



**NOAA**  
**FISHERIES**



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

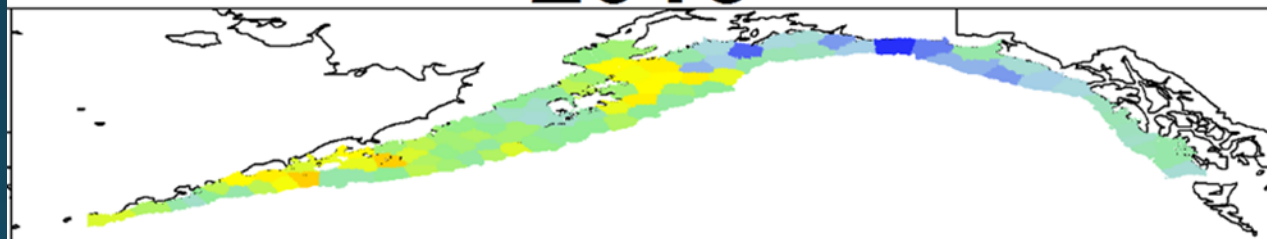
# Gulf of Alaska Pacific cod

NPFMC Ecosystem Research Workshop

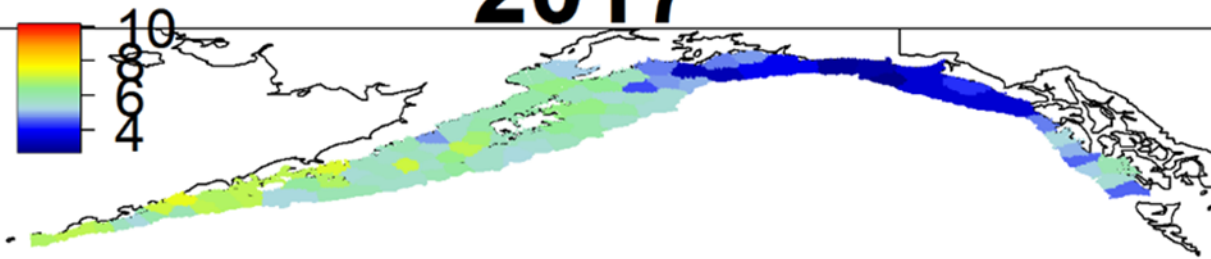
Seattle, Washington

February 7, 2018

**2015**



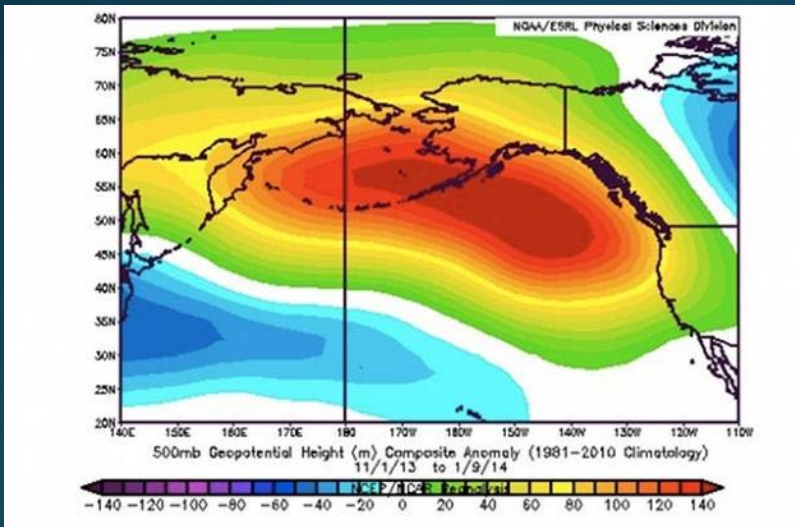
**2017**



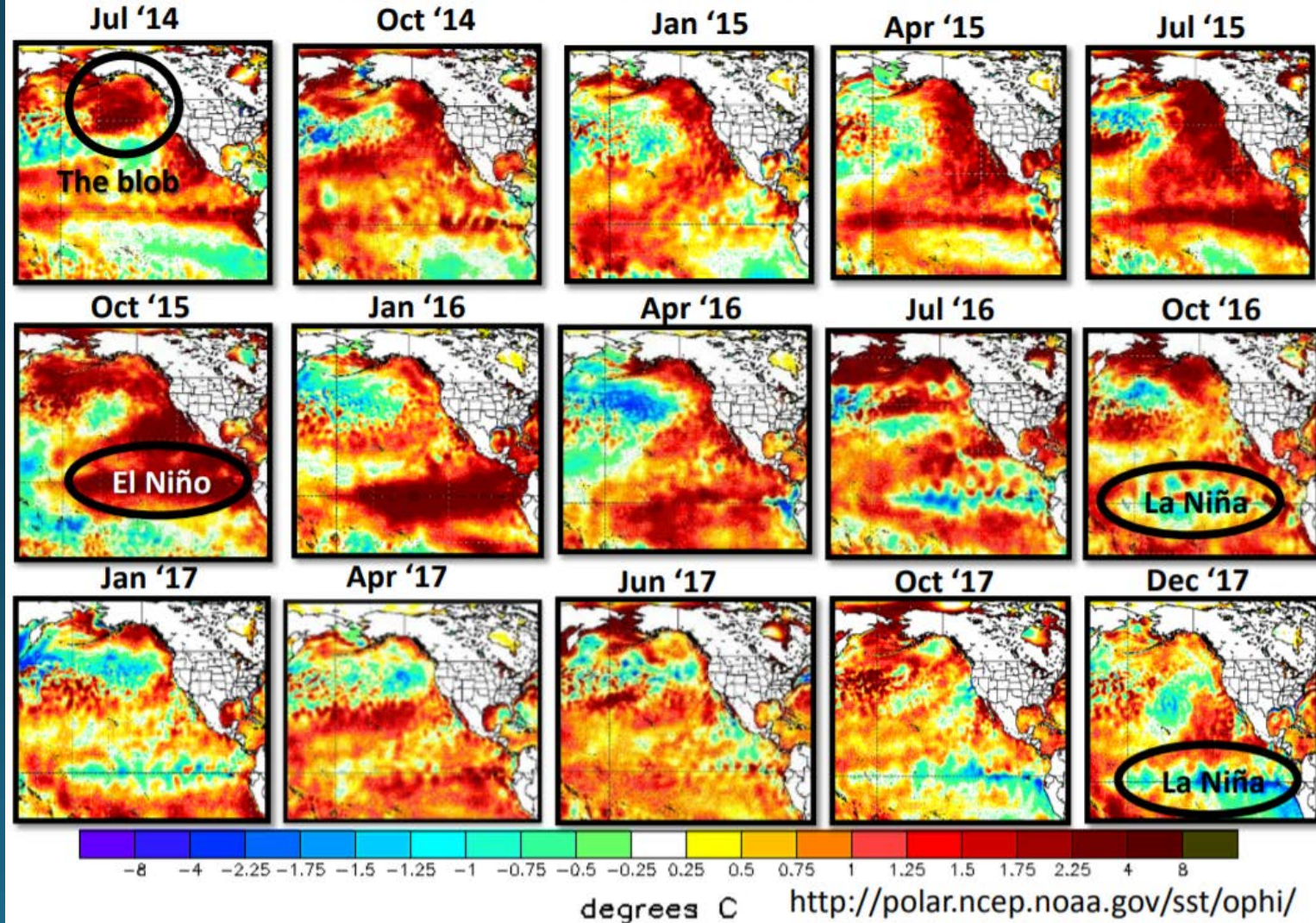
# The Blob!

- 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?



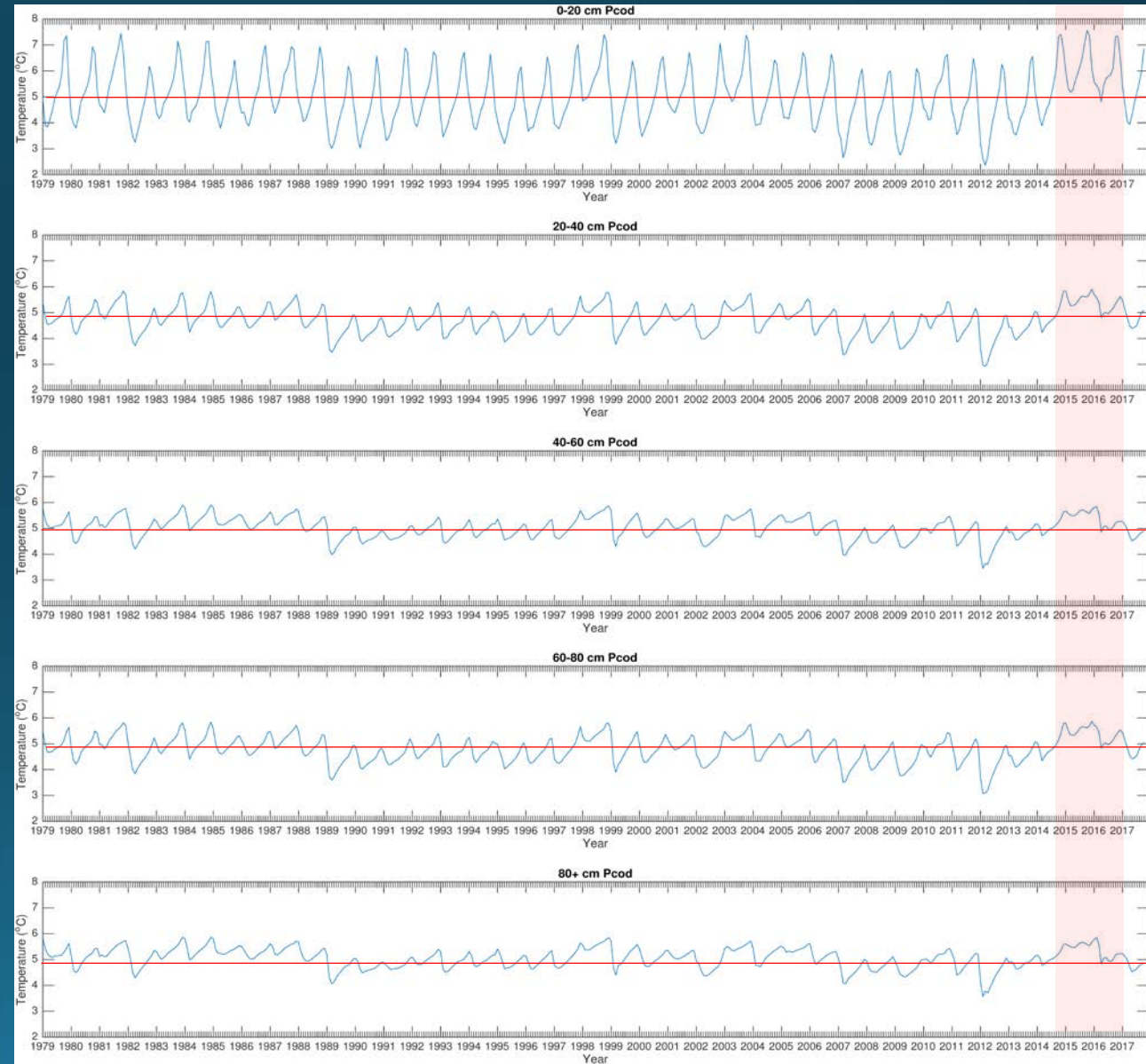
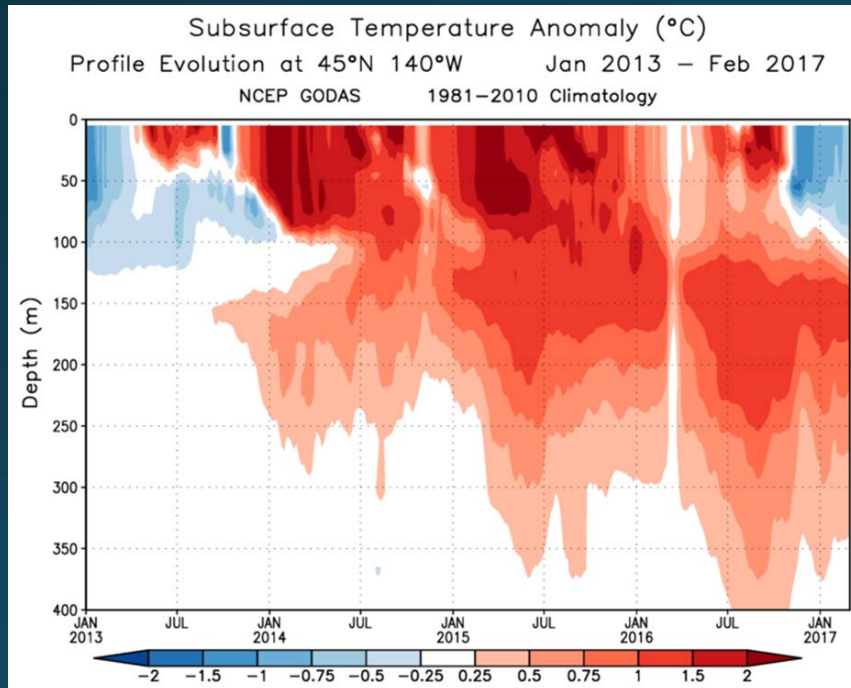
North Pacific surface temperature anomalies

