Ecosystem shifts in Alaska's Large Marine Ecosystems: implications for Pacific halibut and other groundfishes

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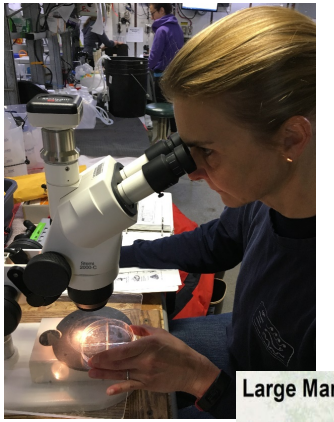
INTRODUCTION

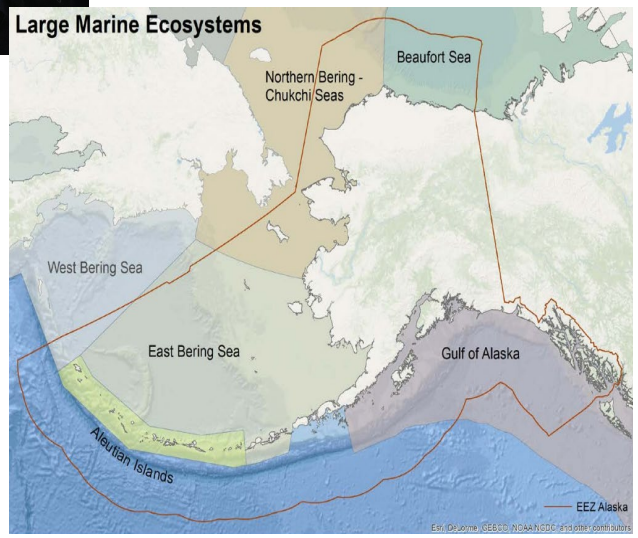
Who? EcoFOCI Program

Fisheries, ecosystem dynamics, and climate change

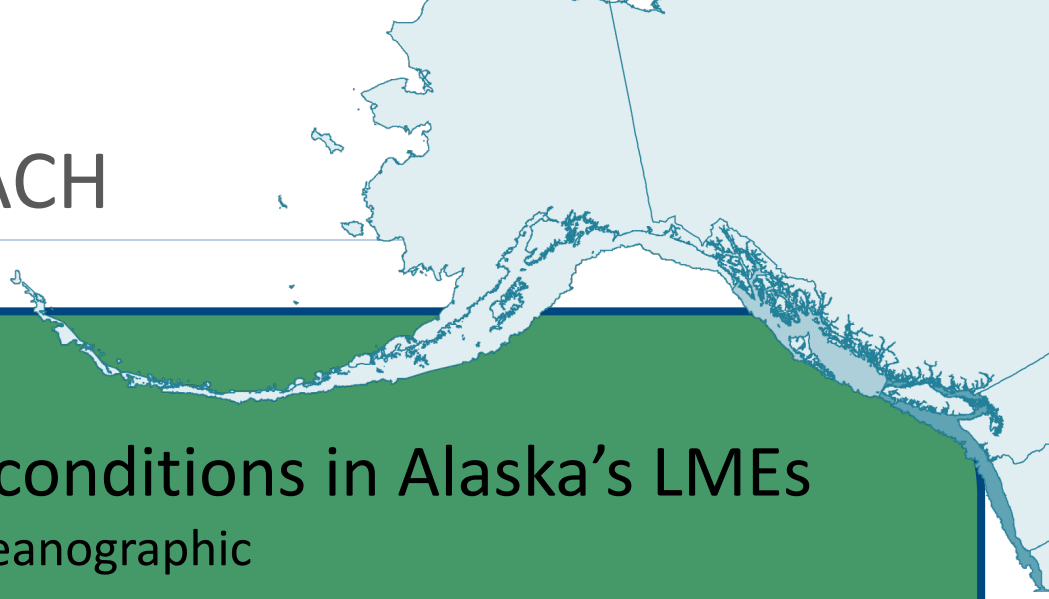
Where? Gulf of Alaska, Bering Sea, Northern Bering Sea, Chukchi Sea, Beaufort Sea

What? General oceanography, algae, zooplankton, young fish





OBJECTIVES / APPROACH



Changing physical conditions in Alaska's LMEs

Atmospheric, Climate, Oceanographic

Ecosystem changes

Anomalous events vs Regime shifts

Effects on Fisheries and Management

Future?

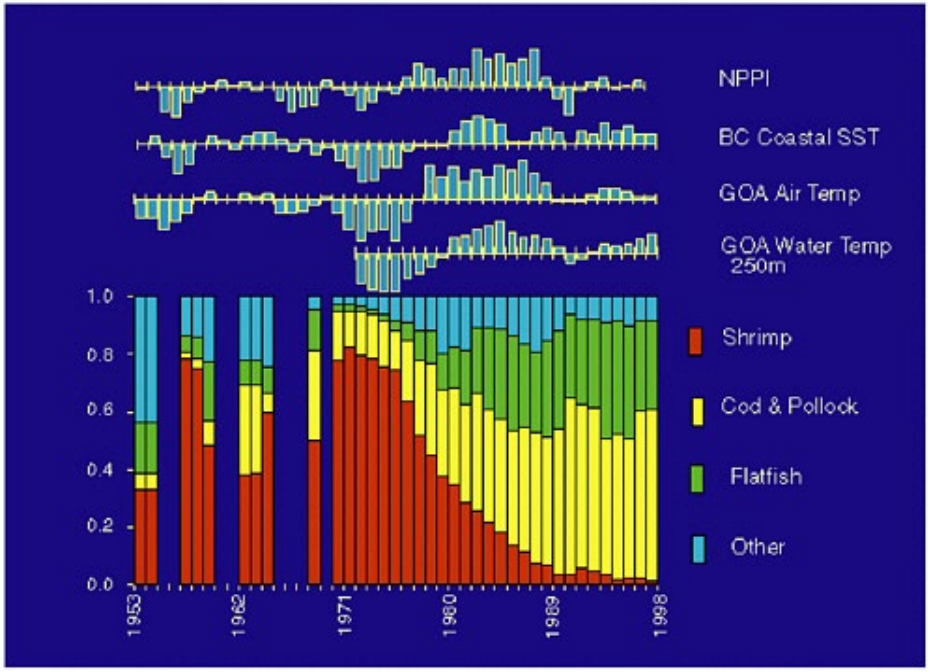
W GULF OF ALASKA – REGIME SHIFT

Regime shift and ecosystem reorganization (1977 gadoid outburst)

Multi-year phenomenon that has persisted

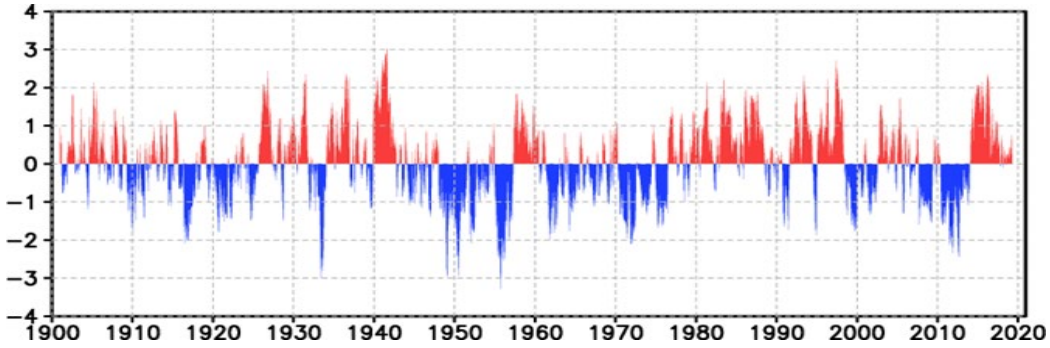
Hypothesized related to physical shifts – PDO alternations

Presumed to be cross trophic, bottom up
- time series data for LTL is less robust



Anderson and Piatt

Monthly PDO Index



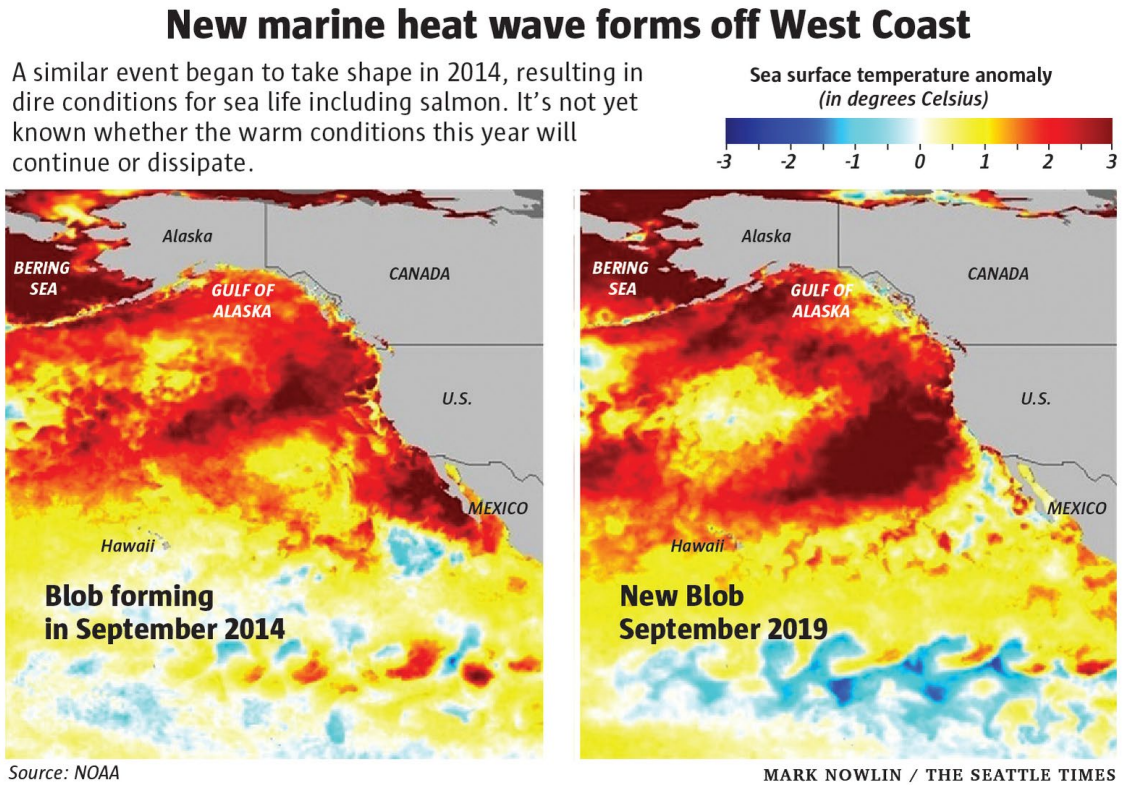
W GULF OF ALASKA – ANOMALOUS EVENTS

Anomalous event – One-offs
Marine heat waves (BLOB: 2015, 2019?)

