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SEFSC

Miami, FL

SEDAR 74 Gulf of Mexico Red Snapper Research Track Stock Assessment: Review Workshop Day 1

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Outline

- Data Review
 - Stock Definition
 - Life History
 - Data
 - Removals
 - Indices
 - Compositions
- Statistical Catch-at-age Model
 - Base Model Setup
 - Model Fits
 - Sensitivities

Base Model Setup

General

- Stock Synthesis version 3.30.20
- Maximum likelihood estimation
- Start year: 1950
- 3 areas, 1 season
- von Bertalanffy Growth forms (fixed)
- SR relationship (assumes no spawner recruit relationship (i.e., Beverton-Holt function with steepness=0.99 as a computational convenience)
- Model ages 0-20+ with age 20 as plus group
- Hybrid selectivity (i.e., length and age base)
- Length based retention
- Data weighting procedures for composition and discards
 - Changes in Lambdas/emphasis factors
 - Dirichlet-multinomial variance inflation

Base Model Setup

Model Structure - Spatial

- 3 areas to recruit to, 1 pooled spawning biomass
- Area specific von Bertalanffy growth parameters (fixed)
- Area specific maturity curves (fixed)

Growth Parameters	East	Central	West
$A_{\min}$	0.25	0.25	0.25
$L_{A\min}$	15.94	17.11	15.94
$L_{A\max}$	85.99	85.43	81.88
K (year ⁻¹)	0.17	0.15	0.14

Maturity Parameters*	East	Central	West
M_{A50}	1.95	1.95	2.47
M Slope _{A50}	-1.57	-1.57	-1.18

*Sensitivity conducted w/ $M_t(SSB_t)$

Base Model Setup

Model Structure - Temporal

- Time varying apportioned recruits
- Selectivity and retention time blocks to align with changes in management:
 - Selectivity
 - Commercial (trip limits and IFQ)
 - 1950-1992, 1993-2006 and 2007-2019
 - Recreational (bag limits)
 - 1950-1994, 1995-2006 and 2007-2019
 - Retention
 - Based on changes in size limits
 - Commercial
 - 1950 - 1984, 1985 - 1994, 1995 - 2006, 2007 - 2019
 - Recreational
 - 1950 - 1989, 1990 - 1994, 1995 - 1998, 1999 - 1999, 2000 - 2019

Base Model Setup

Parameters Estimated: 1828 / 2210

- Initial fishing mortality rates
- $\frac{2}{3}$ Recruitment apportionment parameters (1990-2019)
- Recruitment deviations ($\sigma_R = 0.6$)
- Selectivity parameters
- Dirichlet-multinomial dispersion parameters
- Annual fleet specific fishing mortality rates

Base Model Setup

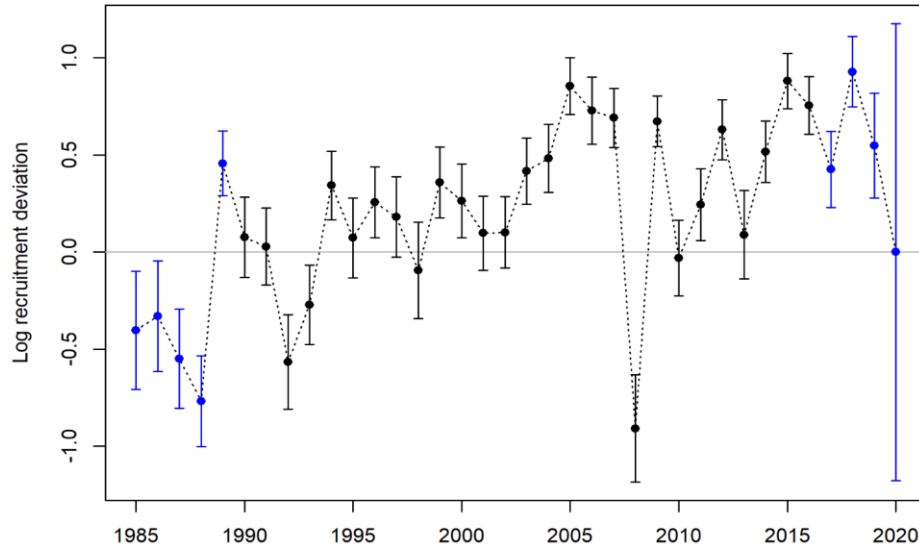
Initial Conditions

- Set initial catch given non-zero starting catch in the model start year
- Initial CV 0.01

	East	West	Central
HL (pre 1950)	457 mt	265 mt	614 mt
LL (began 1980)	0 mt	0 mt	0 mt
Charter (1955)	62,070 fish	386,180 fish	220,670 fish
Headboat	0	317.220	124130
Private	24,839	137,920	110,340

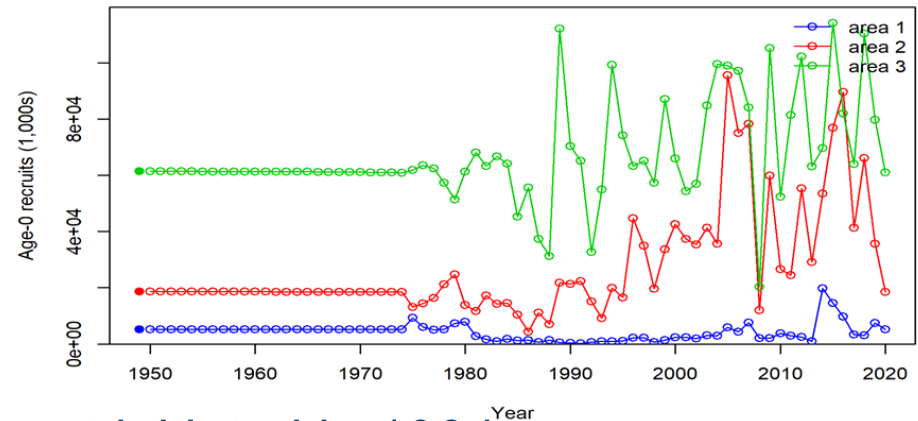
Base Model Setup

Recruitment



- Simple deviations estimated
- Main recruitment deviations start in 1990 given increase in data availability

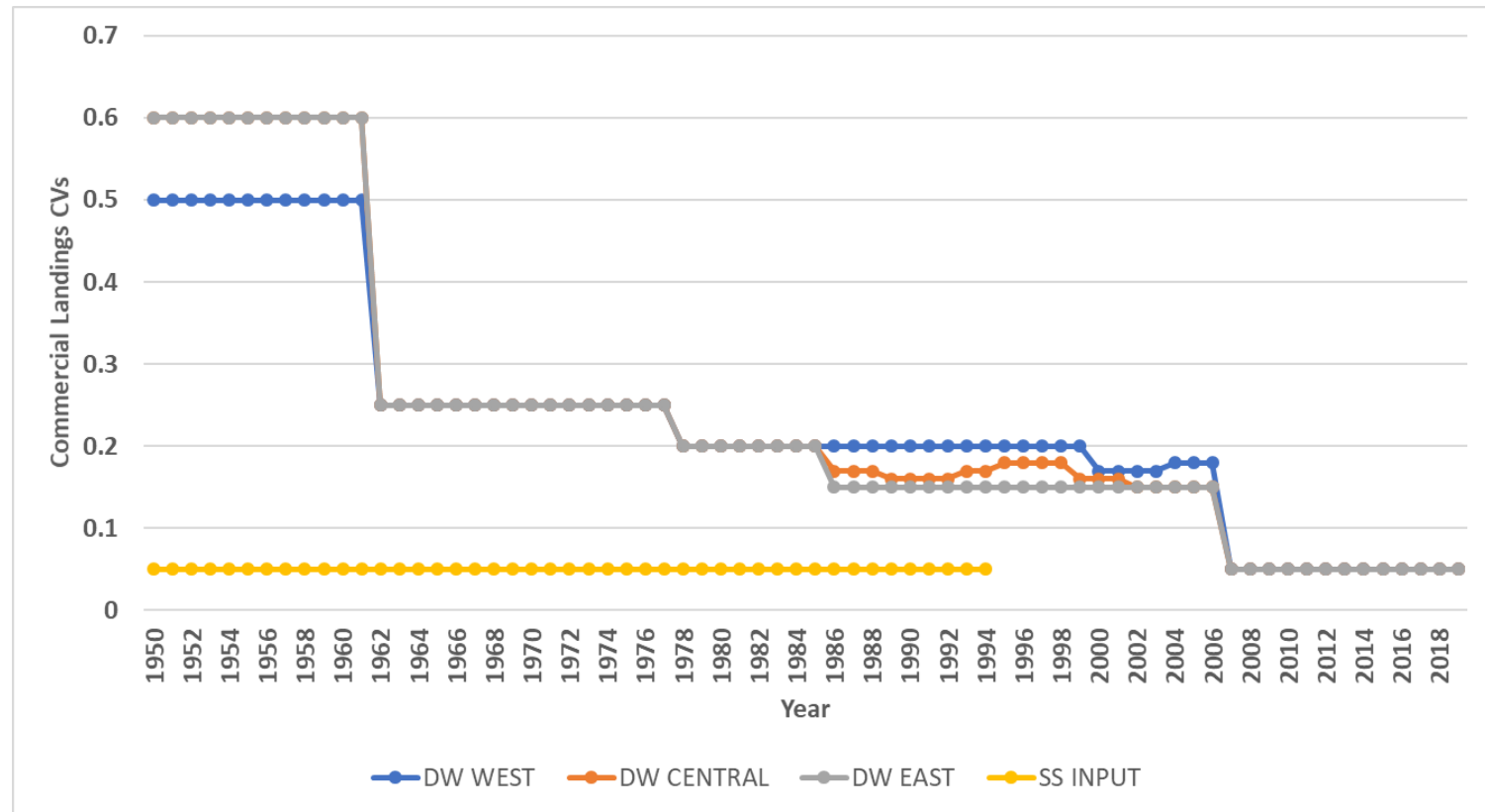
Apportionment estimation starting in 1975 with variability constrained to a CV of 0.5



Full bias adjustment initiated in 1984

Base Model Setup

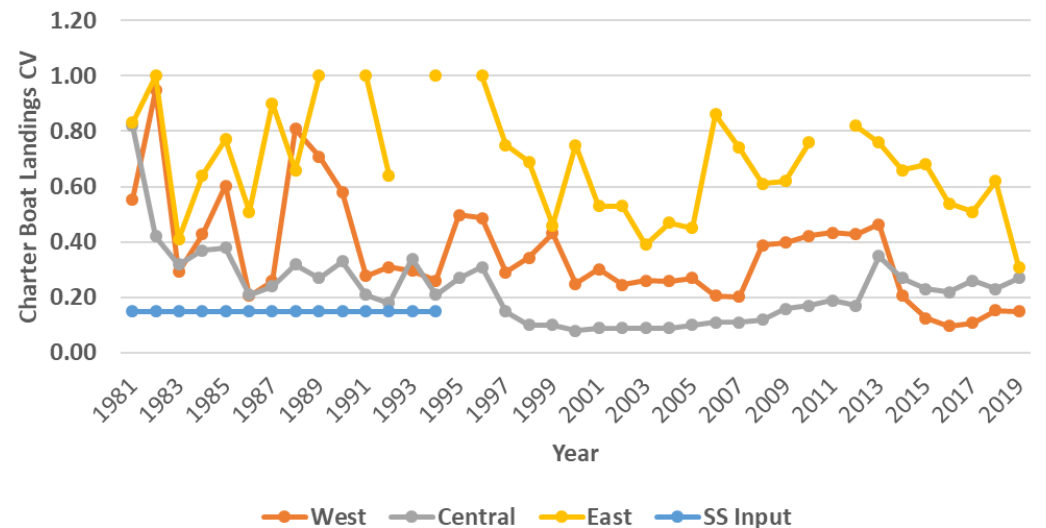
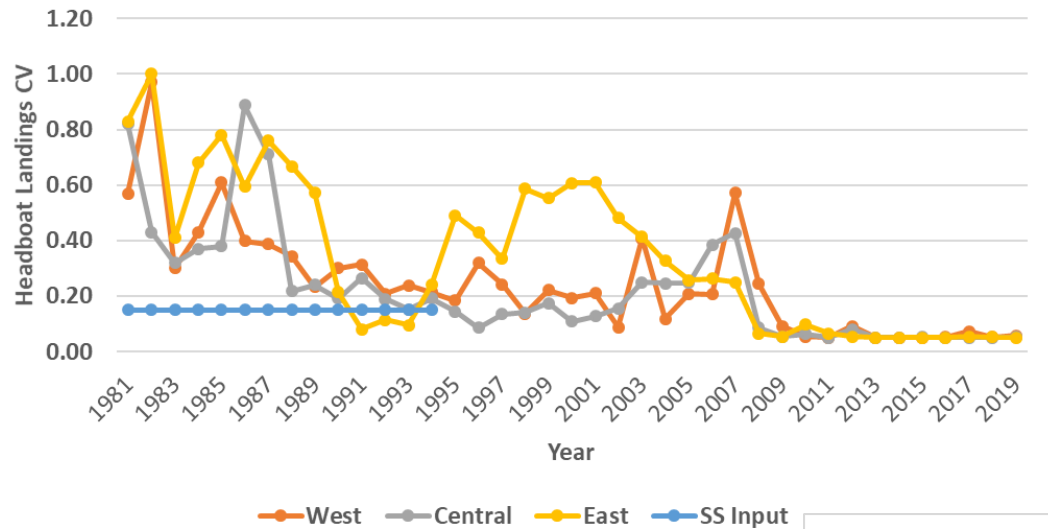
Commercial Landings CVs Provided vs SS Input



Provided CVs caused model instability, including a lack of convergence, nonsensical estimates of exploitation

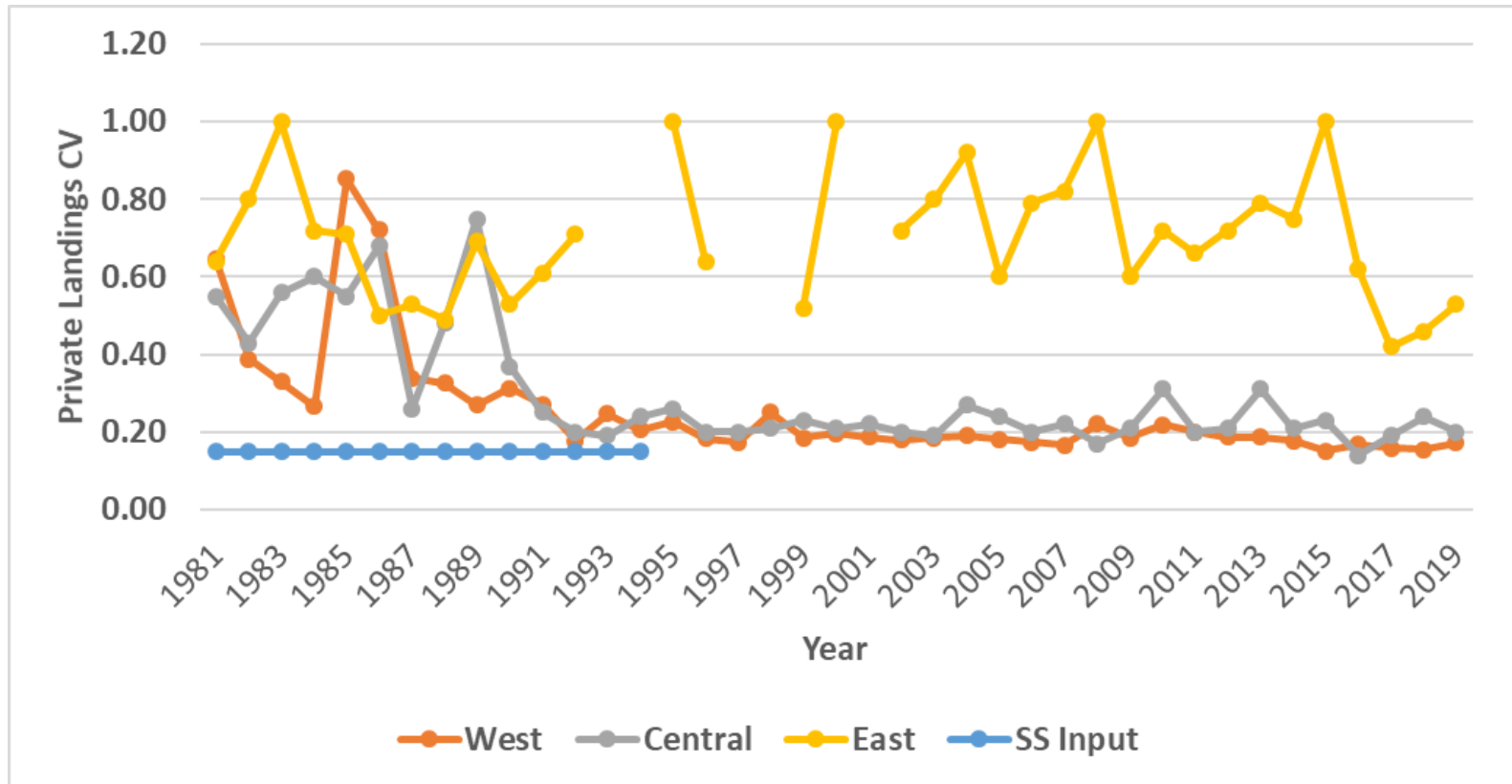
Base Model Setup

Recreational Landings Provided CVs vs SS Input



Base Model Setup

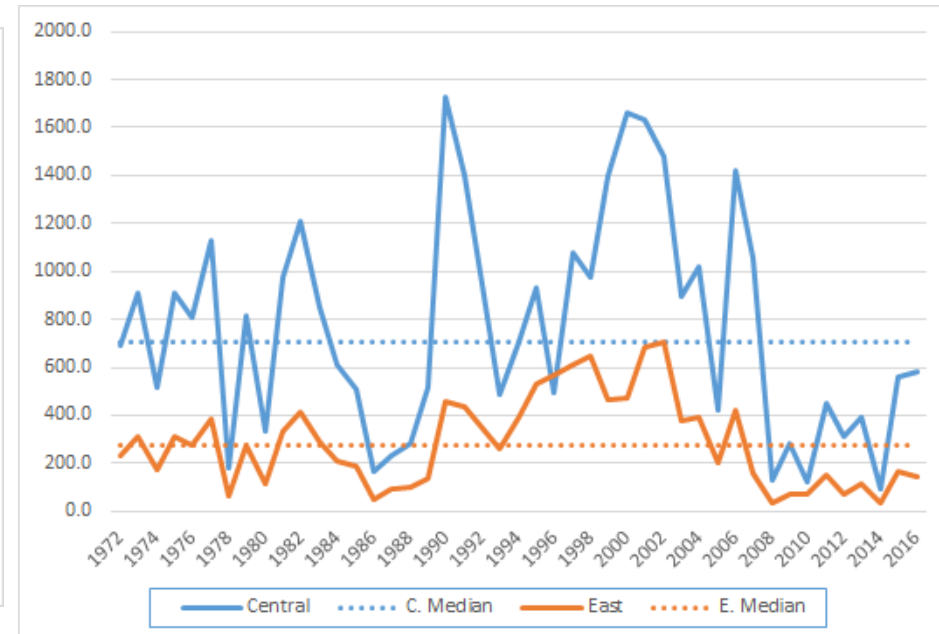
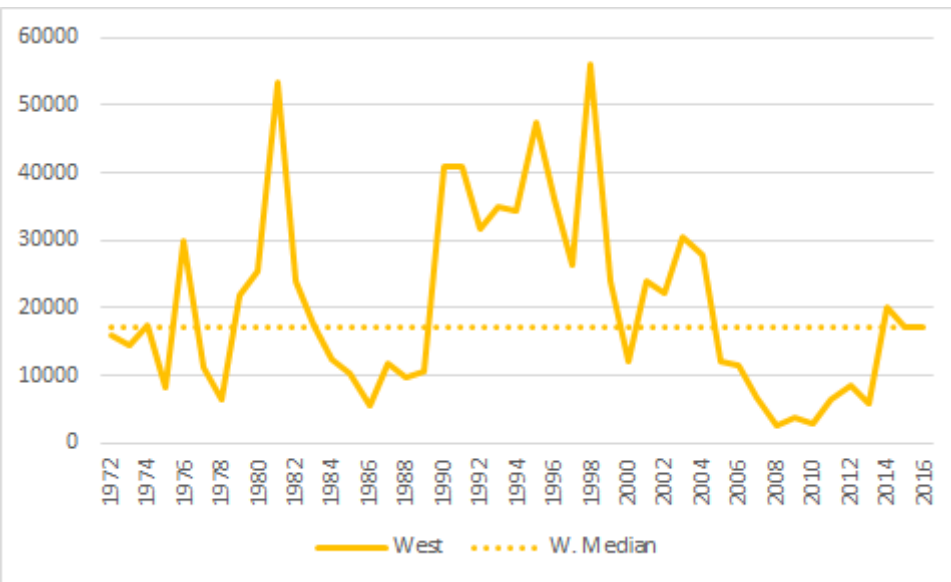
Recreational Landings Provided CVs vs SS Input



High East landings CVs resulted in some model instability.

Base Model Setup

Shrimp Trawl Bycatch



“Super period” used to model shrimp bycatch. Median bycatch (dashed line) scaled by annual effort to estimate fleet fishing mortality.

Base Model Setup

Indices of Abundance

- Reminder:
 - Scaled CVs to a mean of 0.2
- All indices have Q set as a scaling factor
- Larval index used as an index of spawning biomass not recruitment

Base Model Setup

Great Red Snapper Count Inclusion

- Inaugural use of data type for the GOM
- Incorporated as a region-specific absolute survey of age 2+ abundance.
 - Occurring in 2018.
 - Catchability coefficient (q) fixed at 1.
 - Sensitivities suggest model will decrease influence, in order to fit longer term data if q is not fixed at 1
 - Given equal model weight as other data sources ($\text{Lambda} = 1$) - a decision of the ADT

Base Model Setup

Fitting Composition Data Reminders

- Blocking needed to account for management activity for commercial and recreational fleets
- No blocking needed for most survey selectivity or catchability given they were derived to account for changes in management and survey design during DW
 - Combined video central used blocking to account for survey design changes
- Length composition used for all directed fleets
 - Matches the way fishery selects by length rather than age
- Length converted age composition used for BLL survey and SEAMAP Fall Trawl Post 2007
 - Ultimate goal: use collected ages from all surveys, where available
- Sample sizes varied based on source
 - Reweighted using Dirichlet Multinomial inflation factors
 - Non iterative - effective sample size estimated during parameter estimation
 - Unbiased to clusters of individuals in a sample
 - Accounts for data overdispersion (formally accounted for in assessments using “trips” as n)

Base Model Setup

Selectivity Decisions and Functional Forms cont'd

Fleet	Functional Form
GRSC West and Central	Age - Double Normal
GRSC East	Age - Fixed @ 100% age 2+

Unable to use length data as is therefore assumptions are based on gear differences and expert opinion (ADT) regionally:

- Peak selectivity of ages 2-5 in the West and Central.
- Assume zero to 100% selectivity prior to age 2 and 100% for 2+.

Base Model Setup

Retention Blocks

- Some discard comp. data available: HL, Shrimp Trawl and LL East in small quantities
- Logistic functional form with 4 parameters based on size: inflection, slope, asymptotic retention, male offset
 - Retention block inflection points based on fleet-specific minimum size changes when no discard data are available
- Commercial
 - 1950 - 1984: no minimum size limit regulation in place
 - 1985 - 1994: 13 inch minimum size limit
 - 1995 - 2006: 15 inch minimum size limit
 - 2007 - 2019: 13 inch minimum size limit
- Recreational
 - 1950 - 1989: no minimum size limit regulation in place
 - 1990 - 1994: 13 inch minimum size limit
 - 1995 - 1998: 15 inch minimum size limit
 - 1999 - 1999: 18 inch minimum size limit
 - 2000 - 2019: 16 inch minimum size limit



Base Model Setup

Retention Blocks cont'd

- Slope parameter for all pre-data blocks and base slopes (prior to 2007) fixed as knife-edged all other slopes are estimated for the possibility of sublegal fish
- Asymptote parameter fixed at 1 except for 2007-present where it was estimated

Questions About Base Model Setup?