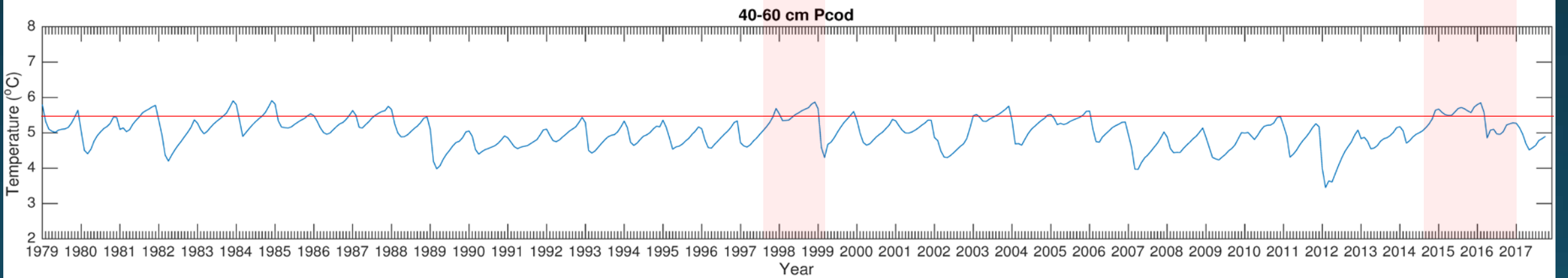
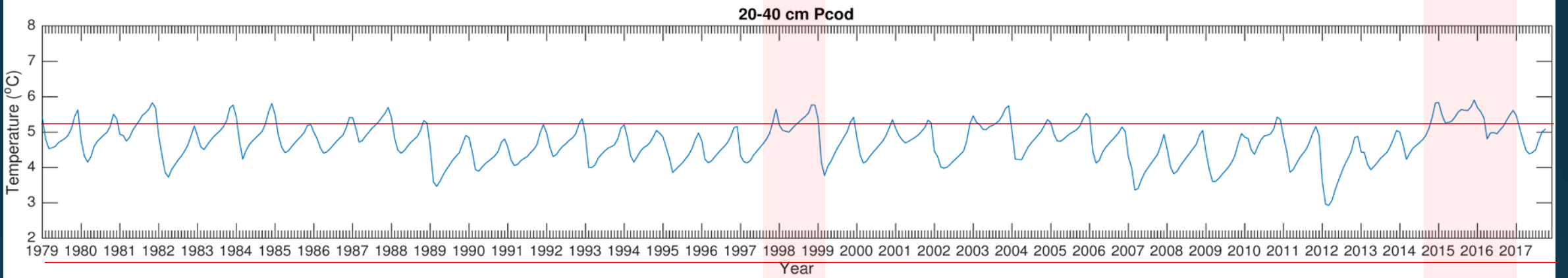
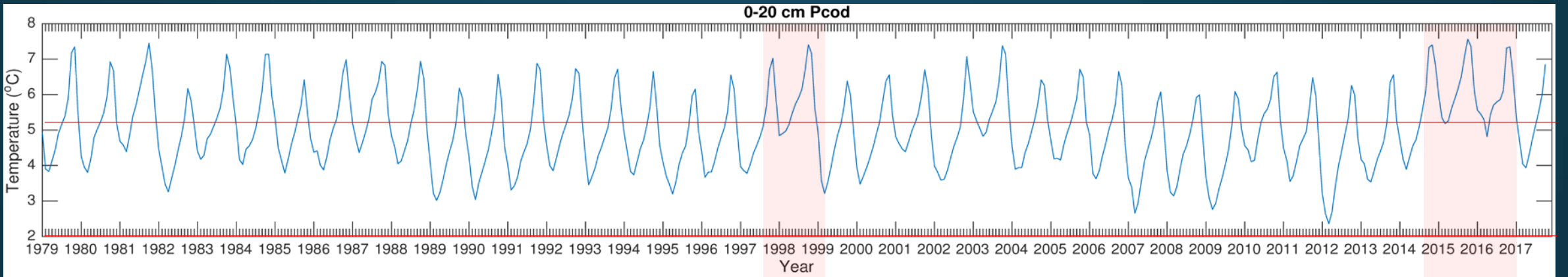


# Anomalously warm waters 2014-2016



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





# Anomalously warm waters 2014-2016



**Alaska Dispatch News** | Alaska News | Alaska Life | Politics | Outdoor/Adventure | Opin

Anchorage 55°F | Subscribe | Obituaries | Customer Service | E-edition | Reader Feedback | Sponsored Co

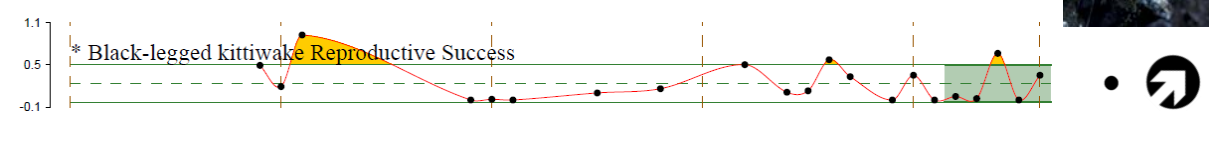
**Science**

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

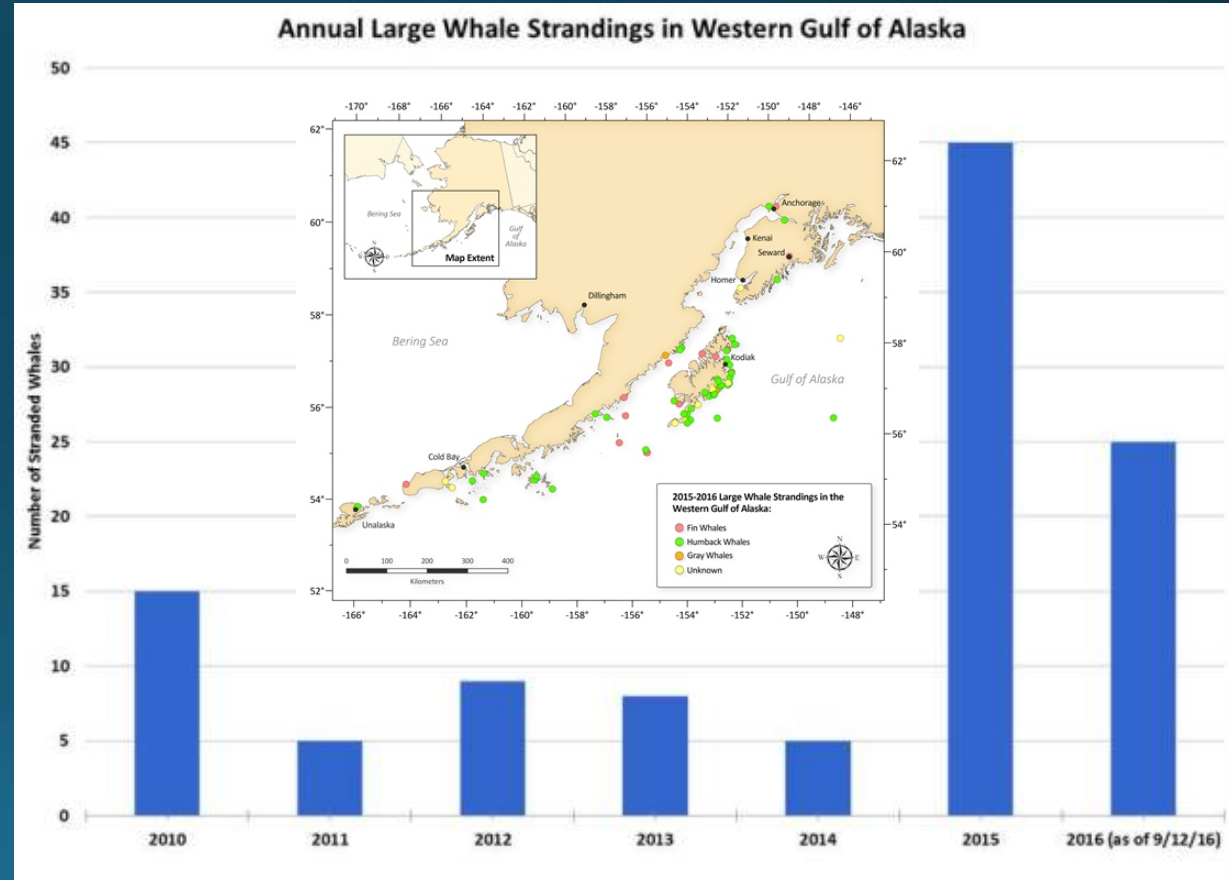
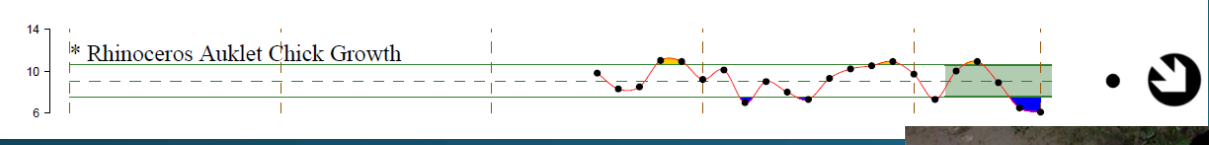
Author: **Yereth Rosen** | Updated: September 30, 2016 | Published January 29, 2016



### West



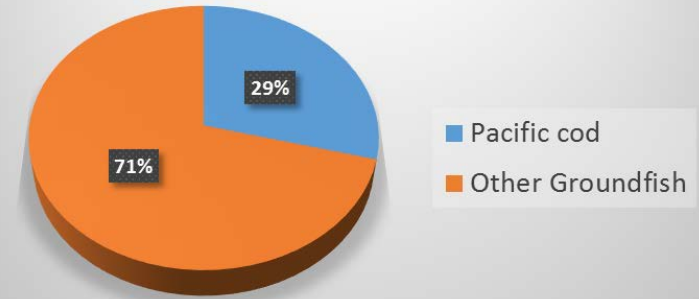
### East



Analysis by Stephani Zador

# GOA Groundfish Economics

Gulf of Alaska groundfish first-wholesale revenue

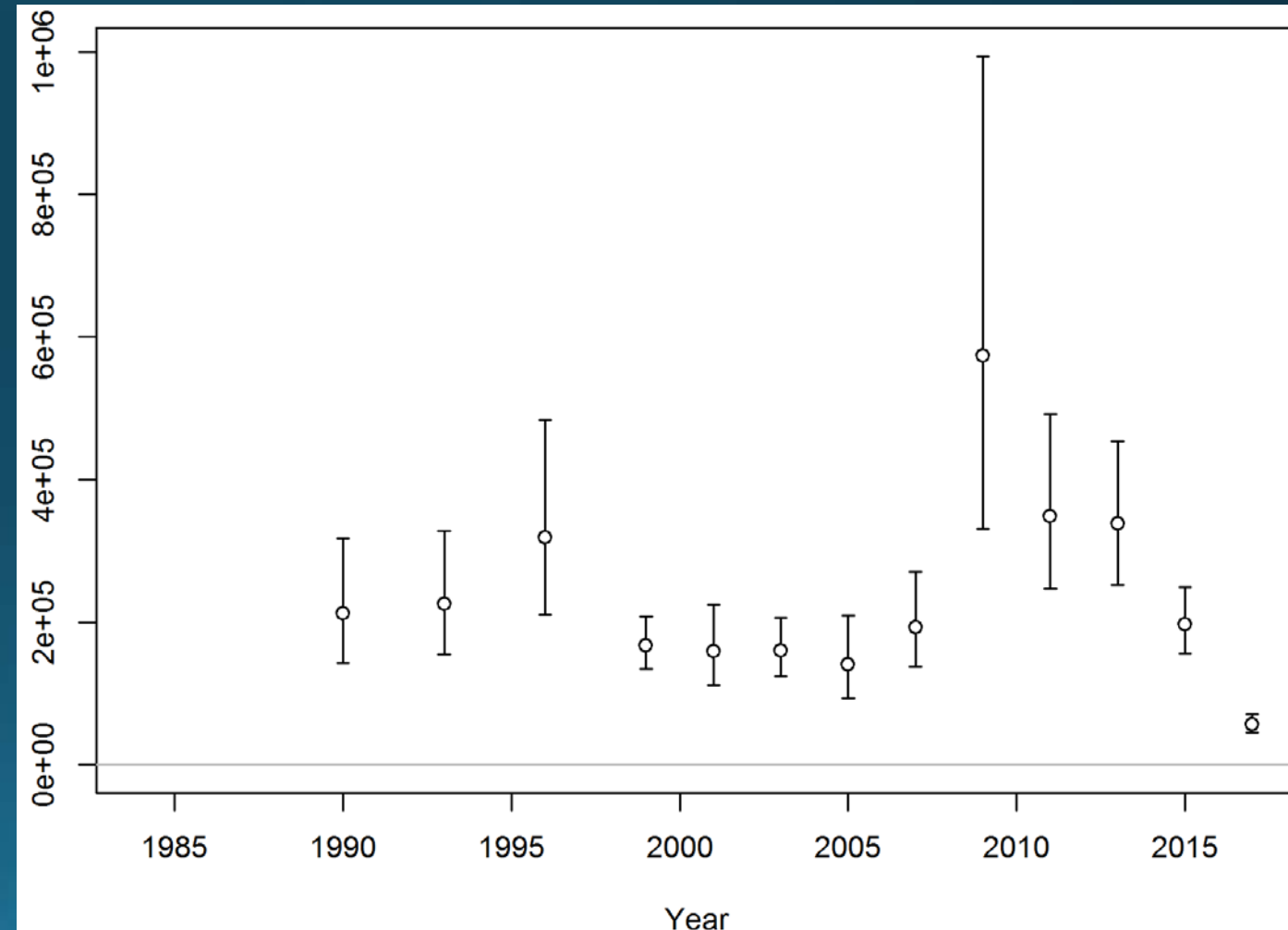


- The 2016 Gulf of Alaska groundfish fisheries generated \$354 million in first-wholesale revenue which represents 15% of the Alaska groundfish value and 30% of the value of all commercial fisheries in the GOA
- The GOA groundfish fisheries support jobs on over 650 vessels with approximately 23,000 crew 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



