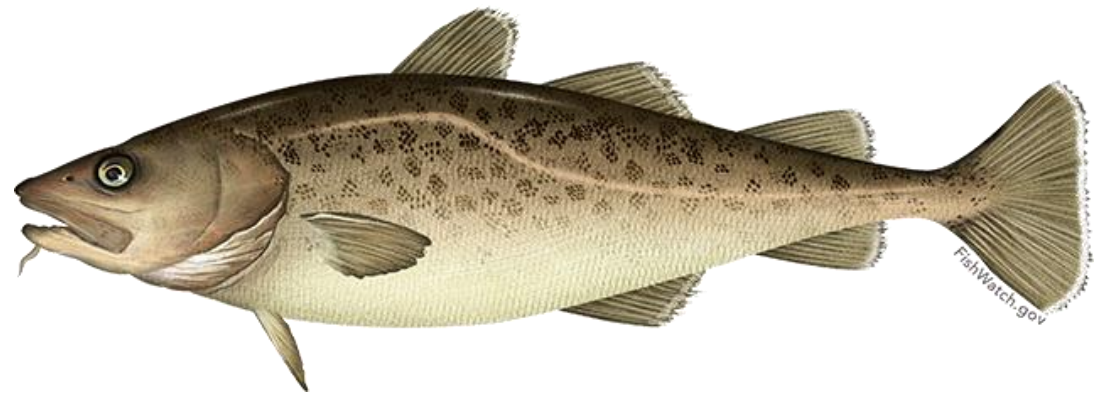
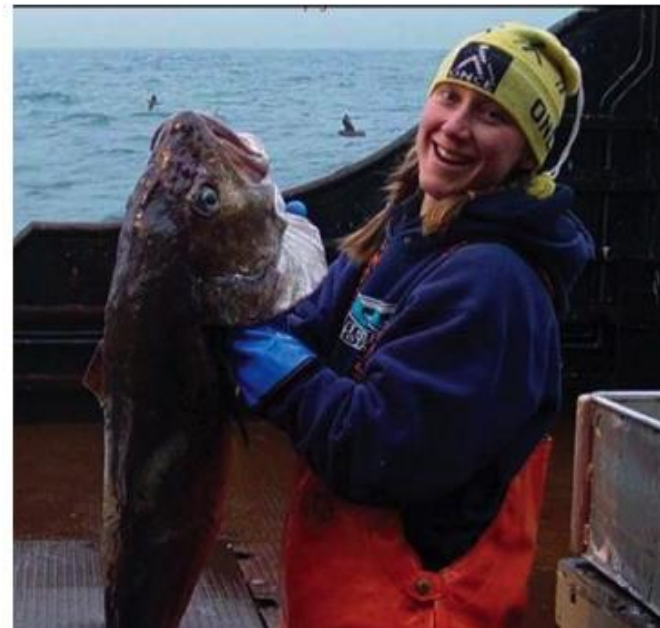


Assessment of the Pacific cod stock in the Aleutian Islands

Ingrid Spies, Grant Thompson, Ivonne Ortiz, Elizabeth Siddon, and Wayne Palsson



Summary Table

Quantity	As estimated or <i>specified</i> <i>last year for:</i>		As estimated or <i>recommended</i> <i>this year for:</i>	
	2020	2021	2021	2022
M (natural mortality rate)	0.34	0.34	0.34	0.34
Tier	5	5	5	5
Biomass (t)	80,700	80,700	80,700	80,700
F_{OFL}	0.34	0.34	0.34	0.34
$maxF_{ABC}$	0.255	0.255	0.255	0.255
F_{ABC}	0.255	0.255	0.255	0.255
OFL	27,400	27,400	27,400	27,400
$maxABC$	20,600	20,600	20,600	20,600
ABC	20,600	20,600	20,600	20,600
Status	2018	2019	2019	2020
Overfishing	No	n/a	No	n/a

Plan Team and SSC Comments

SSC December 2019

The SSC supported the authors' and GPT's recommendation for a Tier 5 status determination and the associated OFL/ABC as well as the use of the random effects model for apportionment. The SSC noted that there may be other apportionment methods if smoother outcomes are desirable such as multiple survey averaging or the use of a VAST model.

Authors' response: Noted, and no VAST models were available for Aleutian Islands stocks this year.

