2023 Pribilof Islands Blue King Crab Stock Assessment and Fishery Evaluation

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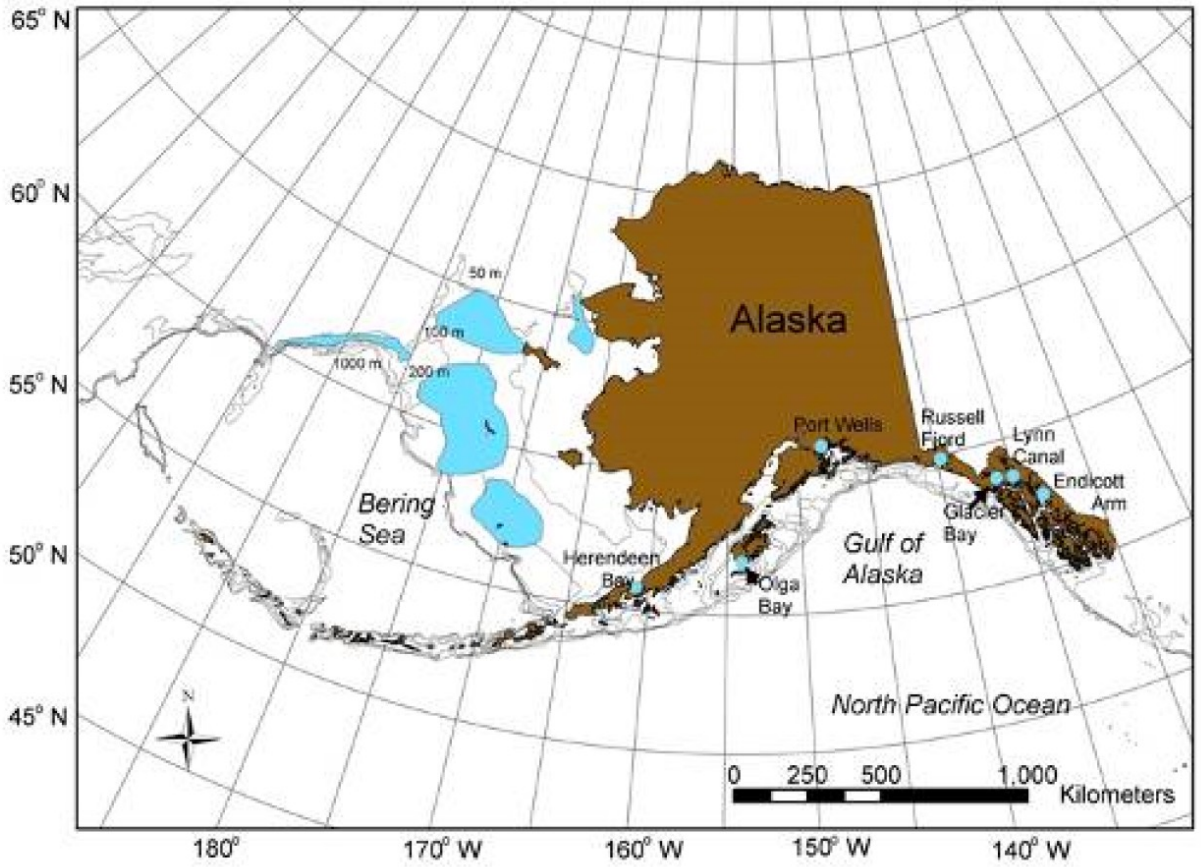
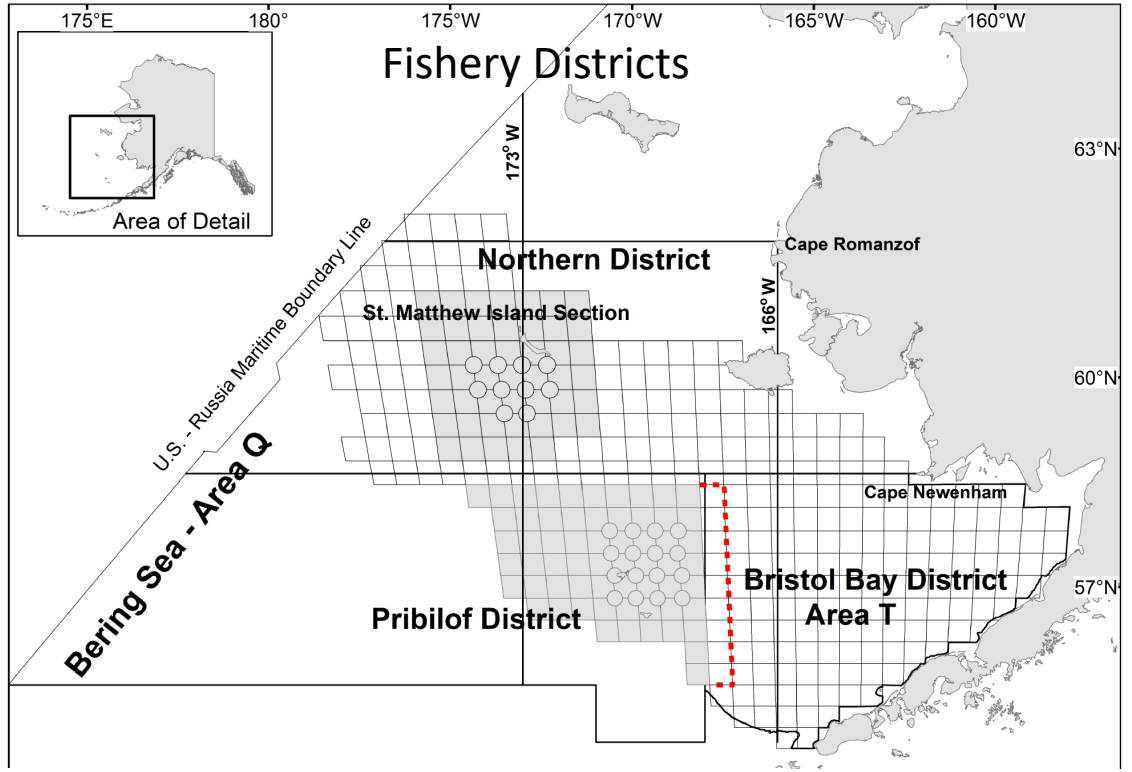
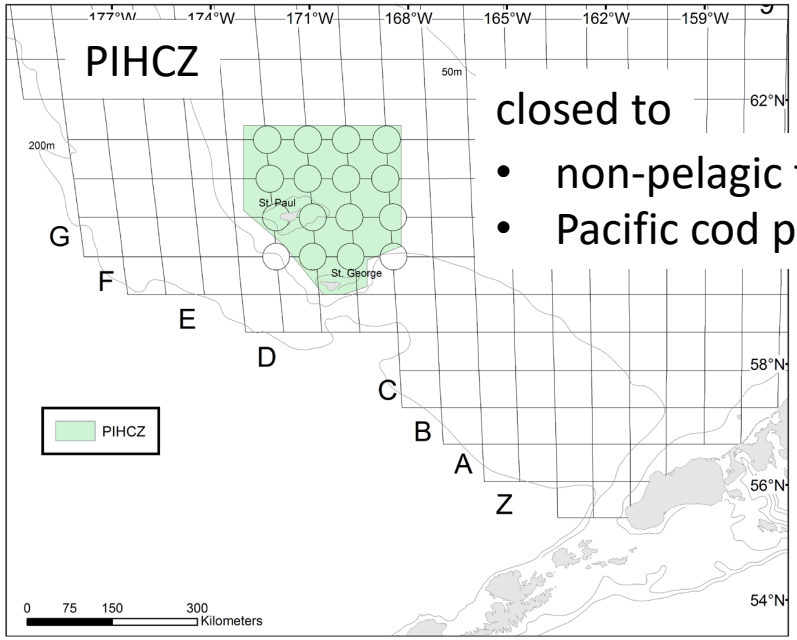
AFSC/NMFS

September 5, 2023

Stock Distribution







closed to

- non-pelagic trawl gear
- Pacific cod pot gear

Assessment Summary

2022/23 Fisheries

- no retained catch
- no bycatch in crab fisheries
- 0.25 t mortality in groundfish fisheries

2023 Survey

- 86 stations
- NO mature/legal males (-2)
- 2 immature/sublegal males (+2)
- 7 mature females (1 station) (~)
- 0 immature females (~)
- Do we need a different survey?