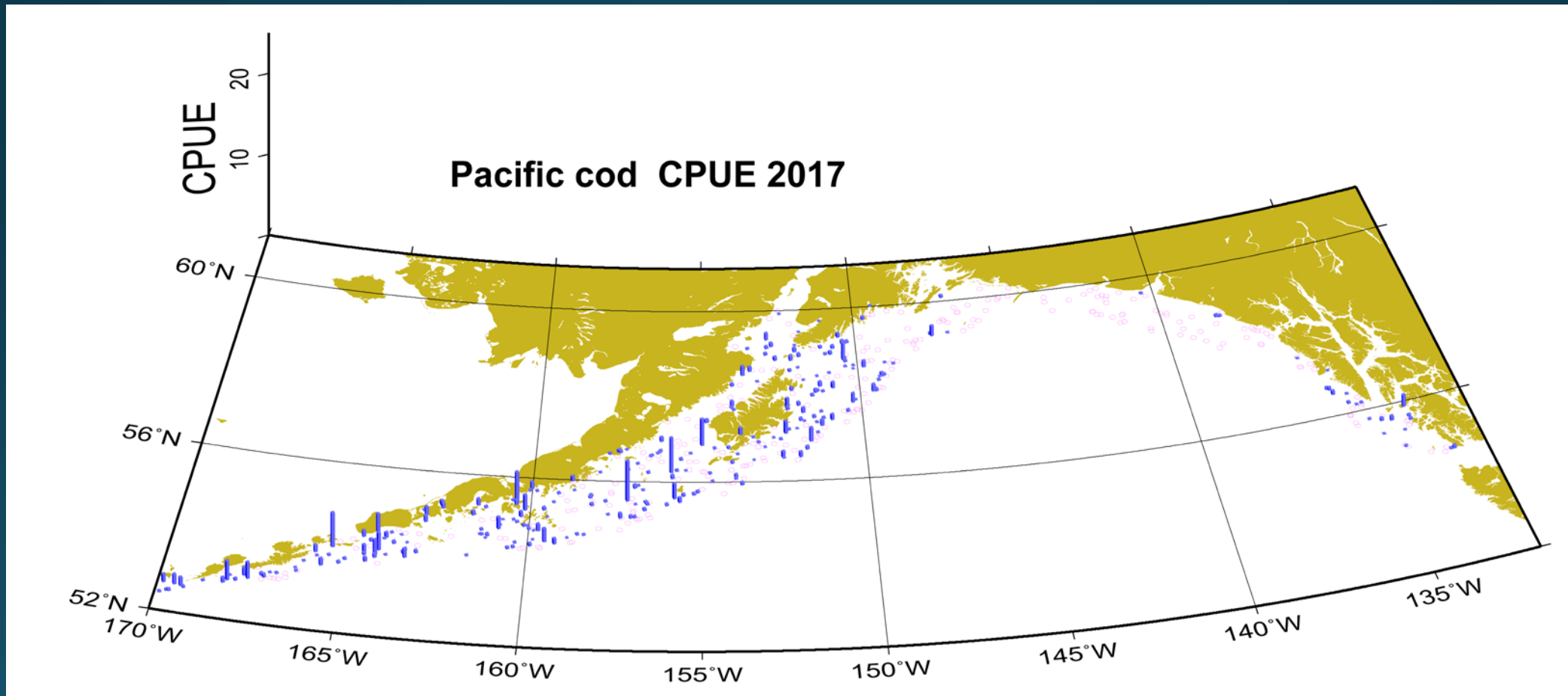
- Lowest estimate ever  
 $1.96 \times 10^8$  fish and 107,324 t
- Precise estimate (0.117 CV)
- 71% decline in abundance  
since 2015 (83% since 2013)
- 58% decline in biomass  
since 2015 (78% since 2013)



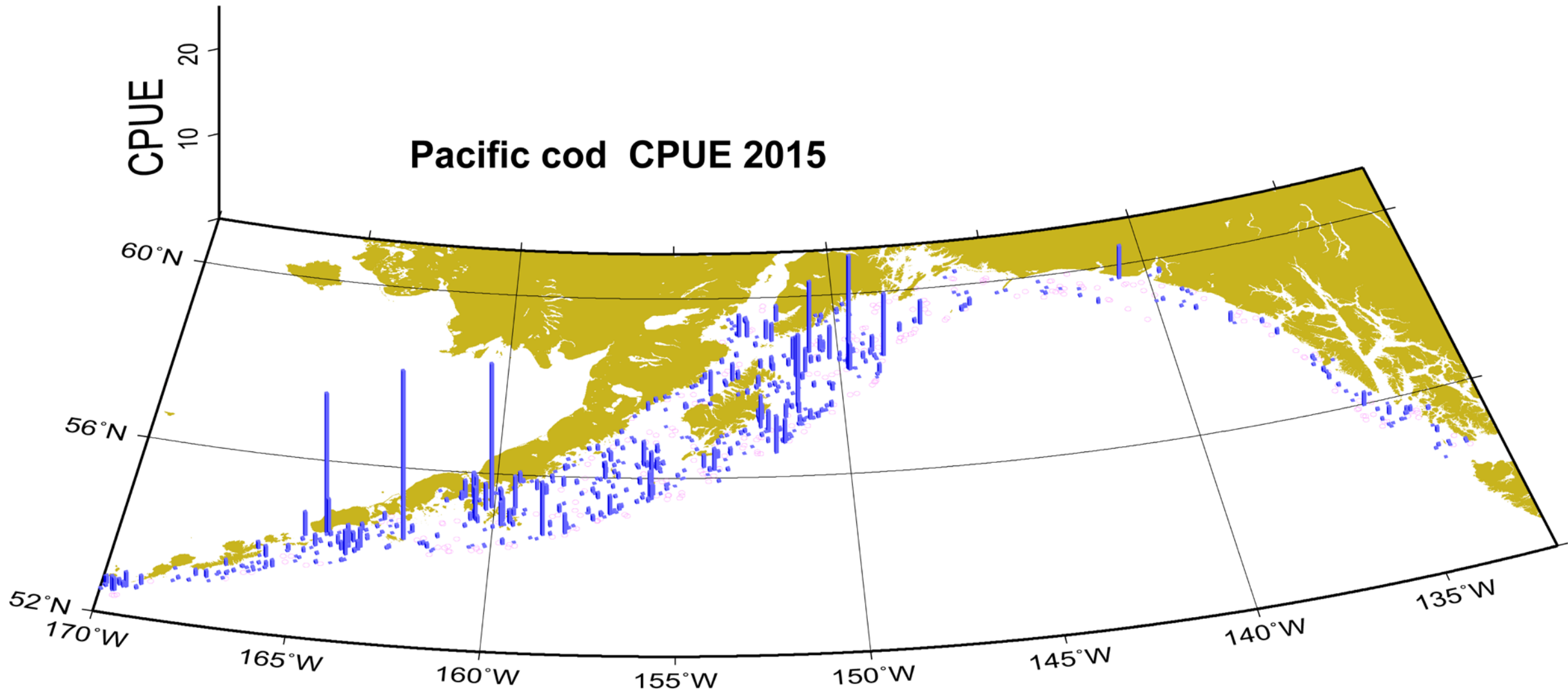
# GOA Pacific cod Bottom trawl survey

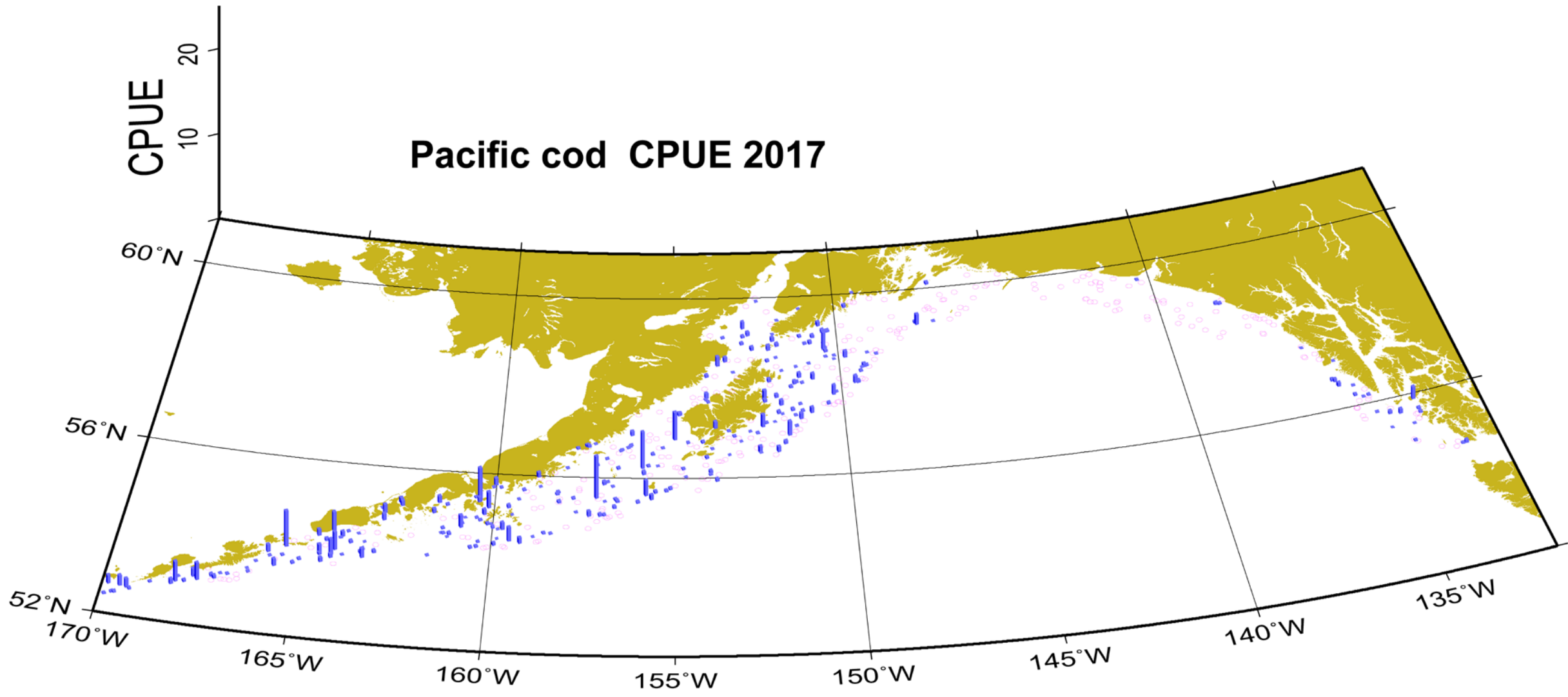


- Low density through surveyed area
- Some medium-low density along Alaska Peninsula and south of Unimak Island