Plan Team and SSC Comments

SSC December 2019

There was a risk table overall score of 2 based on ecosystem concerns. Unlike the EBS, the condition factor for the AI is quite low and continues to be low. However, given the Tier 5 estimates are more conservative than what was estimated for all of the Tier 3 models presented, the SSC concluded that no ABC reduction was necessary.

Authors' response: noted.

Plan Team and SSC Comments

SSC, December 2019

There were several age-structured models presented in an appendix and we appreciate these efforts. It appears that the models were almost viable for consideration this year. We look forward to seeing a vetted alternative in September [2020] that takes into account current GPT and past SSC recommendations. In addition to those recommendations the authors should consider fitting the two maturity curves inside the model similar to some of the GOA rockfish assessments.

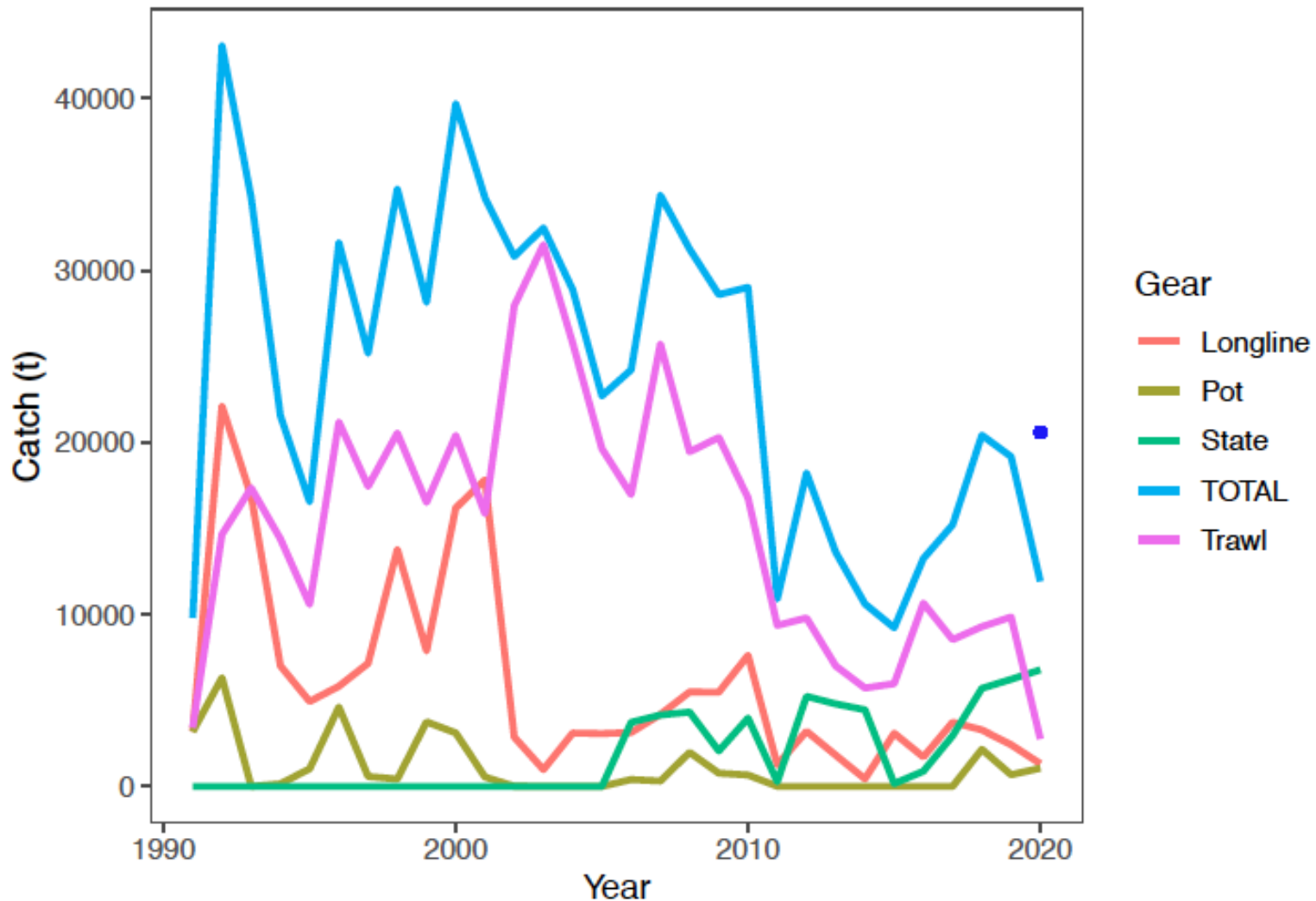
Authors' response: The age structured model was not updated this year due to COVID-19 and no new survey data. An updated age structured model will be provided when requested by Plan Team or SSC.

