



NOAA
FISHERIES



"Would you please elaborate on 'then something bad happened'?"

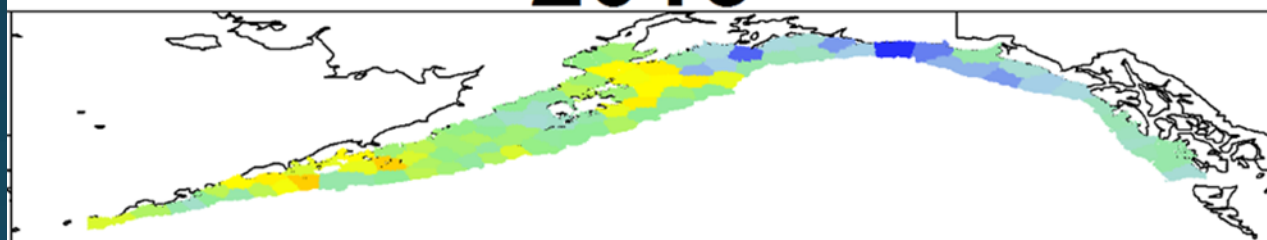
Gulf of Alaska Pacific cod

NPFMC Ecosystem Research Workshop

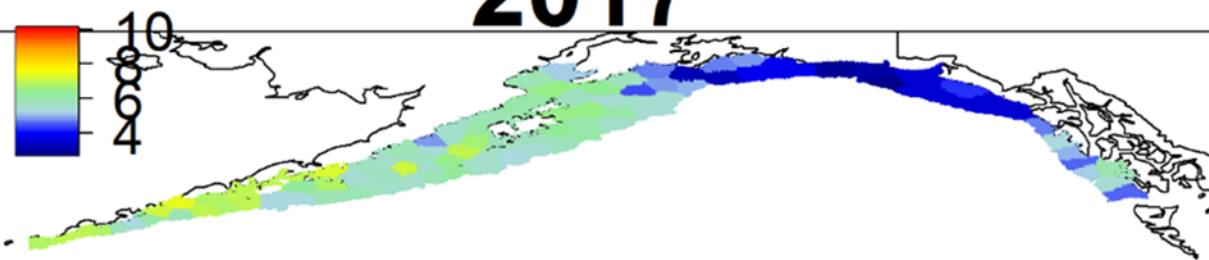
Seattle, Washington

February 7, 2018

2015



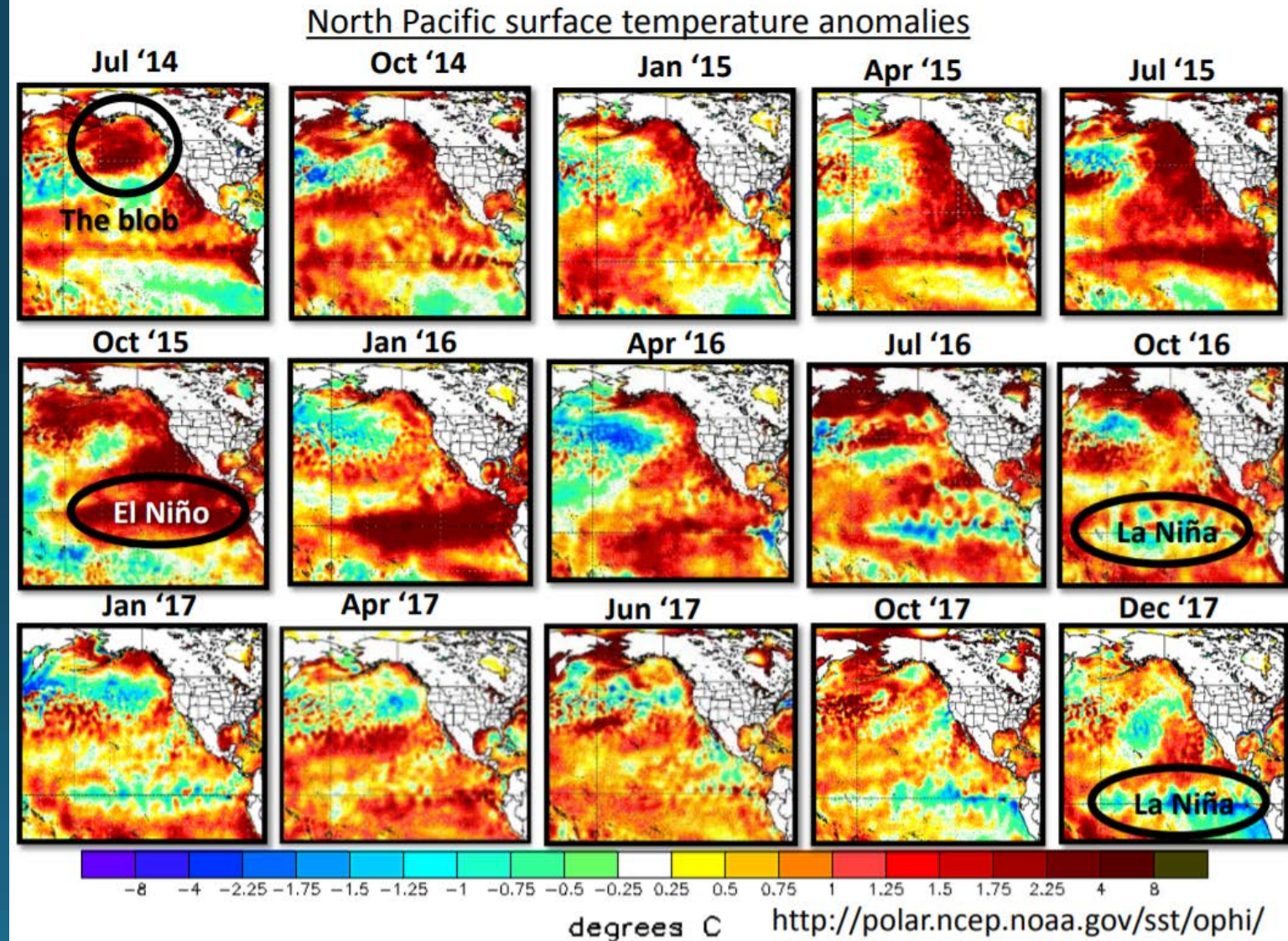
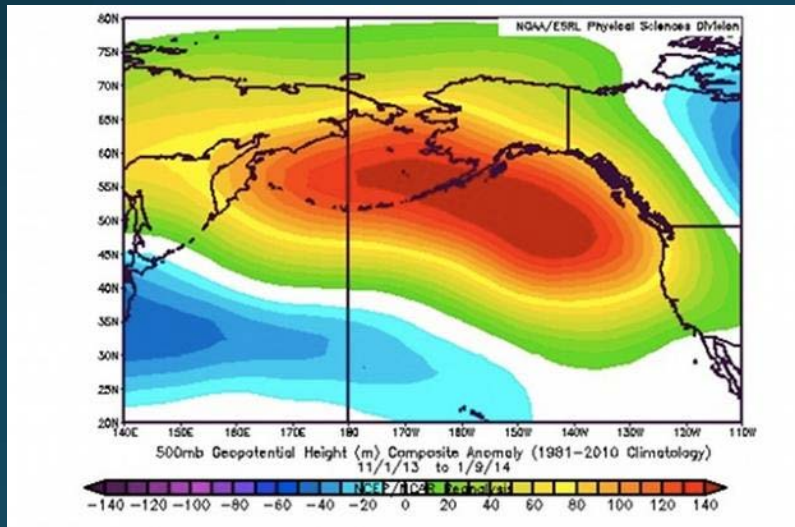
2017



The Blob!

- Anomalously warm waters 2014-2016
- Unusually stable pressure ridge blocking storms and retaining surface temperatures

Not sure which came first, the Redicoulously Resilient Ridge or the blob?



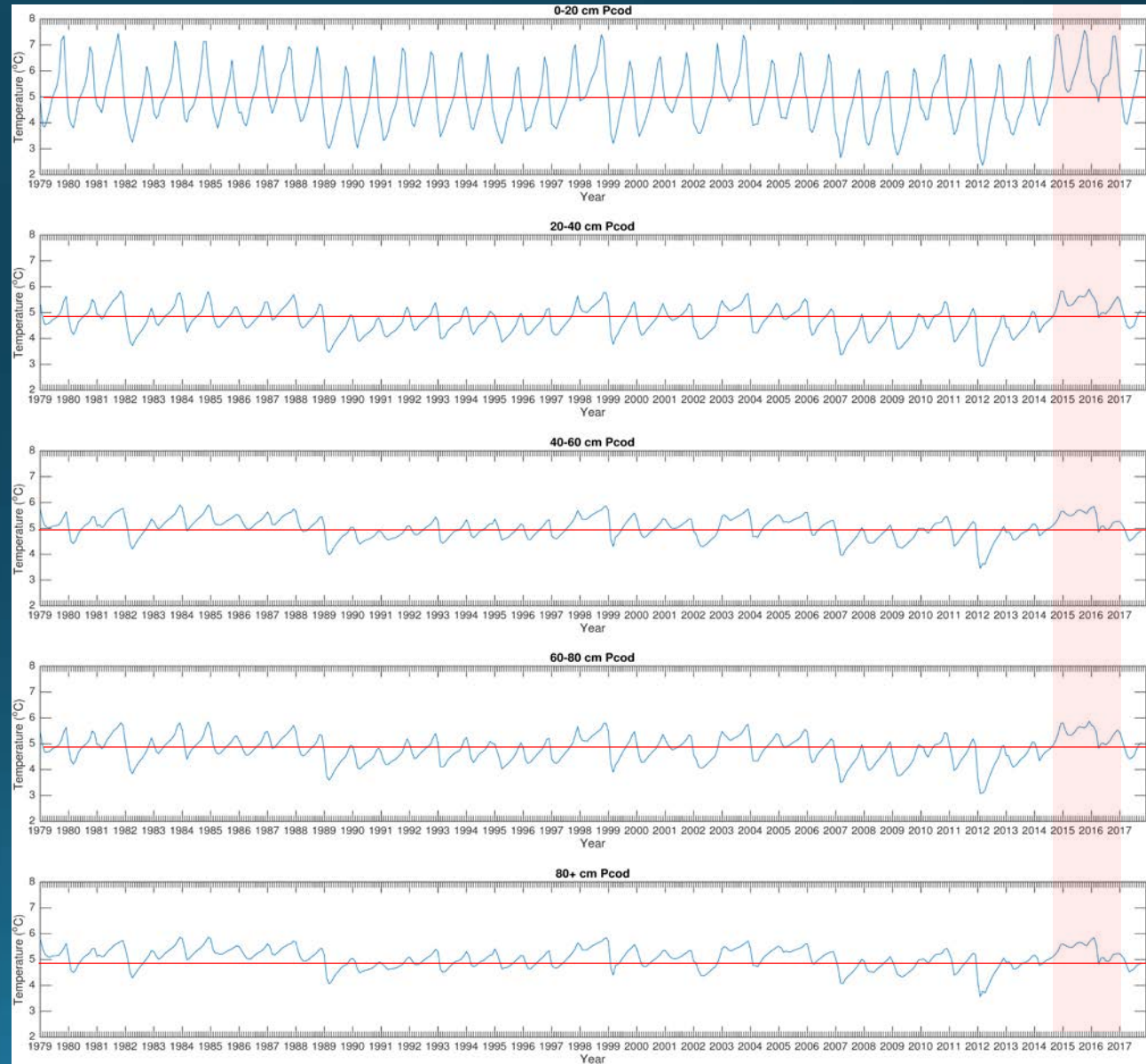
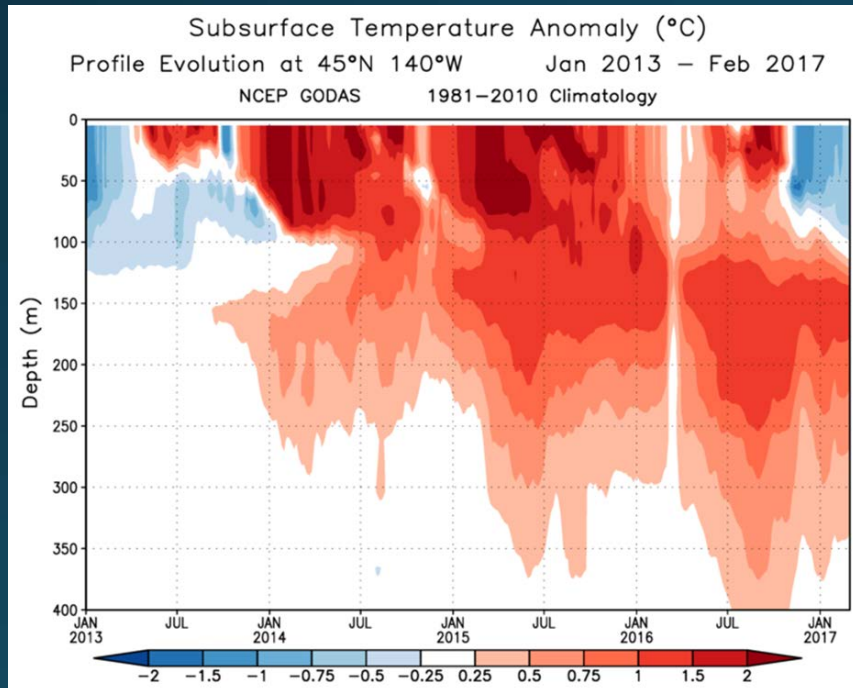
UNDESTRUCTIBLE...
INDESTRUCTIBLE!
NOTHING CAN STOP IT!

