SEDAR 45 Gulf of Mexico Vermilion Snapper Stock Assessment: Data/ Assessment workshop

Matthew W. Smith

Daniel R. Goethel

November 17, 2015

Outline

- Assessment history
- Data comparisons to 2011 update
- Continuity run development
- Final continuity run
- Base model investigations

Assessment History

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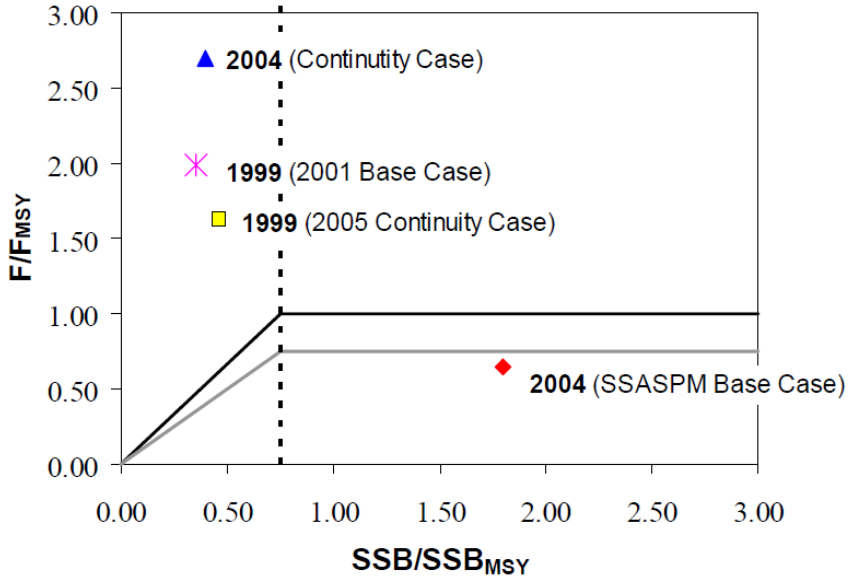
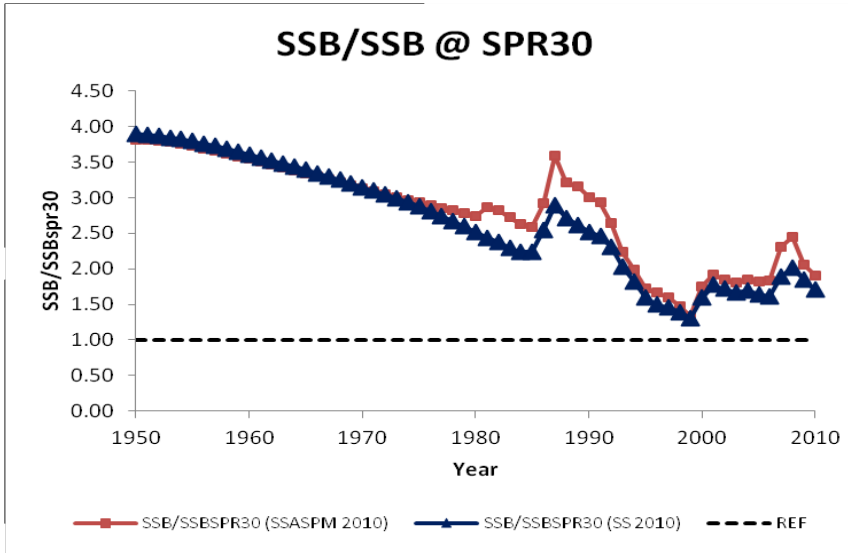
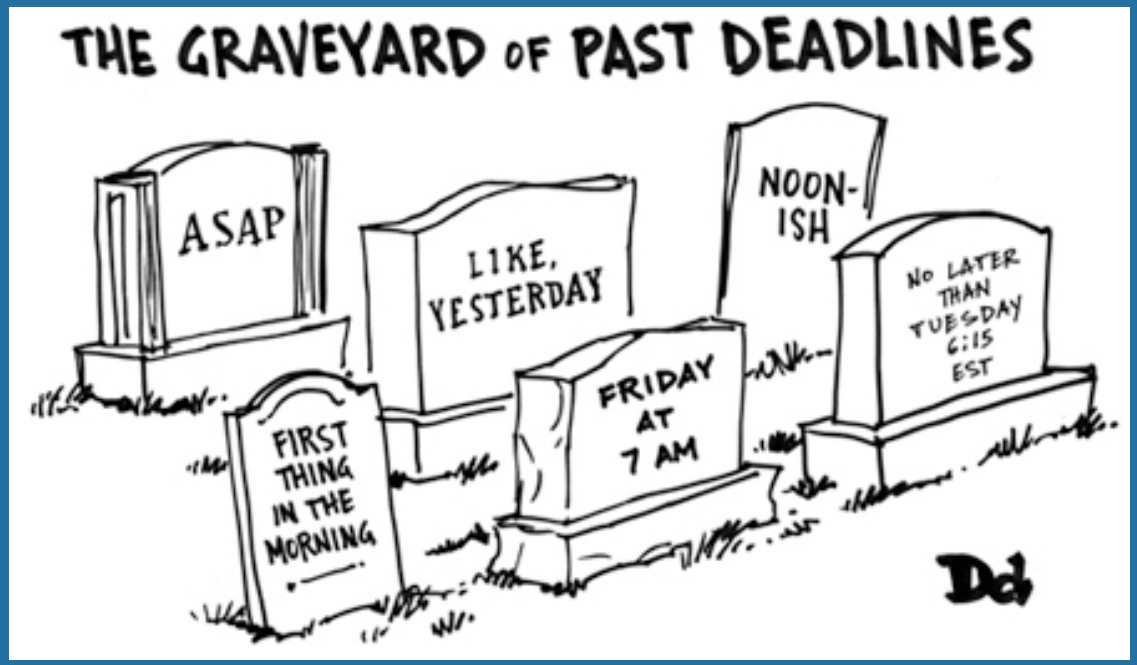
Previous Assessments

- State-space age-structured production model (SSASPM; SEDAR 9, 2006)
  - Direct age samples
  - Assumed virgin conditions in 1950 (linear *F* interpolations)
  - Commercial handline CPUE (East/West)
  - Headboat CPUE (East/West)
  - MRFSS (East)
  - Constant shrimp bycatch
- SSASPM (Calay, 2010)
  - Average shrimp bycatch
  - Shrimp effort index
- Stock Synthesis exploratory run (Linton, 2010)
  - Assumed virgin conditions in 1950 (linear *catch* interpolations)
  - No error in catch
  - Recruitment bias adjustment
  - Constant shrimp bycatch





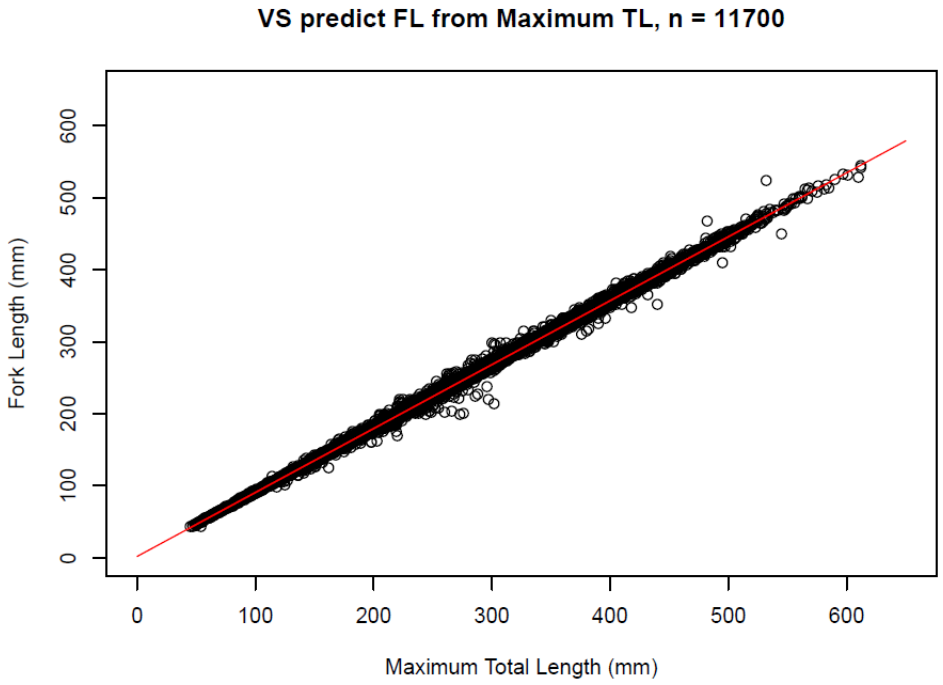
Data


THE GRAVEYARD OF PAST DEADLINES
ASAP
LIKE, YESTERDAY
NOON-ISH
NO LATER THAN TUESDAY 6:15 EST
FIRST THING IN THE MORNING
FRIDAY AT 7 AM
Dd

Data

- Submitted data sets
  - Commercial landings
  - Recreational Landings
  - Recreational Discards
  - Reweighted age composition
  - Shrimp effort
  - Commercial CPUE
  - Recreational CPUE
  - Life history relationships (growth and maturity)
  - SEAMAP survey
  - Video survey
- Needed:
  - Shrimp bycatch
  - Historic rec landings
  - Commercial discards

Length-Weight



SEDAR 45 (converting to FL)

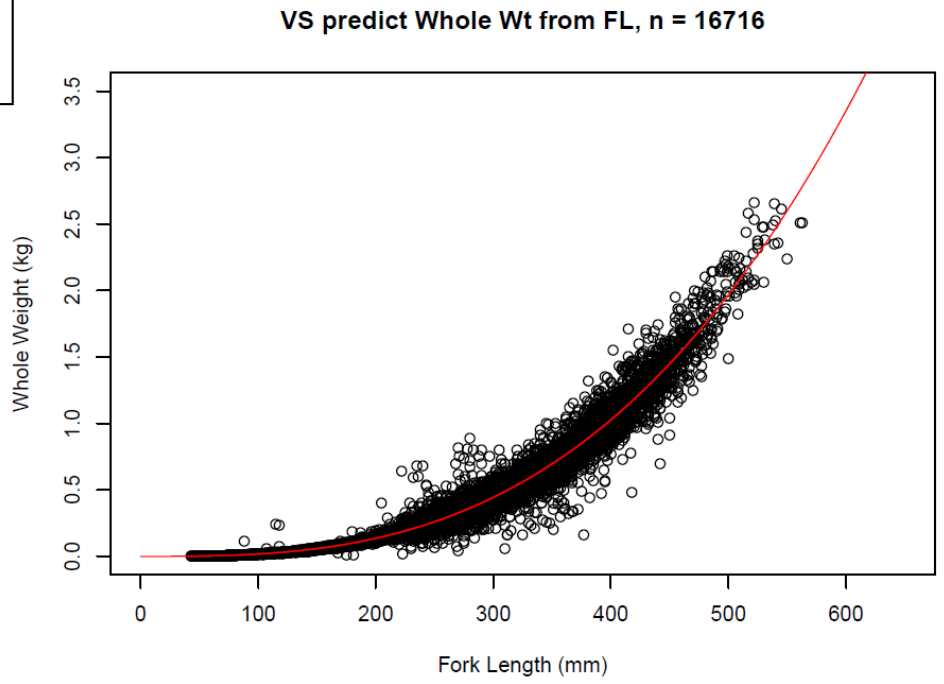
FL (mm)= 0.8876 *TL(mm) + 1.980

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

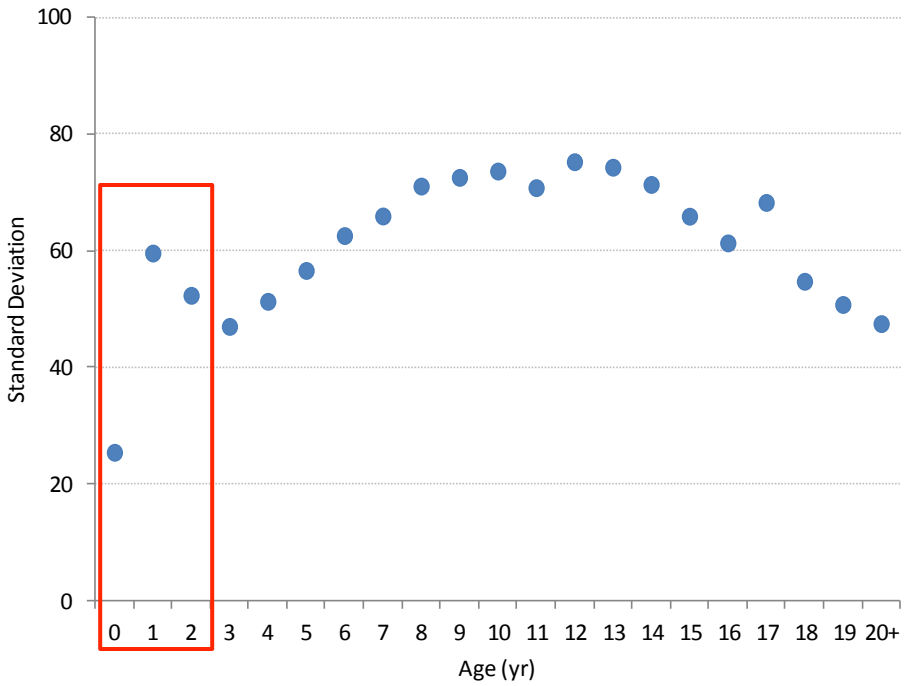
SEDAR 9 (converting to TL)

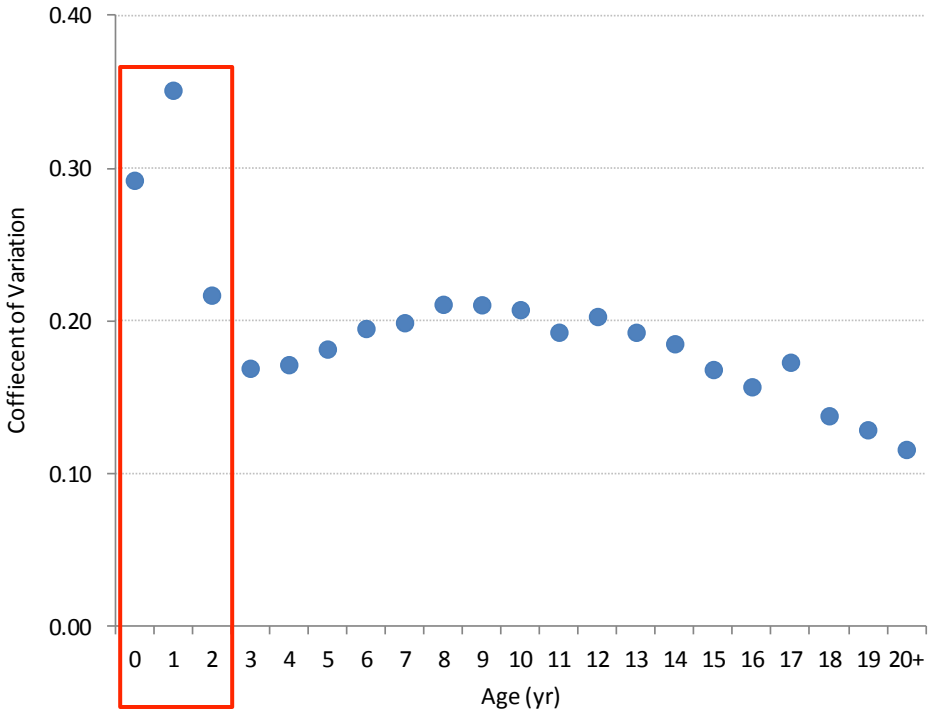
TL(mm)= 1.11 * FL(mm) - 0.16

WW (kg) = 2E-08 * TL(mm) $^{2.98}$



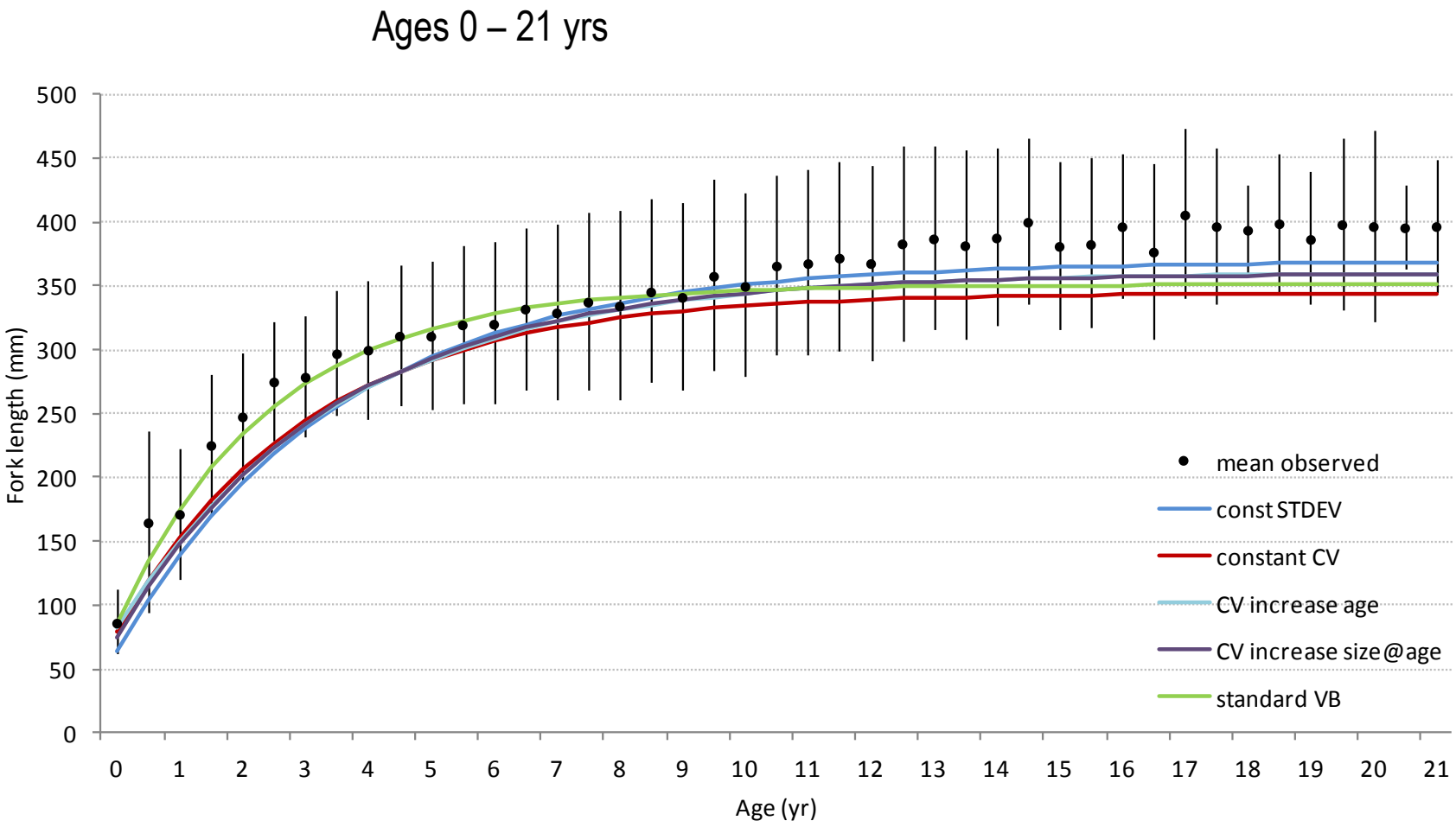
Age and Growth Data: Variation of size-at-age data





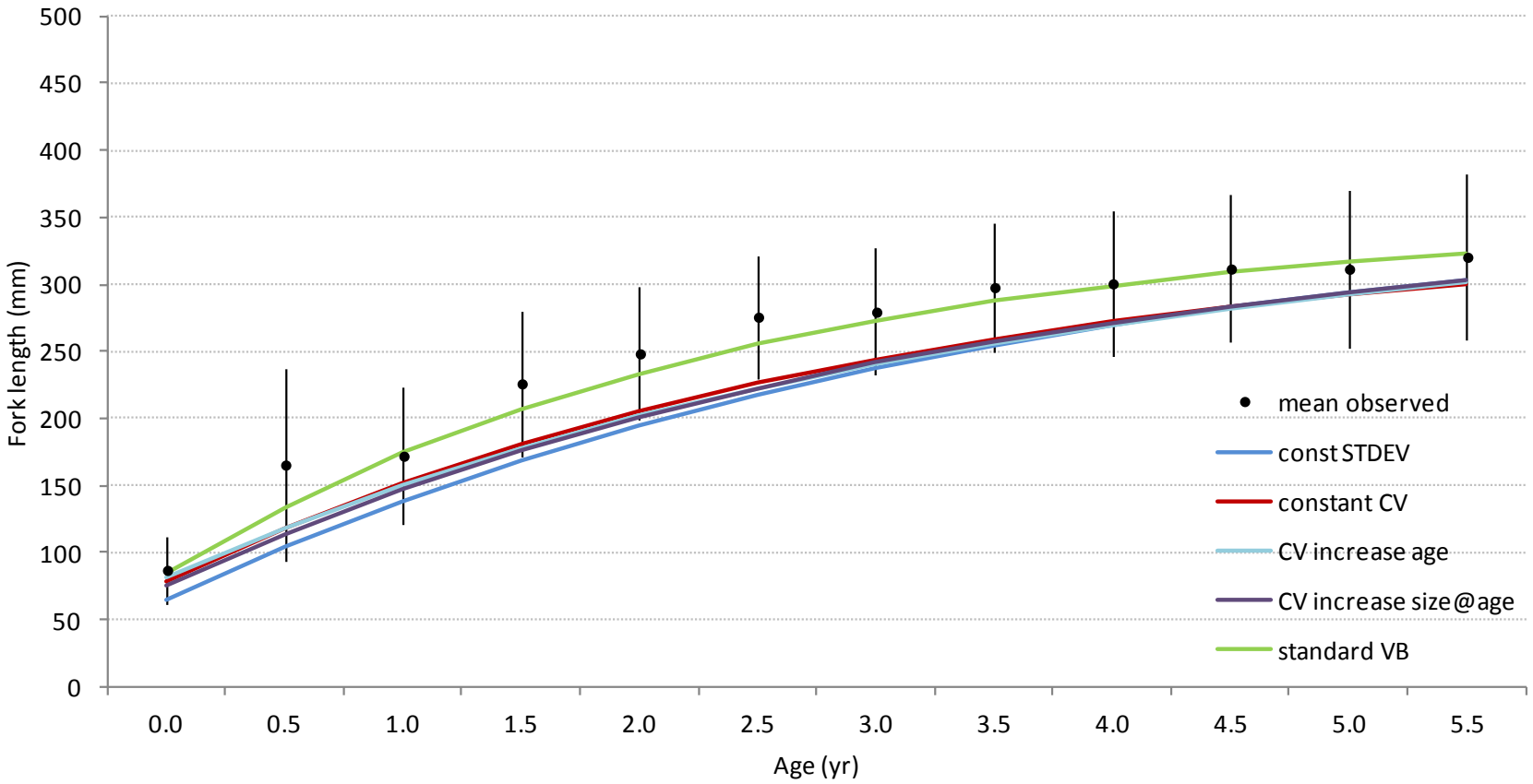
VS unique pattern of variation at size-at-age

Age and Growth Data: predicted vs observed



Age and Growth Data: predicted vs observed

Ages 0 –5.5 yrs



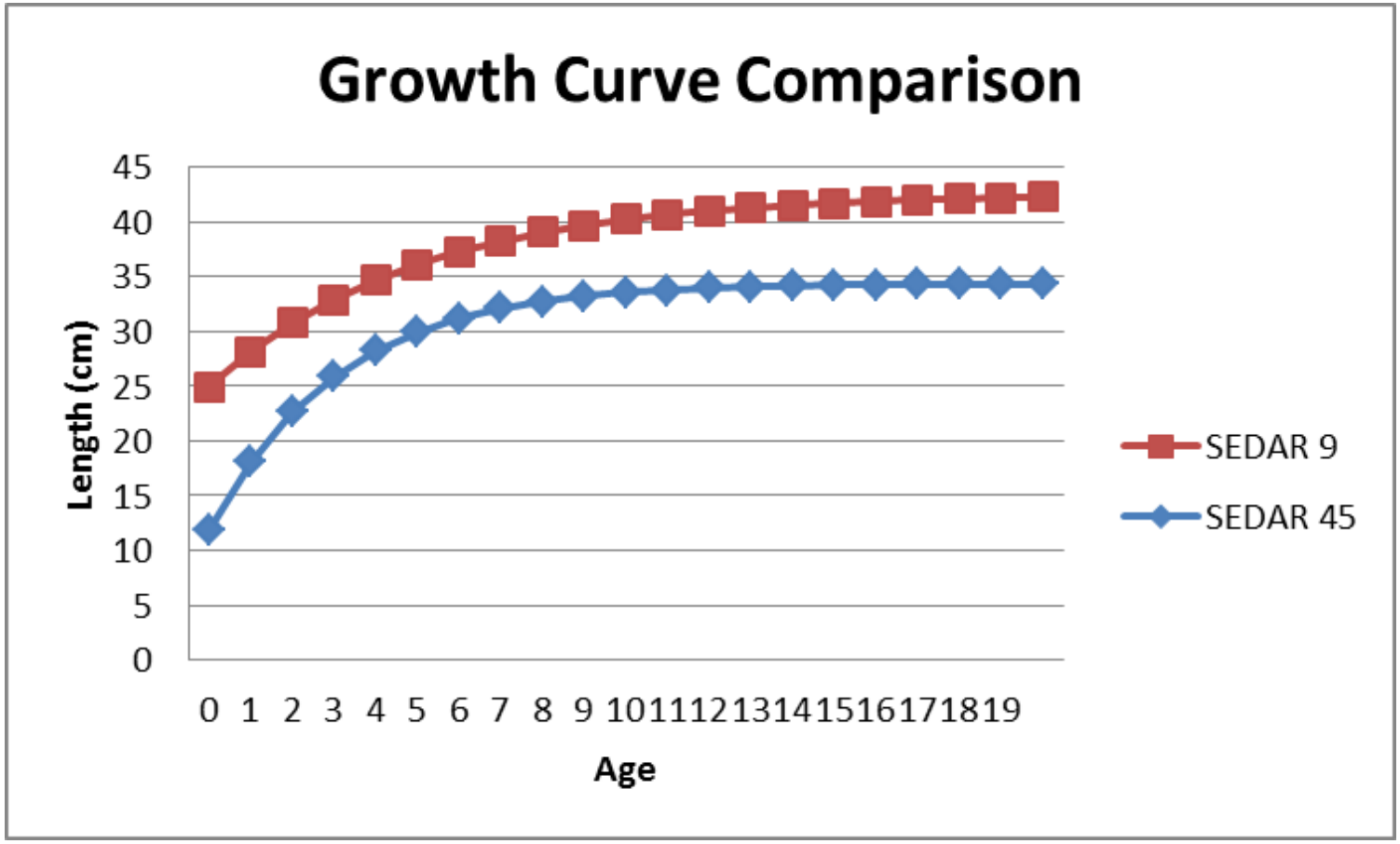
Age and Growth Data: predicted parameters

Growth curve parameters ± standard deviation (L_∞ - asymptotic length, k – growth coefficient, t_0 – size at time zero, sigma – standard deviation, CV – coefficient of variation)

Model	n	L_∞	k	t_0	Sigma	CV
Constant CV	46548 [2]	344 ± 1.28 (FL)	$0.3254 \pm 4.4 \times 10^{-3}$	$-0.7953 \pm 2.1 \times 10^{-2}$		$0.2535 \pm 1.4 \times 10^{-3}$
Constant std dev	46548 [2]	369 ± 1.77 (FL)	$0.2802 \pm 5.7 \times 10^{-3}$	$-0.6799 \pm 4.6 \times 10^{-2}$	68.32 ± 0.30	
Increase CV w/ Age	46548 [2]	360 ± 2.03 (FL)	$0.2817 \pm 5.4 \times 10^{-3}$	$-0.9102 \pm 2.8 \times 10^{-2}$		$0.2798 \pm 2.9 \times 10^{-3}$ $0.1720 \pm 6.6 \times 10^{-3}$
Increase CV w/ Size-at-Age	46548 [2]	360 ± 1.62 (FL)	$0.2922 \pm 4.3 \times 10^{-3}$	$-0.8025 \pm 2.2 \times 10^{-2}$		$0.3350 \pm 4.9 \times 10^{-3}$ $0.2158 \pm 2.3 \times 10^{-3}$
Standard VB	47197	351 ± 7.5 (FL)	$0.4100 \pm 5.4 \times 10^{-3}$	$-0.6721 \pm 2.9 \times 10^{-2}$		
SEDAR9 & update	7980	426 (TL), 380 ([1]FL)	0.20	-3.9		

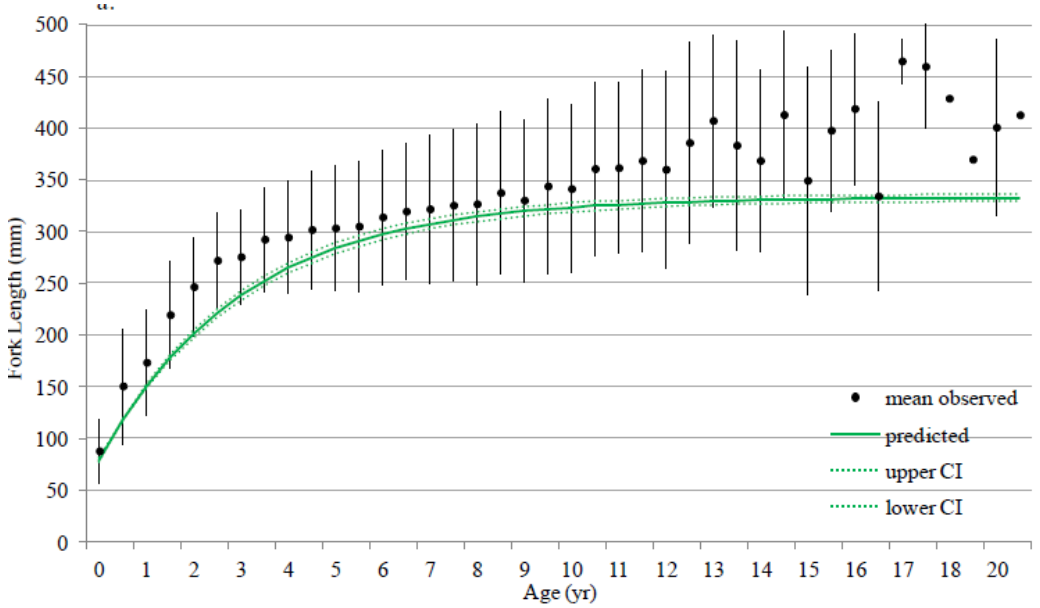
[1] Fork length predicted from total length, using FL = 1.98 + TL * 0.8876
[2] Size-Modified growth model removes records FL < size limit, n = 649

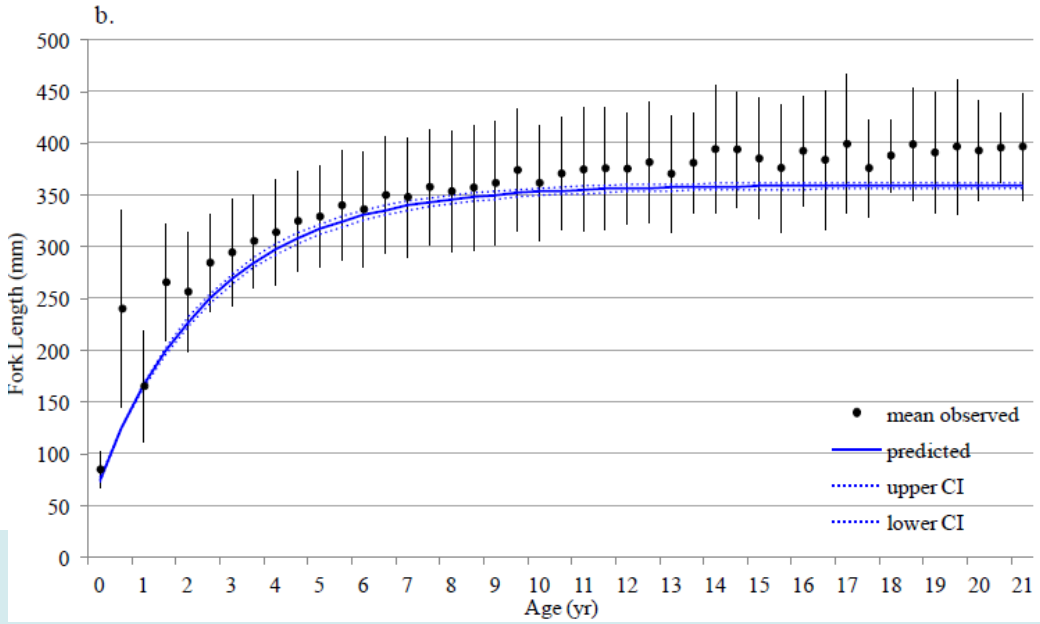
Previous Growth Curve



	SEDAR 9	SEDAR 45
L_∞	42.6	34.4
K	0.2	0.33
t_0	-3.9	-0.8

Growth by Region





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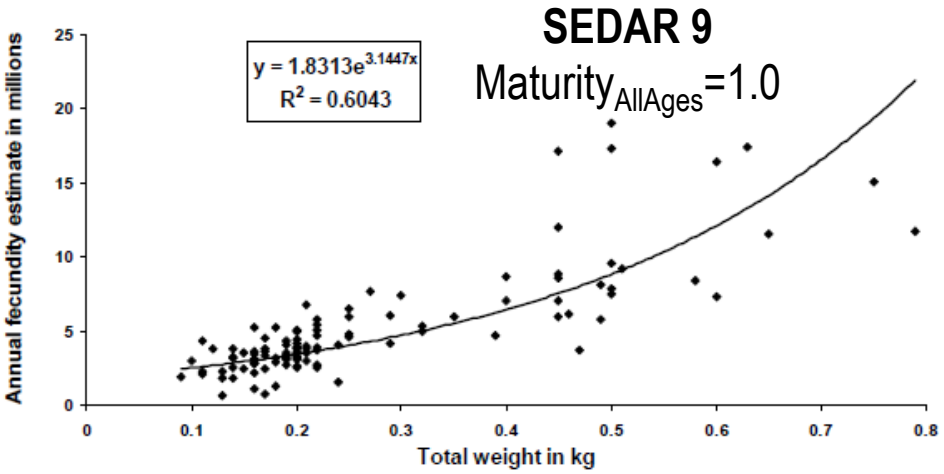
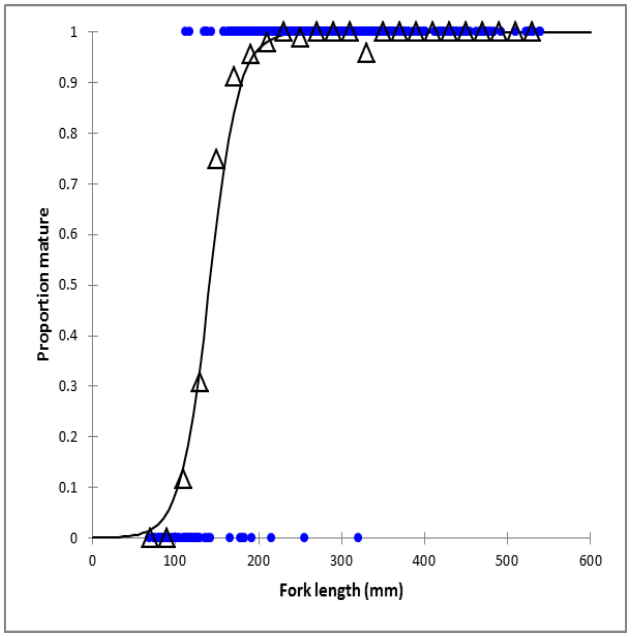
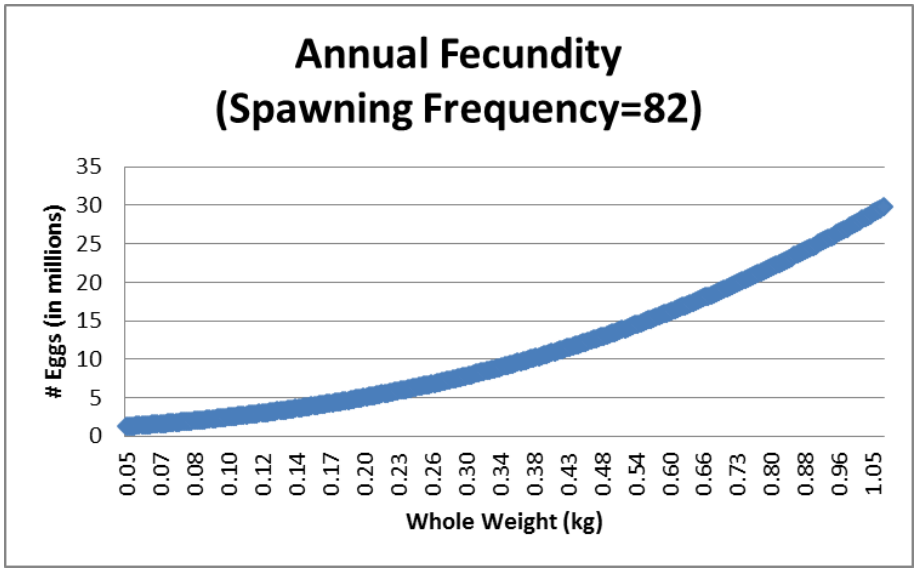
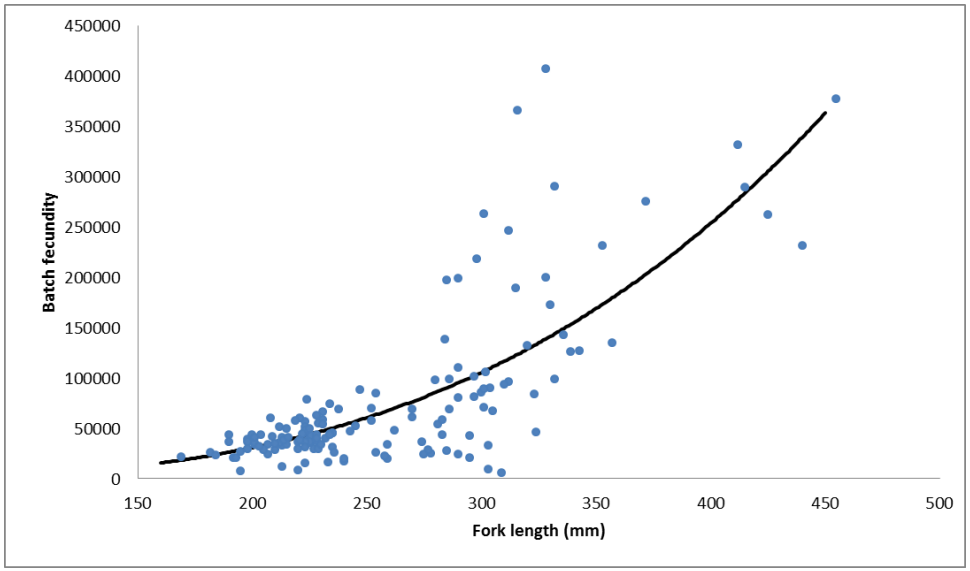
Fecundity and Maturity





