NOAA FISHERIES

Southeast Fisheries Science Center

Vermilion Snapper

SEDAR-55 Standard Assessment

May 2, 2018

Outline

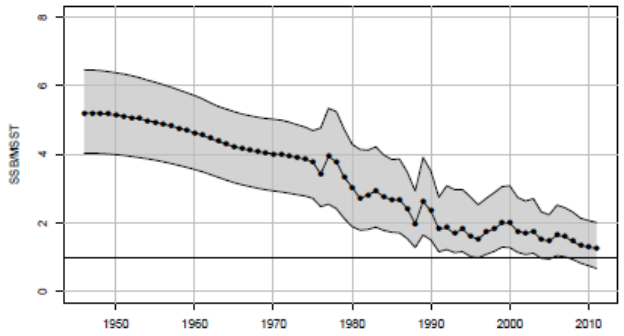
- Background
  - Assessment history
  - Terms of Reference
  - Jurisdiction and regulations
- Data Review
  - Stock definition
  - Life history
  - Removals
  - Compositions
  - Indices of abundance
  - Summary of updates/modifications
- Catch-age model
  - Base run
  - Sensitivities
  - Uncertainty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

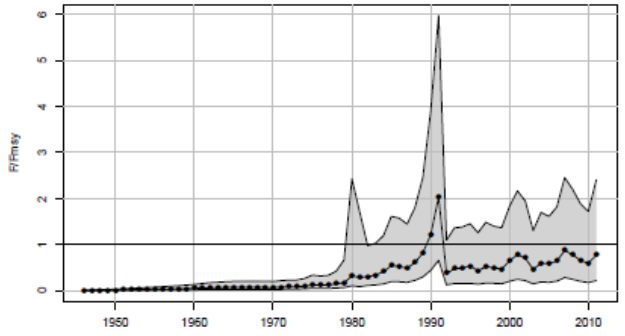
Assessment History

- Early assessments of Vermilion Snapper used a catch-length model

- Last benchmark (SEDAR 17): catch-age model (BAM) with data through 2007
  - $F_{2005\text{-}2007}/F_{msy}$ = 0.997 (not overfishing); SSB_{2011}/MSST=1.10 (not overfished)

- 2012 update of SEDAR 17: catch-age model (BAM) with data through 2011
  - $F_{2009\text{-}2011}/F_{msy}$ = 0.67 (not overfishing); SSB_{2011}/MSST=1.26 (not overfished)





- SEDAR 55 (standard) assessment: catch-age model (BAM) with data through 2016
  - Last update: MSST=(1-M)SSBmsy
  - This assessment: MSST=75%SSBmsy (Amendment 24 changed MSST definition)

Terms of Reference

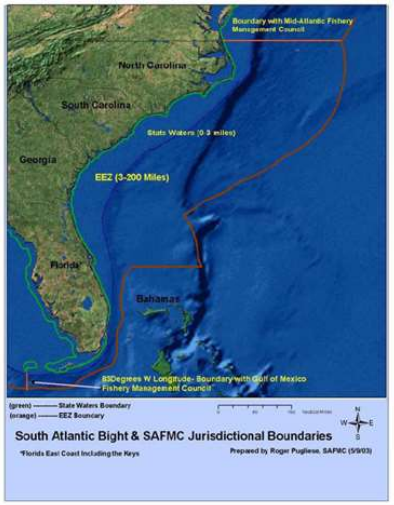
- TOR #1
  - Prepare standard assessment consistent with 2012 SEDAR 17 update

- TOR #2
  - Consider the inclusion of the SERFS video index
  - Incorporate the latest BAM model configurations
  - Re-consider use of age and length data

- TOR #5
  - Provide projections through 2023 (7 yr) with management beginning in 2019

- Additional modifications (briefed SSC at October 2017 meeting)
  - Update selected life history information (batch fecundity, spawning frequency, maturity)
  - Update method of hindcasting historical recreational removals (SWAS to FWHAR method)
  - Include additional years of MARMAP age sampling (1990-2001) and increased FD age sampling

Jurisdiction and Major Regulations



- 1983 Snapper Grouper FMP
- Major Regulations

Year Effective	Recreational	Commercial
1989		Trawl ban
1992	10 inch TL; 10 fish/person/day bag	12 inch TL
1999	11 inch TL; 10 fish/person/day bag	
2006		ACLs in place
2007	12 inch TL; 10 fish/person/day bag	
2009	12 inch TL; 5 fish/person/day bag	split season ACLs
2010	Various ACLs and seasonal closures	Various ACLs and seasonal closures

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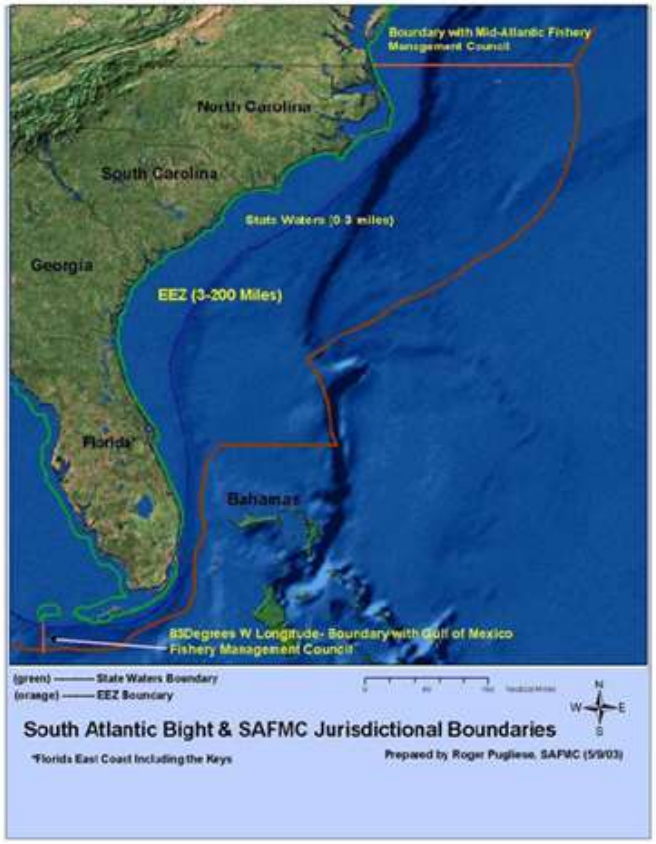
Stock Definition

- Same as SEDAR 17
- Northern boundary: NC-VA border
- Southern boundary: Council jurisdictional east coast FL to Keys
  - Includes Monroe County south of US 1 and out to 83° west longitude

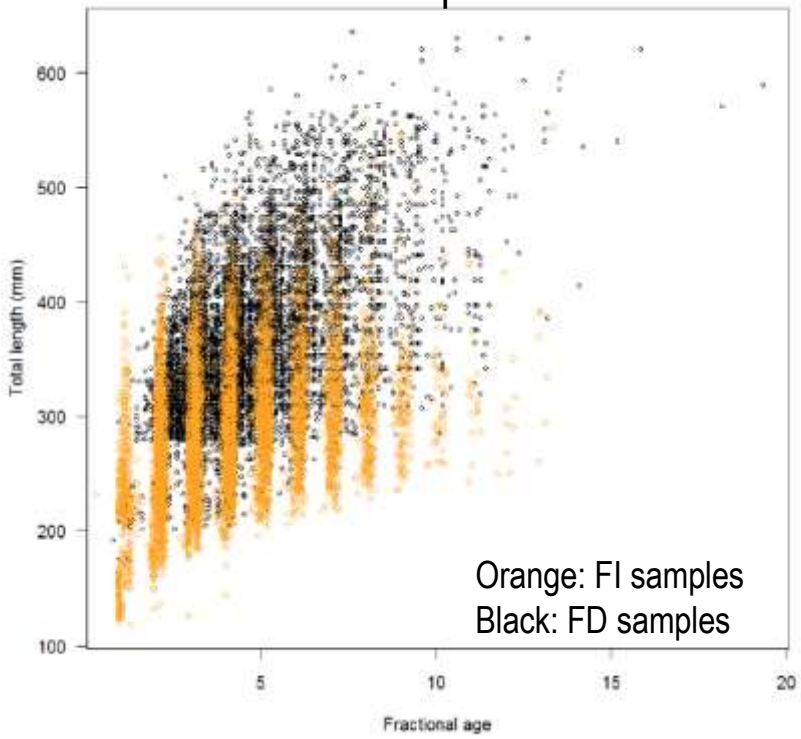


Life History—Growth

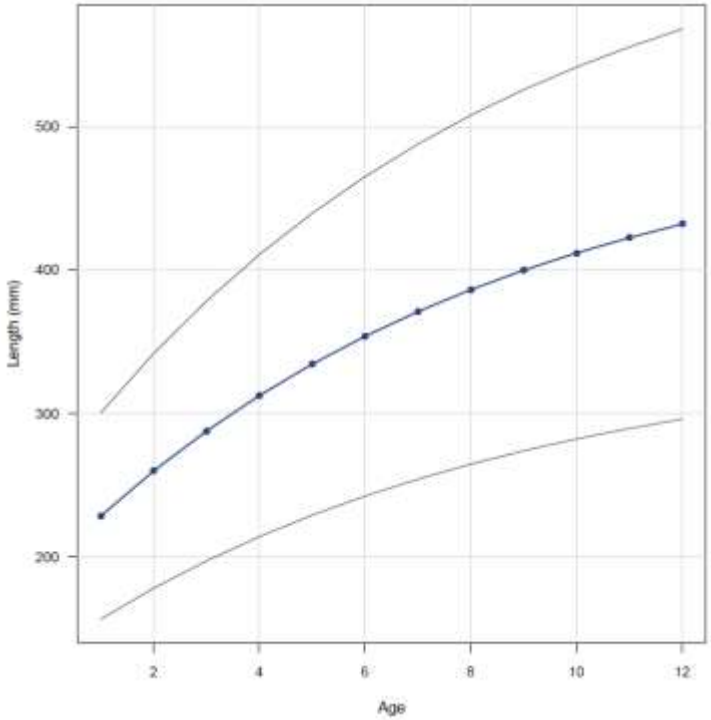
- Von Bertalannfy growth
  - Linf = 506.0 mm , k = 0.12 , t_0 = -3.5
  - Panel considered but did not support updating

High variability in length at age

From SEDAR 17 report

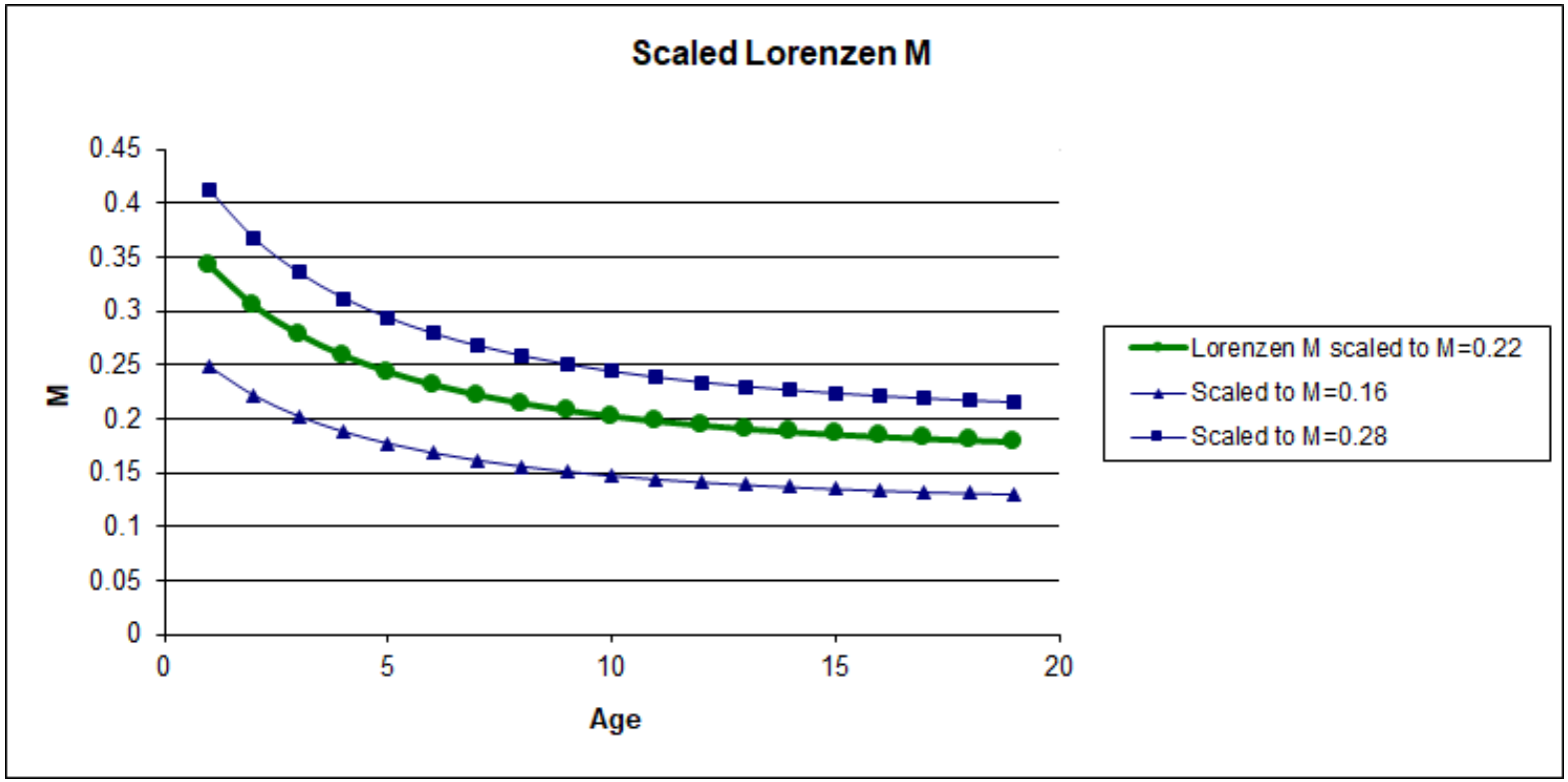


SEDAR 55 growth curve



Life History—Natural Mortality

- Age-based natural mortality Lorenzen M
  - Re-scaled to provide same cumulative survival to max age (19 yrs) as Hoenig point estimate (M = 0.22)
  - Panel considered but did not support updating



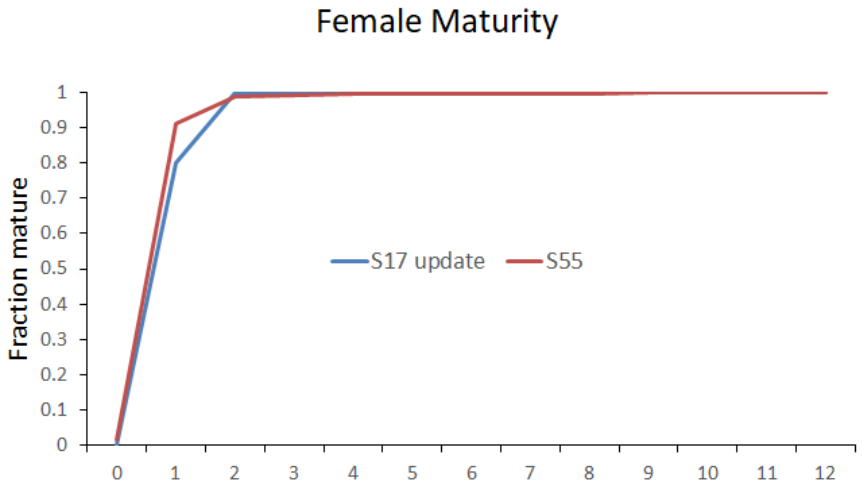
Discard Mortality

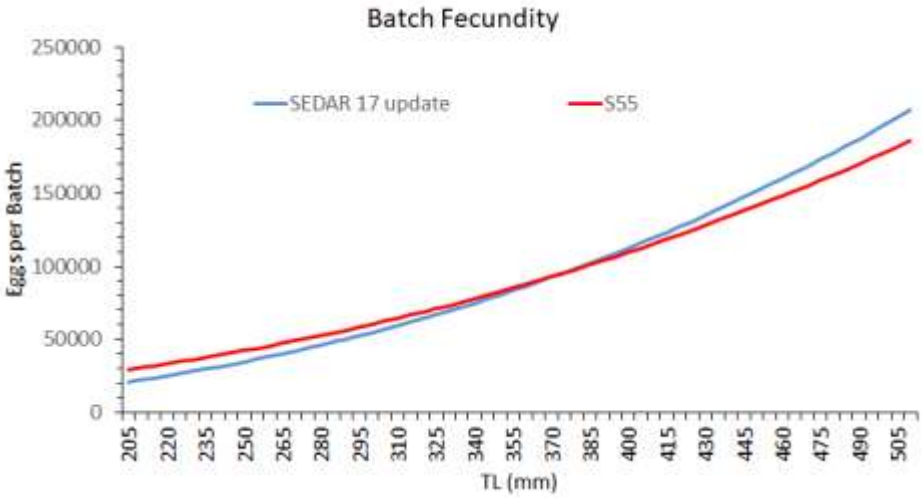
- 0.38 for recreational fleets (headboat and general recreational)
- 0.41 for commercial fleets (handline, historic trawl, other)
- Same as SEDAR 17 (both immediate and delayed mortality; based on Rudershausen et al. 2007)

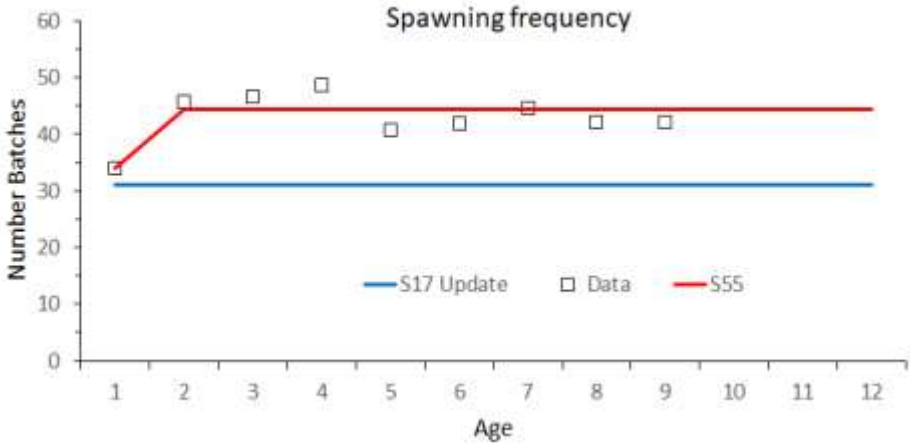
Reproduction

(SEDAR55-WP03)

Updated reproductive inputs recommended by the AP







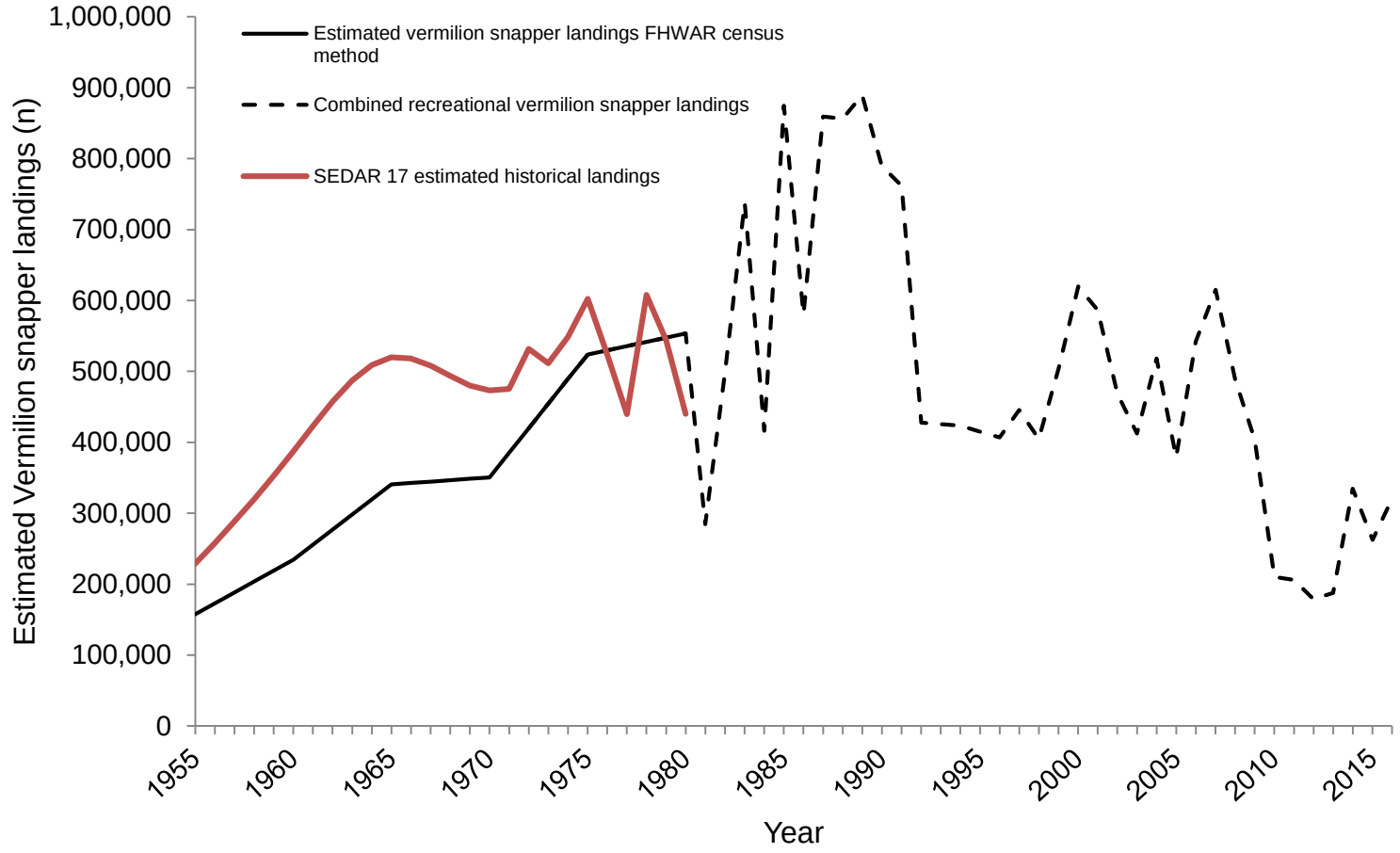
Historical Recreational Landings

(SEDAR55-WP04)

- Historical recreational landings are 1946-1980
- Prior method: Salt Water Angler Survey (SWAS)
  - Recreational landings reported for 1960, 1965, and 1970
  - Linear interpolation between years
  - SEDAR 24 issues: Recall bias, species identification, weight/numbers; consensus that overestimates historical rec removals
- Contemporary method: Fishing, Hunting, and Wildlife-Associated Recreation Survey (FWHAR)
  - Regional estimates of effort along Atlantic seaboard at 5 year intervals (1955-1985) from household interviews
  - Adjusted for recall bias
  - CPUE from MRFSS (landings/trip) used to calculate landings during the period of overlap (post 1981)

    Landings = CPUE x Effort
  - Average CPUE from 1981-1983 assumed constant back in time and used to reconstruct landings from effort pre-1981
- SEDAR assessments changed from SWAS to FWHAR in SEDAR 32
- FHWAR has been used in all subsequent assessments and recommended by SEDAR best practices
- Assessment panel recommended use of FHWAR method

Historical Recreational Landings Comparison



Length and Age Compositions

(SEDAR55-WP06 and WP09)

- Length compositions
  - Weighted by trip level landings for commercial handline (same as S17)
  - Weighted by region level (NC-SC, GA-FL) landings for recreational headboat (same as S17)
  - Attempted to weight length compositions for general recreational
    - Private mode most landings but few lengths; Charter mode few landings but most of length
    - Panel recommended nominal length compositions for general recreational (same as S17)
  - Nominal length compositions for commercial and recreational discards (same as S17)

- Age compositions weighted by length composition

- Minimum annual sample size of 30 trips for inclusion of length comps and 10 trips for inclusion of age comps in the model

Length and Age Compositions

- Panel considered the inclusion of both length and age composition data
  - VS 17 update included length and age compositions for all fleets
  - Issues discussed by the panel:
    - Inclusion of length and age data can result in over-weighting of composition data
    - Length compositions not informative unless estimating growth curves internally or sufficient age data not available for estimating selectivity
    - Variability in length-at-age of Vermilion Snapper
    - Recent SEDARs have excluded length compositions when sufficient ages data available (>10 trips and > 30 fish)

- Panel recommendation:
  - Exclude length compositions from base run when age compositions are available
  - Include length compositions as a sensitivity run

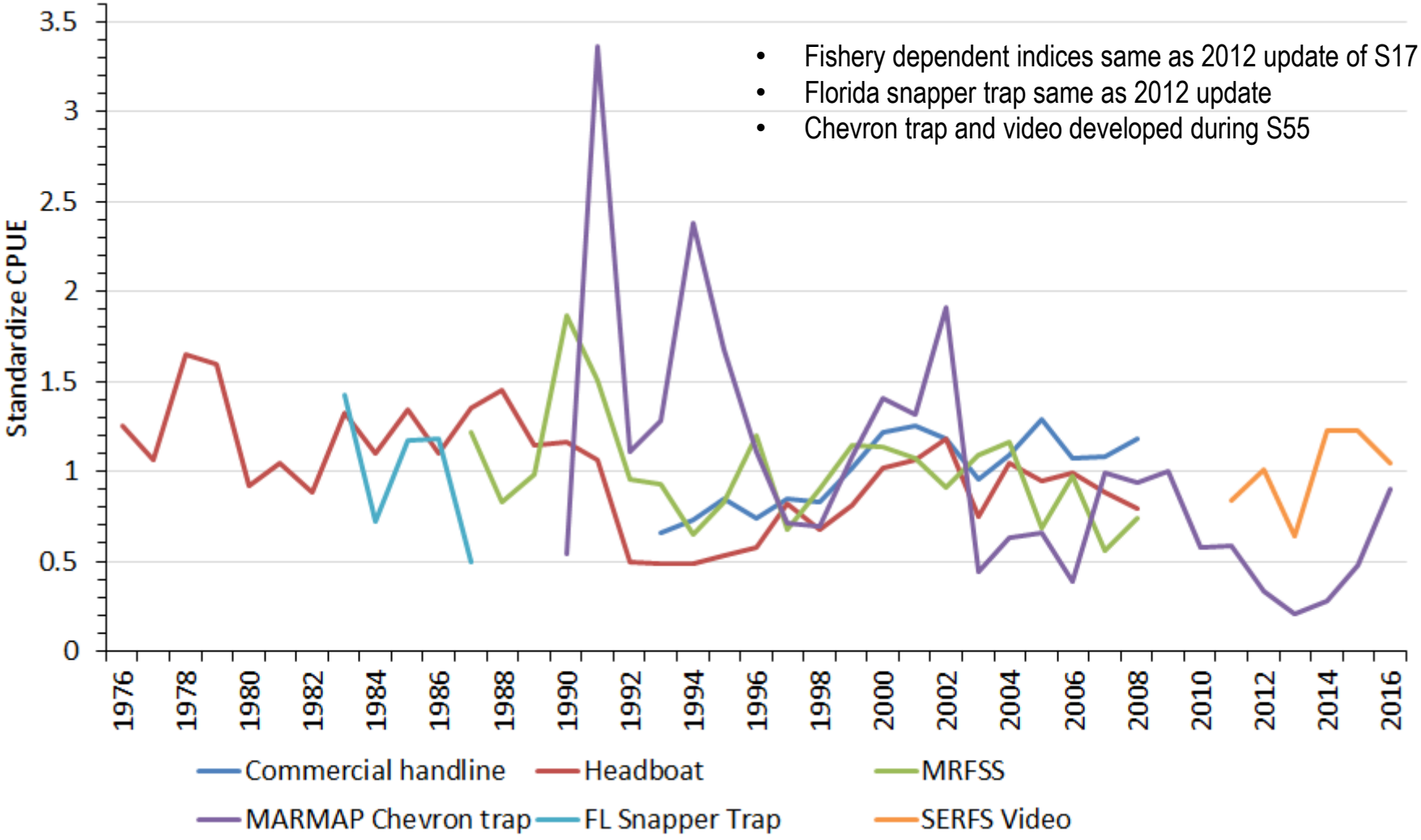
Length and Age Compositions

Indices of Abundance

- Fishery-Independent Indices
  - MARMAP Florida snapper trap (1983-1987): Panel recommended retaining from S17
  - MARMAP Chevron trap: updated and re-standardized with delta-GLM (1990-2016)
  - SERFS video: developed and standardized with zero-inflated negative binomial (2011-2016)
  - Methods to combine trap and video data:
    - Conn Method (Conn, P.B. 2010. Hierarchical analysis of multiple noisy abundance indices. CJFAS 67:108–120; used in prior SEDAR assessments)
    - Gwinn Method (newly developed; SEDAR 55 WP07)

- Fishery-Dependent Indices
  - Commercial handline (1993-2008)
  - Recreational headboat (1976-2008)
  - General recreational (MRFSS, 1987-2008)
  - All fishery-dependent indices were truncated in 2008 in the S17 update due to effects of mgmt regulations (5 fish bag limit and seasonal closures) that decoupled catch rates from abundance
  - Panel recommended retaining these indices but not extending them beyond 2008

Indices of Abundance



- Fishery dependent indices same as 2012 update of S17
- Florida snapper trap same as 2012 update
- Chevron trap and video developed during S55

Vermilion Nominal and Standardized Video Index

- Standardized with ZINB (ZIP also considered)
- Response: SumCount
- Factors: season, depth, latitude, temperature, several env variables
- 2015-16 adjusted for camera change based on calibration study
- Uncertainty (CVs) based on 1000 bootstraps
- Details in SEDAR55-WP01

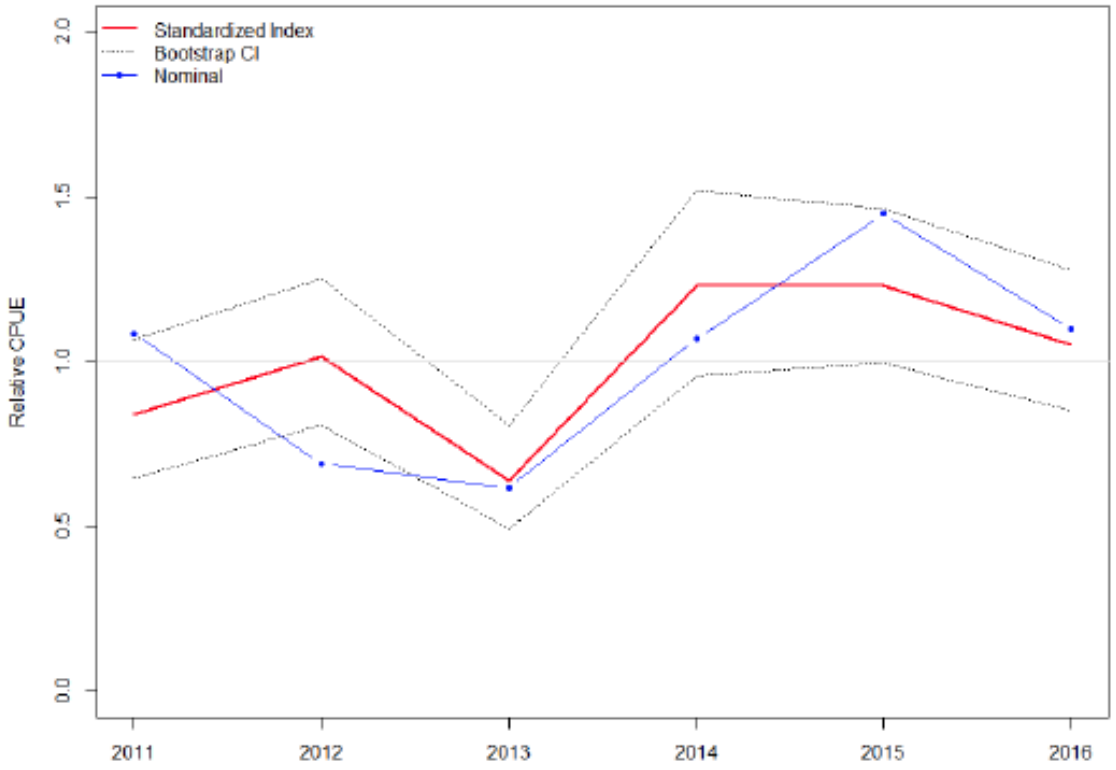
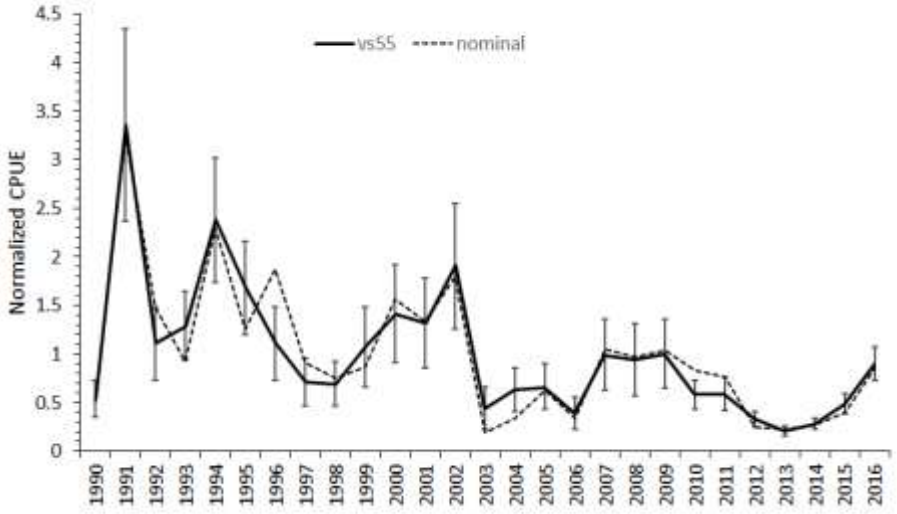


Figure 13: Relative standardized index (solid line) with 2.5% and 97.5% confidence intervals (dashed lines) and the relative nominal index (blue) for vermilion snapper in the SERFS video survey.