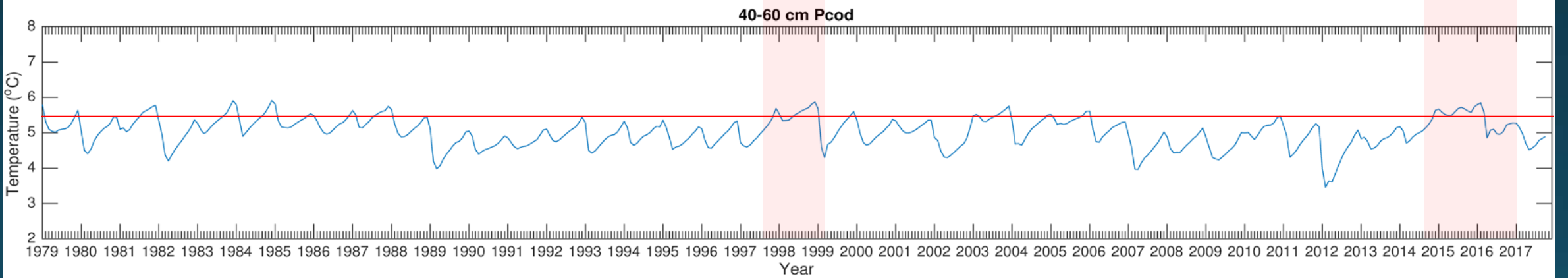
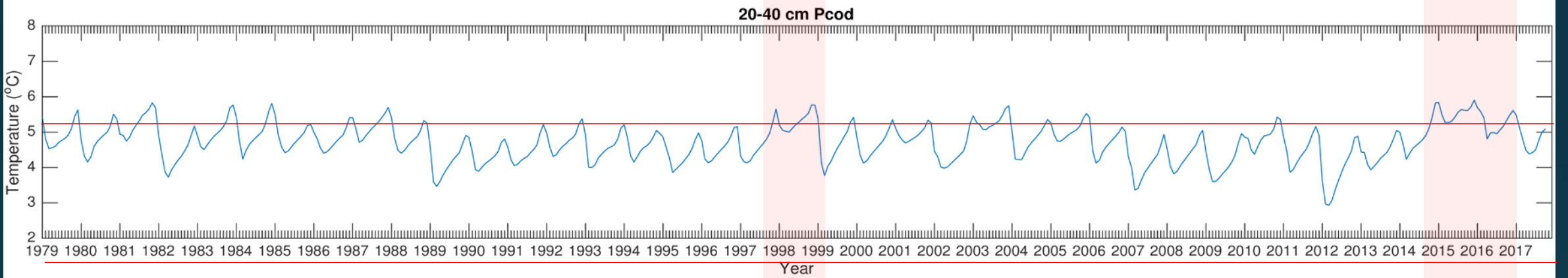
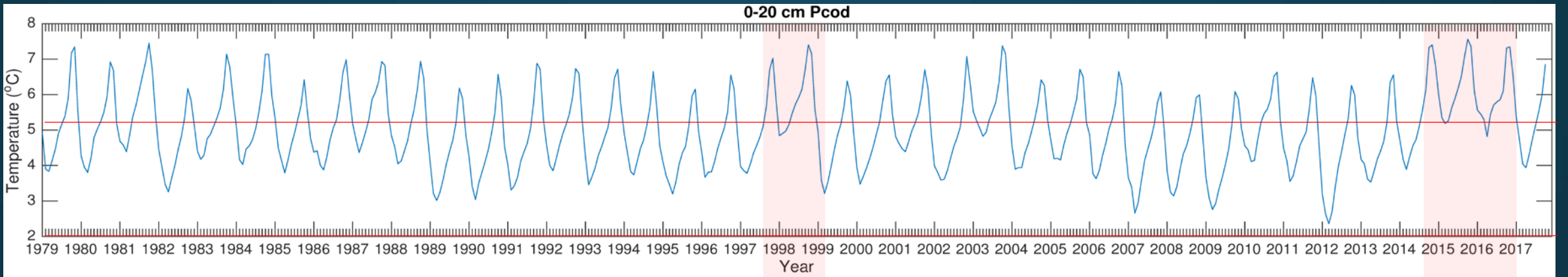
THE BLOB

STEVEN SEAGAL
THE QUEEN
OF
CRAZY NIGHTS

CAST: SEAGAL, SEYMOUR, CAMPBELL, DUNN, SINGH, AND PHILLIPS

- Anomalously warm waters 2014-2016
- Deep and continued throughout the year
- “Endless summer”





Anomalously warm waters 2014-2016



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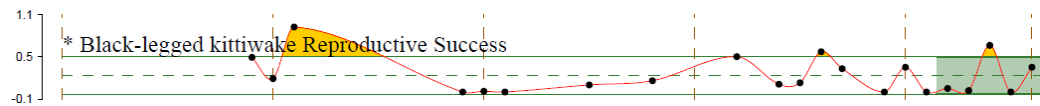
Science

Scientists think Gulf of Alaska seabird die-off is biggest ever recorded

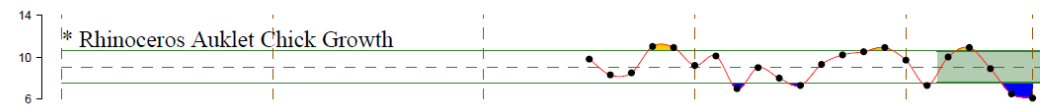
Author: **Yereth Rosen** | Updated: September 30, 2016 | Published January 29, 2016



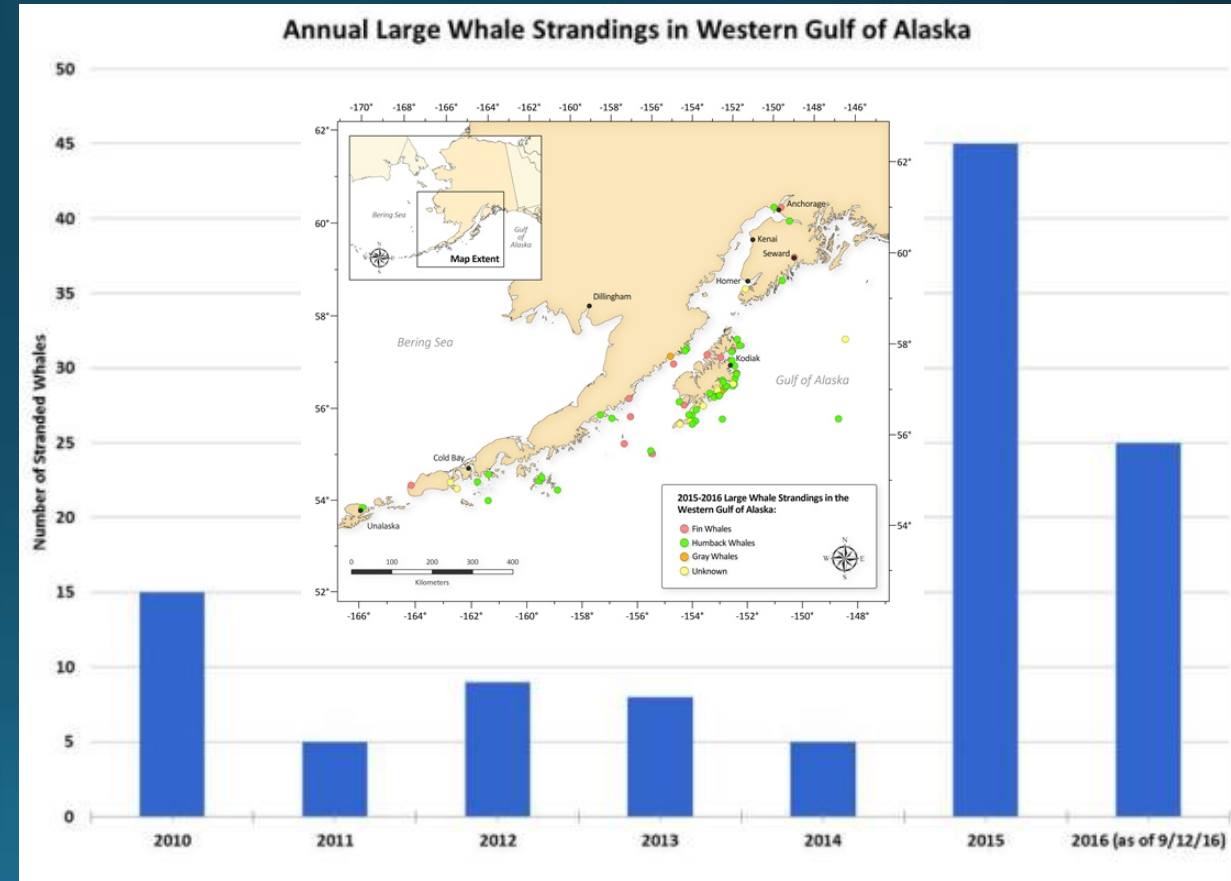
West



East

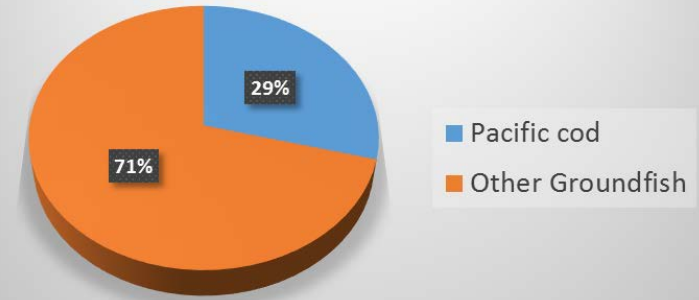


Analysis by Stephani Zador



GOA Groundfish Economics

Gulf of Alaska groundfish first-wholesale revenue



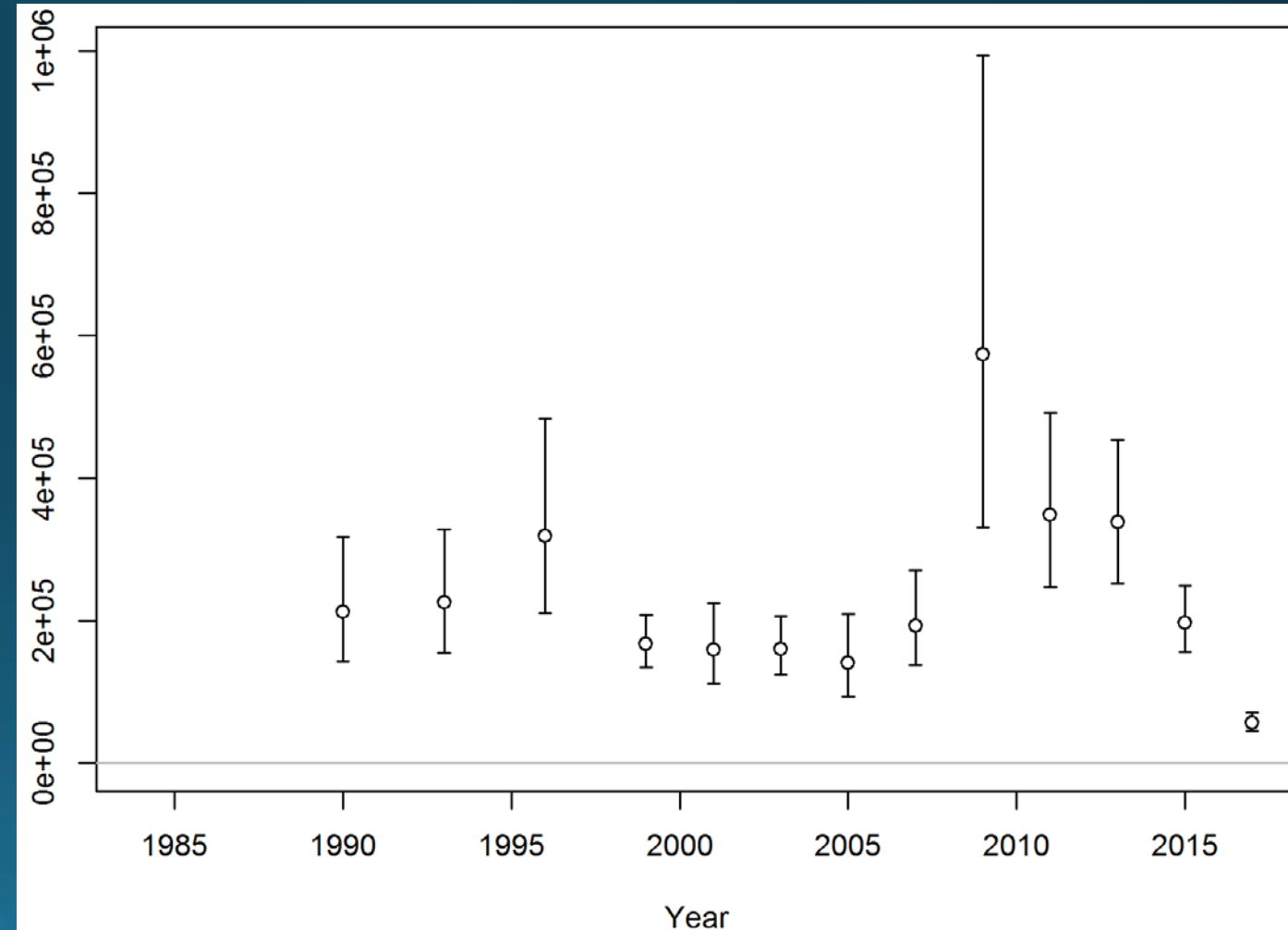
- The 2016 Gulf of Alaska groundfish fisheries generated \$354 million in first-wholesale revenue which represents 15% of the Alaska groundfish value and 30% of the value of all commercial fisheries in the GOA
- The GOA groundfish fisheries support jobs on over 650 vessels with approximately 23,000 crew weeks.
- The average annual first-wholesale revenue of P. cod over the past 10 years (2007-2016) is \$103 million.

GOA Pacific cod

2017 Bottom trawl survey



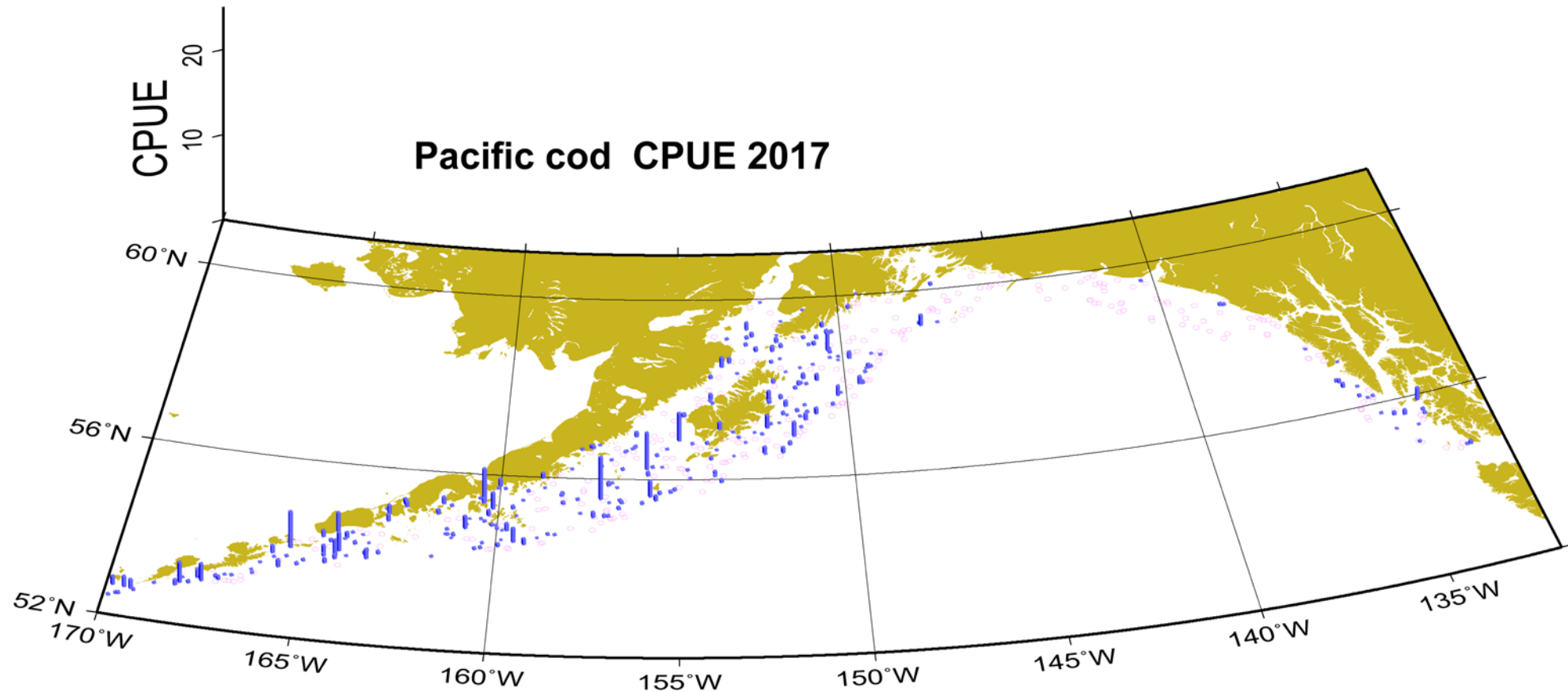
- Lowest estimate ever
 1.96×10^8 fish and 107,324 t
- Precise estimate (0.117 CV)
- 71% decline in abundance
since 2015 (83% since 2013)
- 58% decline in biomass
since 2015 (78% since 2013)

