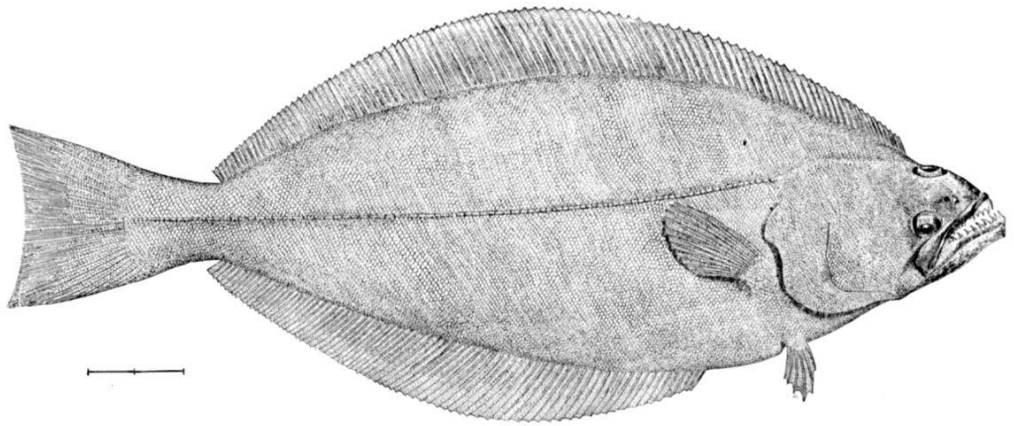


Greenland turbot Stock Structure and Assessment Update

Meaghan D. Bryan

September Plan Team Meeting

2018

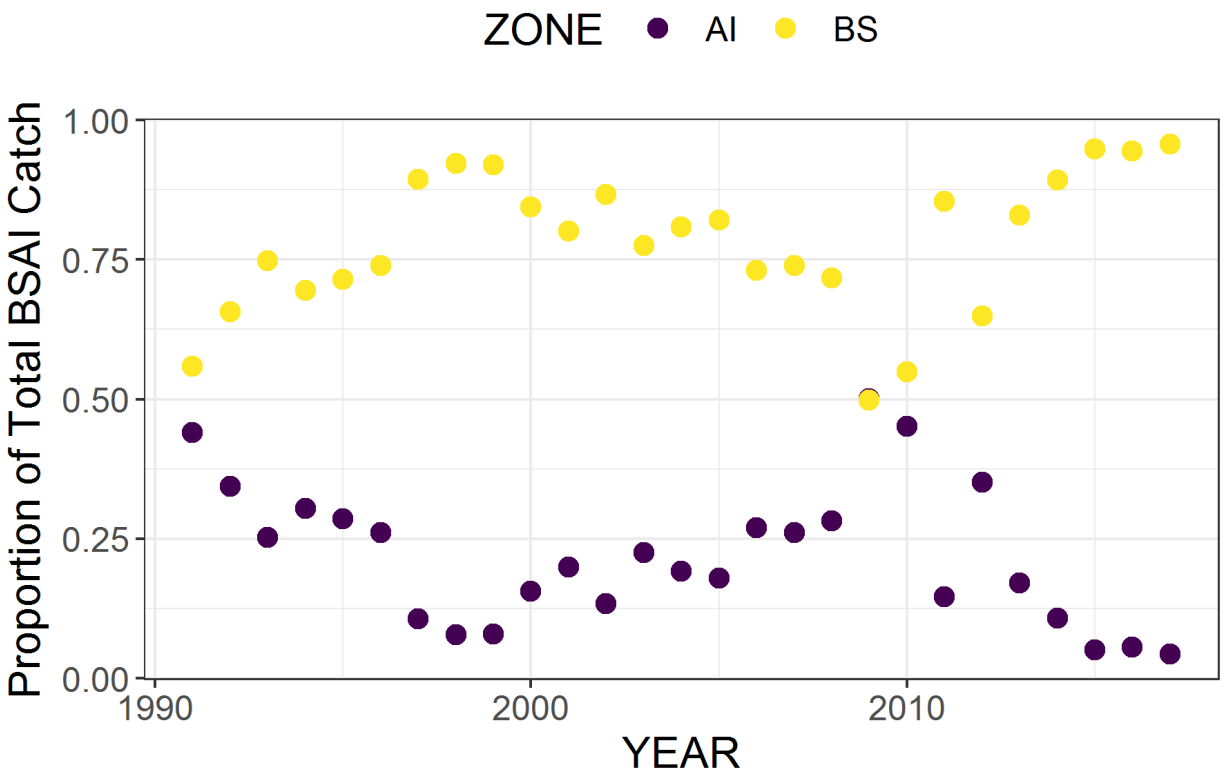
Introduction

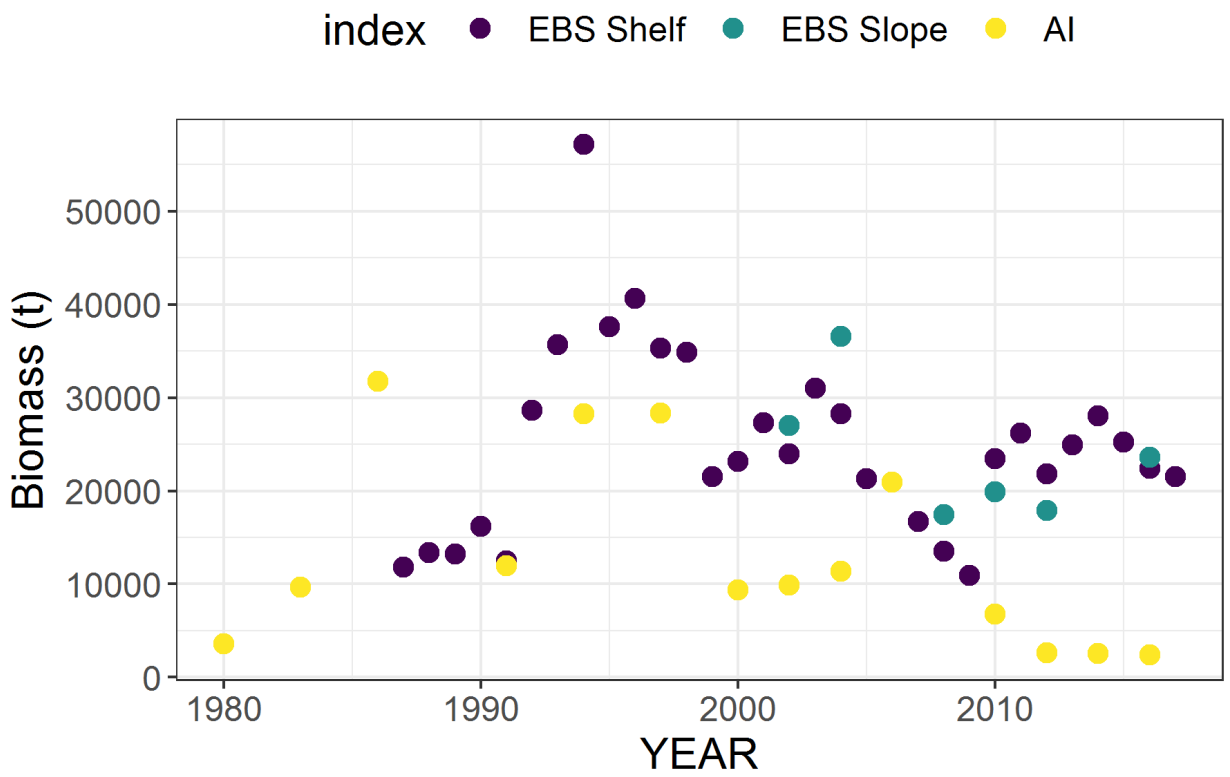
- Followed guidance in Spencer et al. (2010), mainly Table 1
- Available data
  - NMFS AKRO BLEND/Catch Accounting System
  - FMA Observer database
  - AFSC's Groundfish Assessment Program's bottom trawl surveys
    - Shelf (annual)
    - Slope (biennial)
    - Aleutian Islands (biennial)
- Literature review
  - Majority of information is from the North Atlantic

Conclusion

- The data do not suggest differentiation between the eastern Bering Sea and the Aleutian Islands
  - Genetic studies are needed to confirm
- Length frequency data reflect the ontogeny of the species
  - Generally smaller fish found on the shelf and larger fish on the slope and Aleutian Islands
  - EBS slope and the Aleutian Islands length distributions are similar

Catch and biomass





Aleutian Islands catch and biomass estimates

	Catch (t)				Biomass (t)			
Year	Eastern	Central	Western	Other	Eastern	Central	Western	Total
1991	-	-	-	3465	4,607	3,320	2,195	10,122
1994	2720	404	7	-	15,862	4,007	2,401	22,269
1997	544	194	26	-	22,708	3,130	2,146	27,984
2000	513	540	33	-	5,703	2,351	839	8,893
2002	304	149	32	-	6,996	1,658	793	9,448
2004	128	297	9	-	2,564	2,948	2,588	8,100
2010	1687	178	4	-	3,695	1,507	1,071	6,272
2012	1532	120	6	-	181	1,231	1,091	2,502
2014	128	46	5	-	490	989	553	2,031

- Abridged versions of Tables 2 and 4
  - Survey years where catch and survey areas match
  - Removed years with confidential data
- Catch and relative biomass are generally highest in the eastern AI

Eastern Bering Sea catch and biomass

Year	Catch (t)		Biomass (t)	
	EBS shelf	EBS slope	EBS Shelf	EBS Slope
2002	158	2,993	24,000	27,029
2004	256	1,570	28,287	36,557
2008	251	1,838	13,511	17,426
2010	90.7	2,177	23,414	19,873
2012	91.7	2,966	21,792	17,922
2016	42.3	2,074	22,429	23,573