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Model Fits

Landings and Discards

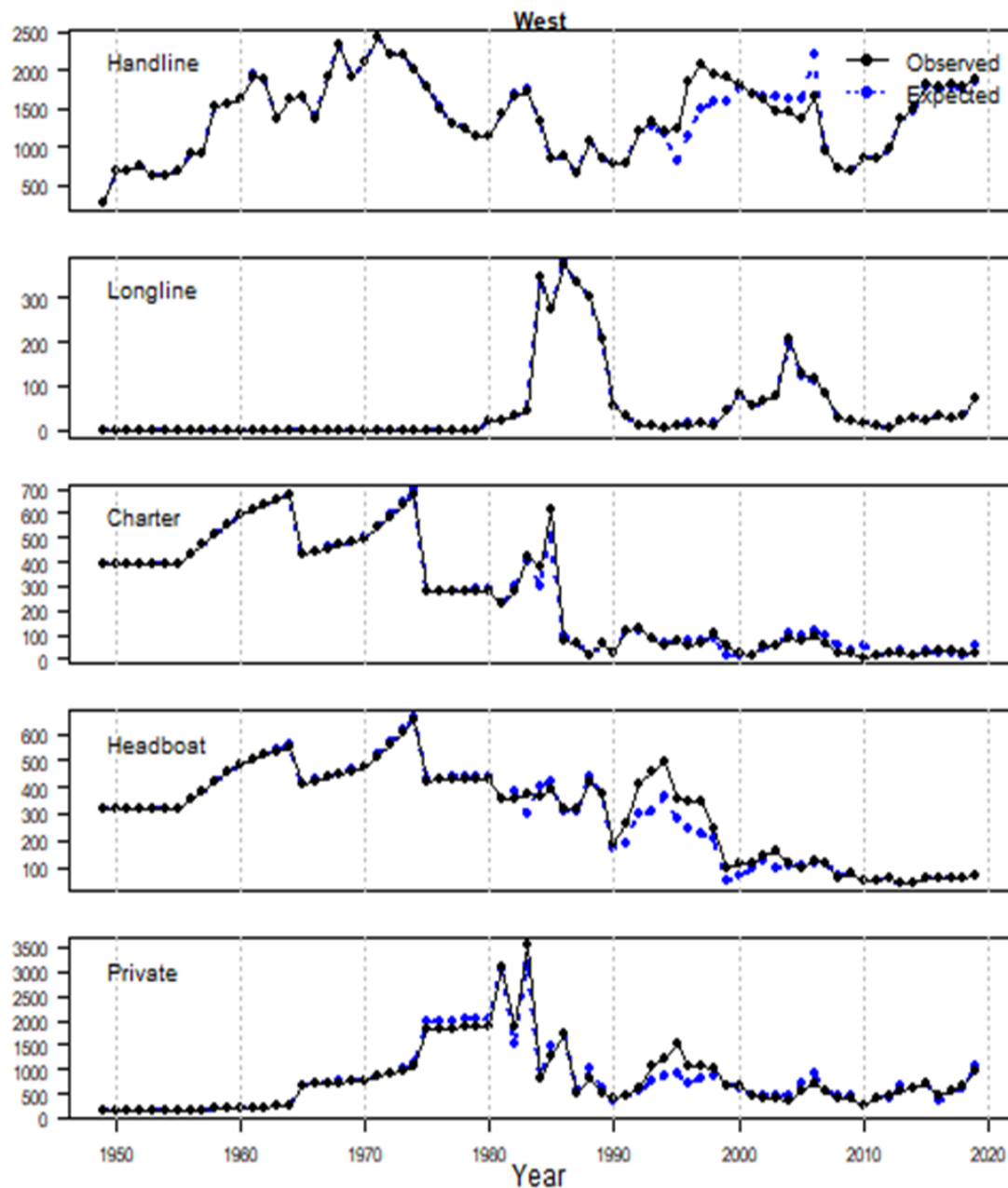
Fit to Landings

West area

Commercial CV = 0.05
until 1995

Recreational CV = 0.15
until 1995

● = Observed
● = Expected



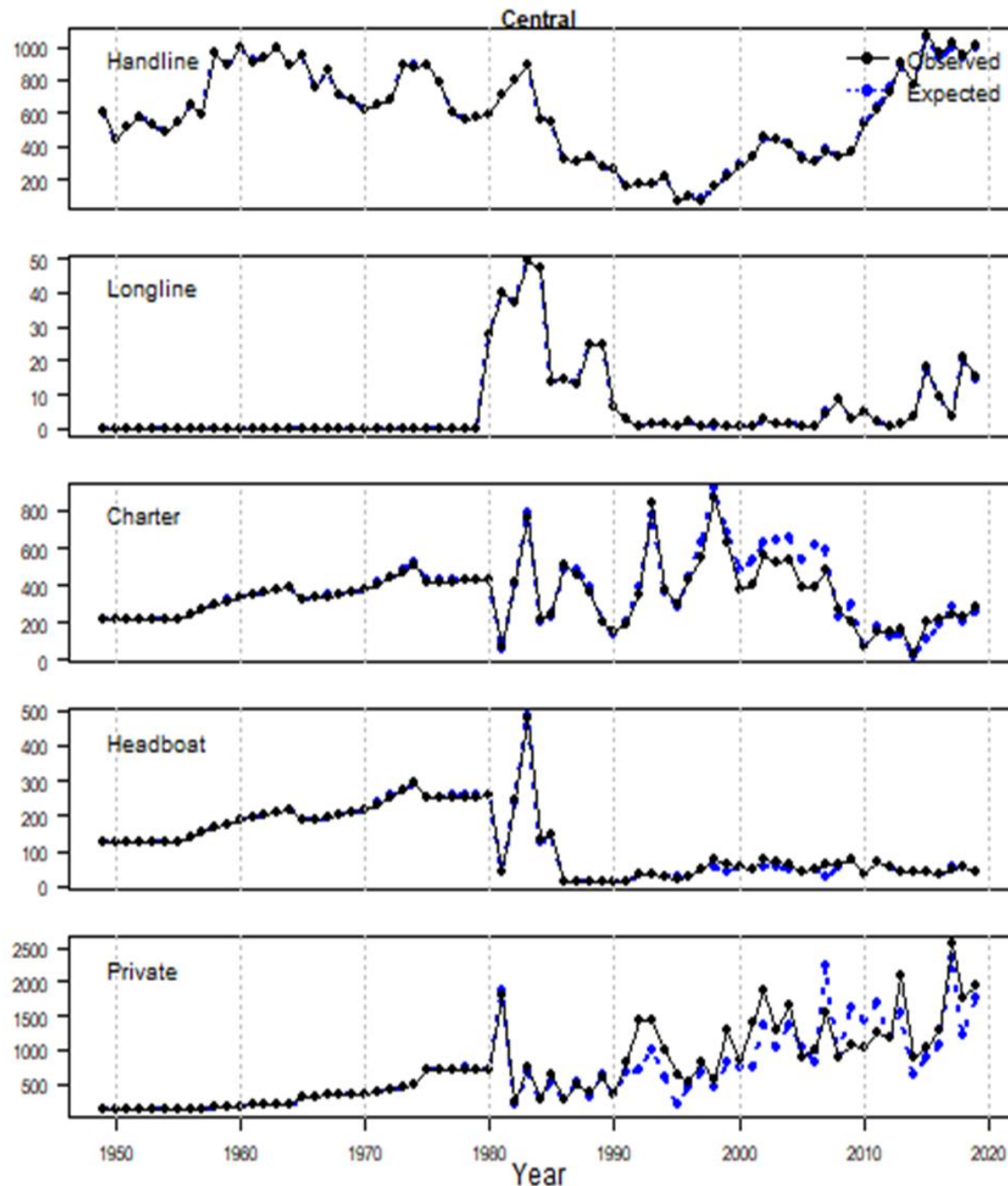
Fit to Landings

Central area

Commercial CV = 0.05
until 1995

Recreational CV = 0.15
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● = Observed
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Fit to Landings

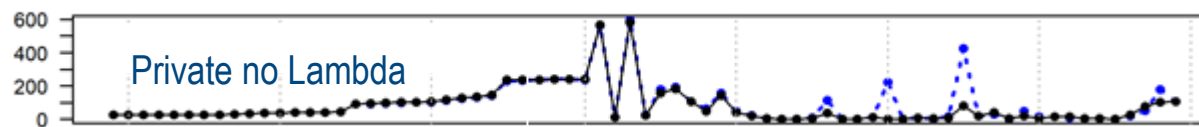
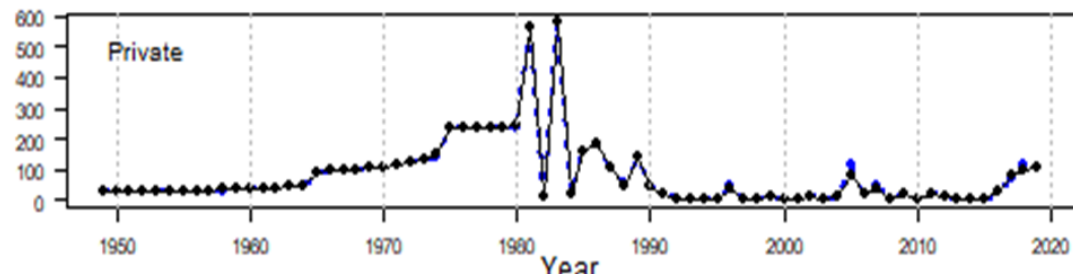
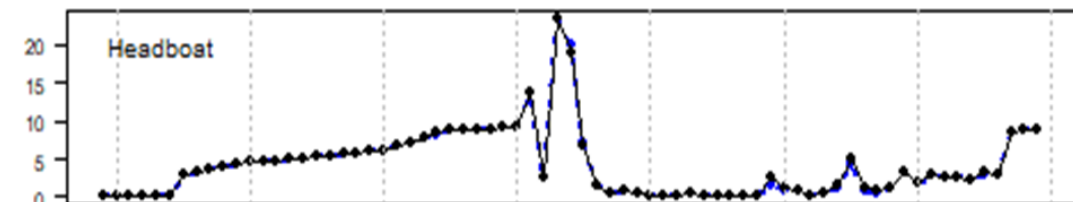
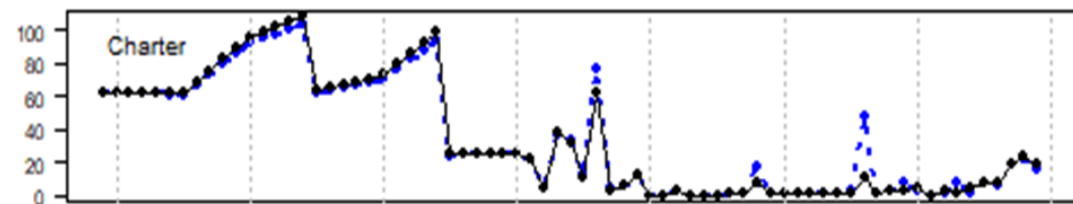
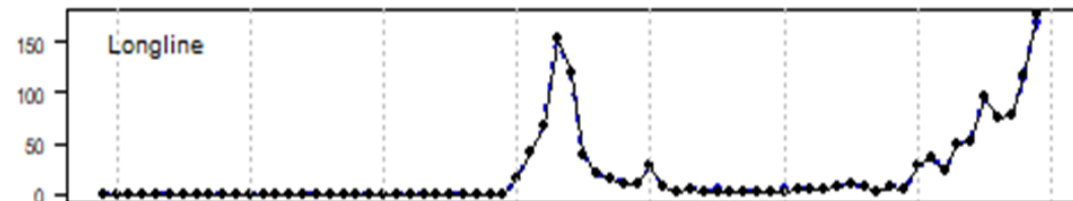
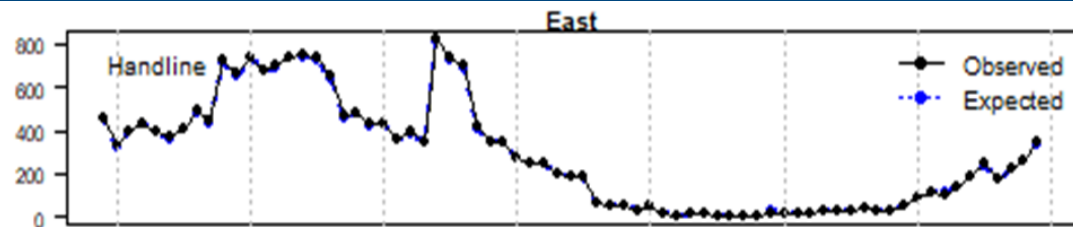
East area

Commercial CV = 0.05
until 1995

Recreational CV = 0.15
until 1995

Lambda on Private fleet

● = Observed
● = Expected

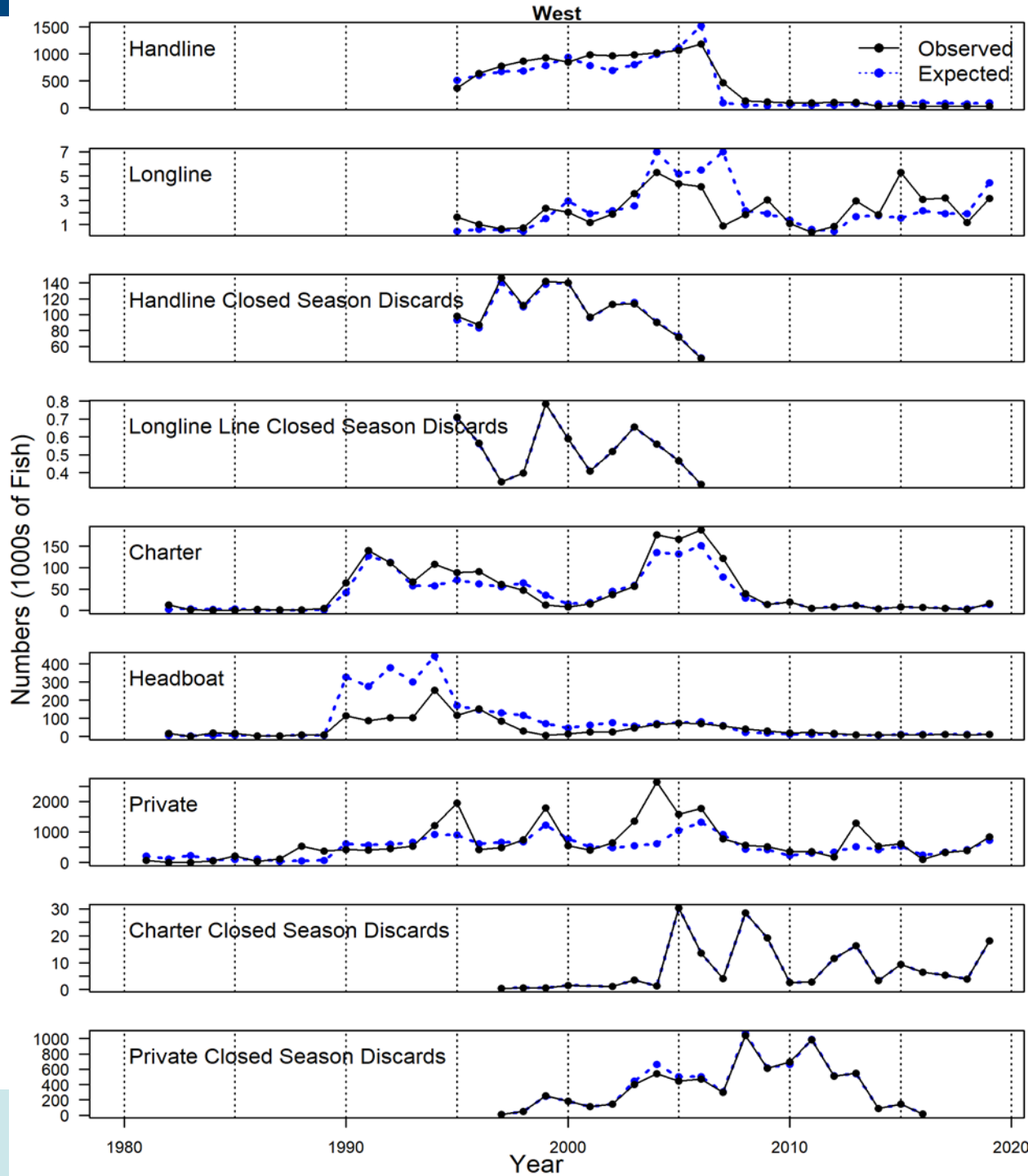


Fit to Discards

West area

Closed season discards generally estimated well due to lack of competing sources of data for the fleet

● = Observed
● = Expected

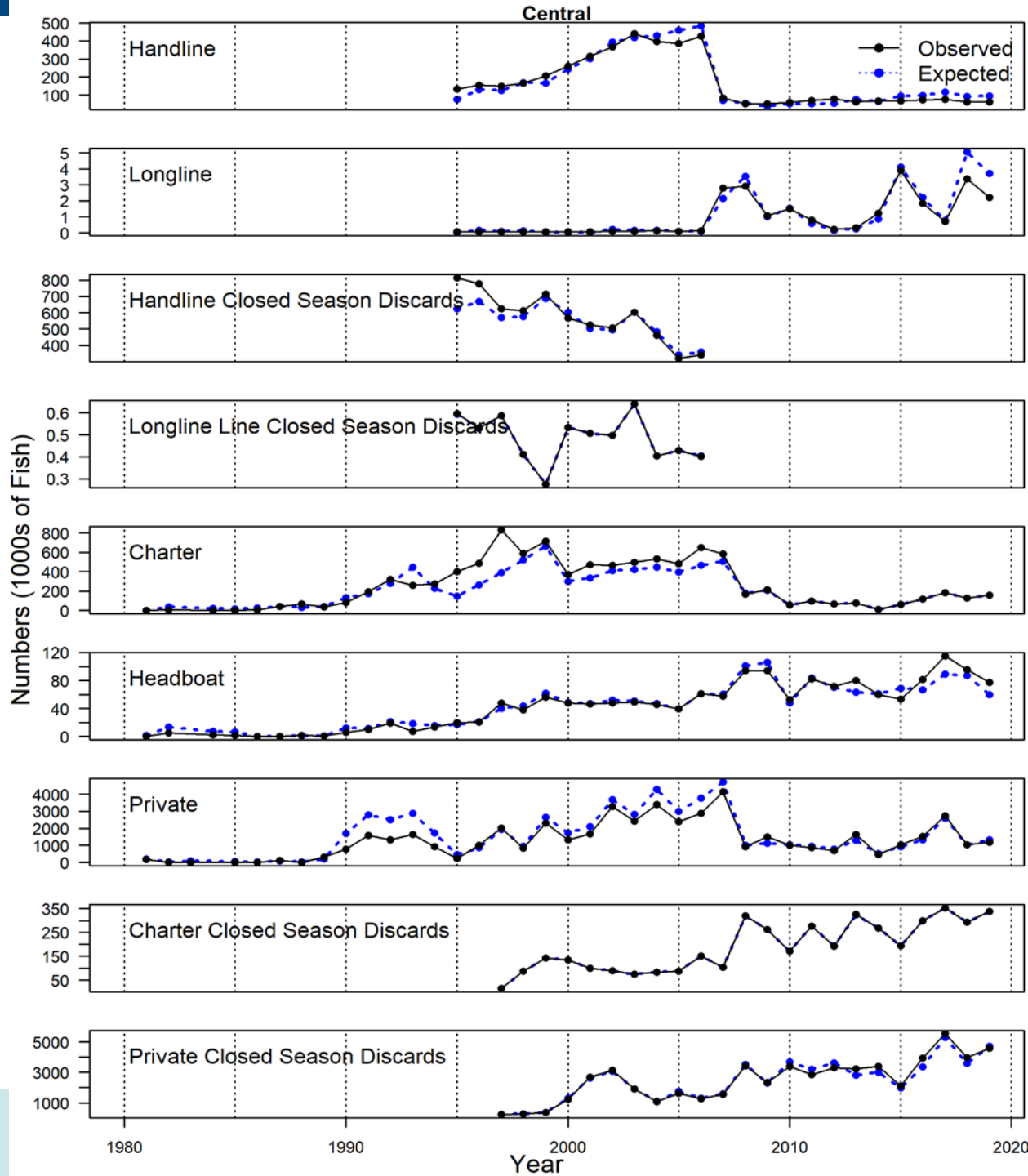


Fit to Discards

Central area

Closed season discards generally estimated well due to lack of competing sources of data for the fleet

● = Observed
● = Expected



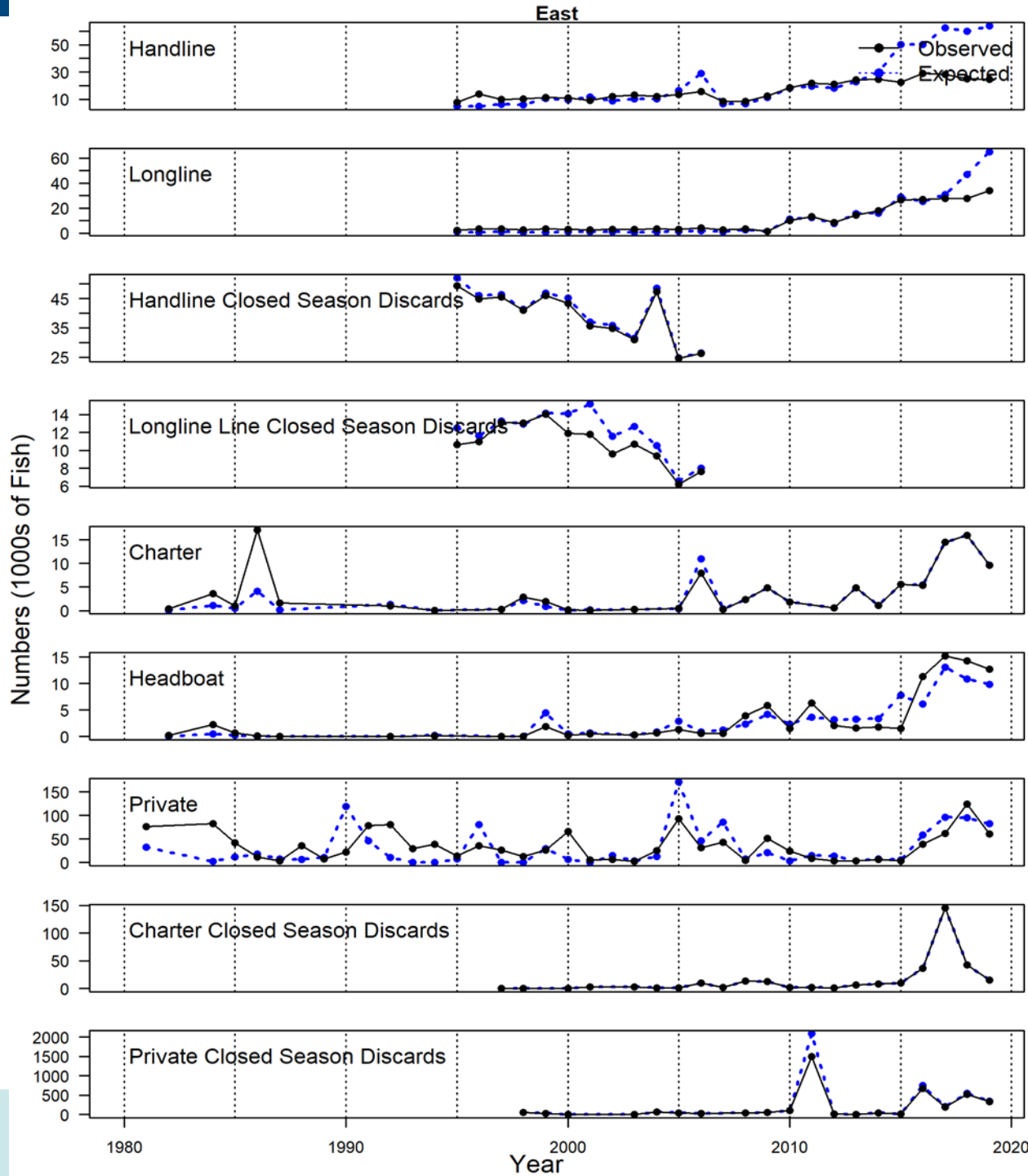
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Fit to Discards

