SEDAR 68 – Gulf Scamp (*Mycteroperca phenax*)

Review Workshop

Assessment

August 30, 2021

NOAA FISHERIES

Gulf Branch,
Miami, FL

Outline

- Data Review
  - Stock definition
  - Regulations
  - Life history
  - Removals
  - Size compositions
  - Age compositions
  - Index of abundance
  - Survey length composition

Scamp Grouper: *Mycteroperca phenax*

- Assessment model
  - Base configuration
  - Base results
  - Diagnostics
  - Sensitivities

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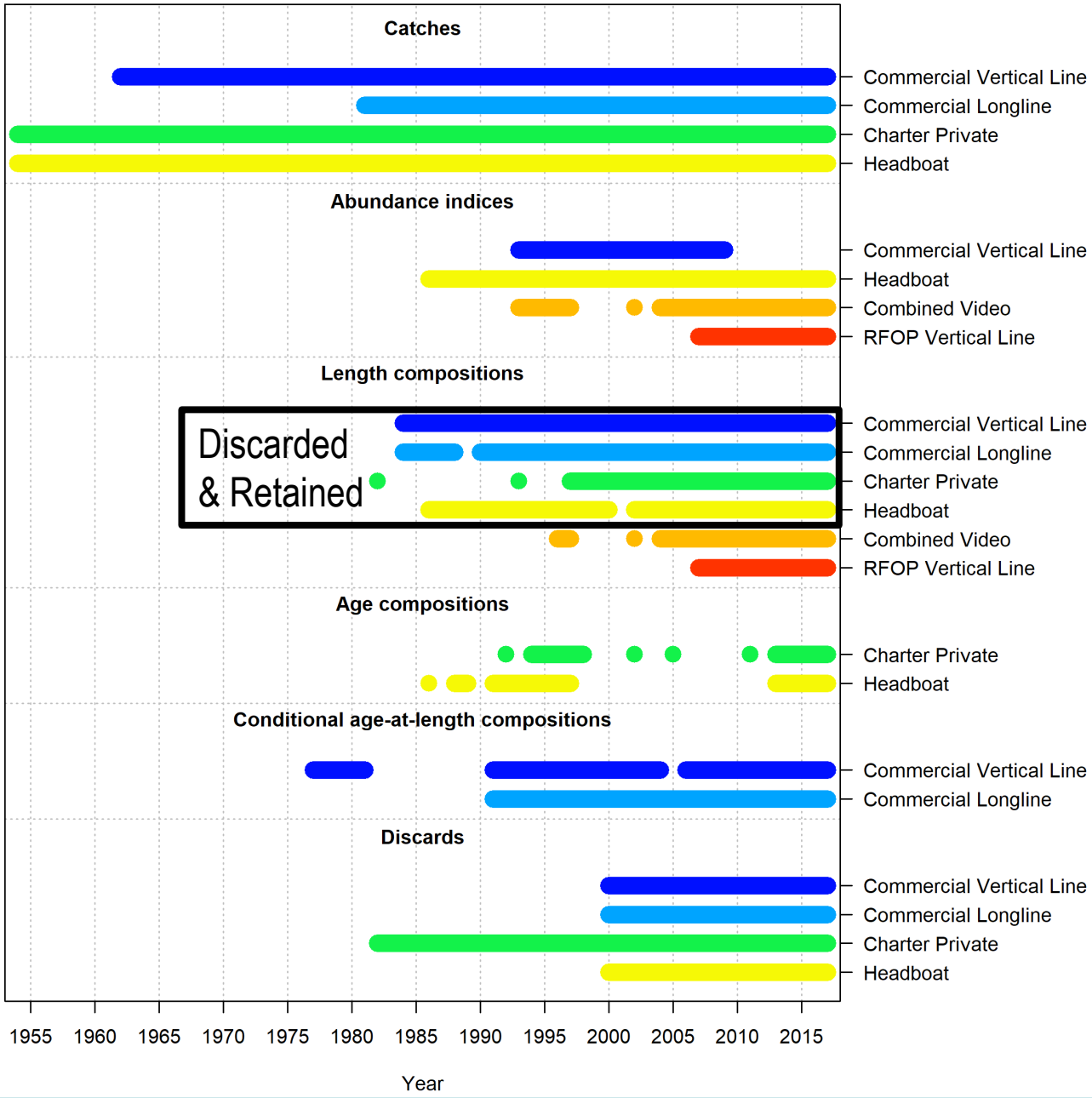
Data


Catches
Commercial Vertical Line
Commercial Longline
Charter Private
Headboat
Abundance indices
Commercial Vertical Line
Headboat
Combined Video
RFOP Vertical Line
Length compositions
Discarded
& Retained
Commercial Vertical Line
Commercial Longline
Charter Private
Headboat
Combined Video
RFOP Vertical Line
Age compositions
Charter Private
Headboat
Conditional age-at-length compositions
Commercial Vertical Line
Commercial Longline
Discards
Commercial Vertical Line
Commercial Longline
Charter Private
Headboat
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Available data inputs

- **Landings**
  - Vertical line **GWT**: 1962-2017 (include "Other")
  - Longline **GWT**: 1981-2017
  - Private/Charter **GWT** or Numbers: 1955-2017
  - Headboat **GWT** or Numbers: 1955-2017
- **Discards**
  - Vertical line GWT or **Numbers**: 2000-2006 (reconstructed), 2007-2017 (NMFS observer program)
  - Longline GWT or **Numbers**: 2000-2006 (reconstructed), 2007-2017 (NMFS observer program)
  - Private/Charter **Numbers**: 1981-2017
  - Headboat **Numbers**: 2000-2017
- **Length composition of discards**
  - Vertical line **Nominal**: 2006-2017 (NMFS observer program)
  - Longline **Nominal**: 2006-2017 (NMFS observer program)
  - Charter **Nominal**: 2010-2017 (FWC observer program)
  - Headboat **Weighted** (by trip type): 2005-2007, 2010-2017 (FWC observer program)
- **Length composition of retained catch**
  - Vertical line **Weighted**: 1986-2017
  - Longline **Weighted**: 1986-2017
  - Charter **Nominal**: 1992, 1997-2017
  - Headboat **Nominal**: 1986-2017
- **Conditional age-at-length and mean length-at-age of retained catch**
  - **Vertical line: 1977-2017**
  - **Longline: 1991-2017**
- **Age composition of retained catch (Nominal)**
  - Vertical line: 1977-2017
  - Longline: 1991-2017
  - **Private/Charter: 1981-2017**
  - **Headboat: 1979-2017**
- **Abundance indices**
  - Vertical line: 1993-2009*
  - Headboat: 1986-2017
  - Video survey (FWRI, PC, SEAMAP): 1993-1997, 2002, 2004-2017
  - RFOP vertical line: 2007-2017
- **Length composition of survey data**
  - Combined video survey: 1996-2017
  - RFOP vertical line: 2007-2017

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Modeling approach

- Gulf scamp uses Stock Synthesis (Methot and Wetzel 2013), an integrated assessment modeling platform
  - Statistical catch-at-age model
- Advantages
  - Do not have to split time series
    - Time varying selectivity or retention
  - Can use both length and age composition data
  - Can link parameters to environmental series
  - Explicitly incorporates imprecision of observation processes (e.g., aging imprecision)

SS model configuration

- 1986–2017 (data pre-1986 very unreliable/uncertain)
- Stock not assumed to be at unexploited equilibrium level, therefore estimated initial F for all fleets except Headboat:
  - Equilibrium catch = 1986-1990 mean catch for fleet
  - Headboat catches minor throughout time series
- Use Continuous F method
  - Recommended where catch is known imprecisely
    - High errors on recreational Charter Private and Headboat (log-scale SE = 0.3)

SS model configuration cont'd

- 1 area, 1 season model
- Two gender model (males and females treated identically)
- Maturity and protogyny a function of age
  - Hermaphroditism function in Stock Synthesis
- Combined male and female SSB (metric tons)
- von Bertalanffy growth (fixed, but estimating L_{Amin})
- Lorenzen natural mortality (fixed, includes shift for peak spawning)
- Ageing error matrix included

SS model configuration cont'd

- 2 commercial (vertical line, longline) and 2 recreational (charter-private and headboat) fishing fleets
  - Landings (gutted weight)
  - Discards (numbers of fish)
  - Discard length compositions
  - Retained/landed length compositions
  - Nominal age compositions (recreational)
  - Conditional age-at-length (commercial)
  - CPUE indices for pre-IFQ Commercial Vertical Line and Headboat

SS model configuration cont'd

- Fishery-independent video survey:
  - Index of relative abundance
  - Length composition
- Reef Fish Observer Program Vertical Line:
  - Index of relative abundance
  - Length composition
  - Treated as a survey in Stock Synthesis because it includes total catch and follows a stratified sampling scheme

Beverton-Holt stock recruitment model

- Estimated 3 parameters:
  - ln(R_0): unexploited equilibrium recruitment on log-scale
  - Steepness (h): fraction of the unexploited recruits produced at 20% of the equilibrium spawning biomass level
  - SigmaR: standard deviation in recruitment
- Recruitment deviations estimated in main period (1986-2014)
  - Not estimated early or from 2015-2017 (high uncertainty)
- Bias adjustment for main recruitment deviations (1987 - 2014)

SS model configuration

- Scaled SE of fishery-dependent CPUE indices to a common mean of 0.2 (sensu Francis et al. 2003)
- Iterative reweighting of index variances was applied, and extra variance estimated by SS model was added
- Constant catchability
- Ages 1-34 modeled, with 20+ as a plus group
  - Plus group based on saturation of the life history parameters and < 4% of data over age 20

220 estimated parameters

- Growth (1 parameter, length at the minimum age (L_{Amin}))
- Annual fishing mortality rates for each fleet (128 parameters, 32 parameters per fleet)
- Initial fishing mortality (3 parameters: Commercial Vertical Line, Commercial Longline, and Recreational Charter Private)
- Recruitment (3 parameters: LN(R0), steepness, and sigmaR)
- Recruitment deviations (29 parameters, 1986-2014)
- Selectivity parameters (20 parameters, 2 to 6 parameters per fleet)
- Dirichlet-multinomial variance inflation factors (10 parameters, 1 per fleet/survey and data type)
- Retention parameters (26 parameters)
- Catchability coefficient associated with each index (floated in Stock Synthesis, analytical solution used)

SS likelihood components

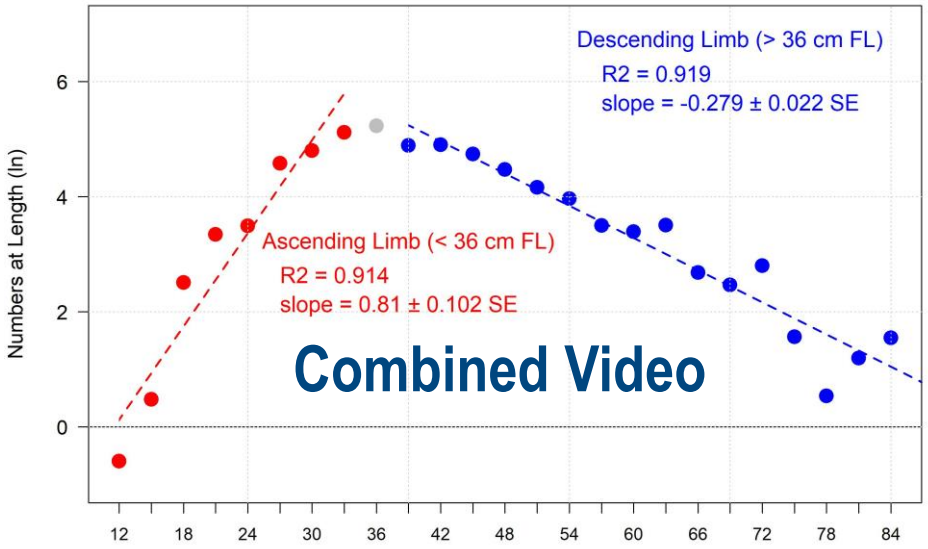
- Landings: Lognormal with commercial SE = 0.05 (1986-2009) or 0.01 (2010+) and recreational SE = 0.3
- Equilibrium catch: normal with SE = 0.05
- Index: Lognormal with annual SEs from catch rate standardization for surveys or SEs scaled to a common mean of 0.2 for CPUE indices
- Discards: Lognormal with SEs as provided at Data Workshop or assumed (Headboat ~ 0.5)
- Length Composition: Dirichlet multinomial with annual N = number of sampled trips
- Age Composition: Dirichlet multinomial with annual N = number of sampled trips
- Recruitment deviations: Lognormal with estimated variance of rec devs (sigma-R)
- Parameter priors: Steepness, Dirichlet parameters

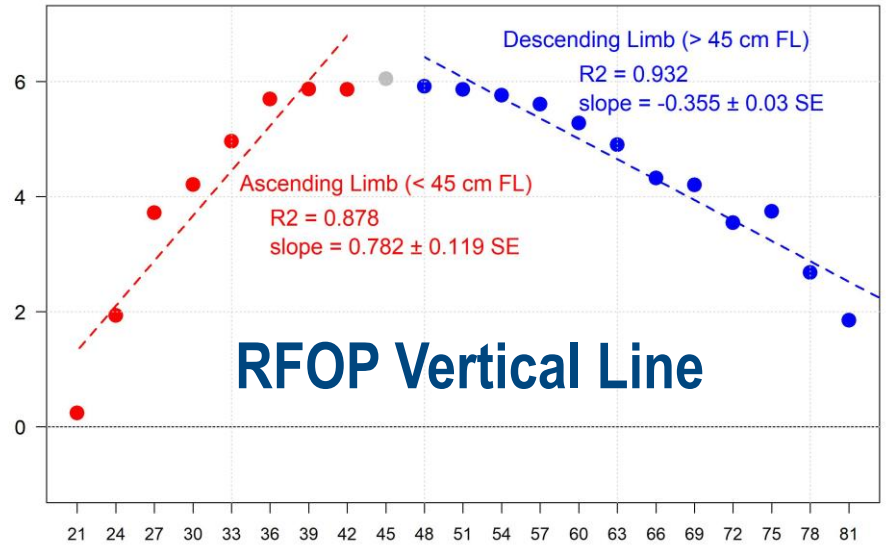
Selectivity

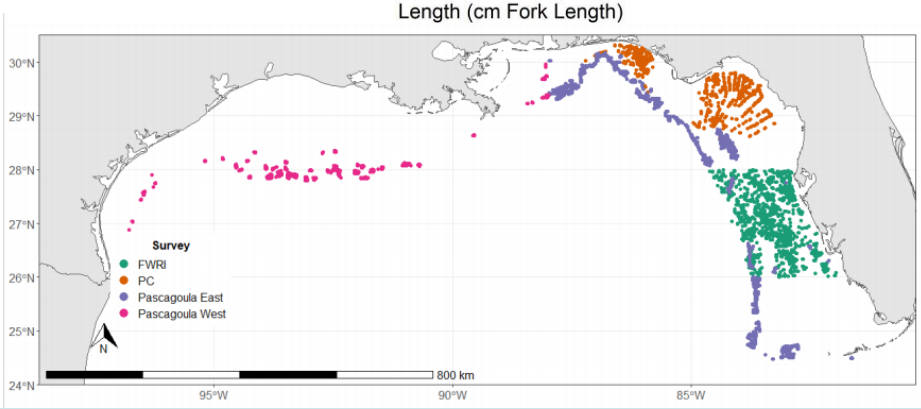
- Length-based selectivity used for the fleets and surveys
  - Logistic: Commercial Vertical Line, Commercial Longline, Combined Video, and RFOP Vertical Line
  - Double normal: Recreational Charter Private and Headboat
- Assumed constant selectivity for all fleets and surveys
- Modeled time-varying retention to account for changes in management regulations

Catch curves using length bins for surveys

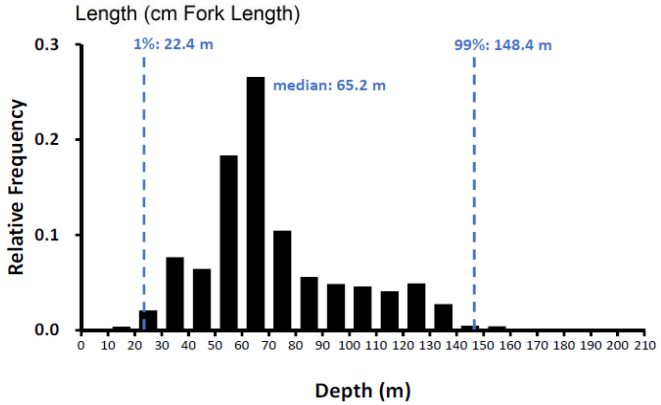
- Steep decline with size would support dome-shaped selectivity







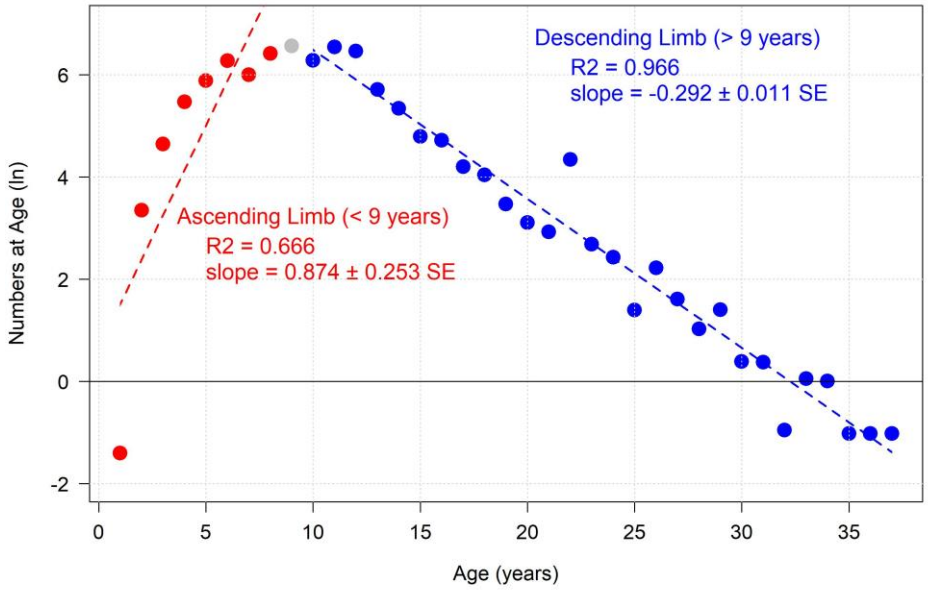
Scamp Catch Grid Cells
n=1,894
depth range: 15 – 208 m



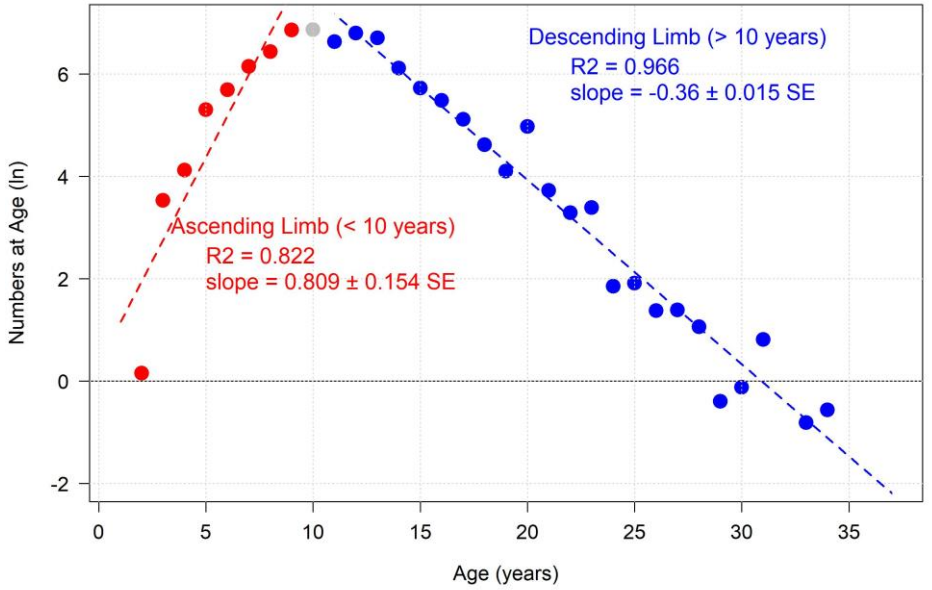
Catch curve using ages for commercial fleets

- Steep decline with size would support dome-shaped selectivity

Commercial Vertical Line



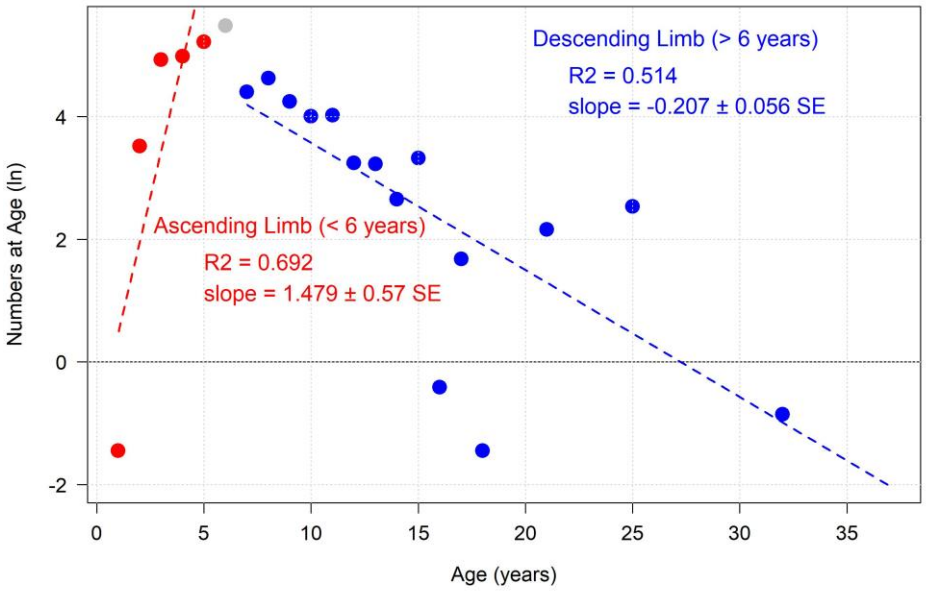
Commercial Longline



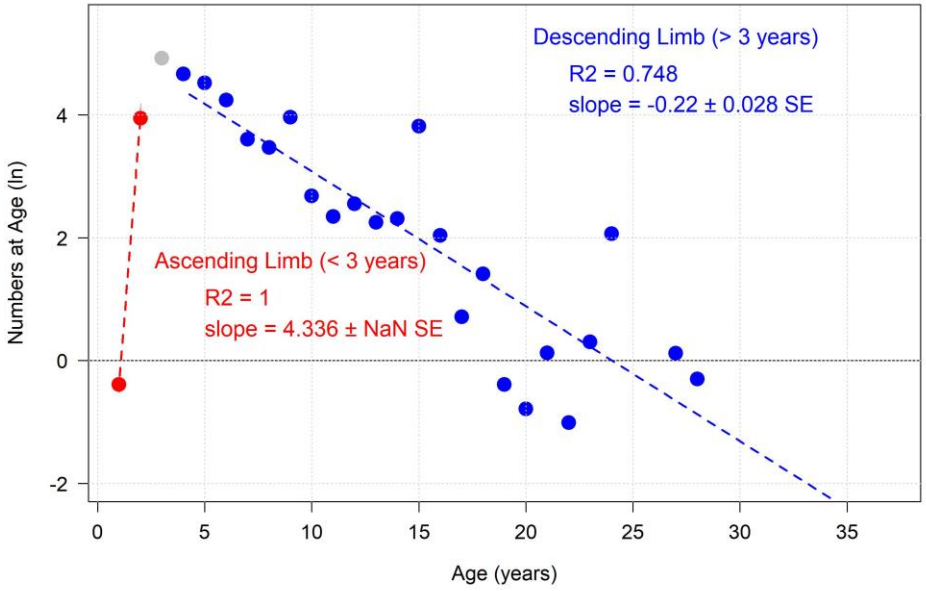
- Logistic selectivity pattern used based on relatively shallow slope (<1)

Catch curve using ages for recreational fleets

Charter Private



Headboat

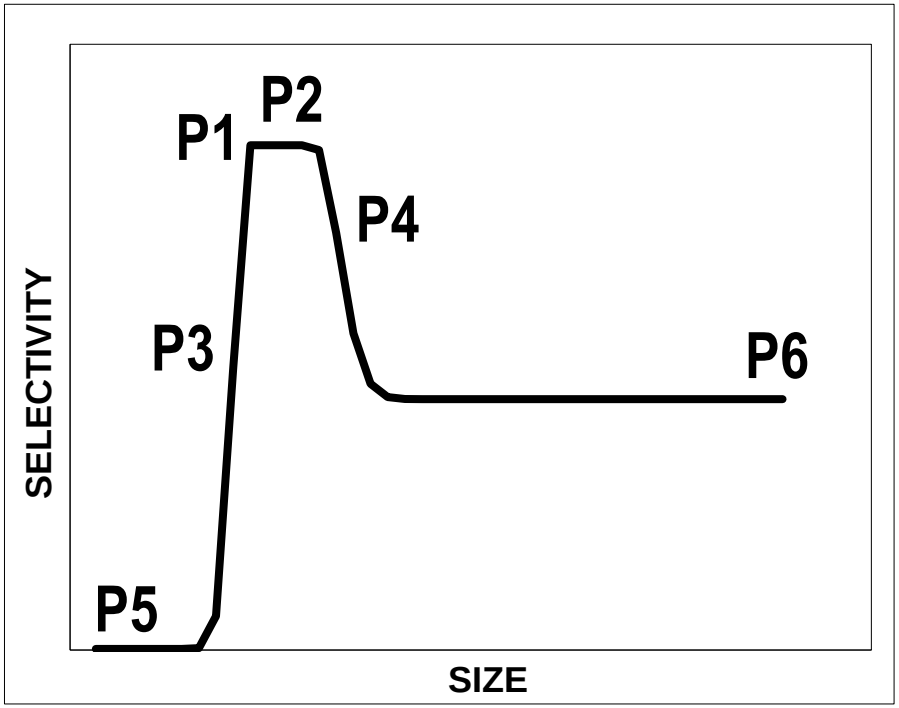


- Data are limited and depths sampled are relatively shallow compared to species range

Catch Type	Average Depth (range)
CP Discard	26 m (9-72 m)
CP Harvest	56 m (12-122 m)
HB Discard	36 m (10-68 m)
HB Harvest	44 m (10-84 m)

Length-based selectivity – double normal

- Double normal selectivity
  - All parameters estimated for each recreational fleet
    1. Peak – beginning size for the plateau
    2. Top – width of plateau
    3. Ascending width – parameter describing incline to plateau
    4. Descending width – parameter describing decline from plateau to final size bin
    5. Initial – selectivity of first size bin
    6. Final – selectivity of final size bin