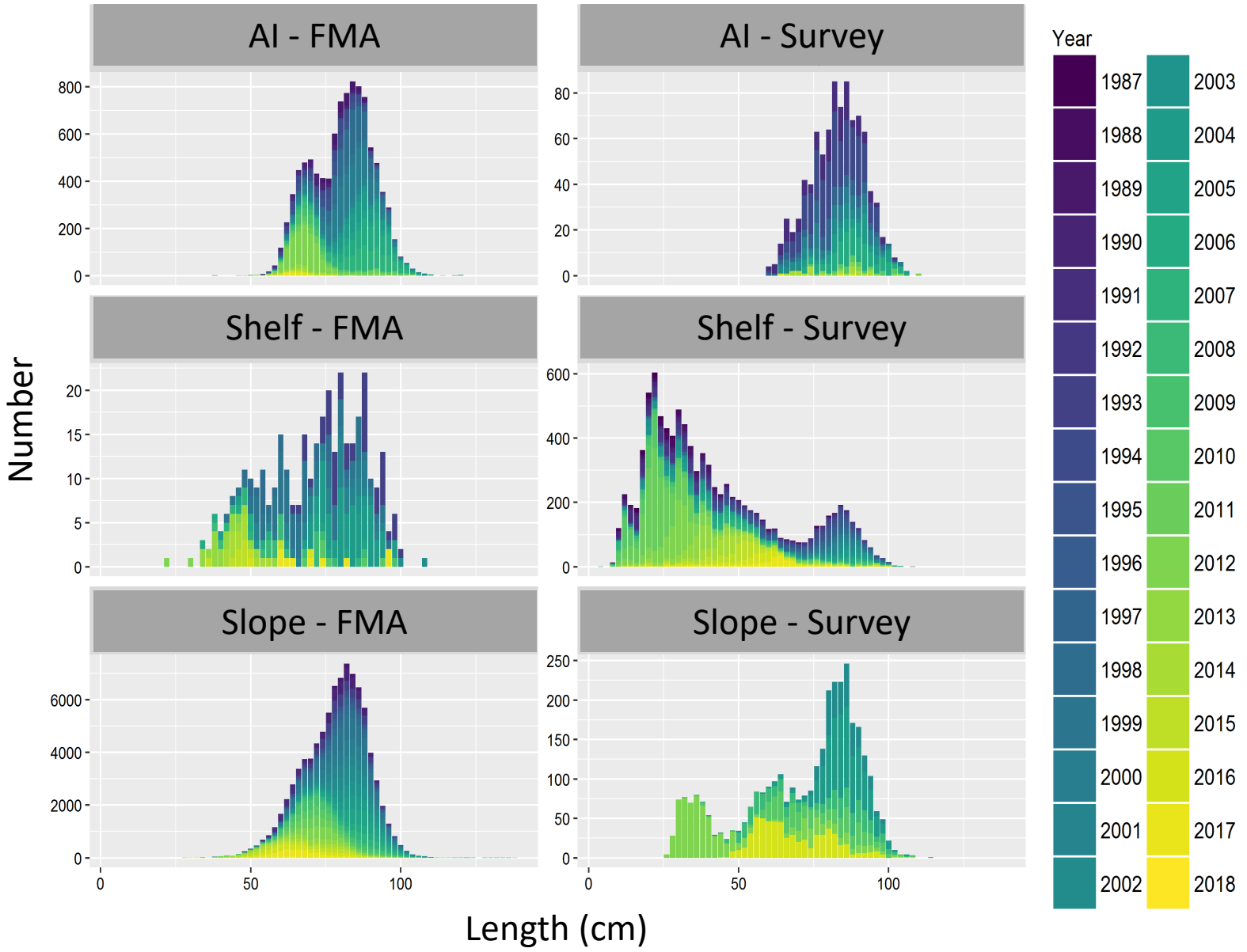
- Abridged version of Tables 2 and 3
  - Years where there are biomass estimates from the shelf and slope surveys
  - 2006 and 2014 slope survey was not conducted
- Catch is higher on the slope than shelf

Fishing mortality

	Aleutian Islands				Eastern Bering Sea		
Year	Eastern	Central	Western	Total	Shelf	Slope	Total
1994	0.17	0.10	0.00	0.14	0.005		
1995					0.009		
1996					0.007		
1997	0.02	0.06	0.01	0.03	0.011		
1998					0.014		
1999					0.013		
2000	0.09	0.23	0.04	0.12	0.010		
2001					0.009		
2002	0.04	0.09	0.04	0.05	0.007	0.11	0.06
2003					0.009		
2004	0.05	0.10	0.00	0.05	0.009	0.04	0.03
2005					0.012		
2006				0.03	0.010		
2007					0.015		
2008					0.019	0.11	0.07
2009					0.014		
2010	0.46	0.12	0.00	0.30	0.004	0.11	0.05
2011					0.004		
2012	8.46	0.10	0.01	0.66	0.004	0.17	0.08
2013					0.003		
2014	0.26	0.05	0.01	0.09	0.005		
2015					0.006		
2016				0.09	0.002	0.09	0.05

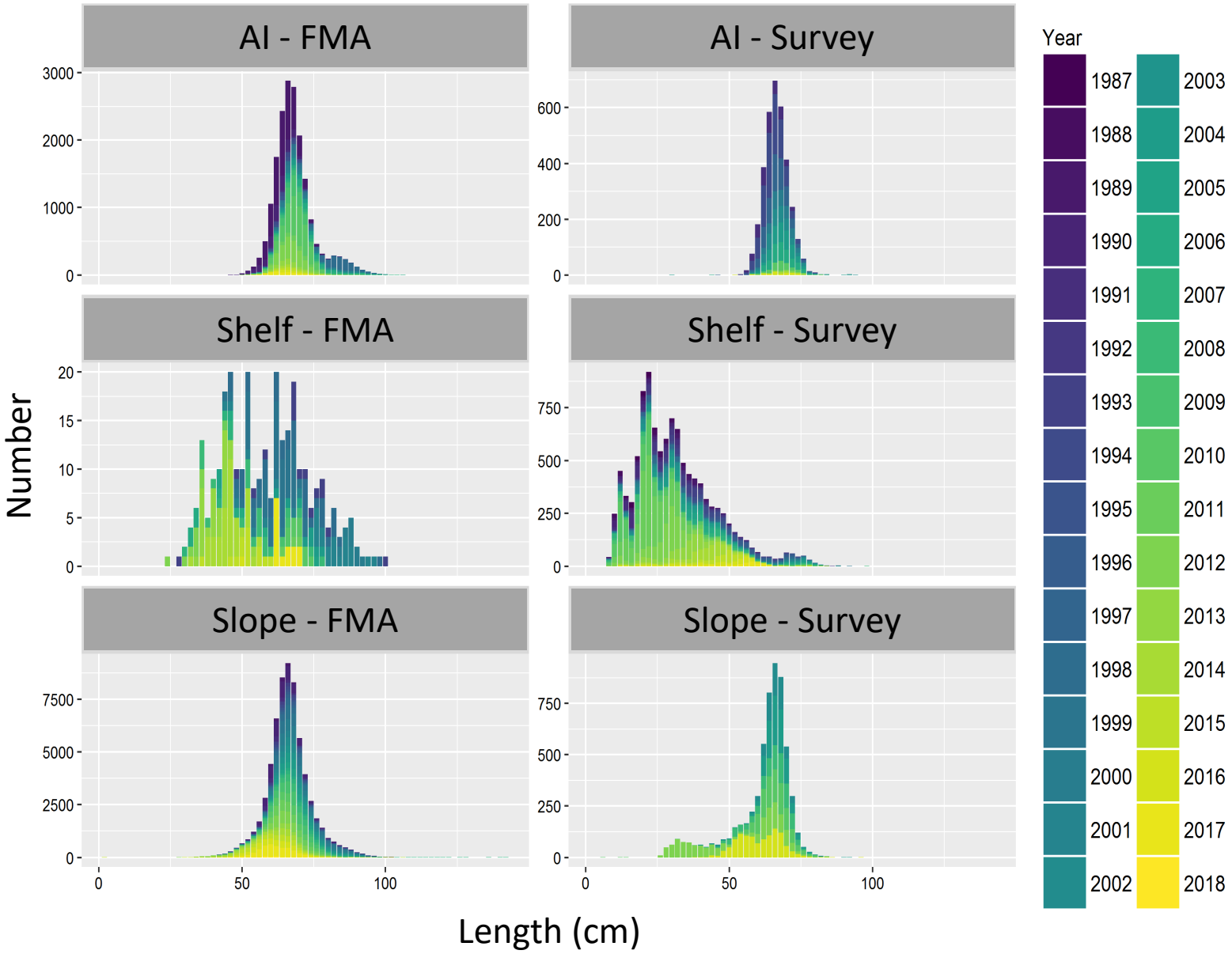
- Exploitation rates are generally below F_{OFL} and F_{ABC}
- Maximum sampling depth of Aleutian Islands survey is 500m
  - Underestimates Greenland turbot abundance
  - Helps to explain the large exploitation estimates in the Aleutian Islands

Size structure - Female



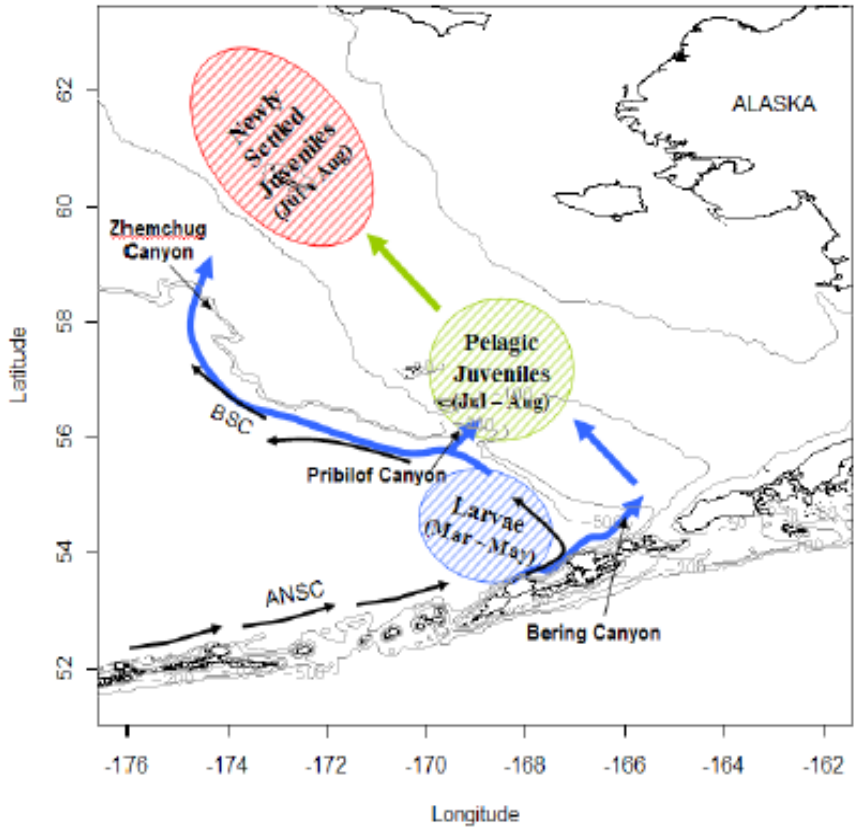
- Size structure in the Aleutian Islands and the EBS slope is similar
  - Distribution is skewed towards larger fish
- EBS shelf size distribution is skewed towards smaller fish