Estimates for harvest specifications, estimates of OFL, ABC, and M for 2021 and 2022*

Quantity	2021	2022
Biomass (t)	80,694	80,694 t
M	0.34	0.34 t
F_{OFL}	0.34	0.34
$\max F_{ABC}$	0.255	0.255
OFL (t)	27,436	27,436
$\max ABC$ (t)	20,577	20,577

*Weights rounded to the nearest hundredth for the summary table.

Aleutian Islands Pacific cod catch, 1990-2020. Blue dot = ABC for 2020.



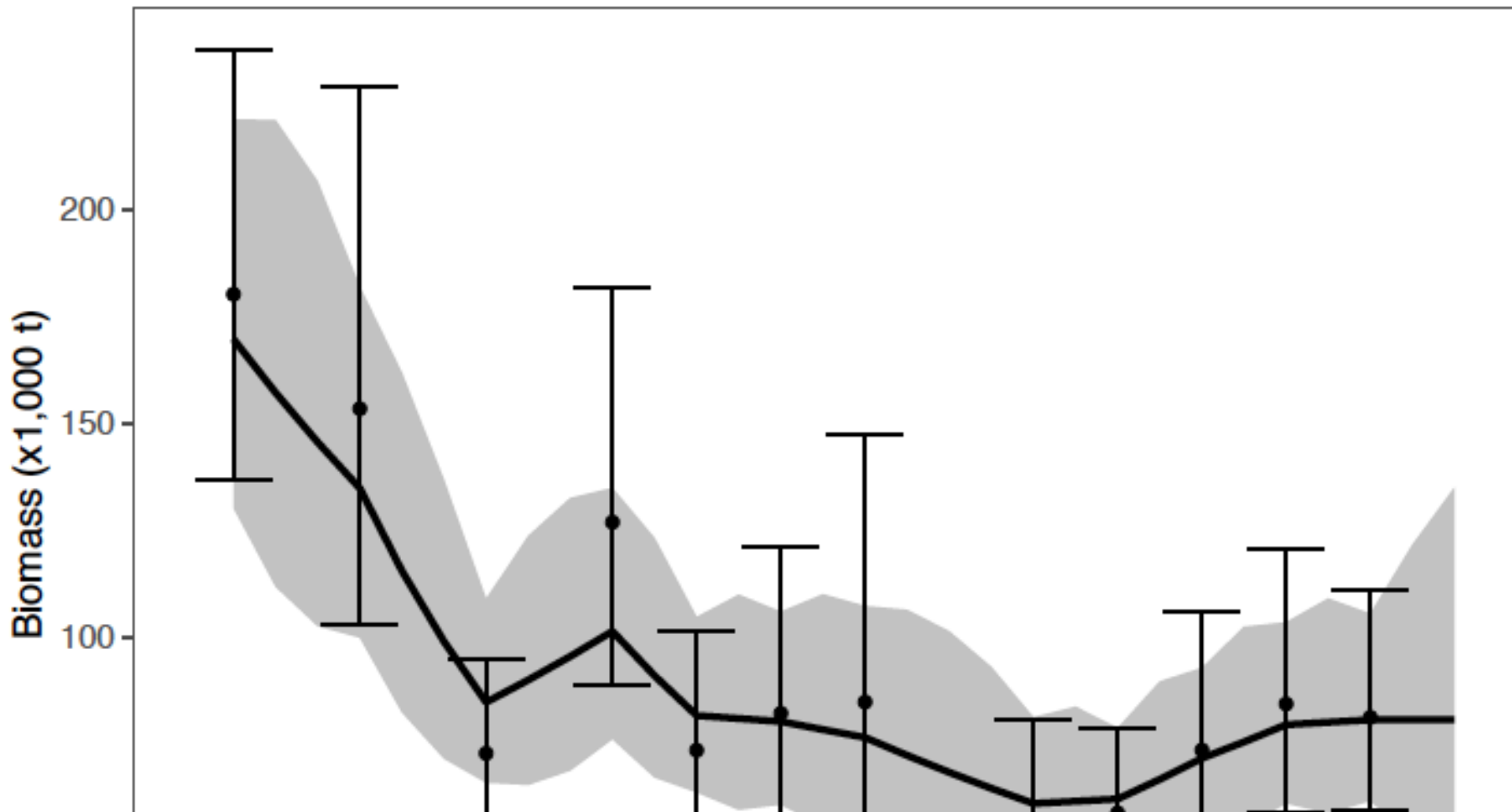
State fishery for cod in the AI is a proportion of the AI ABC

