Hybrid topics

BSAI CRAB PLAN TEAM

May 13th, 2026

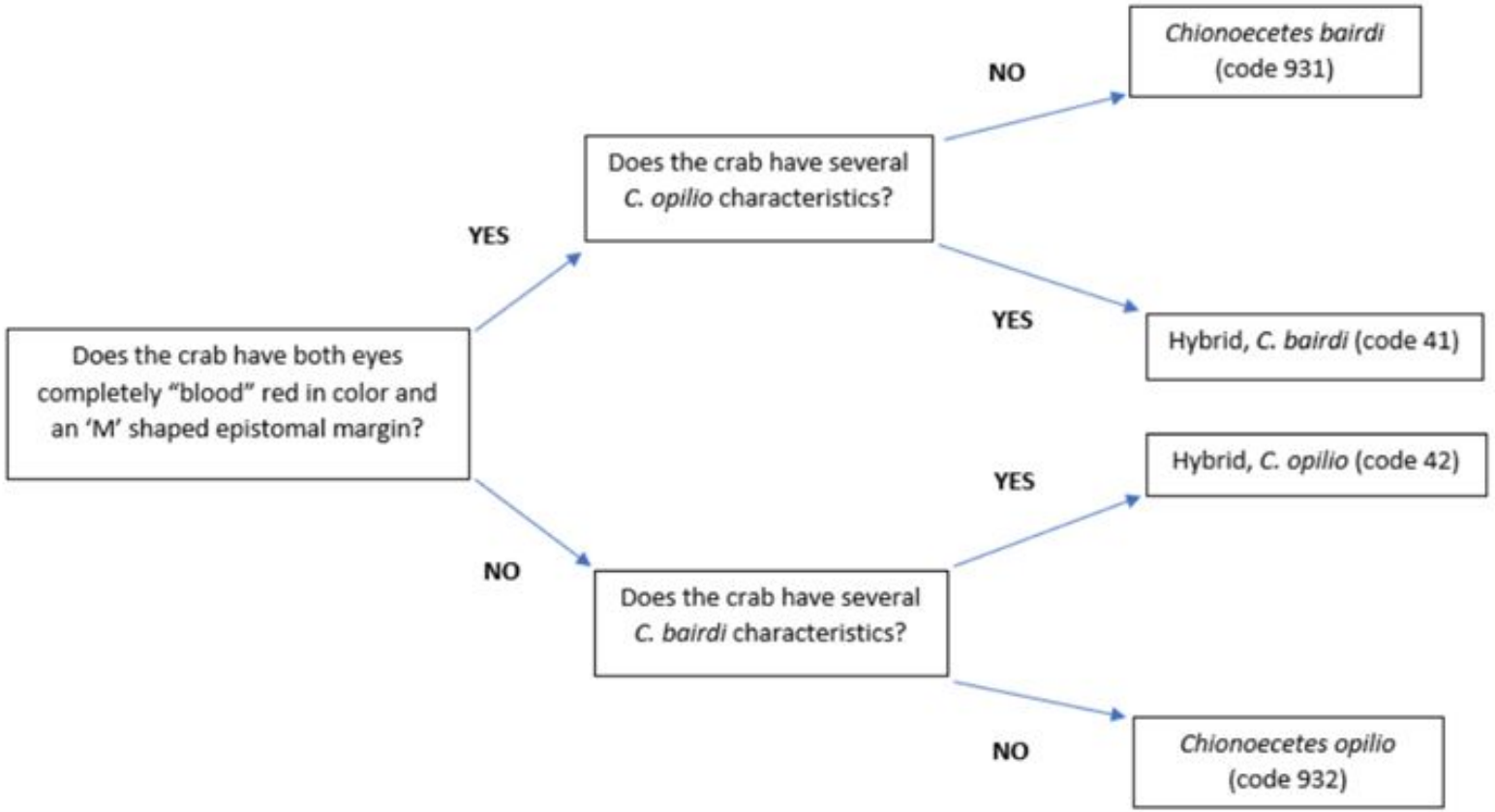
Group presentation

Outline

- Goals
- State data and TAC setting (Tyler Jackson & Ethan Nichols)
- NOAA survey data (Chris Long)
- Snow crab model sensitivity runs (Grant Adams)
- Tanner crab model sensitivity runs (Buck Stockhausen)
- Hybrid research (Mike Litzow)
- Plan for Fall 2026

Goals

- Review of data and understanding of hybrids
- Consistency in assessment process with hybrid data
- Plan for Fall 2026 considerations
  - working within the current FMP framework
  - recommendations for future changes?



Hybrids identified by 3 species codes that refer to Hybrid (non-specific), Hybrid – bairdi, Hybrid – opilio

"Type" indicates whether it has red eyes and M shaped epistome (Tanner in regulation)

History of Hybrids in Observer Program

ID criteria and proficiency has evolved over time

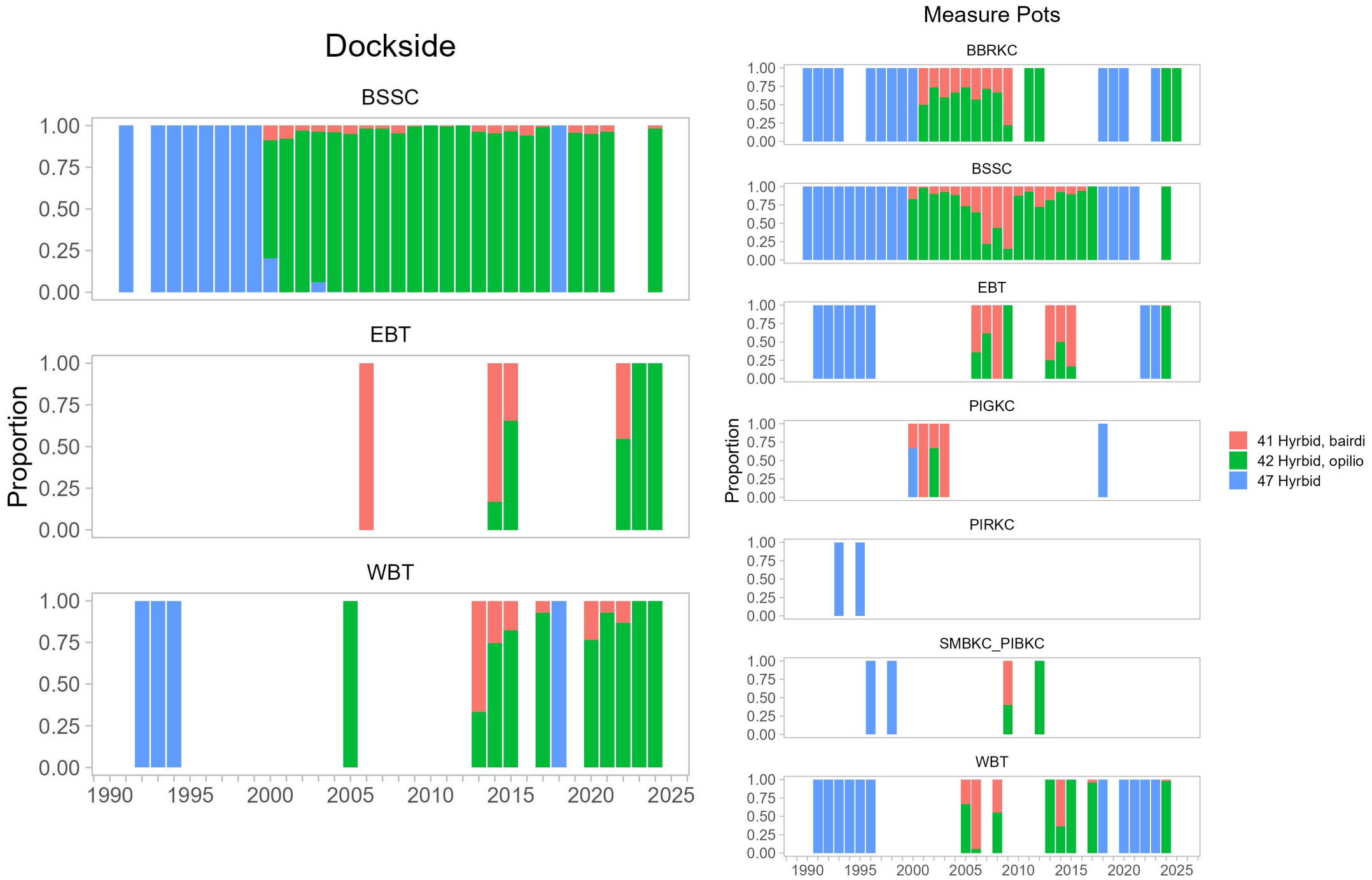
Hybrids not collected before 1989

New observers required to photo document

Historical Documentation

- **Jeanette Alas' Hybrid Notes**: Dockside Sampling and Hybrids - long version
- **1991 Hybrid Regulation Memo By Gordon Kruse - 3 memos** 12-12-10-91 "The eye specifications for Chionoecetes fisheries
  12-31-1991 "Up to Our Eye Balls Again"
  04-09-1995 "Red Eyes Again, Read It and Weep"
- **OTC Trainer Kyle Hogrefe Hybrid Training Observations**An analysis of "Instruction crabs" from 2001.
- **Dan Urban's Hybrid Guide - paper published in 2002**
- **Hybrid Materials in Observer Manuals 1991 - 2010**A collection of hybrid materials
- **Observer data collection and codes as relates to Tanner crab hybrids**Presentatio sampling codes.
- **How are observer personnel trained to identify hybrids?**Presentation given at the trained to identify hybrids.
- **Doug Pengilly's preliminary review/assessment of 5 AAC 35.521**
- **Observer Hybrid Powerpoint 2010**
- **Observer Manual 1995 Hybrid - extra**

*Timeline of observer training well documented, available upon request


Dockside
BSSC
EBT
WBT
Proportion
1.00
0.75
0.50
0.25
0.00
1990
1995
2000
2005
2010
2015
2020
2025
Measure Pots
BBRKC
BSSC
EBT
PIGKC
PIRKC
SMBKC_PIBKC
WBT
Proportion
41 Hyrbid, bairdi
42 Hyrbid, opilio
47 Hyrbid

Hybrids in the Fishery

Hybrids have **always** been included in retained catch data

Retention of hybrids has always been allowed in either parent species fishery, but why/*how* they were retained has changed over time

Incidental *Chionoecetes* retention

- Earlier years: mostly based on preferred size (4” snow / 5.5” Tanner)
- 2008 – 2017: 5% incidental retention rate established in regulation
- 2018 onwards: change to 35% incidental retention rate for snow crab during Tanner fishery
    - Some industry desire to dual target snow and Tanner crab concurrently. This type of fishing likely to occur in areas with higher hybrid abundance.

Catch Estimation

Presented a little bit in January, mostly straightforward, same as other species/fisheries

If hybrid data are used in assessments:

Makes most sense to use “Type” data or remove bairdi types

- Hybrid, bairdi makes up 1-2% of data

Need to make some assumptions about Hybrid non-specific data

Can remove hybrids from retained catch if desired

State data and TAC Setting

2025/26 Eastern Bering Tanner Crab (E of 166° W long.)

- TAC: 1,130,000 lbs(-36% from previous season TAC)
- Harvest: 1,124,328 lbs (99%), 15 vessels, CPUE: 48, avg wt: 1.89 lbs.

2025/26 Western Bering Tanner Crab (W of 166° W long.)

- TAC: 10,120,000 pounds (+125% from previous season TAC)
- Harvest: 10,138,624 lbs (100%), 34 vessels, CPUE: 86, avg wt: 1.53 lbs.

2025/26 Bering Sea Snow Crab *5/12/26

- TAC: 9,300,000 pounds total (8.3M pure opilio + 1.0M hybrid; +97% from previous season TAC)
- Harvest: 8,534,774 lbs (92%), 40 vessels, CPUE:129, avg wt: 1.32 lbs.

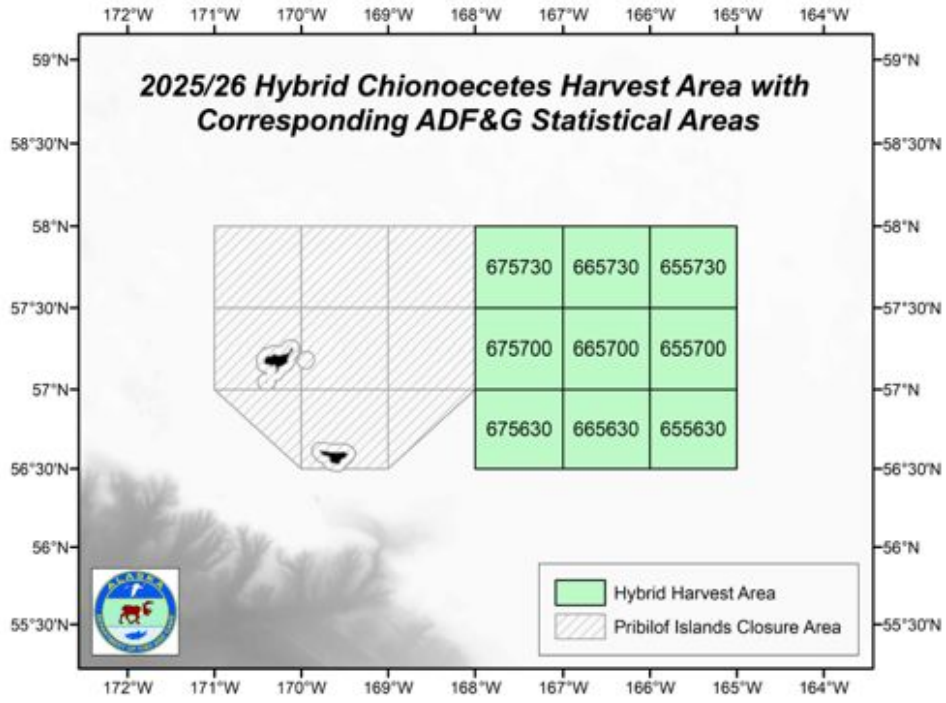
Bering Sea Snow Crab Season Opens October 15
Total Allowable Catch Announced

The Alaska Department of Fish and Game (ADF&G) and National Marine Fisheries Service (NMFS) have completed analysis of 2025 NMFS trawl survey results for the Bering Sea snow crab stock. The 2025 estimate of total mature snow crab biomass is above the threshold required to open the fishery in the Bering Sea District. The 2025/26 Bering Sea snow crab fishery will open in Bering Sea District waters west of 165° W longitude at 12:00 noon October 15, 2025 and close at 11:59 p.m. May 15, 2026 in the Eastern Subdistrict (east of 173° W longitude), and close at 11:59 p.m. May 31, 2026 in the Western Subdistrict (west of 173° W longitude).

The 2025/26 Bering Sea District snow crab fishery total allowable catch (TAC) is apportioned as follows:

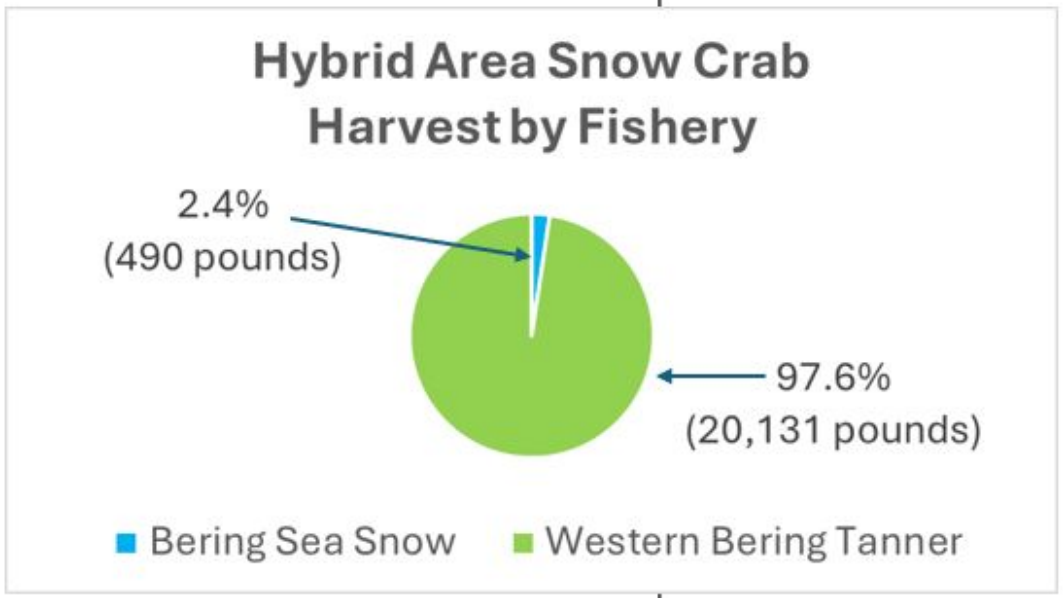
Individual Fishing Quota (IFQ)	8,370,000 pounds
Community Development Quota (CDQ)	930,000 pounds
Total	**9,300,000 pounds**

