SEDAR 56 – South Atlantic Black Sea Bass

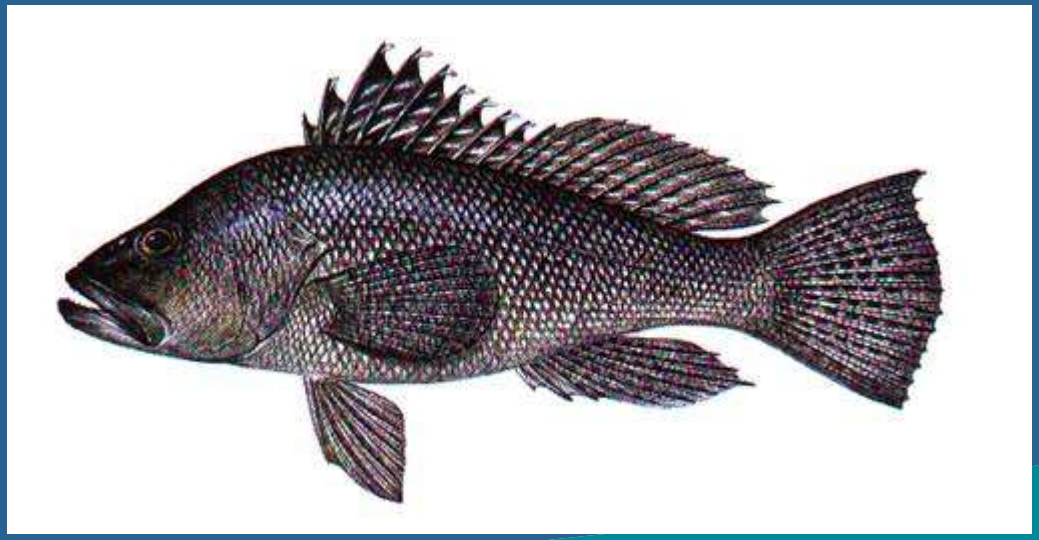
SSC meeting

Charleston, SC

May 1-3, 2018

NOAA FISHERIES

Sustainable Fisheries Branch, Beaufort, NC



Outline

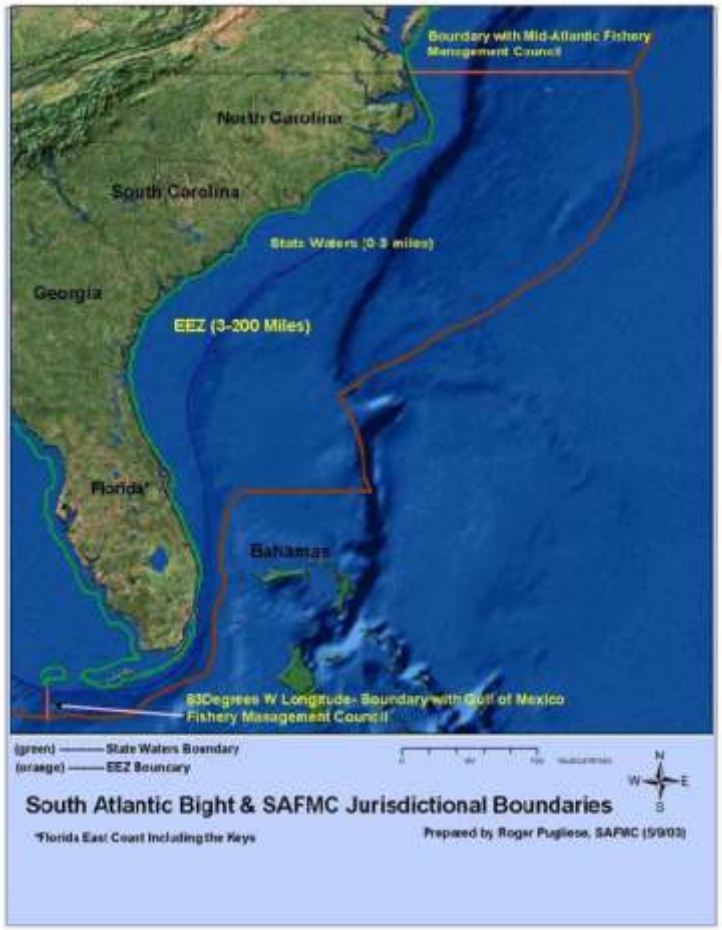
- Background
  - Regulations and Jurisdiction
  - Terms of Reference
- Data Review
  - Stock definition
  - Life history
  - Removals
  - Compositions
  - Indices of abundance
  - Summary of updates/modifications
- Catch-age model
  - Base run
  - Sensitivities
  - Uncertainty analysis
- Projections

Background

- This is a standard assessment evaluating the stock of black sea bass, *Centropristis striata*, off the southeastern United States.
  - Data and modeling decisions were made by the SEDAR 56 Assessment Panel. All meetings were conducted via webinar.
- The assessment was delayed from its original schedule due to data delays.
- The terminal year was shifted to 2016 (differs from the TORs).

Regulations and Jurisdiction

- Complicated management history provided back to 1983
  - Size limit changes from 8”-13” TL, depending on the fleet.
  - Season start and end dates changed based on quotas and other regulations for fleets and gears within those fleets.
  - Handline, trawl, and pot fleets.
  - Bag limit changes for recreational fleet from 20/person/day to 5/person/day.



TOR related to data inputs

2) "Evaluate and document the following specific changes in input data or deviations from the update model. (List below each topic or new dataset that will be considered in this assessment.)

- Consider the inclusion of the SERFS video index
- Incorporate the latest BAM model configurations, and detail the changes made, and impacts of those changes, between the 2013 SEDAR 25 update model and the proposed SEDAR 56 model.
- Re-consider use of age and length composition data"

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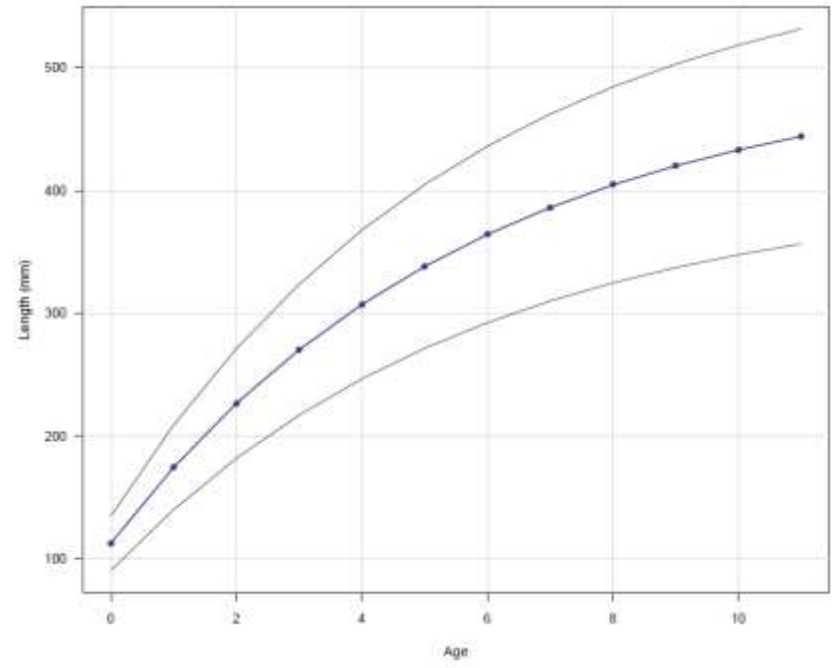
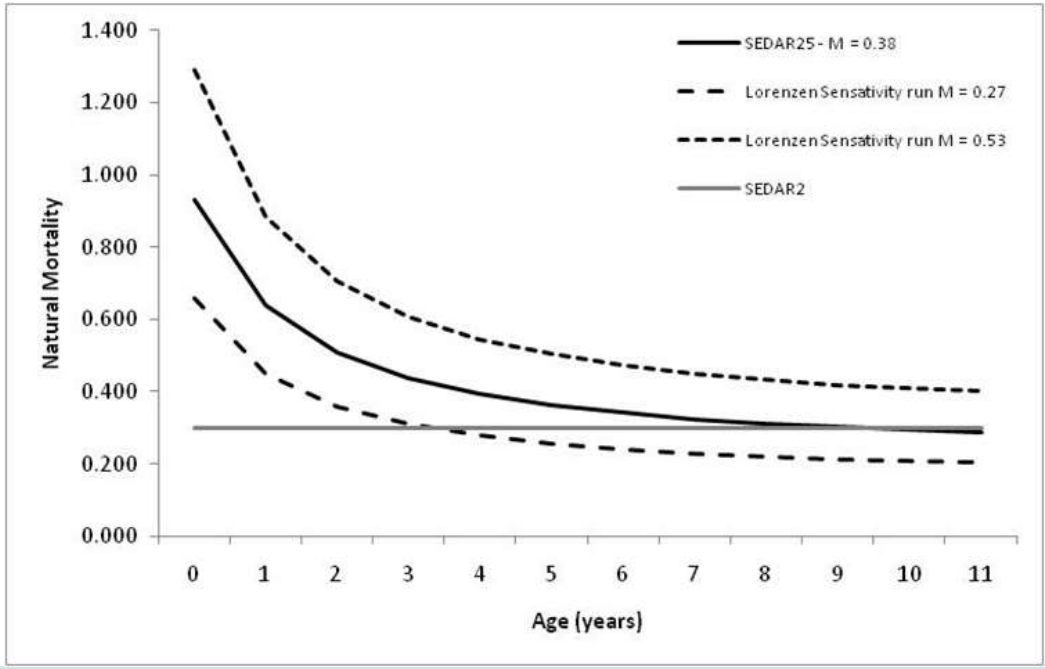
Stock definition

- Northern boundary is Cape Hatteras
- Southern boundary is the Council jurisdictional boundary in the Keys.

Life history

- Von Bert growth (Linf=502.1 mm, k=0.173, t0=-0.97)
- Proportion male: logistic model
- Female maturity: logistic model
- Batch fecundity: log(fecundity) regressed on body weight





Discard Mortality

- SEDAR 25 benchmark and the update:

Gear	Point estimate	Minimum	Maximum
Hook and Line	0.07	0.04	0.15
Trap (1 1/2" panel)	0.05	-	0.15
Trap (2" panel)	0.01	-	0.15

  - Reopened the topic by Panel consensus due to the availability of a new peer-reviewed study:

NRC Research Press

ARTICLE

Estimating reef fish discard mortality using surface and bottom tagging: effects of hook injury and barotrauma

P.J. Rudershausen, J.A. Buckel, and J.E. Hightower

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Paper handled by Associate Editor Josef Michael Jech.

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Corresponding author: P.J. Rudershausen (e-mail: pjrudersn@ncsu.edu).

Can. J. Fish. Aquat. Sci. 71: 514–520 (2014) dx.doi.org/10.1139/cjfas-2013-0337

Published at www.nrcresearchpress.com/cjfas on 18 December 2013.

Discard mortality cont'd.

- Tag-recapture study that used SCUBA to tag trapped fish at depth to provide a control group.
- Fish were captured using traps or hook and line, tagged and released. Subsequent sampling provided a post-release disposition.
- Conducted in Onslow Bay, NC in waters and depths fished by both commercial and recreational fishers for black sea bass (11-35 m overall)
- Mortalities for four dispositions estimated and combined for an overall estimate of 19% for hook and line in 20-35 m depths, and 14% for trap gear in 11-29 m depths.
- Dispositions from FL observer data provided recreational fleet-specific estimates based on mortality rates derived in the Rudershausen et al. 2014 study.

Discard mortality cont'd.

- The panel examined the following:
  - Depths fished in each fleet and with each gear,
  - Disposition data from Florida partners by fleet, and
  - Regulations for mesh size in the commercial pot fishery.
- Rudershausen (2008) study offers a comparison of 2" back panel and 2" all panel, suggesting that discard mortality is similar (2.1% v. 3.6% discard mortality, without accounting for the delayed mortality). Compare that to their estimate of 1.5" all panel :

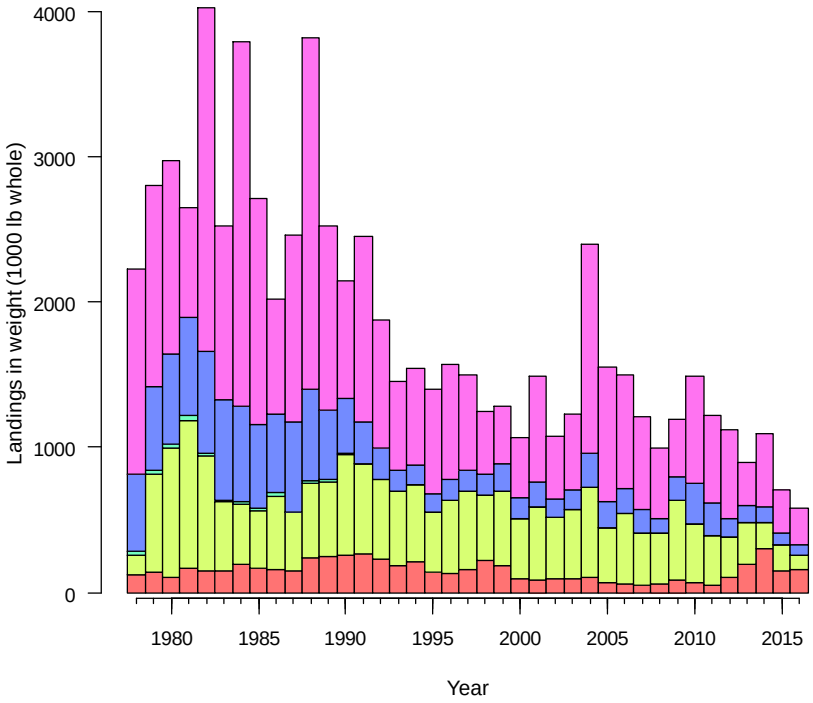
Trap type	Number released	Condition score 1	2	3	4	Presumed mortality (%)
Control	3,093	94.6	1.6	0.2	3.5	5.9
Back panel	388	97.7	1.3	0.3	0.8	2.1
All panel	139	98.6	0.7	0	0.7	3.6

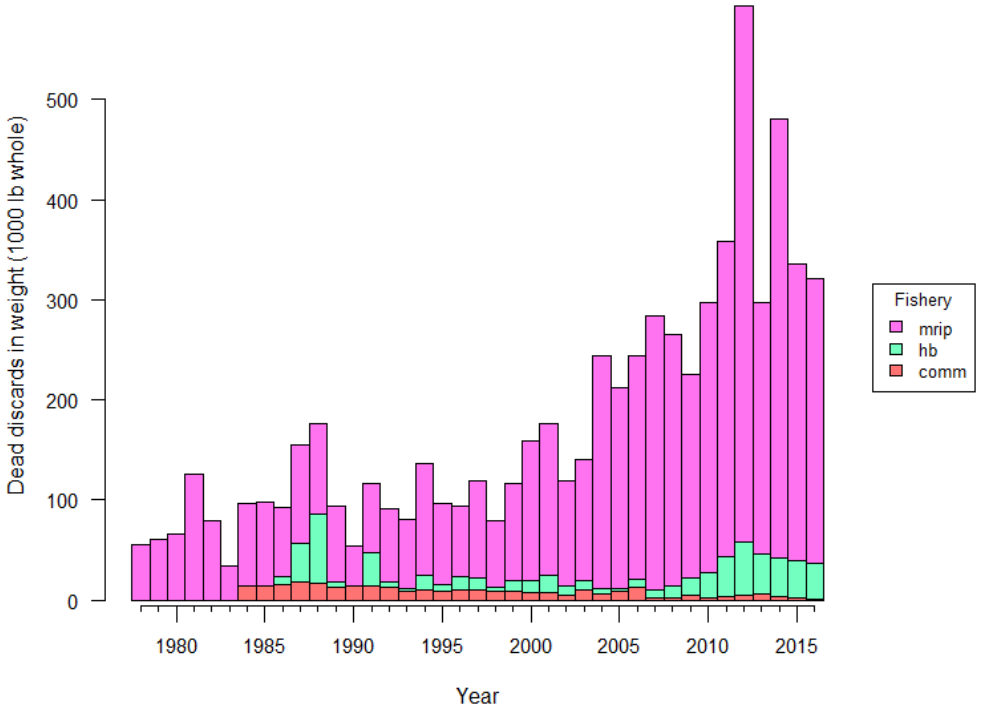
  - 2" mesh ~ 48.3% the mortality of the 1.5" mesh.

New Discard Mortalities used

- Commercial lines – 19%
- Headboat – 15.2%
- Charter – 13.7%
- Commercial Pots 1.5” mesh – 14%
- Commercial Pots 2” back or full panel – 6.8%

Removals – Landings and Discards





Creating Weighted Compositions

- Use a 30 fish minimum per region (Carolinas, FL/GA) annually for length comps, and 10 fish per region annually for age comps or discard comps. (See SEDAR56-WP05)
  - These minimums prevent very small comp sample sizes to be scaled up by large landings.
- Weighted commercial age comps by state landings instead of length. (See SEDAR56-WP06)
- Data were culled if whole haul sampling could not be identified.
- Comps were corrected and updated for all years.

Indices of Abundance

- The chevron trap and video indices are repetitive due to the fact that the video cameras are mounted on the chevron traps.
  - Combined the indices using the Conn method.
- CVID index used chevron trap age compositions.
- The CVs of the fishery dependent indices do not reflect true variation in abundance. Fix the CVs to the highest CV of the combined index (higher for historical series).

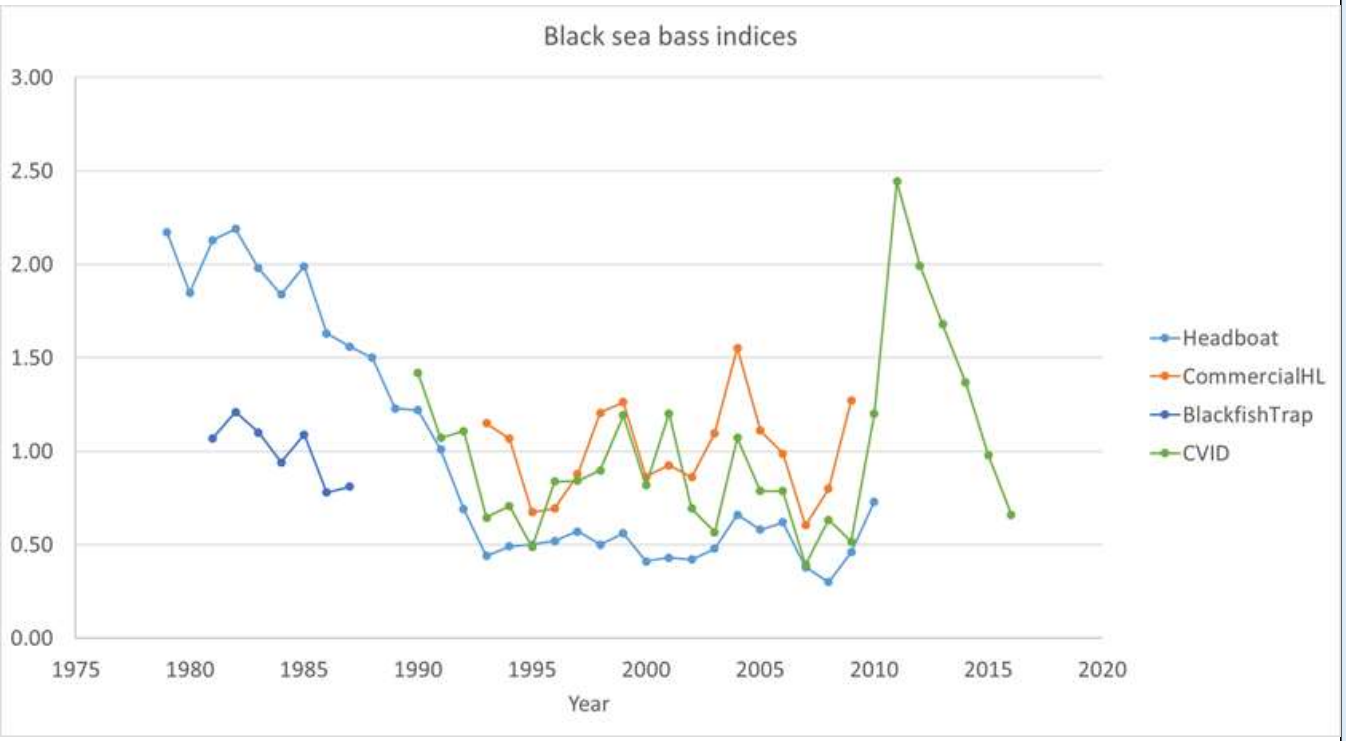
Francis et al. 2003. Quantifying annual variation in catchability for commercial and research fishing. Fish. Bull. 101: 293-304.

Conn, 2009. Hierarchical analysis of multiple noisy abundance indices. Can. J. Fish. Aquat. Sci. 67: 108–120

Indices of Abundance - changes

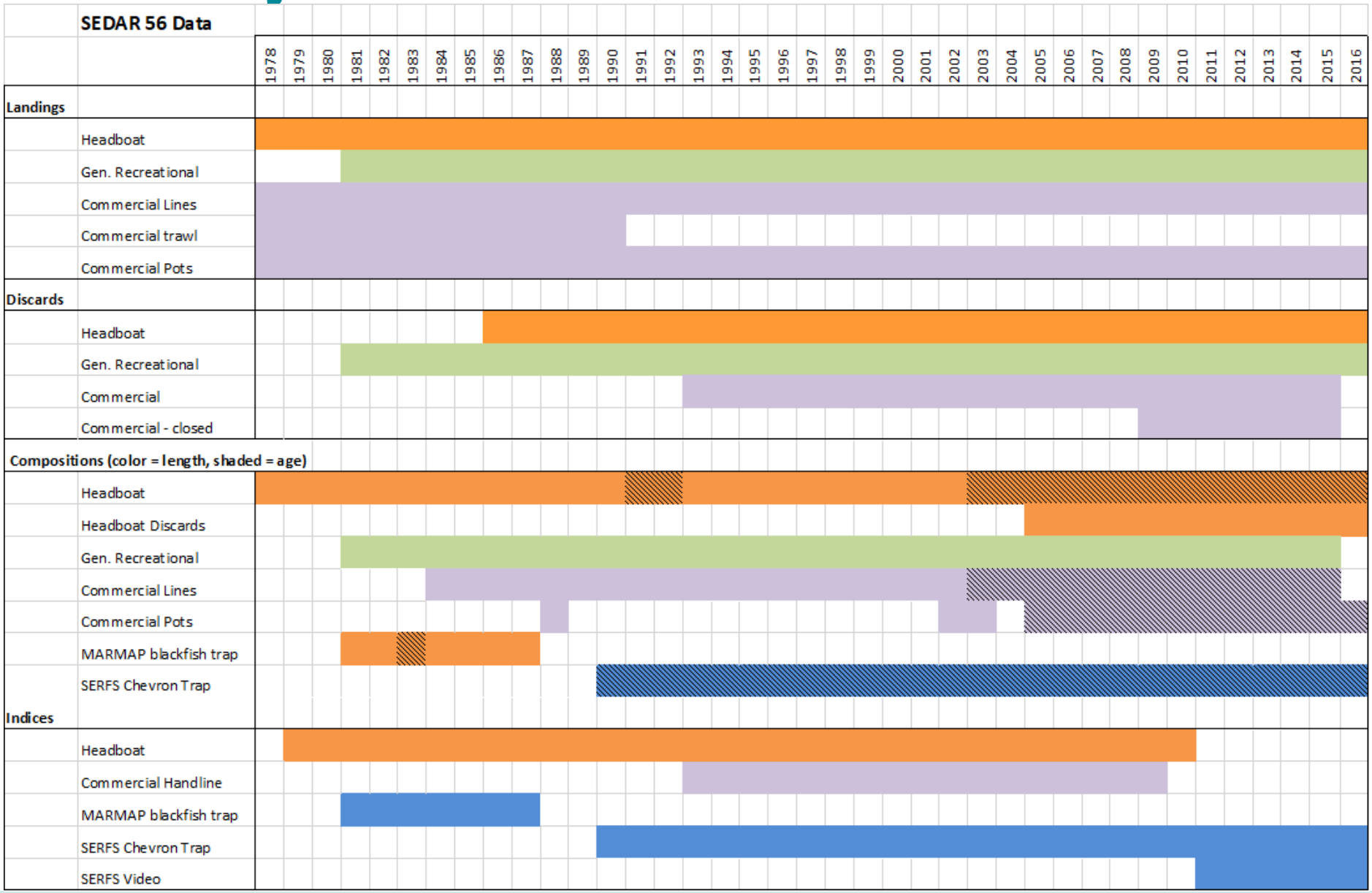
- Excluded HB discard index
  - HB discard index is a shorter time series indexing a similar range and proportion of the population as the chevron trap index.
  - HB Discard length comps used to estimate discard selectivity.
- SERFS Chevron trap index standardized with more recent method – ZINB model

Base run indices and CVs



Year	Headboat	CommercialHL	BlackfishTrap	CVID
1979	0.54			
1980	0.54			
1981	0.54		0.27	
1982	0.54		0.27	
1983	0.54		0.27	
1984	0.27		0.27	
1985	0.27		0.27	
1986	0.27		0.27	
1987	0.27		0.27	
1988	0.27			
1989	0.27			
1990	0.27			0.21
1991	0.27			0.21
1992	0.27			0.22
1993	0.27	0.27		0.24
1994	0.27	0.27		0.22
1995	0.27	0.27		0.24
1996	0.27	0.27		0.24
1997	0.27	0.27		0.22
1998	0.27	0.27		0.21
1999	0.27	0.27		0.22
2000	0.27	0.27		0.23
2001	0.27	0.27		0.23
2002	0.27	0.27		0.24
2003	0.27	0.27		0.25
2004	0.27	0.27		0.23
2005	0.27	0.27		0.23
2006	0.27	0.27		0.23
2007	0.27	0.27		0.27
2008	0.27	0.27		0.23
2009	0.27	0.27		0.24
2010	0.27			0.20
2011				0.17
2012				0.16
2013				0.16
2014				0.16
2015				0.15
2016				0.20

Data fit by the assessment



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Summary of data updates/modifications

- All landings data are complete.
  - For the SEDAR 25 update, some removals were preliminary.
- Removed last year of commercial lines index.
  - Partial closed season.
- Removed MRIP age comps.
  - Panel decided they were not representative of the fleet.
- Updated all discards – model or ratio-based estimates.
- Recalculated all comps and used DM method in the model.
- Chevron trap index standardized using ZINB method and combined with the video index using the Conn method.
- The headboat at-sea index was removed.

