ECOSYSTEM CONSIDERATIONS

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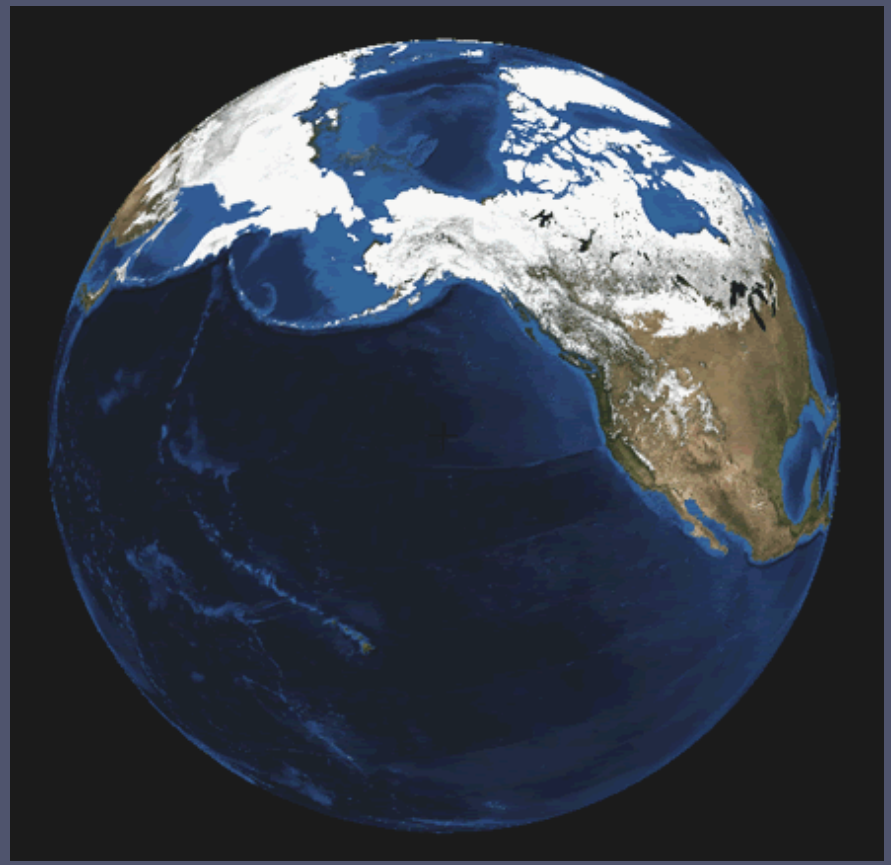
North Pacific Fisheries Management Council
December 2017

Status of the Gulf of Alaska and Eastern Bering Sea Marine Ecosystems

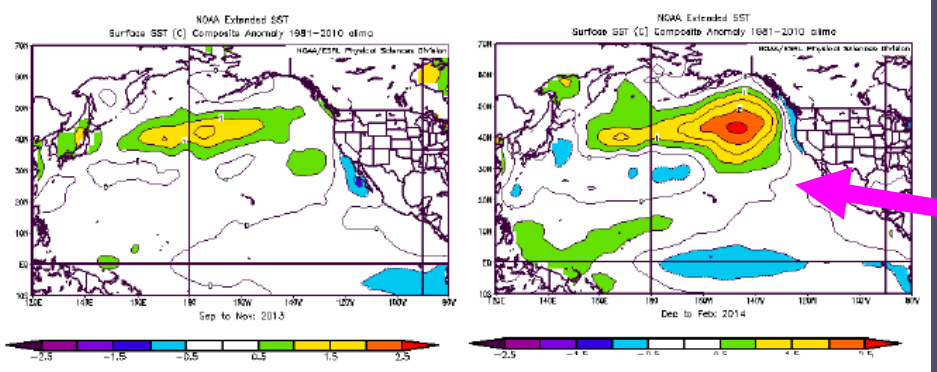


Gulf of Alaska THEMES

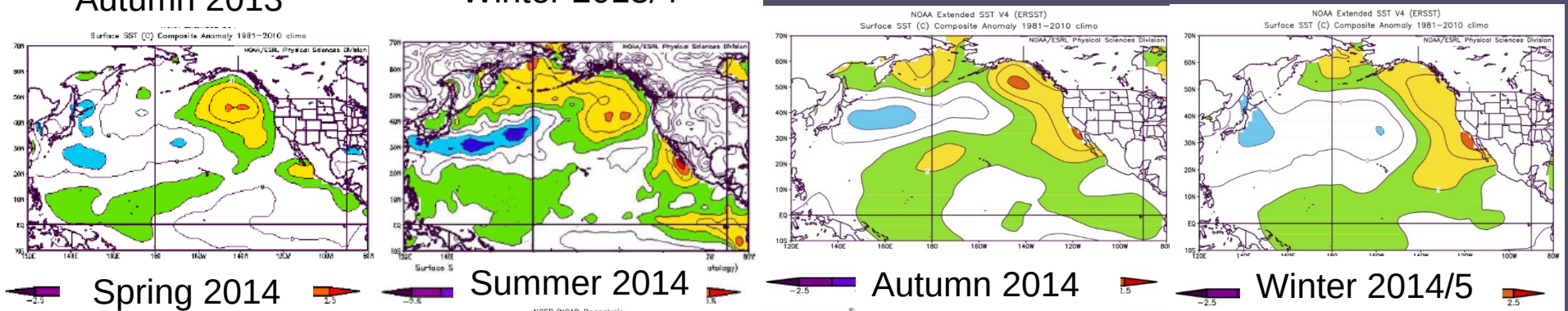
1. Marine heat wave wrap-up
2. Pacific cod

Sustained warm temperatures in the GOA from Winter 2013/2014 to spring 2017

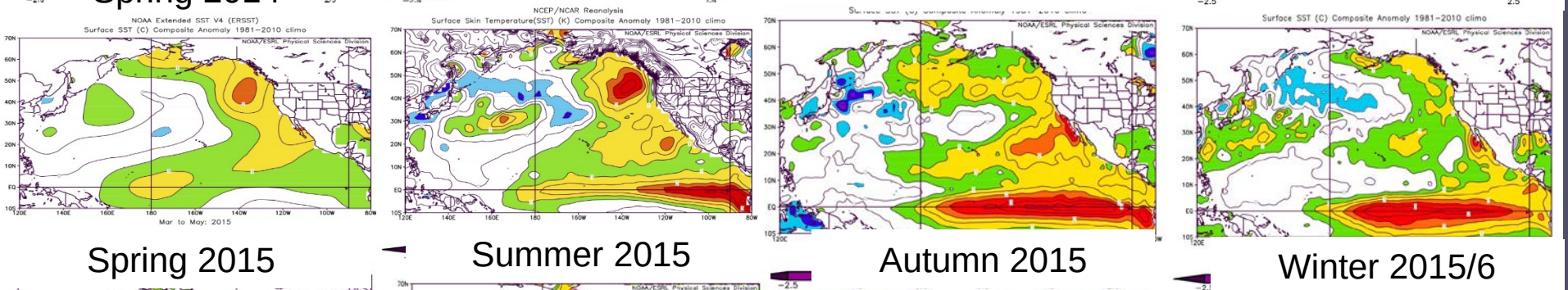
Appearance of The Blob
>2.5°C warm anomalies



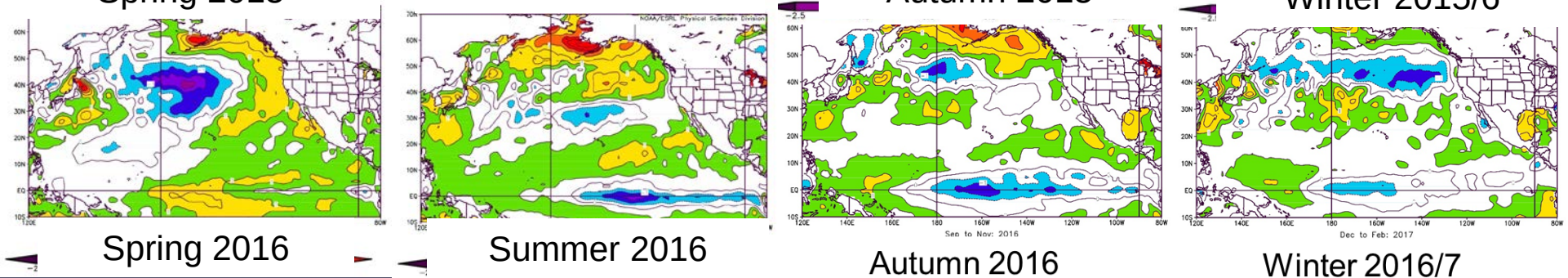
Autumn 2013 Winter 2013/4



Spring 2014 Summer 2014 Autumn 2014 Winter 2014/5

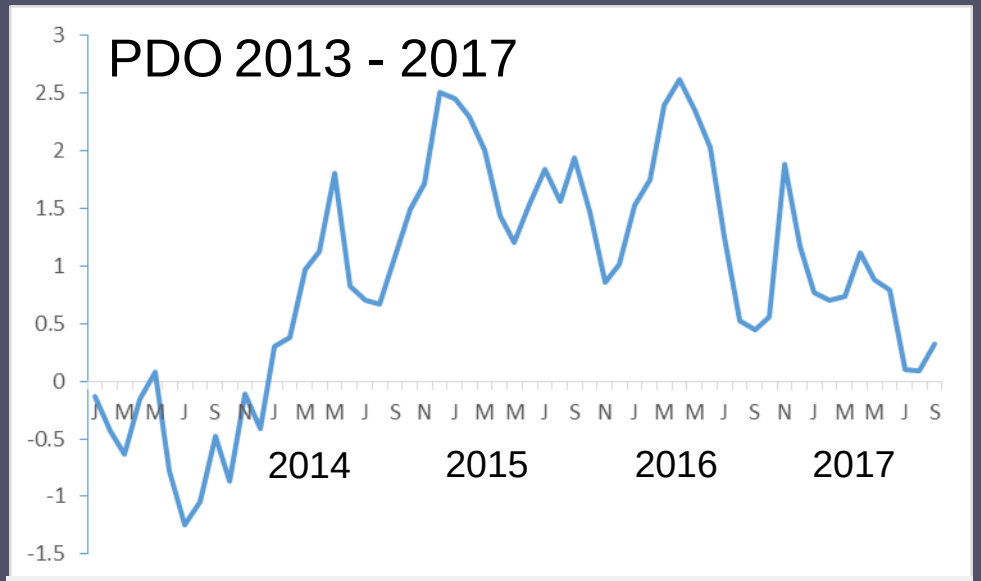


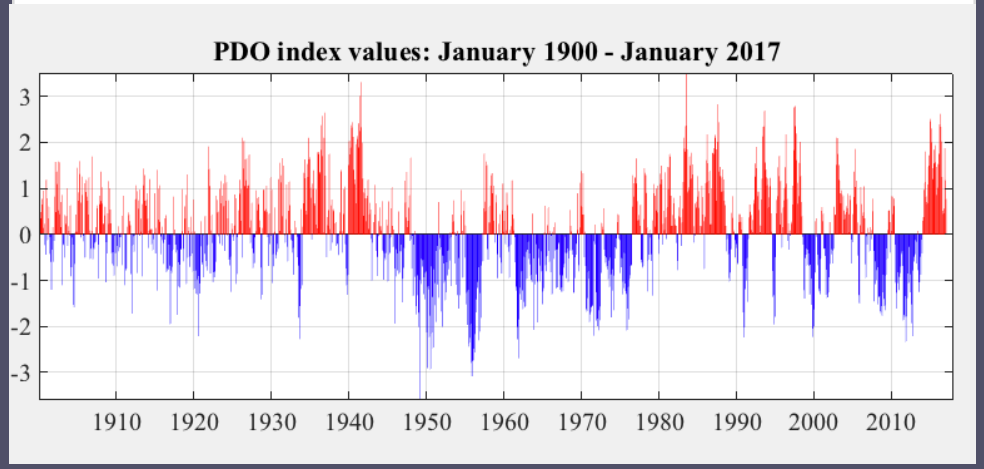
Spring 2015 Summer 2015 Autumn 2015 Winter 2015/6

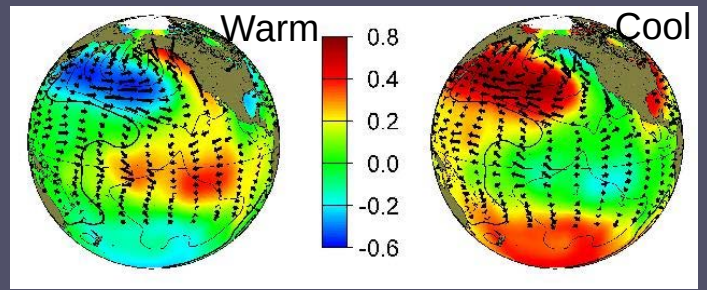


Spring 2016 Summer 2016 Autumn 2016 Winter 2016/7

2017 GOA Physical Conditions

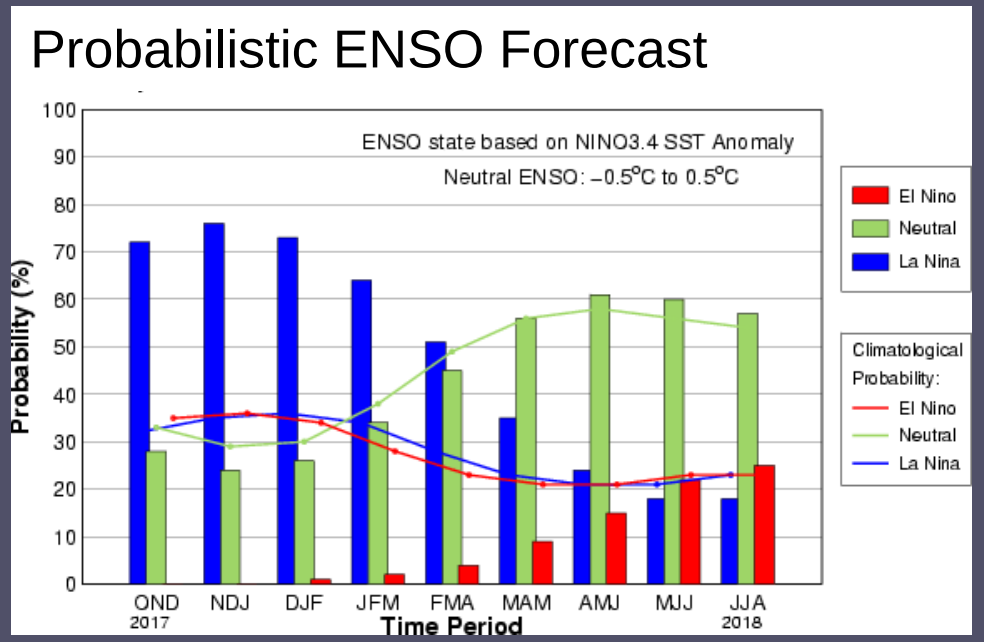


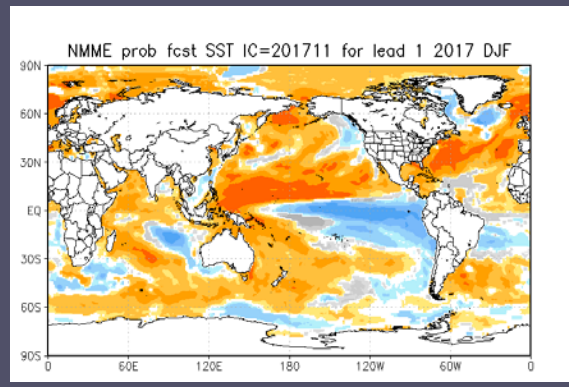




Warm, but trending toward cooler

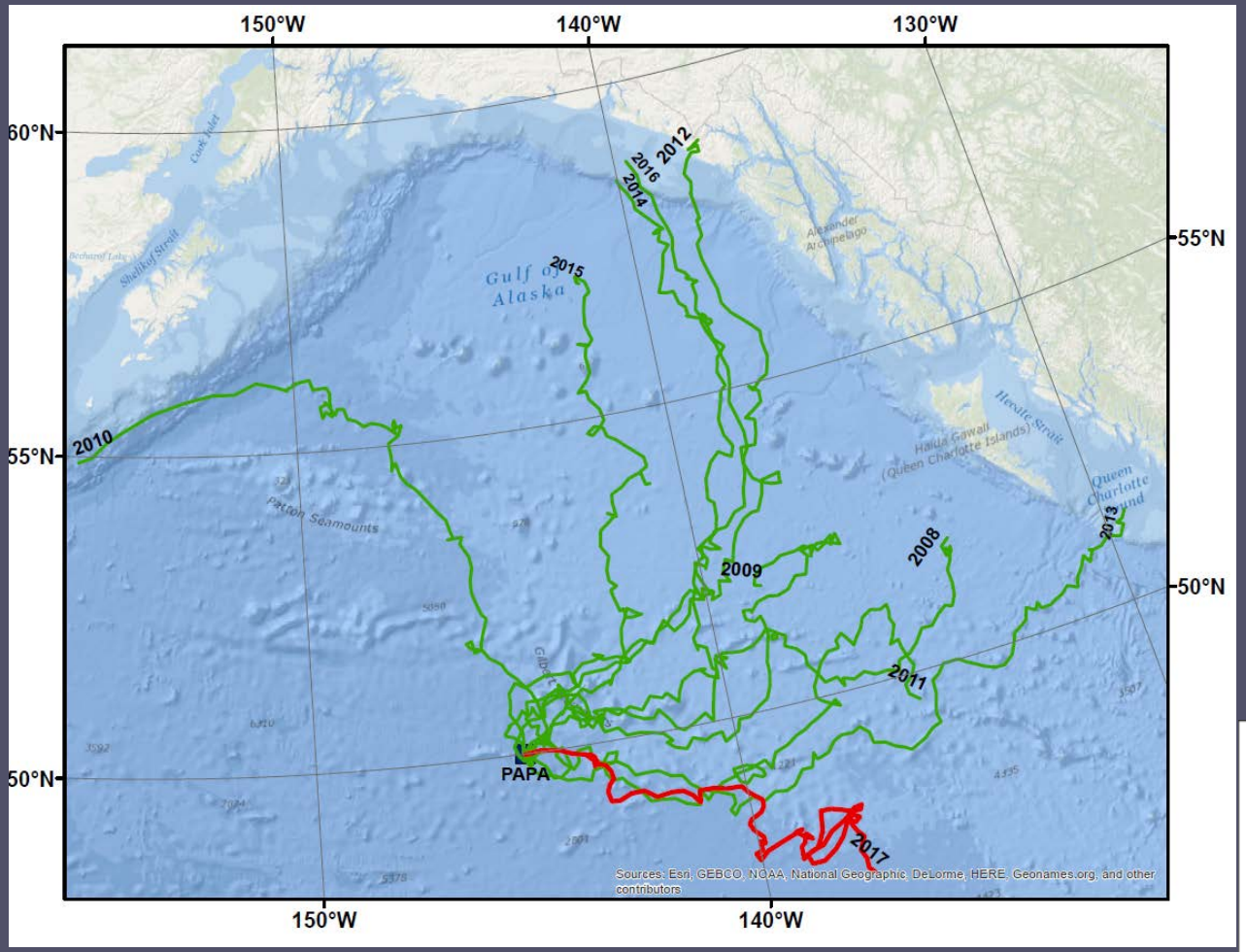
- PDO still (barely) positive
- Weak La Niña forecasted ~70%



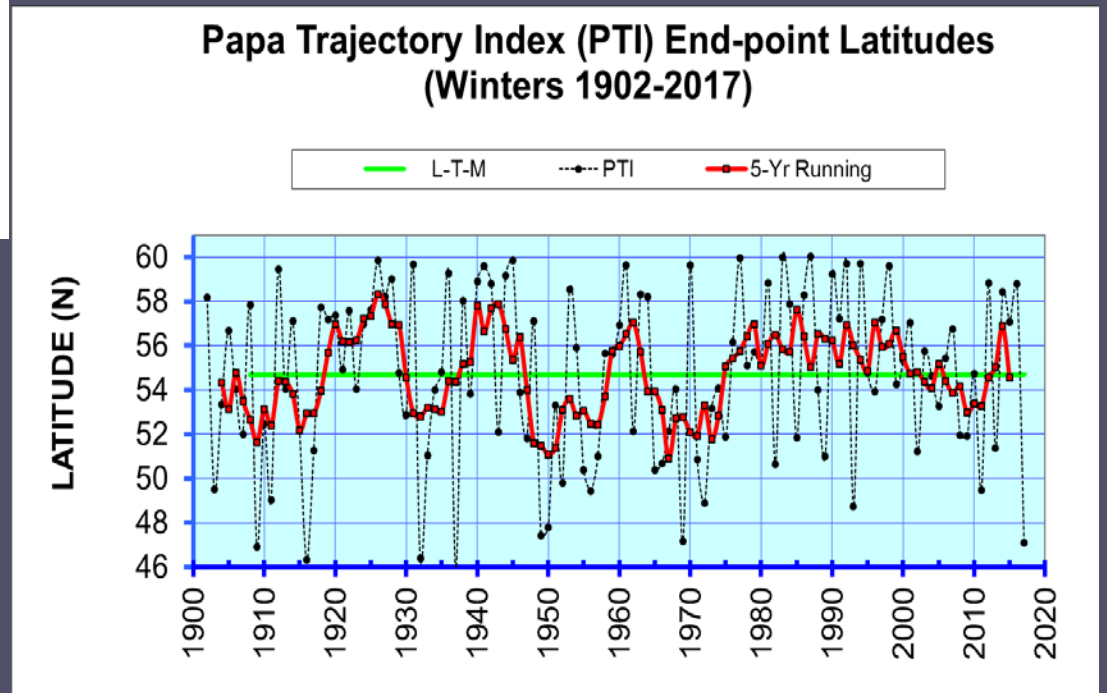


N. Bond

GOA Ocean Surface Currents – PAPA Trajectory Index



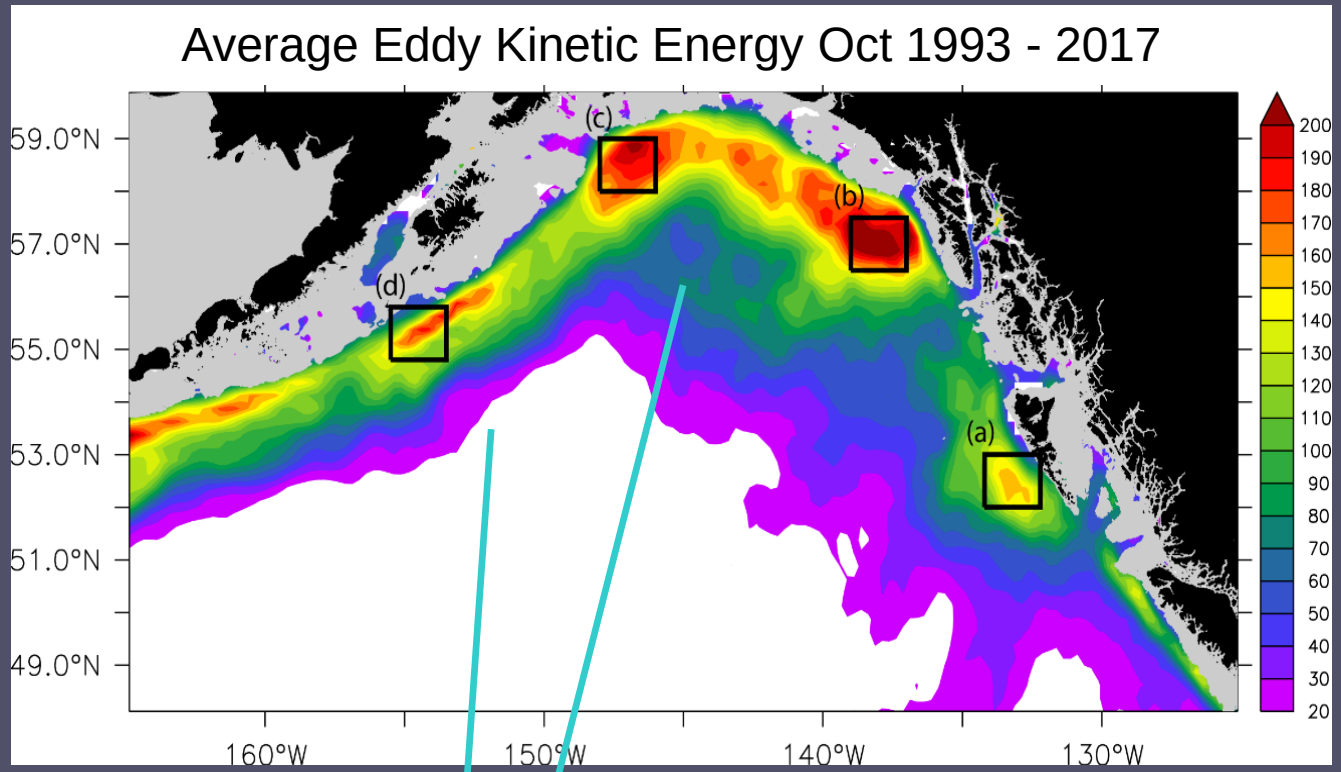
- Simulated surface drifter released from Ocean Station PAPA Dec 1 for 90 days
- 2014-2016 trajectories similar (S wind anomalies -> “Blob”)
- Strong northerly winds pushed drifter farthest south since 1930s

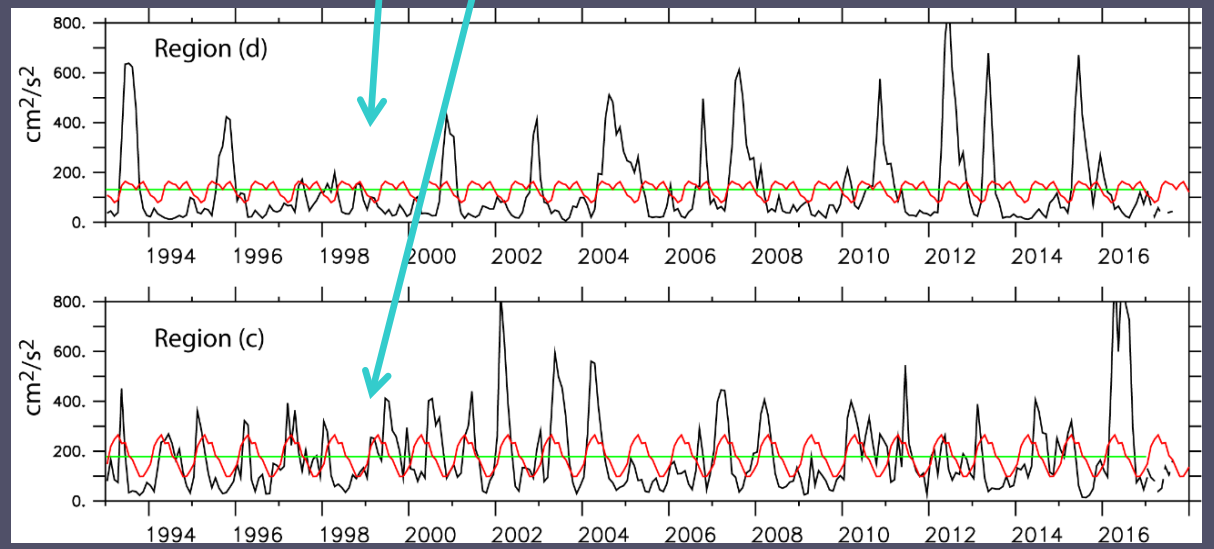


- Big change from past 3 years
- Recent period of mostly southerly flow is shortest in time-series
- PTI currently at mean

Stockhausen

Eddies in the Gulf of Alaska





Both regions have had weak EKE

(c) → Currently weak, strong persistent eddy in 2016.