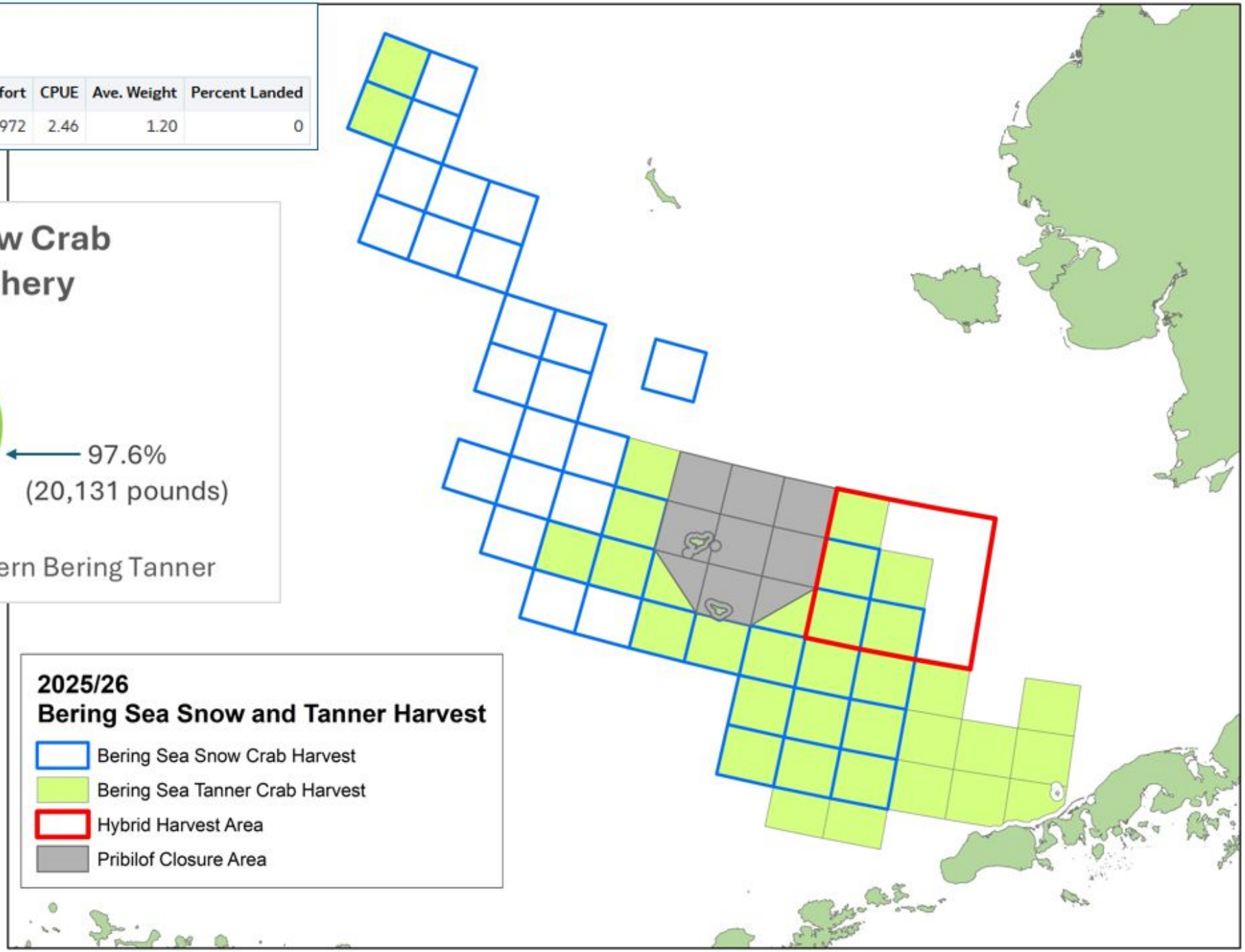
ADF&G recommends a base 2025 snow crab TAC of 8.3 million pounds. Due to the unprecedented high abundance of hybrid *Chionoecetes* crab in the 2025 NMFS trawl survey, ADF&G increased the base snow crab TAC by an additional 1 million pounds to allow vessels to specifically target hybrid *Chionoecetes* crab. In coordination with the Bering Sea crab industry, ADF&G expects that vessels target 1 million pounds or 11% of total 9.3-million-pound Bering Sea District snow crab TAC in the portion of the Bering Sea District with the highest survey abundance of hybrid *Chionoecetes* crab. Based on survey distribution, this area has been identified by ADF&G as waters enclosed by connecting the following coordinates: 58° N, 168° W; 58° N, 165° W; 56° 30′ N, 165° W; 56° 30′N, 168° W; 58° N, 168° W. This area corresponds to ADF&G statistical areas: 655630, 655700, 655730, 665630, 665700, 665730, 675630, 675700, and 675730. A map of the hybrid target area will be provided at the time of registration.



2025/26 BSSC Hybrid Box

Vessels	Landings	Landed Weight	Number of Crab	Effort	CPUE	Ave. Weight	Percent Landed
14	21	20,621	17,116	6972	2.46	1.20	0





Preliminary as of 5/12/26

Bering Sea snow crab fishery retained catch sampling, by species, 2005/06–2025/26.

	Retained Catch Sampling				
BSS Fishery	Num. Opilio	Num. Tanner	Num. Hybrids	Num. Crab	% Hybrids
2005/06	59,097	2,841	2,021	63,959	3.16%
2006/07	34,514	2,520	409	37,443	1.09%
2007/08	49,860	1,231	930	52,021	1.79%
2008/09	49,512	125	406	50,043	0.81%
2009/10	30,745	64	219	31,028	0.71%
2010/11	36,544	42	321	36,907	0.87%
2011/12	58,499	54	202	58,755	0.34%
2012/13	46,330	36	602	46,968	1.28%
2013/14	39,012	171	243	39,426	0.62%
2014/15	45,685	270	1,103	47,058	2.34%
2015/16	30,348	292	786	31,426	2.50%
2016/17	20,470	43	782	21,295	3.67%
2017/18	15,160	97	1,369	16,626	8.23%
2018/19	22,014	68	471	22,553	2.09%
2019/20	31,066	12	838	31,916	2.63%
2020/21	26,523	115	198	26,836	0.74%
2021/22	7,215	7	28	7,250	0.39%
2022/23			*Fishery closed*		
2023/24			*Fishery closed*		
2024/25	3,218	24	61	3,303	1.85%
Avg 2005/06–2024/25	33,656	445	611	34,712	1.76%
2025/26	4,271	31	141	4,443	3.17%

Western Bering Tanner crab fishery retained catch sampling, by species, 2005/06–2025/26.

	Retained Catch Sampling				
WBT Fishery	Num. Tanner	Num. Opilio	Num. Hybrids	Num. Crab	% Hybrids
2005/06	705	73	31	809	3.83%
2006/07	581	0	0	581	0.00%
2007/08	1,658	0	0	1,658	0.00%
2008/09	521	0	0	521	0.00%
2009/10			*Fishery closed*		
2010/11			*Fishery closed*		
2011/12			*Fishery closed*		
2012/13			*Fishery closed*		
2013/14	2,237	2	16	2,255	0.71%
2014/15	6,819	37	112	6,968	1.61%
2015/16	9,095	187	248	9,530	2.60%
2016/17			*Fishery closed*		
2017/18	3,470	0	43	3,513	1.22%
2018/19	3,306	11	105	3,422	3.07%
2019/20			*Fishery closed*		
2020/21	3,323	5	184	3,512	5.24%
2021/22	2,344	2	57	2,403	2.37%
2022/23	2,308	1	15	2,324	0.65%
2023/24	2,993	1	18	3,012	0.60%
2024/25	4,048	2	54	4,104	1.32%
Avg 2005/06–2024/25	3,101	23	63	3,187	1.98%
2025/26	6,714	28	278	7,020	3.96%

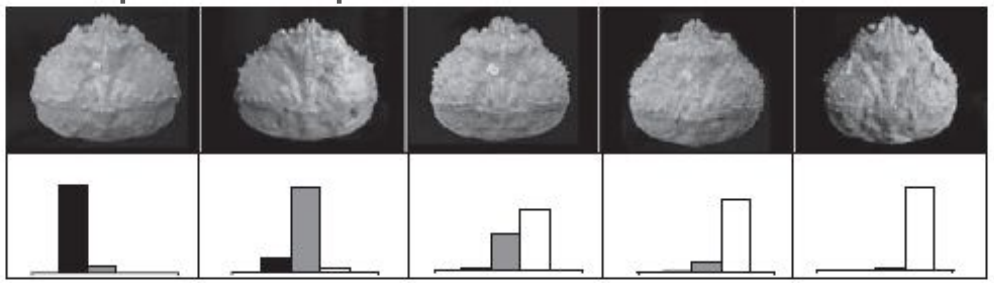
**Preliminary as of 5/12/26*

NOAA EBS bottom-trawl survey: Hybrid data consideration

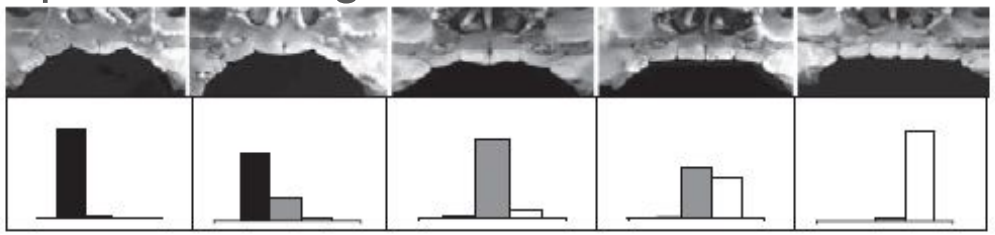
How do we ID hybrids?

Also eye color!

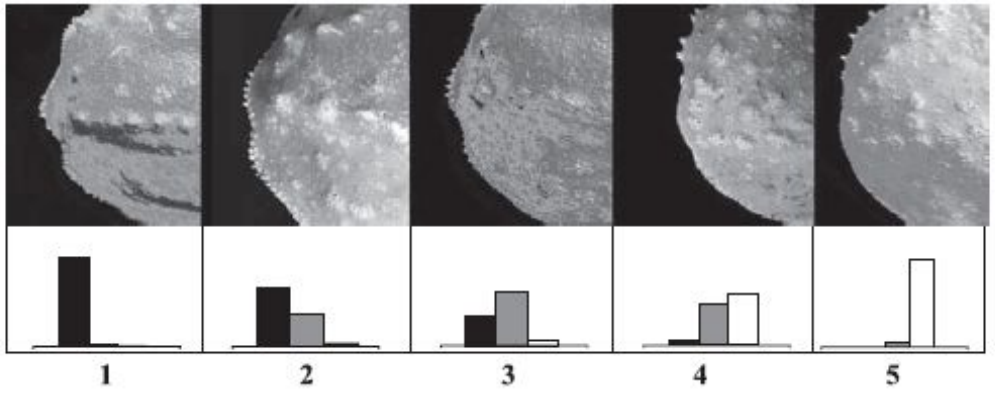
Carapace shape



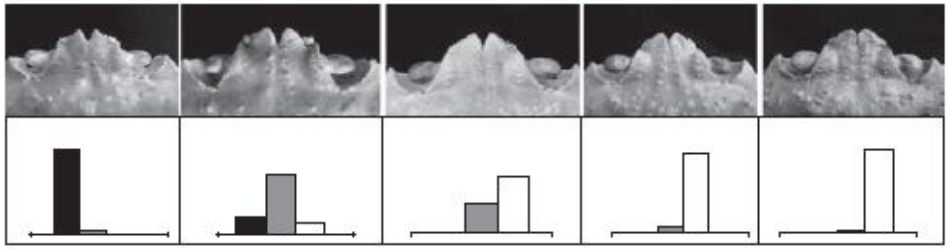
Epistome margin



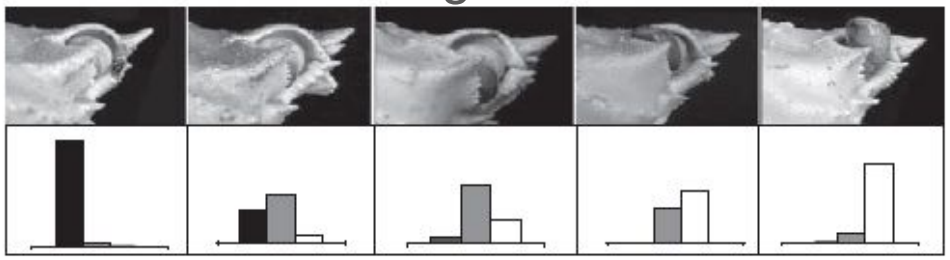
Carapace scalloping



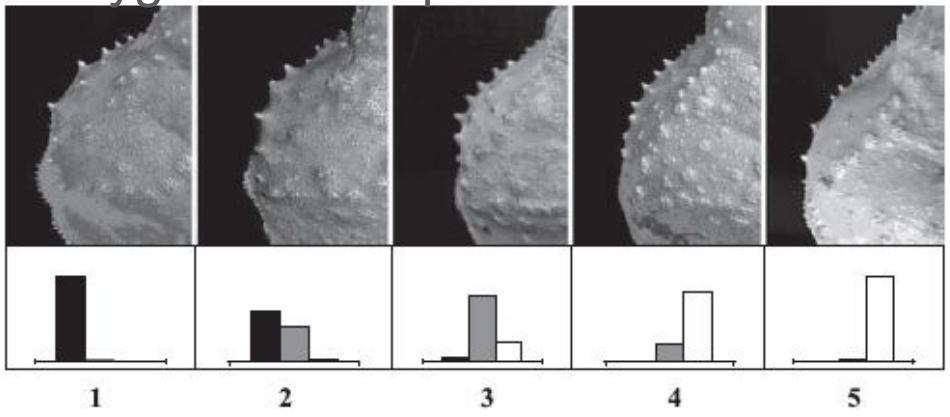
Rostrum notch



Lateral rostrum angle



Pterygostomian spines



Bar charts show proportion Tanner (black), hybrid (grey), and snow (white) for each characteristic and score

Urban, D., Pengilly, D., Jadamec, J., Byersdorfer, S.C., 2002. Testing carapace morphology characteristics for field identification of Chionoecetes hybrids. In: Paul, A.J., Dawe, E.G., Elner, R., Jamieson, G.S., Kruse, G.H., Otto, R.S., Sainte-Marie, B., Shirley, T.C., Woodby, D. (Eds.), Crabs in Cold Water Regions : Biology, Management, and Economics. Alaska Sea Grant College Program, University of Alaska Fairbanks, Anchorage, AK, pp. 97-113.

Urban et al. 2002

- Used 1,114 *genotyped* carapaces
- Smallest snow was >70 mm, smallest Tanner and hybrid >91mm
- All male
- Scored 6 characteristics
- 2 experts scored all on a 1-5 scale
- Developed classification trees based on each expert
- Trained 6 observers who scored a subset

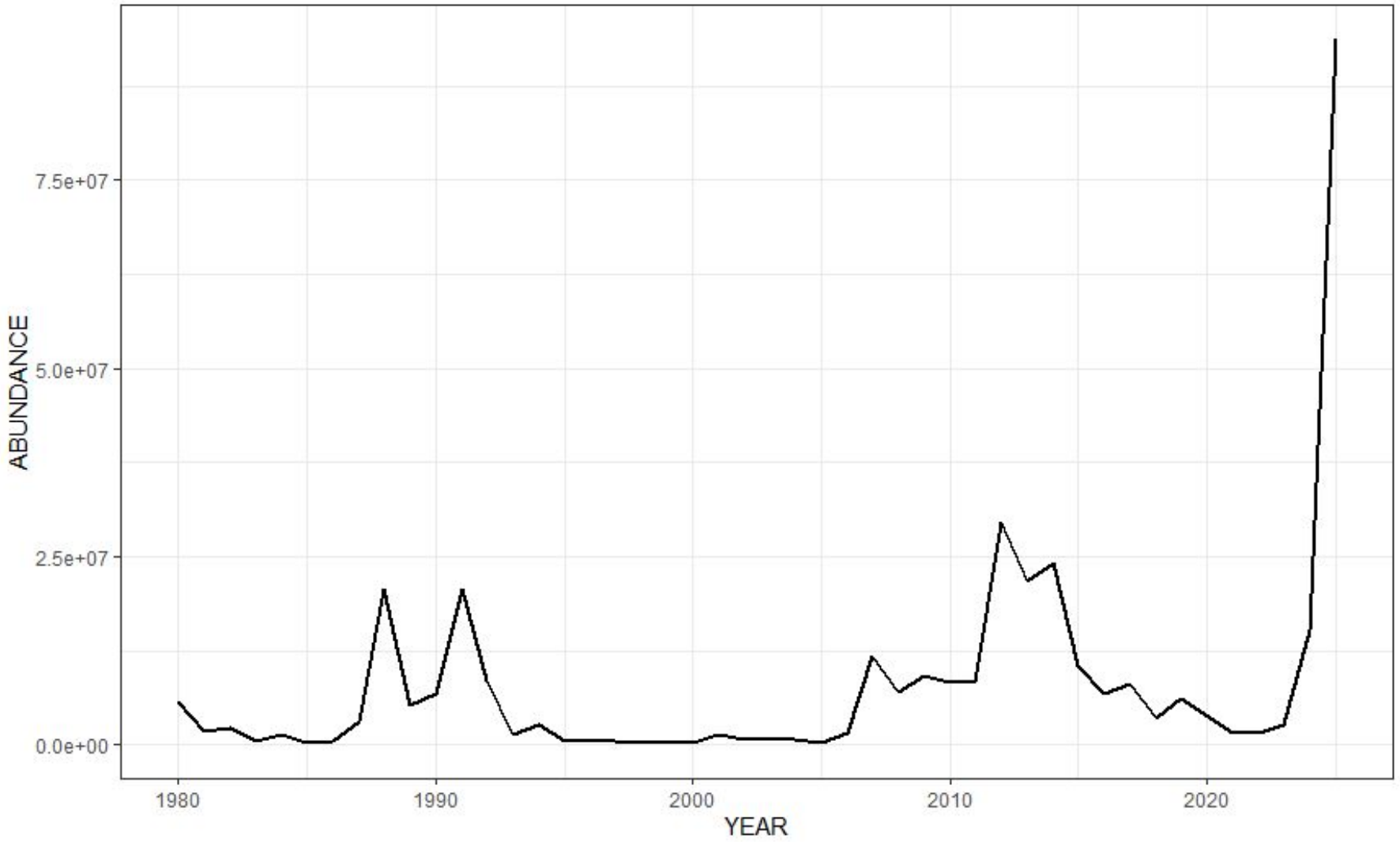
Results:

- Classification tree worked well for a single expert but not between experts (~80% right)
- Worked well in set but not out of set
- High variance between experts
- Poor observer performance (<55% hybrids IDed correctly with one tree)

"The scoring system developed here can be used with good success for developing a classification scheme for a single scorer, but inconsistency of scorers, as demonstrated by components of variance analysis, proved an impediment to developing a broadly applicable scheme."