Stock status

- Tier 4 determination: 4c
- stock is overfished
- overfishing is not occurring

Year	MSST	Biomass	TAC	Retained Catch	Total Catch Mortality	OFL	ABC
2020/21	2,049	181	closed	0	0	1.16	0.87
2021/22	2,098	235	closed	0	0.102	1.16	0.87
2022/23	2,098	180	closed	0	0.25	1.16	0.87
2023/24	–	181	closed	–	–	1.16	0.87
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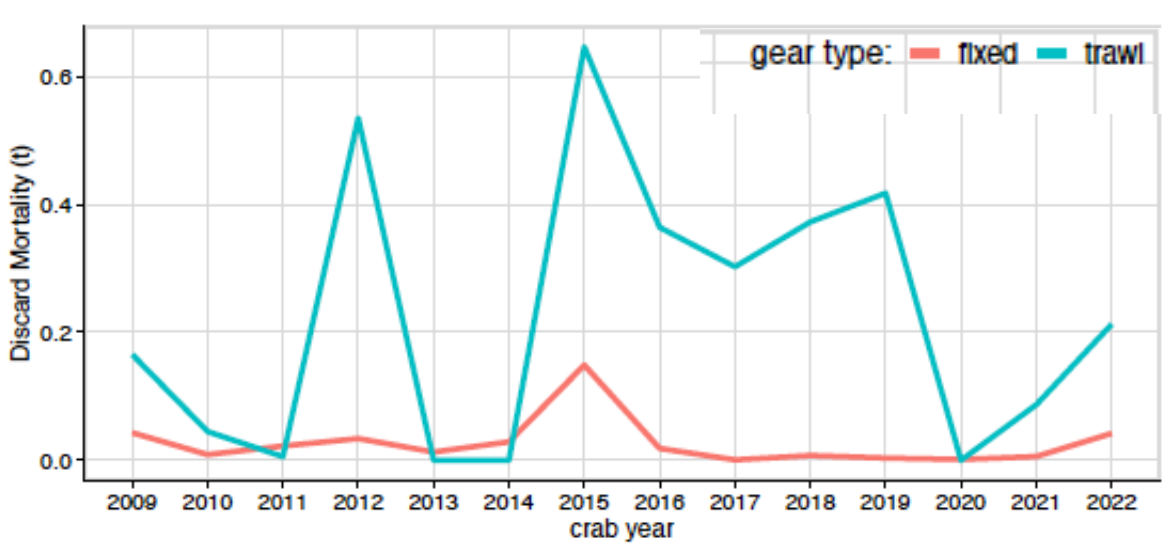
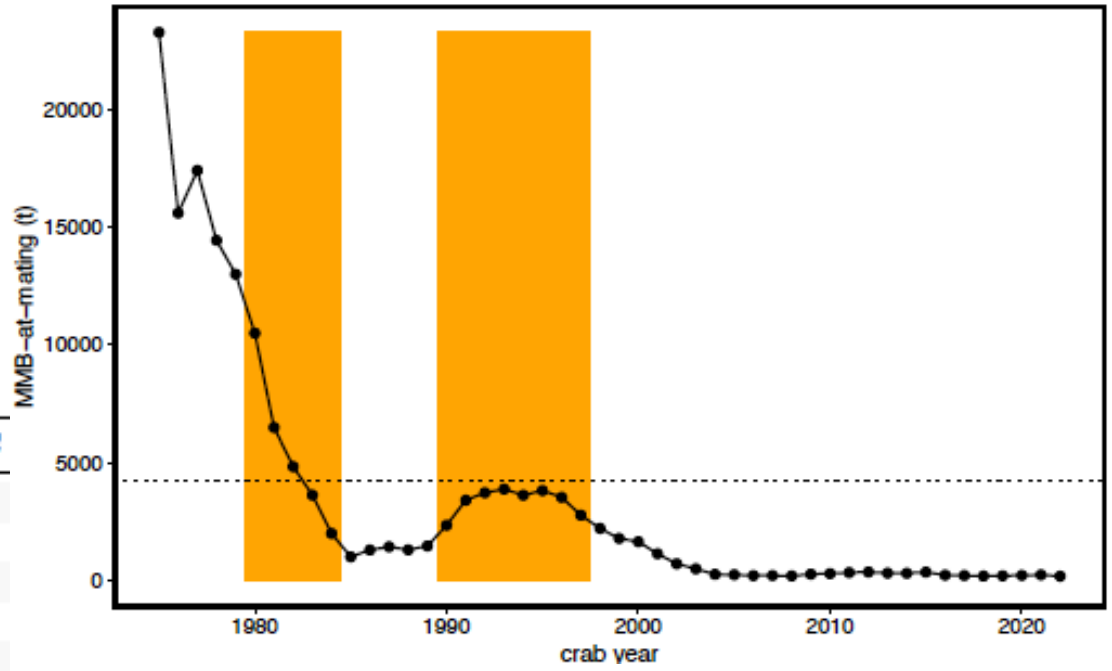




CPT and SSC Comments

May/June 2023

- The CPT and SSC agreed (following the author's recommendation) with the change to use the ***rema*** R package for the assessment.
- *response: done!*

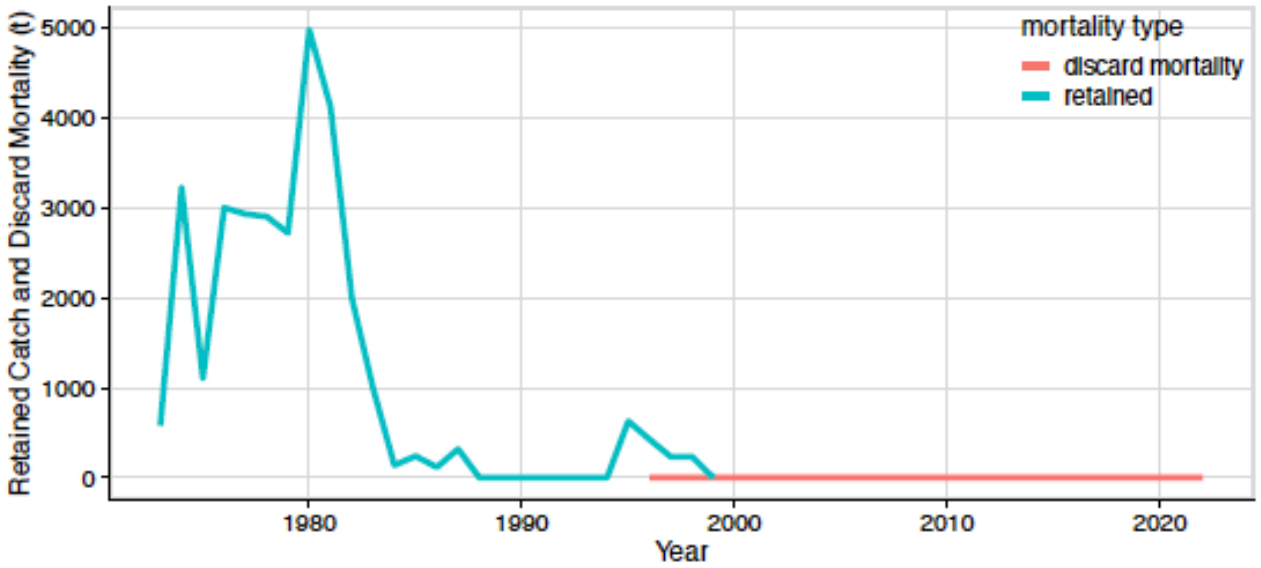
- The SSC also looks forward to the SAFE section on rebuilding in September as the rebuilding plan nears its second decade.
- *response: The revised (2014) rebuilding plan does not have a target rebuild date and NMFS cannot predict when or if rebuilding will occur. In April 2022, the last time a determination of overfished status was made was made, the Regional Administrator determined that PIBKC was "not making inadequate progress" towards rebuilding.*

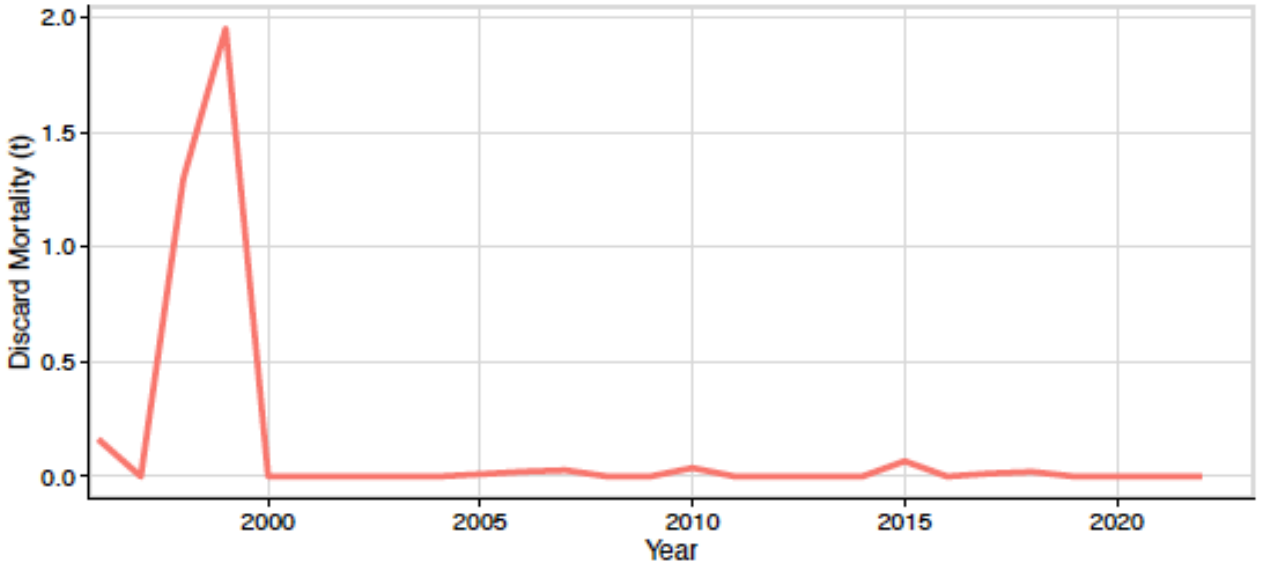
May/June 2021

- The SSC looks forward to the report on the blue king crab stock structure template in the near future.
- *response: staff capacity has not permitted progress on this request.*

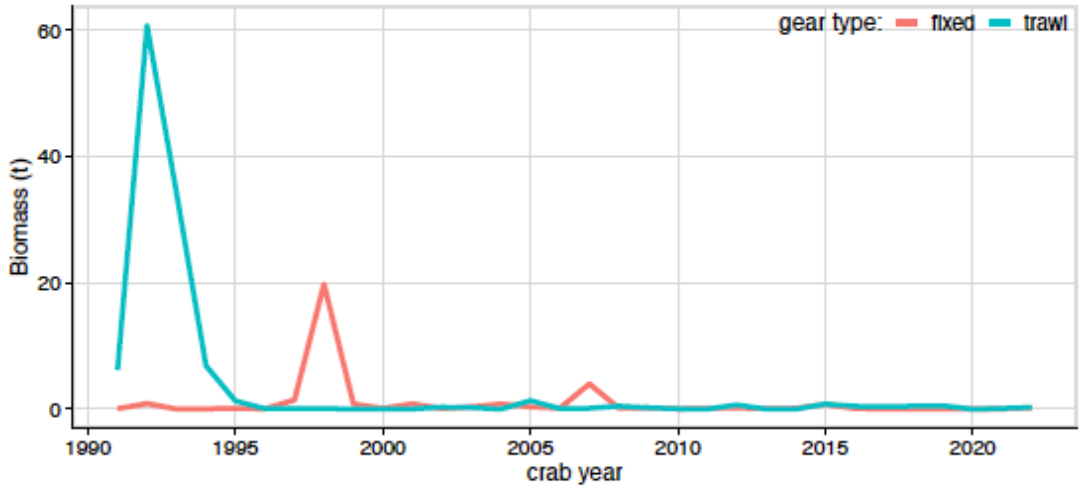
Catch in crab fisheries

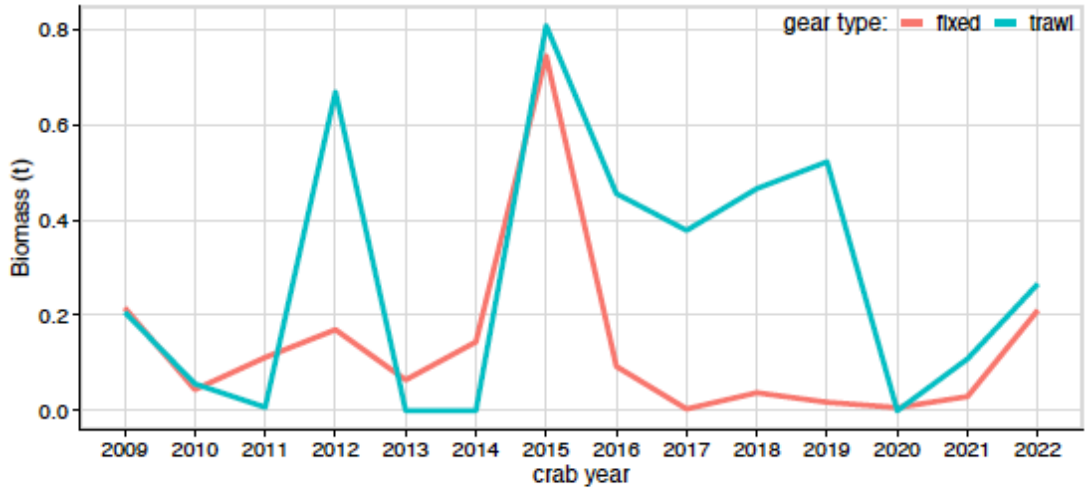
- directed fishery closed since 1999
- bycatch taken in Tanner crab fishery
  - excluded from “home plate”
  - no bycatch since 2018/19
  - no bycatch 11 of last 18 years
  - max bycatch 0.33 t in 2015/16