Intense, punctuated, ocean heating events

Short term phenomenon, transient

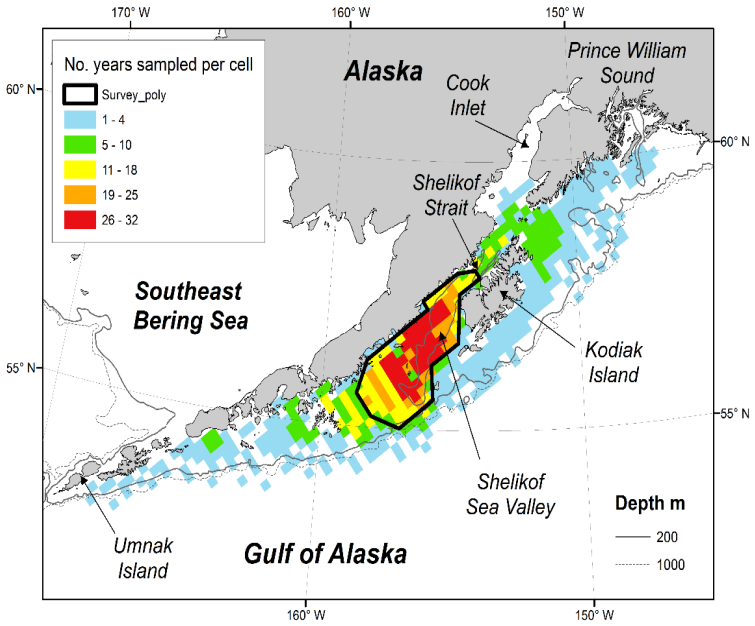
Hypothesized related to physical shifts – high pressure over Pacific Basin

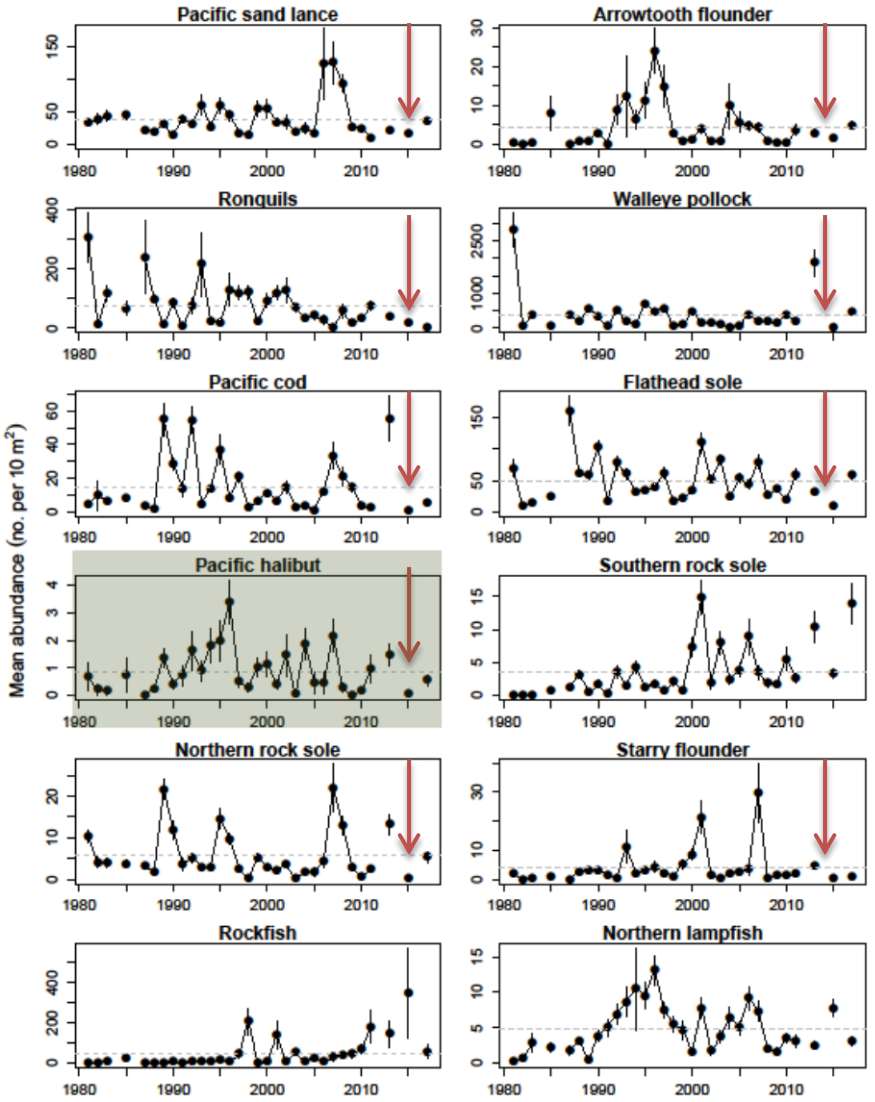


Two "one offs" – cascading effects
How do we evaluate whether these may be leading to regime shift?

W GULF OF ALASKA – larval fish production

2015 – Blob 1





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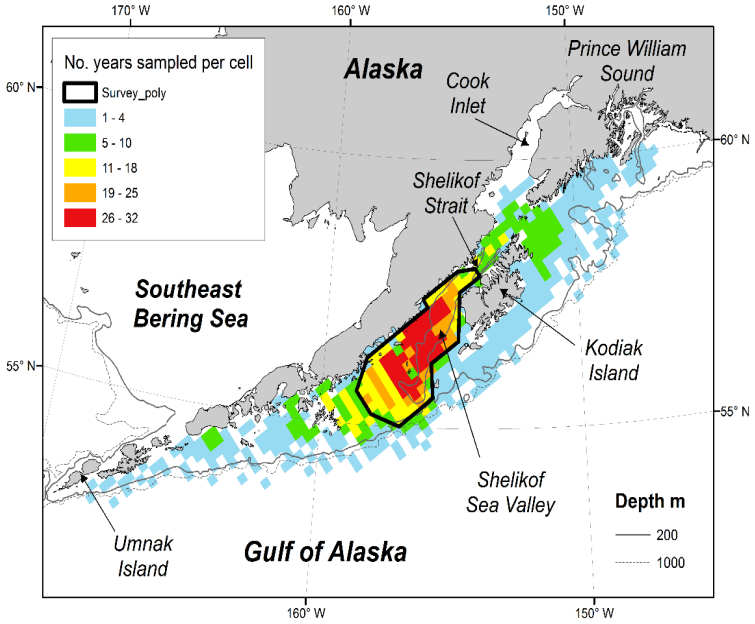
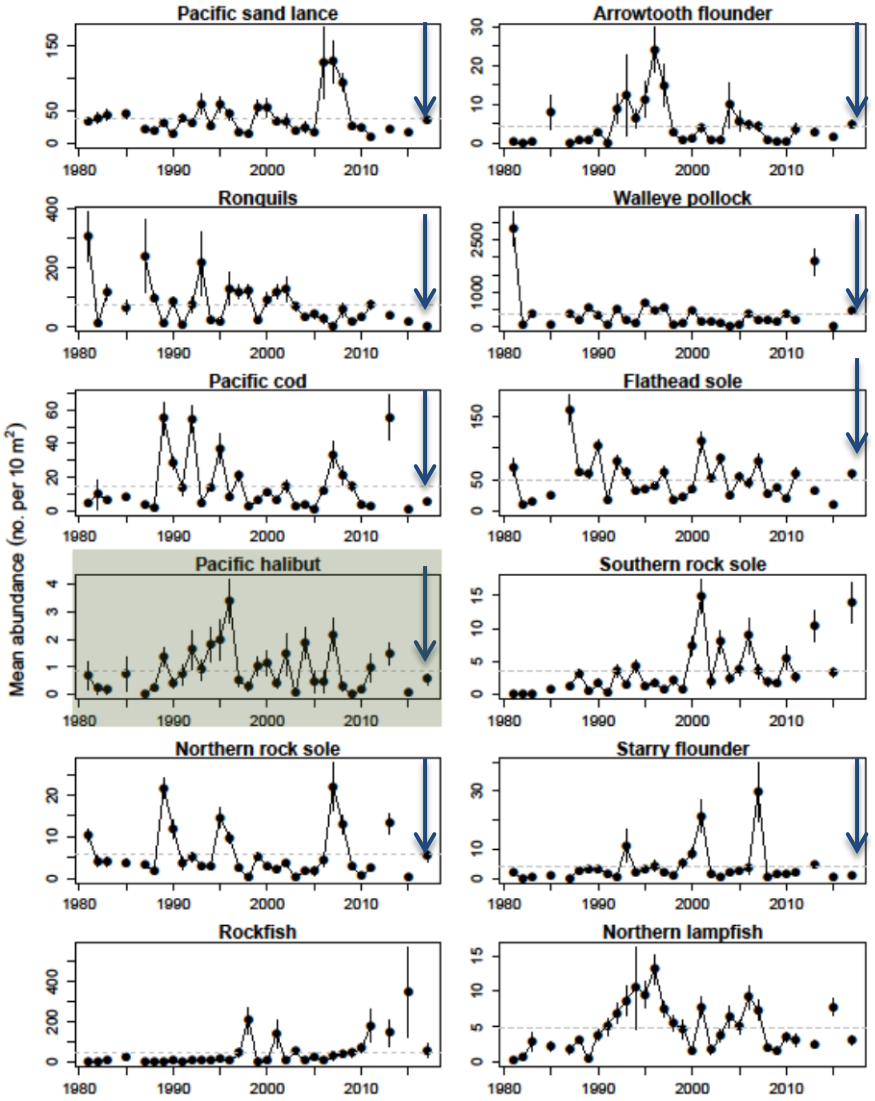
W GULF OF ALASKA – larval fish production