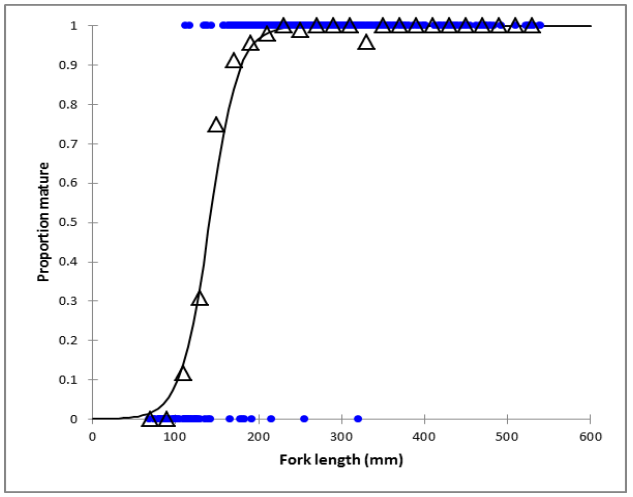


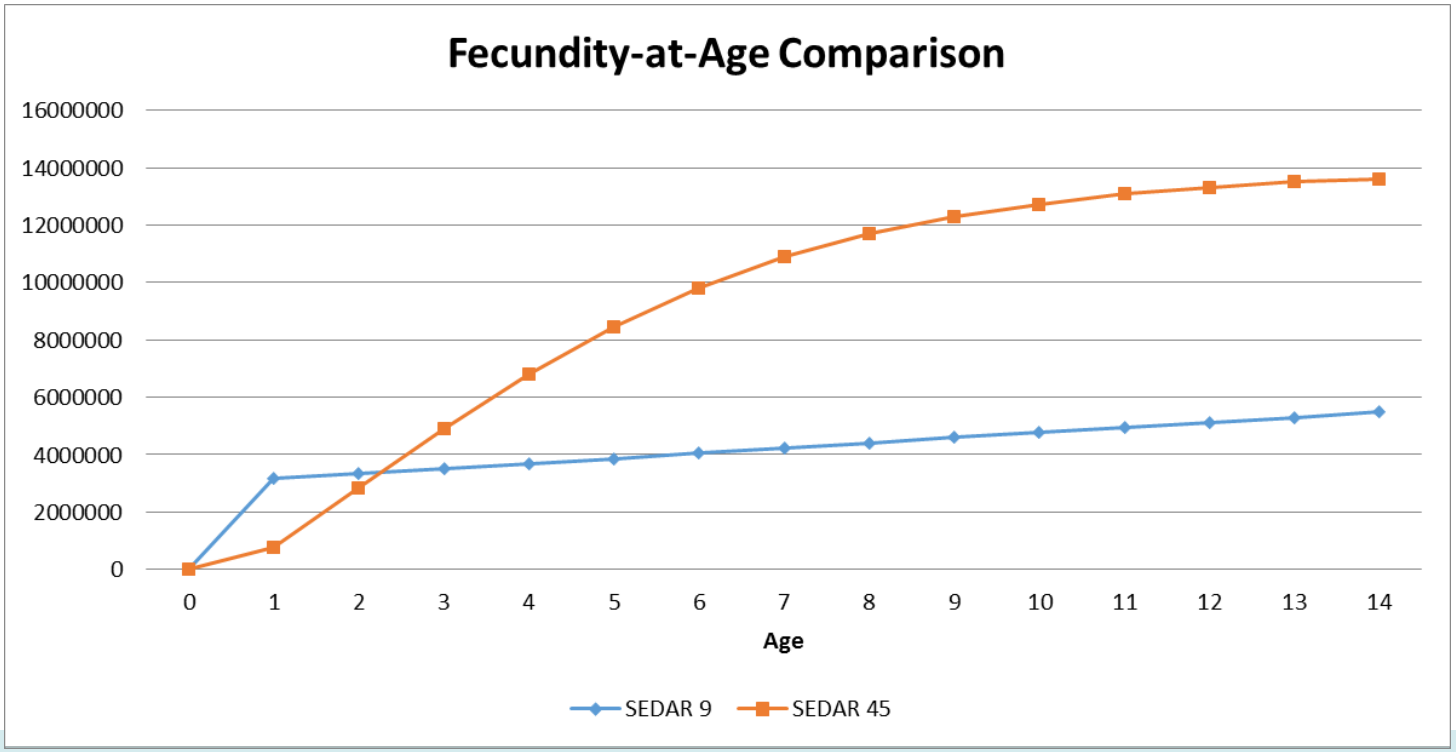


Fecundity and Maturity

SEDAR 9

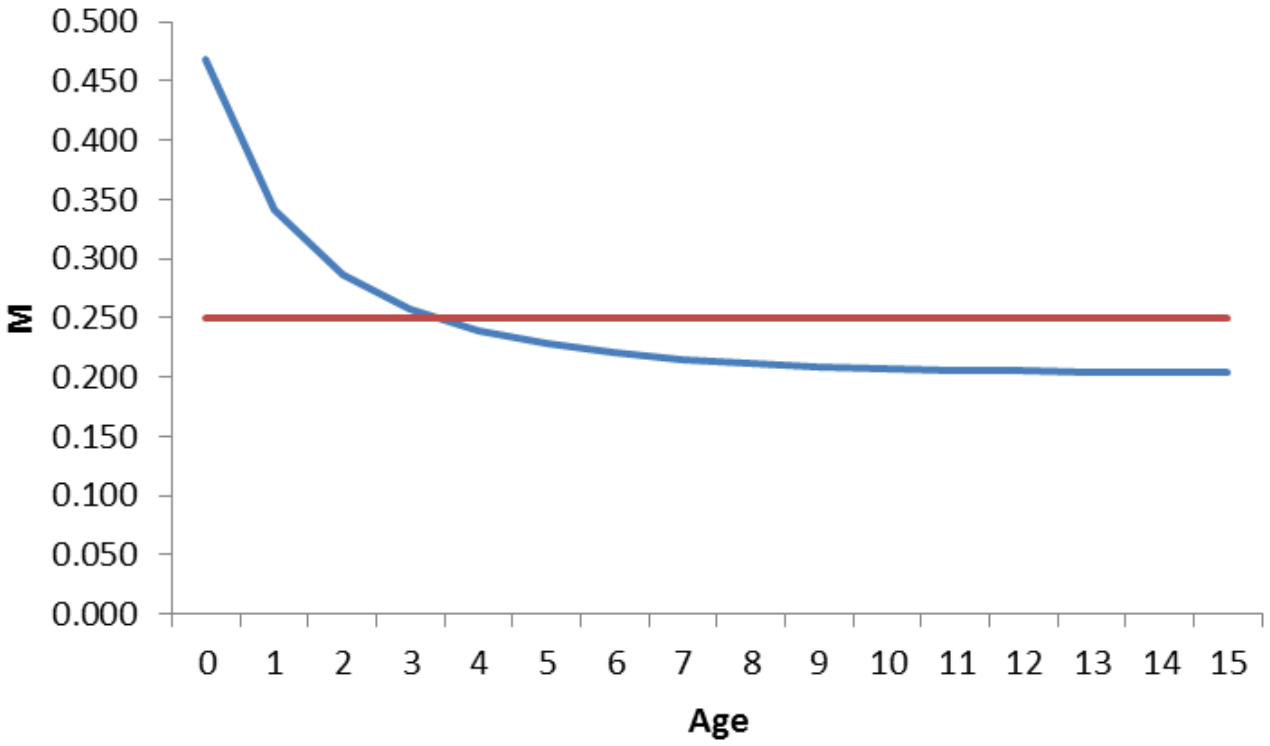
$Maturity_{AllAges}=1.0$





Natural Mortality

SEDAR 9 used a constant M=0.25



Target M	0.25
max age	29
Linf_all	34.4
K_all	0.3254
t0_all	-0.7953
Start Age	0
End Age	14
Loren_M	6.976176

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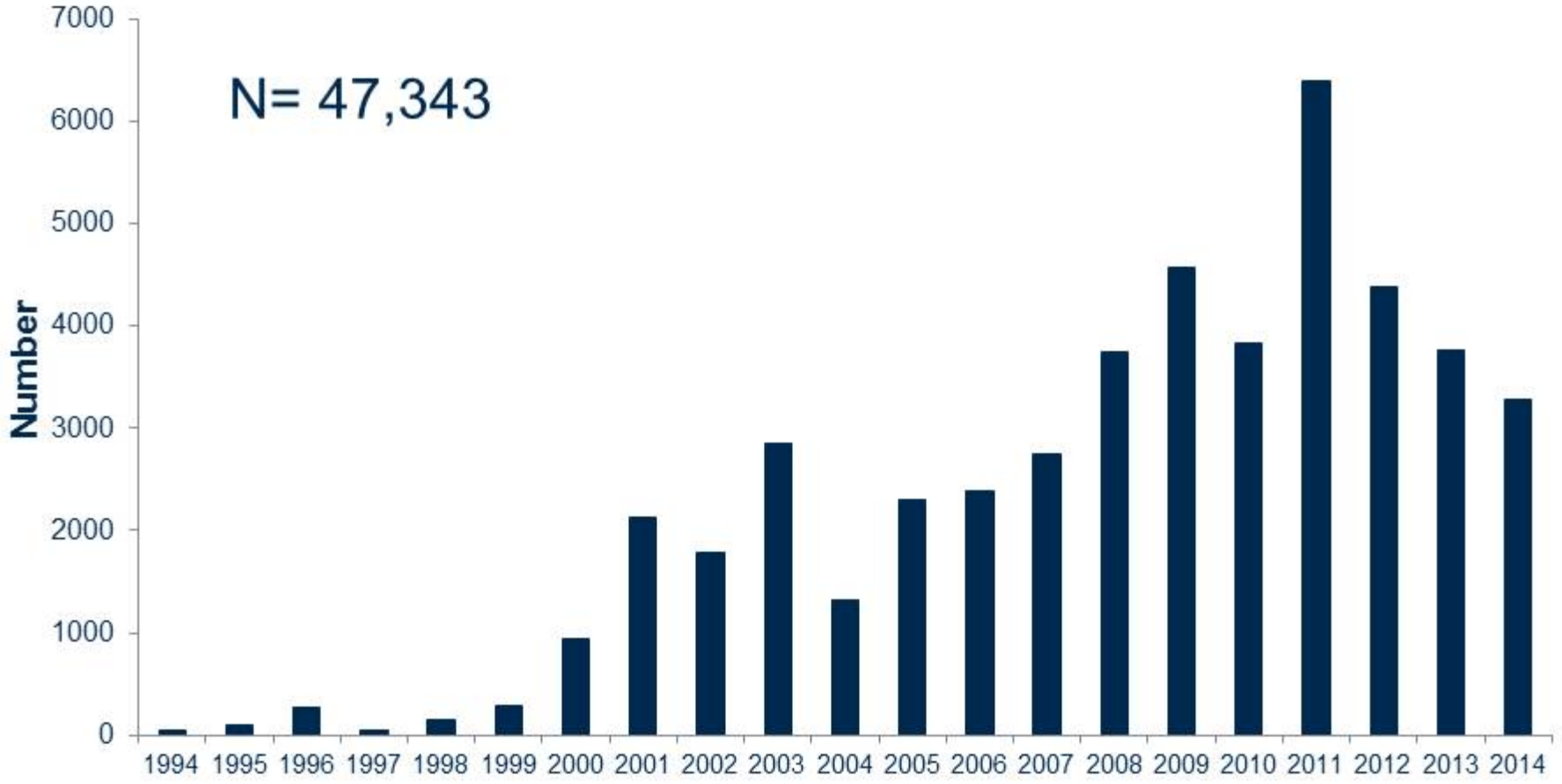
Vermilion snapper Ages by Sampling Year



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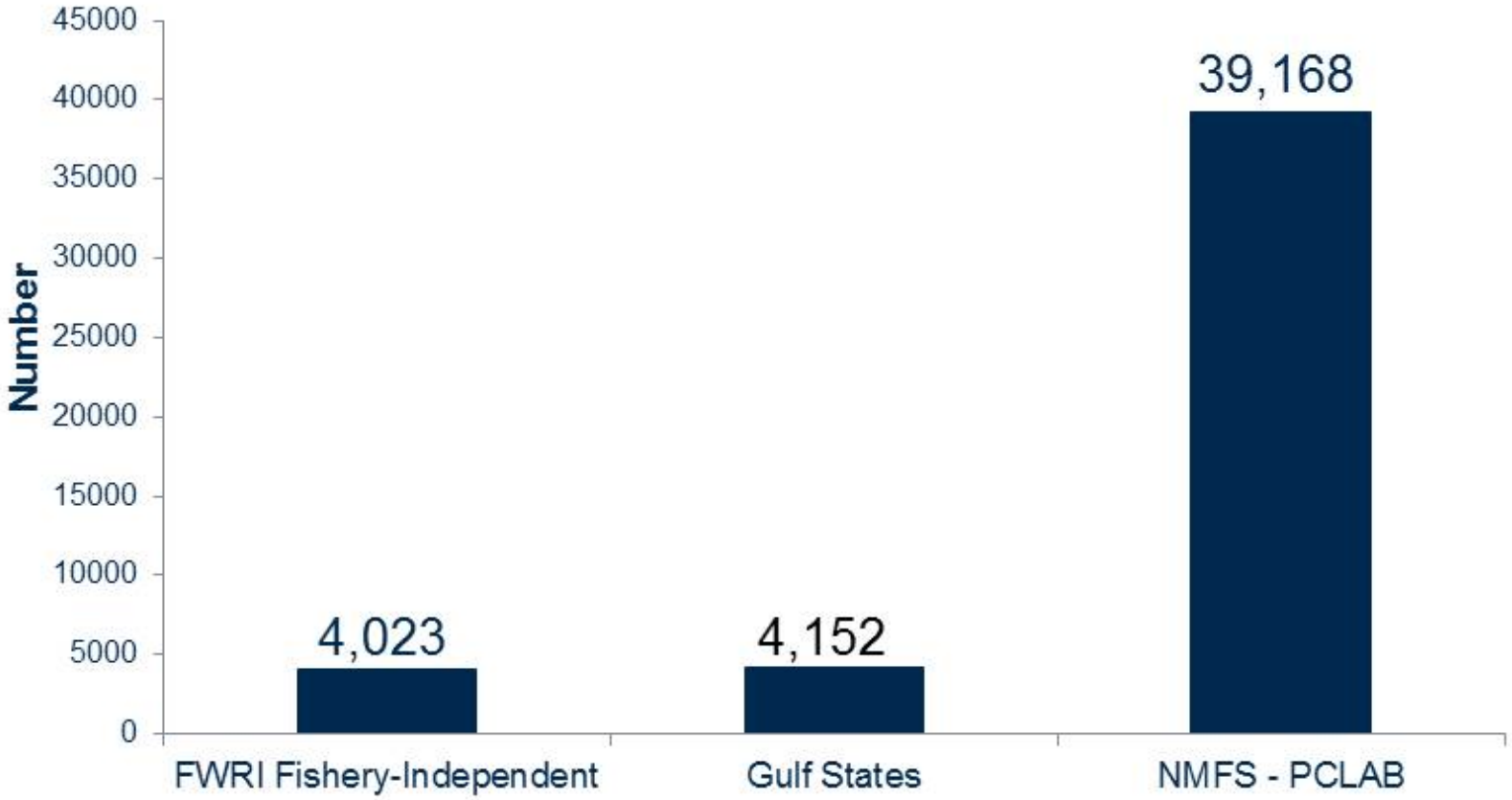
Vermilion Snapper Ages by Program



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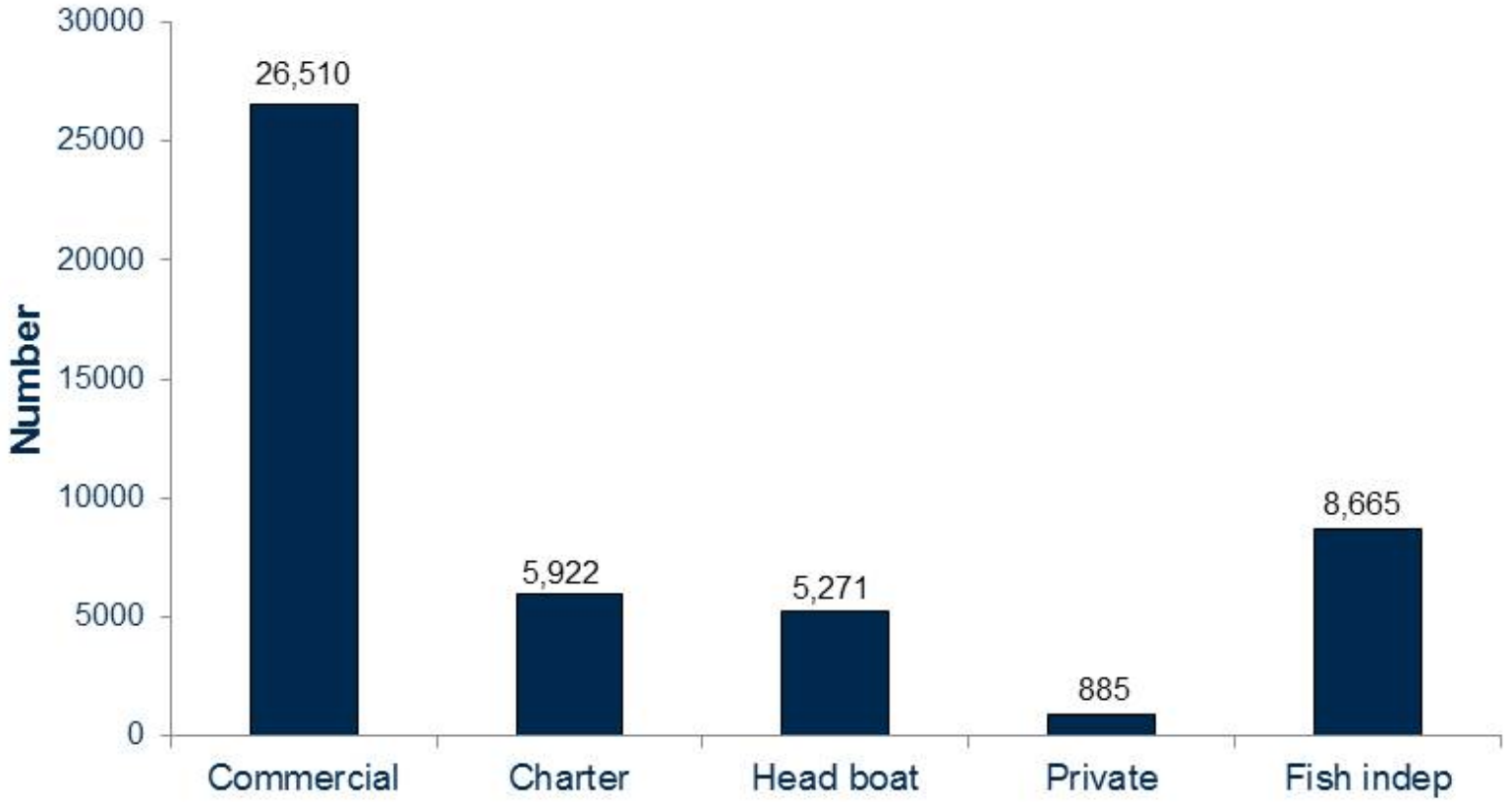
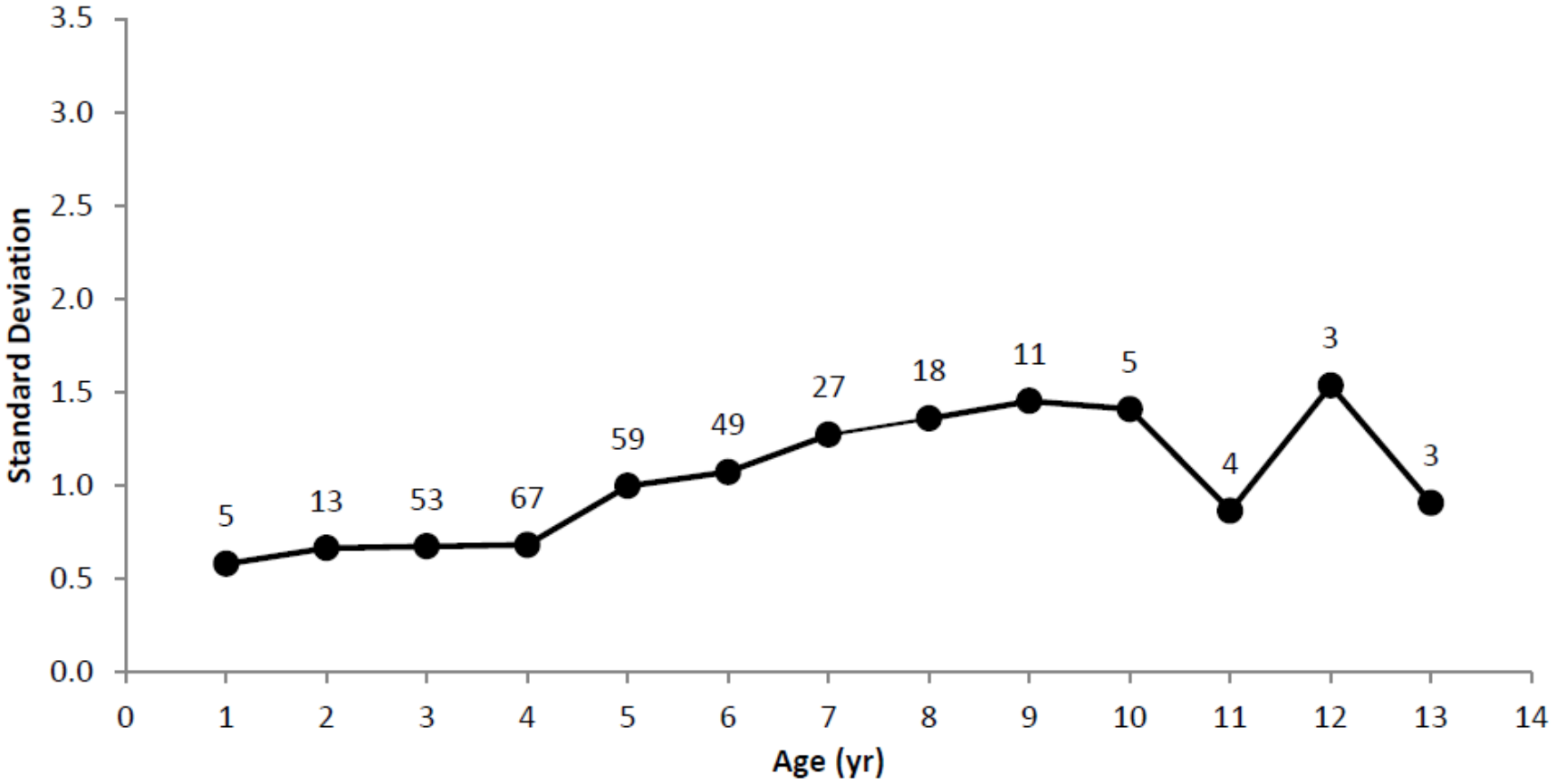
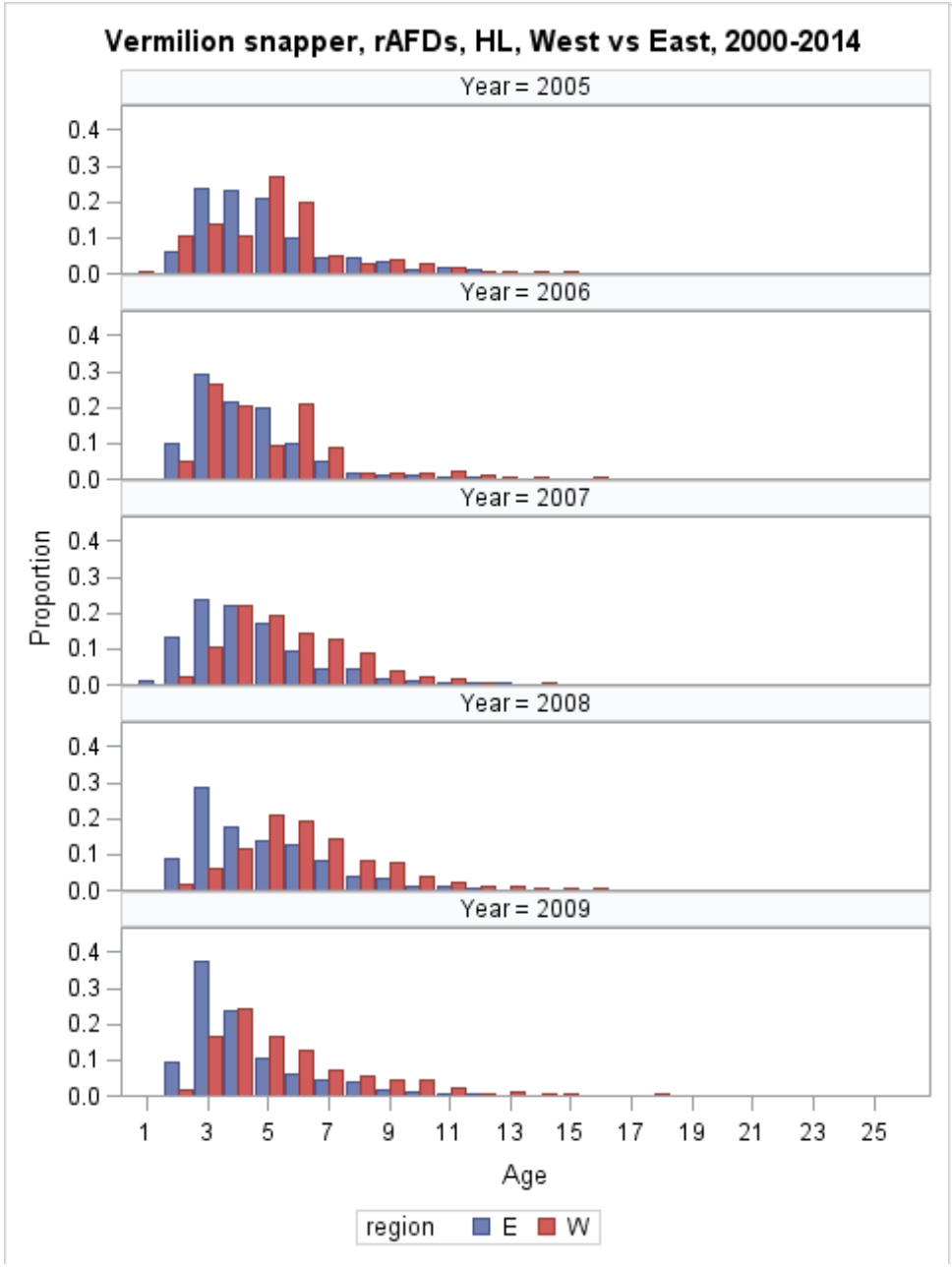
Vermilion snapper Ages by Mode