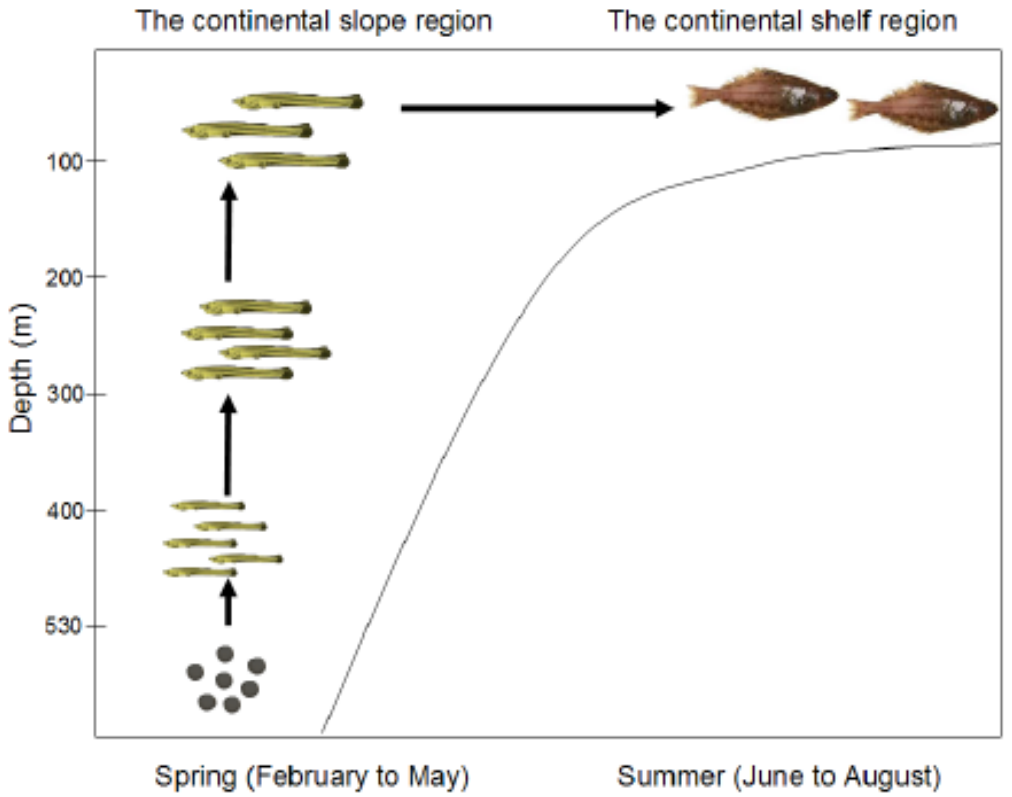
Size structure - Male



- Similar pattern for the males

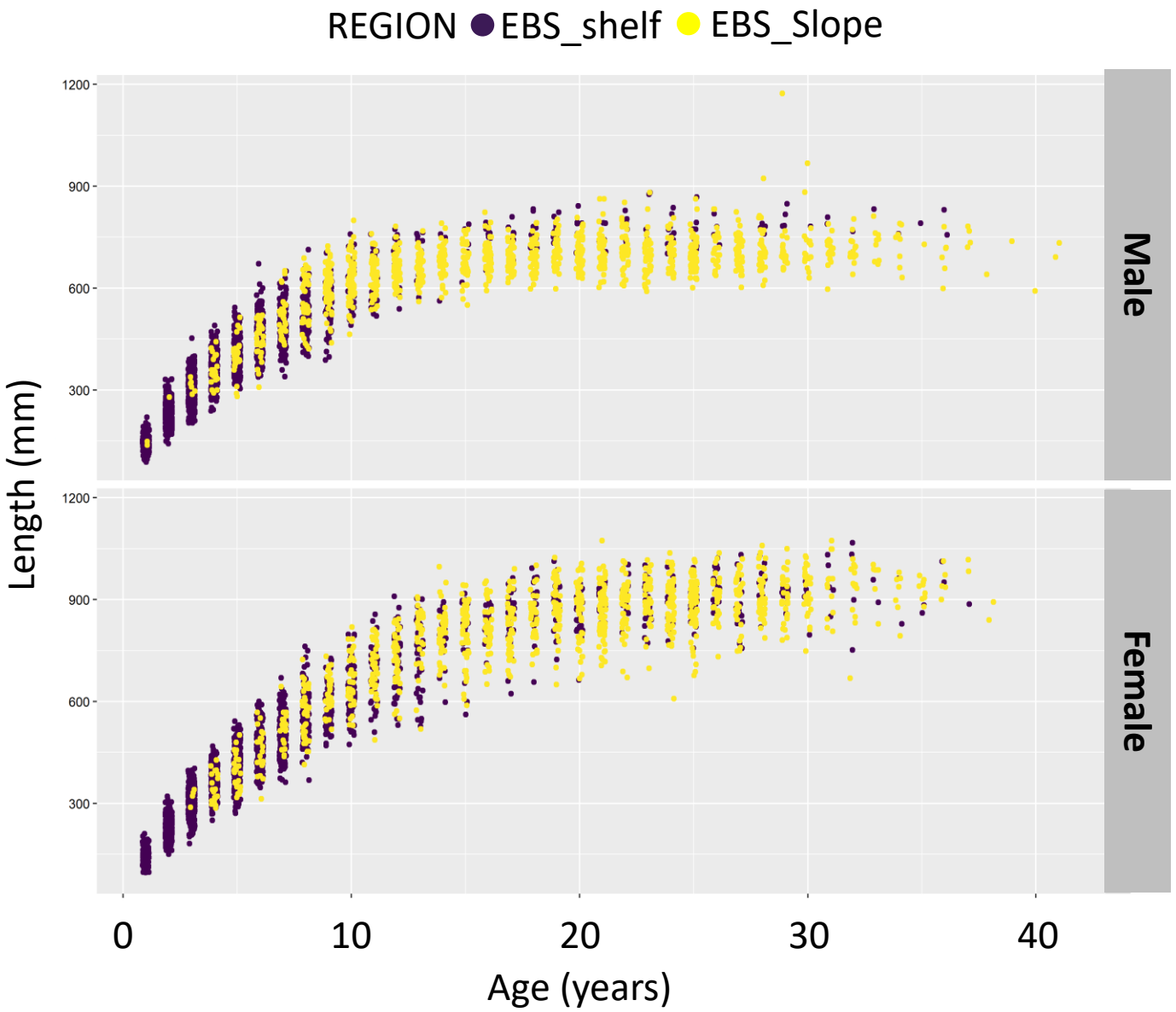
Ontogeny





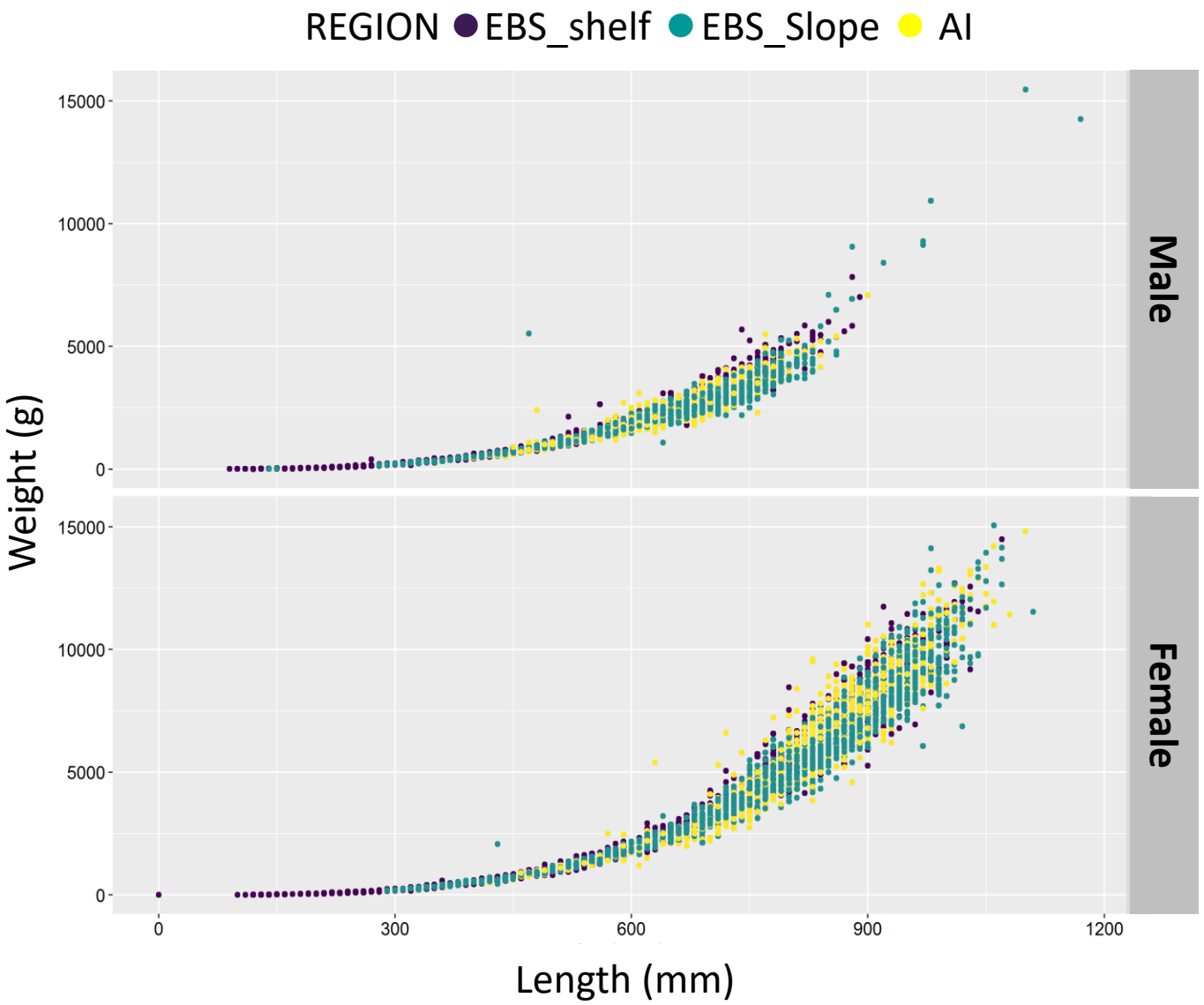
- Sohn (2009)