Year	Formula
2014	$0.03 * (\text{EBS ABC} + \text{AI ABC})$
2015	$0.03 * (\text{EBS ABC} + \text{AI ABC})$
2016	$0.27 * \text{AI ABC}$
2017	$0.27 * \text{AI ABC}$
2018	$0.27 * \text{AI ABC}$
2019	$0.31 * \text{AI ABC}$
2020	$0.35 * \text{AI ABC}$ or 6,804 t, whichever is less
2021	$0.39 * \text{AI ABC}$ or 6,804 t, whichever is less

Risk Table – Assessment Considerations

- Several age structured models were presented in 2019, similar to some of the age-structured models for the Aleutian Islands stock of Pacific cod that were developed between 2012 and 2016.
- Currently assessed as a Tier 5 stock.
- Assessment considerations were rated as level 1 (normal).

Fit of random effects model to survey biomass, 95% confidence intervals for the observations and estimates.



Risk Table – Assessment Considerations

The estimate of biomass that would have resulted during each of the past survey years (2010-present) with and without the recent survey biomass.

Year	No Data Estimate	True (with new survey data)	Difference
2018	79,511 t	80,694 t	-1183 t
2016	68,870 t	79,511 t	-10,641 t
2014	59,036 t	68,870 t	-9,834 t
2012	59,109 t	59,036 t	74 t
2010	83,561 t	59,109 t	24,452 t

Risk Table – Population Dynamics

- Although the long-term (1991-2018) survey biomass trend is downward, the trend since 2010 has been largely positive.
- Population dynamics considerations were rated as level 1 (normal).

Risk Table - Environmental/Ecosystem Considerations

- Pacific cod are typically found between 3.5–5.7°C in the Aleutian Islands survey.
- 100–250 m temperatures warmer than normal since 2016.
- Residual conditions from the 2014–2016 GOA heatwave.
- Days with high SST above the heatwave threshold >since 2013–2014 throughout the Aleutians.
- The number of heatwave days declined in 2020 compared to 2019, which was a record warm year in the eastern AI.
- The pattern of heatwave years differs from GOA.