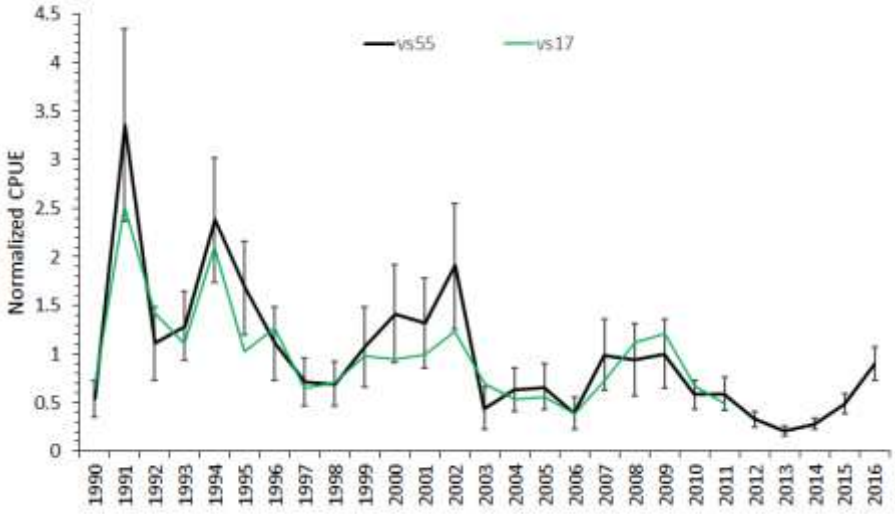
Chevron Trap Index

- Standardized with Delta-GLM
- Response: Catch/trap hr
- Factors: season, depth, latitude, temperature
- Uncertainty (CVs) based on bootstrapping
- Details in SEDAR55-WP02

Standardized vs. Nominal



VS-55 vs. VS-17 update



Combining SERFS Chevron Trap and Video Indices

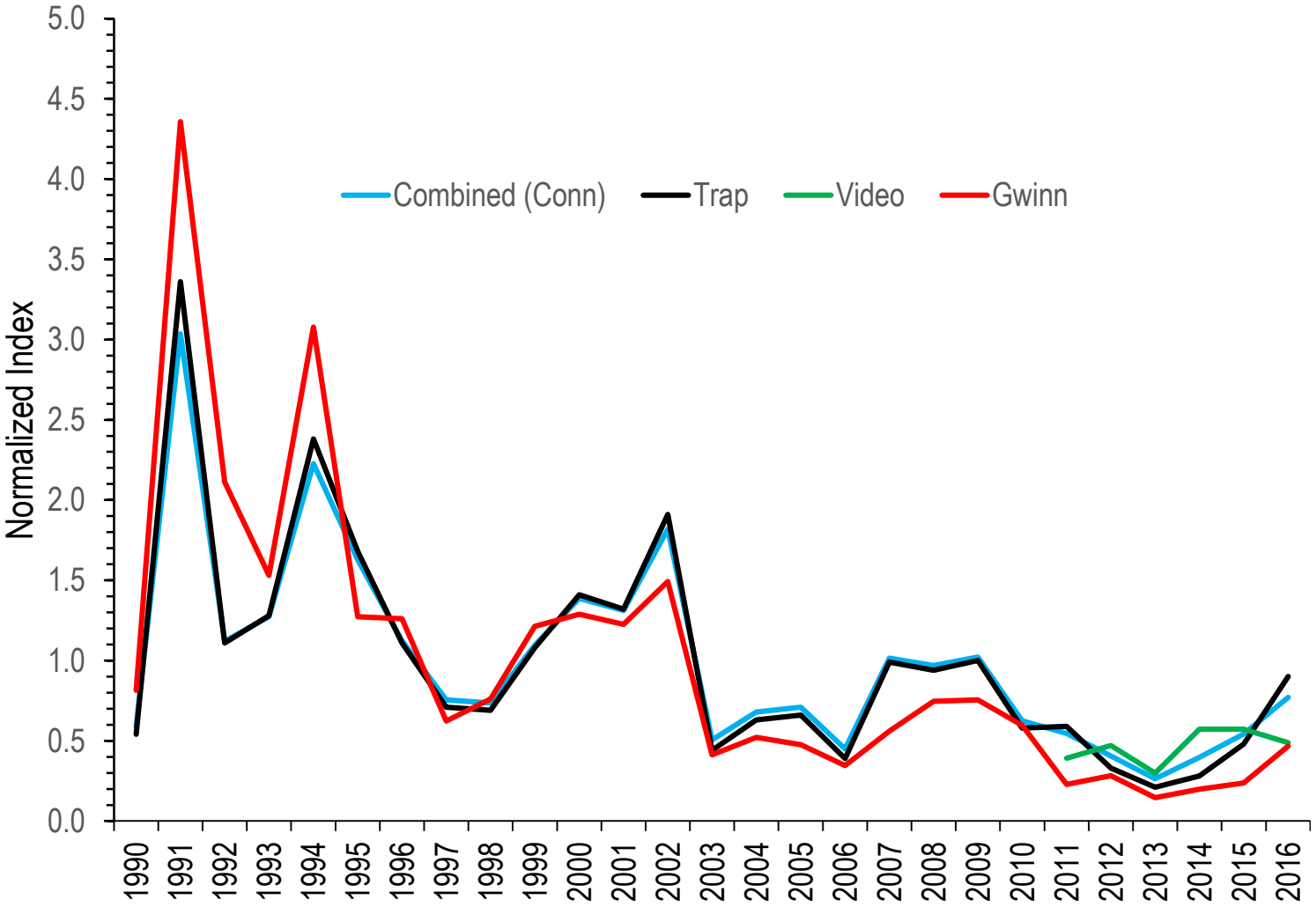
- Rationale: sampling of the two gears is not independent
  - Cameras mounted on traps

Assessment Panel considered two methods:

- Conn method (Conn 2010)
  - Used since SEDAR 41
  - Hierarchical model where each index is assumed to observe the same underlying abundance trend
  - Estimates the underlying trend as a latent variable allowing for both process and observation error
  - Inputs are the two separate standardized indices (trap and video) with their associated uncertainty

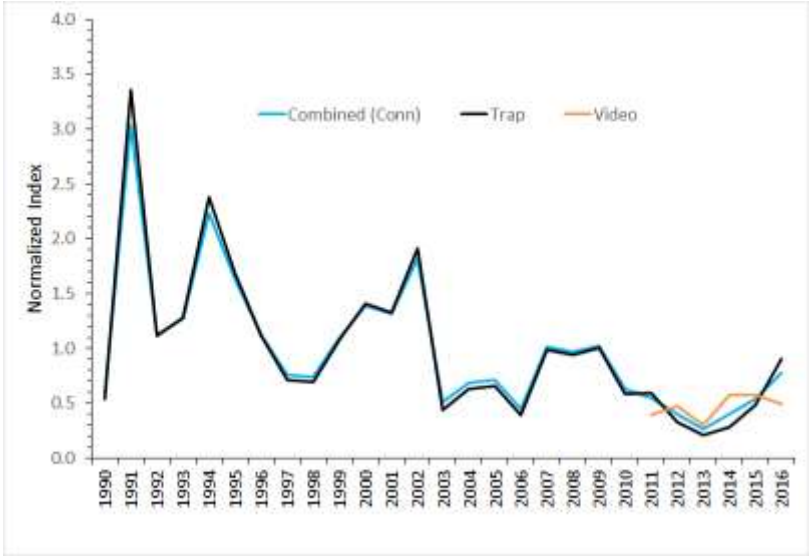
- Gwinn method (S55_WP07)
  - State space model; not yet used in SEDAR assessments
  - Incorporates trap catches and camera counts into a single index
  - Better able to account for imperfect detection in either gear
  - Operates at the level of the sampling station and so accounts for lack of independence explicitly
  - Corrects for shifts in sampling frame via a two stage (temporal & spatial) estimation process
  - Disadvantages: High computing time (Several days to run); preliminary results available during the assessment

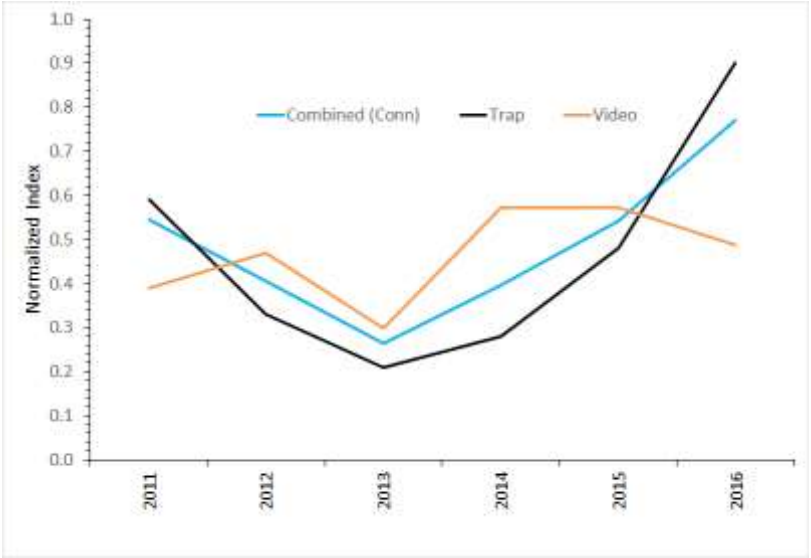
Vermilion Chevron Trap and Video Indices



Vermilion Trap and Video Indices

Assessment panel recommended combining the trap and video indices using the Conn (2010) method for the base run and use the Gwinn method as a sensitivity

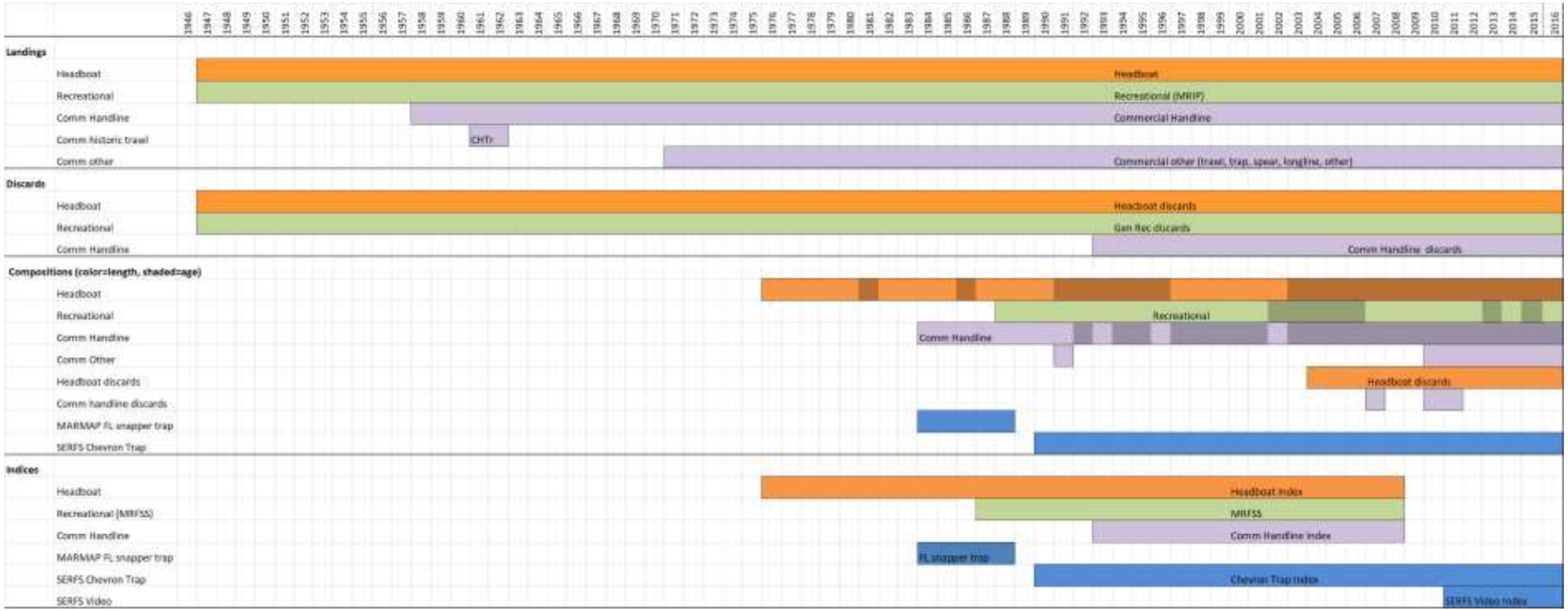




YEAR	CONN	CV	Stdev
1990	0.59	0.37	0.22
1991	3.04	0.29	0.88
1992	1.12	0.34	0.38
1993	1.27	0.32	0.40
1994	2.23	0.30	0.66
1995	1.63	0.31	0.51
1996	1.12	0.34	0.38
1997	0.75	0.36	0.27
1998	0.74	0.35	0.26
1999	1.10	0.35	0.38
2000	1.39	0.33	0.46
2001	1.31	0.33	0.44
2002	1.82	0.31	0.57
2003	0.51	0.41	0.21
2004	0.68	0.37	0.25
2005	0.71	0.36	0.26
2006	0.45	0.40	0.18
2007	1.01	0.35	0.35
2008	0.97	0.35	0.34
2009	1.02	0.34	0.35
2010	0.62	0.35	0.22
2011	0.55	0.27	0.15
2012	0.40	0.30	0.12
2013	0.26	0.31	0.08
2014	0.40	0.38	0.15
2015	0.54	0.27	0.15
2016	0.77	0.28	0.21

Data Available for the Assessment

Assessment period: 1946-2016 (note terminal year of SEDAR17 update was 2011)



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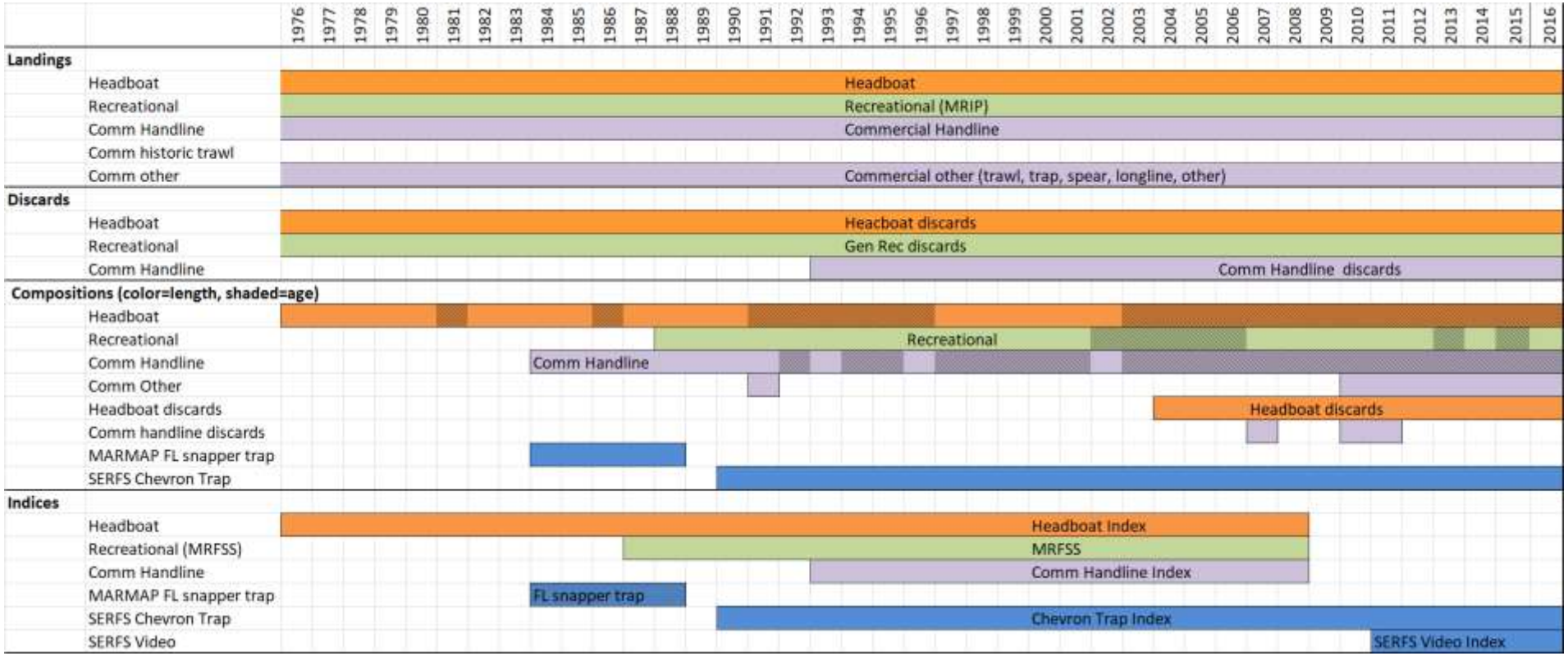
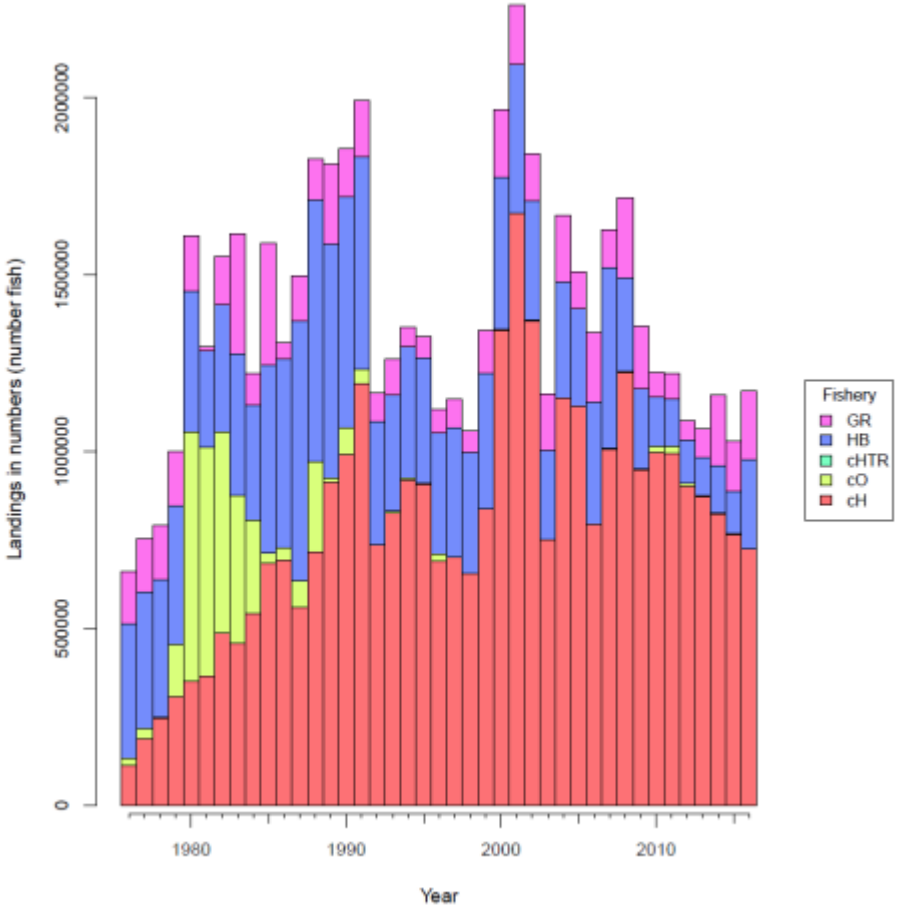
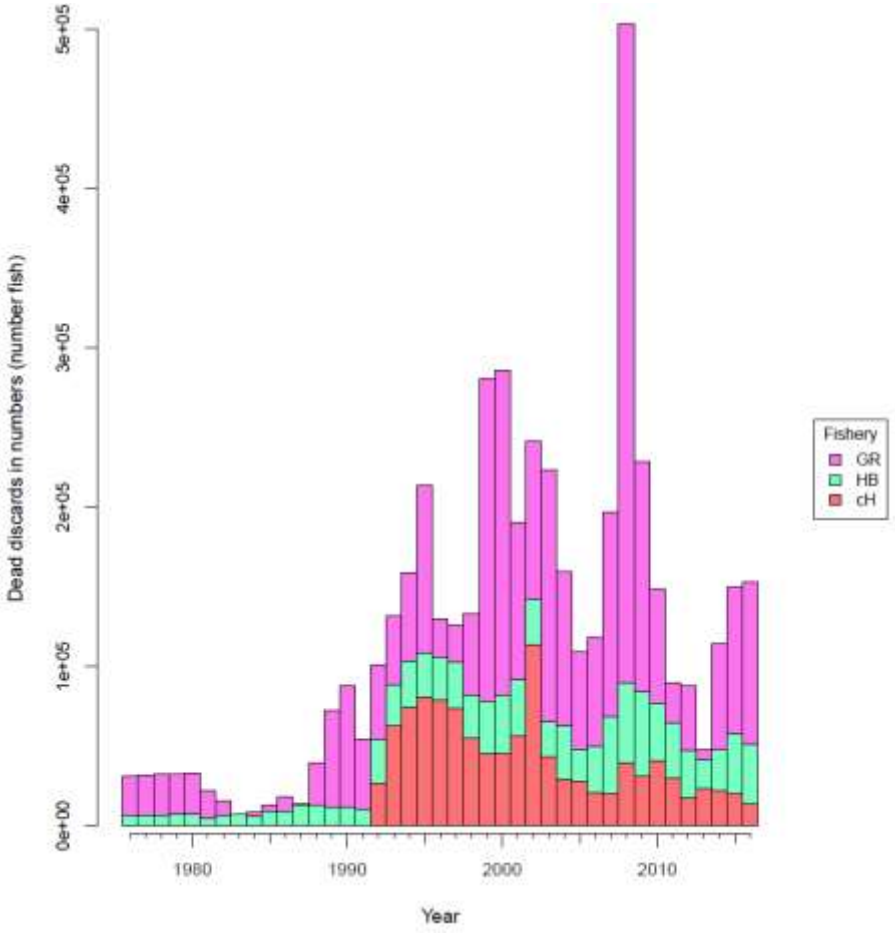


Landings and Discards (in numbers)





Summary of modifications/updates to data

- Five additional years (2012-2016) were added to the end of the time series
- General recreational fleet represented by MRIP methodology (not MRFSS)
- Update reproduction inputs (maturity, batch fecundity, spawning frequency)
- Use more recent FHWAR method for historical recreational removals
- Include additional age samples
- Exclude length compositions when have sufficient age compositions
- Use combined SERFS chevron trap-video index (Conn Method)

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BAM: Same Basic Model as in SEDAR17

- Catch-age formulation, fit to data using maximum likelihood
- Beverton-Holt spawner recruit model with lognormal error
- Age-based (Lorenzen) natural mortality
- Age-based selectivities (same as 2012 update)
  - Allowed to vary across regulatory blocks (mostly around size limit changes)
  - Logistic (flat-topped) for commercial and recreational fleets
  - Dome-shaped for SERFS index and all discards (partially estimated)
  - Commercial other and historic trawl fixed (limited composition data)
  - Headboat and general recreational same selectivity (panel recommendation)
- Assumed virgin conditions in model start year (1946)
- Ages modeled: 1-12+
- Constant (estimated) CV of size at age
- Spawning stock based on population fecundity (egg production)

Fleet Structure and Selectivity Blocks

	COMMERCIAL				RECREATIONAL			
YEAR	Handline	Other	Historic Trawl	Handline Discards	Headboat	Gen Rec	Headboat Discards	Gen Rec Discards
1946	No Size Limit Logistic	Trawl-caught fixed: 100% age-1 50% age-2 0% >age-2	fixed: cO, pd 1		No Size Limit logistic	No Size Limit fixed: HB, pd 1	No Size Limit fixed: HB, pd 2	No Size Limit fixed: HB, pd 1
1961								
1962								
1976								
1977								
1978								
1979								
1980								
1981								
1982								
1983								
1984								
1985								
1986								
1987								
1988								
1989		Pot, other fixed: cHL, pd 2						
1990								
1991								
1992	12 in Limit Logistic			12 in Limit partially estimated: age-2 estimated descending limb fixed	10 in Limit logistic	10 in Limit logistic* (was set to HB pd 2 last update)	10 in Limit	10 in Limit
1993								
1994								
1995								
1996								
1997								
1998								
1999					11 in Limit logistic	11 in Limit logistic	11 in Limit partially estimated	11 in Limit fixed: HB, pd 2
2000								
2001								
2002								
2003								
2004								
2005								
2006								
2007					12 in Limit logistic	12 in Limit logistic	12 in Limit partially estimated	12 in Limit fixed: HB, pd3
2008								
2009				Split season partially estimated: age-2 fixed to pd 1 descending limb est				
2010								
2011								
2012								
2013								
2014								
2015								
2016								

		age-1	age-2	age-3	age-4+
cHL-D	Pd 1:	fixed at 0	estimated	fixed at 1	fixed at age specific p(below 12 in size lt)
	Pd 2:	fixed at 0	fixed at age-2, pd 1	fixed at 1	estimated assuming dome-shaped
HB-D	Pd 1:	fixed at 0	estimated	fixed at 1	fixed at age specific p(below 10 in size lt)
	Pd 2:	fixed at 0	estimated	fixed at 1	fixed at age specific p(below 11 in size lt)
	Pd 3:	fixed at 0	estimated	fixed at 1	fixed at age specific p(below 12 in size lt)
GR-D	All Pds	assumed same as HB discards			

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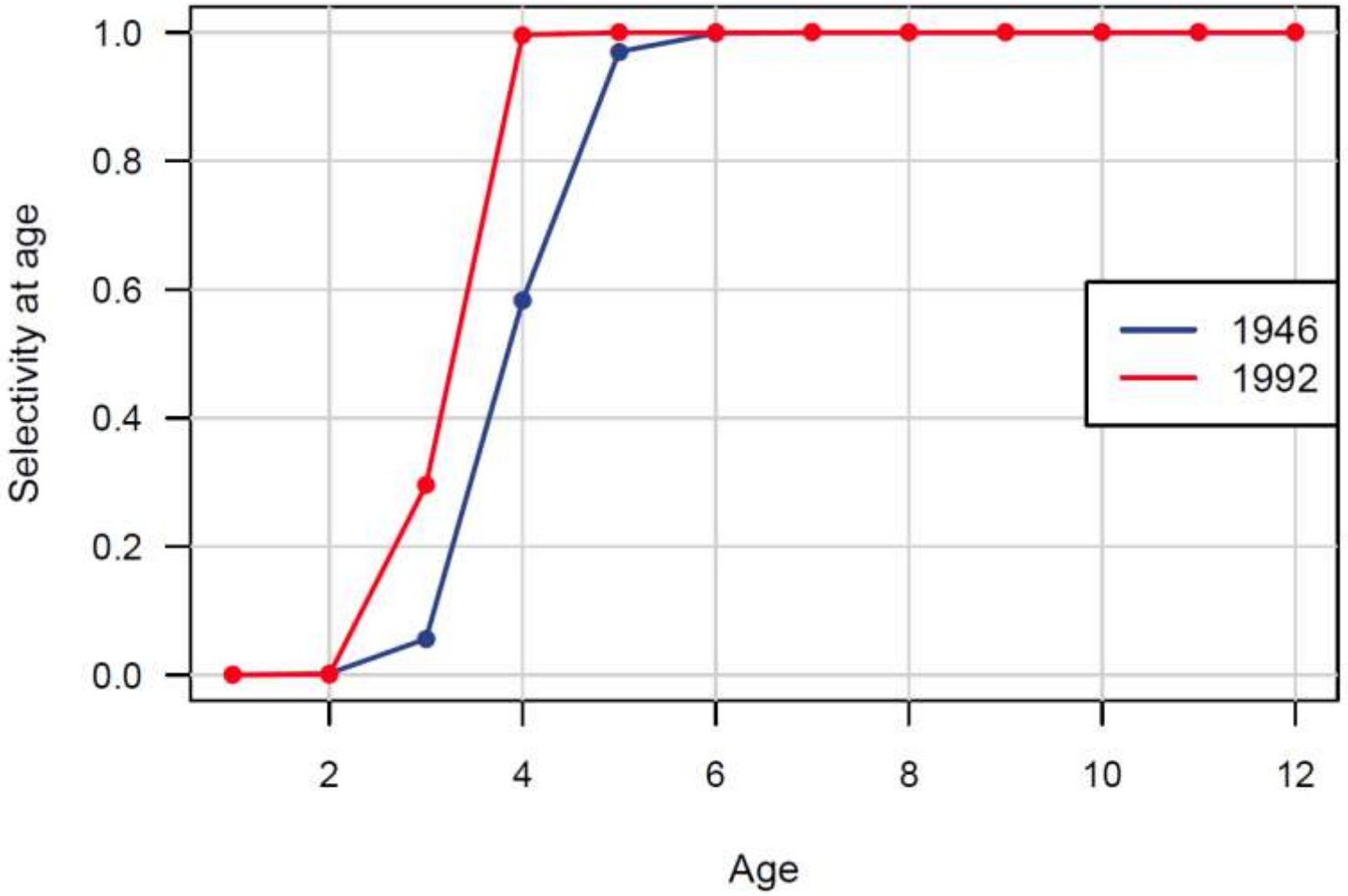
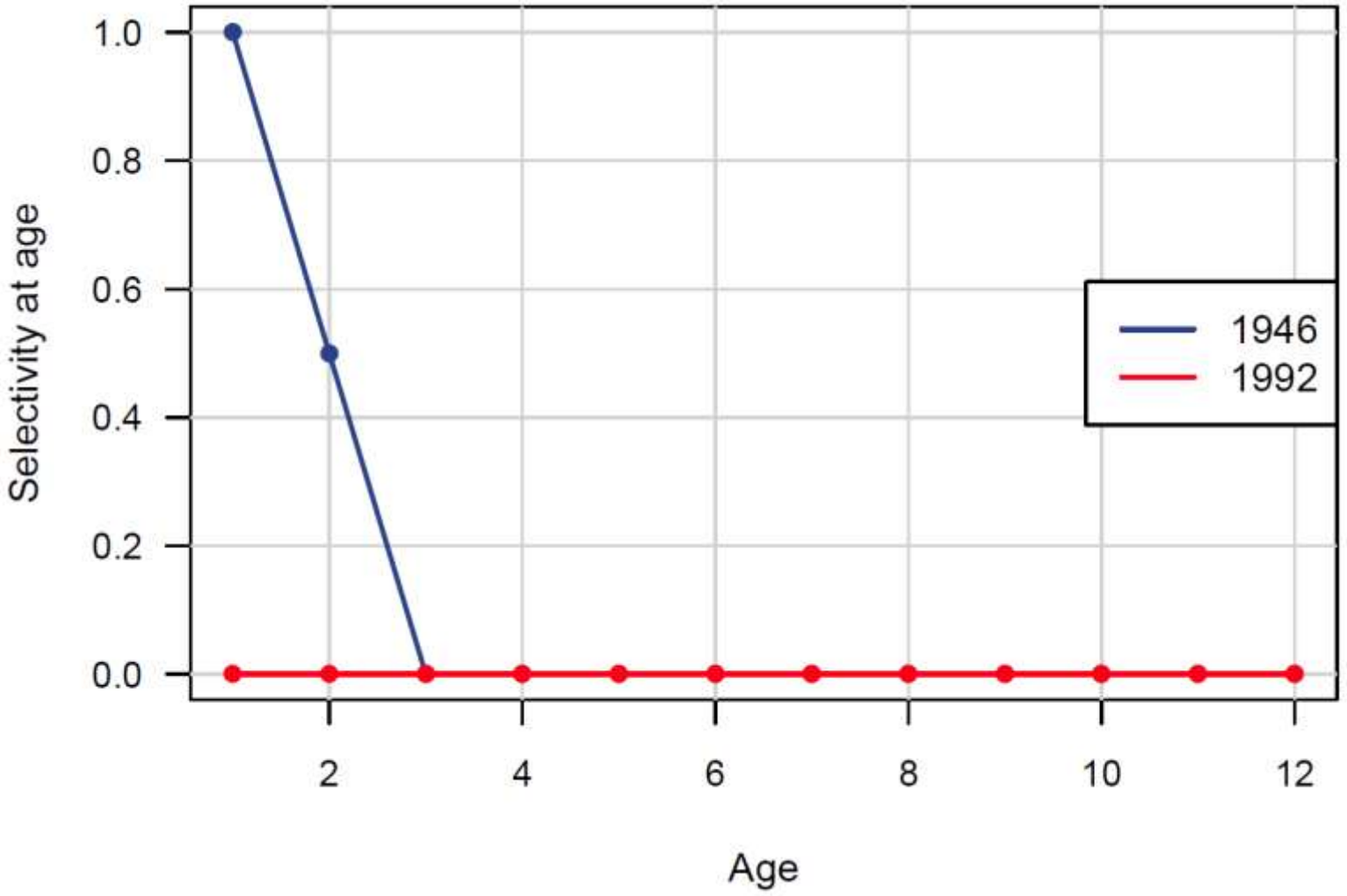
Commercial Handline Selectivity

2 time blocks before and after 12 inch size limit



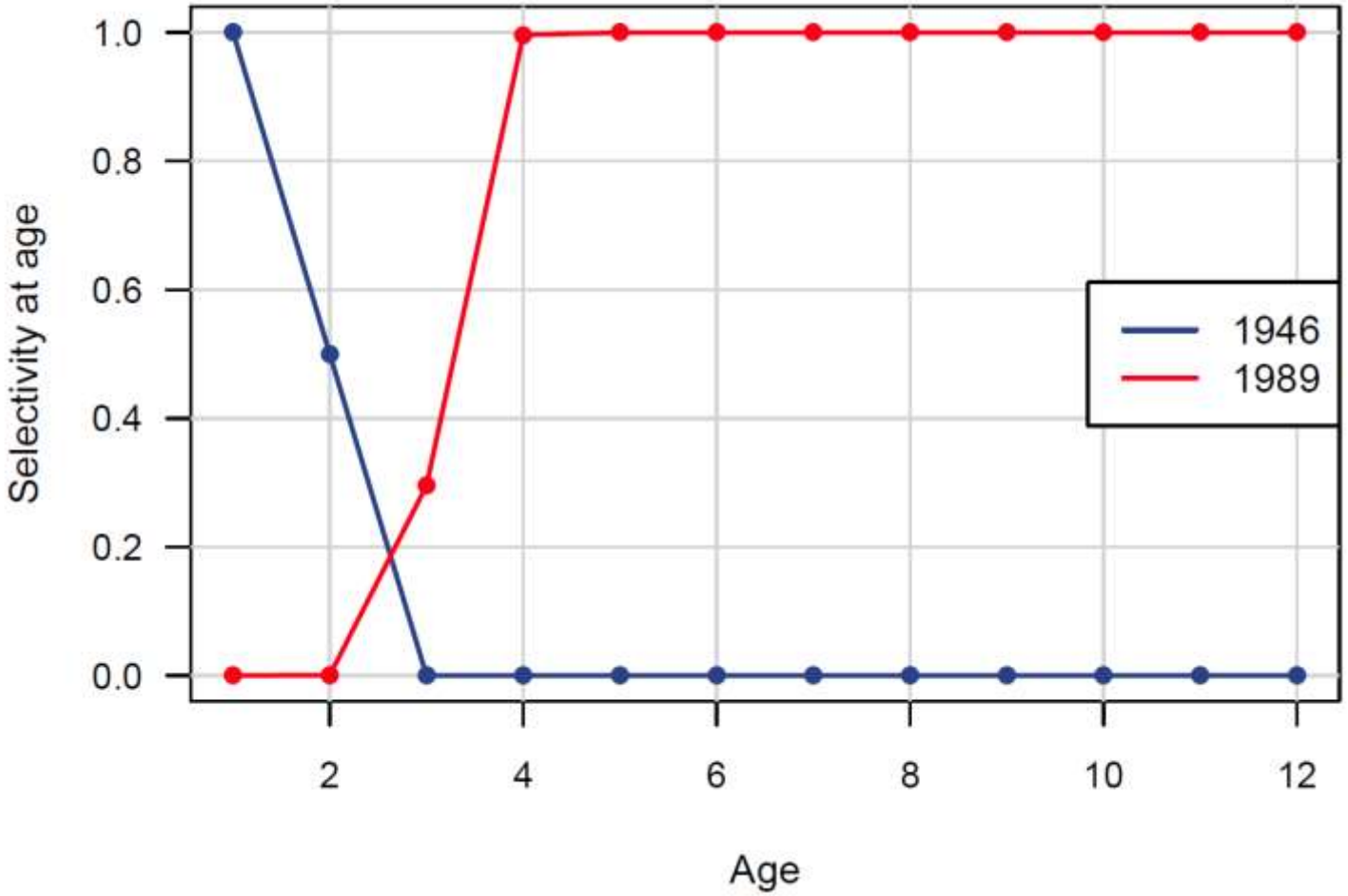
Commercial Historic (1961-1962) Trawl Selectivity

Fixed based on inspection of limited length data



Commercial "Other" Selectivity

- Fixed to historic trawl in period 1 (prior to trawl ban)
- Fixed to commercial handline in period 2 (after trawl ban)

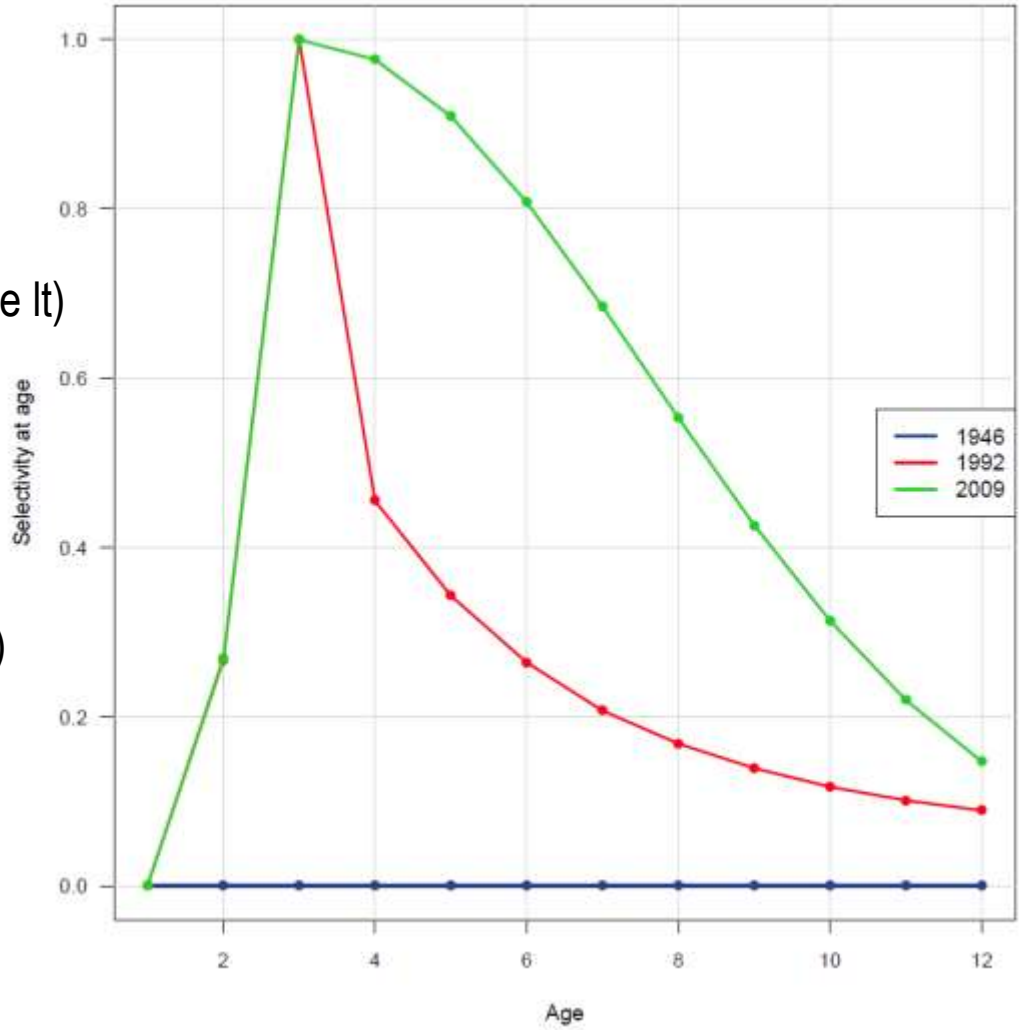


Commercial Discard Selectivity

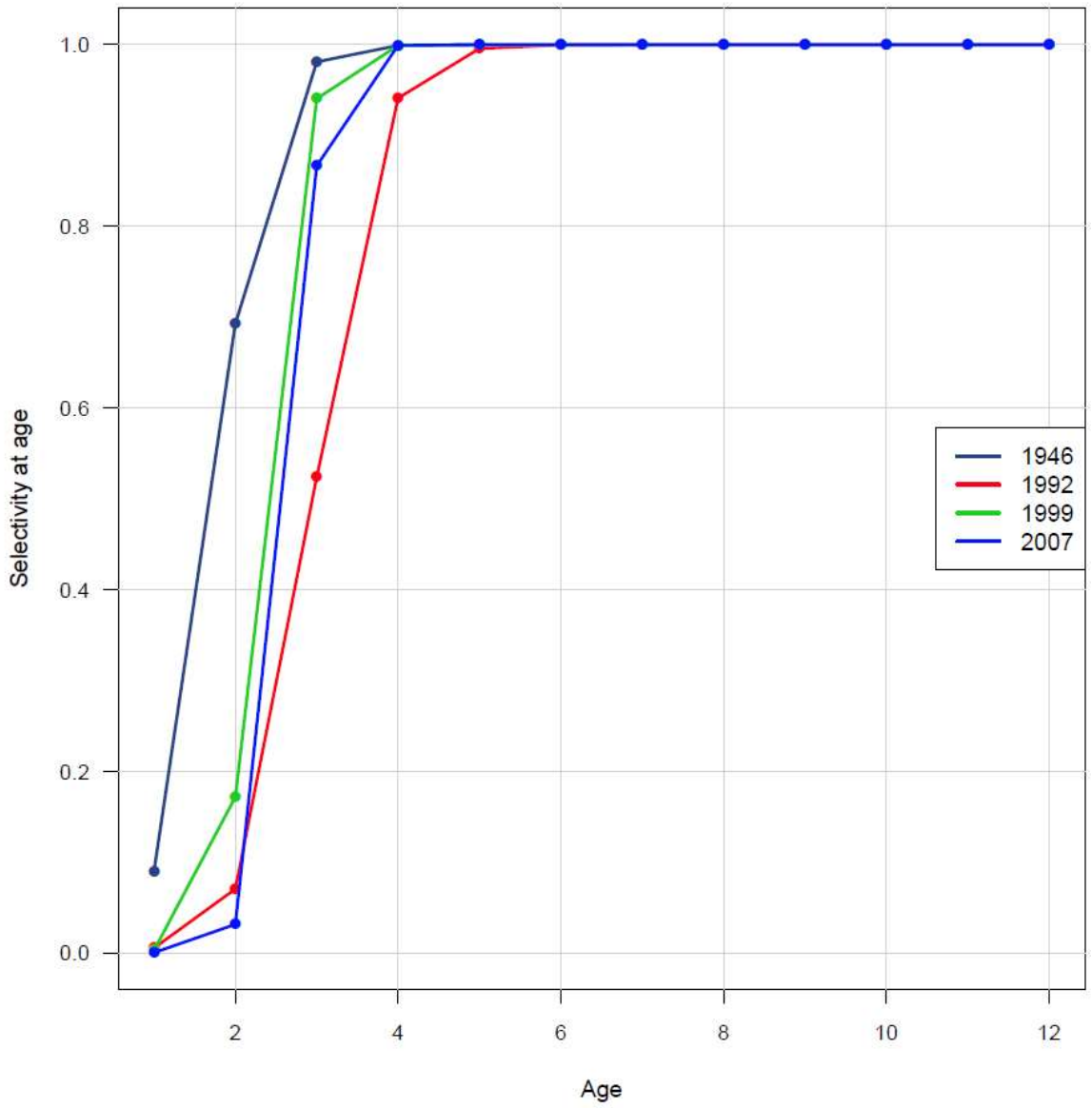
- Assume no discards prior to 1992

- Block 1 (1992-2008):
  - Fix age 1 at 0
  - Fix age 3 at 1
  - Estimate age-2 (logit)
  - Age 4+ fixed at age specific p(below size lt)

