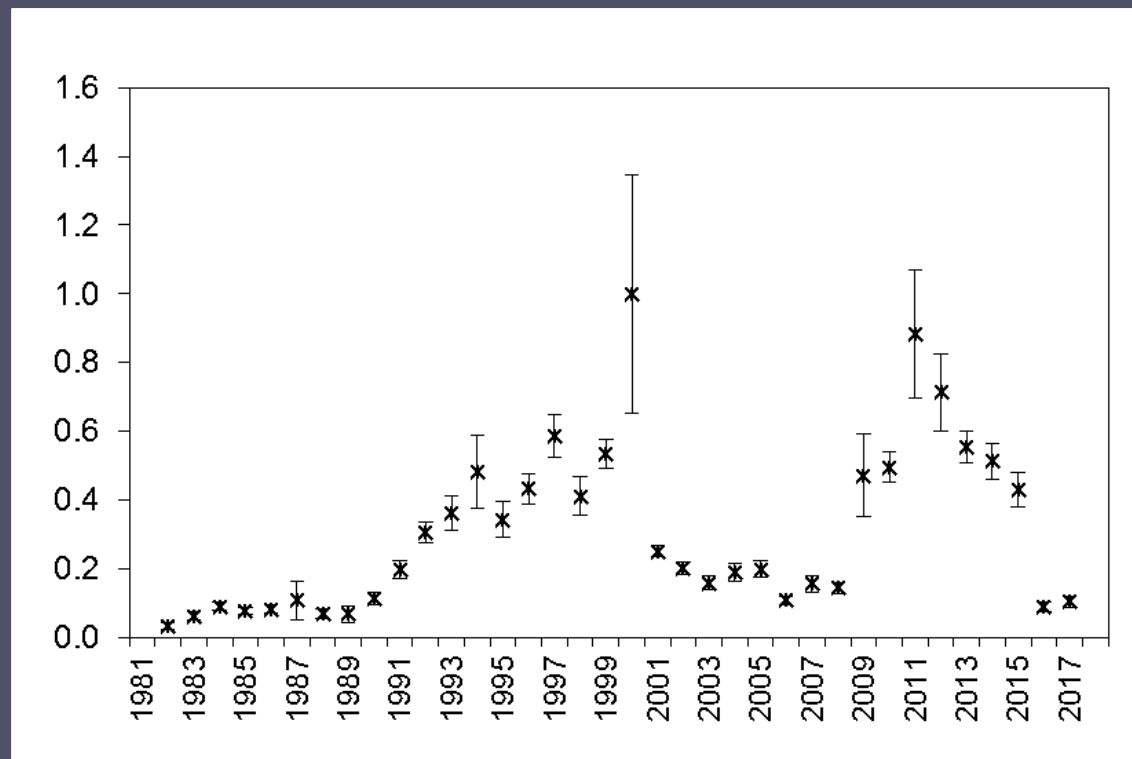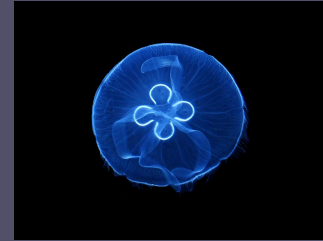
- Euphausiid abundance similar to 2015-2016 over middle shelf
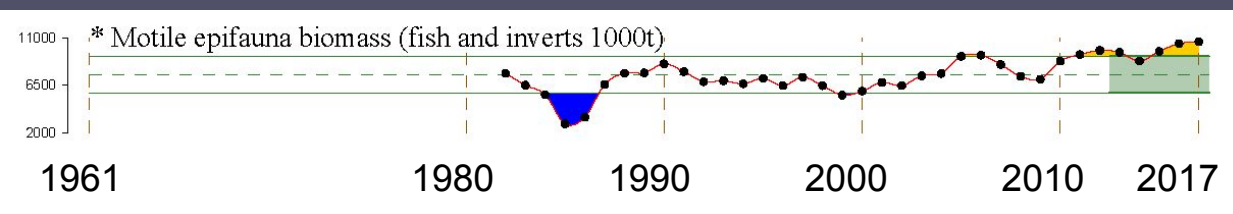- Hot spot over SE shelf

D. Kimmel and C. Harpold

- 2017 Jellyfish abundance remains low (BT survey)

- Primarily *Chrysaora melanaster*

- In 2016, the abundance of smaller-sized species (e.g. *Aurelia*) increased (BASIS survey)

B. Lauth
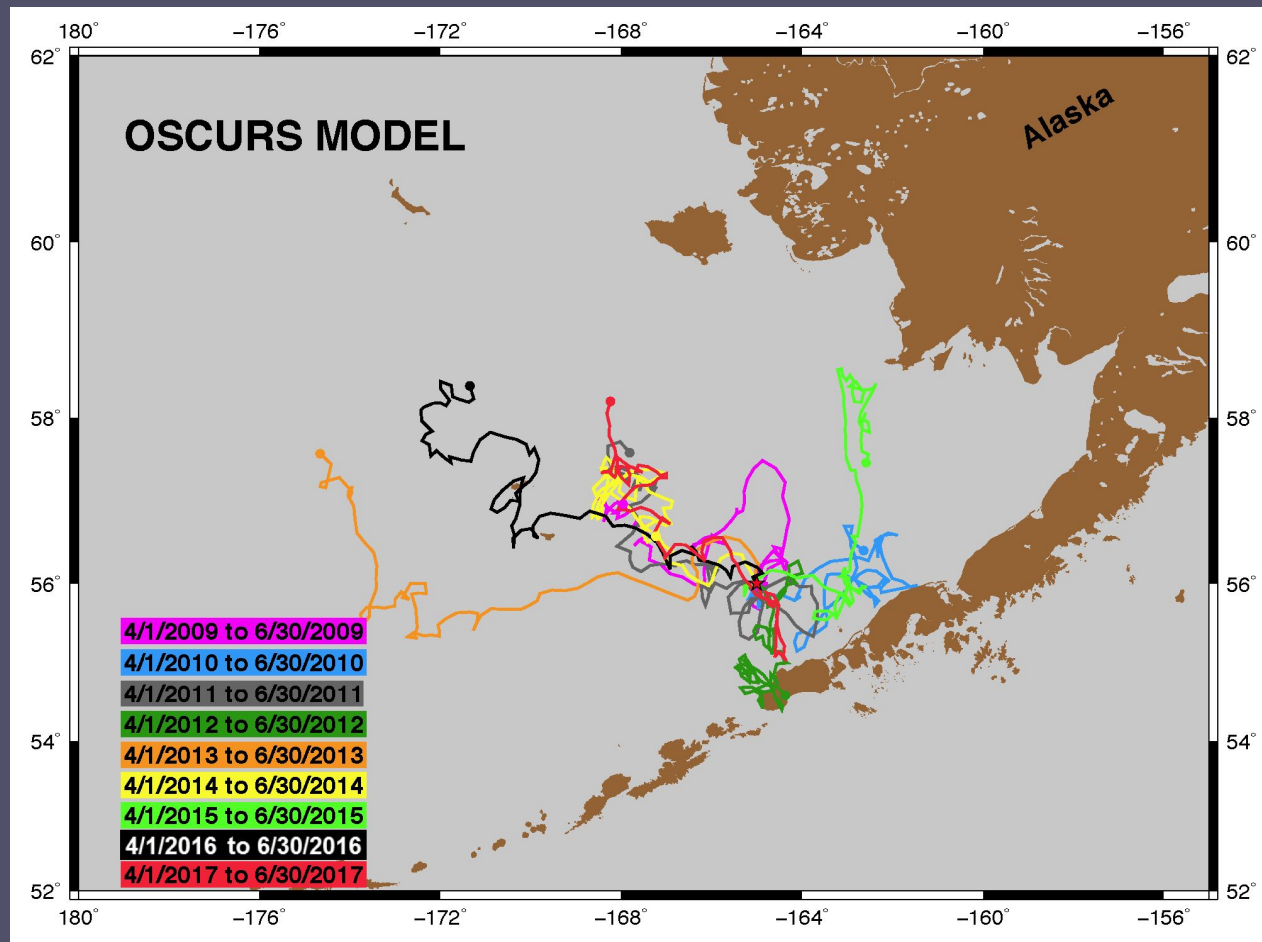K. Cieciel and E. Yasumiishi
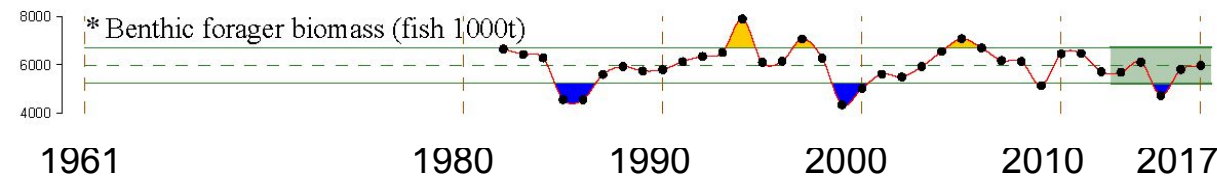
2017 EBS Motile Epifauna

