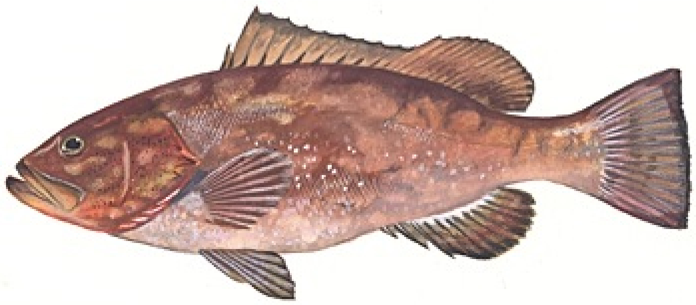
Southeast
Fisheries
Science Center

Red grouper



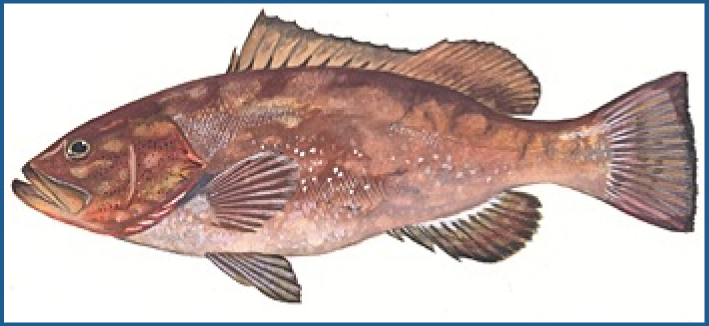
SEDAR-53 Standard Assessment

April 26, 2017

Outline

- Background
- Data
  - Review of data sources from SEDAR19
  - Updates/modifications
- Assessment methods and results
  - Overview of assessment model
  - Updates/modifications since SEDAR19
  - Results

Background



Background

- This assessment was originally scheduled as an *update* of the SEDAR19 assessment, but was changed to a *standard* assessment to allow inclusion of SERFS video data.
- Standard assessment conventions
  - Modeling decisions made by an assessment panel. Meetings conducted via webinars.
  - SSC conducts the review
- TOR #2
  - Consider the inclusion of the SERFS video index
  - Incorporate the latest BAM model configuration
- Strike a balance between fidelity to SEDAR19 and modifications intended to improve the assessment

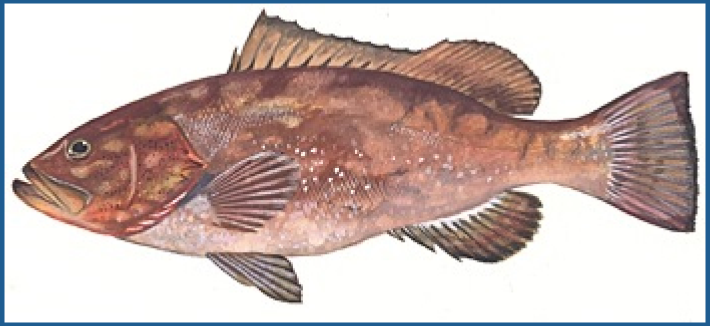
Background – summary of regulations

Year effective	Recreational	Commercial
1984	12in TL	12in TL
1992	20in TL; 5-grouper aggregate bag	20in TL
2010	3-grouper aggregate bag; Spawning season (Jan-April) closure	Spawning season (Jan-April) closure
2011-	Miscellaneous ACL/ABC and AM measures	

Background – summary of previous results

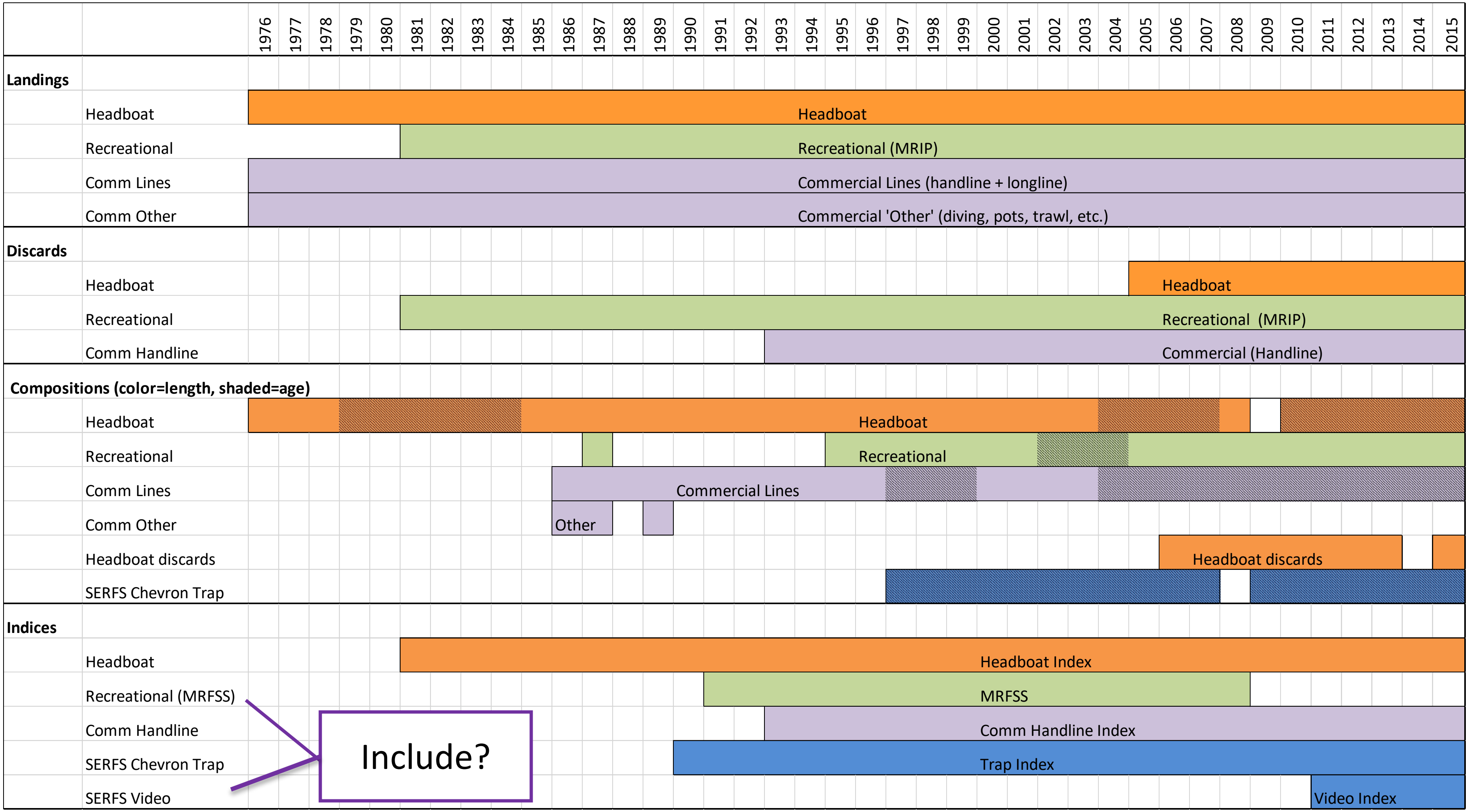
- SEDAR19
  - Overfishing: F2008/Fmsy=1.35
  - Overfished: SSB2008/MSST=0.92
- The S19 MSST was defined by M
  - MSST=(1-M)SSBmsy, with M=0.14.
- Amendment 24 changed that definition
  - MSST=75%SSBmsy
  - The stock was no longer considered overfished
- The new definition is used in this current assessment

Data

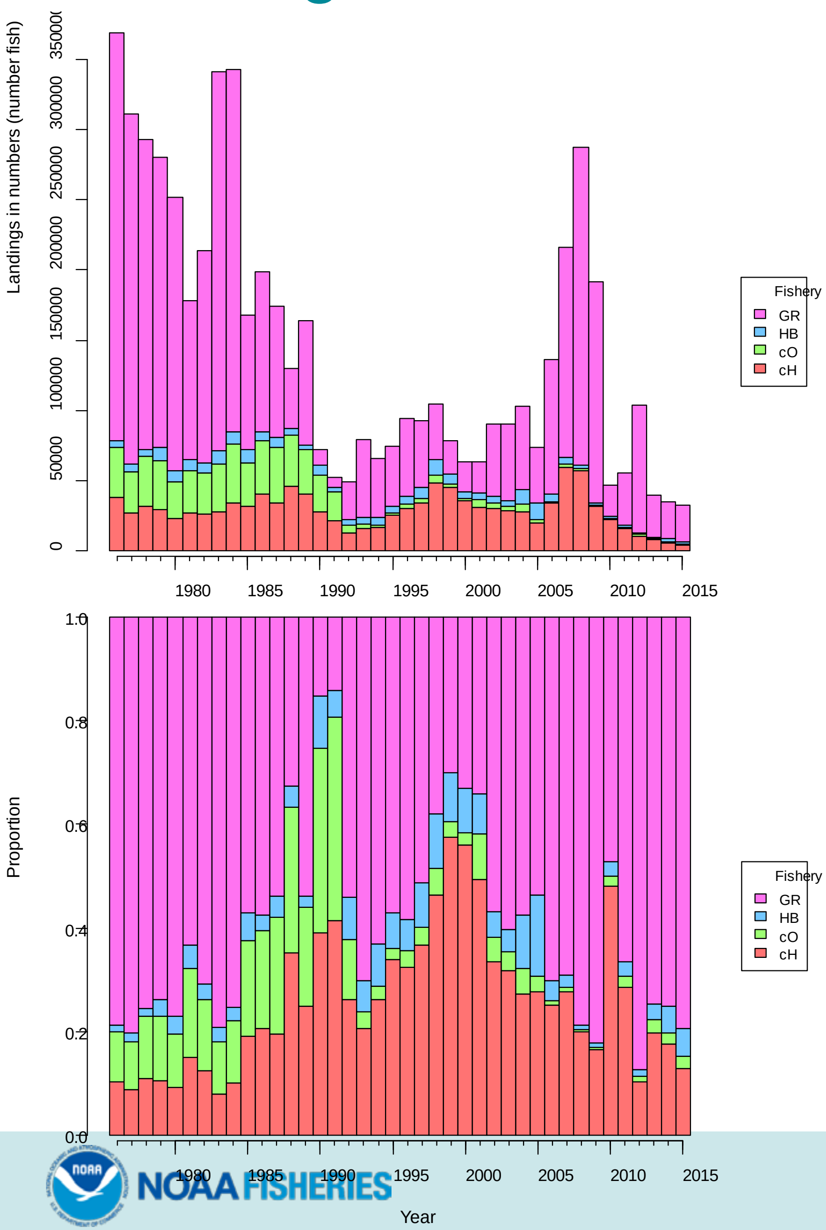


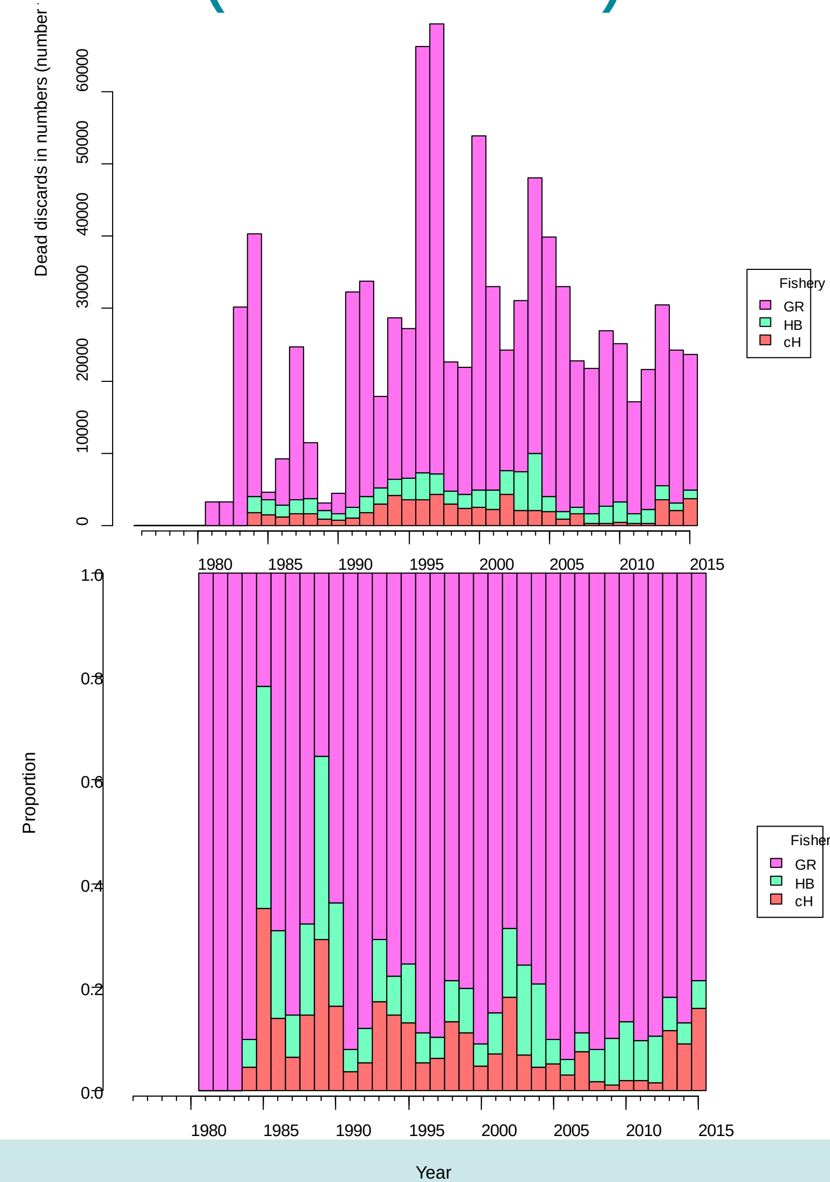
Data fit by the assessment

Note: terminal yr of SEDAR19 was 2008



Landings and discard mortalities (in numbers)





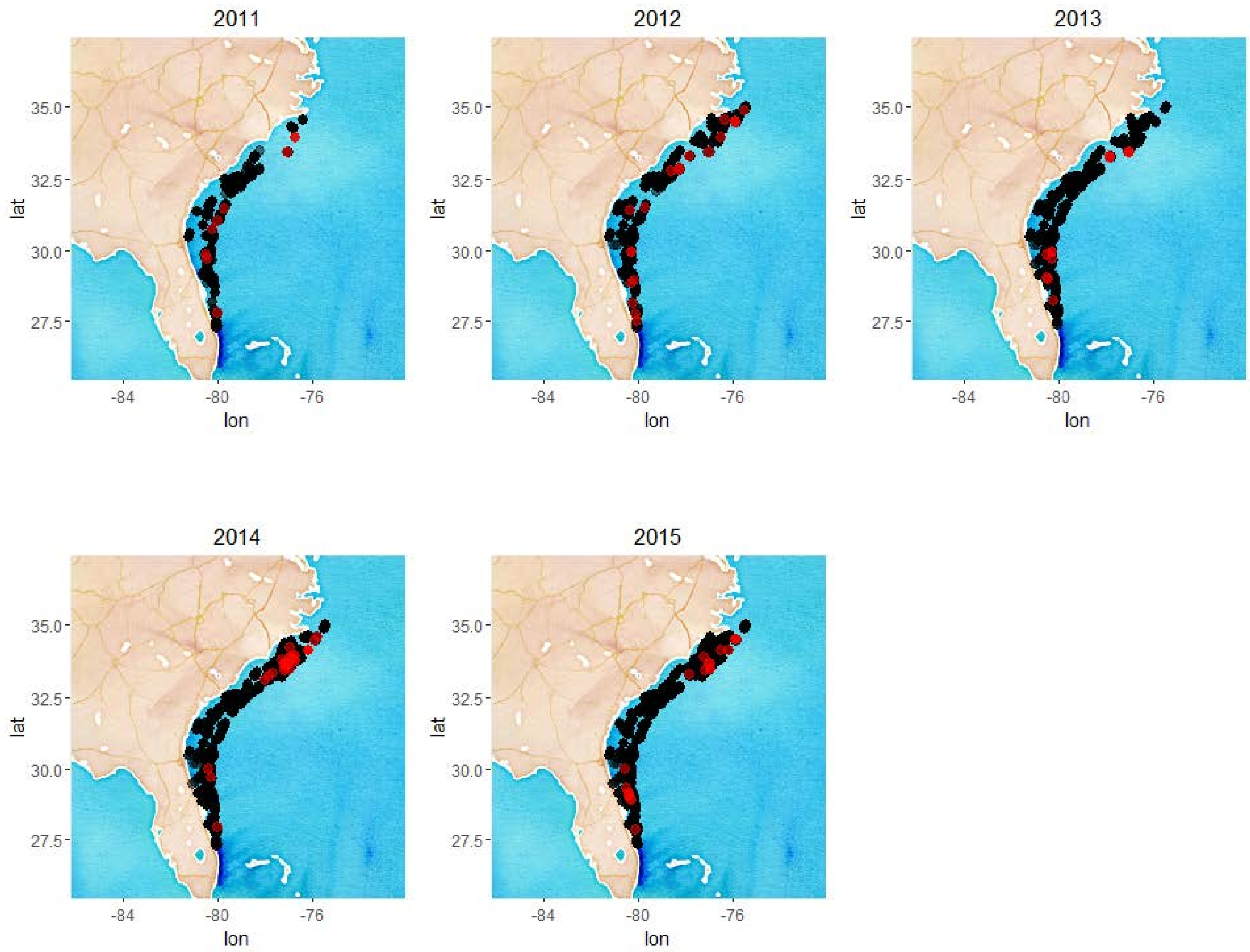
Indices of abundance: Primary decisions made by the assessment panel

- Terminal year of fishery dependent indices was 2015
  - Removed months with spawning season closure for all years (Jan-Apr)
  - Removed all trips within the quota closure in 2012, ~895 trips or 0.36% of all trips in 2012 (11 days in Oct, 9 days Nov, all of Dec)
- Excluded the MRFSS index
  - Runs of S19 model with and without the MRFSS index showed that the index had trivial influence on estimated time series of abundance, SSB, F, SSB/SSBmsy, and F/Fmsy
  - Excluded it in the interest of parsimony, and because other indices were considered to be better measures of relative abundance
- Included the SERFS video index; combined it with the SERFS chevron trap index

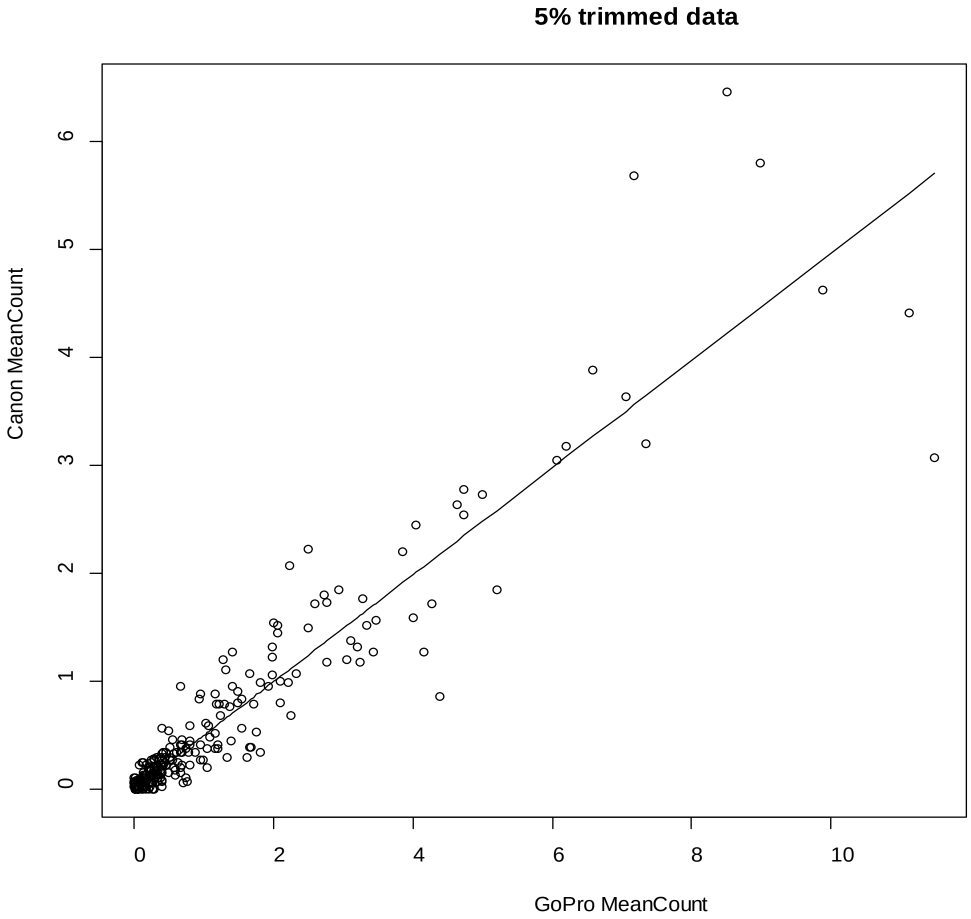
Index of abundance from video data

- Years 2011-2015
- Standardization methods follow those of SEDAR41 (S53-WP01)
  - Factors: year, season, depth, latitude, temperature, turbidity, current direction, biotic density, substrate composition
  - ZIP and ZINB models considered; ZINB preformed best
  - Uncertainty (CVs) computed by bootstrap (n=1000)
- Camera gear change in 2015 (Cannon to GoPro)
  - Adjustment to 2015 index value based on a calibration study
  - Only 4 red grouper observed in calibration study, therefore fish of all species were used to compute the calibration factor

Video sampling sites (black) and locations where red grouper were observed (red)



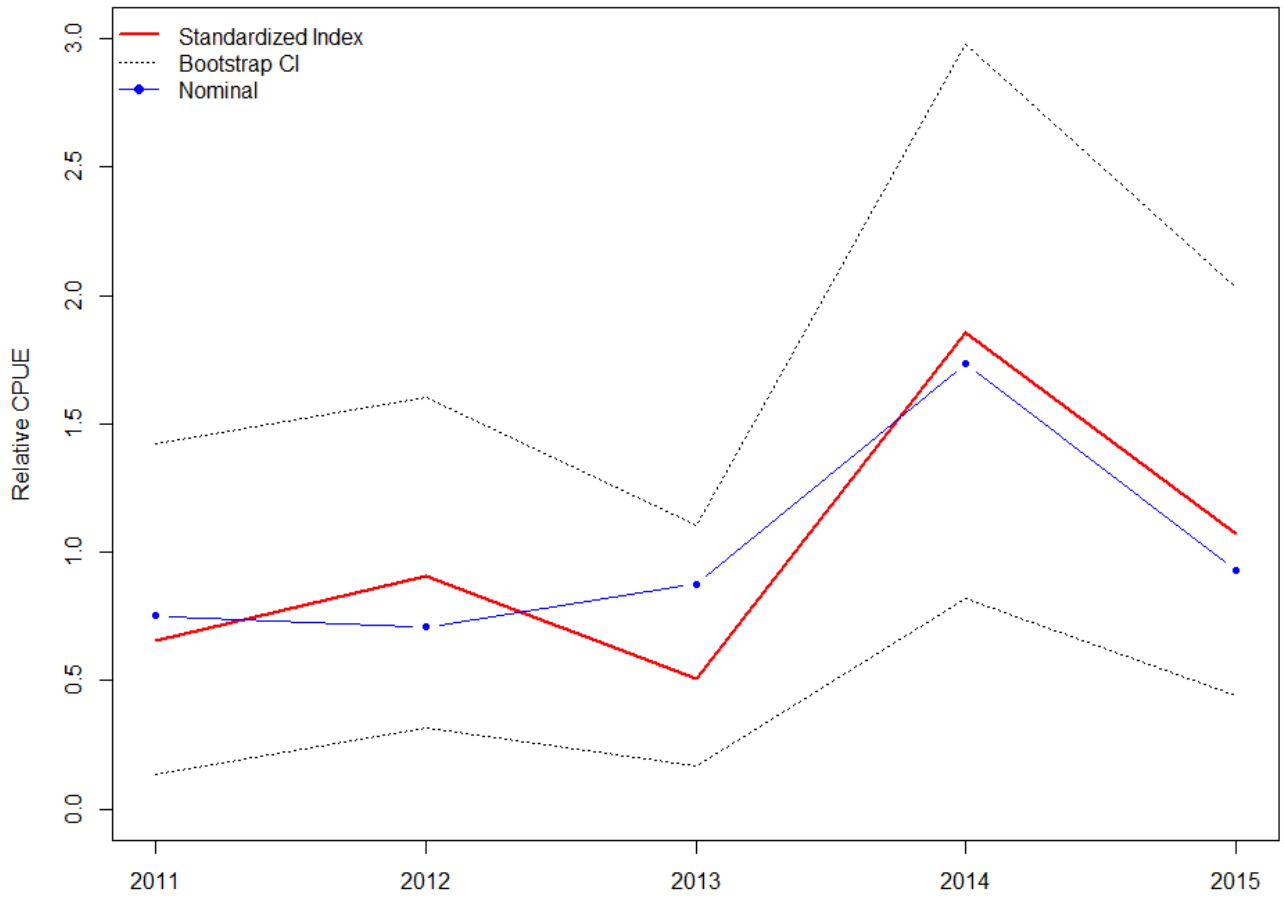
Calibration for 2015



β=0.496 (SE=0.009).