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Catch-age model configuration

- Ages 0-11+
- 1978-2016
  - Initialized assuming equilibrium age structure.
- Fleet structure for landings and discards:
  - Commercial
    - Lines
    - Pots
    - Trawl
  - Recreational
    - Headboat
    - General (charterboat and private boats combined)

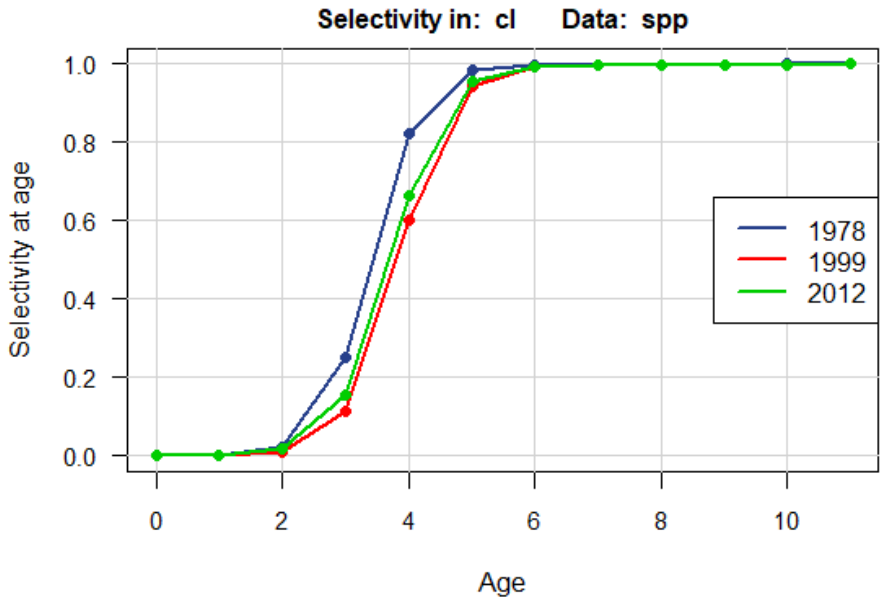
Selectivities time blocks based on regulations

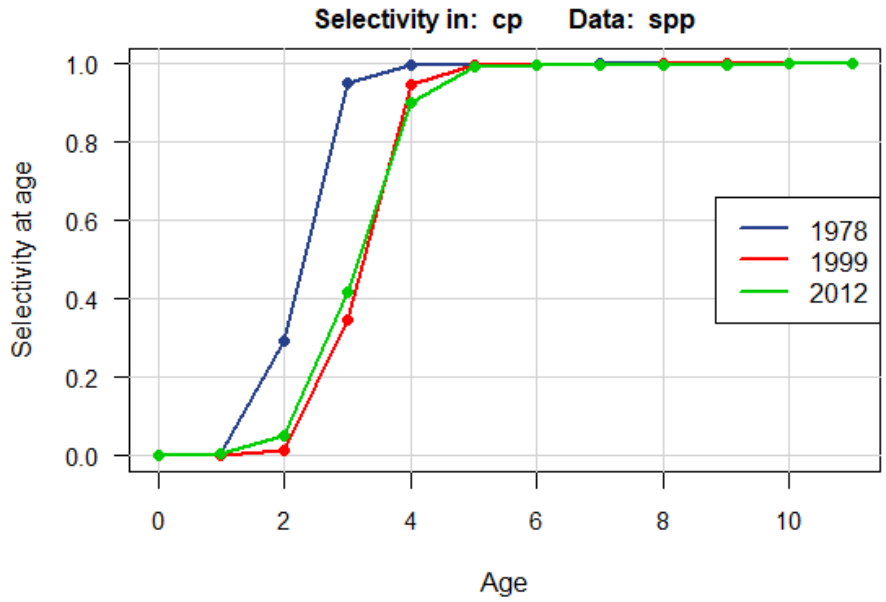
	Recreational	
year	days open	days closed
2010	365	0
2011	182	183
2012	96	269
2013	214	151
2014	365	0
2015	365	0
2016	365	0

	Commercial	
year	days open	days closed
2009	207	158
2010	143	222
2011	44	321
2012	129	236
2013 pots	114	251
2013 HL	365	0
2014 pots	176	189
2014 HL	245	120
2015 pots	184	181
2015 HL	365	0
2016 pots	184	181
2016 HL	365	0

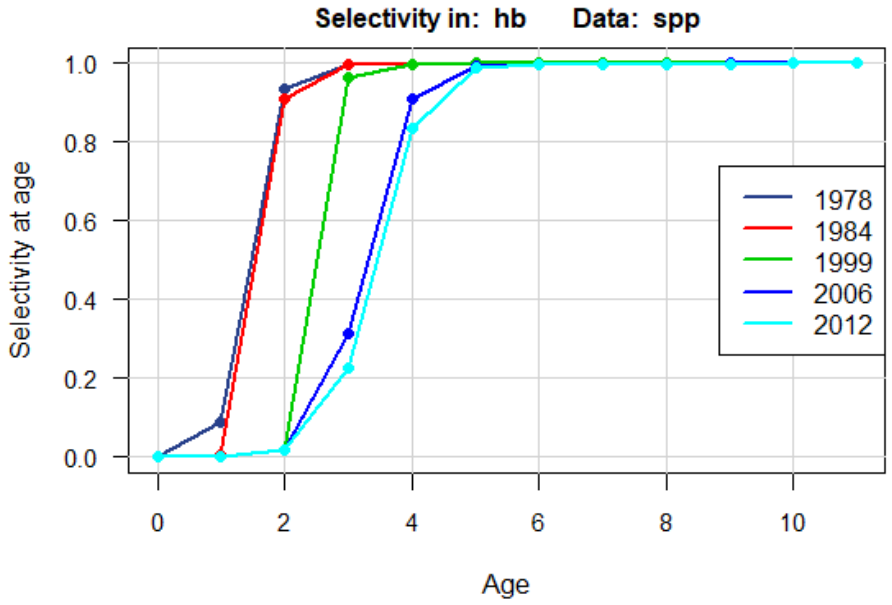
	Size limit (inches)	
Year	Commercial	Recreational
1984	8	8
1985	8	8
1986	8	8
1987	8	8
1988	8	8
1989	8	8
1990	8	8
1991	8	8
1992	8	8
1993	8	8
1994	8	8
1995	8	8
1996	8	8
1997	8	8
1998	8	8
1999	10	10
2000	10	10
2001	10	10
2002	10	10
2003	10	10
2004	10	10
2005	10	10
2006	10	10 and 11
2007	10	12
2008	10	12
2009	10	12
2010	10	12
2011	10	12
2012	10	12
2013	11	13
2014	11	13
2015	11	13
2016	11	13

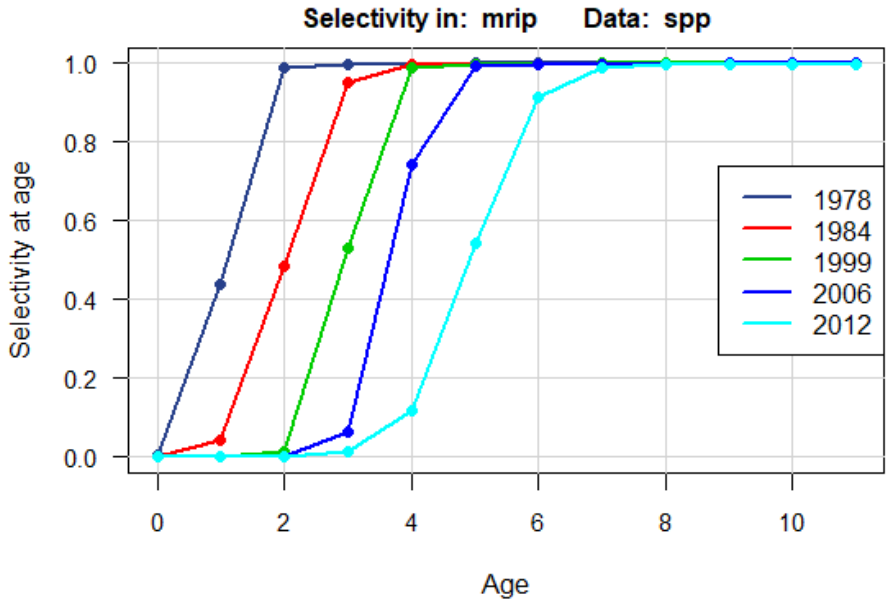
Commercial Landings Selectivities - logistic
3 time blocks based on size limits, trawl mirrors pots





Recreational Landings Selectivities – logistic 5 time blocks based on size limits





Recreational Discard Selectivities – dome shaped

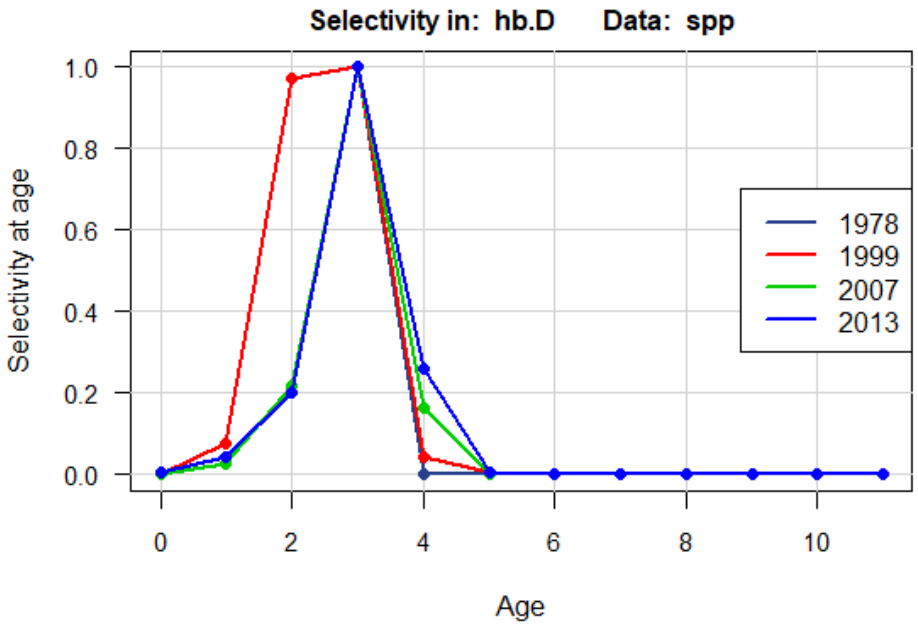
For blocks 1 and 2:

- Age 0,1, and 2 are estimated using a logit function.
- Age 3 is assumed fully selected.
- Ages 4+ follow the probability of being below the size limit at each age.

For blocks 3 and 4:

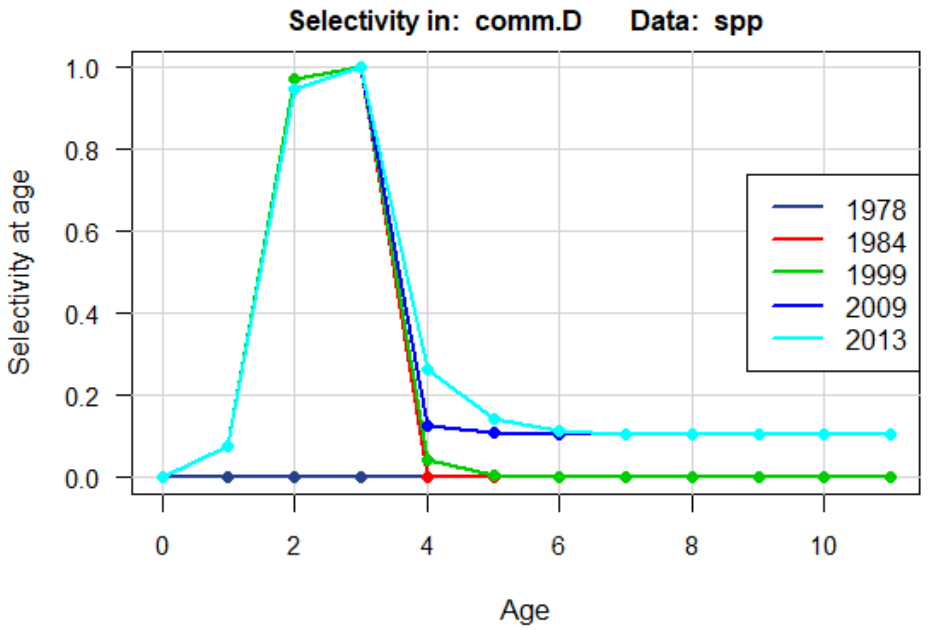
- Selectivity is estimated using a 4-parameter (3 estimated parameters) logistic exponential function.
- Age 3 is assumed fully selected.
- The other parameters are estimated with loose priors (Normal distribution with 0.5 CV)

MRIP discard selectivity mirrors HB discard selectivity



Commercial Discard Selectivities – dome shaped

- Assume no selectivity when there are no size limits.
- All time blocks except for the last mirror HB discard selectivity.
- The last time block matches the HB logit estimates for Ages 0-2, assumes full selectivity of Age3s, and uses the probabilities of being below the size limit at each age for Ages 4+.
- Ages 4+ are also weighted as follows:
  - The discards are provided for both open and closed seasons.
  - The open season discards are assumed to follow discards selectivity.
  - The closed season discards are assumed to follow the landings discards.
- Commercial discards are negligible.



Catchabilities

- Constant catchability was used in the benchmark and update.
- CC can cause non-conservative biases in stock status estimates.
- Using a random walk model for catchability can decrease this bias.
  - A RW catchability may account for factors the standardization model could not.
- SEDAR procedural guidance is to investigate time-varying catchability, and states that, “Time-varying catchability is a common and important phenomenon, with strong theoretical and empirical support. It should be considered in future southeast stock assessments.”
- Used the recommended configuration in Wilberg and Bence (sd~0.17)-apply a random walk catchability to the headboat and commercial lines indices.

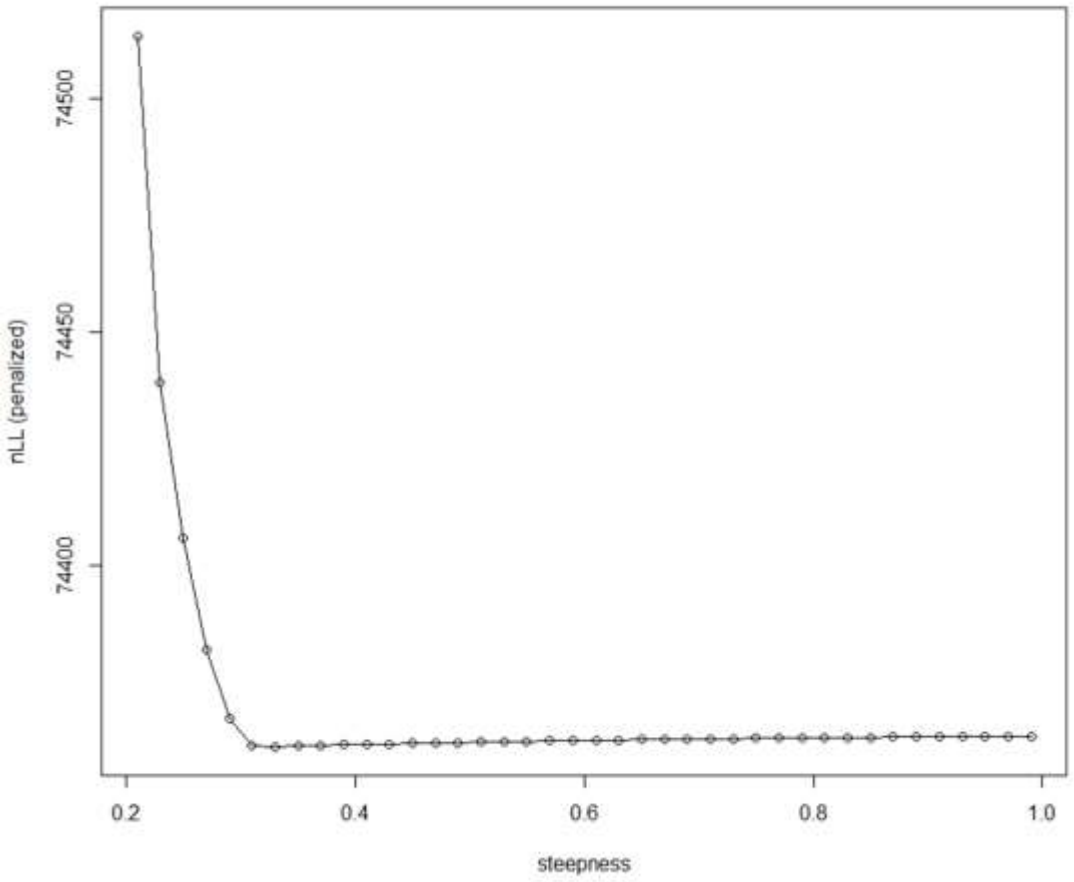
SEDAR Procedural Guidance, 2009. SEDAR Procedural Guidance Document 2: Addressing Time-Varying Catchability.

Wilberg et al. (2010). Incorporating time-varying catchability into population dynamic stock assessment models. Review in Fisheries Science. 18(1) 7-24.

Wilberg, M. & Bence, J. (2006). Performance of time-varying catchability estimators in statistical catch-at-age analysis. Canadian Journal of Fisheries and Aquatic Sciences. 63. 2275-2285.

Steepness profile

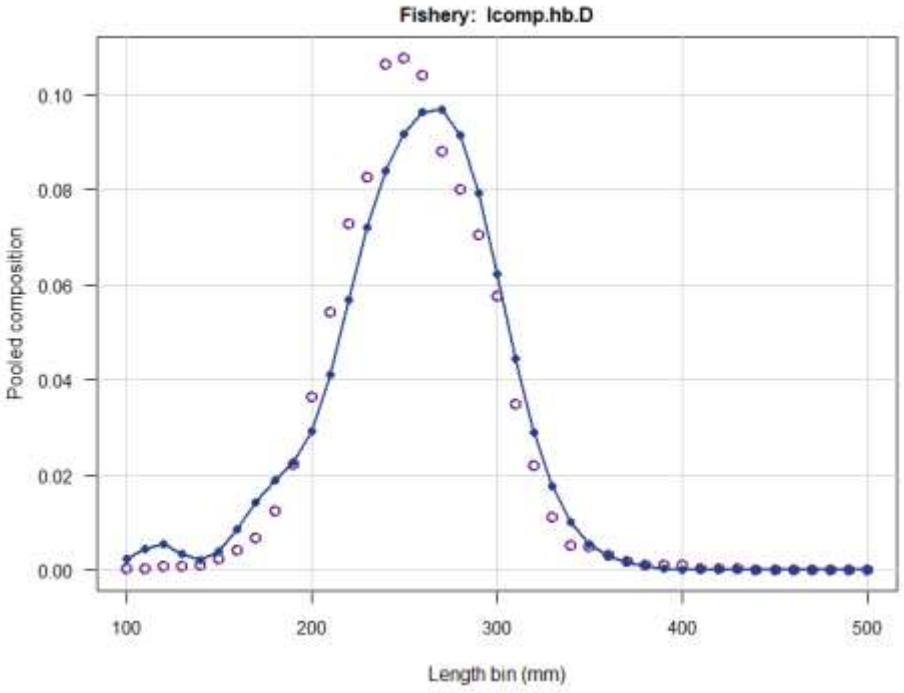
- Likelihood flat (within 2 likelihood units) from 0.31 to 0.97.
- Fixed steepness at the midpoint of the flat range (0.64) for the base run.

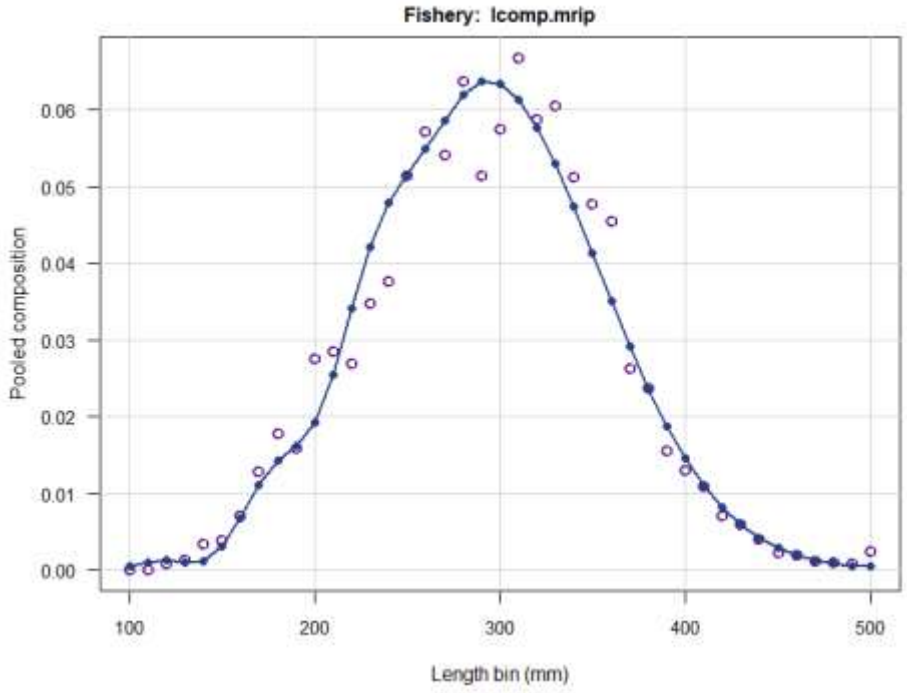


Catch age model configuration cont'd.

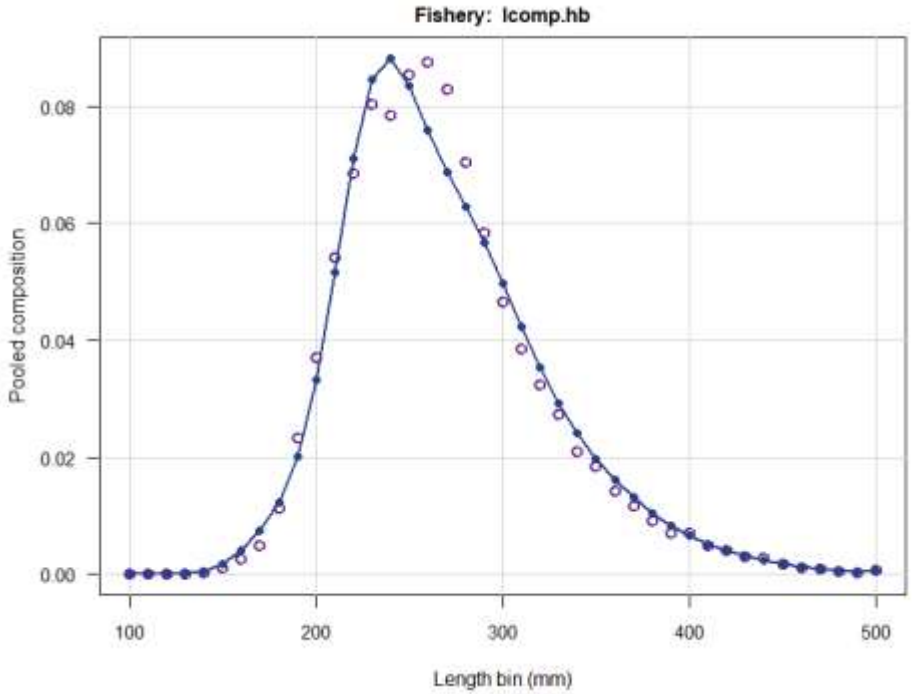
- Include length comps where age comps are missing or sparse.
  - Exclude the MRIP age comps, as they do not reflect the age composition of the fleet.
  - Use Dirichlet multinomial distribution to model the composition data
    - Five DM parameters hit upper bound
- Use data weighting method and assumptions from the benchmark/update.
  - Iterative reweighting attempted but failed to fit the F-I index well.

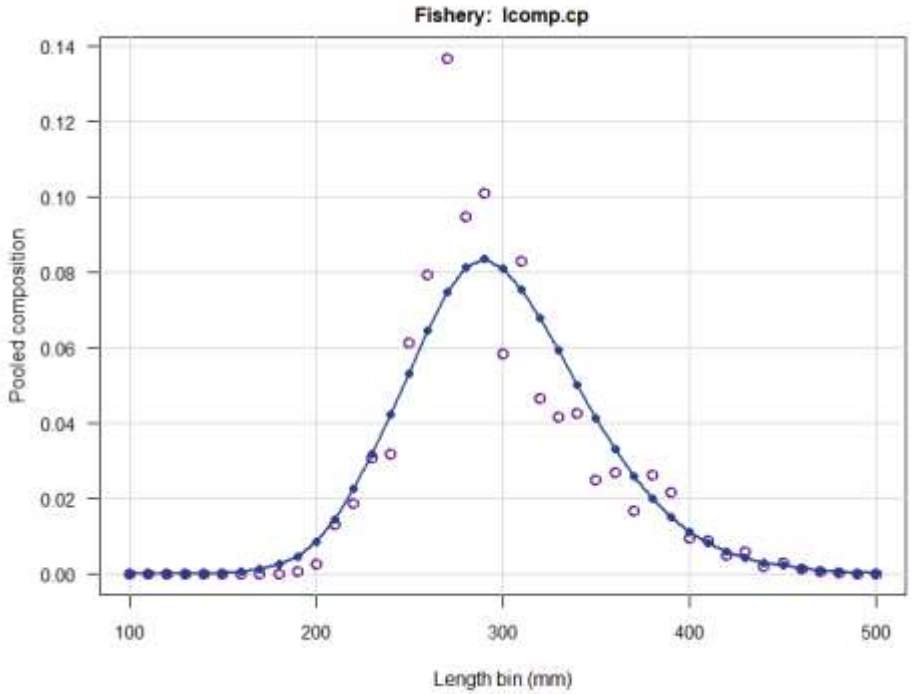
Composition fits



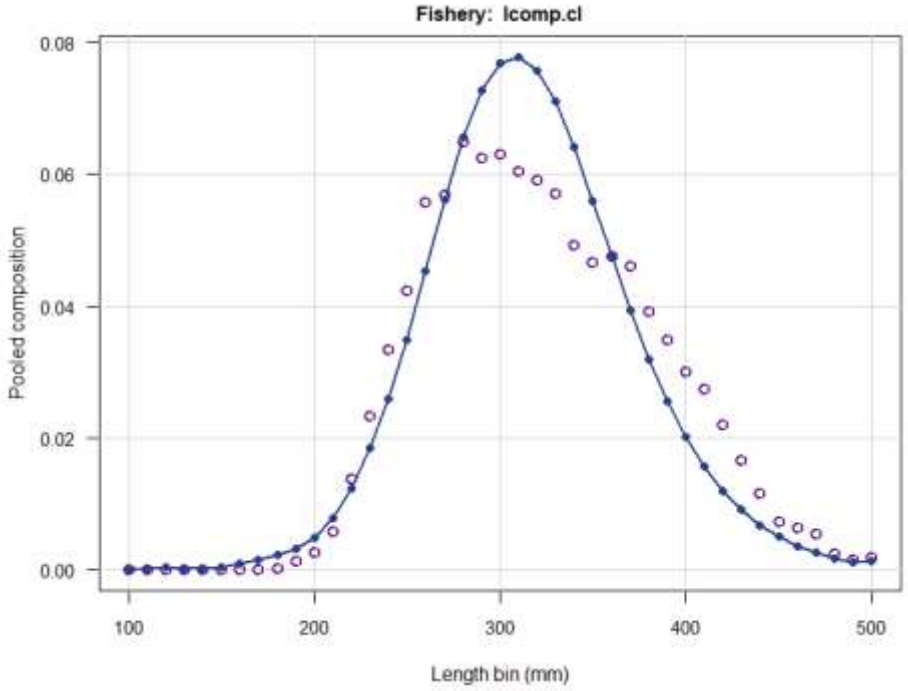


Comps cont'd


Fishery: lcomp.hb
Pooled composition
0.00
0.02
0.04
0.06
0.08
100
200
300
400
500
Length bin (mm)


Fishery: lcomp.cp
Pooled composition
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
100
200
300
400
500
Length bin (mm)

Comps cont'd


Fishery: lcomp.cl
Pooled composition
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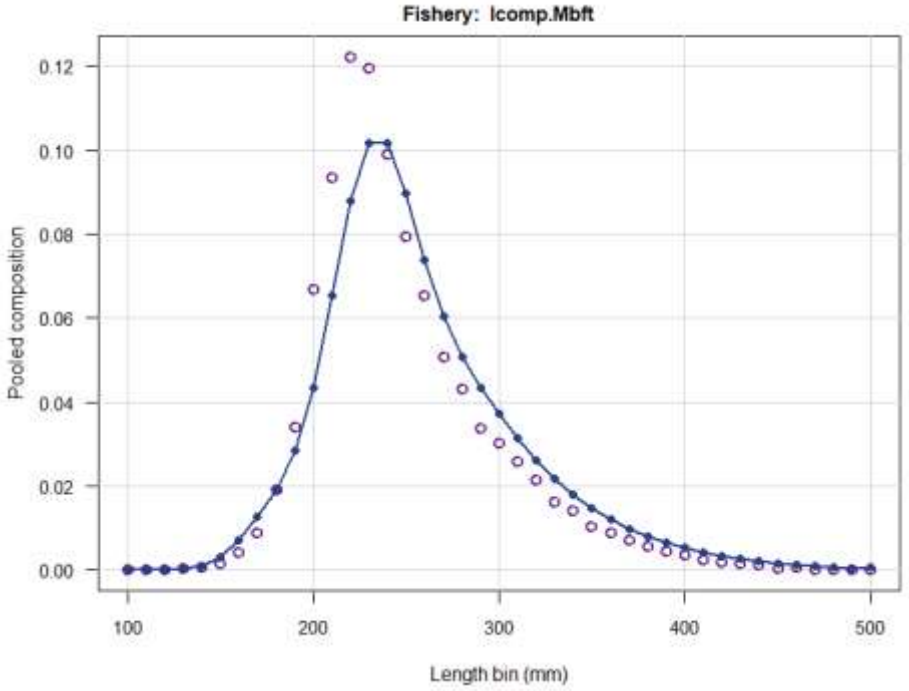
Length bin (mm)