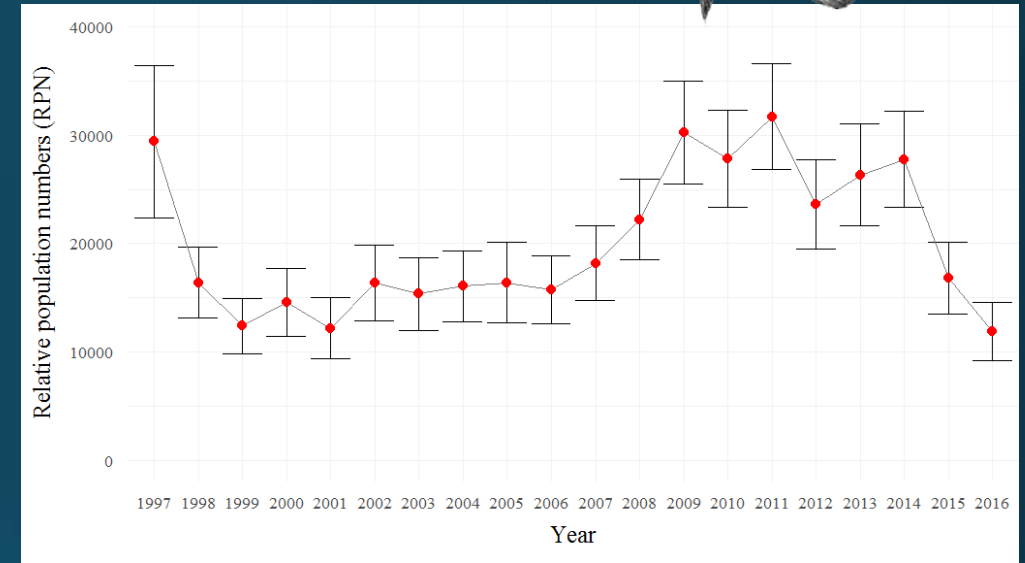


# GOA Pacific cod Other surveys



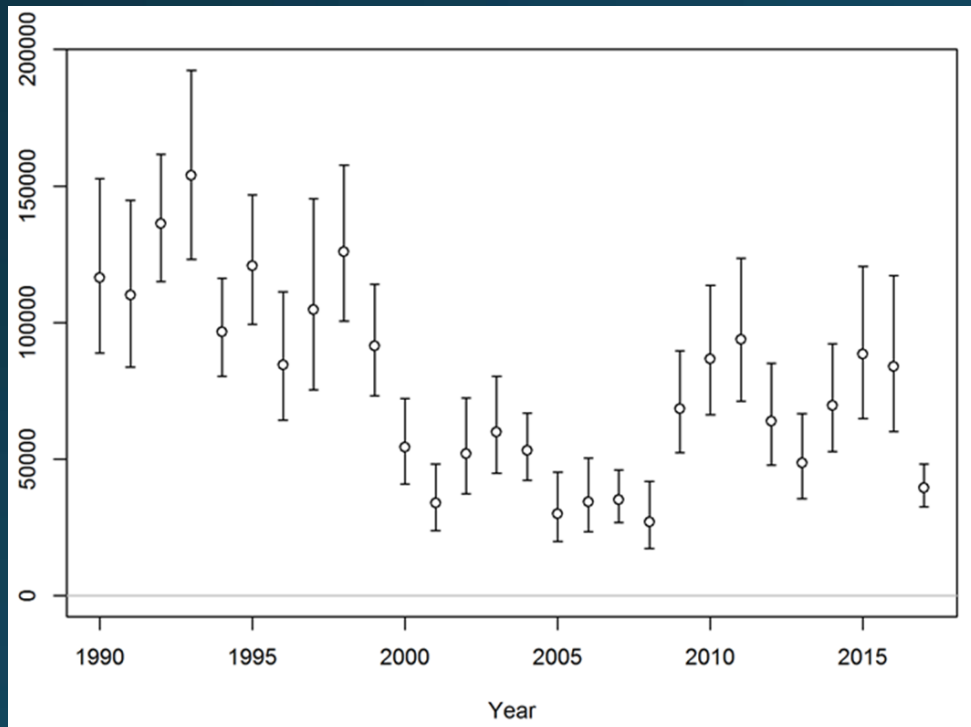
IPHC longline survey 1997-2016

- 2016 Lowest



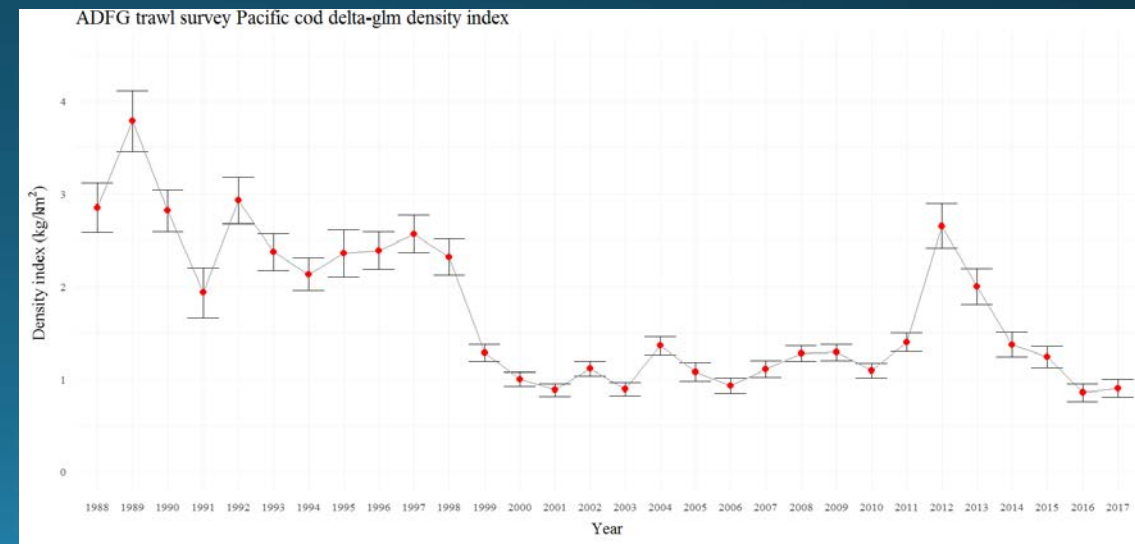
AFSC longline survey 1990-2017

- 53% decline since 2016



ADFG trawl survey 1988-2017

- 2016 lowest



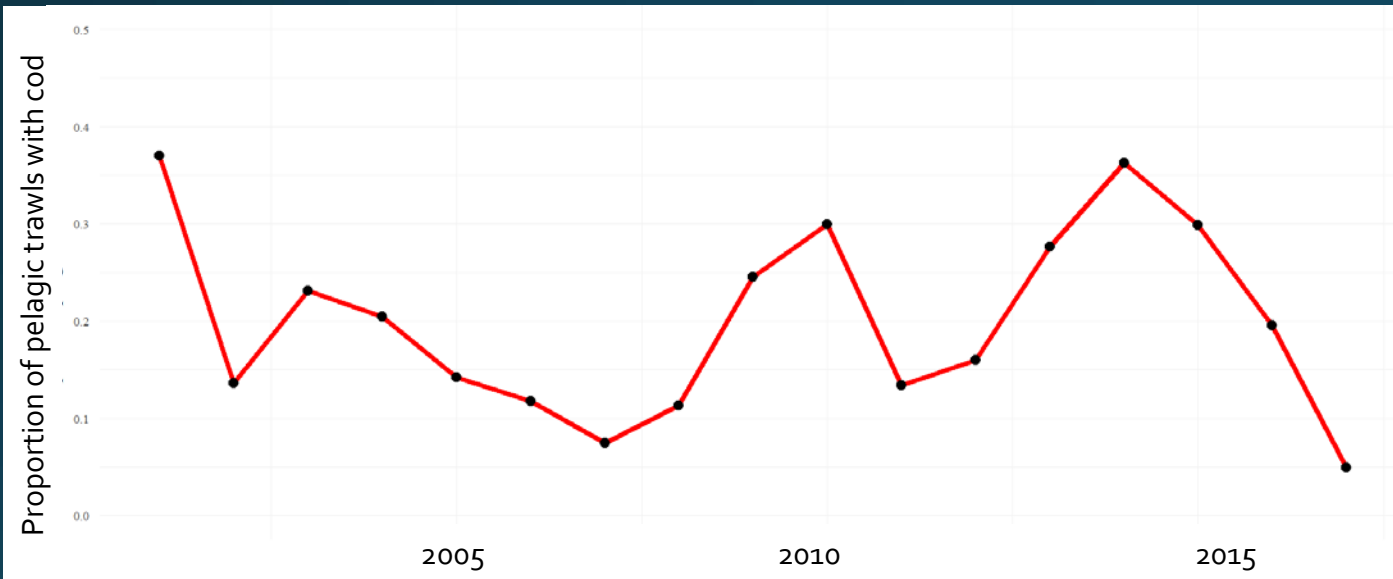
# GOA Pacific cod

## Bycatch in other fisheries

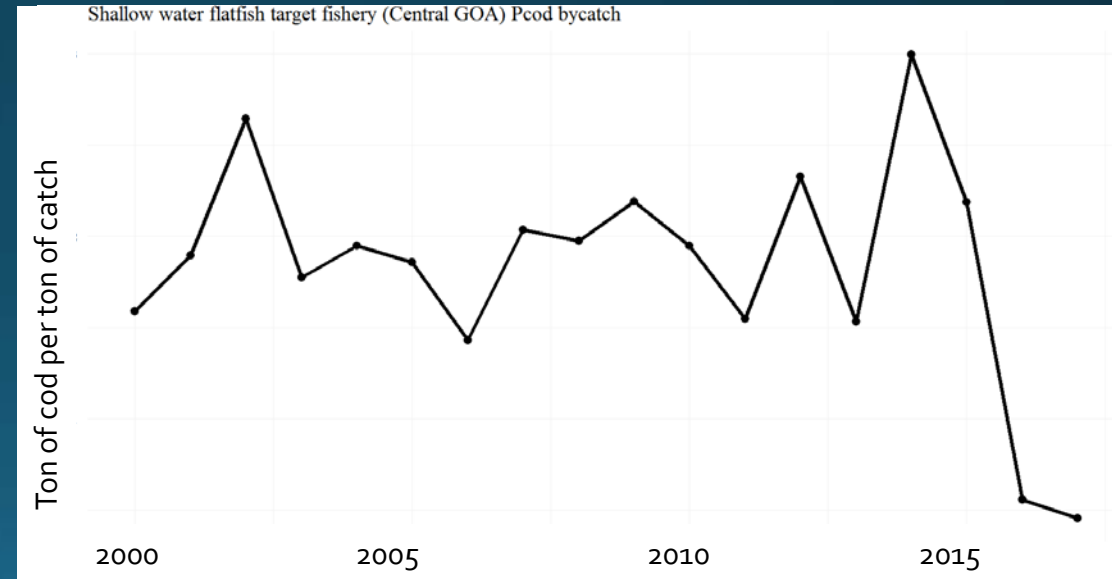


- Low catch rates of Pacific cod in non-target fishery

### Pelagic walleye pollock fishery



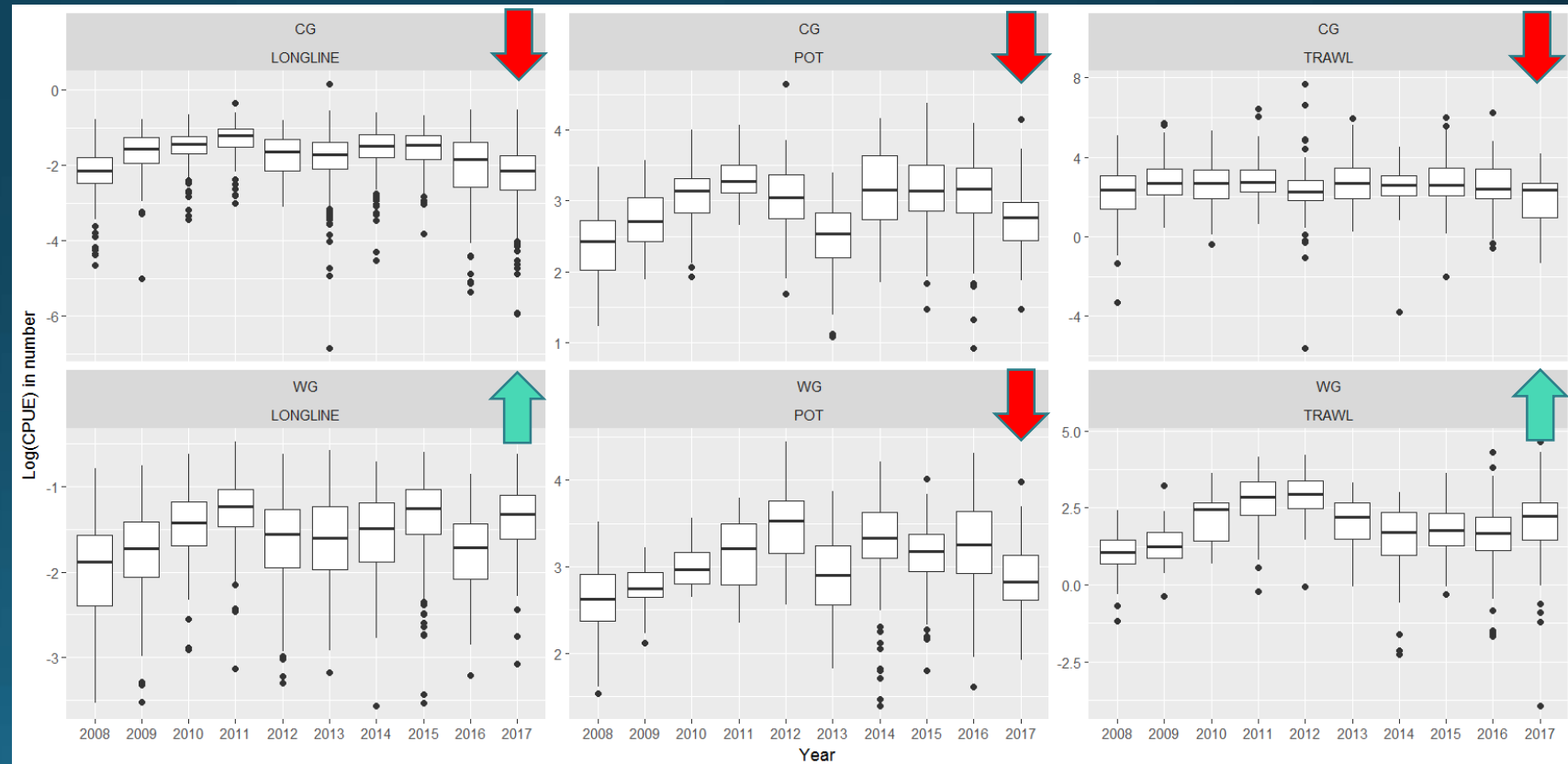
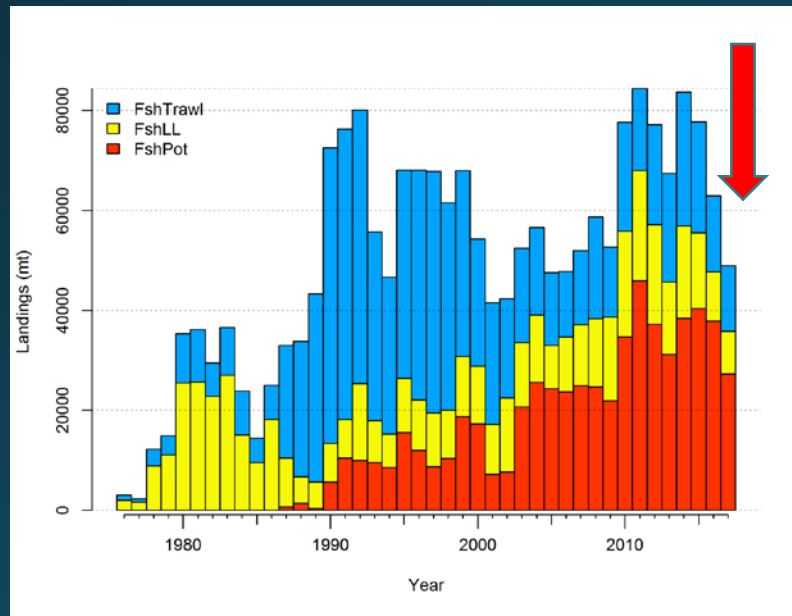
### Shallow water flatfish fishery



# GOA Pacific cod Fishery data



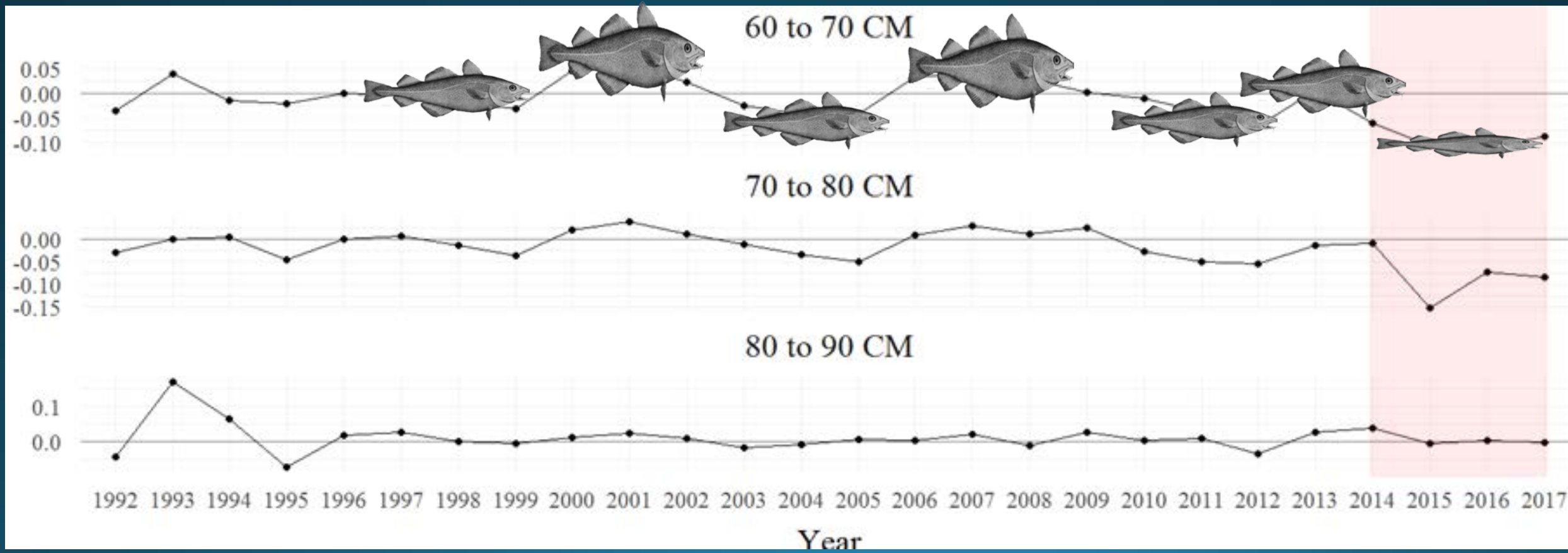
- Catch at < 60% of ABC
- Low CPUE in Central GOA all fisheries
- Low CPUE in pot fishery in Western GOA, high CPUE for other sectors