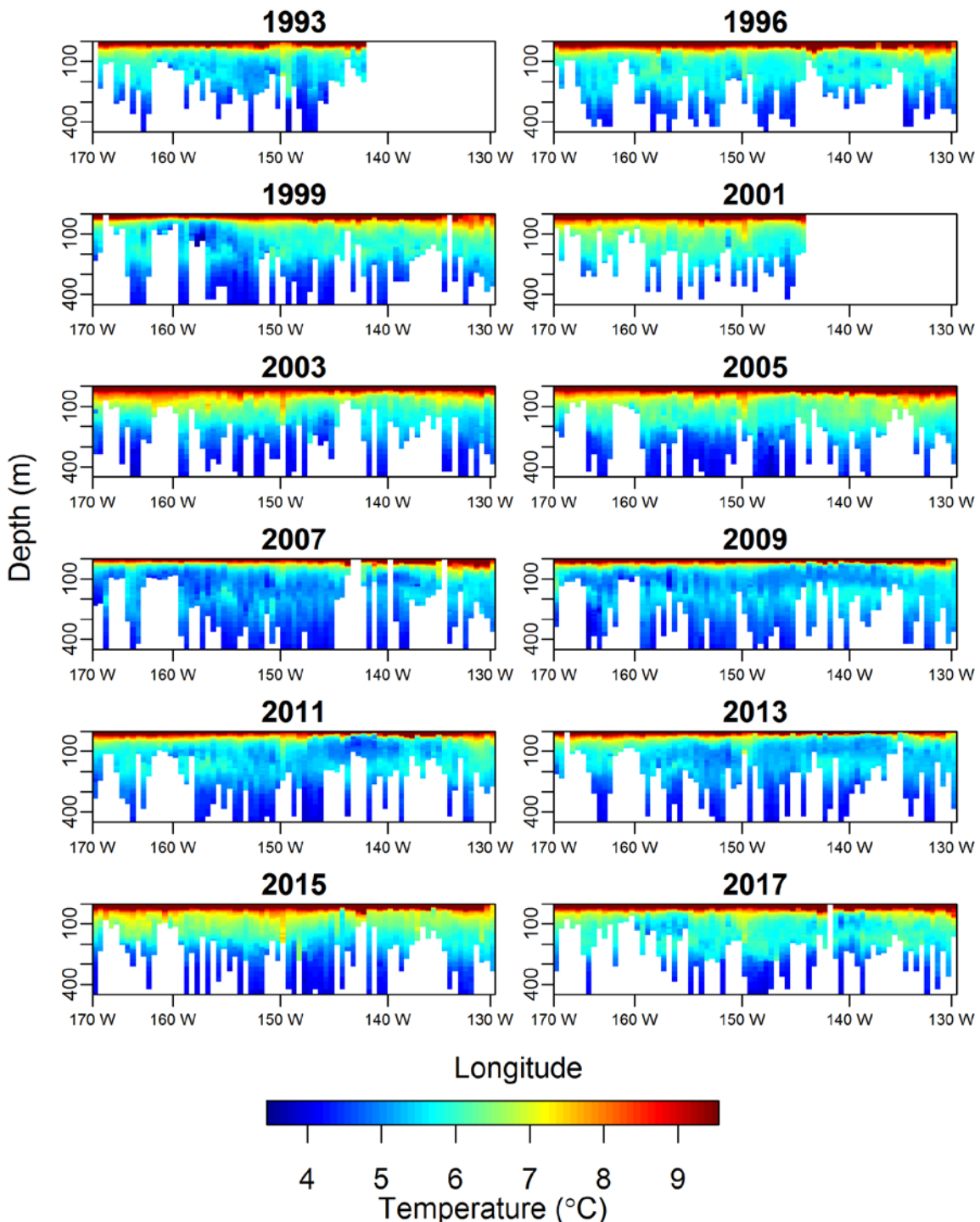
(d)→ Also currently weak, after recent strong ones in 2012, 2013, 2015

E GOA: influenced by winds (climate and gap scale)

W GOA: influenced by propagation and intrinsic variability

C. Ladd

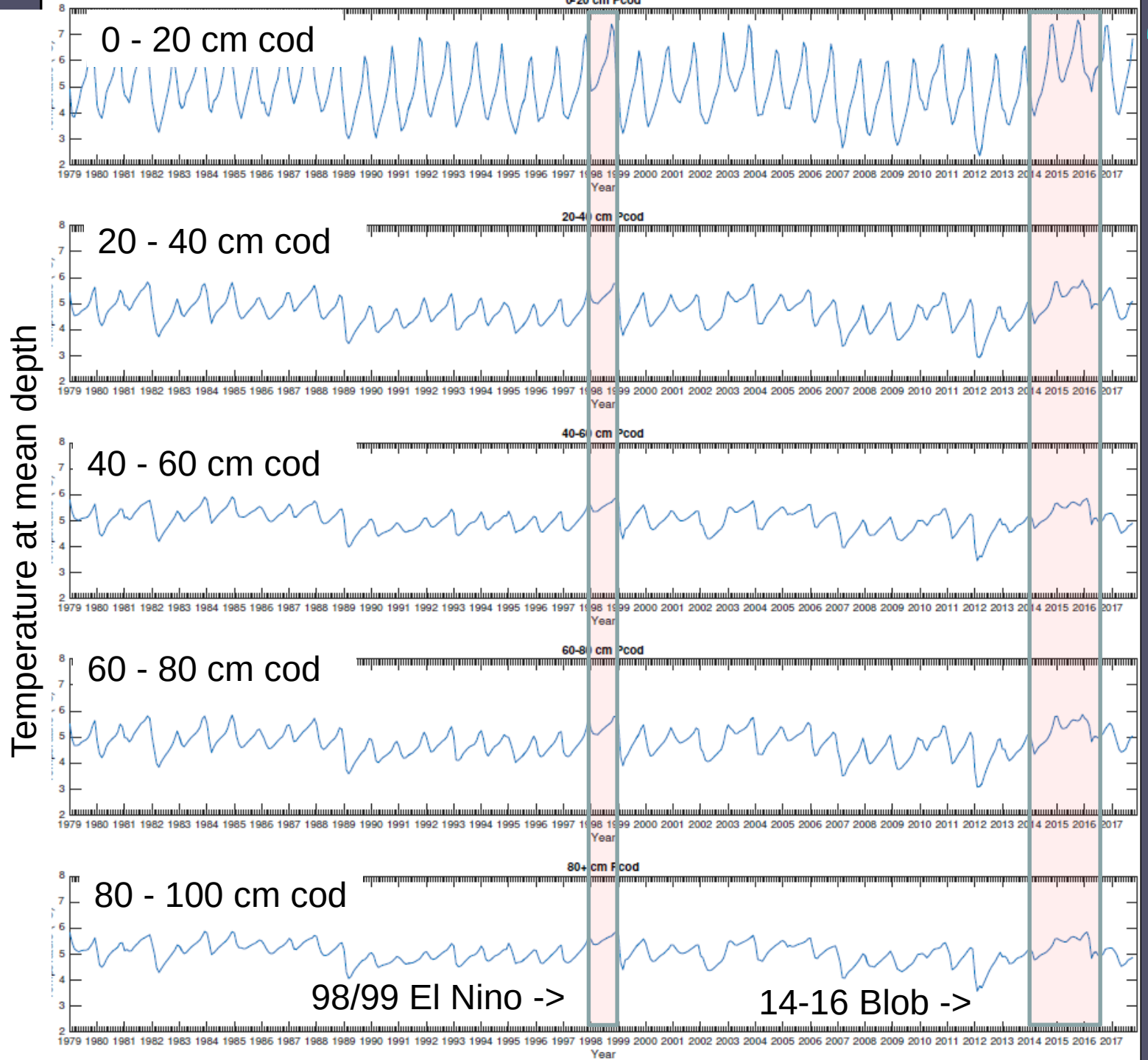
GOA survey water temps



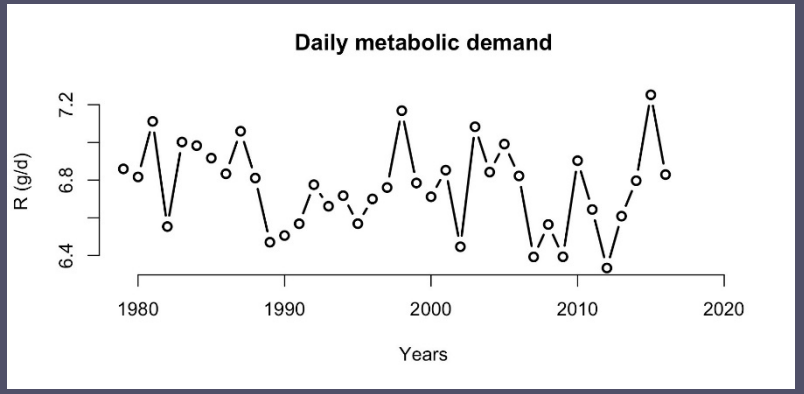
- 2017 slightly cooler than 2015, but still warm relative to 2007-2013
- Warmth mostly shallow
- Warmer than 2017 at depth in Central GOA

N. Laman

“Endless summer” for cod

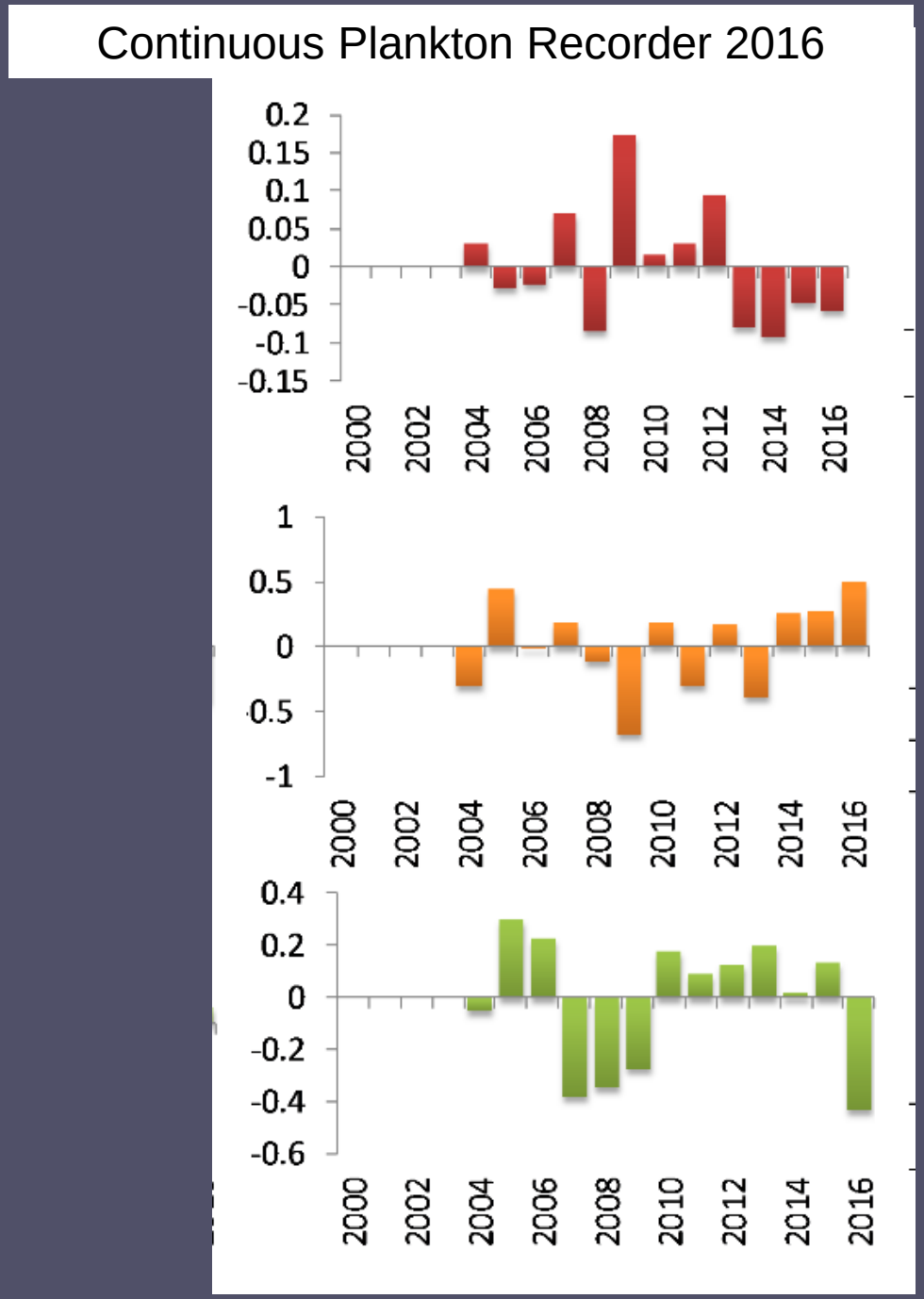


- Larger cod experienced summer temperatures year-round
- Metabolism didn’t slow down
- Ectotherms needed to eat more
- Bottom-up AND top-down forcing
- Not enough food to go around. Competition with other forage fish predators? (skinny fish, skinny/dead birds and whales, poor bird/mammal reproduction)



Yang, Barbeaux, Holsman

WGOA Zooplankton



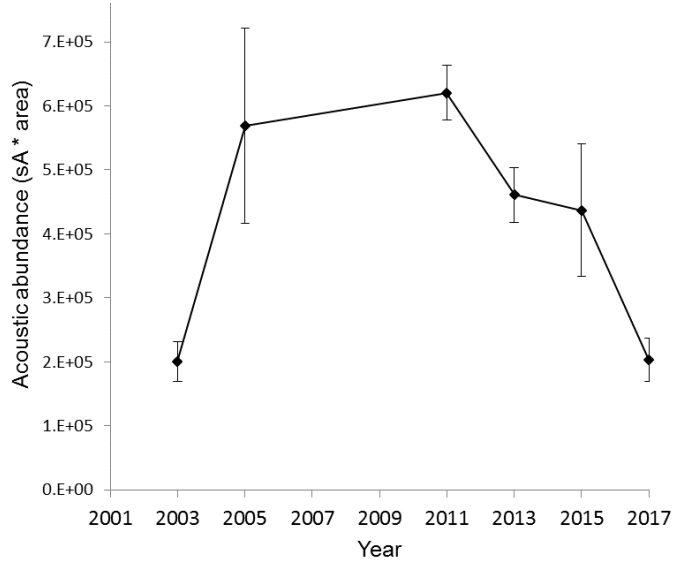
- Mostly abundant but small copepods during heat wave

S. Batten

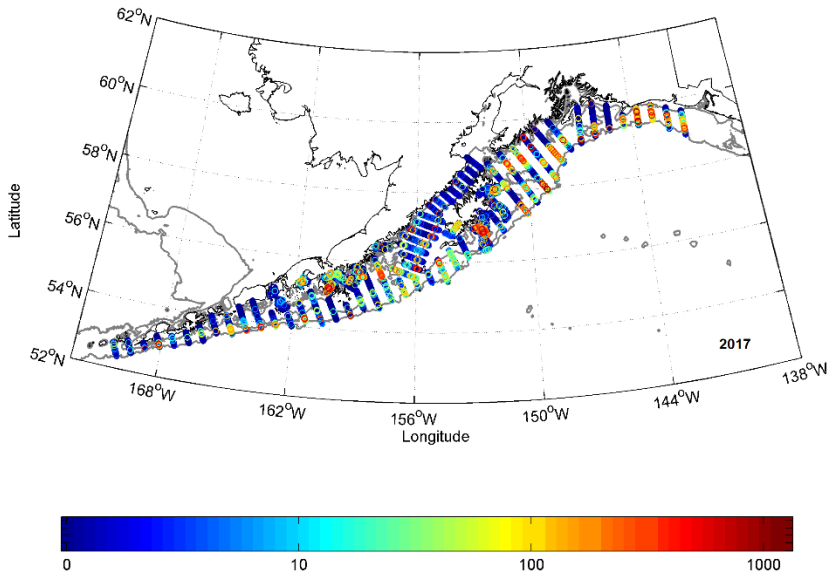
WGOA Euphausiids

Summer Acoustic Survey

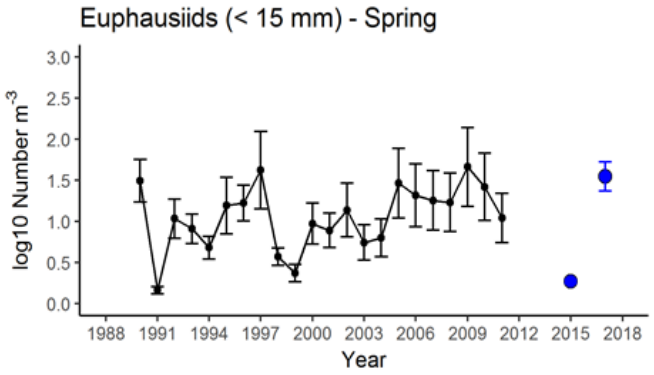
2017preliminary estimate



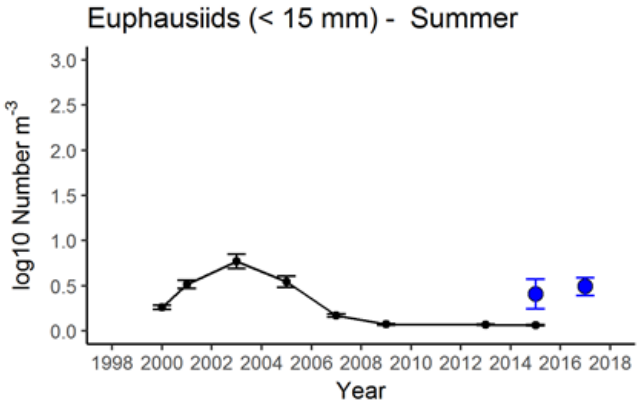
- Low euphausiid acoustic biomass in 2017, similar to 2003
- Moderate abundance during heat wave?
- Different pattern in the RZA due to different ages



Spring Rapid Zooplankton Assessment

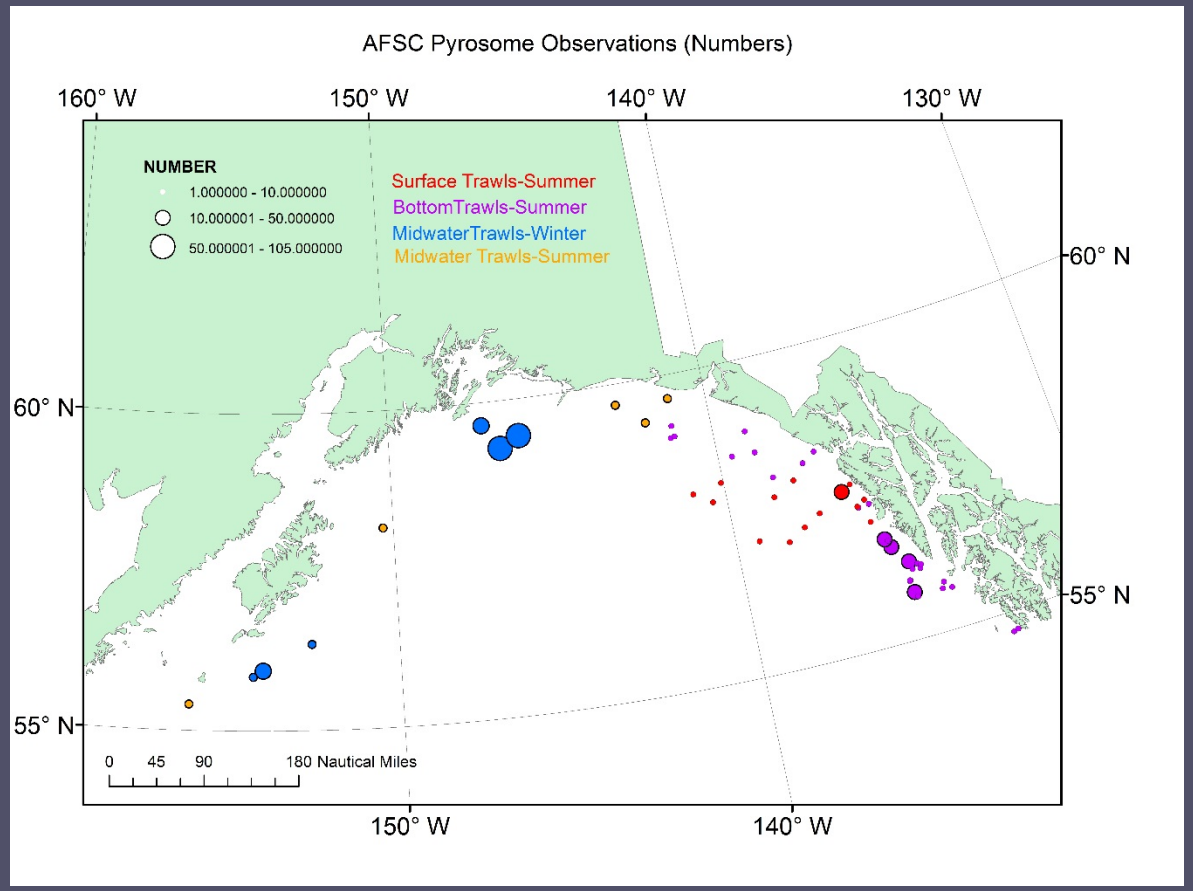


Summer Rapid Zooplankton Assessment



Ressler; EcoFOCI

Hot Topic
Pyrosomes

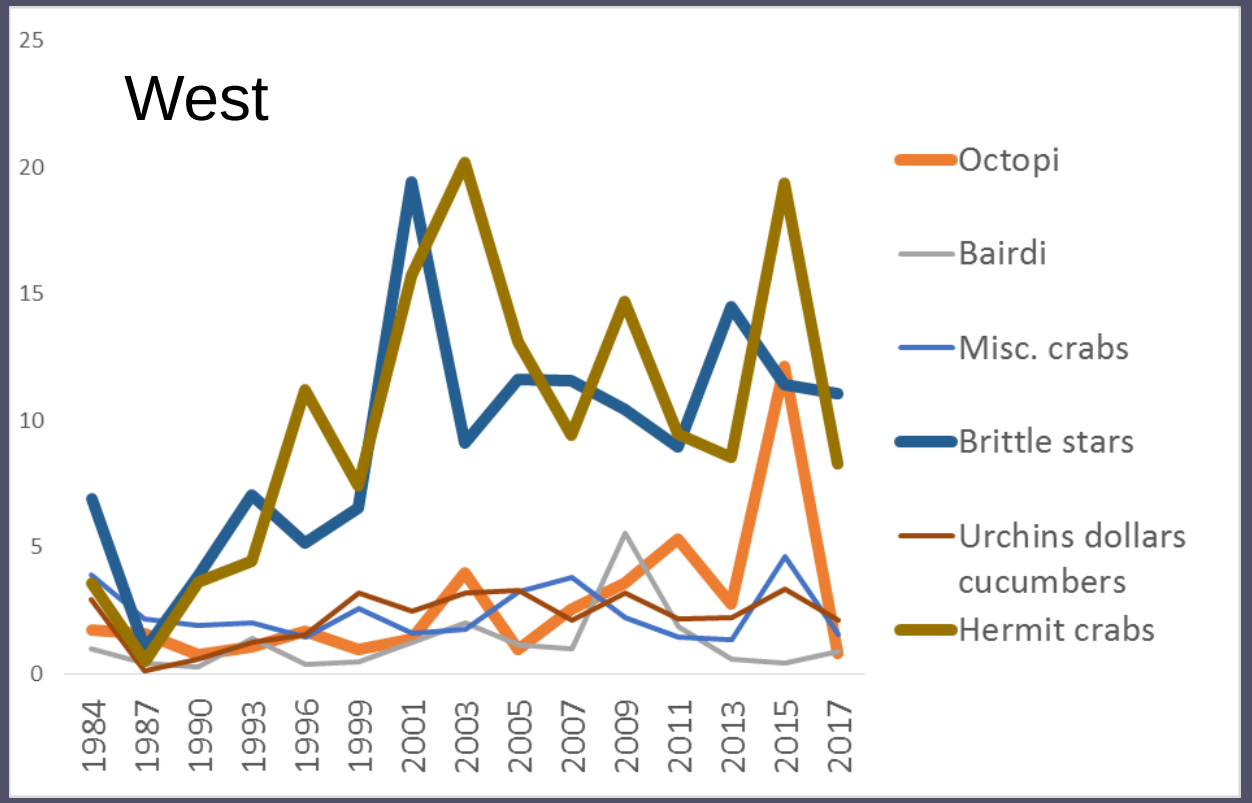


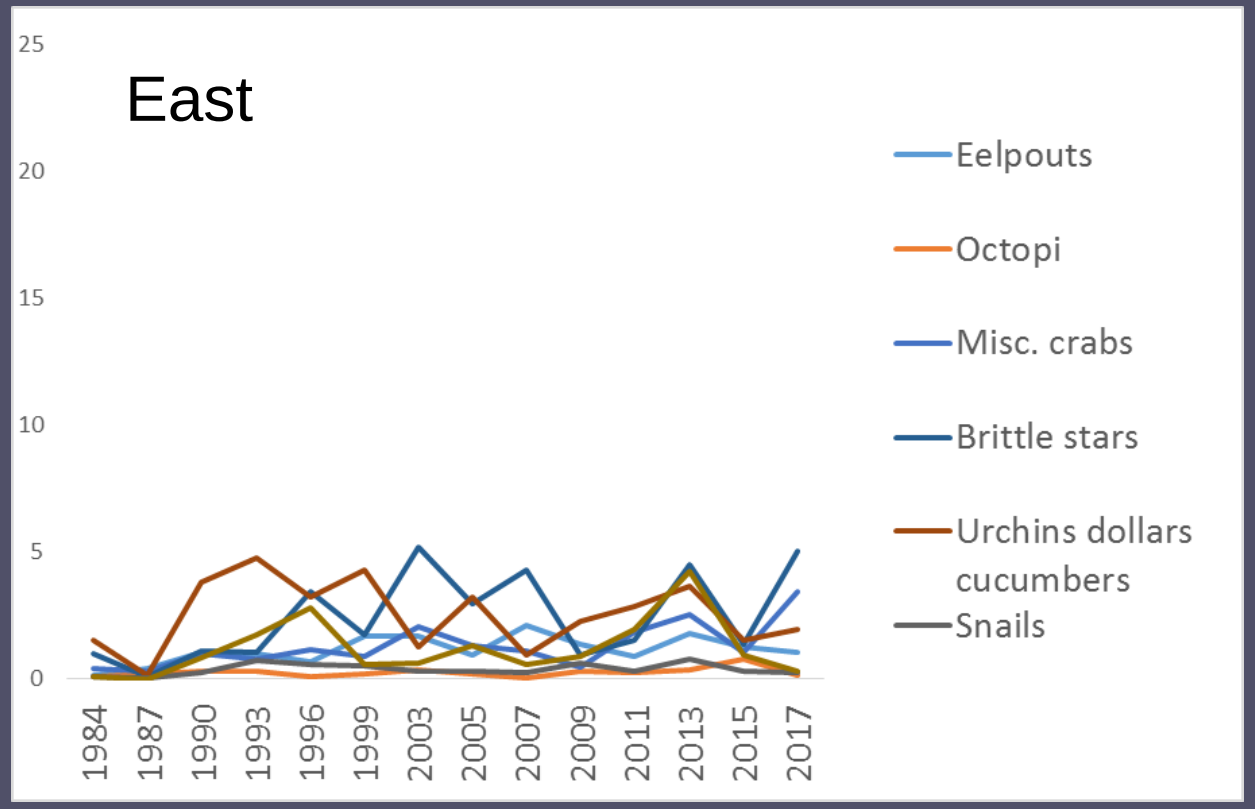
- *Pyrosoma atlanticum* observed for the first time
- Seen in acoustic, surface and bottom trawl surveys
- From March - August
- Pelagic tunicates that typically form colonies
- Typically live in tropical, sometimes sub-tropical, waters
- Observed in stomachs of sablefish and some rockfish