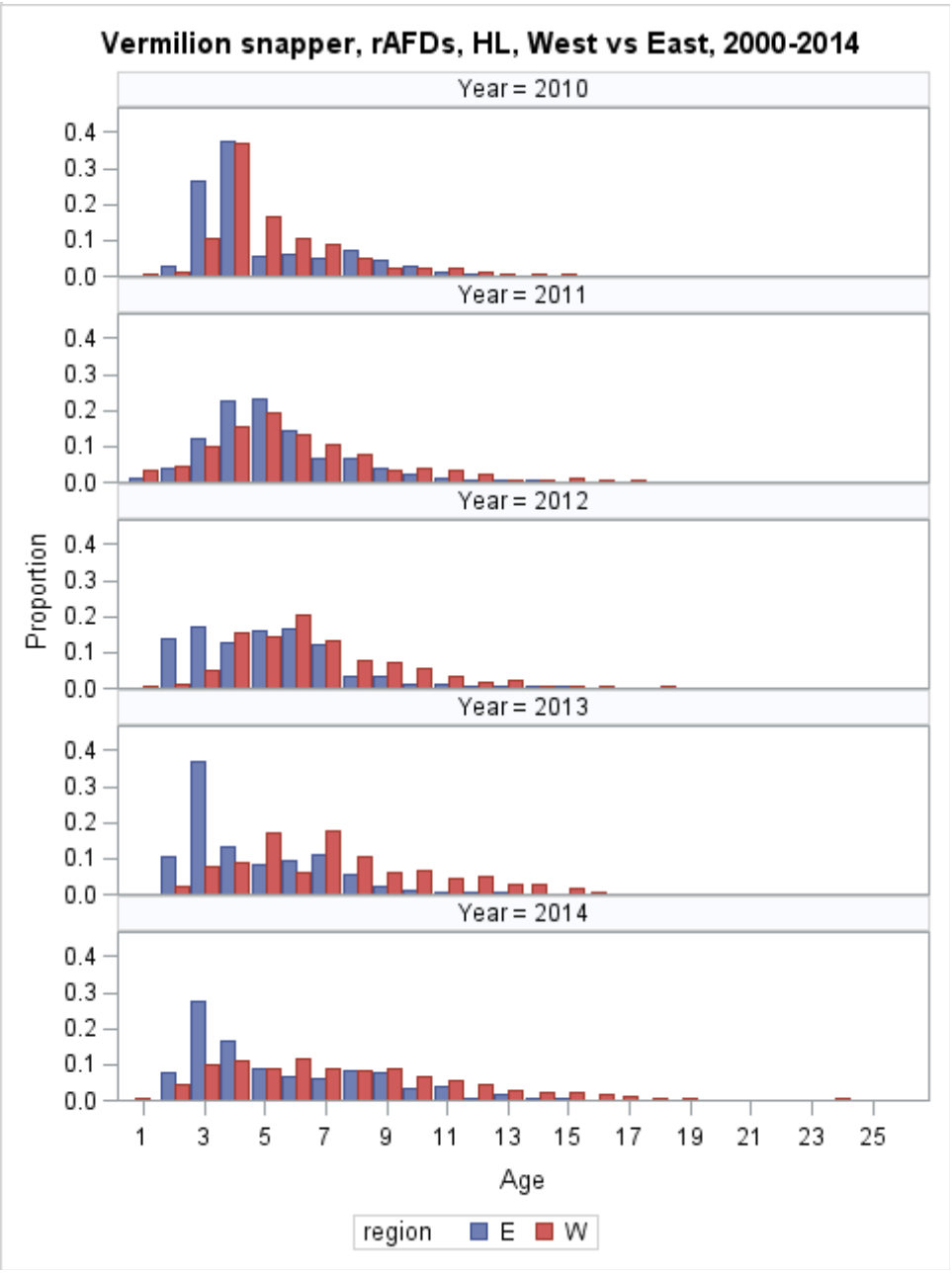


Aging Precision

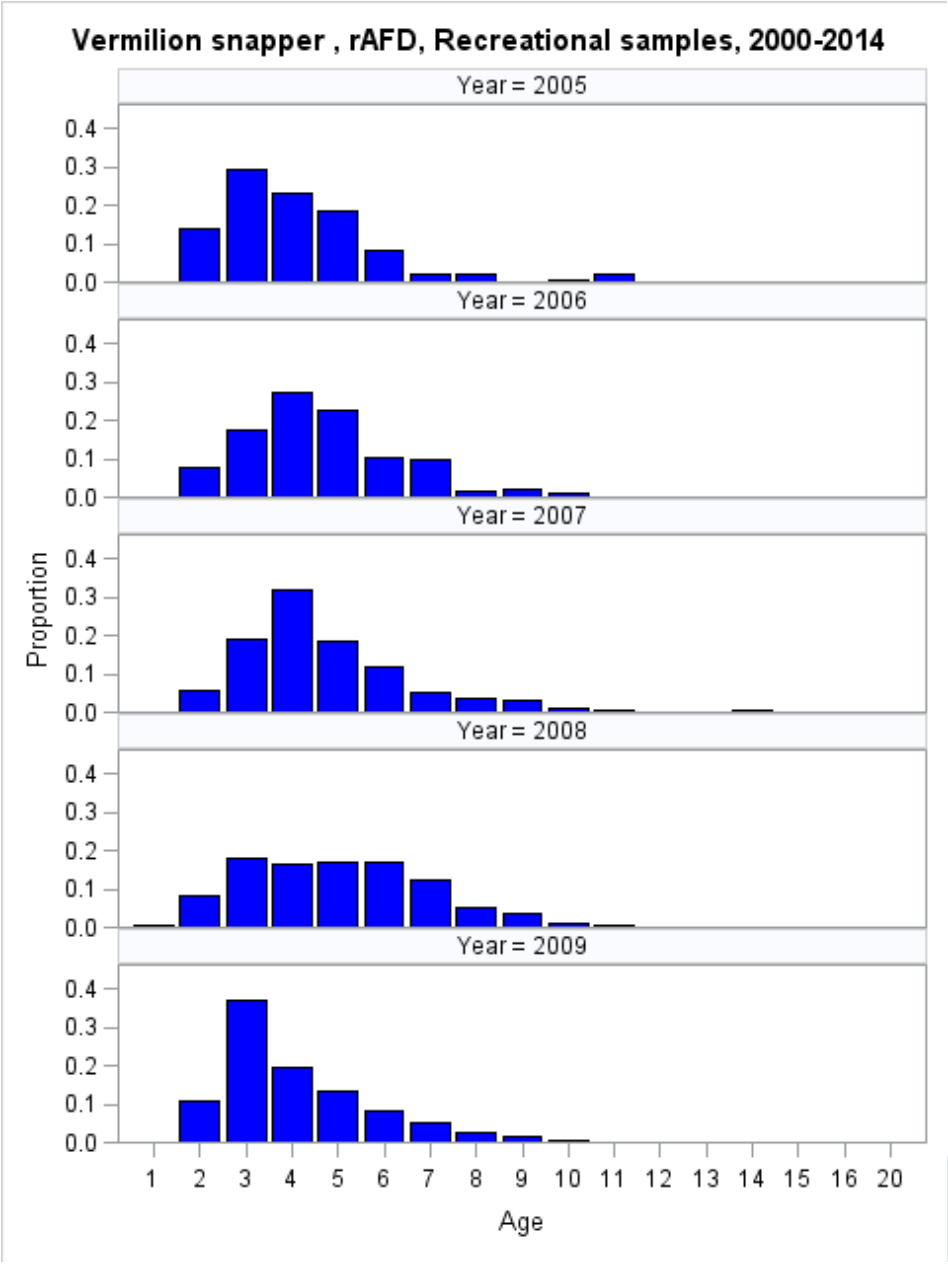


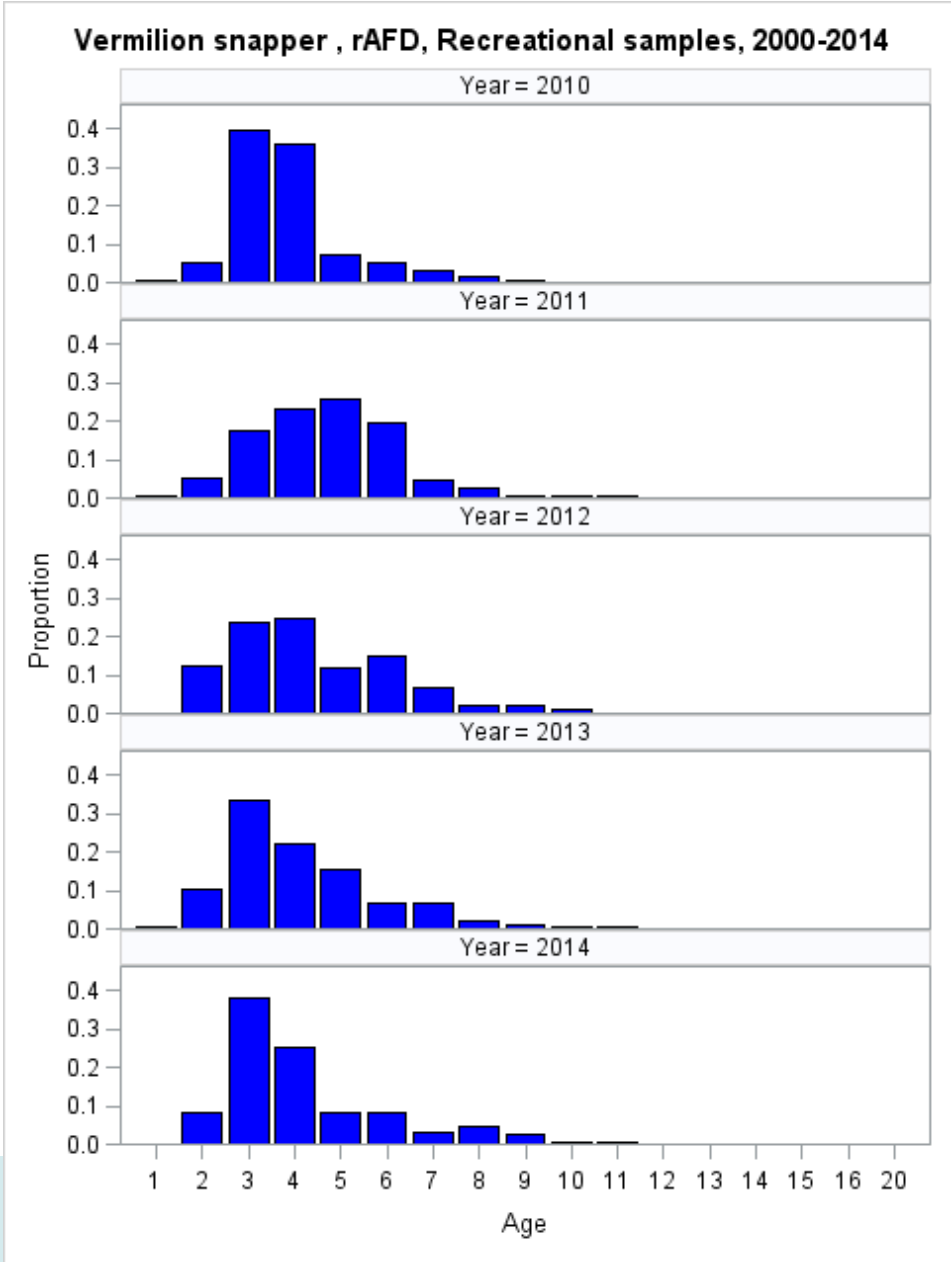
Reweighted Age Compositions—Commercial



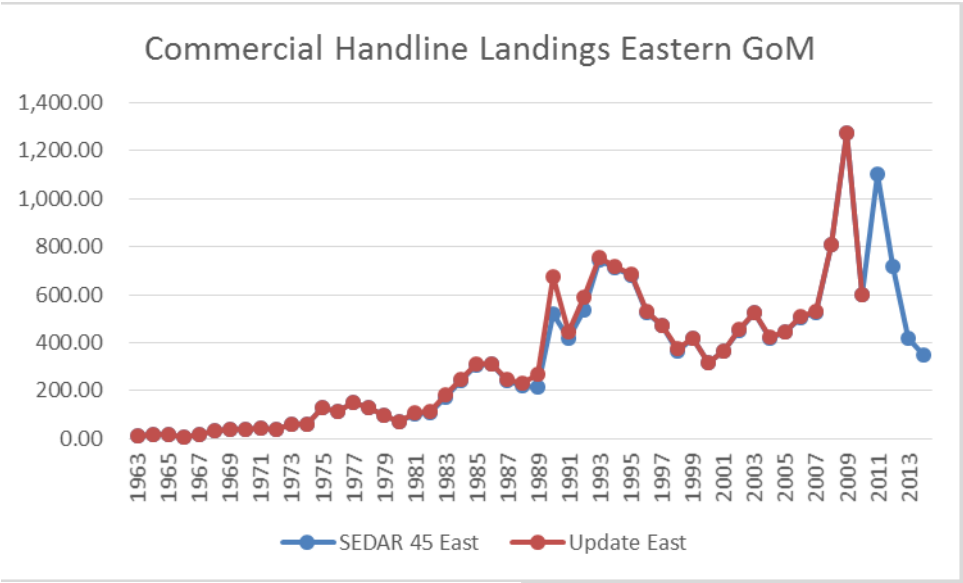


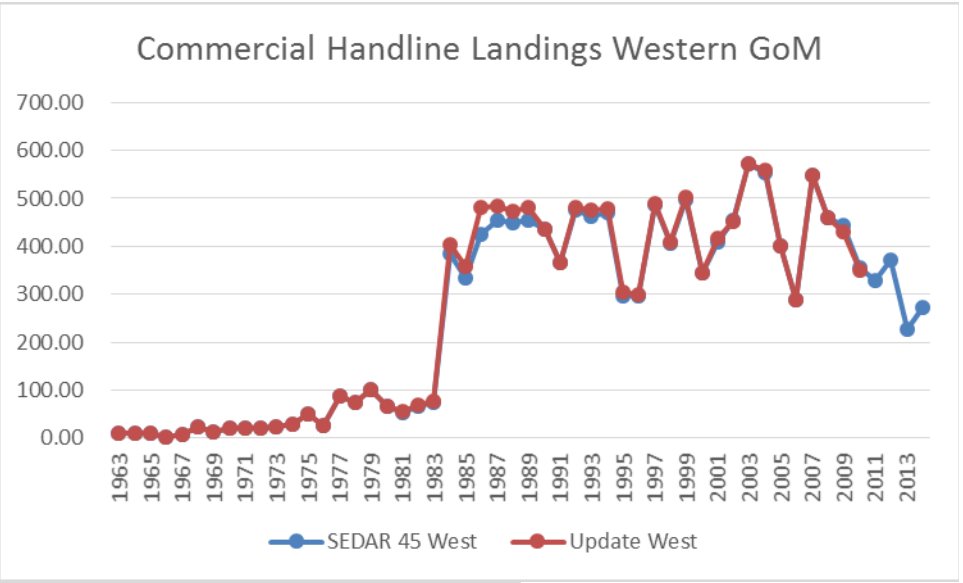
Reweighted Age Compositions—Recreational

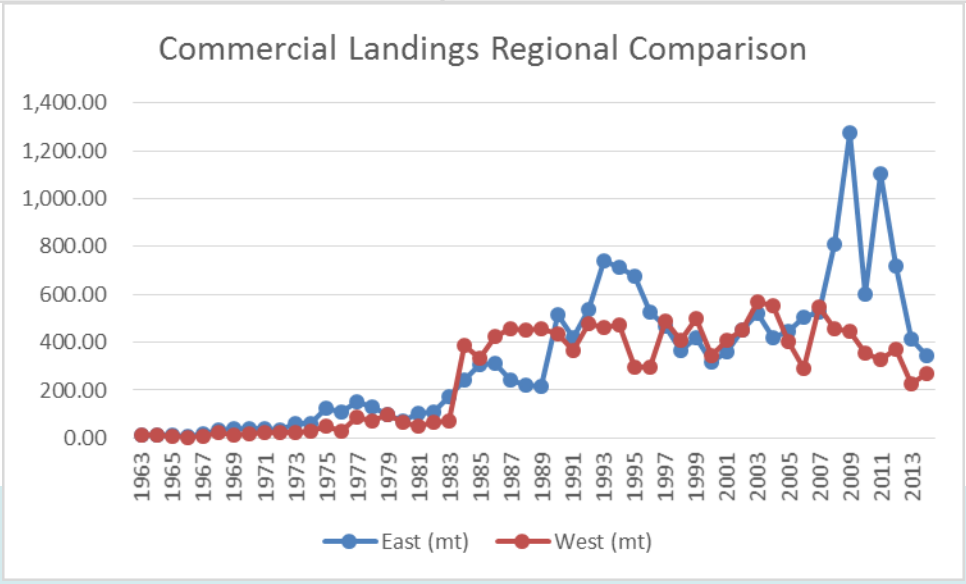




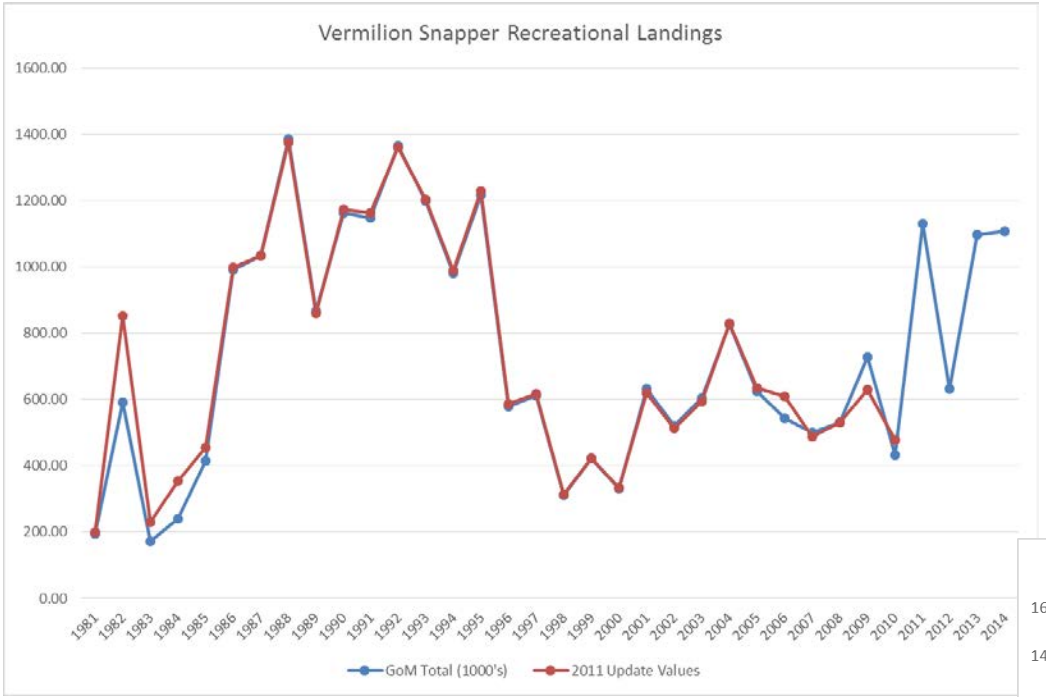
Commercial Landings (mt)





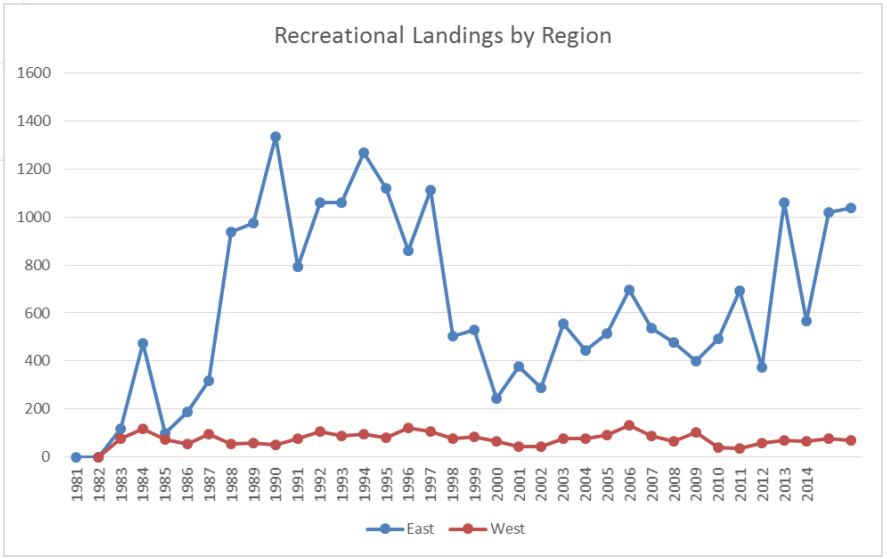


Recreational Landings (thousands of fish)

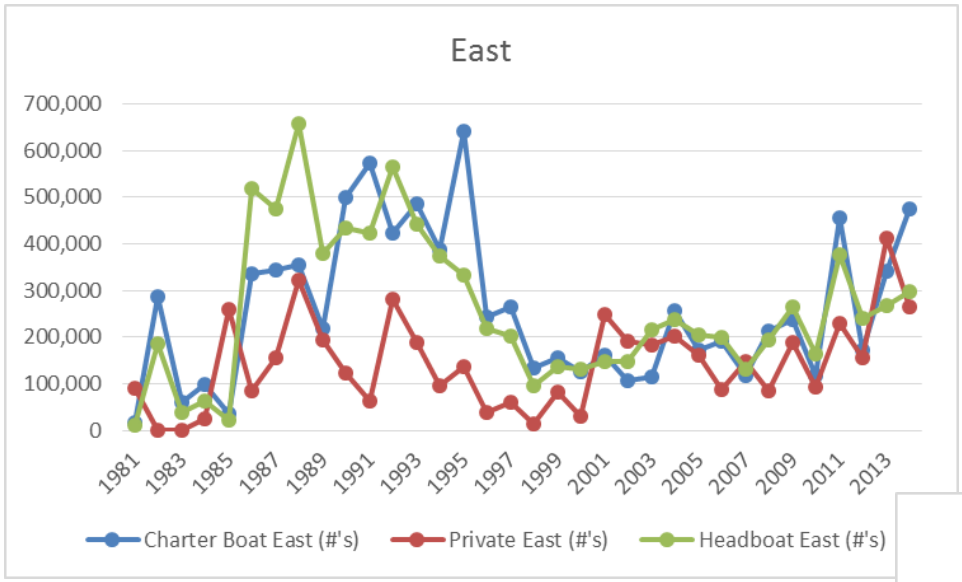


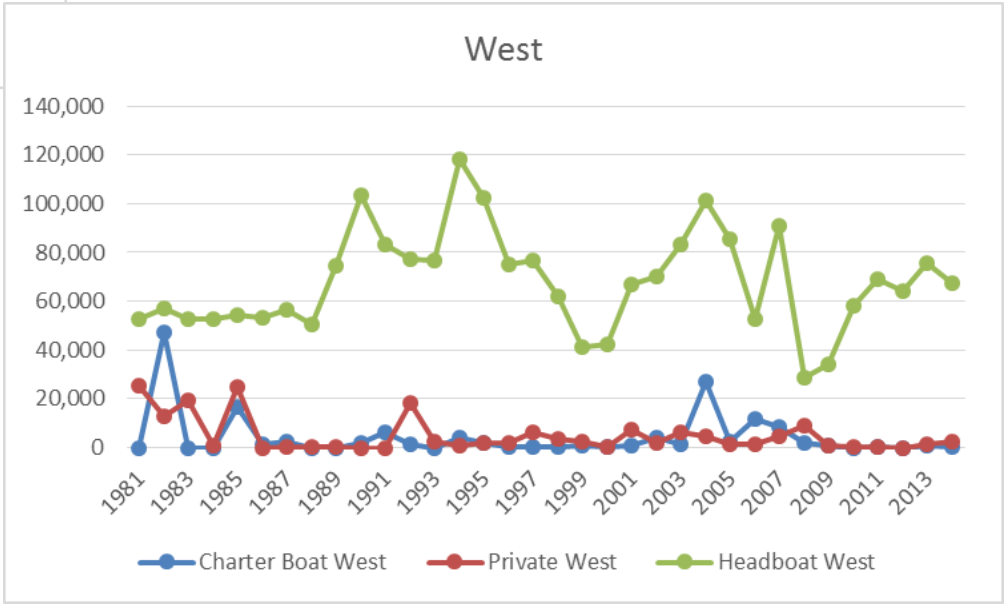
- Calibration ratios changed after 2011 update
- Hbt landings (81 – 85) not affected by change

"The period of 1981-1985 could not be calibrated with the same ratios developed for 1986+ because in the earlier 1981-1985 time period, MRFSS considered charterboat and headboat as a single combined mode in both regions. Thus, in order to properly calibrate the estimates from 1981-1985, headboat data from the Southeast Region Headboat Survey (SRHS) must be included in the analysis. In the Gulf of Mexico, the calibration analysis for 1981-1985 was based on effort estimates from both surveys (SRHS and MRFSS) and assumed that angler trips and angler days are equivalent (SEDAR7-AW-03)."



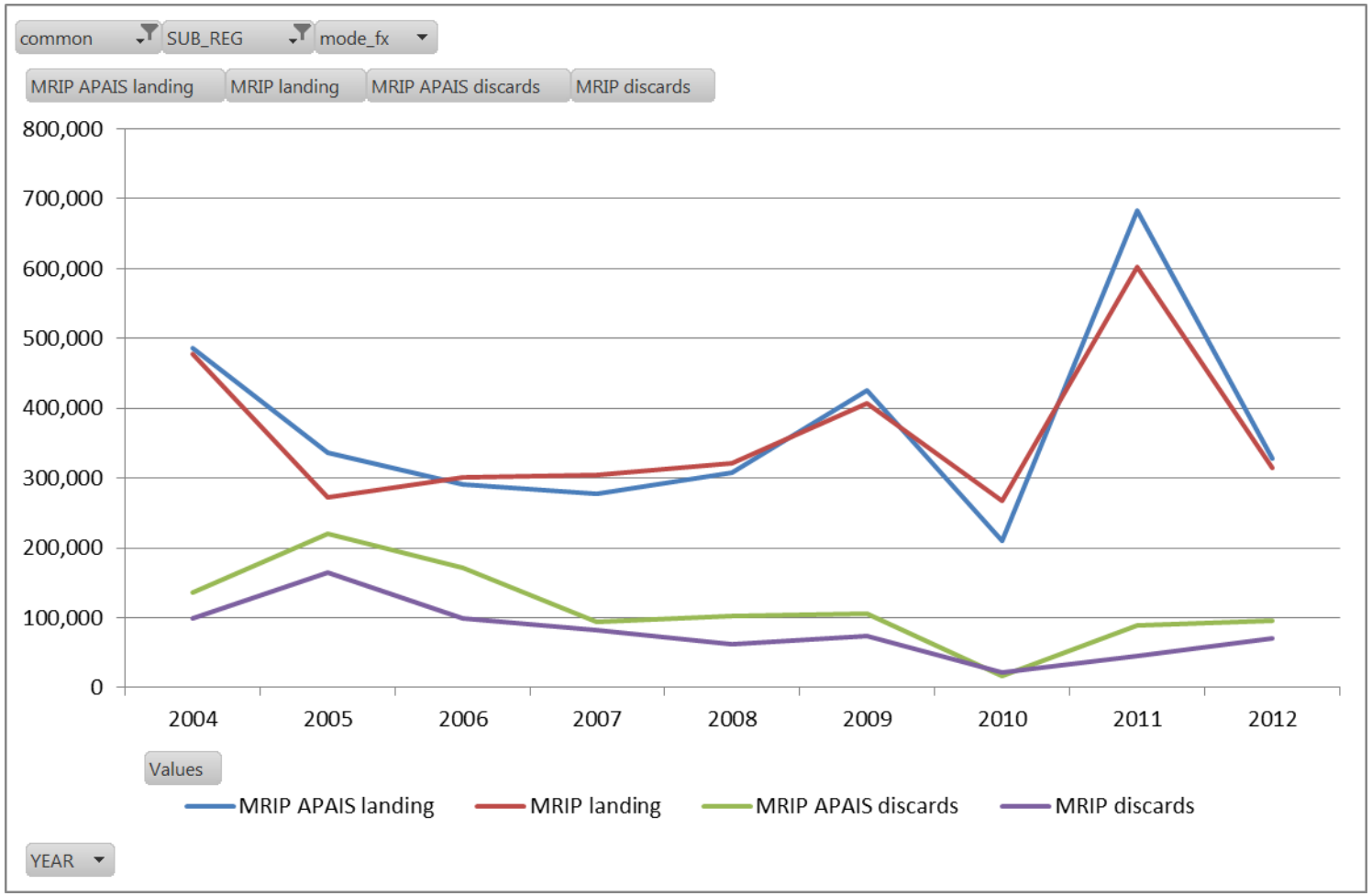
Recreational Landings—Mode (numbers of fish)



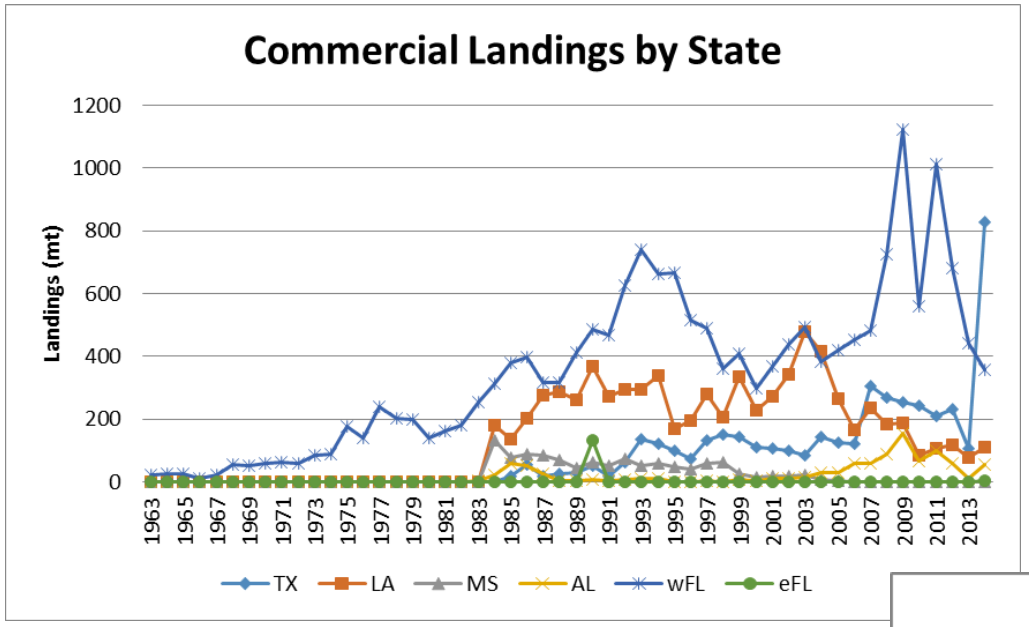


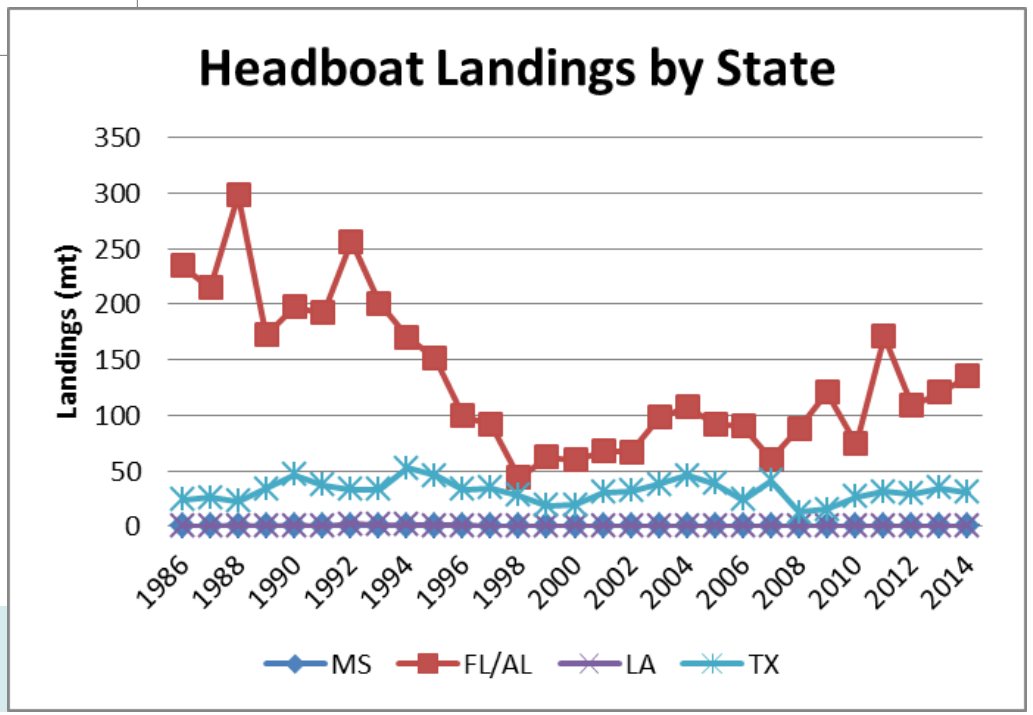
Recreational Landings

APAIS Adjustment

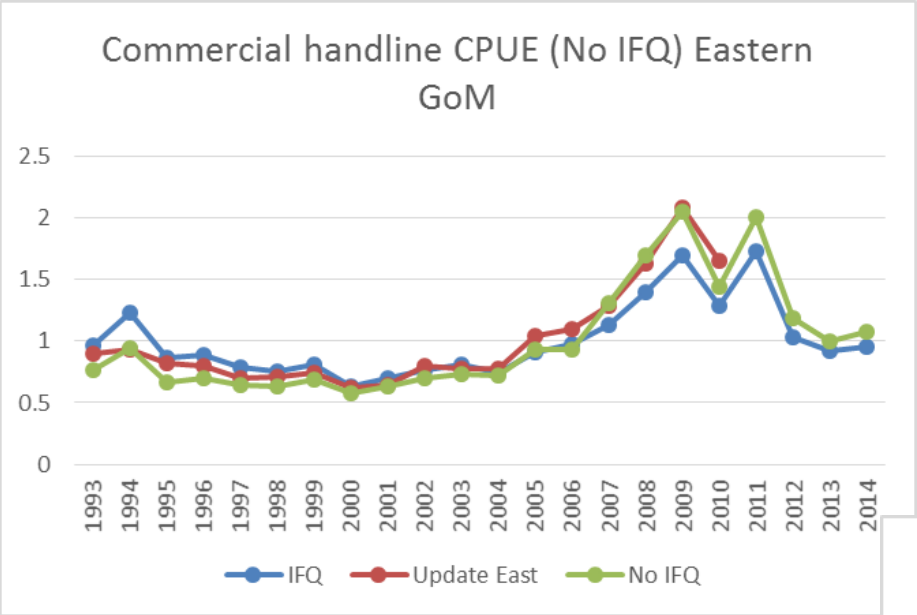


Landings by State



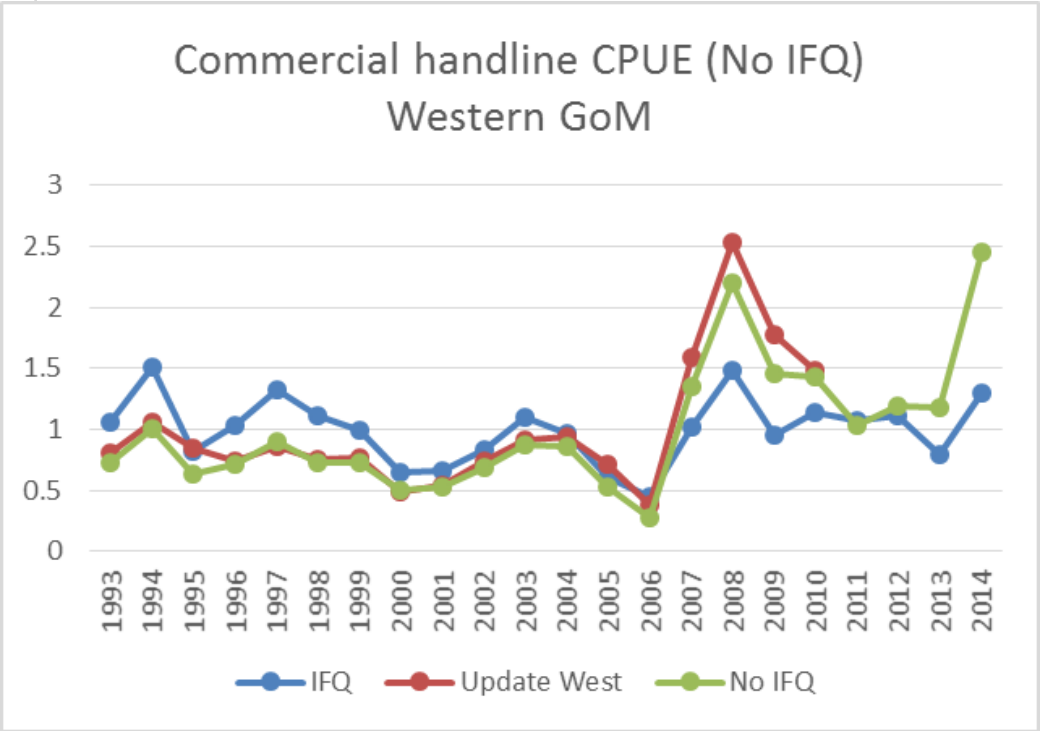


CPUE—Commercial

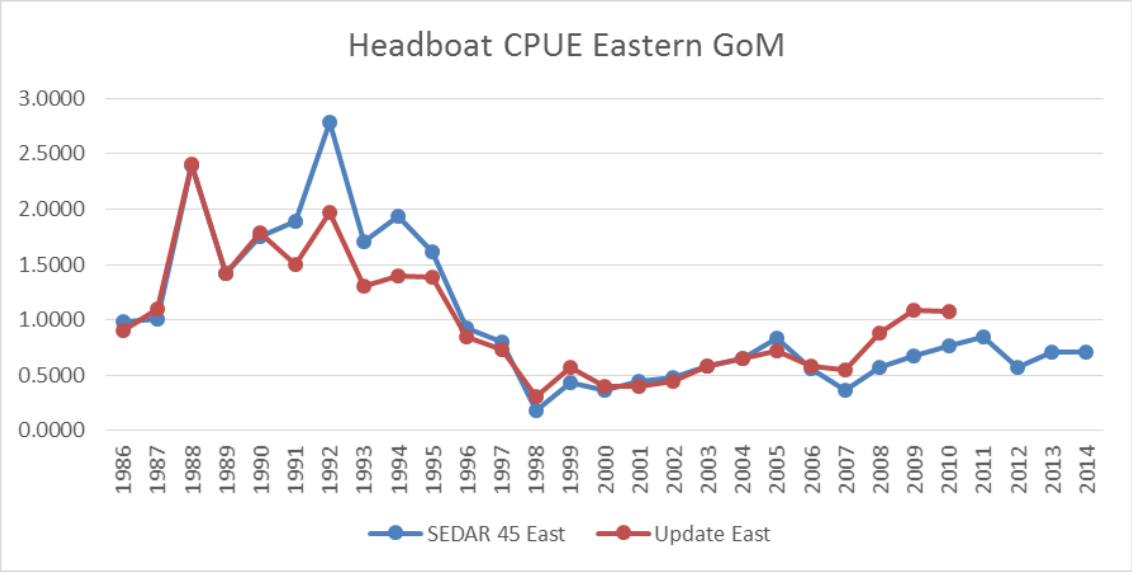


- Red Snapper IFQ introduced in 2007
- Inclusion leads to important differences in CPUE indices (esp. West)
- No standard approach for inclusion in standardization process

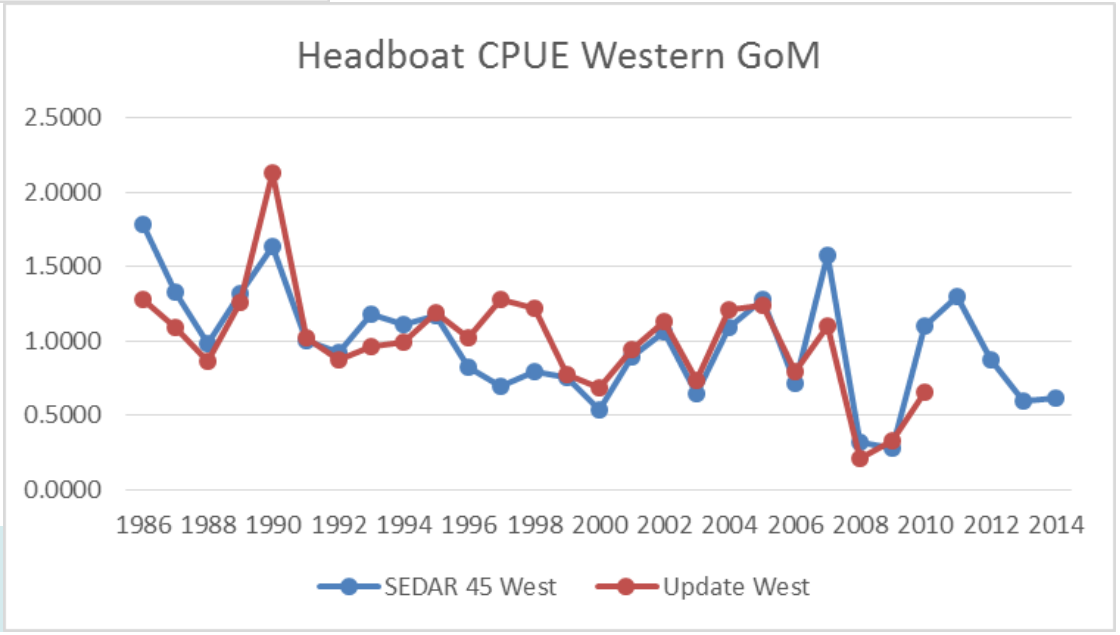
- Options:
  - Use CPUE with no IFQ factor
  - Include IFQ factor if significant
  - Force inclusion of IFQ regardless of significance
  - Split series in 2006 and use IFQ as factor from 2007-2014
  - **Use only pre-2007 series with no IFQ factor**



CPUE—Headboat



- Differences in Factors
  Vessel used in SEDAR 45



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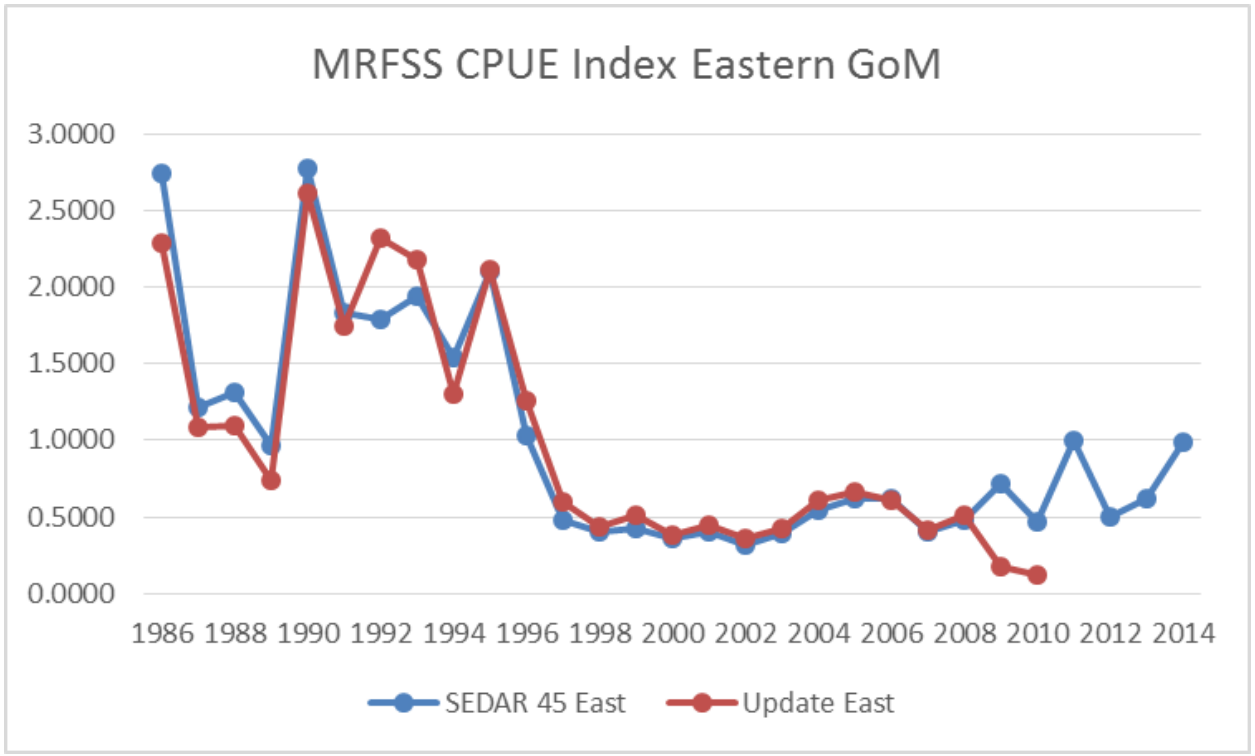
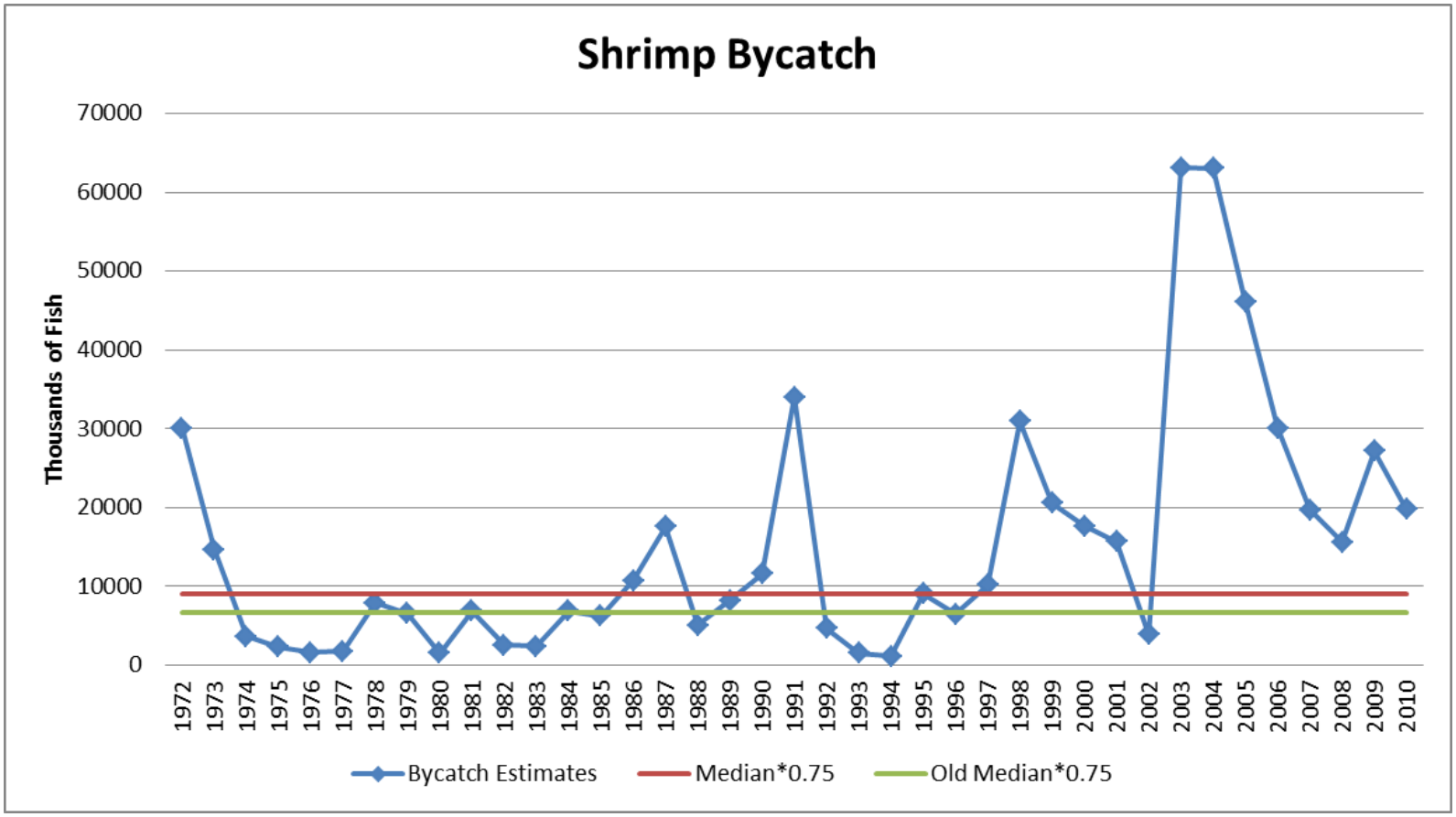
CPUE—MRFSS East