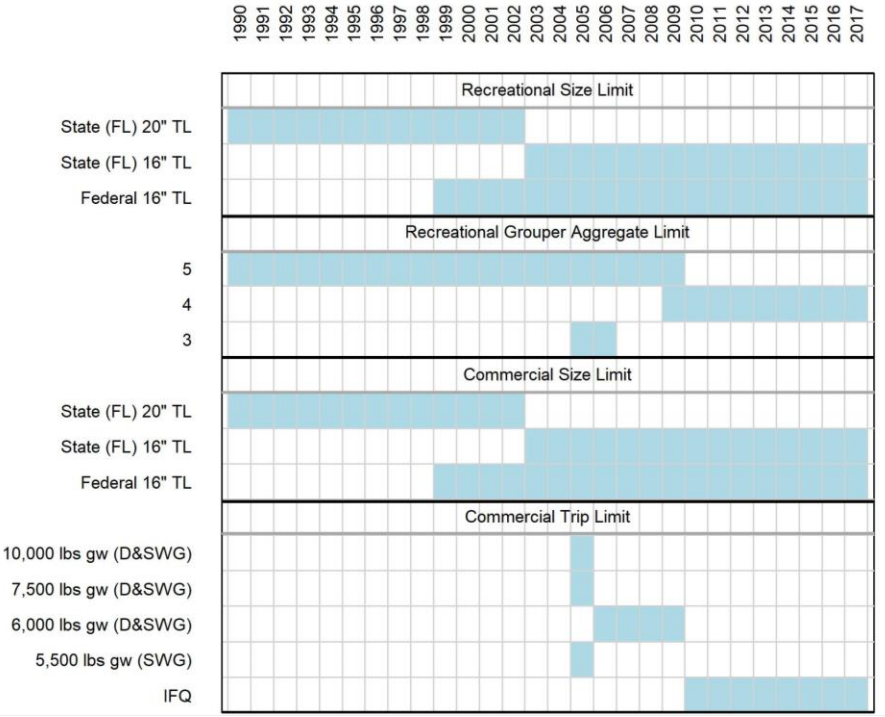
Length-based retention

- Management regulations influence retention
  - Size limits, bag limits, closed seasons, quota
- Retention was assumed to be most effected by changes in the size limit and modeled as a logistic relationship
  - P1 = ascending inflection
  - P2 = ascending slope
  - P3 = maximum retention
  - P4 = male offset to ascending; set to 0 for scamp

$$\text{Retention} = \left(\frac{P3}{1 + e^{\frac{-(L-(P1+P4*male))}{P2}}} \right)$$

Retention blocks

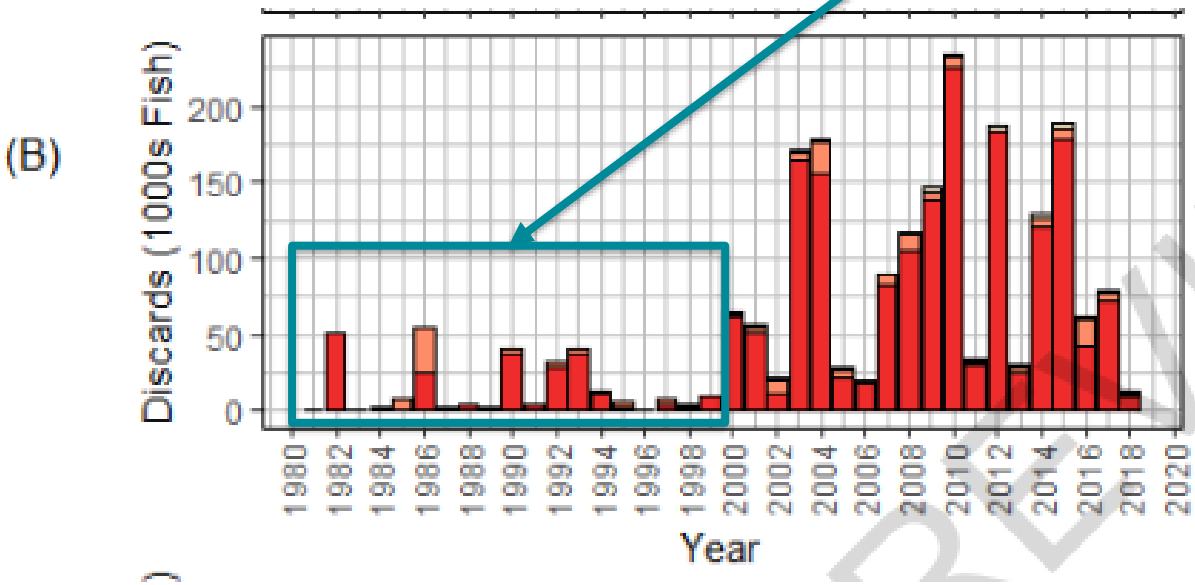
- Commercial: 4 time blocks
- Recreational: 3 time blocks



Time Blocks	Justification
1990-1998	FL state size limit of 20 inches Total Length (TL; 47 cm FL)
1999-2002	FL state and federal size limits of 20 (47 cm FL) and 16 (38 cm FL) inches TL, respectively
2003-2009 (Recreational through 2017)	FL state and federal size limits of 16 inches TL (38 cm FL)
2010-2017 (Commercial only)	FL state and federal size limits of 16 inches TL and IFQ (38 cm FL)

Retention

- Assuming full retention prior to state size limit in 1990 for:
  - Commercial vertical line
  - Commercial longline
  - Headboat
- Discards occurred prior to size limit in 1990 for Charter-Private



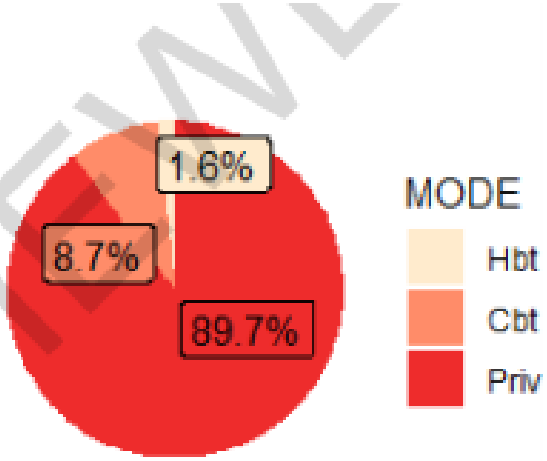


Figure 4.13.3 in SEDAR68 Data Workshop Report

Commercial retention

SL = Size Limit
State: 20 inches TL (47 cm FL)
Federal (fed): 16 inches TL (38 cm FL)

- Fixed inflection point at relevant size limits and estimated the width of the slope
- Assumed full retention above the size limit until implementation of the IFQ in 2010

Time Block	Inflection	Width	Asymptote
Base (pre 1990)	0	Fixed at 1 (knife-edge)	Fixed at 10
1990-1998	Fix at state SL	Estimate	Fixed at 10
1999-2002	Estimate (fed ≠ state SL)	Estimate	Fixed at 10
2003-2009	Fix at fed SL	Estimate	Fixed at 10
2010-2017	Fix at fed SL	Estimate	Estimate (due to IFQ)

Recreational retention

SL = Size Limit
State: 20 inches TL (47 cm FL)
Federal (fed): 16 inches TL (38 cm FL)

- Fixed inflection point at relevant size limits and estimated the width of the slope
- Estimated asymptote since not all scamp are retained (e.g., bag limit)

Time Block	Inflection	Width	Asymptote
CP Base (pre 1990)	Fixed at 31 (peak of retained)	Fixed at 0.5 (knife-edge)	Fixed at 10
HBT Base (pre 1990)	0	Fixed at 1 (knife-edge)	Fixed at 10
1990-1998	Fix at state SL	Estimate	Estimate
1999-2002	Estimate (fed ≠ state SL)	Estimate	Estimate
2003-2017	Fix at fed SL	Estimate	Estimate

Discard Mortality

$$\text{Mortality} = \left(1 - \frac{1 - P3}{1 + e^{\frac{-(L-(P1+P4*male))}{P2}}}\right)$$

- P1 = descending inflection
- P2 = descending slope
- P3 = maximum discard mortality
- P4 = male offset to descending; set to 0 for scamp

Fleet	P3
Commercial Vertical Line	0.47
Commercial Longline	0.68
Charter Private	0.26
Headboat	0.26

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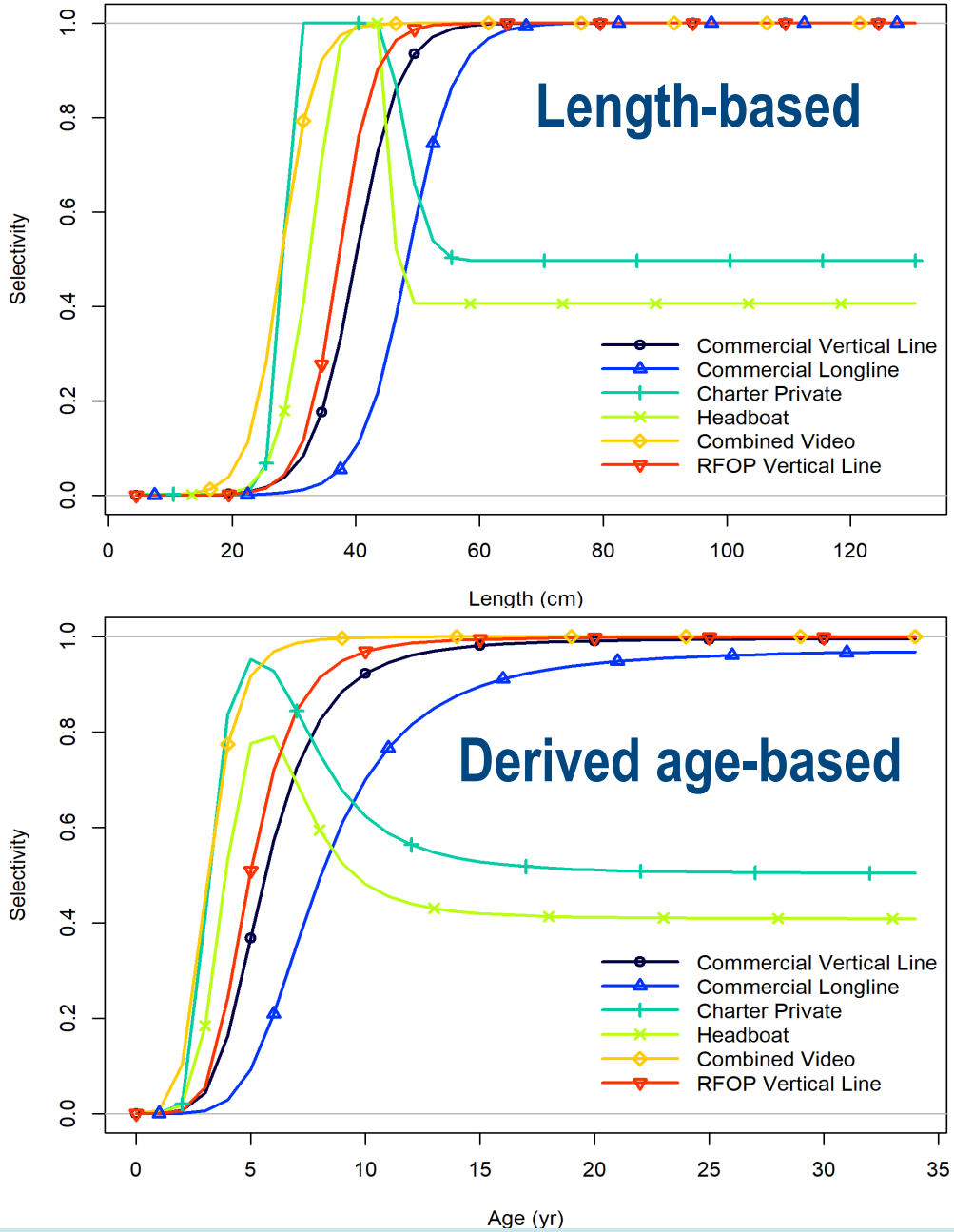
Selectivity in 2017

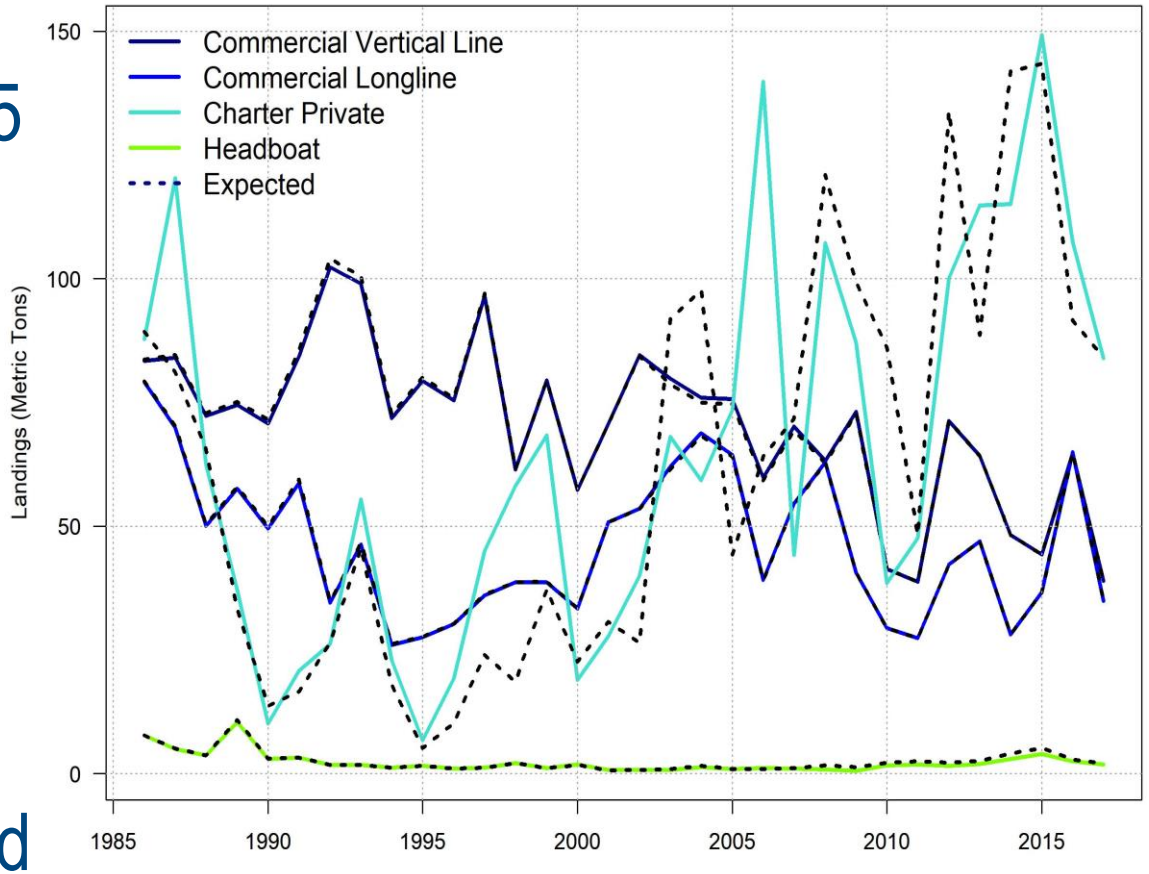
CV>1 in Base:

- Charter Private
  - End logit
- Headboat
  - Descending limb
  - Top logit



Landings

- Commercial SE = 0.05 (SE = 0.01 for IFQ years)
  - Treated as known
- Recreational SE fixed at 0.3
  - Using CVs as provided was tested in a sensitivity analysis

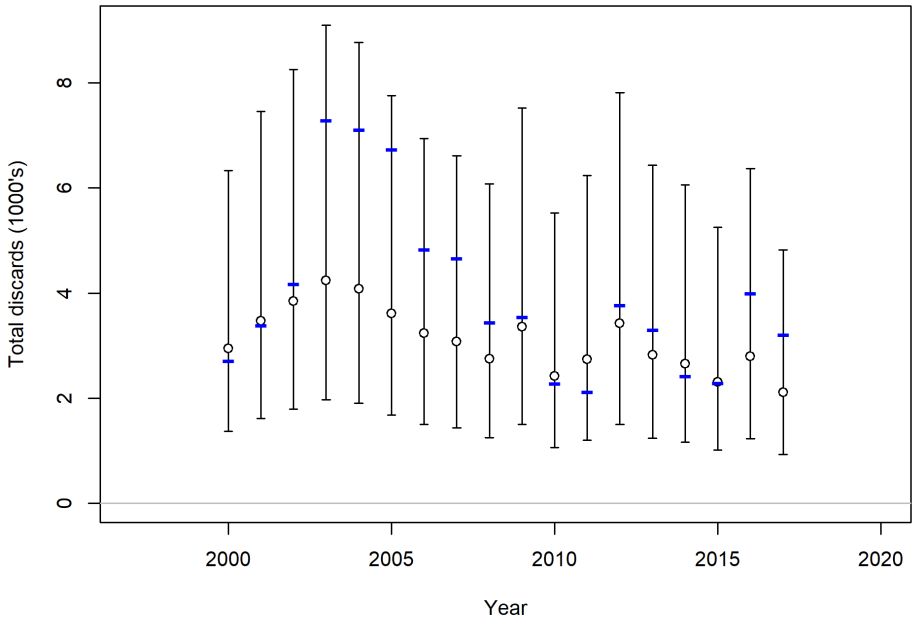


Commercial total discards*

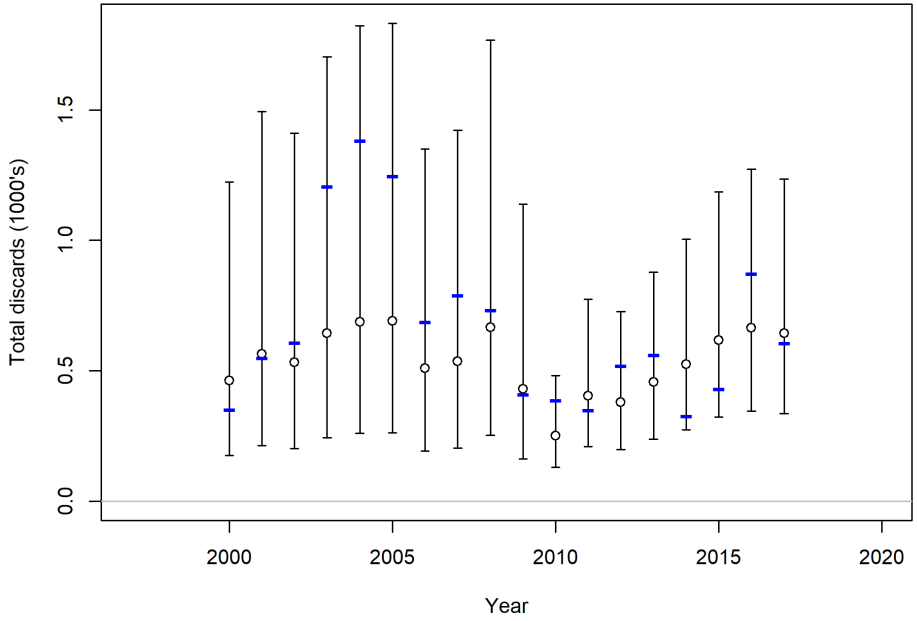
*discards before applying discard mortality

- Poor fit in 2003-2005 due to fixing size limit at federal size limit (~38 cm FL, 16 inches TL)
  - Time block for that period is 2003-2009

Commercial Vertical Line



Commercial Longline

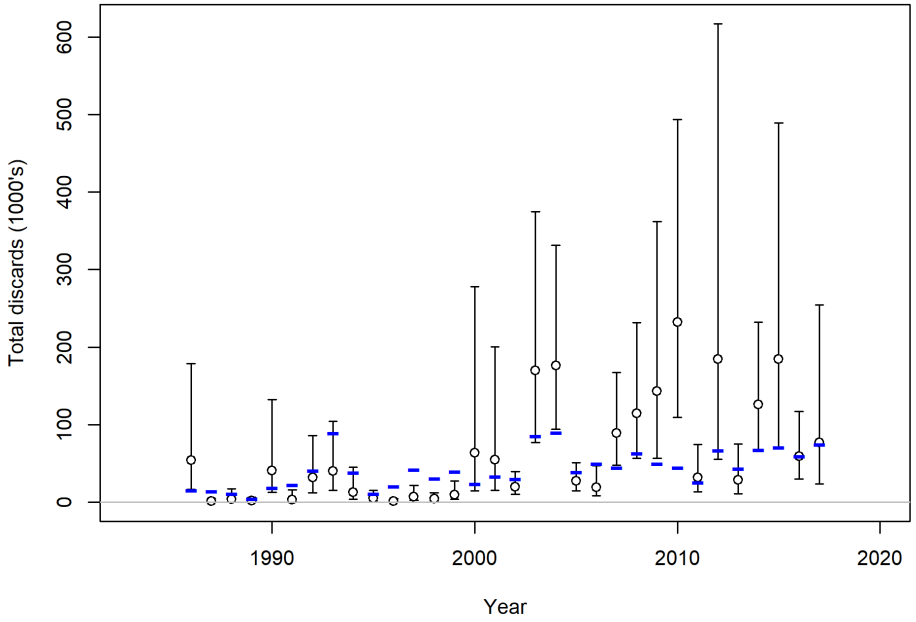


Recreational total discards*

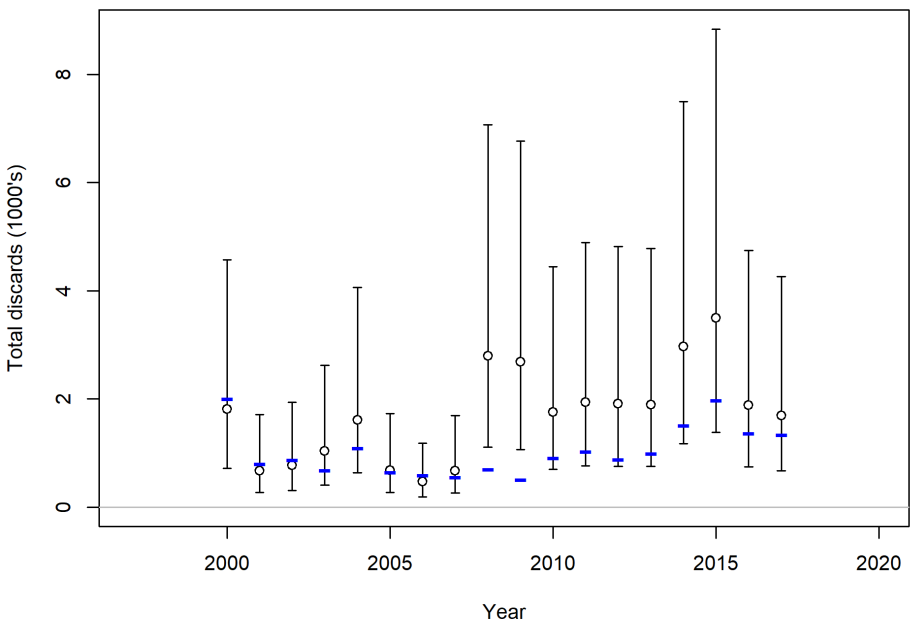
*discards before applying discard mortality

- Charter Private estimates highly variable
- Consistently underestimating headboat discards from 2008-2015

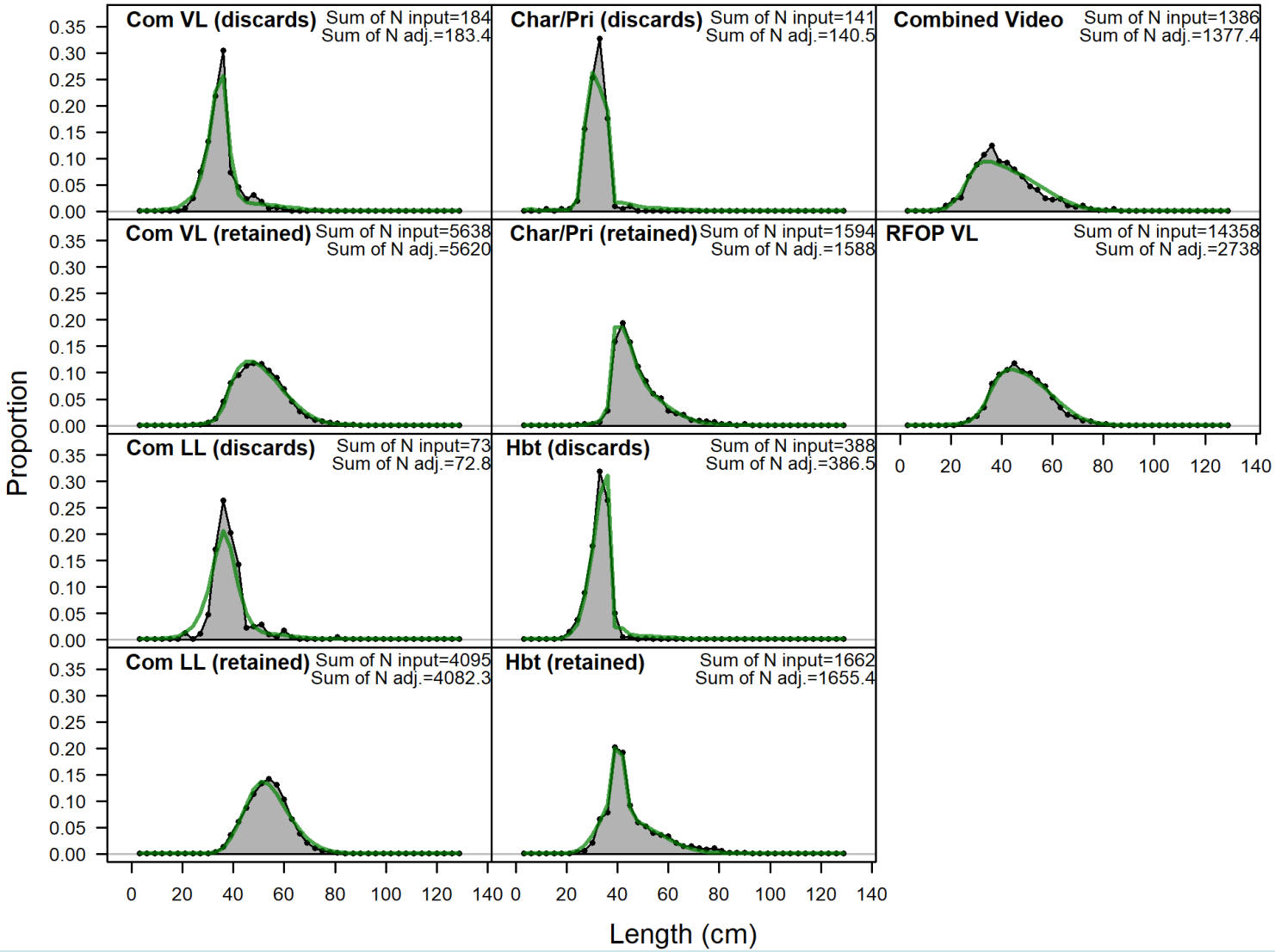
Charter Private



Headboat



Fits to length comps



Estimated Dirichlet parameters

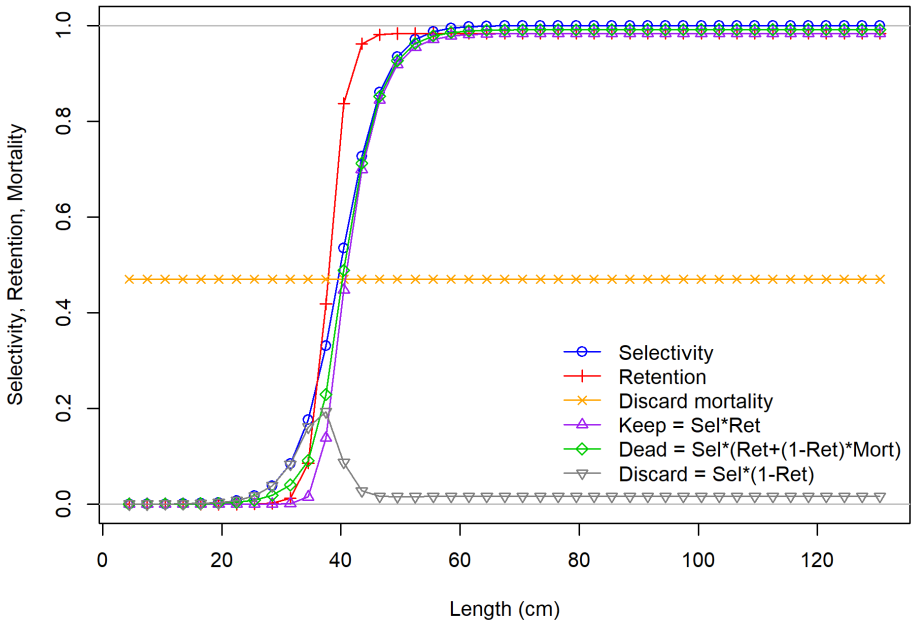
ln(DM_theta)	Value (CV)
Commercial Vertical Line (length)	5.736 (0.121)
Commercial Longline (length)	5.768 (0.12)
Charter Private (length)	5.56 (0.126)
Headboat (length)	5.501 (0.126)
Combined Video Survey (length)	5.06 (0.144)
RFOP Vertical Line Survey (length)	-1.45 (-0.052)
Commercial Vertical Line (conditional age-at-length)	5.475 (0.109)
Commercial Longline (conditional age-at-length)	4.875 (0.117)
Charter Private (age)	0.825 (0.254)
Headboat (age)	0.514 (0.377)