Fishery: lcomp.Mbft
Pooled composition
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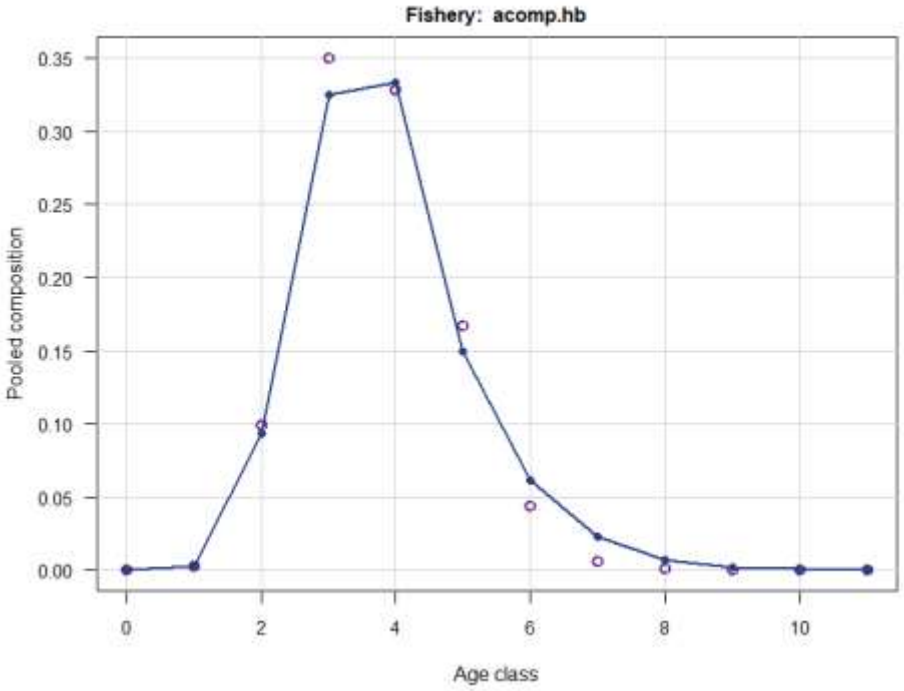
Length bin (mm)

Comps cont'd


Fishery: acomp.hb
Pooled composition
0.35
0.30
0.25
0.20
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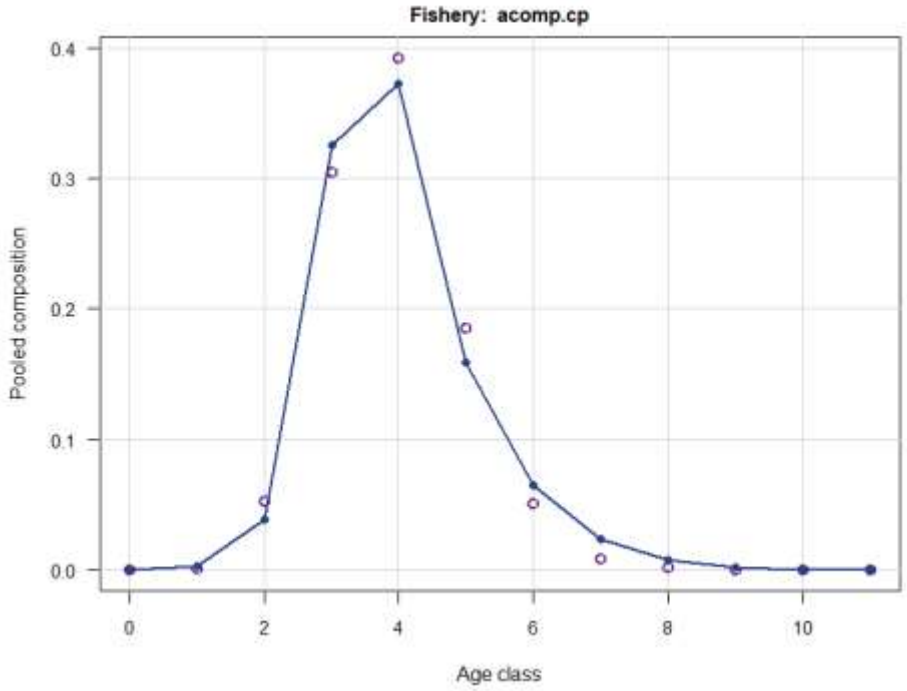
0.10
0.05
0.00
0
2
4
6
8
10
Age class


Fishery: acomp.cp
Pooled composition
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0.3
0.2
0.1
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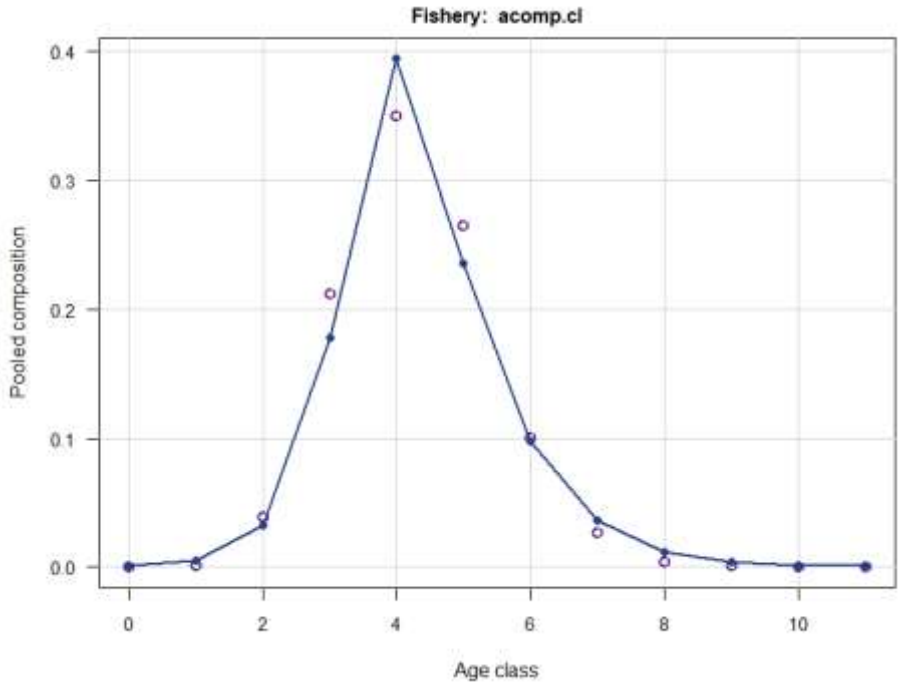
2
4
6
8
10
Age class

Comps cont'd


Fishery: acomp.cl
Pooled composition
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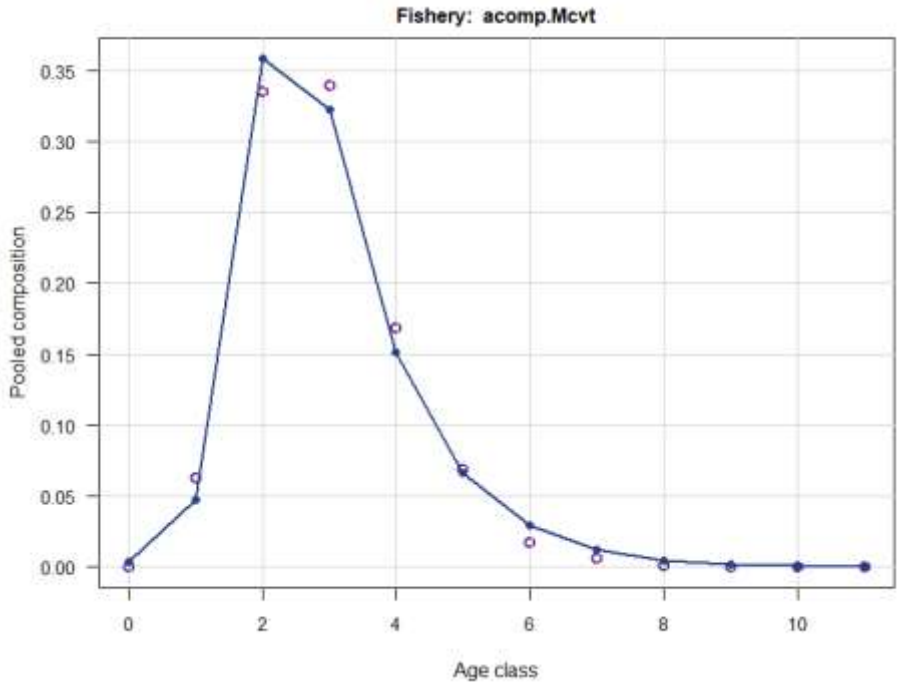
10
Age class


Fishery: acomp.Mcvt
Pooled composition
0.00
0.05
0.10
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0.30
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2
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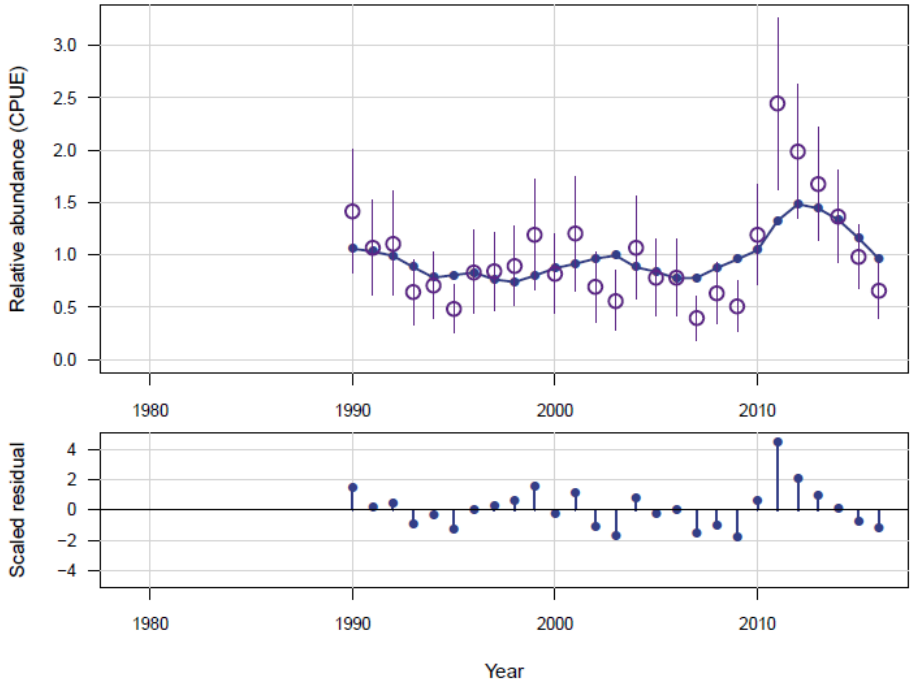
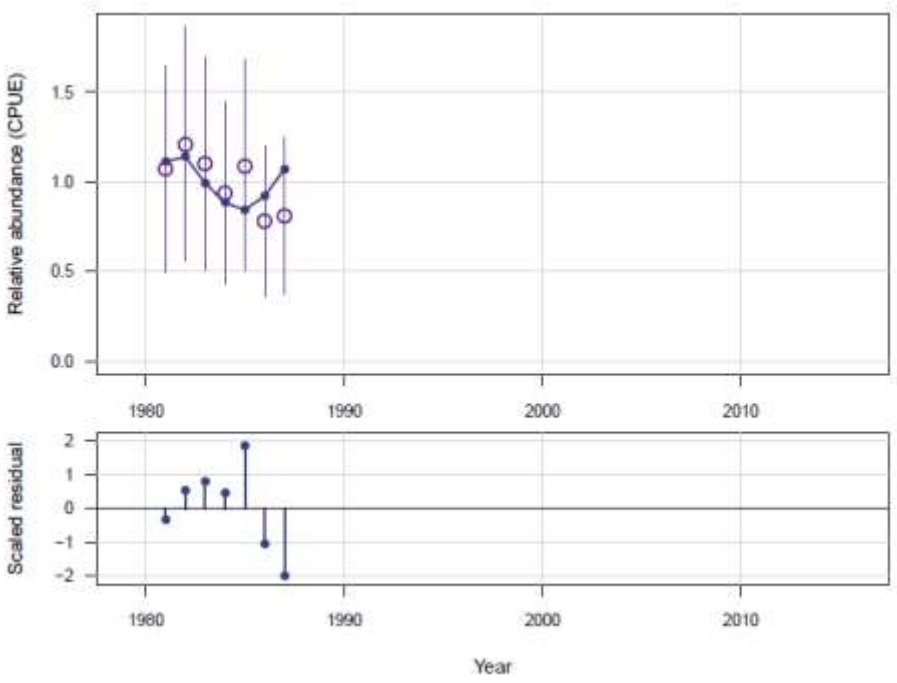
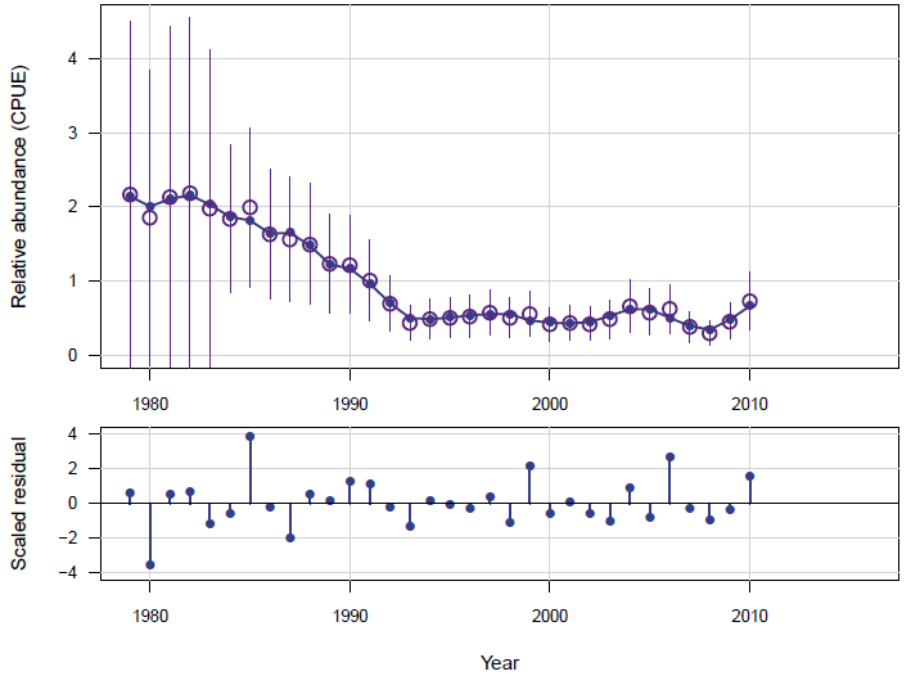
6
8
10
Age class

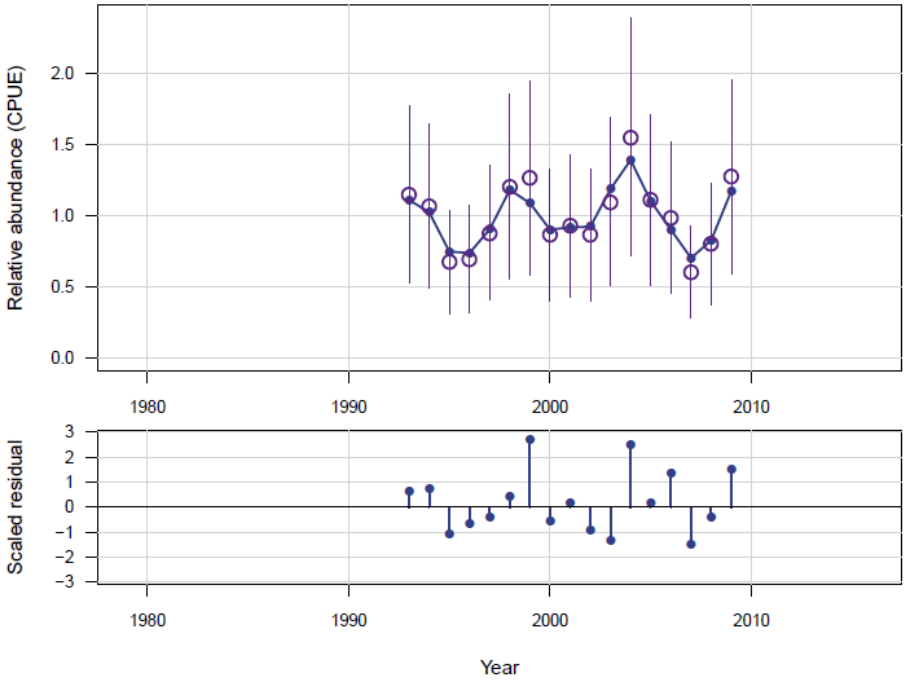
Indices – CVID and MBFT



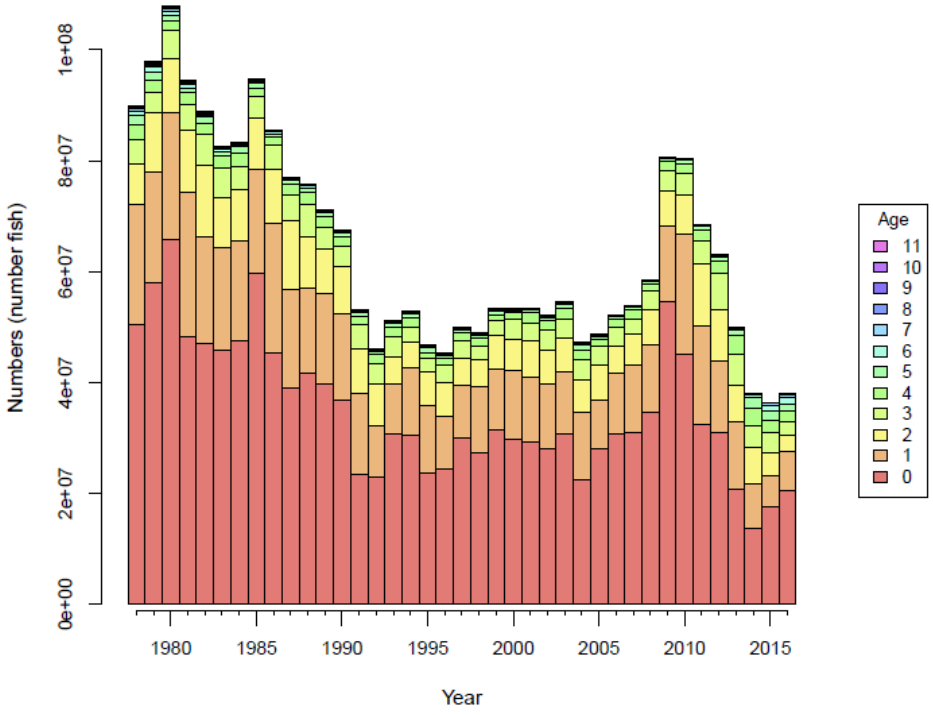


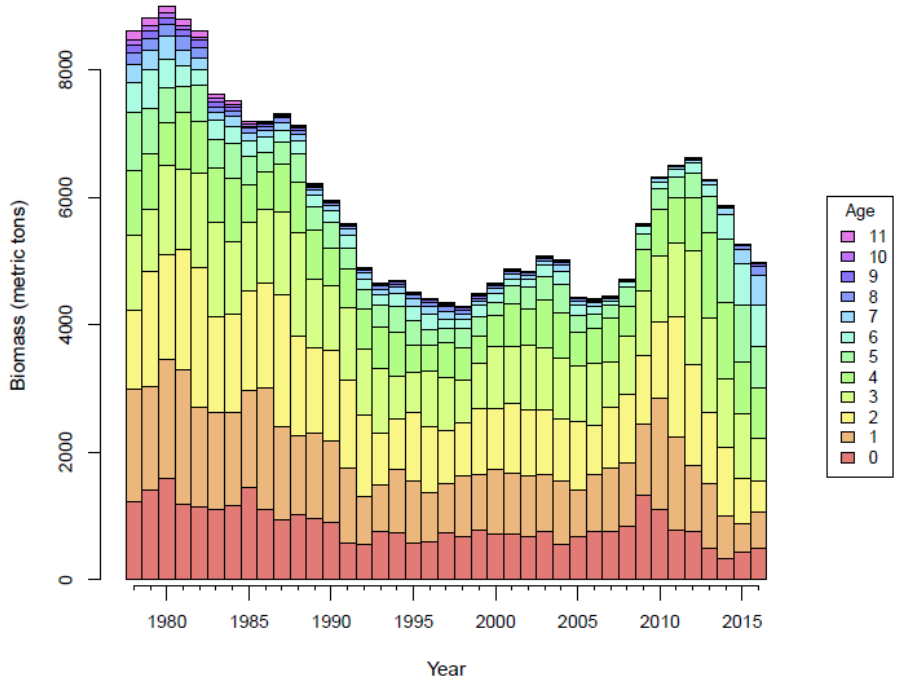
Indices – Headboat and Commercial Lines

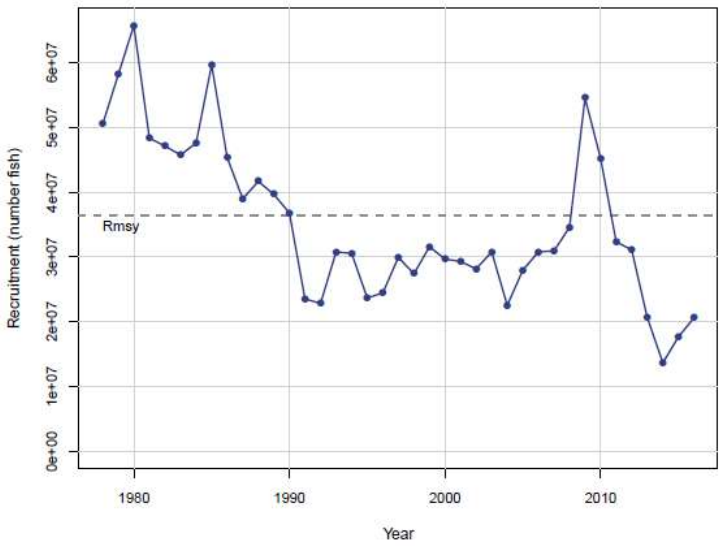




Numbers and Biomass at age

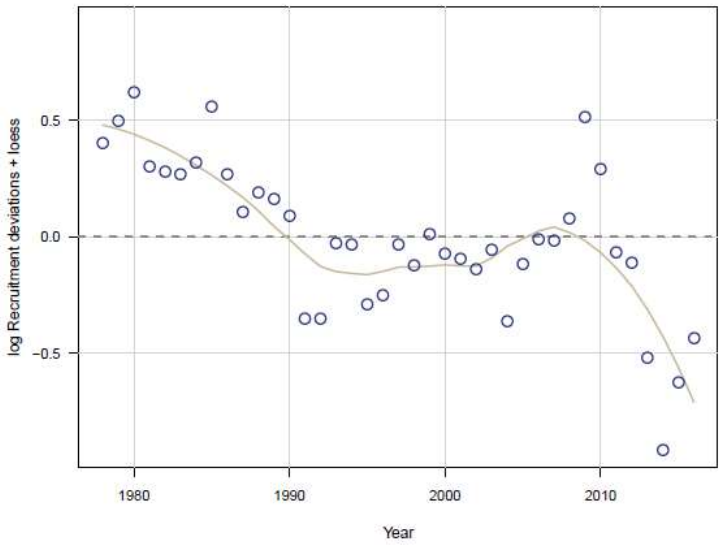


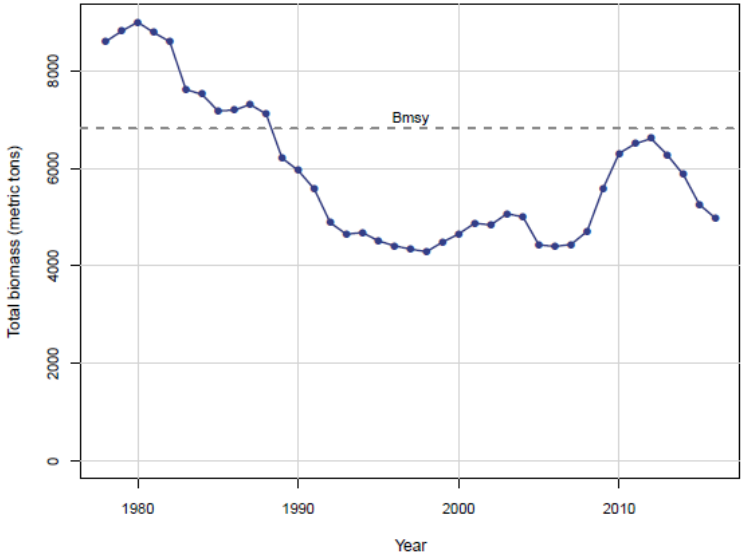




Recruitment

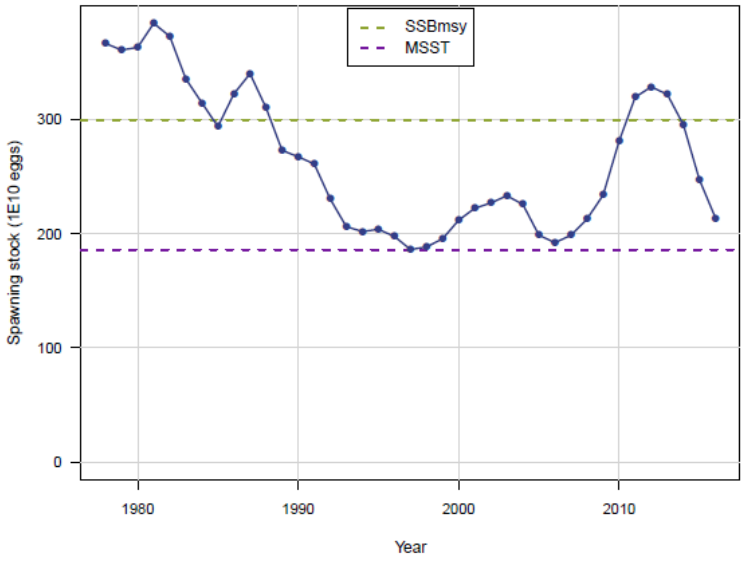
log recruitment residuals



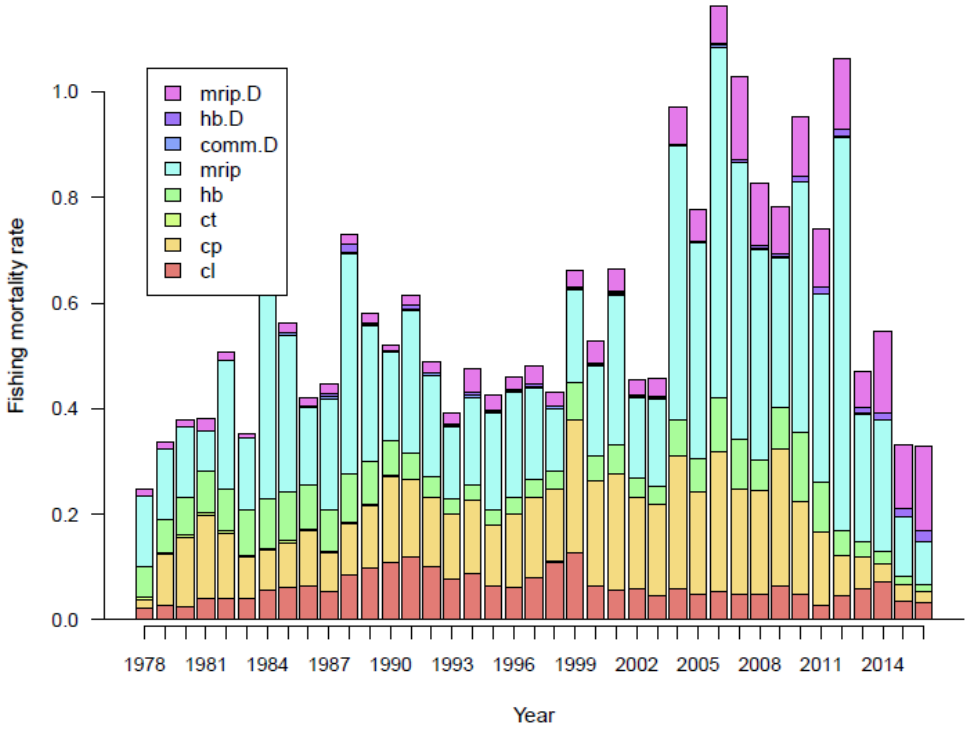


Biomass

SSB status

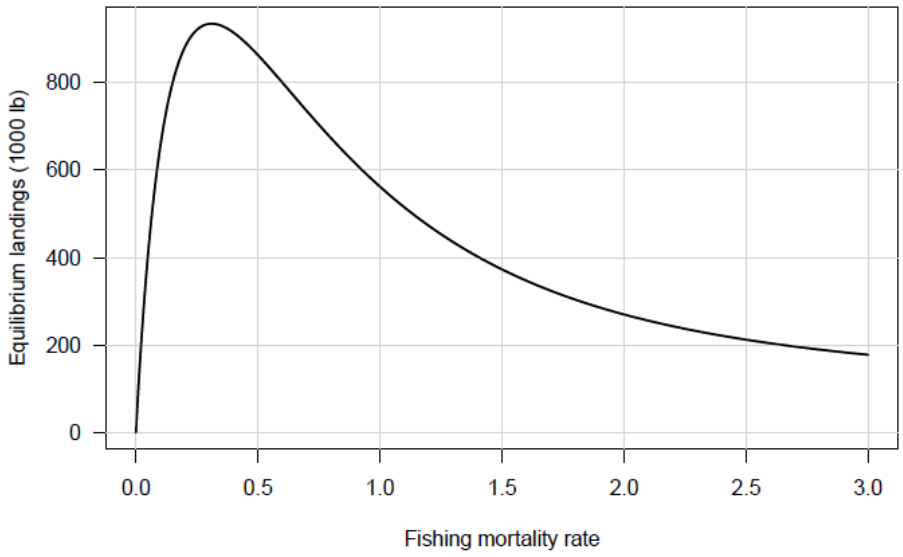


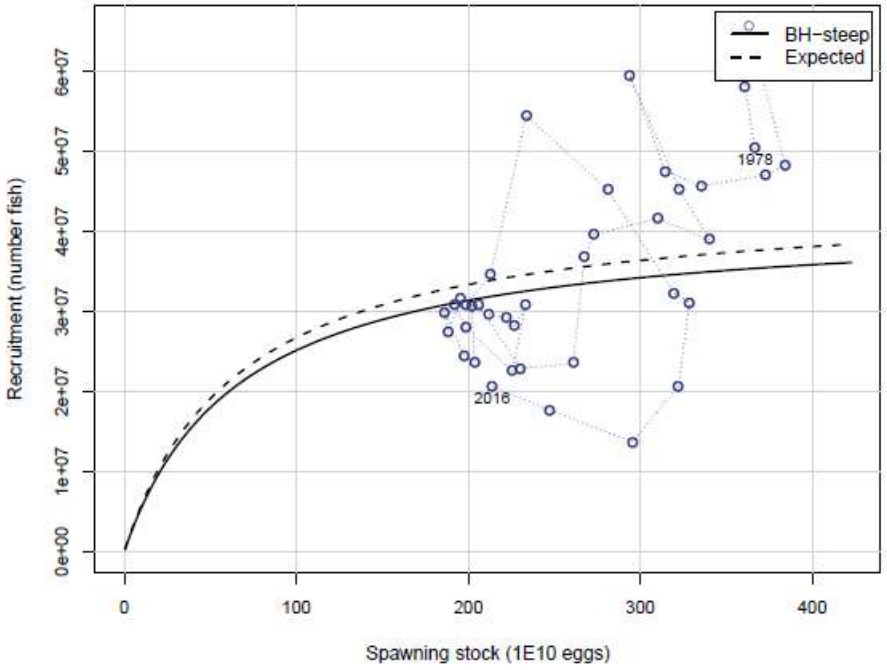
Fishing mortality by fleet



- Commercial fleet used to make up a half to a third, but has seen a large decline since the late 2000s.
- General recreational fleet is the largest source of removals in recent years, but was always a substantial contributor to fishing mortality.