# GOA Pacific cod Fishery data



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



# GOA Pacific cod

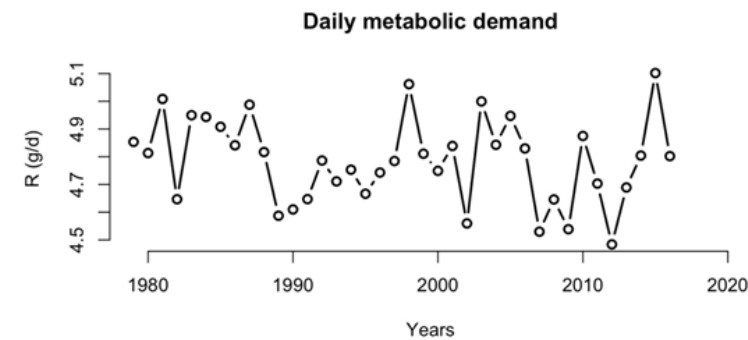
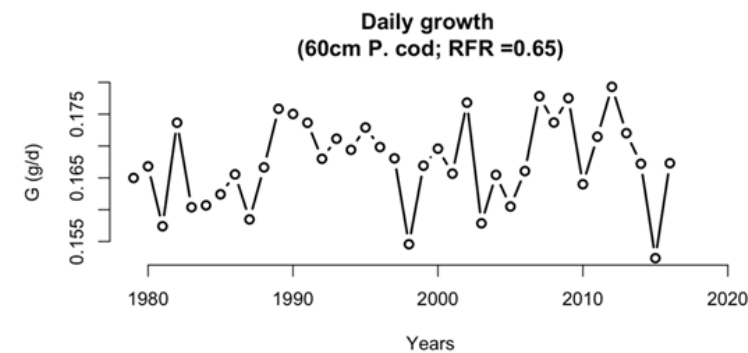
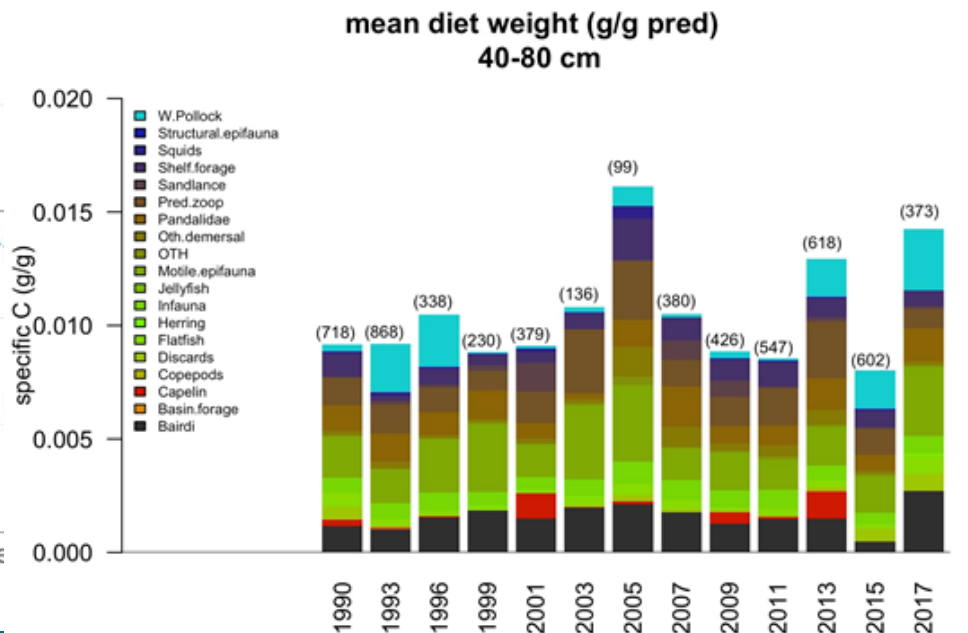
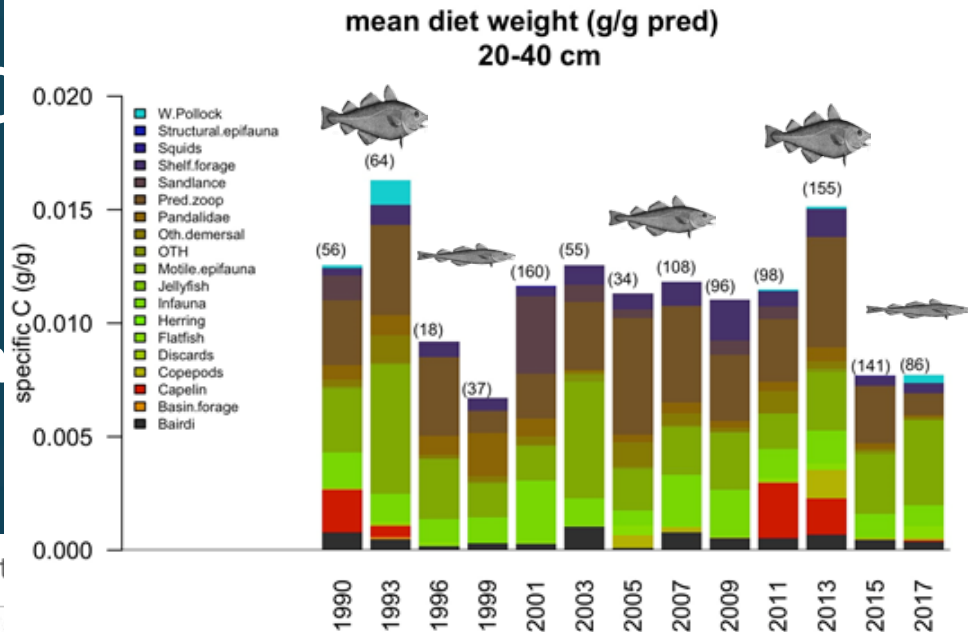
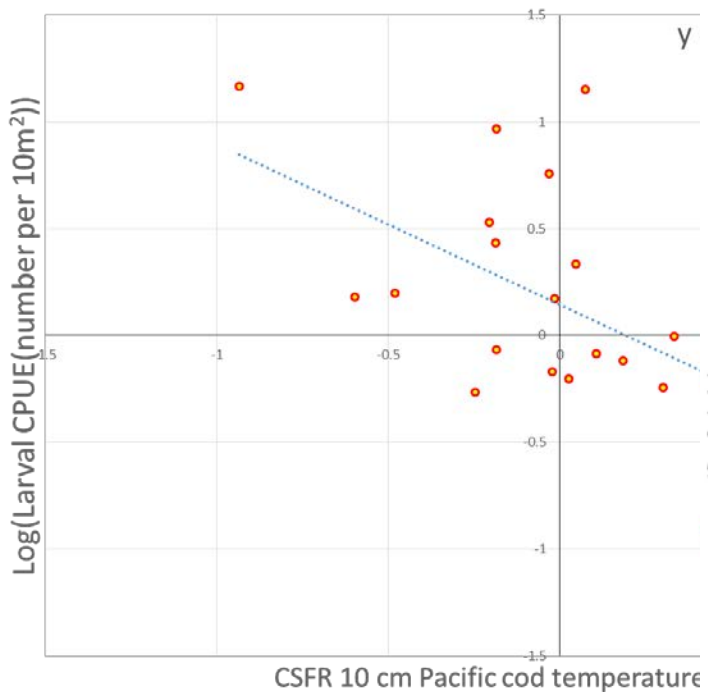
## The Blob

- Likely substantial in



and natural mortality

Larval density and temperature



energetics analysis by Kirsten Holsman

# GOA Pacific cod

## Bio-energetics summary



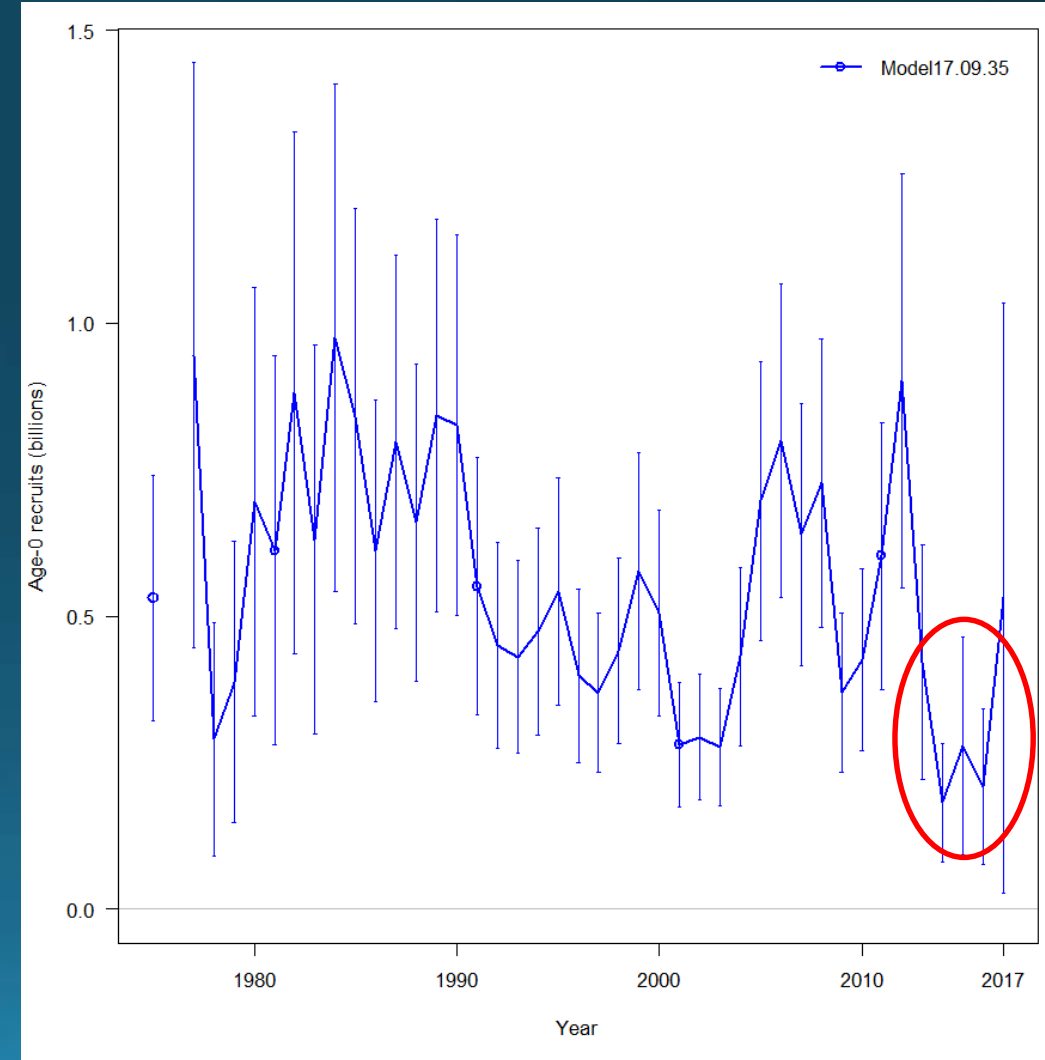
- Warmer temperatures were throughout the year and water column
- Higher metabolism in warmer temps lead to higher forage requirements
- Indications of lower forage amounts in 2015-2016
- Combination likely lead to higher Pacific cod natural mortality for these years.



# GOA Pacific cod Assessment Model Recruitment



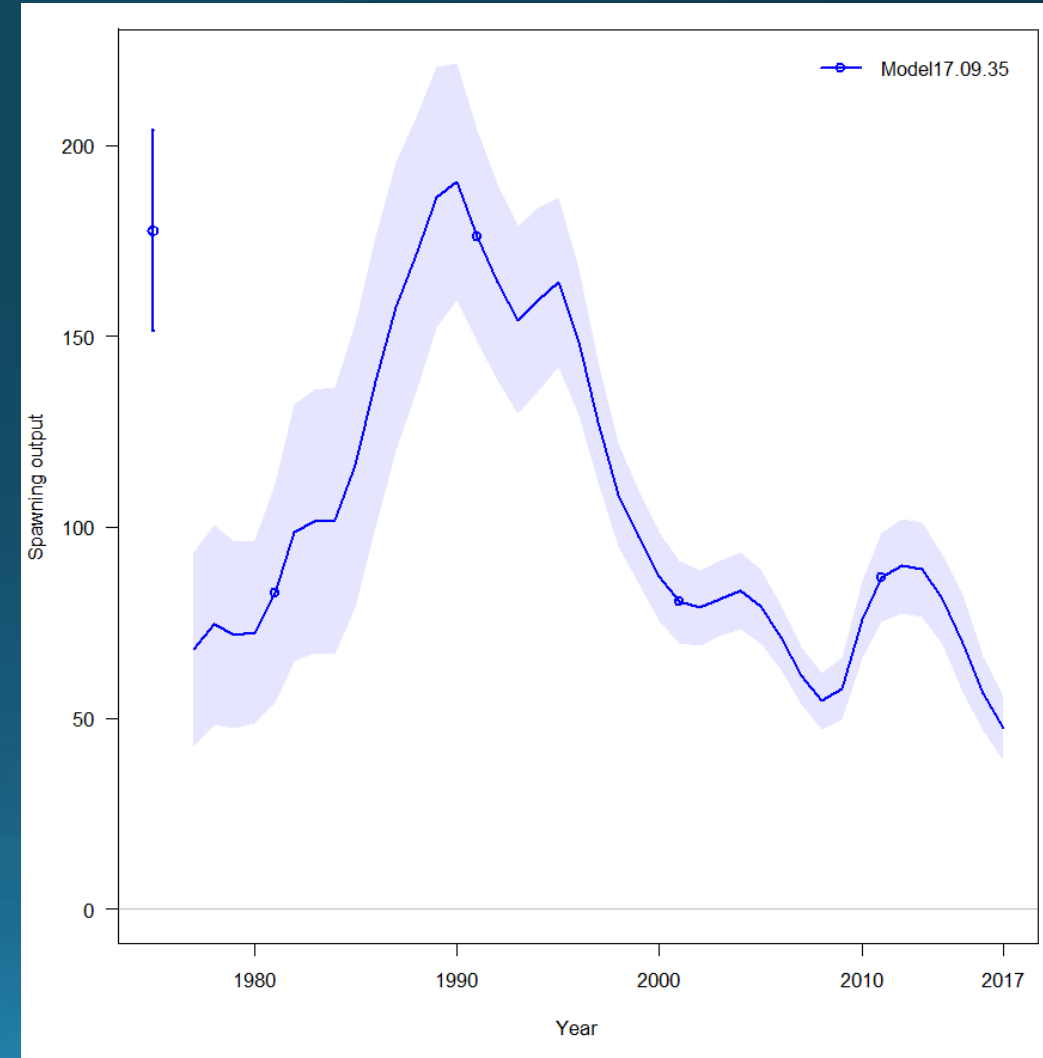
- :Low recruitment in the 2014-2016
  - 2014 lowest recruitment estimate in time series at  $0.14 \times 10^9$
  - 2016 and 2015 second and third lowest recruitment estimates