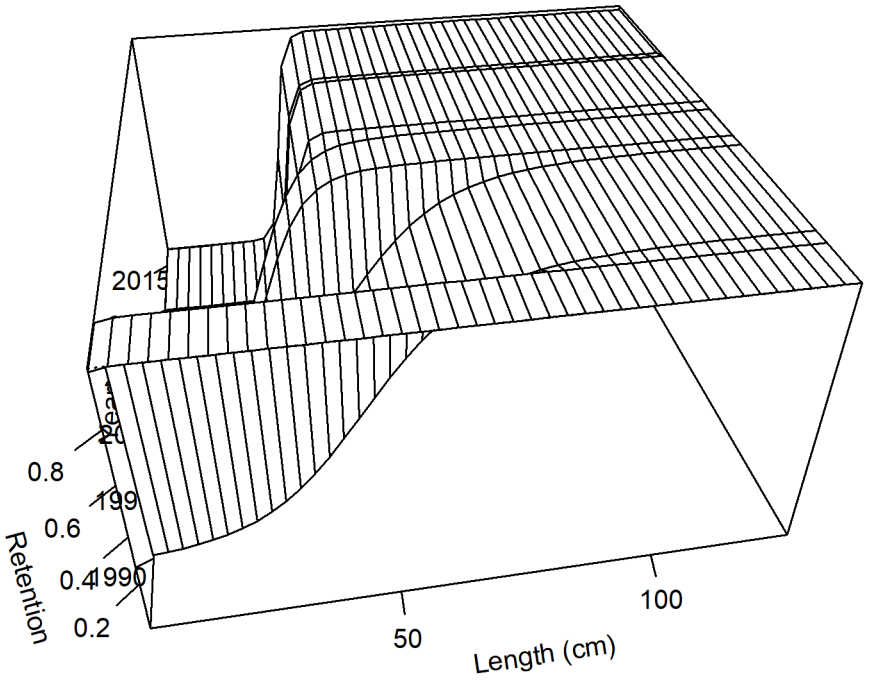
- Lowest for RFOP length data and recreational age comps
- Adjusted sample size converges to the input sample size at large values

Commercial Vertical Line

- No selectivity or retention parameters with CV > 1

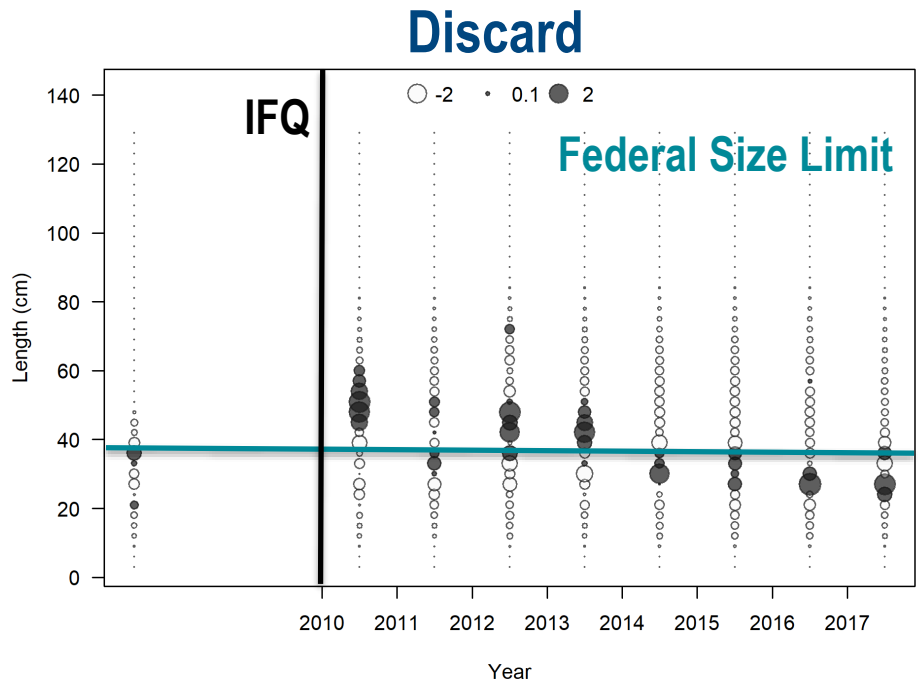
Blocks	Justification
1990-1998	FL 20 inches TL
1999-2002	FL 20 inches TL Federal 16 inches TL
2003-2009	Both 16 inches TL
2010-2017	Both 16 inches TL and IFQ

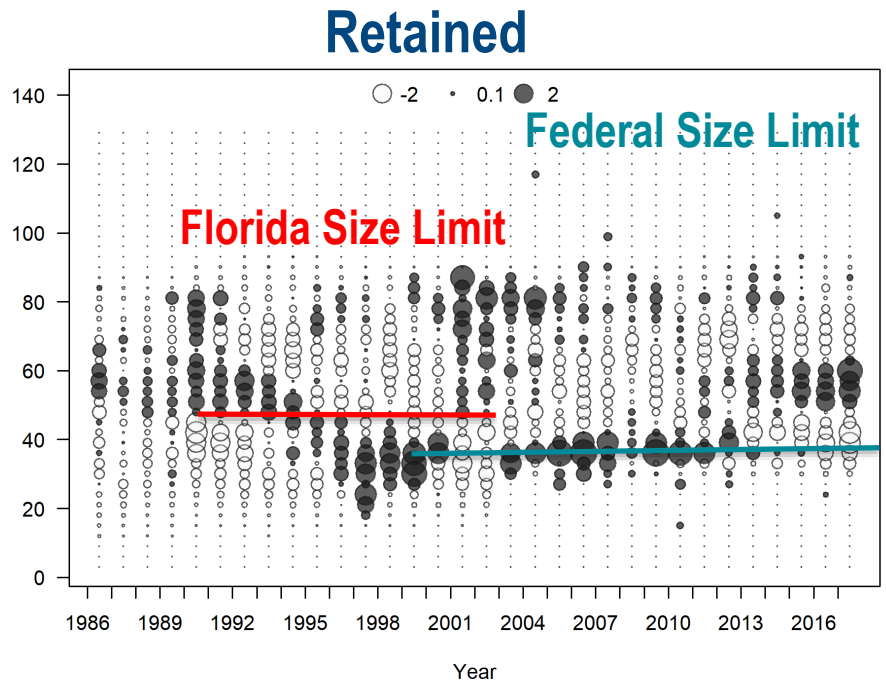




Commercial Vertical Line

- Patterns evident in residuals for retained composition
- Closed = + (observed > expected)
- Open = - (observed < expected)

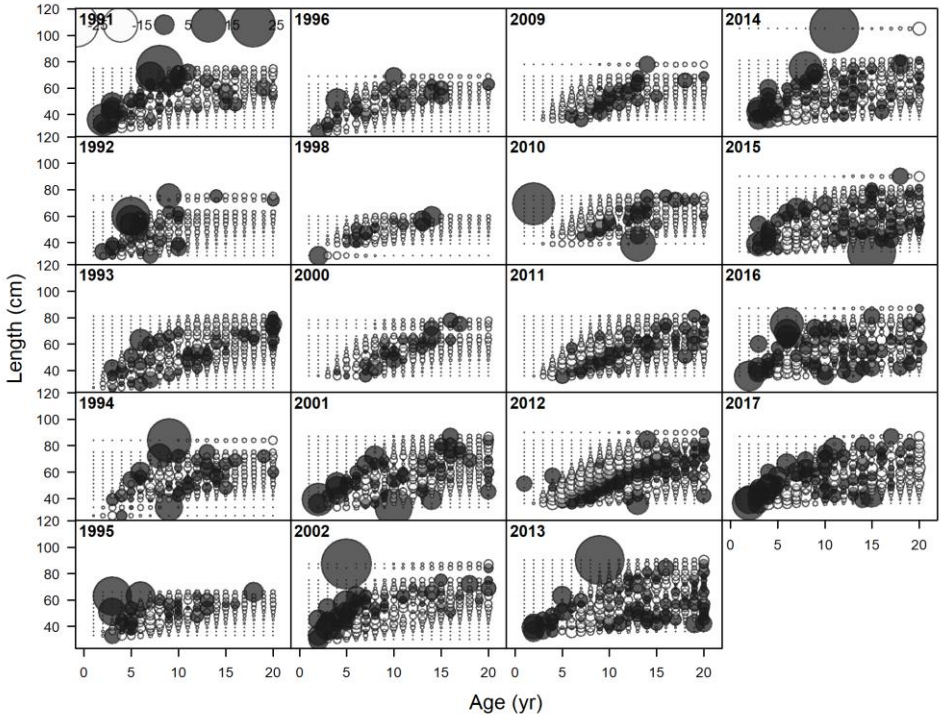




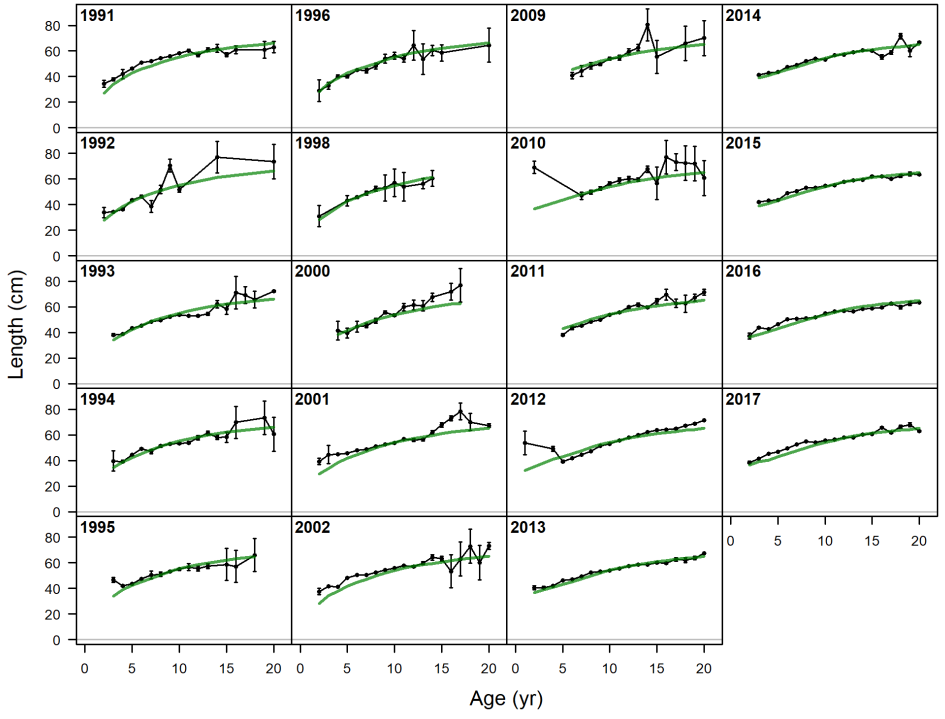
Commercial Vertical line (retained)

- Expected mean length-at-age similar to observed data
- *Not included in likelihood

Conditional age-at-length



Mean length-at-age*



Commercial Longline

- No selectivity or retention parameters with CV > 1

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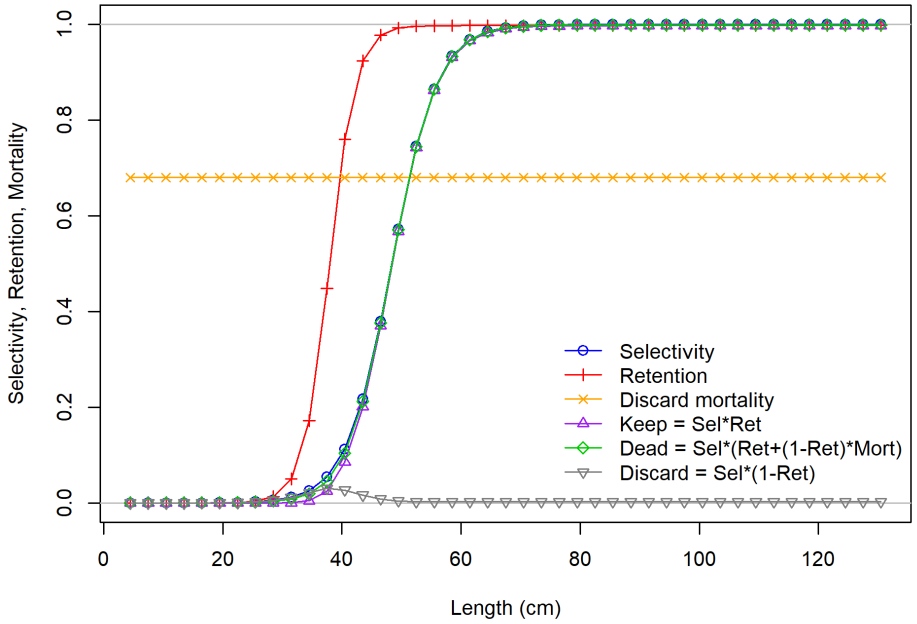
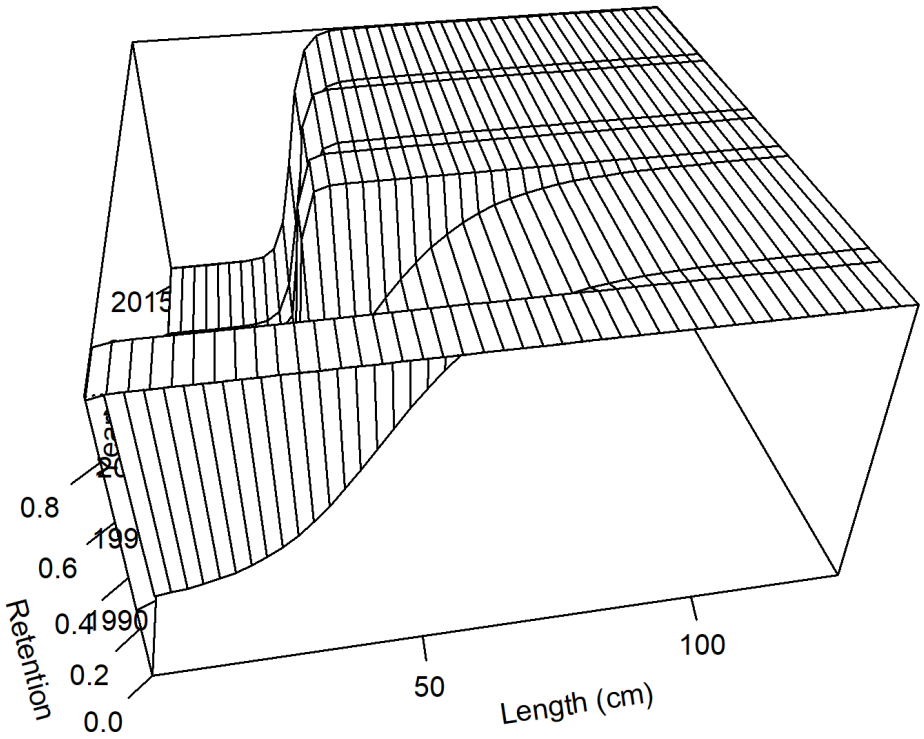
1999-2002	FL 20 inches TL Federal 16 inches TL
2003-2009	Both 16 inches TL
2010-2017	Both 16 inches TL and IFQ

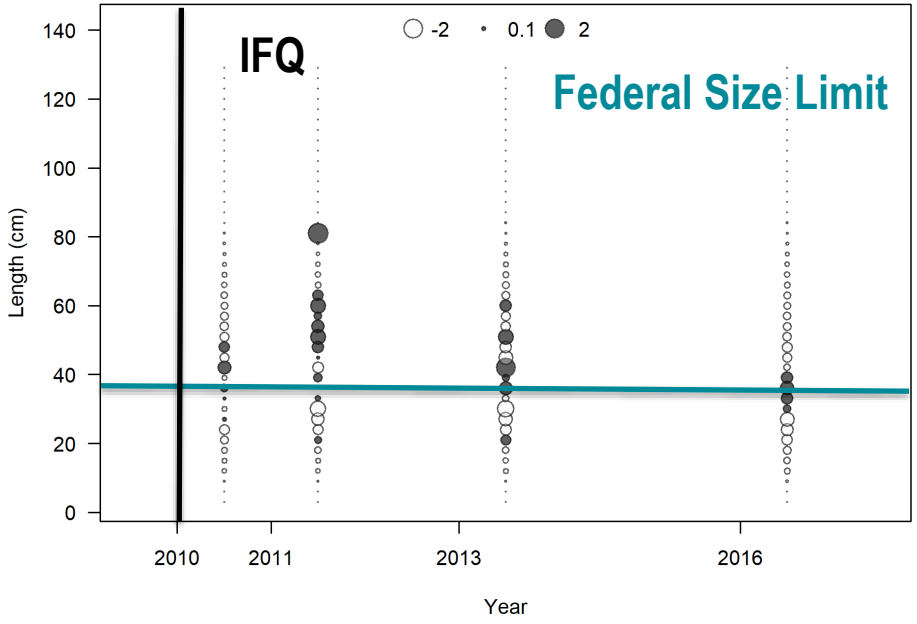




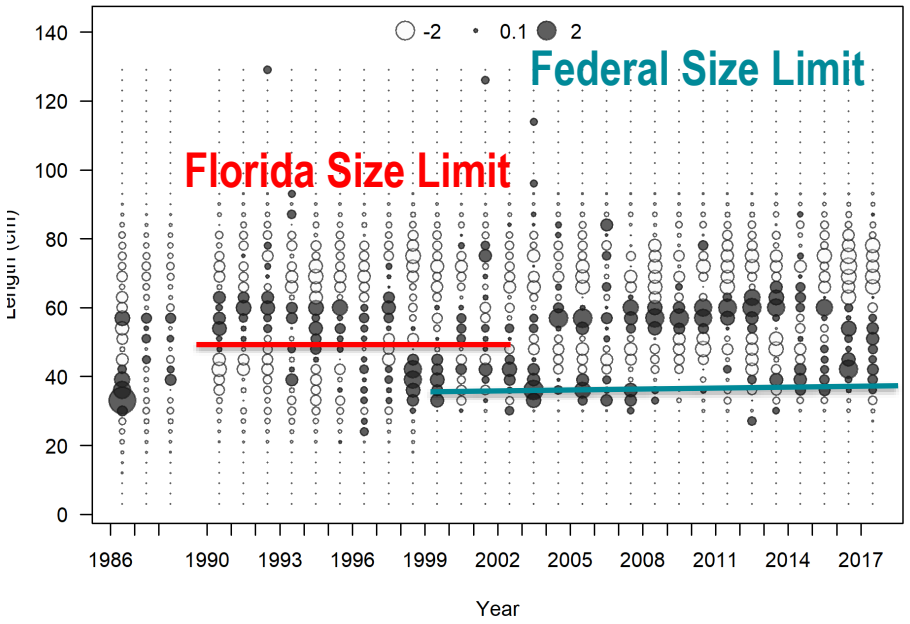
Commercial Longline

- Patterns evident in residuals for retained composition
- Closed = + (observed > expected)
- Open = - (observed < expected)

Discard



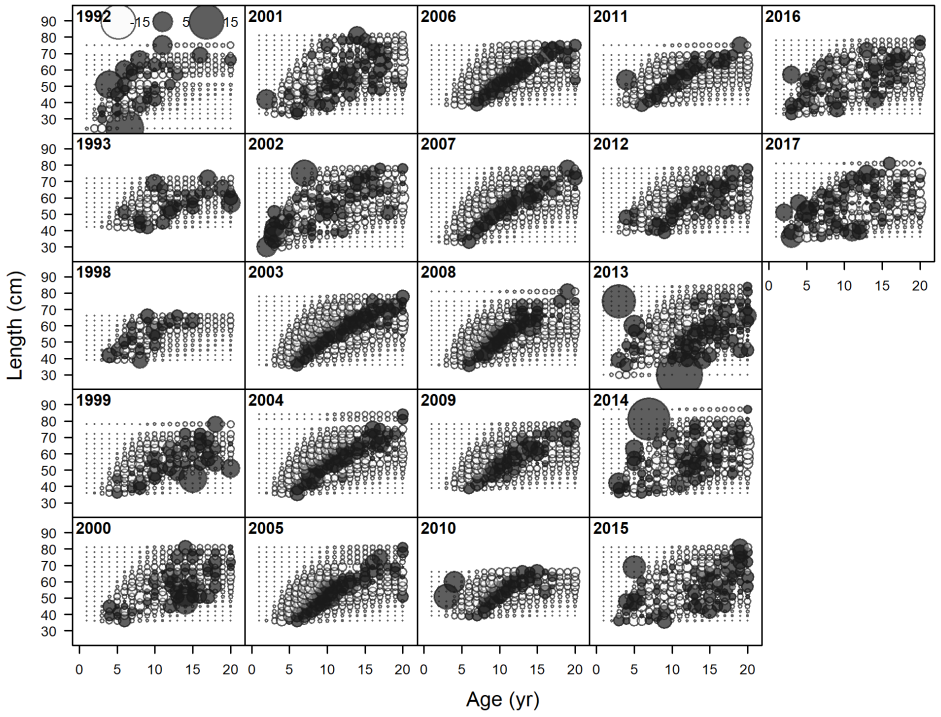
Retained



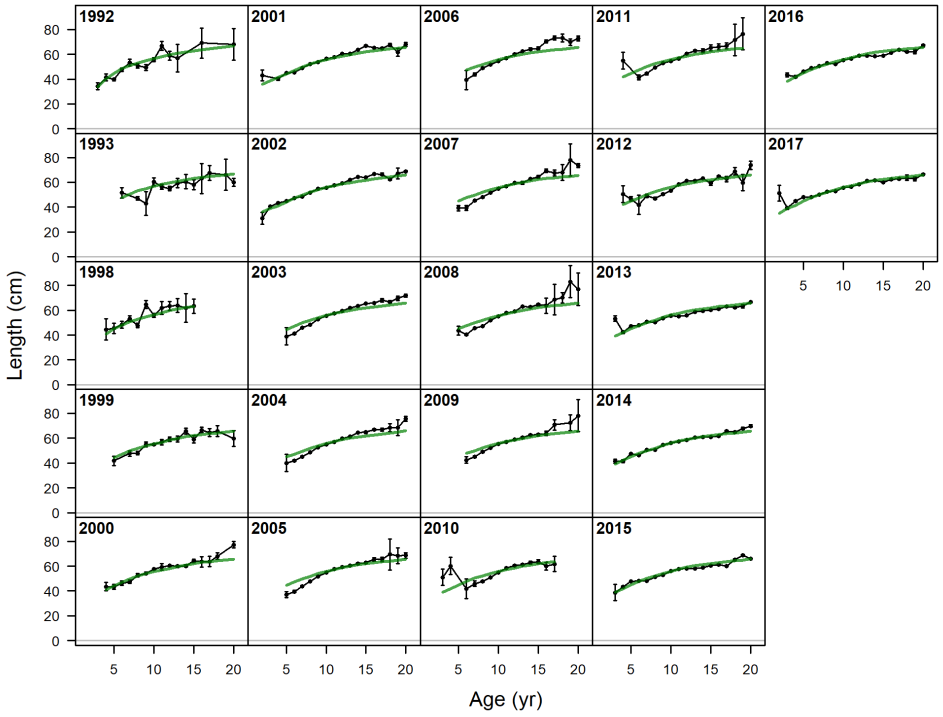
Commercial Longline (retained)

- Expected mean length-at-age similar to observed data
- *Not included in likelihood