East area

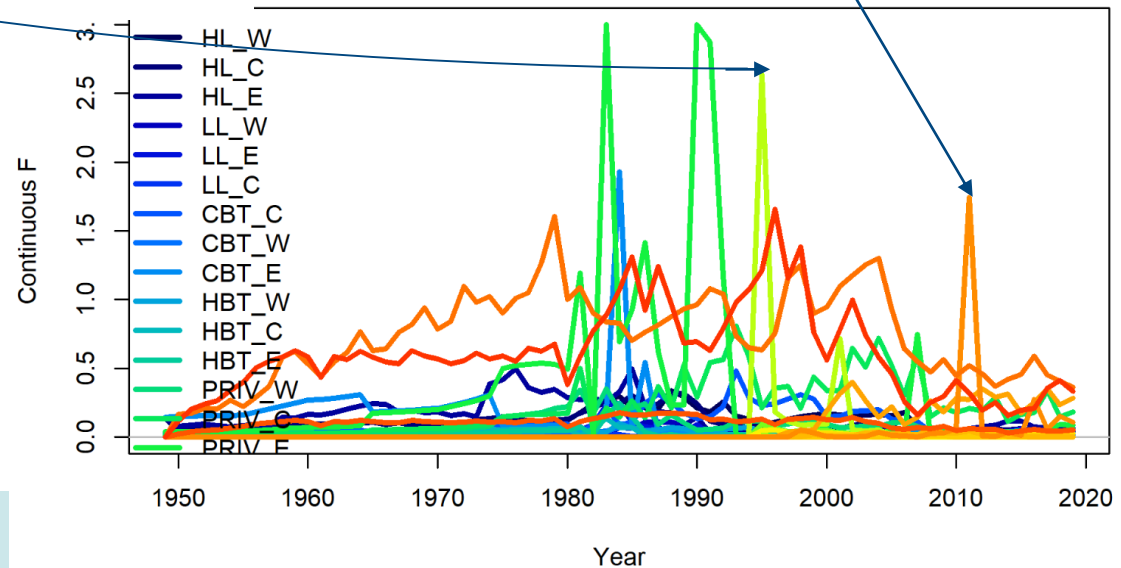
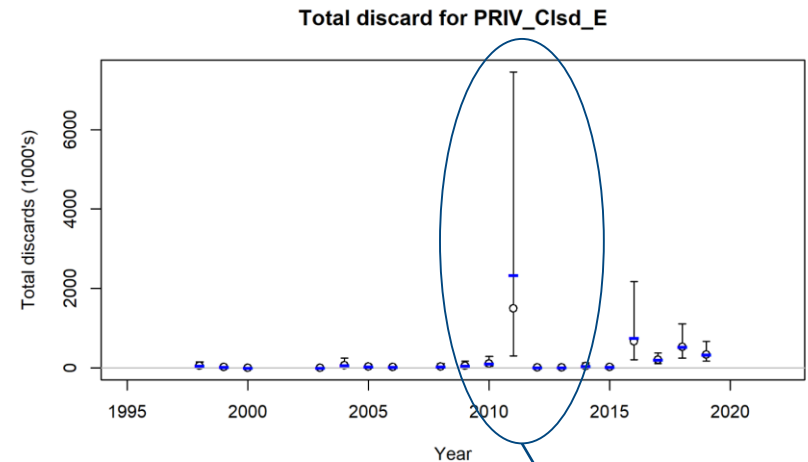
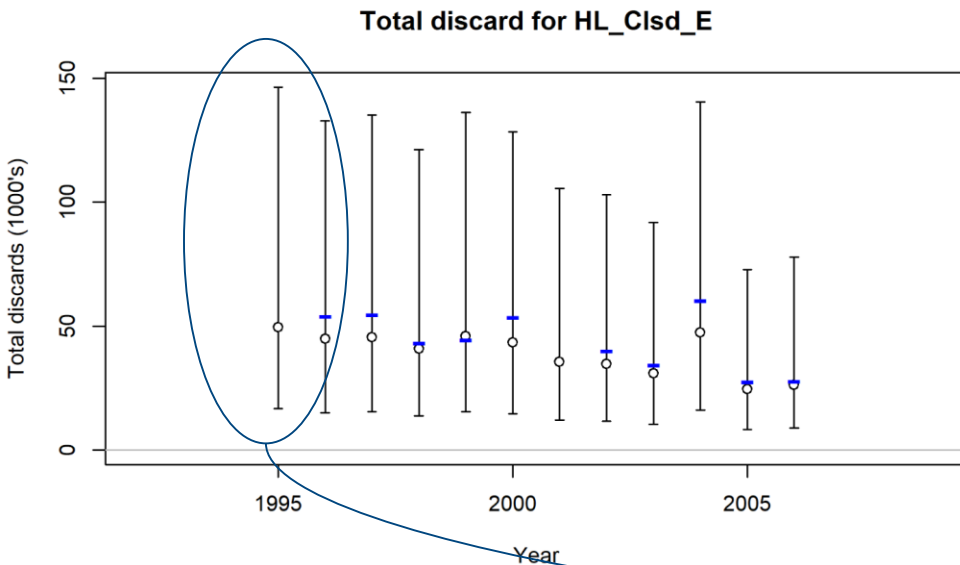
Handline and Private closed season discards required upweighting to eliminate “spikes” in the estimated discards. May indicate some model tension in the east

● = Observed
● = Expected



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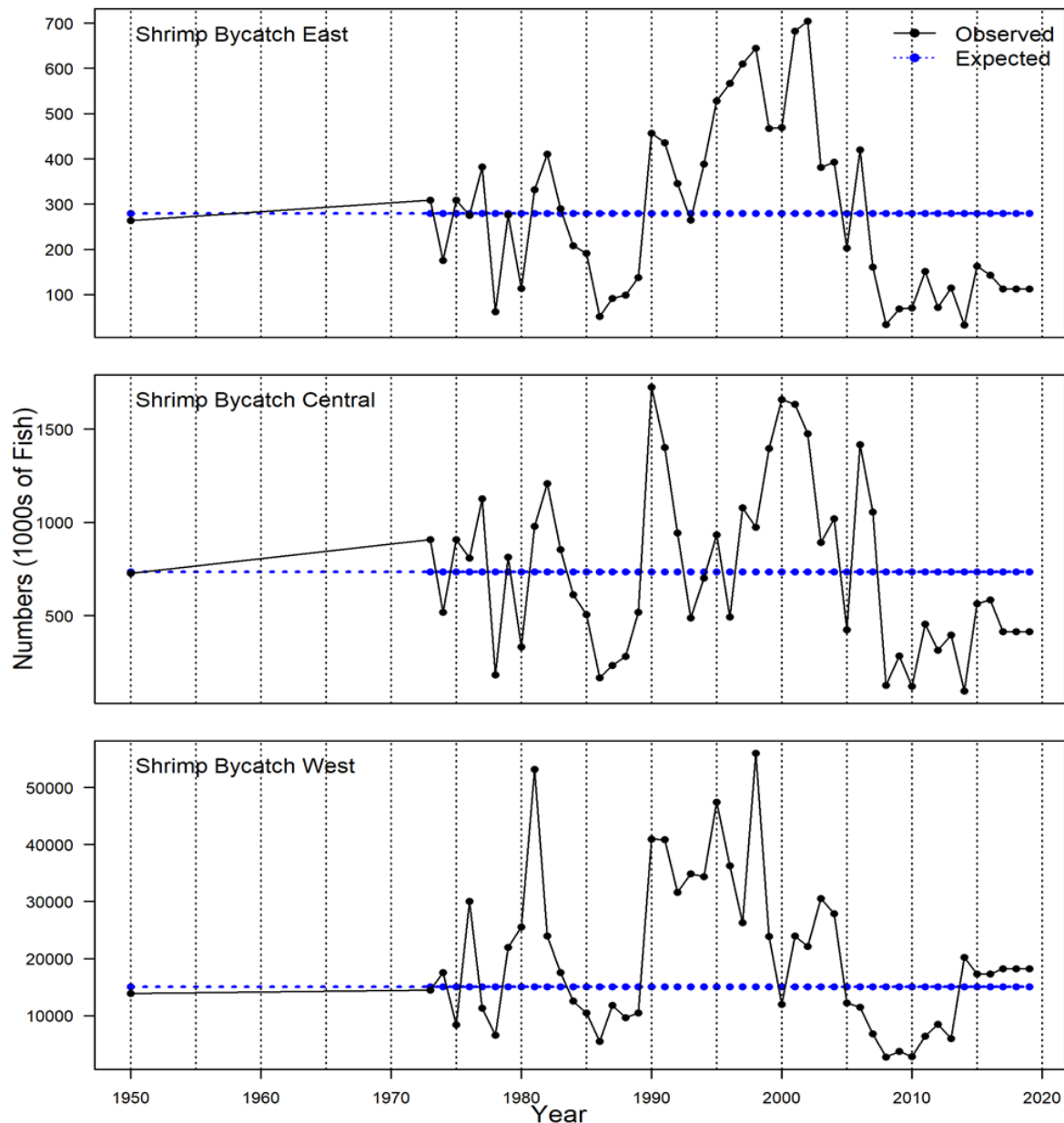
Examples of East area spikes



Fit to Bycatch

Upweight imposed
on the east area
shrimp bycatch to
force model to more
closely fit the data.

● = Observed
● = Expected



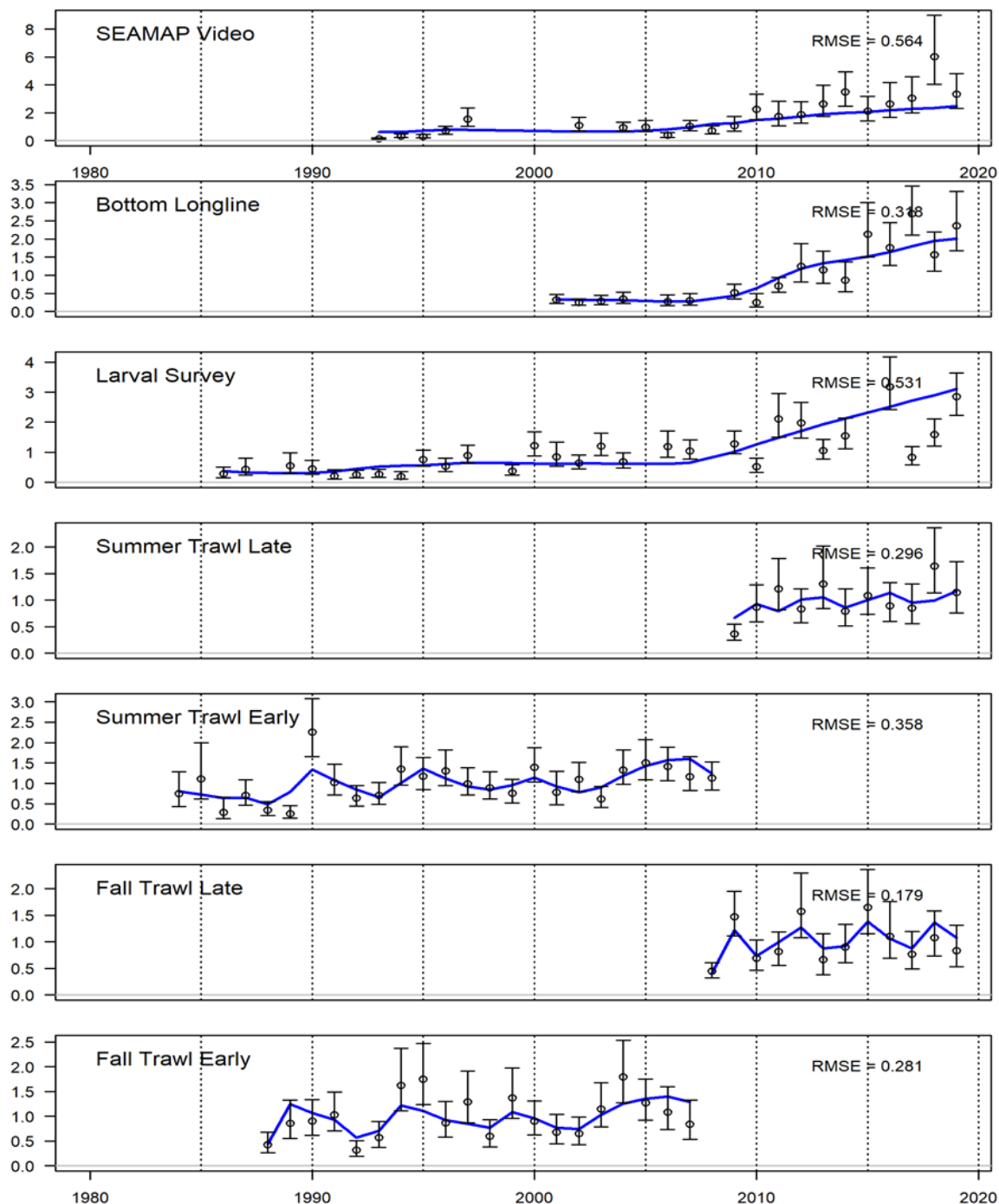
Questions about Fits to Landings and Discards

Model Fits

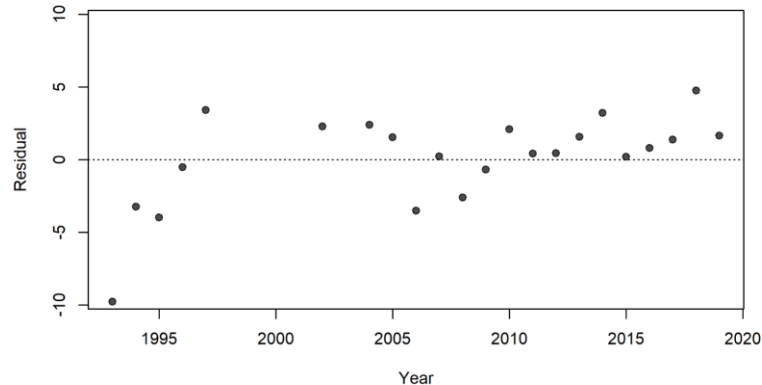
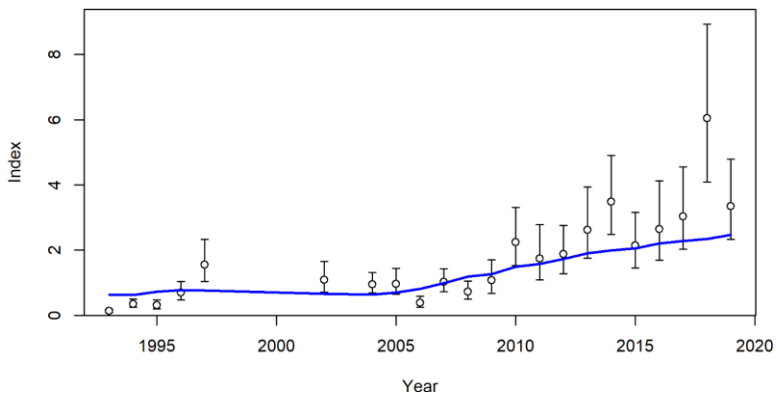
Indices of Relative Abundance

Indices

- West area Indices
- Video and Longline - fully recruited
- Larval = SSB
- Summer Trawl - Age1
- Fall Trawl - Age0

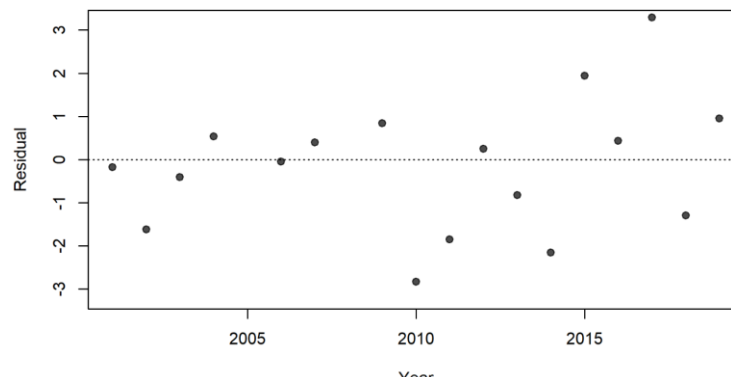
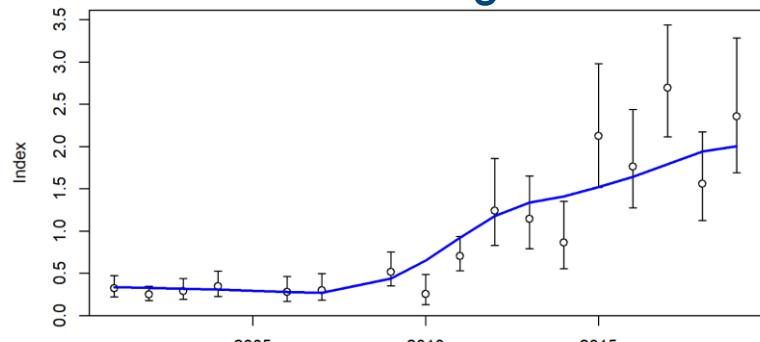


SEAMAP Video



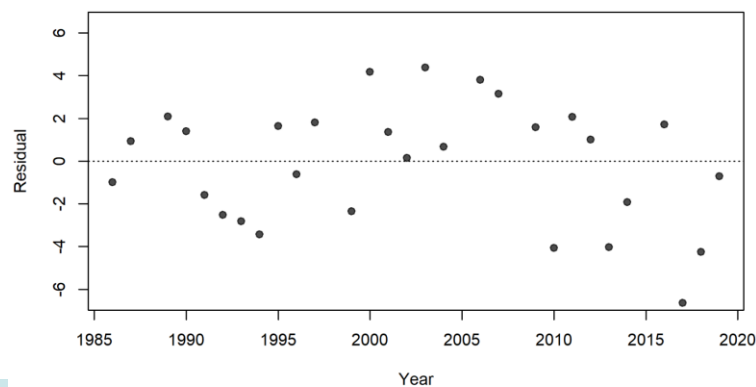
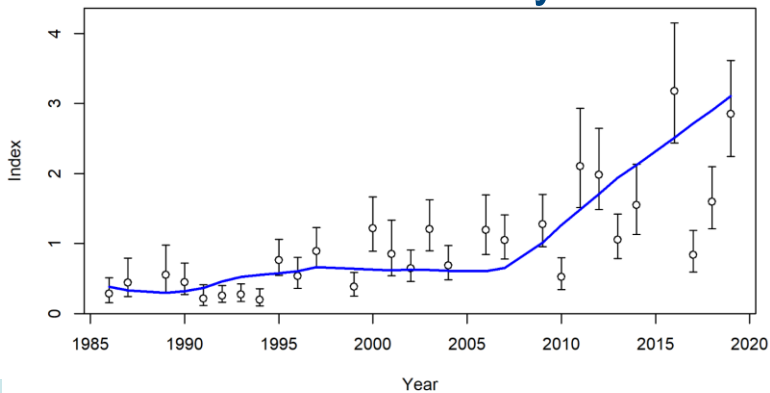
SDNR =3.17

Bottom Longline



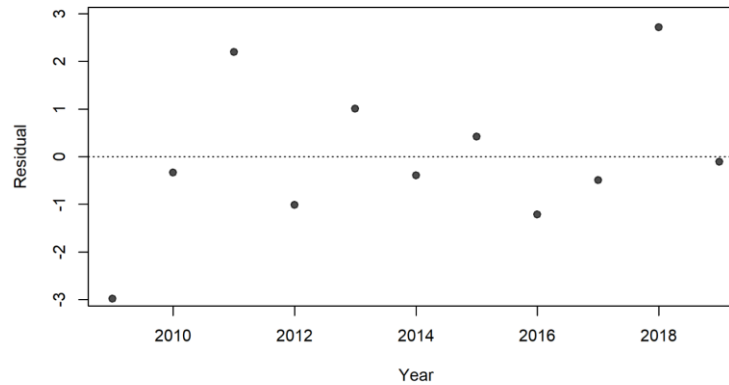
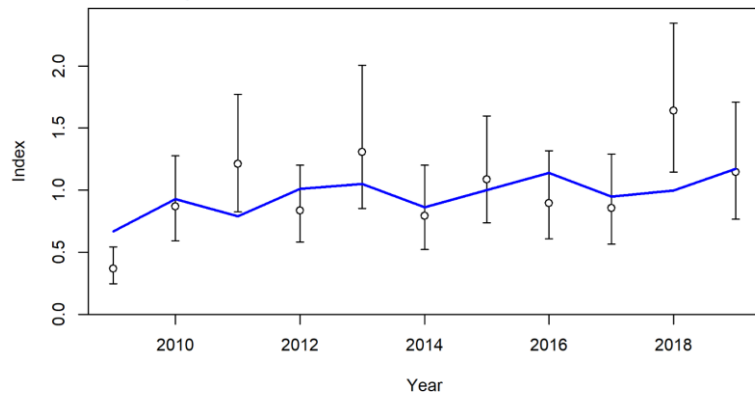
SDNR =1.54

Larval Survey



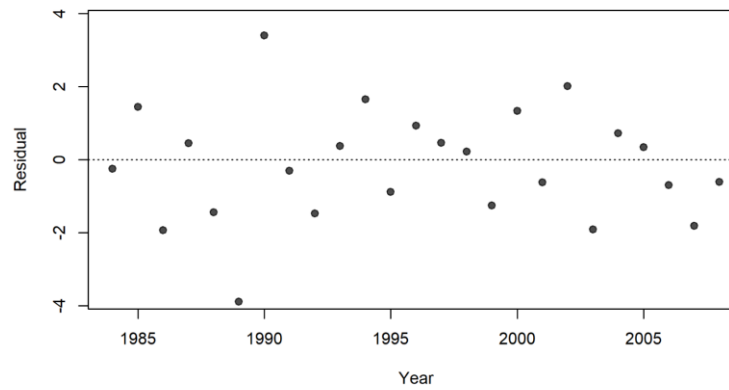
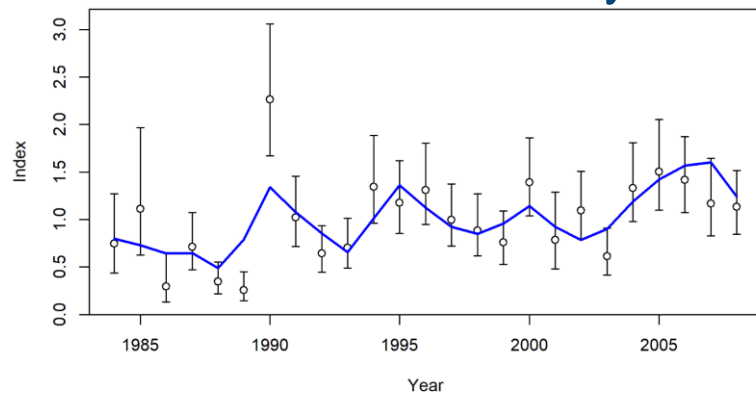
SDNR =2.81

Summer Trawl Late



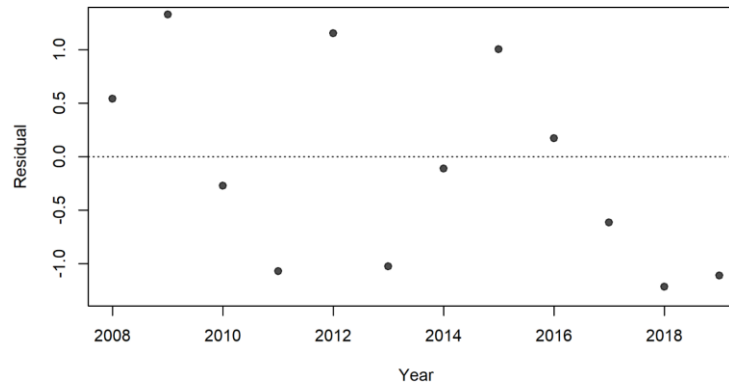
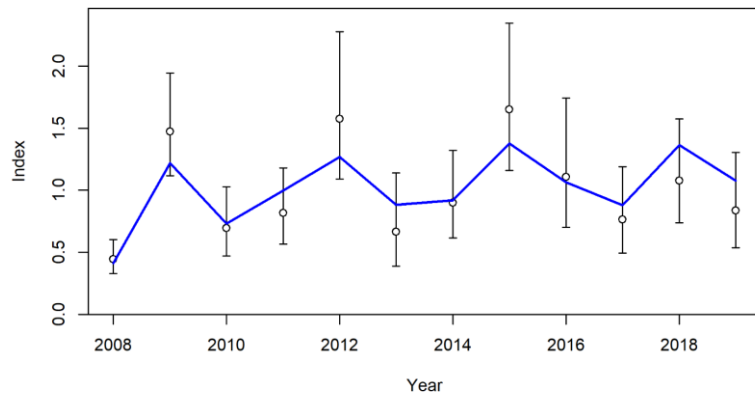
SDNR = 1.59