See about half as many fish on Canon as on GoPro

Relative standardized index (solid line) with 2.5% and 97.5% confidence intervals (dashed lines) and the relative nominal index (blue) for red grouper in the SERFS video survey



Video

Year	N	N pos	Proportion positive	Standardized index	CV
2011	576	8	0.014	0.66	0.50
2012	1076	20	0.019	0.91	0.41
2013	1221	12	0.010	0.51	0.53
2014	1381	29	0.021	1.85	0.30
2015	1364	20	0.015	1.07	0.37

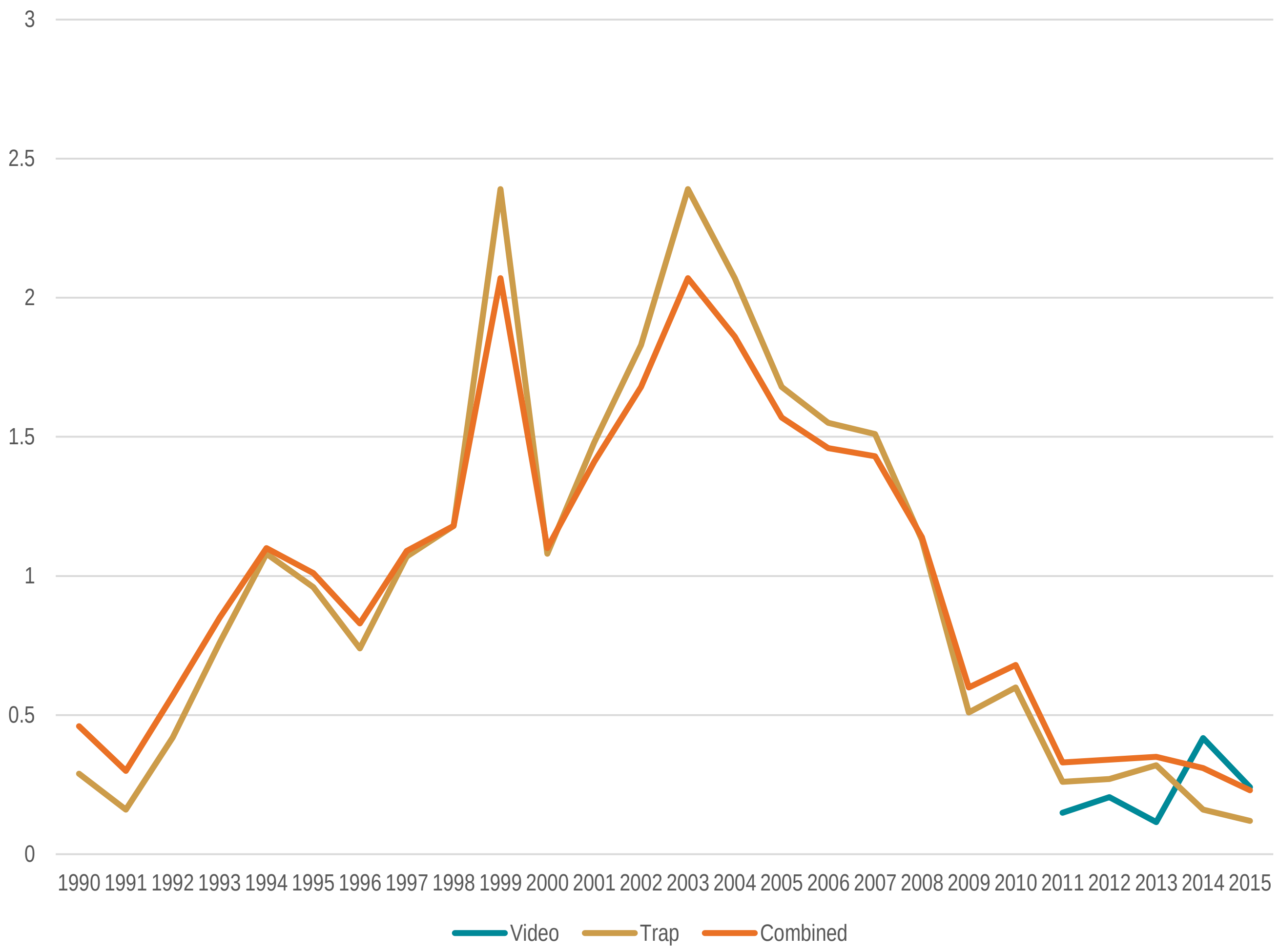
Chevron trap (for comparison)

Year	N	N pos	Proportion positive
2011	668	11	0.02
2012	1106	37	0.03
2013	1308	39	0.03
2014	1435	37	0.03
2015	1409	22	0.02

Combine SERFS chevron trap and SERFS video indices

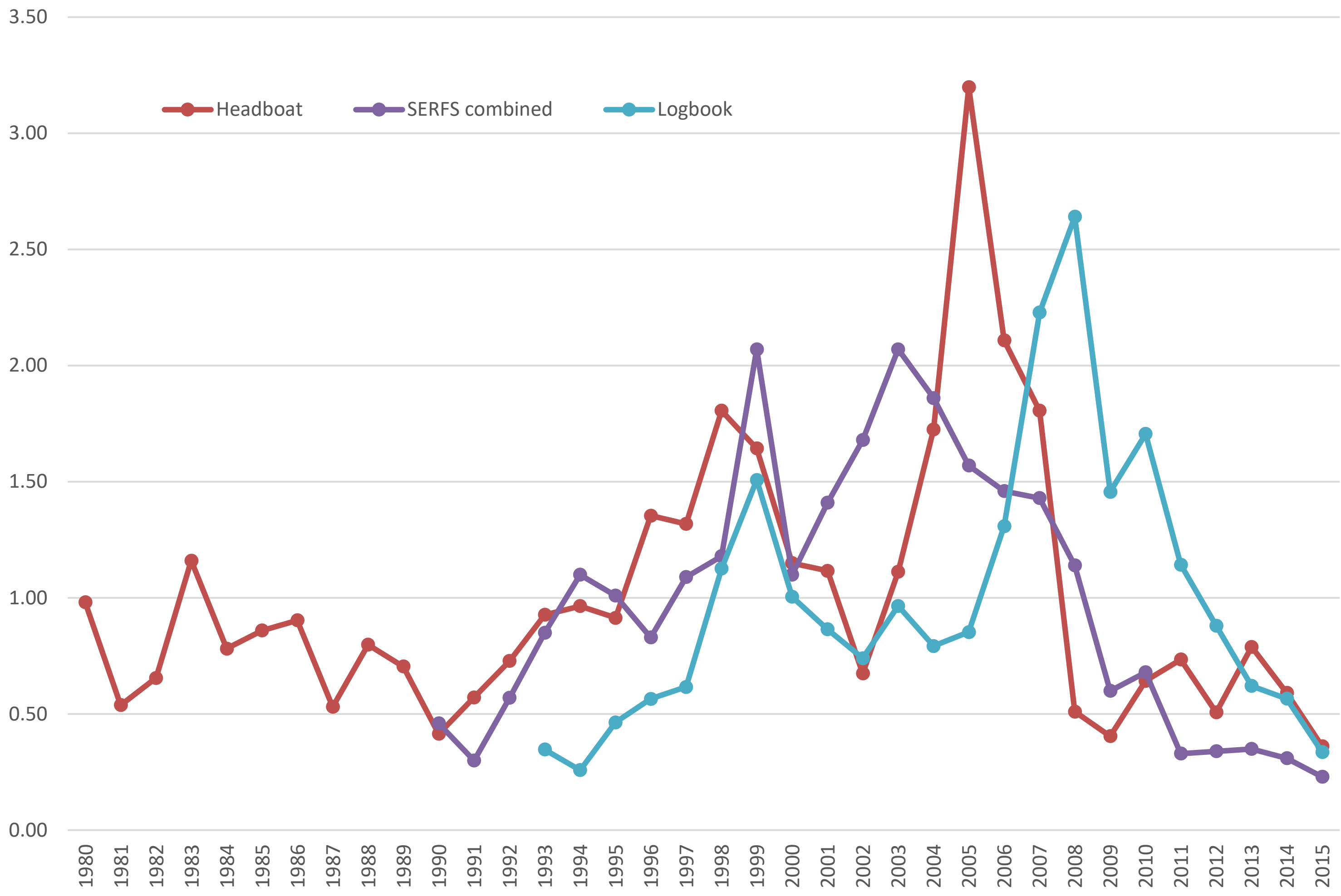
- Rationale: sampling of the two gears is not independent (cameras mounted on traps)
- Applied the Conn (2010) method to combine indices, as in SEDAR41.
  - Hierarchical model, where each index is assumed to observe the same underlying trend, allowing for process and observation error
  - Estimates the underlying trend as a latent variable (the combined index)

Index combination



Year	Combined Index	CV
1990	0.46	0.67
1991	0.3	0.69
1992	0.57	0.62
1993	0.85	0.54
1994	1.1	0.49
1995	1.01	0.54
1996	0.83	0.54
1997	1.09	0.47
1998	1.18	0.44
1999	2.07	0.43
2000	1.1	0.46
2001	1.41	0.44
2002	1.68	0.42
2003	2.07	0.42
2004	1.86	0.41
2005	1.57	0.43
2006	1.46	0.45
2007	1.43	0.44
2008	1.14	0.48
2009	0.6	0.53
2010	0.68	0.5
2011	0.33	0.5
2012	0.34	0.48
2013	0.35	0.44
2014	0.31	0.67
2015	0.23	0.63

Indices of abundance



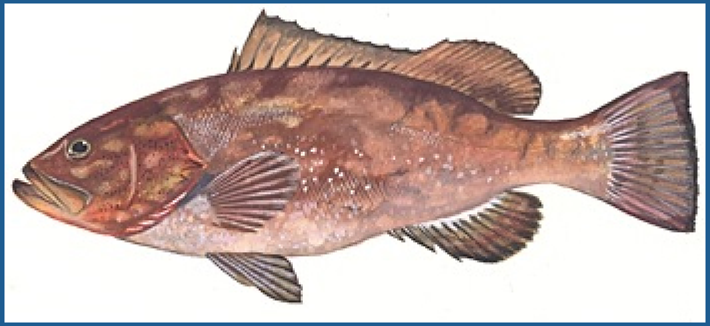
Other features, as in SEDAR19

- Life-history characteristics
  - Length at age (von Bertalanffy growth parameters)
  - Weight at length (power function)
  - Age dependent maturity schedules (male and female)
  - Age dependent sex ratios
  - Natural mortality at age
    - Lorenzen function scaled to M=0.14
    - Max observed age = 26
- Discard mortality
  - 0.2 for all fleets

Summary of modifications/updates to data

- Seven additional years (2009-2015) were added to the end of the time series; start year (1976) unchanged
- Data queries used current methodologies
- Model-based inputs (commercial discards, indices) were refitted using all relevant data, thus earlier years were subject to modification.
- General recreational fleet represented by MRIP methodology, not MRFSS. General recreational landings and discards were smoothed to remove spikes (as in S19).
- No MRFSS index
- Added SERFS video data; index combined with trap index to make a single fishery independent index

Assessment methods and results



BAM: same basic model as in SEDAR19 (1 of 2)

- Catch-age formulation, fit to data using maximum likelihood
- Beverton-Holt spawner recruit model, with lognormal error
- Age-based natural mortality
- Age-based selectivities, allowed to vary across regulation blocks
  - Logistic (flat-topped) for dominant fleets
  - Dome-shaped for commercial other and all discards
- Baranov catch equation
- Spawning stock based on total mature biomass (males+females)

BAM: same basic model as in SEDAR19 (2 of 2)

- Initial age structure in 1976 was estimated
- Recruitment deviations start in 1976
- Ages modeled: 1-16+
- Constant (estimated) CV of size at age
- Years with missing landings or discards predicted with average F from nearby years
- Uncertainty estimated through Monte/Carlo Bootstrap (MCB) approach

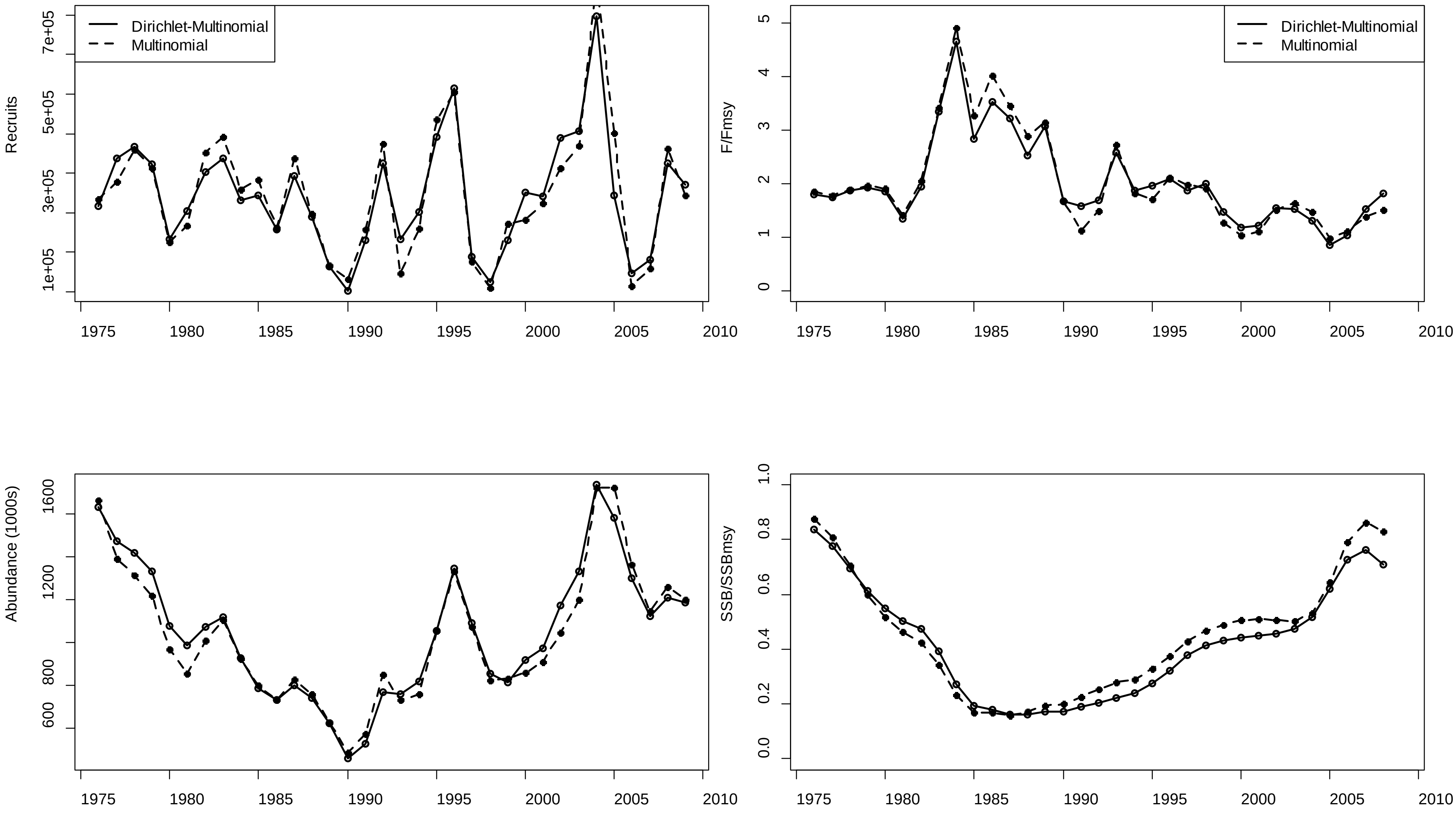
Modifications to the SEDAR19 model (1 of 2)

- SERFS selectivity flat-topped rather than dome-shaped
  - Likelihood profiles supported flat-topped
  - Catch curve Z’s from SERFS similar to headboat and commercial Z’s, indicating similar selectivity
- Commercial other selectivity modeled separately from SERFS
- Random walk to account for time-varying catchability on fishery dependent indices

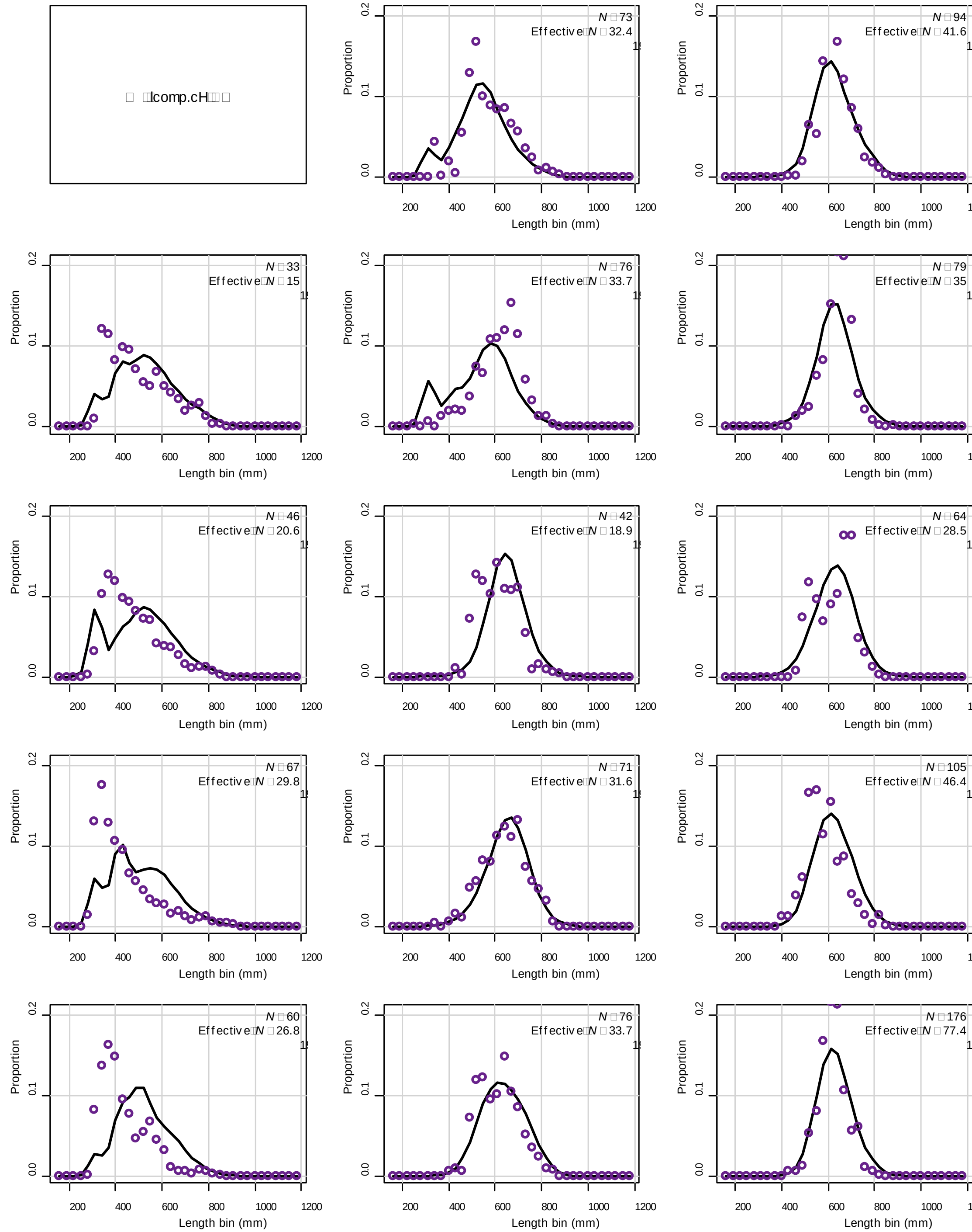
Modifications to the SEDAR19 model (2 of 2)

- Negative log-likelihood applied to spawner-recruit deviations
  - S19 applied a sum of squares penalty (in log space)
  - NLL used in the modern version of BAM
  - NLL approach requires additional parameter, σ_R (prior=0.6)
- Steepness h fixed at 0.87
  - S19 estimated h=0.92, but in S53 it hit the upper bound
  - Likelihood profile indicated a plausible range of (0.75, 0.99); 0.87 is the midpoint
- Comp data fit using the Dirichlet-multinomial, rather than the multinomial distribution
  - Recommended by Francis (In press) and Thorson et al. (In press)
  - Better accounts for correlation in sampling
  - Self-weighting
  - Allows for zeros in the data
  - Recently implemented in Stock Synthesis

Effect multinomial ⟶ Dirichlet-multinomial (S19 model and data)

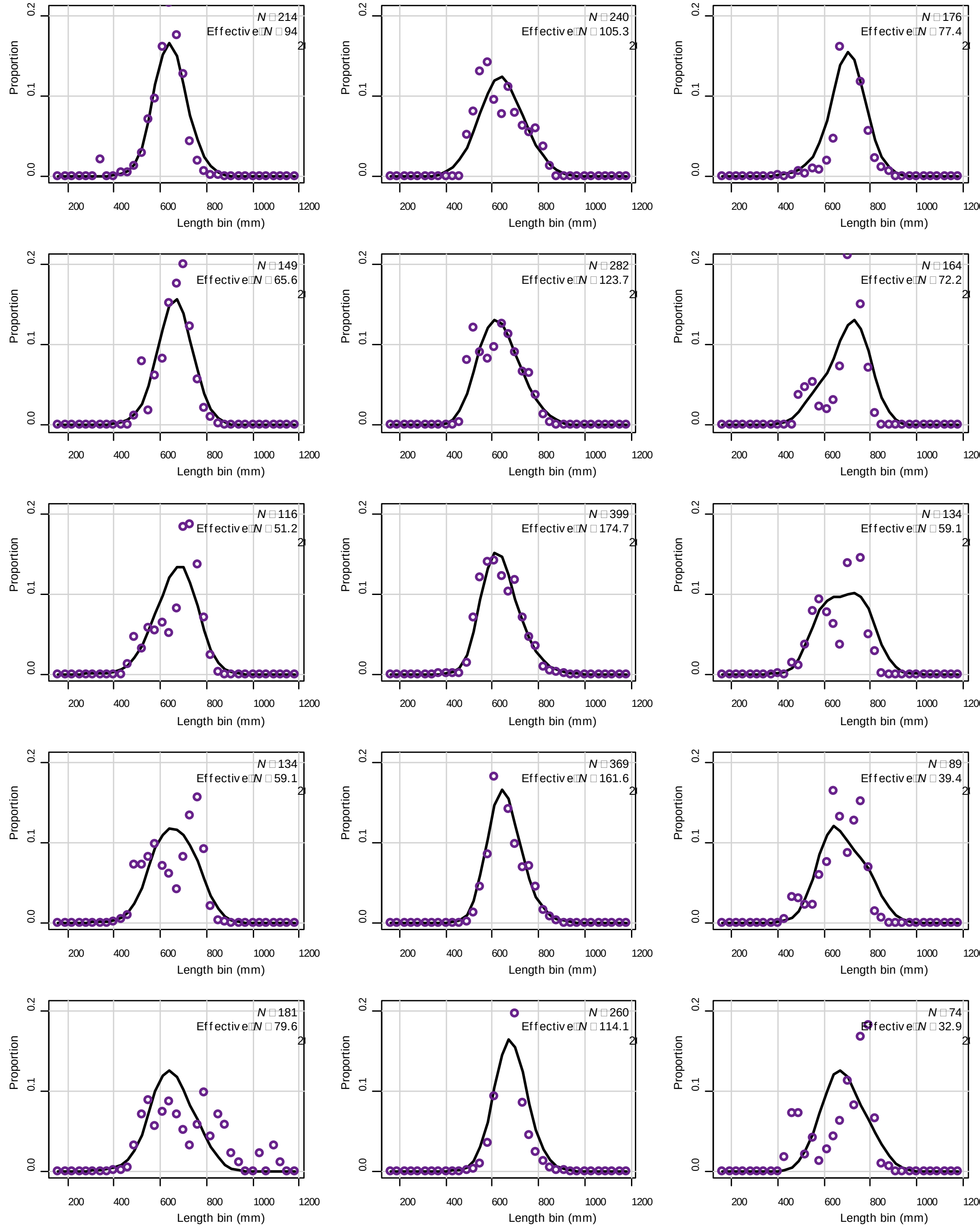


BAM base run – fits to data



NOAA FISHERIES

BAM base run – fits to data



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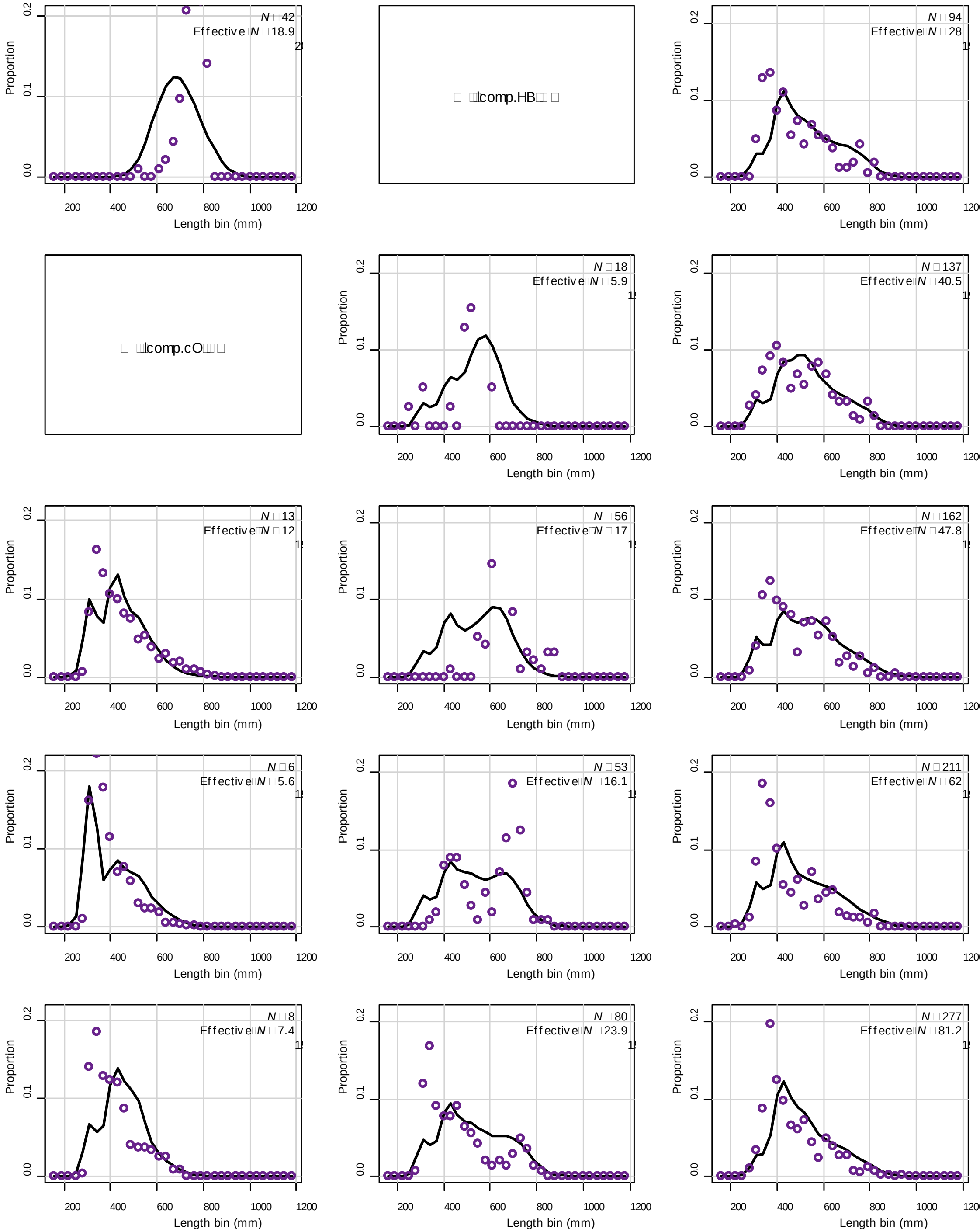

