NOAA FISHERIES

Alaska Fisheries
Science Center

BSAI Plan Team report

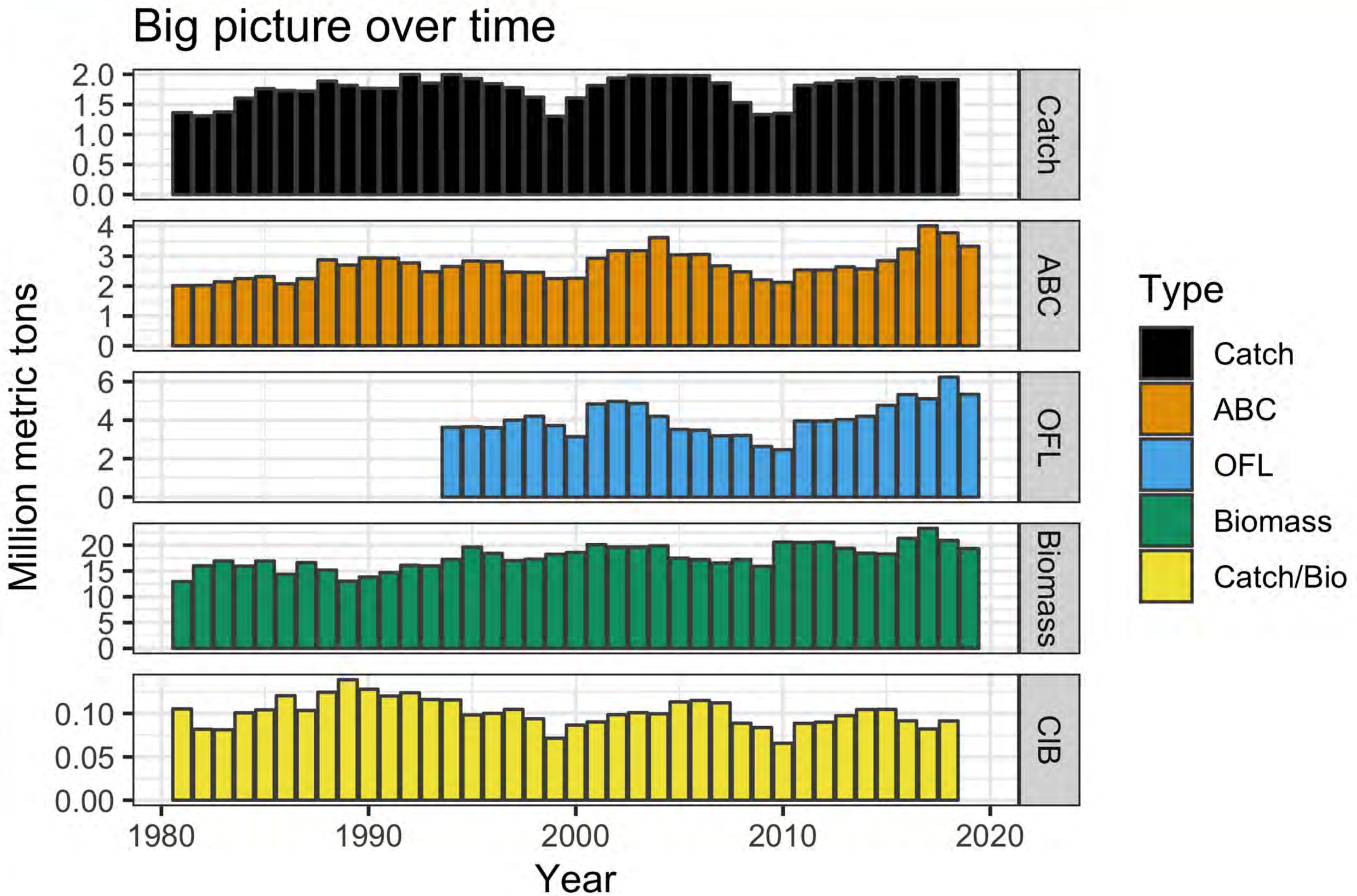
Grant Thompson, chair
Diana Stram, coordinator

December 5, 2018

Team members

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

“Big picture” overview



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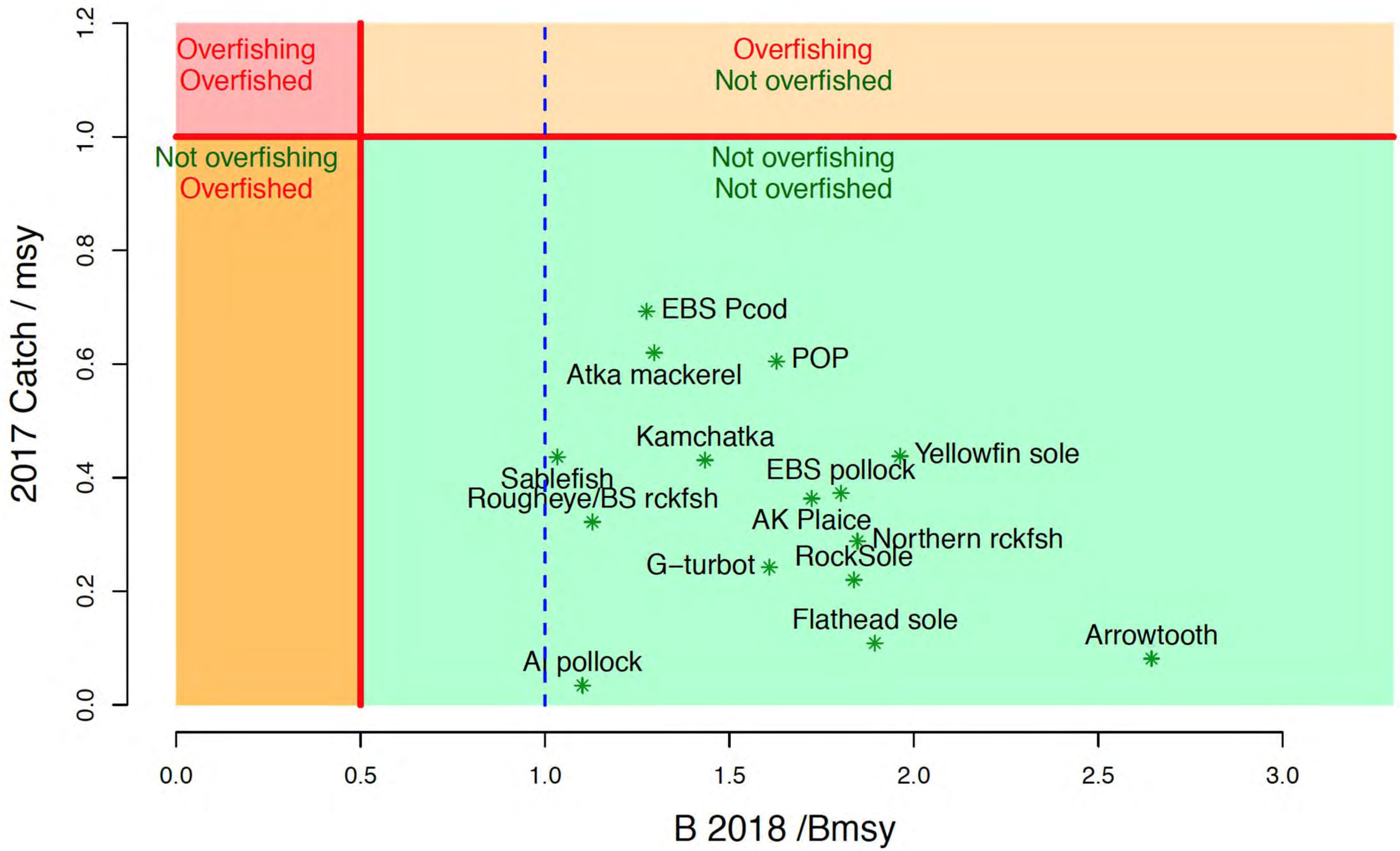
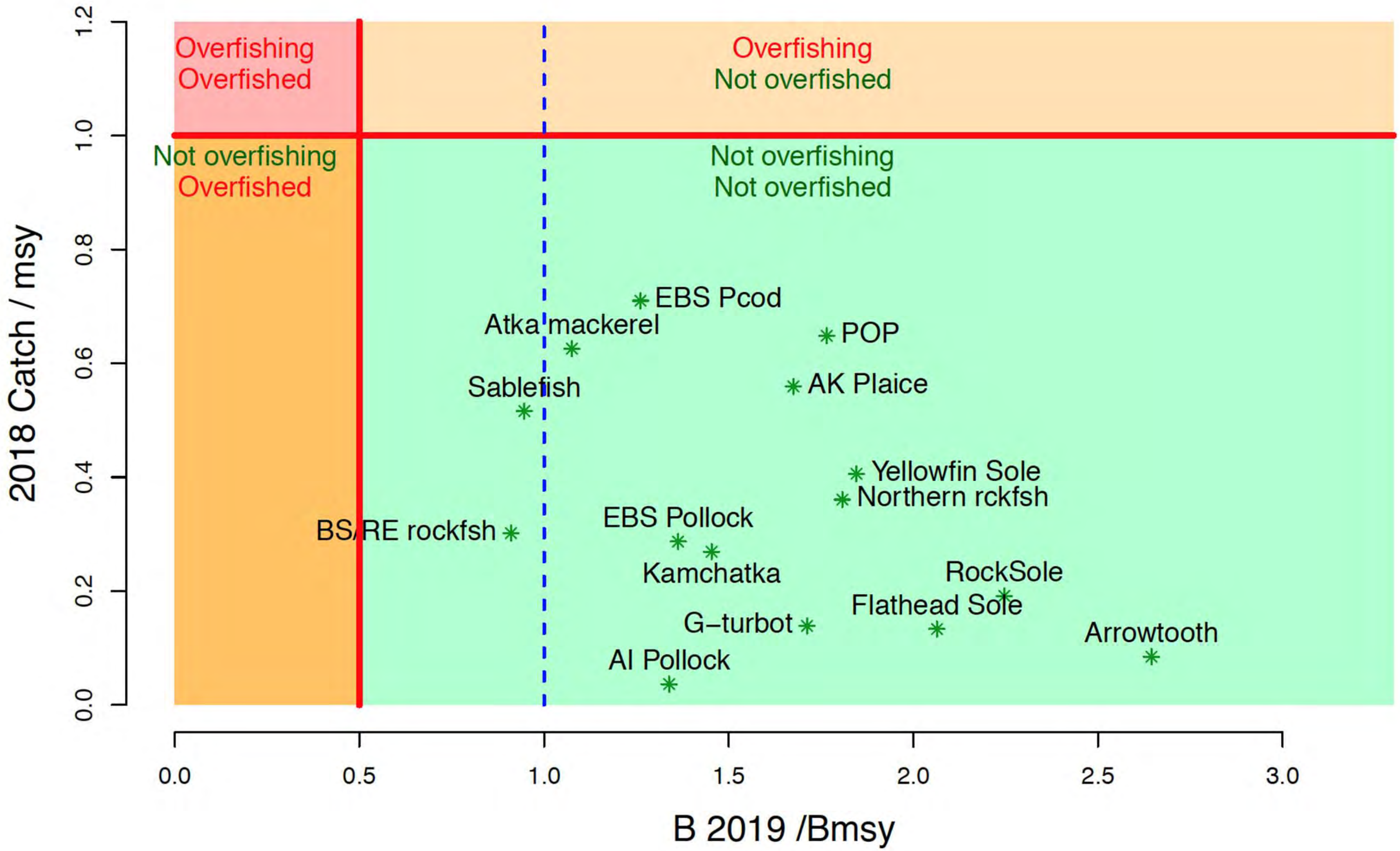
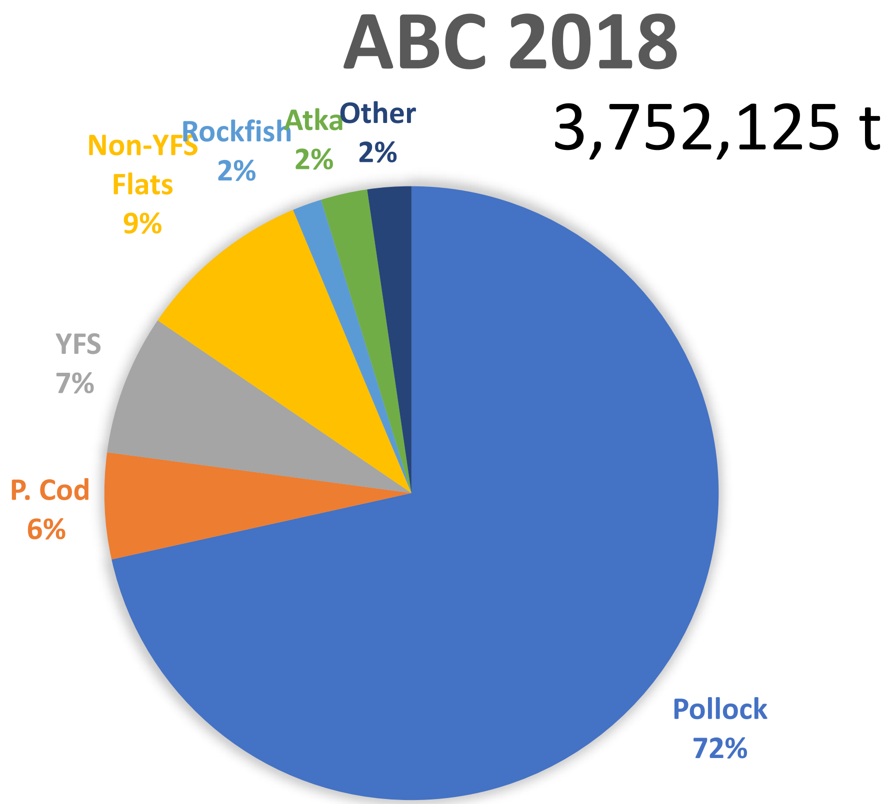
Stock status 2017

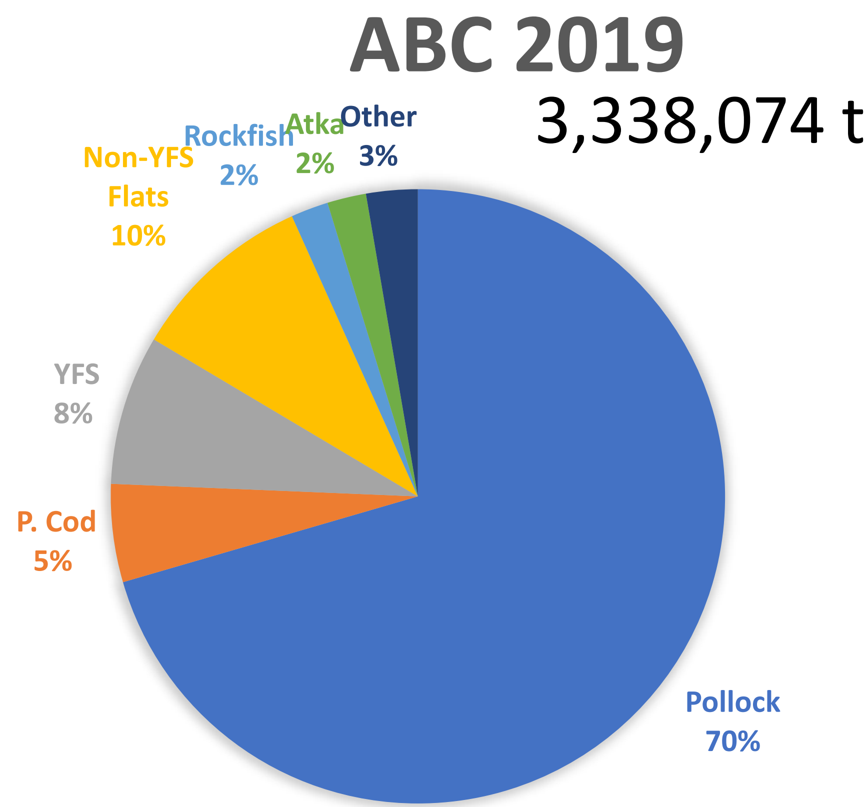


Stock status 2018

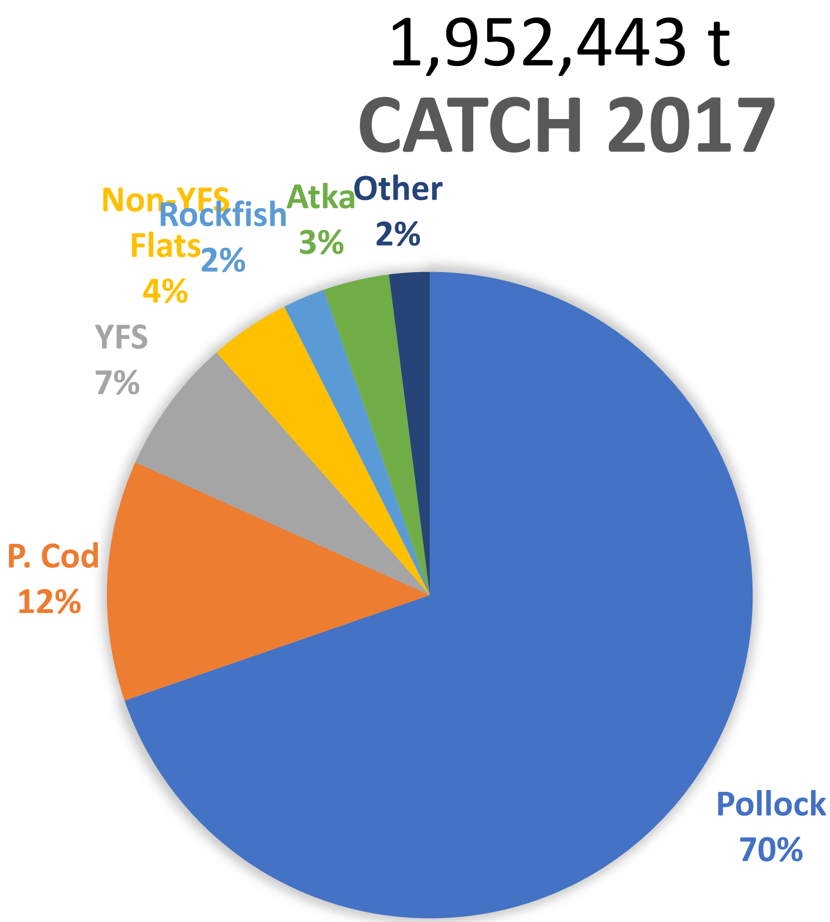


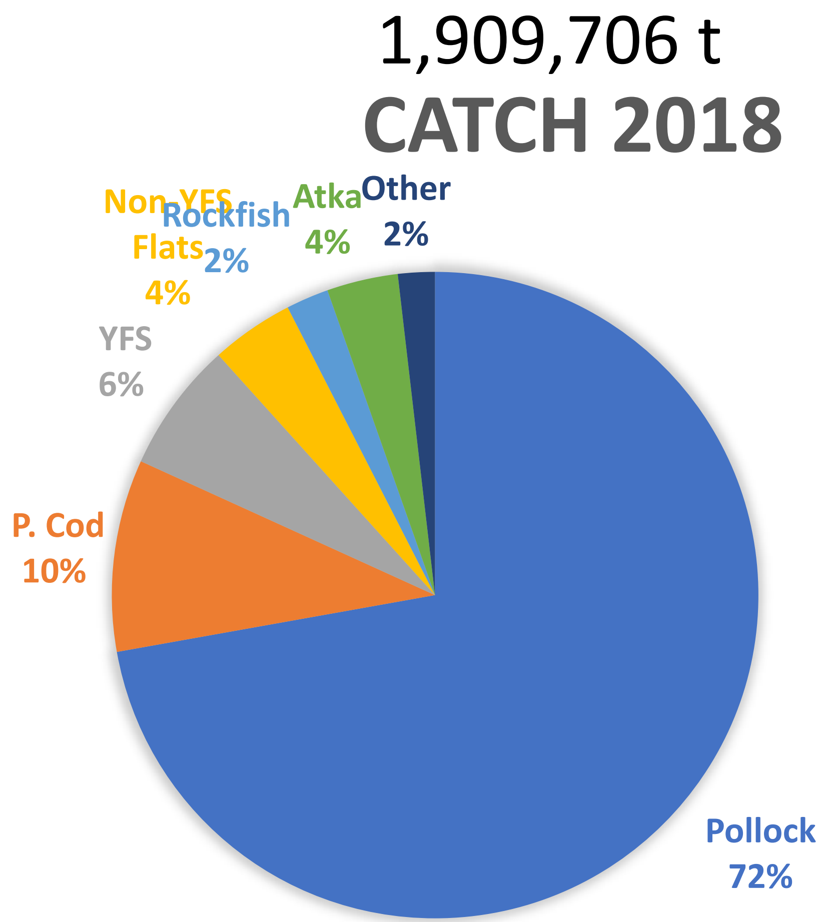
BSAI Plan Team ABCs



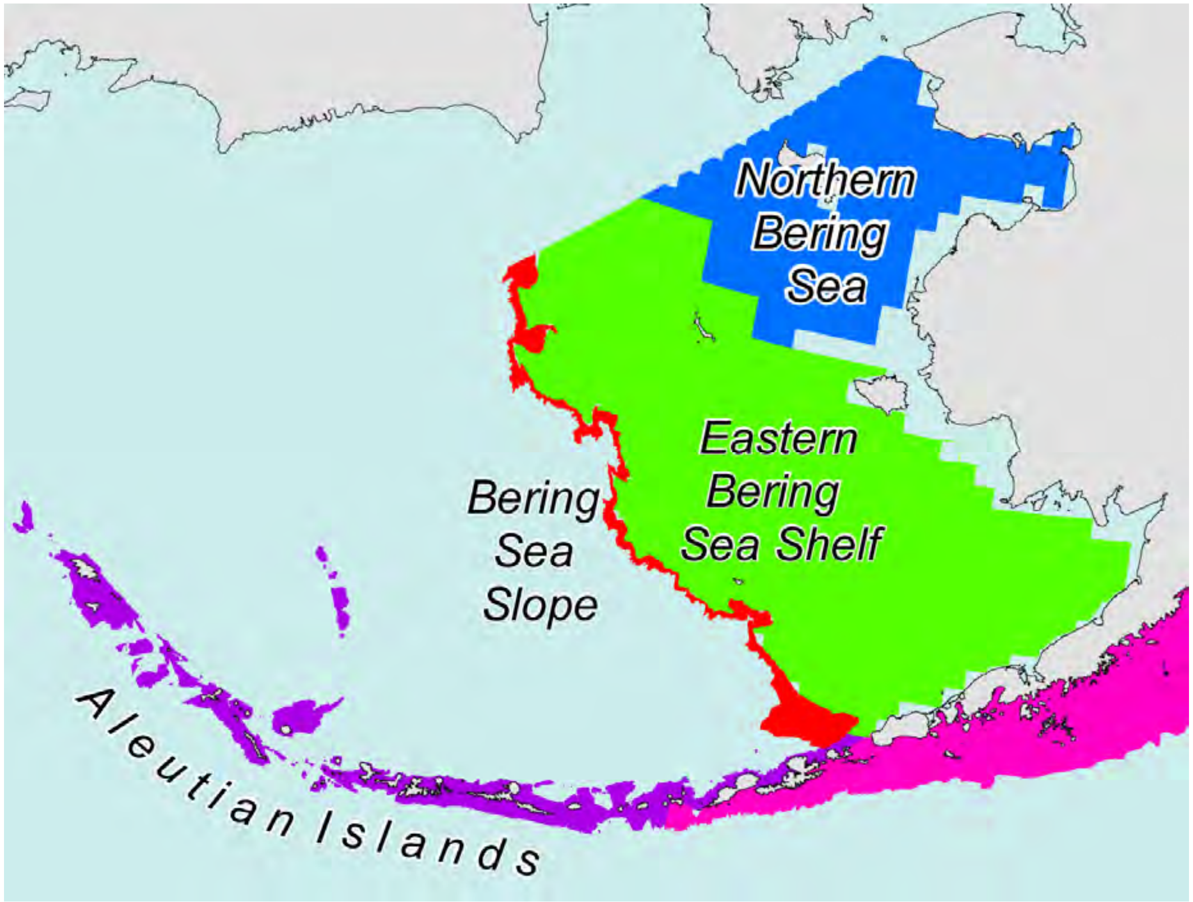


BSAI Catches





BSAI bottom trawl survey areas



Changes in EBS shelf biomass, 1999-2018

- Not included: sablefish, rockfish, Atka mackerel, shark, octopus
- Color gradients are row-specific

Species/complex	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Alaska plaice	0.05	-0.07	0.22	-0.22	0.09	0.04	0.06	0.26	-0.34	0.20	0.04	-0.06	0.04	0.12	-0.13	-0.11	-0.21	0.20	0.15	-0.15
arrowtooth flounder	-0.31	0.31	0.20	-0.17	0.59	0.04	0.28	-0.08	-0.21	0.10	-0.23	0.30	-0.01	-0.23	0.01	0.15	-0.12	0.16	-0.11	0.21
flathead sole	-0.41	-0.04	0.32	0.07	-0.06	0.20	0.04	-0.03	-0.10	-0.04	-0.24	0.19	0.19	-0.34	0.28	0.07	-0.23	0.16	0.19	-0.11
Greenland turbot	-0.38	0.08	0.18	-0.12	0.29	-0.09	-0.25	-0.02	-0.20	-0.19	-0.19	1.14	0.12	-0.17	0.14	0.13	-0.10	-0.11	-0.04	-0.16
Kamchatka flounder	-0.20	0.12	0.45	-0.24	0.17	0.09	0.54	0.33	0.06	-0.11	-0.15	0.18	-0.21	-0.07	0.08	0.25	0.04	-0.08	-0.13	-0.08
other flatfish	-0.06	0.00	0.12	0.24	-0.09	0.44	-0.16	0.39	-0.11	-0.22	-0.01	0.10	-0.18	-0.09	-0.11	0.70	-0.46	0.40	1.17	-0.45
Pacific cod	0.12	-0.13	0.54	-0.28	0.05	-0.08	0.11	-0.15	-0.17	-0.05	0.01	1.02	0.05	-0.02	-0.09	0.35	0.01	-0.11	-0.35	-0.21
rock soles	-0.25	0.26	0.13	-0.20	0.12	0.04	-0.03	0.05	-0.08	0.00	-0.24	0.34	-0.04	-0.03	-0.09	0.06	-0.24	0.03	-0.08	-0.21
sculpin	-0.19	0.09	-0.12	0.22	0.10	0.09	0.08	-0.07	0.02	-0.04	-0.28	0.16	0.03	-0.13	-0.22	0.29	0.08	0.14	-0.12	0.01
skate	-0.06	-0.01	0.28	-0.11	0.06	0.09	0.16	-0.10	0.09	-0.23	-0.03	0.04	0.11	-0.10	0.07	0.04	0.14	0.21	0.04	0.00
walleye pollock	0.41	0.34	-0.18	0.18	0.69	-0.54	0.26	-0.37	0.42	-0.30	-0.25	0.64	-0.17	0.12	0.31	0.62	-0.14	-0.23	-0.02	-0.35
yellowfin sole	-0.43	0.26	0.06	0.14	0.13	0.18	0.11	-0.24	0.01	-0.02	-0.17	0.36	0.01	-0.19	0.17	0.10	-0.23	0.48	-0.03	-0.32

Changes in AI biomass, 1994-2018

- Not included: sablefish, yellowfin, turbot, shortraker, shark, octopus
- Color gradients are row-specific
- Changes are expressed as discrete annual rates

Species/complex	1994	1997	2000	2002	2004	2006	2010	2012	2014	2016	2018
arrowtooth flounder	0.46	0.04	0.01	0.19	0.01	0.37	-0.17	-0.10	0.06	-0.08	-0.13
Atka mackerel	-0.04	-0.16	0.12	0.23	0.07	-0.09	0.03	-0.42	0.62	-0.21	-0.14
blackspotted/rougheye	0.08	-0.07	0.09	-0.23	0.31	-0.24	0.01	0.20	-0.40	0.46	0.00
flathead sole	-0.01	0.05	-0.02	0.06	0.14	-0.10	0.13	-0.32	0.49	-0.33	0.11
Kamchatka flounder	0.41	-0.05	-0.10	0.28	-0.10	-0.03	0.10	-0.16	0.13	-0.24	-0.02
northern rockfish	-0.26	0.00	0.33	-0.07	0.01	0.03	0.03	0.14	0.29	-0.27	-0.16
other flatfish	0.30	0.13	0.06	-0.06	0.32	0.07	0.00	-0.01	0.08	-0.05	-0.07
other rockfish	-0.01	0.16	0.06	0.12	0.12	0.15	-0.06	-0.12	0.27	-0.11	-0.11
Pacific cod	-0.05	-0.22	0.20	-0.24	0.06	0.02	-0.10	0.03	0.12	0.07	-0.02
Pacific ocean perch	0.03	0.15	-0.04	-0.05	0.06	0.13	0.08	-0.01	0.01	0.00	0.00
pollock	-0.17	0.06	0.04	0.29	-0.14	-0.15	0.10	-0.44	0.39	-0.01	0.41
rock soles	0.16	0.00	-0.06	0.14	-0.06	0.27	-0.08	0.14	-0.16	-0.15	0.09
sculpin	0.05	-0.06	-0.05	0.08	0.16	0.04	0.05	-0.01	-0.10	-0.11	0.03
skate	0.28	0.06	-0.01	0.12	0.23	0.00	-0.01	-0.16	0.09	-0.22	0.02

NBS biomass and changes, 2010-2018

- Not included: species/complexes accounting for <1% of biomass
- Color scales are for the entire respective matrix
- Changes are expressed as discrete annual rates
- Values are standardized to the 2018 "truncated" area

	Biomass			Rate of change	
Species/complex	2010	2017	2018	2017	2018
Alaska plaice	306,750	336,841	274,543	0.01	-0.18
Pacific cod	26,140	289,264	564,684	0.41	0.95
rock soles	18,368	55,294	117,639	0.17	1.13
sculpin	61,612	143,985	85,893	0.13	-0.40
skate	48,929	82,399	116,835	0.08	0.42
walleye pollock	19,975	1,338,925	1,146,515	0.82	-0.14
yellowfin sole	310,617	368,156	373,373	0.02	0.01

