SEDAR 67 Gulf of Mexico Vermilion Snapper Stock Assessment: Assessment Review for the SSC

Sustainable Fisheries Division, SEFSC

June 1, 2020

Terms of Reference

- Standard Assessment
  - Update all data
  - Continuity run
  - Consider
    - Effect of IFQ on commercial indices
    - Inclusion of discards
    - FES adjusted MRIP data
    - Combined video survey
    - Estimating selectivity for shrimp bycatch
  - Develop base model and project stock status

Outline

- Continuity model development
  - Data
  - Model fit and results
    - Transition to SS 3.30 and FES
- Base model development
  - Changes to continuity data
  - Model fit
  - Results
  - Model diagnostics
- Projections
  - Assumptions
  - Results

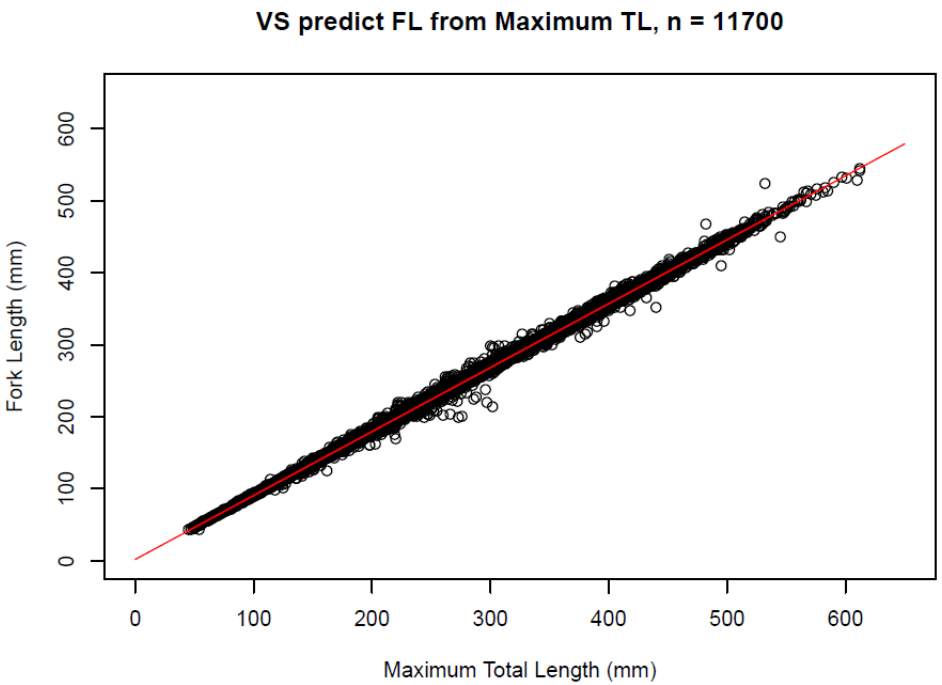
Continuity Model Development: Data

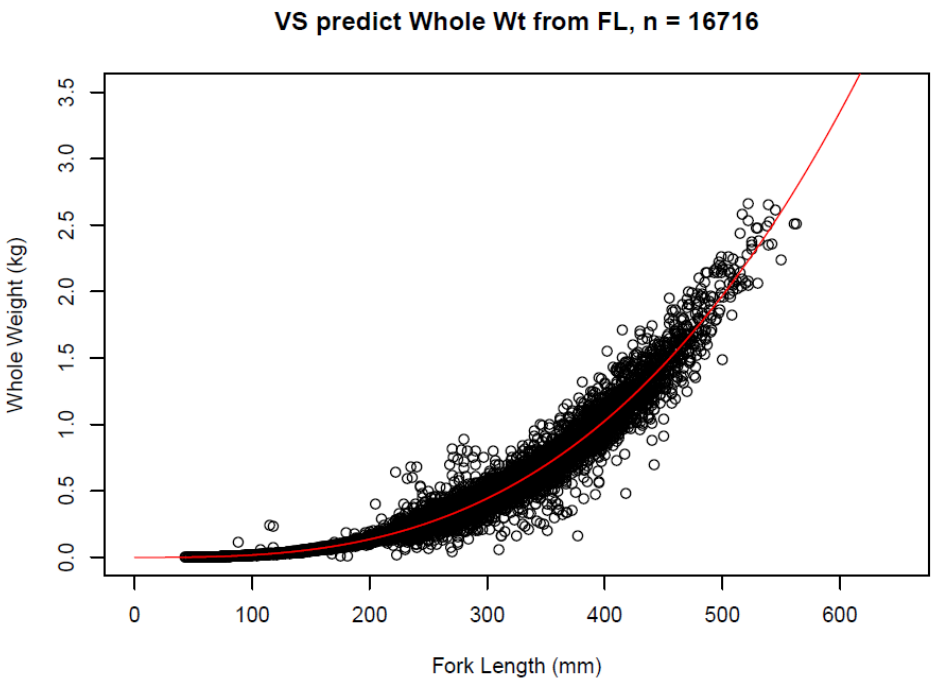
Life history summary

Topic	Decision
Length-Weight Conversion	- Maintain continuity
Maturity/Transition	- Maintain continuity
SSB Metric	- Maintain continuity
Fecundity	- Maintain continuity
Age and Growth	- Maintain continuity
Natural Mortality	- Maintain continuity

All life history parameters unchanged from SEDAR 45

Length and Weight Conversions



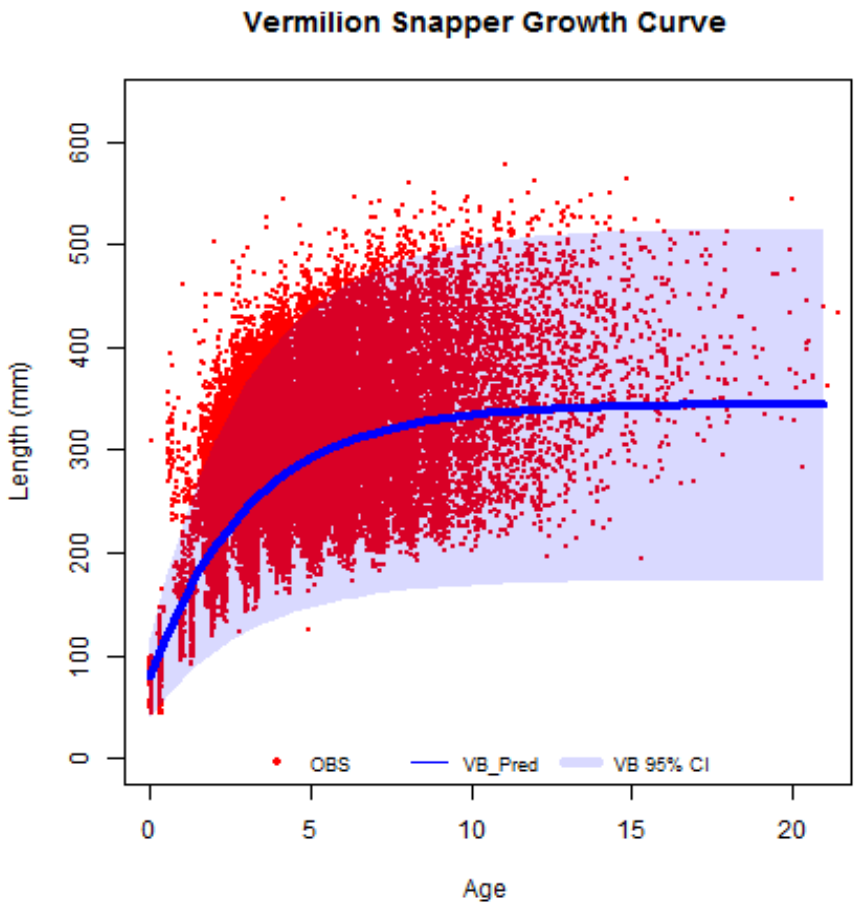


SEDAR 45 Conversions used for SEDAR 67

FL (mm)= 0.8876 *TL(mm) + 1.980

WW(kg) = 2.66 E-08 * FL(mm)$^{2.916}$

Age and Growth Data: predicted vs observed

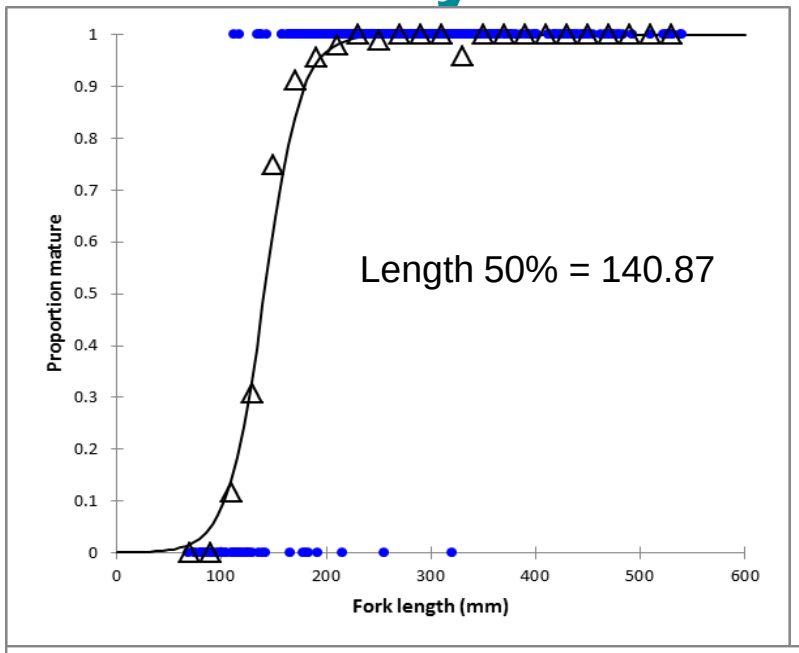


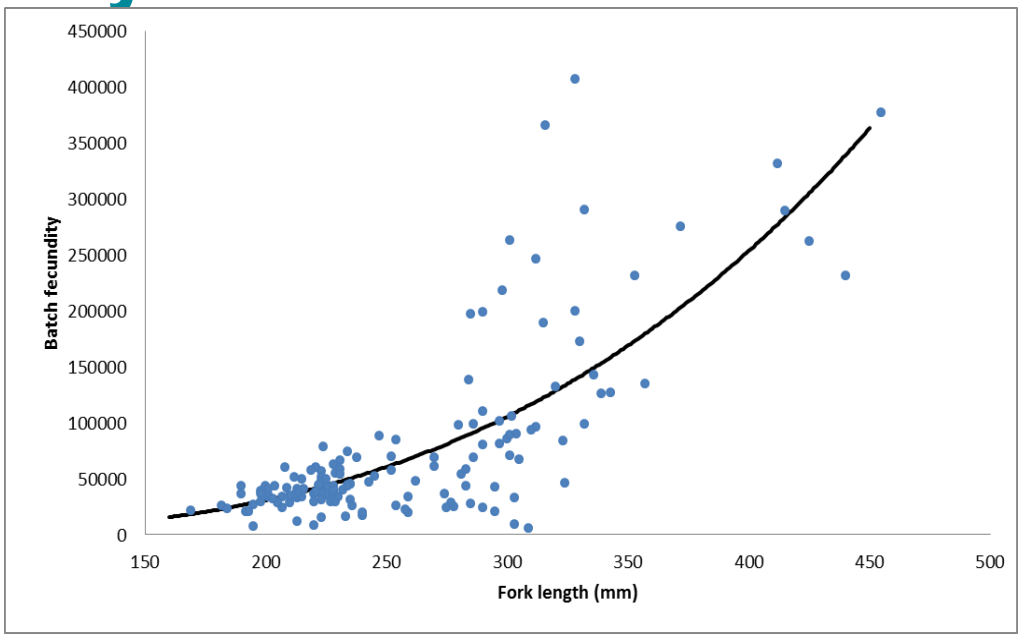
$L_\infty = 34.4$
$k = 0.3254$
$t_0 = -0.7953$

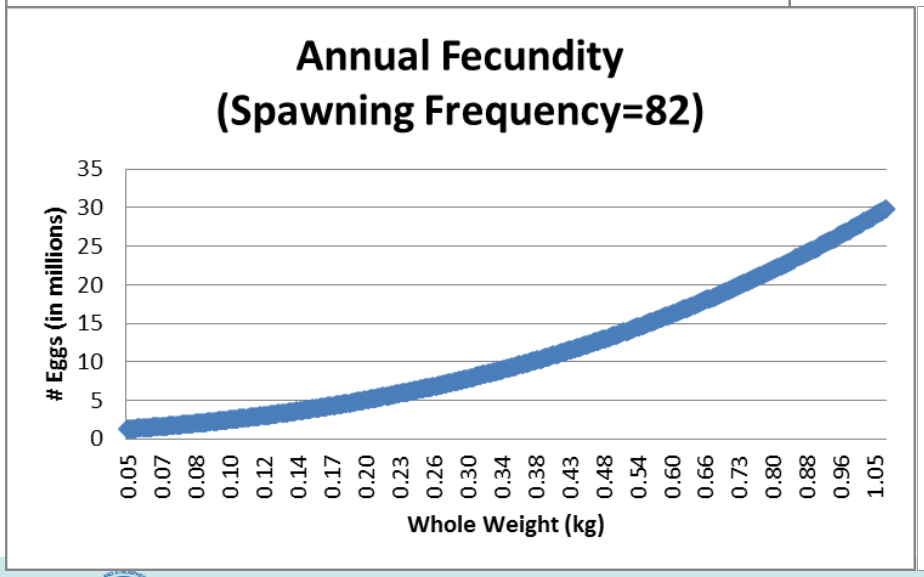
Censored growth curve to account for minimum size regulations

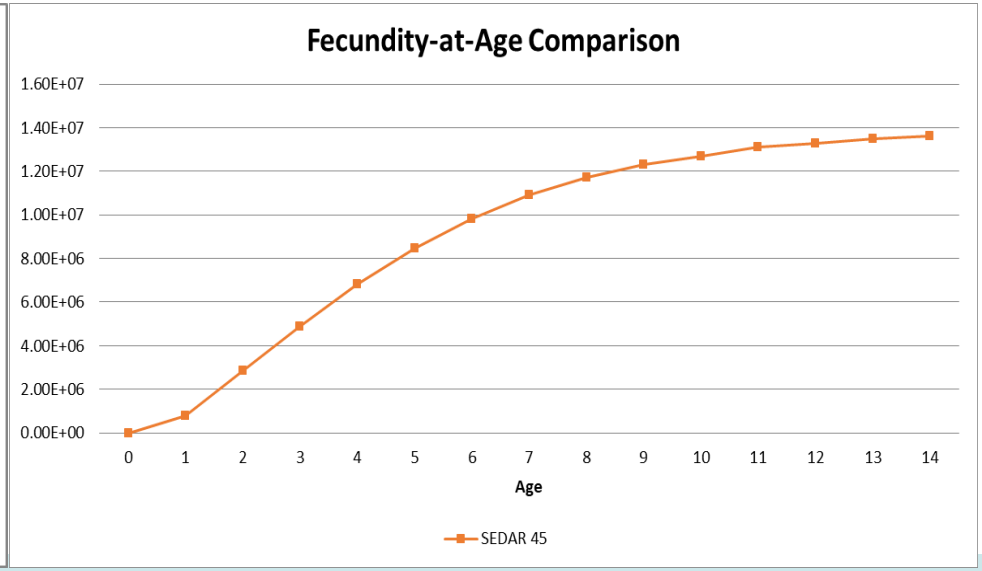
Estimated externally and fixed in assessment model

Fecundity and Maturity

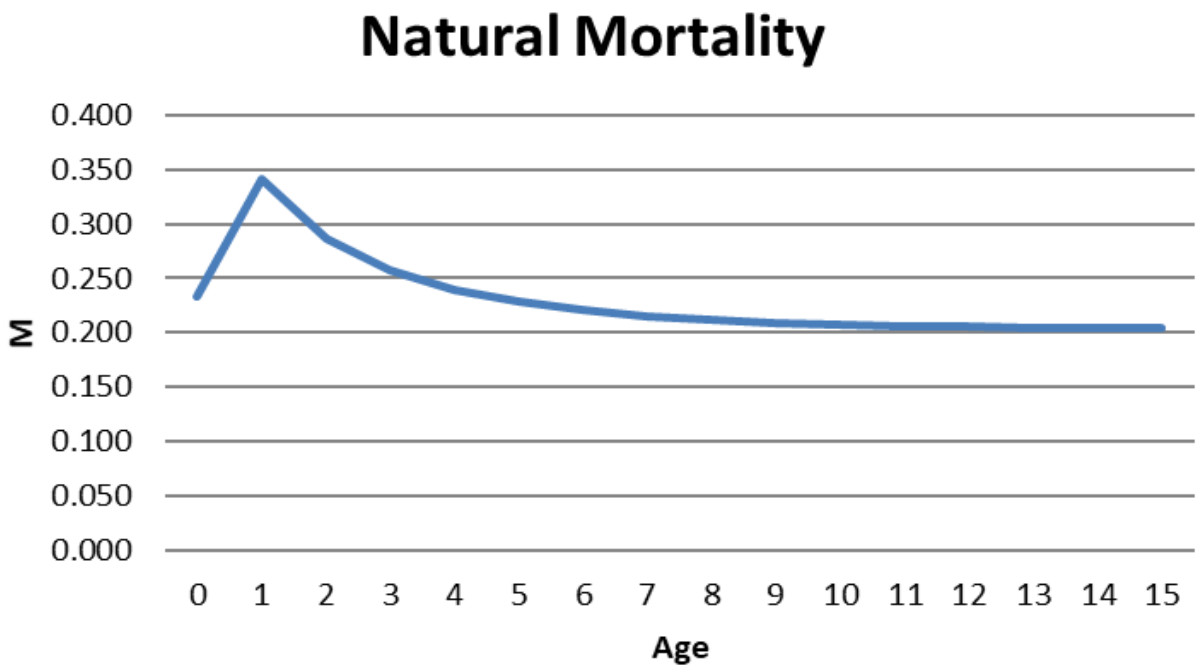








Natural Mortality



Age-0 is prorated to account for assumed mid-year birth

Estimated externally and fixed in assessment model

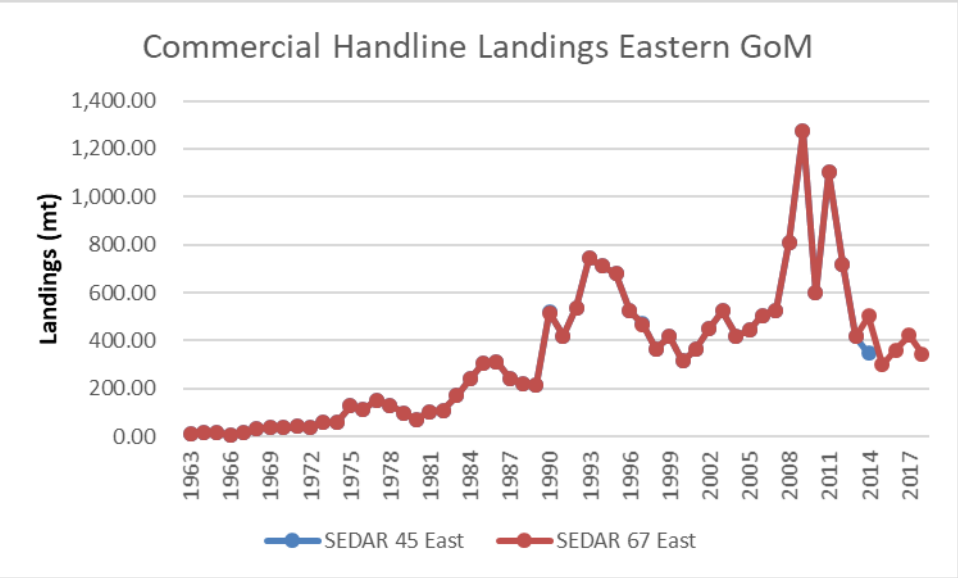
Commercial Fishery Data

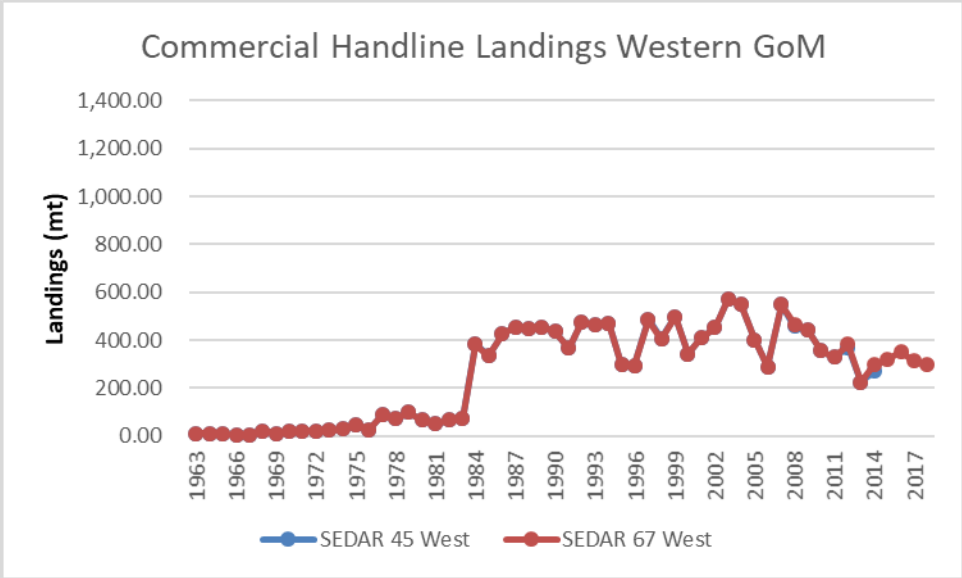
Topic	Decision
Recent Landings	- Use updated time series
Historical Landings	- Unchanged
Age Composition	- Use updated age composition

Discards not included in the previous vermilion snapper assessment (SEDAR 45)

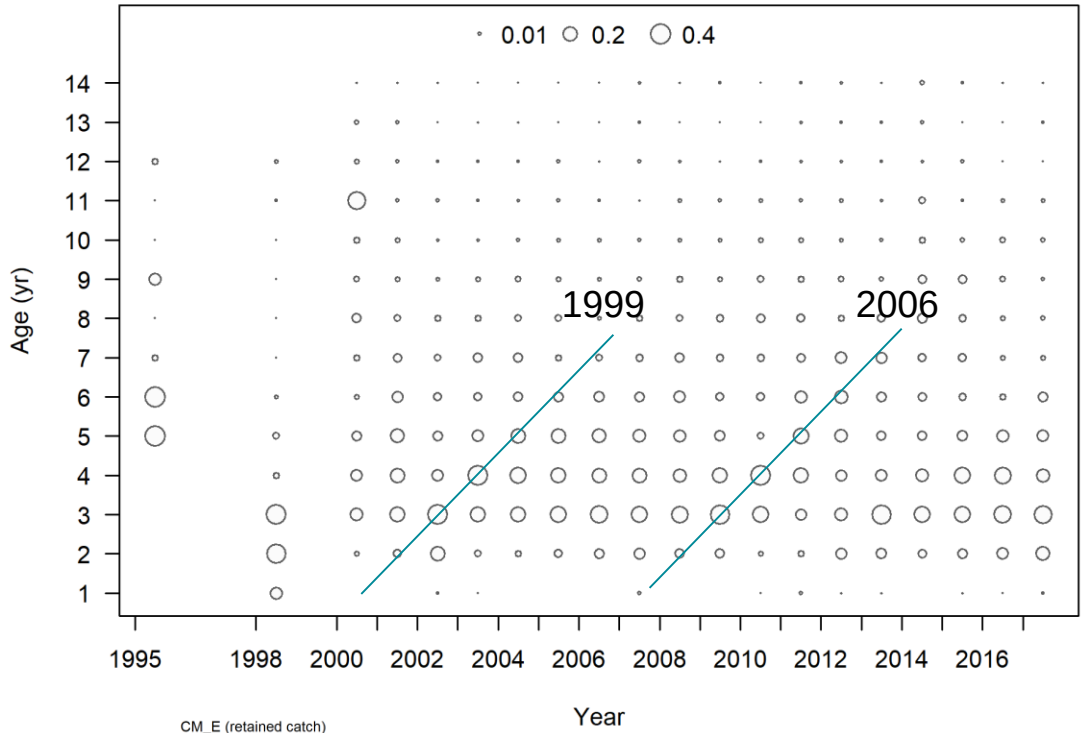
Commercial Landings (mt)

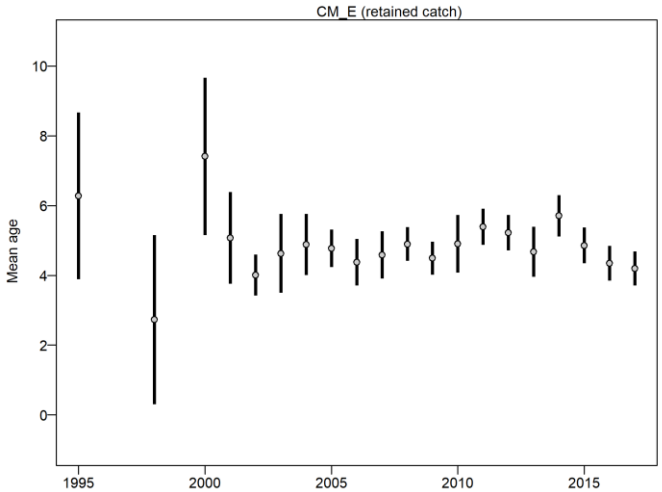
- Only handline data used (other components inconsequential to total landings) and split by region





Commercial East Composition

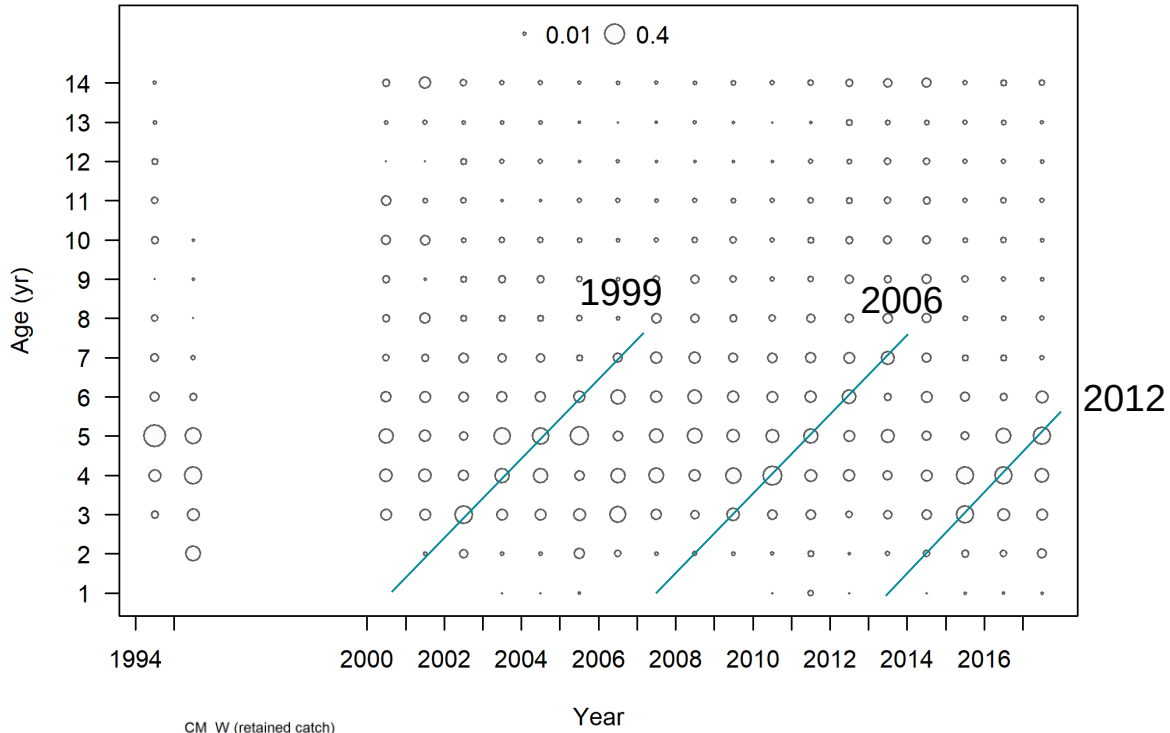




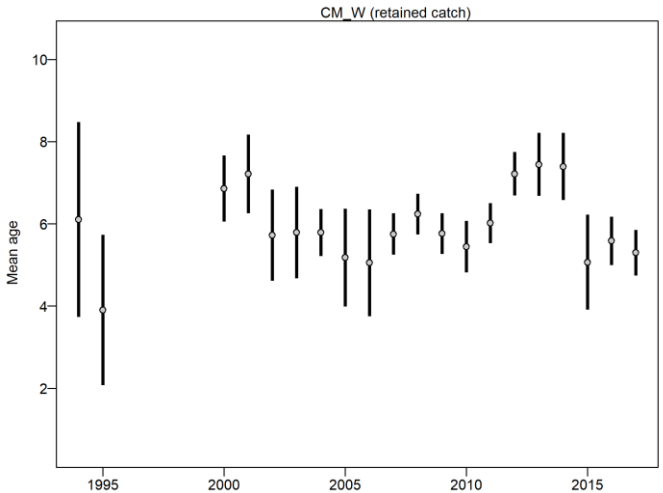
Mean age ~4.5 years, declining recently

Year	Nsamp
1995	8
1998	138
2000	187
2001	1,297
2002	1,334
2003	2,152
2004	667
2005	749
2006	804
2007	761
2008	926
2009	1,243
2010	805
2011	3,013
2012	780
2013	588
2014	581
2015	633
2016	644
2017	559

Commercial West Composition



Year	Nsamp
1994	62
1995	52
2000	66
2001	56
2002	97
2003	559
2004	509
2005	812
2006	871
2007	1273
2008	1355
2009	1085
2010	1175
2011	889
2012	776
2013	529
2014	518
2015	605
2016	621
2017	479



Mean age ~6 years, declining recently

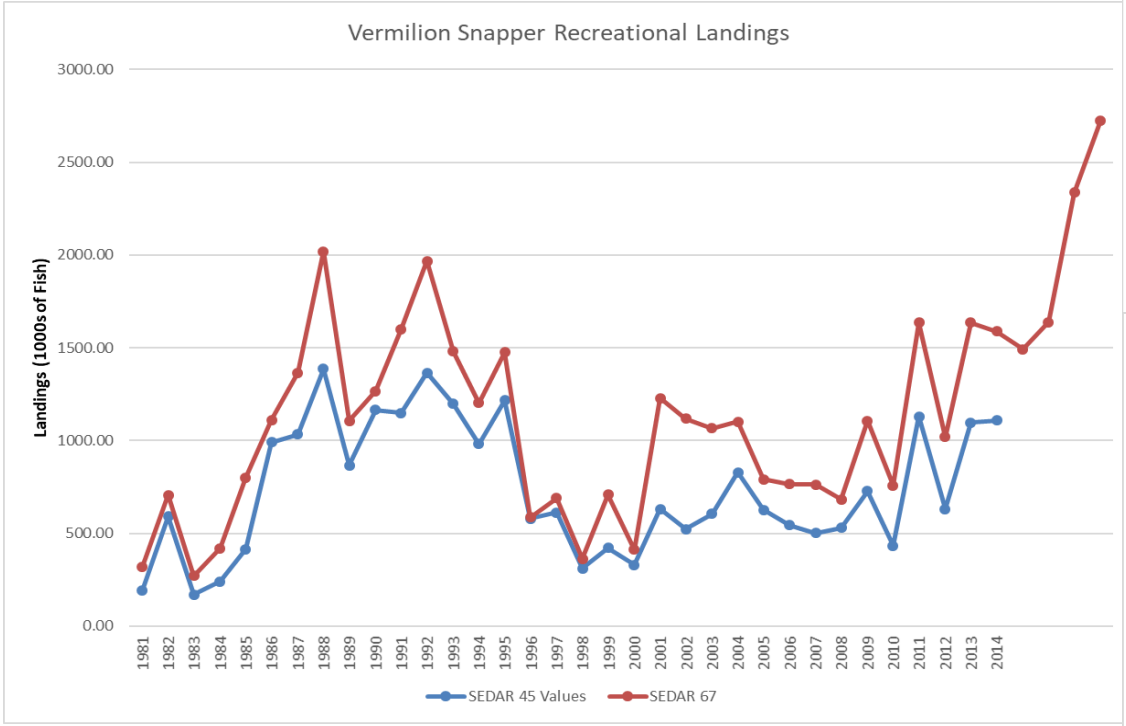
Recreational Fishery Data

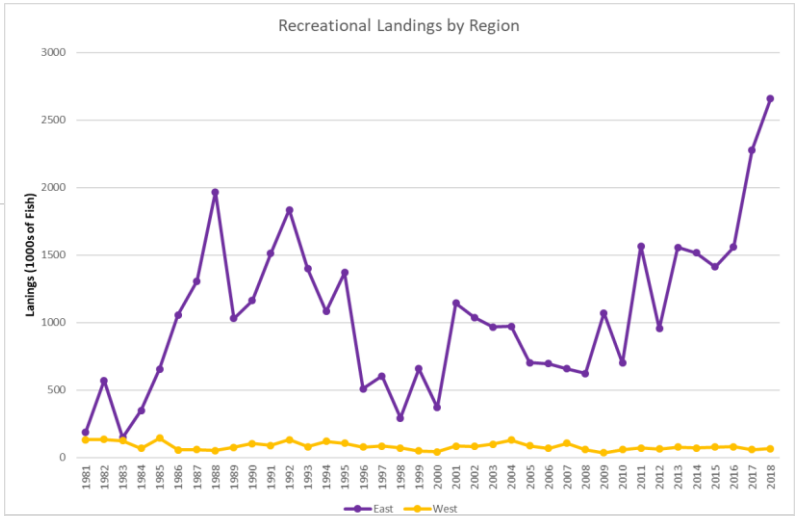
Topic	Decision
Recreational Landings	- Update time series using FES data (1981 – 2017)
Historical Landings	- Update to account for FES
Age Composition	- Use updated age composition