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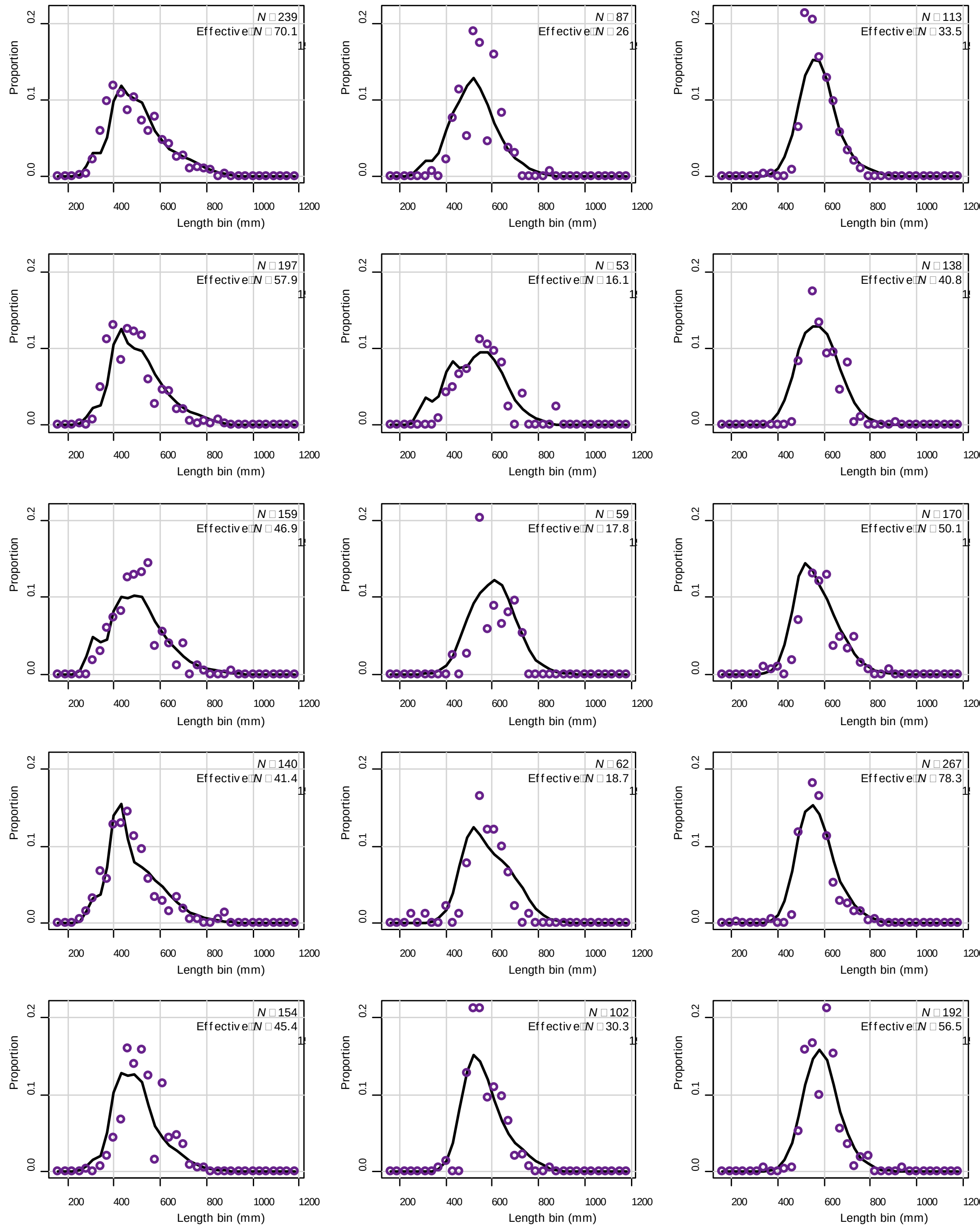

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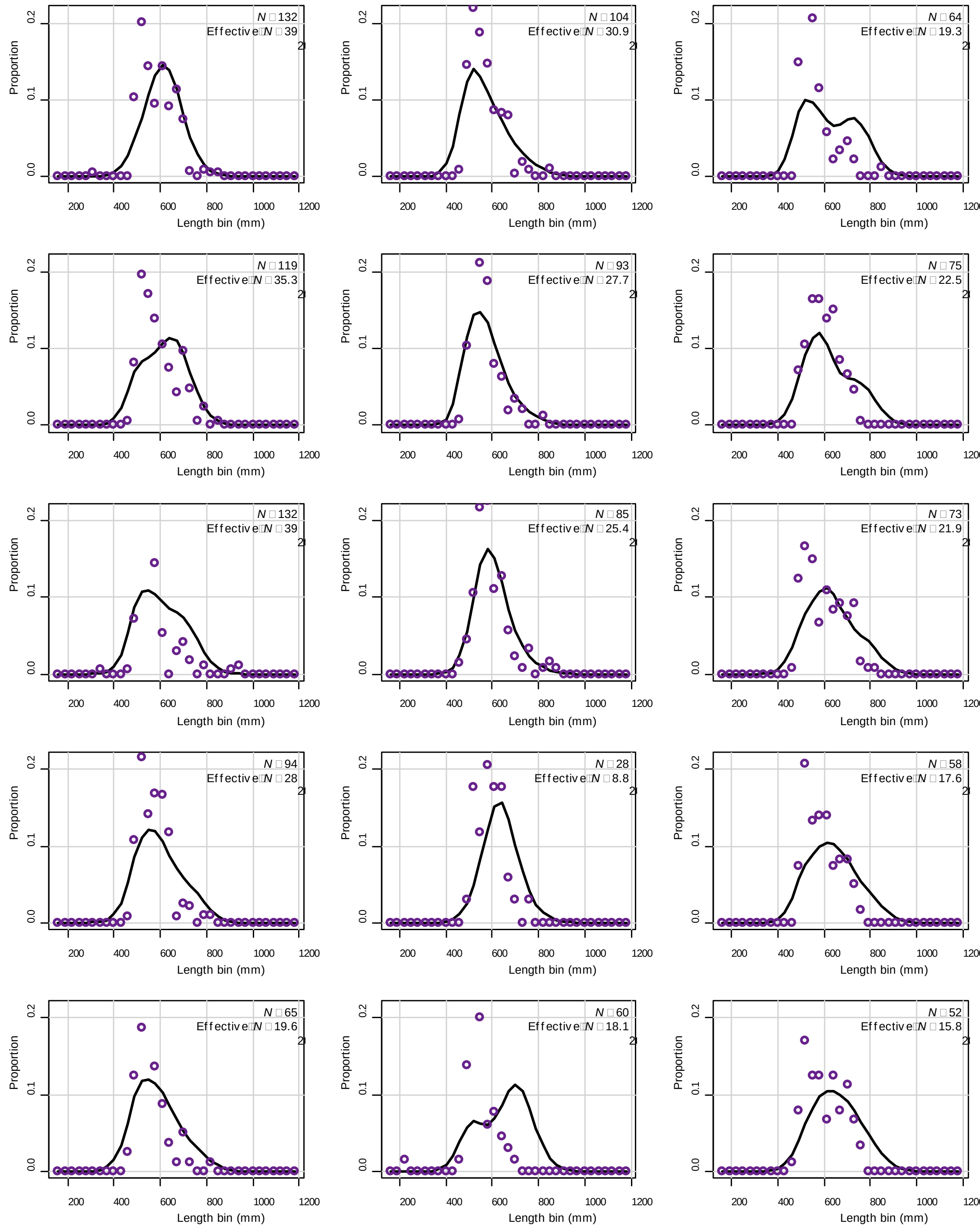

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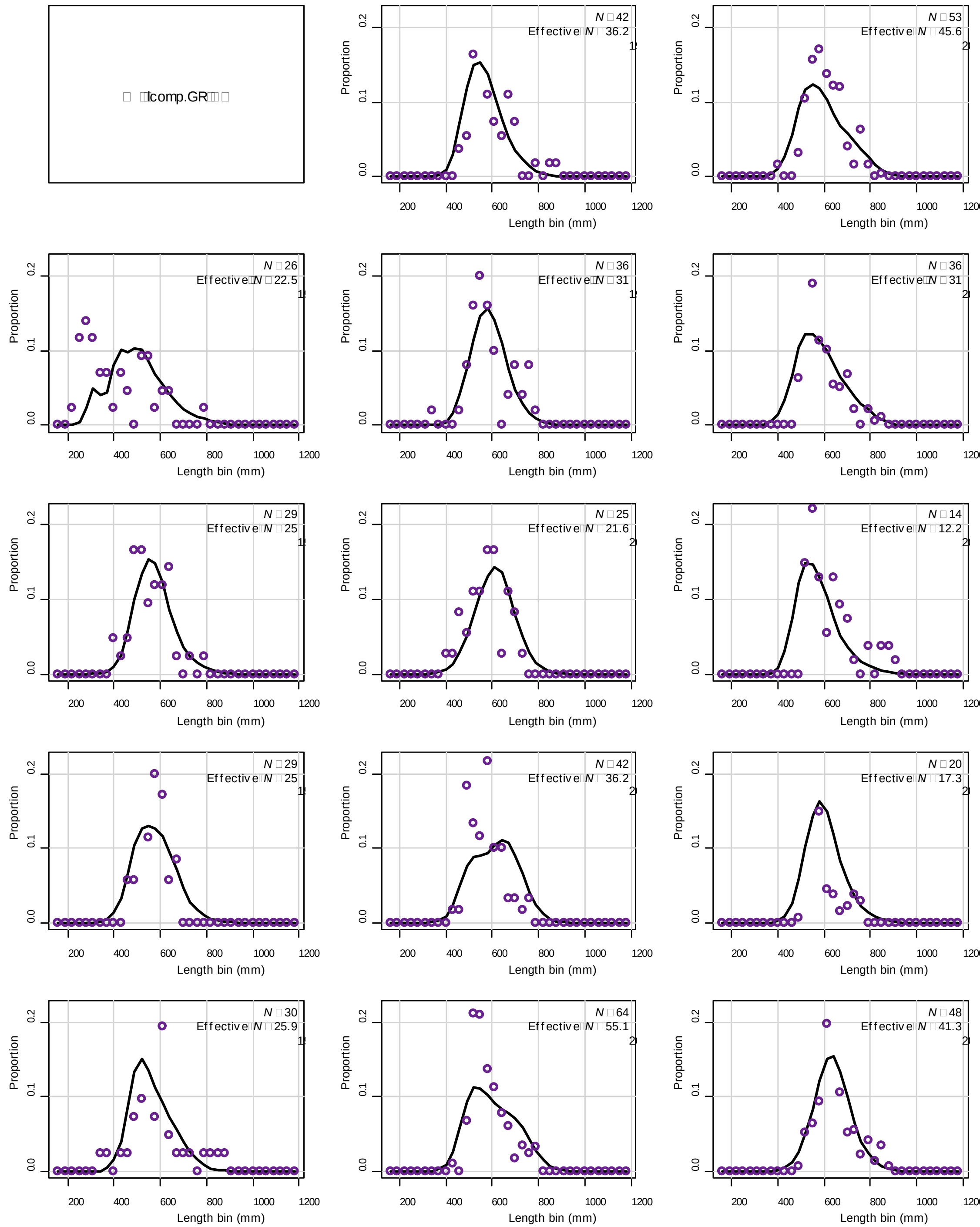

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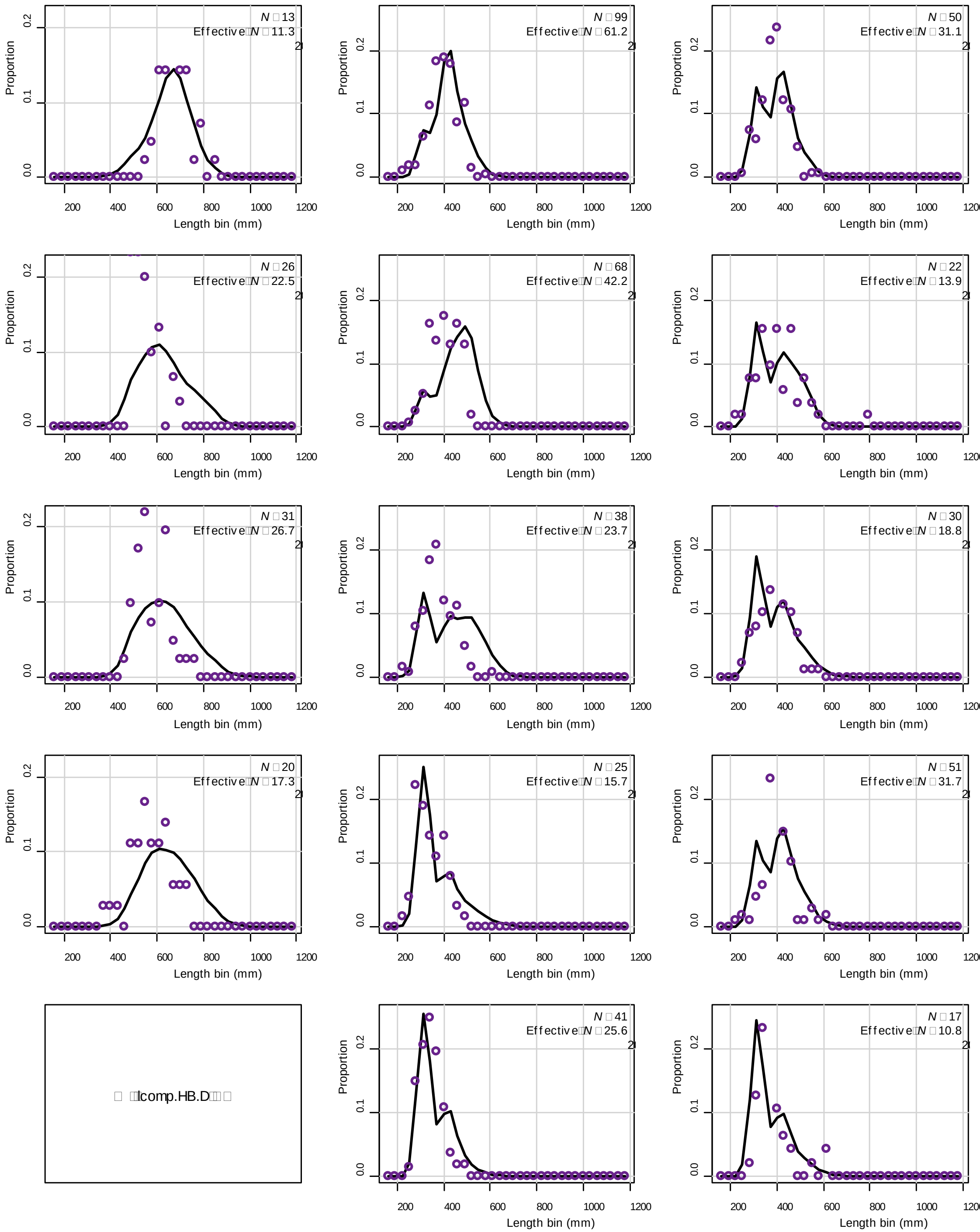

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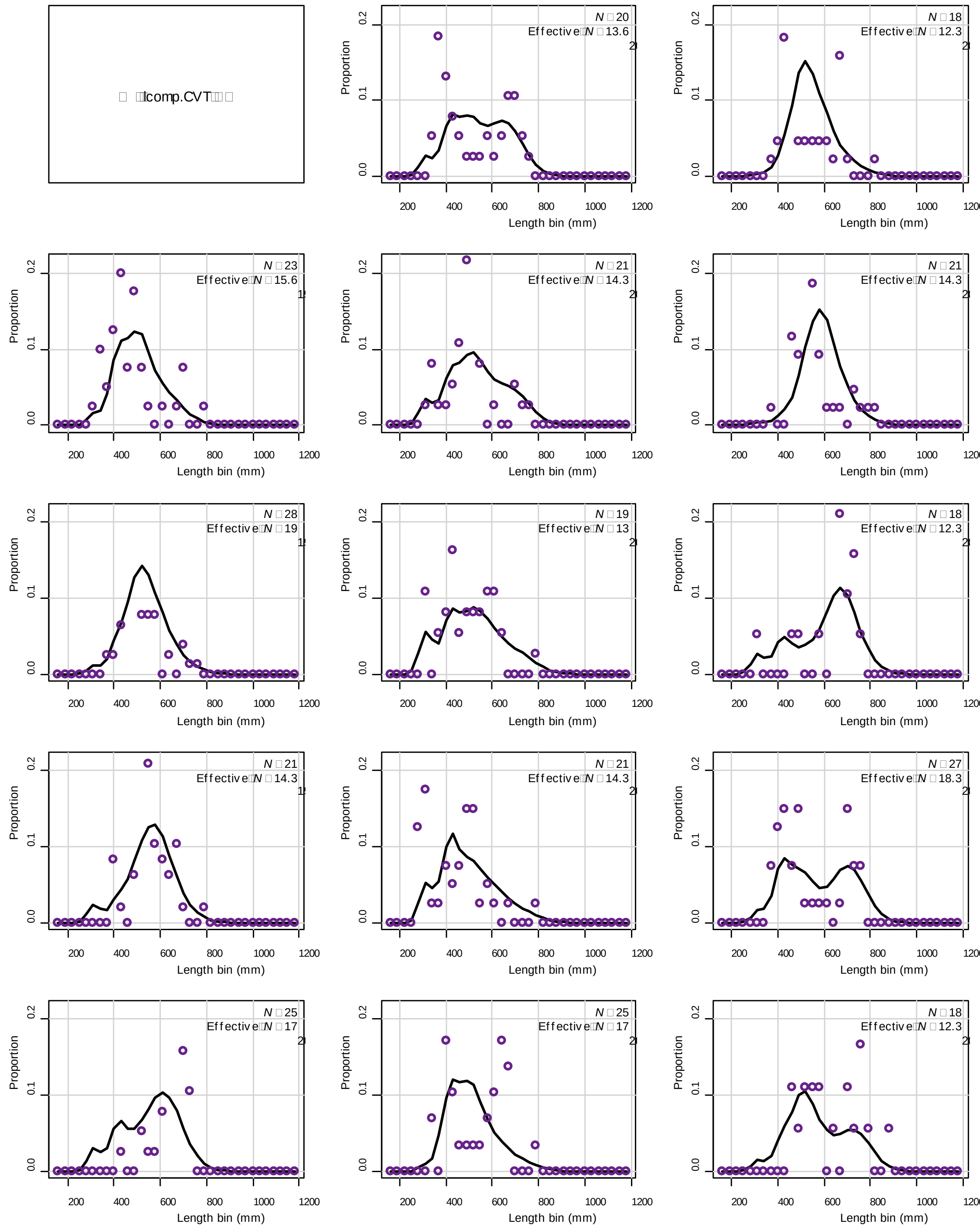

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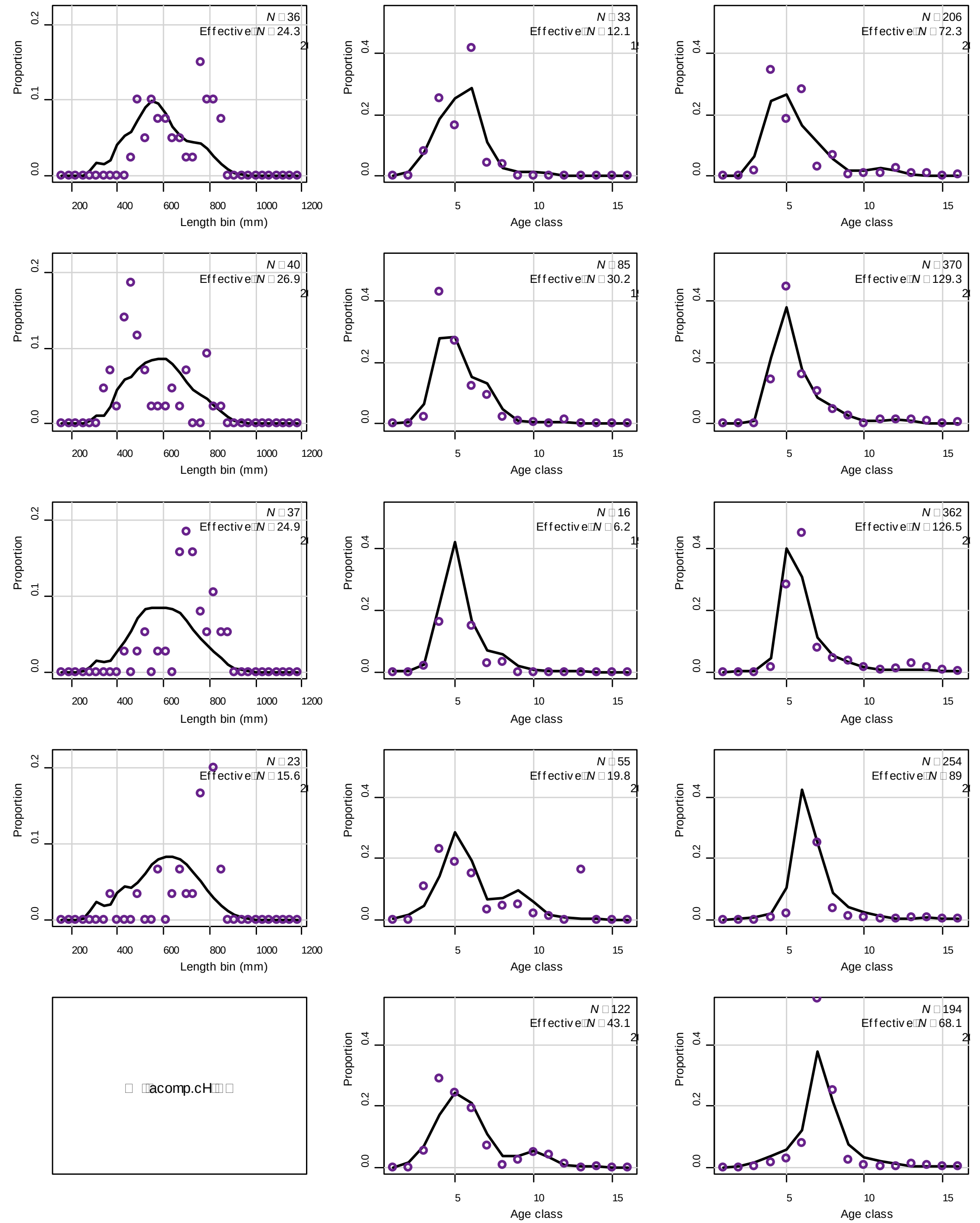

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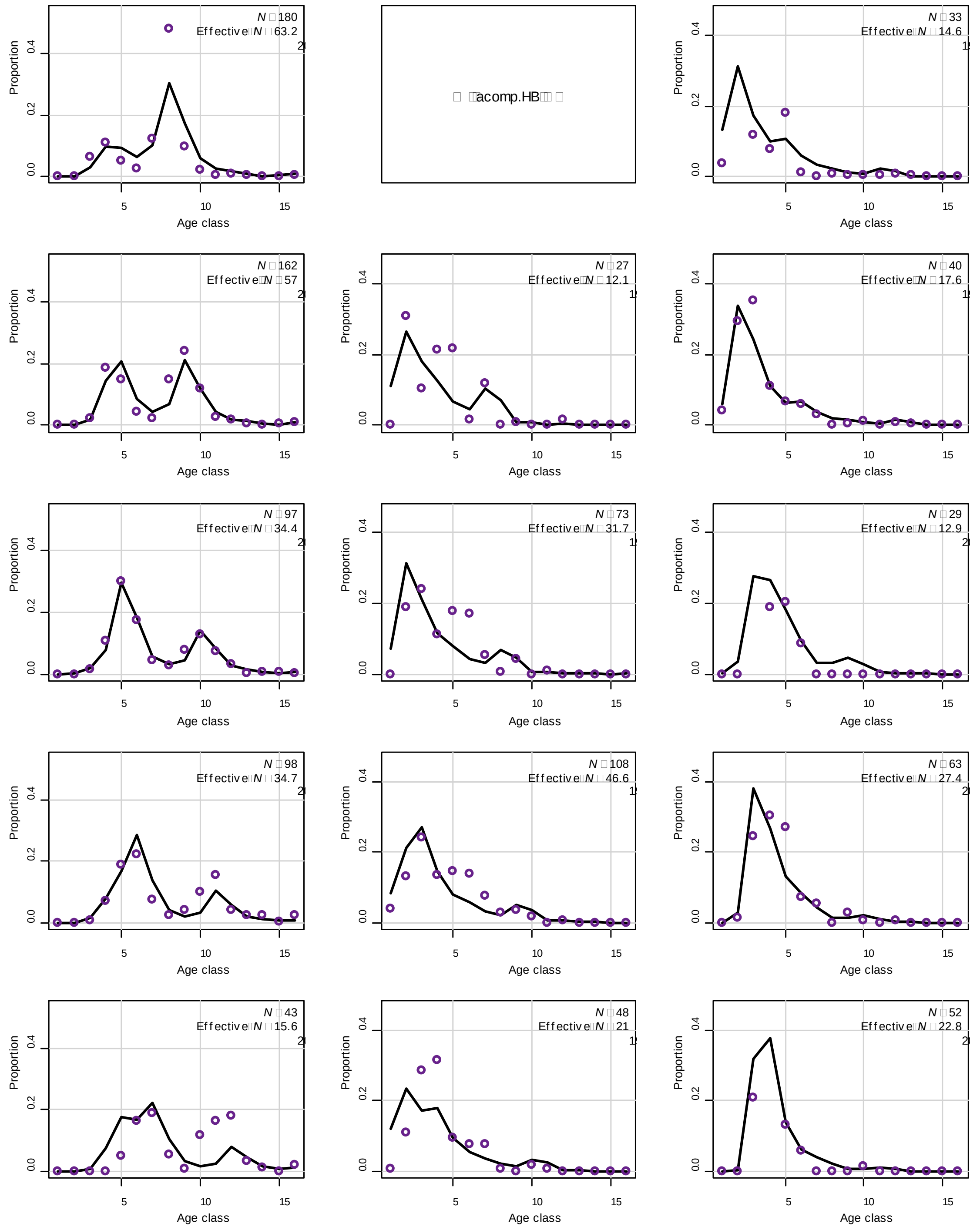