2017 – no Blob





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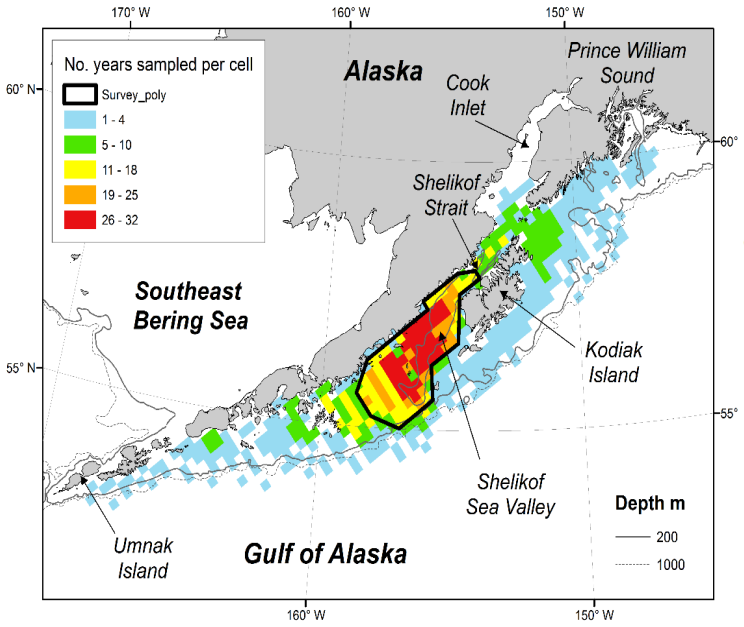
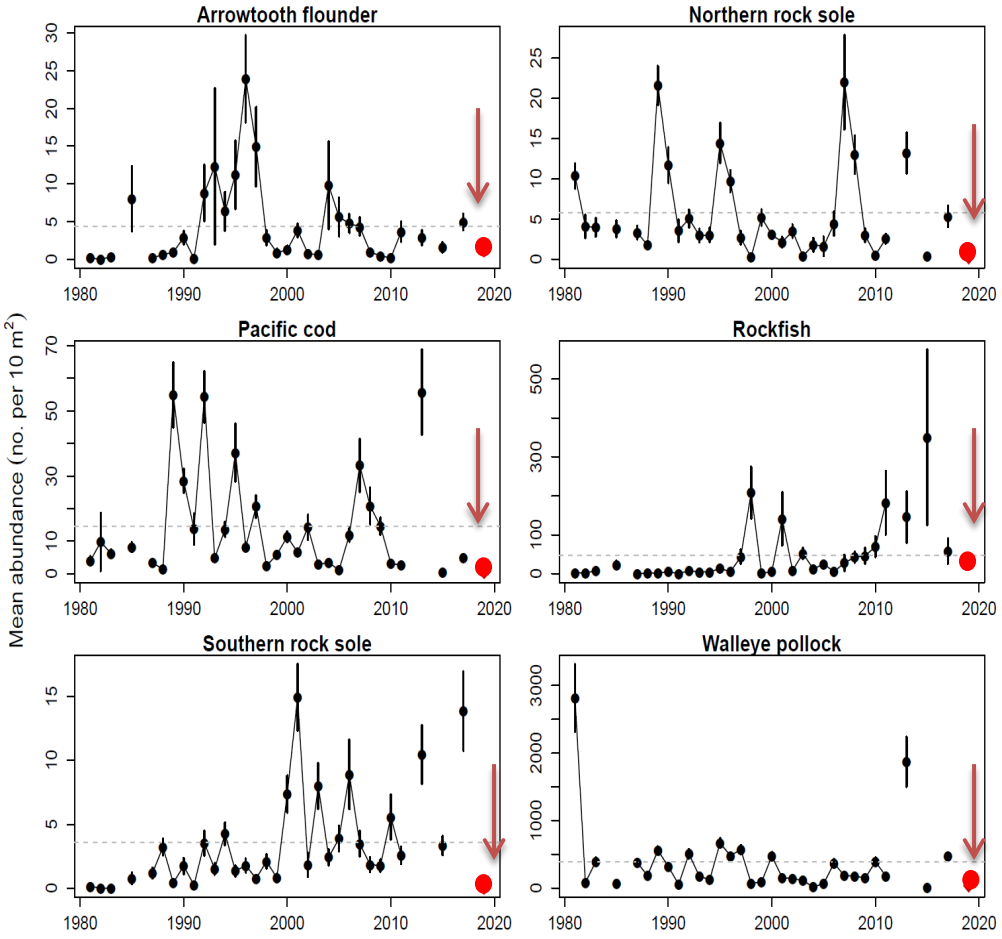
W GULF OF ALASKA – larval fish production

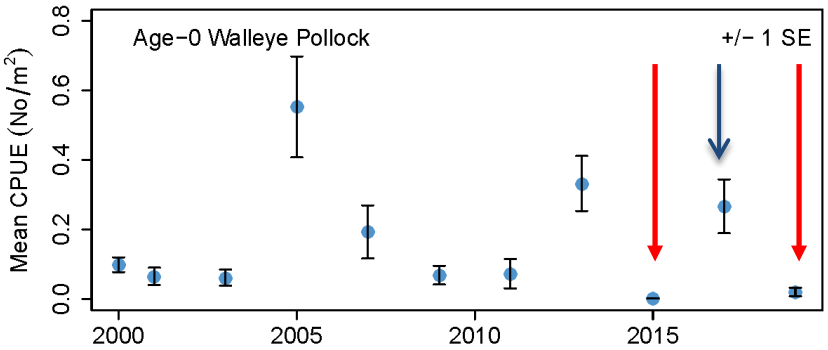
2019 – Blob 2

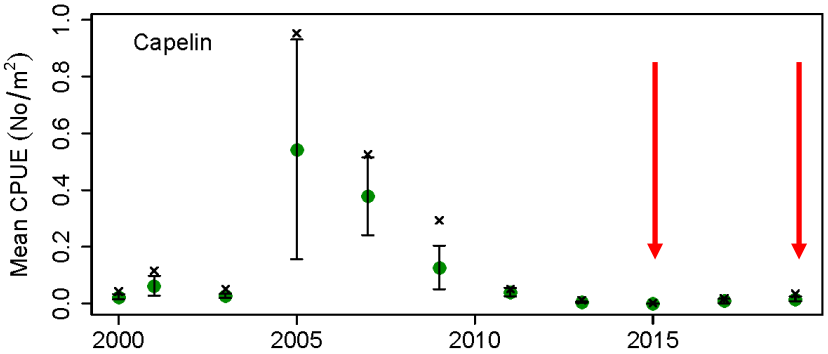


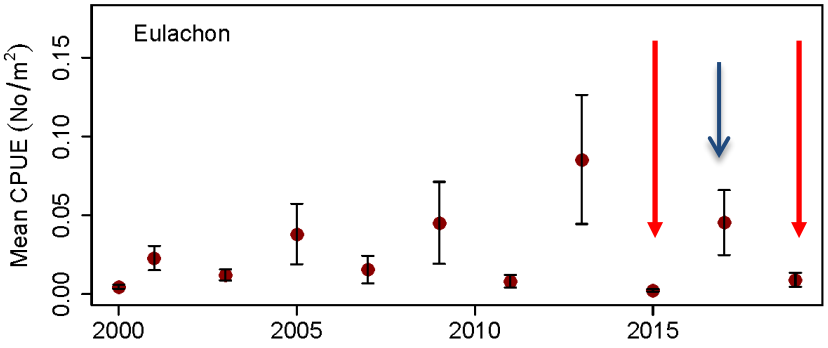


A. Deary, L. Rogers

W GULF OF ALASKA – juvenile fish production



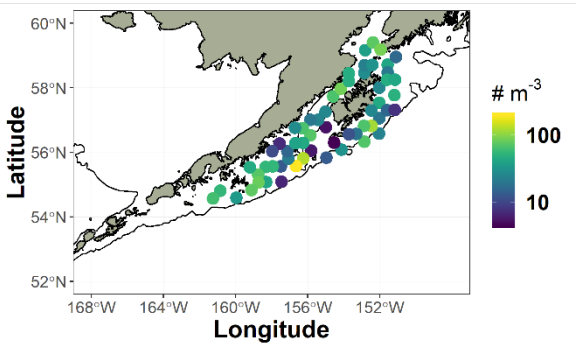


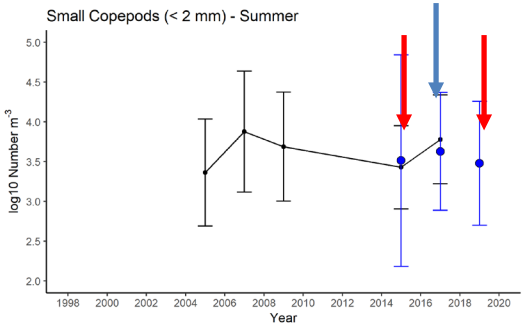


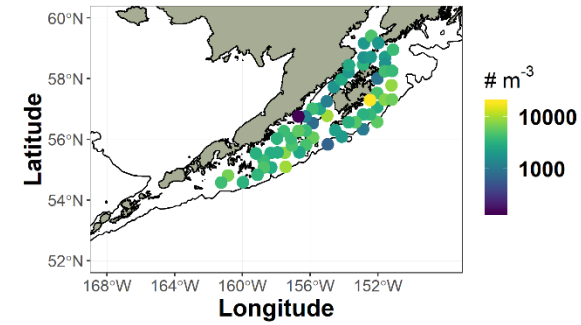
L. Rogers, S. Porter, M. Wilson

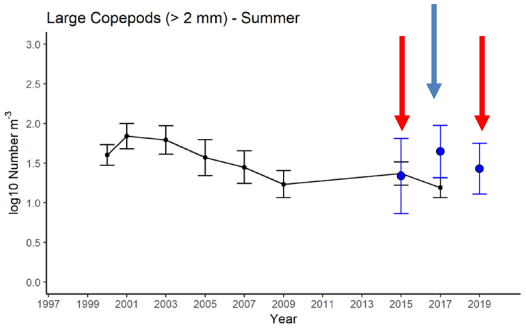
W GULF OF ALASKA – zooplankton

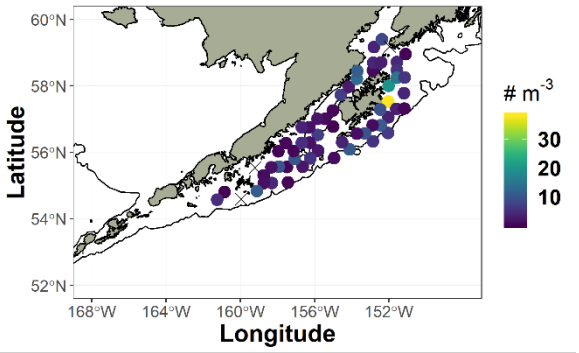
2019

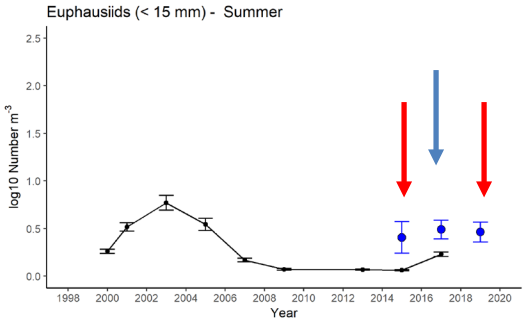






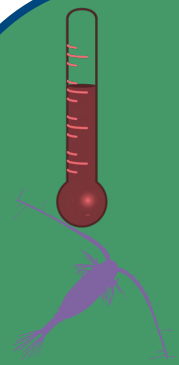






Kimmel, Wilson, Porter

W GULF OF ALASKA – Regime change?



Warming occurred over 2 years, but not consecutive

Cross-trophic shifts – zooplankton, fish

Changes in fish produ… larvae, juveniles)

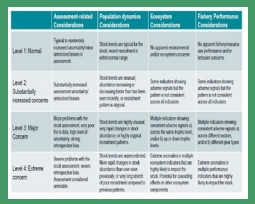
Erratic … ences of lower latitude species …ic, subtropic sp); GF spatial shifts

No evidence of regime shift yet, but what happens as one-offs get more frequent?

UME - seabirds, mammals

W GULF OF ALASKA – management impacts?