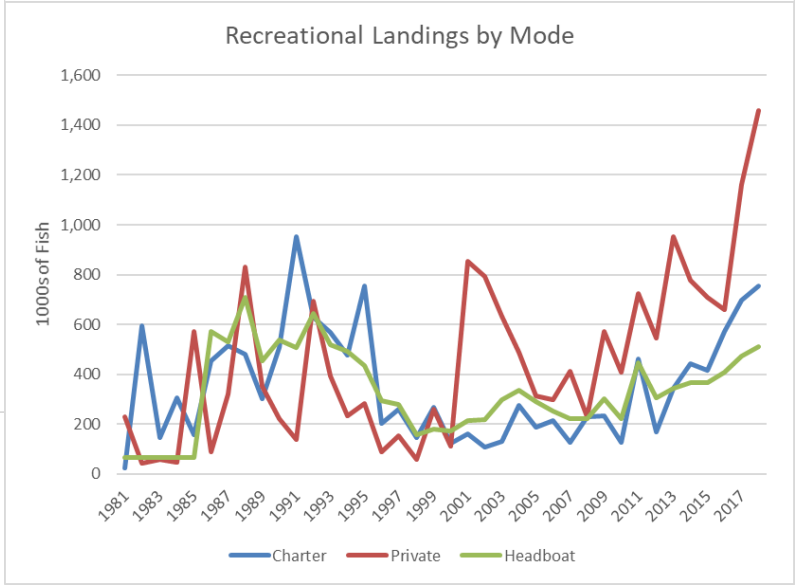
Discards not included in the previous vermilion snapper assessment (SEDAR 45)

Signifies break from true continuity

Recreational Landings



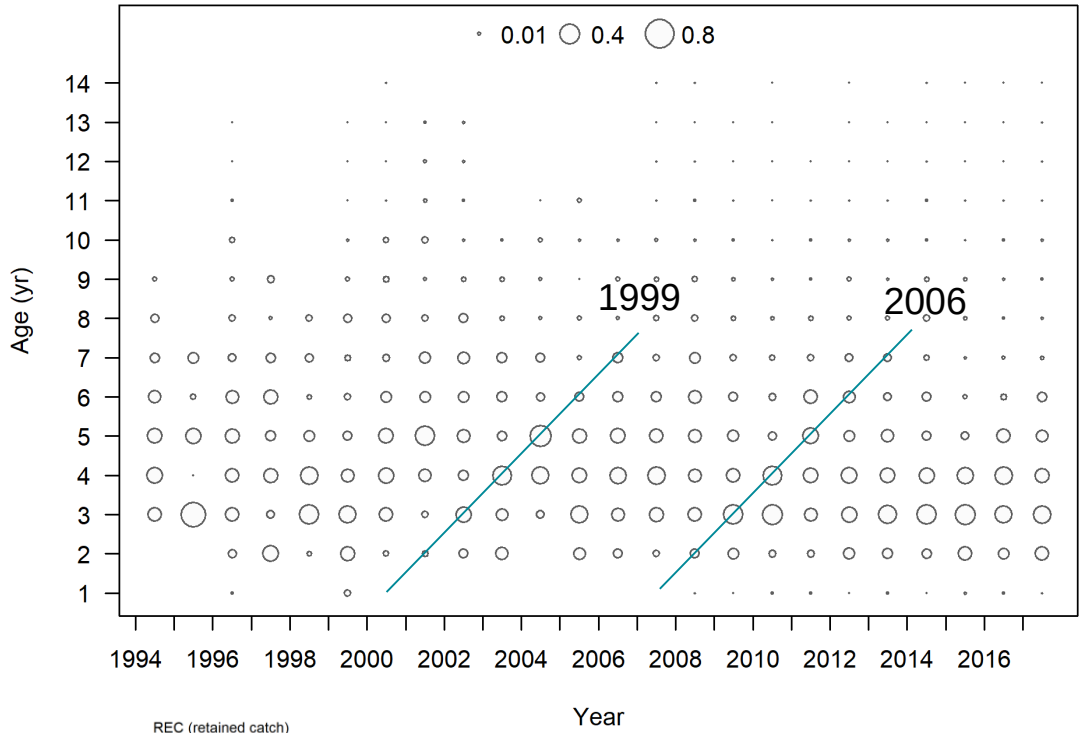


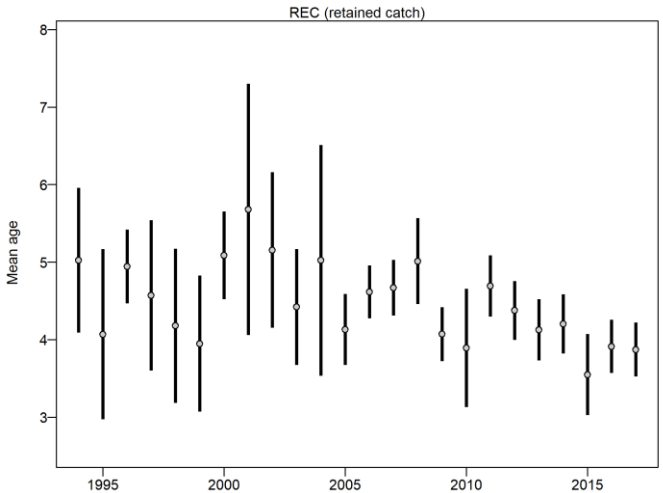


Landings combined by mode and area (SEDAR 45 cont.)

Discrepancies with SEDAR 45 due to FES transition

Recreational Age Composition





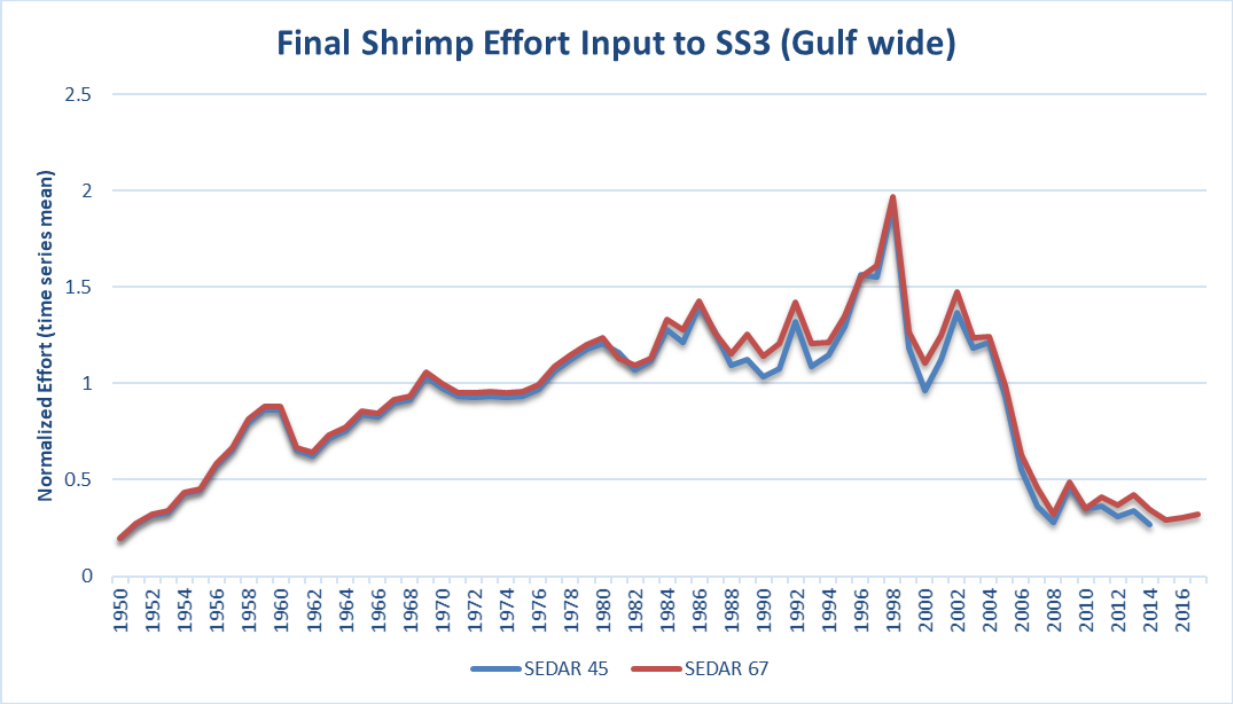
Mean age ~4.5 years, declining recently

Year	Nsamp
1994	33
1995	9
1996	262
1997	45
1998	14
1999	246
2000	210
2001	141
2002	258
2003	91
2004	129
2005	169
2006	171
2007	505
2008	1046
2009	1300
2010	1200
2011	1311
2012	1904
2013	1741
2014	1447
2015	4492
2016	3679
2017	2545

Shrimp Bycatch

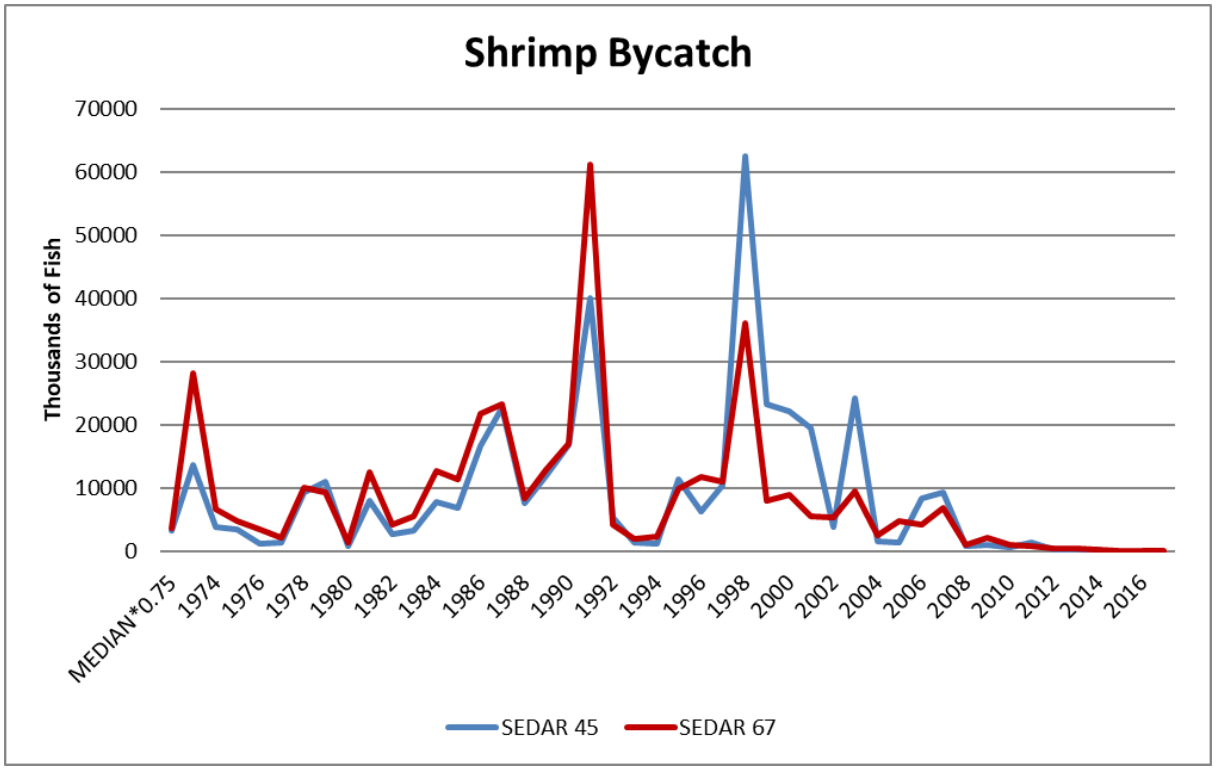
Topic	Decision
Shrimp Effort	- Use updated effort series reweighted by SEAMAP trawl landings
Shrimp bycatch	- Use updated bycatch estimate (superyear)

Shrimp Effort



- Raw effort scaled by upweighting effort in areas where vermilion snapper are more common and more likely to interact with the shrimp fisheries

Shrimp Bycatch



Methodology used to estimate shrimp bycatch changed between S45 and S67.

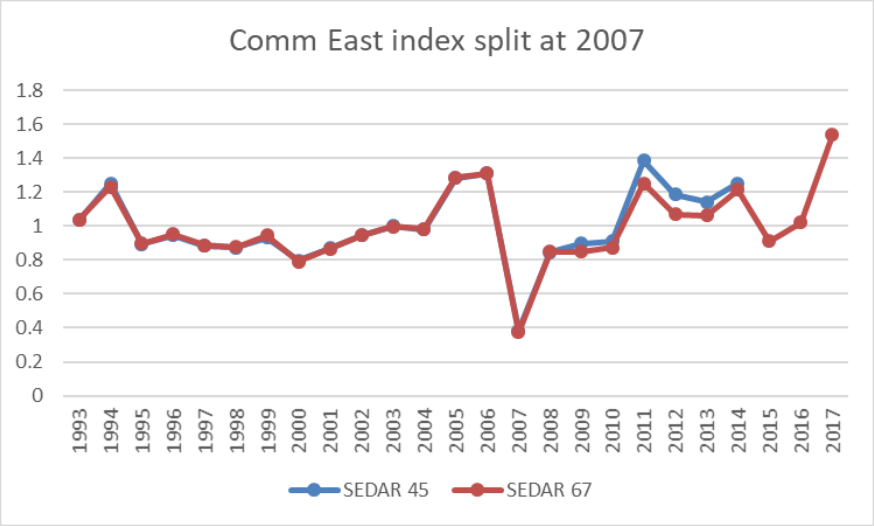
SEDAR 45 superyear = 3,367,500

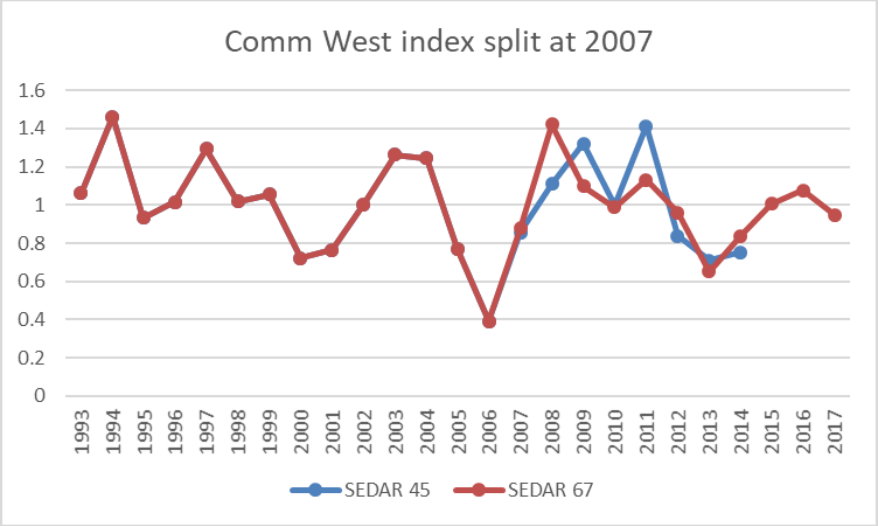
SEDAR 67 superyear = 3,779,000

Indices of Relative Abundance

Topic	Decision
Commercial Vertical line	- Use updated E/W
Headboat	- Use updated E/W
MRIP/MRFSS	- Use updated East only FES adjusted
Larval	- Use updated index
SEAMAP Summer Groundfish Survey (East only)	- Use updated index
Video Survey	- Use updated SEAMAP survey

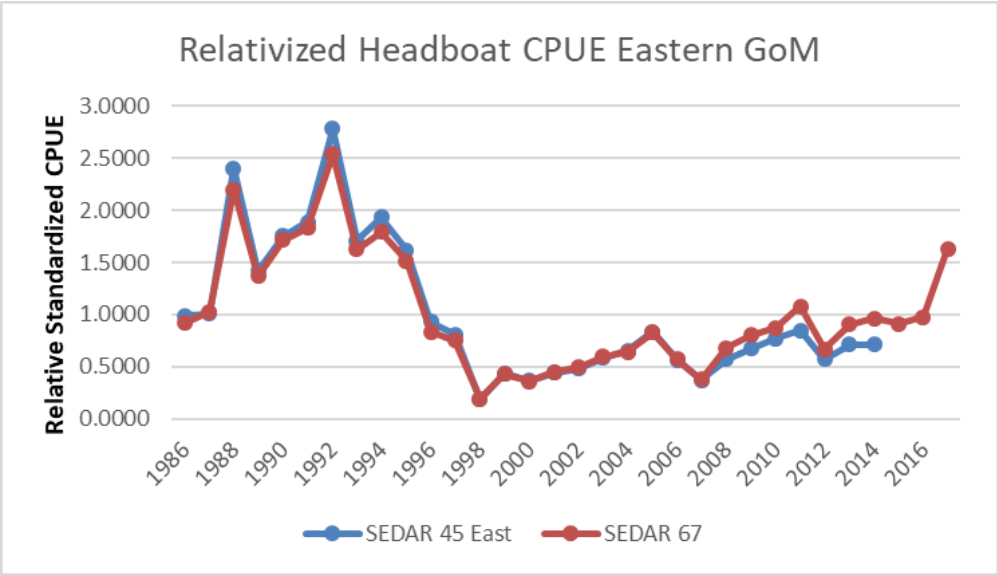
CPUE -Commercial Vertical Line



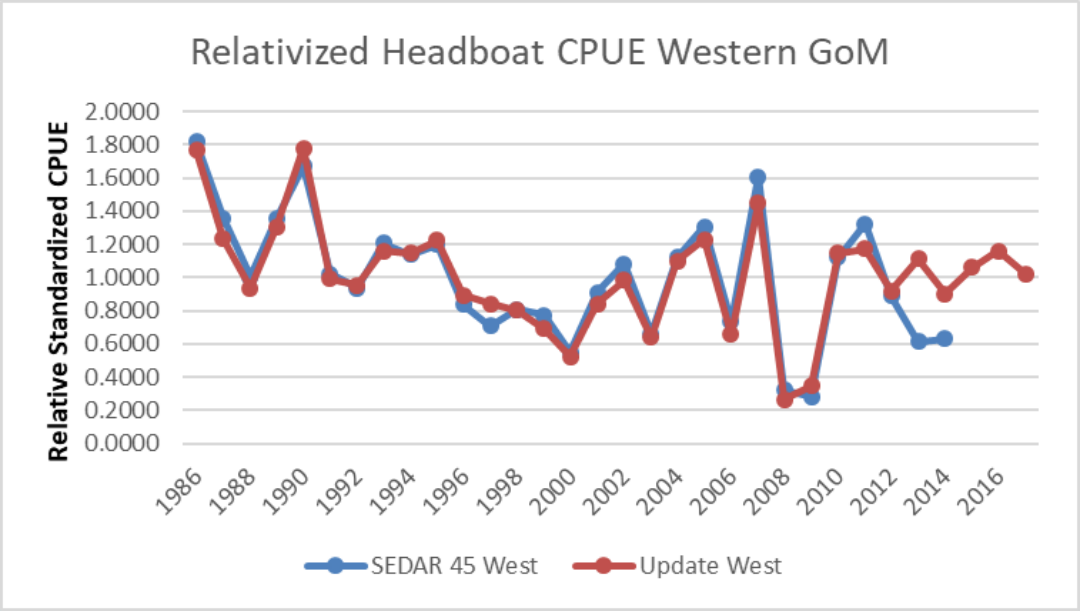


- Differences due to new trip selection and IFQ factors selected in standardization

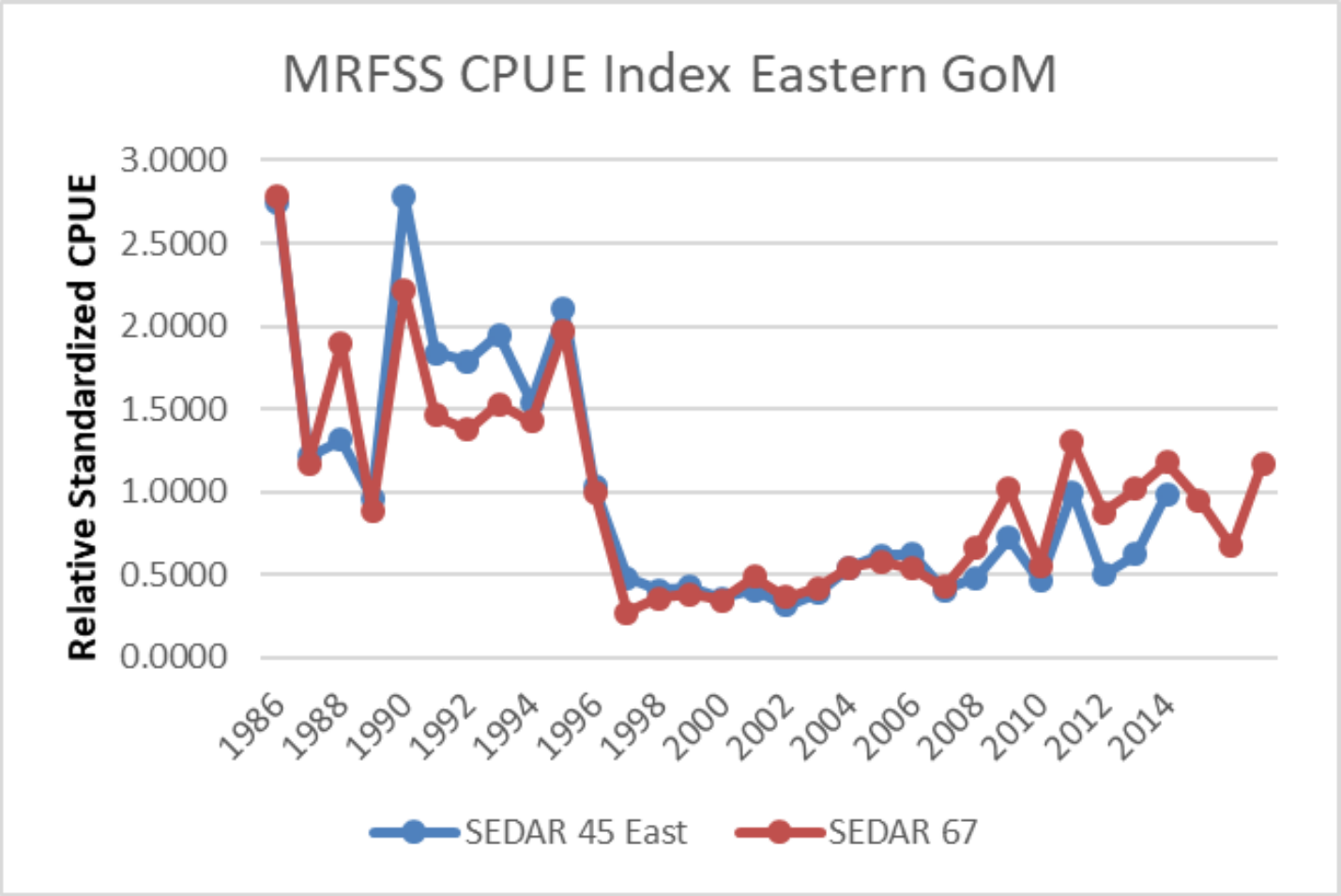
CPUE—Headboat



- Differences due to new trip selection and factors selected in standardization

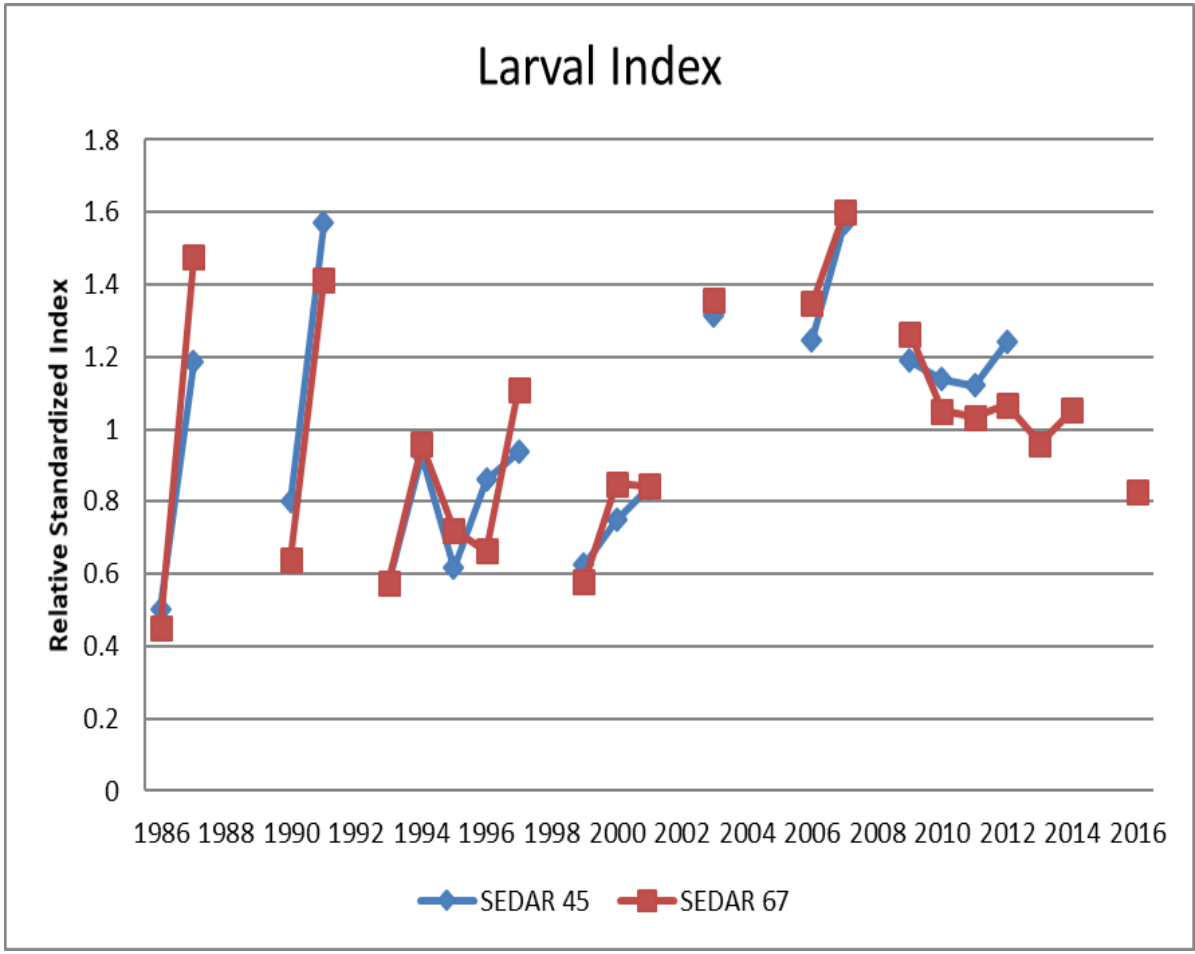


CPUE—MRFSS East

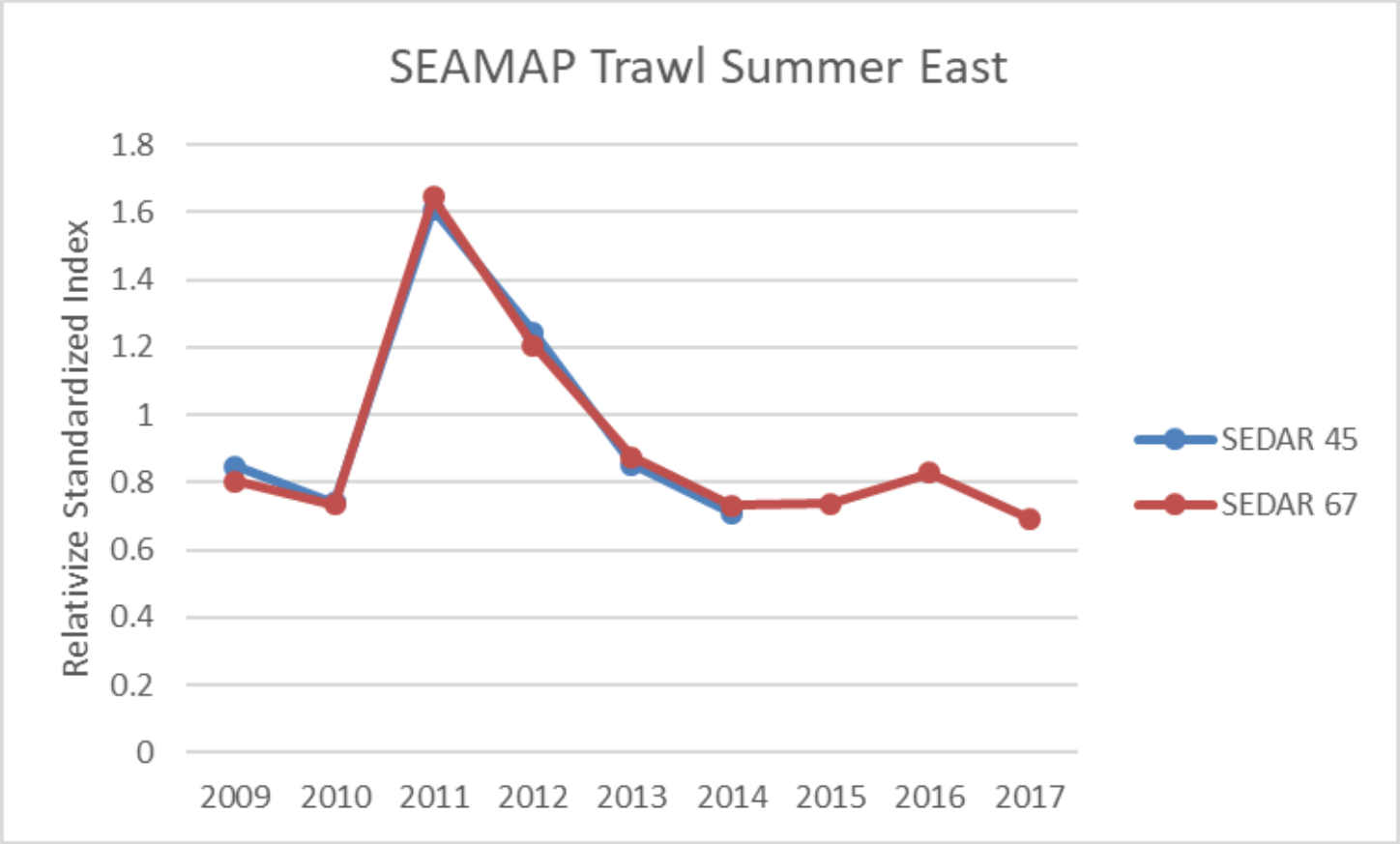


CPUE - Larval

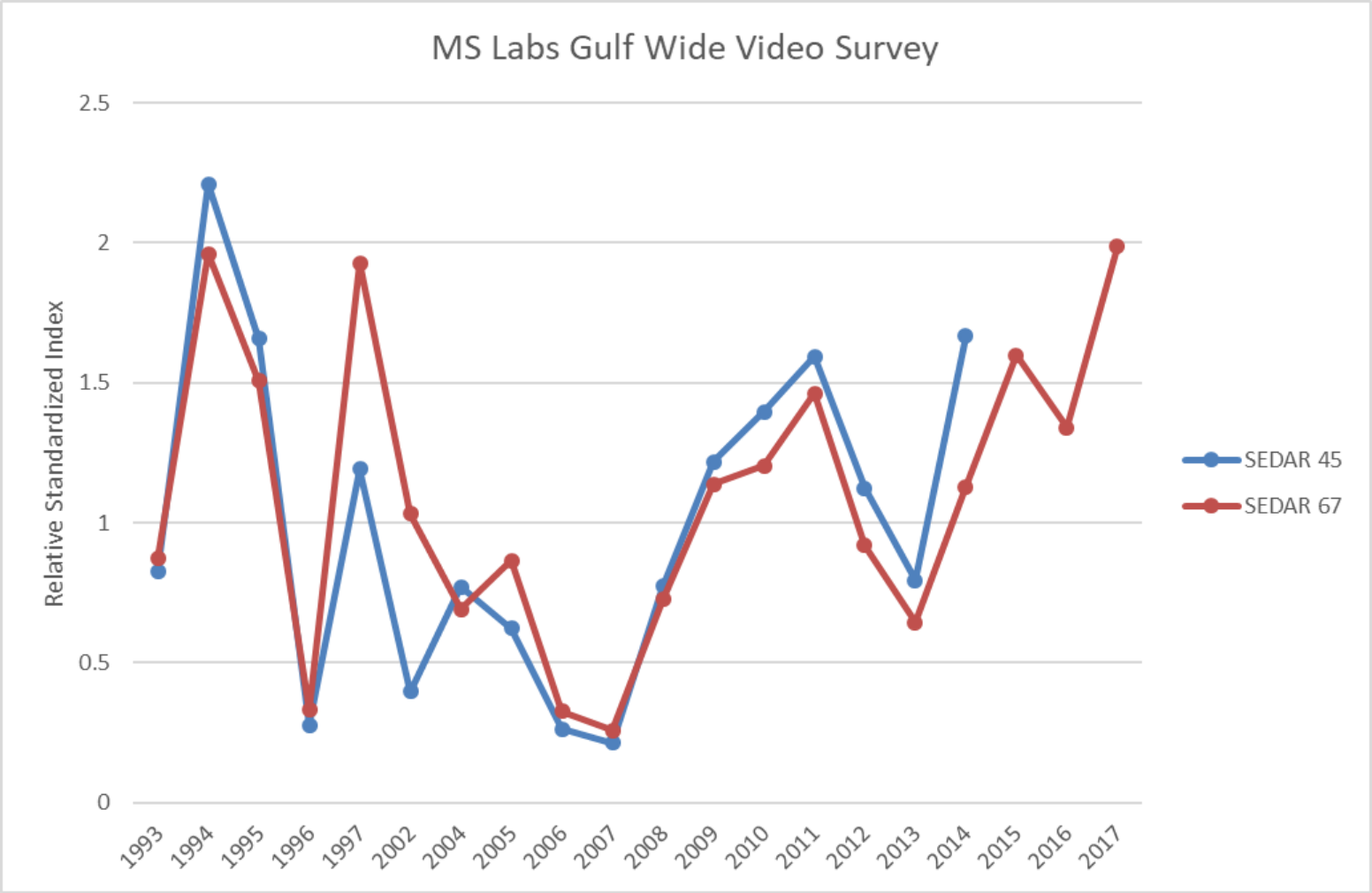
- Larval survey is in numbers-per-area and is an index of spawning stock biomass (SSB)