# GOA Pacific cod Assessment Model Spawning Biomass



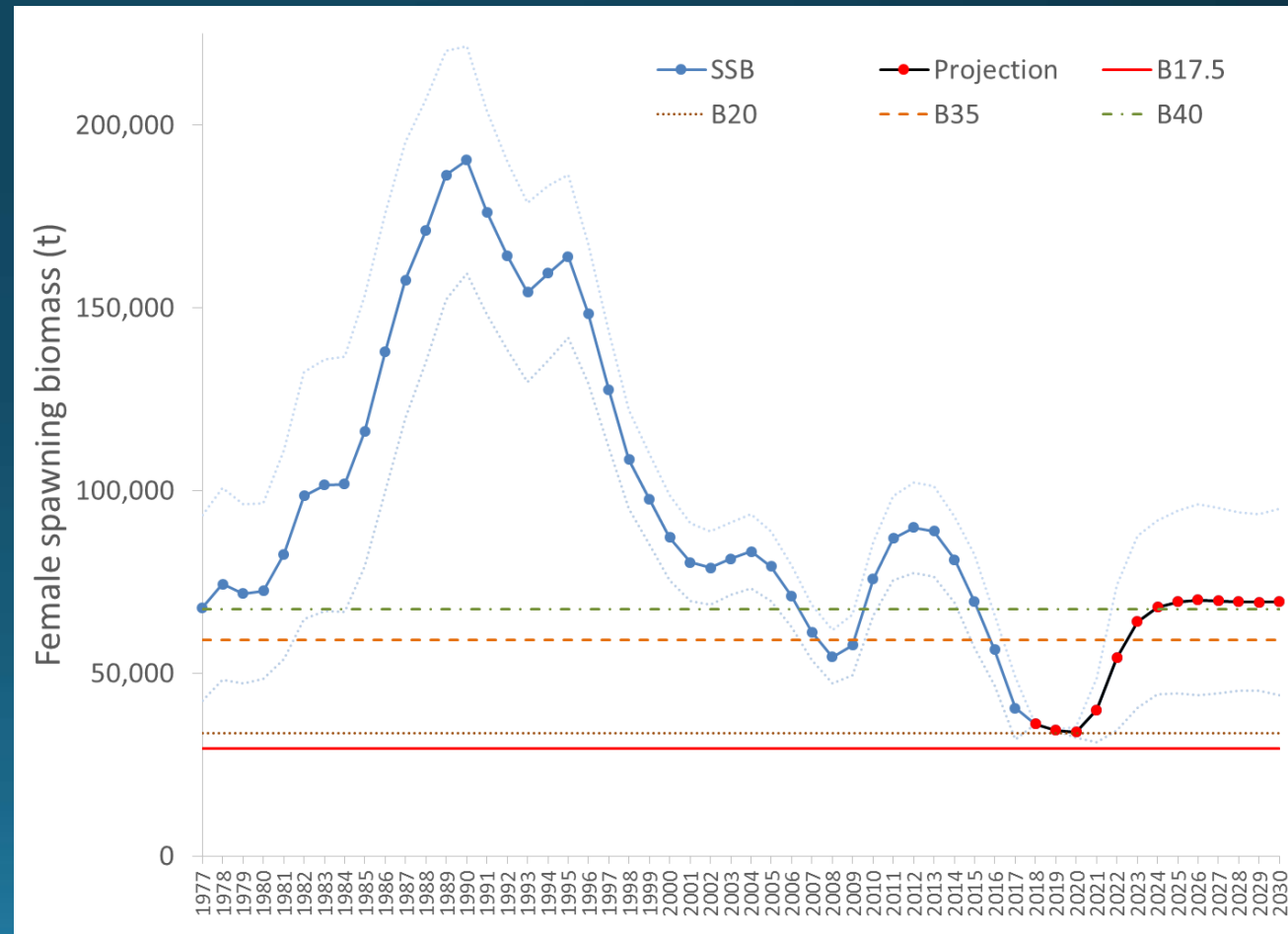
- Lowest female spawning biomass in 2017 (47,326 t)
- Peak female spawning biomass in 1990 (190,465 t)
- 2008 previous low at 54,470 t
- Build up in 2009-2012 based on large 2006-2008 year classes



# 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

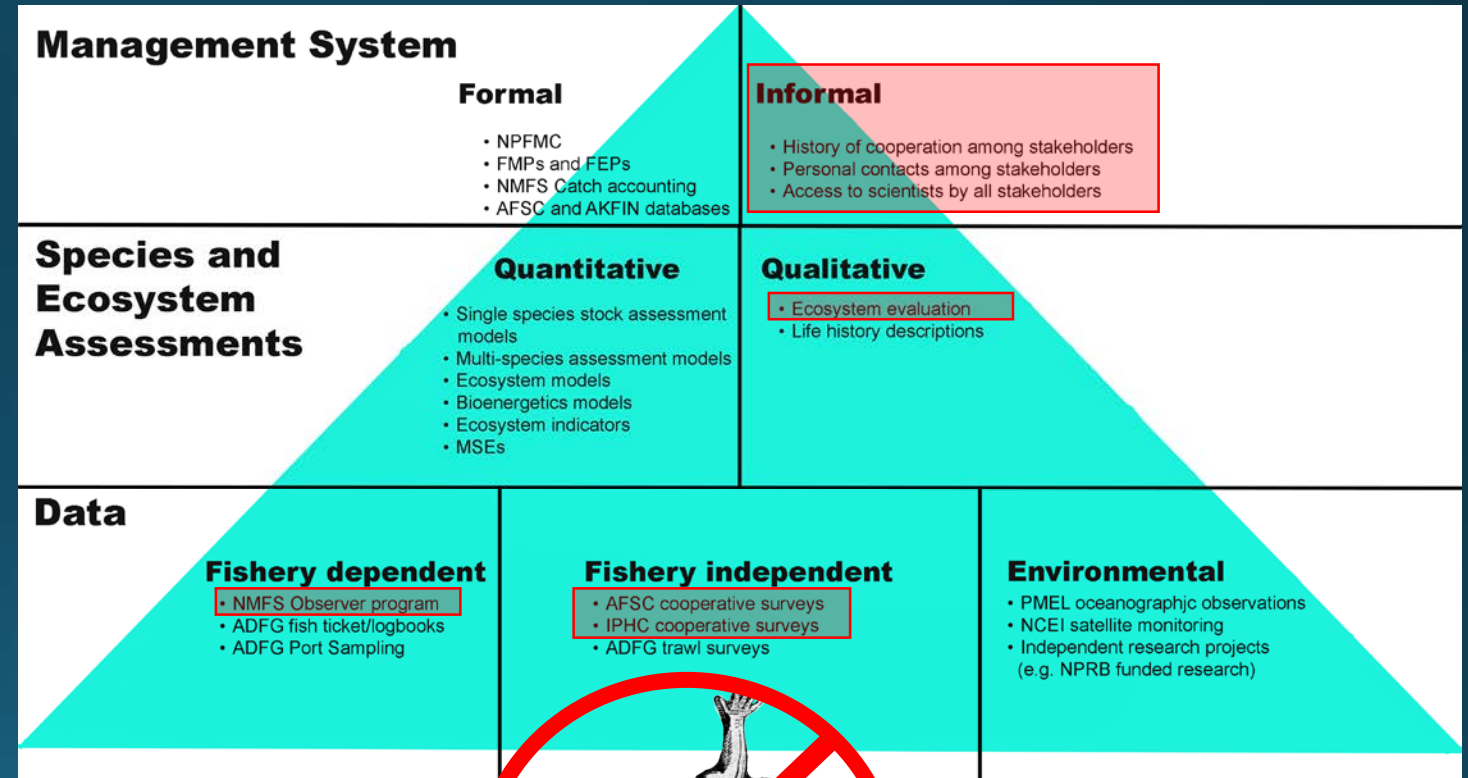
# GOA Pacific cod

## Ecosystem Approach in North Pacific Fisheries



### What's different in the North Pacific?

- Based on 40 years of cooperative research and adaptive management



Assessment authors?

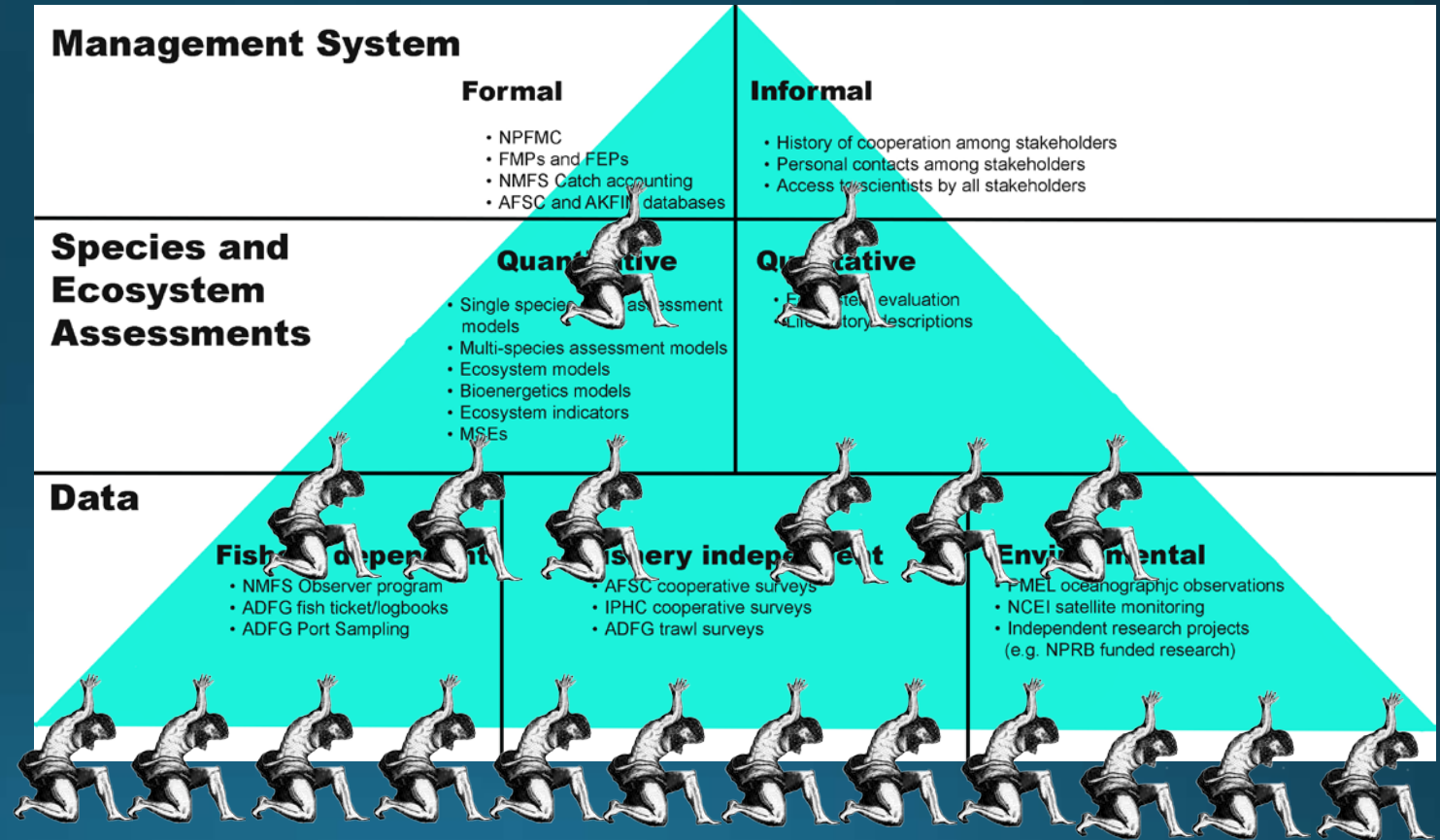
# GOA Pacific cod

## 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



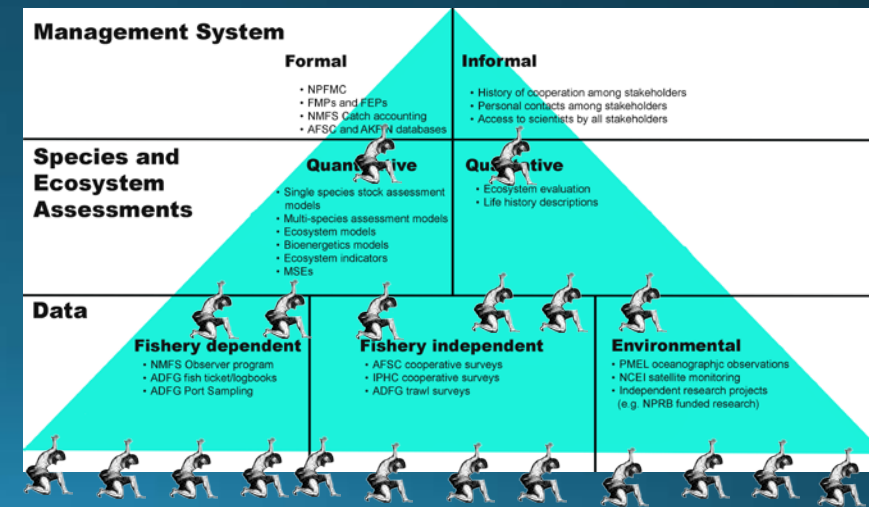
## Bringing it all together for GOA Pacific cod in 2017