Big picture

Ch.	Assessment	Lead author	Tier (2018)	Freq.	Year in cycle	Type	Numbered models (or Tier 5, 6)	Tier change? From 2018	Tier change? From proj.	ABC<maxABC? Author(s)	ABC<maxABC? Team
1	EBS pollock	Ianelli	1	1	n/a	Full	16.1 (base)	none	none	yes	yes
1A	AI pollock	Barbeaux	3	2	1	Full	15.1 (base), 15.2	3b to 3a	3b to 3a	no	no
1B	Bogoslof pollock	Ianelli	5	2	1	Full	Tier 5	none	none	no	no
2	EBS Pacific cod	Thompson	3	1	n/a	Full	16.6 (base), 16.6i, 16.6j, 16.6k, 17.2, 18.6, 18.7, 18.8	none	none	no	yes
2A	AI Pacific cod	Thompson	5	1	n/a	Full	Tier 5	none	none	no	no
3	Sablefish	Hanselman	3	1	n/a	Full	16.5 (base)	none	3a to 3b	yes	yes
4	Yellowfin sole	Wilderbuer	1	1	n/a	Full	14.1 (base), 14.2, 18.1	none	none	no	no
5	Greenland turbot	Bryan	3	2	1	Full	16.1b ("same" as base), 16.1c	none	none	no	no
6	Arrowtooth flounder	Spies	3	2	1	Full	15.1b (base), 15.1c, 18.3, 18.6, 18.9	none	none	no	no
7	Kamchatka flounder	Bryan	3	2	1	Full	16.0a (base), 16.0b	none	none	no	no
8	Northern rock sole	Wilderbuer	1	2	1	Full	15.1 (base), 18.1, 18.2, 18.3, 18.4	none	none	no	no
9	Flathead sole	McGilliard	3	2	1	Full	16.0 (base), 18.0, 18.0b, 18.1, 18.1b, 18.2, 18.2b, 18.2c	none	none	no	no
10	Alaska plaice	Wilderbuer	3	2	2	Partial	11.1 (base)	none	none	no	no
11	Other flatfish	Wilderbuer	5	4	3	Partial	Tier 5	none	none	no	no
12	Pacific ocean perch	Spencer	3	2	1	Full	16.3 (base), 16.3a	none	none	no	no
13	Northern rockfish	Spencer	3	2	2	Partial	16.1 (base)	none	none	no	no
14	Blackspotted/ rougheye rockfish	Spencer	3	2	1	Full	16.5 (base), 18.1, **18.2 (author)**, **(18.1+18.2)/2 (Team)**	none	3a to 3b	no	no
15	Shortraker rockfish	Spies	5	2	1	Full	Tier 5	none	none	no	no
16	Other rockfish	Spies	5	2	1	Full	Tier 5	none	none	no	no
17	Atka mackerel	Lowe	3	1	n/a	Full	16.0b (base)	3a to 3b	3a to 3b	no	no
18	Skates	Ormseth	3/5	2	1	Full	14.2 (base)	none	none	no	no
19	Sculpins	Spies	5	4	4	None	n/a	n/a	n/a	n/a	n/a
20	Sharks	Tribuzio	5	2	1	Full	Tier 6	none	none	no	no
22	Octopus	Ormseth	6	2	1	Full	Tier 6	none	none	no	no

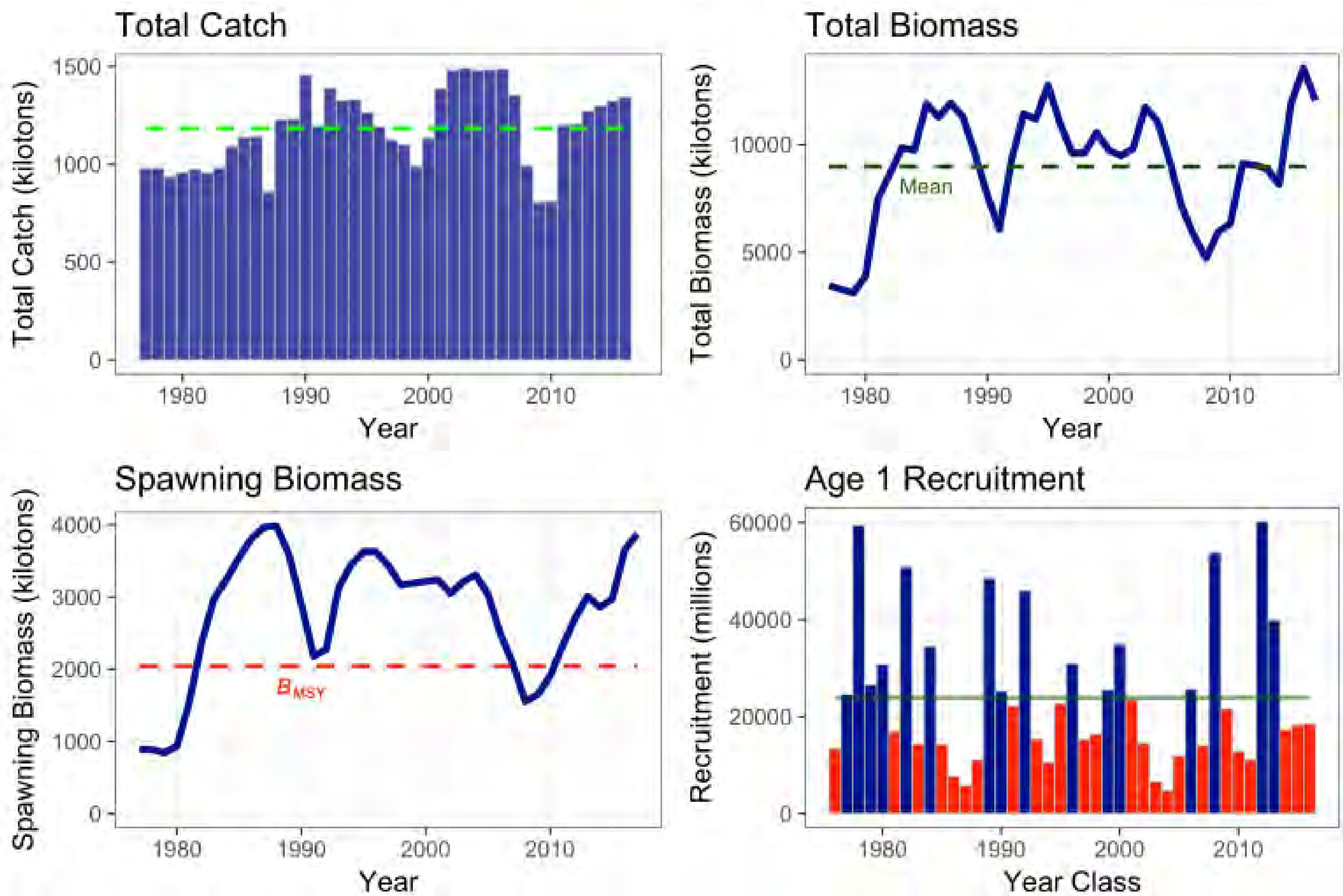
Reference point comparisons (all chapters)

Quantity	Last asmt.	This asmt.	Change
M	0.097	0.097	0.00
2018 tier	3b	n/a	none
2019 tier	3a	3b	↓
2018 age+ biomass	330,655	n/a	0.48
2019 age+ biomass	350,850	488,273	0.39
2018 spawning biomass	88,928	n/a	0.09
2019 spawning biomass	110,974	96,687	-0.13
B100%	245,829	291,845	0.19
B40%	98,332	116,738	0.19
B35%	86,040	102,146	0.19
2019 FOFL	0.114	0.096	-0.16
2019 FABC	0.085	0.044	-0.48
2018 OFL	29,507	n/a	0.11
2019 OFL	46,775	32,798	-0.30
2018 ABC	14,957	n/a	0.01
2019 ABC	21,053	15,068	-0.28

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

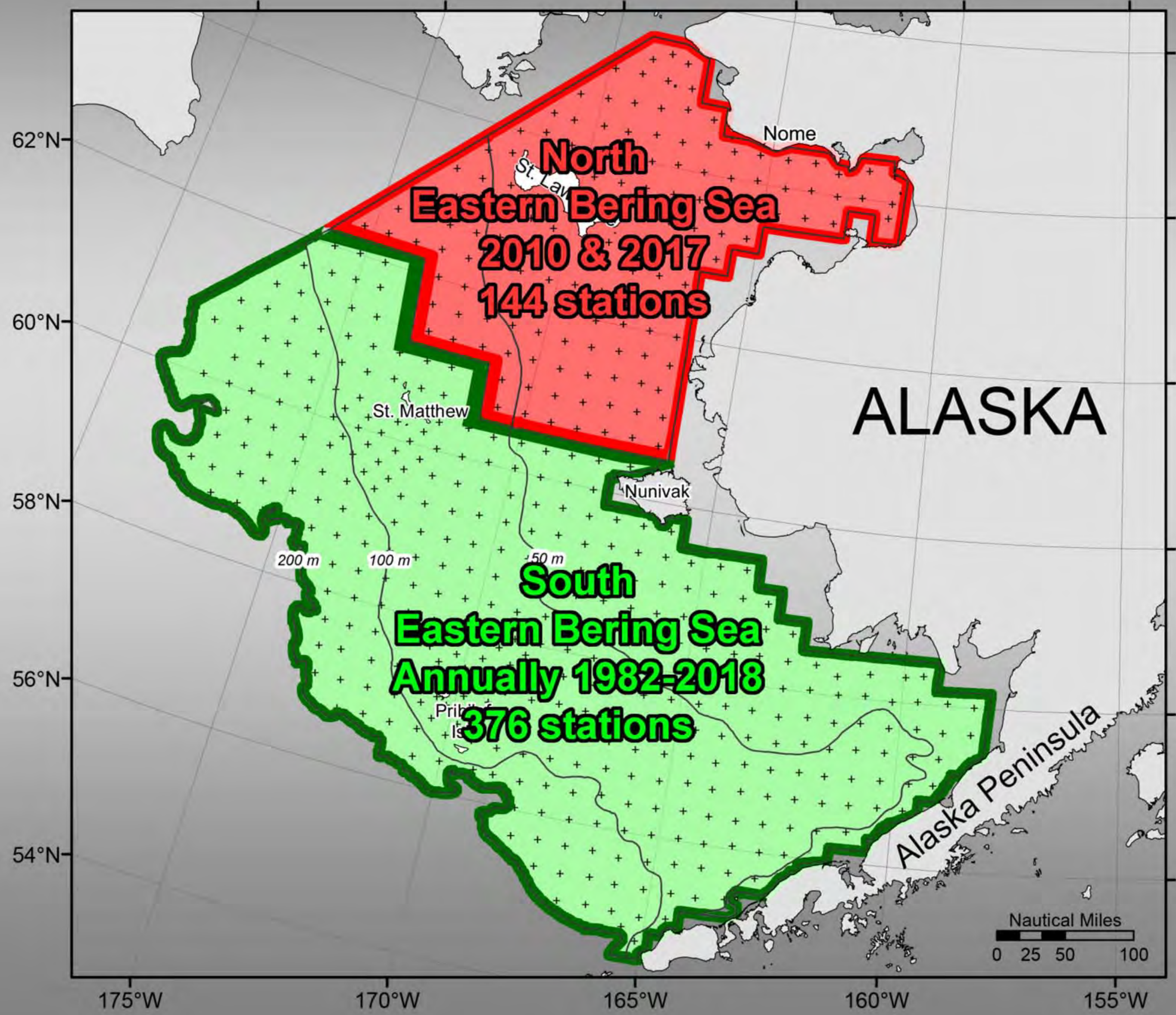
Where “quantity” is shaded, “change” represents the relative difference between *this assessment’s value for 2019* and *last assessment’s value for 2018*.

Graphs for Tiers 1-3 “full” assessments



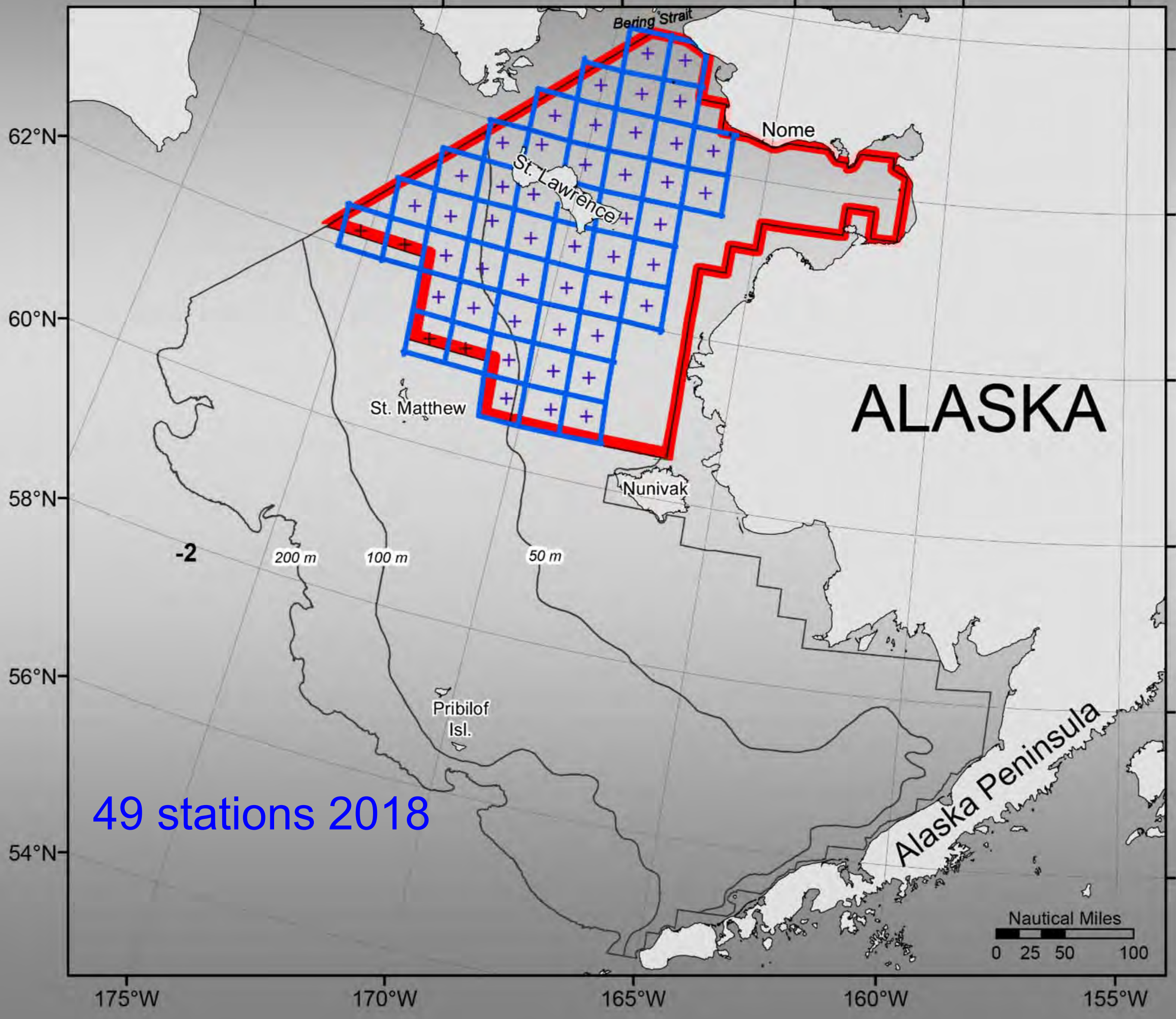
Standard Eastern Bering Sea Shelf Surveys

20 nm^2 grid pattern

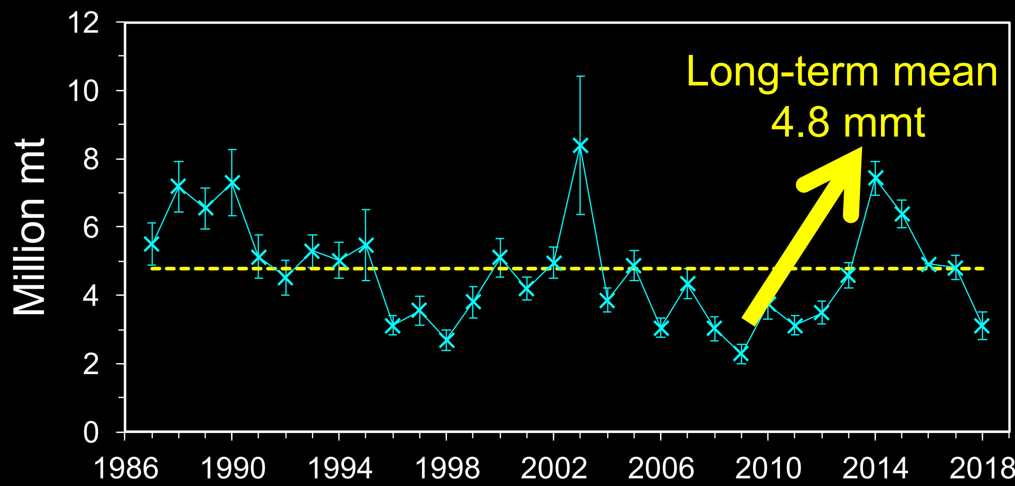


"Rapid response" 2018 NEBS survey

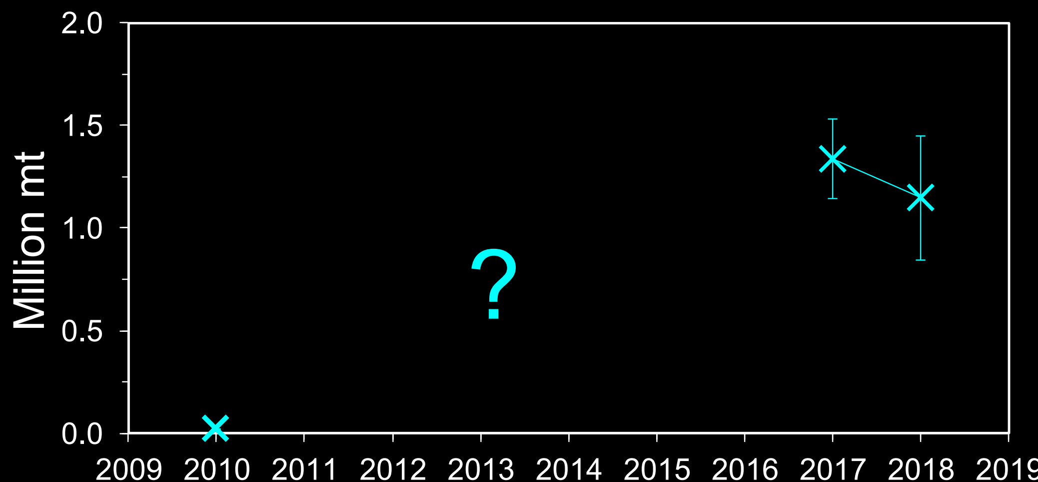
"Special" 30 nm^2 grid pattern



SEBS & NEBS Walleye pollock

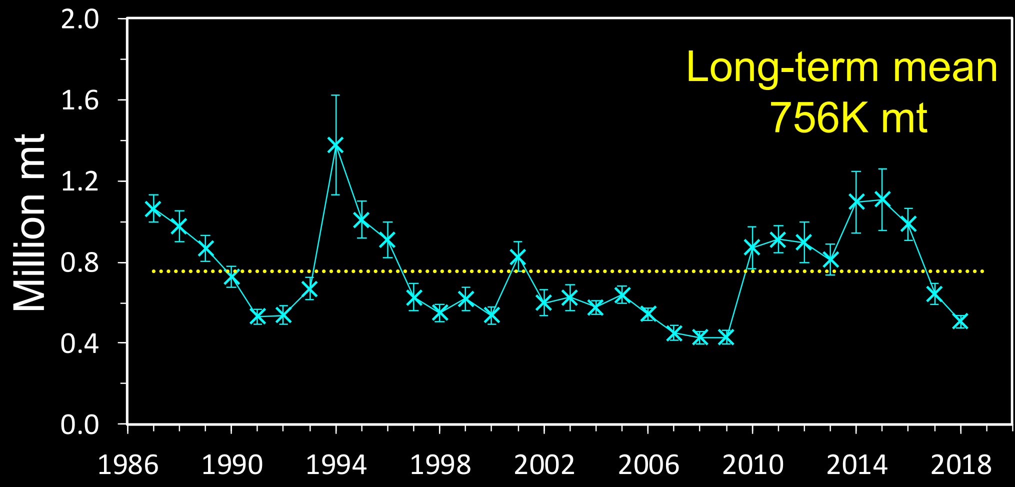


SEBS Biomass
3.1 mmt
-35% from 2017 (4.8 mmt)

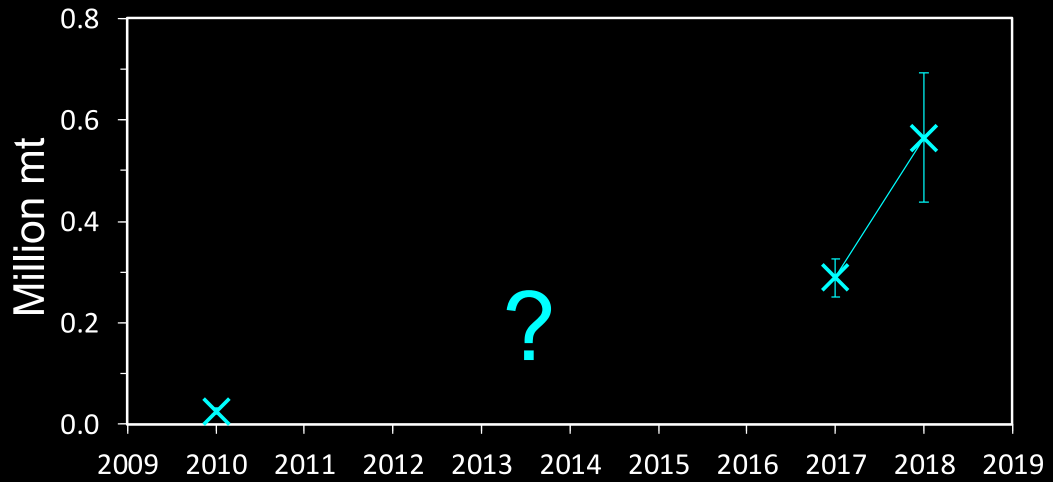


NEBS Biomass
1.15 mmt
-14% from 2017 (1.34 mmt)

SEBS & NEBS Pacific cod

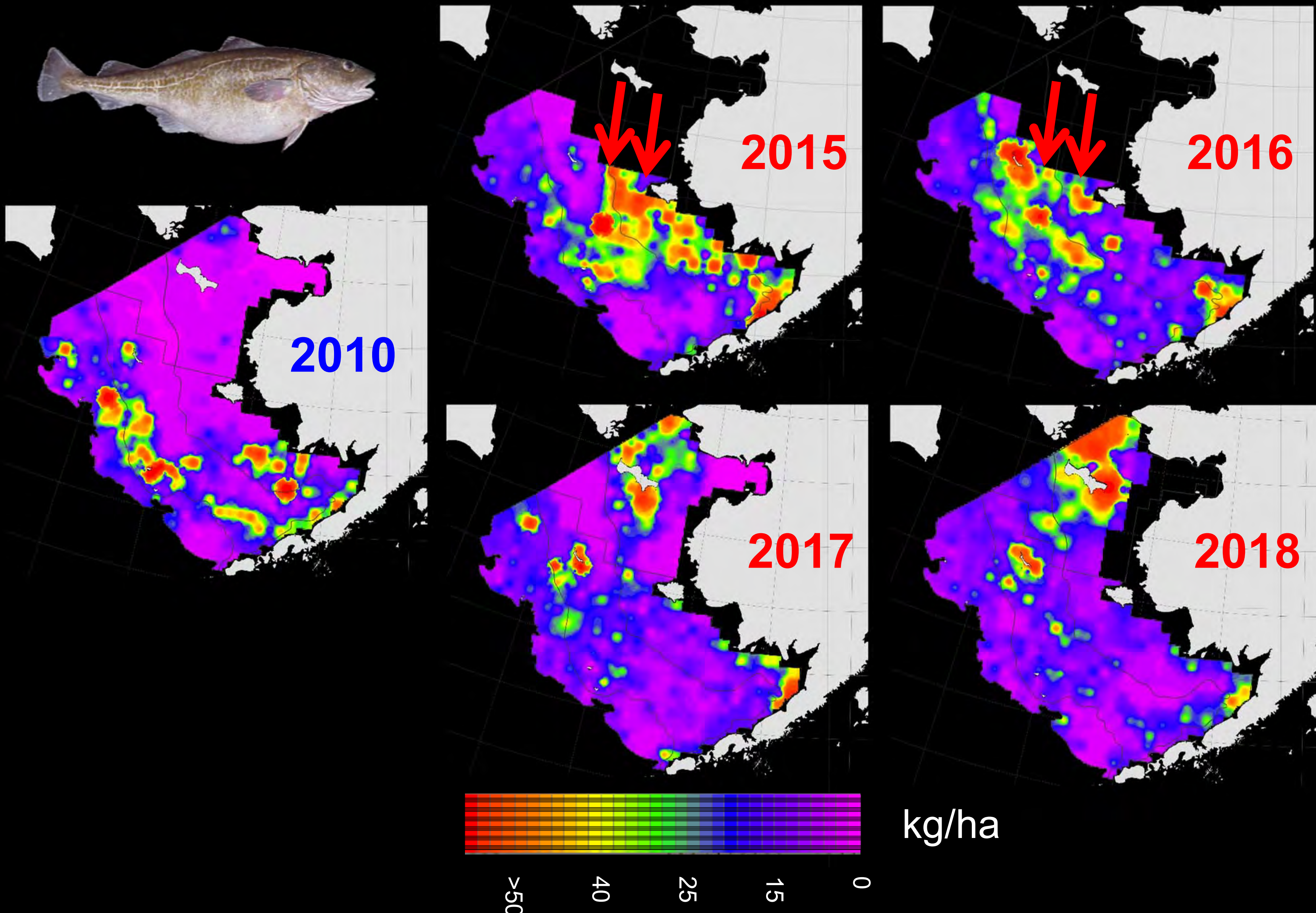


SEBS Biomass
507K mt
-21% from 2017 (644K mt)

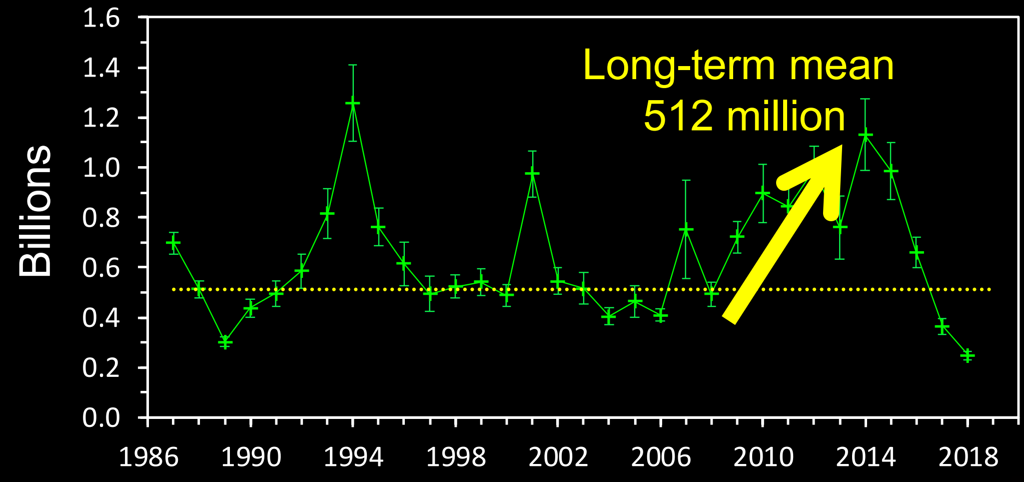


NEBS Biomass
565K mt
+95% from 2017 (289K mt)

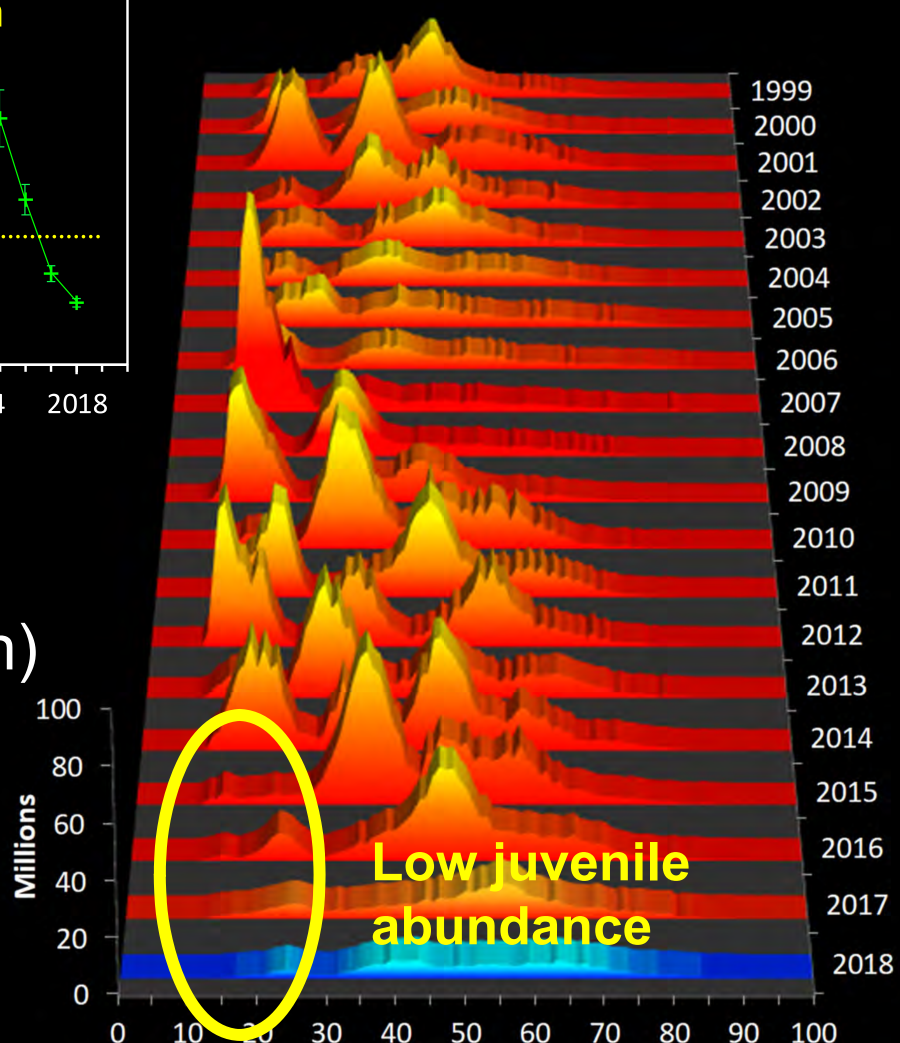
Pacific cod distribution by catch weight