Summer Trawl Early



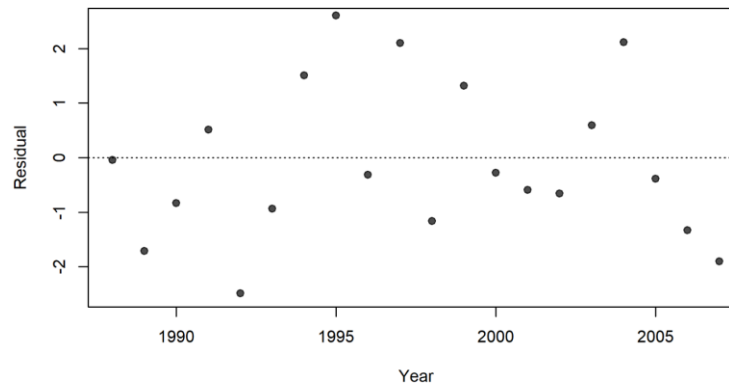
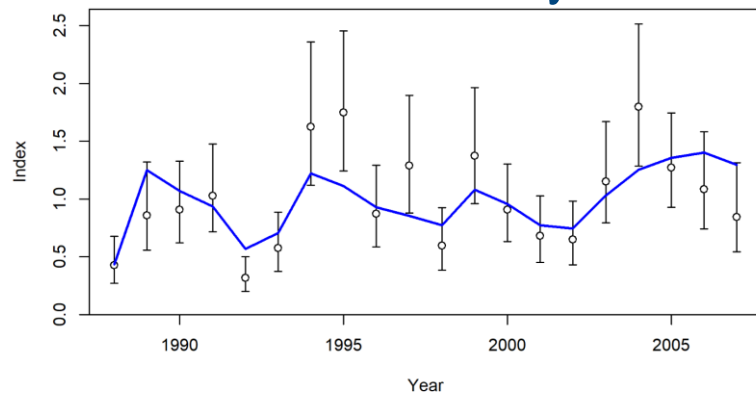
SDNR = 1.55

Fall Trawl Late



SDNR = 0.94

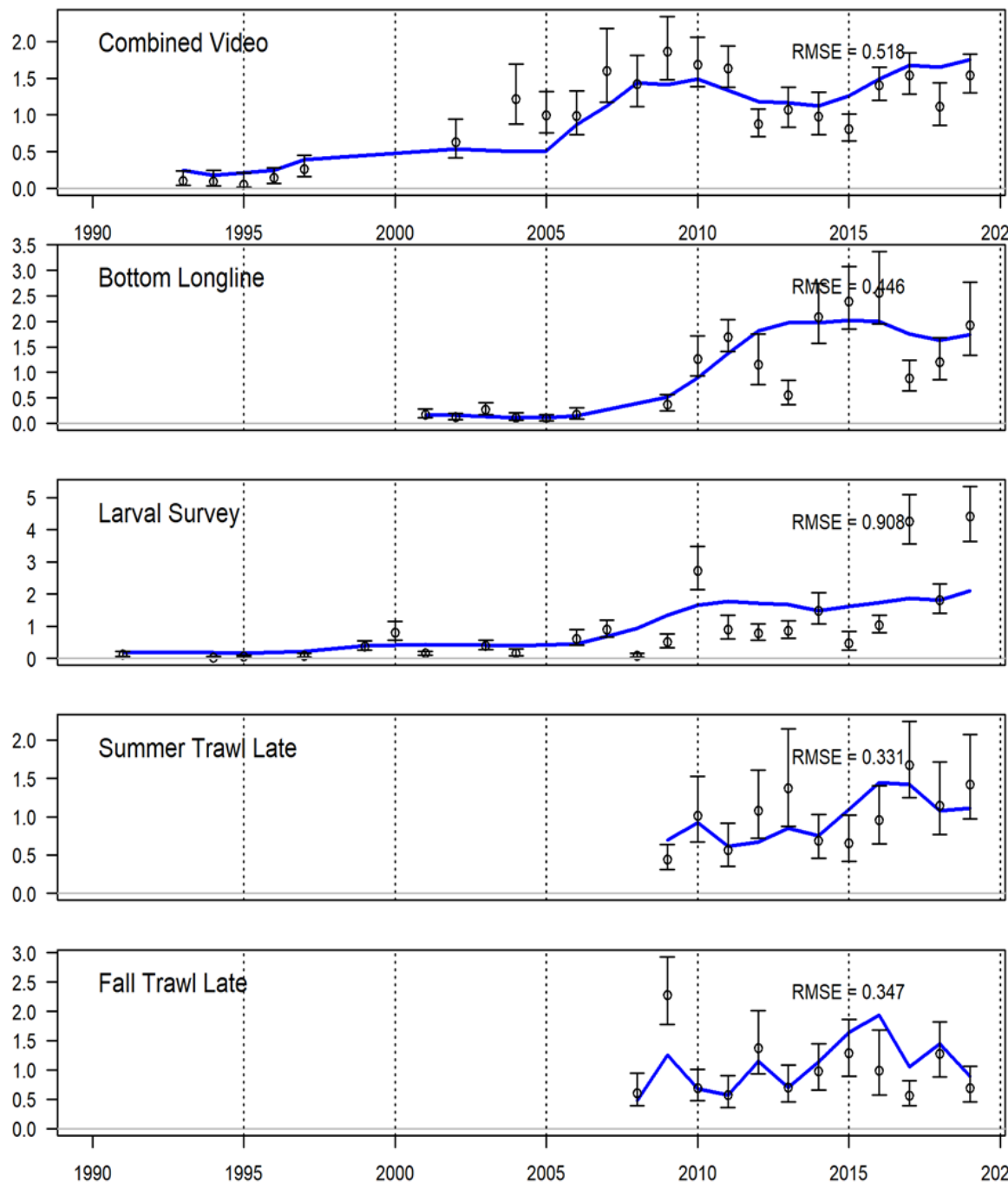
Fall Trawl Early



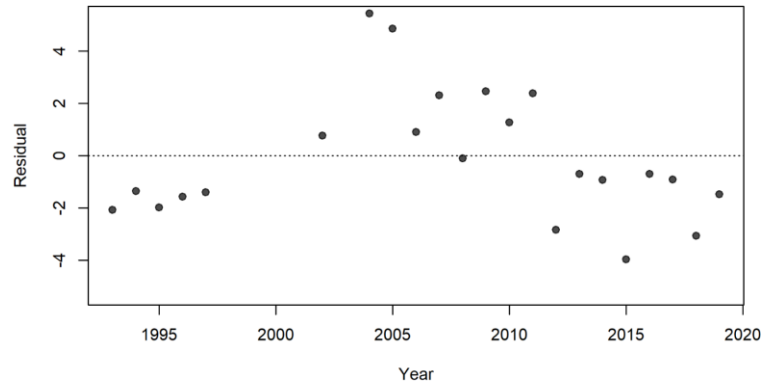
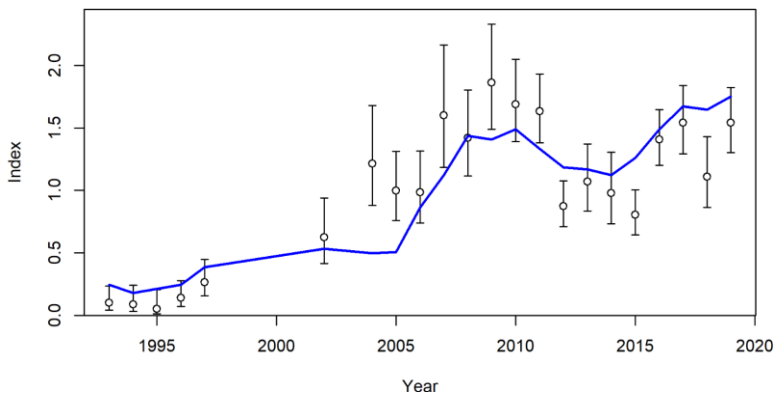
SDNR = 1.43

Indices

- Central area Indices
- Video and Longline - fully recruited
- Larval = SSB
- Summer Trawl - Age 1
- Fall Trawl - Age 0

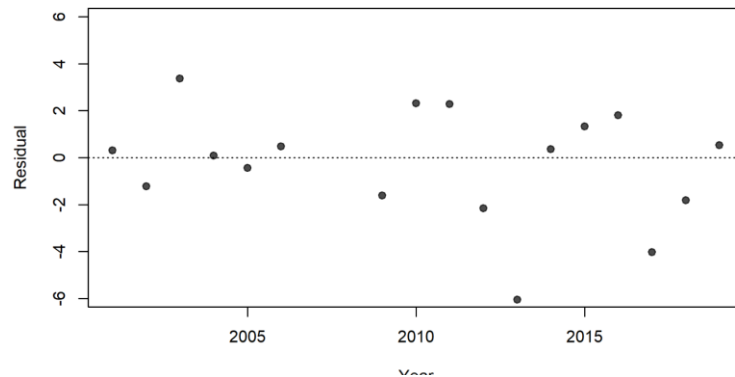
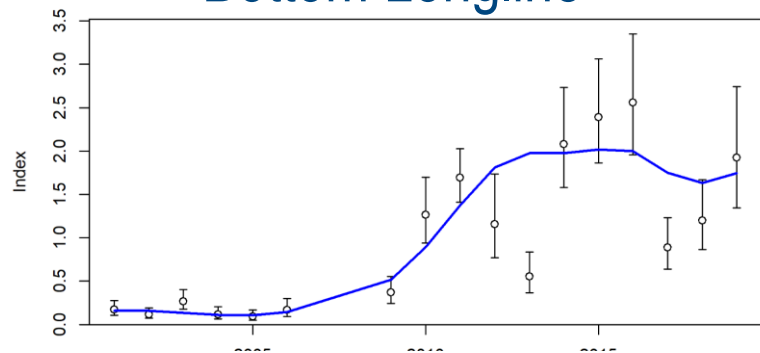


Combined Video



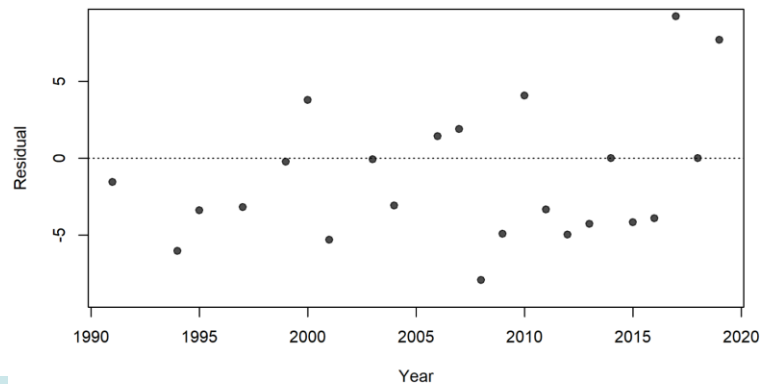
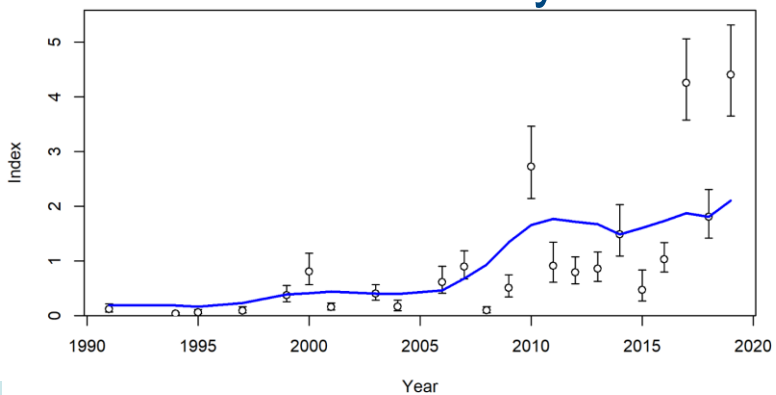
SDNR = 2.45

Bottom Longline



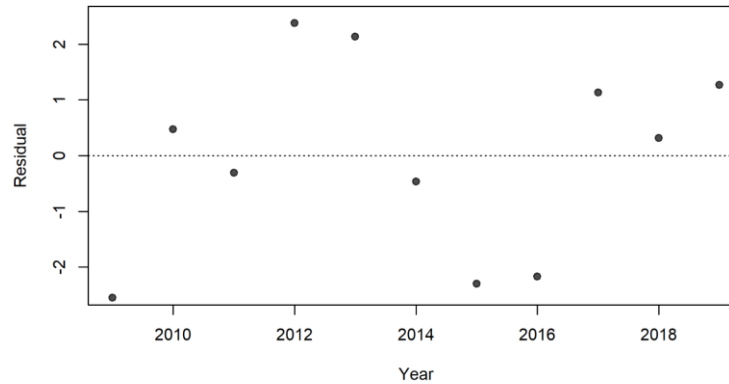
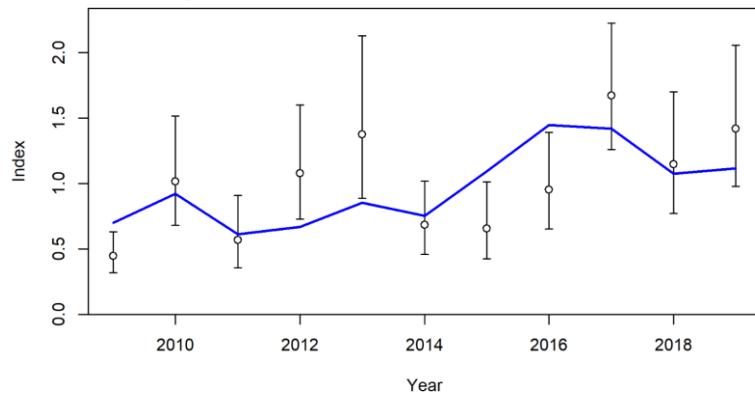
SDNR = 2.39

Larval Survey

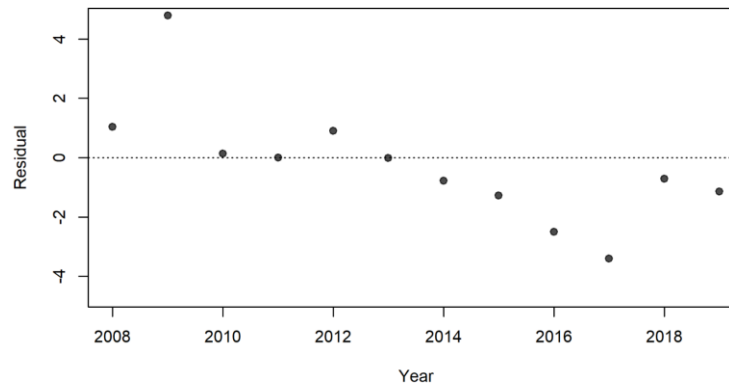
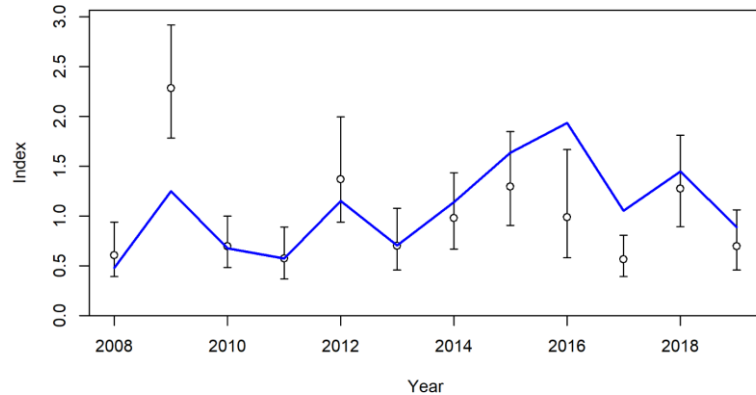


SDNR = 4.35

Summer Trawl Late

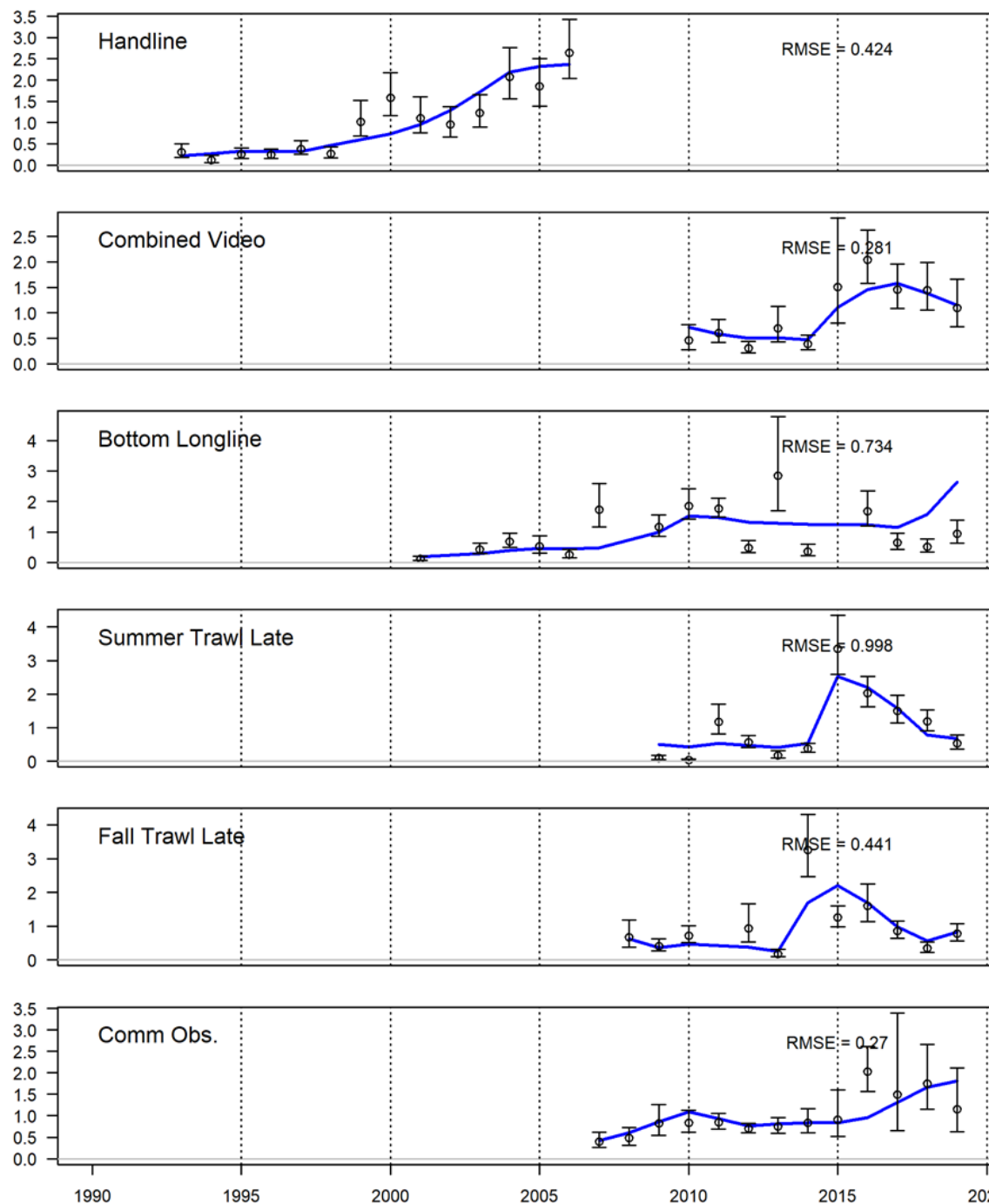


Fall Trawl Late

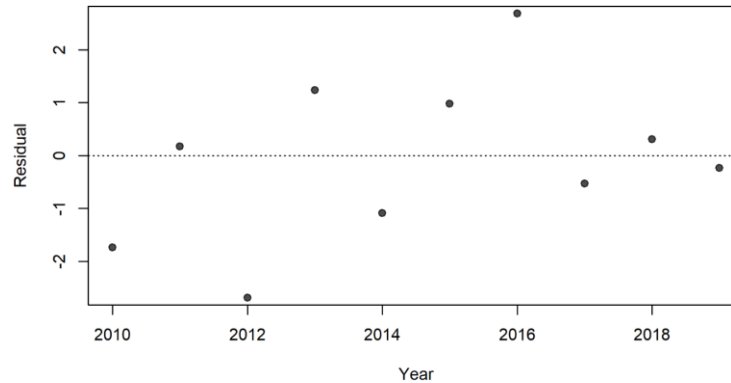
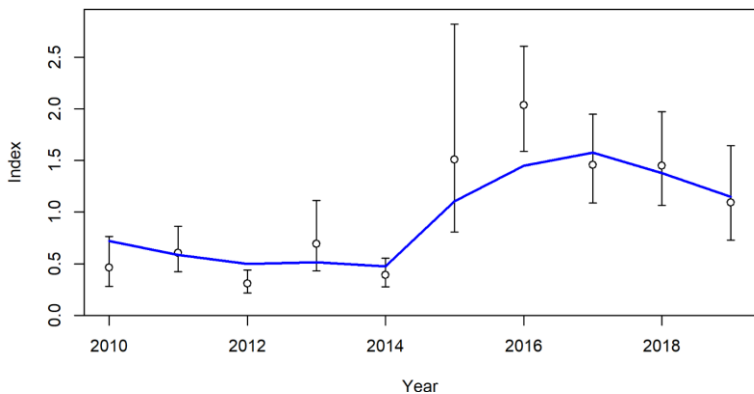


Indices

- East area Indices
- Handline, Comm Obs., Video and Longline - fully recruited
- Summer Trawl - Age1
- Fall Trawl - Age0

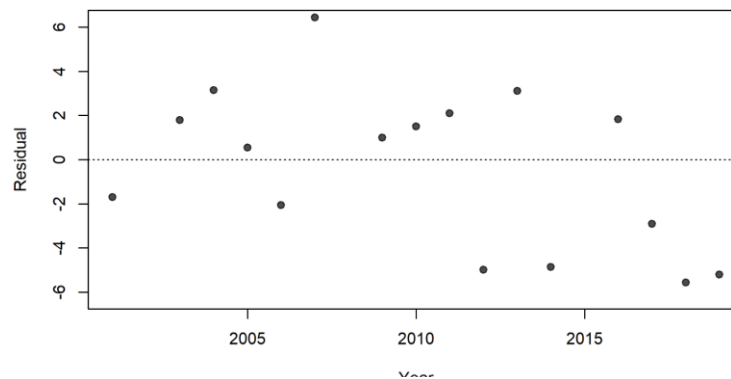
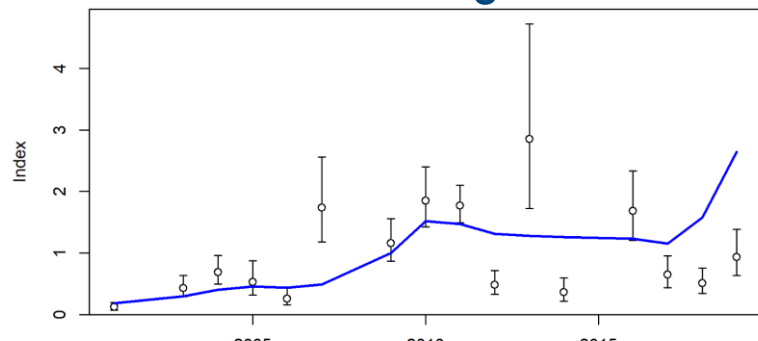