- Difference in Factors:
- Red Snapper Season considered SEDAR 45

Bycatch—Shrimp Discards

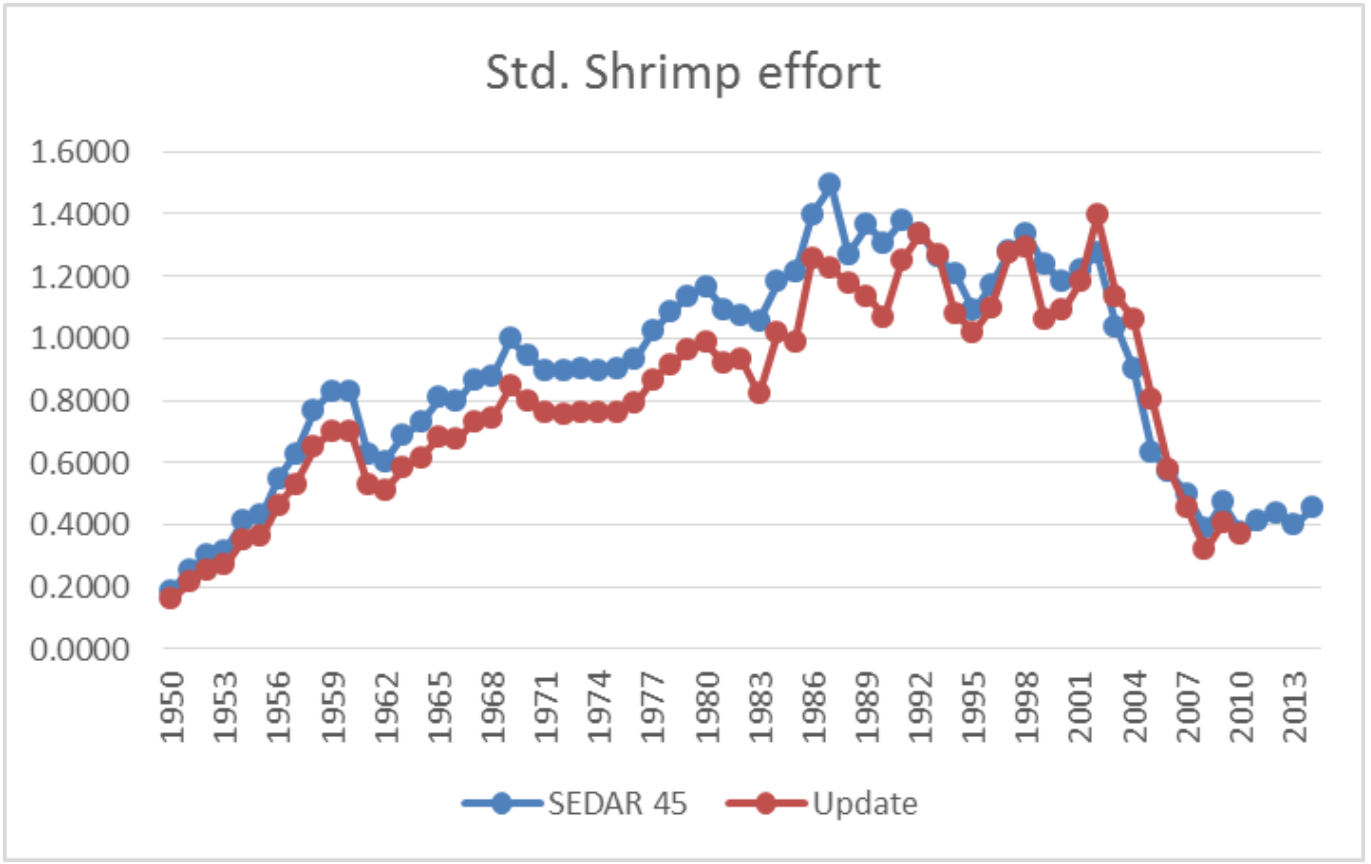


- No updated shrimp bycatch has been provided yet
- Update assessment models assumed a ‘superyear’ median bycatch of 6.65mil fish (0.75*8.87mil)
- Estimate from available data is 6.822mil (0.75*9.096mil)

Shrimp Bycatch

- "The most recent estimate of shrimp trawl bycatch of vermilion snapper is 9.2 million fish annually. According to Porch and Cass-Calay (2001), the length-distribution obtained from the NMFS observer program is bimodal, and suggests that approximately 25 % of the vermilion snapper landed by the shrimp fleet are age-0 and the remainder are at least age-1. Because SSASPM does not accommodate age-0, the shrimp bycatch estimate was multiplied by the proportion of fish expected to be at least age-1 (9.2 million * 0.75 = 6.9 million fish). Shrimp bycatch was modeled using a fixed selectivity (100% vulnerability at age-1, 30% at age-2, 3% at age-3 and 0% at ages 4-14+)."

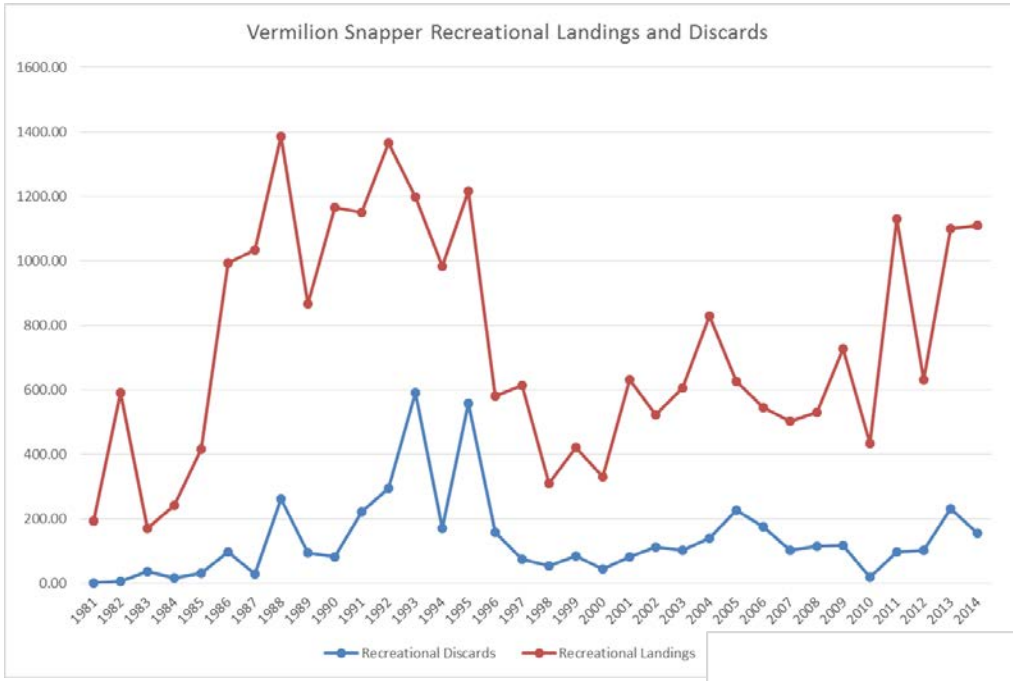
Bycatch—Shrimp Effort

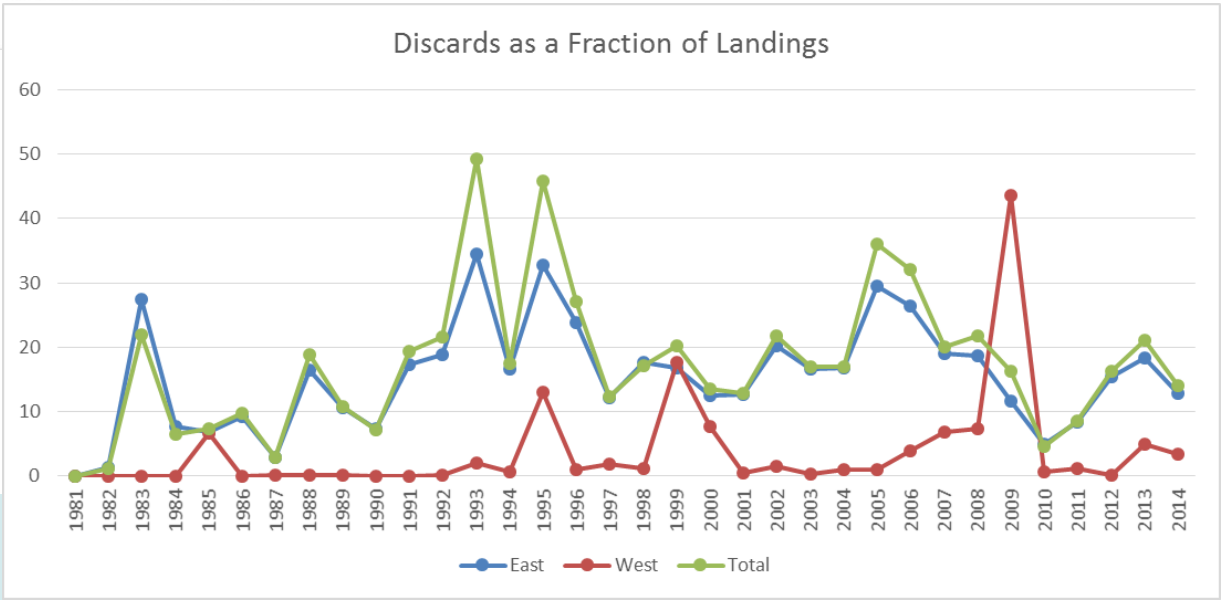


Bycatch—Shrimp Age Composition

- Shrimp observer program does not collect length samples for vermilion snapper
- Still working on compiling available data

Discards—Recreational





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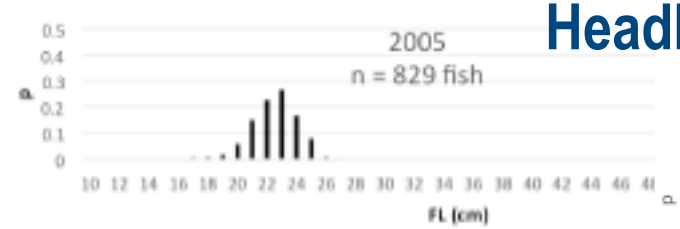
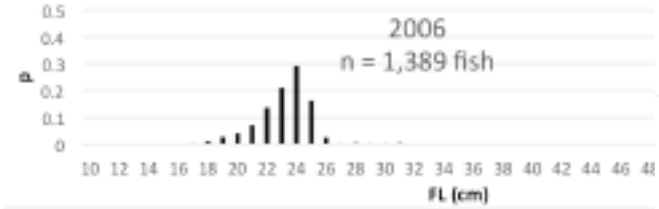
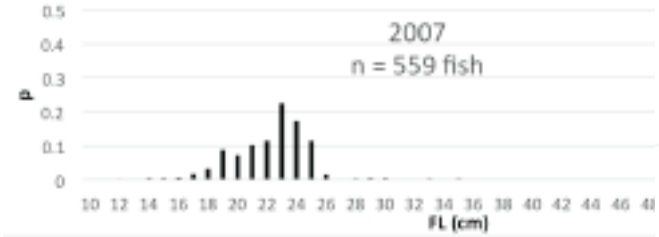
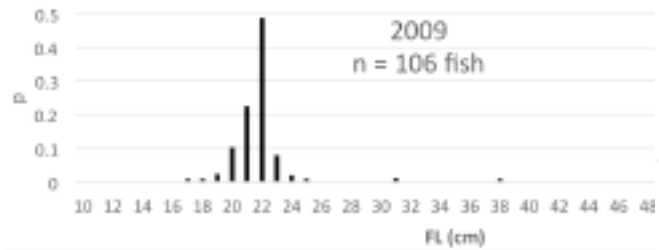
Discards—Recreational Size Composition

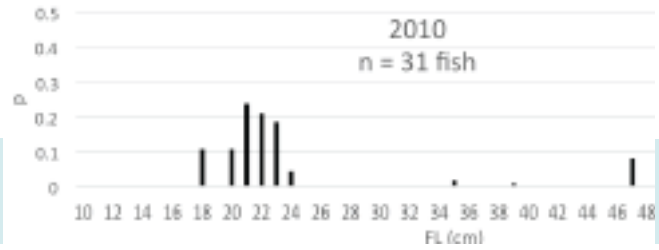
Headboat

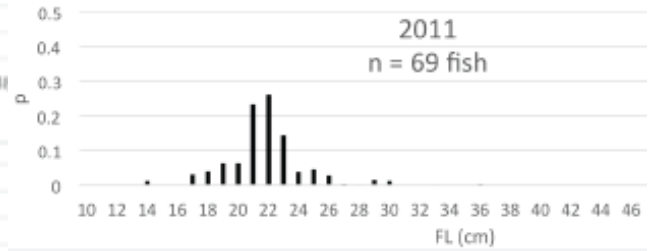


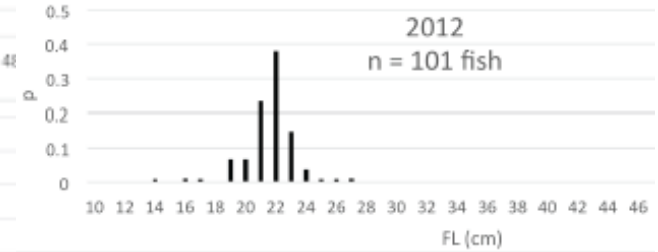


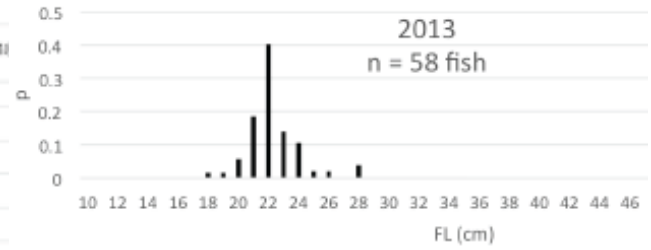


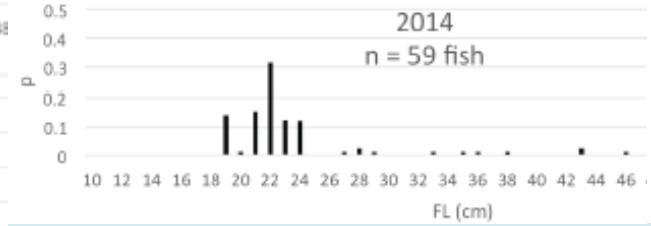




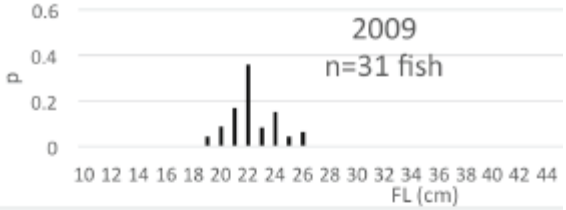


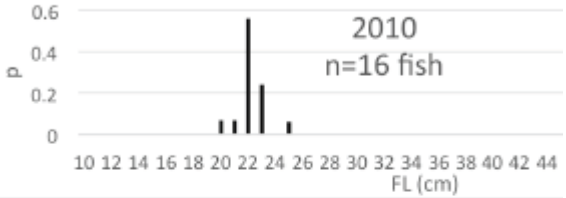


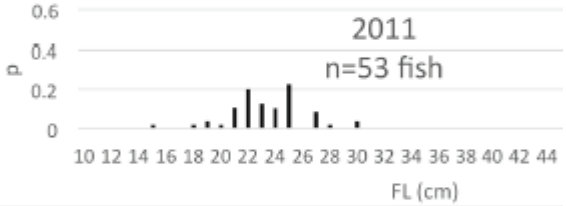


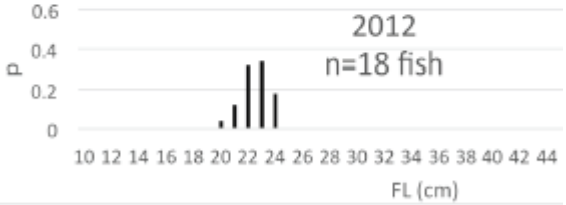


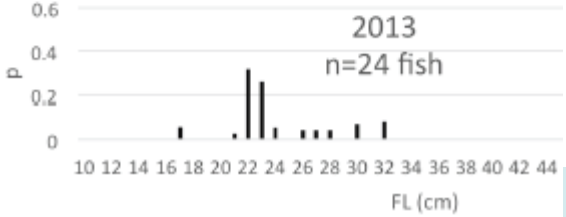
Private/Charter



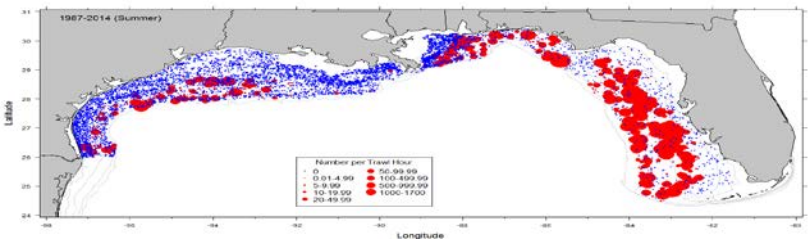


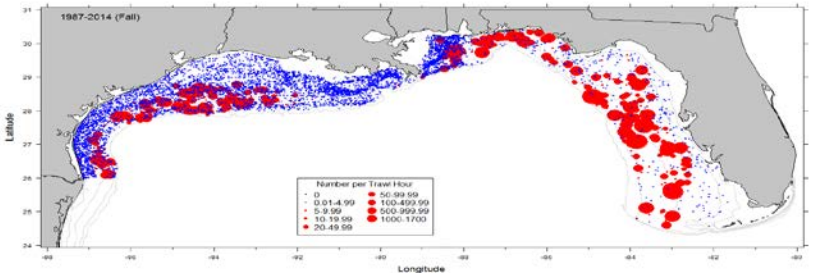




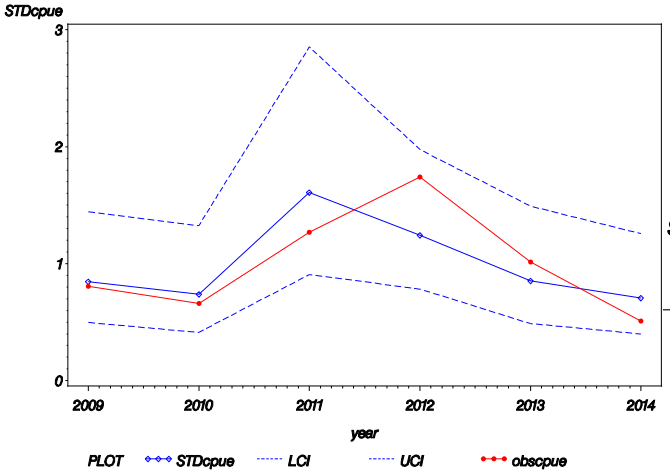


SEAMAP Groundfish Survey

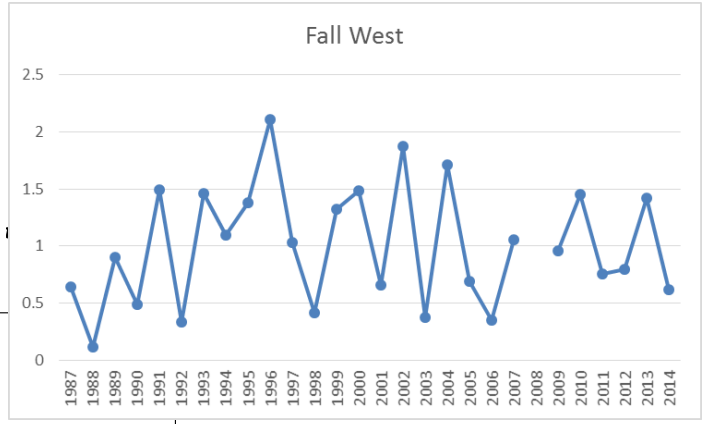


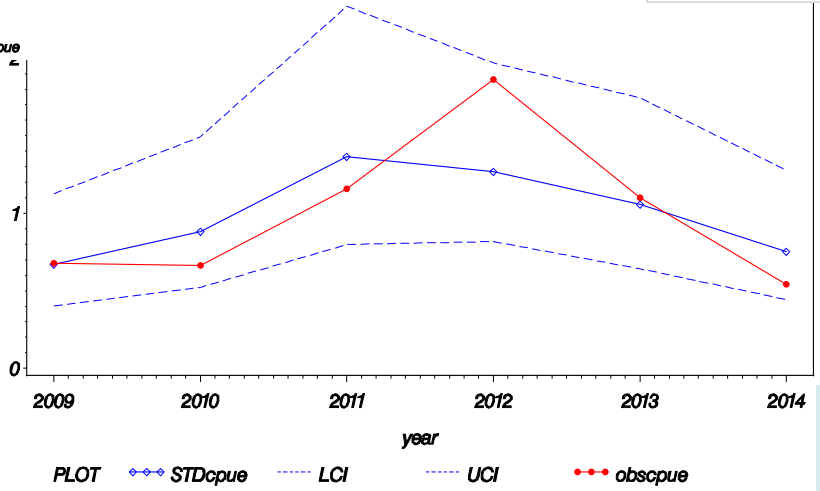


SEAMAP Summer Groundfish Vermilion Snapper Eastern Gulf of Mexico 2009 to 2014
Observed and Standardized CPUE (95% CI)



Summer Groundfish Vermilion Snapper Gulf of Mexico 2009
Observed and Standardized CPUE (95% CI)





Fall survey used a different design prior to 2009

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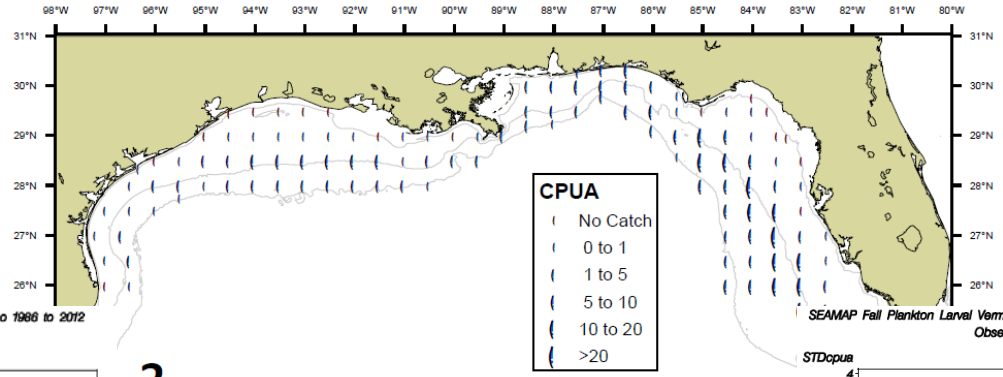
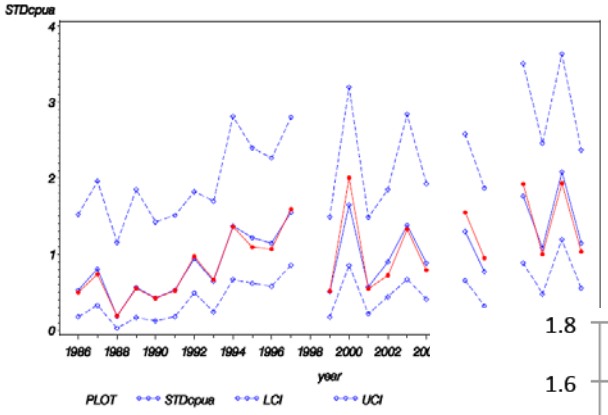
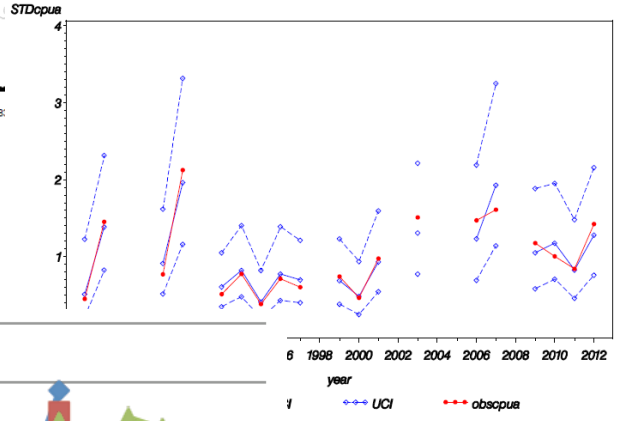
SEAMAP Larval Survey

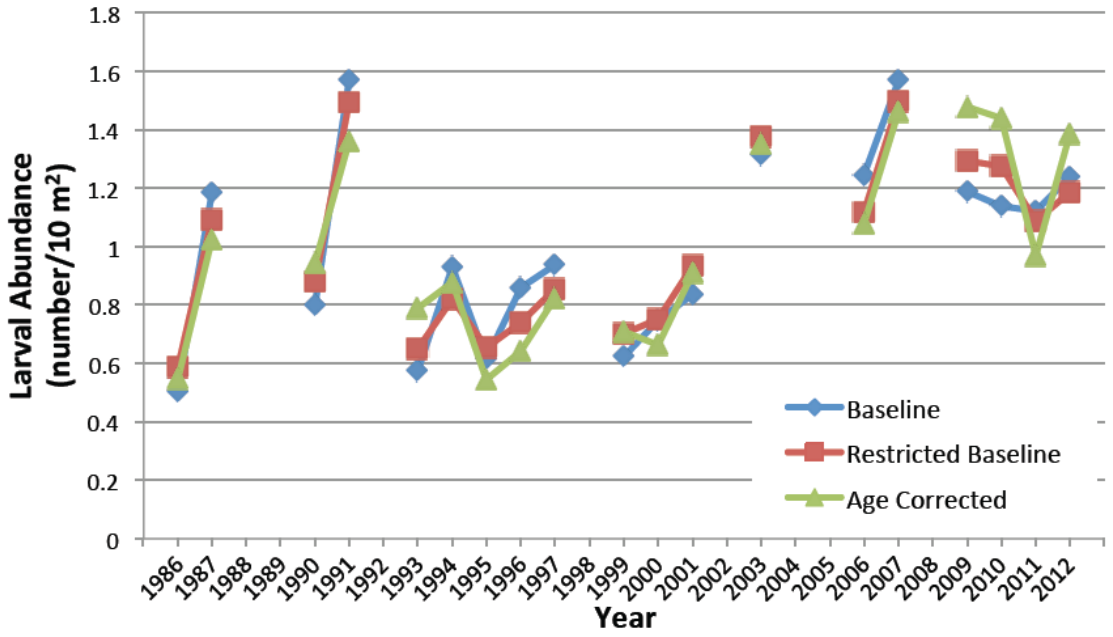


SEAMAP Fall Plankton Larval Vermillion Snapper 3.5 TO 6.4 mm Western Gulf of Mexico 1986 to 2012
Observed and Standardized CPUA (95% CI)



SEAMAP Fall Plankton Larval Vermillion Snapper 3.5 TO 6.4 mm Eastern Gulf of Mexico 1986 to 2012
Observed and Standardized CPUA (95% CI)





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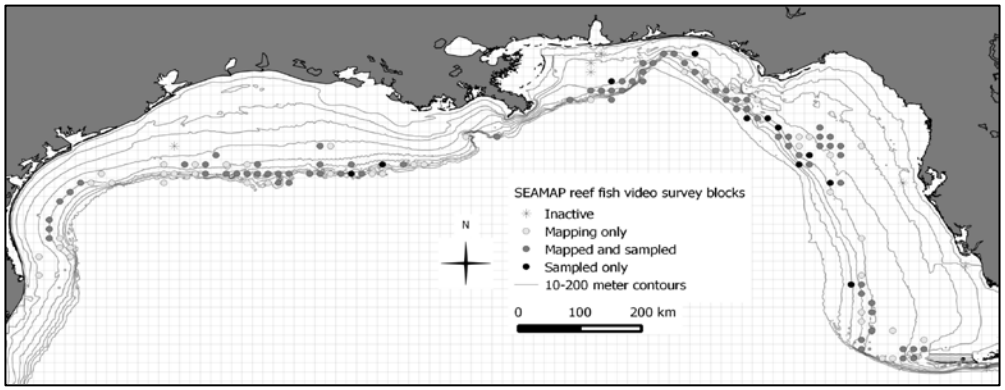
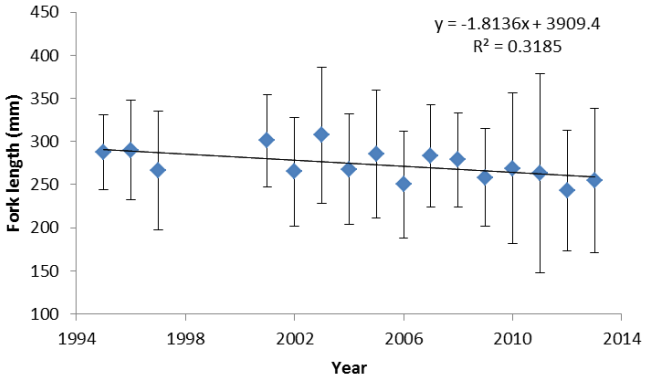
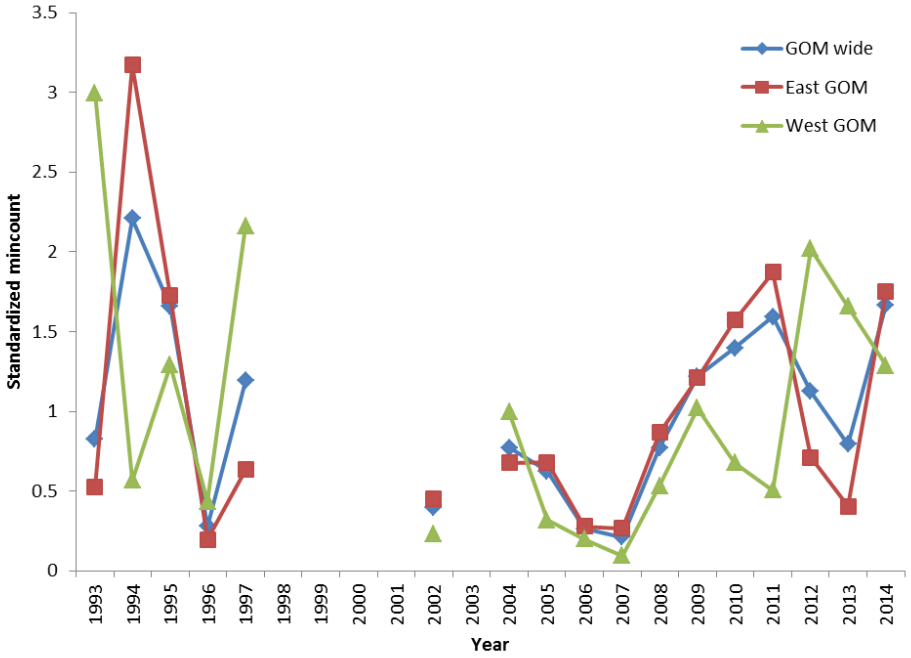
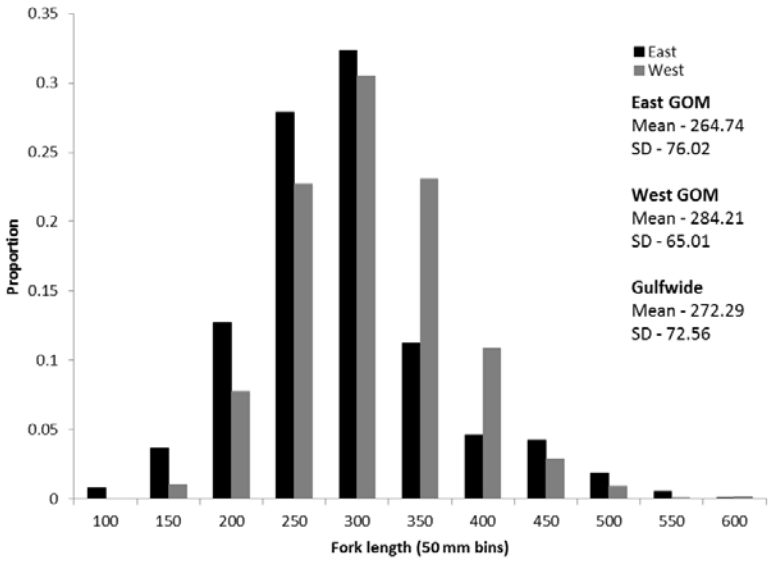
Video Survey





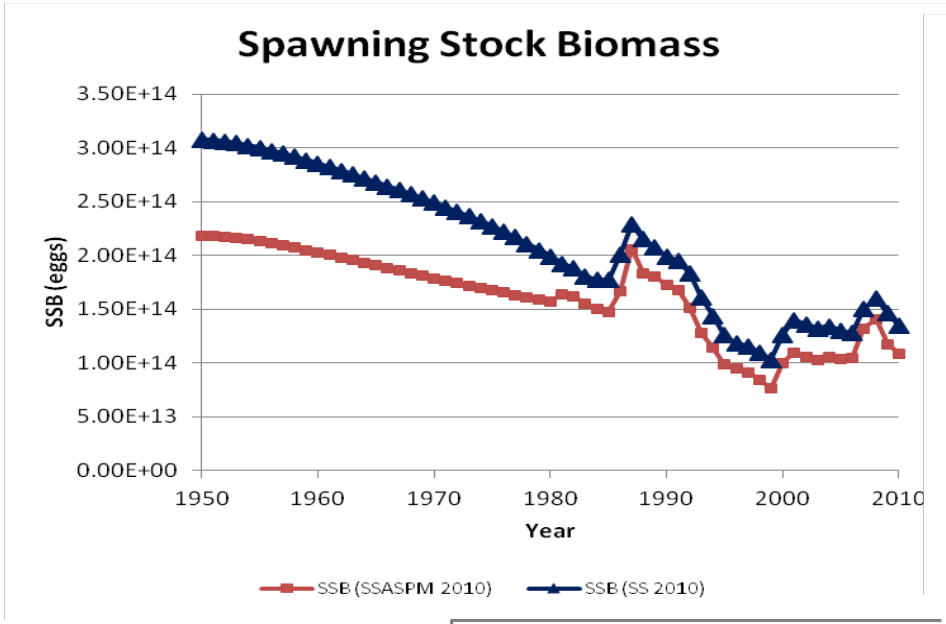


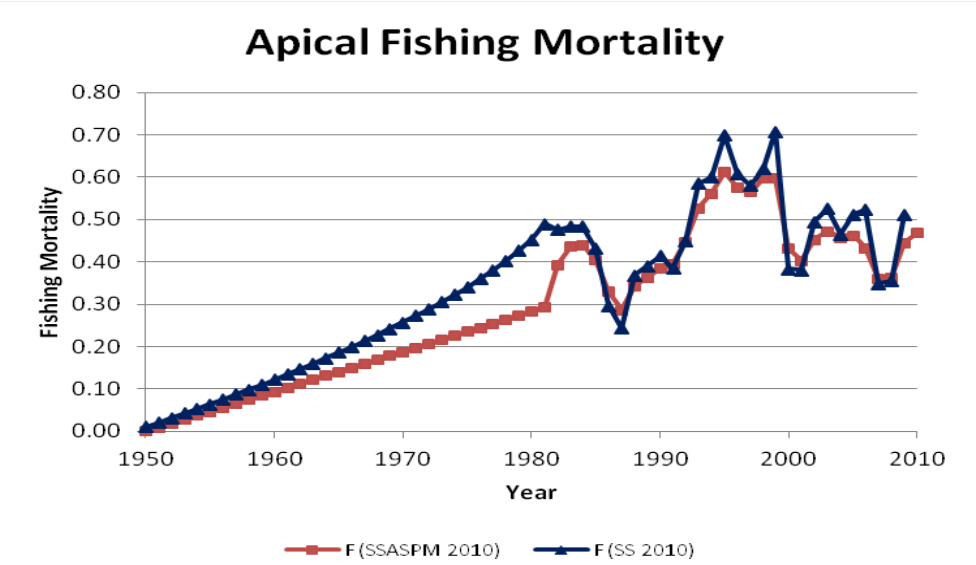


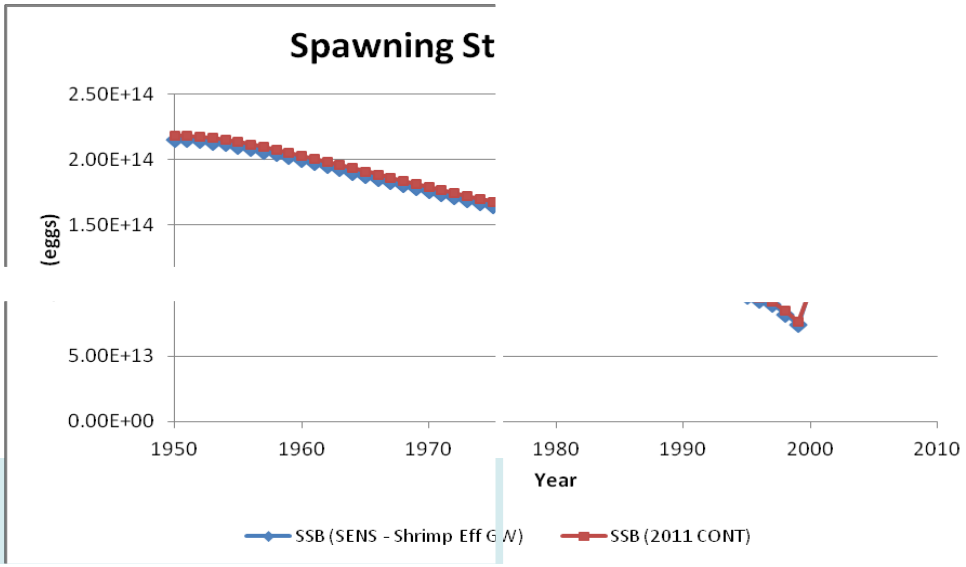
Initial Model Comparisons

SS3 and SSPAM Comparison (2011 Update)

