



**NOAA  
FISHERIES**

Alaska Fisheries  
Science Center

# BSAI Plan Team report

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November 30, 2020

# Team members

- Grant Thompson, co-chair (AFSC REFM)
- Steve Barbeaux, co-chair (AFSC REFM)
- Steve MacLean, coordinator (NPFMC)
- Mary Furuness (NMFS AKRO)
- Alan Haynie (AFSC REFM)
- Allan Hicks (IPHC)
- Lisa Hillier (WDFW)
- Kirstin Holsman (AFSC REFM)
- Andy Kingham (AFSC FMA)
- Kalei Shotwell (AFSC ABL)
- Chris Siddon (ADF&G)
- Cindy Tribuzio (AFSC ABL)



# “Big picture” overview

# Big picture (with big font)

- Assessments of 23 stocks/complexes (21 full, 2 partial, 0 “none”)
  - New lead author for 9 assessments
- Lots of models (including Tier 5 and 6 methods):
  - 25 base models/methods (2 chapters include models for 2 areas)
  - 28 additional models/methods
- The Team agreed with authors’ recommendations regarding preferred models/methods and harvest specifications in all but 1 case
- Change from current base model/method recommended in 7 cases
- Reductions from maxABC recommended in only 2 cases
- Of the 16 stocks/complexes in Tiers 1 or 3, only 3 are in sub-tier “b”
- No stocks/complexes were subjected to overfishing in 2019, and no Tier 1 or 3 stocks/complexes are overfished/approaching as of 2020



# Big picture (with small font)

Ch.	Assessment	Lead author	Tier	Type	Numbered models (or Tier 5, 6)	Risk
1	<b>EBS pollock</b>	Ianelli	1a	Full	16.2 (base), 20.0, 20.1, <b>20.0a</b>	1.50
1A	AI pollock	Barbeaux	3a	Full	<b>15.1 (base)</b> , 15.2	1.00
1B	Bogoslof pollock	Ianelli	5	Full	<b>Tier 5 RE (base)</b> , age-structured model	1.00
2	<b>EBS Pacific cod</b>	Thompson	3b	Full	20.4, 19.12a, 19.15, 19.12 (base), 20.8, 20.9, 20.10; Ens. A {20.4, 19.12a, 19.15, 19.12}, <b>Ens. C {Ens. A, 20.8}, Ens. AB {Ens. C, 20.9, 20.10}</b>	1.25
2A	<b>AI Pacific cod</b>	<b>Spies</b>	5	Full	<b>Tier 5 RE (base)</b>	1.25
3	<b>Sablefish</b>	<b>Goethel</b>	3a	Full	16.5 (base)	2.75
4	<b>Yellowfin sole</b>	Spies	1a	Full	18.1 (base), <b>18.2</b> , 18.3, 18.4	1.00
5	Greenland turbot	Bryan	3a	Full	16.4 (base), <b>16.4a</b>	1.25
6	Arrowtooth flounder	<b>Shotwell</b>	3a	Full	18.9 (base)	1.00
7	Kamchatka flounder	Bryan	3a	Full	16.0a (base), <b>16.0b</b> (same as base, with updated data)	1.00
8	Northern rock sole	<b>McGilliard</b>	1a	Full	15.1 (base), <b>18.3</b> , 18.3 (exploratory)	1.25
9	Flathead sole	<b>Monnahan</b>	3a	Full	18.2c (base)	1.00
10	Alaska plaice	<b>Ormseth</b>	3a	Partial	11.1 (base)	n/a
11	<b>Other flatfish</b>	<b>Monnahan</b>	5	Full	Tier 5 RE (base)	1.00
12	<b>Pacific ocean perch</b>	Spencer	3a	Full	16.3a (base)	1.25
13	Northern rockfish	Spencer	3a	Partial	16.1a (base)	n/a
14	<b>Blackspot/rougheye</b>	Spencer	3b/5	Full	AI: 18.1 (base), <b>20</b> , 20a, 20b, 20c; EBS: Tier 5 RE (base)	2.00
15	Shortraker rockfish	<b>Shotwell</b>	5	Full	Tier 5 RE (base)	1.00
16	<b>Other rockfish</b>	<b>Sullivan</b>	5	Full	Tier 5 RE (base)	1.25
17	Atka mackerel	Lowe	3b	Full	16.0b (base)	1.00
18	Skates	Ormseth	3a/5	Full	Alaska skate: 14.2 (base); other skates: Tier 5 RE (base)	1.00
19	Sharks	Tribuzio	6	Full	Tier 6: <b>16.0 (base)</b> , 20.0, 20.1, 20.2	1.50
22	Octopus	Ormseth	6	Full	Tier 6: cod consumption (base)	1.00



# Reference point comparisons (all chapters)

Quantity	Last asmt.	This asmt.	Change
M	0.105	0.098	-0.07
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	704,683	n/a	0.07
2021 age+ biomass	741,029	753,110	0.02
2020 spawning biomass	113,368	n/a	0.19
2021 spawning biomass	156,854	134,401	-0.14
B100%	264,940	317,096	0.20
B40%	105,976	126,389	0.19
B35%	92,729	110,984	0.20
2021 FOFL	0.121	0.117	-0.03
2021 FABC	0.041	0.042	0.02
2020 OFL	50,481	n/a	0.20
2021 OFL	64,765	60,426	-0.07
2020 ABC	22,009	n/a	0.01
2021 ABC	29,008	22,237	-0.23

Except where "quantity" is shaded, "change" represents the relative difference between *this assessment's value* and *last assessment's value* for the same quantity.

Where "quantity" is shaded, "change" represents the relative difference between *this assessment's value for 2021* and *last assessment's value for 2020*.



# Changes in reference points (Tier 1)

Quantity	<i>EBS pollock</i>	<i>Yellowfin</i>	<i>Rock sole</i>
2020 age+ biomass	-0.11	0.11	-0.14
2021 age+ biomass	-0.04	0.01	-0.43
2020 spawning biomass	-0.13	0.23	-0.23
2021 spawning biomass	-0.03	0.29	-0.17
B0	0.00	0.20	-0.08
Bmsy	0.05	0.17	-0.15
2021 FOFL	-0.24	0.01	0.07
2021 FABC	-0.05	0.02	0.06
2020 OFL	-0.36	0.11	-0.08
2021 OFL	-0.23	0.01	-0.39
2020 ABC	-0.20	0.13	-0.08
2021 ABC	-0.08	0.02	-0.39



# Changes in reference points (Tier 3)

Quantity	<i>AI pollock</i>	<i>EBS P. cod</i>	<i>Sablefish</i>	<i>G. turbot</i>	<i>Arrowtooth</i>	<i>Kamchatka</i>	<i>Flathead</i>	<i>AK plaice</i>	<i>POP</i>	<i>No. rockfish</i>	<i>AI blackspot.</i>	<i>Atka mack.</i>	<i>AK skate</i>
2020 age+ biomass	-0.14	-0.08	0.07	-0.17	0.04	-0.11	-0.12	0.00	-0.17	-0.02	-0.64	0.09	0.03
2021 age+ biomass	-0.20	-0.01	0.02	-0.11	-0.01	-0.11	-0.13	-0.02	-0.15	-0.01	-0.66	0.05	0.05
2020 spawning biomass	-0.08	-0.22	0.19	-0.09	0.03	-0.06	-0.02	-0.03	-0.19	-0.04	-0.67	-0.02	0.05
2021 spawning biomass	-0.12	-0.04	-0.14	-0.03	0.04	-0.06	-0.06	0.03	-0.16	-0.01	-0.71	0.03	0.07
B100%	-0.09	0.01	0.20	-0.02	-0.08	-0.06	-0.04	0.01	-0.09	0.00	-0.70	0.00	0.00
B40%	-0.09	0.01	0.19	-0.02	-0.08	-0.06	-0.04	0.01	-0.09	0.00	-0.70	0.00	0.00
B35%	-0.09	0.01	0.20	-0.02	-0.08	-0.06	-0.04	0.01	-0.09	0.00	-0.70	0.00	0.00
2021 FOFL	-0.06	-0.09	-0.03	0.05	-0.01	0.00	-0.02	0.07	-0.06	0.00	-0.19	0.11	-0.02
2021 FABC	-0.05	-0.04	0.02	0.00	-0.01	0.00	-0.03	0.06	-0.08	0.00	-0.18	0.10	-0.02
2020 OFL	-0.08	-0.41	0.20	-0.24	0.10	-0.08	-0.08	0.01	-0.25	-0.04	-0.38	0.05	0.02
2021 OFL	-0.13	-0.10	-0.07	-0.14	0.08	-0.07	-0.12	0.04	-0.22	-0.01	-0.51	0.14	0.06
2020 ABC	-0.07	-0.39	0.01	-0.24	0.10	-0.07	-0.08	0.00	-0.24	-0.04	-0.36	0.05	0.02
2021 ABC	-0.12	-0.08	-0.23	-0.14	0.08	-0.07	-0.12	0.03	-0.21	-0.01	-0.50	0.14	0.06





# Changes in reference points (Tier 5)

Quantity	<i>Bog. pollock</i>	<i>AI P. cod</i>	<i>O. flatfish</i>	<i>Shorthead</i>	<i>O. rockfish</i>	<i>EBS blackspot.</i>	<i>O. skates</i>
Biomass	-0.38	0.00	0.04	0.00	0.00	0.00	-0.11
2021 FOFL	0.00	0.00	0.01	0.00	-0.02	0.53	0.00
2021 FABC	0.00	0.00	0.01	0.00	-0.02	0.54	0.00
2020 OFL	-0.38	0.00	0.05	0.00	-0.02	0.53	-0.11
2021 OFL	-0.38	0.00	0.05	0.00	-0.02	0.53	-0.11
2020 ABC	-0.38	0.00	0.05	0.00	-0.02	0.53	-0.11
2021 ABC	-0.38	0.00	0.05	0.00	-0.02	0.53	-0.11

- Note that sculpins have been moved to the “ecosystem component”

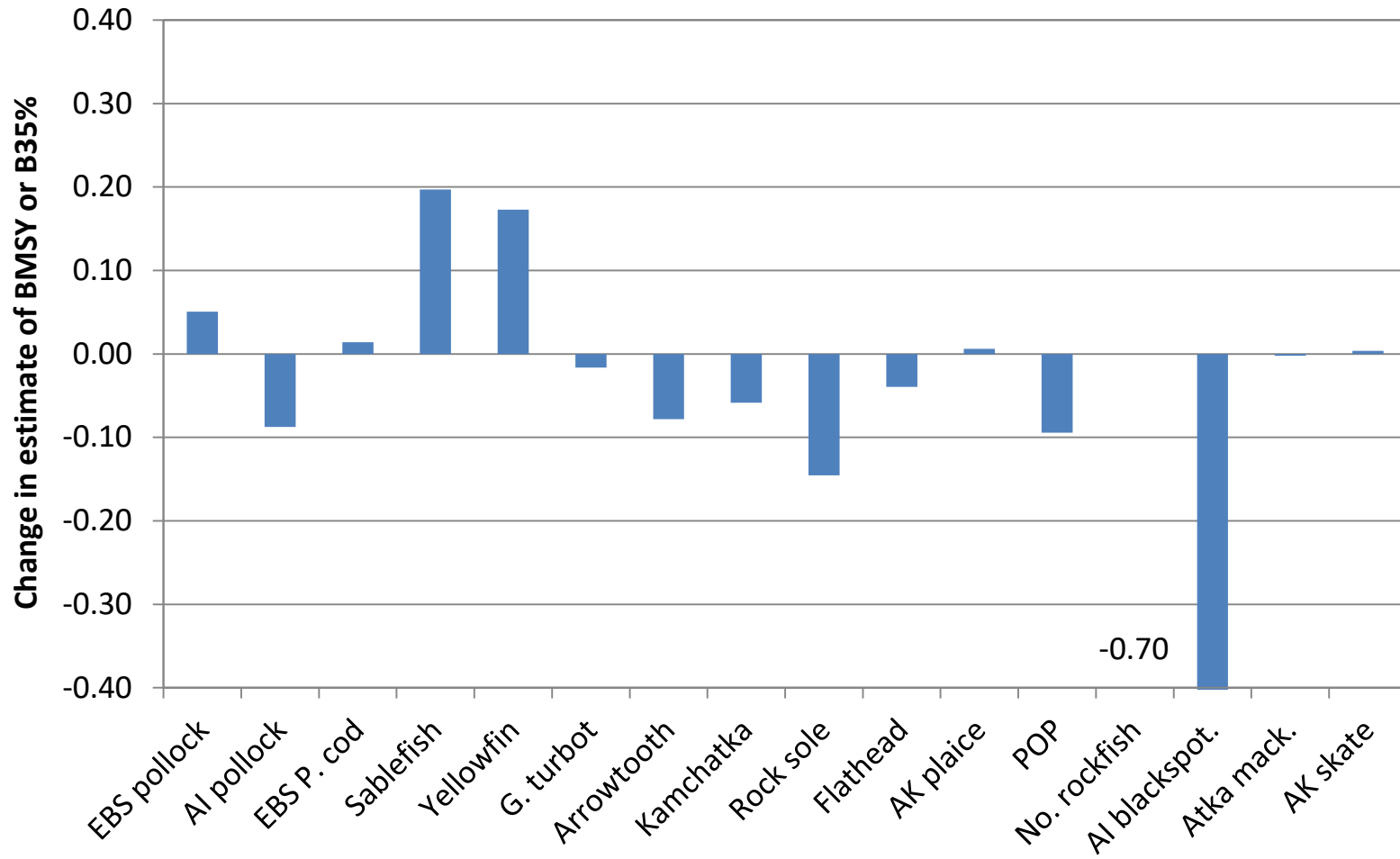


# Changes in reference points (Tier 6)

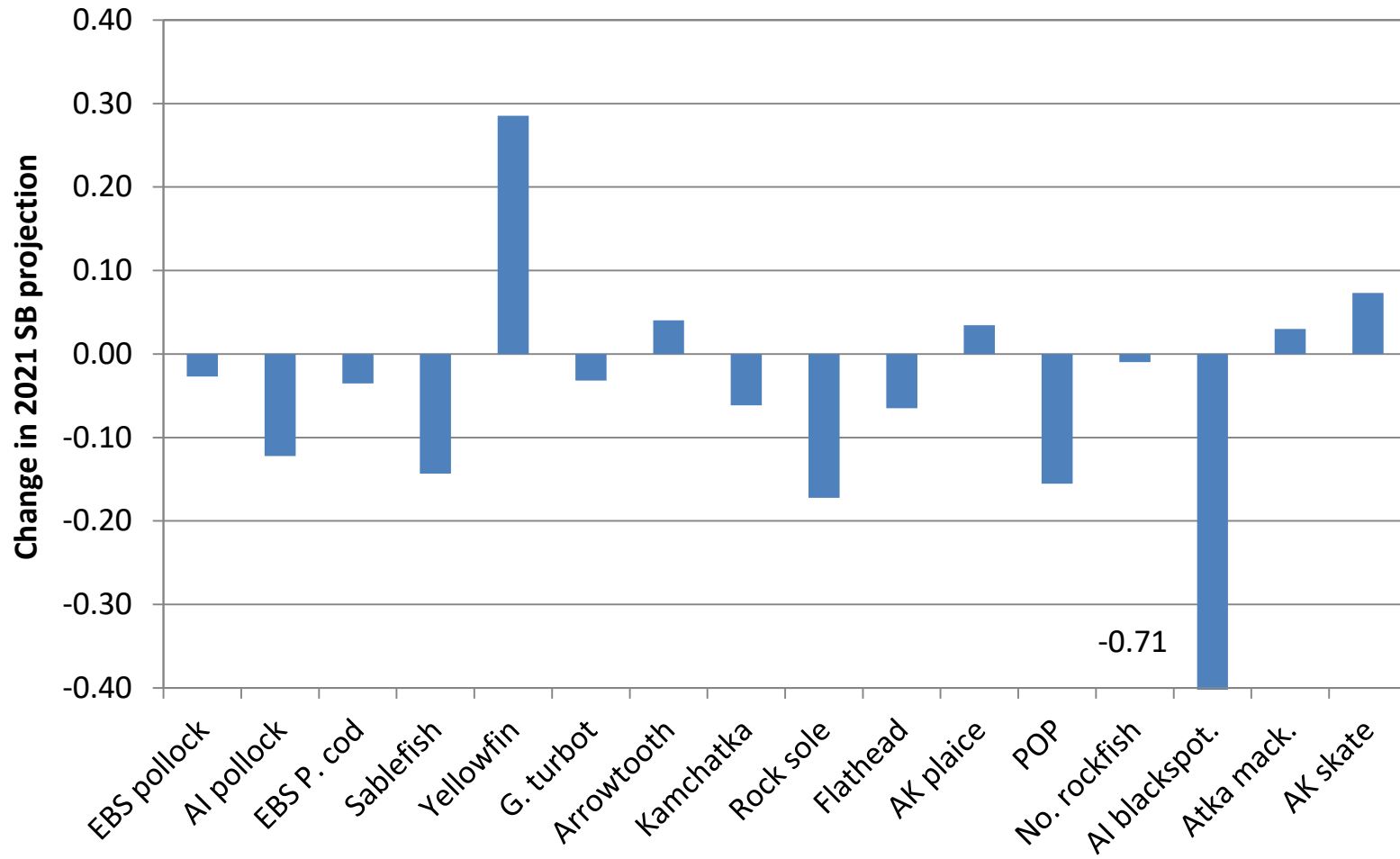
Quantity	<i>Sharks</i>	<i>Octopus</i>
2020 OFL	0.00	0.00
2021 OFL	0.00	0.00
2020 ABC	0.00	0.00
2021 ABC	0.00	0.00



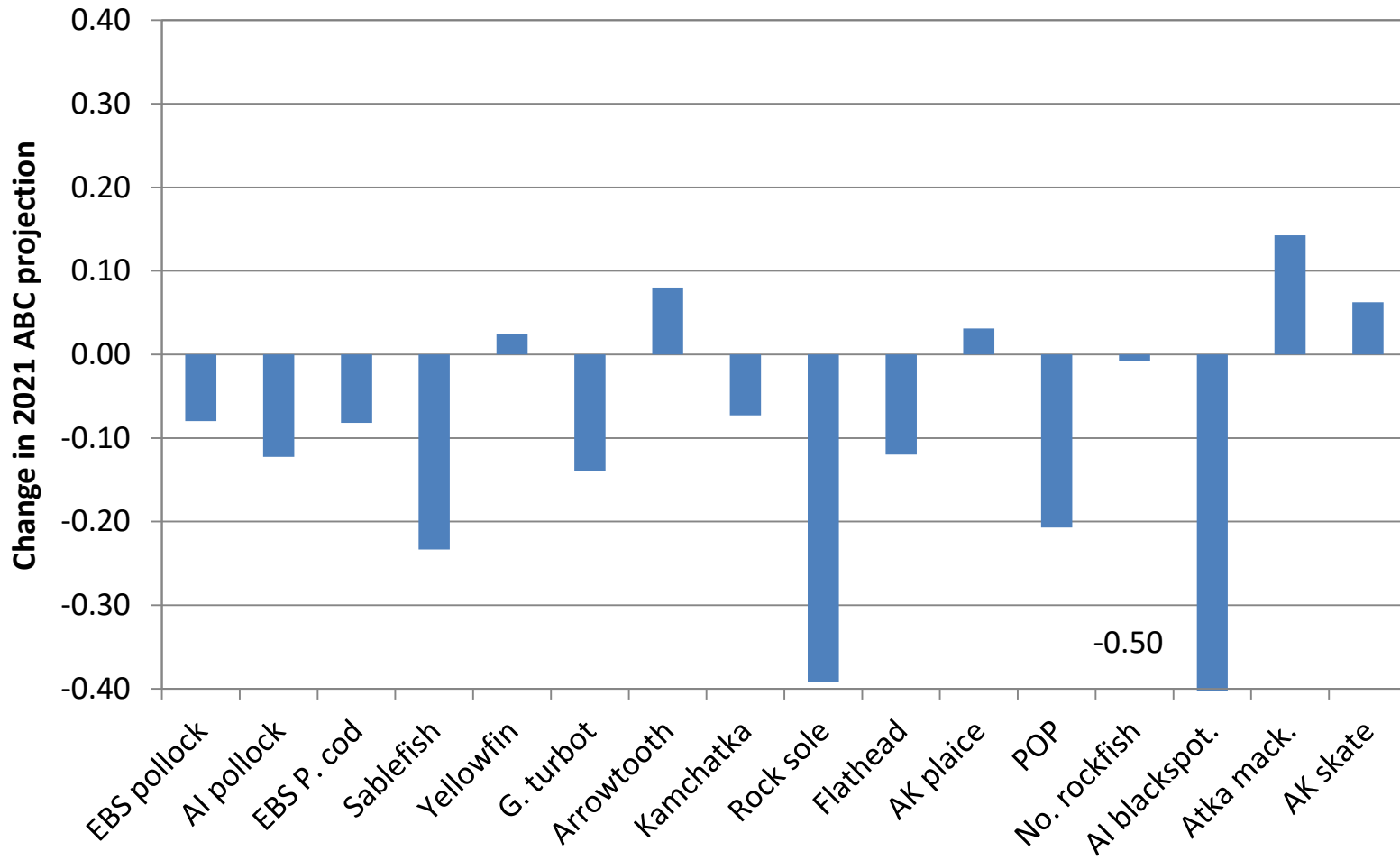
# Change in estimate of $B_{MSY}$ or $B_{35\%}$



# Change in 2021 spawning biomass *projection*



# Change in 2021 ABC projection



# Risk tables (included for all full assessments)

- Authors and the Team continued to struggle with:
  1. Assignment of levels; especially, is “increased” concern relative to:
    - Previous assessments of the same stock/complex, or
    - Typical assessments; and if this is the case, then is it relative to:
      - Typical assessments within the same tier, or
      - Typical assessments across all tiers?
  2. Conditions under which  $levels > 1$  should result in  $ABC < maxABC$
  3. Magnitude of reduction in cases where reduction is warranted
- The Team accepted the authors’ risk levels in all cases, but this should be interpreted more as the Team’s acknowledgment that each author identified reasonable rationales in assigning levels than an assertion that the criteria used to assign levels were consistent across authors



# Typical summary format for full assessments

- Answers (yes, no, or n/a) to the following questions:
  - New author?; >1 model?; change from base?; risk>1?
- New data, if any (updated catch data omitted for brevity)
- Model changes/alternatives, if any
- Stock status or trend:
  - 2021 spawning biomass relative to  $B_0$  or  $B_{100\%}$  (Tiers 1-3 only)
  - Recent survey biomass trend (Tier 5)
- Mohn's  $\rho$  (Tiers 1-3 only)
- Risk levels (assessments with at least one level>1 only)
- Some representative figures from the assessment
- For stocks with separate presentations by the author, skip the above
- Team recommendations (with discussion), if any
- See SAFE Intro for 2022 specs and area allocations (mostly)



# General issues



# EBS slope and AI surveys

- The Team noted that the continued lack of surveys in the eastern Bering Sea slope and the Aleutian Islands region is a concern for many flatfish and rockfish stocks that rely upon this data
- The recent uncertainty analysis by Bryan et al., 2020 notes that stocks that rely on the biennial survey update are more impacted by the loss of one survey
- A large number of stocks will have increased uncertainty in the biomass estimates, if future surveys in the Bering Sea slope and Aleutian Islands are not prioritized
- This may result in increased risk levels in the assessment category



# EBS and AI Ecosystem Status Reports

- See separate presentations by Elizabeth Siddon and Ivonne Ortiz
- The Team encourages continuation, to the extent possible, of the contributions on seabirds and plastics, ROMSNPZ-based cold pool index and hindcast, and standardized marine heatwave index



# Chapter summaries

# Chapter 1: EBS walleye pollock

- New author: no; >1 model: yes; change from base: yes; risk>1: yes
- Switch to authors' presentations (Team comments will follow)



# EBS walleye pollock, continued

- The Team agreed with all of the authors' recommendations, for the reasons summarized in their presentations:
  - Model 20.0a is the recommended model
  - ABCs to be reduced by 30% from Tier 1 maxABC in 2021 and 2022, following the Tier 3 maxABC control rule
  - No recommendation regarding a change in tier designation
- The Team and author discussed the impact of electronic monitoring (EM) in some segments of the fishery on data availability
  - Overall weight composition is still available from shoreside sampling, but tow-by-tow weight frequencies are not
  - The Team recommended that the AFSC stock assessment groups evaluate the impact of data loss associated with the fixed gear EM program and the trawl EM Exempted Fishing Permit



# EBS walleye pollock, continued

Quantity	Last asmt.	This asmt.	Change
M	0.30	0.30	0.00
2020 tier	1a	n/a	none
2021 tier	1a	1a	none
2020 age+ biomass	9,128,000	n/a	-0.11
2021 age+ biomass	8,494,000	8,145,000	-0.04
2020 spawning biomass	2,991,000	n/a	-0.13
2021 spawning biomass	2,674,000	2,602,000	-0.03
B0	5,777,000	5,792,000	0.00
Bmsy	2,148,000	2,257,000	0.05
2021 FOFL	0.449	0.341	-0.24
2021 FABC	0.225	0.214	-0.05
2020 OFL	4,085,000	n/a	-0.36
2021 OFL	3,385,000	2,594,000	-0.23
2020 ABC	2,043,000	n/a	-0.20
2021 ABC	1,767,000	1,626,000	-0.08



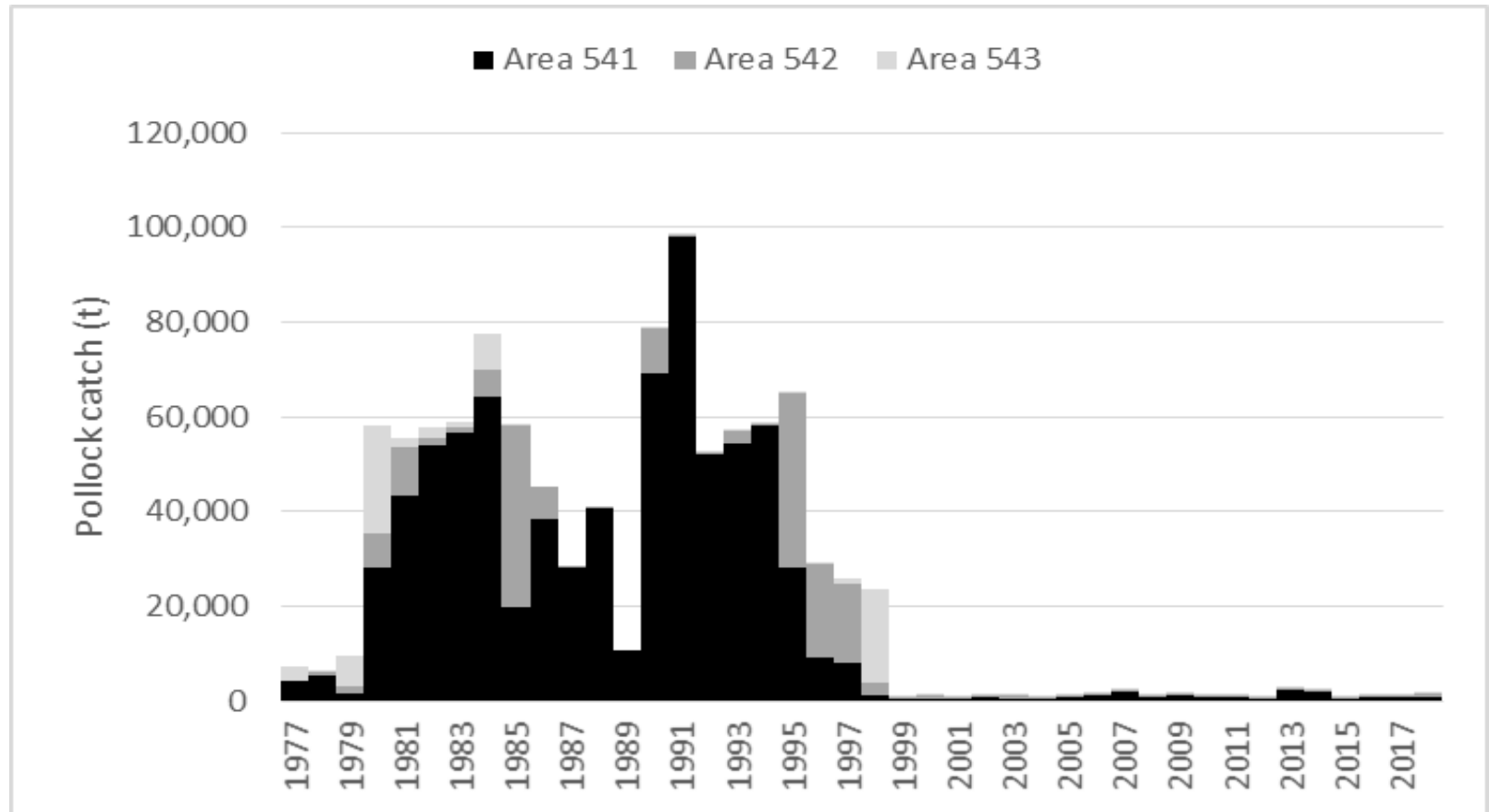
# Chapter 1A: AI walleye pollock

- New author: **no**; >1 model: **yes**; change from base: **no**; risk>1: **no**
- New data: 2018 fishery age composition
- Model changes/alternatives:
  - Models 15.1 (recommended), the current base model
  - Model 15.2, the same as 15.1, but with differential  $M$  at ages 1, 2, and 15
- Stock status: projected 2021 spawning biomass = 48% of  $B_{100\%}$
- Mohn's  $\rho = 0.03$



# AI walleye pollock, continued

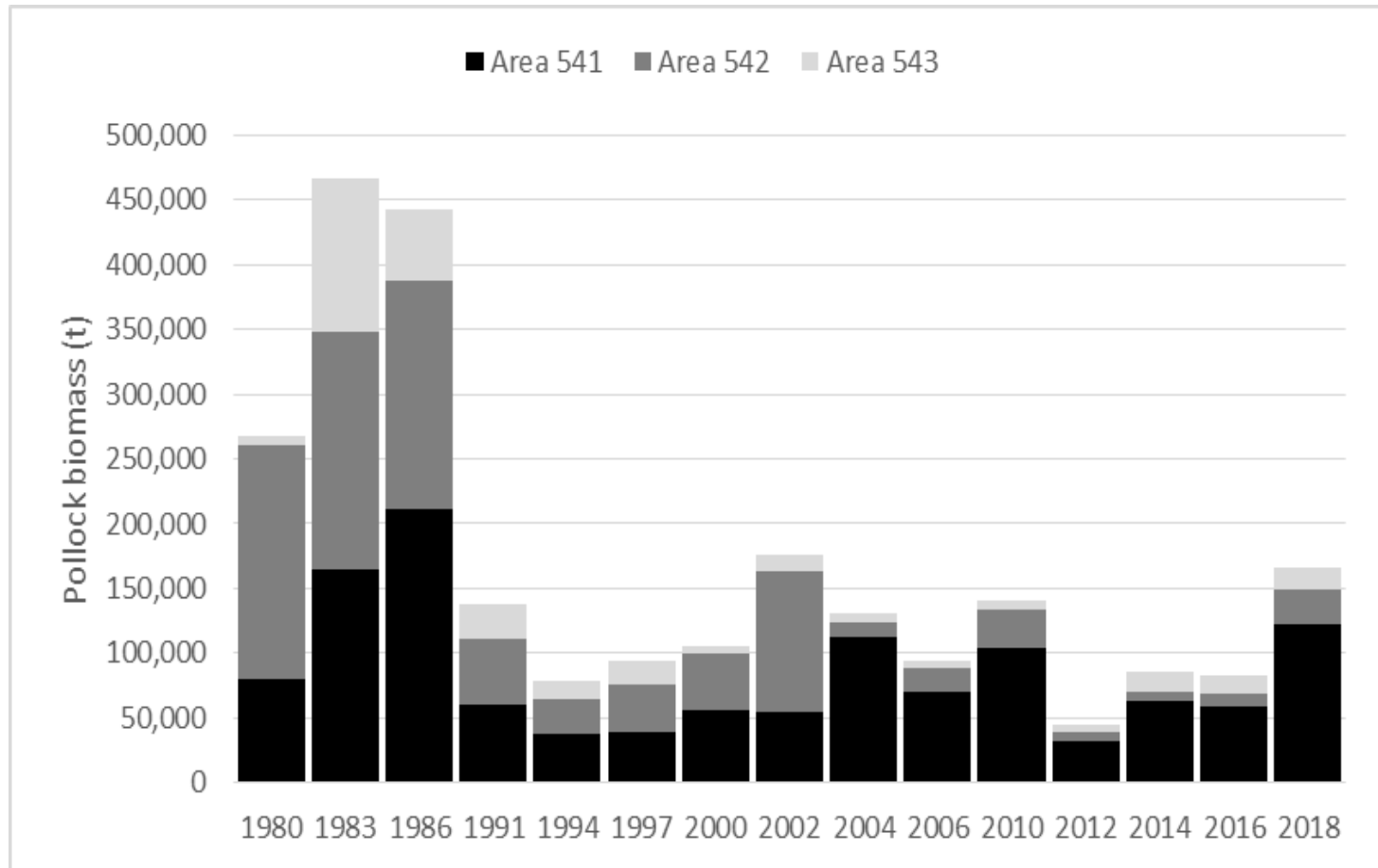
- Catch time series





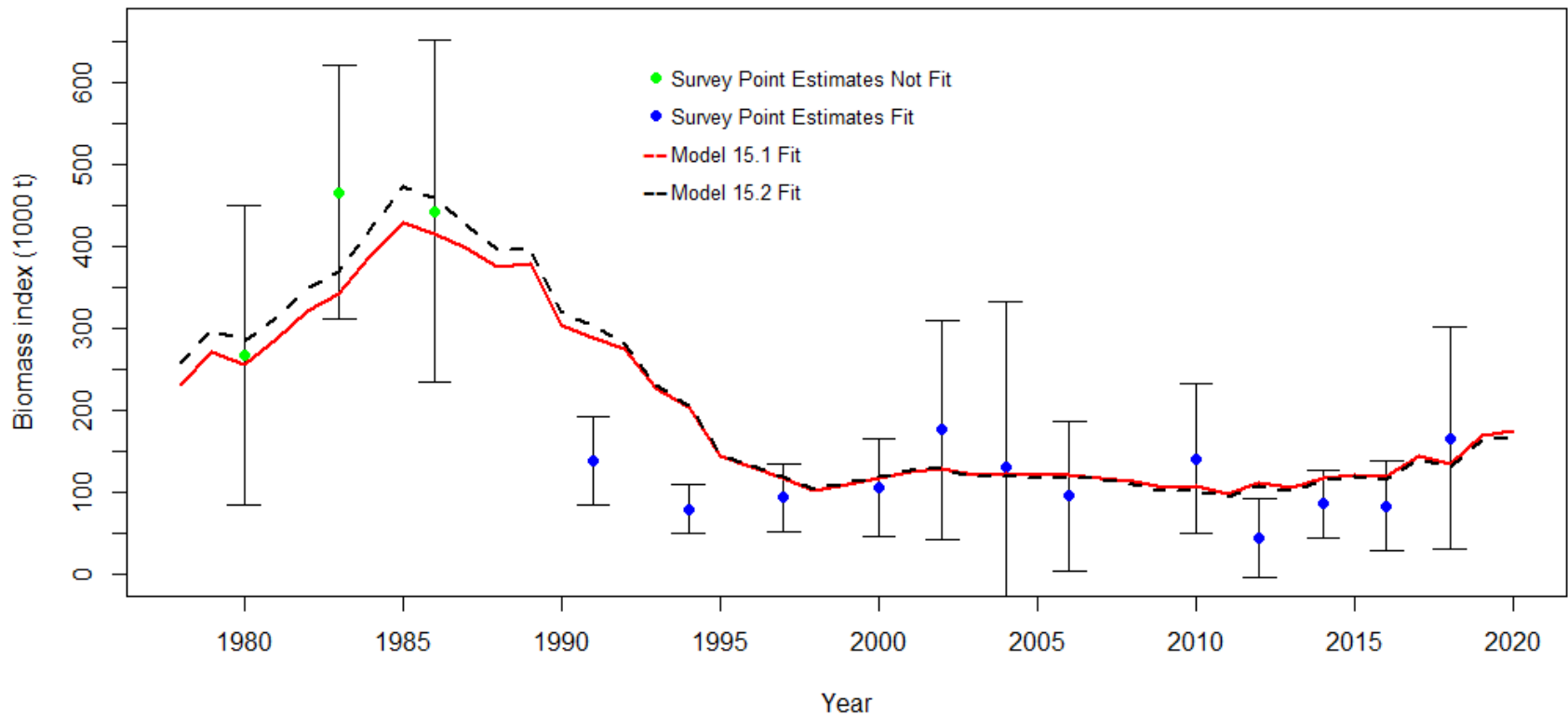
# AI walleye pollock, continued

- Survey biomass time series



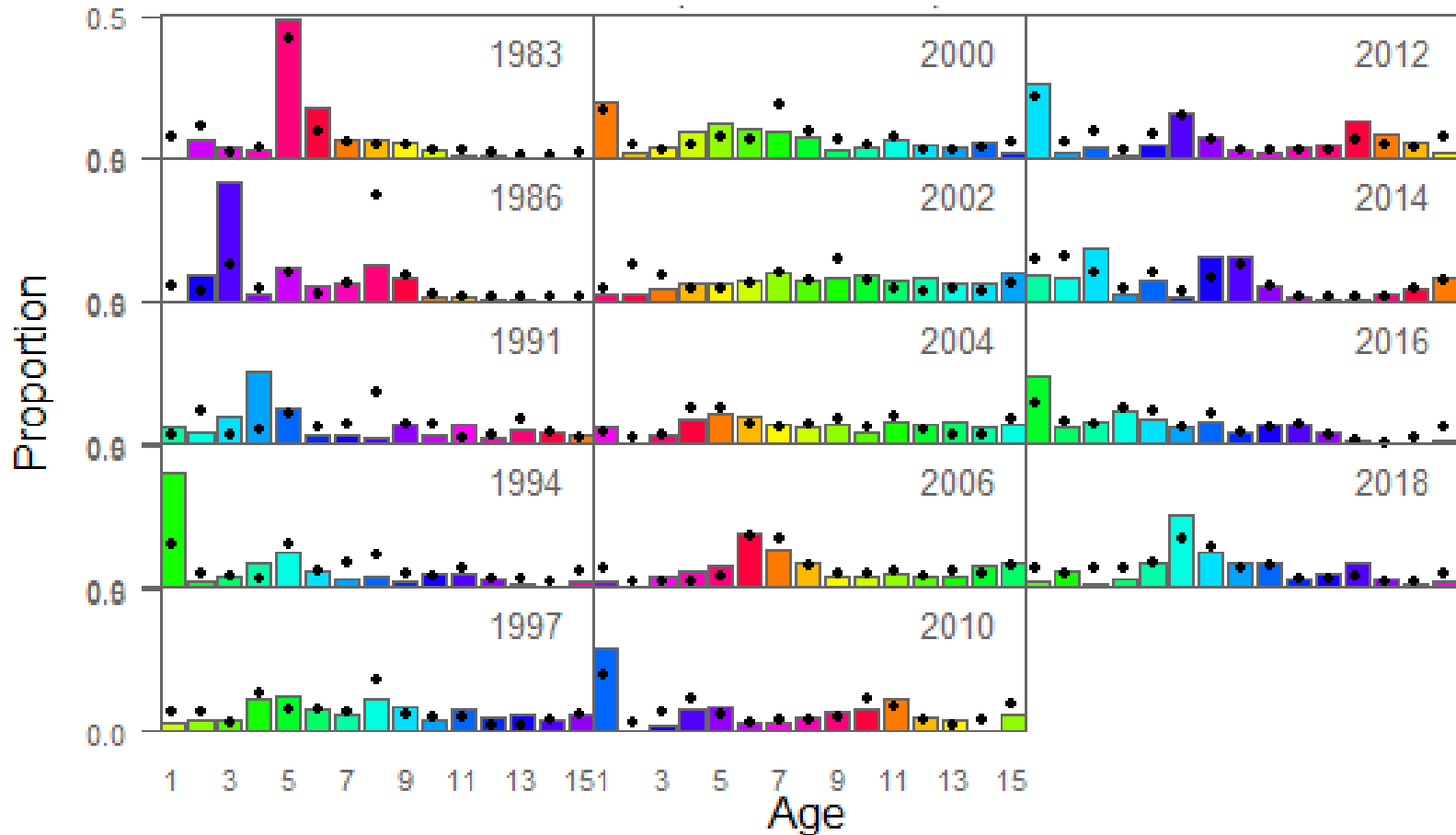
# AI walleye pollock, continued

- Fit to survey index



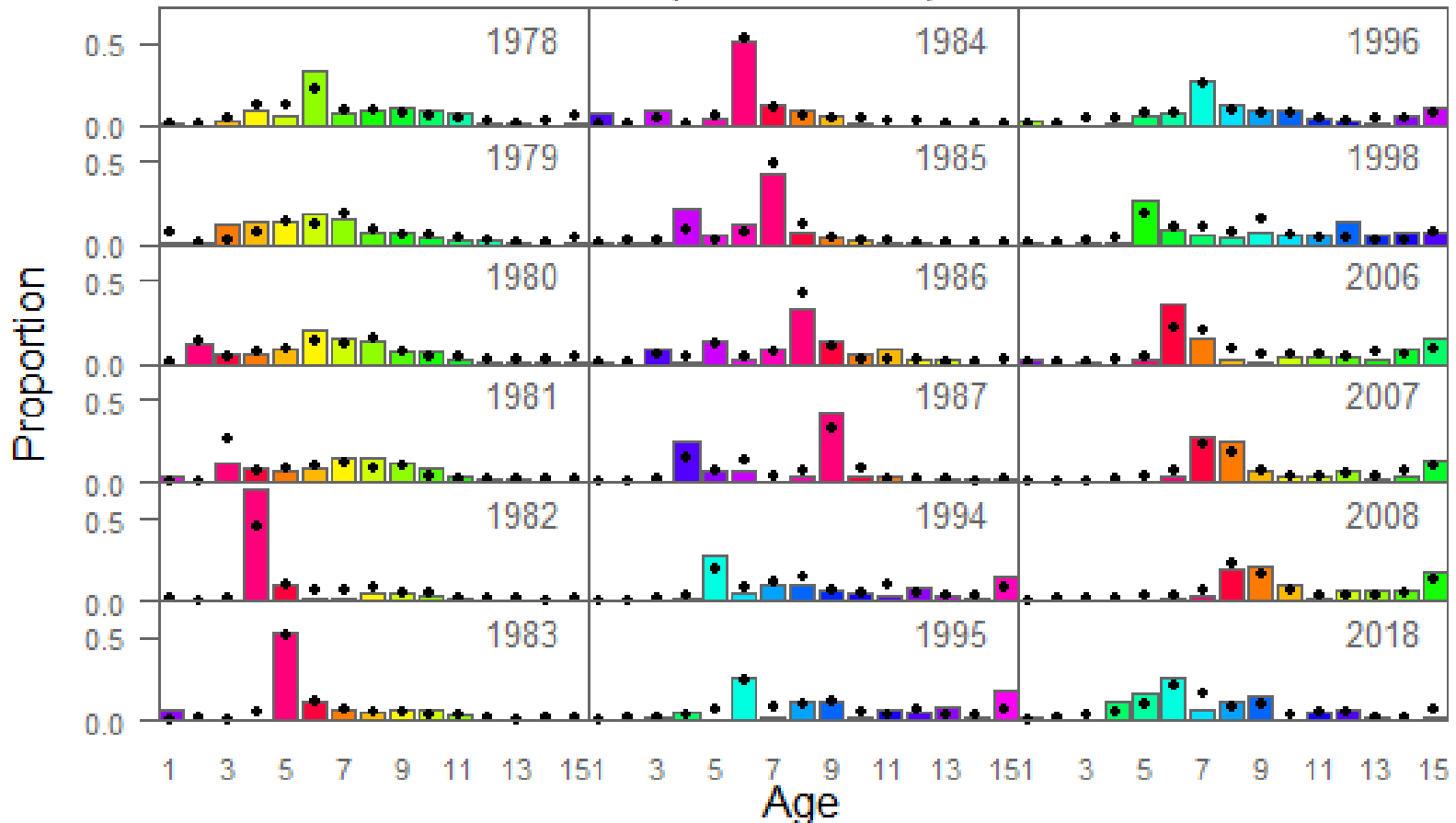
# AI walleye pollock, continued

- Fit to survey age composition data (Model 15.1)



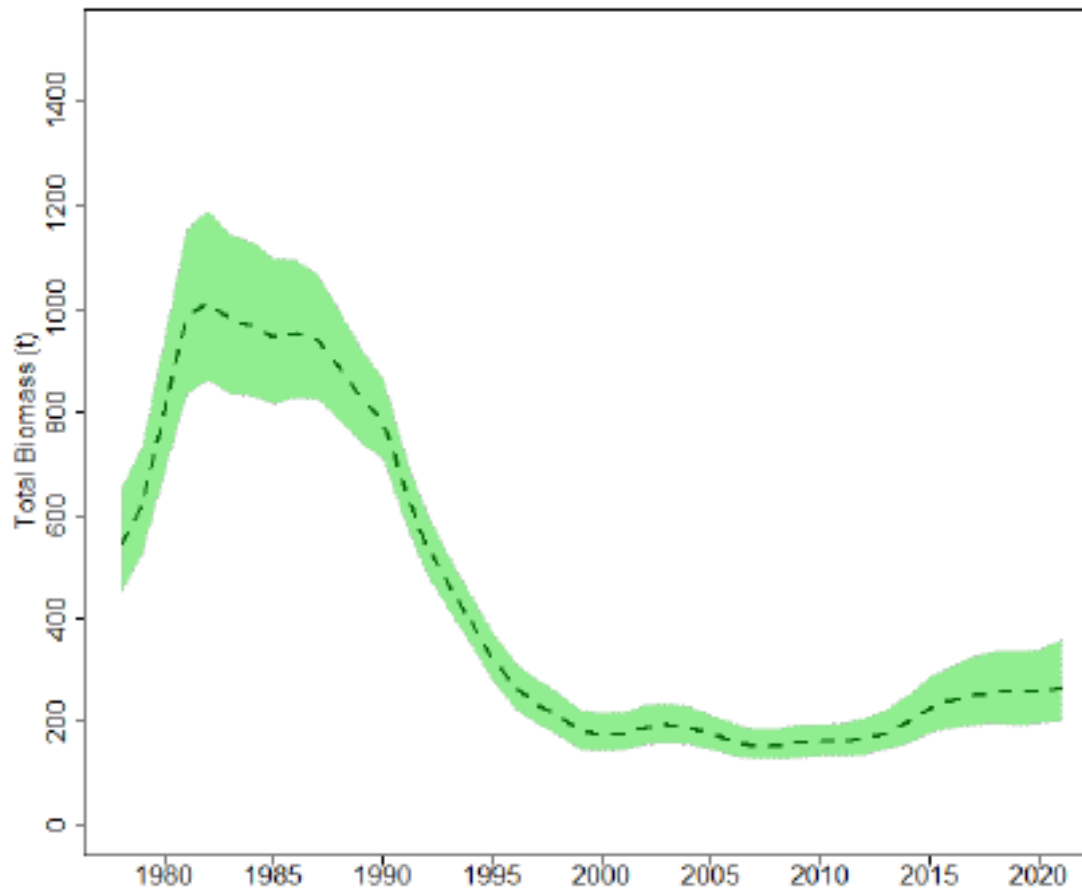
# AI walleye pollock, continued

- Fit to fishery age composition data (Model 15.1)



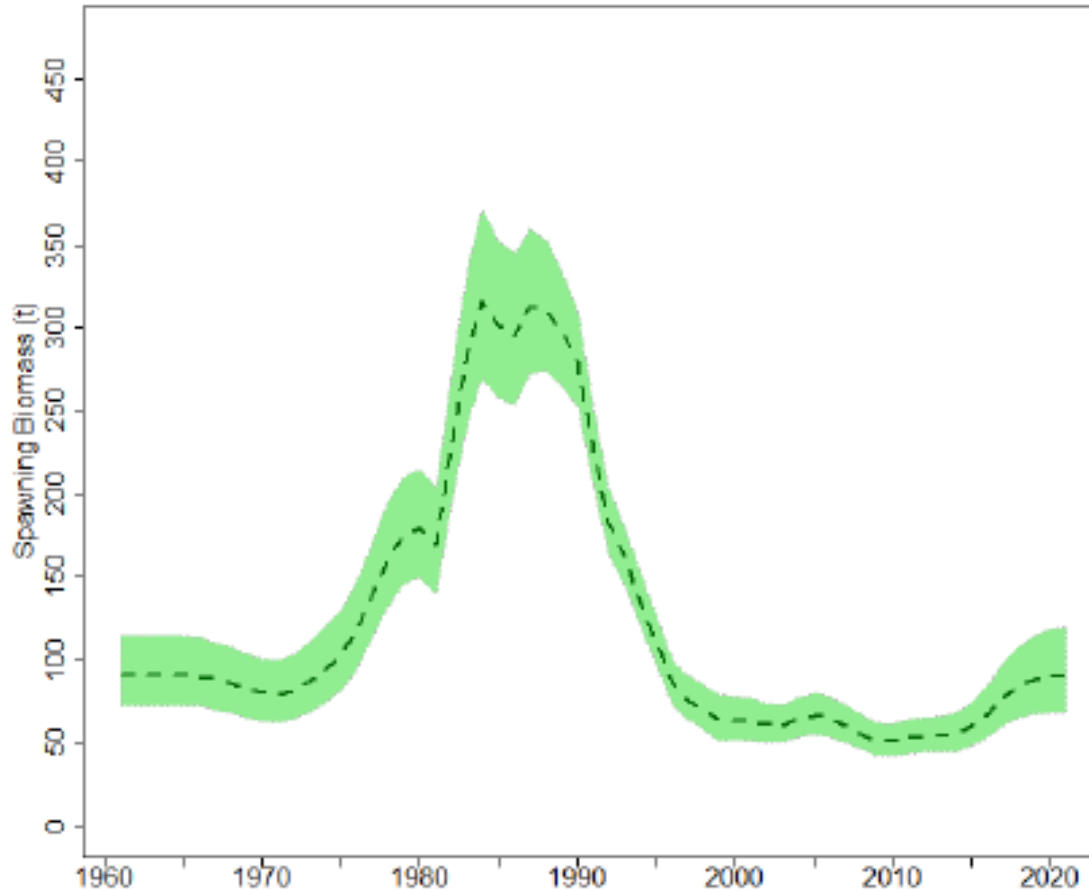
# AI walleye pollock, continued

- Age 1+ biomass time series (Model 15.1)



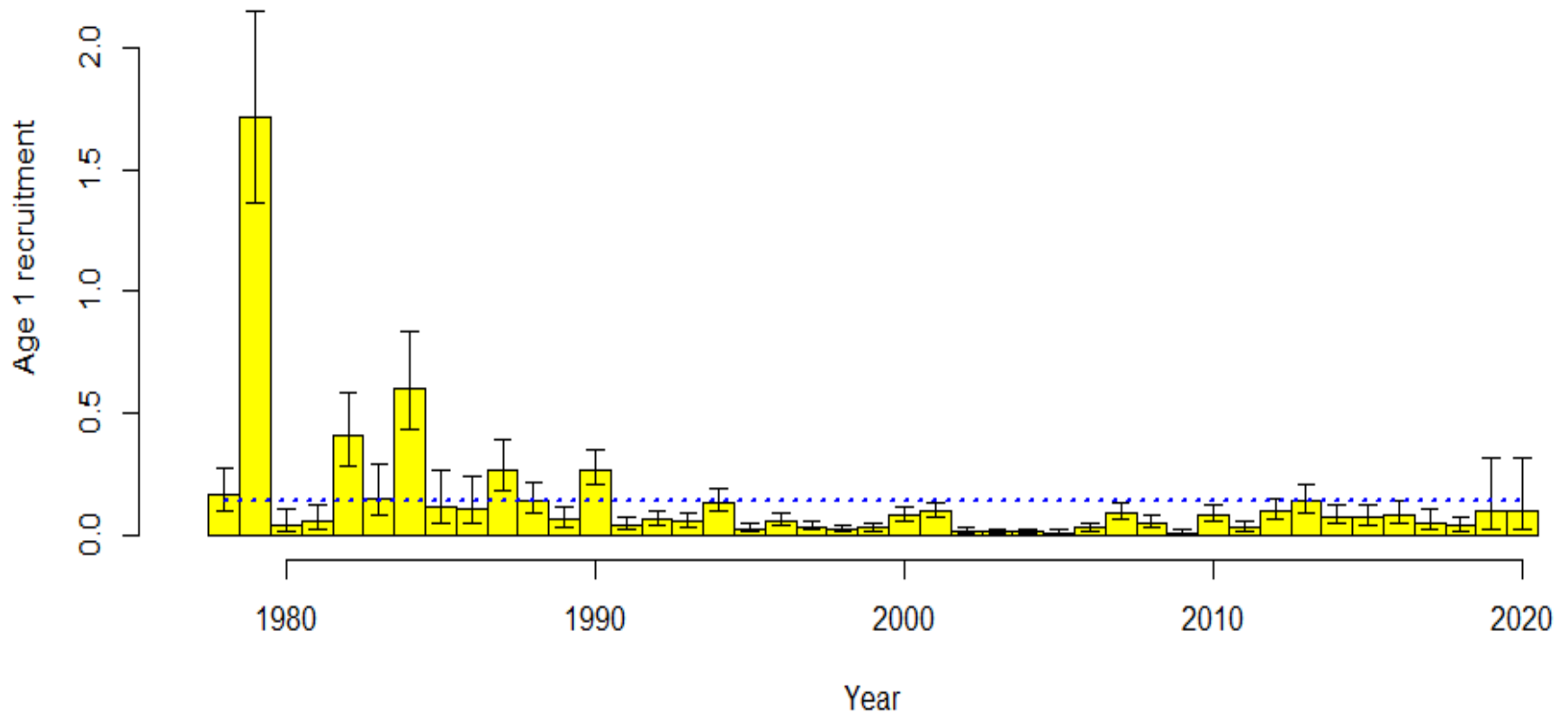
# AI walleye pollock, continued

- Spawning biomass time series (Model 15.1; note time axis scale change)