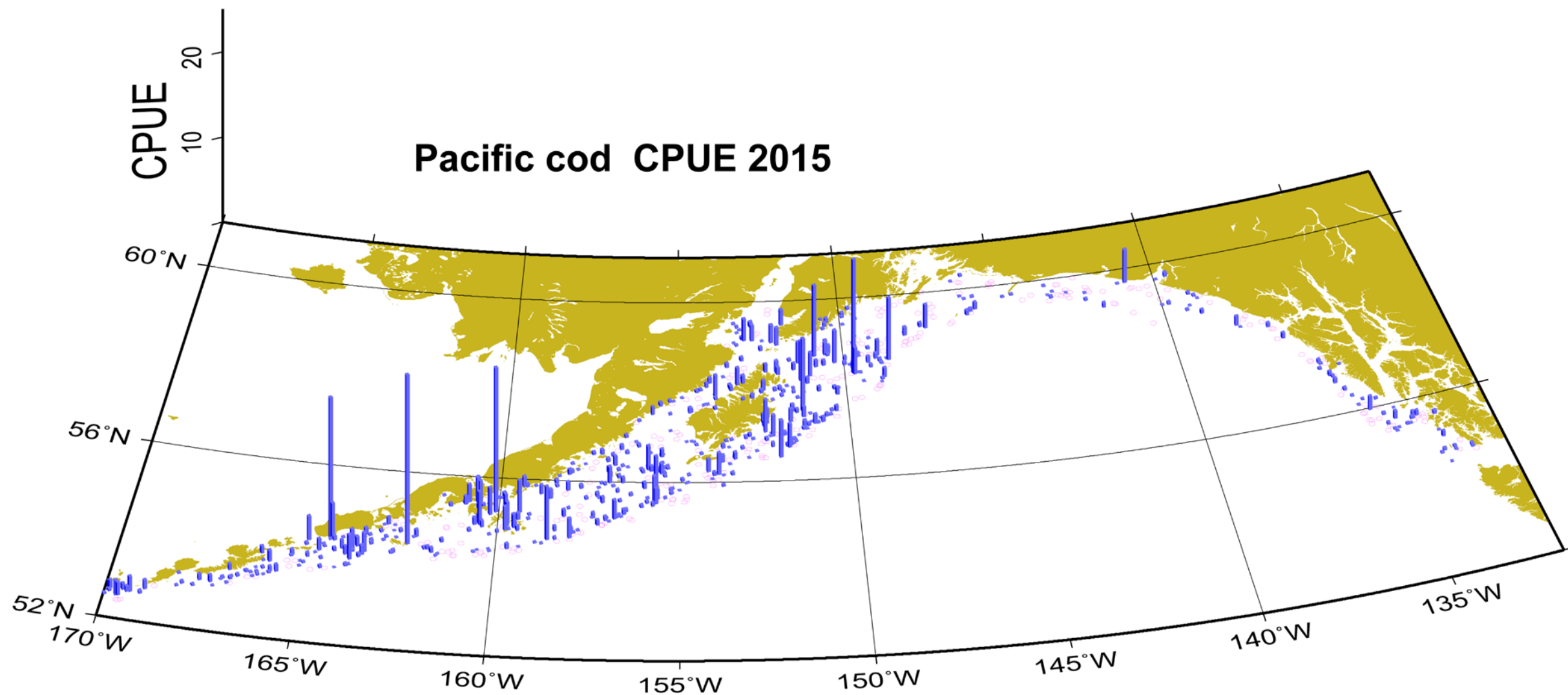


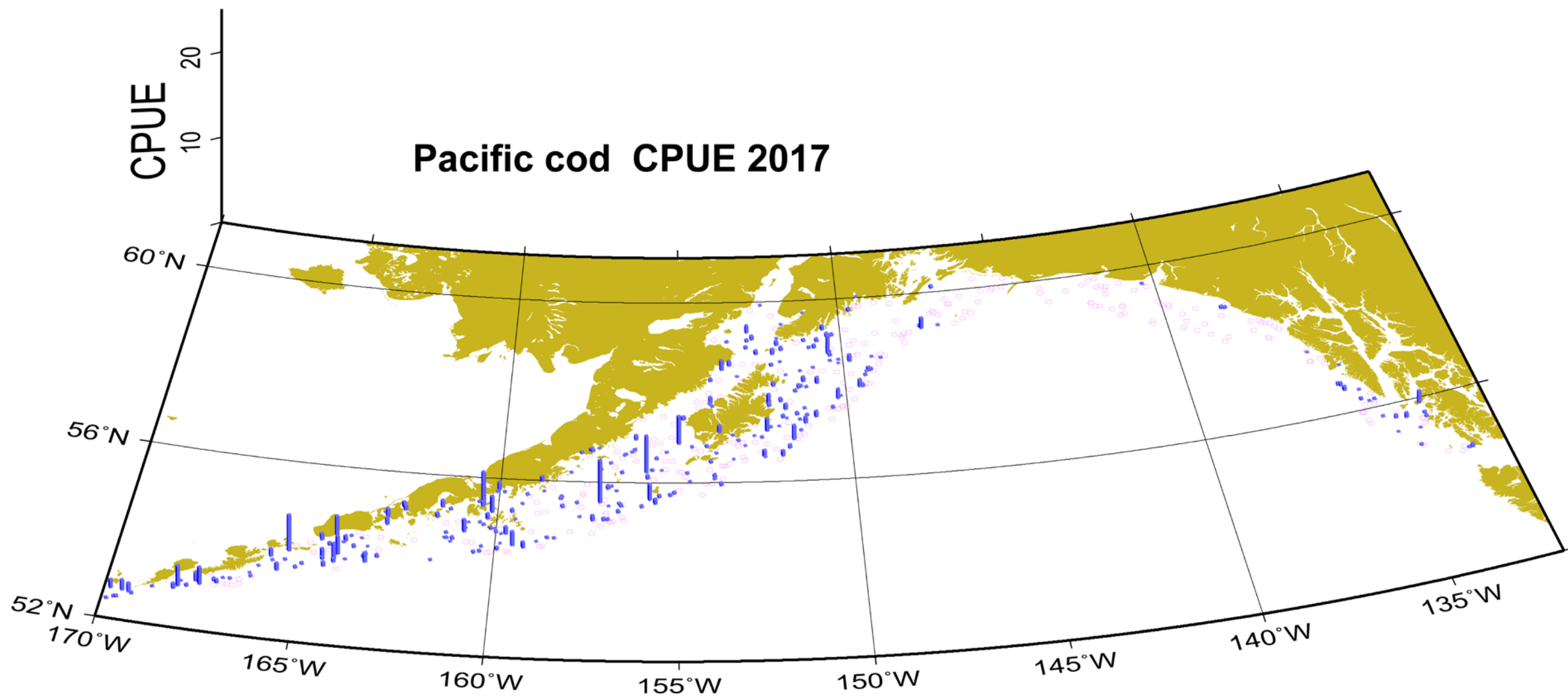
GOA Pacific cod Bottom trawl survey



- Low density through surveyed area
- Some medium-low density along Alaska Peninsula and south of Unimak Island