Adoption of ecosystem indicators into stock assessment - Physical, single species/stock, aggregate, cross-trophic



Species-specific risk tables

More conservative TAC

IPHC – PMEL CTD collaboration

Support for new oceanographic mooring (Semidi Islands)

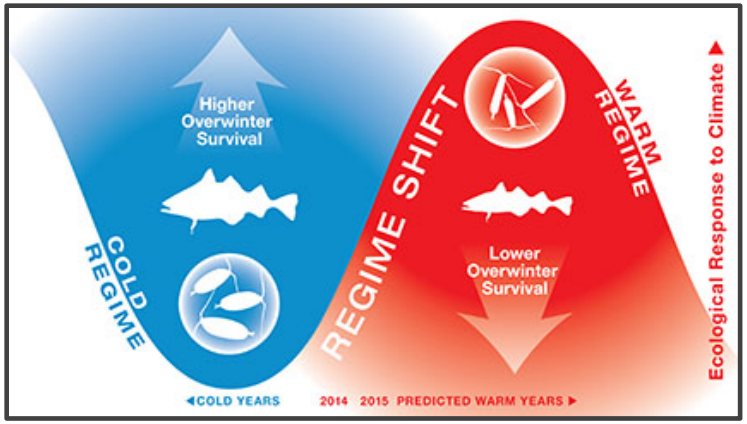
SE BERING SEA – REGIME SHIFT?

Ecosystem reorganization (2001-2005)
Oscillating Control Hypothesis

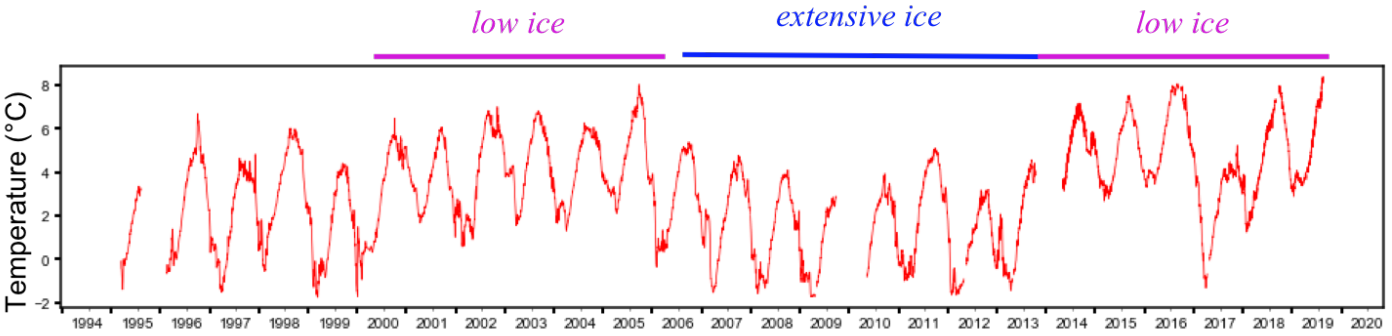
Hypothesized related to physical shifts – SE shelf sea ice

Multi-year phenomena - stanzas

Warm – Cold oscillations

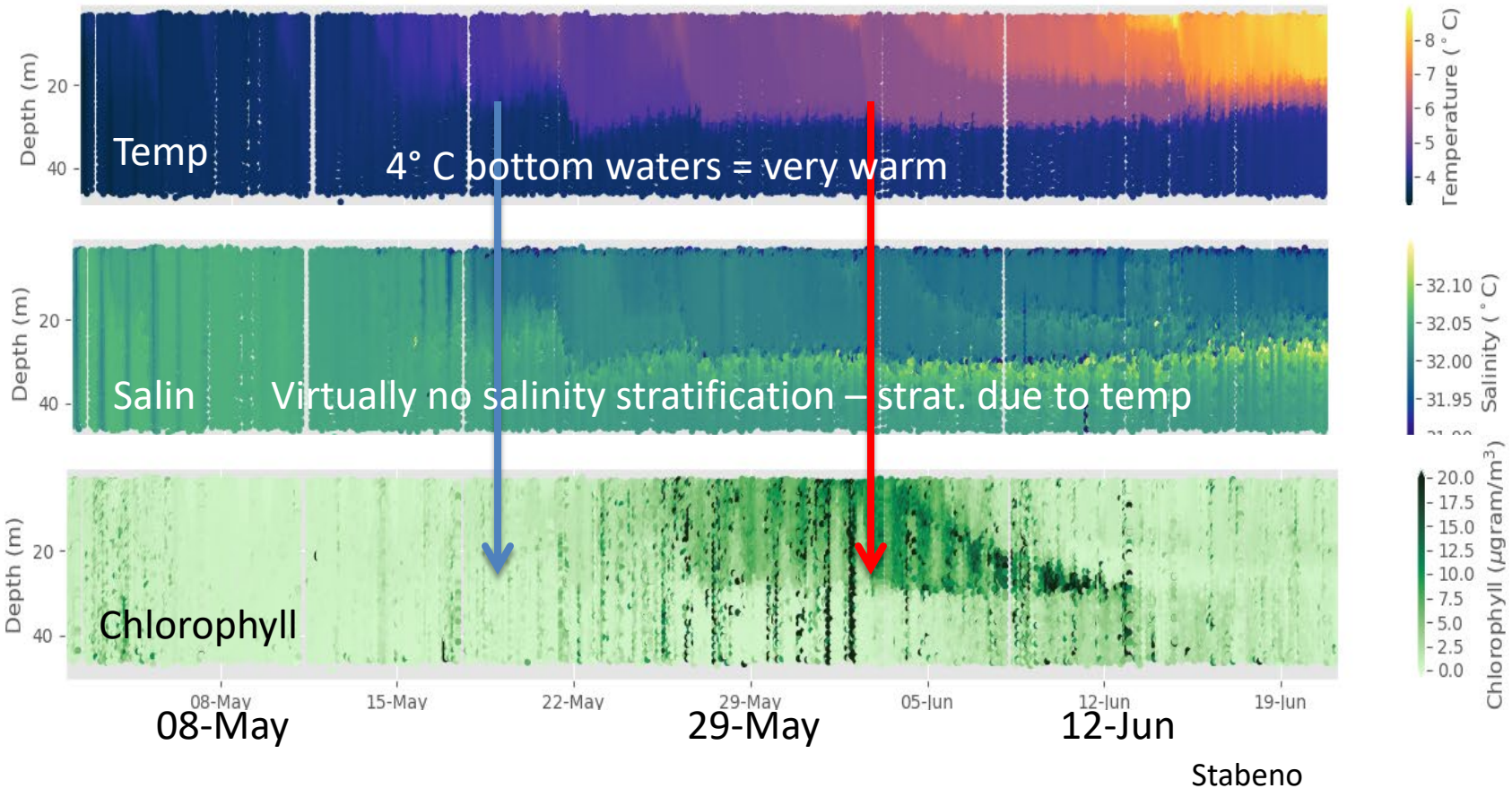


Baier, Duffy-Anderson



Stabeno

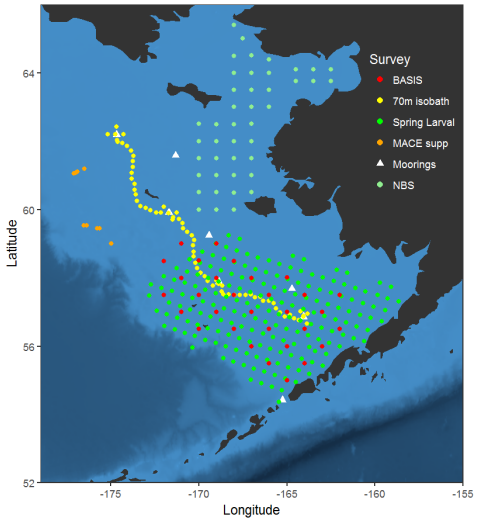
SE BERING SEA – stratification & phytoplankton (M2 mooring, 2019)