- Block 2 (2009-2016):
  - Fix age 1 at 0
  - Fix age 3 at 1
  - Fix age 2 at estimate for block 1
  - Estimate descending limb (exp function)

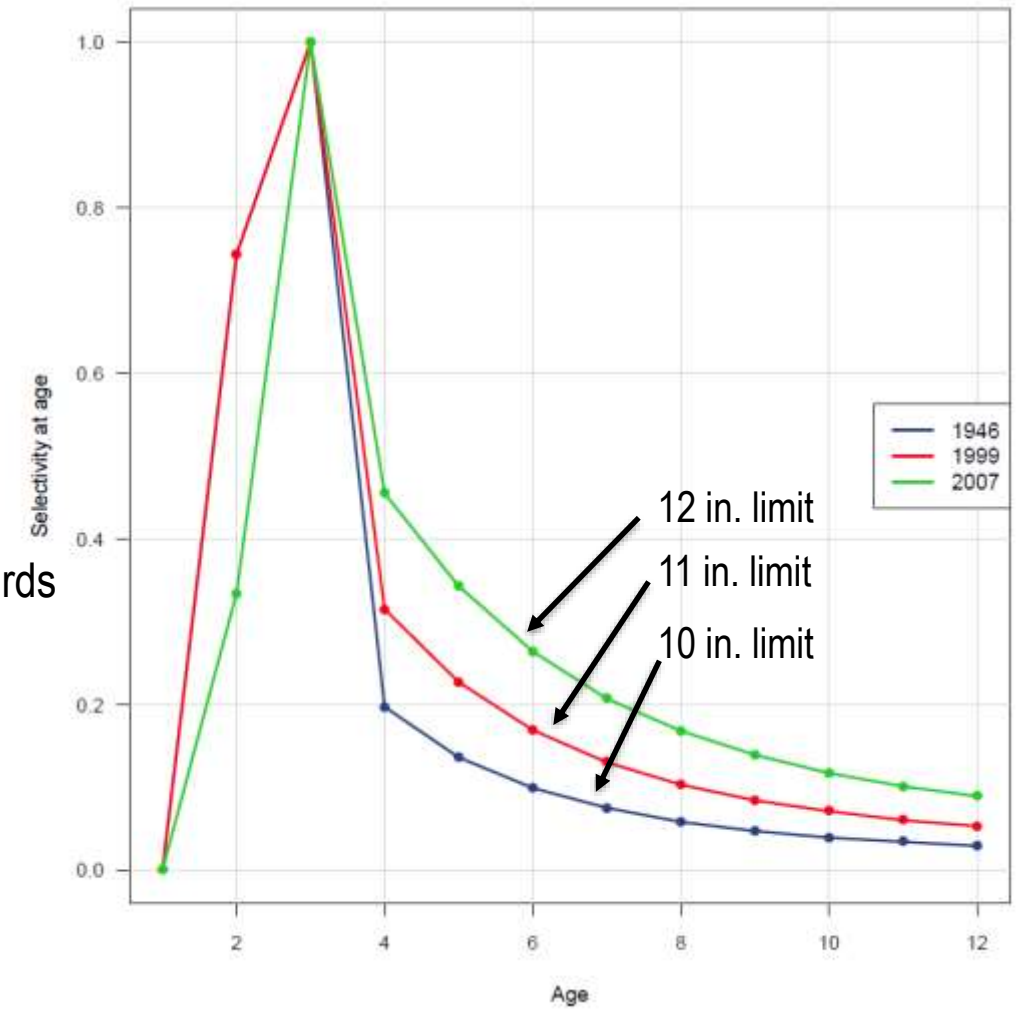


Recreational (HB and GR) Selectivity



Recreational Discard Selectivity

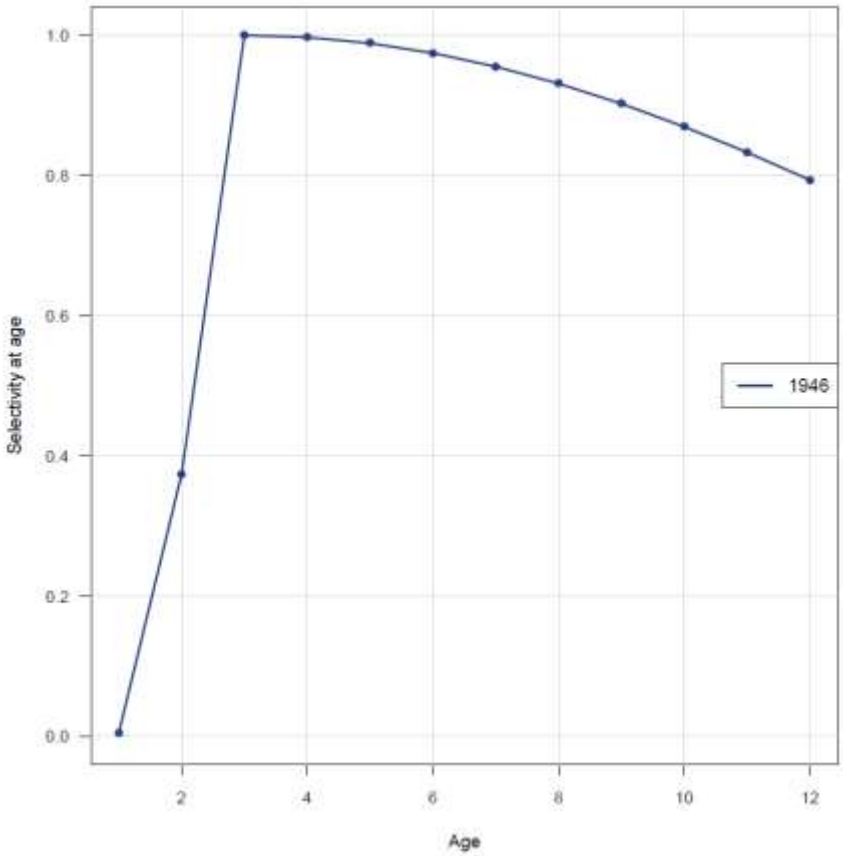
- Discards occurred prior to size limits (SEDAR 17)
-
  - Fix age 1 at 0
  - Fix age 3 at 1
  - Estimate age-2 (logit) for block 2
  - Fix age-2 in block 1 to that in block 2
  - Estimate age-2 (logit) in block 3
  - Age 4+ fixed at age specific p(below size lt) for each block
- Assume same selectivity for HB and GR discards



Fishery Independent Index Selectivity

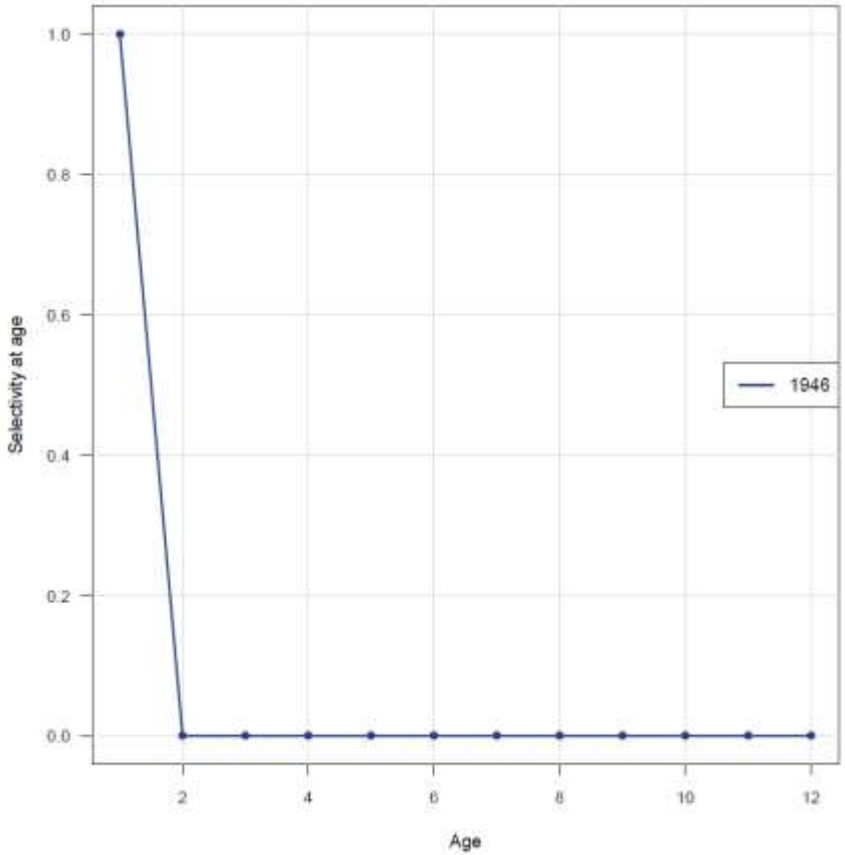
SERFS Chevron Trap

- 3-parameter logistic exponential (full selection at age-3)
- Assumed same for video



Florida Snapper Trap

- Fixed at 1 for age-1
- Based on inspection limited length data



Catchability

- SEDAR 17 assumed linear increasing catchability (2% per year) for all FD indices (through 2008)

- Later SEDAR procedural workshop suggested linear increasing catchability through 2003 and constant thereafter (SEDAR 2009: Addressing Time-Varying Catchability)

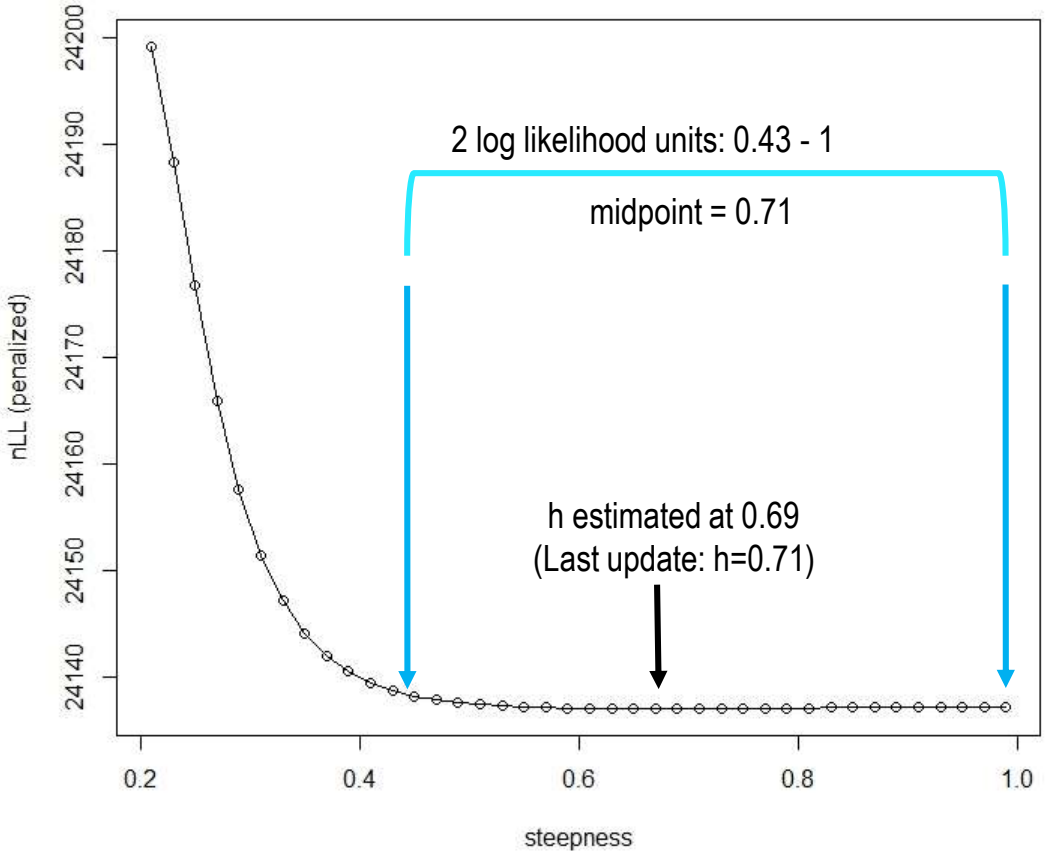
- Recent SEDAR assessments have used a random walk to account for time-varying catchability (SEDAR 41, SEDAR 53)

- Assessment Panel recommended:
  - Random walk catchability for all fishery dependent indices (Standard deviation = 0.17 based on Wilberg et al 2010)
  - Constant catchability for fishery independent indices

- SEDAR Procedural Guidance, 2009. SEDAR Procedural Guidance Document 2: Addressing Time-Varying Catchability.
- Wilberg et al. (2010). Incorporating time-varying catchability into population dynamic stock assessment models. Review in Fisheries Science. 18(1) 7-24.
- Wilberg, M. & Bence, J. (2006). Performance of time-varying catchability estimators in statistical catch-at-age analysis. Canadian Journal of Fisheries and Aquatic Sciences. 63. 2275-2285.

Steepness

- Steepness (*h*) estimated at 0.69 but estimate was highly unstable
- Likelihood components did not provide support for a particular value of steepness
- Likelihood profile was flat from 0.43-1
- Panel recommended fixing steepness at *h* = 0.69



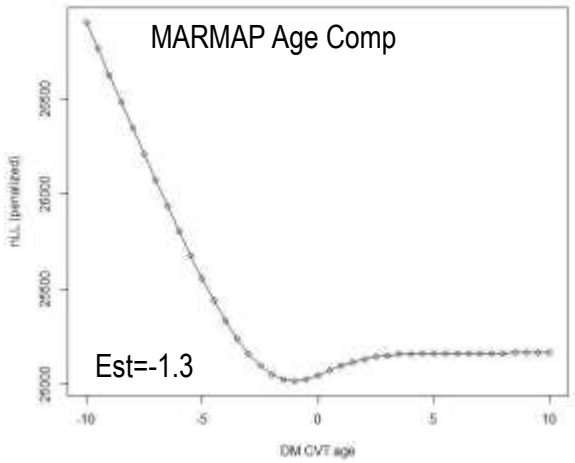
Likelihood for Composition Data

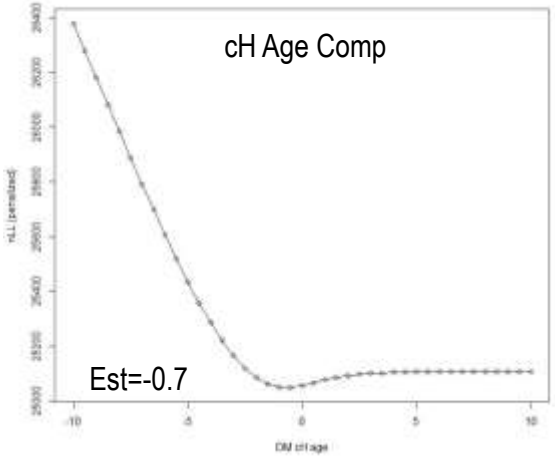
- 2012 SEDAR 17 Update used multinomial likelihood for composition data

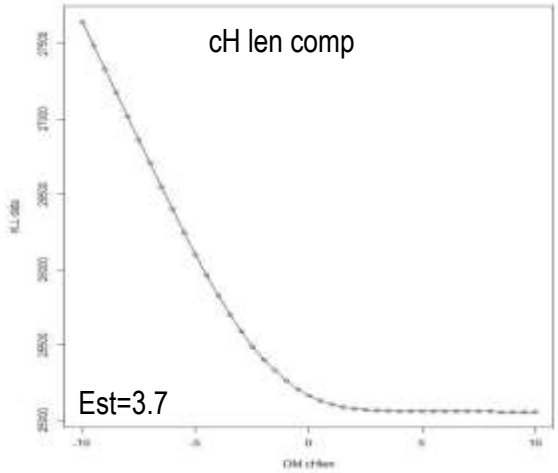
- Panel considered the Dirichlet multinomial for this assessment
  - Better accounts for correlation in sampling
  - Self-weighting
  - Allows for zeros in the data
  - Recommended by Francis (2017) and Thorson et al. (2017)

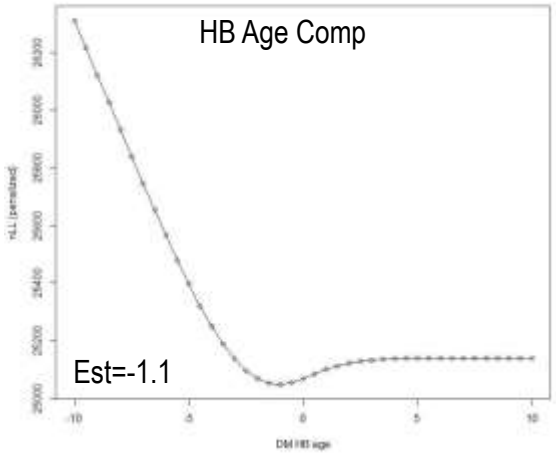
- Panel reviewed profiles for D-M dispersion parameter for composition data
  - No D-M parameters estimated at lower bound (would imply effective N =0)
  - All age compositions: model estimate is near profile minimum
  - Length compositions: model estimate near profile min or at upper bound (suggesting effective N = N)

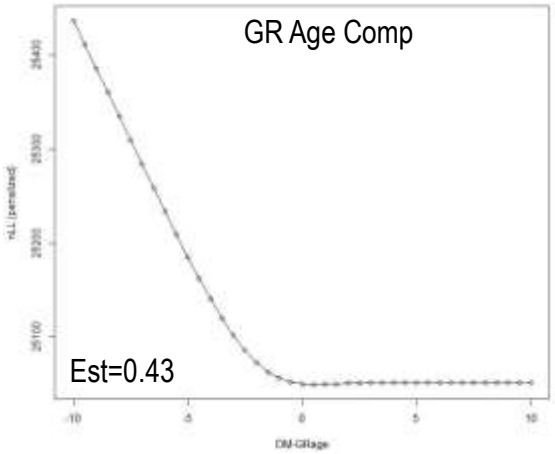
Profiles D-M Dispersion Parameter

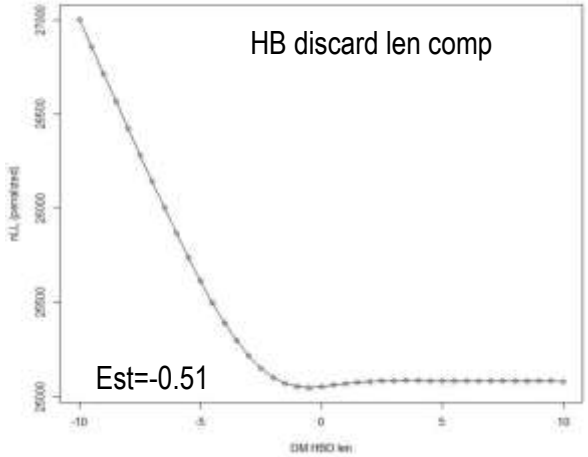












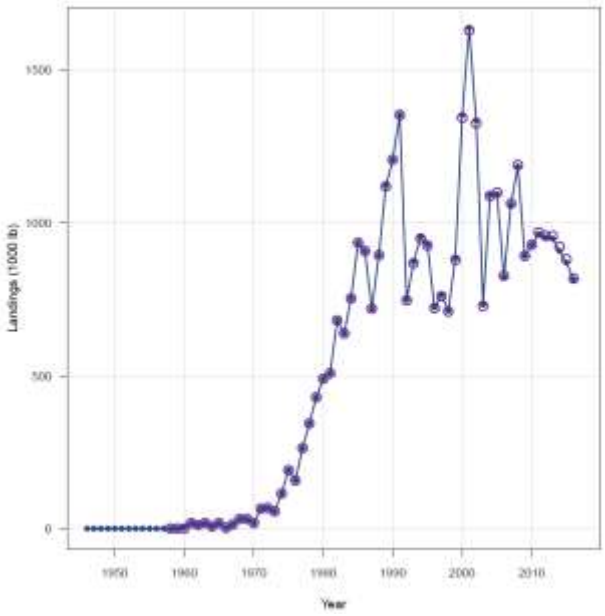
Panel Recommendation: Use Dirichlet multinomial likelihood for compositions

Base Run Configuration

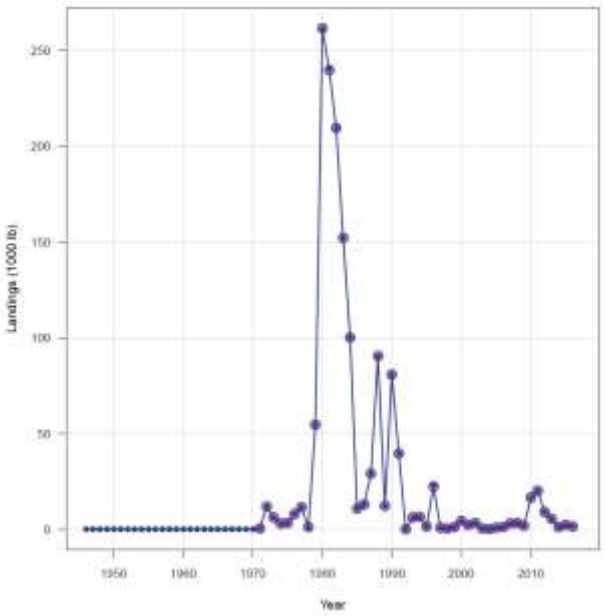
- Combine SERFS trap-video index (Conn Method)
- Exclude length comps except when no age comps available within blocks
- Selectivity as in SEDAR 17
- CVs on fishery dependent indices scaled to max = 0.3 (as in SEDAR 17 update)
- Dirichlet multinomial for composition data
- Stage 2 weights of indices set to 1.0
  - SEDAR 17 update used ad hoc weighting of all data (multiplier on likelihood)
  - Iterative re-weighting did not improve model fits
- RW catchability for FD indices
- Fixed steepness (h=0.69)