# AI walleye pollock, continued

- Age 1 recruitment time series (Model 15.1)



# AI walleye pollock, continued

Quantity	Last asmt.	This asmt.	Change
M	0.20	0.21	0.05
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	340,680	n/a	-0.14
2021 age+ biomass	367,017	292,967	-0.20
2020 spawning biomass	98,172	n/a	-0.08
2021 spawning biomass	102,413	89,906	-0.12
B100%	203,279	185,475	-0.09
B40%	81,312	74,190	-0.09
B35%	71,147	64,916	-0.09
2021 FOFL	0.415	0.390	-0.06
2021 FABC	0.331	0.313	-0.05
2020 OFL	66,973	n/a	-0.08
2021 OFL	70,970	61,856	-0.13
2020 ABC	55,120	n/a	-0.07
2021 ABC	58,384	51,241	-0.12





# Chapter 1B: Bogoslof walleye pollock

- New author: **no**; >1 model: **yes**; change from base: **no**; risk>1: **no**
- New data:
  - 2020 AT survey biomass estimate (down 48% from 2018)
  - 2020 AT survey age composition
- Model changes/alternatives:
  - Tier 5 RE model (recommended), the current base model
  - An age-structured model, used to check the value of  $M$
- Stock trend: Although 2020 AT biomass estimate was down from 2018, biomass estimates from the last 3 AT surveys have all been higher than at any time between 2000 and 2014



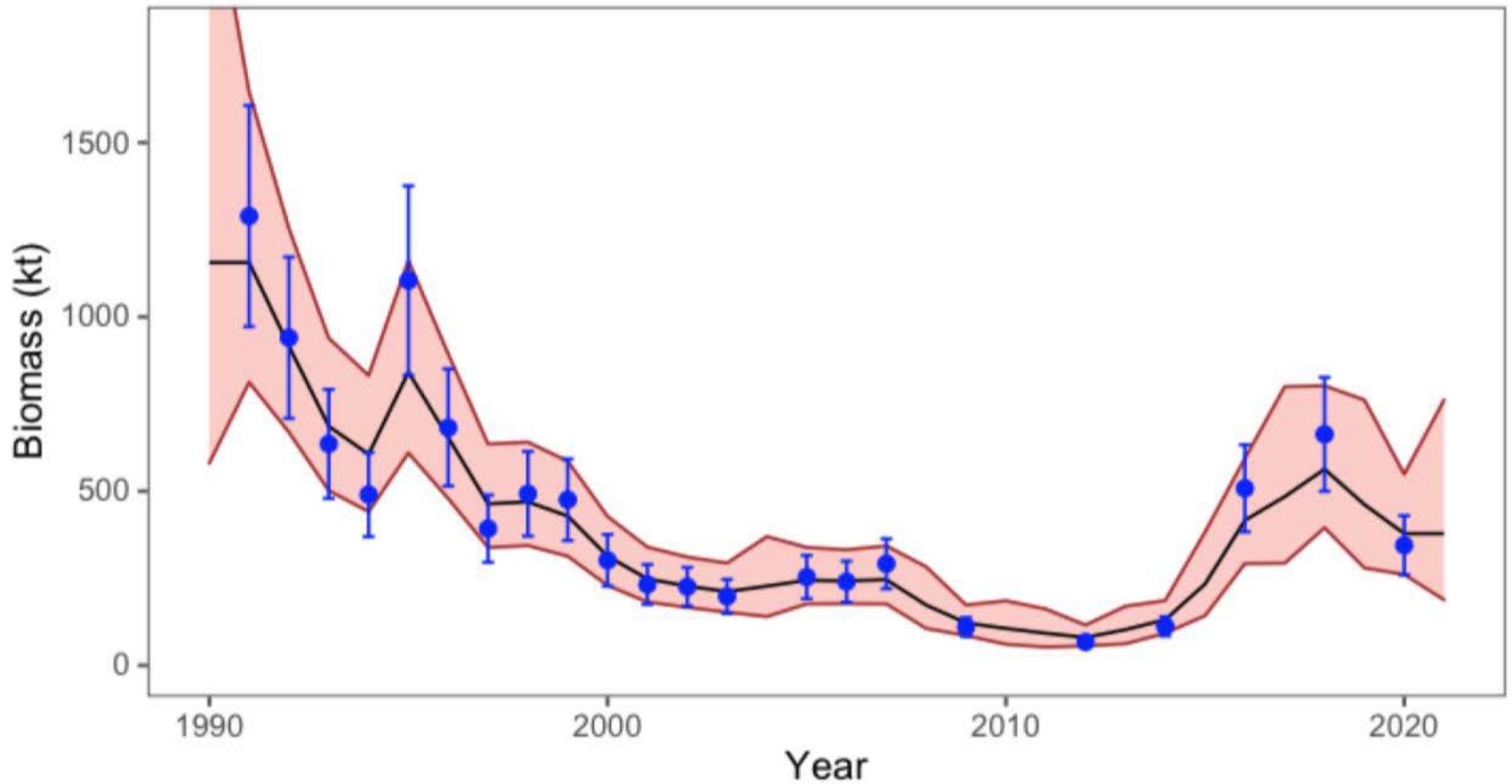
# Bogoslof walleye pollock (continued)

- Age-structured modeling of the Bogoslof stock: some history
  - This has been a Tier 5 stock since the beginning of time
  - The 1999 assessment included an age-structured model with  $Q=1$ 
    - SSC rejected, because the survey covers only part of the stock
  - The 2005 assessment included several age-structured models, some of which estimated  $Q$  internally
    - SSC rejected, citing unknown impacts of Donut Hole catches
  - In 2012, 2013, and 2014, SSC requested that the traditional  $M$  value of 0.2 be compared to the results of a catch curve analysis
  - 2014 assessment used a new variant of the 2005 models for the sole purpose of estimating  $M$  (not for the purpose of moving to Tier 3)
    - Author suggested that this was better than a catch curve analysis
  - Since 2014, the model has been updated in full assessment years



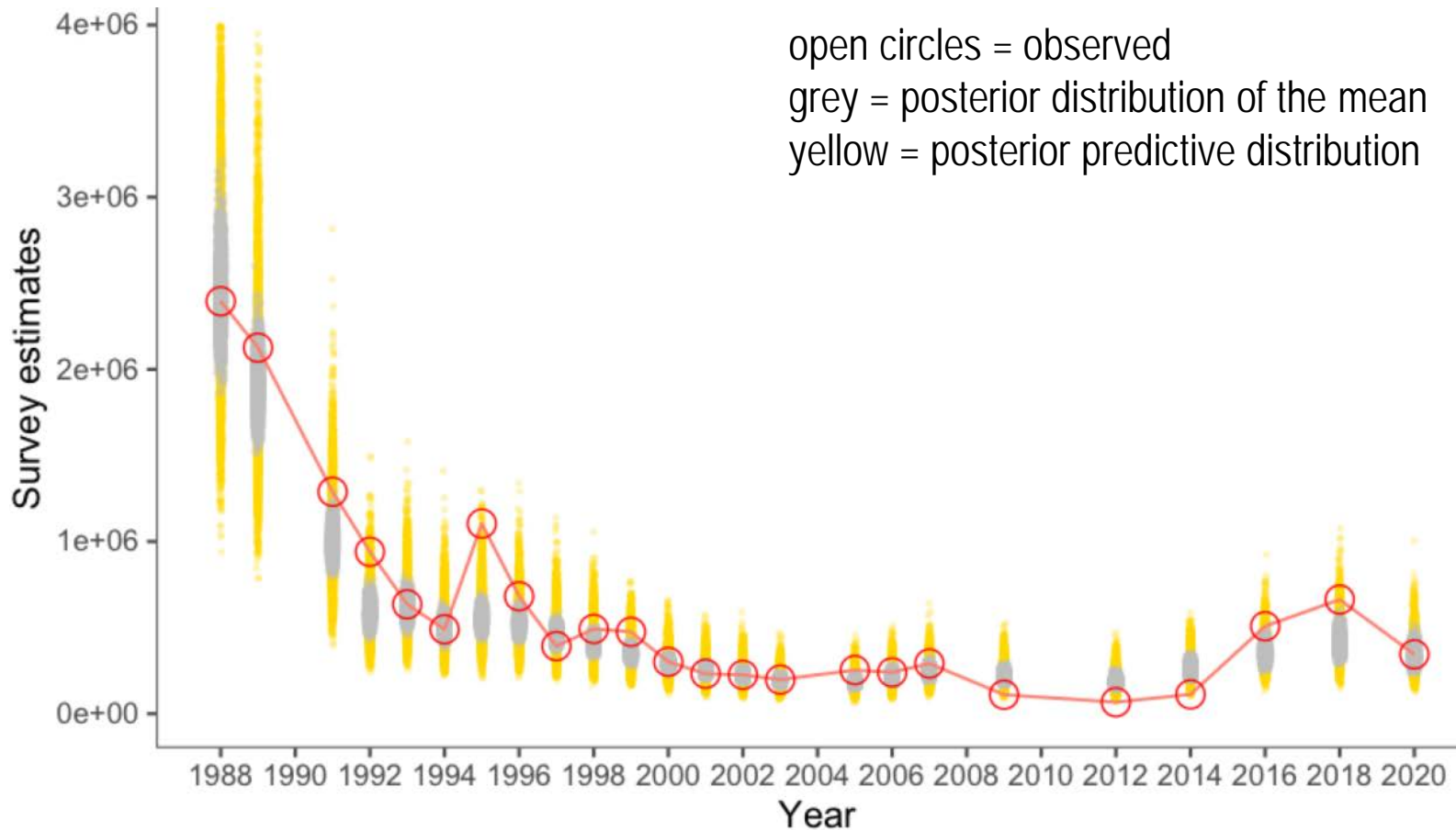
# Bogoslof walleye pollock (continued)

- Survey biomass data with random effects model fit



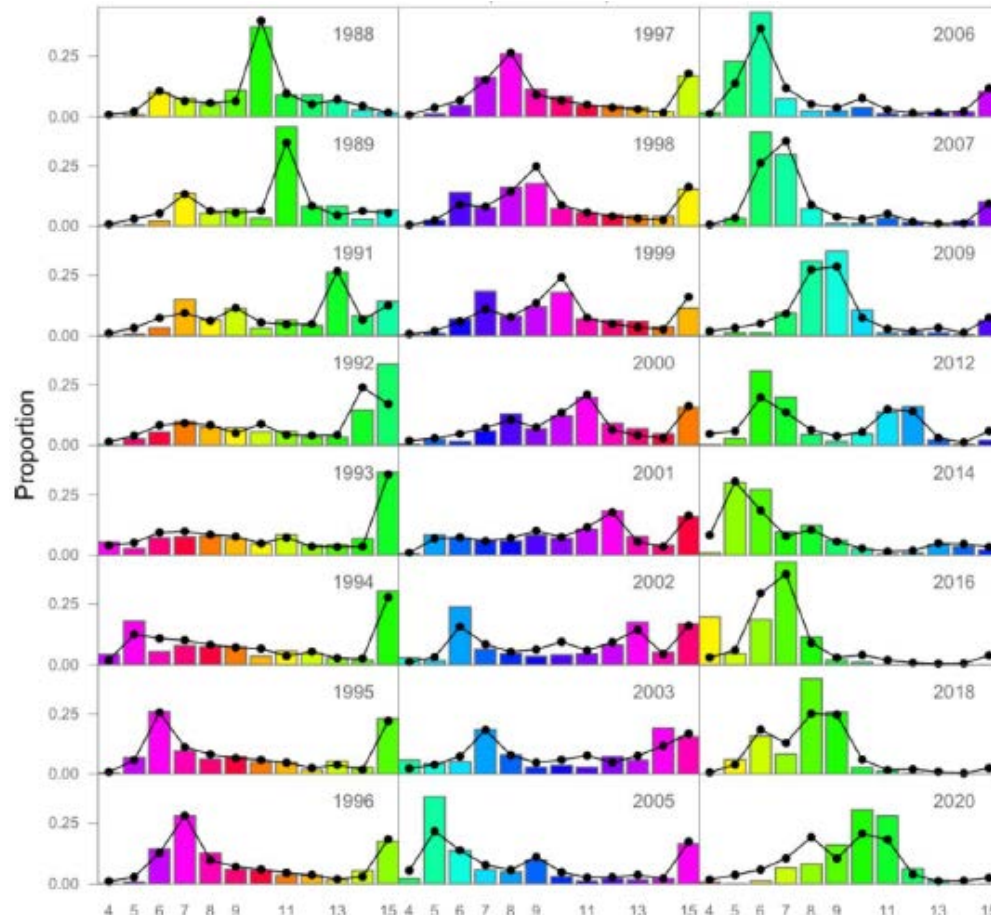
# Bogoslof walleye pollock (continued)

- Survey biomass data with age-structured model fit



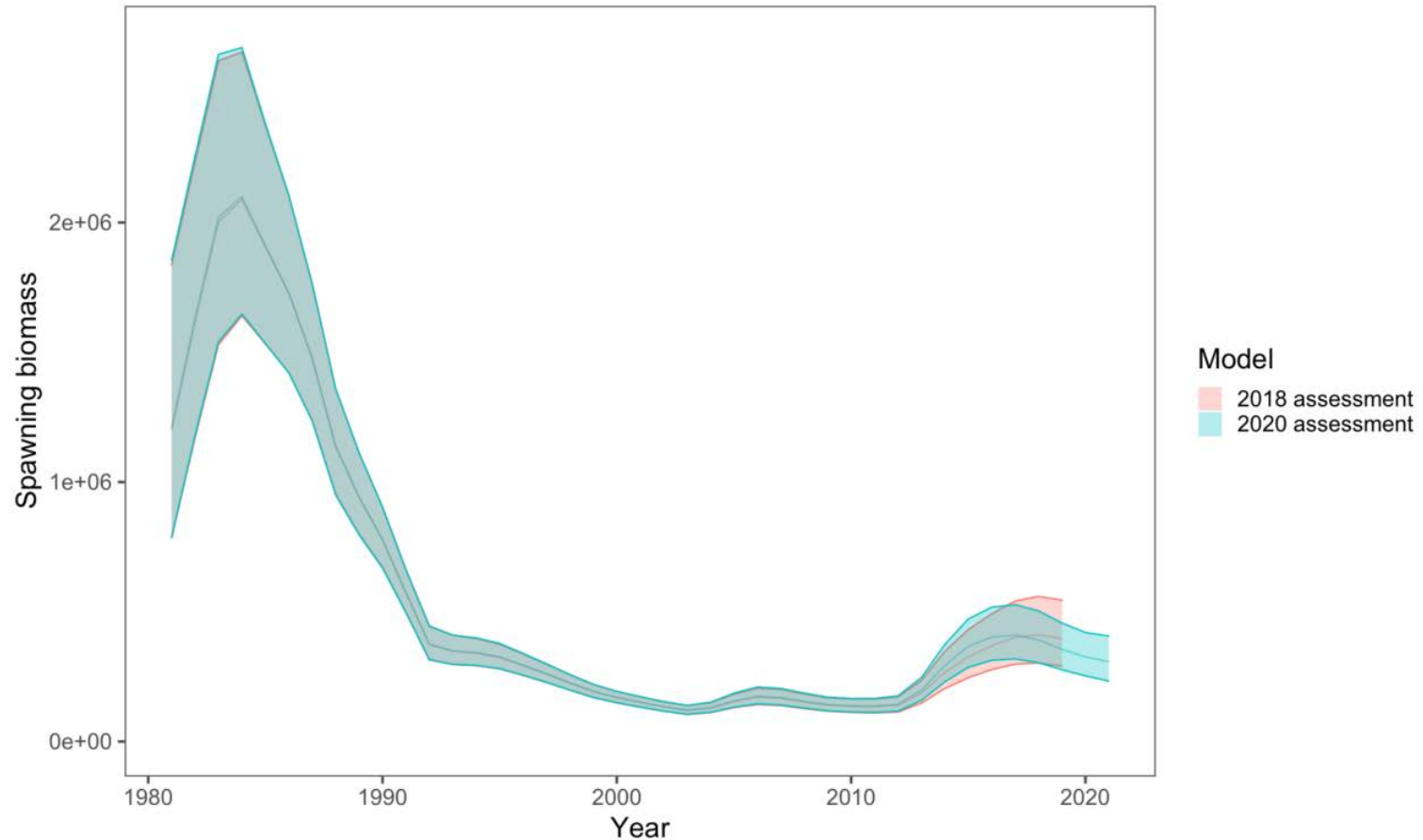
# Bogoslof walleye pollock (continued)

- Survey age composition data with age-structured model fit



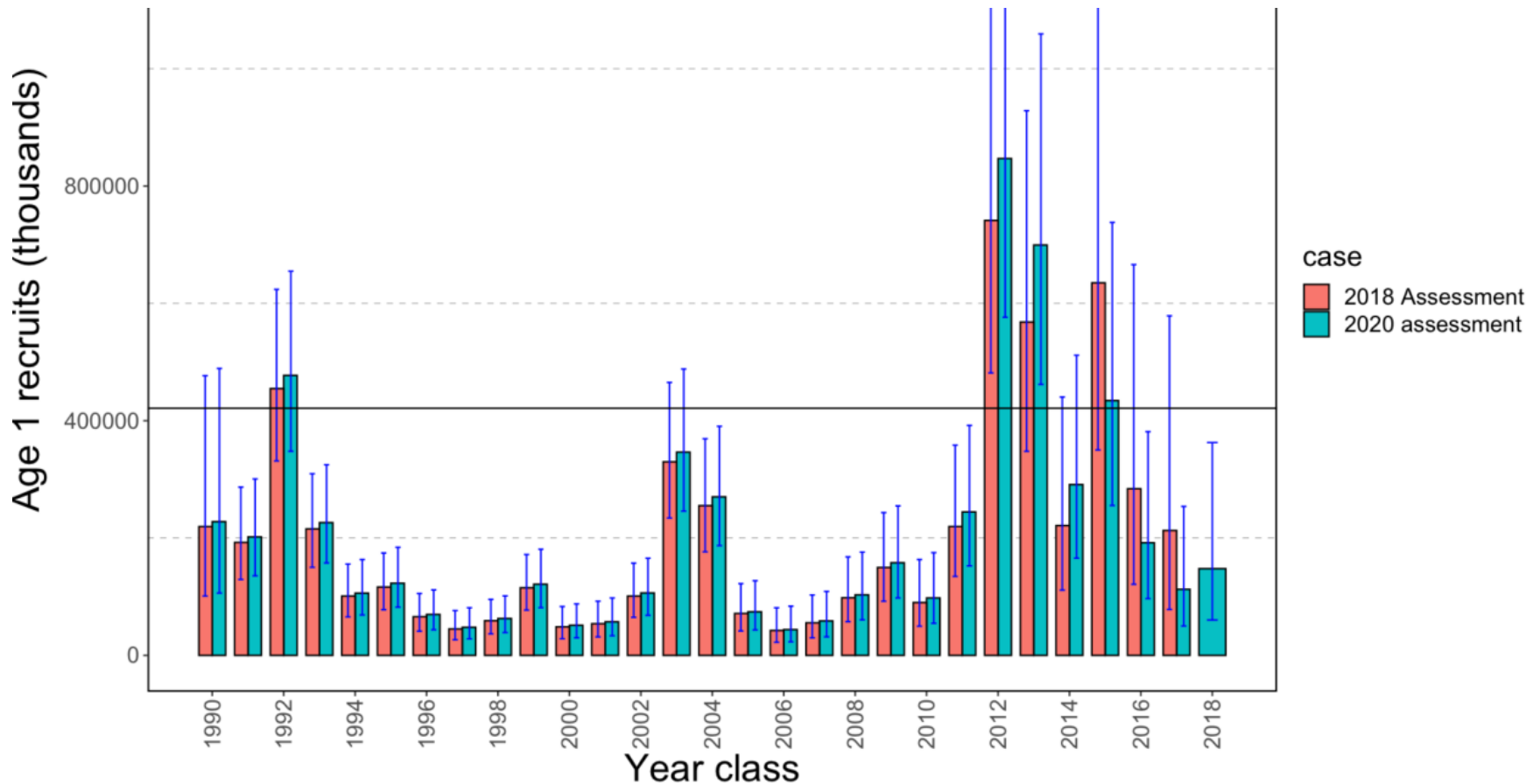
# Bogoslof walleye pollock (continued)

- Spawning biomass time series from age-structured model



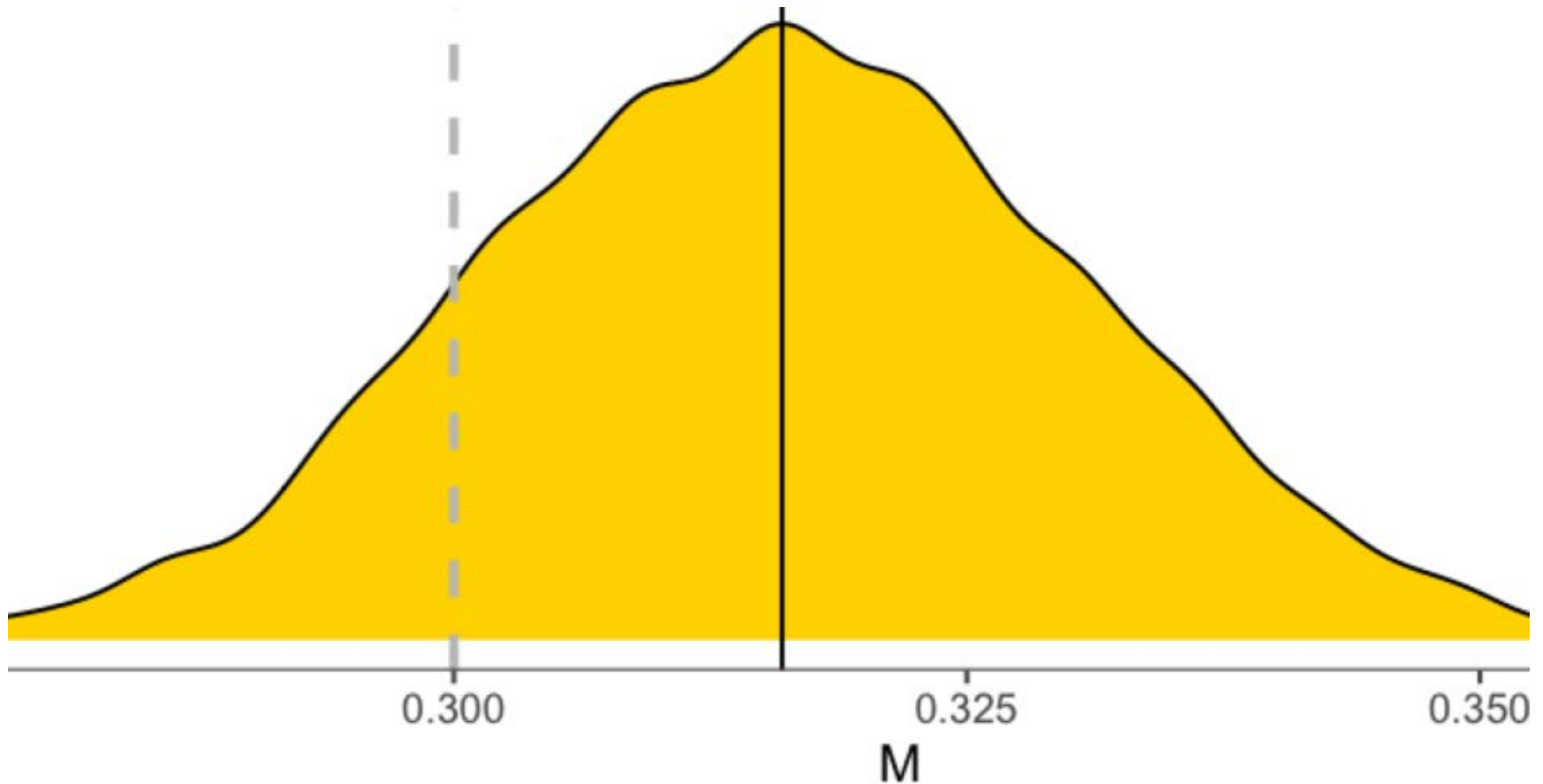
# Bogoslof walleye pollock (continued)

- Age 1 recruitment time series from ASM (note time axis scale change)



# Bogoslof walleye pollock (continued)

- Posterior distribution of natural mortality rate from age-structured model





# Bogoslof walleye pollock (continued)

Quantity	Last asmt.	This asmt.	Change
M	0.30	0.30	0.00
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	610,267	378,262	-0.38
2021 FOFL	0.300	0.300	0.00
2021 FABC	0.225	0.225	0.00
2020 OFL	183,080	n/a	-0.38
2021 OFL	183,080	113,479	-0.38
2020 ABC	137,310	n/a	-0.38
2021 ABC	137,310	85,109	-0.38



# Chapter 2: EBS Pacific cod

- New author: no; >1 model: yes; change from base: yes; risk>1: yes
- Switch to author's presentation (Team comments will follow)



# EBS Pacific cod, continued

- Discussion of new fishery CPUE index
  - Models 20.9 and 20.10 are fit to this index (as well as existing fishery and survey data)
  - A large amount of data is used to create this index and the resulting uncertainty is low; because the fishery CPUE data have much smaller variances than the survey index data, Models 20.9 and 20.10 tend to fit the former much more closely than the latter
  - The Team noted that this CPUE index and method for deriving the index was new for the EBS Pacific cod assessment and has not been reviewed previously
  - In agreement with written public comment, it would be worthwhile to investigate statistical standardizing methods for CPUE, especially at the upcoming CIE review
  - (continued on next slide)



# EBS Pacific cod, continued

- Discussion of new fishery CPUE index (continued)
  - The fishery CPUE time-series was fit with time-varying selectivity (Models 20.9 and 20.10) and time-varying catchability (20.9), which are confounded
  - Model 20.10 showed no deviations in catchability because selectivity was able explain much of the variation
  - This resulted in accurate fits to the CPUE data
  - Examining a simpler model for fitting CPUE data may be worthwhile as 20.9 and 20.10 may be overparameterized



# EBS Pacific cod, continued

- Discussion of ensemble composition
  - The ensemble represents structural uncertainty and therefore it is useful to have a range of models depicting alternative modelling assumptions and various data sources
  - The justifications for picking a single model are likely different than justifications for choosing an ensemble
  - The Team felt that this is an important concept to consider when choosing an ensemble model
  - The Team noted that the retrospective bias of both ensembles was very low, especially in comparison to past models that showed significant retrospective bias



# EBS Pacific cod, continued

- Discussion of model weighting as used in the assessment
  - A set of nine criteria were defined to determine weighting for each model in the assessment ensemble, with each criterion given an emphasis of 1, 2, or 3
  - These criteria were originally developed to provide contrast between models in past ensembles, but the model set has been reduced and the current suite of models are more similar
  - Therefore, the criteria are often scored the same between models and the models are nearly weighted equally



# EBS Pacific cod, continued

- Public comment was provided in person by three individuals and also in the form of a submitted document
  - The work that the authors have done on the assessment was commended and the consideration of industry input was appreciated
  - It was noted that fishery observations have been increasing and indicating that the abundance appears to up in the Bering Sea, the Pacific cod estimate from the IPHC survey had increased by 32% in 2019, bycatch of Pacific cod has increased, fish conditions are above average, and many stakeholders are reporting the best fishing they have seen
  - The assessment models were quite different years ago (e.g., dome-shaped selectivity) and it may be that none of the current models are worth accepting
  - (Continued on next slide)



# EBS Pacific cod, continued

- Public comment (continued)
  - Therefore, it was noted that another option is not to accept any model and instead roll over last year's ABC until a CIE review can be conducted and additional observations are reported from 2021
  - Another commenter noted that industry has been monitoring the size of fish and has noticed a spike in small fish that may be indicative of a strong 2018 year class
  - Furthermore, boats are going to fish where CPUE is high and the stock is at a level where it is fairly easy to maintain high CPUE





# EBS Pacific cod, continued

- The Team recommended omitting the models containing fishery CPUE from the ensemble and including the additional model with dome-shaped selectivity along with the four models representing Ensemble A
  - This ensemble of five models (Models 20.4, 19.12, 19.12a, 19.15, and 20.8) is labeled “Ensemble C”
  - The Team encourages new models and data to be presented in September and was concerned that the new CPUE index may not be proportional to abundance and needs further review
  - The Team also noted that if an ensemble was not selected, the preferred single model was 19.12



# EBS Pacific cod, continued

- The Team recommended retaining only the following weighting criteria: those with an emphasis of 3; the fits consistent with variances; and new criteria of whether asymptotic survey selectivity is used and whether the model was previewed in September, both with an emphasis of 1
  - The new criterion would apply a 0 to the model with dome-shaped selectivity and a 1 to the four others, and a similar scoring for the September preview criterion
  - This resulted in the following weights for each model:
    - M20.4 = 0.1509
    - M19.12a = 0.2075
    - M19.15 = 0.1887
    - M19.12 = 0.2453, and
    - M20.8 = 0.2075



# EBS Pacific cod, continued

- The Team recommended that the fishery CPUE be standardized using alternative statistical methods and that it be discussed at the CIE review in 2021
  - This should also include a discussion of historical changes in the fishery that may affect the relationship of the index to abundance
- The Team recommended collating fishery information in the ESP
  - Although the CPUE index was of concern to the Team, the Team recognizes that fishery performance has been improving and that these observations should not be ignored
  - Inclusion of fishery performance in the ESP and evaluation of the CPUE index with those performance metrics may help provide important insights



# EBS Pacific cod, continued

- The Team recommended the following topics could be considered for the 2021 CIE review: development of a fishery CPUE index, incorporation of dome-shaped survey selectivity, models to include in an ensemble, whether to apply the sloping HCR before or after ensemble averaging of SSB and other reference points, and development of movement models



# EBS Pacific cod, continued

Quantity	Last asmt.	This asmt.*	Change
M	0.35	0.34	-0.03
2020 tier	3b	n/a	none
2021 tier	3b	3b	none
2020 age+ biomass	756,811	n/a	-0.08
2021 age+ biomass	702,235	694,707	-0.01
2020 spawning biomass	267,333	n/a	-0.22
2021 spawning biomass	216,255	208,640	-0.04
B100%	672,795	682,270	0.01
B40%	269,118	272,908	0.01
B35%	235,478	238,795	0.01
2021 FOFL	0.33	0.30	-0.09
2021 FABC	0.26	0.25	-0.04
2020 OFL	191,386	n/a	-0.41
2021 OFL	125,734	112,851	-0.10
2020 ABC	155,873	n/a	-0.39
2021 ABC	102,975	94,552	-0.08

\*"This asmt." column based on Ensemble C.



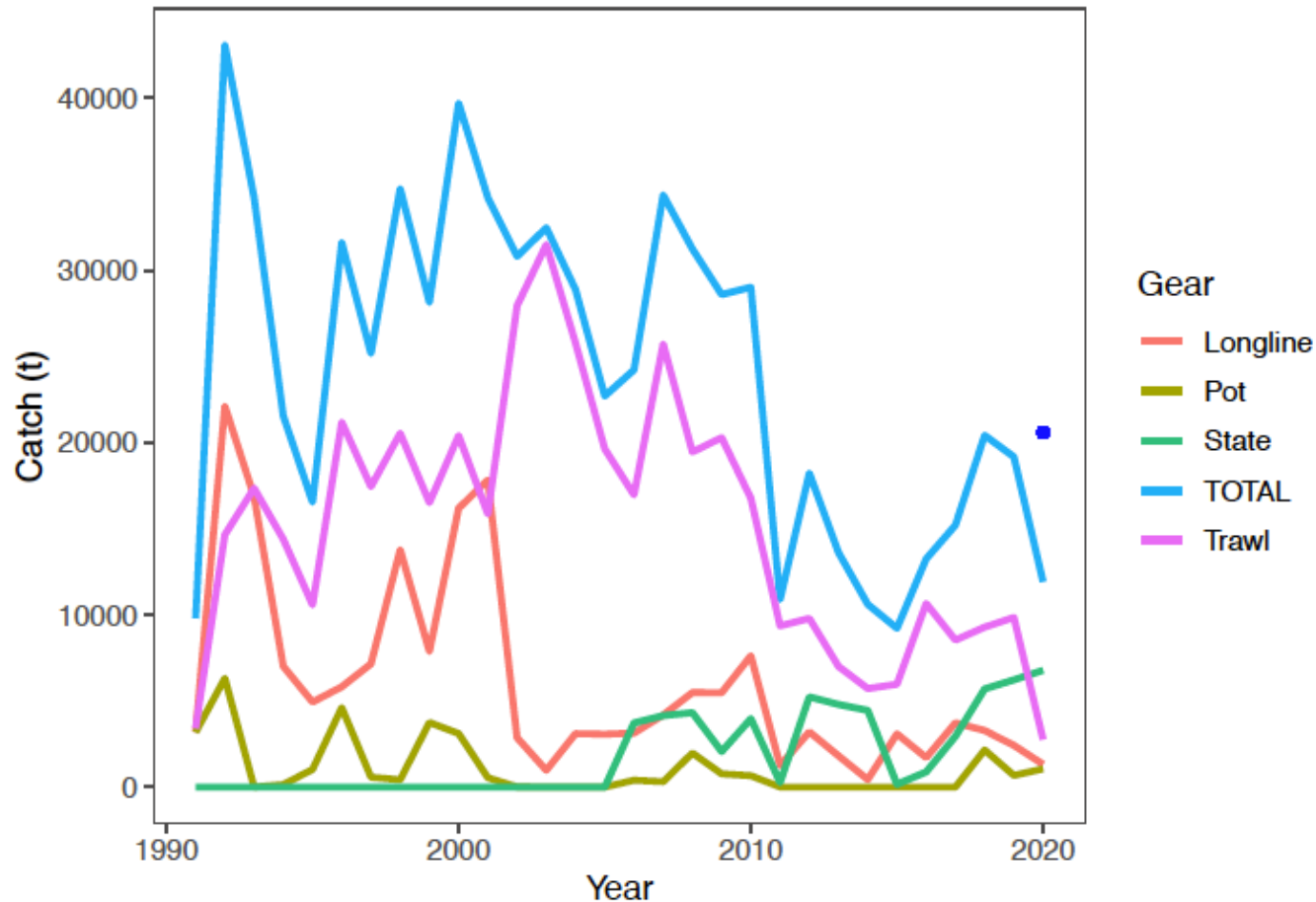
# Chapter 2A: AI Pacific cod

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **yes**
- New data: none
- Model changes/alternatives: none (Tier 5 RE model)
- Stock trend: Tier 5 RE model estimates that survey biomass has increased continuously since the all-time low observed in 2010
  - 2018 estimate is 32% higher than 2010 estimate
  - 2018 estimate is 11% lower than time series average
- Risk levels: assess. = 1, pop. dy. = 1, **env./eco. = 2**, fishery = 1
  - Temperatures and heatwave days above average since 2013-2016
    - Increased bioenergetics costs
  - Since 2014, diet has been changing to potentially lower quality prey
  - Pelagic predator assemblage now dominated by rockfish
  - Fish condition has been below average since 2012



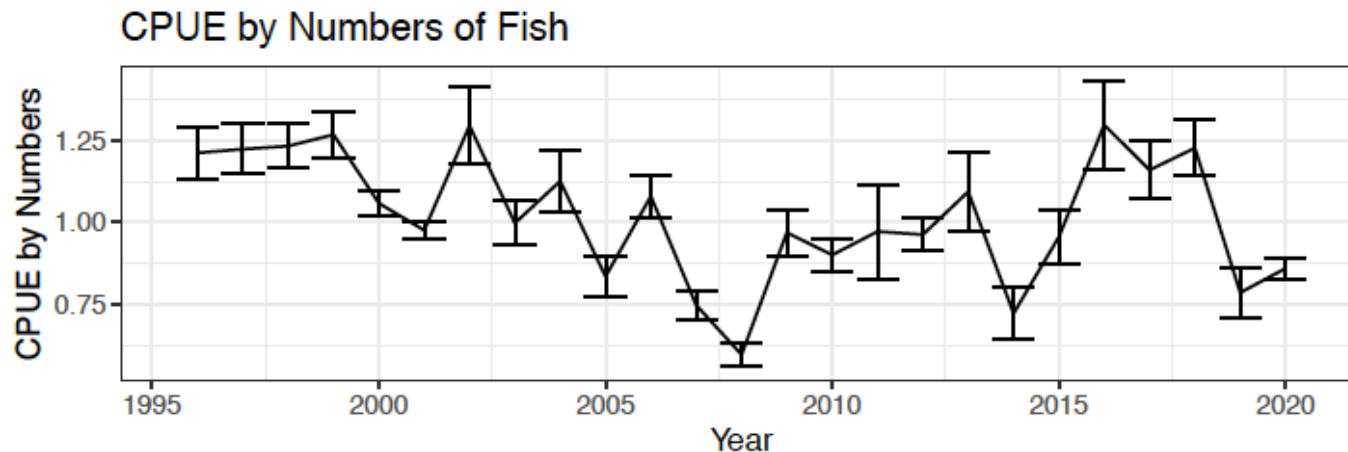
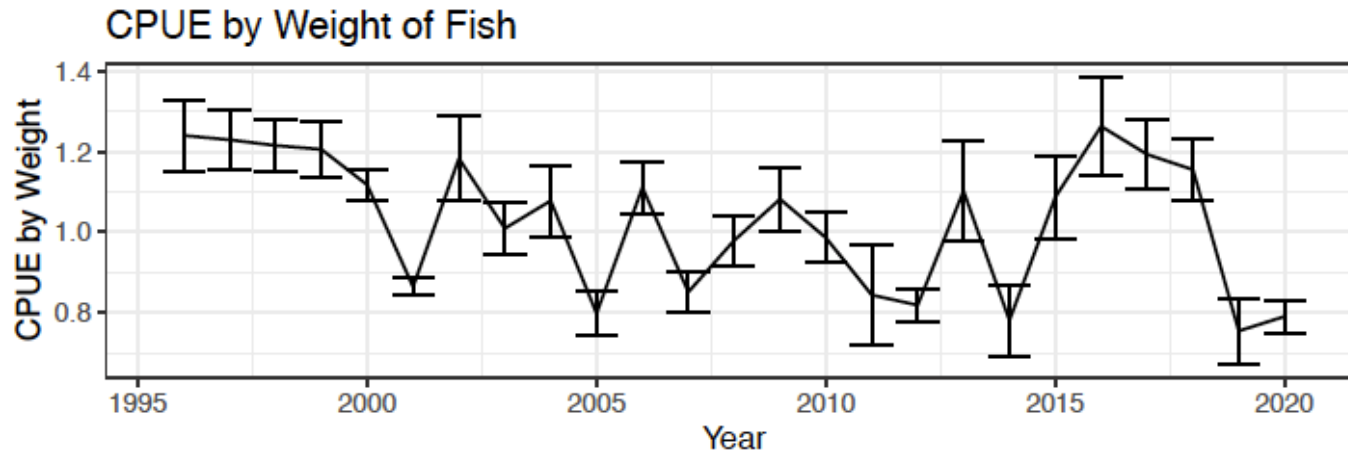
# AI Pacific cod, continued

- Catch time series



# AI Pacific cod, continued

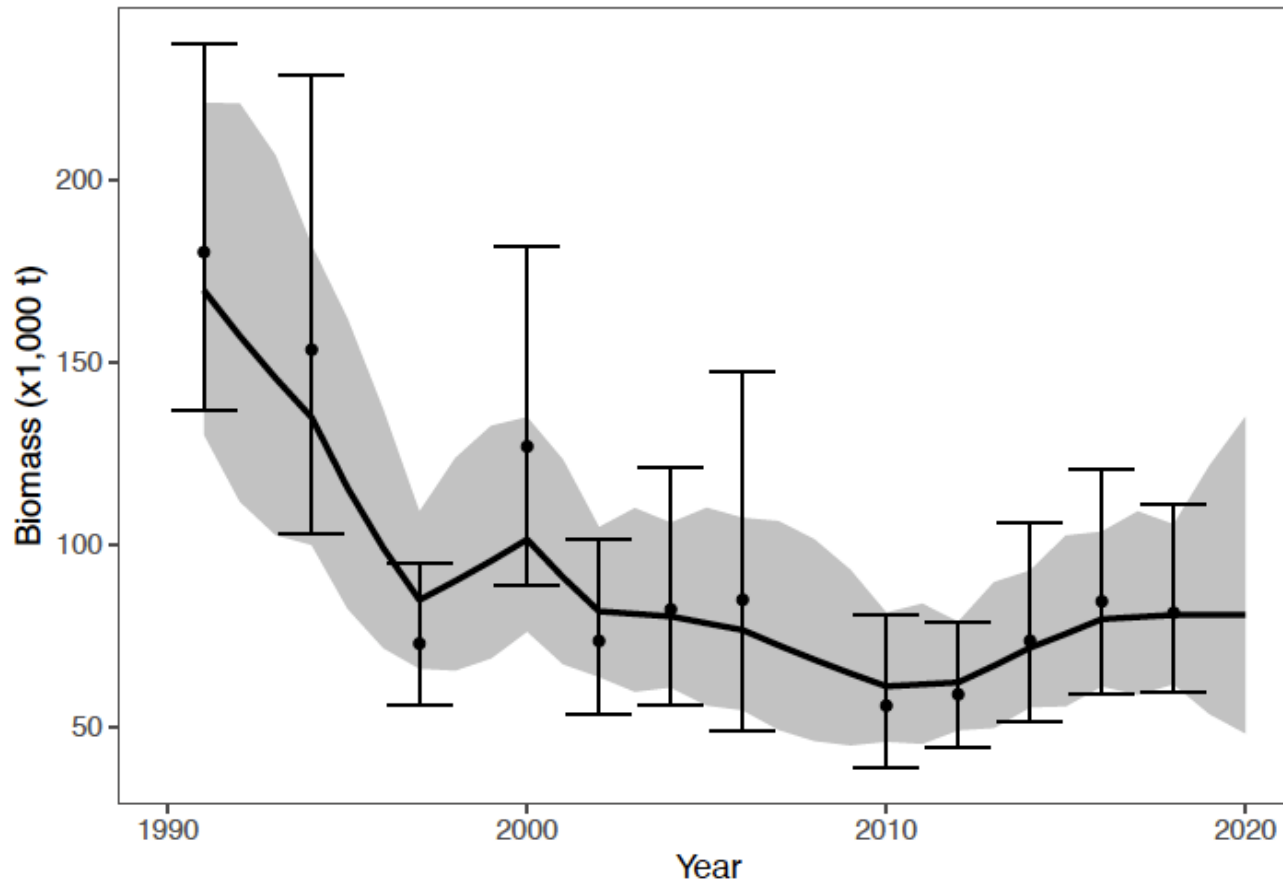
- Catch per unit effort time series





# AI Pacific cod, continued

- Survey biomass time series



# AI Pacific cod, continued

- The Team recommended that an age-structured assessment be presented to the Team in September 2021

Quantity	Last asmt.	This asmt.	Change
M	0.34	0.34	0.00
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	80,700	80,700	0.00
2021 FOFL	0.34	0.34	0.00
2021 FABC	0.255	0.255	0.00
2020 OFL	27,400	n/a	0.00
2021 OFL	27,400	27,400	0.00
2020 ABC	20,600	n/a	0.00
2021 ABC	20,600	20,600	0.00



# Chapter 3: sablefish

- Covered in Joint Team presentation (thank you, Jim!)

Quantity	Last asmt.	This asmt.	Change
M	0.105	0.098	-0.07
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	704,683	n/a	0.07
2021 age+ biomass	741,029	753,110	0.02
2020 spawning biomass	113,368	n/a	0.19
2021 spawning biomass	156,854	134,401	-0.14
B100%	264,940	317,096	0.20
B40%	105,976	126,389	0.19
B35%	92,729	110,984	0.20
2021 FOFL	0.121	0.117	-0.03
2021 FABC	0.041	0.042	0.02
2020 OFL	50,481	n/a	0.20
2021 OFL	64,765	60,426	-0.07
2020 ABC	22,009	n/a	0.01
2021 ABC	29,008	22,237	-0.23



# Chapter 4: yellowfin sole

- New author: **no**; >1 model: **yes**; change from base: **yes**; risk>1: **no**
- New data:
  - Fishery and survey agecomps for 2019
  - Fishery weight at age was re-estimated
- Model changes/alternatives:
  - Model 18.1 is the base model, with  $M=0.12$  for both sexes
  - Model 18.2 (recommended) fixes female  $M=0.12$ , but estimates male  $M=0.135$
  - Model 18.3 is the same as Model 18.2, except with VAST estimates of the EBS survey biomass time series
  - Model 18.4 is the same as Model 18.2, except with VAST estimates of the combined EBS and NBS survey biomass time series
    - Authors view Models 18.3 and 18.4 as “exploratory”



# Yellowfin sole, continued

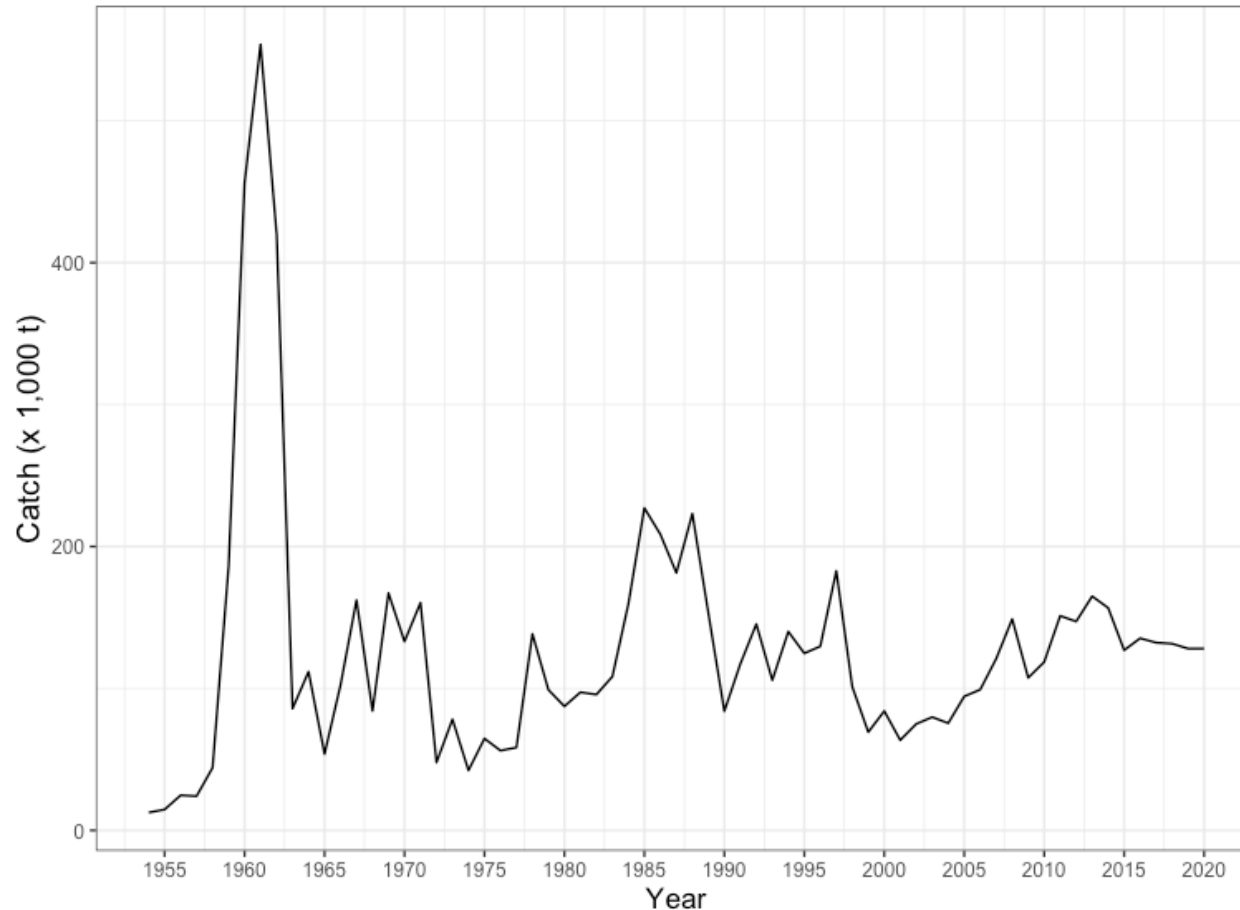
- Stock status:
  - 2021 spawning biomass is 68% of  $B_0$  and 86% above  $B_{MSY}$
- Mohn's  $\rho = -0.18$
- Negative log likelihoods for Models 18.1 and 18.2:

Likelihood component	Model 18.1	Model 18.2
Survey age	604.51	575.56
Fishery age	658.01	620.17
Selectivity	61.41	61.16
Survey biomass	93.23	96.41
Recruitment	28.88	29.67
Catchability	0.0084	0.007
Total	1446.05	1382.98



# Yellowfin sole, continued

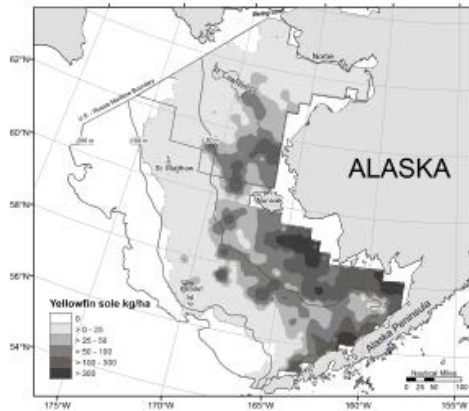
- Catch time series



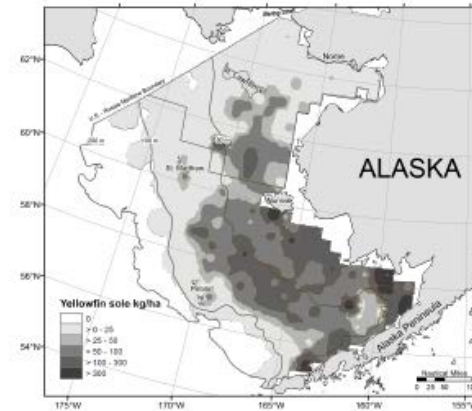
# Yellowfin sole, continued

- Survey catches of yellowfin sole in recent NBS survey years

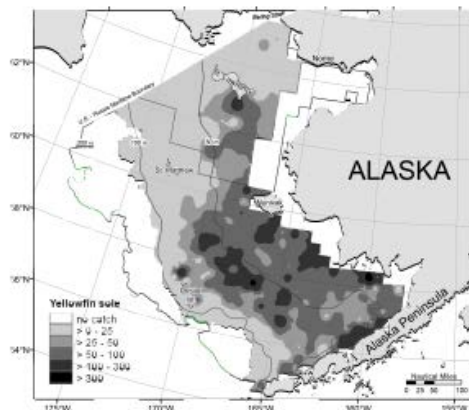
2010



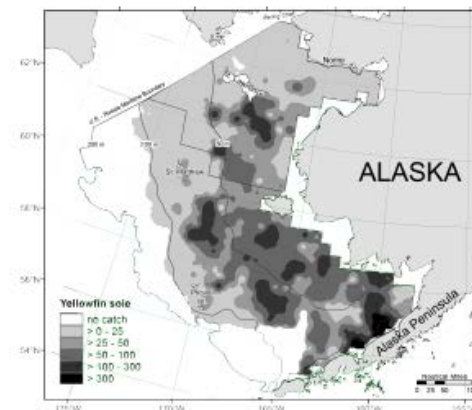
2017



2018 ("rapid response")