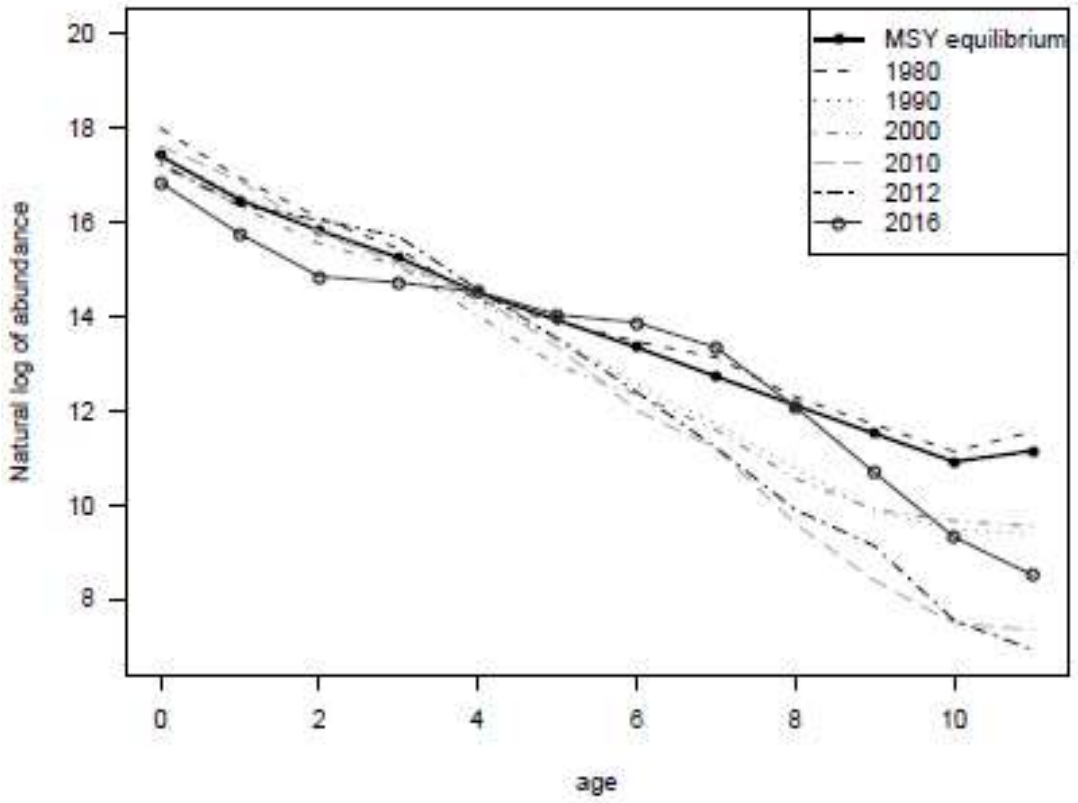
Equilibrium yield at SSB with h=0.64





Equilibrium age structure

- Youngest and oldest age classes are below equilibrium values.



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  - Uncertainty analysis
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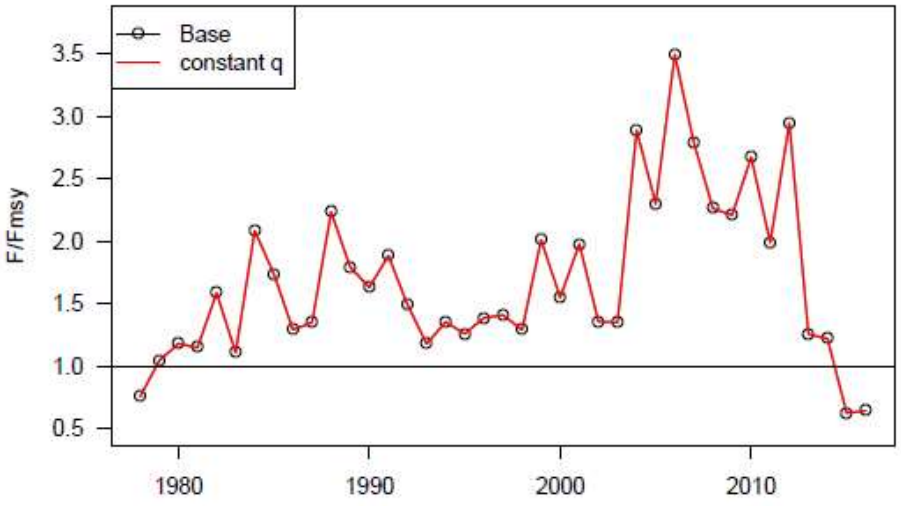
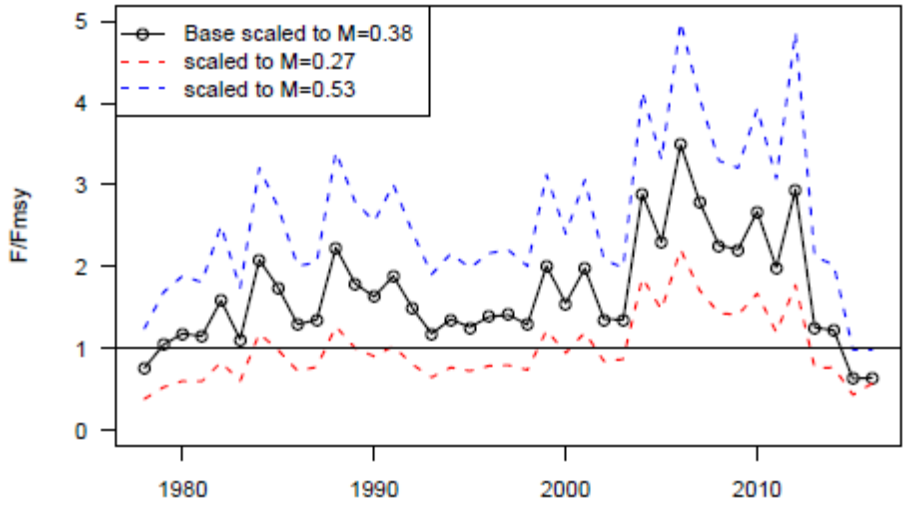
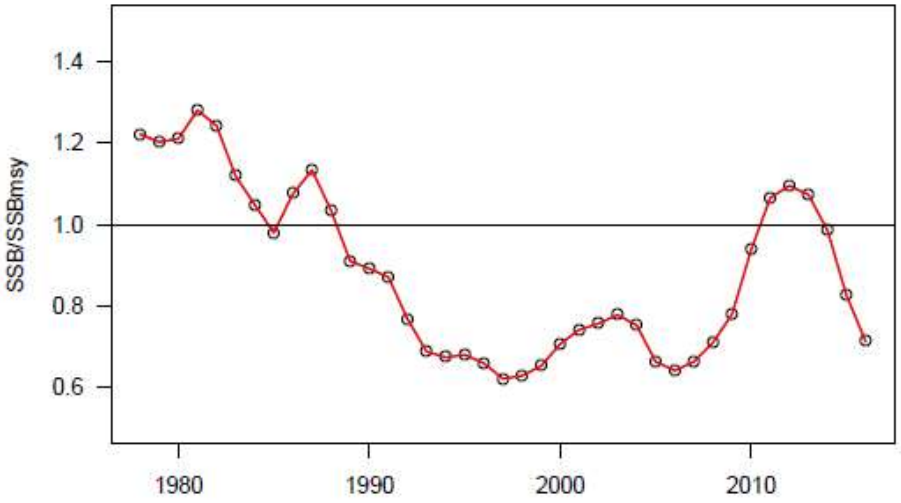
Sensitivities

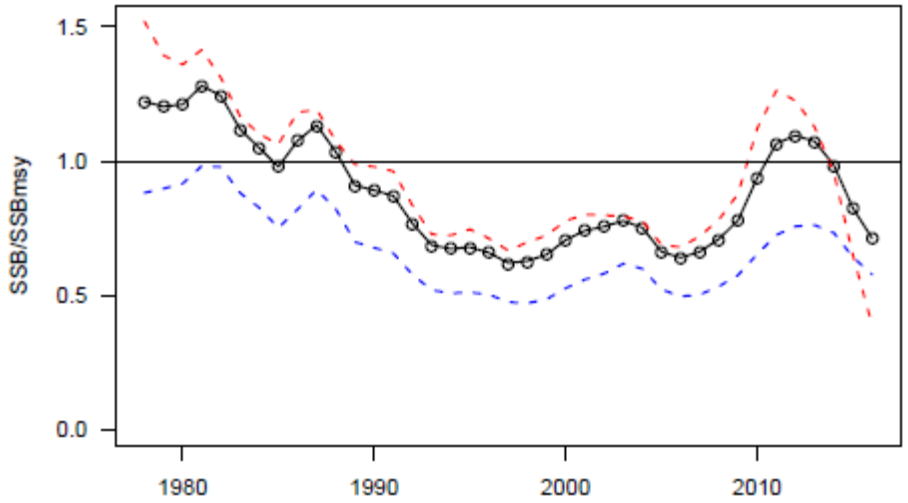
- S1: High natural mortality $M = 0.53$ used to scale the Lorenzen (1996) age-based estimator.
- S2: Low natural mortality $M = 0.27$ used to scale the Lorenzen (1996) age-based estimator.
- S3: High weight on indices $w = 5.0$.
- S4: Low weight on indices $w = 1.0$.
- S5: Steepness $h = 0.97$, at the upper bound of the range identified by likelihood profiling.
- S6: Steepness $h = 0.31$, at the lower bound of the range identified by likelihood profiling.
- S7: Constant catchability for all indices.
- S8: The chevron trap index rather than the CVID index.
- S9: High recreational landings and all discards (+2 sd).
- S10: Low recreational landings and all discards (-2 sd).
- S11: High discard mortalities (38% and 33% for lines and pots, respectively).
- S12: Low discard mortalities (7% and 5% for lines and pots, respectively).
- S13: Continuity configuration, including the multinomial likelihood for composition data, discard mortalities from the benchmark assessment, including MRIP age comps, and a constant catchability for all indices.
- S14-16: Retrospectives, with 2015-2013 as the terminal year, respectively.

Sensitivity to catchability and natural mortality



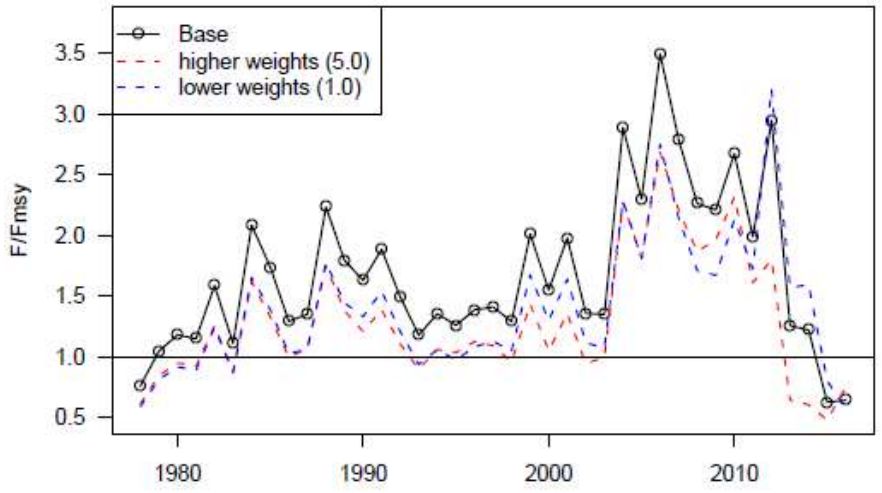


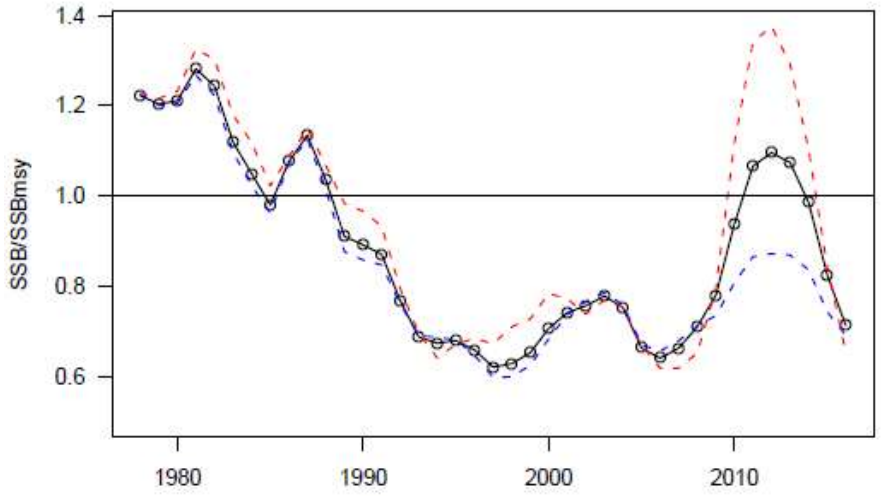




Sensitivity to index weights

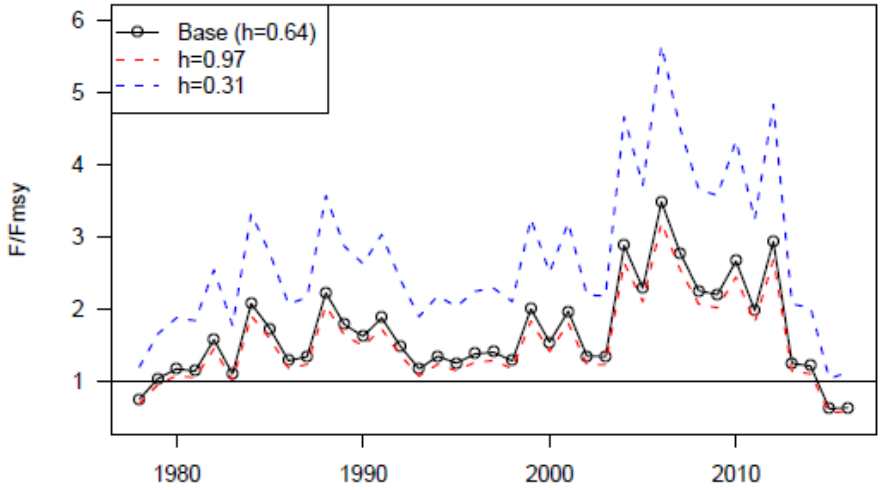
- CVID catchability parameter goes to lower bound in the higher weights run.

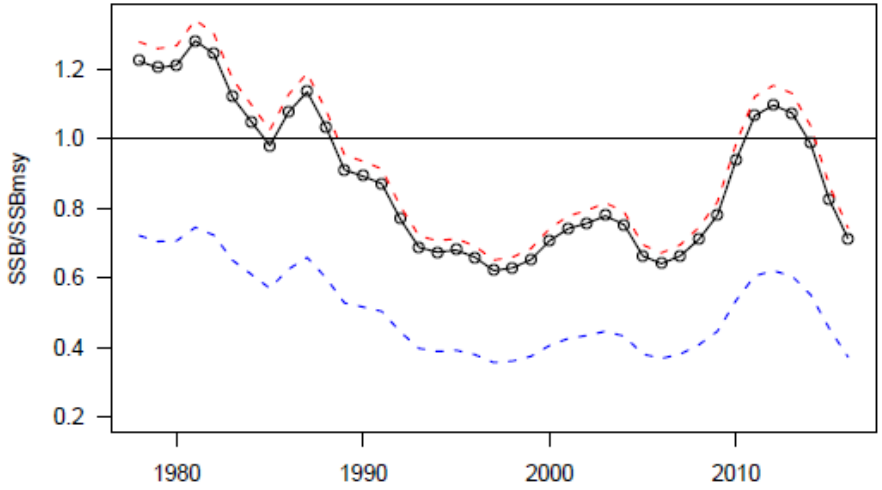




Sensitivity to steepness

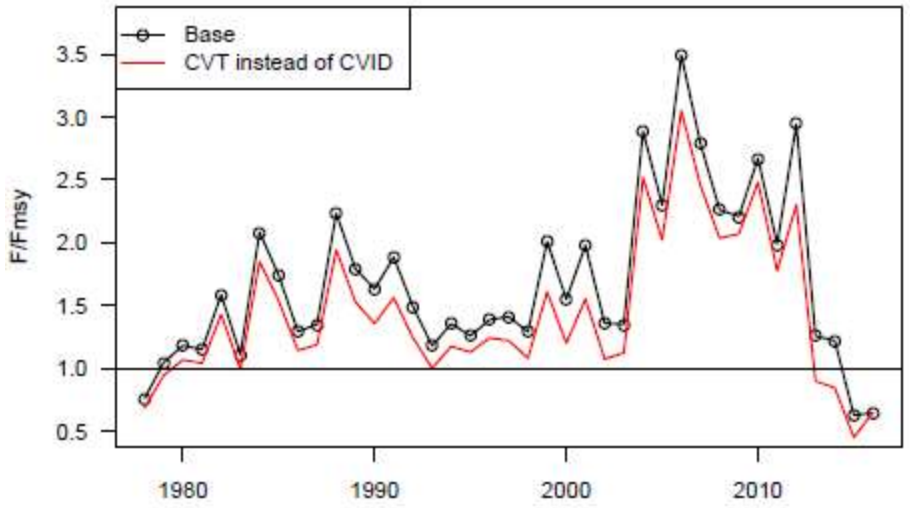
- Lower steepness has larger effects on status.

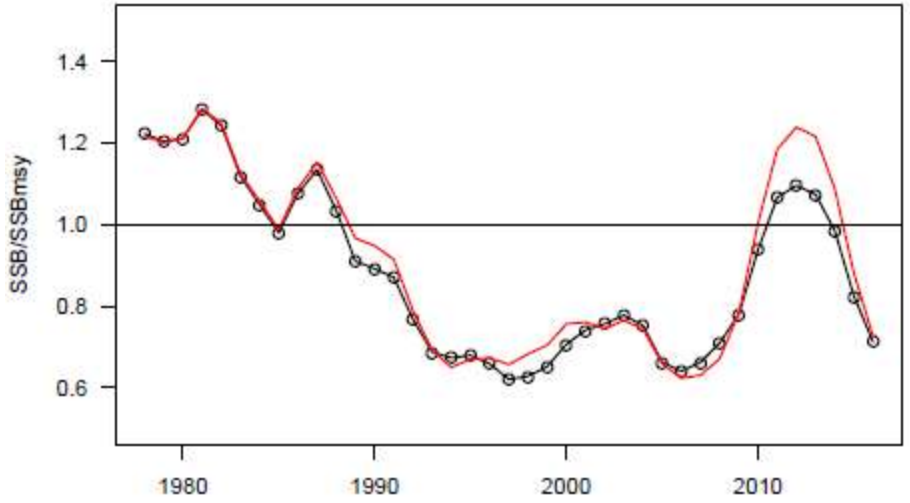




Sensitivities – to FI index changes

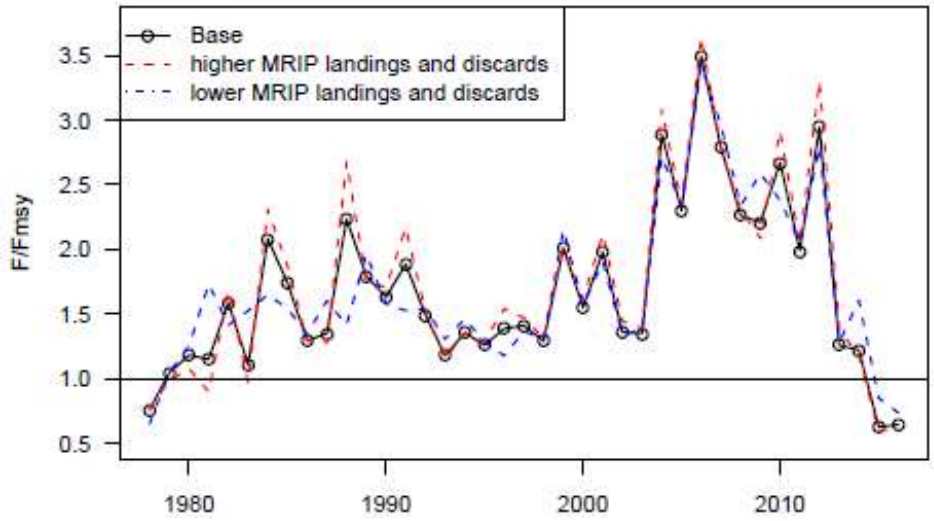
- Chevron trap index and CVs instead of the combined trap/video index and CVs.
- Terminal status similar.

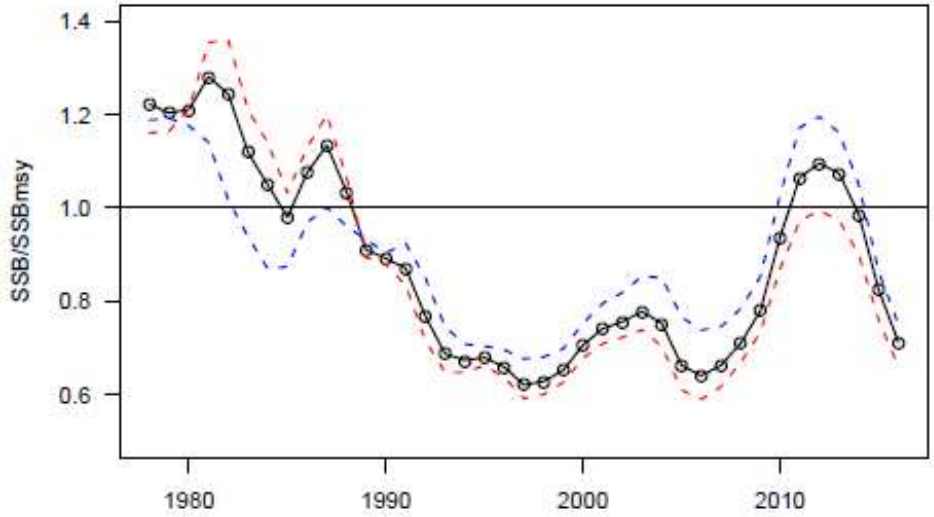




Sensitivity to landings and discard uncertainty

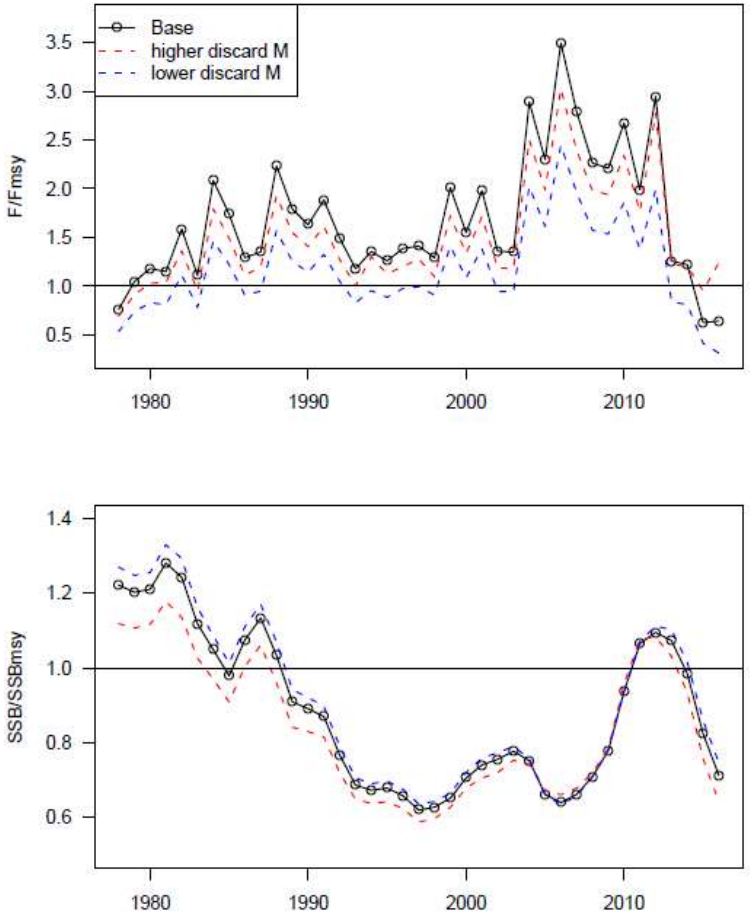
- Used the +/- 2 sd to create alternative landings and discards streams.