BAM base run – fits to landings

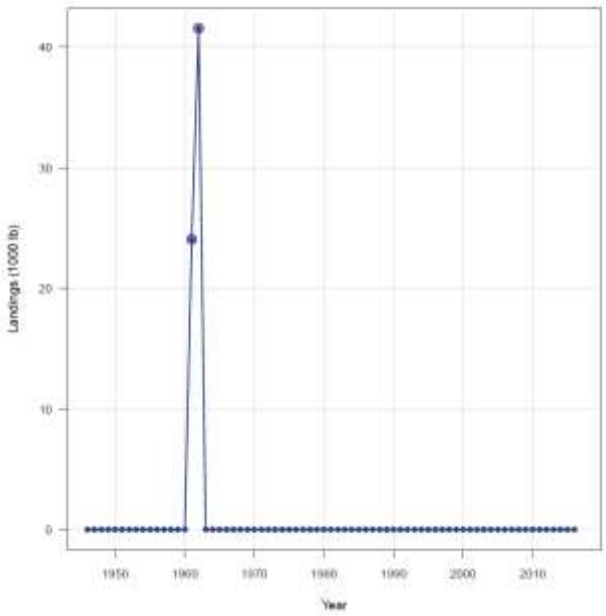
Comm Handline Landings



Comm Other Landings

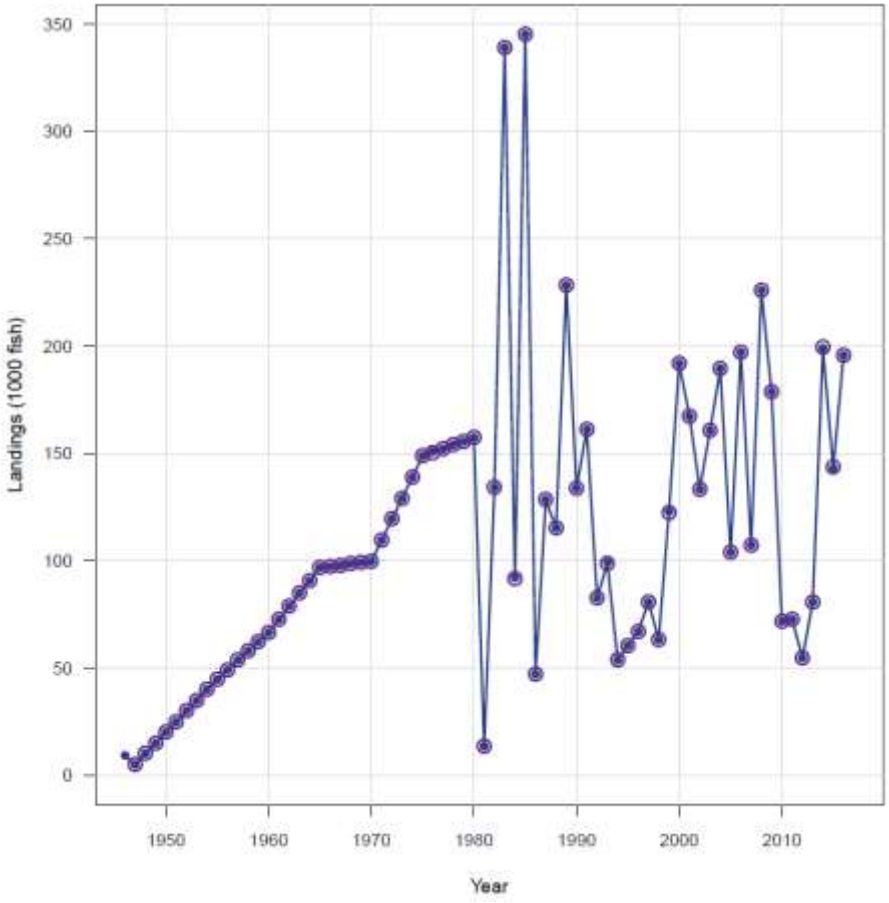


Comm Historic Trawl Landings

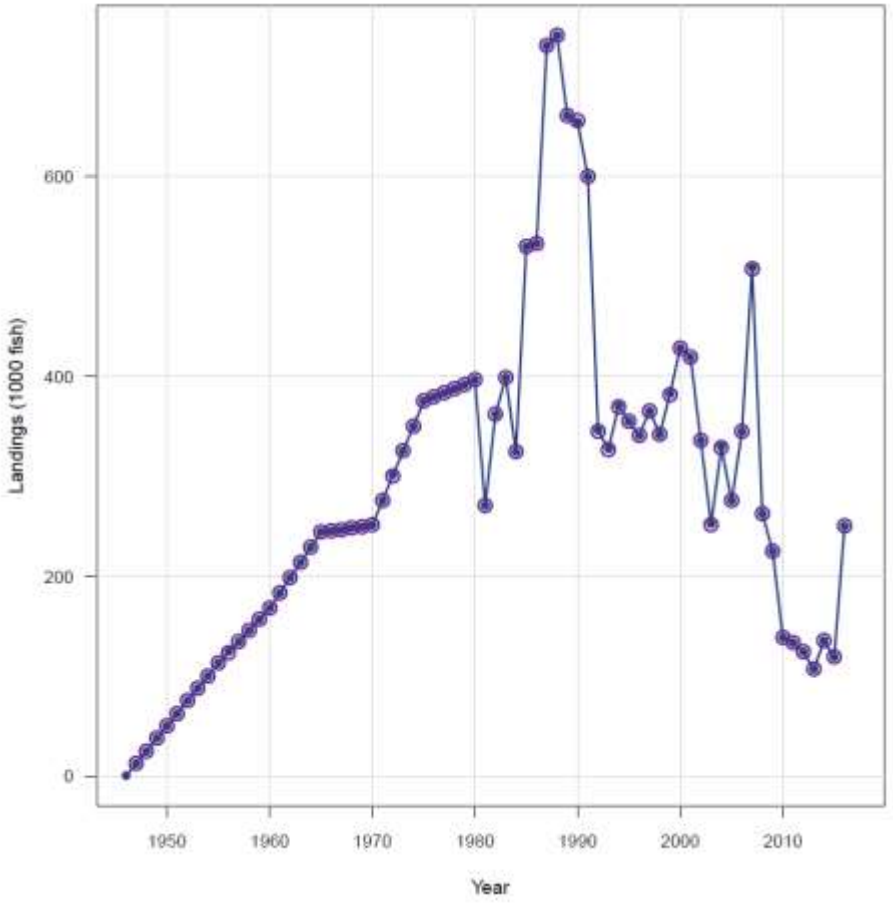


BAM base run – fits to landings

General Rec Landings

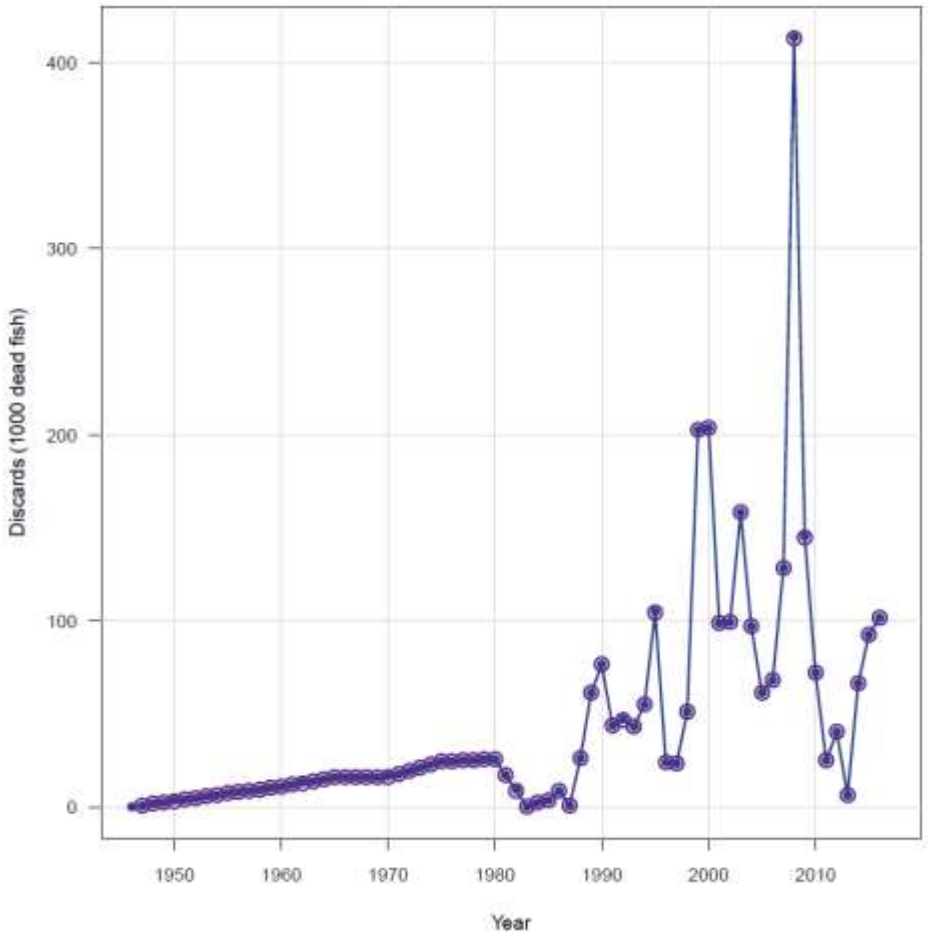


Headboat Landings

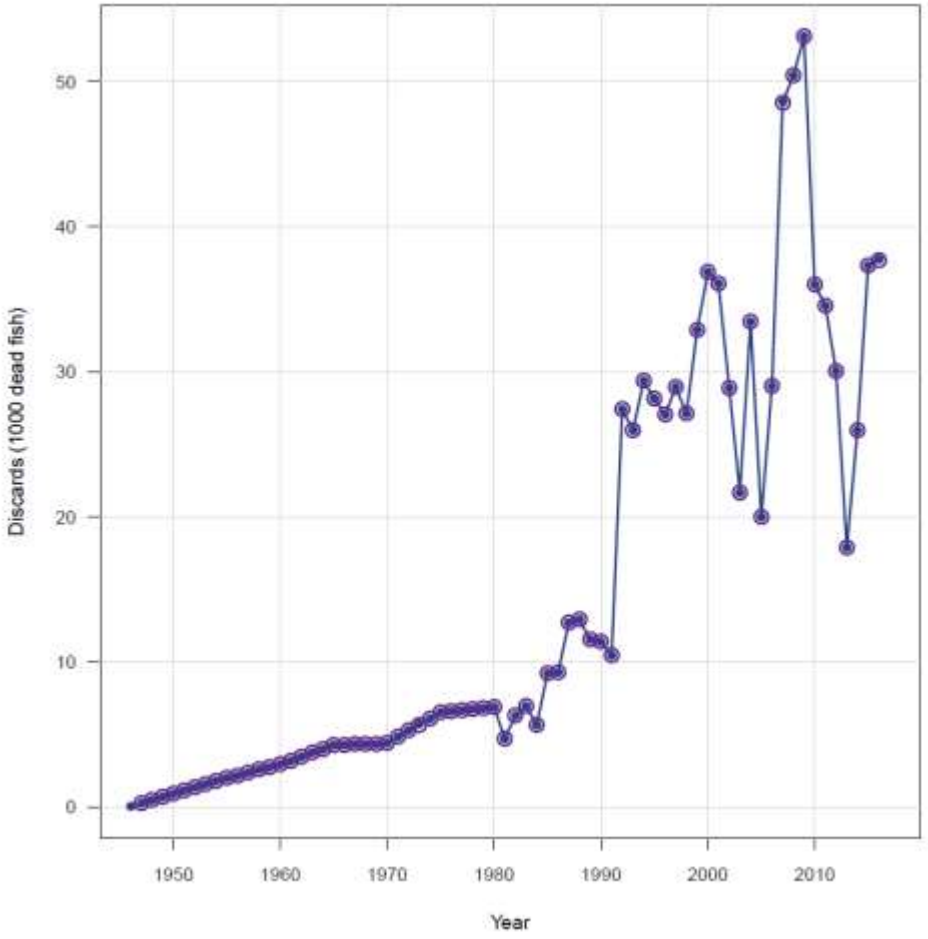


BAM base run – fits to landings

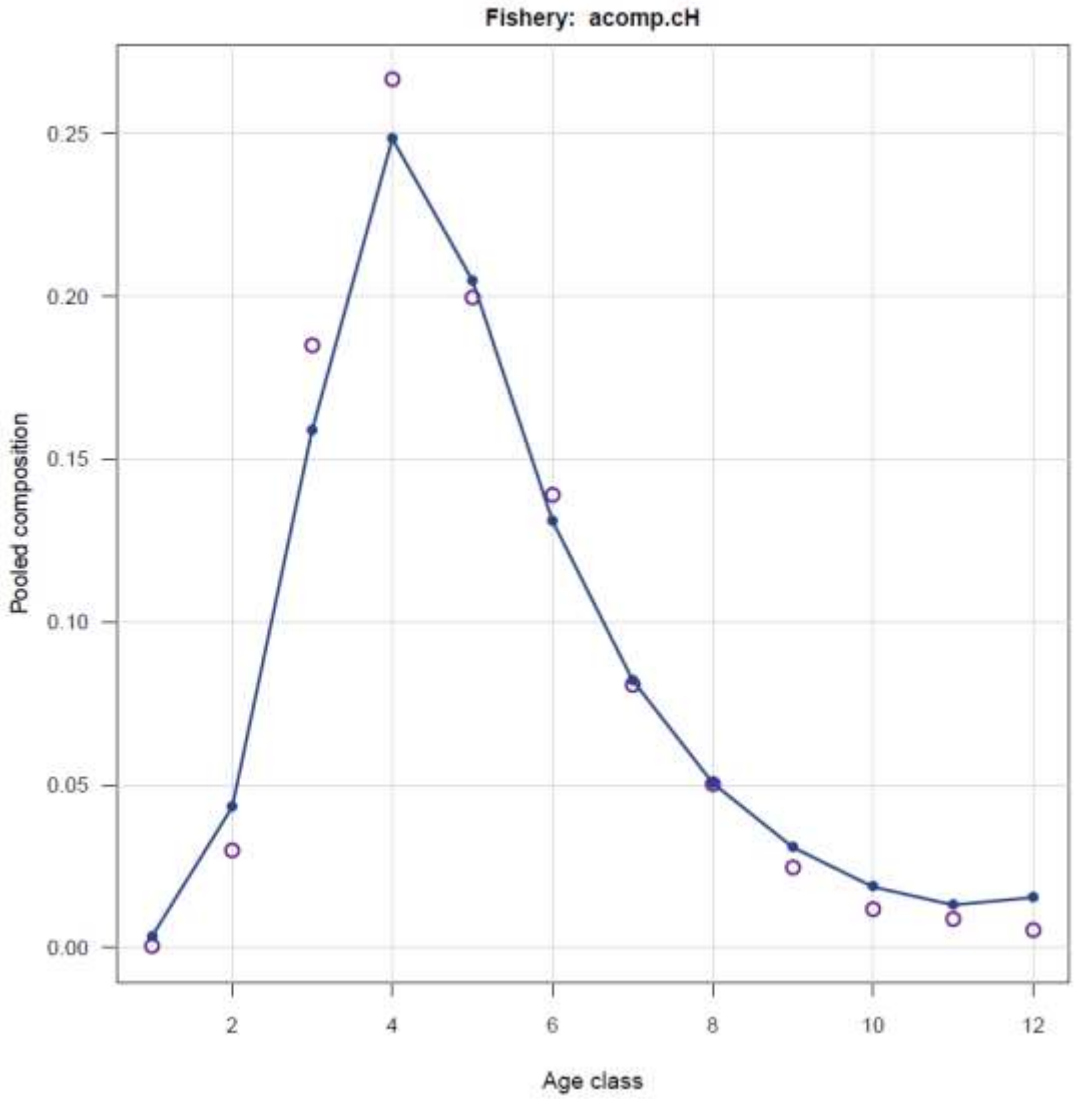
General Rec Discards



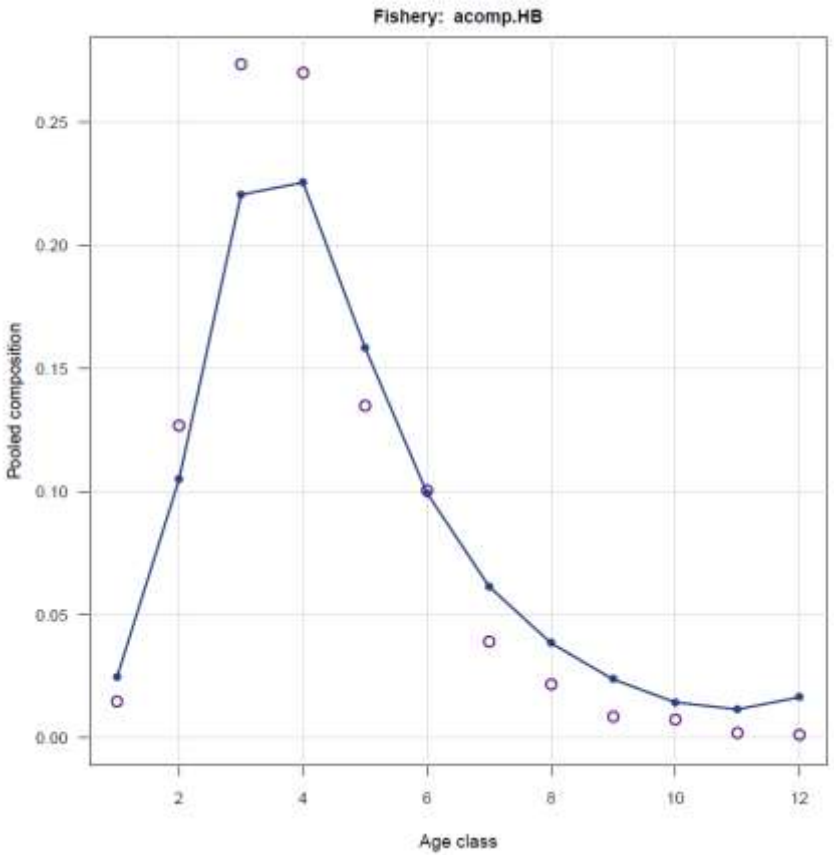
Headboat Discards

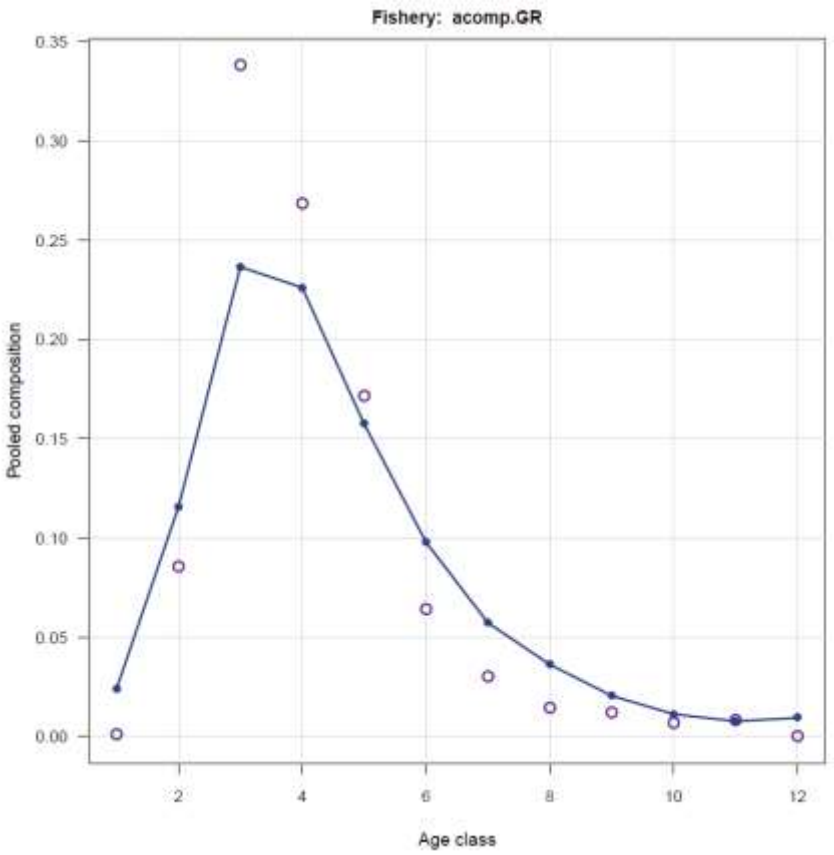


BAM base run – fits to pooled cHL age comps

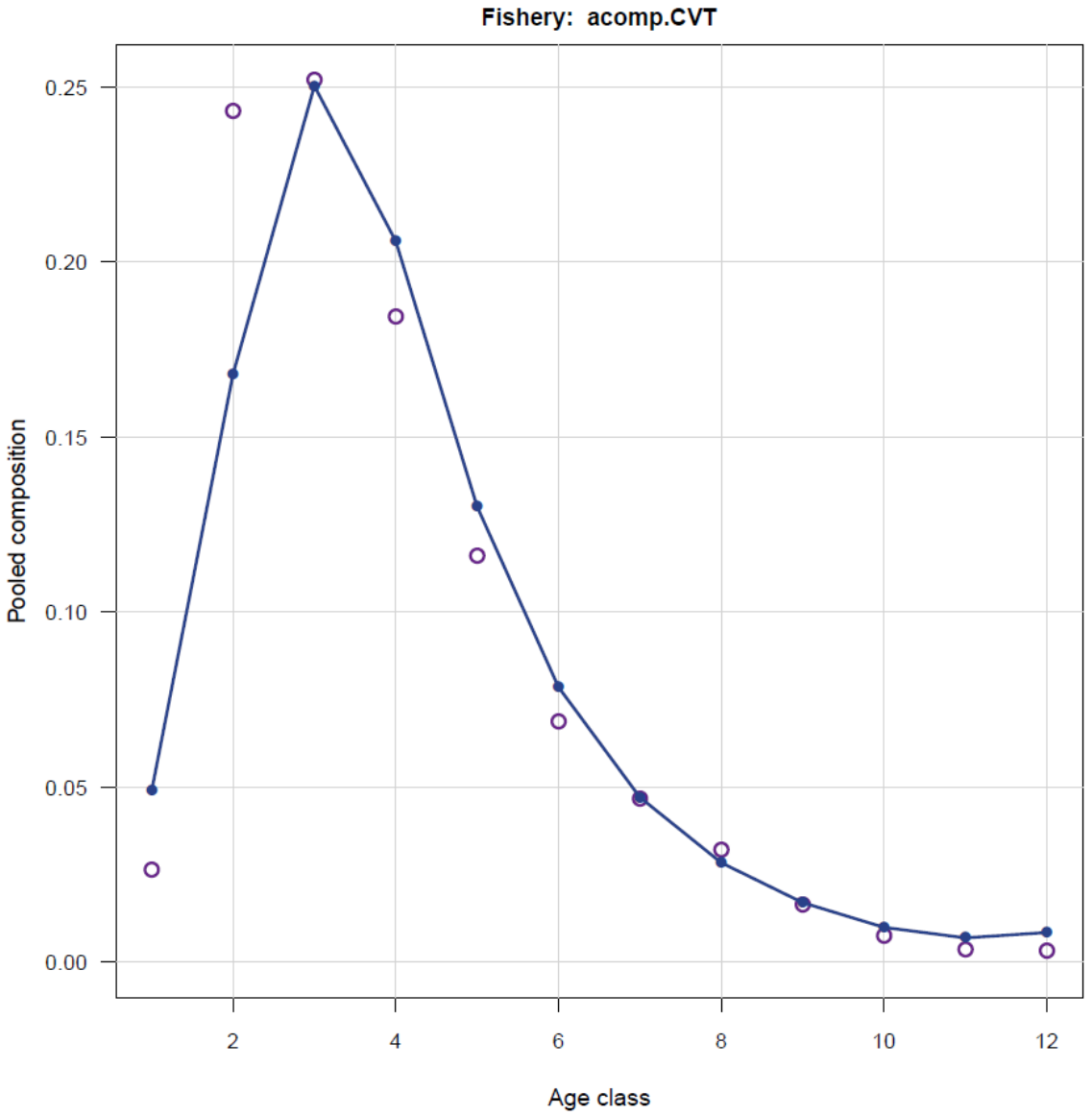


BAM base run – fits to pooled HB and GR age comps

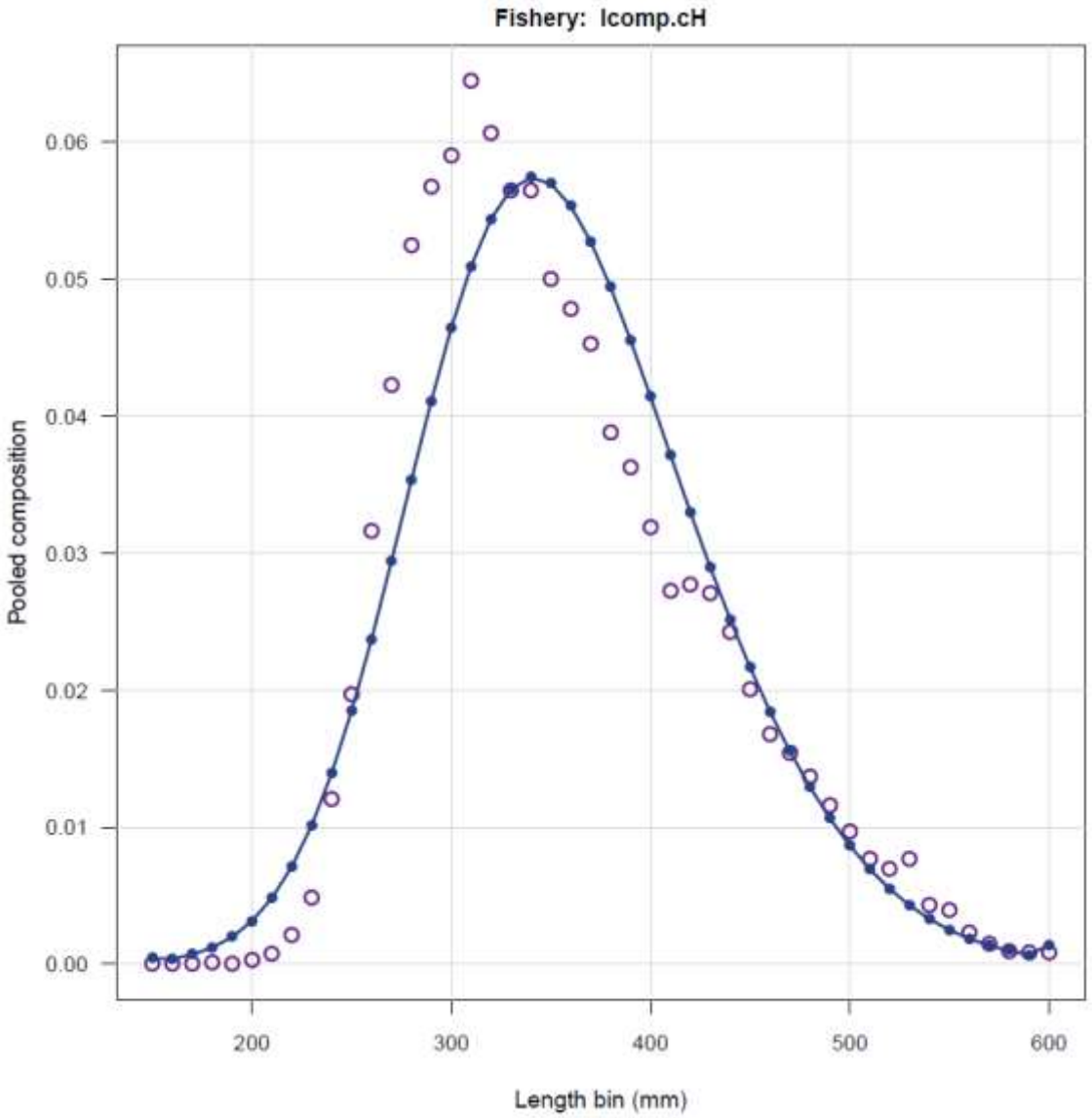




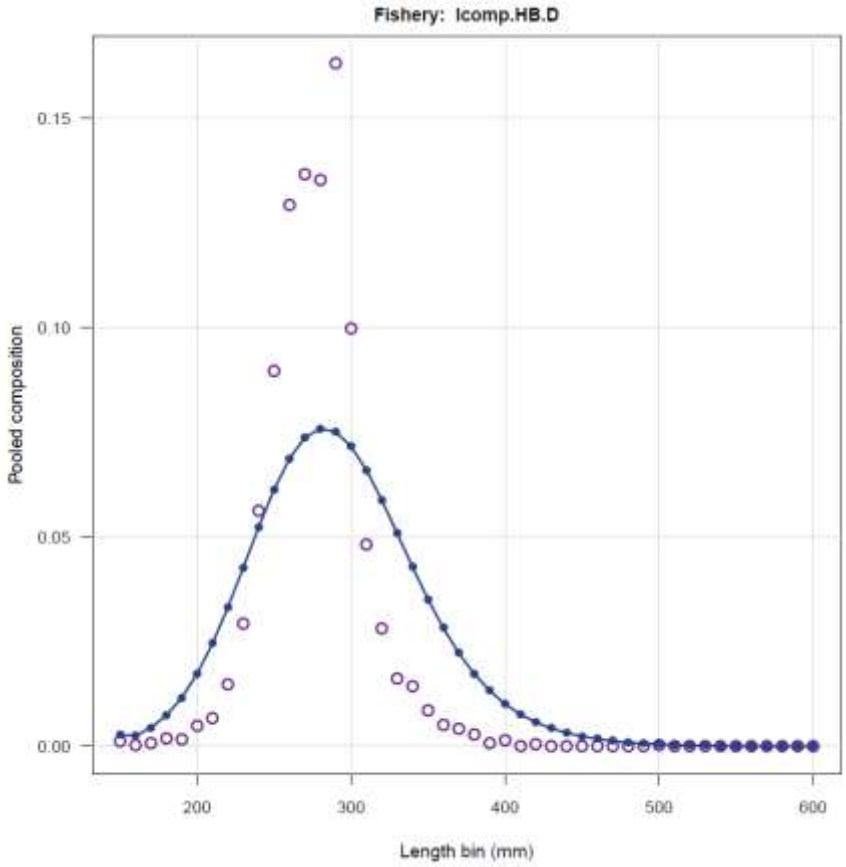
BAM base run – fits to pooled Chevron Trap age comps

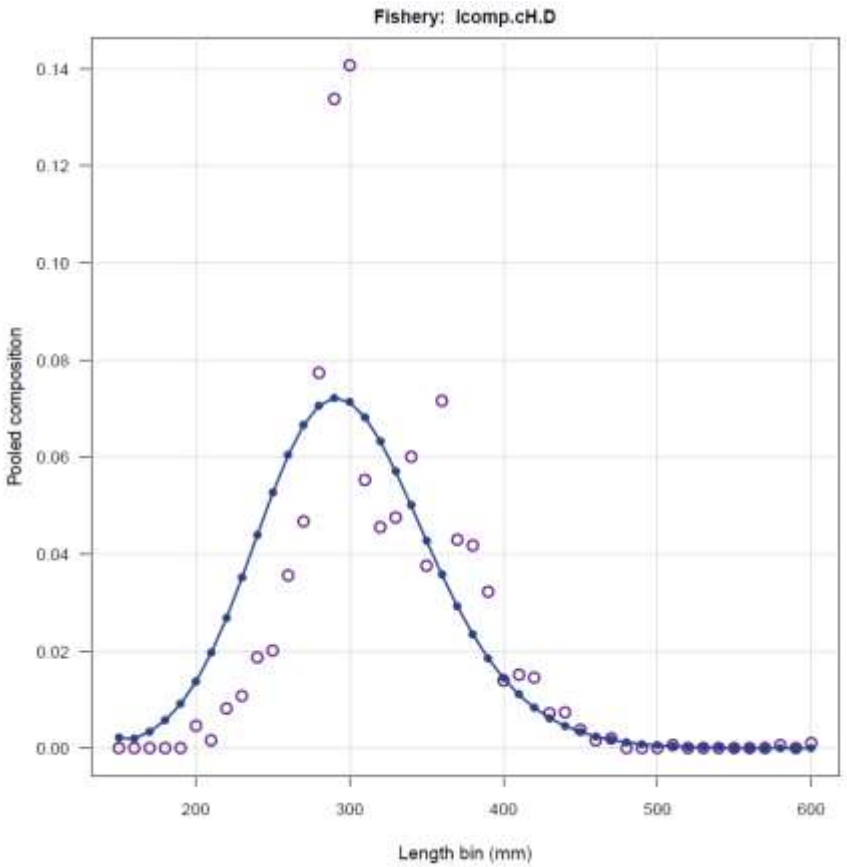


BAM base run – fits to pooled cHL length comps

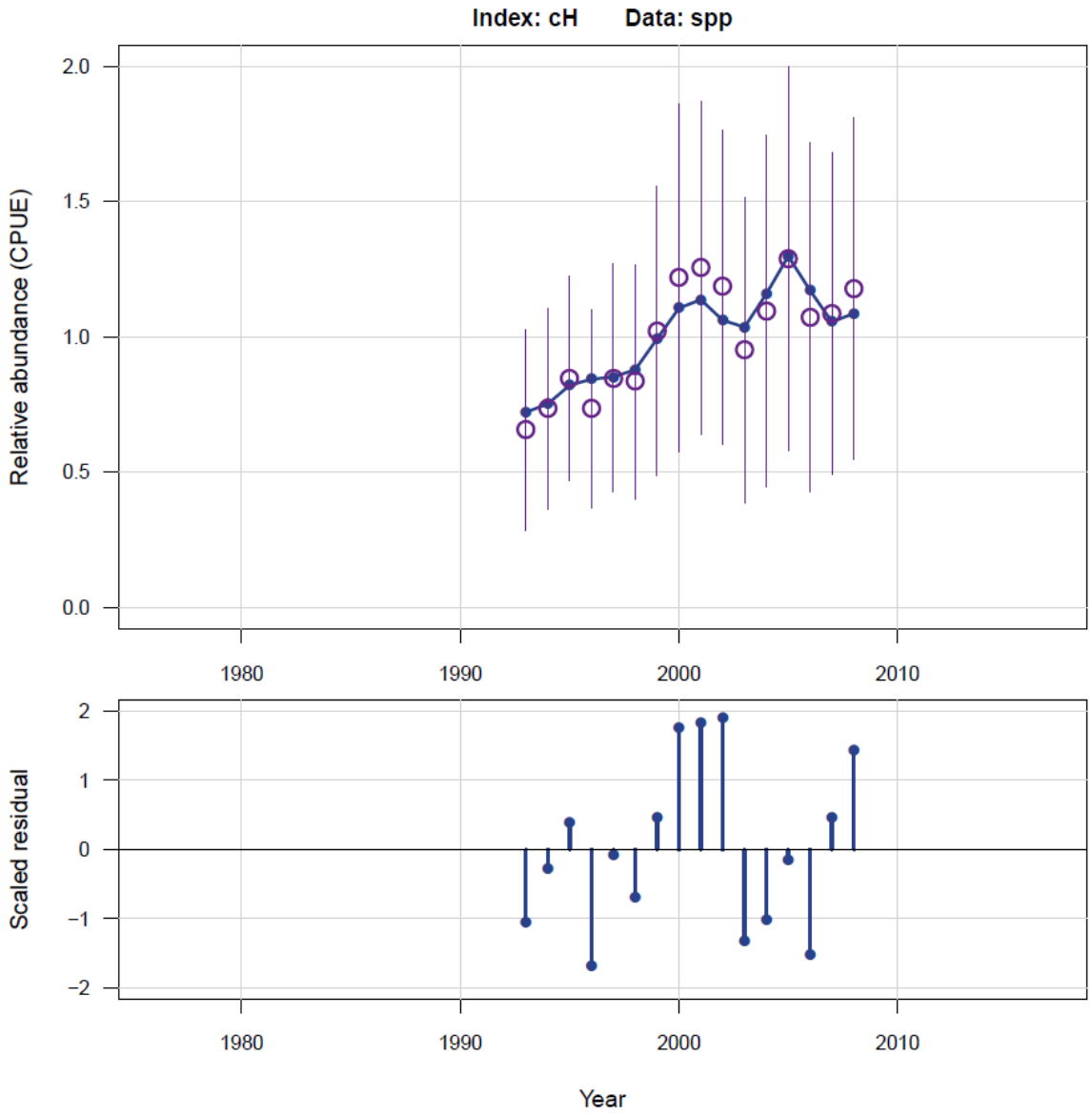


BAM base run – fits discard length comps

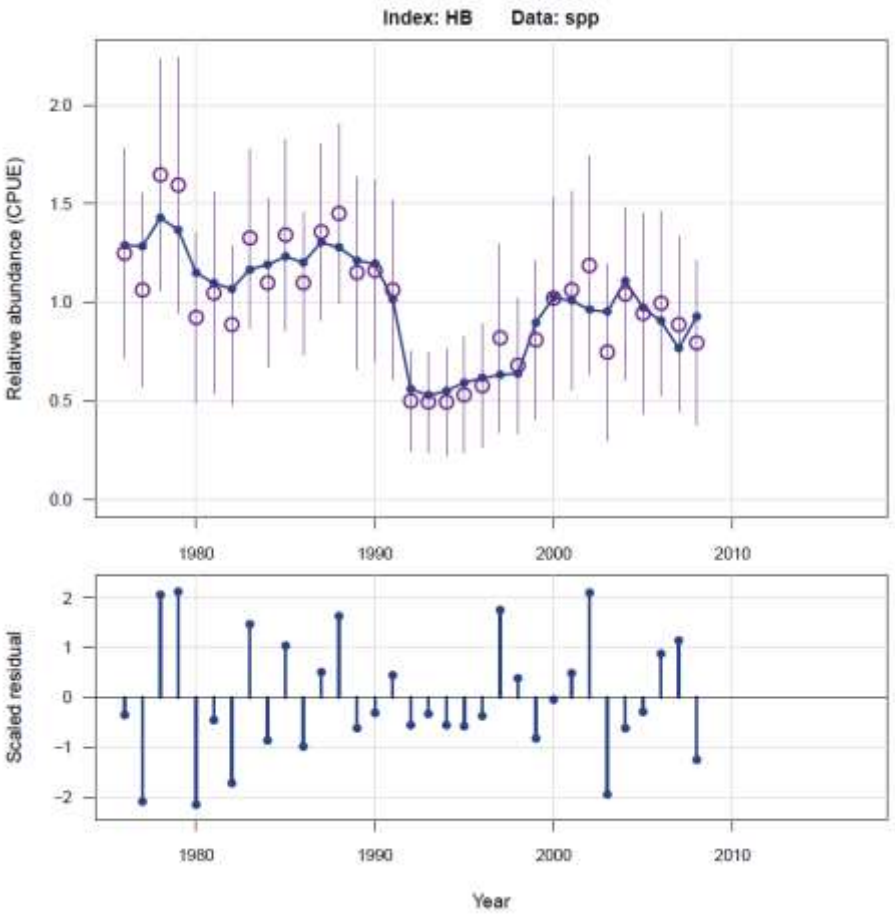


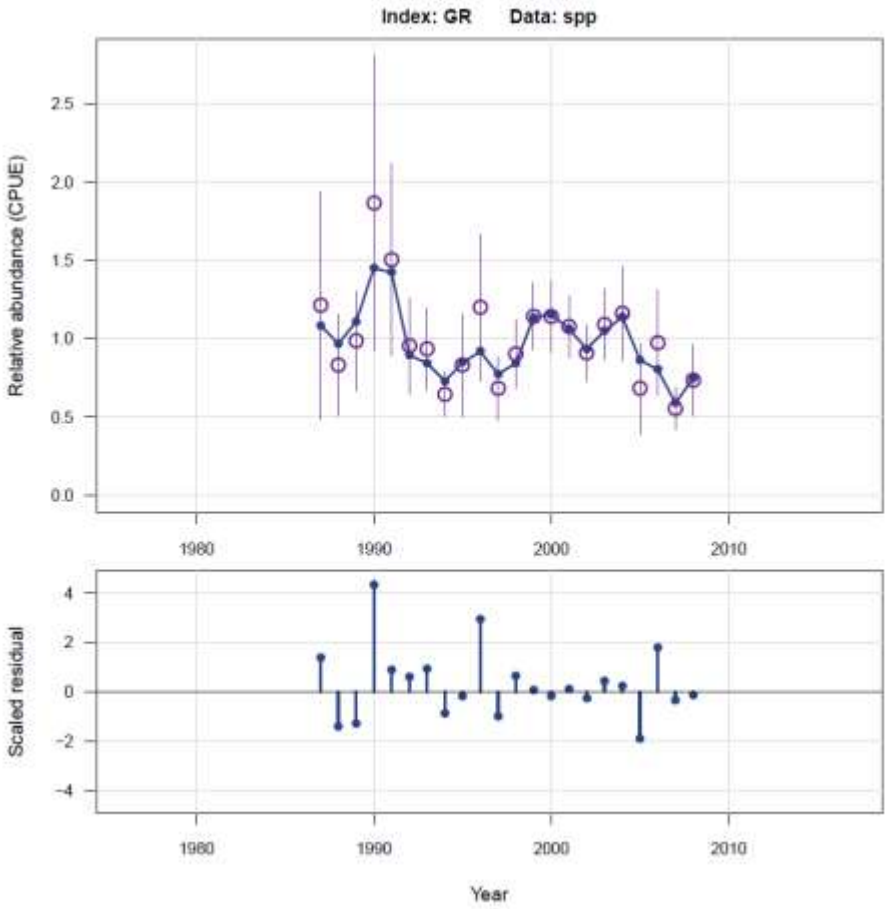


BAM base run – Com Handline Index

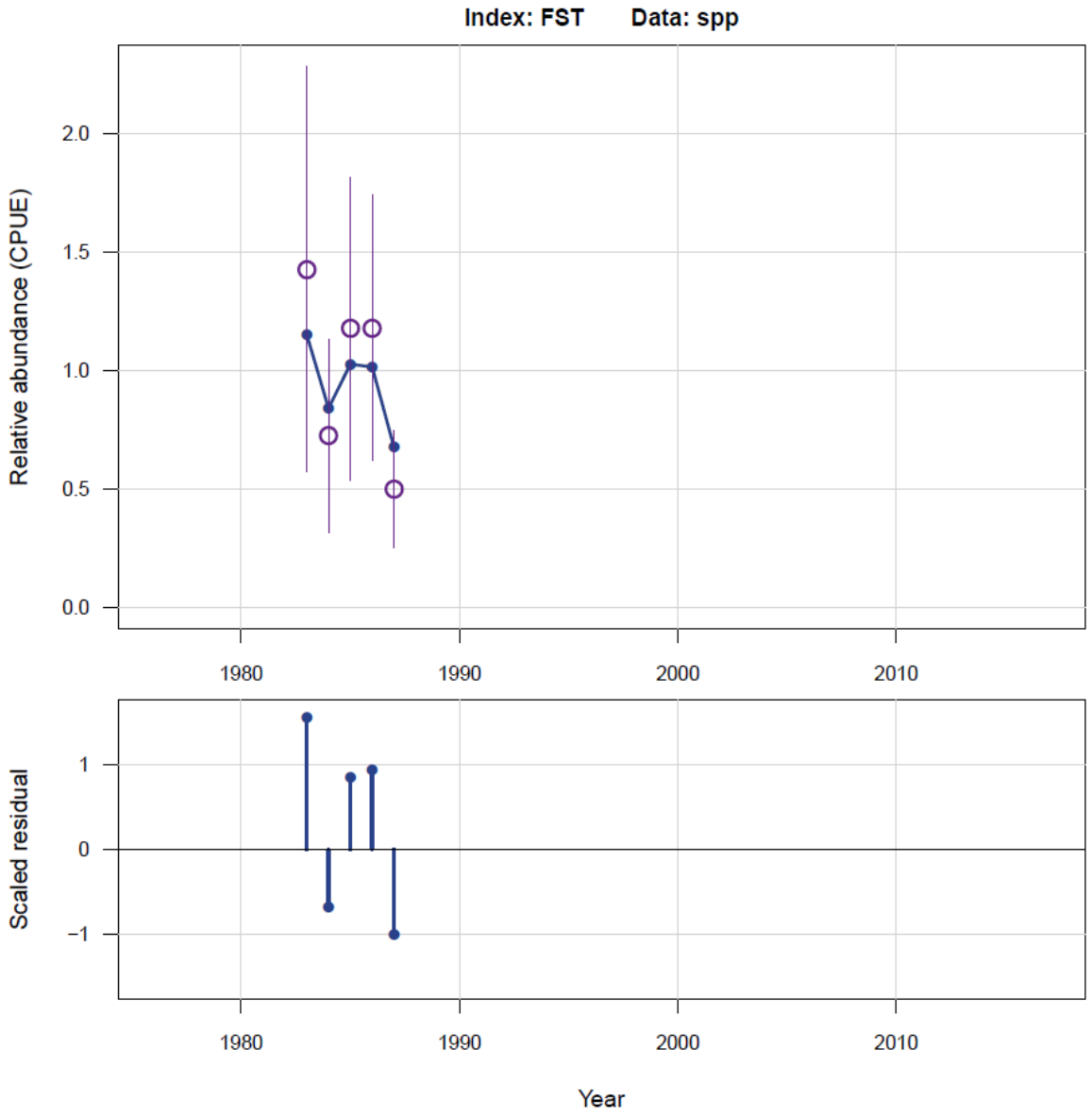


BAM base run – Recreational Indices

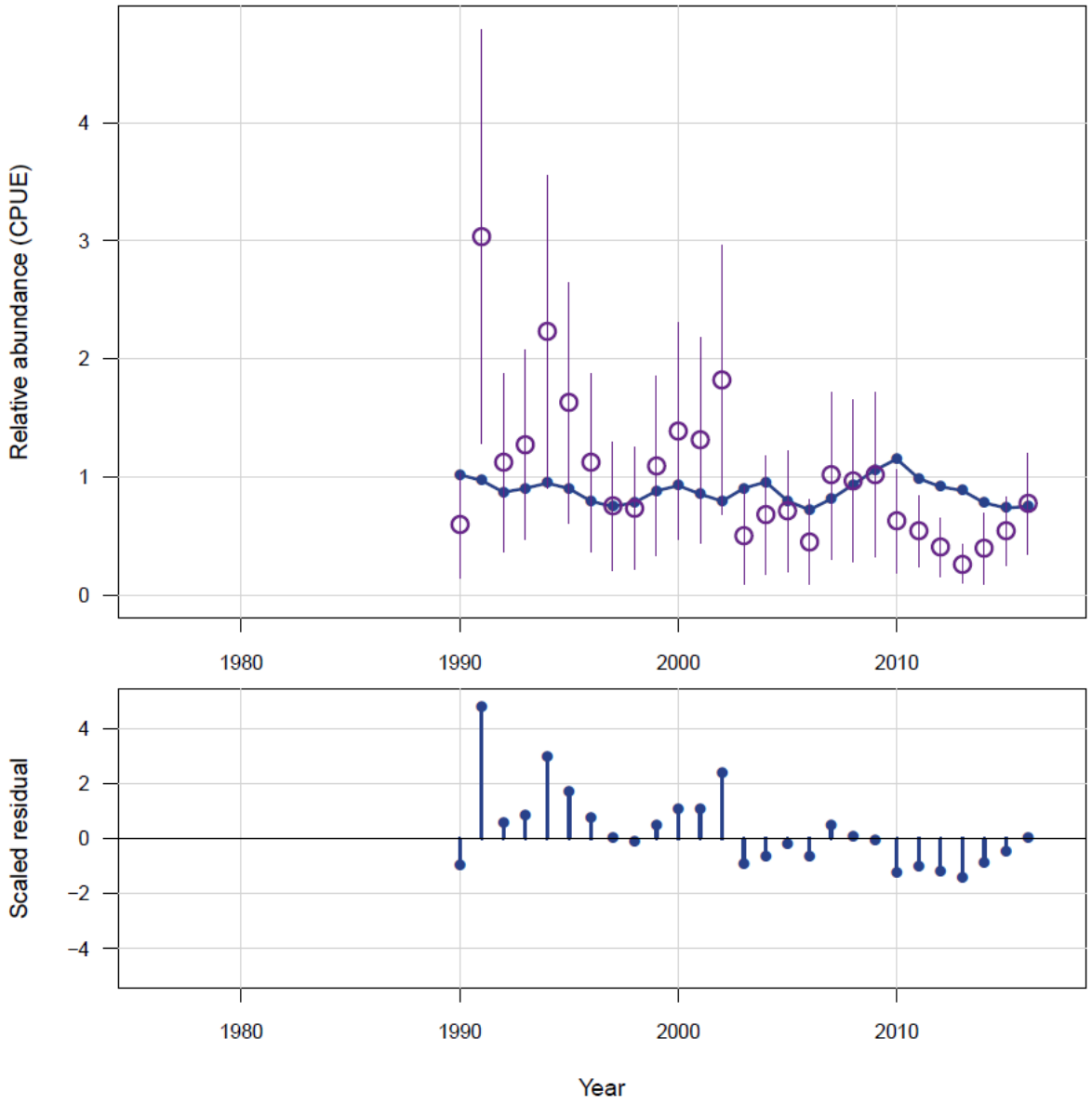




BAM base run – Florida Snapper Trap



BAM base run – Combine CVID Index

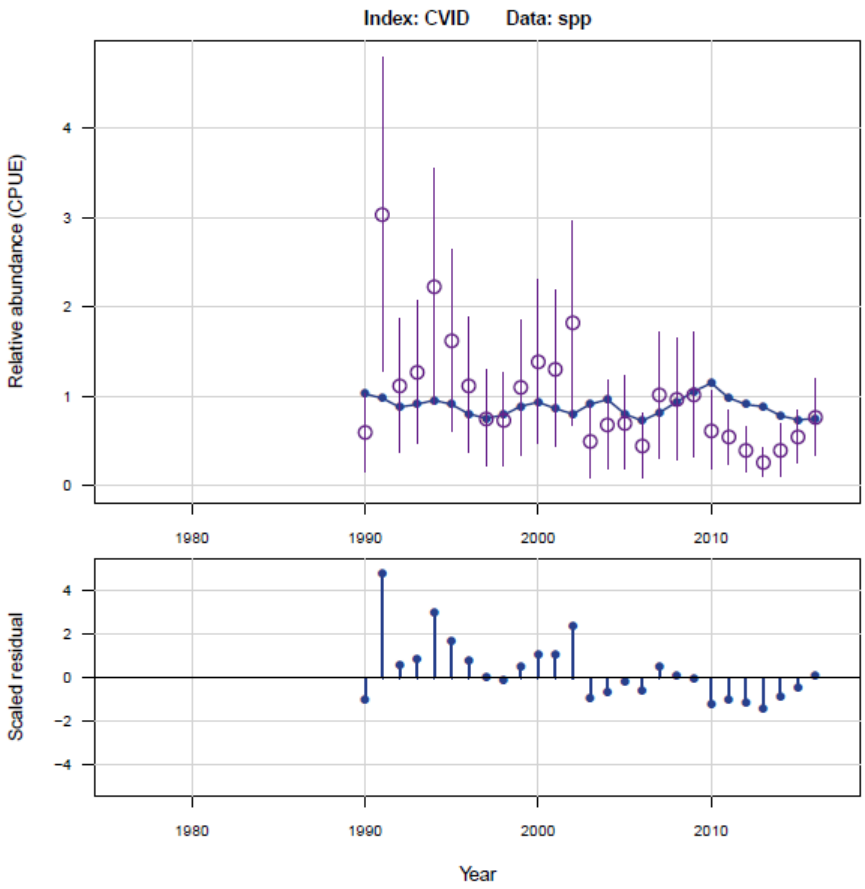


BAM base run – Combine CVID Index

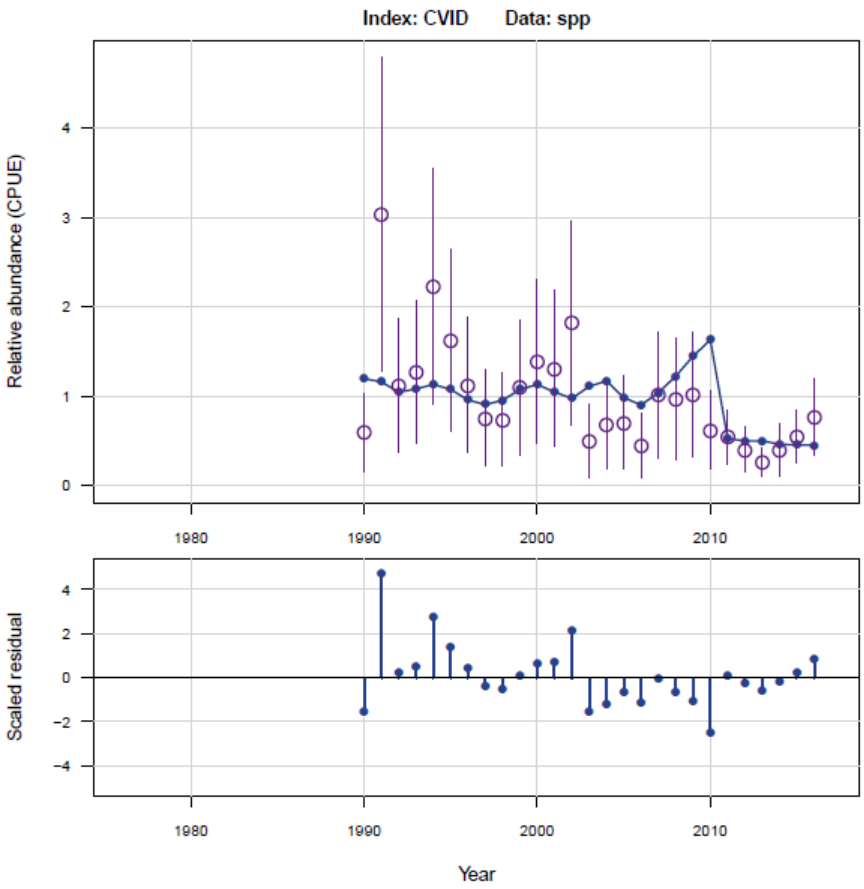
- Assessment panel considered two approaches to improve index fit:
  - Blocking catchability around the expansion in geographic coverage of the SERFS Trap-Video survey (1990-2010, 2011-2016)
  - Upweighting CVID index (considered upweightin 2-8 fold and evaluated loss of fit to other data source
- Neither was satisfactory