- **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%



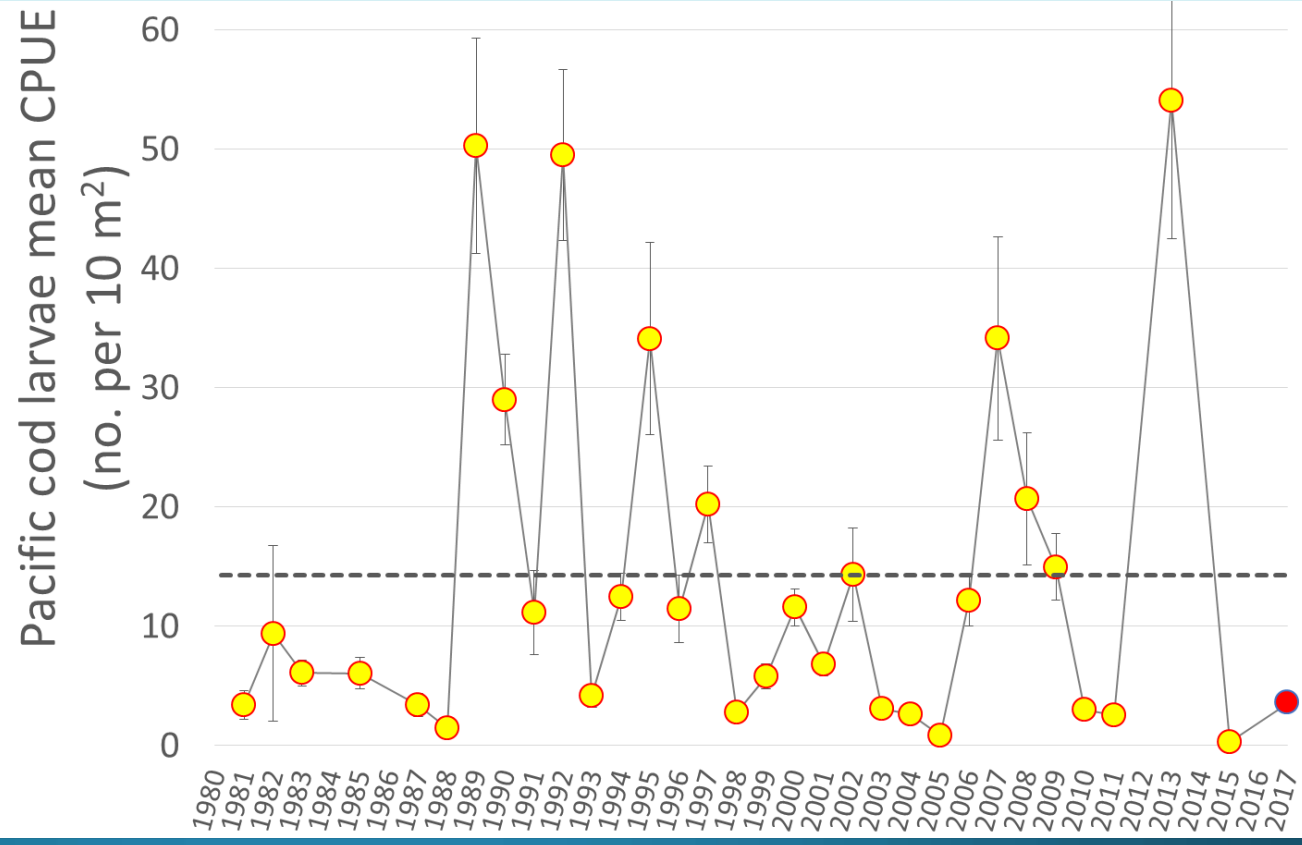
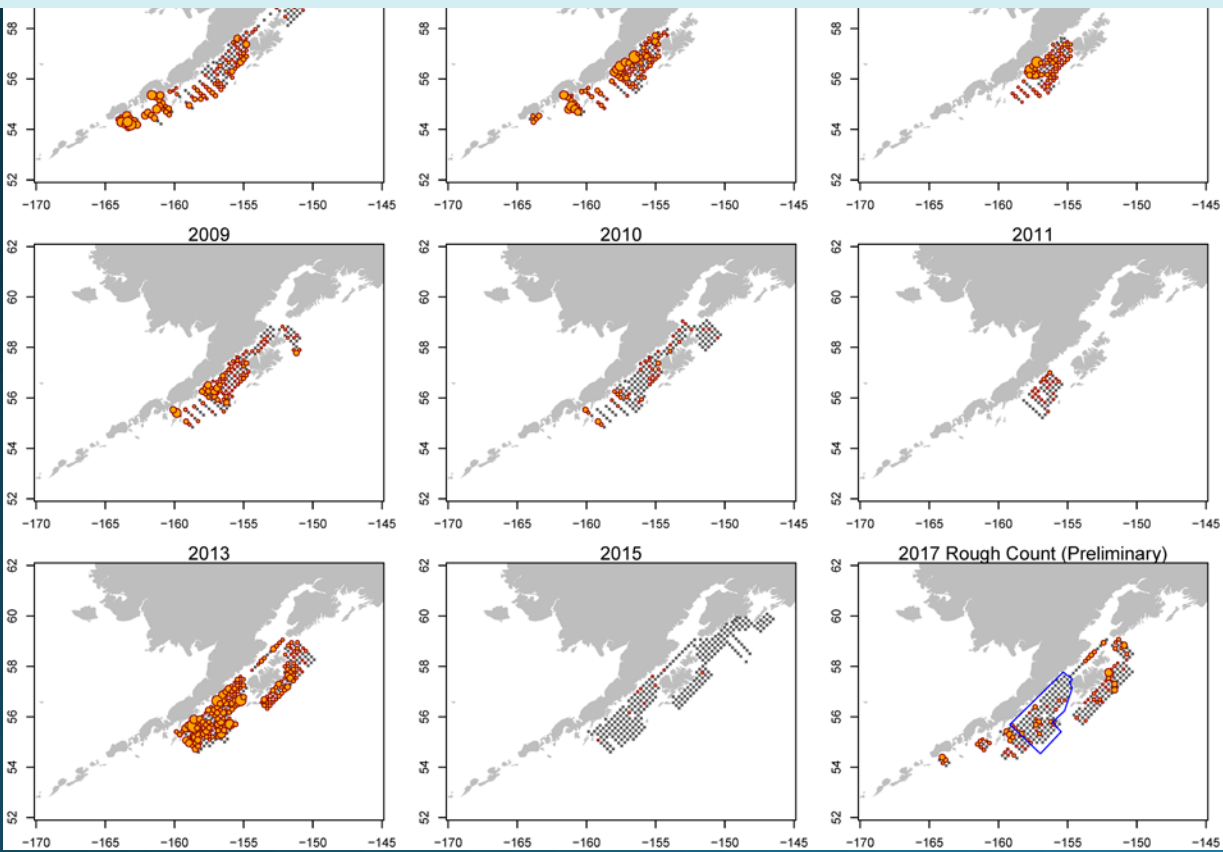


# GOA Pacific cod Future outlook



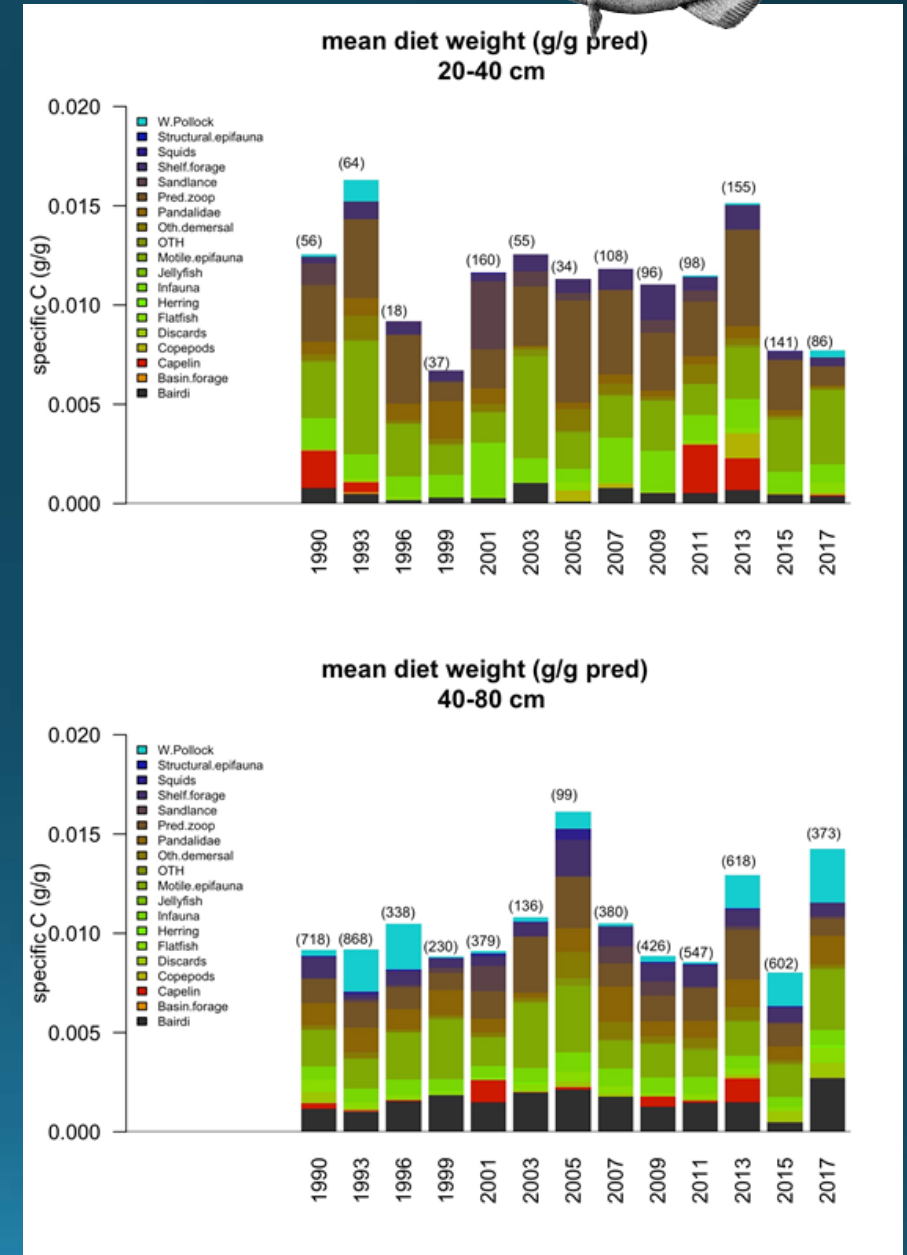
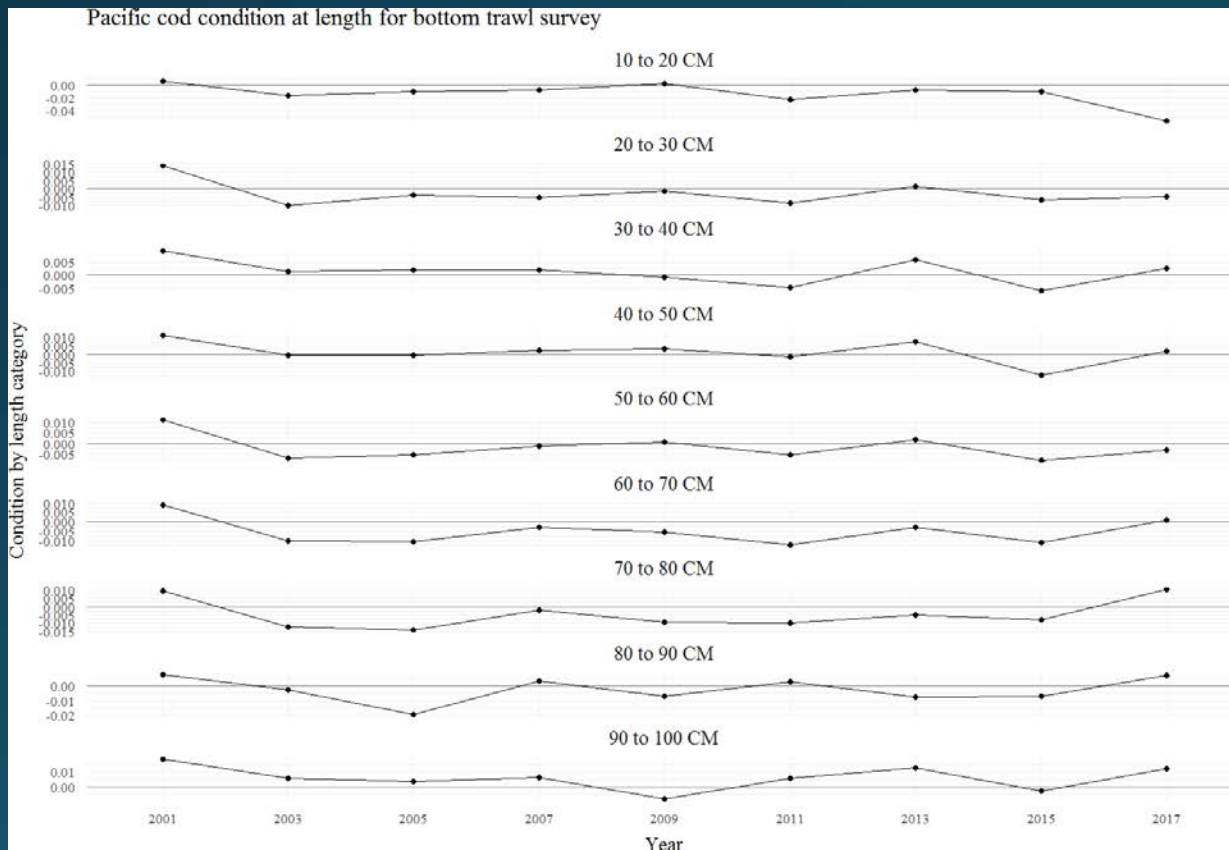
- Preliminary 2017 larval survey densities below average