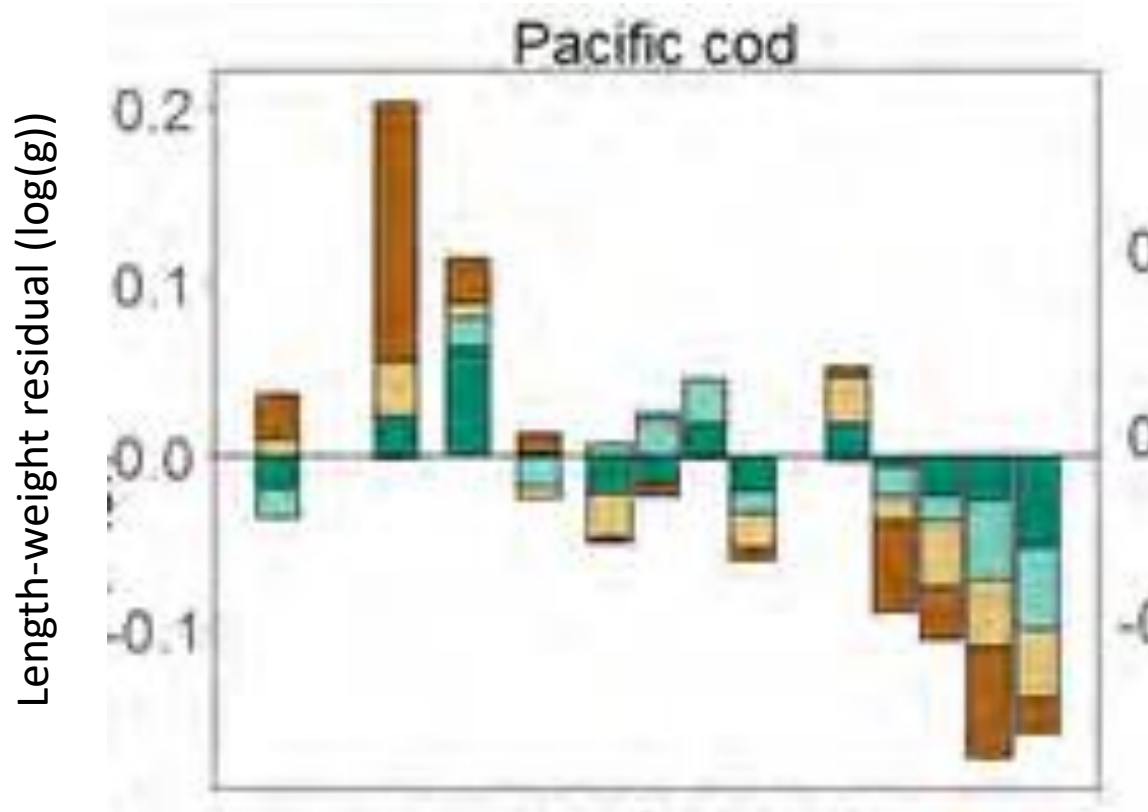
Risk Table - Environmental/Ecosystem Considerations

- Diet decreases in Atka mackerel in western and central AI over the past few years.
- Also declining biomass and body condition of Atka mackerel in these areas, potentially reflecting scarcer and lower quality prey available.
- Eastern AI: Atka mackerel increased to >20% of Pacific cod diet by biomass since 2014.

Risk Table - Environmental/Ecosystem Considerations

- Availability may have decreased: the combined proportion of pelagic predators is currently dominated by rockfish (POP and Northern Rockfish).
- Atka mackerel and walleye pollock previously comprised the larger proportion of this group across AI.
- Pacific cod is a generalist, can switch between fish and benthic crustacean prey.
- Body condition from 2012-2018 was lower than the 1984-2018 survey average.

Aleutian Islands Pacific cod body condition (length-weight residual)