With Shrimp Bycatch







SSPAM Comparisons:

- **Shrimp Bycatch**
- **Shrimp Effort (with average bycatch)**

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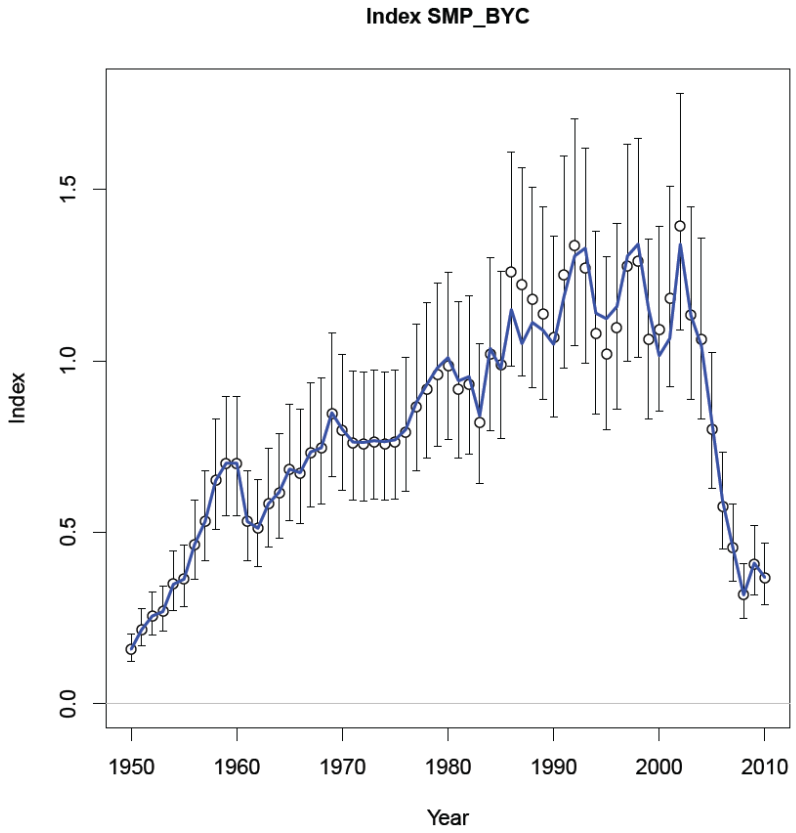
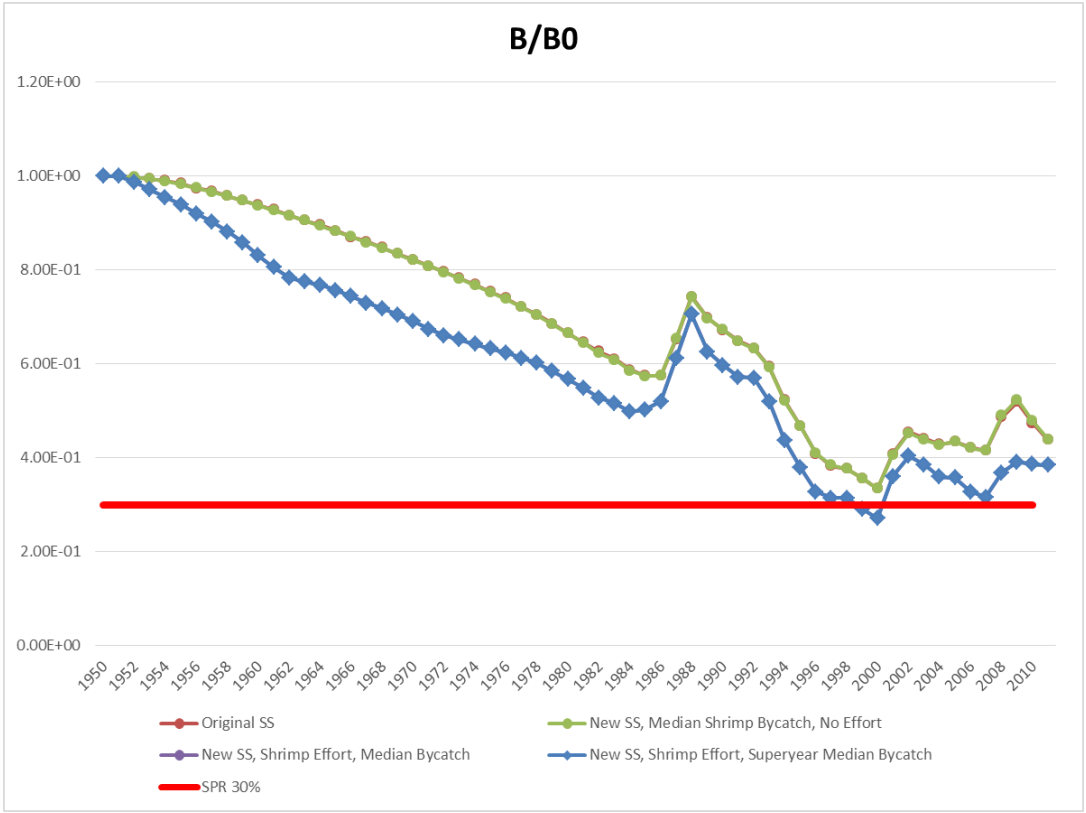
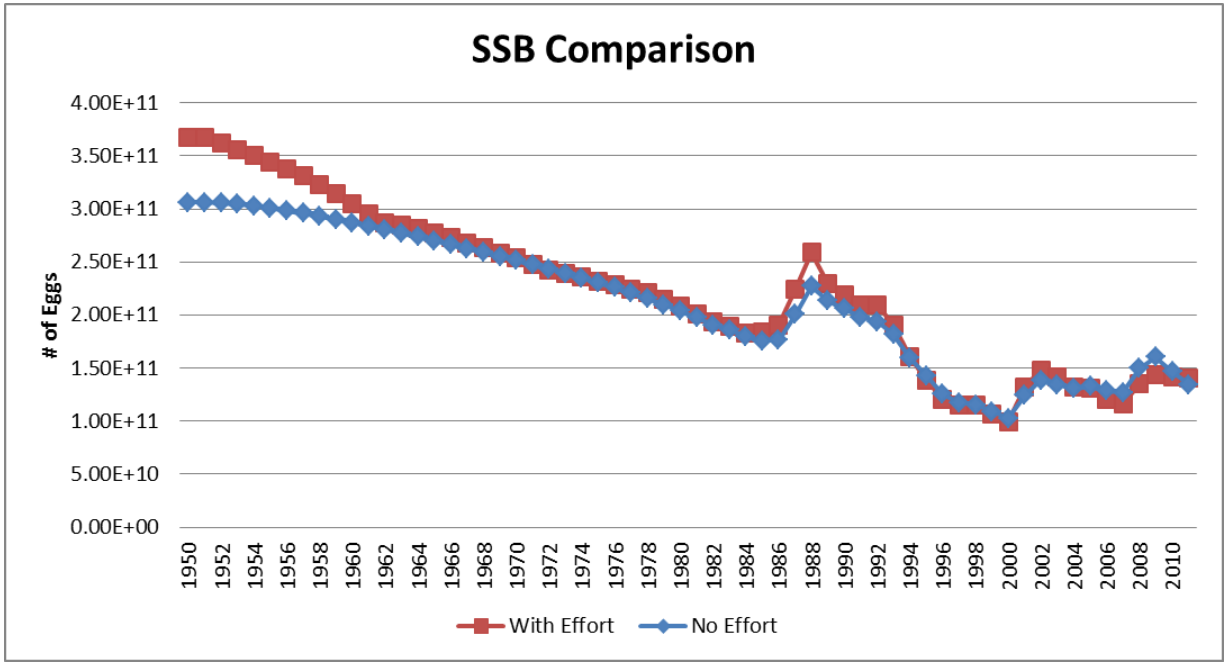
SS3 Continuity Runs—Shrimp Effort and Bycatch

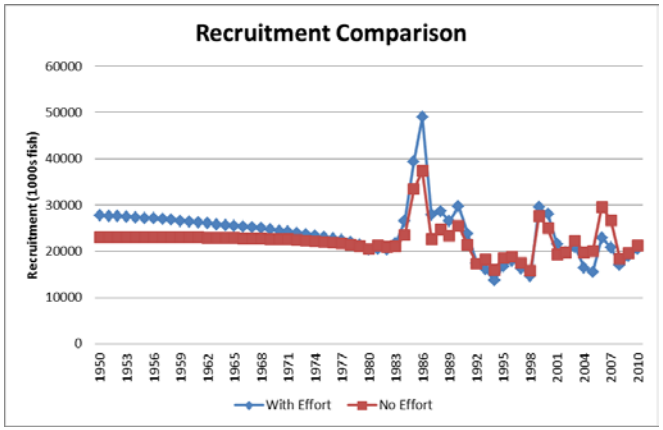




- Median Shrimp Bycatch=6.65mil fish
- Old SS approach fit median bycatch in each year with a linear landings ramp
- Superyear approach assumes median bycatch of 6.65 mil fish (no ramp)
- Including shrimp effort is only change with a significant impact

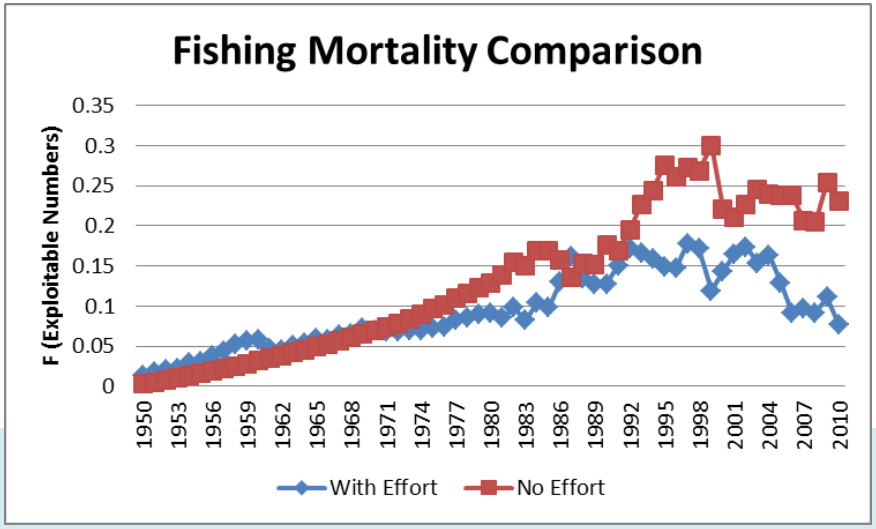
SS3 Continuity Runs—Shrimp Effort and Bycatch



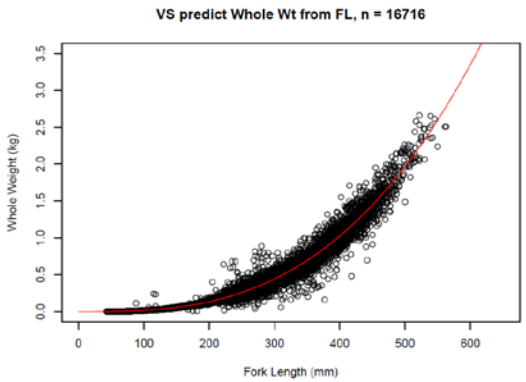


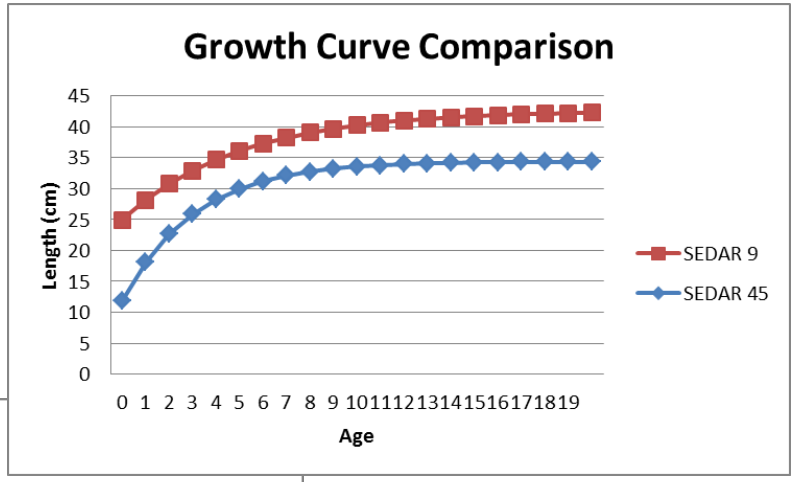
	B0	R0	Steep
No Effort	3.06E+11	10.05	8.23E-01
Effort	3.67E+11	10.2	5.45E-01

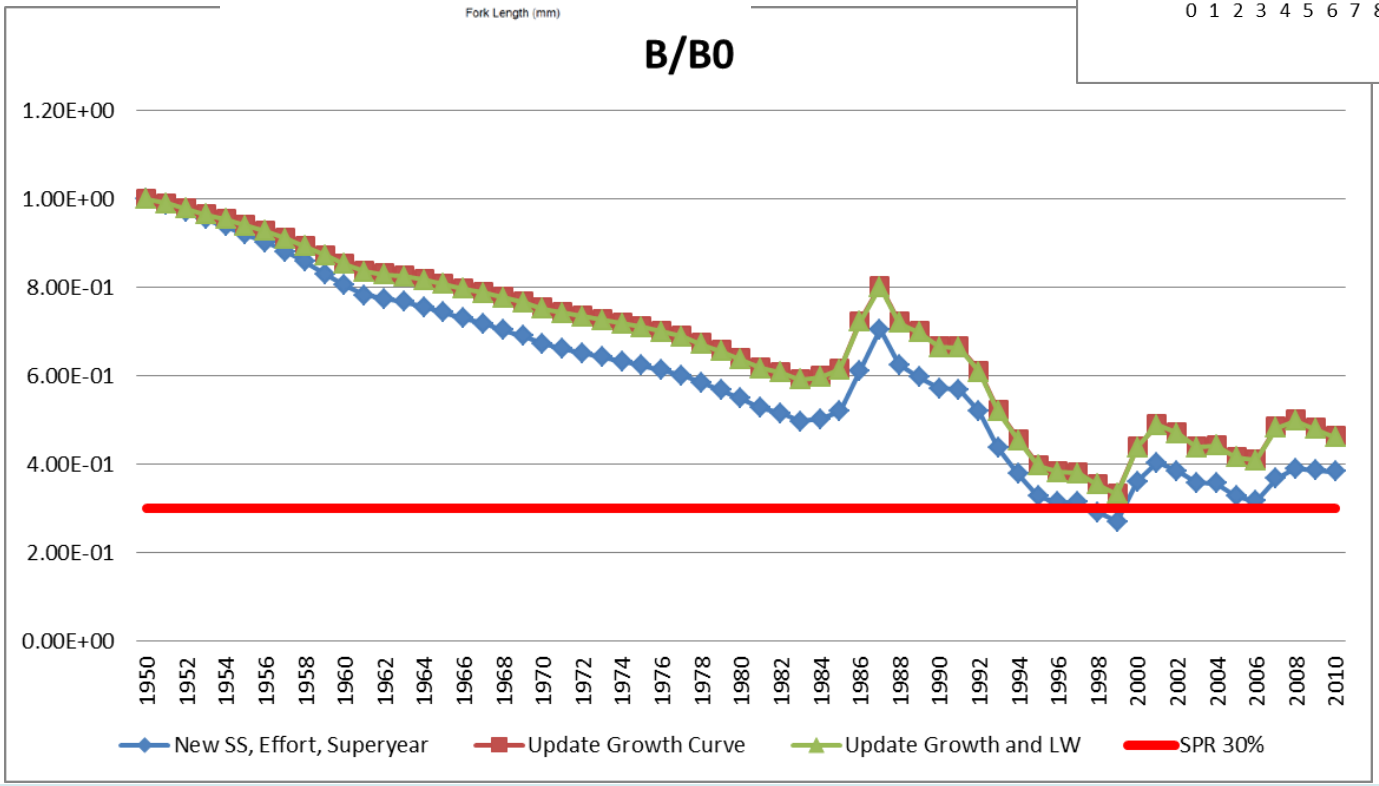
- Initial SSB is much higher with effort, but is otherwise comparable for remainder of timeseries
- F starts off higher, but is reduced considerably in last two decades



SS3 Continuity Runs—Growth



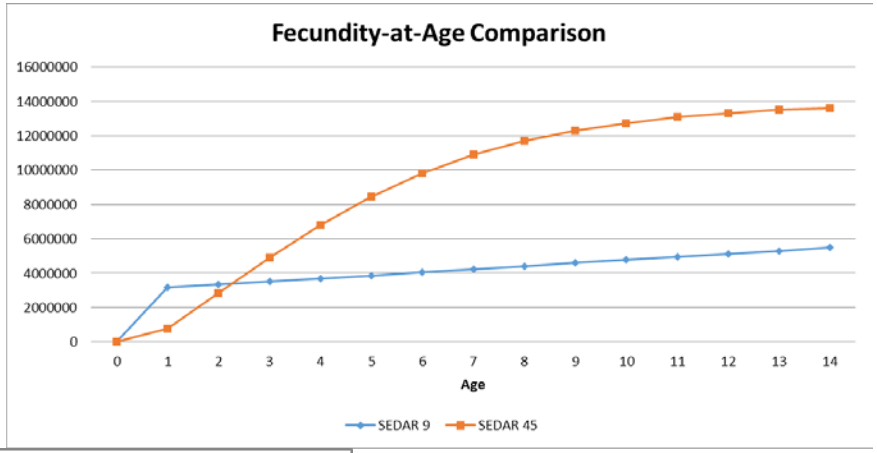


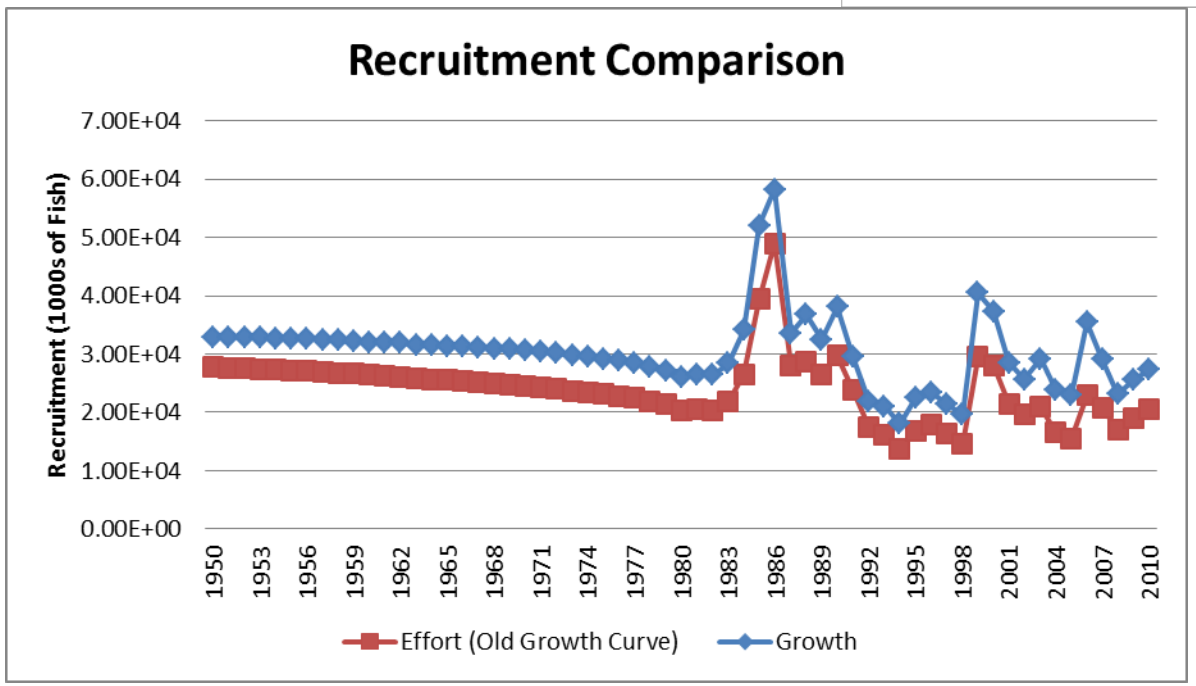


- Faster growing, but smaller sizes
- Little weight difference in smaller fish

SS3 Continuity Runs—Growth

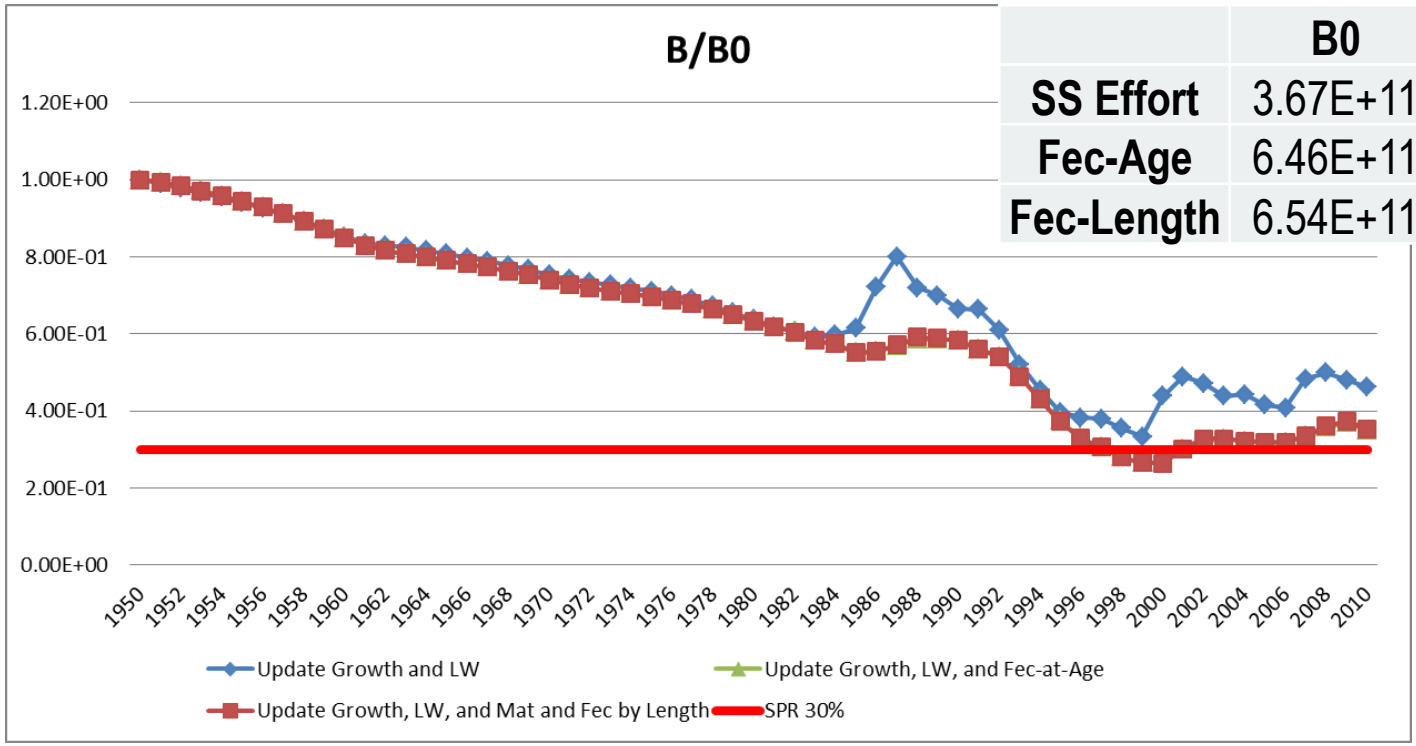
	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Growth	4.36E+11	10.4	0.607
Growth+LW	4.33E+11	10.39	0.606





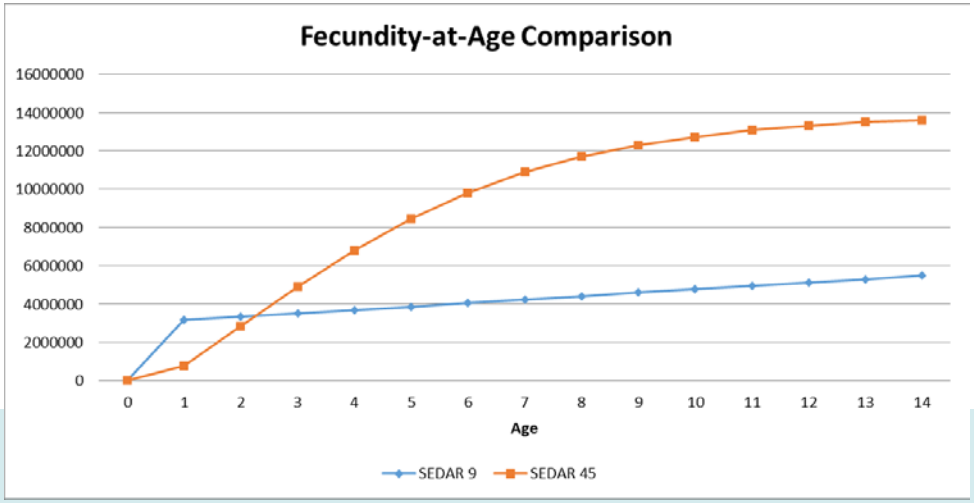
- Higher recruitment driving differences in SSB
- SEDAR 9 Fecundity-at-Age vector assumes 100% maturity at Age-1

SS3 Continuity Runs—Maturity



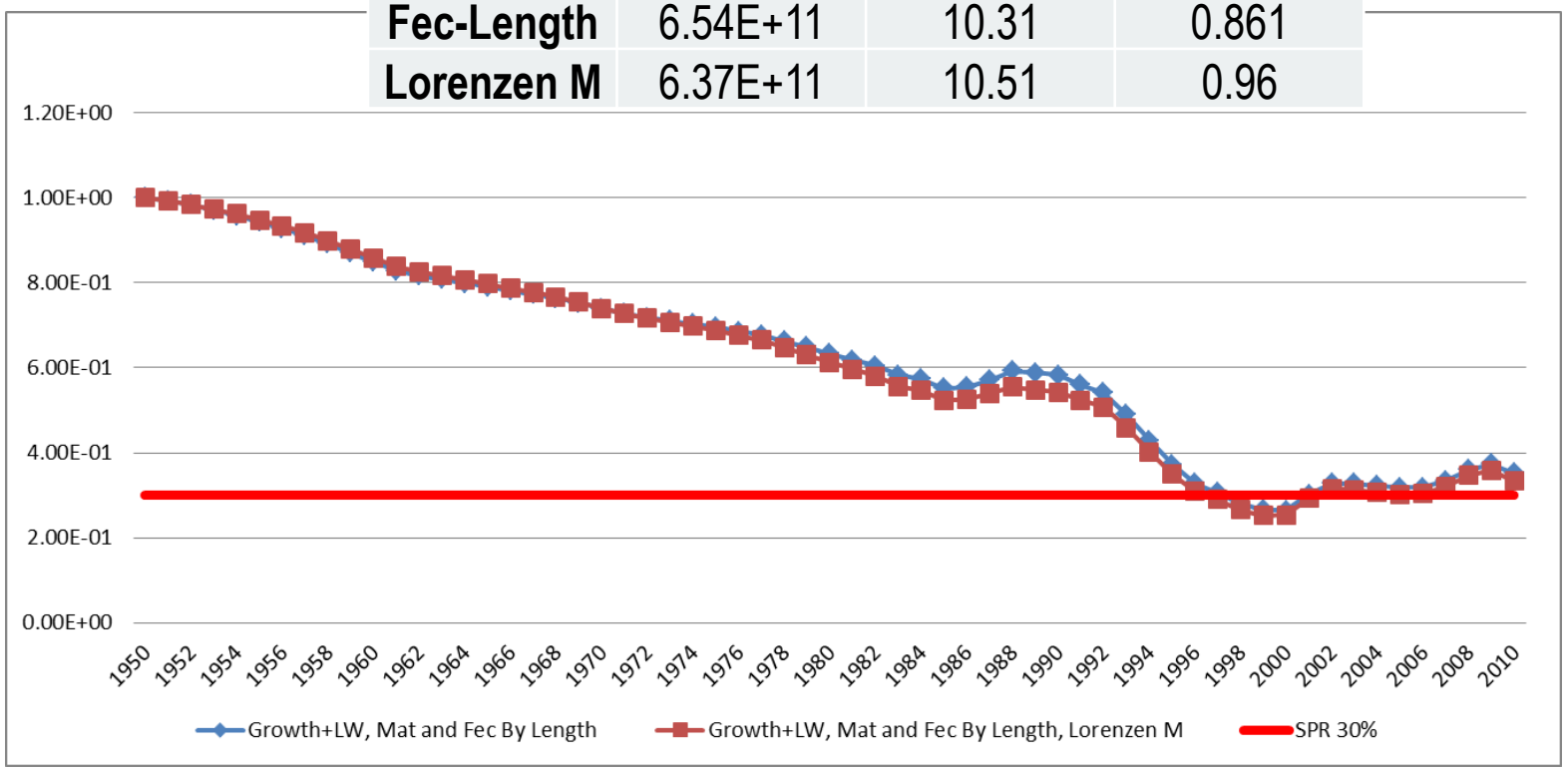
	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Fec-Age	6.46E+11	10.31	0.861
Fec-Length	6.54E+11	10.31	0.861

- New fecundity estimates result in smoother SSB curve and lower SSB (no longer follows recruitment spikes as closely)
  - No longer 100% mature at age-1
  - Lower fecundity at younger ages

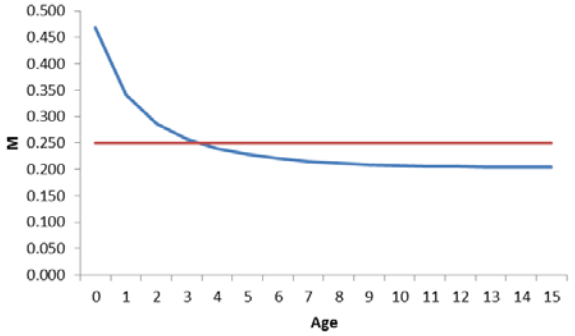


SS3 Continuity Runs—Lorenzen M

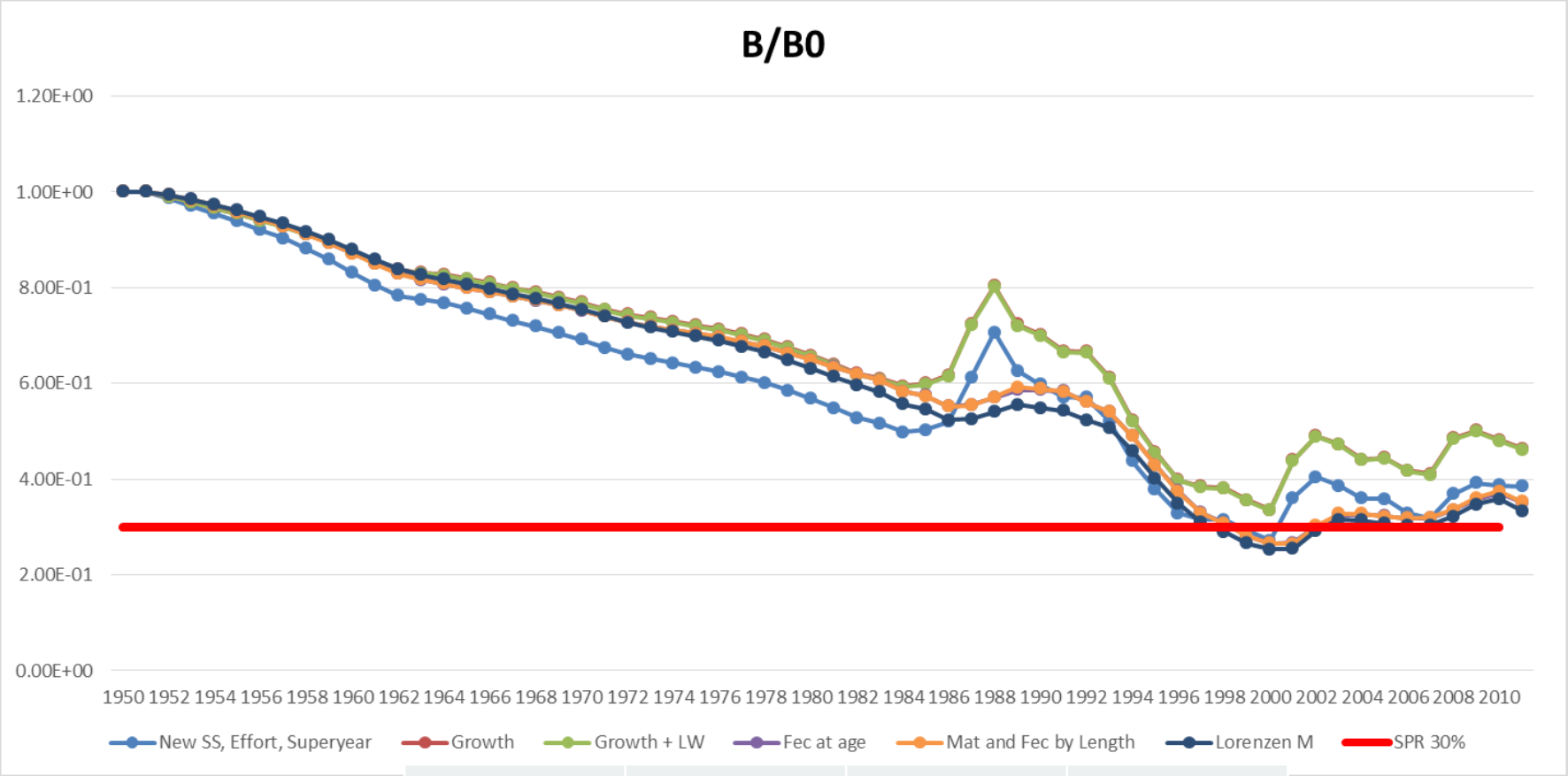
	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Fec-Length	6.54E+11	10.31	0.861
Lorenzen M	6.37E+11	10.51	0.96



- Higher M at younger ages further reduces SSB
- Reduced fecundity at younger ages (compared to SEDAR 9) minimizes impact on SSB