- Motile epifauna biomass remains above long-term mean; trend increasing
- Urchins, dollars, cucumbers up 12%
- King and tanner crabs down 28% and 21%
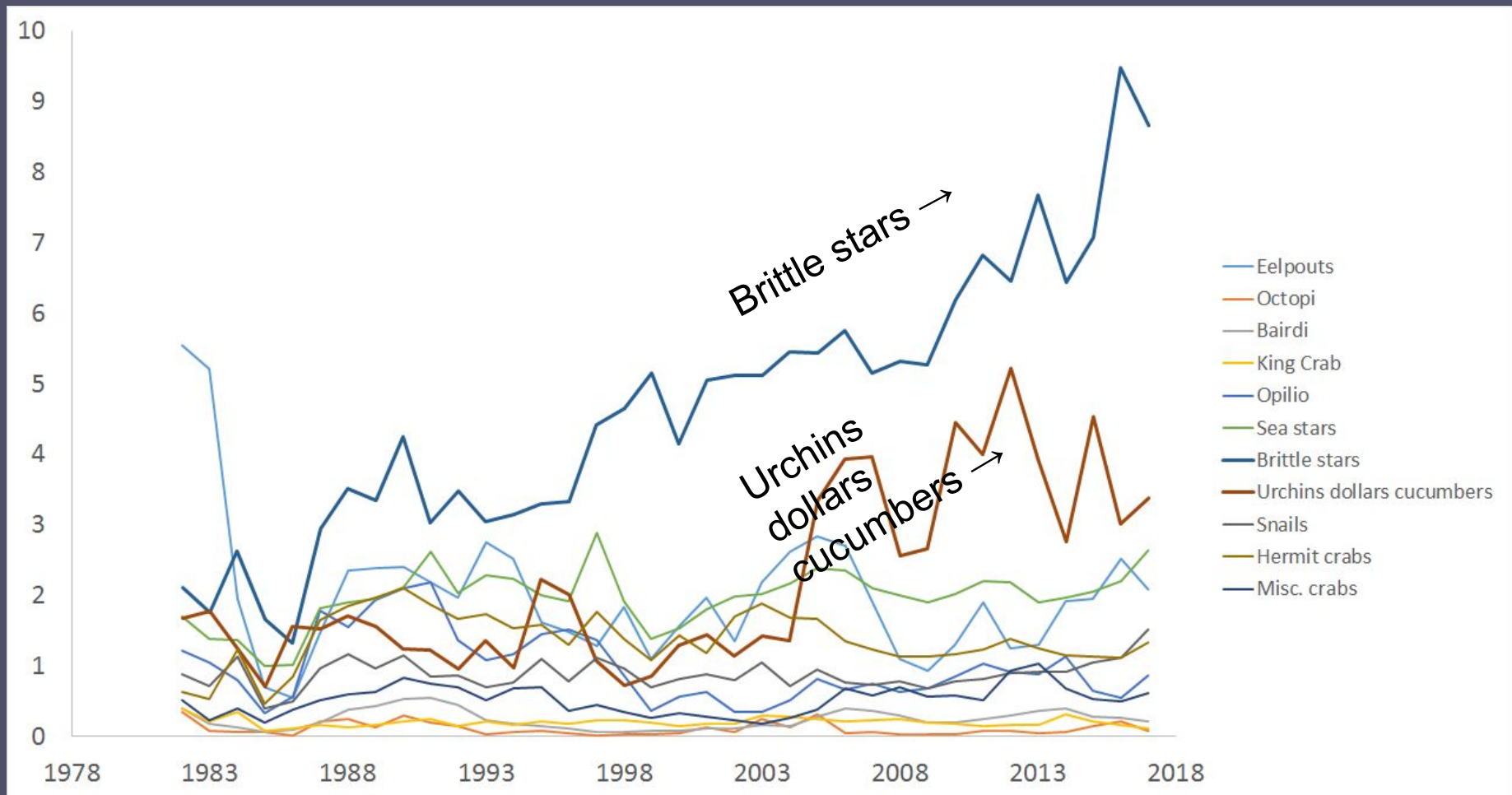
2017 EBS Benthic foragers

- 2015 drop due to decreased YFS and NRS adult biomass

- Recent trend is stable

- "Miscellaneous" flatfish and FHS increased

- 2015 had favorable drift patterns for flatfish recruitment

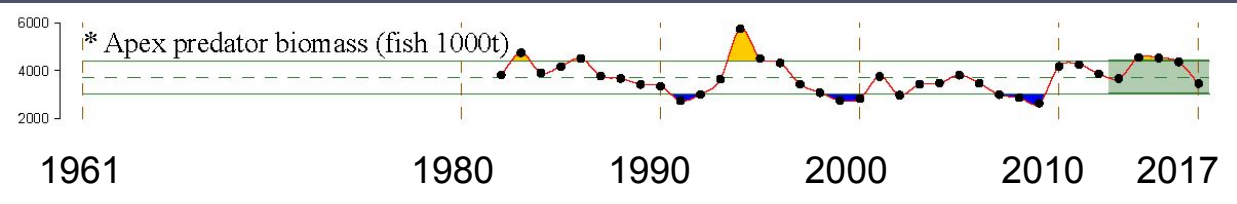- 2017 had mixed drift pattern; may be more consistent with below-average recruitment

T. Wilderbuer

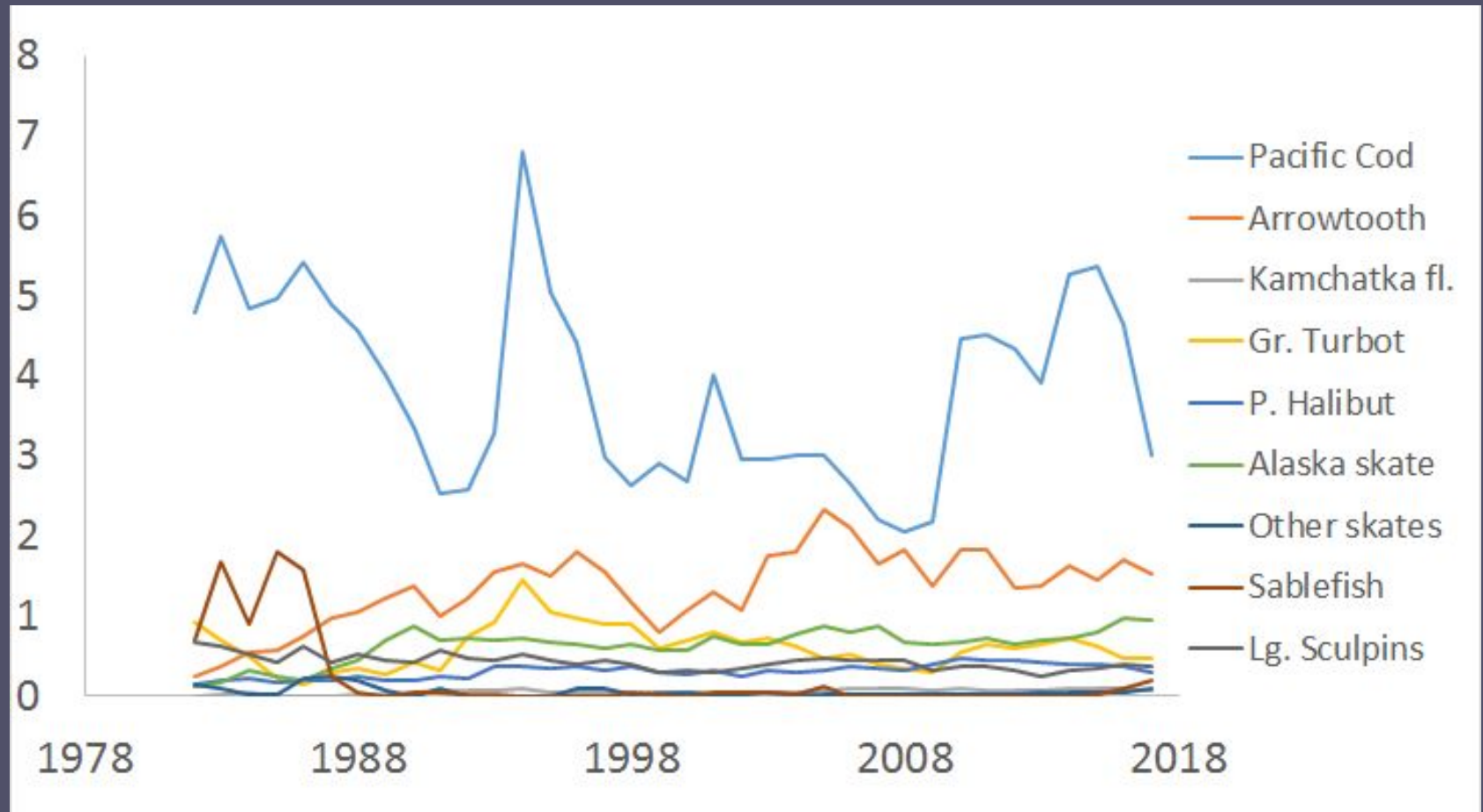* Pelagic forager biomass (fish 1000t)