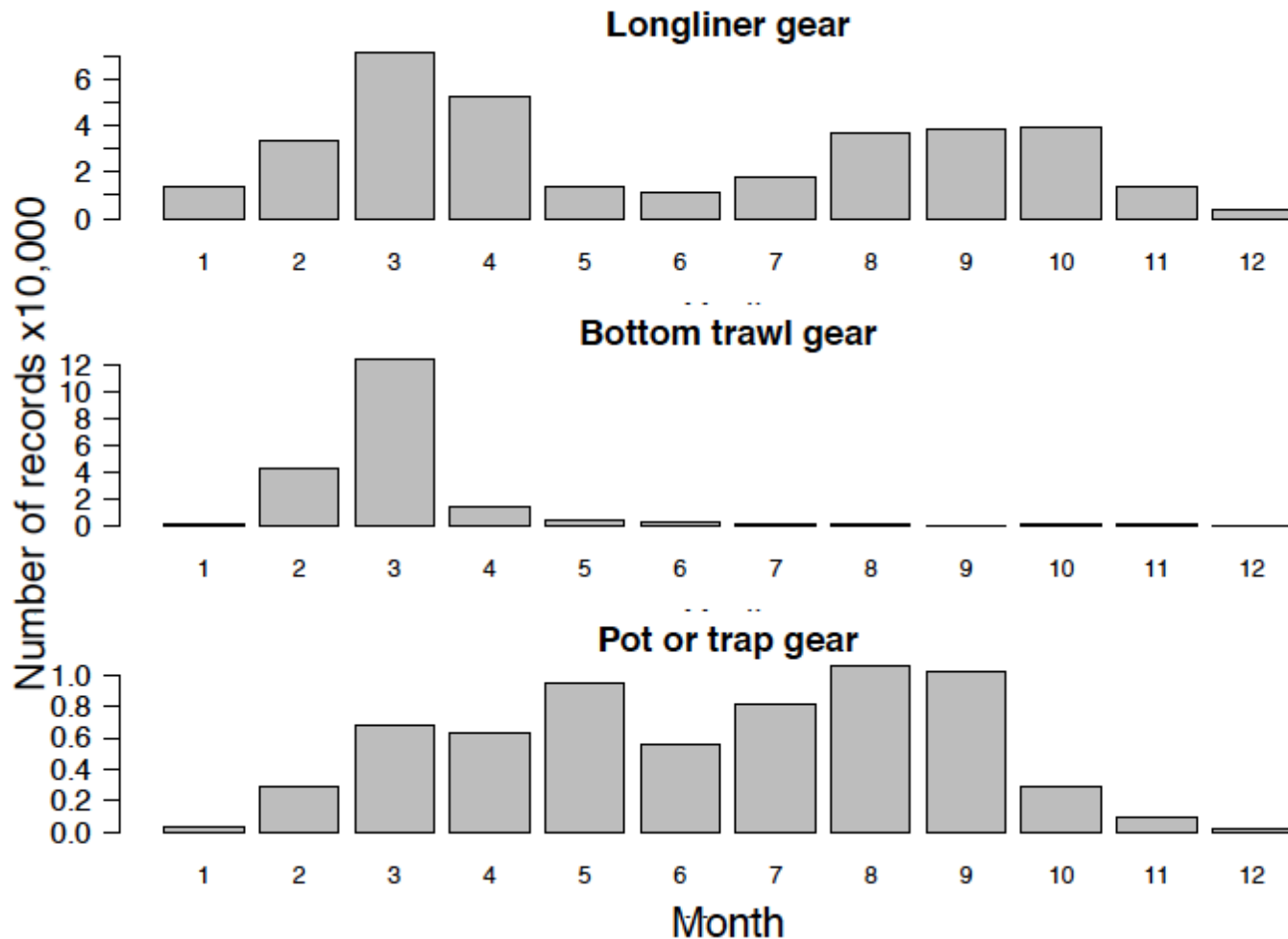
Risk Table - Environmental/Ecosystem Considerations

- Updated diet for Pacific cod (not consistent across all areas).
- Recent increased warm temperatures are of particular concern for Pacific cod.
- Environmental/ecosystem considerations were rated as level 2 (substantially increased concern).