SEAMAP - Trawl Survey



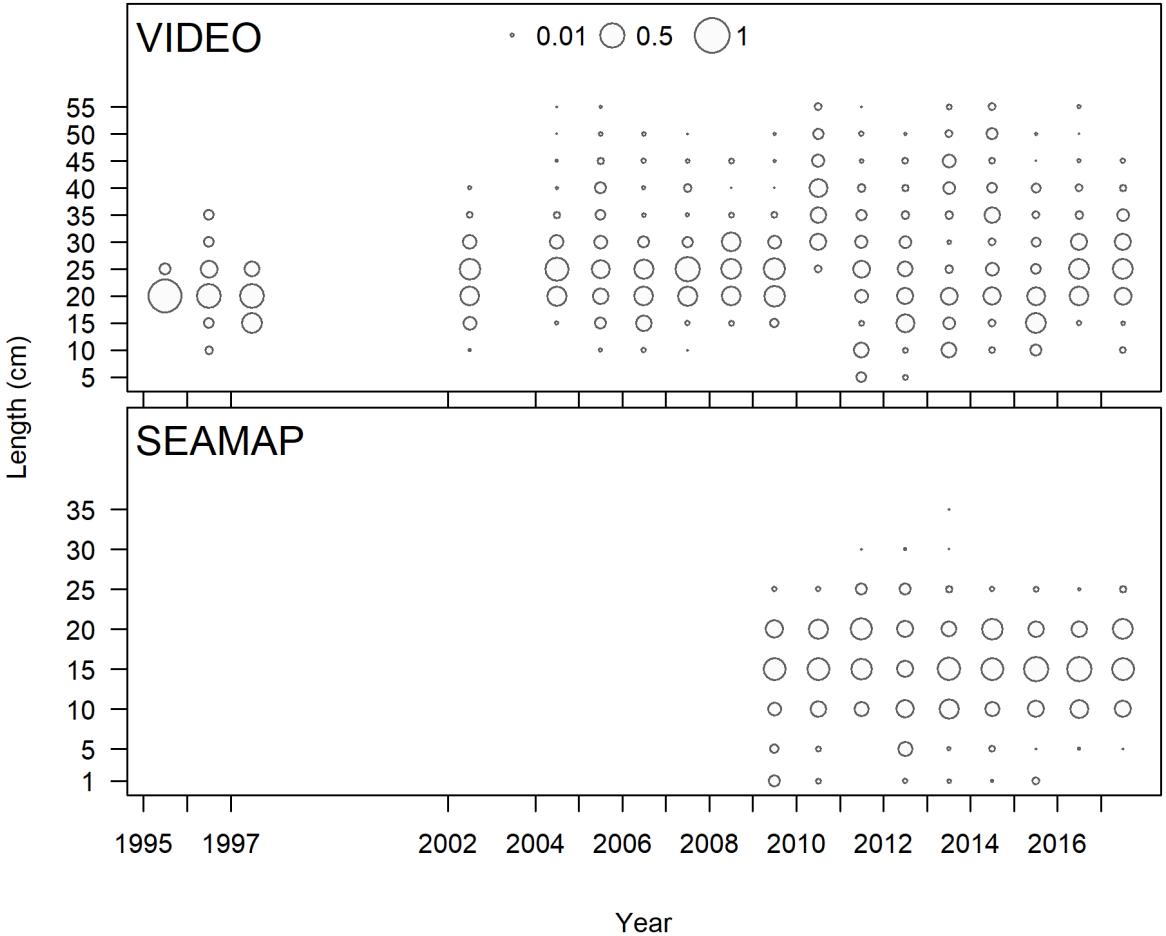
SEAMAP - Video Survey



Survey Length Composition

Topic	Decision
SEAMAP Summer Groundfish Survey	- Use updated length composition
SEAMAP Video	- Use updated length composition

Survey Length Composition



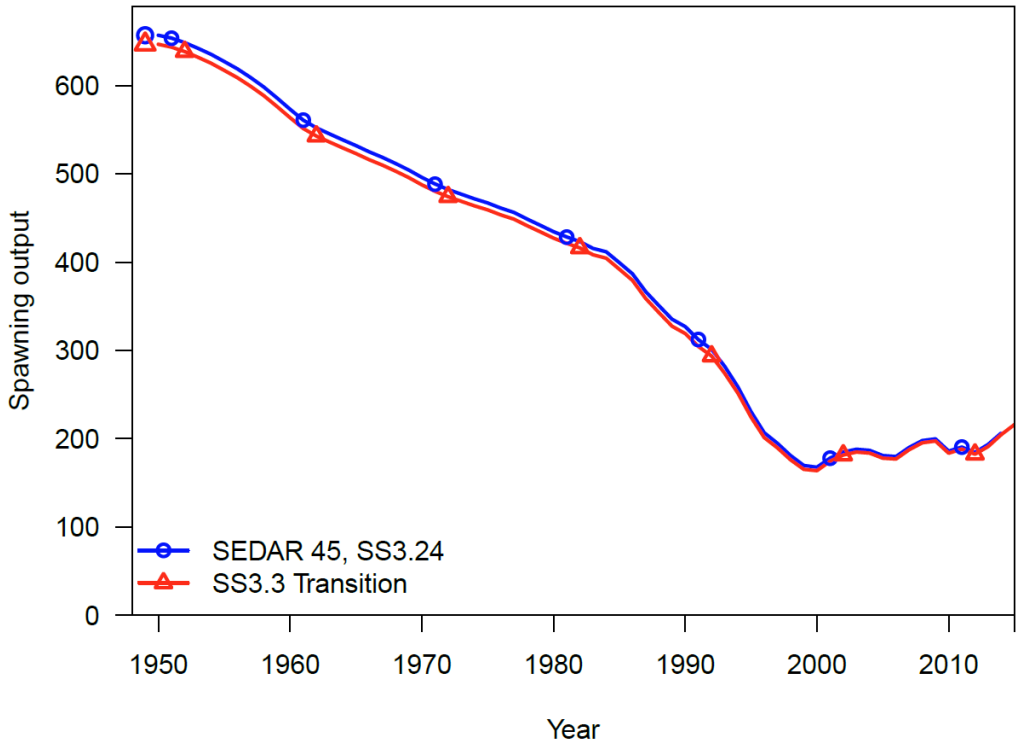
- Video generally selects larger fish

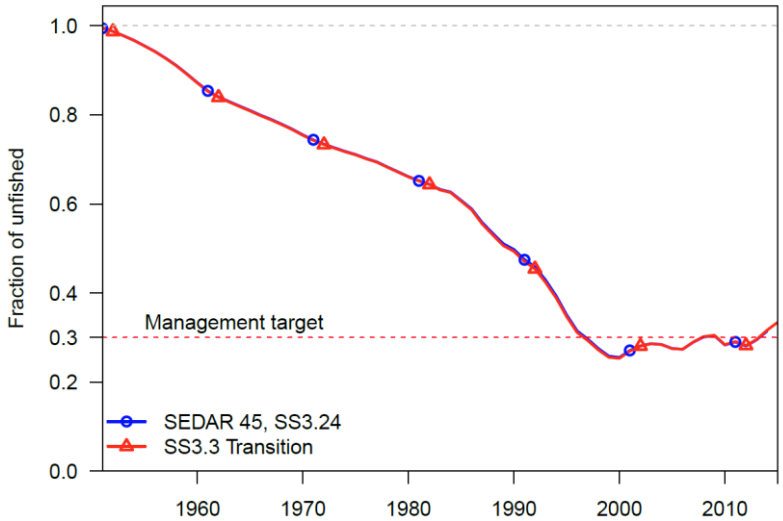
Continuity Model Development: Model Fit and Results

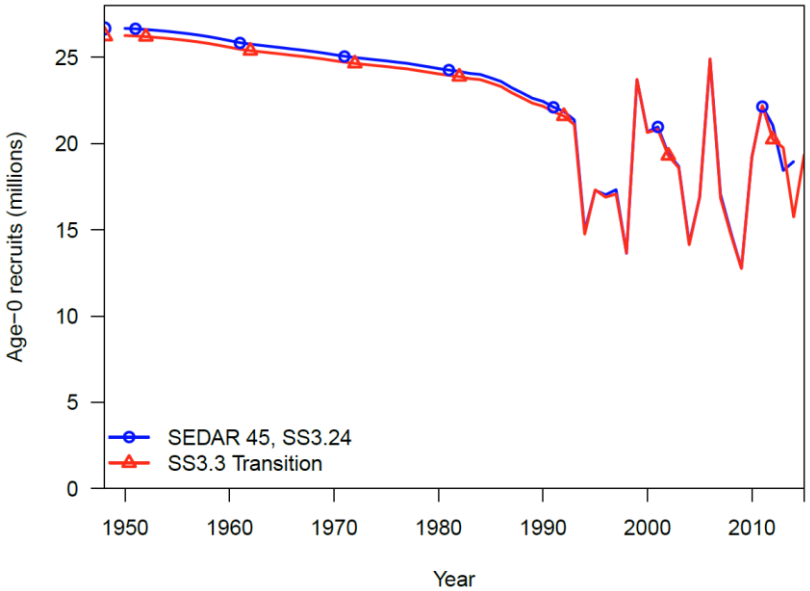
Continuity Model Configuration

- 1950 – 2017 (comm. ‘63, rec. ’81, shrimp ‘50)
- 1 area, 1 season model
- Landings only (no discards)
- Combined gender model
- SSB in number of eggs
- Beverton-Holt spawner-recruitment relationship
  - All parameters estimated
- Age-based selectivity
  - Directed fleets (estimated)
  - Time block on CM_E and CM_W (2007)
- Length-based selectivity
  - SEAMAP Trawl and Video (estimated)
- Fixed selectivity - Shrimp

Impact of SS Conversion to 3.3

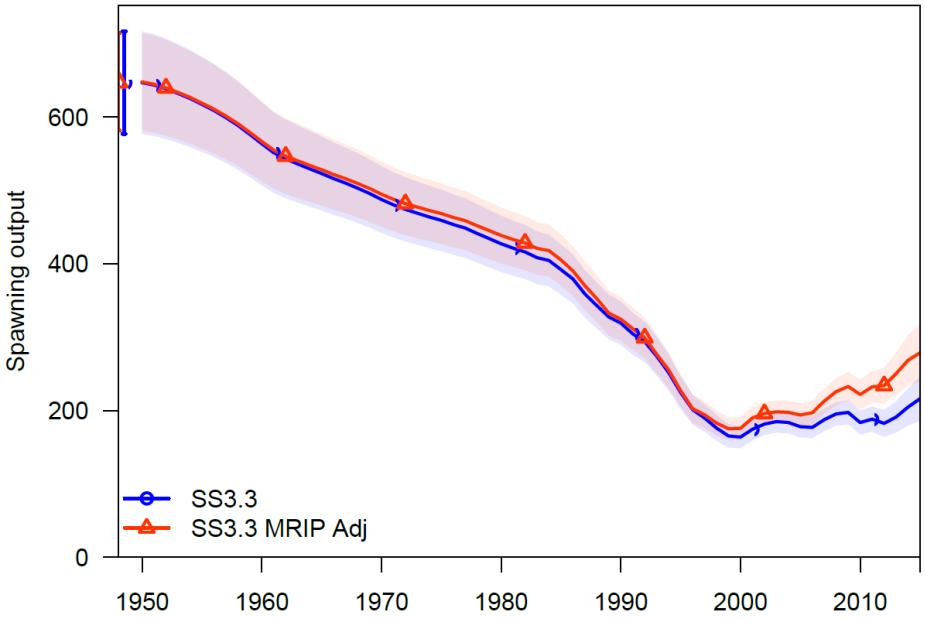


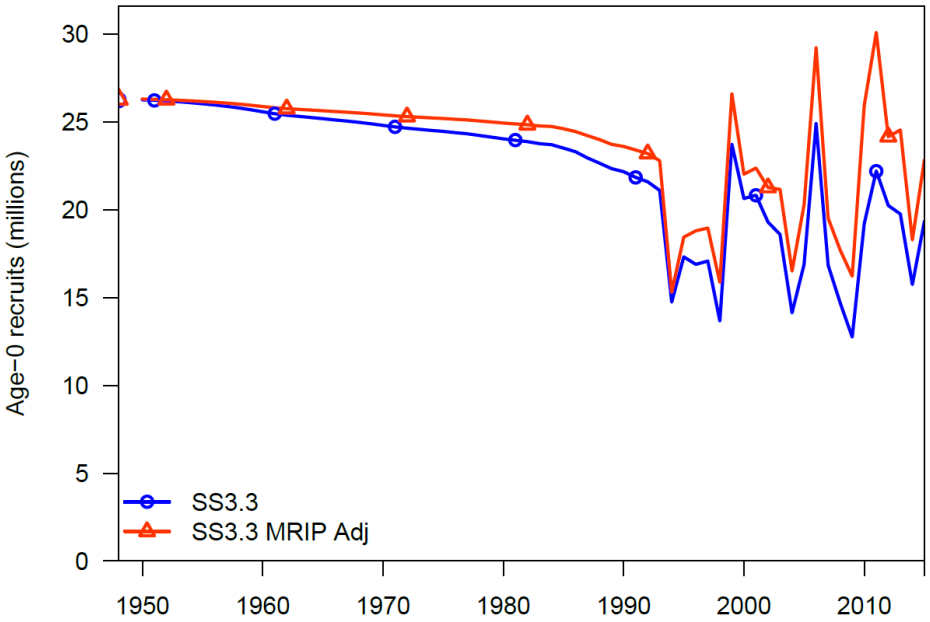




No issues. Divergence in recruitment plot occurs in recruitment forecast years only (2013+)

Update rec. landings from CHTS to FES

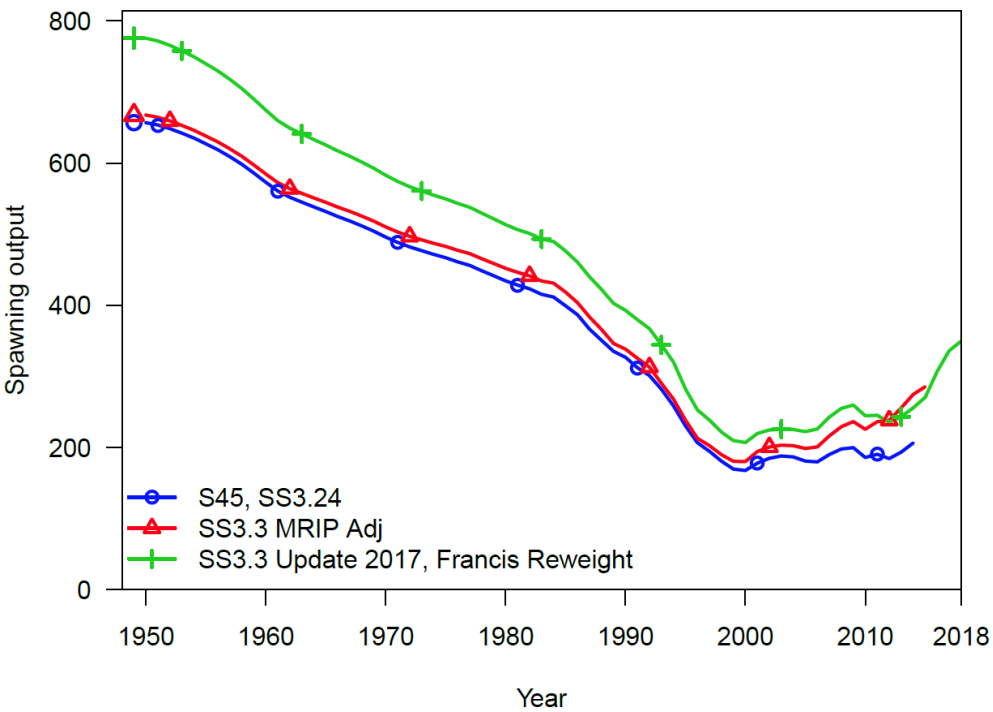


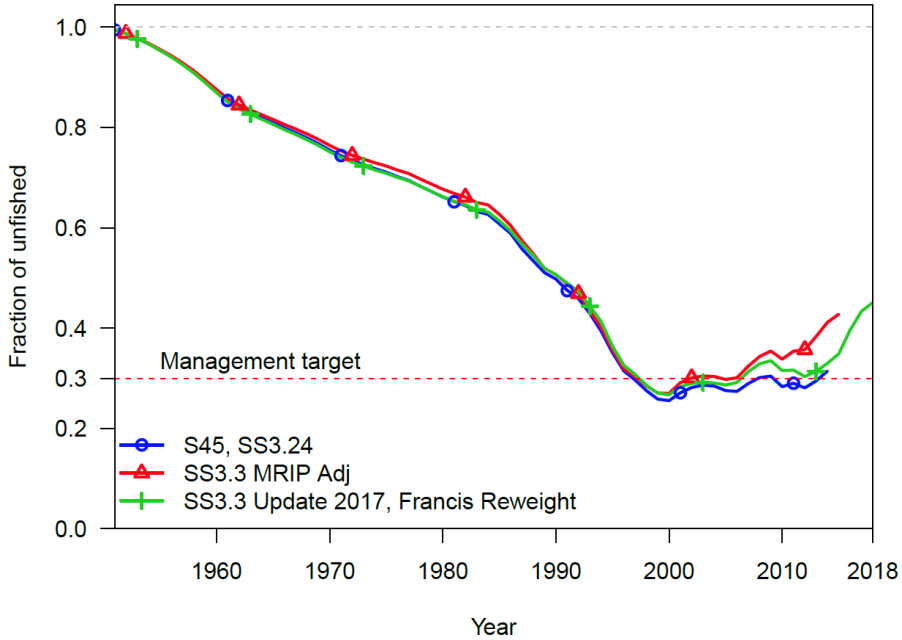


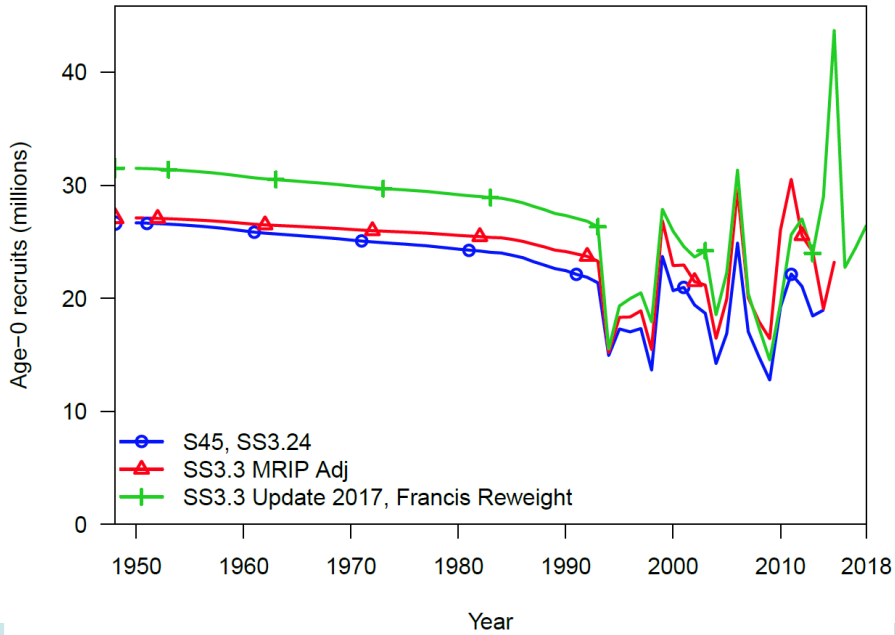
	S45 3.30	S45 3.30 FES
h	0.58	0.69
ln(R0)	10.18	10.18
sigmaR	0.228	0.226
SSB0	6.47E+11	6.48E+11

All SR parameters freely estimated

Continuity Model







Base Model Development: Changes to Continuity Data

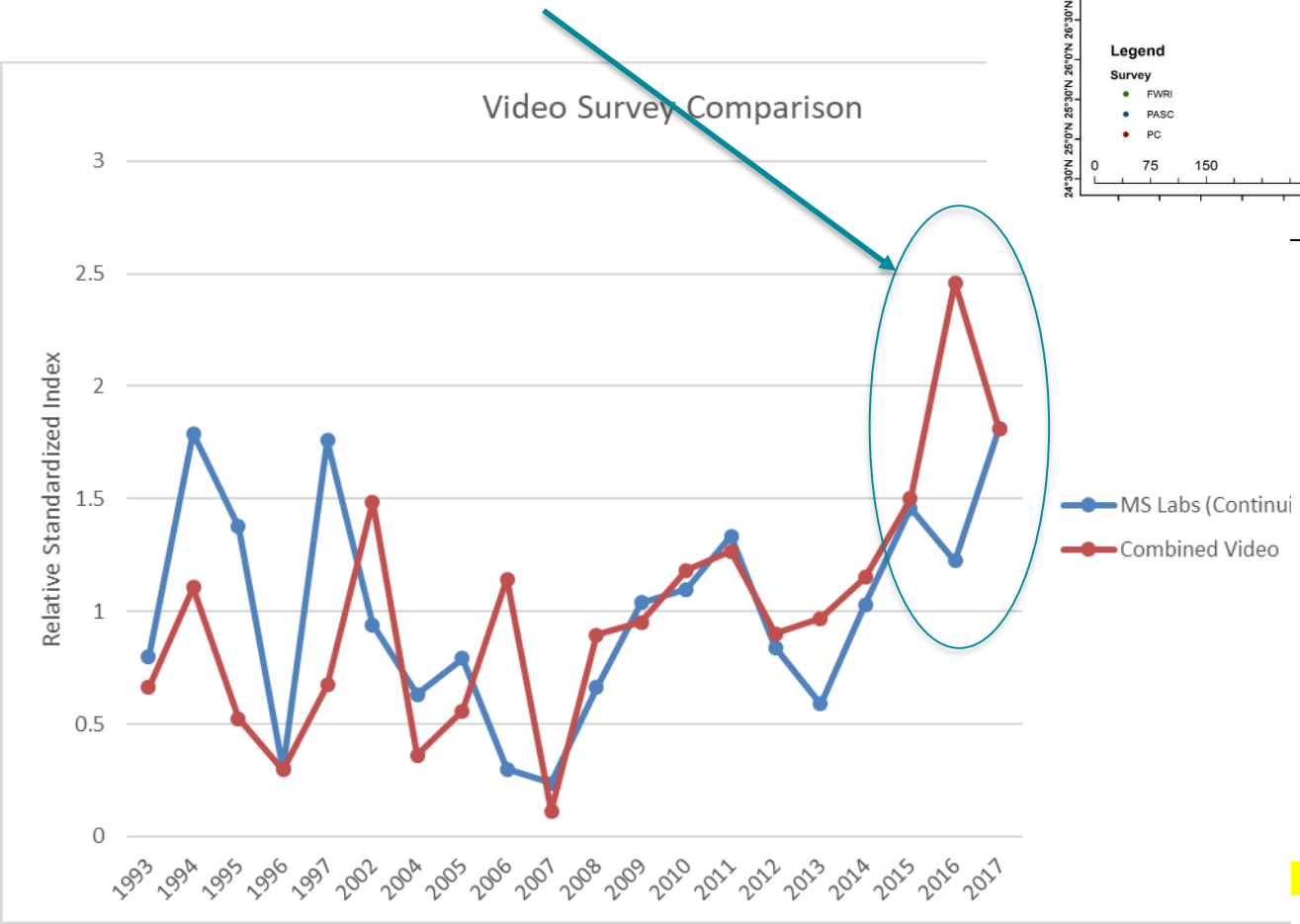
Base Model Data

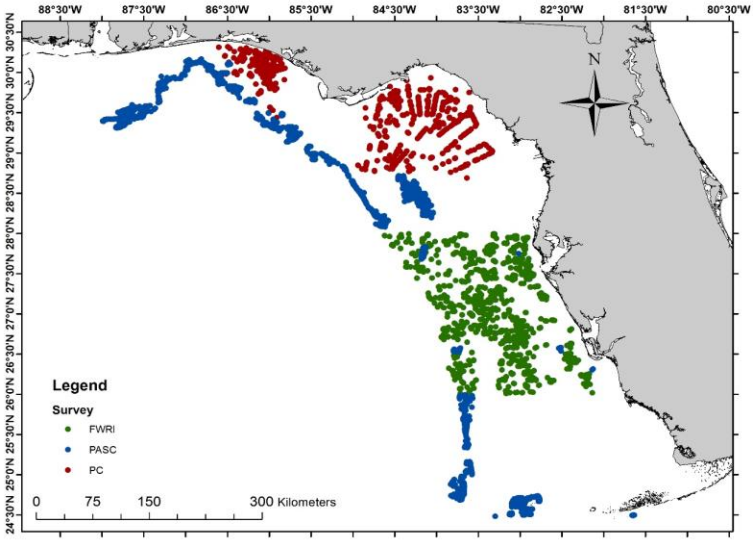
- Base model data was the same as the continuity model with the following exceptions:
  - Combined video survey used
  - Commercial indices of abundance truncated
  - Discards were included but not fit

- New survey data were evaluated but not included

Combined Video Survey

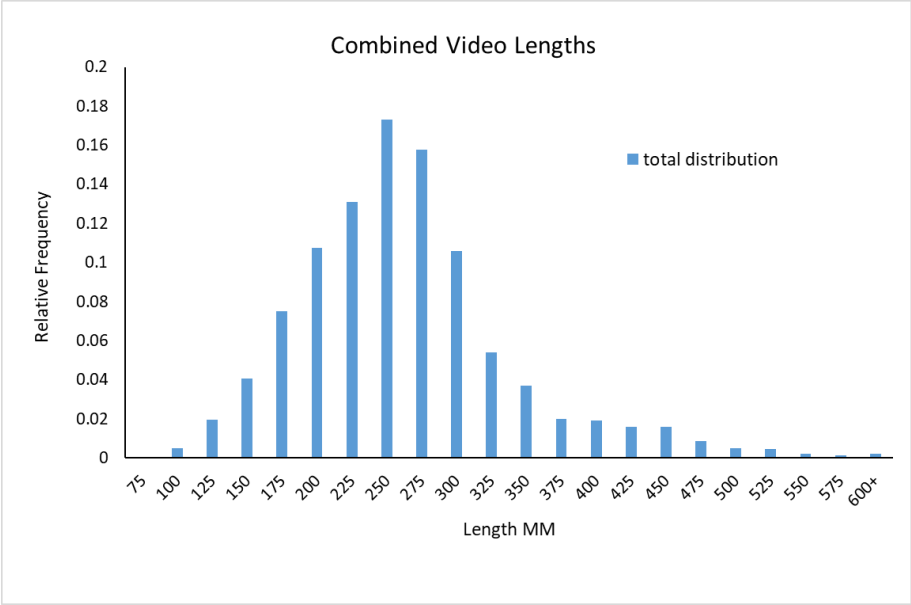
Hypothesized that differences in recent trends may be due to strong inshore recruitment that becomes available to MS labs survey on 1-2 year delay

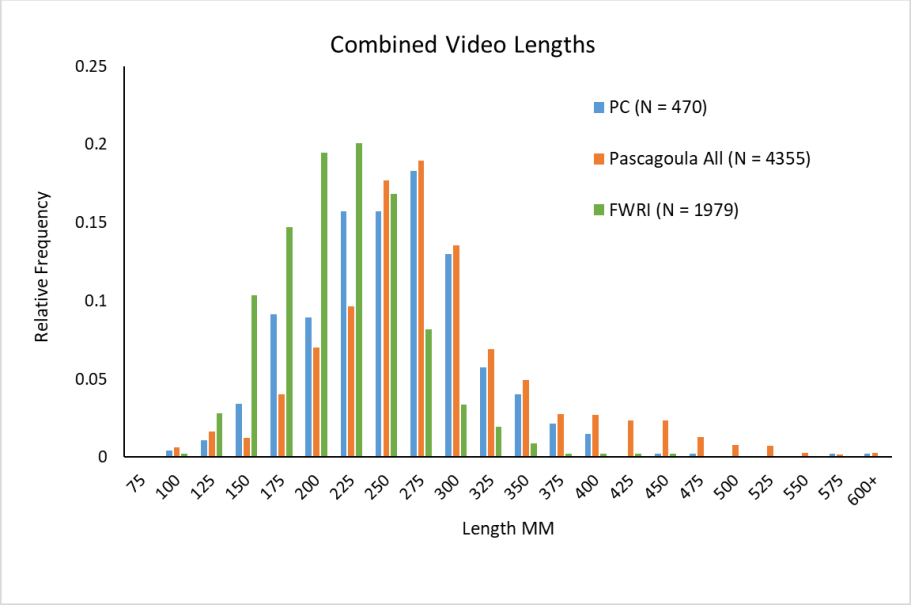


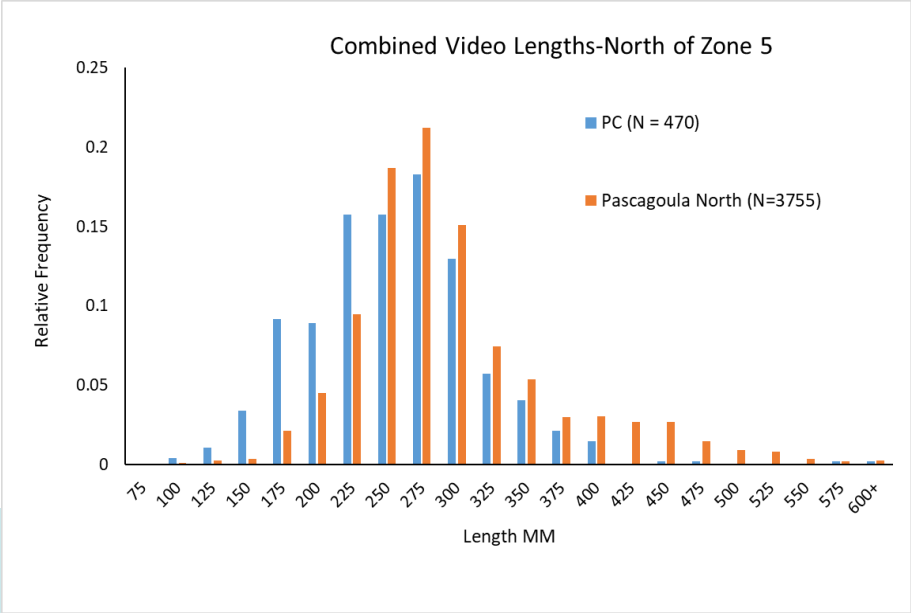


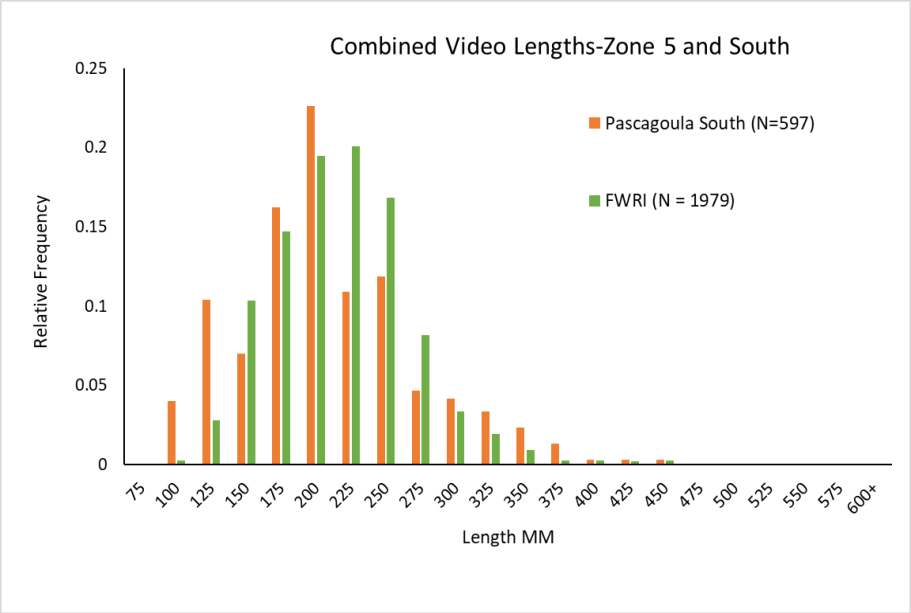
Year	FWRI	Pasc	PC	Grand Total
1993		2.03252		2.03252
1994		3.40404		3.40404
1995		1.608696		1.608696
1996		0.907143		0.907143
1997		2.074074		2.074074
2002		4.572368		4.572368
2004		1.107383		1.107383
2005		1.718978		1.718978
2006		0.614583	2.031579	0.966057
2007		0.469697	0.126984	0.414758
2008		1.975962	4.2	2.647651
2009		2.849057	3.084112	2.916667
2010	2.531034	4.040359	3.668966	3.508772
2011	2.429864	4.094556	4.56962	3.692308
2012	2.341772	2.070671	4.366667	2.680597
2013	4.548913	1.053892	5.443299	3.439732
2014	6.325175	1.646809	5.060976	4.417518
2015	5.665179	4.513158	4.059524	4.847426
2016	13.76289	2.131068	13.24561	9.411559
2017	7.207317	2.883408	9.393333	6.022346