Combined Video



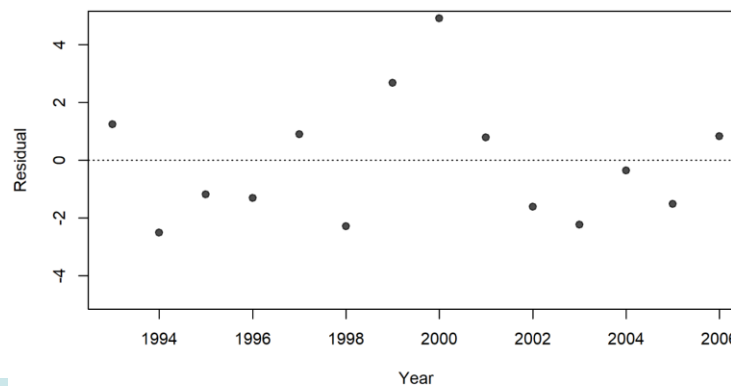
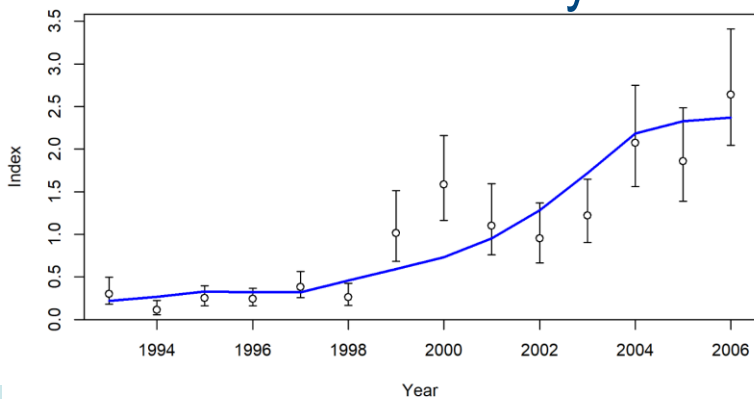
SDNR = 1.54

Bottom Longline



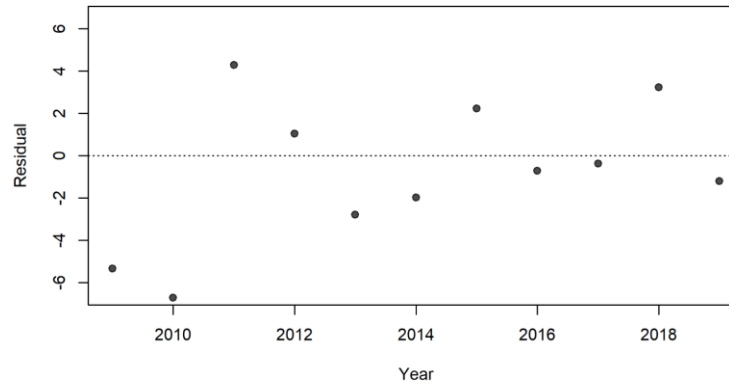
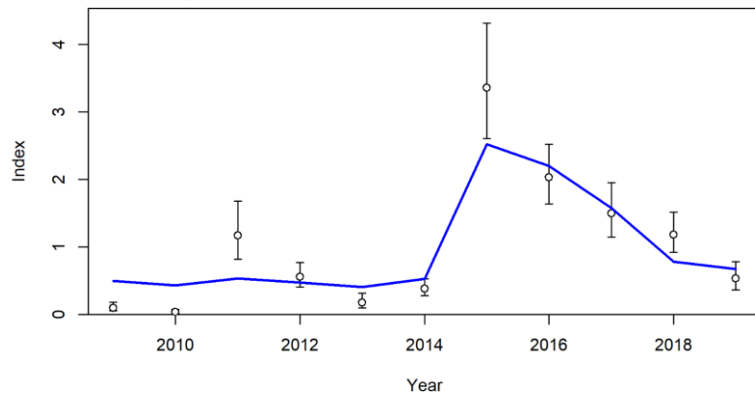
SDNR = 3.61

Handline Survey



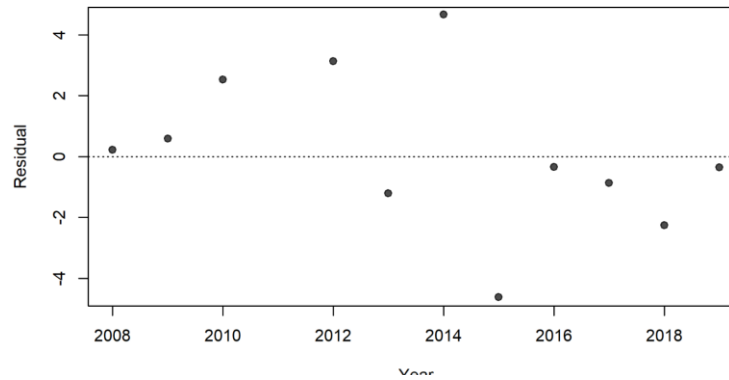
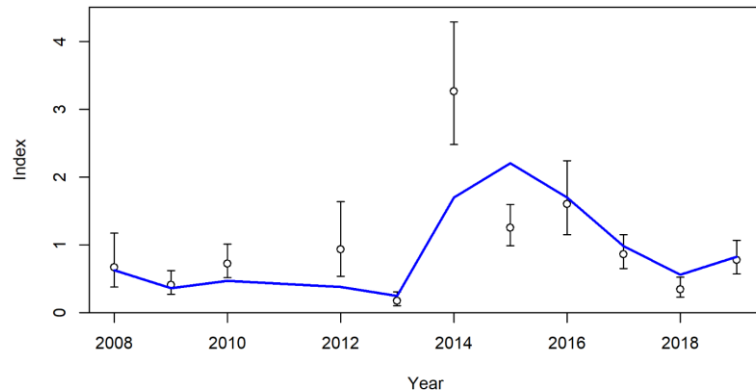
SDNR = 2.14

Summer Trawl Late



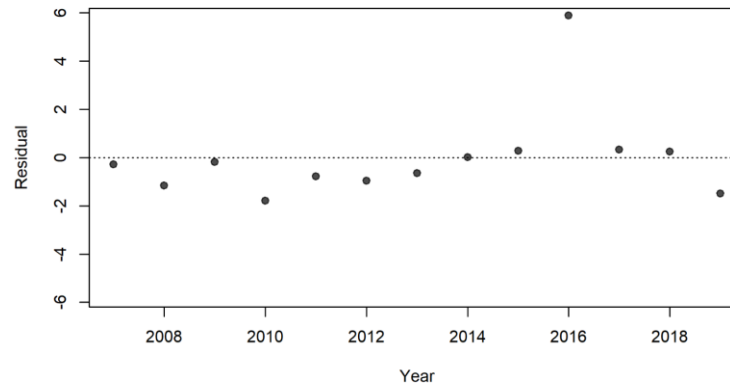
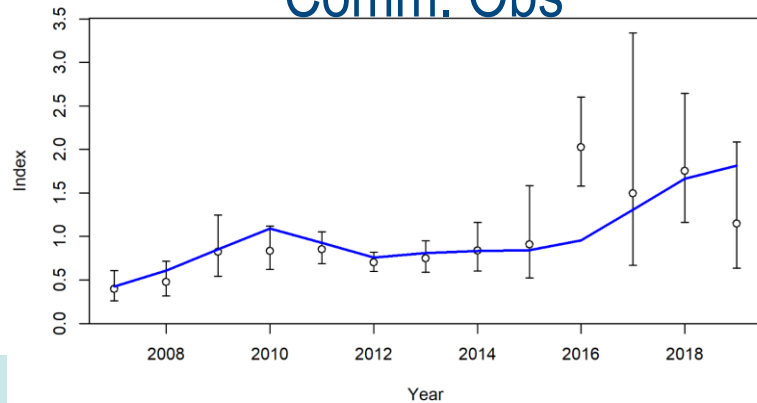
SDNR = 3.41

Fall Trawl Late



SDNR = 2.59

Comm. Obs

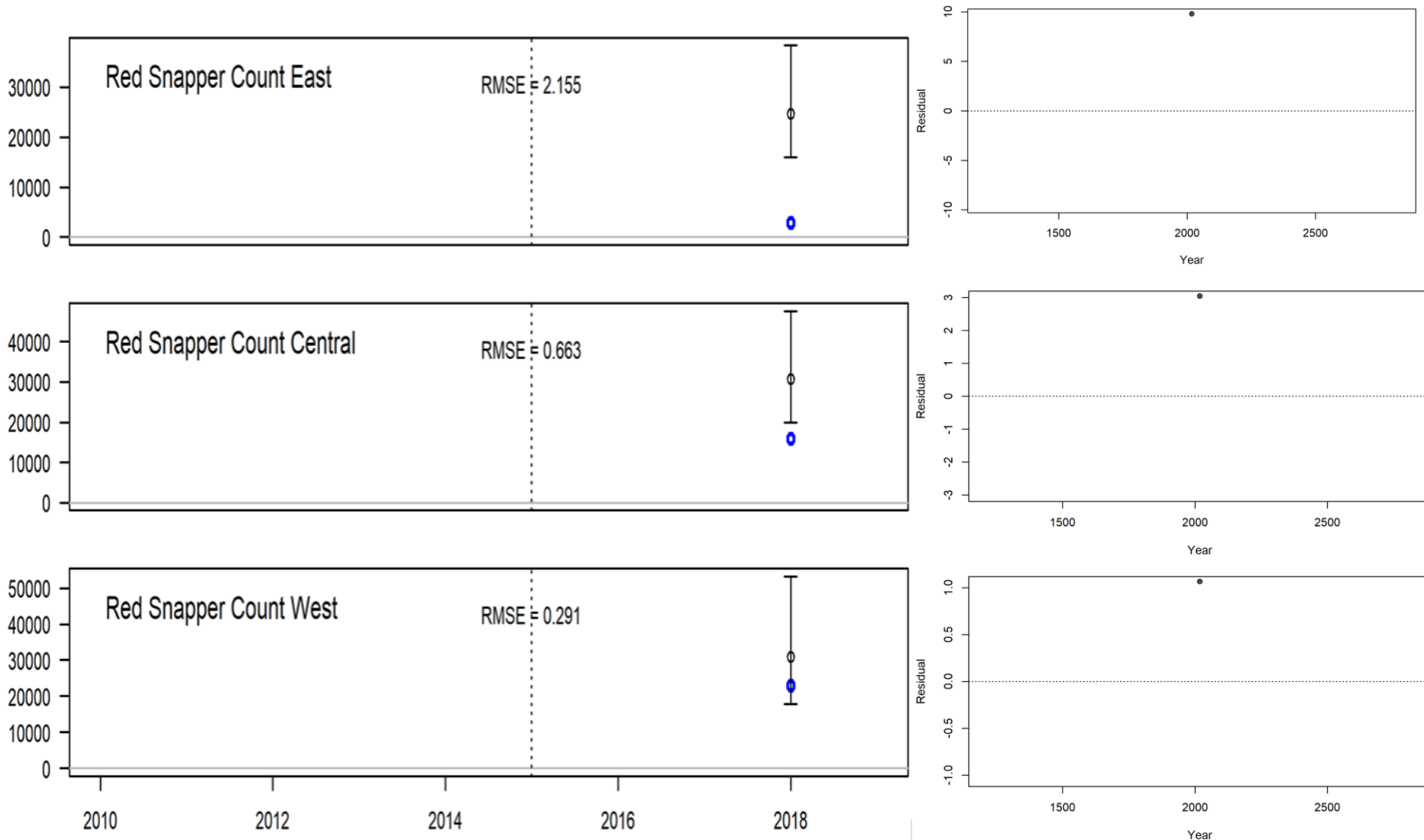


SDNR = 1.91

Model Fits

Index of Absolute Abundance

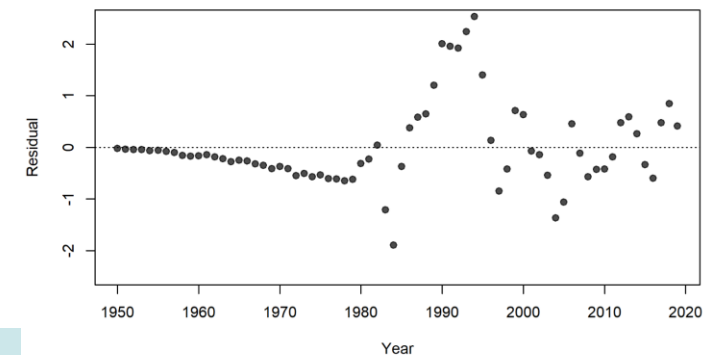
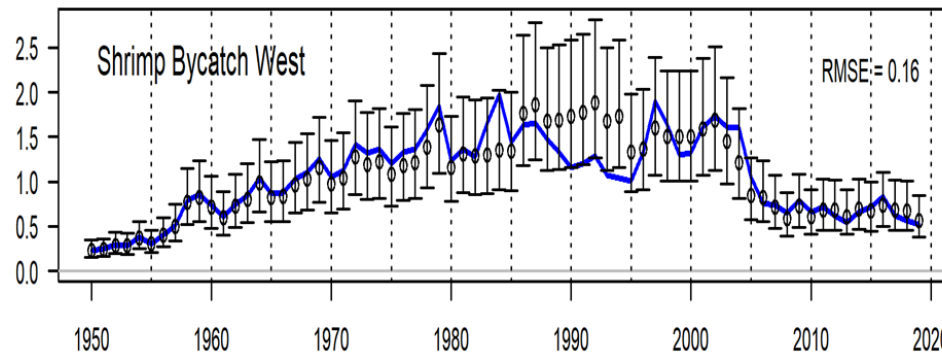
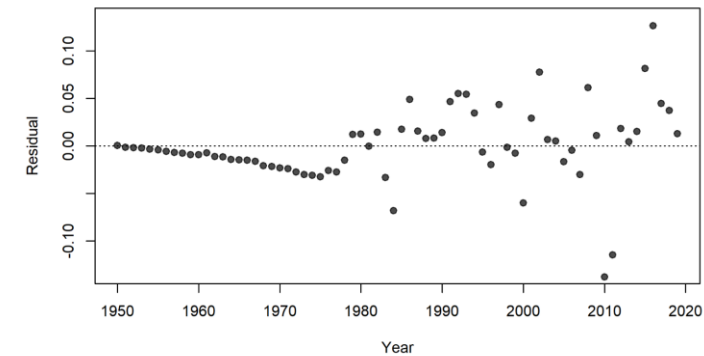
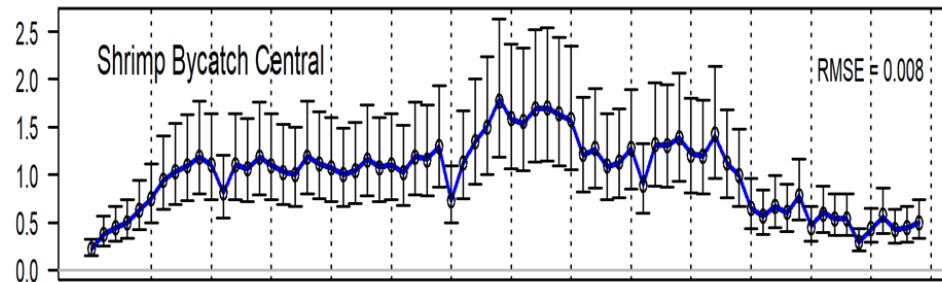
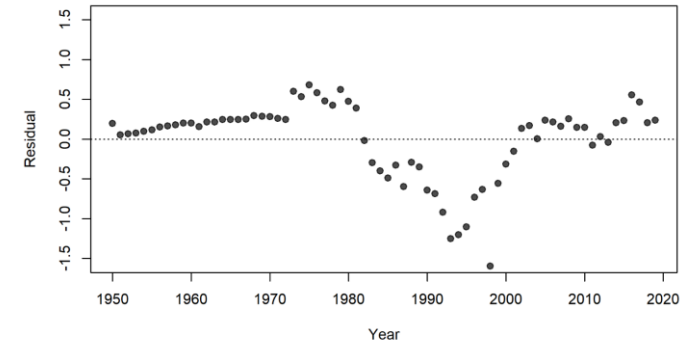
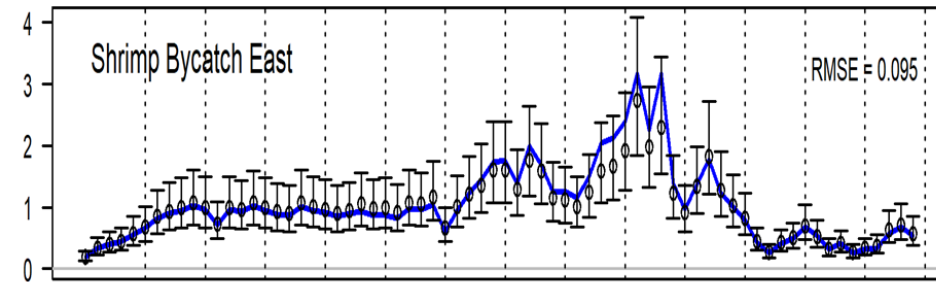
GRSC index of absolute abundance



Model Fits

Shrimp Effort Time series

Shrimp Effort Time Series

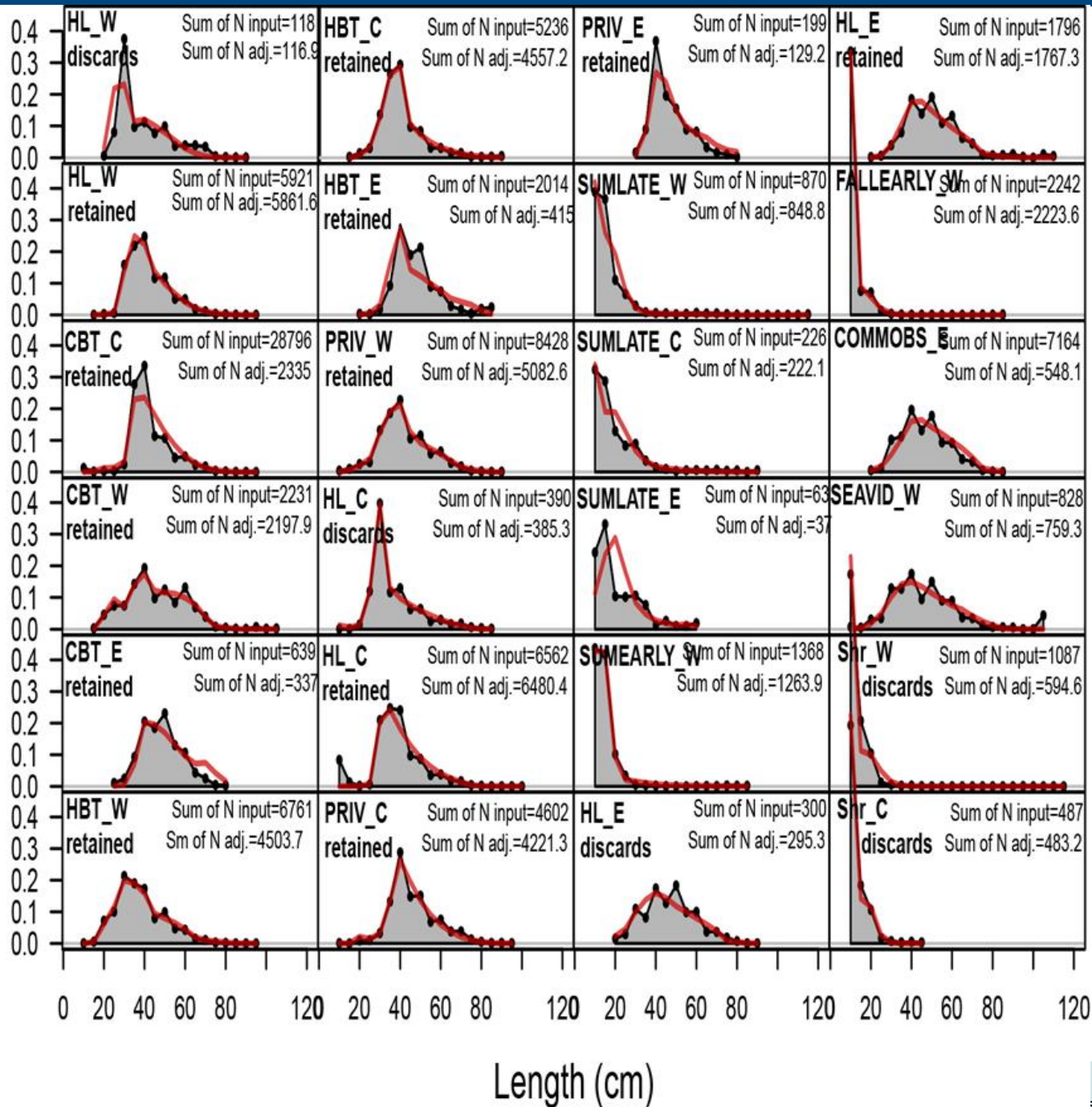


Questions about Fits to Indices

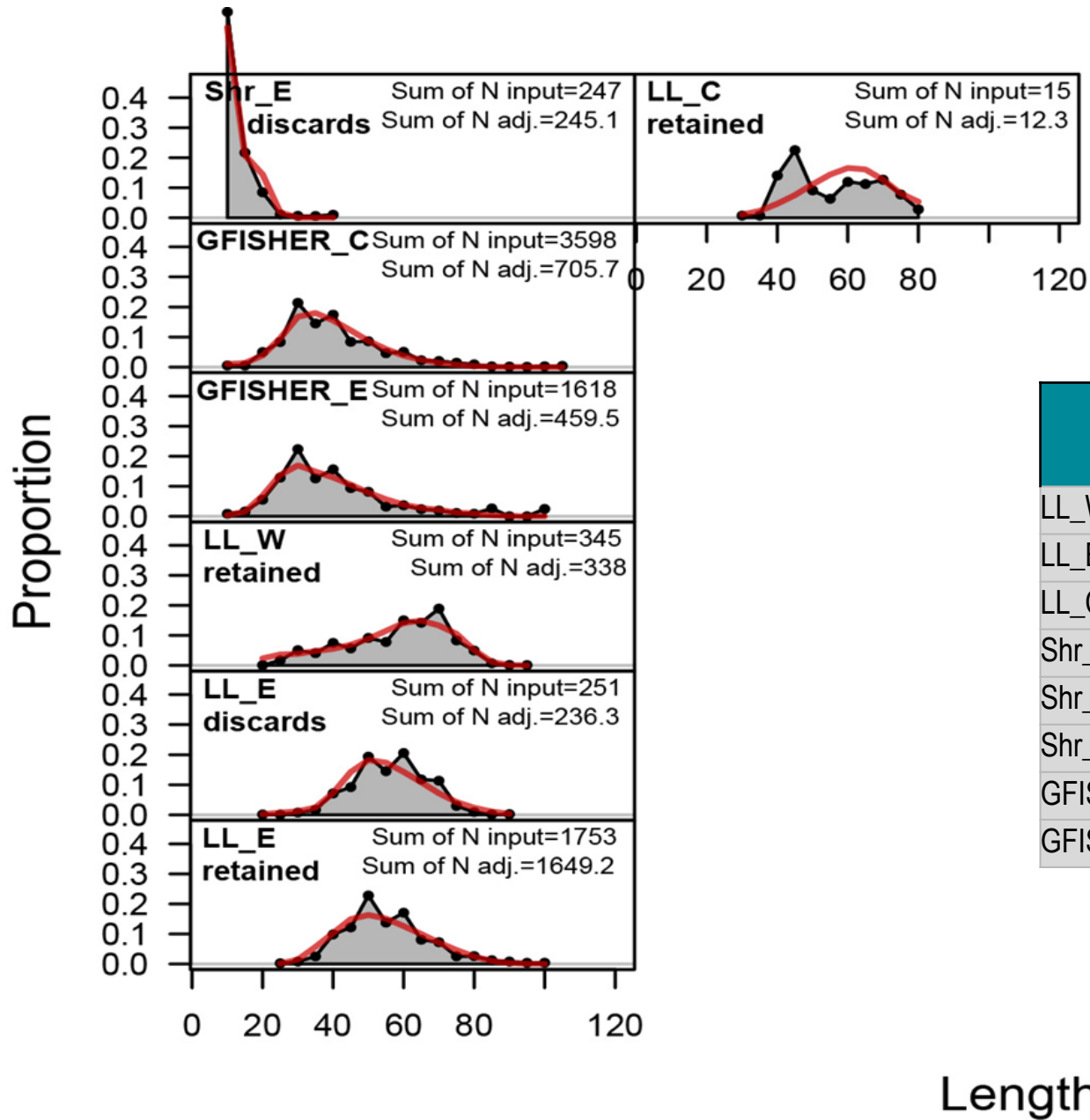


Model Fits

Length Based Selectivity and Composition



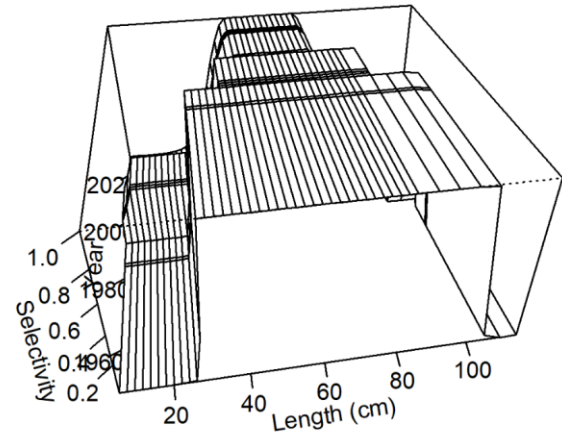
Fleet	Ln(Theta)
HL_W	4.585
HL_C	4.37
HL_E	4.1
SEAVID_W	2.377
CBT_C	-2.44
CBT_W	4.182
CBT_E	0.07
HBT_W	0.683
HBT_C	1.896
HBT_E	-1.39
PRIV_W	0.411
PRIV_C	2.398
PRIV_E	0.559
SUMLATE_W	3.676
SUMLATE_C	3.997
SUMLATE_E	0.238
SUMEARLY_W	2.479
FALLEARLY_W	4.784
COMMOBS_E	-2.51