Block on catchability of CVID Index

No Block on CVID *q*



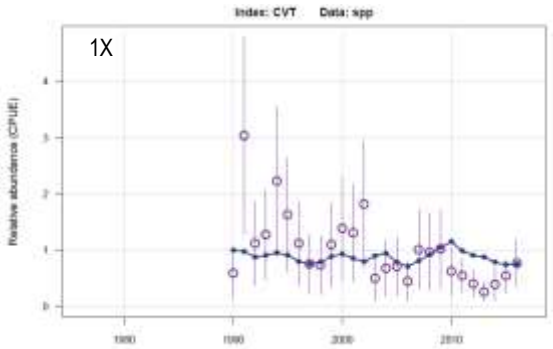
Block on CVID *q*

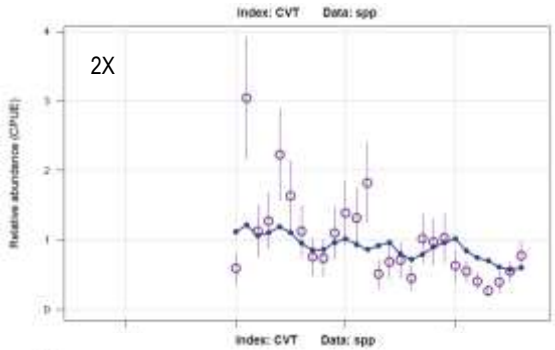


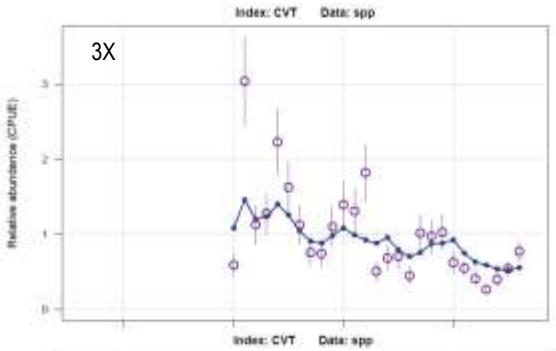
Upweighting CVID Index

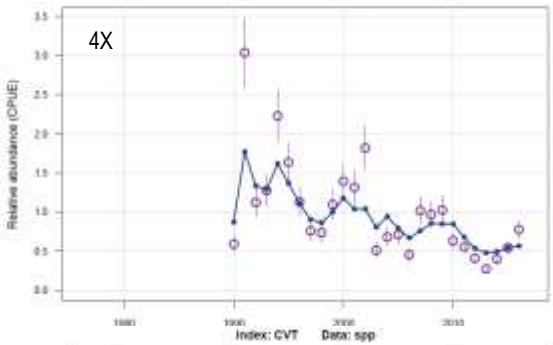
- Loss of fit to all data sources (landings, indices, age compositions)
- CVID index in conflict with as cHL age comps and Chevron trap (CVT) age comps
- The loss of fit to the age comps alters the recruitment pattern, missing recent strong year classes that are present in multiple independent age compositions (CVT and cHL)
- The altered recruitment pattern is due to correlation between the landings and the index (both declining since 2000s) that the model can only explain by decreased recruitment

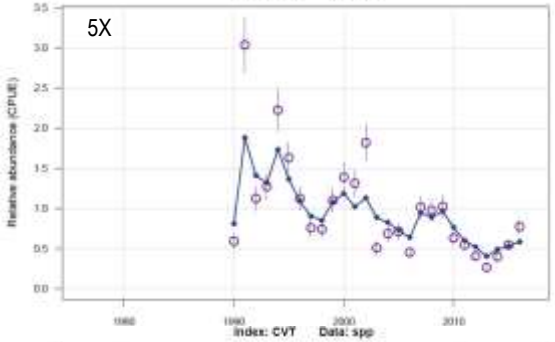
Upweighting CVID Index

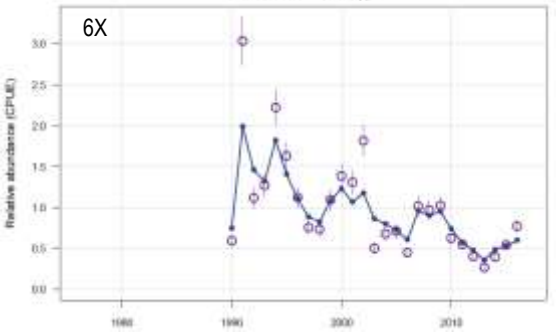


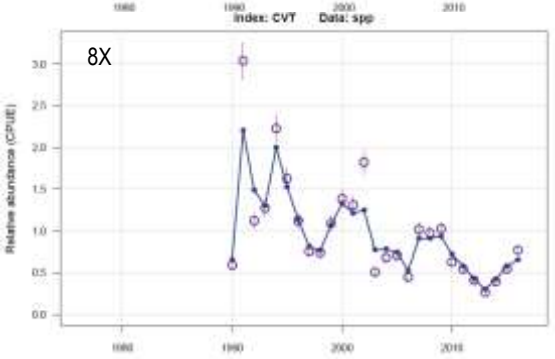








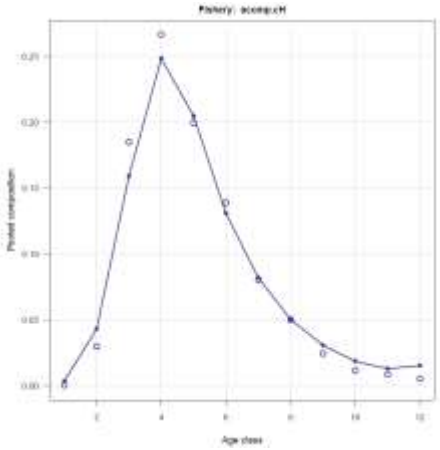




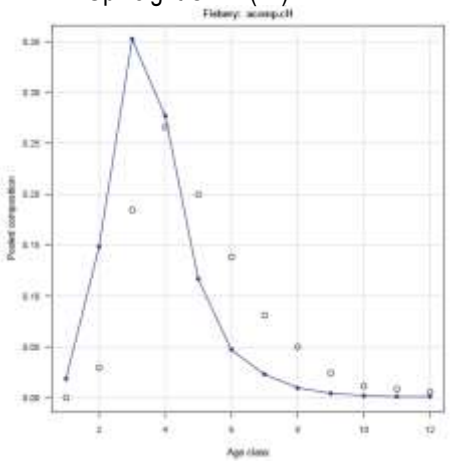
Loss of Fit to Age Compositions

cH Pooled age comps

No Upweighting CVID

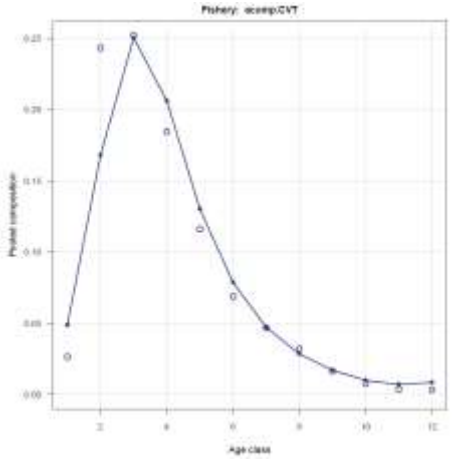


Upweight CVID (4x)

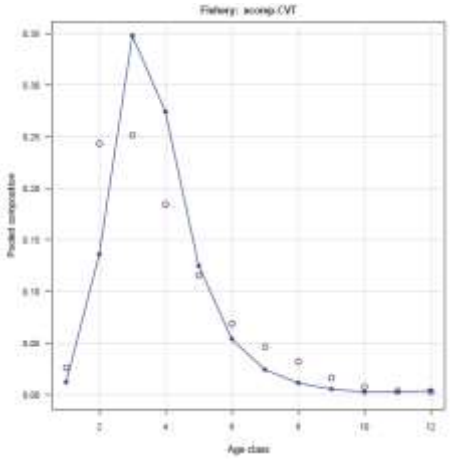


CVT Pooled age comps

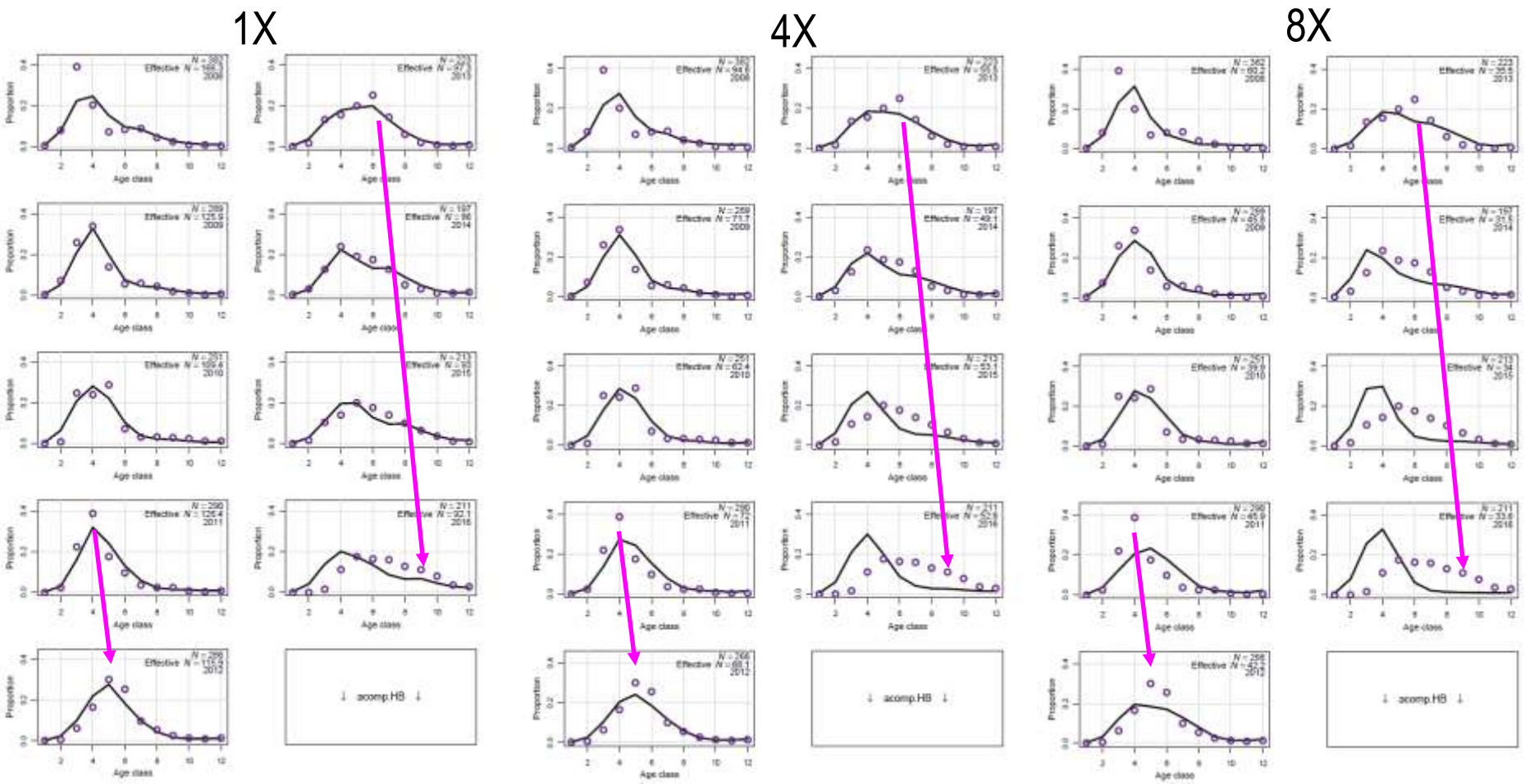
No Upweighting CVID



Upweight CVID (4x)



Com Handline Age Compositions



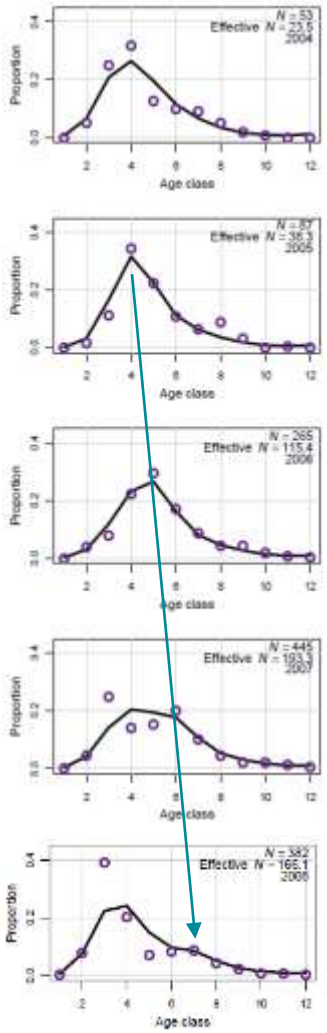
Similar Recruitment Signals in cHL and CVT Age Comps

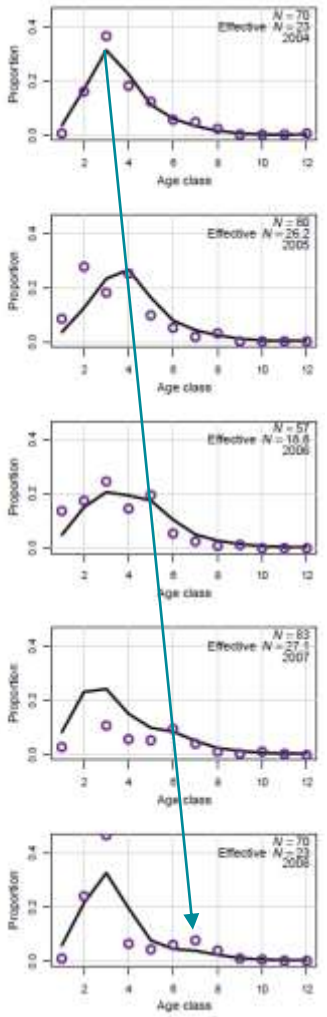
cHL age comps

Ex: 2002 Year Class

CVT age comps

Age-4 in 2005

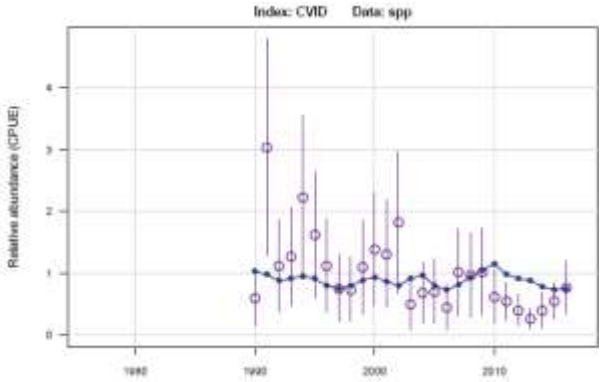


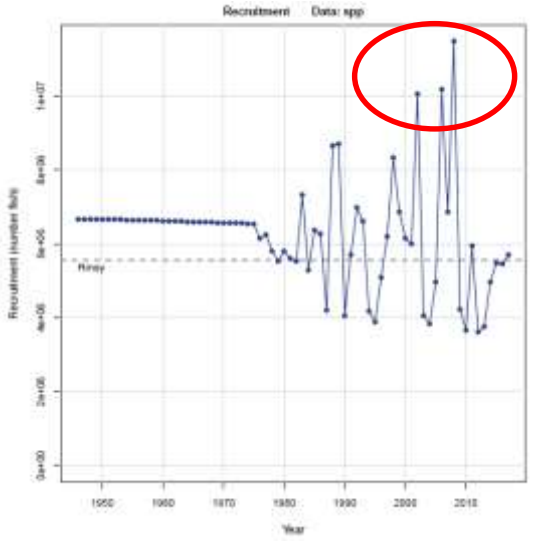


Age-3 in 2004

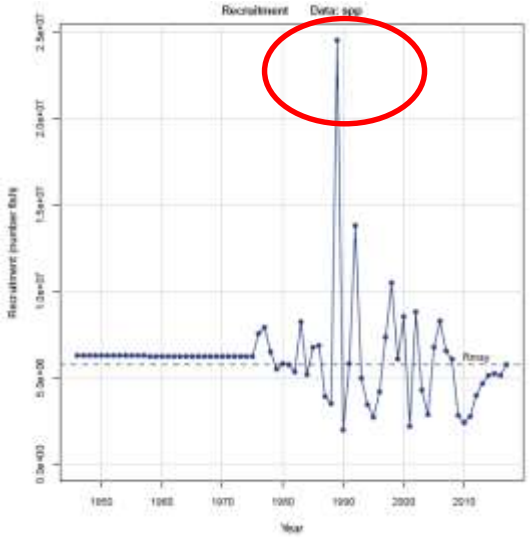
Loose Recruitment Signals when Upweight CVID Index

No up-weighting

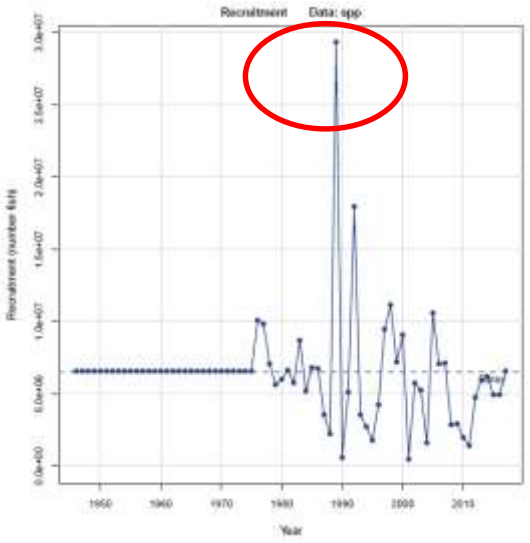




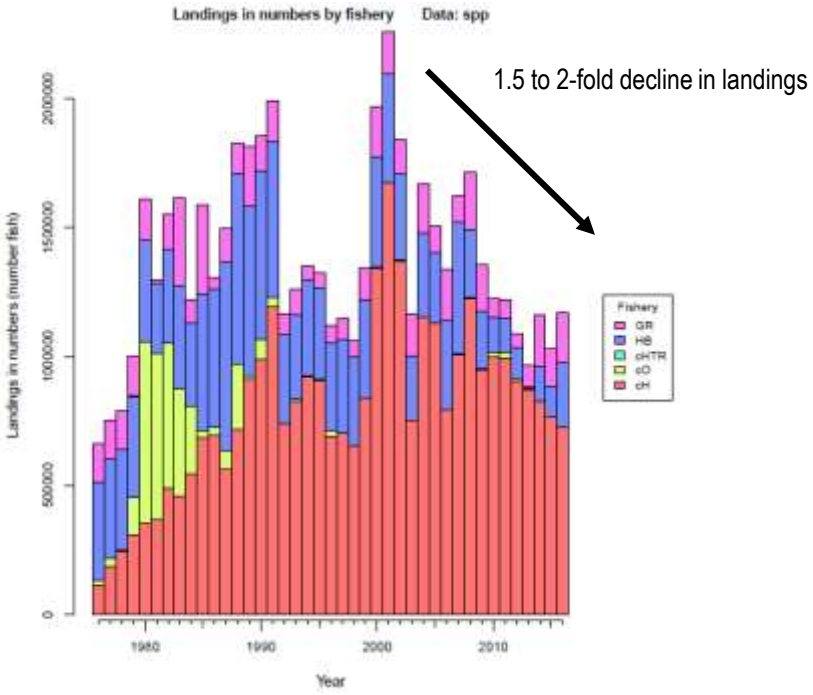
4X Upweight

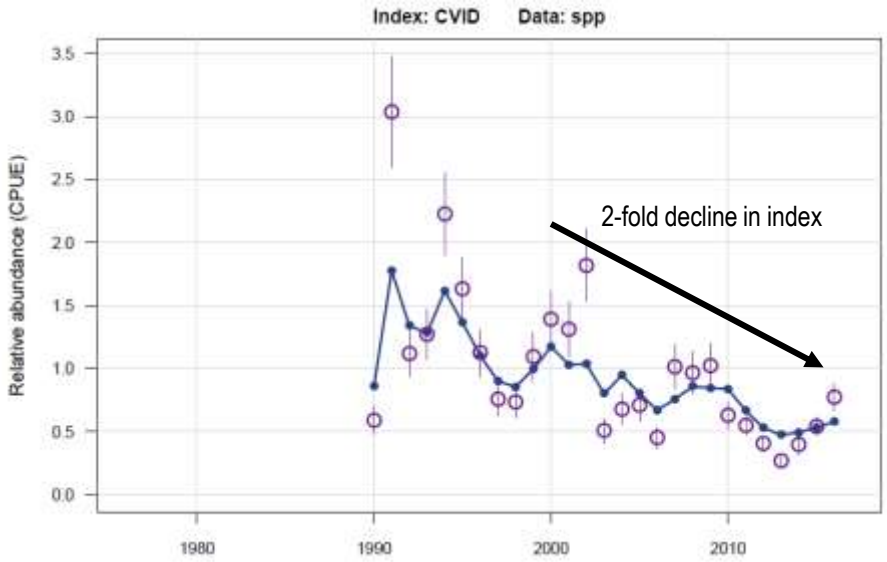


8X Upweight

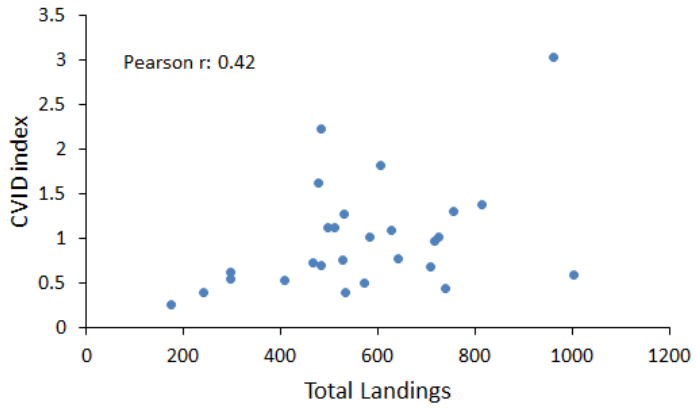


Landings and CVID index Correlated





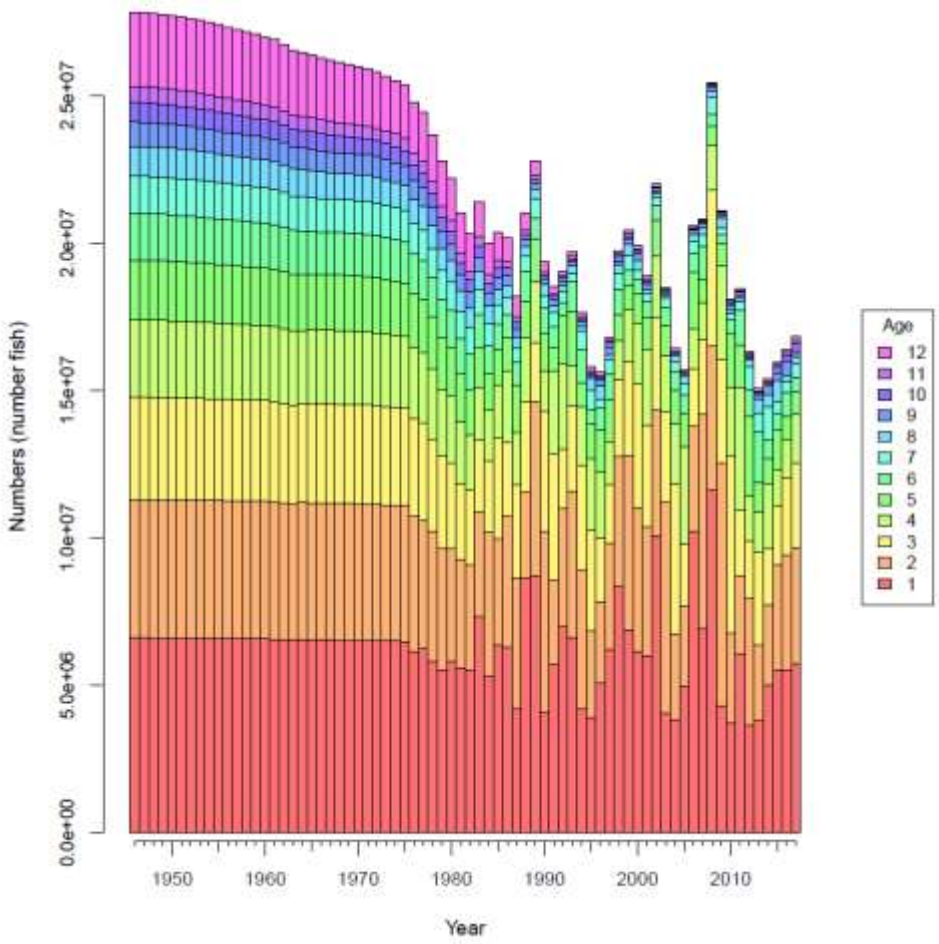
- Landings and CVID index both declining since early 2000s
- Model can only explain this by decreased recruitment
- Decreased recruitment is inconsistent with the age comps

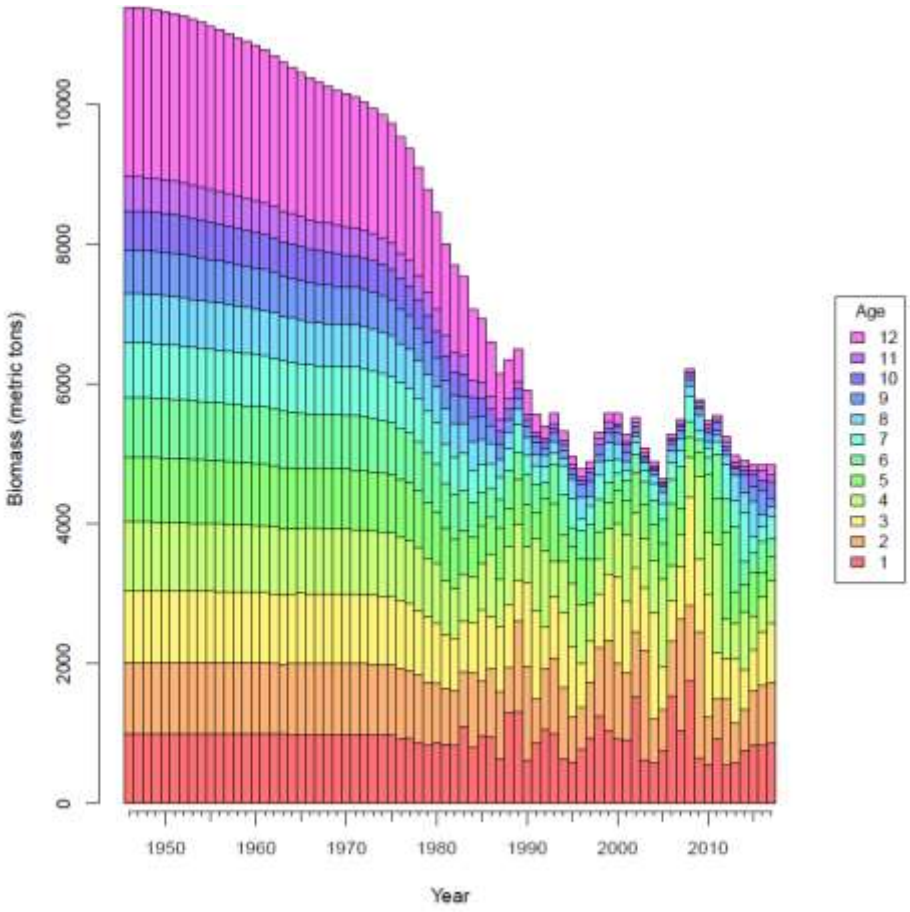


Upweighting CVID Index

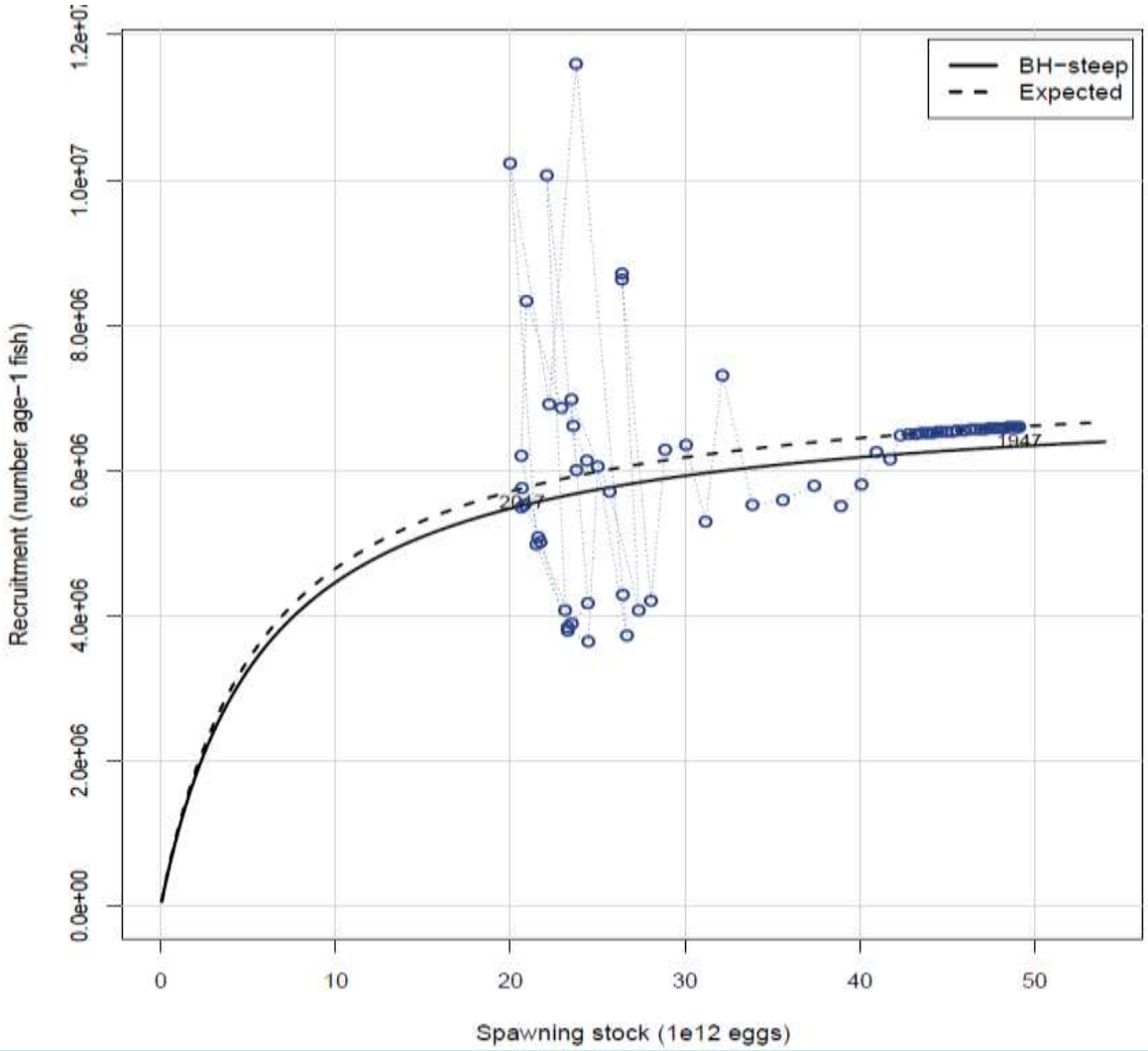
- Chevron trap (CVT) age compositions and cHL age compositions are consistent (show similar recruitment signals)
- CVID index positively correlated with landings (r=0.40) but not other index during period of overlap (r = -0.037 to 0.075)
- Assessment panel recommending retaining the CVID index but not upweighting, in effect giving greater weight to the age compositions