Video Survey Length Composition





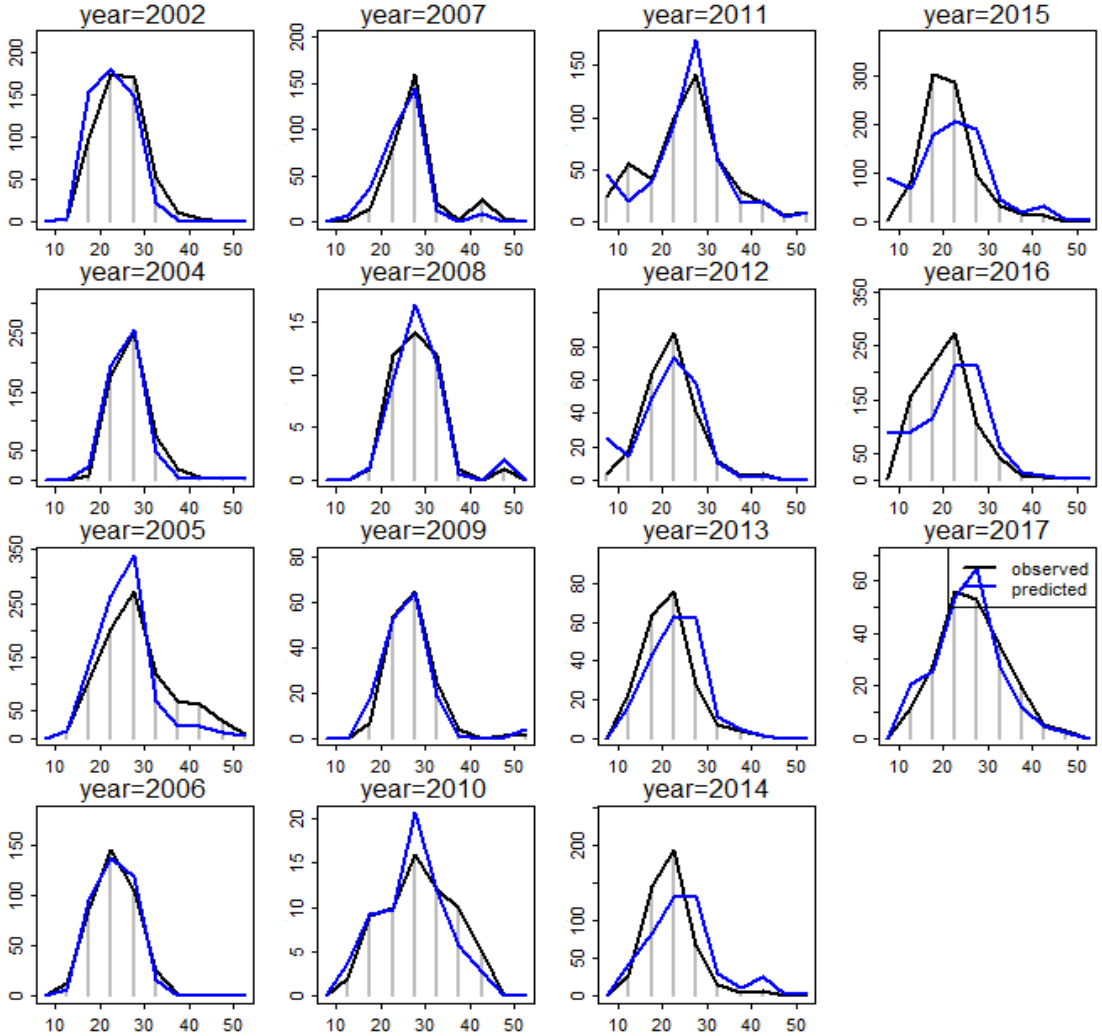




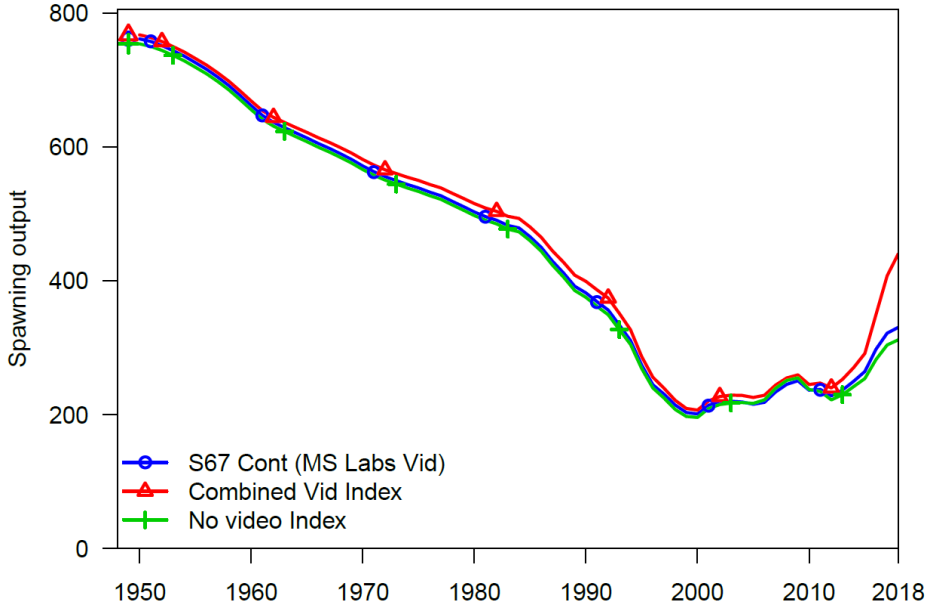
Video Survey Length Composition

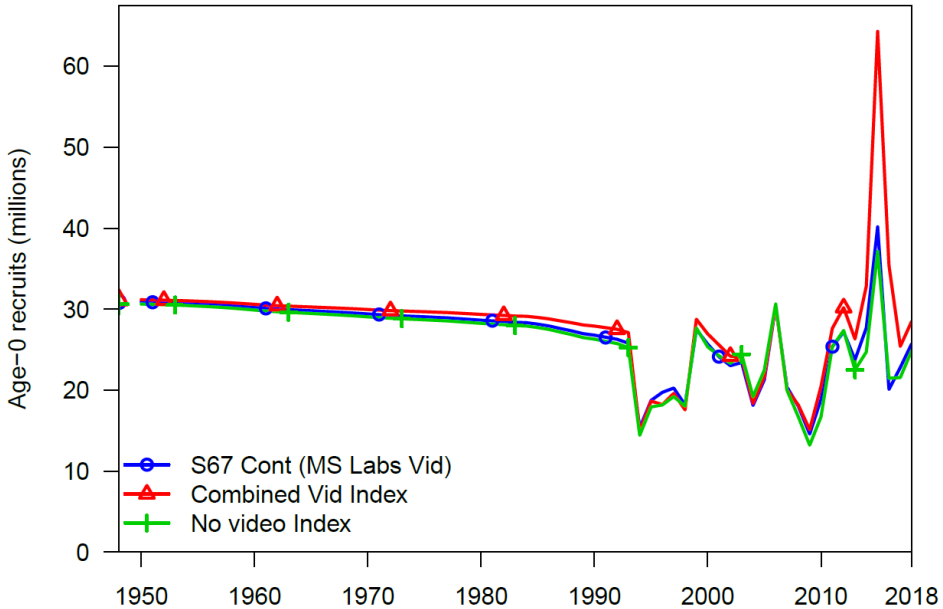
- Length composition combined using model based approach (SEDAR 67 WP16).
- Final model included factors for year, reef type, depth, latitude, and data source (PC, MS, FWRI)
- Predicted length frequency was similar to observed
- Divergences occur in the early years when only MS lab samples are available and in the later years during recruitment peaks

Combined Video Survey—Standardized Length Comps



Video survey effect on base model





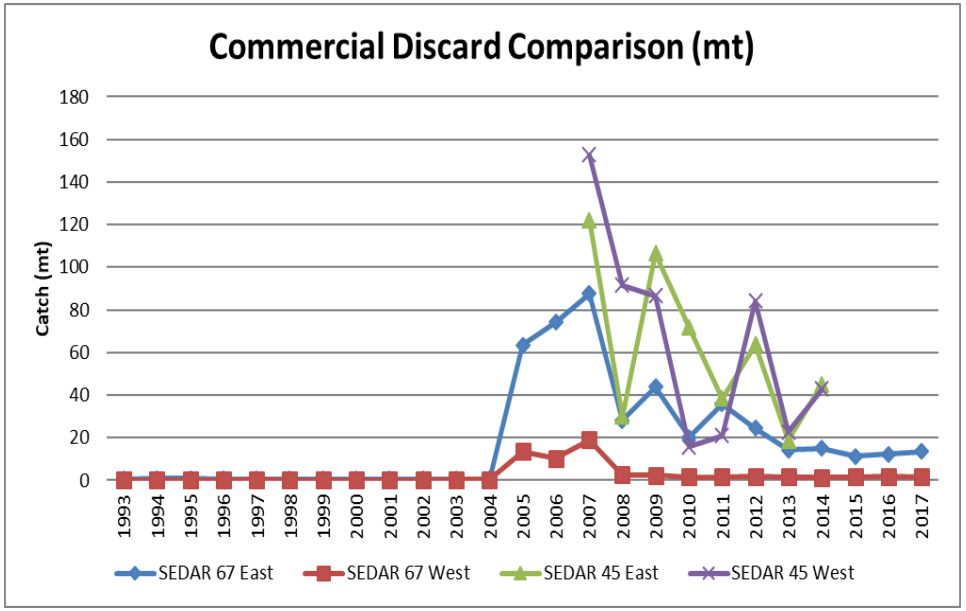
Recent uptick in biomass supported by multiple sources of data

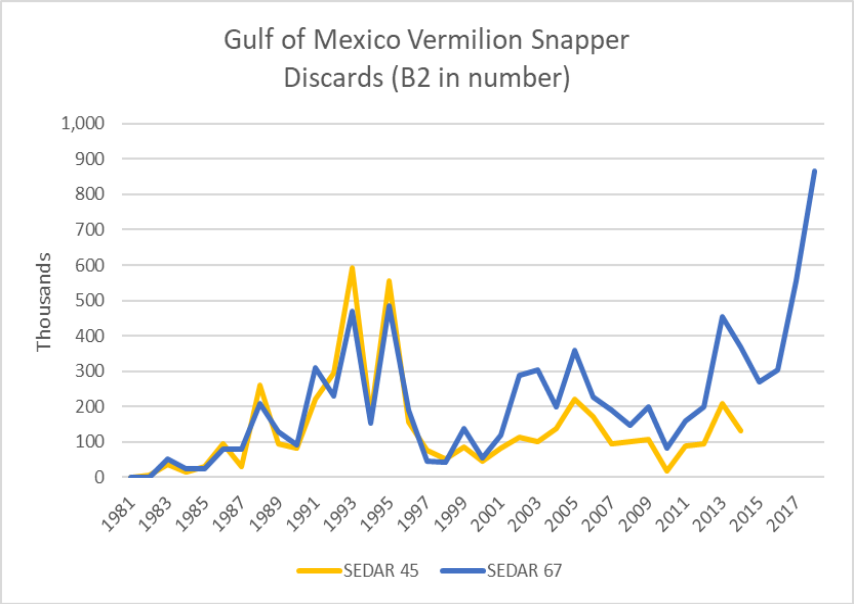
Using combined video survey results in model estimating large recruitment event in 2015 and 2016, which occurs in all model runs (i.e., time series high recruitment event estimated in 2015 regardless of whether video surveys are incorporated).

Discards

Topic	Decision
Commercial Discards	- Use revised methodology for estimating commercial discards. Included but not fit
Commercial Discard Length Composition	- Data available from coastal reef fish observer program, but not used for fitting retention functions
Recreational Discards	- Included but not fit
Recreational Discard Length Composition	- Data available from FWRI Observer program. Not used to estimate retention function

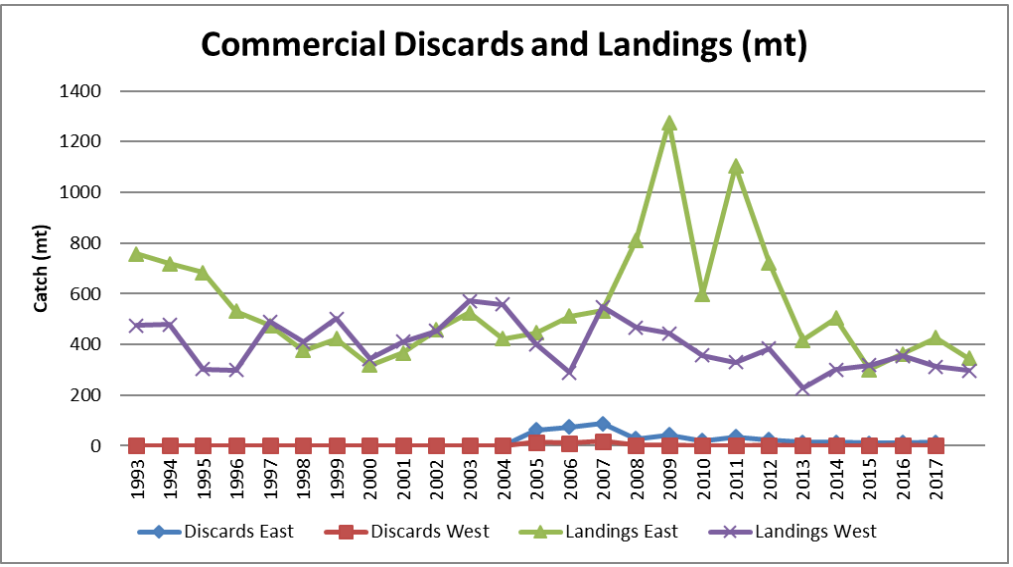
Discards

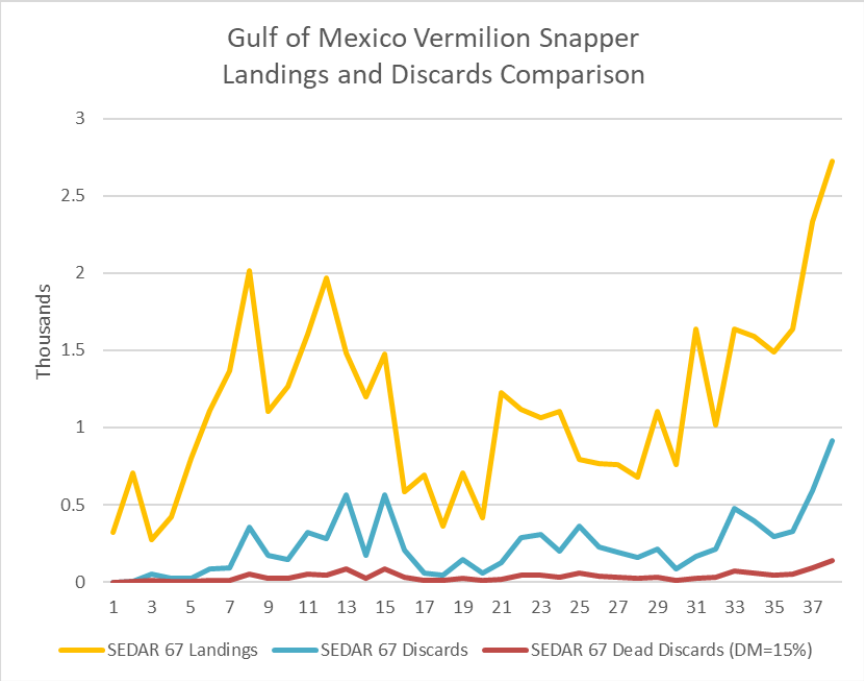




- Commercial estimation method changed
- FES data results in increased estimates of recreational discards

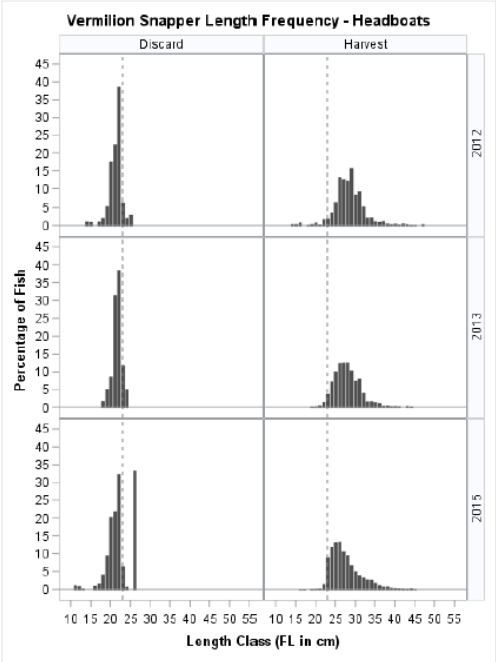
Discards are very low in comparison to landings

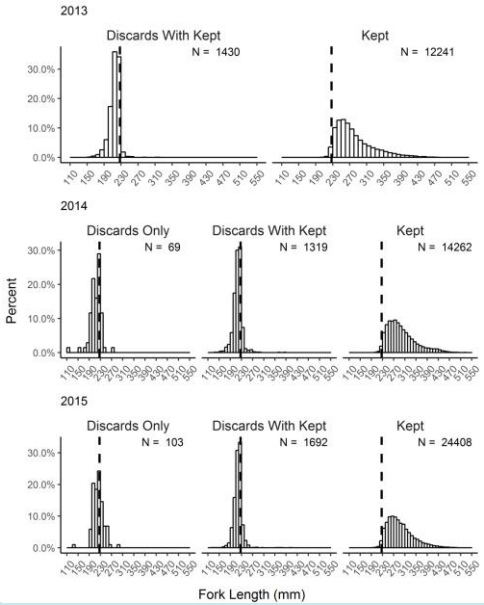




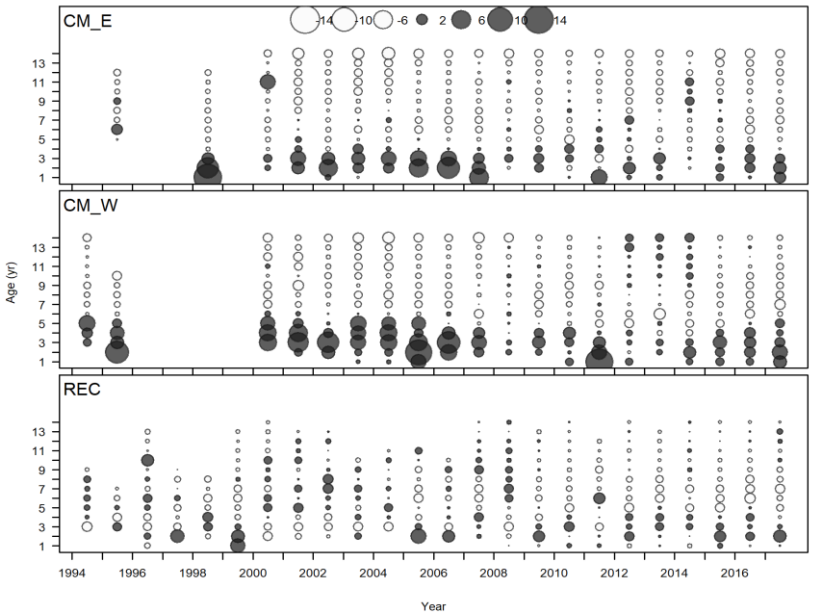
Discard formulation

- Most discards represent fish below the minimum size
  - Commercial:
    - Prior to 7/2005 – 8 in.
    - 7/2005 – 2/2008 – 11 in.
    - 2/2008 – present – 10 in.
  - Recreational
    - Prior to 1998 – 8 in.
    - 1998 – 2004 – 10 in.
    - 2005 – 2007 – 11 in.
    - 2008 – present – 10 in.
- Limited length composition available across entire Gulf and all fishery components
- Decided to implement fixed knife-edge retention functions forcing discards below minimum sizes
- Do not fit discard length composition directly

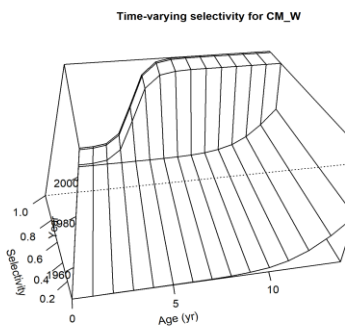


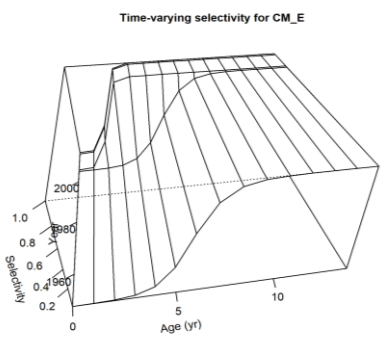


Fitting discard observations creates model instability



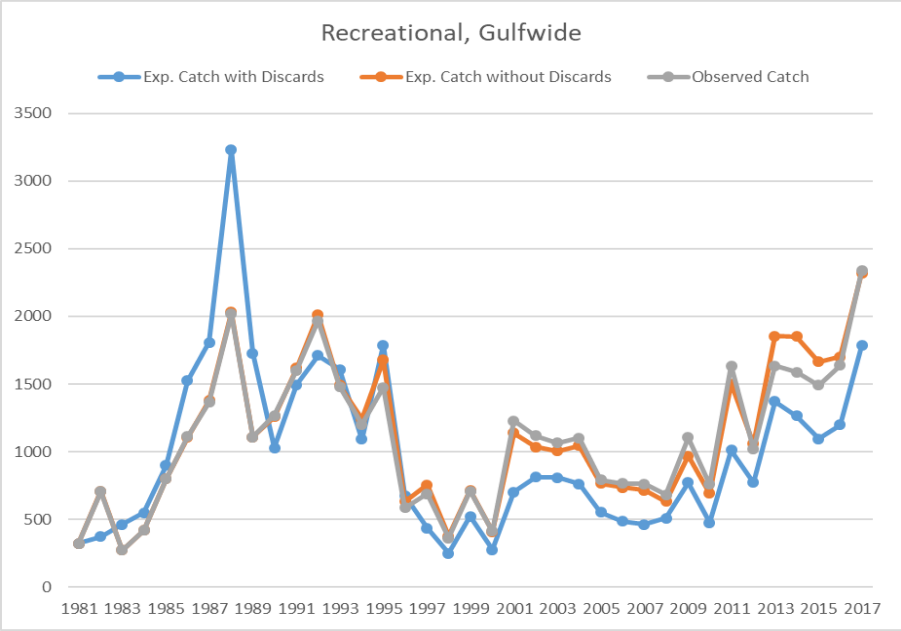
- CV = 0.3
  - Landings CV = 0.05 comm., 0.15 rec
  - Indices 0.2
- Degrades fit to catch data
- Creates issues estimating selectivity
  - Fewer fish selected, fewer fish discarded (below min. size)
- Severely underestimates young fish
  - Fewer recruits/selected fish, fewer discards (below min. size)

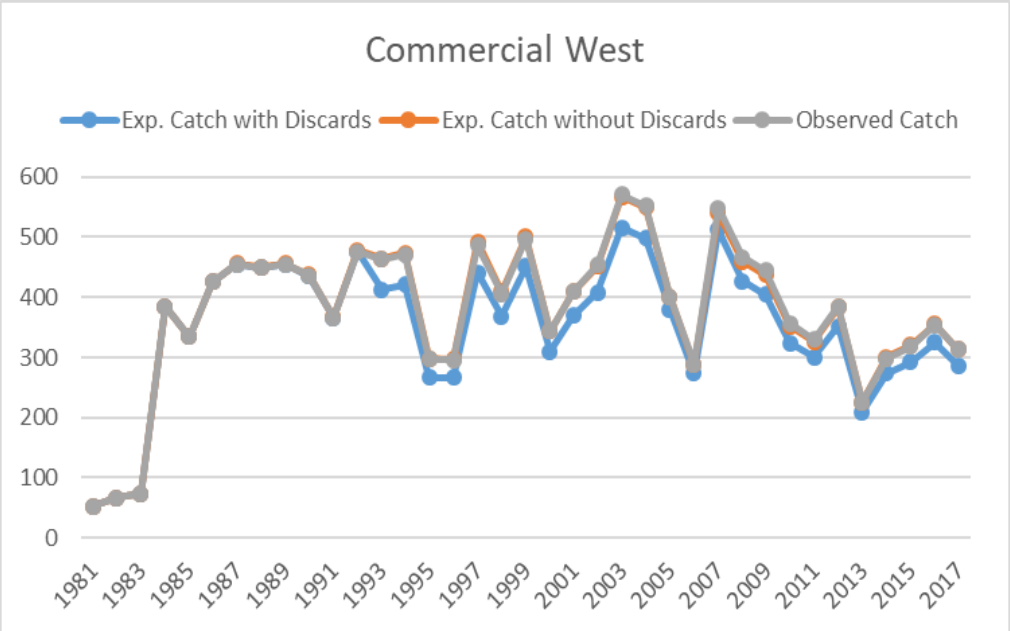




Likelihood Components	Cont	2. Comb Vid	4. Cont w Disc	7. Comb Vid w Disc	7b. Comb Vid w Disc CV 0.5	8b. Comb Vid, Trunc CPUE, Include Disc CV 0.0	8j. Cont Vid, Trunc CPUE, Include Disc CV 0.0
TOTAL	314.128	351.096	2210.52	1896.62	963.443	349.501	305.805
Catch	3.6796	4.06656	130.177	121.157	22.8276	3.31552	3.2269
Survey	-23.1652	26.5231	-46.2778	-6.42855	-4.0839	18.5092	-30.4535
Discard	-1.05535	-0.86514	1587.75	1309.49	590.874	-1.82489	-1.76759
Length_comp	92.2831	84.3862	101.567	81.8654	86.5769	88.5899	98.3925
Age_comp	254.688	250.274	446.981	395.904	272.952	254.791	257.678
Recruitment	-12.4162	-13.7733	-10.0411	-5.74802	-6.22868	-14.9065	-21.4321
Parm_softbounds	0.017116	0.01399	0.011802	0.016211	0.011269	0.013238	0.01722

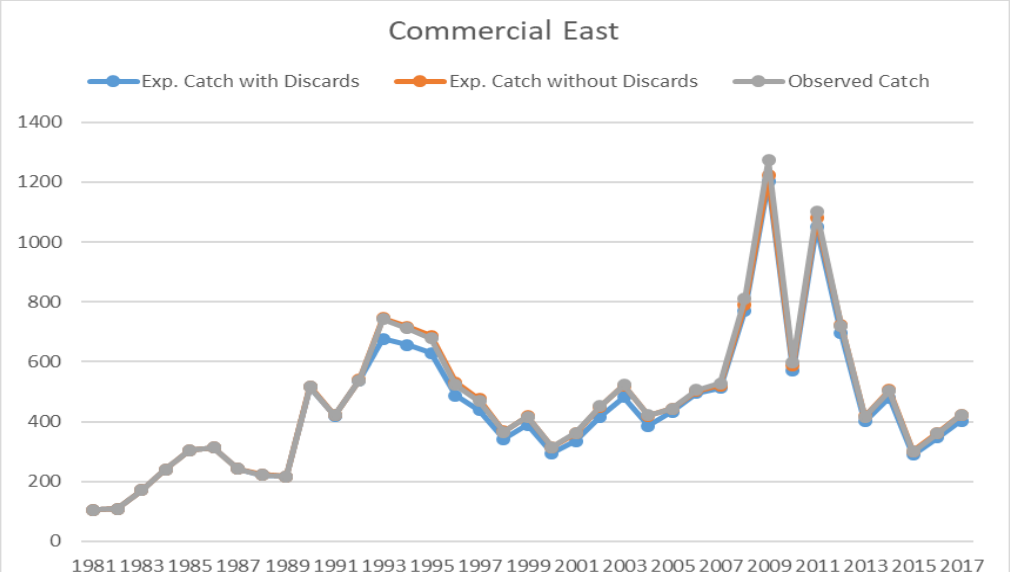
Fit to catch data



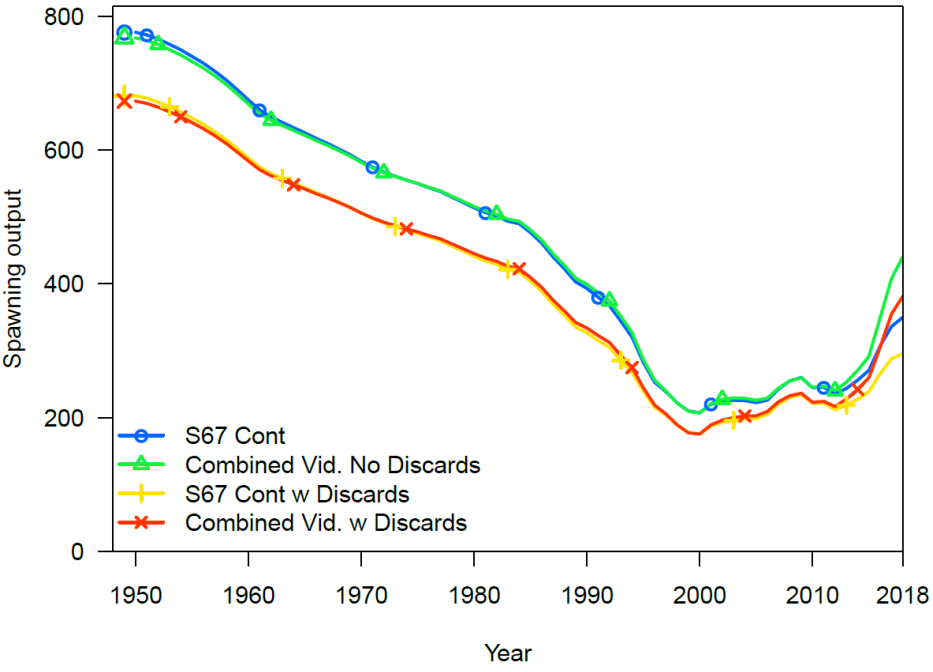


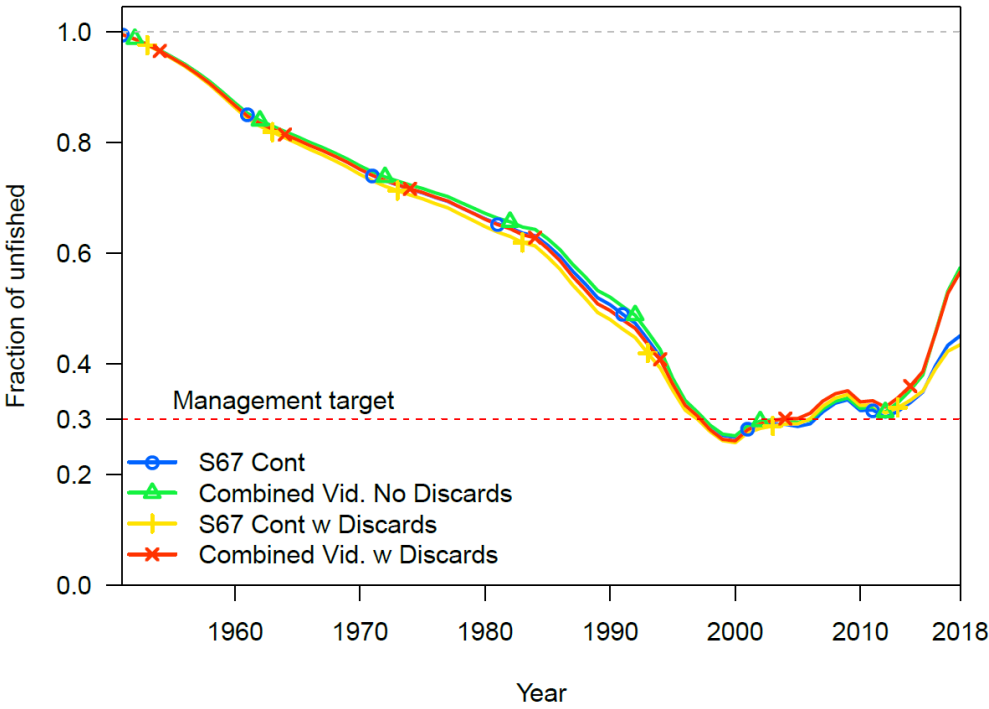
Catch is underestimated when discards are included and fit

Model reduces fishing effort (directed fishing mortality), to fit low discards



Discard Comparisons when Discard –LL=0



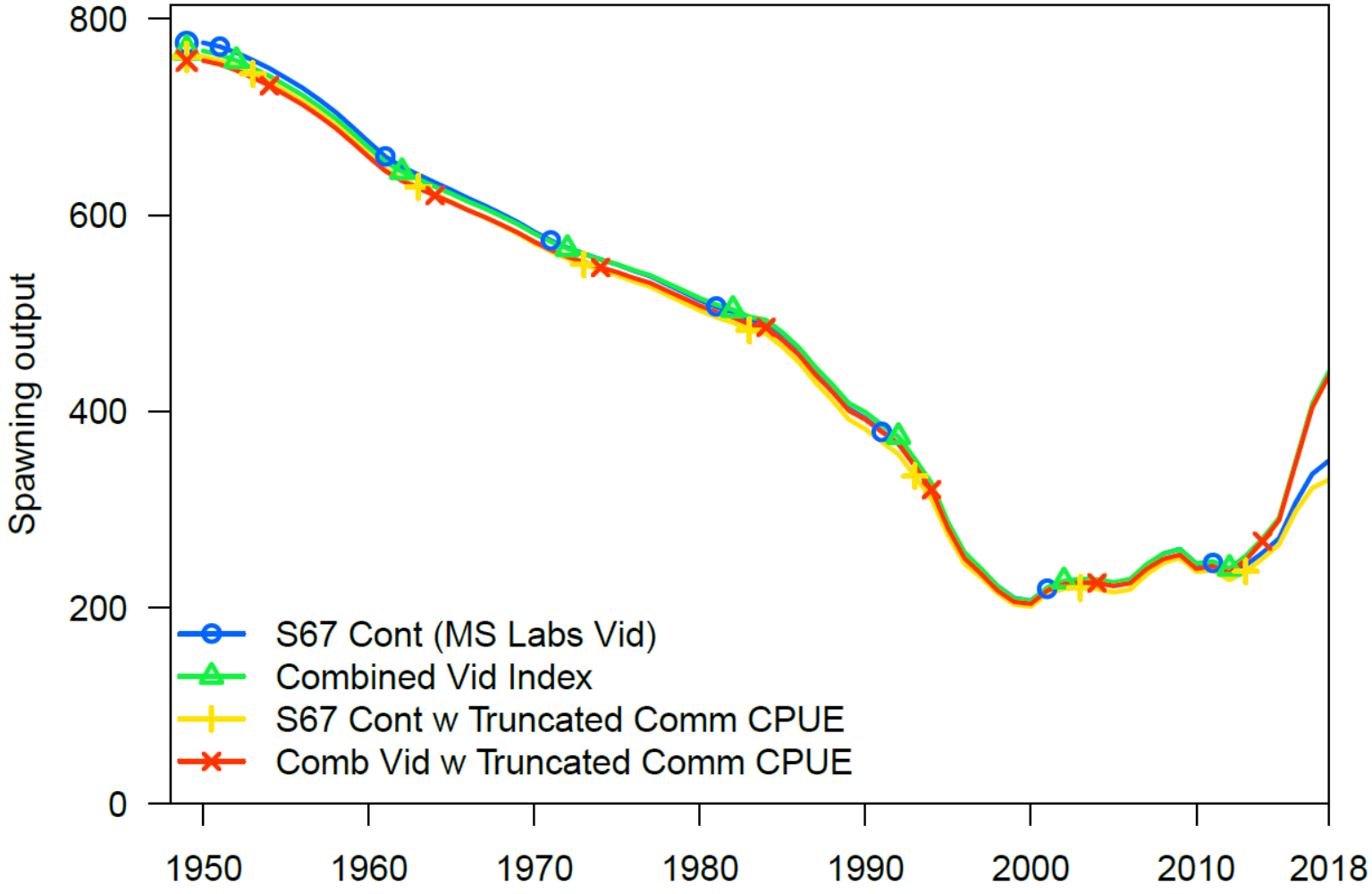


Allowing the model to remove biomass via discards rescales the assessment (left) but doesn't change perception of stock status (right)