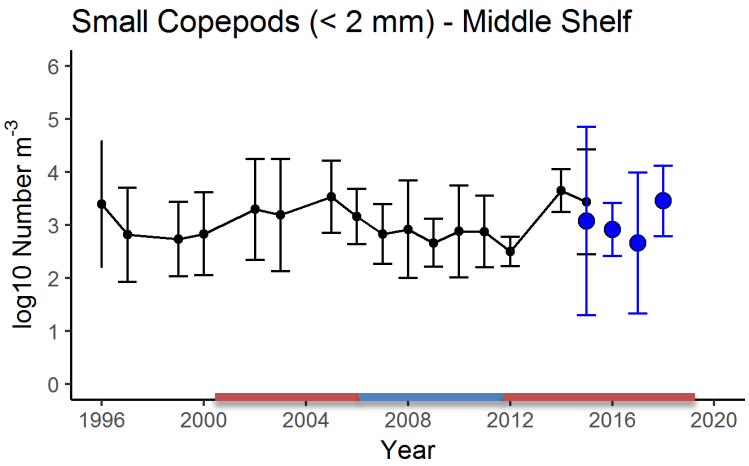


Strong wind mixing

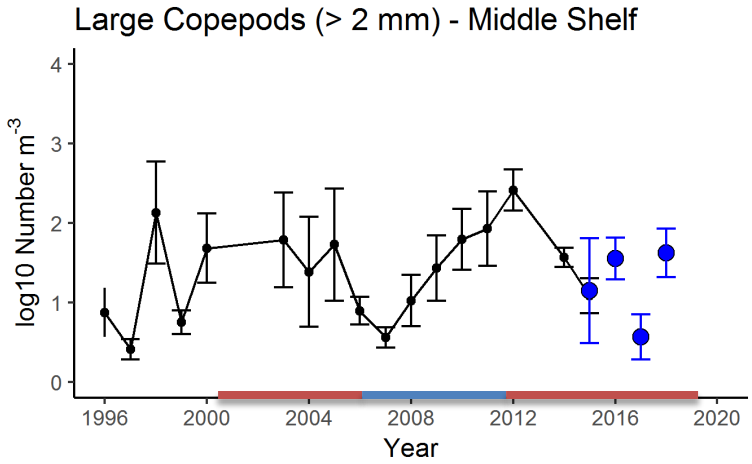
Bloom started late

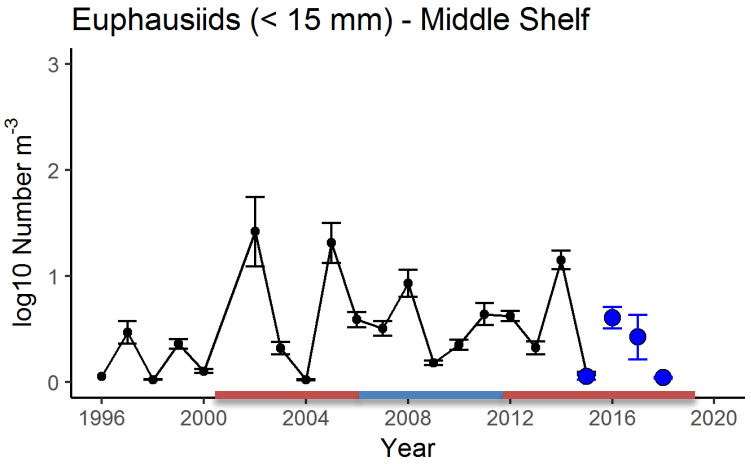
SE BERING SEA – zooplankton



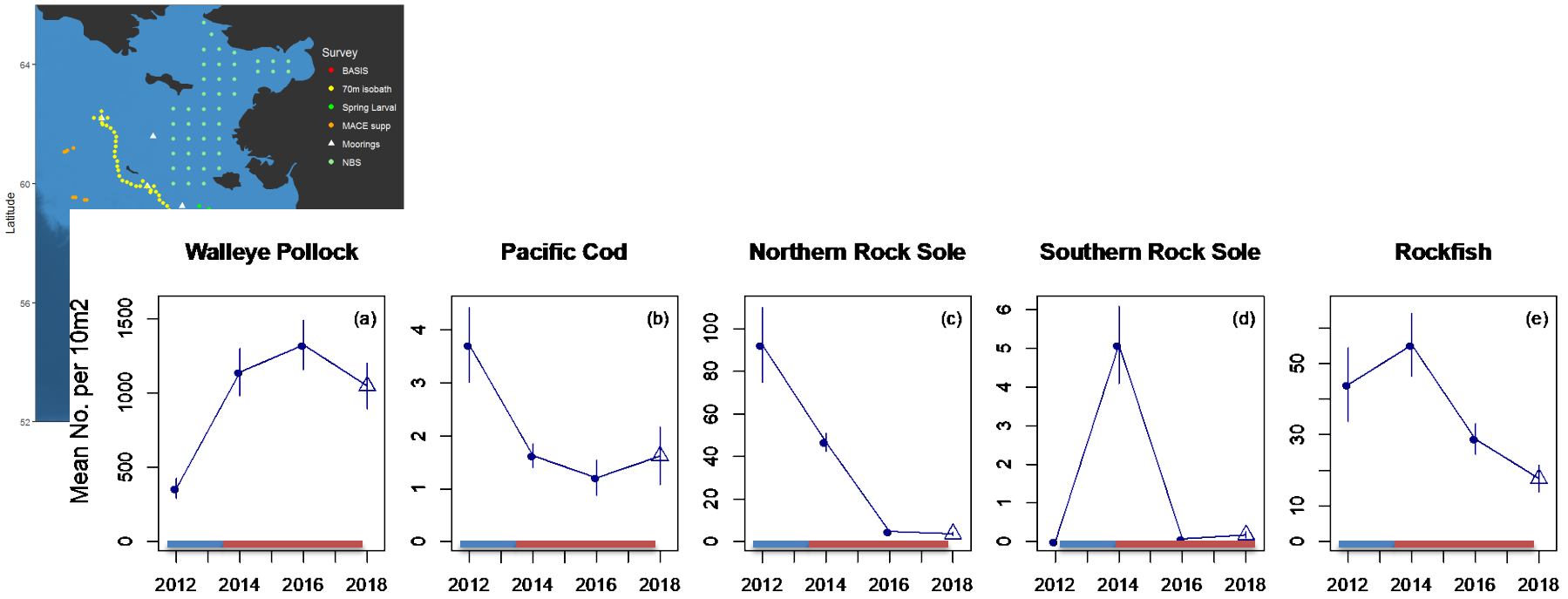


Kimmel





SE BERING SEA – larval fish production

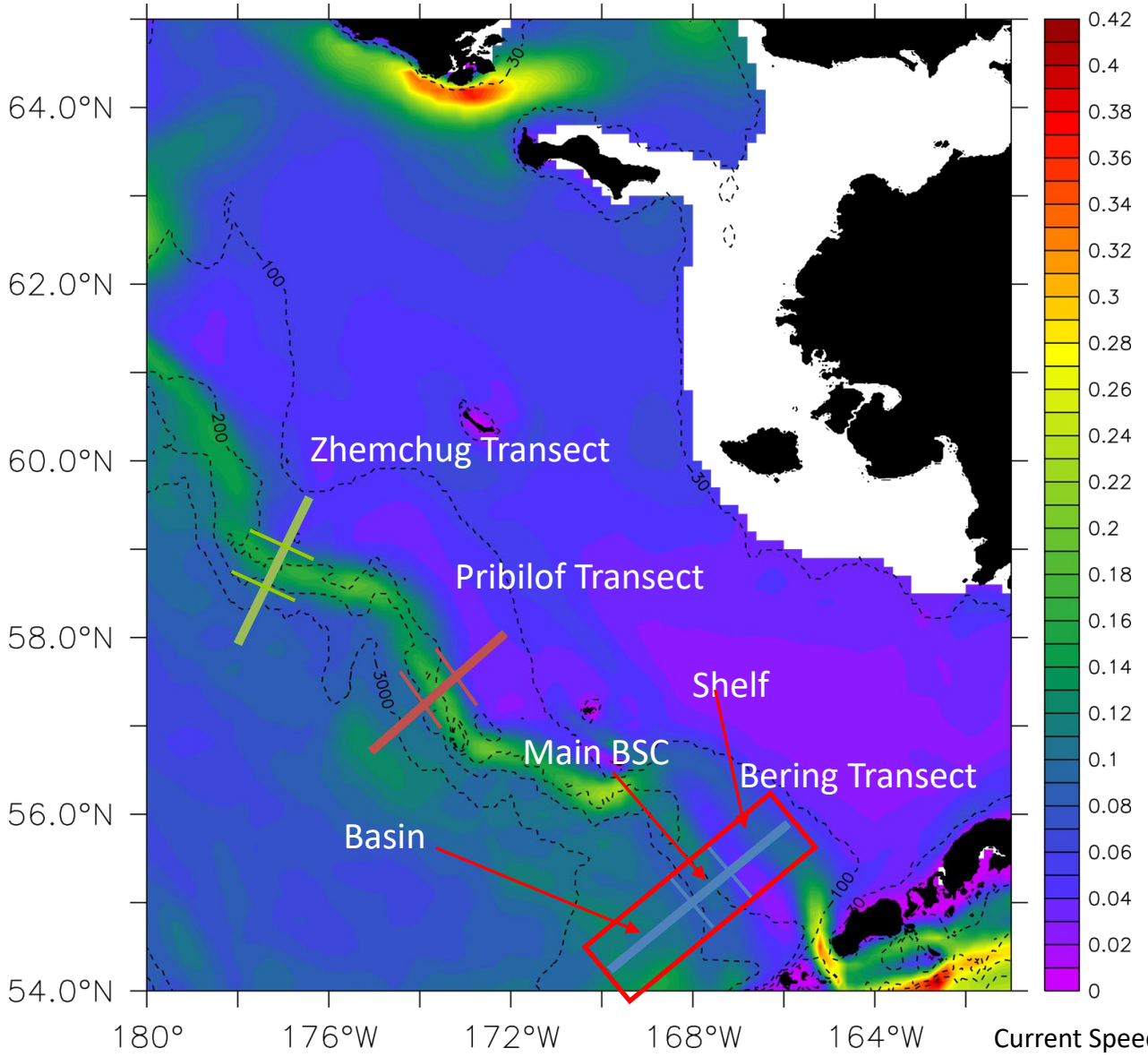


Rogers, Porter

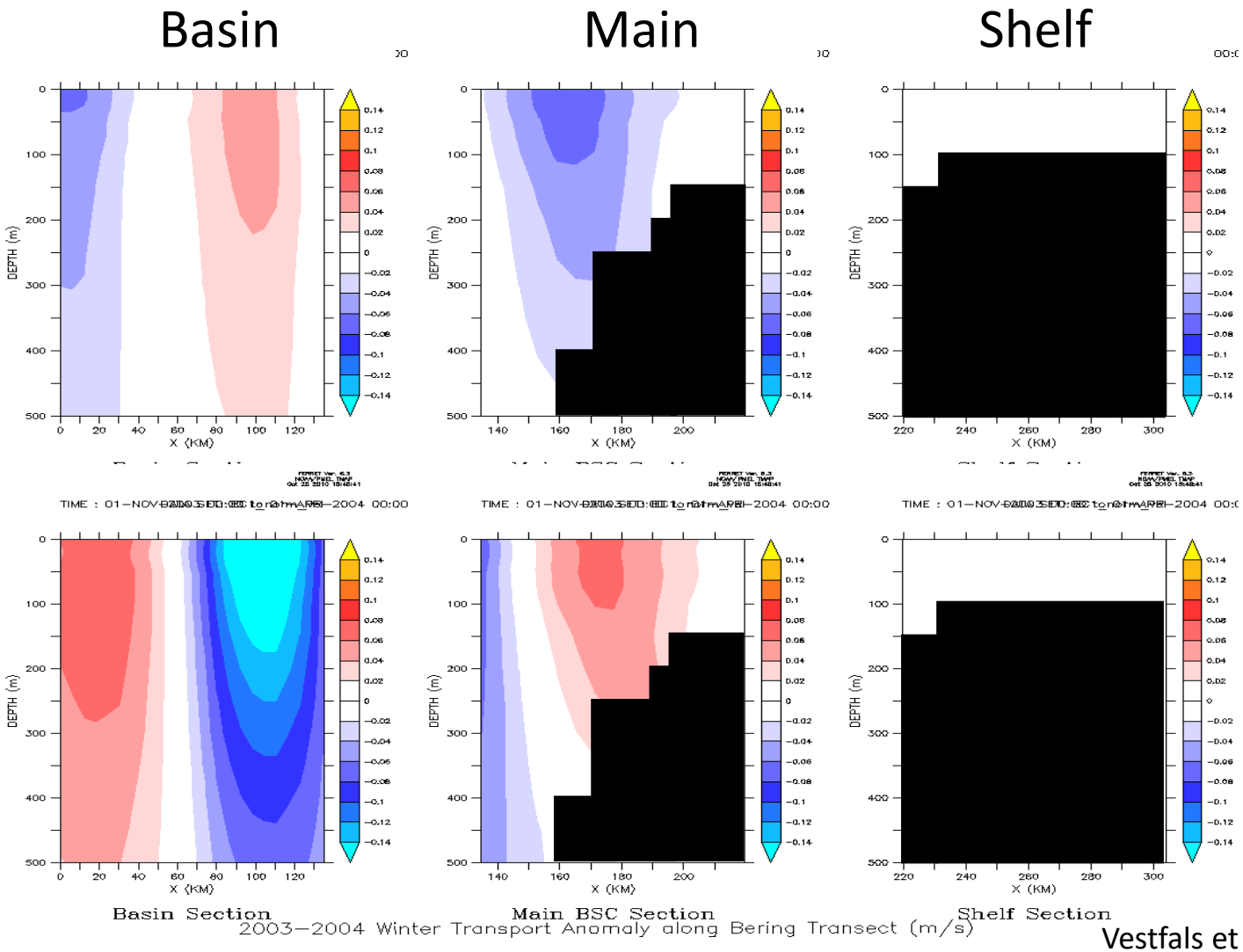
SE BERING SEA – oceanographic shifts

Warm – Cold oscillations

Oceanographic variations
Influence on connectivity?