Conditional age-at-length



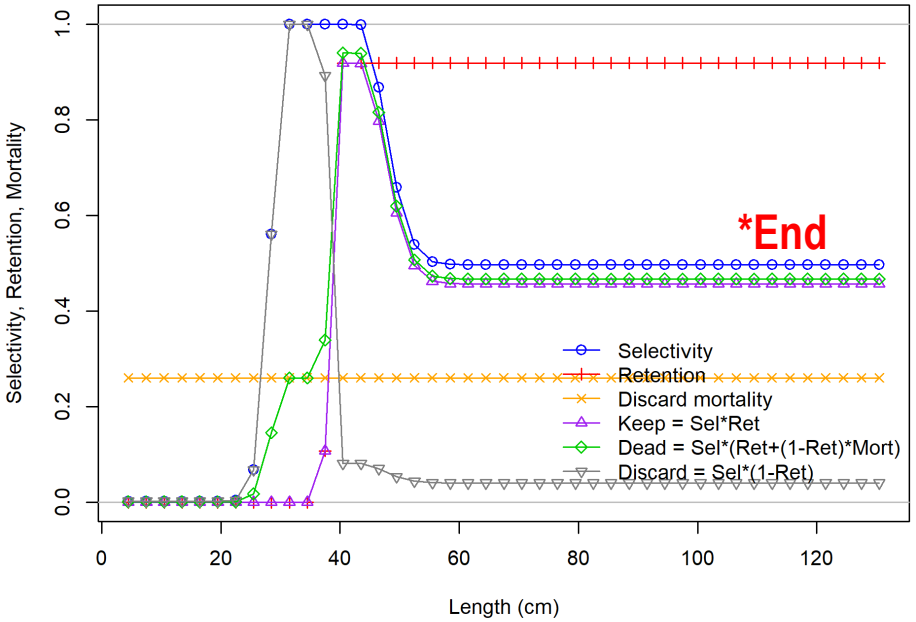
*Mean length-at-age

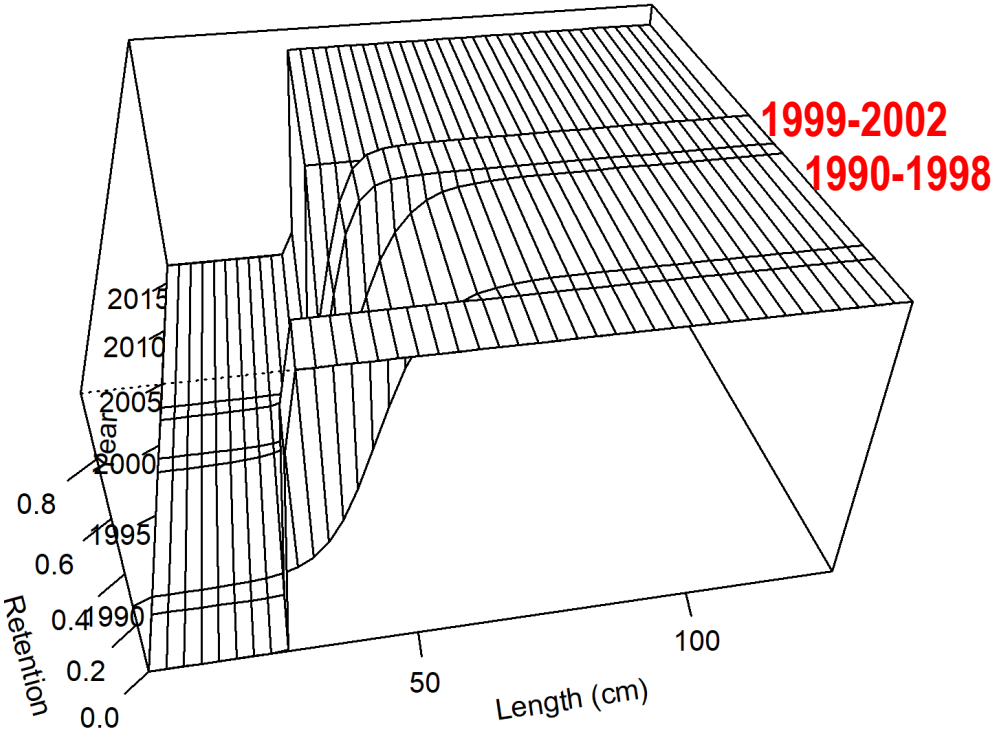


Charter-Private

- Selectivity parameters with CV > 1: end logit
- 1990-1998 & 1999-2002 blocks: asymptote CV > 1

Blocks	Justification
1990-1998	FL 20 inches TL
1999-2002	FL 20 inches TL Federal 16 inches TL
2003-2017	Both 16 inches TL

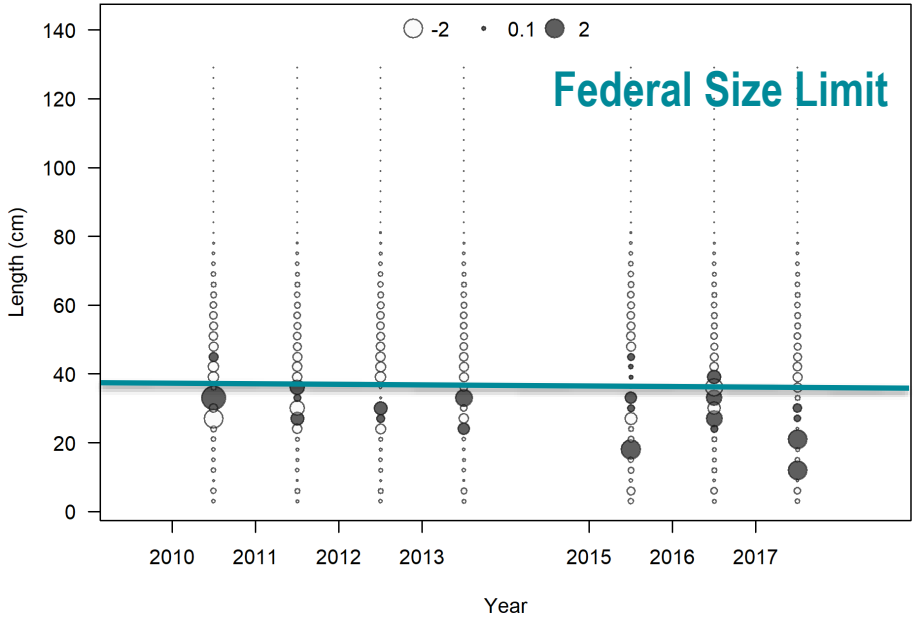




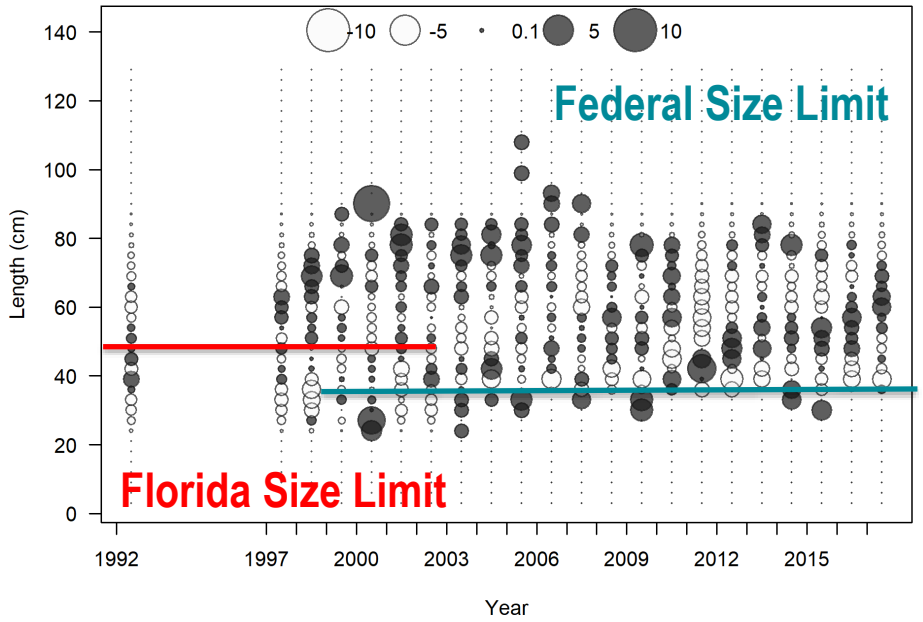
Charter Private length composition

- Patterns evident in residuals for retained composition, which also show relatively large magnitude
- Closed = + (observed > expected)
- Open = - (observed < expected)

Discard

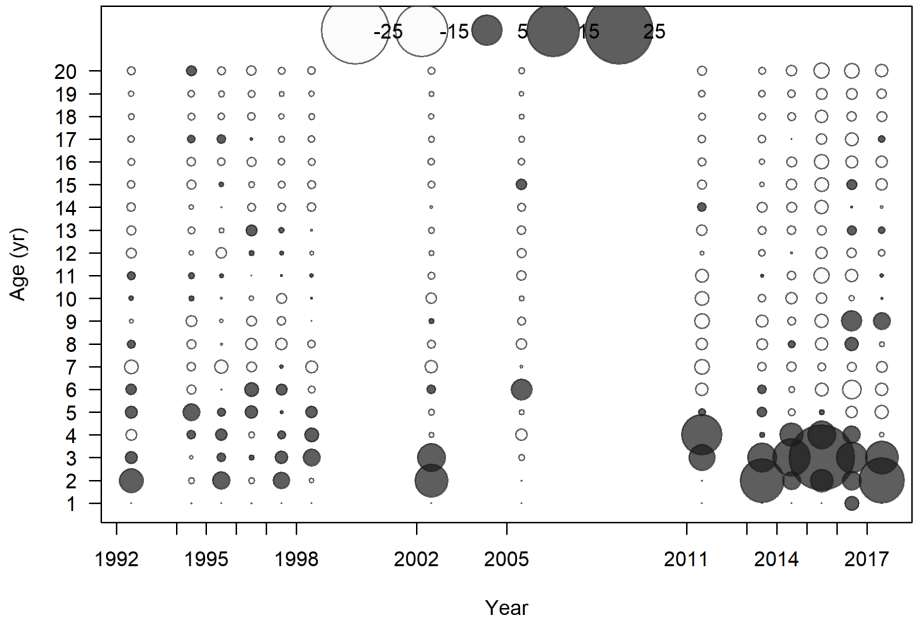


Retained



Charter Private age composition

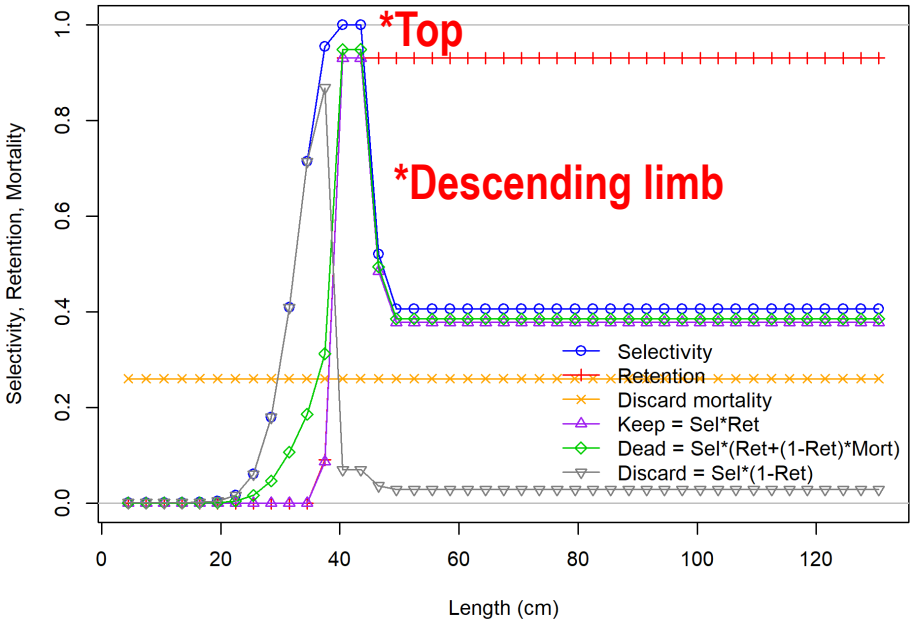
- Very large residuals from 2011-2017
- Need a better understanding of regulations for other species, which might be driving these patterns

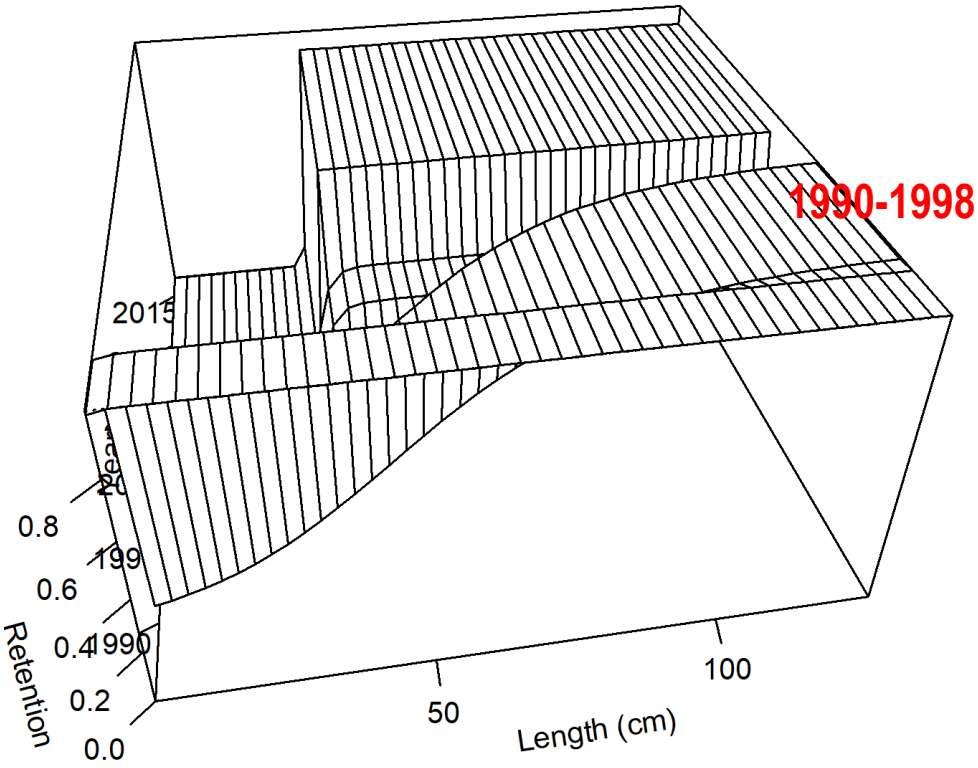


Headboat

- Selectivity parameters with CV > 1: top logit, descending limb
- **1990-1998 block**: asymptote CV > 1, HBT width bounding at 20

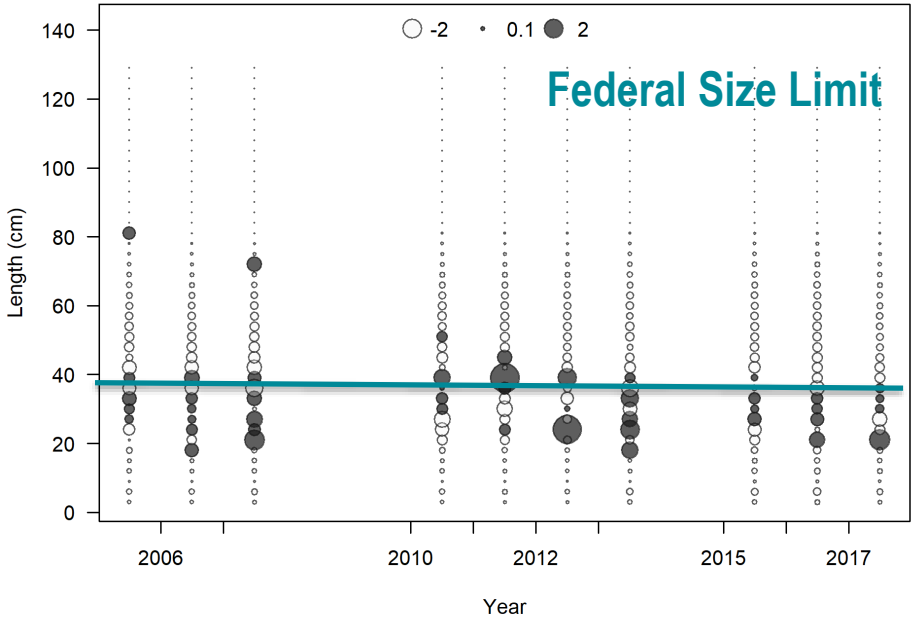
Blocks	Justification
1990-1998	FL 20 inches TL
1999-2002	FL 20 inches TL Federal 16 inches TL
2003-2017	Both 16 inches TL

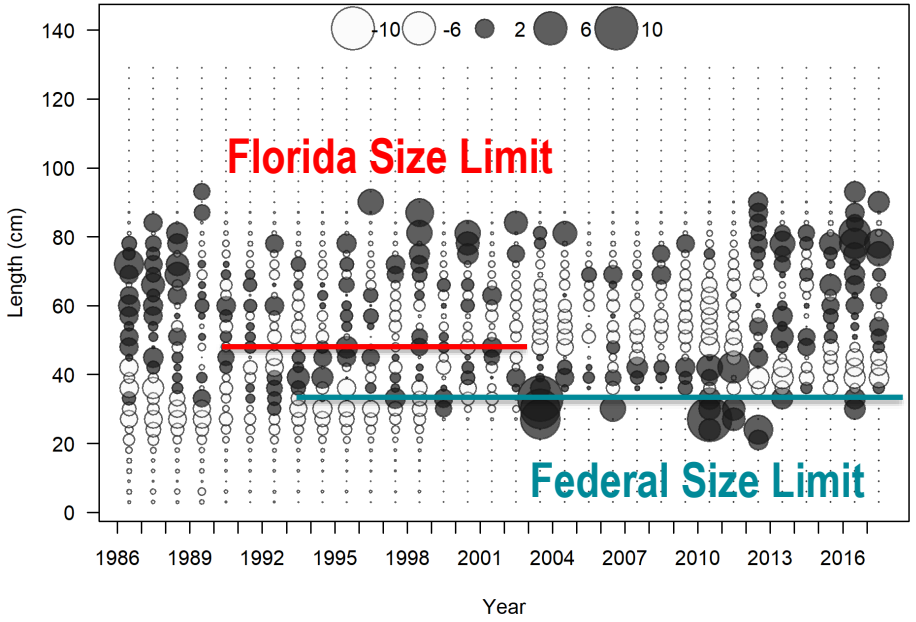




Headboat length composition

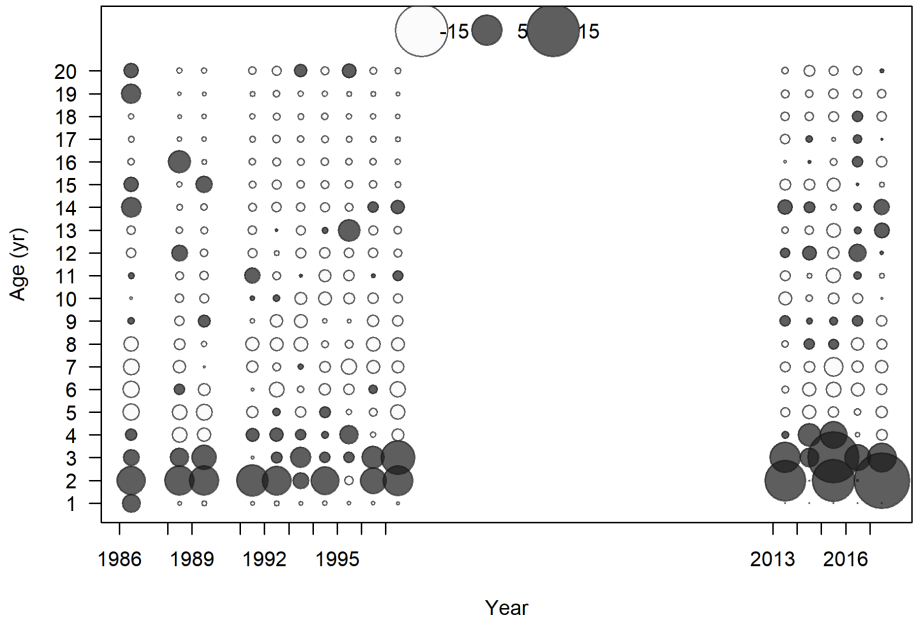
- Patterns evident in residuals for retained composition, which also show relatively large magnitude
- Closed = + (observed > expected)
- Open = - (observed < expected)





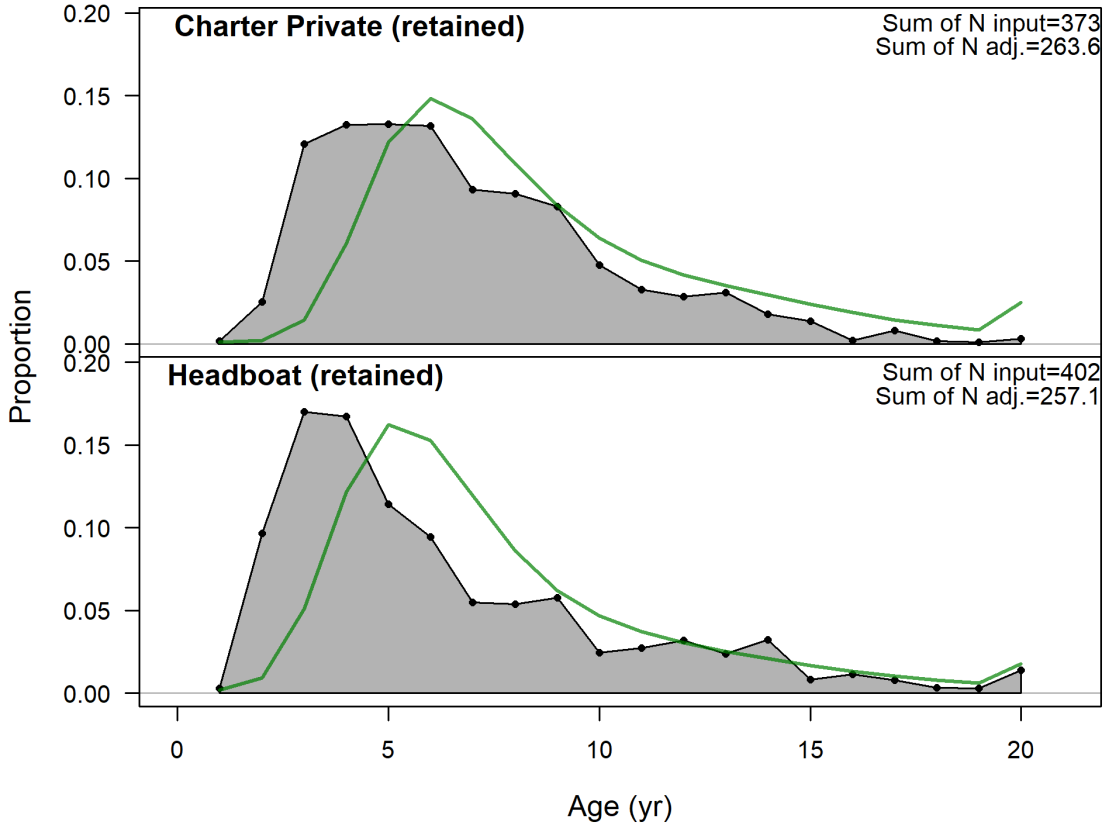
Headboat age composition

- Very large residuals for younger ages throughout time series, but especially from 2013-2017
- Need a better understanding of regulations for other species, which might be driving these patterns



Fits to Age Comps

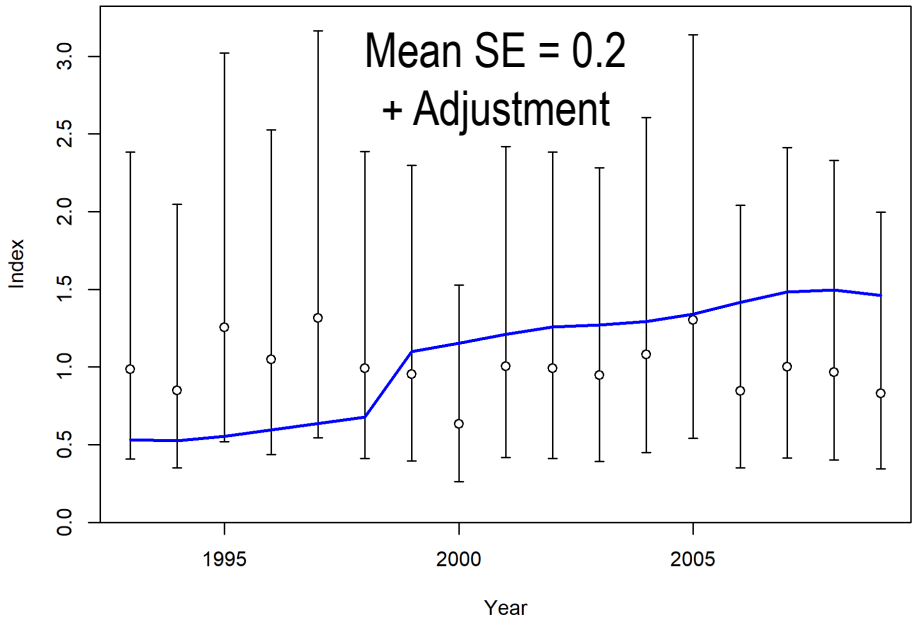
- Clear trade-off in model between fitting either the length comps or the age comps for recreational fleets



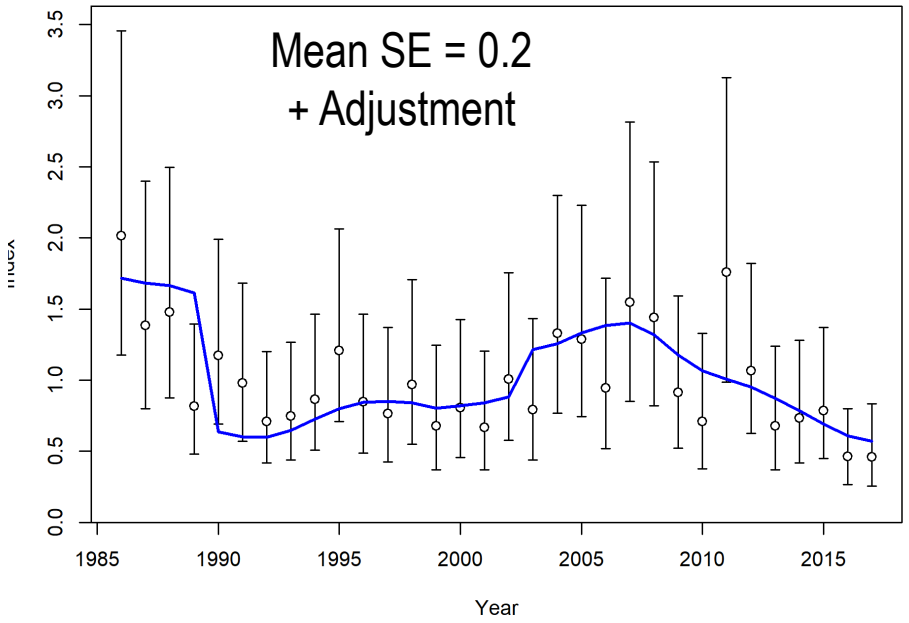
CPUE indices

Index	RMSE	Modifications
Pre-IFQ Com VL	0.472	Variance adjustment of 0.249 added to index
Headboat	0.287	Variance adjustment of 0.087 added to index