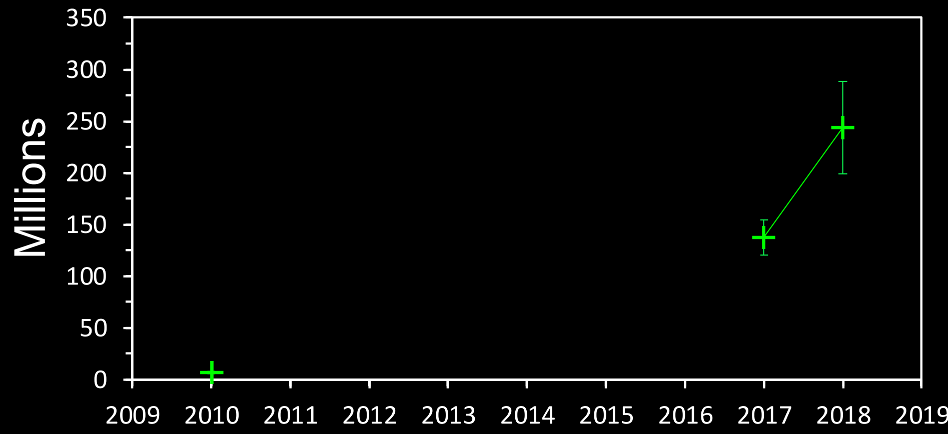
SEBS Pacific cod



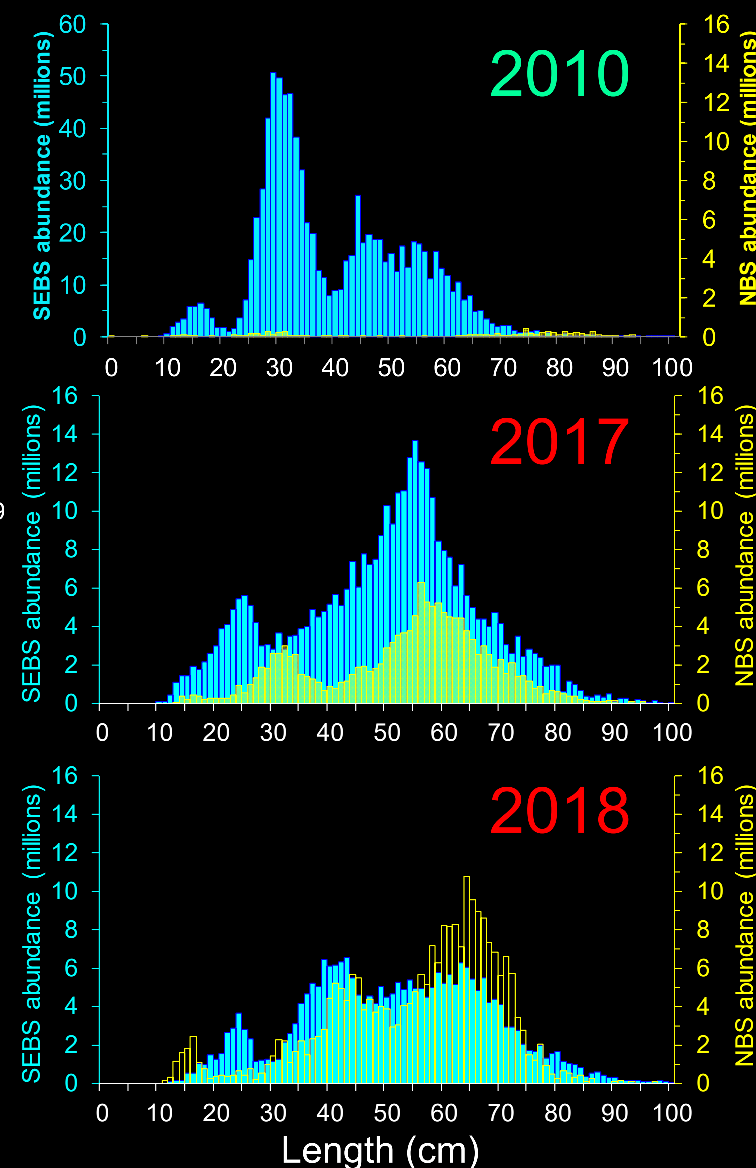
SEBS Abundance
248 million
-32% from 2017 (364 million)



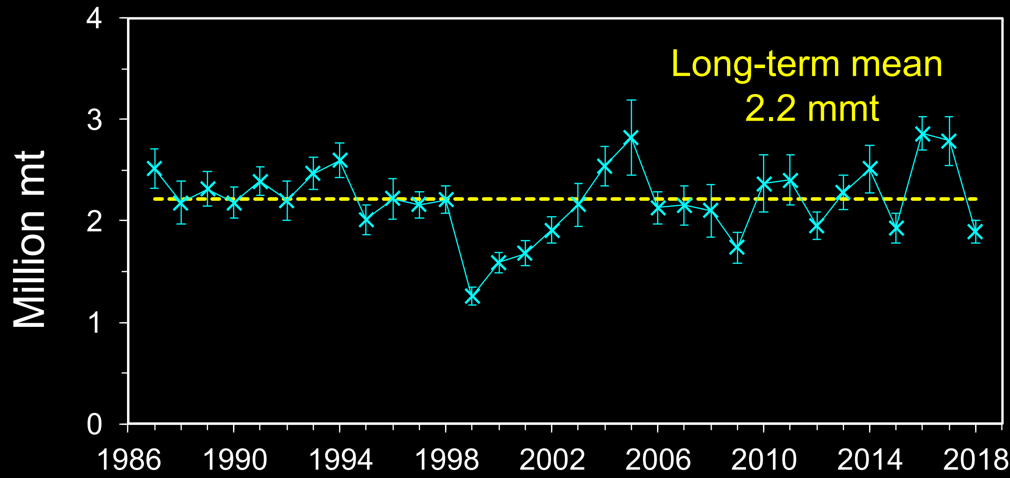
NEBS Pacific cod



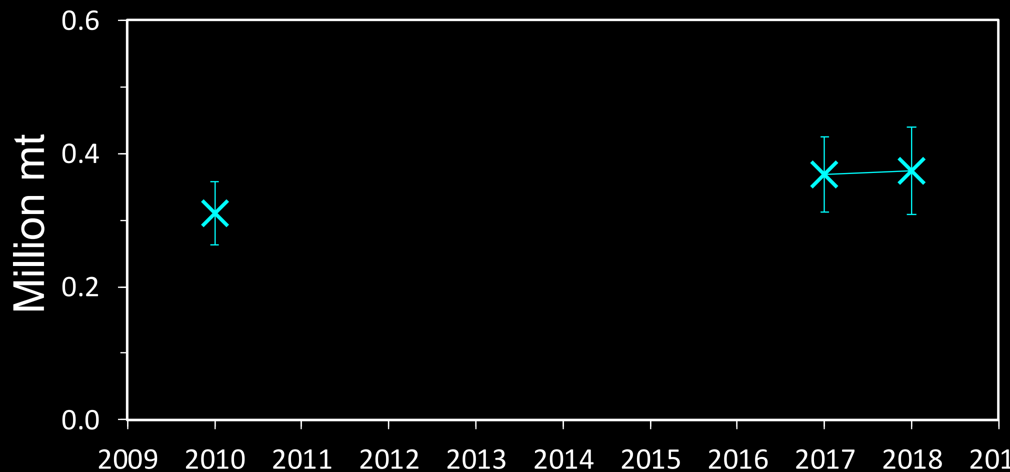
NEBS Abundance
244 million
+78% from 2017 (137 million)



SEBS & NEBS Yellowfin sole

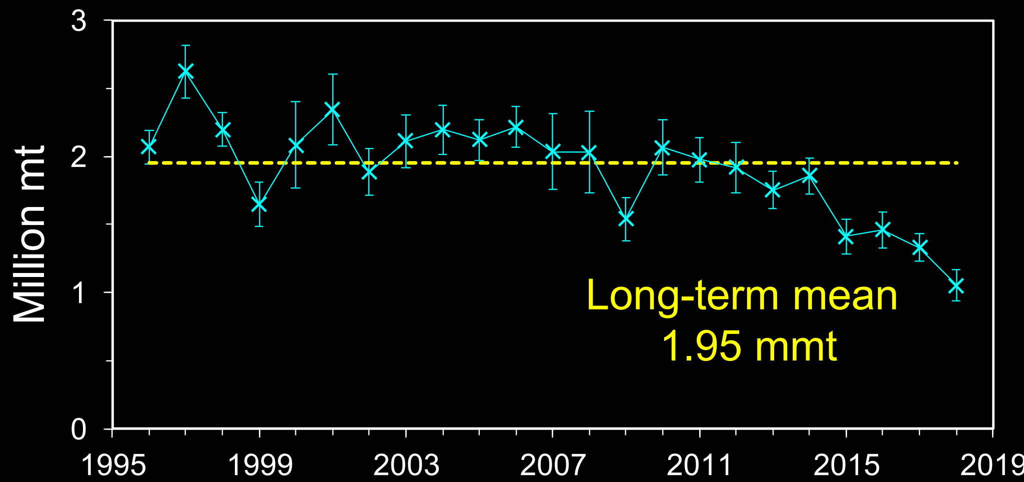


SEBS Biomass
1.9 mmt
-32% from 2017 (2.8 mmt)



NEBS Biomass
373K mt
+1% from 2017 (368K mt)

SEBS & NEBS Northern rock sole



SEBS Biomass
1.05 mmt
-21% from 2017 (1.33 mmt)

NEBS Biomass
118K mt
+113% from 2017 (55K mt)

Chapter summaries

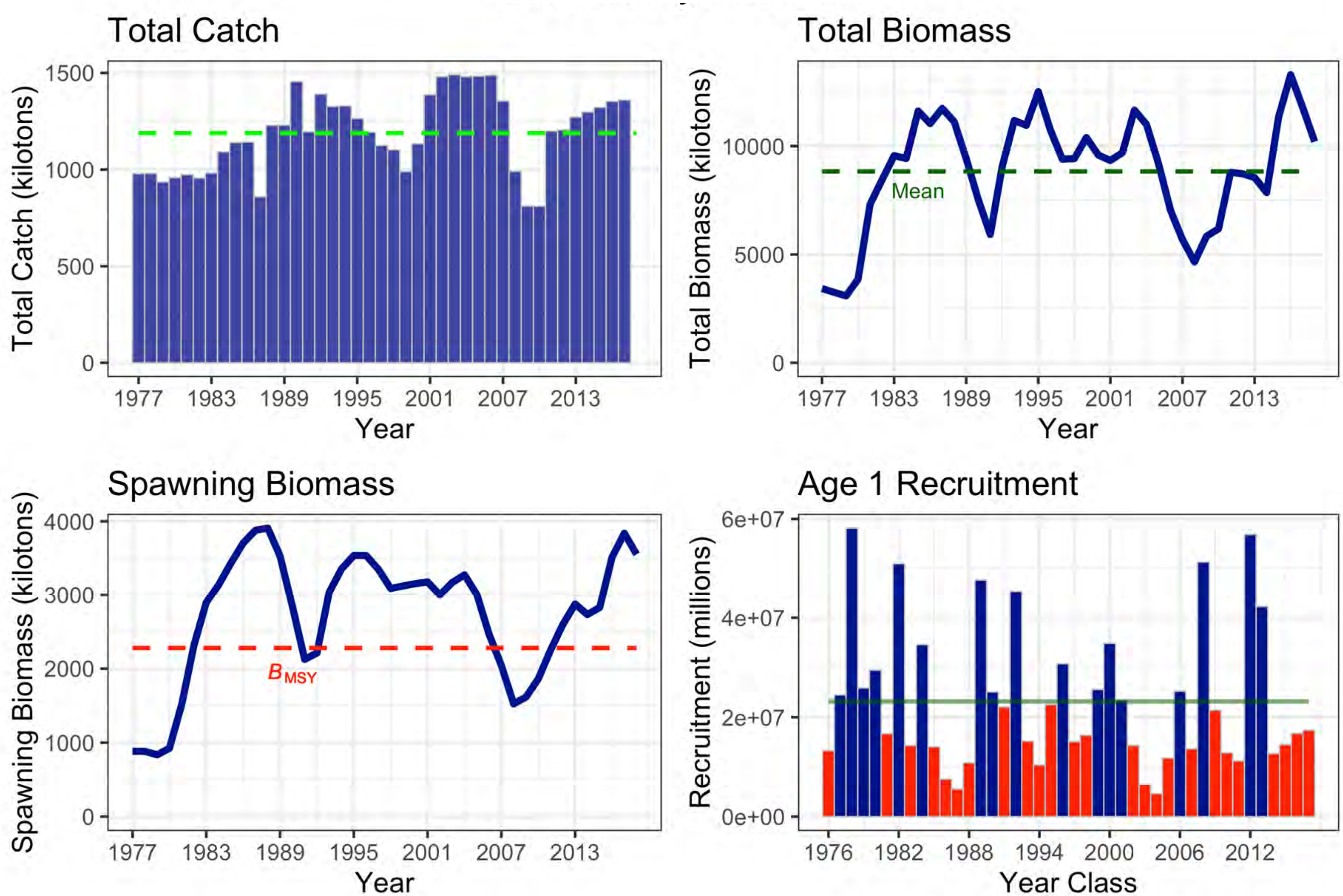
Chapter 1: EBS walleye pollock (full)

- Switch to author's presentation (Team comments will follow)

EBS walleye pollock, continued

- Tier 1a but authors recommend setting ABC at the Tier 3a level, consistent w/ past SSC practice
  - See “risk table” in chapter (concern level 2)
  - Discussion (no consensus) on tier system and the risk table:
    - Is this really a Tier 1 assessment?
    - Should a “tier concerns” column be added to the risk table?
    - Should the “assessment” and “pop dy” concern levels be higher?
    - Concerns about the tier system in general

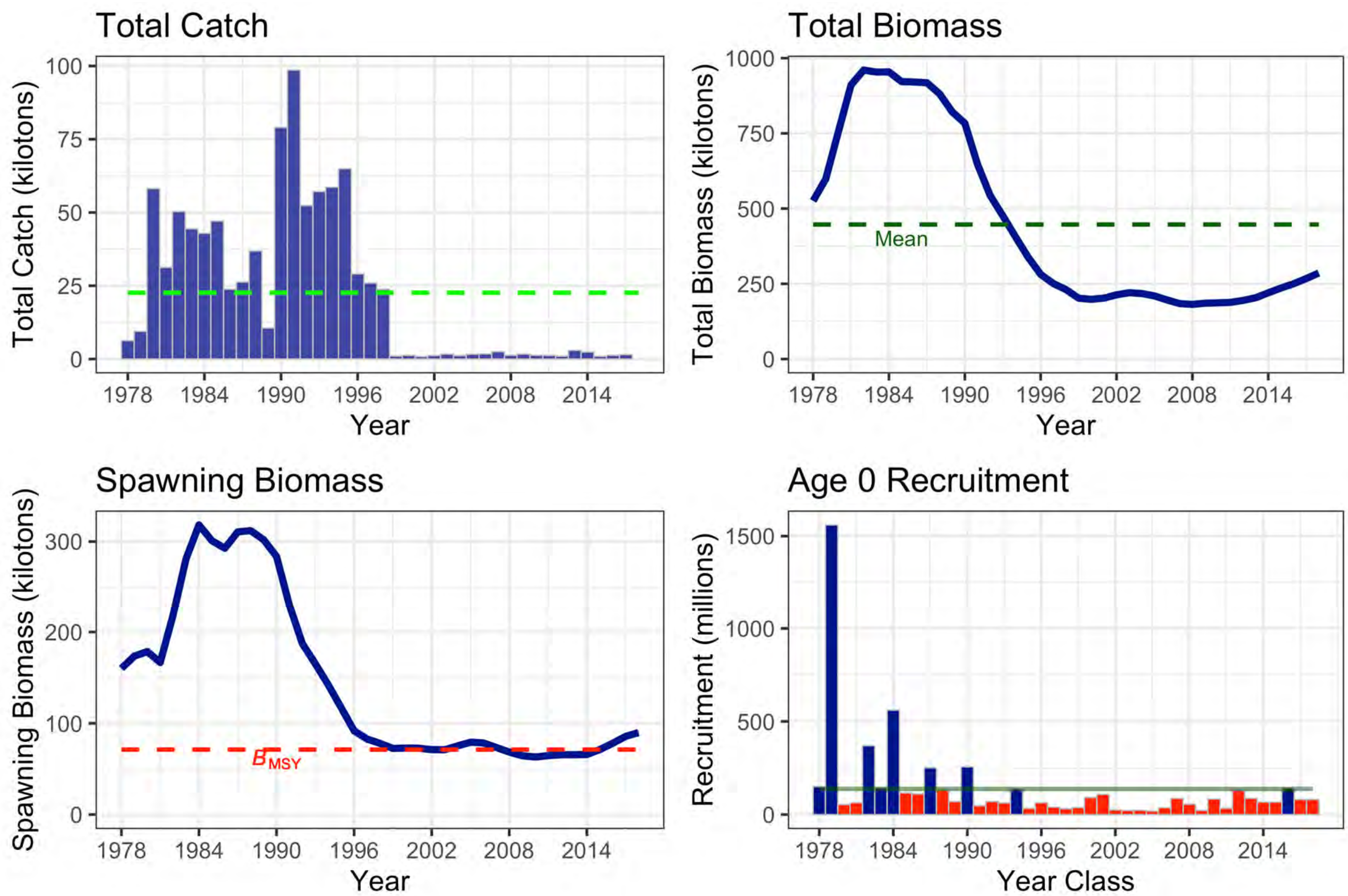
EBS walleye pollock, continued



EBS walleye pollock, continued

Quantity	Last asmt.	This asmt.	Change
M	0.30	0.30	0.00
2018 tier	1a	n/a	none
2019 tier	1a	1a	none
2018 age+ biomass	10,965,000	n/a	-0.17
2019 age+ biomass	10,117,000	9,110,000	-0.10
2018 spawning biomass	3,678,000	n/a	-0.16
2019 spawning biomass	3,365,000	3,107,000	-0.08
B0	5,394,000	5,866,000	0.09
Bmsy	2,042,000	2,280,000	0.12
2019 FOFL	0.621	0.645	0.04
2019 FABC	0.336	0.356	0.06
2018 OFL	4,797,000	n/a	-0.18
2019 OFL	4,592,000	3,914,000	-0.15
2018 ABC	2,592,000	n/a	-0.17
2019 ABC	2,467,000	2,163,000	-0.12

AI walleye pollock, continued

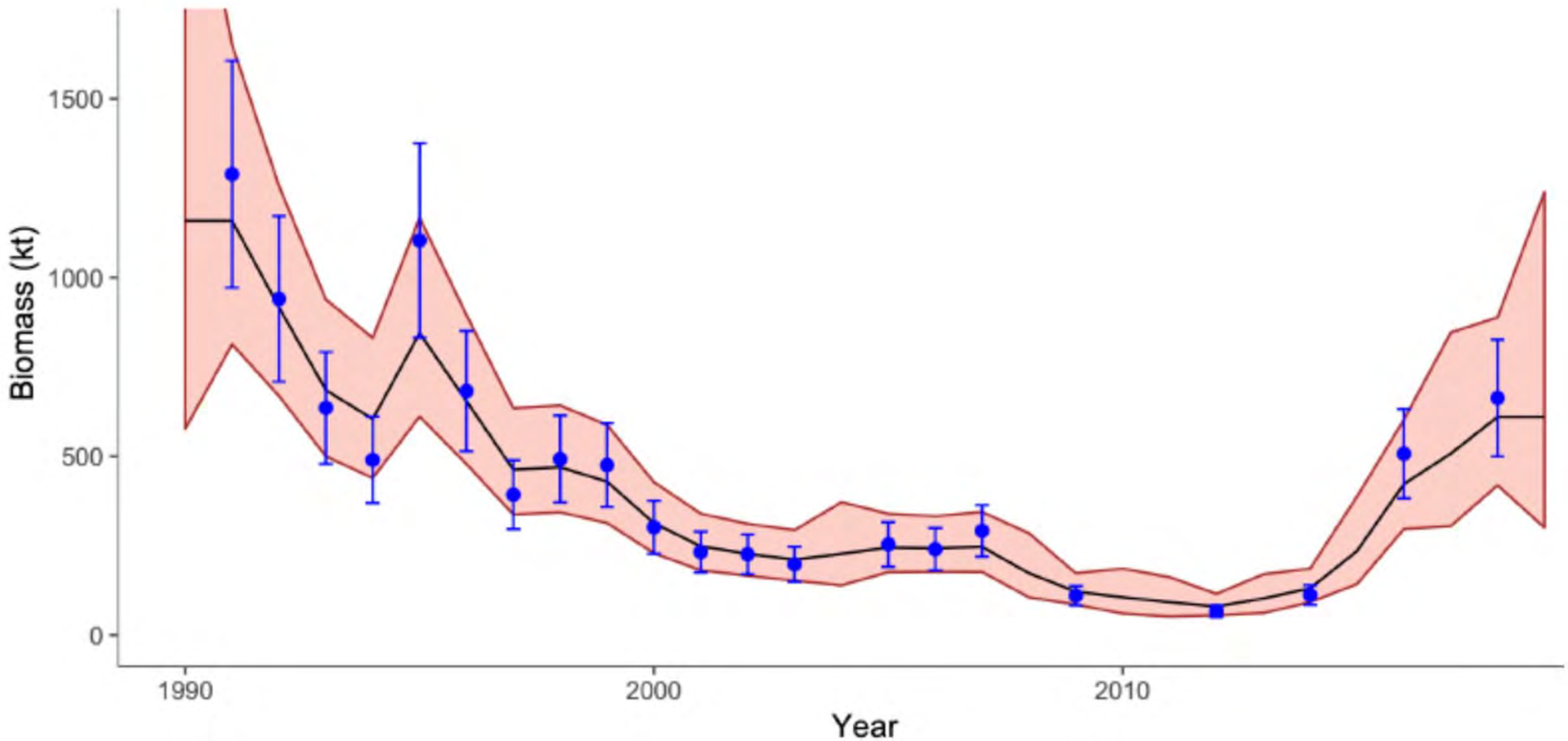


AI walleye pollock (continued)

Quantity	Last asmt.	This asmt.	Change
M	0.19	0.20	0.05
2018 tier	3b	n/a	↑
2019 tier	3b	3a	↑
2018 age+ biomass	272,675	n/a	0.17
2019 age+ biomass	262,010	319,892	0.22
2018 spawning biomass	78,305	n/a	0.22
2019 spawning biomass	67,627	95,253	0.41
B100%	203,100	203,279	0.00
B40%	81,240	81,312	0.00
B35%	71,085	71,147	0.00
2019 FOFL	0.341	0.415	0.22
2019 FABC	0.273	0.331	0.21
2018 OFL	49,289	n/a	0.30
2019 OFL	37,431	64,240	0.72
2018 ABC	40,788	n/a	0.30
2019 ABC	30,803	52,887	0.72

Bogoslof walleye pollock

- Survey biomass data with random effects model fit



Bogoslof walleye pollock (continued)

Quantity	Last asmt.	This asmt.	Change
M	0.30	0.30	0.00
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	434,760	610,267	0.40
2019 FOFL	0.300	0.300	0.00
2019 FABC	0.140	0.225	0.61
2018 OFL	130,428	n/a	0.40
2019 OFL	130,428	183,080	0.40
2018 ABC	60,800	n/a	1.26
2019 ABC	60,800	137,310	1.26

Alaska Fisheries
Science Center

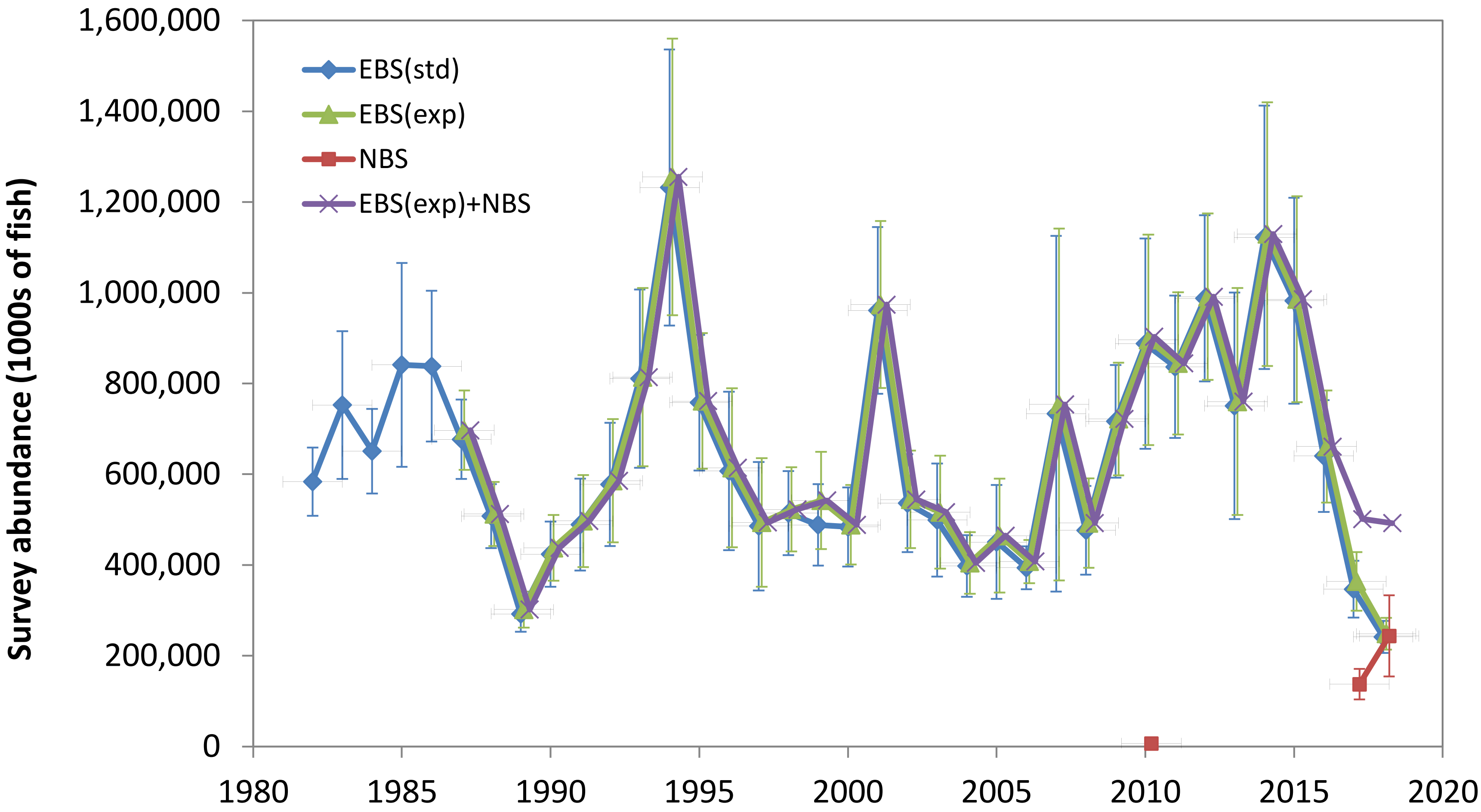
Assessment of Pacific cod in the eastern Bering Sea

Grant Thompson

NOAA FISHERIES

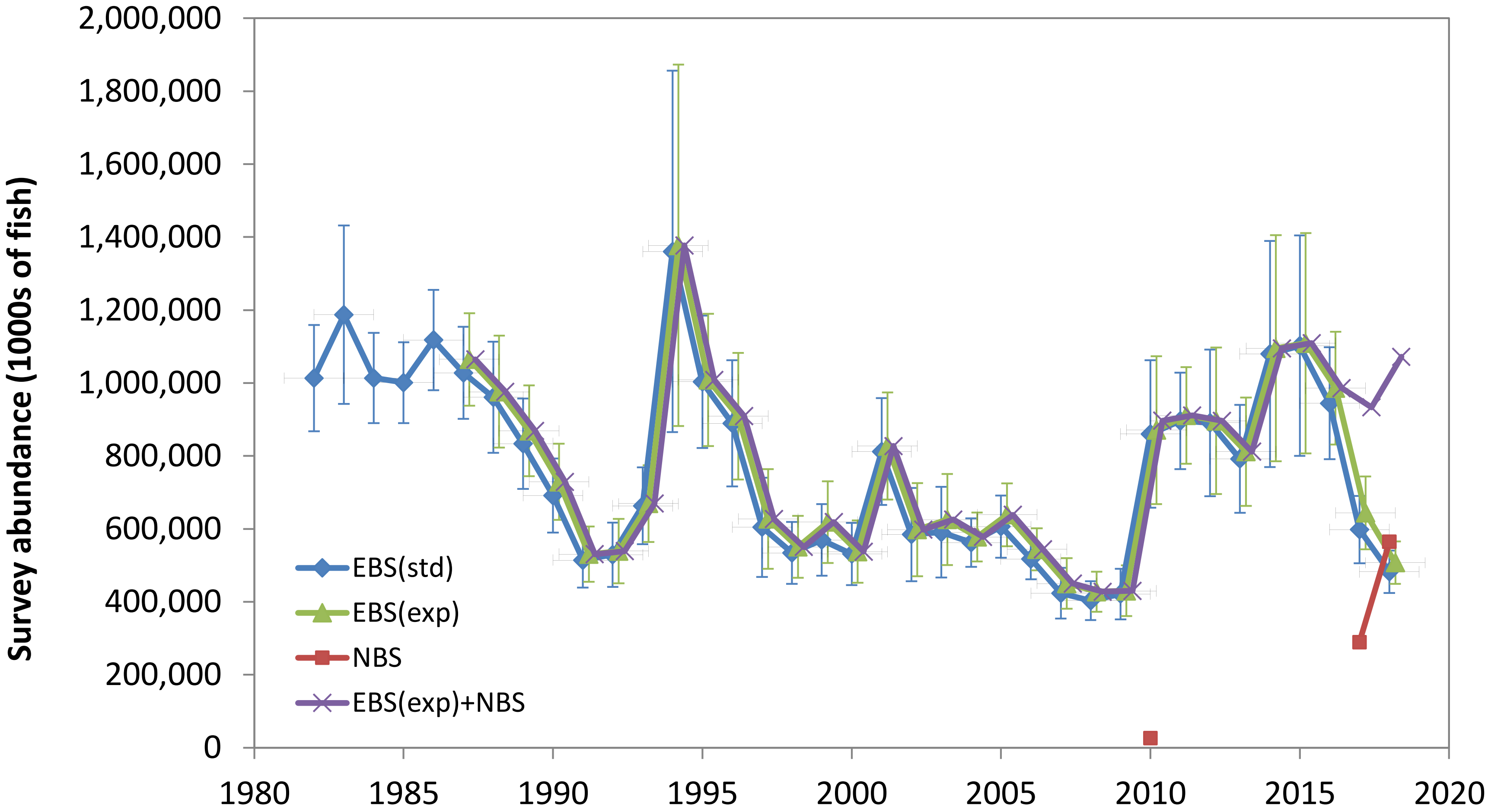
EBS, NBS shelf survey abundance (no. of fish)