IFQ CPUE Truncation

- Reasoning for truncation:
  - Previous method for standardizing for fishery targeting changes due to red snapper IFQs was not optimal
    - Impact of red snapper IFQ availability on vermilion snapper targeting not fully understood
  - SEDAR52 panel decided to truncate commercial CPUE post-IFQ (2007)
  - CPUE IFQ time series demonstrates limited information value (short time series with no trends)

Truncate Commercial Indices of Abundance



New data

Topic	Decision
FWRI repetitive time drop survey & length composition (SEDAR67-WP5)	- Considered and not included
FWRI vertical line survey (SEDAR67-WP4)	- Considered and not included

Base Model Development: Model Configuration

Vermilion snapper base model configuration

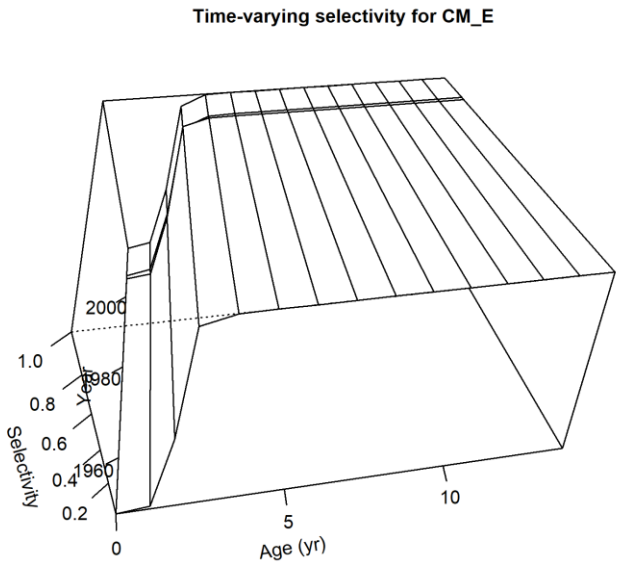
- 1950 – 2017 (comm. ‘63, rec. ’81, shrimp ‘50)
- 1 area, 1 season model
- Combined gender model
- Maturity and fecundity functions of length
- SSB in number of eggs
- von Bertalanffy growth (fixed)
- Lorenzen natural mortality (fixed)
- Beverton-Holt spawner-recruitment relationship
  - Fix recruit variation term at profile minimum (σ =0.3)

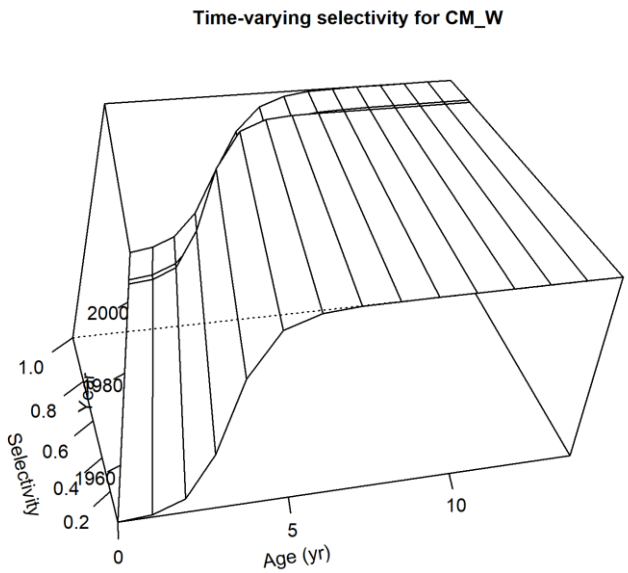
Vermilion snapper base model configuration

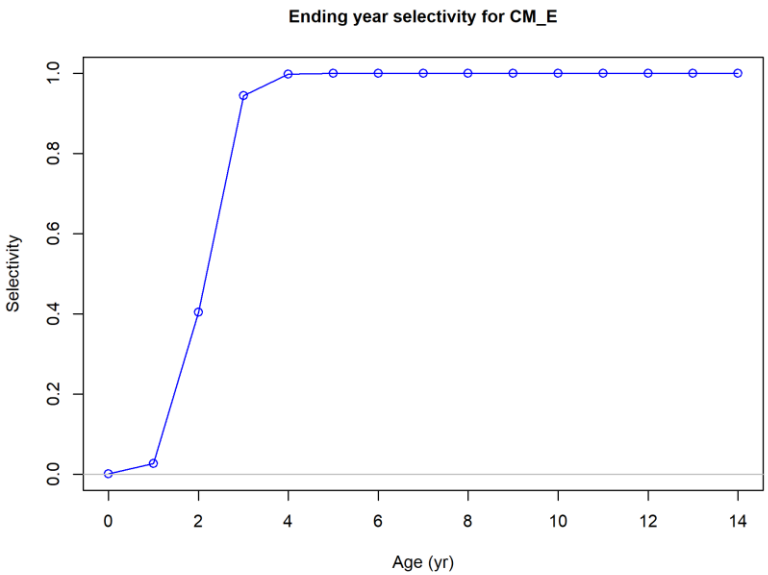
- 3 fishing fleets – landings and minimum size based discards (observations not fit, -LL=0 for discard data)
  - CM_E, CM_W, Rec
- 3 fishery-independent indices of abundance
  - Larval, SEAMAP Trawl, Combined Video
- 7 fishery-dependent indices of abundance
  - CM_E, CM_W, MRIP, HB_E, HB_W, ~~CM_E and CM_W post IFQ~~
- 1 bycatch only fleet (Shrimp)
- Age-based selectivity
  - Directed fleets (estimated)
  - ~~Time block on CM_E and CM_W (2007)~~
- Length-based selectivity
  - SEAMAP Trawl and Combined Video (estimated)
- Fixed selectivity – Shrimp
- Fixed retention functions – blocking for minimum size by fleet
- Discard mortality – fixed at 0.15 for all fleets with sensitivity runs

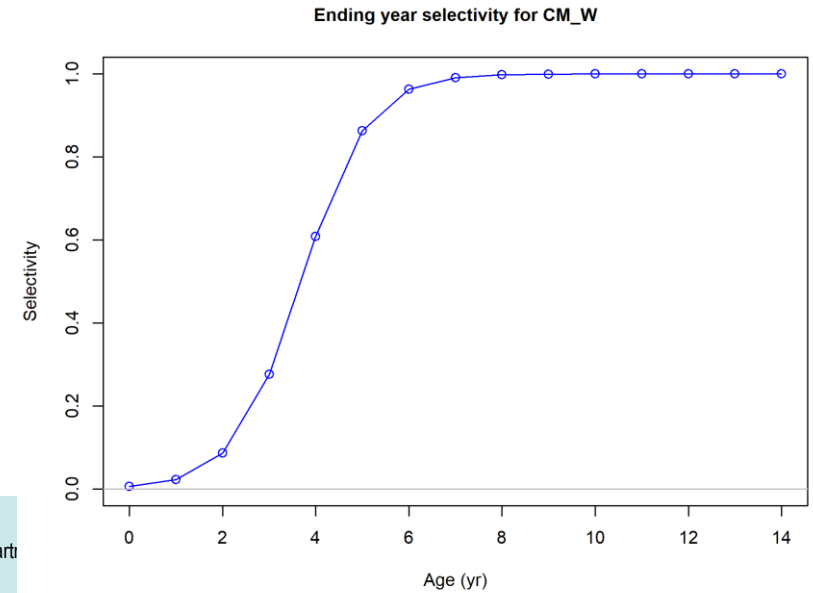
SEDAR 67 base model: Configuration Changes

Removing selectivity time blocks impact

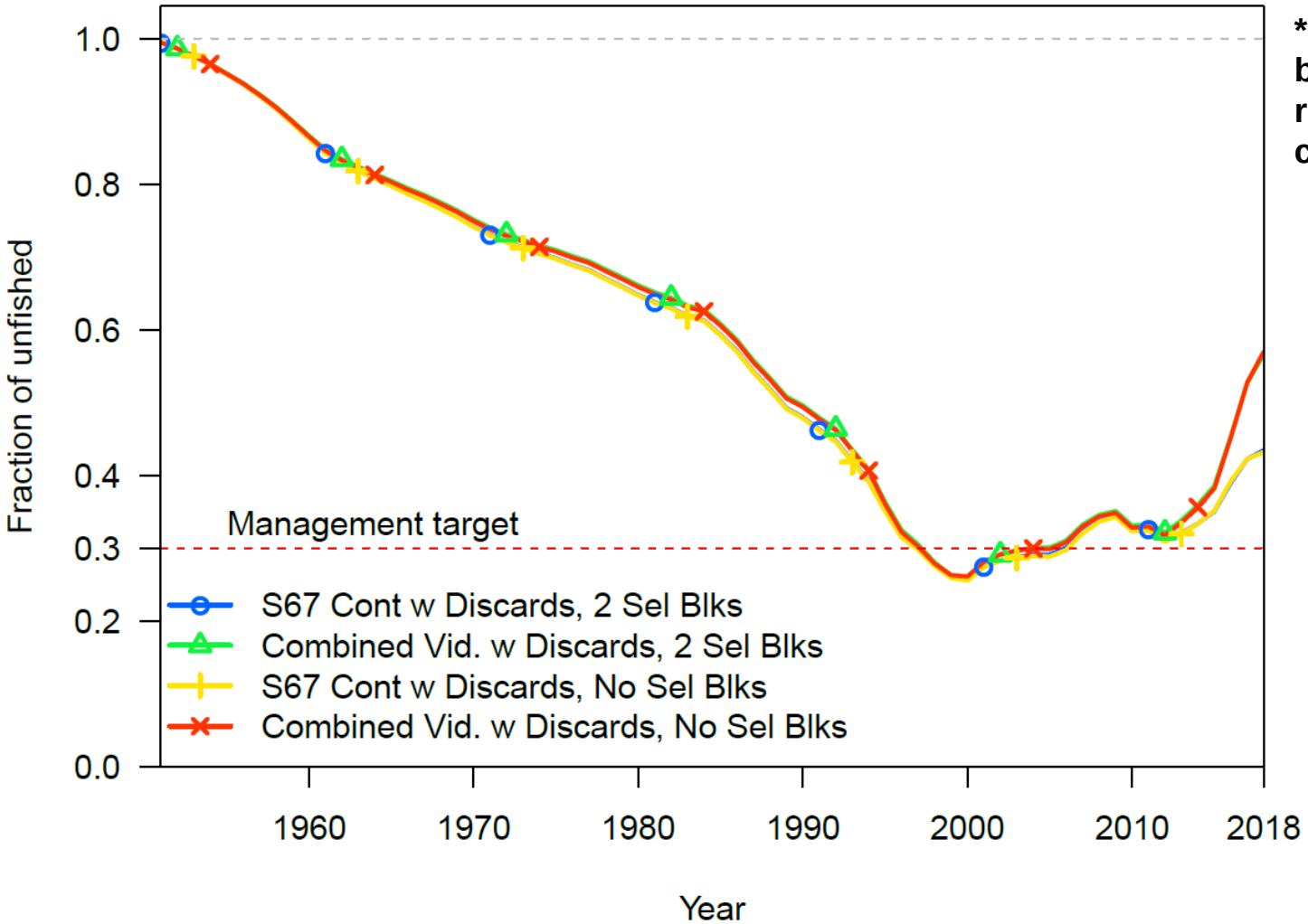






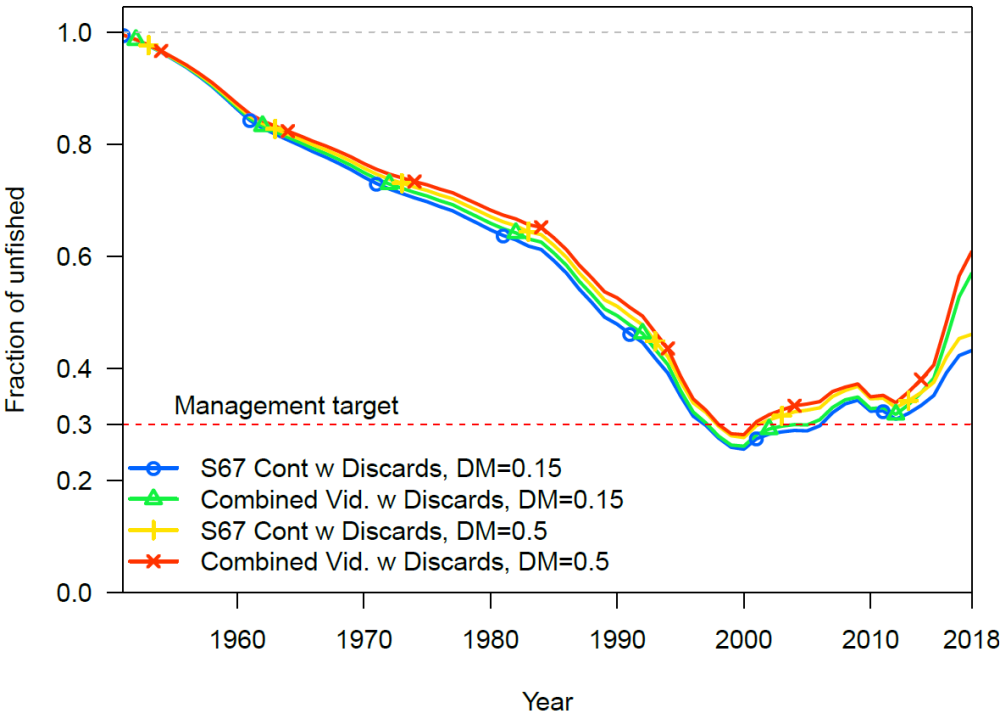


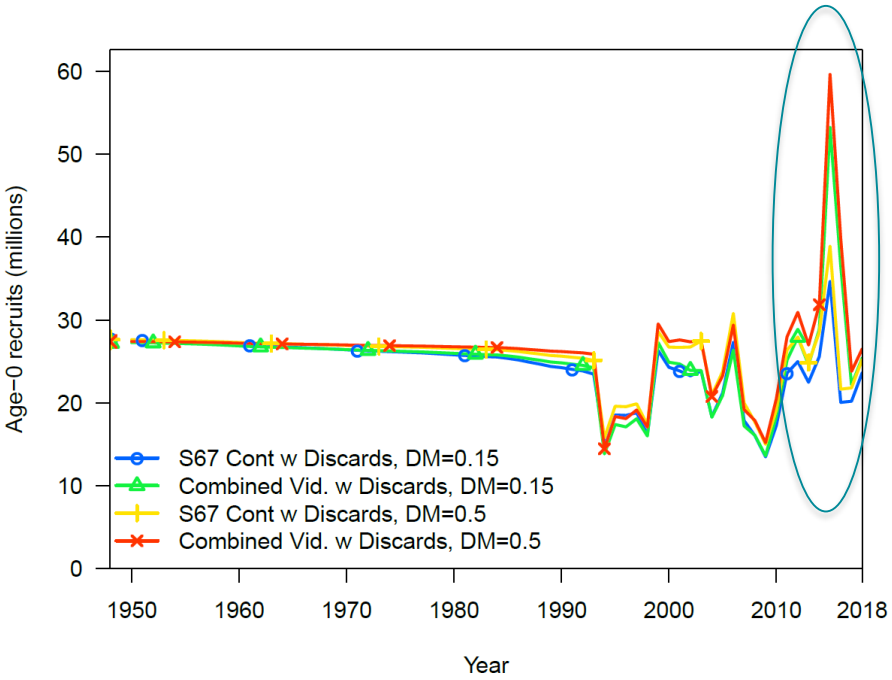
Removing selectivity time blocks impact



***No selectivity time block models used for remainder of model comparisons**

Discard mortality impact



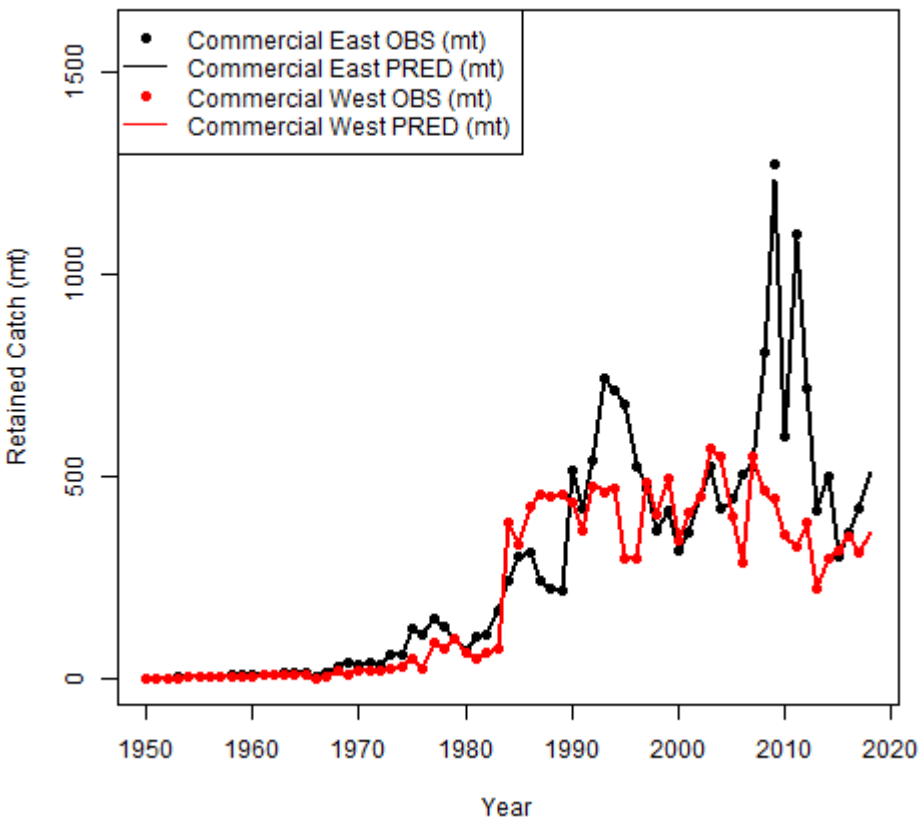


Increasing discard mortality results in model generating more fish through increased recruitment.