Numbers and Biomass At Age



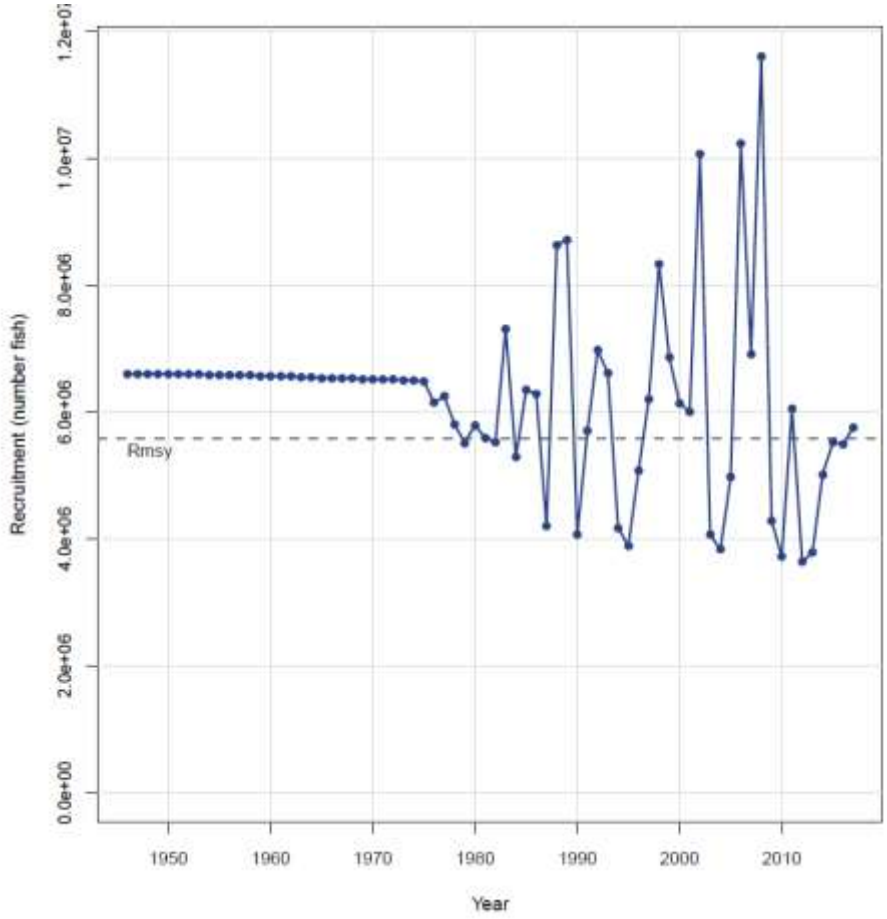


BAM base run – Spawner-recruit curve

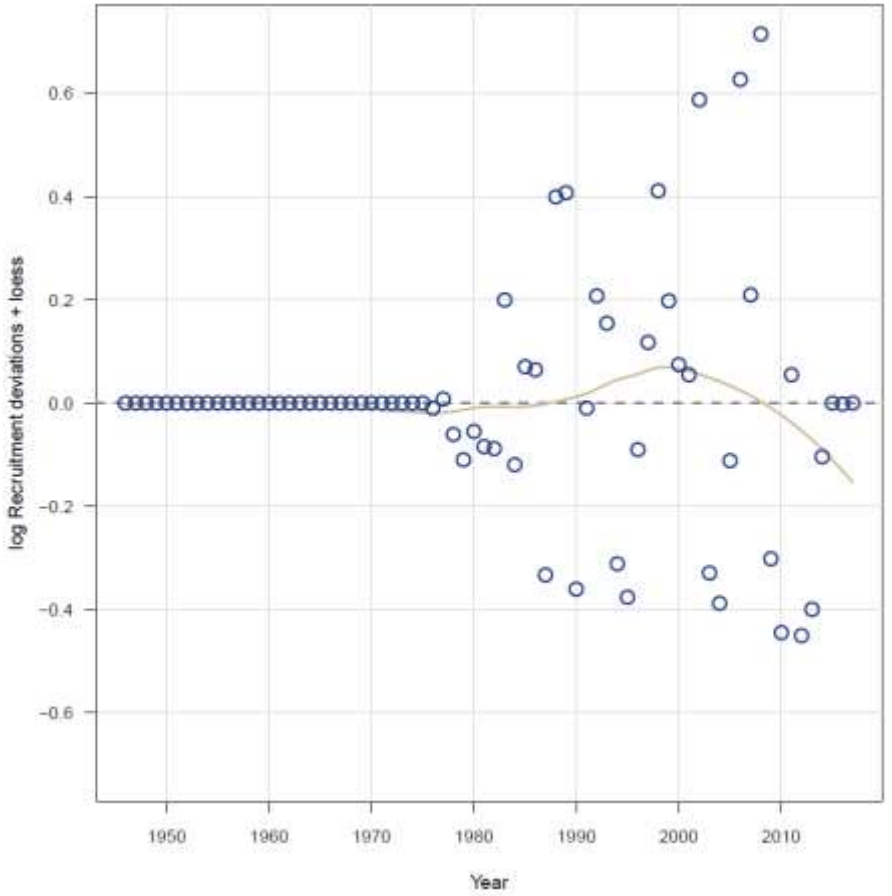


BAM base run – Recruitment

Recruitment

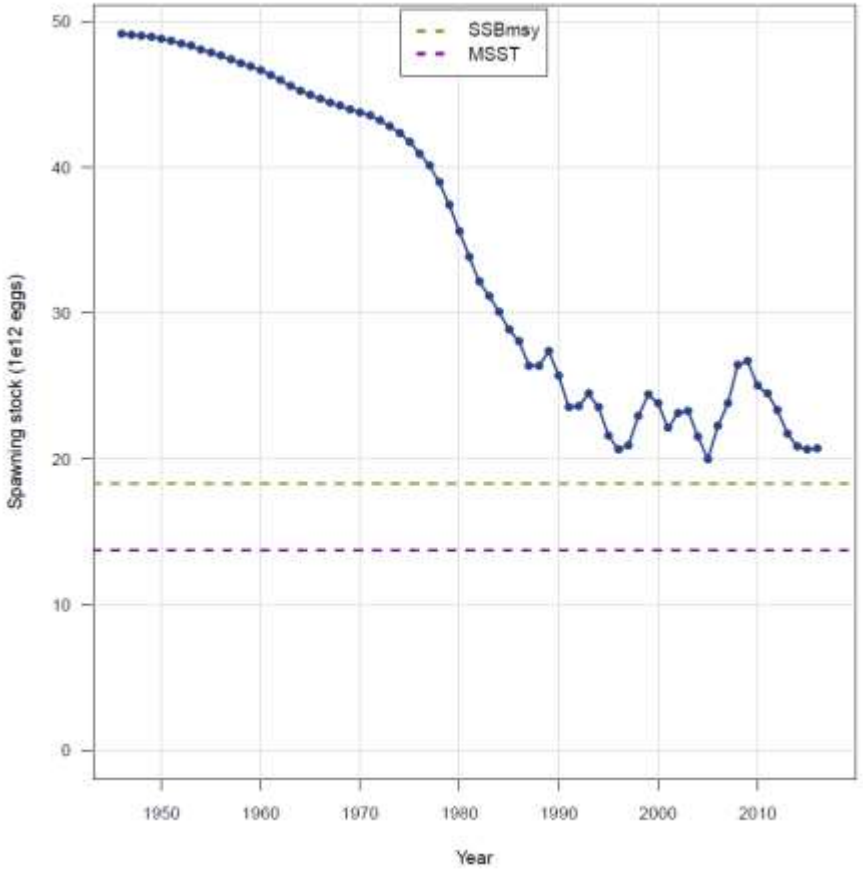


Recruitment deviations

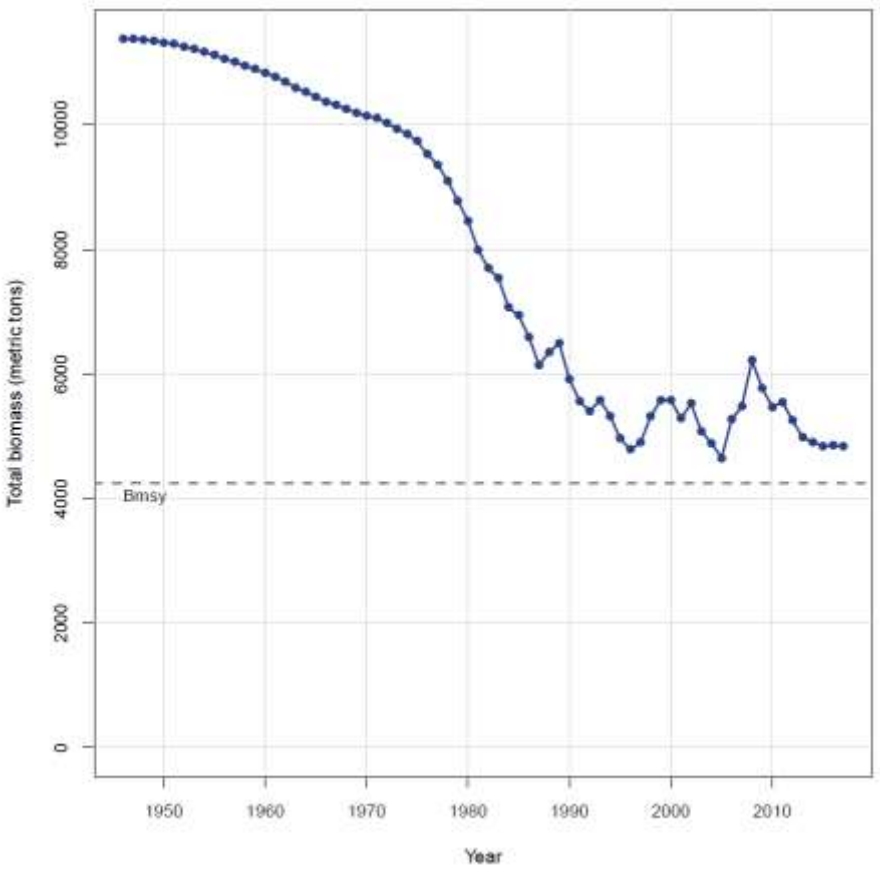


BAM base run – SSB

Spawning biomass

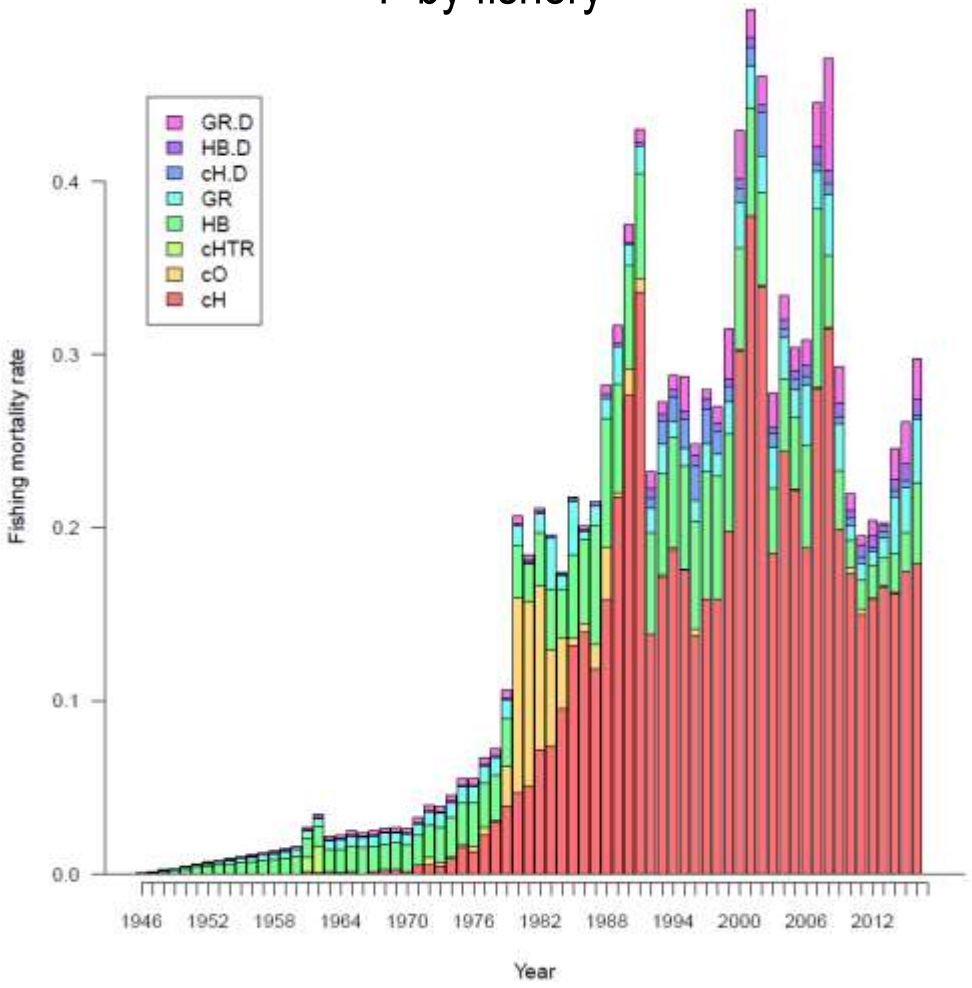


Total biomass

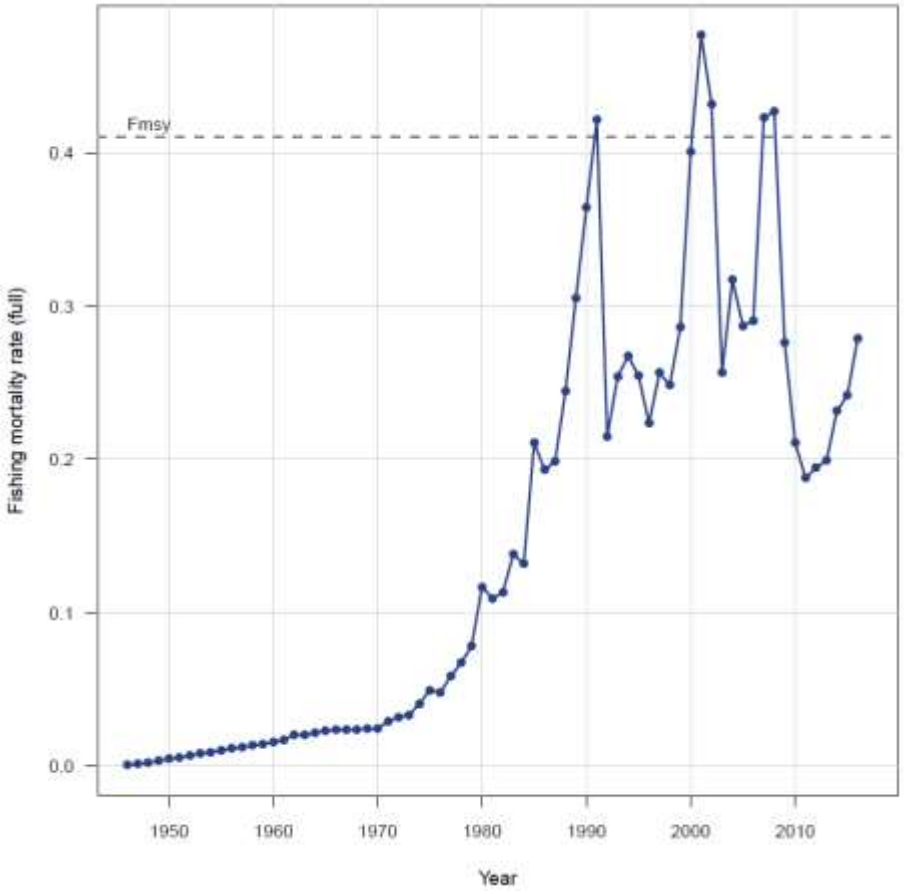


BAM base run – Fishing mortality

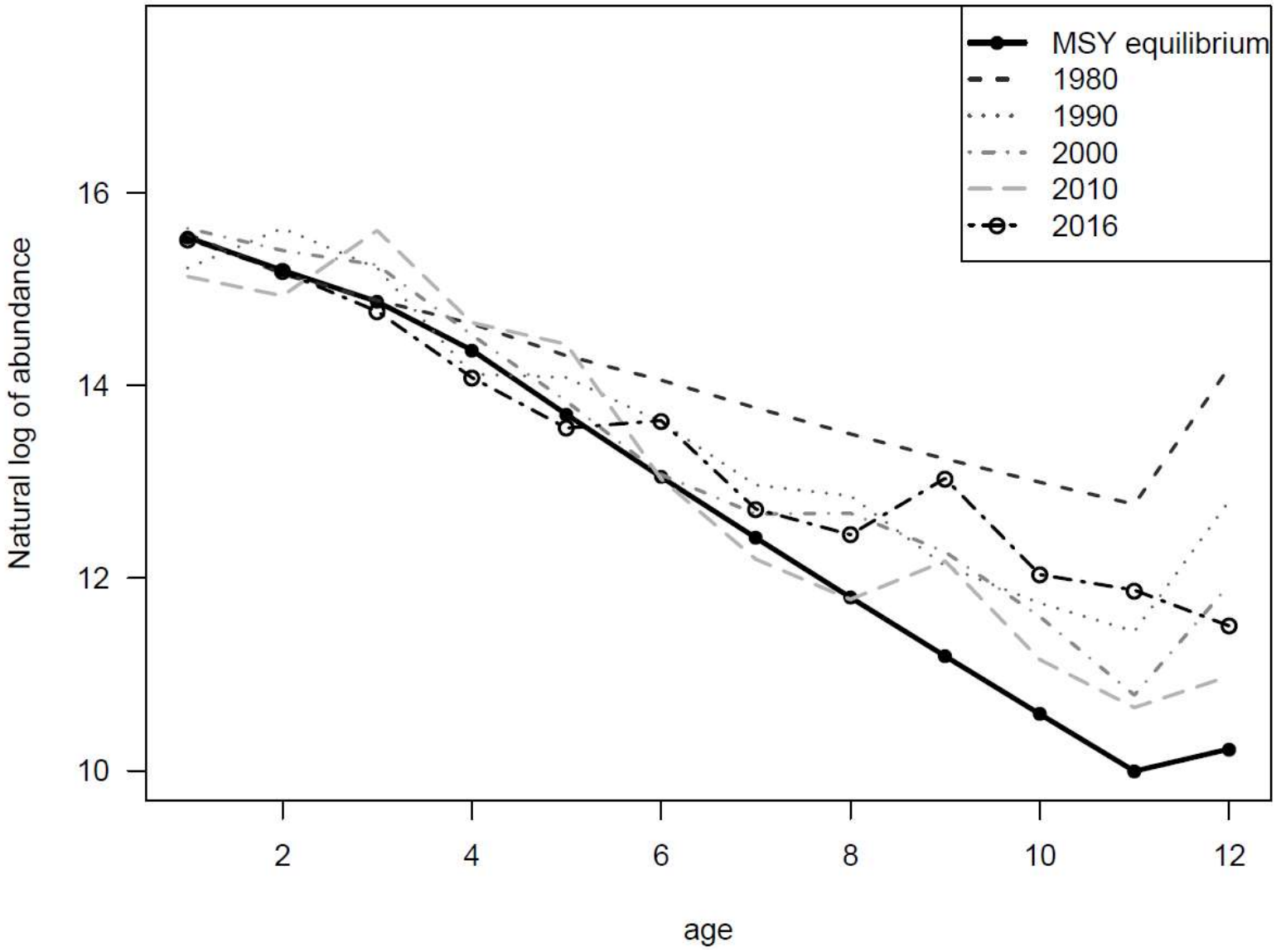
F by fishery



Full F



BAM base run – Fishing mortality



Outline

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

Sensitivity analyses

M and *h*

- S1: Low natural mortality ($M = 0.16$) used to scale the Lorenzen (1996) age-based estimator.
- S2: High natural mortality ($M = 0.28$) used to scale the Lorenzen (1996) age-based estimator.
- S3: Constant natural mortality ($M = 0.22$) based on Hoenig point estimate.
- S4: Natural mortality follows the Charnov et al. (2015) age-based estimator with no rescaling.
- S5: Steepness ($h = 0.84$) at the mode of Shertzer and Conn (2012).
- S6: Steepness ($h = 0.43$) at the lower bound of the range identified by likelihood profiling.
- S7: Steepness ($h = 0.99$) at the upper bound of the range identified by likelihood profiling.
- S8: Maturity, size dependent batch fecundity, and constant spawning frequency with age from SEDAR17.

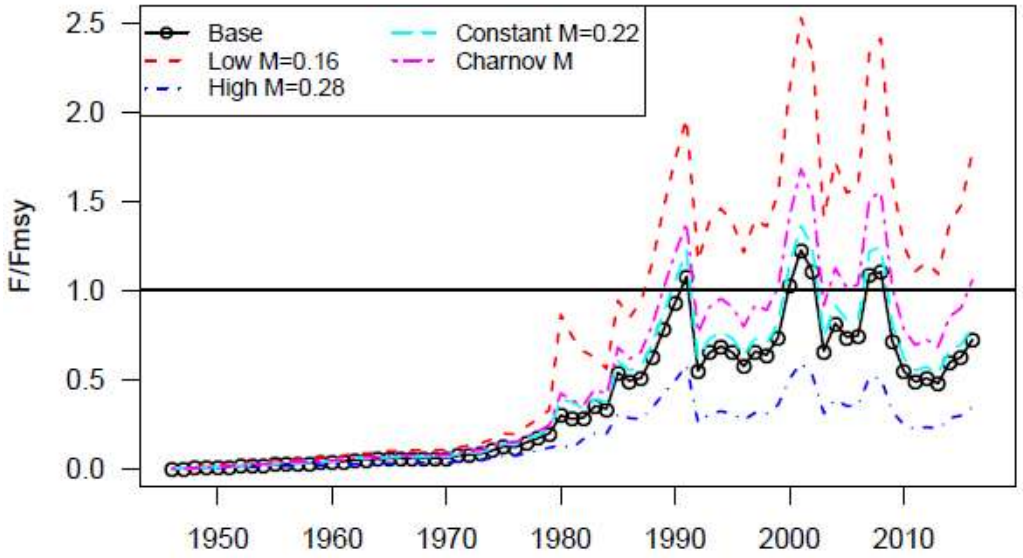
Historical rec

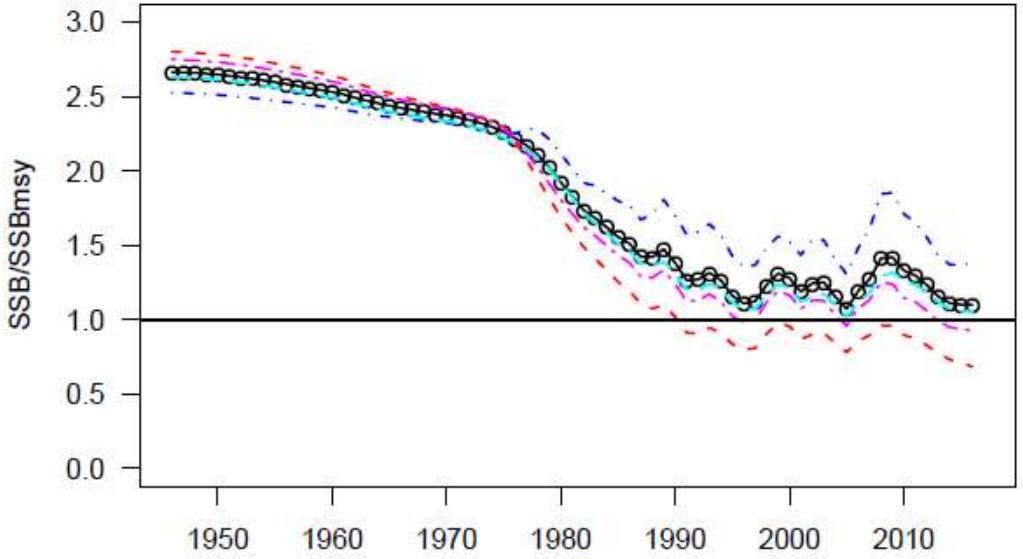
- S9: Saltwater Angler Survey (SWAS) method for estimating historical recreational removals.
- S10: 1.25 X FHWAR historical recreational removals.
- S11: 0.75 X FHWAR historical recreational removals.
- S12: Include length composition data.

Indices

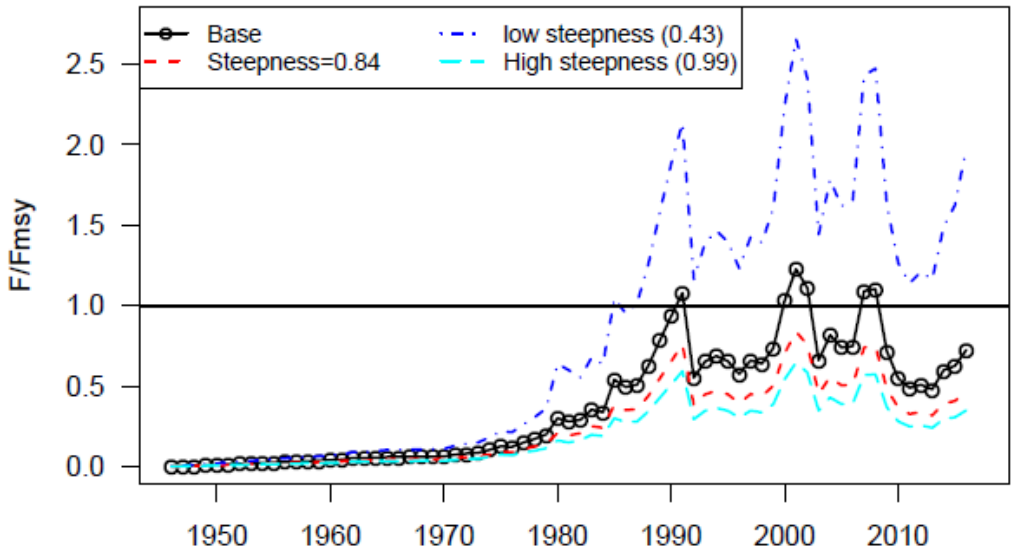
- S13: SERFS chevron trap index only (no video).
- S14: SERFS video index only (no trap).
- S15: SERFS trap and video index combined based on Gwinn method (SEDAR55-WP07 2017).
- S16: Upweight combined SERFS trap/video index 2X.
- S17: Upweight combined SERFS trap/video index 4X.
- S18: Upweight combined SERFS trap/video index 8X.
- S19: Remove 1990 (low) value from combined SERFS trap/video index.
- S20: Remove 1990 (low) and 1991 (high) values from combined SERFS trap/video index.
- S21: Block SERFS trap/video index catchability around expansion of the survey (1990-2010, 2011-2016).
- S22: Constant catchability on fishery dependent indices.
- S23: Linearly increasing catchability (2% per year) on fishery dependent indices.
- S24: Multinomial likelihood for composition data.
- S25: No ageing error matrix.
- S26: Continuity configuration, including the multinomial likelihood for composition data, inclusion of length compositions, linear increasing catchability on fishery dependent indices, only SERFS trap index (no video), limited SERFS age compositions (2002-2016), steepness fixed at $h = 0.71$, and reproductive inputs (maturity, batch fecundity, spawning frequency) from SEDAR17.

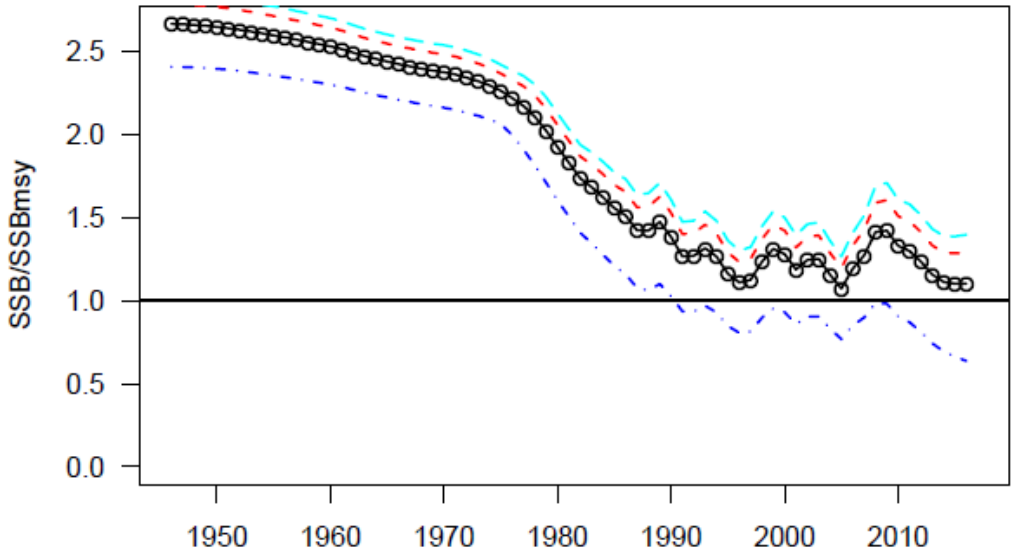
Natural mortality



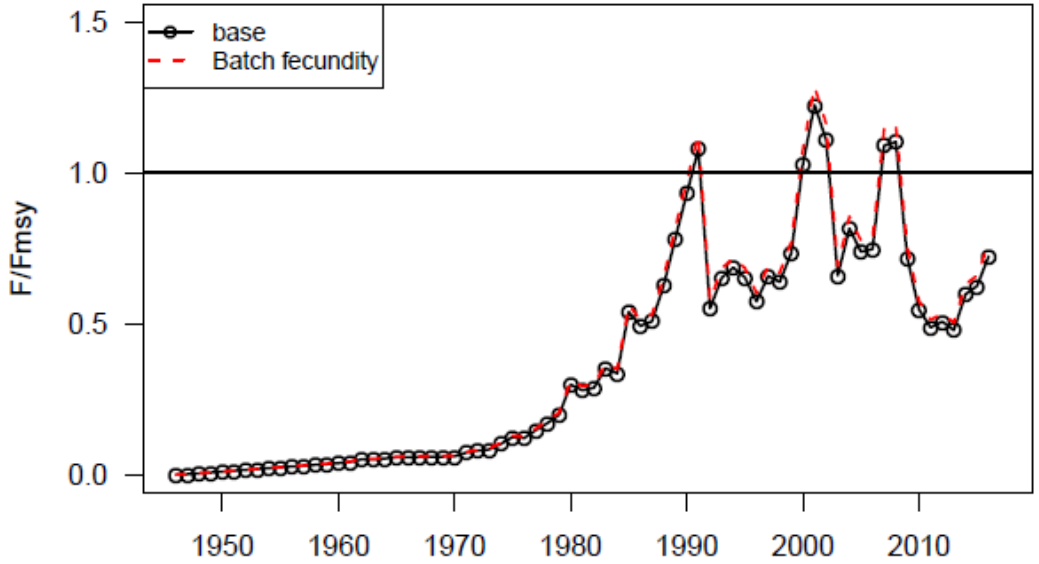


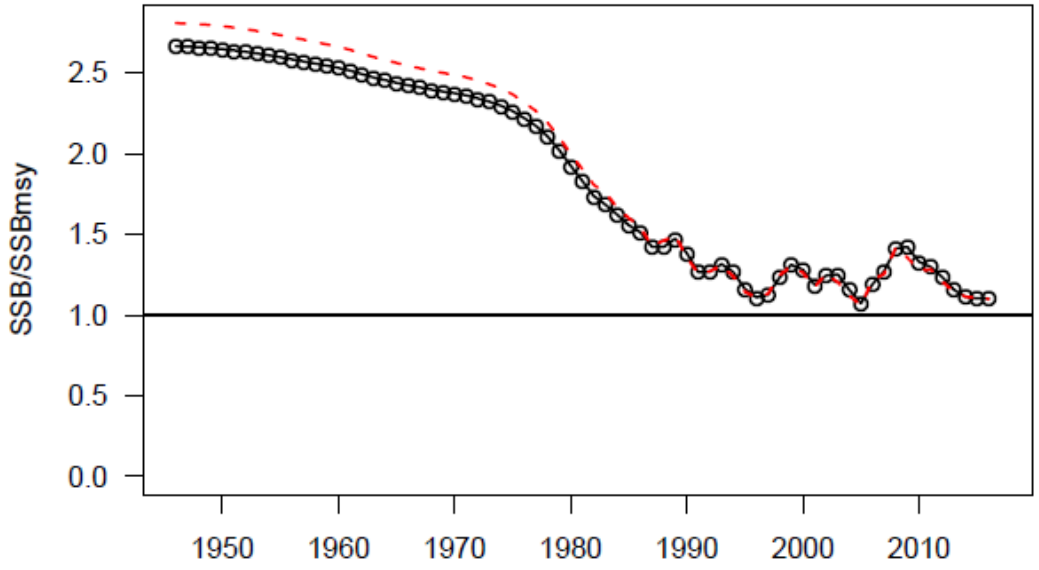
Steepness


Base
Steepness=0.84
low steepness (0.43)
High steepness (0.99)
F/Fmsy
2.5
2.0
1.5
1.0
0.5
0.0
1950
1960
1970
1980
1990
2000
2010

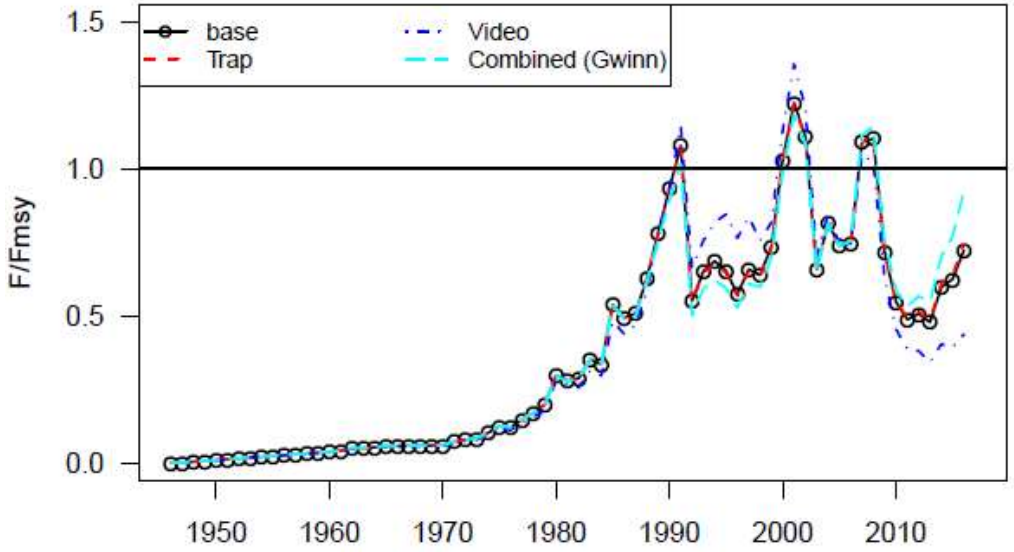

SSB/SSBmsy
2.5
2.0
1.5
1.0
0.5
0.0
1950
1960
1970
1980
1990
2000
2010

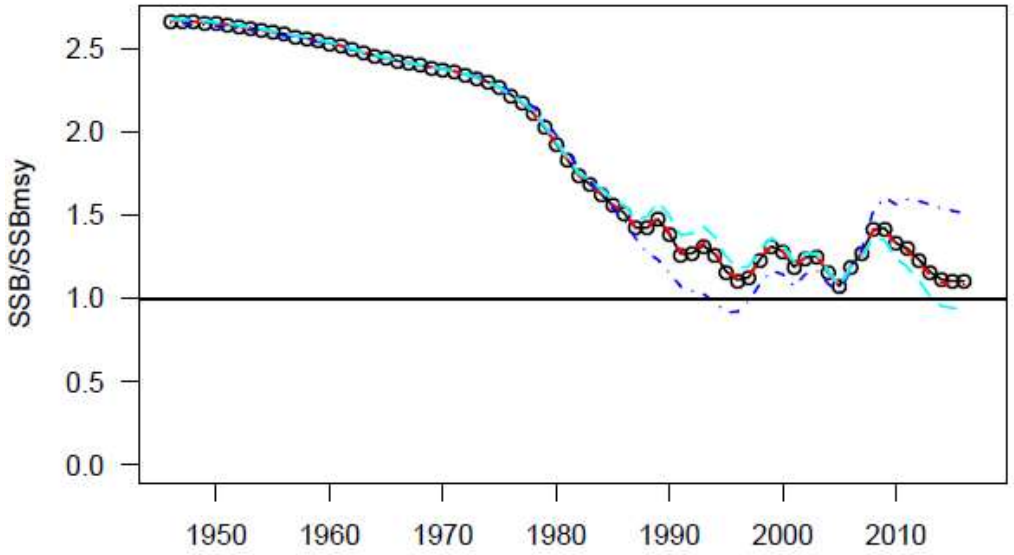
Reproduction



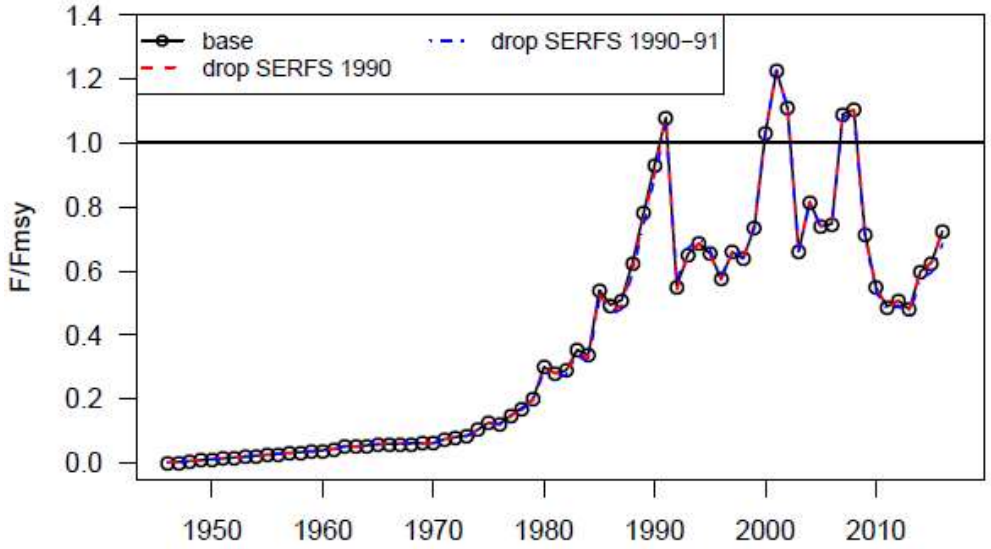


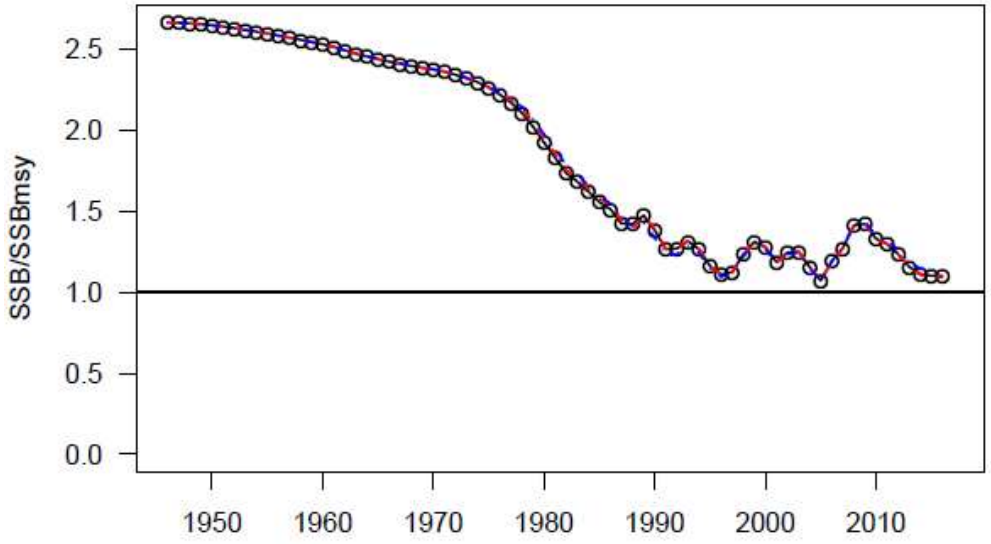
Fishery Independent Indices



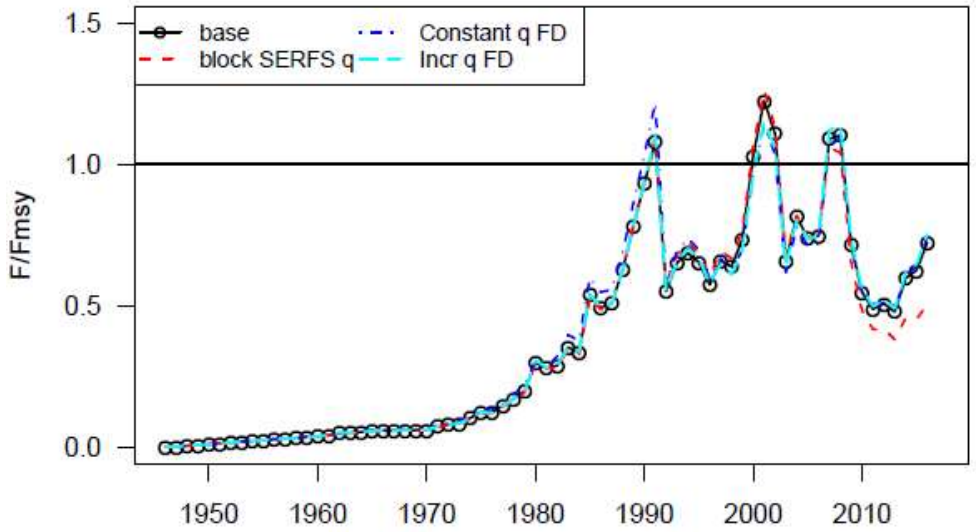


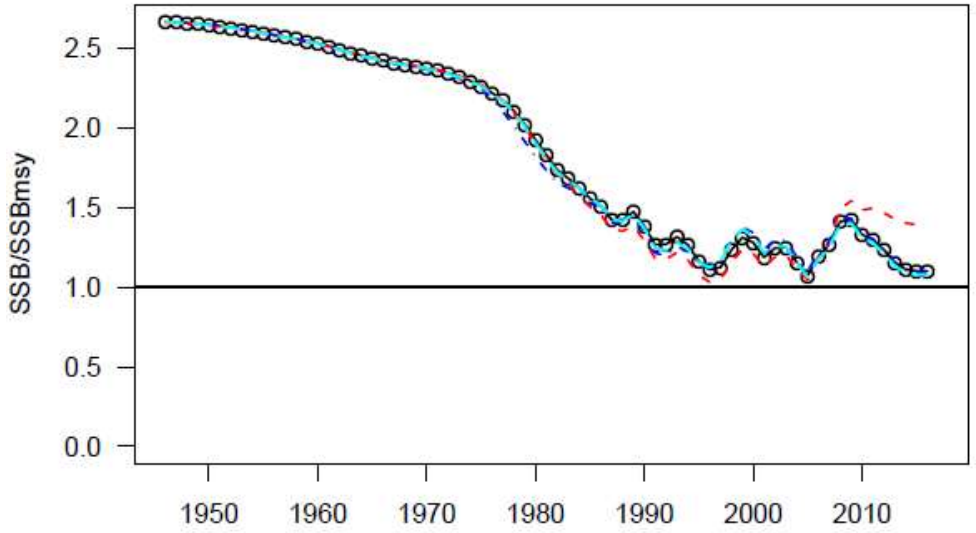
Initial SERFS Index Values



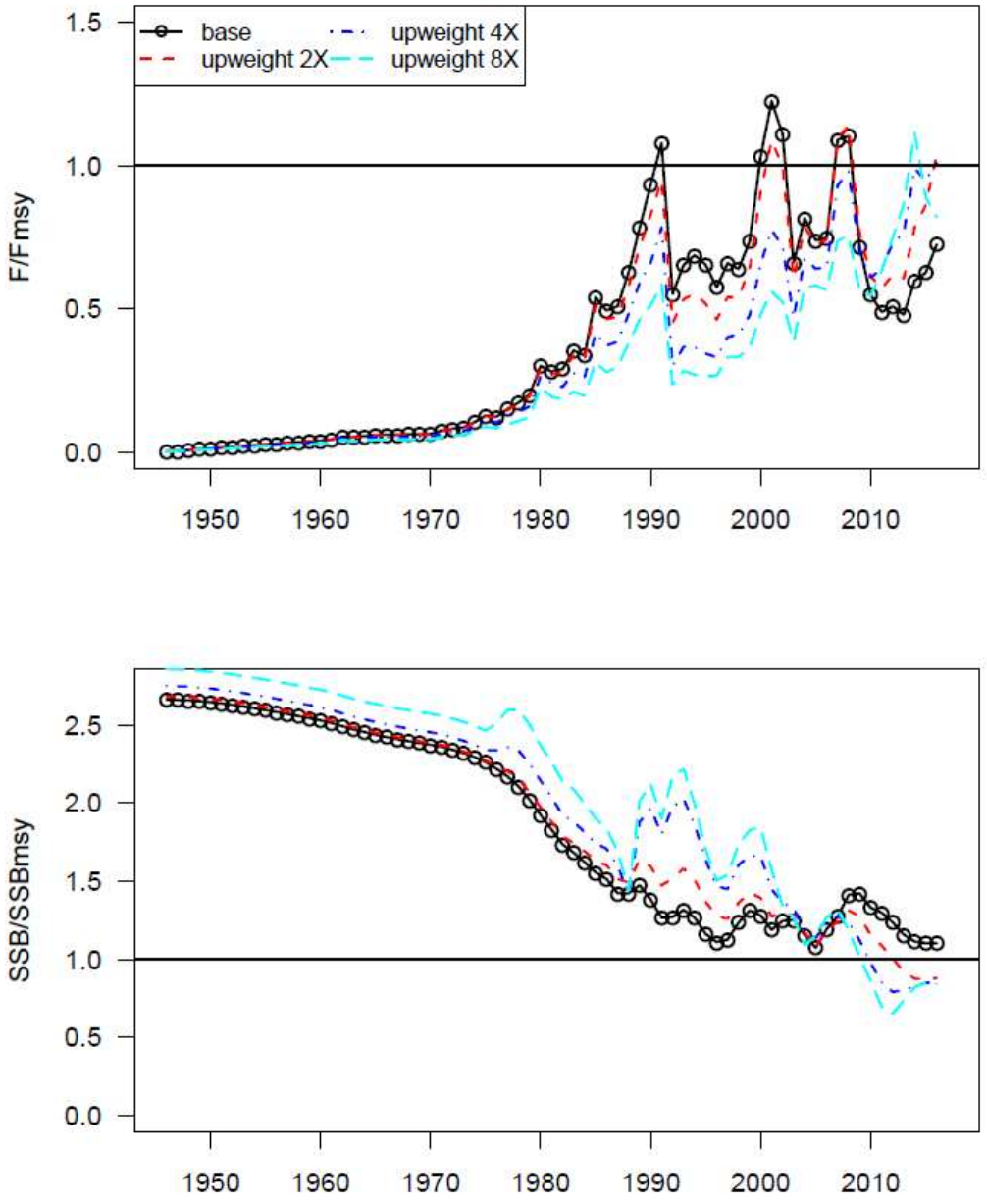


Index Catchability (q)