- EBS has dropped 78% since 2014; 2018 EBS is all-time low



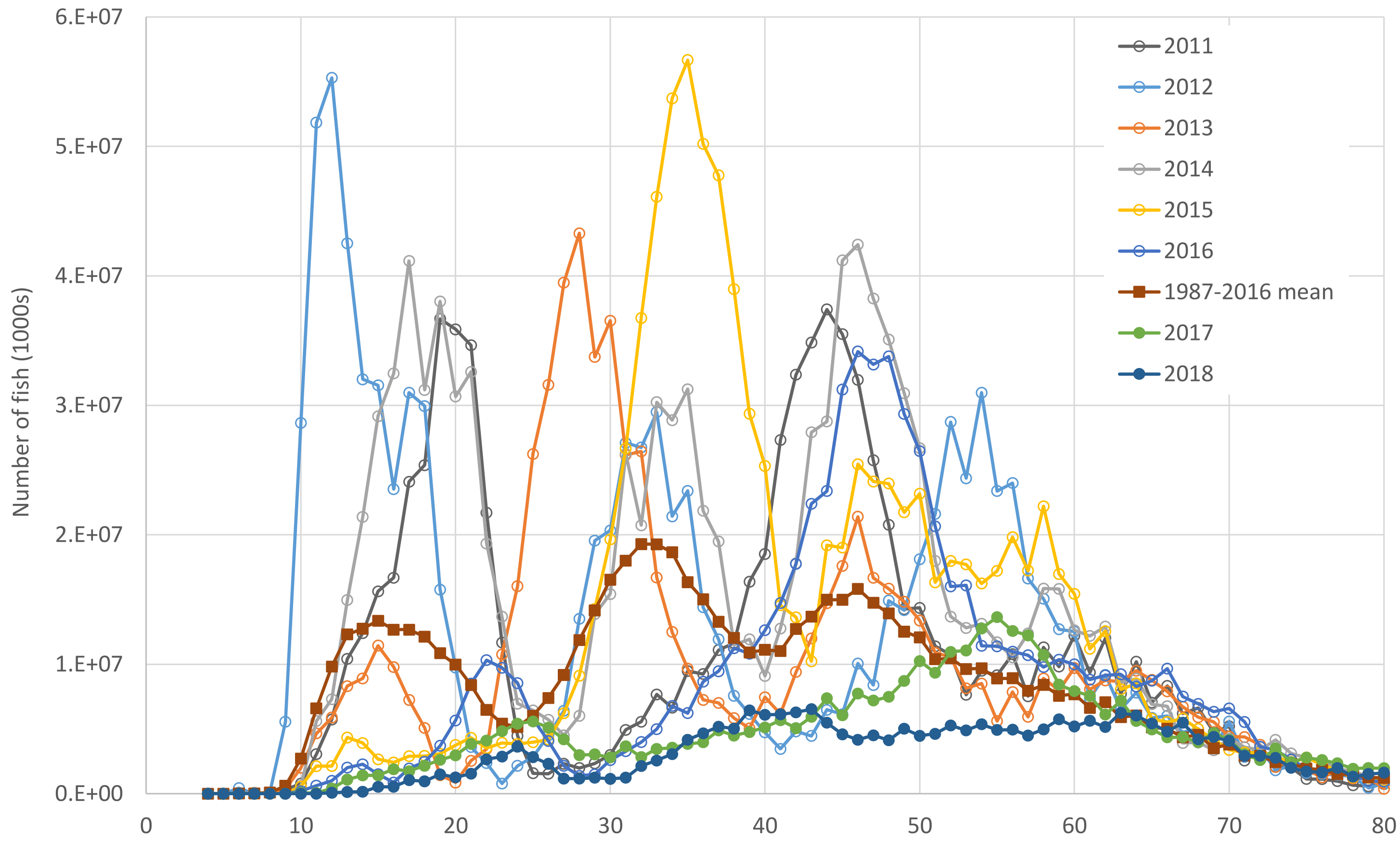
EBS, NBS shelf survey biomass

- EBS has dropped 54% since 2014



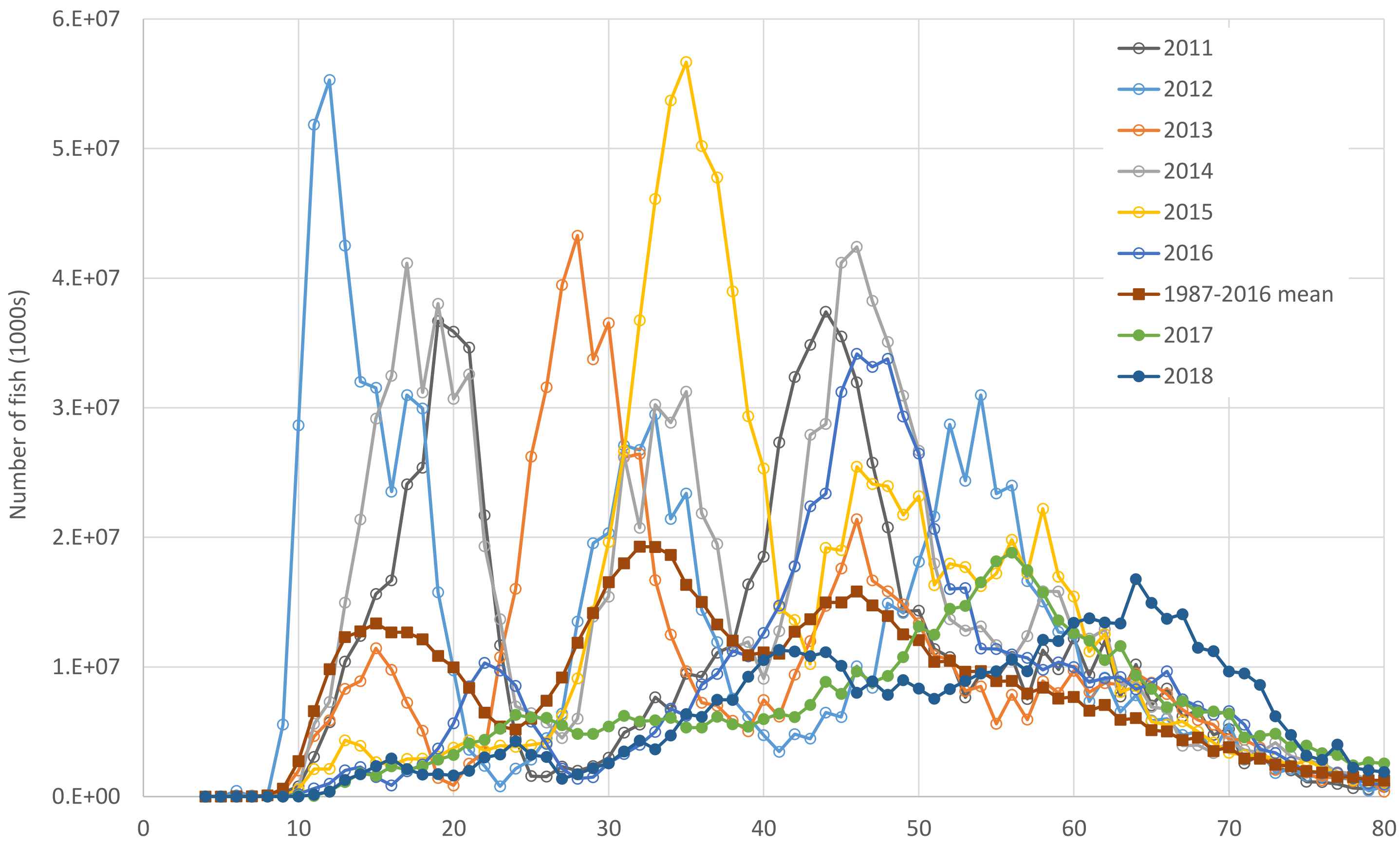
EBS shelf survey size composition

- 2017 below mean until 52 cm; 2018 below mean until 63 cm



EBS+NBS shelf survey size composition

- 2017 below mean until 50 cm; 2018 below mean until 54 cm



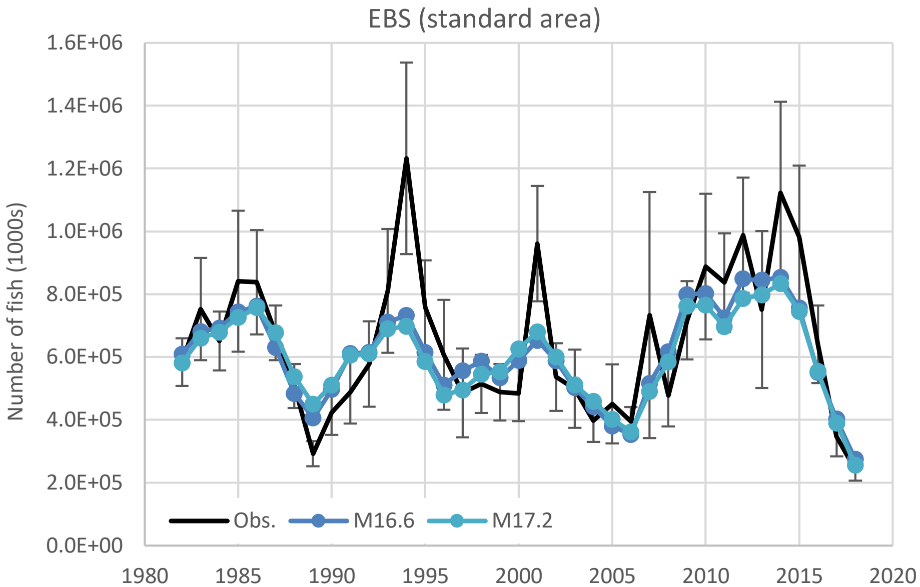
Model features

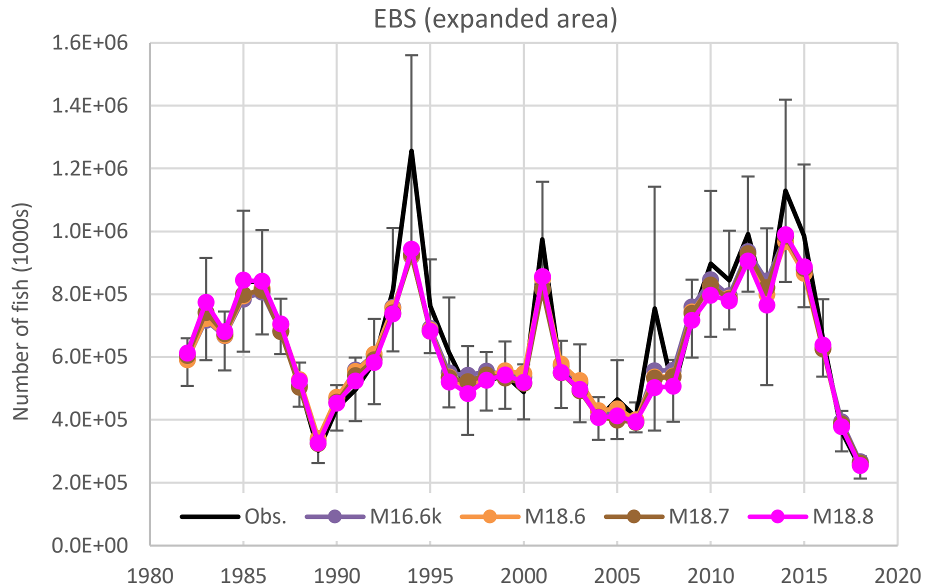
Model

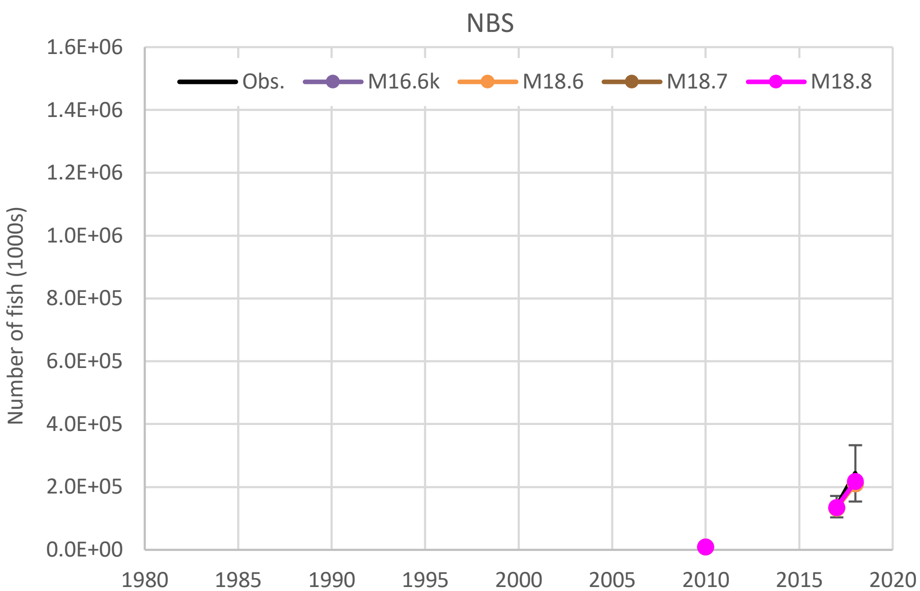
Feature	16.6	16.6i	16.6j	16.6k	17.2	18.6	18.7	18.8
EBS survey strata 82 and 90		x	x	x		x	x	x
NBS survey as separate data set				x		x	x	x
Summed EBS and NBS data sets		x	x					
Fishery agecomps					x	x		x
EBS catchability estimated	x			x	x	x		
Annnually varying EBS catchability				x		x	x	x
NBS catchability estimated				x		x		
Annnually varying NBS catchability				x		x	x	x
EBS+NBS catchability estimated		x	x					
Annually varying EBS+NBS catchability			x					
Prior distribution for natural mortality					x	x		x
Flat-topped double normal selectivity					x	x		x
Annually varying fishery selectivity					x	x		x
Composition N = number of hauls					x	x		x
Harmonic mean composition weights					x	x		x

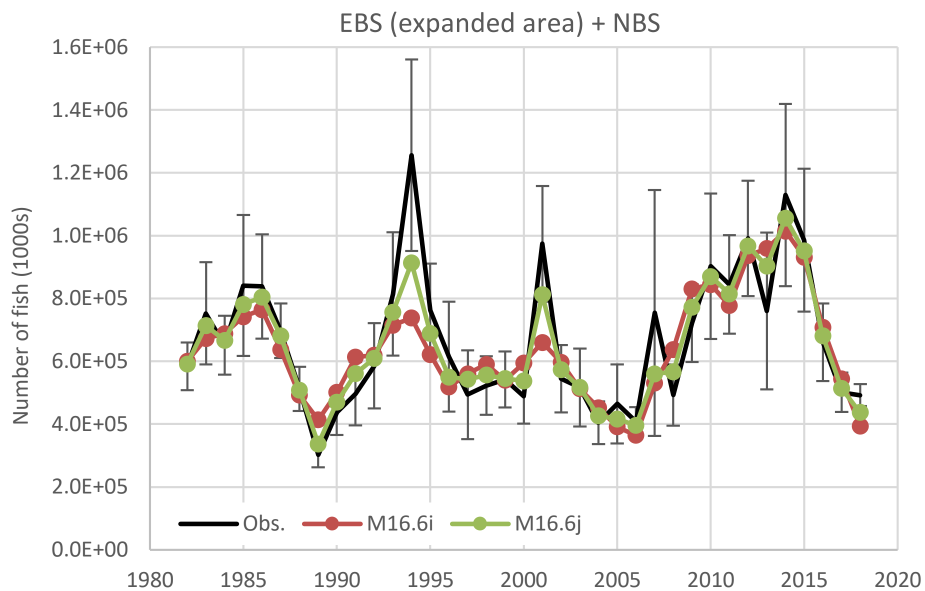
Results

Fit to survey abundance index (all models)

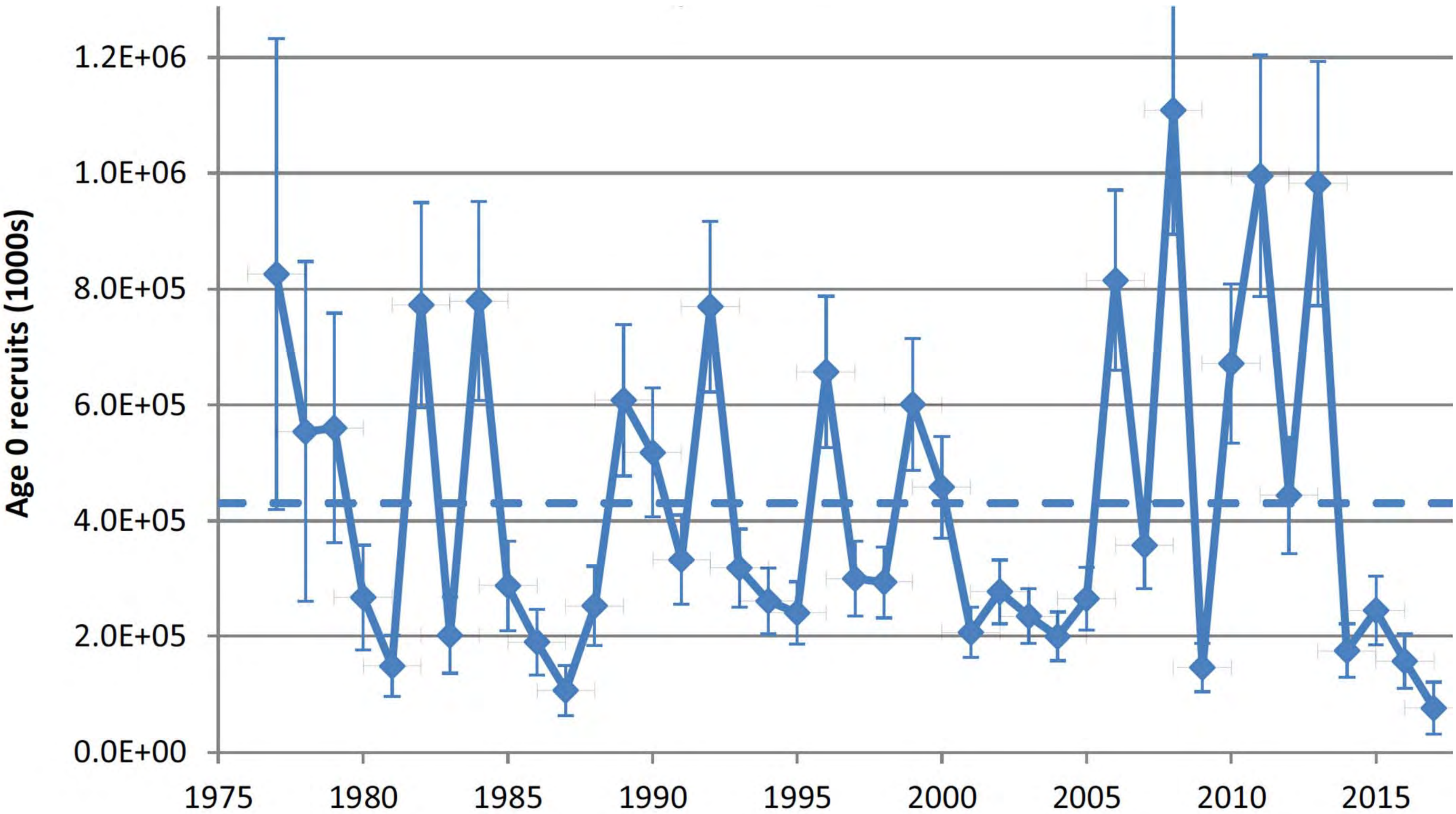




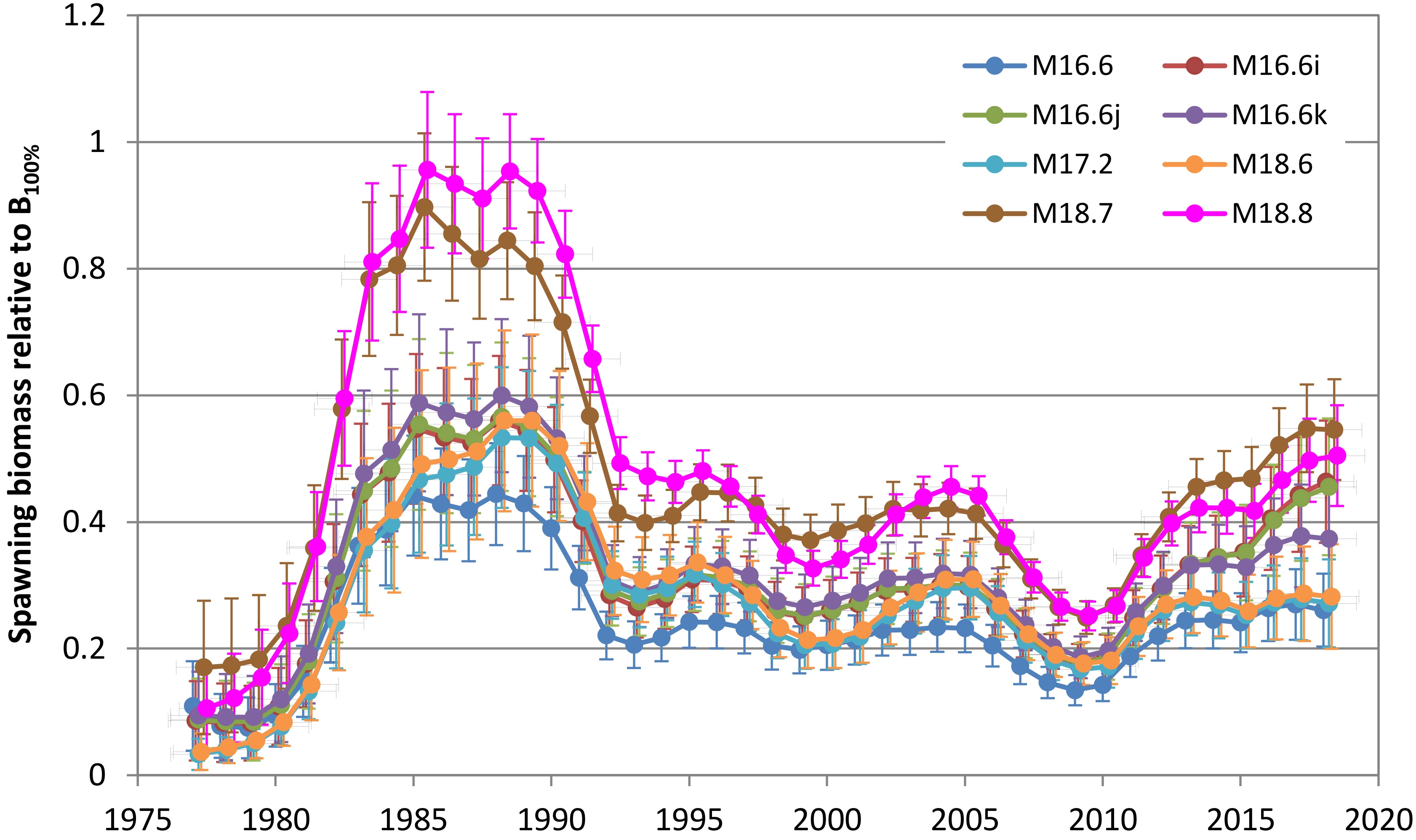




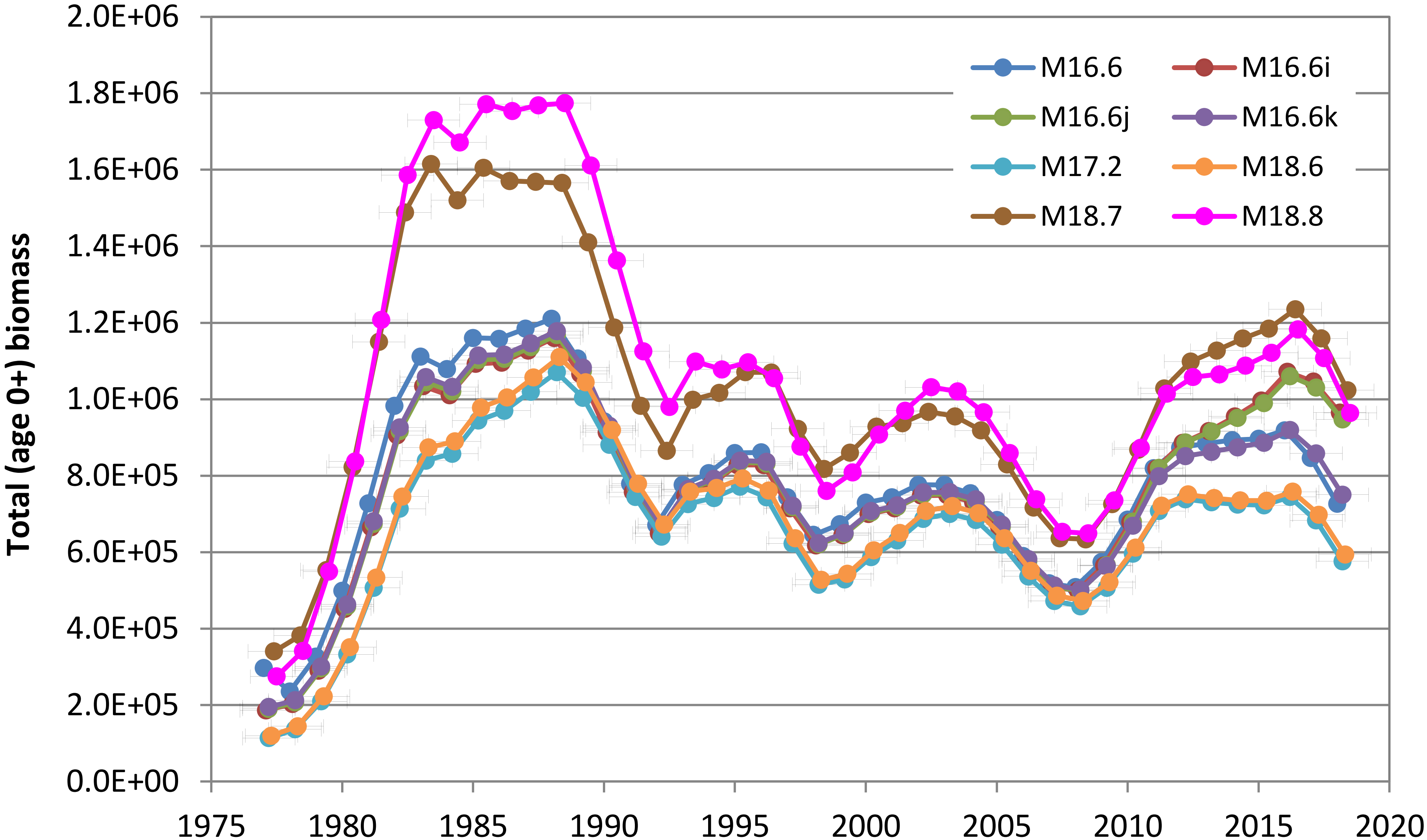
Recruitment estimates



Depletion, EBS Pcod, alternative models



Total (age 0+) biomass, EBS Pcod



Choice of final model, EBS Pcod

Criteria and choice of final model

The following criteria were used to choose the final model:

- Are catchability estimates plausible?
- Is retrospective performance acceptable?
- Are changes in the complexity of model structure justified?
- Are changes in model structure appropriately incremental?

Evaluation of the eight models with respect to the above criteria resulted in a choice of Model 16.6i as the final model

Final recommendations

Management reference points

Year	Quantity	M16.6	M16.6i	M16.6j	M16.6k	M17.2	M18.6	M18.7	M18.8
n/a	B100%	623,000	658,000	656,000	623,000	609,000	598,000	594,000	556,000
n/a	B40%	249,000	263,000	263,000	249,000	244,000	239,000	238,000	222,000
n/a	B35%	218,000	230,000	230,000	218,000	213,000	209,000	208,000	195,000
n/a	F40%	0.32	0.31	0.31	0.31	0.31	0.32	0.38	0.46
n/a	F35%	0.40	0.38	0.38	0.38	0.37	0.39	0.47	0.58
2019	Female spawning biomass	195,000	290,000	283,000	206,000	141,000	145,000	290,000	249,000
2019	Relative spawning biomass	0.23	0.44	0.43	0.33	0.23	0.24	0.49	0.45
2019	Pr(B/B100%<0.2)	0.17	0.00	0.00	0.00	0.19	0.16	0.00	0.00
2019	maxFABC	0.25	0.31	0.31	0.25	0.17	0.18	0.38	0.46
2019	maxABC	103,000	181,000	177,000	111,000	53,900	59,900	212,000	216,000
2019	Catch	103,000	181,000	177,000	111,000	53,900	59,900	206,000	208,000
2019	FOFL	0.31	0.38	0.38	0.31	0.21	0.22	0.47	0.58
2019	OFL	123,000	216,000	211,000	132,000	60,900	72,000	253,000	257,000
2019	Pr(maxABC>truOFL)	0.24	0.07	0.11	0.26	0.30	0.32	0.03	0.07
2020	Female spawning biomass	176,000	246,000	240,000	187,000	146,000	148,000	221,000	180,000
2020	Relative spawning biomass	0.20	0.38	0.37	0.30	0.24	0.25	0.37	0.32
2020	Pr(B/B100%<0.2)	0.38	0.00	0.00	0.00	0.04	0.04	0.00	0.00
2020	maxFABC	0.22	0.29	0.28	0.23	0.18	0.19	0.35	0.37
2020	maxABC	78,900	137,000	131,000	86,100	53,800	58,600	144,000	123,000
2020	Catch	78,900	137,000	131,000	86,100	53,800	58,600	144,000	123,000
2020	FOFL	0.28	0.35	0.34	0.28	0.21	0.23	0.44	0.46
2020	OFL	94,800	164,000	157,000	103,000	64,600	70,400	173,000	147,000
2020	Pr(maxABC>truOFL)	0.25	0.23	0.27	0.28	0.28	0.34	0.22	0.31

Author's reasons for not setting ABC<maxABC

SSC guidance

- Last year, when the SSC concluded that no reduction was warranted:
  - Combined EBS+NBS survey biomass was down 5%
  - Persistence of NBS biomass was unknown
  - Genetic relationship between EBS and NBS fish was unknown
- This year:
  - Combined EBS+NBS survey biomass is up 15%
  - Persistence of NBS biomass has been corroborated
  - EBS and NBS fish have been shown to be genetically similar

2019 maxABC is already down significantly from 2018 ABC (-10%)

- With an even bigger drop from 2019 to 2020 (-24%)

Reasons for not setting ABC<maxABC (2 of 2)

- Difficulty in navigating the new rules
  - How to map risk matrix "concerns" into reductions without violating new prohibition against including socioeconomic concerns in ABC?
  - If it is *just* a matter of adjusting ABC to account for a retrospective bias, this might not be too hard, but M16.6i's retrospective bias is low
  - What is gained/lost by various reductions, and how to choose an objective that does not involve socioeconomic concerns?