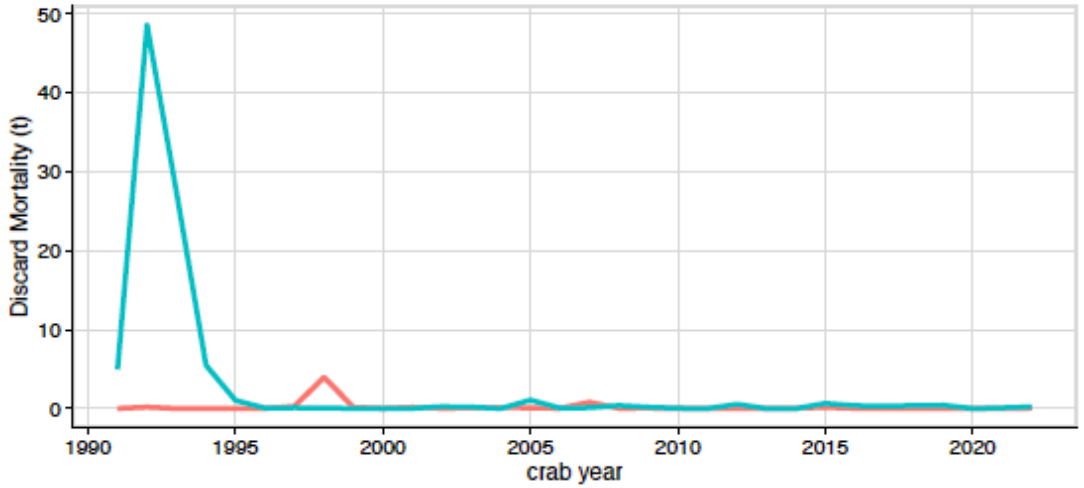


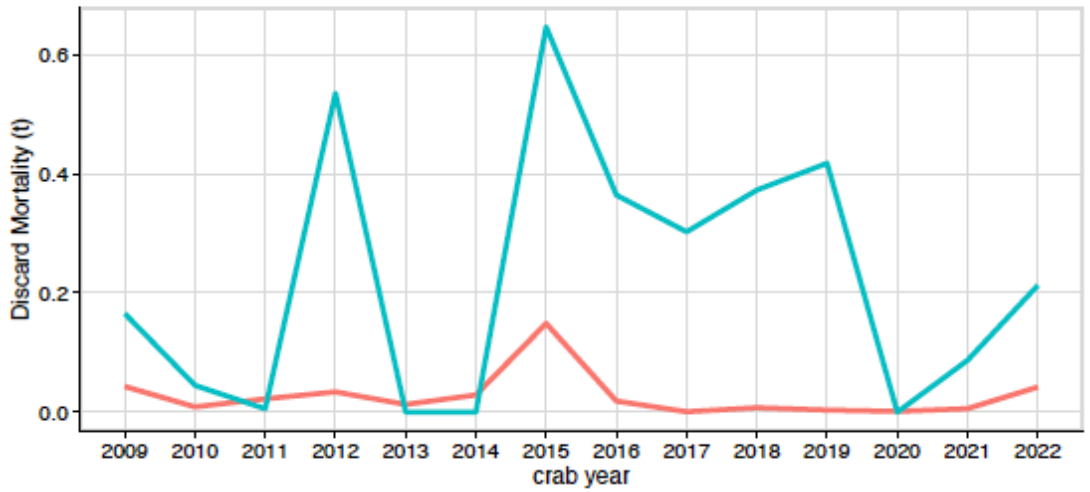


Bycatch in groundfish fisheries









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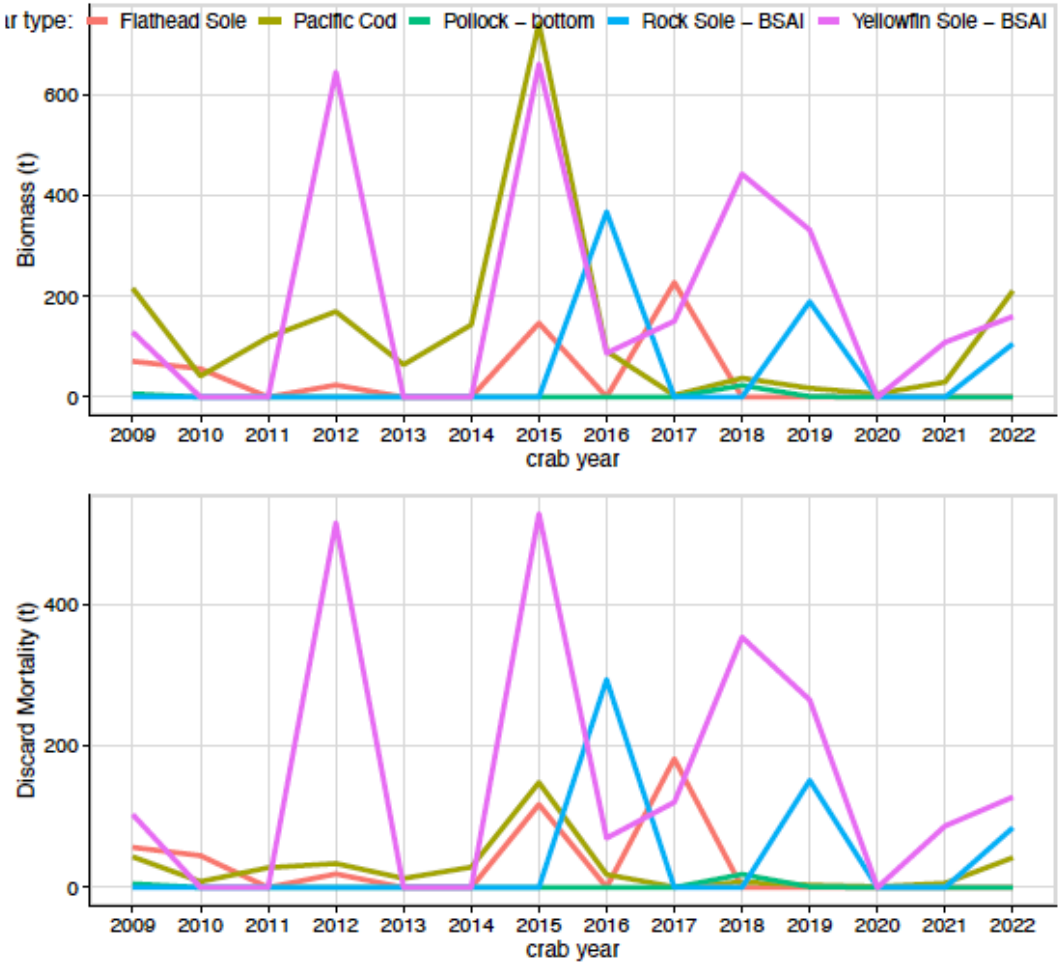
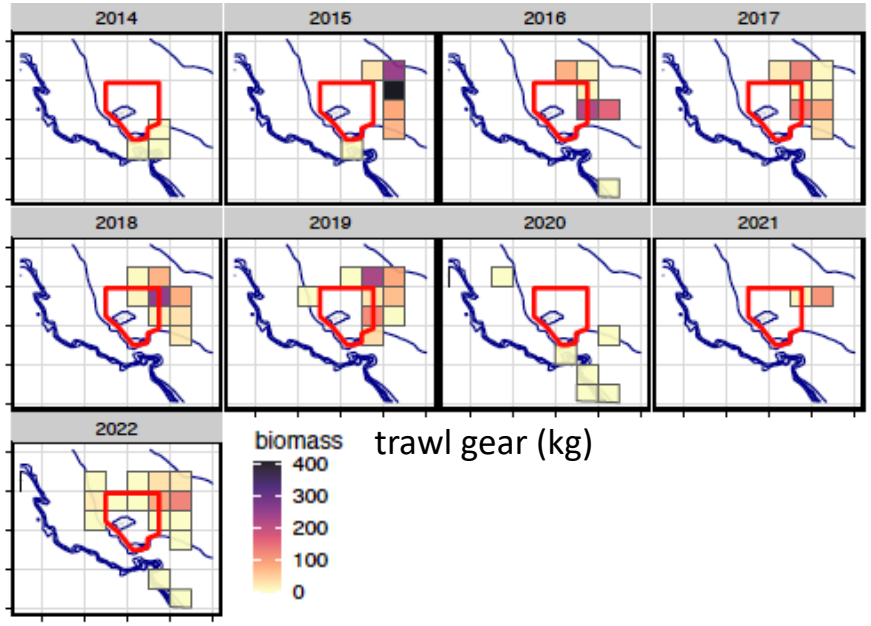
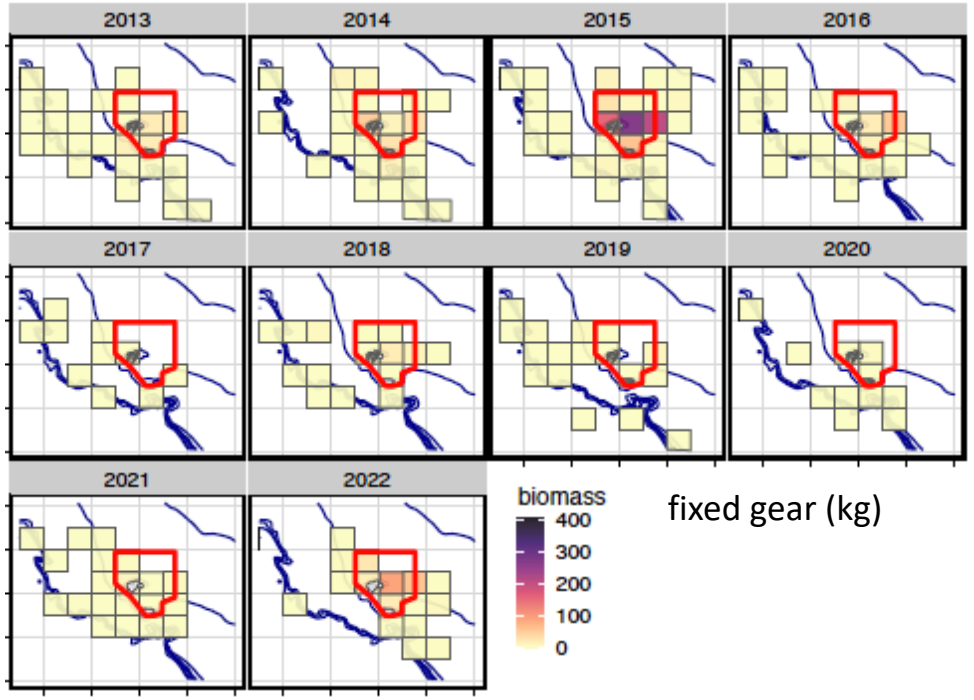