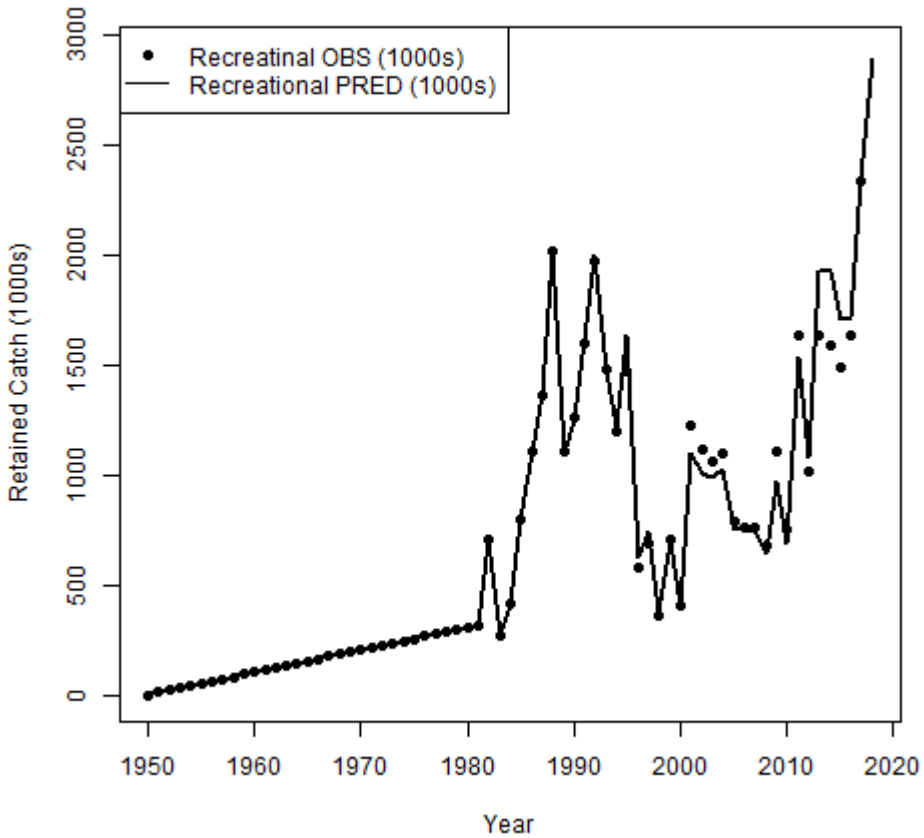
Base Model Development: Model Fit

Landings

Commercial

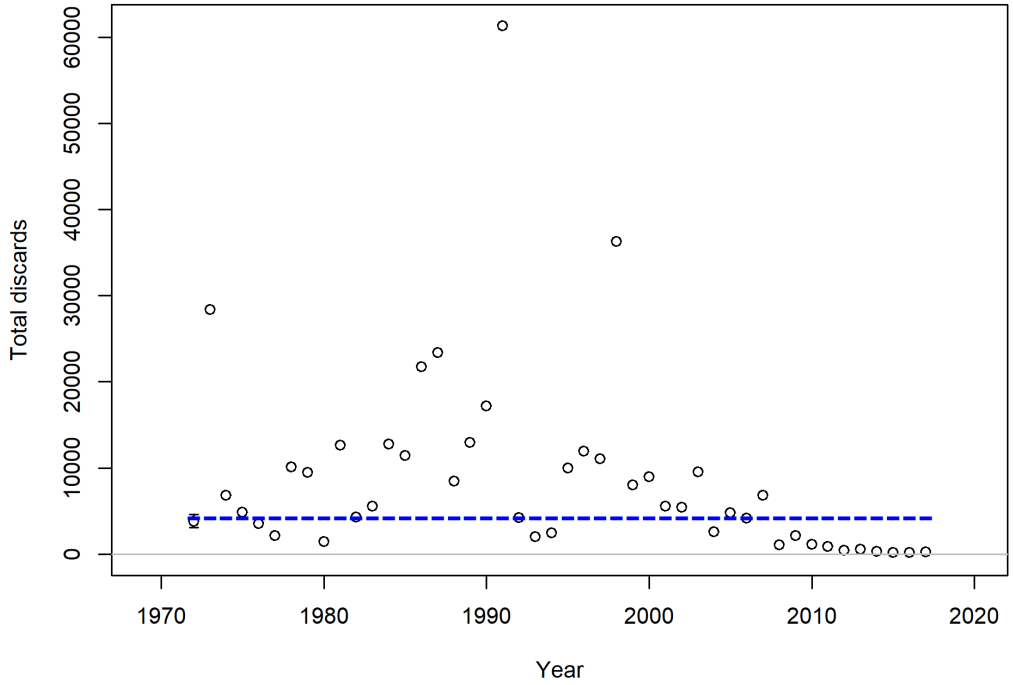


Recreational

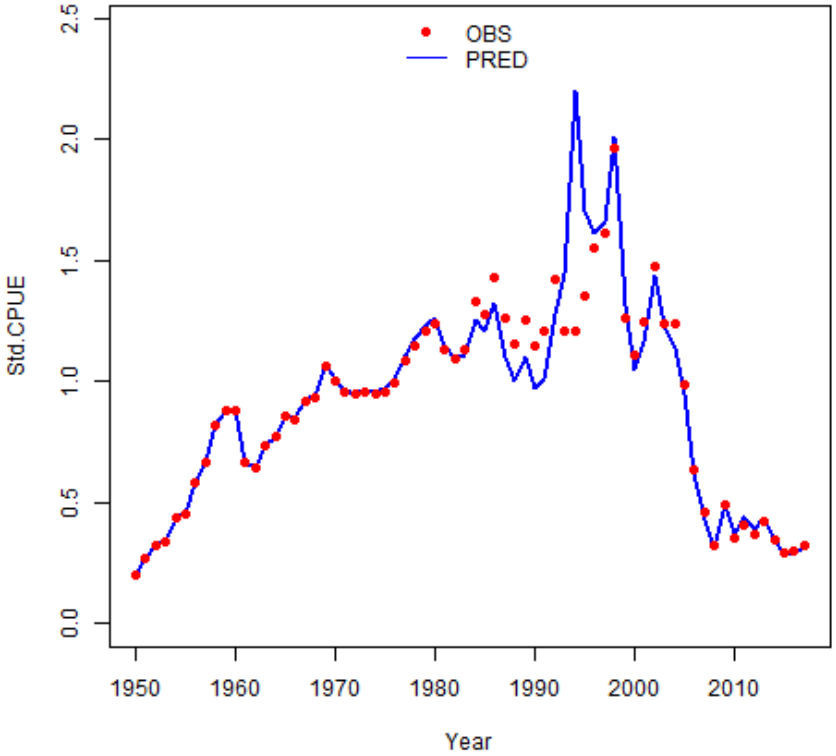


Shrimp Bycatch

Bycatch

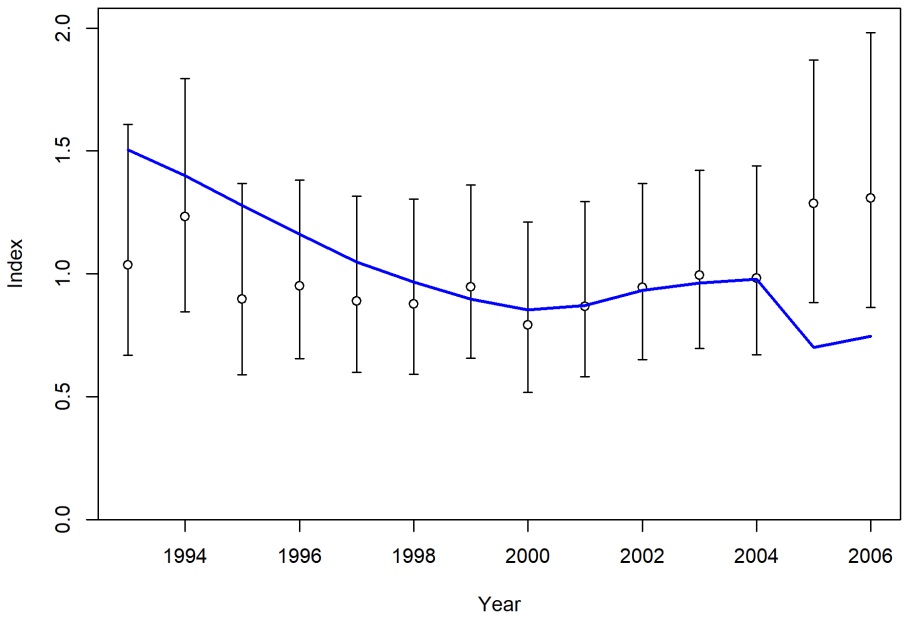


Effort

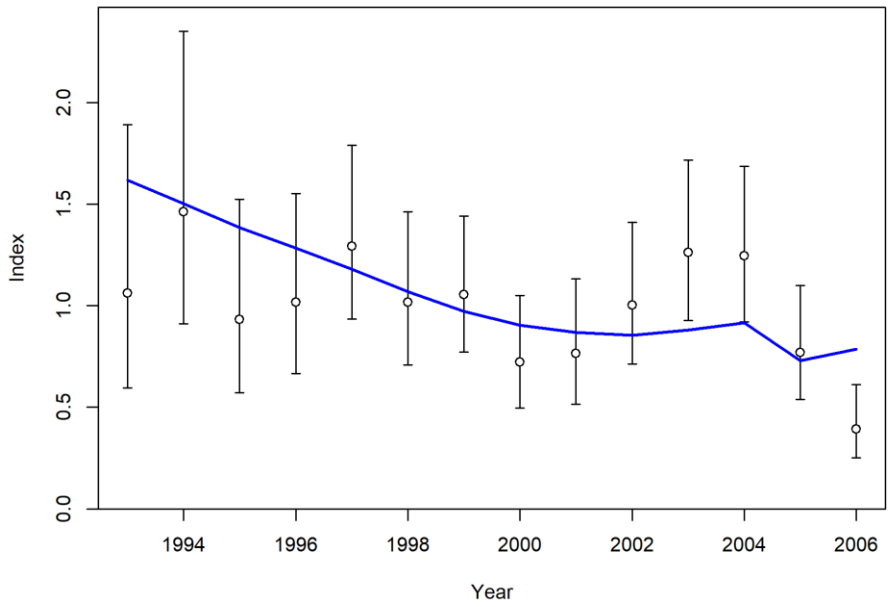


Commercial CPUE Pre-IFQ

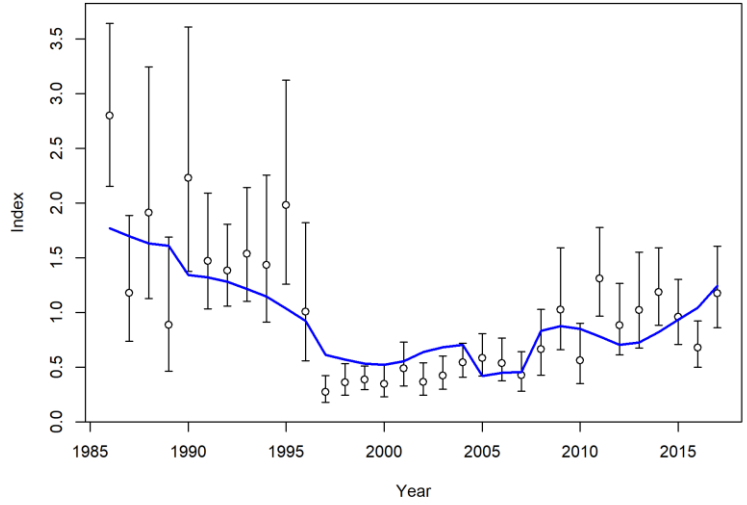
East



West

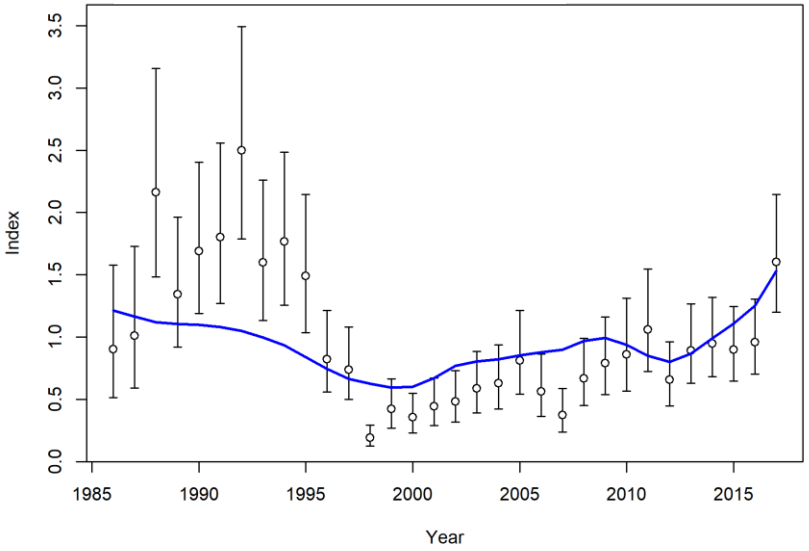


Recreational CPUE

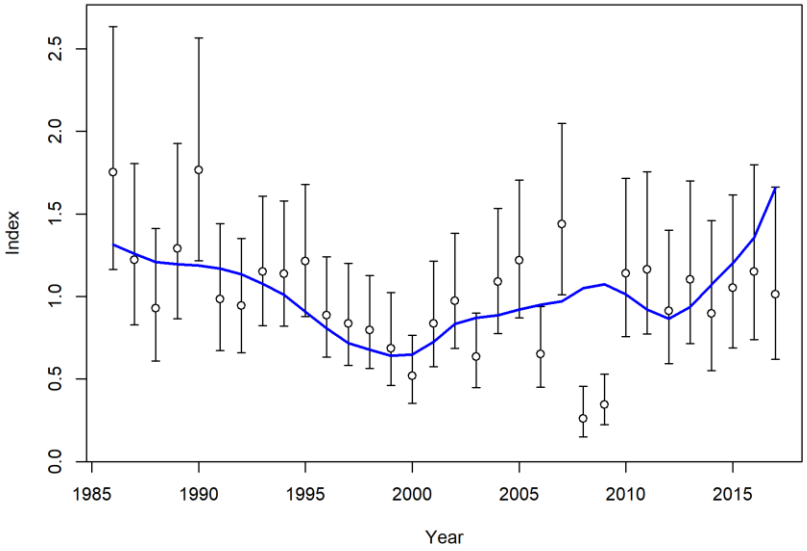


MRIP East

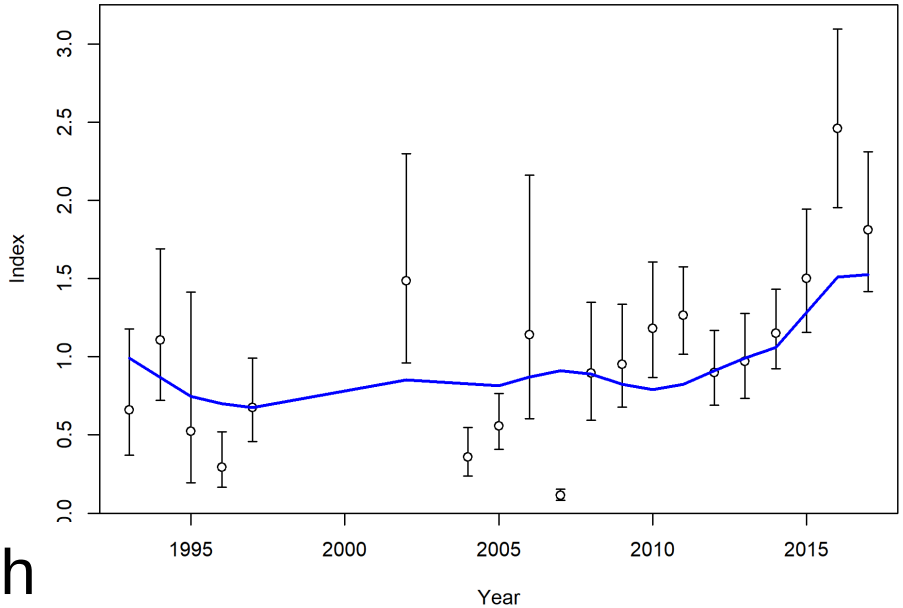
HBT East



HBT West

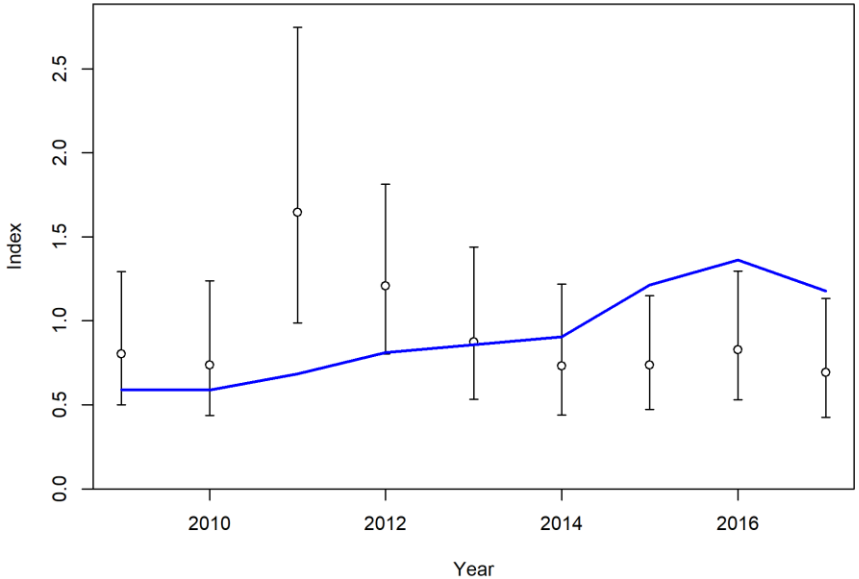


Fishery-Independent Surveys

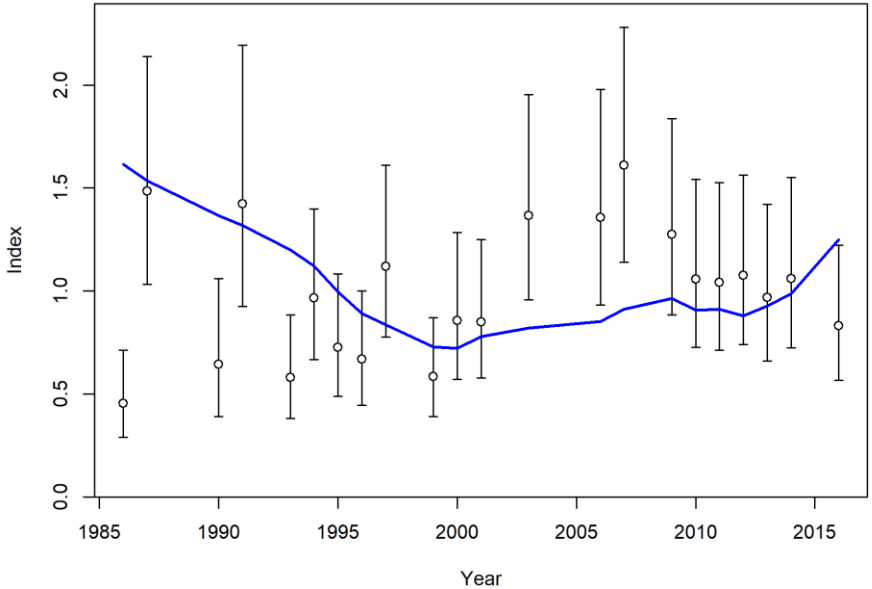


Combined Video

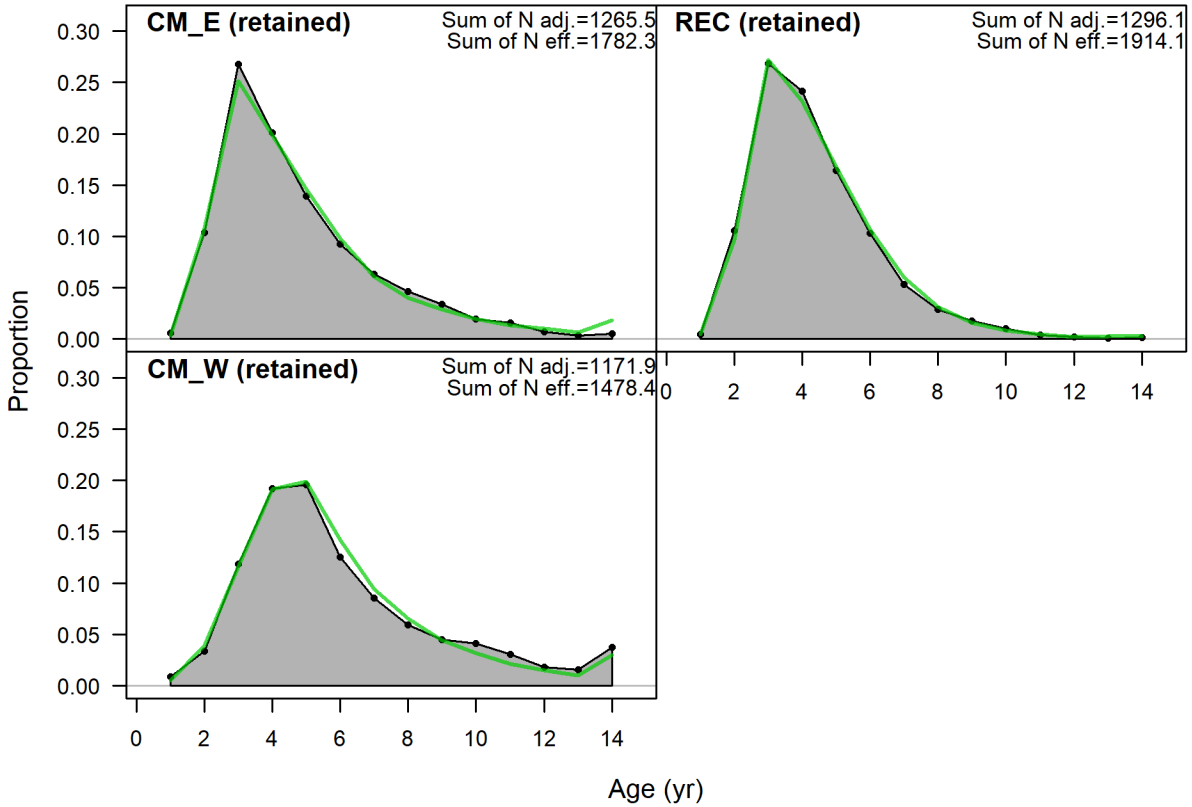
Groundfish



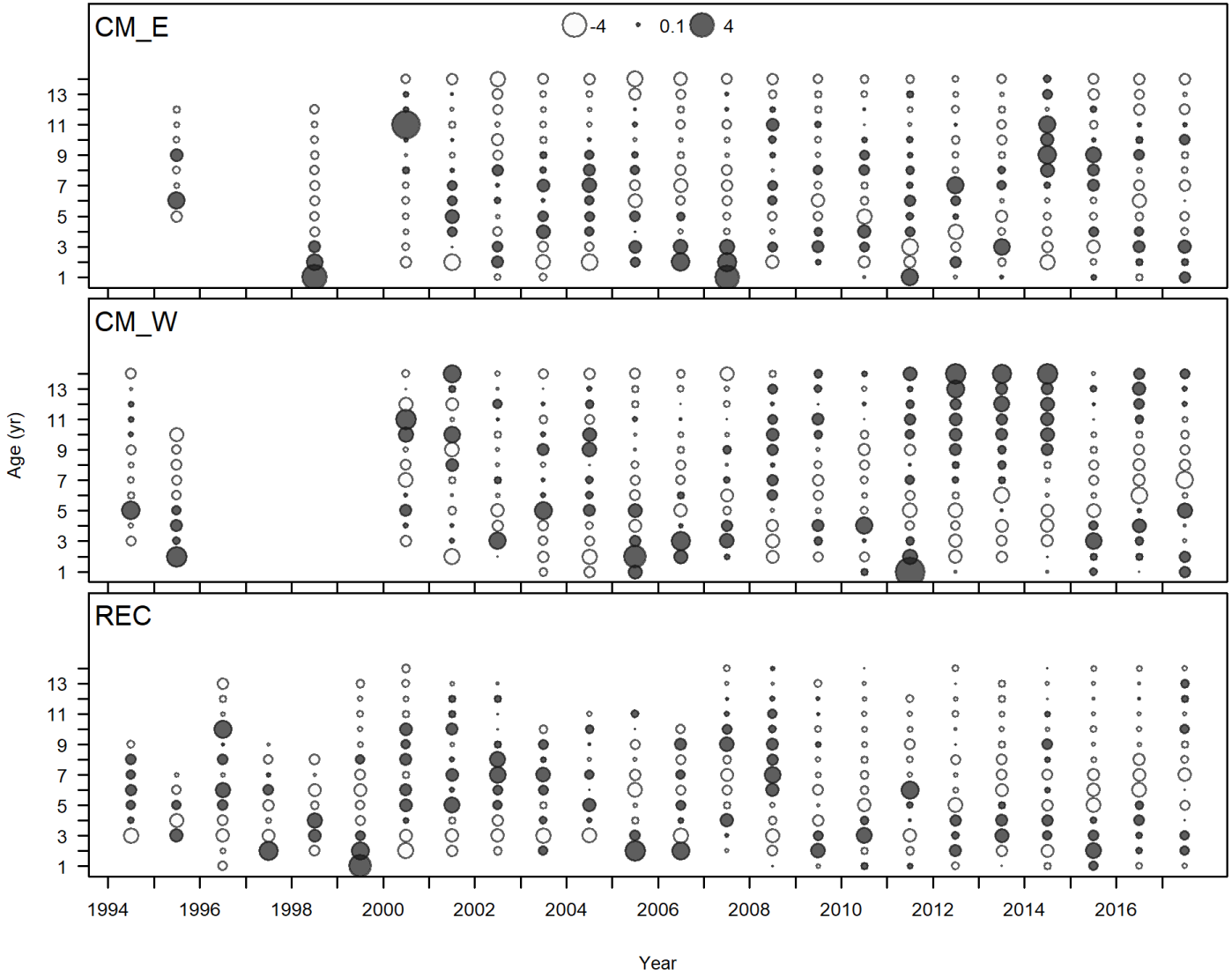
Larval



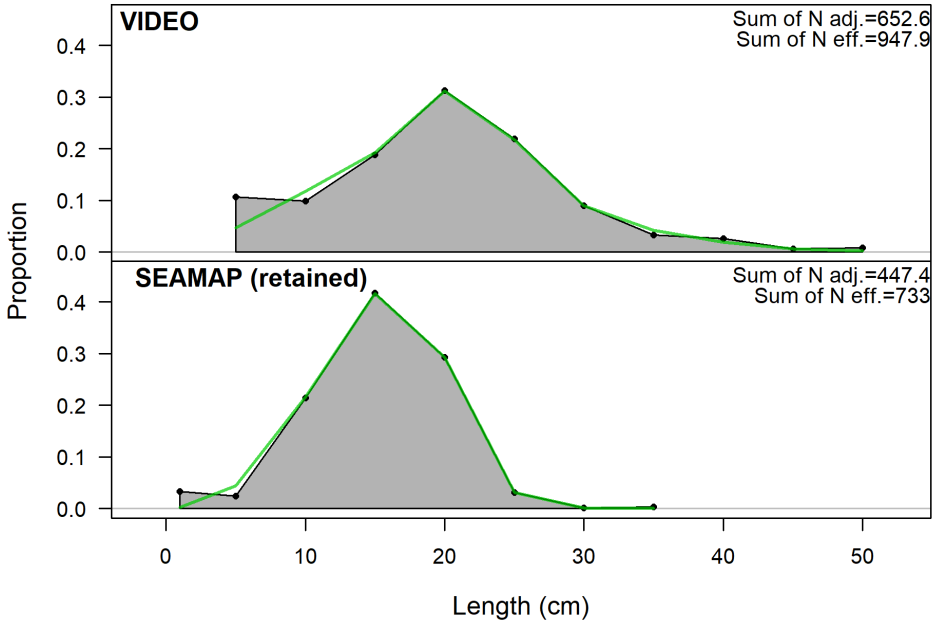
Fishery Age Composition

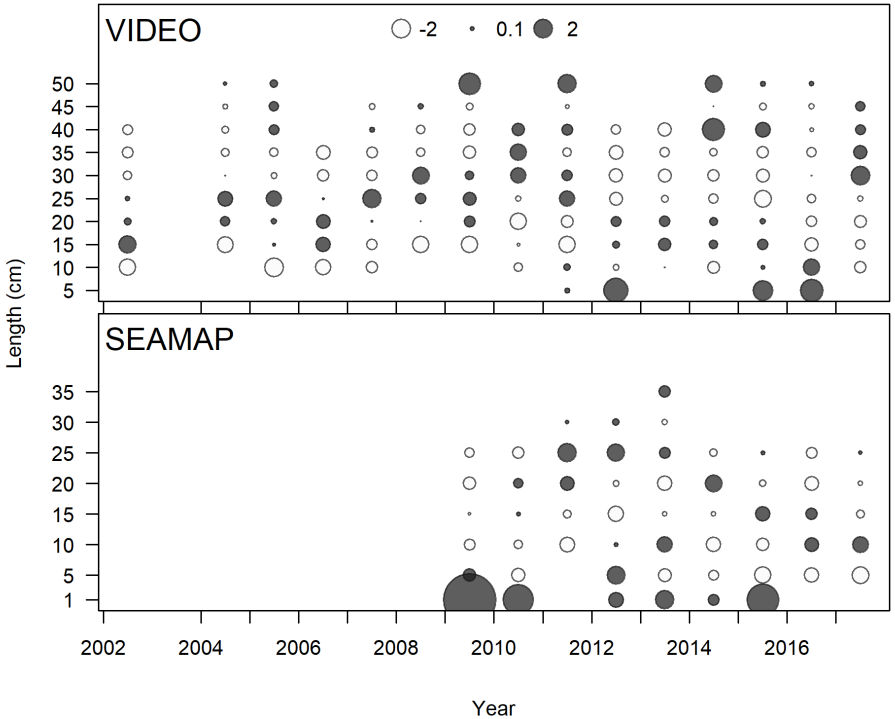


Fishery Age Composition Residuals



Survey Length Composition

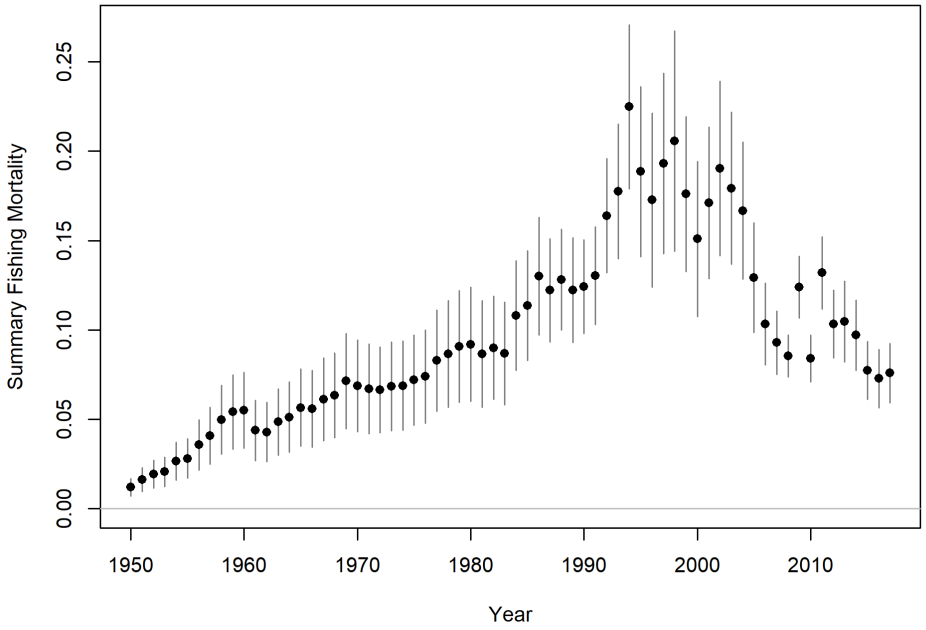




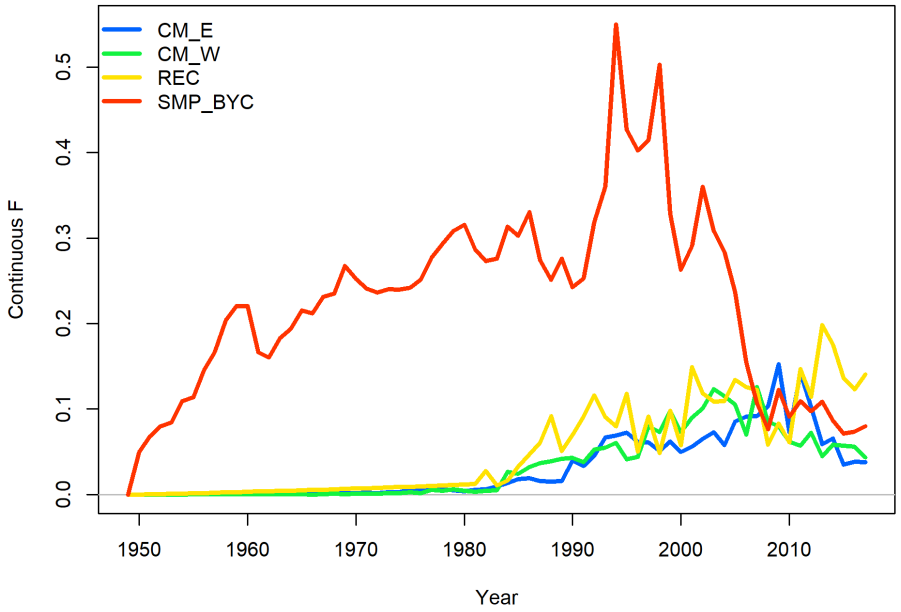
Base Model Development: Model Results

Fishing Mortality

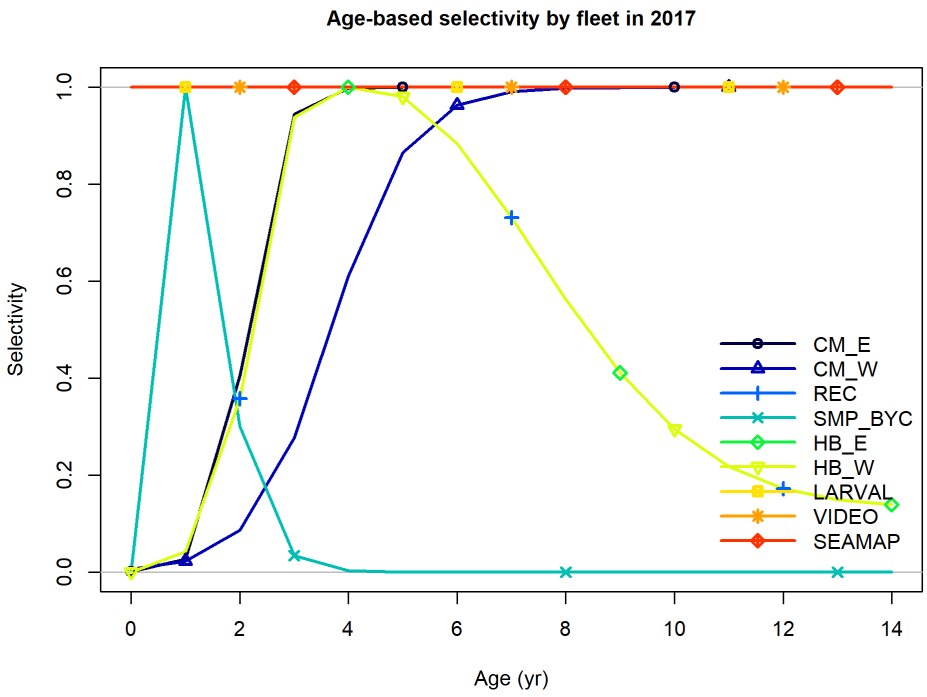
Harvest Rate
(total number killed/exploitable numbers, Age-1+)

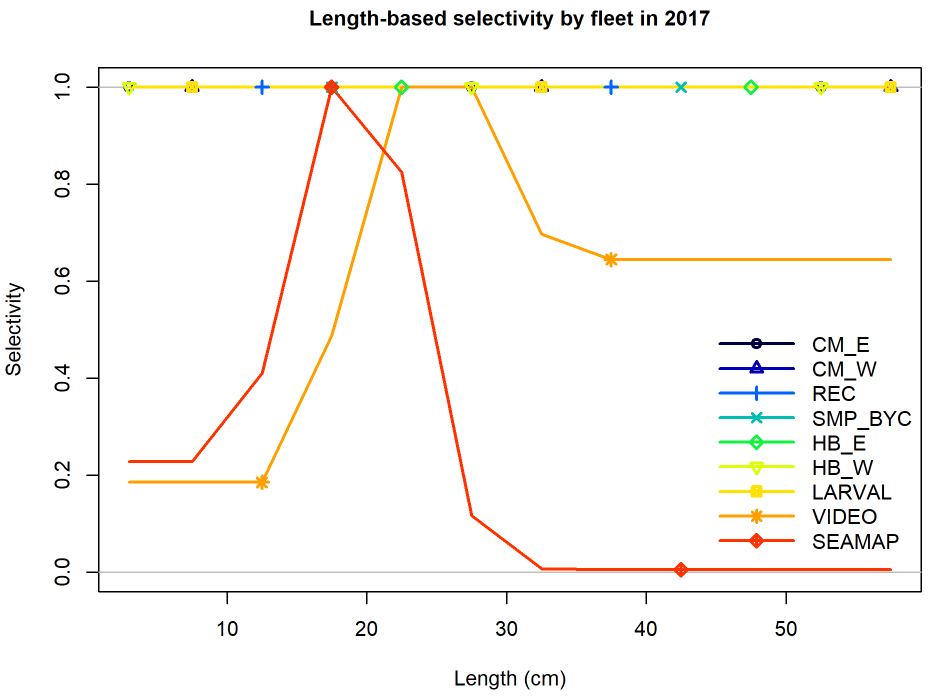


Fleet Specific F



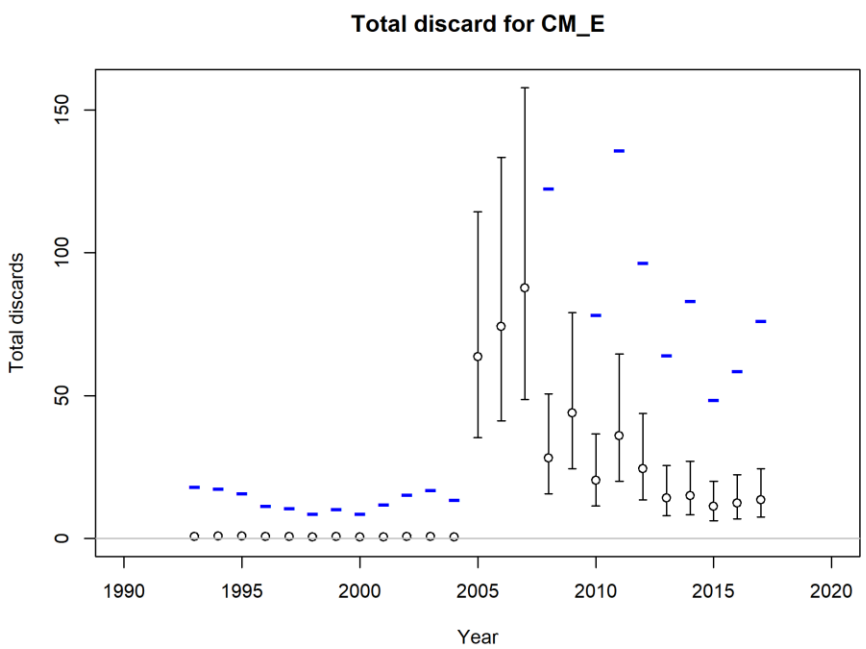
Selectivity

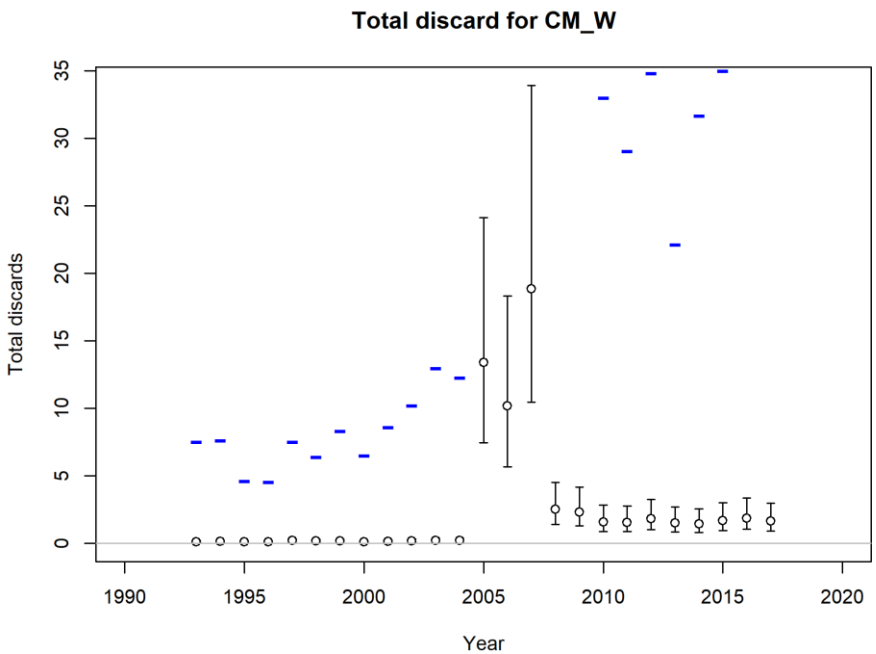


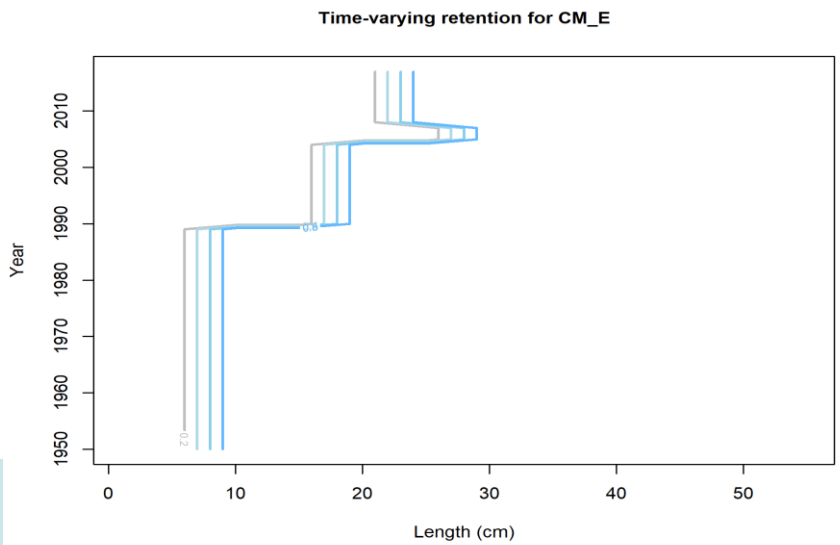


No selectivity time blocks were included in the final base model

Commercial Discards



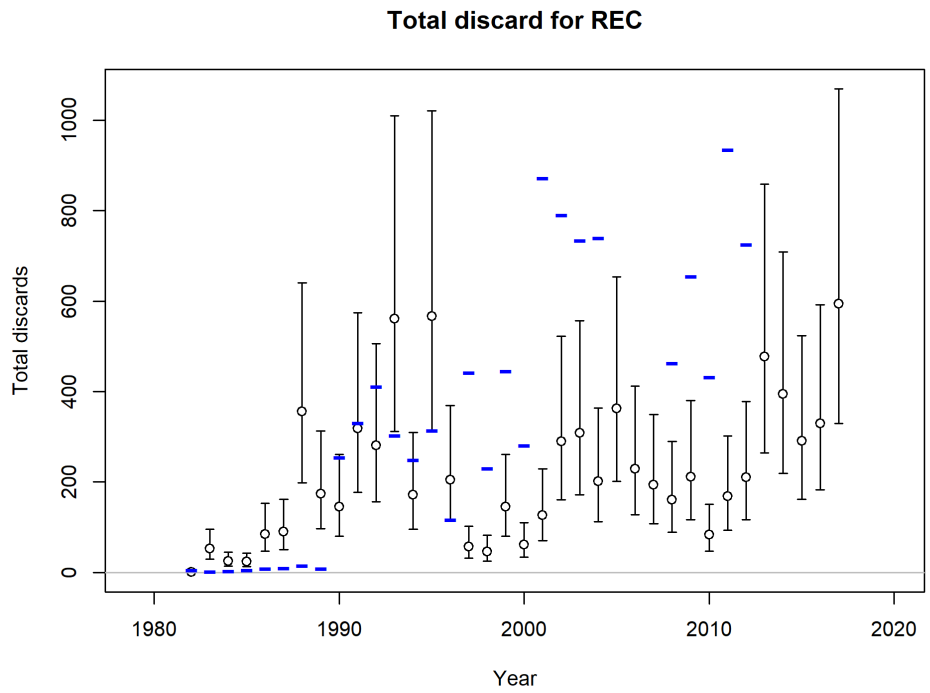


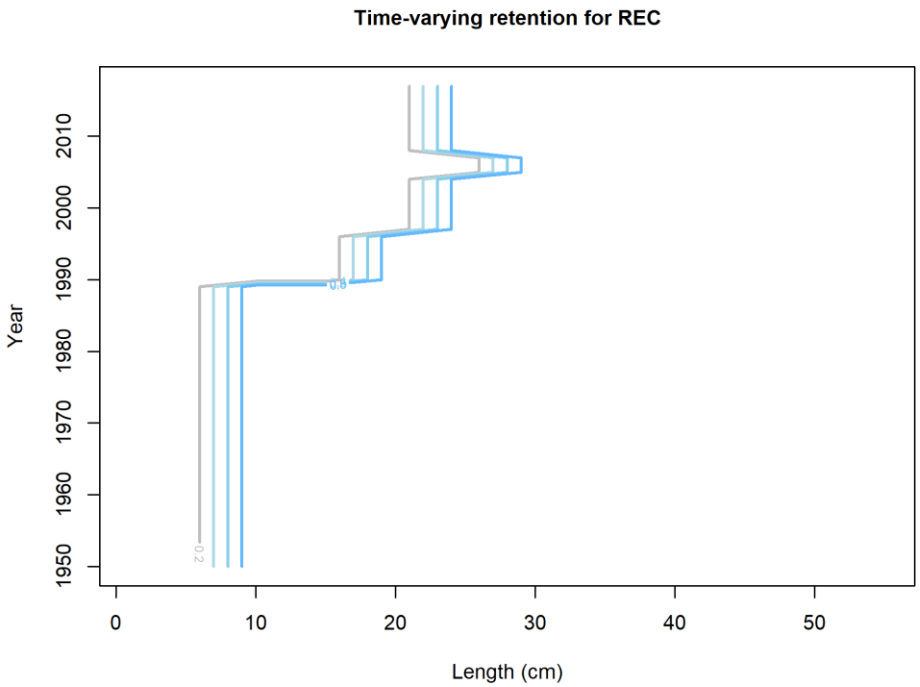


Retention Blocks:

- 1990 – 7/2005: 8 in.
- 7/2005 – 2/2008: 11 in.
- 2/2008 – present: 10 in.