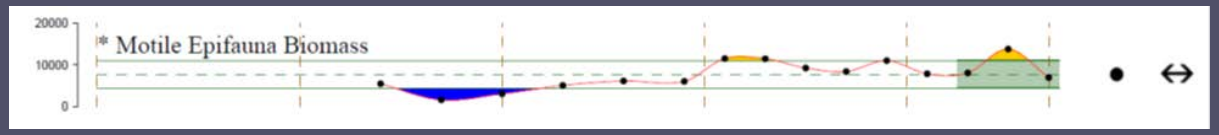
Palsson, Murphy, Ressler

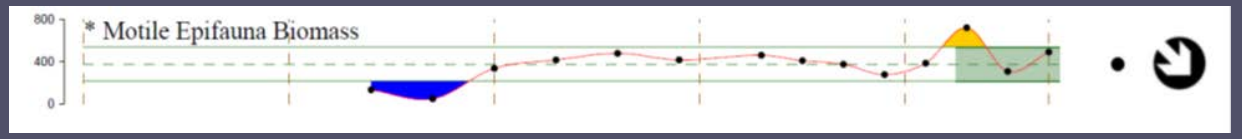
Motile Epifauna

Aggregated biomass from the BT survey



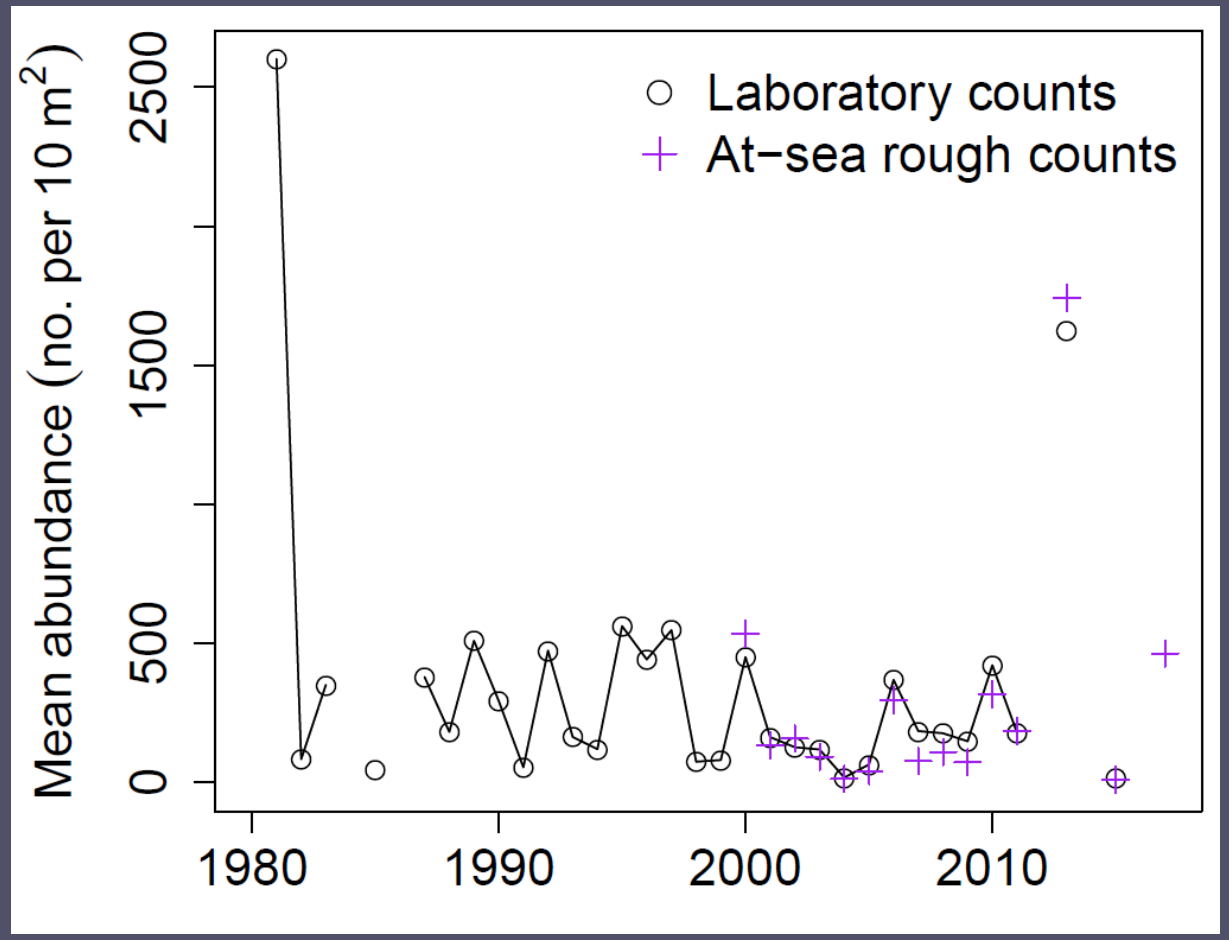


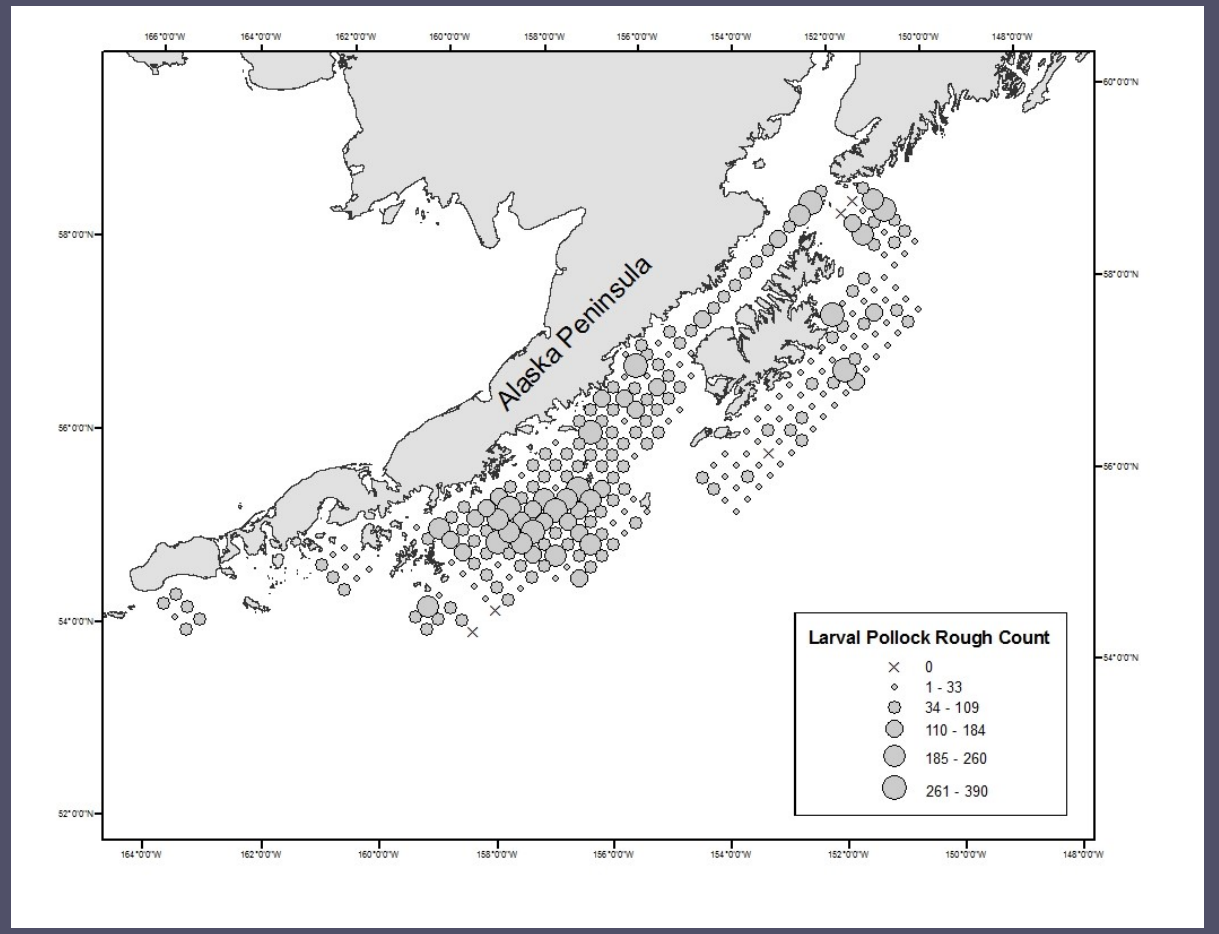




WGOA Larval Pollock

Spring larval pollock (and cod) counts above average

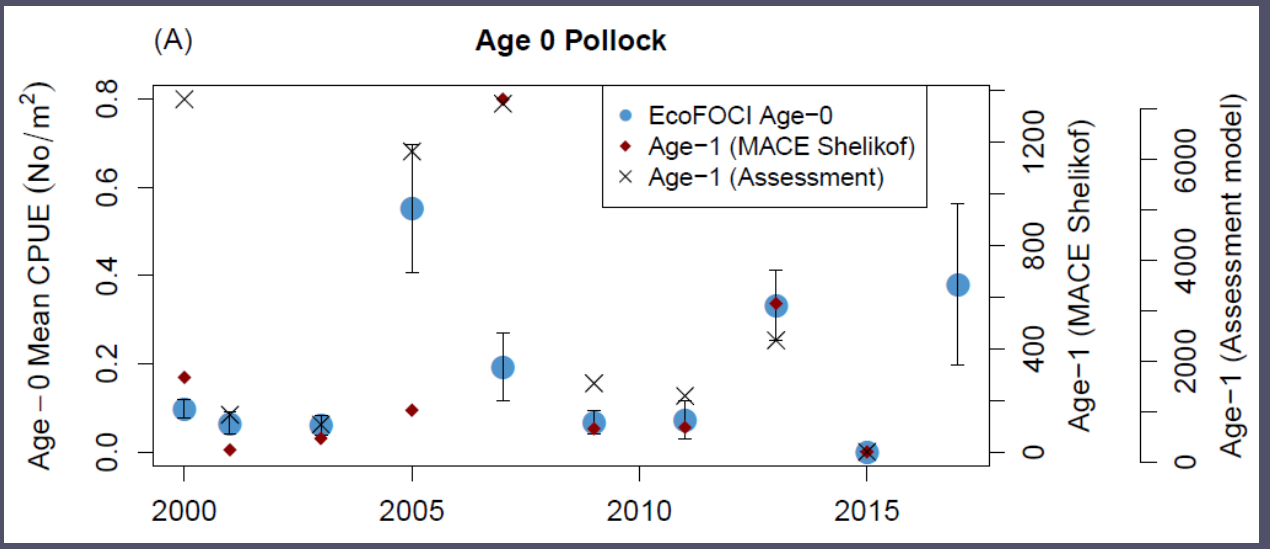


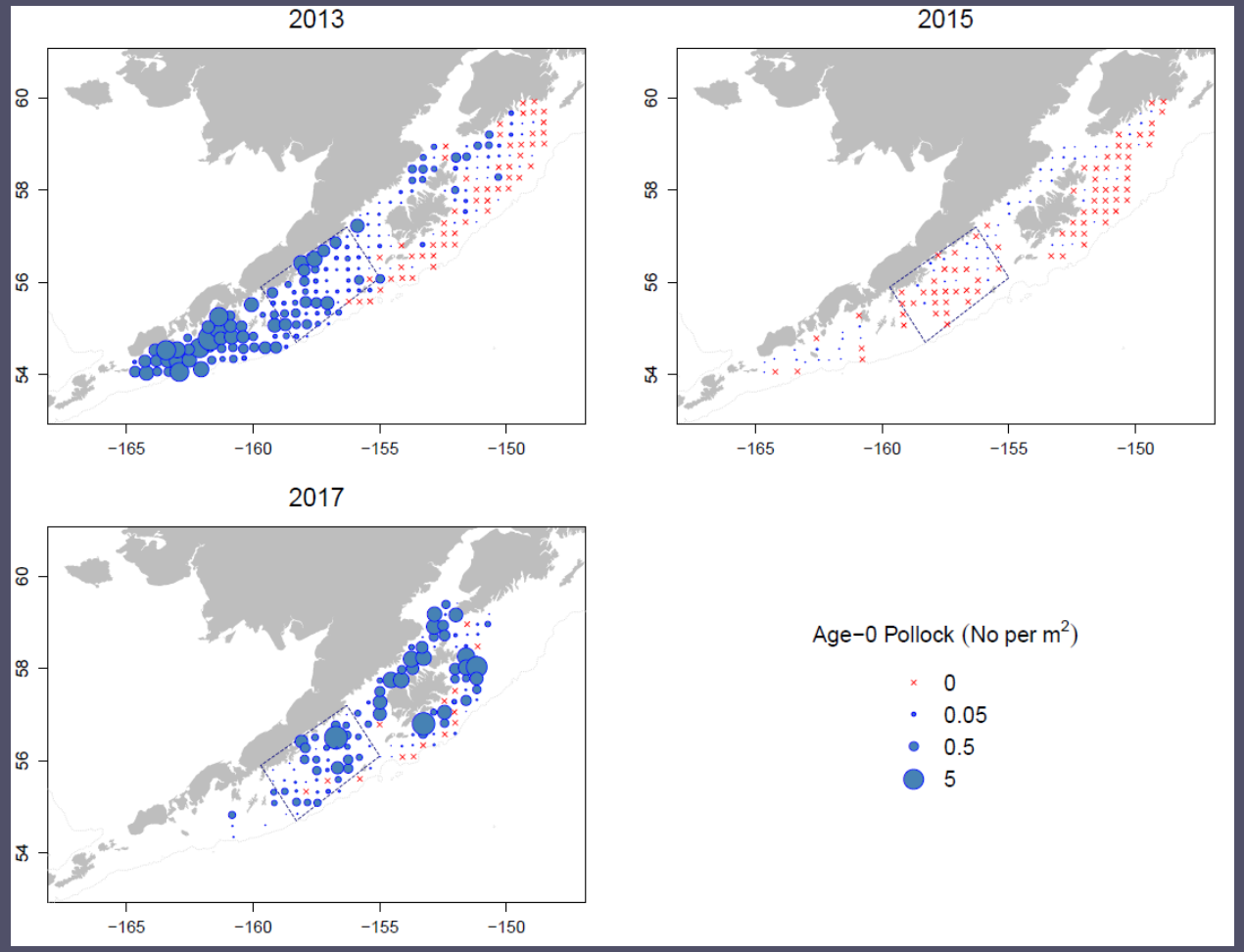


WGOA Age-0 Pollock

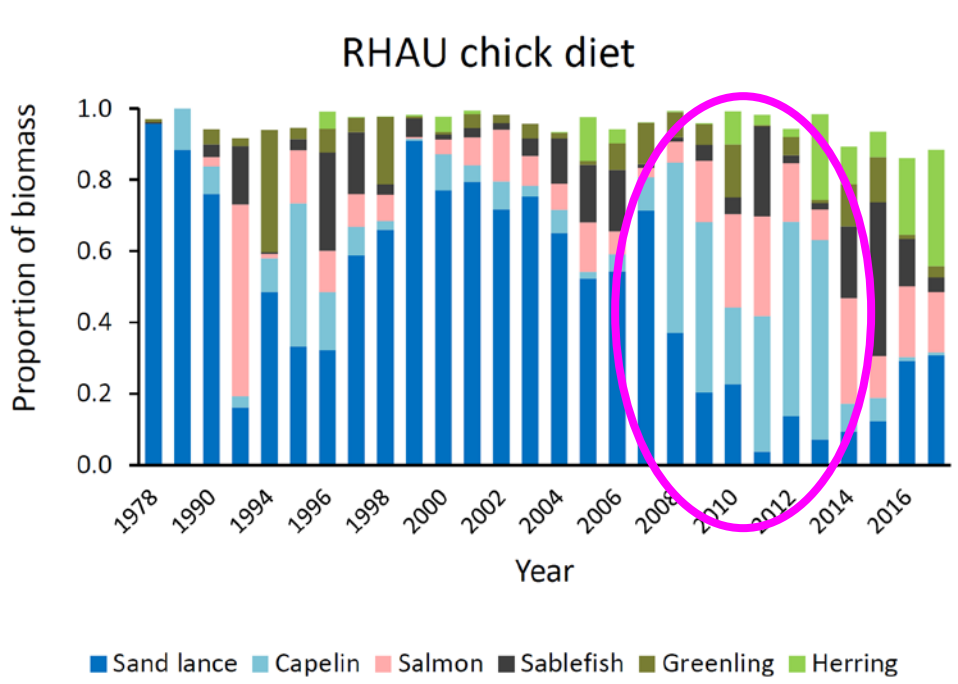
Late summer

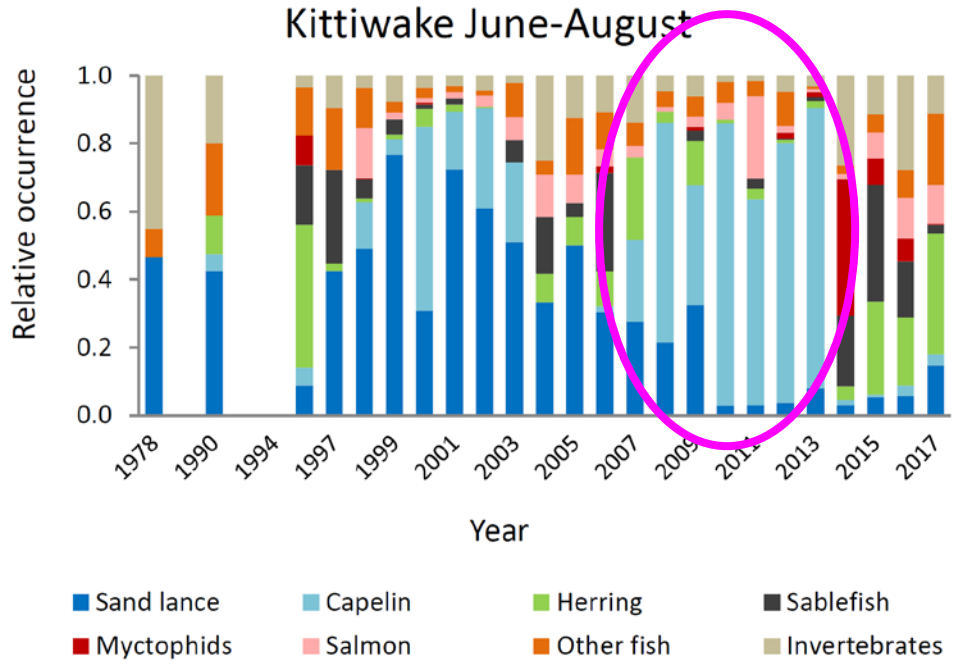
- Late summer age-0 CPUE 2nd highest in time series
- Pollock found around Kodiak, unlike in 2013



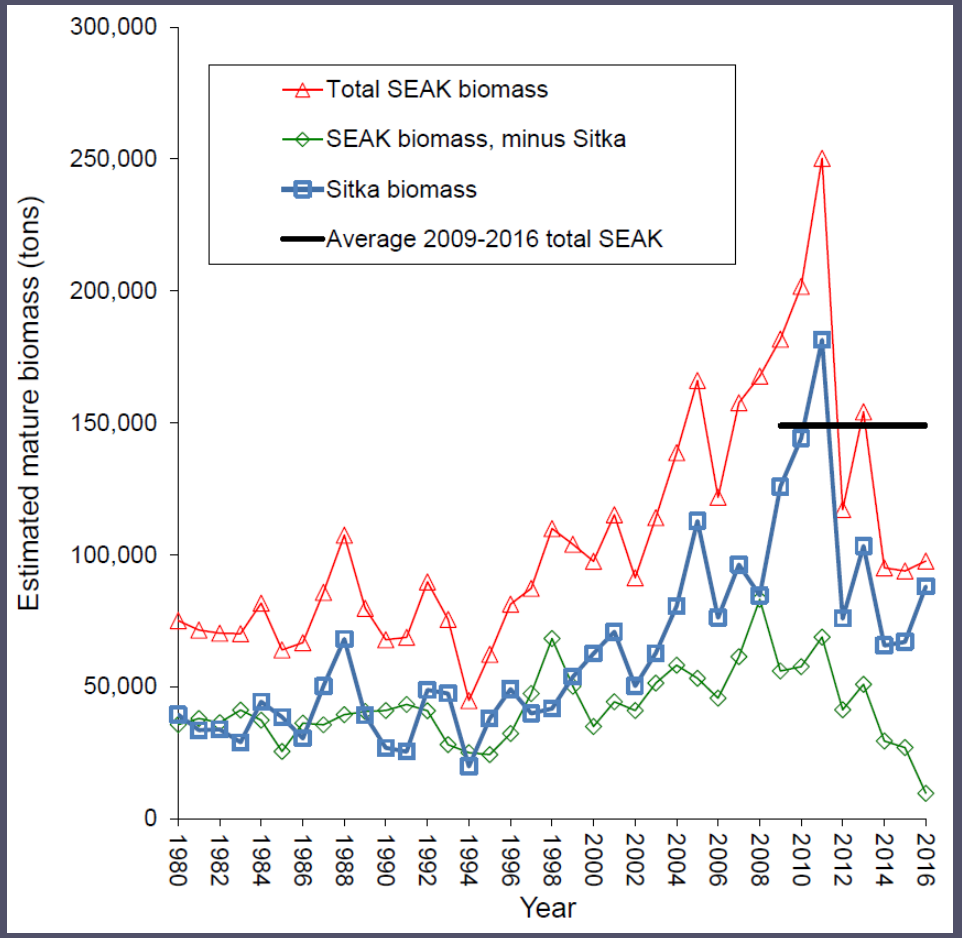


Forage Fish





- Fish collected from rhinoceros auklets and black-legged kittiwakes
- Disappearance of capelin in warm years
- SEAK herring had large declines in 2012, 2014
- Little change in 2015-2016 herring overall

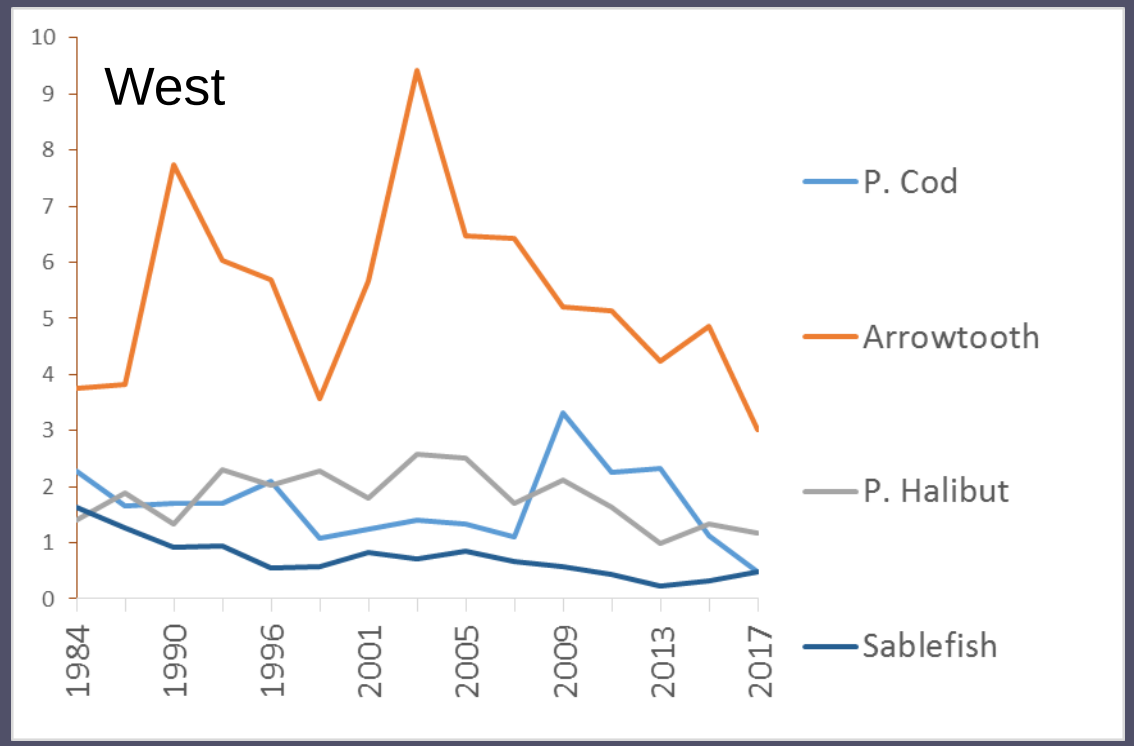


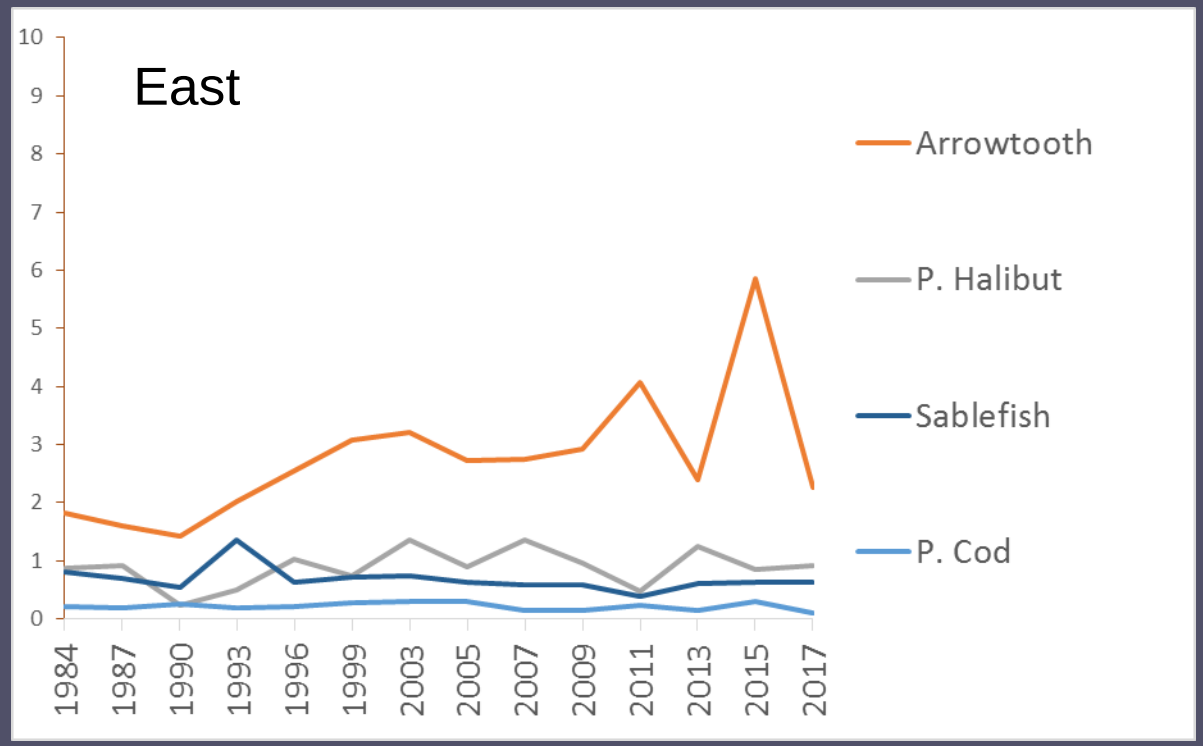
Hatch et al.; Hebert and Dressel

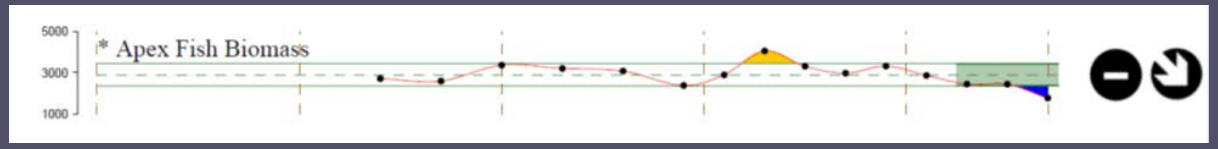
Apex Fish

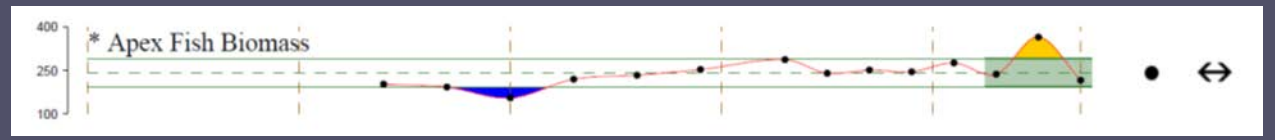
Aggregated biomass from the BT survey

- ATF increased during 2015, but cod dropped

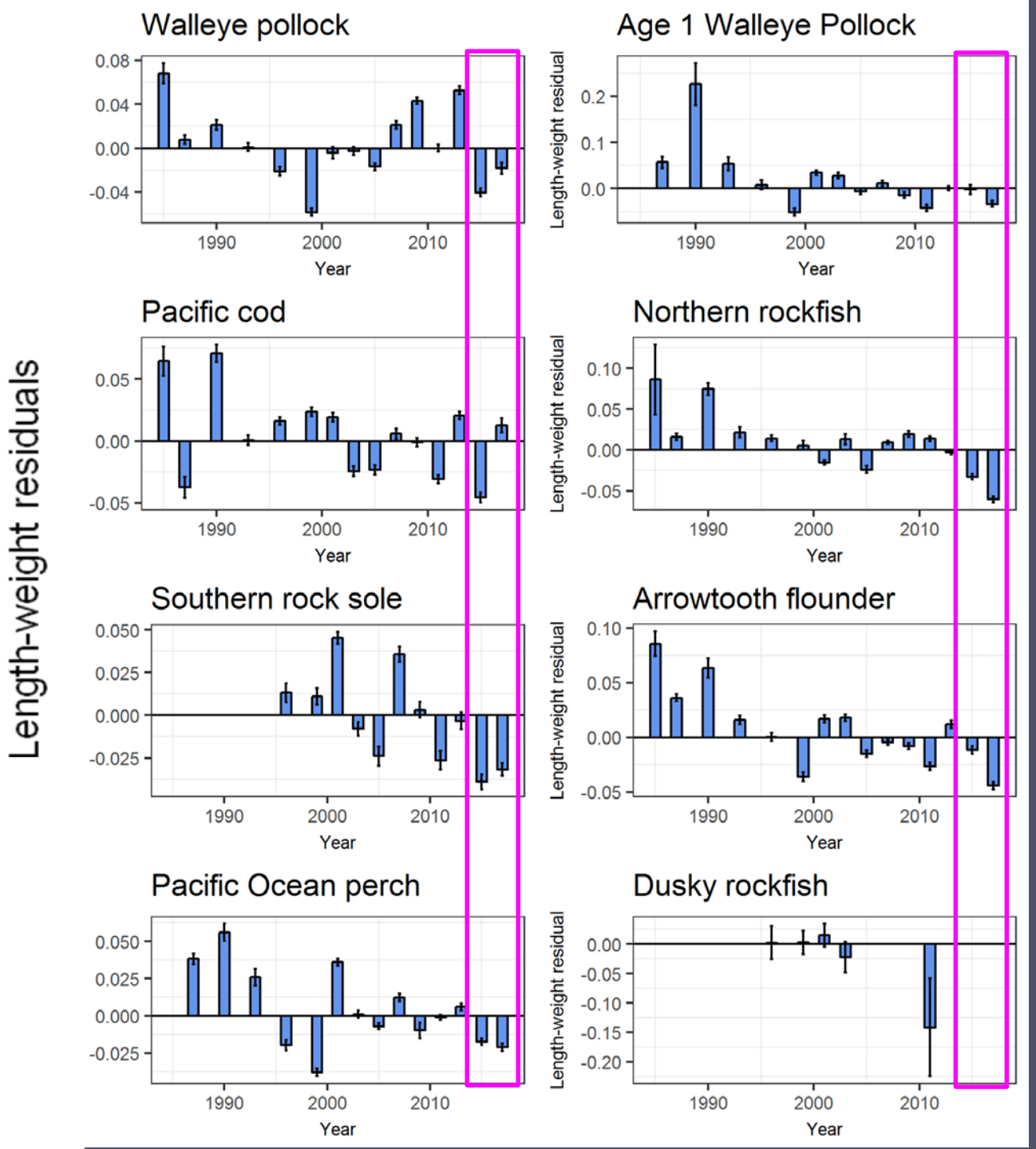








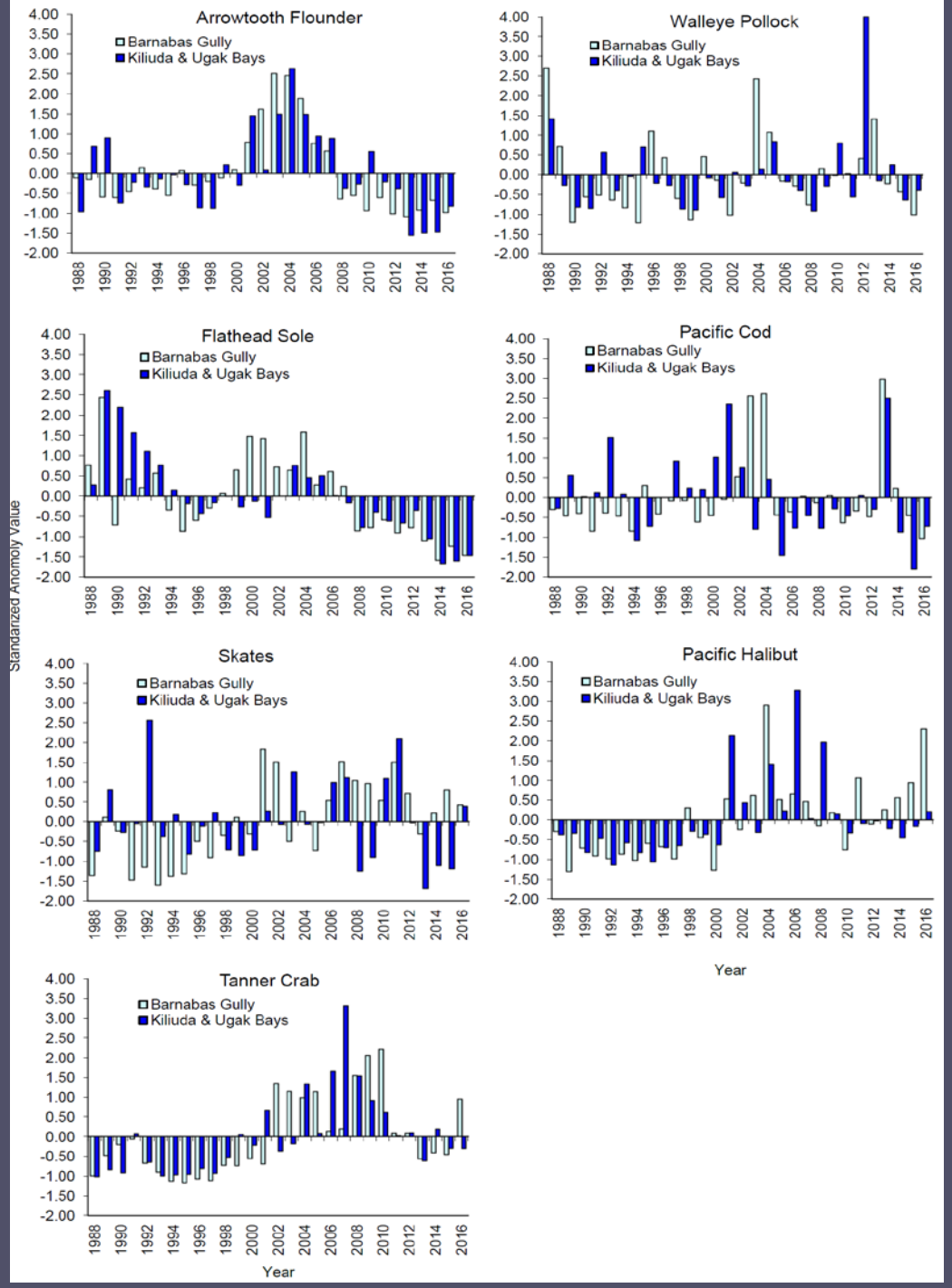
Groundfish Condition from BT Survey



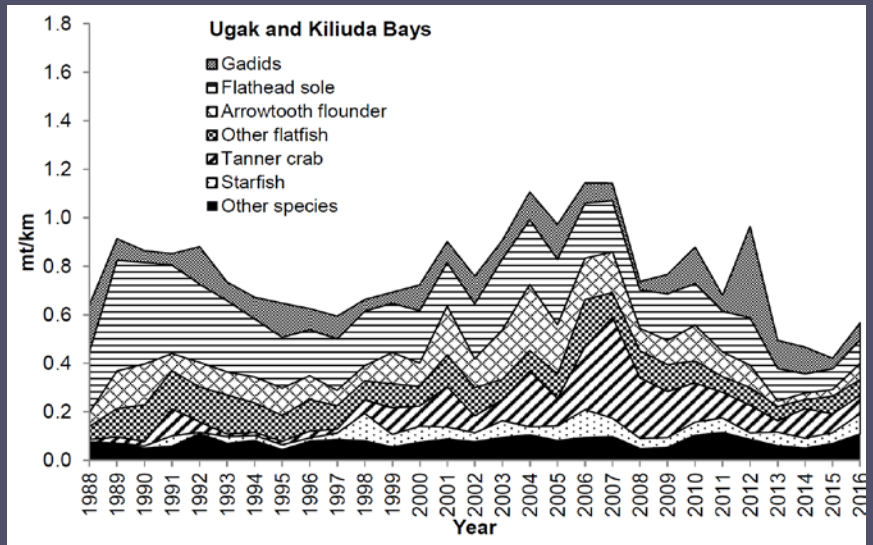
- Weight-length residuals
- Overall negative in 2015
- All but cod negative in 2017

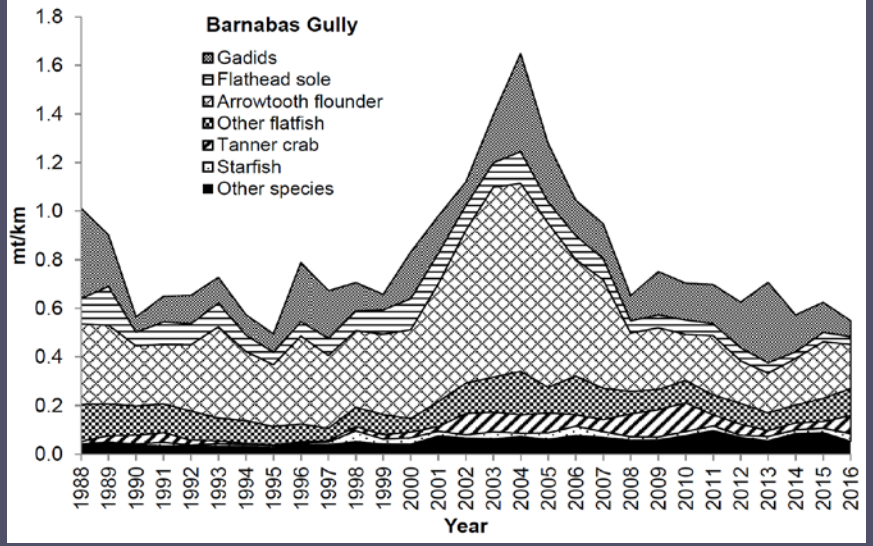
Boldt, Rooper et al.

