Preliminary assessment of northern and southern rock sole (*Lepidopsetts polyxtra and bilineata*) in the Gulf of Alaska

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CIE review details

Where: Virtual

When: April 5-9, 2021

Chair: Kalei Shotwell (AFSC, SSMA)

Reviewers:

Sven Kupchus (Centre for Environment, Fisheries and Aquaculture Science, UK)

Anders Nielsen (DTU Aqua, Denmark)

Colin Millar (ICES, Denmark)

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Participants

Name	Program	Responsibility
Daniel Armellino*	Fisheries Monitoring and Analysis	Review of rock soles in the observer program
John Brogan*	Age and Growth Program	Review of aging for Greenland turbot and rock soles
Wayne Palsson*	Groundfish Assessment Program	Review of Gulf of Alaska bottom trawl survey and rock soles data, program supervisor
Jim Ianelli	Status of Stocks and Multispecies Assessment	Historical stock assessment
Sandra Lowe	Status of Stocks and Multispecies Assessment	Supervisor of stock assessment authors

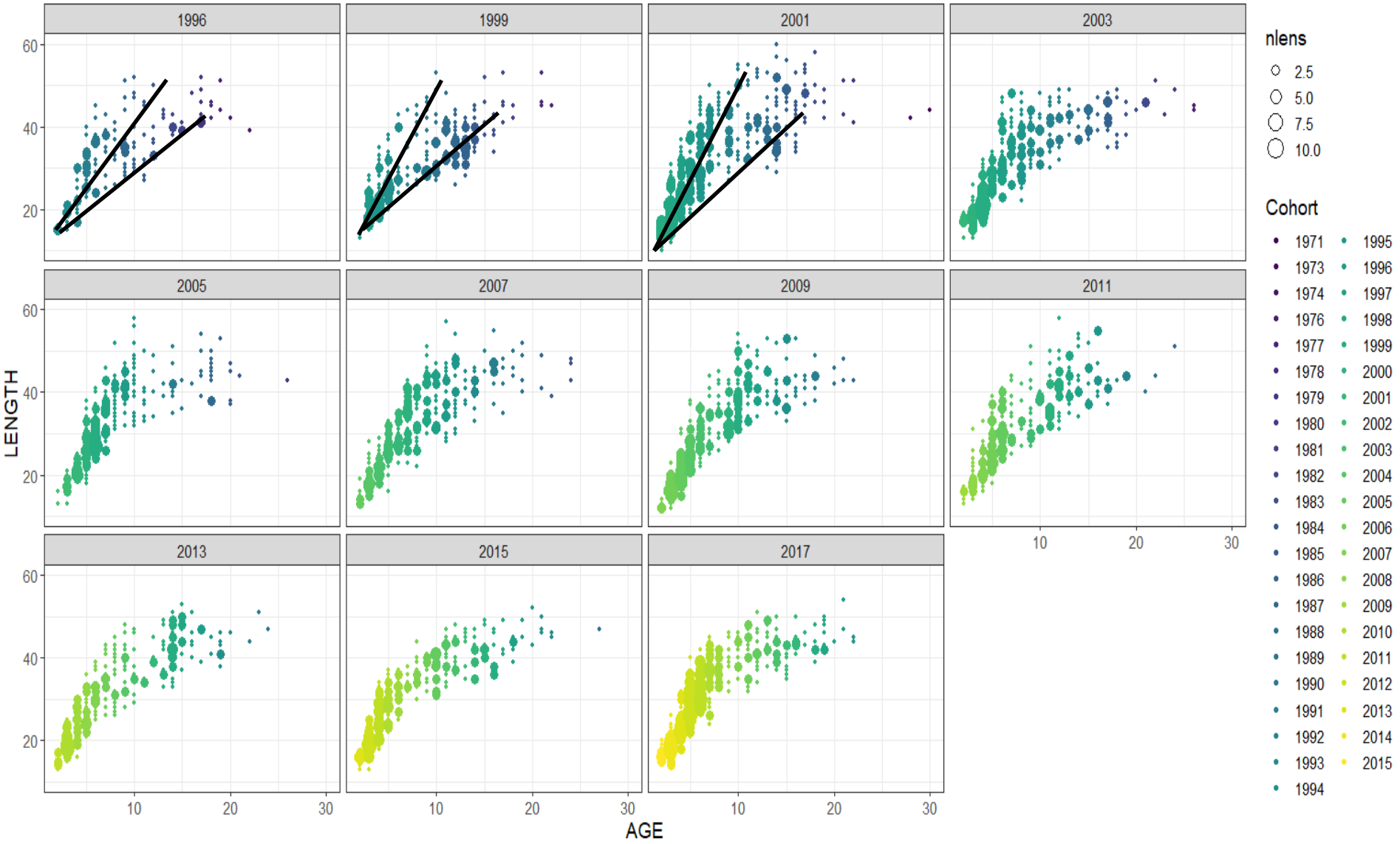
* Presenters

Recommendations

- Improved modeling of growth
- Investigate the possibility of estimating catchability to relax assumption that survey biomass is an absolute index
- Develop model-based indices and use as input
  - Partially to address concern about assuming survey biomass is an absolute index
- Encouraged research of untrawlable habitat to better understand the relative abundance of the rock soles in these habitats
- Catch split – justification for 50% lacking
  - Model catch with uncertainty
  - Use annual proportions from FMA observer data