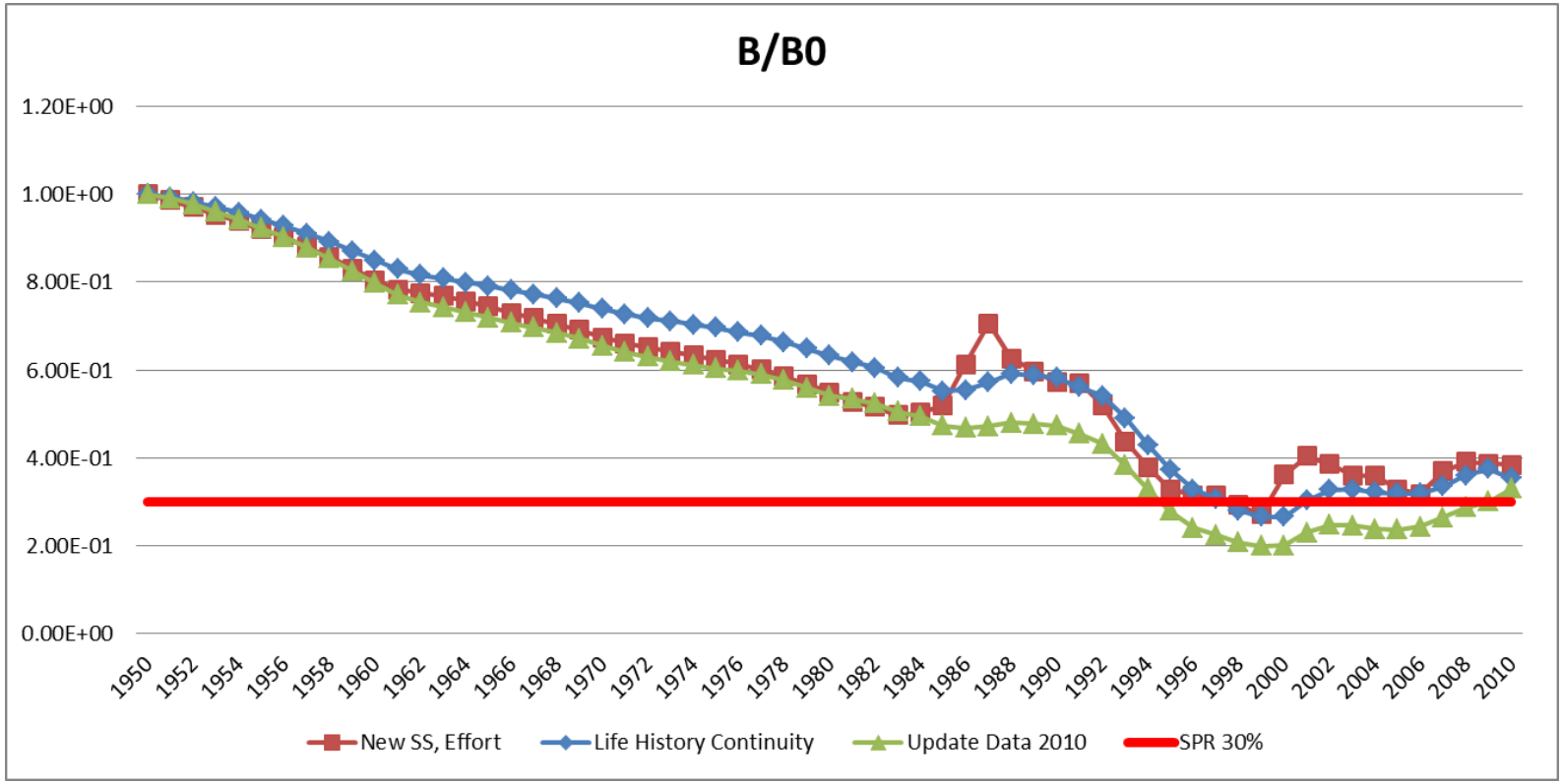


SS3 Continuity Runs—All Life History Updates



	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Growth	4.36E+11	10.4	0.607
Growth+LW	4.33E+11	10.39	0.606
Fec-Age	6.46E+11	10.31	0.861
Fec-Length	6.54E+11	10.31	0.861
Lorenzen M	6.37E+11	10.51	0.96

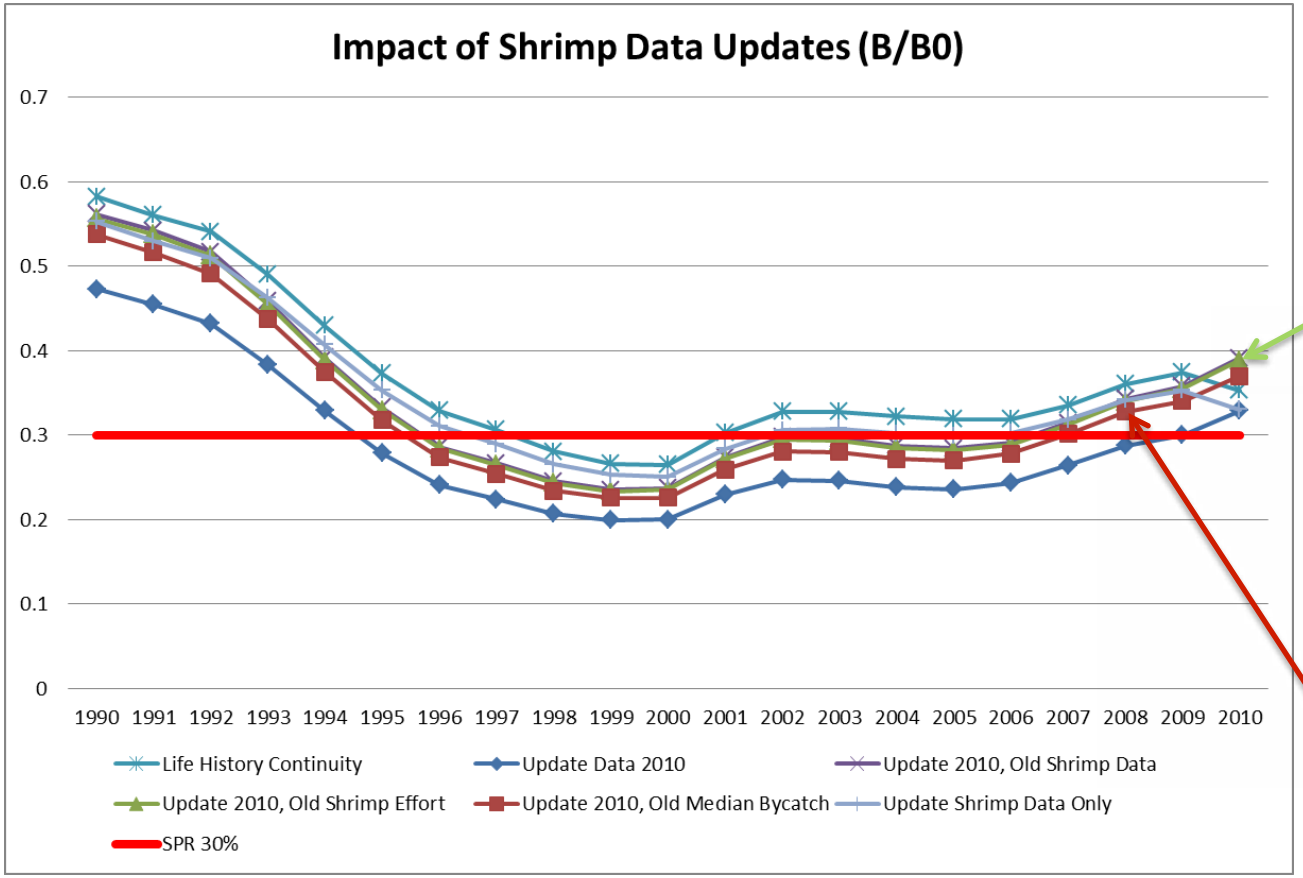
SS3 Continuity Runs—Update Data through 2010



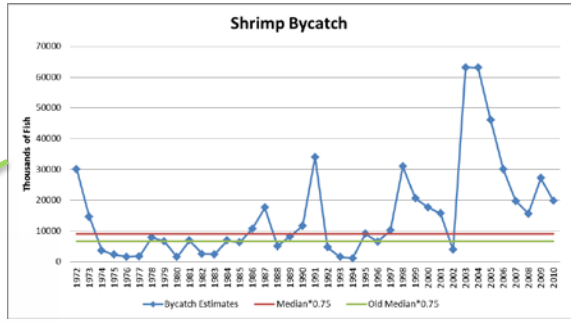
***Shrimp bycatch data has not been updated**
****Using 0.75*Median of available shrimp bycatch (slightly higher than previous median used in update)**

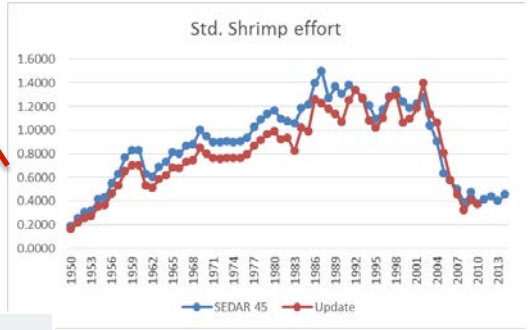
	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Fec-Length	6.54E+11	10.31	0.861
Update 2010	6.90E+11	10.37	0.76

SS3 Continuity Runs—Impact of Shrimp Bycatch



Superyear median changed from 6.65mil to 6.822mil





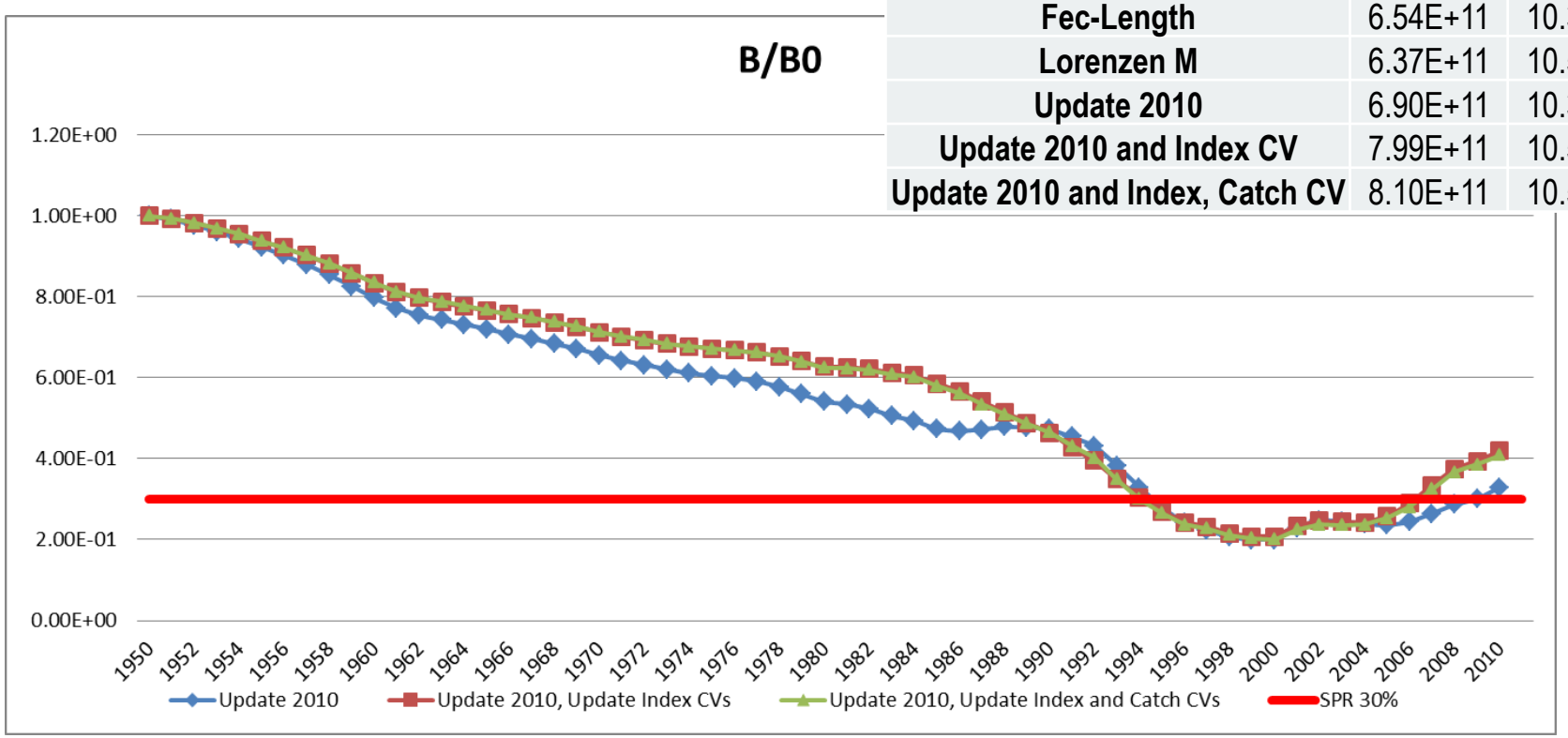
	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Fec-Length	6.54E+11	10.31	0.861
Update 2010	6.90E+11	10.37	0.76
Update 2010, Old Shrimp Data	6.55E+11	10.31	0.85
Update 2010, Old Shrimp Median Bycatch	6.82E+11	10.34	0.76
Update 2010, Old Shrimp Effort	6.62E+11	10.32	0.85

Steepness

- SEDAR 9:
  - The level of assumed shrimp bycatch also impacts the status of vermilion snapper (SEDAR9-AW-04). Lower levels of shrimp bycatch cause lower estimates of productivity (steepness), and consequently poorer status. Therefore, the stock status of vermilion snapper is predicted to be less optimistic if the assumed shrimp bycatch is overestimated.

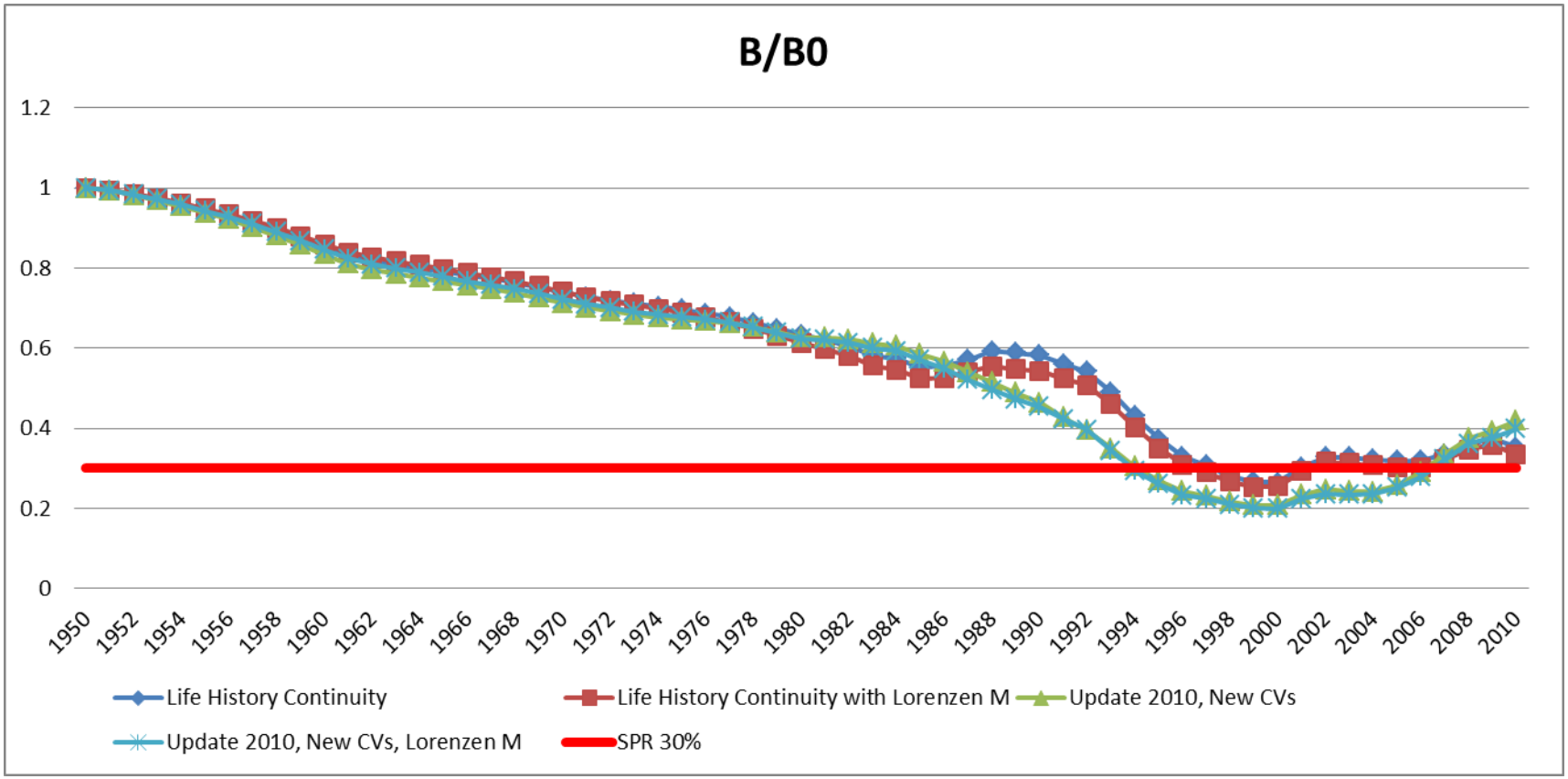
SS3 Continuity Runs—Update CVs

	B0	R0	Steep
Fec-Length	6.54E+11	10.31	0.861
Lorenzen M	6.37E+11	10.51	0.96
Update 2010	6.90E+11	10.37	0.76
Update 2010 and Index CV	7.99E+11	10.51	0.69
Update 2010 and Index, Catch CV	8.10E+11	10.53	0.68



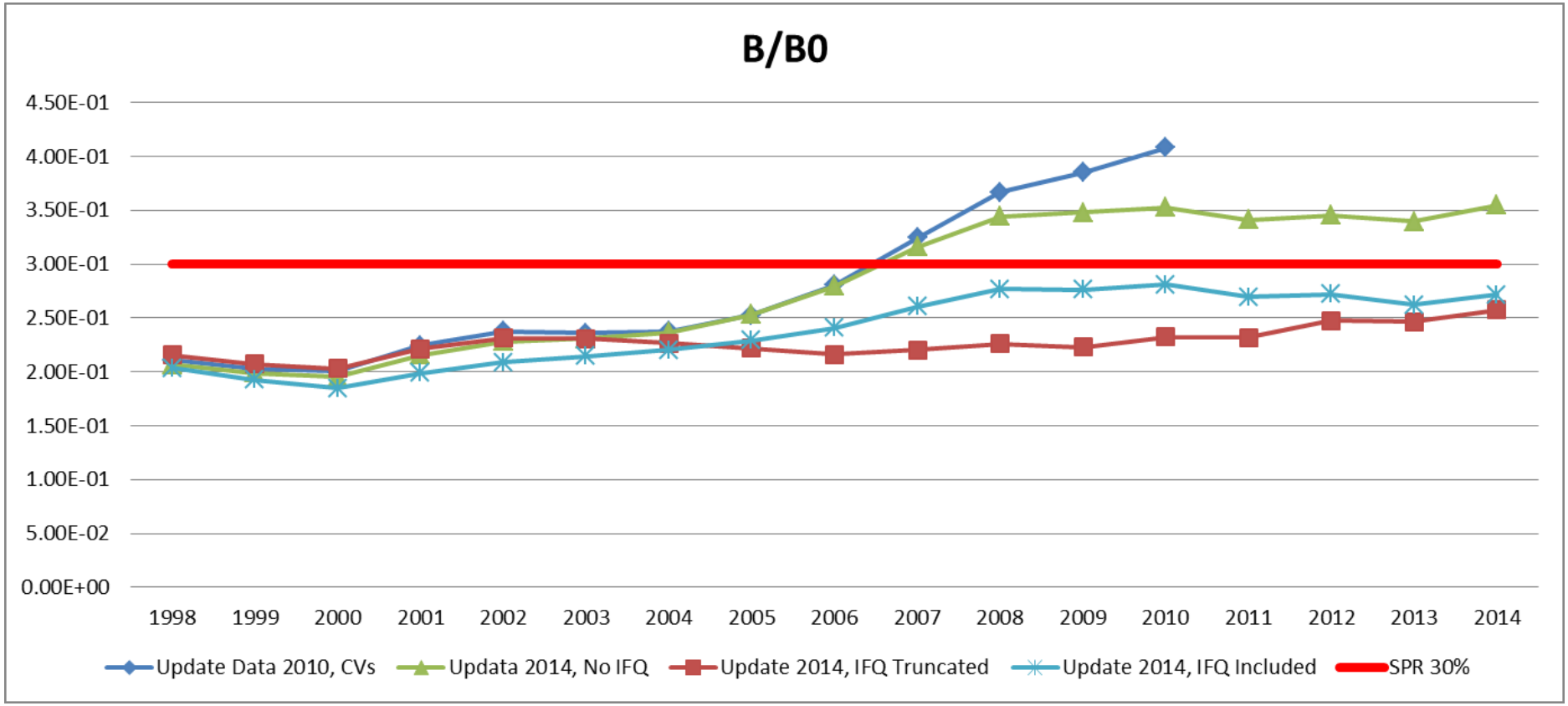
- Update assessment assumed constant index CVs and catch CV=0.05
- Index CVs are updated to those output by standardization routines
- Catch CVs have been updated to reflect assumed relative error per SEFSC best practices (Commercial CV=0.1, Recreational CV=0.3)

SS3 Continuity Runs—Lorenzen M



	B0	R0	Steep
Fec-Length	6.54E+11	10.31	0.861
Lorenzen M	6.37E+11	10.51	0.96
Update 2010	6.90E+11	10.37	0.76
Update 2010 and Index, Catch CV	8.10E+11	10.53	0.68
Update 2010, CVs, Lorenzen M	7.66E+11	10.69	0.79

SS3 Continuity Runs—Update Data 2014



- ****Shrimp bycatch data has not been updated**
- Using superyear through 2010

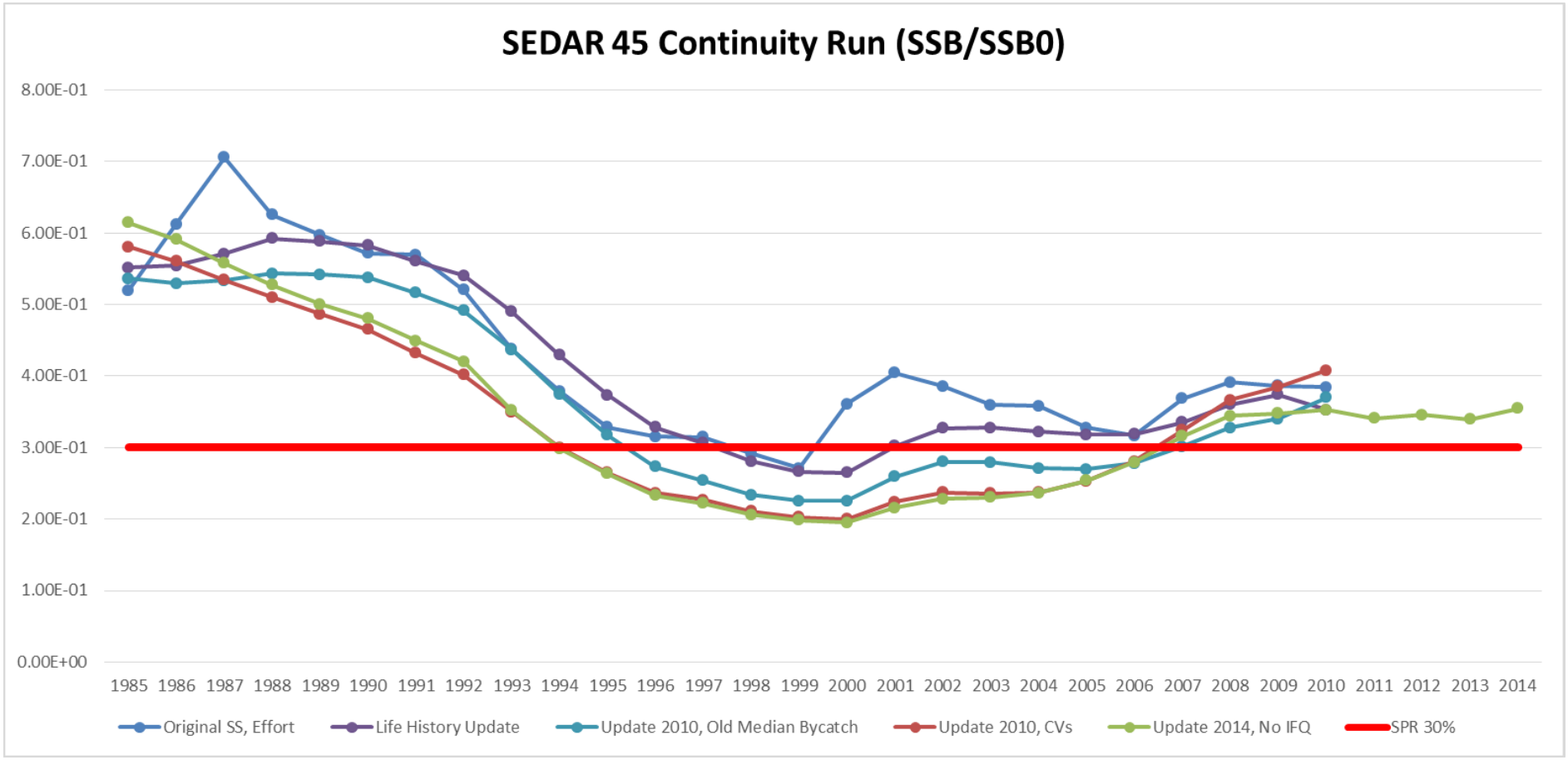
	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Update 2010 and Index, Catch CV	8.10E+11	10.53	0.68
Update 2014 No IFQ	8.76E+11	10.6	0.57
Update 2014 IFQ	9.61E+11	10.7	0.49
Update 2014 No IFQ Truncated	9.96E+11	10.73	0.48

Final Continuity Run

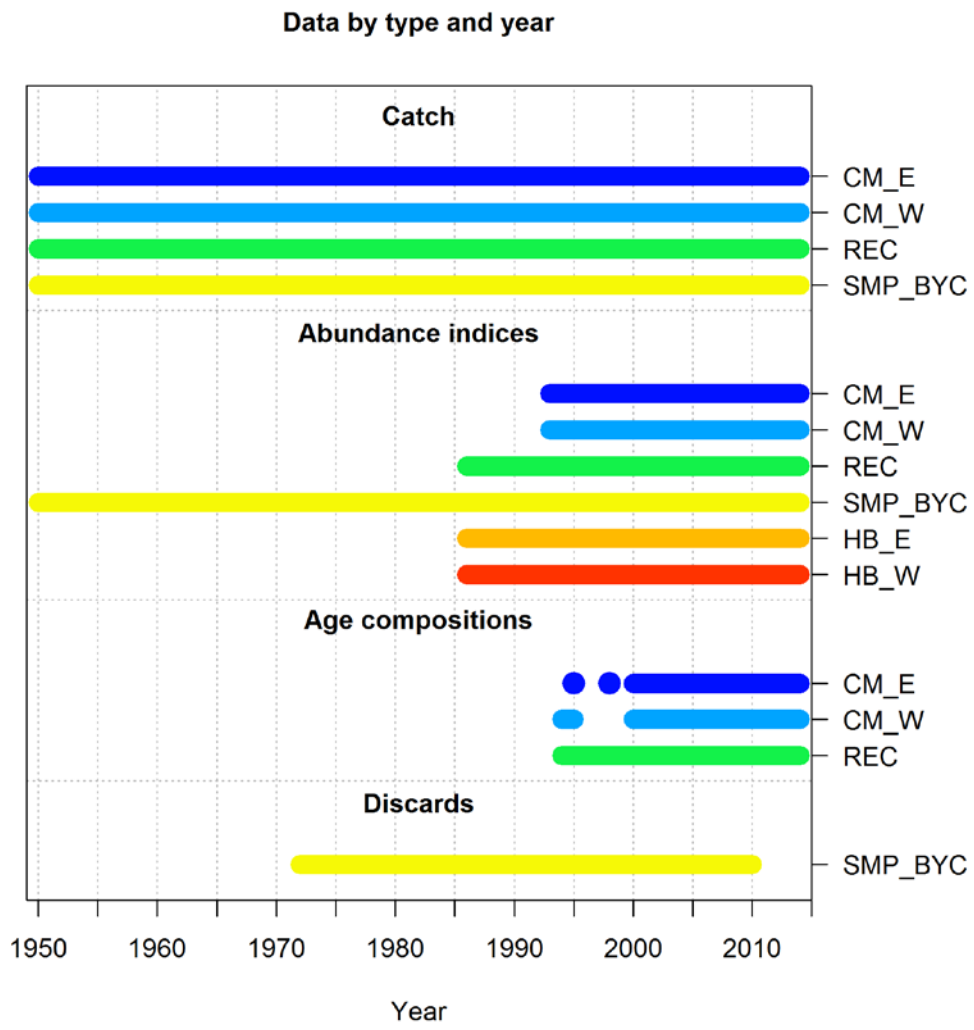
Final Continuity Run

- Constant natural mortality
- Prior on stock-recruit steepness
- Updated life history relationships
- Updated data through 2014
- Gulf-wide shrimp bycatch (fitting median using superyear approach) and fitting to shrimp effort
- No shrimp age compositions (fix selectivity assuming double normal with 100% selection of age-1, 30% age-2, and 3% age-3)
- Updated index CVs (SEDAR 9 assumed constant CV)
- Updated relative catch CVs based on best practices (downweight recreational catch; SEDAR 9 assumed equal weighting)
- Logistic selectivity with no timeblocks
- No discards
- No surveys

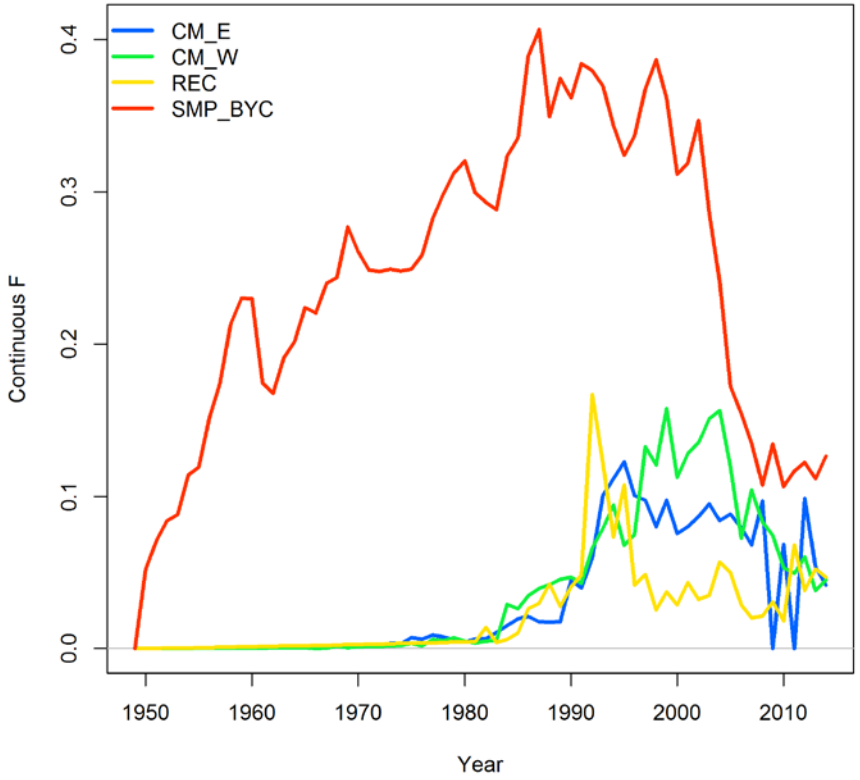
Final Continuity Run

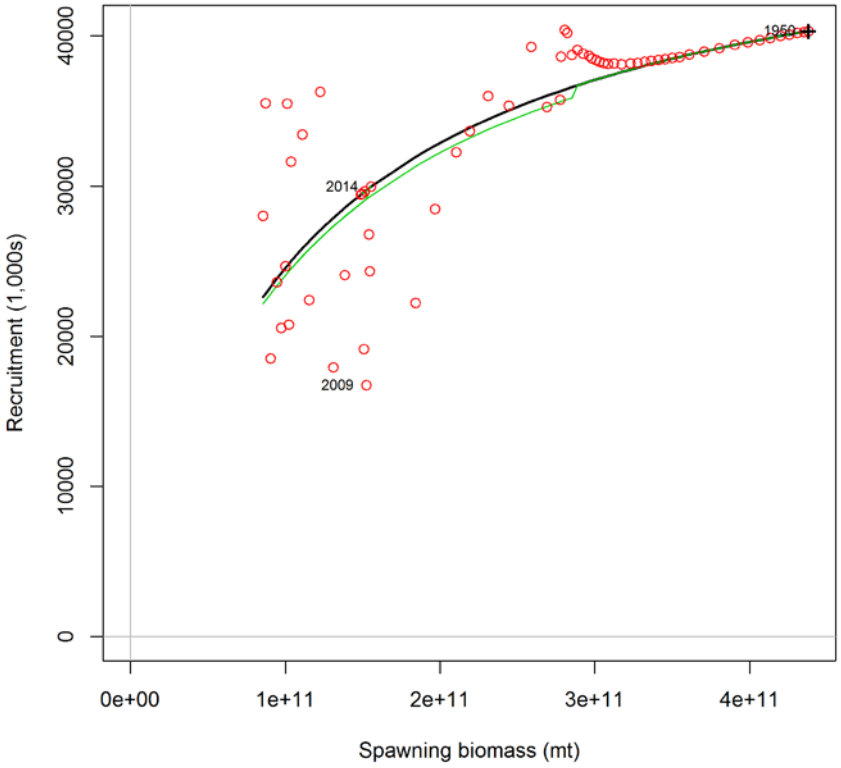


Data

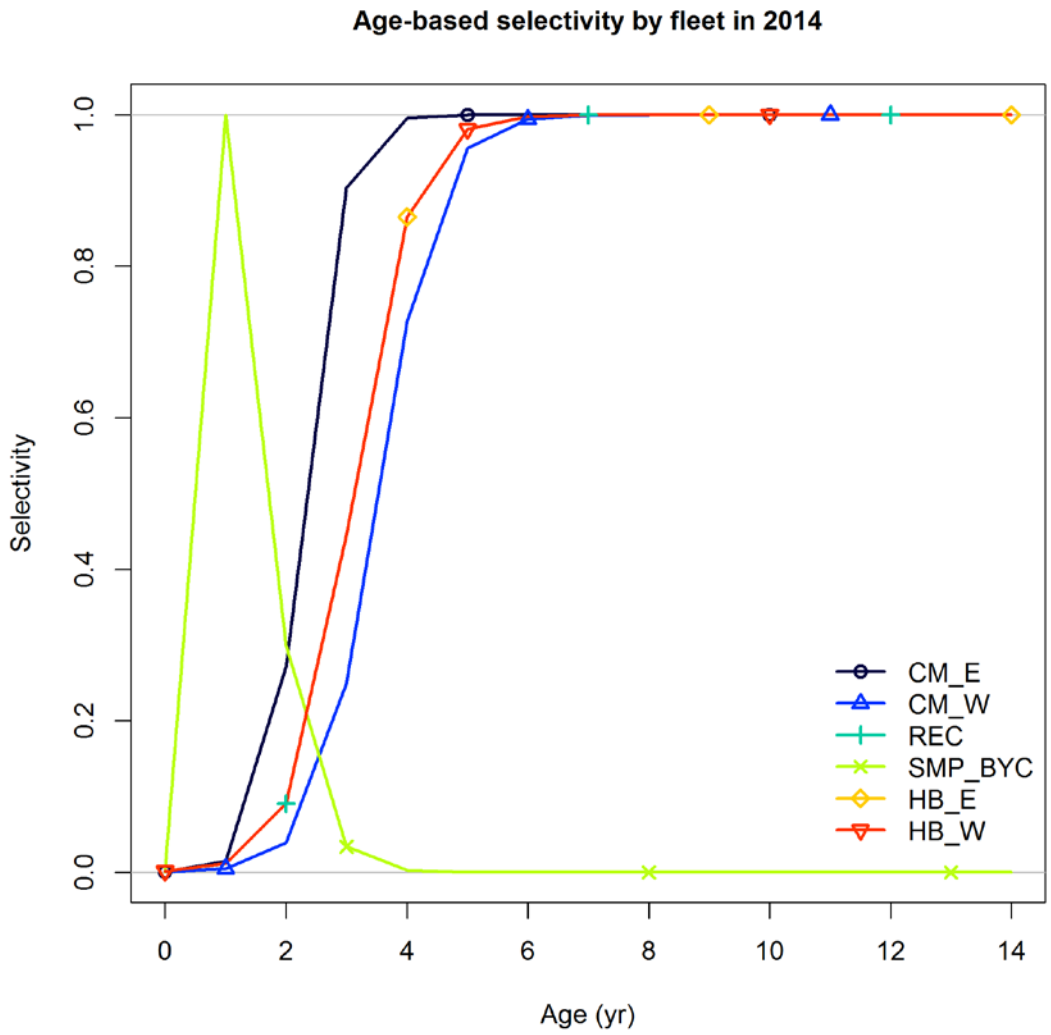

Data by type and year
Catch
CM_E
CM_W
REC
SMP_BYC
Abundance indices
CM_E
CM_W
REC
SMP_BYC
HB_E
HB_W
Age compositions
CM_E
CM_W
REC
Discards
SMP_BYC
1950
1960
1970
1980
1990
2000
2010
Year

Estimates

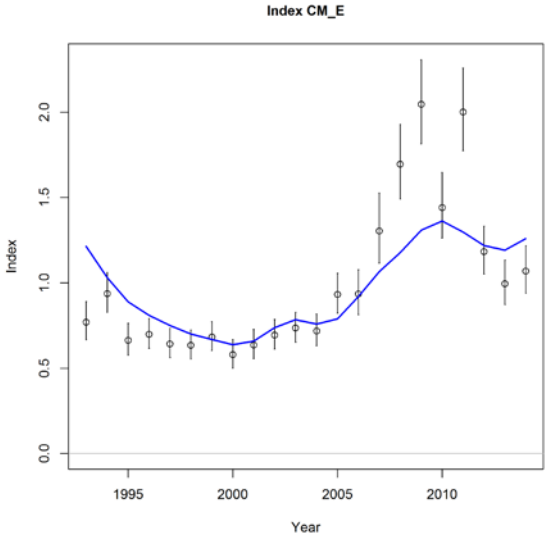

CM_E
CM_W
REC
SMP_BYC
Continuous F
0.0
0.1
0.2
0.3
0.4
1950
1960
1970
1980
1990
2000
2010
Year