2025 Surprise

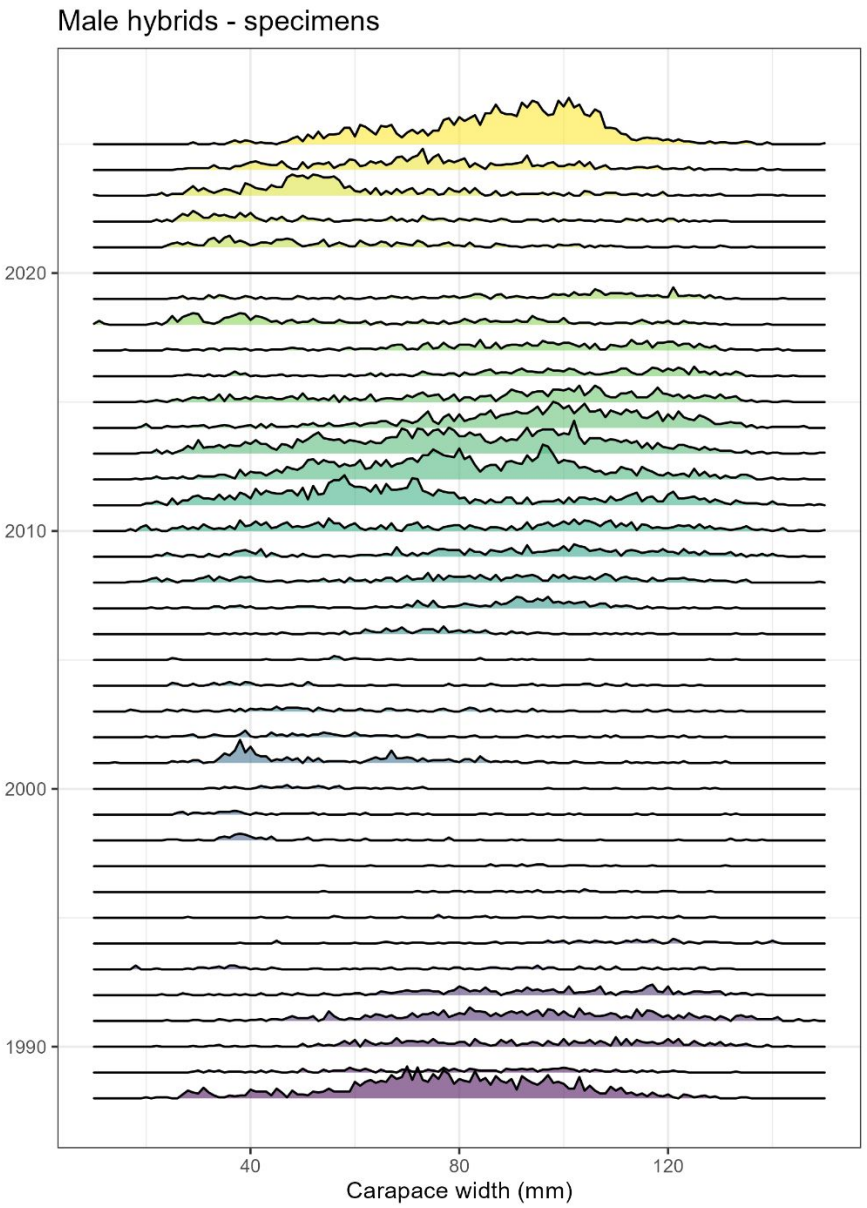
EBS male hybrid abundance over time (CW >80mm)- NMFS trawl survey

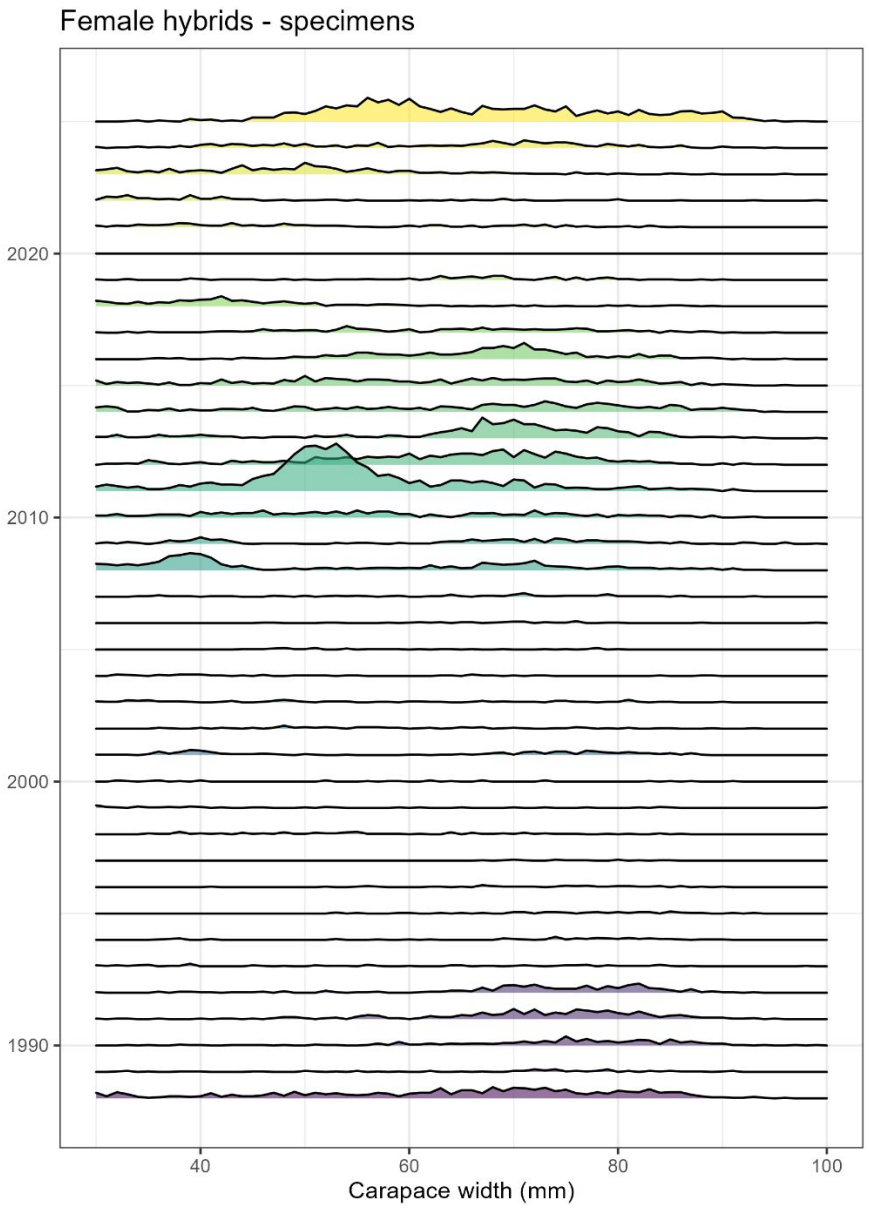


- 471% increase in legal males
- 20% of all *Chionoecetes* males >101mm
- Large impact on fishery and management

Zacher, L.S., Hennessey, S.M., Richar, J.I., Fedewa, E.J., Ryznar, E.R., Litzow, M.A., 2026. The 2025 eastern and northern Bering Sea continental shelf trawl surveys: Results for commercial crab species. NOAA Technical Memorandum NMFS-AFSC. NOAA National Marine Fisheries Service, pp. 299.

Did we see this coming?

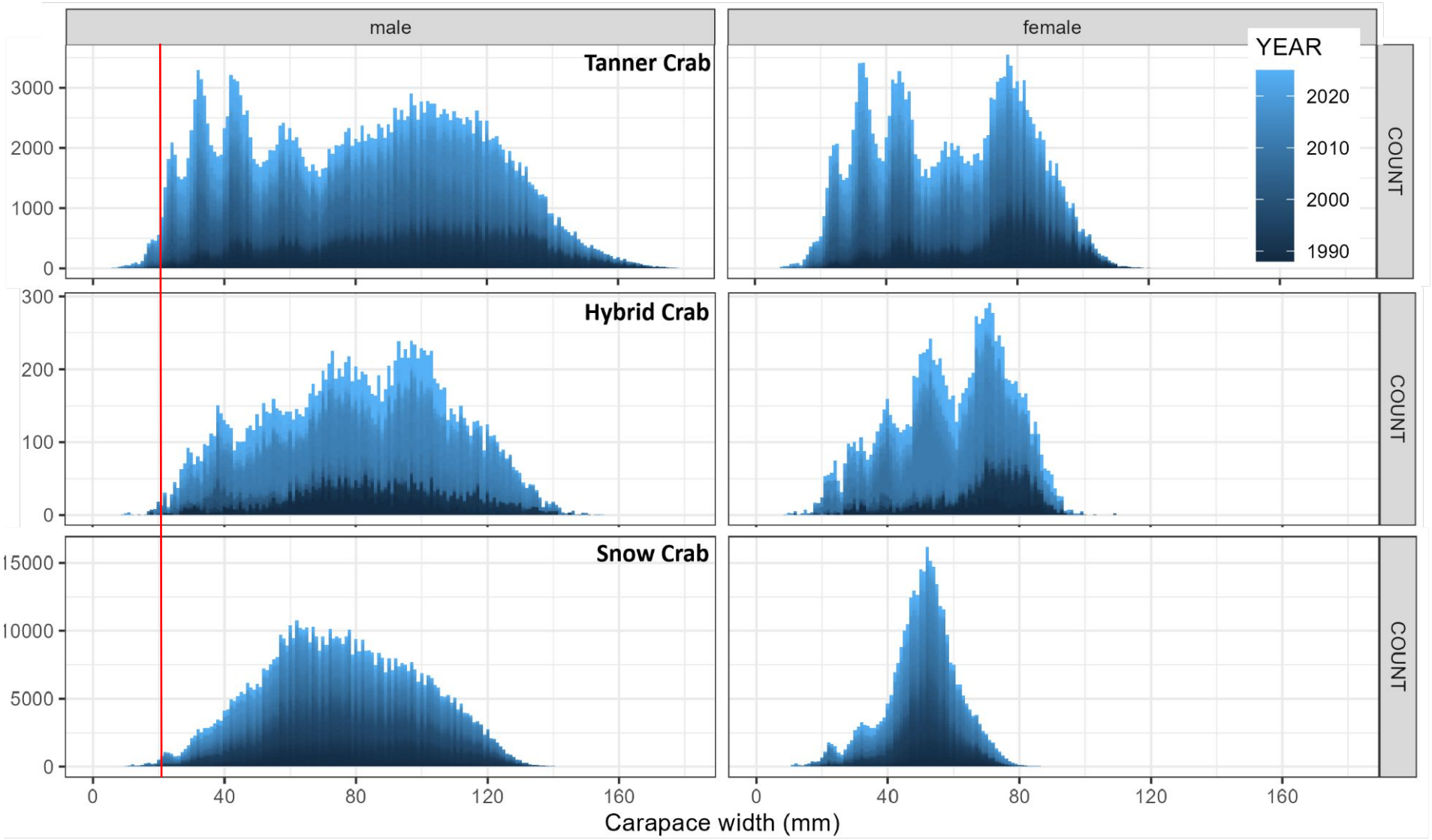




Maybe hint on the males?

Nothing on the females

NOAA survey crabs measured



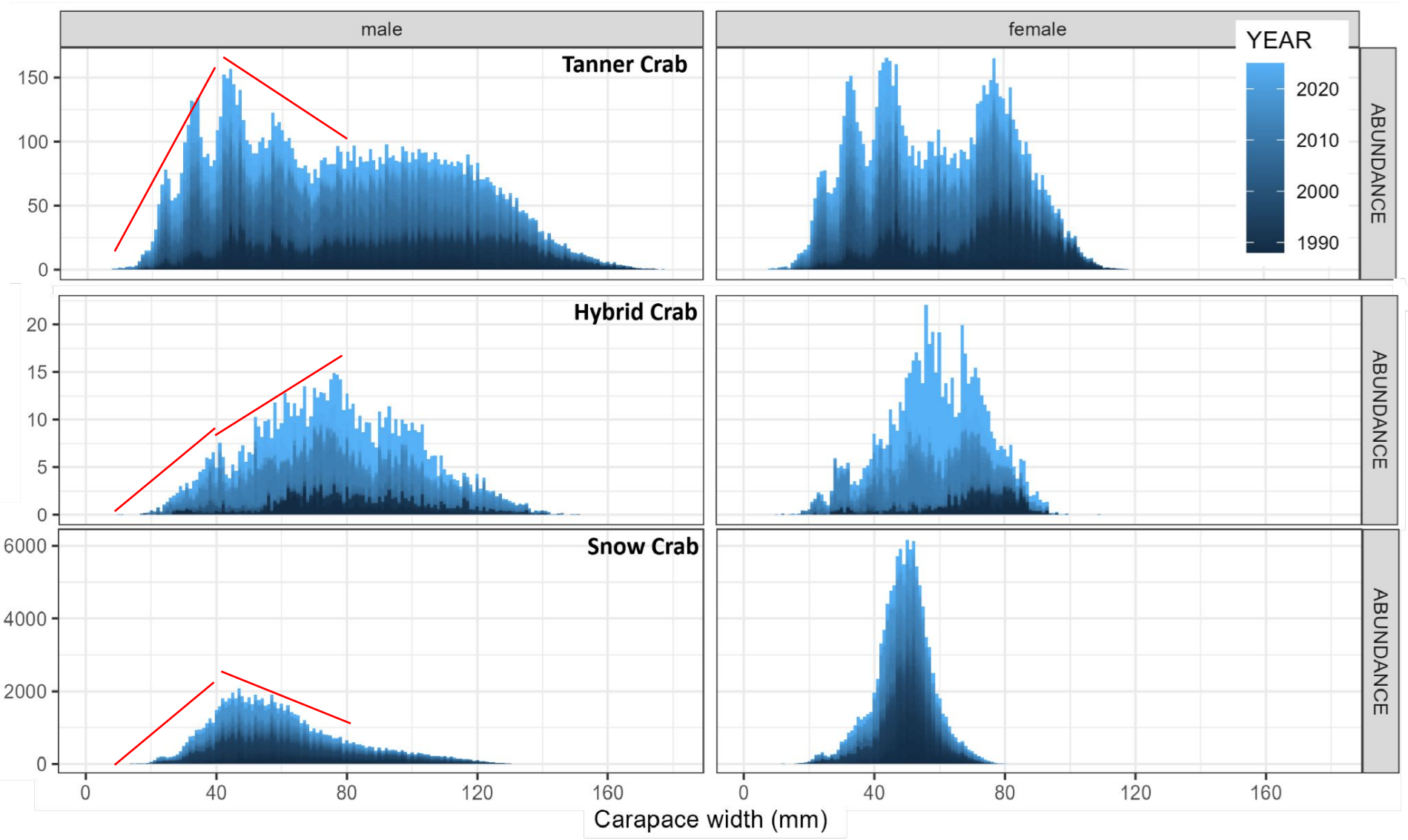
We measure about 10x more Tanners than hybrids