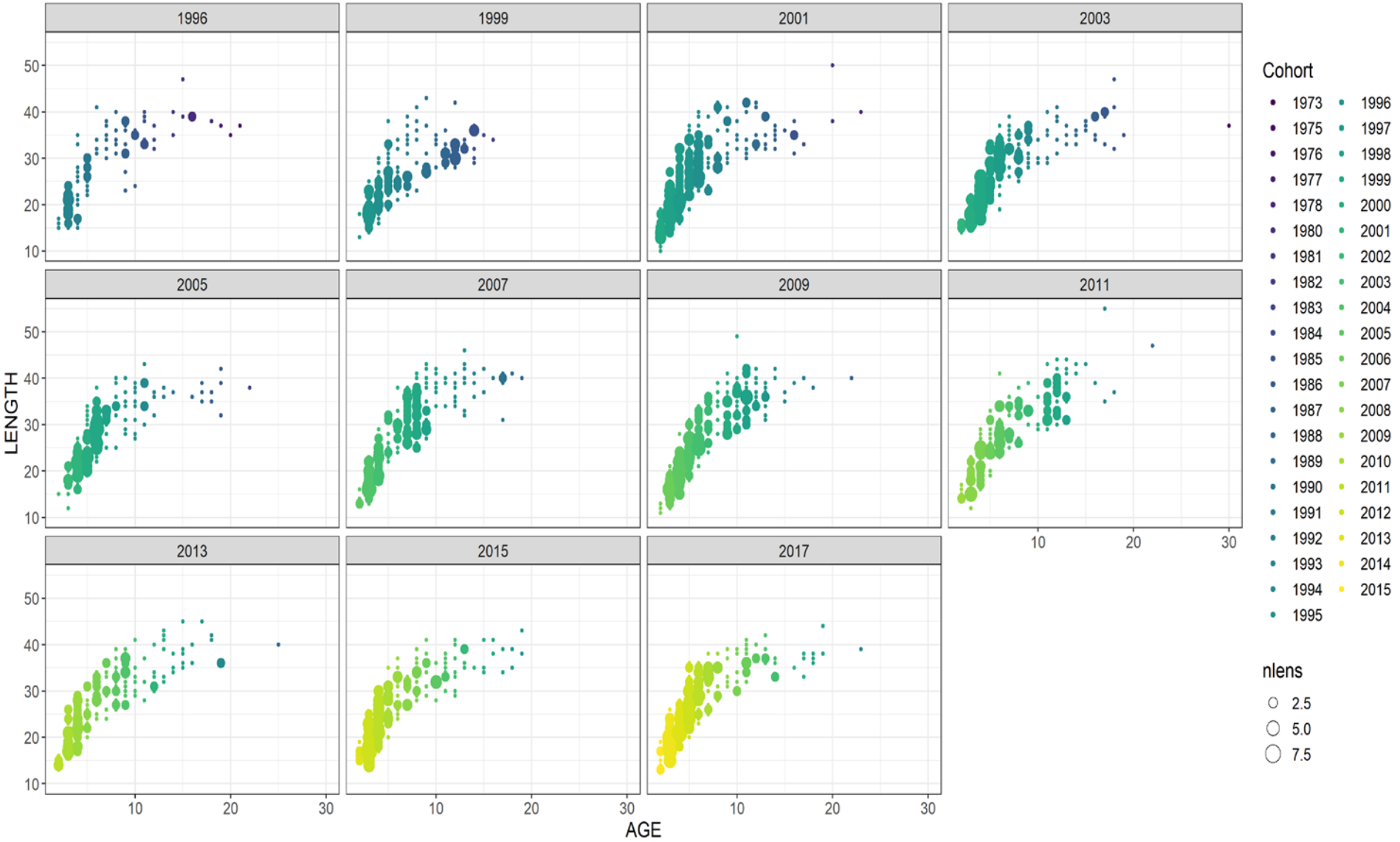
Northern rock sole growth

Female data



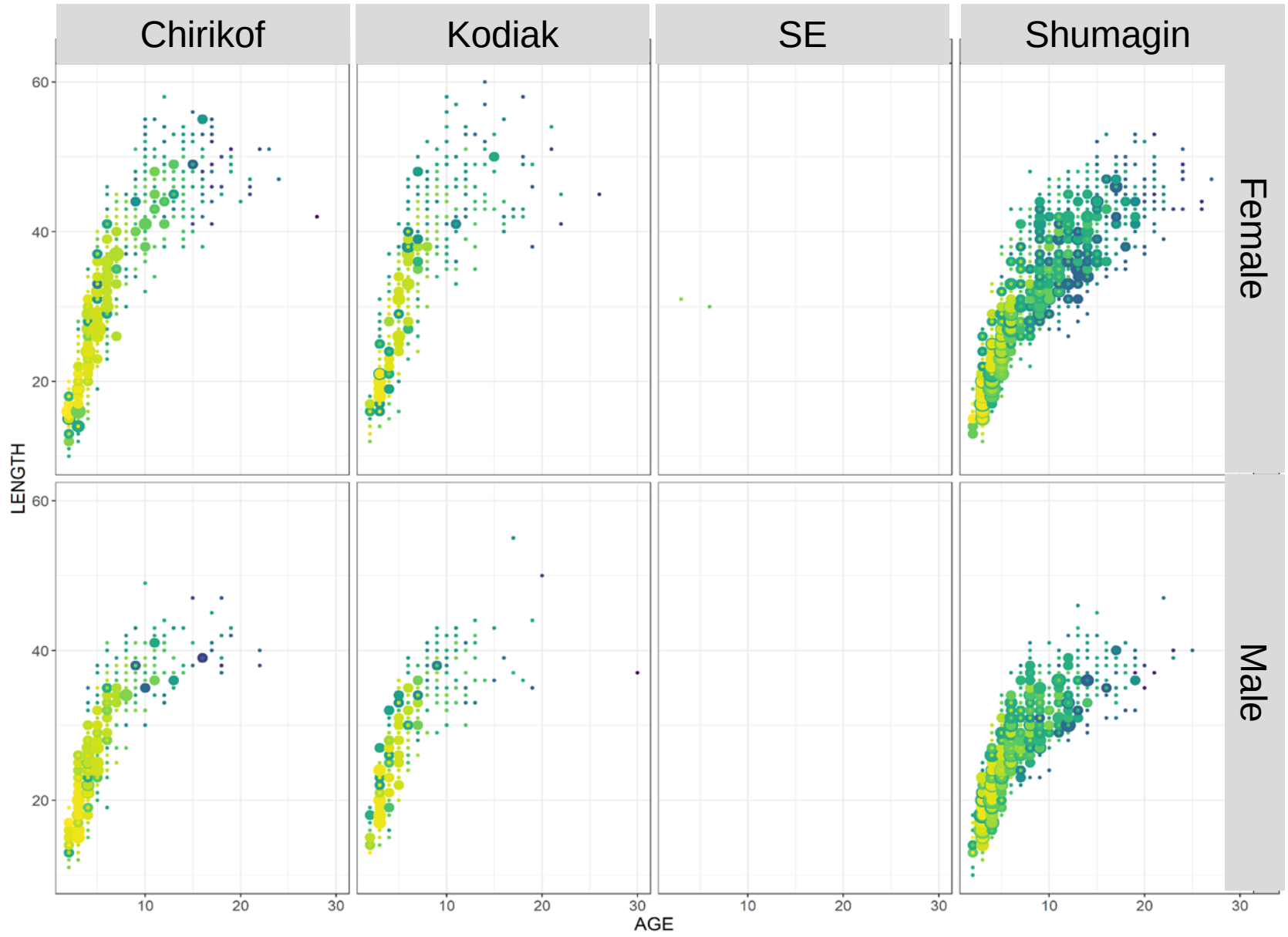
Northern rock sole growth

Male data



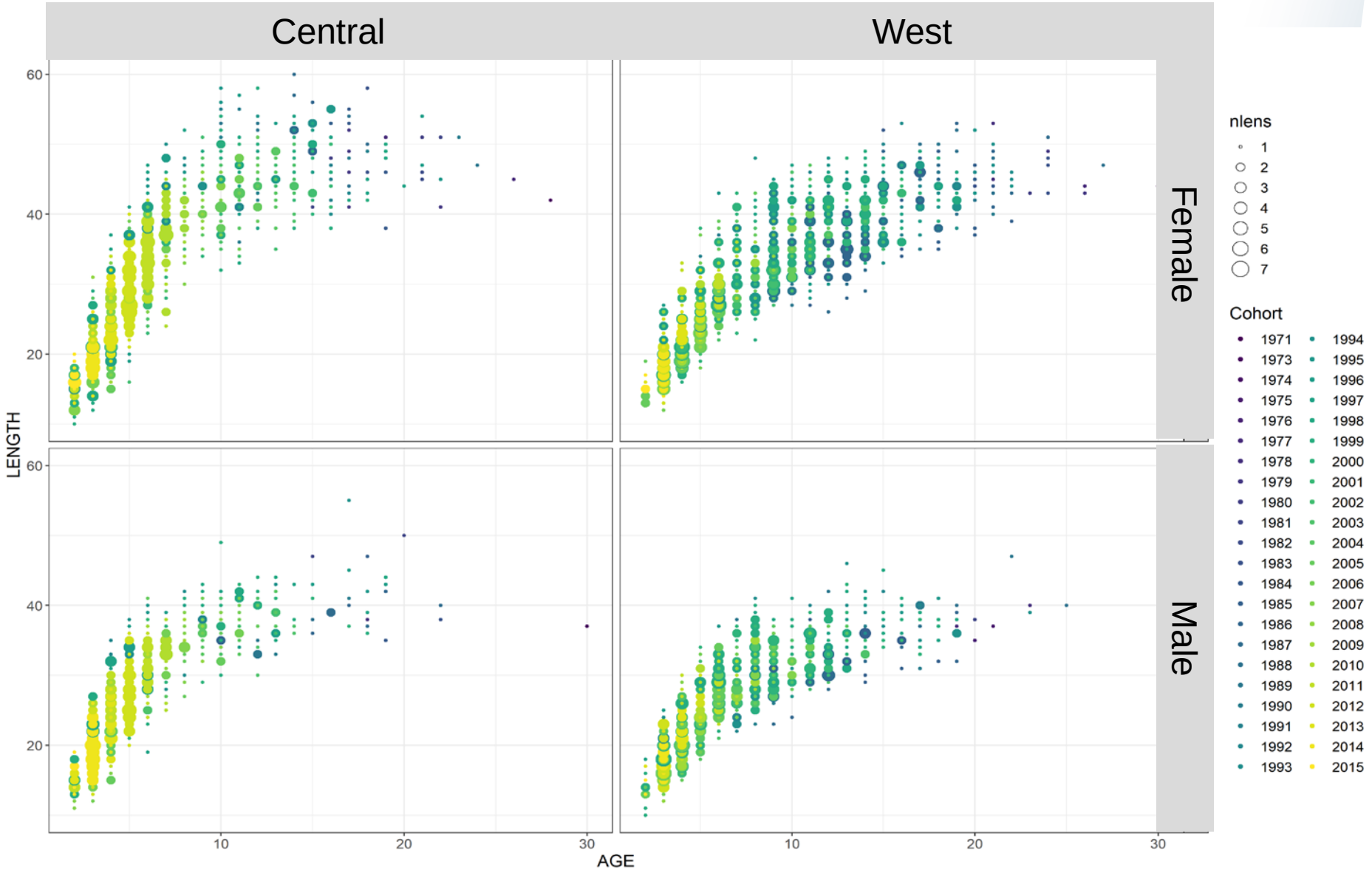
Area specific growth

Northern rock sole



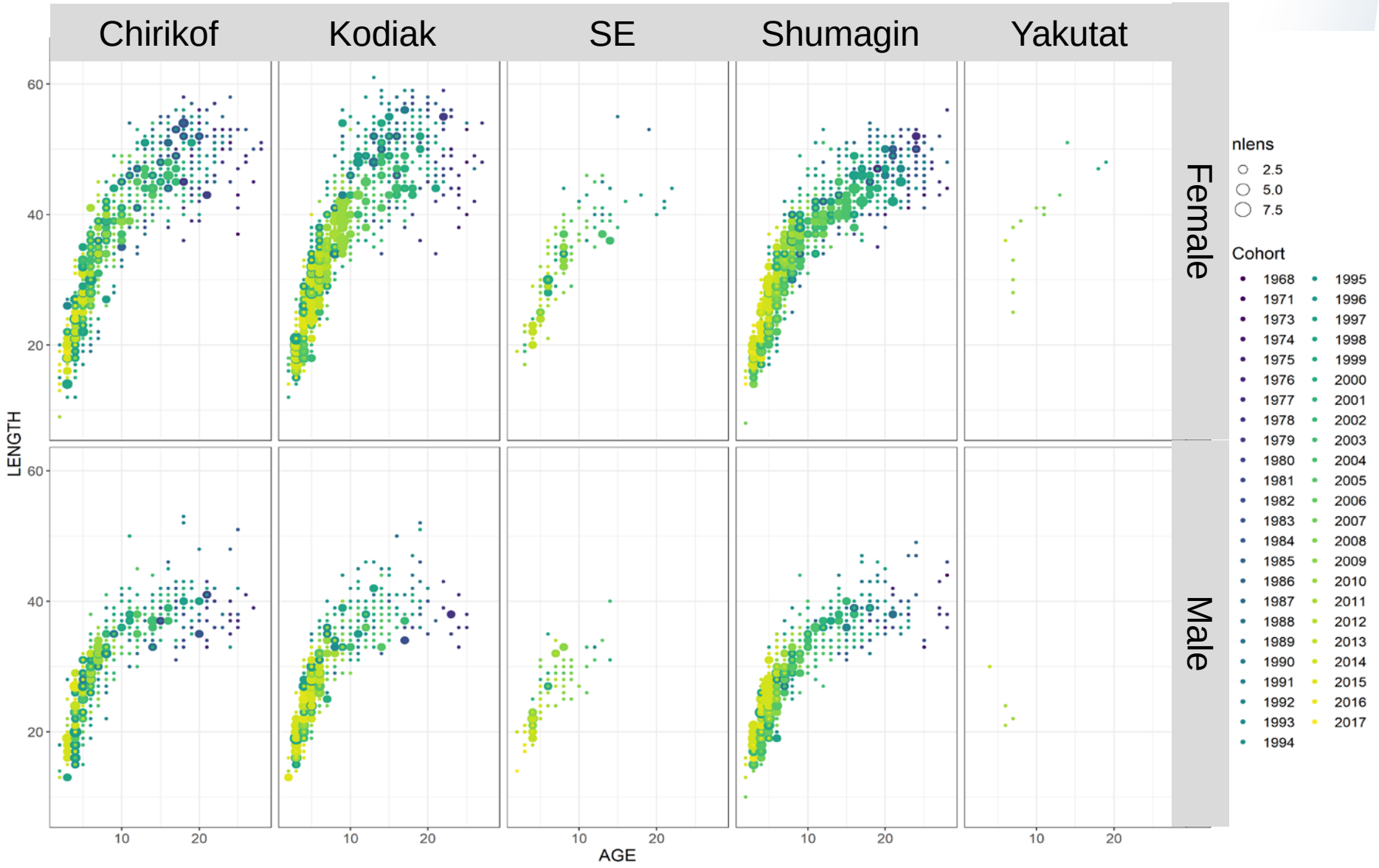
Area specific growth

Northern rock sole



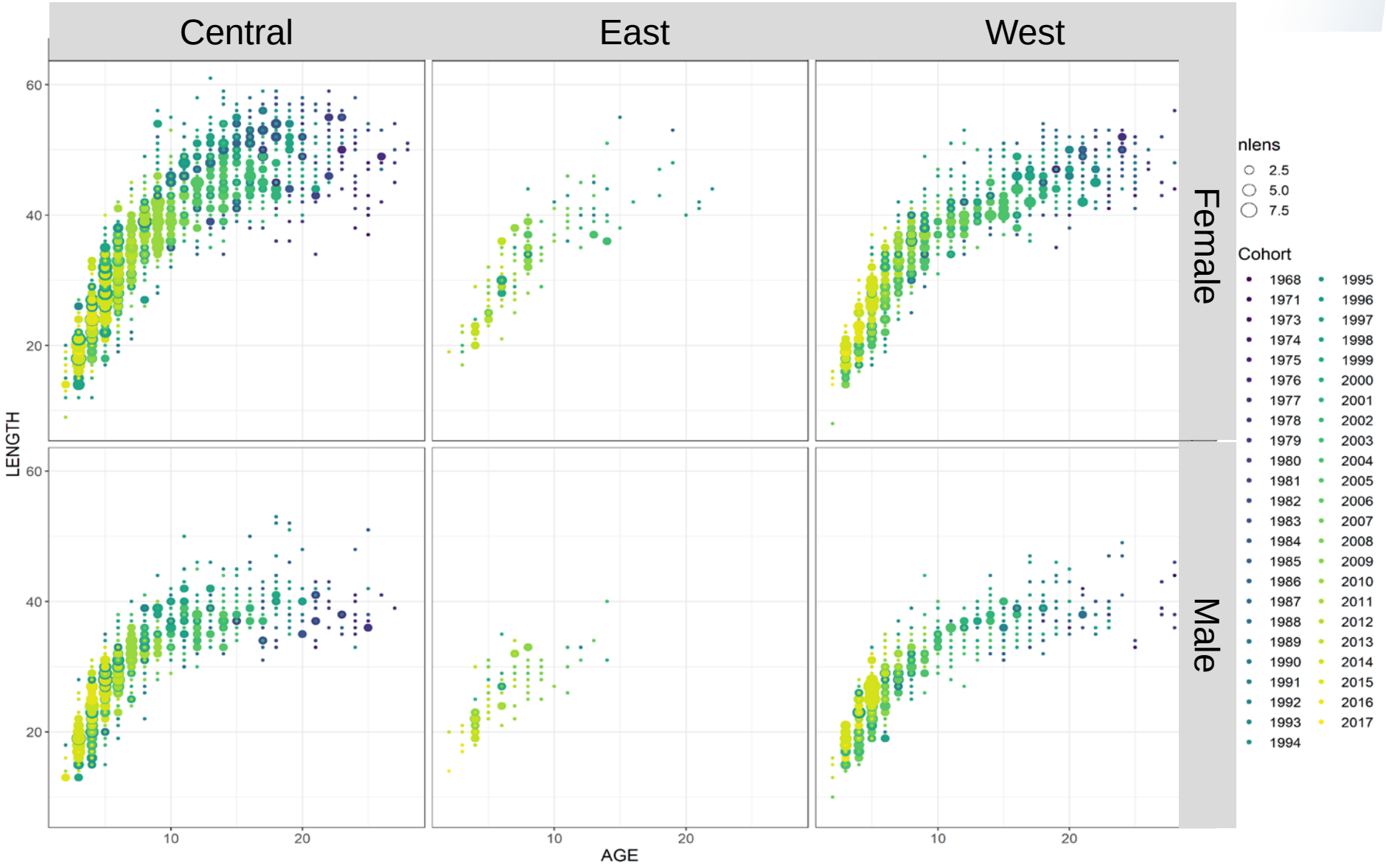
Area specific growth

Southern rock sole



Area specific growth

Southern rock sole



Differences in growth

- fishmethods package (v4.0.5, Nelson, 2021)
- Hypothesis test
  - H0 : Growth differs
  - HA1 : Asymptotic growth is equal
  - HA2 : Growth coefficients are equal
  - HA3 : t0 is equal
  - HA4: Growth is equal
- Female growth differs between the central (Chirikof and Kodiak) and western (Shumagin) GOA
- Male growth also differs
  - AIC results provide support for assuming either K or t0 are equal
  - Does not support the model assuming growth is equal

NRS Females		
Model	RSS	AIC
H0	**52659.85**	**16395.05**
HA2	53164.96	16420.22
HA3	53256.27	16425.1
HA1	53258.69	16425.23
HA4	72864.55	17313.29

NRS Males		
Model	RSS	AIC
H0	**23270.58**	**10803.28**
HA2	23298.55	10803.74
HA3	23316.7	10805.33
HA1	23668.64	10836.02
HA4	28958.42	11245.12

Differences in growth

fishmethods package (v4.0.5, Nelson, 2021)

- Hypothesis test
  - H0 : Growth differs
  - HA1 : Asymptotic growth is equal
  - HA2 : Growth coefficient (K) is equal
  - HA3 : t0 is equal
  - HA4: Growth is equal
- Model with lowest AIC values
- Assumes that t0 is the same while asymptotic length and K differ
  - Next lowest AIC value provides
  - support for the model that assumes growth differs

SRS Females		
Model	RSS	AIC
HA3	**57082.51**	**20420.68**
H0	57069.08	20421.82
HA2	57103.47	20422.02
HA1	57478.97	20445.96
HA4	63012.69	20777.73

SRS Males		
Model	RSS	AIC
HA3	**22945.19**	**11434.47**
H0	22935.90	11435.58
HA1	22957.61	11435.66
HA2	22965.33	11436.40
HA4	23804.63	11511.55

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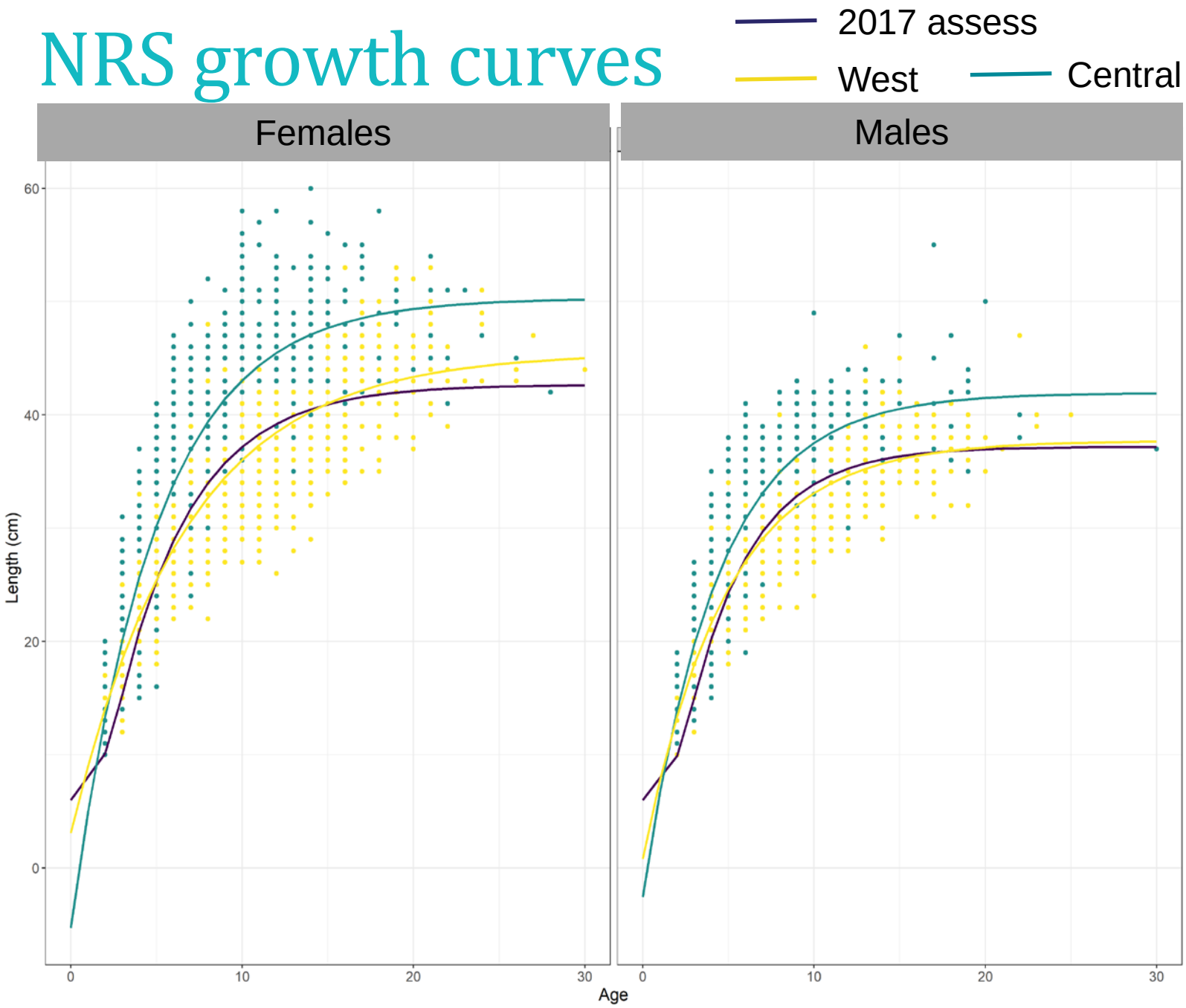
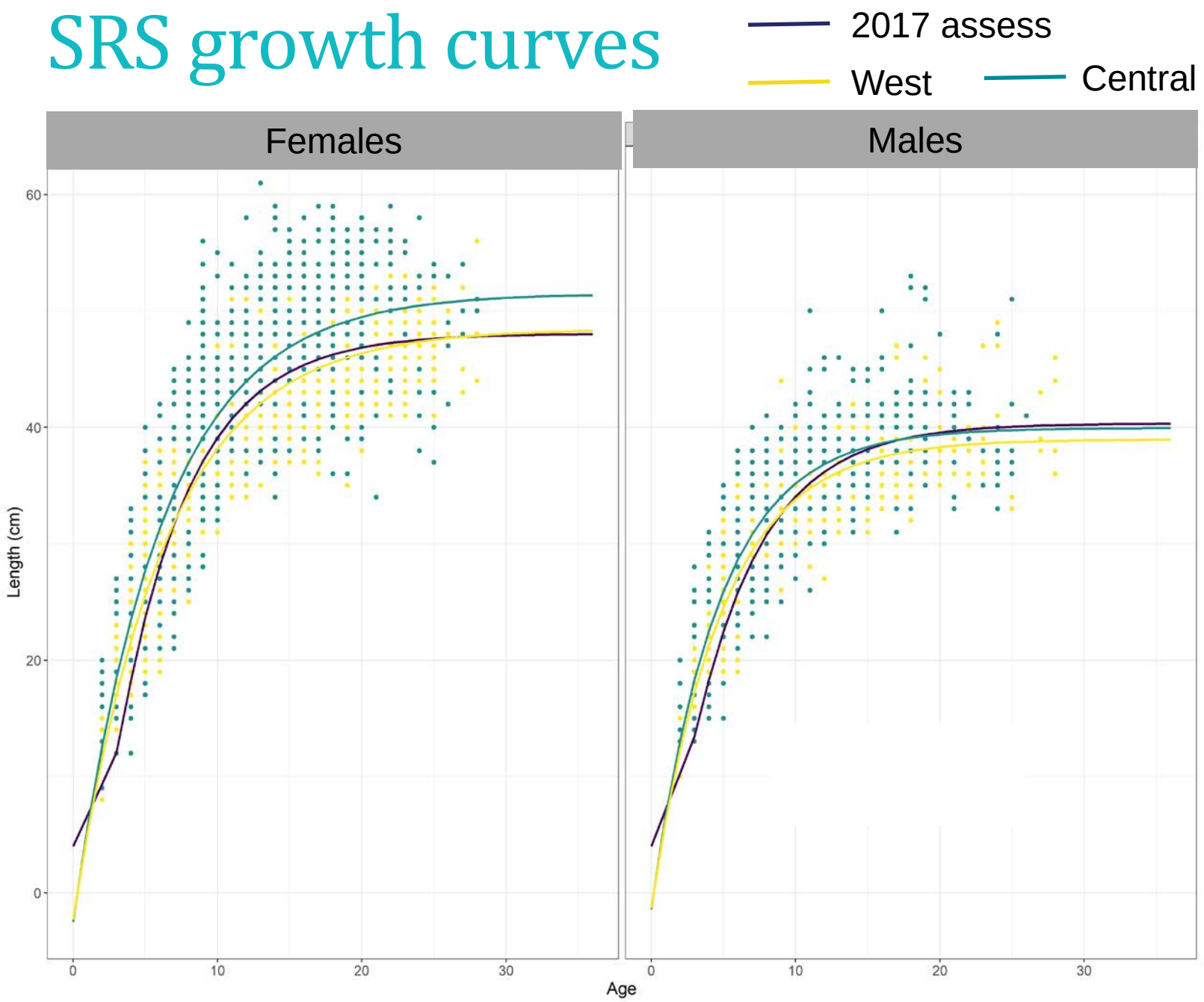
NRS growth curves



SRS growth curves

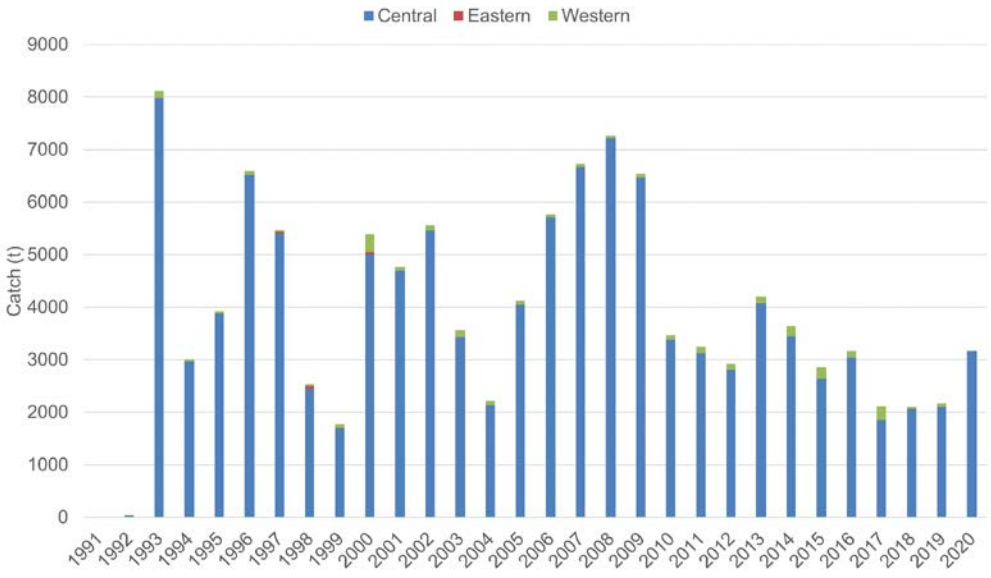


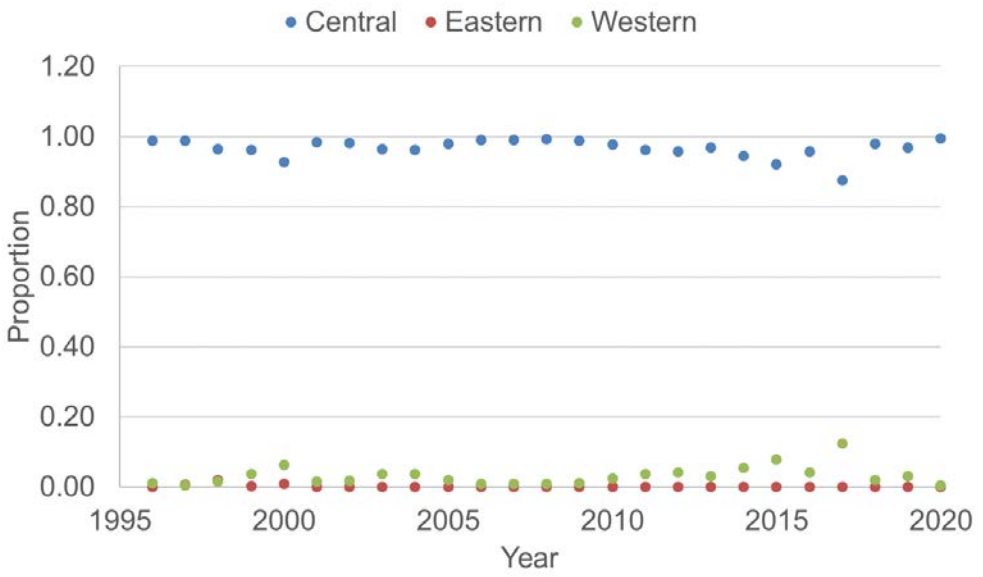
Area specific growth?

- Difference in growth is apparent for NRS
  - Growth in Chirikof and Kodiak are similar
  - Growth in Shumagin seems slower and the asymptotic size is lower than Chirikof and Kodiak
- Some support for area specific growth for SRS
- SS3 has the option to model growth morphs (e.g., McGilliard et al. 2017 used this for rex sole)

Modeling growth differences: NRS

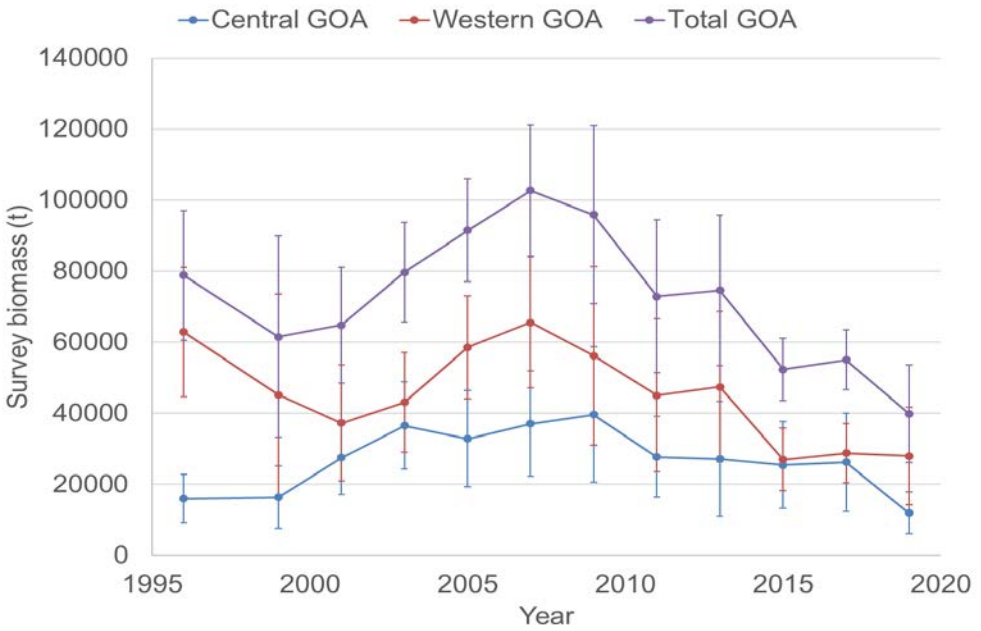
- 2-area model in SS3
  - Central (Kodiak and Chirikof)
  - West (Shumagin)
  - Data inputs:
    - Total rock sole catch was split by 50% to get NRS catch