WGOA 2016 ADF&G Trawl Survey



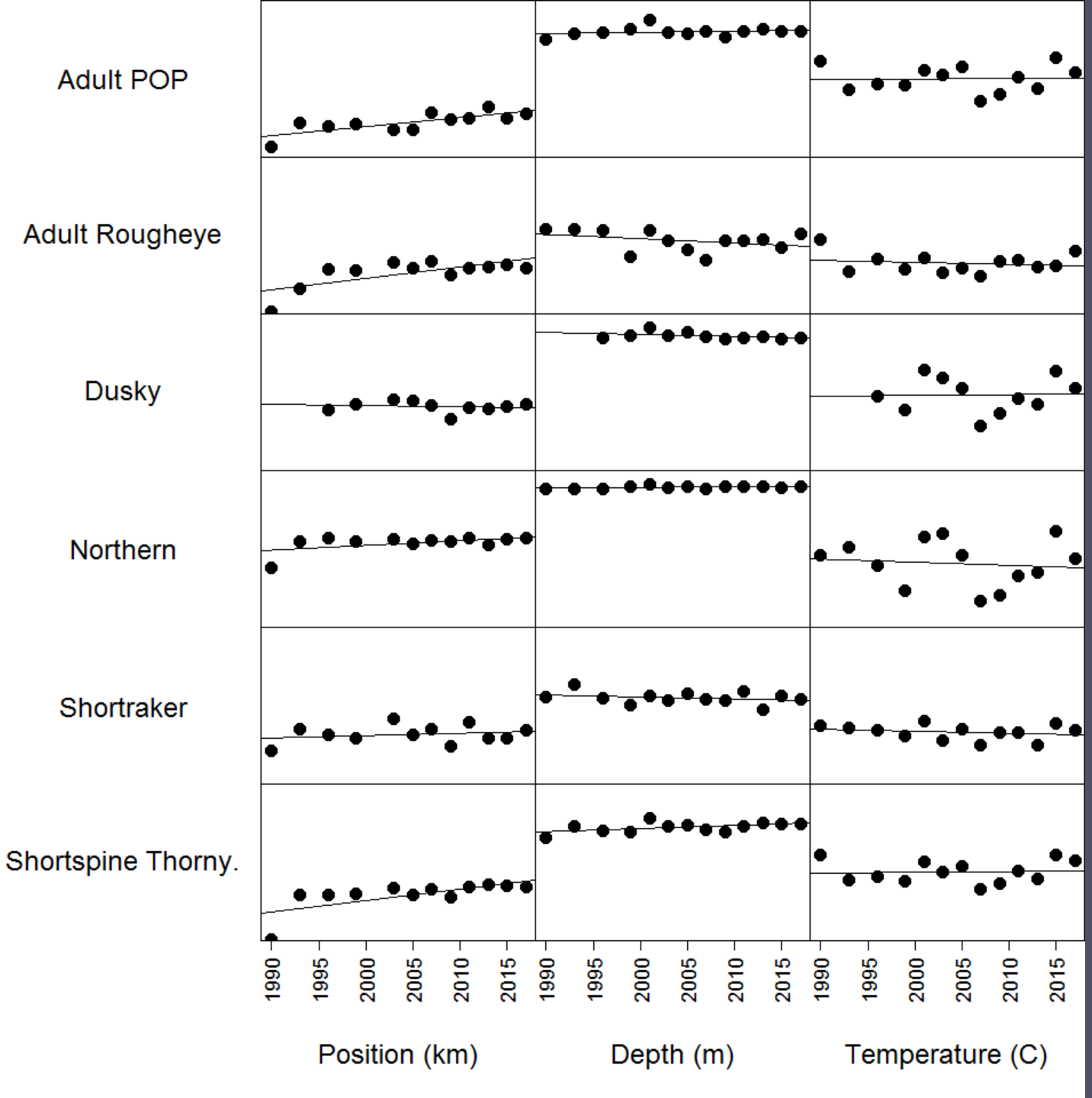
- ATF, FHS, pollock, and cod have remained low since at least 2014
- Halibut show an increasing trend in Barnabus Gully
- Overall CPUE continued to decline offshore through 2016, but increased inshore





Worton

Rockfish Distribution by Longitude, Depth, and Temperature

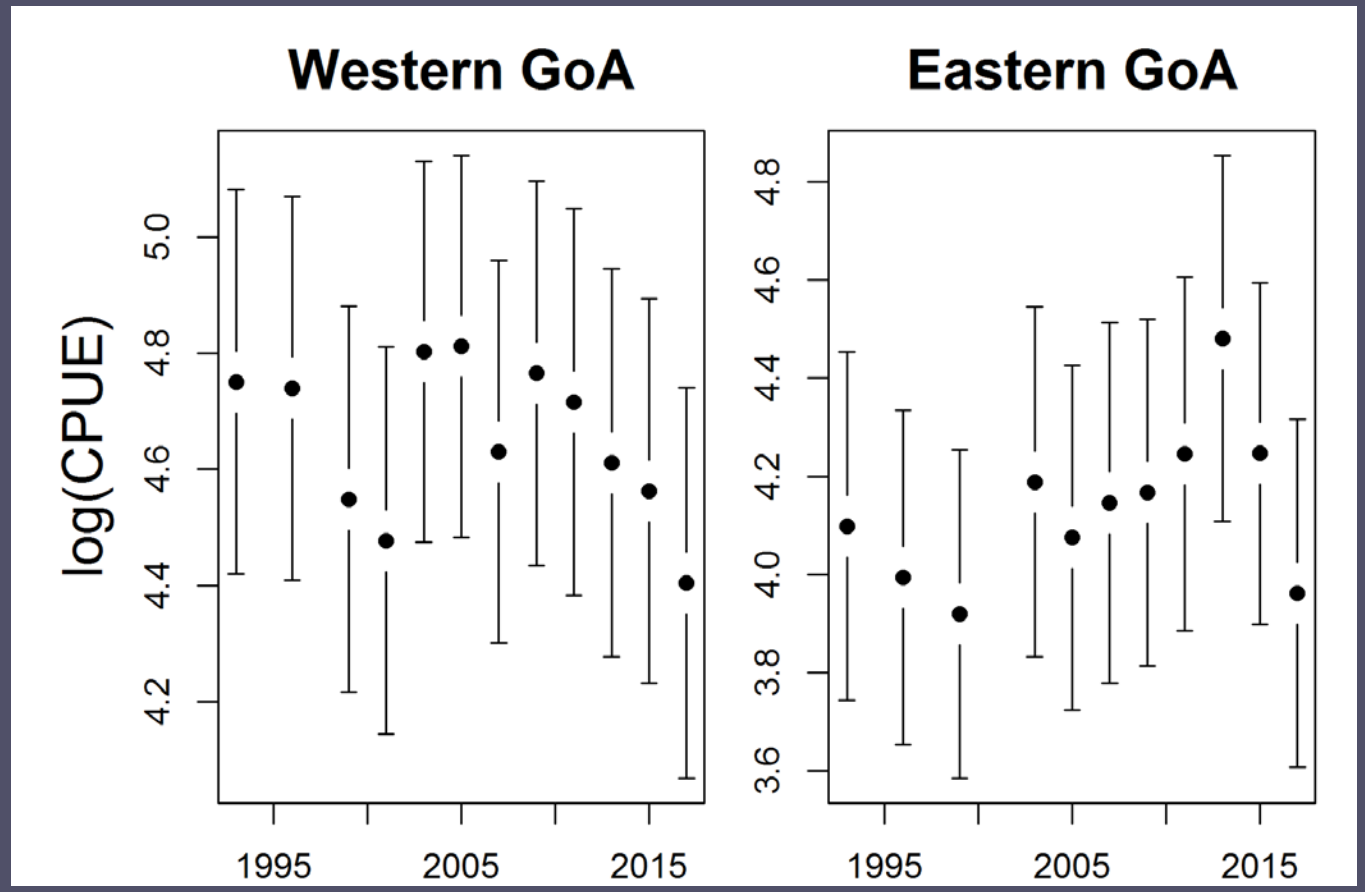


- Despite change in temperature range (but no significant overall trend), average rockfish depth range has not changed

Position is distance from Hinchinbrook Is (PWS)
West (+) ← PWS → (-) East

Rooper et al.

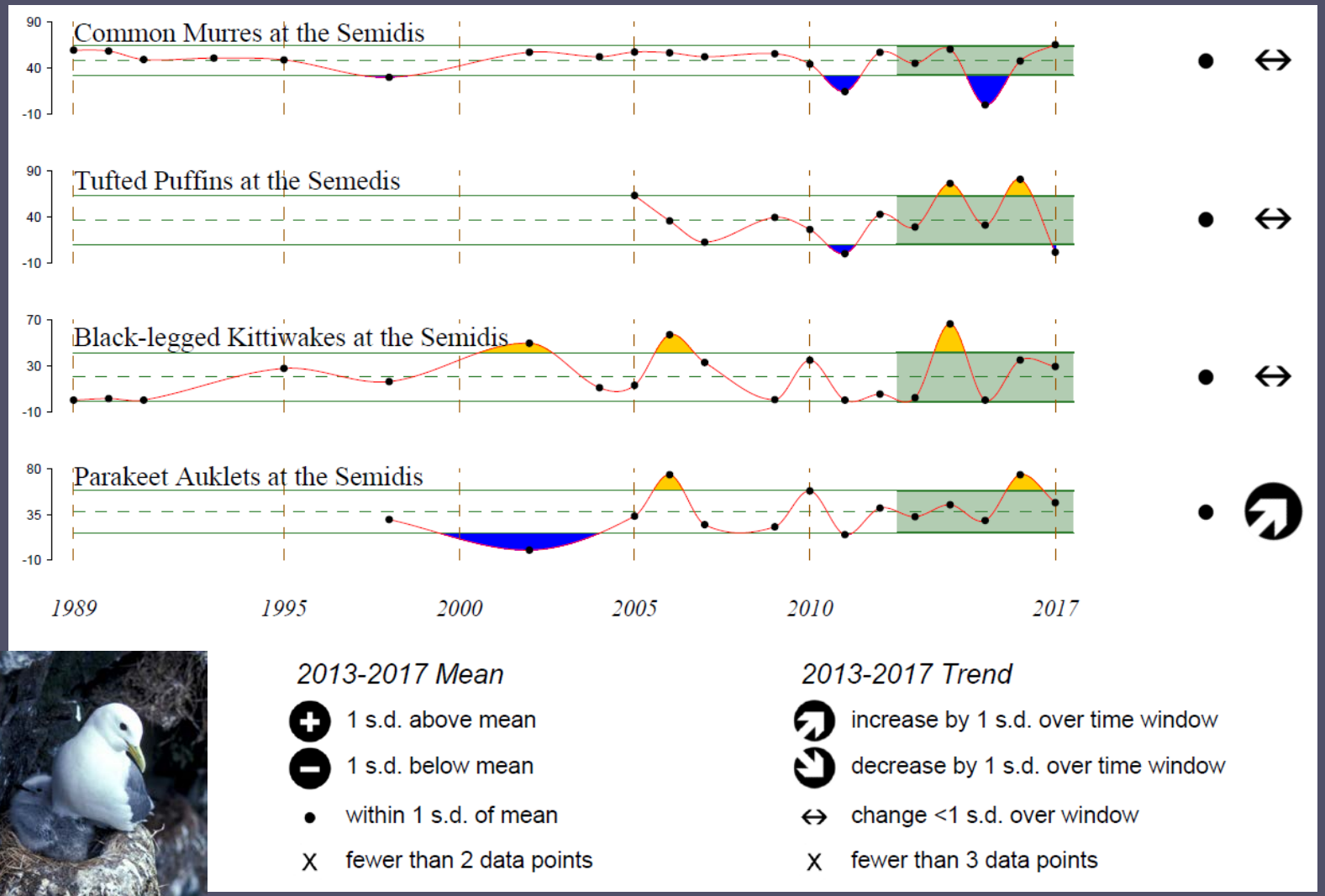
BT Survey CPUE



- Aggregated CPUE of fish and invertebrates in bottom trawl survey
- WGOA 2017
  - Lowest in time series
  - Pollock, cod, ATF, northern rockfish
- EGOA 2017
  - Second lowest
  - ATF, shortraker, cod, spiny dogfish

Mueter

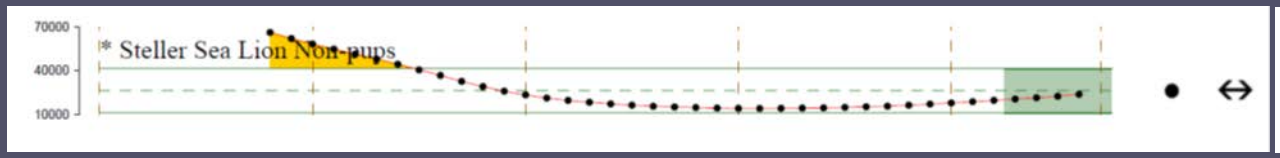
WGOA Seabirds



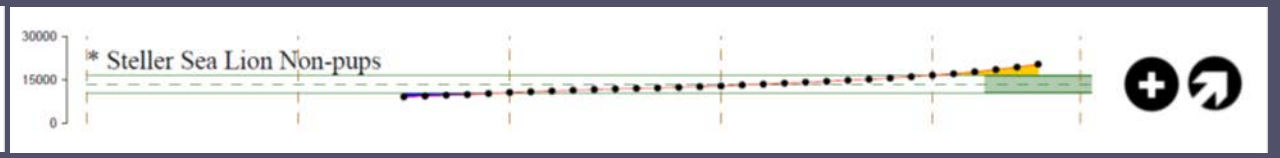
- Several fish-eating seabirds had unusually low reproductive success in 2017 (tufted, horned puffin)
- Broad failures and die-offs in 2015
- Common murres had rare widespread reproductive failure in 2015-2016, but better in 2017 although the number of birds breeding was low
- Black-legged kittiwakes, storm-petrels (mixed fish and invertebrate diet) and planktivorous auklet had productivity near average

Steller sea lions

West



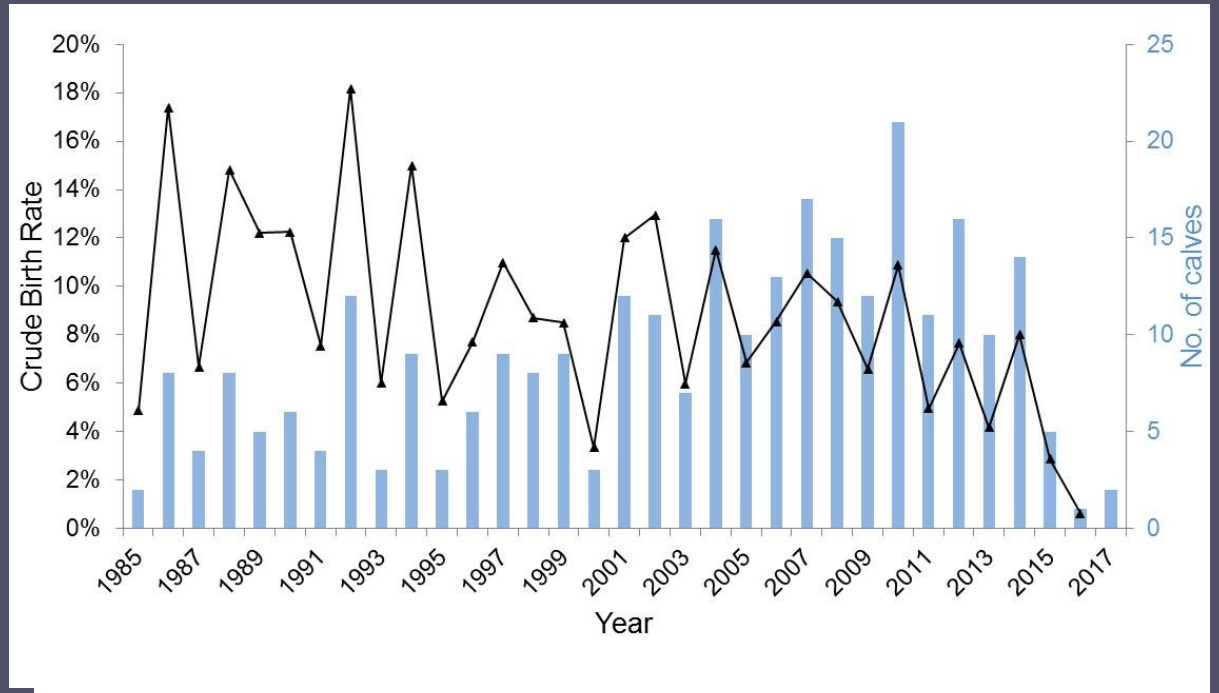
East

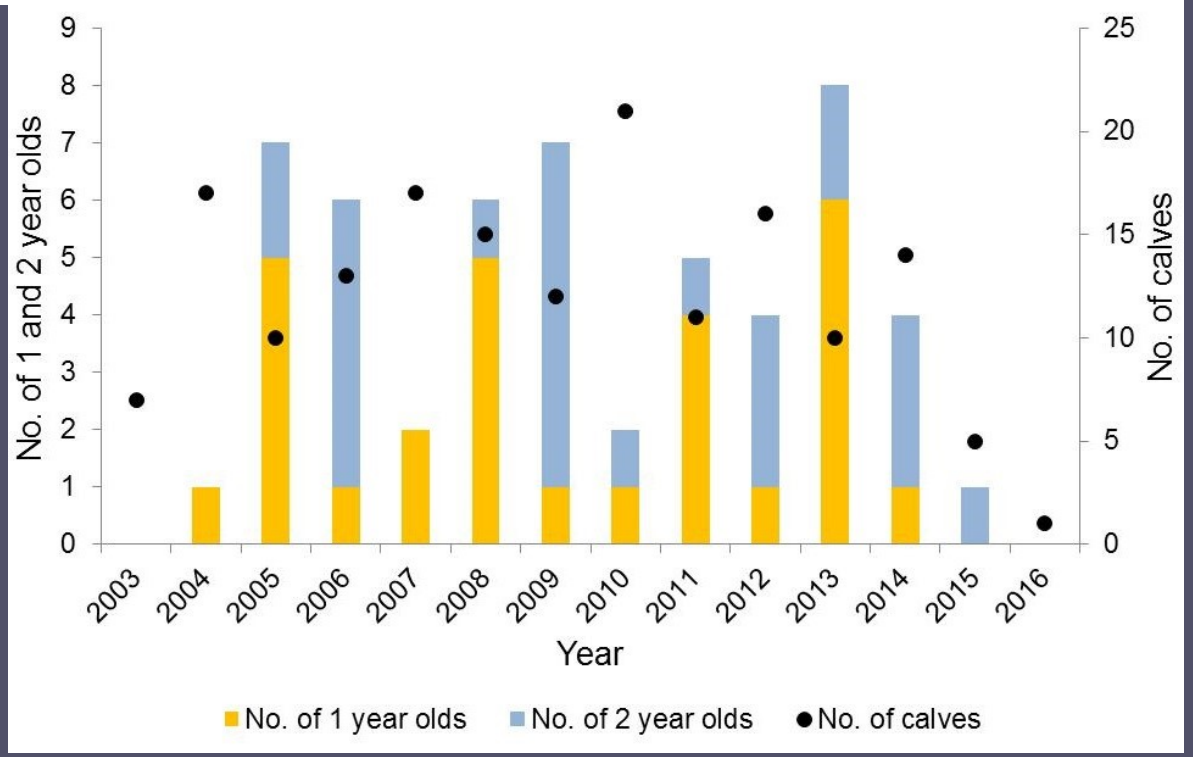


- Model abundance estimates of non-pups not yet updated
- Southeast Alaska 2015 - 2017
  - Non-pups 12% decline
  - Pups 6% decline
- Eastern Gulf of Alaska (PWS)
  - Non-pups 16% decline
  - Pups 33% decline
- Central Gulf of Alaska
  - Non-pups 14% increase
  - Pups 18% decline

Sweeney, Fritz et al.

Humpback Whales



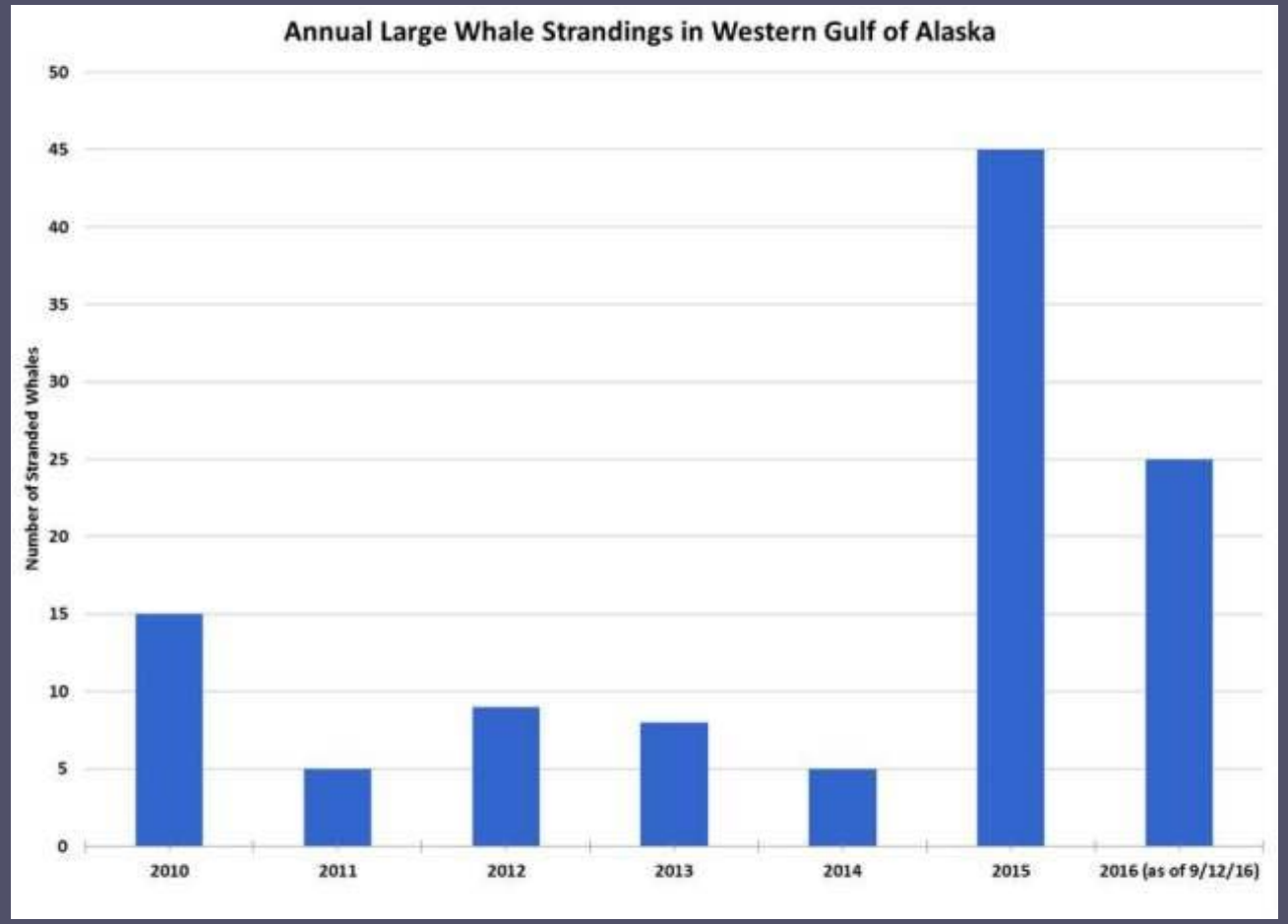


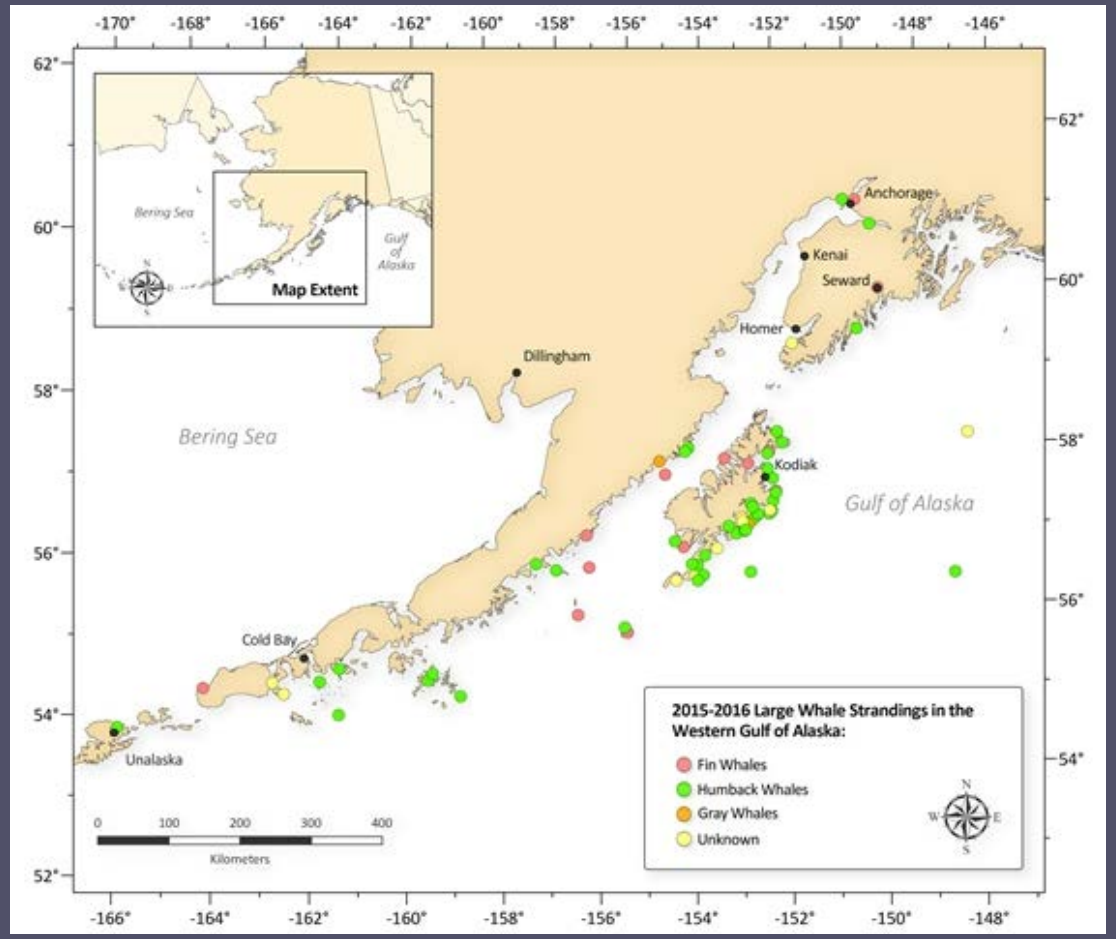
- Humpback whale calving and juvenile return rates in Glacier Bay and Icy Strait declined in recent years
- Anomalously low crude birth rate expected 2017
- May be related to recent changes in whale prey availability and/or quality, which may in turn be negatively affecting maternal body condition and reproductive success and/or overall juvenile survival
- Observations throughout Prince William Sound and SEAK suggest a long-term pre-related trend
- If prey is limiting and humpback whale populations have fully recovered to carrying capacity, there is potential for top-down forcing on forage species and competition with fish, other marine mammals, and seabirds

Neilson et al.; Moran et al.