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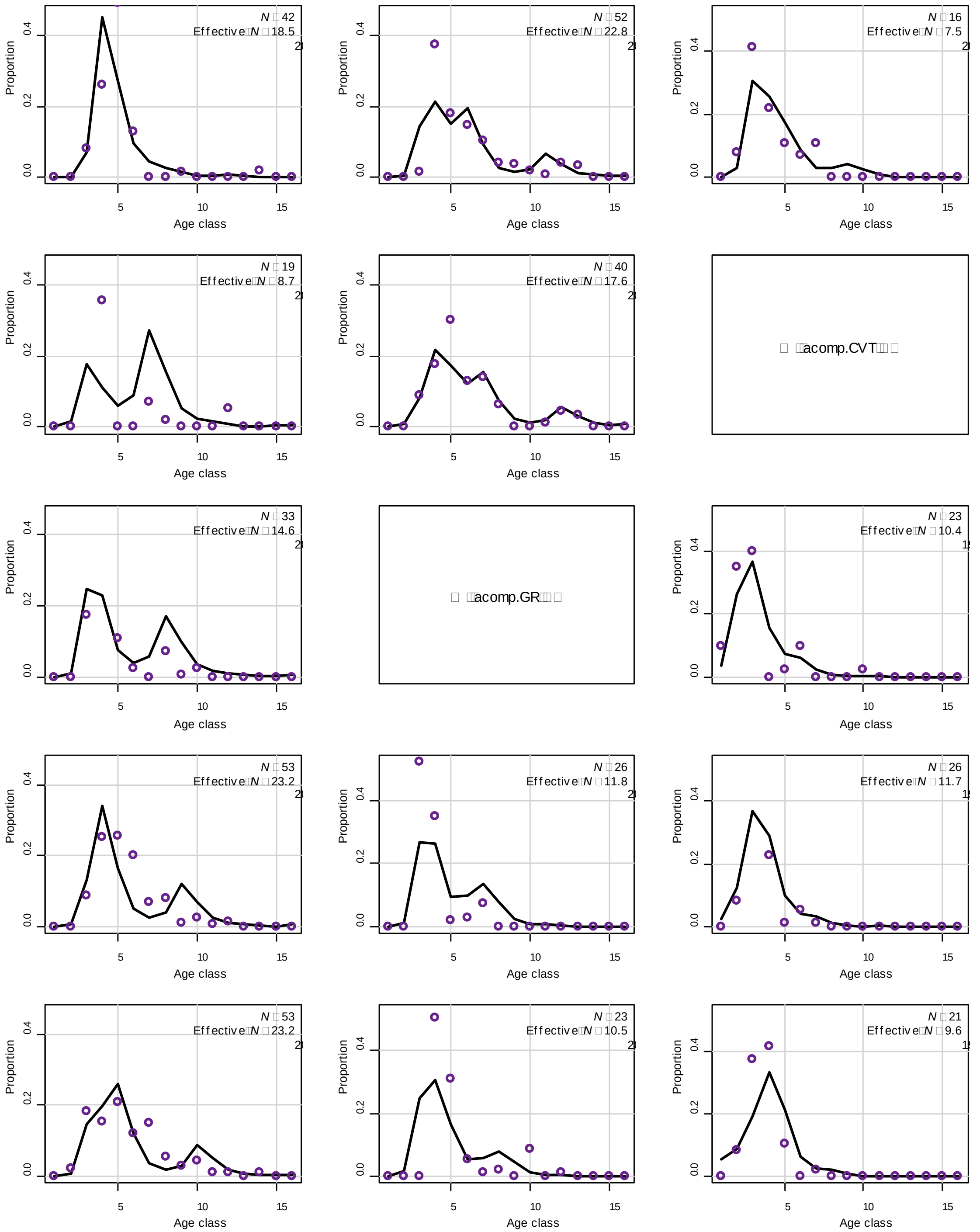

NOAA FISHERIES

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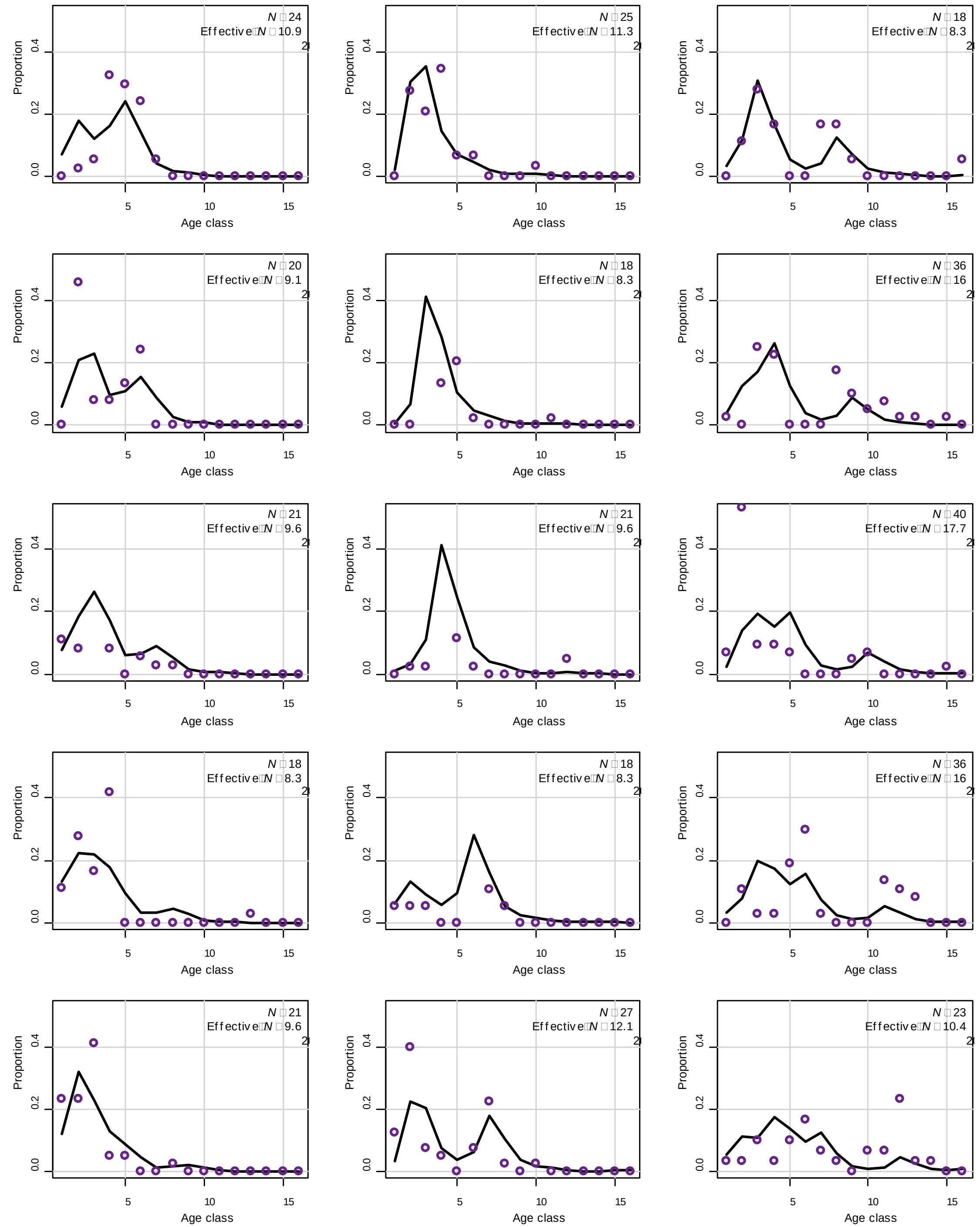

NOAA FISHERIES

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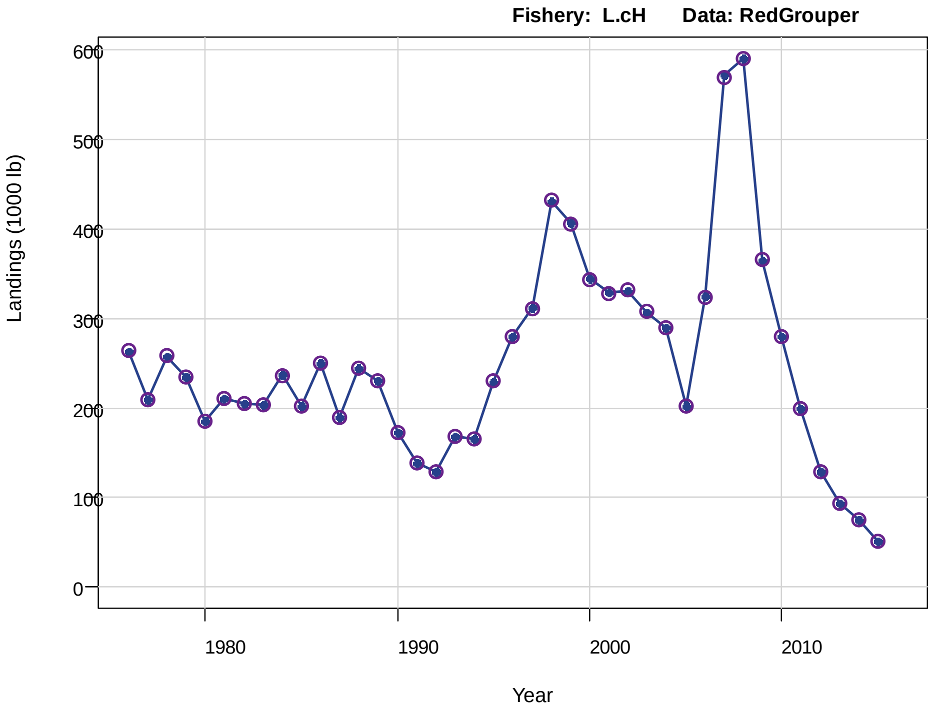

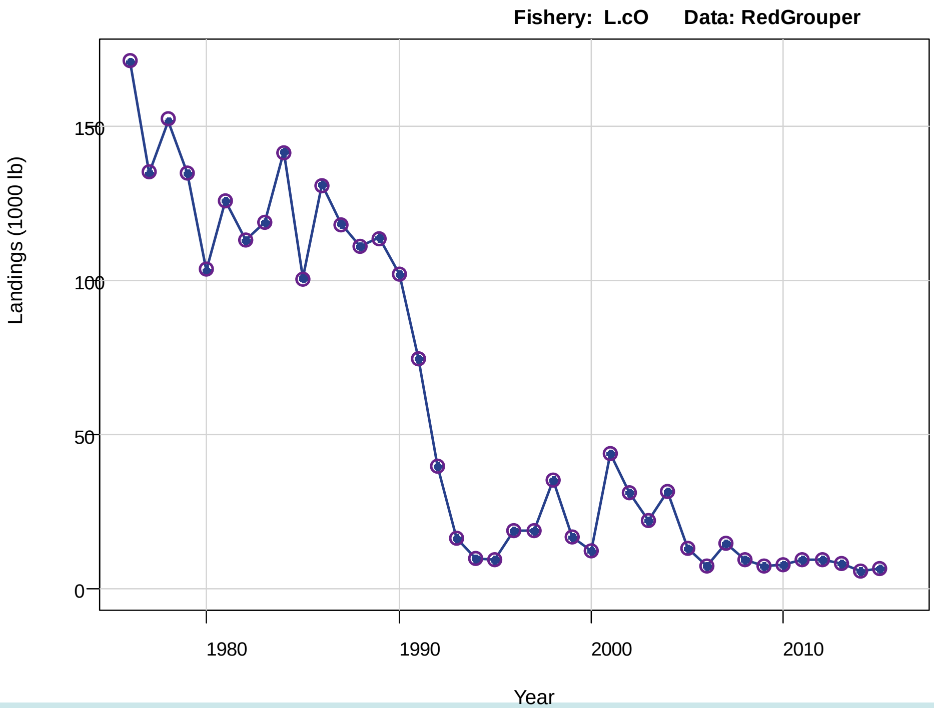

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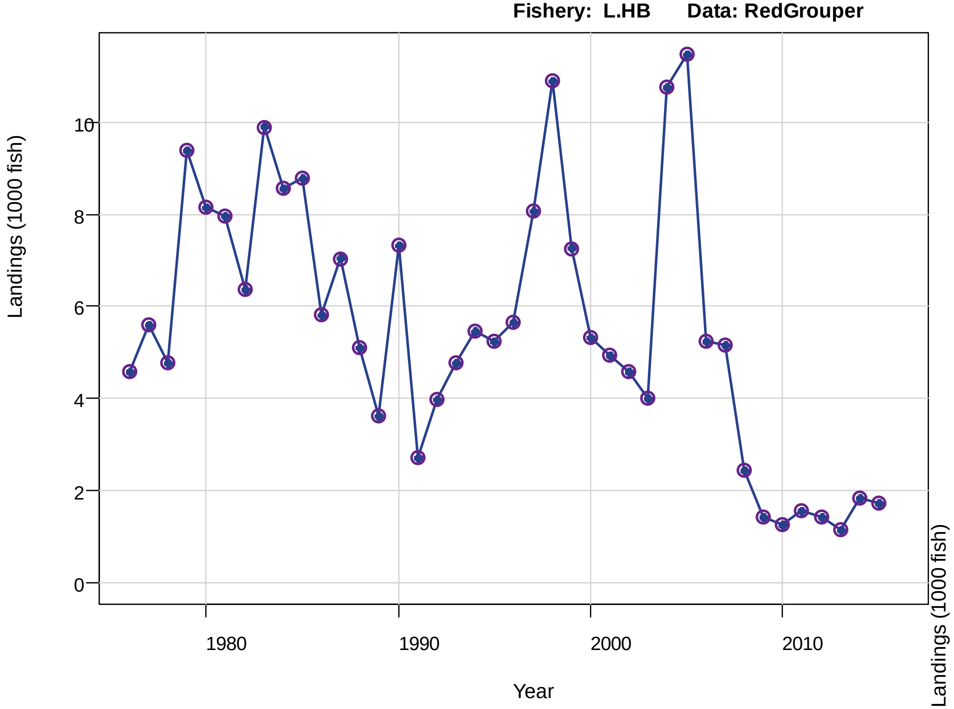

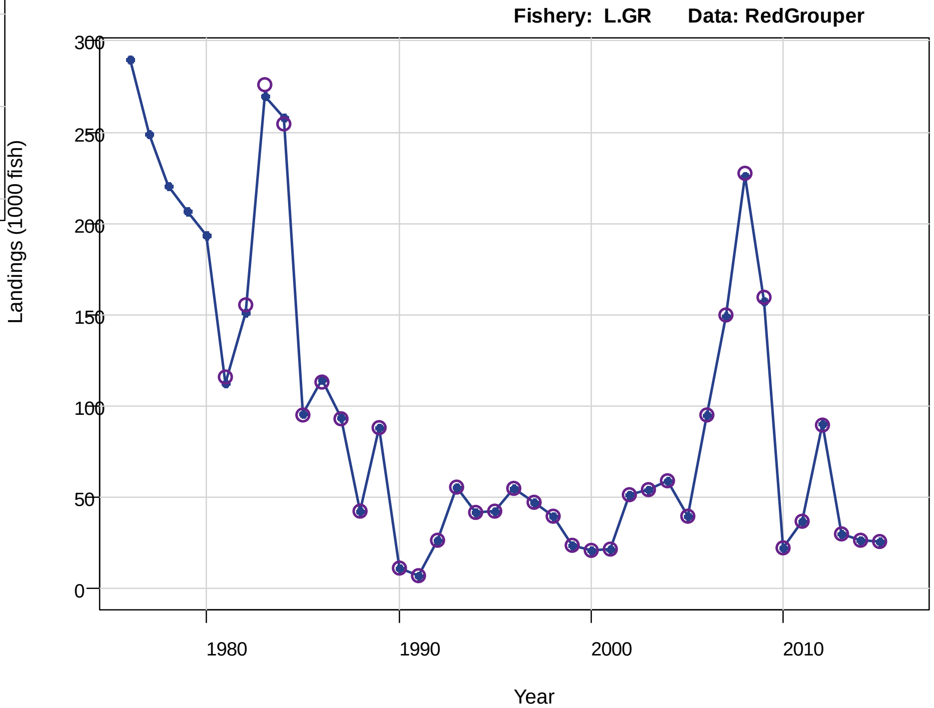

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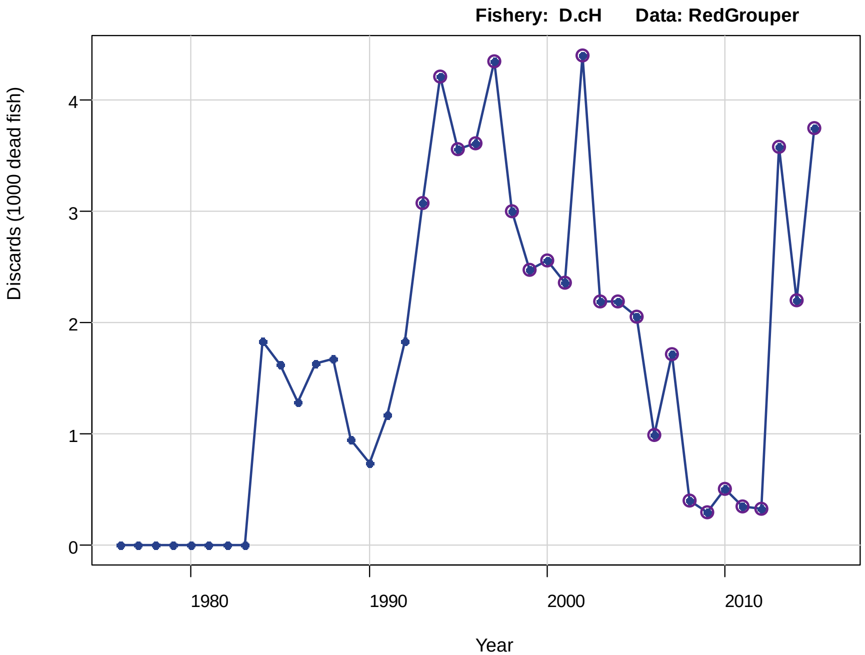

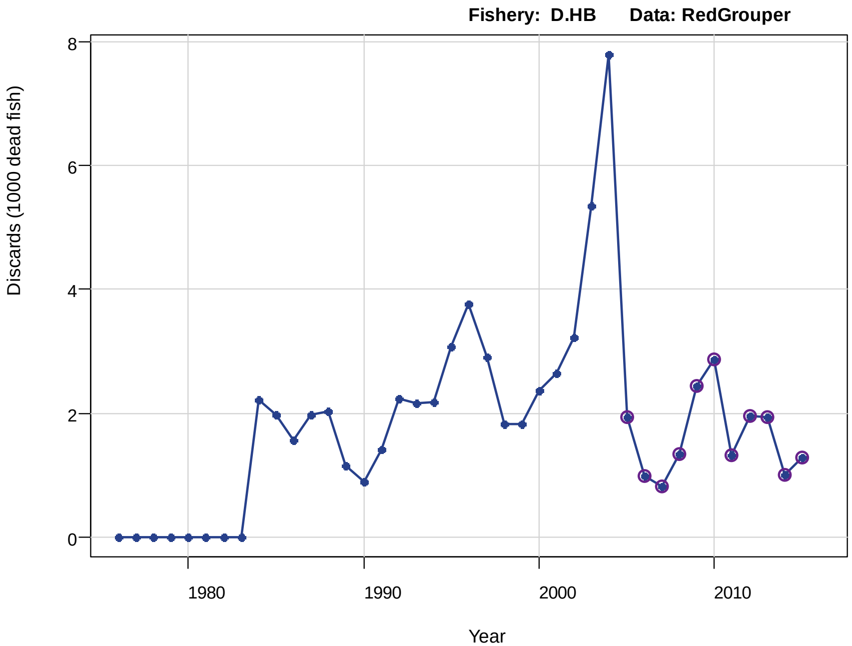

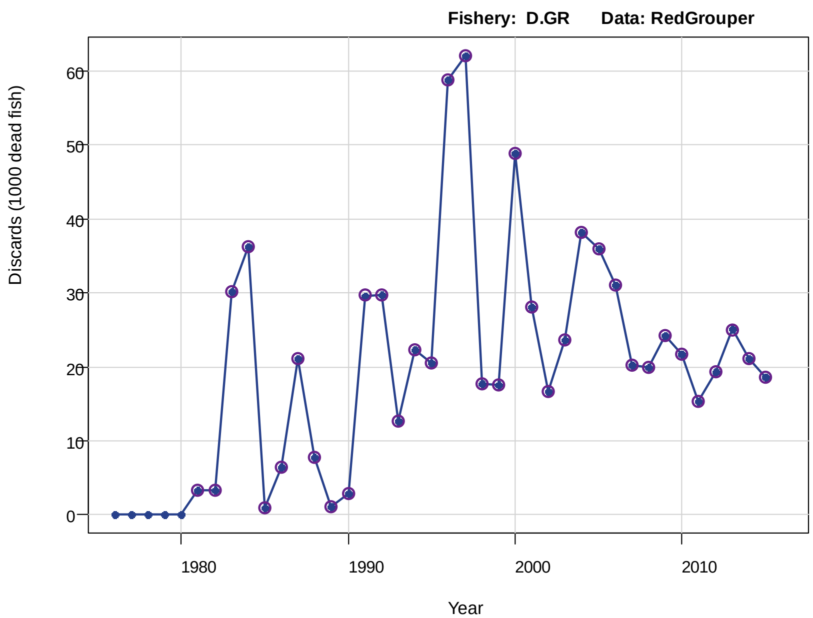

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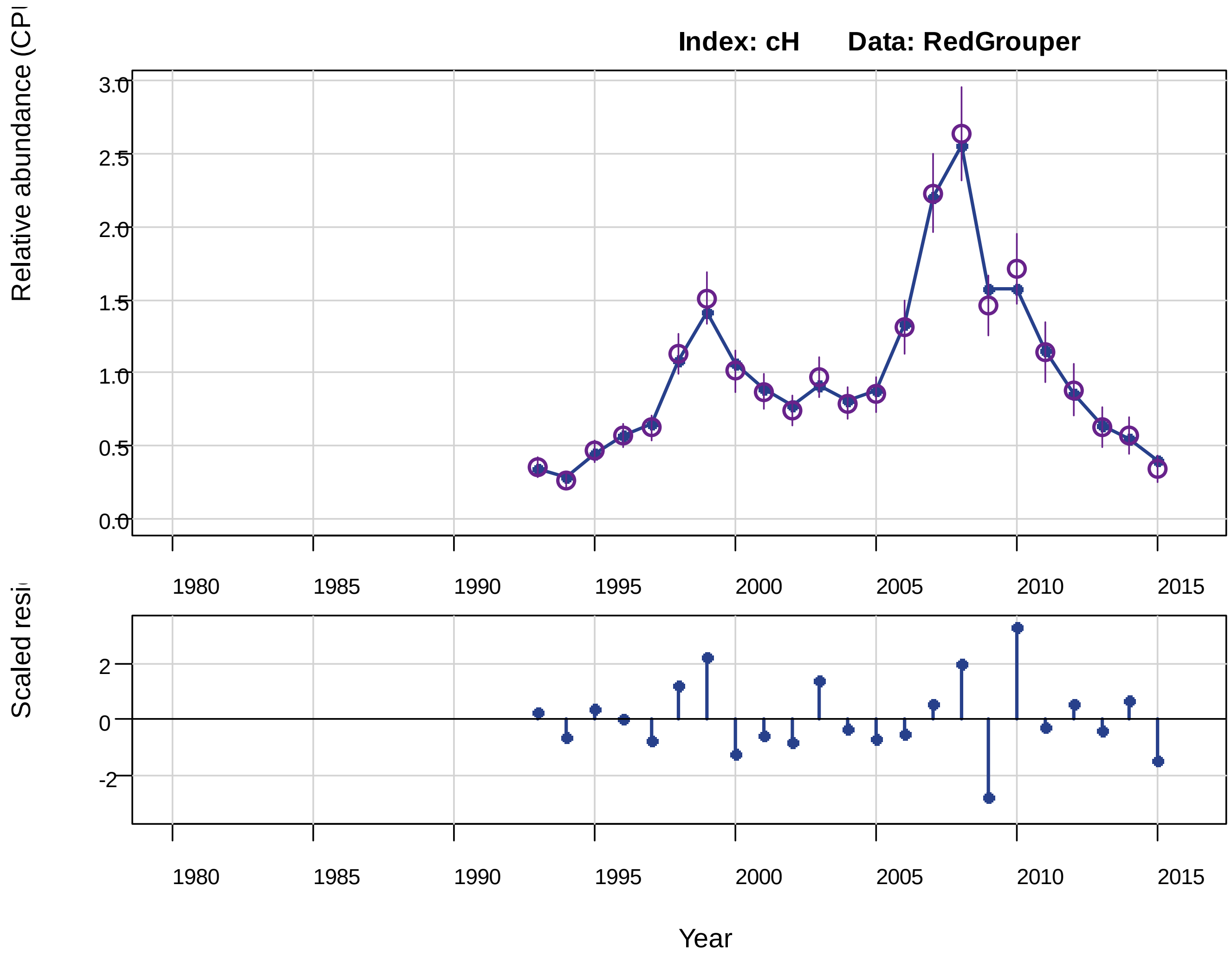

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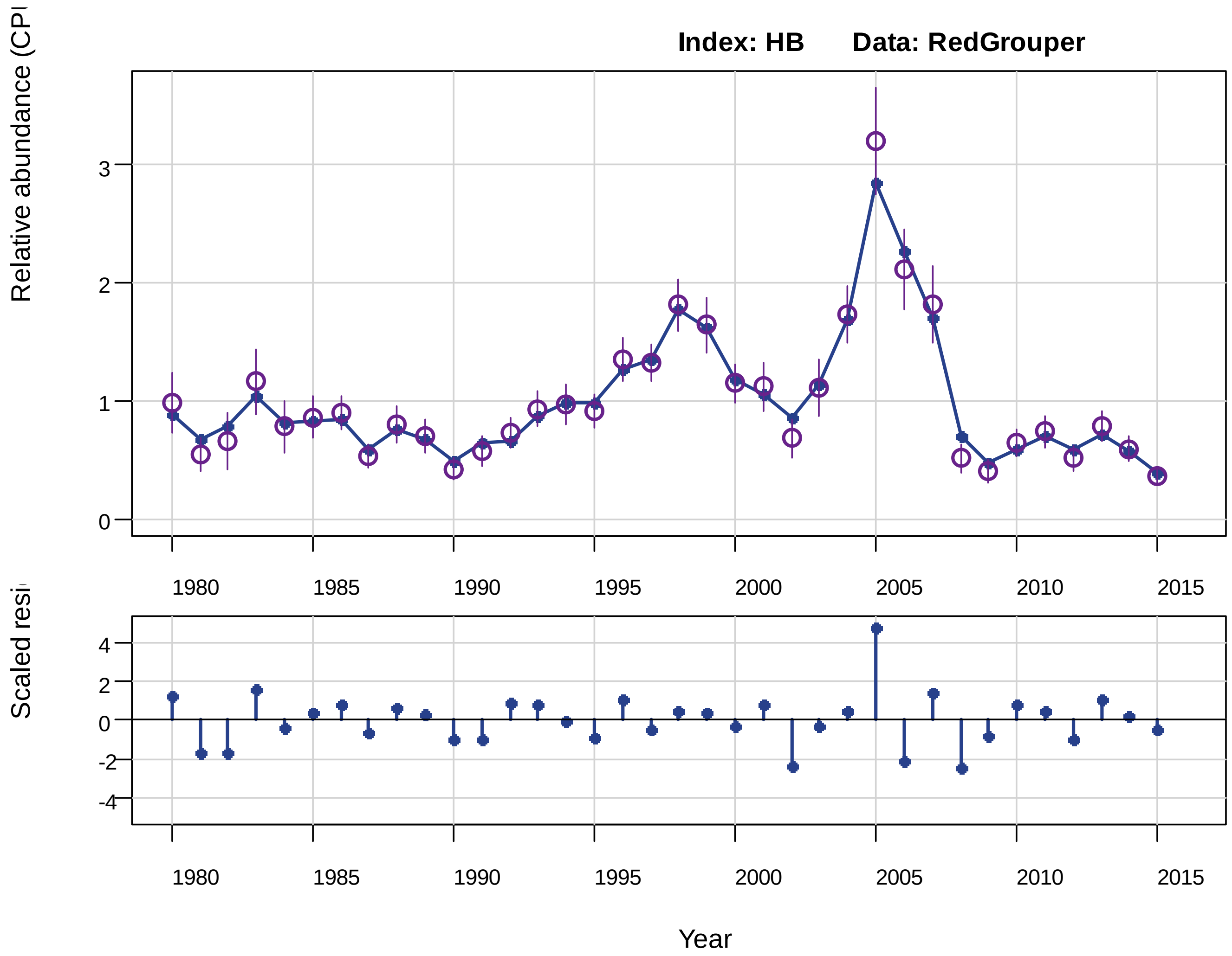