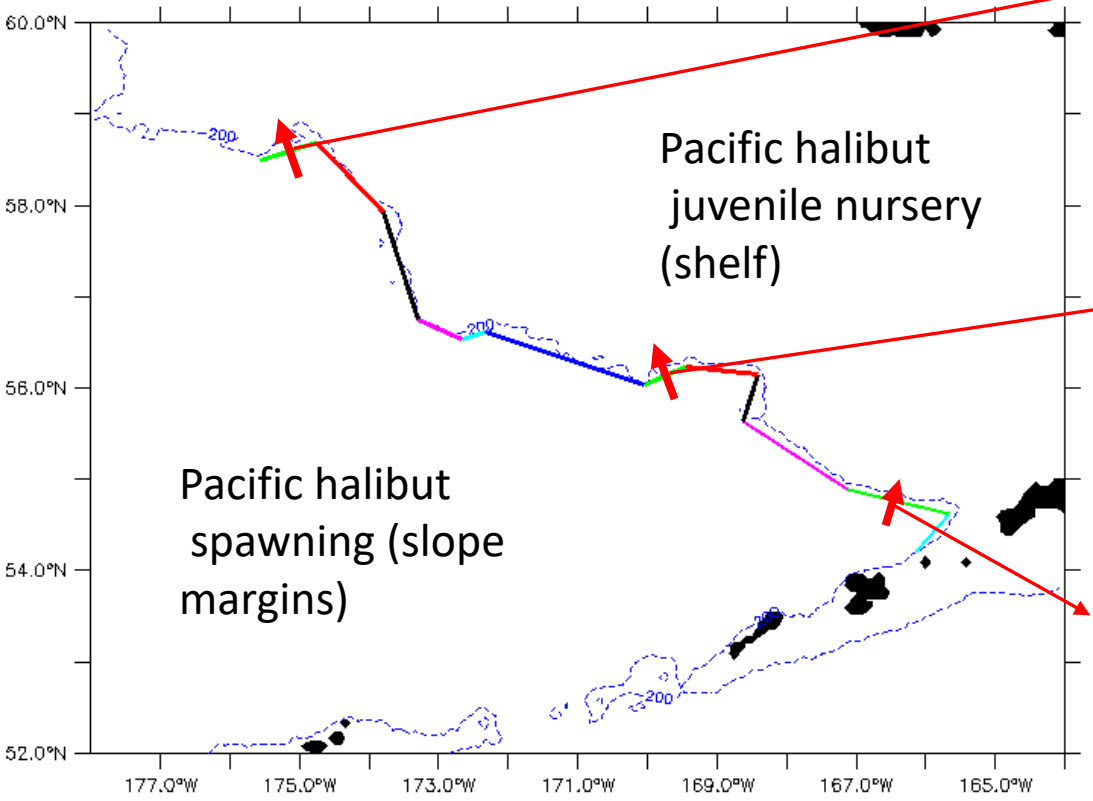


SE BERING SEA – oceanographic shifts



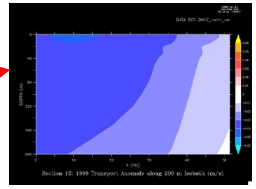
Vestfals et al

SE BERING SEA - connectivity

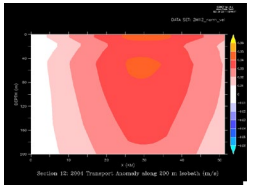


1999: Cold

2004: Warm

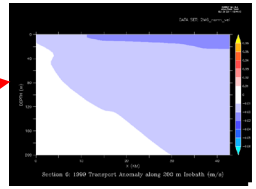


Section 12



Lower on-shelf

Higher on-shelf



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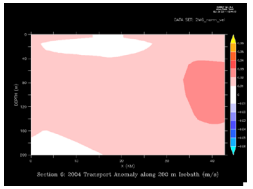
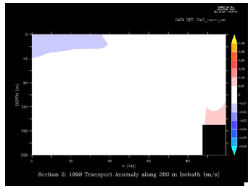


Lower on-shelf

Higher on-shelf



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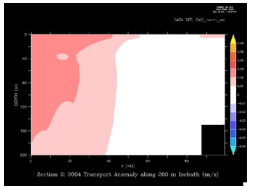


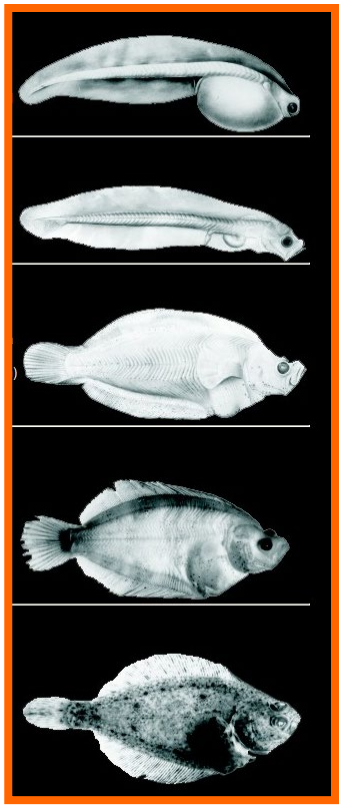
Lower on-shelf

Higher on-shelf

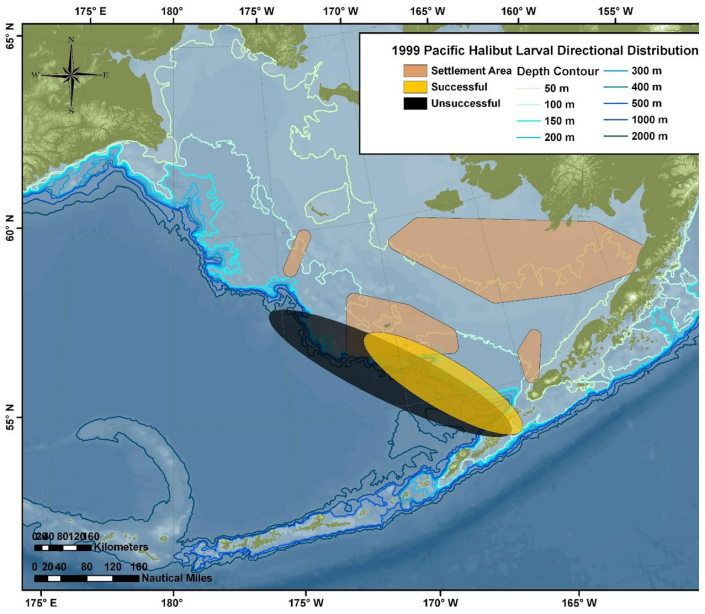
Vestfals et al

SE BERING SEA – settlement success

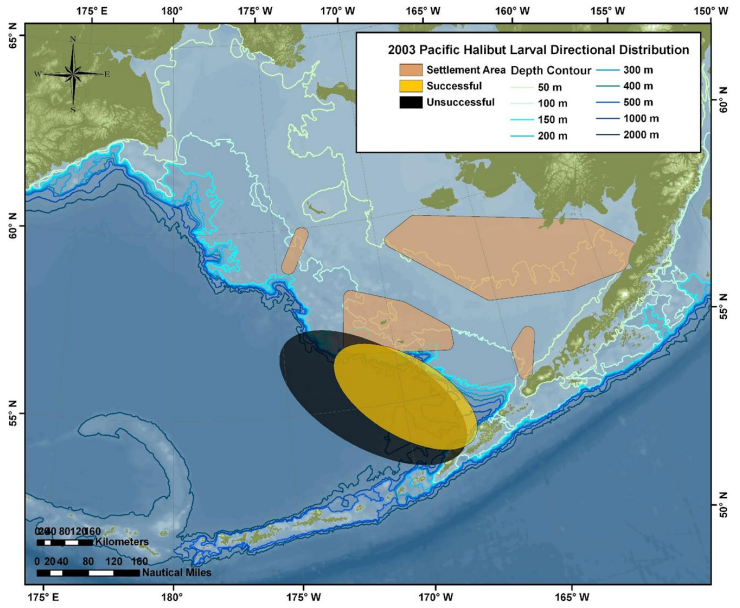
PACIFIC HALIBUT



Cold Year 1999



Warm Year 2004



Vestfals et al

SE BERING SEA – Regime change vs. Anomalous events?

Historical warming occurred over 3-5 consecutive years, ecosystem shifted but returned.

Cross-trophic shifts –phytoplankton b… …ing, zooplankton

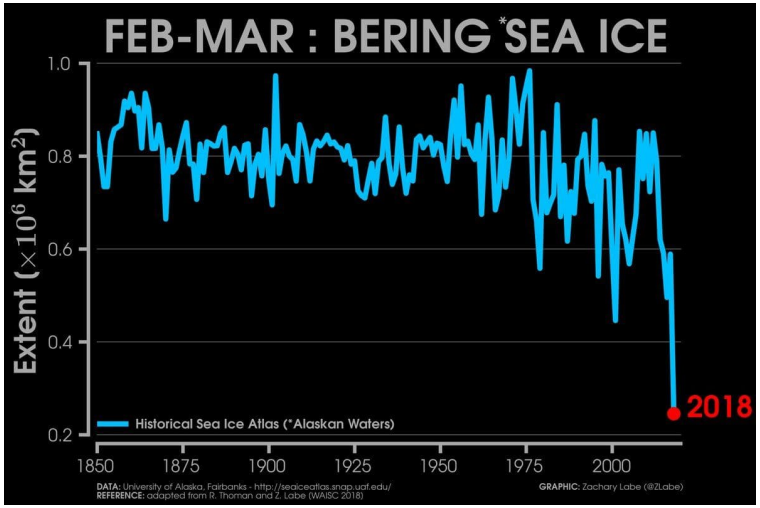
Changes in fi… …ction;
Histo… …nges in oceanography, connectivity/settlement
… equivocal

No evidence for regime shift yet, but what happens with continued LOSI?

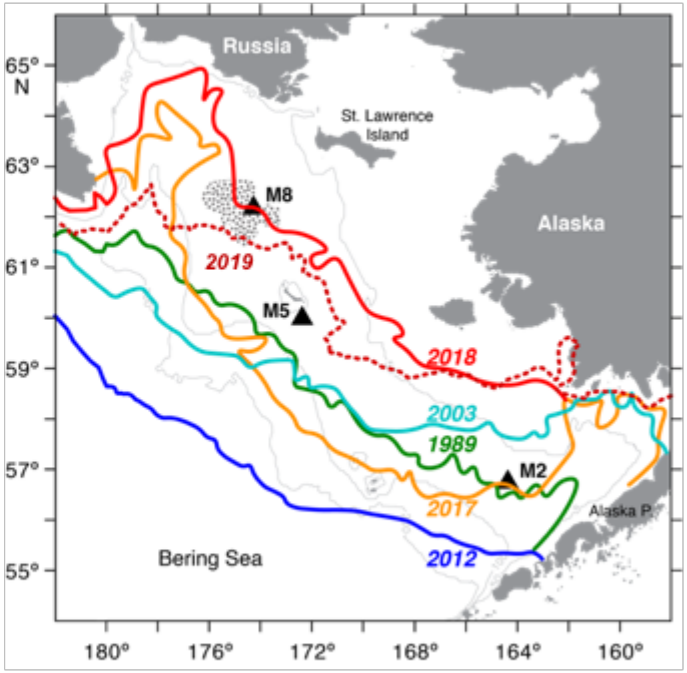
Spatial shifts in fish abundance
Shifts in distribution (E-W, vertical position in water column, but return to prior conditions

NORTHERN BERING SEA – REGIME SHIFT?