Humpback Whales

- 2015-2016 Unusual Mortality Event for large whales





NOAA

2016 Observations: Is Whale Stress on the Rise?

Cyamid “Whale Lice”

Calf Presence

Adult condition – “skinny”

Diet shifts: krill-salmon

Low #s in Hawaii last winter

Evaluating historic observations to develop context

John Moran

2016 Fishing and Human Dimensions

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 (A. Lavoie)

Population trends (A. Lavoie)

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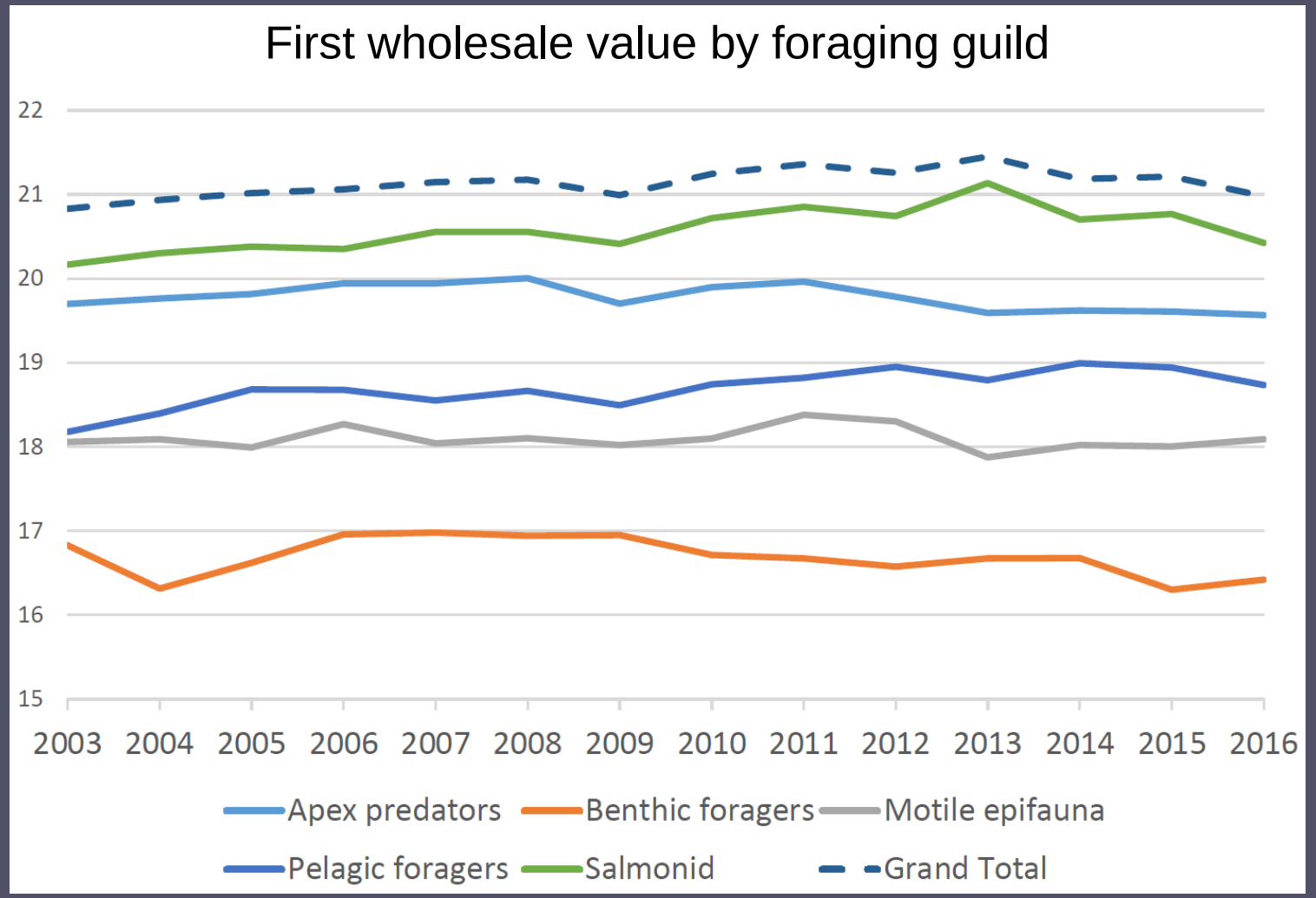
These indicators do not depict any red flags (generally), but detailed patterns need further investigation

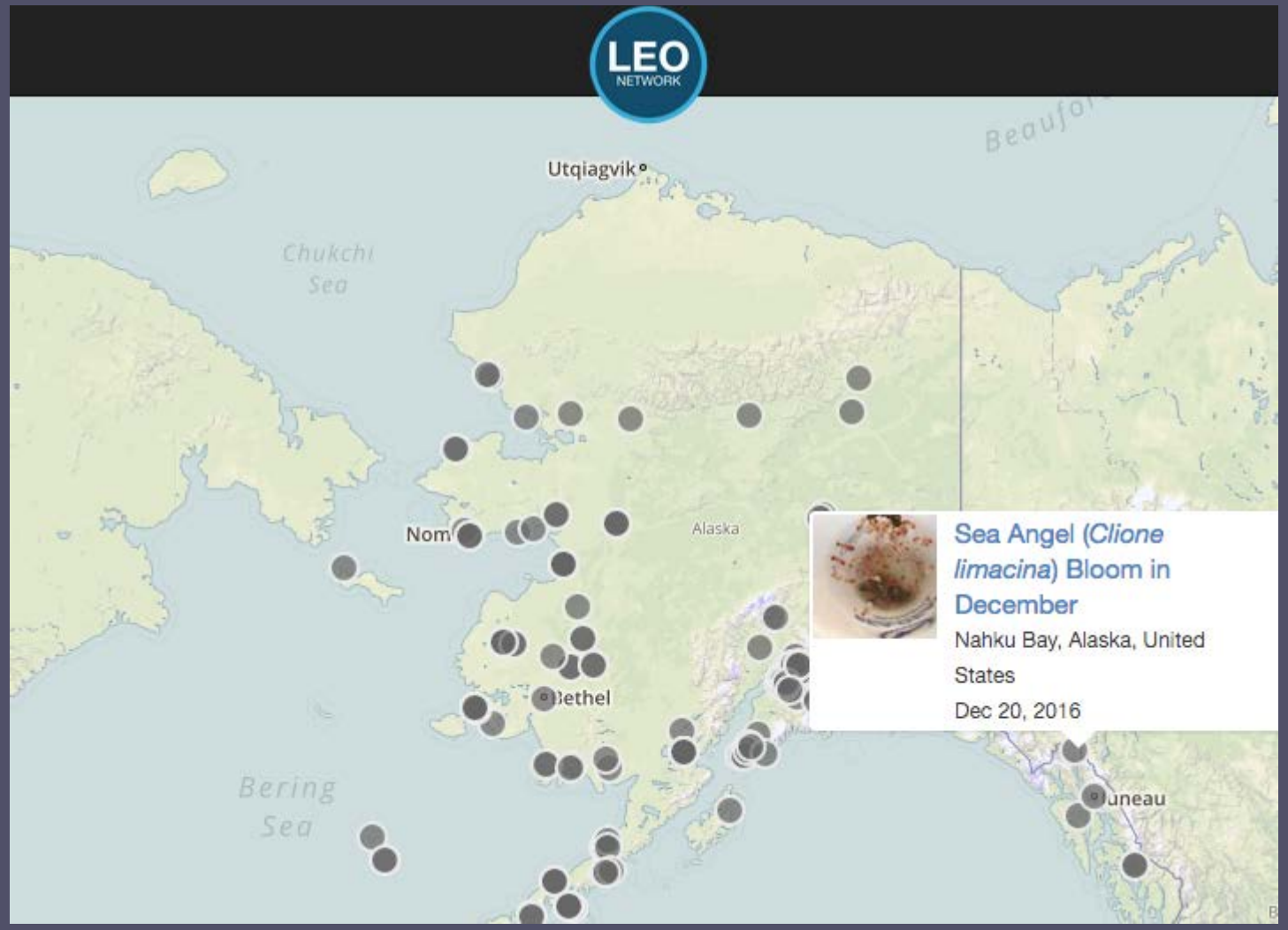
2016 Fishing and Human Dimensions



- New indicator example
- Will this be able to track effects of a reduced TAC?
- For example, if cod TAC is reduced in 2018, prediction:
  - Landings will go down
  - Prices will go up
  - BUT we don't know by how much
- 2019 will be the first time we would see an effect of drop in 2018

B. Fissel

Hot Topic
Local Environmental Observer (LEO) Network

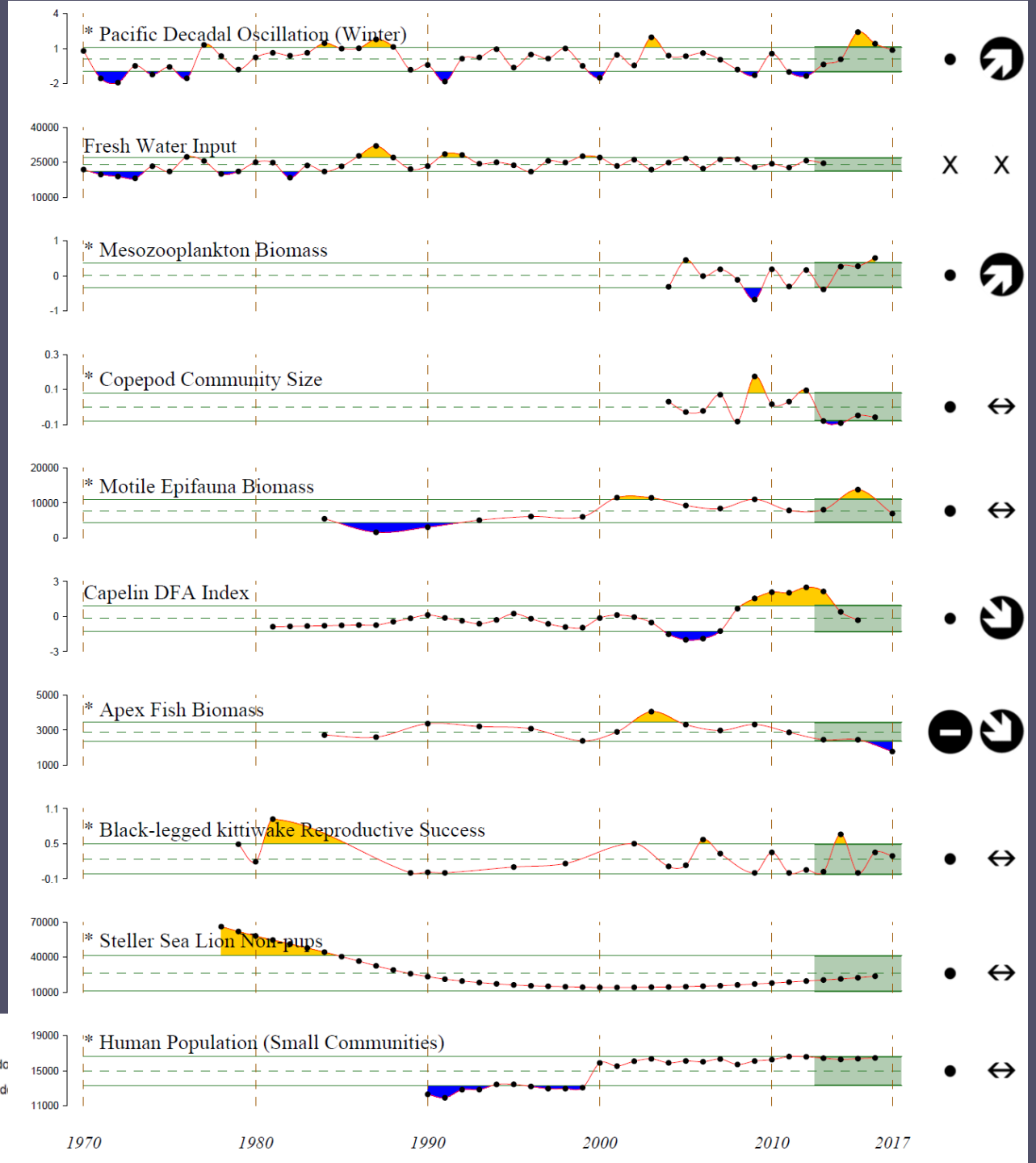


- Citizen science observations
- Launched in 2012
- Unusual/notable environmental events
- Classified by relevant category
- Avenue for community engagement in fisheries management process
- Seeking feedback

M. Szymkowiak

2017 Western Gulf of Alaska Report Card

1. PDO
2. (Fresh Water Input)
3. Mesozooplankton
4. Copepod Size
5. Motile Epifauna Biomass
6. Capelin
7. Apex Fish Biomass
8. Kittiwake Reproductive Success
9. Steller Sea Lions
10. Human Population



2013-2017 Mean

- 1 s.d. above mean
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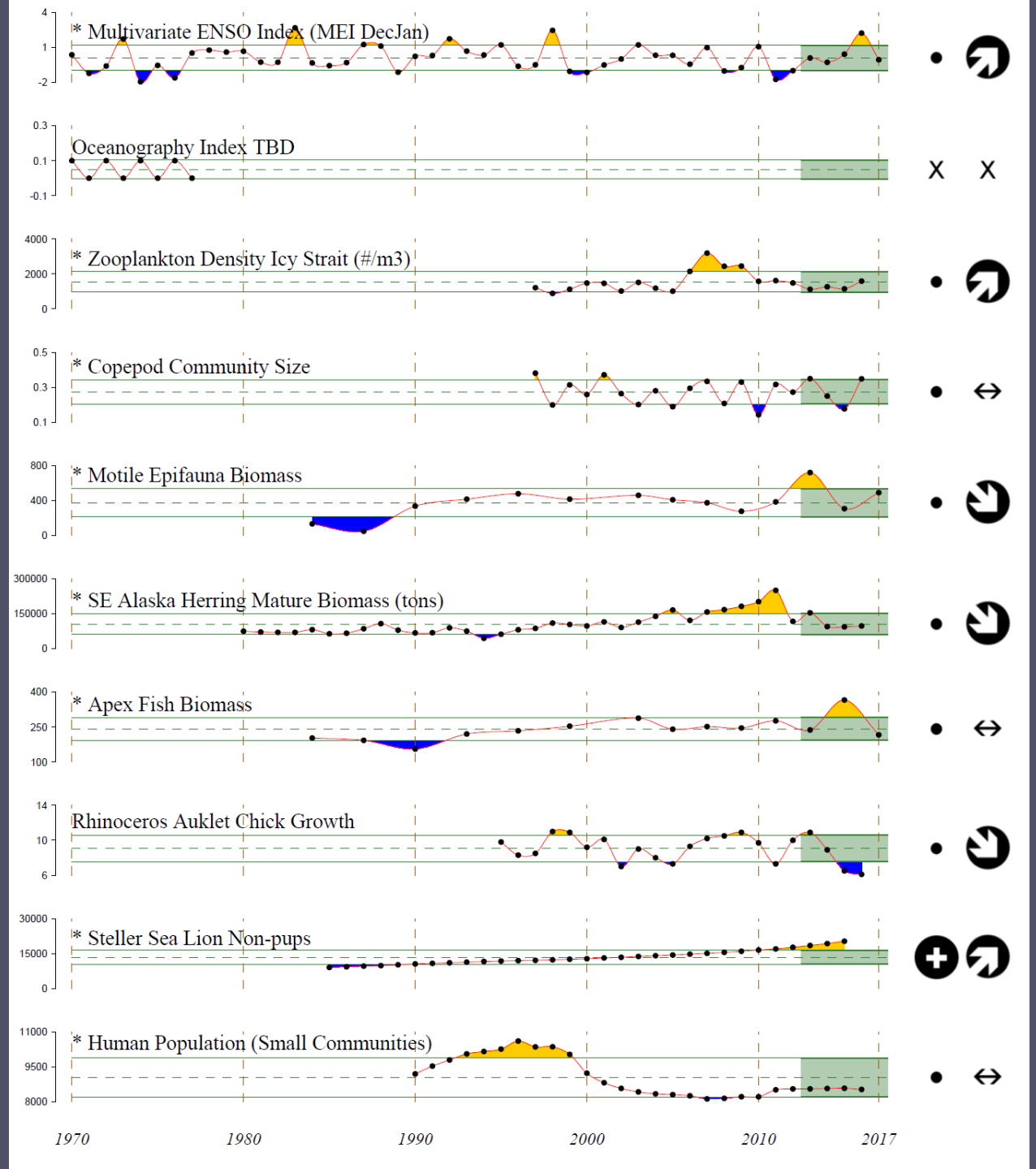


2017 Eastern Gulf of Alaska Report Card

1. MEI
2. (Oceanography)
3. Zooplankton density
4. Copepod Size
5. Motile Epifauna Biomass
6. SE AK Herring
7. Apex Fish Biomass
8. Rhinoceros auklet chick growth
9. Steller Sea Lions
10. Human Population

Gulf of Alaska Summary

2016

- Continuation of warm conditions
- Moderate zooplankton density but small copepods predominant
- Low CPUE, mushy halibut
- Poor seabird productivity, die-offs; whales skinny, stressed, poor reproduction

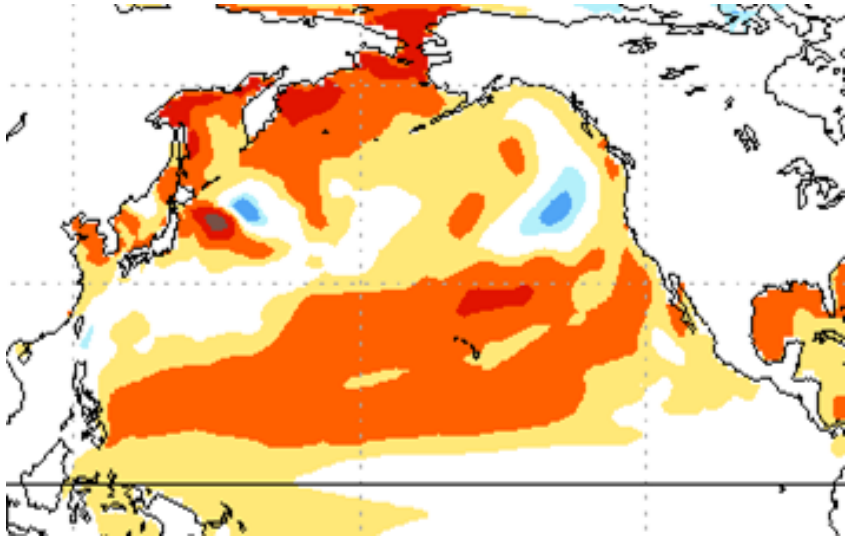
2017

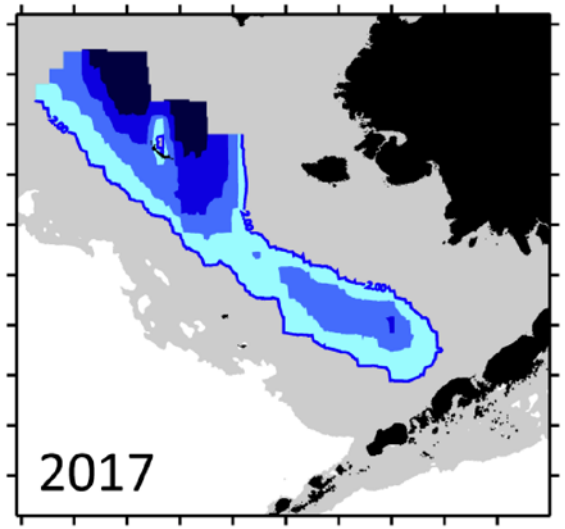
- Moderation of climate forcing, further cooling likely
- Sparse zooplankton, but abundant pollock and cod larvae
- Mostly skinny groundfish, low CPUE in bottom trawl surveys
- Mixed seabird productivity
- Poor sea lion and humpback whale production

Contributors

Mayumi Arimitsu, Sonia Batten, Jennifer Boldt, Nick Bond, Jennifer Cedarleaf, Kristin Cieciel, Seth Danielson, Annette Dougherty, Sherri Dressel, AnneMarie Eich, Nissa Ferm, Emily Fergusson, Ben Fissel, Shannon Fitzgerald, Christine Gabriele, Sarah Gaichas, Andrew Gray, Chuck Guthrie, Dana Hanselman, Coleen Harpold, Bradley Harris, Scott Hatch, Kyle Hebert, Jerry Hoff, Steve Kasperski, Arthur Kettle, David Kimmel, Carol Ladd, Ned Laman, Jesse Lamb, Anna Lavoie, Jean Lee, Daniel Lew, Steve Lewis, Jennifer Mondragon, John Moran, Jamal Moss, Franz Mueter, Jim Murphy, Janet Neilson, Joseph Orsi, Wayne Palsson, Melanie Paquin, Heidi Pearson, John Piatt, Alexei Pinchuk, Steven Porter, Heather Renner, Patrick Ressler, Lauren Rogers, Nora Rojek, Chris Rooper, Joshua Russell, Kalei Shotwell, Kim Sparks, William Stockhausen, Janice Straley, Wes Strasburger, Andy Szaba, Marysia Szymkowiak, Louise Taylor-Thomas, Scott Vulstek, Jordan Watson, Andy Whitehouse, Matthew Wilson, Sarah Wise, Carrie Worton, Ellen Yasumiishi, and Stephani Zador

Thank you!



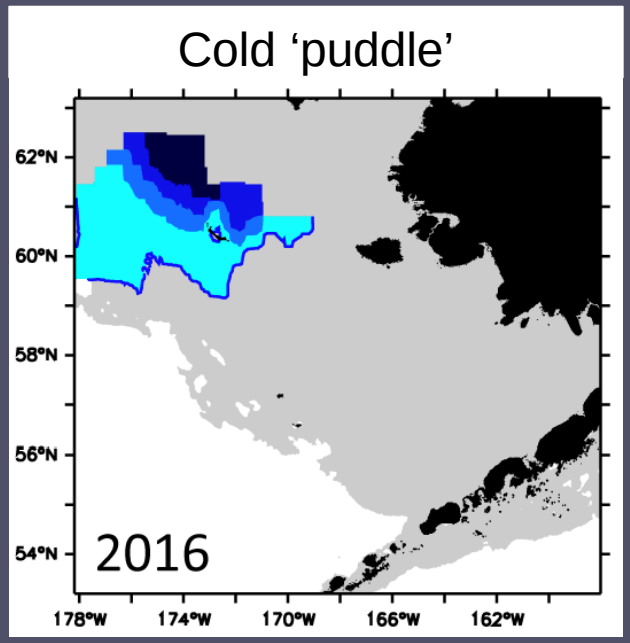


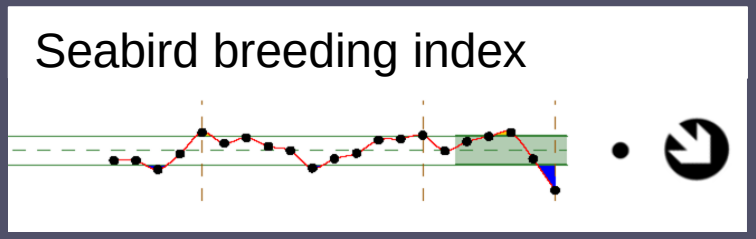
Eastern Bering Sea Themes

- Recent warm stanza: are things cooling off?
- Causes and consequences of a narrow cold pool
- Pacific cod and commercial crab stocks down

Complete recap of 2016

- 3rd WARM year (but 2015 was different)
- Small copepods predominant
- Euphausiids were rare
- Jellyfish declined from peak
- Aggregated CPUE in BT survey remained high
- Groundfish condition improved for all, except arrowtooth
- Poor seabird productivity, die-off, and high bycatch rates
- Northern fur seal pup production mixed





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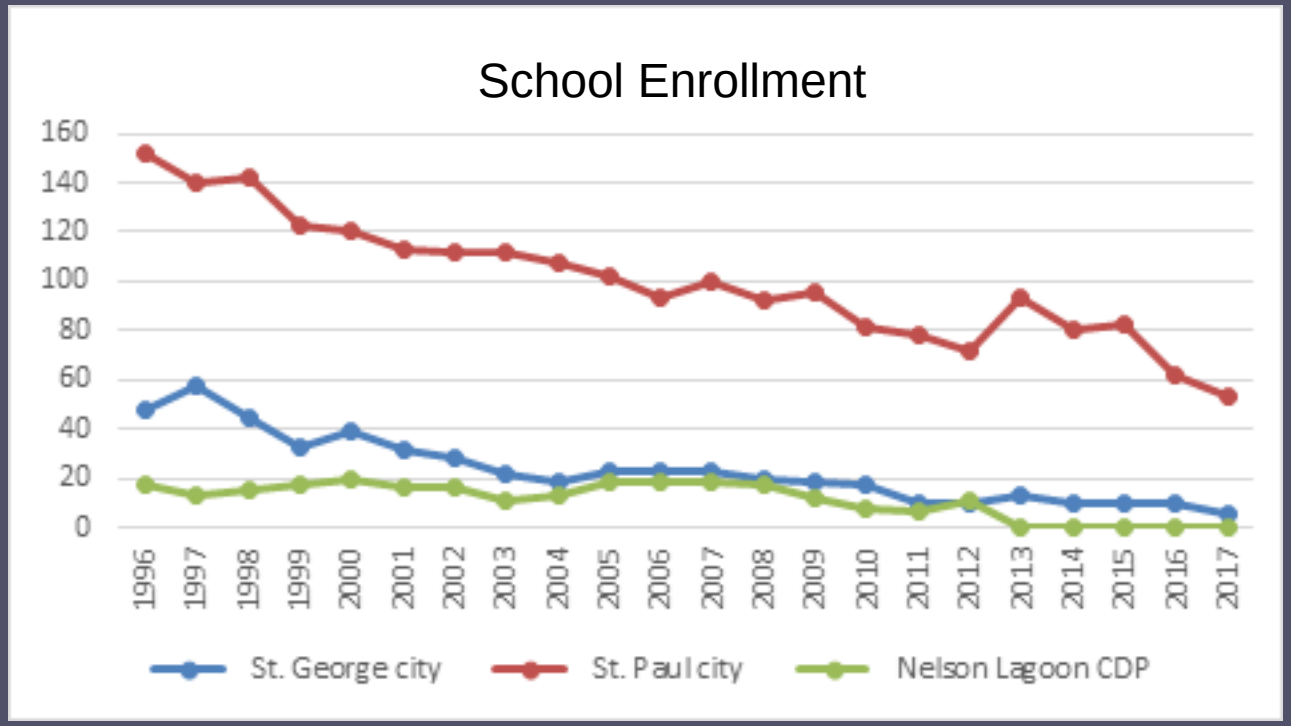
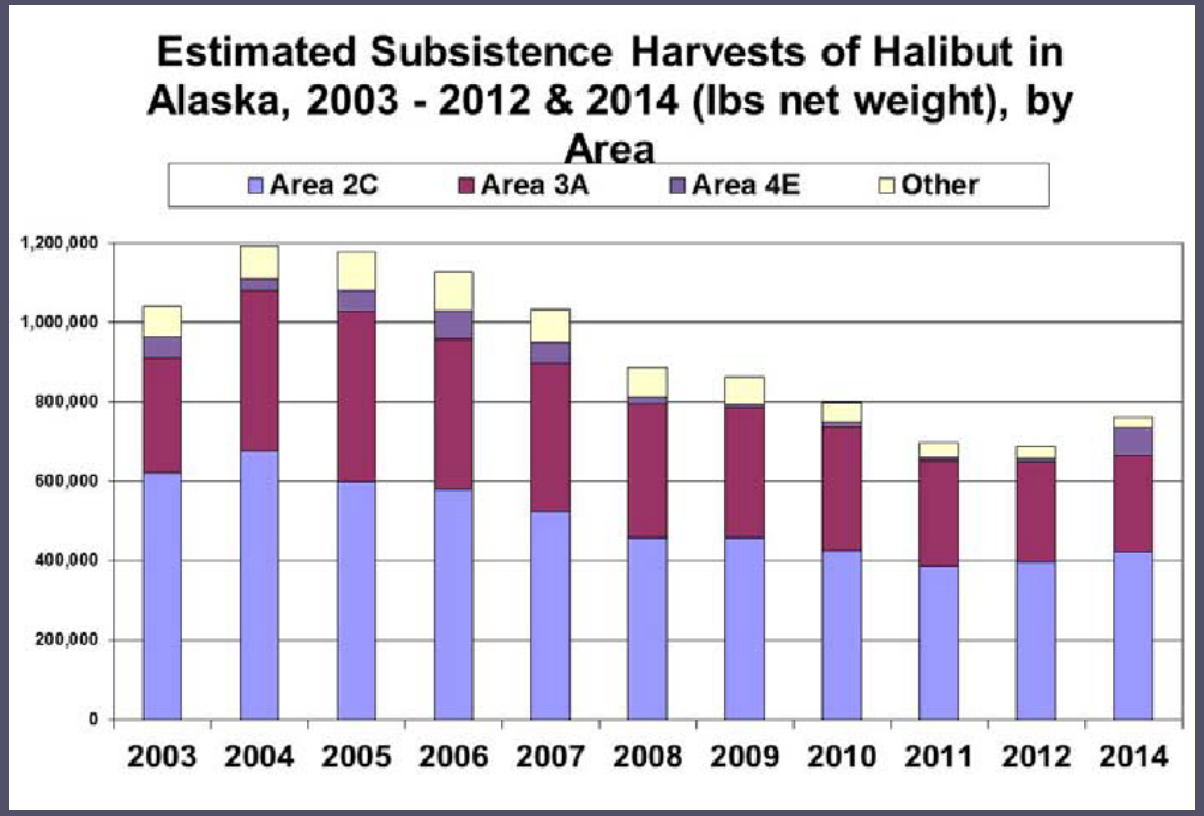
2016 Fishing and Human Dimensions

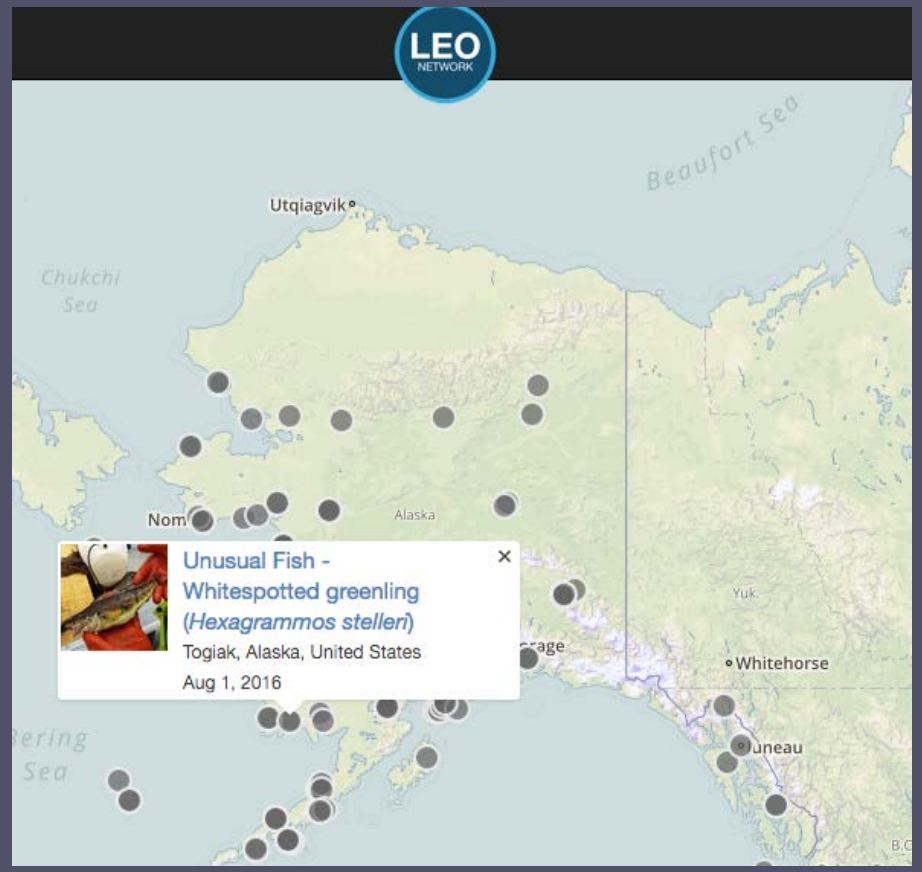


- Declining trends
- St George at risk of losing school



- Less subsistence relative to GOA
- Challenges with timeliness and uncertainty

Hot Topic:
Local Environmental Observer (LEO) Network
(M. Szymkowiak)