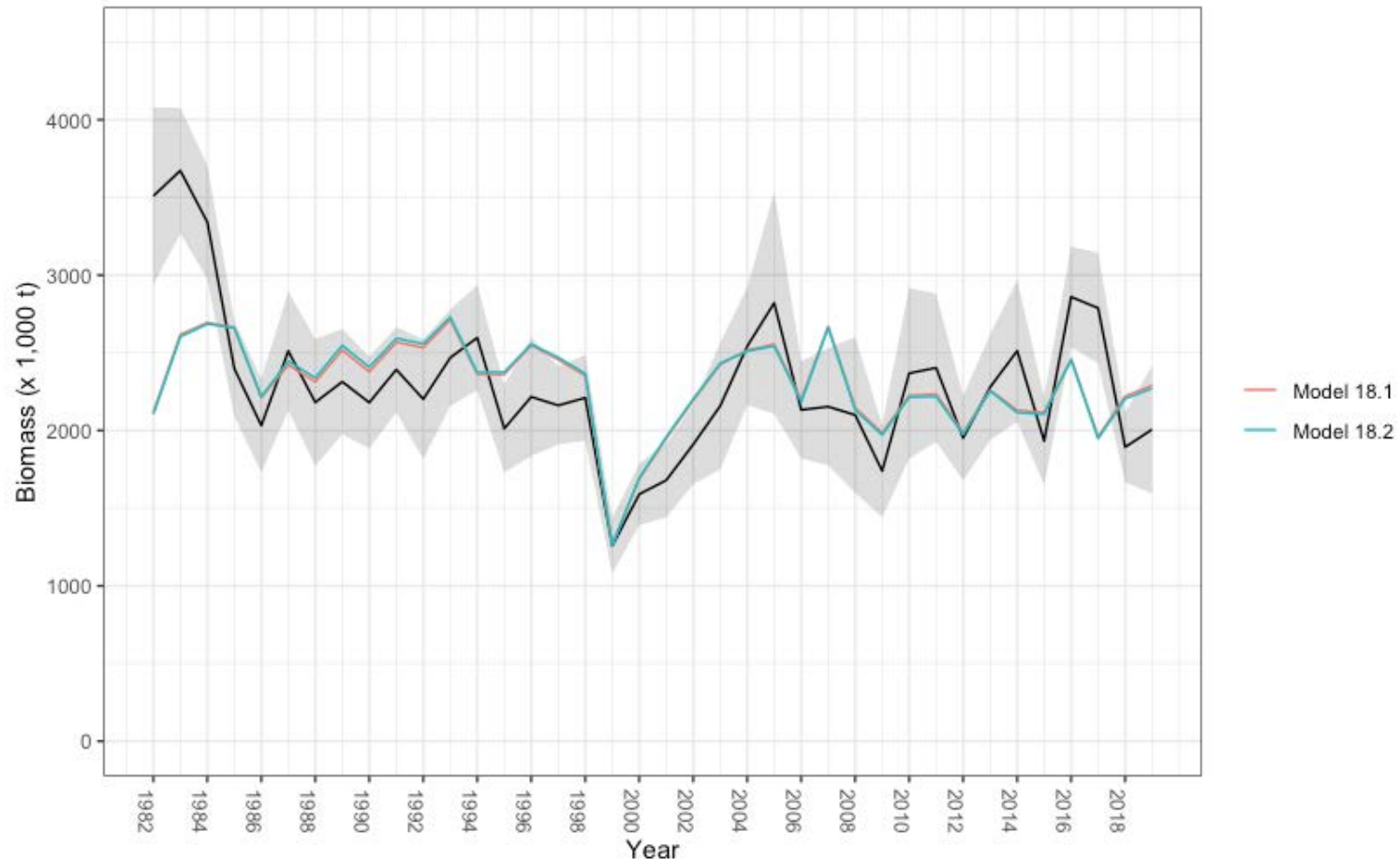


2019



# Yellowfin sole, continued

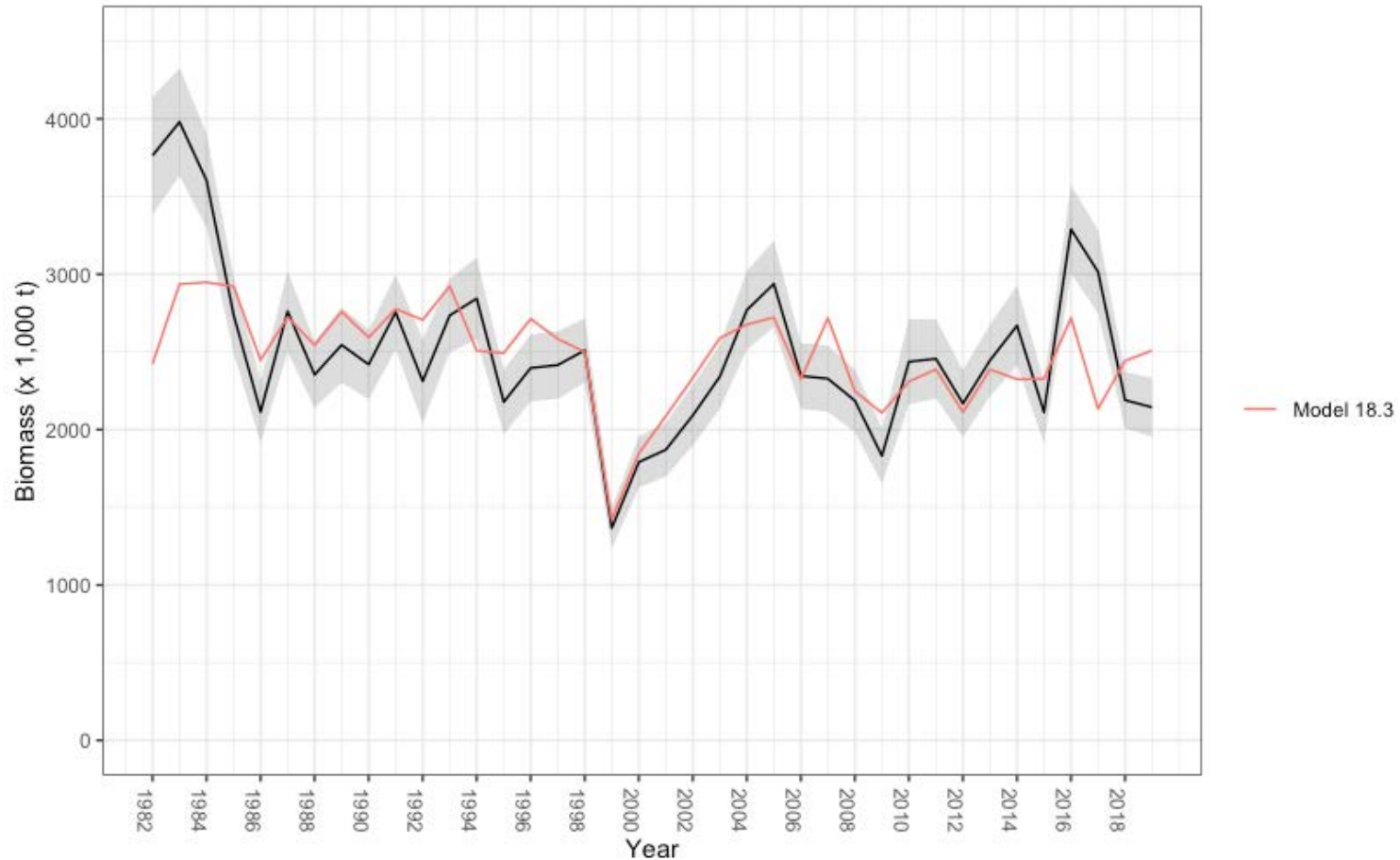
- Fits to design-based EBS survey biomass





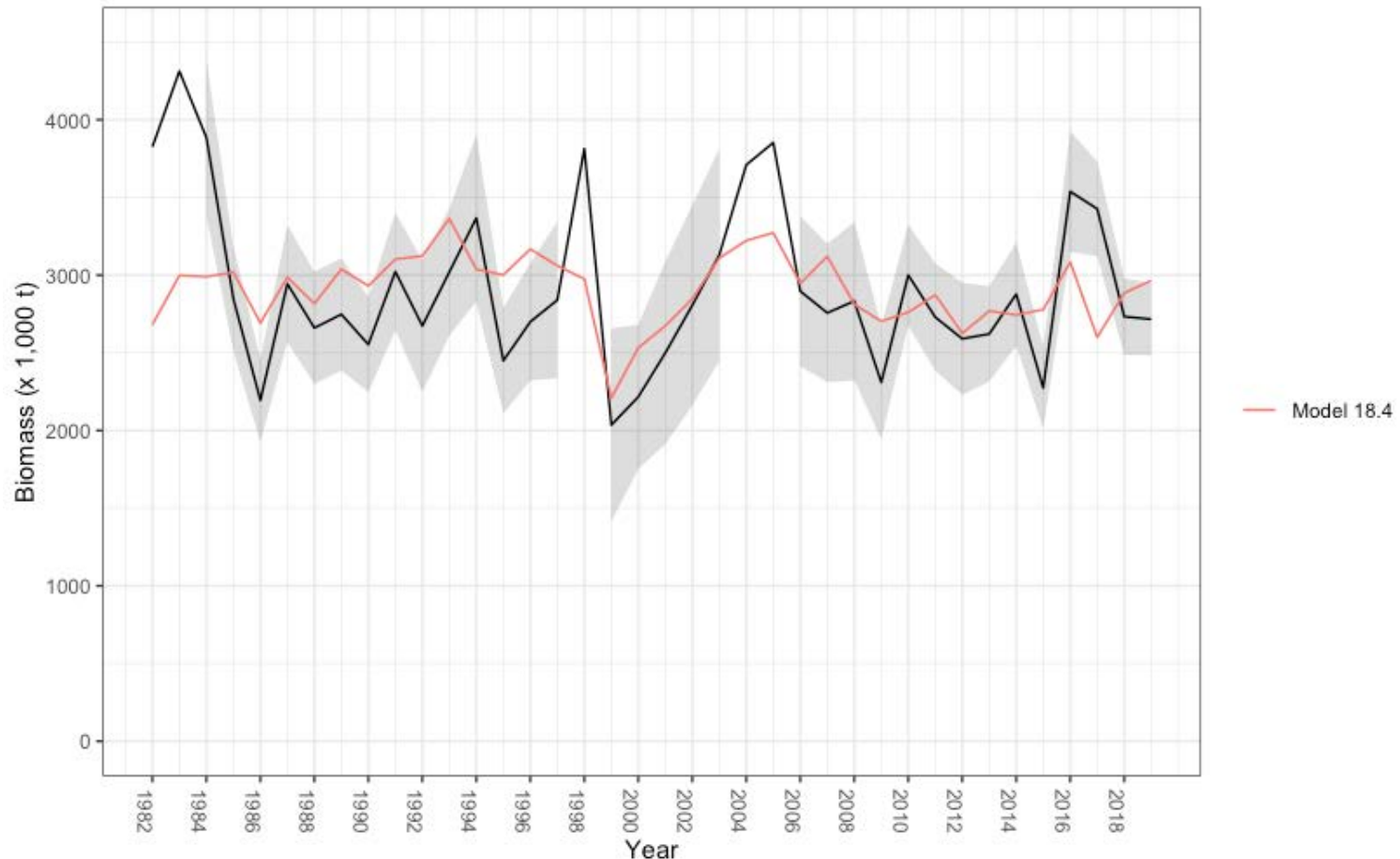
# Yellowfin sole, continued

- Fits to VAST-based EBS survey biomass



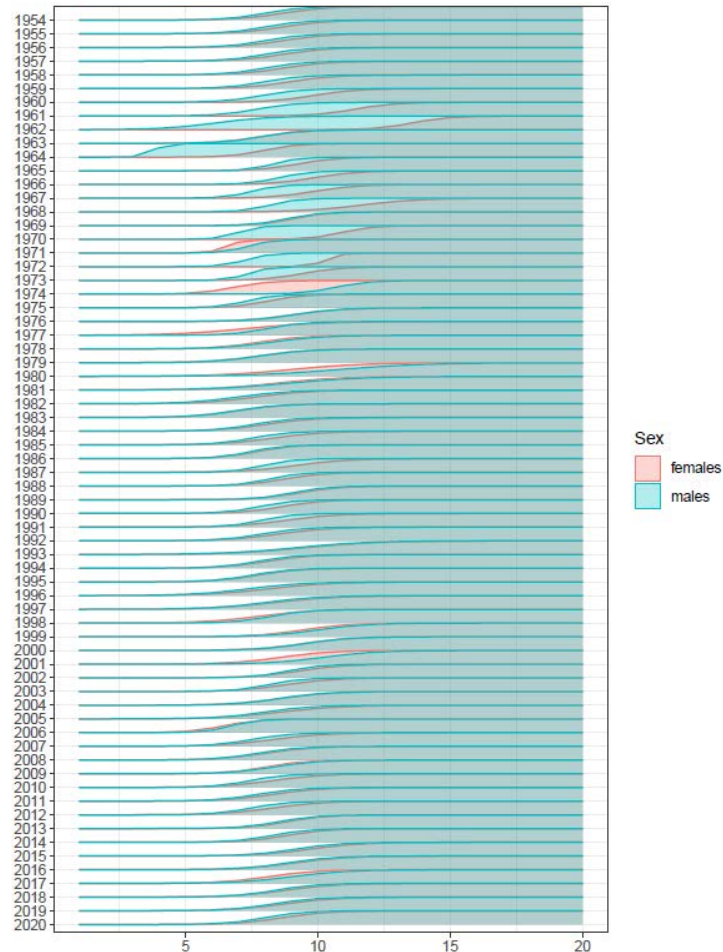
# Yellowfin sole, continued

- Fits to VAST-based EBS+NBS survey biomass



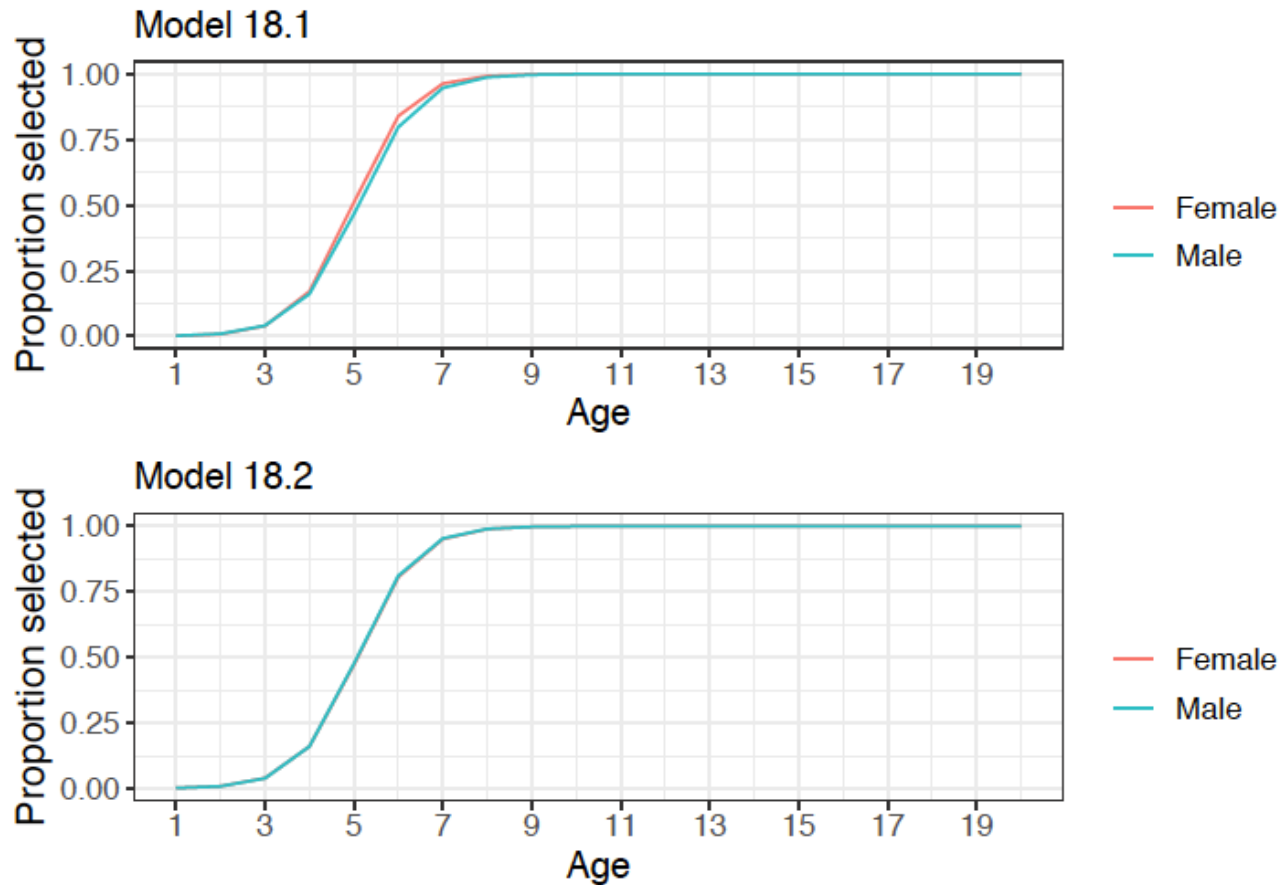
# Yellowfin sole, continued

- Fishery selectivity as estimated by Model 18.2



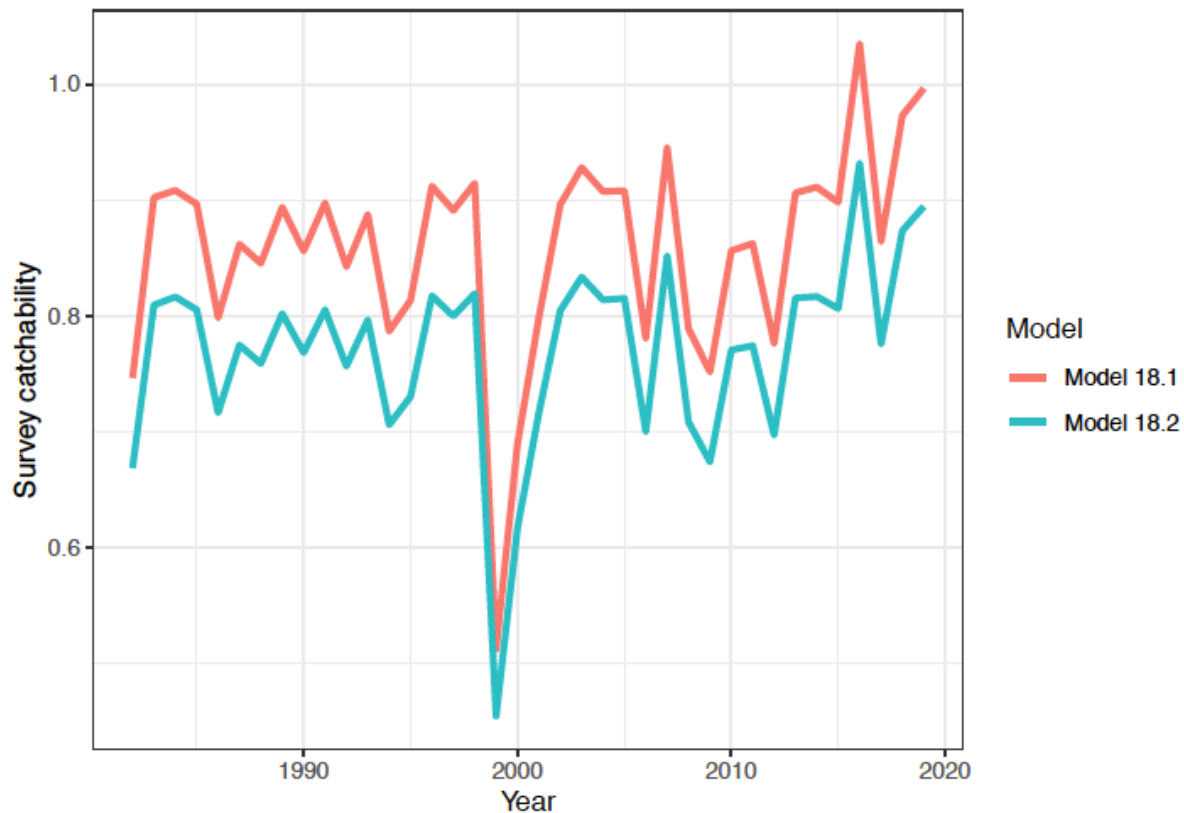
# Yellowfin sole, continued

- Survey selectivity as estimated by Models 18.1 and 18.2



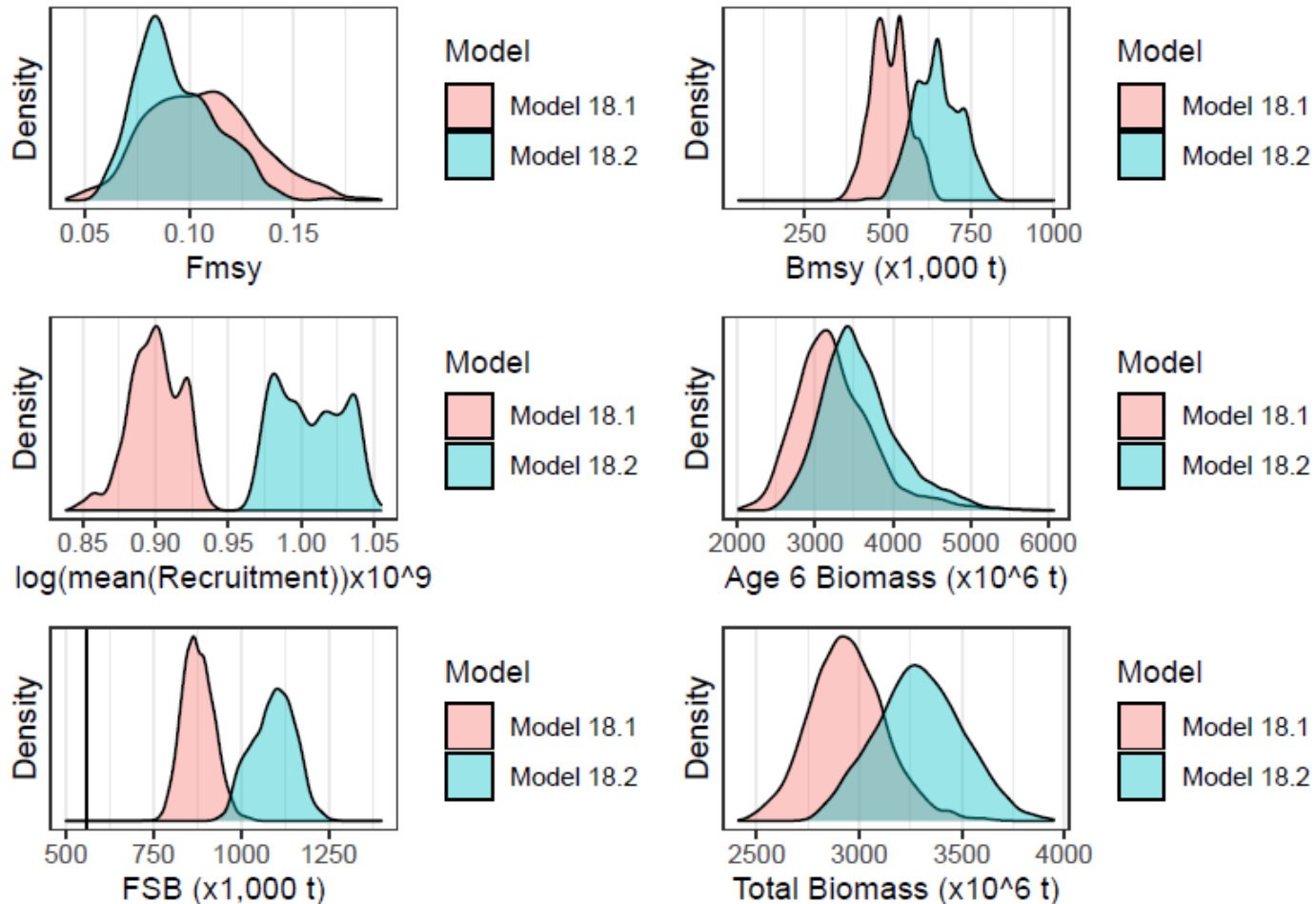
# Yellowfin sole, continued

- Survey catchability as estimated by the Models 18.1 and 18.2
  - A function of temperature, survey start date, and interaction



# Yellowfin sole, continued

- MCMC posterior distributions of various quantities



# Yellowfin sole, continued

- Public comment:
  - YFS fishers struggled to find areas of low halibut bycatch in 2019
  - In 2020 bottom temperatures were cooler and fishing was better
  - Market issues drove the differences in the fishery this year
  - The YFS market had issues in 2020 with the pandemic affecting European/US “white table cloth” markets and tariffs affecting product reprocessed in China; however, these circumstances had normalized towards the end of the year
- The Team recommended that the authors investigate decreased female natural mortality and weight at age next year to help address the issue of a positive retrospective bias in the recommended model
  - In addition to the Team’s September recommendation on estimating sex-specific  $M$ , one suggestion was to fix the male  $M$  at the current value in model 18.2 and fit the female  $M$



# Yellowfin sole, continued

Quantity	Last asmt.	This asmt.	Change
M (female/male)	0.12	0.12/0.135	0/0.13
2020 tier	1a	n/a	none
2021 tier	1a	1a	none
2020 age+ biomass	2,486,700	n/a	0.11
2021 age+ biomass	2,733,340	2,755,870	0.01
2020 spawning biomass	847,101	n/a	0.23
2021 spawning biomass	809,813	1,040,900	0.29
B0	1,275,940	1,528,700	0.20
Bmsy	477,288	559,704	0.17
2021 FOFL	0.123	0.124	0.01
2021 FABC	0.112	0.114	0.02
2020 OFL	306,410	n/a	0.11
2021 OFL	336,801	341,571	0.01
2020 ABC	278,370	n/a	0.13
2021 ABC	305,980	313,477	0.02





# Chapter 5: Greenland turbot

- New author: no; >1 model: yes; change from base: yes; risk>1: yes
- New data:
  - 2019 EBS trawl survey biomass and size composition
  - 2019 and 2020 AFSC longline survey relative biomass
  - 2018 and 2019 EBS trawl survey size at age
  - 2019 and 2020 fishery size composition
- Model changes/alternatives:
  - Model 16.4, the current base model
  - Model 16.4a (recommended), the same as 16.4, except that an error in the units specified for the AFSC longline index has been corrected
- Stock status: projected 2021 spawning biomass is 58% of  $B_{100\%}$
- Mohn's  $\rho = 0.04$



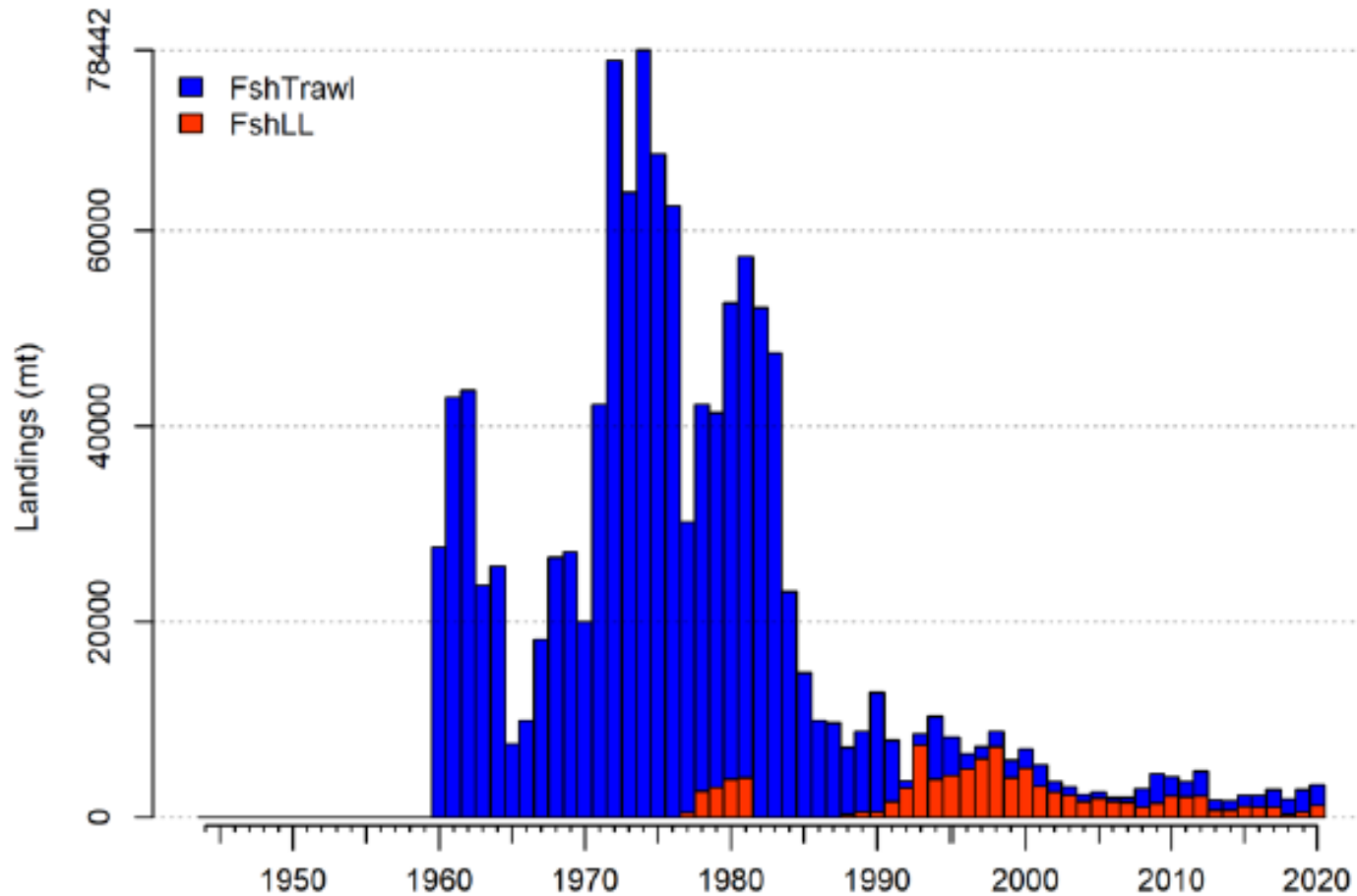
# Greenland turbot, continued

- Risk levels: assess. = 1, pop. dy. = 1, env./eco. = 2, fishery = 1
  - Recent EBS shelf survey data indicate that the length distribution is truncating, with few to no young recruits in 2019
  - Although 2020 has an average cold pool extent, there is concern that with increased frequency of years with little to no cold pool there will be a continued lack of recruitment in the future
  - Few clear concerns about prey abundance
  - Arrowtooth flounder, Kamchatka flounder, and Pacific halibut can be considered competitors based on overlap in their ecological niches, and these are largely abundant or increasing
  - Trends in predator abundances that would indicate a change in predation impact on turbot are unknown
  - Environmental impacts on future recruitment are uncertain



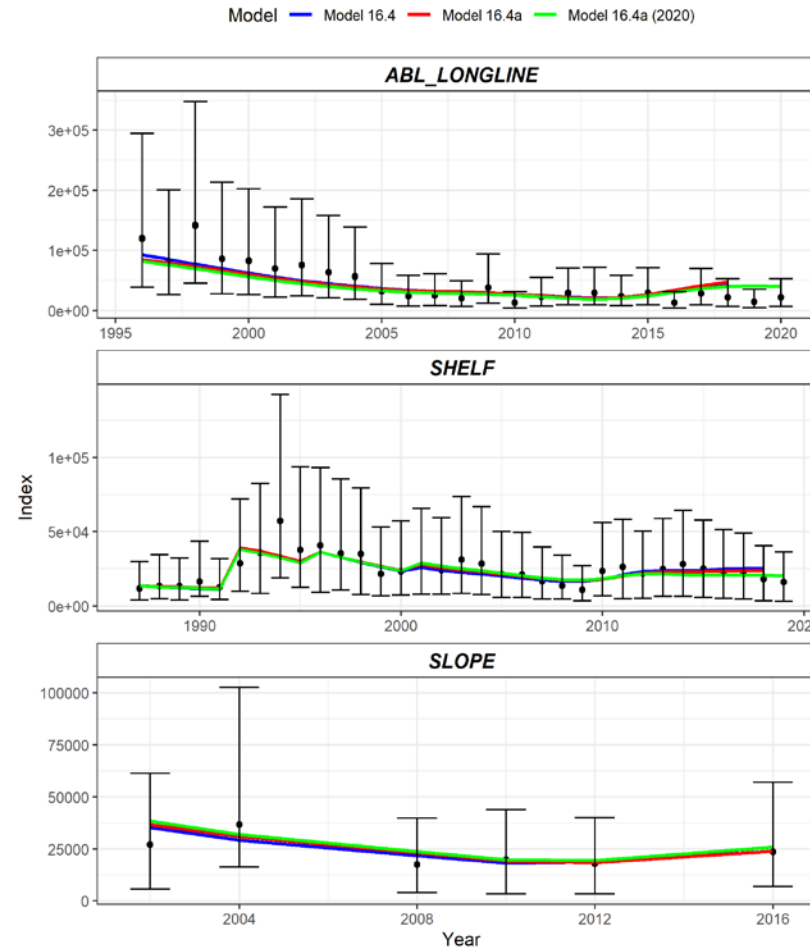
# Greenland turbot, continued

- Catch time series



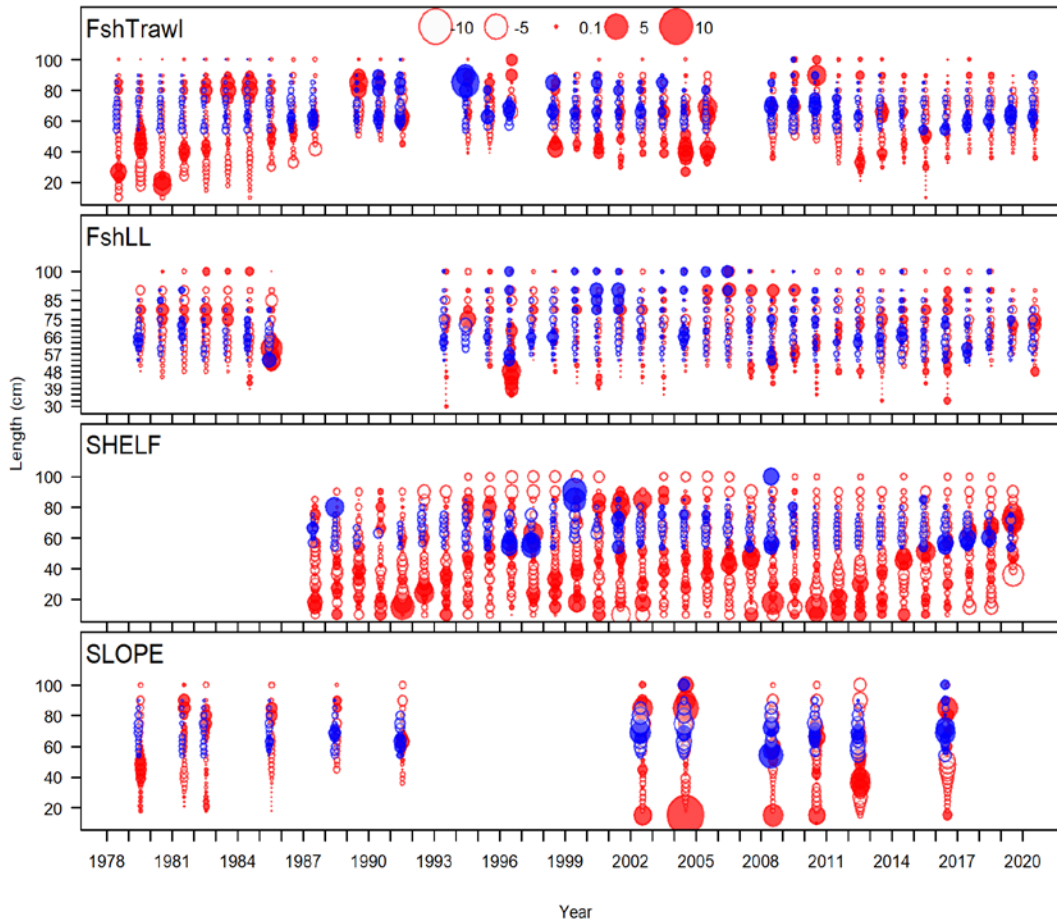
# Greenland turbot, continued

- Fits to survey indices



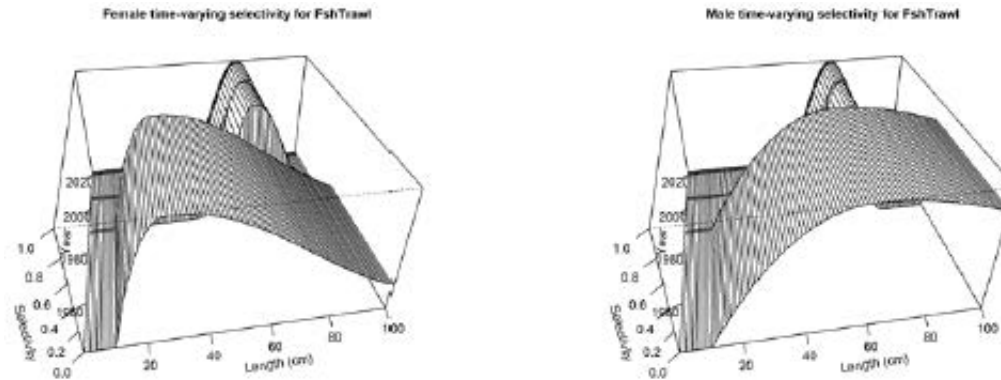
# Greenland turbot, continued

- Fits to size composition data (Model 16.4a; red=female, blue=male)

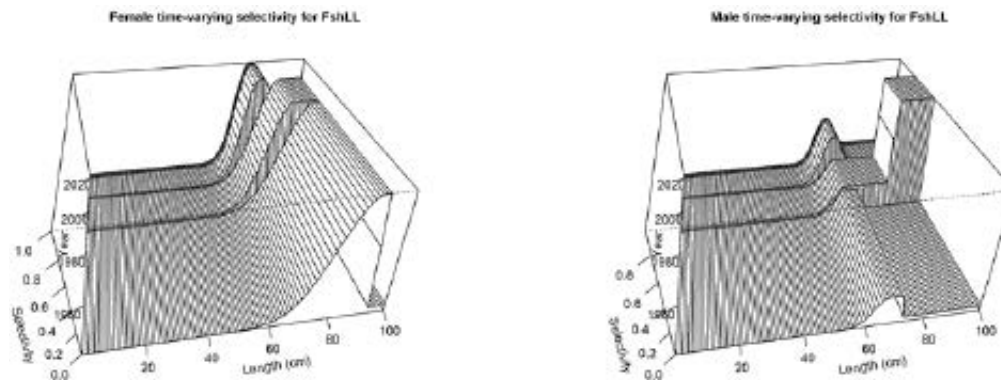


# Greenland turbot, continued

- Trawl fishery selectivity (Model 16.4a; female on left, male on right)

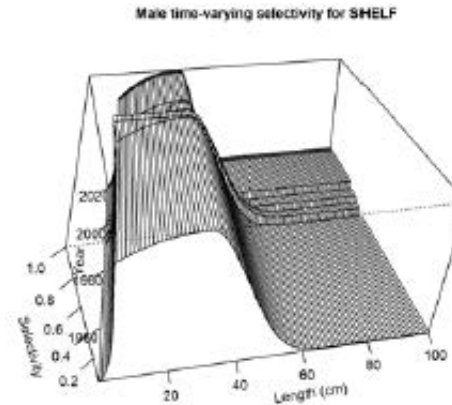
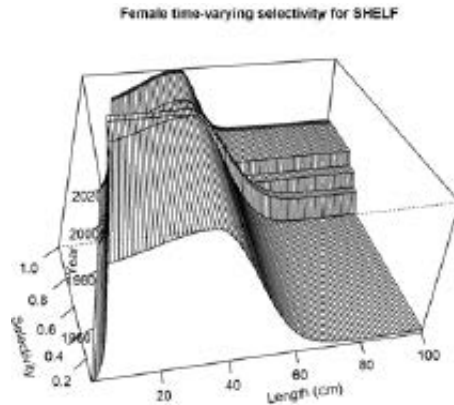


- Longline fishery selectivity (Model 16.4a; female on left, male on right)

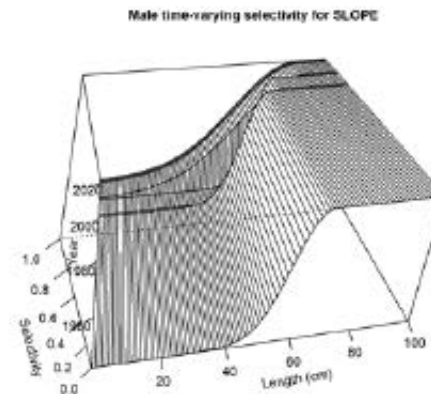
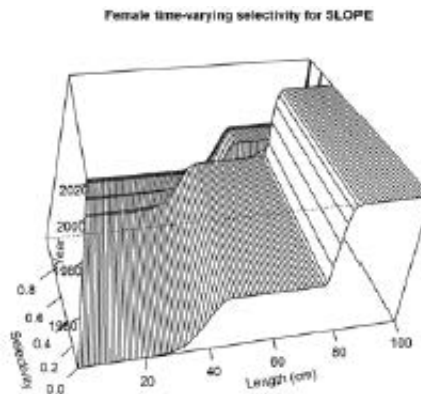


# Greenland turbot, continued

- Shelf trawl survey selectivity (Model 16.4a; female on left, male on right)

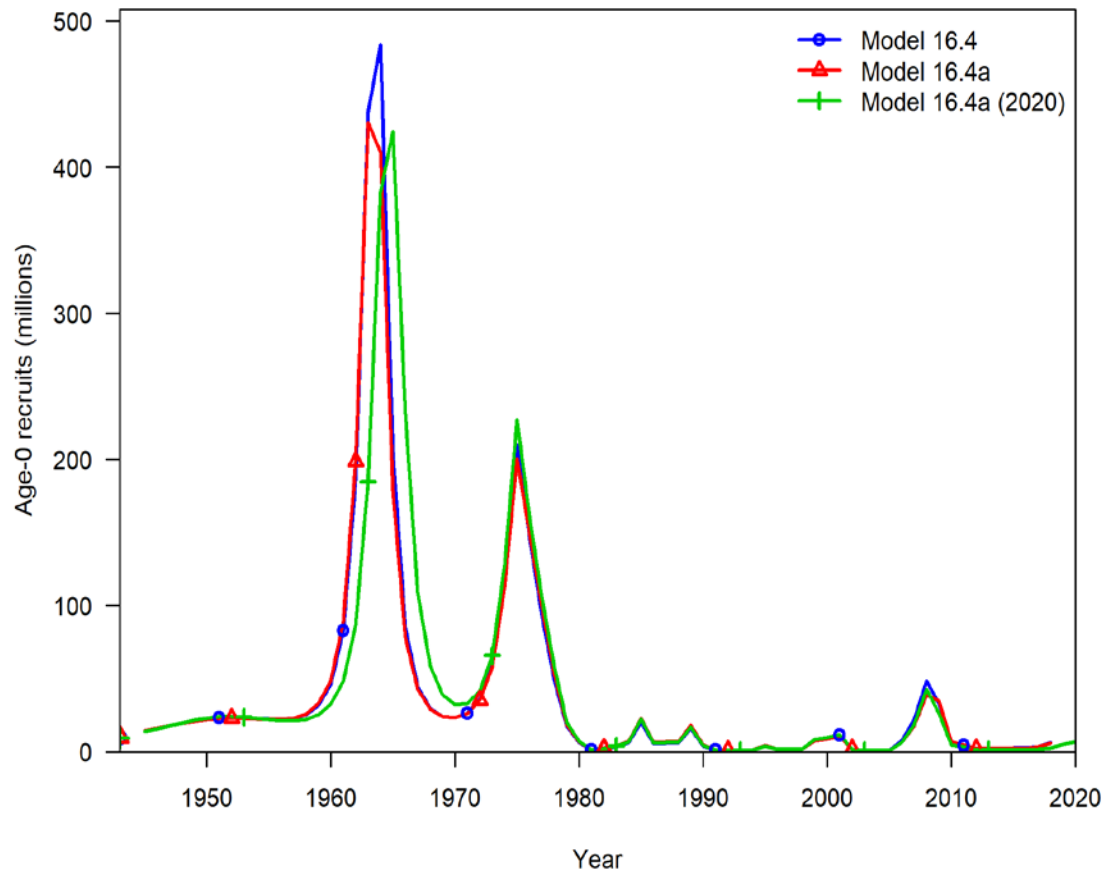


- Slope trawl survey selectivity (Model 16.4a; female on left, male on right)



# Greenland turbot, continued

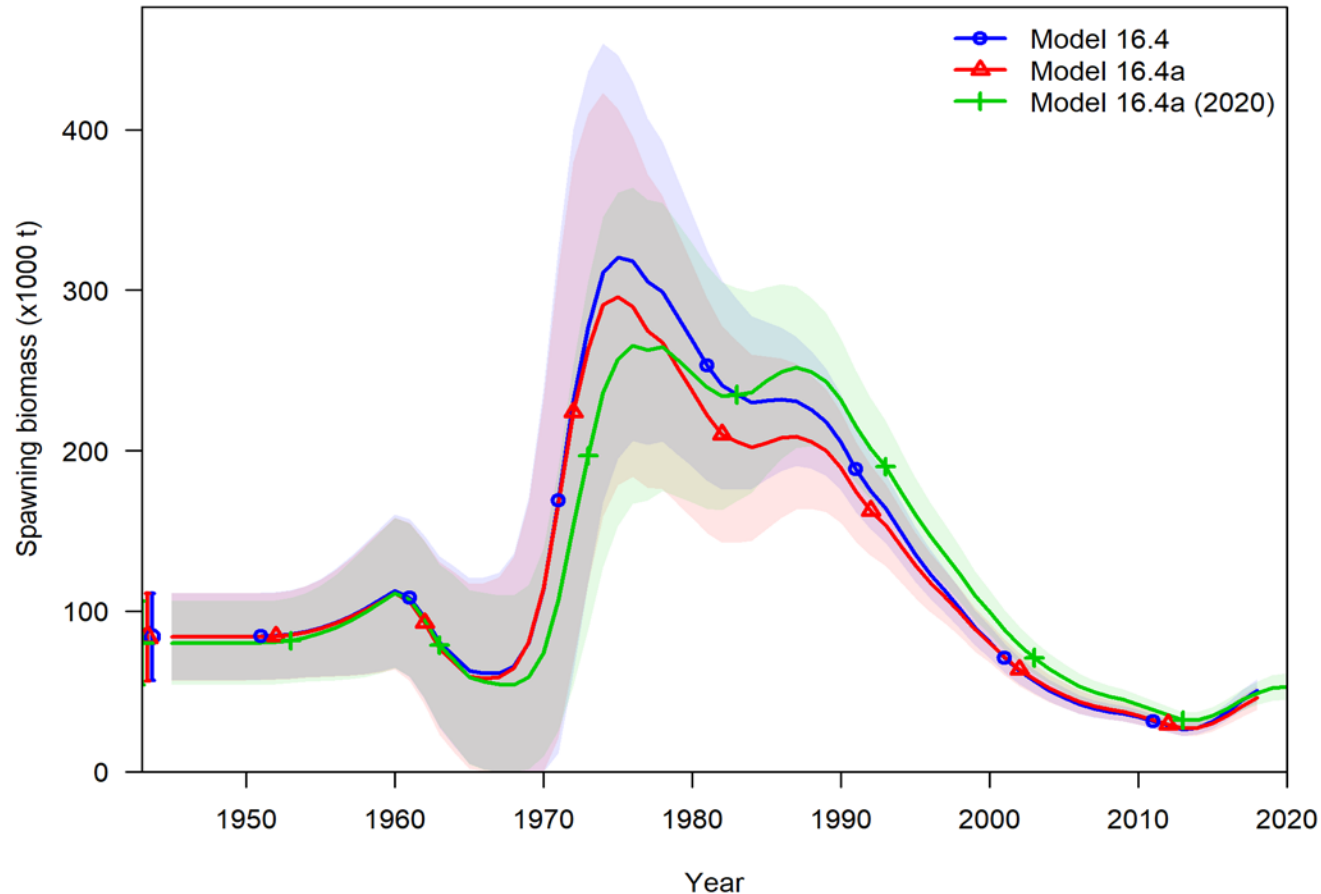
- Age 0 recruitment time series





# Greenland turbot, continued

- Spawning biomass time series



# Greenland turbot, continued

Quantity	Last asmt.	This asmt.	Change
M	0.112	0.112	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	106,101	n/a	-0.17
2021 age+ biomass	98,532	87,849	-0.11
2020 spawning biomass	57,094	n/a	-0.09
2021 spawning biomass	53,617	51,914	-0.03
B100%	90,534	89,054	-0.02
B40%	36,213	35,622	-0.02
B35%	31,687	31,169	-0.02
2021 FOFL	0.21	0.22	0.05
2021 FABC	0.18	0.18	0.00
2020 OFL	11,319	n/a	-0.24
2021 OFL	10,006	8,568	-0.14
2020 ABC	9,625	n/a	-0.24
2021 ABC	8,510	7,326	-0.14



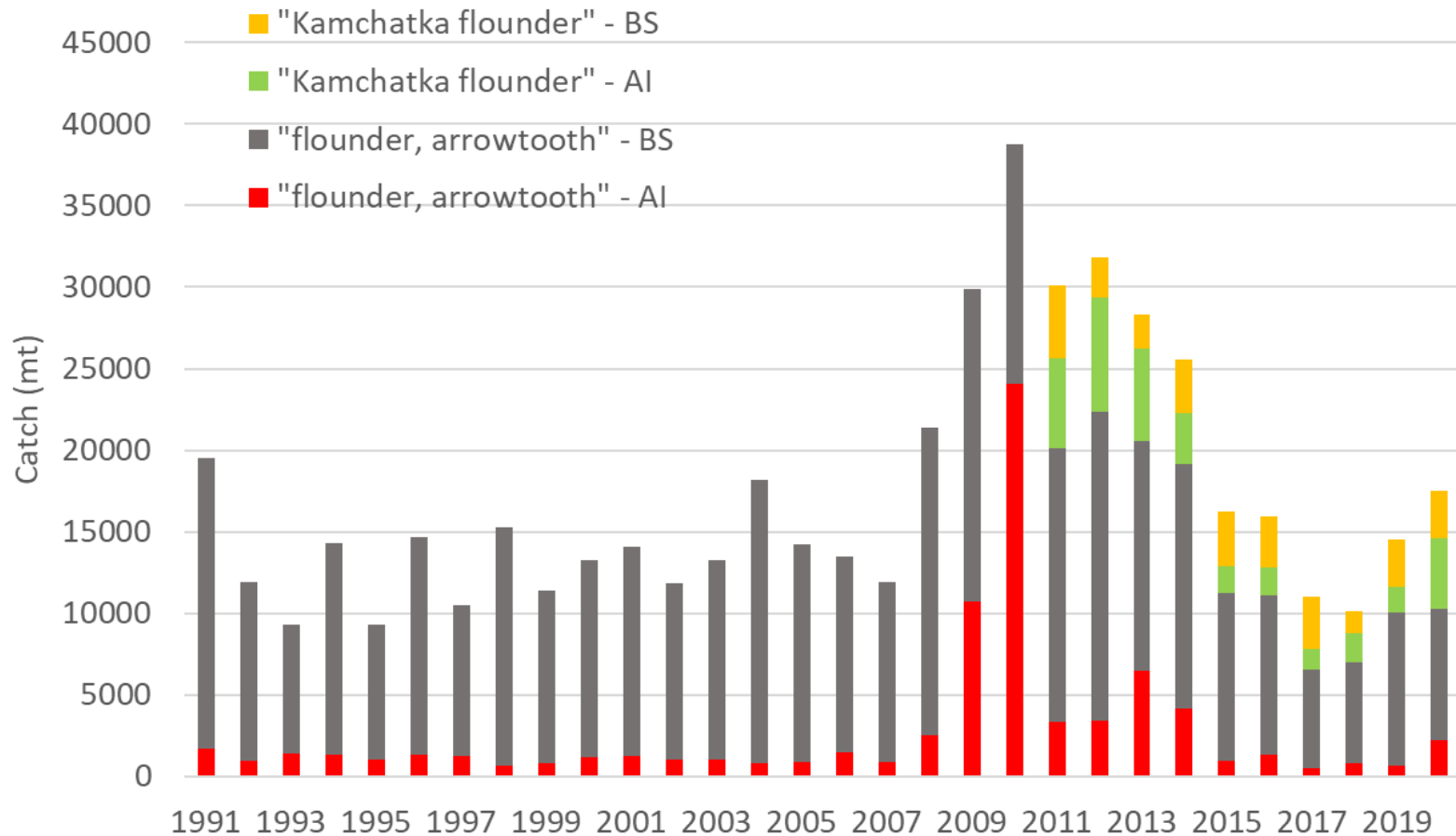
# Chapter 6: arrowtooth flounder

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **no**
- New data:
  - Size composition from the 2018 (updated) and 2019 fisheries
  - Biomass estimate from 2019 EBS shelf survey
  - Age composition from 2018-19 EBS shelf and 2018 AI surveys
  - Size composition from the 2019 EBS shelf survey
  - Minor corrections based on species ID (arrowtooth vs. Kamchatka):
    - Shelf survey index
    - 2008-2010 catch
- Model changes/alternatives: none (Model 18.9)
- Stock status: 2021 spawning biomass is 89% of  $B_{100\%}$
- Mohn's  $\rho = 0.07$