EBS Pacific cod, Team Discussion

- The Team discussed the NBS survey results, what they imply about the population, and how it should be used in the assessment model, leading to identification of three hypotheses:
  1. Pacific cod in the NBS are insignificant to the stock and should not be considered in management
  2. Pacific cod have the capability to migrate from the EBS to the NBS each year, and the stock extends over these two areas
  3. The population in the EBS and the NBS may simply be a mixture of the same stock, or the fish in these two areas are sub-populations of the same stock with different life-history characteristics
- More observations (e.g., genetic studies, tagging) are needed to reject any of these hypotheses

EBS Pacific cod, continued

- If Pacific cod are undertaking an annual migration, that migration may occur at the same time as the survey, and there is a possibility that the survey is double-counting some fish, making catchability greater than 1
- Catchability could be affected by the truncated area surveyed in 2018
  - Pacific cod were observed by other surveys outside of the truncated area in 2018, and a bias in the 2018 estimate may be present
- Furthermore, NBS surveys were conducted in only three years, and if a single summed index is considered in the assessment model, this implies that years without NBS survey estimates have zero biomass in that area
- Models with time-varying catchability may have captured some of these concerns, but a spatial analysis of the survey data with temporal and spatial correlation may provide a useful index

EBS Pacific cod, continued

- Investigating fishery CPUE data throughout the year at specific locations may help understand migration patterns and the intersection of a migrating population with the survey
- The longline fleet has recently started fishing on the population in the NBS, which suggests that the population has expanded in the NBS
- There is a sense that the fishery follows the fish northward, but the break between A and B seasons makes it difficult to tell
  - Industry participants reported that when they arrive on the grounds in the north for B-season, the fish are already there
- Industry participants reported that they also follow fish south at the end of the season
- Additionally, connections may occur with GOA (e.g., Unimak Pass), but the implications of these connections are unknown

EBS Pacific cod, continued

- Models 16.6, 16.6i, 16.6j, and 16.6k capture the three hypotheses:
  - *Model 16.6* is a strong bookend and assumes either that the fish in the NBS are insignificant to management of the stock, or that the fish in that area are unlikely to contribute reproductively to the population
    - e.g., they could die if the climate quickly shifted back to cold years with quick formation of ice or were harvested in Russian waters
  - *Model 16.6i* assumes that the fish in the NBS and EBS are all from the same population and should be modeled as one, with no fish in the NBS in years without a NBS survey
  - *Model 16.6j* incorporates time-varying catchability that may compensate for assuming zero NBS fish in years with no survey
  - *Model 16.6k* models the observations in the two areas separately but as a single population

EBS Pacific cod, continued

- After considering many options for a management model, including averaging various models, the Team recommended that Model 16.6i be used for management because it is the author recommended model and the author clearly itemized the justifications for selecting this model as the preferred model
- In particular, the Team noted:
  - Model 16.6i is an incremental change that includes the NBS survey data without introducing too much complexity
  - While all of the models exhibit positive retrospective bias, Model 16.6i had the lowest retrospective bias of the models presented
  - Model 16.6i satisfies many SSC requests
- Although the Team accepted Model 16.6i, other models, such as 16.6j and 16.6k, may more appropriately handle years where there are no survey data from the NBS as well as capture changes in distribution

EBS Pacific cod, continued

- Moreover, the Team identified the following concerns with Model 16.6i:
  - Years without an NBS survey implicitly assume that the biomass in the NBS was zero, which may result in a conservative view of the decline in recent years (e.g., 2014-2018) of the survey index
  - Larger fish were observed in the NBS, but the composition data were simply summed, which may not accurately reflect selectivity of the combined survey
  - This simple summation of the survey abundances assumes a survey of a population at a particular moment in time, but the timing of the north-south migration is not completely understood, and the survey may be following and interacting with migrating fish, possibly resulting in double-counting and a bias at the EBS/NBS boundary
  - (continued on the next slide)

EBS Pacific cod, continued

- Concerns with Model 16.6i (continued):
  - The EBS and NBS survey observations are based on slightly different grids and occur in slightly different time periods and therefore may have different selectivity patterns and availability, warranting the separate treatment of the two indices
  - Although the summed EBS-NBS biomass index has remained somewhat constant over the last 5 years, this may reflect a bias resulting from the larger fish in the NBS agecomps relative to EBS
  - It is uncertain if the fish in the NBS will contribute to current and future spawning biomass
  - Given the unprecedented shift in distribution and uncertain future climate conditions, there could be additional natural mortality in the NBS that is not accounted for in the present model

EBS Pacific cod, continued

- Alternative to a single model, the Team discussed and seriously considered averaging some or all of the 16.x models to characterize structural uncertainty related to the three hypotheses stated earlier
- In the end, the Team did not average models, largely because:
  - Additional work would be needed to clean up major concerns with all models (of which 16.6i had the fewest):
    - strong retrospective patterns
    - use of options not common for surveys (time-varying catchability)
    - omission of observations (NBS survey)
  - Model 16.6i was the most parsimonious and satisfied the principle of Occam's Razor
  - (continued on next slide)

EBS Pacific cod, continued

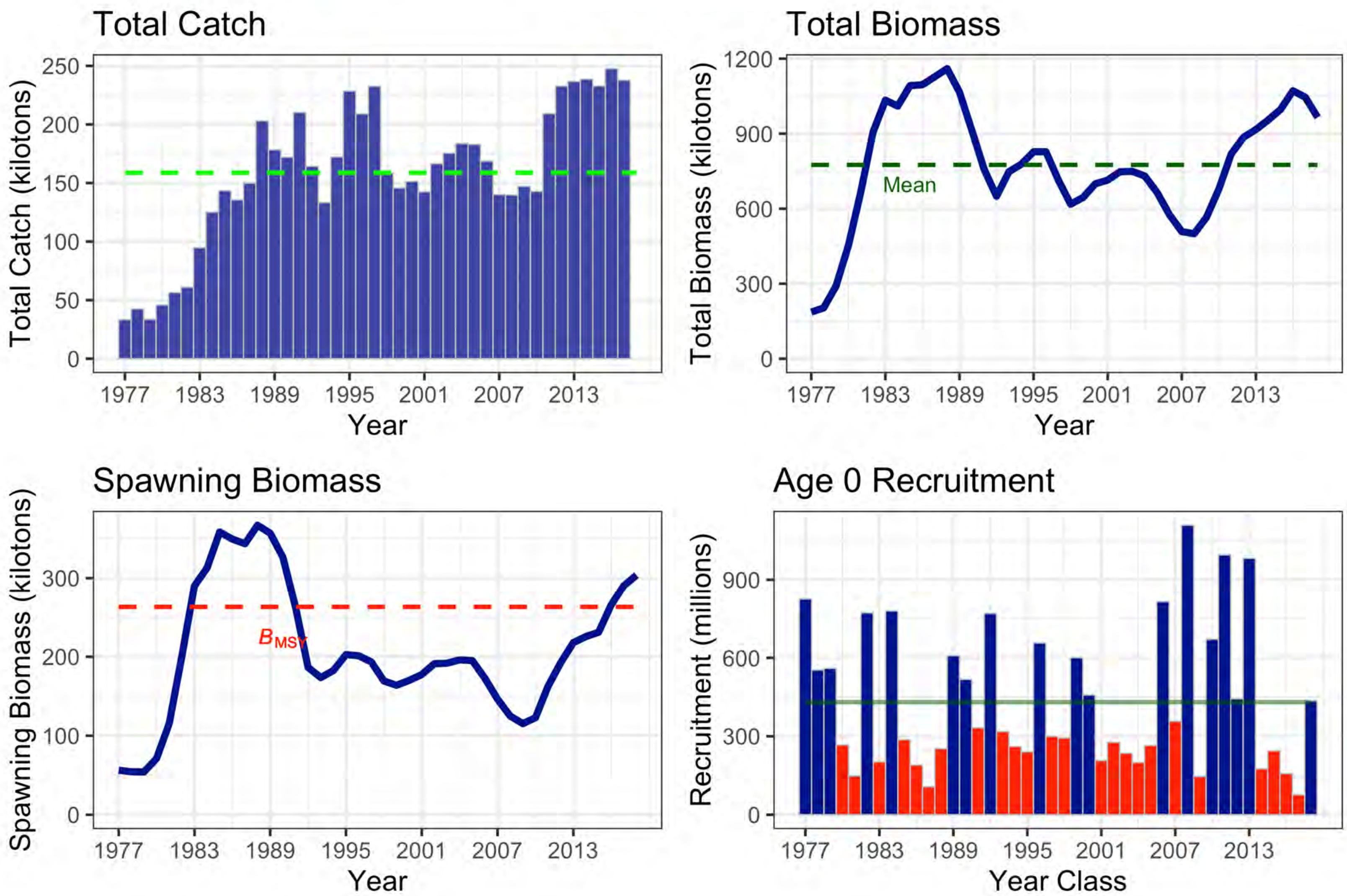
- Reasons why the Team did not average models (continued):
  - After much discussion (until 6:30 pm Wednesday), Model 16.6i was the model that the Team felt most comfortable with
    - The Team made the rounds attempting to justify each model and always came back to Model 16.6i
  - The author did not put forward any support for an ensemble
  - The Team did not have time to adequately discuss, choose, and defend an ensemble
  - The Team discussed this again on Friday afternoon per the schedule adopted Wednesday evening upon adjourning, revisiting minutes to confirm the notes
    - With additional time, the Team might have revisited the decision not to create an ensemble

EBS Pacific cod risk table

Assessment-related	Population dynamics	Environmental/ ecosystem
Retrospective bias, age data potentially unreliable, wide range of results with different model assumptions, (B23%-B49%) uncertainty in stock structure. Conclusion: Level 2-3, substantially increased concerns to major concerns	Recent low recruitment, including the lowest observed, strong decline in survey numbers, spatial distribution is unprecedented, with unknown consequences. Potential for increased natural mortality. Conclusion: Level 2-3, substantially increased concerns to major concerns	Unprecedented lack of sea ice, and absent cold pool. Reduced primary and secondary production, forecasts of continued warm conditions, unprecedented extent and duration of bird die offs with indications of insufficient prey resources. Conclusion: Level 2-3, substantially increased concerns to major concerns

Overall score is Level 2-3: Author's recommended ABC = maxABC. Plan Team filled out risk table during meeting, and recommended 20% reduction by referencing the historical distribution of percent reductions.

EBS Pacific cod, continued

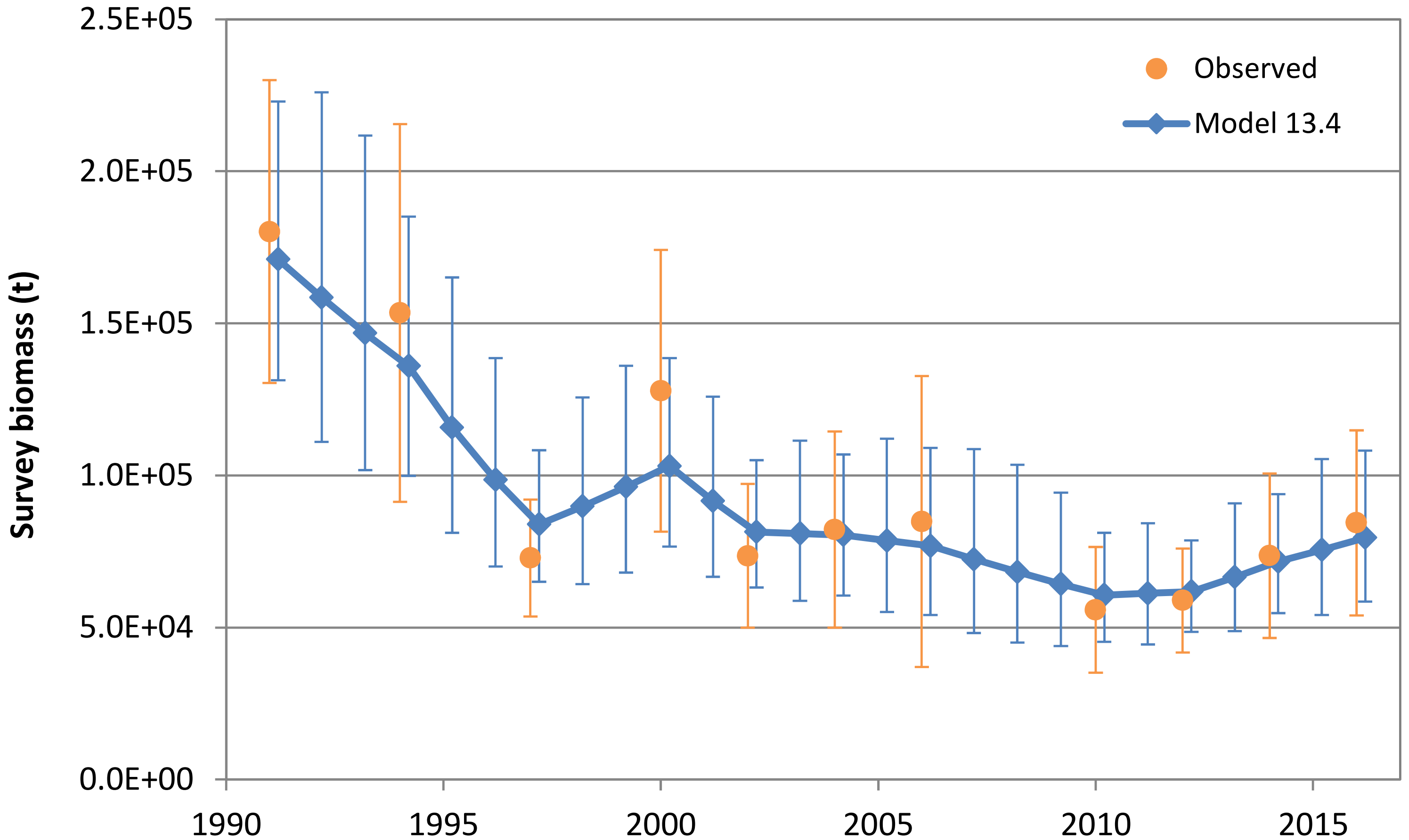


EBS Pacific cod, continued

Quantity	Last asmt.	This asmt.	Change
M	0.36	0.34	-0.06
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	918,000	n/a	-0.10
2019 age+ biomass	762,000	824,000	0.08
2018 spawning biomass	292,000	n/a	-0.01
2019 spawning biomass	262,000	290,000	0.11
B100%	593,000	658,000	0.11
B40%	237,000	263,000	0.11
B35%	207,000	230,000	0.11
2019 FOFL	0.38	0.38	0.00
2019 FABC	0.31	0.24	-0.23
2018 OFL	238,000	n/a	-0.09
2019 OFL	201,000	216,000	0.07
2018 ABC	201,000	n/a	-0.28
2019 ABC	170,000	144,800	-0.15

AI Pacific cod

- Survey biomass



AI Pacific cod, continued

- Biomass apportionment
  - “Harvest limit” for the WAI is computed by subtracting State GHL from AI ABC, then multiplying by proportion of biomass in WAI
  - Proportion “determined by the annual stock assessment process”
  - Based on 2019 estimate from RE model, proportion = 15.7%
    - Down from 25.6% estimated in 2016-2017 assessments
  - GHL has been 27% of ABC since 2016; increasing to 31% in 2019
  - Recommended 2019 ABC is 20,600 t, implying a 2019 WAI harvest limit of 20,600 t × (1.00–0.31) × 0.157 = 2,232 t
    - 2018 WAI catch through 11/24 = 2,694 t
  - (continued on next 3 slides)

AI Pacific cod, continued

- Biomass apportionment, continued
  - Team discussion:
    - Options include basing the proportion on:
      - the raw survey data or the RE model estimates
      - the most recent estimate or an average over recent years
    - Using the model-based estimate intrinsically introduces some level of smoothing compared to the survey observations
    - Team ultimately agreed that 15.7% is the appropriate proportion

AI Pacific cod, continued

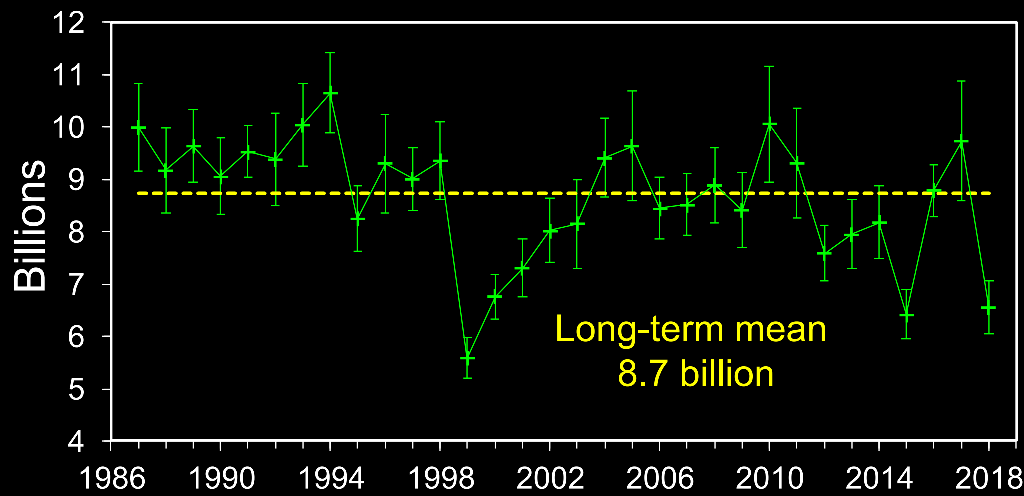
- Following past practice, the value of M used in the Tier 5 harvest control rule is borrowed from the EBS assessment, resulting in a change from 0.36 to 0.34 this year

Quantity	Last asmt.	This asmt.	Change
M	0.36	0.34	-0.06
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	79,600	80,700	0.01
2019 FOFL	0.36	0.34	-0.06
2019 FABC	0.27	0.255	-0.06
2018 OFL	28,700	n/a	-0.05
2019 OFL	28,700	27,400	-0.05
2018 ABC	21,500	n/a	-0.04
2019 ABC	21,500	20,600	-0.04

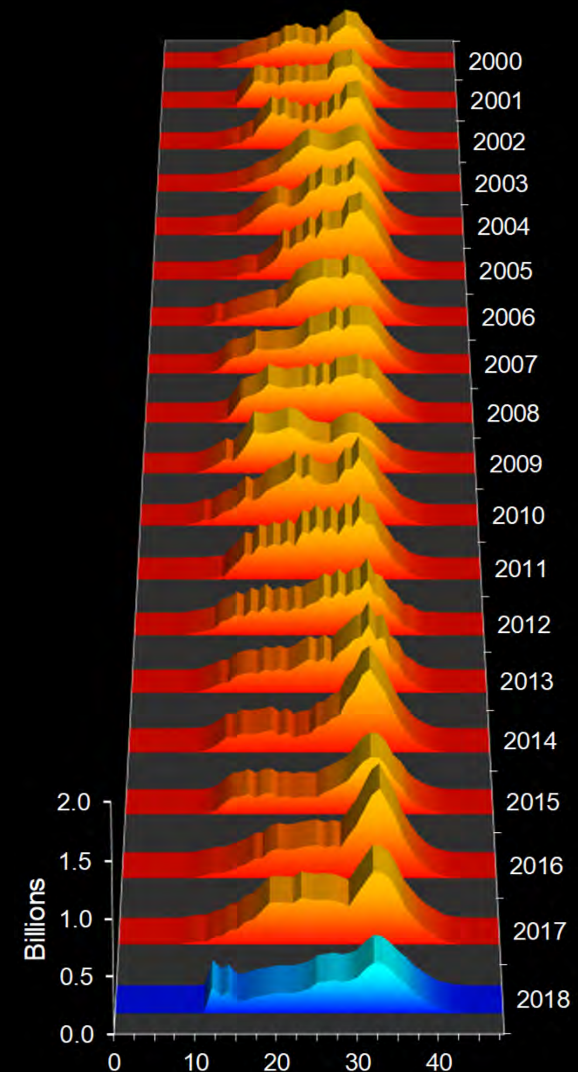
Chapter 3: sablefish (full)

- Covered in GOA Team presentation

EBS Yellowfin sole

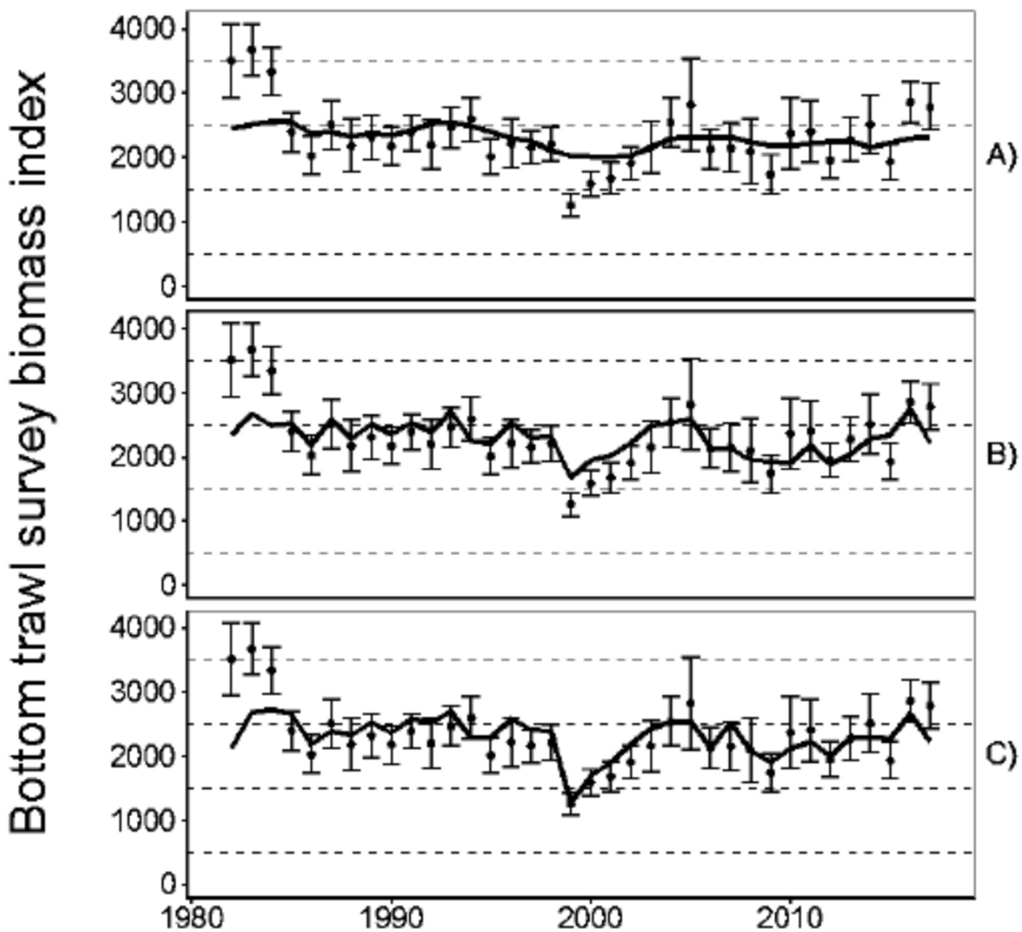


SEBS Abundance
6.5 billion
-33% from 2017 (9.7 billion)



Yellowfin sole, continued

- A: constant *Q*; B: temperature only; C: temp., start date, and interaction



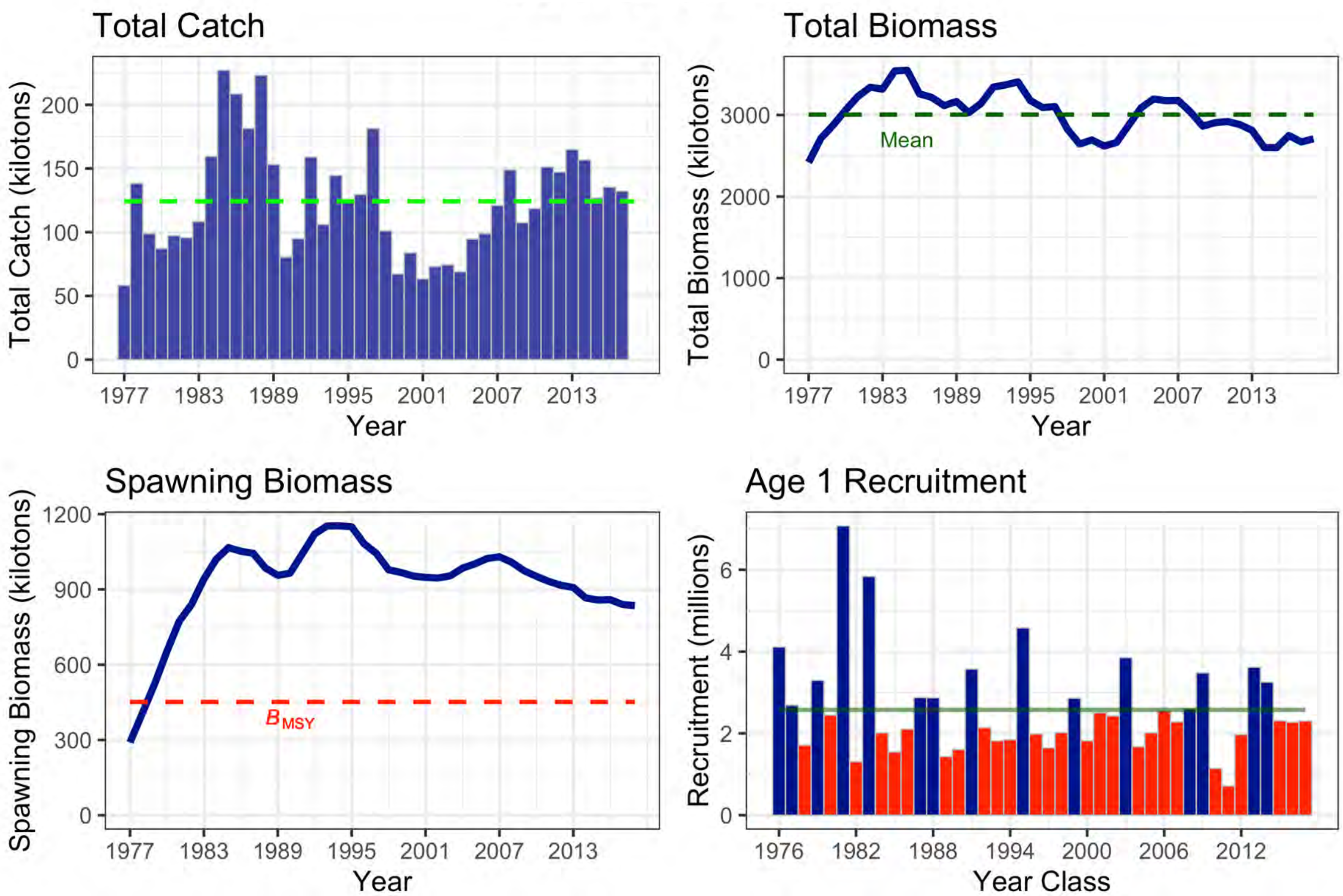
Yellowfin sole, continued

- Stock status and trend:
  - 2003 and 2009 cohorts are 49% and 21% above average
    - However, 9 of the last 12 cohorts are below average
  - Spawning biomass has declined almost continuously since 2007
  - 2019 spawning biomass is 68% of B_0 and 85% above B_{MSY}

Authors' chose not to include the NBS survey data in a model despite the high abundance of yellowfin sole in that region

- The author did not think that the 2018 NBS survey was fully appropriate for this stock as it did not include shallow stations that would have been informative for yellowfin sole