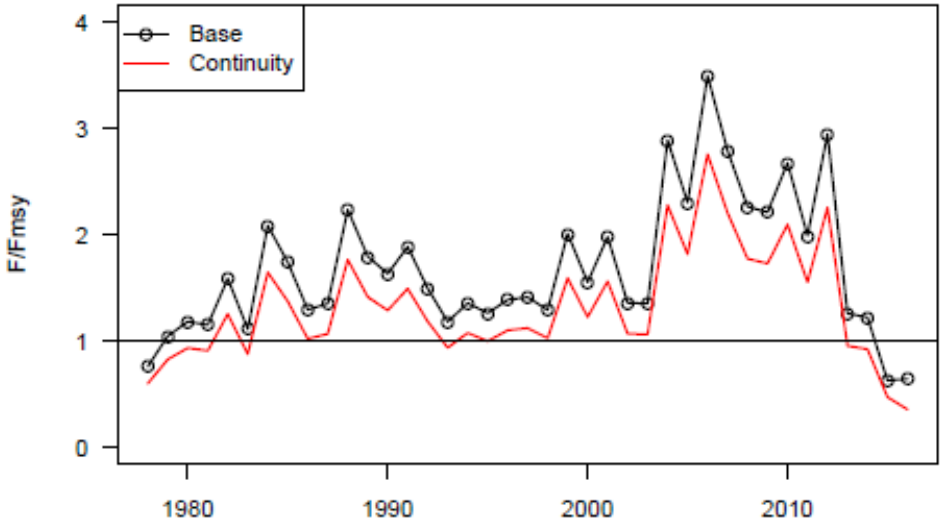
Sensitivity to discard mortality

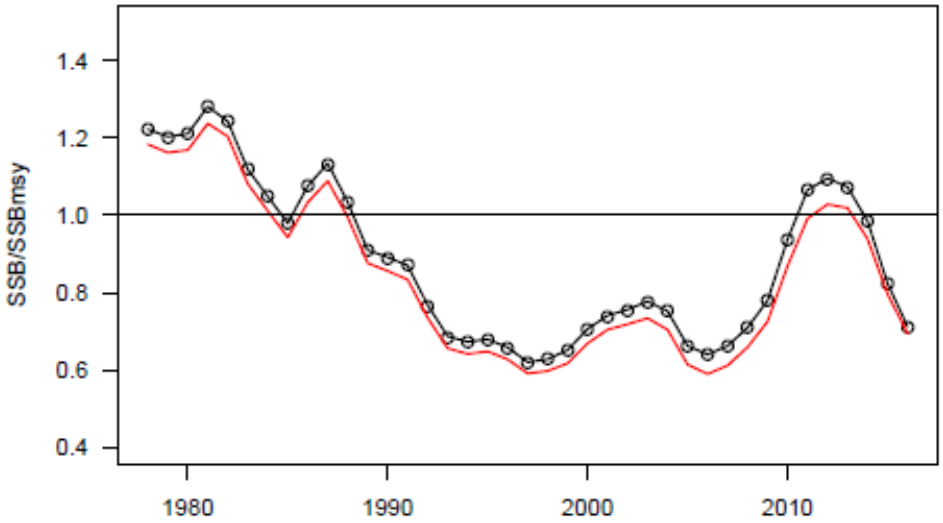
- The higher discard mortality affects the ratio of fishing mortality between landings and discards
- Changes the weighted selectivity of landings.



Continuity

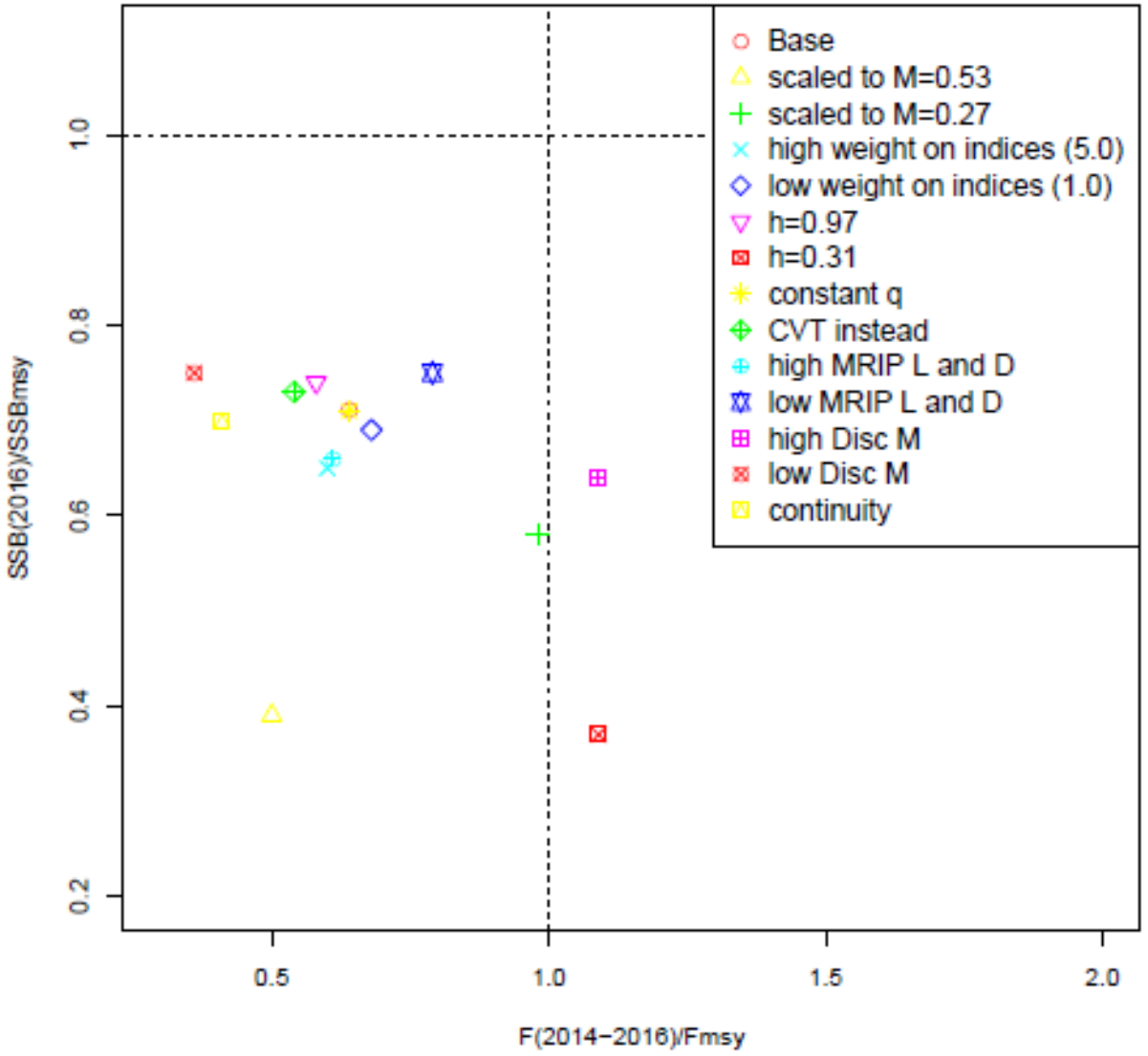
- Changes include SEDAR 25 values for:
  - Natural mortality
  - Steepness
  - Recruitment SD
  - Discard mortalities
  - Composition likelihoods and iterative reweighting
- Not exactly the inputs from the previous assessment, so should not be used as a guidepost.





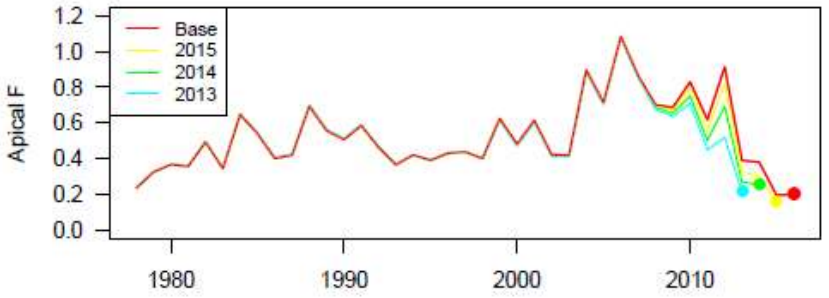
Phase plot:

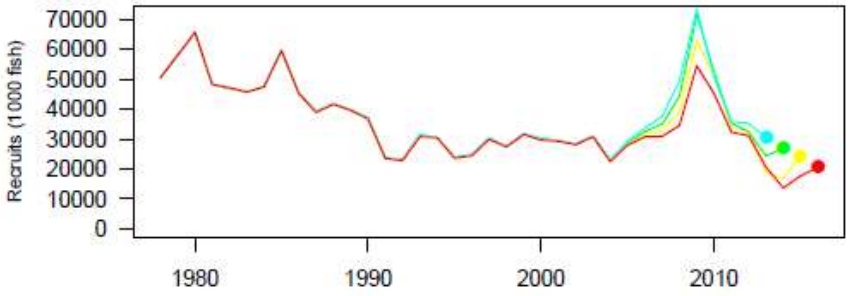
- Only a very low steepness or a very high discard mortality cause the fishing status to change.

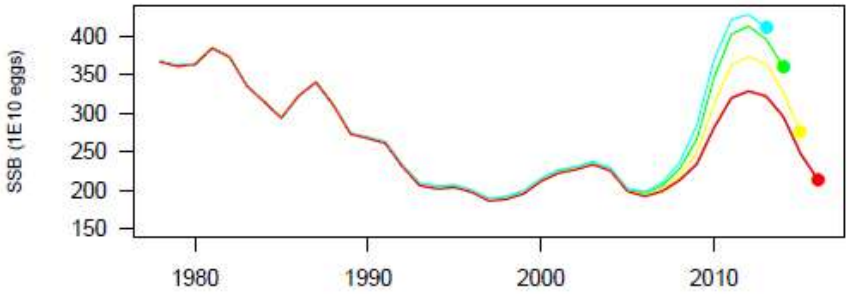


Retrospectives

- Able to remove 3 years of data before data input structure changed.
  - Video index
  - Last selectivity block
- No alarming retrospective pattern.







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MCB – Bootstrapping the data

- New time series of landings, discards, and CPUEs created by assuming lognormal error with mean equal to the point estimates and CV from model input (0.05 for commercial landings).
- New length comps, age comps created each year by drawing N_{fish}, with each fish placed in a bin with probability equal to those in the original data.

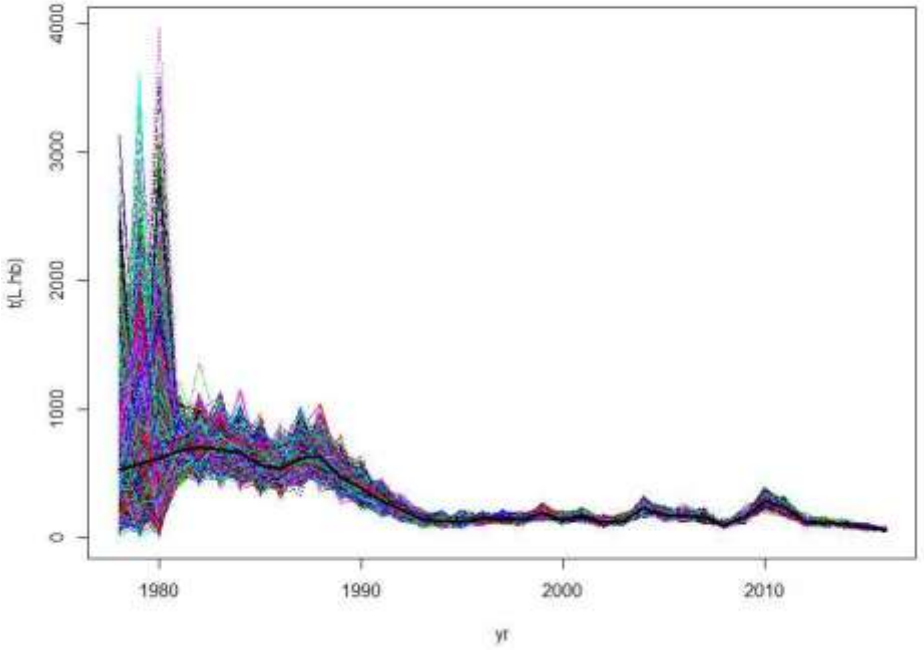
Uncertainty in recreational landings

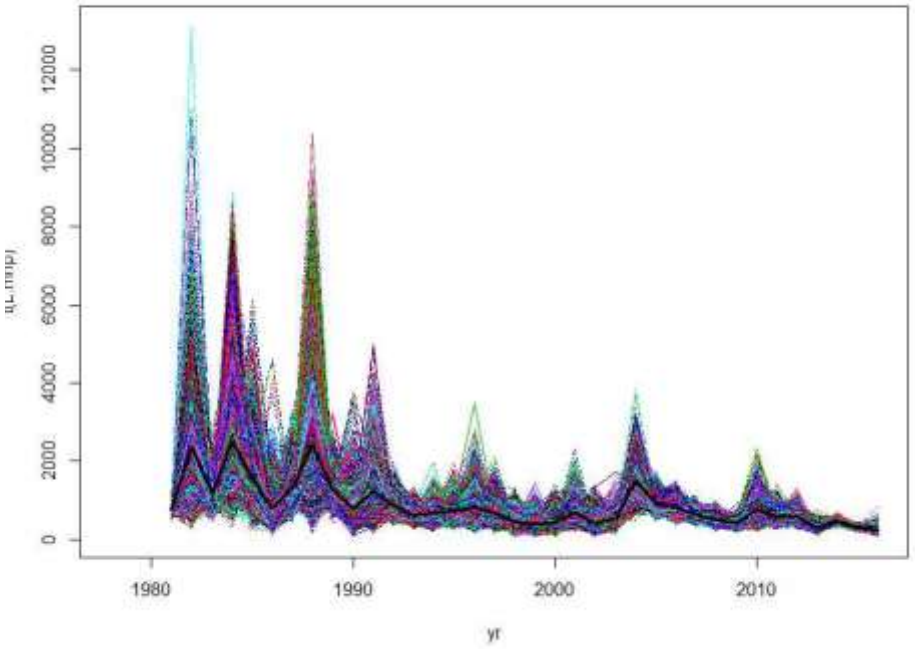
- For MRIP landings, apply a lognormal error with mean from base point estimates and CVs provided by the Recreational Working Group.
- For Headboat landings:
  - 1978-1981 – CV of 0.59 to indicate less certainty in historic time period, and than MRIP, but before the mandatory reporting and full compliance.
  - 1981-1995 – CV of 0.15, improvement from mandatory reporting.
  - 1996-current – CV of 0.10, improvement from full compliance.

Uncertainty in Discards

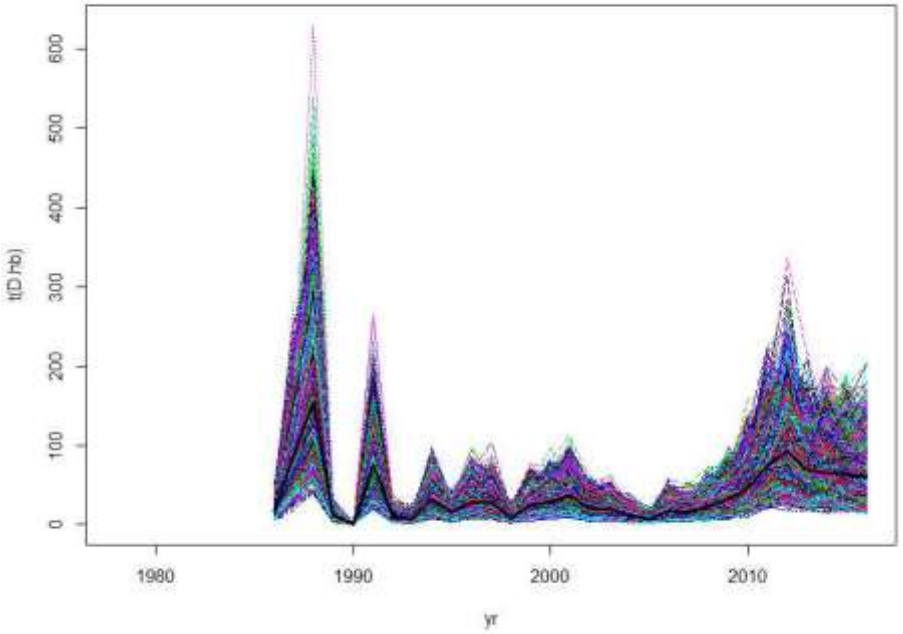
- If no CVs were provided, we used a CV of 0.2, which is larger than most years of landings, and smaller than the MRIP discard uncertainty in earlier years.

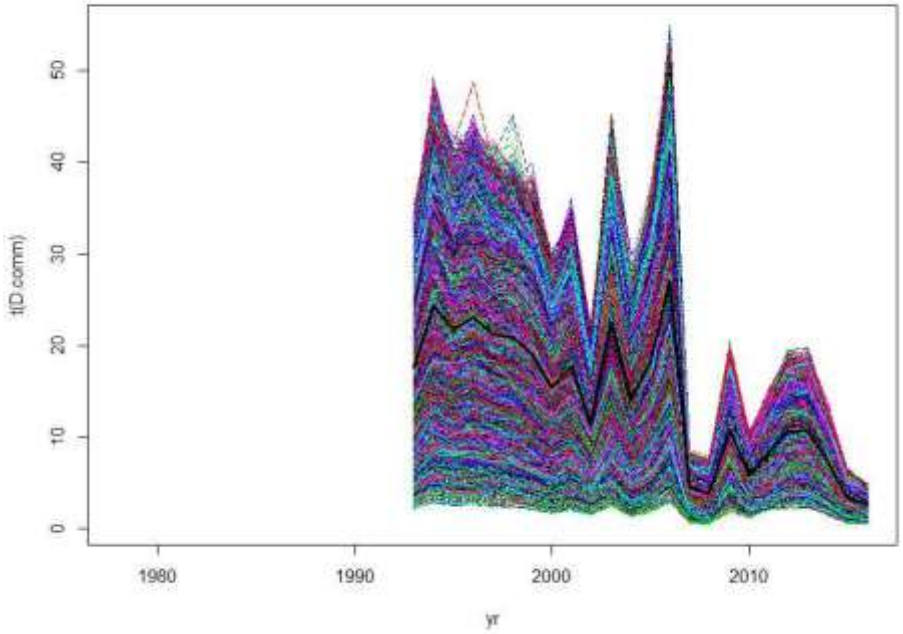
Examples of bootstrapped data – headboat and MRIP landings





Headboat and Handline discards





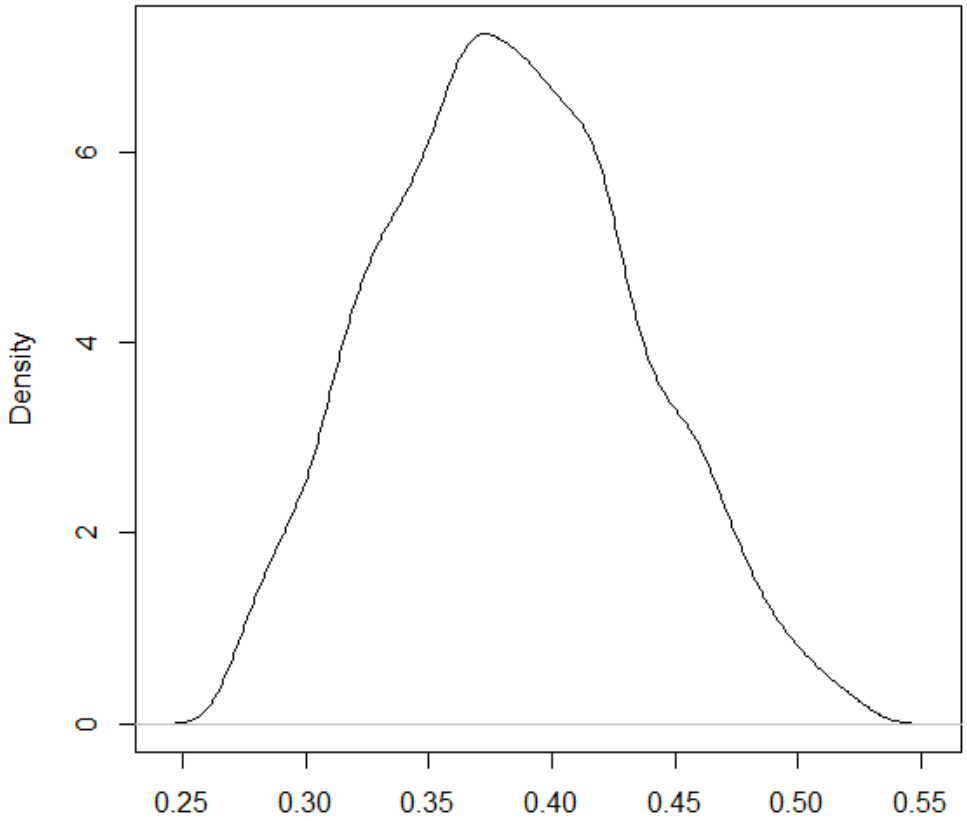
Monte Carlo Sampling

- Natural mortality
- Discard mortality
- Index weighting
- Steepness

Natural mortality

- Monte Carlo sampling was used to generate deviations from the point estimate of 0.38.
  - A new M value was drawn for each MCB trial from a truncated normal distribution (range [0.27, 0.53]) with mean equal to the point estimate (M = 0.38) and standard deviation set to provide a lower and upper confidence limit consistent with the range.
  - Each realized value of M was used to scale the age-specific Lorenzen M, as in the base run.

Natural mortality distribution



Discard mortality

- A new value for commercial lines discard mortality was drawn for each MCB trial from a truncated normal distribution (range [0.05, 0.33]) with mean equal to the point estimate (0.19) and standard deviation set to provide a lower and upper 95% confidence limit consistent with the range.
- General recreational and headboat lines discard mortality was estimated using information from both Rudershausen et al. (2014) and data provided by Panel members from FWRI.
  - Actual trip samples and dispositions were provided by the FL partners from both charterboat and headboat trips.
  - The disposition mortalities from Rudershausen et al. (2014) were applied to those using a truncated normal distribution for each disposition (1-4) as follows:

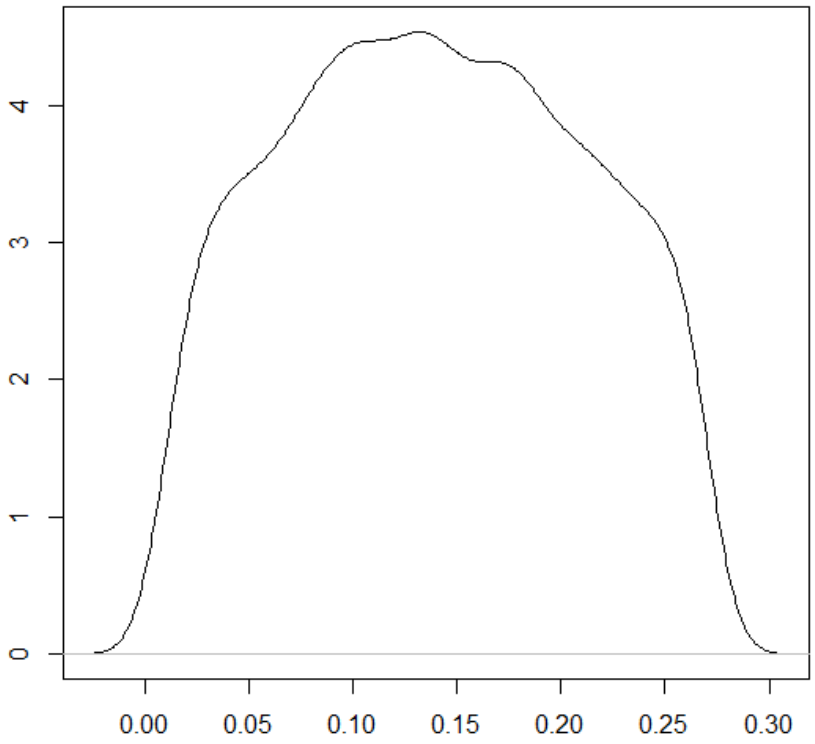
- For disposition 1, the range was [0.0, 0.33] with mean equal to the point estimate (0:13) and standard deviation set to provide a lower 95% confidence limit at 0.00.
- For disposition 2, the range was [0.0, 0.31] with mean equal to the point estimate (0:09) and standard deviation set to provide a lower 95% confidence limit at 0.00.
- For disposition 3, the range was [0.33, 0.83] with mean equal to the point estimate (0:64) and standard deviation set to provide a lower 95% confidence limit at 0.33.
- For disposition 4, the range was [0.70, 0.92] with mean equal to the point estimate (0:84) and standard deviation set to provide a lower 95% confidence limit at 0.70.

Discard Mortality

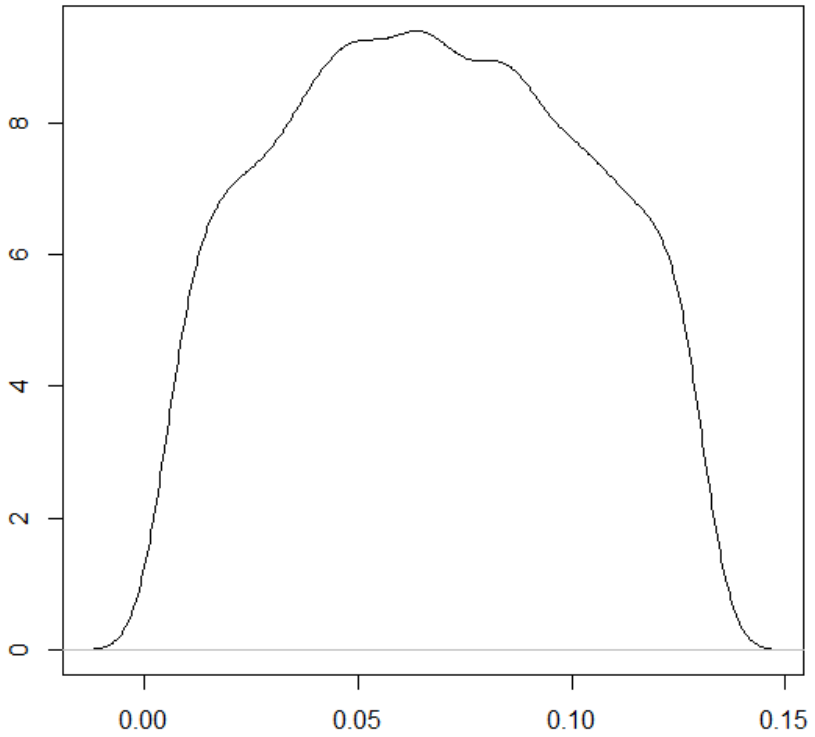
- The fish from the samples were resampled using a multinomial distribution and combined into one mortality using the frequency of occurrence.
- A new estimate was drawn as described for each fleet for each MCB trial.
- A new value for 1.5 in commercial pots discard mortality was drawn for each MCB trial from a truncated normal distribution (range [0.01, 0.27]) with mean equal to the point estimate (0.14) and standard deviation set to provide a lower 95% confidence limit at 0.01.
- The 2 in pots discard mortality was scaled to be 48.3% of the 1.5 in pots draw.