1961　　　　1980　　1990　　2000　　2010　2017
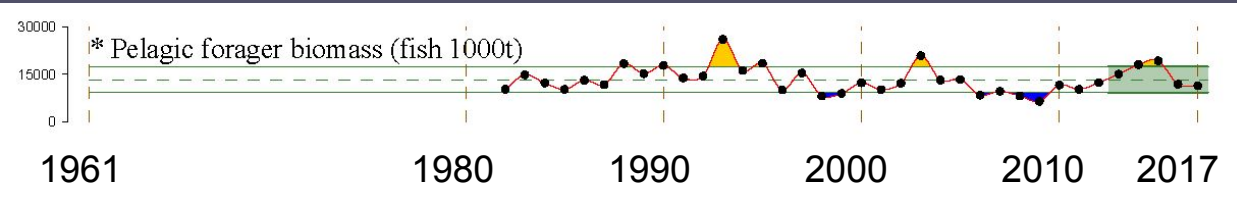
- At long-term mean
- Pollock level from 2016-2017
- Increase in Pacific herring offset by decrease in Capelin
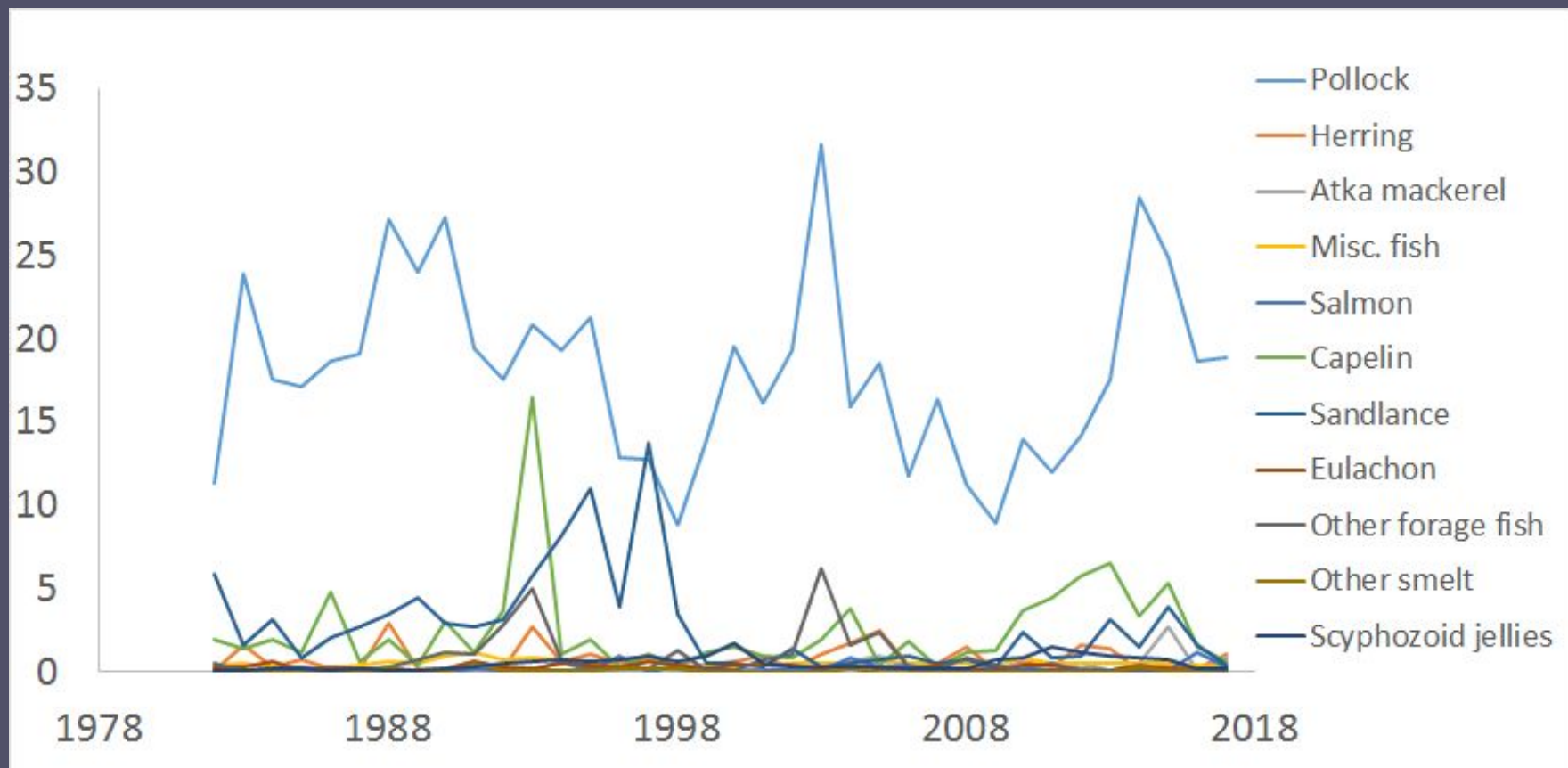
- Apex predator biomass declined
- 35% decrease in Pacific cod biomass
- 11% decrease in Arrowtooth flounder biomass

* Multivariate seabird breeding index (PC1)

- Breeding index below the long-term mean

- Poor reproductive success at the Pribilof Islands for all species, except Red-faced Cormorants

Black legged kittiwakes at St George
Black legged kittiwakes at St Paul
Red legged kittiwakes at St George
Red legged kittiwakes at St Paul
Thick billed murres at St George
Thick billed murres at St Paul
Common murres at St George
Common murres at St Paul
Red faced cormorants at St Paul

2013-2017 Trend

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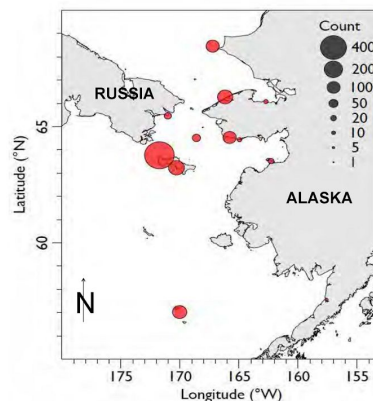change <1 s.d. over window
X   fewer than 3 data points

H. Renner and M. Romano
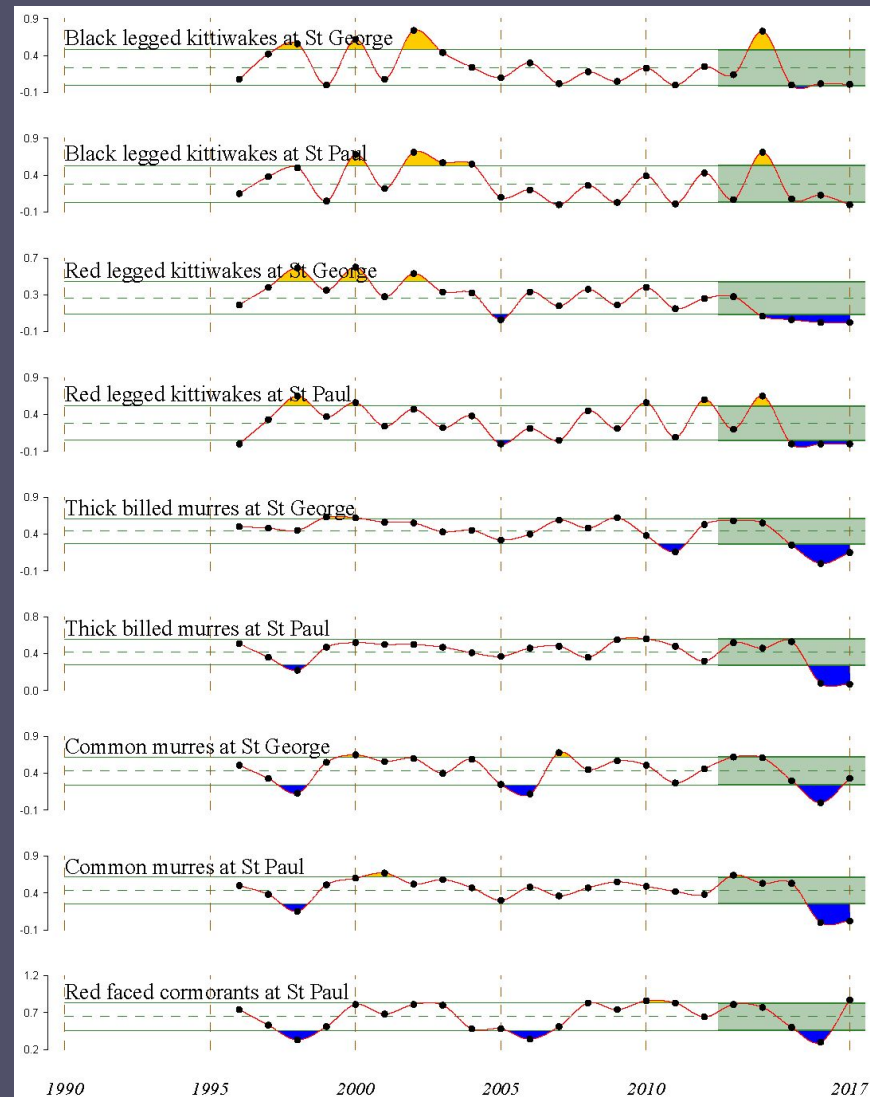
Hot Topic:
Dead and Dying Seabirds
(Kuletz et al.)

USFWS Alaska Region
Migratory Bird Management
1011 E. Tudor Rd.
Anchorage AK 99503
1-866-527-3358 (phone) AK_MBM@fws.gov

September 2017

What is Happening?
Dead and dying seabirds have been reported from Point Hope south to the Pribilof Islands. First responders in coastal communities with the USFWS, Aleut Community of St. Paul Island Ecosystem Conservation Office (ACSPI ECO), Kawerak, Inc., Alaska Sea Grant program and others have counted over *1200 beached seabird carcasses since early August 2017*, including northern fulmars, shearwaters, and kittiwakes. Murres and auklets have also been reported. The USFWS is coordinating with the Coastal Observation and Seabird Survey Team (COASST) to monitor beaches. ACSPI ECO and Alaska Sea Grant have collected carcasses for examination by the USGS National Wildlife Health Center (NWHC).