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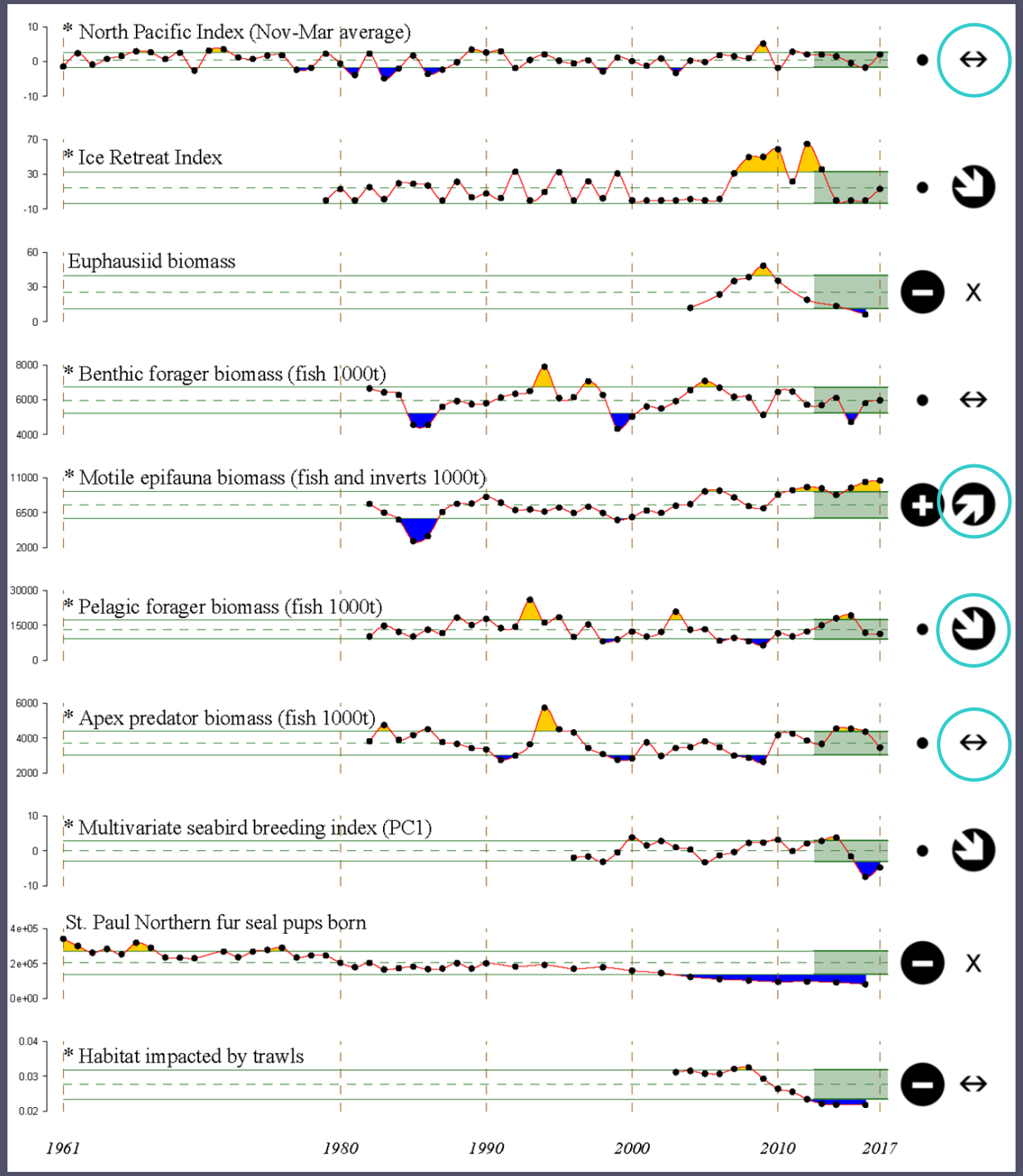
2017 EBS Report Card



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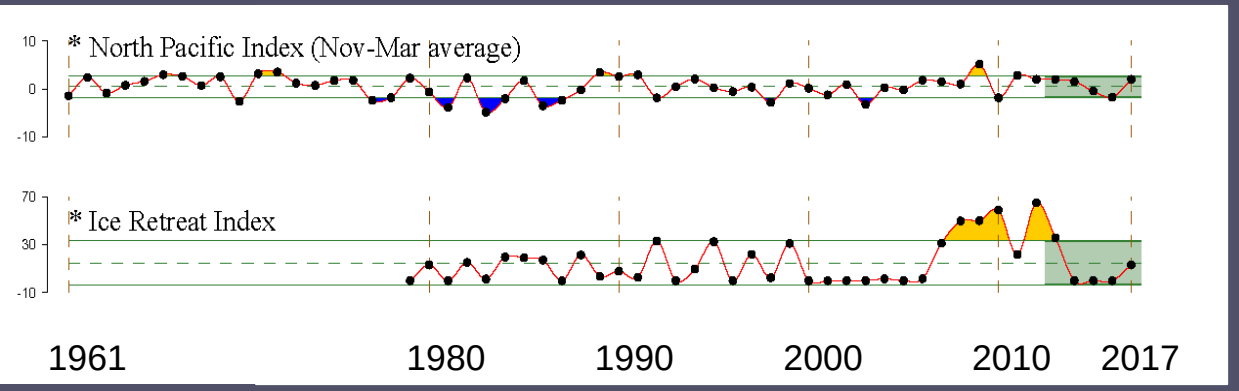
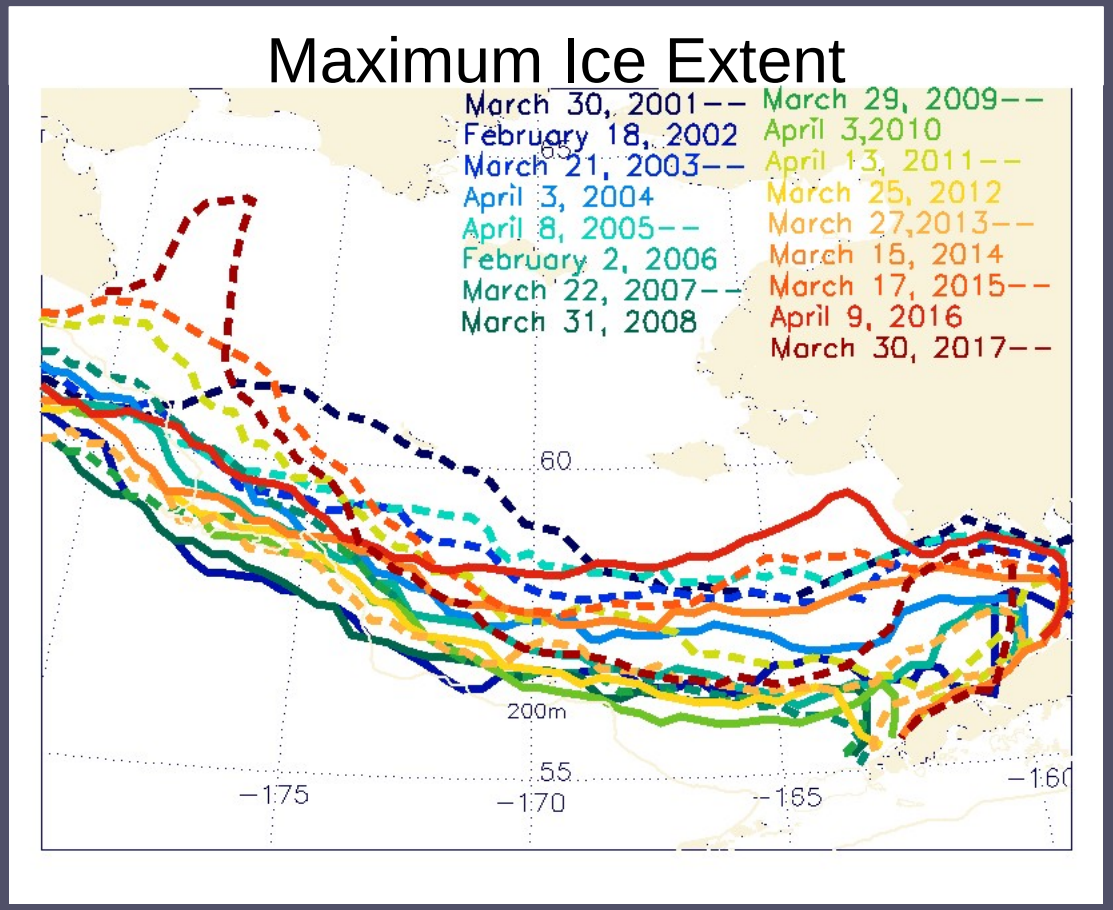
2017 EBS Physical Conditions





Unusual sea ice extent pattern

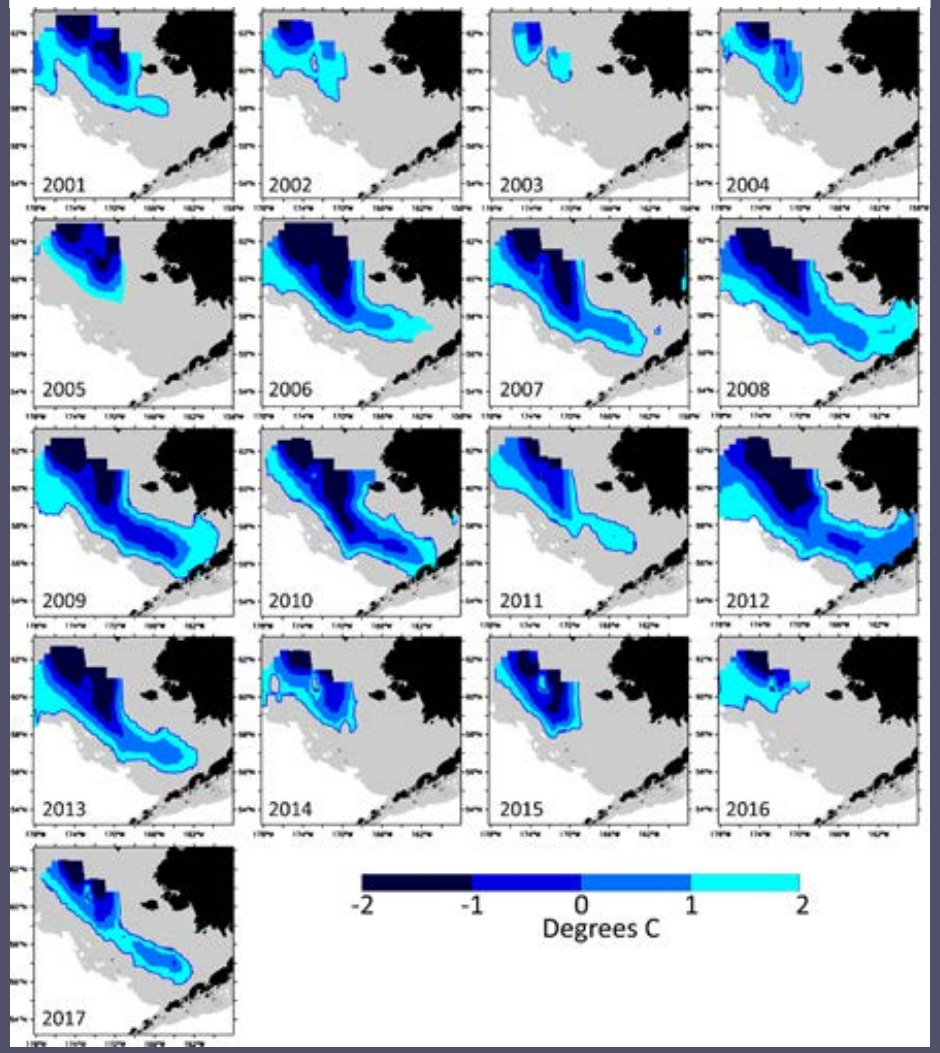
Similar to 2012, but retraction in Gulf of Anadyr and Bristol Bay

Overland et al.

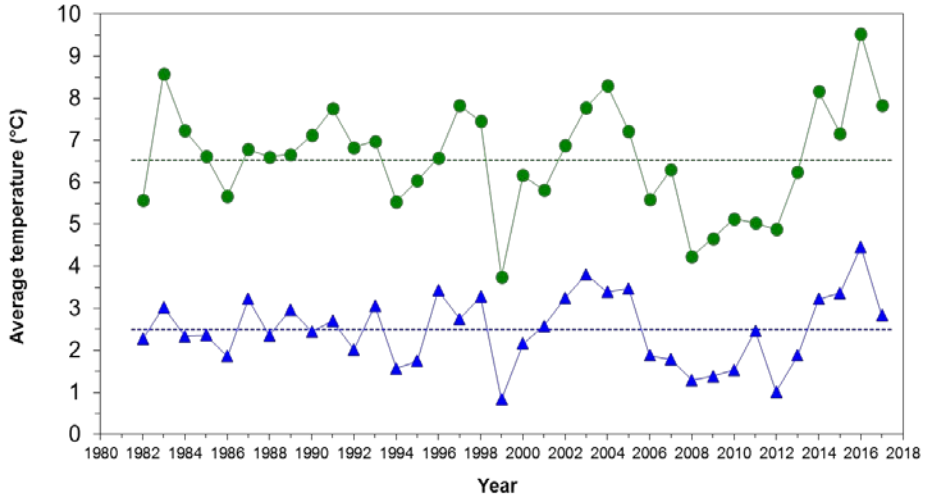
Temperature Comparisons

2017 could be considered warm, cool, or average depending on frame of reference

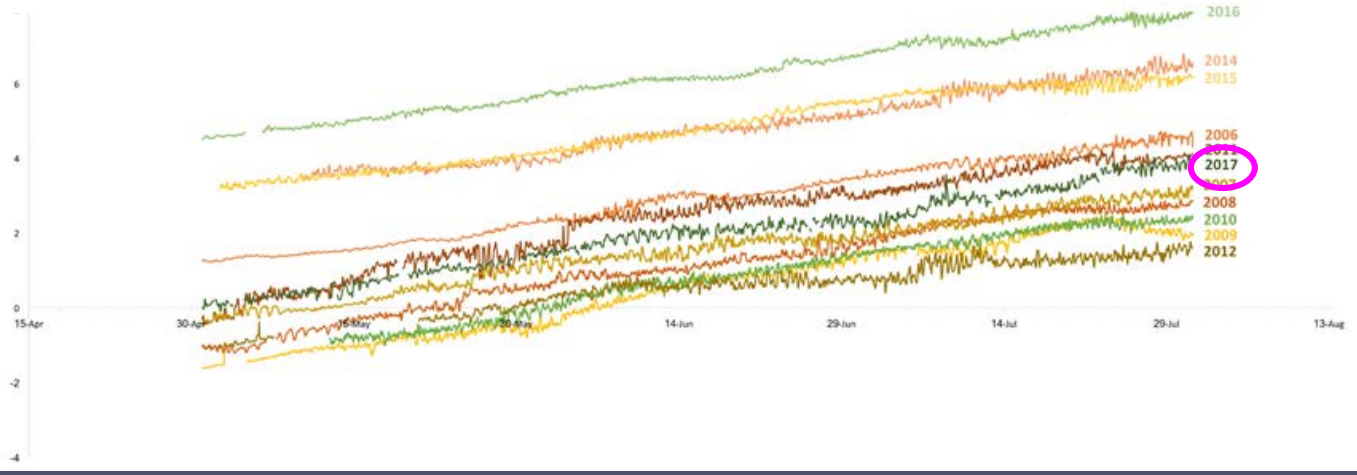
Cold Pool: 2017 extensive, but narrow



Surface and Bottom: moderately warm



Depth-averaged at M2 mooring: average

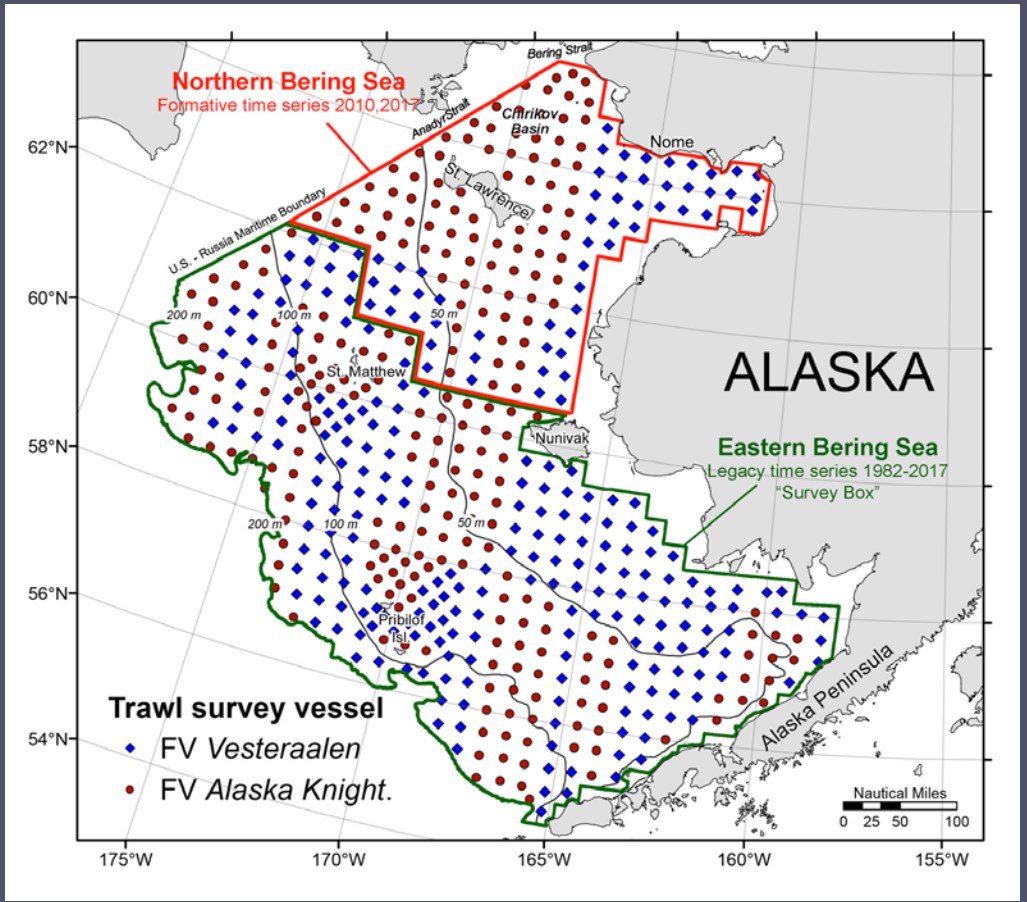


LEFT: Overland et al., RIGHT bottom: Stabeno et al, RIGHT top: B. Lauth.

Hot Topic:
Thinking Outside the Survey Box

(B. Lauth and L. Britt)

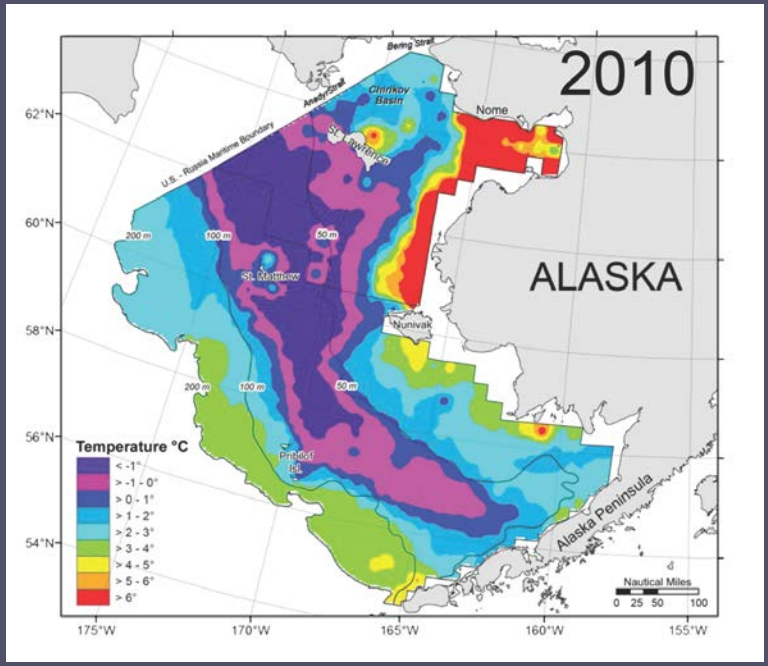
In 2017, the bottom trawl survey extended northward to study the impacts of diminished sea ice on the ecosystem

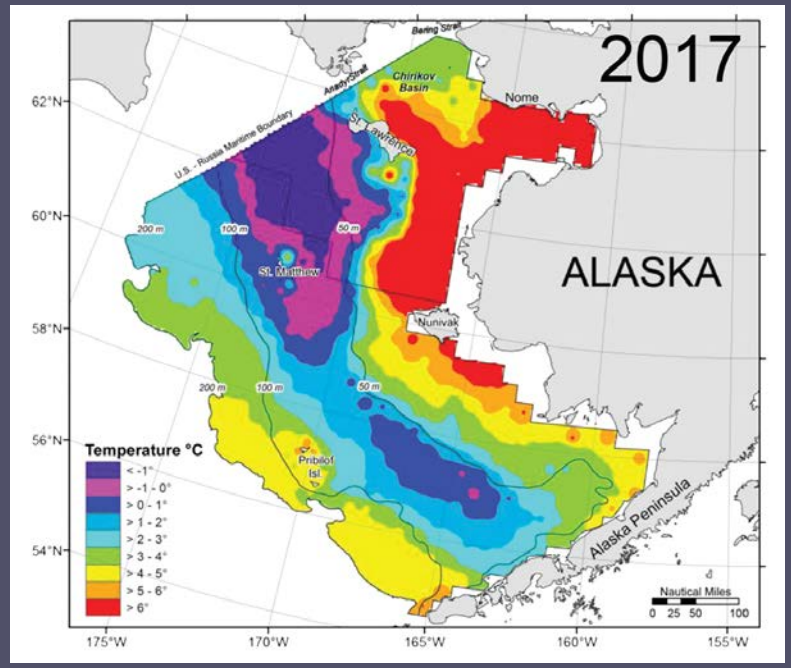


Hot Topic:
Thinking Outside the Survey Box

(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

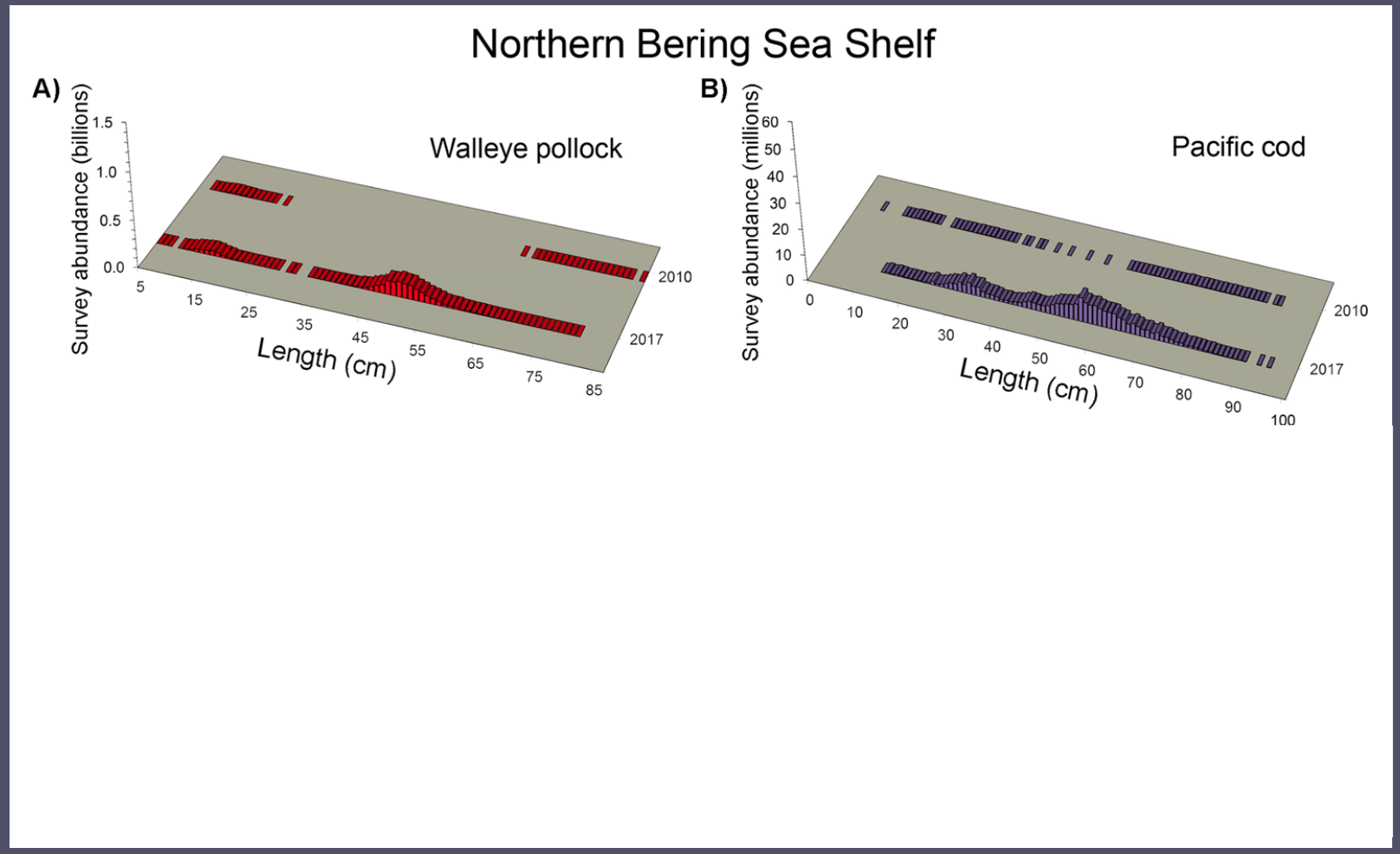
(B. Lauth and L. Britt)

		Biomass (mt)		
Common name	Taxon	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)

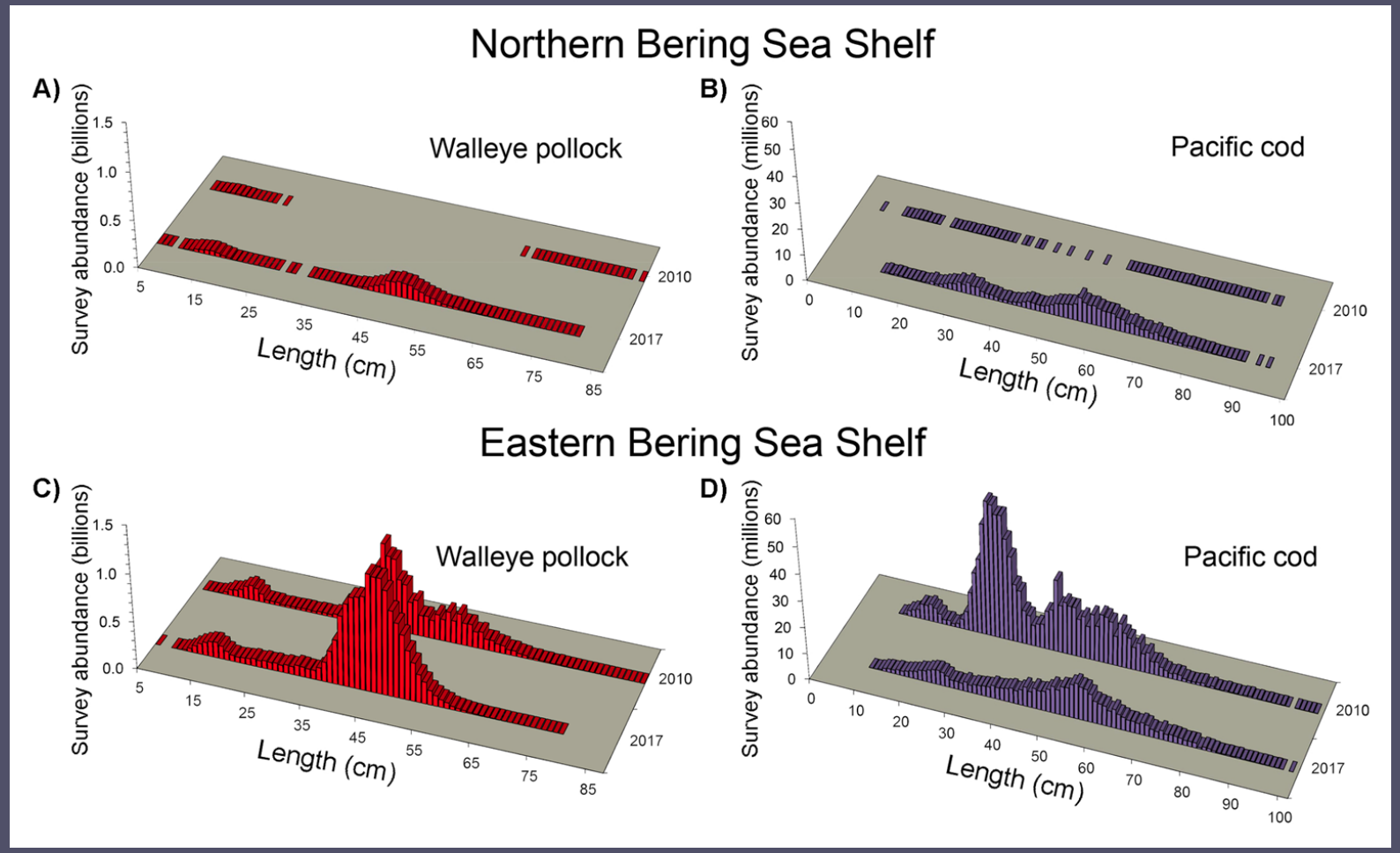
"...the inner shelf was certainly an open corridor for north-south movement…."