Discard mortality – Commercial Pots

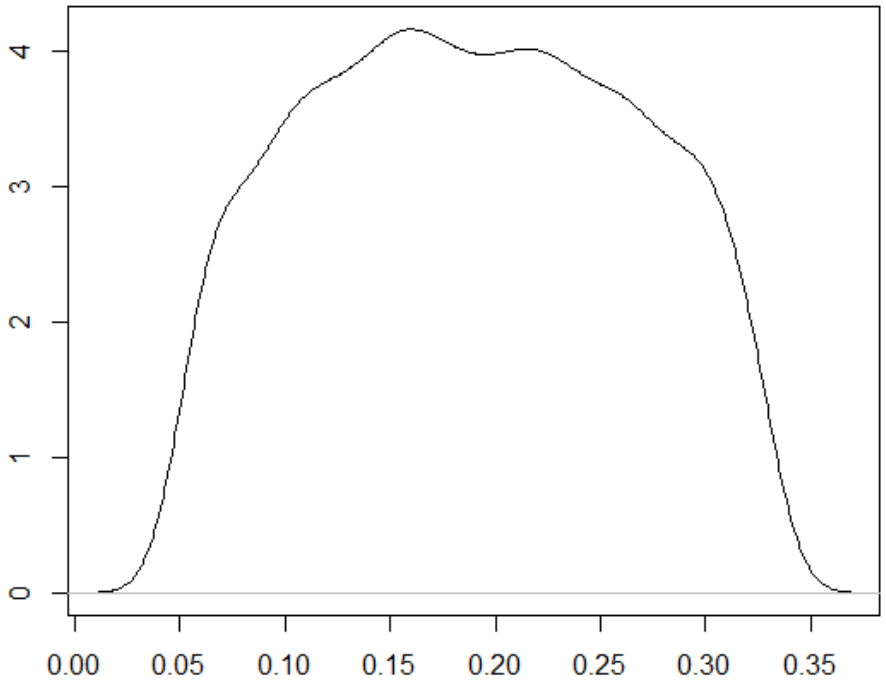
1.5 in pots



2 in pots

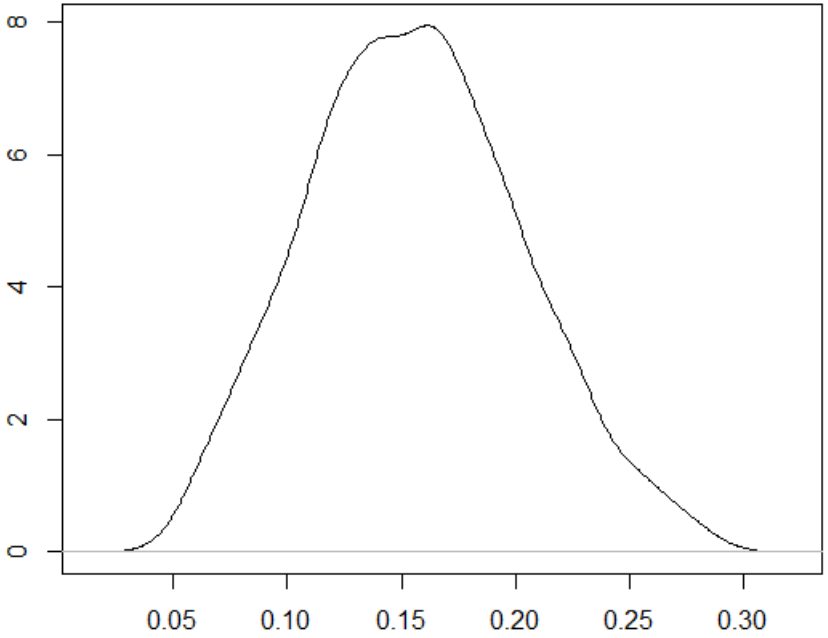


Discard mortality – Commercial Lines

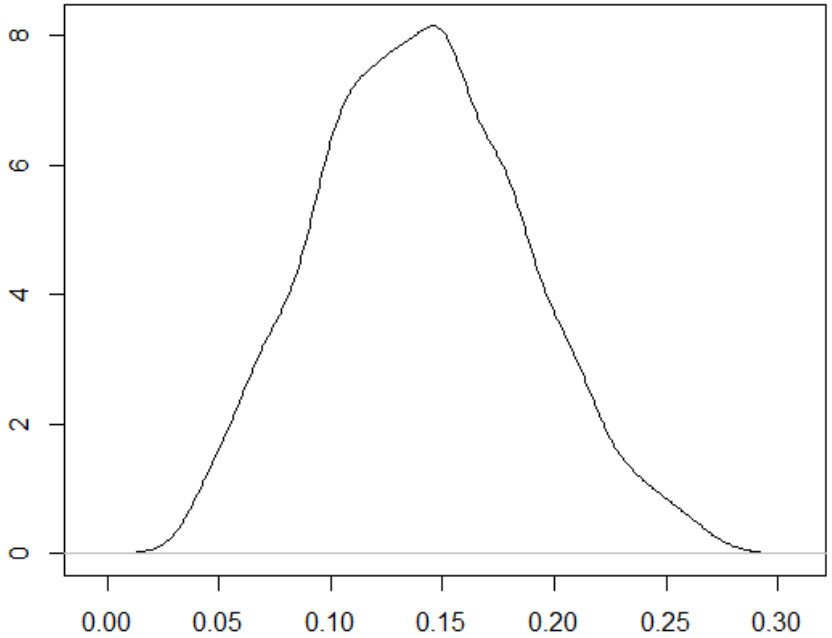


Discard mortality – Recreational Lines

Headboat

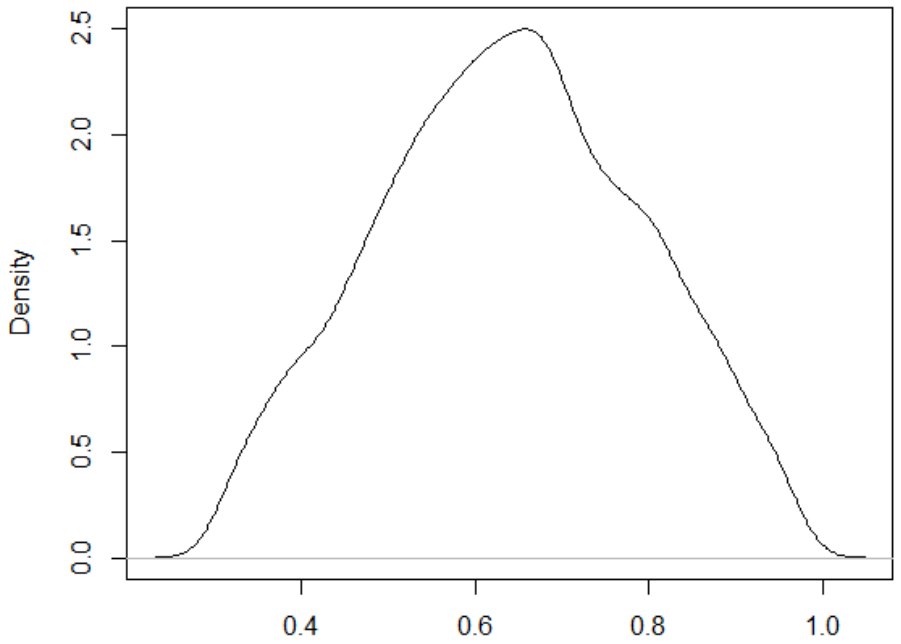


General Recreational

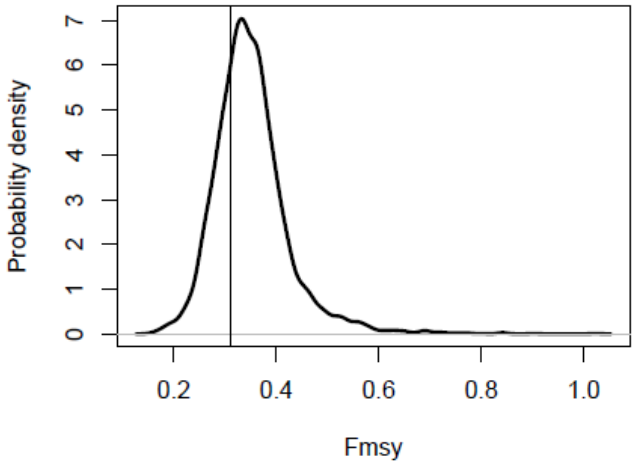


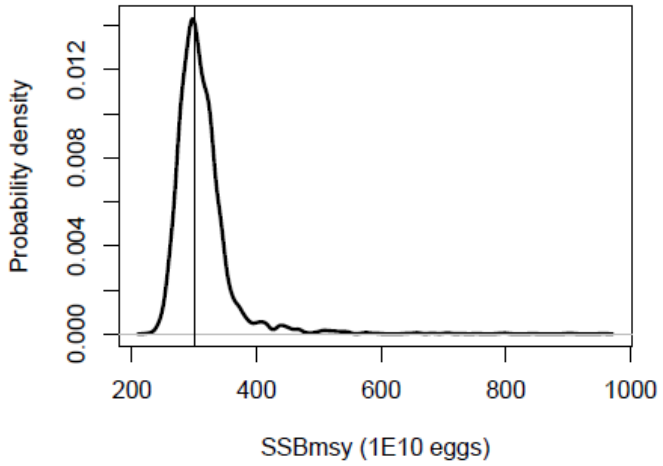
Steepness

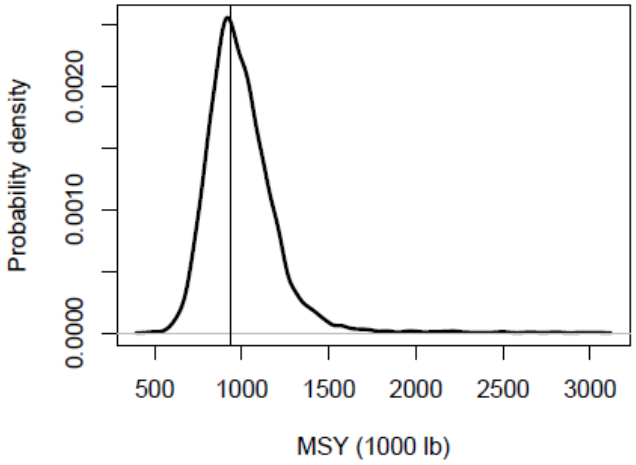
- Truncated normal distribution with mean = 0.64, and sd such that the lower and upper bounds were 0.31 and 0.97 respectively.

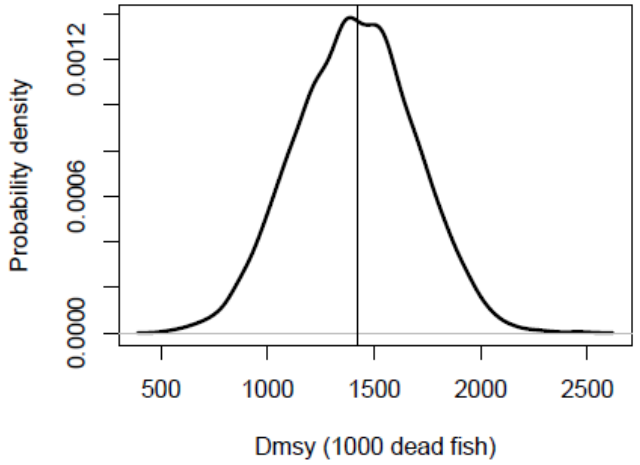


Benchmarks (solid line is from the base)

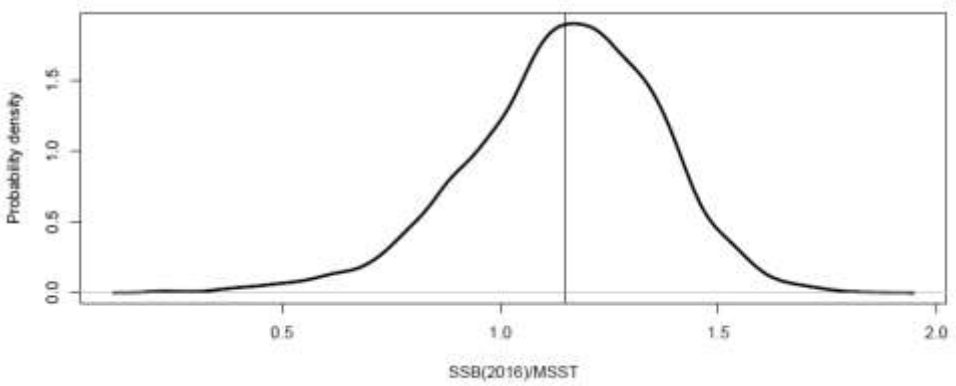


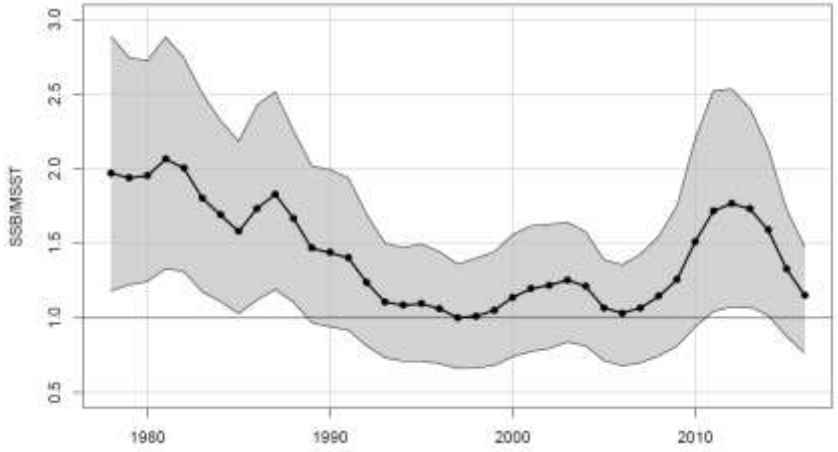


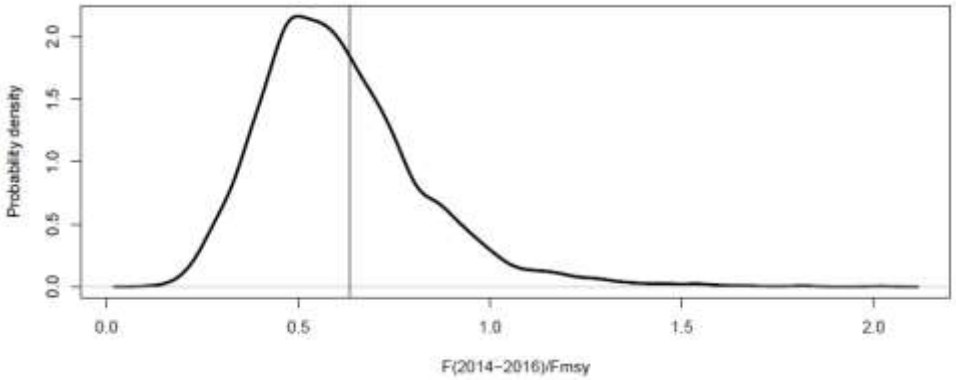


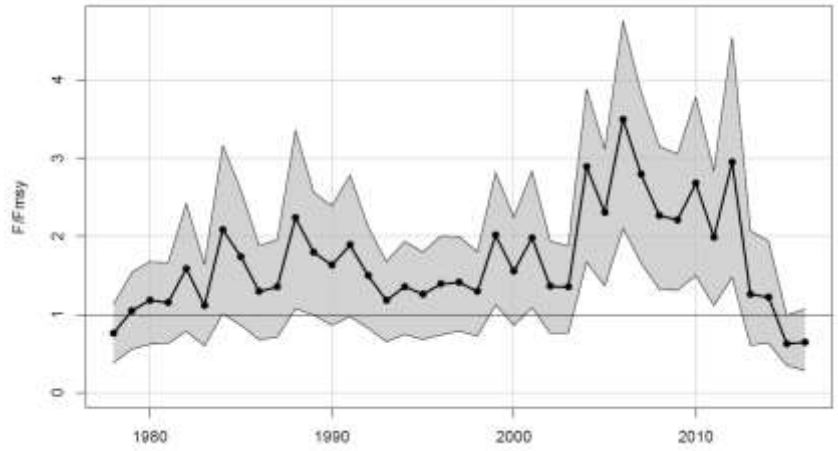


Status and uncertainty

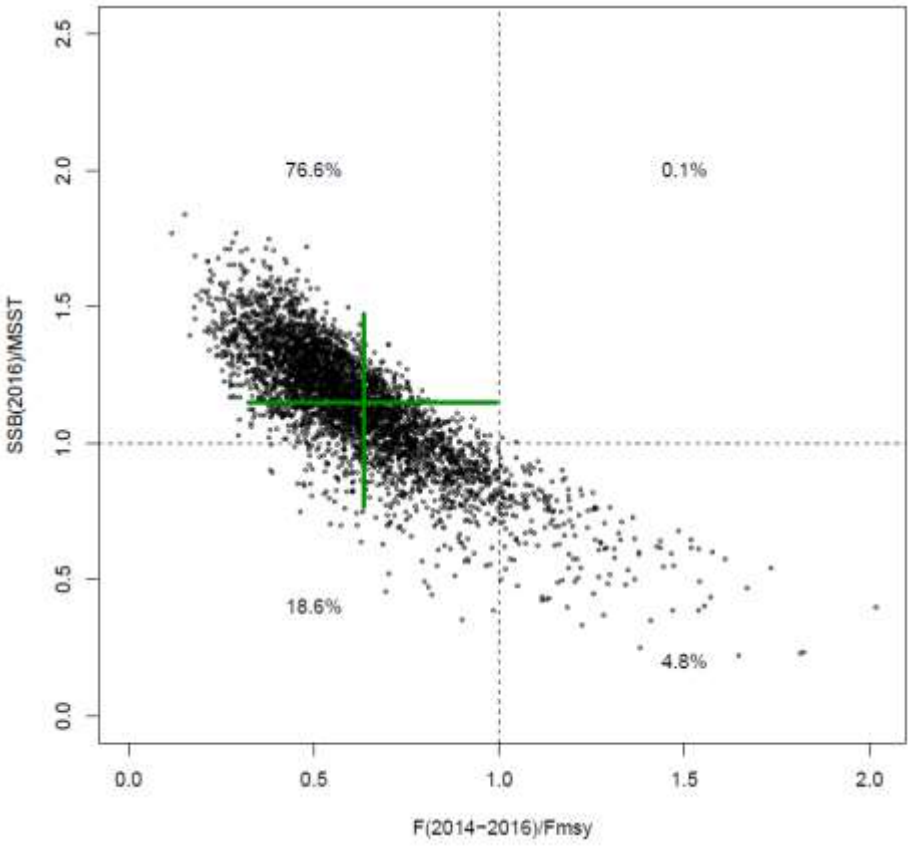








Uncertainty analysis – phase plot



- 76.7% of the runs indicate that the stock is not overfished.
- 95.2% of the runs indicate the stock is not experiencing overfishing.

Outline

- Background
  - Regulations and Jurisdiction
  - Terms of Reference
- Data Review
  - Stock definition
  - Life history
  - Removals
  - Compositions
  - Indices of abundance
  - Summary of updates/modifications
- Catch-age model
  - Base run
  - Sensitivities
  - Uncertainty analysis
- Projections

TOR about projections

5) “The panel shall provide guidance on appropriate assumptions to address harvest and mortality levels in the interim years between the assessment terminal year (2015) and the first year of management (2019).

Projection criteria:

- To determine OFL: (1) P* (annual probability of overfishing) = 50%; (2) F_{MSY}
- To determine ABC: (1) P* = 40%; (2) F@75%F_{MSY}”

$F_{current}$ assumed in the interim years (2017-2018), and a weighted selectivity from the terminal years of the assessment was used.

Projection scenarios in the TORs

1. $F = F_{MSY}$ (also P*=0.5)
2. F = F at P*=0.4
3. $F = 75\%F_{MSY}$

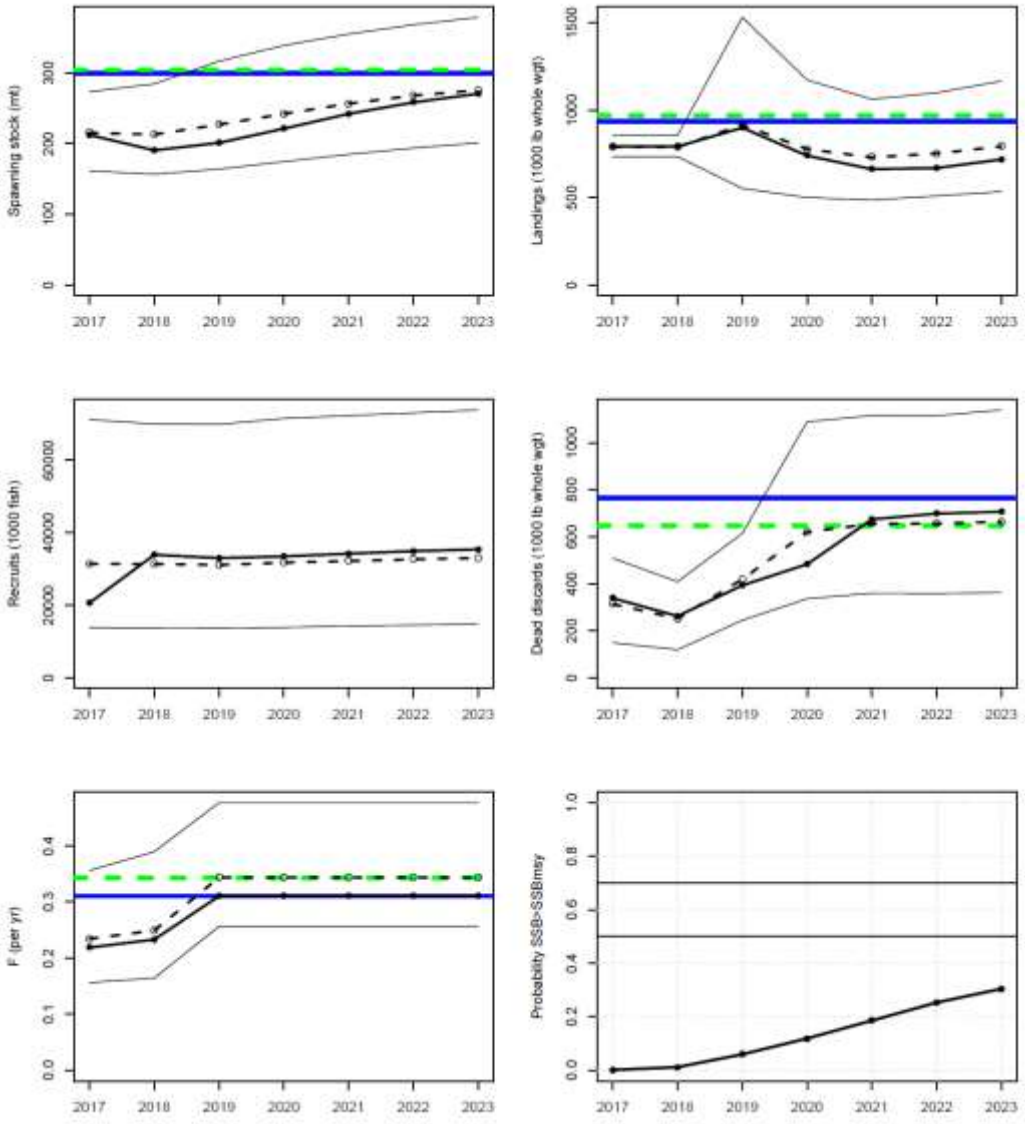
Projection methodology

- Projections were run to predict stock status in years after the assessment, 2017–2023.
- The structure of the projection model was the same as that of the assessment model, and parameter estimates were those from the assessment.
- Any time-varying quantities, such as recreational selectivity, were fixed to the most recent values of the assessment period.
- A single selectivity curve was applied to calculate removals, averaged across fleets using geometric mean *F*s from the last three years of the assessment period.
- Fishing rates that define the projections were assumed to start in 2019.

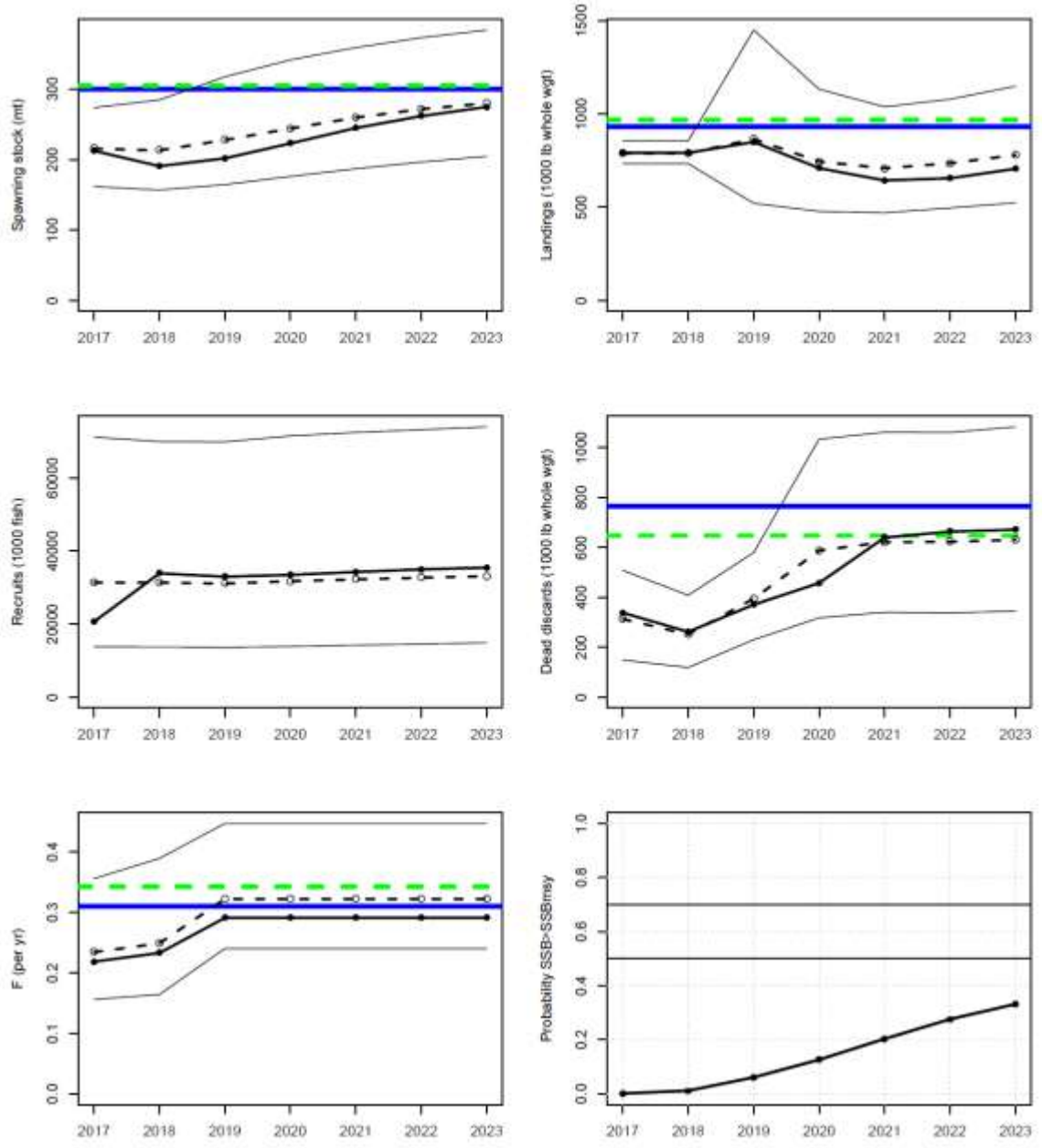
Projection plot layout

- Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5th and 95th percentiles of replicate projections.