About 50x more snow crab than hybrids

Subsampling is much higher for snow crab

Very few crabs <20mm

Survey abundance estimates by size over time



Below ~45mm increasing trend for all species

Net selectivity increasing

~40-80 mm decreasing trend for snow and Tanner

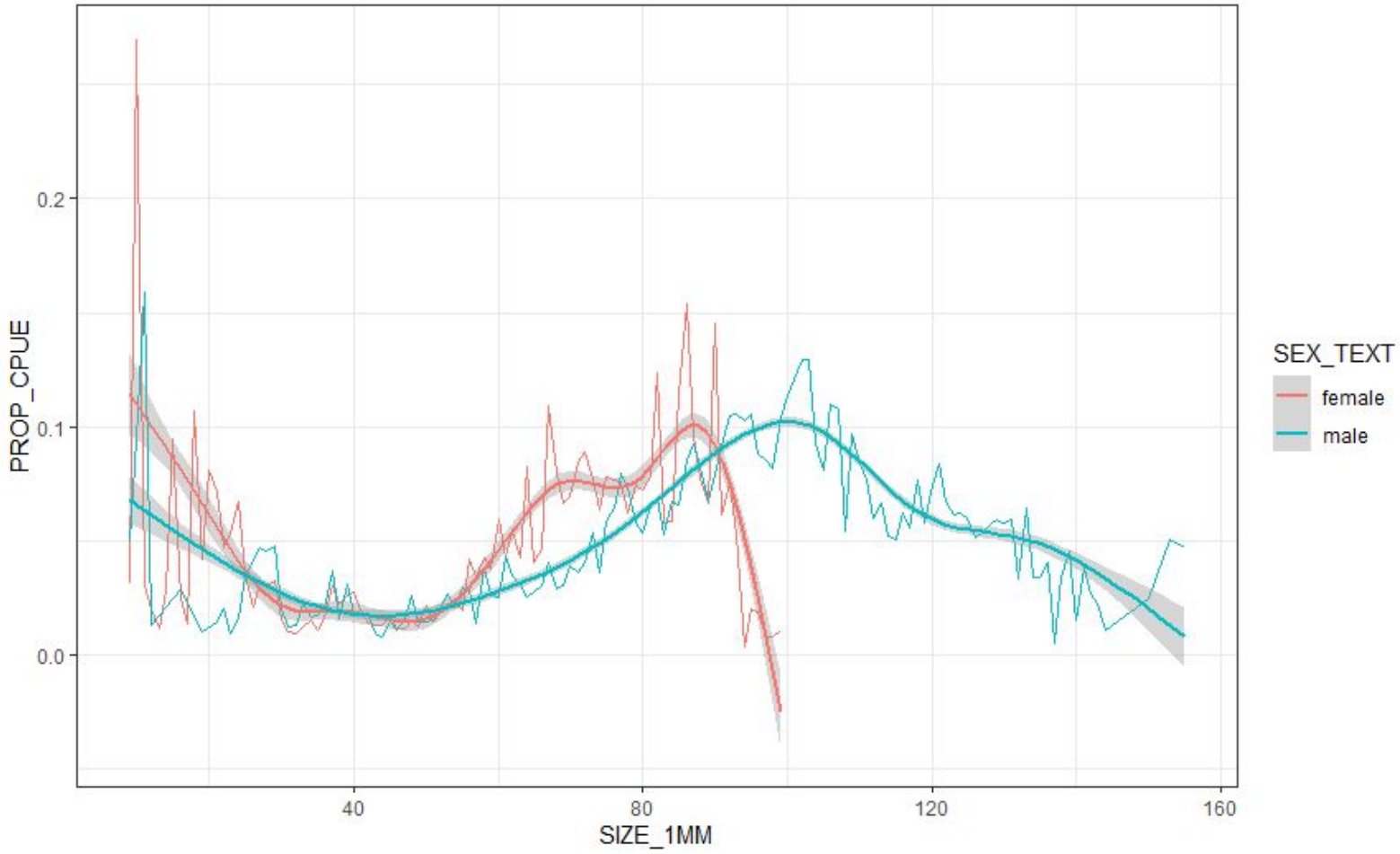
Natural mortality

~40-80 mm *increasing* trend for hybrids

Identification selectivity

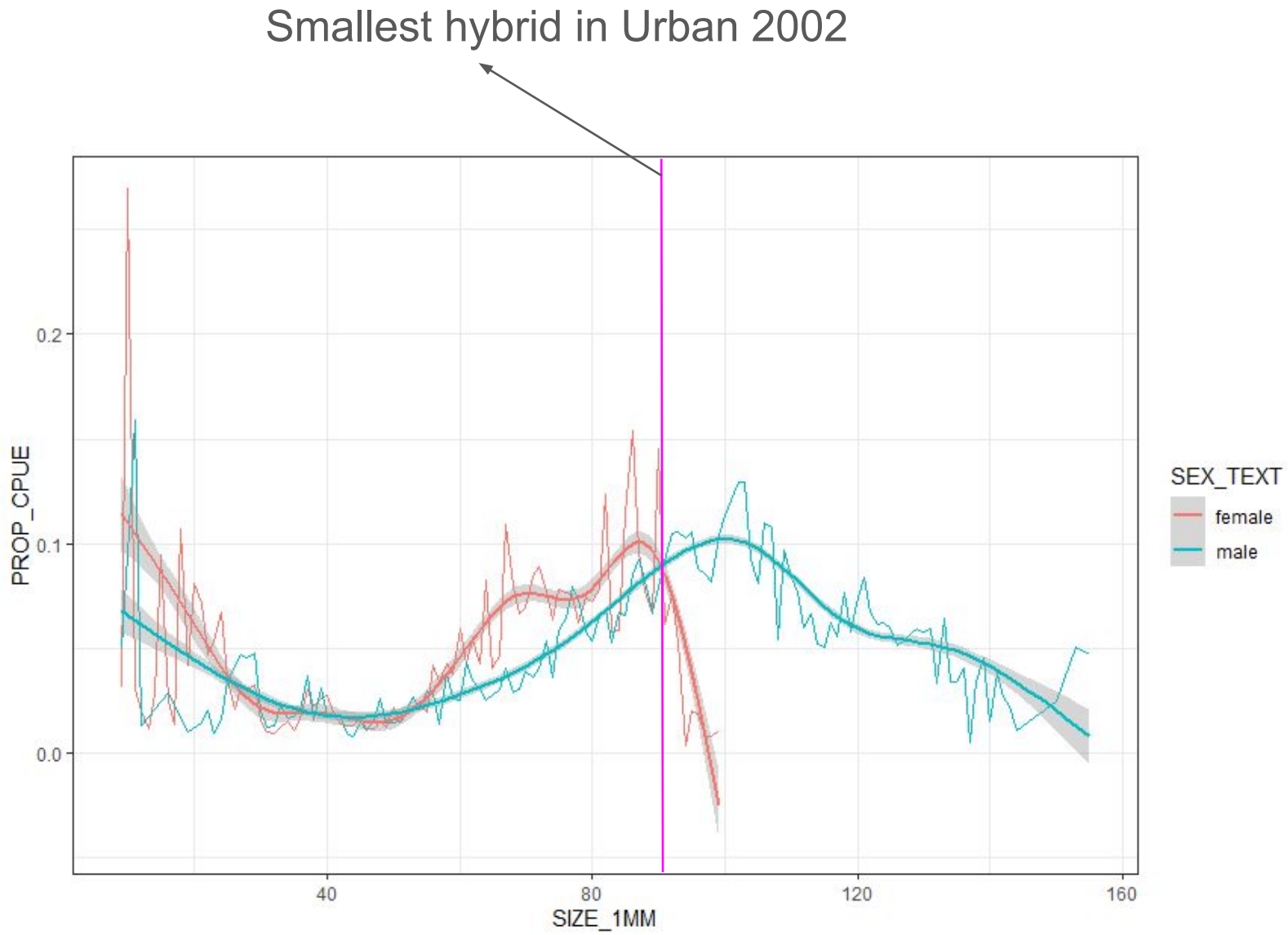
Size-dependent ID

- Last 10 years of data from EBS
- Only stations where hybrids were caught
- Proportion of the *Chionoecetes* that were hybrids
- Binned by 1mm size class
- Separated by sex



Size-dependent ID

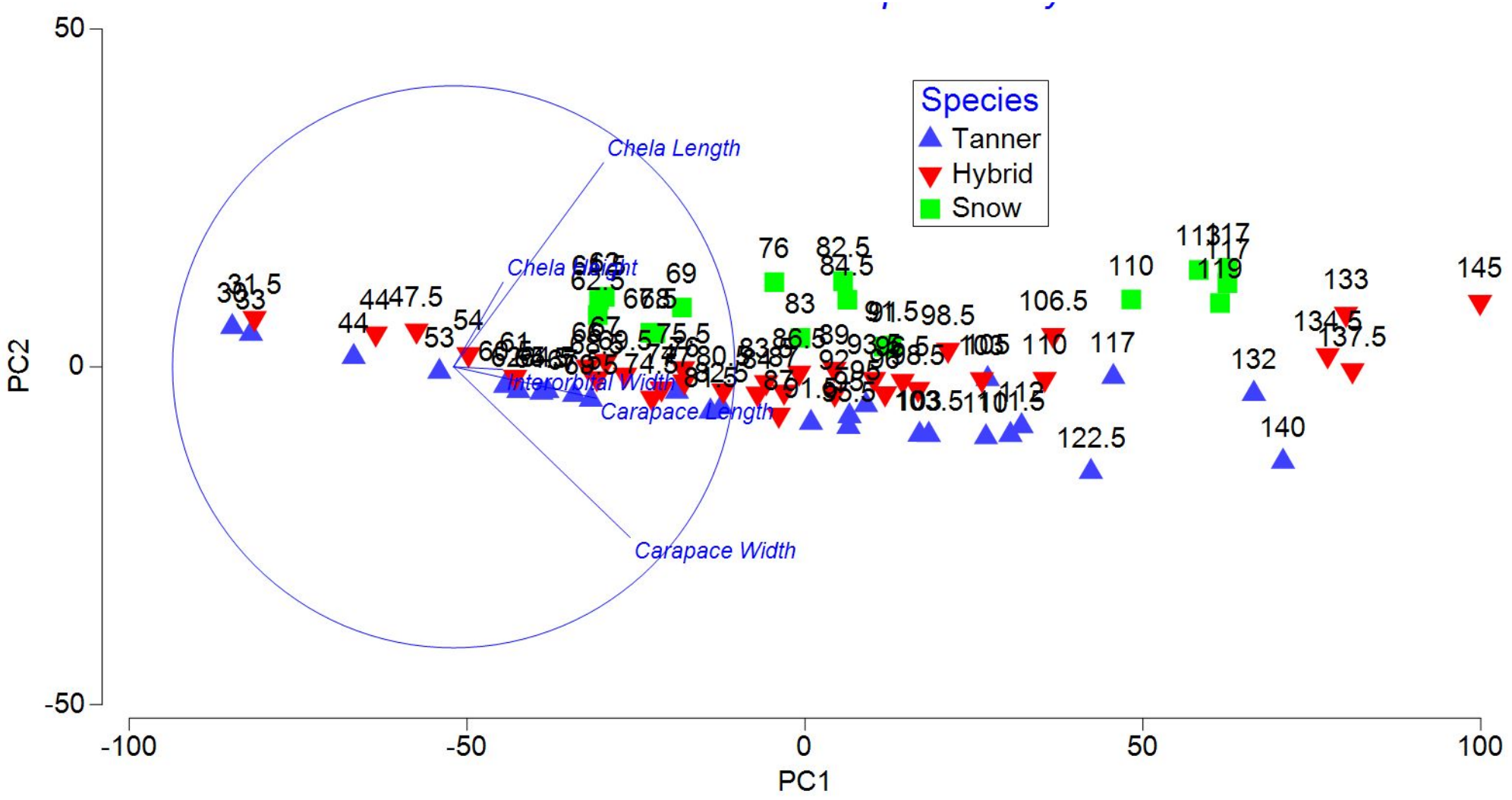
- High proportion of very small crabs (<20mm) are hybrids
- Low proportion hybrids between ~30-50mm
- Females have highest proportion hybrids at mature sizes
- Proportion of males increases to about 90-110mm
- Proportion of hybrid males decreases above 110 mm



Thoughts and questions

- Very small crabs (<20mm)
  - Very small sample size- potential for bias
  - IDs are very tricky (personal observation that very small snow crab often have a ‘M’ shaped epistome)
  - We have low confidence in our ability to identify hybrids at this size
- We seem do a poorer job of identifying small/immature hybrids (below about 65mm for females and 80mm for males)
- We maximize our ability to identify hybrids for crabs around 70mm (females) and 90-110mm (males)
  - Are mature crabs easier to distinguish or is it just size?
  - Changes in morphometry may make hybrids more distinct from snows and Tanners
- Decreases in proportion of hybrids at the largest sizes likely driven by size-at-maturity being smaller than Tanner crab

Why are small hybrids hard to identify?

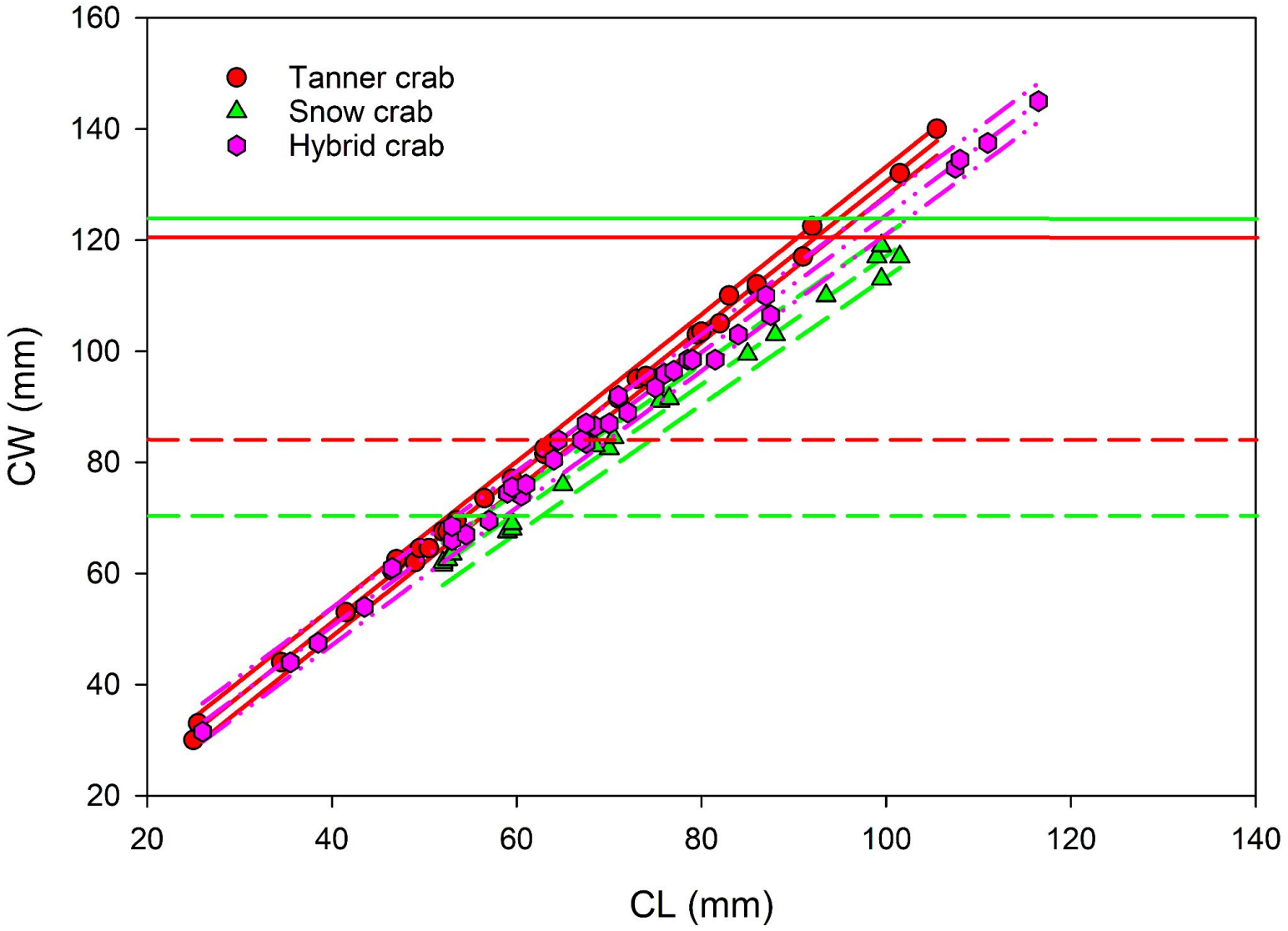


- Data from Karinen 1988
- All male
- Confounded by morphometric maturity
- No genetic ID

- PCA of raw morphometric data
- Overlap between hybrids and both species especially at small sizes

Karinen, J., 1988. Morphological and morphometric characteristics useful for identifying eastern Bering Sea *Chionoecetes baridi* Rathbun, *C. opilio* (O. Fabricius), and a hybrid of these species. Northwest and Alaska Fisheries Science Center, NOAA, Auke Bay, Alaska, pp. 24.

Looking at the carapace width/length relationship



- Linear regression +/- 95% prediction interval
- 95% PIs start to overlap at about 120mm as CW decreases
- 95% PI of hybrids overlaps the mean of the other species
  - Tanners- 85mm
  - Snows- 70mm
- Beginning at about 60 mm Tanner and hybrids are not distinguishable using this metric

Conclusions 1

- EBS survey data limitations
  - Immature crabs under 60mm likely have high error/observer bias
  - Mature/legal crabs probably have the lowest error rate/observer bias
    - Likely reliable
    - Urban 2002 suggests ~80% correct hybrid ID by experts
- Original datasets used for description/identification are limited
  - 100% male crabs
  - Almost all the hybrids were legal sized and above
- Identification is tricky
  - On survey, we rely on semi-subjective characteristics
  - Overlap in morphological characteristics- worse for small crabs
  - Interobserver variance is likely high- again, worse for small crabs
  - It is difficult to standardize across observers
    - Months between training and survey
    - No way to calibrate during survey
  - No genetic ID to provide true answer!

What do we trust?/Caution against

- Large pulses of hybrids are real
  - We see cohorts moving through population
  - They show up in the fishery
- Identification is tricky and accuracy size dependent
  - Large and mature crabs are probably seldom misidentified
  - The smaller the size the more error is likely- use at your own risk
- Observer bias is real
  - In some years you see a clear difference in proportion of hybrids between boats
  - Likely most pronounced in smaller crabs
- Hybrid data are useful
  - We have used our survey data to parametrize a sdmtmb (species distribution model) with all sexes/sizes
  - This implies that they are behaving in a consistent manner year to year relative to abiotic conditions

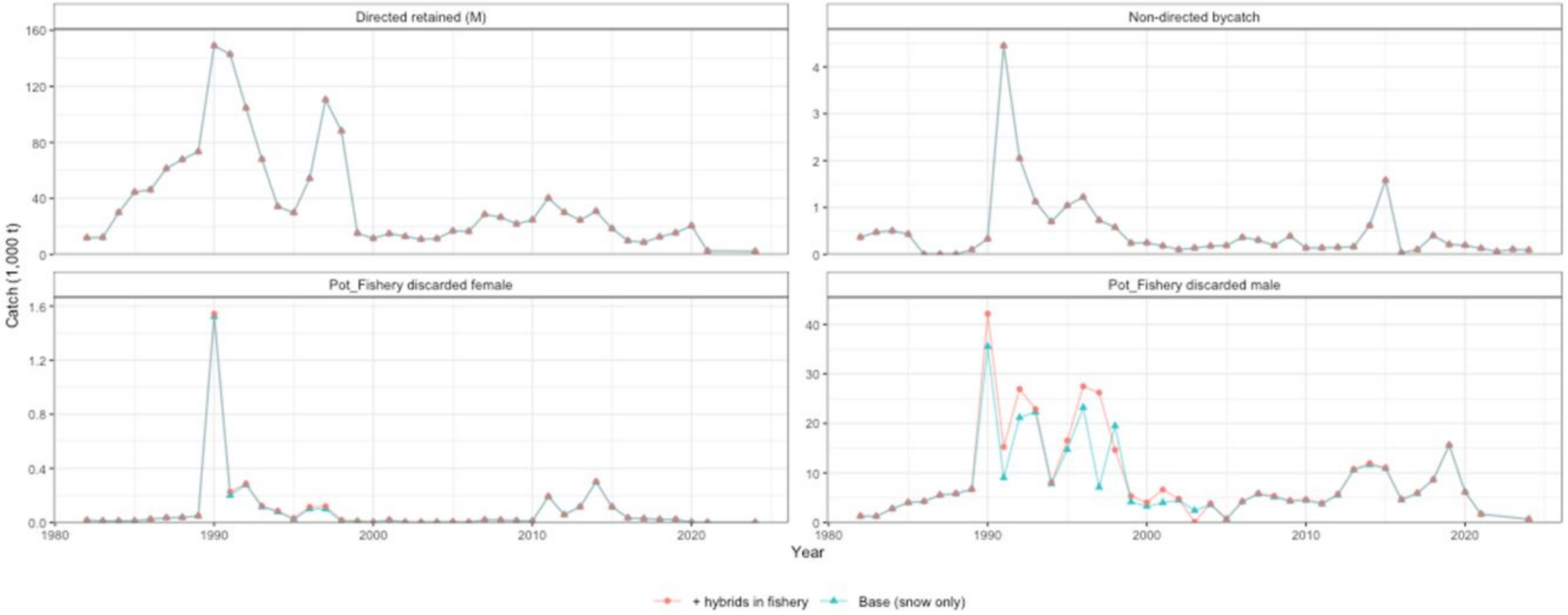
Whither now?