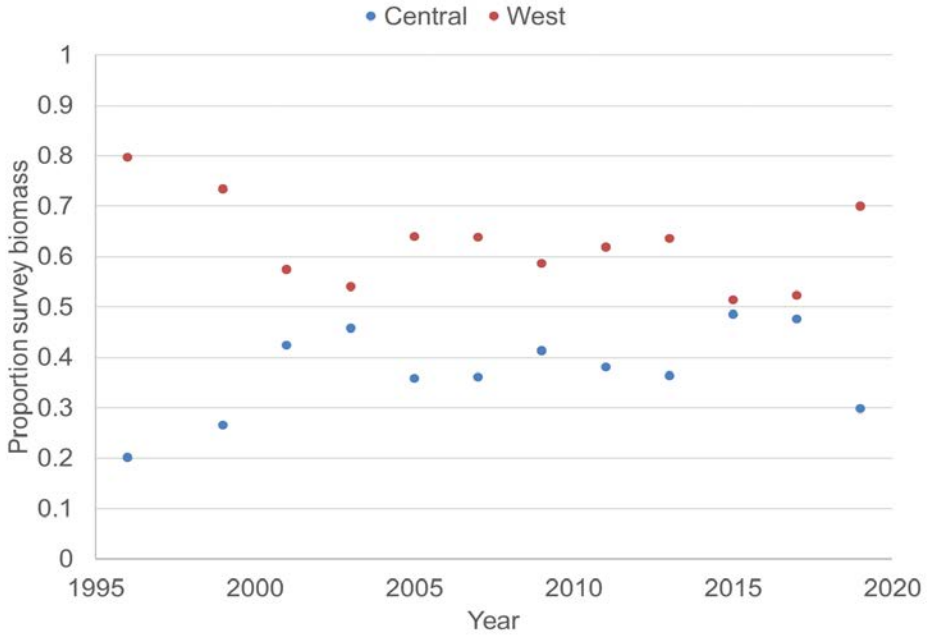




Modeling growth differences: NRS

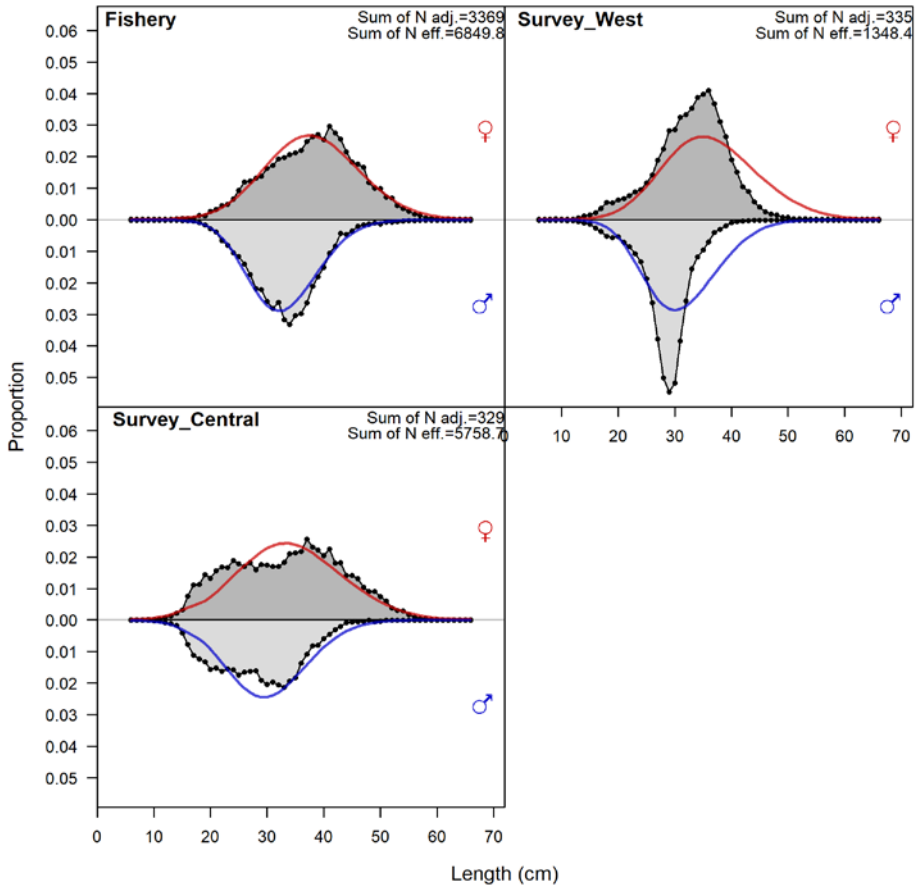
- 2-area model in SS3
  - Central (Kodiak and Chirikof) and west (Shumagin)
  - Data inputs:
    - Total rock sole catch was split by 50% to get NRS catch
    - Survey biomass
      - Average of 62% of survey biomass is from West (Shumagin)





Modeling growth differences: NRS

- 2-area model in SS3
  - Central (Kodiak and Chirikof) and west (Shumagin)
  - Data inputs:
    - Total rock sole catch was split by 50% to get NRS catch
    - Then split into areas
    - Survey biomass
      - Average of 62% of survey biomass is from West (Shumagin)
    - Length composition data



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Modeling growth differences: NRS

- 2-area model in SS3
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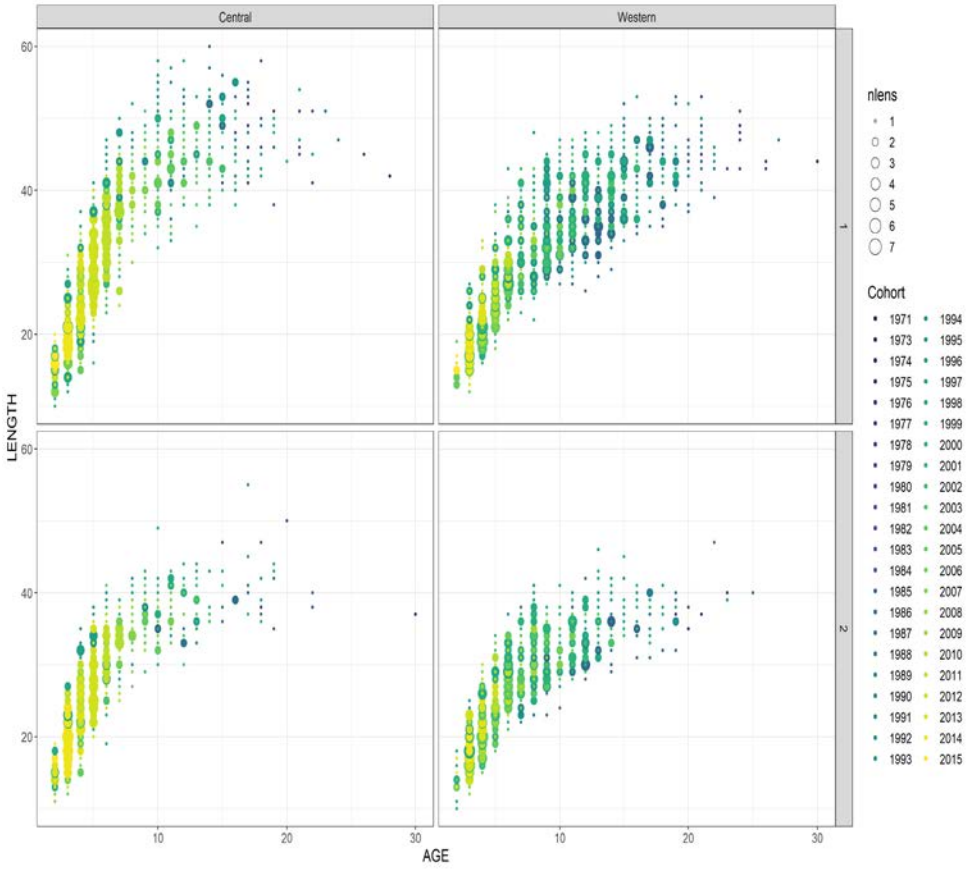
  - Data inputs:
    - Total rock sole catch was split by 50% to get NRS catch
    - Then split into areas
    - Survey biomass
      - Average of 62% of survey biomass is from West (Shumagin)
    - Length composition data
    - Survey CAAL data



Modeling growth differences: NRS

- 2-area model in SS3
  - Biology of species was specified for each area and sex
  - Selectivity was age-based and sex-specific
    - Survey selectivity in west mirrored the selectivity in the central area
  - Recruitment distribution:
    - p_i **- estimated parameter**
      - Determines how the population is distributed between the areas

Modeling growth differences: NRS

- Model runs
  - Run 1
    - Fixed growth parameters to external estimates
    - The p_i parameter was fixed at 62% to match the average biomass distribution from the survey
    - Selectivity was estimated
  - Run 2
    - Fixed growth parameters to external estimates
    - Selectivity was fixed to estimates from run 1
    - The p_i parameter was estimated
  - Run 3
    - Same as run 2, with a weak prior on p_i
  - Run 4
    - Same as run 3, but estimate growth parameters

Modeling growth differences

- Difficult to estimate the p_i parameter
  - Estimated at lower bound when freely estimated, so model wanted to estimate a 1-area model
  - When a weak prior was used, estimated value was lower than *a priori* expectations based on area-specific proportions of biomass from the bottom trawl survey
- When p_i was fixed, the growth parameters in the western GOA were essentially not estimated.
  - Parameters were estimated at initial parameter values and with unreasonably large standard errors

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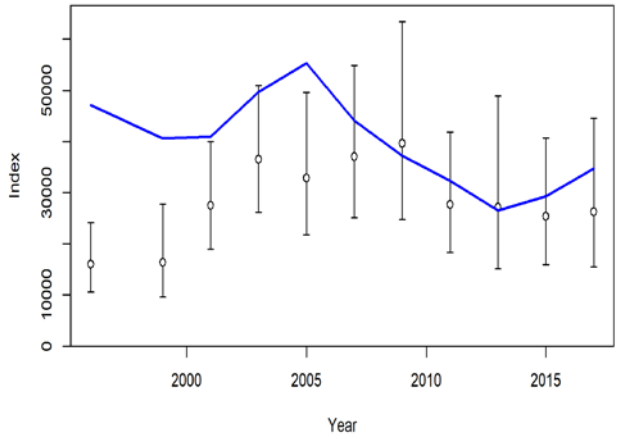
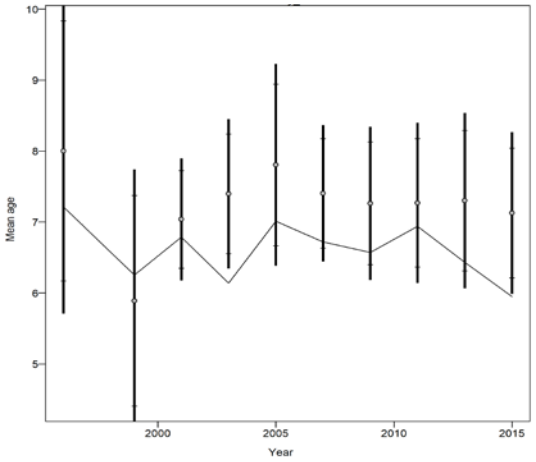
Modeling growth differences

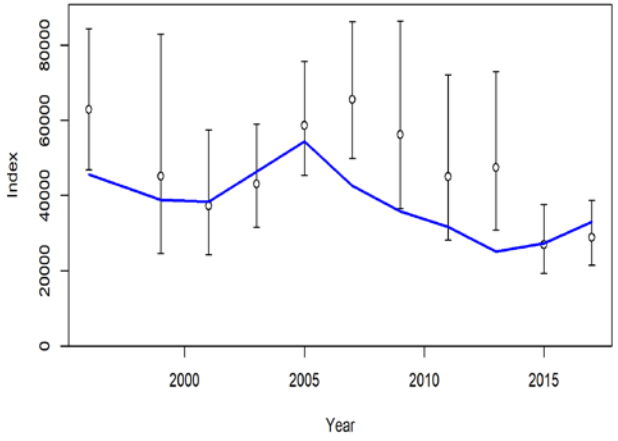
Central



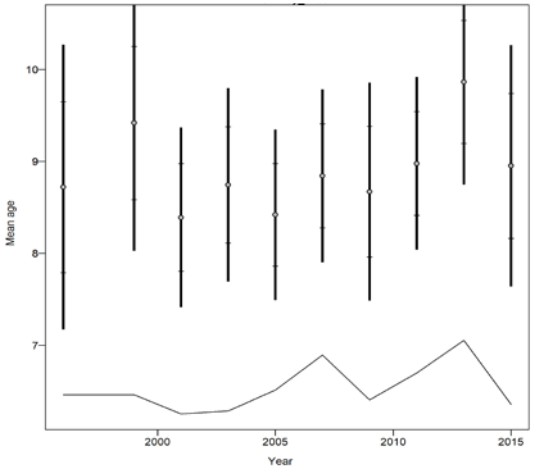
Central

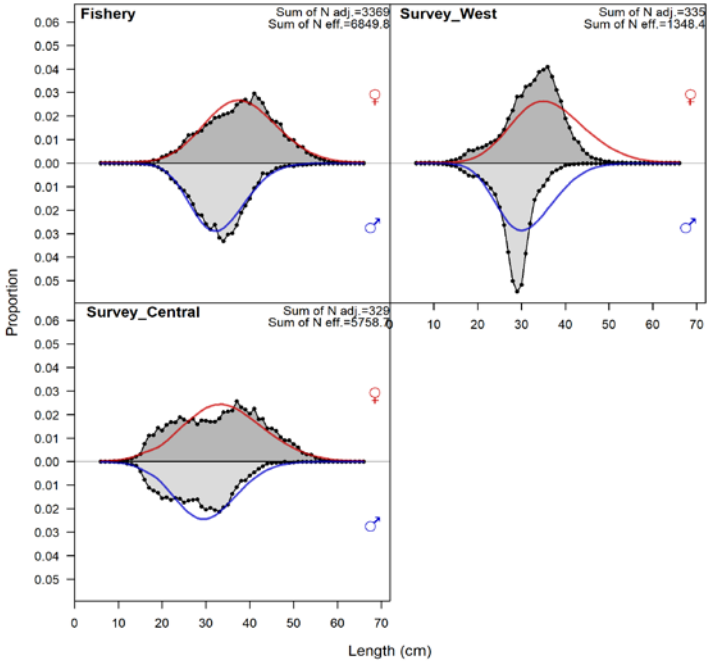


West



West





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Modeling growth differences

- 2-area model is not a viable option at this time
- Does Plan Team have any suggestions or recommendations about methods to address growth differences?

NRS base model structure

- Single area, sex specific
- Growth estimated, assumed von Bertalanffy
- Female M=0.2, Male M estimated
- Survey catchability = 1
- Fishery selectivity modeled with double normal pattern and allowed to dome
- Survey selectivity modeled with double normal pattern and forced to be logistic
- Average recruitment estimated (steepness = 1 and sigmaR = 0.6)
- Annual recruitment deviations estimated

Sensitivity runs: NRS

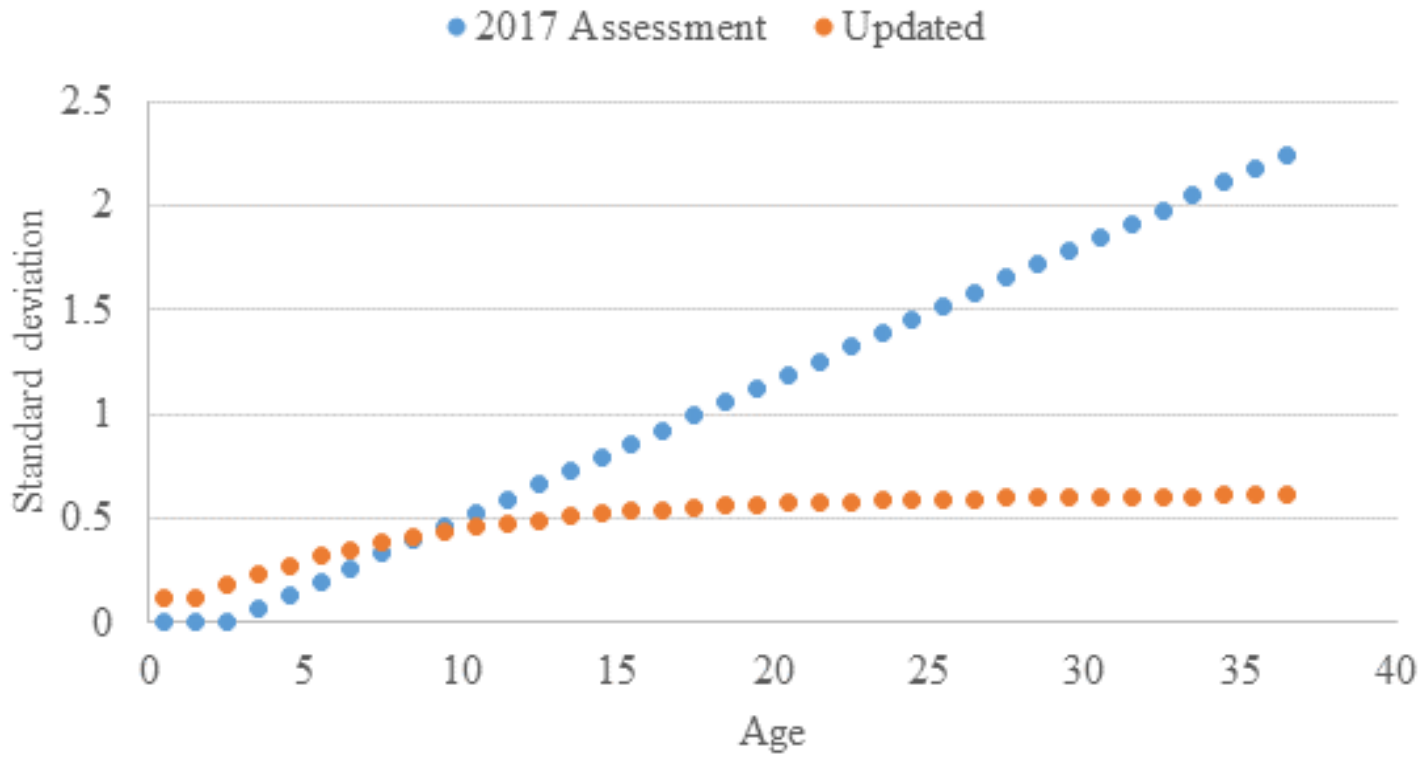
Model	Model description
17.1	**2017 assessment**
17.1a	Minimum sample size fix for CAAL
17.1b	Updated fishery length comp
17.1c	Combination of a and b
17.1d	**Updated age error matrix**
17.1e	**d plus estimate catchability**
17.1f	**d plus VAST survey biomass**
17.1g	**d and McAllister-Ianelli reweighting**
17.1h	**d with Francis reweighting**
17.1i	**f with McAllister-Ianelli reweighting**
17.1j	**f with Francis reweighting**

Estimating catchability

- Work done by Lou Rugolo in 2018 suggests a fair proportion of NRS escape the survey net
- Unknown proportion of the population in untrawlable habitat
- These concerns led the CIE reviewers to suggest estimating catchabilty (run 17.1e)
- Catchability was estimated to be ~ 2.97
- Recommend continuing research on both issues

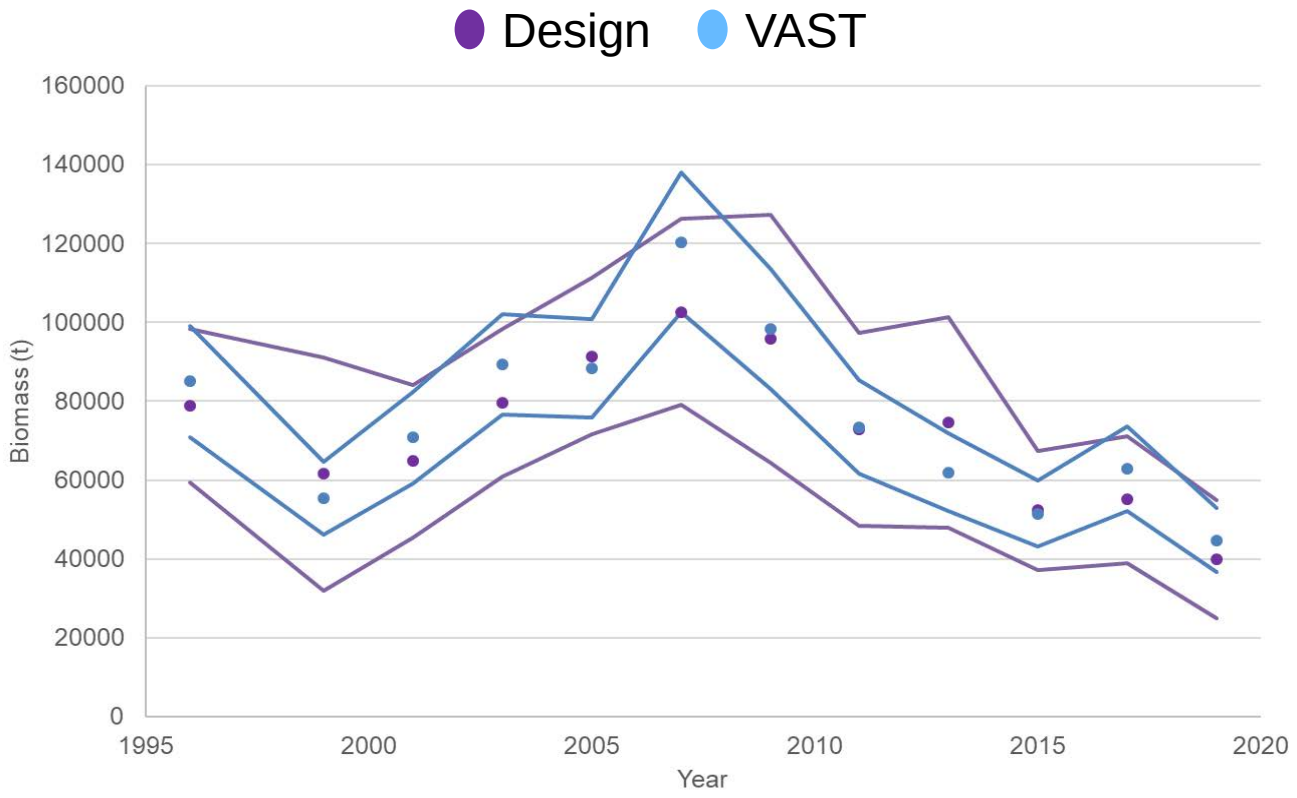
Updated age error matrix

- Method proposed in Punt et al. (2008)
- nwfscAgeingError package (Thorson et al. 2012) for model selection