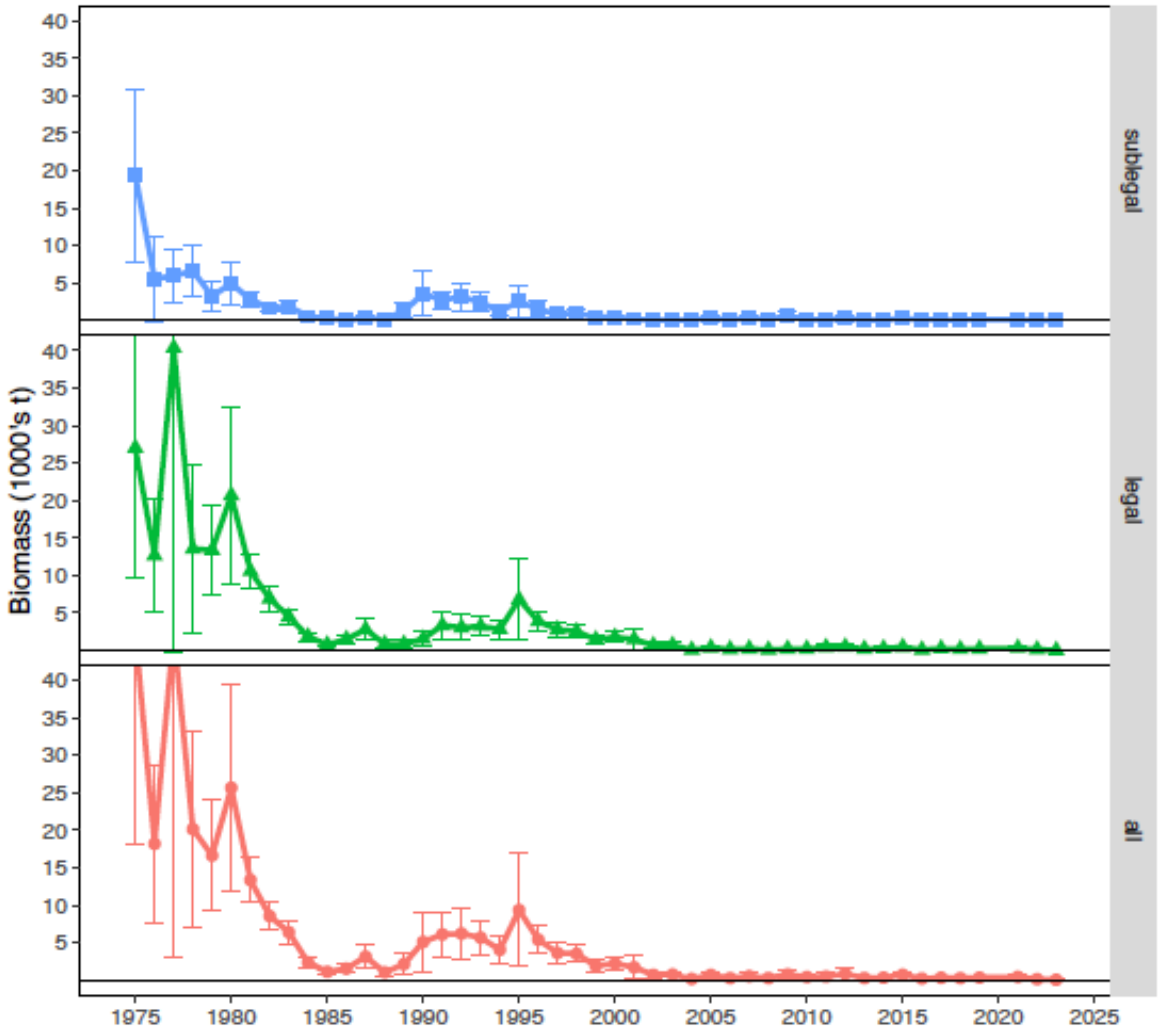


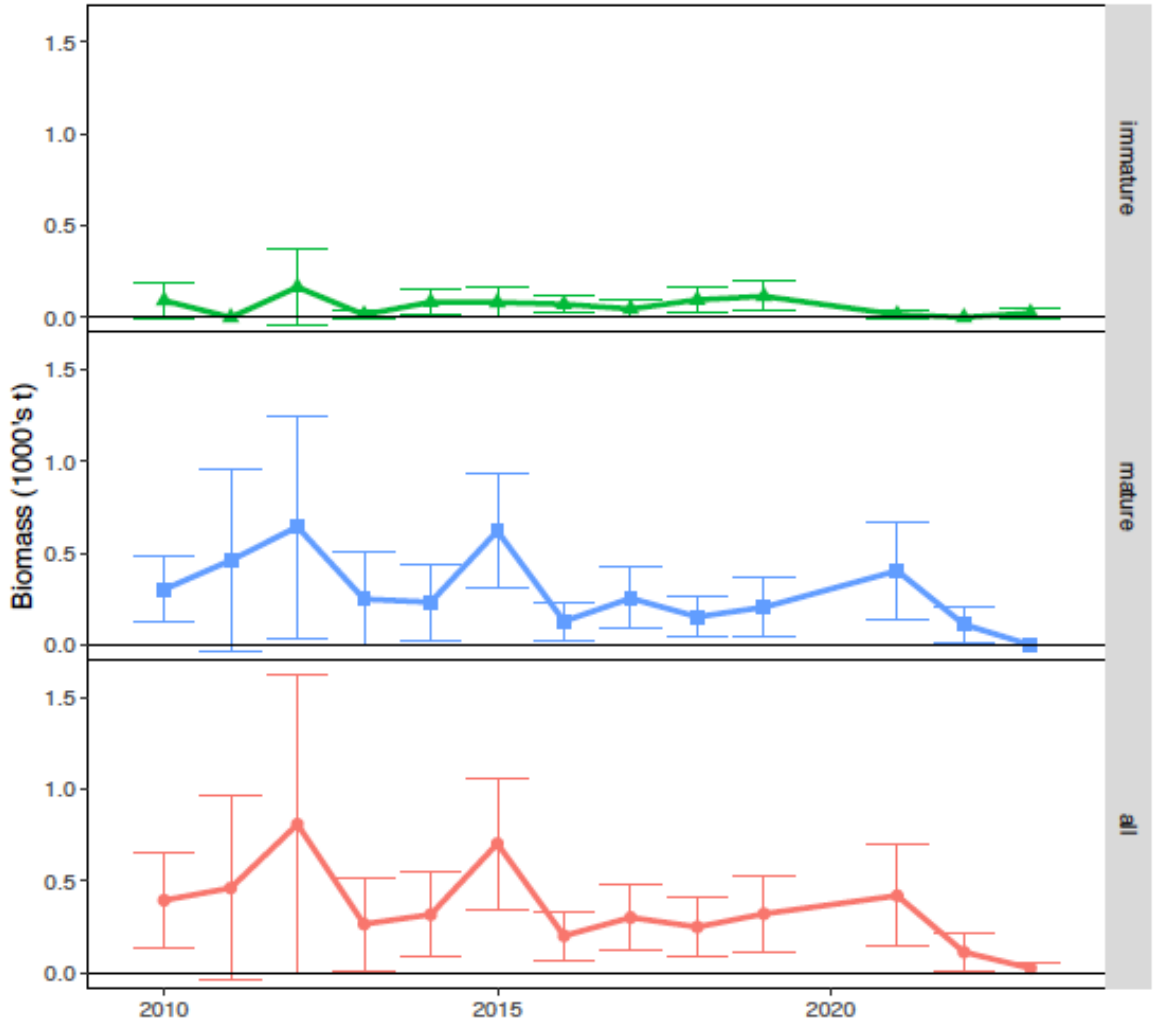
trawl gear (kg)