Winters of 2018 and 2019 unprecedented



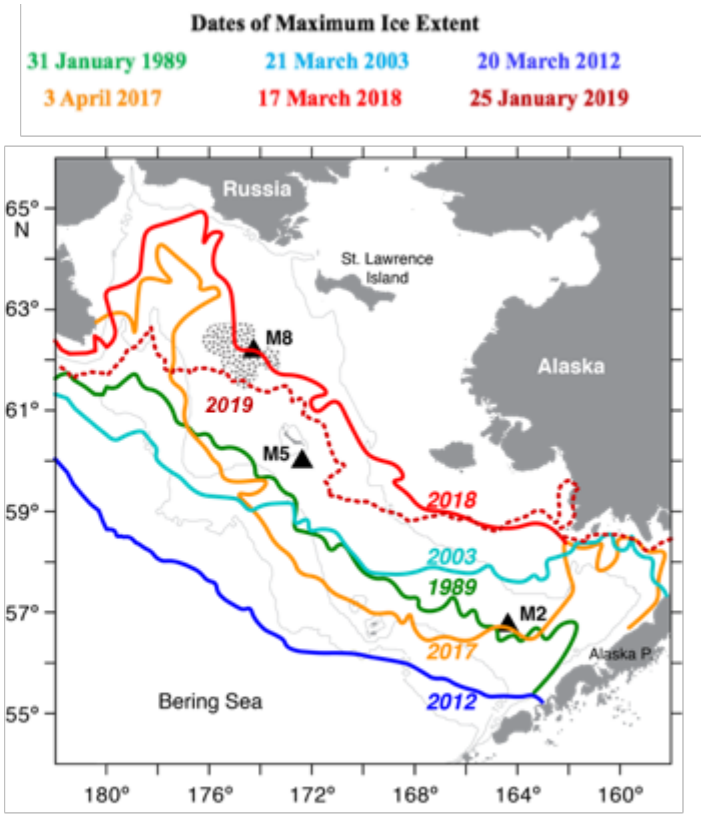
Z. Labe



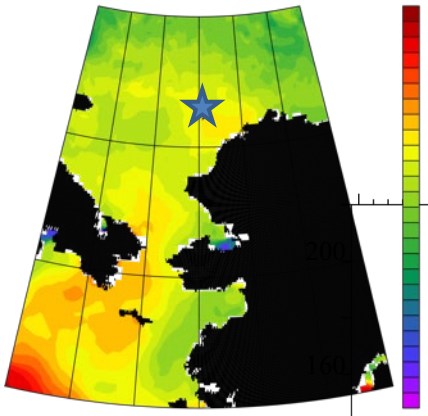
P. Stabeno

NORTHERN BERING SEA – physics

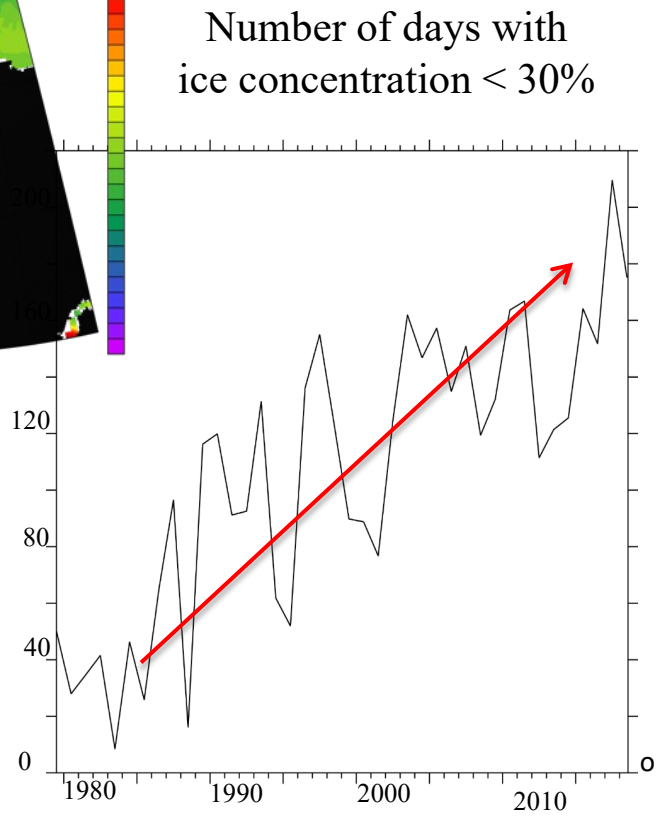
Winters of 2018 and 2019 unprecedented



Bering freeze up depends on Chukchi freeze up



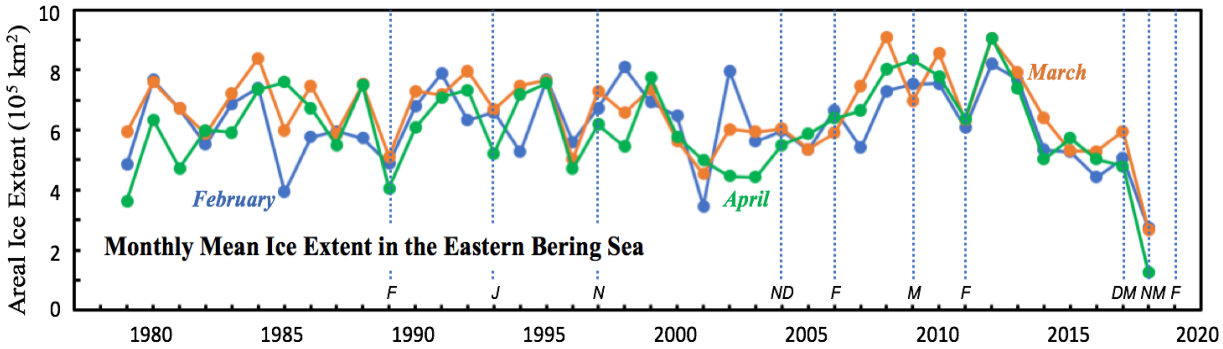
P. Stabeno



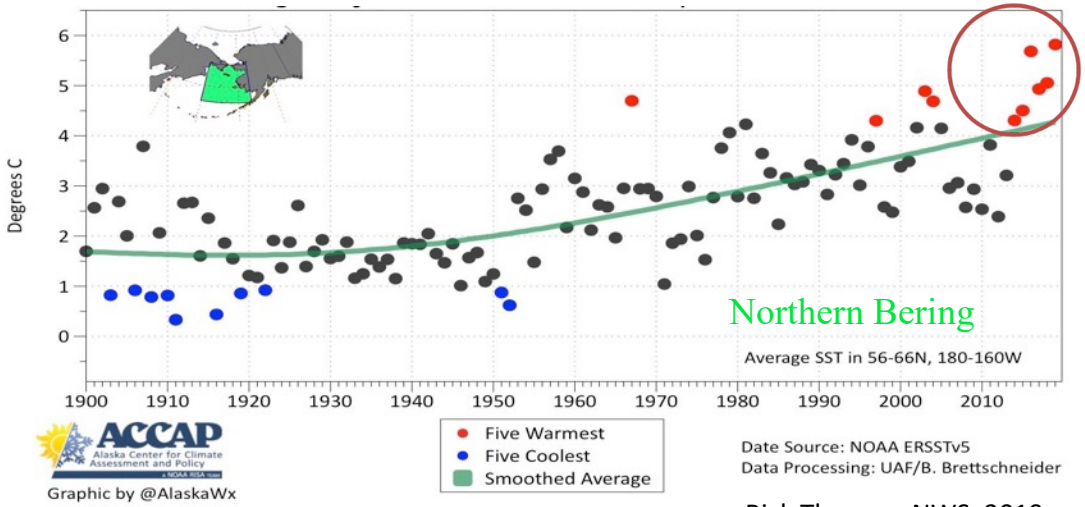
NORTHERN BERING SEA – physics

Why is winter ice not advancing southwards?
Winds, Ocean Temperature

Occurrence of 31-day periods when winds are out of the south



P. Stabeno



Rick Thoman, NWS, 2019

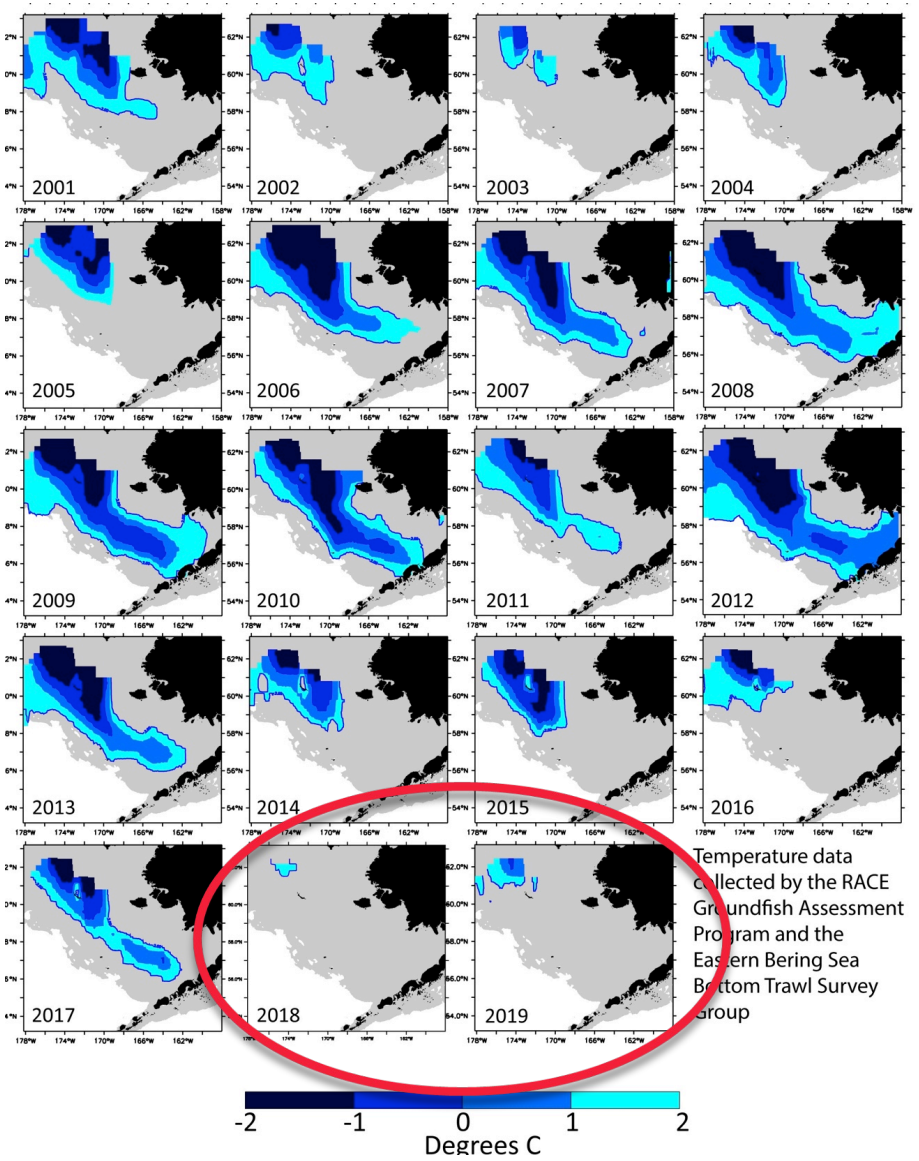
-NBS never been warmer
-6 of 10 warmest springs in the past 120 years occurred in the last 6 years