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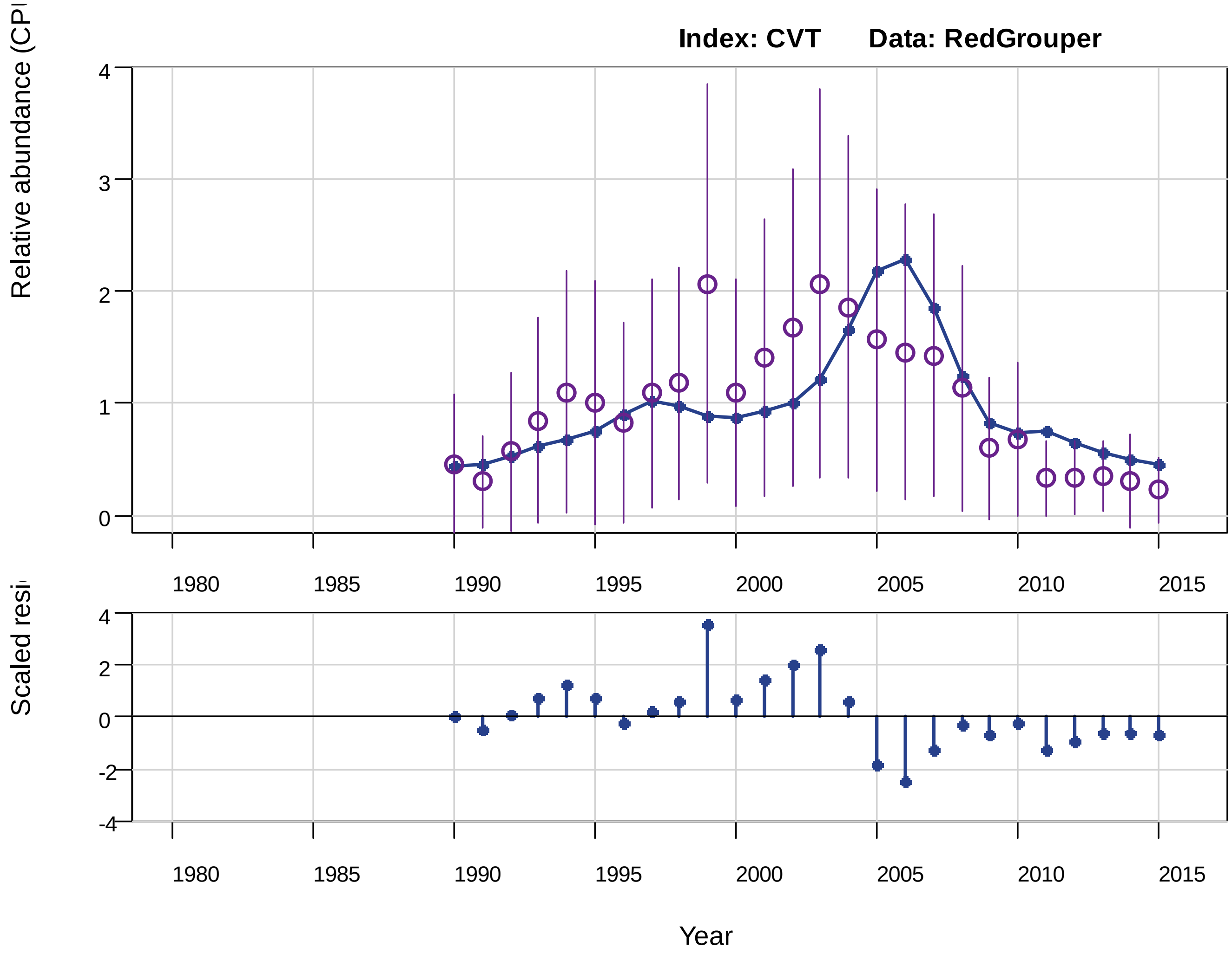
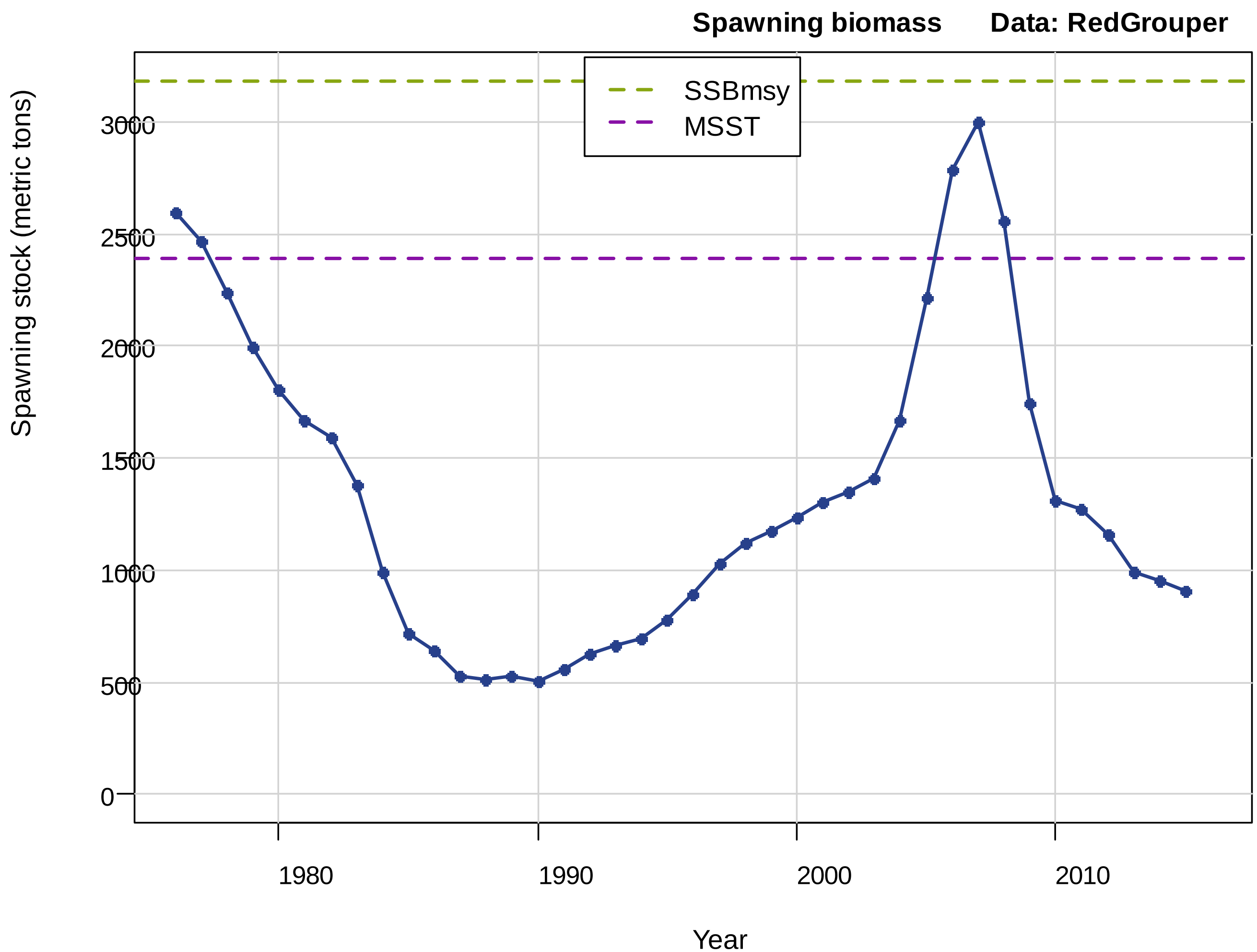
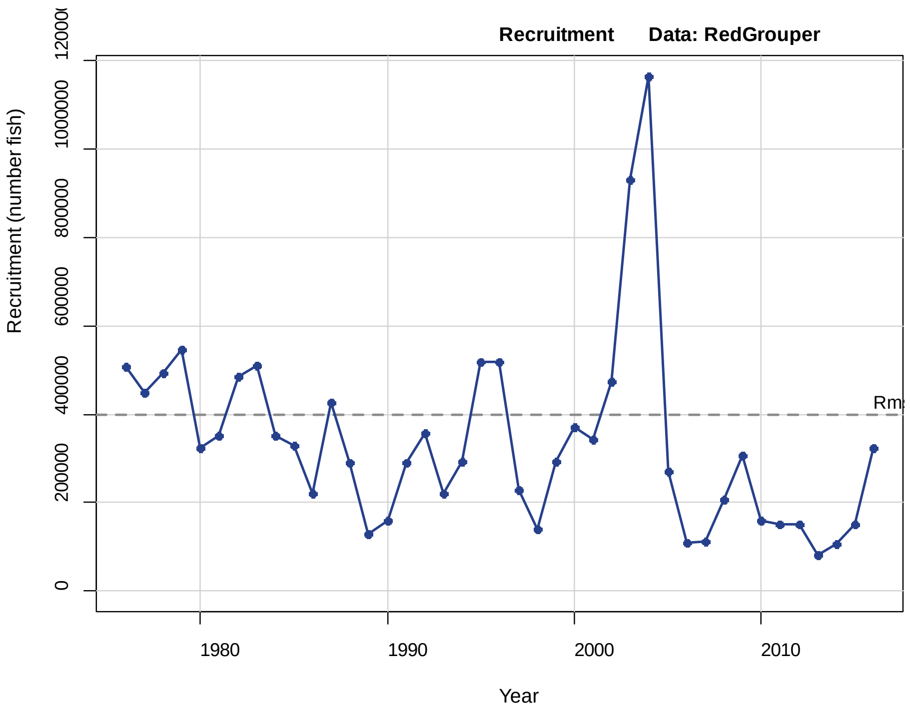
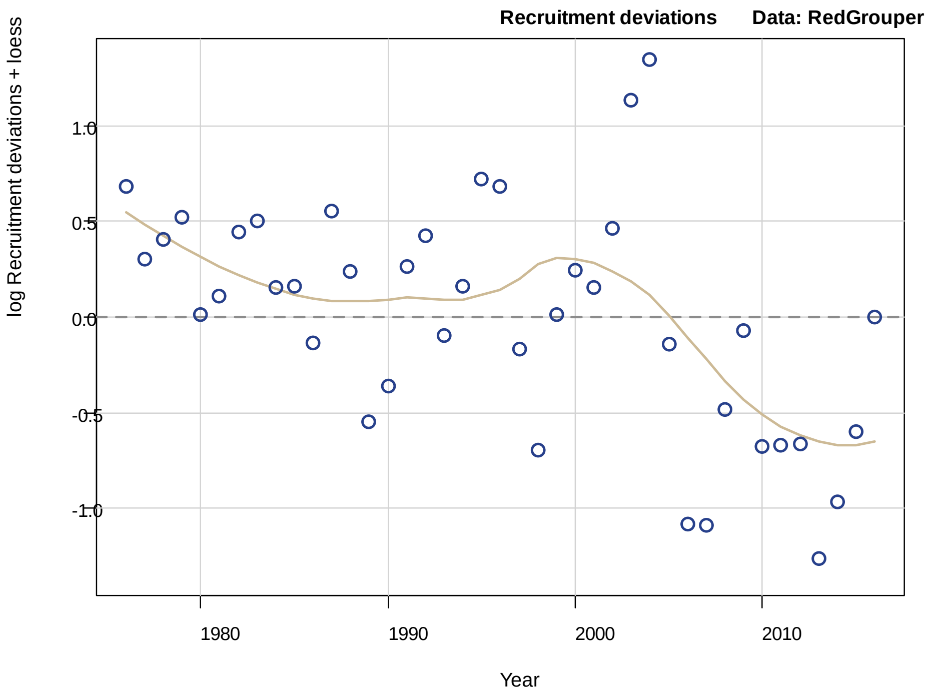


BAM base run – SSB

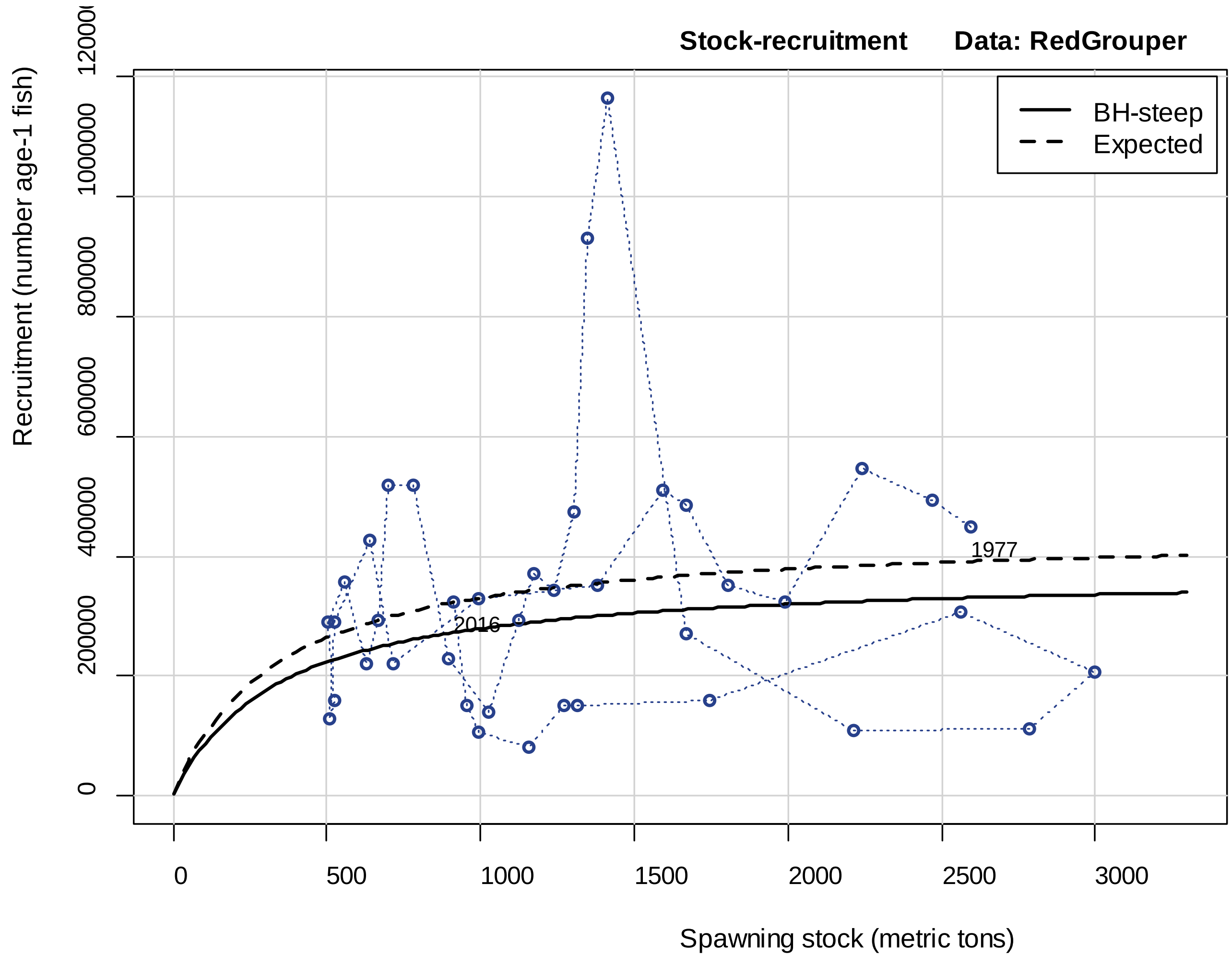


BAM base run – Recruitment

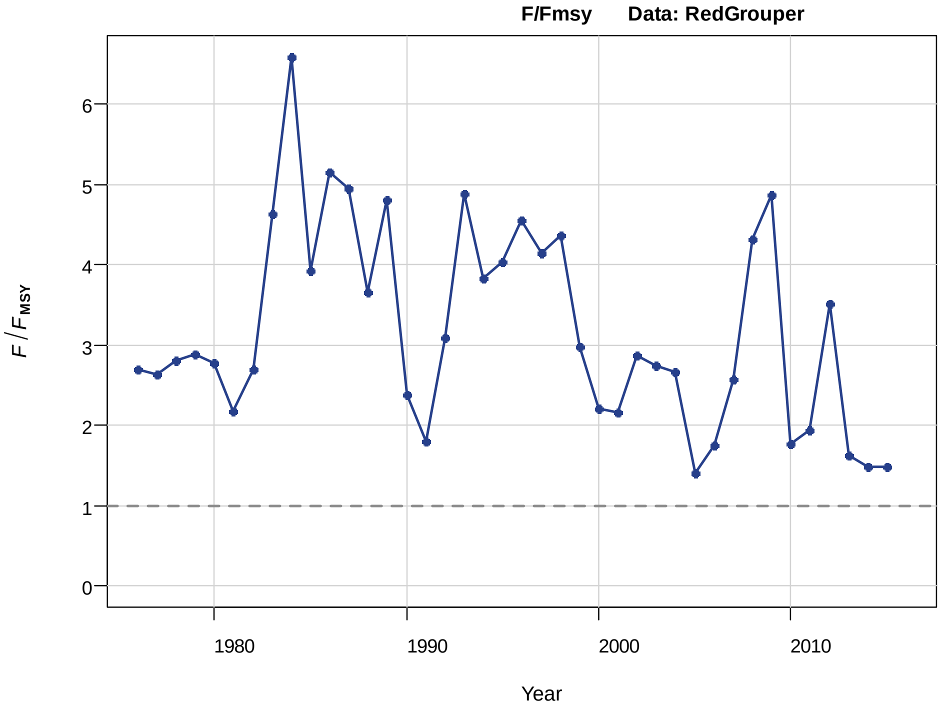


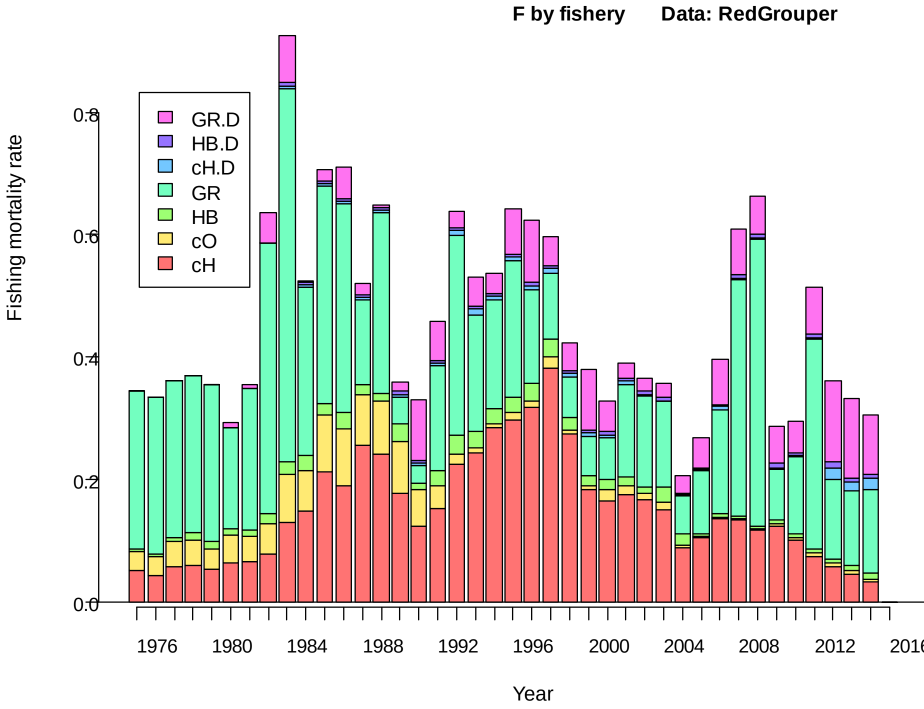


BAM base run – Spawner-recruit curve



BAM base run – Fishing mortality





Uncertainty – Combined Monte Carlo and Bootstrap (MCB) approach

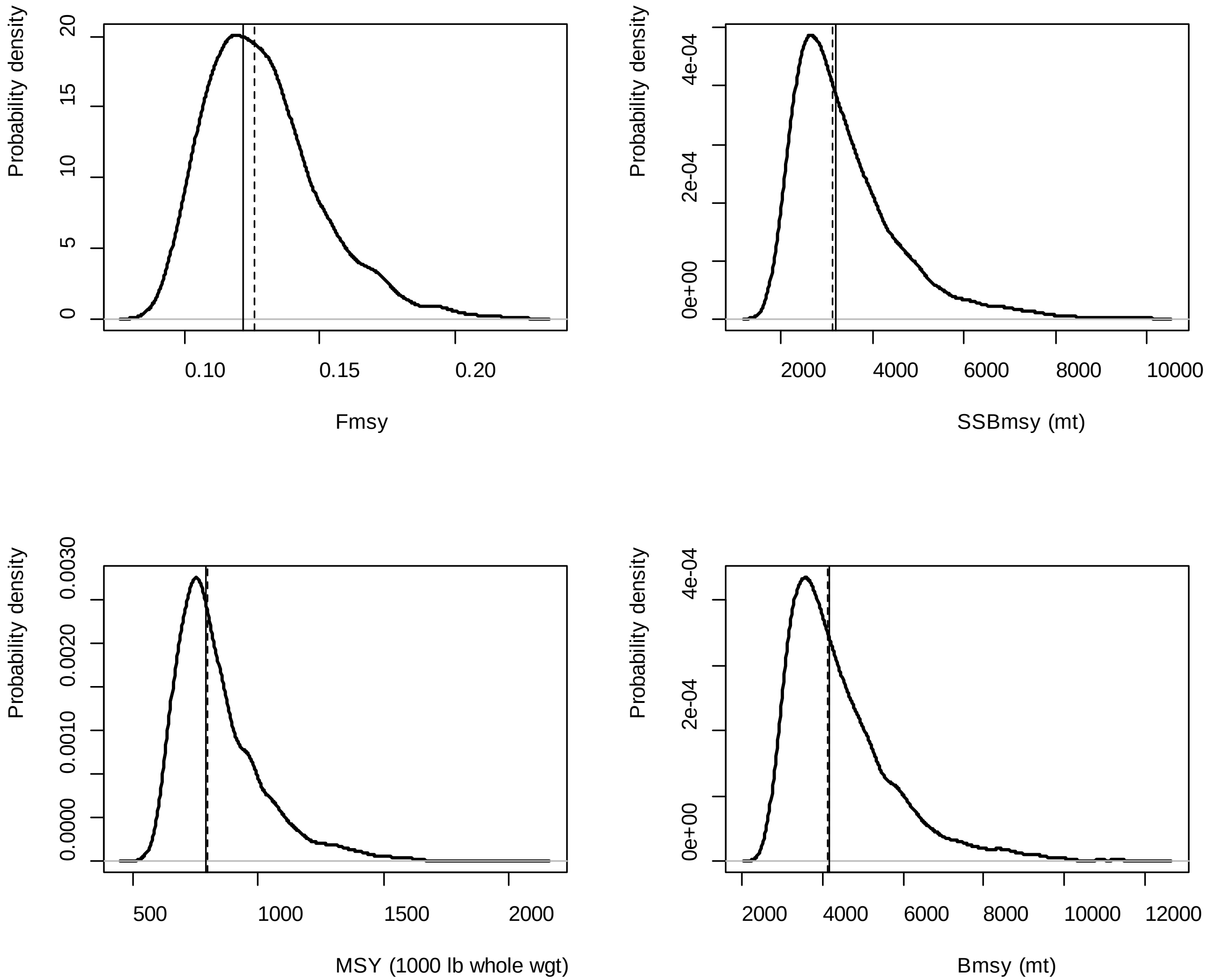
- n=4000 MCB trials attempted; n=3943 retained

- Bootstrap components:
  - Landings, discards, and indices: parametric bootstrap of original data, with CVs as applied in the fitting procedure
  - Length and age comps: resample Nfish and assign them to bins with probabilities equal to those from original data

MCB approach

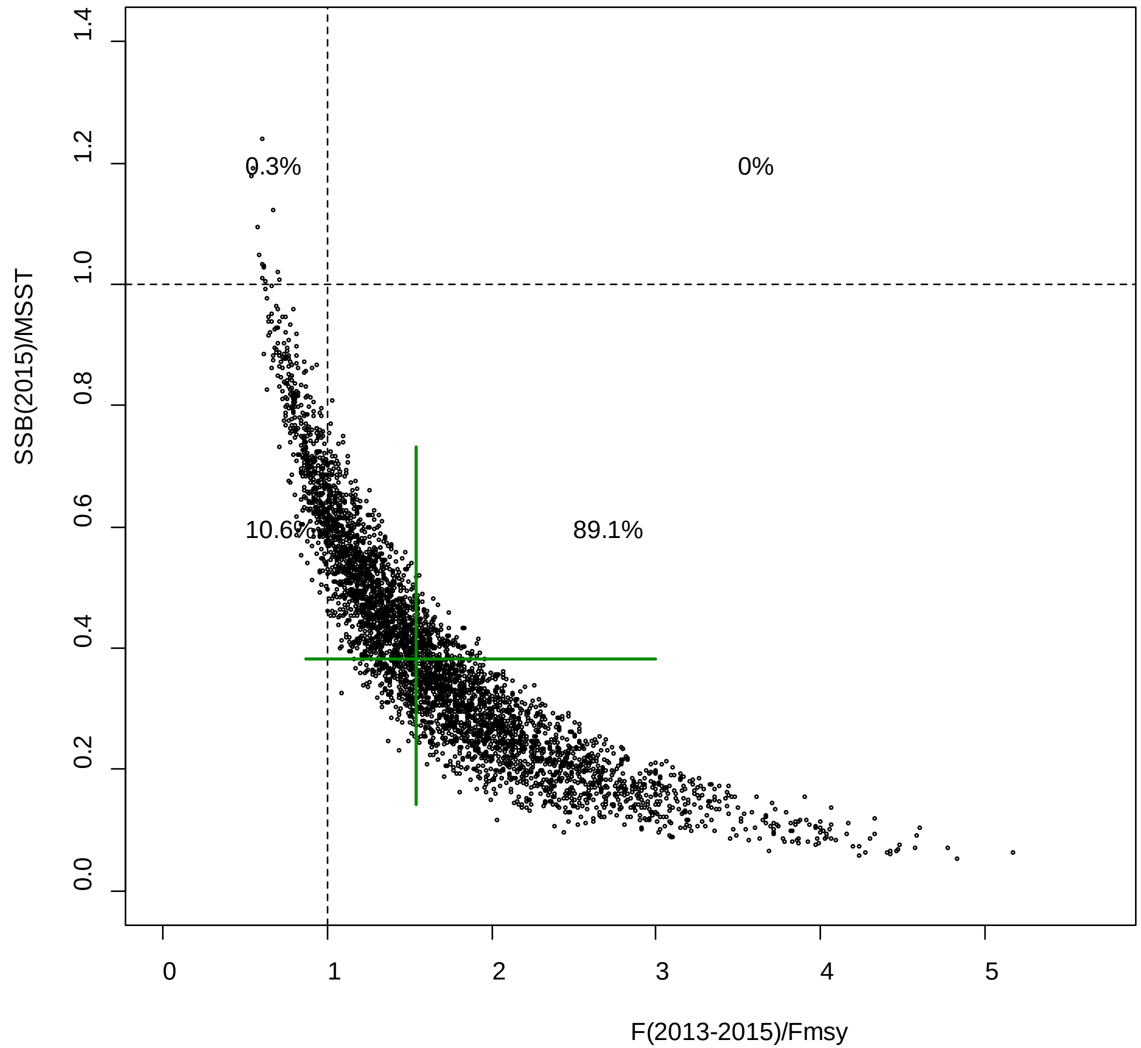
- Monte Carlo components:
  - M: drawn from a truncated normal distribution, with mean equal to base value (0.14), and bounds [0.1, 0.2]. Chosen value scales age-based Lorenzen M.
  - Release mortality: drawn from a uniform distribution, $\delta \sim U(0.1, 0.3)$
  - Steepness: drawn from a uniform distribution, $h \sim (0.75, 0.99)$