Yellowfin sole, continued



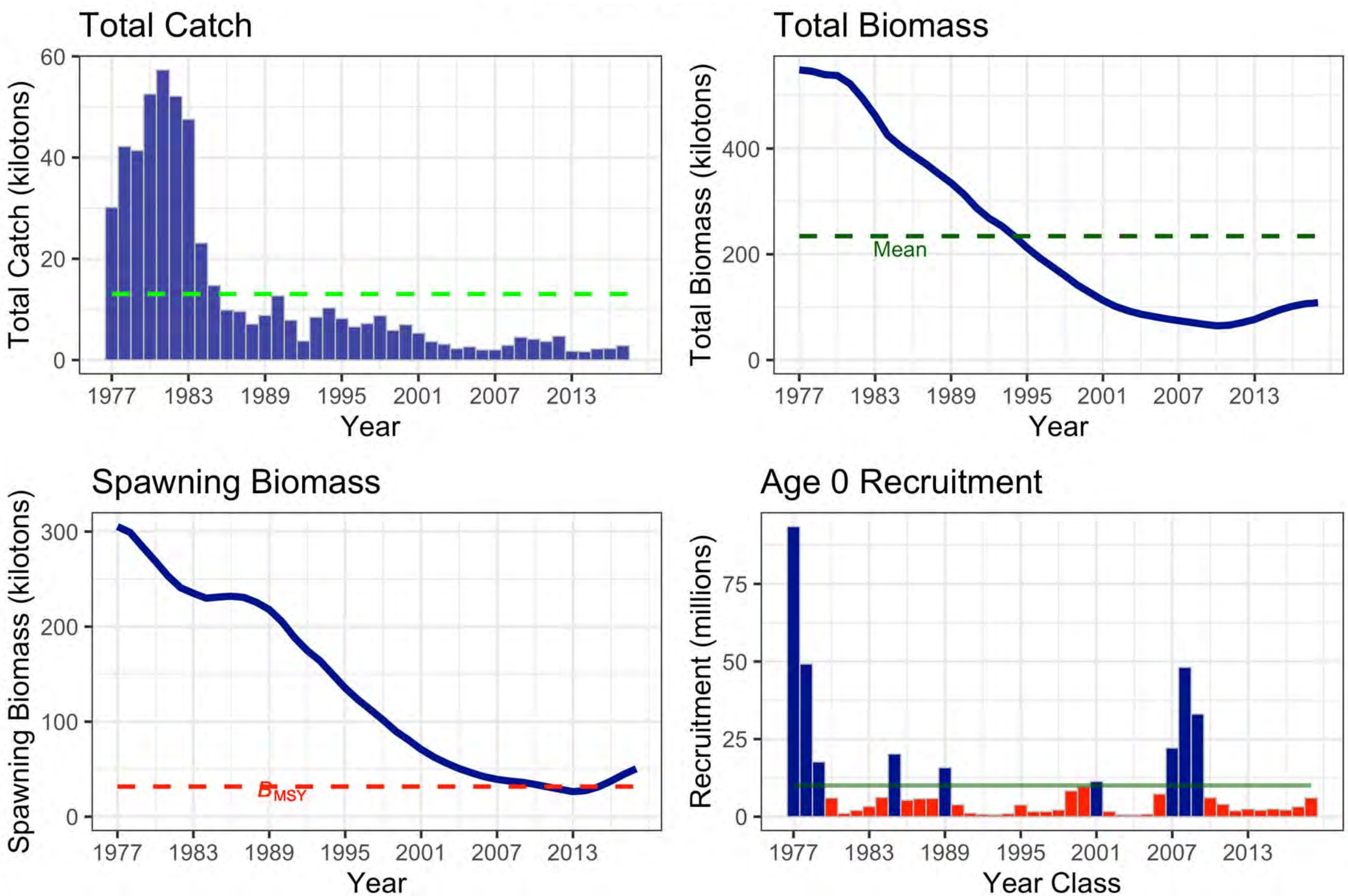
Yellowfin sole, continued

Quantity	Last asmt.	This asmt.	Change
M	0.12	0.12	0.00
2018 tier	1a	n/a	none
2019 tier	1a	1a	none
2018 age+ biomass	2,553,100	n/a	-0.04
2019 age+ biomass	2,460,700	2,462,400	0.00
2018 spawning biomass	895,600	n/a	-0.05
2019 spawning biomass	890,000	850,600	-0.04
B0	1,204,000	1,245,400	0.03
Bmsy	456,000	460,800	0.01
2019 FOFL	0.12	0.118	-0.02
2019 FABC	0.109	0.107	-0.02
2018 OFL	306,700	n/a	-0.05
2019 OFL	295,600	290,000	-0.02
2018 ABC	277,500	n/a	-0.05
2019 ABC	267,500	263,200	-0.02

Other 2018 survey results

Taxon	Year	SEBS Biomass mt	SEBS Biomass change	SEBS Abund. X1000	SEBS Abund. change	NEBS Biomass mt	NEBS Biomass change	NEBS Abund. X1000	NEBS Abund. change
Arrowtooth fl.	2017	424,194	21%	742,123	46%	-		-	+
	2018	511,192		1,086,953		852		1,056	
Kamchatka fl.	2017	48,084	-8%	111,180	-16%	99	663%	93	487%
	2018	44,000		93,721		758		548	
Greenland turbot	2017	21,519	-16%	10,518	-30%	62	1703%	94	627%
	2018	18,017		7,361		1,116		685	
Pacific halibut	2017	126,684	-1%	52,718	-4%	15,022	22%	4,220	9%
	2018	125,702		50,416		18,397		4,607	
Flathead sole	2017	538,018	-8%	2,099,347	11%	83	516%	180	470%
	2018	492,623		2,329,667		510		1,028	
Bering fl.	2017	27,404	-53%	122,044	-50%	20,712	45%	239,346	15%
	2018	12,995		61,152		30,025		275,082	
Alaska plaice	2017	491,050	-15%	666,201	-14%	336,841	-18%	438,662	-29%
	2018	419,509		569,754		274,543		310,564	
Alaska skate	2017	544,657	0%	118,976	7%	82,399	42%	18,497	50%
	2018	545,994		126,778		116,835		27,670	

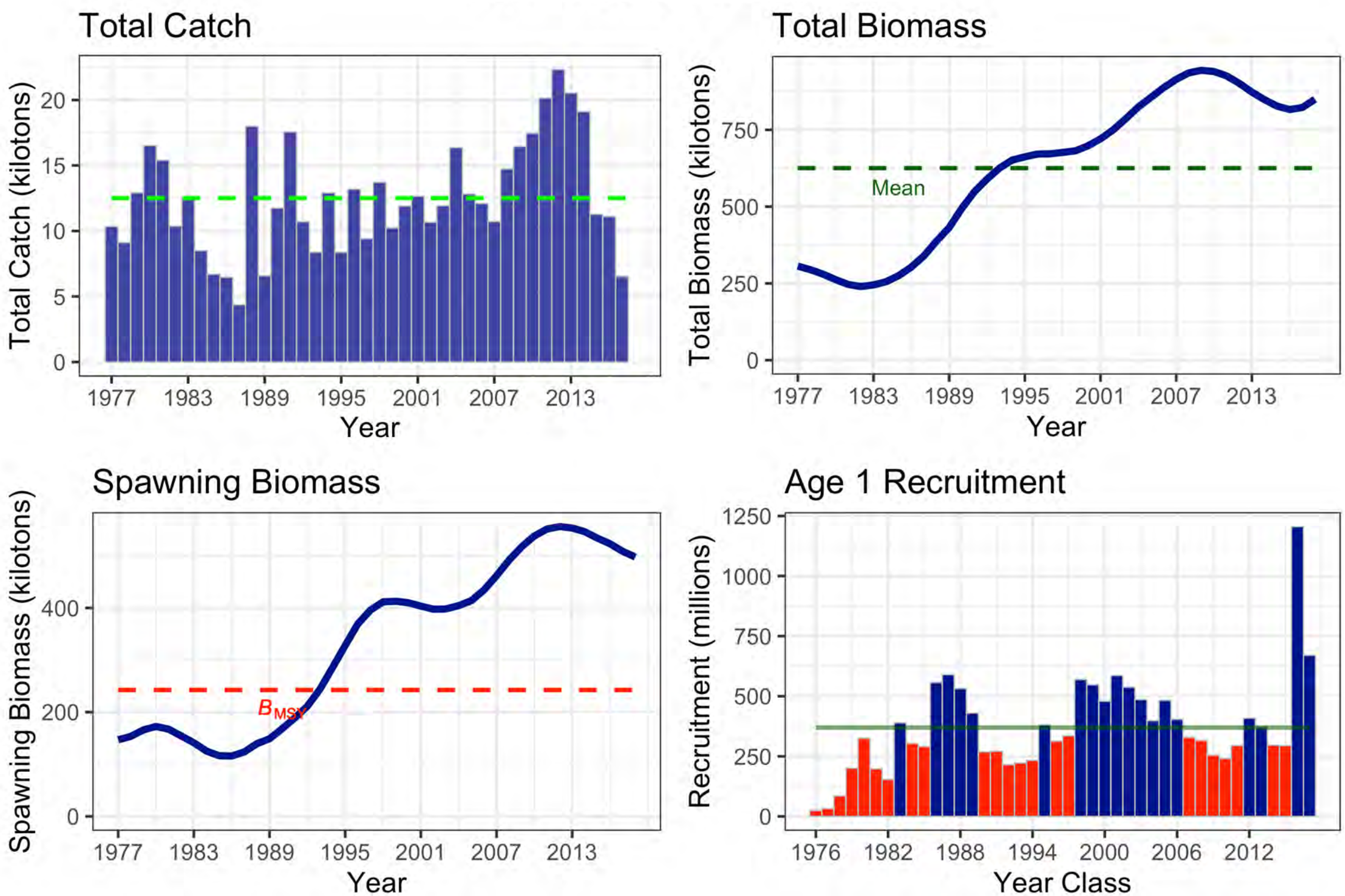
Greenland turbot, continued



Greenland turbot, continued

Quantity	Last asmt.	This asmt.	Change
M	0.112	0.112	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	126,417	n/a	-0.16
2019 age+ biomass	127,021	105,930	-0.17
2018 spawning biomass	58,035	n/a	-0.07
2019 spawning biomass	61,878	54,244	-0.12
B100%	103,097	90,534	-0.12
B40%	41,239	36,213	-0.12
B35%	36,084	31,687	-0.12
2019 FOFL	0.22	0.21	-0.05
2019 FABC	0.18	0.18	0.00
2018 OFL	13,148	n/a	-0.14
2019 OFL	13,540	11,362	-0.16
2018 ABC	11,132	n/a	-0.13
2019 ABC	11,473	9,658	-0.16

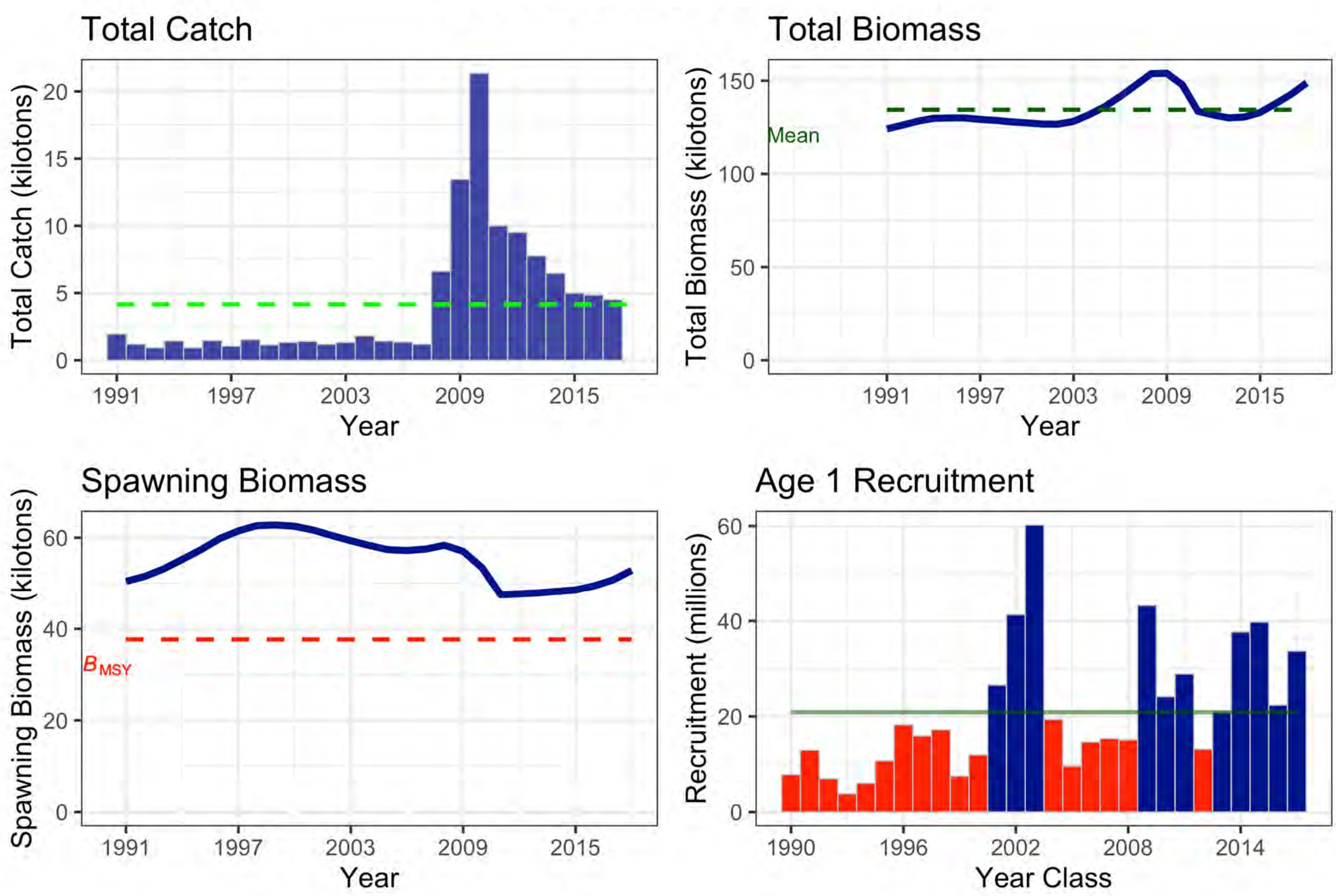
Arrowtooth flounder, continued



Arrowtooth flounder, continued

Quantity	Last asmt.	This asmt.	Change
M	0.35/0.20	0.35/0.20	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	785,141	n/a	0.14
2019 age+ biomass	782,840	892,591	0.14
2018 spawning biomass	490,663	n/a	-0.02
2019 spawning biomass	472,562	482,174	0.02
B100%	530,135	606,237	0.14
B40%	212,054	242,495	0.14
B35%	185,547	212,183	0.14
2019 FOFL	0.151	0.161	0.07
2019 FABC	0.129	0.136	0.05
2018 OFL	76,757	n/a	0.08
2019 OFL	75,084	82,939	0.10
2018 ABC	65,932	n/a	0.07
2019 ABC	64,494	70,673	0.10

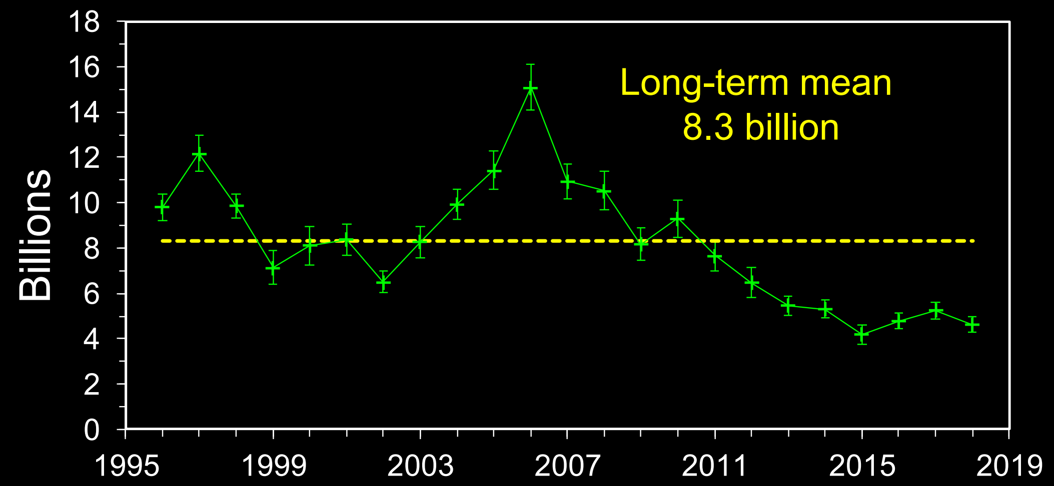
Kamchatka flounder, continued

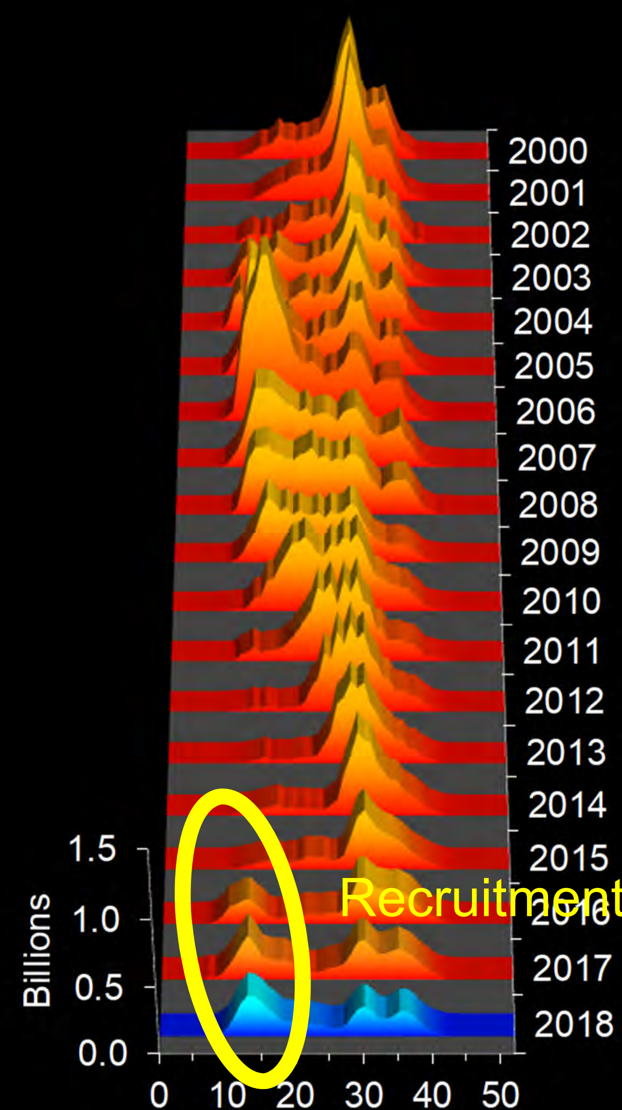


Kamchatka flounder, continued

Quantity	Last asmt.	This asmt.	Change
M	0.11	0.11	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	189,868	n/a	-0.18
2019 age+ biomass	199,223	155,251	-0.22
2018 spawning biomass	63,718	n/a	-0.14
2019 spawning biomass	67,390	54,779	-0.19
B100%	126,954	107,673	-0.15
B40%	50,782	43,069	-0.15
B35%	44,434	37,685	-0.15
2019 FOFL	0.075	0.108	0.44
2019 FABC	0.064	0.090	0.41
2018 OFL	11,347	n/a	-0.03
2019 OFL	12,022	10,965	-0.09
2018 ABC	9,737	n/a	-0.05
2019 ABC	10,317	9,260	-0.10

EBS Northern rock sole



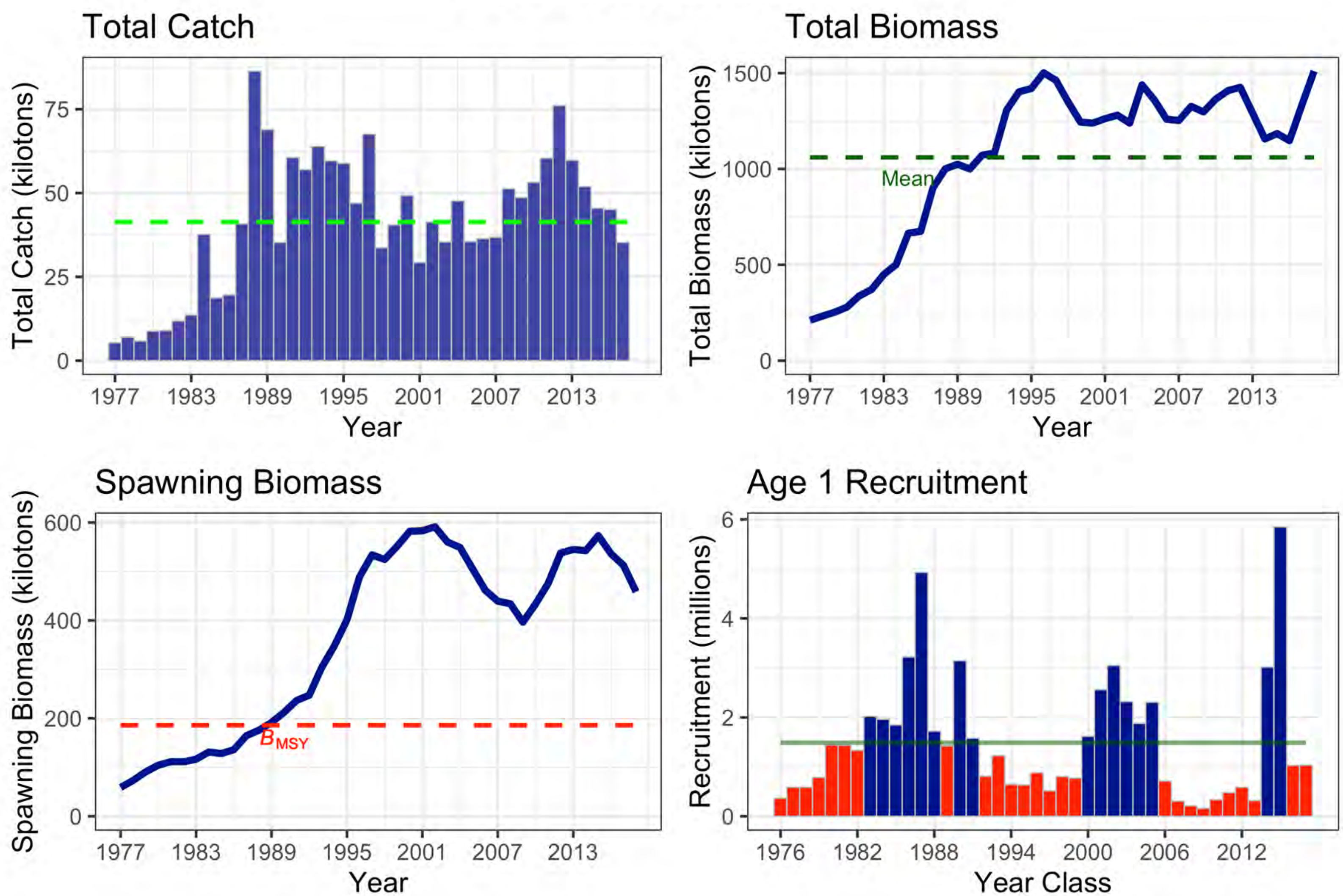


SEBS Abundance

4.63 billion

-12% from 2017 (5.26 billion)

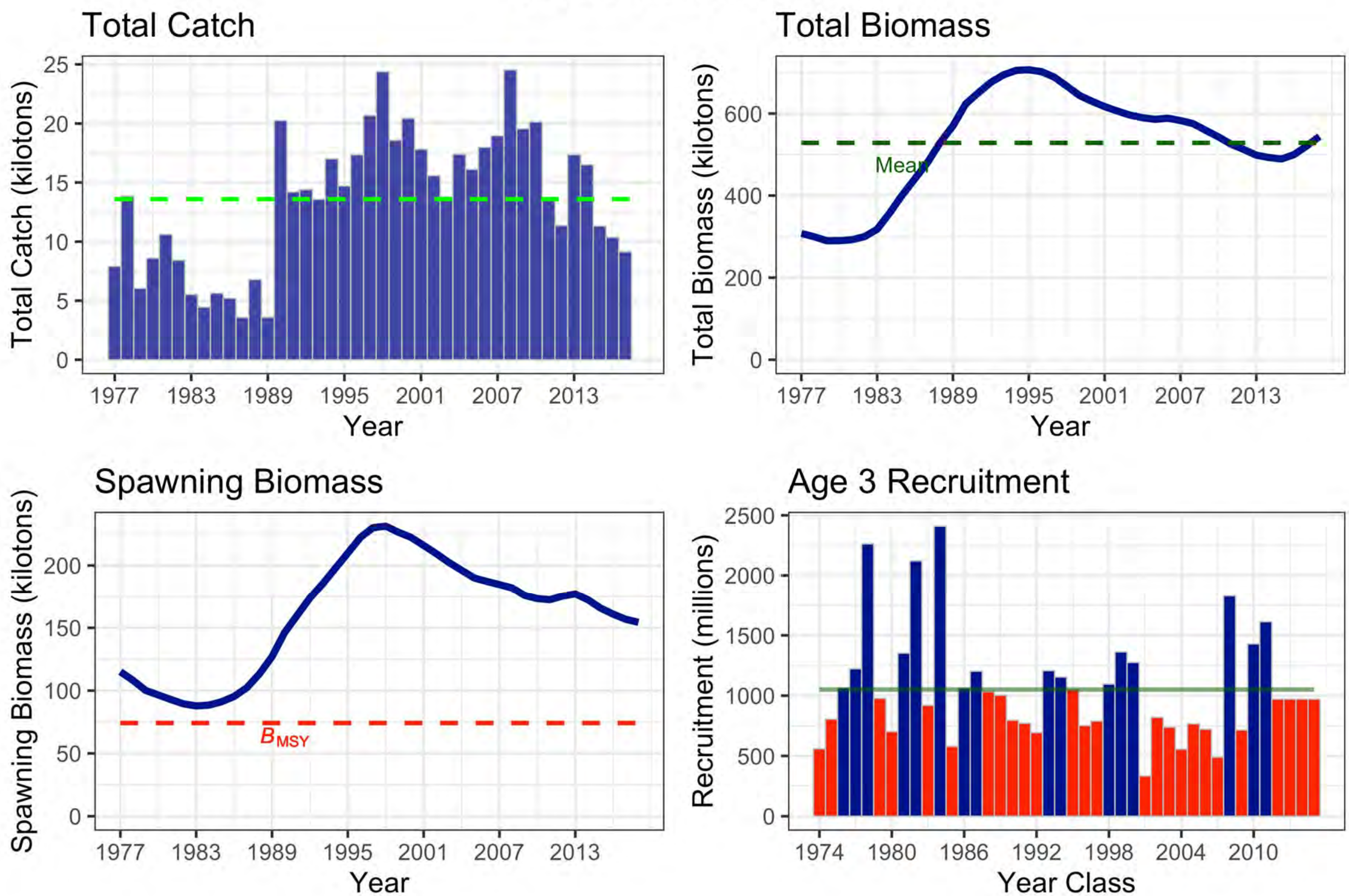
Northern rock sole, continued



Northern rock sole, continued

Quantity	Last asmt.	This asmt.	Change
M	0.15	0.15	0.00
2018 tier	1a	n/a	none
2019 tier	1a	1a	none
2018 age+ biomass	923,200	n/a	-0.10
2019 age+ biomass	852,000	828,000	-0.03
2018 spawning biomass	472,200	n/a	-0.12
2019 spawning biomass	413,300	417,800	0.01
B0	678,310	515,680	-0.24
Bmsy	257,000	186,000	-0.28
2019 FOFL	0.160	0.147	-0.08
2019 FABC	0.155	0.144	-0.07
2018 OFL	147,300	n/a	-0.17
2019 OFL	136,000	122,000	-0.10
2018 ABC	143,100	n/a	-0.17
2019 ABC	132,000	118,900	-0.10

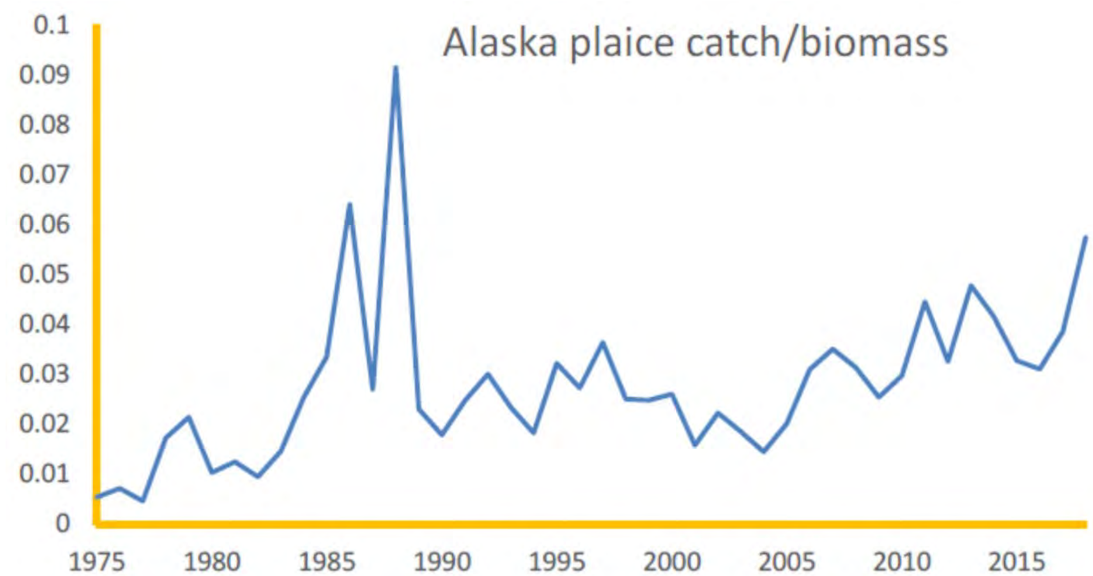
Flathead sole, continued



Flathead sole, continued

Quantity	Last asmt.	This asmt.	Change
M	0.20	0.20	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	762,513	n/a	-0.12
2019 age+ biomass	777,961	673,718	-0.13
2018 spawning biomass	214,124	n/a	-0.28
2019 spawning biomass	205,156	153,203	-0.25
B100%	322,938	212,060	-0.34
B40%	129,175	84,824	-0.34
B35%	113,028	74,221	-0.34
2019 FOFL	0.41	0.47	0.15
2019 FABC	0.34	0.38	0.12
2018 OFL	79,862	n/a	0.01
2019 OFL	78,036	80,918	0.04
2018 ABC	66,773	n/a	0.00
2019 ABC	65,227	66,625	0.02

Chapter 10: Alaska plaice (partial)