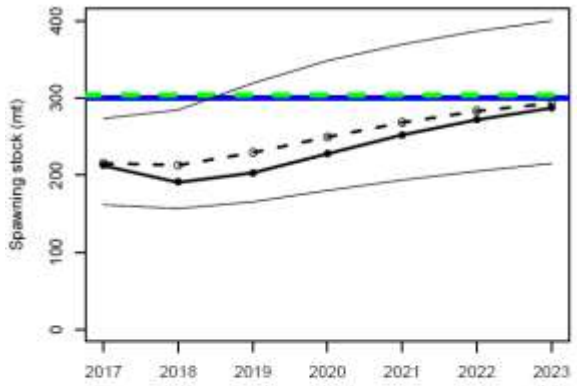
F=Fmsy (also P*=0.5)

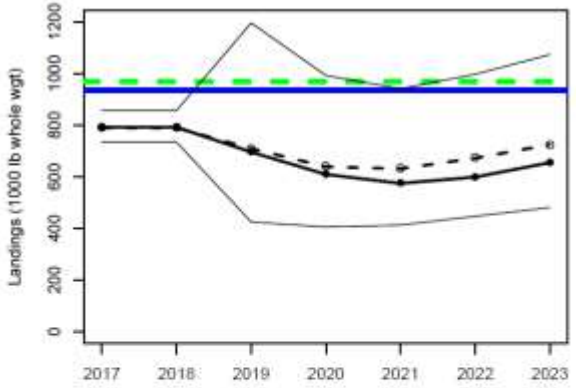


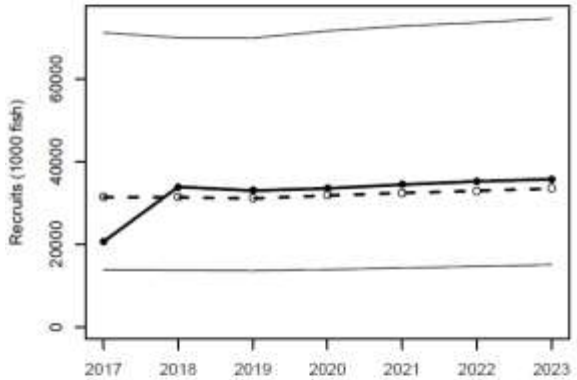
F at P*=0.4

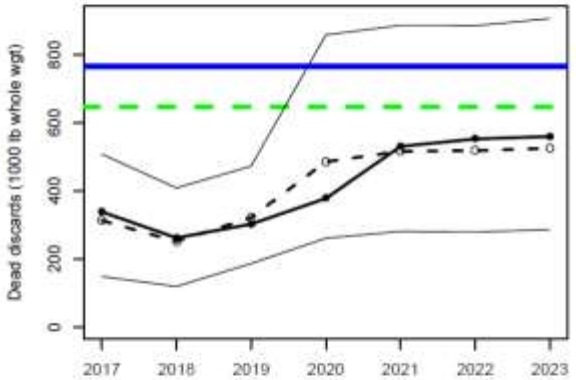

Spawning stock (mt)
0
100
200
300
2017
2018
2019
2020
2021
2022
2023
Landings (1000 lb whole wgt)
0
500
1000
1500
Recruits (1000 fish)
0
20000
40000
60000
Dead discards (1000 lb whole wgt)
0
200
400
600
800
1000
F (per yr)
0.0
0.1
0.2
0.3
0.4
Probability SSB>SSBmsy
0.0
0.2
0.4
0.6
0.8
1.0

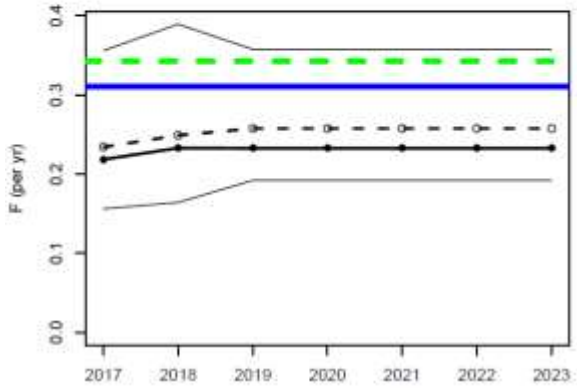
F=75%Fmsy

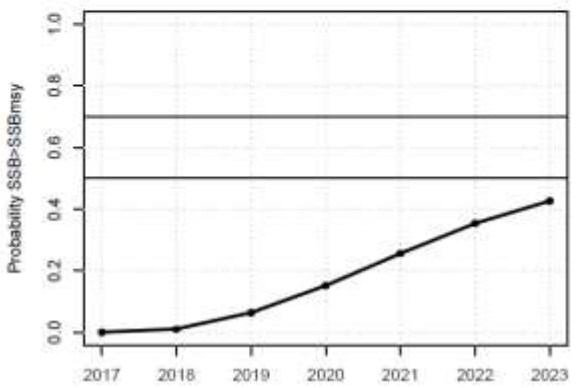

Spawning stock (mt)
0
100
200
300
400
2017
2018
2019
2020
2021
2022
2023


Landings (1000 lb whole wgt)
0
200
400
600
800
1000
1200
2017
2018
2019
2020
2021
2022
2023


Recruits (1000 fish)
0
20000
40000
60000
2017
2018
2019
2020
2021
2022
2023


Dead discards (1000 lb whole wgt)
0
200
400
600
800
2017
2018
2019
2020
2021
2022
2023


F (per yr)
0.0
0.1
0.2
0.3
0.4
2017
2018
2019
2020
2021
2022
2023


Probability SSB>SSBmsy
0.0
0.2
0.4
0.6
0.8
1.0
2017
2018
2019
2020
2021
2022
2023

F = Fmsy

Interim years

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2017	20626	31382	0.22	0.23	212	215	635	633	792	789	582	557	338	313	0.001
2018	33872	31347	0.23	0.25	191	213	597	595	792	789	505	509	262	252	0.012
2019	32977	31072	0.31	0.34	201	227	657	677	899	916	794	872	393	419	0.060
2020	33430	31726	0.31	0.34	221	242	555	604	739	777	976	1197	483	620	0.119
2021	34199	32162	0.31	0.34	242	257	540	612	663	730	1274	1234	674	655	0.186
2022	34897	32609	0.31	0.34	258	268	581	655	669	752	1300	1240	699	656	0.253
2023	35370	33015	0.31	0.34	271	276	635	694	718	793	1318	1255	706	664	0.304

F = F at P*=0.4

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2017	20626	31382	0.22	0.23	212	215	635	633	792	789	582	557	338	313	0.001
2018	33872	31347	0.23	0.25	191	213	597	595	792	789	505	509	262	252	0.012
2019	32977	31072	0.29	0.32	202	228	621	640	850	866	748	821	371	395	0.061
2020	33449	31744	0.29	0.32	223	244	532	578	710	745	922	1132	458	588	0.126
2021	34254	32222	0.29	0.32	245	259	522	592	644	709	1207	1169	640	622	0.203
2022	34971	32690	0.29	0.32	262	272	566	637	655	736	1233	1175	664	623	0.276
2023	35459	33117	0.29	0.32	275	280	620	678	706	780	1250	1190	671	631	0.332

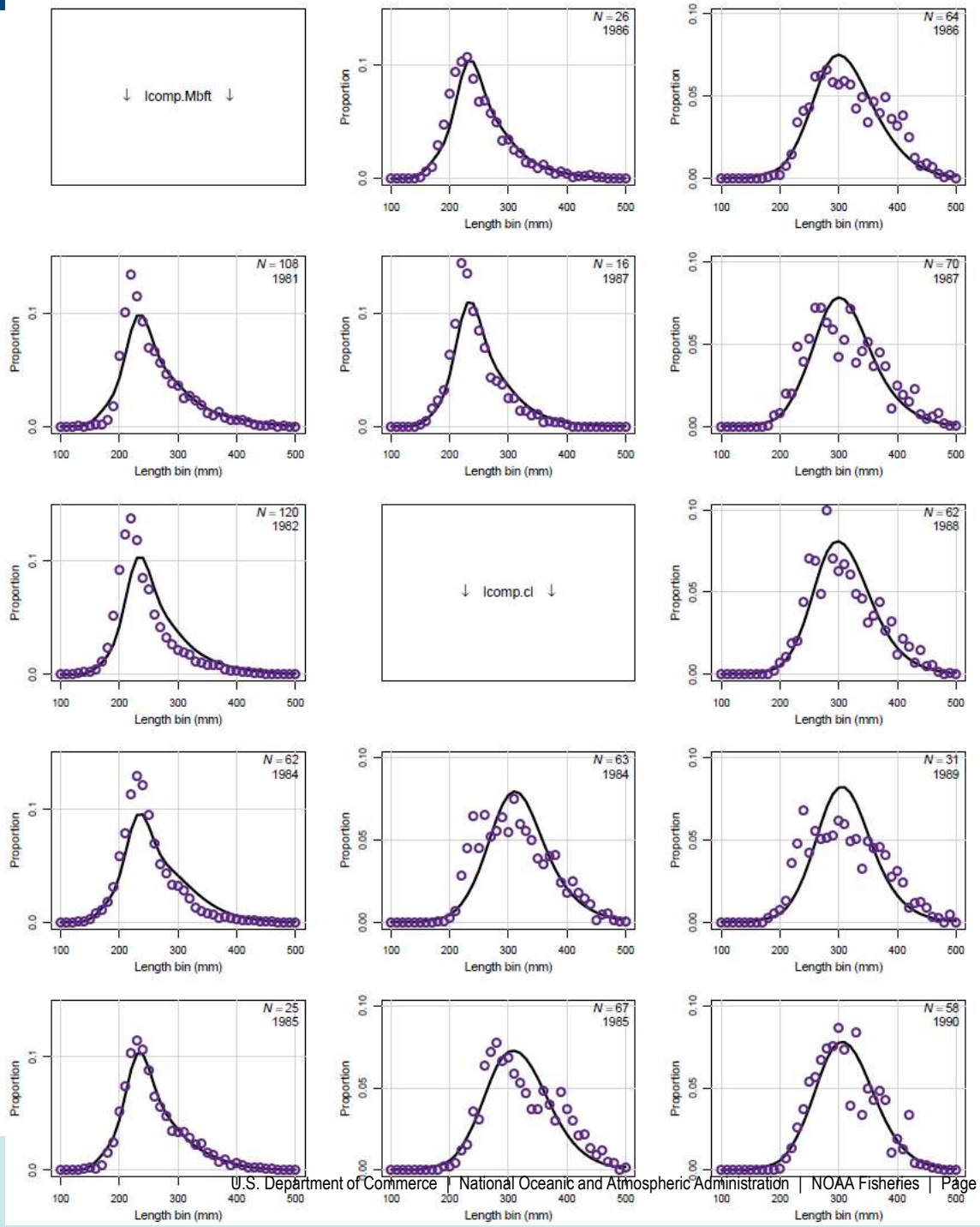
F = 75%Fmsy

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2017	20626	31382	0.22	0.23	212	215	635	633	792	789	582	557	338	313	0.001
2018	33872	31347	0.23	0.25	191	213	597	595	792	789	505	509	262	252	0.012
2019	32977	31072	0.23	0.26	203	229	508	523	696	709	608	667	302	322	0.065
2020	33507	31793	0.23	0.26	228	249	454	493	609	639	756	930	378	486	0.153
2021	34425	32404	0.23	0.26	252	268	459	520	574	631	995	964	531	517	0.256
2022	35197	32938	0.23	0.26	272	283	506	570	599	672	1019	970	553	518	0.354
2023	35732	33445	0.23	0.26	287	293	561	615	655	724	1035	984	560	525	0.427

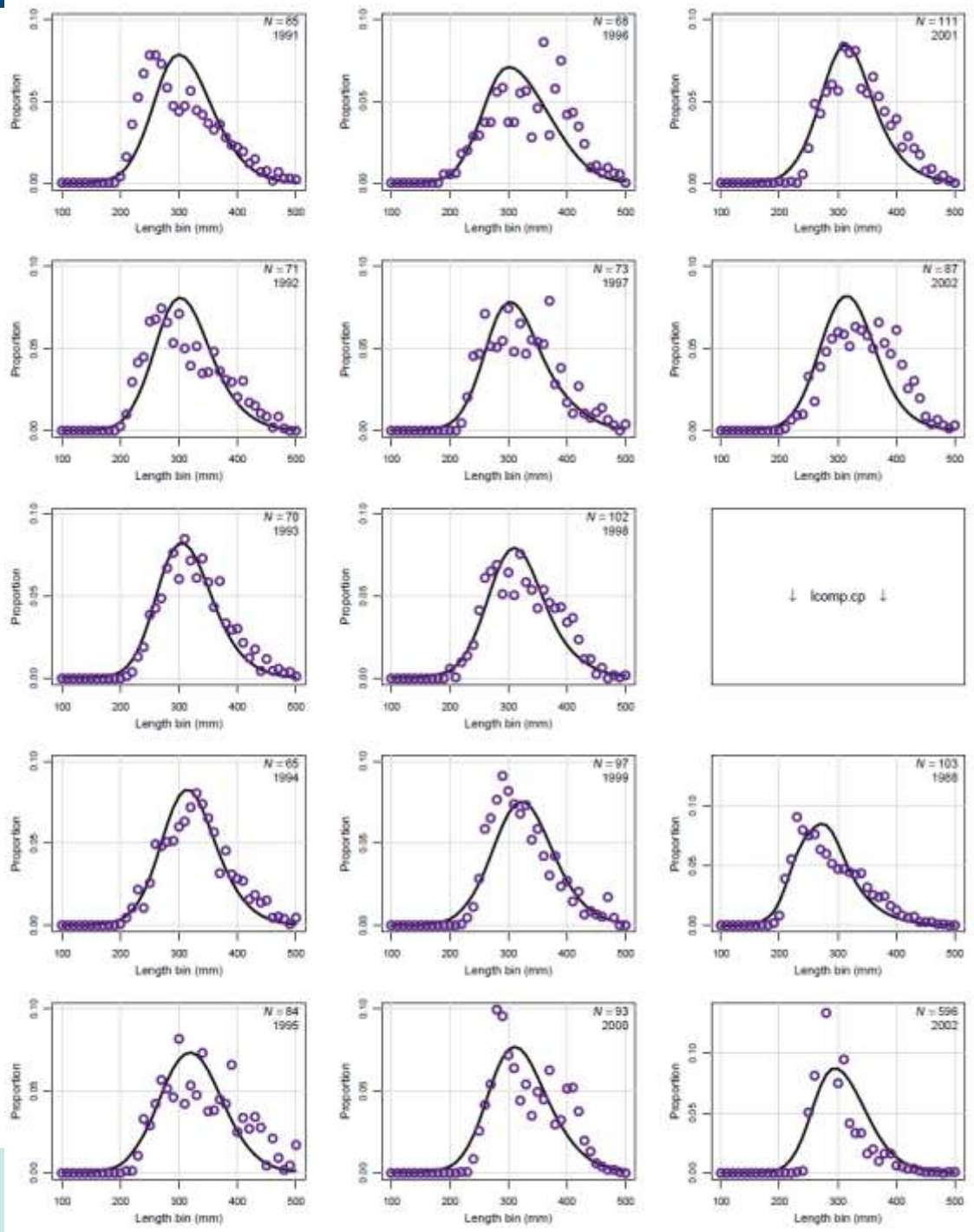
Questions?

Extra slides

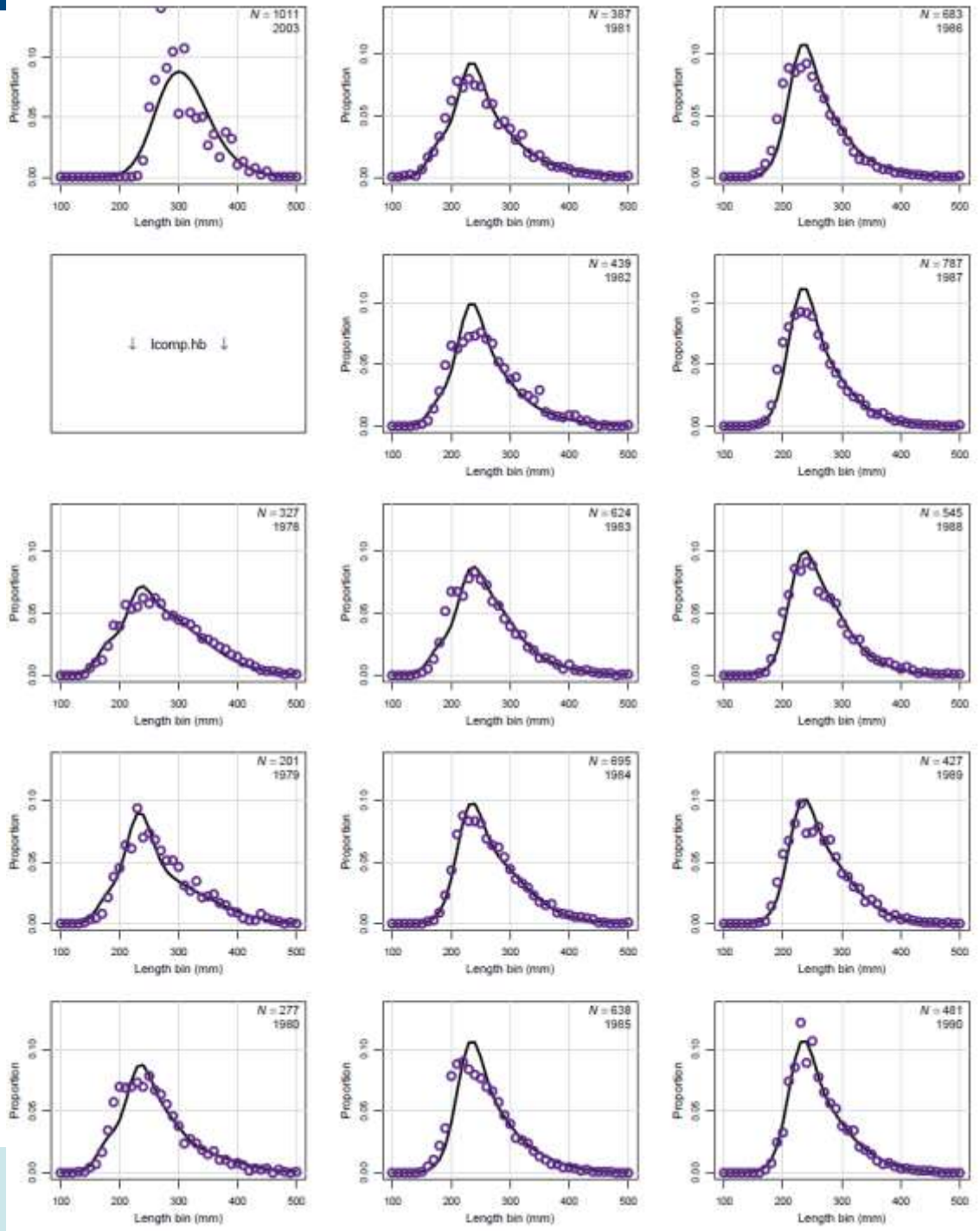
Yearly comps



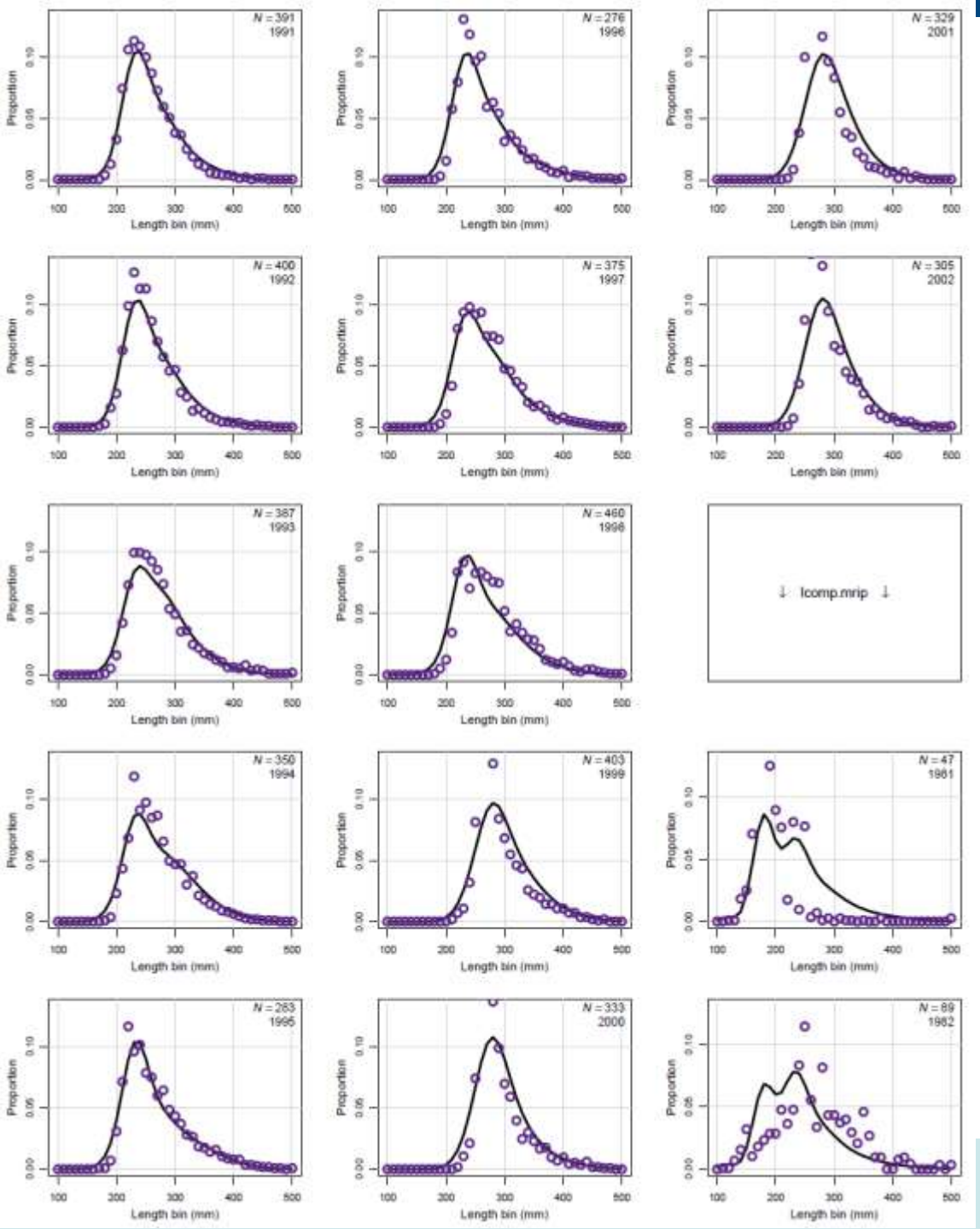
Yearly comps cont'd.



Yearly comps cont'd.



Yearly comps cont'd.



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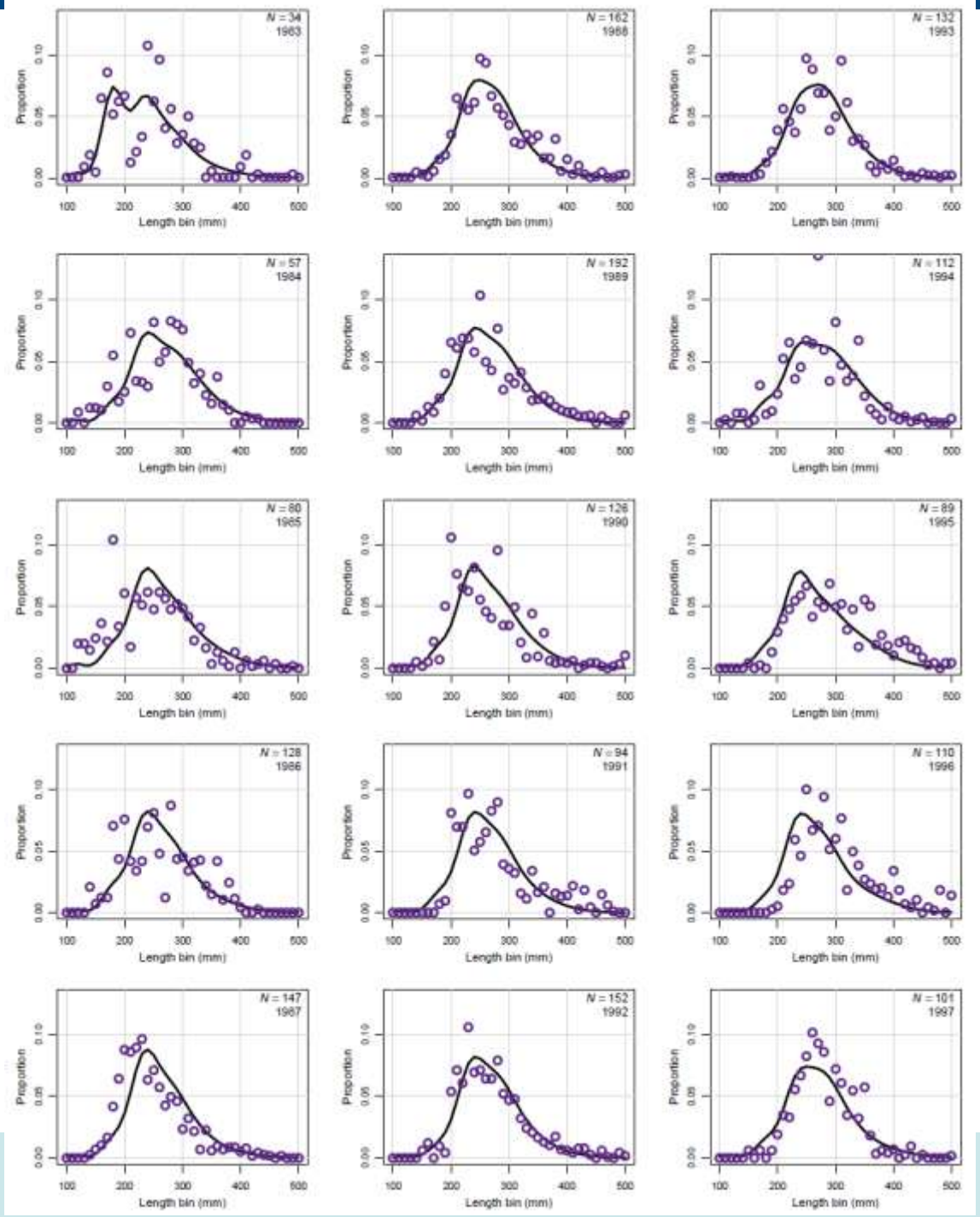
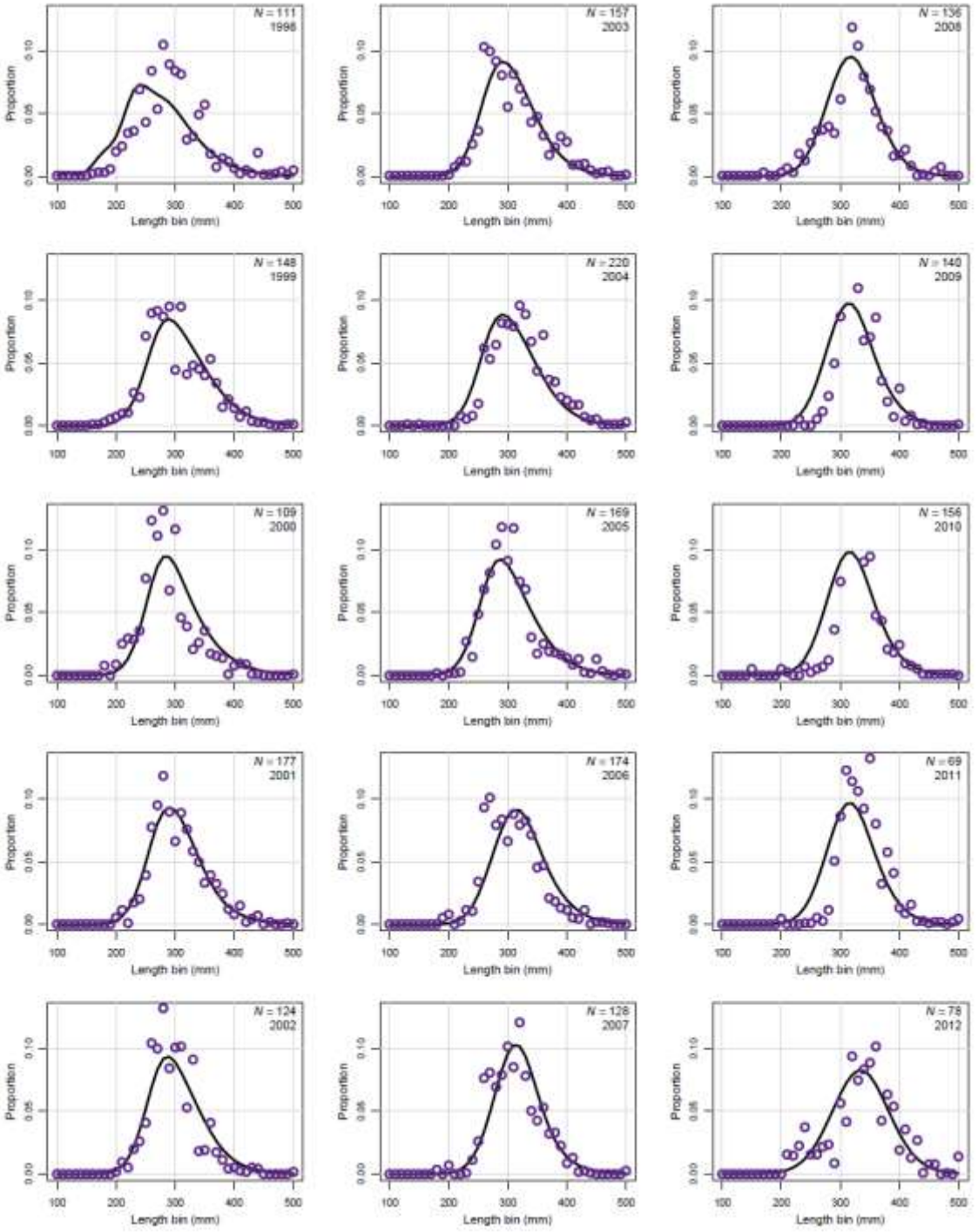
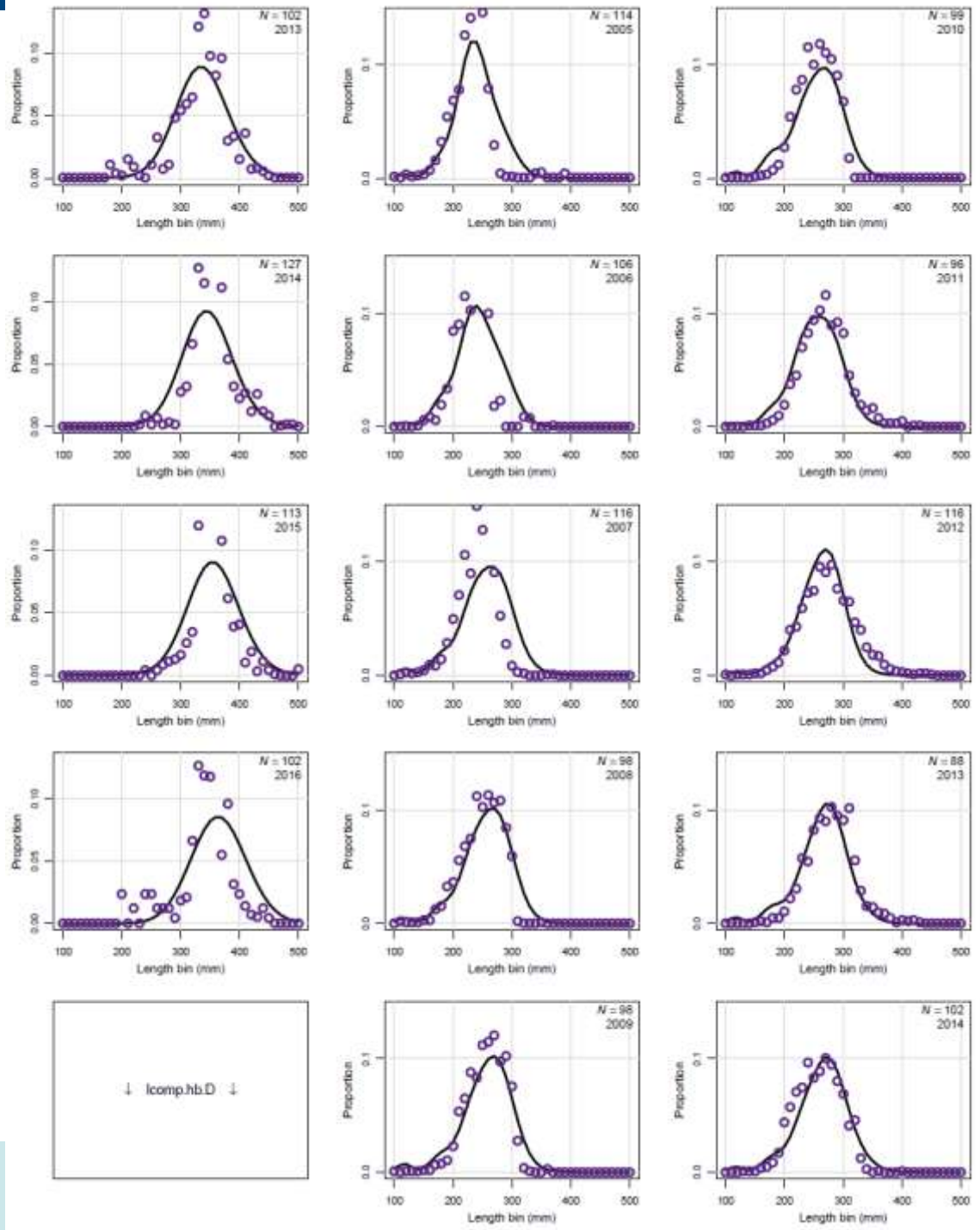


Yearly comps cont'd.