## Larval abundance is not correlated with recruitment

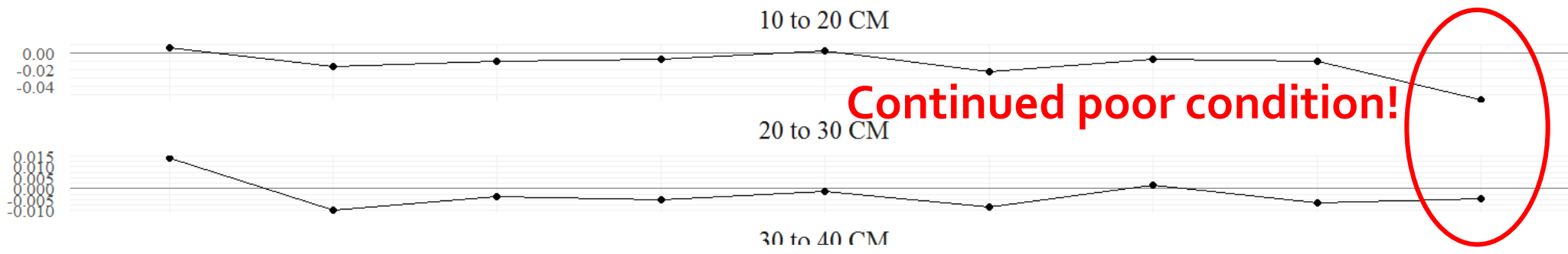


# GOA Pacific cod Future outlook

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

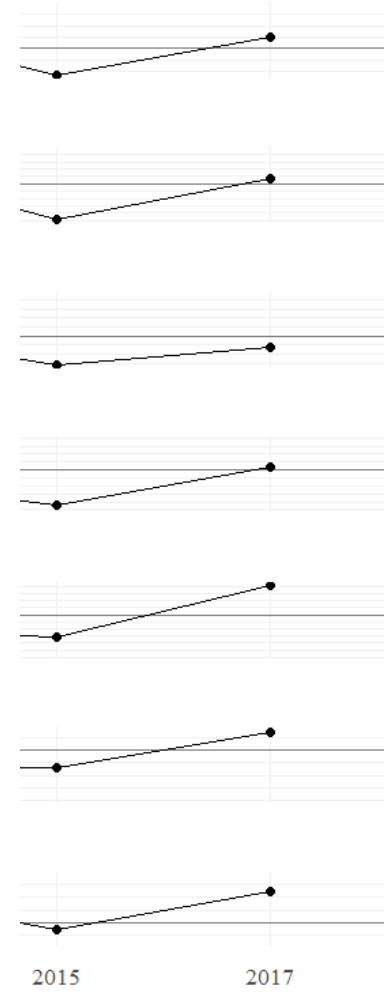
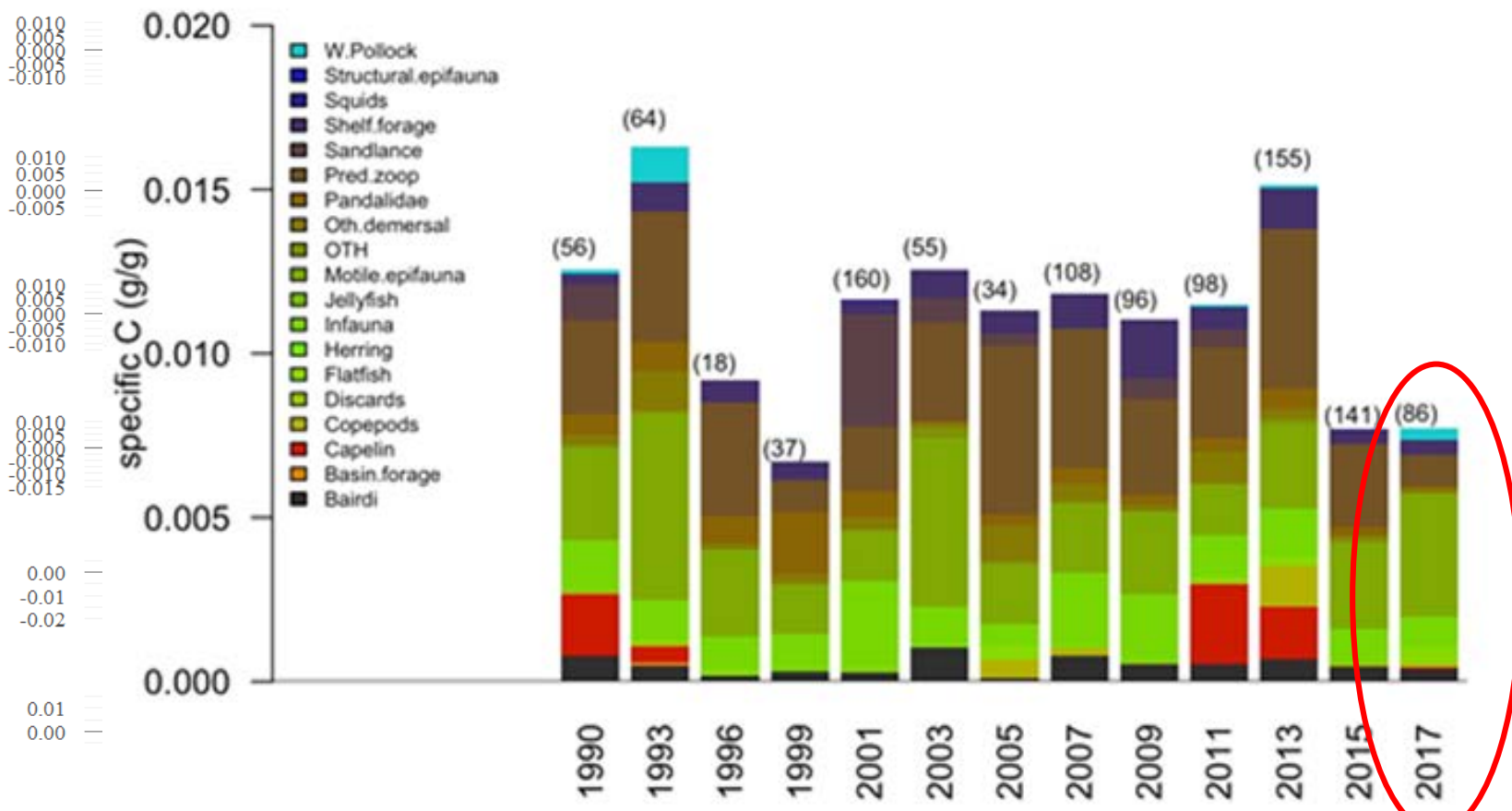


Pacific cod condition at length for bottom trawl survey



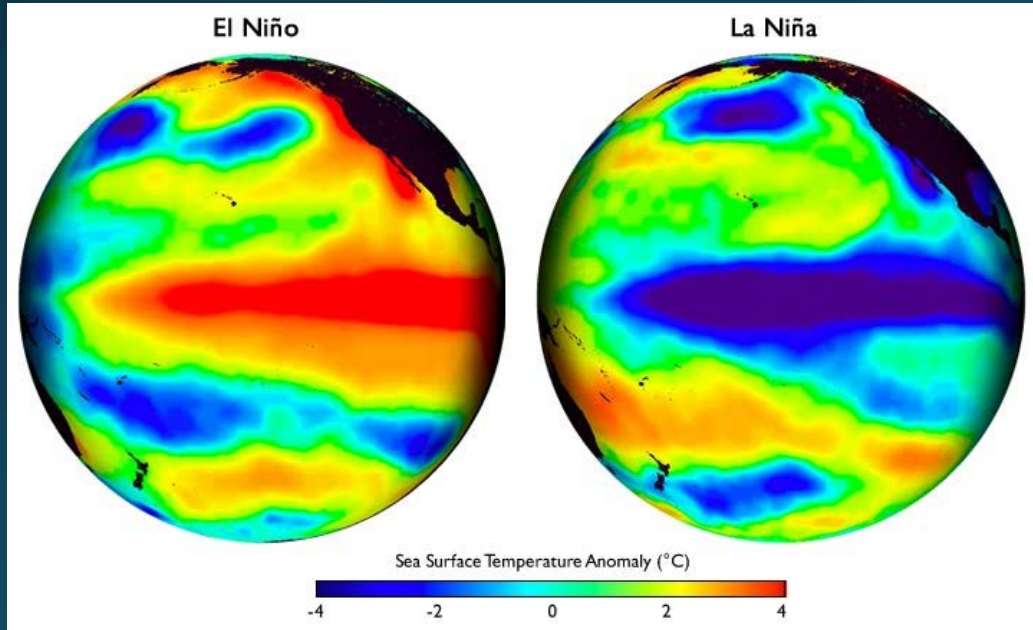
mean diet weight (g/g pred)  
20-40 cm

Condition by length category



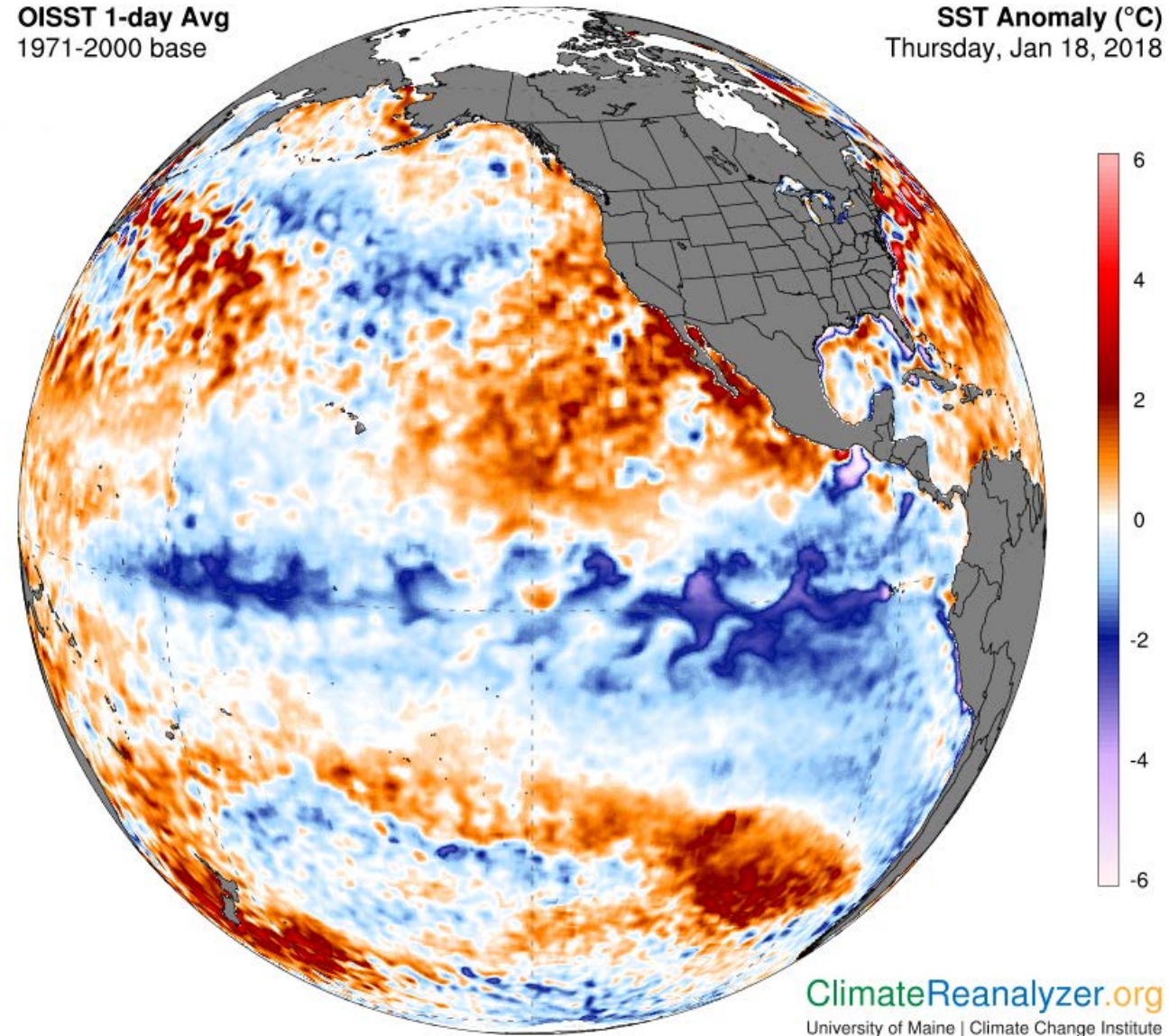
# GOA Pacific cod Future outlook

- 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

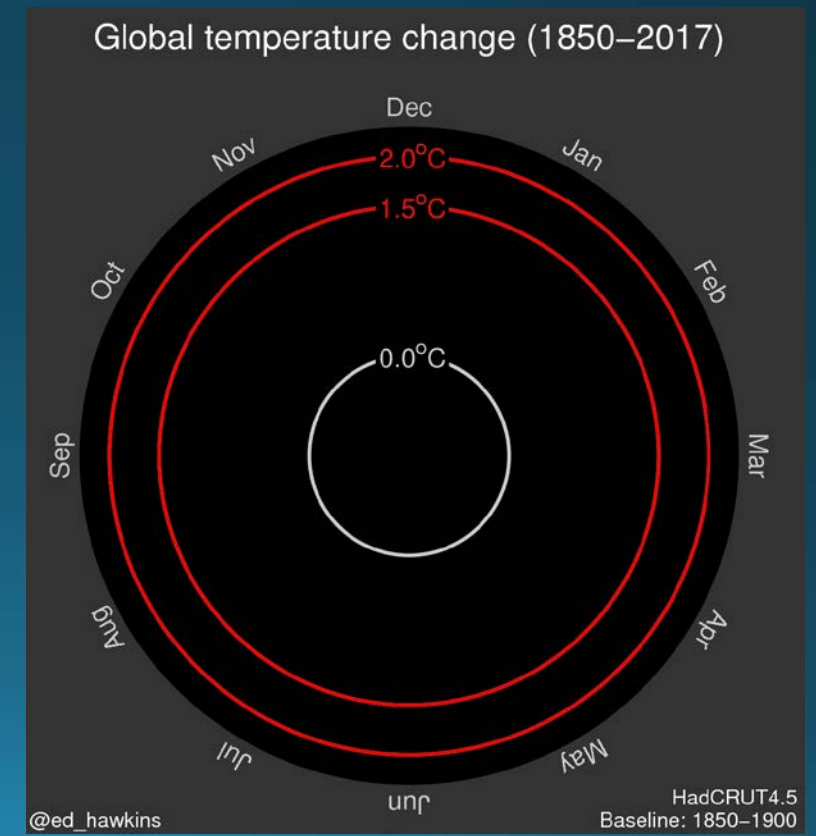
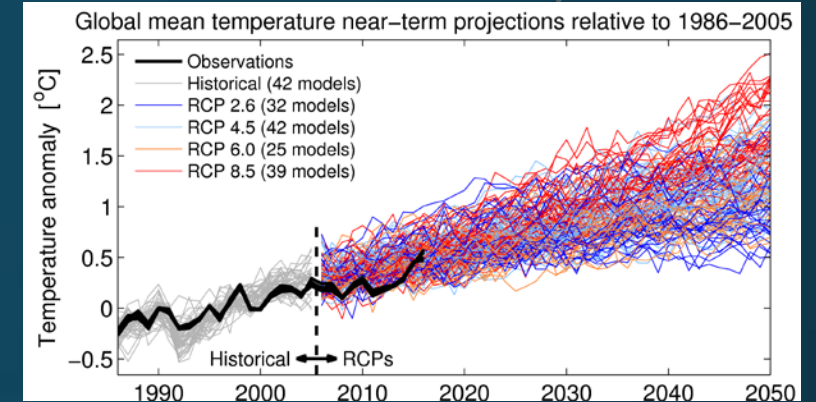
Southern Hemisphere  
+ 0.1 °C

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
$\max F_{ABC}$	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
$\max ABC$ (t)	88,342	79,272	19,401	17,634
ABC (t)	88,342	79,272	<b>18,000</b>	<b>17,000</b>
	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