Growth



- Age – length curves are similar between the shelf and slope
- Shelf samples smaller fish that are not sampled by the slope

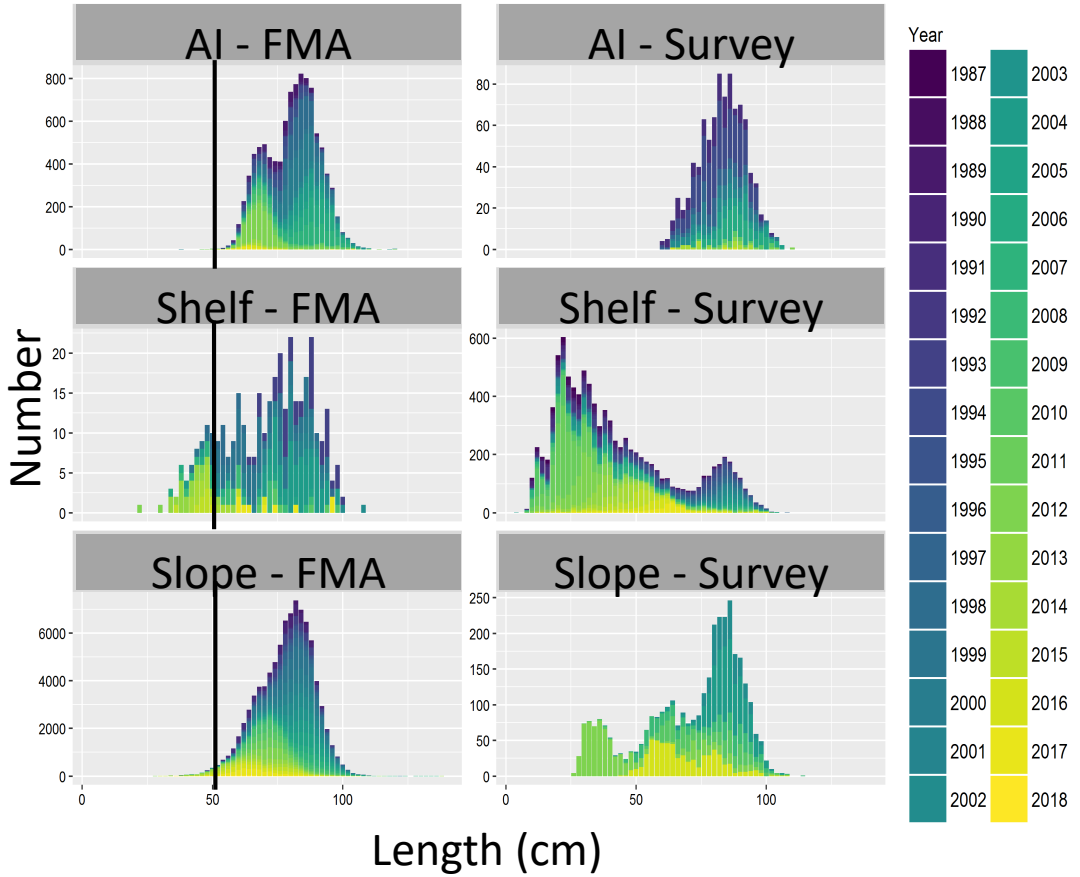
Length – weight relationship



- Length-weight relationship is similar among the areas

Generation time

- Maturity at age
  - North Atlantic (Morgan et al. 2003)
    - 5 – 10 years old (males)
    - 8 – 13 years (females)
  - Eastern Bering Sea (TenBrink unpublished)
    - 7.1 – 10 years (combined males and females)
    - L50 ~ 57.1cm
- Maximum age – 30+
- Age at which they can spawn is less than half of maximum age



Genetics

- Genetic studies are lacking for Greenland turbot in the North Pacific
  - Cannot make conclusions about isolation by distance
- Weak differentiation has been found in the North Atlantic between the Faroe Islands and Greenland

Conclusion

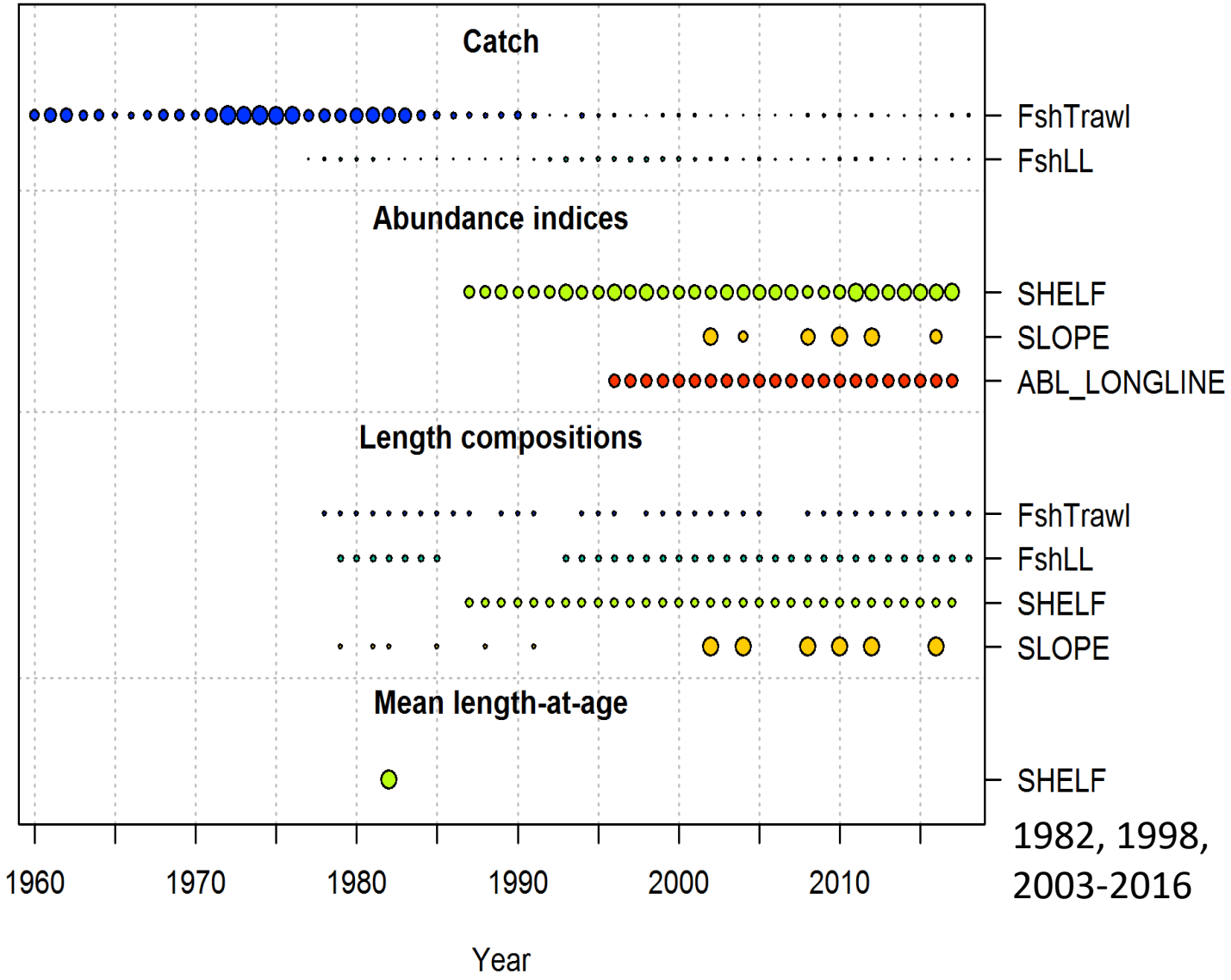
- Data do not suggest differentiation between the eastern Bering Sea and the Aleutian Islands
  - Genetic analyses are needed to confirm
- Length frequency data reflect the ontogeny of the species
  - Generally smaller fish found on the shelf and larger fish on the slope and Aleutian Islands
  - EBS slope and the Aleutian Islands length distributions are similar suggesting a possible connection