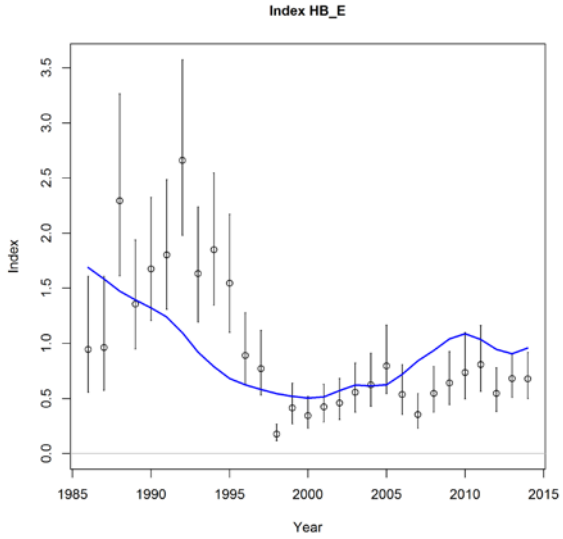

Recruitment (1,000s)
0
10000
20000
30000
40000
2014
2009
1950
0e+00
1e+11
2e+11
3e+11
4e+11
Spawning biomass (mt)

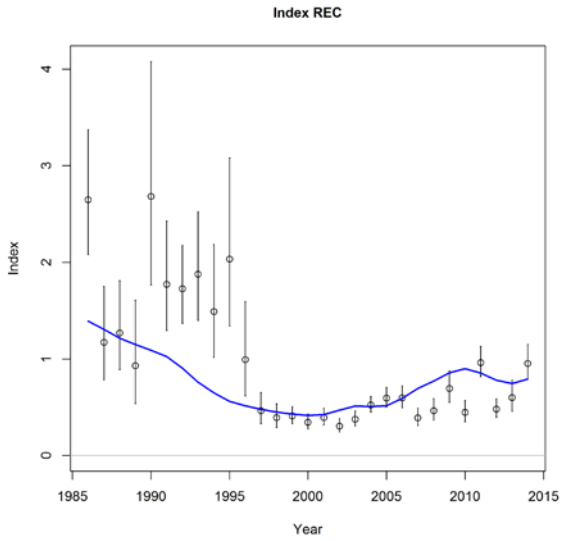
Estimates

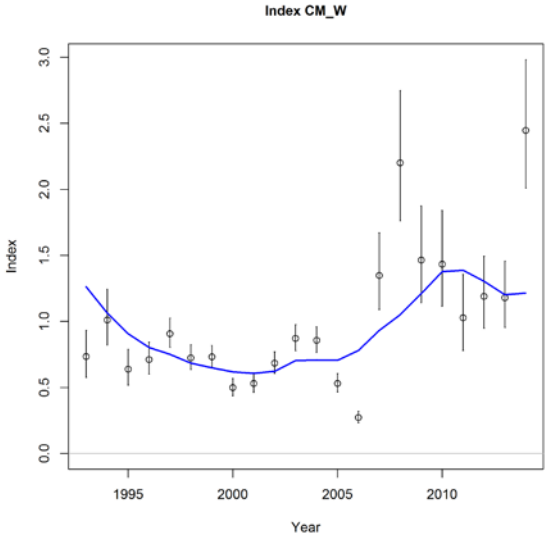

Age-based selectivity by fleet in 2014
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14
Age (yr)
CM_E
CM_W
REC
SMP_BYC
HB_E
HB_W

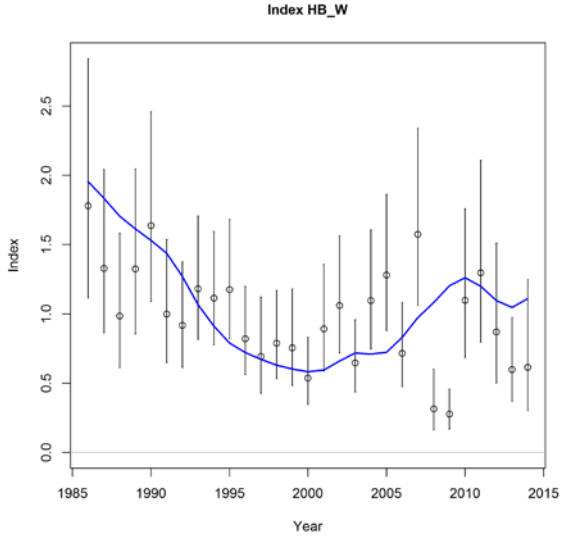
Data Fits

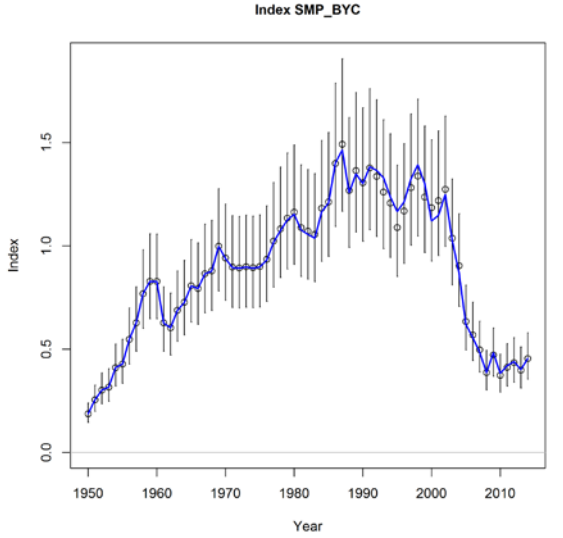

Index CM_E
Index
Year
0.0
0.5
1.0
1.5
2.0
1995
2000
2005
2010


Index HB_E
Index
Year
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1985
1990
1995
2000
2005
2010
2015

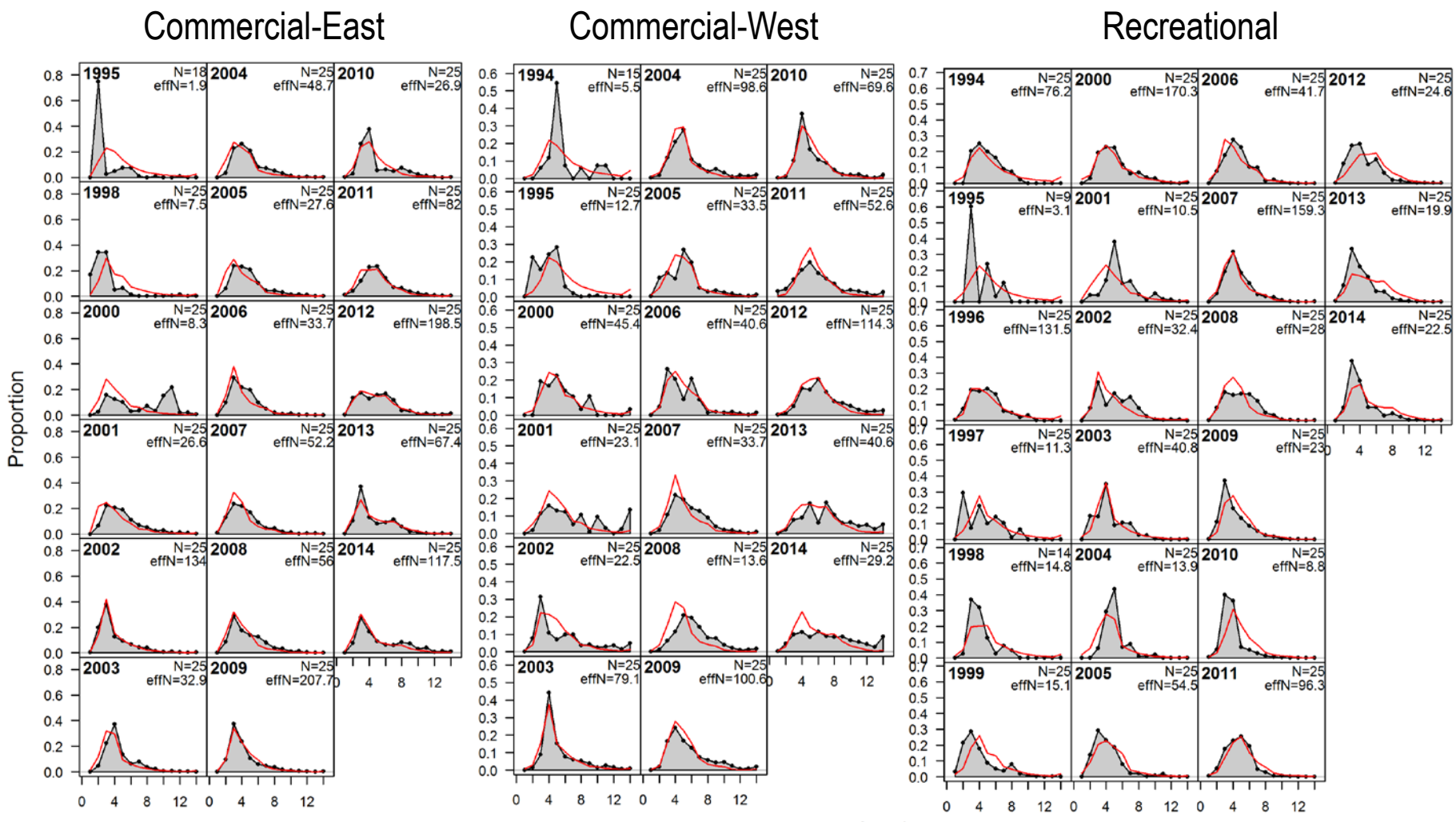

Index REC
Index
Year
0
1
2
3
4
1985
1990
1995
2000
2005
2010
2015


Index CM_W
Index
Year
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1995
2000
2005
2010


Index HB_W
Index
Year
0.0
0.5
1.0
1.5
2.0
2.5
1985
1990
1995
2000
2005
2010
2015


Index SMP_BYC
Index
Year
0.0
0.5
1.0
1.5
1950
1960
1970
1980
1990
2000
2010

Age Composition Fits



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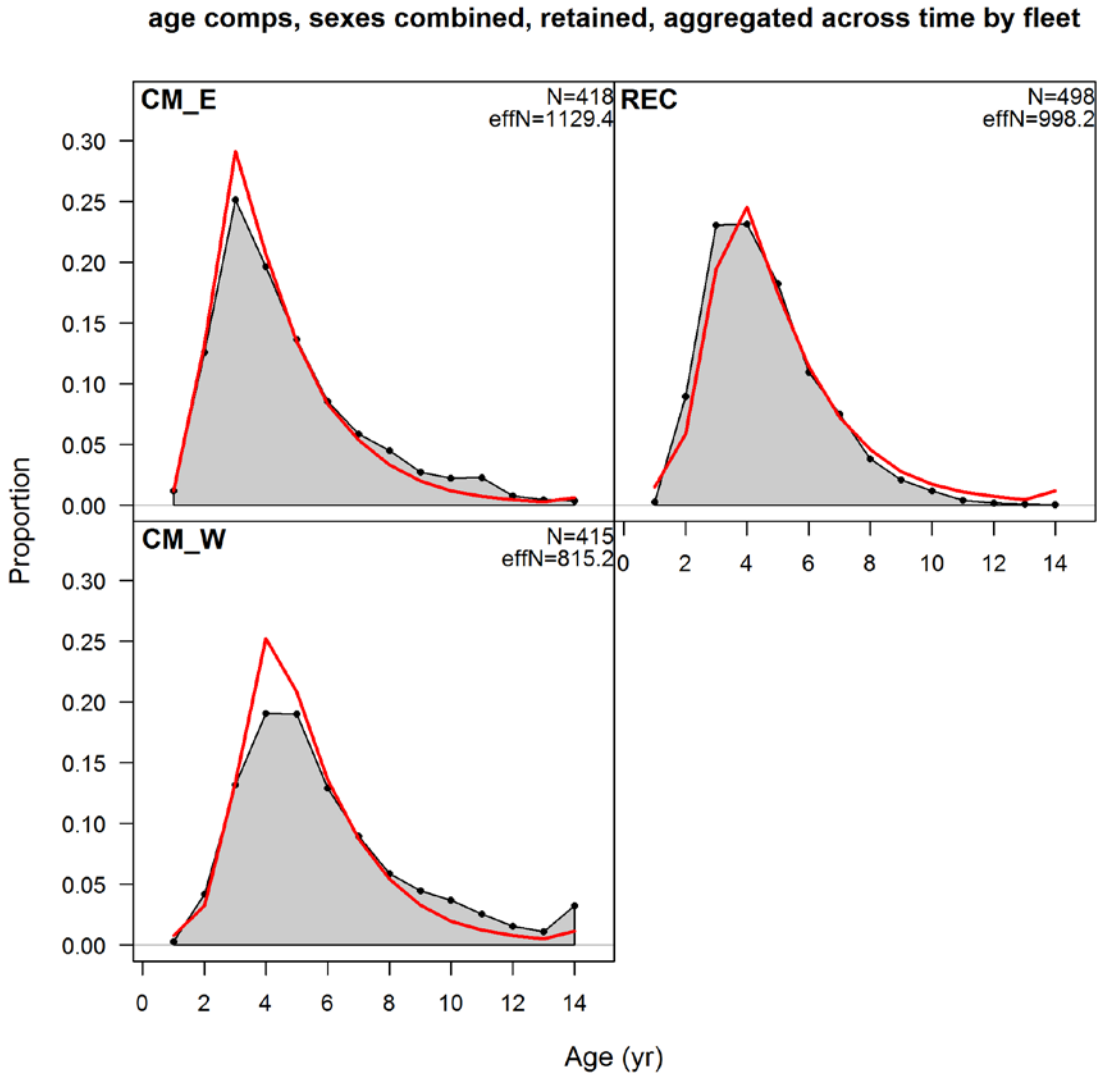
Age Composition Fits

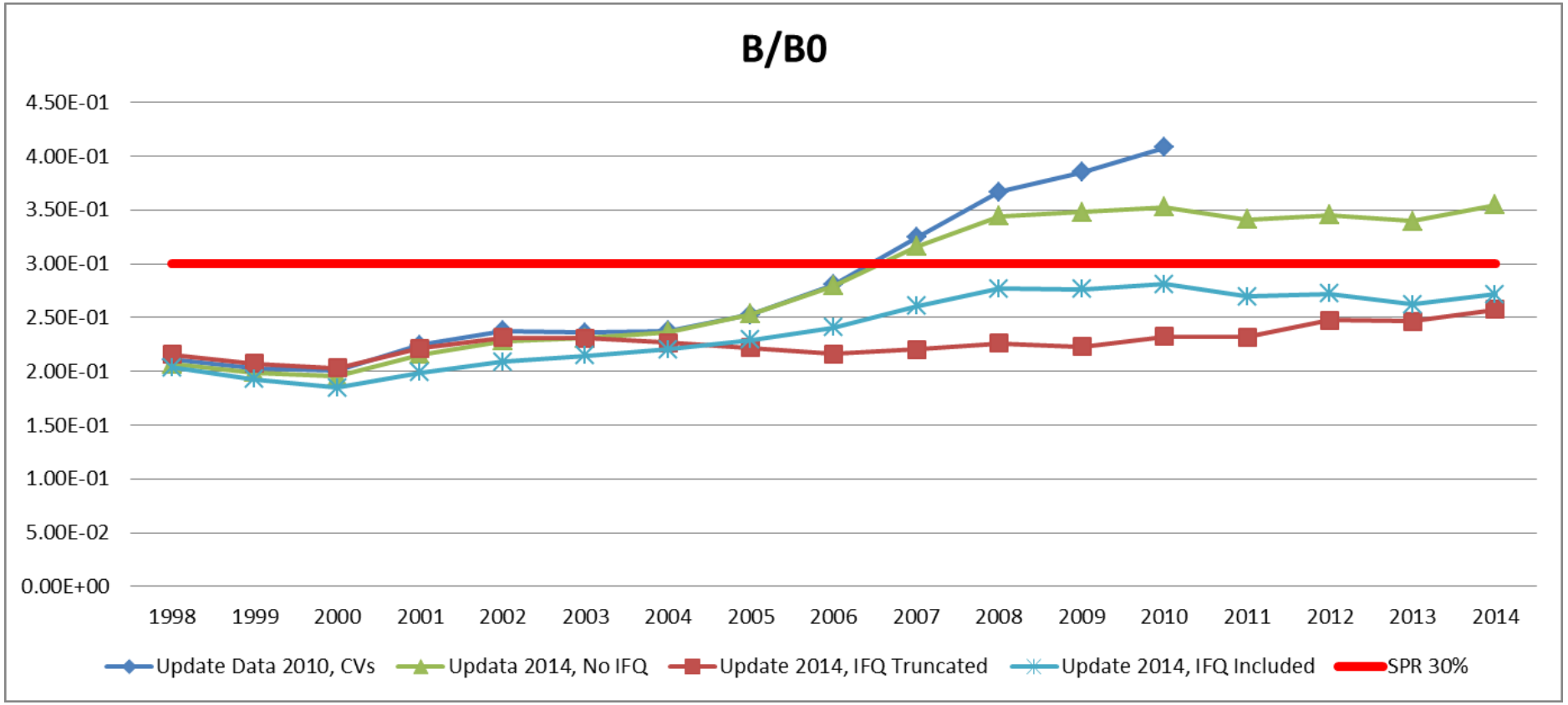


Base Model Methods

Base Model Decisions

- Treatment of IFQ in commercial CPUE index
  - No IFQ variable, include IFQ or split series
- Data weighting
  - Relative catch CVs (commercial vs. recreational)
  - Index CVs (fixed vs. true)
  - Relative index CVs (relative to each other and relative to catch; i.e., lambda values)
  - Age composition effective sample sizes
- Shrimp data
  - Fit to shrimp age compositions or fix selectivity
- Natural Mortality
  - Constant M=0.25 (SEDAR 9) or Lorenzen M
- Stock-recruit
  - Estimate parameters, prior on steepness (SEDAR 9) or fix parameters
- Selectivity functions
  - Logistic (SEDAR 9) or other (e.g., estimate at age)
  - Timeblocks (SEDAR 9 had no timeblocks)
- Discards
  - Recreational available but no commercial yet
  - Need to setup retention functions (min size/fully recruited retention)
  - Discard mortality
- Surveys
  - SEAMAP
  - Larval
  - Video

IFQ Factor

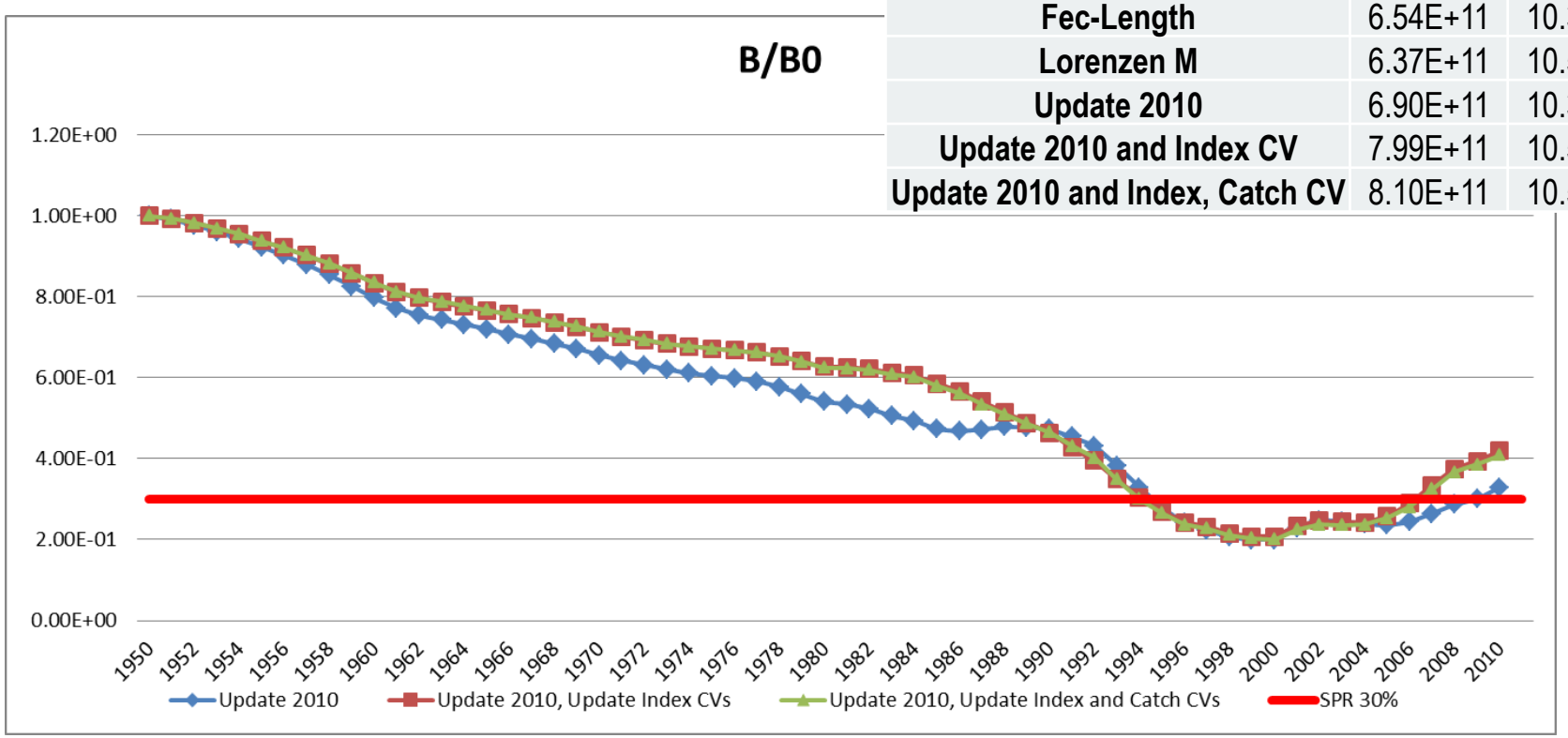


- **Shrimp bycatch data has not been updated
- Using superyear through 2010

	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Update 2010 and Index, Catch CV	8.10E+11	10.53	0.68
Update 2014 No IFQ	8.76E+11	10.6	0.57
Update 2014 IFQ	9.61E+11	10.7	0.49
Update 2014 No IFQ Truncated	9.96E+11	10.73	0.48

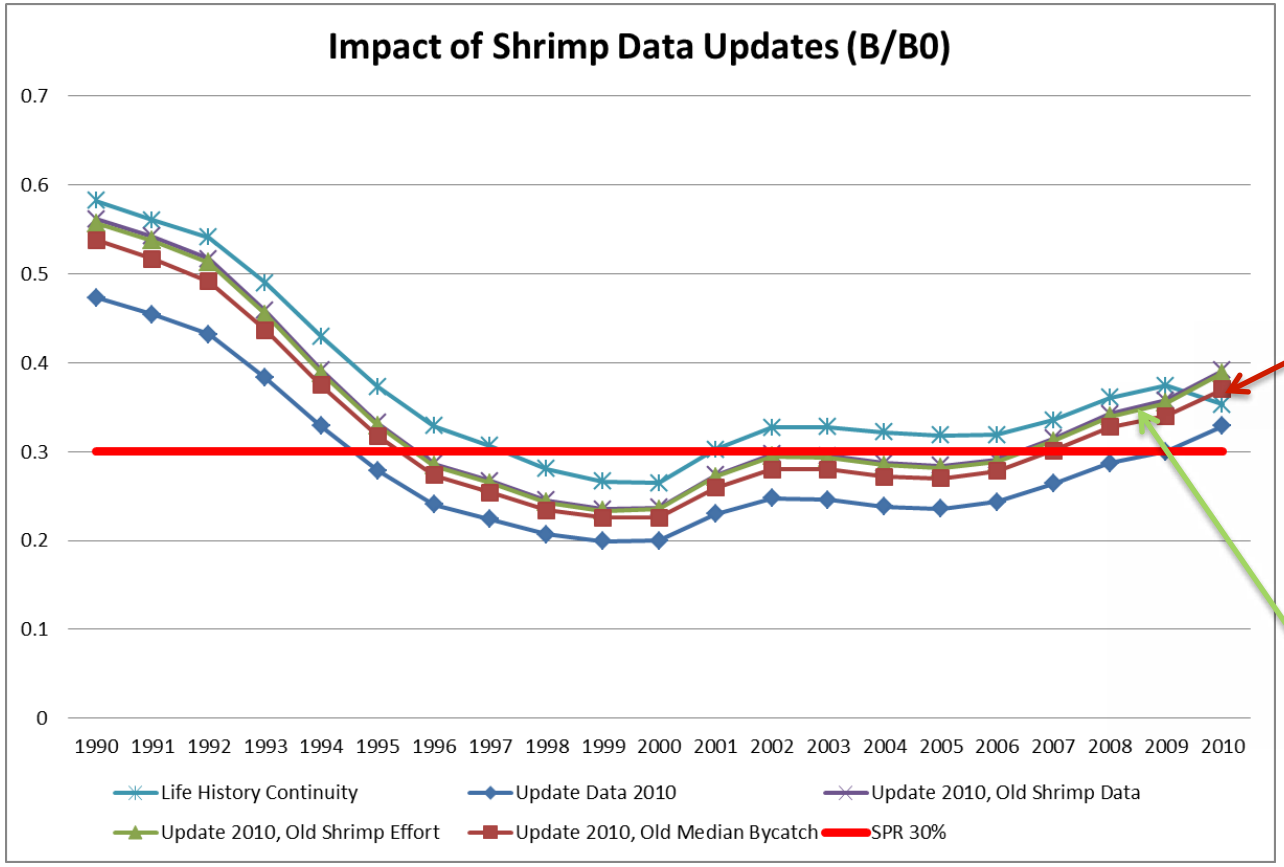
Data Weighting

	B0	R0	Steep
Fec-Length	6.54E+11	10.31	0.861
Lorenzen M	6.37E+11	10.51	0.96
Update 2010	6.90E+11	10.37	0.76
Update 2010 and Index CV	7.99E+11	10.51	0.69
Update 2010 and Index, Catch CV	8.10E+11	10.53	0.68

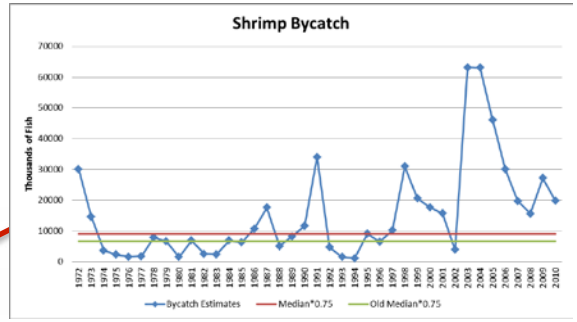


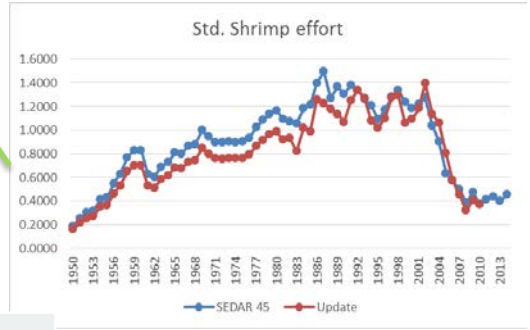
- Update assessment assumed constant index CVs and catch CV=0.05
- Index CVs are updated to those output by standardization routines
- Catch CVs have been updated to reflect assumed relative error per SEFSC best practices (Commercial CV=0.1, Recreational CV=0.3)

Bycatch



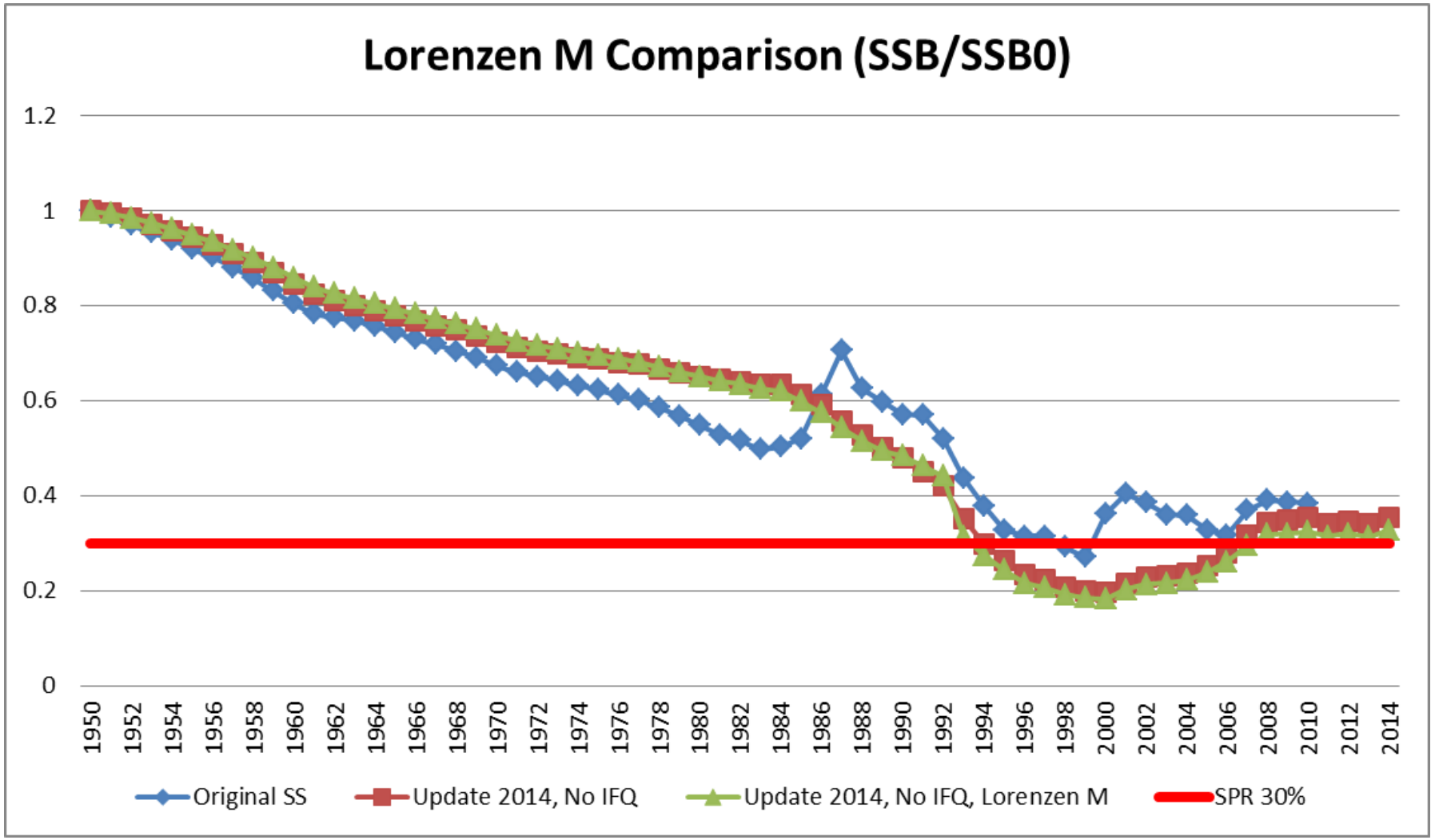
Superyear median changed from 6.65mil to 6.822mil





	B0	R0	Steep
SS Effort	3.67E+11	10.2	0.545
Fec-Length	6.54E+11	10.31	0.861
Update 2010	6.90E+11	10.37	0.76
Update 2010, Old Shrimp Data	6.55E+11	10.31	0.85
Update 2010, Old Shrimp Median Bycatch	6.82E+11	10.34	0.76
Update 2010, Old Shrimp Effort	6.62E+11	10.32	0.85

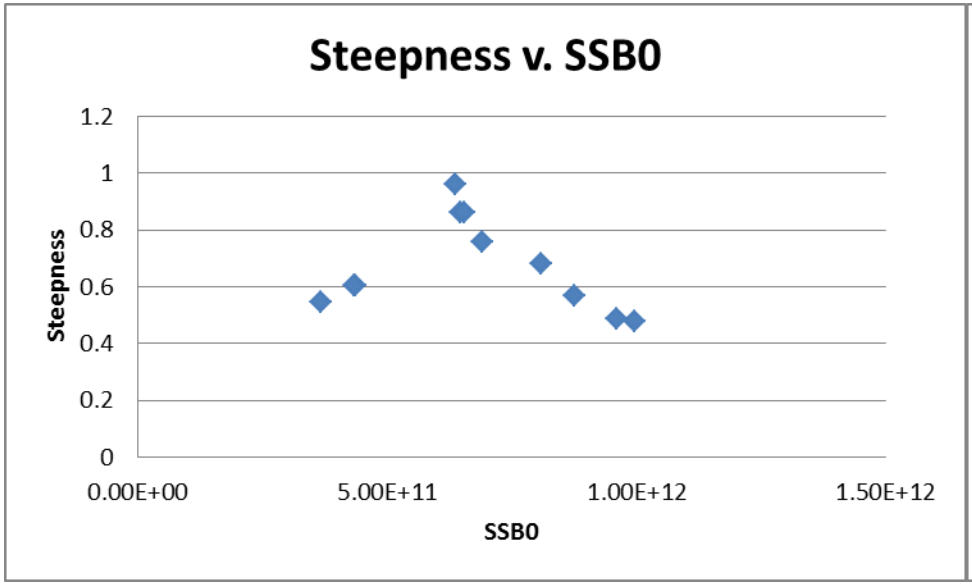
Lorenzen M

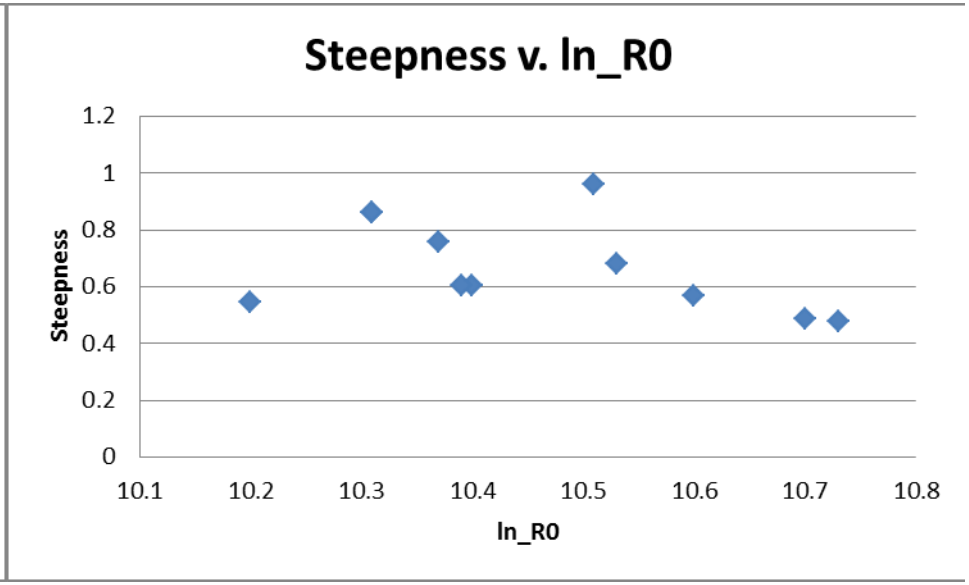

Lorenzen M Comparison (SSB/SSB0)
1.2
1
0.8
0.6
0.4
0.2
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Original SS
Update 2014, No IFQ
Update 2014, No IFQ, Lorenzen M
SPR 30%

Stock-Recruit Parametrization

- Steepness not well estimated
  - Ranges from ~0.5-0.96
- Not a strong relationship between R0 and steepness
- SSB0 varies widely and is an important influence on overfishing determination

	B0	ln_R0	Steep
SS Effort	3.67E+11	10.2	0.545
Growth	4.36E+11	10.4	0.607
Growth+LW	4.33E+11	10.39	0.606
Fec-Age	6.46E+11	10.31	0.861
Fec-Length	6.54E+11	10.31	0.861
Lorenzen M	6.37E+11	10.51	0.96
Update 2010	6.90E+11	10.37	0.76
Update 2010 and Index, Catch CV	8.10E+11	10.53	0.68
Update 2014 No IFQ	8.76E+11	10.6	0.57
Update 2014 IFQ	9.61E+11	10.7	0.49
Update 2014 No IFQ Truncated	9.96E+11	10.73	0.48





Steepness

- "The classification scheme developed at the FAO second technical consultation on the suitability of the CITES criteria for listing commercially-exploited aquatic species (Windhoek, Namibia, 22-25 October 2001; FAO 2001) was used to characterize the relative productivity of vermilion snapper. This information is provided in Table 1.3. A productivity rank was assigned to each life-history characteristic (a value of 1 was assigned for low, 2 for medium, and 3 for high productivity characteristics) and the ranks were averaged to produce an overall productivity score. This score was then used to prescribe a prior density function on steepness in the stock-recruitment relationship from the Periodic Life History strategists distribution of steepness values as summarized by Rose et. al. (2001). The dominant portion of the steepness values from these analogous species range from 0.6-0.8 with 90% of the values less than 0.9. As the vermilion snapper productivity score from this exercise is somewhat below the medium category, the data work group recommends that the prior probability density function on steepness for this species be lognormal with a mode of 0.6 and a CV such that there is no greater than a 10% probability of steepness values greater than 0.9."

Steepness

Table 1.3. Proposed guideline indices of productivity for exploited fish species.