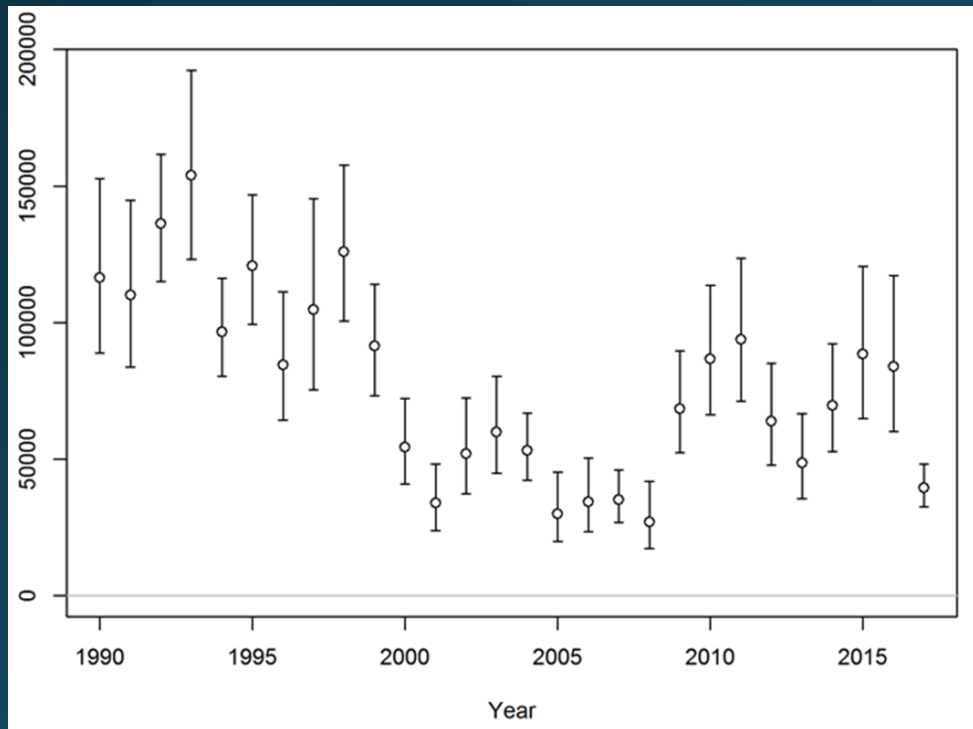


GOA Pacific cod

Other surveys

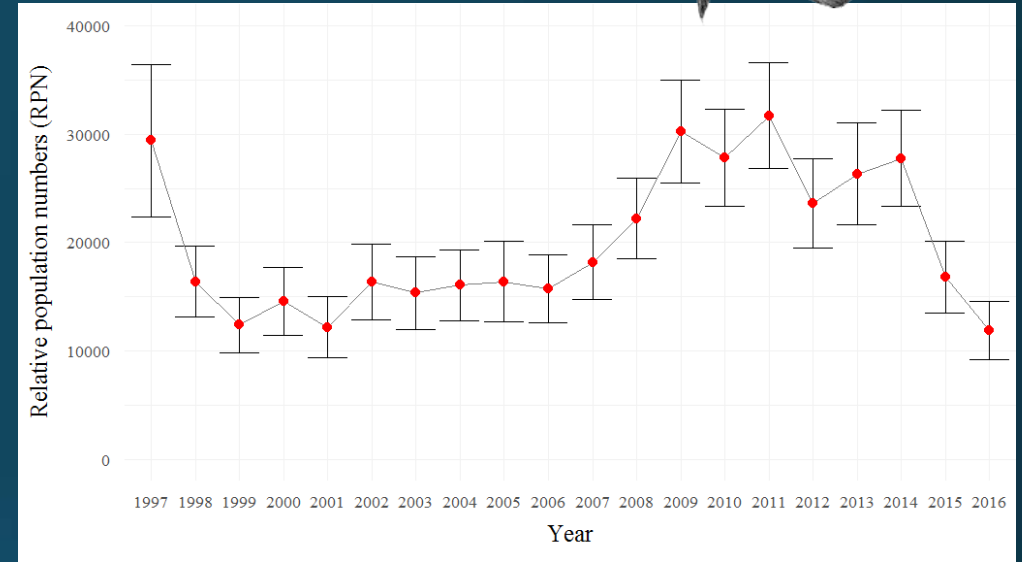
AFSC longline survey 1990-2017

- 53% decline since 2016



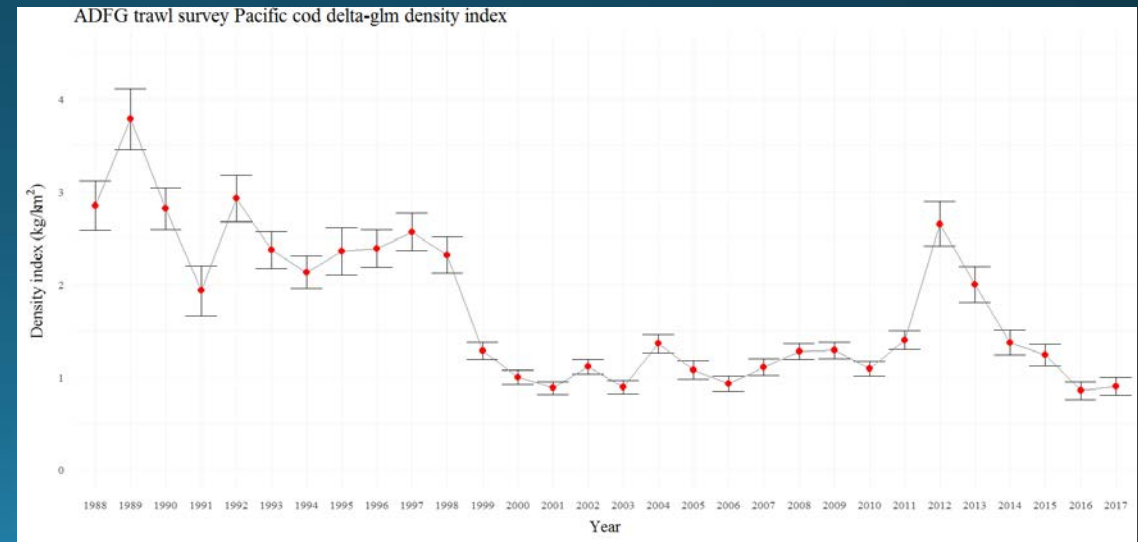
IPHC longline survey 1997-2016

- 2016 Lowest



ADFG trawl survey 1988-2017

- 2016 lowest



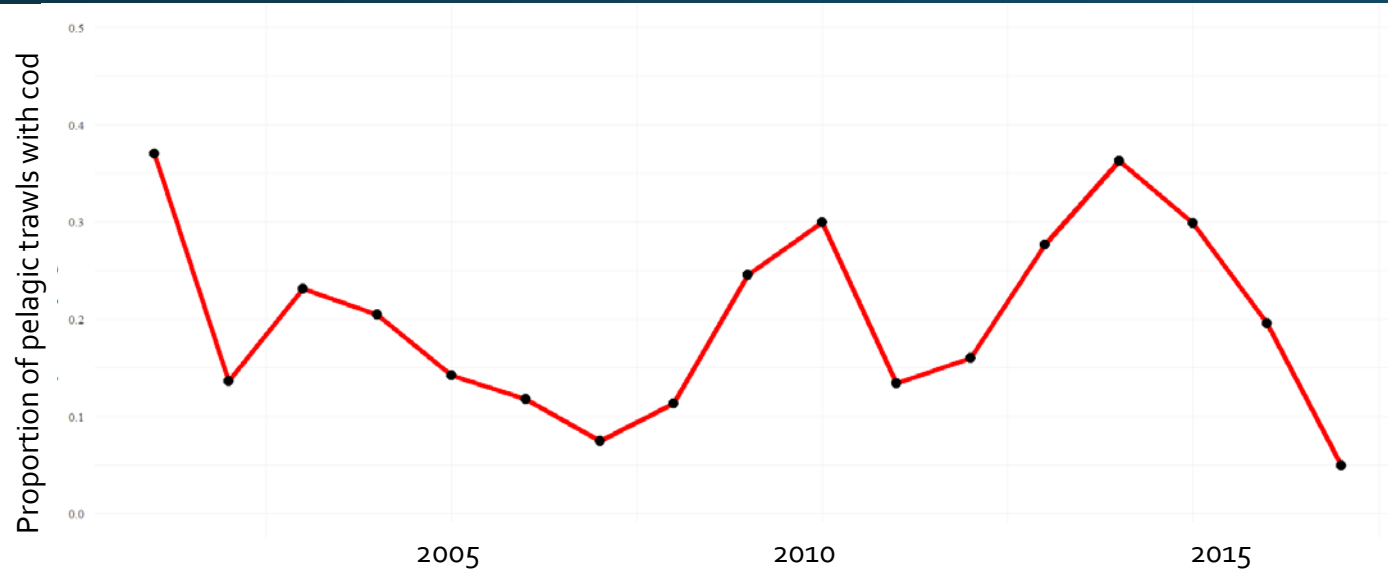
GOA Pacific cod

Bycatch in other fisheries

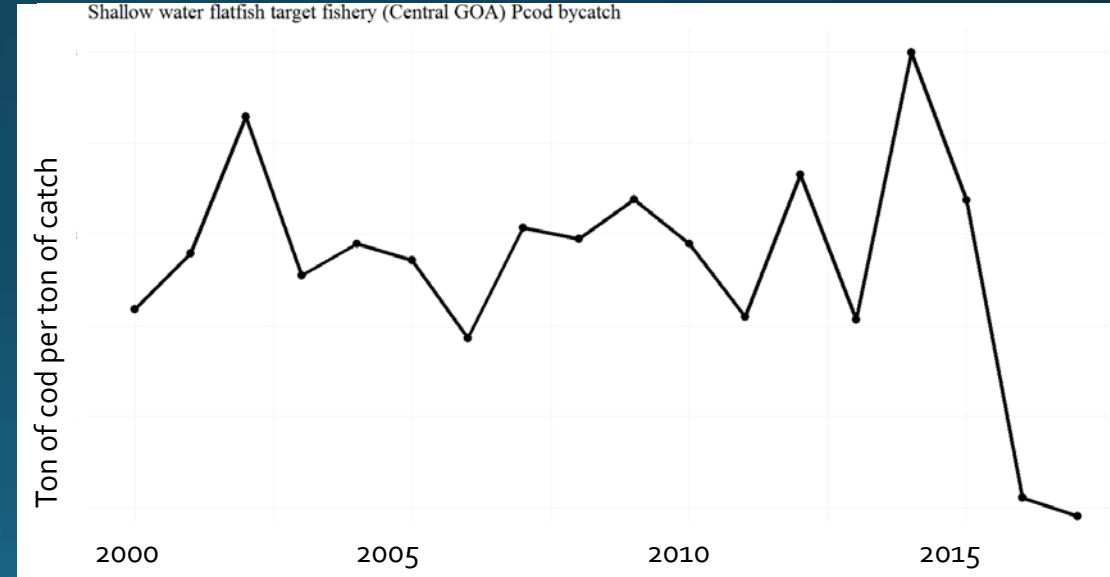


- Low catch rates of Pacific cod in non-target fishery

Pelagic walleye pollock fishery



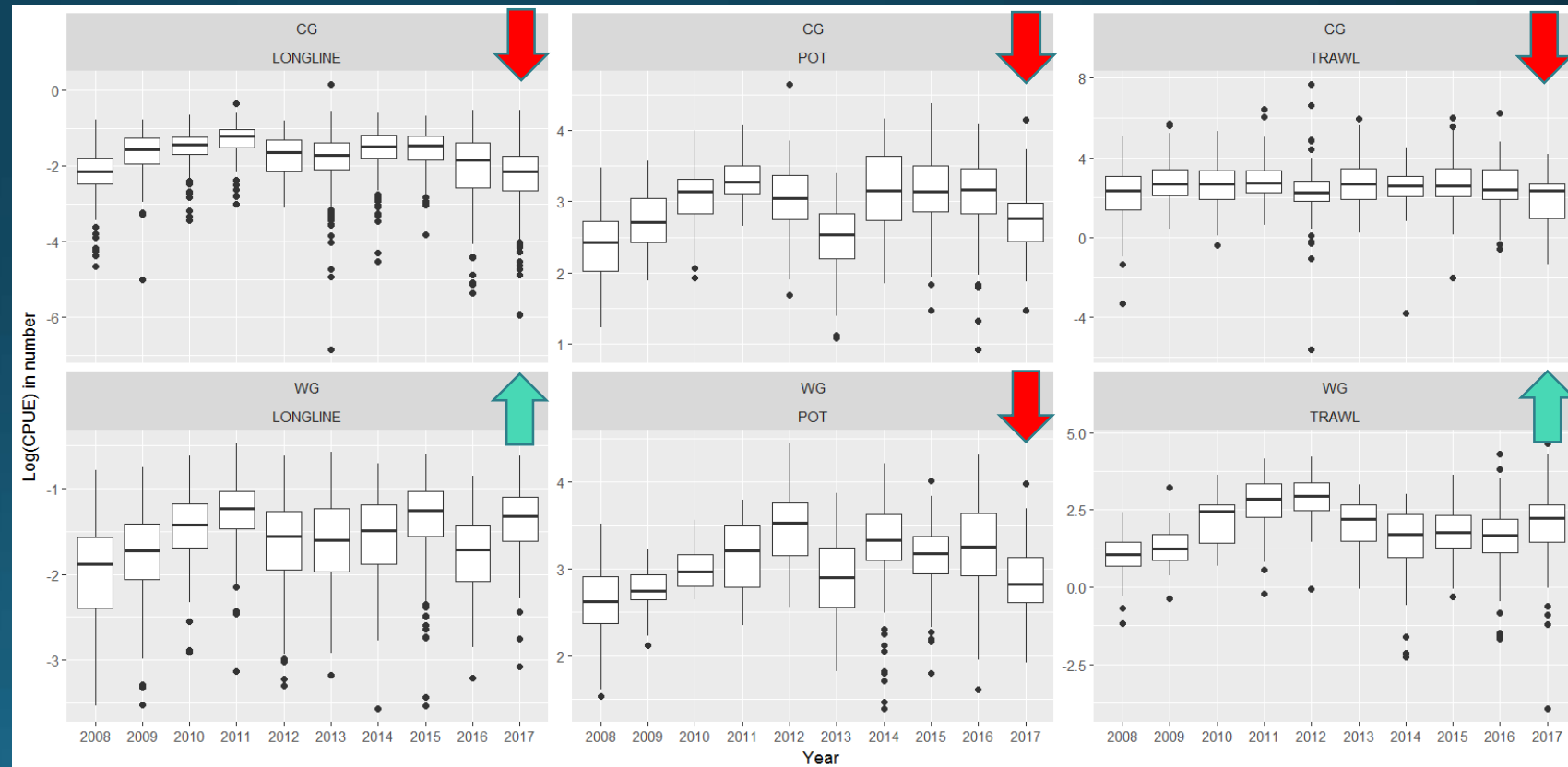
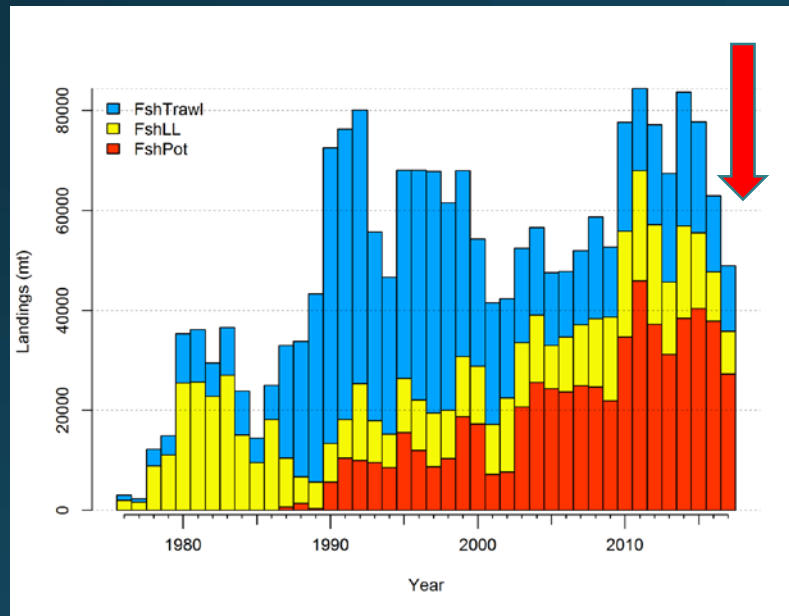
Shallow water flatfish fishery



GOA Pacific cod Fishery data



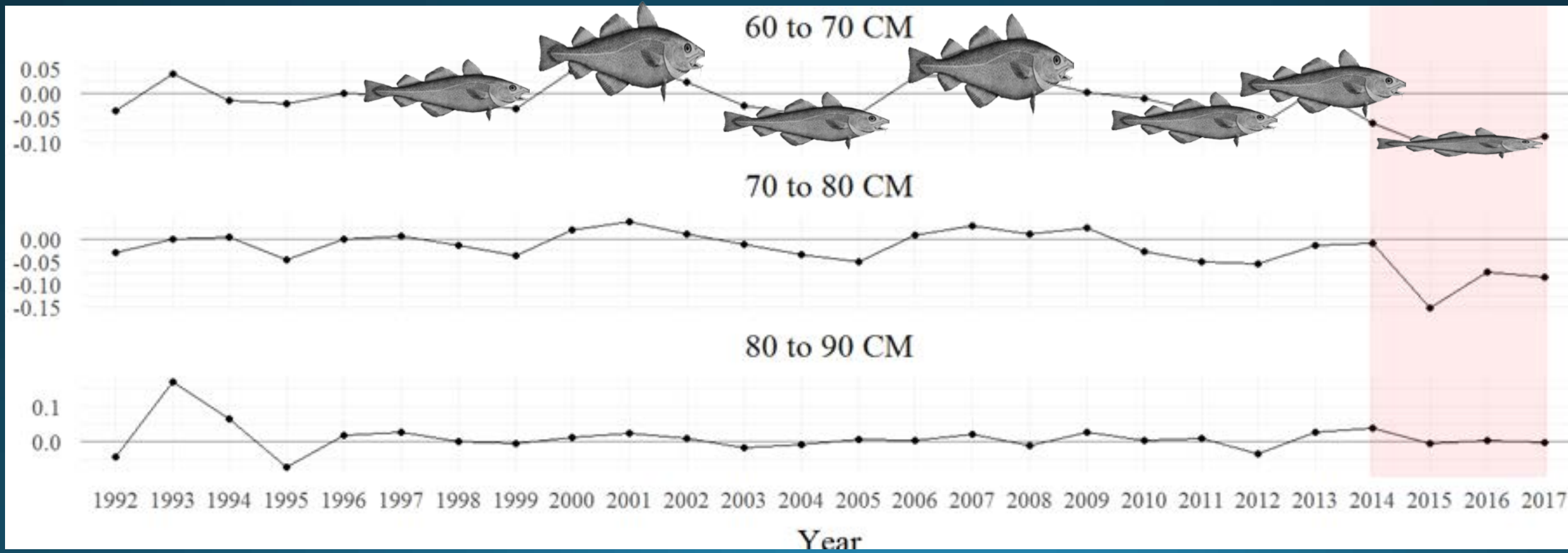
- Catch at < 60% of ABC
- Low CPUE in Central GOA all fisheries
- Low CPUE in pot fishery in Western GOA, high CPUE for other sectors