Contributing Partners:

U.S. Fish & Wildlife Service

Dead and Dying Seabirds
Seward Peninsula to Pribilof Islands

Species Identification

Melissa Good, COASST   Ken Steneck, COASST   Ken Steneck, COASST

Short-tailed Shearwater	Northern Fulmar *dark morph*	Northern Fulmar *light morph*
Bill: thin, dark	**Bill**: stocky, pale	**Bill**: stocky, pale
Body: dark	**Body**: dark	**Body**: pale-to-white

What Do We Know?
Necropsies on 21 carcasses from Point Hope, Shishmaref, Gambell, St. George and St. Paul Islands indicate drowning and severe emaciation (empty stomachs and intestinal tracts, little body fat). To date, there is no microscopic or laboratory culture evidence of infectious disease. While examined birds appeared to have died of starvation, underlying factors (disease, toxins, lack of food) have yet to be identified. Testing of carcass tissues, including Harmful Algal Bloom toxins, is ongoing and results will be shared as soon as available.

What Can I Do?
Report unusual numbers of sick or dead birds to:
1-866-527-3358 or email AK_MBM@fws.gov
Please provide:
• Time & Date
• Location (GPS coordinates, beach length walked)
• Type/species & number of birds (count or estimate for each)
• Photos (see above; include scale if possible)
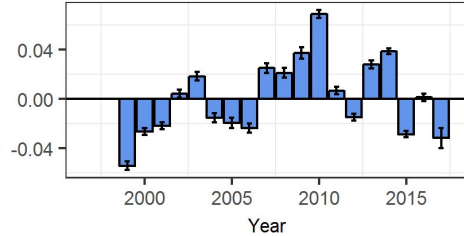• Videos of live birds displaying unusual behaviors (lethargic, drooping head and wings, etc.)

Participate in monitoring efforts on your local beaches
The Coastal Observation and Seabird Survey Team (COASST) provides training in how to identify birds and collect data that are shared with researchers and resource management agencies. Visit www.coasst.org to learn more or contact COASST at 1-206-221-6893 or email coasst@uw.edu.
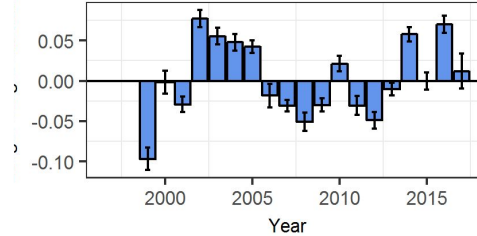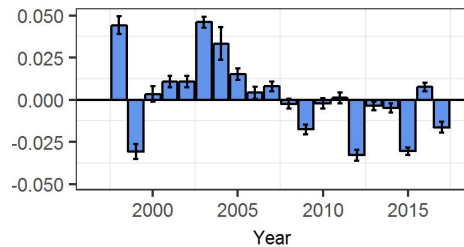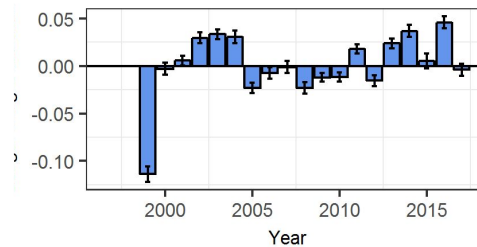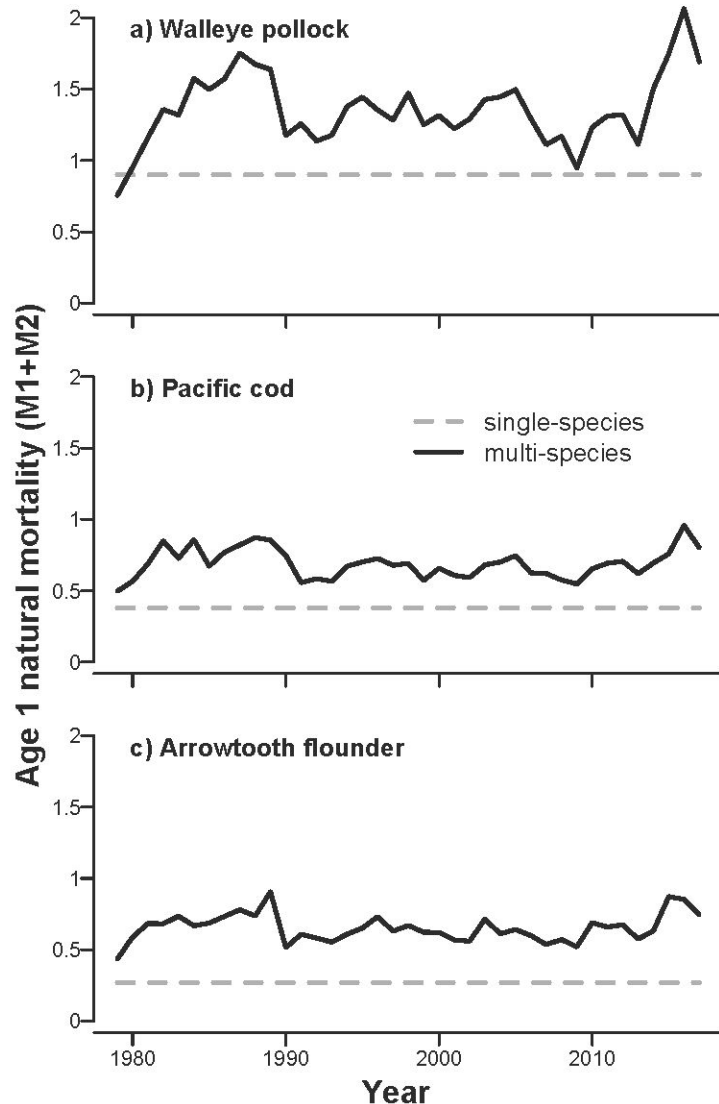
- Length-weight residuals from bottom trawl survey

- Residuals negative for all but age-1 pollock and AK plaice

- Pacific cod have been declining since 2003 with positive residuals in 2016

Boldt et al.

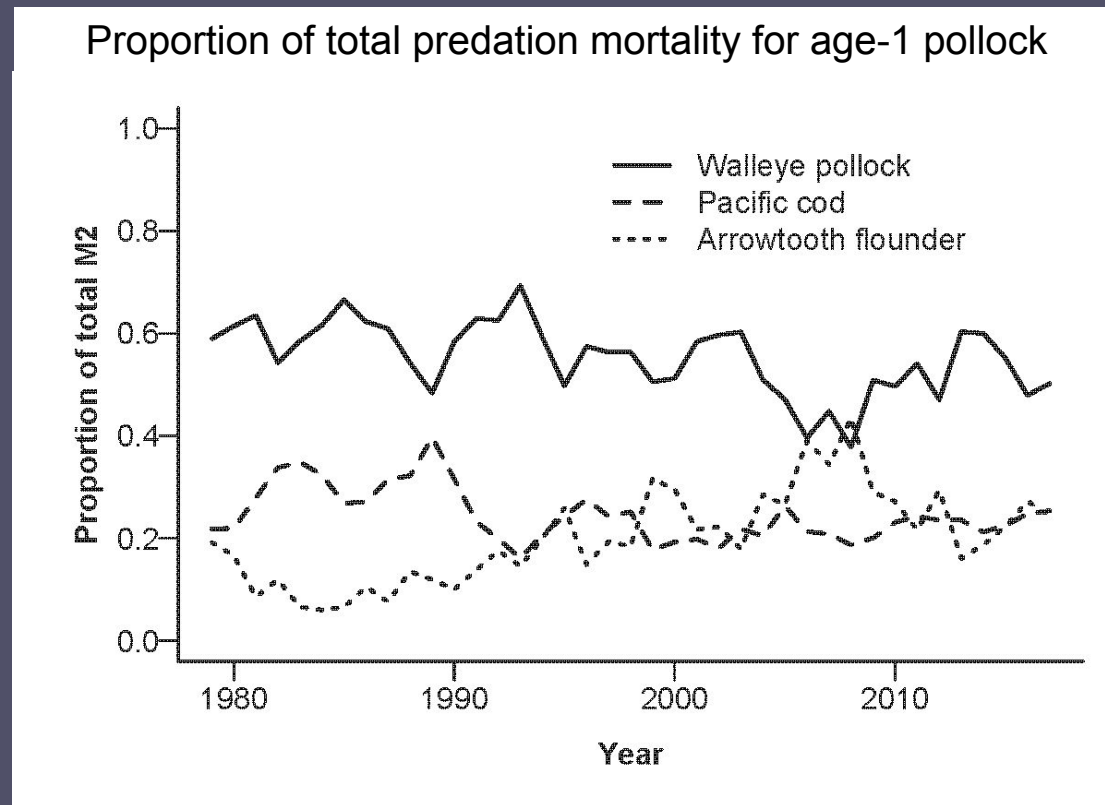## Annual variation in total mortality (M1 + M2) for age 1 groundfish

- Age-1 mortality peaked in 2016 for all 3 species, but has remained elevated in 2015-2017.