NRS model-based survey biomass

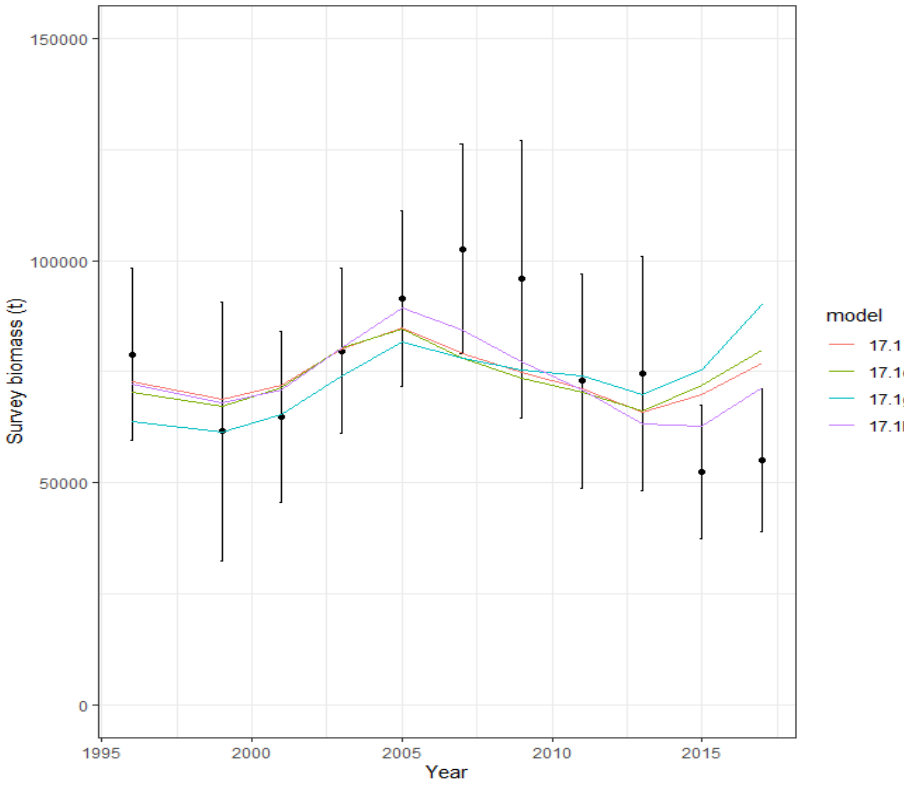
- Model 17.1f used model-based survey biomass
- Model-based biomass similar to design-based biomass and smaller SE



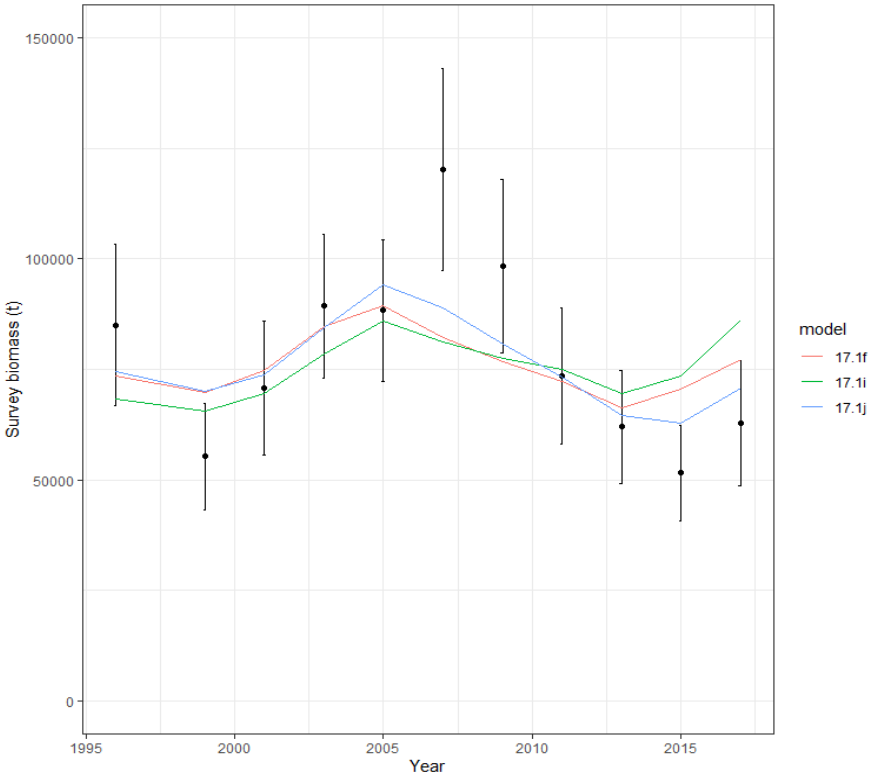
NRS survey biomass

- Models 17.1h and 17.j that implemented Francis re-weighting had lowest RMSE value (0.15 and 0.16)
- Models 17.1g and 17.1i (McAllister-Ianelli) had poorest fits
- Models 17.1d and 17.1f similar fit (RMSE ~ 0.2)

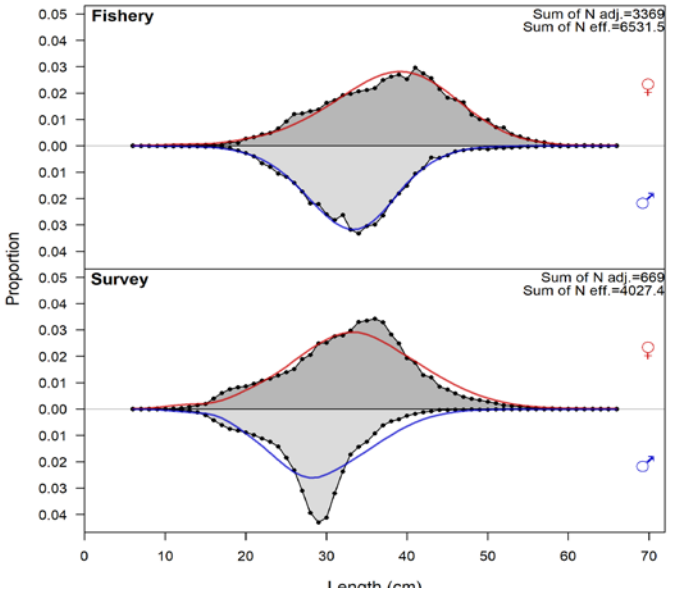
Design-based survey biomass

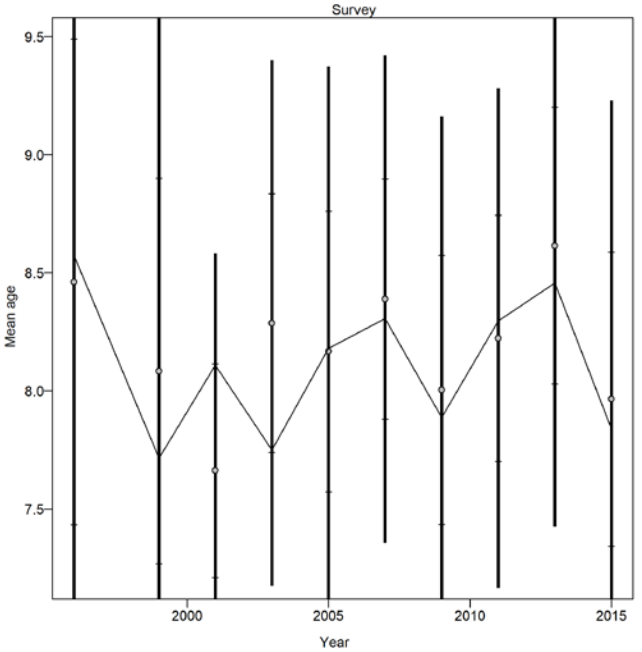


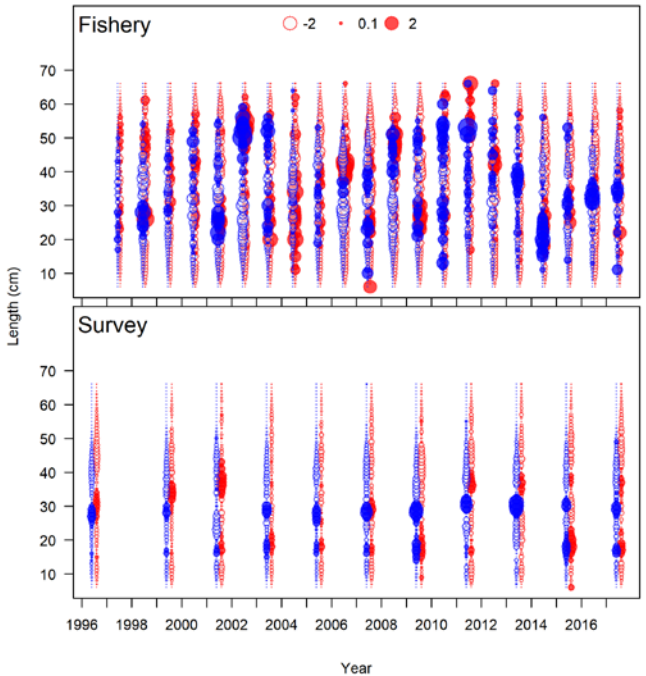
Model-based survey biomass

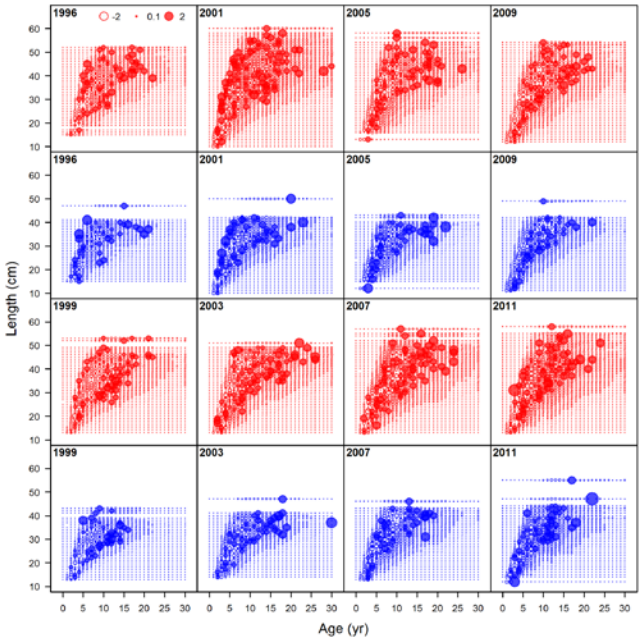


NRS length composition and CAAL



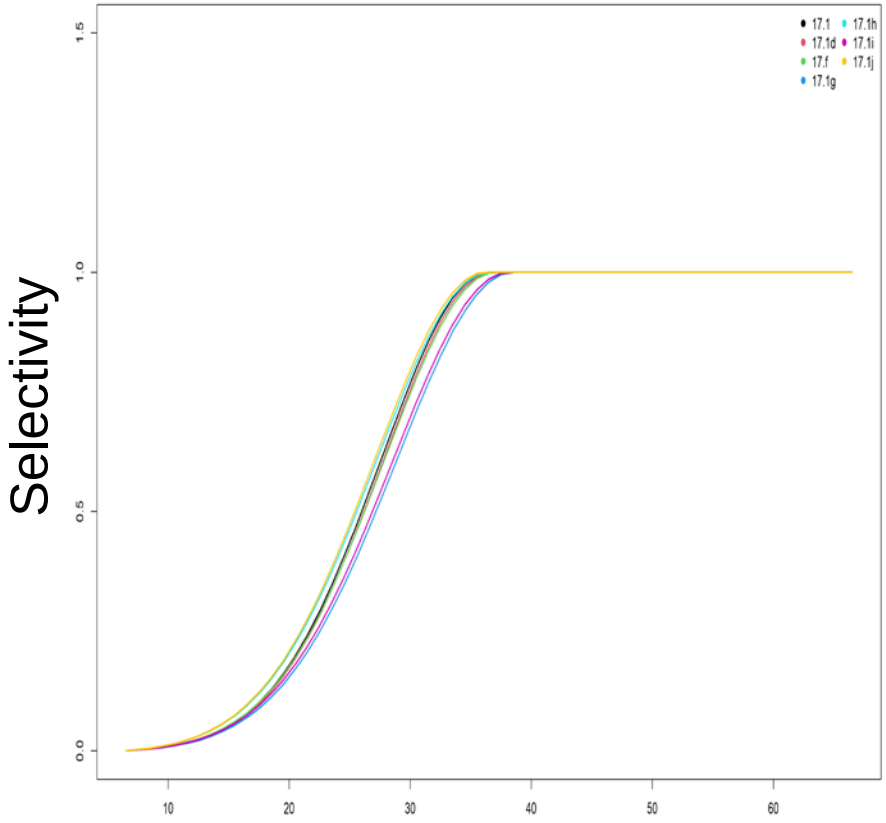




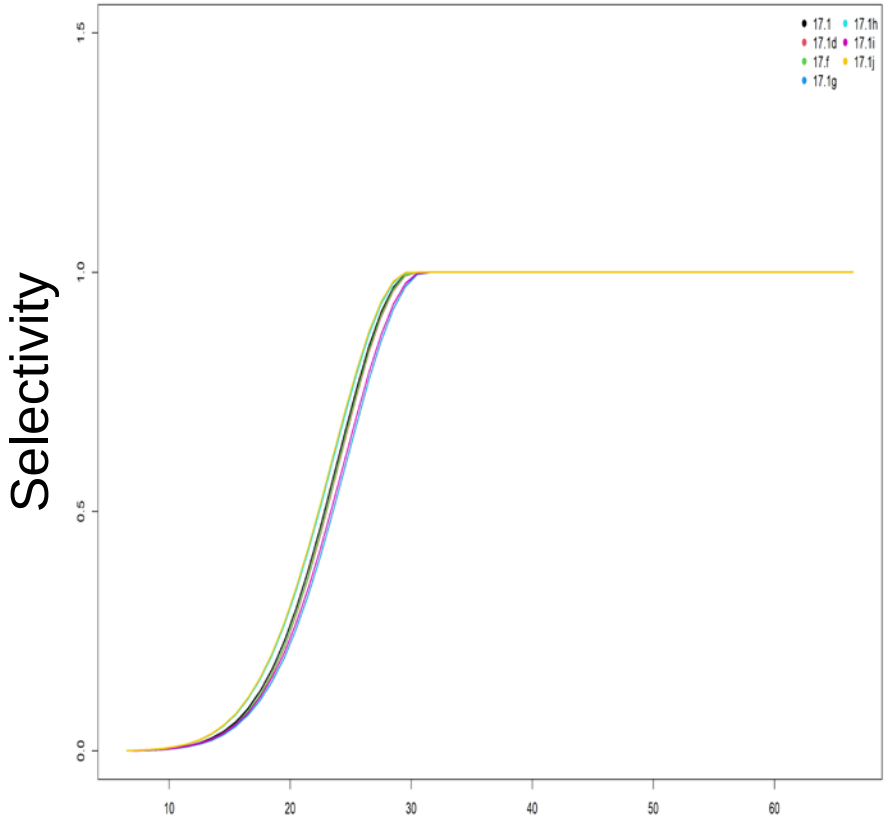


NRS survey selectivity

Female



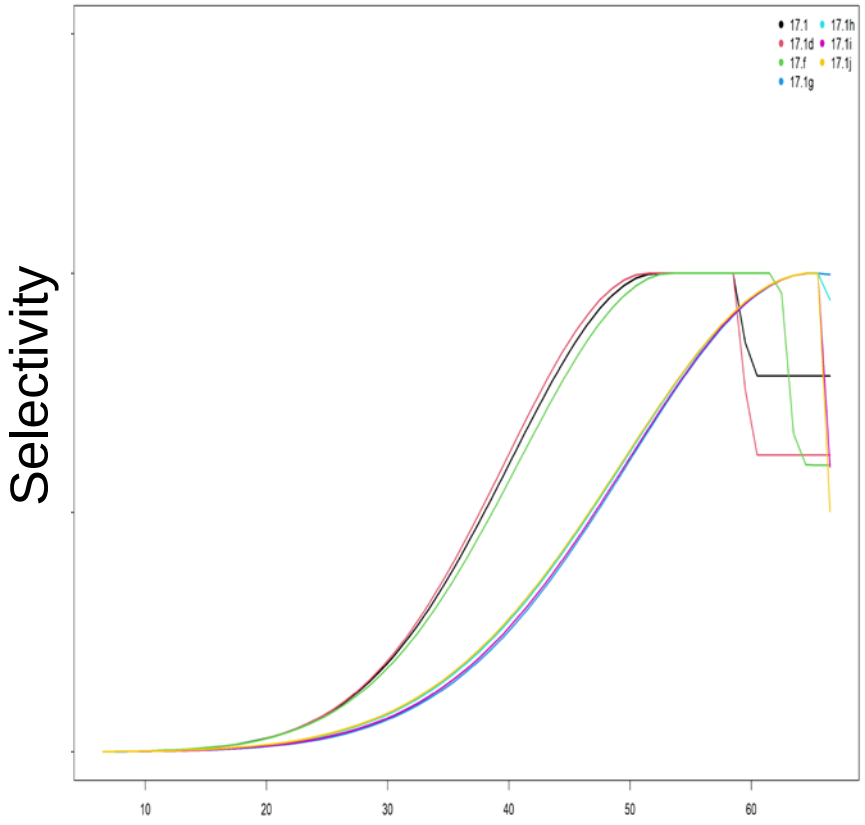
Male



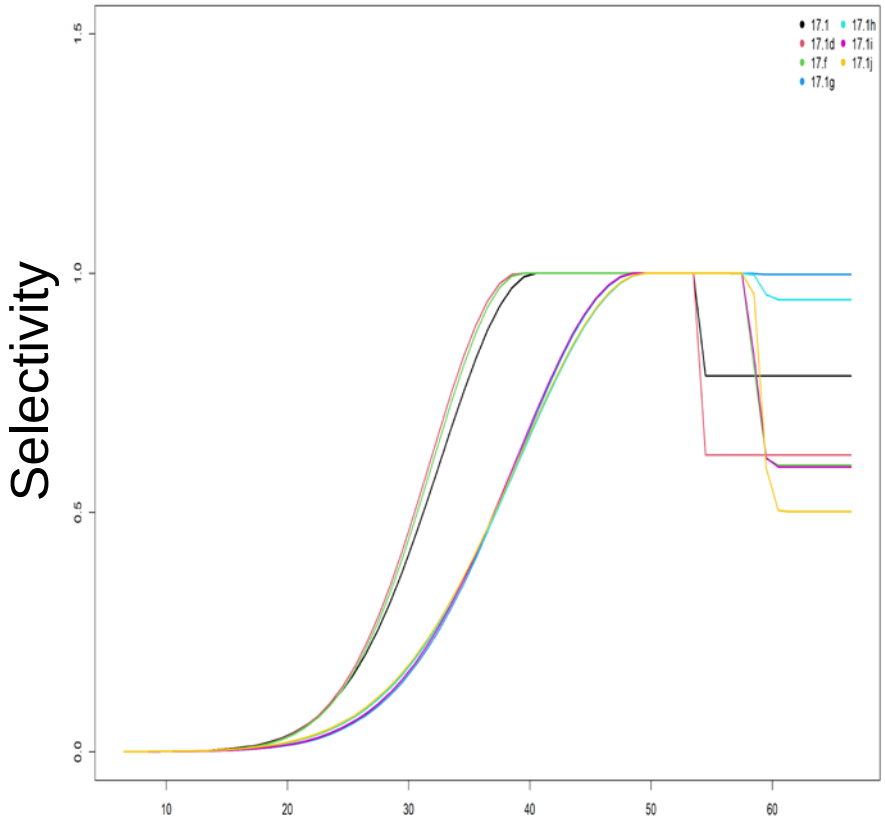
Length (cm)