MCB – uncertainty in benchmarks



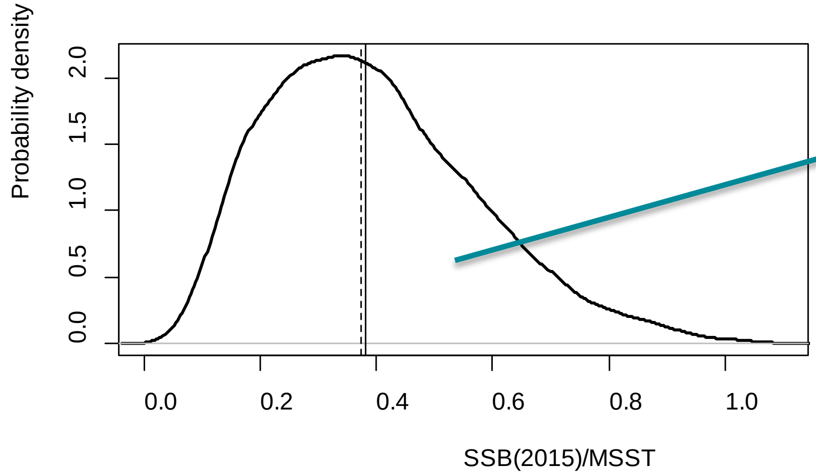
Solid=MLE (base)
Dash=Median

MCB – stock and fishery status

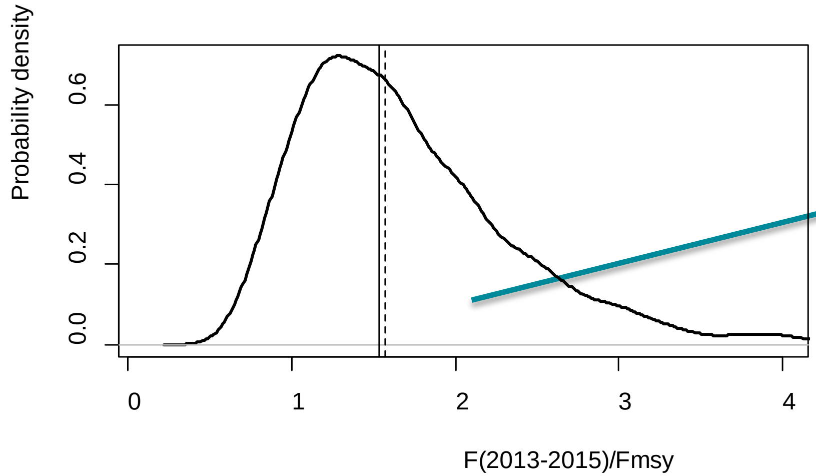


MCB – stock and fishery status

Solid=MLE (base)
Dash=Median



~97.7% of distribution below 1.0 (i.e., overfished)



~89.1% of distribution exceeds 1.0 (i.e., overfishing)

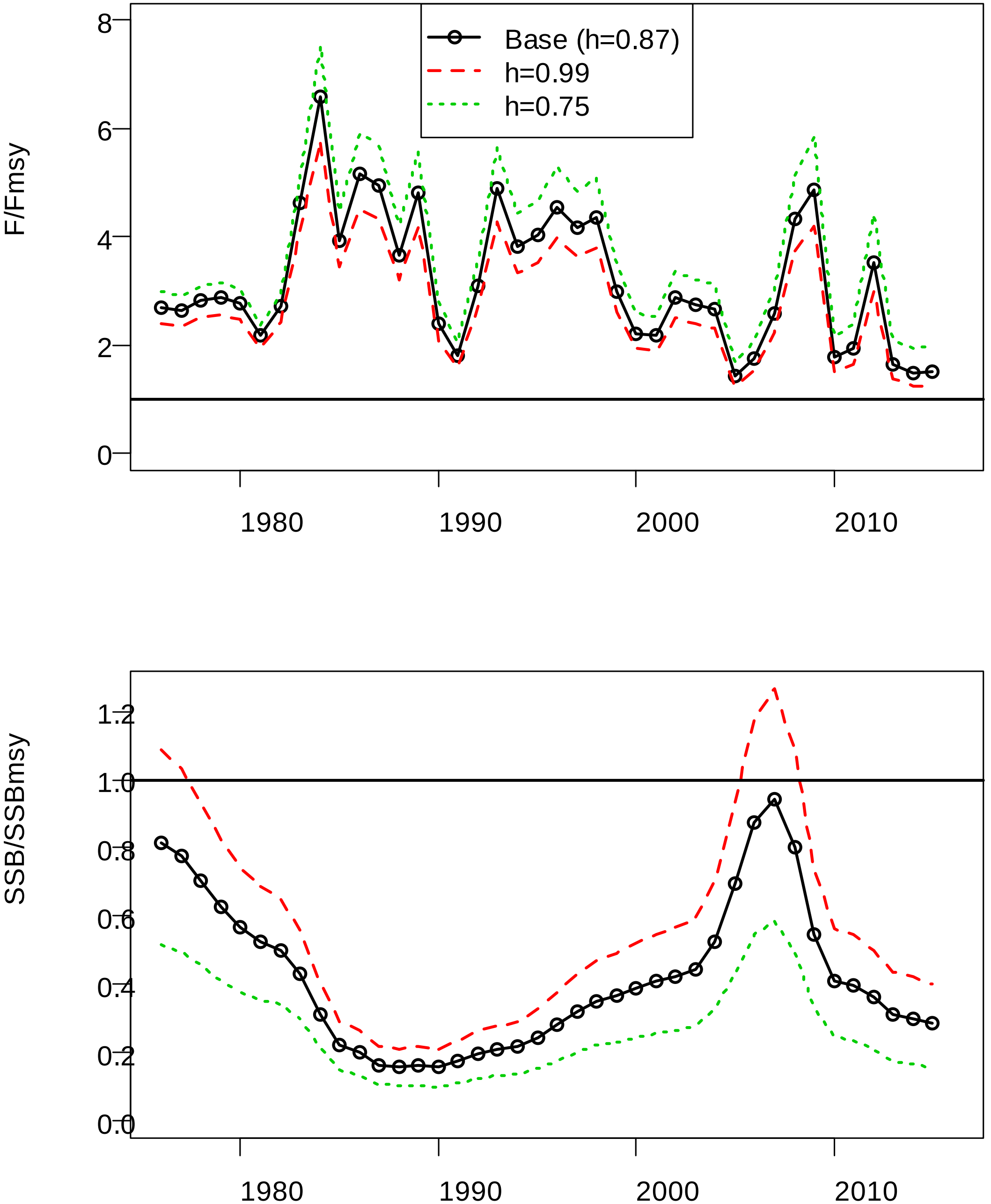
BAM results – Management quantities

Quantity	Units	Estimate	Median	SE
F_{MSY}	y^{-1}	0.12	0.13	0.02
$85\%F_{MSY}$	y^{-1}	0.10	0.11	0.02
$75\%F_{MSY}$	y^{-1}	0.09	0.09	0.02
$65\%F_{MSY}$	y^{-1}	0.08	0.08	0.01
$F_{20\%}$	y^{-1}	0.20	0.21	0.03
$F_{30\%}$	y^{-1}	0.14	0.14	0.02
$F_{40\%}$	y^{-1}	0.10	0.10	0.01
B_{MSY}	mt	4188.3	4149.6	1333.
SSB_{MSY}	mt	3183.4	3145.4	1165.1
MSST	mt	2387.6	2359	873.8
MSY	1000 lb	794.3	806.7	180.0
D_{MSY}	1000 fish	60.9	61.2	13.5
R_{MSY}	1000 age-1 fish	399.8	414.8	69.2
Y at $85\%F_{MSY}$	1000 lb	787.0	794.3	178.0
Y at $75\%F_{MSY}$	1000 lb	772.0	779.7	174.1
Y at $65\%F_{MSY}$	1000 lb	746.4	754.7	167.6
$F_{2013-2015}/F_{MSY}$	—	1.54	1.58	0.57
$SSB_{2015}/MSST$	—	0.38	0.37	0.13
SSB_{2015}/SSB_{MSY}	—	0.29	0.27	0.11

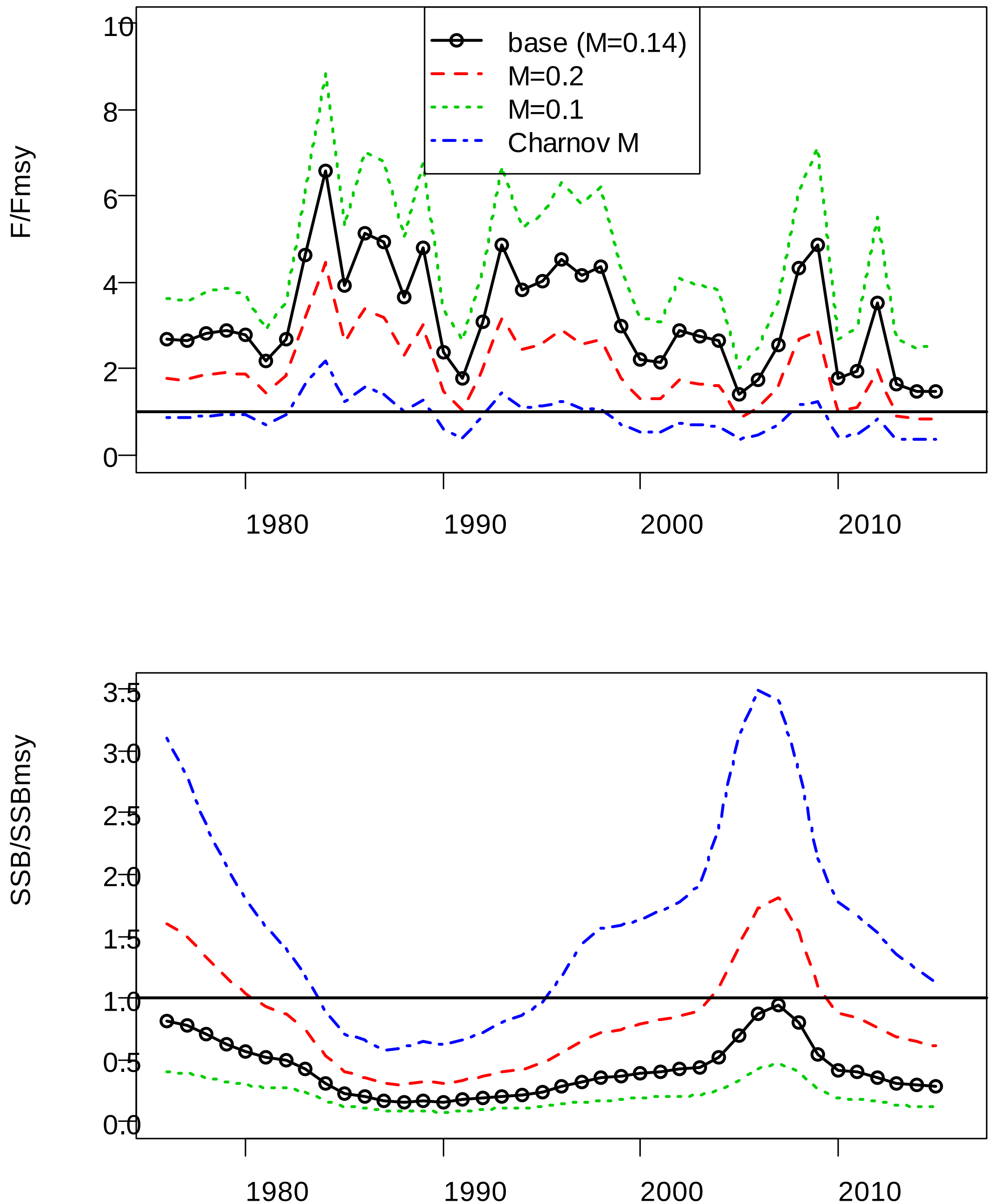
Sensitivity analyses

- S1: Steepness $h = 0.99$, at the upper bound of the range identified by likelihood profiling.
- S2: Steepness $h = 0.75$, at the lower bound of the range identified by likelihood profiling.
- S3: High natural mortality $M = 0.2$ used to scale the Lorenzen (1996) age-based estimator.
- S4: Low natural mortality $M = 0.1$ used to scale the Lorenzen (1996) age-based estimator.
- S5: Natural mortality follows the Charnov et al. (2015) age-based estimator with no rescaling.
- S6: Up-weight the SERFS index by a factor of six.
- S7: No video data.
- S8: Continuity configuration, including the multinomial likelihood for composition data, commercial other selectivity mirrors that of SERFS, steepness $h = 0.92$, MRFSS index included, and constant catchability for all indices.
- S9: Logistic-normal likelihood applied to composition data.
- S10: Release mortality rate equals 0.4 for all discards.

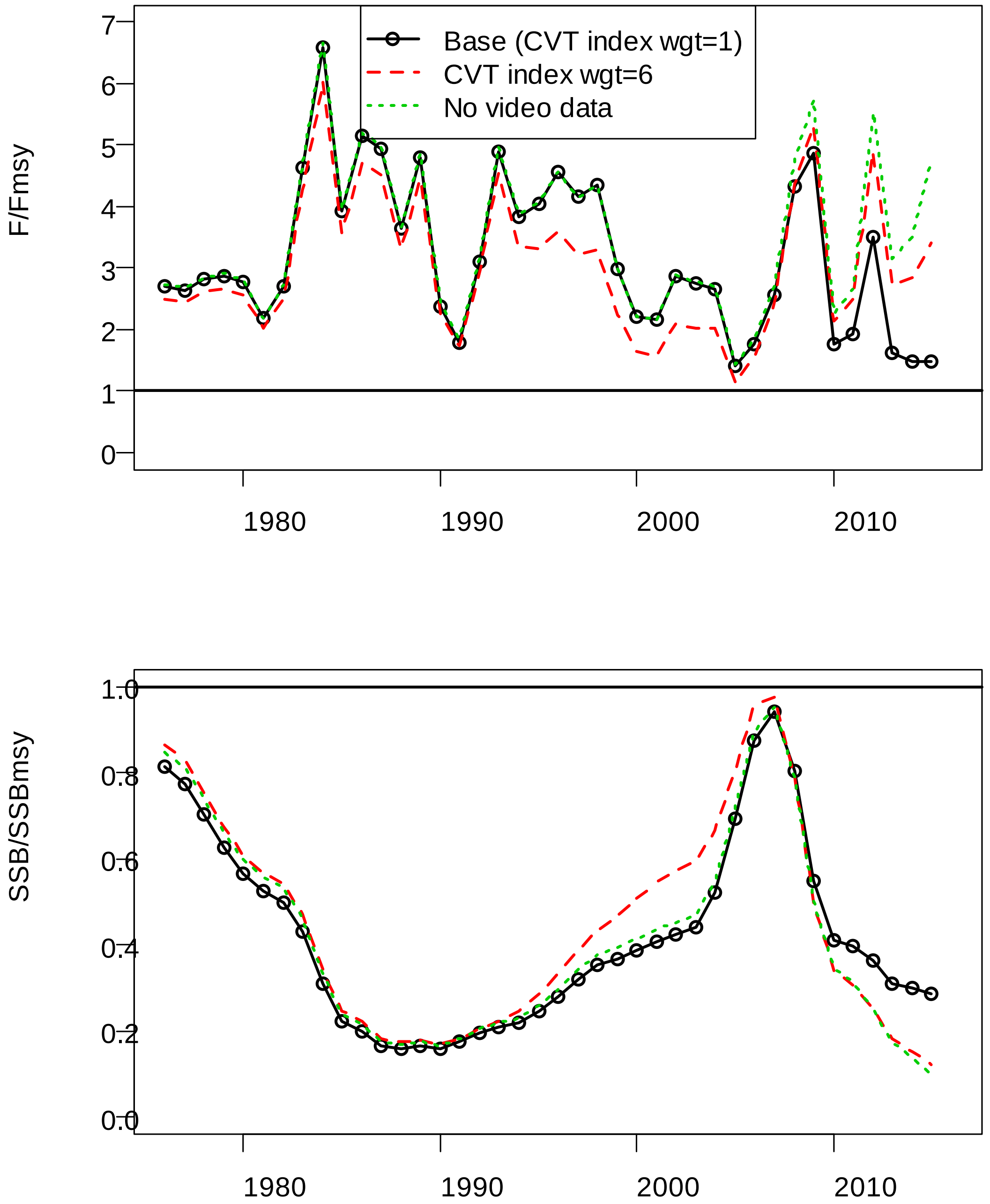
Steepness


Base (h=0.87)
h=0.99
h=0.75
F/Fmsy
8
6
4
2
0
1980
1990
2000
2010
SSB/SSBmsy
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1980
1990
2000
2010

Natural mortality



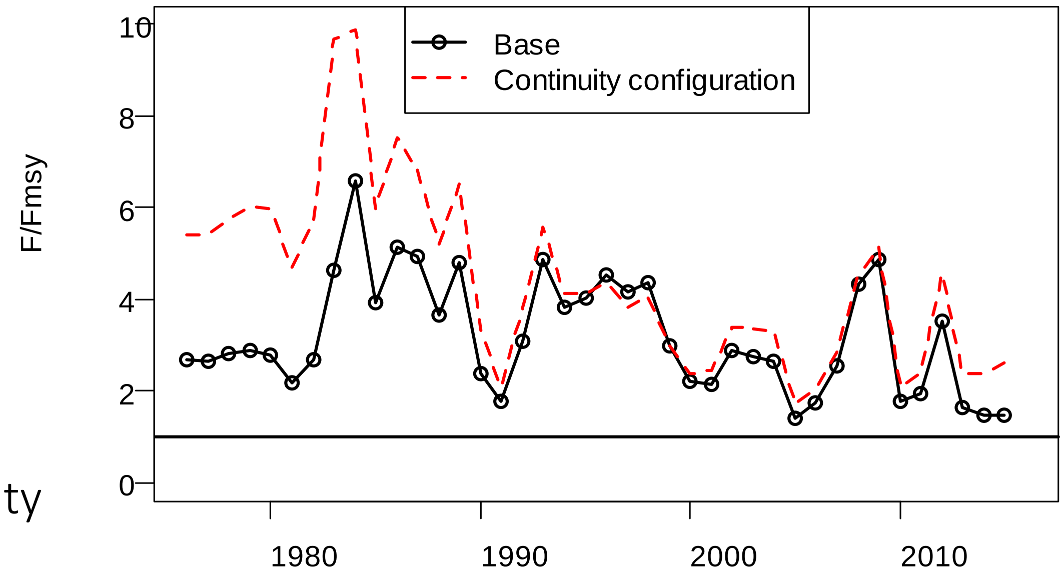
Indices

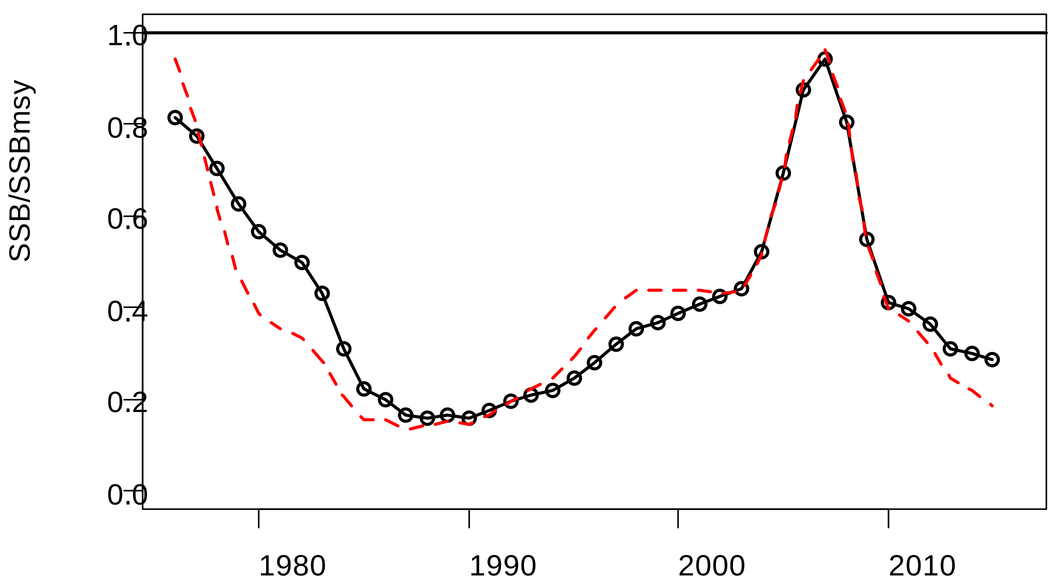


F/Fmsy
Base (CVT index wgt=1)
CVT index wgt=6
No video data
0
1
2
3
4
5
6
7
1980
1990
2000
2010
SSB/SSBmsy
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990
2000
2010

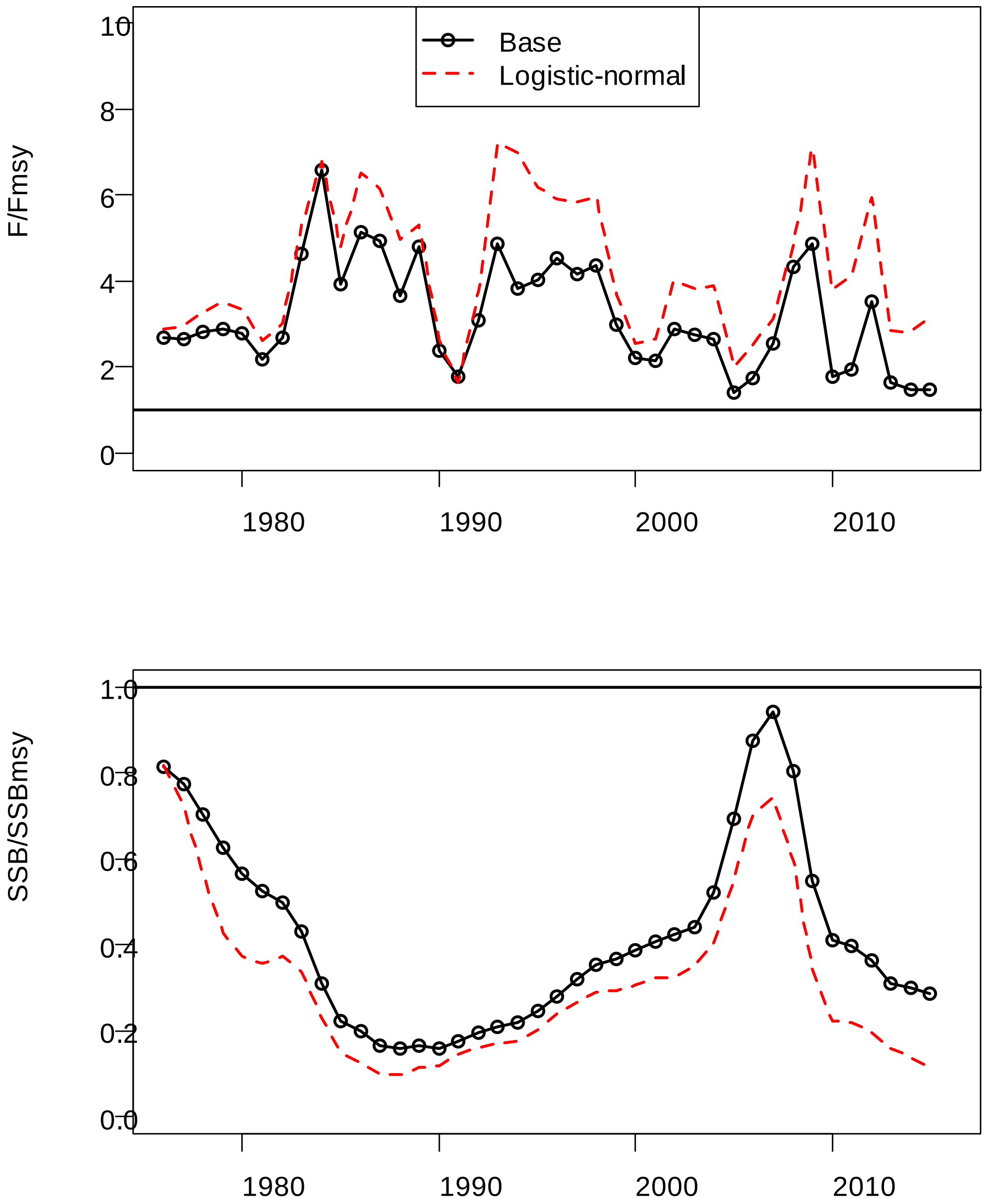
Continuity

-Multinomial
-cO selectivity mirrors CVT selectivity
-h=0.92
-MRFSS index included
-No random walk on q's