GOA Pacific cod Fishery data



- Poor condition for 2014-2017 in longline and pot fisheries for fish < 80cm



GOA Pacific cod

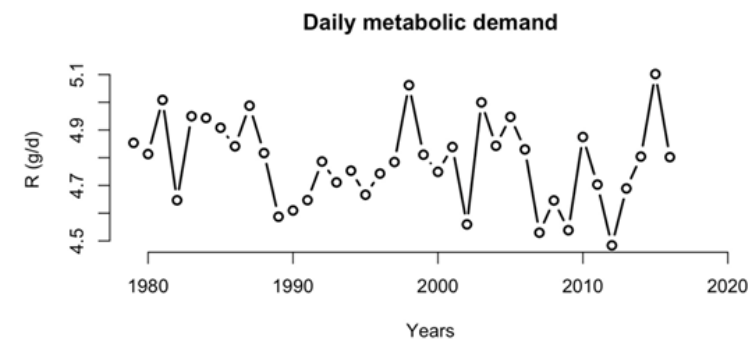
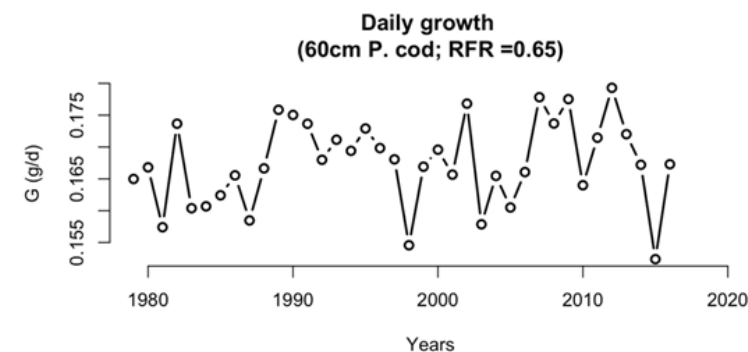
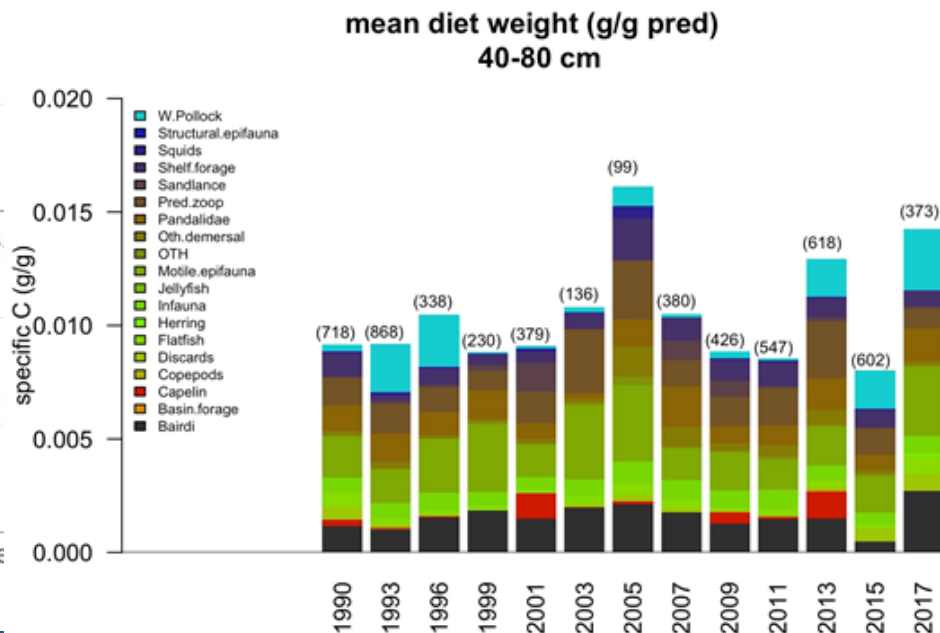
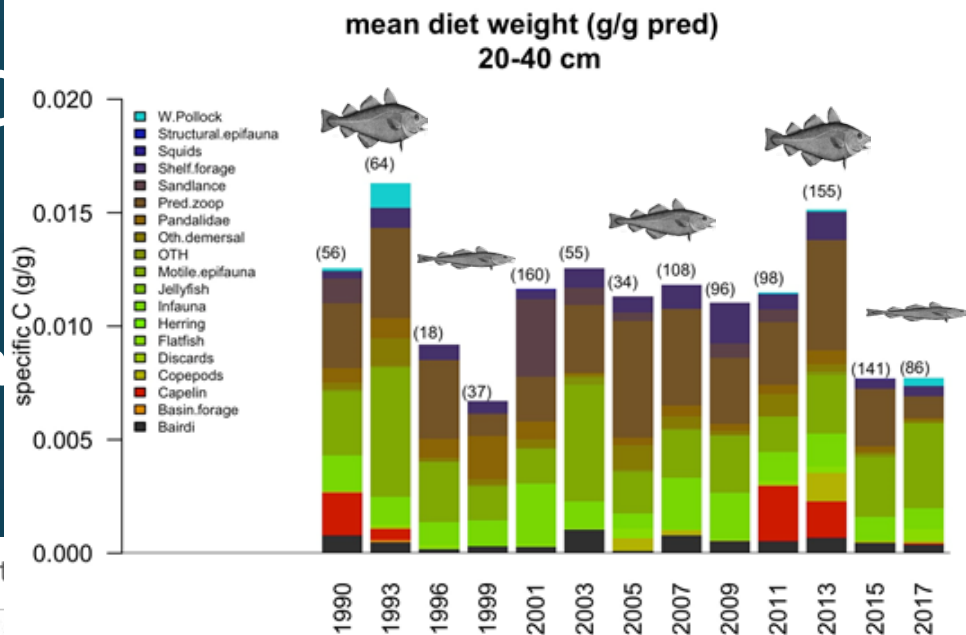
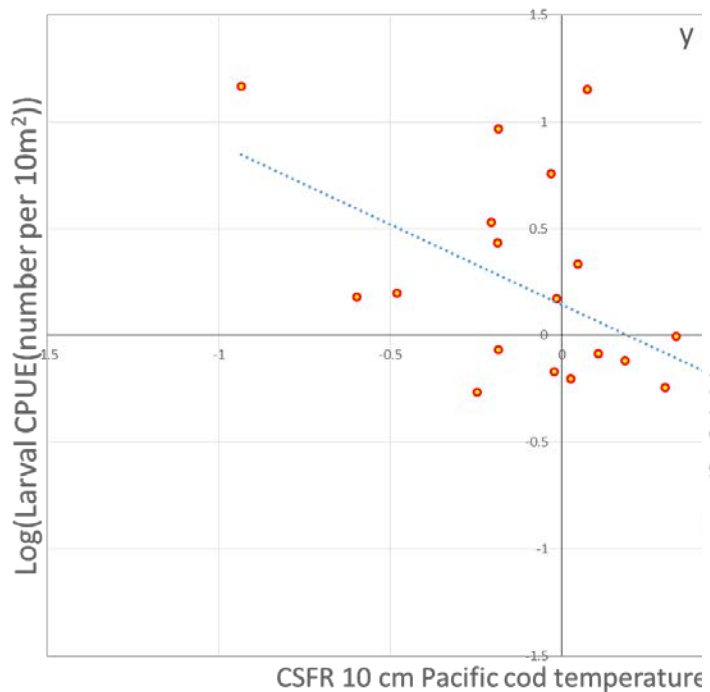
The Blob

- Likely substantial in



and natural mortality

Larval density and temperature



energetics analysis by Kirsten Holsman

GOA Pacific cod

Bio-energetics summary

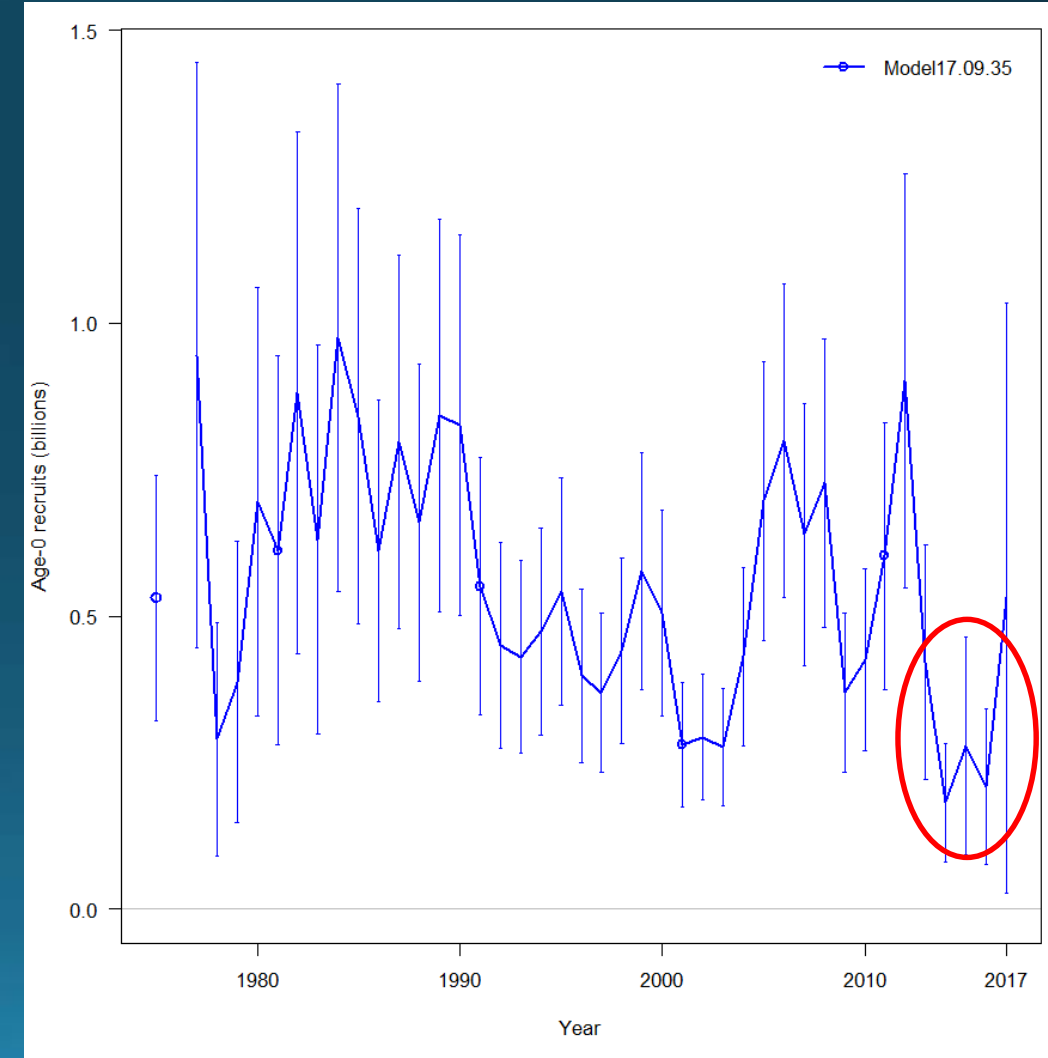


- Warmer temperatures were throughout the year and water column
- Higher metabolism in warmer temps lead to higher forage requirements
- Indications of lower forage amounts in 2015-2016
- Combination likely lead to higher Pacific cod natural mortality for these years.

GOA Pacific cod Assessment Model Recruitment



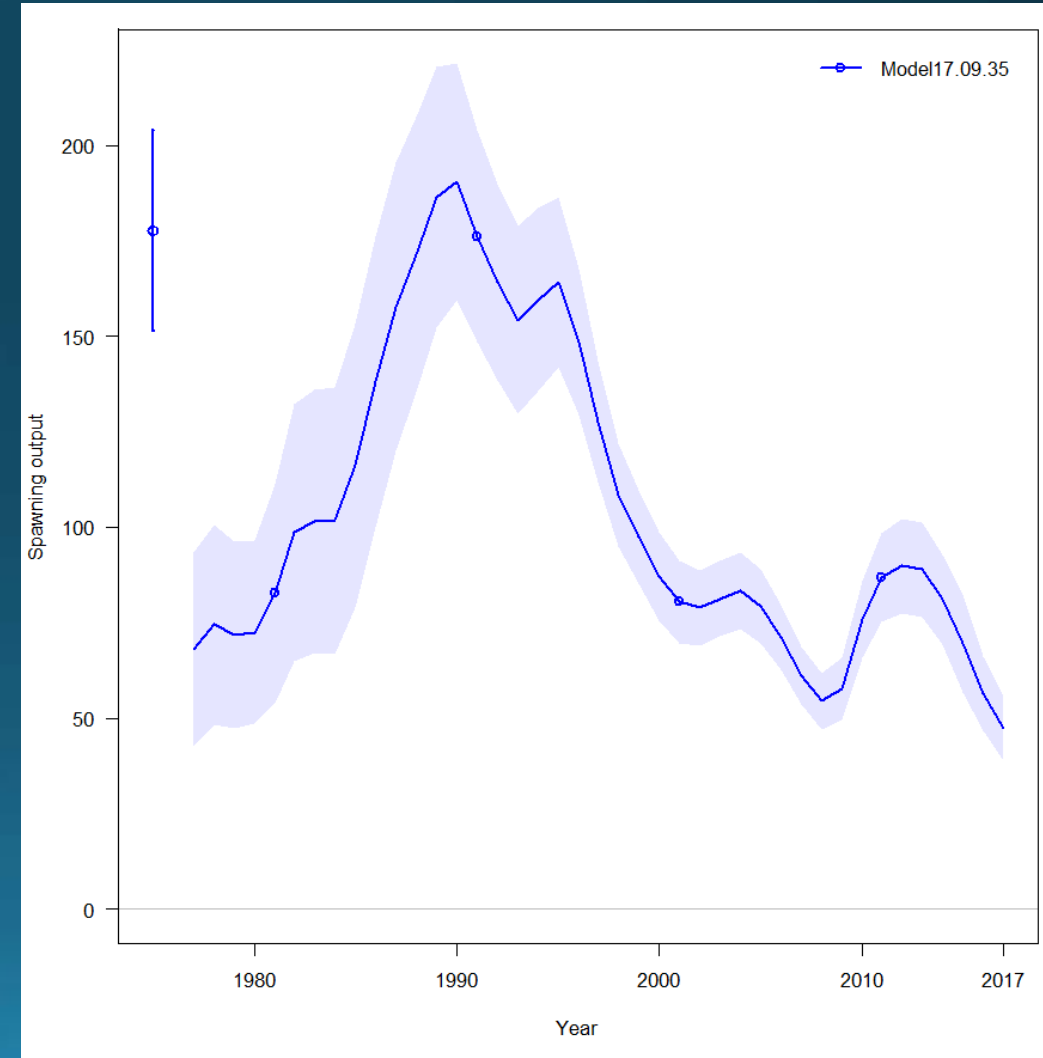
- :Low recruitment in the 2014-2016
 - 2014 lowest recruitment estimate in time series at 0.14×10^9
 - 2016 and 2015 second and third lowest recruitment estimates