NRS fishery selectivity

Female

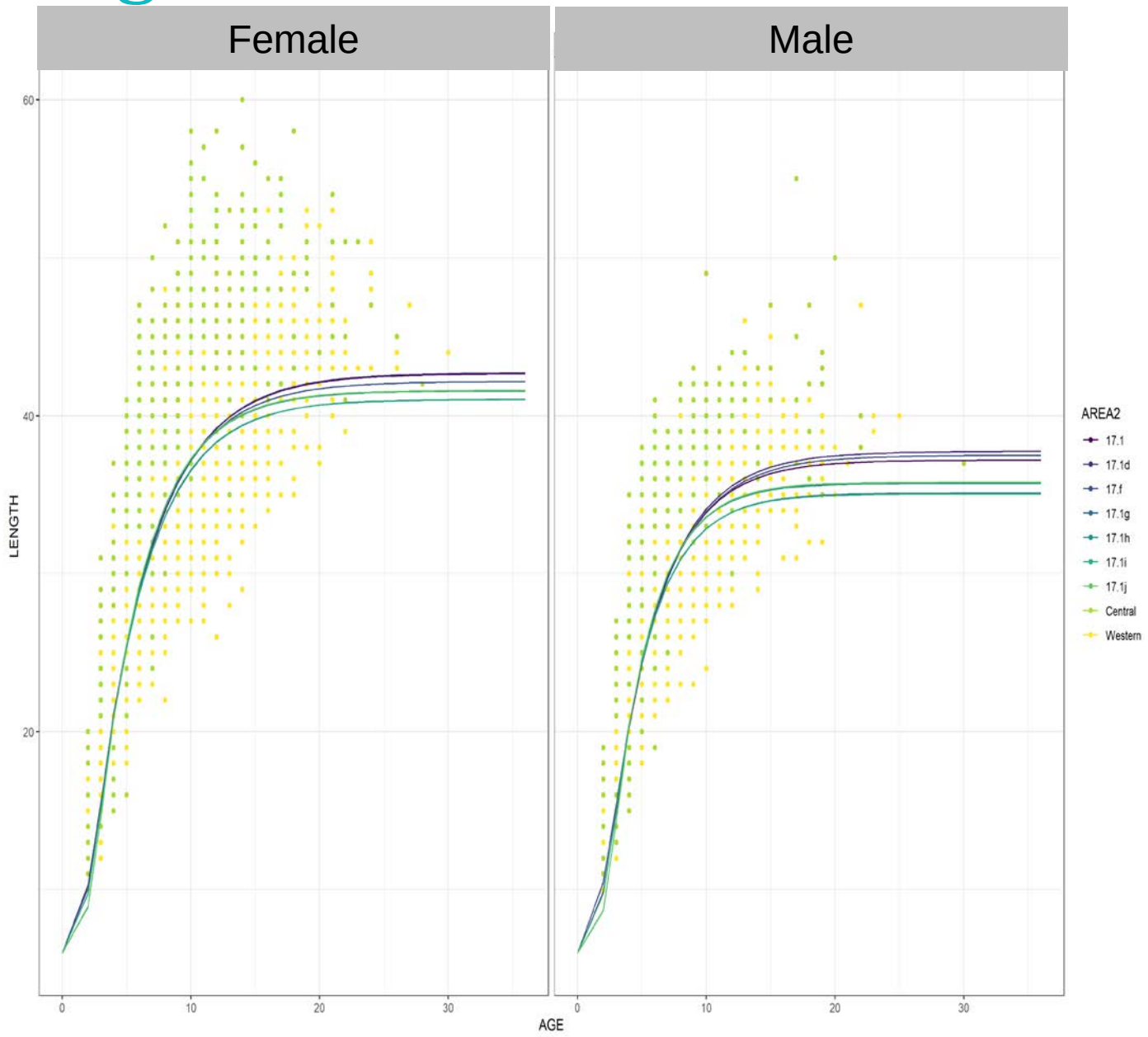


Male



Length (cm)

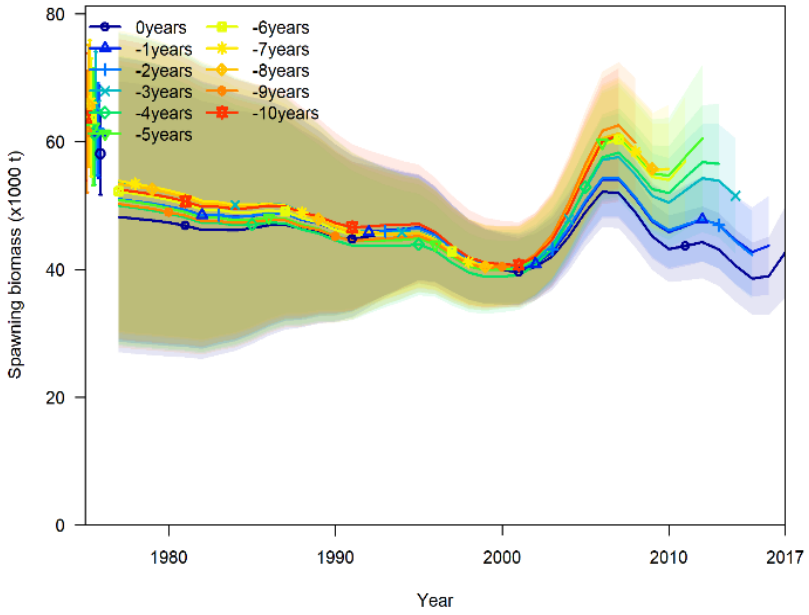
NRS growth estimates



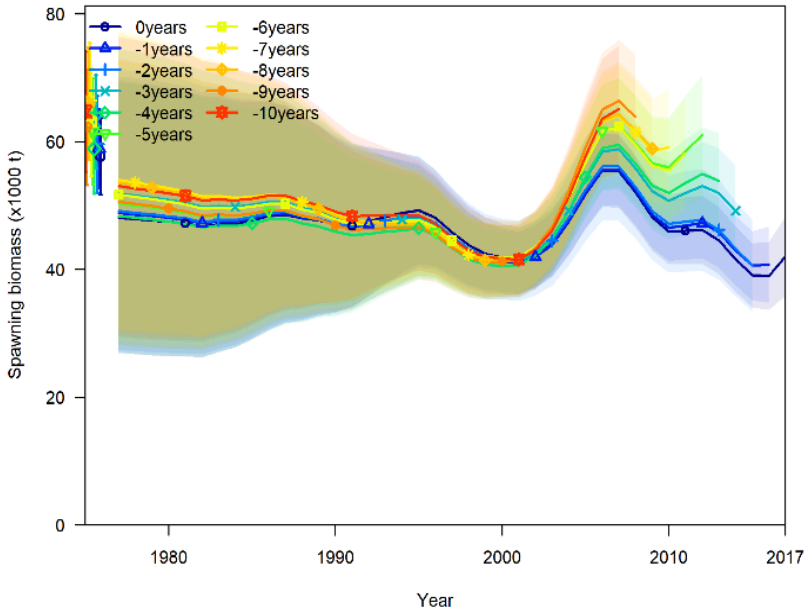
Retrospective analysis

Model	Model description	SSB	Recruitment	Fishing mortality
17.1d	Updated age error matrix	0.24	0.17	-0.15
17.1f	d plus VAST index	0.20	0.20	-0.17
17.1h	d with Francis reweighting	0.11	0.18	-0.04
17.1j	f with Francis reweighting	0.10	0.22	-0.01

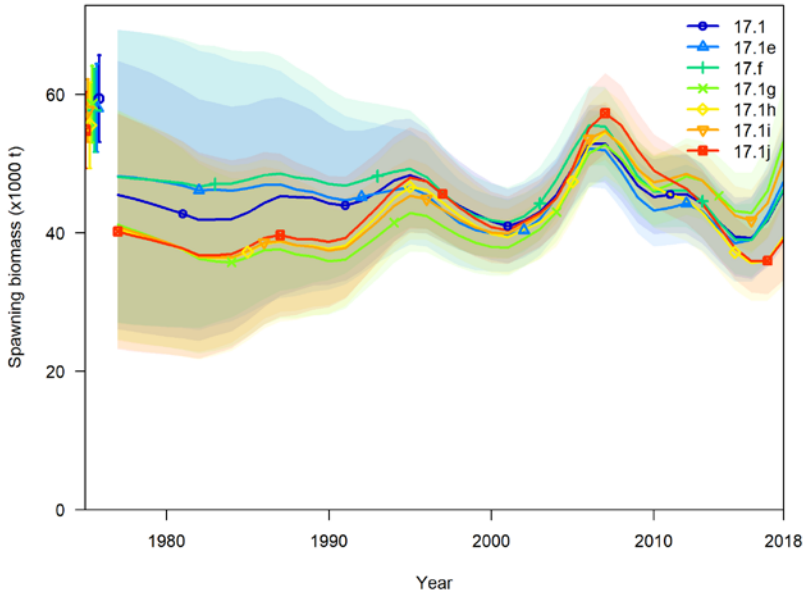
17.1d

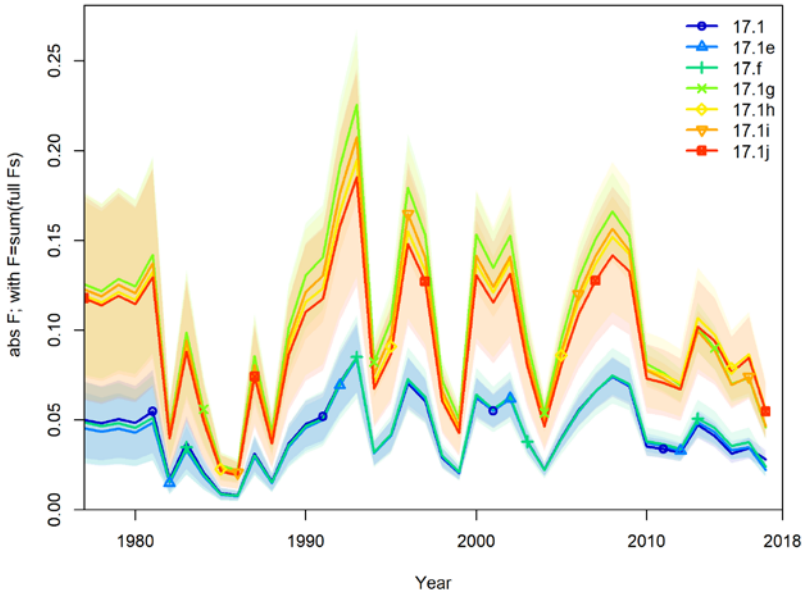


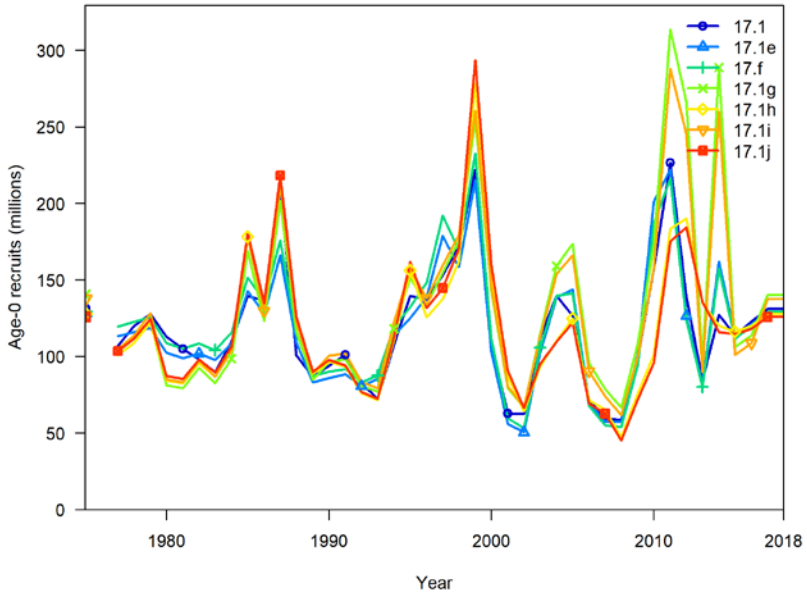
17.1f



Time series


Spawning biomass (x1000 t)
0
20
40
60
1980
1990
2000
2010
2018
Year
17.1
17.1e
17.f
17.1g
17.1h
17.1i
17.1j


abs F; with F=sum(full Fs)
0.00
0.05
0.10
0.15
0.20
0.25
1980
1990
2000
2010
2018
Year
17.1
17.1e
17.f
17.1g
17.1h
17.1i
17.1j


Age-0 recruits (millions)
0
50
100
150
200
250
300
1980
1990
2000
2010
2018
Year
17.1
17.1e
17.f
17.1g
17.1h
17.1i
17.1j

Conclusion from sensitivities

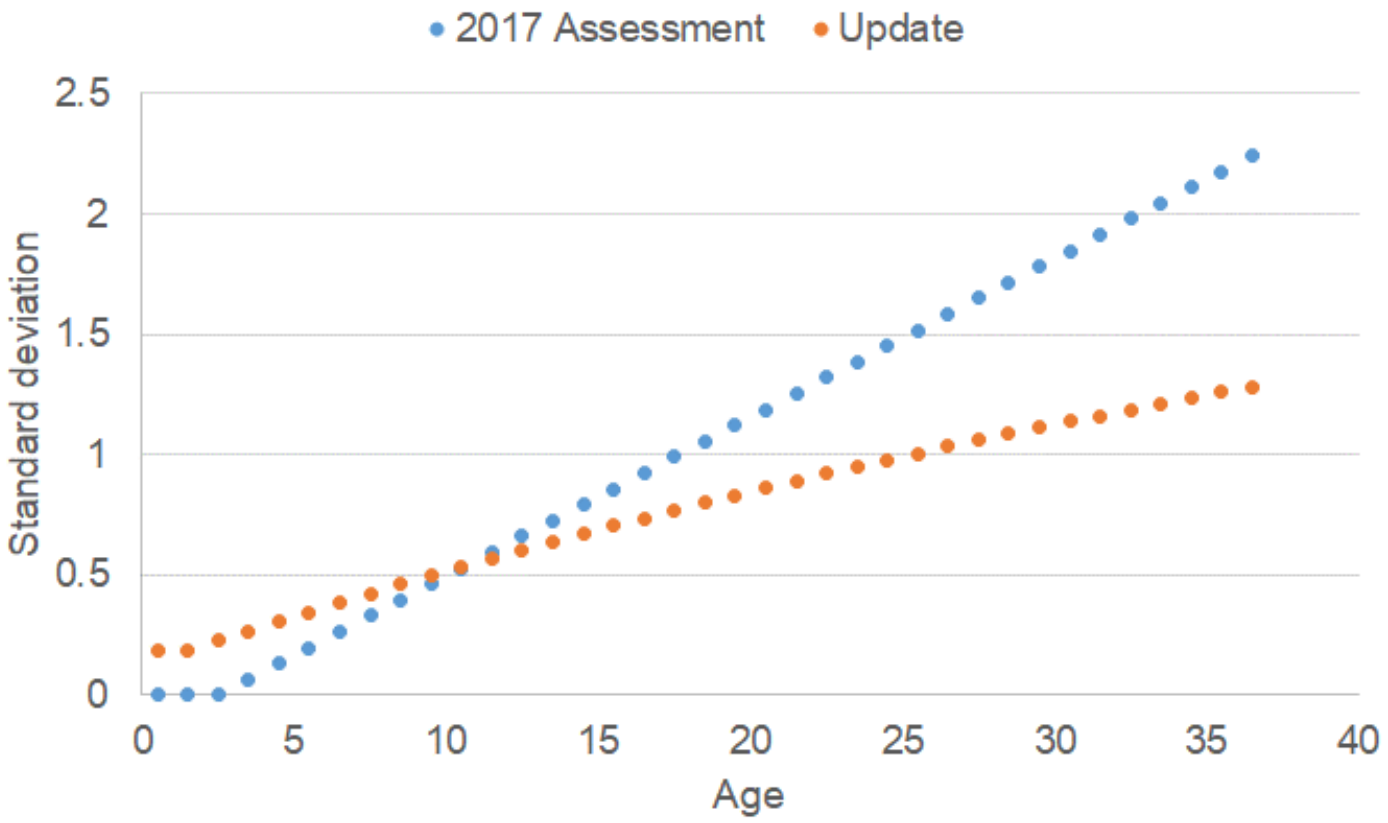
- Improvements can be made with retrospective pattern by better fitting survey biomass data (re-weighting approaches)
- Iterative re-weighting approaches lead to poorer estimation of growth and residual patterns in length and CAAL still persist
- Recommend bringing forward runs 17.1d and 17.1f for November

Sensitivity runs: SRS

Model	Model description
17.1	2017 assessment
17.1b	Updated fishery length composition data
17.1c	b plus corrected CAAL minimum sample size
17.1d	c plus updated age error matrix
17.1e	d plus estimated catchability
17.1f	d plus VAST biomass and standard error
17.g	d and McAllister-Ianelli reweighting
17.1h	d plus Francis reweighting
17.1i	f with McAllister-Ianelli reweighting
17.1j	f with Francis reweighting
17.1k	e with McAllister-Ianelli reweighting
17.1l	e with Francis reweighting

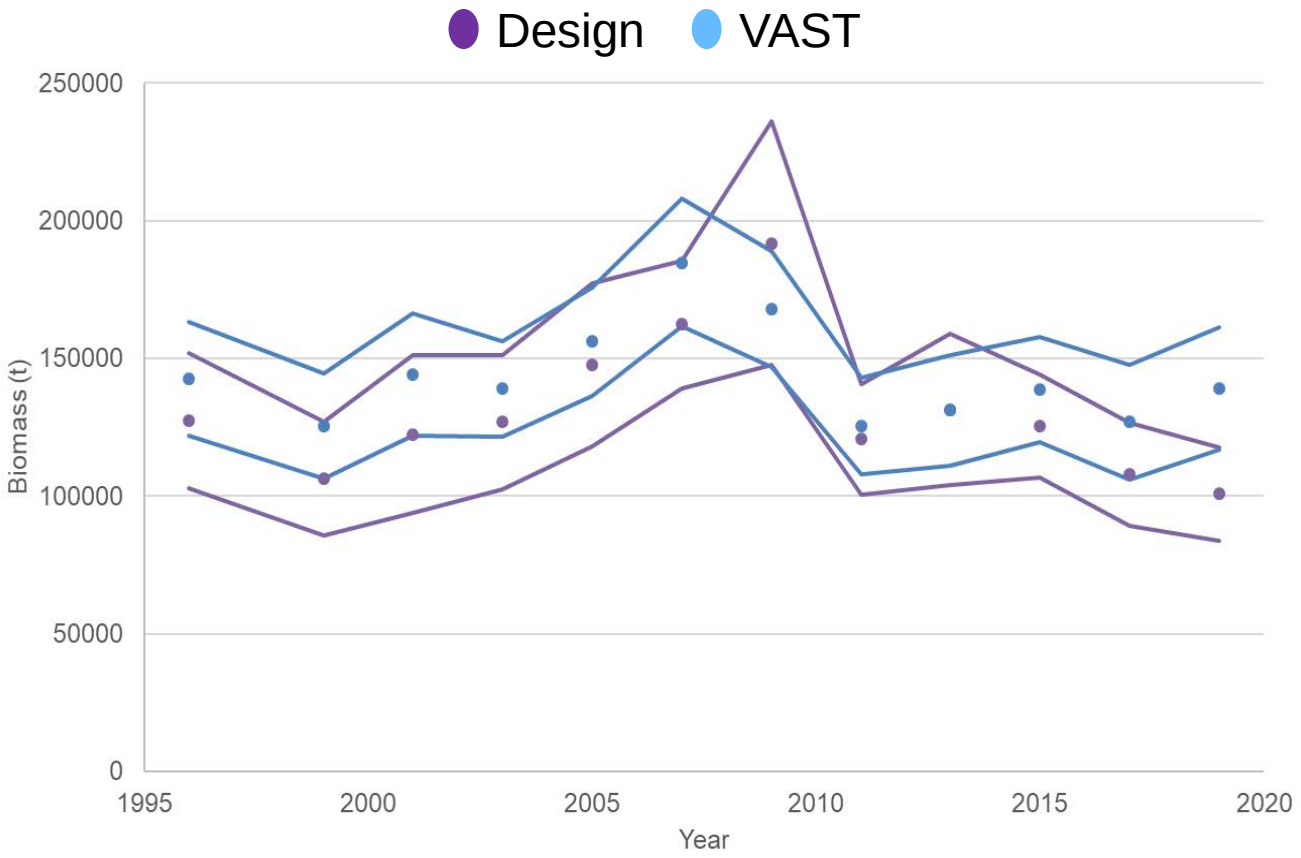
Updated age error matrix

- Method proposed in Punt et al. (2008)
- nwfscAgeingError package (Thorson et al. 2012) for model selection