DOUBLE WHAMMY

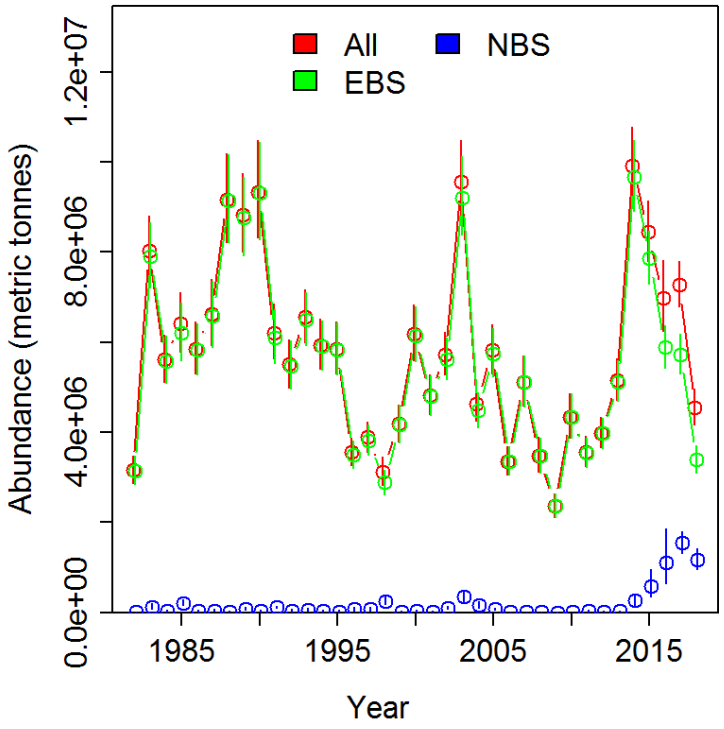
NORTHERN BERING SEA - physics

Changes in summer NBS Cold Pool

Influence on Fish?

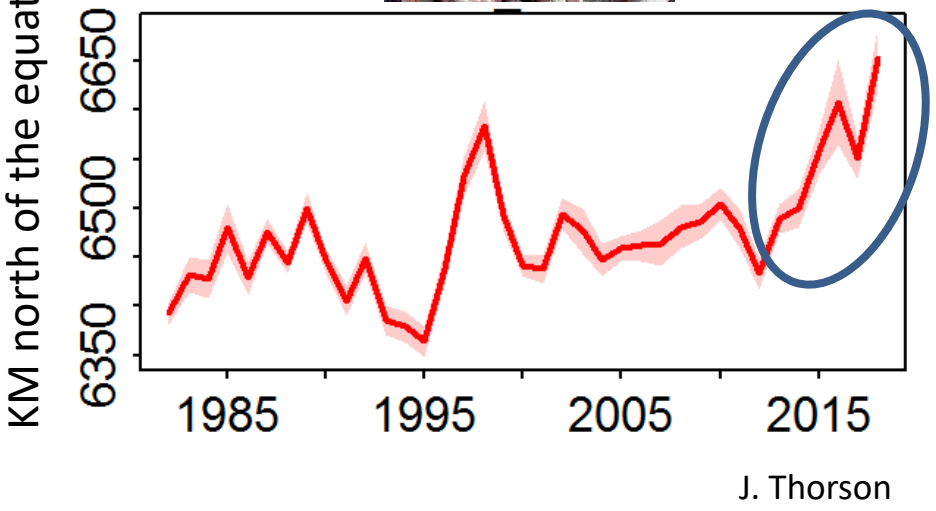


NORTHERN BERING SEA – spatial shifts



Thorson, Lauth, Wilson, Logerwell

WALLEYE POLLOCK



J. Thorson

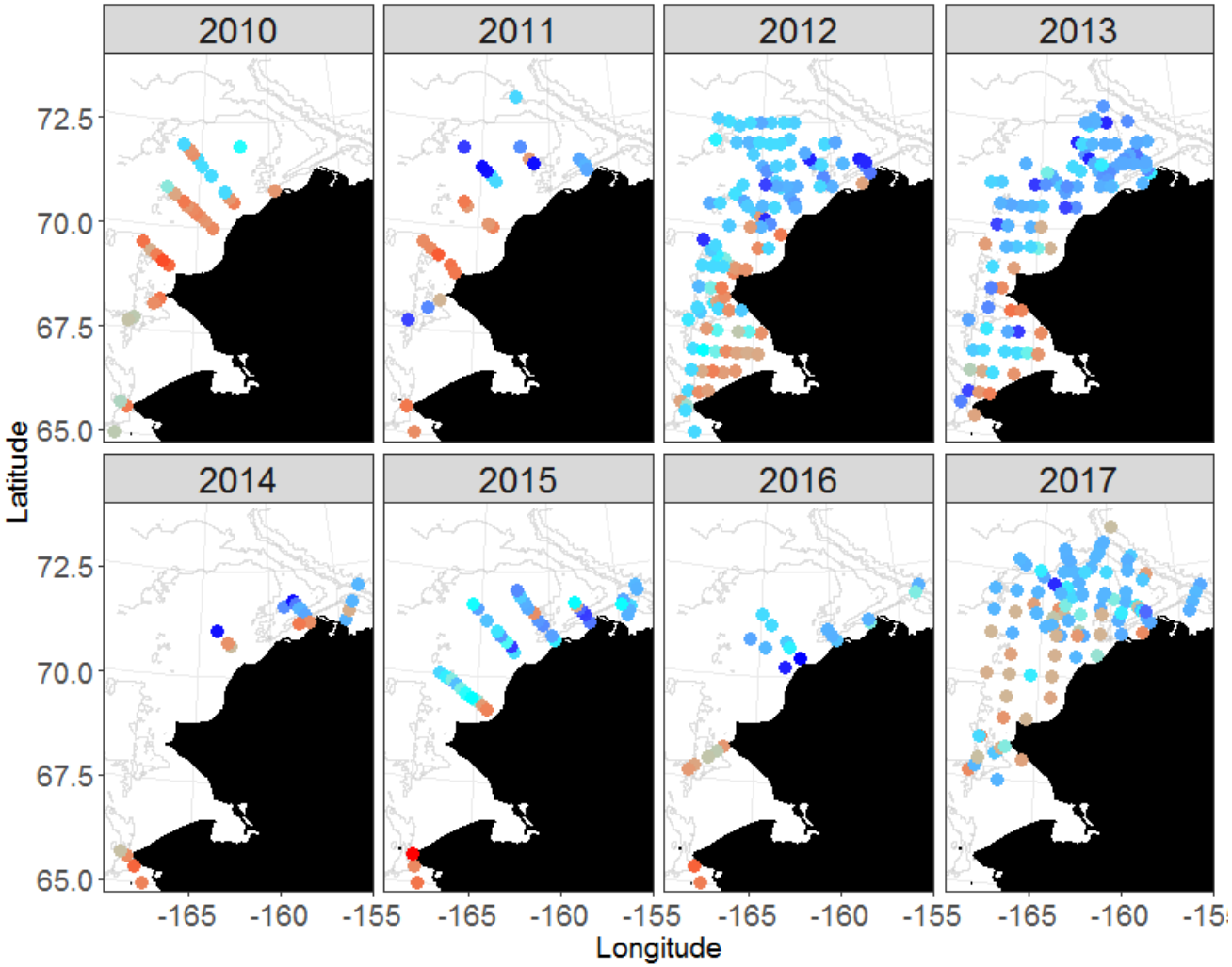
>30 km/year; fastest ever observed for a commercial stock!

NORTHERN BERING SEA – community changes

LARVAL FISH COMMUNITIES

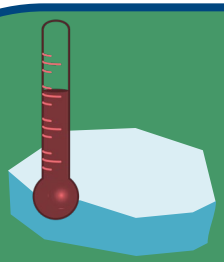
Red = warm water fishes (ex: walleye pollock, YFS, Bering flounder)

Blue = cold water fishes (ex: Arctic cod, Greenland halibut, longhead dab)



Goldstein and Duffy-Anderson

NORTHERN BERING SEA – Regime change vs. Anomalous events?



Does lack of sea ice in the Arctic and NBS change things?

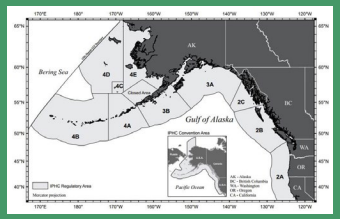
Cross-trophic shifts –phytoplankton bloom timing, zooplankton

Communities are changing, spawning by low latitude species
Colonization?

Spatial shifts in fish distributions – NBS and further? Will they ever come back?

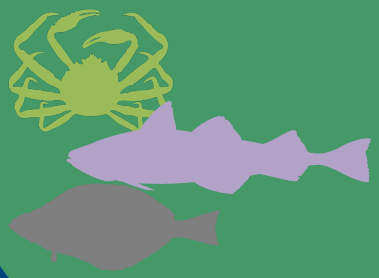
SOUTHEAST & NORTHERN BERING SEA – management impacts?

Adoption of ecosystem indicators into stock assessment - Physical, single species/stock, aggregate, cross-trophic



Periodic evaluation of management areas

Ecosystem surveys



High Arctic sampling (NBS, Chukchi, Beaufort)

ALL TOGETHER – TAKE AWAYS

Changing physical conditions in Alaska's LMEs Ocean heating, loss of sea ice, oceanographic variations

Ecosystem changes

Anomalous events vs. Regime shifts
Single year vs. multi year stanzas
Cross-trophic changes
Still haven't located the tipping point – where's the Point of No Return?

Effects on Fisheries and Management

Managers have mitigation tools
Process studies and monitoring
Incorporate ecosystem thinking - assessments, population models, management areas

THANK YOU

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Lab teams

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