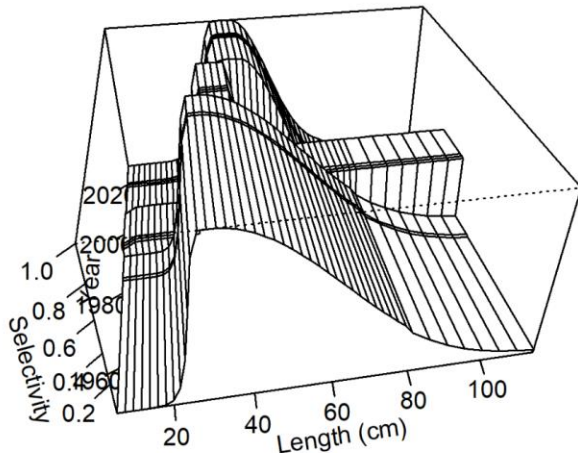
Fleet	Ln(Theta)
LL_W	3.827
LL_E	2.745
LL_C	1.451
Shr_W	0.149
Shr_C	4.799
Shr_E	4.779
GFISHER_C	-1.44
GFISHER_E	-0.95

Handline Fleets (Double Normal Form)

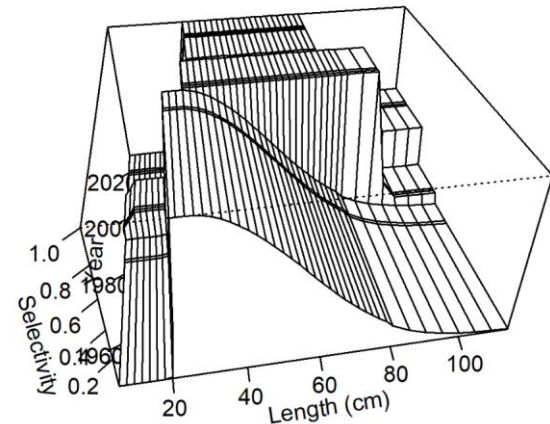
- All parameters estimated except start and end logit params for base block



East



West



Central

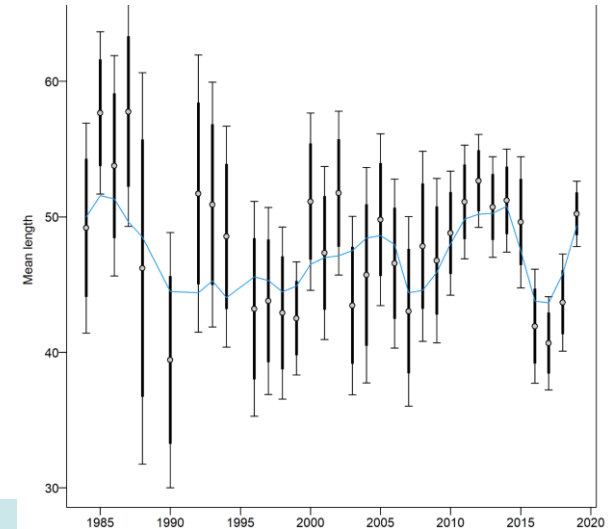
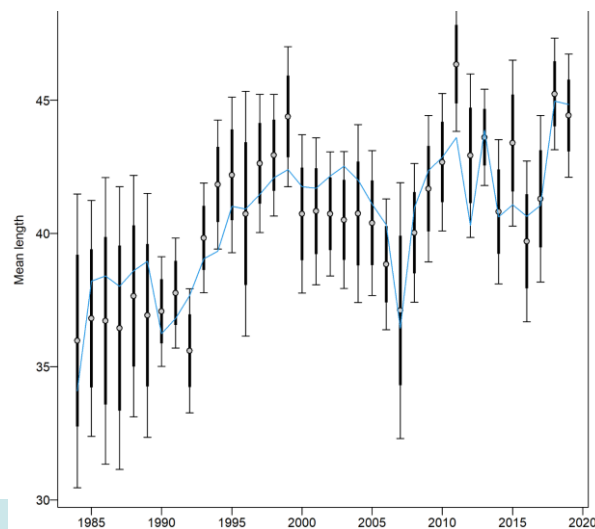
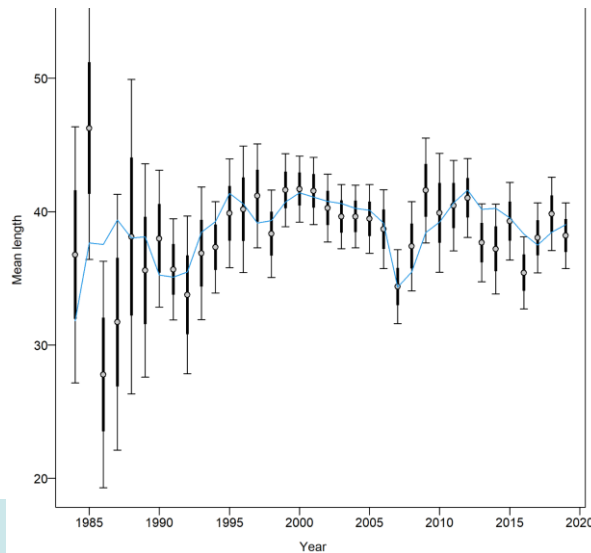
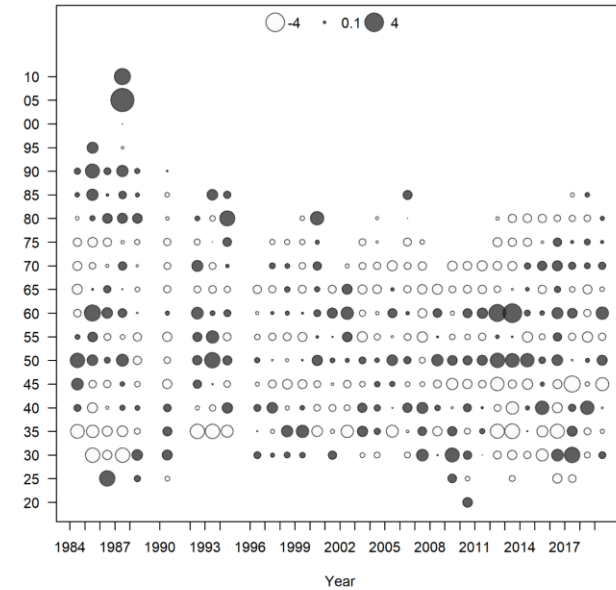
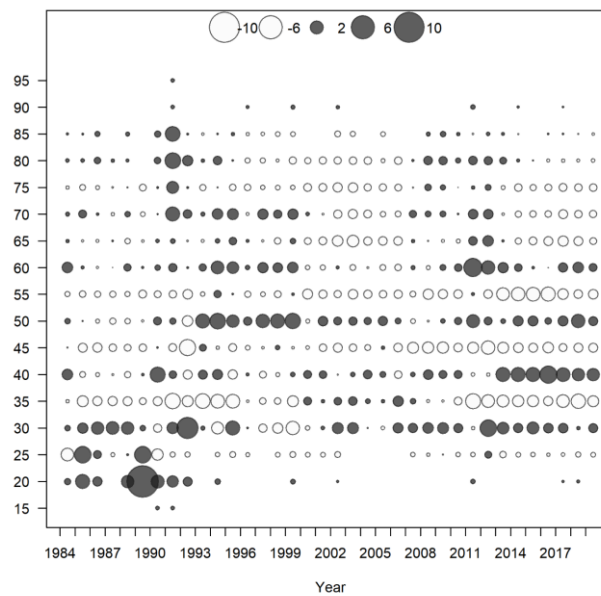
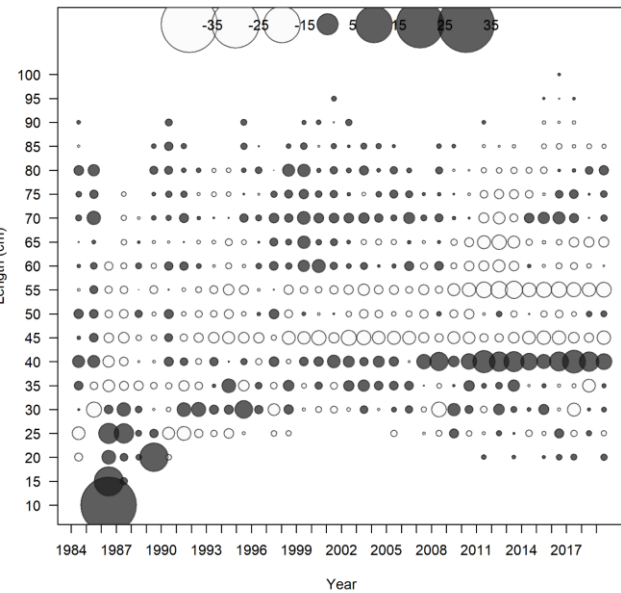
Handline Retained Length Comp Fits

● = pos
○ = neg

Central

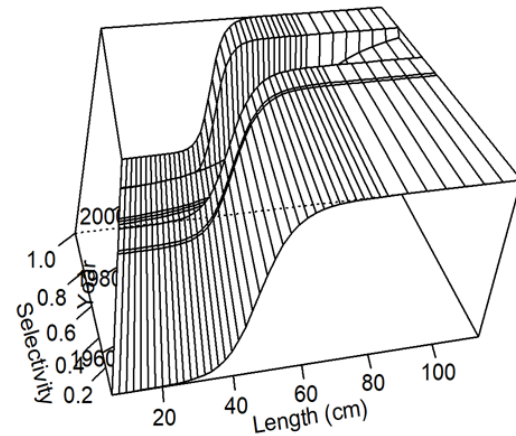
West

East

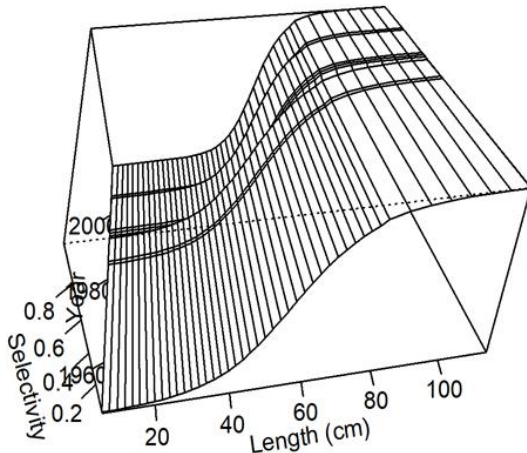


Longline fleets (logistic form)

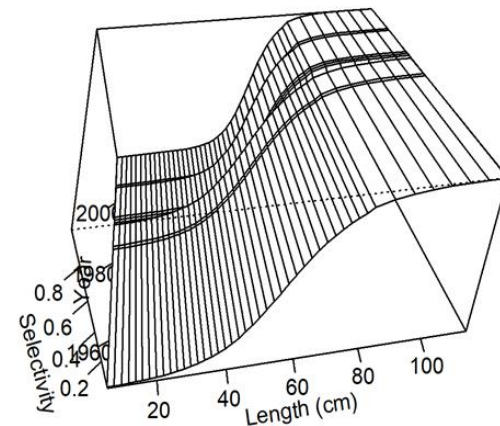
- Central mirrored to the West
- All parameters estimated for all blocks



East



West



Central

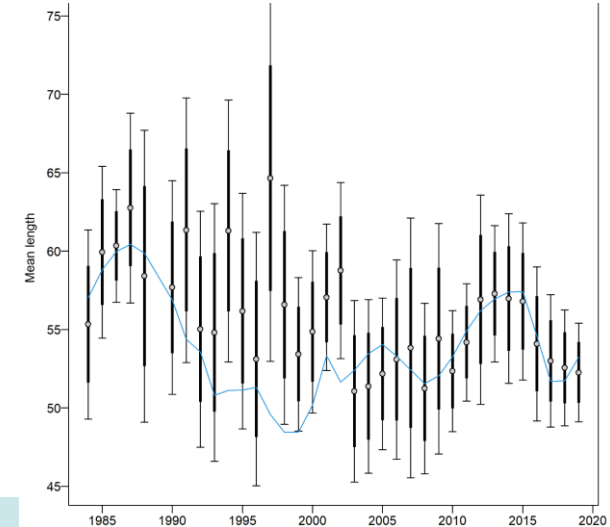
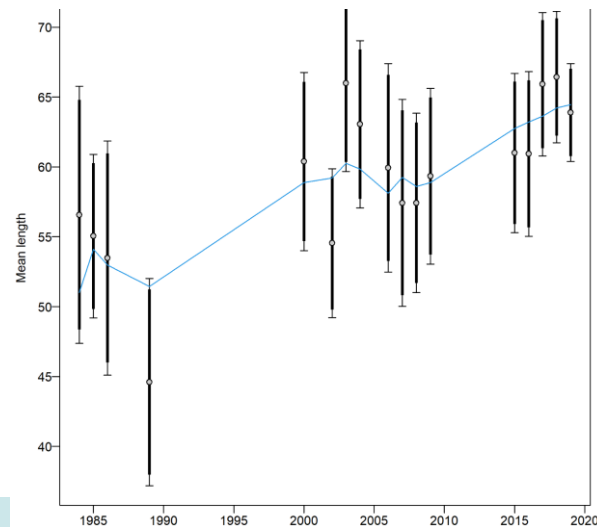
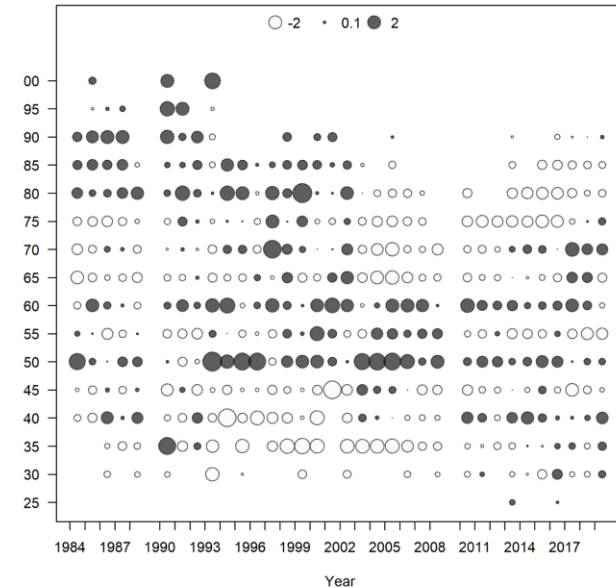
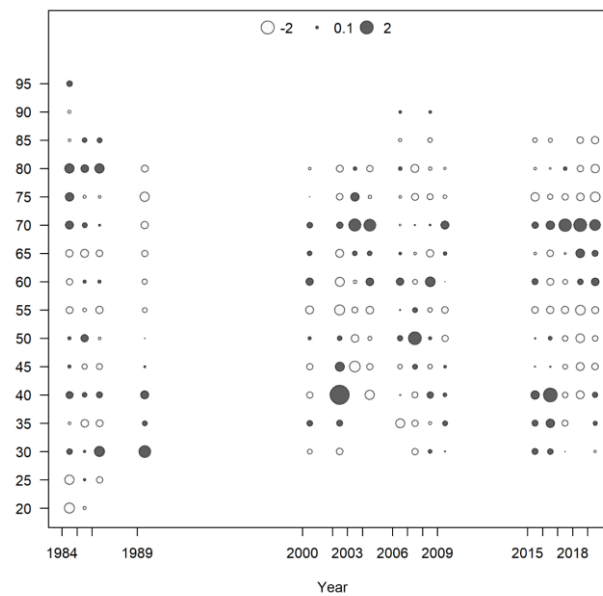
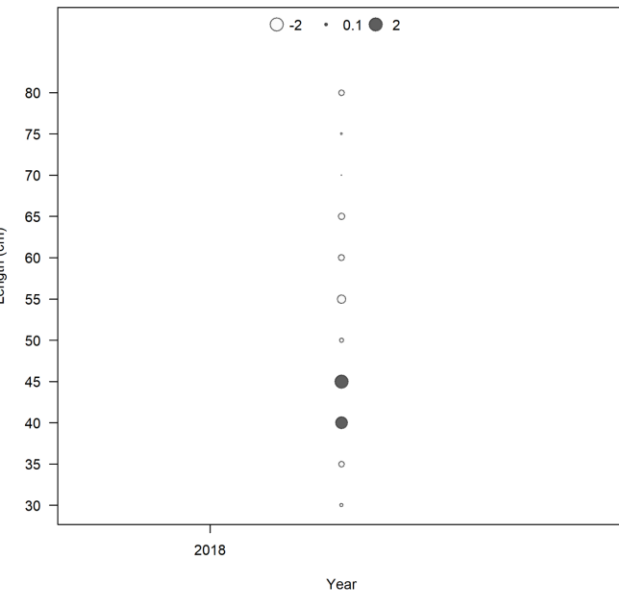
Longline Retained Length Comp Fits

● = pos
○ = neg

Central

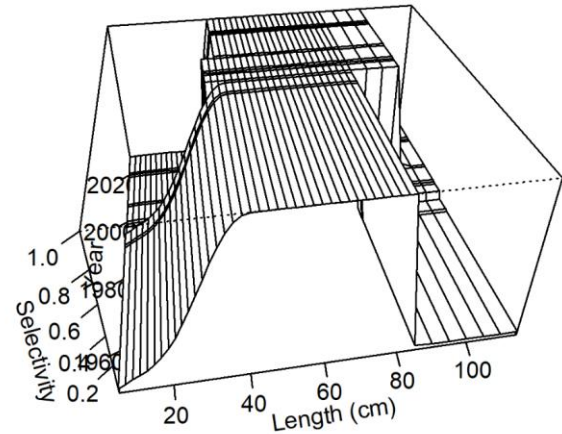
West

East

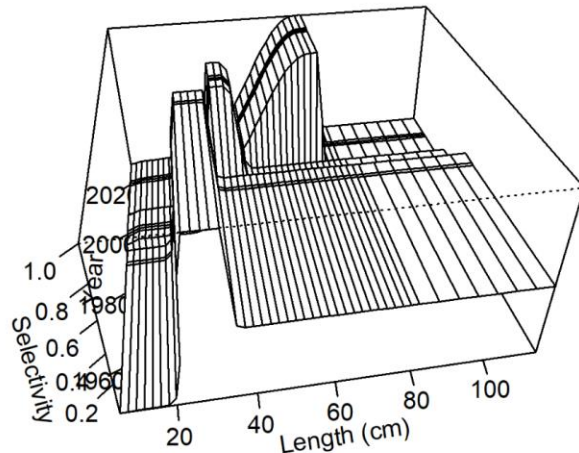


Charter Boat Fleets (Double Normal Form)

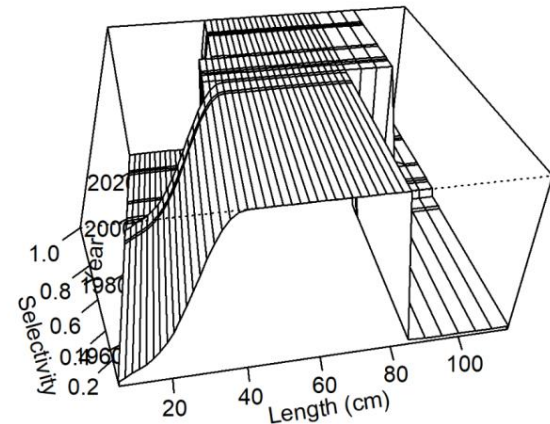
- East mirrored to Central
- All parameters estimated for all blocks