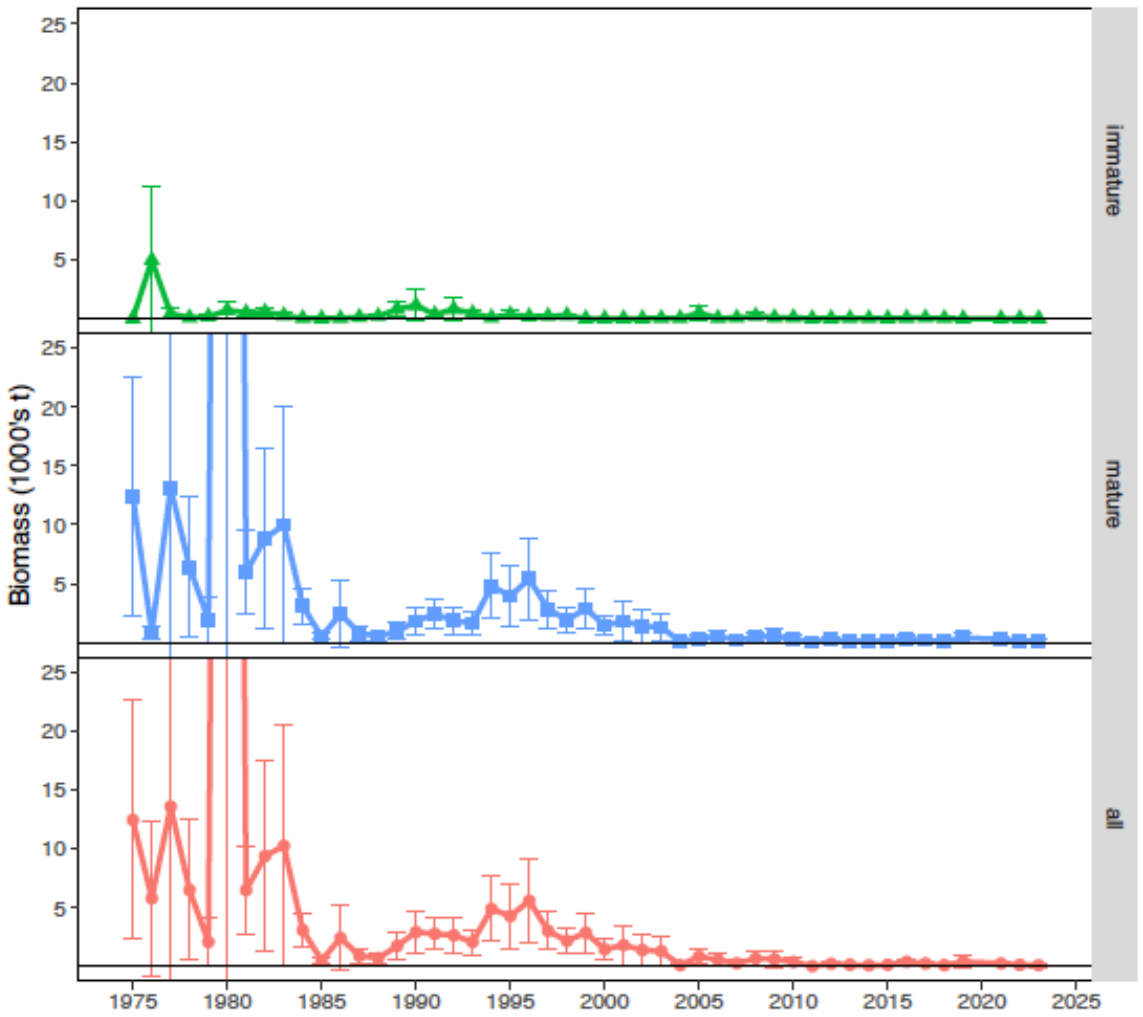
fixed gear (kg)

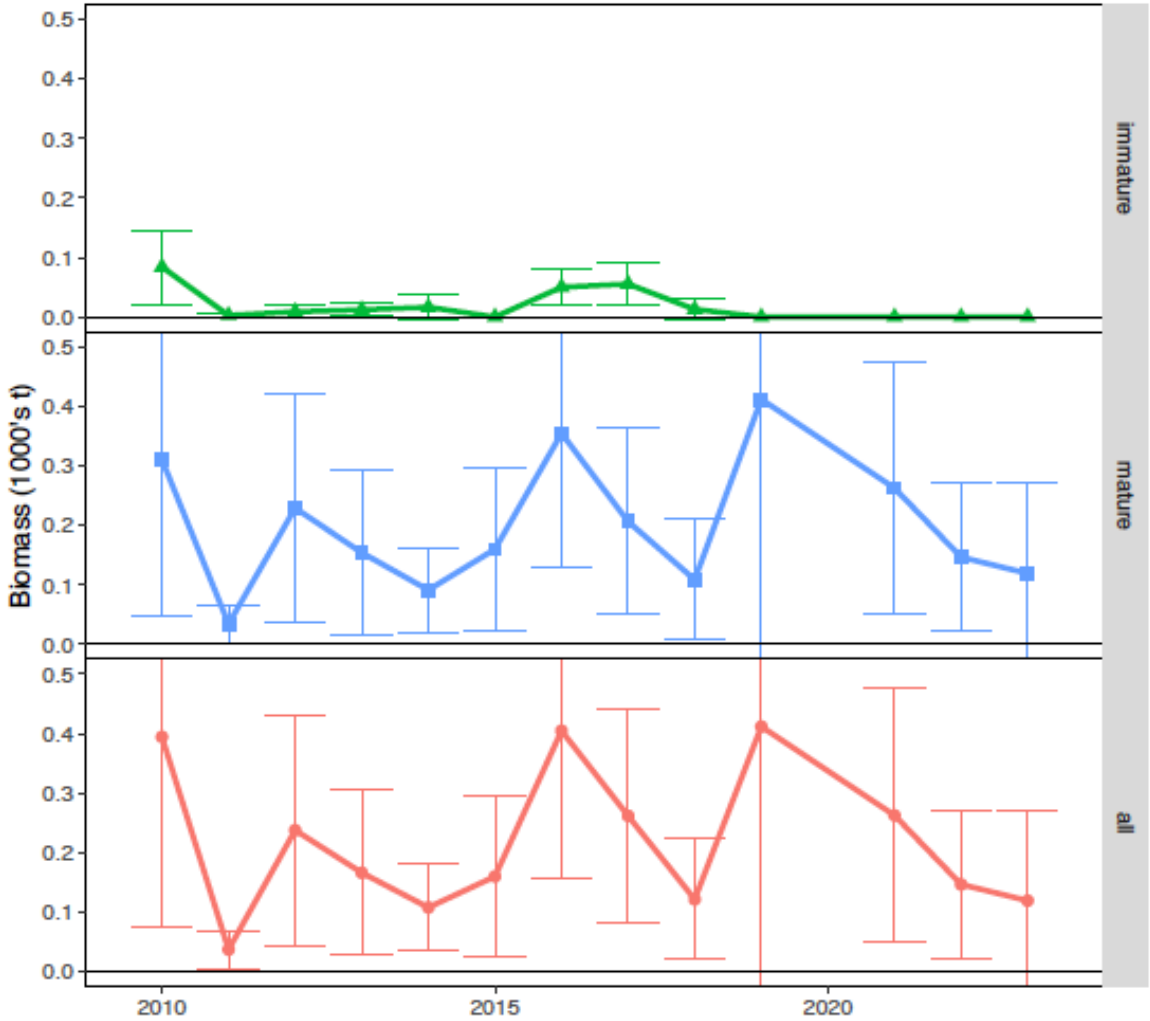
Survey Trends (male biomass)



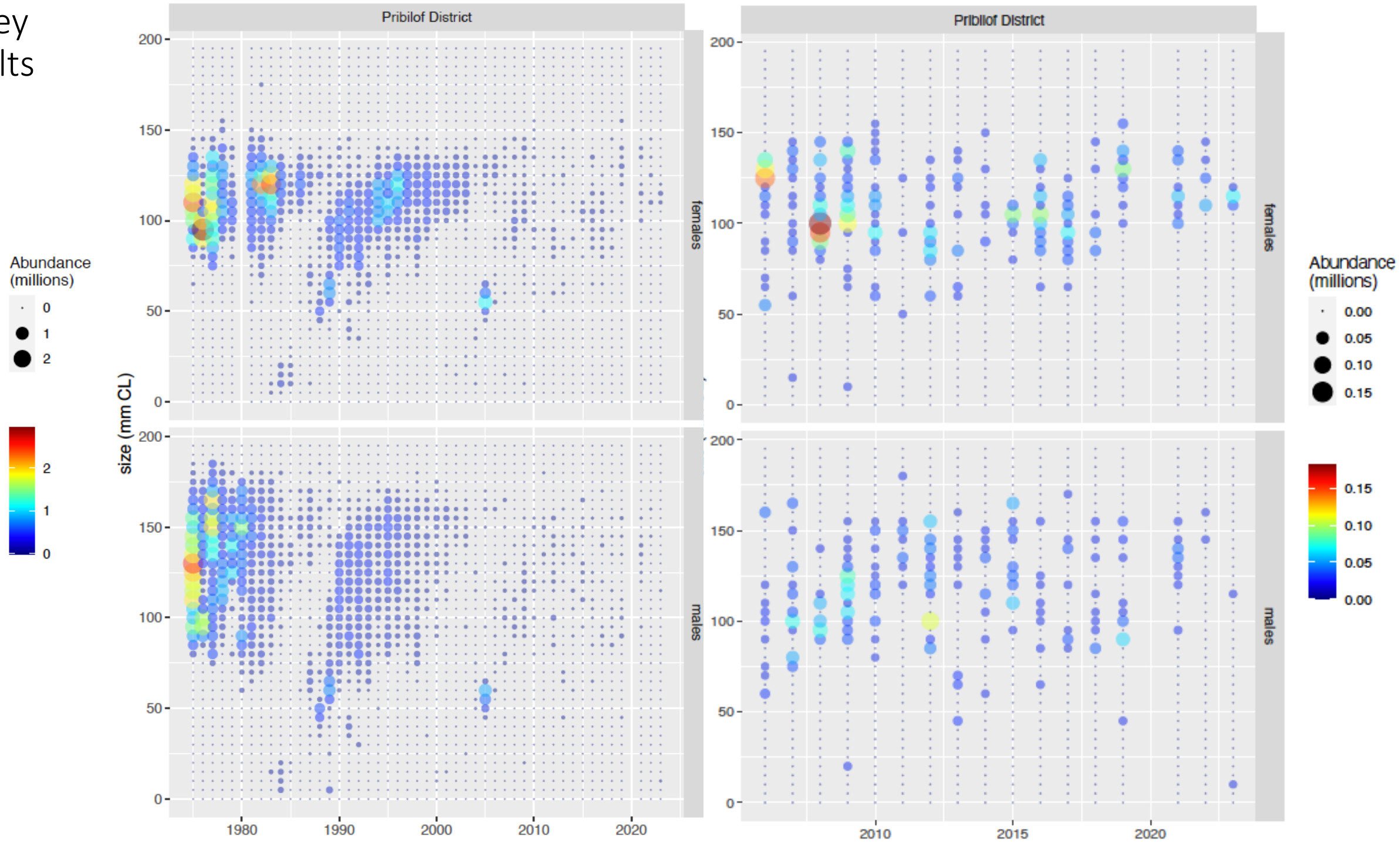


Survey Trends (female biomass)