- Is there a better method for identification
  - Modernize genetic ID: develop RT-PCR protocol
  - Develop/expand morphometric methods
    - Are there other morphological measurements that are more diagnostic?
      - Carapace height?
      - Silver bullet would be a single measurement that can be used with CW
    - Expand
      - Females!!!!
      - Immature crabs
- Could we develop a “selectivity curve” that accounts for incorrect identification?
    - Could account for error rate, but may be tricky on observer bias

Snow crab model sensitivity runs

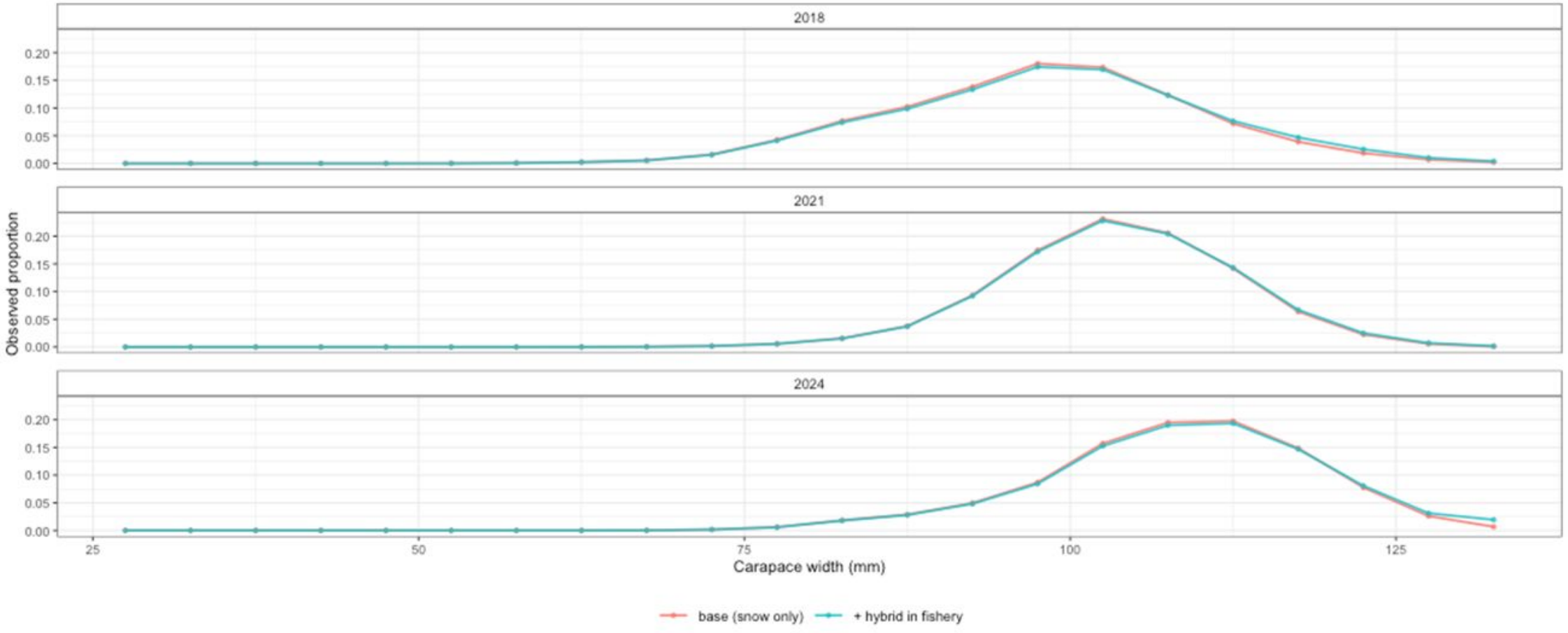
- 2025 assessment model
- 2025AM + (Hybrid+Snow) survey data
  - all hybrids treated as snow crab
- 2025AM + (Hybrid+Snow) fishery data
  - all hybrids in ADFG at-sea observer coverage treated as snow crab
  - all hybrids in retained catch size comps treated as snow crab
  - retained catch **not** apportioned between hybrids and species
- 2025AM + (Hybrid+Snow) survey + fishery data

Catch data – retained, discards, bycatch



Retained catch and trawl bycatch are identical across scenarios; Hybrid-fishery models add hybrids to directed discards.

Catch data – retained, discards, bycatch

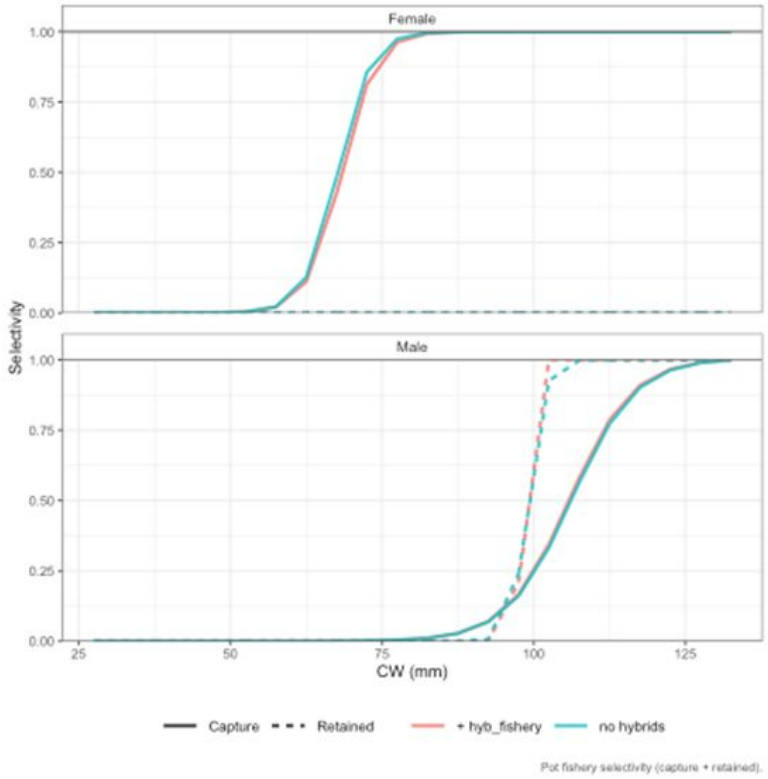


Pot-fishery total-male size composition. Hybrid catch inflates the larger size bins.

Fishery sensitivity

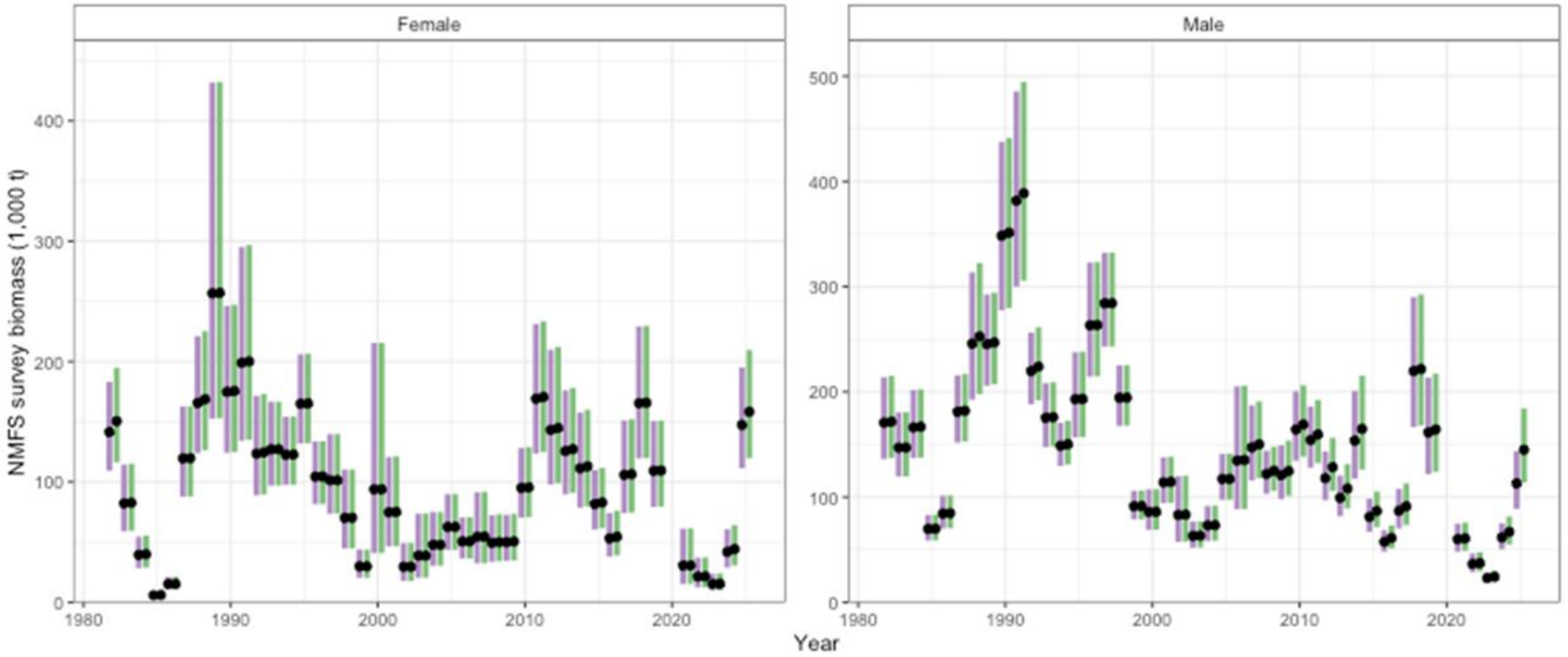
Adding hybrids to the directed pot fishery **increases discards** in some years – e.g. legal-male hybrid catch ~18 kt in 1997 and ~15 kt in 1998 (flagged by ADF&G as needing QC).

Models accommodate the added discards primarily through changes in **estimated discard fishing mortality**, not selectivity.



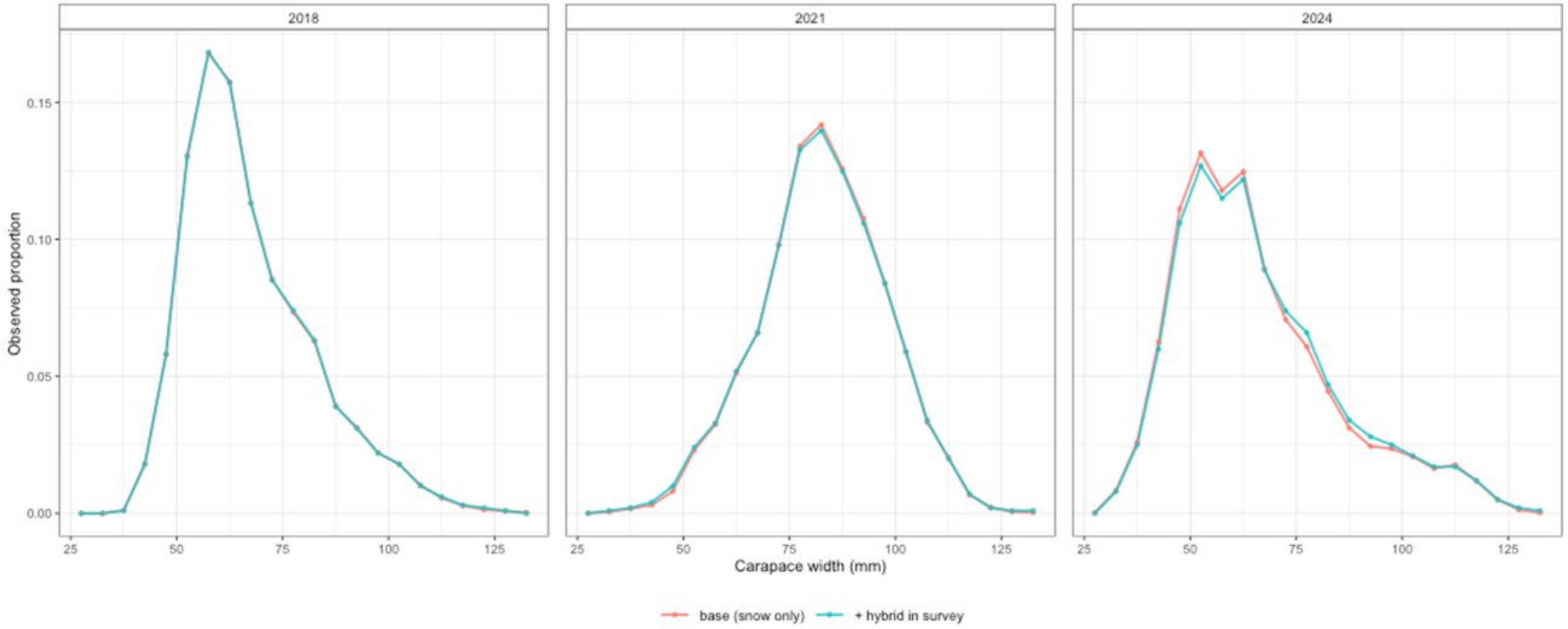
Pot fishery selectivity (capture + retained).

NMFS survey biomass index



Adding hybrids to the survey index inflates mature biomass by the additional hybrid crab. Trends are unchanged.

NMFS survey composition – mature males

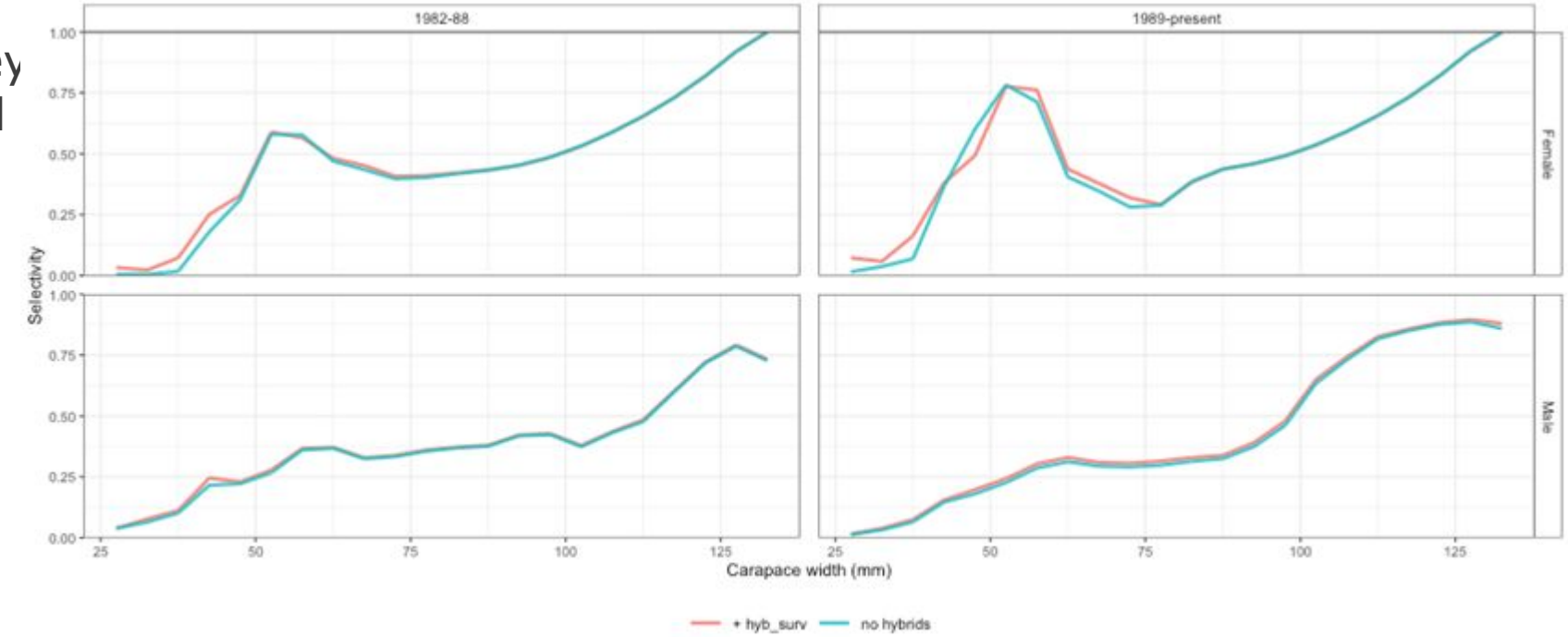


NMFS 1989-present mature-male size composition. Hybrids inflate the larger size bins.

NMFS summer trawl survey

Visibly higher predicted survey biomass in some years; trend through time is unchanged.

Hybrid identification quality decreases further back in the time series (consistency between ADF&G and NMFS criteria is currently an issue).



NMFS summer-trawl survey selectivity by era and sex.

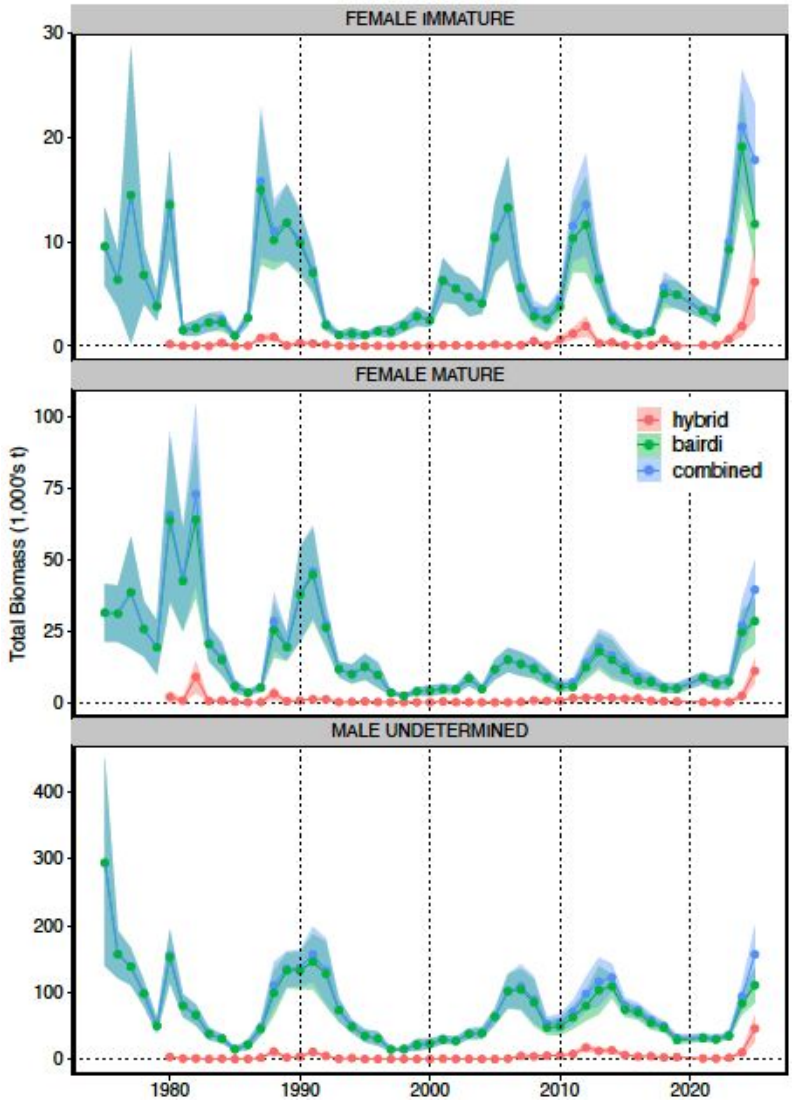
BRPs

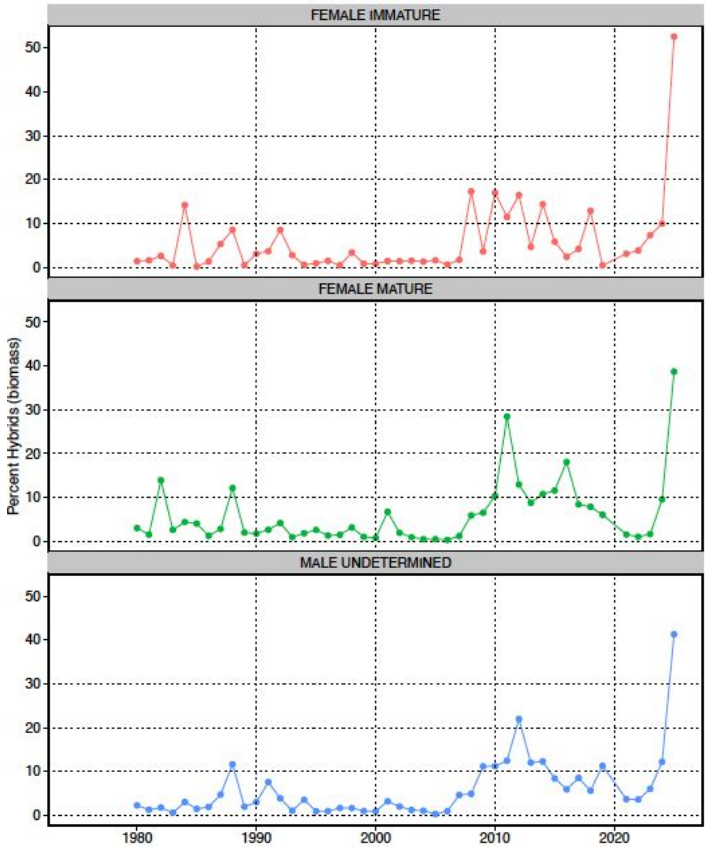
Model	Hybrids	BMSY	Status	Mature M (2024)	Immature M (2024)
Model 25.1c	None	179.46	0.89	0.285	0.292
Model 25.3a	Fishery	169.34	0.91	0.293	0.277
Model 25.3b	Survey	176.33	0.93	0.285	0.270
Model 25.3c	Fishery + Survey	168.16	0.95	0.293	0.271