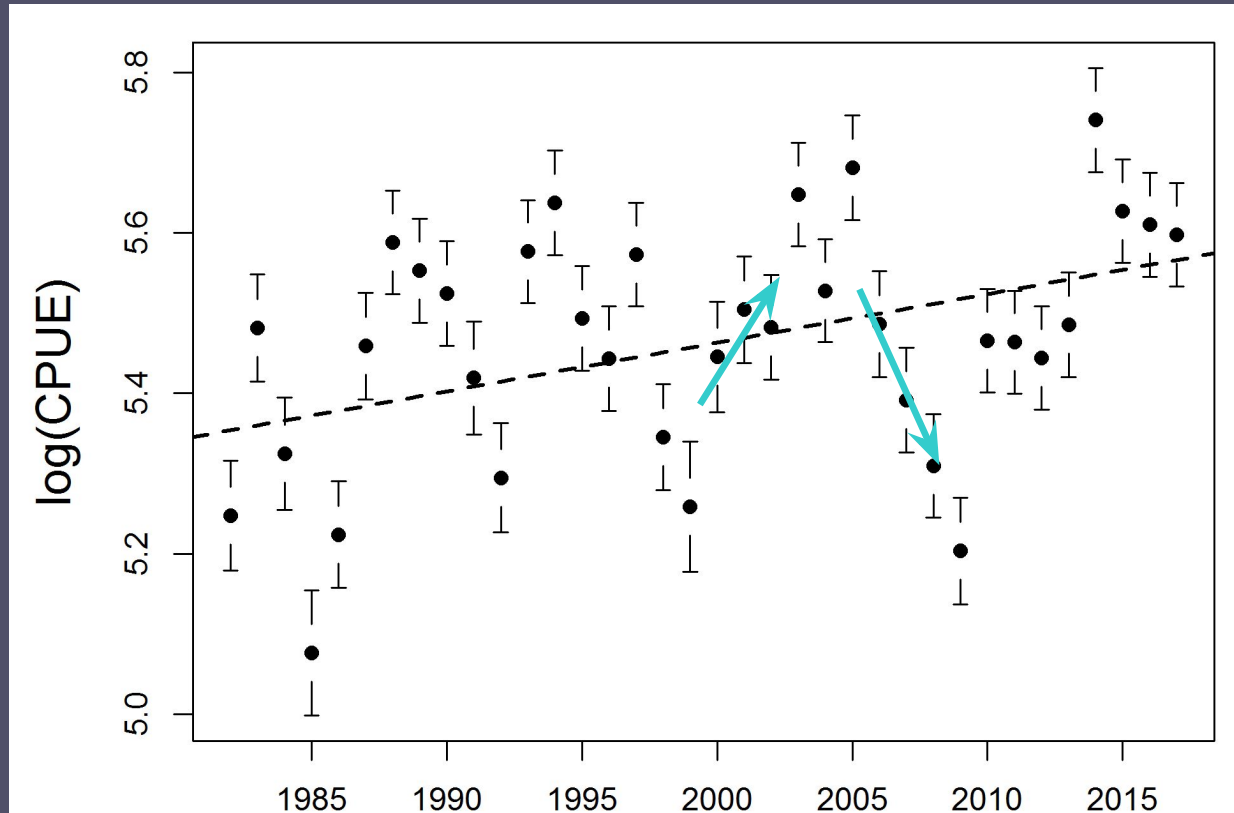- Natural mortality was greatest for pollock relative to PCod or ATF

Holsman et al.

- Annual predation demand of pollock, PCod, and ATF was down slightly in 2017 compared to warm years (2014-2016)

- Pollock represent ~78% of model estimates of combined prey consumed

Proportion of total predation mortality for age-1 pollock

Legend: Walleye pollock, Pacific cod, Arrowtooth flounder. Y-axis: Proportion of total M2. X-axis: Year.
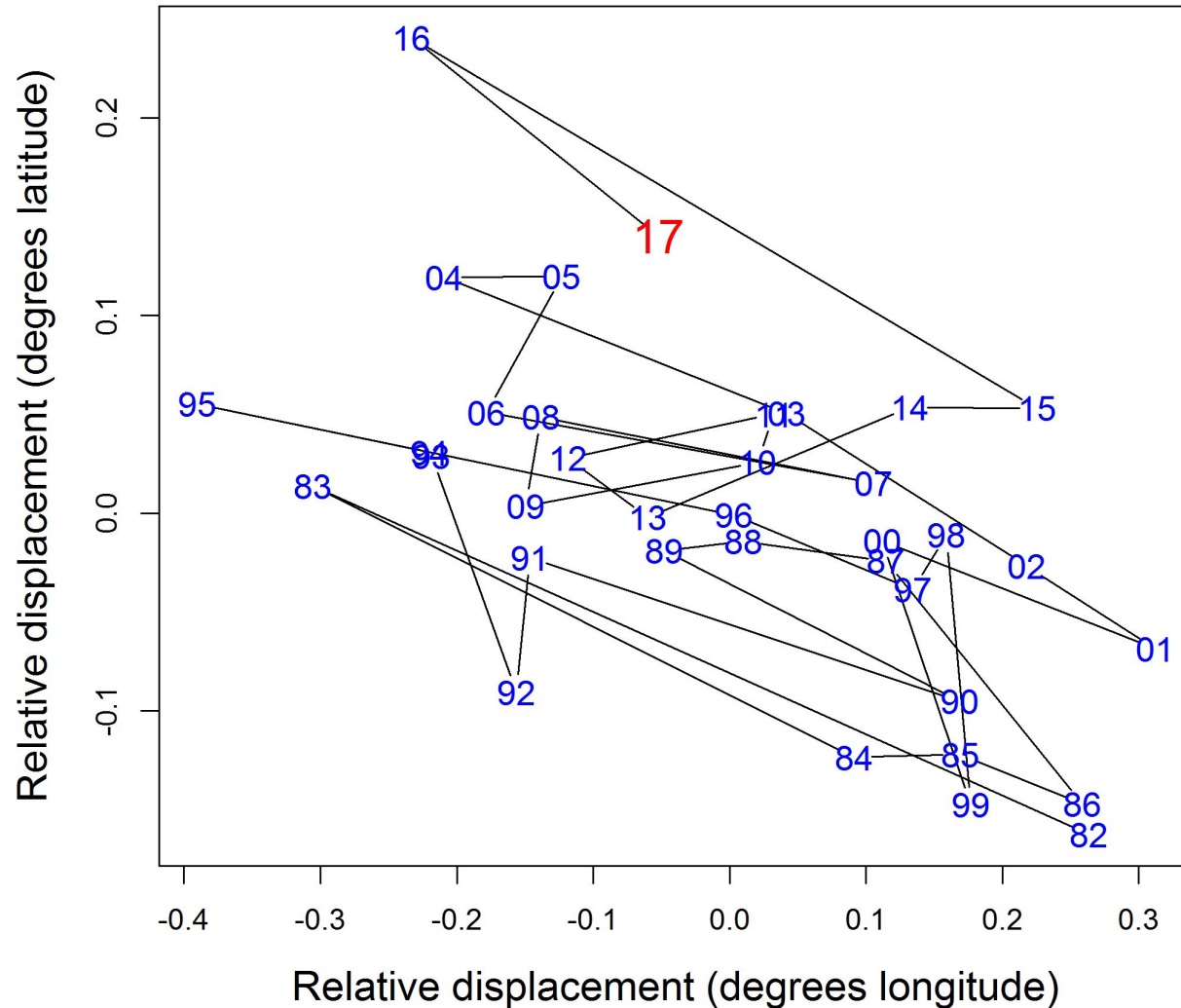
Holsman et al.

- Increase in 2000s due to pollock and flatfish
- Decrease in 2006-2009 due to pollock
- Increase in 2010 due to pollock and Pacific cod
- Stable in 2015-2017

F. Mueter and B. Lauth

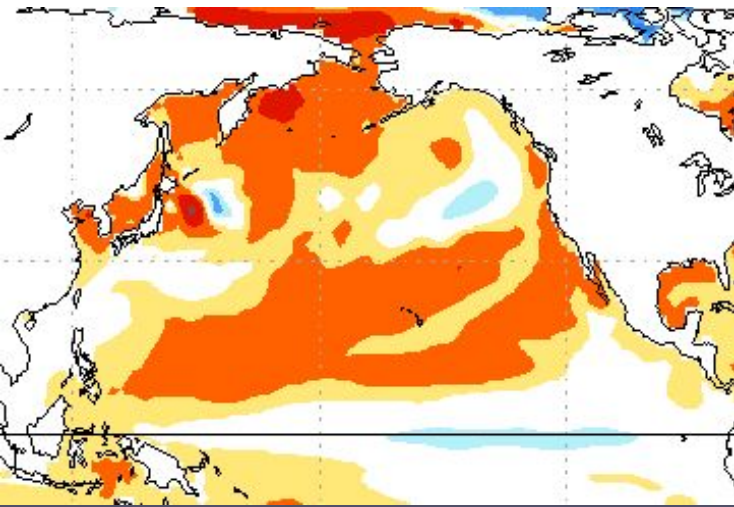Average north-south and east-west displacement

- 39 taxa included
- Shifted NW in 2016
- Shifted S in 2017

Mueter et al.