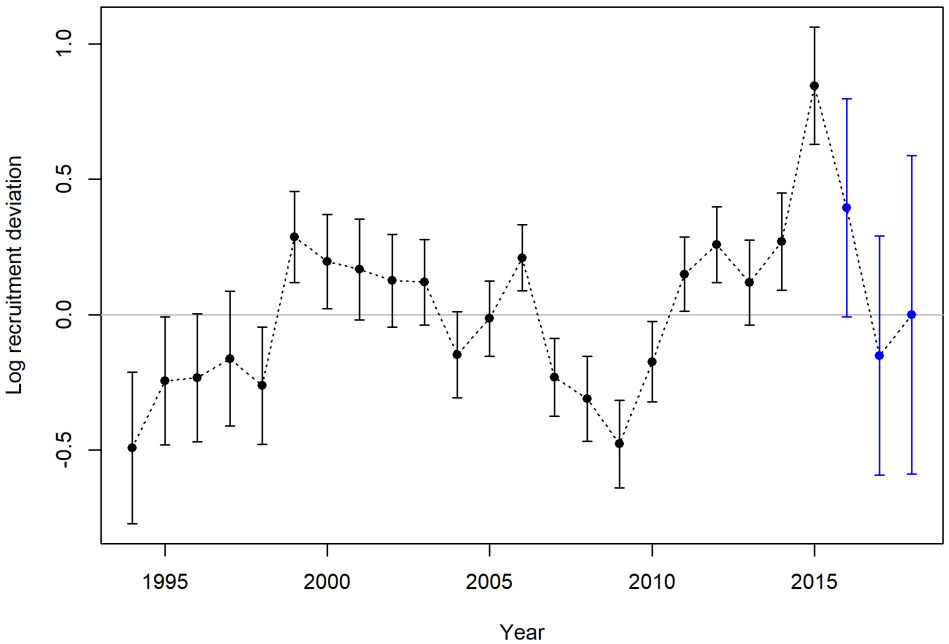
Recreational Discards

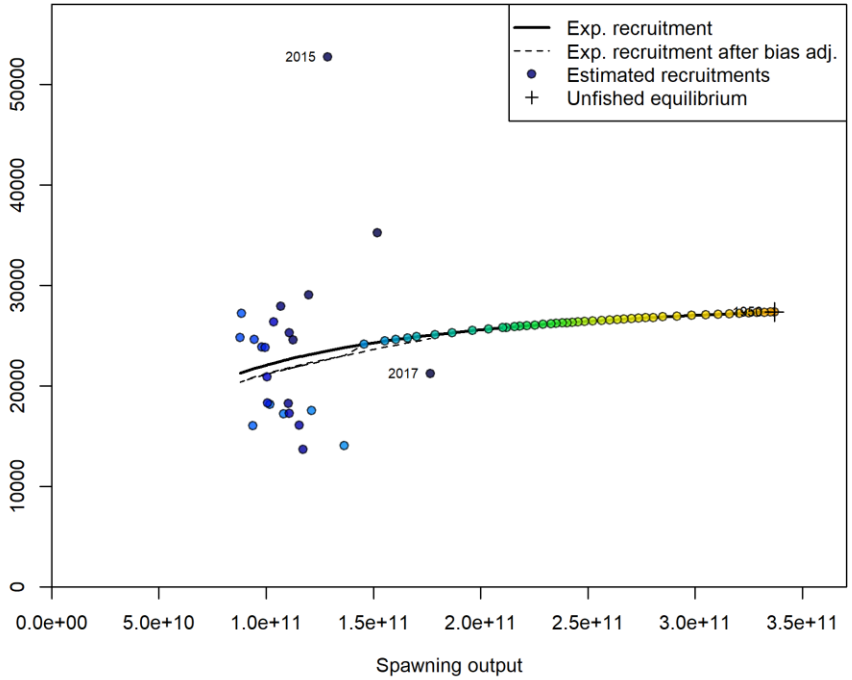




- Retention Blocks
  - 1990 – 1998: 8 in.
  - 1998 – 2004: 10 in.
  - 2005 – 2007: 11 in.
  - 2008 – present: 10 in.

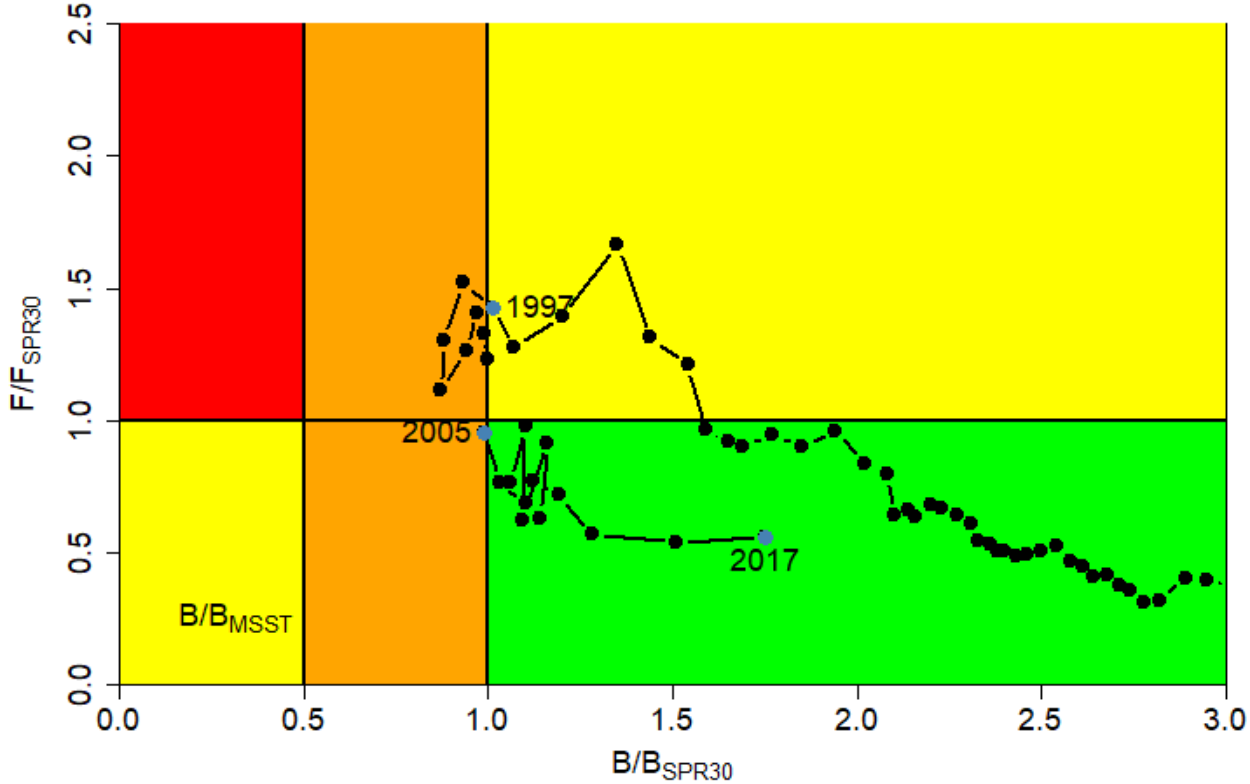
Recruitment





- S/R relationship poorly defined
- 2015 and 2016 are estimated to be the largest recruitment events on record

Stock Status

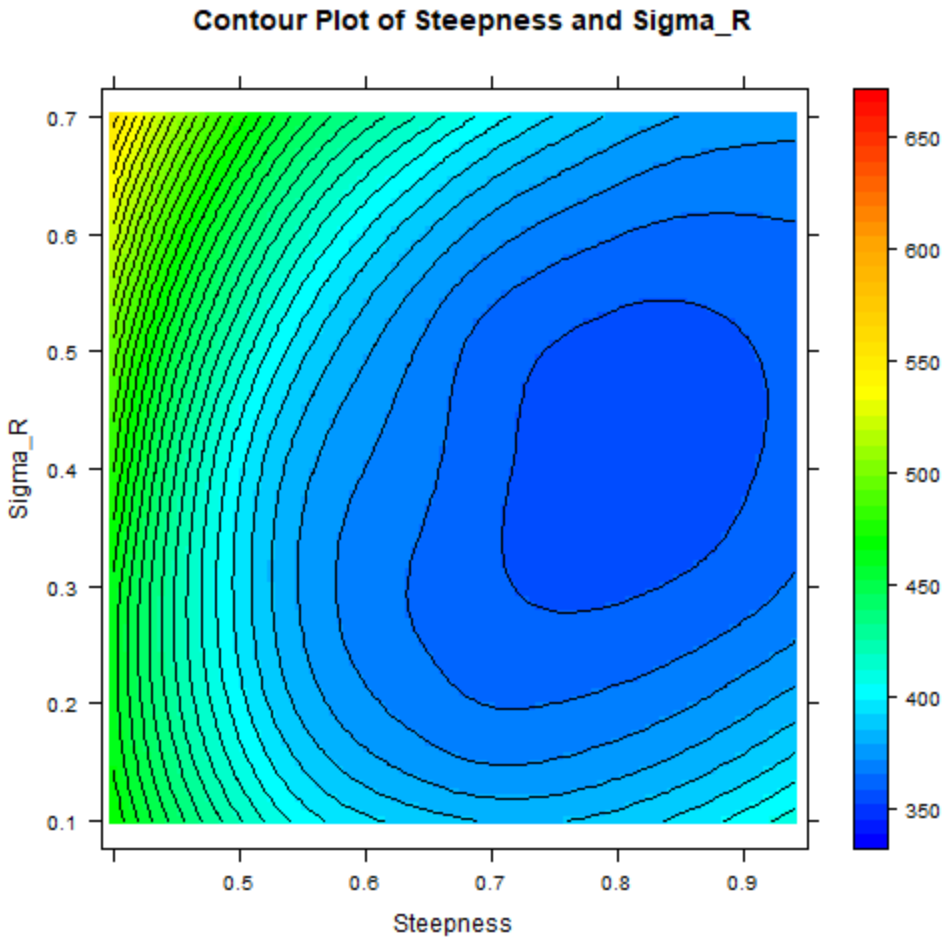


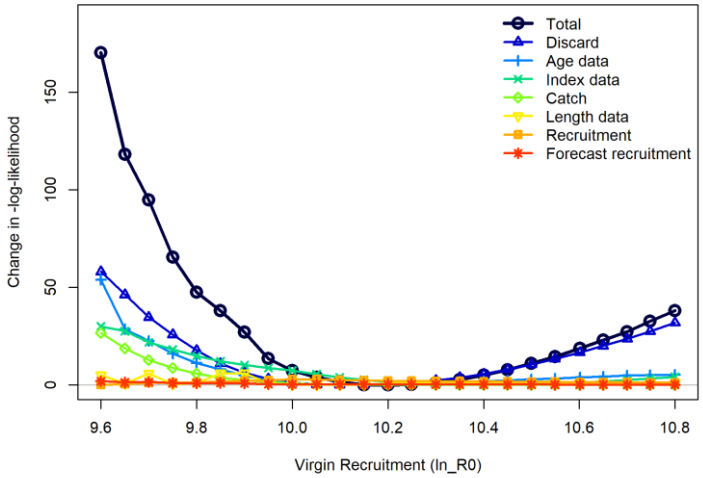
Overfishing is not occurring and the stock is not overfished

Model estimates overfishing occurred from 1992 – 2004 and stock has never been overfished

Base Model Development: Diagnostics

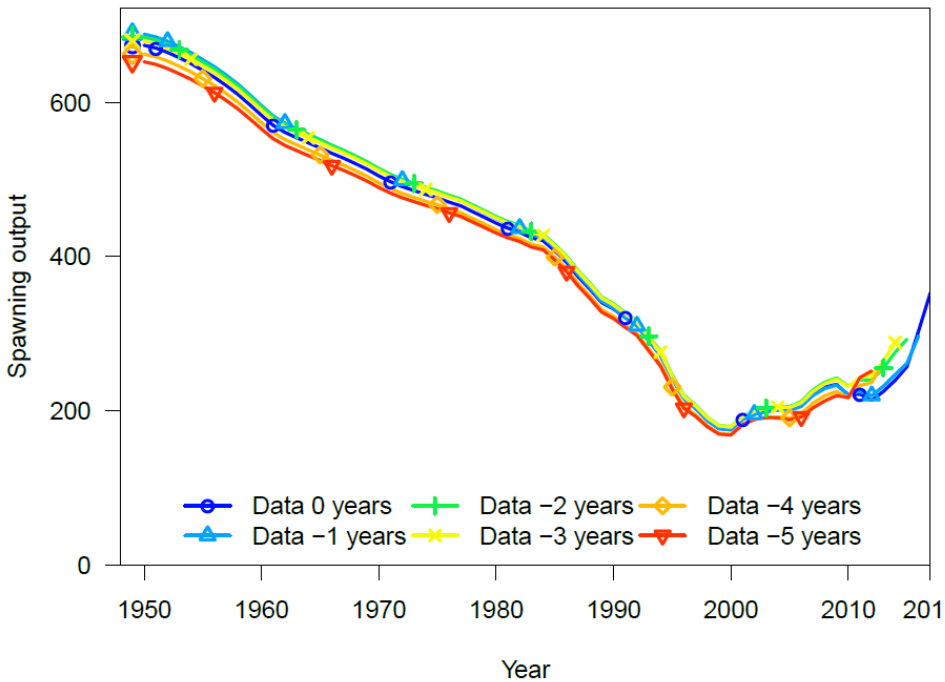
Stock Recruitment Profiles

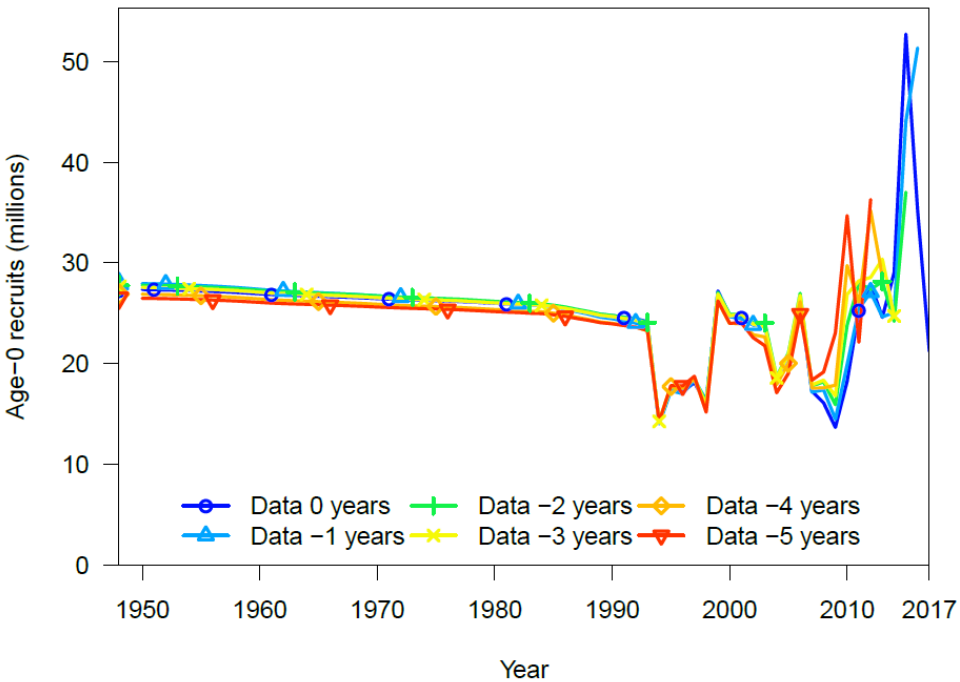




- R_0 (27.3 million fish) well estimated
- Steepness (0.713) and variance (0.3) highly correlated
  - Fixing variance effectively fixes steepness
- Higher steepness values are plausible for highly productive vermilion snapper

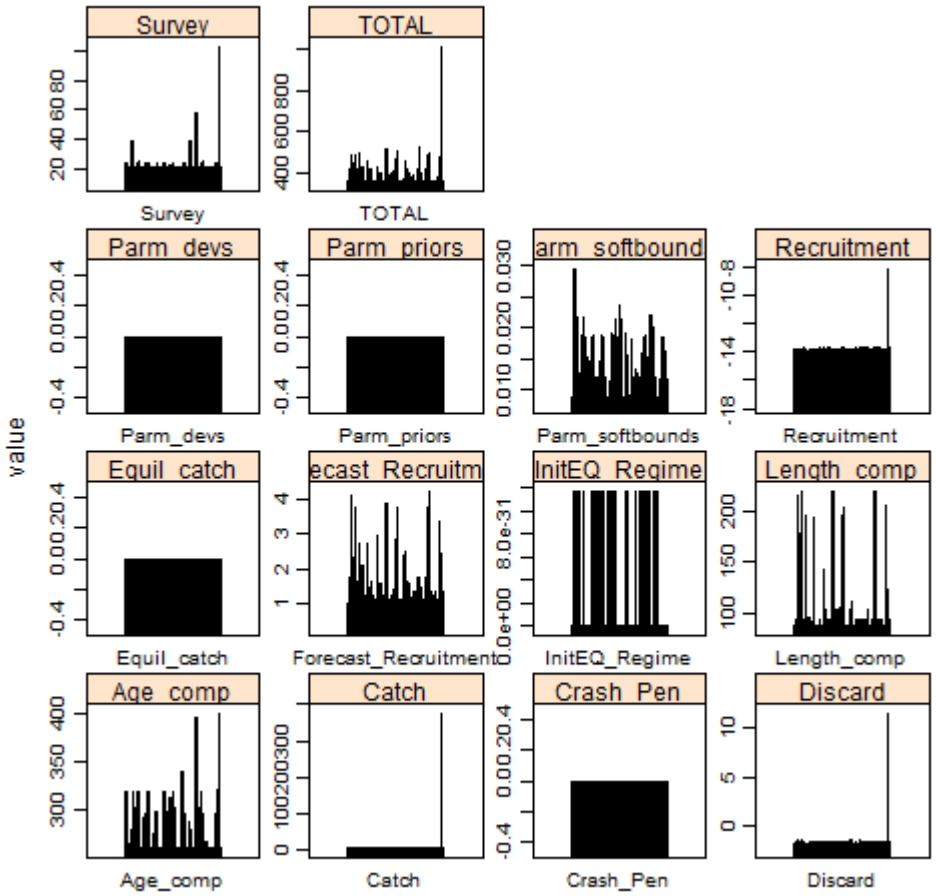
Retrospective Analysis

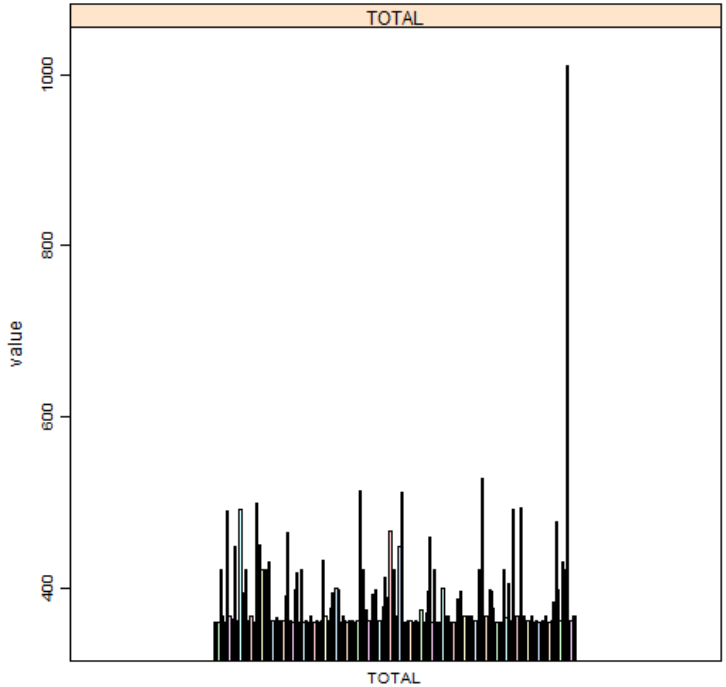




- No pathological trends in estimates of spawning output
- Removing the 2015/2016 recruitment events increases past recruitment estimates

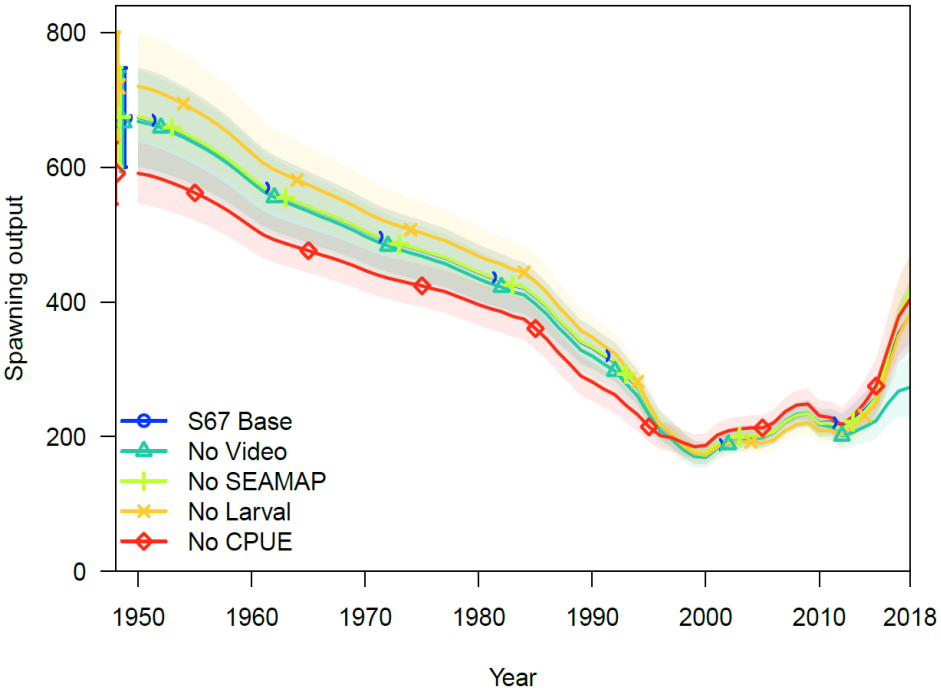
Jitter Analysis

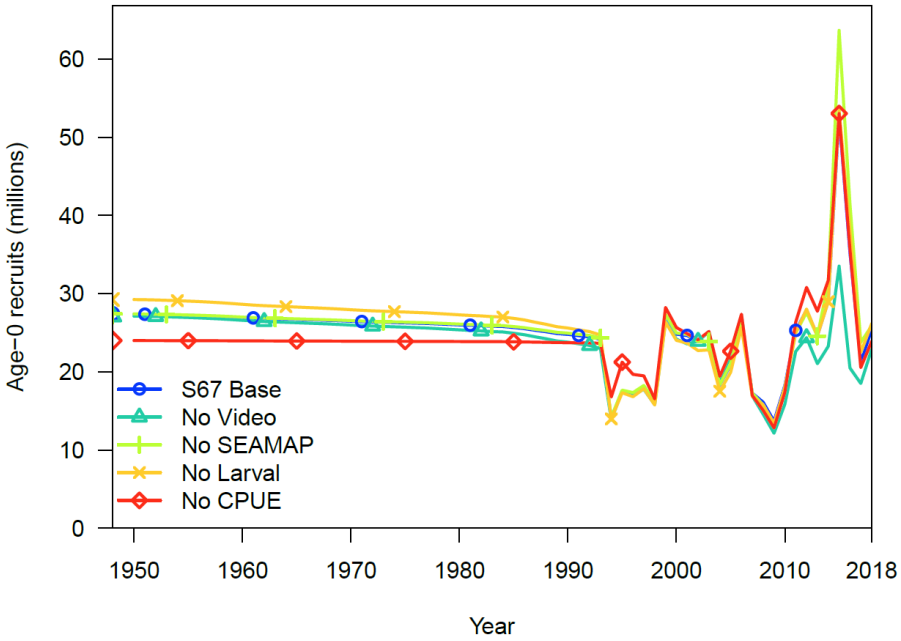




- Jitter value=0.2
- Model is relatively stable
- Survey parameter correlations cause minor instability

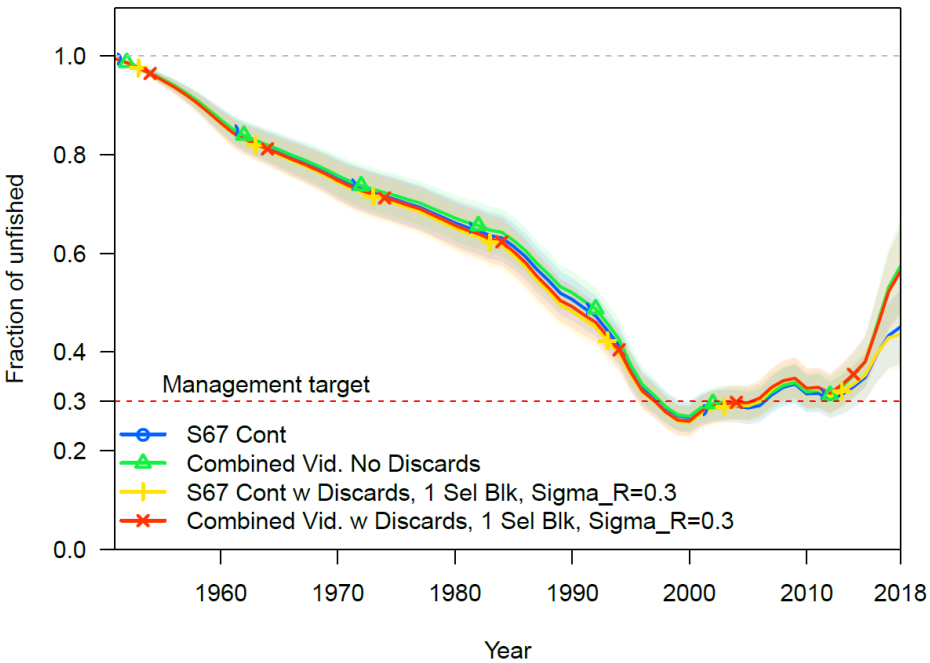
Index Jack-knife

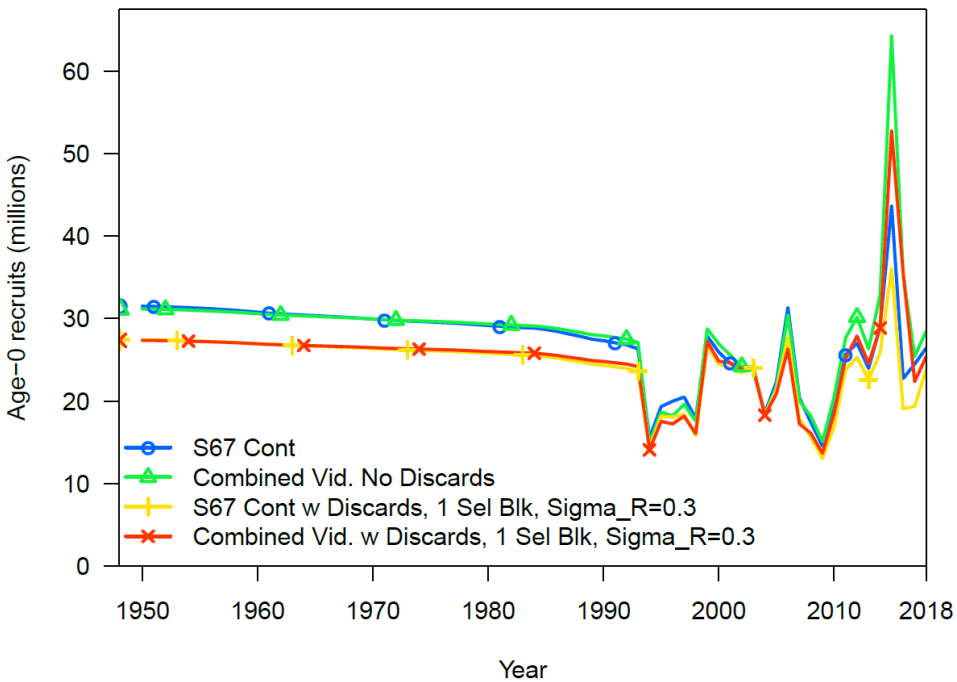




- Indices are generally in agreement
- Video index is a strong driver in estimating the magnitude of the 2015/2016 recruitment event

Continuity vs. Proposed Base Models





- Continuity and Base are in general agreement with the exception of the 2015/2016 recruitment pulse emphasized by the combined video survey

Projections: Assumptions

Projection Assumptions

- Proxies were calculated based on 100 year projections
  - Equilibrium assumed over last 10 years
- $MSST=(0.5)*SSB_{proxy}$
- Recruitment was fixed at (2005-2014) geometric mean
  - Stock-recruit function parameters were not reliably estimated (i.e., uninformative S/R data and high correlation among parameters)

Projection Settings

Parameter	Value	Comment
Relative F	Average from 2015 – 2017	Avg. relative fishing mortality (2015-2017)
Selectivity	Estimates from 2017	Fleet specific selectivity estimated in terminal year
Recruitment	21,965,800	Bias adjusted geometric mean recruitment (2005 – 2014)
Shrimp Bycatch	F = 0.075	Avg. shrimp bycatch fishing mortality (2015-2017)
2018 Landings	4,840,039 lbs. WW	Finalized landings (SEFSC)
2019 Landings	4,366,021 lbs. WW	Three year (2016-2018) avg.
2020 Landings	4,366,021 lbs. WW	Three year (2016-2018) avg.

Uncertainty

- Fixing recruitment and other parameters (e.g., M) led to underestimated uncertainty in SS3 projections
  - Low SR variance also influenced uncertainty
- Uncertainty around forecast yield appears too small to support use of P* approach to setting ABC
- Alternate approach for accounting for uncertainty (e.g., 75%F_{SPR30}) is recommended

Projections: Results

Mortality Rate Metrics

- All values are harvest rates
  - (Age-1+ Number Killed)/(Age-1+ Abundance)

Mortality Rate Criteria	
$F_{SPR30\%}$	0.135
F at Optimum Yield	0.115
$F_{Current}$	0.076
$F_{Current}/MFMT_{FSPR30\%}$	0.56
Geo. Mean $F_{2015\text{-}2017}$	0.075
Mean $F/MFMT_{FSPR30\%}$	0.56

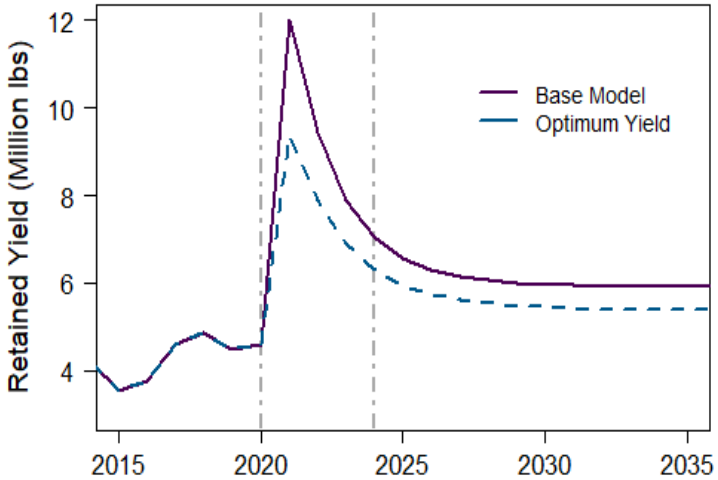
Biomass Metrics

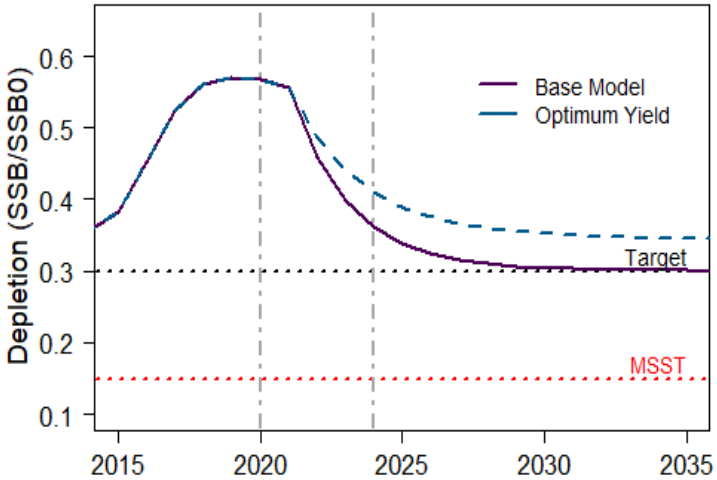
- SSB is in number of eggs

Biomass Criteria	
$SSB_{FSPR30\%}$	2.02E+14
$MSST_{FSPR30\%}$	1.01E+14
SSB at Optimum Yield	2.32E+14
SSB_0	6.73E+14
$SSB_{Current}$	3.53E+14
$SSB_{Current}/SSB_{FSPR30\%}$	1.75
$SSB_{Current}/MSST_{FSPR30\%}$	3.5
$SSB_{Current}/SSB_0$	0.52

Projections at SPR 30%

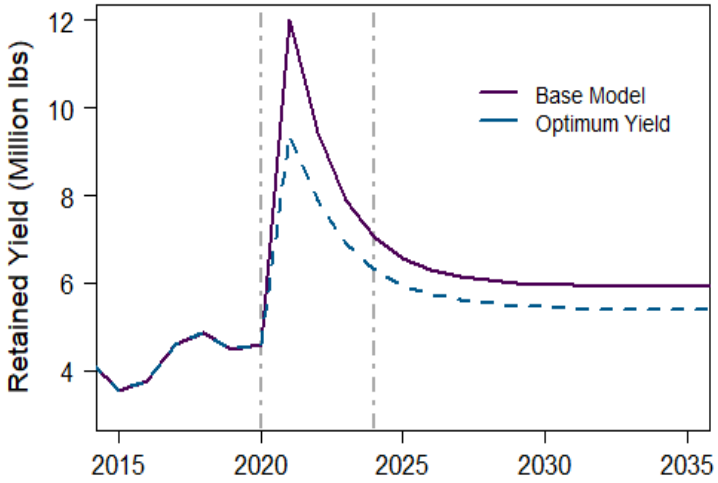
YEAR	R	SSB	$SSB/SSB_{FSPR30\%}$	SSB/MSST	SSB/SSB_0	OFL	ABC
2021	21965.8	3.73E+14	1.85	3.70	0.55	12.03	11.73
2022	21965.8	3.09E+14	1.53	3.06	0.46	9.45	9.25
2023	21965.8	2.68E+14	1.33	2.66	0.40	7.90	7.77
2024	21965.8	2.43E+14	1.21	2.41	0.36	7.04	6.94
2025	21965.8	2.28E+14	1.13	2.26	0.34	6.57	6.48
2026	21965.8	2.19E+14	1.09	2.17	0.33	6.31	6.22
2027	21965.8	2.13E+14	1.06	2.11	0.32	6.16	6.07
2028	21965.8	2.09E+14	1.04	2.07	0.31	6.07	5.98
2029	21965.8	2.07E+14	1.02	2.05	0.31	6.01	5.93
2030	21965.8	2.05E+14	1.02	2.03	0.30	5.97	5.89