Pre-IFQ Commercial Vertical Line



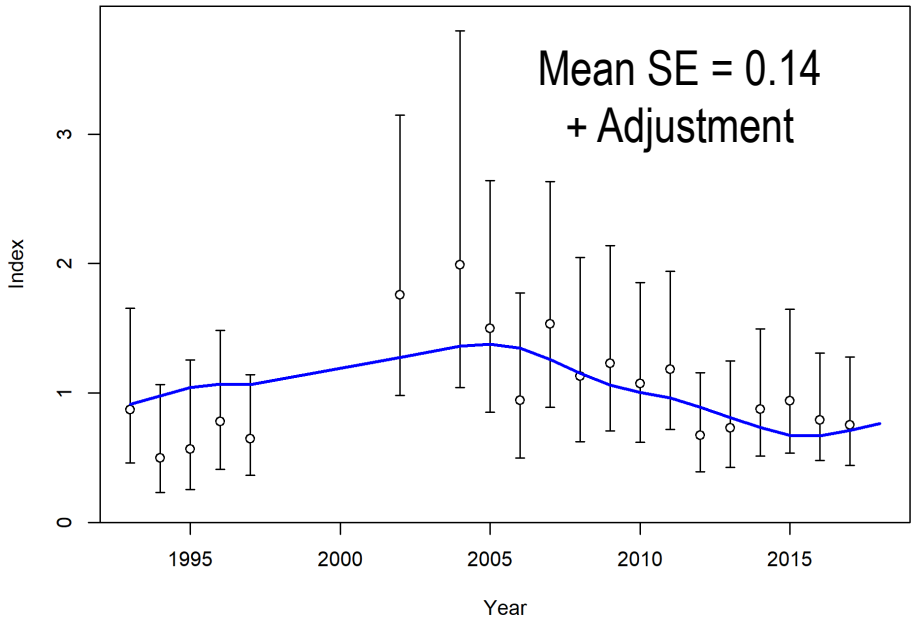
Headboat



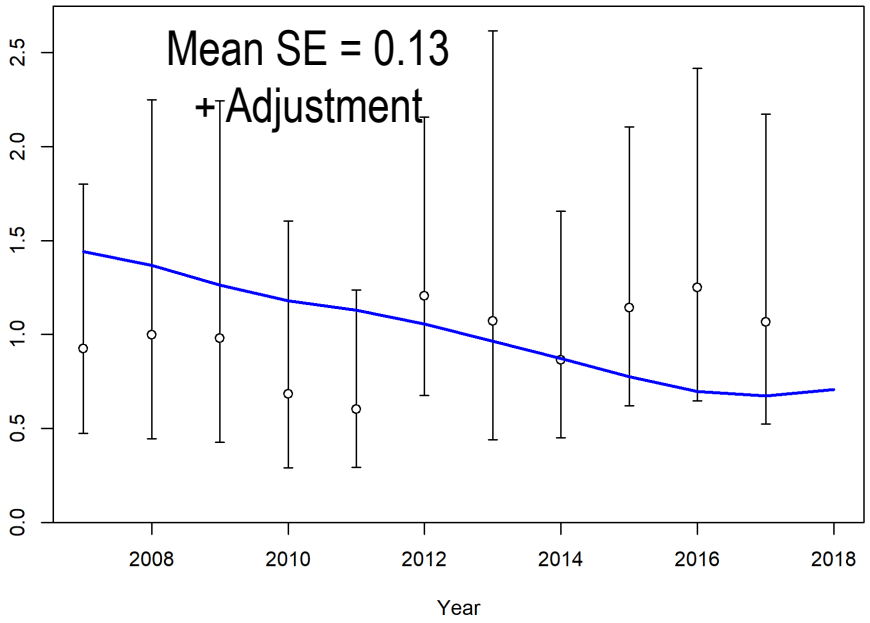
Surveys

Index	RMSE	Modifications
Combined video	0.311	Variance adjustment of 0.156 added to index
RFOP VL	0.404	Variance adjustment of 0.238 added to index

Combined Video

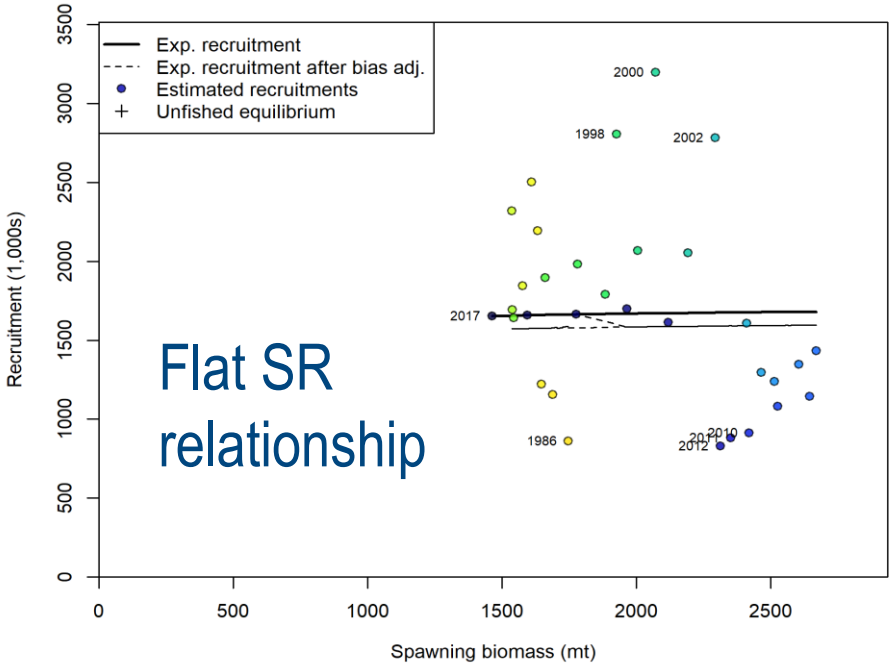


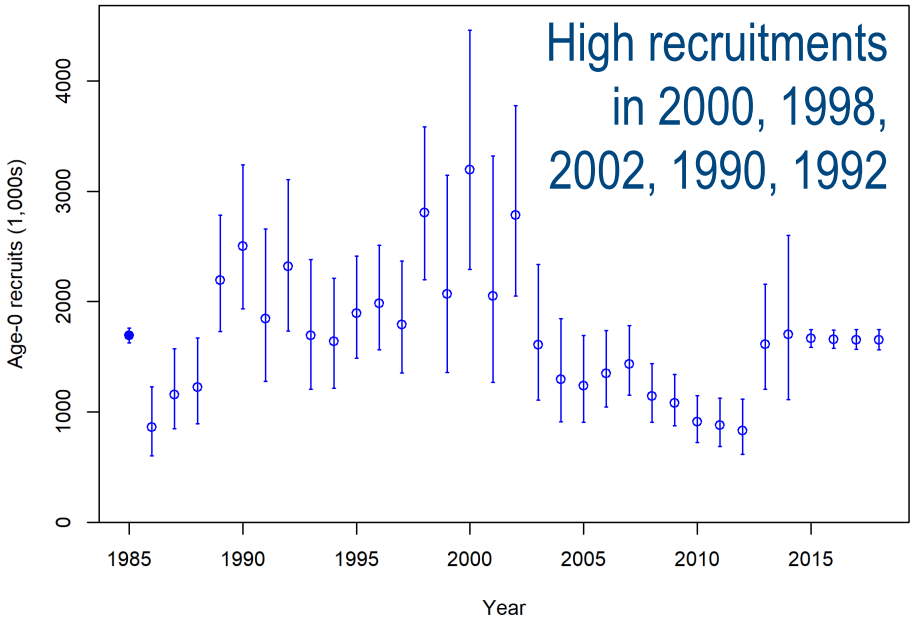
RFOP Vertical Line

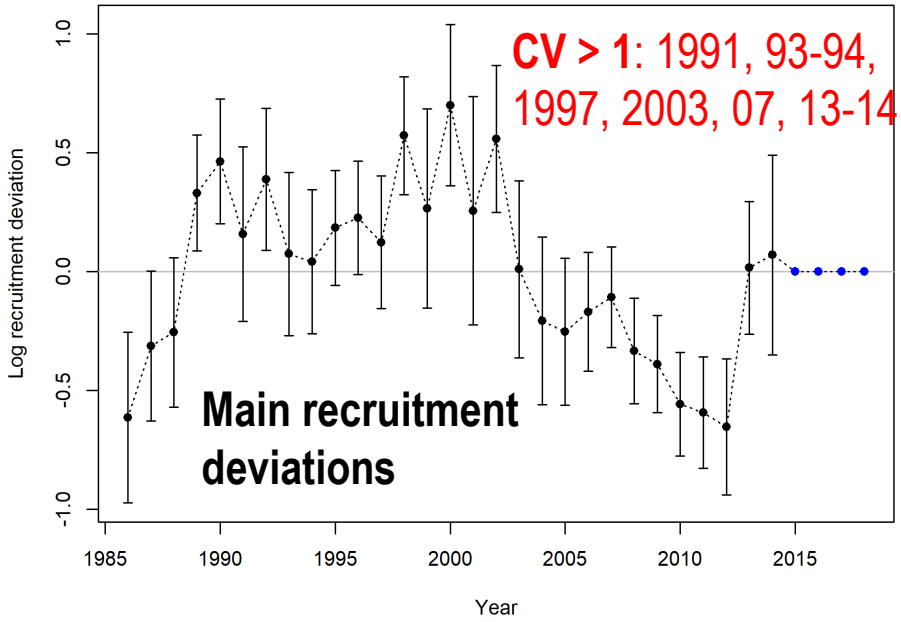


Recruitment

Parameter	Value (CV)
Ln(R0)	7.433 (0.003)
R0	1,691,010
Steepness	0.949 (0.041)
SigmaR	0.356 (0.127)

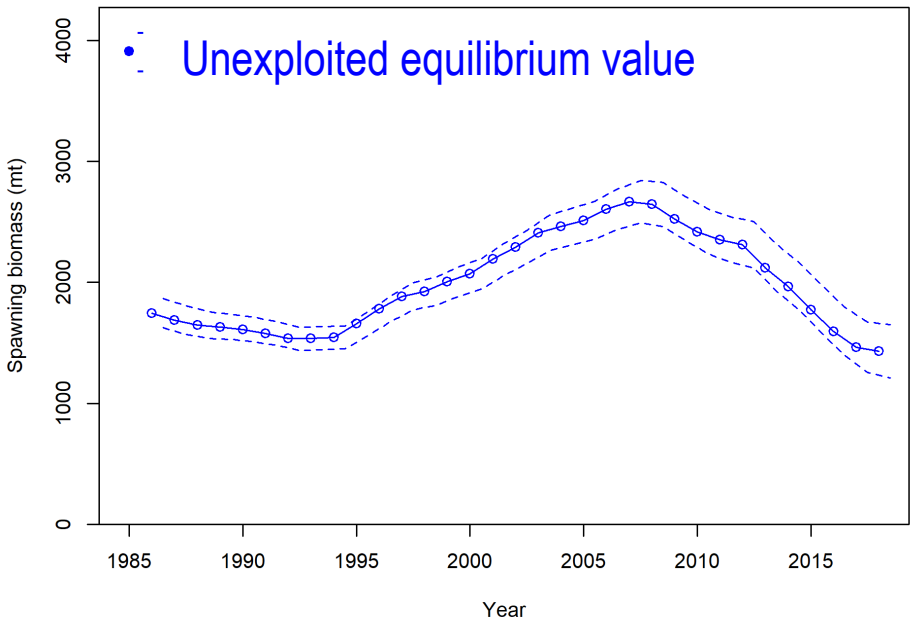




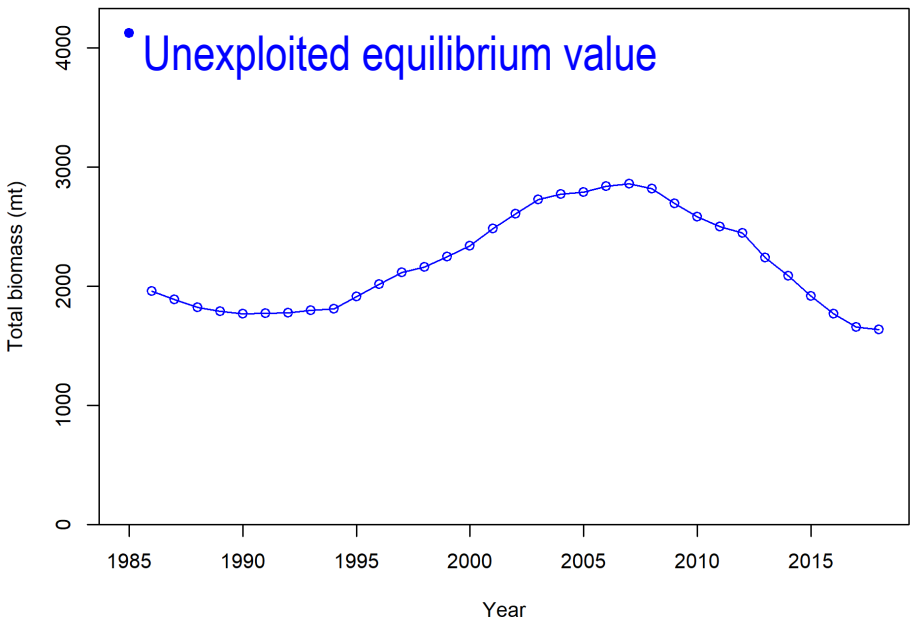


Biomass

Spawning Stock Biomass



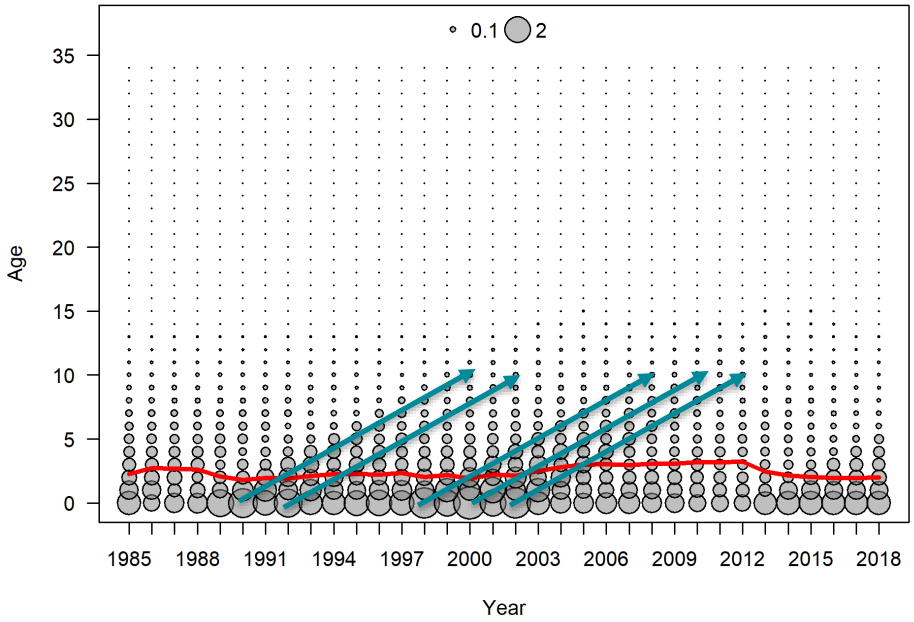
Total Biomass



- Increased to peak levels in 2007 then declined
  - Driven by composition data

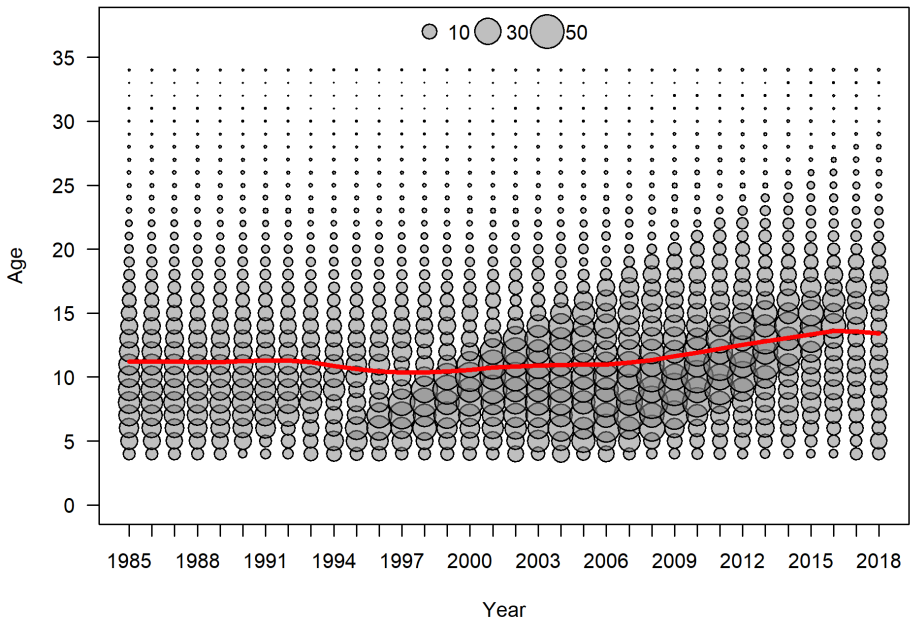
Numbers at age

Female (Millions)



- Average age between 2-3 years
  - Declines in years of high recruitment
  - Lack of evidence of strong recruitment events after 2002

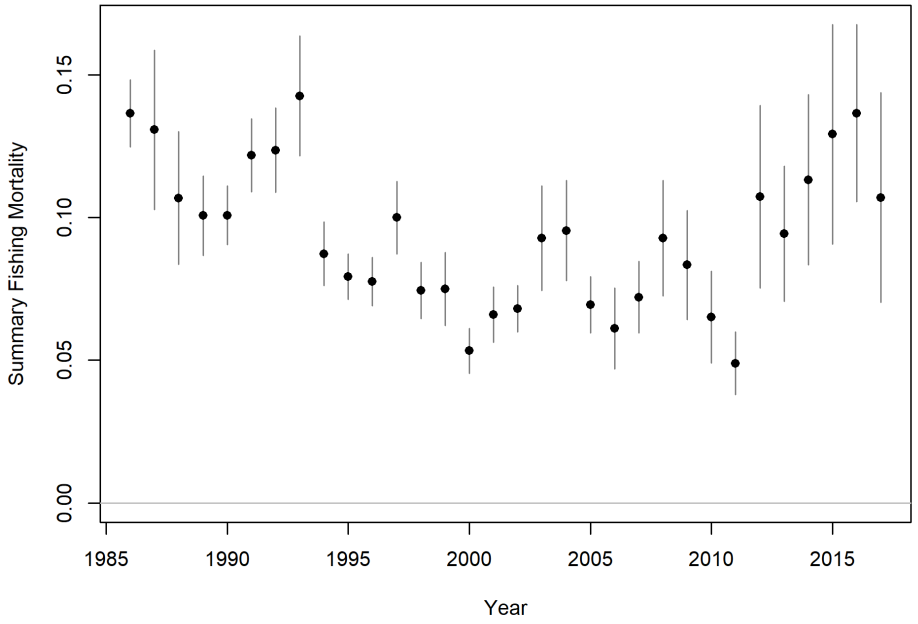
Males (Thousands)

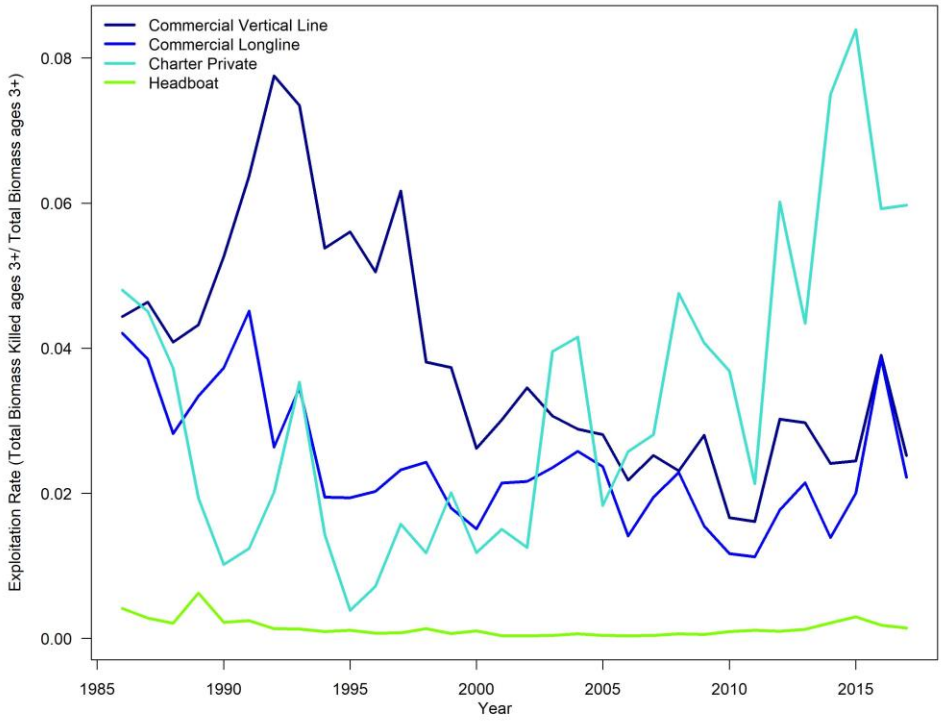


- Average age between 10-13 years
  - Older mean age in more recent years

Fishing Mortality

	Com VL	Com LL	Charter Private	Headboat
Initial F	0.056 (0.071)	0.062 (0.078)	0.051 (0.068)	None





- High exploitation in the 1980s-1990 from commercial fishery
- High exploitation recently due to increased Charter Private fishing

Questions about the base run?

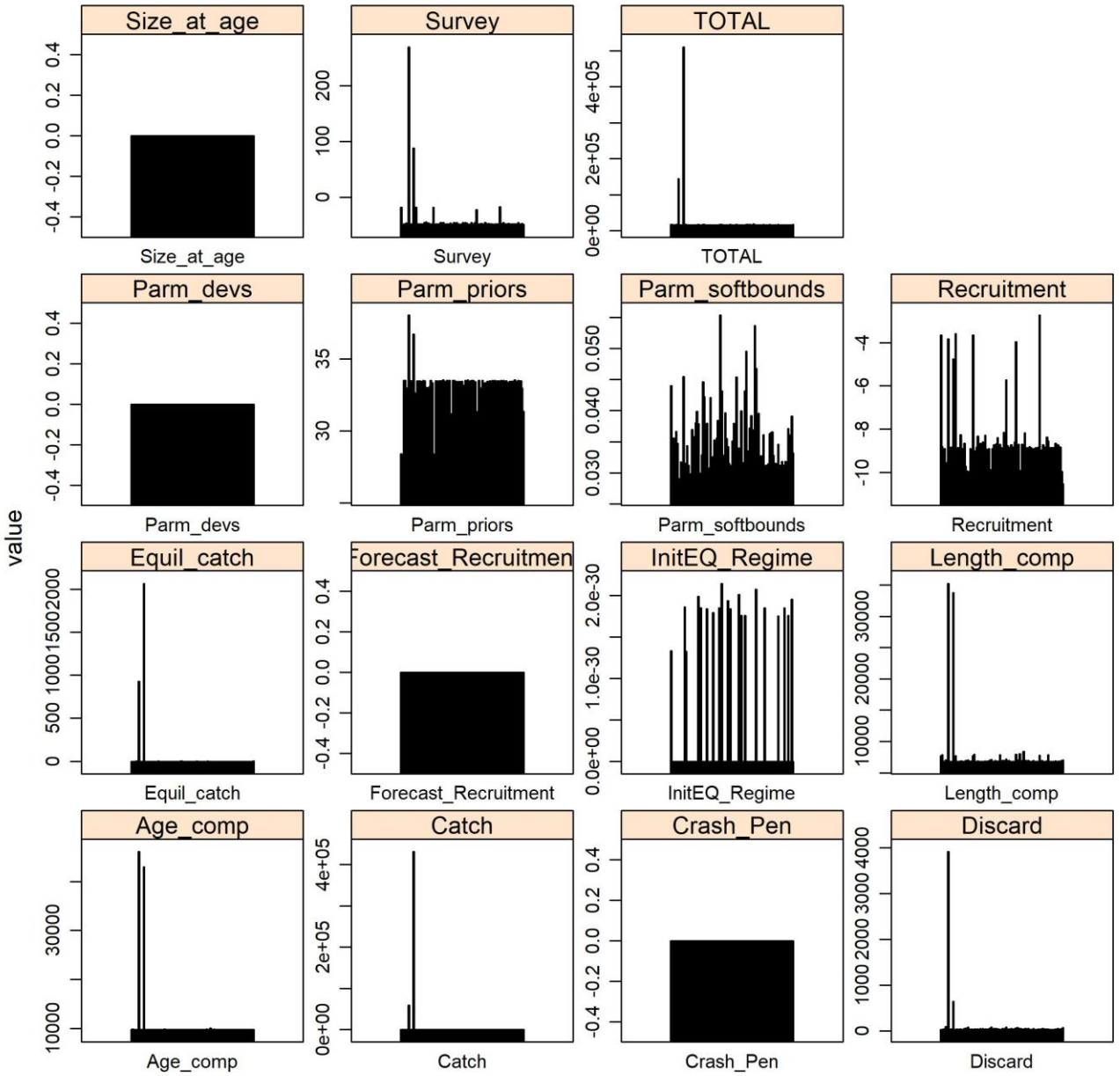
Outline

- Data Review
  - Stock definition
  - Regulations
  - Life history
  - Removals
  - Size compositions
  - Age compositions
  - Index of abundance
  - Survey length composition
- Assessment model
  - Base configuration
  - Base results
  - **Diagnostics**
  - Sensitivities

Jitter analysis

- Instability identified in jitter analysis
- Of 100 runs:

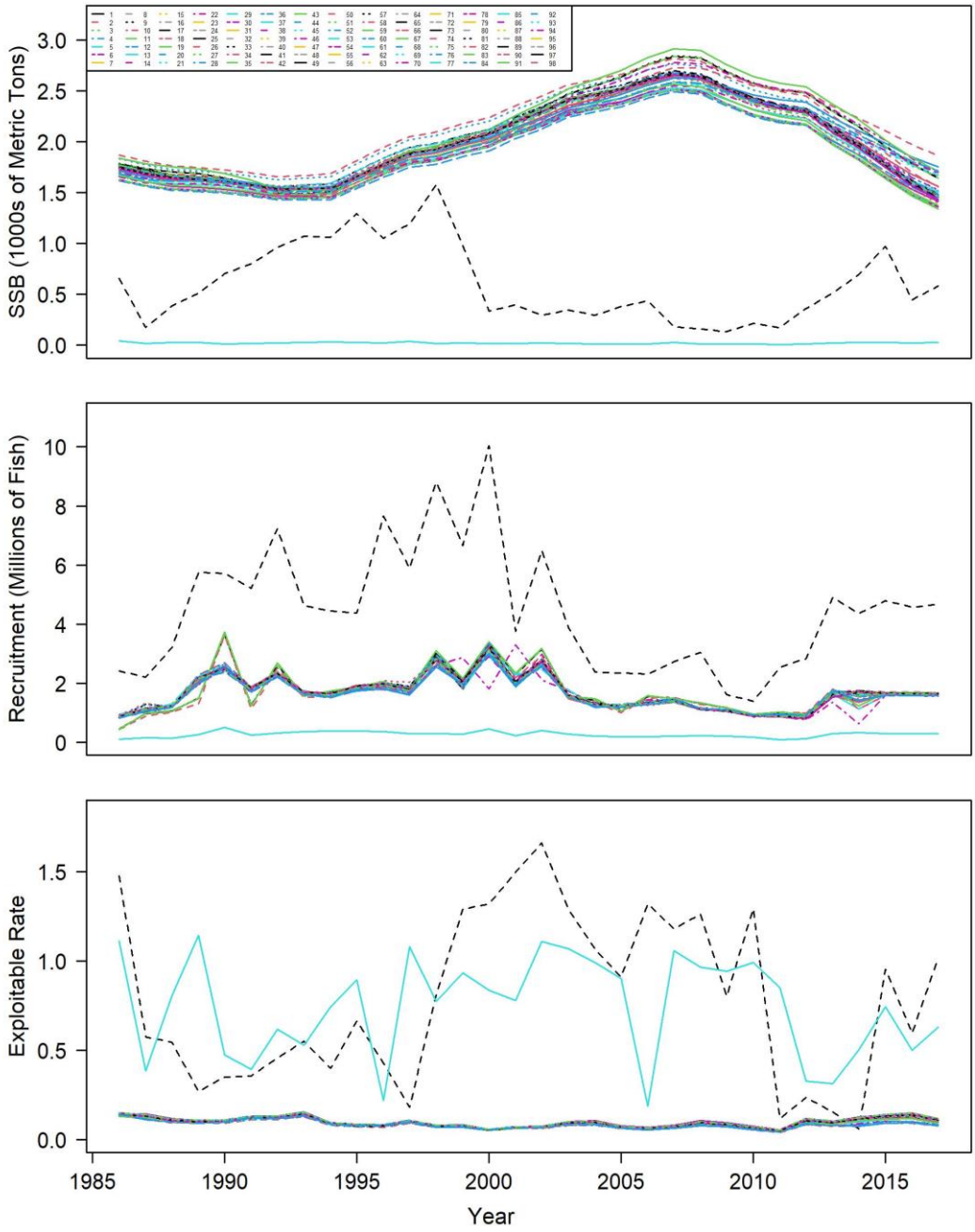
Results	Percent
Same NLL	9
Within 1 NLL	14
Within 5 NLL	34
Within 25 NLL	55
Within 50 NLL	58



Jitter analysis

- Majority of runs result in similar trends
- A few runs had very high gradients (i.e., lack of convergence)

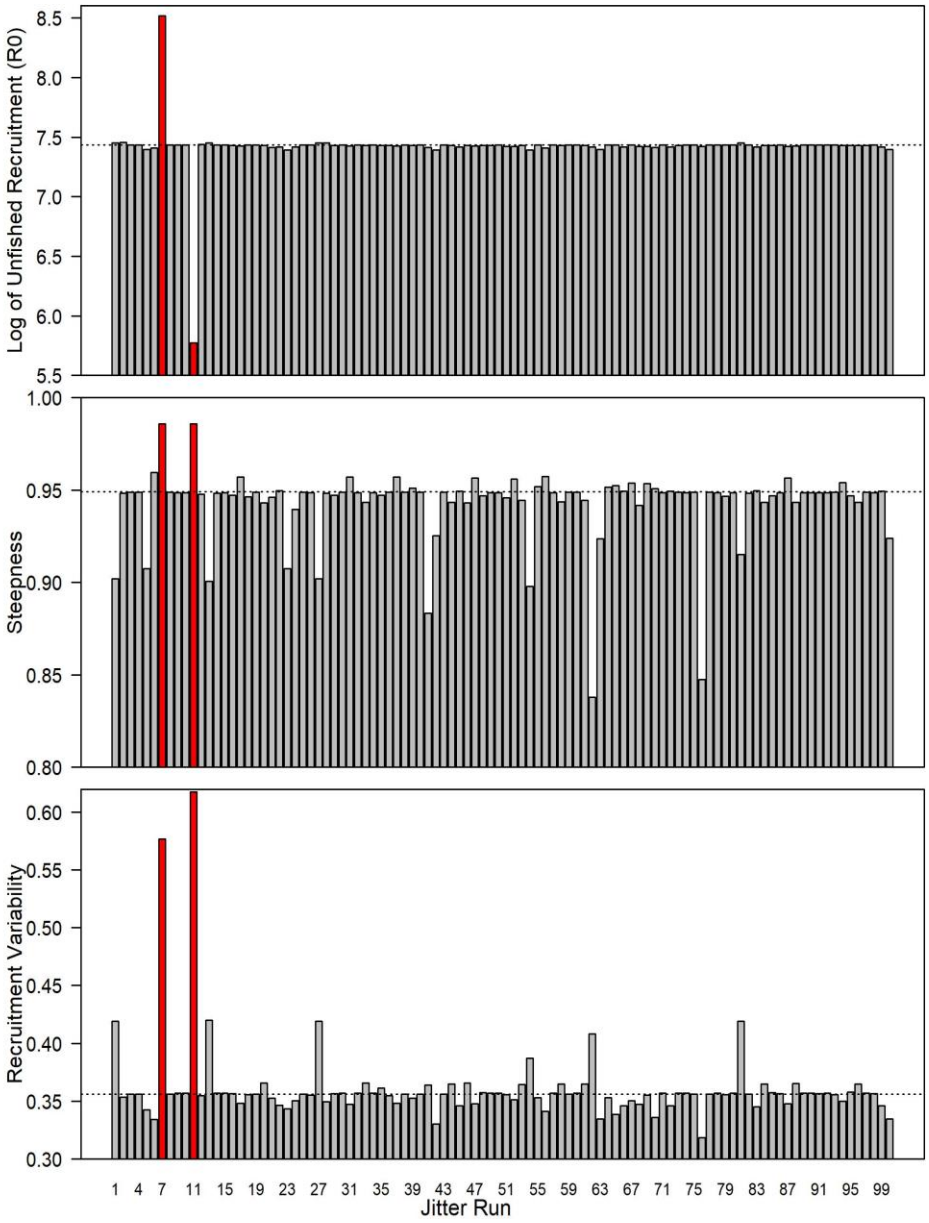
Run #	Gradient	NLL
7	116,211	145,235
11	19,900.8	511,200



Jitter analysis

- R0, steepness and SigmaR generally similar across runs

Parameter with Top Gradient	Number
F_fleet_1_YR_2017_s_1	1
F_fleet_2_YR_2014_s_1	1
F_fleet_3_YR_2014_s_1	1
F_fleet_4_YR_1986_s_1	10
SR_LN(R0)	42
Retain_L_infl_Charter_Private(3)_BLK2repl_1999	1
Retain_L_infl_ComLL(2)_BLK1repl_1999	7
Retain_L_infl_ComVL(1)_BLK1repl_1999	1
Retain_L_infl_Headboat(4)_BLK2repl_1999	4
Size_DblN_peak_Charter_Private(3)	1
Size_DblN_peak_Headboat(4)	1
Size_DblN_top_logit_Charter_Private(3)	4
Size_DblN_top_logit_Headboat(4)	20
Size_inflection_ComLL(2)	1

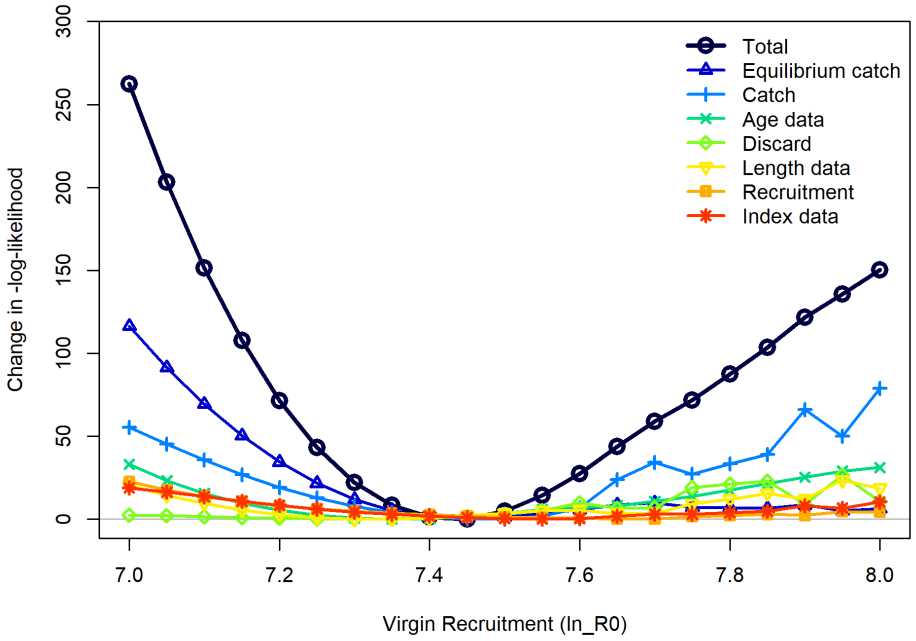


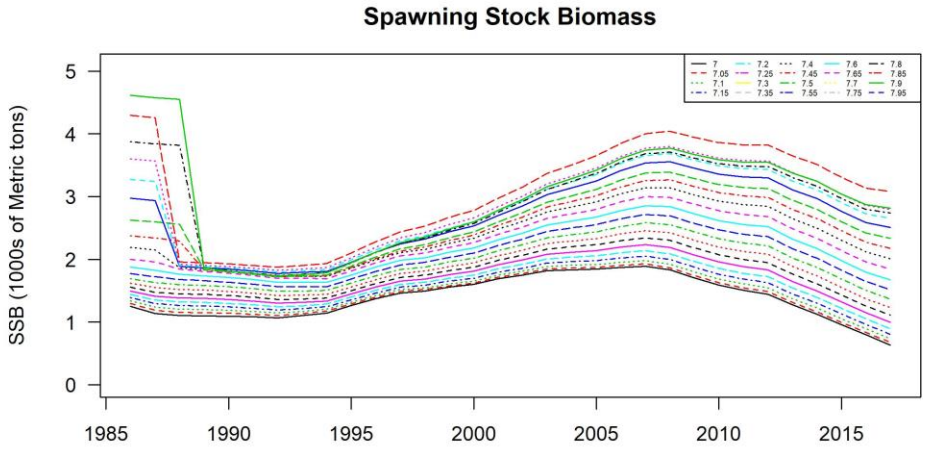
Likelihood profiles

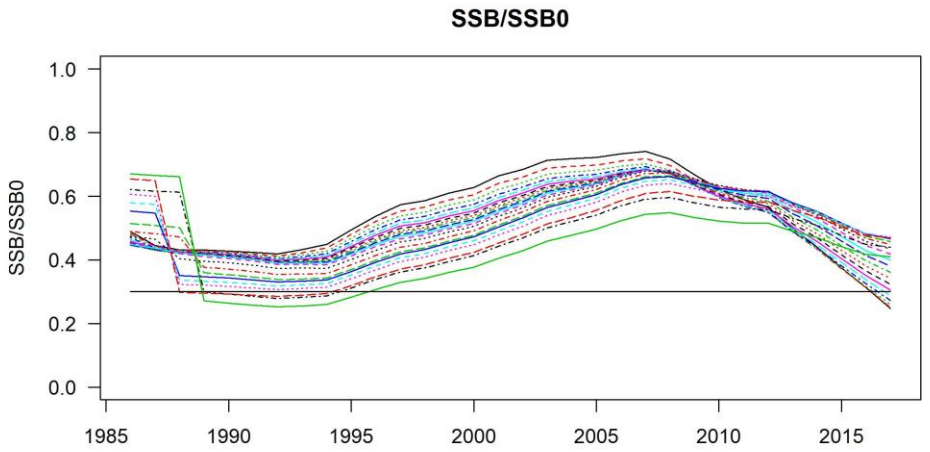
- Evaluate ability to estimate various parameters and most likely values
  - Ln R0: Log of equilibrium recruitment
  - Sigma R: standard deviation in recruitment
  - Steepness (h): fraction of the unexploited recruits produced at 20% of the equilibrium spawning biomass level
  - Initial Fs for each fleet
  - Von Bertalanffy Growth Parameter K

Likelihood profile: Virgin recruitment (R0)

- Total NLL Minimum: 7.45
- 7.4-7.45 within 2 NLL
- Most data sources show minimum close to model estimate



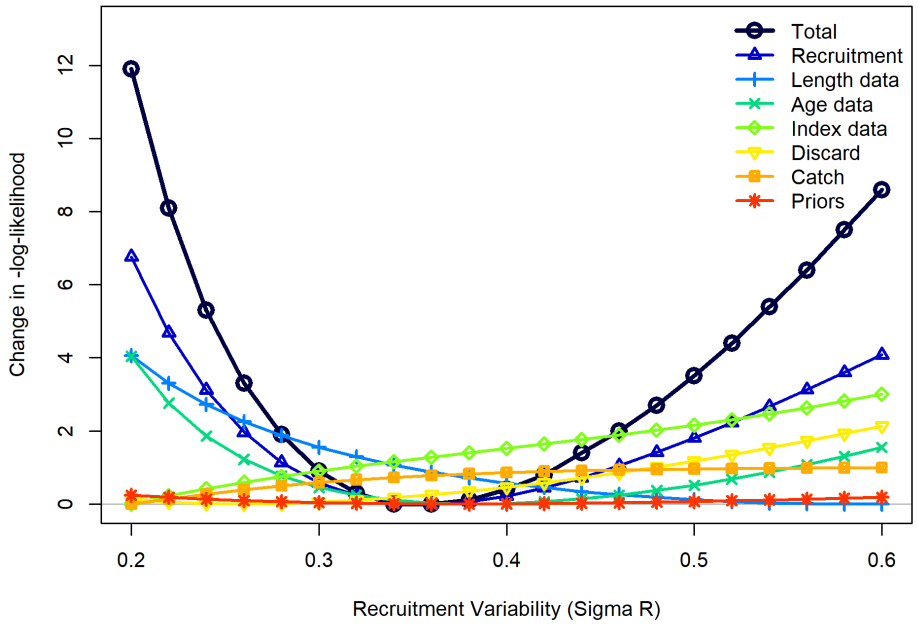


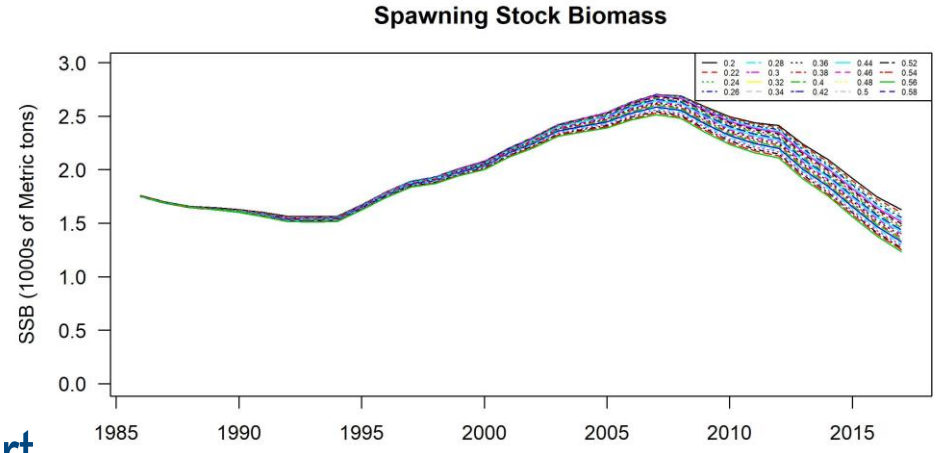


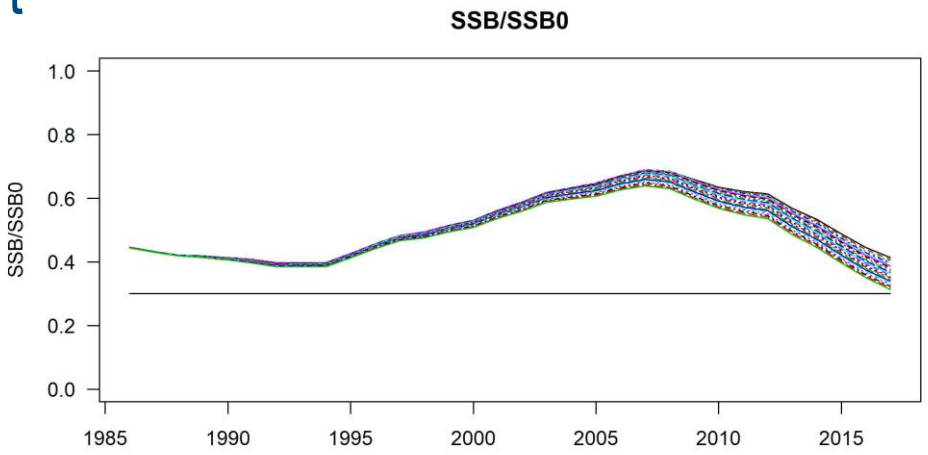
Label	Value	Parm_StDev	CV
SR_LN(R0)	7.433	0.021	0.003

Likelihood profile: Recruitment variance

- Total NLL Minimum: 0.34-0.36
- 0.28-0.46 within 2 NLL
- **Catch**, **Discards** and **Index** support low, **Length** supports high values



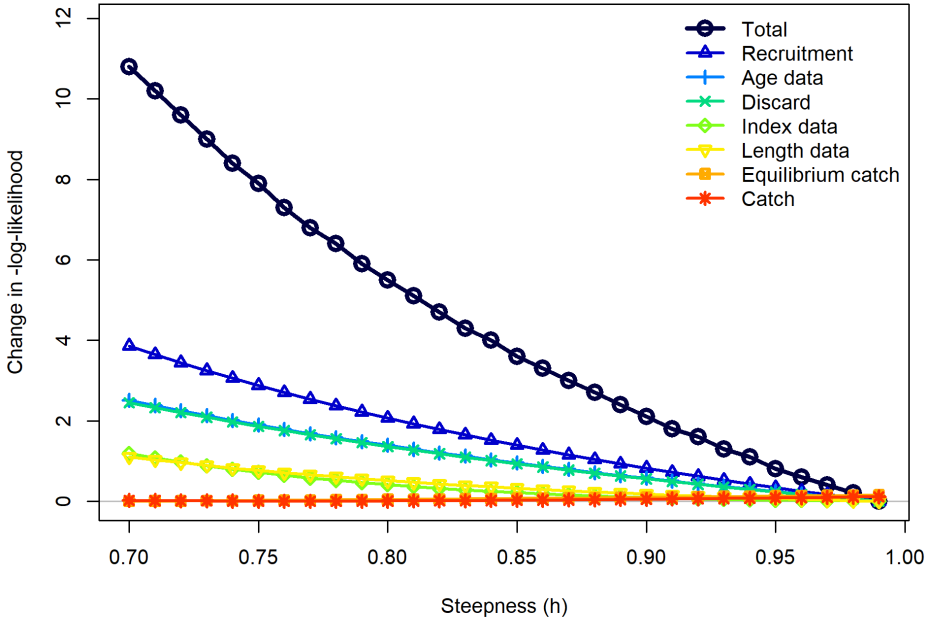


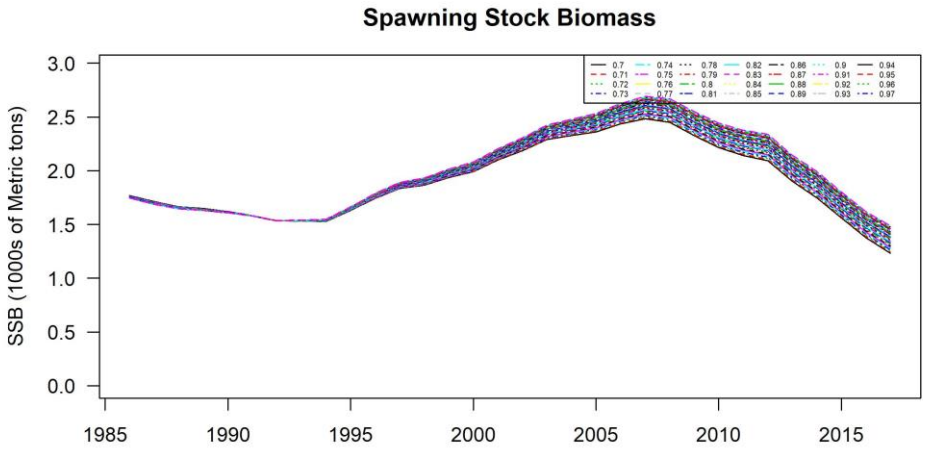


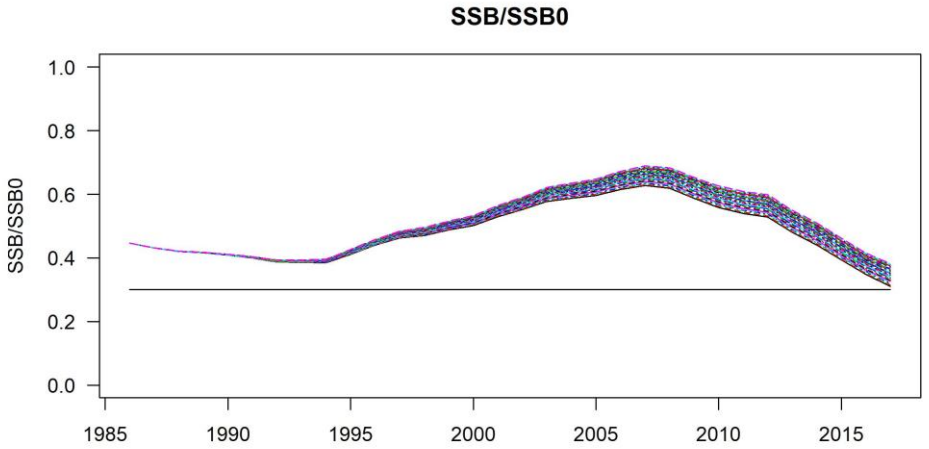
Label	Value	Parm_StDev	CV
SR_sigmaR	0.356	0.045	0.127

Likelihood profile: Steepness – no prior

- Total NLL Minimum: 0.99
- 0.91-0.99 within 2 NLL
- Most data sources support high values except **Catch**



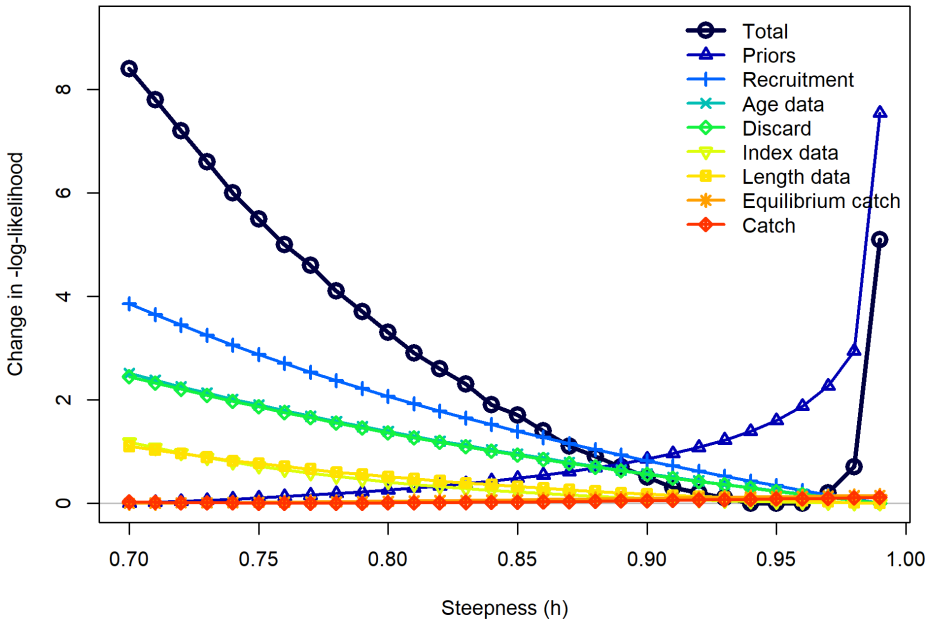


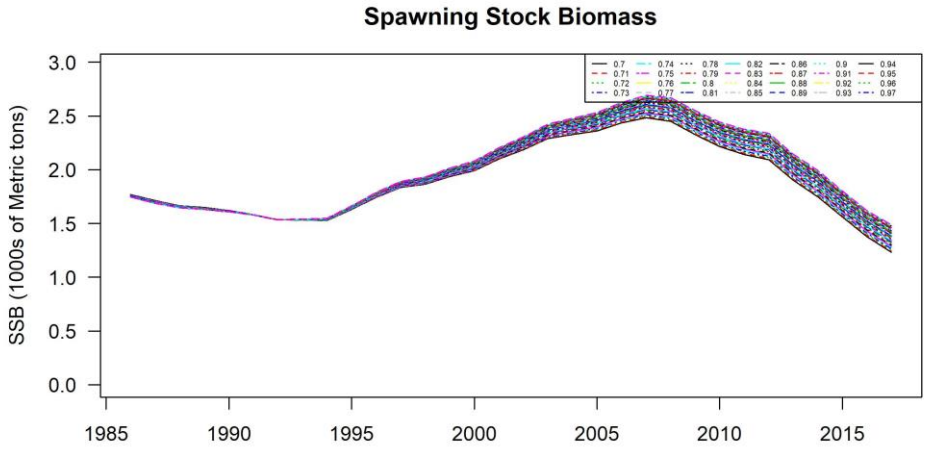


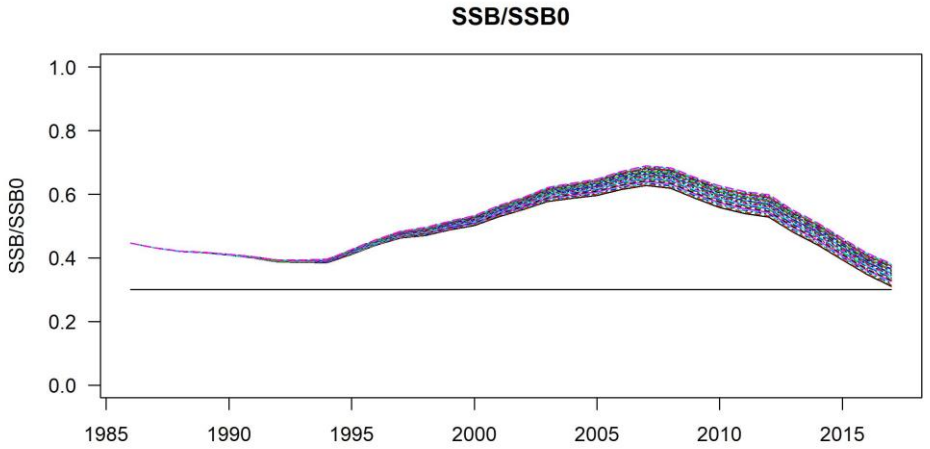
Label	Value	Parm_StDev	CV
SR_BH_steep	0.84	-	-