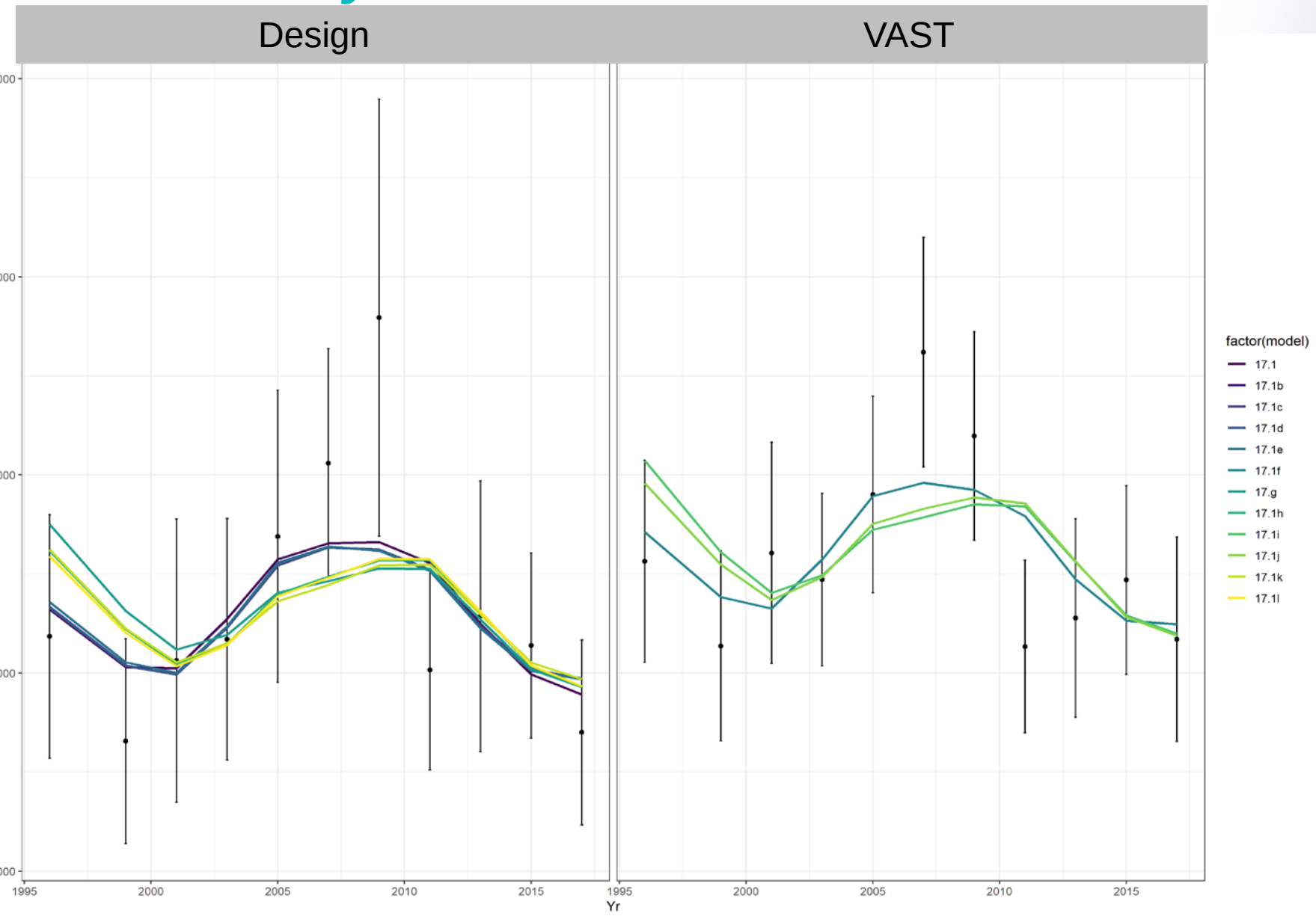


NRS model-based survey biomass

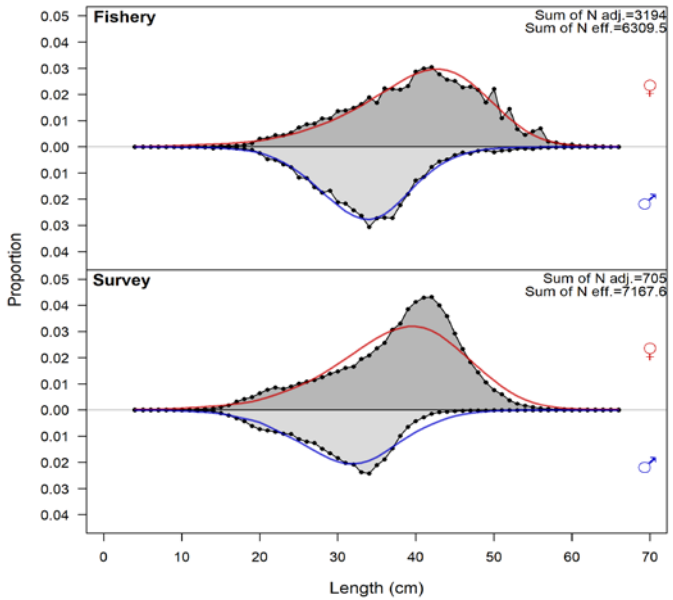
- Model 17.1f used model-based survey biomass
- Model-based biomass similar to design-based biomass and somewhat lower SE

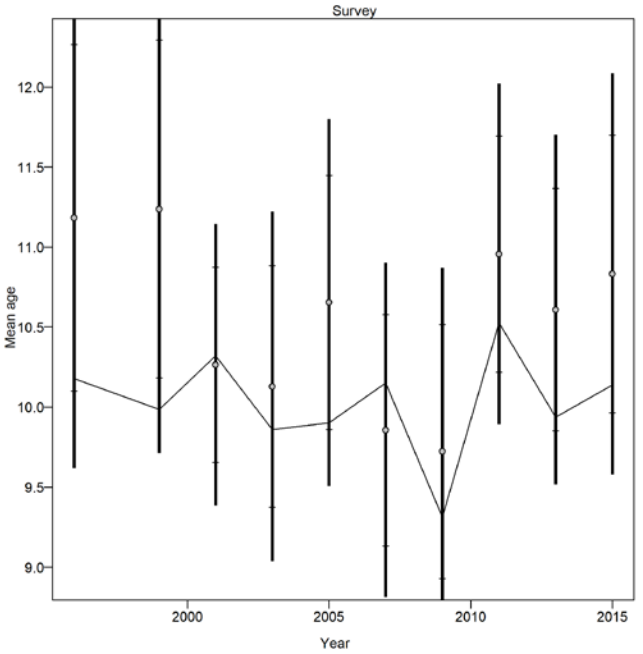


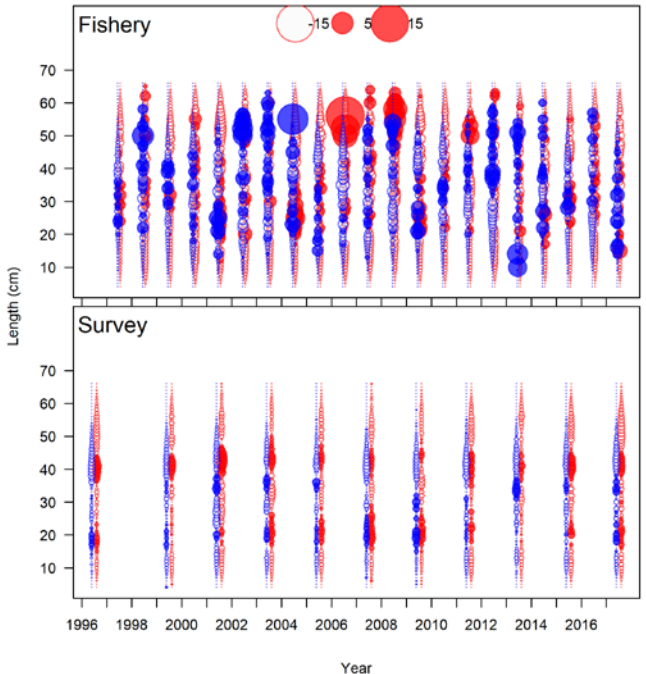
SRS survey biomass

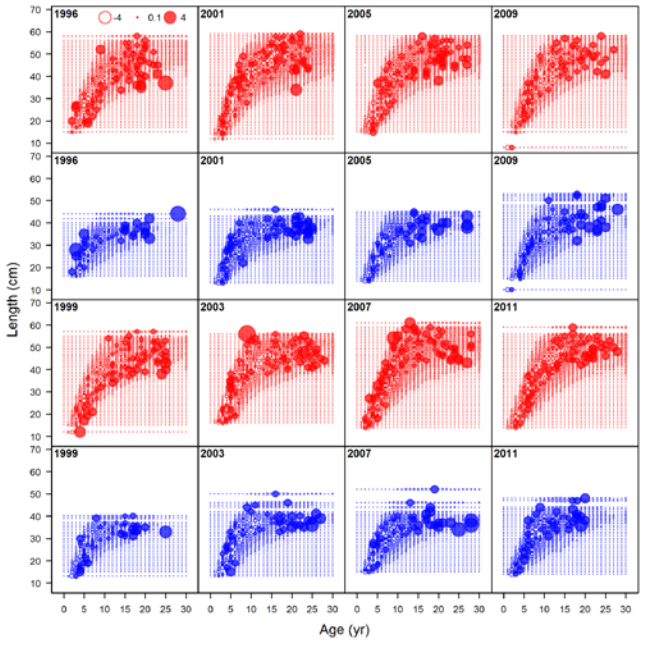


SRS length composition and CAAL

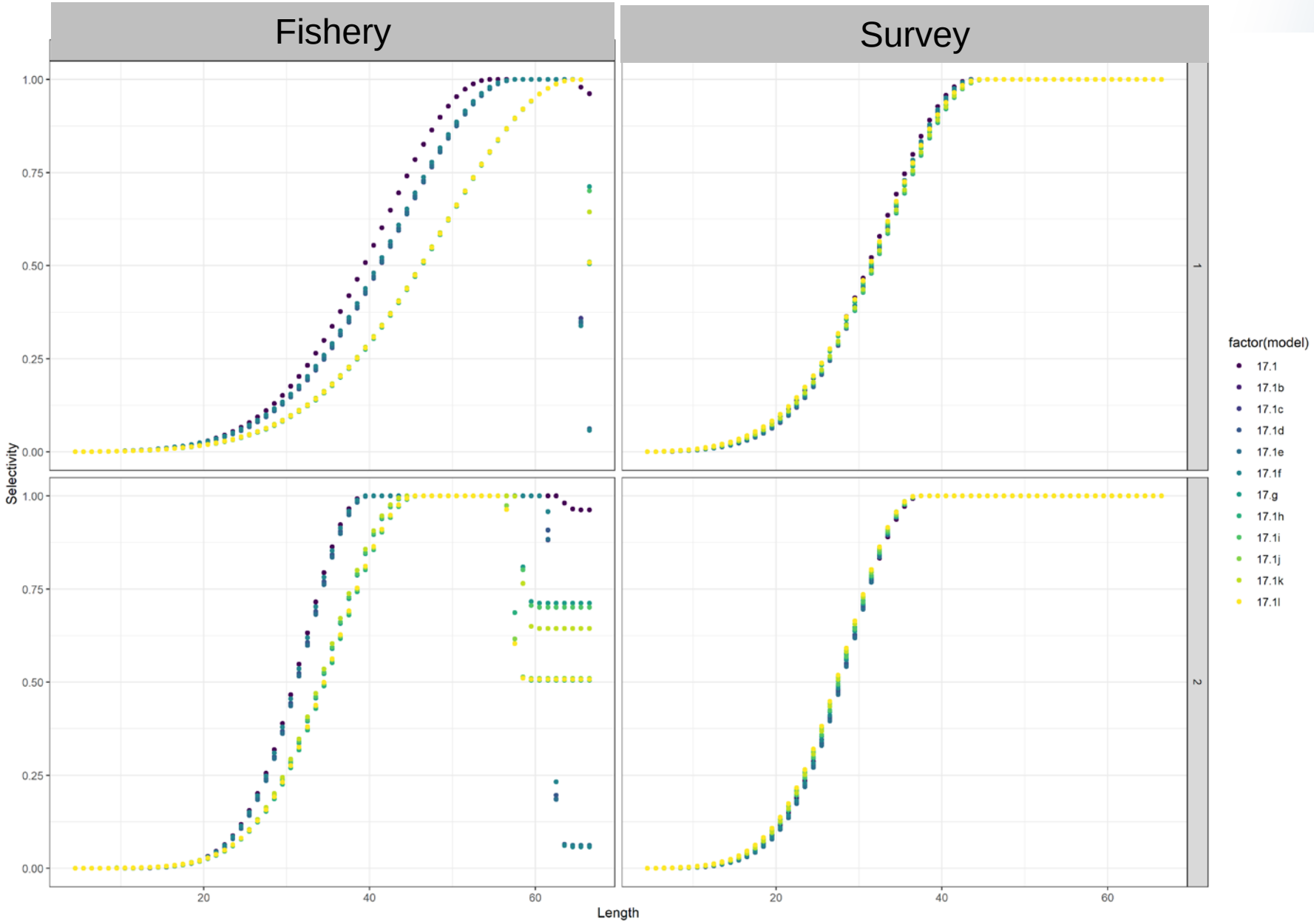




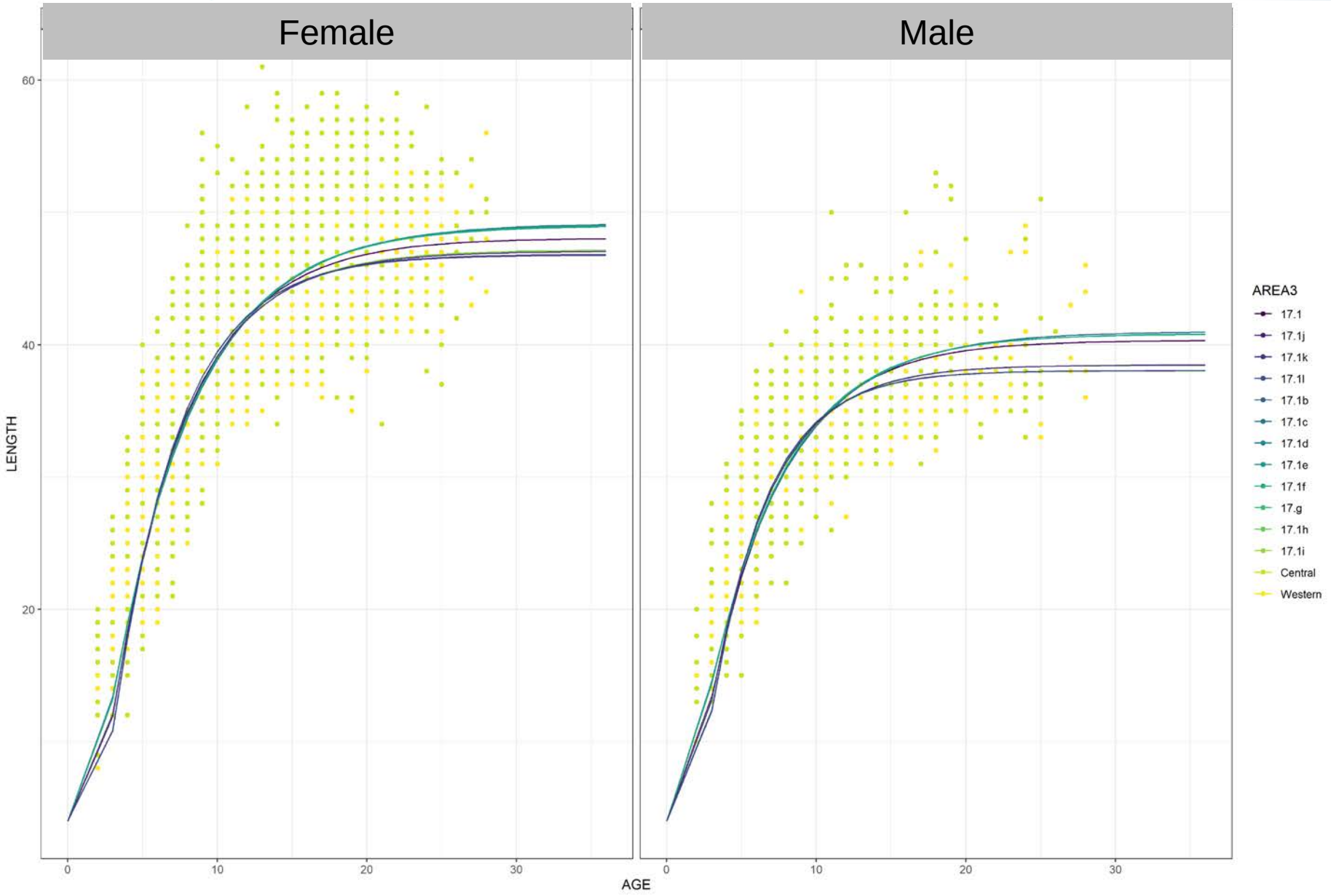




SRS selectivity



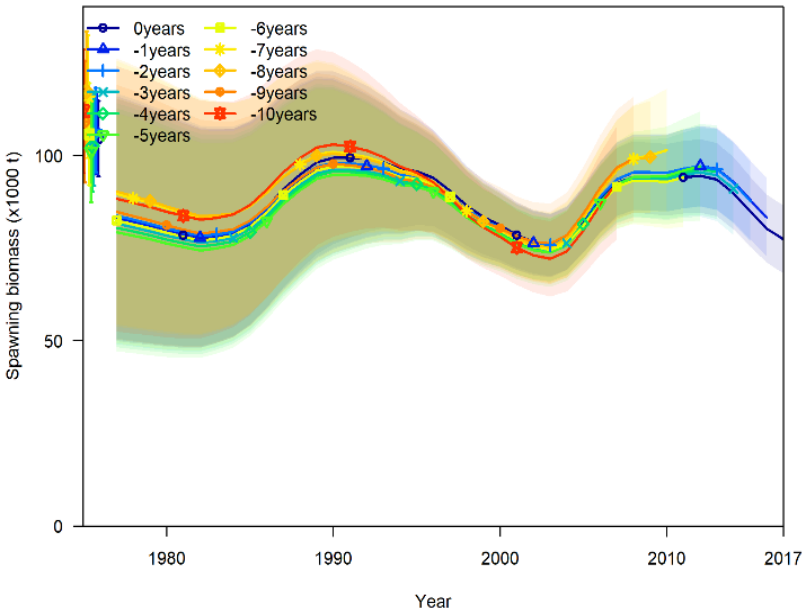
SRS growth curves



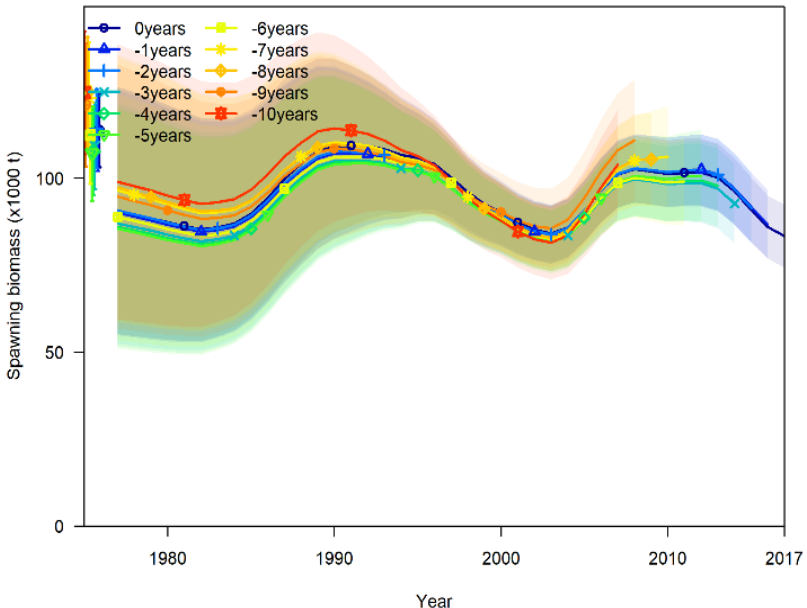
Retrospective analysis

Model	Description	SSB	Fishing mortality	Recruitment
17.1	2017 assessment	0.01	0.19	-0.13
17.1d	c plus updated age error matrix	0.03	0.13	-0.12
17.1e	d plus estimated catchability	0.03	0.11	-0.11
17.1f	d plus VAST biomass and standard error	0.01	0.12	-0.11
17.1h	d plus Francis reweighting	0.05	0.28	-0.07
17.1j	f with Francis reweighting	0.02	0.26	-0.06
17.1l	e with Francis reweighting	-0.04	0.15	0.03