2017 Forecasts and Predictions

National Multi-Model Ensemble (NMME)

2017 Oct-Nov-Dec

2018 Feb-Mar-April

- SST projections

- Continuation of warm conditions across the North Pacific through December 2017, especially in western Bering Sea

- Negative anomalies in central/eastern Pacific *may* constitute weak La Niña (~70% chance)
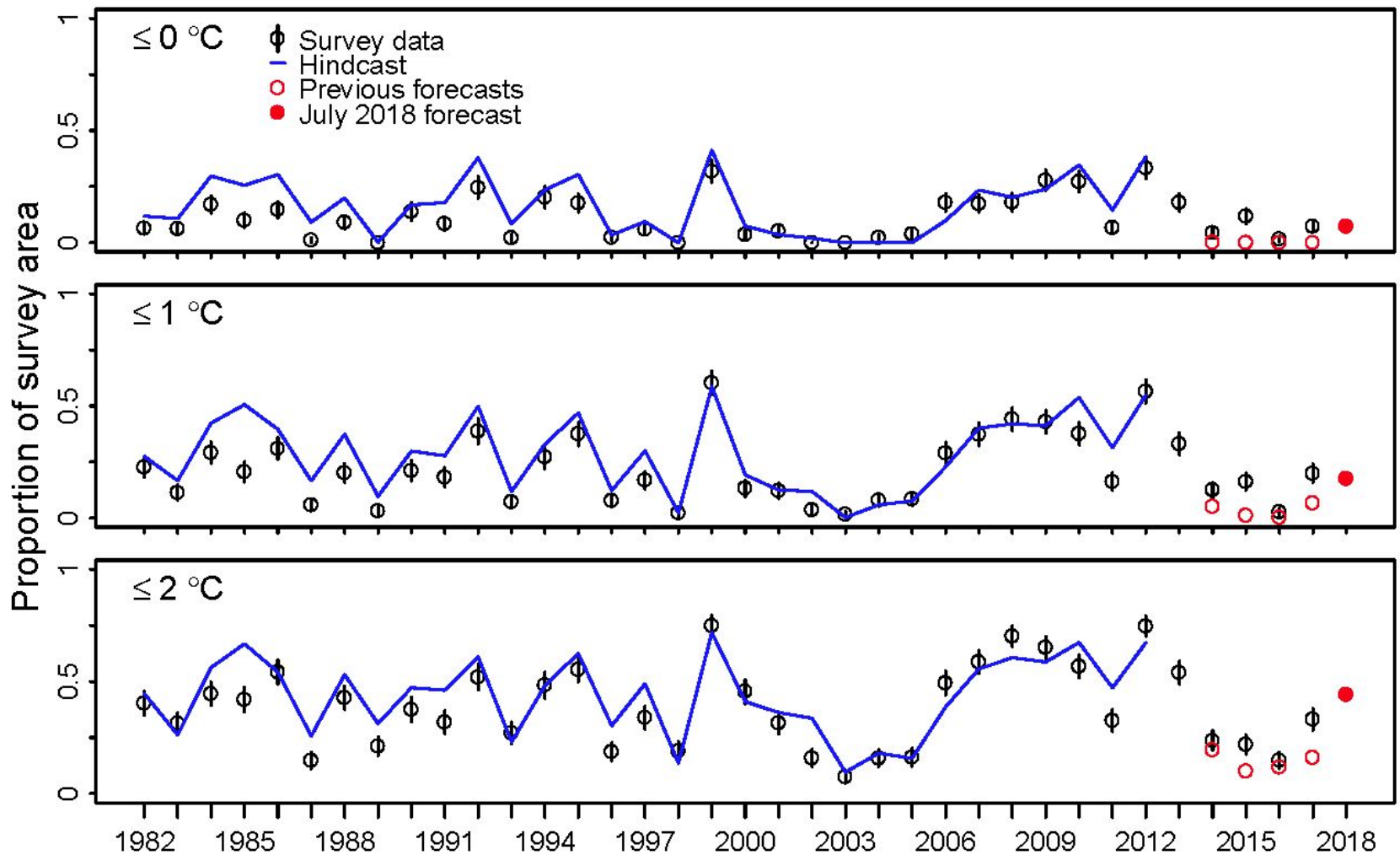
- Slight cooling in EBS and GOA through April 2018

N. Bond
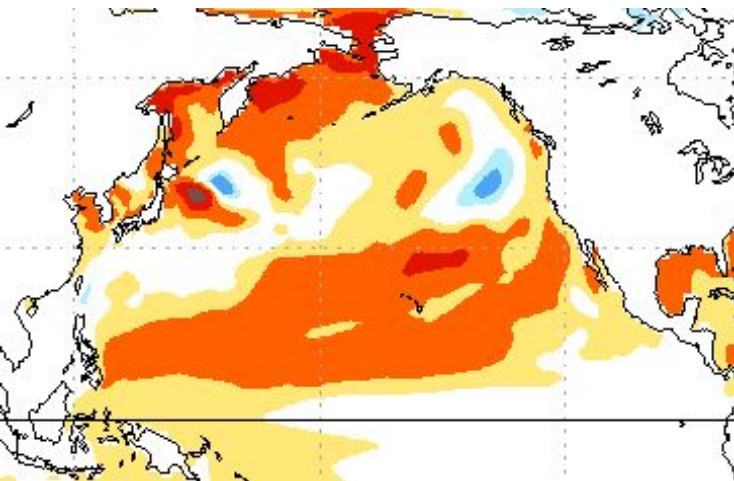
Summer 2018:
- Smaller, but near-average based on ≤0°C or ≤1°C
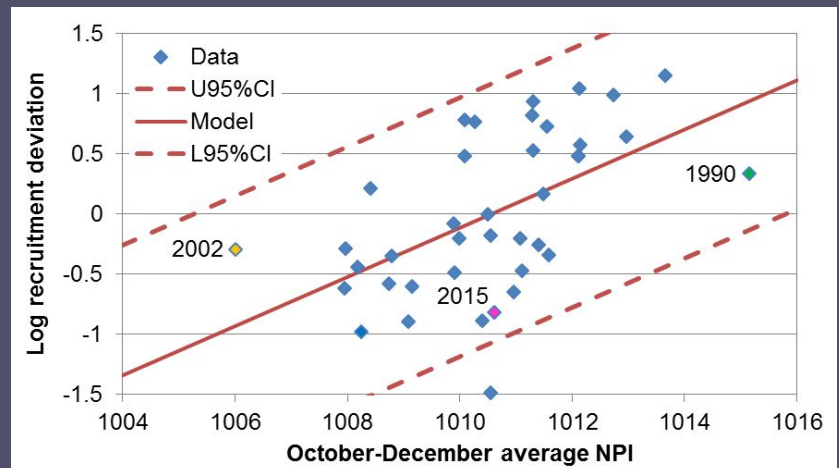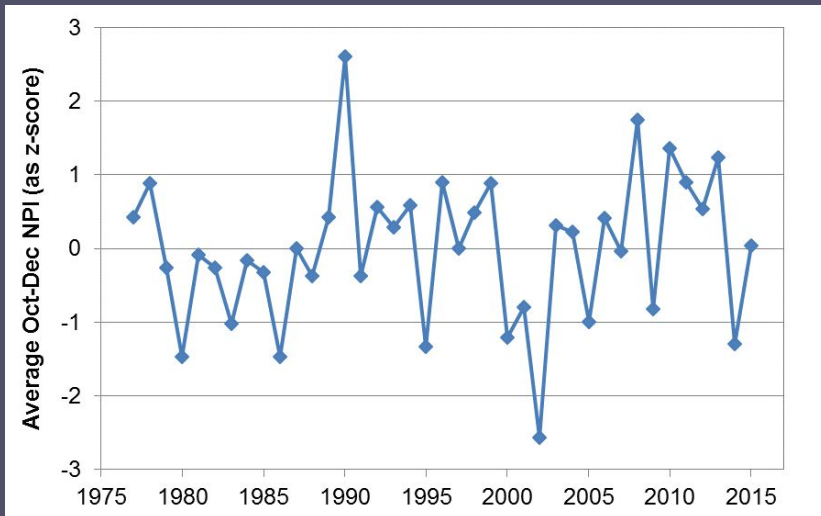- Larger-than-average ≤2°C cold pool

Cold Pool

K. Aydin

Pacific cod recruitment prediction

2015 year class

- Age-0 recruitment predicted by the average NPI (Oct.-Dec.)
- 2015 NPI barely positive (z-score=0.018)
- Probability of 2015 year class being higher than median is 51%
- 2015 point below predicted value from regression
- 2016 estimate: largest negative residual

G. Thompson

Several pollock recruitment predictions

2015 year class

- Temperature Change index: above-average
  - Yasumiishi
- Surface silicic acid concentrations: above-average
  - Gann et al.
- Age-0 diet energy density: intermediate
  - Andrews et al.
- Age-0 energy content: intermediate
  - Heintz et al.
- Large zooplankton abundance: below-average
  - Eisner and Yasumiishi
- Chum salmon growth, temperature, and predator abundance: below-average
  - Yasumiishi and Kondzela

2016 year class

- Surface silicic acid concentrations: above-average
  - Gann et al.
- Age-0 energy content: intermediate
  - Heintz et al.
- Temperature Change index: below-average
  - Yasumiishi

2017 year class

- Temperature Change index: below-average
  - Yasumiishi

Cold pool refuge hypothesis

The cold pool acts as a refuge for age-0 pollock due to its:

- Low temperatures (metabolic)
- Enhanced prey base (foraging)
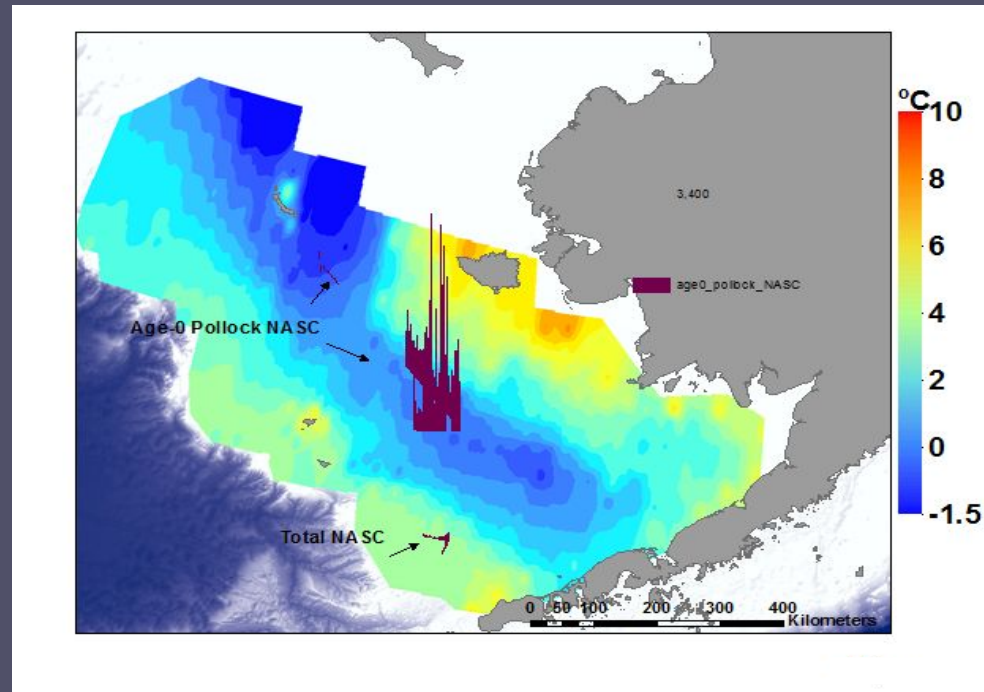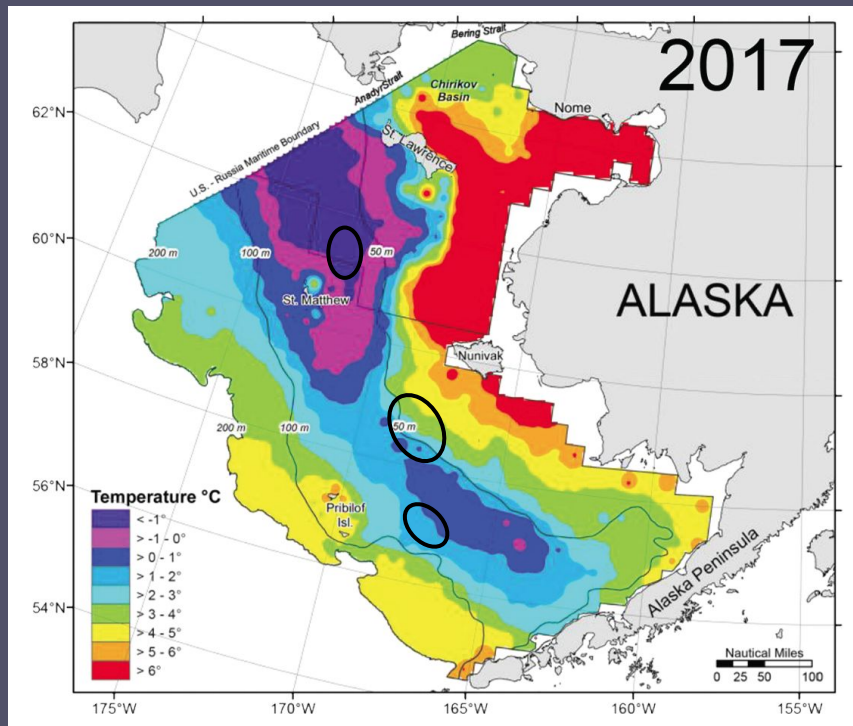- Paucity of large predators (predation)

Hot Hot Topic:
Nodal sampling: September-October 2017
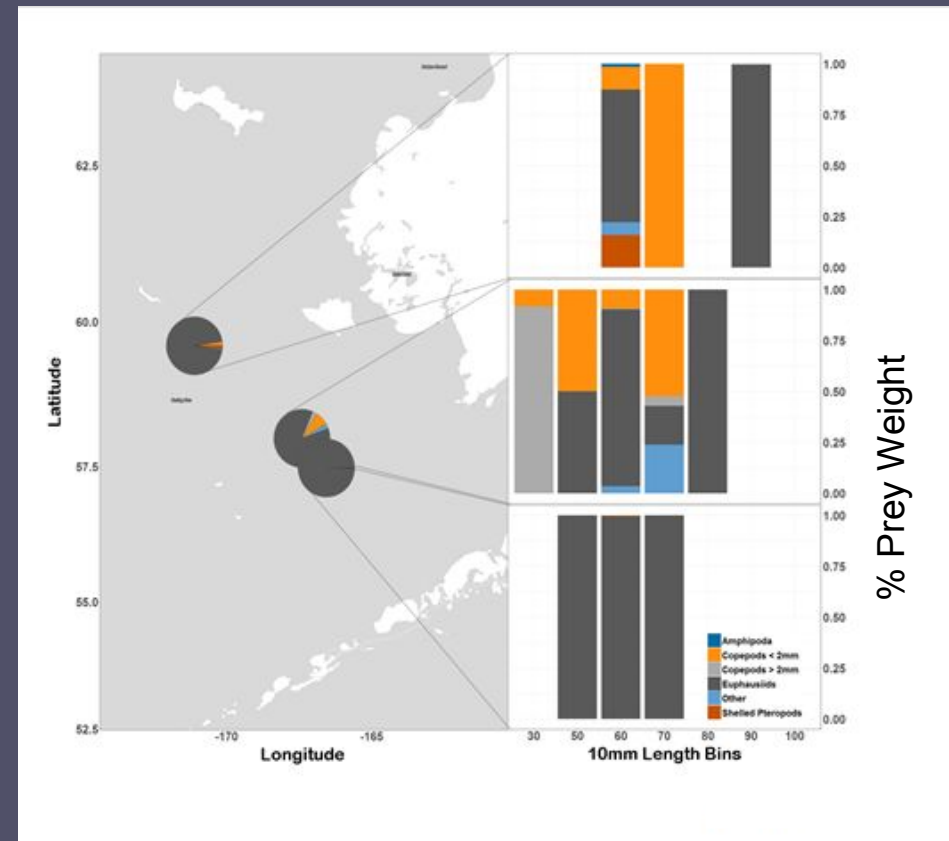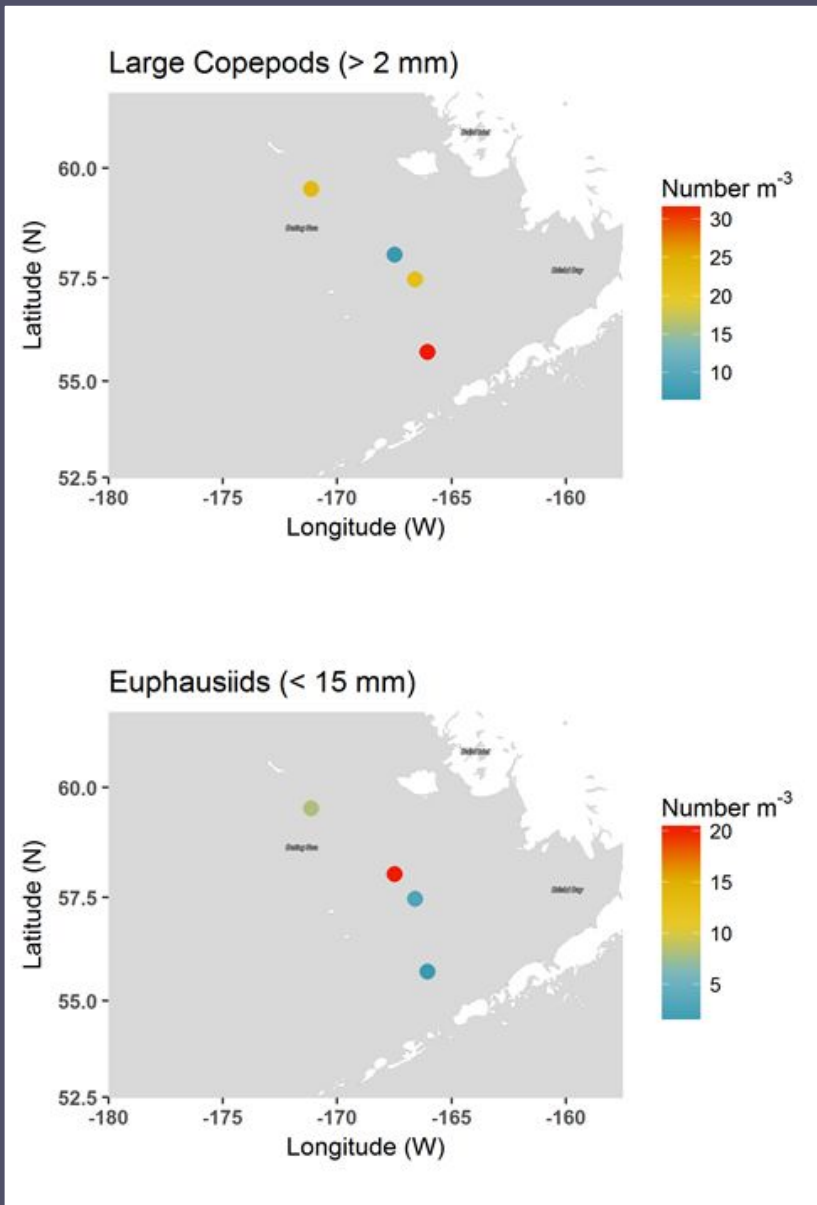(S&T funded; RPA conducted sampling)