Assessment of Greenland turbot in the eastern Bering Sea and Aleutian Islands

Main outcomes

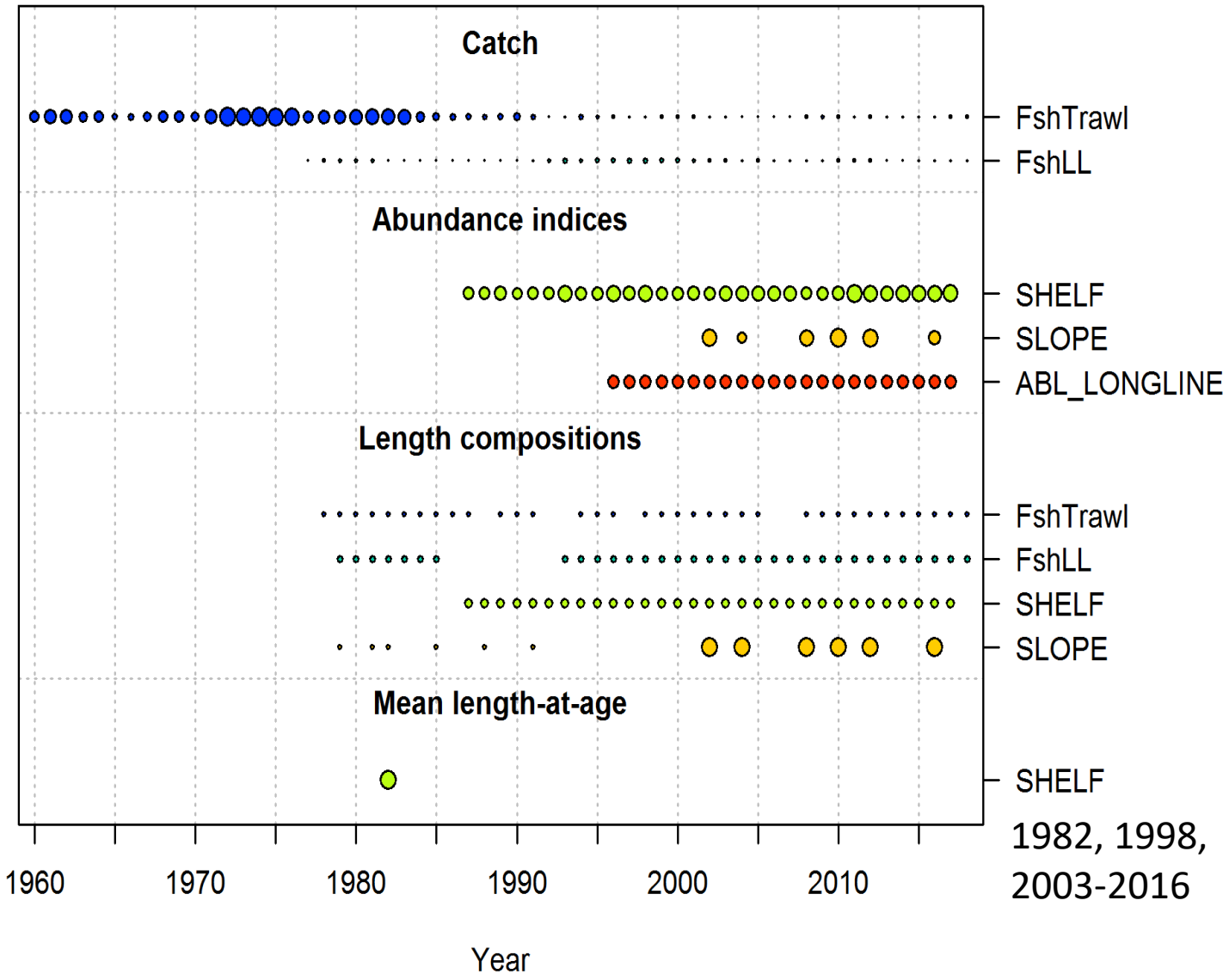
- Transitioned the 2016 assessment model from SS3.24 to SS3.30
  - Results were similar
- Continuity run
  - Run with updated data – seemed in line with 2016 assessment
  - Diagnostics suggested model instability
    - Suggest a minor change to the model to address this
  - A number of selectivity parameters are poorly determined
    - Still needs to be evaluated more and addressed

Data overview and base model structure



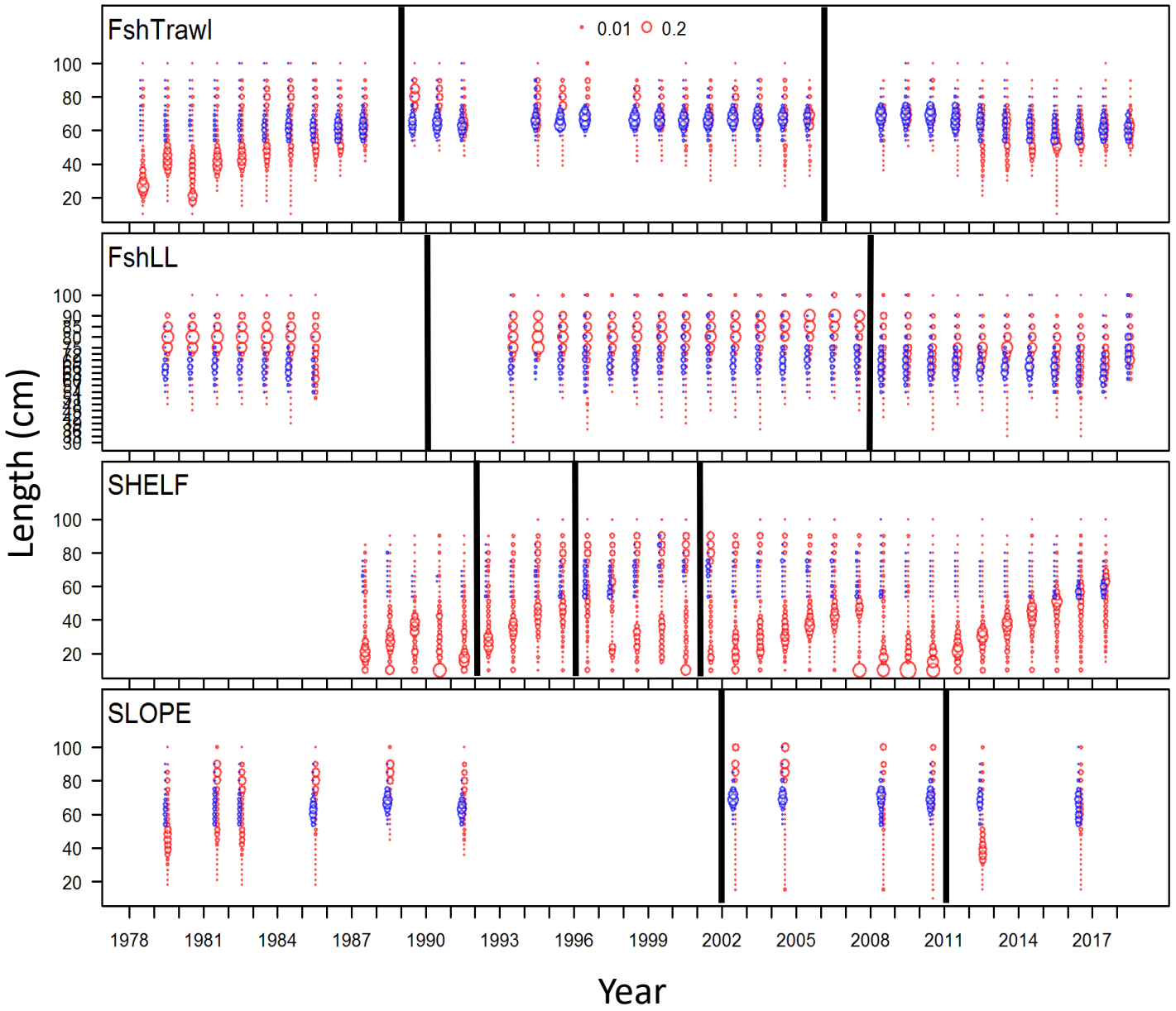
- Model was developed in Stock Synthesis
- 2 fleets and 3 surveys
  - Shelf q and slope q are fixed
  - ABL LL q – analytically determined
- Split sex model
  - Natural mortality was fixed at 0.112
    - Assumed the same for males and female
  - von Bertalanffy growth was estimated
    - Length at minimum age
    - Length at maximum age
    - Growth coefficient

Data overview and base model structure



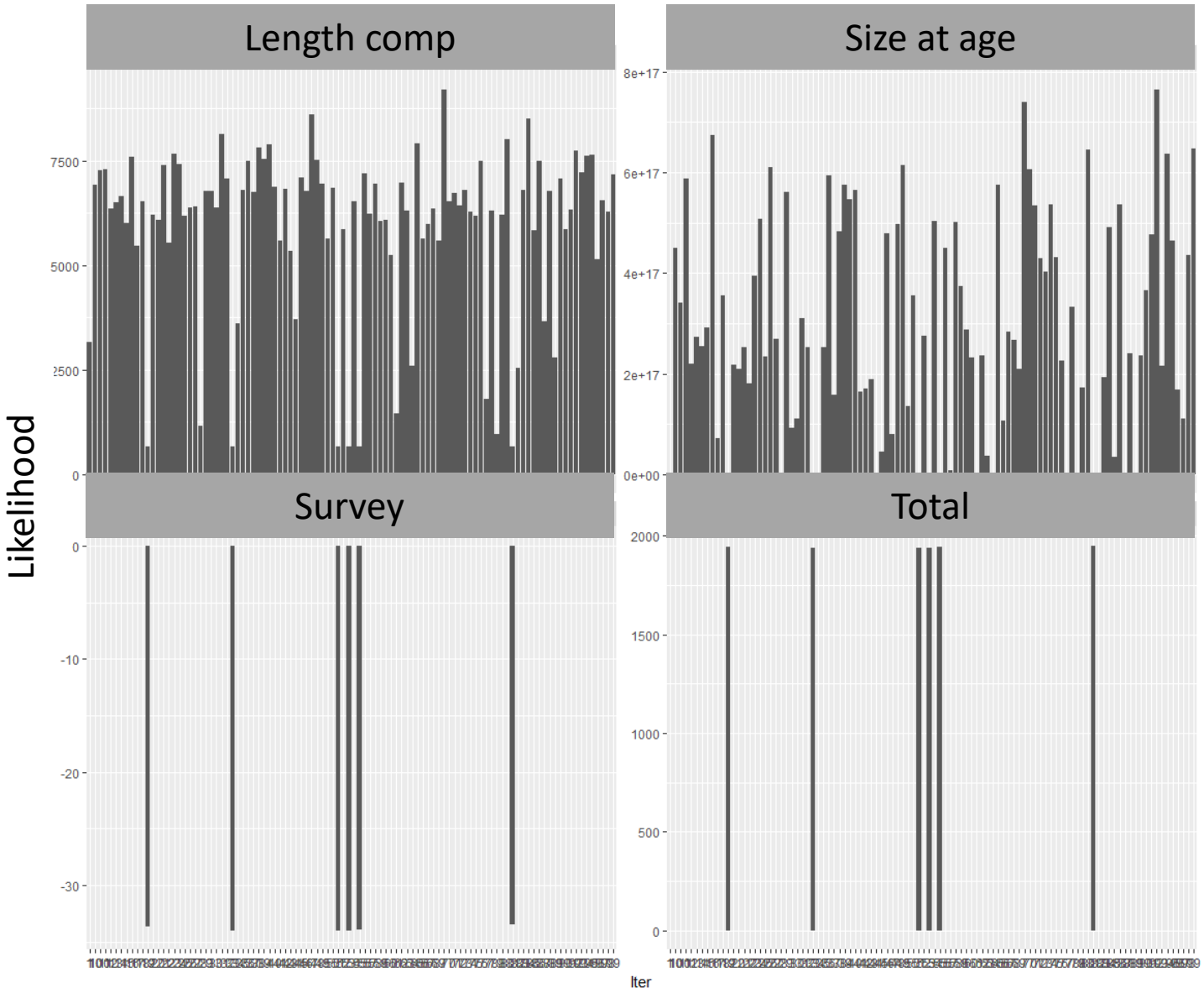
- Stock recruitment
  - R0: Estimated
  - Steepness: Fixed = 0.79
  - Sigma R: Fixed = 0.6
  - Autocorrelation parameter: Estimated
  - Recruitment deviations: Estimated