Hot Topic:
Thinking Outside the Survey Box

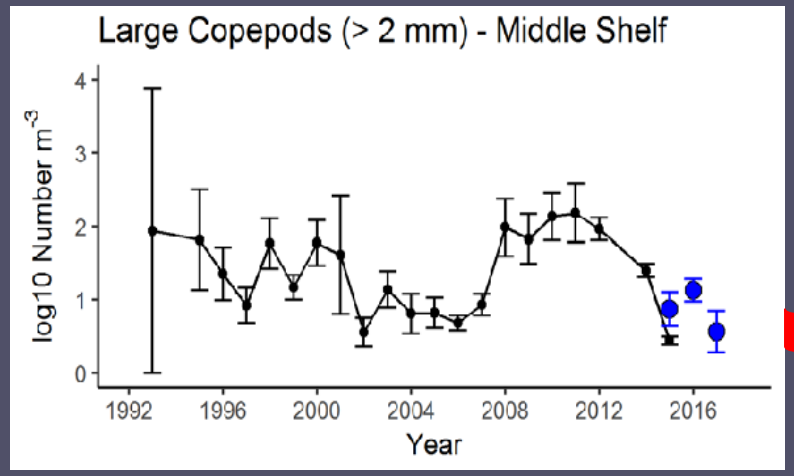
(B. Lauth and L. Britt)

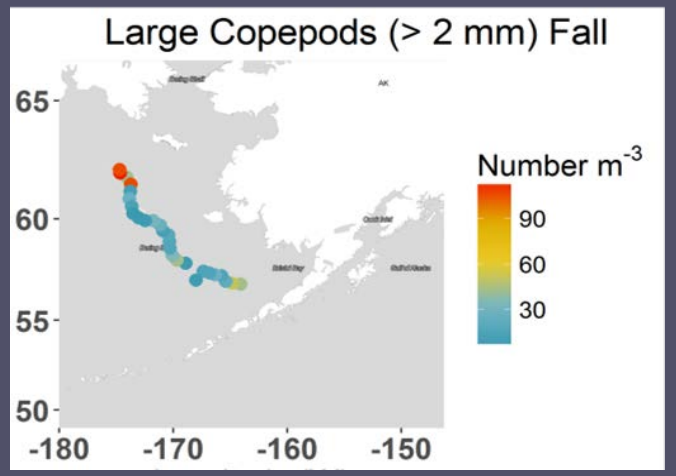
"The similar size distributions between areas for both species suggests they could be from the same populations."



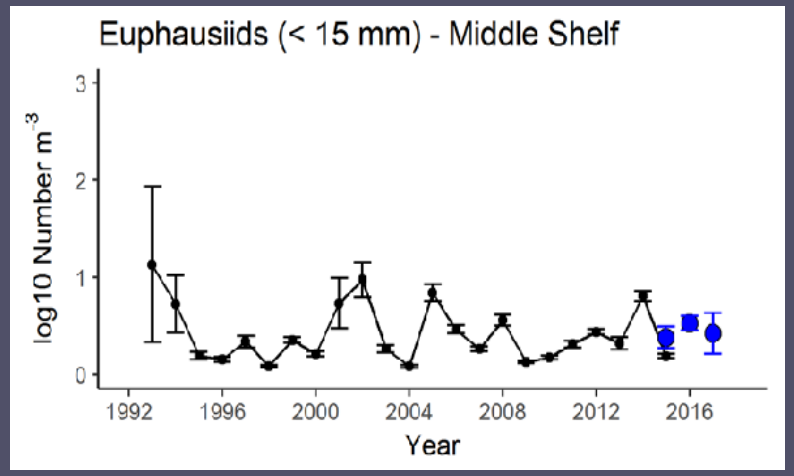
2017 EBS Zooplankton

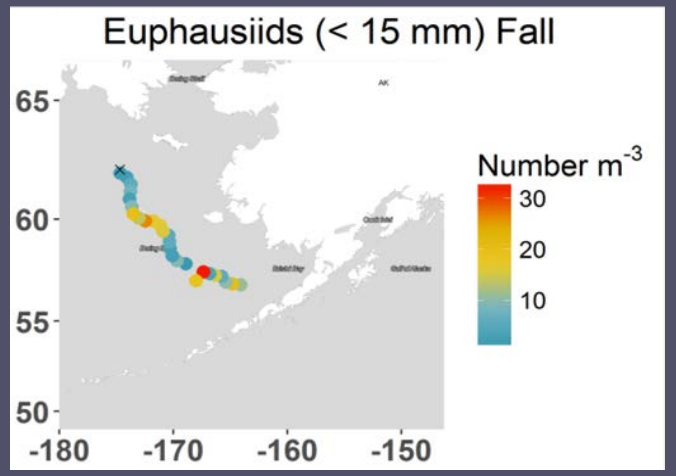
- Large copepod abundance decreased over middle shelf
- Hot spot over NW shelf





- Euphausiid abundance similar to 2015-2016 over middle shelf
- Hot spot over SE shelf

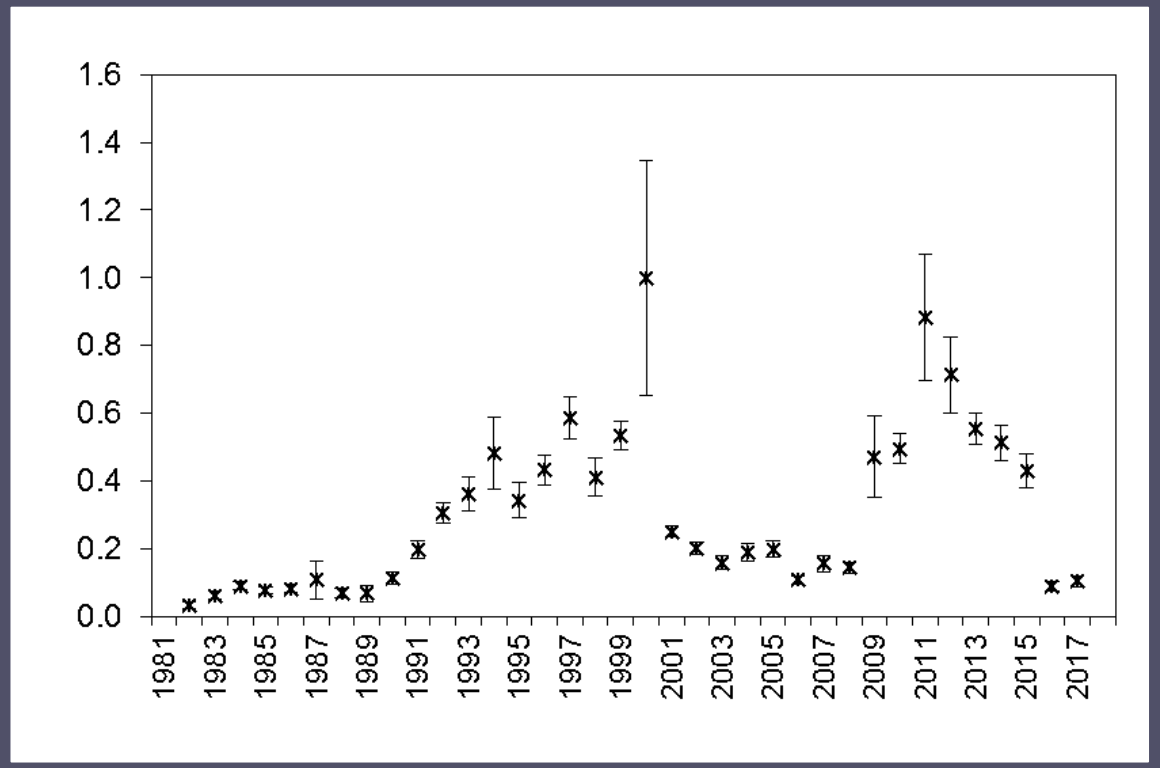




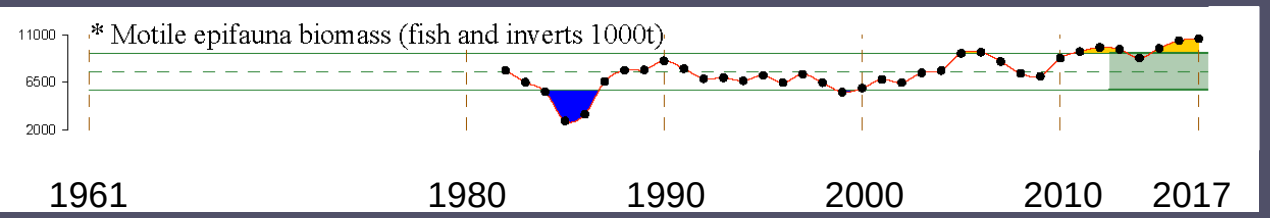
D. Kimmel and C. Harpold

2017 EBS Jellyfish

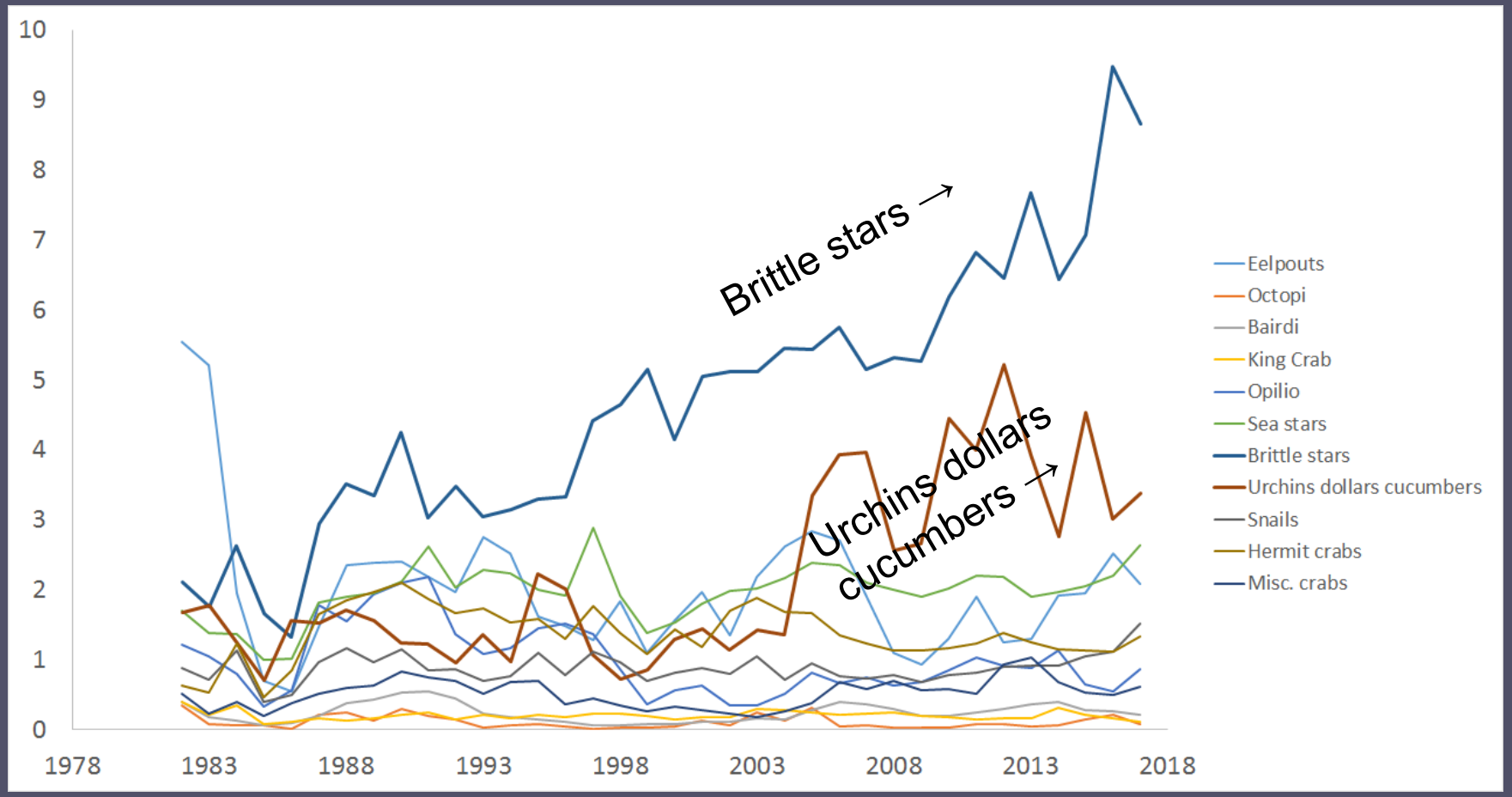
- 2017 Jellyfish abundance remains low (BT survey)
- Primarily *Chrysaora melanaster*
- In 2016, the abundance of smaller-sized species (e.g., *Aurelia*) increased (BASIS survey)
- Warm/cold influences?



B. Lauth, K. Cieciel and E. Yasumiishi



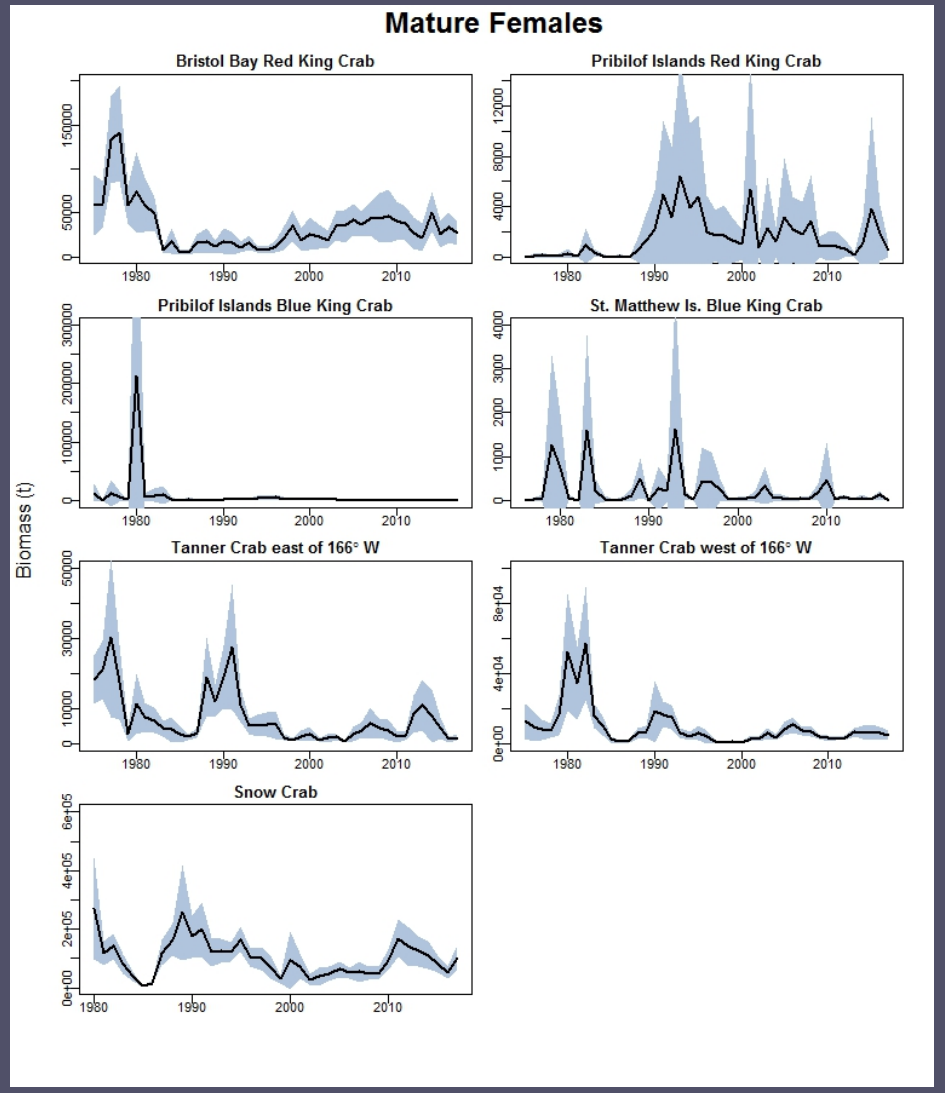
2017 EBS Motile Epifauna

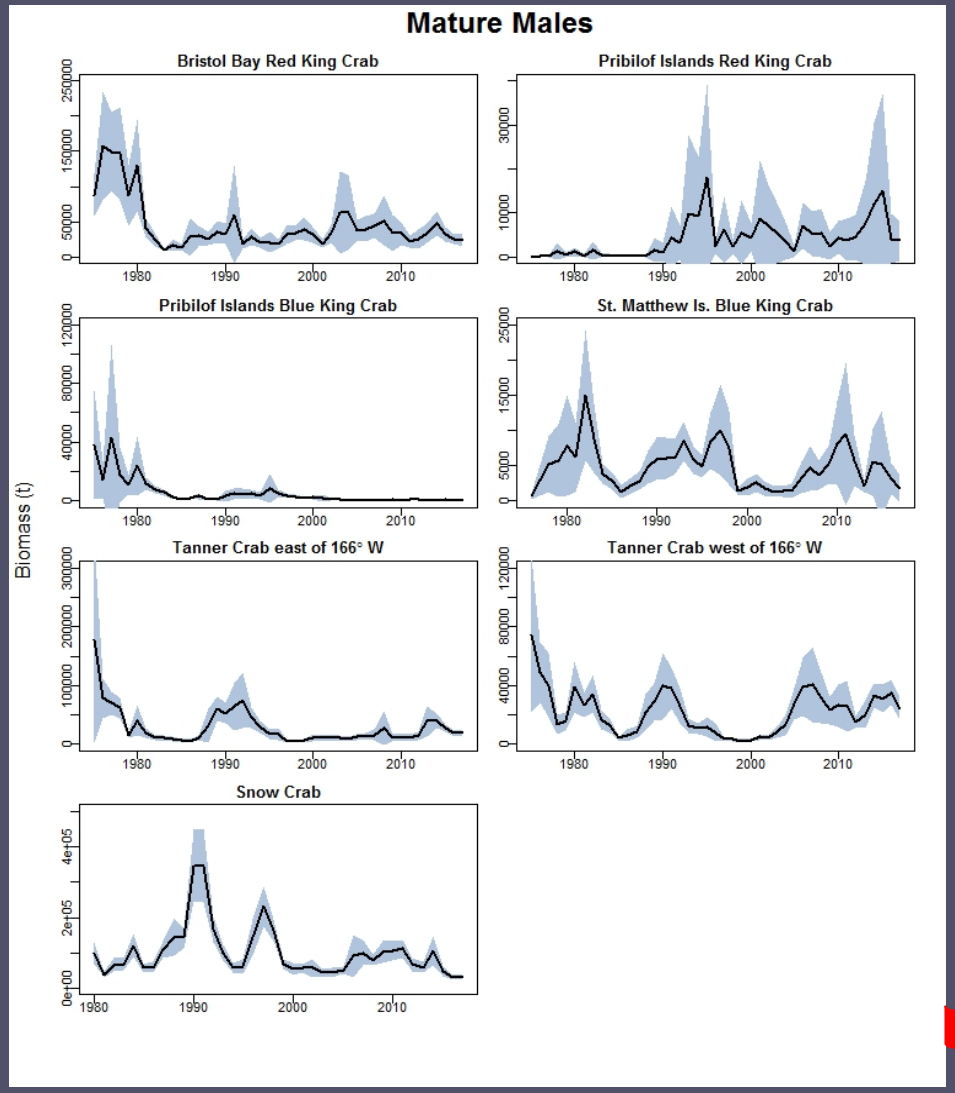


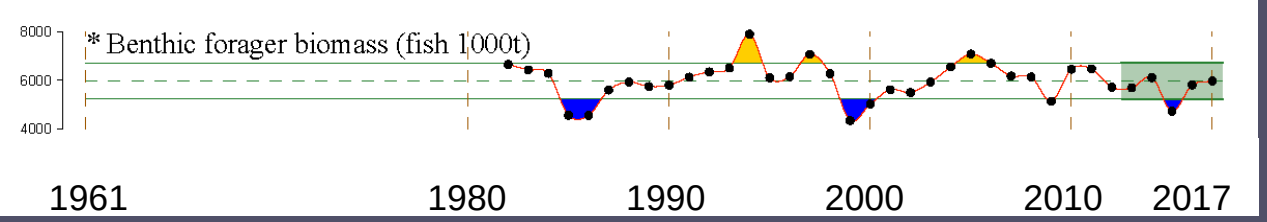
- Motile epifauna biomass remains above long-term mean; trend increasing
- Urchins, dollars, cucumbers up 12%
- King and tanner crabs down 28% and 21%

2017 EBS Commercial crab

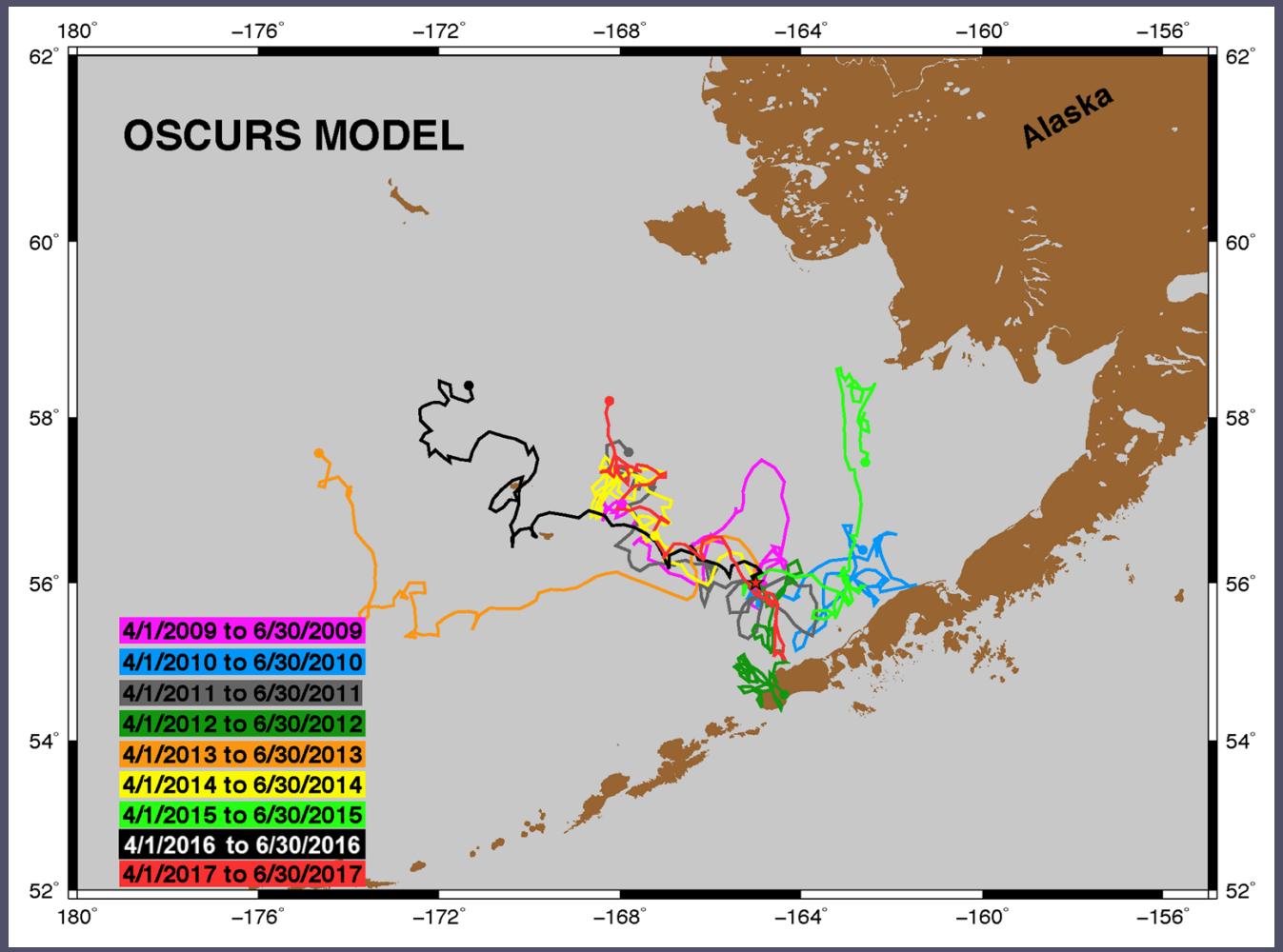
- Biomass trends are negative for most species in 2017





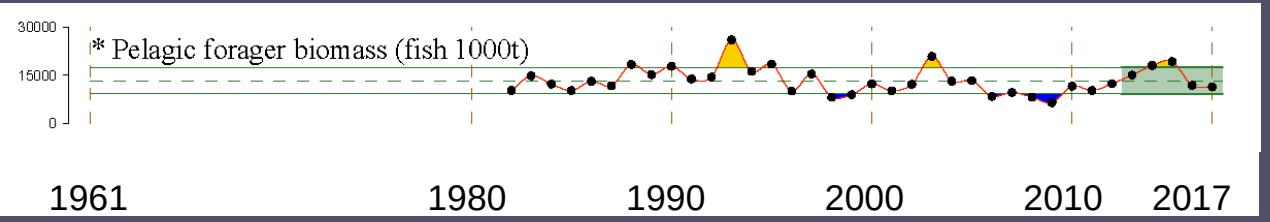


2017 EBS Benthic foragers

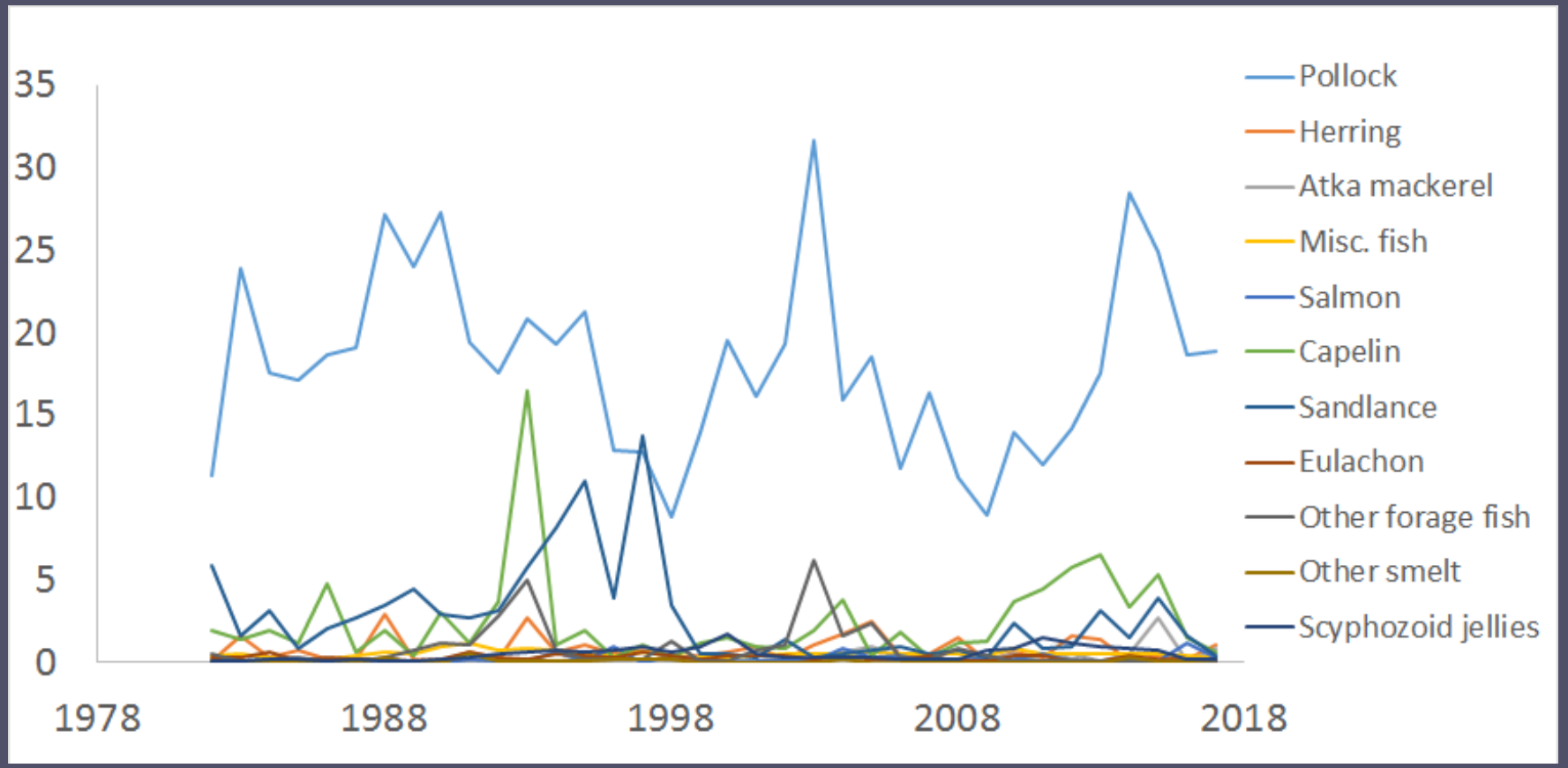


- 2015 drop due to decreased YFS and NRS adult biomass
- Recent trend is stable
- “Miscellaneous” flatfish and FHS increased
- 2015 had favorable drift patterns for flatfish recruitment
- 2017 had mixed drift pattern; may be more consistent with below-average recruitment