# Arrowtooth flounder, continued

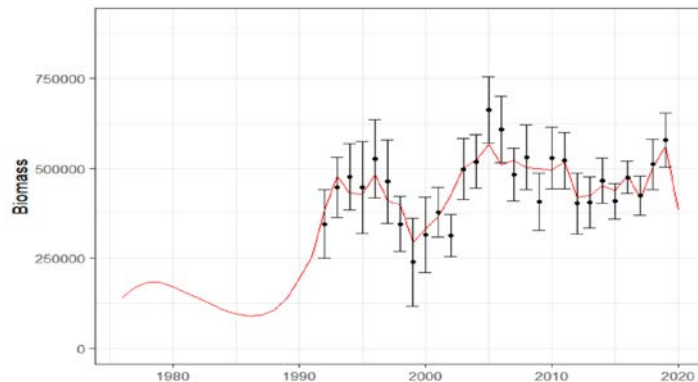
- Catch time series



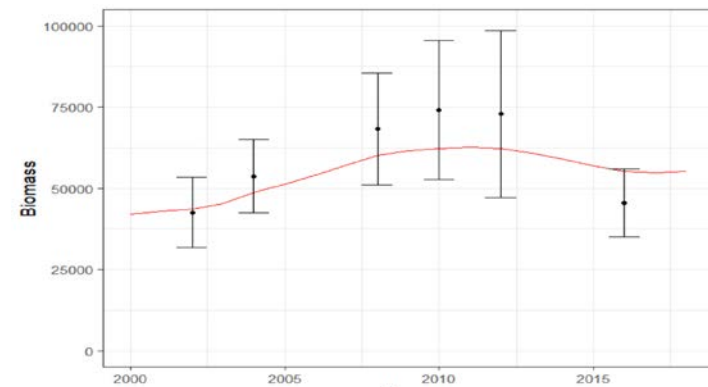
# Arrowtooth flounder, continued

- Survey biomass time series

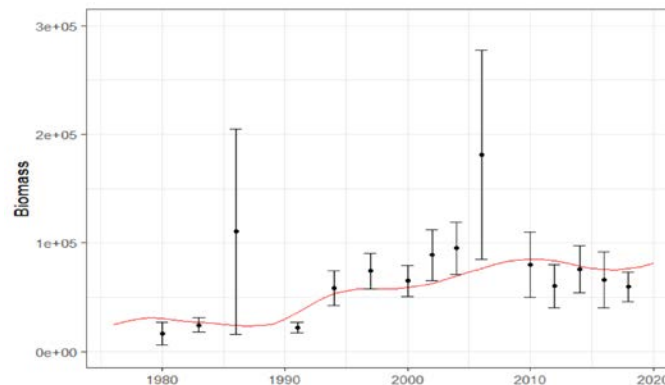
EBS shelf



EBS slope

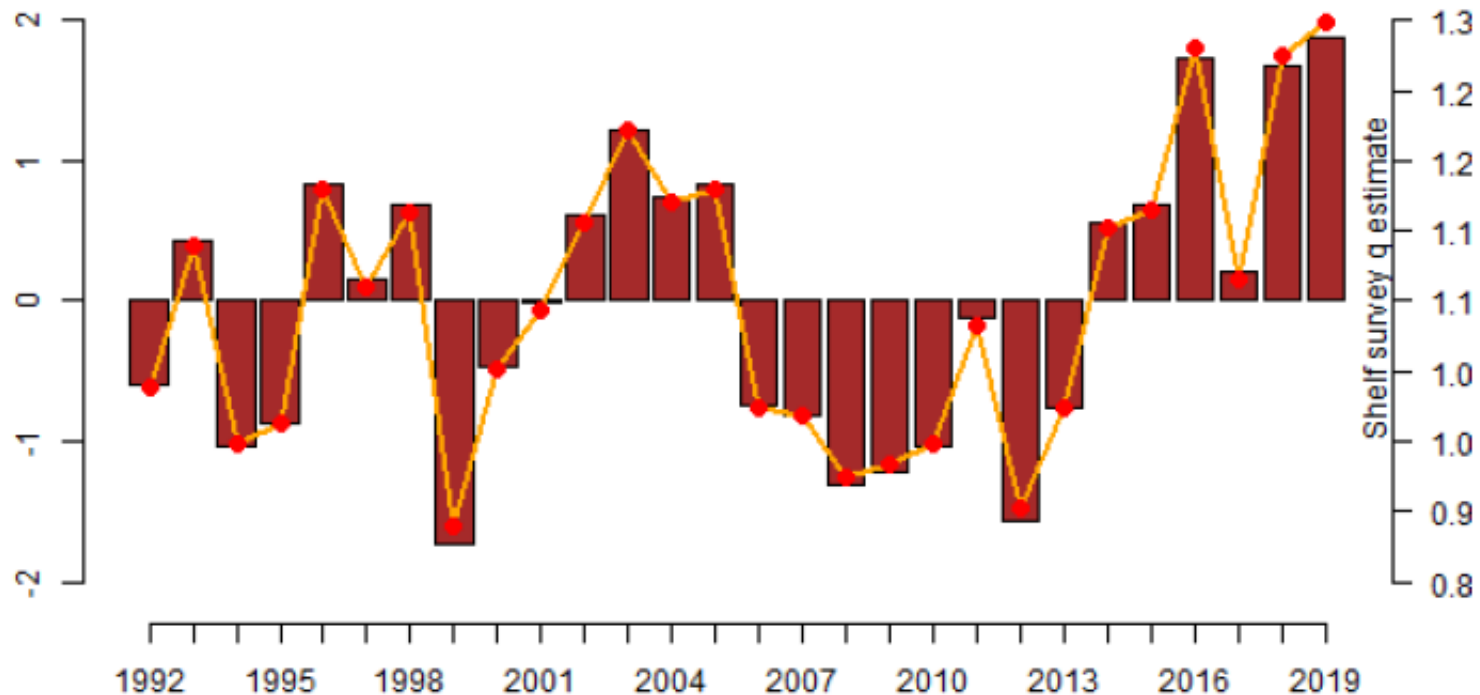


Aleutians



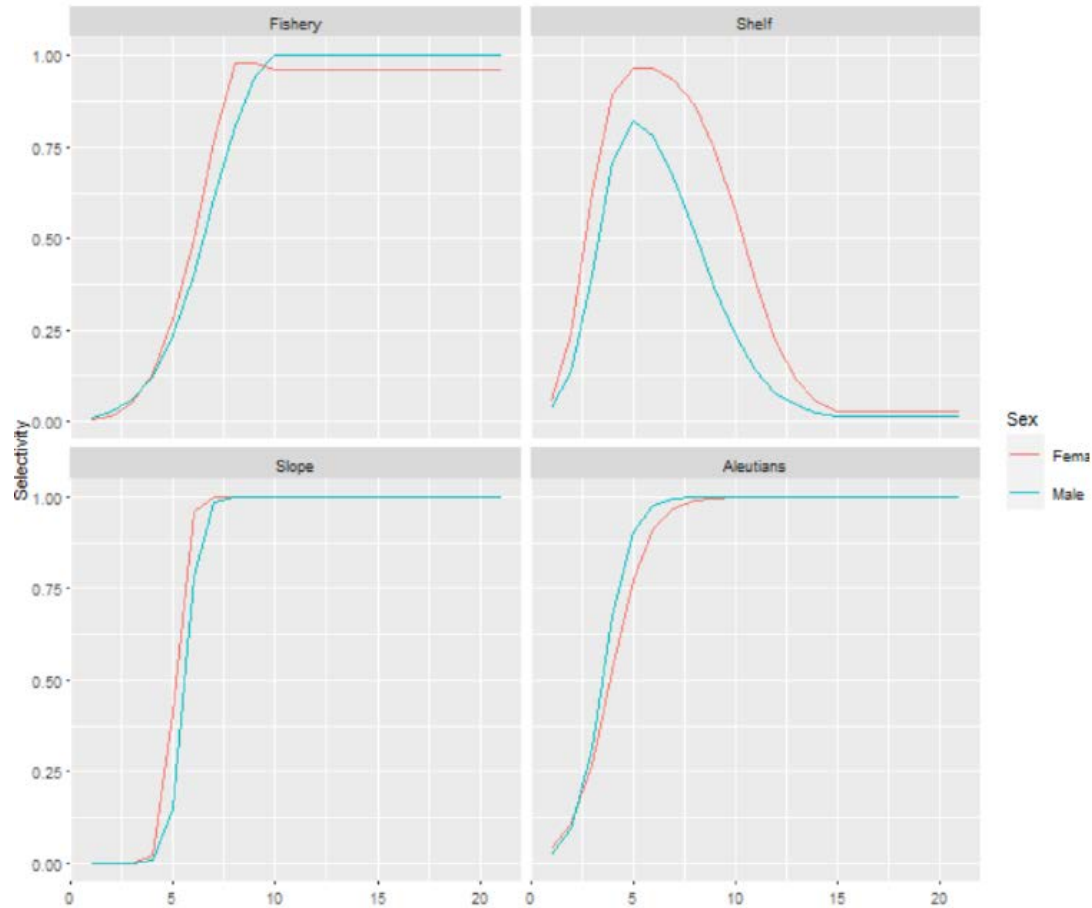
# Arrowtooth flounder, continued

- Catchability time series (a function of temperature)



# Arrowtooth flounder, continued

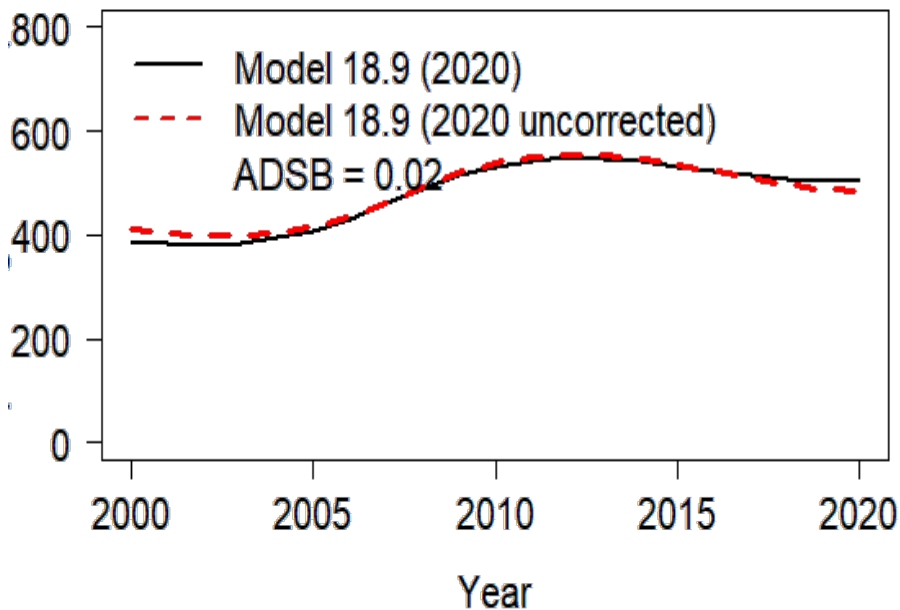
- Selectivity



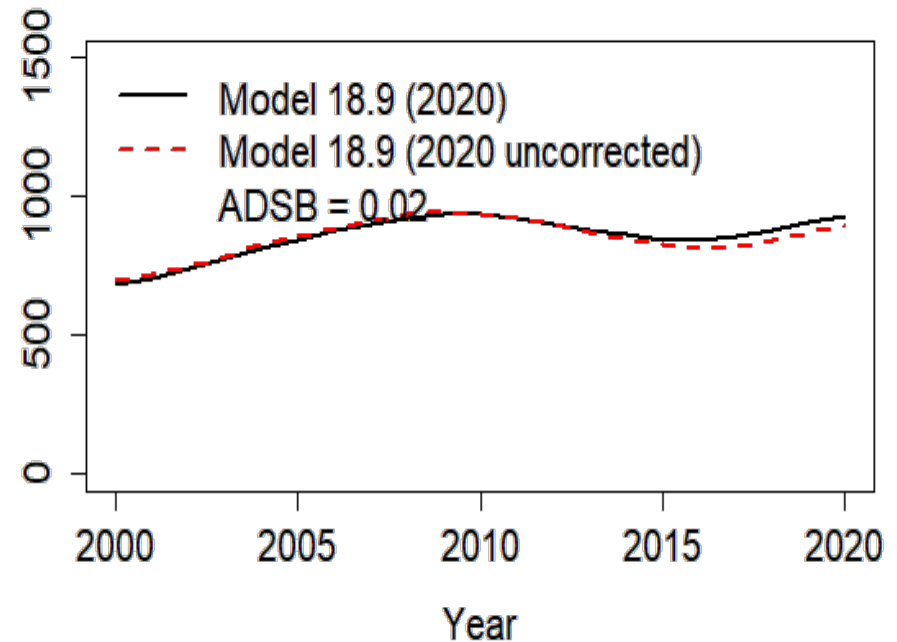
# Arrowtooth flounder, continued

- Biomass time series estimated by M18.9, showing effects of corrections

## Female spawning biomass



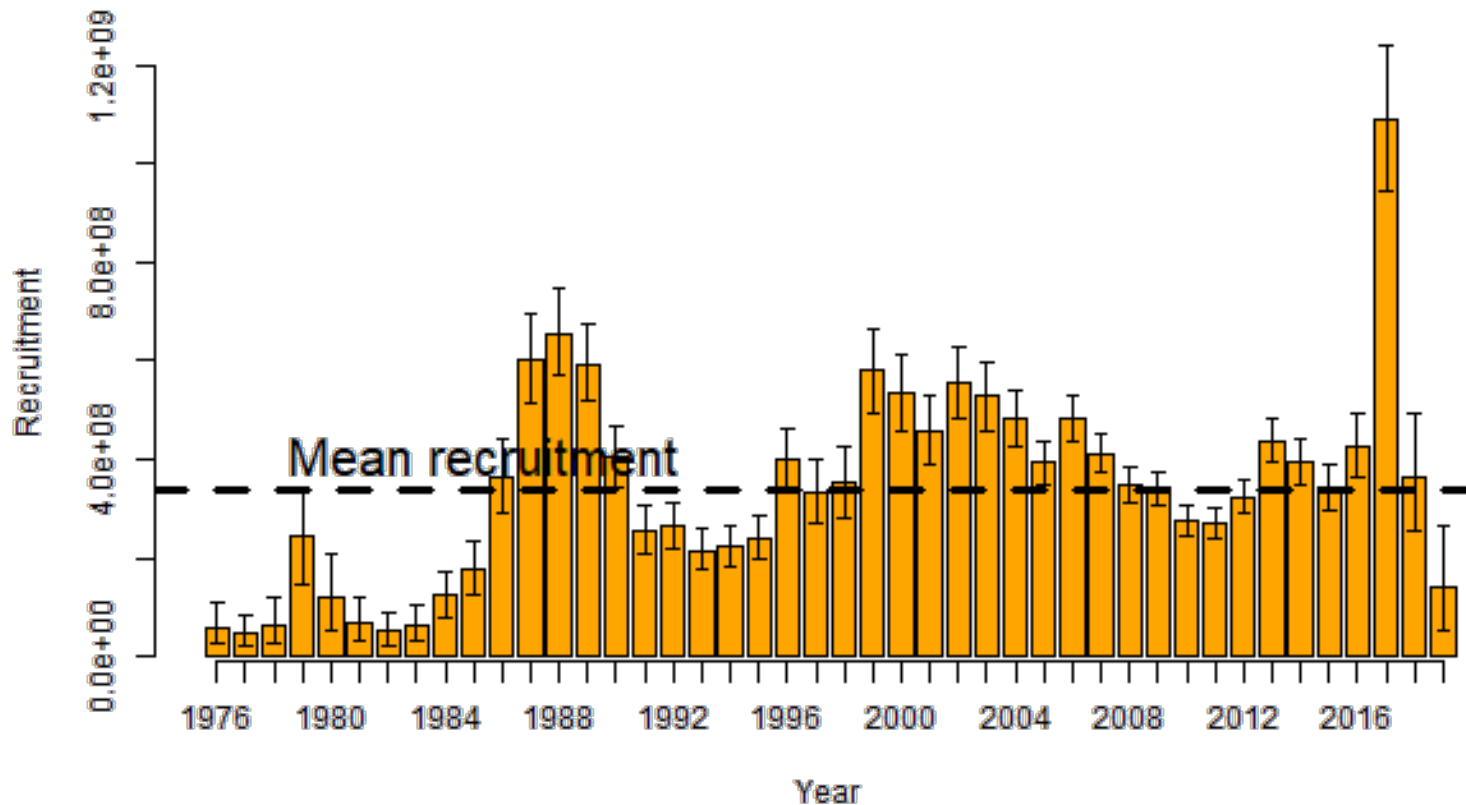
## Total biomass





# Arrowtooth flounder, continued

- Age 1 recruitment time series



# Arrowtooth flounder, continued

Quantity	Last asmt.	This asmt.	Change
M (female/male)	0.20/0.35	0.20/0.35	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	891,959	n/a	0.04
2021 age+ biomass	934,008	923,646	-0.01
2020 spawning biomass	481,845	n/a	0.03
2021 spawning biomass	478,260	497,556	0.04
B100%	606,237	558,826	-0.08
B40%	242,495	223,530	-0.08
B35%	212,183	195,589	-0.08
2021 FOFL	0.161	0.160	-0.01
2021 FABC	0.136	0.135	-0.01
2020 OFL	82,860	n/a	0.10
2021 OFL	84,057	90,873	0.08
2020 ABC	70,606	n/a	0.10
2021 ABC	71,618	77,349	0.08



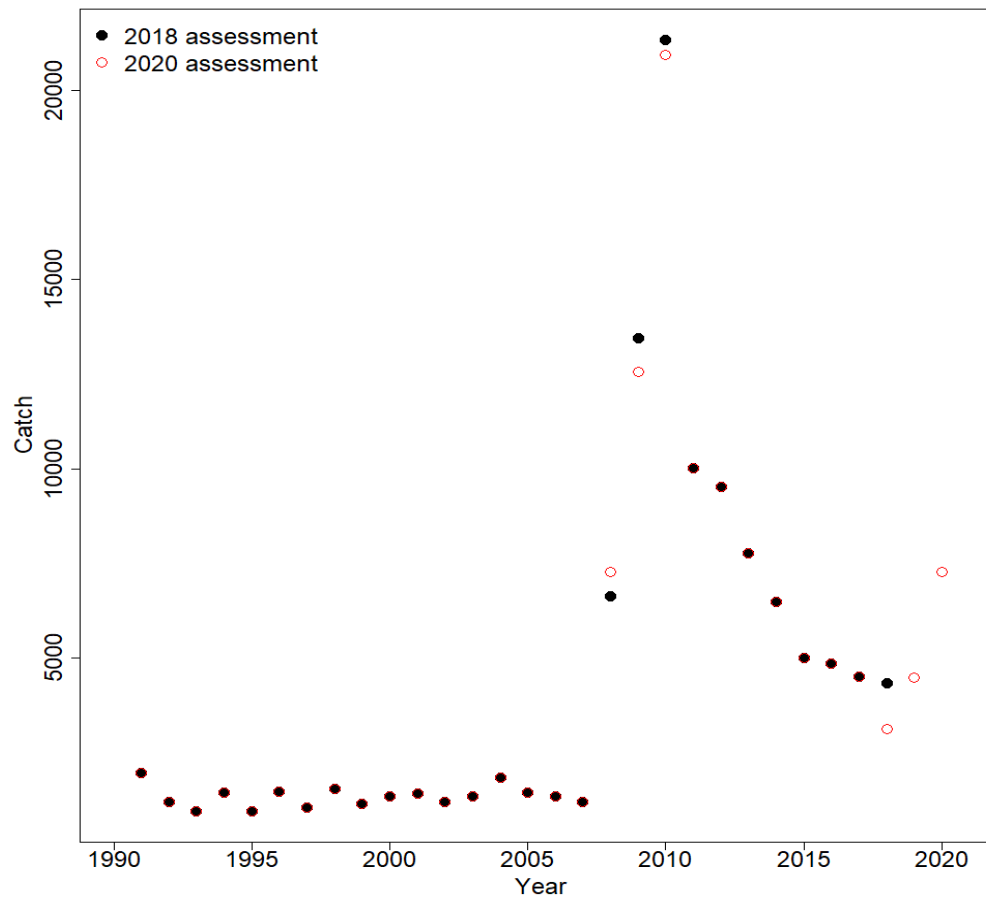
# Chapter 7: Kamchatka flounder

- New author: no; >1 model: yes\*; change from base: yes\*; risk>1: no
- New data:
  - 2019 and 2020 fishery size composition
  - 2019 EBS shelf survey biomass
  - 2016 EBS slope survey age composition
  - 2016 and 2018 AI survey age composition
  - Minor corrections based on species ID (complementing arrowtooth)
- Model changes/alternatives:
  - Model 16.0a, the current base model
  - Model 16.0b (recommended), the same as 16.0a, but with updated externally estimated parameters (growth, age-length conversion)
- Stock status: projected 2021 spawning biomass is 54% of  $B_{100\%}$
- Mohn's  $\rho = 0.02$



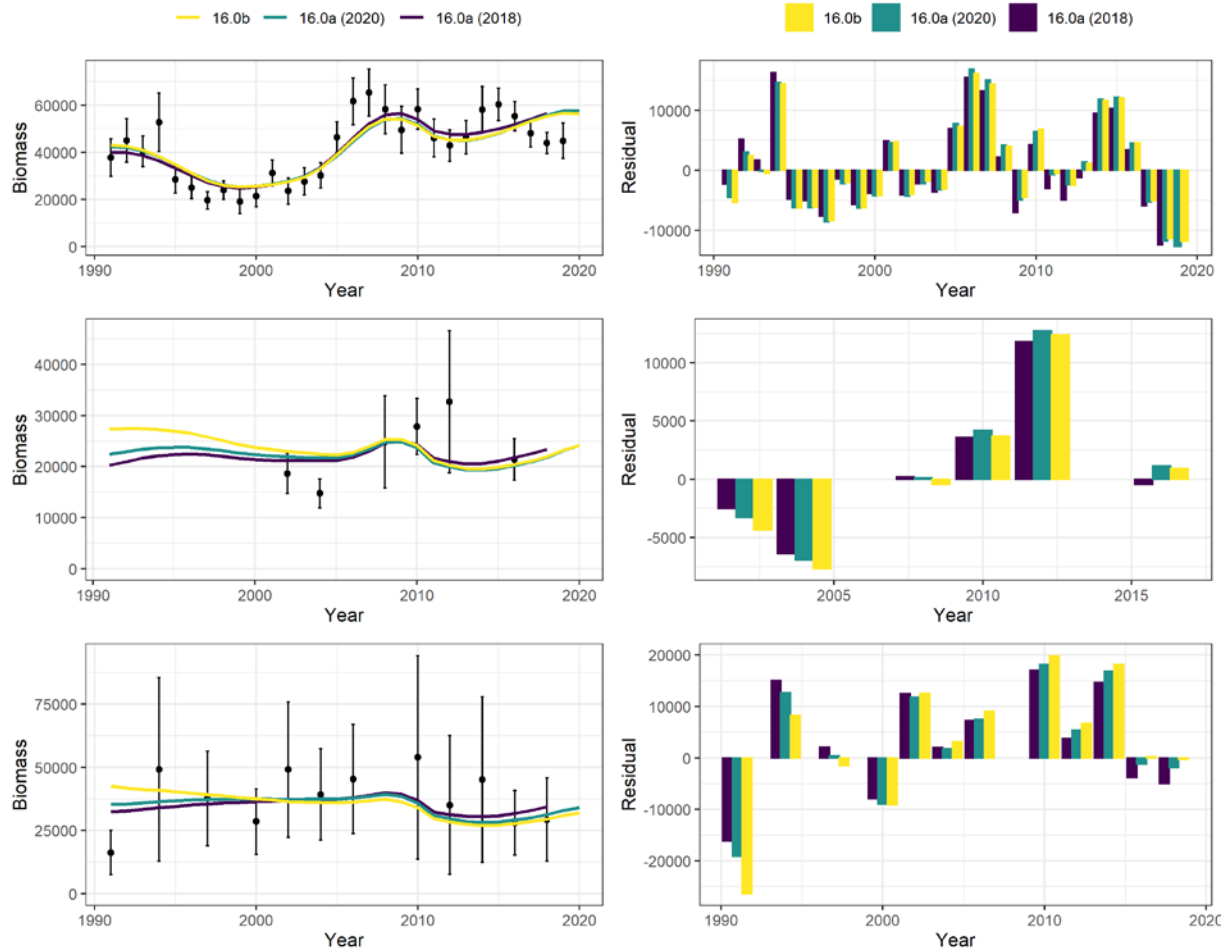
# Kamchatka flounder, continued

- Catch time series (showing effects of minor corrections)



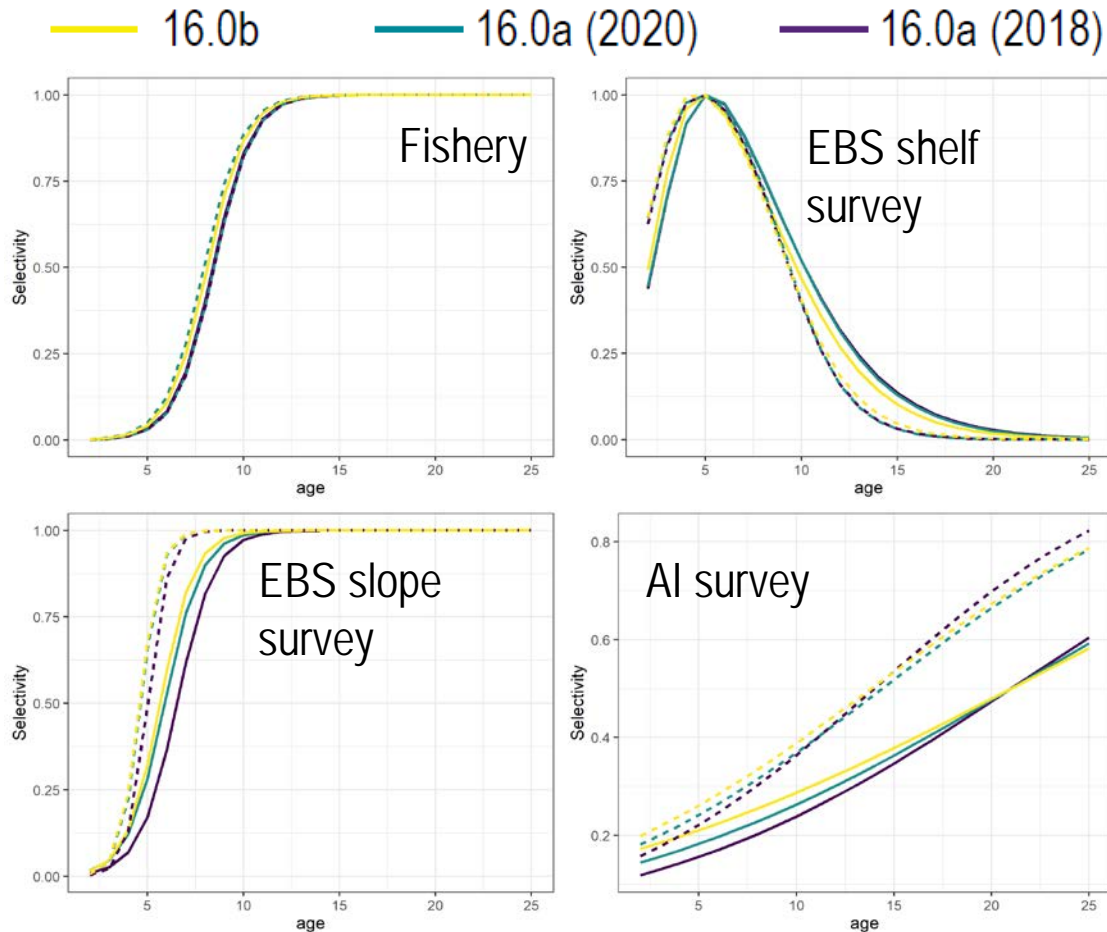
# Kamchatka flounder, continued

- Fits to survey biomass indices; residuals



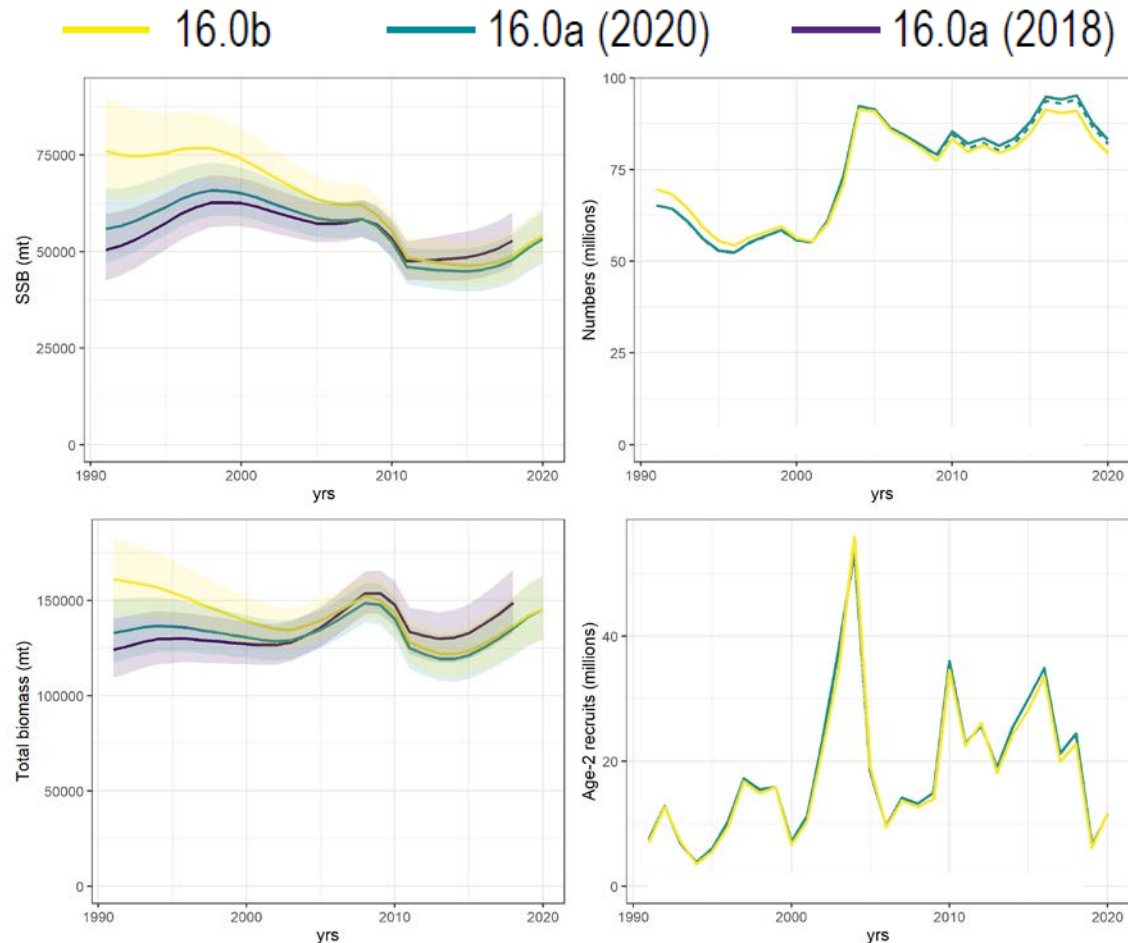
# Kamchatka flounder, continued

- Selectivity (female = solid, male = dashed)



# Kamchatka flounder, continued

- Time series estimated by models



# Kamchatka flounder, continued

Quantity	Last asmt.	This asmt.	Change
M	0.11	0.11	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	162,709	n/a	-0.11
2021 age+ biomass	163,158	144,671	-0.11
2020 spawning biomass	57,948	n/a	-0.06
2021 spawning biomass	57,892	54,341	-0.06
B100%	107,673	101,376	-0.06
B40%	43,069	40,550	-0.06
B35%	37,685	35,482	-0.06
2021 FOFL	0.108	0.108	0.00
2021 FABC	0.090	0.090	0.00
2020 OFL	11,495	n/a	-0.08
2021 OFL	11,472	10,630	-0.07
2020 ABC	9,708	n/a	-0.07
2021 ABC	9,688	8,982	-0.07





# Chapter 8: northern rock sole

- New author: **yes**; >1 model: **yes**; change from base: **yes**; risk>1: **yes**
- New data:
  - 2018-2019 fishery age composition
  - 2018-2019 survey age composition
  - 2019 EBS survey biomass
- Model changes/alternatives:
  - Model 15.1, the current base model
  - Model 18.3 (recommended), the same as 15.1, but with estimated male  $M$ , survey  $Q$ , and male selectivity offset
  - Model 18.3 (exploratory), the same as 18.3, but with 75% reduction in age composition sample sizes
- Stock status: projected 2021 spawning biomass is 62% of  $B_{100\%}$
- Mohn's  $\rho = 0.12$



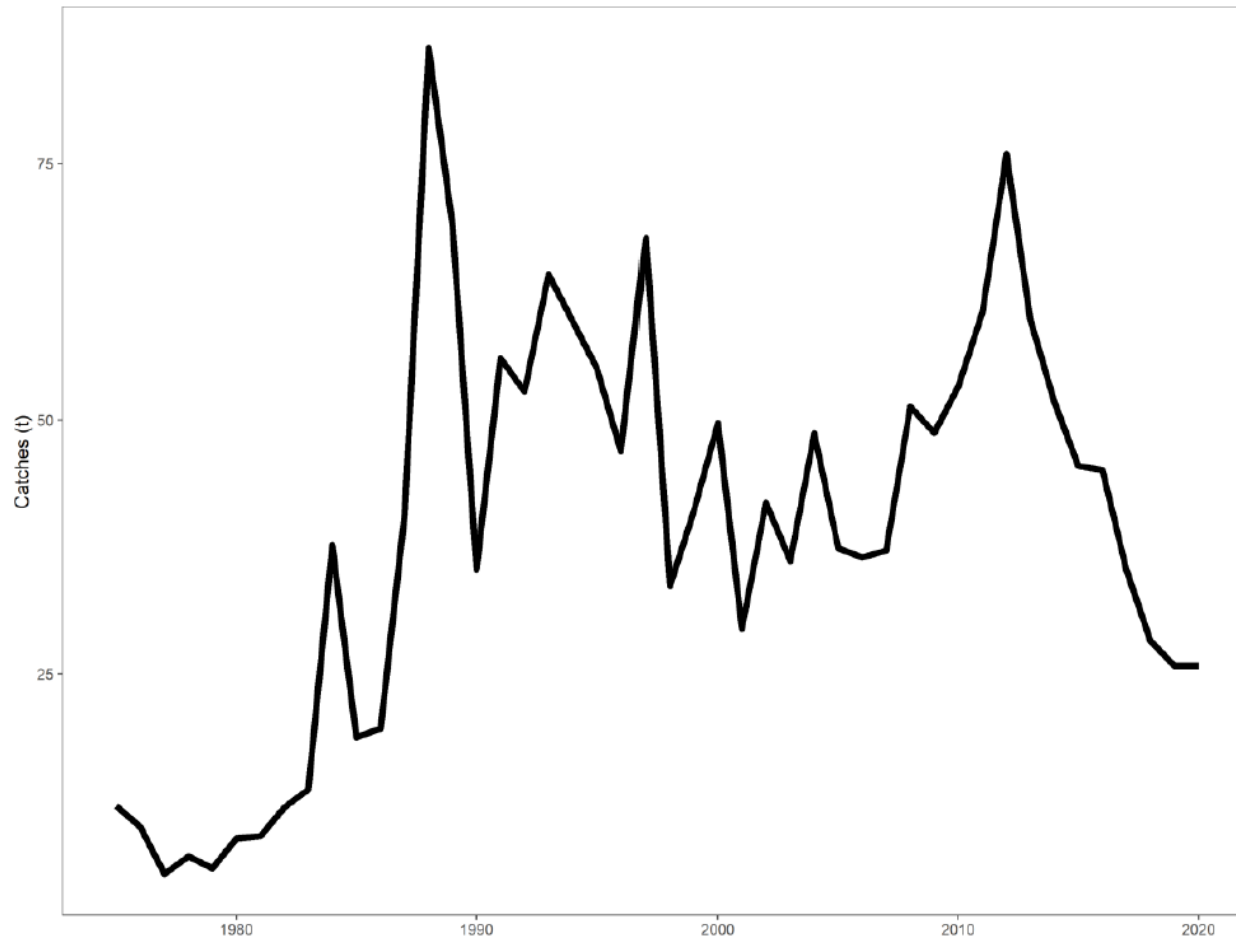
# Northern rock sole, continued

- Risk levels: **assess.** = 2, pop. dy. = 1, env./eco. = 1, fishery = 1
  - Data inputs are generally adequate
  - In the 2018 and 2019 data there appears to be a conflict between the fit to survey biomass and fits to survey and fishery agecomps
    - In particular, the agecomp data showed large recruitments of age 1 fish in 2017 and 2018; this led to an increase in model predicted survey biomass but the observed values declined
    - It is possible that availability of young fish has shifted, perhaps due to changes in habitat conditions for young fish
  - Lack of a 2020 EBS bottom trawl survey meant no confirmation of either the positive recruitment pattern or the biomass decline
  - The retrospective pattern is modest



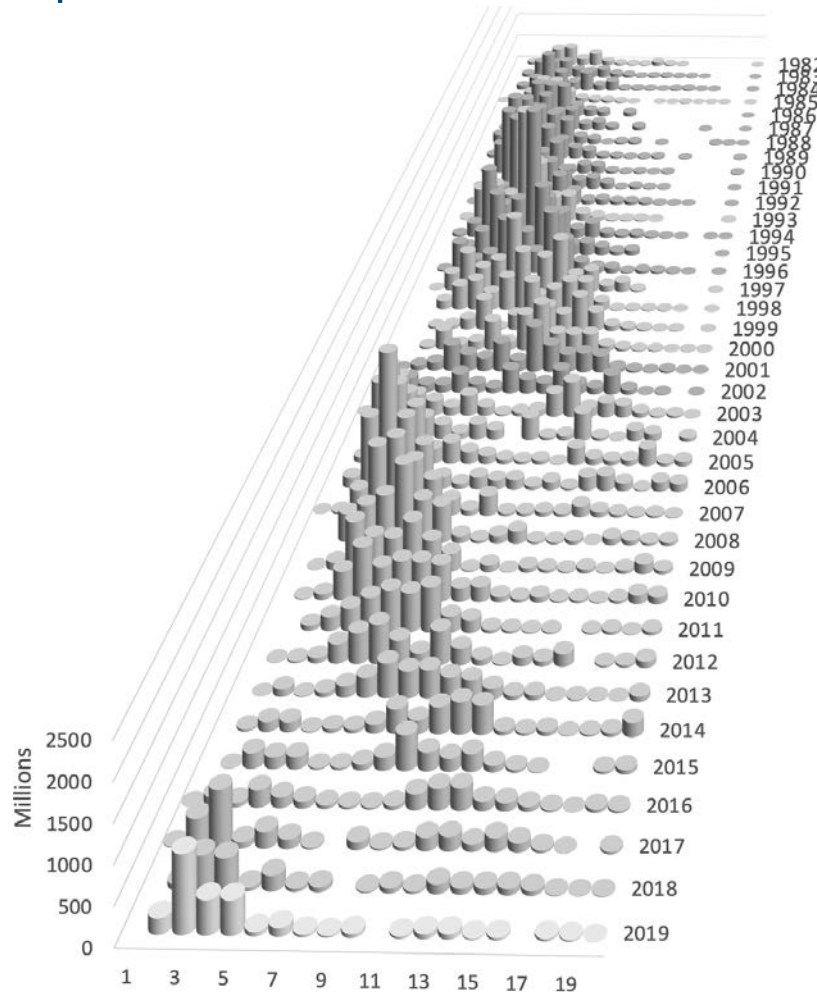
# Northern rock sole, continued

- Catch time series



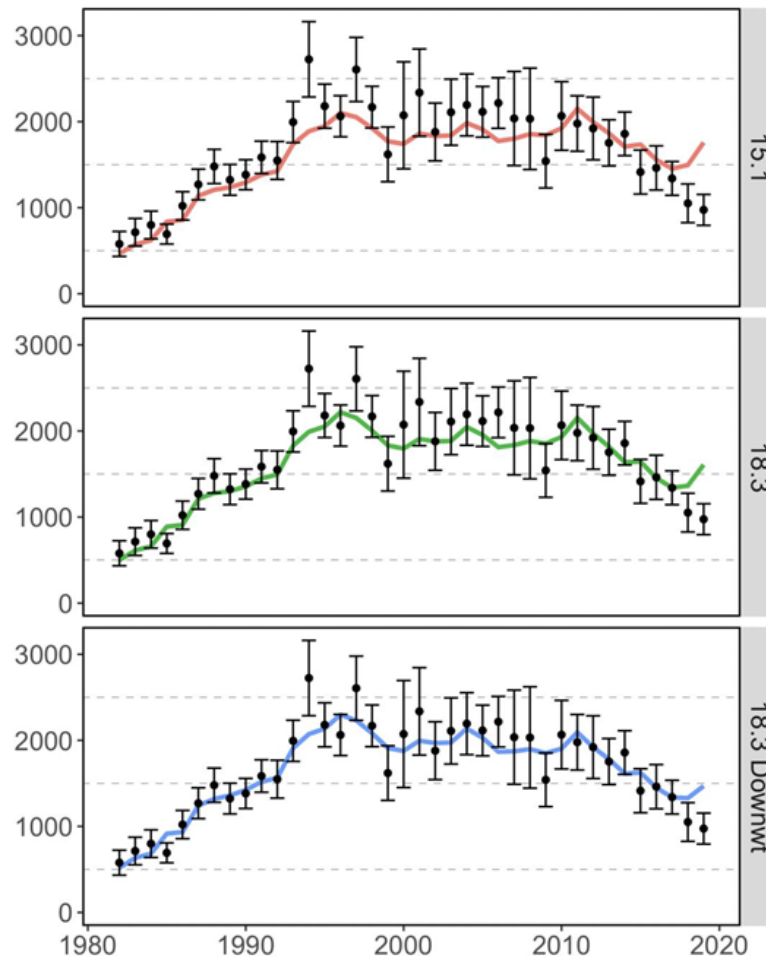
# Northern rock sole, continued

- Survey age composition



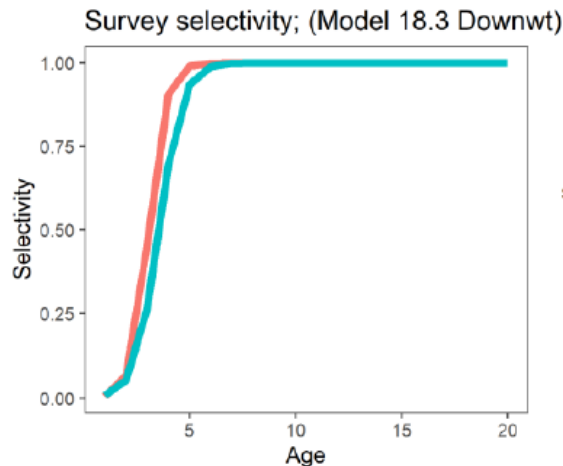
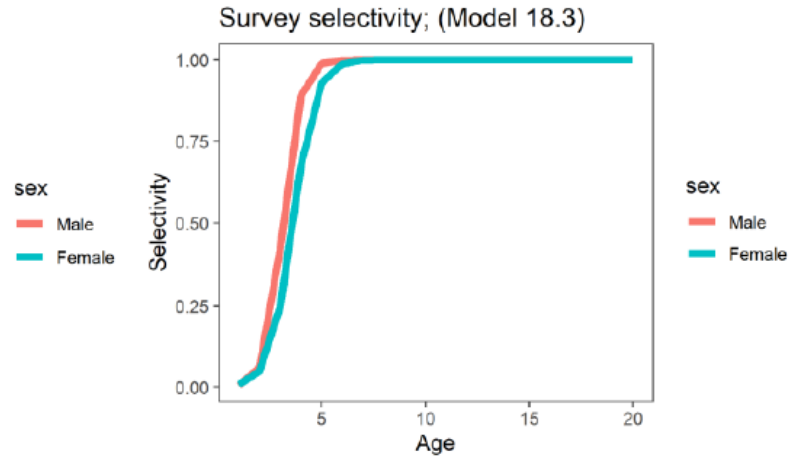
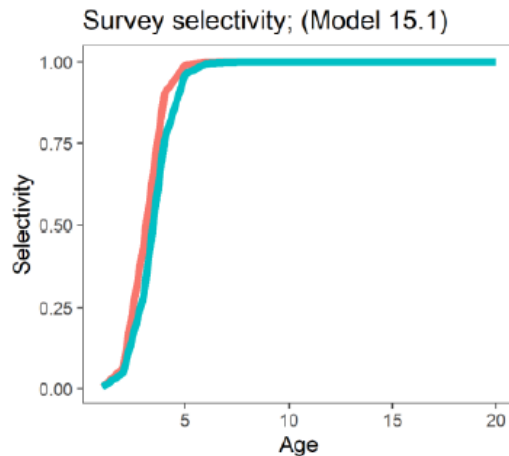
# Northern rock sole, continued

- Fits to survey biomass (1000s of t)



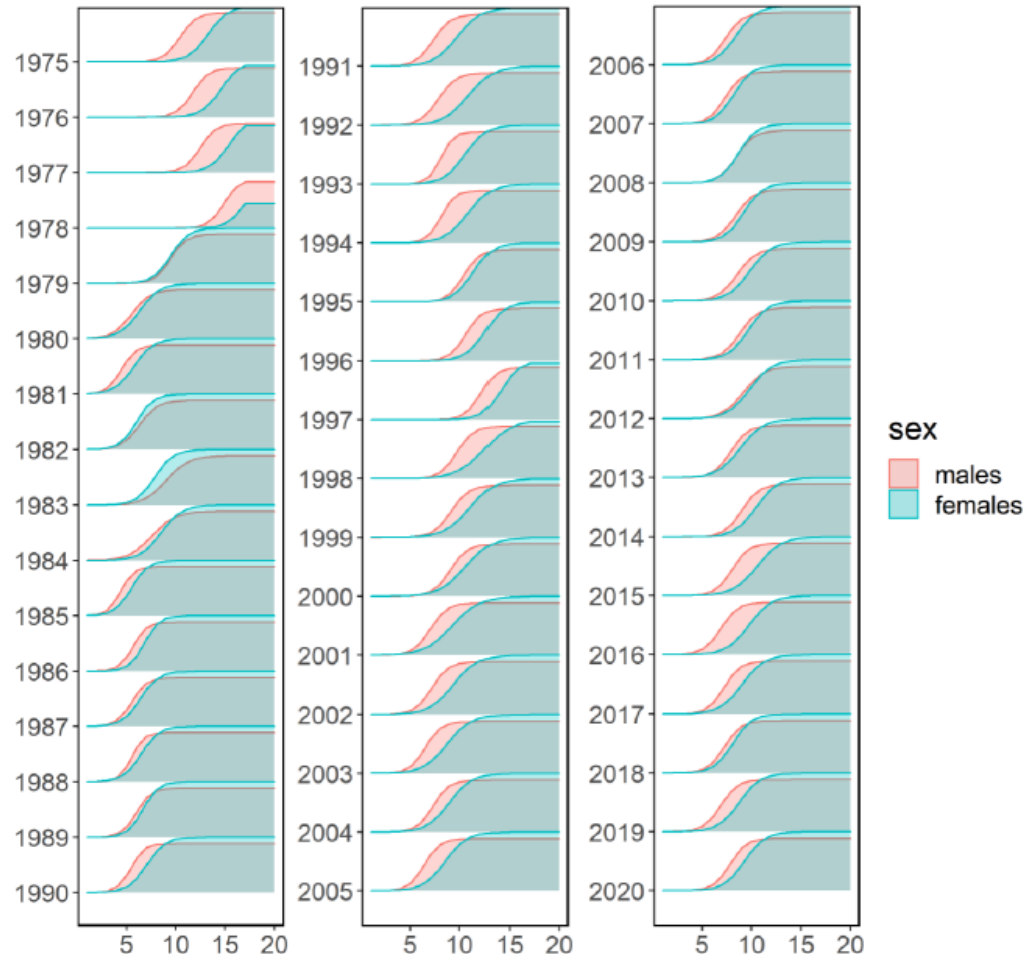
# Northern rock sole, continued

- Survey selectivity



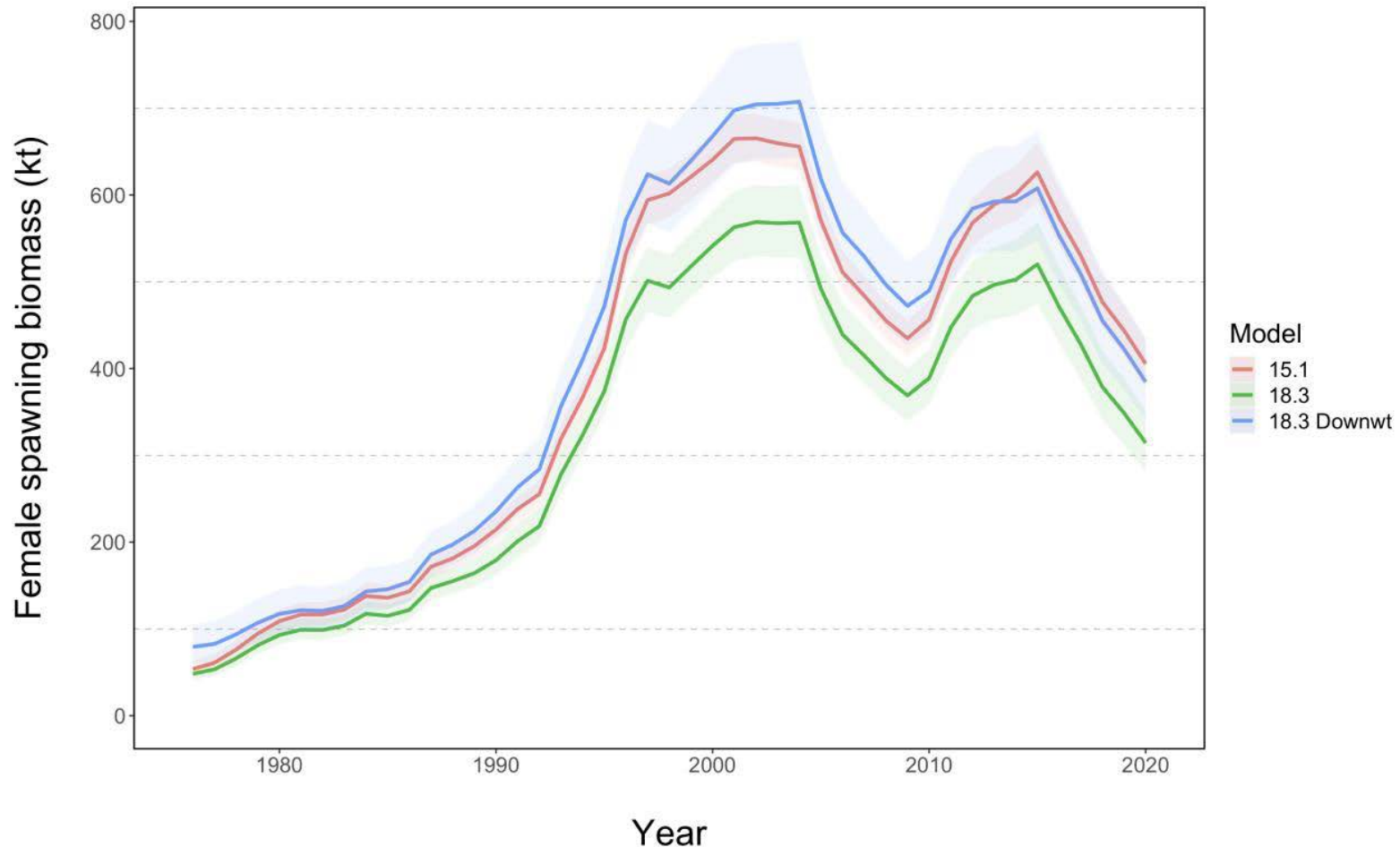
# Northern rock sole, continued

- Fishery selectivity (Model 18.3 only)