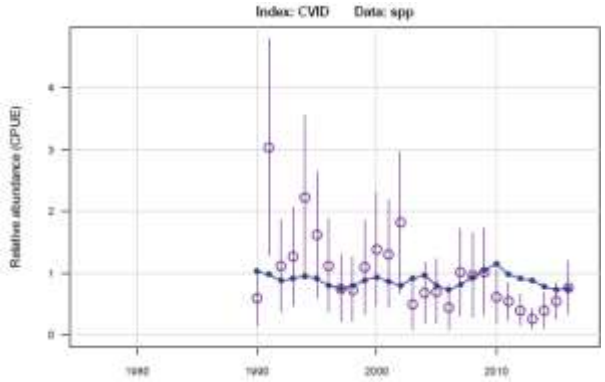


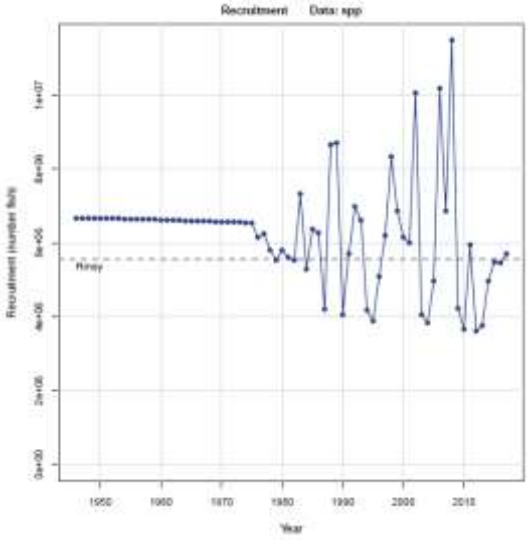
Upweighting CVID index



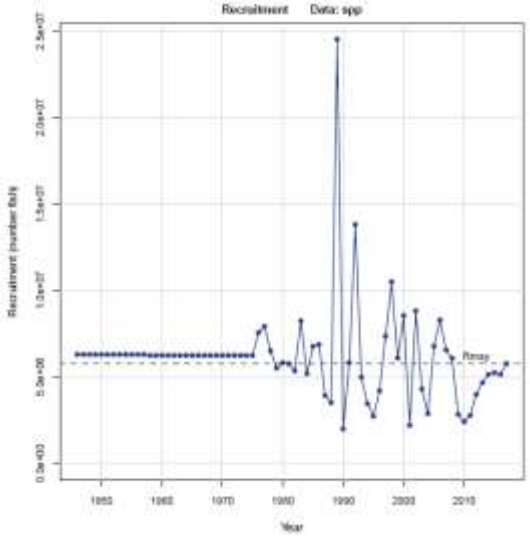
Upweighting CVID index

No up-weighting

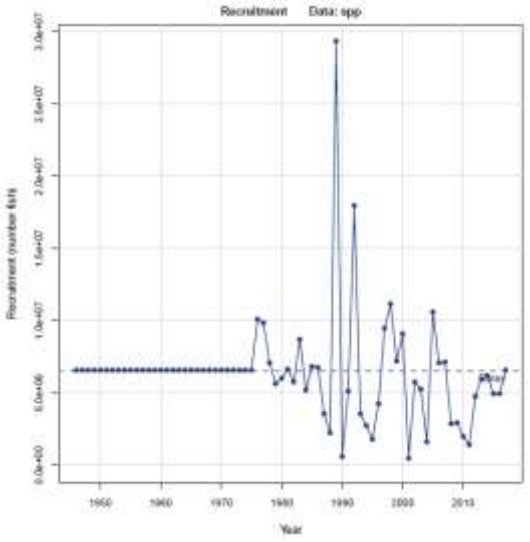




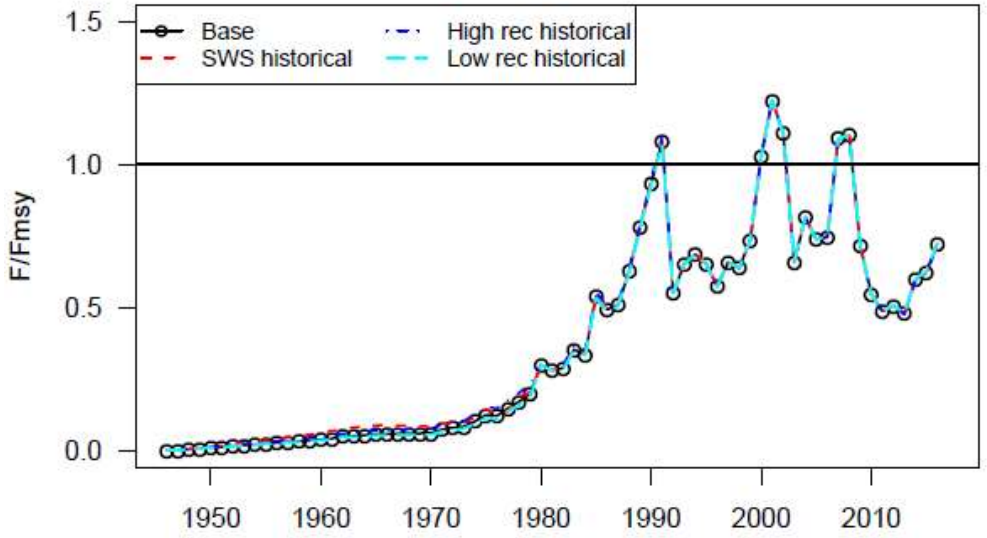
4X Upweight

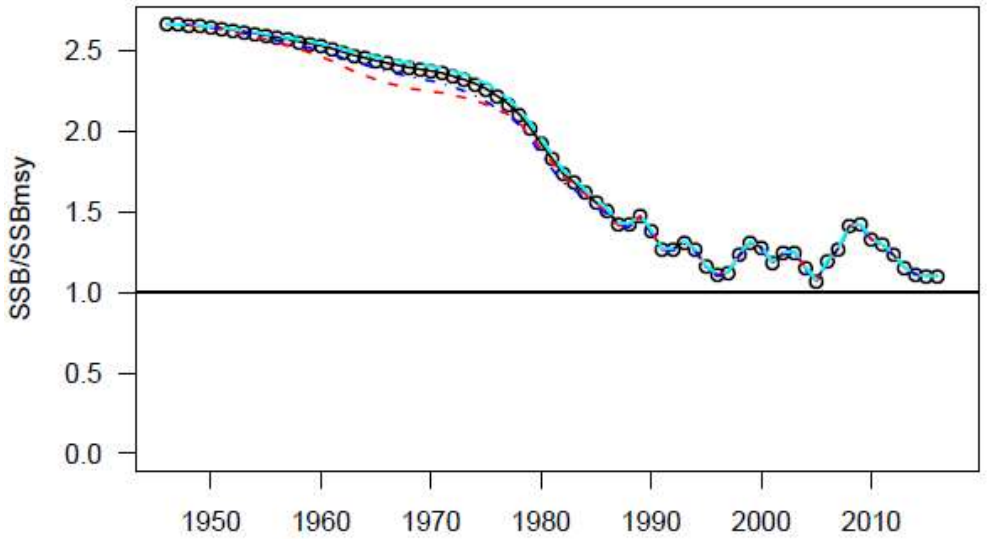


8X Upweight

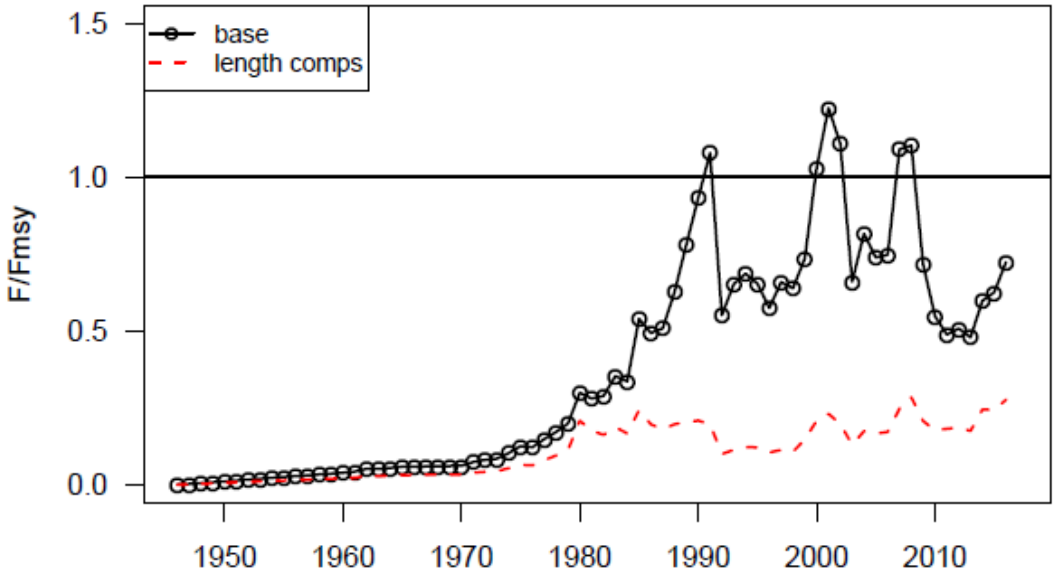


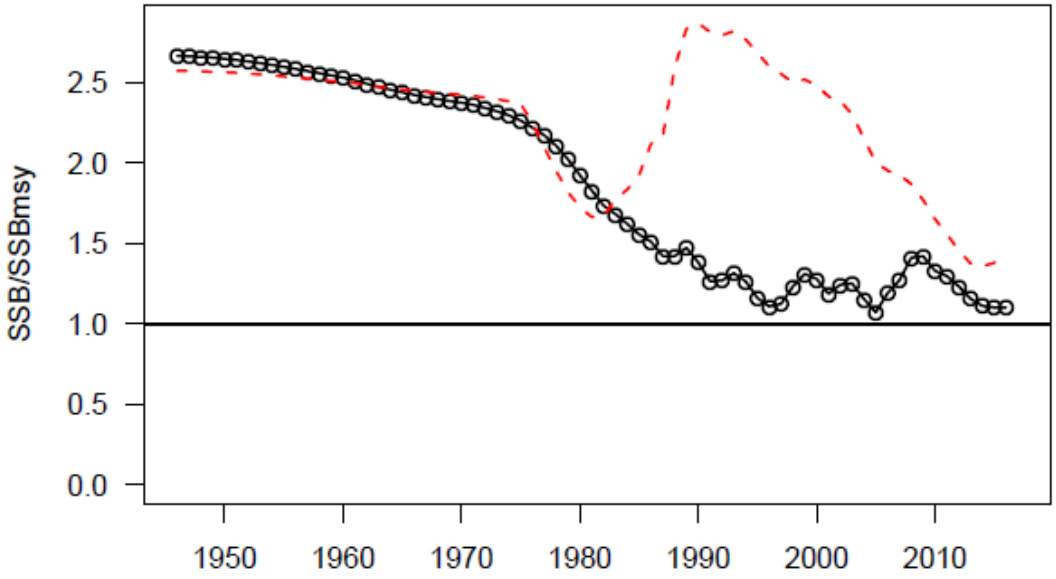
Historical Recreational Removals



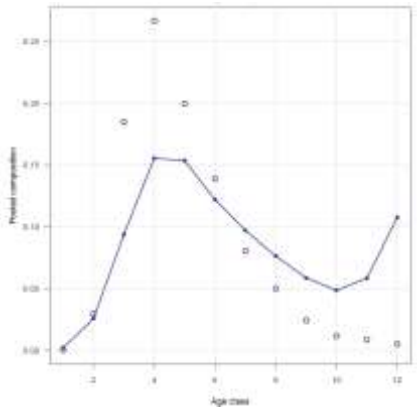


Length Compositions

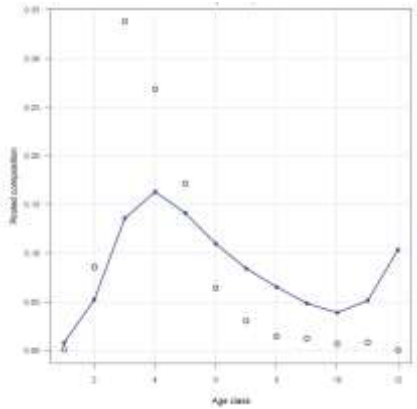




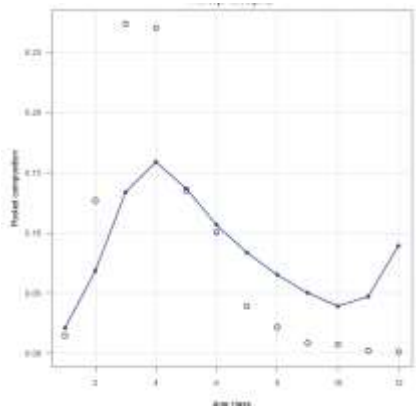
Include Length Compositions



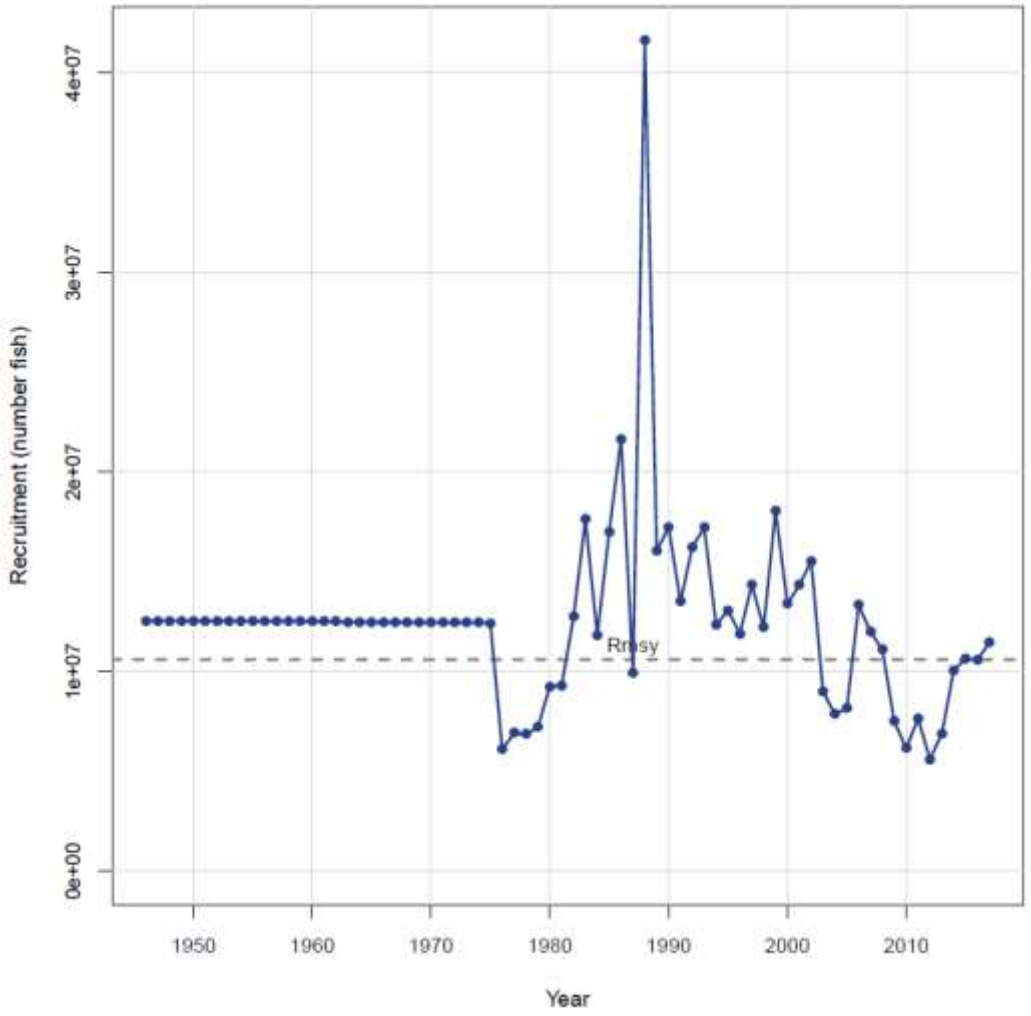
Handline



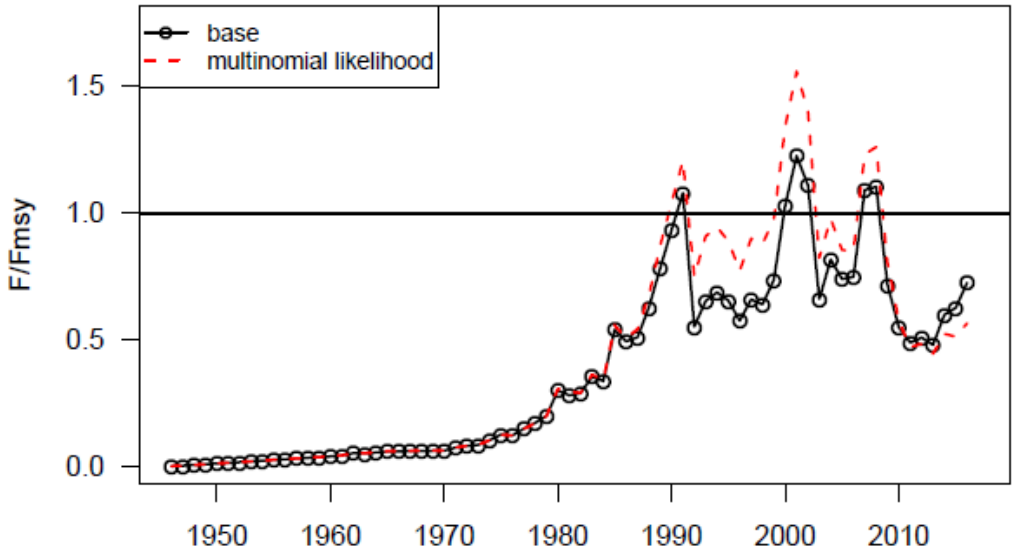
Headboat

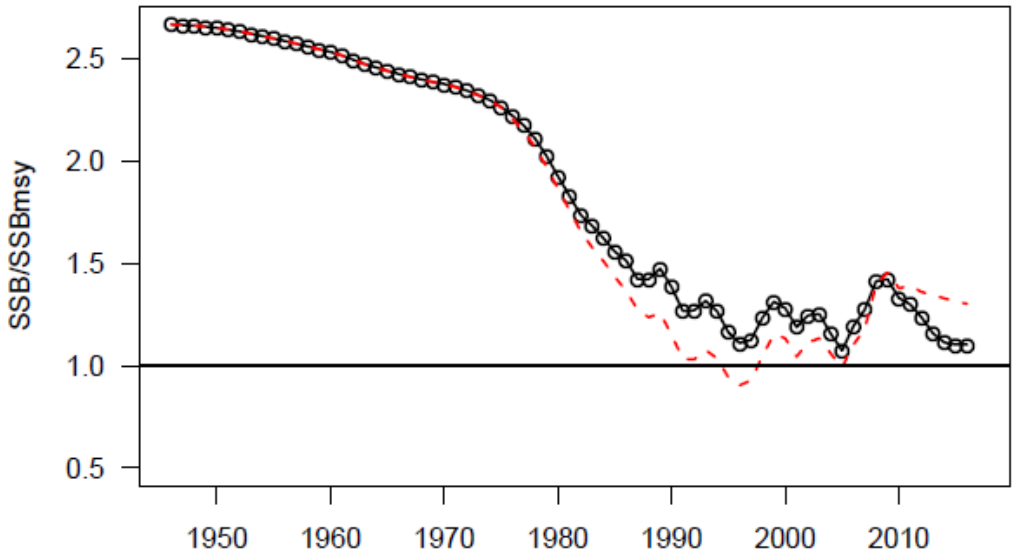


General Rec

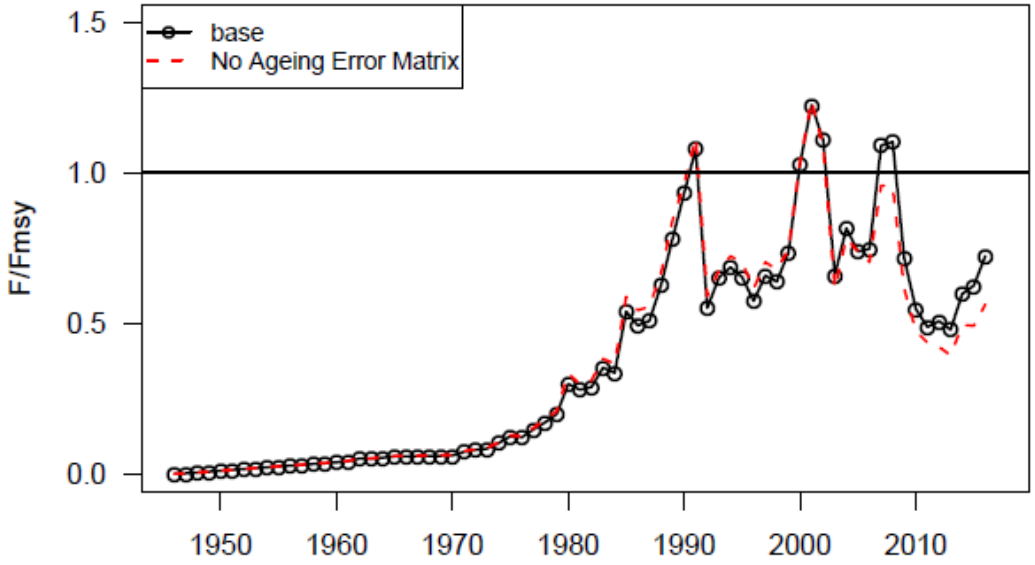


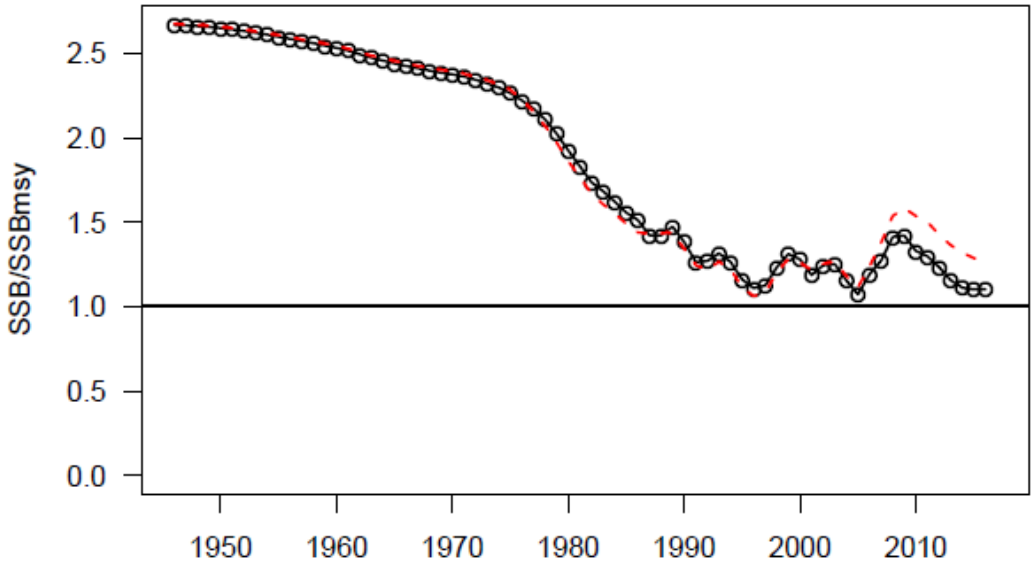
Multinomial Likelihood





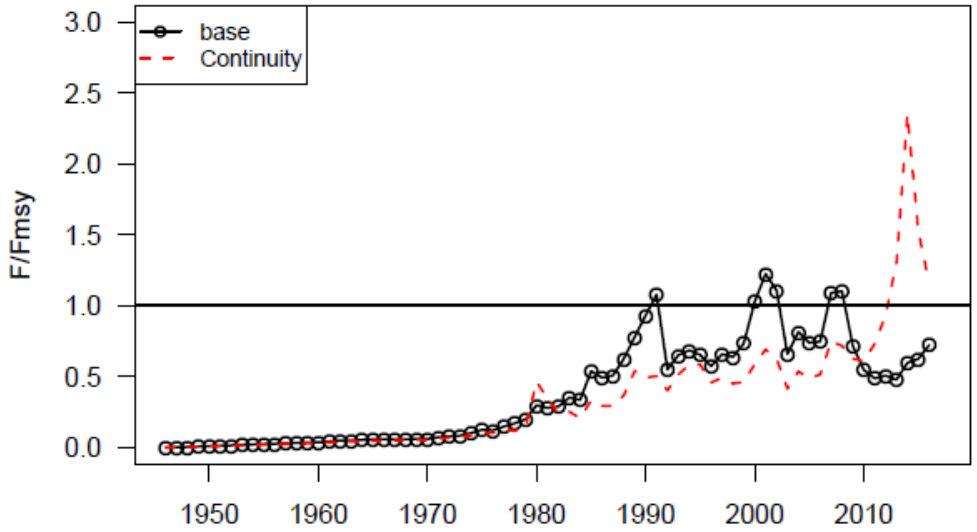
Ageing Error

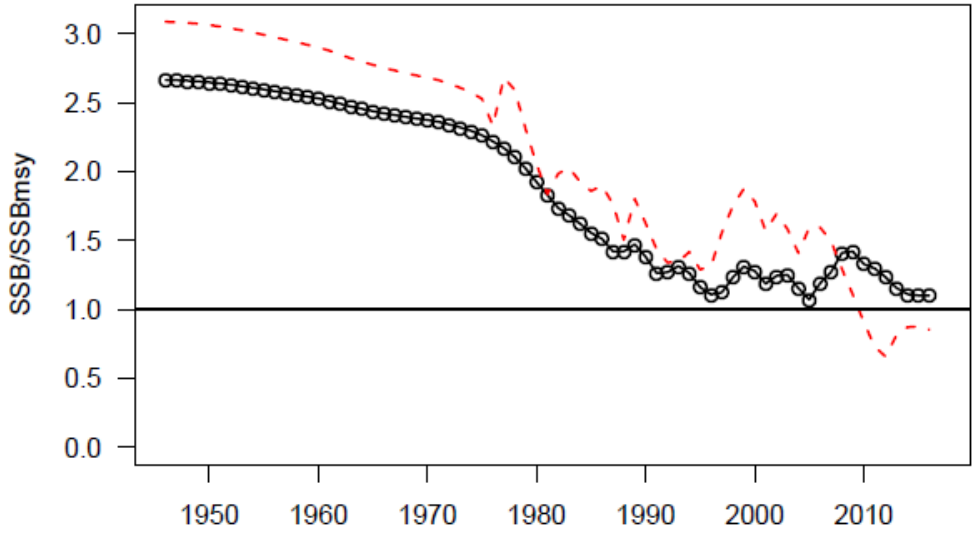




Continuity

-Multinomial likelihood
-Linear increasing q on FD indices
-SERFS trap index only
-Limited SERFS age comps (2002-2016)
-Include length comps
-Steepness fixed at h = 0.71
-Reproductive inputs from 2012 update
-SWAS method for historic recreational removals





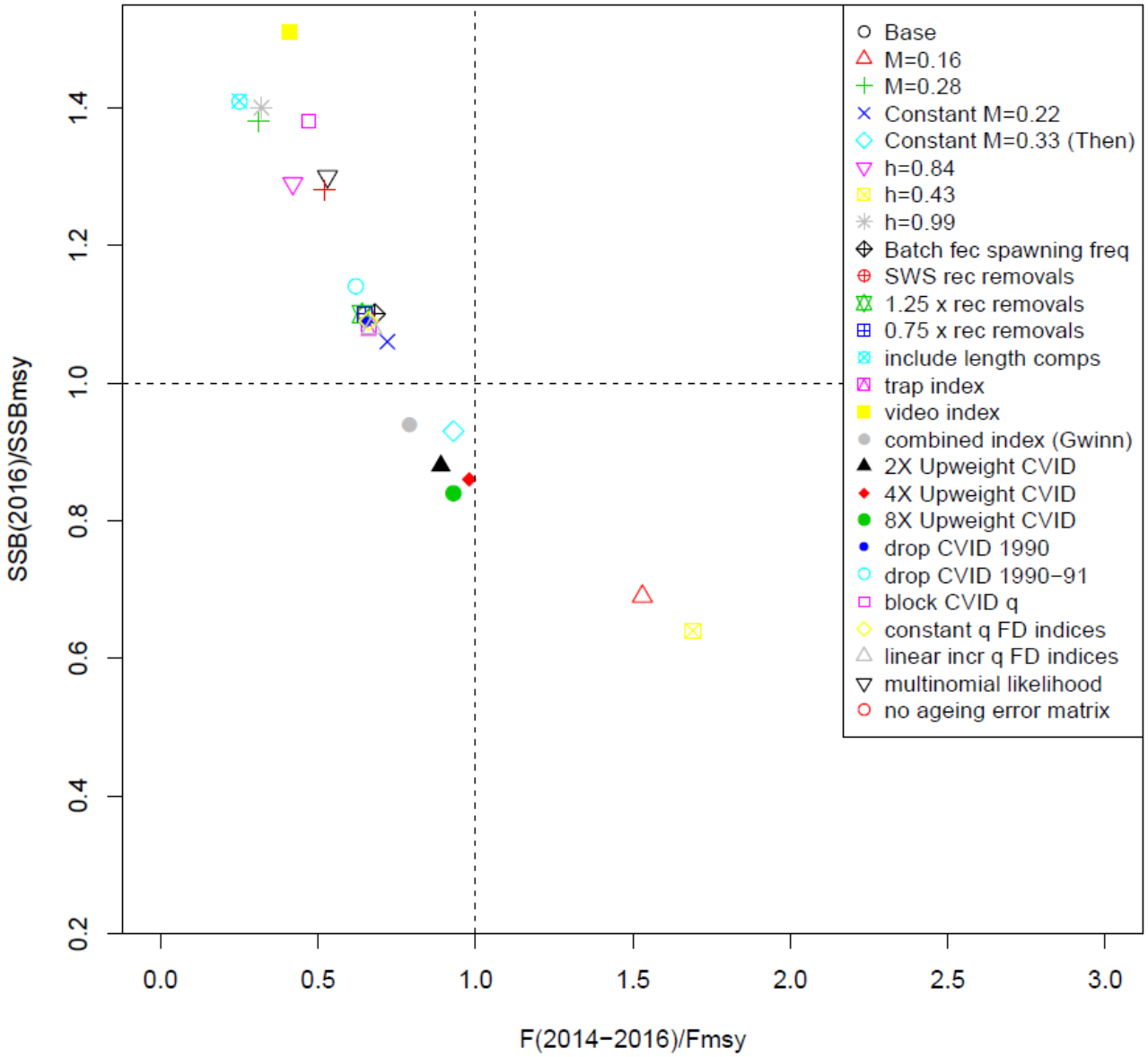
Phase plot

Altered fishing status:

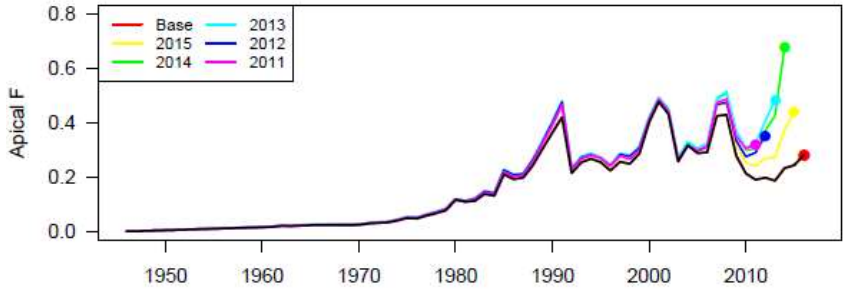
- Low M
- Low h alter fishing status

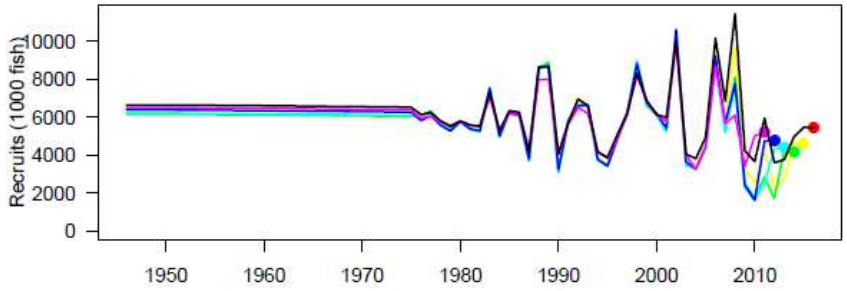
Altered biomass (SSBmsy):

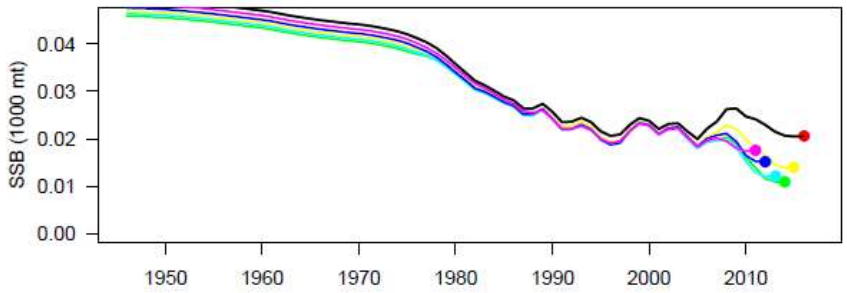
- Upweight CVID
- Gwinn method
- Alternative M
- Not based on MSST (overfished definition)

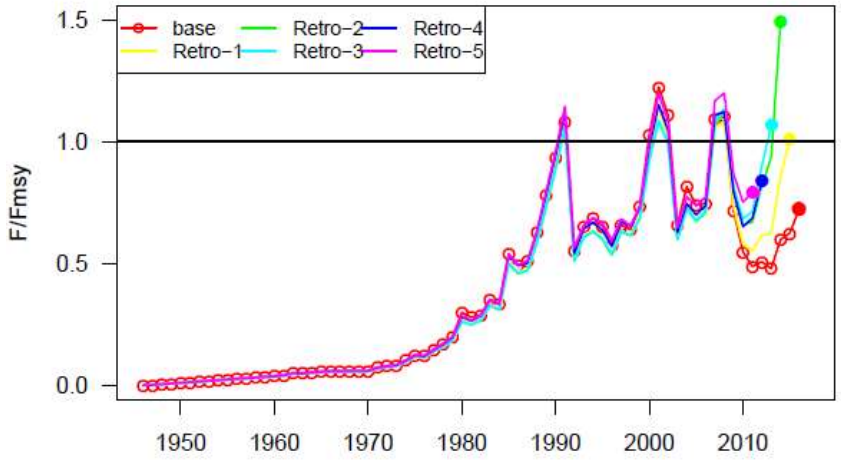


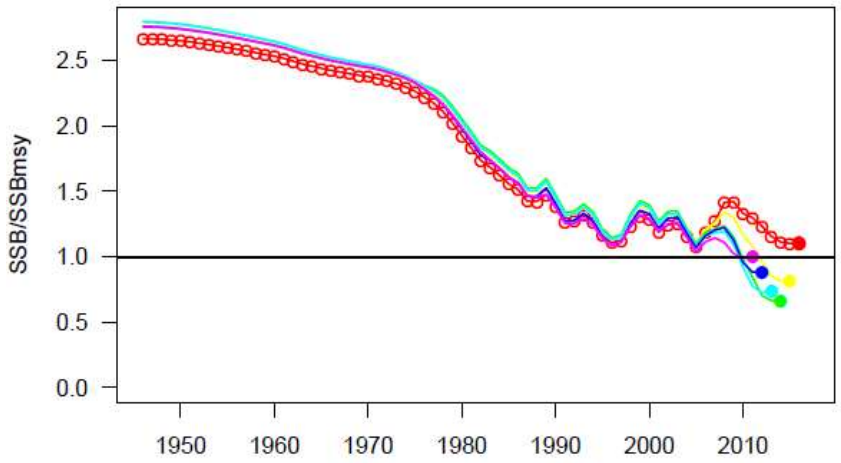
Retrospective analyses











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Uncertainty—Combined Monte Carlo Bootstrap (MCB)