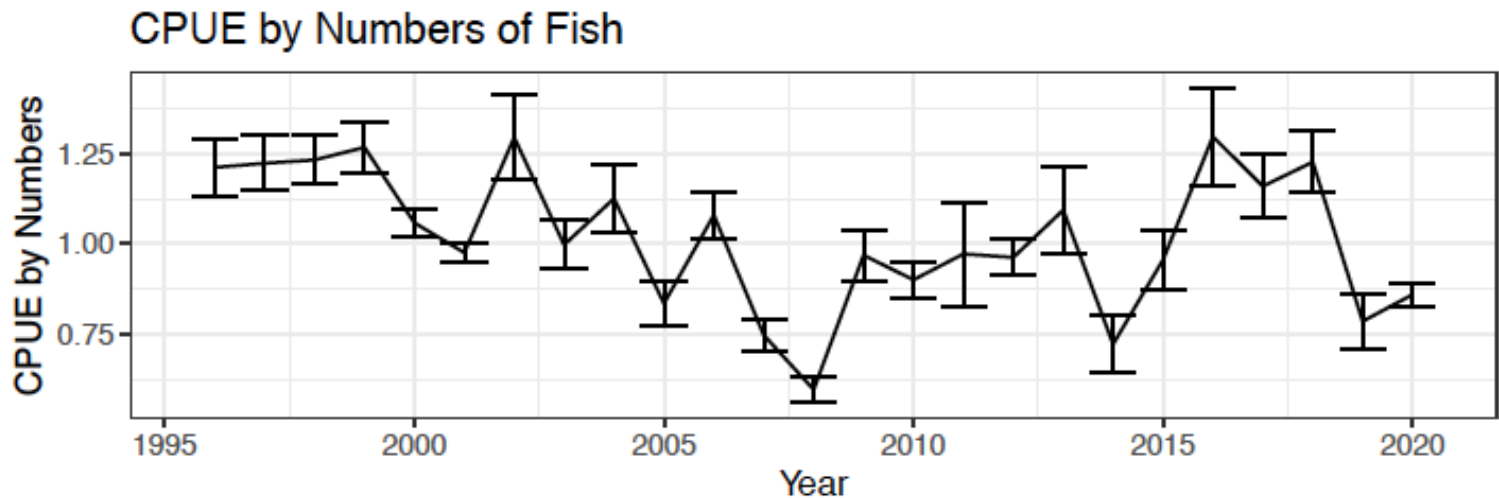
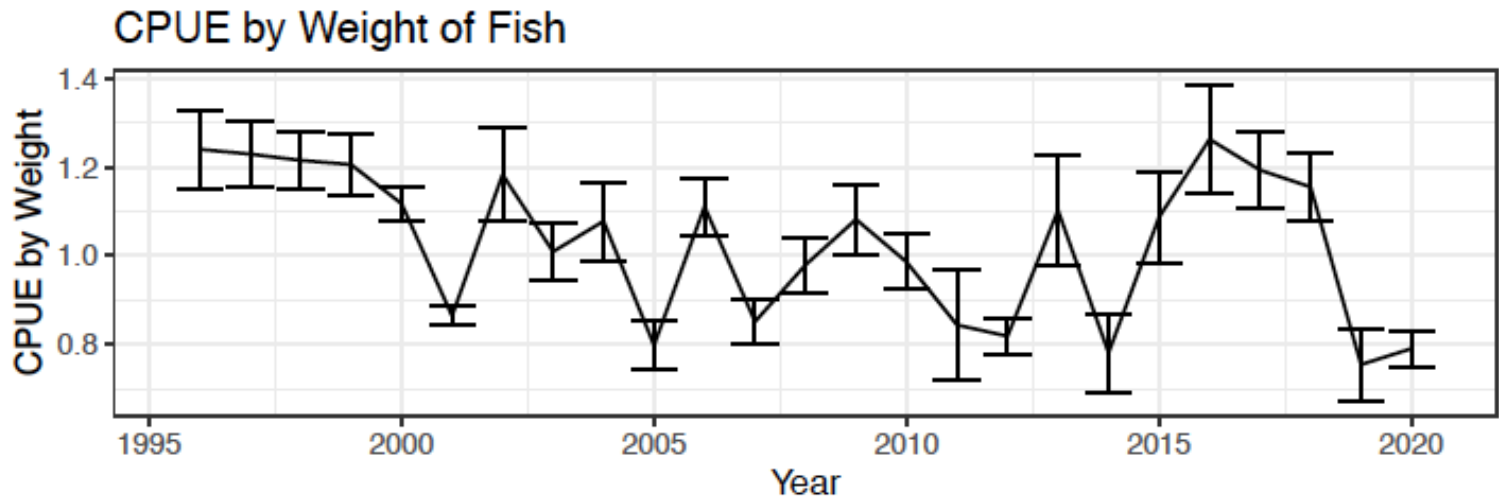
Risk Table - Fishery Performance Considerations

- The winter fishery targets spawning populations of Pacific cod.
- The relationship between stock size and CPUE is uncertain and should not be used to draw conclusions about stock size.
- Fishery performance considerations were rated as level 1 (normal).

Proportion of fishery lengths taken by month by each gear type, 1990-2018.



CPUE for all AI cod fisheries, relative to long-term average, 1996-2020.



Risk Table – no reduction in ABC

Assessment consideration	Population dynamics	Environmental ecosystem	Fishery performance	Overall
Level 1: Normal	Level 1: Normal	Level 2: Substantially increased concern	Level 1: Normal	Level 2: Substantially increased concern

In 2019 the risk table score was 2 and SSC concluded that no ABC reduction was necessary because Tier 5 estimates are more conservative than Tier 3 models presented in 2019.

Conclusions

Quantity	As estimated or <i>specified</i> <i>last year for:</i>		As estimated or <i>recommended</i> <i>this year for:</i>	
	2020	2021	2021	2022
M (natural mortality rate)	0.34	0.34	0.34	0.34
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$maxABC$	20,600	20,600	20,600	20,600
ABC	20,600	20,600	20,600	20,600
Status	2018	2019	2019	2020
Overfishing	No	n/a	No	n/a

What is the future of the Tier 3 age structured model for AI Pacific cod?