# Northern rock sole, continued

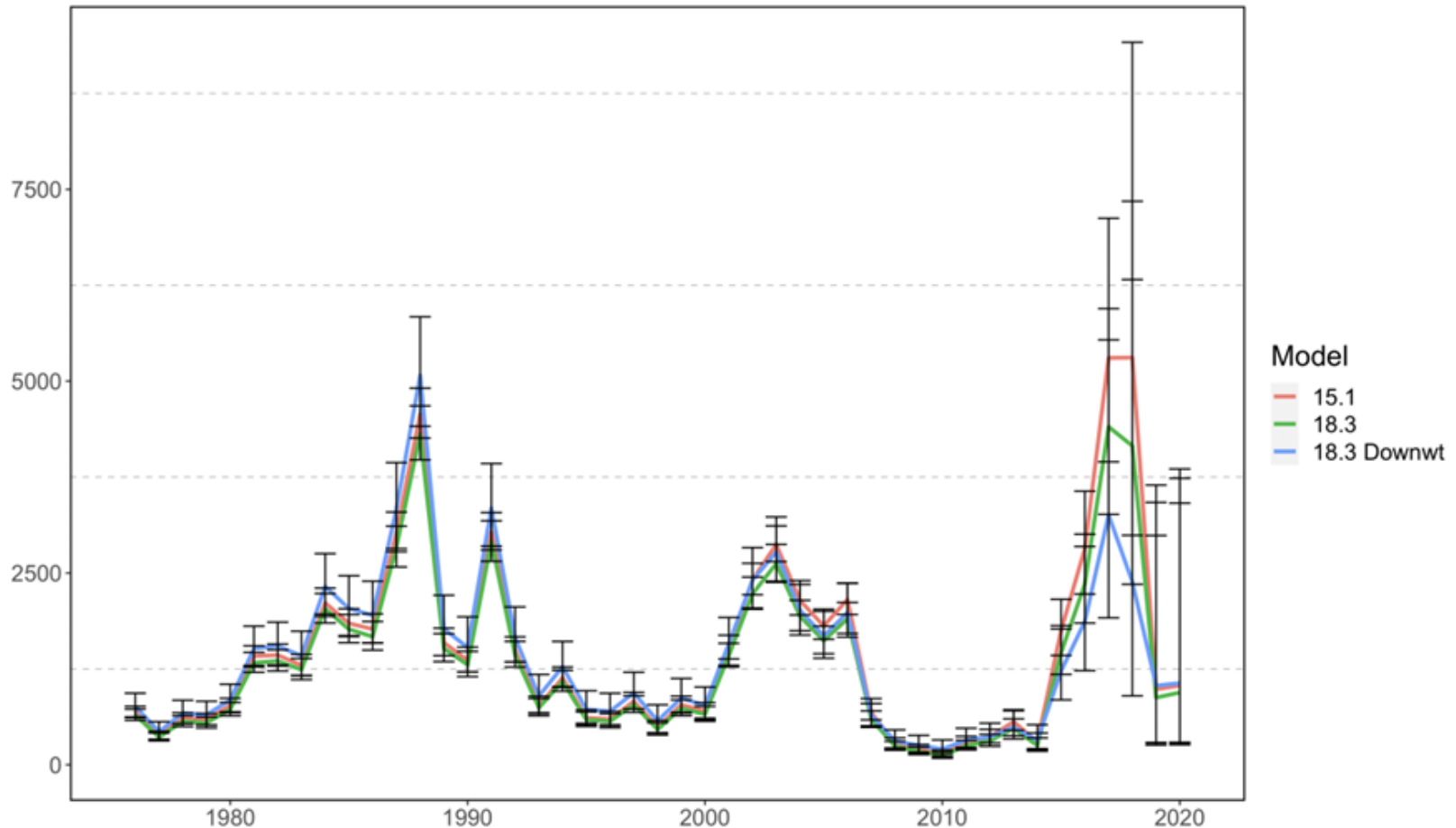
- Spawning biomass time series estimated by the models





# Northern rock sole, continued

- Age 1 recruitment time series estimated by models



# Northern rock sole, continued

- Negative log likelihoods (Model 18.3 “exploratory” is not comparable)

<b>Likelihood Component</b>	<b>15.1</b>	<b>18.3</b>
<b>Total</b>	1599	1476
<b>Survey Biomass</b>	87	59
<b>Survey Age</b>	680	673
<b>Fishery Age</b>	646	541



# Northern rock sole, continued

Quantity	Last asmt.*	This asmt.	Change
M (female/male)	0.15	0.15/0.17	0/0.13
2020 tier	1a	n/a	none
2021 tier	1a	1a	none
2020 age+ biomass	1,068,000	n/a	-0.14
2021 age+ biomass	1,608,000	923,197	-0.43
2020 spawning biomass	380,600	n/a	-0.23
2021 spawning biomass	356,000	294,627	-0.17
B0	515,680	476,820	-0.08
Bmsy	186,000	158,972	-0.15
2021 FOFL	0.147	0.157	0.07
2021 FABC	0.144	0.152	0.06
2020 OFL	157,300	n/a	-0.08
2021 OFL	236,800	145,180	-0.39
2020 ABC	153,300	n/a	-0.08
2021 ABC	230,700	140,306	-0.39

\*"Last asmt." column as shown *last* year



# Northern rock sole, continued

Quantity	Last asmt.*	This asmt.	Change
M	0.15	0.15/0.17	0/0.13
2020 tier	1a	n/a	none
2021 tier	1a	1a	none
2020 age+ biomass	1,154,000	n/a	-0.20
2021 age+ biomass	1,729,000	923,197	-0.47
2020 spawning biomass	415,000	n/a	-0.29
2021 spawning biomass	389,000	294,627	-0.24
B0	546,800	476,820	-0.13
Bmsy	197,400	158,972	-0.19
2021 FOFL	0.147	0.157	0.07
2021 FABC	0.142	0.152	0.07
2020 OFL	168,000	n/a	-0.14
2021 OFL	251,800	145,180	-0.42
2020 ABC	163,700	n/a	-0.14
2021 ABC	245,400	140,306	-0.43

\*"Last asmt." column as shown **this** year



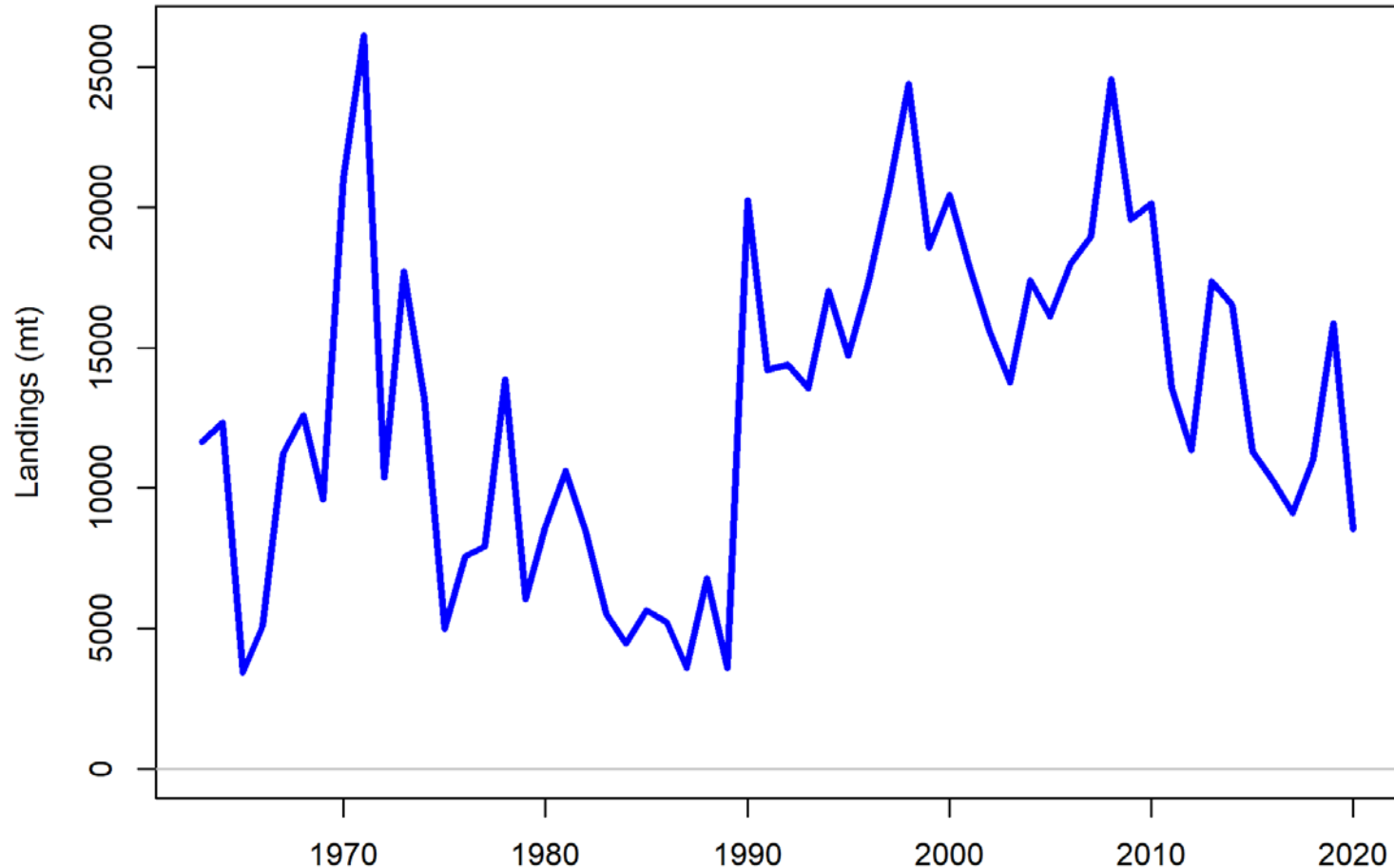
# Chapter 9: flathead sole

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **no**
- New data:
  - 2018-2019 fishery age composition
  - 2020 fishery size composition
  - 2019 EBS survey biomass (also used to estimate AI biomass)
  - 1999 and 2018-2019 survey age composition (conditional A at L)
  - 2019 EBS survey size composition
  - Survey ages 1-2 added to model; Bering flounder age data removed
- Model changes/alternative: none (Model 18.2c)
- Stock status: projected 2021 spawning biomass is 74% of  $B_{100\%}$
- Mohn's  $\rho = -0.05$



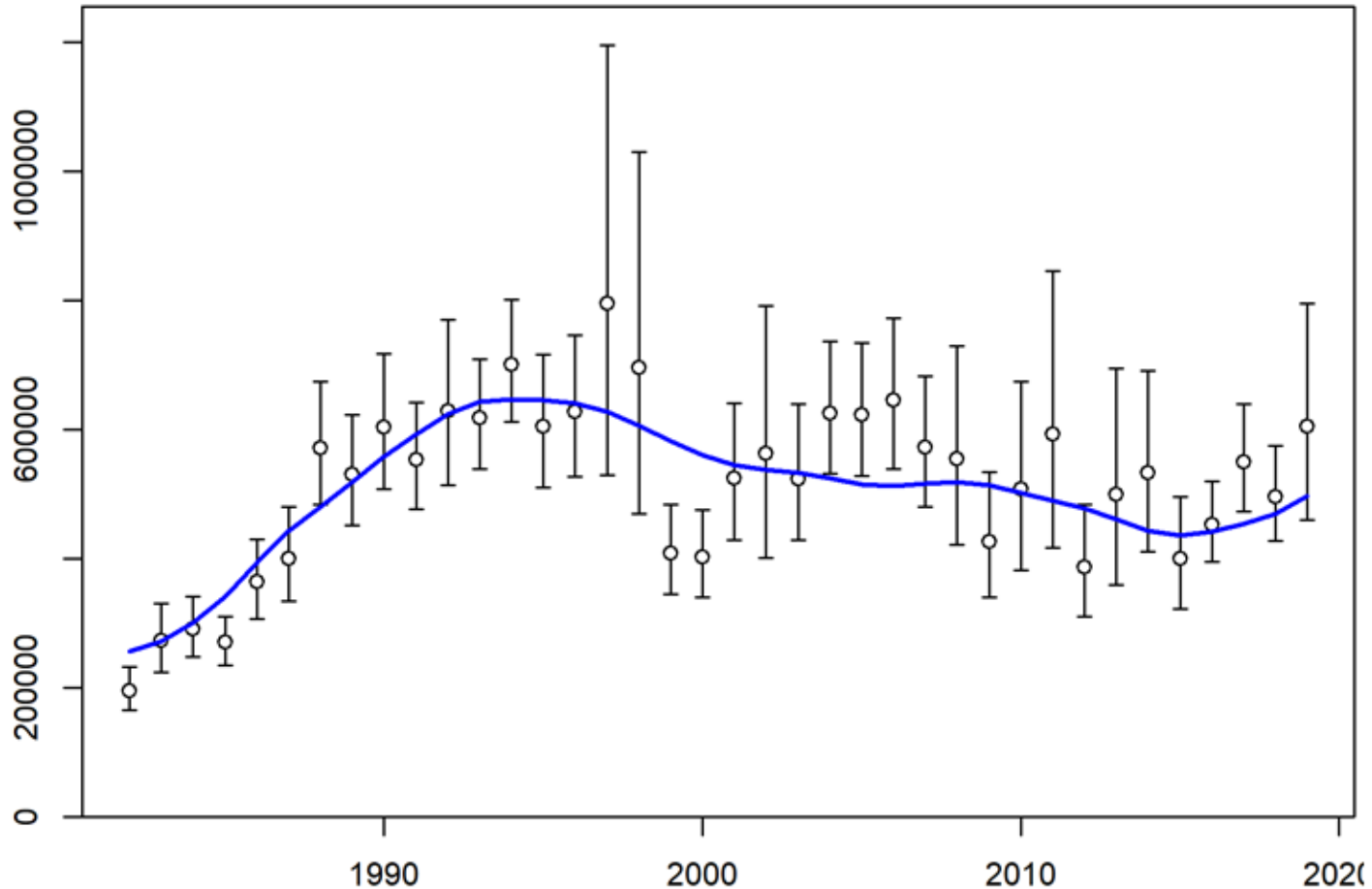
# Flathead sole, continued

- Catch time series



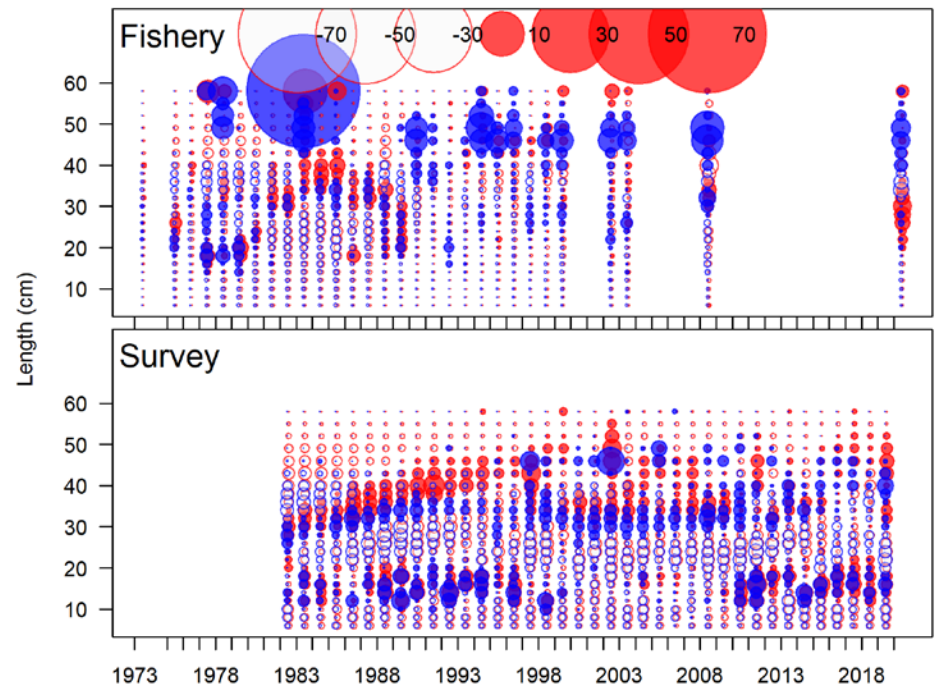
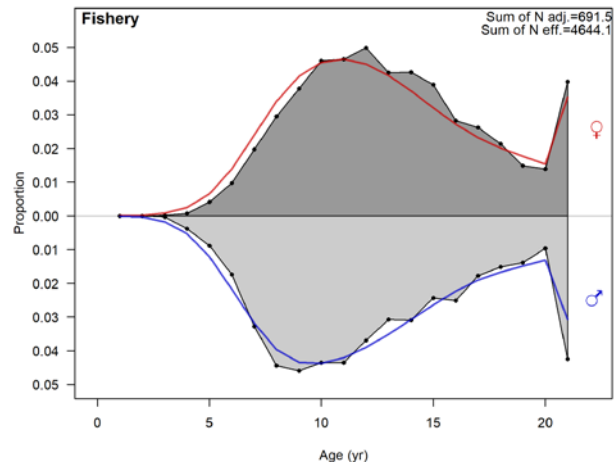
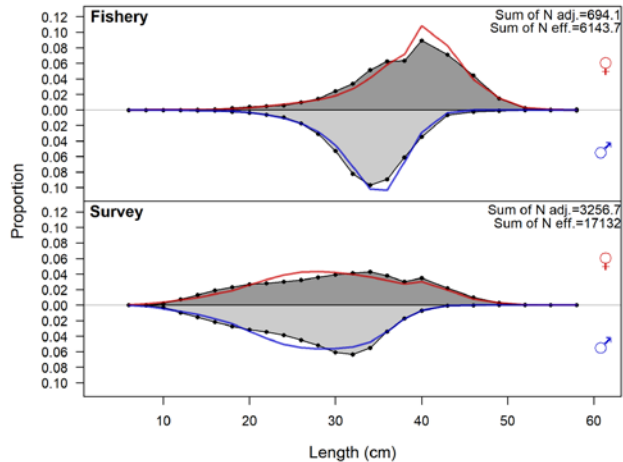
# Flathead sole, continued

- Fit to survey biomass



# Flathead sole, continued

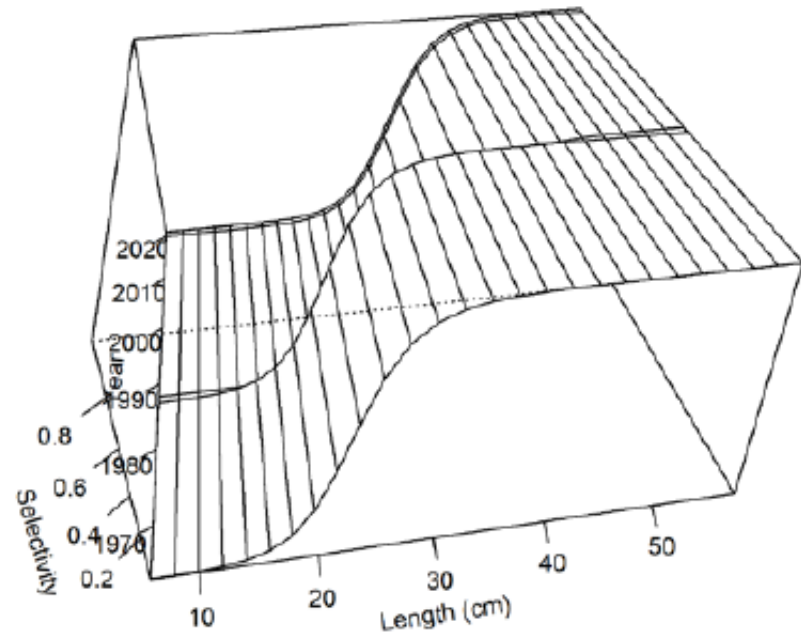
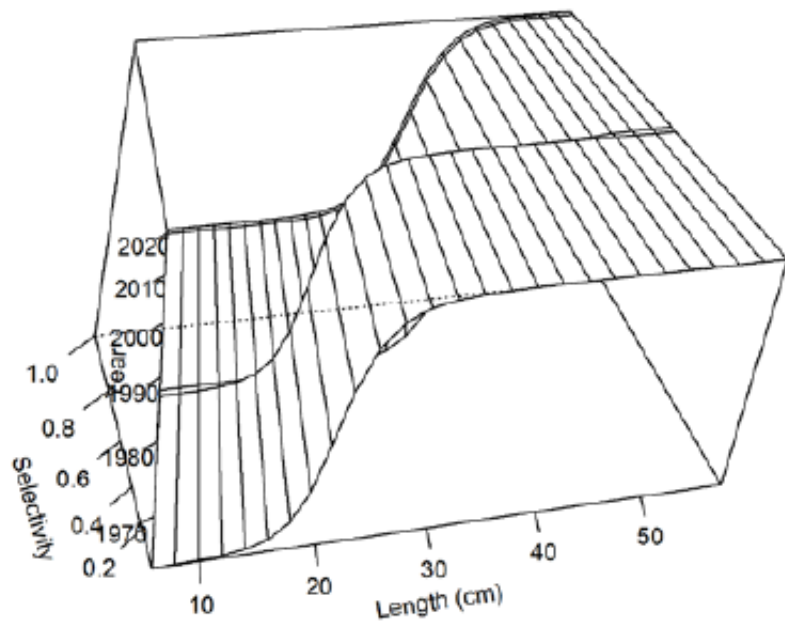
- Fits to composition data





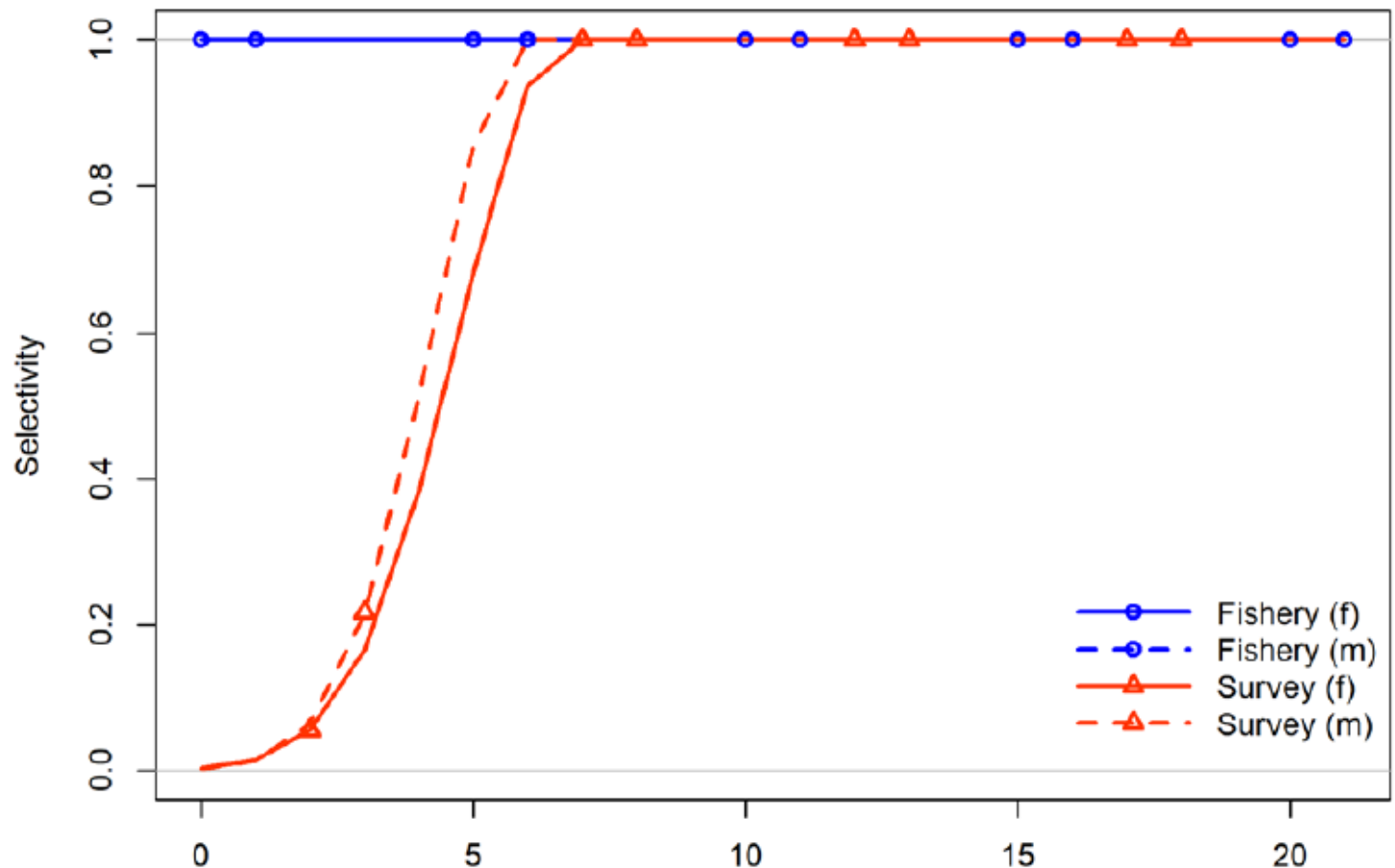
# Flathead sole, continued

- Fishery selectivity (female on left, male on right)



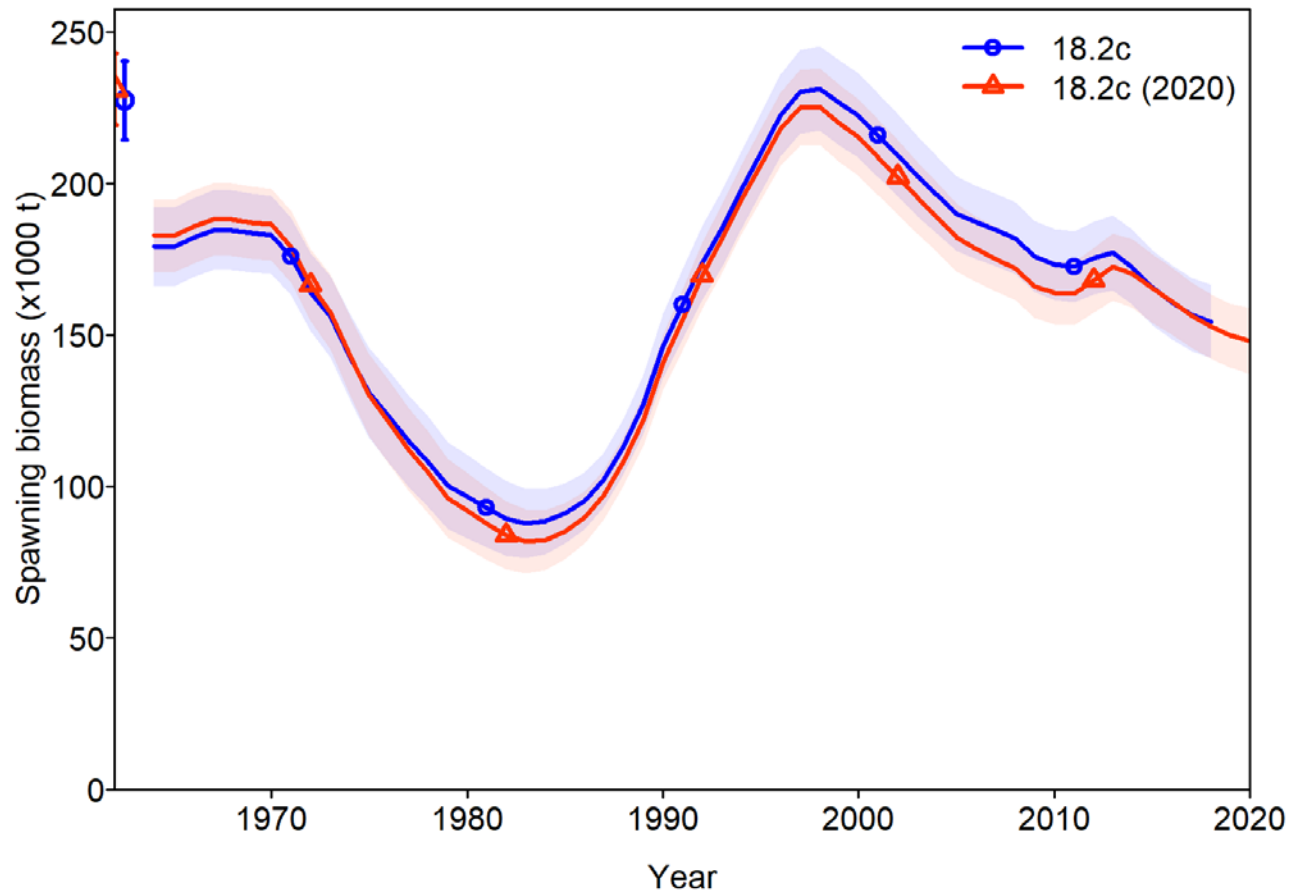
# Flathead sole, continued

- Survey selectivity



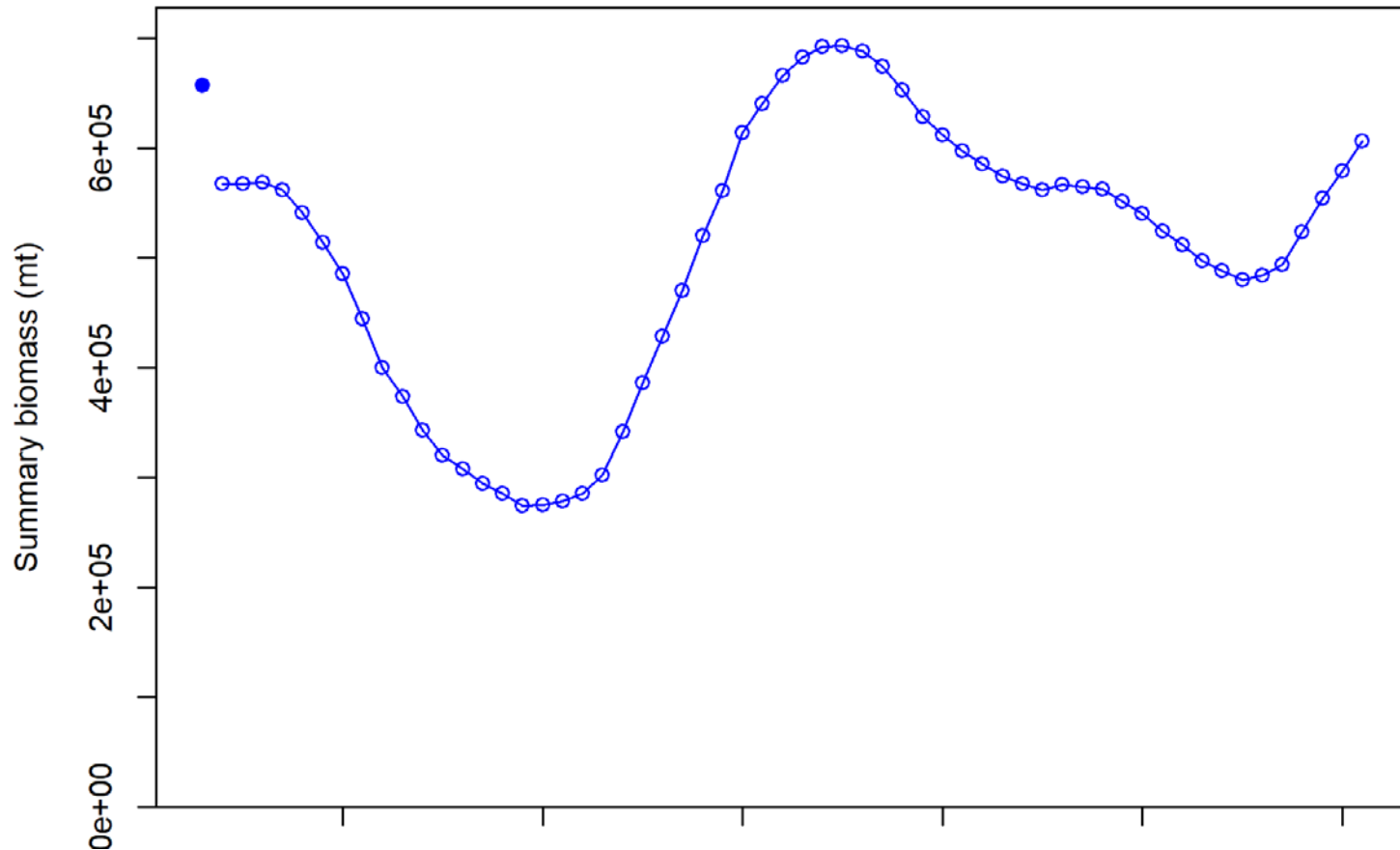
# Flathead sole, continued

- Spawning biomass time series as estimated by the model



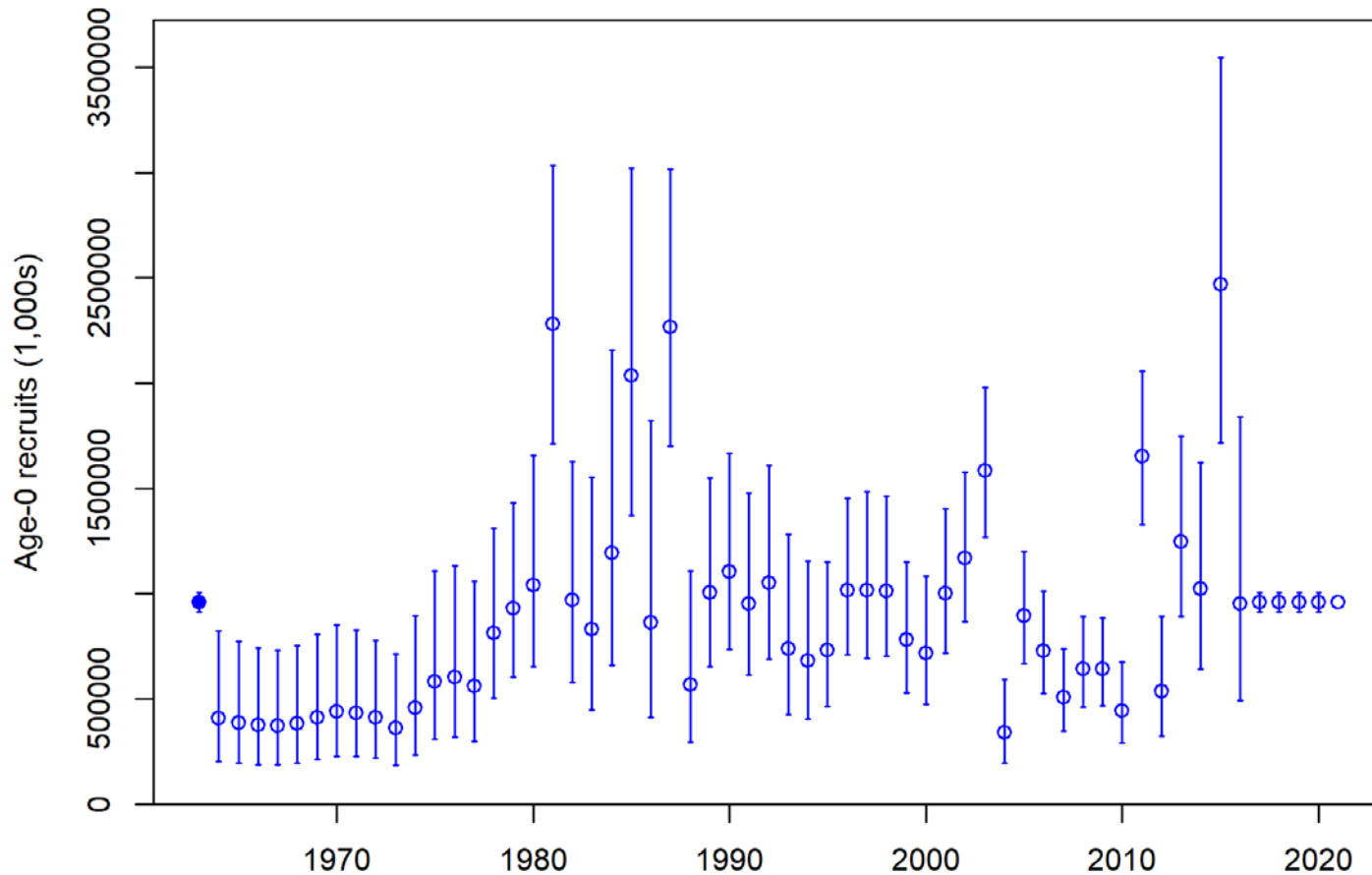
# Flathead sole, continued

- Total biomass time series as estimated by the model



# Flathead sole, continued

- Age 0 recruitment time series as estimated by the model



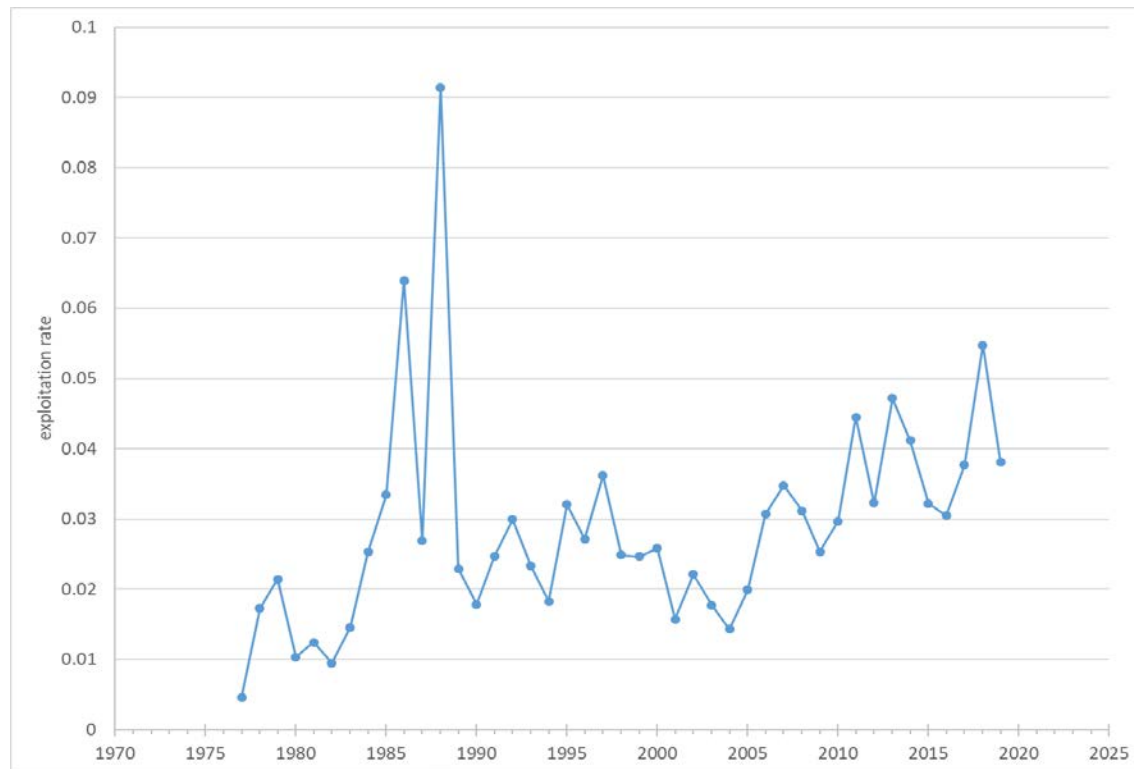
# Flathead sole, continued

Quantity	Last asmt.	This asmt.	Change
M	0.20	0.20	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	684,768	n/a	-0.12
2021 age+ biomass	692,915	602,497	-0.13
2020 spawning biomass	154,195	n/a	-0.02
2021 spawning biomass	160,864	150,433	-0.06
B100%	212,060	203,658	-0.04
B40%	84,824	81,463	-0.04
B35%	74,221	71,280	-0.04
2021 FOFL	0.47	0.46	-0.02
2021 FABC	0.38	0.37	-0.03
2020 OFL	82,810	n/a	-0.08
2021 OFL	86,432	75,863	-0.12
2020 ABC	68,134	n/a	-0.08
2021 ABC	71,079	62,567	-0.12



# Chapter 10: Alaska plaice (partial)

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **n/a**
- Stock status: projected 2021 spawning biomass is 50% of  $B_{100\%}$
- Catch/biomass time series:



# Alaska plaice, continued

Quantity	Last asmt.	This asmt.	Change
M	0.13	0.13	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	428,800	n/a	0.00
2021 age+ biomass	435,700	427,587	-0.02
2020 spawning biomass	170,800	n/a	-0.03
2021 spawning biomass	161,000	166,528	0.03
B100%	333,300	335,172	0.01
B40%	133,300	134,069	0.01
B35%	116,600	117,310	0.01
2021 FOFL	0.150	0.160	0.07
2021 FABC	0.125	0.132	0.06
2020 OFL	37,600	n/a	0.01
2021 OFL	36,500	37,924	0.04
2020 ABC	31,600	n/a	0.00
2021 ABC	30,700	31,657	0.03





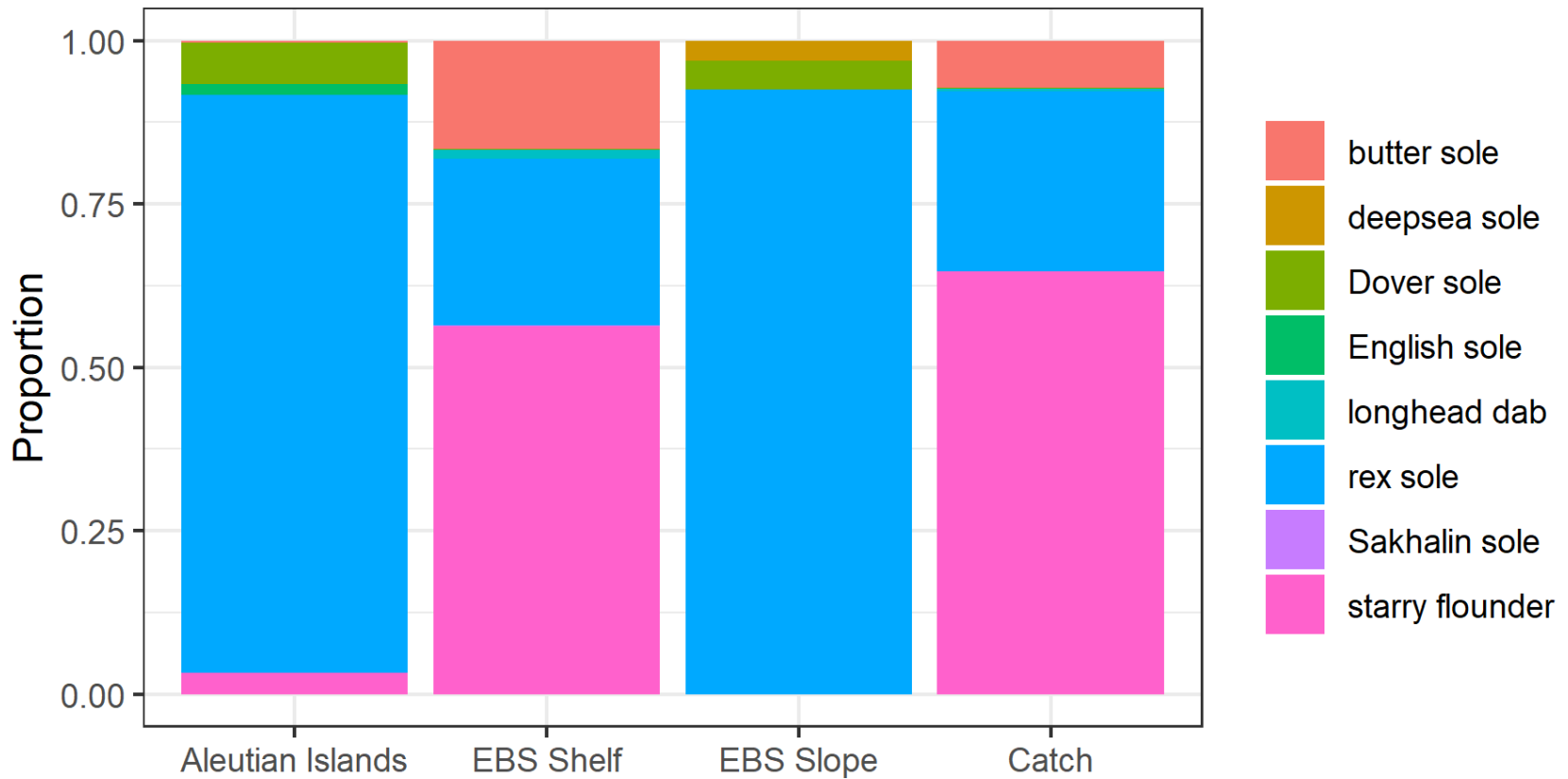
# Chapter 11: other flatfish

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **no**
- New data:
  - 2016 updated catch, 2017 through 2020 (preliminary) catch
  - 2017, 2018, 2019 EBS survey biomass
  - 2018 AI survey biomass
- Model changes/alternatives: none (Tier 5 RE model)
- Stock trends, since 2010:
  - Dover sole down by a discrete annual rate of -2.8%, to 1,790 t
  - Rex sole up by a discrete annual rate of 2.7%, to 51,660 t
  - Starry flounder up by a discrete annual rate of 0.2%, to 76,429 t



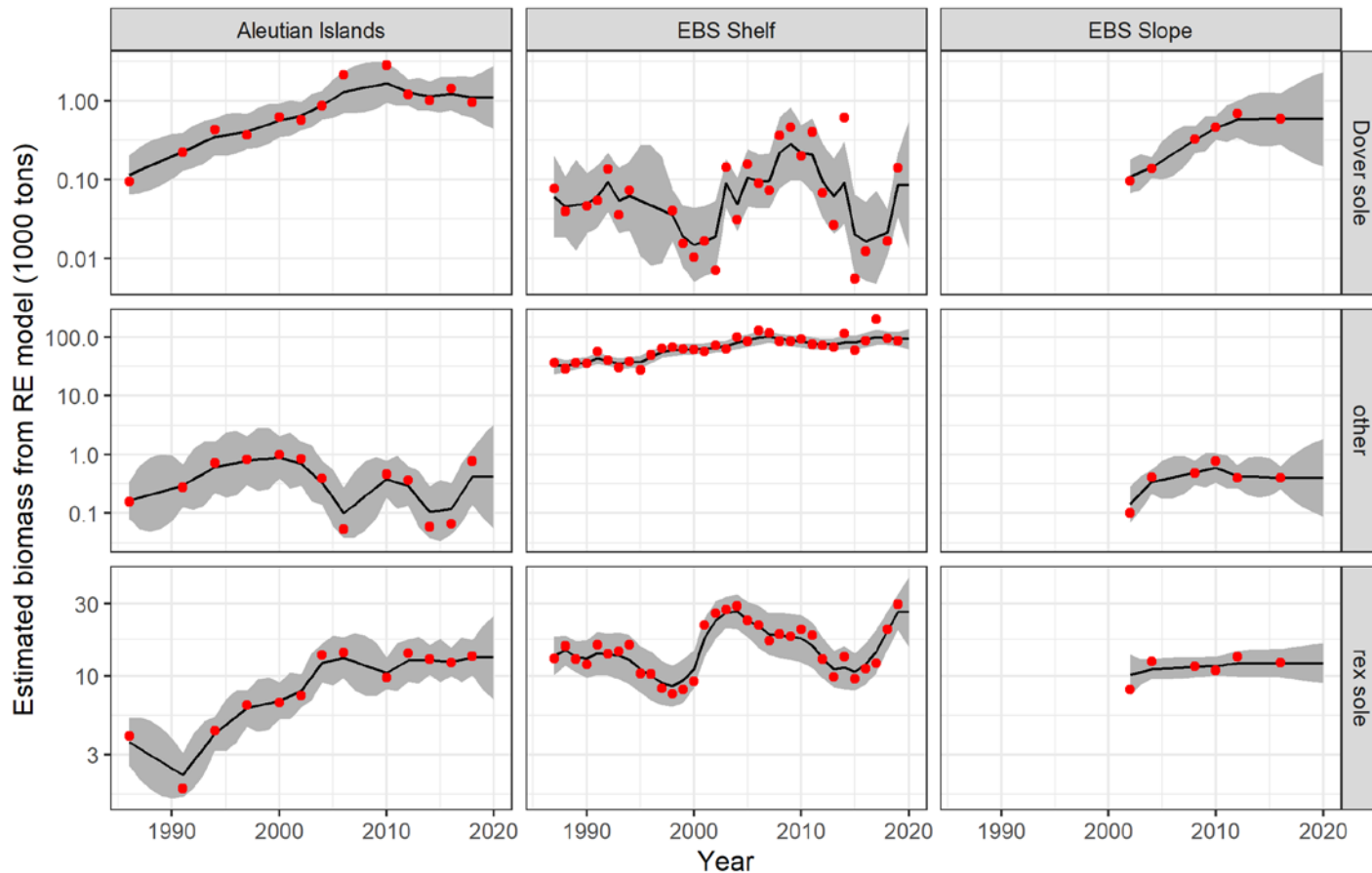
# Other flatfish, continued

- Species composition of the surveys and catch



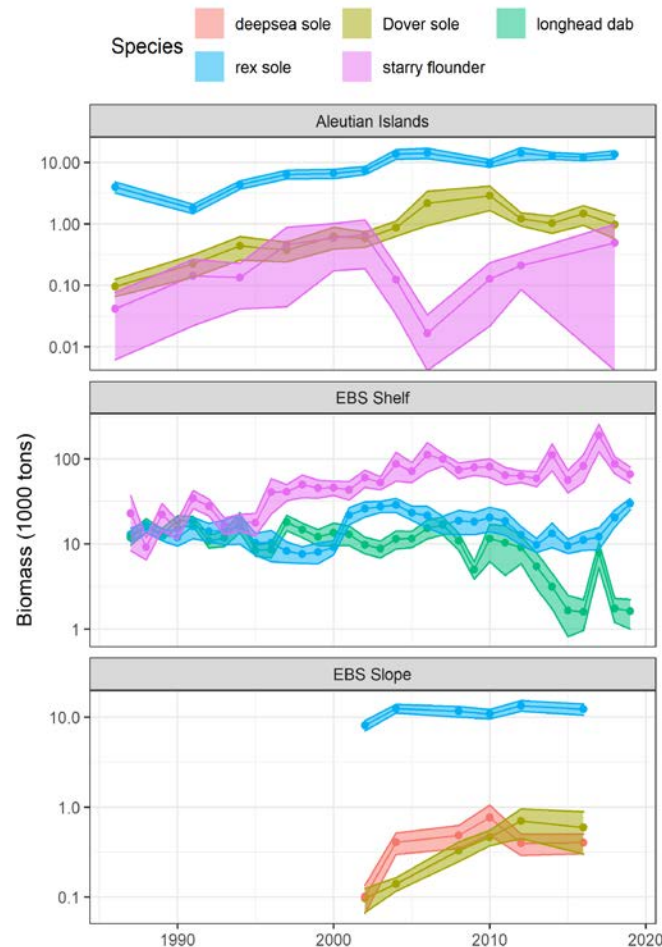
# Other flatfish, continued

- Example fits to survey biomass data (slide 1 of 2; note log scale)



# Other flatfish, continued

- Example fits to survey biomass data (slide 2 of 2; note log scale)



# Other flatfish, continued

- The author reported that longhead dab showed an extreme decrease in survey biomass on the EBS shelf, but the cause is unknown
- Team members discussed the difficulties of assessing multiple stocks and highlighting concerns, if any, for individual species in the risk table
- The Team recommended that the author consider adding a secondary table, by species, to the risk table
  - This breakdown will highlight species specific concerns that can be tracked over time



# Other flatfish, continued

Quantity*	Last asmt.	This asmt.	Change
M	0.154	0.156	0.01
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	141,325	146,679	0.04
2021 FOFL	0.154	0.156	0.01
2021 FABC	0.116	0.117	0.01
2020 OFL	21,824	n/a	0.05
2021 OFL	21,824	22,919	0.05
2020 ABC	16,368	n/a	0.05
2021 ABC	16,368	17,189	0.05