GOA Pacific cod Assessment Model Spawning Biomass



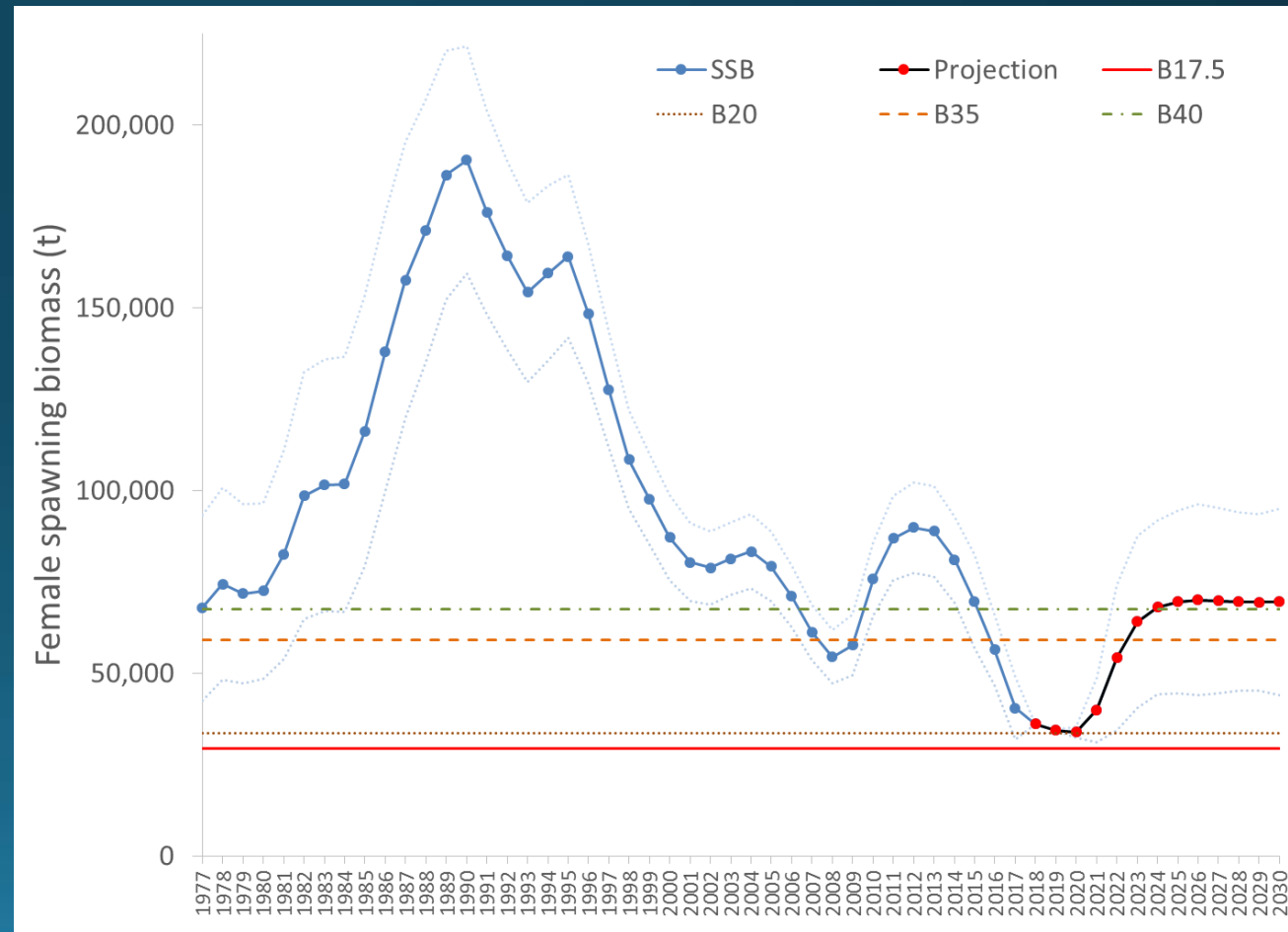
- Lowest female spawning biomass in 2017 (47,326 t)
- Peak female spawning biomass in 1990 (190,465 t)
- 2008 previous low at 54,470 t
- Build up in 2009-2012 based on large 2006-2008 year classes



GOA Pacific cod Assessment Model Projections



- Projected to reach all-time low in 2020
- Due to high mortality of the 2011 and 2012 age classes and expected poor recruitment 2013-2016
- First increase expected in 2021 given mean recruitment post-2016



North Pacific Fishery EBFM Practices

MSA and Applicable Laws and Executive Orders

- MSA: All optimum yield amounts account for protection of marine ecosystems; all FMPs identify and include measures to protect and enhance essential fish habitat; national standards 1 (marine ecosystem), 8 (fishing communities), 9 (minimize bycatch)
- NEPA: Consider effects of Federal actions on the environment
- RFA: Consider effects of Federal actions on small business entities
- ESA: Ensure actions are not likely to jeopardize threatened or endangered species or adversely modify critical habitat
- MMPA: Responsibility to conserve marine mammals
- EO 12866: Assess costs and benefits of Federal regulations
- EO 13175: Consultation and Coordination with Indian Tribal Governments
- EO 13186: Take action to implement the Migratory Bird Treaty Act



Specific Management Actions Implemented

- Prohibition on directed fishing for forage fish
- Numerous closed areas and catch limits to conserve prey for endangered Steller sea lions
- Closed areas to conserve crab, herring and salmon
- Prohibited species catch limits on halibut, crab, herring and salmon
- Required seabird avoidance gear in hook-and-line fisheries
- Large area closures to fishing with bottom trawl gear to conserve habitat and reduce competition
- Required bottom trawl gear modifications to avoid damage to benthic habitat
- Seasonal TAC apportionments to temporally disperse catch
- Transit closures around walrus haul outs to prevent disturbance
- Industry agreements including measures to avoid salmon bycatch
- Implementation of catch share programs to control effort and reduce waste and bycatch
- Prohibition on directed fishing in the U.S. Arctic EEZ



Key Science and Monitoring

- Frequent, on-going resource assessment surveys
- Continual refinement of stock assessment methods
- Annual Stock Assessment and Fishery Evaluation Reports, including Ecosystem Considerations Chapters
- Continual salmon bycatch genetic information
- Ecosystem modeling and System Process Research
- Species vulnerability assessments
- Habitat suitability and vulnerability modeling and mapping
- Marine mammal stock assessments including anthropogenic mortality estimates

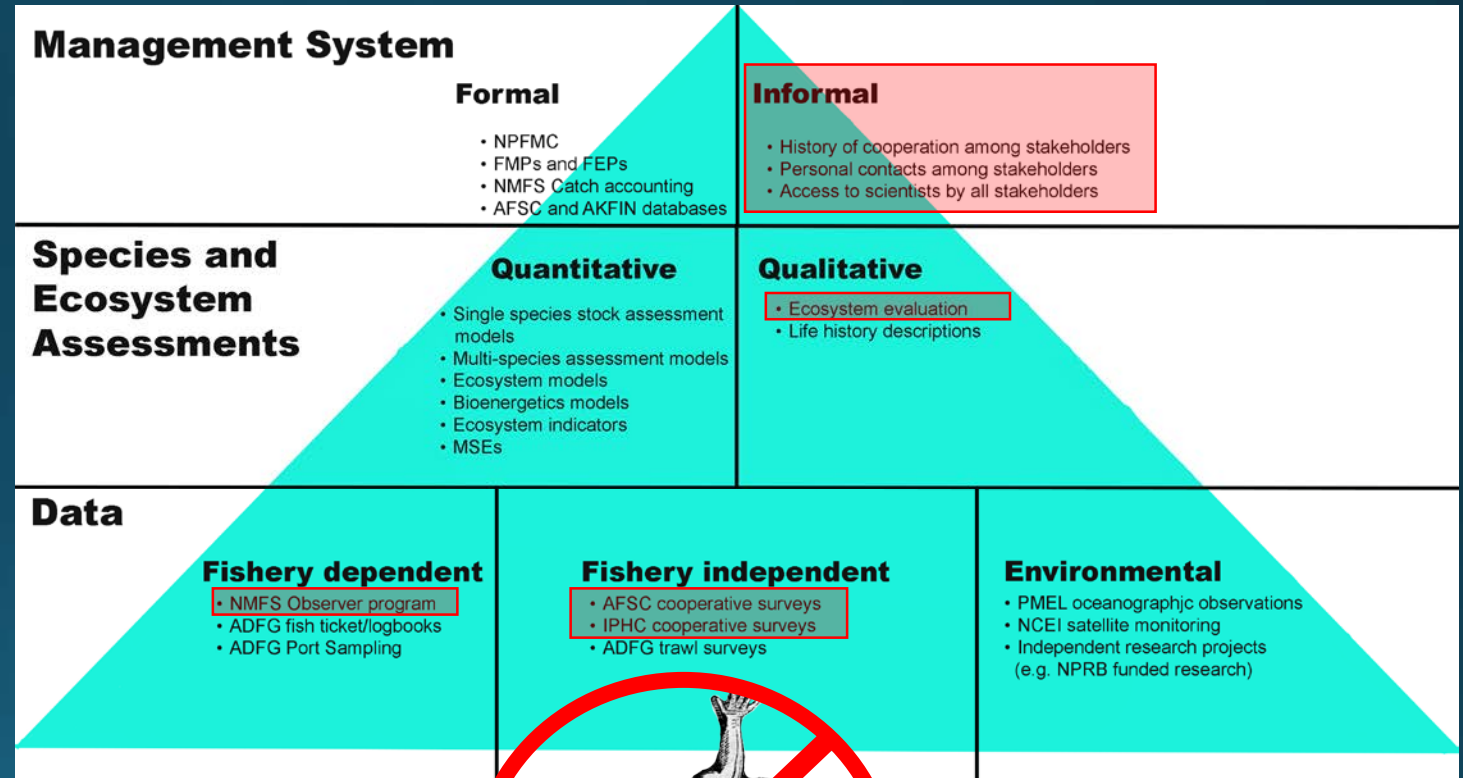
GOA Pacific cod

Ecosystem Approach in North Pacific Fisheries



- Based on 40 years of cooperative research and adaptive management

What's different in the North Pacific?



Assessment authors?

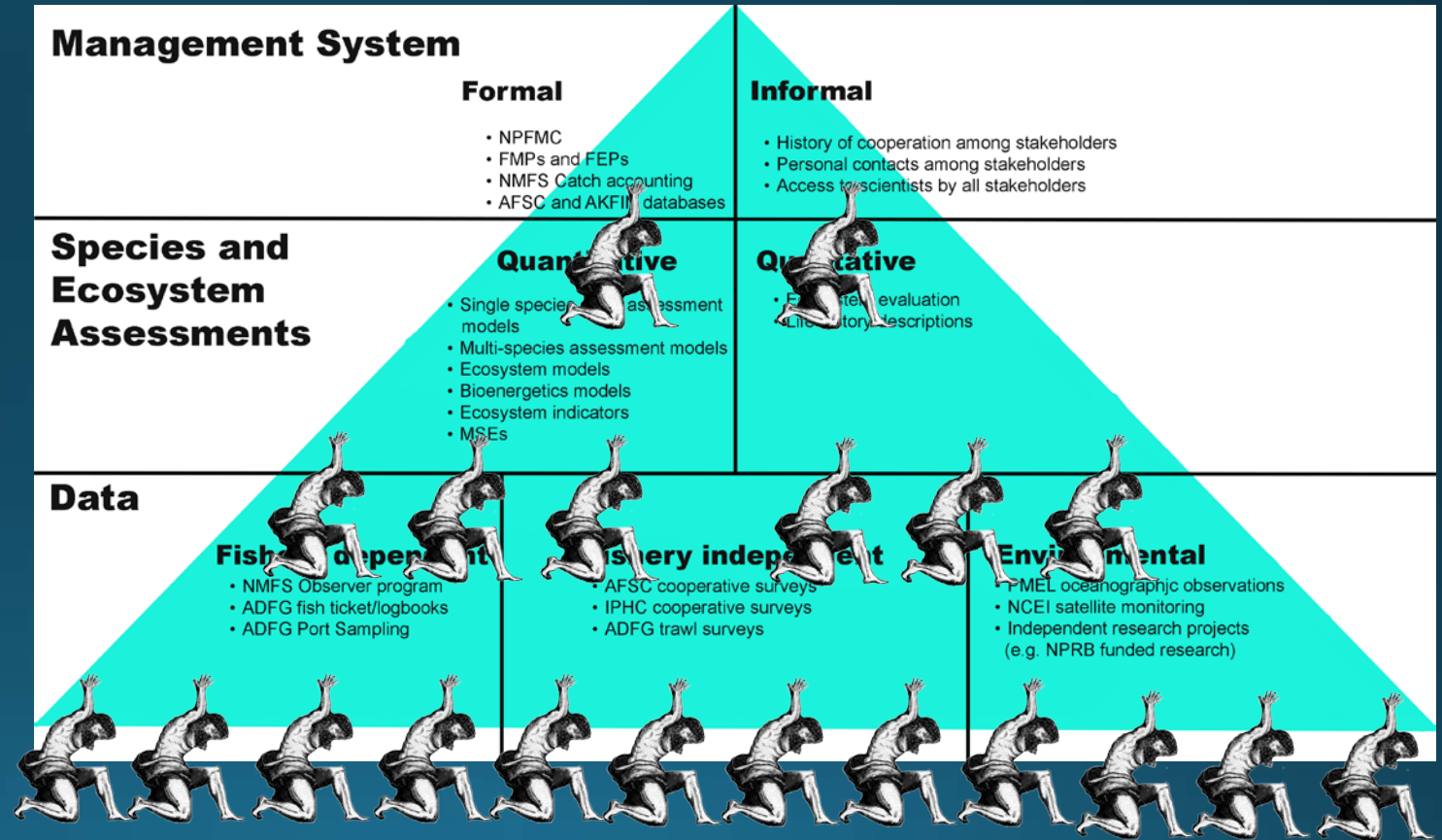
GOA Pacific cod

Bringing it all together for GOA Pacific cod in 2017

What's different in the North Pacific?



- Perception of a shared responsibility among stakeholders
- Diverse expertise
- Communication
- Trust



GOA Pacific cod



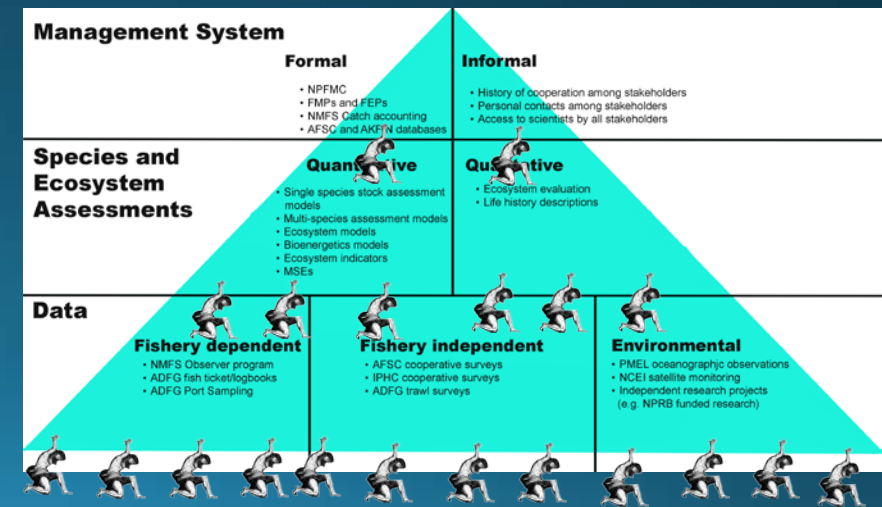
Bringing it all together for GOA Pacific cod in 2017

- **Collaboration** among researchers of **diverse expertise** with access to extensive **data** sets
- Development of a **coherent story** based on state-of-the-art assessment model, oceanography, bioenergetics, and ecological evidence.
- Frequent informal **communication** among all stakeholders to evaluate consistency of findings with their **experience**
- Early and wide **communication** of preliminary results through NPFMC public meetings and the media allowing for managers and fishing industry participants time for planning and adaptation

GOA Pacific cod Management result in 2017



- Recognition of severe decline in Gulf of Pacific cod abundance by all stakeholder groups
- Buy-in and support of scientific findings by fishing industry
- Reduction of 2018 Allowable biological catch by 80%