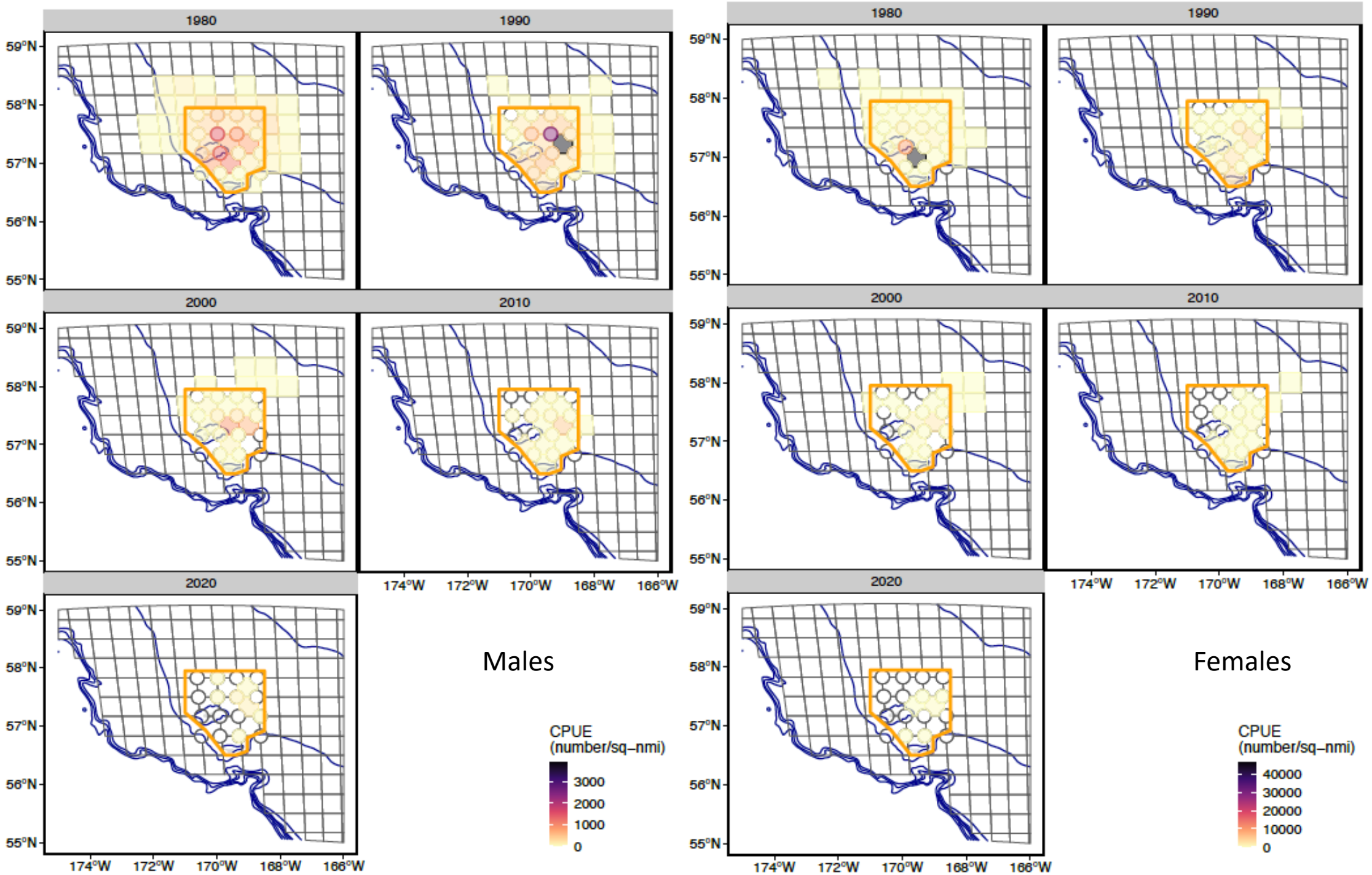




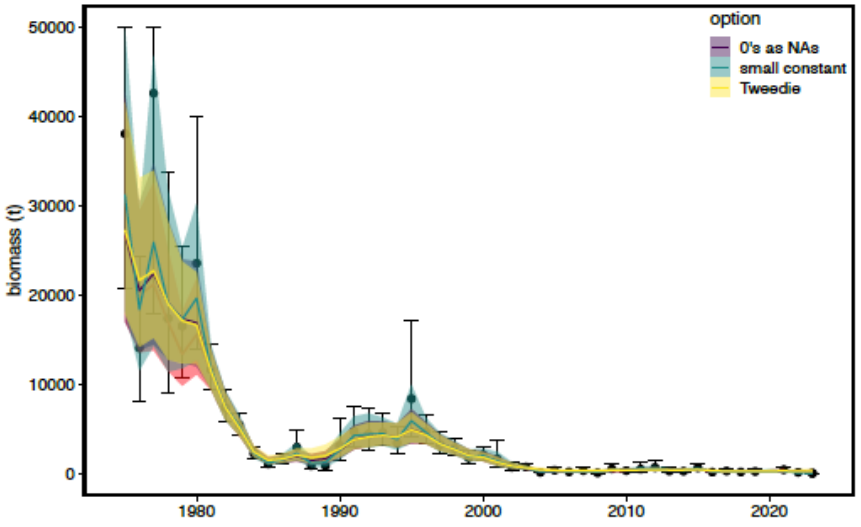
Survey Results

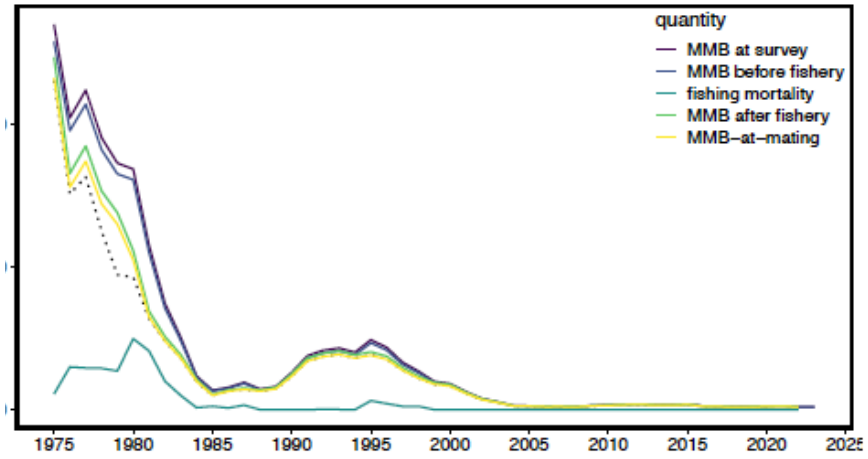


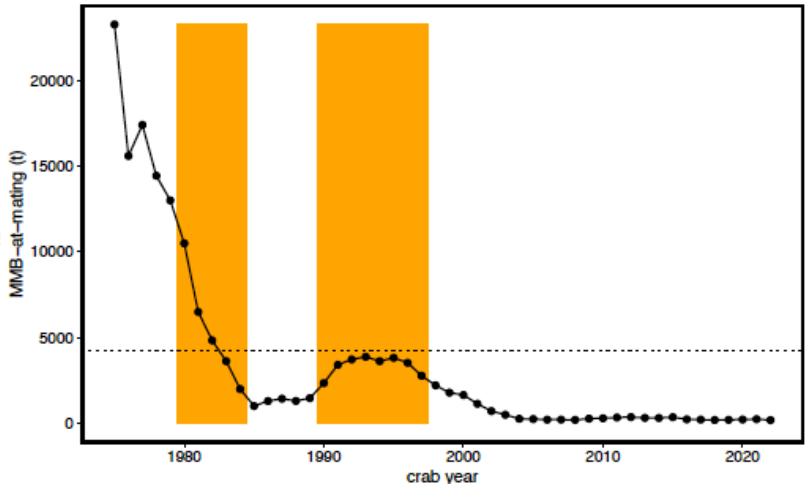
Survey Trends

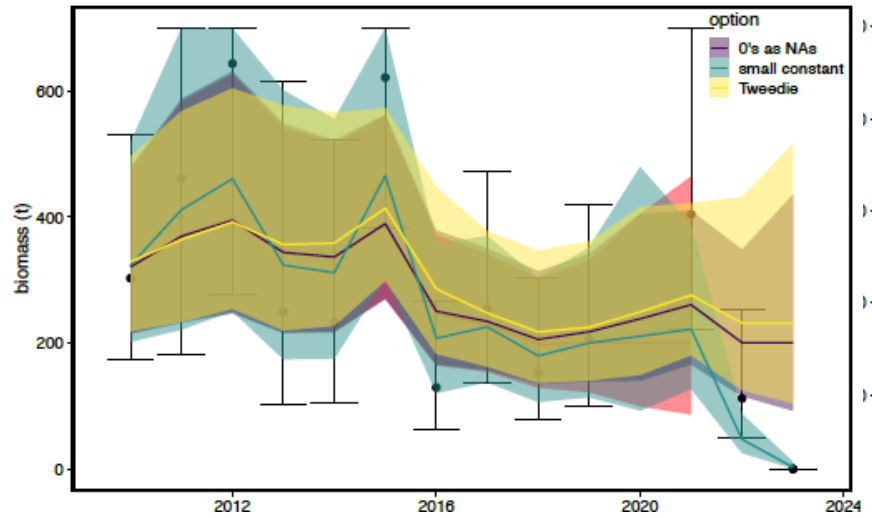


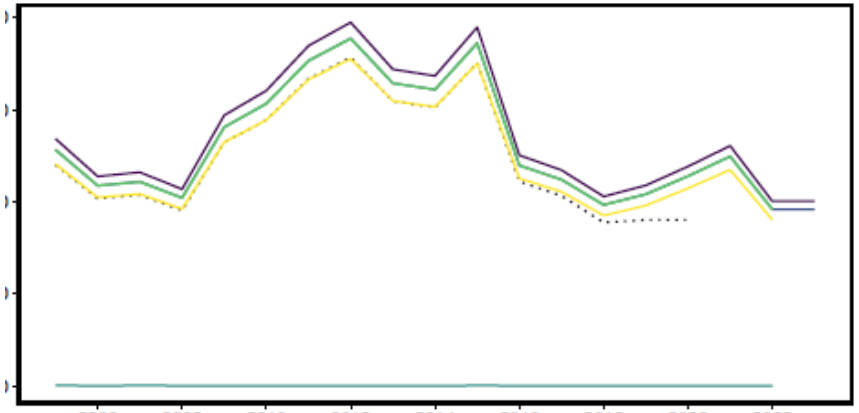
Tier 4 Assessment











SS/RE RW model fit to Survey MMB

Projected to MMB-at-Mating

Averaged to get B_{MSY}

State-space/Random Effects Random Walk model

- Estimate mature male survey biomass time series
  - reduce observation errors
  - fill in missing surveys (i.e., 2020)