Model structure - selectivity

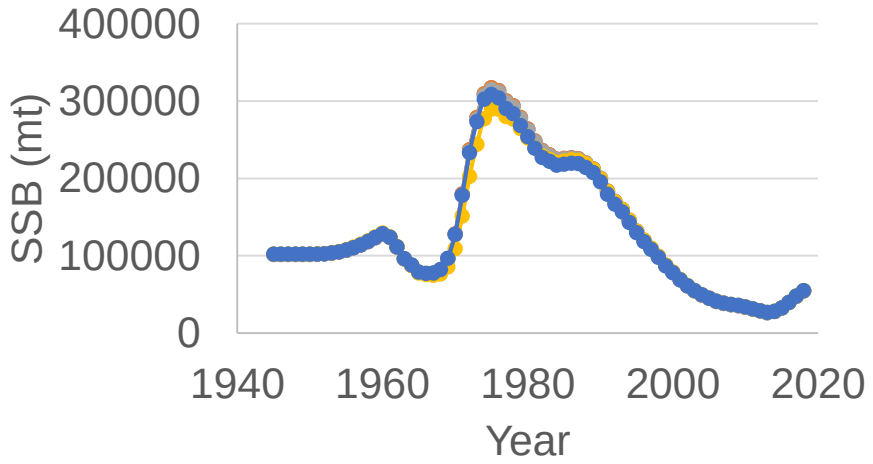


- ABL longline survey
  - Fixed logistic pattern
  - Model is not fit to the length data because they are not sex-specific
- All others
  - Double normal
    - Slope selectivity is constrained to be logistic
    - Female longline and slope selectivity offset from males
    - Male trawl and shelf selectivity were offset from female
  - Time-varying selectivity using time blocks

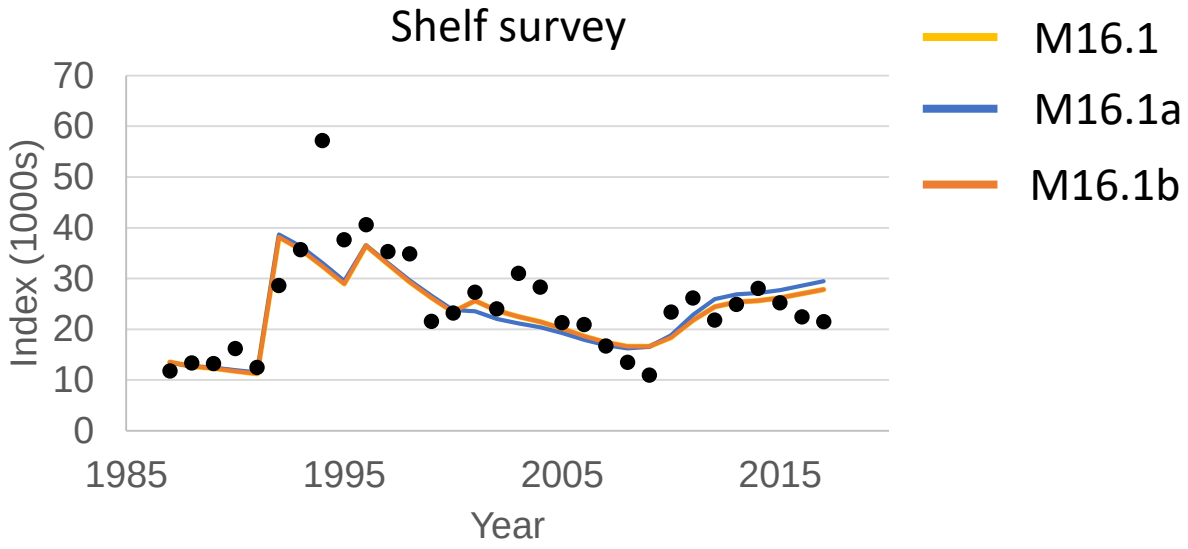
Jitter analysis: Model 16.1



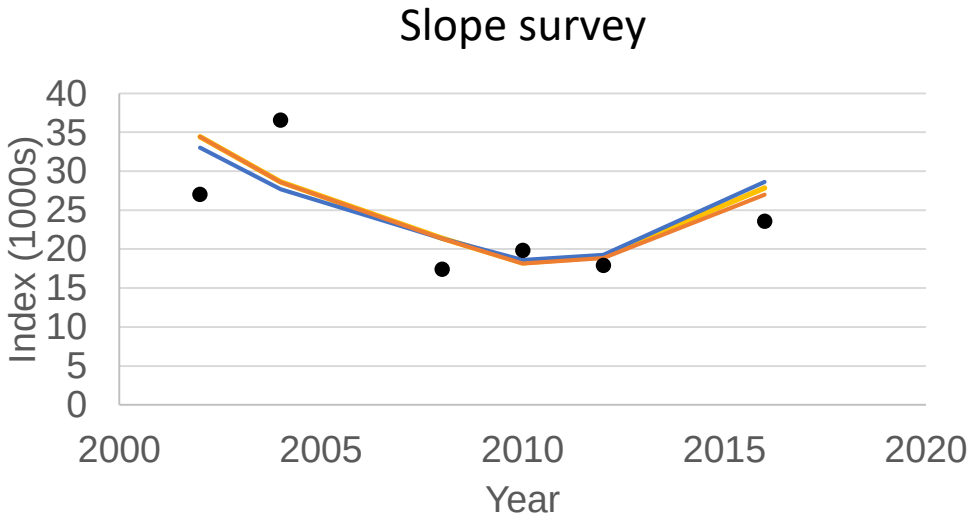
- Six out of the 100 iterations resulted in a solution
- Indicates model instability
- What caused the instability?
  - Estimation of selectivity?
  - ABL longline catchability?

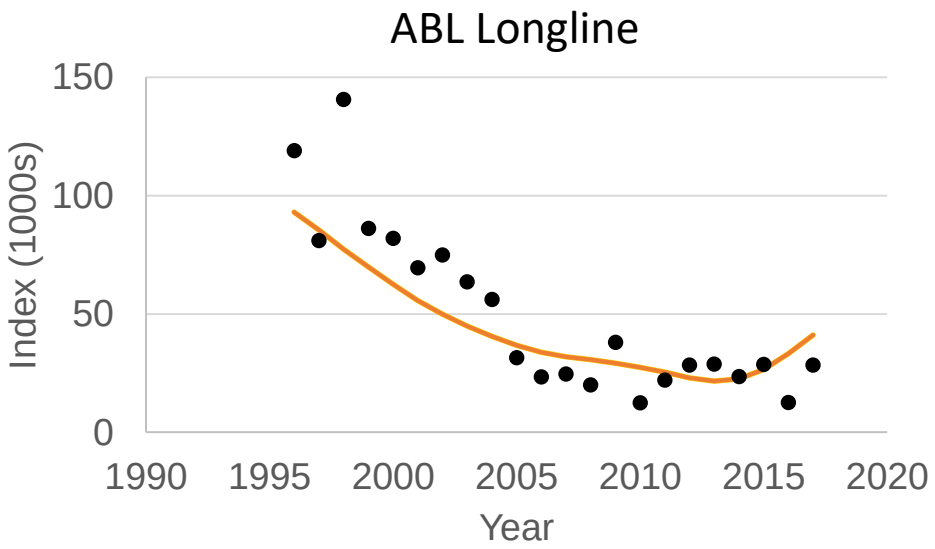


Model fit to indices of abundance

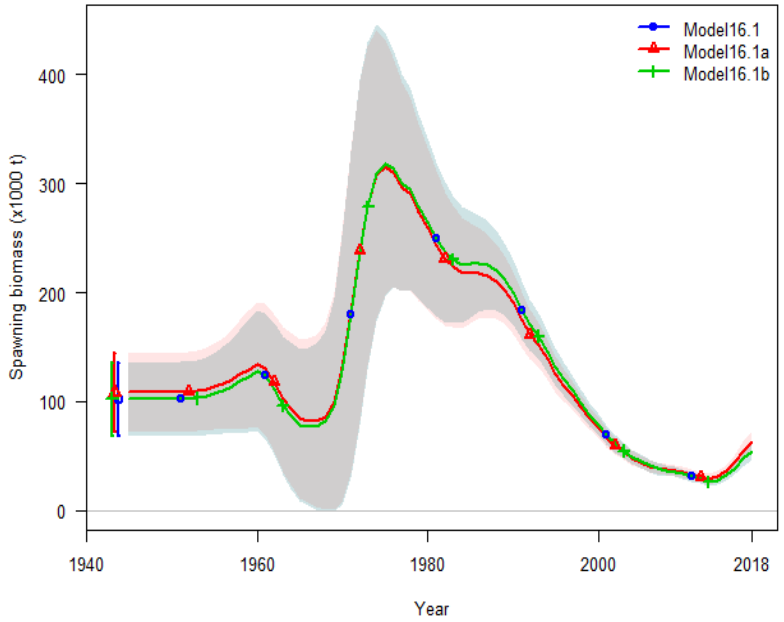


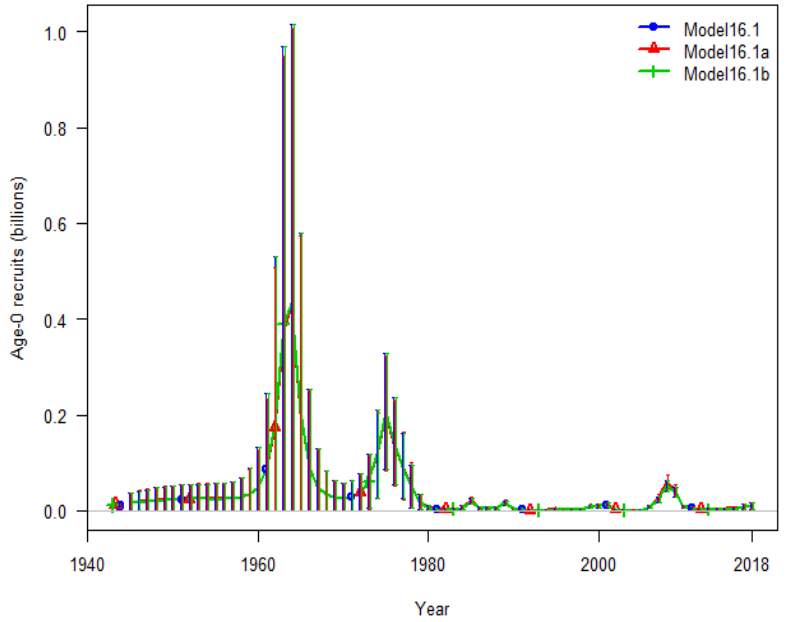
- Model 16.1 – 2016 assessment model
- Model 16.1a – Removed the ABL longline survey index
- Model 16.1b – Estimated the ABL longline survey catchability