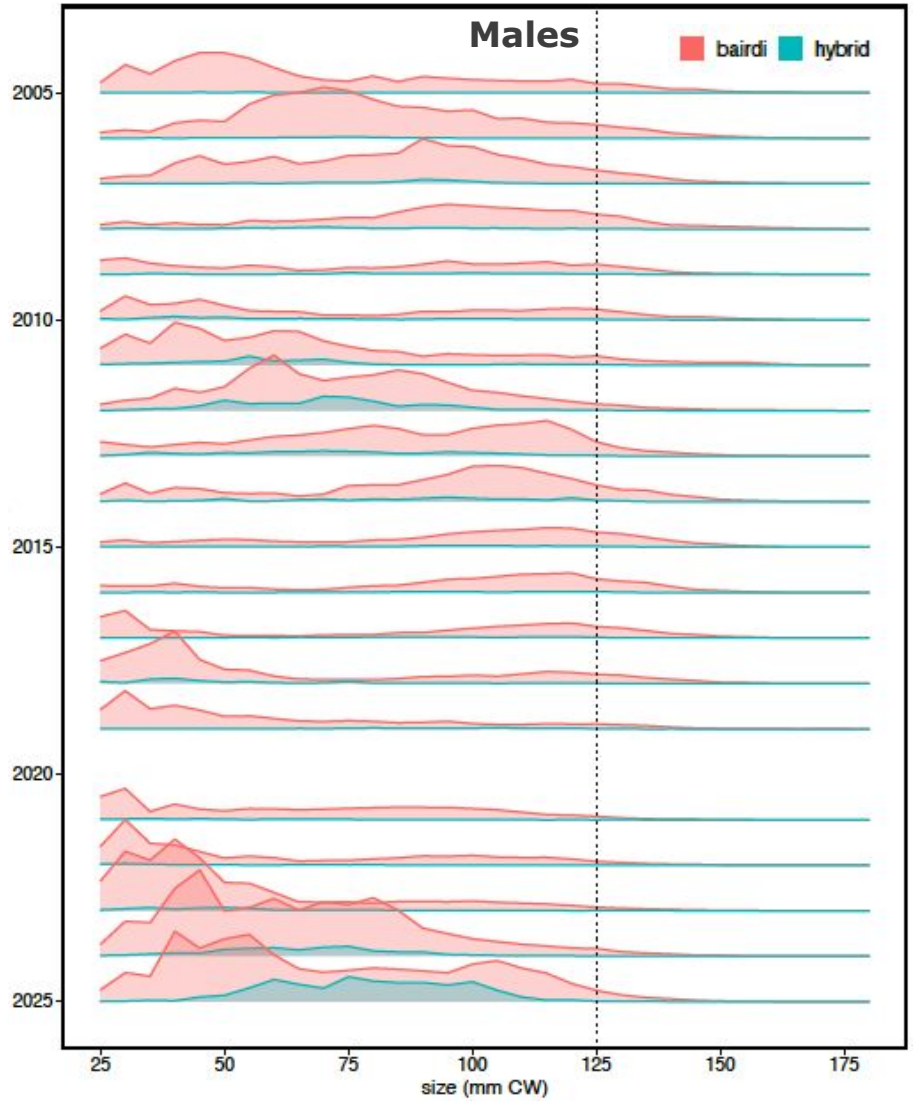
Tanner crab model sensitivity runs

- 2025 assessment model
- 2025AM + (Hybrid+Tanner) survey data
  - all hybrids treated as Tanner crab
- 2025AM + (Hybrid+Tanner) fishery data
  - all hybrids in ADFG at-sea observer coverage treated as Tanner crab
  - all hybrids in retained catch size comps treated as Tanner crab
  - retained catch **not** apportioned between hybrids and species
- 2025AM + (Hybrid+Tanner) survey + fishery data

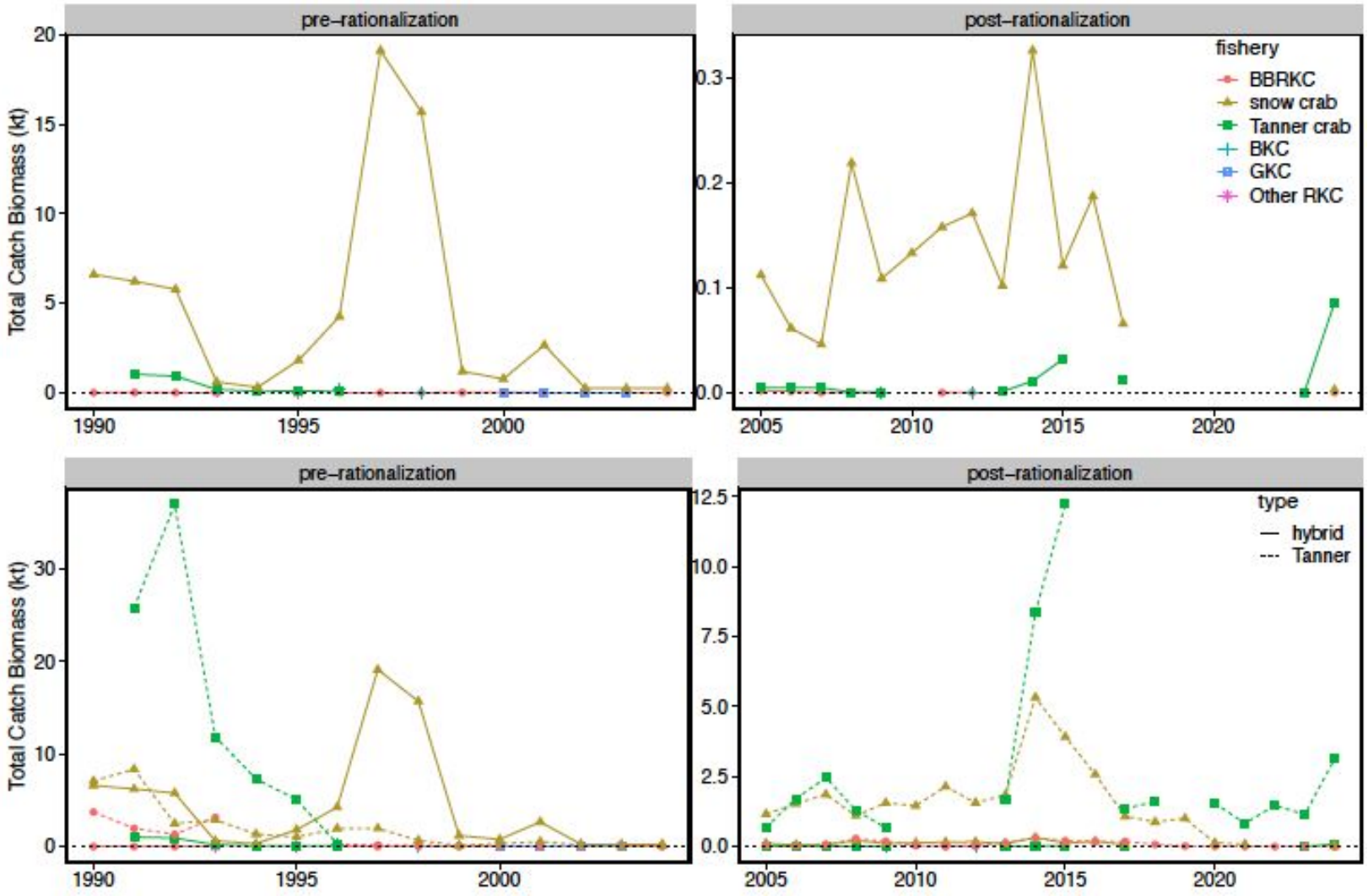
Tanner crab model sensitivity runs: hybrids survey data



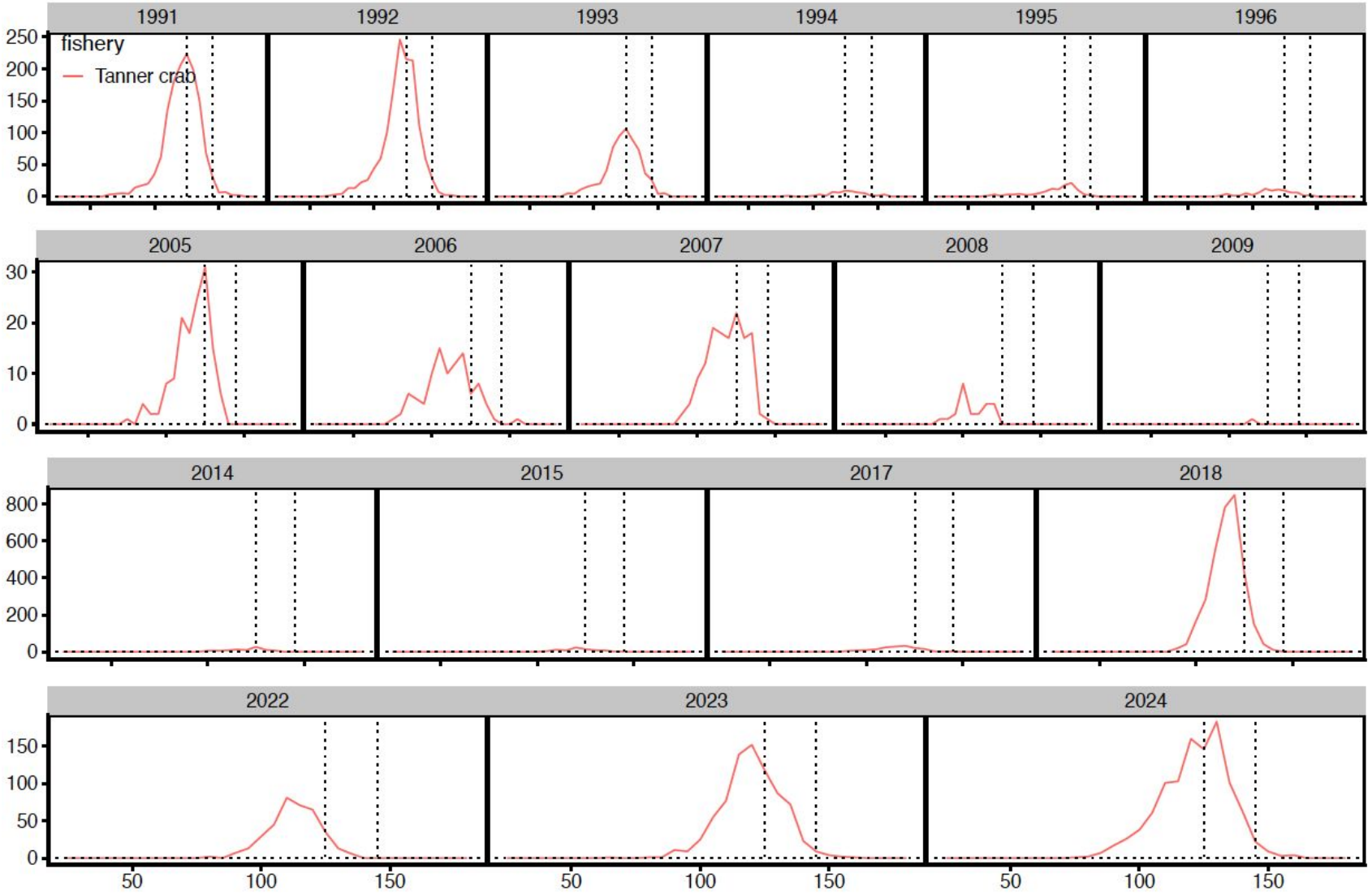




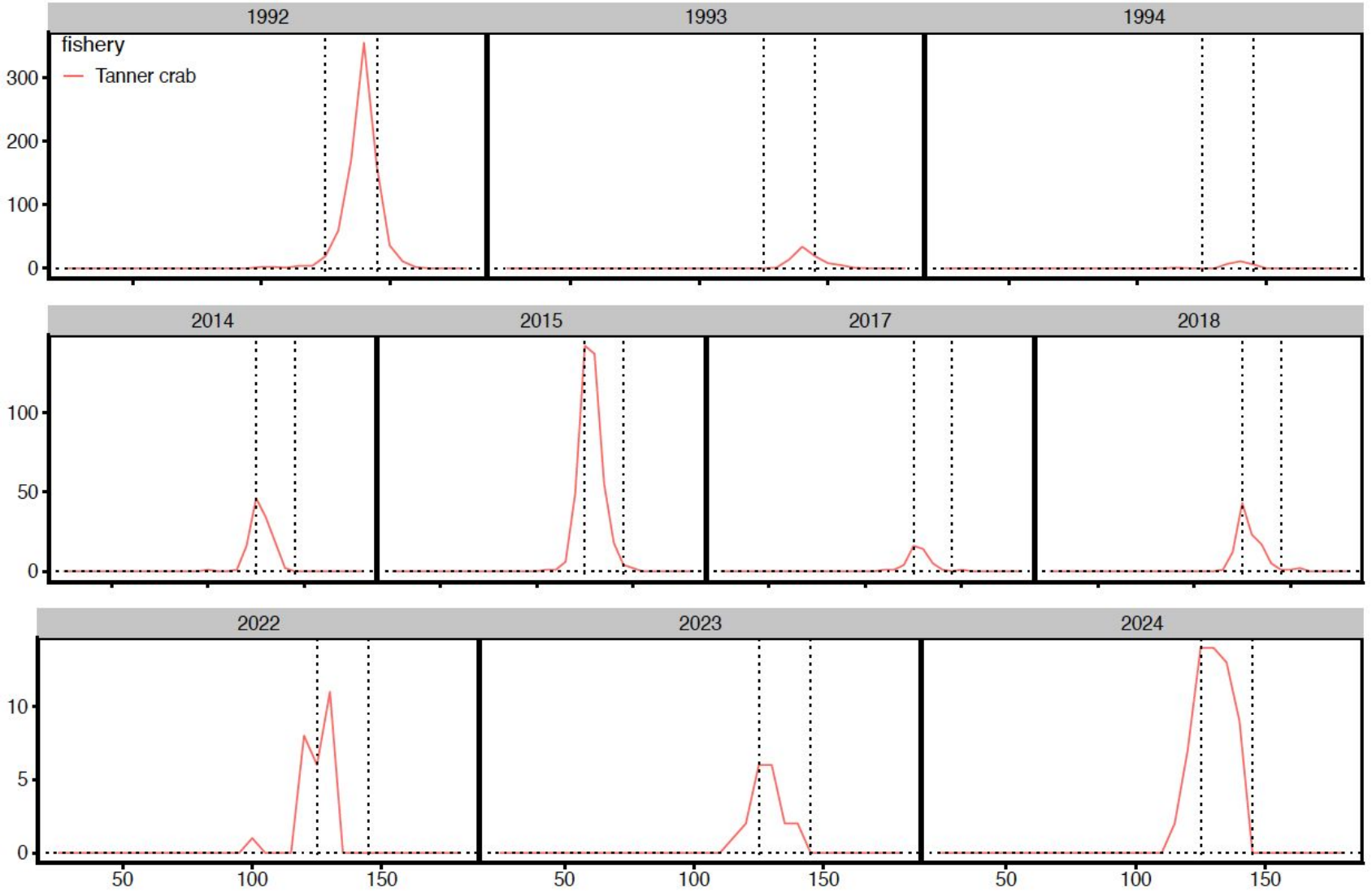
Tanner crab model sensitivity runs: hybrids fishery data