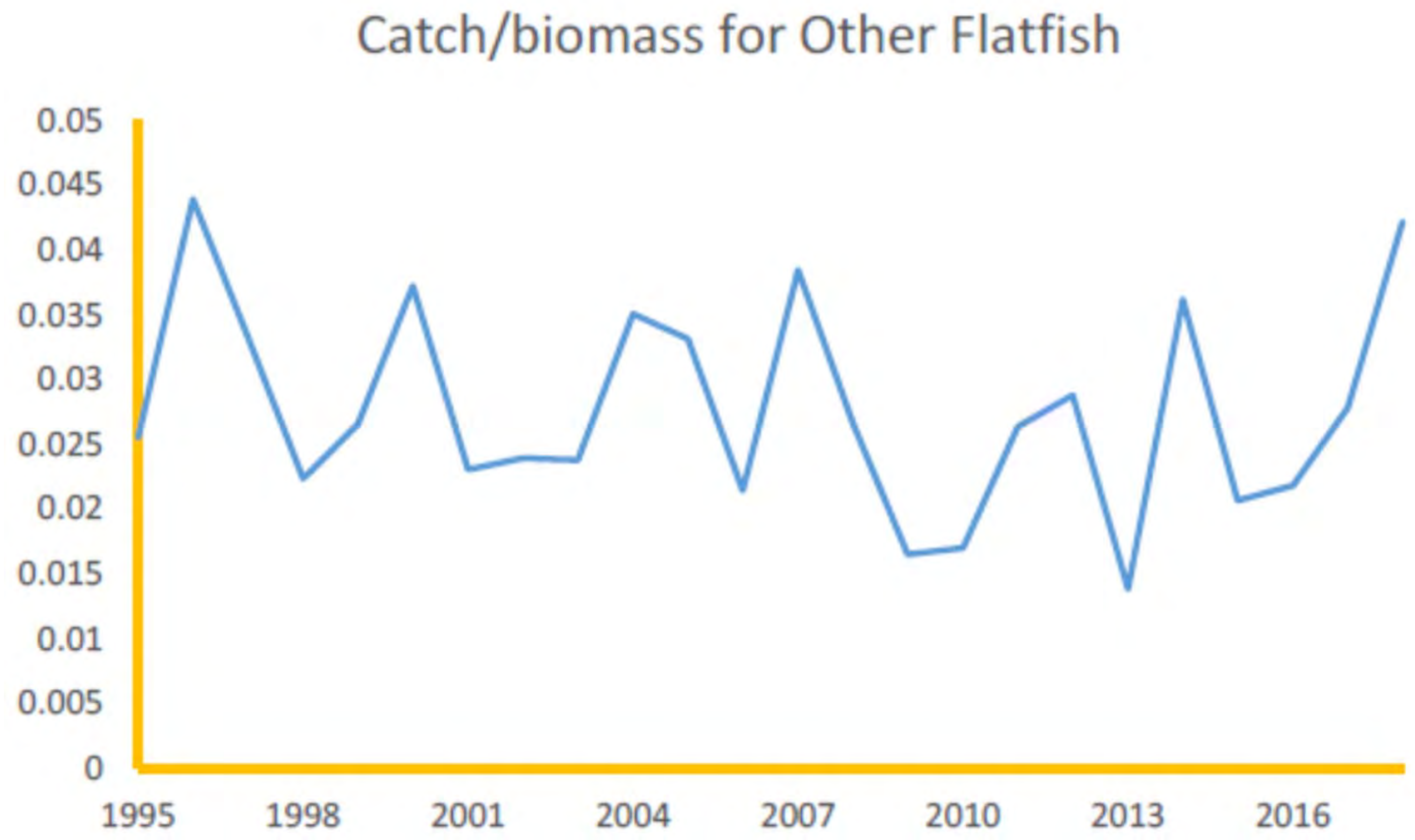


- 2019 spawning biomass is 59% of $B_{100\%}$
  - 38 - 40% of Alaska plaice were in the Northern Bering Sea

Alaska plaice, continued

Quantity	Last asmt.	This asmt.	Change
M	0.13	0.13	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	417,300	n/a	-0.04
2019 age+ biomass	412,000	400,700	-0.03
2018 spawning biomass	191,460	n/a	-0.03
2019 spawning biomass	181,730	186,100	0.02
B100%	317,360	317,360	0.00
B40%	126,900	126,900	0.00
B35%	111,100	111,100	0.00
2019 FOFL	0.149	0.149	0.00
2019 FABC	0.124	0.124	0.00
2018 OFL	41,170	n/a	-0.03
2019 OFL	38,800	39,880	0.03
2018 ABC	34,590	n/a	-0.03
2019 ABC	32,700	33,600	0.03

Chapter 11: other flatfish (partial)



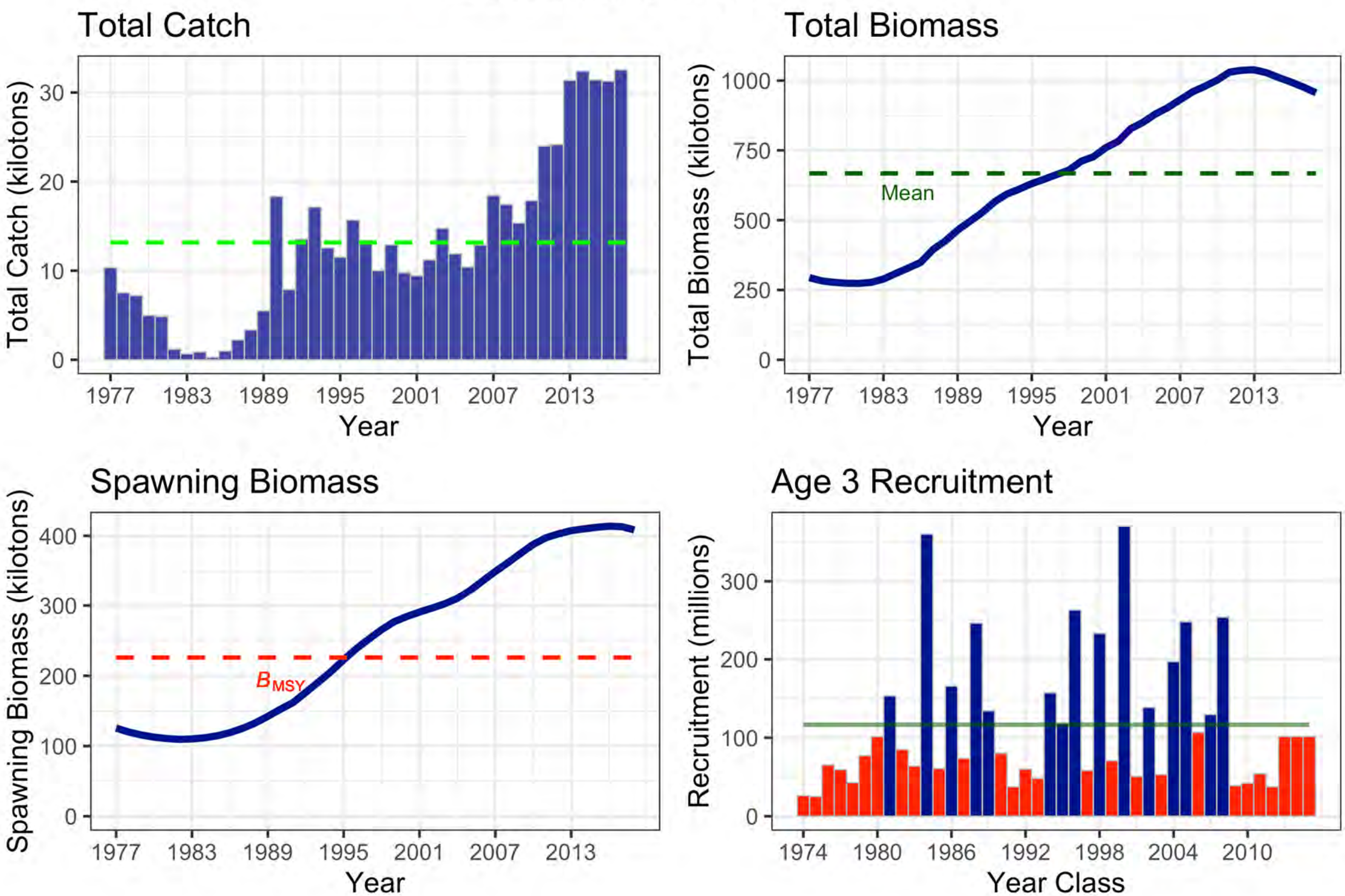
Other flatfish, continued

- Tier 5 random effects model was re-run with updated data

Quantity*	Last asmt.	This asmt.	Change
M	0.155	0.154	0.00
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	113,450	141,325	0.25
2019 FOFL	0.155	0.154	0.00
2019 FABC	0.116	0.116	0.00
2018 OFL	17,591	n/a	0.24
2019 OFL	17,591	21,824	0.24
2018 ABC	13,193	n/a	0.24
2019 ABC	13,193	16,368	0.24

*Instantaneous rates are biomass-weighted averages

Pacific ocean perch, continued



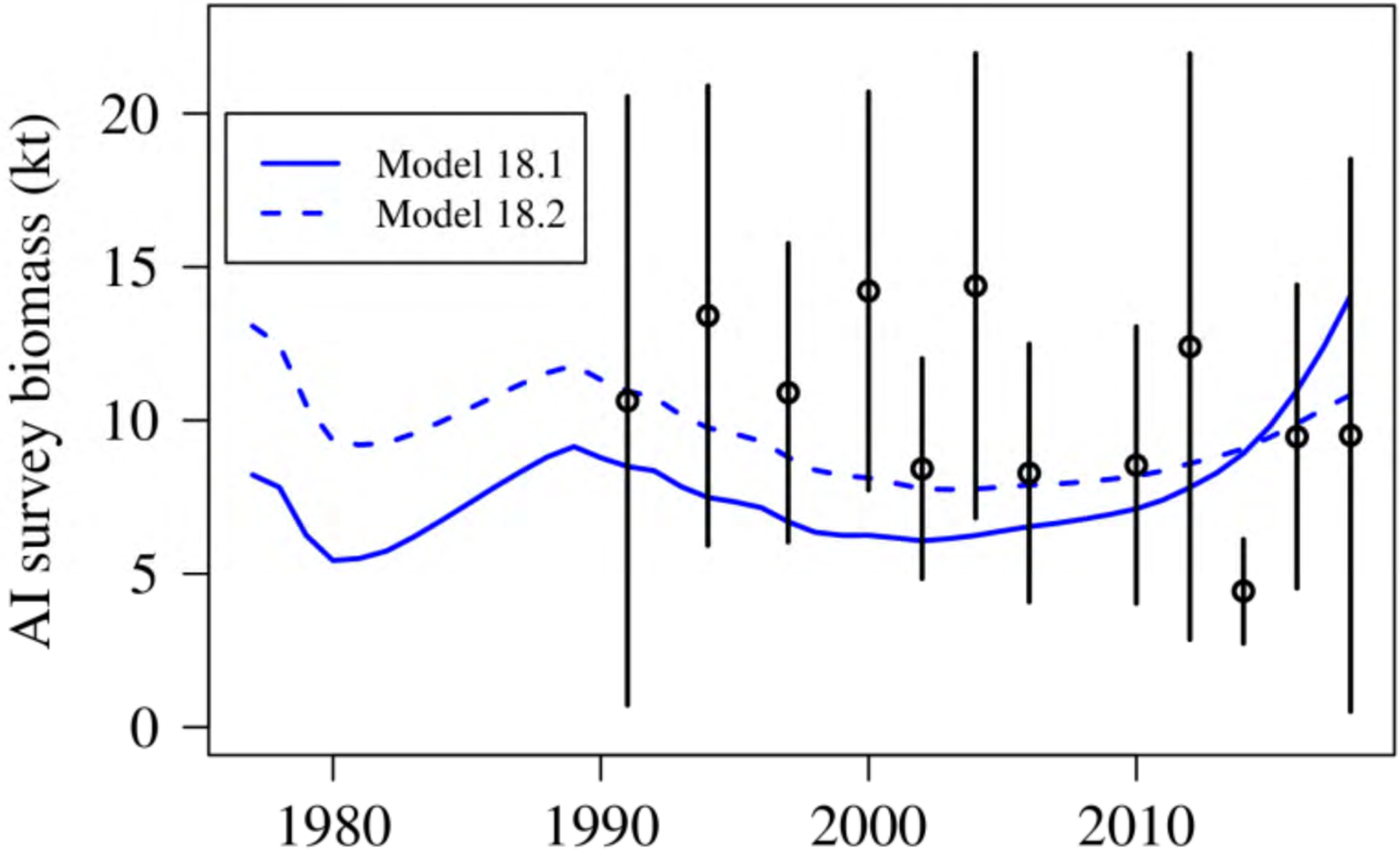
Pacific ocean perch, continued

Quantity	Last asmt.	This asmt.	Change
M	0.058	0.056	-0.03
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	749,925	n/a	0.25
2019 age+ biomass	734,431	934,293	0.27
2018 spawning biomass	305,804	n/a	0.30
2019 spawning biomass	295,593	399,024	0.35
B100%	536,713	645,738	0.20
B40%	214,685	258,295	0.20
B35%	187,849	226,008	0.20
2019 FOFL	0.101	0.095	-0.06
2019 FABC	0.082	0.079	-0.04
2018 OFL	51,675	n/a	0.18
2019 OFL	50,098	61,067	0.22
2018 ABC	42,509	n/a	0.19
2019 ABC	41,212	50,594	0.23

Northern rockfish, continued

Quantity	Last asmt.	This asmt.	Change
M	0.046	0.046	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	246,160	n/a	-0.01
2019 age+ biomass	244,963	244,196	0.00
2018 spawning biomass	106,486	n/a	-0.02
2019 spawning biomass	104,699	104,201	0.00
B100%	164,674	164,674	0.00
B40%	65,870	65,870	0.00
B35%	57,636	57,636	0.00
2019 FOFL	0.080	0.080	0.00
2019 FABC	0.065	0.065	0.00
2018 OFL	15,888	n/a	-0.02
2019 OFL	15,563	15,507	0.00
2018 ABC	12,975	n/a	-0.02
2019 ABC	12,710	12,664	0.00

Blackspotted/rougheye rockfish



Blackspotted/rougheye, continued

Stock status and trend (AI only, based on Model 18.2):

- Following a string of 20 consecutive below-average cohorts, 1998-2011 cohorts are all above average
- Spawning biomass has increased steadily since 2007 (28% by 2018)
- 2019 spawning biomass is 32% of $B_{100\%}$

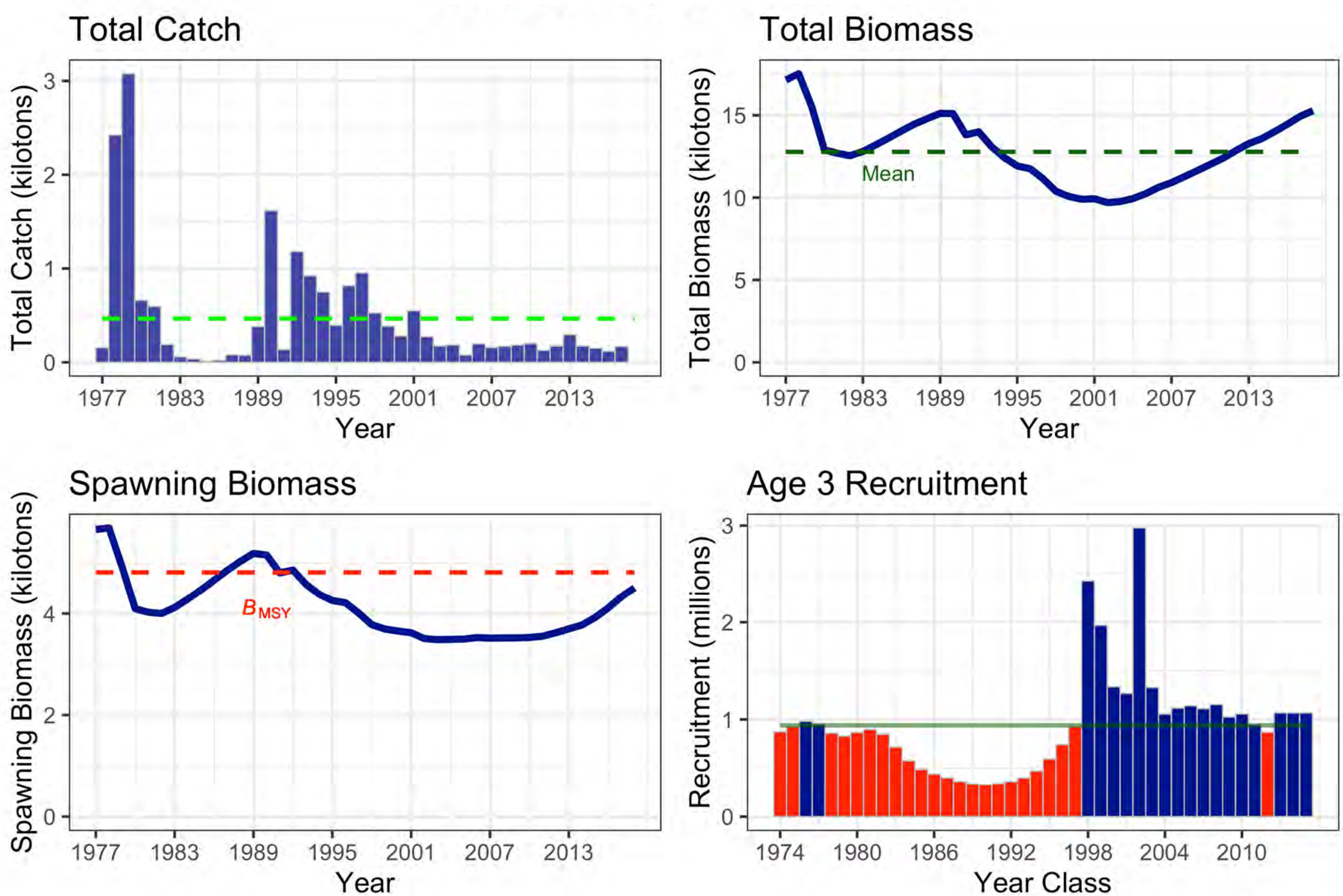
- The Team recommended that the results of Models 18.1 and 18.2 be averaged in order to arrive at the 2019 and 2020 harvest specs

Blackspotted/rougheye, continued

- Team discussion (continued):
  - Additionally, the utility of the MSSC as a guideline for fishery removals on a finer spatial scale was discussed
    - Industry participants generally liked having the MSSC as a guideline to work toward
    - Team opinion was mixed regarding subarea ABCs versus MSSCs
    - Team to reconsider separate area-specific ABCs in September

Year	WAI MSSC	WAI Catch	Catch/MSSC
2015	46	67	1.46
2016	58	38	0.65
2017	29	34	1.17
2018	35	65	1.86

Blackspotted/rougheye, continued



Blackspotted/rougheye, continued

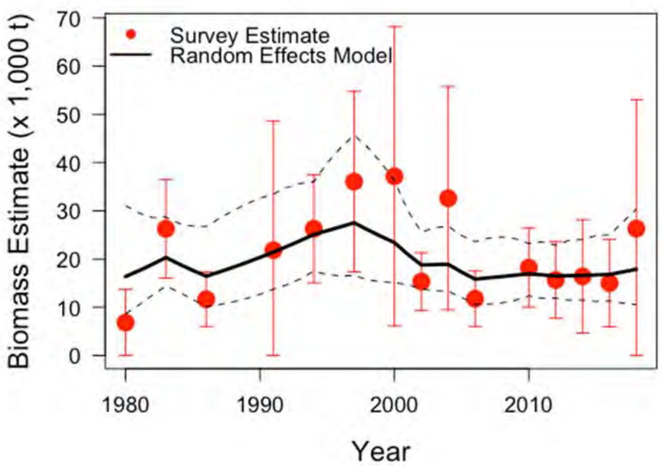
Quantity	Last asmt	This asmt*	Change
M	0.033	0.032	-0.03
2018 tier	3b	n/a	none
2019 tier	3a	3b	↓
2018 age+ biomass	37,453	n/a	-0.13
2019 age+ biomass	39,169	32,436	-0.17
2018 spawning biomass	8,208	n/a	-0.16
2019 spawning biomass	9,163	6,858	-0.25
B100%	20,777	21,527	0.04
B40%	8,311	8,611	0.04
B35%	7,272	7,534	0.04
2019 FOFL	0.054	0.0325	-0.40
2019 FABC	0.044	0.027	-0.39
2018 OFL	749	n/a	-0.33
2019 OFL	829	503	-0.39
2018 ABC	613	n/a	-0.32
2019 ABC	678	418	-0.38

* M, age+ biomass, OFL, and ABC are BSAI; others are AI

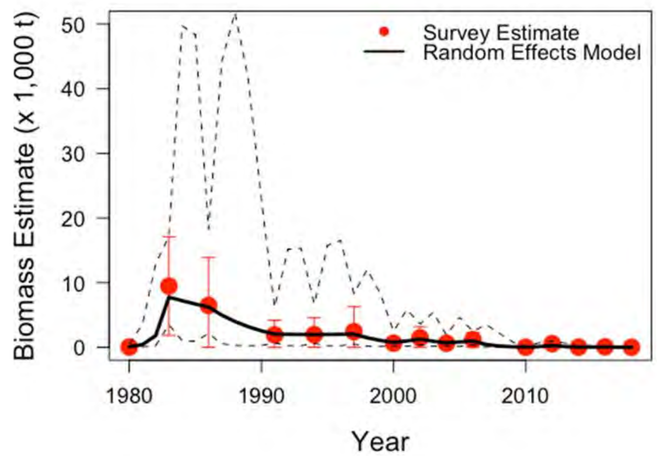
Shortraker rockfish

Biomass estimates based on random effects model

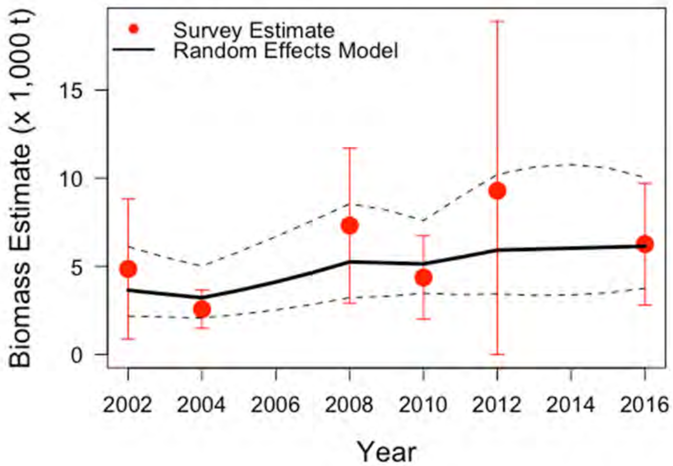
Aleutian Islands



Southern Bering Sea



Bering Sea slope



Shortraker rockfish, continued

Quantity	Last asmt.	This asmt.	Change
M	0.030	0.030	0.00
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	22,191	24,055	0.08
2019 FOFL	0.030	0.030	0.00
2019 FABC	0.0225	0.0225	0.00
2018 OFL	666	n/a	0.08
2019 OFL	666	722	0.08
2018 ABC	499	n/a	0.08
2019 ABC	499	541	0.08

Chapter 16: other rockfish (full)

New data:

- 2018 AI survey biomass (down 14% from 2016)

Model alternatives:

- Tier 5 random effects
- For non-SST species combined, EBS shelf survey yielded estimates of zero for both biomass and standard error in 12 of 37 years

Stock status and trend

- Model biomass generally increasing throughout time series

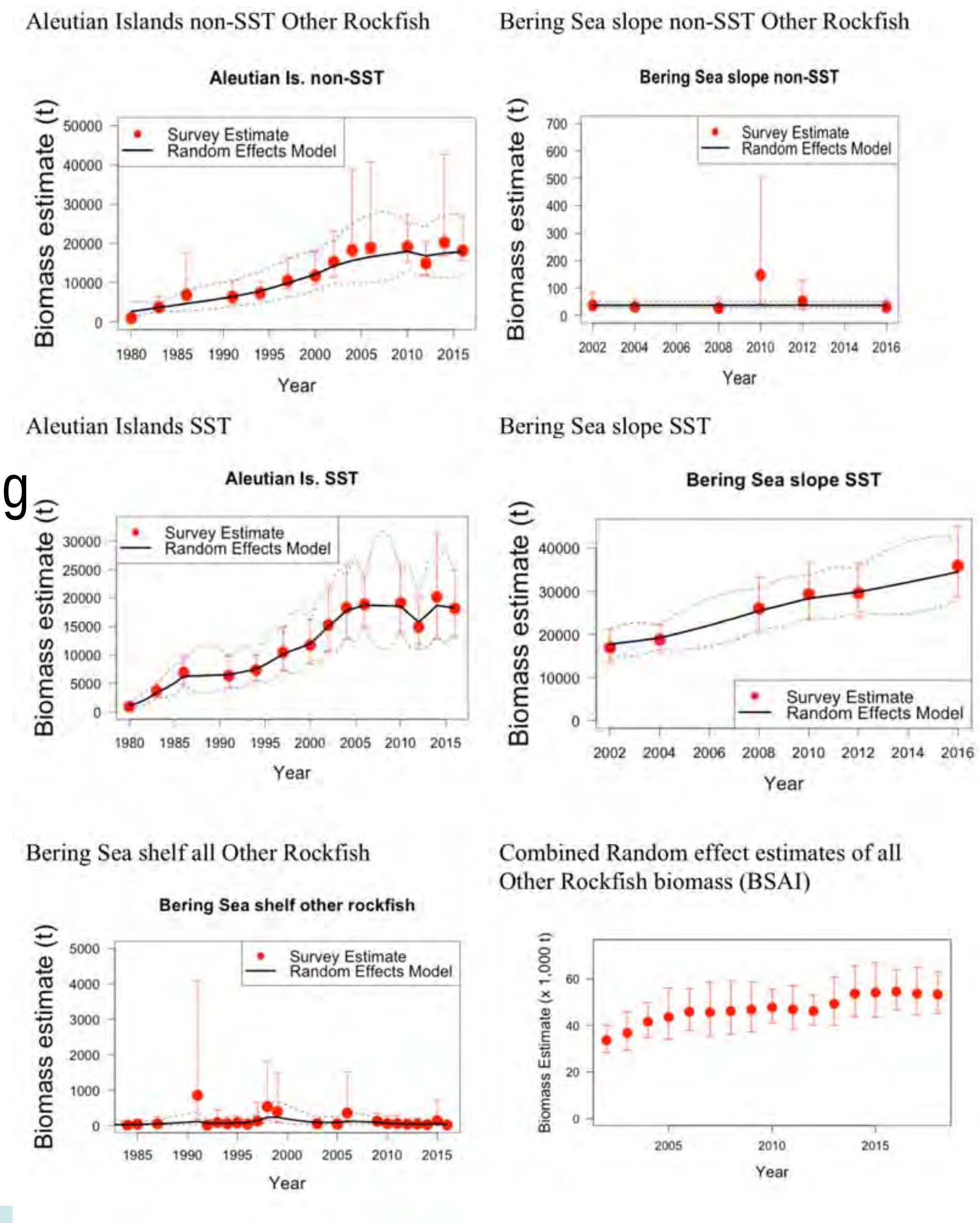
What are Bering Sea and Aleutian Islands "Other Rockfish"

- Most abundant:
- shortspine thornyhead; *Sebastolobus alascanus*,
- dusky rockfish; *Sebastes variabilis*,
- harlequin rockfish; *Sebastes variegatus*,
- redbanded rockfish; *Sebastes babcocki*, redstriped rockfish; *Sebastes proriger*,
- yelloweye rockfish; *Sebastes ruberrimus*, and sharpchin rockfish; *Sebastes zacentrus*

24 species, including unidentified.

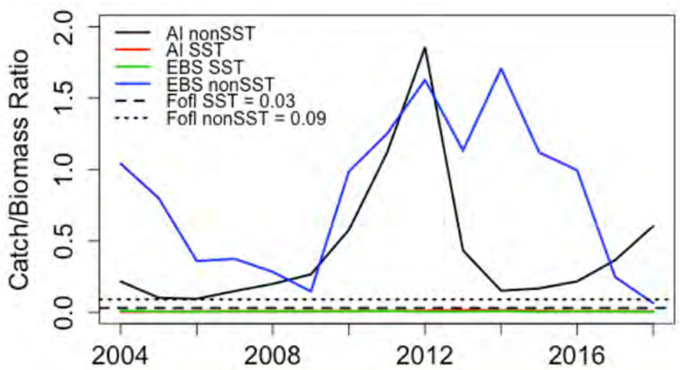
Survey biomass estimates

- Shortspine thornyhead increasing
- Other rockfish not increasing



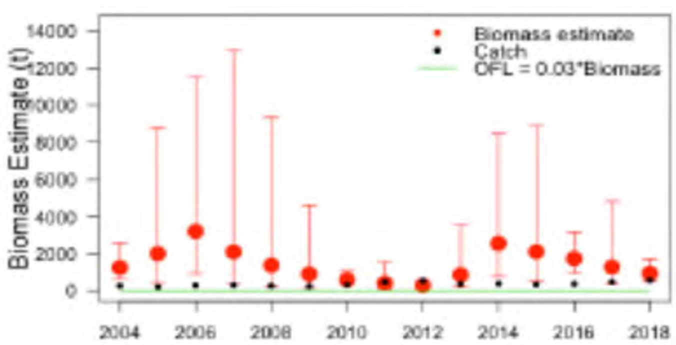
Other rockfish, continued

- Potential overharvest of non-SST species



- Exploitation rates > 1 are suspect

- However, survey estimates of non-SST species are highly imprecise



- Possible mixing with GOA?