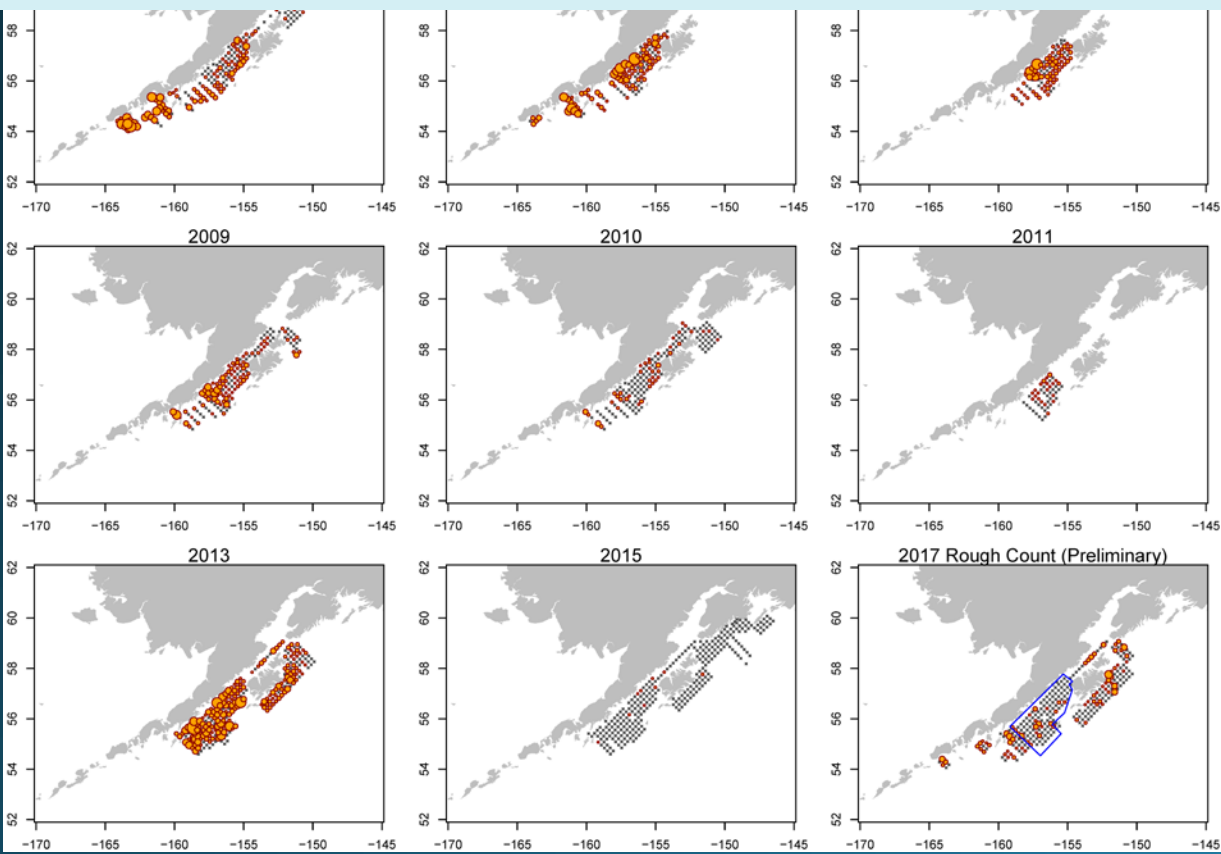
GOA Pacific cod

Future outlook



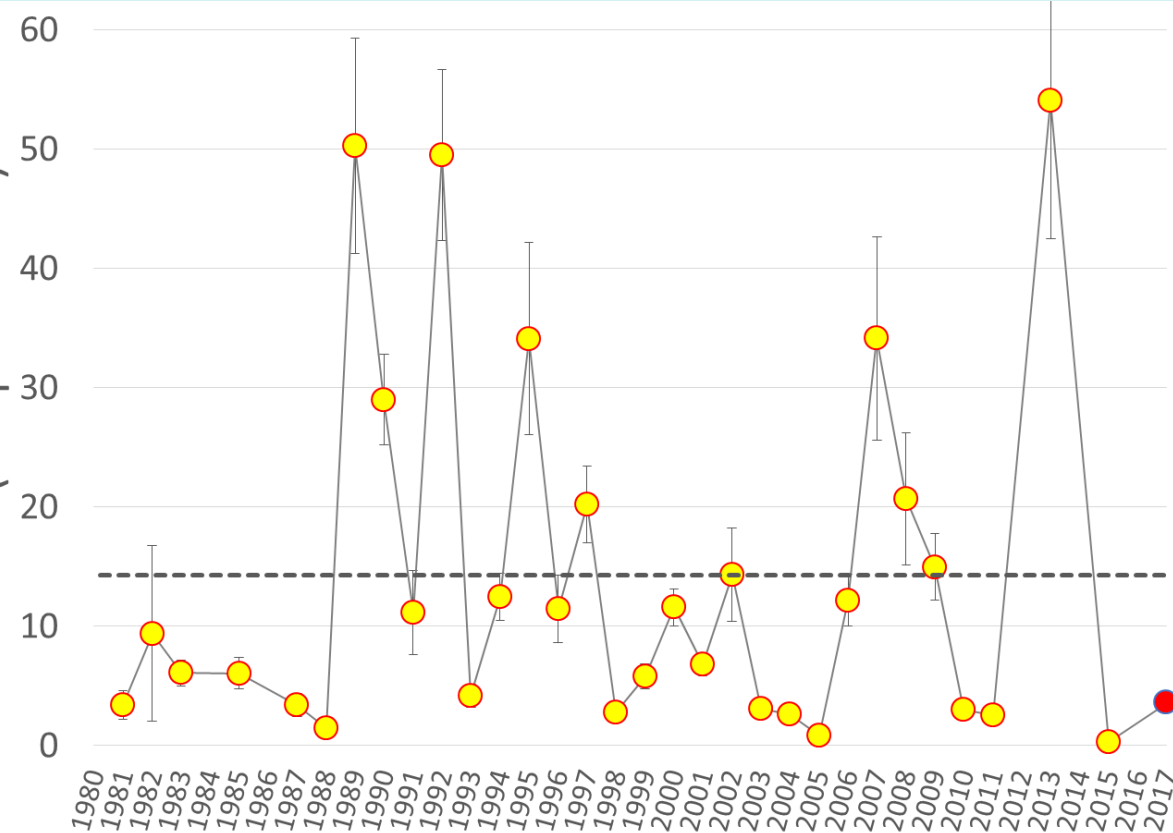
- Preliminary 2017 larval survey densities below average

Larval abundance is not correlated with recruitment



Pacific cod larvae mean CPUE

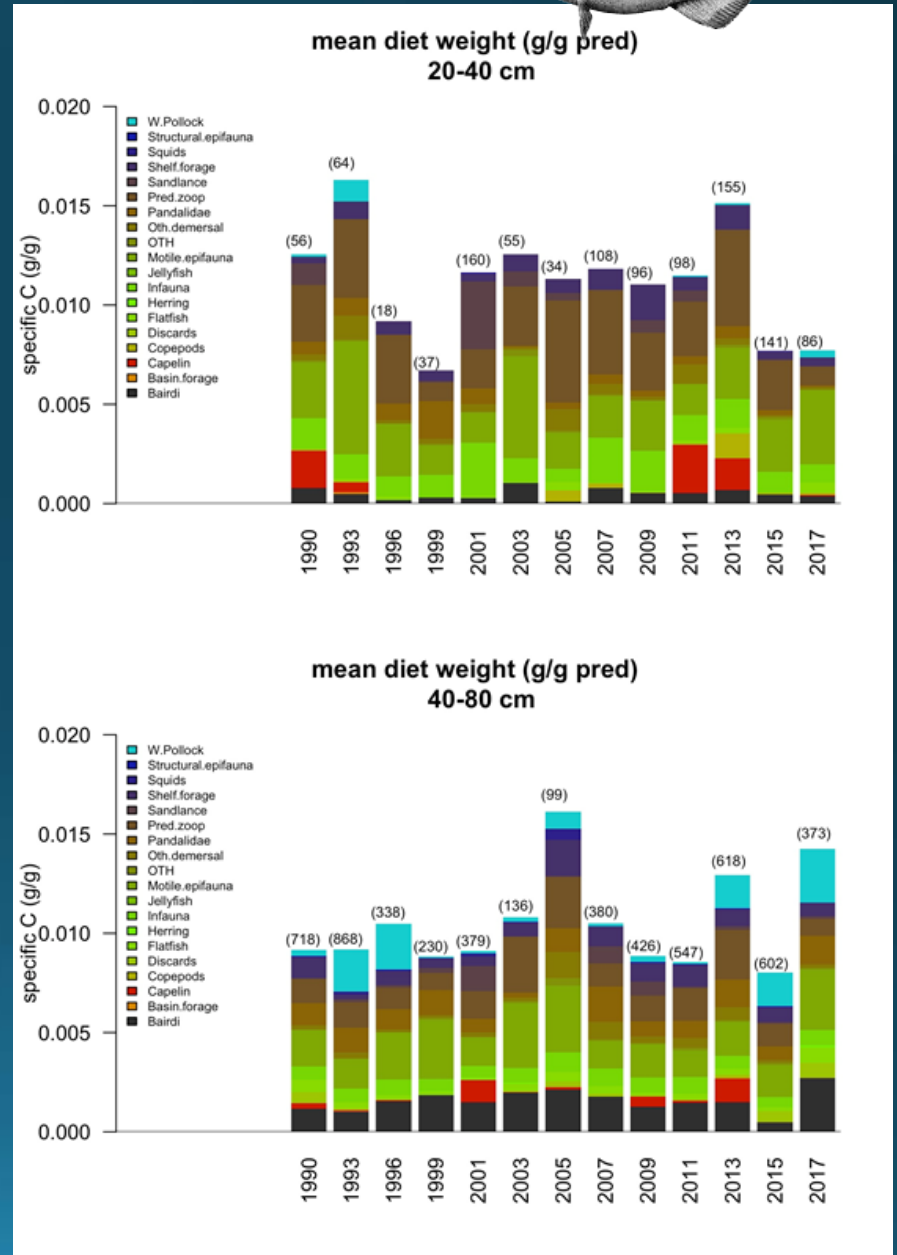
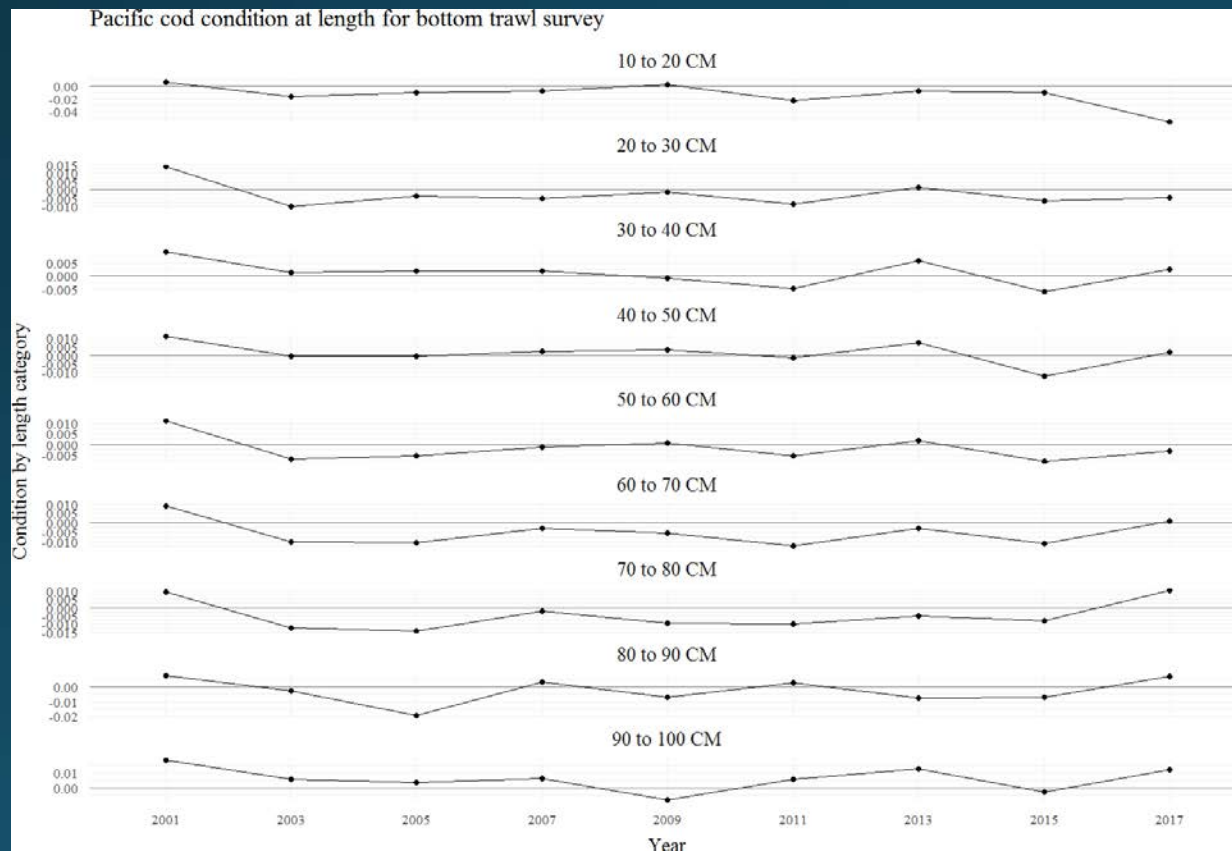
(no. per 10 m²)