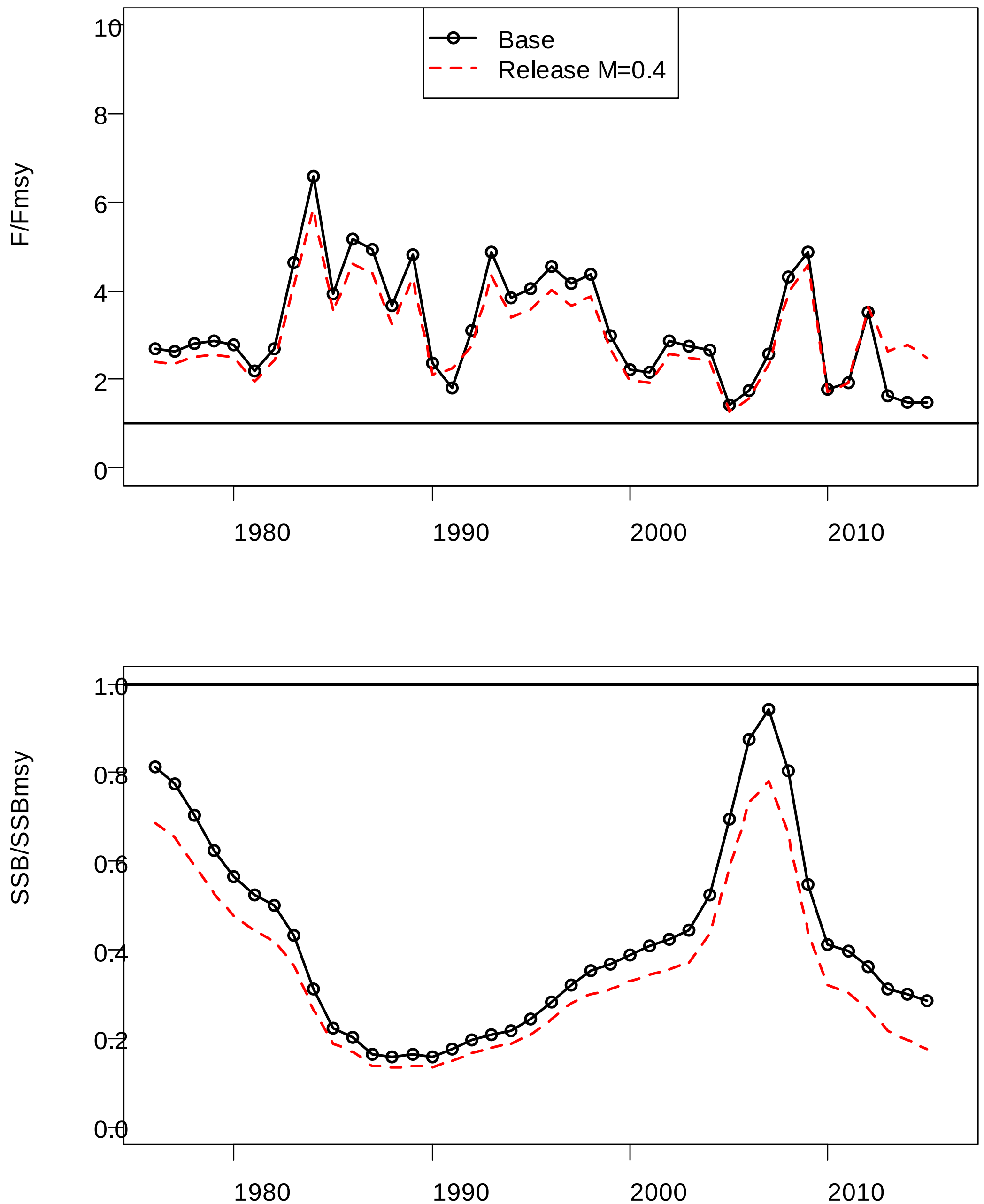


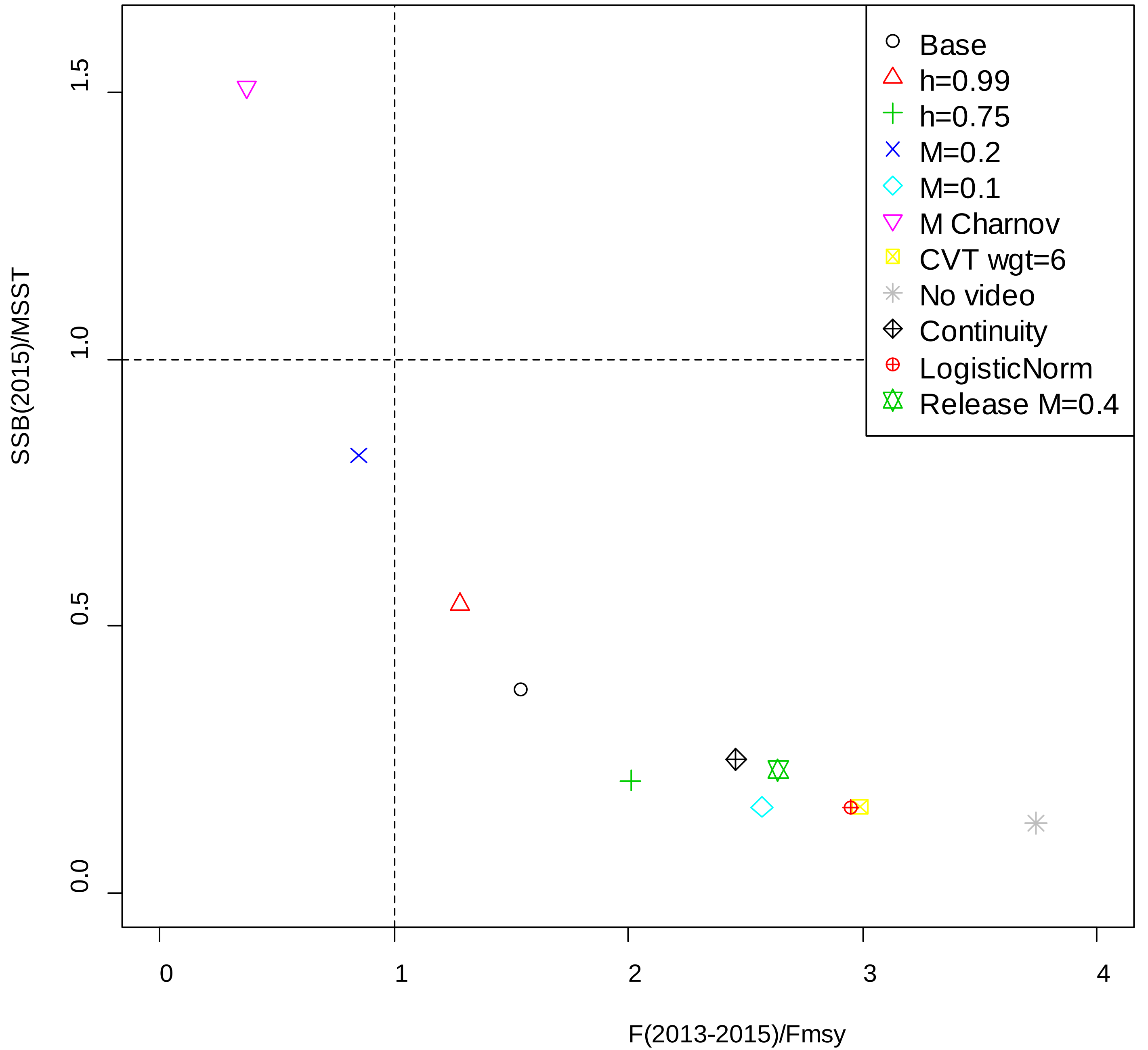
Logistic-normal



High release M

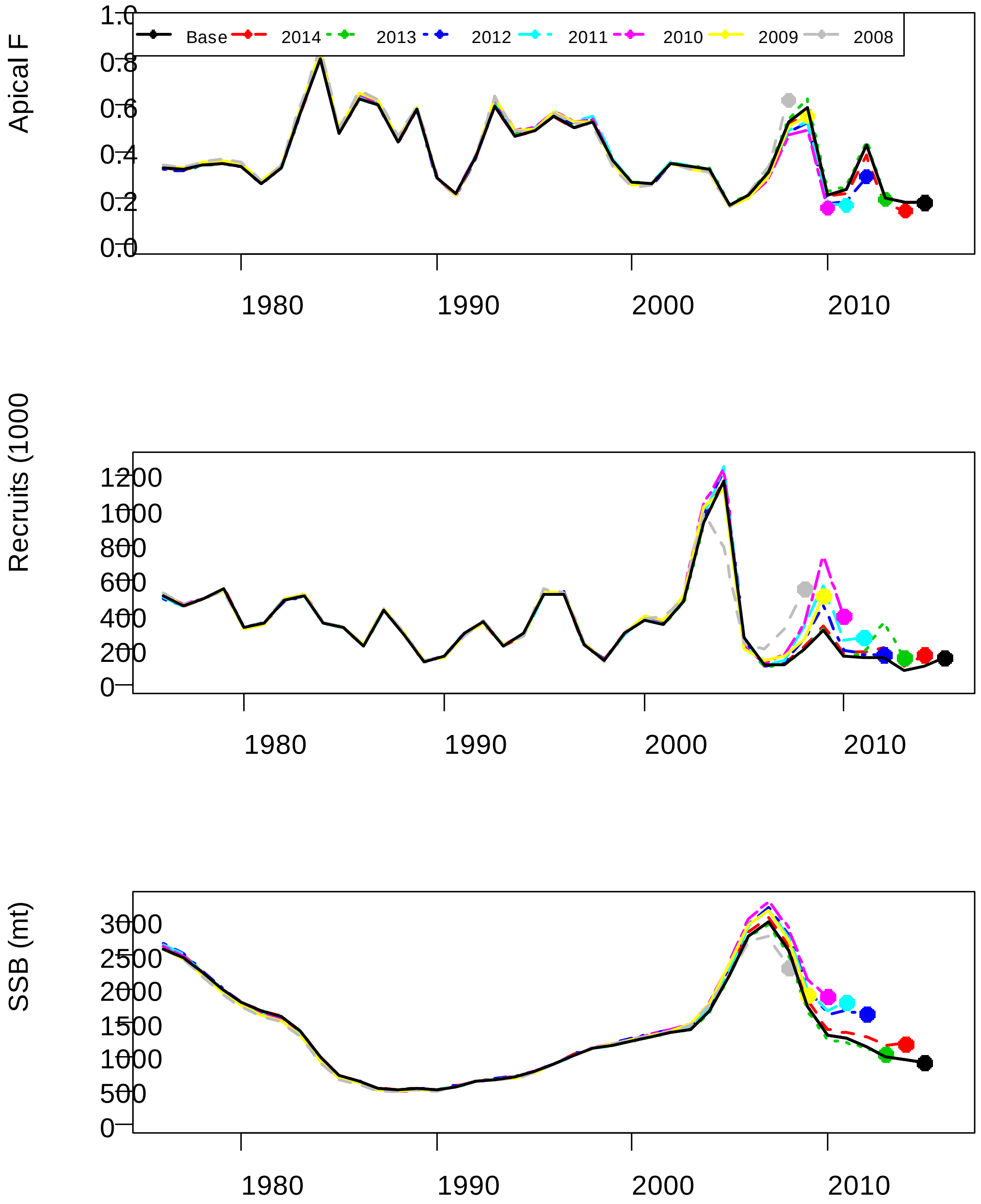
- Pulver (2017) found immediate release mortality in the GoM to be 0.26
- Scaled up to 0.4 to account for delayed release mortality
- Not necessarily a defensible value, but rather to explore the effects of something higher than 0.2





Base
h=0.99
h=0.75
M=0.2
M=0.1
M Charnov
CVT wgt=6
No video
Continuity
LogisticNorm
Release M=0.4
SSB(2015)/MSST
0.0
0.5
1.0
1.5
F(2013-2015)/Fmsy
0
1
2
3
4

Restrospective analyses



Projections

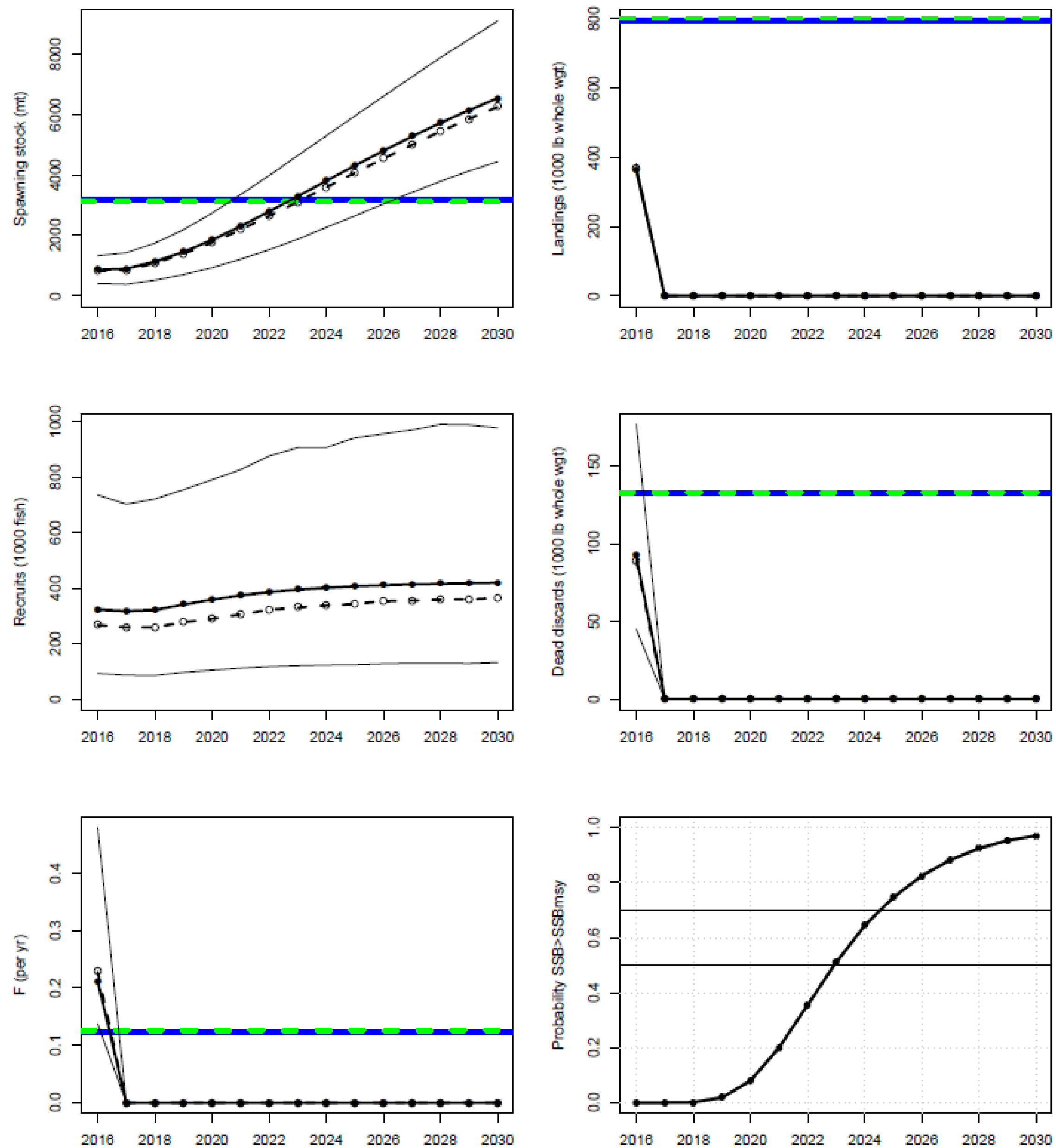
- Carry forward uncertainties from MCB runs
  - Uncertainties in initial (2016) abundance at age, spawner-recruit function, natural mortality, discard mortality, selectivities, recruitment deviations, growth CV
- Uncertainty in Fmsy uses distribution from MCB runs
- Landings in years between assessment and start of projected F is equal to the average from 2013-2015 (365K lb ww).
- Based on results, the assessment panel considered additional scenarios than specified in the TORs
  - Current rebuilding time frame ends in 2020, but it does not appear the stock can rebuild by then. Considered F=0 rather than F=Frebuild
    - Estimated generation time is 14 years.
  - Considered low recruitment scenarios, projecting with expected recruitment as the mean from 2006-2015

Projection scenarios

Scenario	F	Recruitment	Start year
1	Fmsy	Expected	2017
2	75%Fmsy	Expected	2017
3	0	Expected	2017
4	Fmsy	Low	2017
5	75%Fmsy	Low	2017
6	0	Low	2017
7	0	Expected	2019
8	75%Fmsy	Expected	2019

Example projection Scenario 3: F=0

Thick blue solid=base benchmark
Thick green dash=median benchmark
Thin solid, closed circles=deterministic
Thin dash, open circles=median
Thin solid=5th and 95th percentiles



Scenario 1: F=Fmsy, Expected R, 2017

Table 20. Projection results with fishing mortality rate fixed at $F = F_{MSY}$ starting in 2017. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), pr.reb = proportion of stochastic projection replicates with $SSB \geq SSB_{MSY}$. *The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

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
2016	323	267	0.21	0.23	860	817	33	34	365	368	56	51	92	89	0.000
2017	318	259	0.12	0.13	867	823	19	19	203	198	42	36	79	69	0.000
2018	318	257	0.12	0.13	977	932	24	24	226	221	47	41	99	86	0.000
2019	329	267	0.12	0.13	1133	1076	31	30	268	263	49	42	105	91	0.001
2020	341	275	0.12	0.13	1318	1242	37	35	318	311	51	43	108	93	0.002
2021	352	286	0.12	0.13	1510	1412	42	40	369	359	52	45	112	97	0.006
2022	361	301	0.12	0.13	1699	1580	46	44	418	404	54	47	115	100	0.015
2023	369	306	0.12	0.13	1877	1739	50	48	463	446	55	48	119	104	0.028
2024	375	313	0.12	0.13	2042	1889	53	51	505	486	56	49	121	107	0.045
2025	380	317	0.12	0.13	2193	2028	56	54	543	523	57	50	123	110	0.066
2026	383	327	0.12	0.13	2328	2156	59	56	578	556	58	51	125	111	0.088
2027	386	329	0.12	0.13	2449	2275	61	59	608	586	58	52	126	113	0.112
2028	389	332	0.12	0.13	2556	2378	63	61	635	612	59	53	127	115	0.139
2029	391	333	0.12	0.13	2649	2476	64	62	659	637	59	53	128	116	0.165
2030	392	339	0.12	0.13	2730	2563	66	64	680	657	60	54	129	117	0.192

Scenario 4: F=Fmsy, Low R, 2017

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
2016	144	121	0.21	0.23	860	817	33	34	365	368	35	33	70	71	0
2017	144	120	0.12	0.13	824	780	19	19	202	197	21	18	44	40	0
2018	144	120	0.12	0.13	849	805	20	20	208	205	22	19	46	41	0
2019	144	120	0.12	0.13	881	835	21	21	217	213	22	19	47	42	0
2020	144	118	0.12	0.13	917	867	22	22	227	223	22	19	48	42	0
2021	144	119	0.12	0.13	952	897	23	23	237	231	22	19	48	42	0
2022	144	121	0.12	0.13	985	924	24	23	245	239	22	19	48	42	0
2023	144	120	0.12	0.13	1014	951	24	24	252	245	22	19	48	42	0
2024	144	120	0.12	0.13	1038	973	25	24	259	250	22	19	48	43	0
2025	144	119	0.12	0.13	1059	994	25	24	264	255	22	19	48	42	0
2026	144	121	0.12	0.13	1076	1011	25	25	268	259	22	19	48	42	0
2027	144	121	0.12	0.13	1089	1028	26	25	272	263	22	19	48	42	0
2028	144	121	0.12	0.13	1101	1040	26	25	275	266	22	19	48	42	0
2029	144	120	0.12	0.13	1110	1050	26	25	277	269	22	19	48	42	0
2030	144	121	0.12	0.13	1117	1060	26	25	279	271	22	19	48	42	0

Scenario 2: F=75%Fmsy, Expected R, 2017

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
2016	323	267	0.21	0.23	860	817	33	34	365	368	56	51	92	89	0.000
2017	318	259	0.09	0.09	875	831	15	14	154	150	32	28	60	52	0.000
2018	319	258	0.09	0.09	1014	968	19	18	177	173	36	31	76	66	0.000
2019	332	269	0.09	0.09	1206	1148	25	24	216	212	38	33	82	71	0.001
2020	346	279	0.09	0.09	1434	1356	30	29	262	257	39	34	85	73	0.006
2021	358	291	0.09	0.09	1677	1572	35	33	310	303	41	35	88	76	0.022
2022	368	306	0.09	0.09	1920	1792	39	37	357	348	42	37	91	79	0.050
2023	376	313	0.09	0.09	2155	2006	43	41	403	390	43	38	94	83	0.091
2024	382	320	0.09	0.09	2377	2206	46	44	445	430	44	39	96	85	0.141
2025	387	325	0.09	0.09	2584	2398	49	47	485	469	45	40	98	87	0.201
2026	391	334	0.09	0.09	2773	2576	51	50	521	505	46	40	100	89	0.268
2027	394	337	0.09	0.09	2944	2742	54	52	554	536	46	41	101	91	0.337
2028	397	340	0.09	0.09	3098	2894	56	54	583	565	46	42	102	92	0.400
2029	399	341	0.09	0.09	3235	3031	57	56	609	592	47	42	102	93	0.464
2030	400	347	0.09	0.09	3355	3154	59	58	633	615	47	42	103	94	0.522

Scenario 5: F=75%Fmsy, Low R, 2017

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
2016	144	121	0.21	0.23	860	817	33	34	365	368	35	33	70	71	0
2017	144	120	0.09	0.09	831	787	14	14	154	150	16	14	34	30	0
2018	144	120	0.09	0.09	881	837	16	15	163	161	17	15	36	32	0
2019	144	120	0.09	0.09	940	893	17	17	175	172	17	15	37	33	0
2020	144	118	0.09	0.09	1002	950	18	18	188	185	17	15	37	33	0
2021	144	119	0.09	0.09	1063	1005	19	19	200	196	17	15	37	33	0
2022	144	121	0.09	0.09	1120	1056	20	20	211	206	17	15	37	33	0
2023	144	120	0.09	0.09	1171	1103	21	20	221	215	17	15	37	33	0
2024	144	120	0.09	0.09	1216	1143	21	21	229	223	17	15	37	33	0
2025	144	119	0.09	0.09	1254	1179	22	21	237	230	17	15	37	33	0
2026	144	121	0.09	0.09	1286	1210	22	22	243	236	17	15	37	33	0
2027	144	121	0.09	0.09	1313	1239	22	22	248	241	17	15	37	33	0
2028	144	121	0.09	0.09	1336	1263	23	22	252	245	17	15	37	33	0
2029	144	120	0.09	0.09	1355	1283	23	22	256	249	17	15	37	33	0
2030	144	121	0.09	0.09	1371	1301	23	23	259	253	17	15	37	33	0

Scenario 3: F=0, Expected R, 2017

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
2016	323	267	0.21	0.23	860	817	33	34	365	368	56	51	92	89	0.000
2017	318	259	0.00	0.00	900	856	0	0	0	0	0	0	0	0	0.000
2018	322	260	0.00	0.00	1133	1087	0	0	0	0	0	0	0	0	0.002
2019	341	277	0.00	0.00	1453	1393	0	0	0	0	0	0	0	0	0.018
2020	359	290	0.00	0.00	1850	1766	0	0	0	0	0	0	0	0	0.080
2021	374	305	0.00	0.00	2302	2190	0	0	0	0	0	0	0	0	0.200
2022	386	322	0.00	0.00	2788	2640	0	0	0	0	0	0	0	0	0.355
2023	394	330	0.00	0.00	3292	3105	0	0	0	0	0	0	0	0	0.510
2024	401	338	0.00	0.00	3801	3591	0	0	0	0	0	0	0	0	0.644
2025	406	343	0.00	0.00	4305	4068	0	0	0	0	0	0	0	0	0.746
2026	410	353	0.00	0.00	4796	4537	0	0	0	0	0	0	0	0	0.825
2027	413	355	0.00	0.00	5268	4992	0	0	0	0	0	0	0	0	0.883
2028	416	358	0.00	0.00	5718	5435	0	0	0	0	0	0	0	0	0.925
2029	418	359	0.00	0.00	6141	5853	0	0	0	0	0	0	0	0	0.953
2030	419	366	0.00	0.00	6537	6246	0	0	0	0	0	0	0	0	0.971

Scenario 6: F=0, Low R, 2017

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
2016	144	121	0.21	0.23	860	817	33	34	365	368	35	33	70	71	0.000
2017	144	120	0.00	0.00	855	810	0	0	0	0	0	0	0	0	0.000
2018	144	120	0.00	0.00	987	942	0	0	0	0	0	0	0	0	0.000
2019	144	120	0.00	0.00	1141	1092	0	0	0	0	0	0	0	0	0.001
2020	144	118	0.00	0.00	1309	1255	0	0	0	0	0	0	0	0	0.006
2021	144	119	0.00	0.00	1485	1426	0	0	0	0	0	0	0	0	0.016
2022	144	121	0.00	0.00	1661	1592	0	0	0	0	0	0	0	0	0.032
2023	144	120	0.00	0.00	1831	1751	0	0	0	0	0	0	0	0	0.056
2024	144	120	0.00	0.00	1992	1899	0	0	0	0	0	0	0	0	0.086
2025	144	119	0.00	0.00	2142	2044	0	0	0	0	0	0	0	0	0.120
2026	144	121	0.00	0.00	2280	2175	0	0	0	0	0	0	0	0	0.156
2027	144	121	0.00	0.00	2407	2298	0	0	0	0	0	0	0	0	0.193
2028	144	121	0.00	0.00	2522	2411	0	0	0	0	0	0	0	0	0.231
2029	144	120	0.00	0.00	2627	2516	0	0	0	0	0	0	0	0	0.268
2030	144	121	0.00	0.00	2721	2606	0	0	0	0	0	0	0	0	0.302

Scenario 7: F=0, Expected R, 2019

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
2016	323	266	0.21	0.23	860	817	33	34	365	368	56	50	92	89	0.000
2017	318	261	0.23	0.25	839	794	35	35	365	367	77	70	144	133	0.000
2018	315	253	0.23	0.25	857	806	39	39	365	367	82	75	168	156	0.000
2019	317	249	0.00	0.00	974	914	0	0	0	0	0	0	0	0	0.002
2020	329	253	0.00	0.00	1290	1209	0	0	0	0	0	0	0	0	0.019
2021	351	273	0.00	0.00	1673	1566	0	0	0	0	0	0	0	0	0.070
2022	368	289	0.00	0.00	2111	1970	0	0	0	0	0	0	0	0	0.168
2023	381	304	0.00	0.00	2586	2408	0	0	0	0	0	0	0	0	0.297
2024	391	315	0.00	0.00	3084	2859	0	0	0	0	0	0	0	0	0.438
2025	399	321	0.00	0.00	3592	3336	0	0	0	0	0	0	0	0	0.566
2026	404	333	0.00	0.00	4099	3800	0	0	0	0	0	0	0	0	0.669
2027	409	338	0.00	0.00	4597	4261	0	0	0	0	0	0	0	0	0.751
2028	412	343	0.00	0.00	5078	4711	0	0	0	0	0	0	0	0	0.814
2029	415	343	0.00	0.00	5538	5157	0	0	0	0	0	0	0	0	0.862
2030	417	346	0.00	0.00	5973	5570	0	0	0	0	0	0	0	0	0.895
2031	419	350	0.00	0.00	6380	5943	0	0	0	0	0	0	0	0	0.919
2032	420	354	0.00	0.00	6758	6305	0	0	0	0	0	0	0	0	0.934
2033	421	356	0.00	0.00	7106	6654	0	0	0	0	0	0	0	0	0.946
2034	422	357	0.00	0.00	7425	6965	0	0	0	0	0	0	0	0	0.954
2035	423	357	0.00	0.00	7716	7248	0	0	0	0	0	0	0	0	0.960
2036	424	359	0.00	0.00	7981	7515	0	0	0	0	0	0	0	0	0.964
2037	424	359	0.00	0.00	8220	7774	0	0	0	0	0	0	0	0	0.967
2038	425	359	0.00	0.00	8437	8009	0	0	0	0	0	0	0	0	0.968
2039	425	360	0.00	0.00	8633	8207	0	0	0	0	0	0	0	0	0.969
2040	426	366	0.00	0.00	8809	8395	0	0	0	0	0	0	0	0	0.970