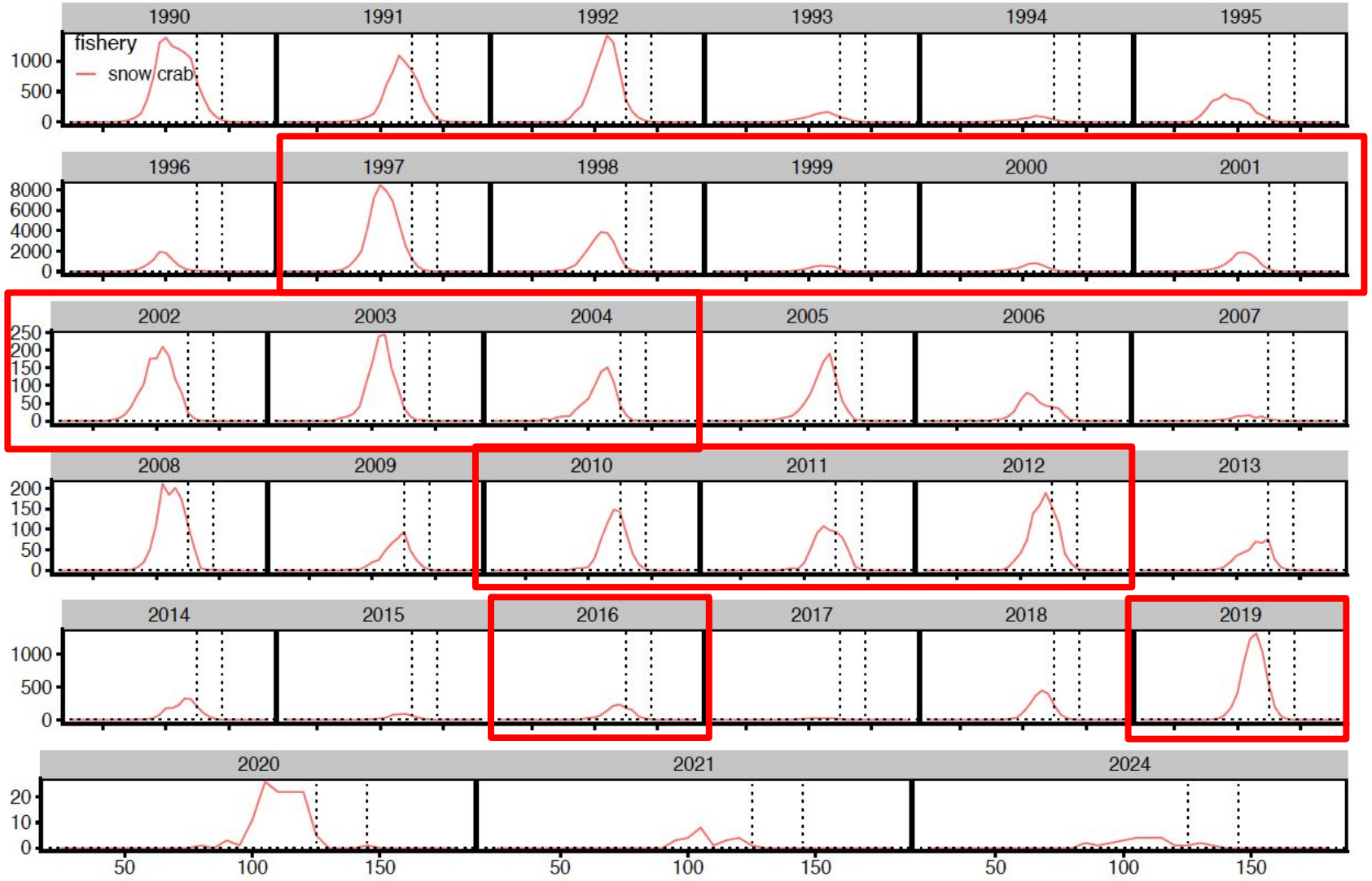
Tanner crab model sensitivity runs: hybrids total catch data



Tanner crab model sensitivity runs: hybrids retained catch data

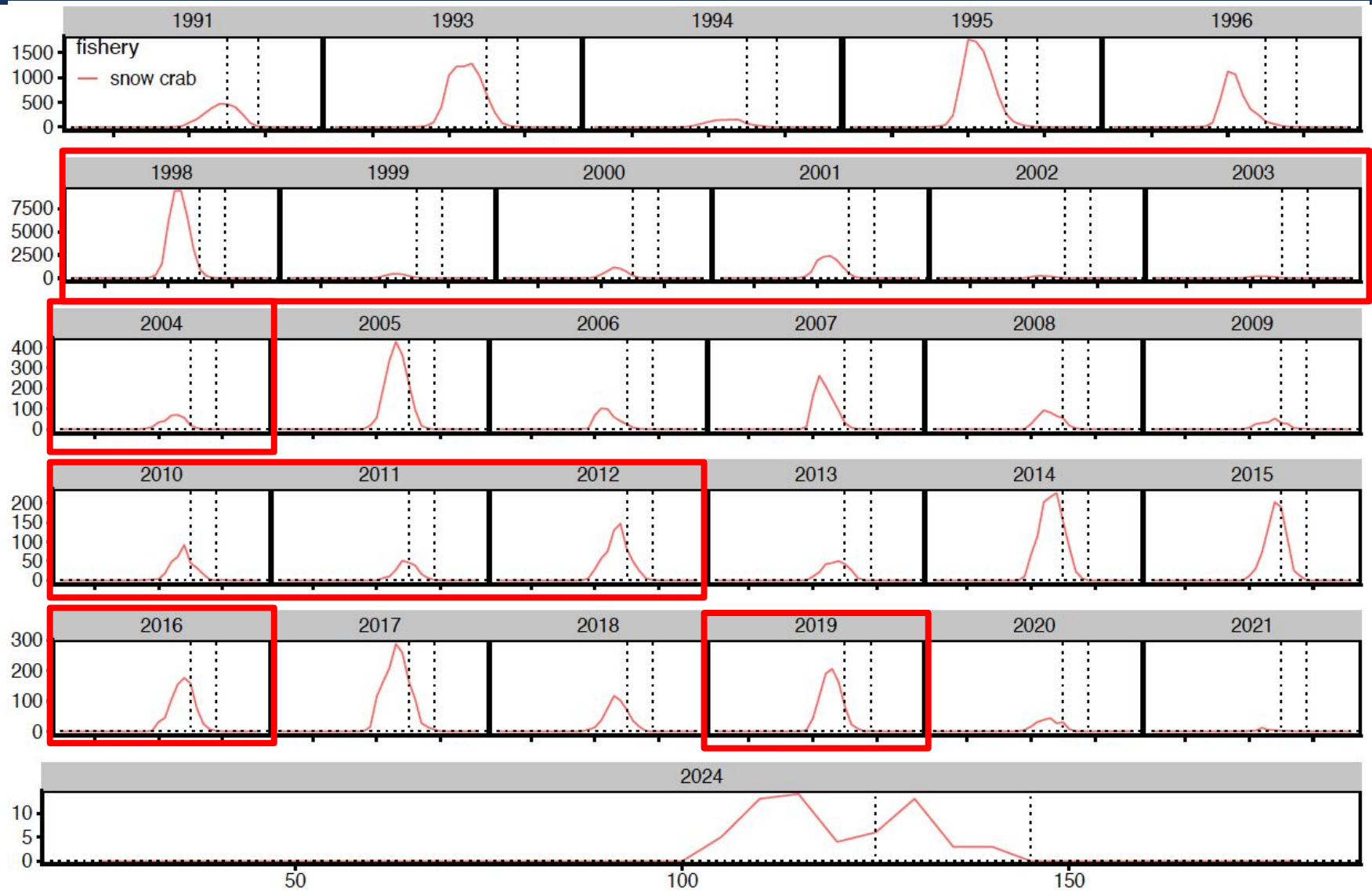


Tanner crab model sensitivity runs: hybrids total catch data



directed fisheries closed

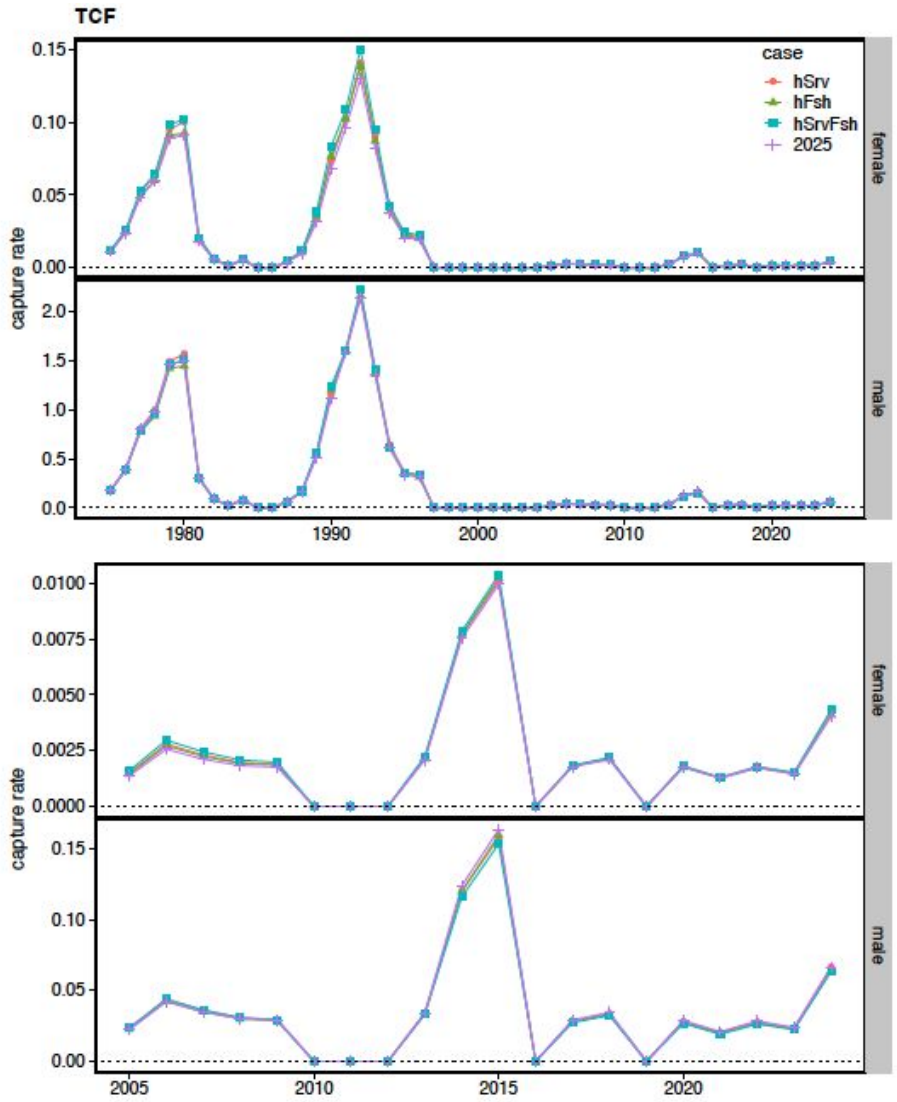
Tanner crab model sensitivity runs: hybrids retained catch data

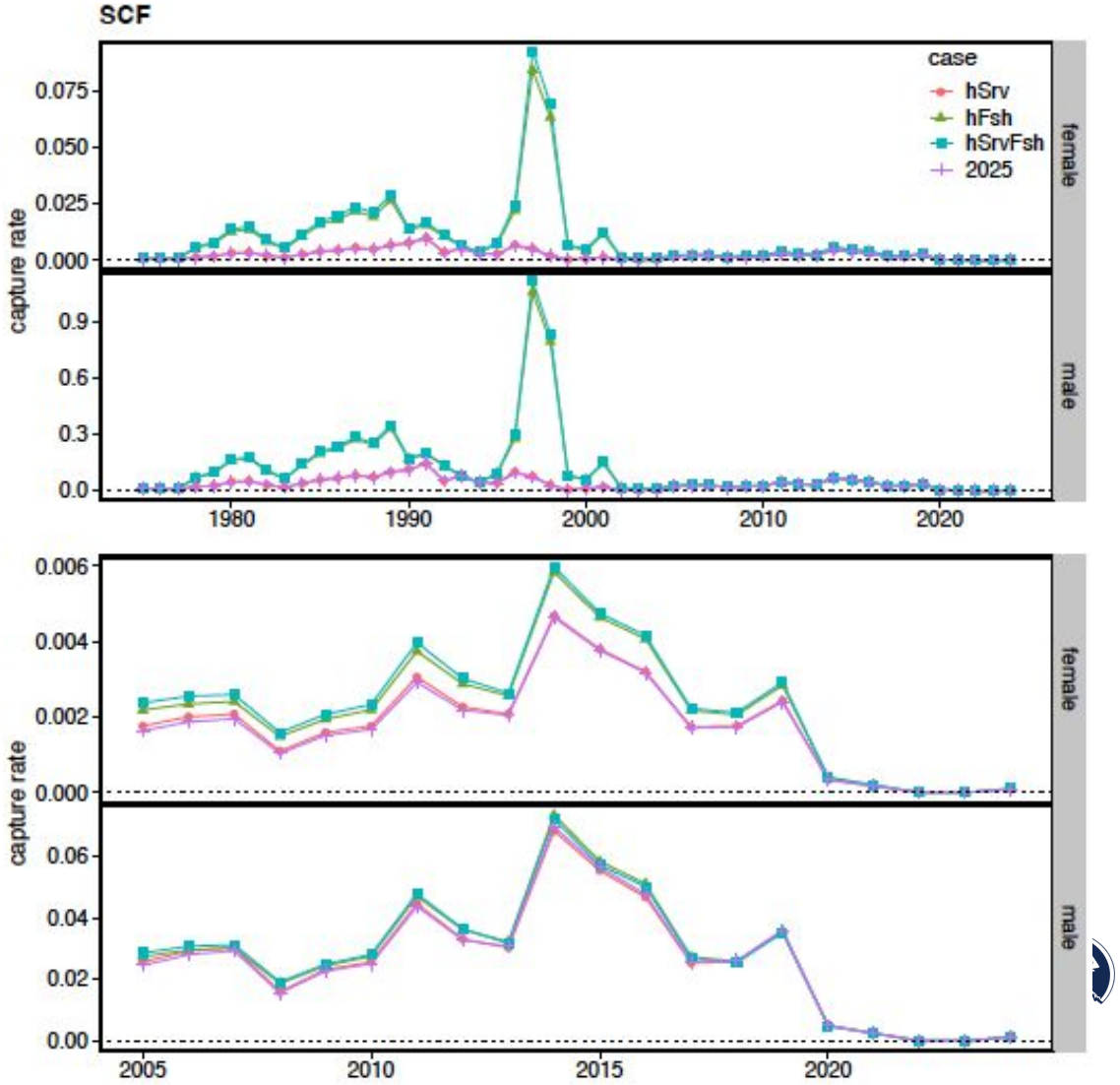


1997?

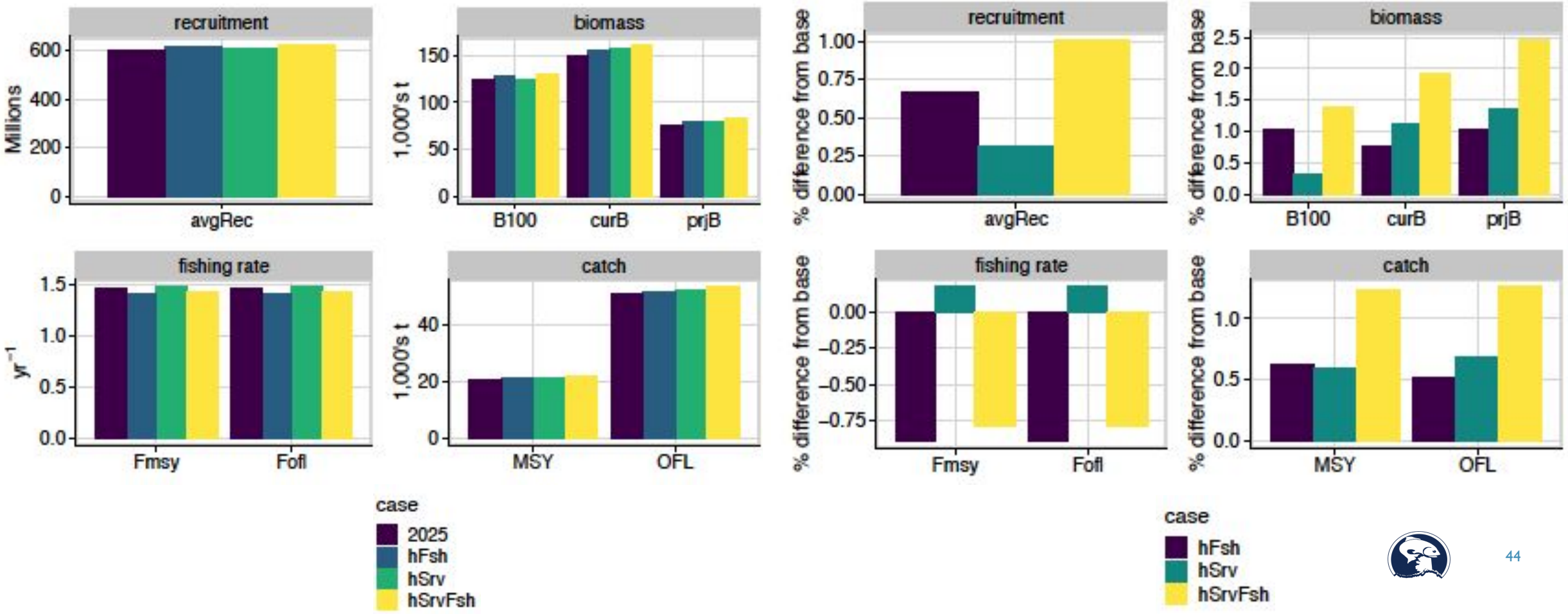
directed fisheries closed

Tanner crab model sensitivity runs: estimated capture rates





Tanner crab model sensitivity runs: management quantities



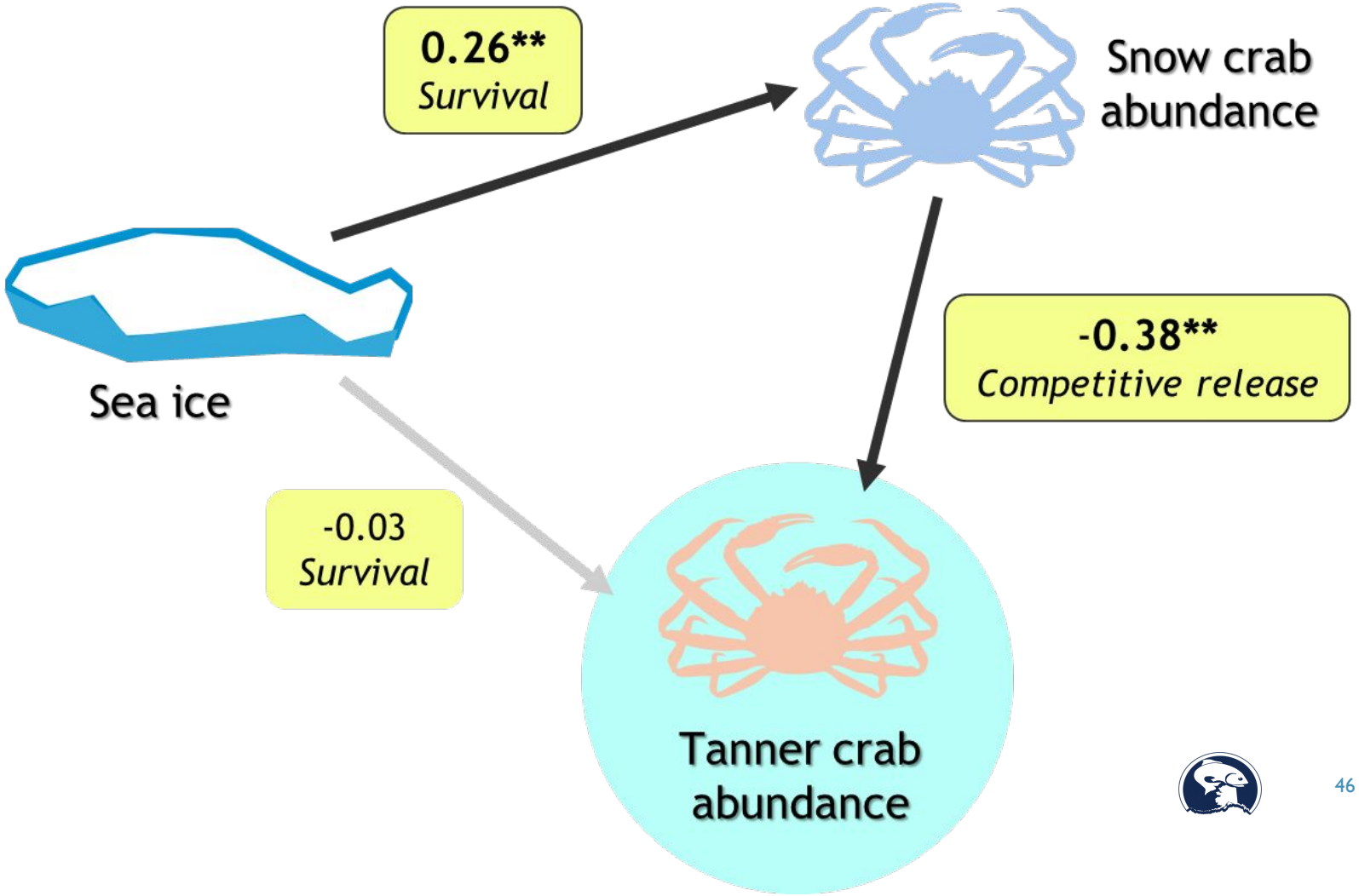
Hybrid research - Fedewa / Ryznar / Litzow

What are the causes and implications of increased hybrid abundance?