N = 3800 MCB trials; N = 3462 retained (91.1%)

Bootstrap component:

- New time series of landings, discards, and indices
  - parametric bootstrap of original data
  - CVs as applied in the fitting procedure (0.05 for landings & discards; standardization for indices)

- Length and age comps
  - resample N_{fish} and assigned to bins with probabilities equal to those from original data

Uncertainty—Combined Monte Carlo Bootstrap (MCB)

Monte Carlo component:

1. Natural Mortality (M):
   - Truncated normal distribution with mean = 0.22 and range =0.16-0.28
   - Each realized value of M was used to scale the age-specific Lorenzen M (as in the base run)

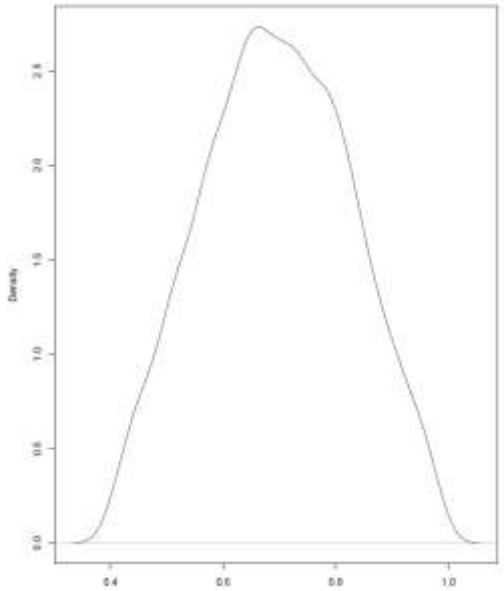
2. Discard Mortality:
   - Truncated normal distribution
   - Commercial handline: mean = 0.41 (range= 0.24-0.53); stdev set so that 95% CI = 053
   - Headboat and General Recreational: mean = 0.38 (range=0.2-0.5); stdev set so that 95% CI = 0.5

3. Steepness
   - truncated normal distribution
   - mean = 0.69 (range=0.43-0.99); stdev set so that 95% CI = 0.99

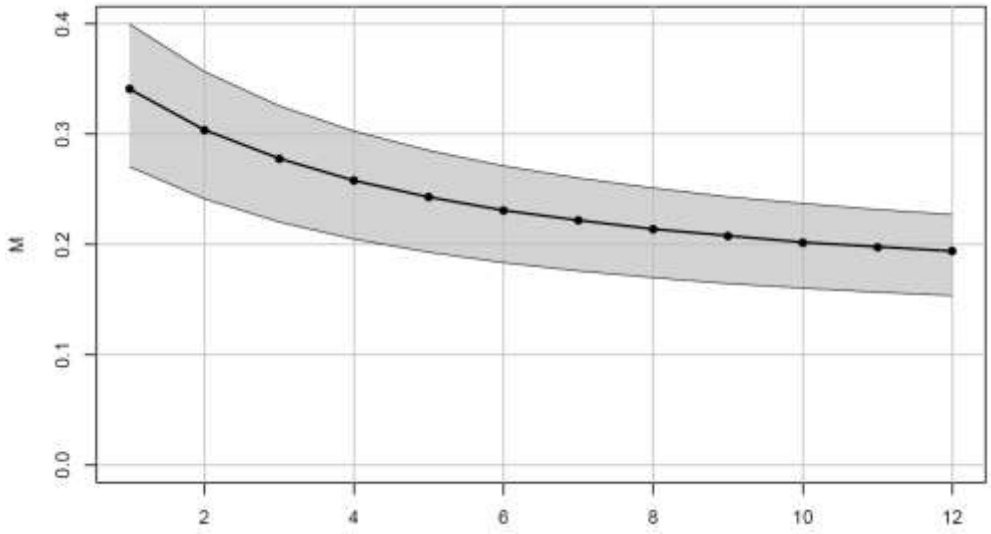
4. Historical recreational landings
   - Uniform distribution +- 25% of baseline values from FHWAR method

Uncertainty—Distns for Monte Carlo parameters

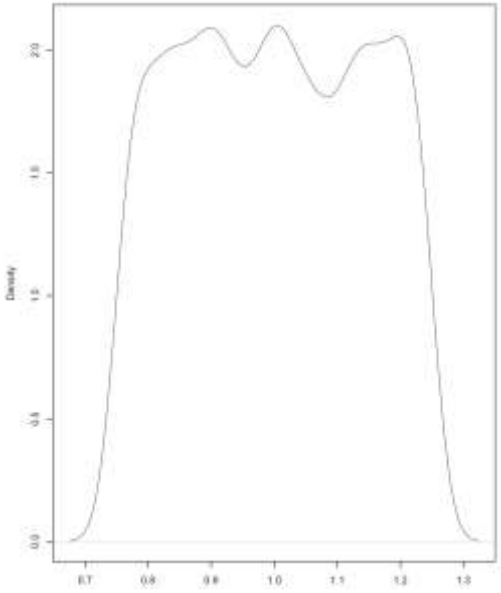
Steepness



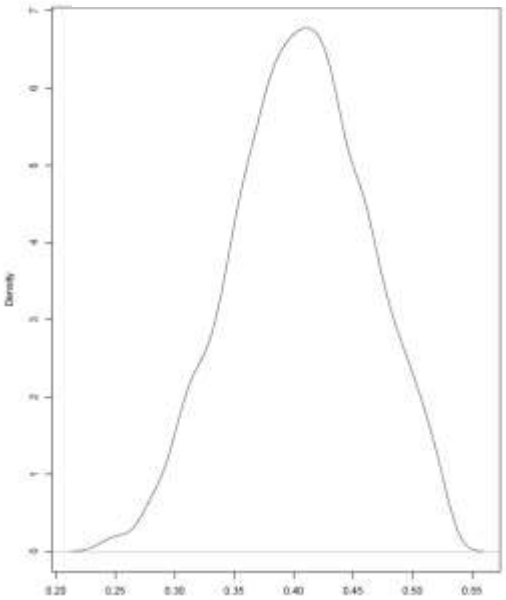
Natural Mortality



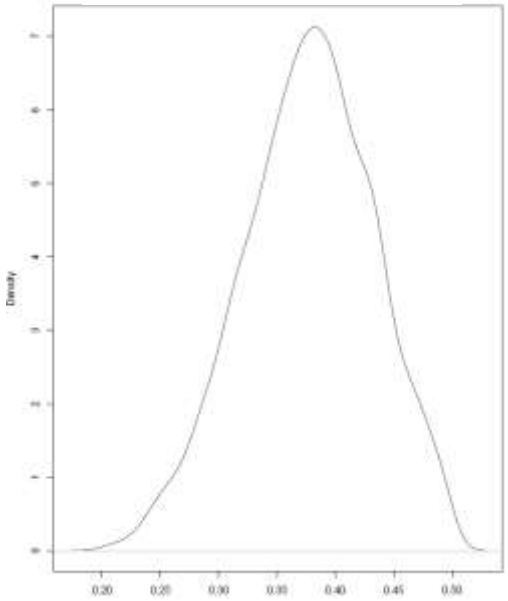
Historical Rec Removals (scalar)



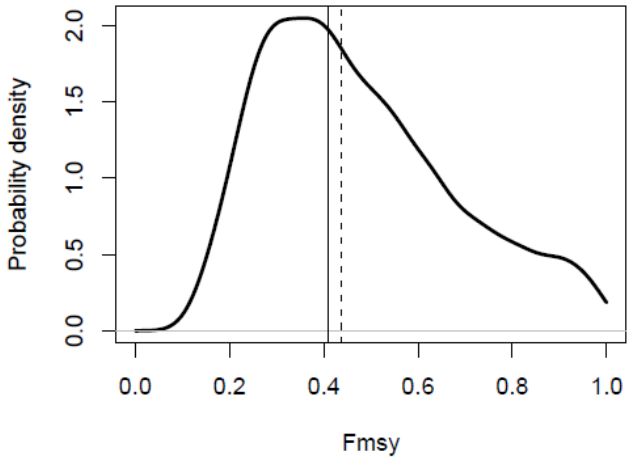
Comm Discard Mortality

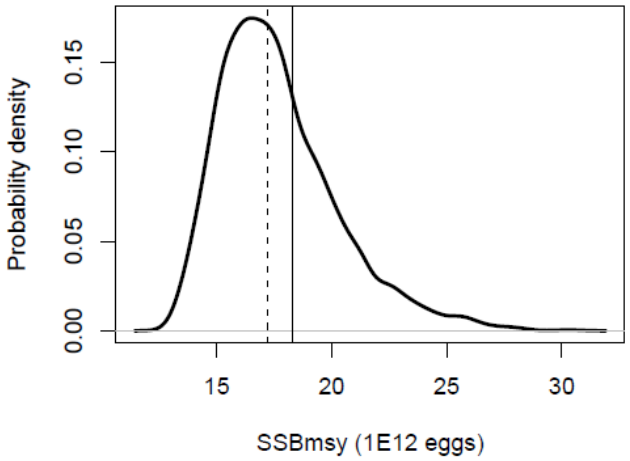


Rec Discard Mortality

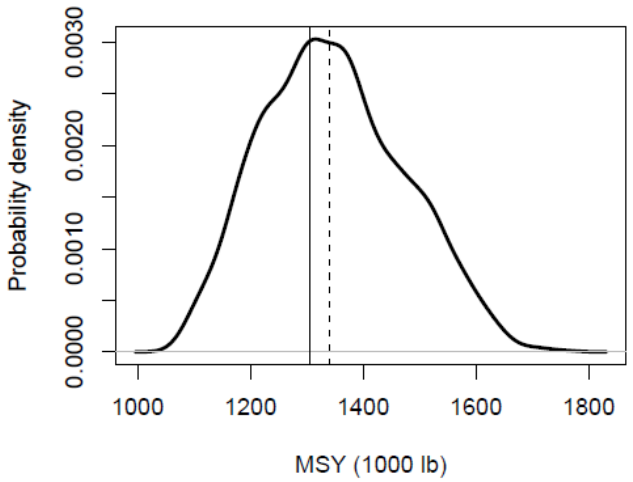


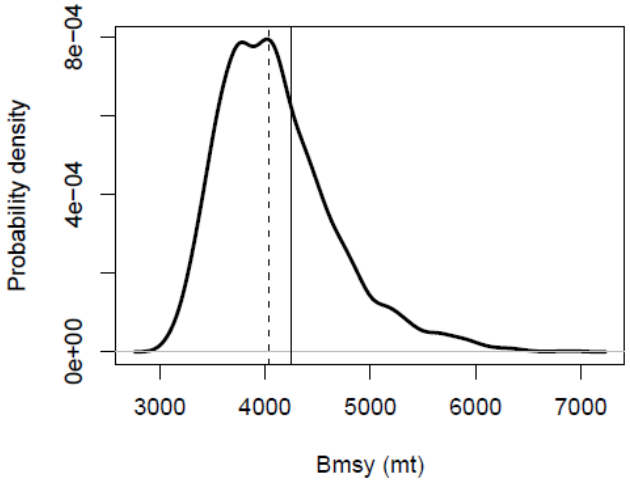
MCB – uncertainty in benchmarks



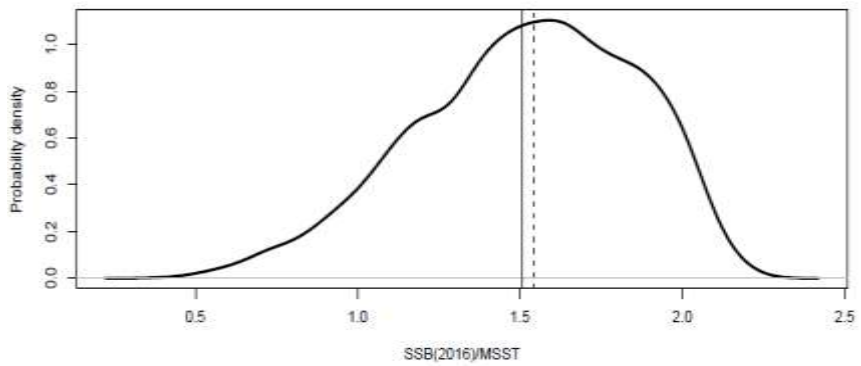


Solid=base run
Dash=Median of MCBs

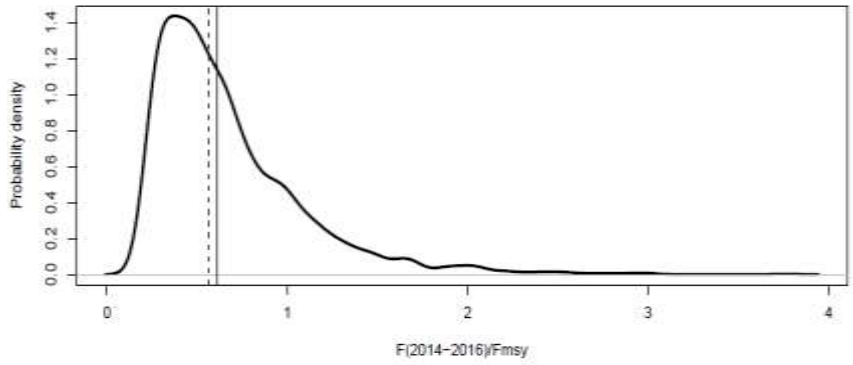


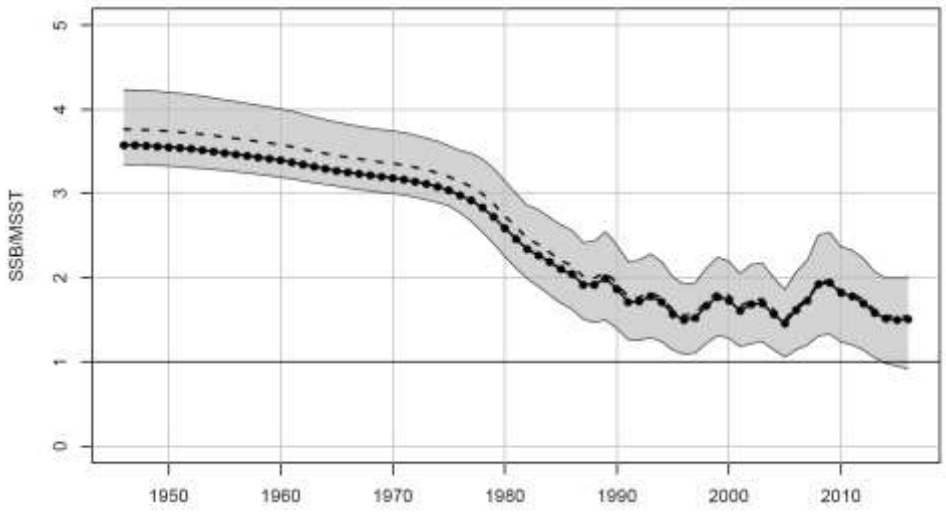


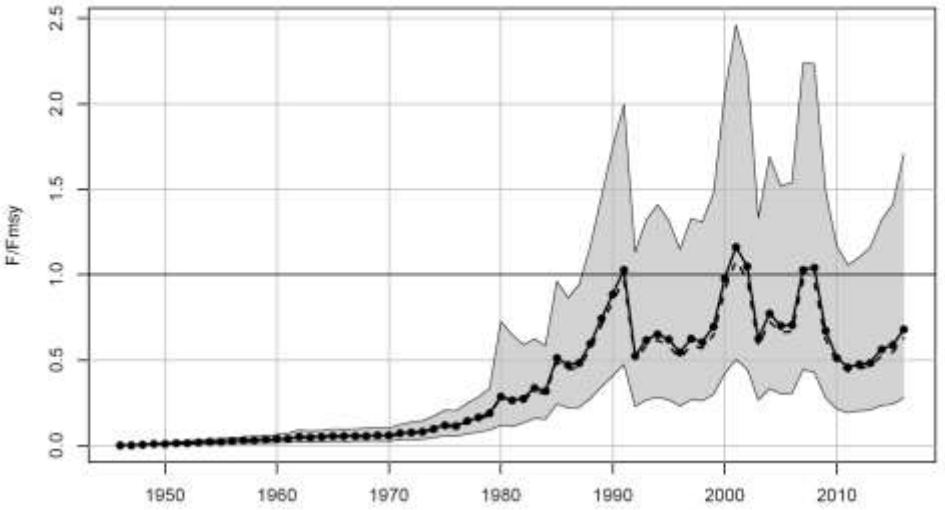
MCB – stock and fishery status



Solid=base run
Dash=Median of MCBs

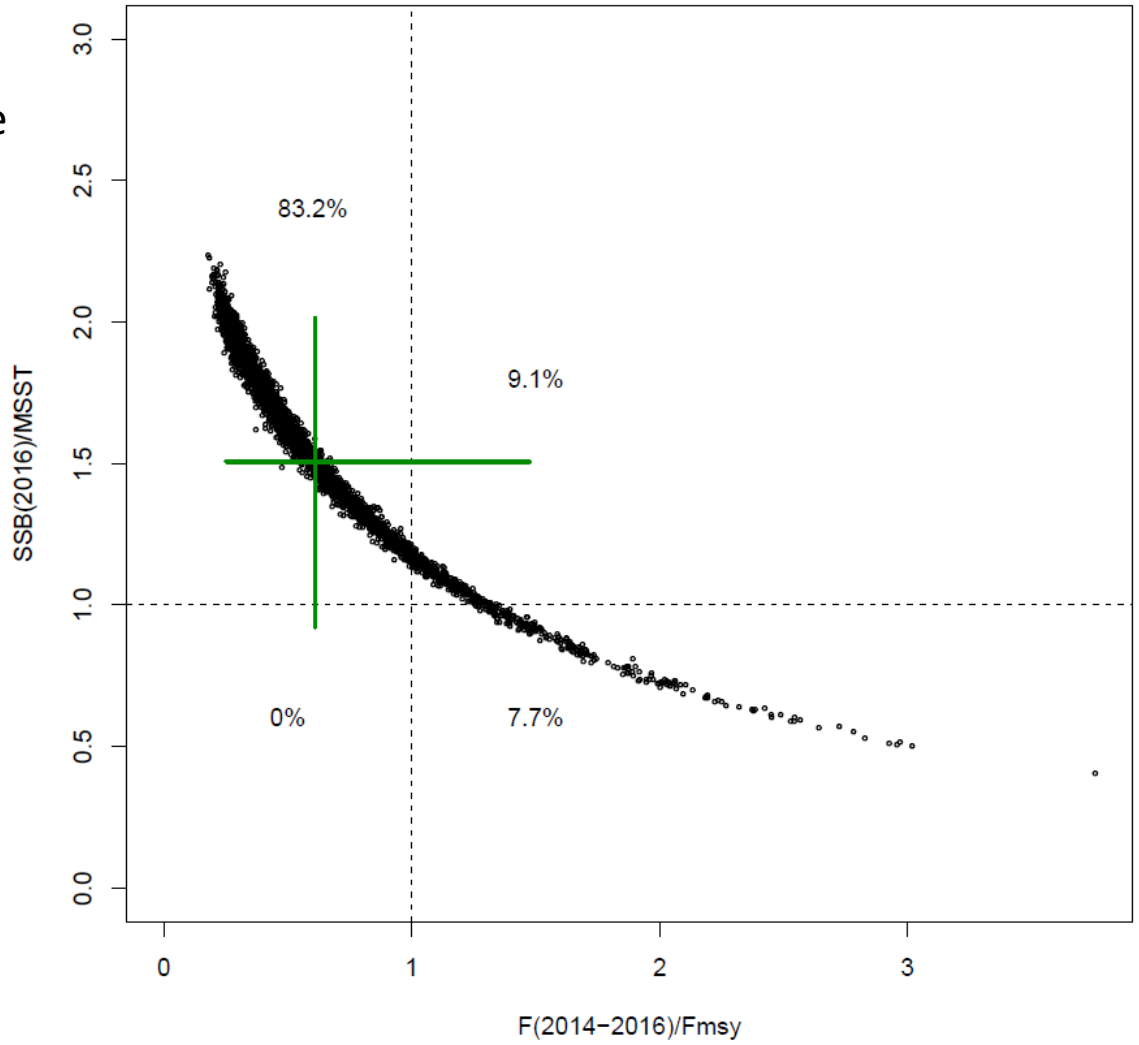






MCB – phase plot

- 92.3% of the runs indicate that the stock is not overfished
- 83.2% of the runs indicate the stock is not experiencing overfishing



BAM results – Management quantities

Quantity	Units	Estimate	Median	SE
F_{MSY}	y^{-1}	0.41	0.44	0.20
$85\%F_{\text{MSY}}$	y^{-1}	0.35	0.37	0.17
$75\%F_{\text{MSY}}$	y^{-1}	0.31	0.33	0.15
$65\%F_{\text{MSY}}$	y^{-1}	0.27	0.29	0.13
B_{MSY}	mt	4249.2	4030.8	560.5
SSB_{MSY}	1E12 eggs	18.3	17.2	2.59
MSST	1E12 eggs	13.7	12.9	1.94
MSY	1000 lb	1305.8	1339.6	125.5
D_{MSY}	1000 fish	245.9	97.8	43.2
R_{MSY}	1000 age-1 fish	5591	5230	926
Y at $85\%F_{\text{MSY}}$	1000 lb	1300.3	1334.9	127.2
Y at $75\%F_{\text{MSY}}$	1000 lb	1288.2	1324.6	130.5
Y at $65\%F_{\text{MSY}}$	1000 lb	1266.0	1305.2	136.0
$F_{2014-2016}/F_{\text{MSY}}$	—	0.609	0.564	0.41
$\text{SSB}_{2016}/\text{MSST}$	—	1.51	1.54	0.34
$\text{SSB}_{2016}/\text{SSB}_{\text{MSY}}$	—	1.13	1.16	0.25

Outline

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

Projection methodology

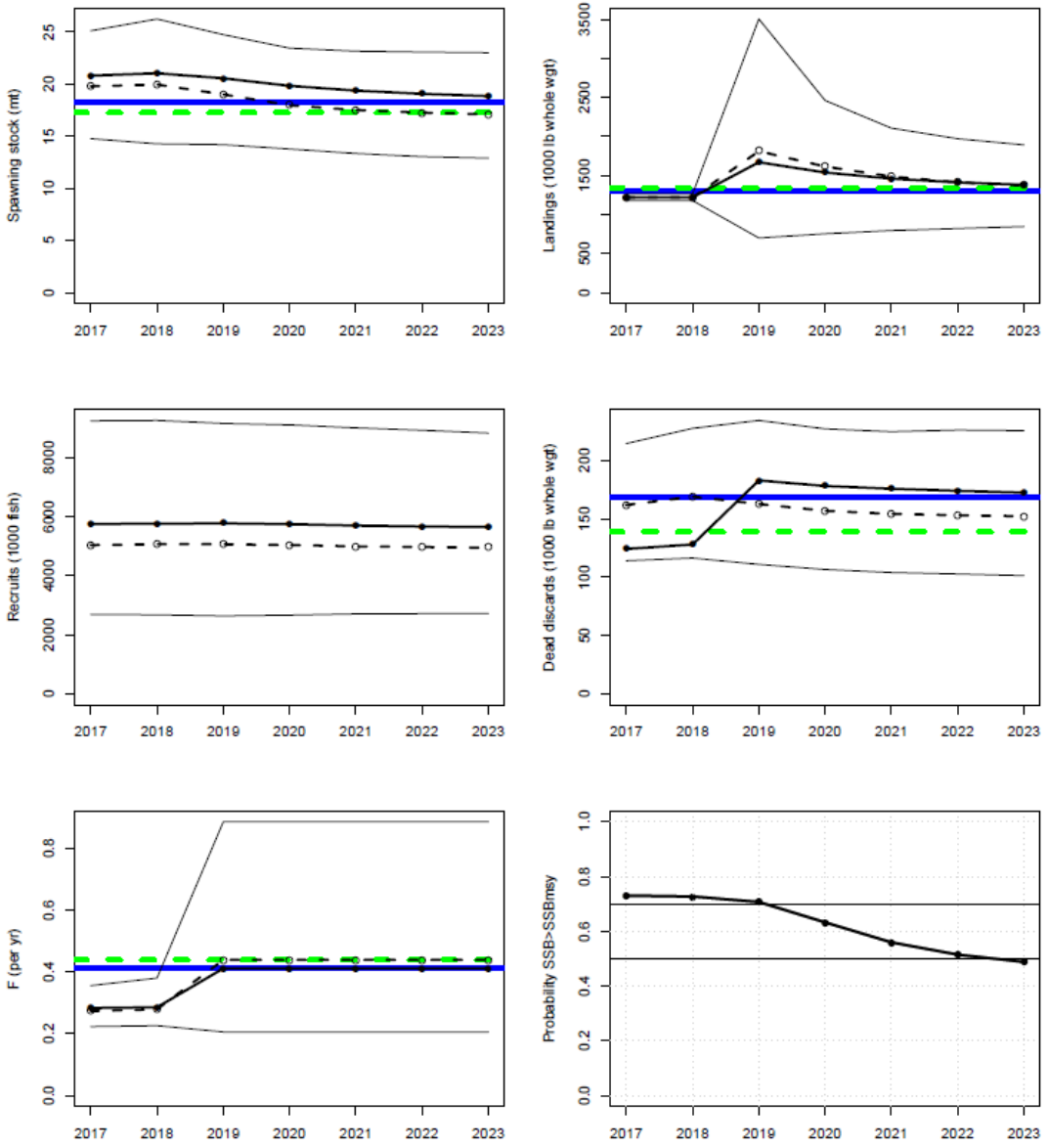
- The structure of the projection model was the same as that of the assessment model, and parameter estimates were those from the assessment
- Carry forward uncertainties from MCBs (i.e., 2017 abundance at age, spawner-recruit function, natural mortality, discard mortality, selectivities, recruitment deviations, growth CV)
- Any time-varying quantities (e.g., selectivities) were fixed to the most recent values of the assessment period
- A single selectivity curve was applied to calculate removals, averaged across fleets using geometric mean *F*s from the last three years of the assessment period
- Initial age structure at the start of 2017 was computed by the assessment model
- Fishing rates that define the projections were assumed to start in 2019

Projection Configuration

- 7 year projections to predict stock status in years after the assessment (2017-2023)
- Interim years 2017 and 2018; first year of management 2019
- Panel recommendations for interim years:
  - $F_{current}$ (geometric mean F from last 3 years of the assessment)
  - Weighted selectivity from the terminal year of the assessment
- Three Projection Scenarios (specified in TORs):
  1. $F = F_{MSY}$ (equivalent to P*=0.5)
  2. F = F at P*=0.4
  3. $F = 75\%F_{MSY}$

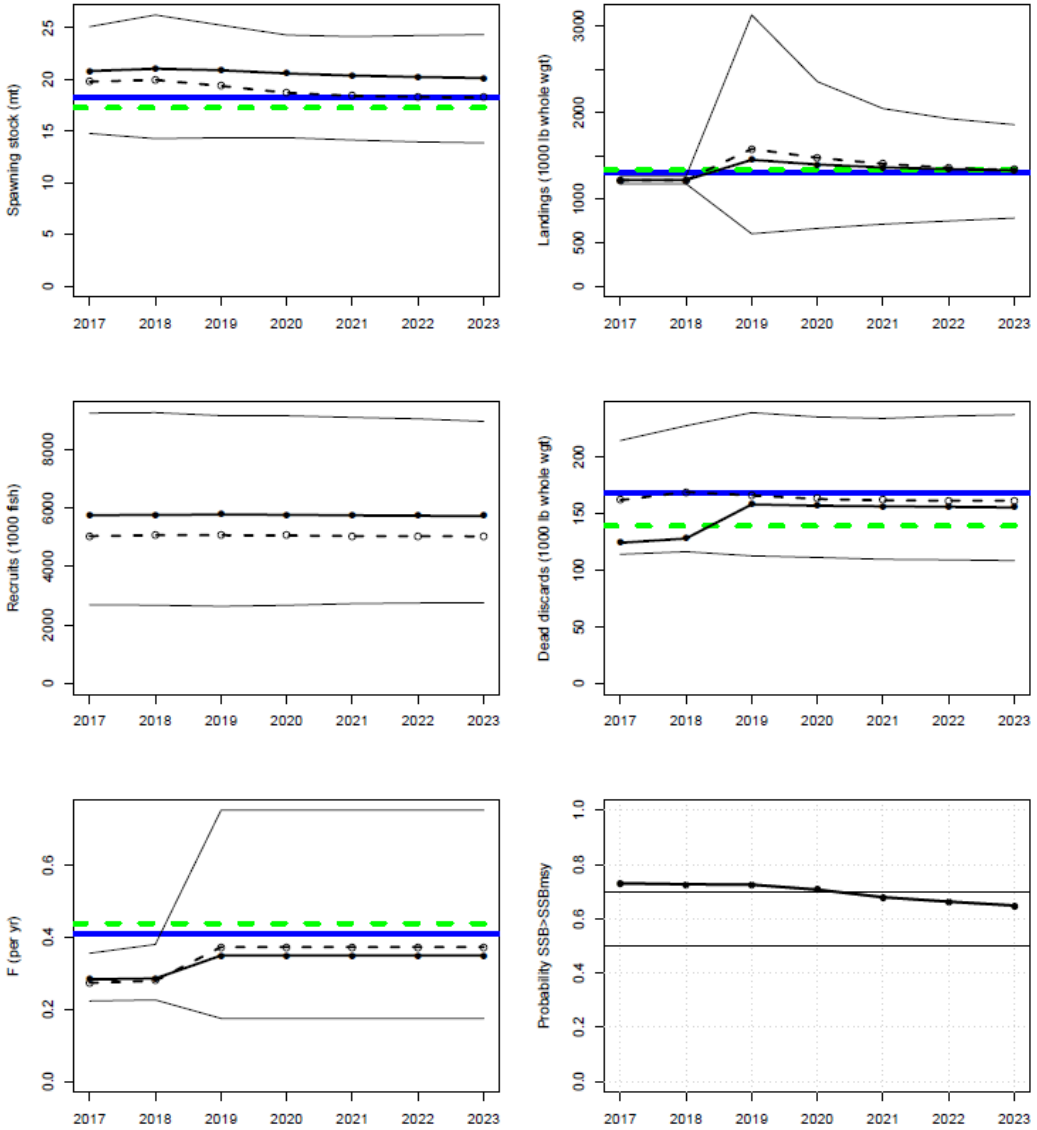
Projections: F = F_{msy}

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



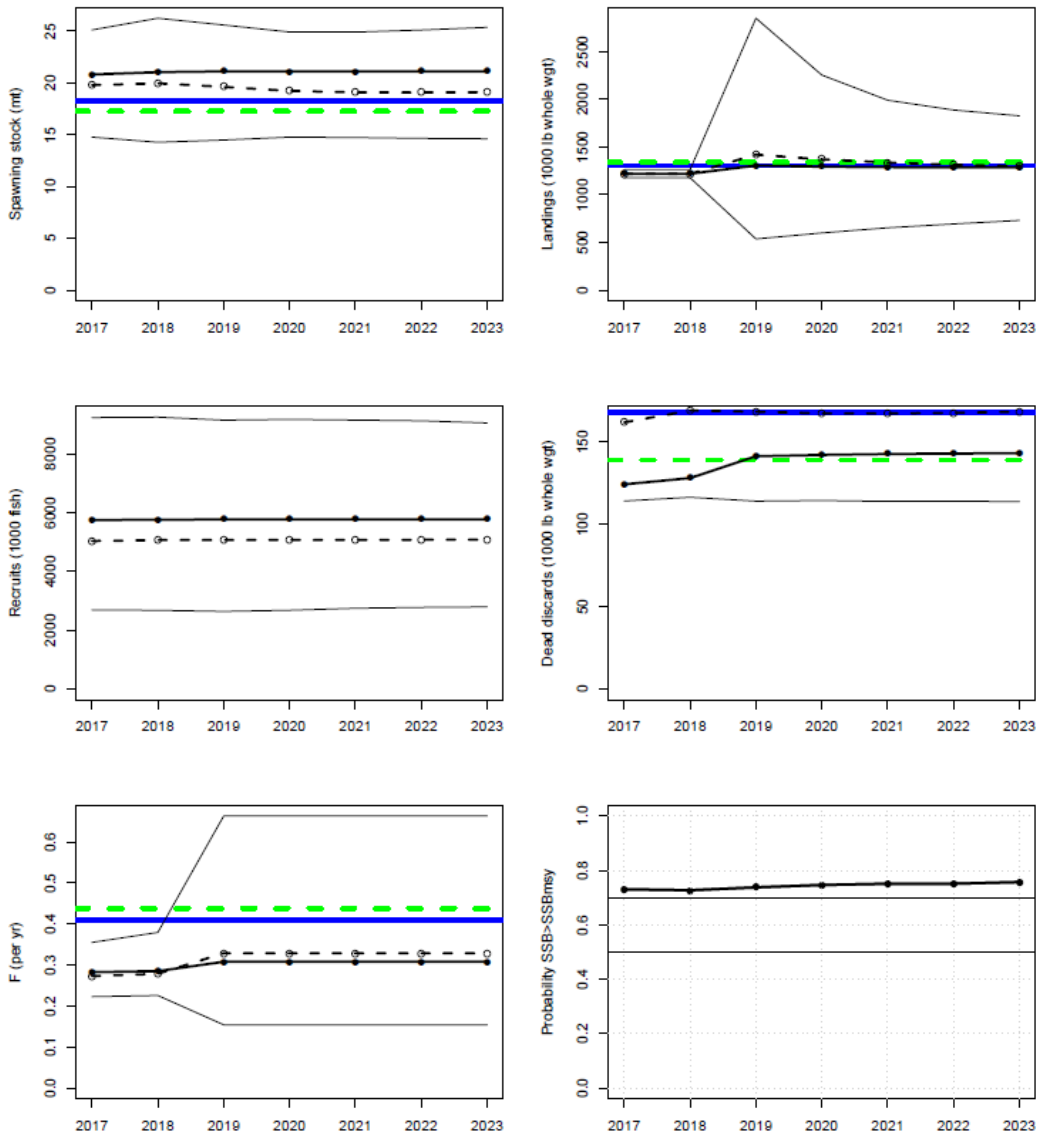
Projections: P* = 0.40

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



Projections: F = 75%F_{msy}

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



Projection Results (Table 20-22 in Report)

$F = F_{msy}$

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2017	5752	5040	0.28	0.27	21	20	1167	1123	1220	1218	176	224	124	162	0.730
2018	5761	5067	0.28	0.28	21	20	1199	1168	1220	1218	182	235	128	169	0.727
2019	5774	5067	0.41	0.44	21	19	1673	1788	1669	1810	261	232	183	163	0.707
2020	5745	5038	0.41	0.44	20	18	1578	1643	1538	1614	257	227	178	157	0.633
2021	5698	4994	0.41	0.44	19	18	1526	1563	1459	1486	255	225	176	154	0.559
2022	5668	4972	0.41	0.44	19	17	1496	1525	1411	1412	253	223	174	153	0.515
2023	5646	4952	0.41	0.44	19	17	1476	1497	1380	1371	251	222	172	152	0.488

F = F at P* = 0.4

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2017	5752	5040	0.28	0.27	21	20	1167	1123	1220	1218	176	224	124	162	0.730
2018	5761	5067	0.28	0.28	21	20	1199	1168	1220	1218	182	238	128	169	0.727
2019	5774	5067	0.35	0.37	21	19	1457	1559	1454	1579	225	235	158	166	0.726
2020	5765	5057	0.35	0.37	21	19	1426	1492	1400	1478	225	233	157	163	0.707
2021	5746	5041	0.35	0.37	20	18	1409	1454	1366	1408	224	233	156	162	0.679
2022	5734	5035	0.35	0.37	20	18	1399	1433	1346	1362	224	232	156	161	0.663
2023	5725	5028	0.35	0.37	20	18	1391	1419	1333	1336	223	232	155	161	0.648

$F = 75\% F_{msy}$

Year	R.b	R.med	F.b	F.med	S.b(mt)	S.med(mt)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2017	5752	5040	0.28	0.27	21	20	1167	1123	1220	1218	176	224	124	162	0.730
2018	5761	5067	0.28	0.28	21	20	1199	1168	1220	1218	182	238	128	169	0.727
2019	5774	5067	0.31	0.33	21	20	1307	1400	1306	1420	201	238	141	168	0.738
2020	5779	5071	0.31	0.33	21	19	1313	1378	1294	1371	202	238	142	167	0.746
2021	5778	5071	0.31	0.33	21	19	1316	1365	1289	1338	203	238	143	167	0.751
2022	5778	5079	0.31	0.33	21	19	1319	1357	1287	1314	203	238	143	168	0.751
2023	5778	5082	0.31	0.33	21	19	1320	1352	1286	1299	203	240	143	168	0.757

Assessment Summary and Conclusions

- This assessment indicates that vermilion snapper are currently not overfished and not experiencing overfishing
- Landings have decreased significantly since the early 2000s but have increased slightly in the most recent years
- Several strong year classes evident from 2002 to 2008 but mostly average to below average recruitment since then
- Age compositions played a more prominent role in this assessment than in the SEDAR 17 benchmark and the 2012 update
- The assessment revealed conflicts with the indices, particularly the fishery independent CVID index, that warrant further investigation

Questions