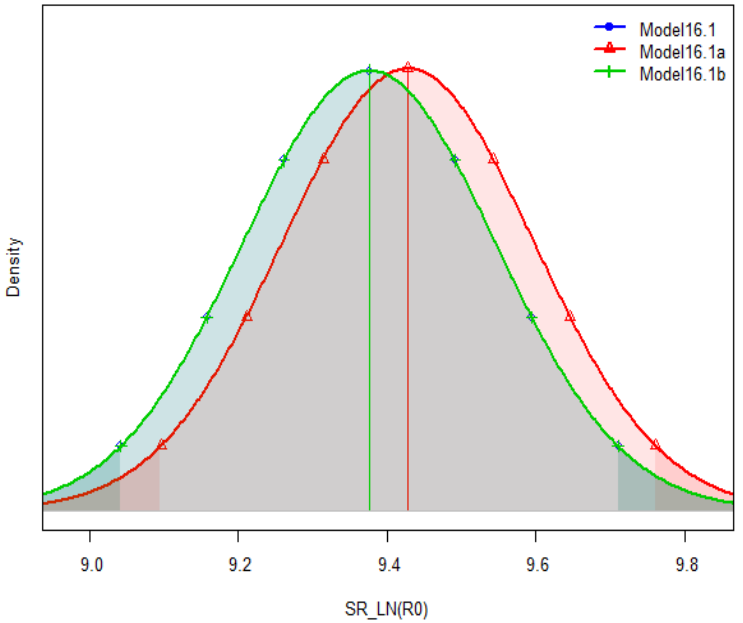


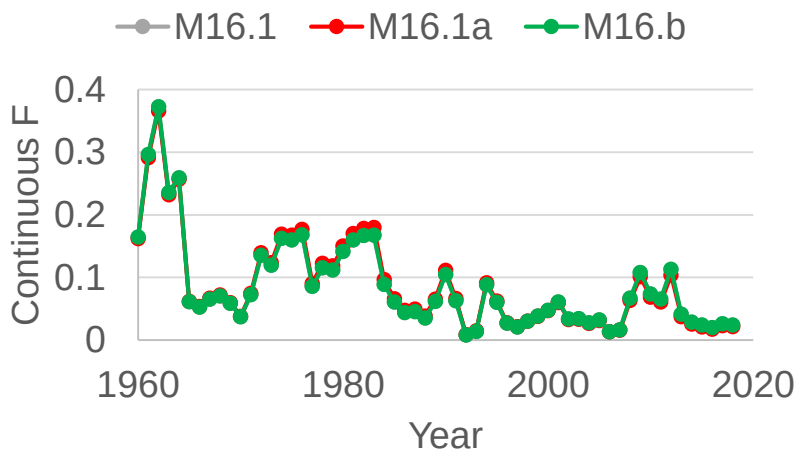


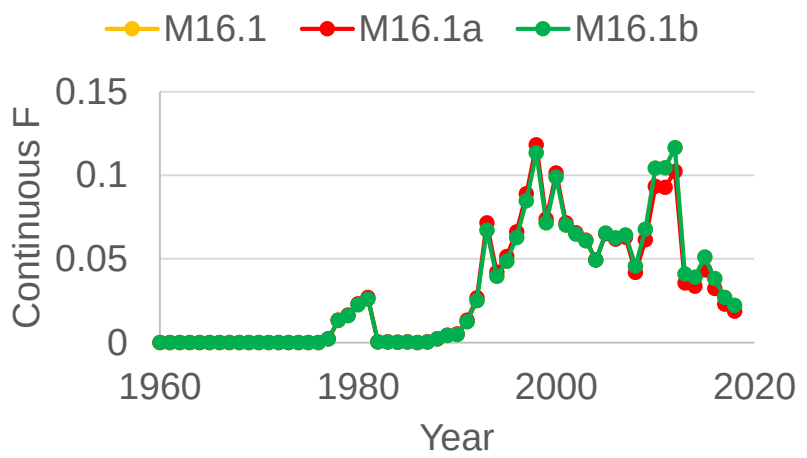
Model comparisons



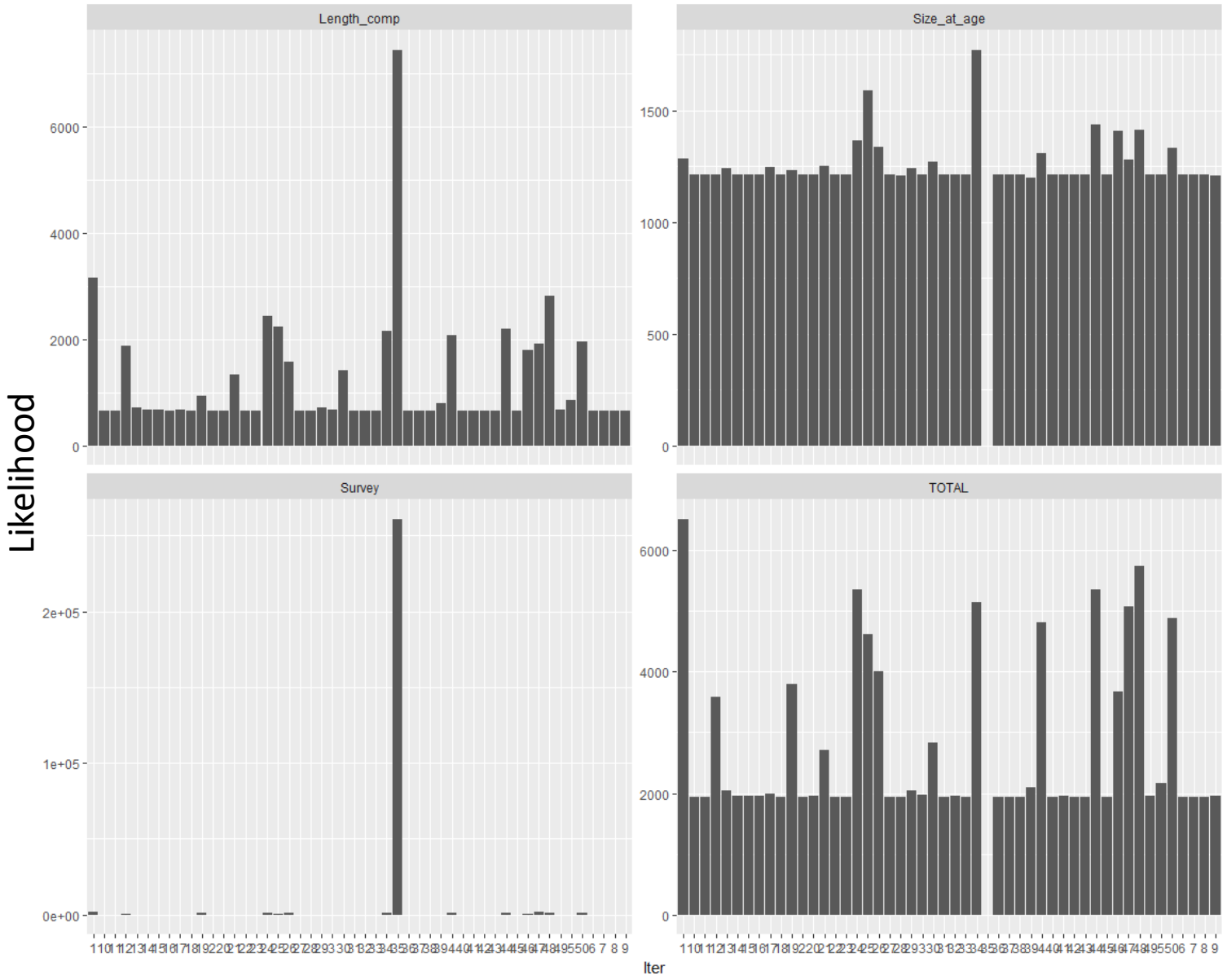




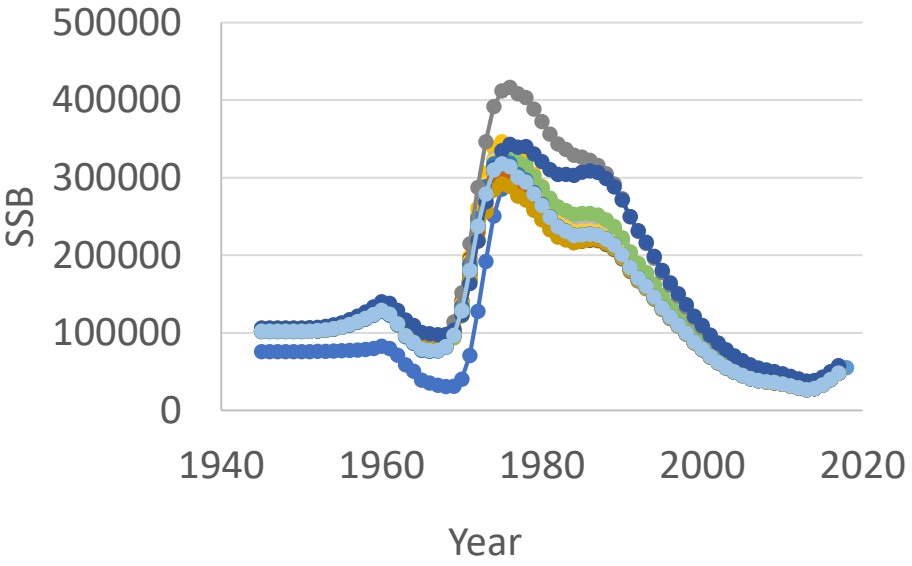




Jitter analysis Model 16.1b



- Improved model stability
- Generally give similar results

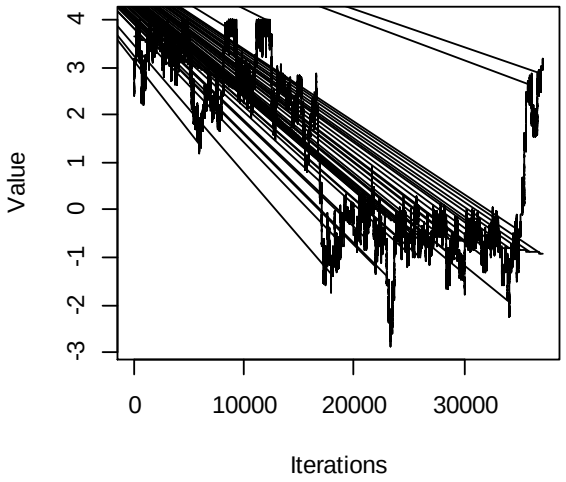


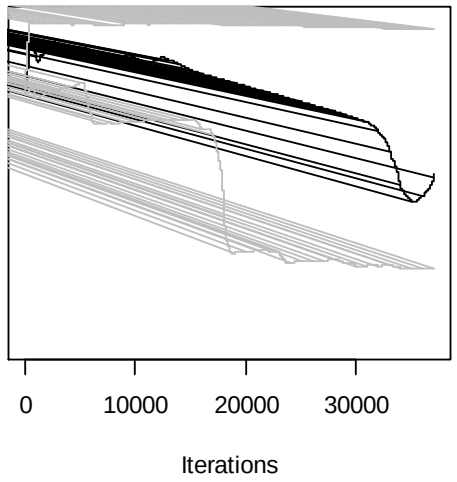
Selectivity estimation

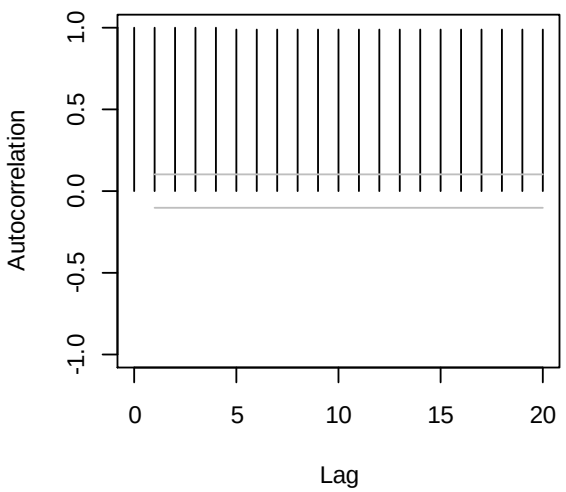
Fleet	Block	Sex	Parameter	Mean	CV (SD/Mean)
FshLL	1945-1990	Female	Ascend	-1.15999	0.55
FshLL	1945-1990	Female	End	-2.14911	0.76
FshLL	1945-1990	Female	Final	-0.76965	2.50
FshLL	1945-1990	Female	Top	-8.63019	3.36
FshLL	1991-2007	Female	Ascend	-1.47029	0.57
FshLL	1991-2007	Female	Descend	-2.66097	4.39
FshLL	2008-2018	Female	Top	-8.65079	3.31
FshLL	2008-2018	Male	Ascend	-0.78105	0.63
FshLL	2008-2018	Male	Descend	-1.62064	1.10
FshLL	2008-2018	Male	Final	1.10789	0.97
FshTrawl	2006-2018	Female	Descend	0.563823	1.88
FshTrawl	2006-2018	Female	Final	-2.20E-12	5.07E+13
FshTrawl	2006-2018	Female	Peak	0.647345	4.24
FshTrawl	1989-2005	Male	Final	-4.43E-10	2.5E+11
FshTrawl	1989-2005	Male	Peak	-0.4013	5.44
Shelf	1945-1991	Female	Start	1.73435	0.94