Likelihood profile: Steepness

- Total NLL Minimum: 0.94-0.96
- 0.84-0.98 within 2 NLL
- Most data sources support high values except **priors**



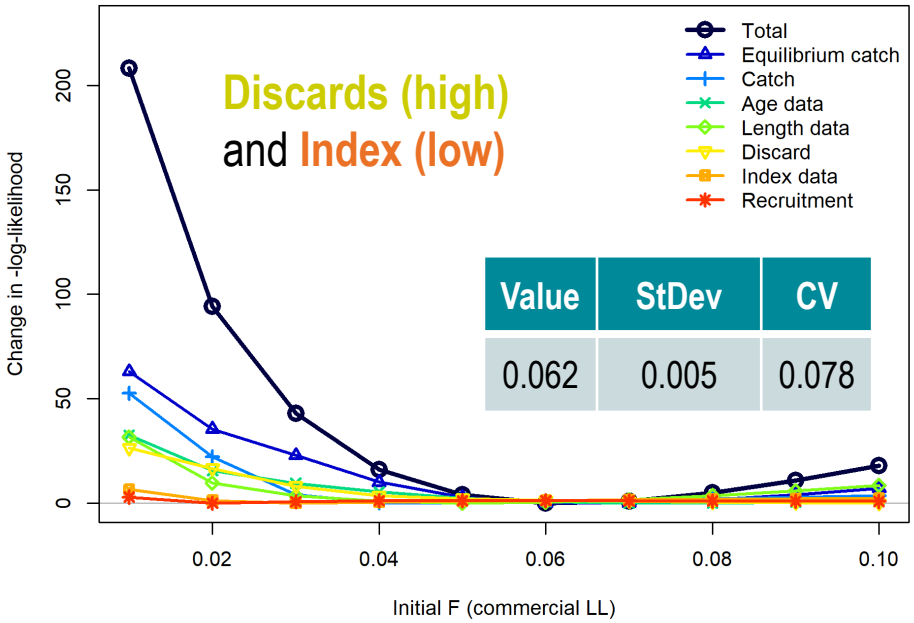


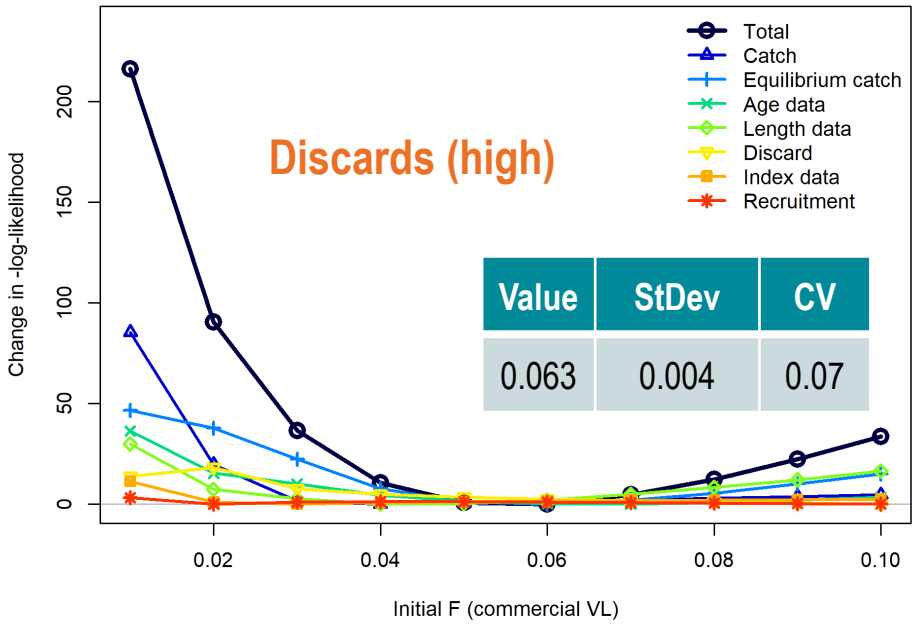


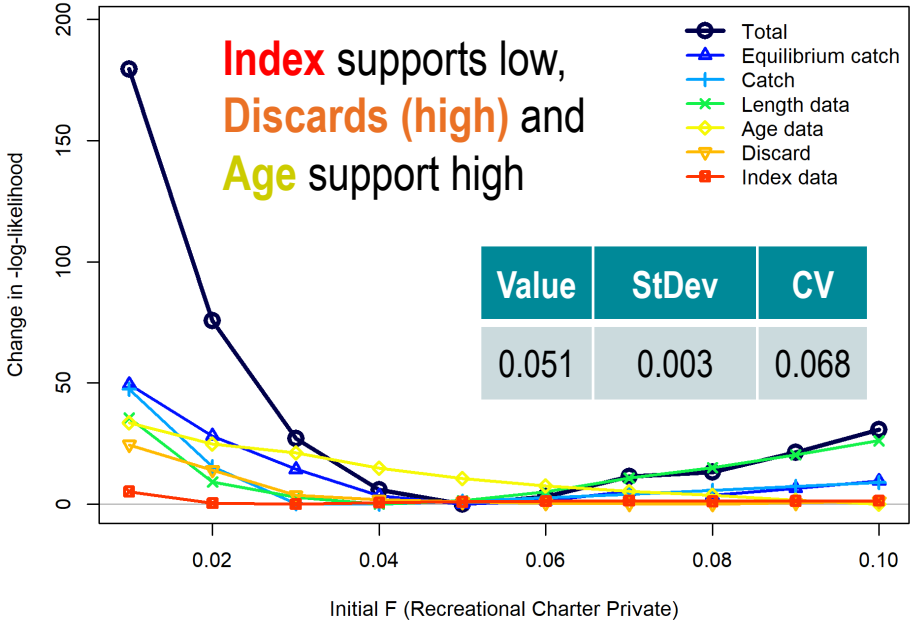
Label	Value	Parm_StDev	CV
SR_BH_steep	0.949	0.039	0.041

Likelihood profile: Initial F

- Most data sources show minimum close to model estimate

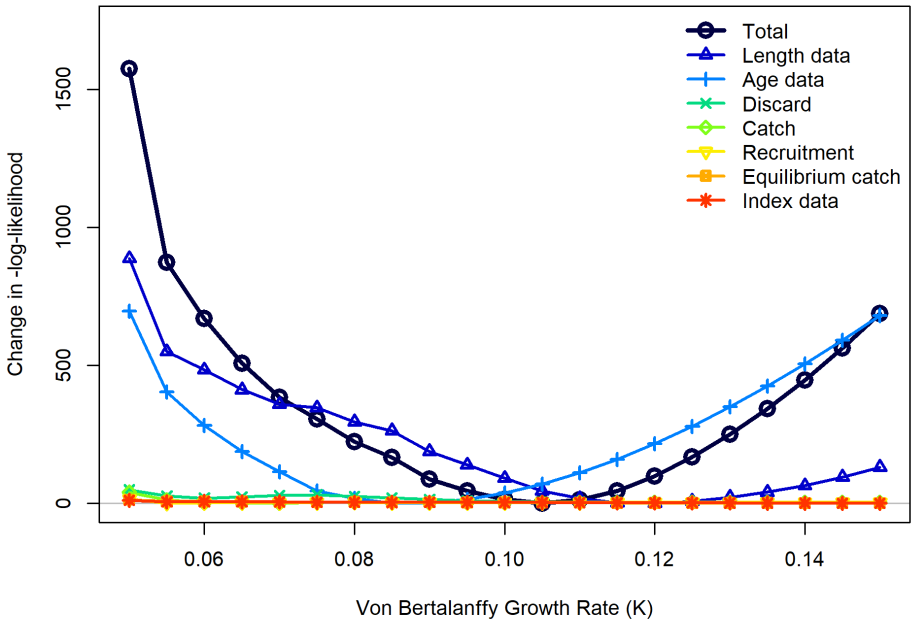


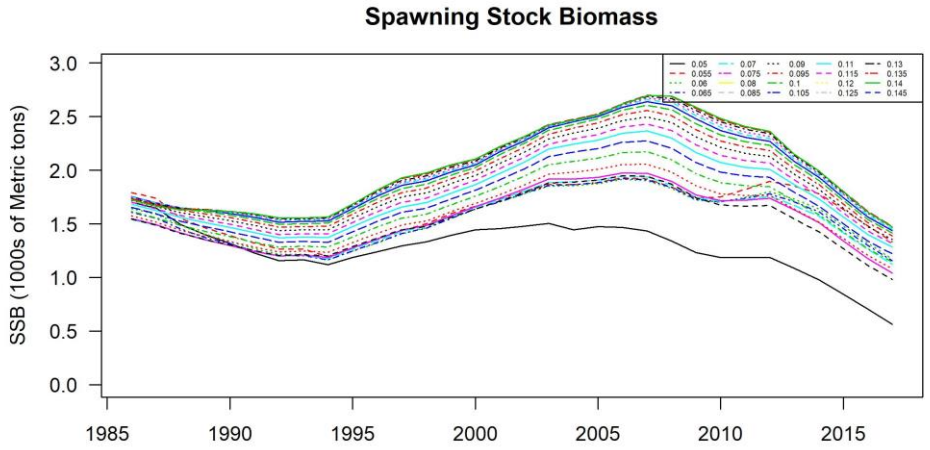


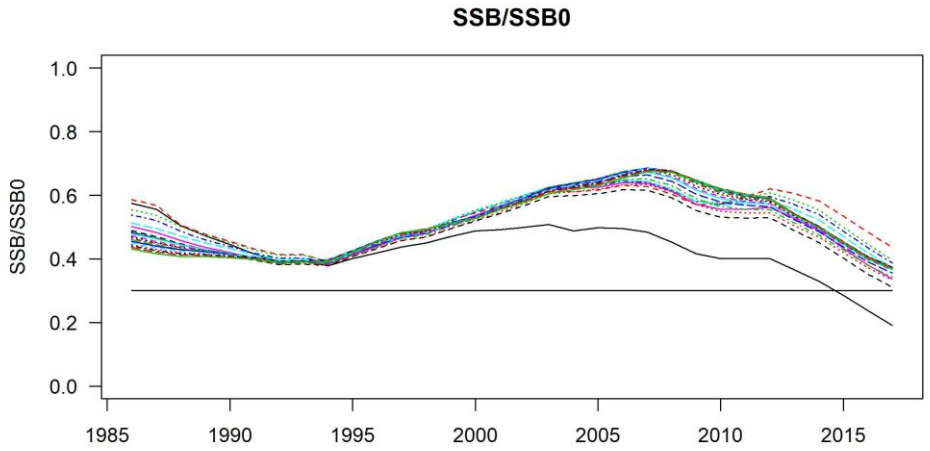


Likelihood profile: K

- Total NLL Minimum: 0.105
- None within 2 NLL
- **Age** supports 0.085, **Length** support ~0.12



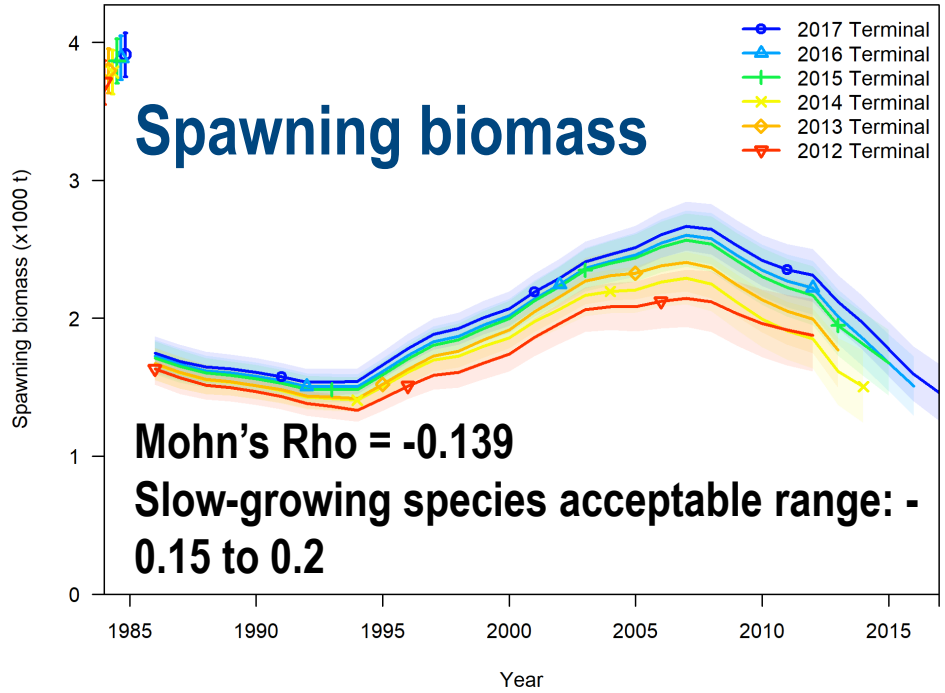


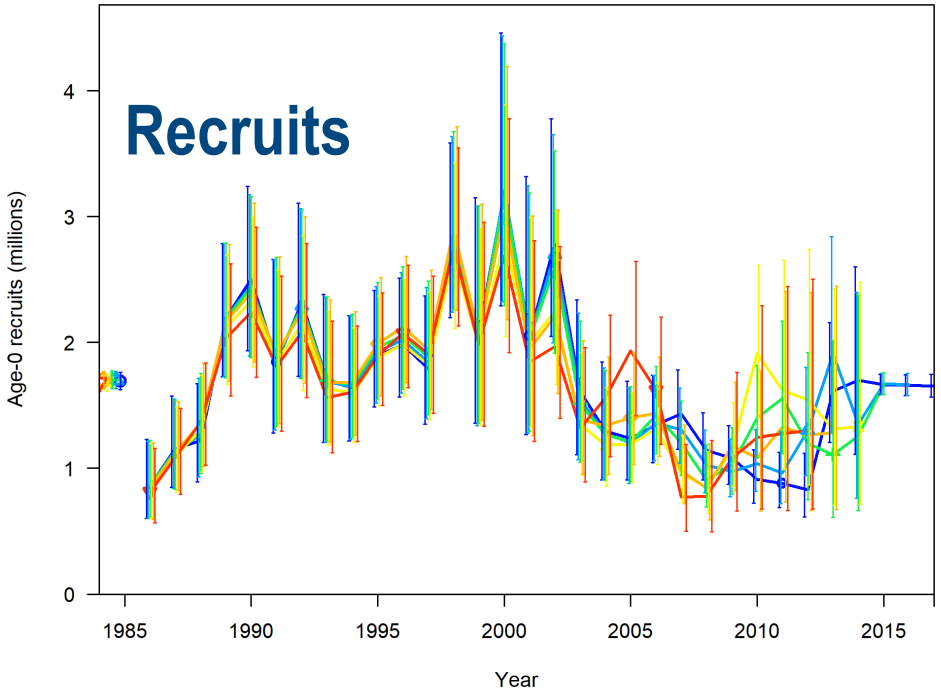


Label	Value	StDev	CV
K	0.13406	-	-

Retrospective runs

- Purpose: assess consistency of stock assessment results and potential biases

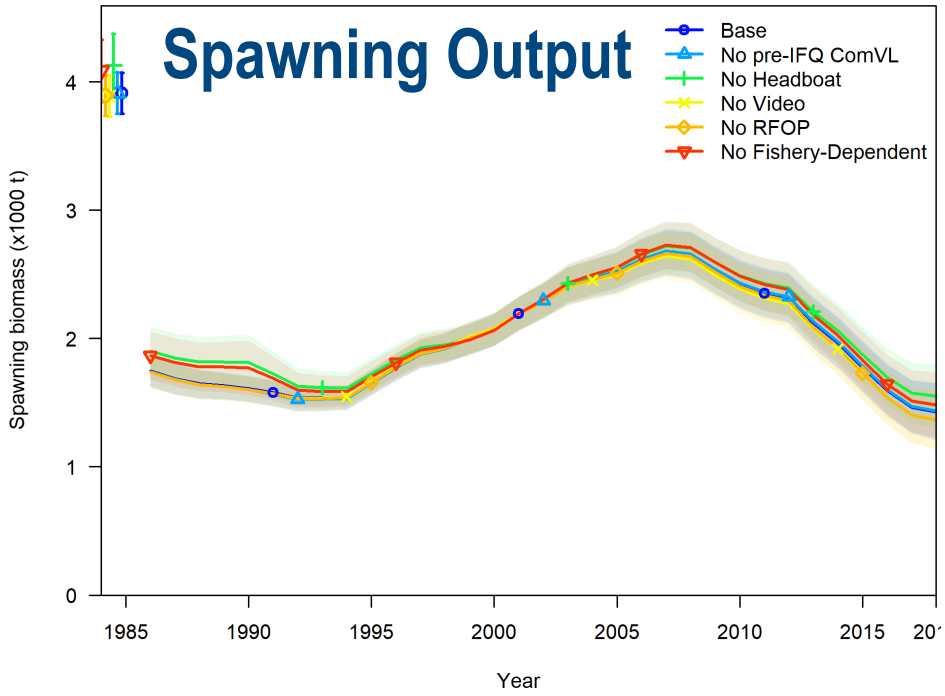


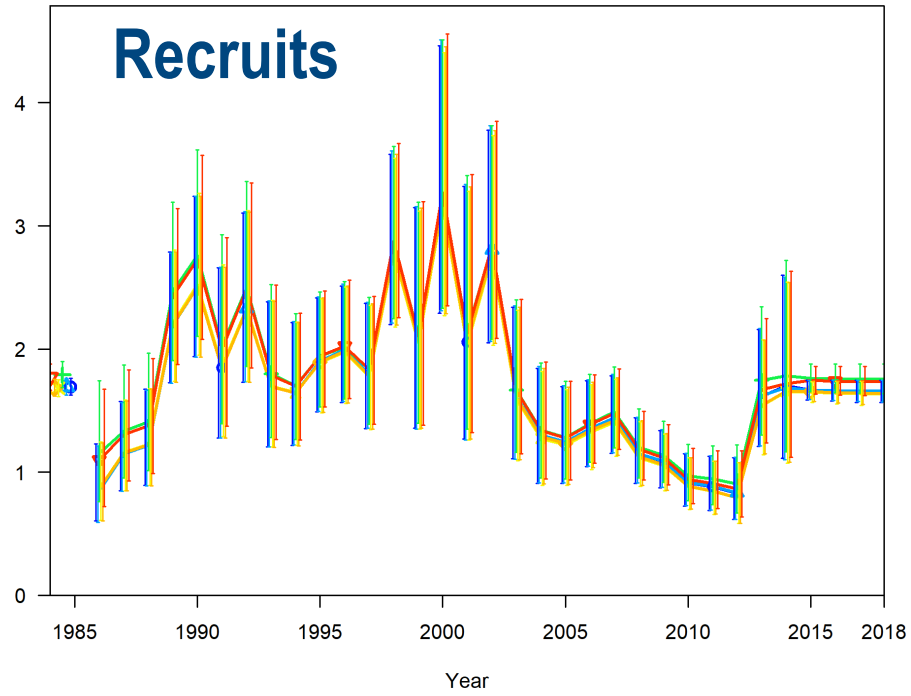


- Last year of estimation of recruitment deviations is 2014

Index Jack-knife runs

- Purpose: determine which index or indices were most influential on derived quantities





- Exclusion of RFOP index leads to slightly lower SSB in recent years (RFOP index increases in recent years)

Outline

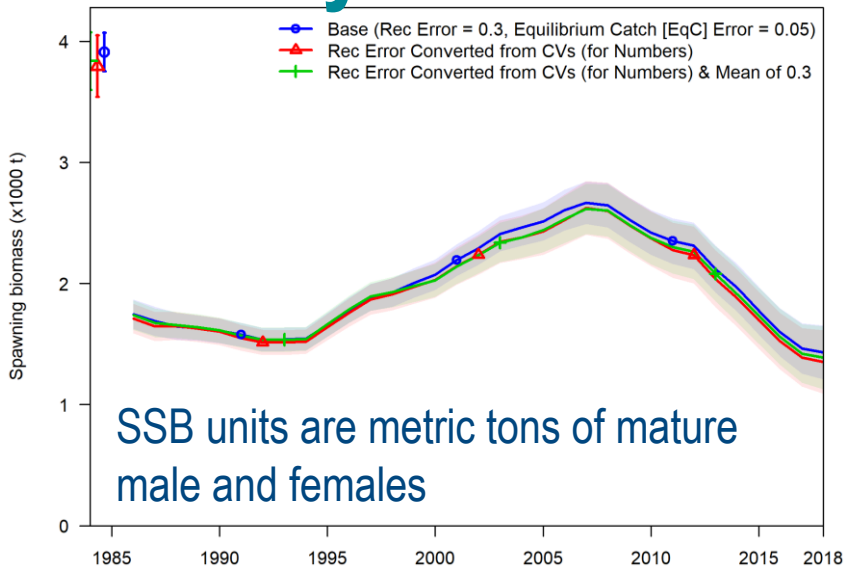
- Data Review
  - Stock definition
  - Regulations
  - Life history
  - Removals
  - Size compositions
  - Age compositions
  - Index of abundance
  - Survey length composition
- Assessment model
  - Base configuration
  - Base results
  - Diagnostics
  - **Sensitivities**

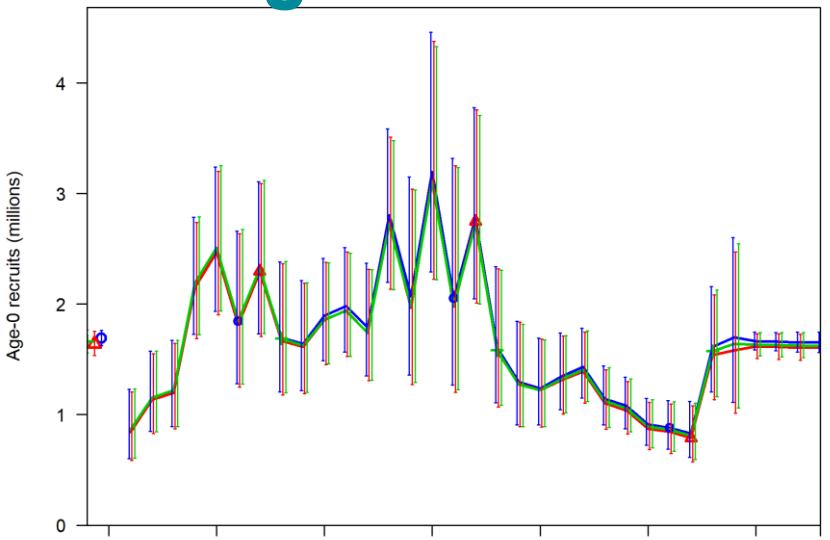
Sensitivity to assumptions

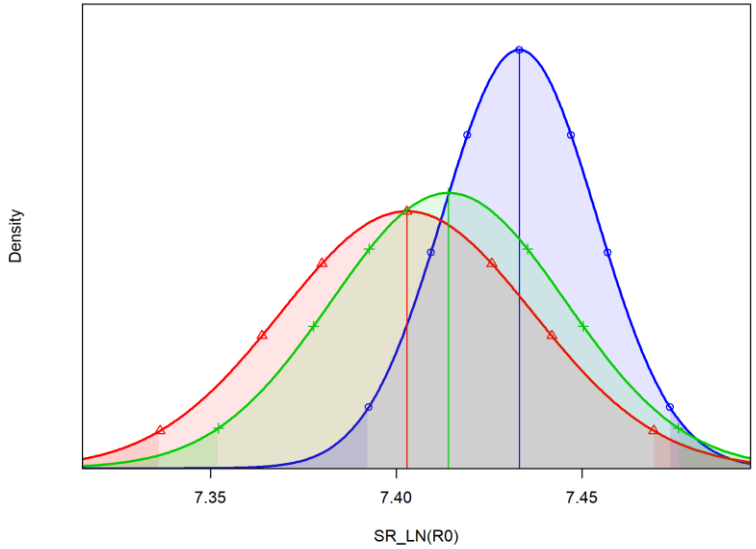
- Recreational landings standard errors (SEs)
- Steepness
- Natural mortality (low and high)
- Male contribution to SSB
- Estimate growth parameters