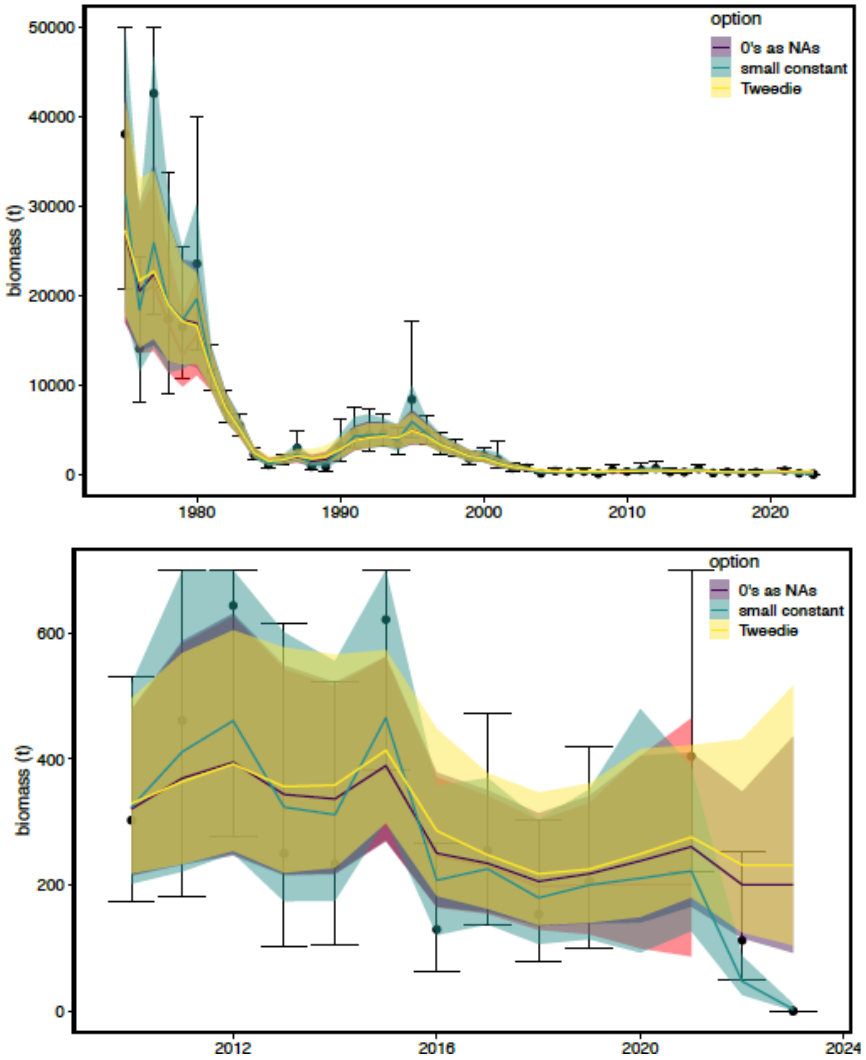
$$p(< ln(MMB^s_y) > | < ln(MMB^s_{y-1}) >) \sim N(0, \phi^2)$$ process error (RW)

$$ln(MMB^s_y) =< ln(MMB^s_y) > +\eta_y, \text{ where } \eta_y \sim N(0, \sigma^{s2}_y)$$ observation error

$$\Lambda = \sum_y \left[ln(2\pi\phi) + \left(\frac{< ln(MMB^s_y) > - < ln(MMB^s_{y-1}) >}{\phi} \right)^2 \right] +$$ process error (RW)

$$\sum_y \left(\frac{ln(MMB^s_y) - < ln(MMB^s_y) >}{\sigma^s_y} \right)^2$$ observation error

- estimation uses GPTs' *rema* R package
  - MMB = 0 in 2023 introduces a problem!
  - 3 alternative approaches considered

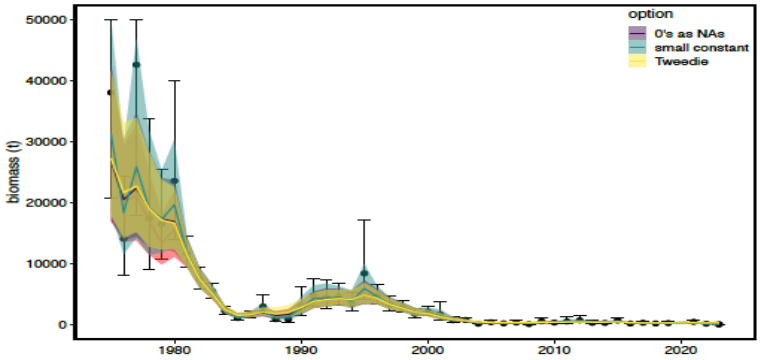


SS/RE RW model fit to Survey MMB

State-space/Random Effects Random Walk model

parameter estimates

	0's as NAs			small constant			Tweedie		
parameter	estimate	lci	uci	estimate	lci	uci	estimate	lci	uci
process_error	0.4255	0.3393	0.5337	0.7766	0.5827	1.035	0.3948	0.3138	0.4967
tweedie_p	–	–	–	–	–	–	1.5947	1.2981	1.8352

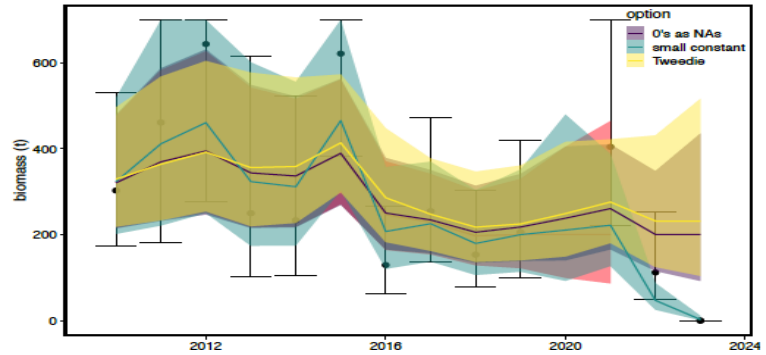


model convergence

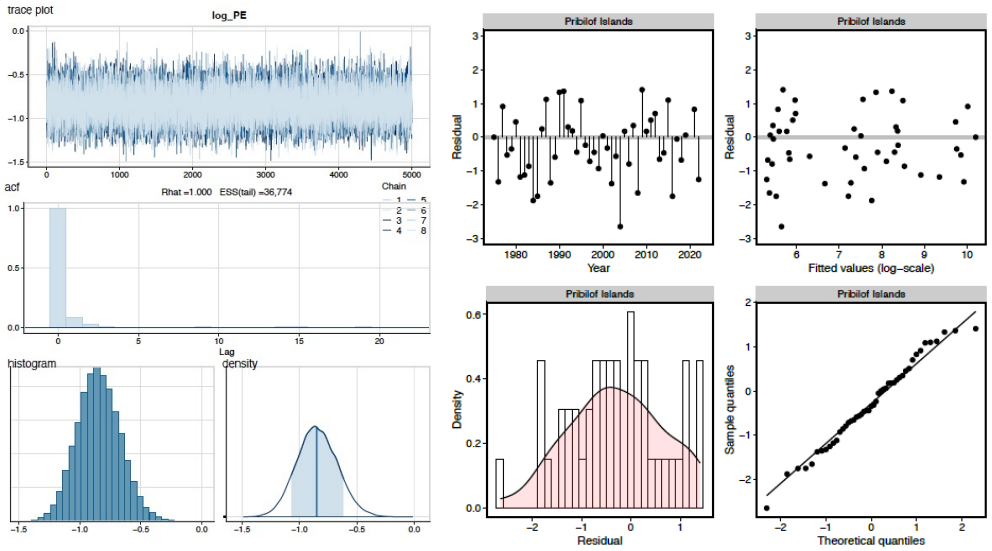
zeros option	max gradient
0's as NAs	5.4e-14
small constant	2.2e-14
Tweedie	2e-11

terminal year estimate (t)

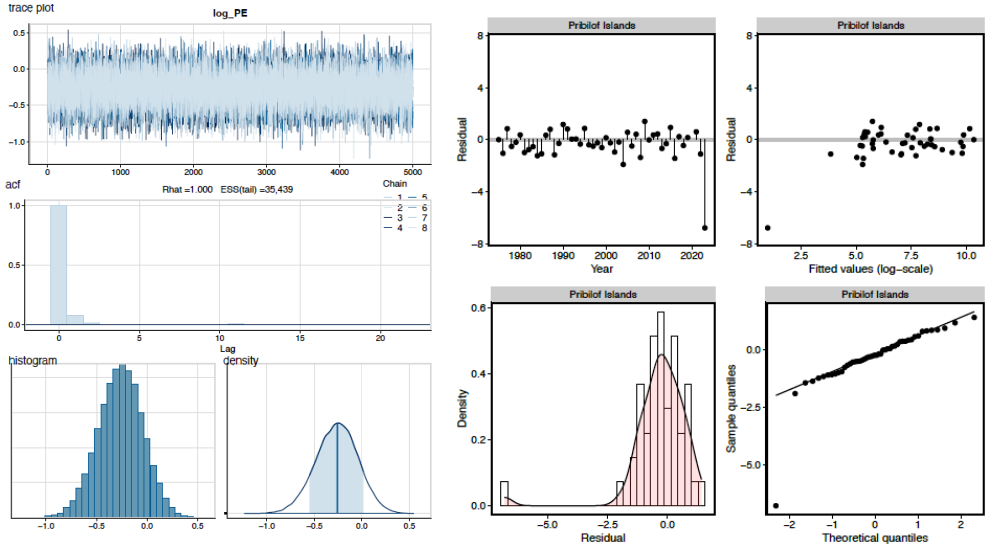
approach	estimate	LCI	UCI
0's as NAs	201	92	436
small constant	2.7	0.6	11.3
Tweedie	232	104	516