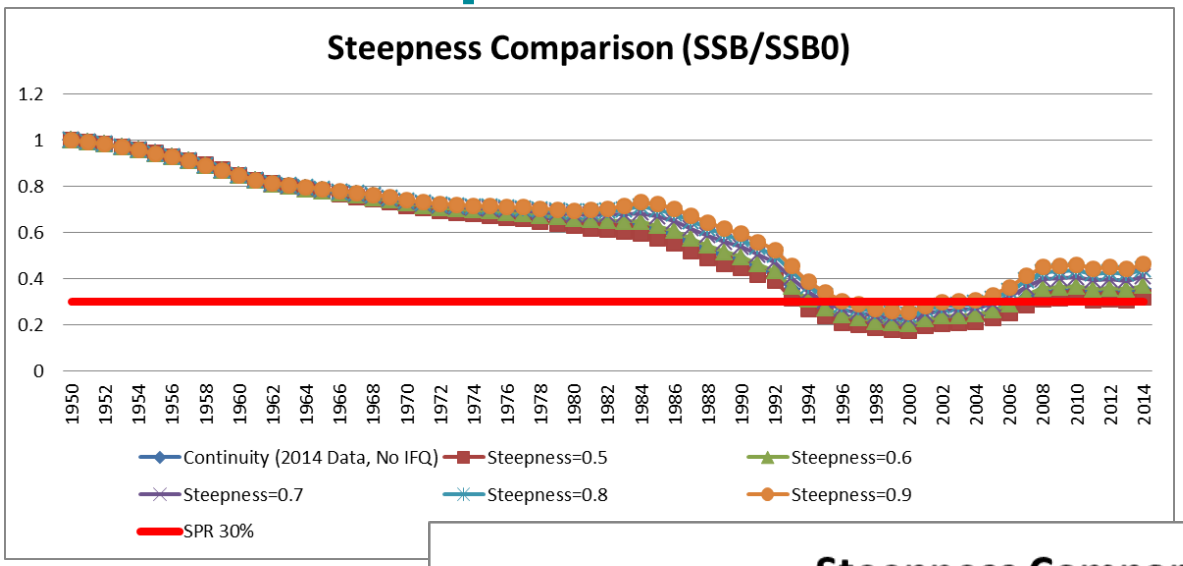
Parameter	Productivity			Species
	Low	Medium	High	Vermilion Snapper
M	<0.2	0.2 - 0.5	>0.5	0.15, **0.25**, 0.35
K	<0.15	0.15 - 0.33	> 0.33	0.20
t_{mat} (years)	> 8	3.3 - 8	< 3.3	1
t_{max} (years)	>25	14 - 25	<14	26
Examples	orange roughy, many sharks	cod, hake	sardine, anchovy	Vermilion Snapper Productivity Score = 1.88 (Low Medium)

New K=0.33

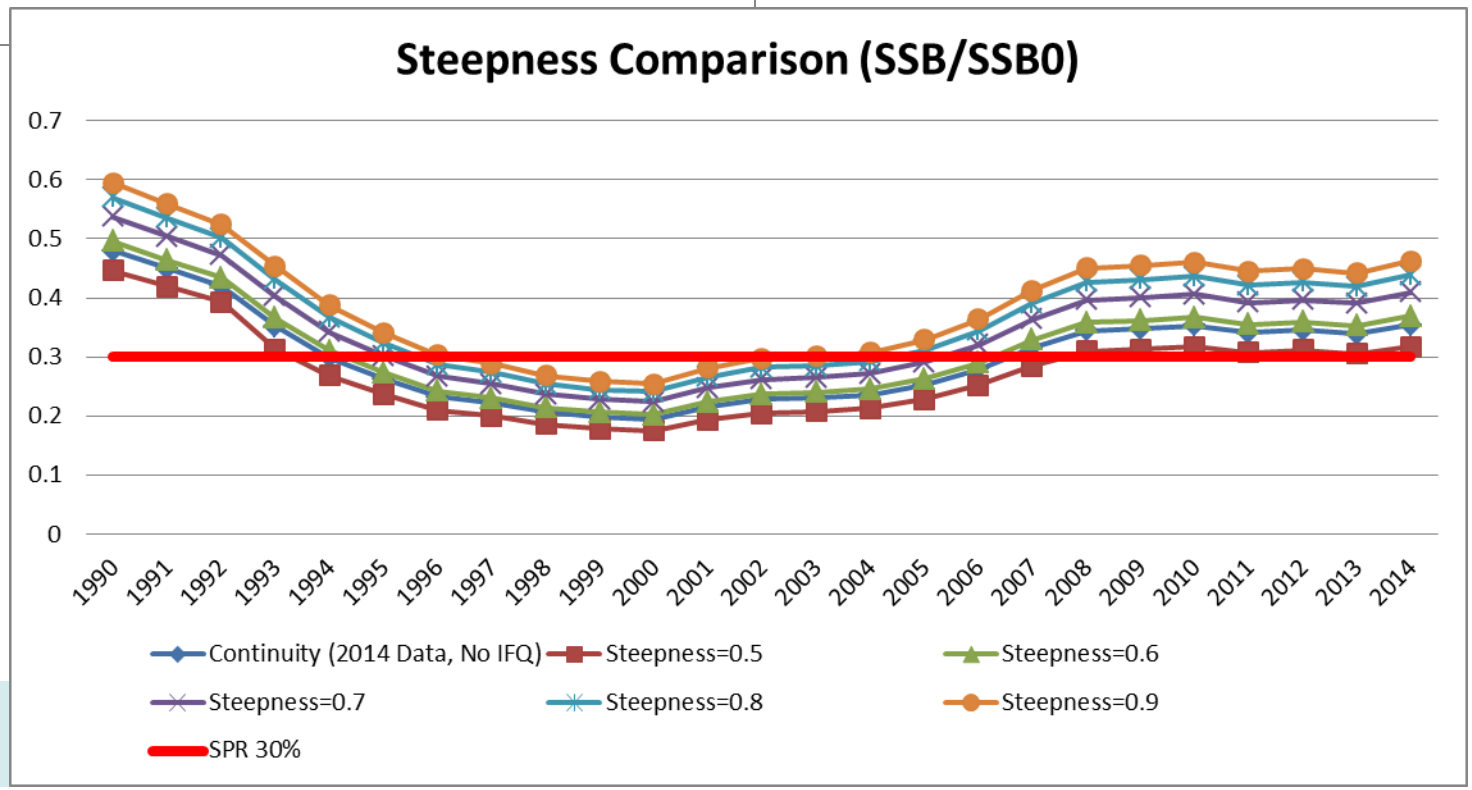
Steepness

- SEDAR 9:
  - “The level of assumed shrimp bycatch also impacts the status of vermilion snapper (SEDAR9-AW-04). Lower levels of shrimp bycatch cause lower estimates of productivity (steepness), and consequently poorer status. Therefore, the stock status of vermilion snapper is predicted to be less optimistic if the assumed shrimp bycatch is overestimated.”

Fixed Steepness Runs



	SSB0	ln_R0	Steep
Steep=0.5	9.82E+11	10.72	0.5
Continuity	1.00E+12	10.74	0.57
Steep=0.6	8.40E+11	10.56	0.6
Steep=0.7	7.59E+11	10.46	0.7
Steep=0.8	7.09E+11	10.39	0.8
Steep=0.9	6.74E+11	10.34	0.9



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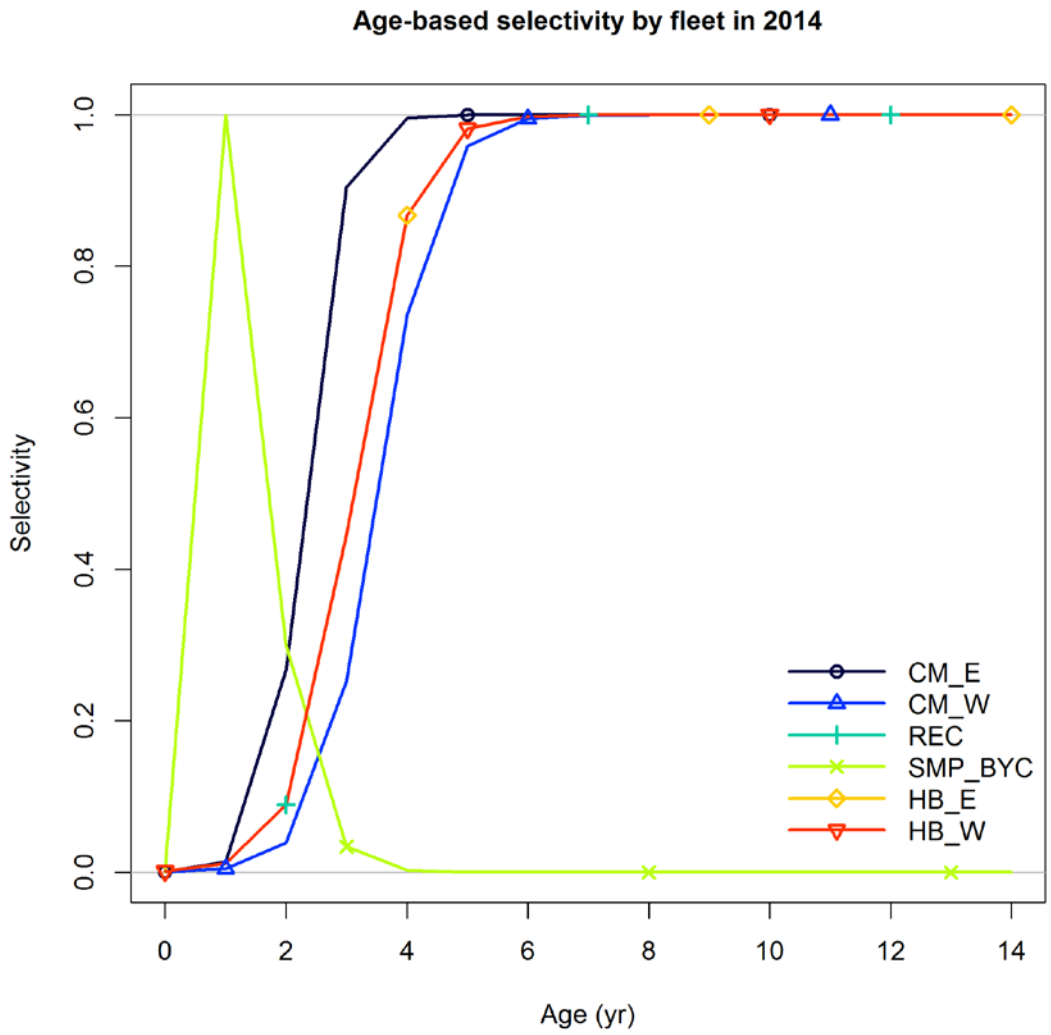
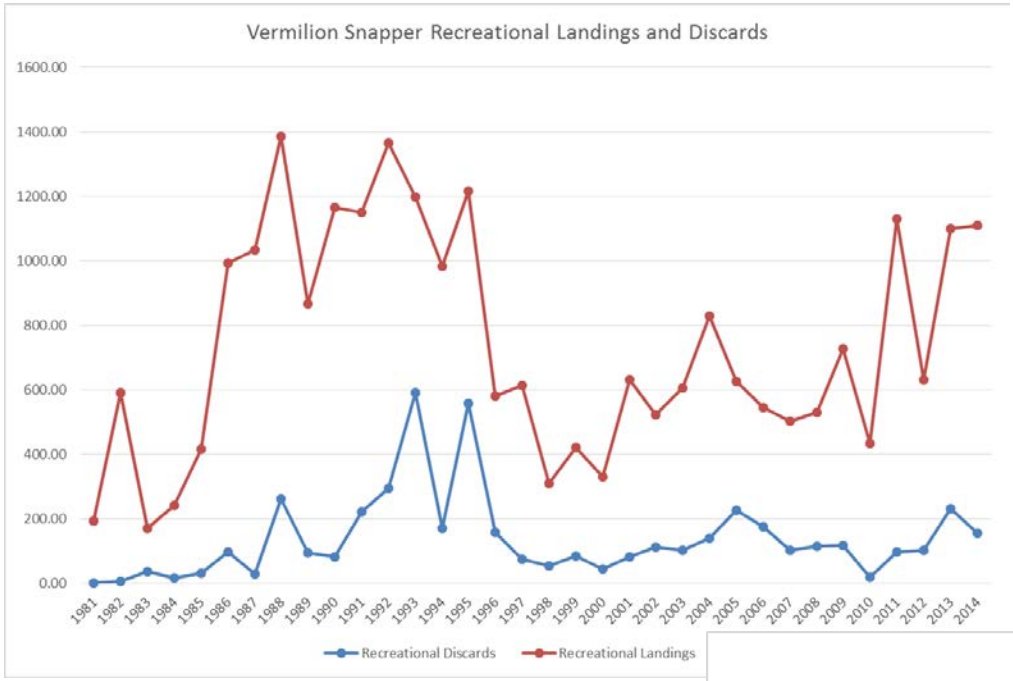
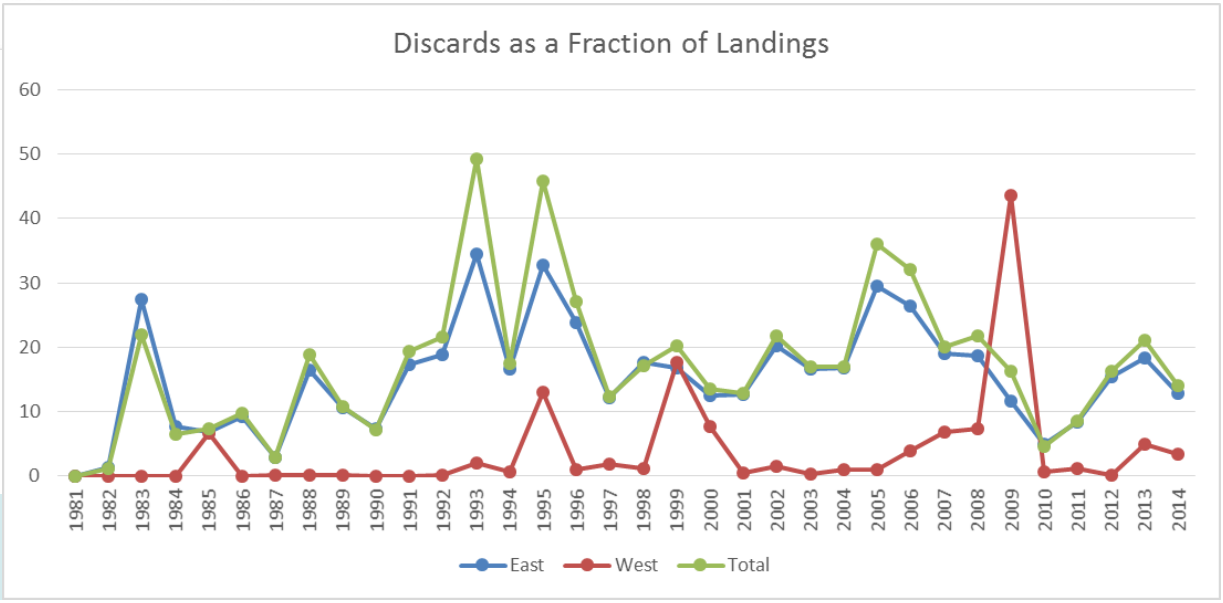
Selectivity



Discards—Recreational





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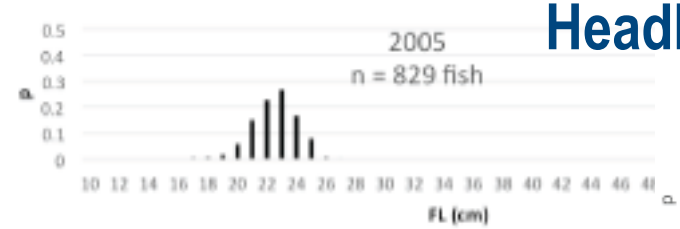
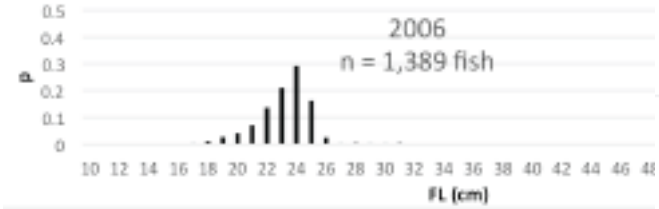
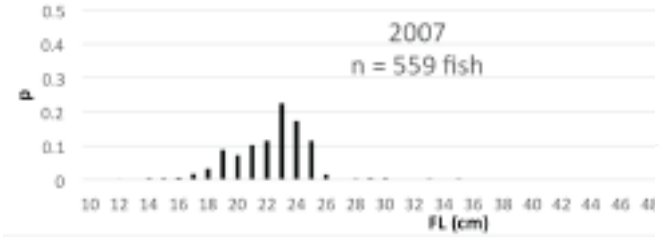
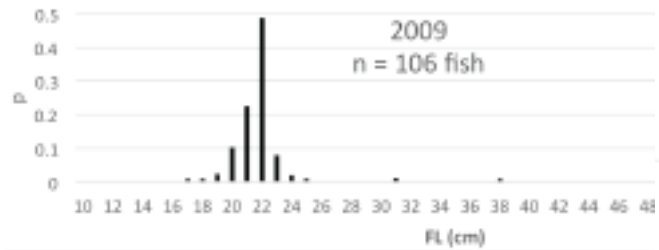
Discards—Recreational Size Composition

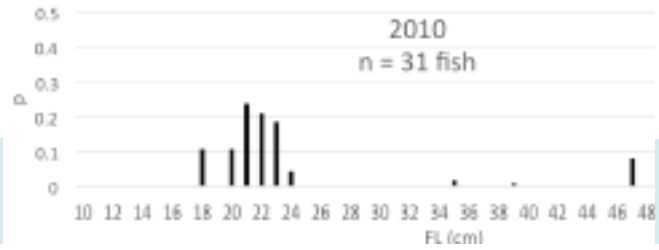
Headboat

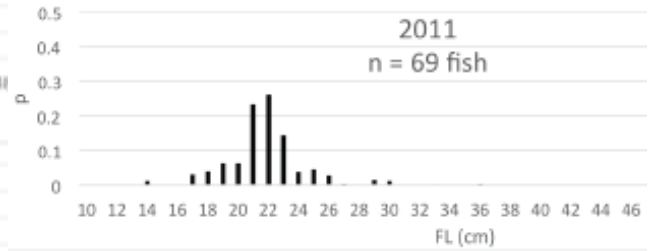


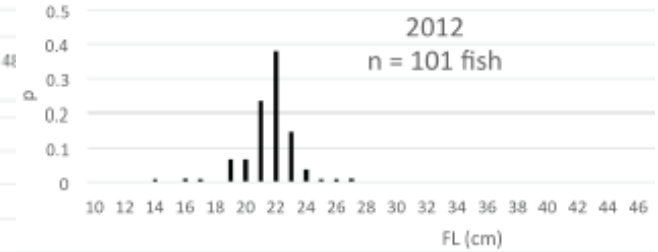


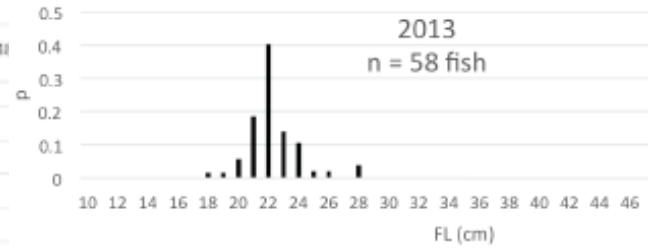


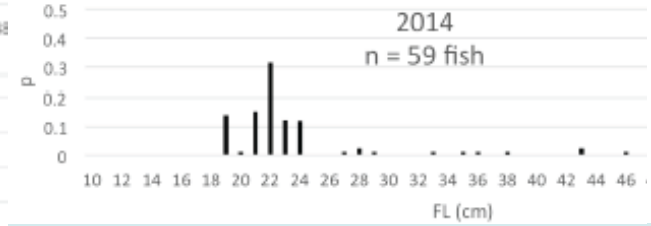




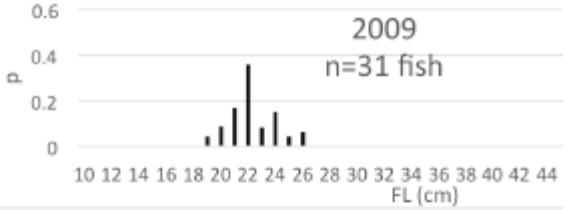


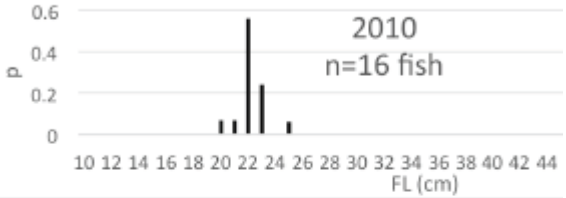


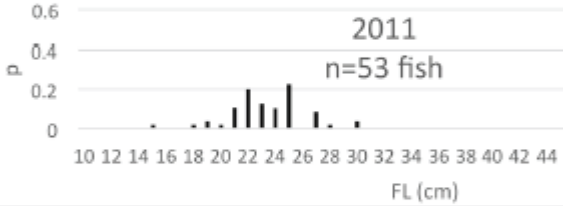


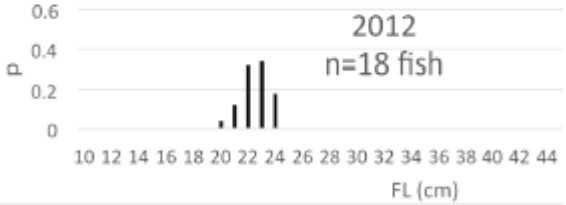


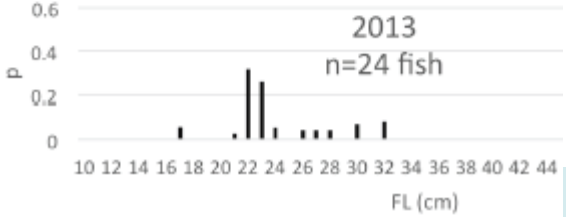
Private/Charter



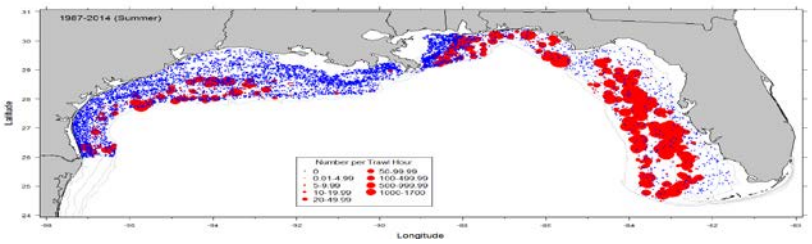


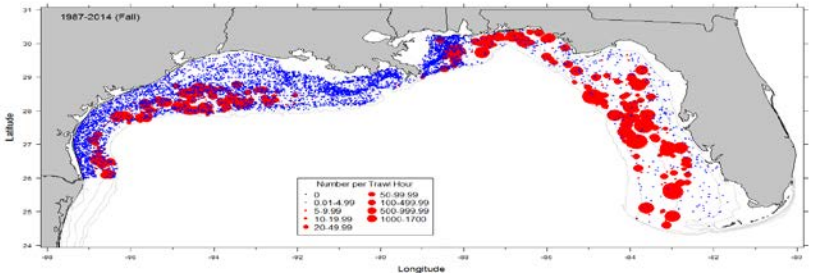




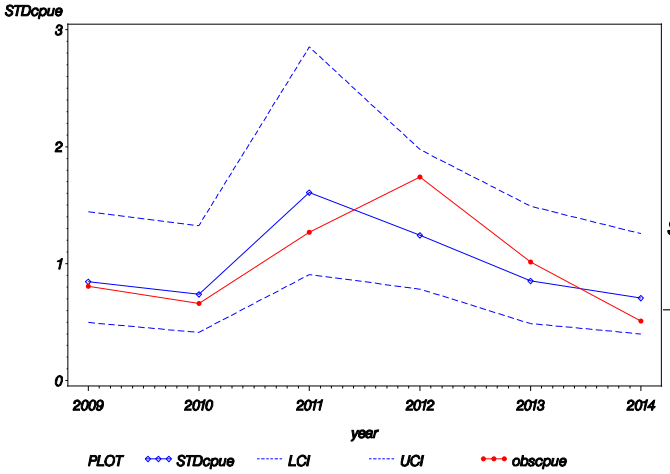


SEAMAP Groundfish Survey

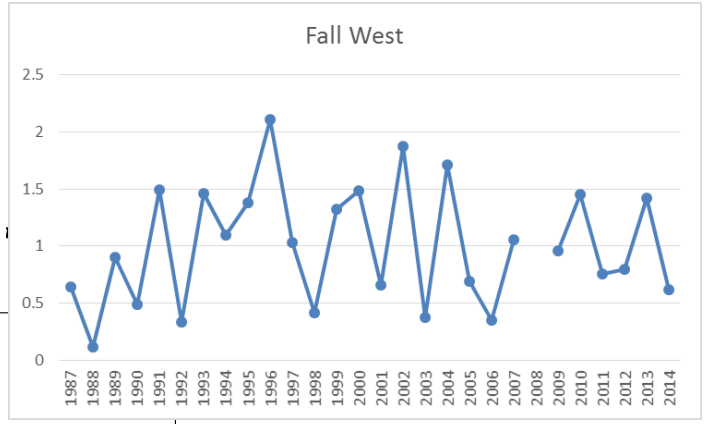


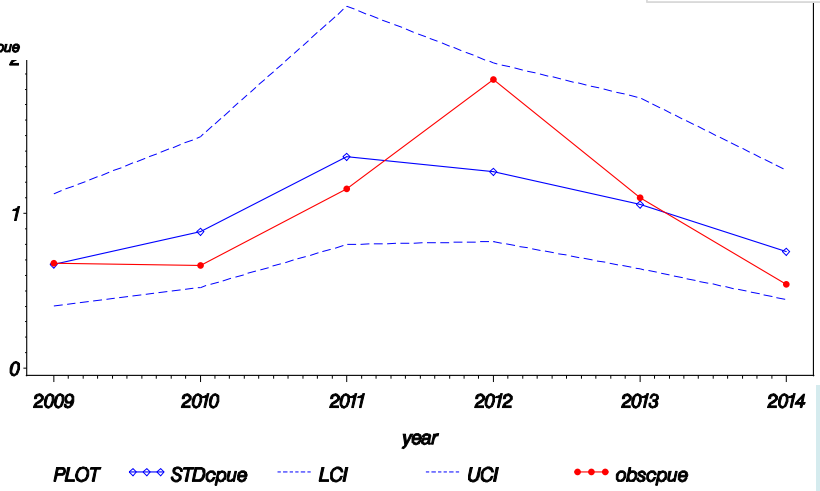


SEAMAP Summer Groundfish Vermilion Snapper Eastern Gulf of Mexico 2009 to 2014
Observed and Standardized CPUE (95% CI)



Summer Groundfish Vermilion Snapper Gulf of Mexico 2009
Observed and Standardized CPUE (95% CI)





Fall survey used a different design prior to 2009

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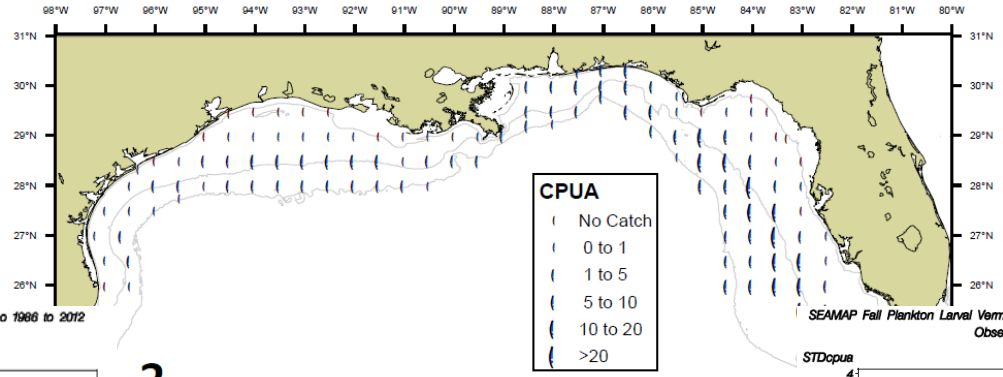
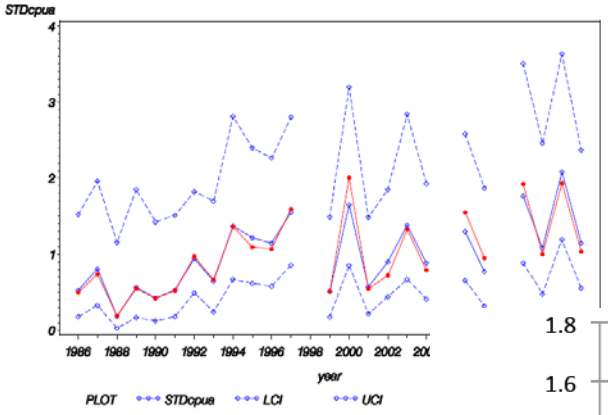
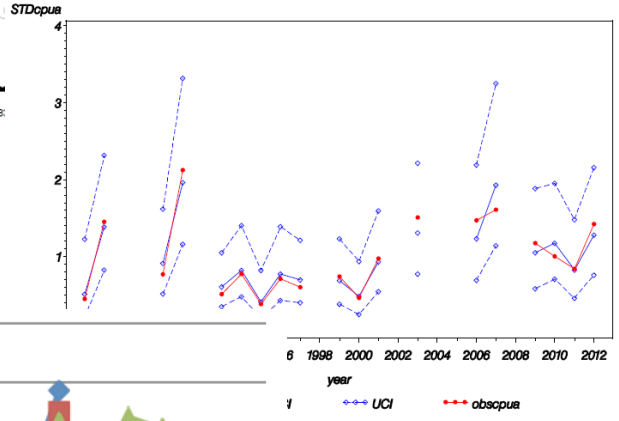
SEAMAP Larval Survey

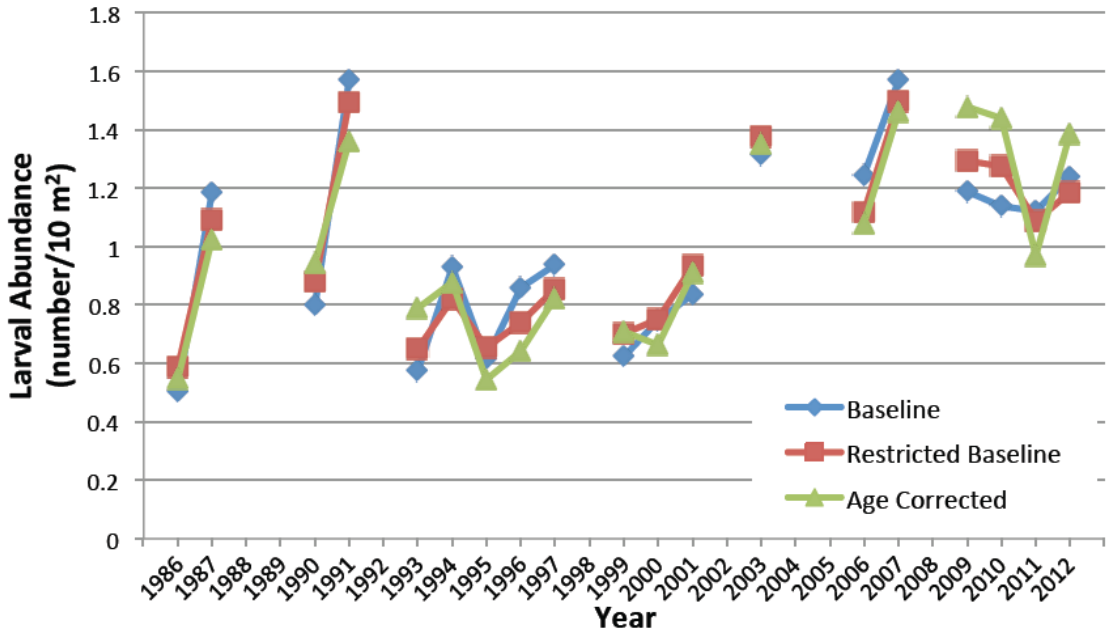


SEAMAP Fall Plankton Larval Vermillion Snapper 3.5 TO 6.4 mm Western Gulf of Mexico 1986 to 2012
Observed and Standardized CPUA (95% CI)



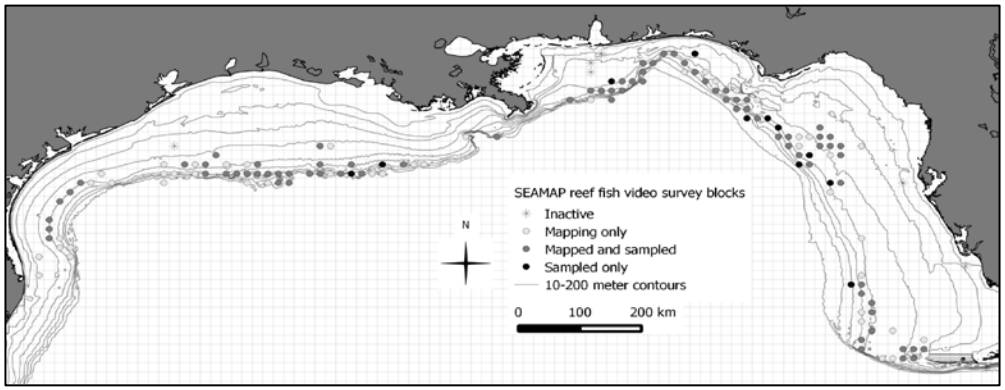
SEAMAP Fall Plankton Larval Vermillion Snapper 3.5 TO 6.4 mm Eastern Gulf of Mexico 1986 to 2012
Observed and Standardized CPUA (95% CI)

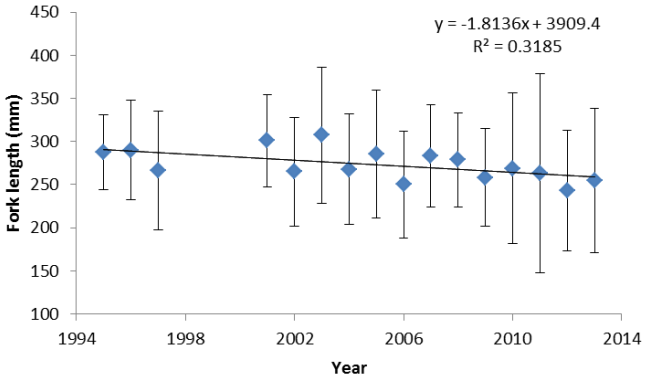


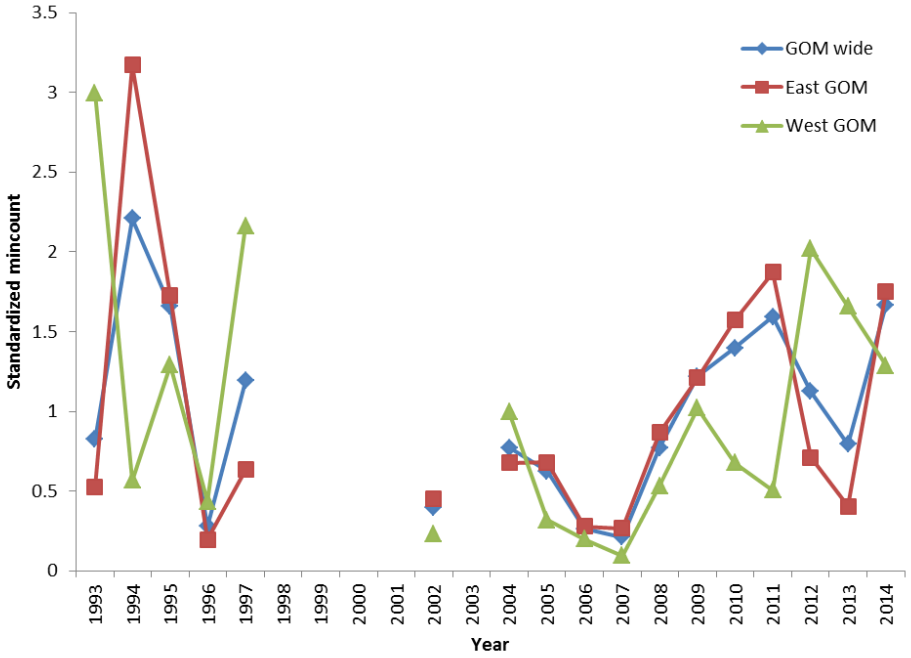


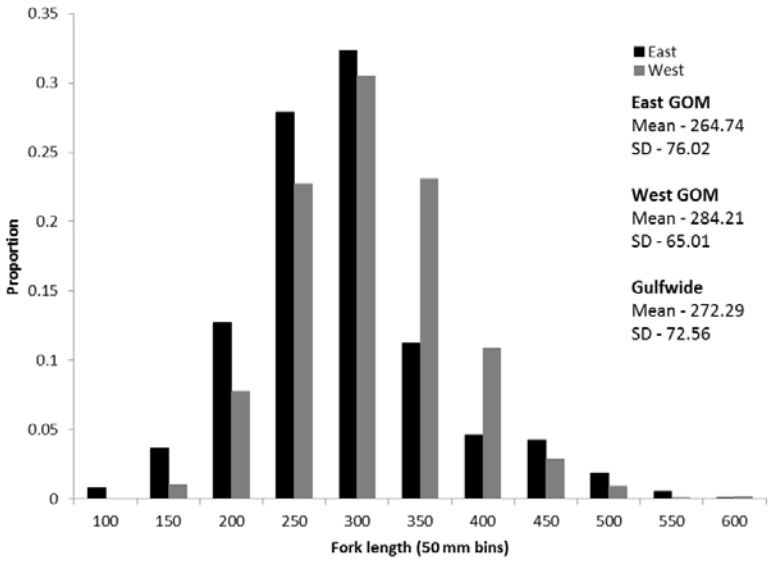
NOAA FISHERIES

Video Survey









Projection Methods

- SPR Value (30%)
- P* value
- Bycatch assumptions
  - Fix shrimp and discard F at recent years
- Maximize directed yield
- Catch in 2015
- Recruitment values
- Selectivity values
- ABC and OFL
- MSST