\*Instantaneous rates are biomass-weighted averages



# Chapter 12: Pacific ocean perch

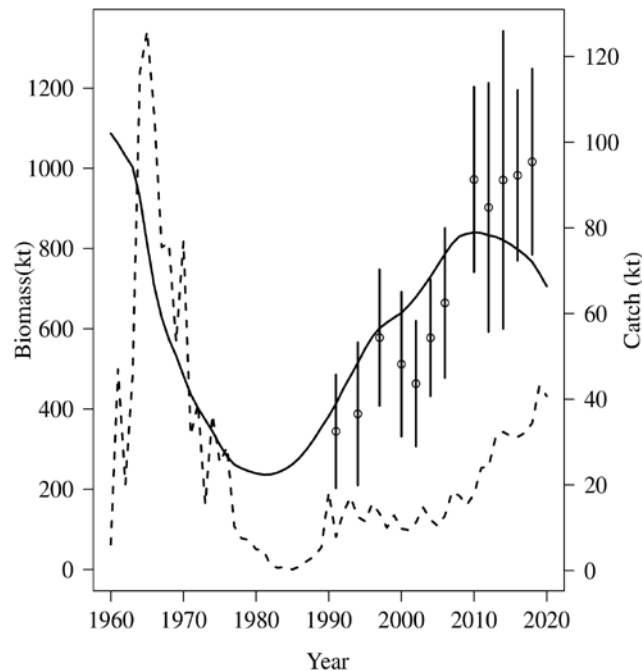
- New author: **no**; >1 model: **no**; change from base: **no**; risk>1: **yes**
- New data:
  - 2018 AI survey age composition
  - 2018 fishery size composition
  - 2019 fishery age composition
  - Length-at-age, age-at-length matrix, weight-at-age updated
- Model changes/alternatives: none (Model 16.3a)
- Stock status: projected 2021 spawning biomass is 53% of  $B_{100\%}$
- Mohn's  $\rho = -0.24$  (compare to  $-0.45$  in 2018 assessment)
- Risk levels: **assess.** = 2, pop. dy. = 1, env./eco. = 1, fishery = 1
  - Large Mohn's  $\rho$
  - Residual pattern in AI survey biomass estimates (see next slide)
  - Estimate of  $M$  is strongly constrained (see slide after next)



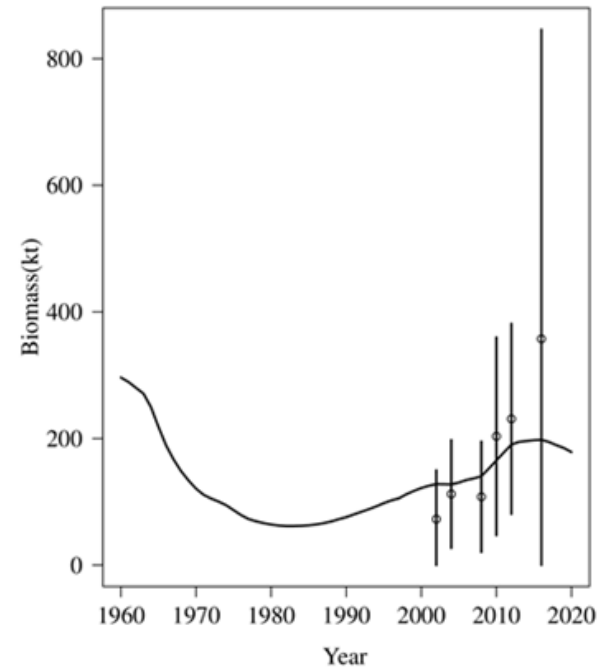
# Pacific ocean perch, continued

- Fits to survey biomass indices

## Aleutians



## EBS slope



- The Team recommended investigating Francis weighting and trying different time blocks of natural mortality to help improve the fit to the Aleutian Islands survey index





# Pacific ocean perch, continued

- The Team requested (11/18) exploration of methods for estimating  $M$
- Some methods from Then et al. (2015) give:

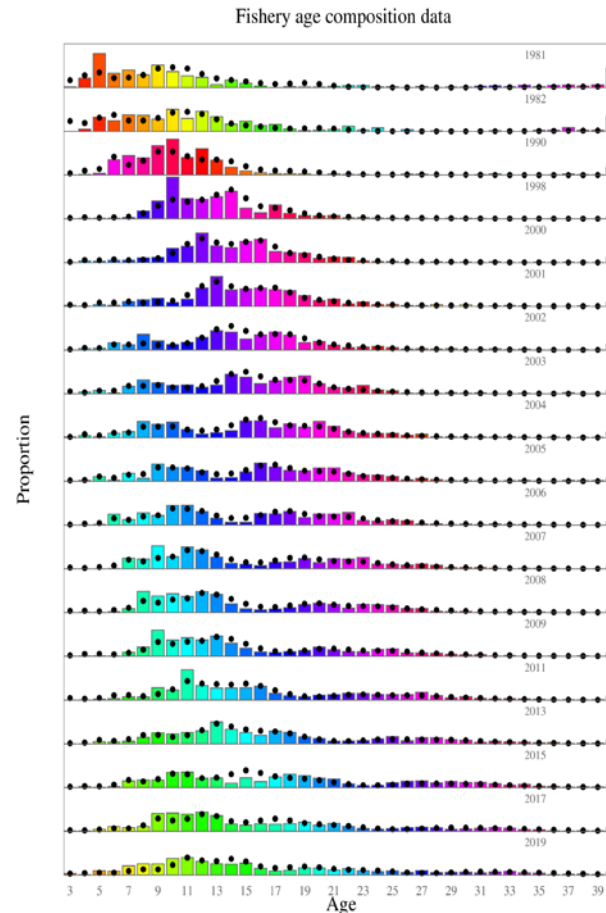
Method	Model	Maximum Age		
		79	104	129
Then <sub>1parm</sub>	$M = a/t_{max}$	0.065	0.049	0.040
Then <sub>lm</sub>	$\log(M) = a + b \log(t_{max})$	0.067	0.051	0.041
Then <sub>nls</sub>	$M = at_{max}^b$	0.090	0.070	0.057

- The average of the above values is 0.059
- The assessment model uses a prior distribution with mean = CV = 0.05 (unchanged from previous assessments)
- The resulting estimate from this year's assessment is 0.056



# Pacific ocean perch, continued

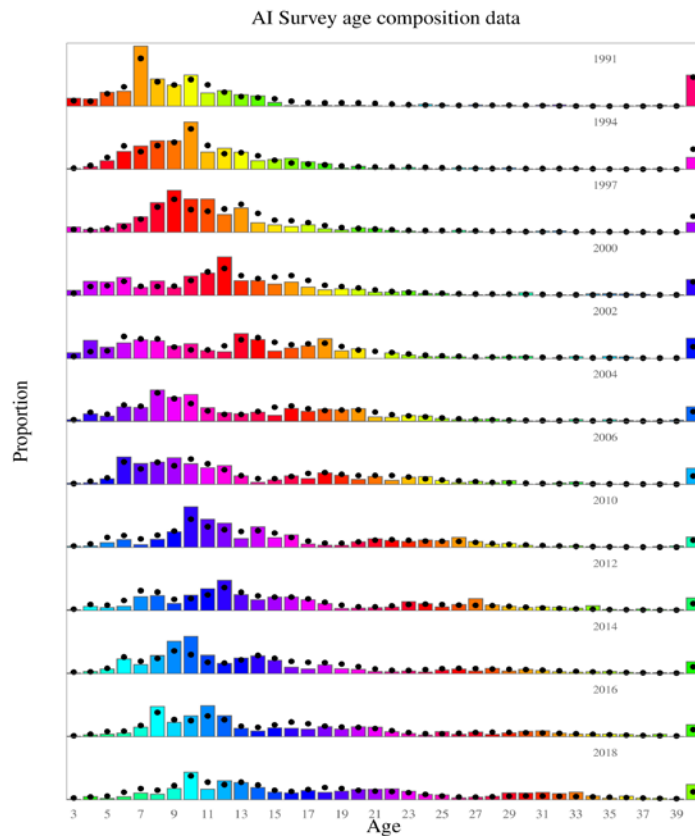
- Fit to fishery age composition



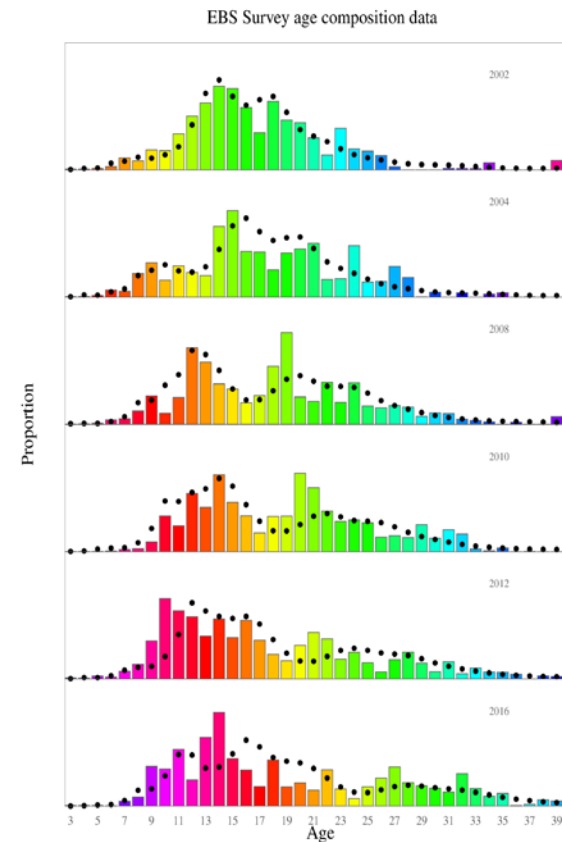
# Pacific ocean perch, continued

- Fits to survey age composition

## Aleutians

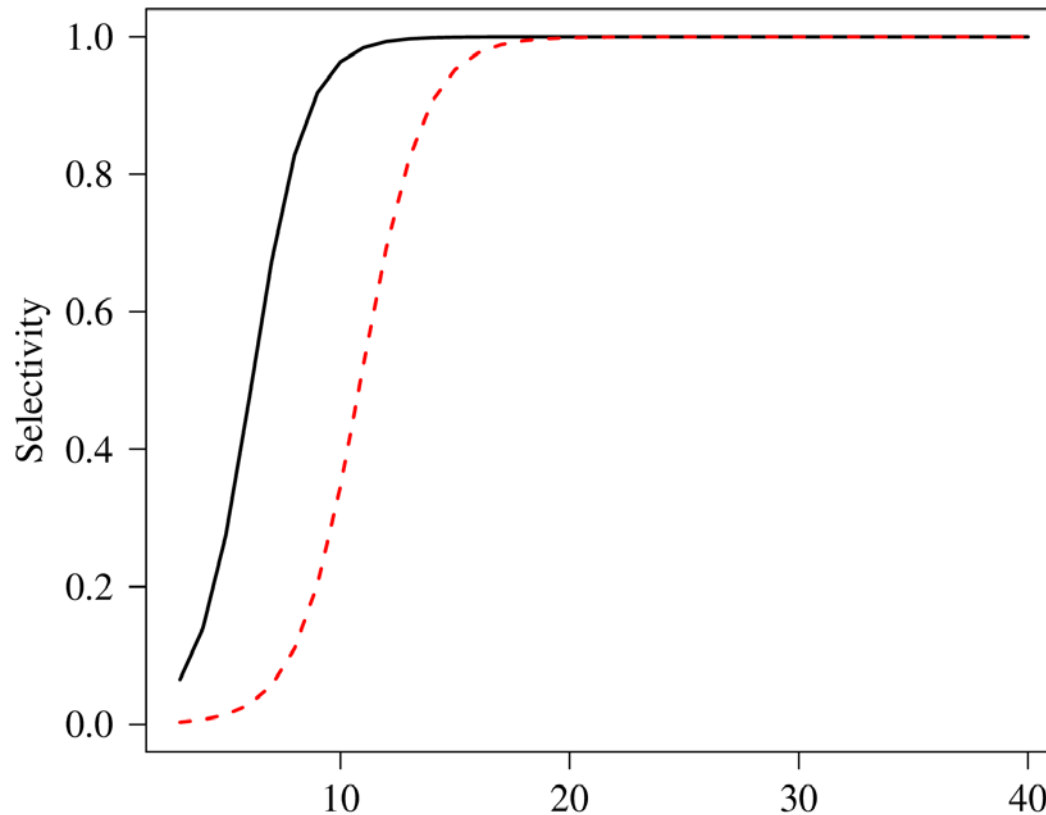


## EBS slope



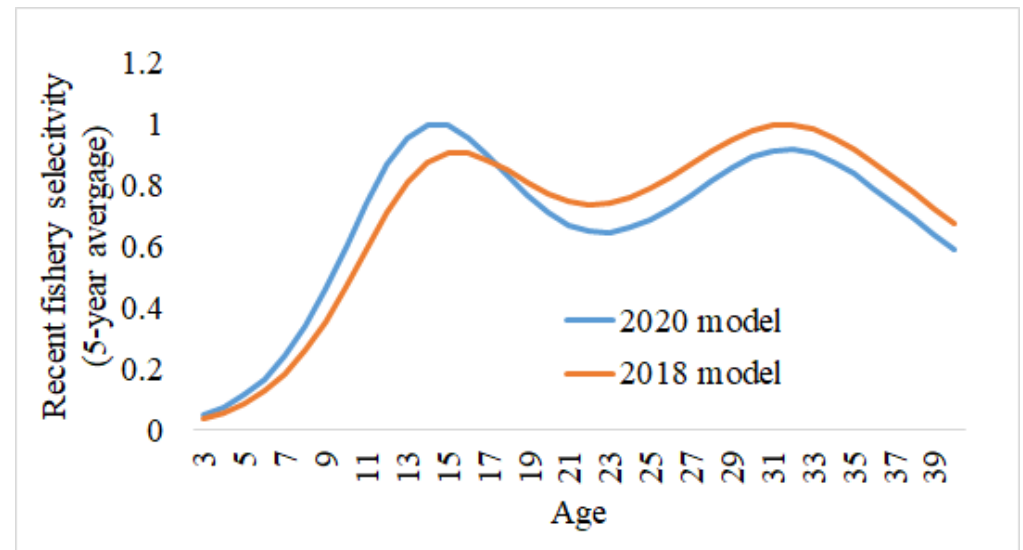
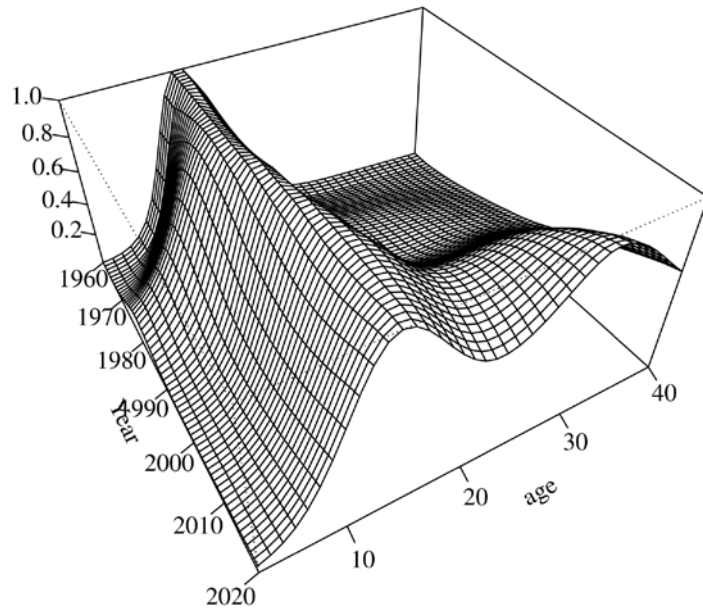
# Pacific ocean perch, continued

- Survey selectivity (solid black = AI, dashed red = EBS slope)



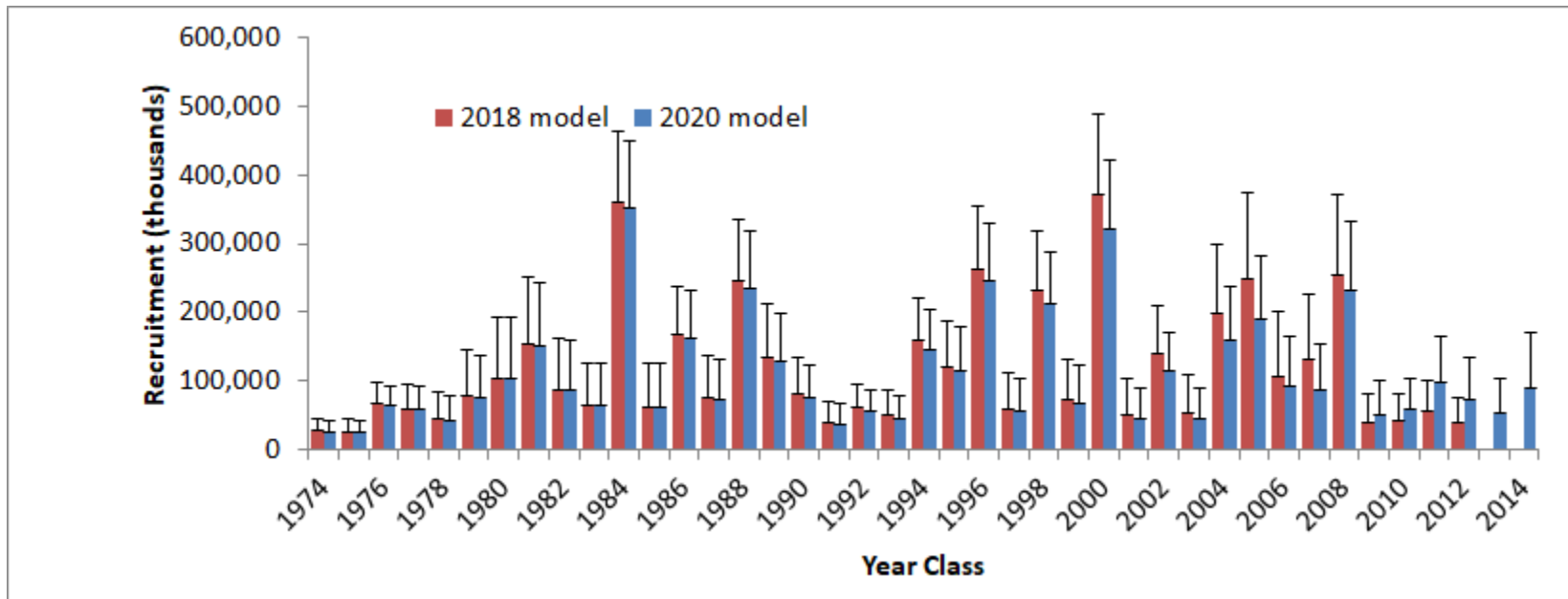
# Pacific ocean perch, continued

- Fishery selectivity
- Recent 5-year average at young ages is higher,  $F_{SPR}$  values lower



# Pacific ocean perch, continued

- Recruitment time series estimated by model



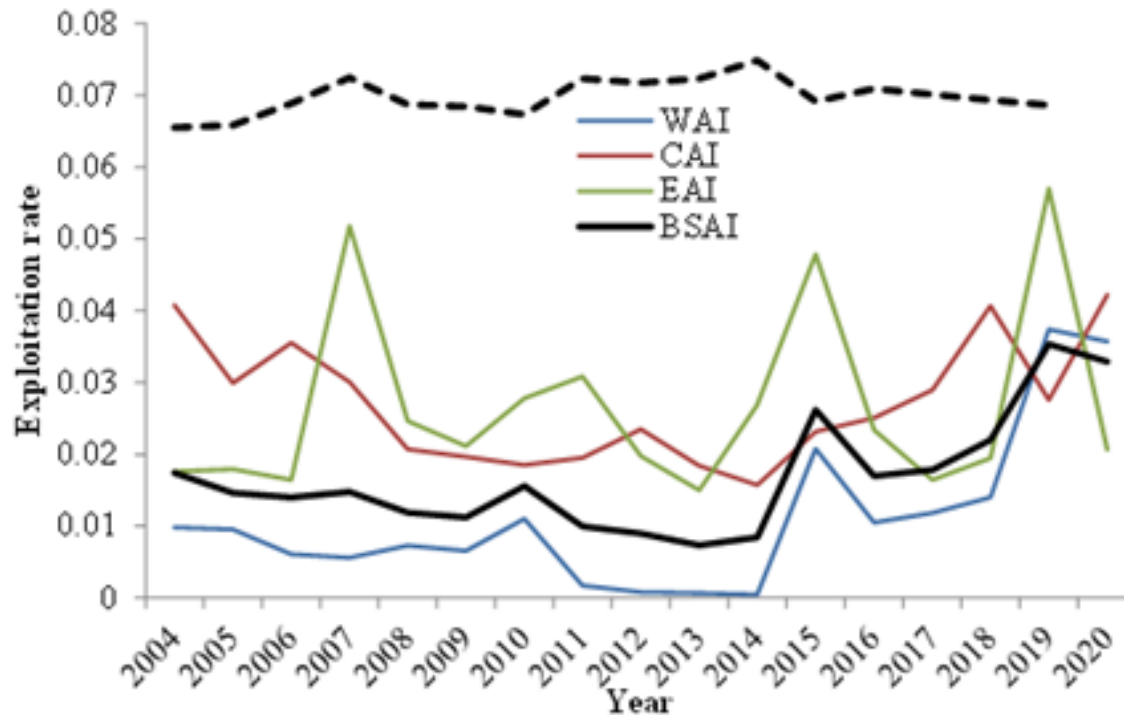
# Pacific ocean perch, continued

Quantity	Last asmt.	This asmt.	Change
M	0.056	0.056	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	908,529	n/a	-0.17
2021 age+ biomass	885,439	756,011	-0.15
2020 spawning biomass	383,178	n/a	-0.19
2021 spawning biomass	367,062	310,036	-0.16
B100%	645,738	584,747	-0.09
B40%	258,295	233,899	-0.09
B35%	226,008	204,661	-0.09
2021 FOFL	0.095	0.089	-0.06
2021 FABC	0.079	0.073	-0.08
2020 OFL	58,956	n/a	-0.25
2021 OFL	56,589	44,376	-0.22
2020 ABC	48,846	n/a	-0.24
2021 ABC	46,885	37,173	-0.21



# Chapter 13: northern rockfish (partial)

- New author: no; >1 model: no; change from base: no; risk>1: n/a
- Stock status: projected 2021 spawning biomass is 67% of  $B_{100\%}$
- Catch/biomass time series (dashed line corresponds to  $F_{40\%}$  ratio):





# Northern rockfish, continued

Quantity	Last asmt.	This asmt.	Change
M	0.048	0.048	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	250,235	n/a	-0.02
2021 age+ biomass	246,384	244,600	-0.01
2020 spawning biomass	111,476	n/a	-0.04
2021 spawning biomass	108,063	107,003	-0.01
B100%	159,850	159,850	0.00
B40%	63,940	63,940	0.00
B35%	55,947	55,947	0.00
2021 FOFL	0.075	0.075	0.00
2021 FABC	0.061	0.061	0.00
2020 OFL	19,751	n/a	-0.04
2021 OFL	19,070	18,917	-0.01
2020 ABC	16,243	n/a	-0.04
2021 ABC	15,683	15,557	-0.01



# Chapter 14: blackspotted/rougheye rockfish

- New author: no; >1 model: yes; change from base: yes; risk>1: yes
- New data:
  - 2018 AI survey age composition
  - 2018 and 2019 AI fishery size composition
  - Length-at-age, age-at-length matrix, weight-at-age updated
- Model changes/alternatives:
  - Model 18.1, the current base model
  - Model 20 (recommended), same as 18.1, but with additional updated data (ageing error, maturity) and use of Francis weighting
  - Model 20a, same as 20, but with McAllister-Ianelli weighting
  - Model 20b, same as 20, but with fishery sizecomps removed
  - Model 20c, same as 20a, but with fishery sizecomps removed



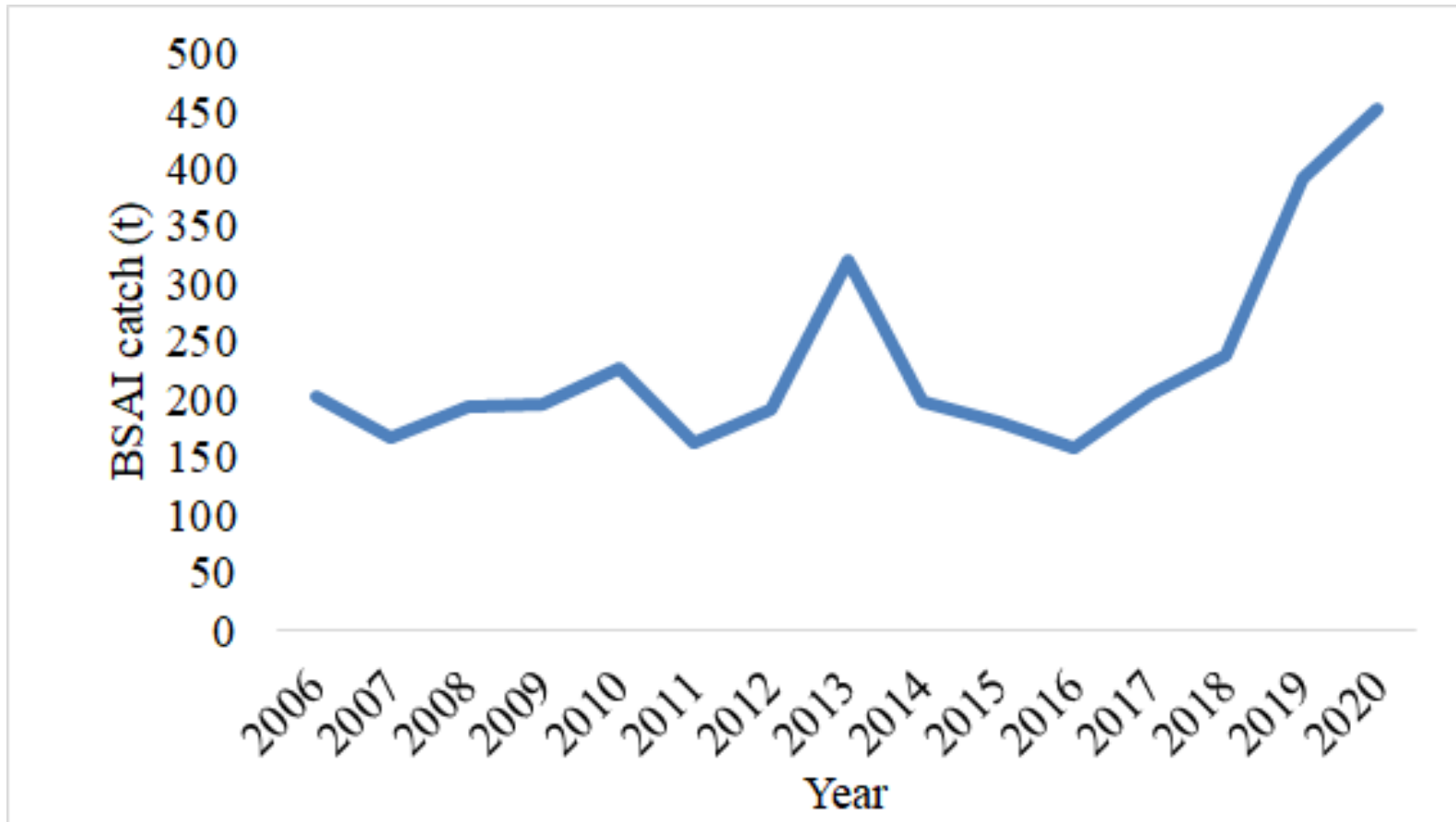
# Blackspotted/rougheye rockfish, continued

- Stock status/trend:
  - AI: projected 2021 spawning biomass is 38% of  $B_{100\%}$
  - EBS: Slope survey shows upward trend through 2012
    - 2016 slope estimate may be unreliable (29% of stations failed)
- Mohn's  $\rho = 0.30$  (compare to 0.55 from Model 18.1)
- Risk levels: **assess.** = 3, **pop. dy.** = 2, env./eco. = 1, **fishery** = 2
  - These will be summarized later in the presentation



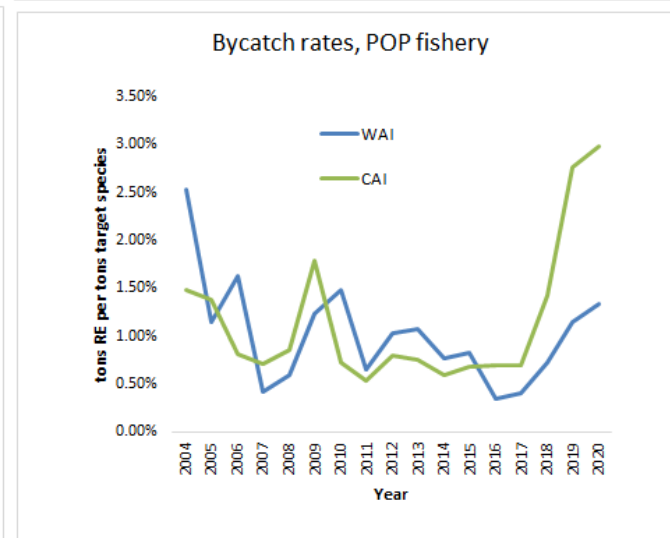
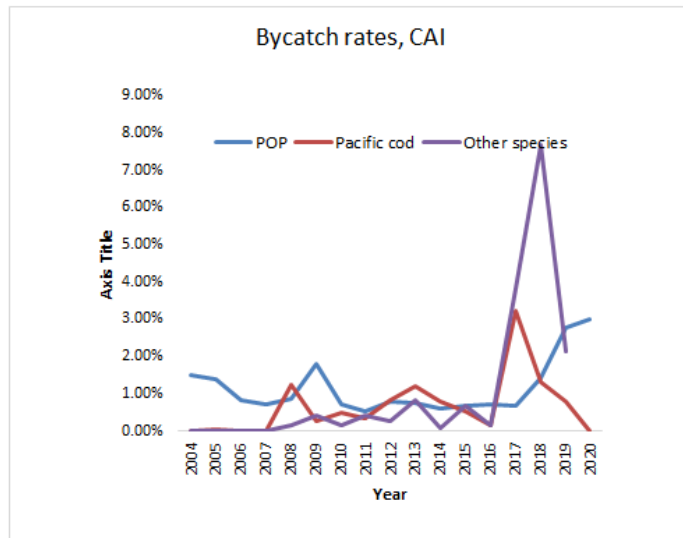
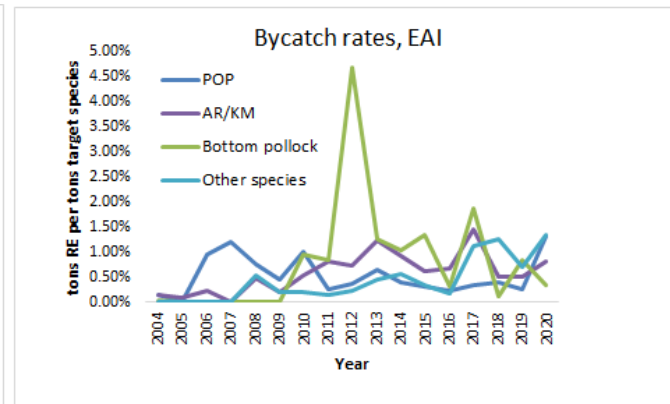
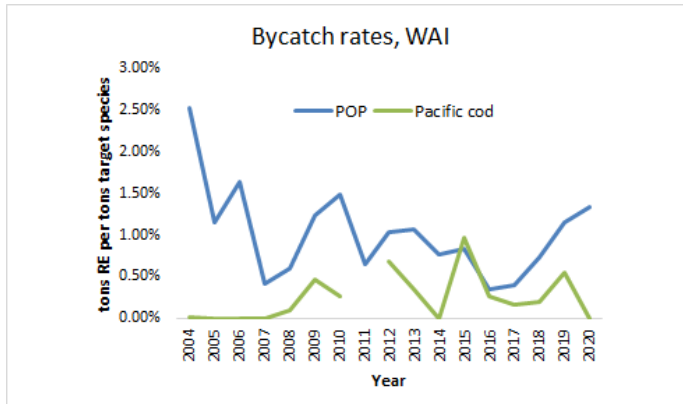
# Blackspotted/rougheye rockfish, continued

- Recent catch time series



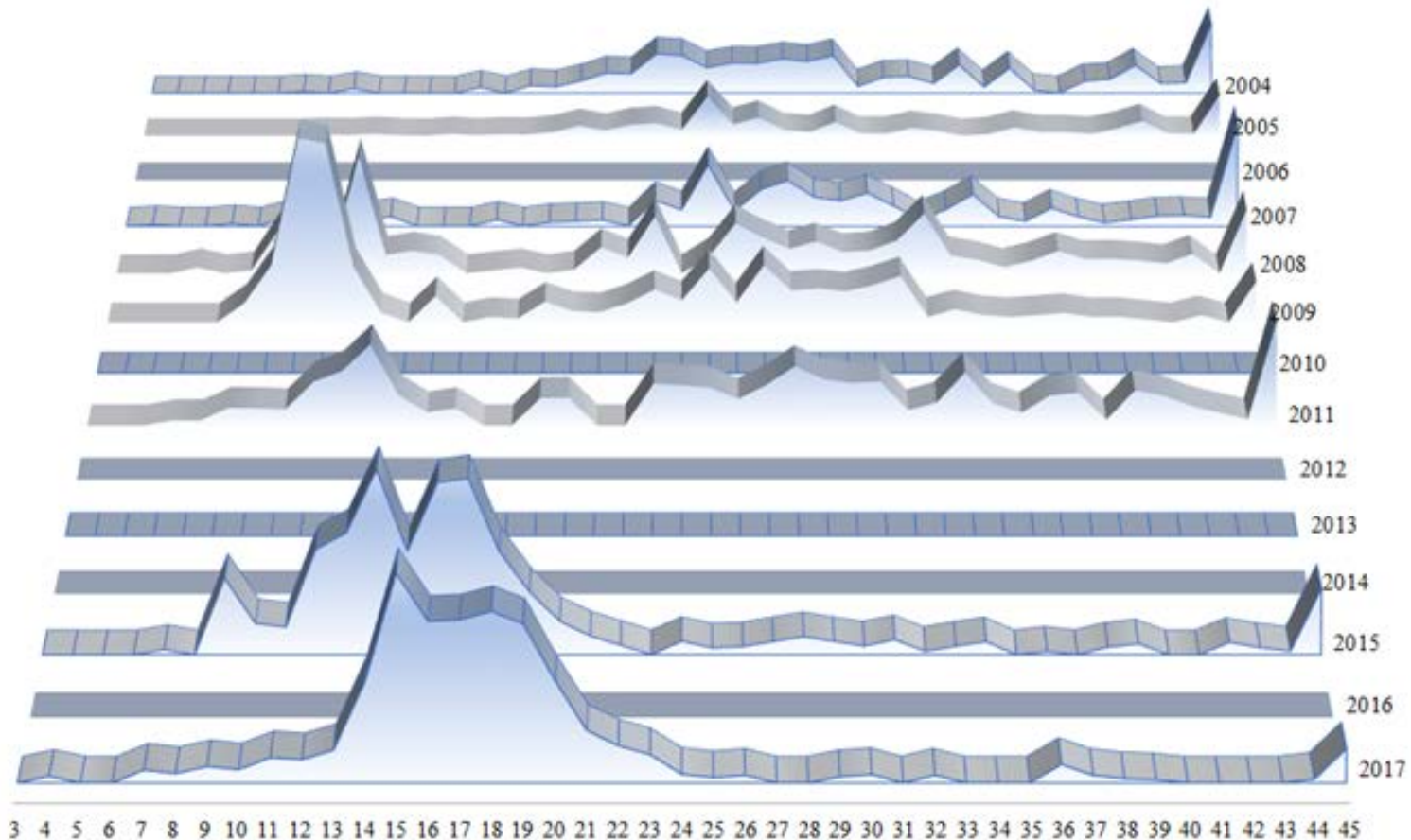
# Blackspotted/rougheye rockfish, continued

- Bycatch rates (BS/RE catch per target catch)



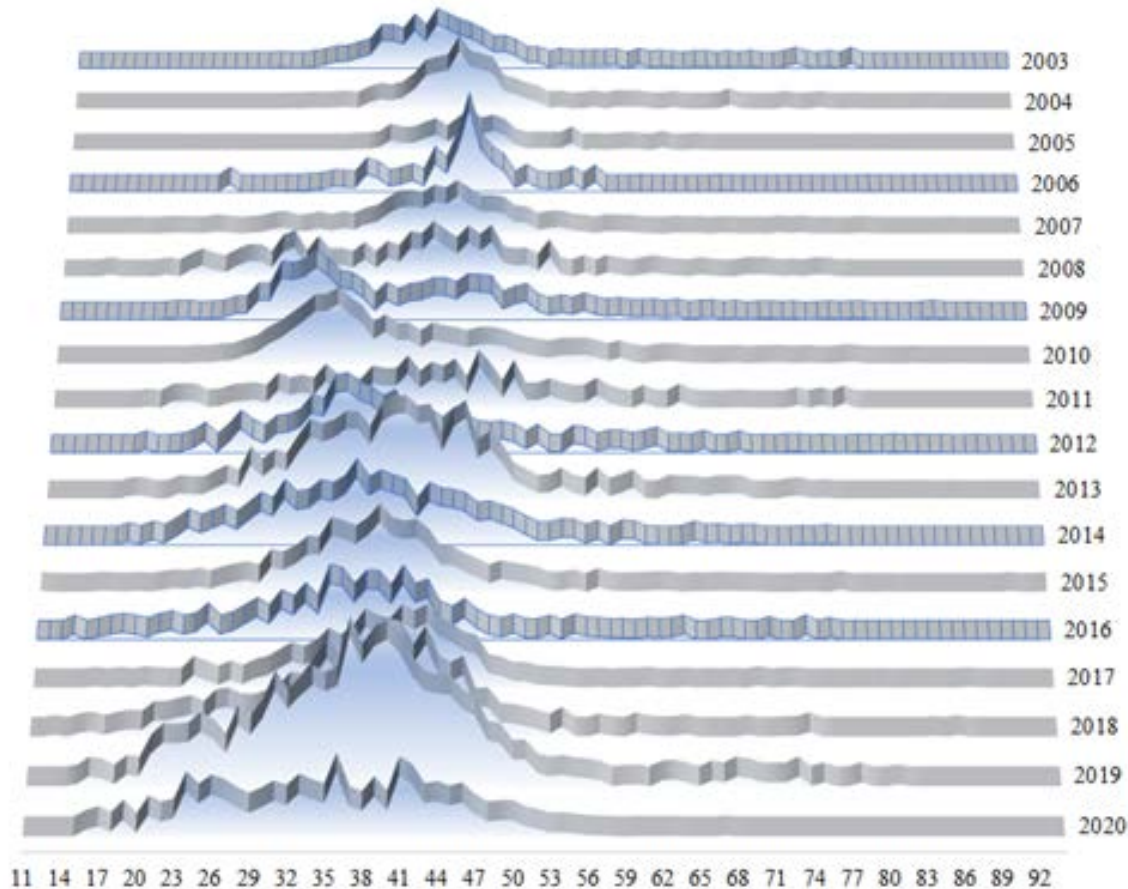
# Blackspotted/rougheye rockfish, continued

- Fishery age composition data



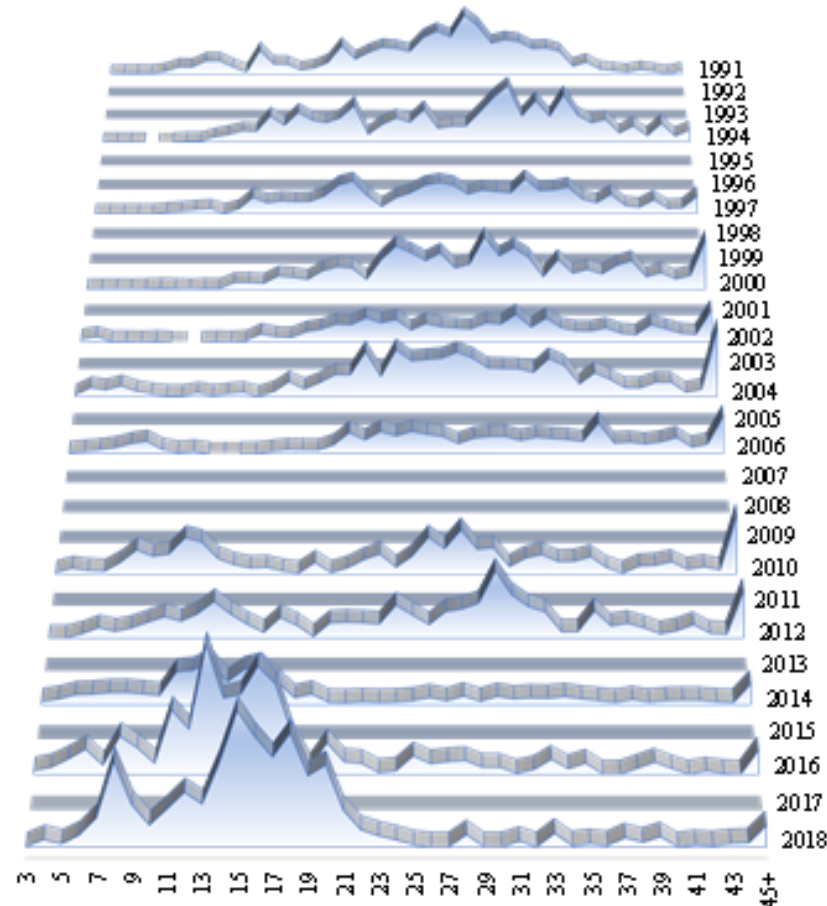
# Blackspotted/rougheye rockfish, continued

- Fishery size composition data



# Blackspotted/rougheye rockfish, continued

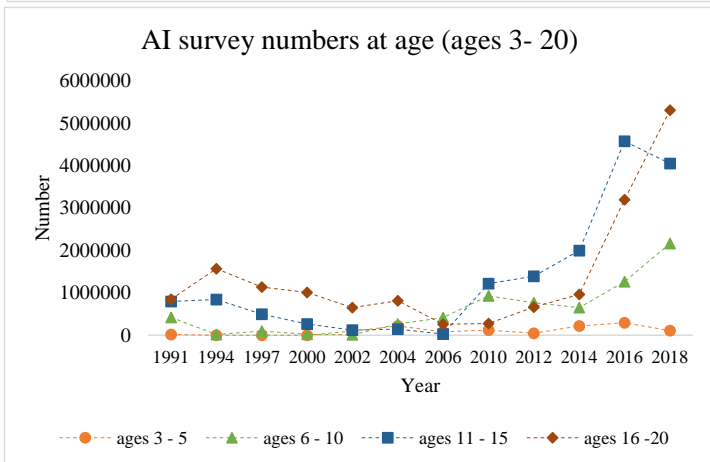
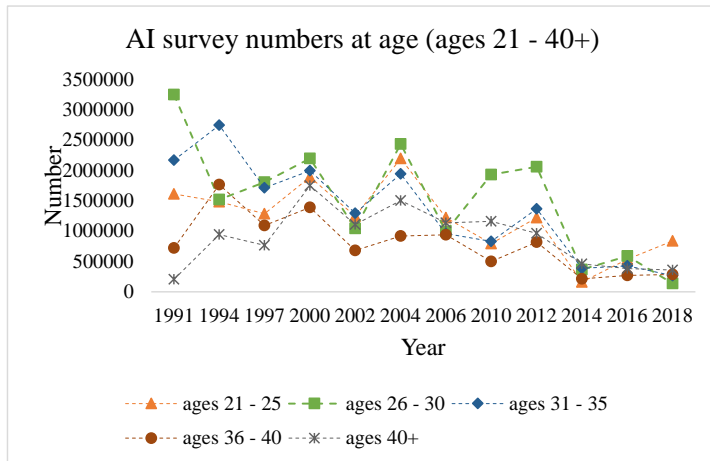
- AI survey age composition data (note recent lack of older fish)





# Blackspotted/rougheye rockfish, continued

- More on decline of older fish, increasing number of younger fish



## Decline from 2012-2014

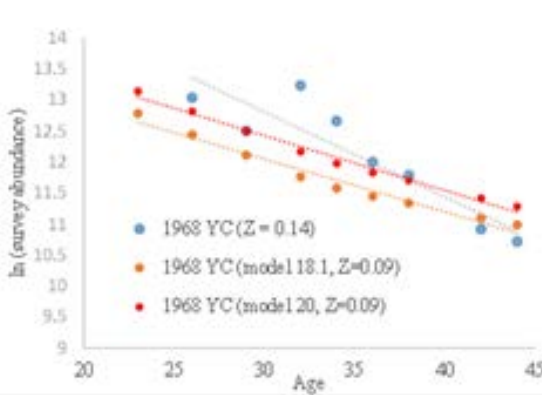
Age group	Rate of decline
21-25	87%
26-30	82%
31-35	72%
36-40	74%
40+	52%



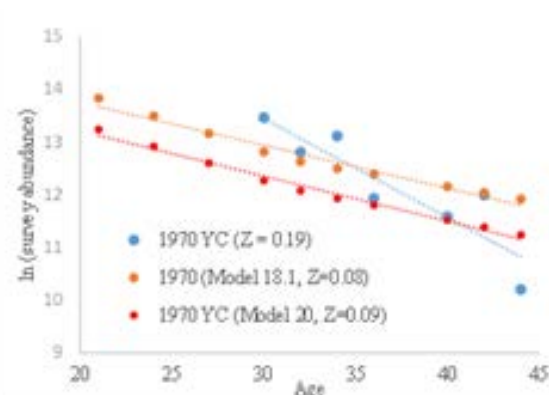
# Blackspotted/rougheye rockfish, continued

- Conflict between the compositional data and the AI survey index
  - Cohort-specific mortality rates from assessment models are smaller than those estimated via catch curves
  - The models do not have a mechanism for explaining the declines

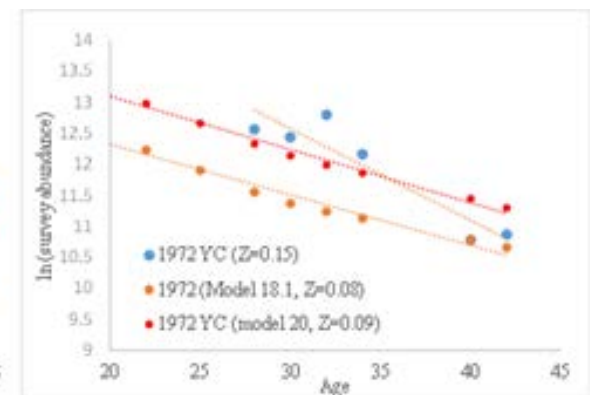
1968 cohort



1970 cohort



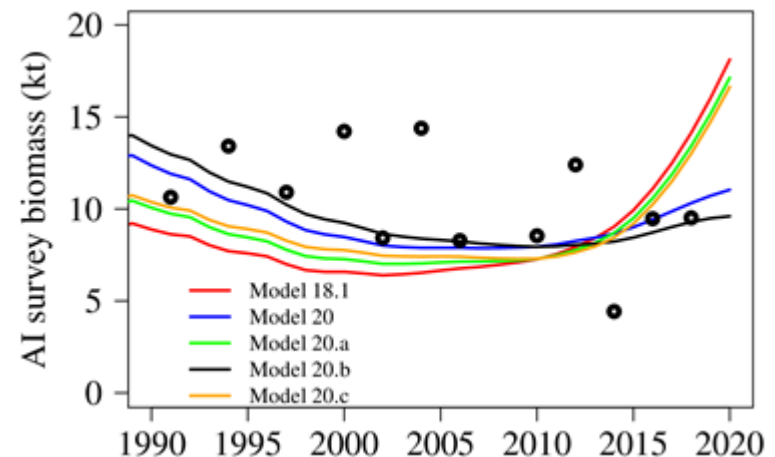
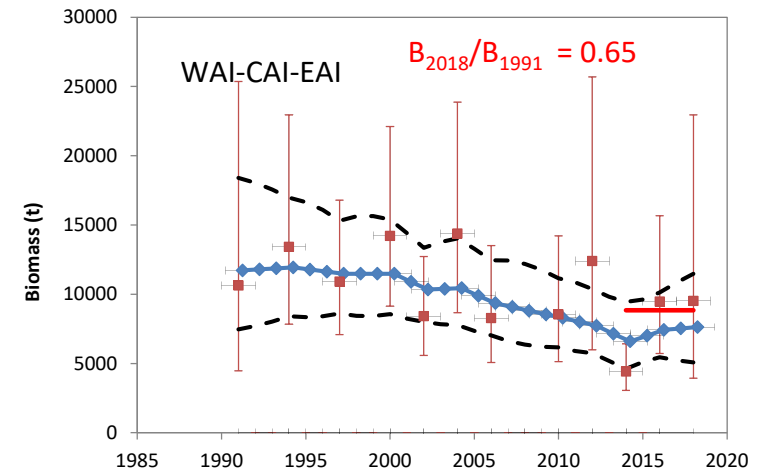
1972 cohort



- (Continued on next slide)

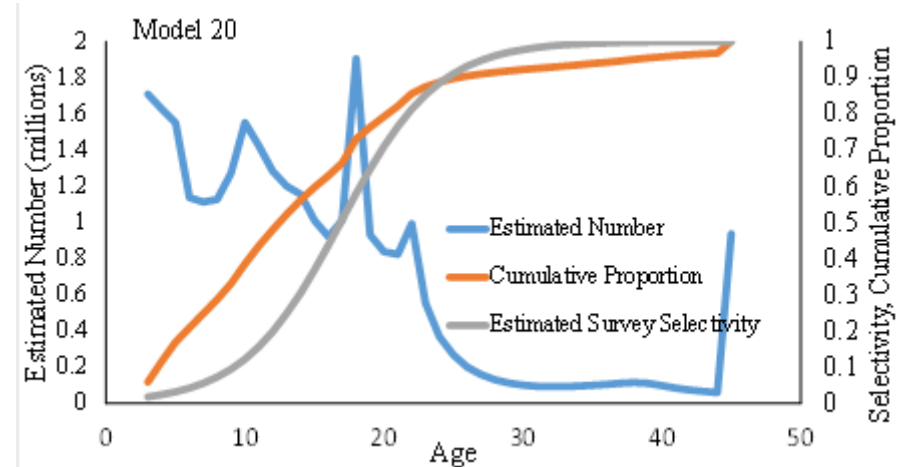
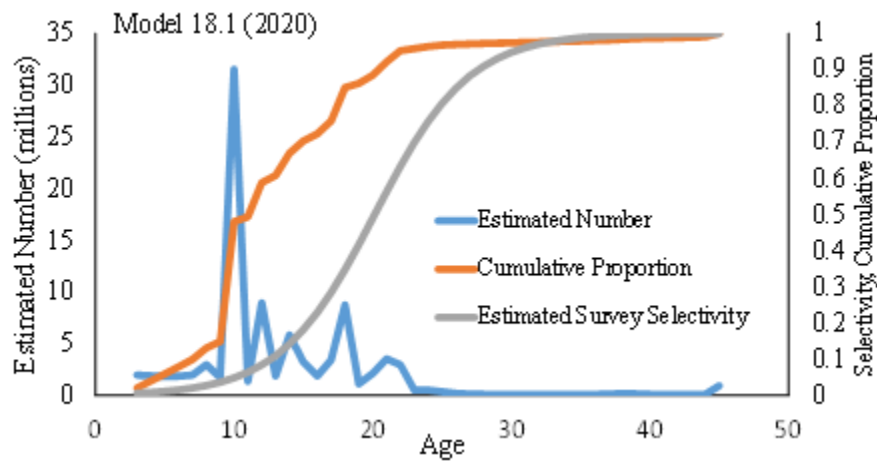
# Blackspotted/rougheye rockfish, continued

- Data conflict (continued)
  - By themselves, index data suggest a biomass decrease
    - Tier 5 RE model fit
- When compositional data are added, recent trend reverses
  - Note ABC implications
  - Models 20 and 20.b are the two that use Francis
  - These give better fits



# Blackspotted/rougheye rockfish, continued

- McAllister-lanelli weighting (e.g., M18.1) does give a slight improvement to compositional data fit, but it does so by estimating immense recruitments at ages with low survey selectivity
- Note differences in vertical scale below:



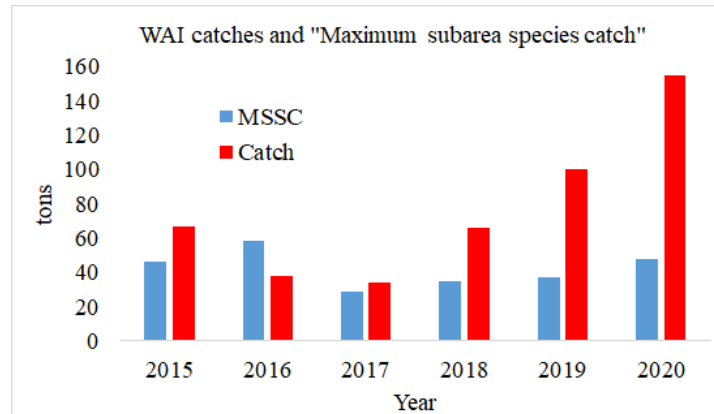
# Blackspotted/rougheye rockfish, continued

- Author recommends Model 20; compared to M18.1, it gives:
  - Decreased retrospective bias ( $\rho=0.55$  in M18.1,  $\rho=0.30$  in M20)
  - Decreased recruitment variability
  - Improved fit to AI survey index overall
  - Recent biomass trend more consistent with recent AI survey index
  - Greater stability in inter-assessment ABC advice
    - M18.1 projects dramatic increases, but these will likely later be shown to be high due to retrospective bias

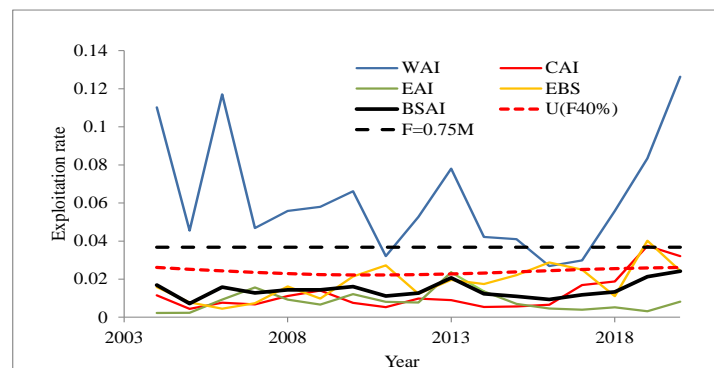


# Blackspotted/rougheye rockfish, continued

- Catches continue to exceed MSSC in WAI:



- In terms of exploitation rate:



# Blackspotted/rougheye rockfish, continued

- Risk table
  - Assessment (Level 3):
    - Very poor fits to data (data conflict)
    - High level of uncertainty
    - Inability of model to explain decline in abundance of older fish
    - Highly constrained estimate of  $M$
    - Strong retrospective bias
  - Population dynamics (Level 2):
    - Abundance (particularly older fish) decreasing faster than usual
    - Unusual pattern of recent strong recruitments
    - Existing spatial management structure is inadequate
  - (Continued on next slide)



# Blackspotted/rougheye rockfish, continued

- Risk table (continued)
  - Environmental/ecosystem (Level 1)
  - Fishery performance (Level 2):
    - For a bycatch stock, fishery performance can be evaluated with respect to how well the target fishery can avoid bycatch
    - Fishery CPUE in the WAI is higher than would be expected based on the spatial distribution of survey biomass estimates
    - The WAI catches have consistently exceeded the MSSC, and these overages have increased over time
    - The catches in the WAI/CAI subarea have also exceeded the subarea ABC in 2019 and 2020
  - Author does not recommend a reduction from maxABC





# Blackspotted/rougheye rockfish, continued

- Discussion:
  - The Team discussed the improvements that Francis weighting provided and commented on the decreased positive retrospective bias and recruitment variability
  - The Team agrees with the authors' model choice and agrees that data weighting is a critical component of the model
  - An industry member stated that fleet fishing behavior has changed to avoid these fish in deeper water and now they fish shallower, resulting in increased catch of smaller/younger fish
  - The lack of large fish in the AI survey data was also discussed
  - One idea discussed was to look at the longline survey for information that could be used
  - (Continued on next slide)



# Blackspotted/rougheye rockfish, continued

- Discussion, continued
  - The MSSC was intended to help guide the fleet to voluntarily reduce catch in the WAI, but catch has exceeded the MSSC for 5 out of the past 6 years, with “overages” increasing to 3 times the MSSC in recent years
  - The Team is extremely concerned with the effectiveness of the MSSC
  - A member of the public reported that it has been useful for the fleet
  - Although several members of the Team noted the ineffectiveness of the MSSC, the Team does not recommend removing the MSSC because a superior alternative has not yet been clearly identified, and the MSSC may have some positive influence
- The Team requests guidance from the SSC and Council on how to reduce incidental catch in areas with disproportionate spatial exploitation because the MSSC tool has not provided enough protection



# Blackspotted/rougheye rockfish, continued

- The Team agreed with the authors' recommendations with respect to:
  - Adoption of Model 20 (with the Francis weighting), which better matches the scale and trend in the survey estimates and lowers the 2021 and 2022 ABCs relative to the 2020 ABC
  - Risk levels greater than 1 for three categories
  - No reduction from maxABC, because, given the incidental nature of these species' removals, an ABC reduction may simply increase discards without reducing catch
- The Team recommended that the author assess the depth distribution of the survey samples to evaluate trends by depth, to help determine risk considerations and potentially help inform the industry on how to reduce incidental catch



# Blackspotted/rougheye rockfish, continued

Quantity (AI portion)	Last asmt	This asmt	Change
M	0.032	0.049	0.53
2020 tier	3b	n/a	none
2021 tier	3b	3b	none
2020 age+ biomass	49,005	n/a	-0.64
2021 age+ biomass	51,451	17,632	-0.66
2020 spawning biomass	10,213	n/a	-0.67
2021 spawning biomass	11,551	3,372	-0.71
B100%	29,287	8,811	-0.70
B40%	11,715	3,524	-0.70
B35%	10,250	3,083	-0.70
2021 FOFL	0.047	0.038	-0.19
2021 FABC	0.039	0.032	-0.18
2020 OFL	817	n/a	-0.38
2021 OFL	1,046	509	-0.51
2020 ABC	675	n/a	-0.36
2021 ABC	866	432	-0.50

\* Note that the WAI MSSC was exceeded again in 2020



# Blackspotted/rougheye, continued

Quantity ( <b>EBS portion</b> )	Last asmt.	This asmt.	Change
M	0.032	0.049	0.53
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	1,371	1,371	0.00
2021 FOFL	0.032	0.049	0.53
2021 FABC	0.024	0.037	0.54
2020 OFL	44	n/a	0.53
2021 OFL	44	67	0.53
2020 ABC	33	n/a	0.53
2021 ABC	33	50	0.53



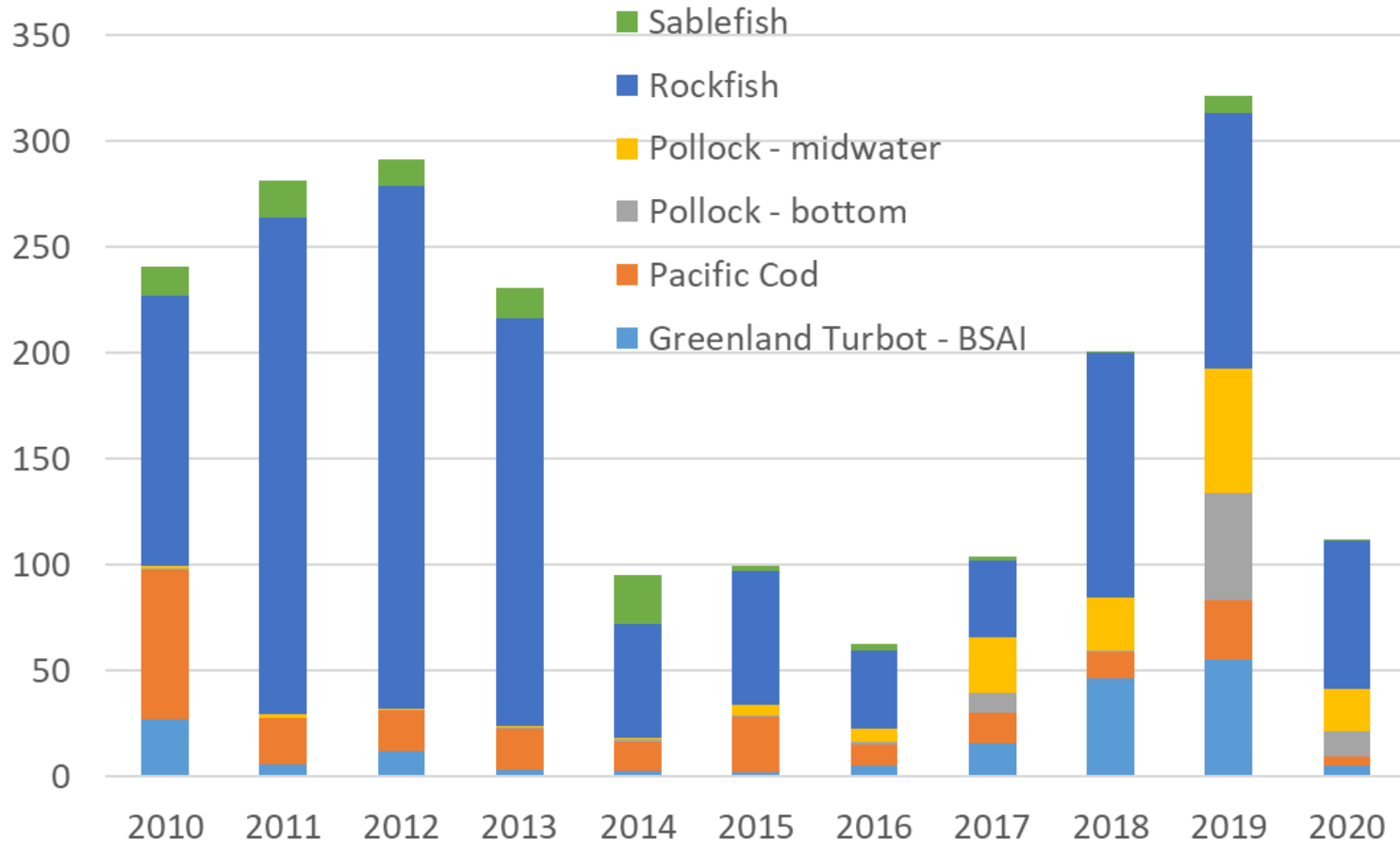
# Chapter 15: shortraker rockfish

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **no**
- New data: none
- Model changes/alternatives: none (Tier 5 RE model)
- Stock trend:
  - Aggregate is very stable since 2002 (low = 20,932 t, high = 24,055 t)
  - Although subareas of AI, EBS slope show variability (with large CVs)



# Shortraker rockfish, continued

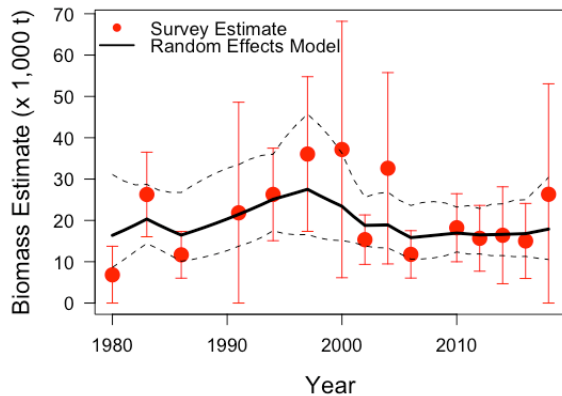
- Catch time series, by target fishery



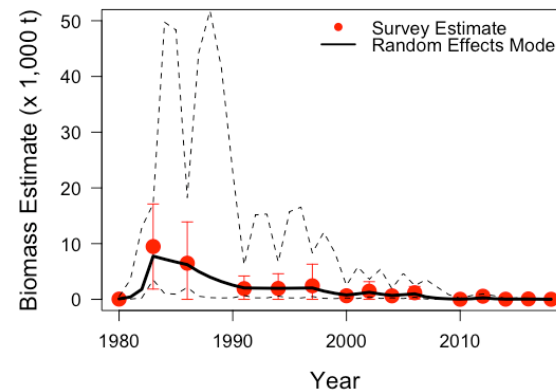
# Shortraker rockfish, continued

- Survey biomass time series

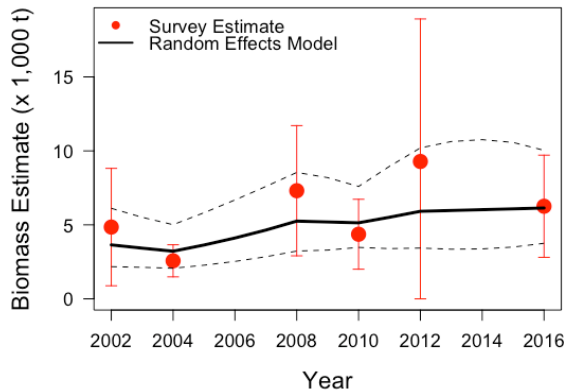
## Aleutian Islands



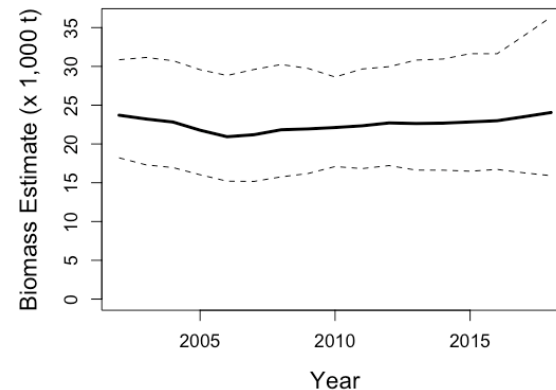
## Southern Bering Sea



## Bering Sea slope



## BSAI total





# Shortraker rockfish, continued

Quantity	Last asmt.	This asmt.	Change
M	0.030	0.030	0.00
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	24,055	24,055	0.00
2021 FOFL	0.030	0.030	0.00
2021 FABC	0.0225	0.0225	0.00
2020 OFL	722	n/a	0.00
2021 OFL	722	722	0.00
2020 ABC	541	n/a	0.00
2021 ABC	541	541	0.00



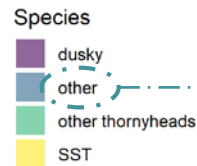
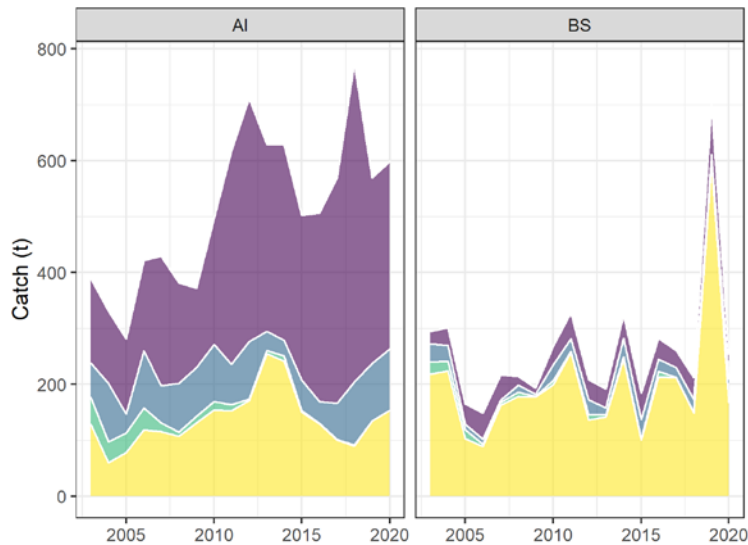
# Chapter 16: other rockfish

- New author: **yes**; >1 model: **no**; change from base: **no**; risk>1: **yes**
- New data:
- Model changes/alternatives: none (Tier 5 RE model)
- Stock trend:
- Risk levels: **assess.** = 2, pop. dy. = 1, env./eco. = 1, fishery = 1
  - SST comprises 95% of the total biomass and the RE model fits the data well, but the area (EBS slope) with the largest SST biomass has not been surveyed since 2016
  - Use of the RE model for the non-SST species is problematic in that the data include many zero (or close to zero) values with very tight CIs, interspersed with high values accompanied by very large CIs
  - Catch often exceeds biomass, or at least tacit ABCs and OFLs, for non-SST species, casting doubt on the reliability of those estimates

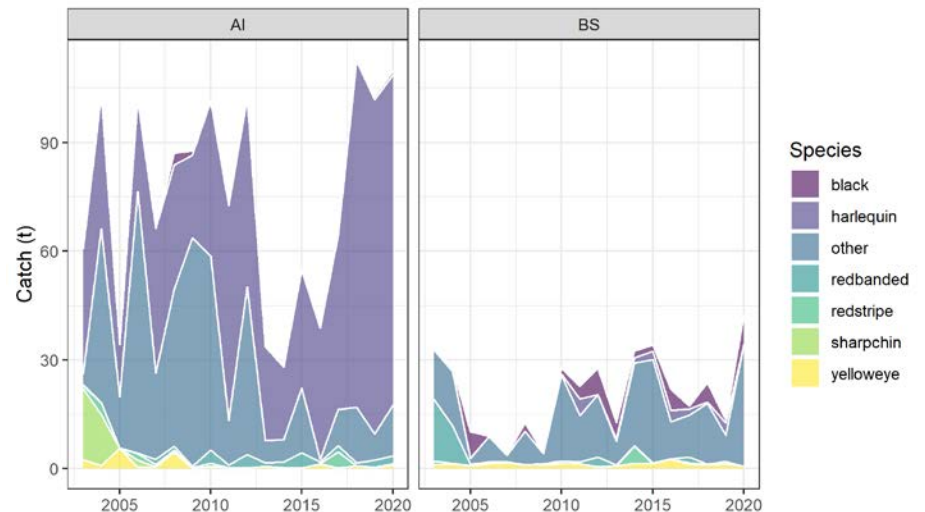


# Other rockfish, continued

- Catch time series

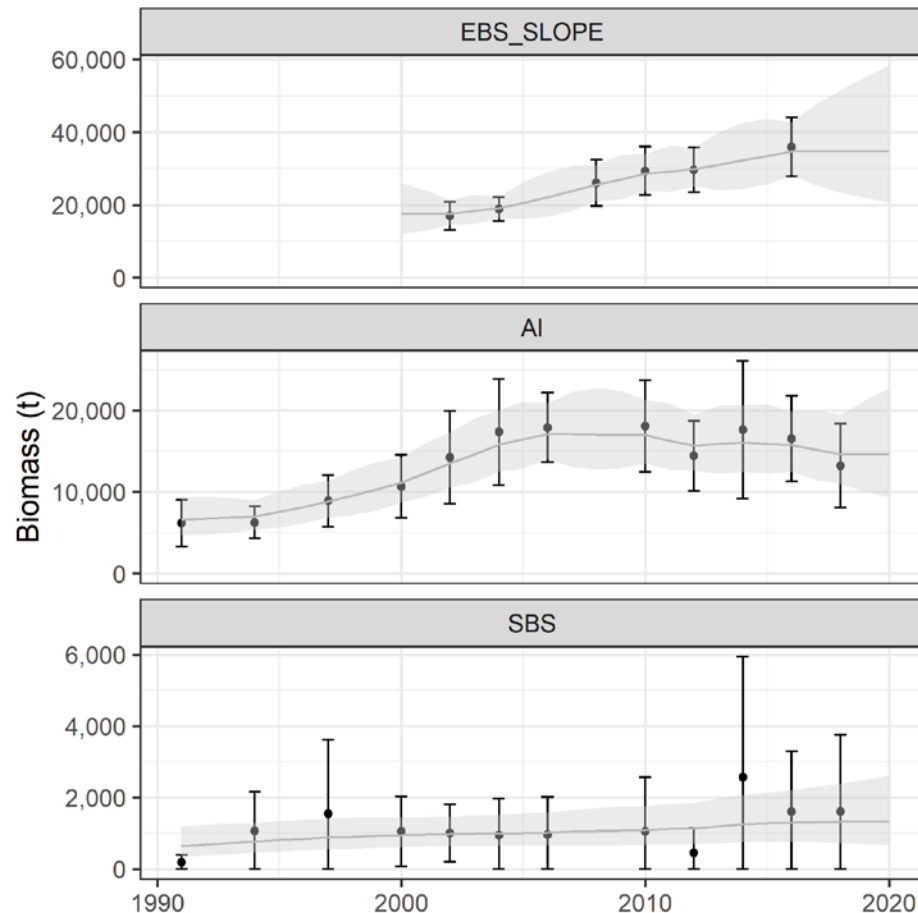


The other, other rockfish



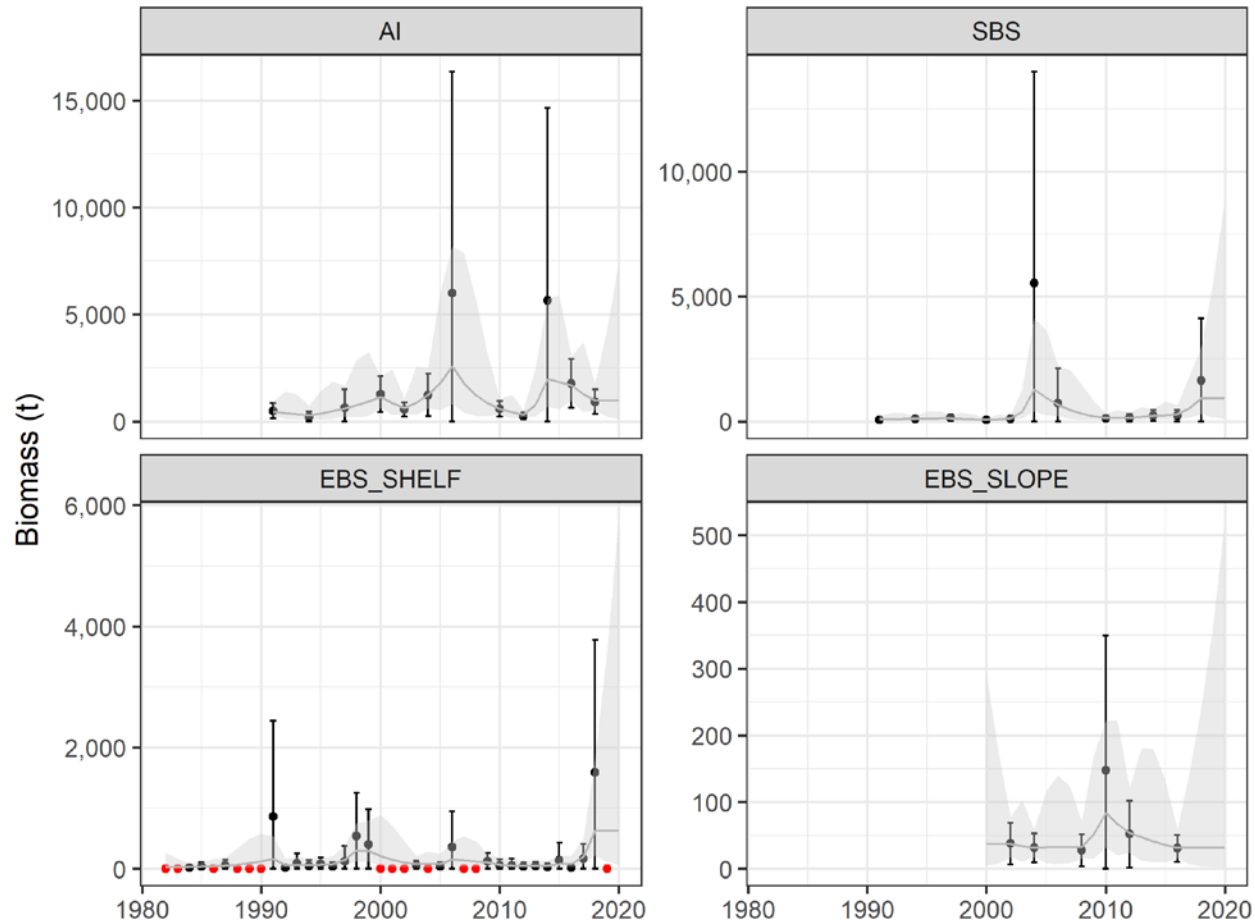
# Other rockfish, continued

- Shortspine thornyhead survey biomass time series



# Other rockfish, continued

- Non-SST survey biomass time series (zeros treated as missed surveys)



# Other rockfish, continued

- Author's suggestions for future research:
  - An analysis of the spatial patterns of survey and fishery catch as they relate to trawlable and untrawlable habitat may be informative
  - Additionally, the utility of the AI survey as an abundance index for SST and non-SST species should be evaluated given the unique design of this survey
  - AI and SBS biomass in both untrawlable habitats and deeper waters not sampled in the AI survey is likely underestimated
    - The NMFS longline or IPHC setline surveys may be useful in this context but have not been explored to date
  - Further research into the connectivity or overlap of dusky rockfish in the EAI (area 541) and WGOA (area 610) would inform understanding of stock structure and exploitation rates in this area



# Other rockfish, continued

- Discussion:
  - A Team member noted that for September 2021, the authors of all Tier 5 assessments will research new approaches
  - There was some discussion of whether the non-SST portion of the stock should be moved to Tier 6, but there was a recognition that the default Tier 6 formulae could either fail to give adequate protection to some species or prove to be unduly constraining in the future, given the upward trend in biomass estimates for some species
  - The author noted that there were challenges for the risk table when an assessment covers multiple species
  - The Team notes the significant issues with the non-SST share of the biomass estimate but did not recommend a change to Tier 6 at this point given research planned this year as well as the increasing trend in catch in the AI non-SST component of other rockfish



# Other rockfish, continued

- The Team recommended that the author pursue the planned work in collaboration with other authors to consider issues with the Tier 5 model process for stocks with variable, and at times sparse or missing, survey observations
  - Specifically, the manner in which biomass estimates of 0 are handled (i.e., currently ignored) should be revisited
- The Team recommended that the author consult with other rockfish assessment authors to consider revising  $M$  for the non-SST portion of the population in future assessments, noting that recent assessments reported to have based the  $M=0.09$  assumption on GOA dusky rockfish, when in fact  $M=0.07$  has been the GOA dusky rockfish value used since 2006





# Other rockfish, continued

- The Team recommended that the author do more spatial analysis of AI catch of non-SST rockfish
  - The Team recommended the author explore the locations, depths, seasons, the encounter rates and concentration of catch (i.e., frequent constant bycatch rates or a smaller number of highly concentrated hauls)



# Other rockfish, continued

Quantity*	Last asmt.	This asmt.	Change
M	0.034	0.033	-0.02
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	53,290	53,248	0.00
2021 FOFL	0.034	0.033	-0.02
2021 FABC	0.025	0.025	-0.02
2020 OFL	1,793	n/a	-0.02
2021 OFL	1,793	1,751	-0.02
2020 ABC	1,344	n/a	-0.02
2021 ABC	1,344	1,313	-0.02

\*Instantaneous rates are biomass-weighted averages



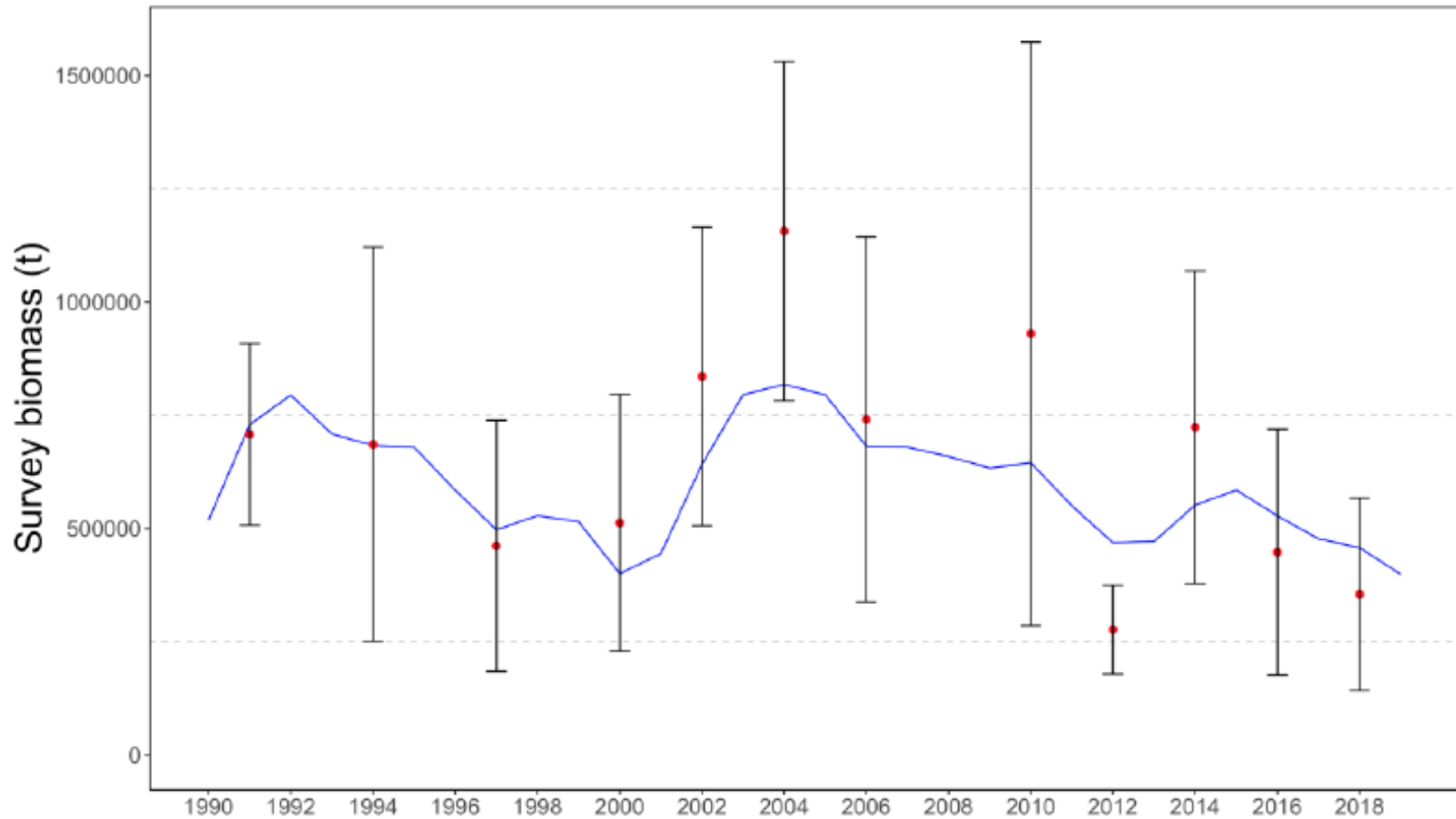
# Chapter 17: Atka mackerel

- New author: no; >1 model: no; change from base: no; risk>1: no
- New data: 2019 fishery age composition
- Model changes/alternatives: none (Model 16.0b)
- Stock status: projected 2021 spawning biomass is 37% of  $B_{100\%}$
- Mohn's  $\rho = 0.05$



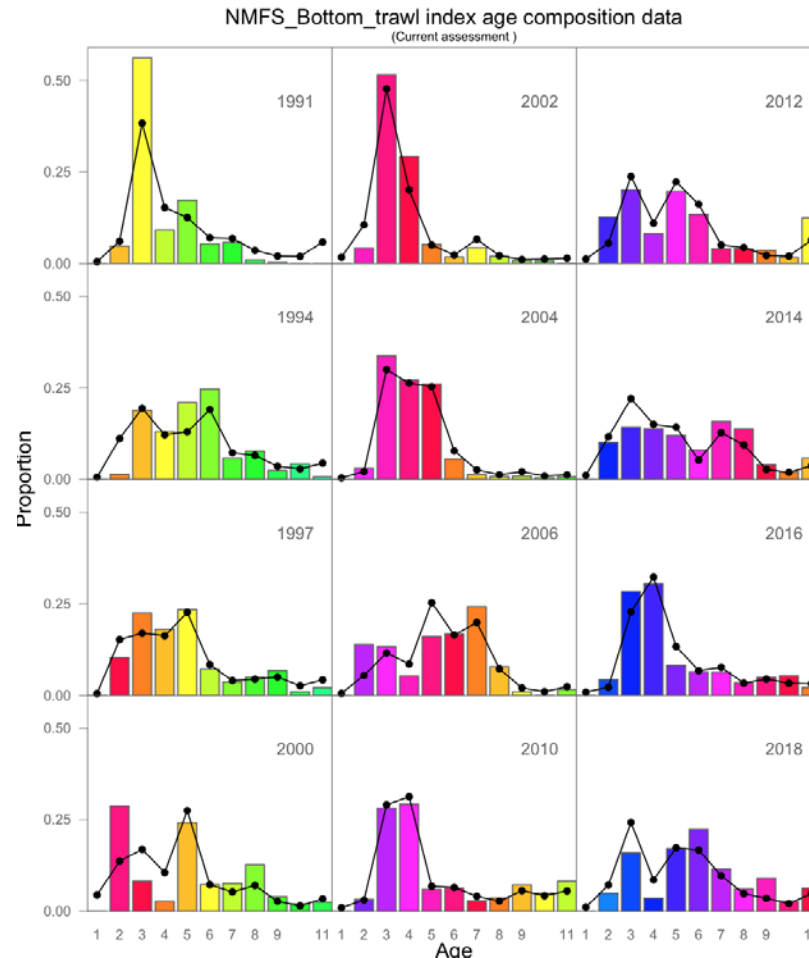
# Atka mackerel, continued

- Fit to AI survey biomass data



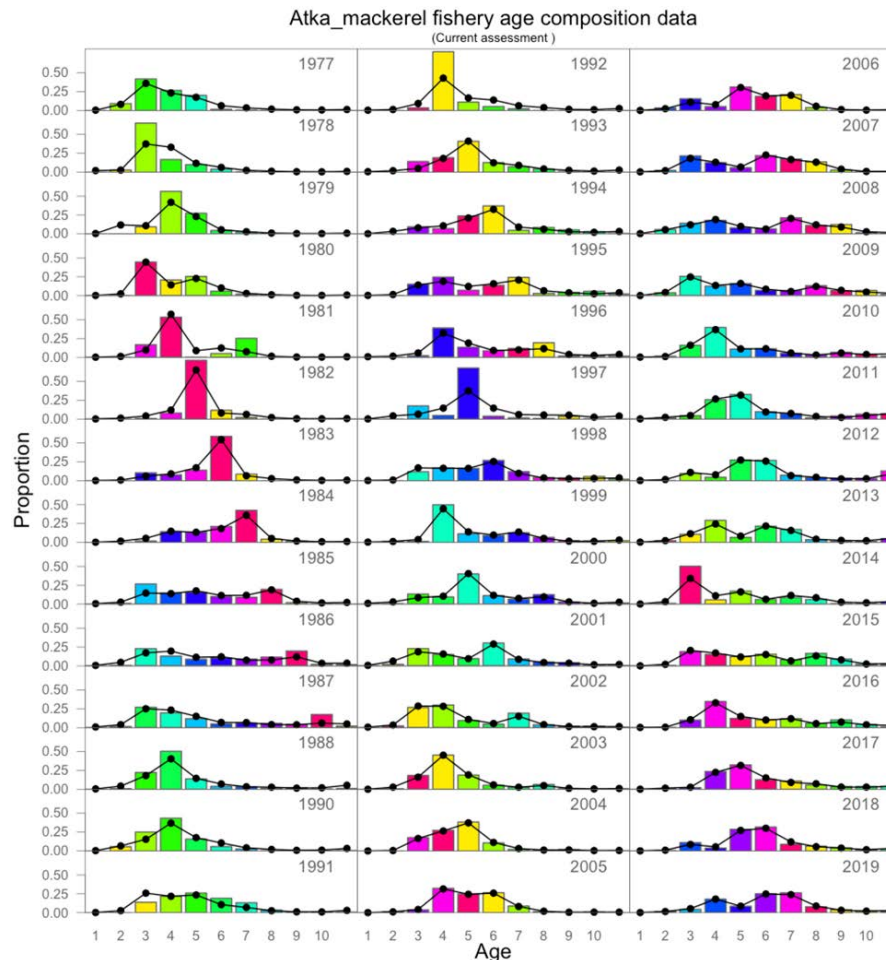
# Atka mackerel, continued

- Fit to survey age composition data (dots = estimated, bars = observed)



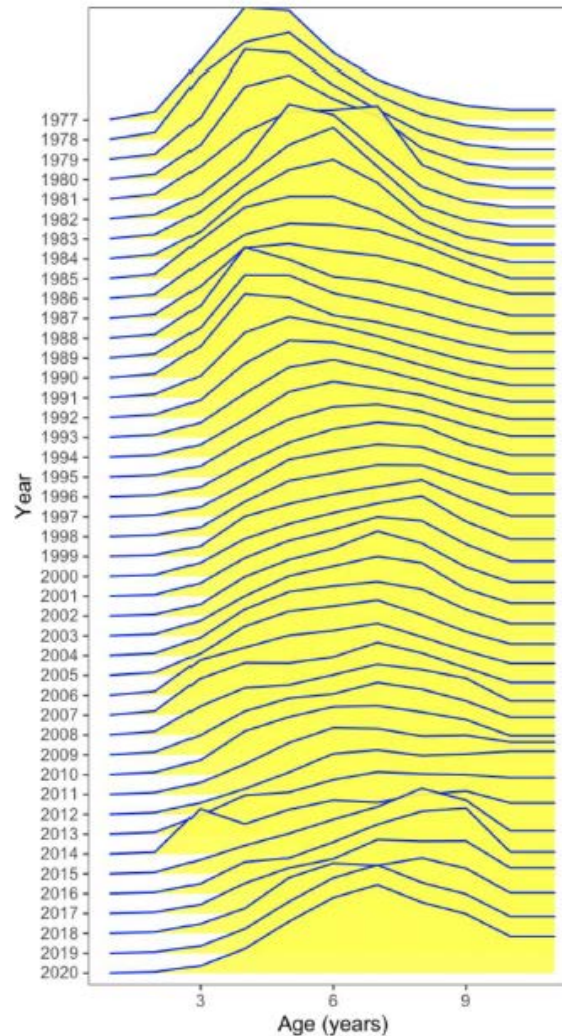
# Atka mackerel, continued

- Fit to fishery age composition data (dots = estimated, bars = observed)



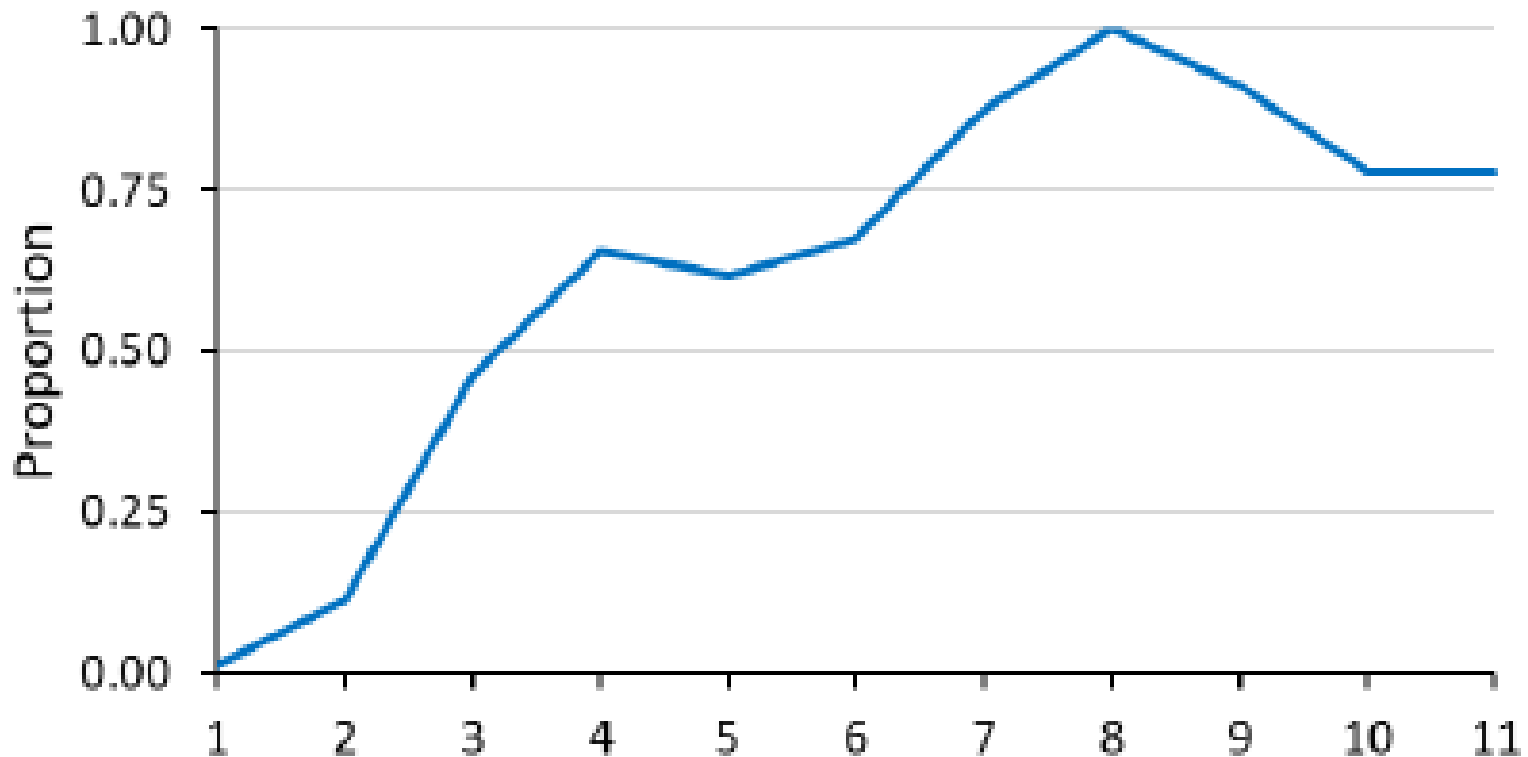
# Atka mackerel, continued

- Fishery selectivity



# Atka mackerel, continued

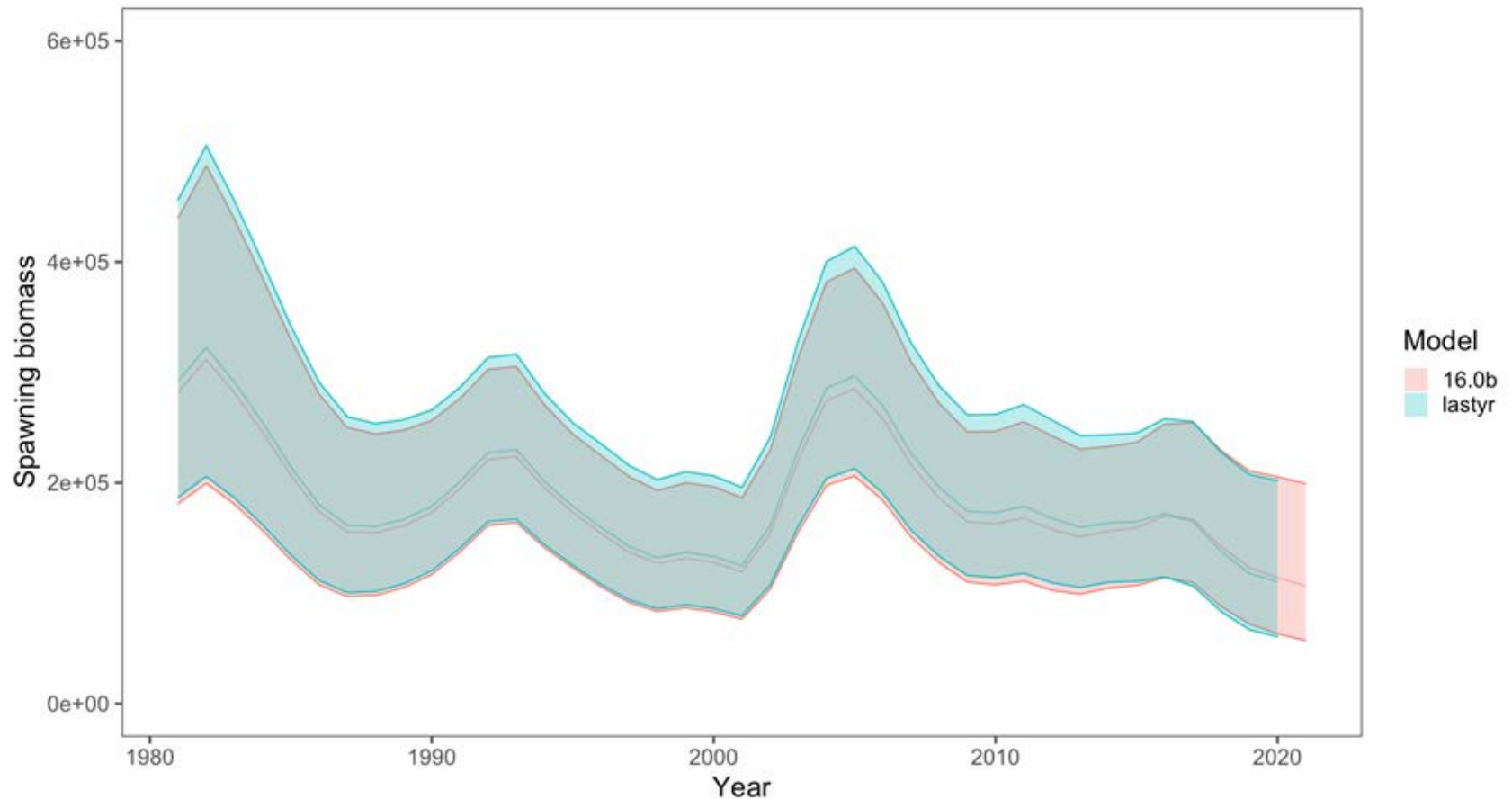
- Survey selectivity





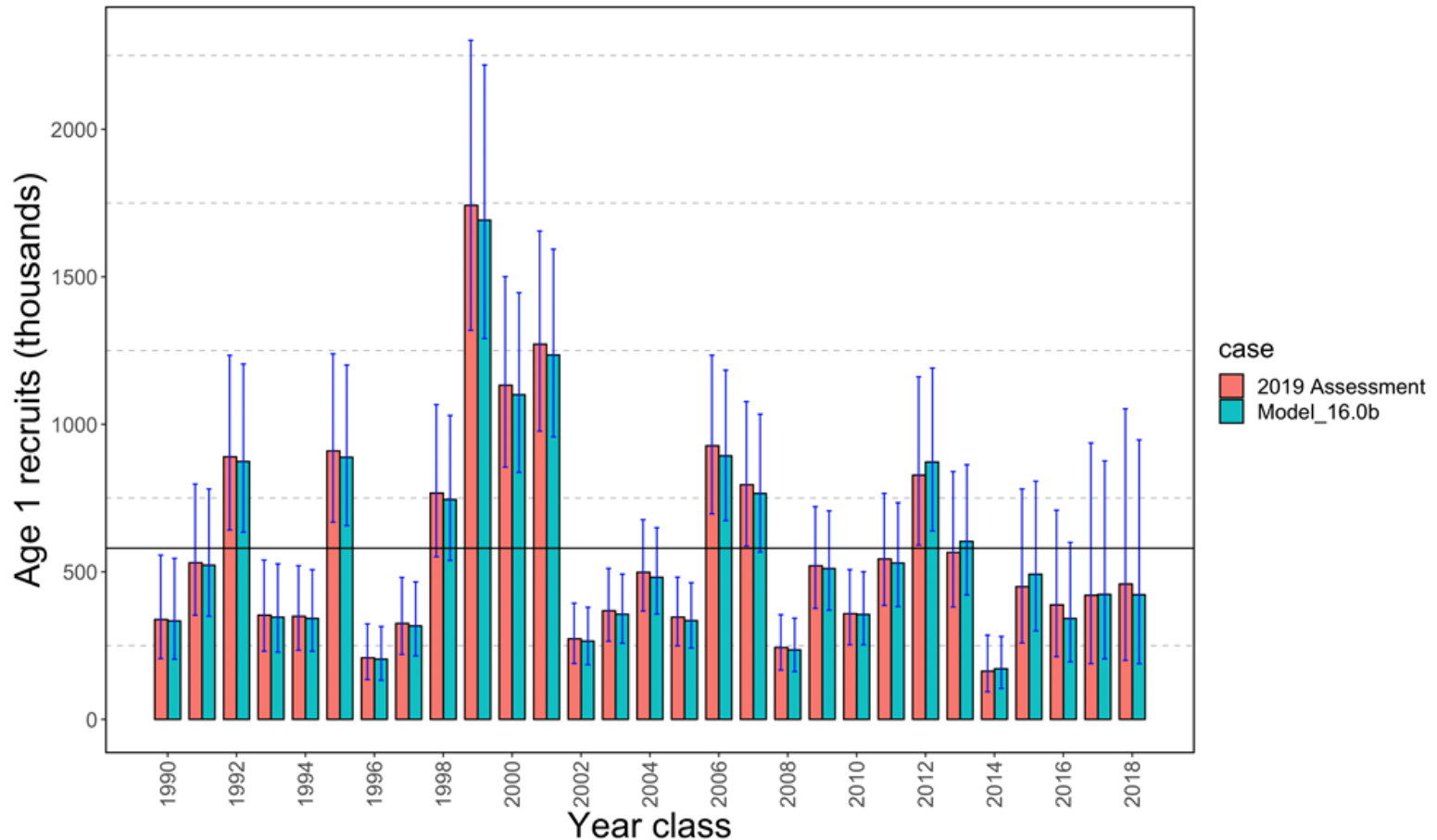
# Atka mackerel, continued

- Spawning biomass time series estimated by model (last year and this)



# Atka mackerel, continued

- Age 1 recruitment time series estimated by model (last year and this)



# Atka mackerel, continued

- Apportionment:
  - Except for the 2016 and 2017 assessments, when area apportionments were based on the Tier 5 RE model, apportionments of Atka mackerel since the 2001 assessment have been based on a 4-survey weighted average, with weights of 8:12:18:27
  - Because no AI surveys have been conducted since 2018, the relative apportionments remain the same as in 2018 and 2019
- Other:
  - During discussion, it was noted that the fishery was somewhat different this year, with additional catch early in the season due to low demand for yellowfin sole and the fleet switching to Atka Mackerel in the spring



# Atka mackerel, continued

Quantity	Last asmt.	This asmt.	Change
M	0.30	0.30	0.00
2020 tier	3b	n/a	none
2021 tier	3b	3b	none
2020 age+ biomass	515,890	n/a	0.09
2021 age+ biomass	534,220	560,360	0.05
2020 spawning biomass	109,900	n/a	-0.02
2021 spawning biomass	104,700	107,830	0.03
B100%	291,780	290,820	0.00
B40%	116,600	116,330	0.00
B35%	102,020	101,790	0.00
2021 FOFL	0.46	0.51	0.11
2021 FABC	0.39	0.43	0.10
2020 OFL	81,200	n/a	0.05
2021 OFL	74,800	85,580	0.14
2020 ABC	70,100	n/a	0.05
2021 ABC	64,400	73,590	0.14