East



West



Central

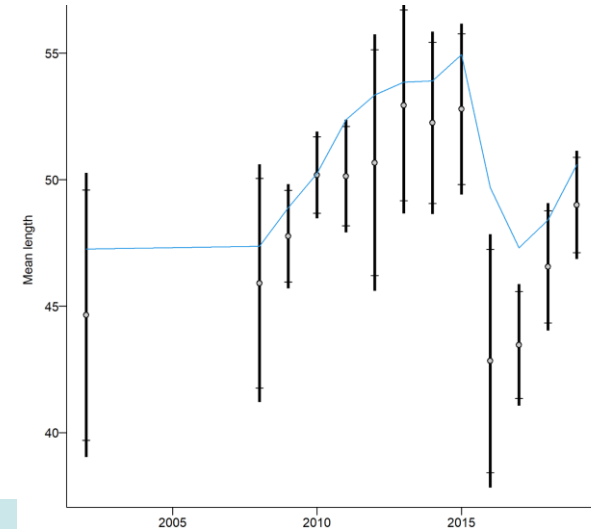
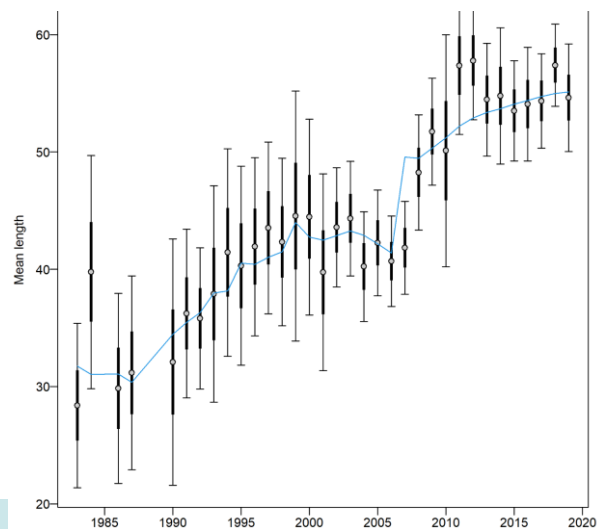
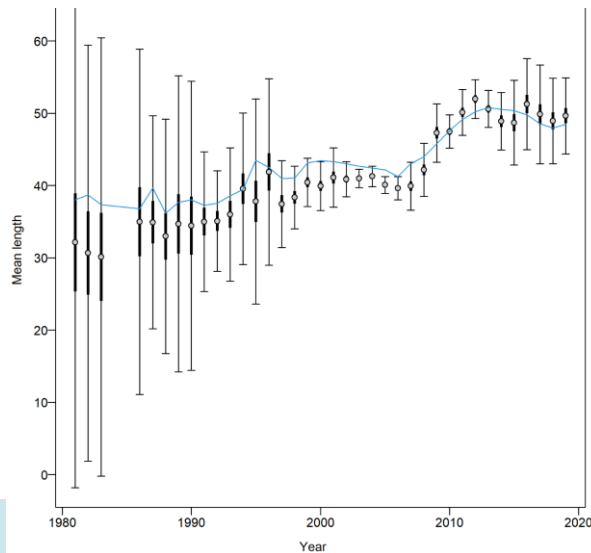
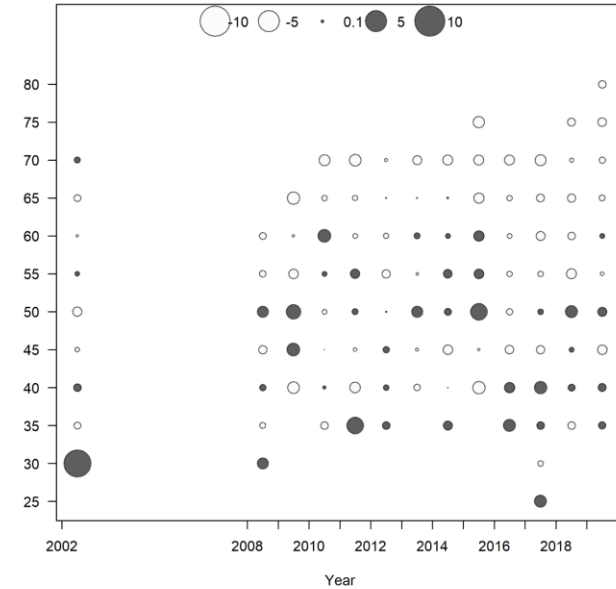
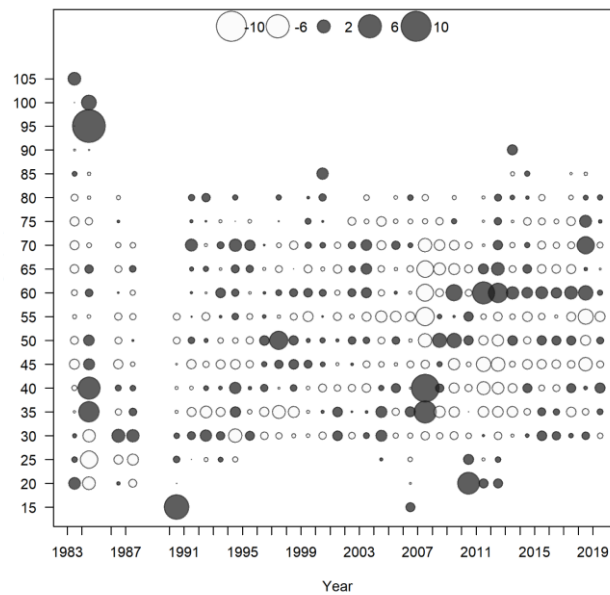
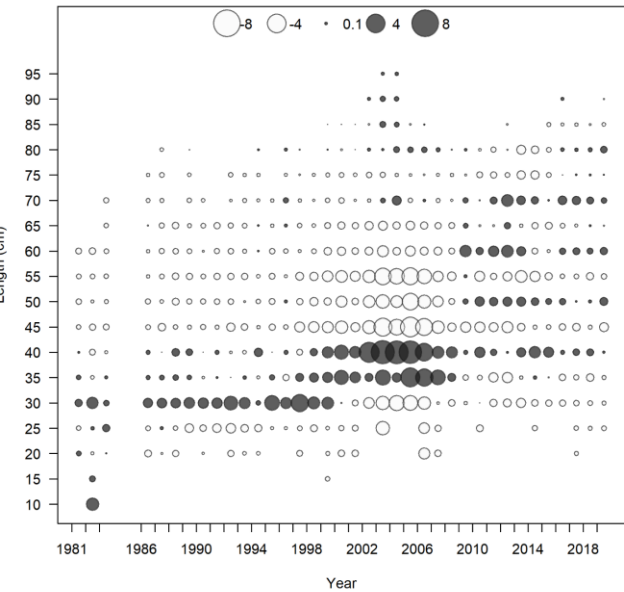
Charter Boat Retained Length Comp Fits

● = pos
○ = neg

Central

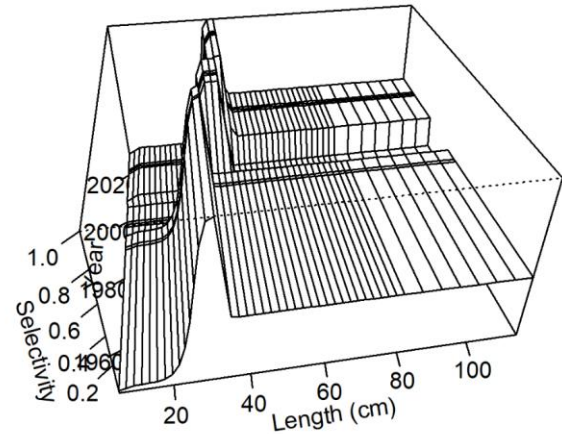
West

East

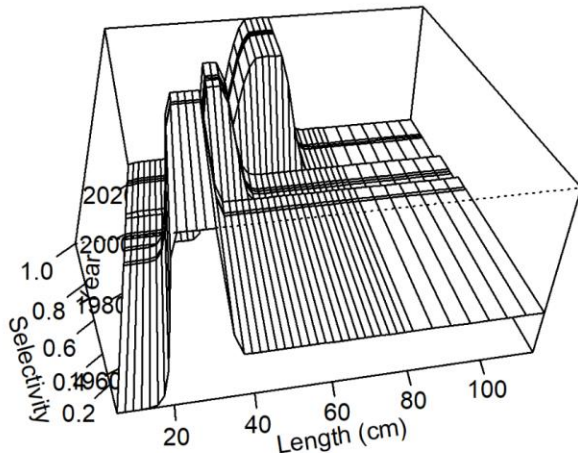


Headboat Fleets (Double Normal Form)

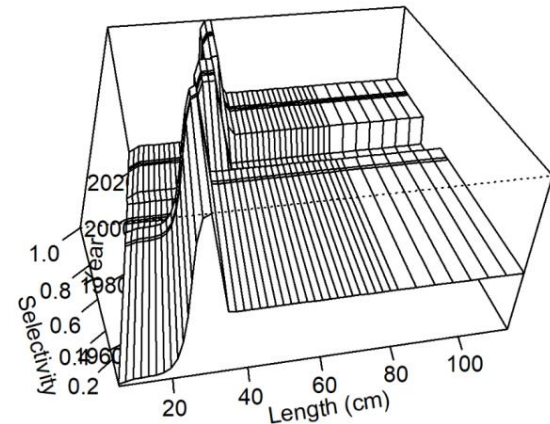
- East mirrored to Central
- All parameters estimated for all blocks



East



West



Central

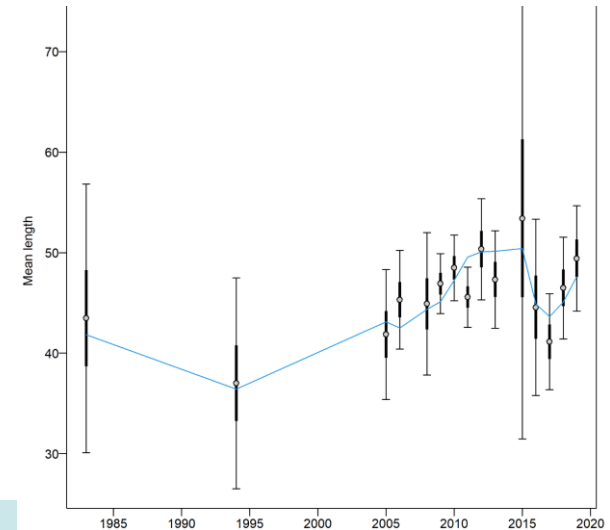
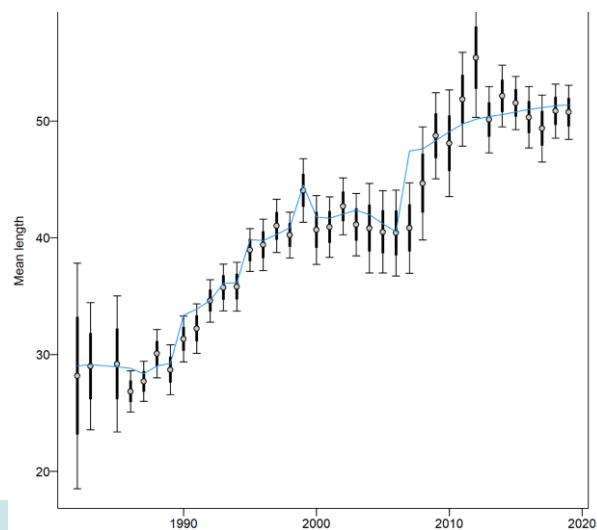
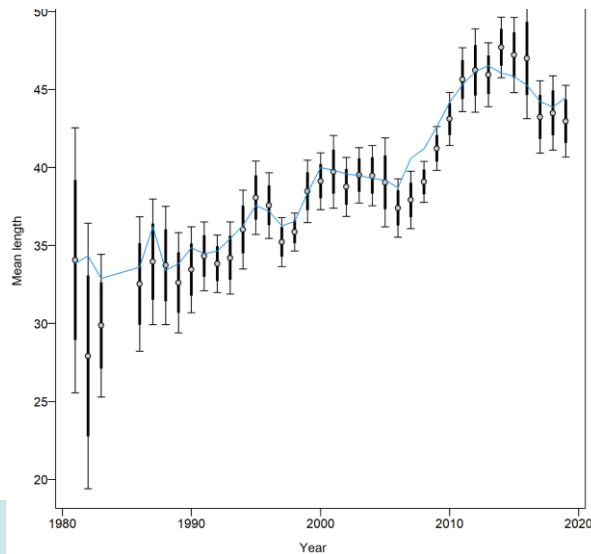
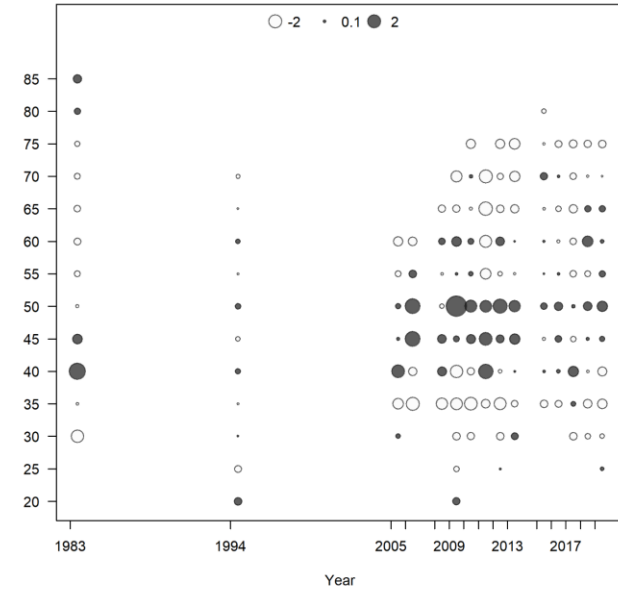
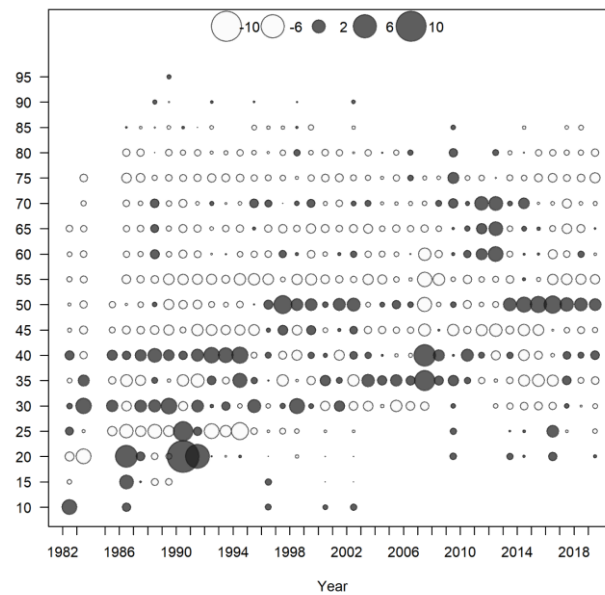
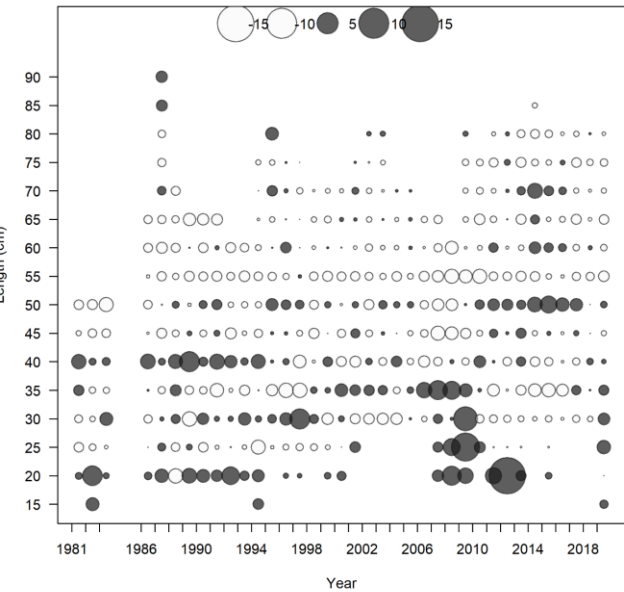
Headboat Retained Length Comp Fits

● = pos
○ = neg

Central

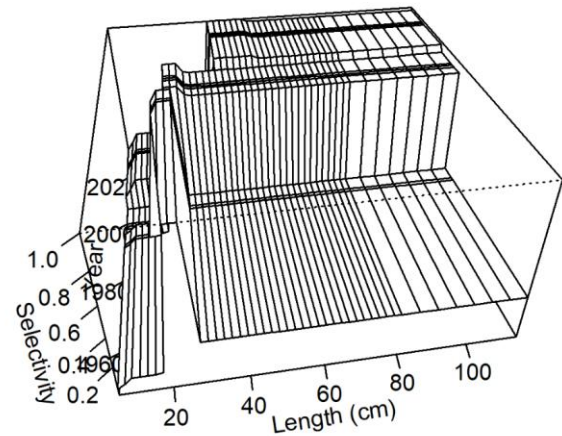
West

East

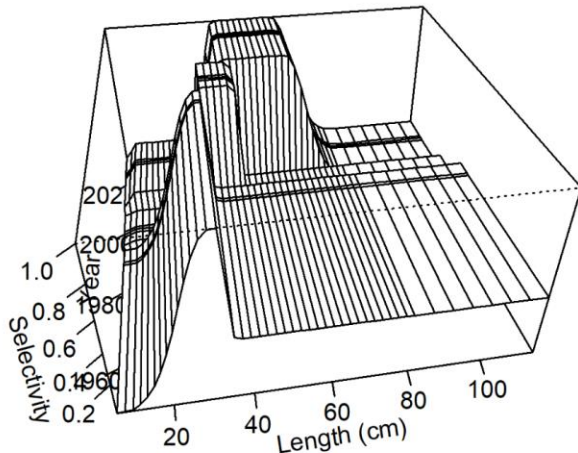


Private Rec. Fleets (Double Normal Form)

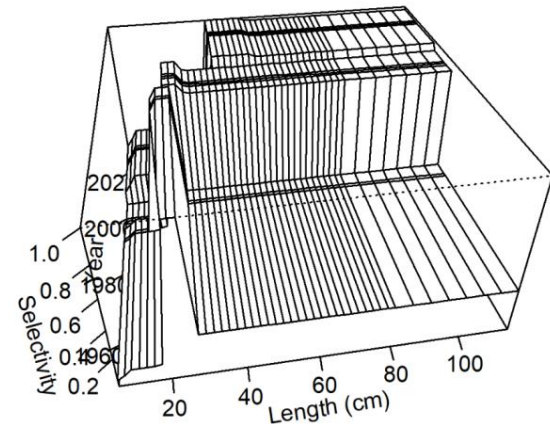
- East mirrored to Central
- All parameters estimated for all blocks



East



West



Central

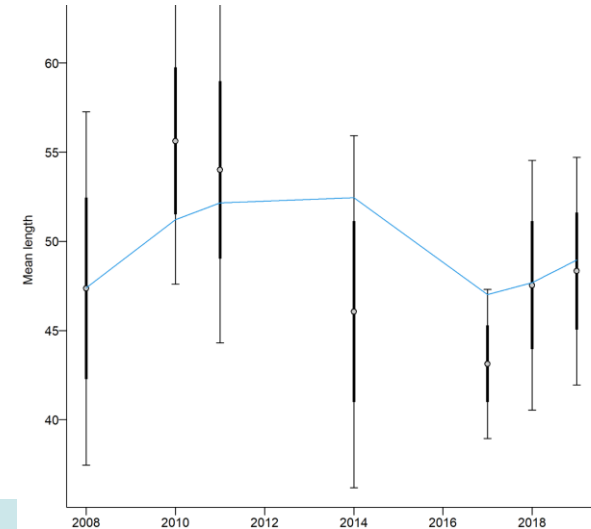
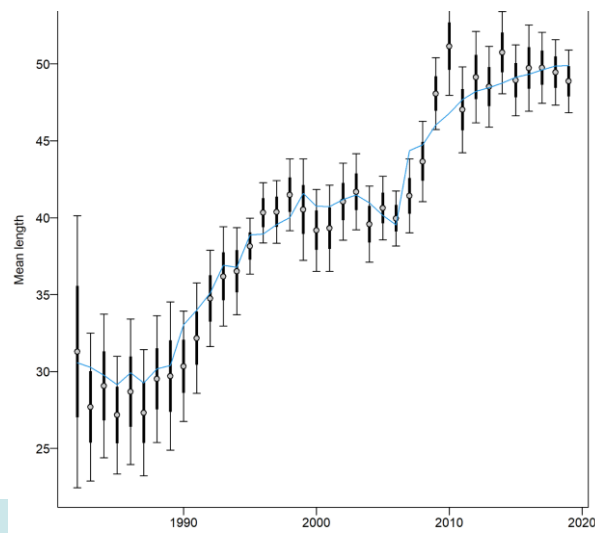
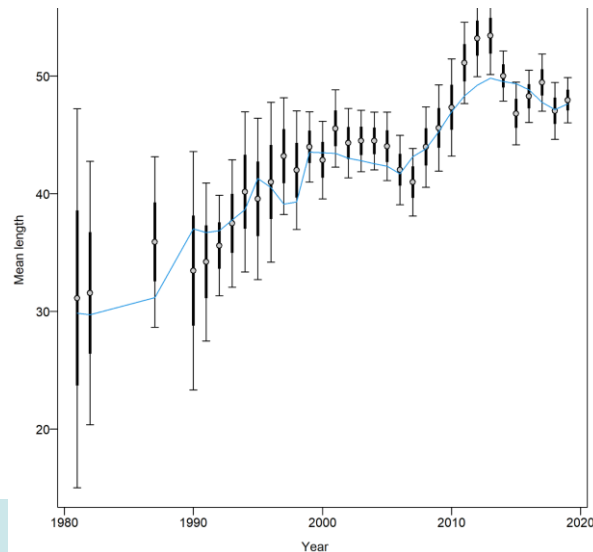
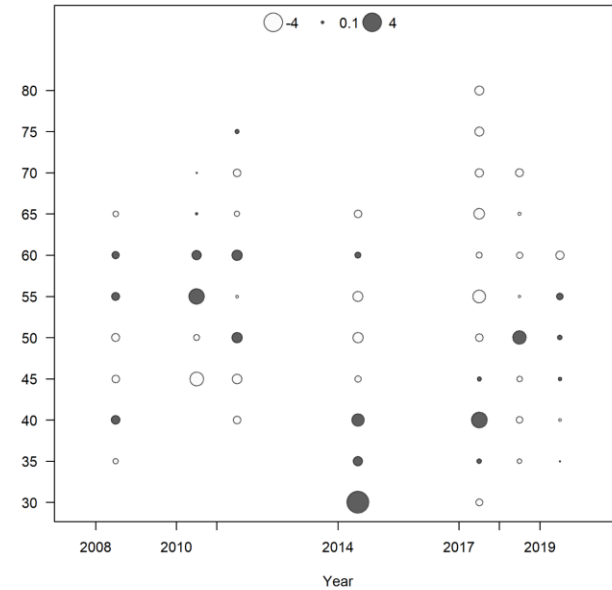
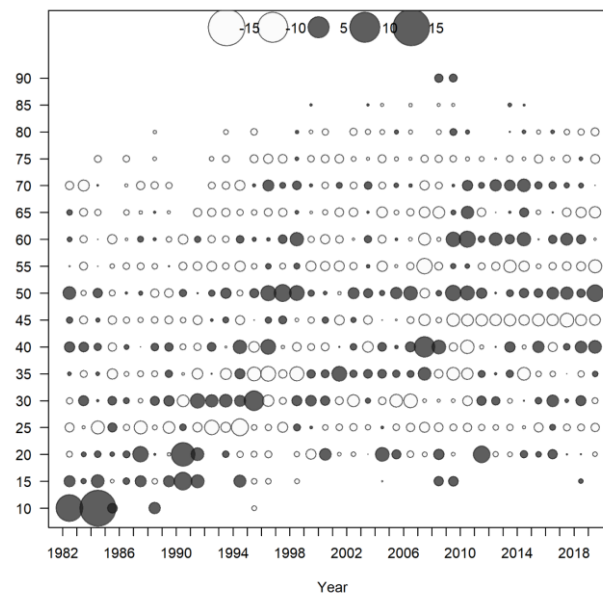
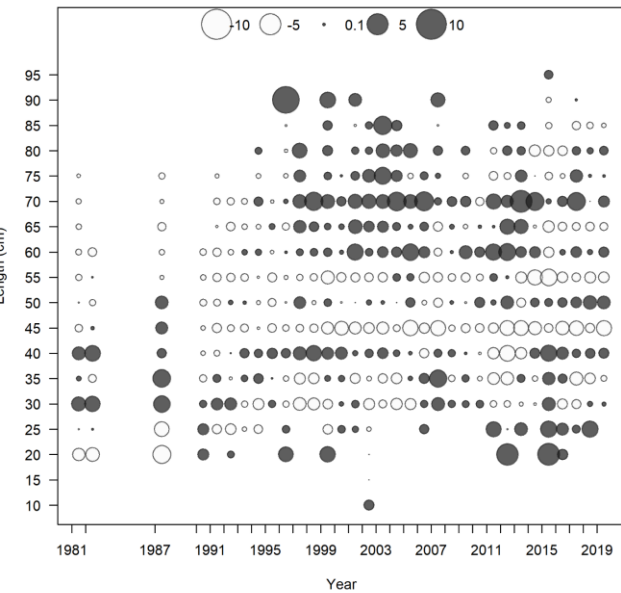
Private Rec. Retained Length Comp Fits