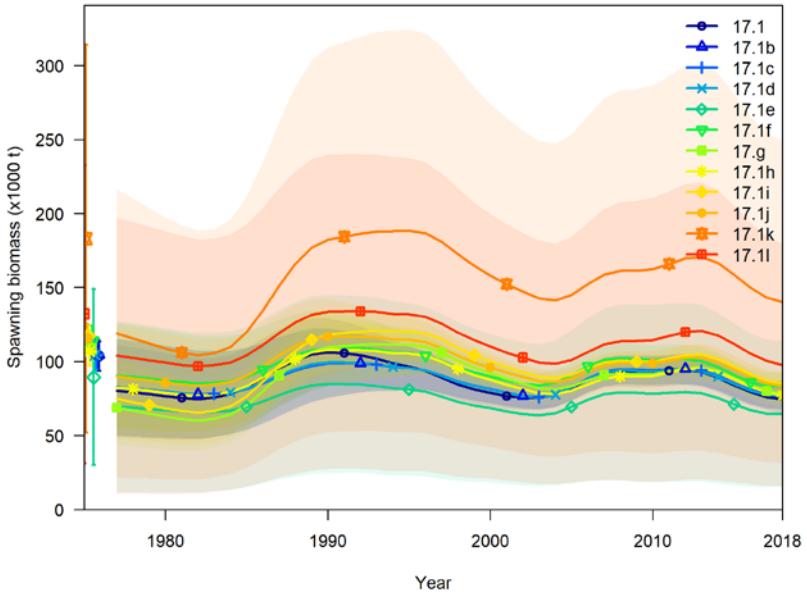
17.1d

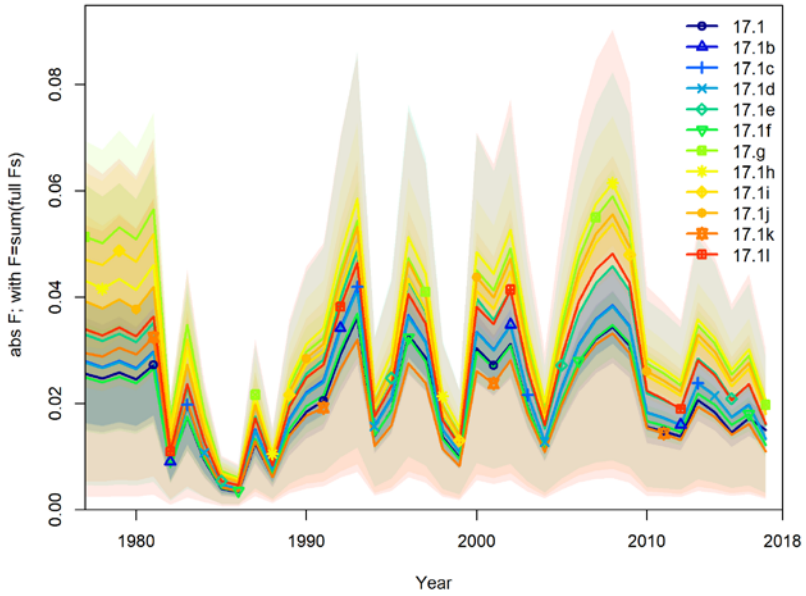


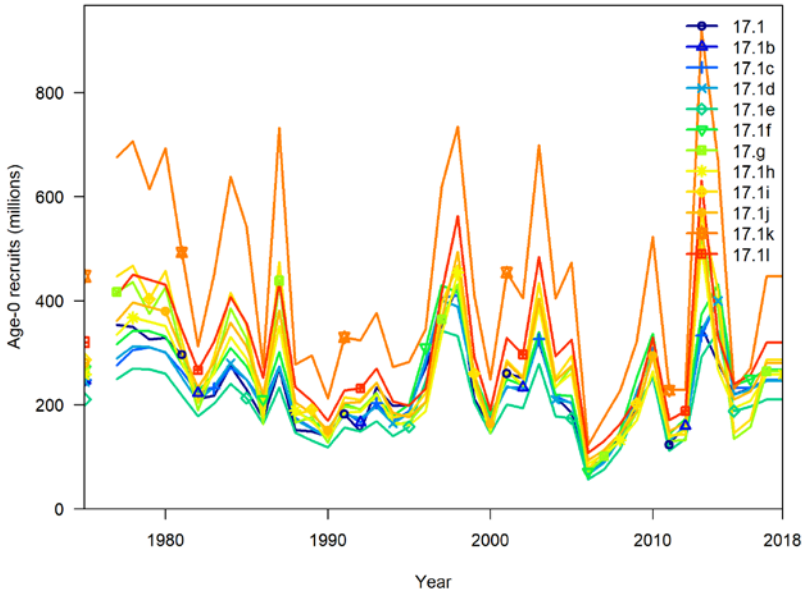
17.1f



Time series


Spawning biomass (x1000 t)
0
50
100
150
200
250
300
1980
1990
2000
2010
2018
Year
17.1
17.1b
17.1c
17.1d
17.1e
17.1f
17.g
17.1h
17.1i
17.1j
17.1k
17.1l


abs F; with F=sum(full Fs)
0.00
0.02
0.04
0.06
0.08
1980
1990
2000
2010
2018
Year
17.1
17.1b
17.1c
17.1d
17.1e
17.1f
17.g
17.1h
17.1i
17.1j
17.1k
17.1l


Age-0 recruits (millions)
0
200
400
600
800
1980
1990
2000
2010
2018
Year
17.1
17.1b
17.1c
17.1d
17.1e
17.1f
17.g
17.1h
17.1i
17.1j
17.1k
17.1l

Conclusion from SRS sensitivities

- Recommend bringing forward runs 17.1d and 17.1f for November

Extra slides

NRS

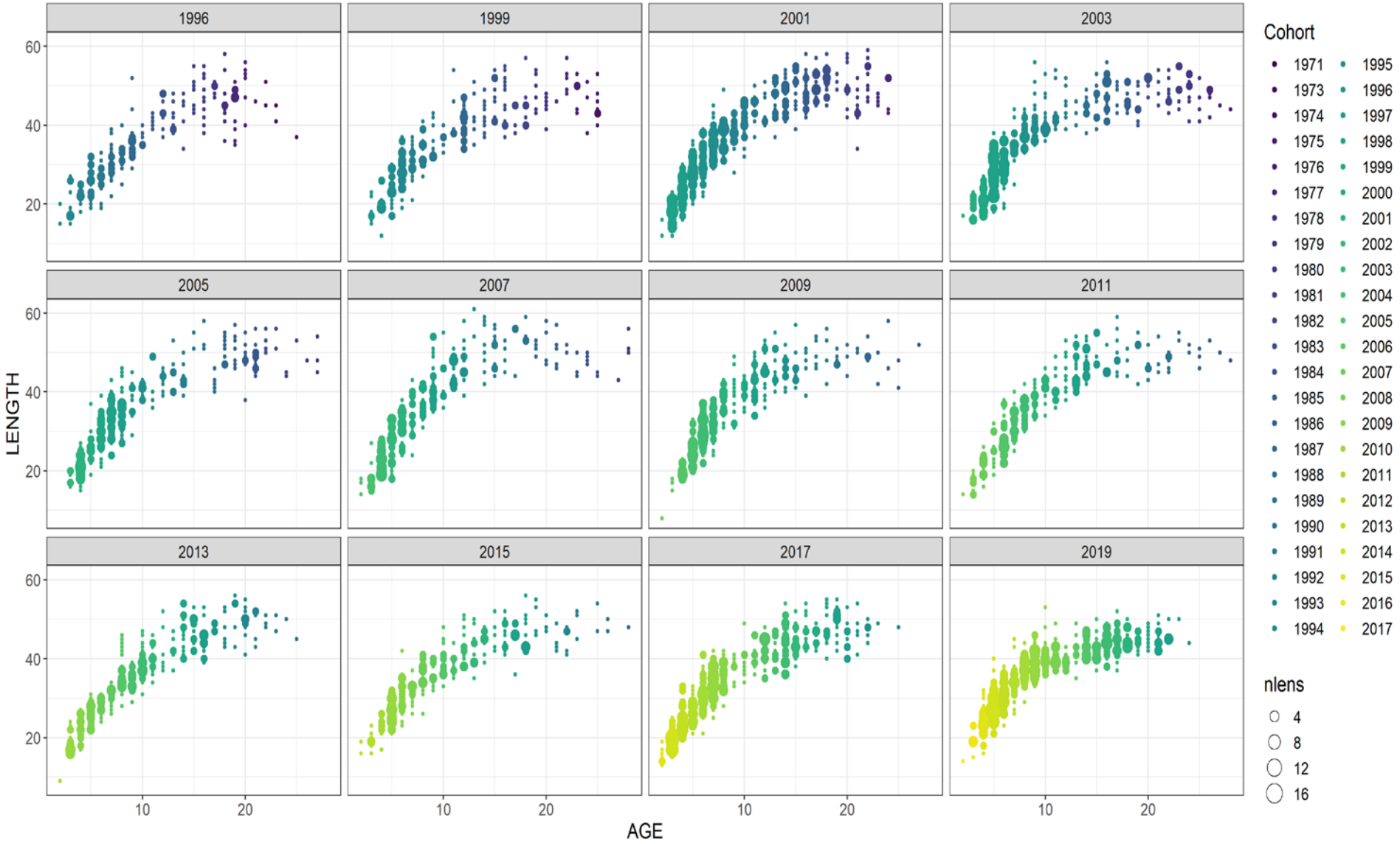
Model	Model description	Likelihood	
		Age_comp	Length_comp
17.1	2017 assessment	727.65	298.59
17.1a	Minimum sample size fix for CAAL	431.52	294.60
17.1b	Updated fishery length comp	727.62	463.72
17.1c	Combination of a and b	431.99	459.55
17.1d	Updated age error matrix	430.85	458.79
17.1e	d plus estimate catchability	436.35	448.70
17.1f	d plus VAST survey biomass	430.53	462.06
17.1g	d and McAllister-Ianelli reweighting	1902.14	839.72
17.1h	d with Francis reweighting	1503.92	103.45
17.1i	f with McAllister-Ianelli reweighting	1903.82	840.69
17.1j	f with Francis reweighting	1448.91	98.73

SRS

Model	Model description	Index RMSE	Age_comp	Catch	Length_comp	Recruitment	Survey	Total
17.1	2017 assessment	0.11	787.11	0.00	189.01	-9.96	-18.70	953.25
17.1b	Updated fishery length composition data	0.12	470.76	0.00	525.00	-10.33	-18.33	973.14
17.1c	b plus corrected CAAL minimum sample size	0.12	470.76	0.00	525.00	-10.33	-18.33	973.14
17.1d	c plus updated age error matrix	0.12	470.27	0.00	524.57	-10.04	-18.28	972.62
17.1e	d plus estimated catchability	0.12	470.95	0.00	524.26	-10.03	-18.22	972.53
17.1f	d plus VAST biomass and standard error	0.09	469.72	0.00	524.84	-10.08	-20.04	970.90
17.g	d and McAllister-Ianelli reweighting	0.15	1927.80	0.00	954.17	-5.74	-13.63	2871.30
17.1h	d plus Francis reweighting	0.14	648.05	0.00	152.84	-9.69	-14.94	782.80
17.1i	f with McAllister-Ianelli reweighting	0.11	1927.47	0.00	954.89	-5.82	-14.51	2871.05
17.1j	f with Francis reweighting	0.11	658.29	0.00	151.81	-9.84	-16.01	791.07
17.1k	e with McAllister-Ianelli reweighting	0.14	1927.69	0.00	956.94	-5.95	-14.31	2875.21
17.1l	e with Francis reweighting	0.14	647.86	0.00	153.65	-9.71	-15.07	784.04

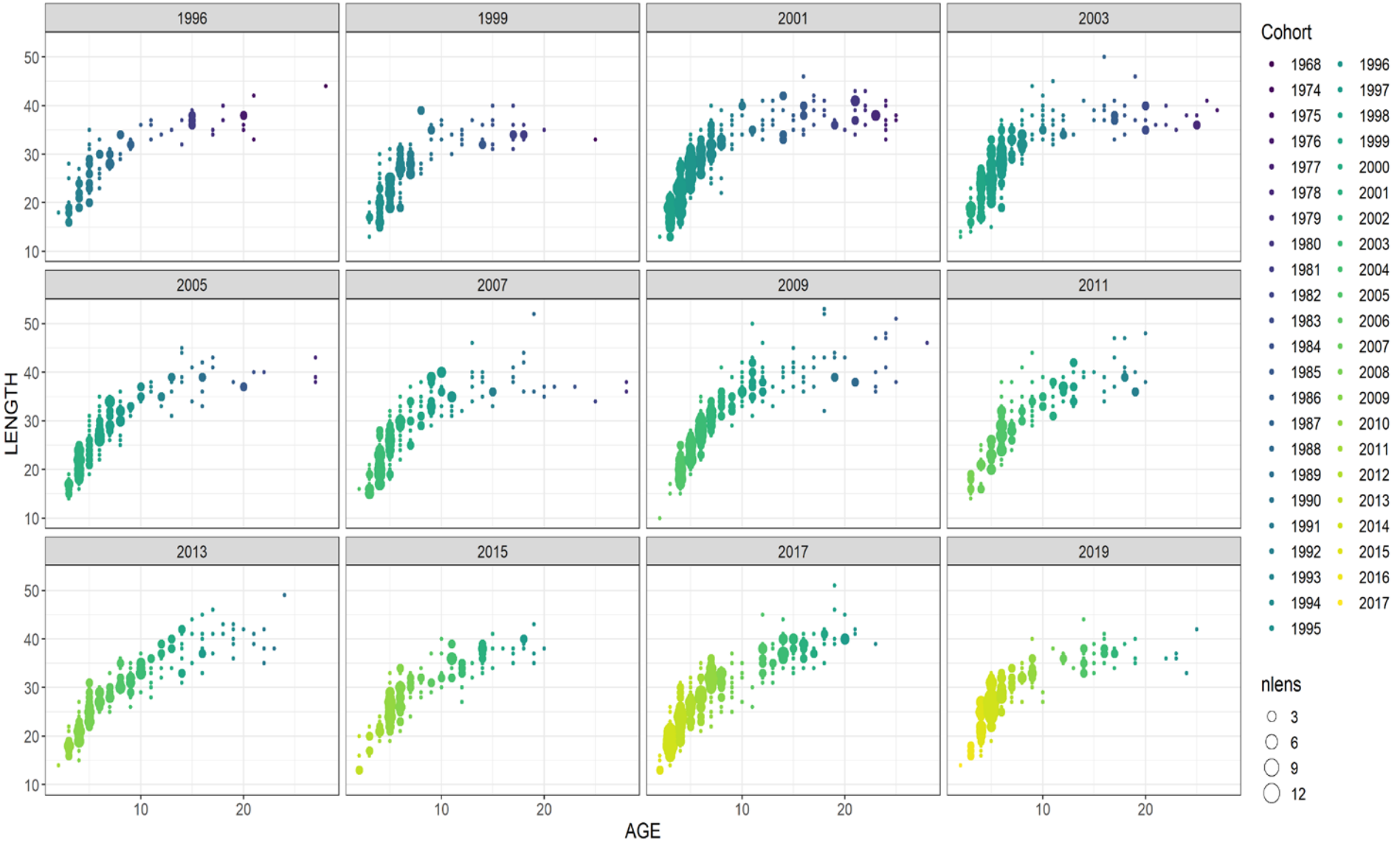
Southern rock sole growth

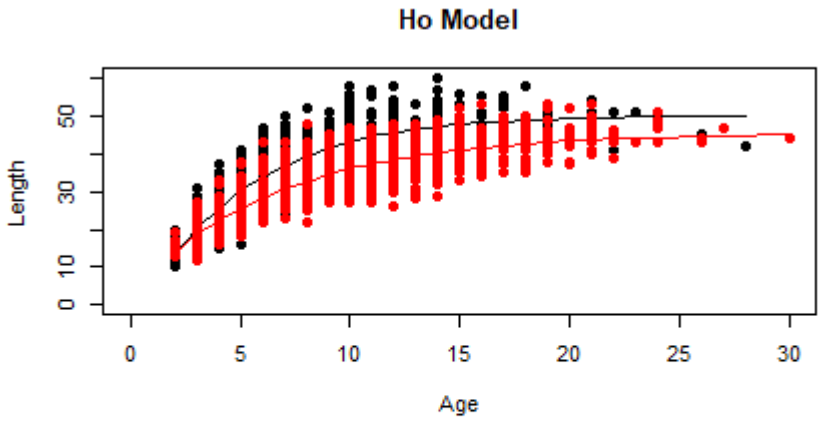
Female data



Southern rock sole growth

Male data




Ho Model
Length
Age
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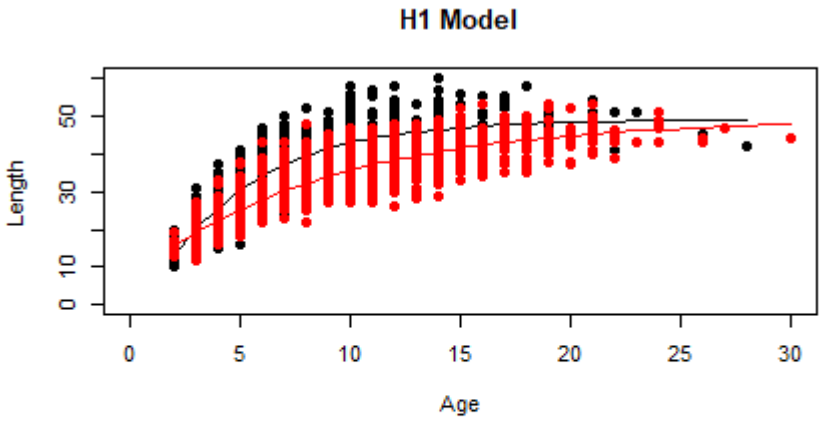
30
50
0
5
10
15
20
25
30