Other rockfish, continued

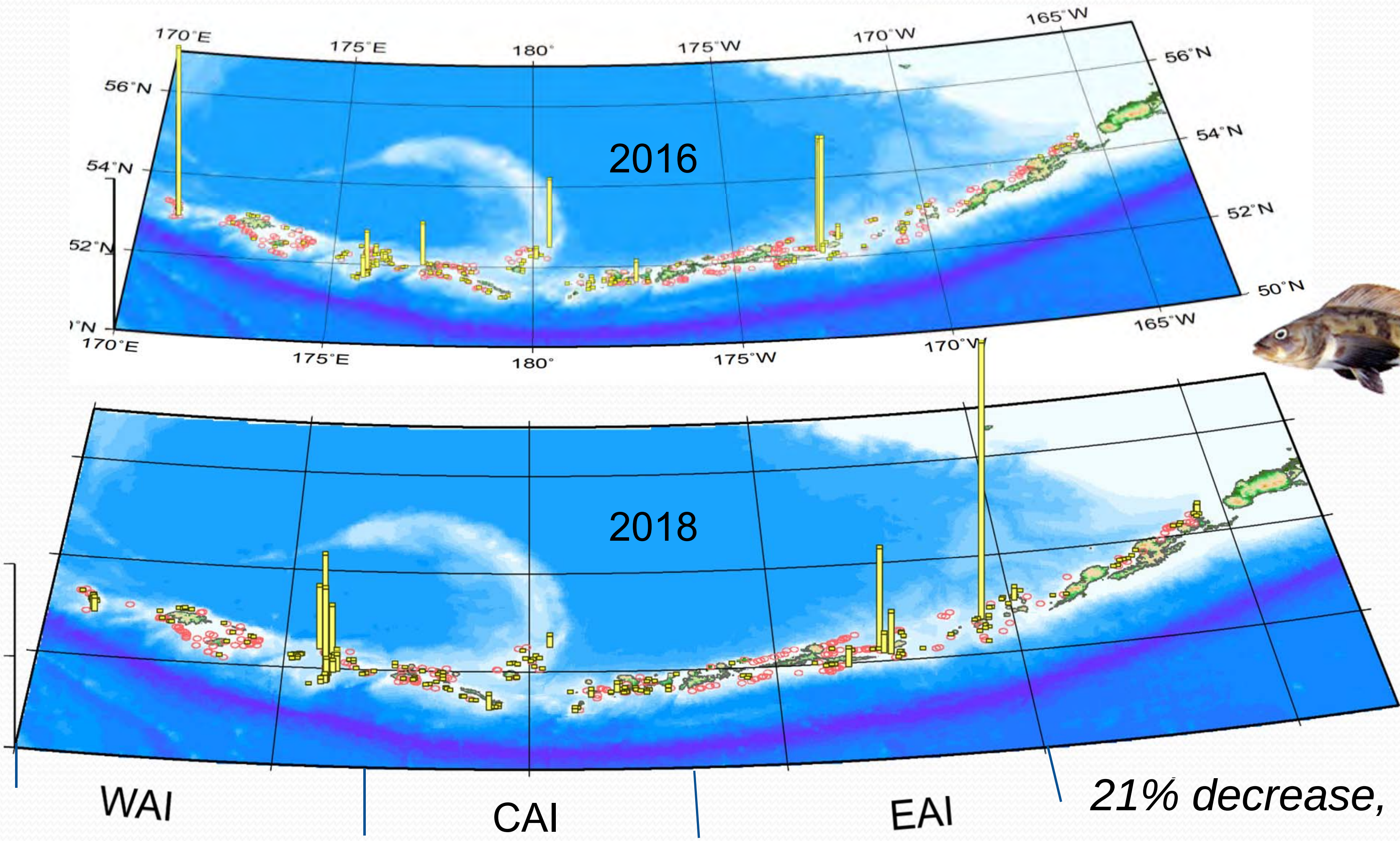
Quantity*	Last asmt.	This asmt.	Change
M	0.033	0.034	0.02
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	55,312	53,290	-0.04
2019 FOFL	0.033	0.034	0.02
2019 FABC	0.025	0.025	0.02
2018 OFL	1,816	n/a	-0.01
2019 OFL	1,816	1,793	-0.01
2018 ABC	1,362	n/a	-0.01
2019 ABC	1,362	1,345	-0.01

*Instantaneous rates are biomass-weighted averages

Chapter 17: Atka mackerel (full)

- New data:
  - 2017 fishery agecomp
  - 2018 AI survey biomass (down 21%)
  - 1986 survey agecomp removed
- Model alternatives:
  - Model 16.0b: base model (introduced last year)
- Stock status and trend:
  - 1998-2001 cohorts were all very strong, and the 2006 and 2007 cohorts are 56% and 33% above average
  - Spawning biomass reached all-time high in 2005; decreasing since
    - Overall decrease of 57% through 2018
  - 2019 spawning biomass is 38% of $B_{100\%}$

Bottom trawl survey CPUE distributions of Atka mackerel catches



21% decrease, CV 30%

Atka mackerel, continued

Area apportionment:

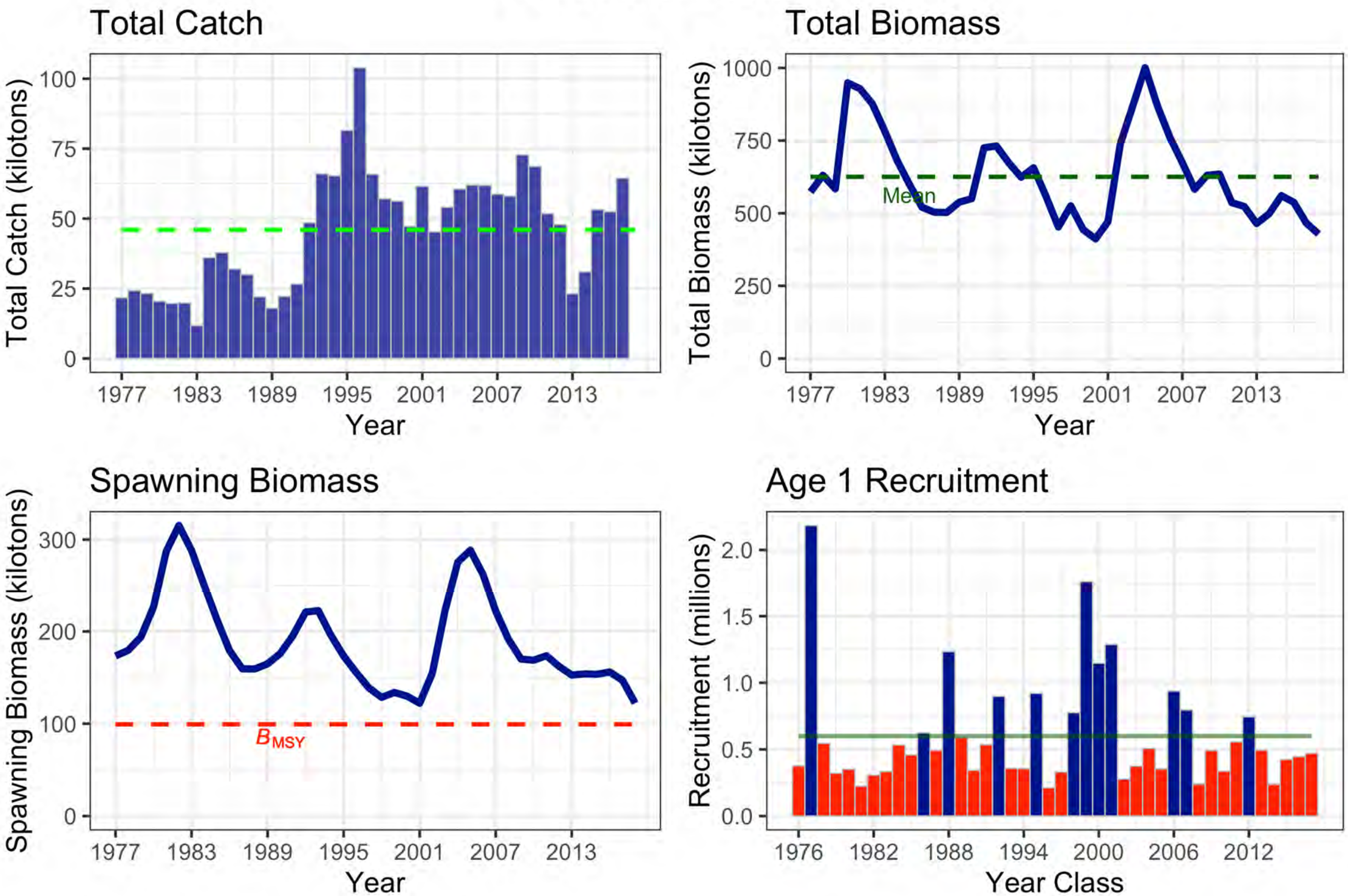
- Authors conducted a thorough examination of the survey and fisheries data to determine if the survey decline reflects the stock
- Fishery data from the CAI inconsistent w/ survey

Atka mackerel

- Area apportionment

Subarea	2018	2019	
		Most recent	4-year ave.
EAI/SBS	0.4001	0.50	0.35
CAI	0.3478	0.10	0.21
WAI	0.2520	0.40	0.44

Atka mackerel, continued



Atka mackerel, continued

Quantity	Last asmt.	This asmt.	Change
M	0.30	0.30	0.00
2018 tier	3a	n/a	↓
2019 tier	3a	3b	↓
2018 age+ biomass	599,000	n/a	-0.17
2019 age+ biomass	600,440	498,320	-0.17
2018 spawning biomass	139,300	n/a	-0.23
2019 spawning biomass	125,600	106,800	-0.15
B100%	307,150	283,780	-0.08
B40%	122,860	113,510	-0.08
B35%	107,500	99,320	-0.08
2019 FOFL	0.46	0.53	0.15
2019 FABC	0.38	0.44	0.16
2018 OFL	108,600	n/a	-0.27
2019 OFL	97,200	79,200	-0.19
2018 ABC	92,000	n/a	-0.26
2019 ABC	84,400	68,500	-0.19

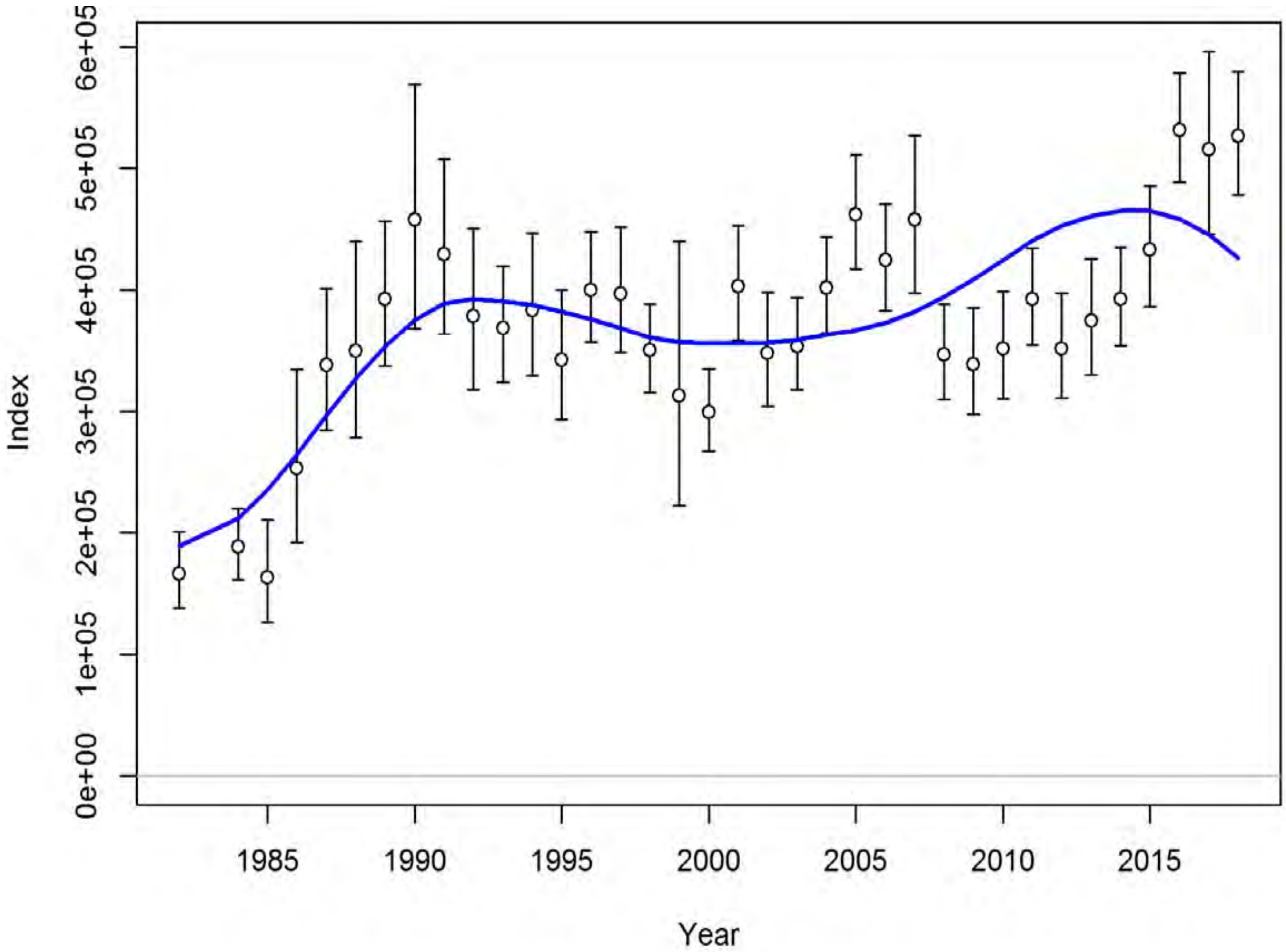
Chapter 18: skates (full)

- New data:
  - A new time series of skate catches by species was created for this assessment (previewed in September/October)
  - 2017 EBS shelf survey biomass
    - down 3% from 2016 (Alaska skate), up 79% (other skates)
  - 2018 EBS shelf survey biomass
    - up 2% from 2017 (Alaska skate), down 3% (other skates)
  - 2018 AI survey biomass
    - up 50% from 2016 (AK skate, minor part), up 3% (other skates)
  - 2017 and 2018 EBS shelf survey sizecomps (Alaska skate only)
  - 2017 fishery sizecomps (Alaska skate only)

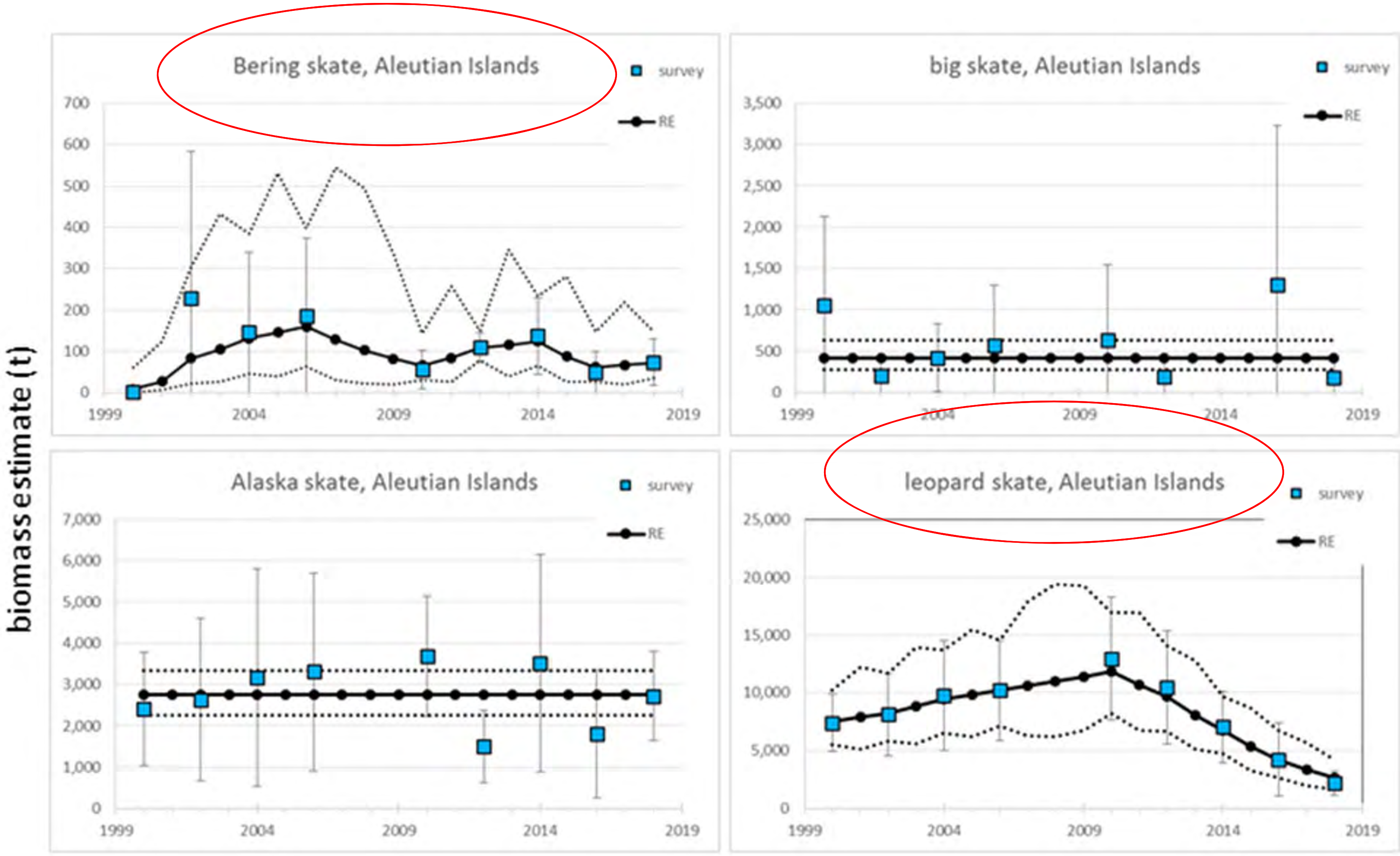
Skates, continued

- Model alternatives:
  - Alaska skate: Model 14.2 (base model)
  - Other skates: Tier 5 random effects
- Stock status and trend:
  - Alaska skate:
    - 2003-2010 cohorts all above average, more recent all below
    - Spawning biomass increased continuously from 2006-2018
      - Currently at all-time high
    - 2019 spawning biomass is 65% of $B_{100\%}$
  - Other skates:
    - Survey biomass has been relatively flat or increasing, except AI whiteblotched and AI leopard (declining since 2006 and 2010)

Alaska skate fit to survey



“other skate” biomass – Aleutian Islands



Skates, continued

- Alaska skate:

Quantity	Last asmt.	This asmt.	Change
M	0.13	0.13	0.00
2018 tier	3a	n/a	none
2019 tier	3a	3a	none
2018 age+ biomass	478,306	n/a	0.05
2019 age+ biomass	452,245	504,551	0.12
2018 spawning biomass	107,136	n/a	0.08
2019 spawning biomass	103,953	115,957	0.12
B100%	180,556	177,761	-0.02
B40%	72,222	71,105	-0.02
B35%	63,195	62,217	-0.02
2019 FOFL	0.092	0.094	0.02
2019 FABC	0.079	0.081	0.03
2018 OFL	36,655	n/a	0.07
2019 OFL	34,189	39,173	0.15
2018 ABC	31,572	n/a	0.07
2019 ABC	29,447	33,730	0.15

Skates, continued

- Other skates:

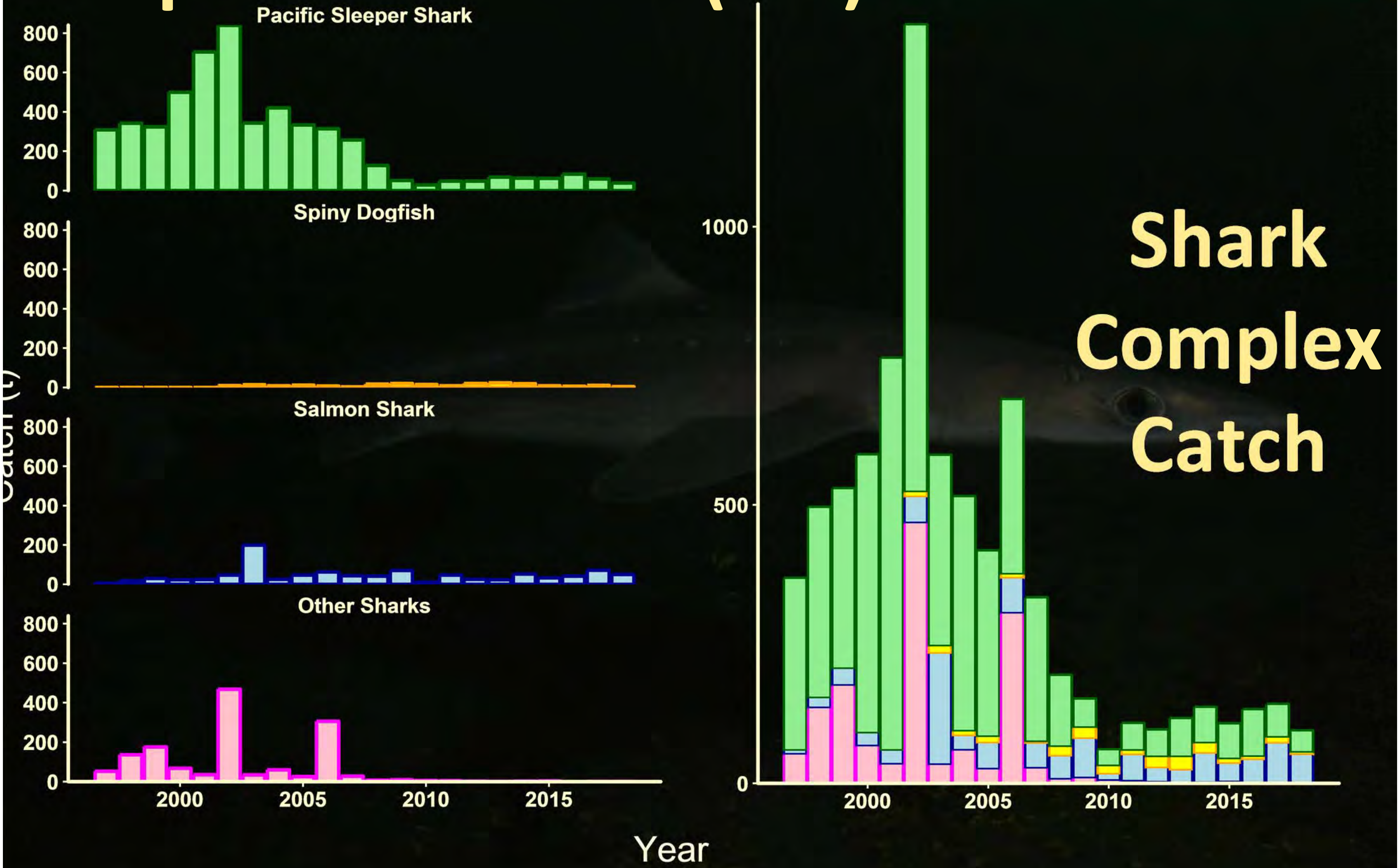
Quantity	Last asmt.	This asmt.	Change
M	0.10	0.10	0.00
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	100,130	119,787	0.20
2019 FOFL	0.10	0.10	0.00
2019 FABC	0.075	0.075	0.00
2018 OFL	10,013	n/a	0.20
2019 OFL	10,013	11,979	0.20
2018 ABC	7,510	n/a	0.20
2019 ABC	7,510	8,984	0.20

Chapter 19: sculpins (none)

Quantity*	Last asmt.	This asmt.	Change
M	0.282	0.282	0.00
2018 tier	5	n/a	none
2019 tier	5	5	none
Biomass	188,656	188,656	0.00
2019 FOFL	0.282	0.282	0.00
2019 FABC	0.212	0.212	0.00
2018 OFL	53,201	n/a	0.00
2019 OFL	53,201	53,201	0.00
2018 ABC	39,995	n/a	0.00
2019 ABC	39,995	39,995	0.00

*Instantaneous rates are biomass-weighted averages

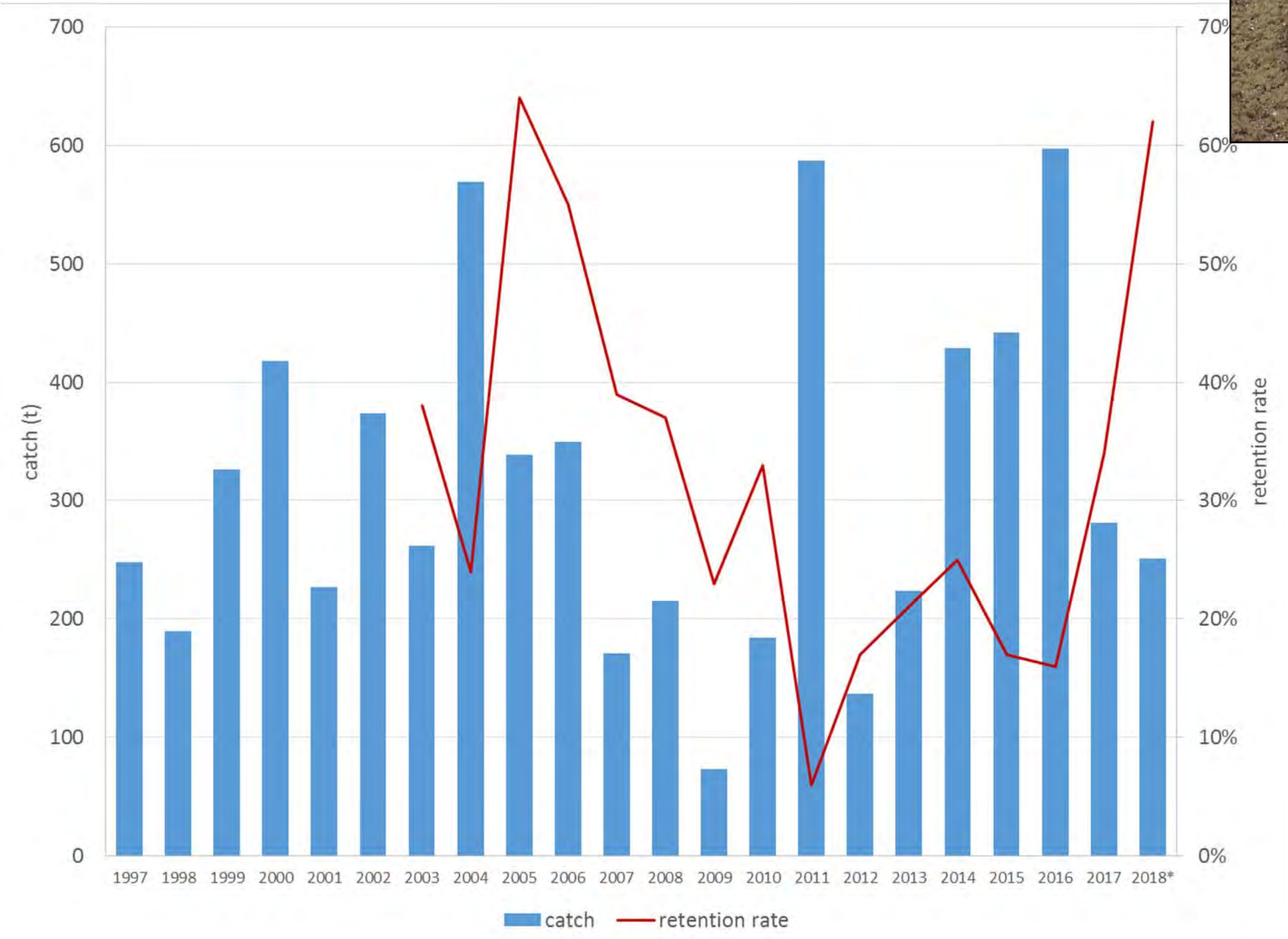
Chapter 20: sharks (full)



Chapter 20: sharks (full)

Quantity	Last asmt.	This asmt.	Change
2018 tier	6	n/a	none
2019 tier	6	6	none
2018 OFL	689	n/a	0.00
2019 OFL	689	689	0.00
2018 ABC	517	n/a	0.00
2019 ABC	517	517	0.00

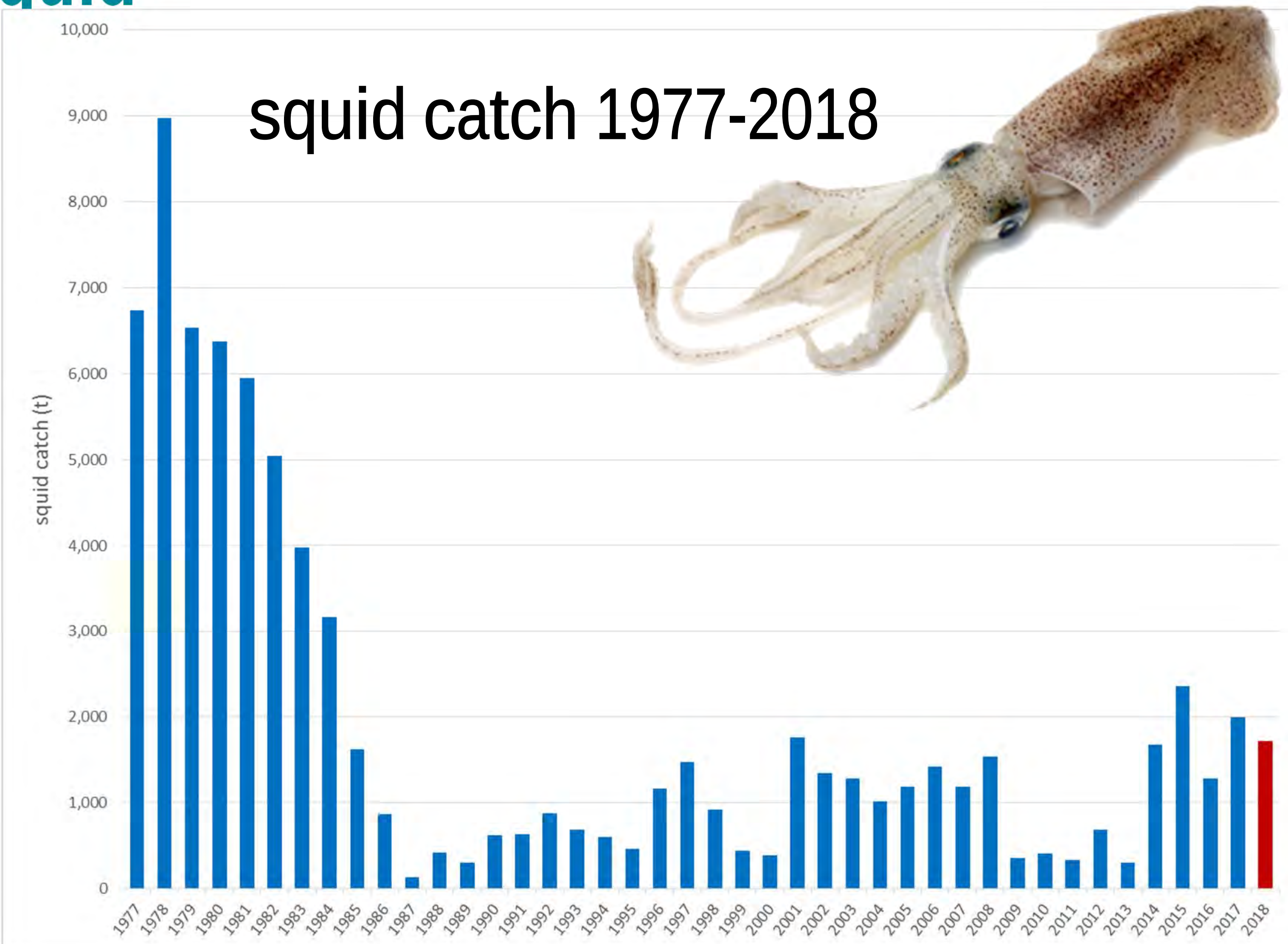
Chapter 22: octopus (full)



Octopus

Quantity	Last asmt.	This asmt.	Change
2018 tier	6	n/a	none
2019 tier	6	6	none
2018 OFL	4,769	n/a	0.00
2019 OFL	4,769	4,769	0.00
2018 ABC	3,576	n/a	0.00
2019 ABC	3,576	3,576	0.00

Squid



squid catch 1977-2018
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