0's as NAs (GPT choice)



small constant



- Tweedie MCMC terminated

B_{MSY} and Stock Status

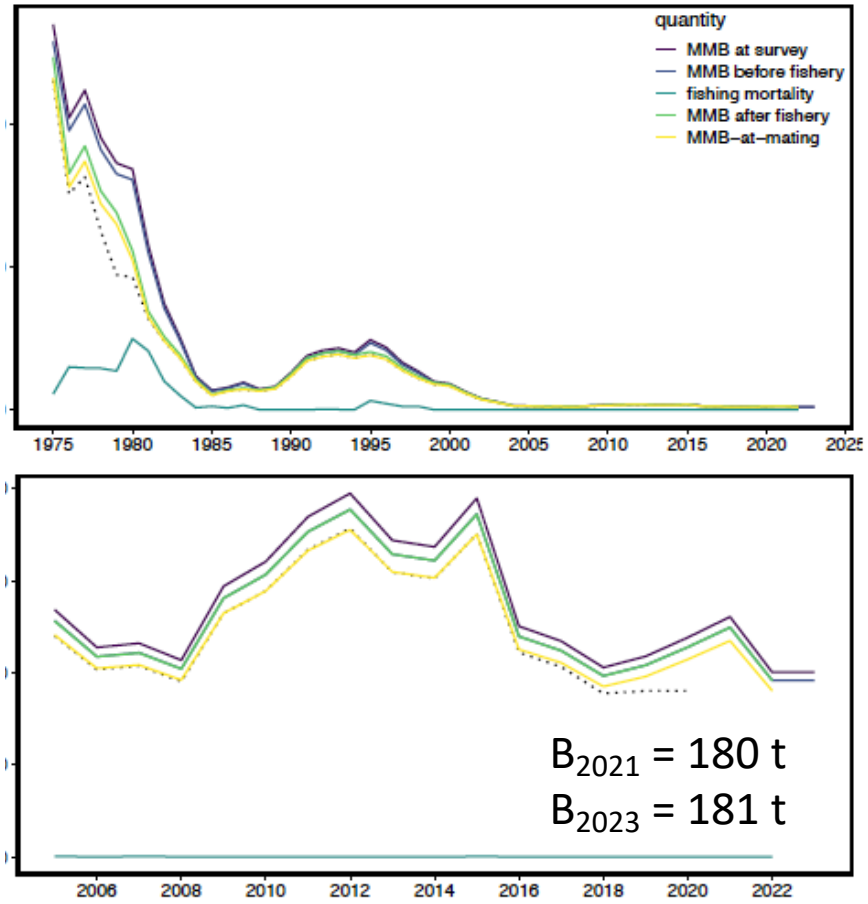
Projecting to MMB-at-Mating

$$MMB_y^{bf} = < MMB_y^s > \cdot e^{-M \cdot t_{sf}}$$

$$MMB_y^{af} = MMB_y^{bf} - RM_y - DM_y^{MM}$$

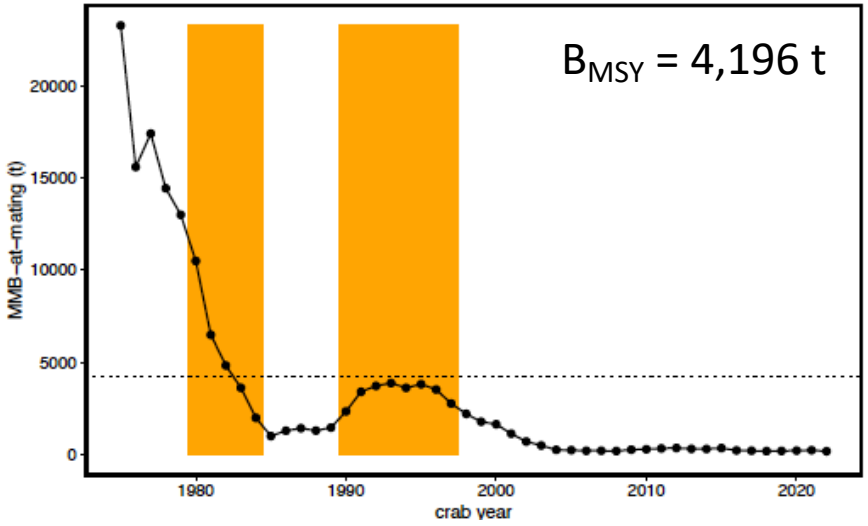
$$MMB_y^{am} = MMB_y^{af} \cdot e^{-M \cdot t_{fm}}$$

Projected to MMB-at-Mating



Averaged to get B_{MSY}

Time period to determine B_{MSY}:
1980/81-1984/85; 1990/91-1997/98



Stock status (Tier 4 calculations)

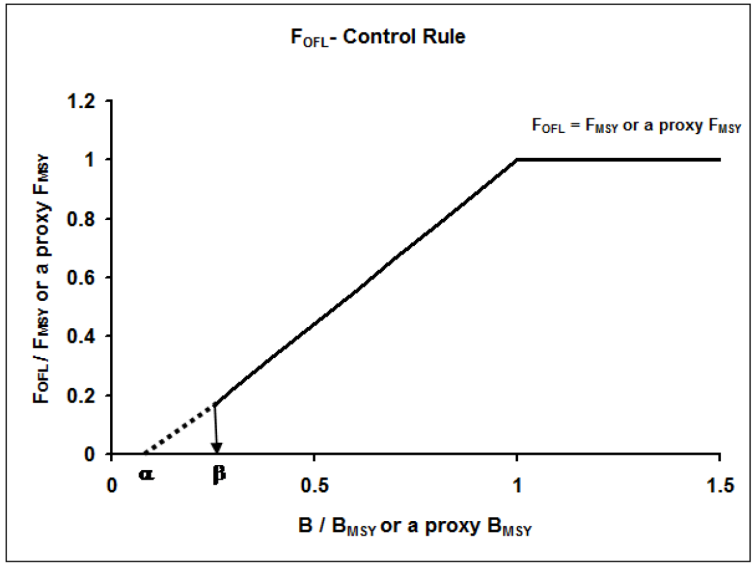
$$F_{OFL_{max}} = \gamma \cdot M$$

$$MMB_f = MMB_s \cdot e^{-M \cdot t_{sf}}$$

$$RM_{OFL} = \left(1 - e^{-F_{OFL}}\right) \cdot MMB_s \cdot e^{-M \cdot t_{sf}}$$

$$DM_{OFL} = \theta \cdot \frac{MMB_f}{p_{male}} \qquad \theta = \frac{1}{N} \sum_y \frac{DM_{MMB_y}}{MMB_{f_y}}$$

$$MMB_m = \left[MMB_{f_y} - \left(RM_{OFL} + p_{male} \cdot DM_{OFL}\right)\right] \cdot e^{-M \cdot t_{fm}}$$



status ratio = B/B_{MSY} = 0.043
stock in Tier 4c; stock is overfished

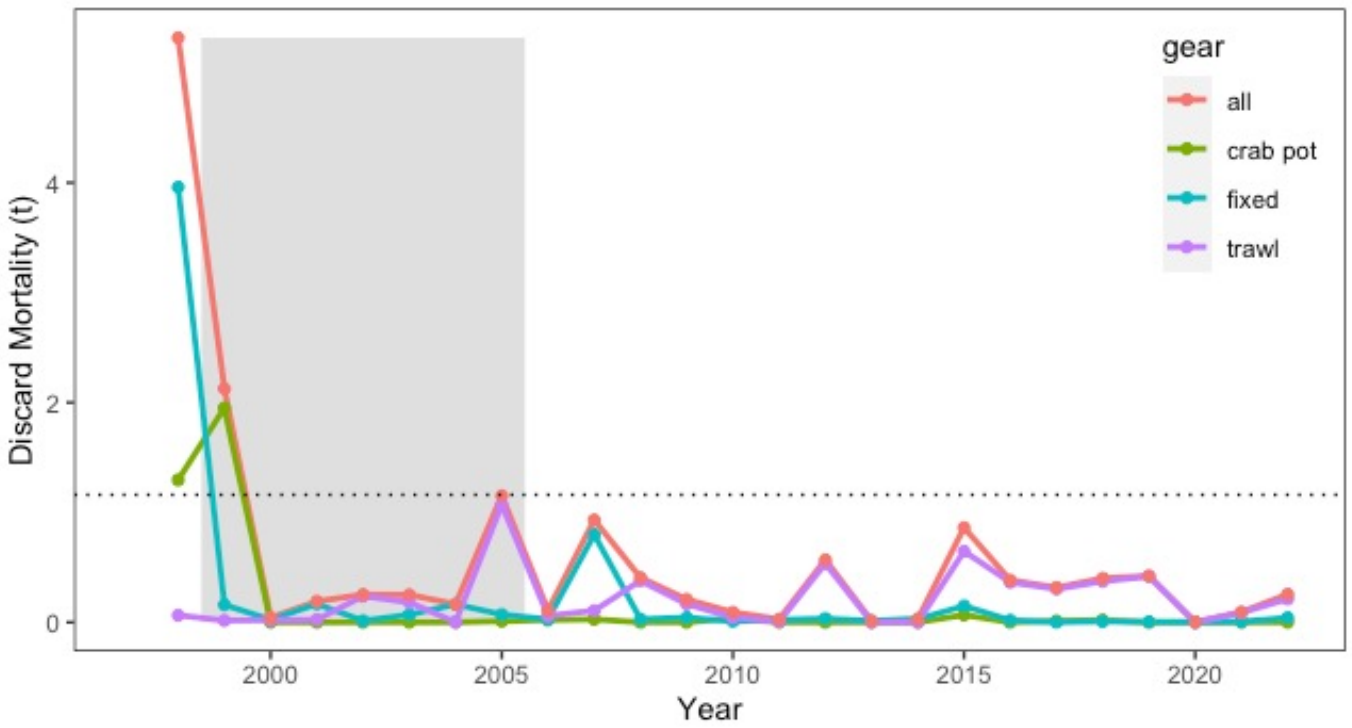
	quantity	units	value
1	B	t	181
2	B_{MSY}	t	4,196
3	stock status	–	overfished
4	F_{OFL}	$year^{-1}$	0
5	RM_{OFL}	t	0
6	DM_{OFL}	t	0.116
7	OFL	t	0.116

OFL (Tier 5)

Tier 5 calculation: 1.16 t

- Specified in rebuilding plan
- Average catch mortality 1999/00-2005/06
- Thought to
  - adequately address conservation needs
  - acknowledge existing non-directed catch mortality
- Additional measures
  - Prohibited in PI Habitat Conservation Zone
    - trawling
    - pot cod fishing
  - ADFG excludes directed Tanner crab fishery from annually-determined area
    - PIHCZ “home plate”
    - additional areas as necessary

Tier 5



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- Do we need a different survey?

Stock status

- Tier 4 determination
- stock is overfished (B < MSST)
- directed fishery is closed ($B/B_{MSY}<\beta$)
- overfishing is not occurring (TCM < OFL)

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