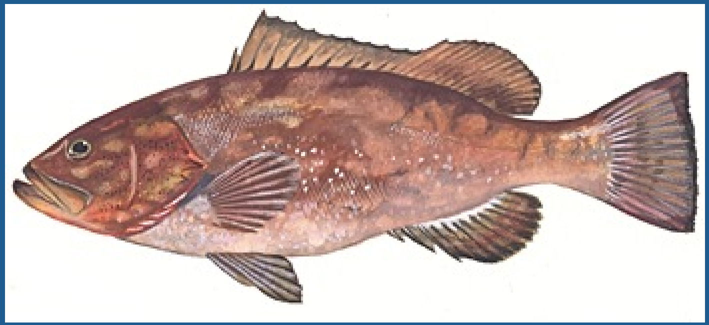
Scenario 8: F=75%Fmsy, Expected R, 2019

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
2016	323	266	0.21	0.23	860	817	33	34	365	368	56	50	92	89	0.000
2017	318	261	0.23	0.25	839	794	35	35	365	367	77	70	144	133	0.000
2018	315	253	0.23	0.25	857	806	39	39	365	367	82	75	168	156	0.000
2019	317	249	0.09	0.09	948	888	19	18	168	161	35	28	72	60	0.001
2020	326	252	0.09	0.09	1156	1079	24	23	208	200	37	30	79	65	0.005
2021	342	267	0.09	0.09	1389	1289	29	28	254	244	39	32	83	69	0.016
2022	356	278	0.09	0.09	1632	1507	34	32	302	289	41	33	87	73	0.035
2023	366	290	0.09	0.09	1876	1719	38	36	349	333	42	35	91	76	0.064
2024	375	299	0.09	0.09	2112	1925	42	40	394	375	43	36	94	80	0.103
2025	381	304	0.09	0.09	2337	2123	45	43	437	417	44	37	96	82	0.150
2026	386	315	0.09	0.09	2546	2306	48	46	478	455	45	38	98	84	0.203
2027	390	321	0.09	0.09	2739	2482	51	48	514	490	45	39	99	86	0.262
2028	394	325	0.09	0.09	2913	2642	53	51	548	522	46	40	100	88	0.323
2029	396	325	0.09	0.09	3071	2782	55	53	578	551	46	40	101	89	0.381
2030	398	327	0.09	0.09	3211	2912	57	55	605	578	47	40	102	89	0.438
2031	400	332	0.09	0.09	3334	3032	59	56	629	602	47	41	103	90	0.491
2032	402	335	0.09	0.09	3442	3141	60	58	649	621	47	41	103	91	0.539
2033	403	338	0.09	0.09	3536	3234	61	59	667	640	47	41	104	92	0.585
2034	404	339	0.09	0.09	3617	3324	62	60	682	658	47	42	104	93	0.628
2035	404	339	0.09	0.09	3687	3398	63	61	696	672	47	42	104	93	0.666
2036	405	342	0.09	0.09	3747	3471	63	62	707	685	47	42	104	93	0.702
2037	406	342	0.09	0.09	3798	3534	64	63	717	695	48	42	105	94	0.730
2038	406	342	0.09	0.09	3842	3585	65	63	725	705	48	42	105	94	0.755
2039	406	343	0.09	0.09	3879	3629	65	64	733	714	48	42	105	94	0.774
2040	407	349	0.09	0.09	3911	3668	65	64	739	721	48	43	105	95	0.793

Assessment summary and conclusions

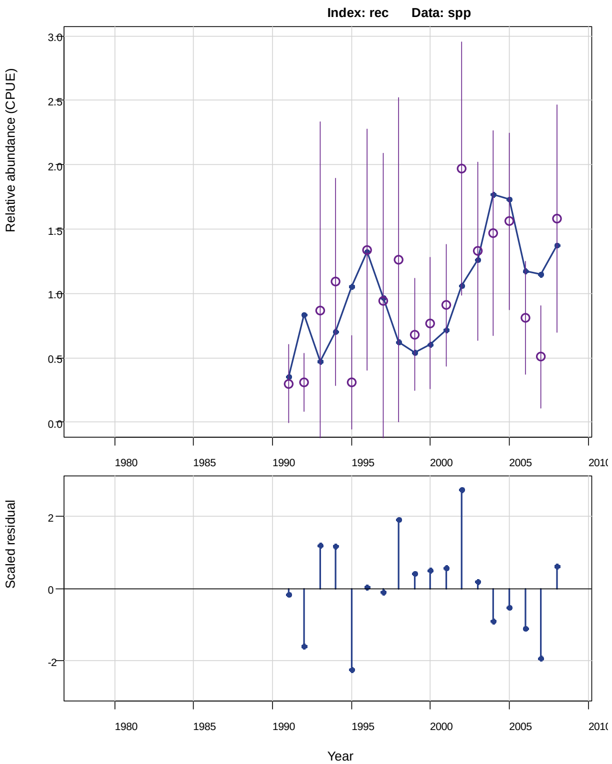
- This assessment indicates that red grouper are currently overfished and experiencing overfishing
- Decreases in abundance over the past decade appear to be due to low recruitment since 2005, combined with high landings in 2007-2009, particularly from the general recreational fleet.
- A regime shift toward low recruitment is a plausible hypothesis, however it seems premature to draw that conclusion (Klaer et al. 2015)
  - No mechanism for low recruitment has been identified
  - Duration of low recruitment is shorter than one generation
- Low recruitment could be considered in short-term projections

Questions

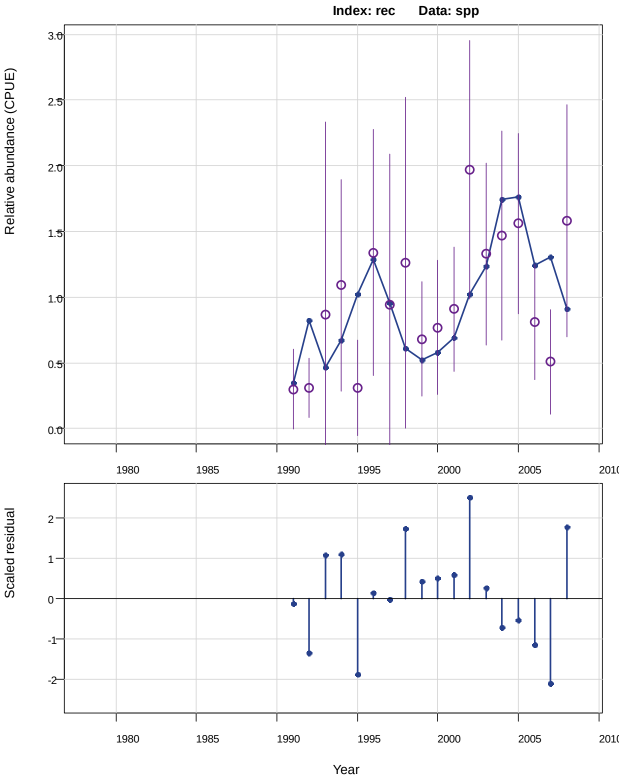


Comparison: S19 model with and without MRFSS index

With MRFSS index

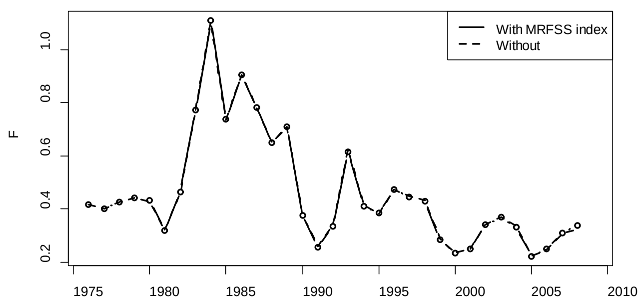


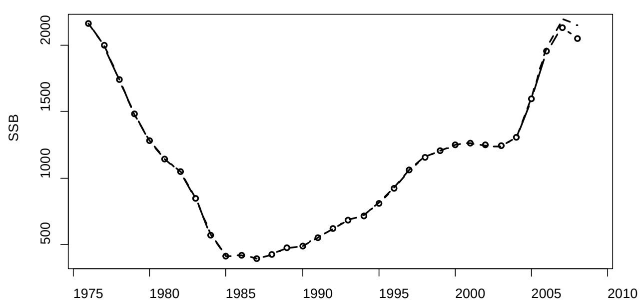
Without MRFSS index. Not in objective function, q fixed at the previously estimated value.



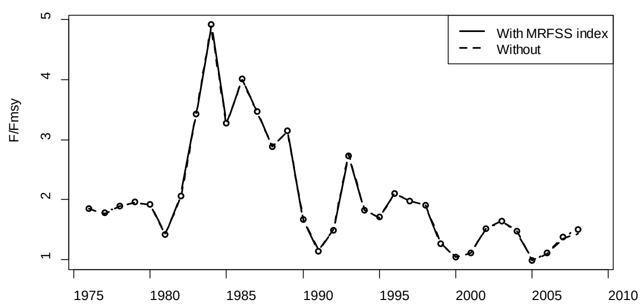
Comparison: S19 model with and without MRFSS index

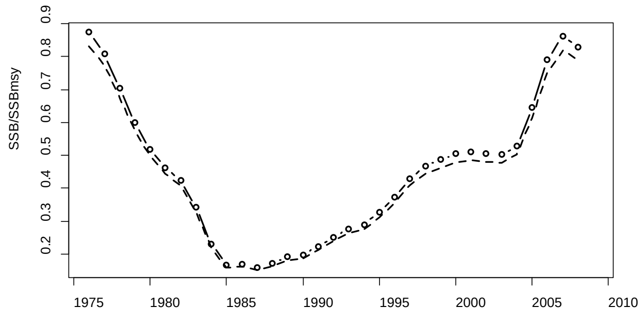
F and SSB





Relative F/Fmsy and SSB/SSBmsy



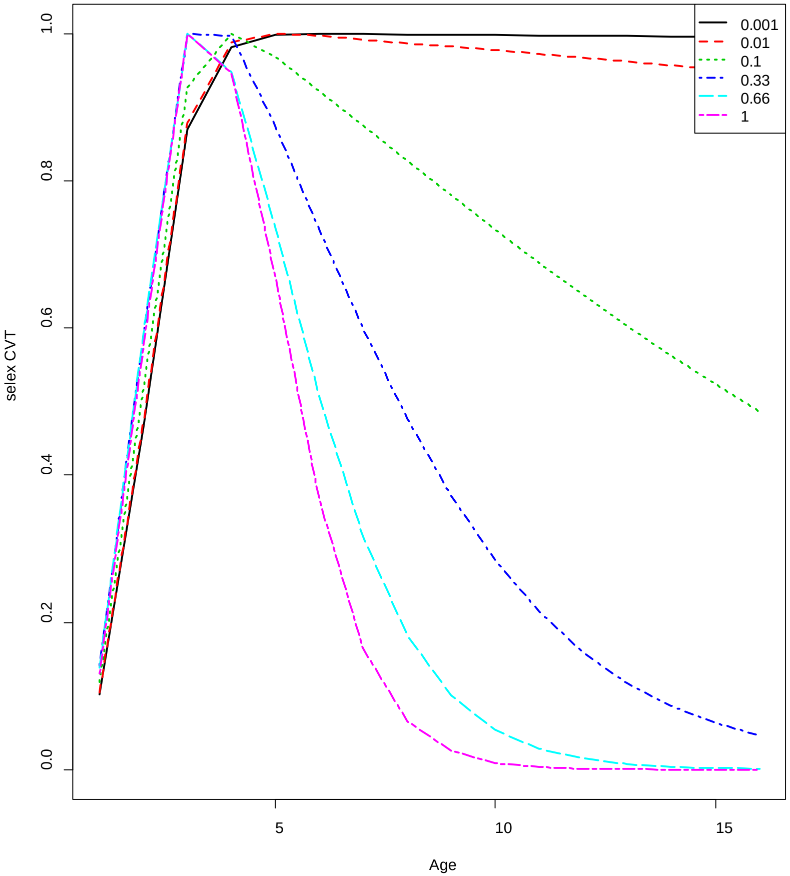


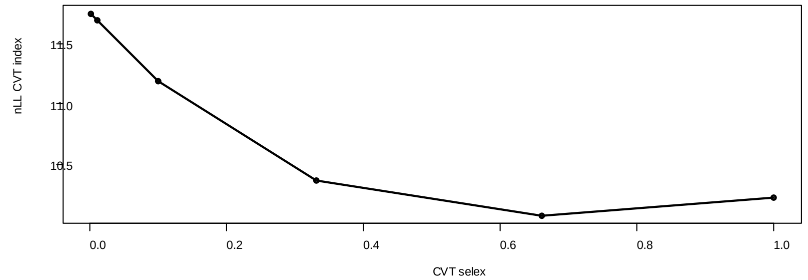
Overlap in video sightings and trap catches

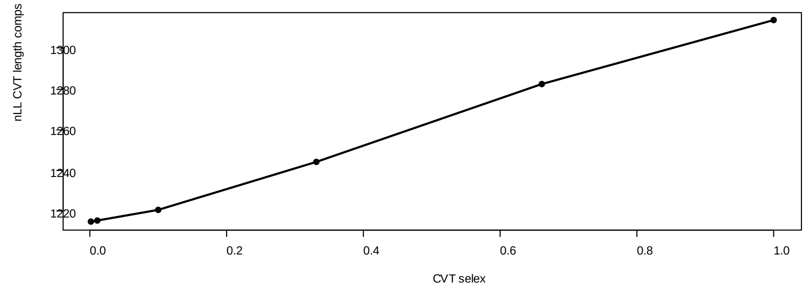
- Overlap
  - Prob(Both gears|Either gear)=0.21
  - Prob(Video|Trap)=0.29
  - Prob(Trap|Video)=0.43

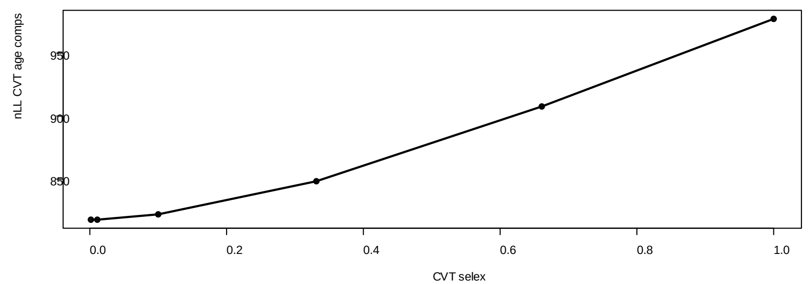
- Recommendation: Continue using both gears. There is probably some redundancy in individuals sampled, but we already knew the sampling was not independent. Indices from the two gears are combined into one using the Conn method.

Likelihood profiles



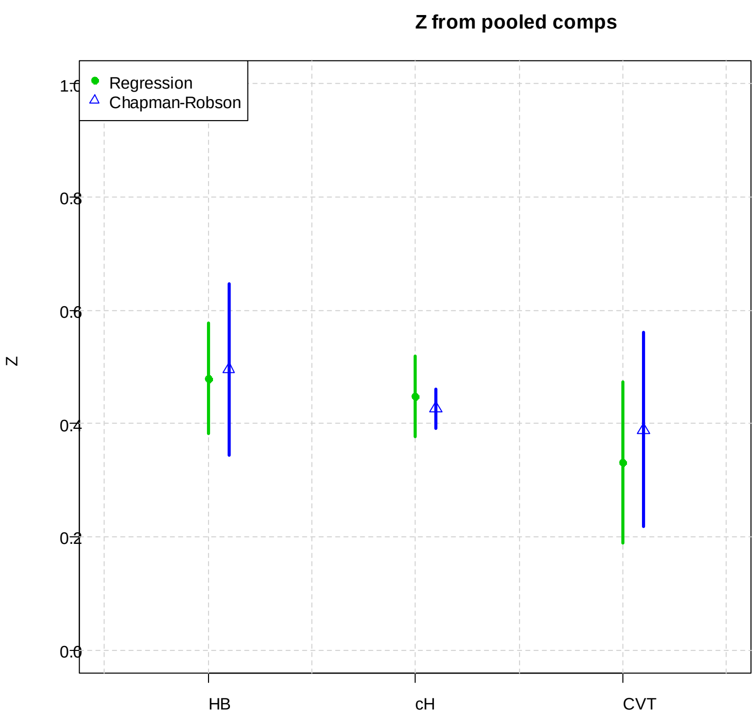




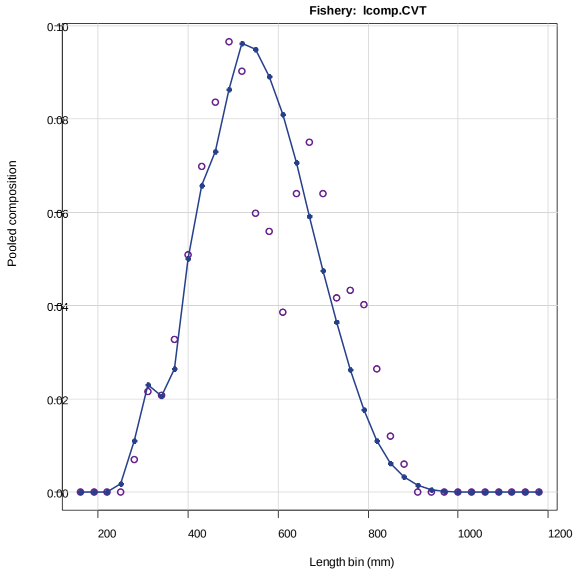


Catch curve analysis

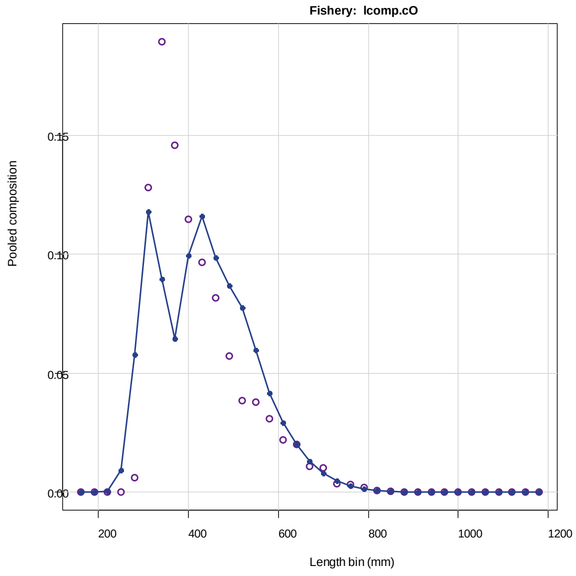
- Headboat and commercial line selectivities assumed flat-topped
- Higher relative Z of chevron traps would be consistent with dome-shaped selectivity, but that's not what we see.



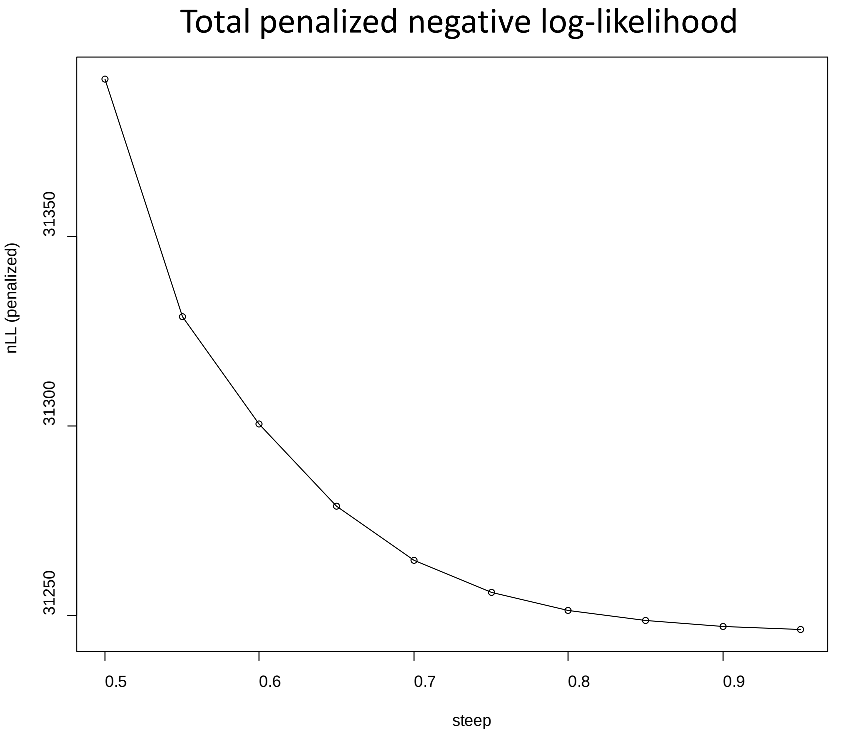
CVT pooled lengths

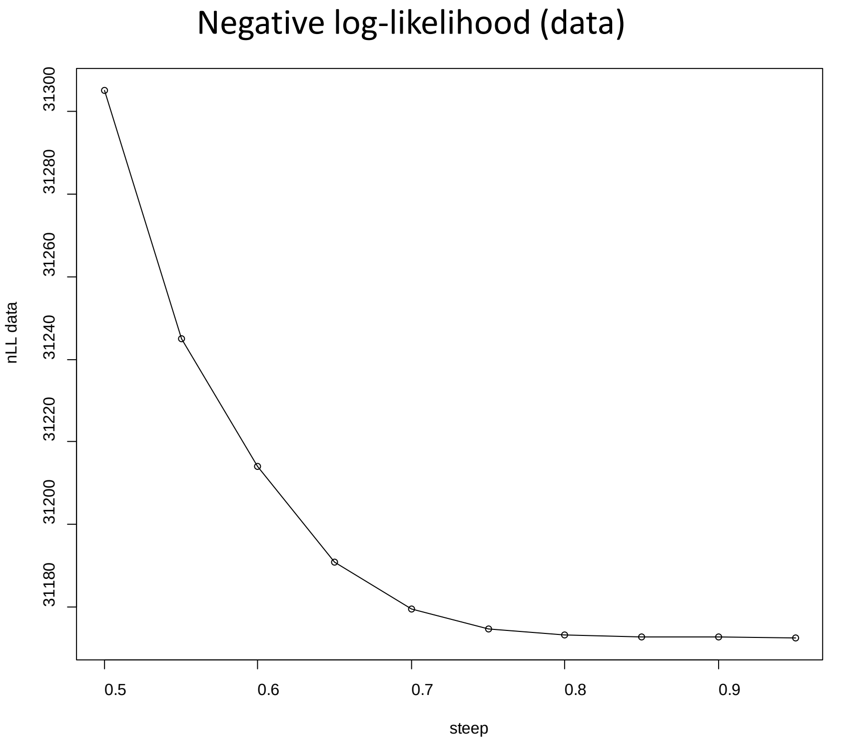


Comm other pooled lengths

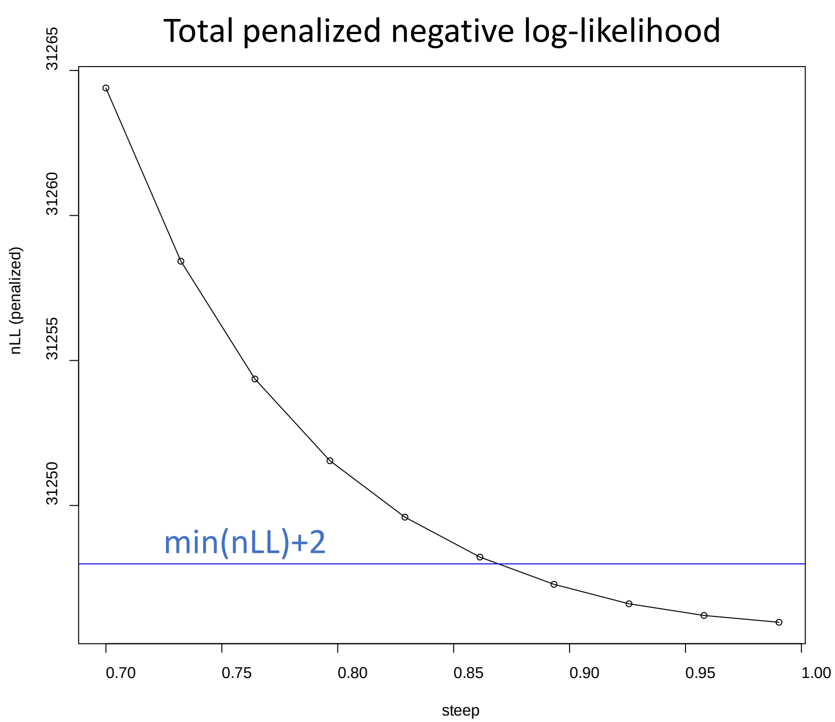


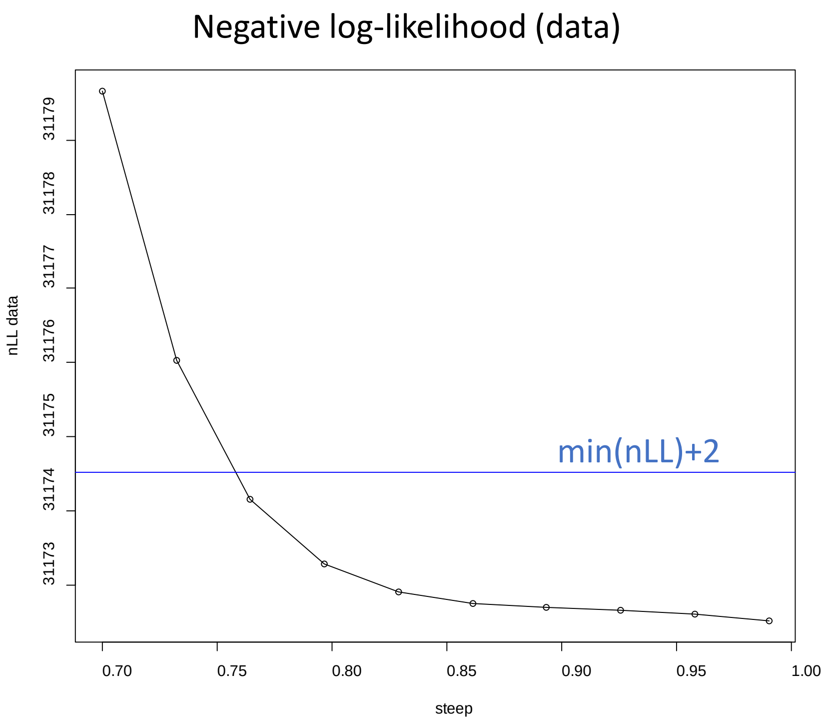
Likelihood profile on steepness





Likelihood profile on steepness: a closer look





Likelihood profile on steepness: a closer look