- Drivers of increased Tanner / hybrid abundance (DSEM approach)
- Changes in species overlap pre/post heatwave (sdmTMB)
- Emerging changes in niche space (sdmTMB covariate models)

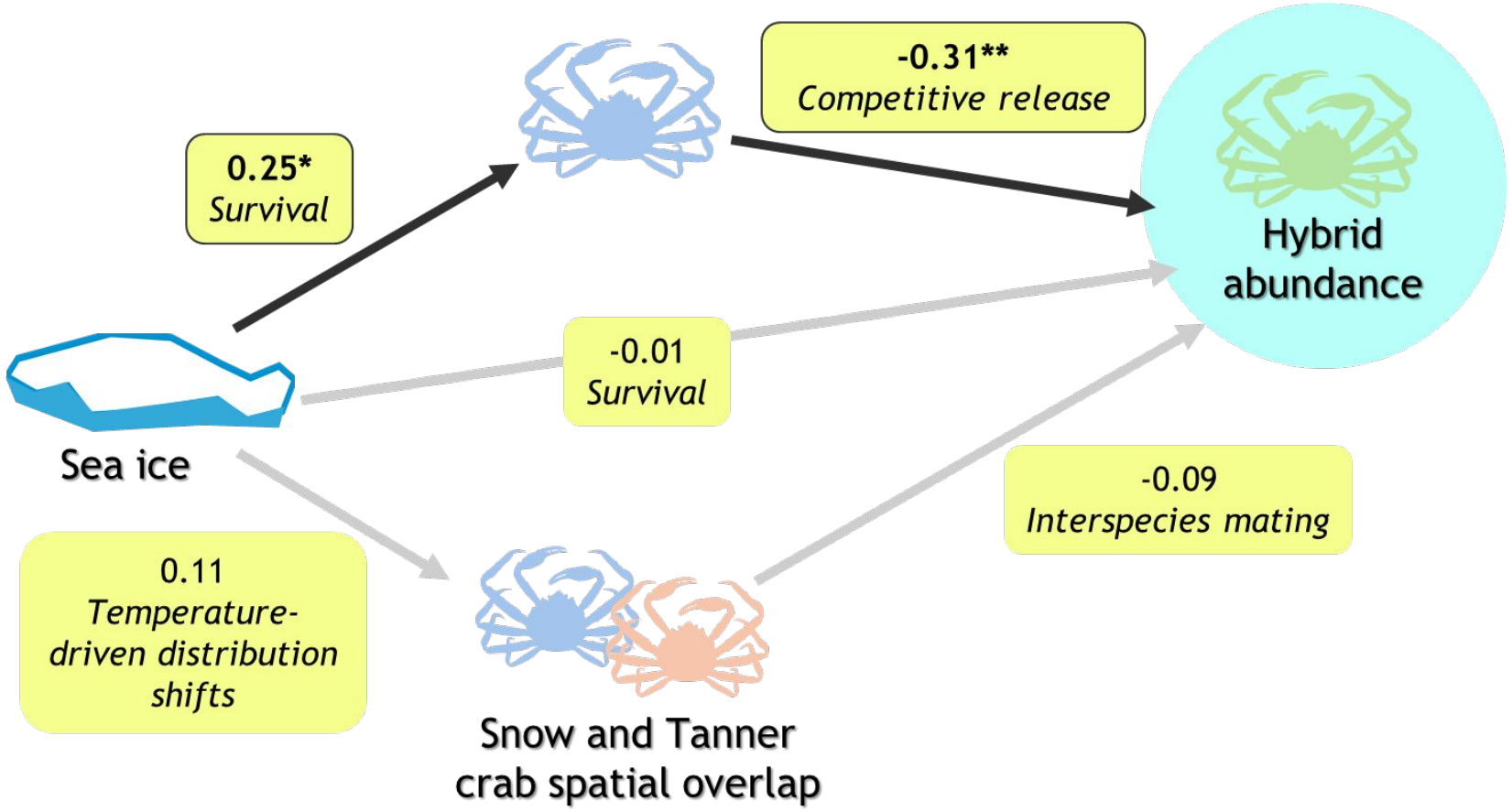
Hybrid research - causes of increased Tanner abundance

- DSEM #1: drivers of Tanner crab abundance
- Distinguishes direct sea ice from sea ice -> snow crab causal pathways
- Causal links are robust to lags used



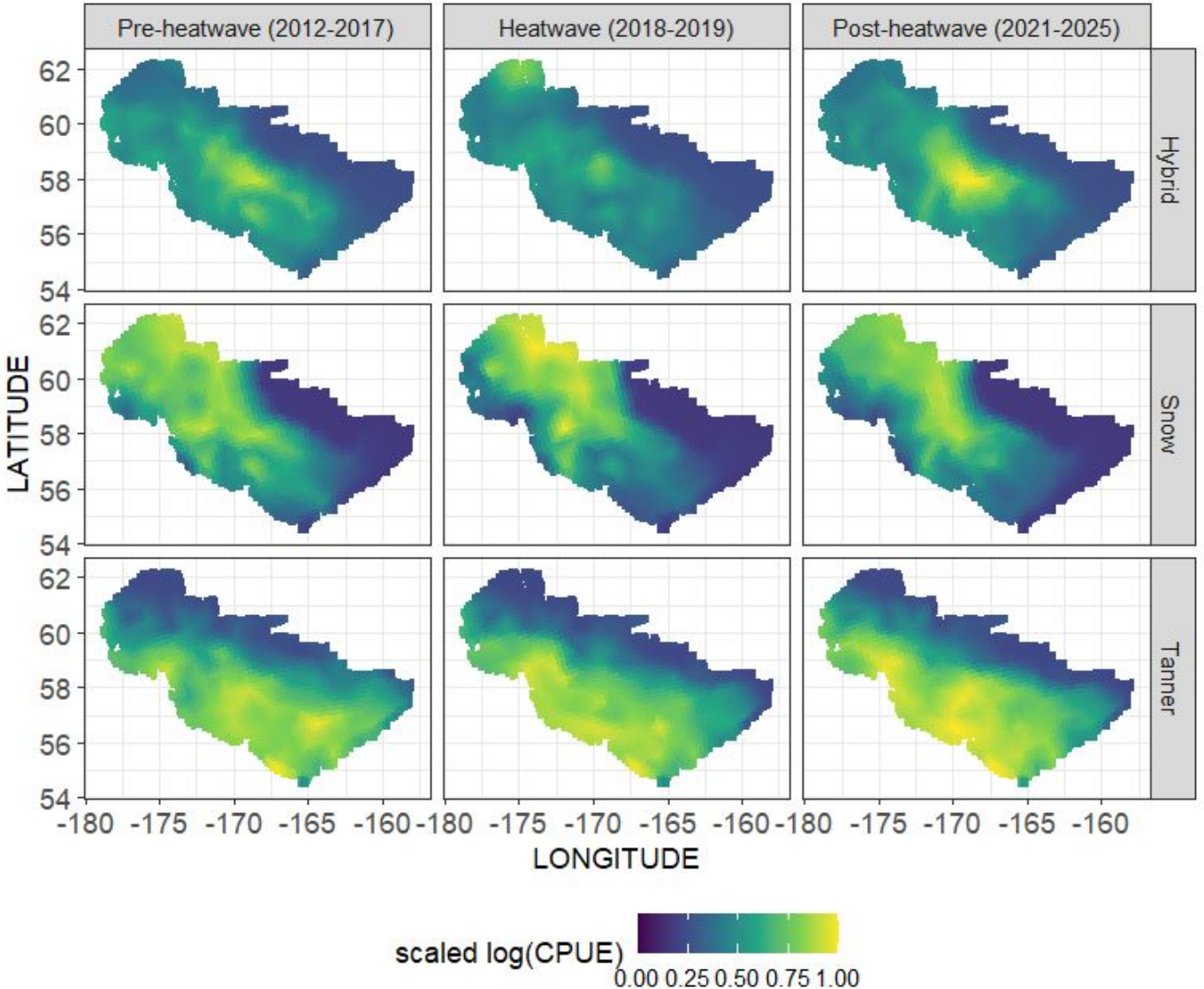
Hybrid research - causes of increased hybrid abundance

- DSEM #2: drivers of snow x Tanner hybrid abundance
- Distinguishes pre-mating hybrid barrier (snow-Tanner overlap) from post-mating barriers (sea ice effects on survival, effects through snow crab abundance)
- Causal links are robust to lags used



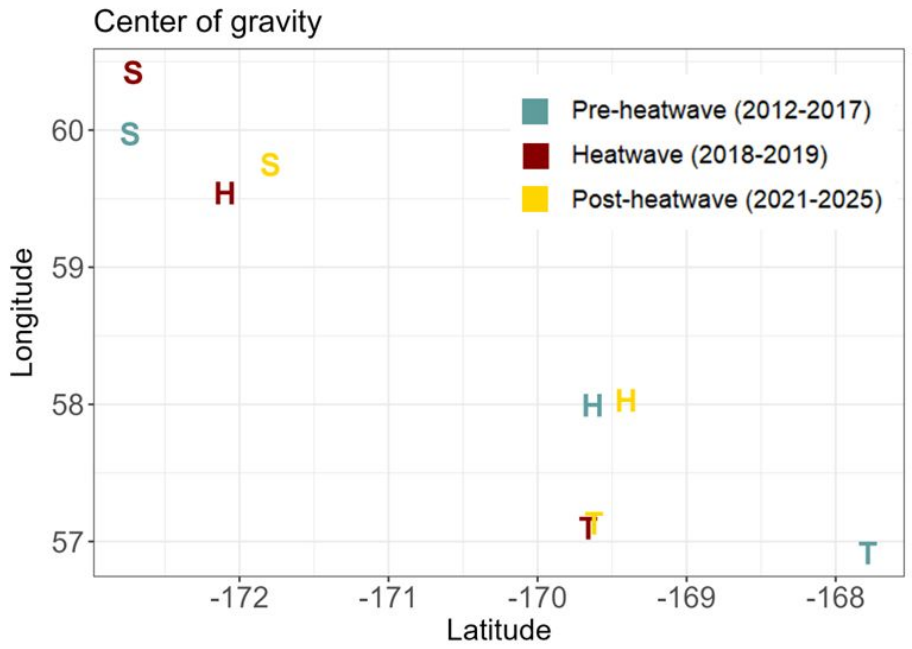
Hybrid research - changes in distribution and overlap

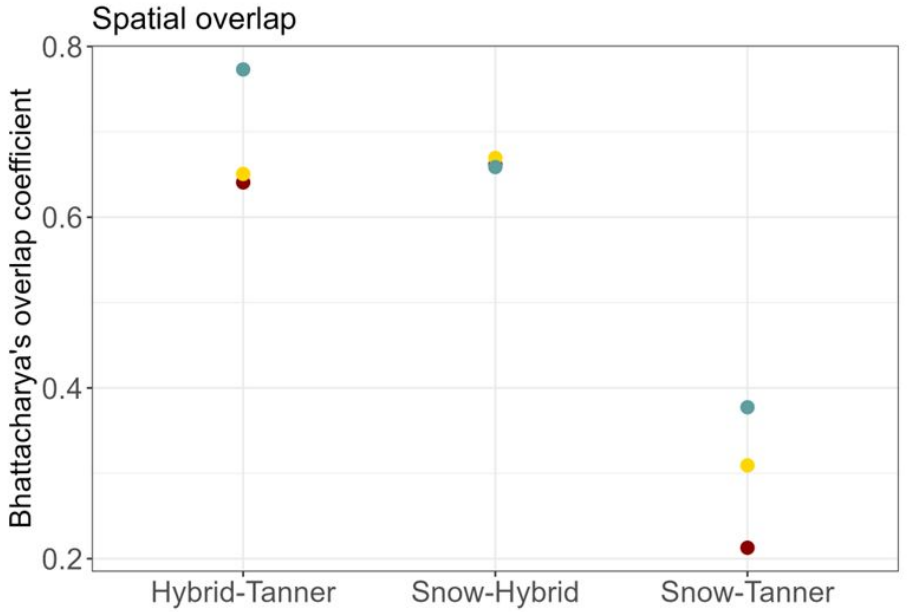
- sdmTMB models for all size-sex categories involved
- Core area of hybrid abundance similar pre/post heatwave
- Area of highest Tanner density shifting west
- Overlap of mature snow and Tanner does not explain hybrid spike in time (DSEM results)

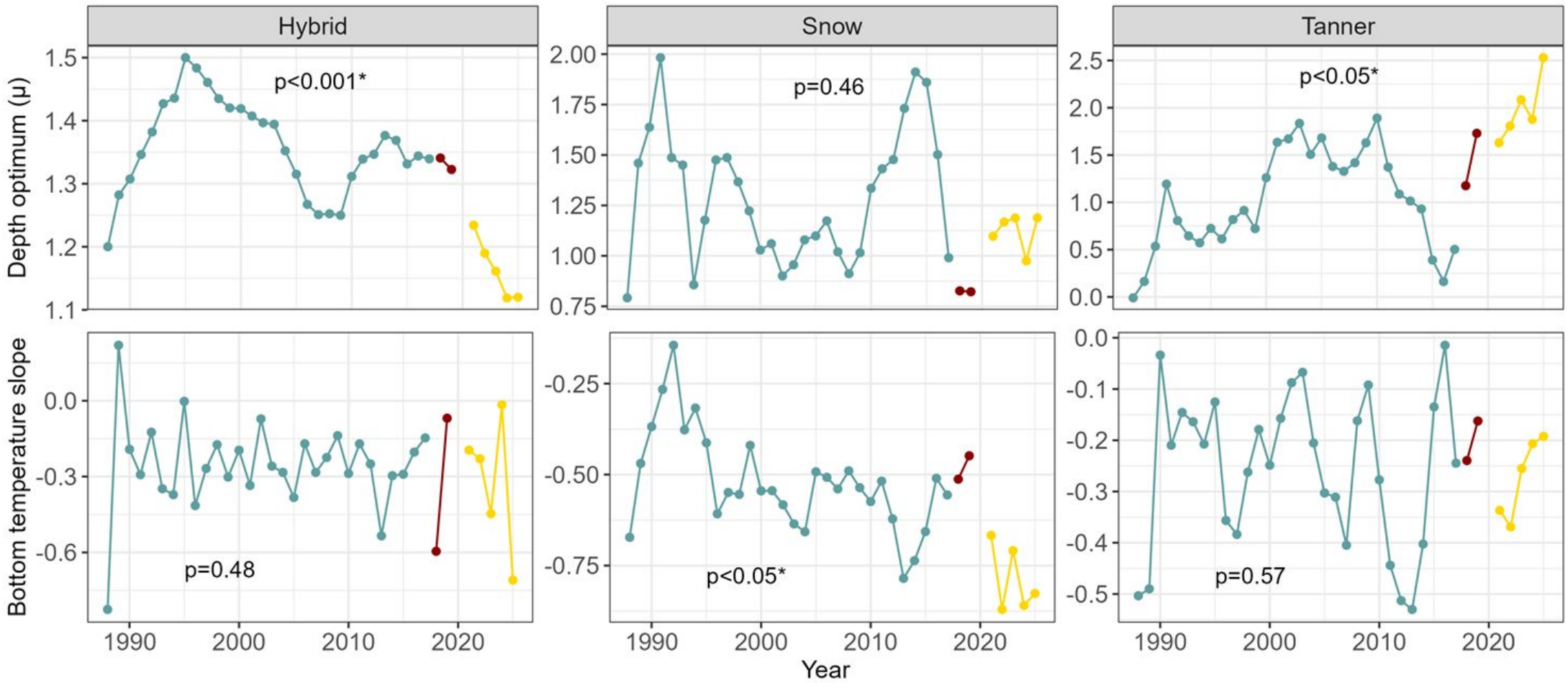


Hybrid research - changes in distribution and overlap

- Hybrid center of gravity (COG) shifted west during heatwave
- Hybrid COG similar pre/post heatwave
- Tanner COG shifted west during and post-heatwave
- Snow-Tanner overlap higher post-heatwave







- Hybrids shifting deeper; Tanner shallower
- Snow crab increasingly restricted to cold water

Review of Goals

- Review of data and understanding of hybrids
- Consistency in assessment process with hybrid data
- Plan for Fall 2026 considerations
  - working within the current FMP framework
  - recommendations for future changes?

Plan for Fall 2026

What do we want brought forward

Examples:

- Buffer option
- Data stream moving forward
  - Status quo
  - take hybrids out of retained catch
- Options for inclusion of hybrids in ESP