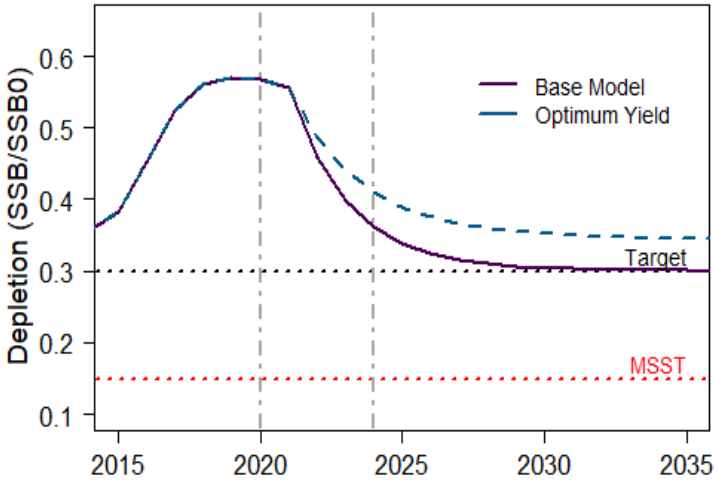




Projections at F_{OY}

YEAR	R	SSB	$SSB/SSB_{FSPR30\%}$	SSB/MSST	SSB/SSB_0	OY
2021	21965.8	3.73E+14	1.85	3.70	0.55	9.37
2022	21965.8	3.28E+14	1.62	3.25	0.49	7.87
2023	21965.8	2.96E+14	1.47	2.94	0.44	6.89
2024	21965.8	2.75E+14	1.36	2.73	0.41	6.29
2025	21965.8	2.61E+14	1.30	2.59	0.39	5.95
2026	21965.8	2.52E+14	1.25	2.50	0.37	5.74
2027	21965.8	2.46E+14	1.22	2.44	0.37	5.62
2028	21965.8	2.42E+14	1.20	2.40	0.36	5.54
2029	21965.8	2.39E+14	1.18	2.37	0.35	5.48
2030	21965.8	2.37E+14	1.17	2.34	0.35	5.45





Project SEDAR 45 with FES Landings

- Update S45 base model with FES landings
  - For gap fill years in projections:
    - Use finalized 2015 and 2016 FES landings, for rec
    - Use original (provisional/assumed) landings for all other fleets

Model	Terminal Year	SSB	R	F_{SPR30}	SSB_0	SSB_{FSPR30}	Equil. Yield
SEDAR 45	2014	1.91E+14	17343.3	0.103	6.56E+14	1.97E+14	3.35
SEDAR 45 FES	2014	2.28E+14	22561.0	0.14	6.51E+14	1.96E+14	5.19
SEDAR 67 Base	2017	2.22E+14	21965.8	0.135	6.73E+14	2.02E+14	5.91

  - FES accounts for majority of increase in forecast yield

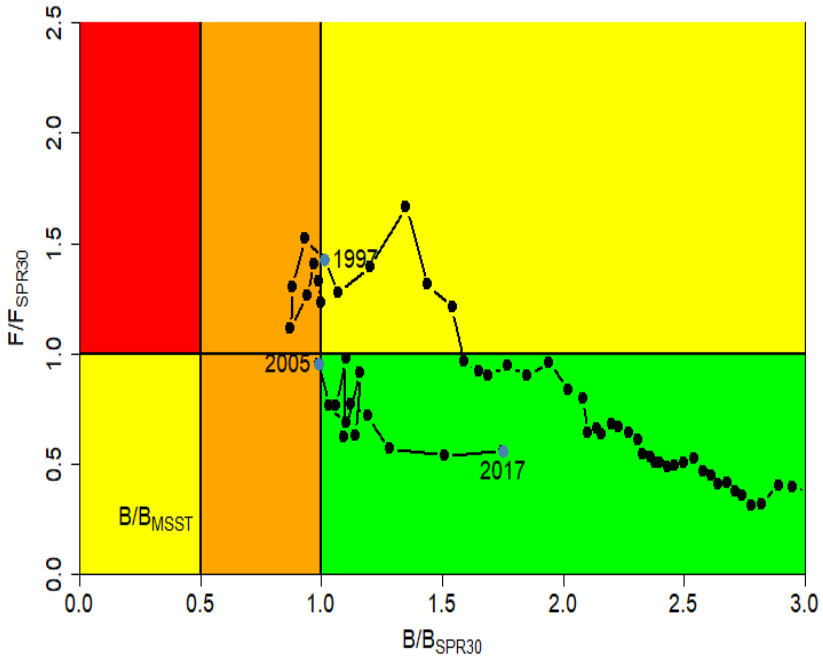
Summary

Important Model and Data Changes

- Migrated SS 3.24 to SS 3.30
- Transition to FES MRIP data
  - Increases estimates of SSB, recruitment, and stock status
- Discards included but not fit
- Combined video index favored over continuity
  - Major impact on the estimated magnitude of recent recruitment events
- Commercial CPUE timeseries was truncated
- Projections severely underestimated uncertainty requiring an alternate method to account for uncertainty buffer

Model Results

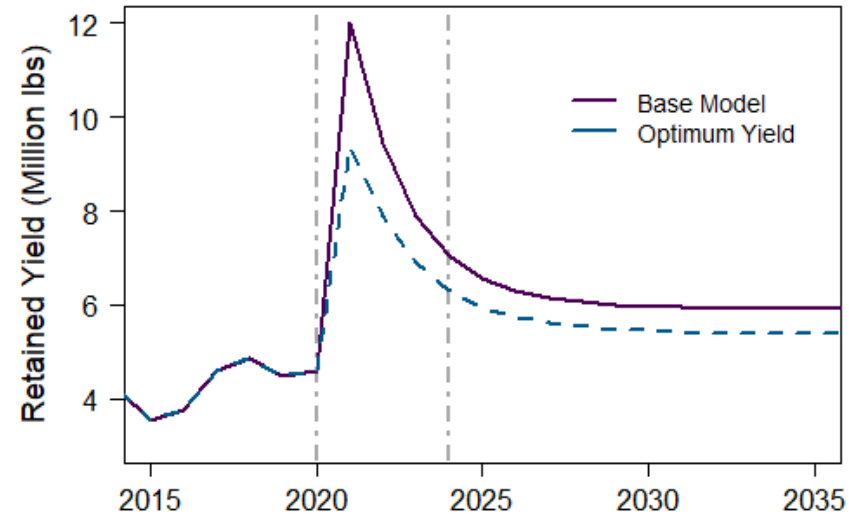
- The SS3 model was generally stable once discards were no longer fit
- F has generally declined and SSB has rapidly increased over the last decade due in part to favorable recruitment events
- Stock status:
  - Not overfished
  - Overfishing is not occurring

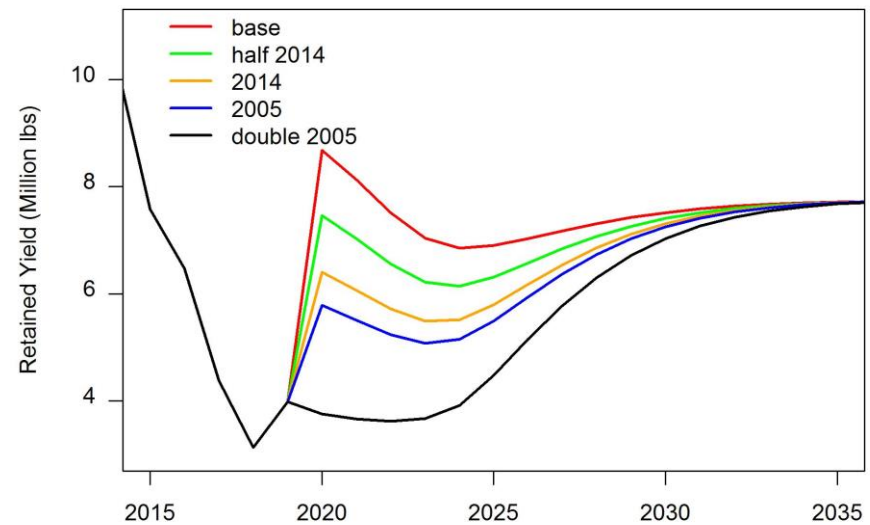


YEAR	F/FSPR30%	$SSB/SSB_{FSPR30\%}$	$SSB/MSST_{FSPR30\%}$	SPR
2017	0.56	1.75	3.50	0.52
2018	0.56	1.87	3.74	0.56
2019	0.54	1.90	3.80	0.57
2020	0.56	1.89	3.79	0.57

Understanding Yield“Spikes”

- “Spikes” in forecasted yield occur commonly in assessment
- Occurrence of spikes has raised questions over the validity of projection methodology.

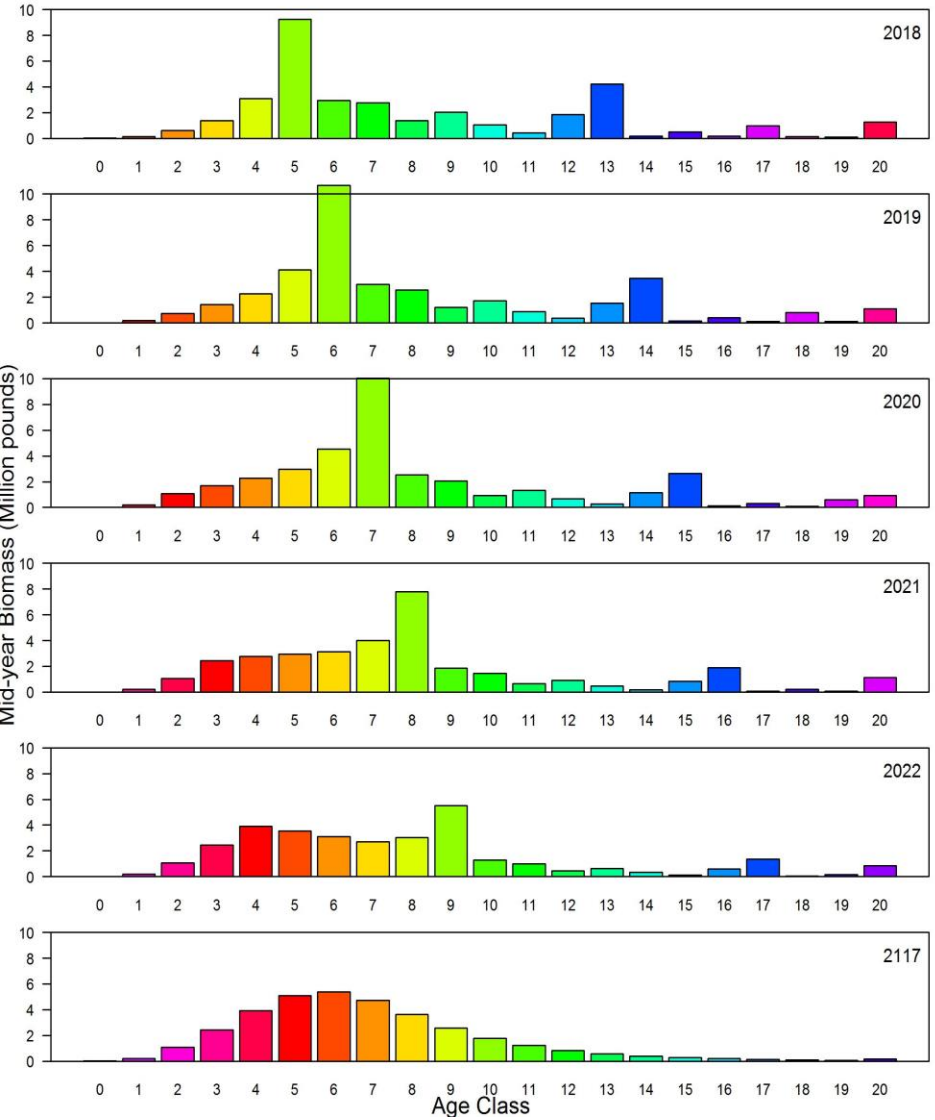


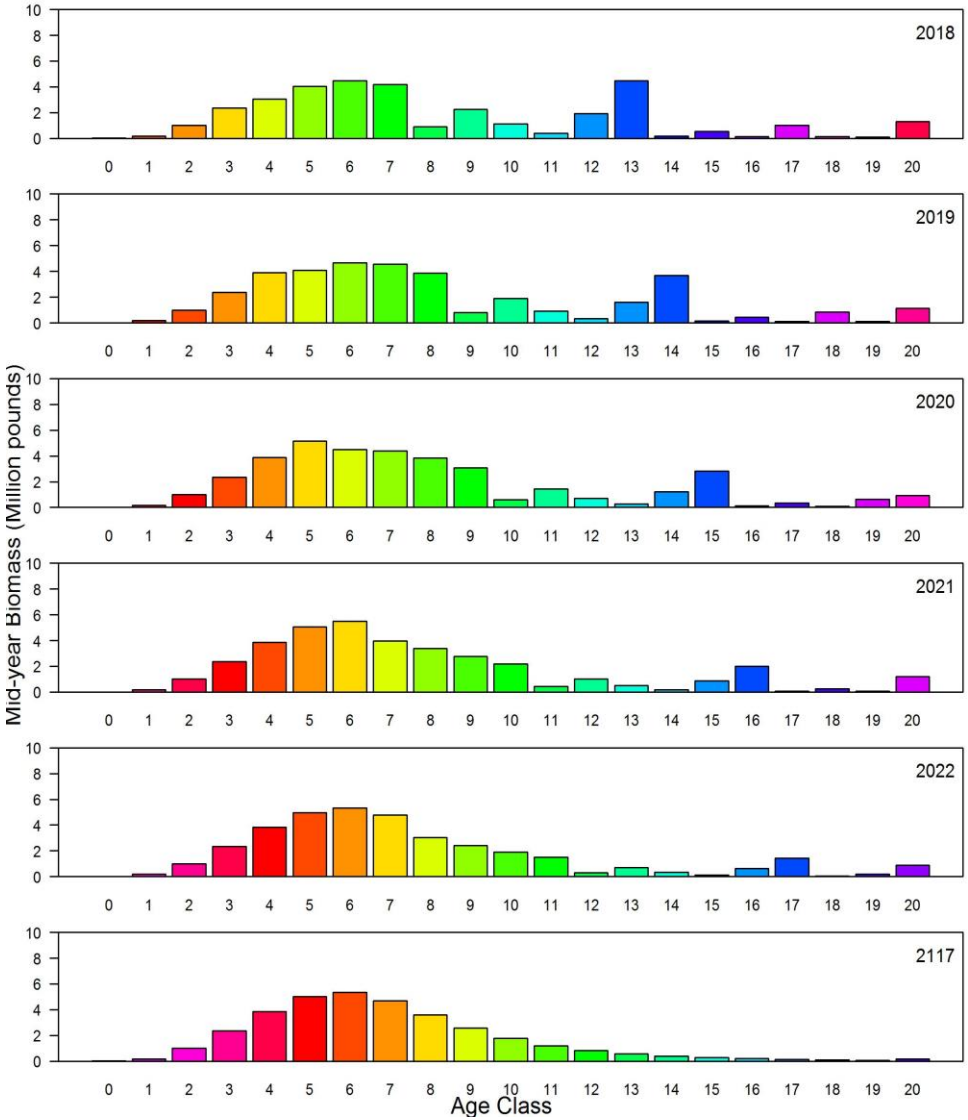


Understanding Yield Spikes

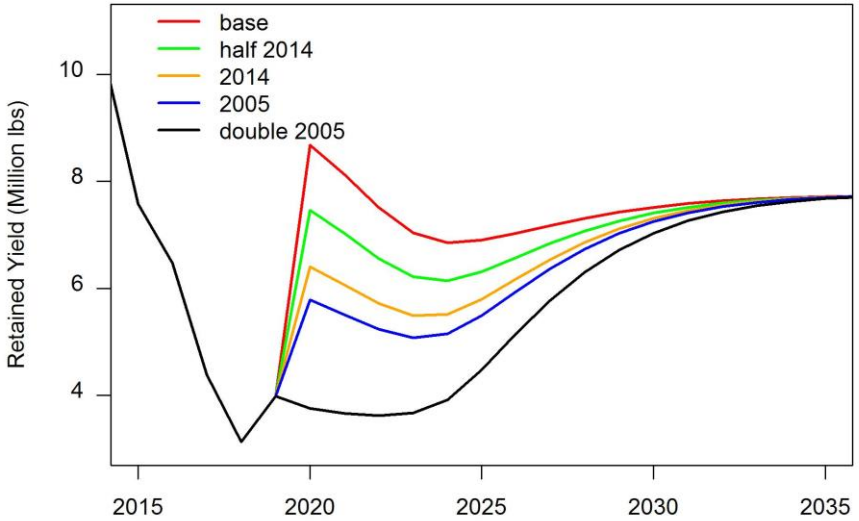
- Investigations by NMFS have determined that spikes are not being produced in error and come about from 3 main factors
  - Extant composition vs. Equilibrium composition
  - Ratio of F/F_{MSY}
  - Intractable forecast request in SS

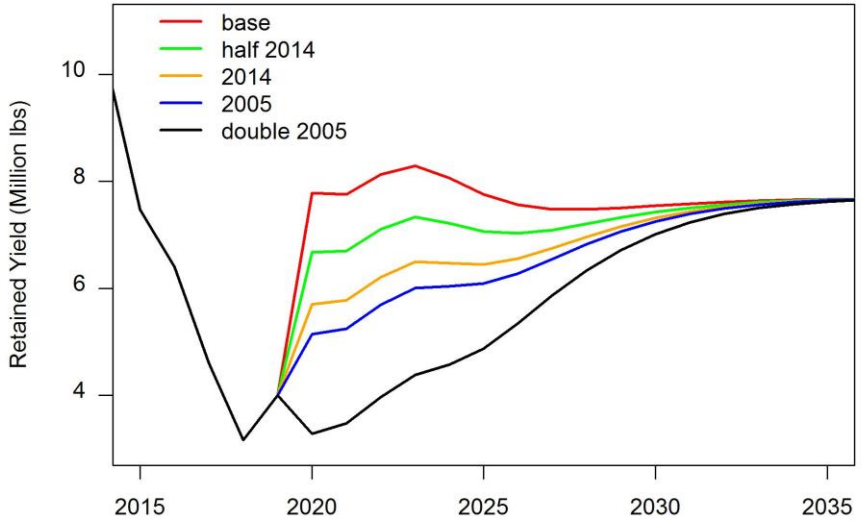
F30%SPR Projection Excluding 2011-17 Rec devs

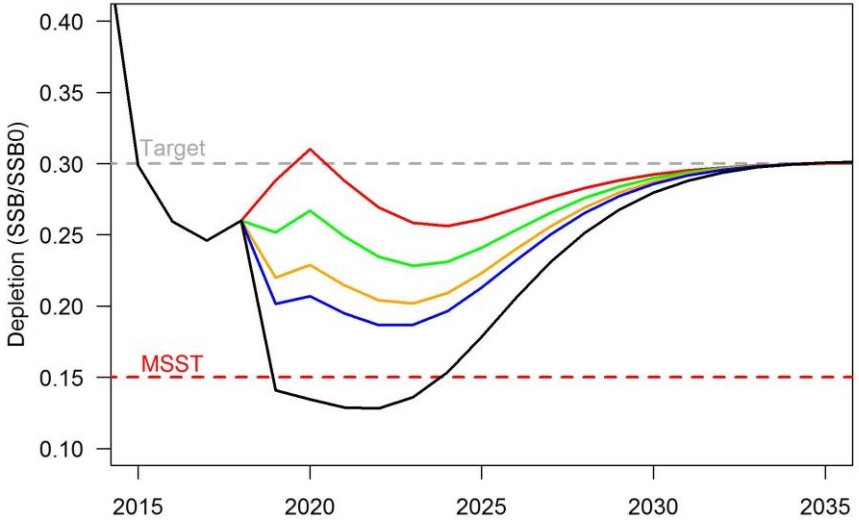


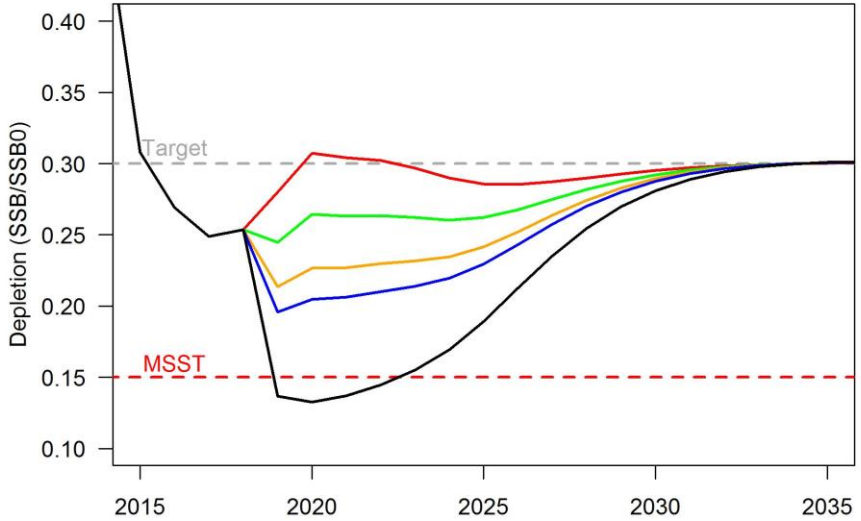


F30%SPR Projection Excludes 2011-17 Rec devs









Ratio of F/F_{MSY}

- F/F_{MSY} often below 1
- We should hope to see this in well managed fishery
- However, projections fish at F_{MSY} (i.e., F increase in projections)

Year	F	F/MFMT	SSB	$SSB/SSB_{SPR30\%}$	$SSB/MSST_{OLD}$	$SSB/MSST_{NEW}$	SSB/SSB_0
2010	0.10	0.40	1,129,040	1.51	1.76	3.02	0.45
2011	0.15	0.56	1,279,980	1.71	2.00	3.42	0.51
2012	0.18	0.70	1,342,310	1.79	2.10	3.59	0.54
2013	0.19	0.74	1,291,330	1.73	2.02	3.45	0.52
2014	0.22	0.83	1,165,080	1.56	1.82	3.11	0.47
2015	0.23	0.89	745,182	1.00	1.16	1.99	0.30
2016	0.22	0.84	647,213	0.86	1.01	1.73	0.26
2017	0.16	0.62	613,517	0.82	0.96	1.64	0.25

YEAR	F	F/FSPR30%	SSB	$SSB/SSB_{FSPR30\%}$	$SSB/MSST_{FSPR30\%}$	SPR
2010	0.08	0.62	2.21E+14	1.09	2.19	0.33
2011	0.13	0.98	2.22E+14	1.10	2.20	0.33
2012	0.10	0.77	2.14E+14	1.06	2.12	0.32
2013	0.10	0.78	2.26E+14	1.12	2.24	0.34
2014	0.10	0.72	2.40E+14	1.19	2.38	0.36
2015	0.08	0.57	2.58E+14	1.28	2.55	0.38
2016	0.07	0.54	3.04E+14	1.51	3.02	0.45
2017	0.08	0.56	3.53E+14	1.75	3.50	0.52

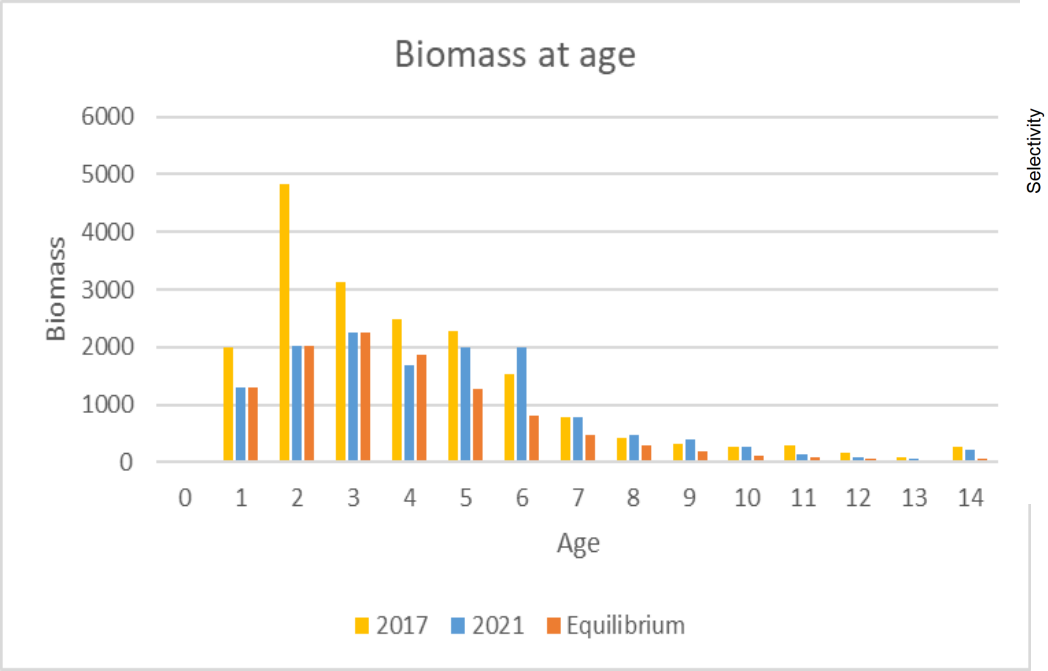
Asking too much from Forecast

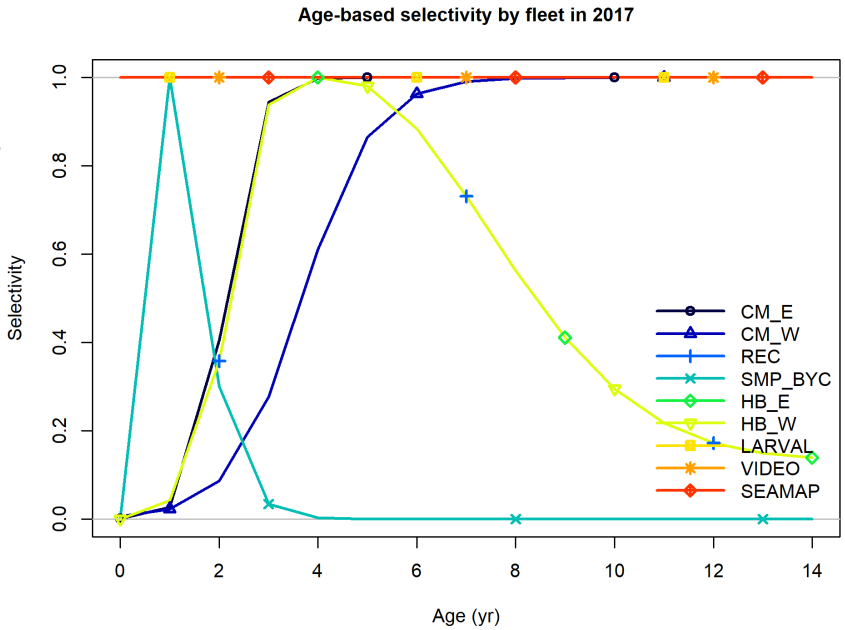
- Can't hold fleet allocation and relative F constant throughout projections with variable selectivity and age composition

Year	Harvest Rate	HL_E	HL_W	LL_E	LL_W	MRIP_E	MRIP_W	HBT_E	HBT_W
2018	0.064	0.178	0.133	0.017	0.002	0.309	0.039	0.024	0.017
2019	0.062	0.173	0.129	0.016	0.002	0.322	0.041	0.025	0.018
2020	0.060	0.168	0.125	0.016	0.002	0.336	0.042	0.027	0.018
2021	0.060	0.164	0.122	0.015	0.002	0.349	0.044	0.028	0.019
2022	0.059	0.161	0.119	0.015	0.001	0.360	0.045	0.028	0.020
2023	0.059	0.159	0.118	0.015	0.001	0.368	0.046	0.029	0.020
2024	0.059	0.158	0.116	0.015	0.001	0.374	0.047	0.030	0.020
2073	0.059	0.156	0.114	0.015	0.001	0.386	0.048	0.031	0.021
2074	0.059	0.156	0.114	0.015	0.001	0.386	0.048	0.031	0.021
2075	0.059	0.156	0.114	0.015	0.001	0.386	0.048	0.031	0.021
2076	0.059	0.156	0.114	0.015	0.001	0.386	0.048	0.031	0.021

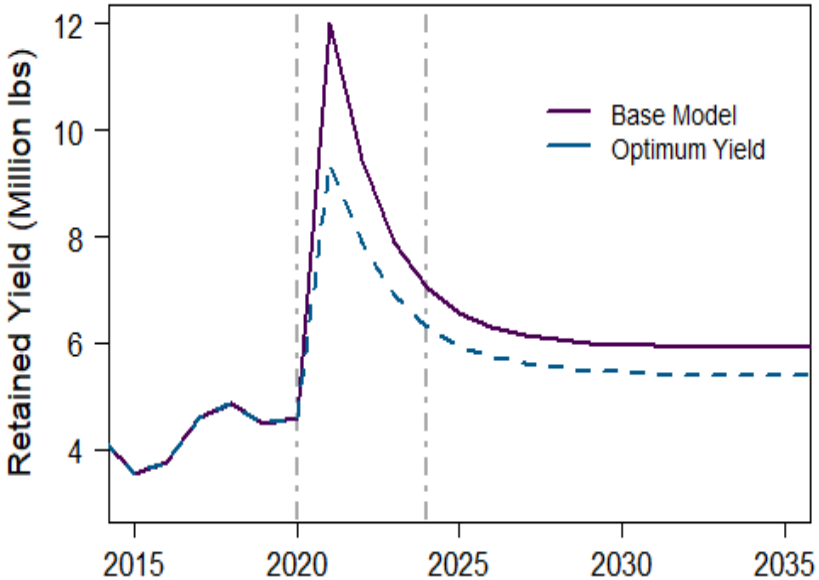
C_Clsd_E	C_Clsd_W	R_Clsd_E	R_Clsd_W	Shr_E	Shr_W
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154
0.003	0.001	0.428	0.032	0.007	0.154

Vermilion conditions





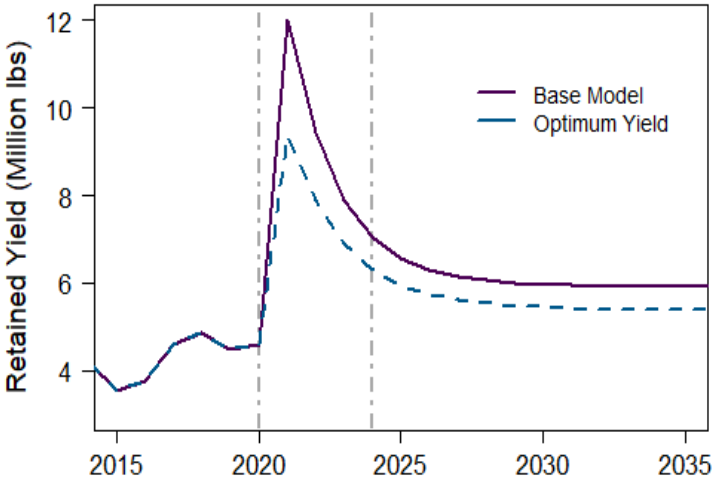
YEAR	F	F/FSPR30%	SSB	$SSB/SSB_{FSPR30\%}$	$SSB/MSST_{FSPR30\%}$
2010	0.08	0.62	2.21E+14	1.09	2.19
2011	0.13	0.98	2.22E+14	1.10	2.20
2012	0.10	0.77	2.14E+14	1.06	2.12
2013	0.10	0.78	2.26E+14	1.12	2.24
2014	0.10	0.72	2.40E+14	1.19	2.38
2015	0.08	0.57	2.58E+14	1.28	2.55
2016	0.07	0.54	3.04E+14	1.51	3.02
2017	0.08	0.56	3.53E+14	1.75	3.50

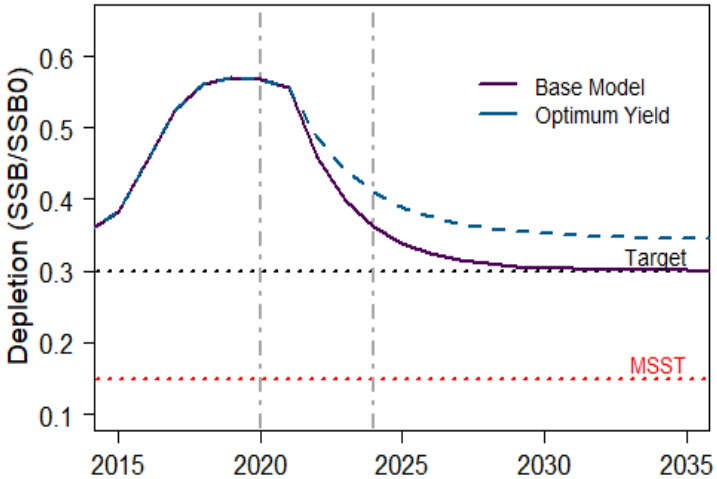


Proposed ABC yield streams

Year	OFL	ABC (P*)	ABC (75%F_{SPR30})
2021	12.03	11.73	9.37
2022	9.45	9.25	7.87
2023	7.9	7.77	6.89
2024	7.04	6.94	6.29
2025	6.57	6.48	5.95
3yr Avg.	9.79	9.58	8.04
5yr Avg.	8.60	8.43	7.27
10yr Avg.	7.35	7.23	6.42

P* = 0.398





Questions

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