Shelf	1992-1995	Female	Start	7.72639	3.55
Shelf	2001-2018	Female	End	-0.00556	27.50
Shelf	2001-2018	Female	Start	0.923675	0.64
Shelf	2001-2018	Male	Ascend	7.95955	4.89
Shelf	2001-2018	Male	Descend	-0.57082	0.70
Shelf	2001-2018	Male	Peak	-1.4272	1.72
Slope	Pre-2002	Female	Final	0.638255	134.38
Slope	2002-2010	Male	Final	-4.85468	1.00
Slope	2002-2010	Male	Peak	-1.95064	2.88
Slope	2002-2010	Male	Top	-3.39006	1.97
Slope	2011-2018	Male	Top	-0.27257	1.83
Slope	Pre-2002	Male	Top	-8.27687	4.16

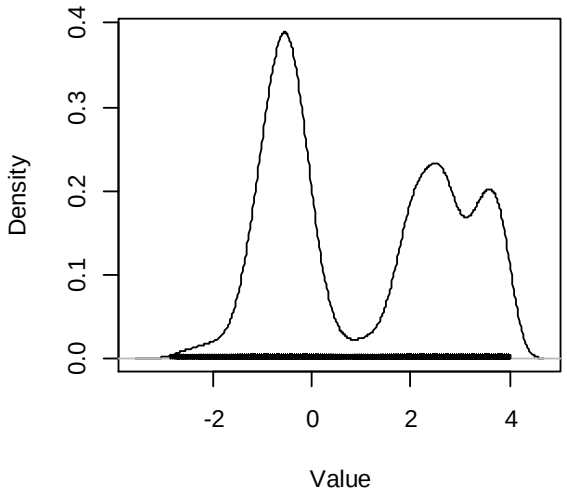
- 79 estimated selectivity parameters
- One-third have CVs that are greater than 50%
  - Fair amount of uncertainty
- MCMC results using Model 16.1b indicate model poorly estimates these parameters

Slope survey: Top width parameter

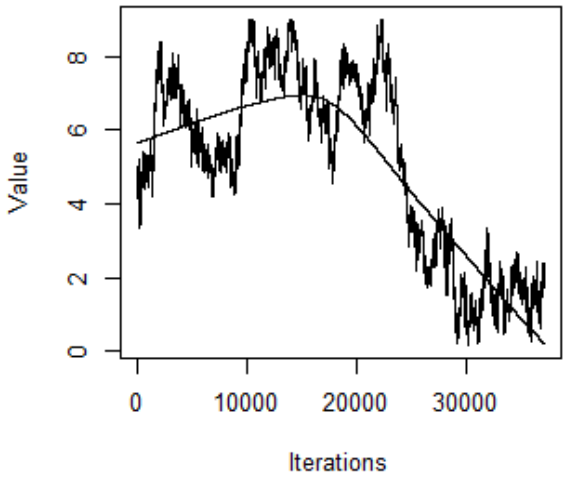


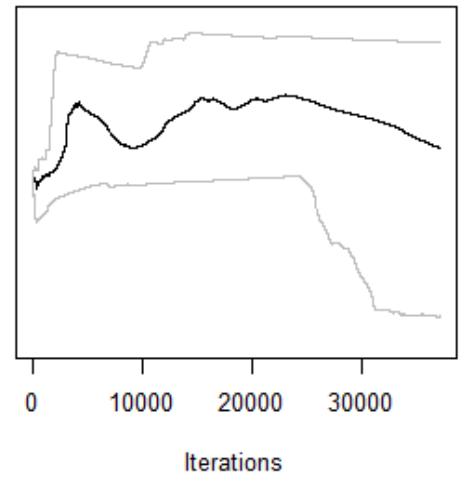


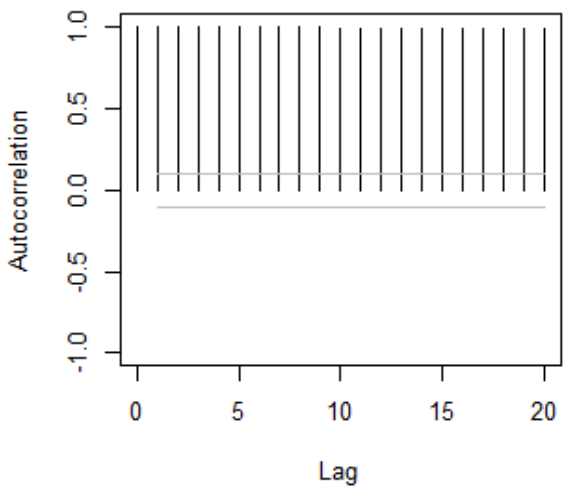


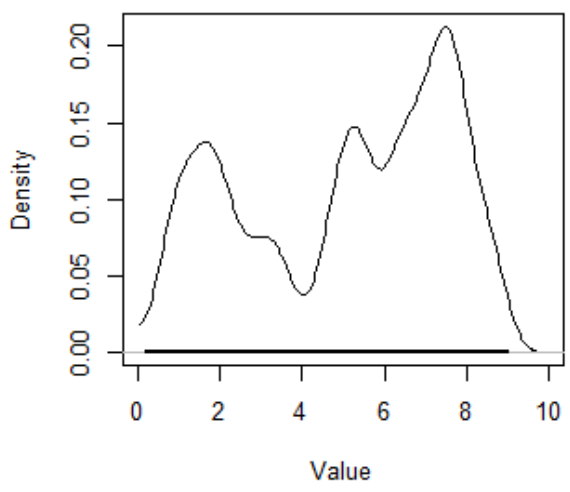


Shelf survey: Selectivity of first length bin









November

- Move forward with estimating the ABL longline survey's catchability
- Evaluate whether simplifying the time-blocks improves estimating the some of the selectivity parameters
  - Reduce time blocks