- Oceanography, phytoplankton, zooplankton, acoustics, trawling, diet, and fish condition

- More pollock inside the cold pool than outside, along 70m isobath

LEFT: B. Lauth, RIGHT: A. Spear

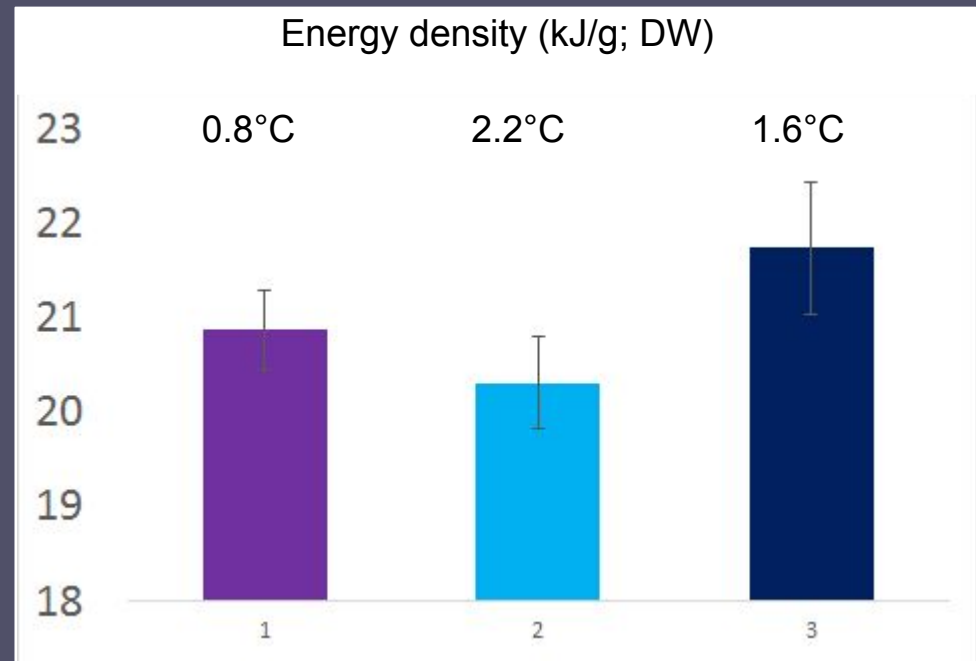# Hot Hot Topic:
Nodal sampling: September-October 2017

- Age-0 pollock inside cold pool consumed primarily krill
- At northerly stations, more large copepods available

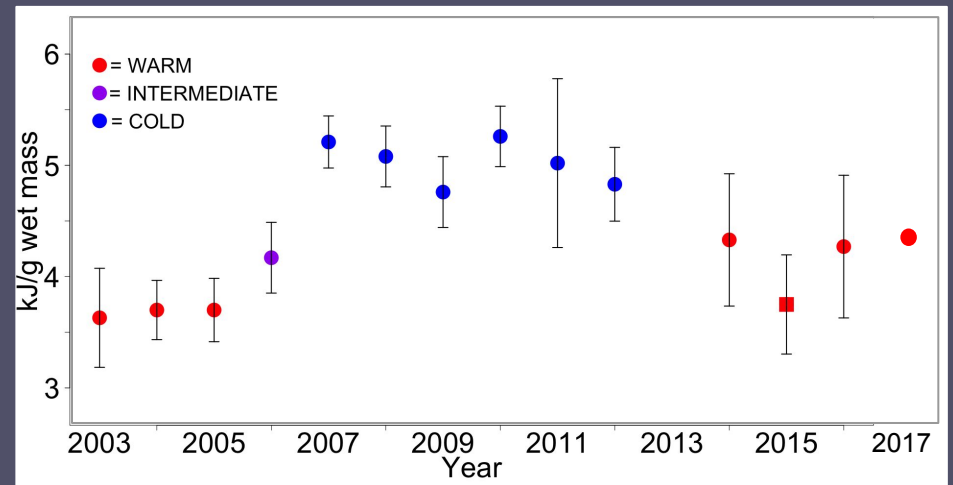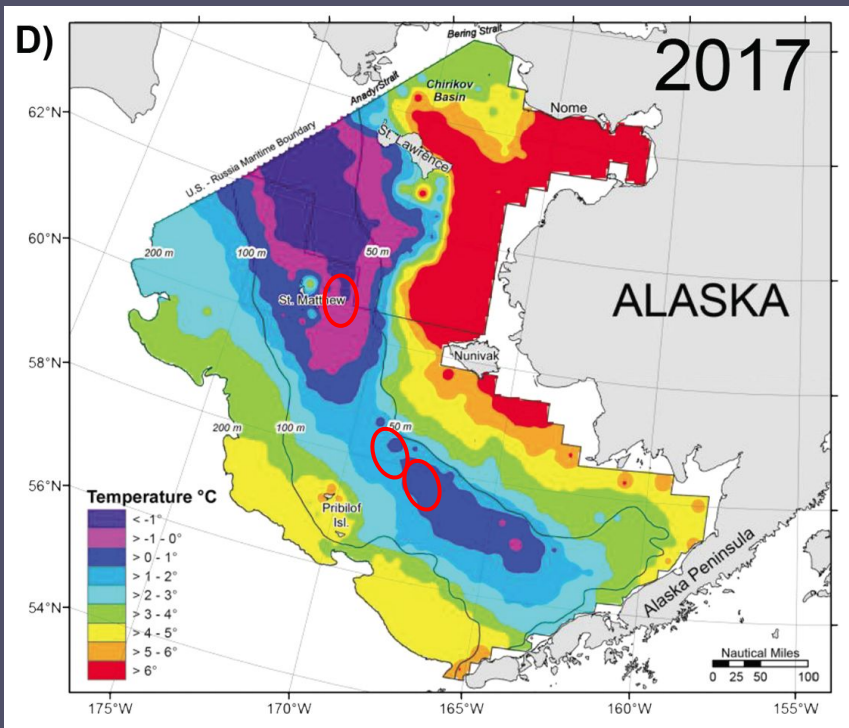LEFT: D. Kimmel and A. Spear, RIGHT: N. Ferm

Hot Hot Topic:
Nodal sampling: September-October 2017

- Fish condition was measured at 3 stations
- Age-0 pollock inside the cold pool had higher energy density
- Supports cold pool refuge hypothesis

LEFT: B. Lauth, RIGHT: R. Heintz and T. Jarvis

Hot Hot Topic:
Nodal sampling: September-October 2017

LEFT: B. Lauth, RIGHT: Heintz et al.
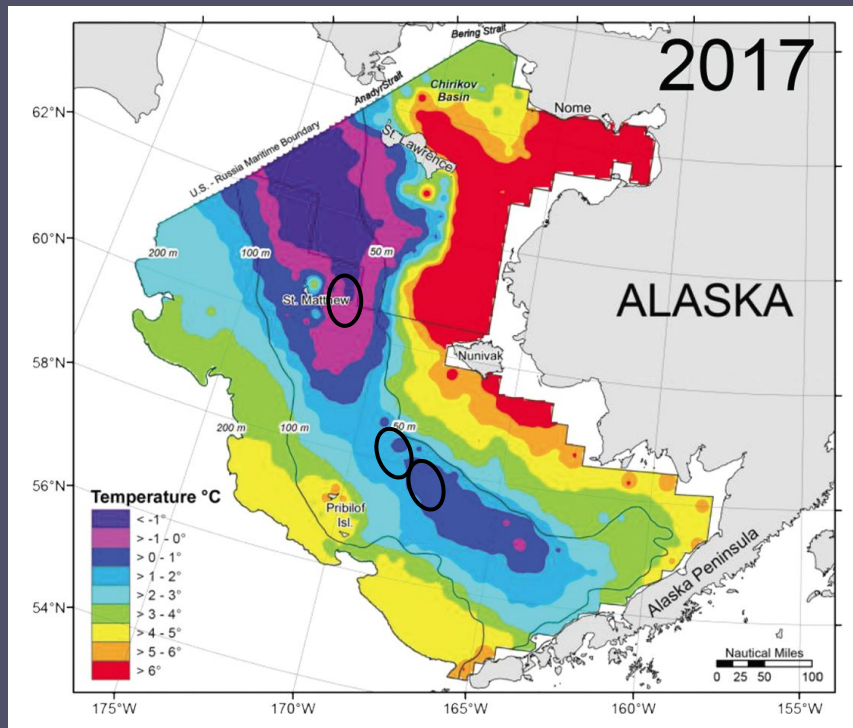
Summary

2016

- Extremely warm conditions; low productivity; groundfish condition metric increased; poor seabird productivity, die-off, high bycatch; fur seal pup production mixed

2017

- Moderately warm conditions; unique sea ice extent; narrow cold pool; groundfish condition metric decreased; poor seabird productivity and die-off; age-1 groundfish natural mortality estimates high (CEATTLE)

Website

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

Contributors

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Thank you !