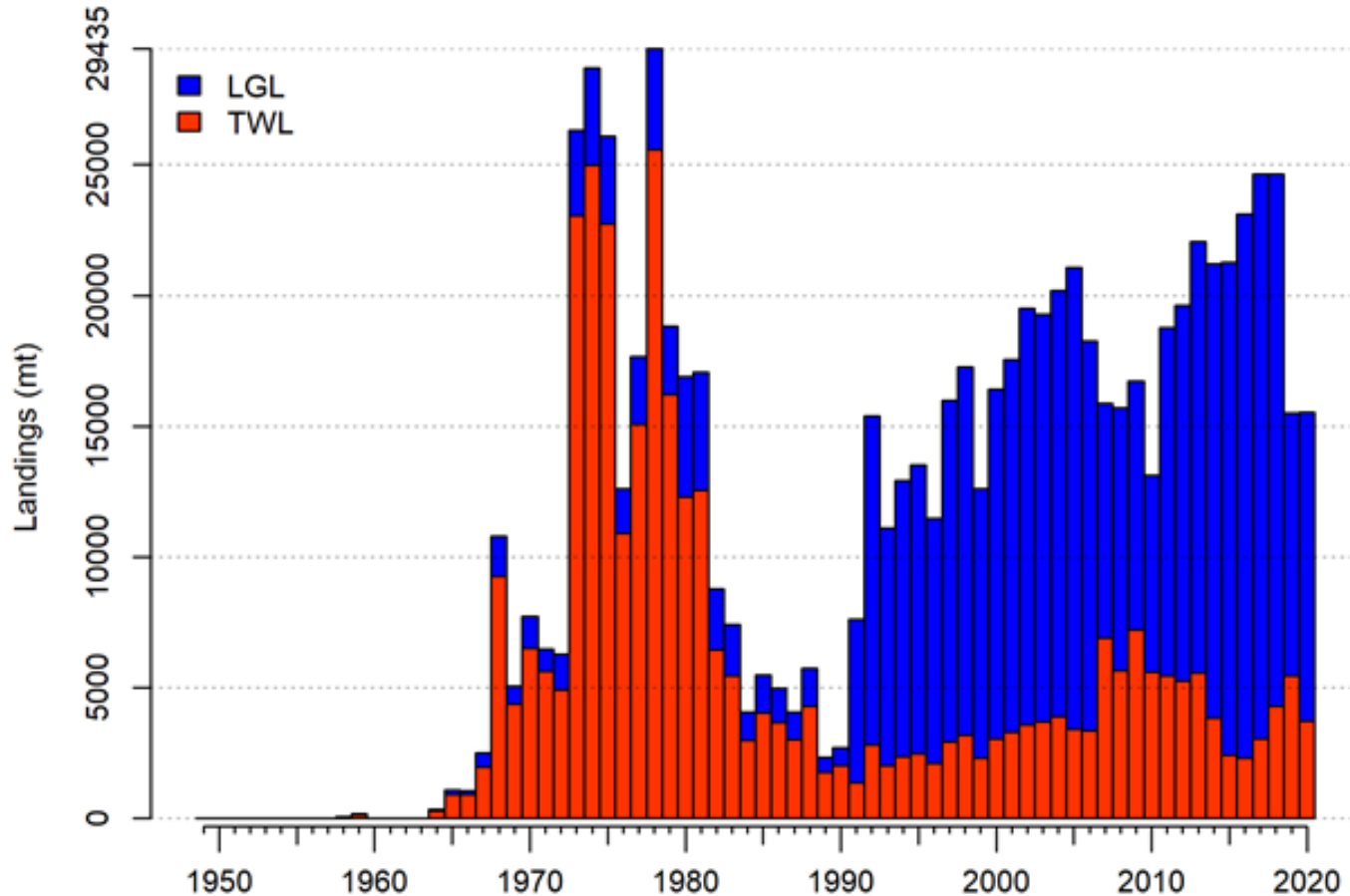
# Chapter 18: skates

- New author: no; >1 model: no\*; change from base: no; risk>1: no
- New data:
  - 2019 EBS shelf survey biomass
  - 2019 EBS shelf survey size composition
  - 2019 fishery size composition
- Model changes/alternatives: none (AK skate = M14.2, other = Tier 5)
- Stock status (AK skate): 2021 spawning biomass is 69% of  $B_{100\%}$
- Stock trend (other): shelf = increasing, slope = variable, AI = declining
- Mohn's  $\rho = 0.14$  (AK skate)



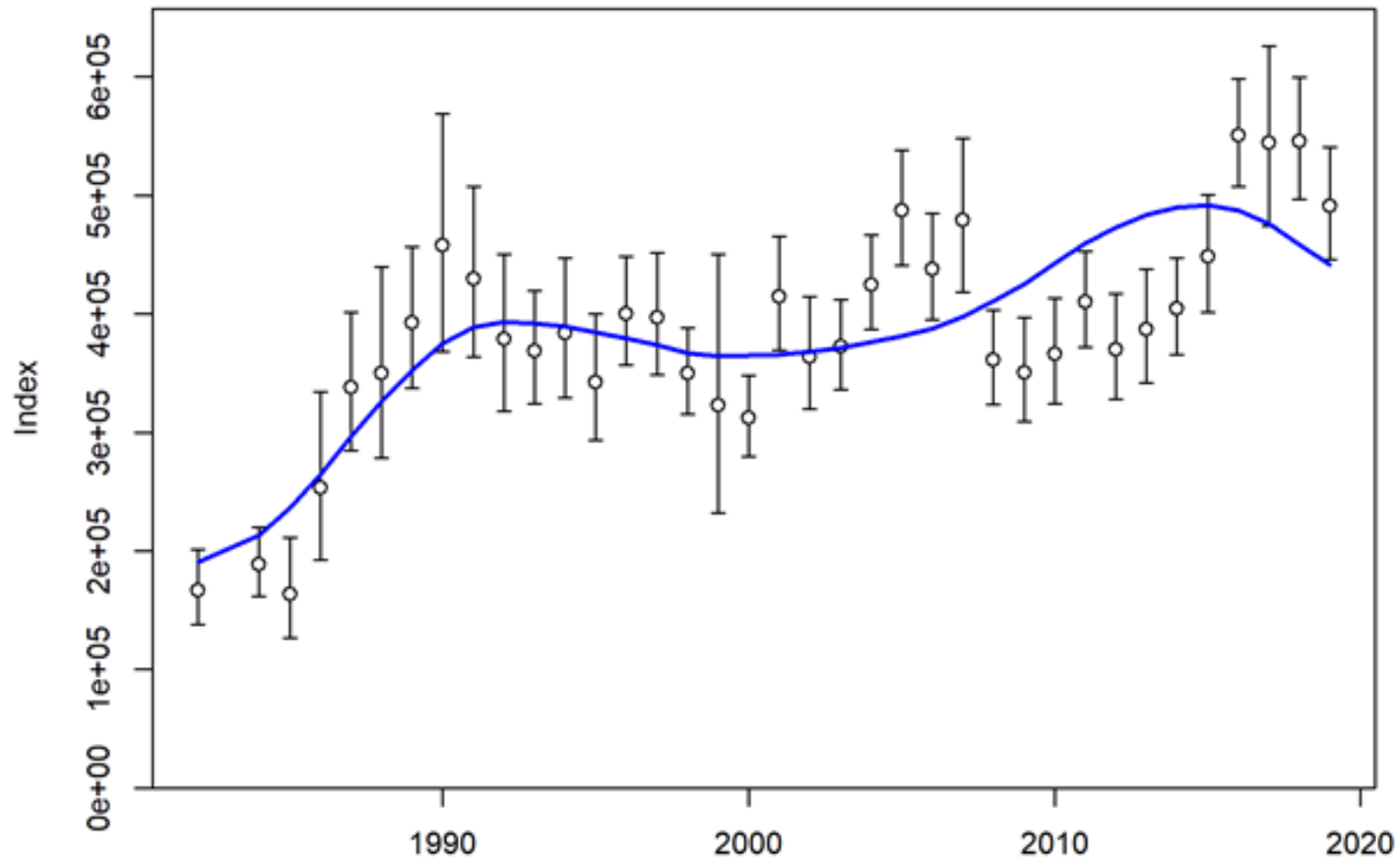
# Skates, continued

- Catch time series (Alaska skate)



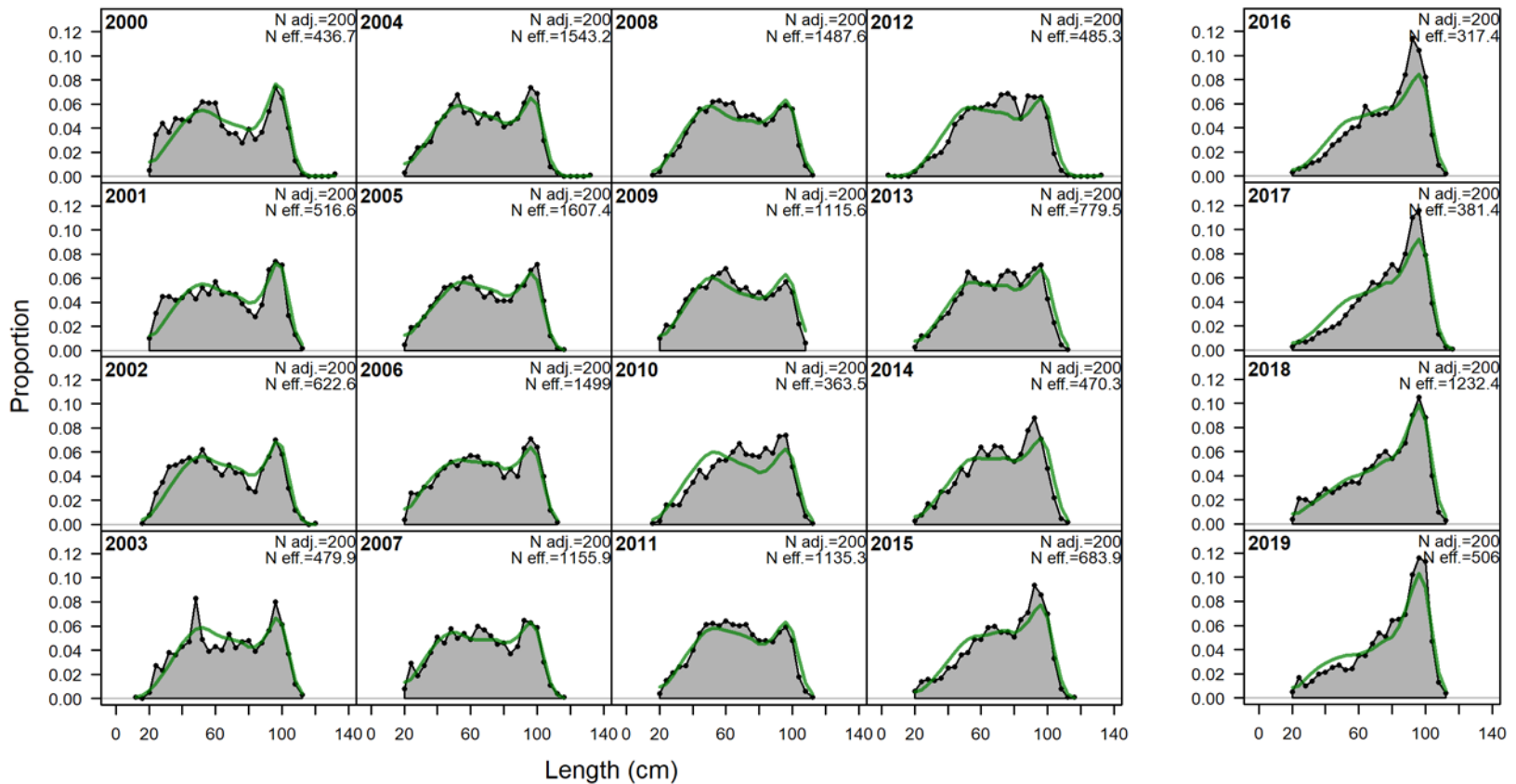
# Skates, continued

- Fit to EBS shelf survey biomass data (Alaska skate)



# Skates, continued

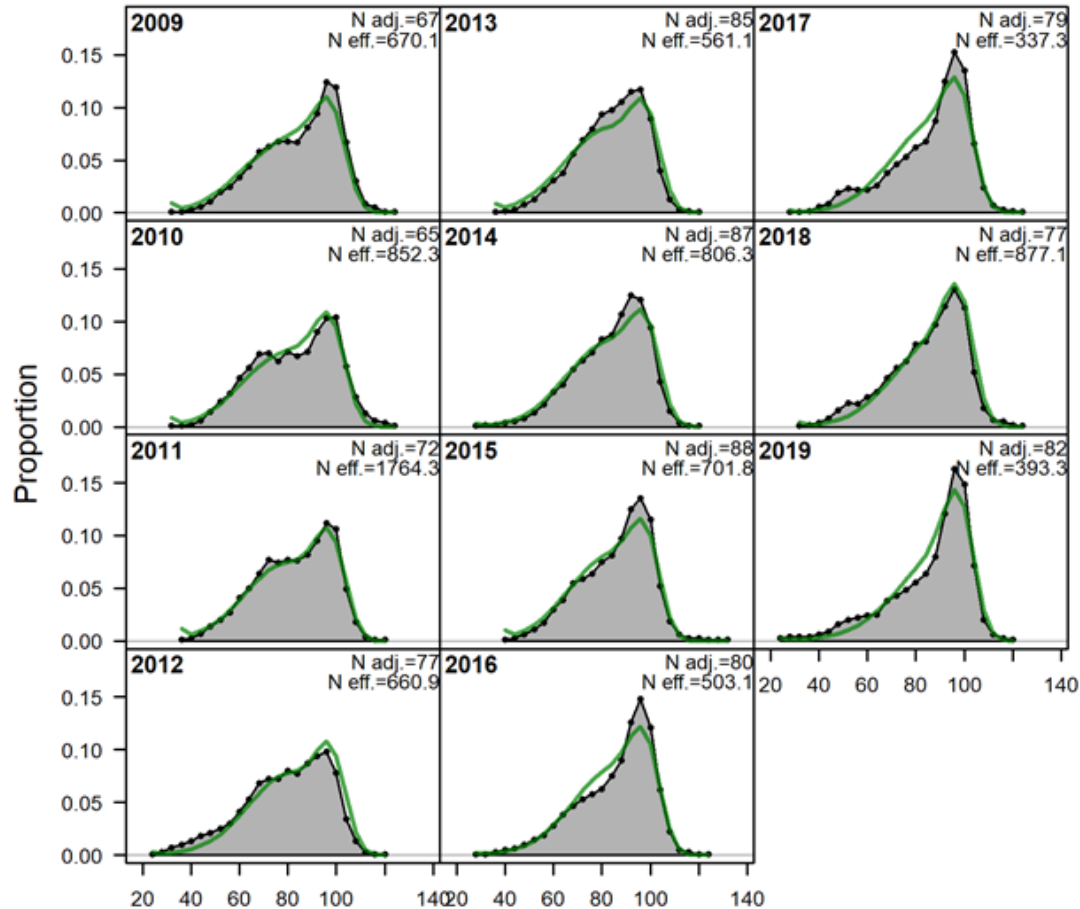
- Fit to survey size composition data (Alaska skate)





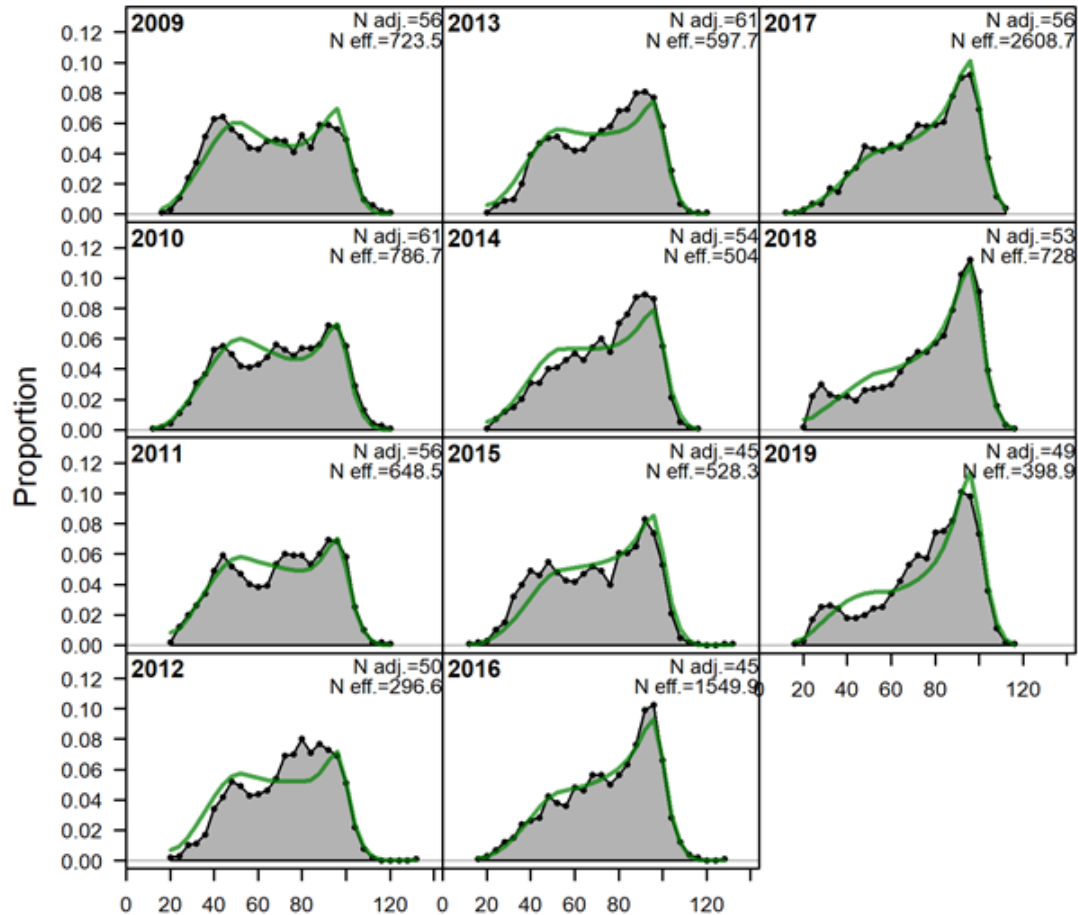
# Skates, continued

- Fit to longline fishery size composition data (Alaska skate)



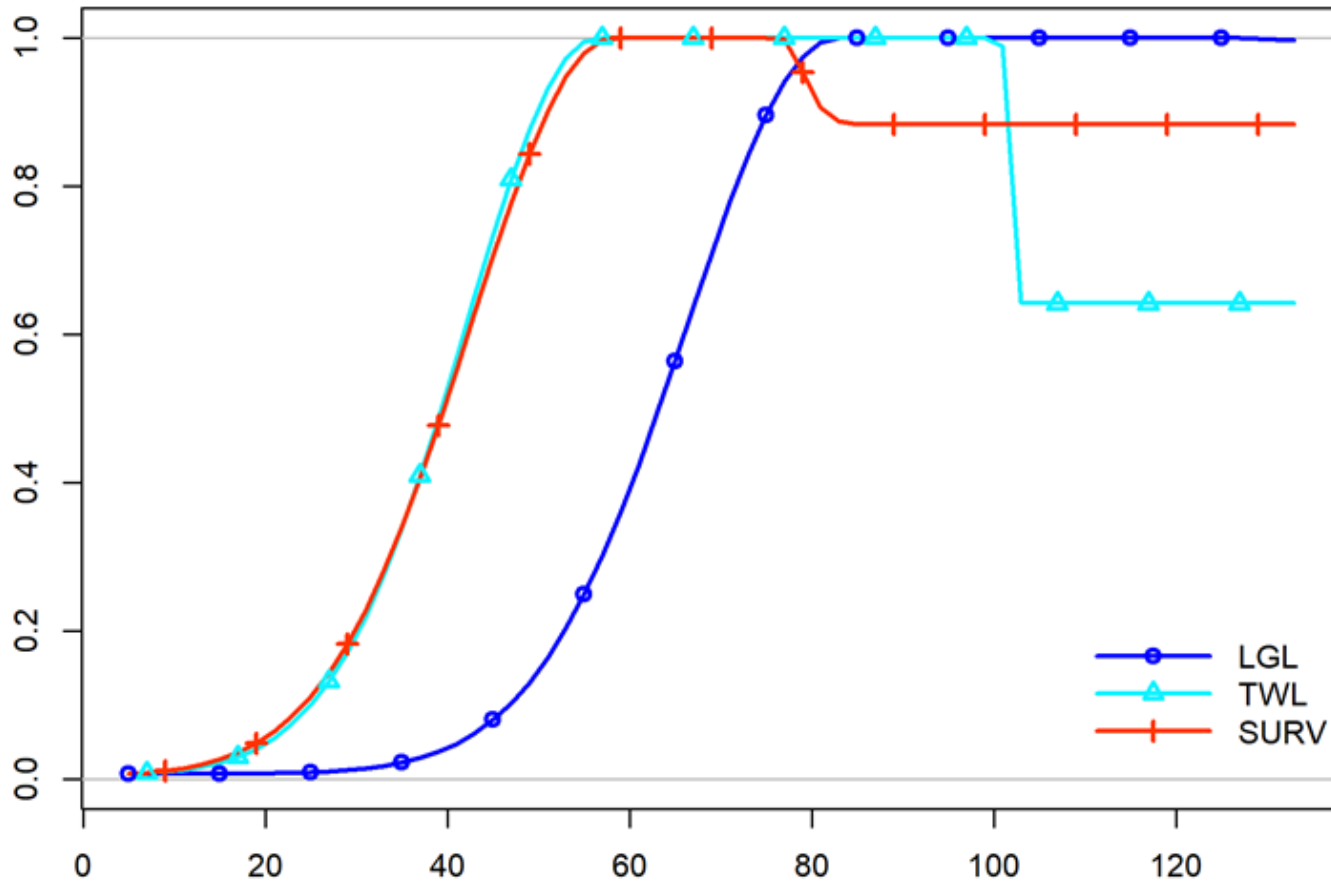
# Skates, continued

- Fit to trawl fishery size composition data (Alaska skate)



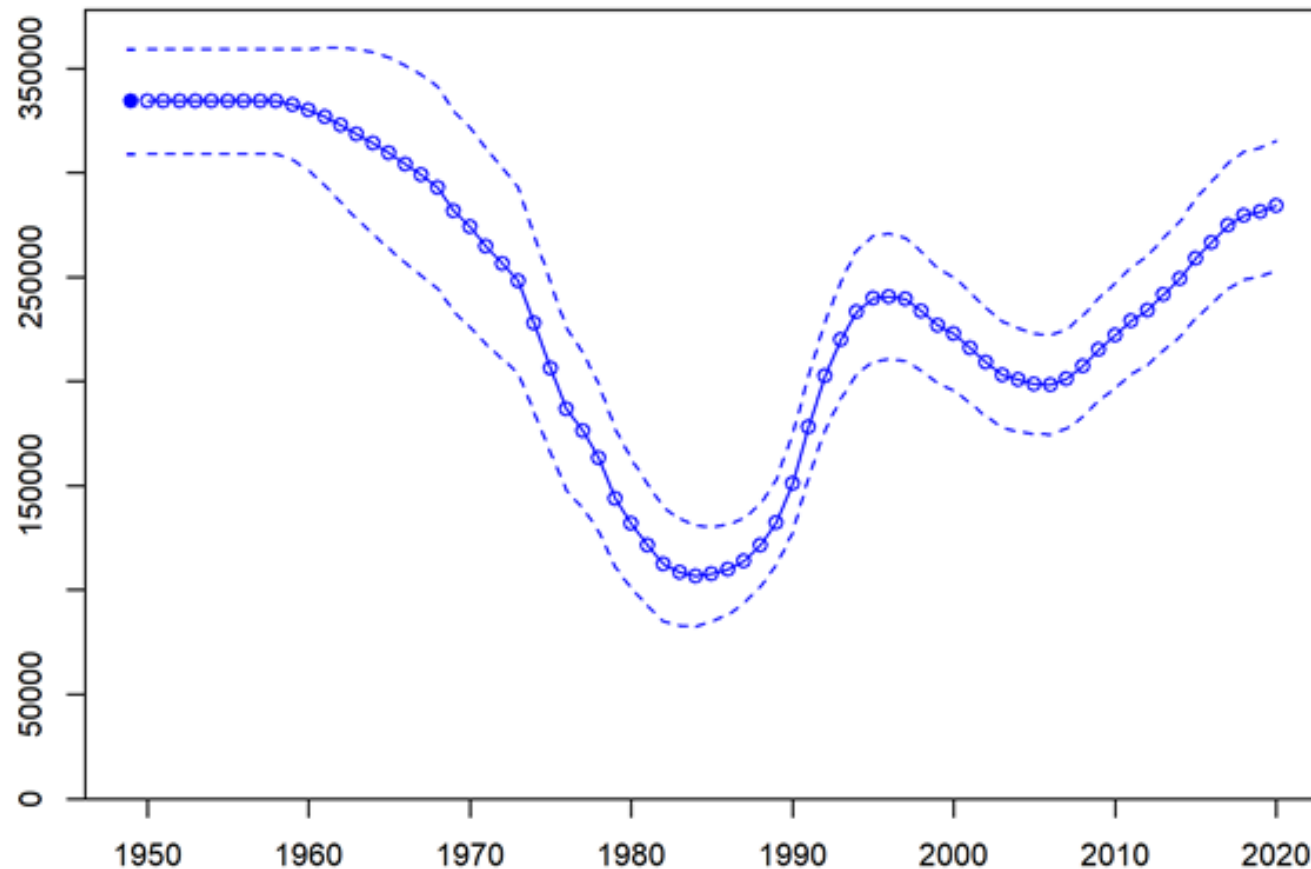
# Skates, continued

- Selectivity (Alaska skate)



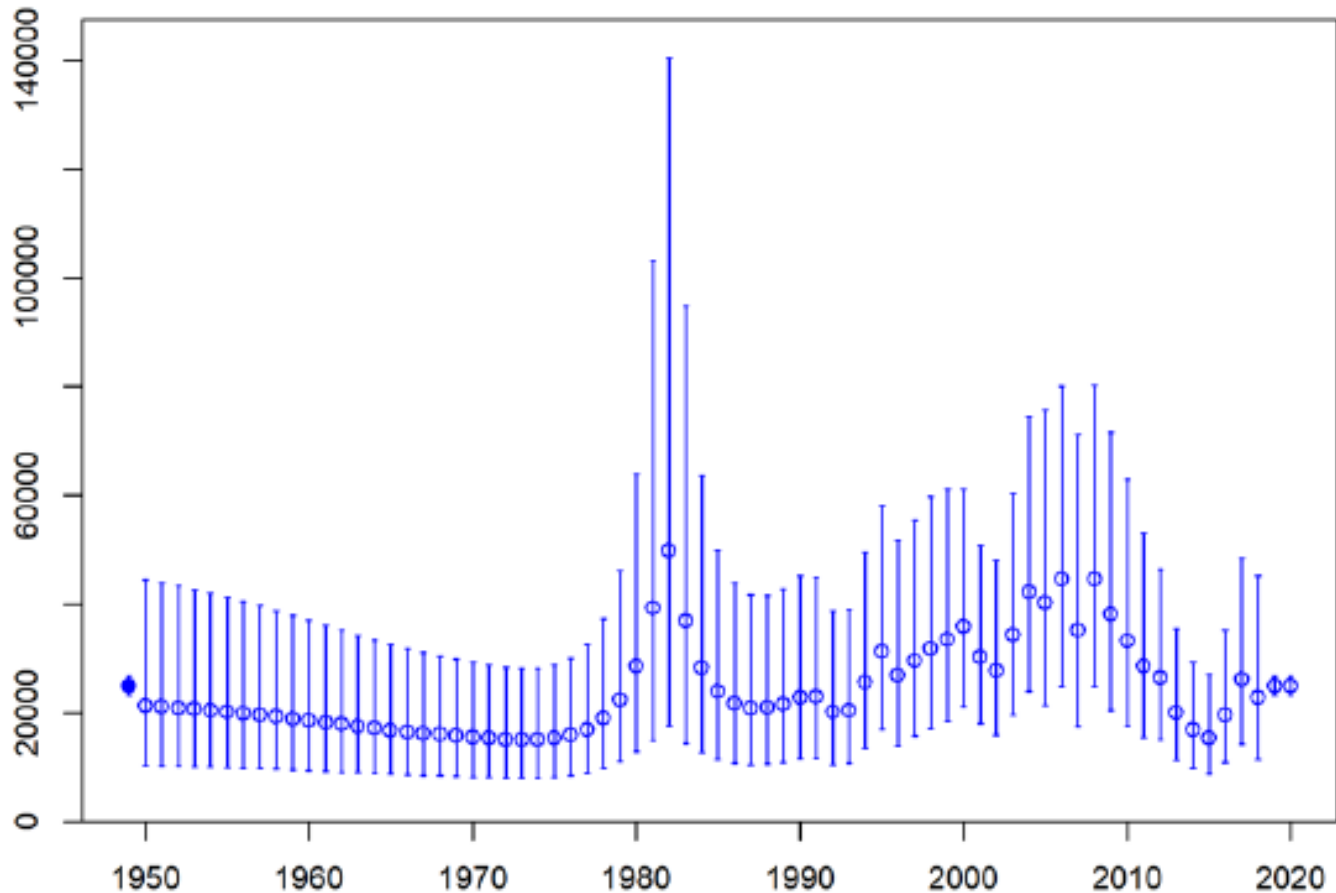
# Skates, continued

- Spawning biomass time series estimated by the model (Alaska skate)



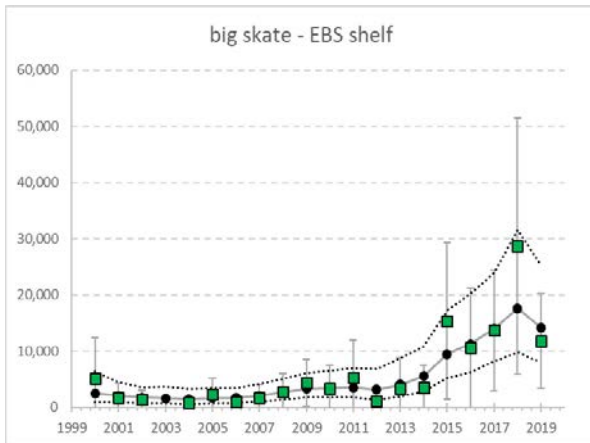
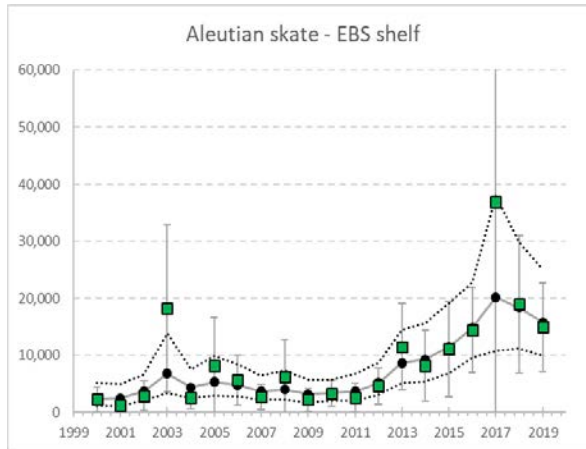
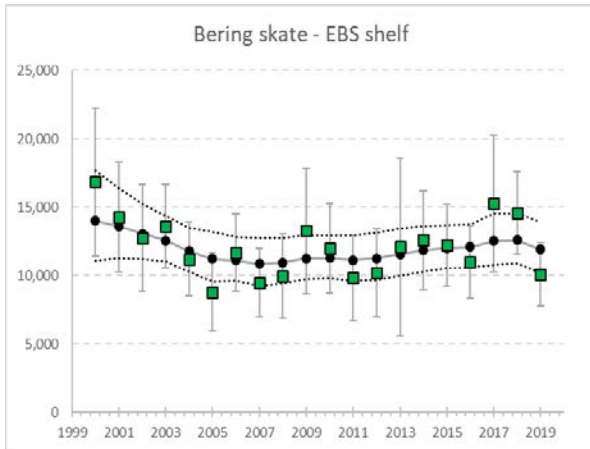
# Skates, continued

- Age 0 recruitment time series estimated by the model (Alaska skate)



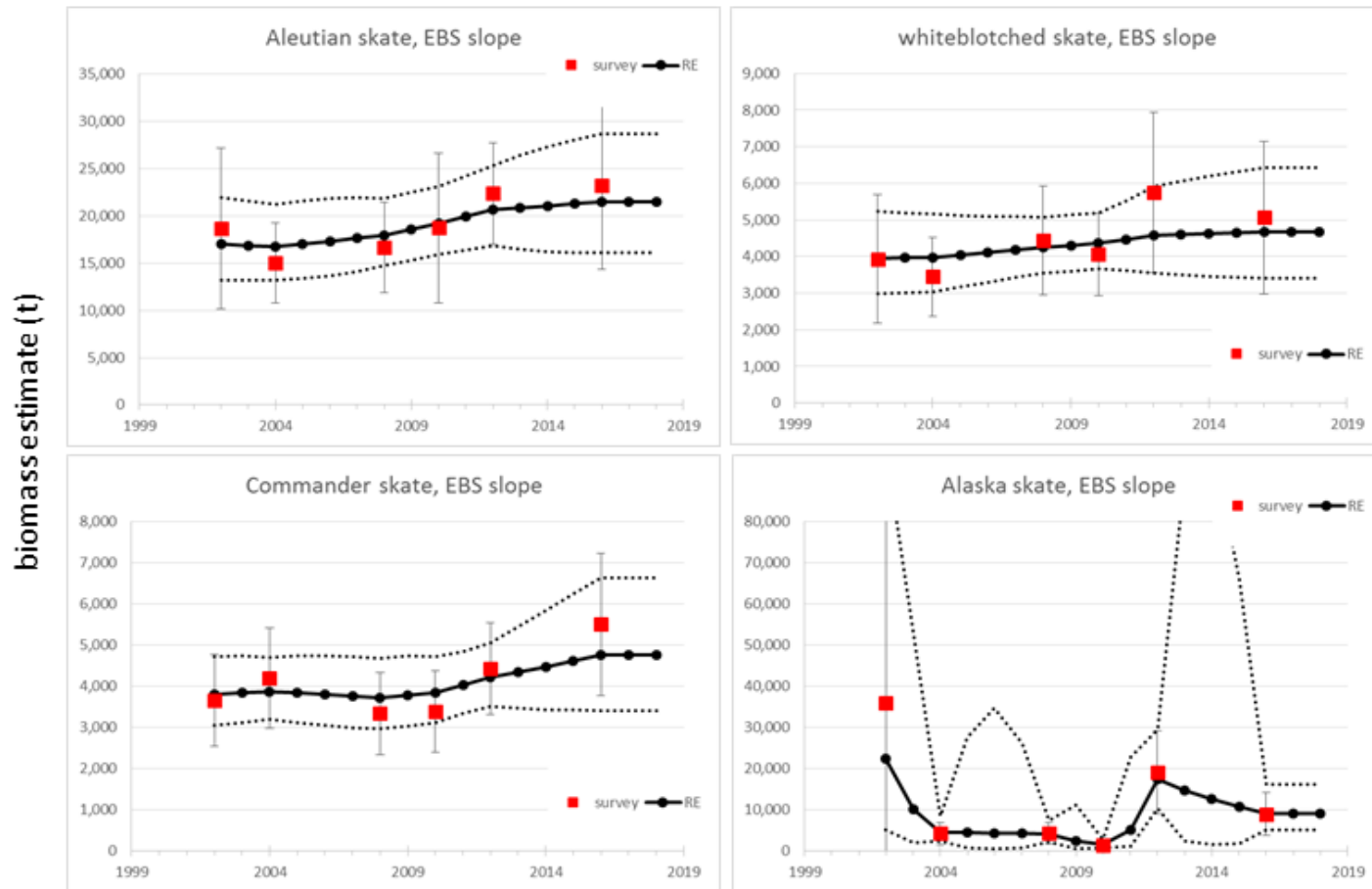
# Skates, continued

- EBS shelf survey biomass time series (other skates)



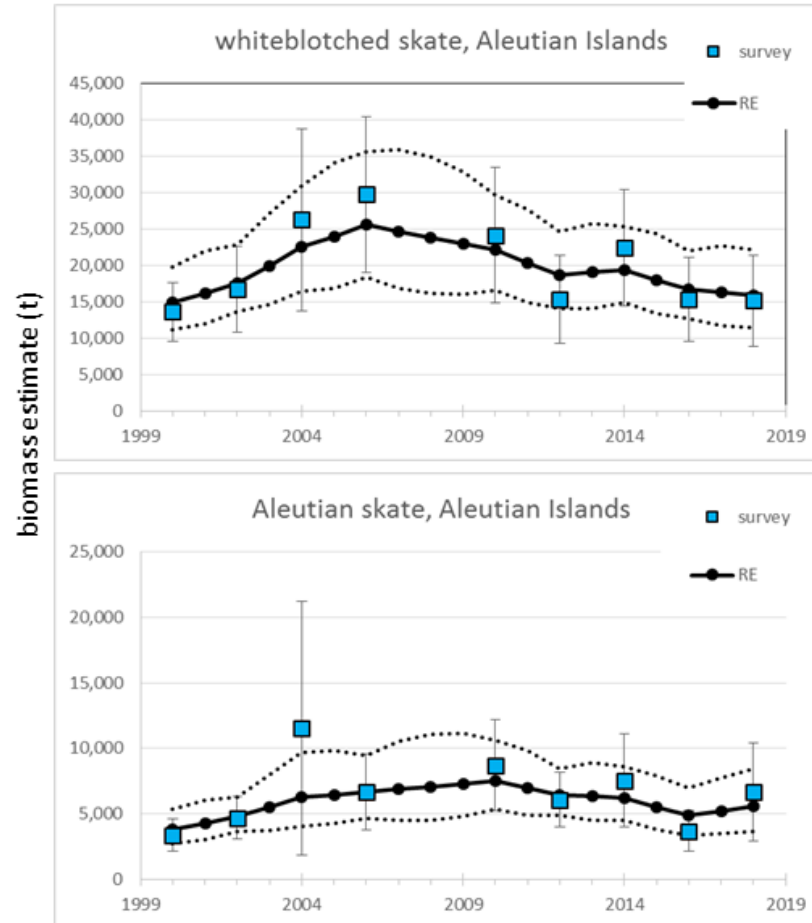
# Skates, continued

- EBS slope survey biomass (other skates)



# Skates, continued

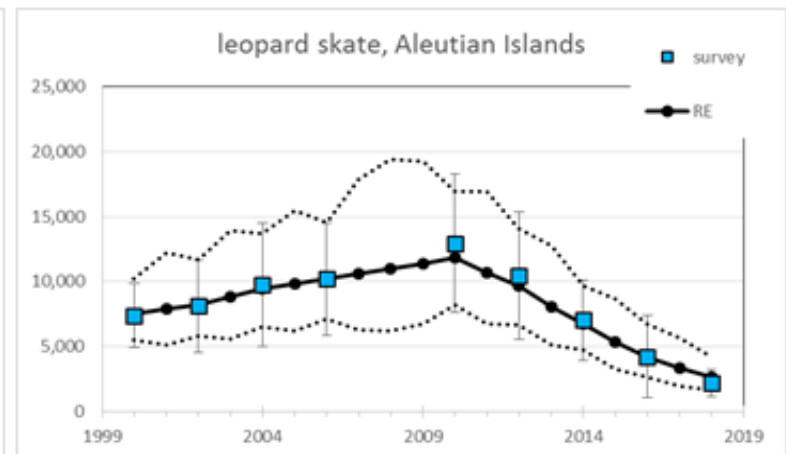
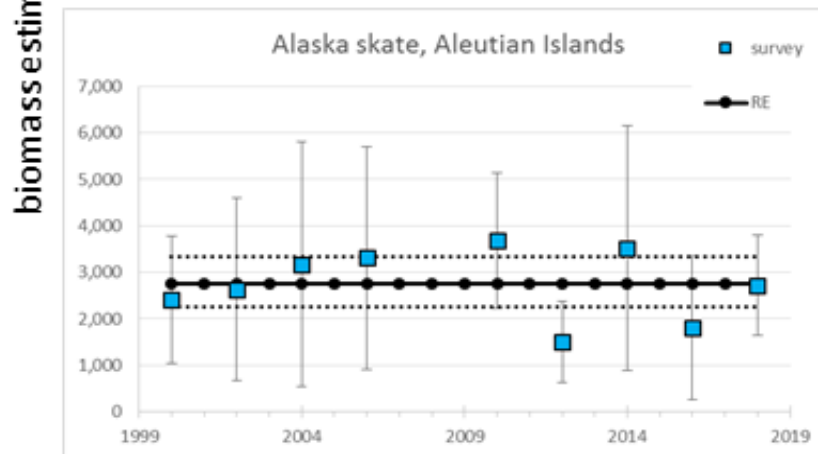
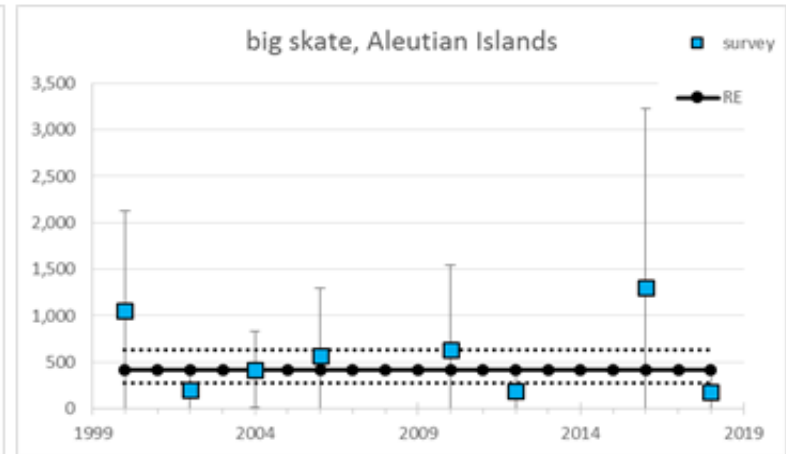
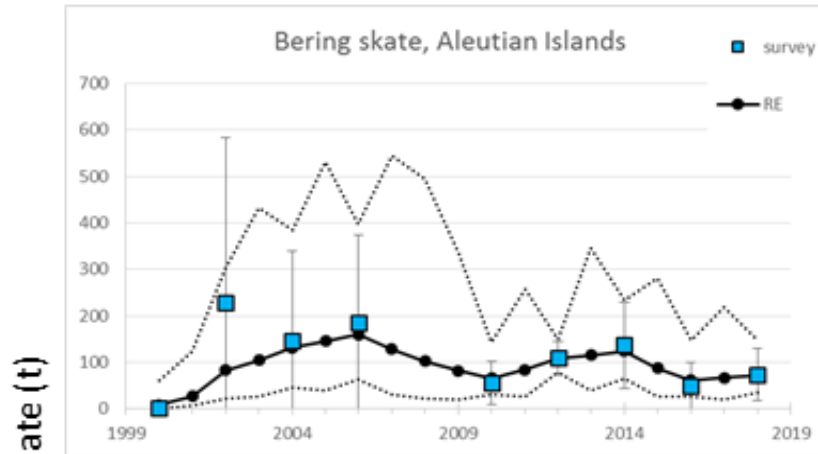
- AI survey biomass (other skates, slide 1 of 2)





# Skates, continued

- AI survey biomass (other skates, slide 2 of 2)



# Skates, continued

Quantity ( <b>Alaska skate</b> )	Last asmt.	This asmt.	Change
M	0.13	0.13	0.00
2020 tier	3a	n/a	none
2021 tier	3a	3a	none
2020 age+ biomass	491,974	n/a	0.03
2021 age+ biomass	478,477	504,691	0.05
2020 spawning biomass	117,973	n/a	0.05
2021 spawning biomass	114,985	123,390	0.07
B100%	177,761	178,425	0.00
B40%	71,105	71,370	0.00
B35%	62,217	62,449	0.00
2021 FOFL	0.094	0.092	-0.02
2021 FABC	0.081	0.079	-0.02
2020 OFL	37,813	n/a	0.02
2021 OFL	36,310	38,580	0.06
2020 ABC	32,559	n/a	0.02
2021 ABC	31,264	33,219	0.06



# Skates, continued

Quantity ( <b>other skates</b> )	Last asmt.	This asmt.	Change
M	0.10	0.10	0.00
2020 tier	5	n/a	none
2021 tier	5	5	none
Biomass	119,787	107,174	-0.11
2021 FOFL	0.10	0.10	0.00
2021 FABC	0.075	0.075	0.00
2020 OFL	11,979	n/a	-0.11
2021 OFL	11,979	10,717	-0.11
2020 ABC	8,984	n/a	-0.11
2021 ABC	8,984	8,038	-0.11



# Chapter 19: sharks

- New author: **no**; >1 model: **yes**; change from base: **no**; risk>1: **yes**
- New data:
  - IPHC longline survey RPN updated through 2019
  - EBS shelf trawl survey biomass updated through 2019
- Model changes/alternatives (all Tier 6):
  - Model 16.0, the current base method (max. catch 2003-2015)
  - Model 20.0, median catch 2003-2015
  - Model 20.1, 5<sup>th</sup> catch percentile 2003-2015
  - Model 20.2, 99<sup>th</sup> catch percentile 2003-2015
- Stock trend: difficult to quantify
- Risk levels: **assess.** = 2, **pop. dy.** = 2, env./eco. = 1, fishery = 1



# Sharks, continued

- Risk table
  - Assessment considerations (Level 2):
    - As a Tier 6 complex data are severely limited, and the assessment does not incorporate life history or any other biological information in the OFL/ABC calculations
    - For non-targeted, low value (i.e., discarded) species, a catch-scalar approach may suffice if the species is sufficiently productive to be sustainably harvested at that rate
    - For Pacific sleeper sharks, it is unclear how productive the species is, and indications are that it is highly vulnerable to overfishing
    - There are concerns over the accuracy of the catch estimates due to the difficulty in sampling such large species
  - (Continued on next slide)



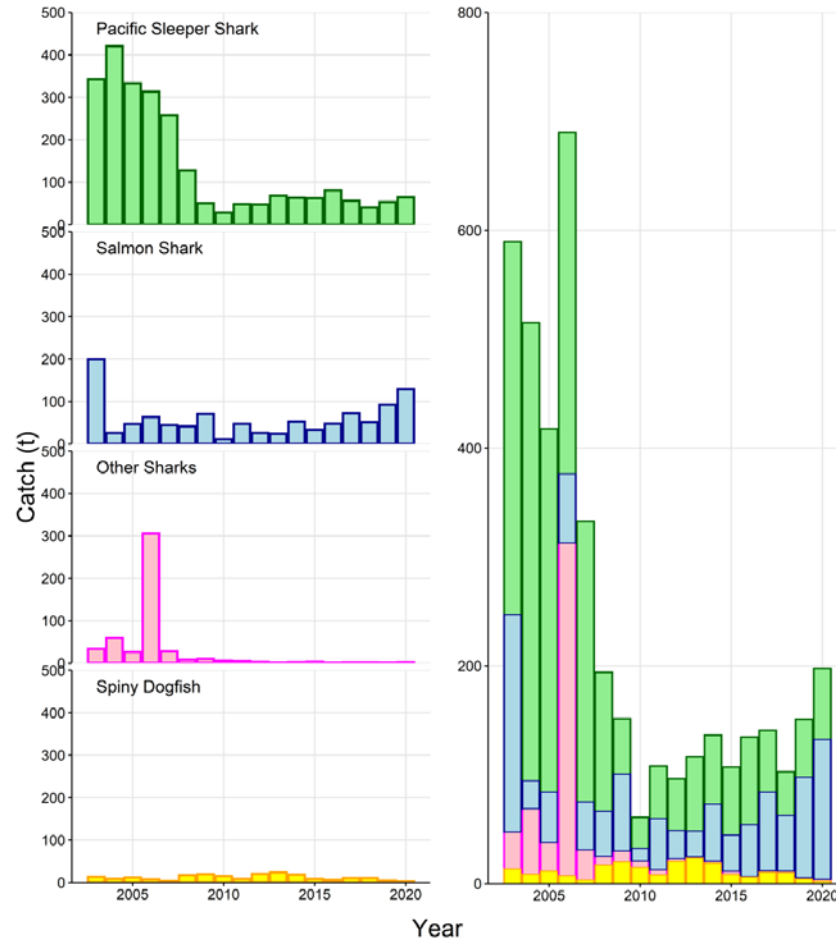
# Sharks, continued

- Risk table, continued:
  - Population dynamics considerations (Level 2):
    - The only informative indicator of stock trends is the IPHC longline survey RPNs
    - The index is not included in considerations of OFL within this assessment
    - The Pacific sleeper shark RPNs declined from their peak at the beginning of the time series and have remained low since 2004
    - This trend is mirrored in other regions (e.g., GOA, Canada and U.S. West Coast) of the IPHC survey and in other surveys, such as the ADF&G Southeast Alaska longline survey
    - It is unclear if the peak at the beginning of the time series was unusual, or if the current low state reflects low population sizes



# Sharks, continued

- Catch time series



# Sharks, continued

- Alternative methods for setting harvest specifications

Species	Spiny dogfish	Pacific sleeper shark	Salmon shark	Other/Unidentified shark	Total shark Complex*
Maximum Catch (t)	24	421	199	305	689
Model 16.0 OFL	24	421	199	305	689
Model 16.0 ABC	18	315	149	229	517
Median Catch (t)	8	68	44	13	151
Model 20.0 OFL	8	68	44	13	151
Model 20.0 ABC	6	51	33	10	113
5th Percentile	5	38	19	2	82
Model 20.1 OFL	5	38	19	2	82
Model 20.1 ABC	4	30	14	1	61
99 <sup>th</sup> Percentile	276	411	184	23	677
Model 20.2 OFL	276	411	184	23	677
Model 20.2 ABC	207	308	138	17	508

\*The complex total is based on the whole complex, not the sum of the individual species maximums.





# Sharks, continued

Quantity	Last asmt.	This asmt.	Change
2020 tier	6	n/a	none
2021 tier	6	6	none
2020 OFL	689	n/a	0.00
2021 OFL	689	689	0.00
2020 ABC	517	n/a	0.00
2021 ABC	517	517	0.00



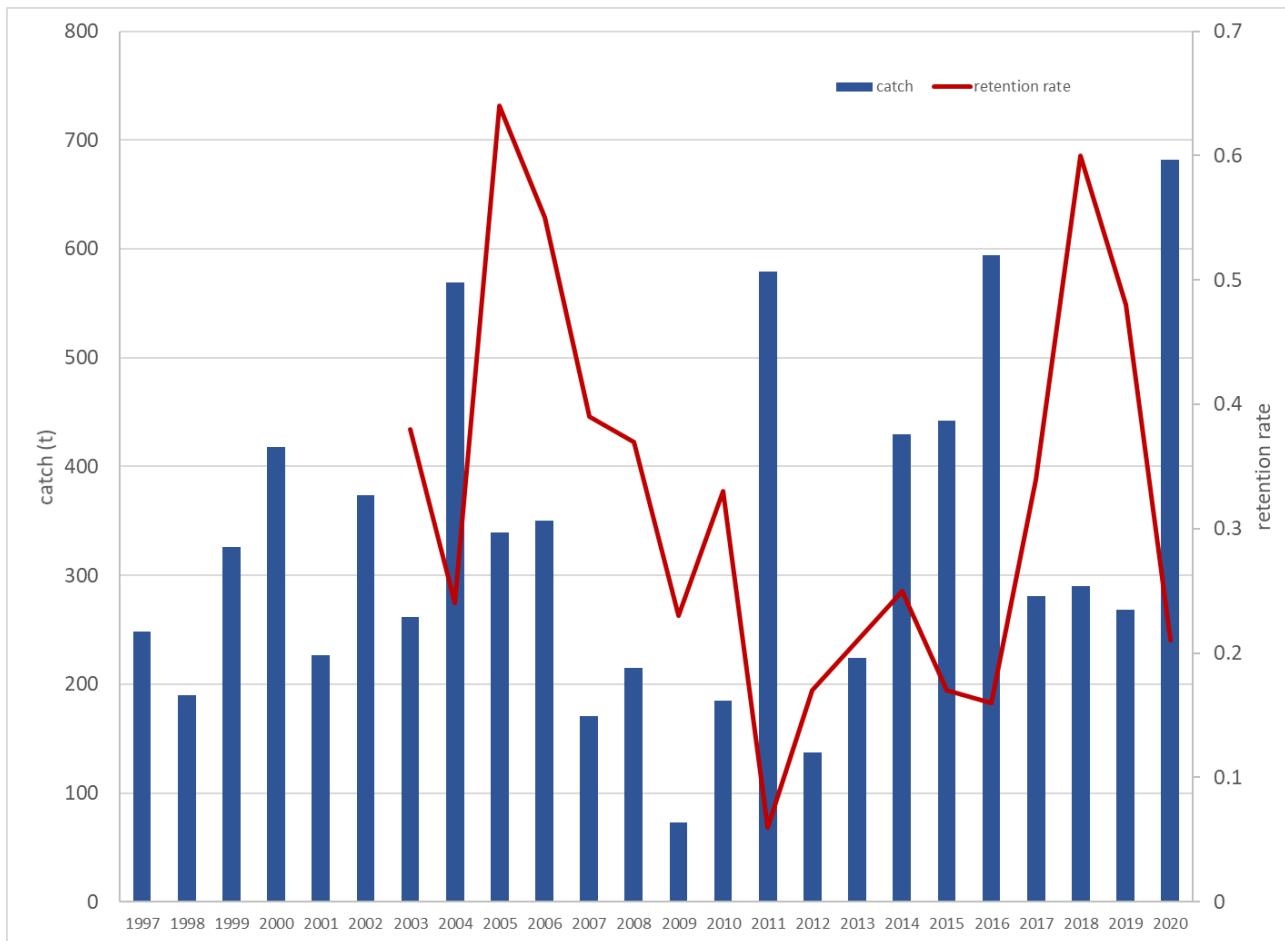
# Chapter 22: octopus

- New author: no; >1 model: no; change from base: no; risk>1: no
- New data:
- Model changes/alternative: none (Tier 6)
- Stock trend: unknown



# Octopus, continued

- Catch and retention



# Octopus, continued

Quantity	Last asmt.	This asmt.	Change
2020 tier	6	n/a	none
2021 tier	6	6	none
2020 OFL	4,769	n/a	0.00
2021 OFL	4,769	4,769	0.00
2020 ABC	3,576	n/a	0.00
2021 ABC	3,576	3,576	0.00