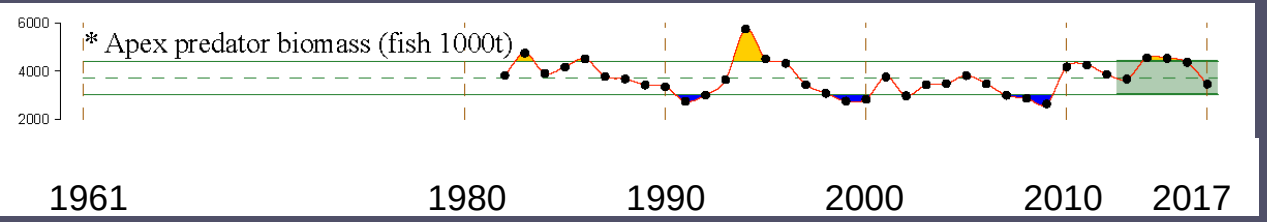
T. Wilderbuer



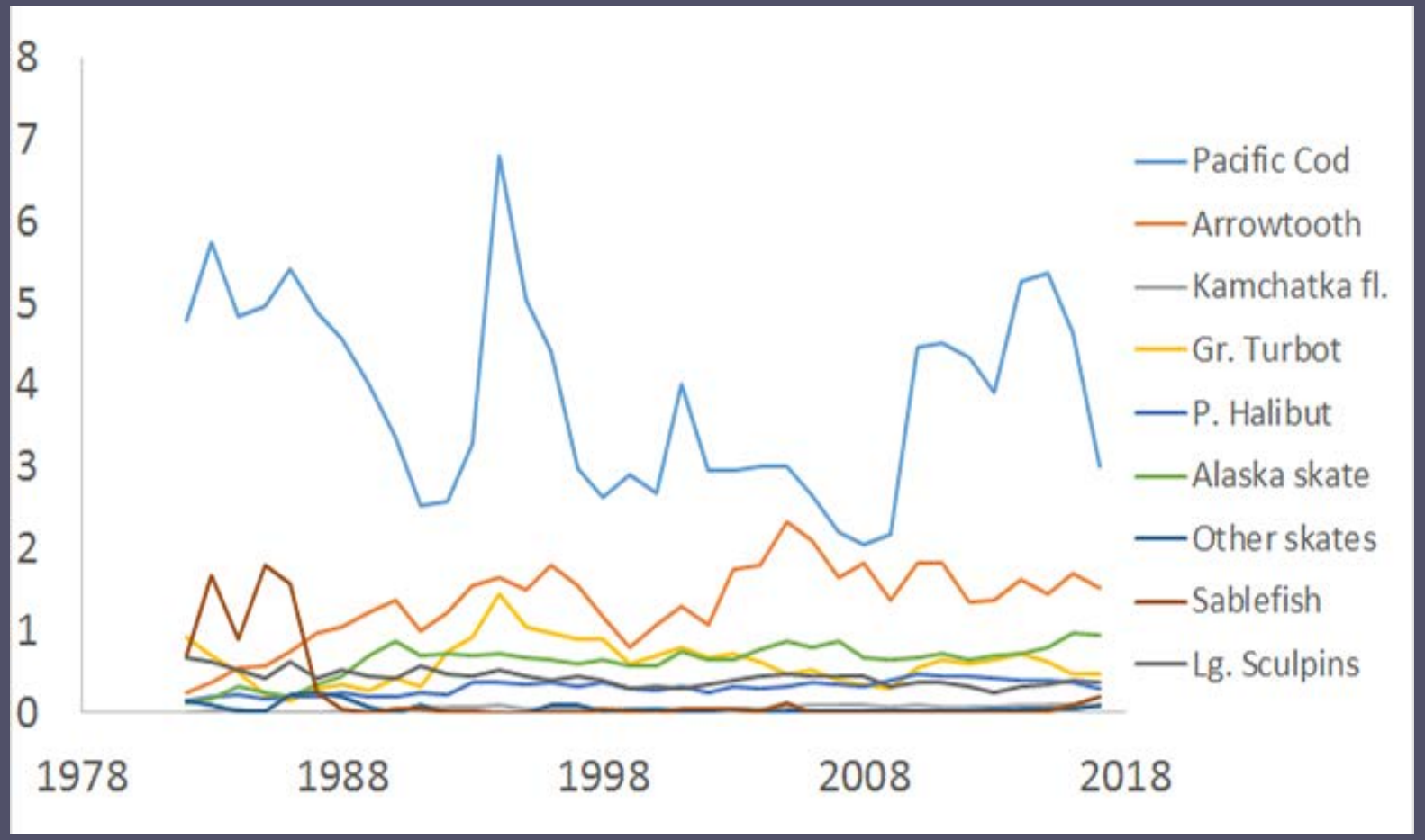
2017 EBS Pelagic foragers



- At long-term mean
- Pollock level from 2016-2017
- Increase in Pacific herring offset by decrease in capelin

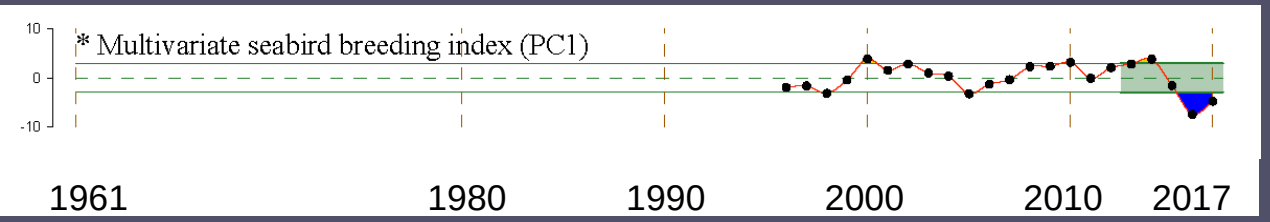


2017 EBS Apex fish

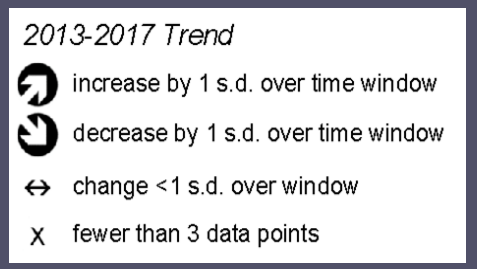


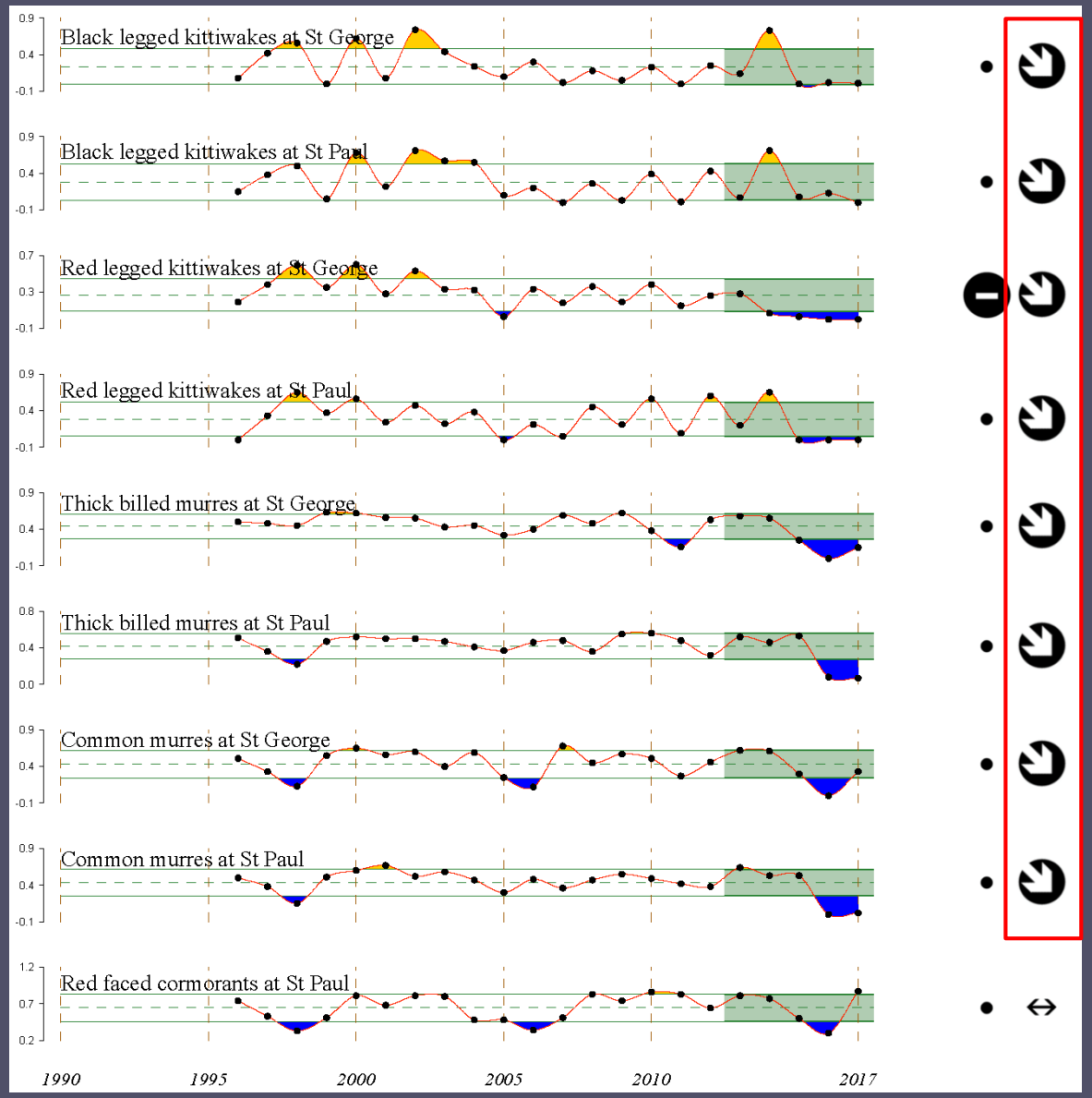
- Apex predator biomass declined
- 35% decrease in Pacific cod biomass
- 11% decrease in arrowtooth flounder biomass

2017 EBS Seabirds



- Breeding index below the long-term mean
- Poor reproductive success at the Pribilof Islands for all species, except Red-faced Cormorants





H. Renner and M. Romano

Hot Topic: Dead and Dying Seabirds

(Kuletz et al.)

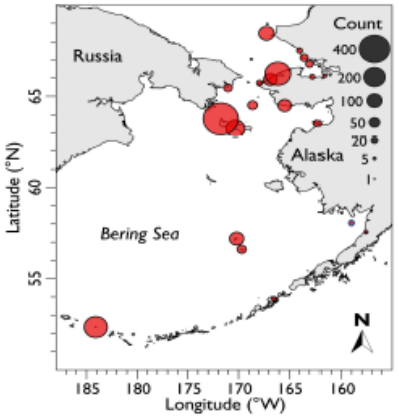
- Drowning, severe emaciation
- Lab work indicates exposure to naturally occurring algal toxins
- Impacts on birds unknown

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

U.S. Fish & Wildlife Service

Seabird Die Off: Point Hope to Bristol Bay, June to September 2017

December 2017



What Happened?

During June to September 2017, USFWS received reports of dead and dying seabirds from the Bering and Chukchi regions - from Point Hope south to the Bristol Bay. Responders at Deering, Gambell, Nome, Point Hope, Shishmaref, Unalaska, Unalakleet, St. George, St. Paul and other coastal areas have counted nearly ***1600 beached seabird carcasses since early June 2017***, including northern fulmars, shearwaters, and kittiwakes. Murres, auklets, gulls, and puffins have also been reported. The USFWS coordinated with the Coastal Observation and Seabird Survey Team (COASST) to monitor several beaches. Twenty-one carcasses were examined by the USGS National Wildlife Health Center, USGS Alaska Science Center, and the NOAA Laboratory in Beaufort, North Carolina.

Contributing Partners:

Sea Grant Alaska · KAWERAK, INC.

What Did We Learn?

Seabird carcasses from Point Hope, Shishmaref, Gambell, St. George and St. Paul Islands indicated death by drowning and starvation. There was no evidence that the deaths were caused by an infection. Saxitoxin is a biotoxin naturally produced by algae that can affect the mammalian nervous system if ingested in high concentrations. Saxitoxin was detected in the intestinal contents and livers of five northern fulmars from Shishmaref, Gambell, St. George and St. Paul Islands. ***All samples were below human consumption limits for shellfish (80 µg/100 g); however, potential impacts of algal toxins on birds are unknown***. Domoic acid, which is also associated with algae, was not detected in any samples. We do not have evidence of acute toxicity as a direct cause of seabird deaths, but it is possible that exposure to saxitoxin may have been a contributing factor.

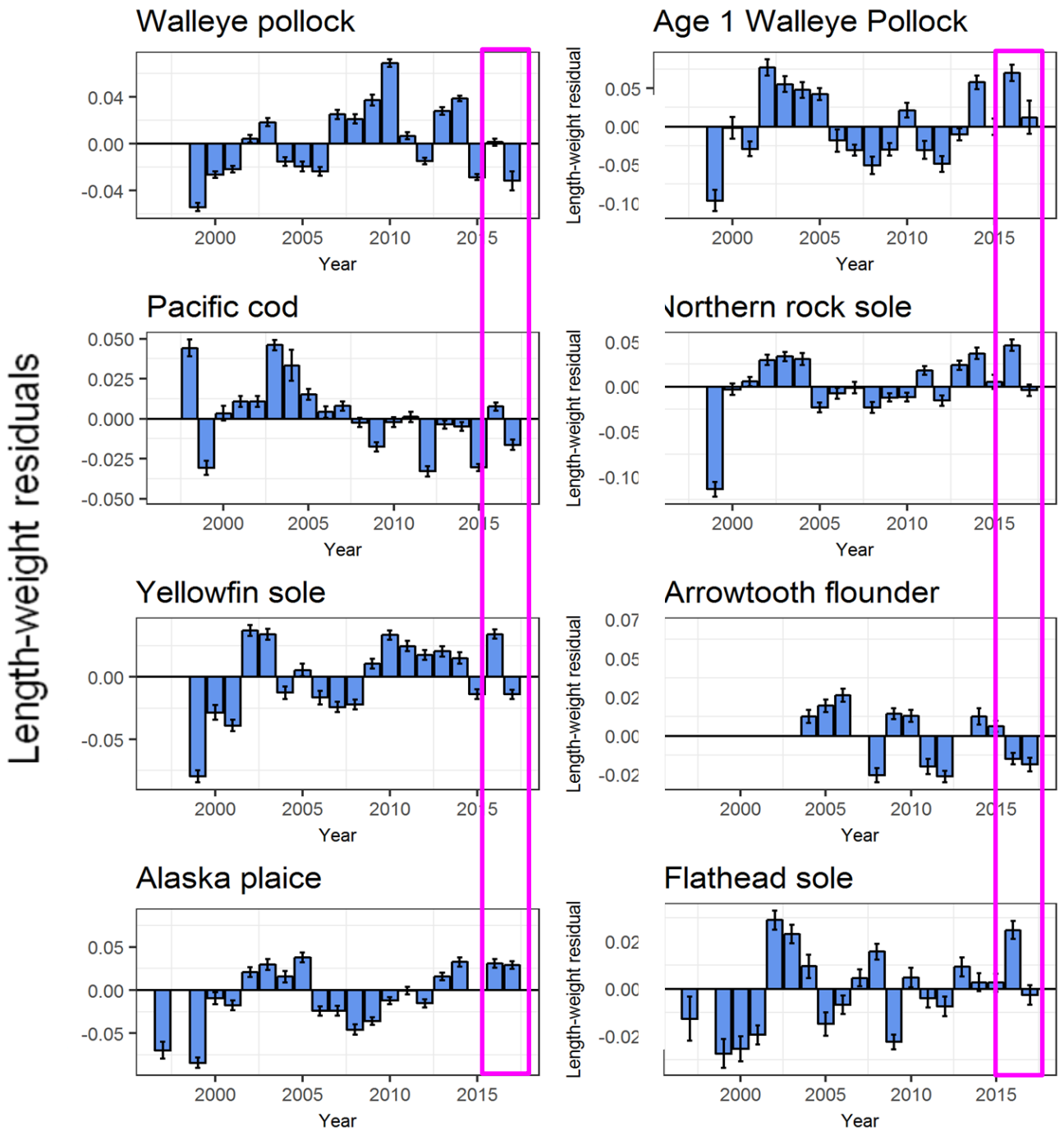
Remember to…

Report unusual numbers of sick or dead birds to:
1-866-527-3358 or email **AK_MBM@fws.gov**
Information needed includes:

- Time & Date you see sick or dead birds
- Location of the sick or dead birds
- Type & number of birds (count or estimate)
- Photos of sick/dead birds (see above; include scale if possible)
- Videos of any unusual behaviors (approachable, 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.

COASST · USGS science for a changing world · National Park Service · NOAA

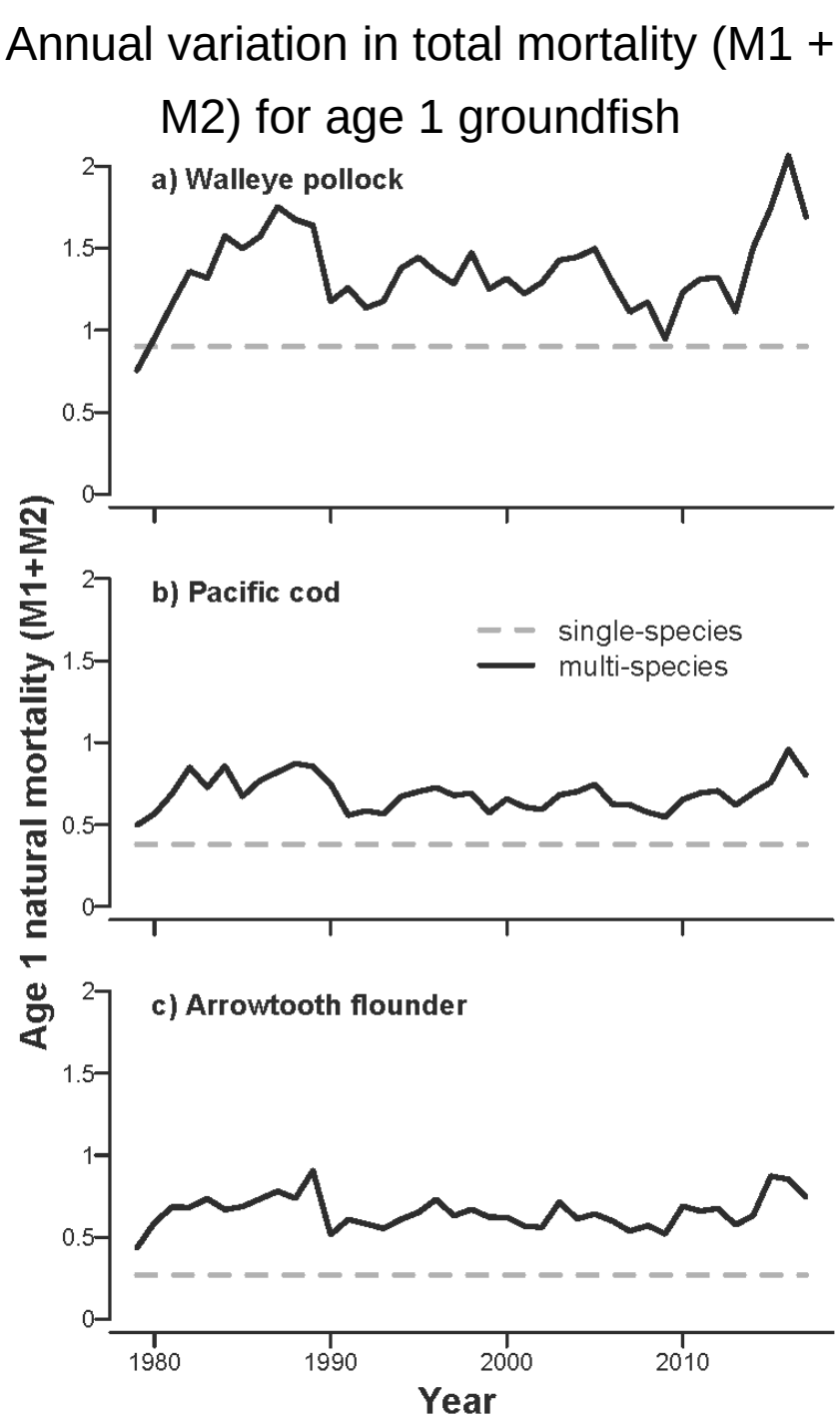


2017 EBS Groundfish condition

- 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.

2017 EBS Natural mortality estimates (CEATTLE)

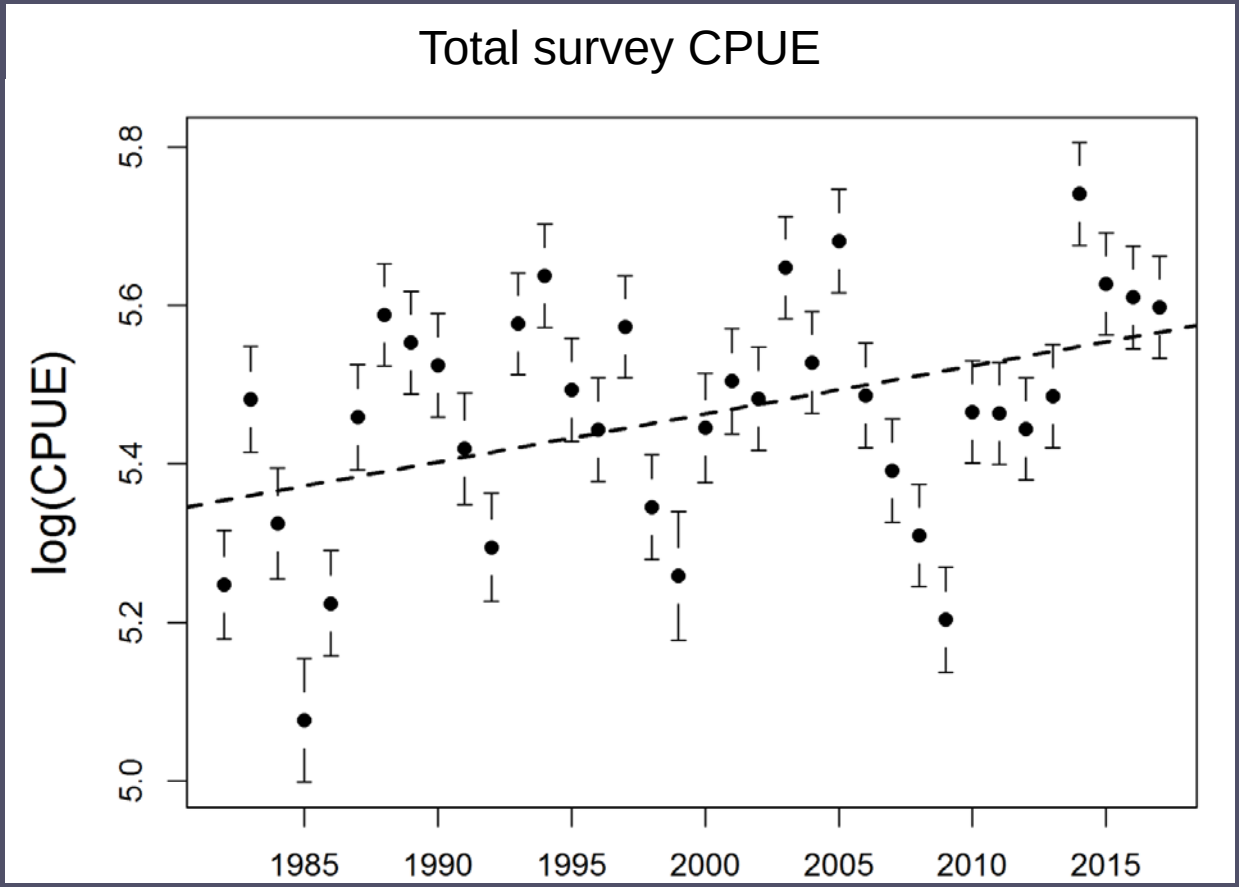


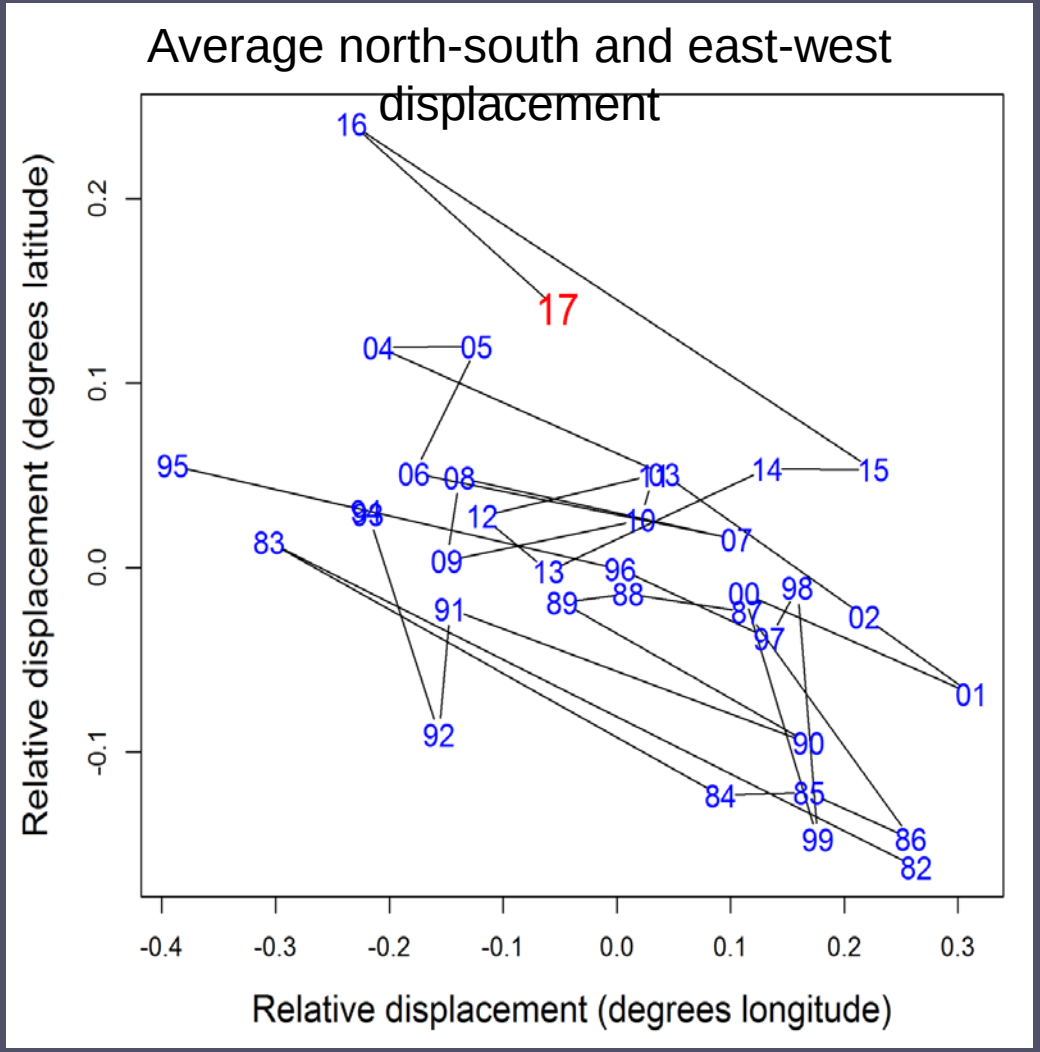
- Age-1 mortality peaked in 2016 for all 3 species, but has remained elevated in 2015-2017
- Natural mortality was greatest for pollock relative to PCod or ATF

Holsman et al.

2017 EBS Aggregated CPUE

- Survey CPUE stable 2015 - 2017
- Shift in distribution back from 2016

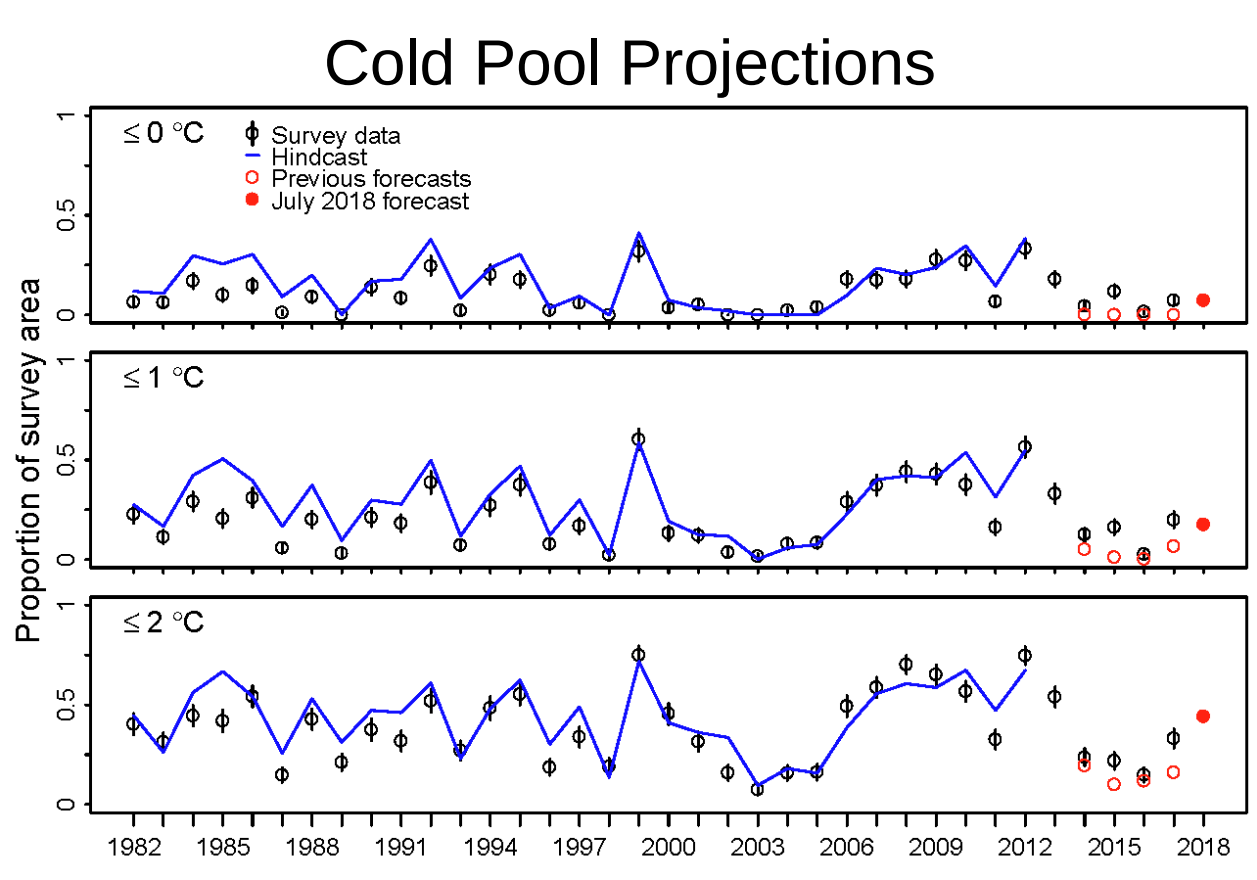




F. Mueter and B. Lauth

2017 Forecasts and Predictions

9-month forecast



Summer 2018:

- Smaller, but near-average based on ≤0°C or ≤1°C
- Larger-than-average ≤2°C cold pool

K. Aydin

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

Several pollock recruitment predictions

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

Several pollock recruitment predictions

2017 year class

- Temperature Change index: below-average
  - Yasumiishi

EBS 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)

Thank you !

Contributors

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Website

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