Yearly comps cont'd.



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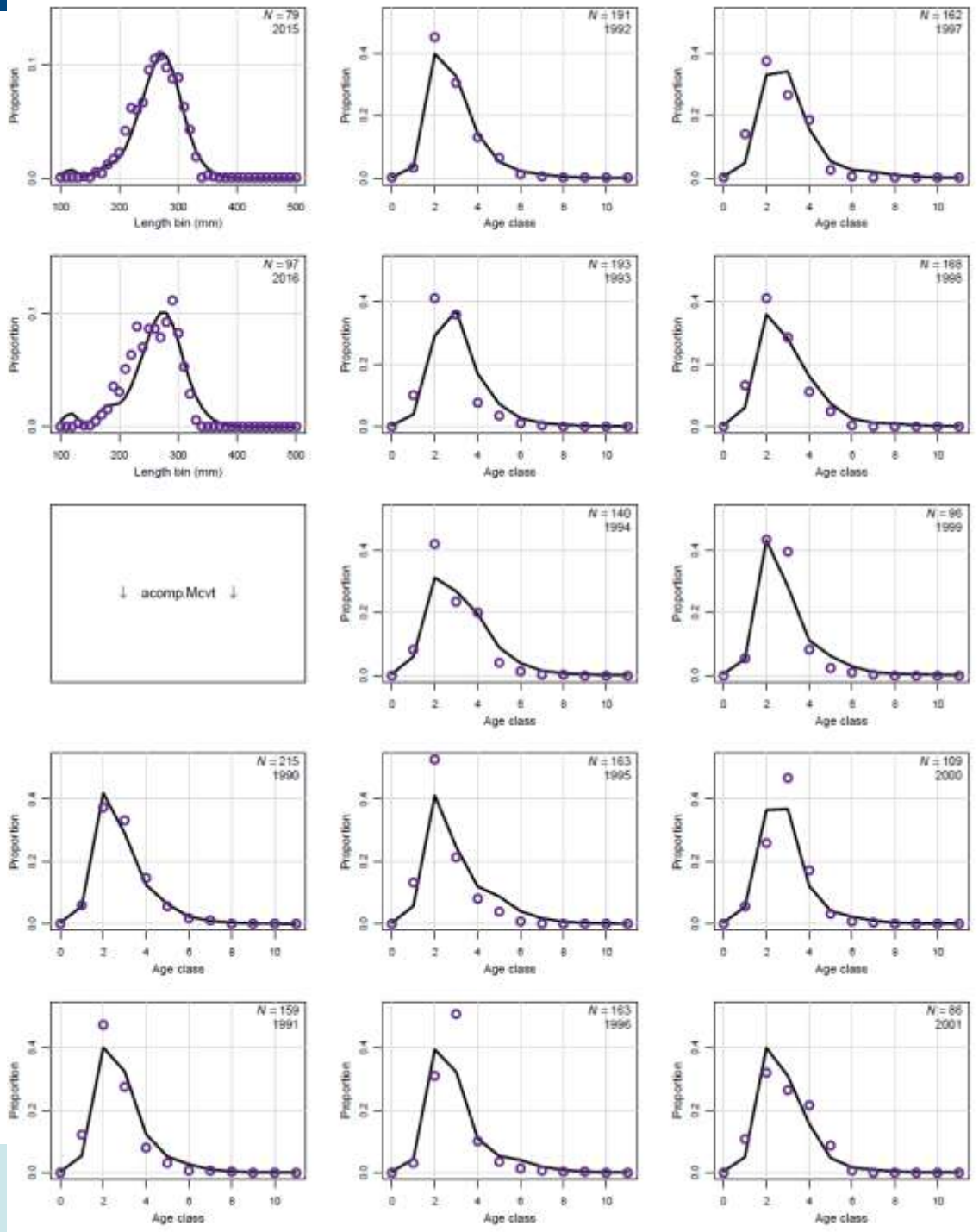

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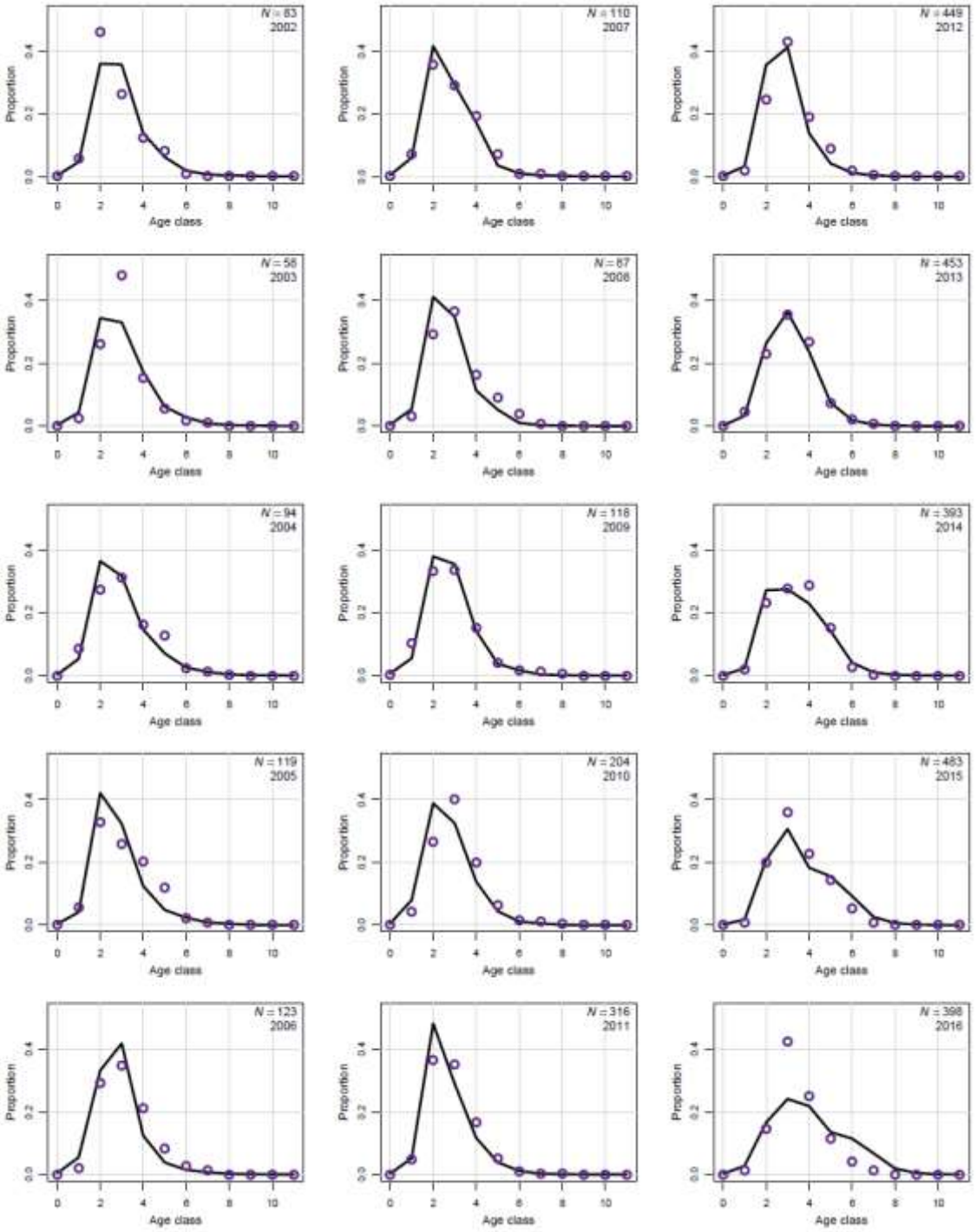

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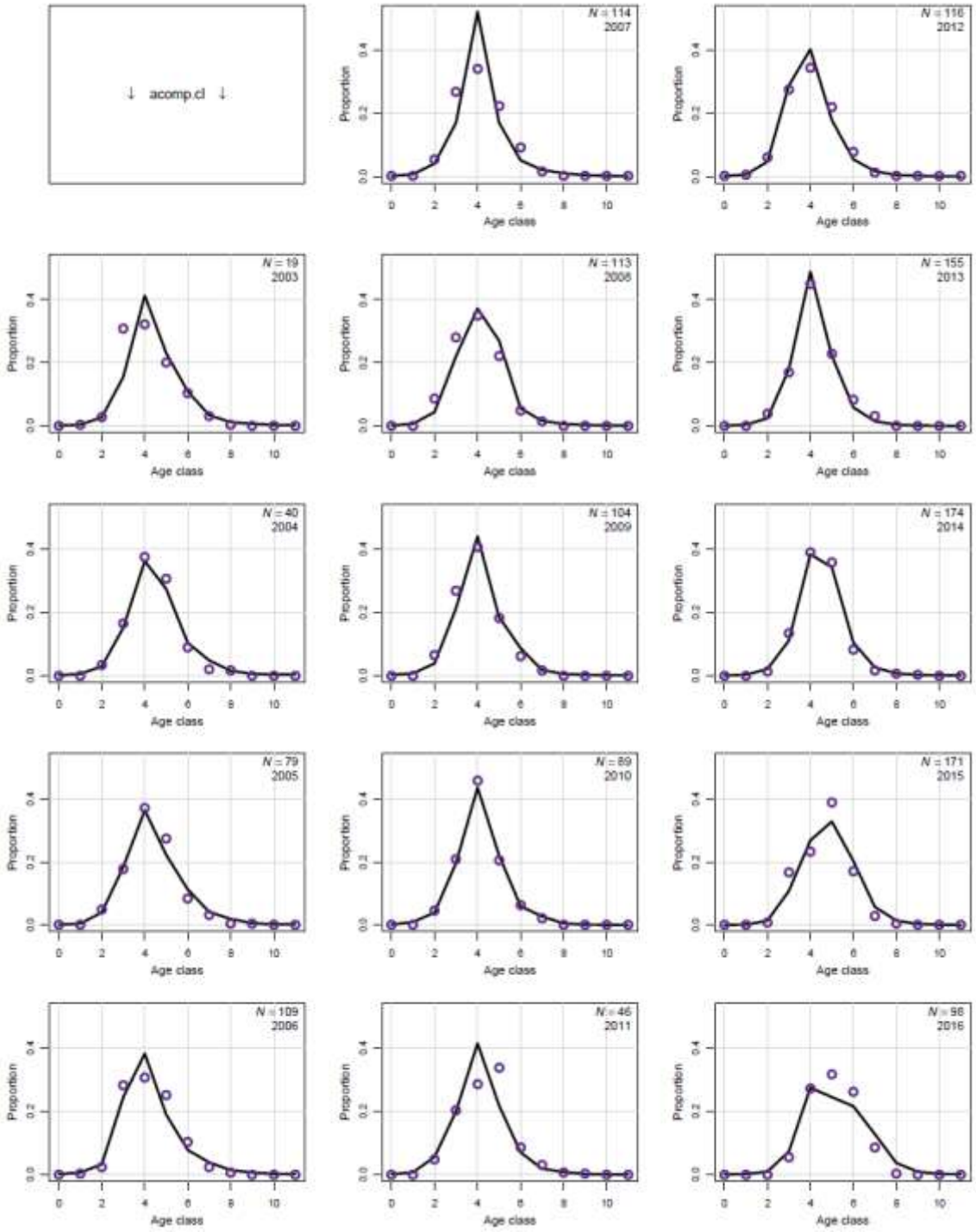

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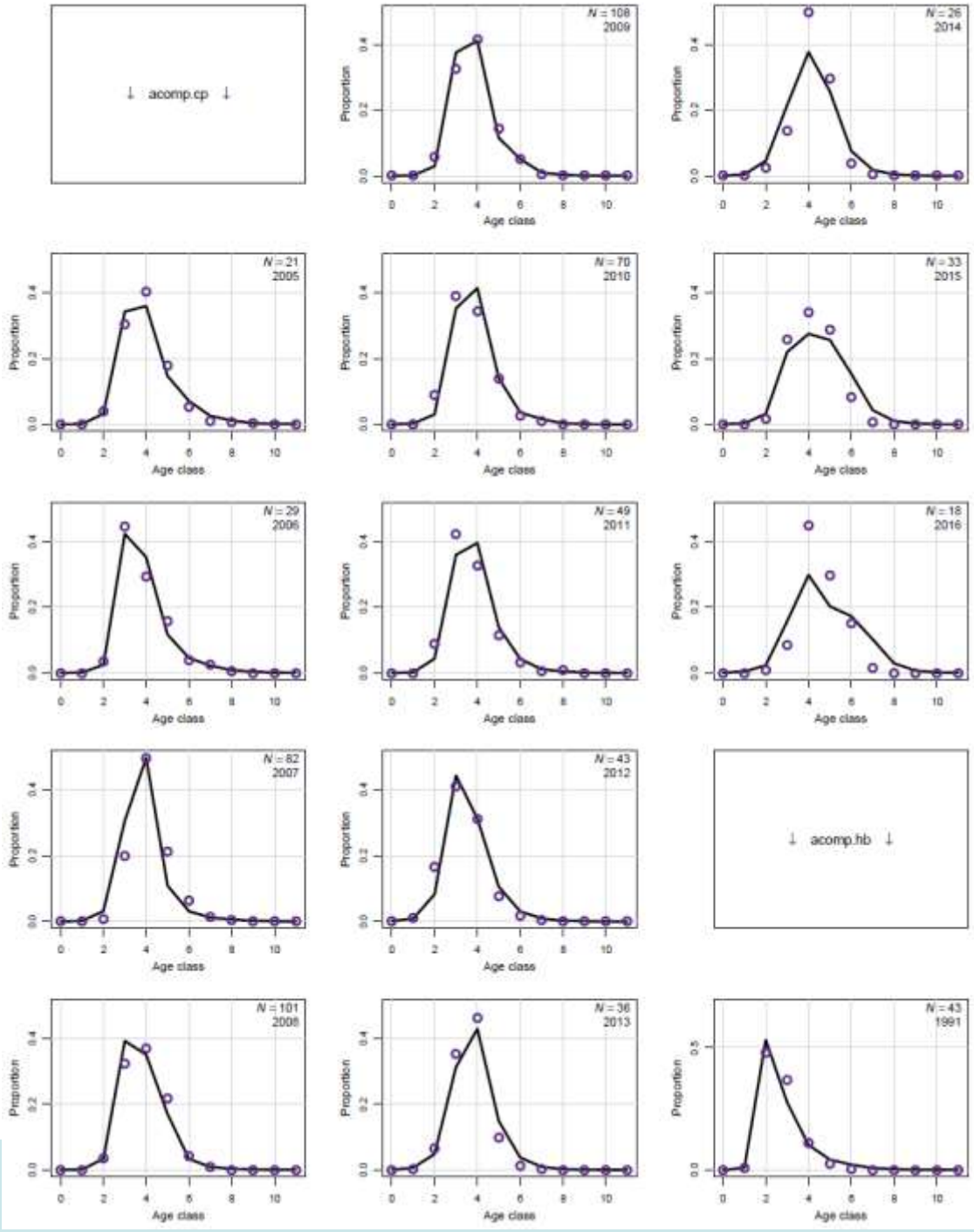


Yearly comps cont'd.

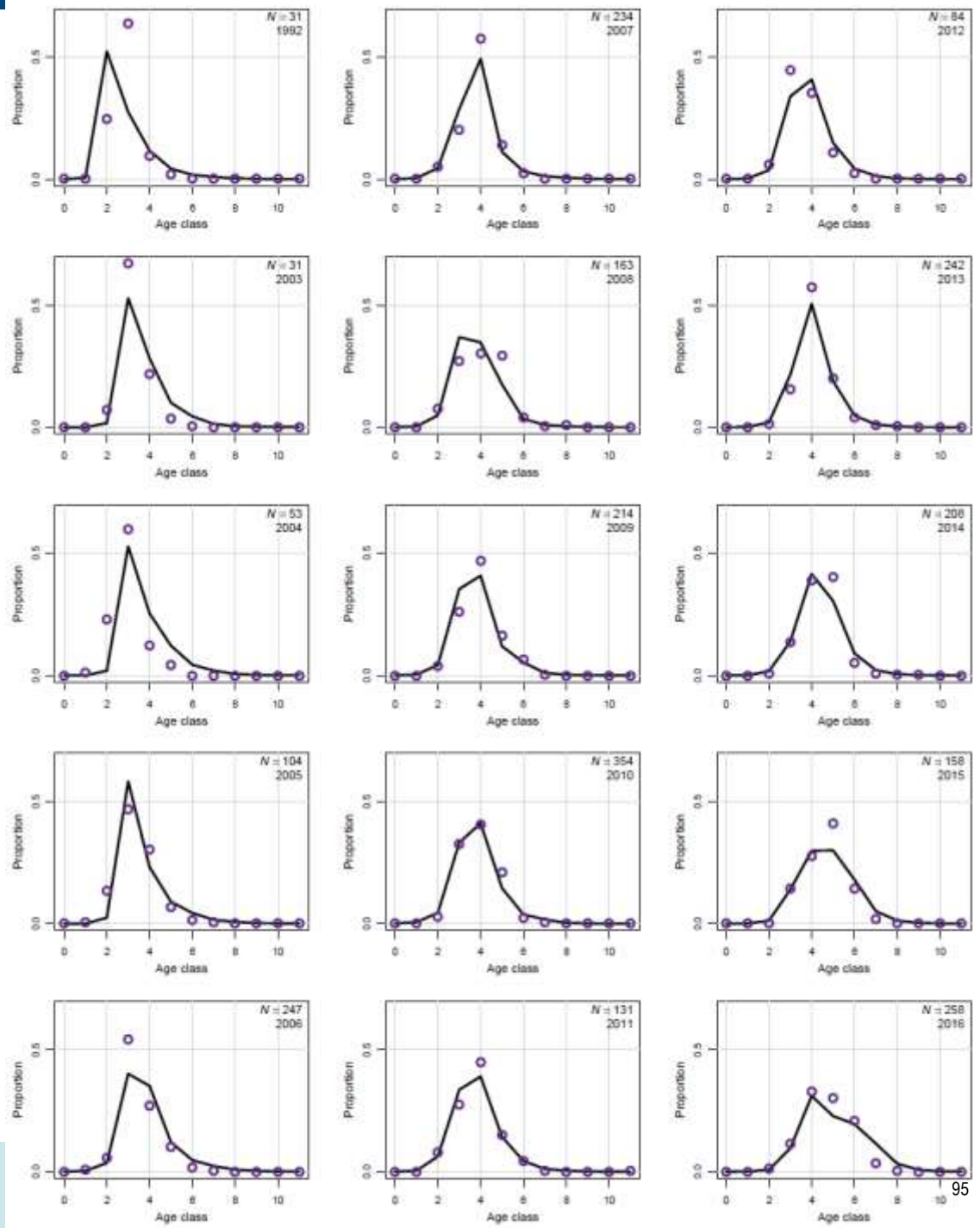


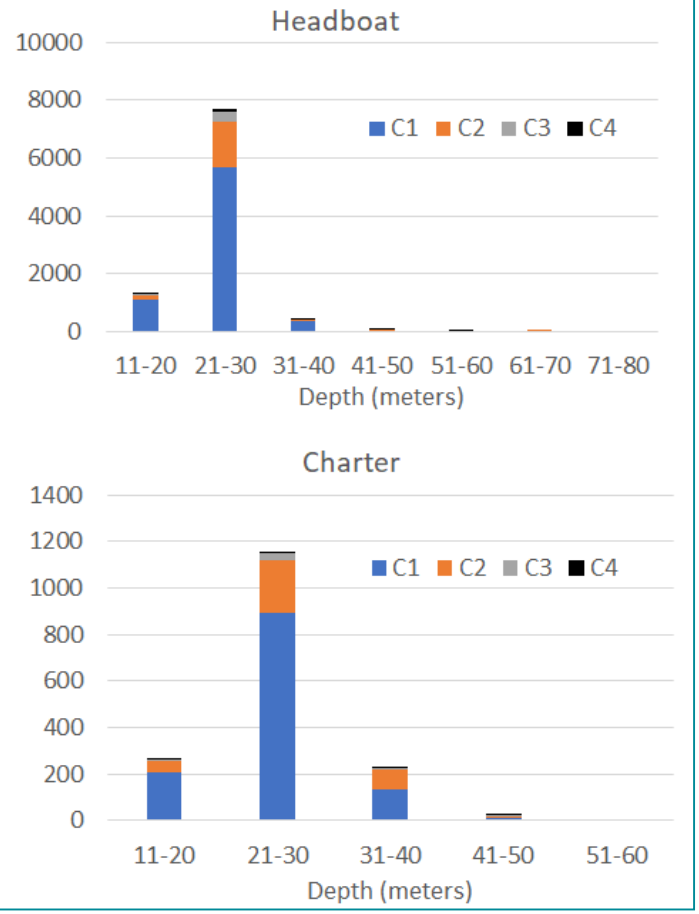
Table 2. Depths, numbers by release condition, and estimates of discard survival (median, 2.5% and 97.5% credible intervals (CI)) of black sea bass (*Centropristis striata*) captured and observed in four release conditions from 11 recreational (R) and commercial (C) hook and line (HL) data sets and three release conditions from 10 commercial trap data sets collected in Onslow Bay, North Carolina, USA.

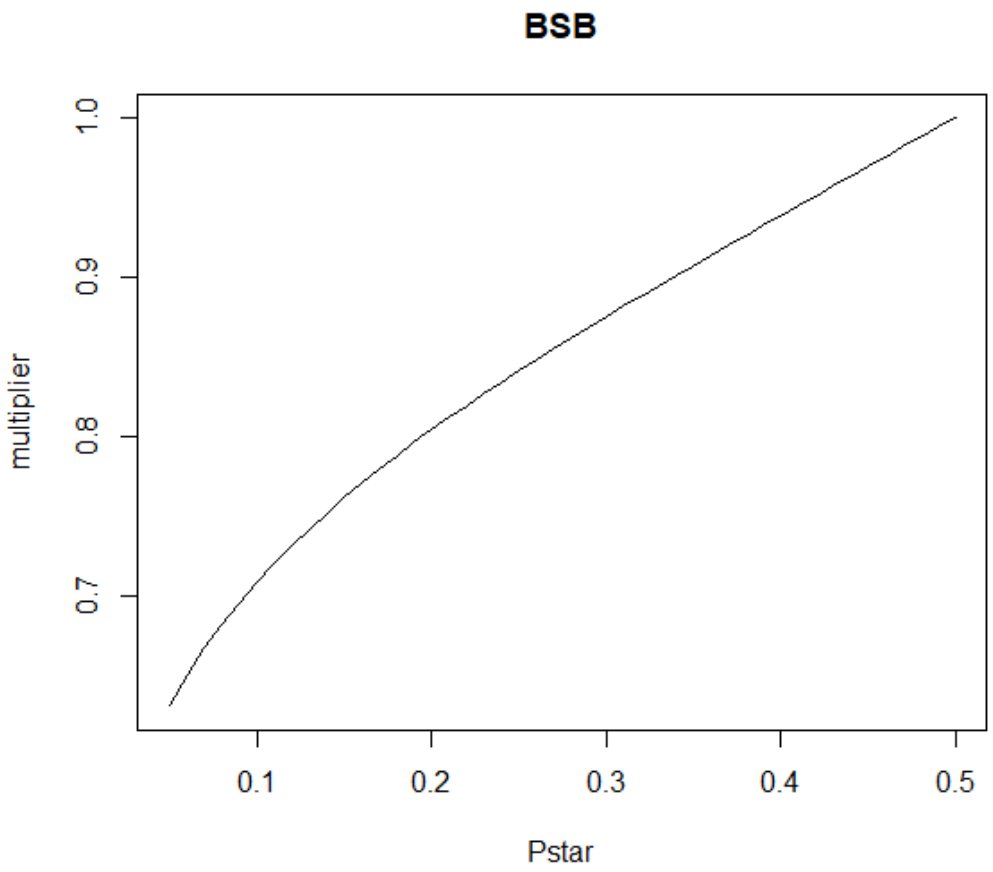
Gear	Fishery	Depth (m)	No. released: total	No. released: condition 1	No. released: condition 2	No. released: condition 3	No. released: condition 4	2.5% CI survival	Median survival	97.5% CI survival
HL-M	R	20	201	95	82	22	2	0.63	0.82	1.12
HL-E	R	20	12	12	0	0	0	0.59	0.79	1.10
HL-E	C	29	20	10	8	2	0	0.59	0.80	1.10
HL-M	R	30	52	8	38	3	3	0.61	0.81	1.12
HL-E	R	30	31	4	19	3	5	0.52	0.71	1.01
HL-M	R	31	200	40	134	12	14	0.62	0.81	1.12
HL-M	R	31	20	3	13	1	3	0.53	0.73	1.04
HL-E	C	31	60	17	40	3	0	0.65	0.85	1.17
HL-E	R	31	69	8	49	9	3	0.60	0.79	1.09
HL-M	R	32	61	13	34	9	5	0.56	0.75	1.04
HL-M	R	35	14	1	9	1	3	0.47	0.68	0.98
HL-Overall			730	201	426	65	38	0.62	0.81	1.11
Traps	C	11	24	24	0	—	0	0.65	0.84	1.14
Traps	C	13	103	103	0	—	0	0.67	0.86	1.17
Traps	C	15	20	19	0	—	1	0.61	0.81	1.11
Traps	C	17	7	7	0	—	0	0.58	0.80	1.12
Traps	C	19	15	15	0	—	0	0.63	0.83	1.14
Traps	C	21	19	19	0	—	0	0.65	0.84	1.15
Traps	C	23	63	59	3	—	1	0.66	0.85	1.16
Traps	C	25	27	26	1	—	0	0.65	0.85	1.16
Traps	C	27	41	36	3	—	2	0.63	0.82	1.13
Traps	C	29	26	25	0	—	1	0.63	0.82	1.12
Traps-Overall			344	332	7	—	5	0.67	0.86	1.17

Note: Data sets are further separated by hook and line with manual reels (HL-M) and hook and line with electric reels (HL-E). These were non-tagging trips. Condition categories: 1, fish in best condition with no signs of trauma and swam down; 2, external signs of barotrauma but swam down; 3, hook trauma but swam down 4, floating or presumed dead.

Observed Discards - FL

- Majority discards in 21-30 meters
- Majority in release condition 1
  - Swam down, no barotrauma
  - M = 0.13
- Very few released with hook injury or floating
- Mortality
  - Charter = 0.137
  - Headboat = 0.152
  - Overall = 0.150




BSB
multiplier
1.0
0.9
0.8
0.7
0.1
0.2
0.3
0.4
0.5
Pstar