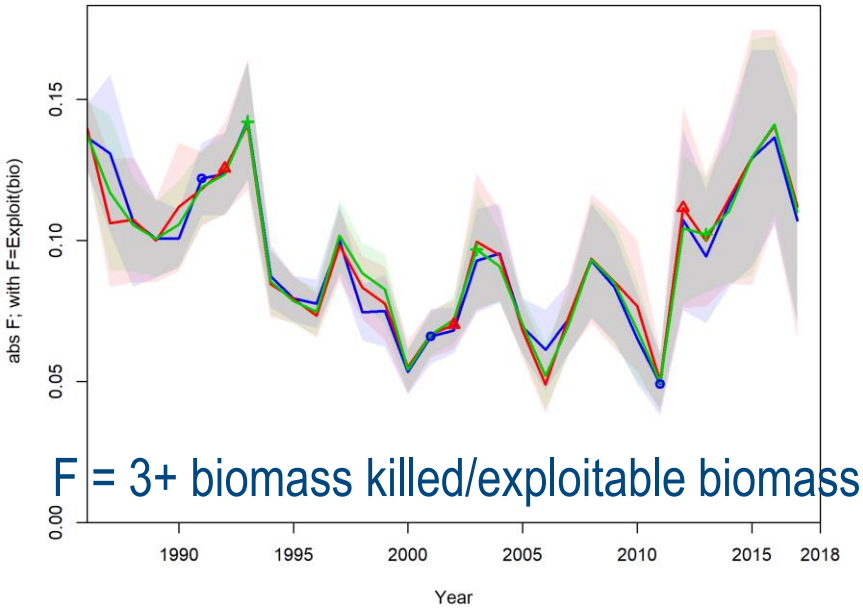
Recreational Landings CV

Sensitivity – recreational landings error

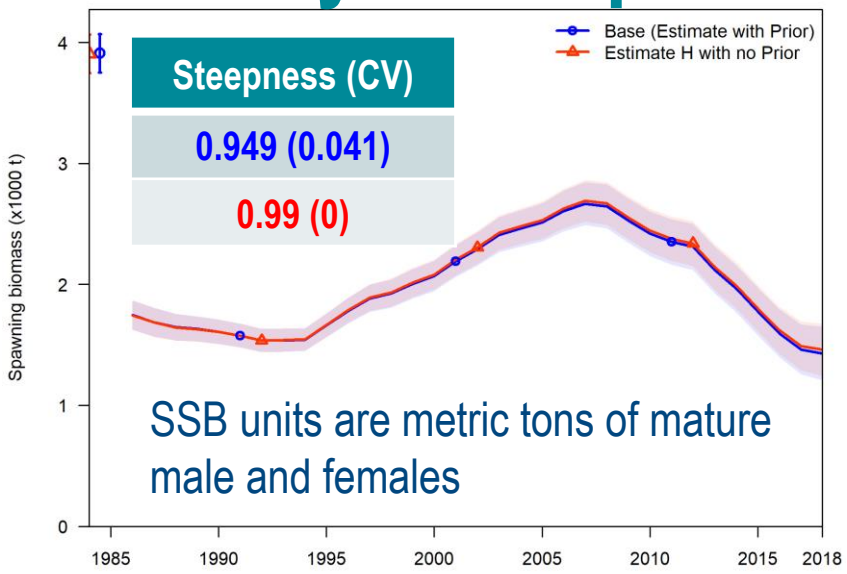


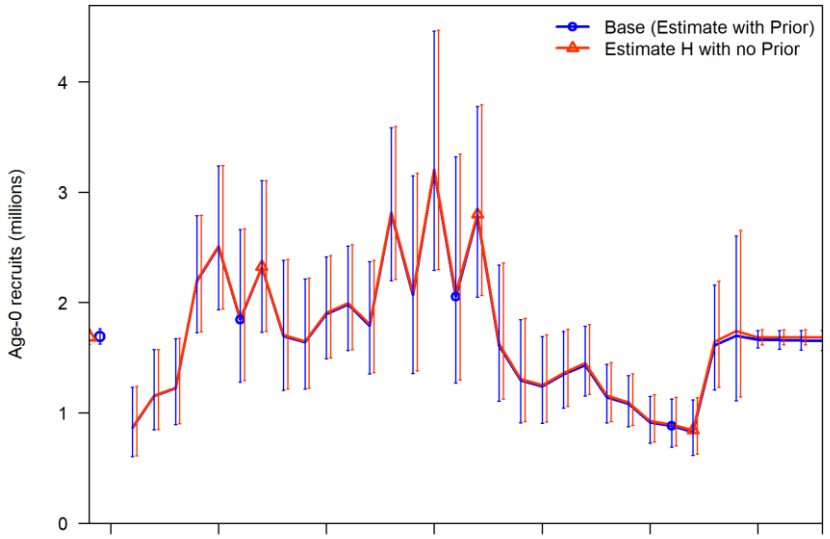


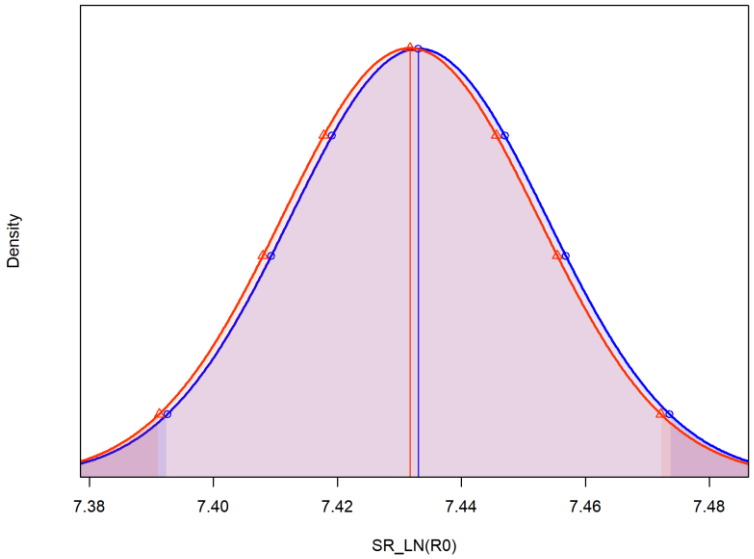


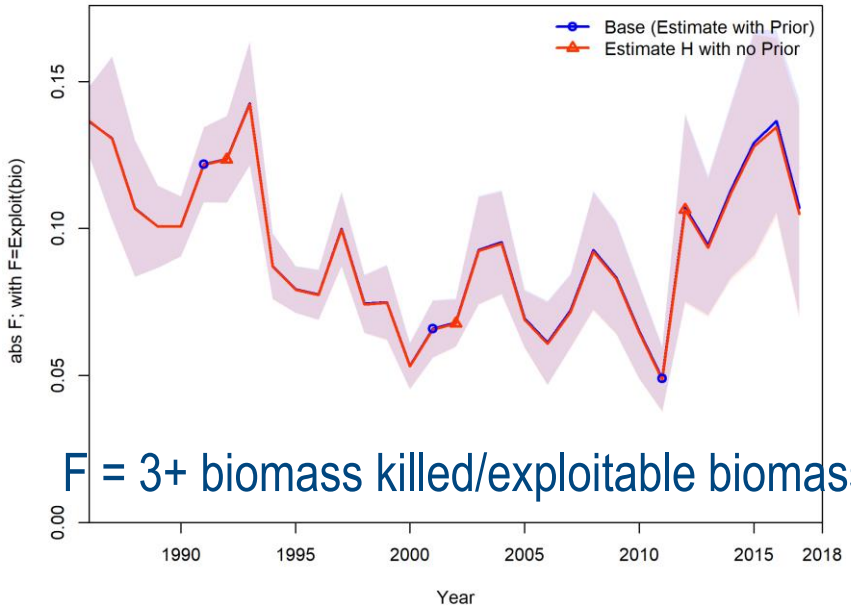


Sensitivity – steepness



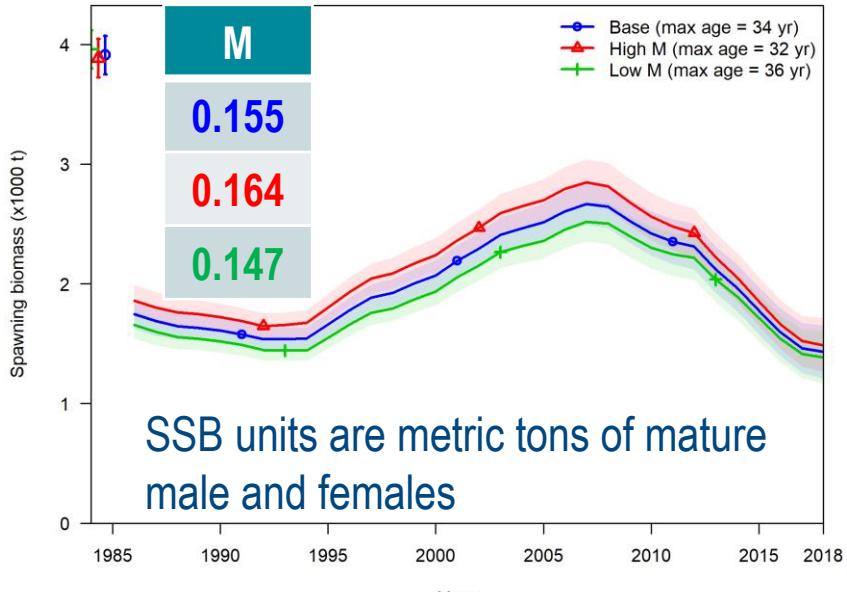


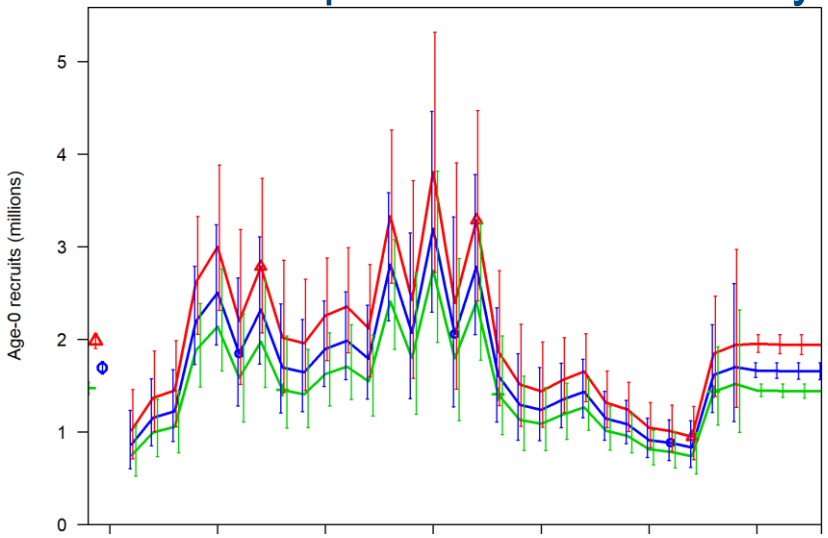


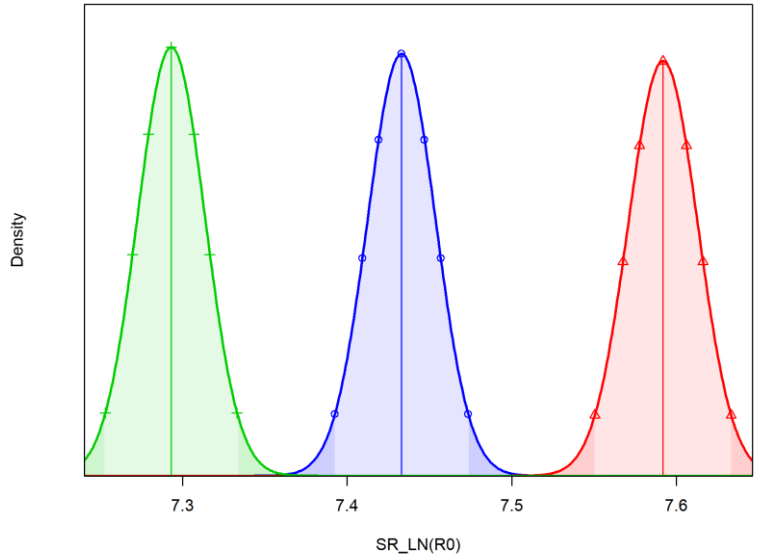


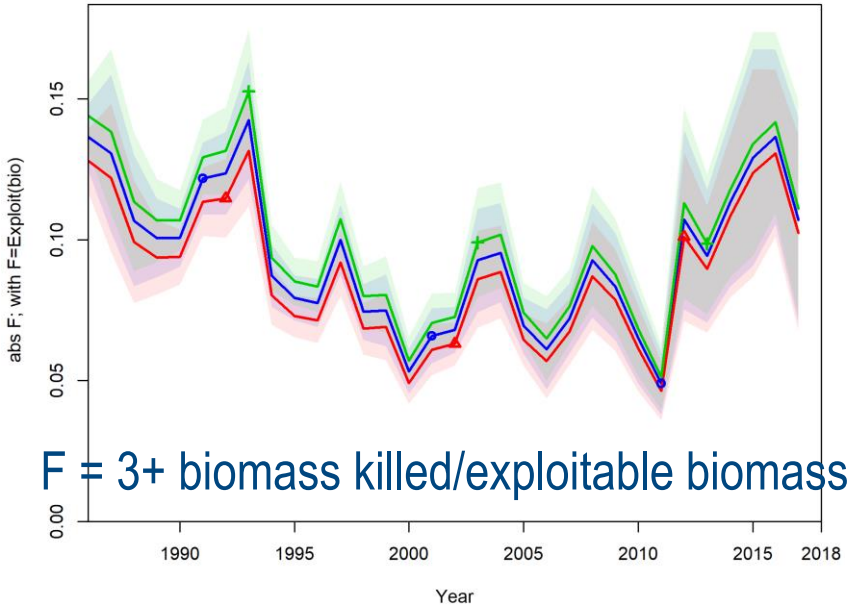
Sensitivity – natural mortality*

*Likely not wide enough to capture real uncertainty

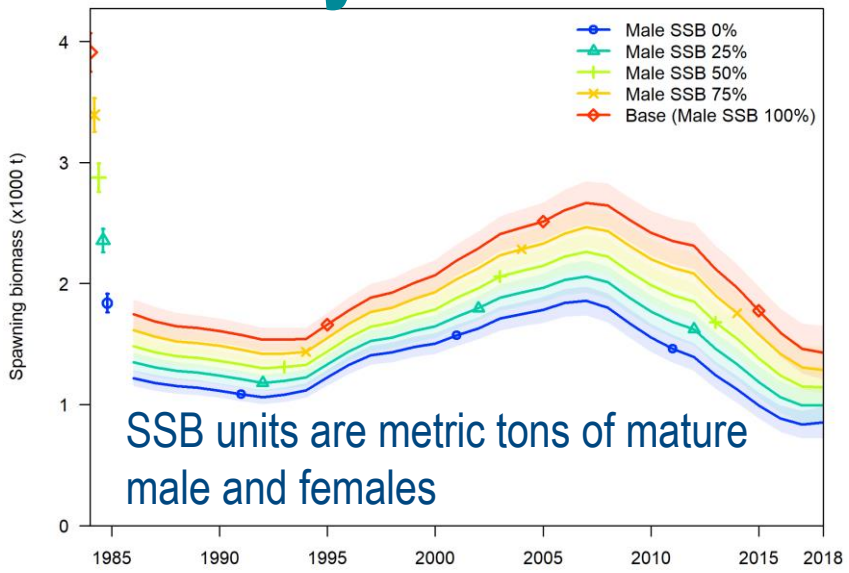




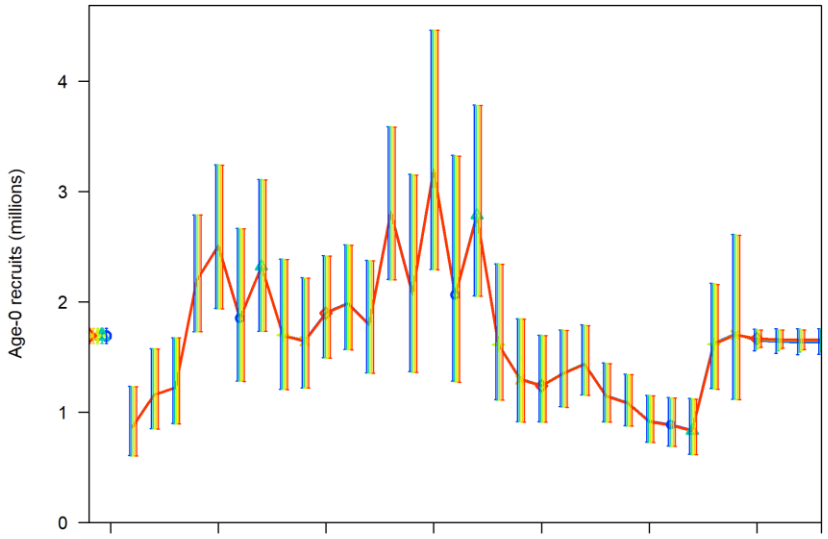


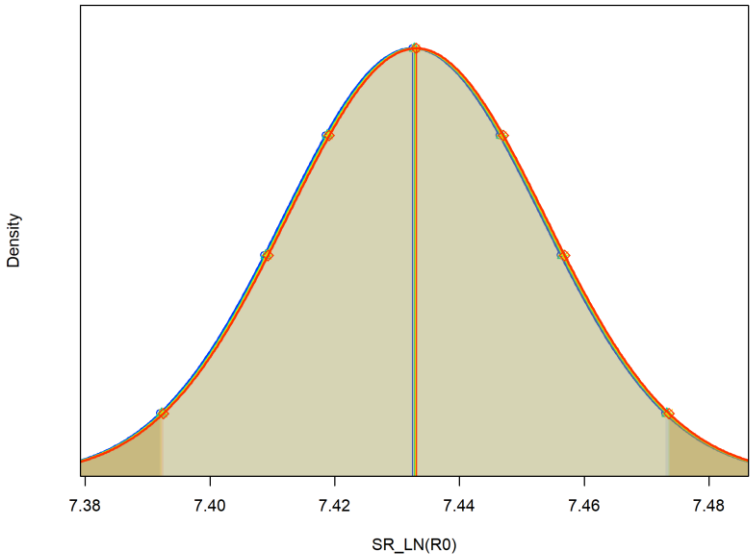


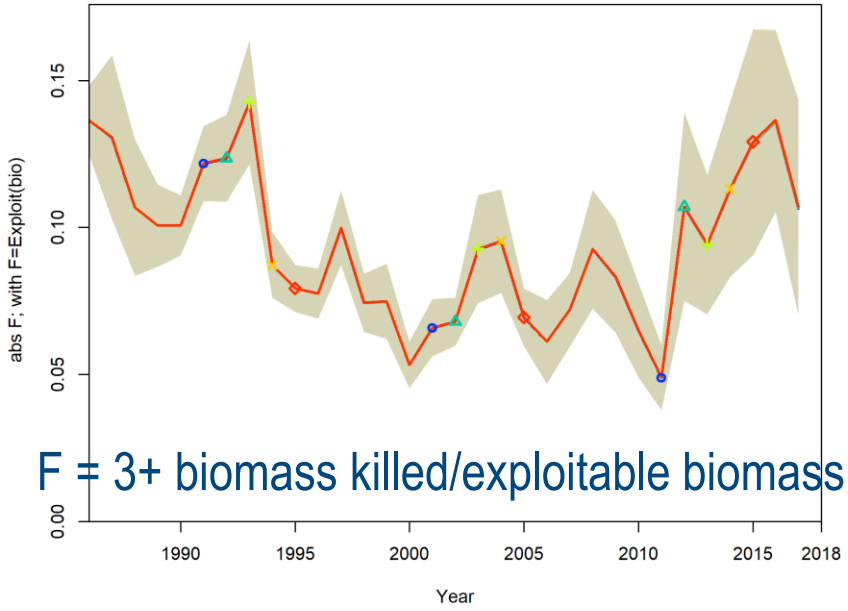
Sensitivity – male contribution to SSB



SSB units are metric tons of mature male and females

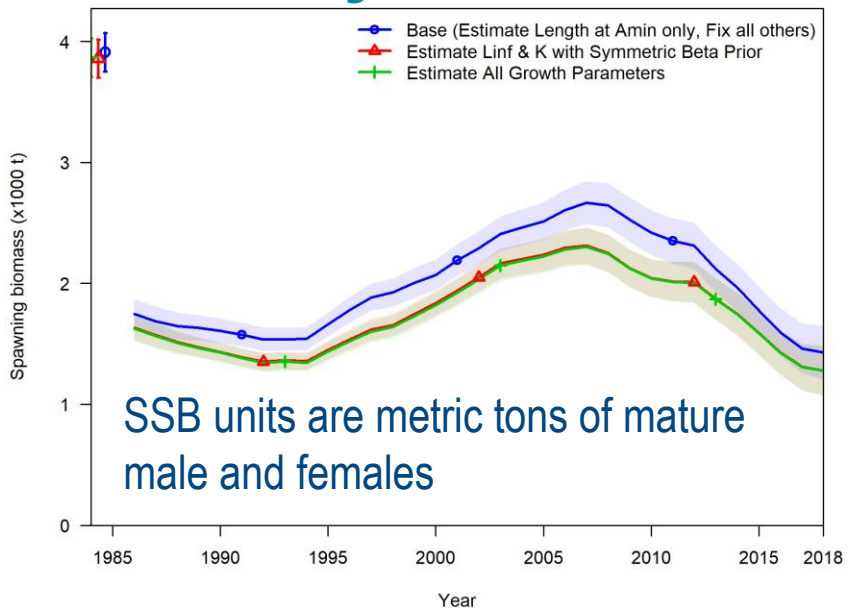


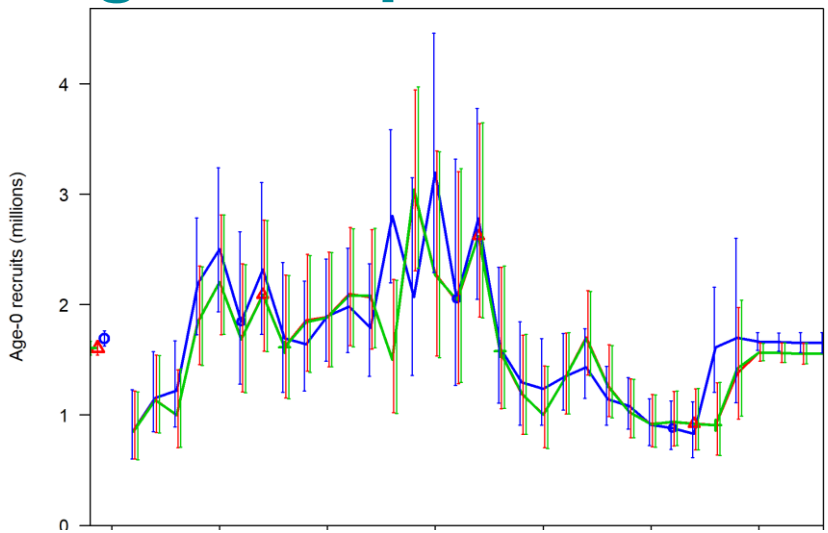




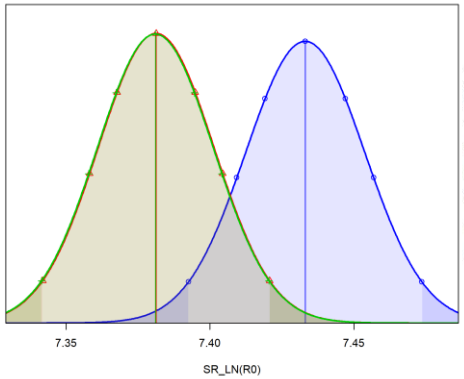
F = 3+ biomass killed/exploitable biomass

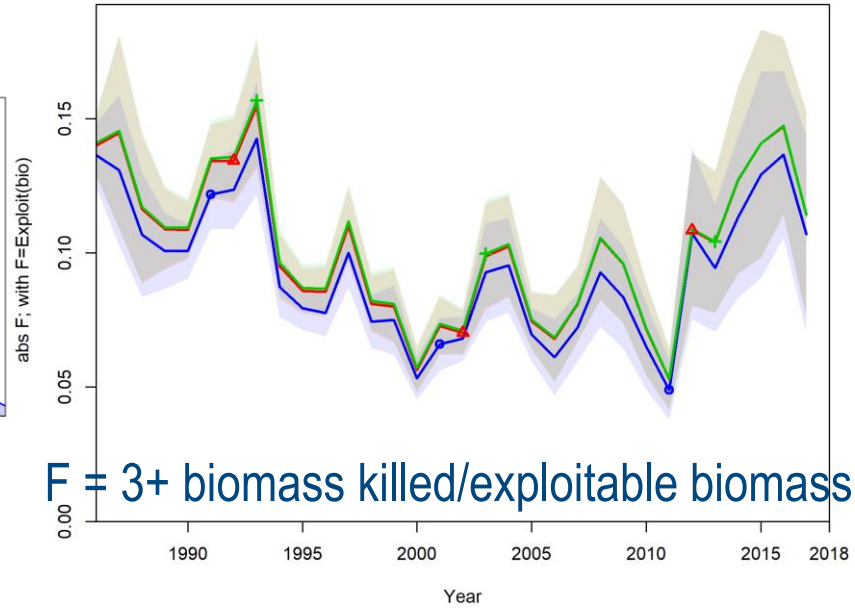
Sensitivity – estimation of growth parameters





Label	Value
L at Amin	22.648 (0.015)
L at Amax (Linf)	**93.914 (0.021)**
K	**0.053 (0.043)**
CV young	0.138 (0.029)
CV old	0.105 (0.073)



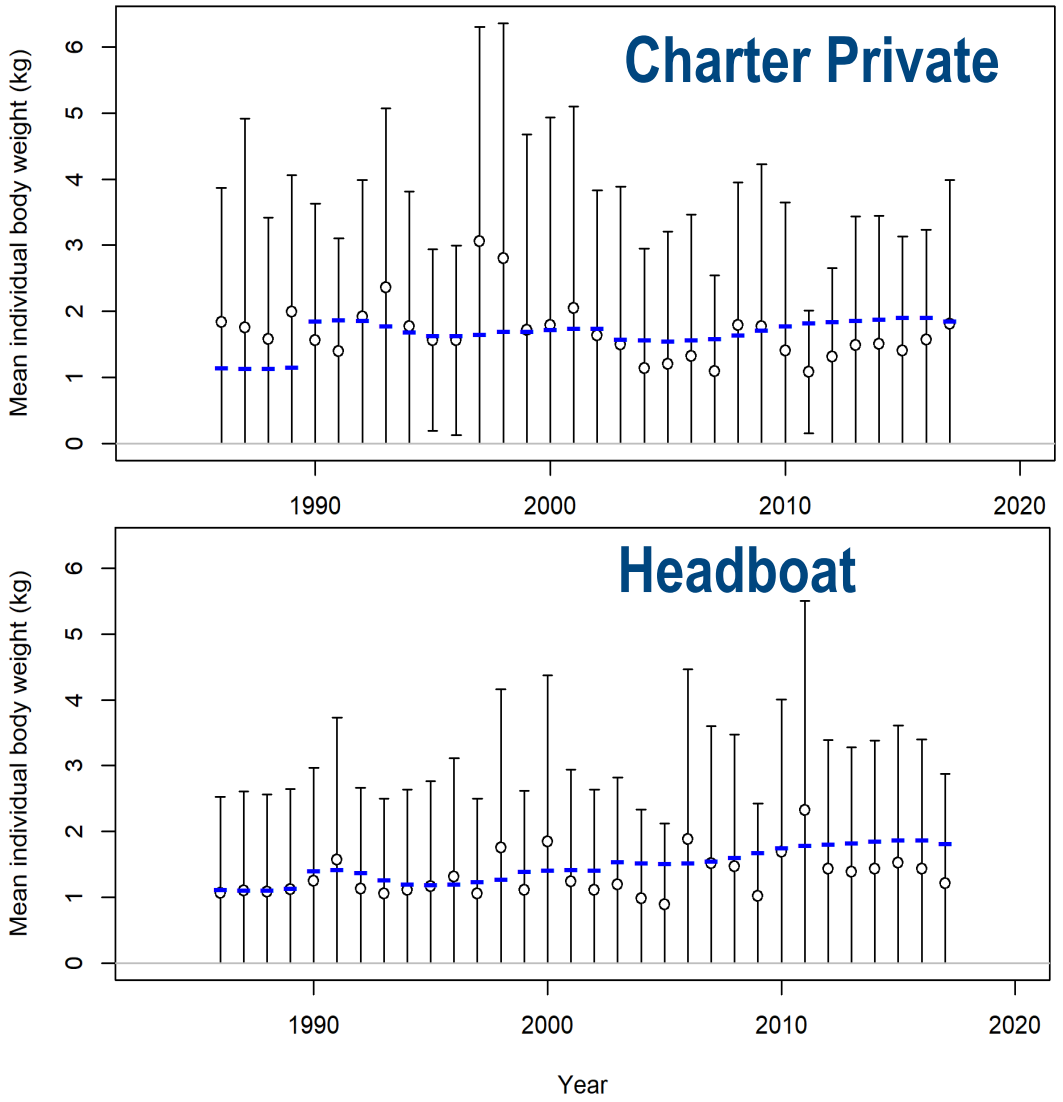


Other Issues

- Including recreational landings in weight or number
- Time-varying retention estimation
  - Current configuration leads to very high discards in the 1990s
- Composition data – commercial conditional age-at-length vs nominal age composition

Recreational landings in weight vs number Alternative approach for consideration

- Input recreational landings in numbers and fit to mean weight
  - Weight/numbers
- Would remain consistent with the native units of the recreational surveys
- **SEDAR68-RW-01**



Sensitivity – rec landings weight vs numbers