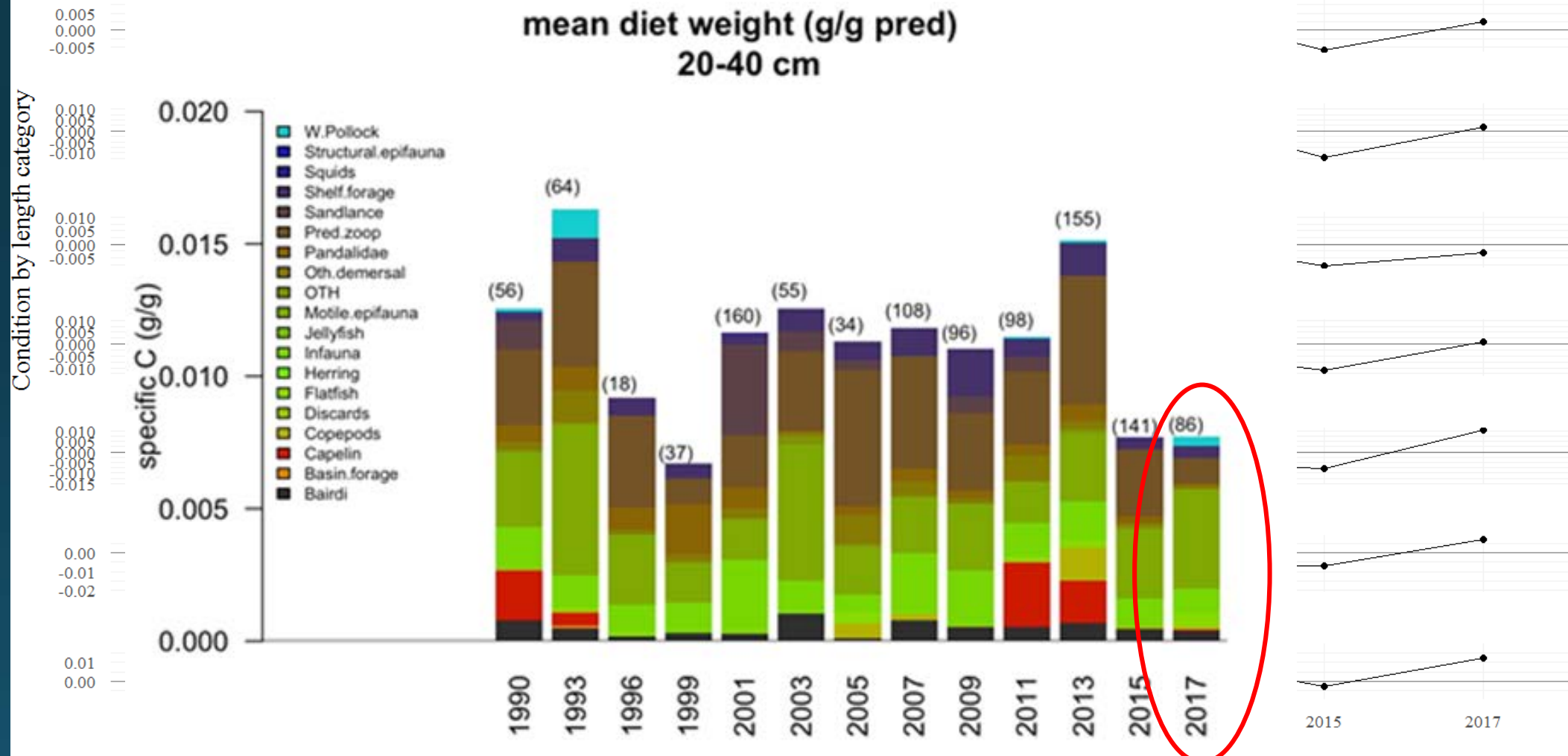
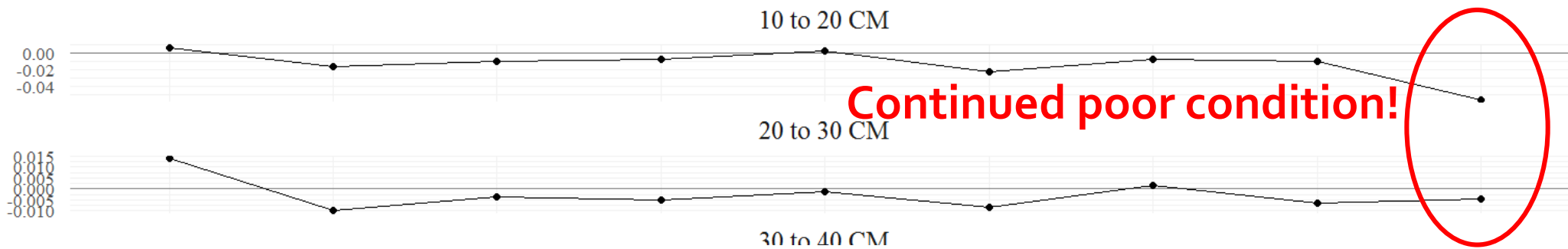
GOA Pacific cod

Future outlook

- 2017 stomach analysis
 - small fish remain below average
 - large fish (Pollock, Bairdi, Oth, shrimp ↑)

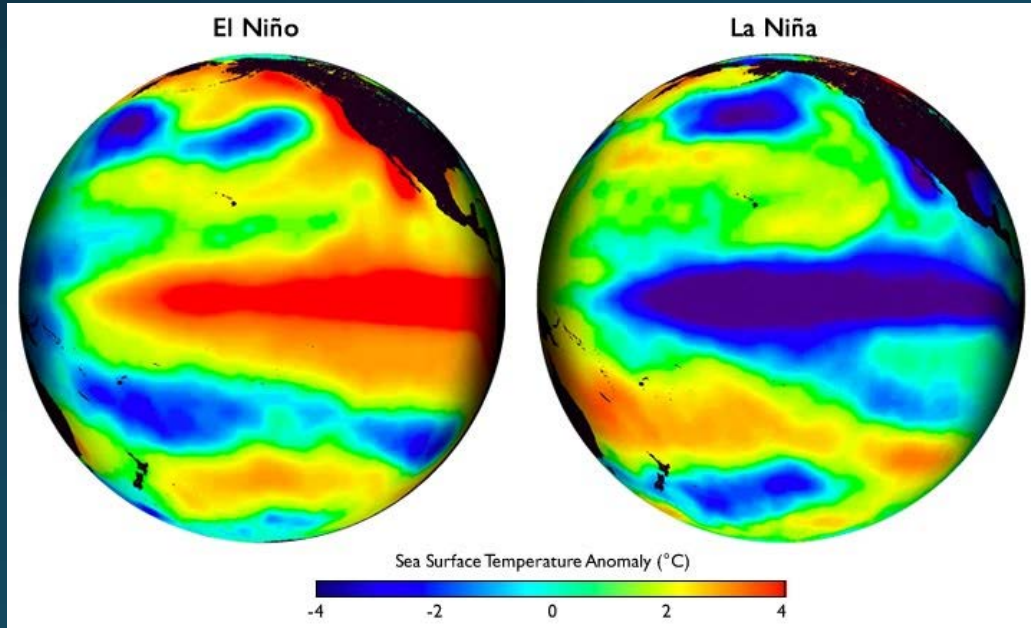


Pacific cod condition at length for bottom trawl survey



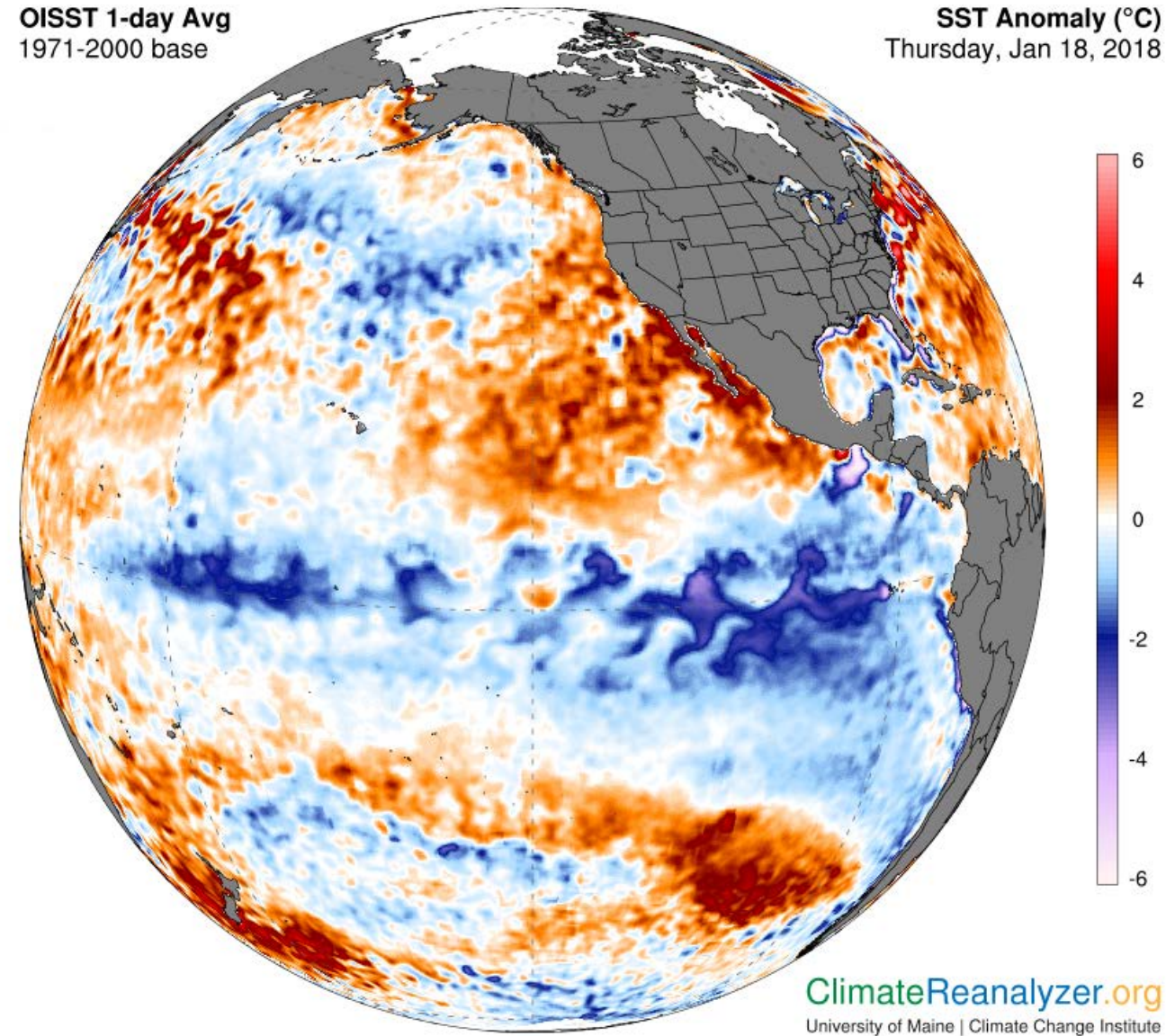
GOA Pacific cod Future outlook

- Weak La Niña through winter and early spring then return to neutral conditions



OISST 1-day Avg
1971-2000 base

SST Anomaly (°C)
Thursday, Jan 18, 2018



World
+ 0.1 °C

Northern Hemisphere
+ 0.2 °C

North Atlantic
+ 0.5 °C

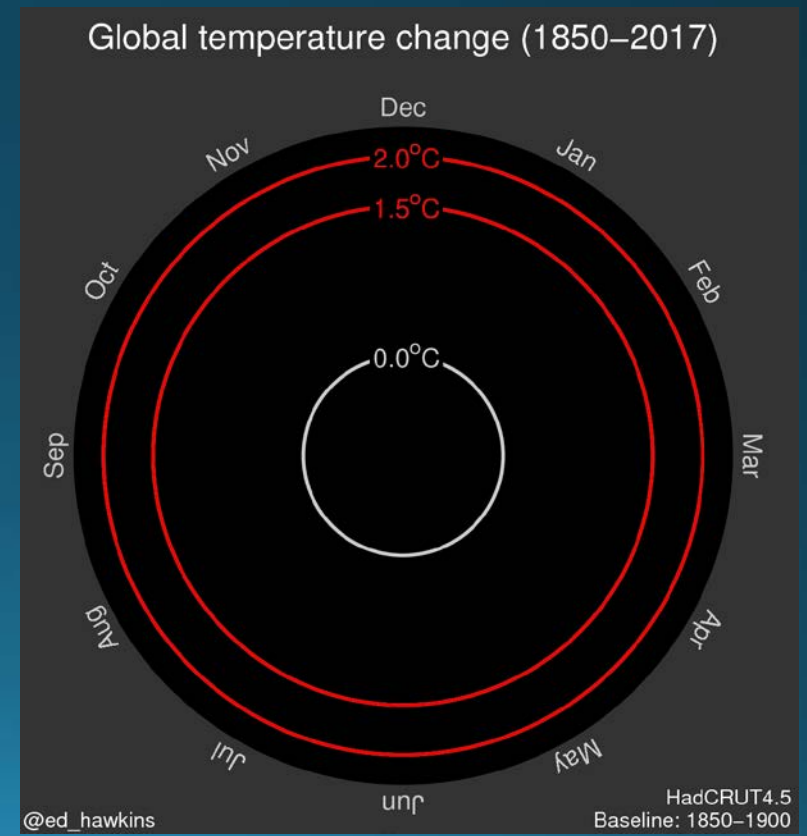
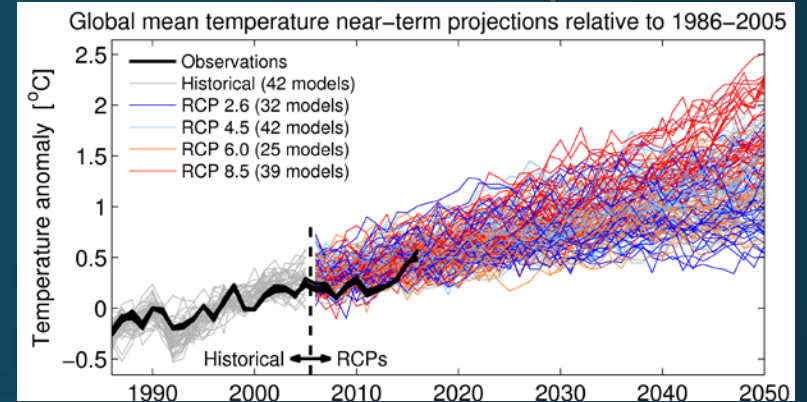
Equatorial Pacific
- 0.4 °C

Southern Hemisphere
+ 0.1 °C

North Pacific
+ 0.1 °C

GOA Pacific cod Under climate change?

- Climate models suggest the endless summer conditions to be more common in the future.
- Pacific cod recruitment appears to be temperature limited.
- The long-term (+30 years) outlook doesn't look particularly good for GOA Pacific cod.



GOA Pacific cod Status

- $B_{2018} = B_{21.5\%}$
- 77% decrease in ABC from last year's projection
 - Max ABC 2018 = 19,401 t
 - Recommended ABC 2018 = 18,000 t
 - Max ABC 2019 = 17,634 t
 - Recommended ABC = 17,000 t

Authors' recommended Model 17.09.35



Quantity	As estimated or specified last year for:		As estimated or specified this year for:	
	2017	2018	2018	2019
M (natural mortality rate)	0.47	0.47	0.49	0.49
Tier	3a	3a	3b	3b
Projected total (age o+) biomass (t)	426,384	428,885	170,565	198,942
Female spawning biomass (t)				
Projected	91,198	98,479	36,209	34,424
$B_{100\%}$	196,776	196,776	168,583	168,583
$B_{40\%}$	78,711	78,711	67,433	67,433
$B_{35\%}$	68,872	68,872	59,004	59,004
F_{OFL}	0.652	0.652	0.42	0.40
$maxF_{ABC}$	0.530	0.530	0.34	0.32
F_{ABC}	0.530	0.530	0.31	0.31
OFL (t)	105,378	94,188	23,565	21,412
maxABC (t)	88,342	79,272	19,401	17,634
ABC (t)	88,342	79,272	18,000	17,000
As determined this year for:				
Status	2015	2016	2016	2017
Overfishing	no	n/a	No	n/a
Overfished	n/a	no	n/a	No
Approaching overfished	n/a	no	n/a	No

Larval abundance is not correlated with recruitment