H1 Model
Length
Age
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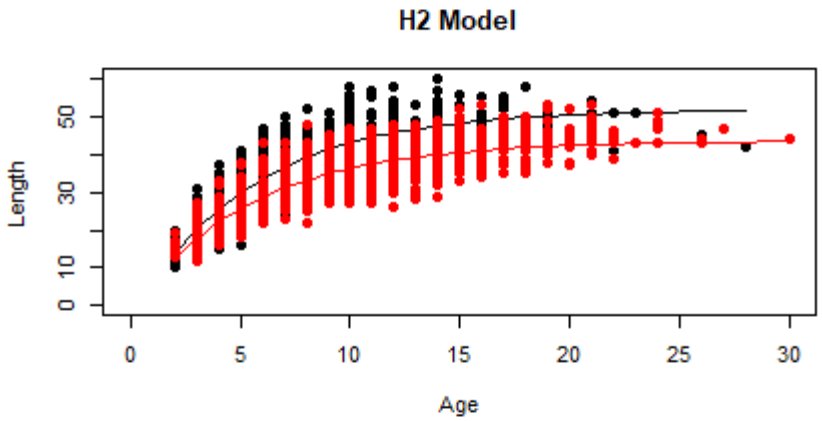
30
50
0
5
10
15
20
25
30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Length
Age
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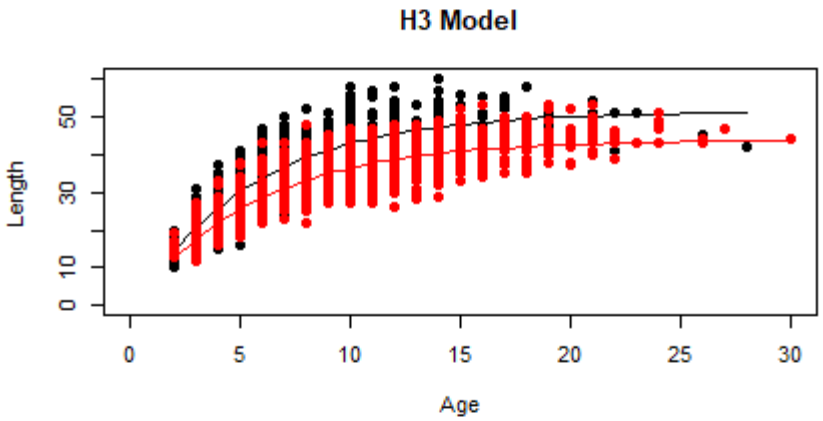
30
50
0
5
10
15
20
25
30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Length
Age
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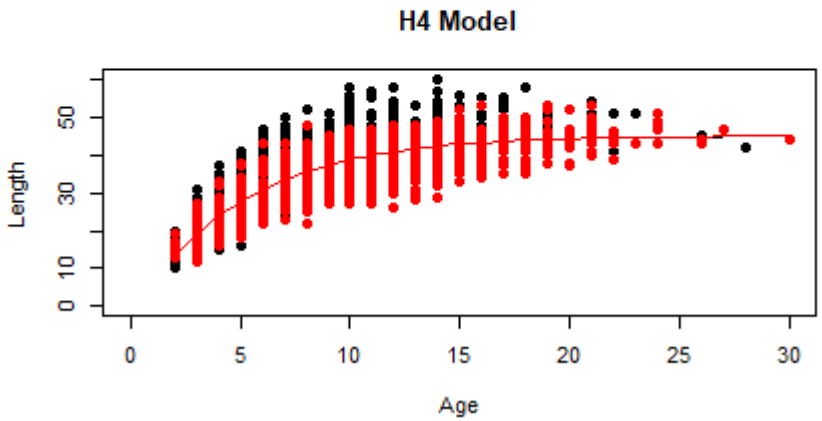
0
5
10
15
20
25
30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5
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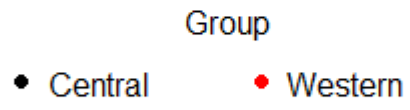
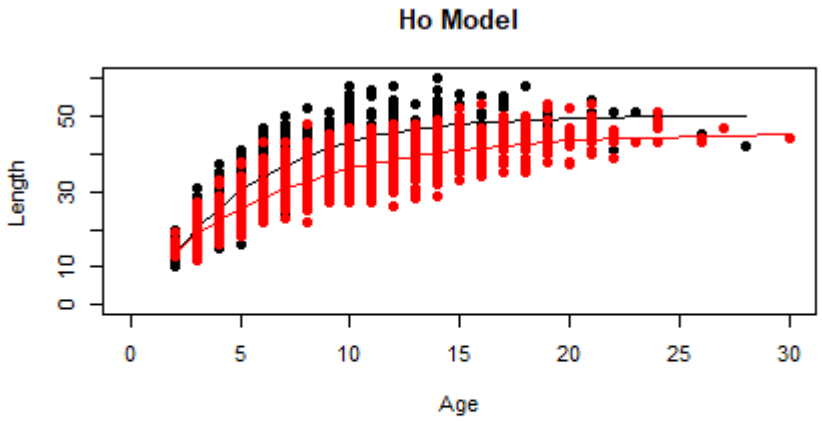
15
20
25
30


Group
Central
Western


Ho Model
Length
Age
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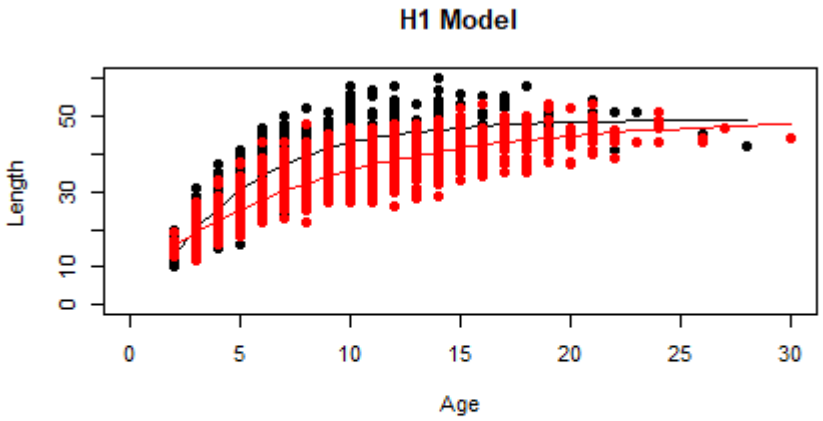
10
30
50
0
5
10
15
20
25
30


H1 Model
Length
Age
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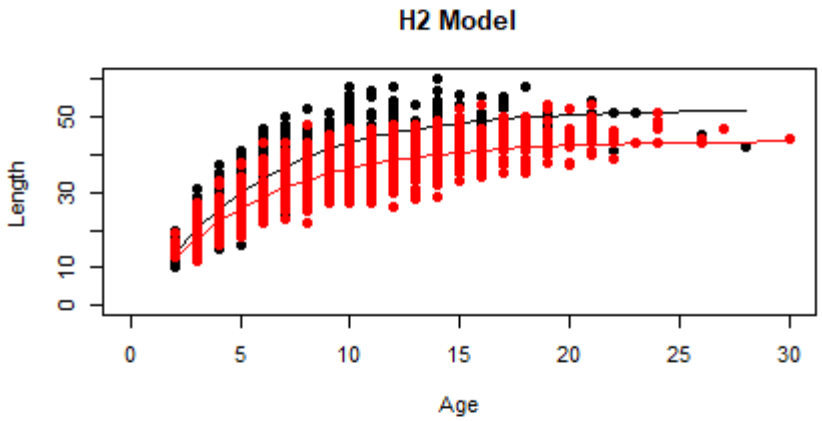
30
50
0
5
10
15
20
25
30


H2 Model
Length
Age
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30
50
0
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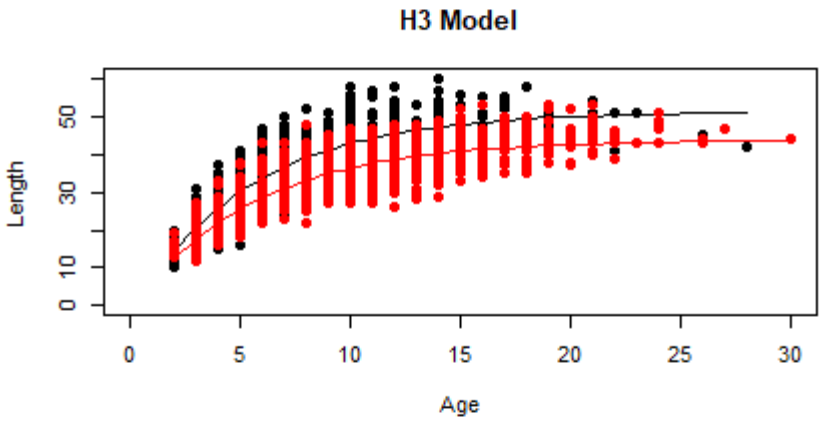
15
20
25
30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Length
Age
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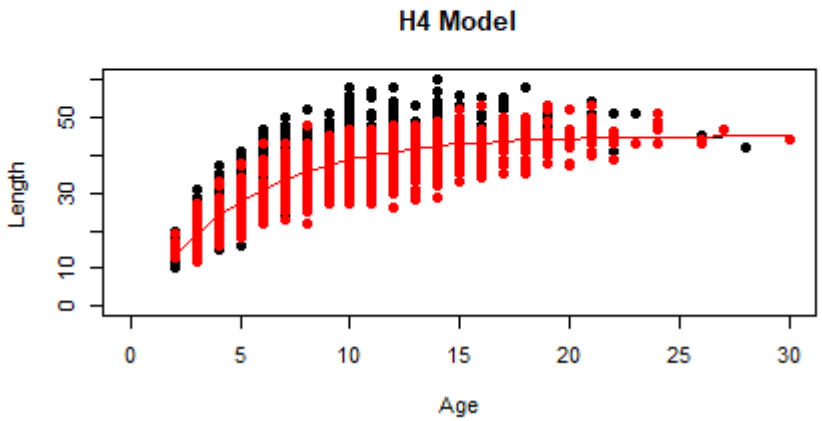
15
20
25
30


H4 Model
Length
Age
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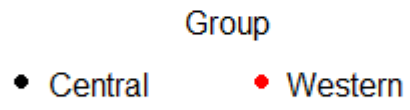
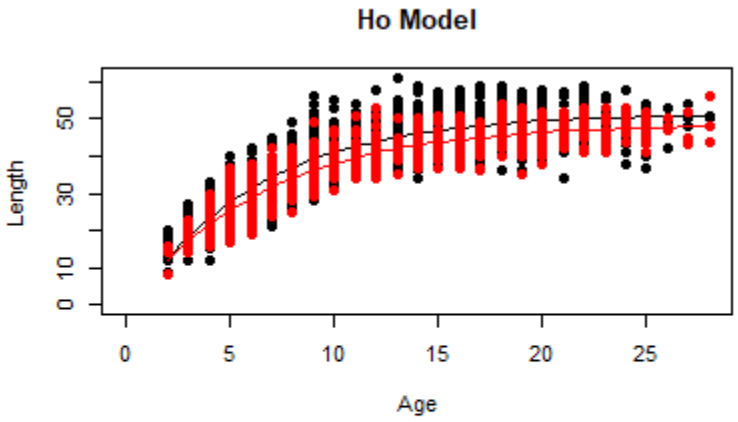
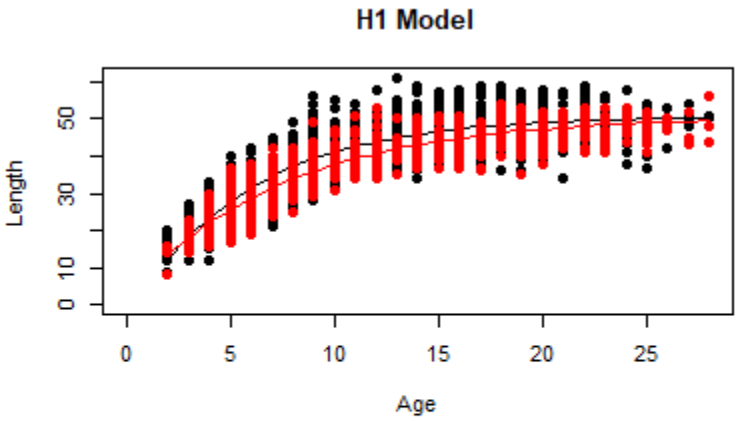
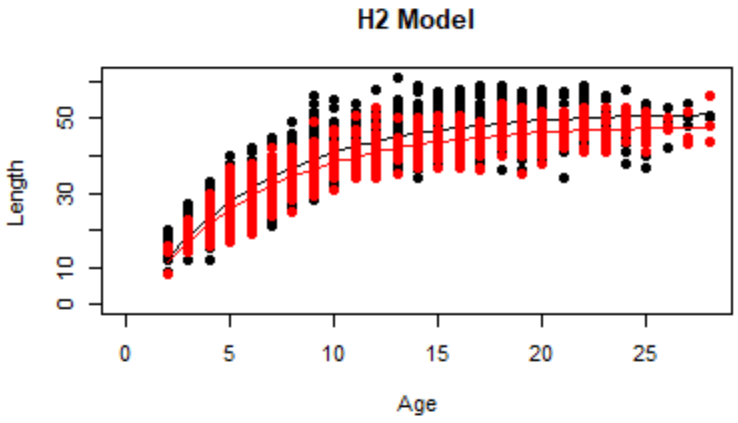
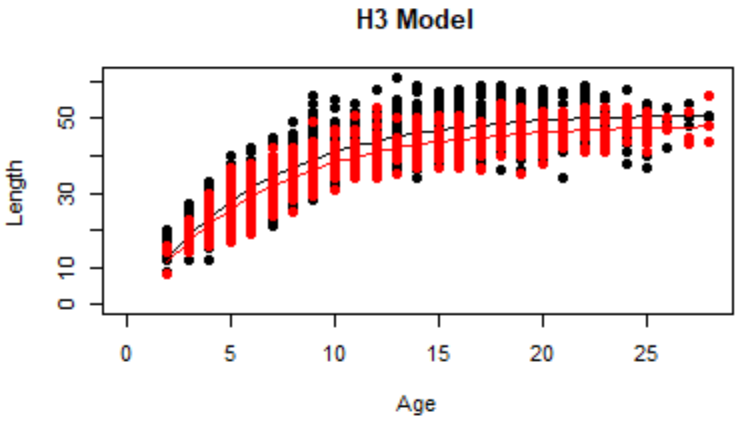
30
50
0
5
10
15
20
25
30

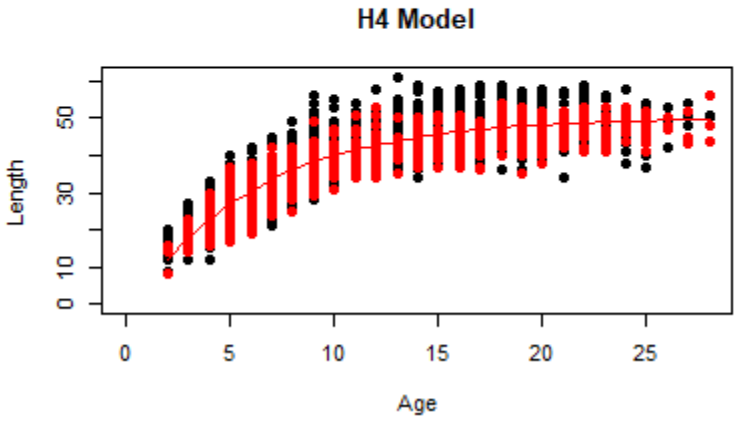

Group
Central
Western



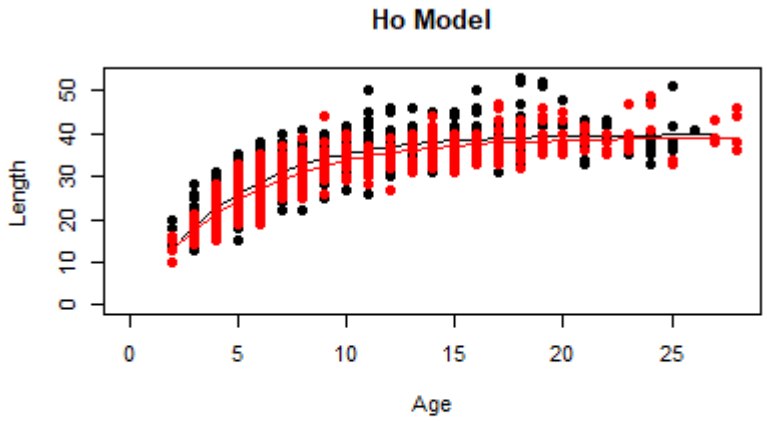








Central West


Ho Model
Length
Age
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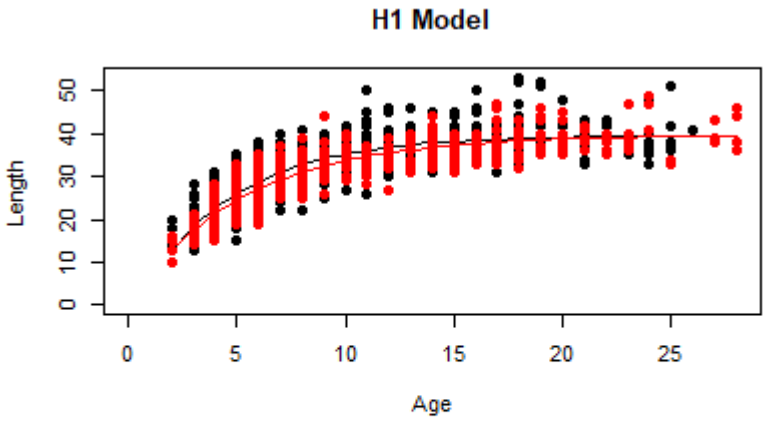
10
20
30
40
50
0
5
10
15
20
25


H1 Model
Length
Age
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30
40
50
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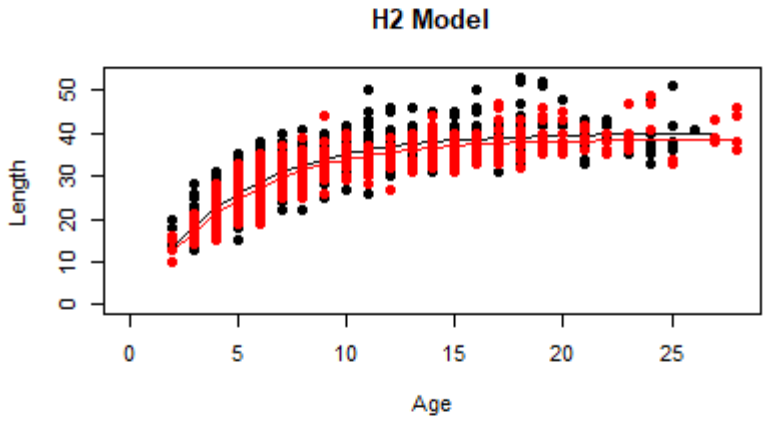
5
10
15
20
25


H2 Model
Length
Age
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40
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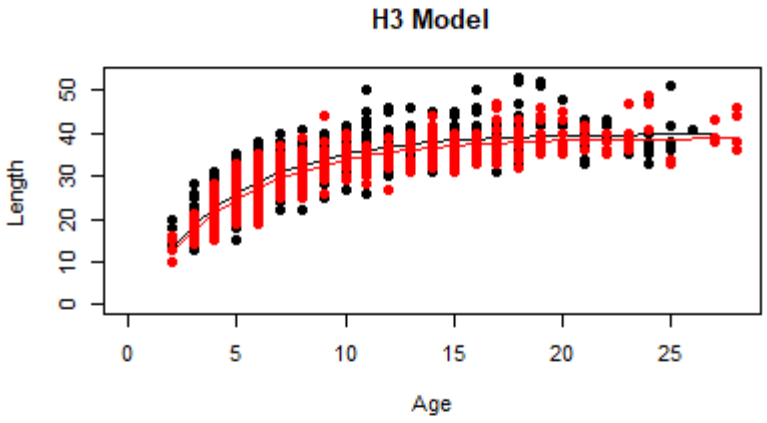
10
15
20
25


H3 Model
Length
Age
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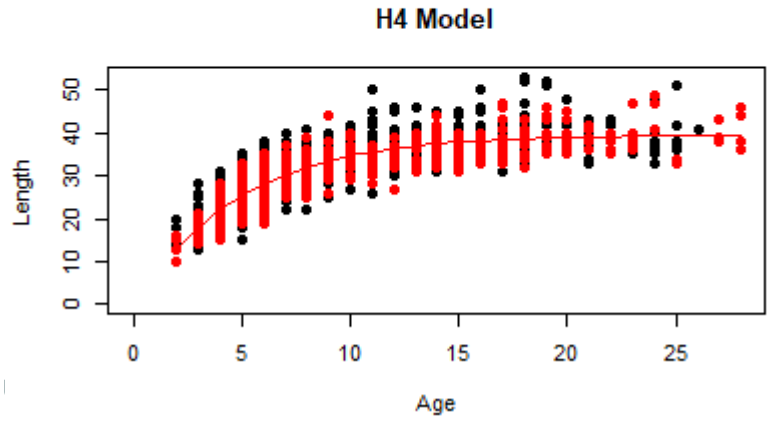
30
40
50
0
5
10
15
20
25


H4 Model
Length
Age
0
10
20
30
40
50
0
5
10
15
20
25


Central
West