● = pos
○ = neg

Central

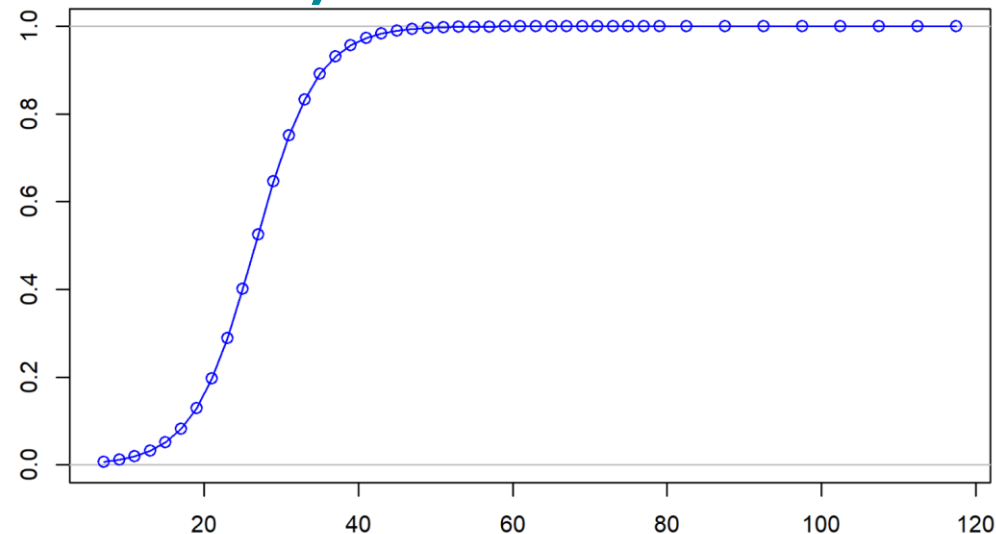
West

East

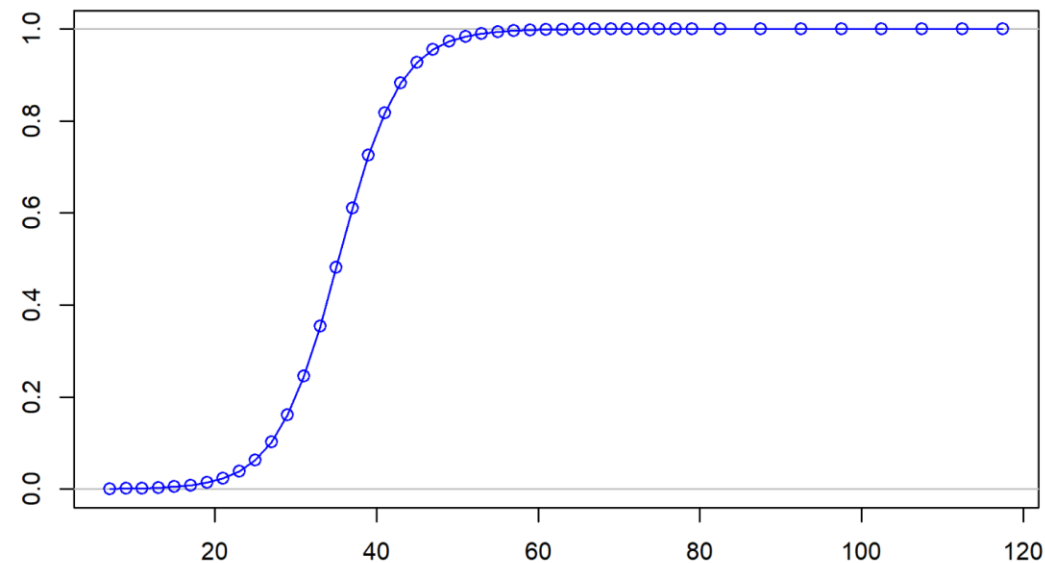


Video Surveys (Logistic Form)

- All parameters estimated.
- Only central used time blocks

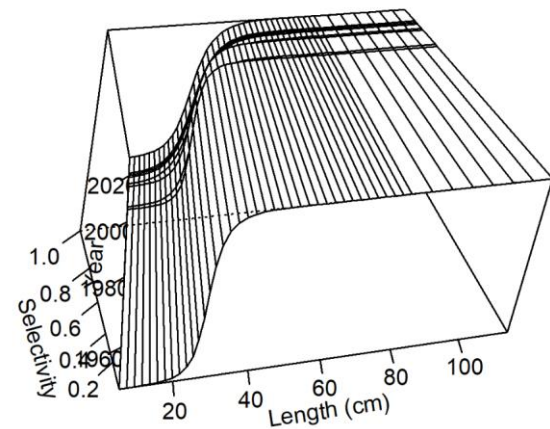


East



West

Length (cm)



Central

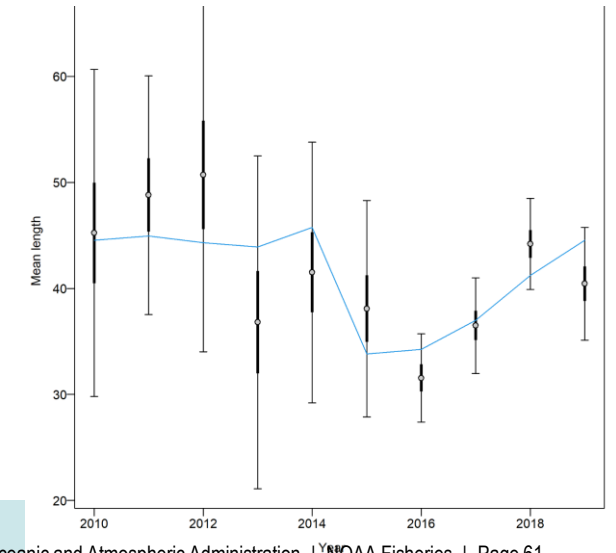
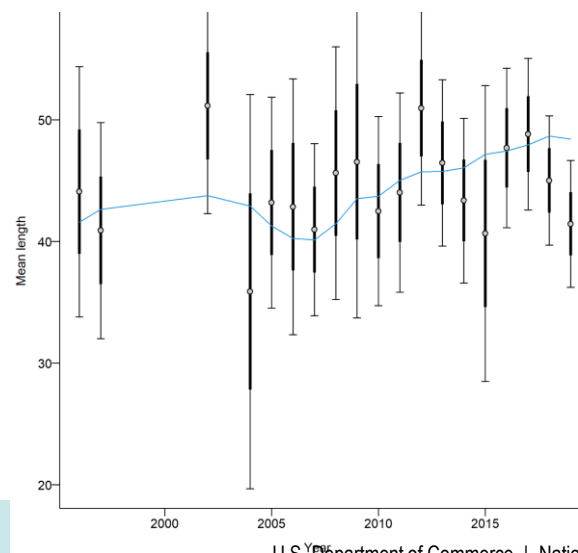
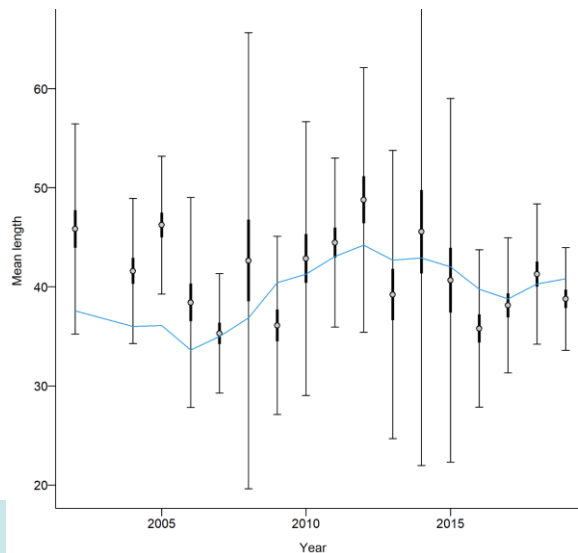
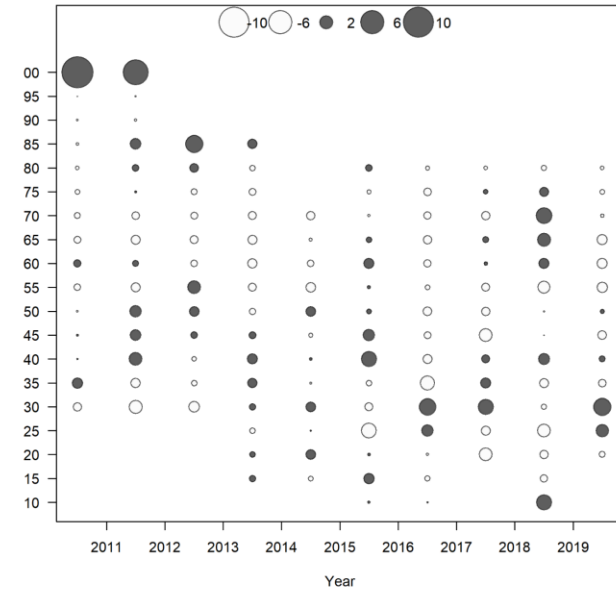
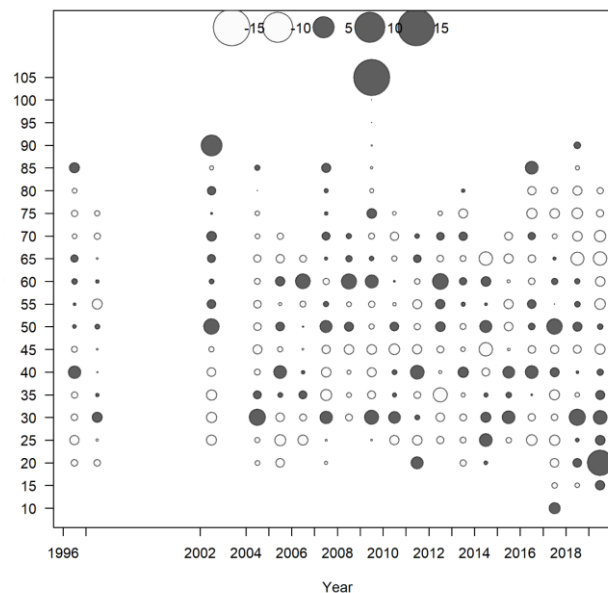
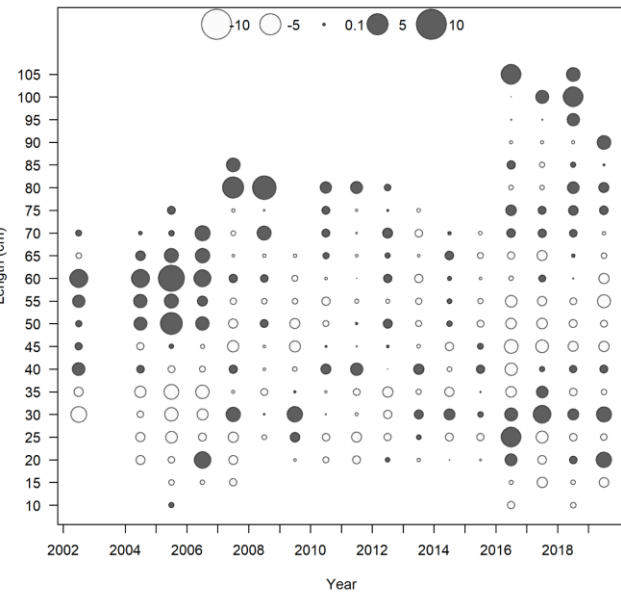
Video Survey Length Comp Fits

● = pos
○ = neg

Central

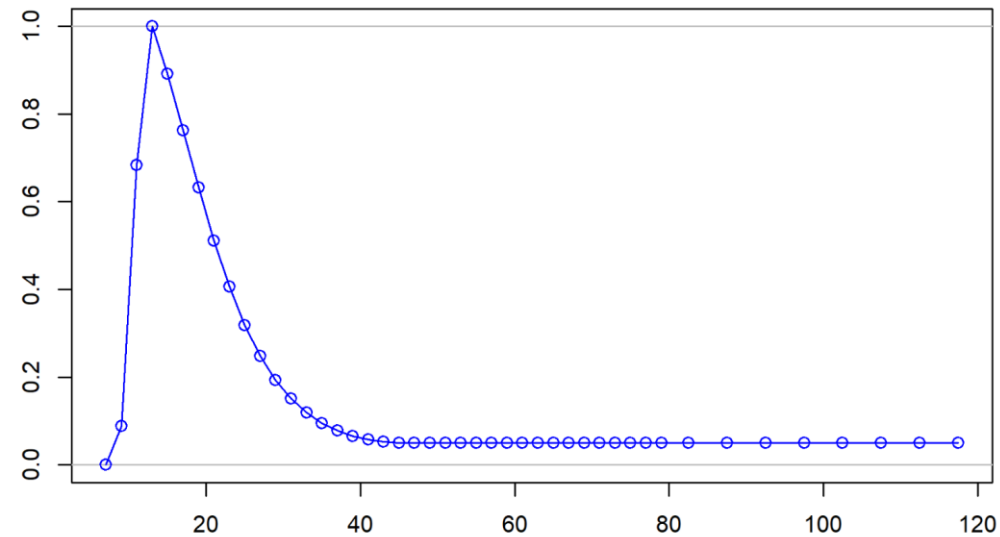
West

East

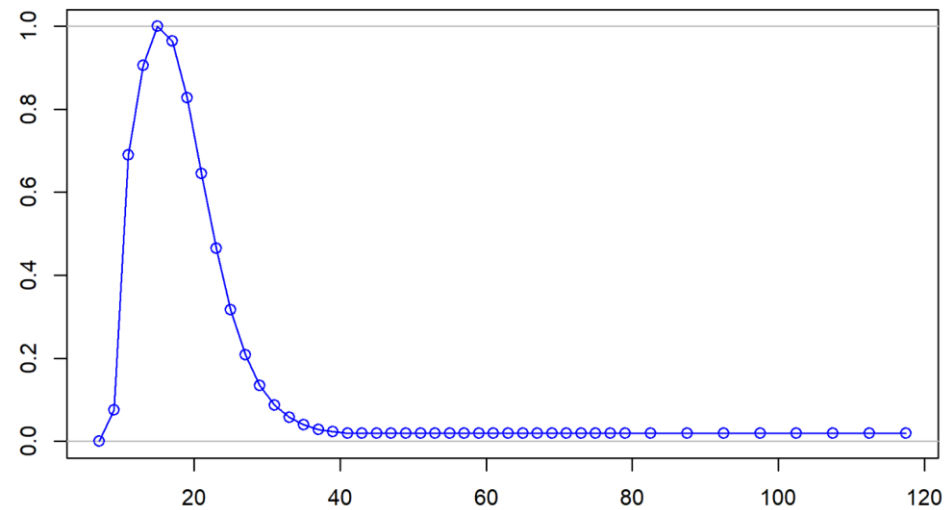


Summer Trawl Late (3 Node Cubic Spline Form)

- Node location set separately for each area based on data quantiles.

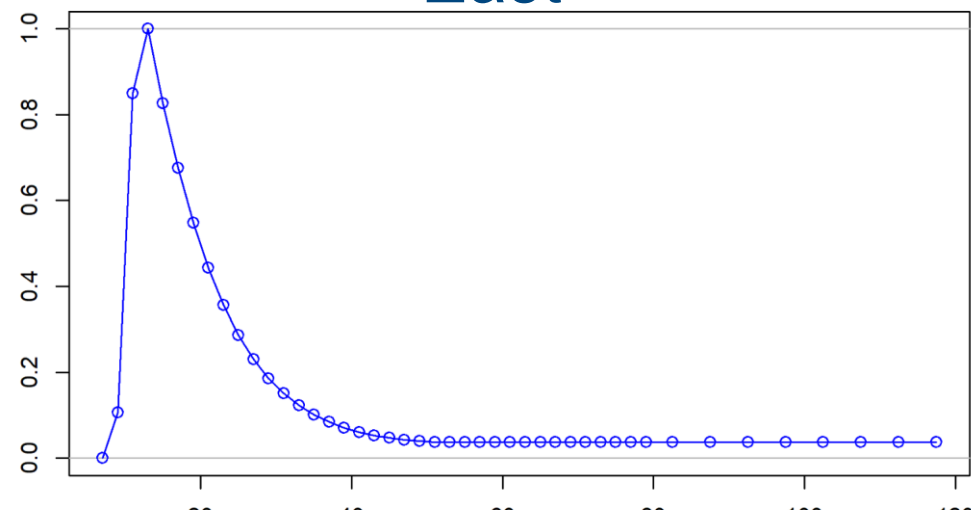


East



West

Length (cm)



Central

Length (cm)

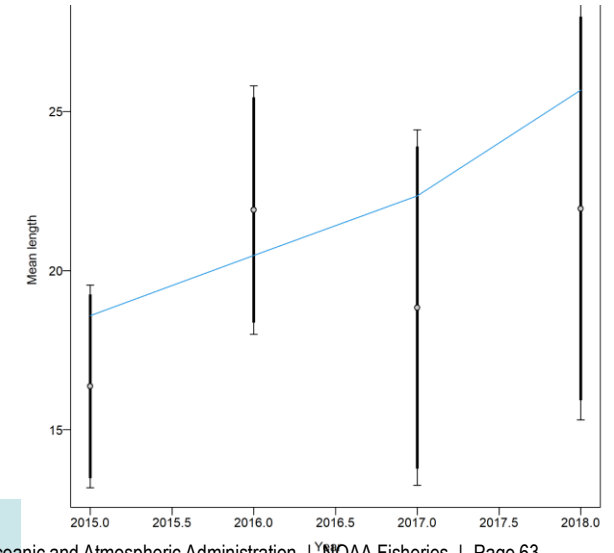
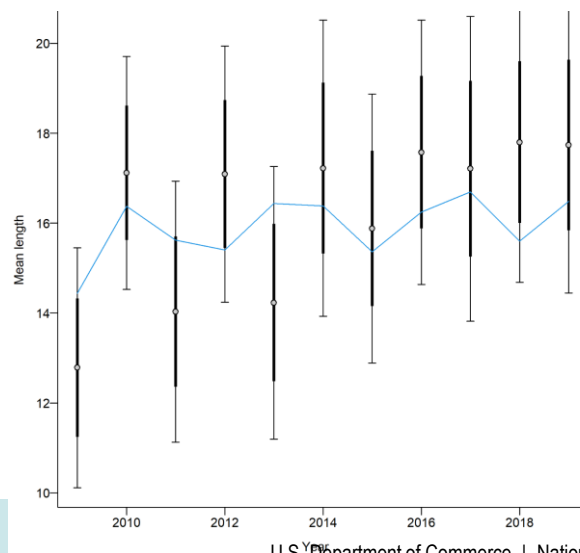
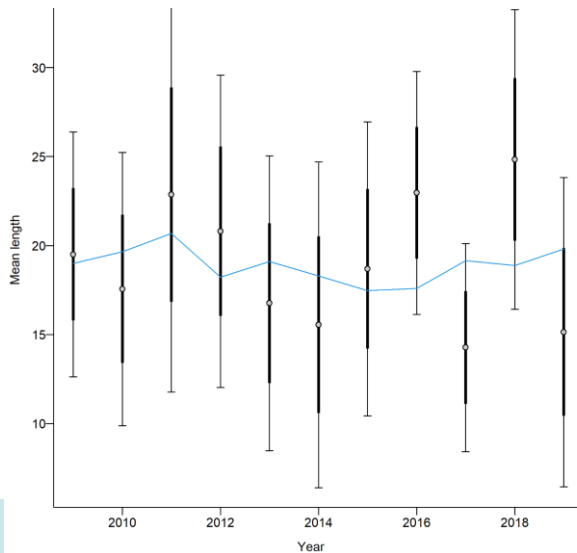
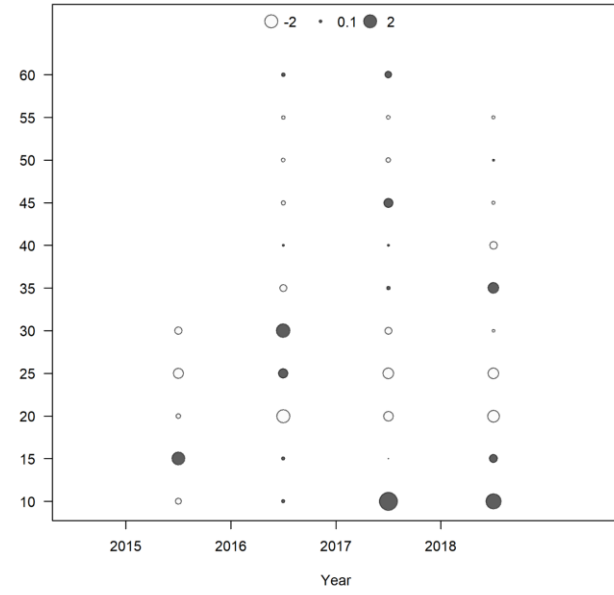
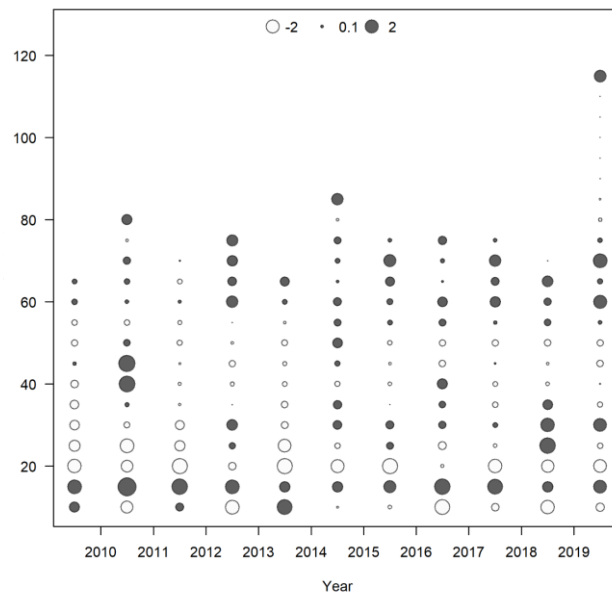
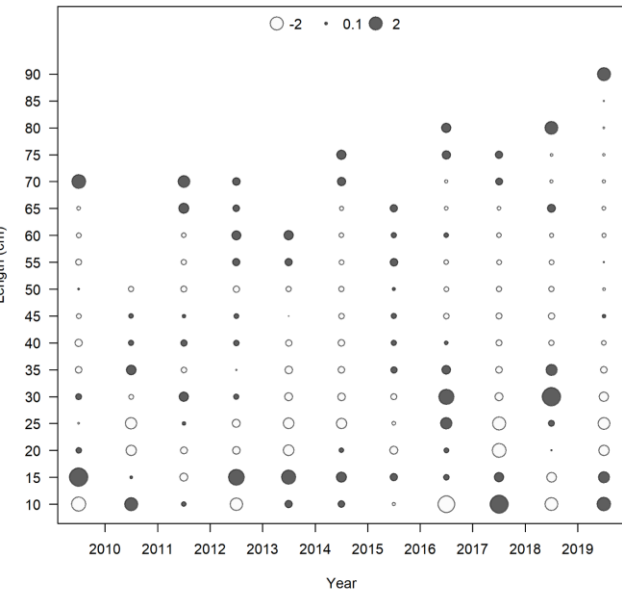
Summer Trawl (Late) Length Comp Fits

● = pos
○ = neg

Central

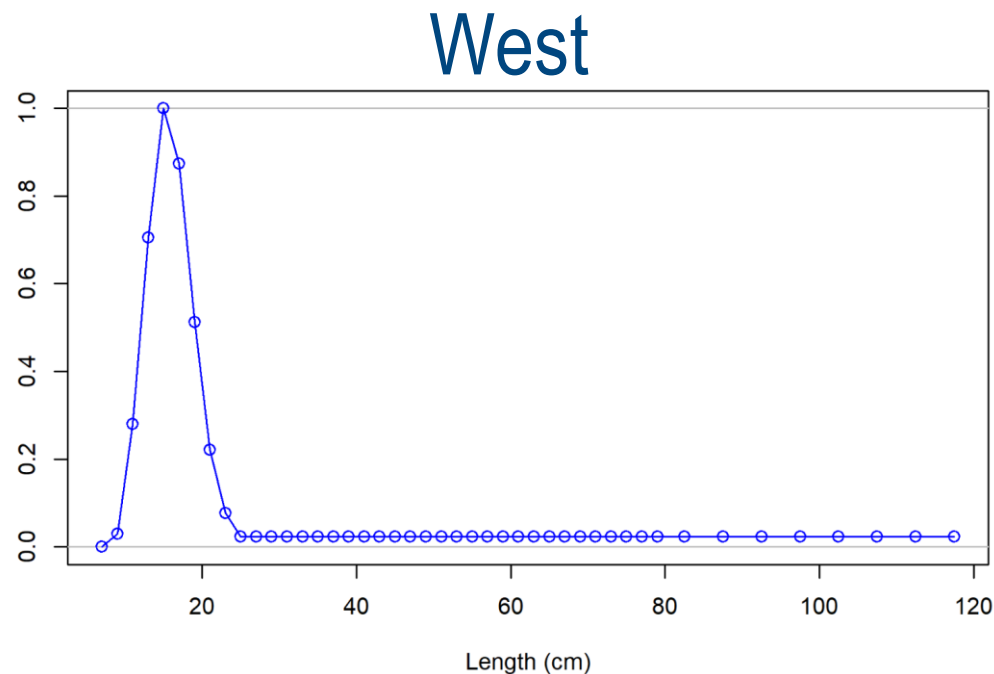
West

East



Summer Trawl Early (3 Node Cubic Spline Form)

- Node location set based on data quantiles.



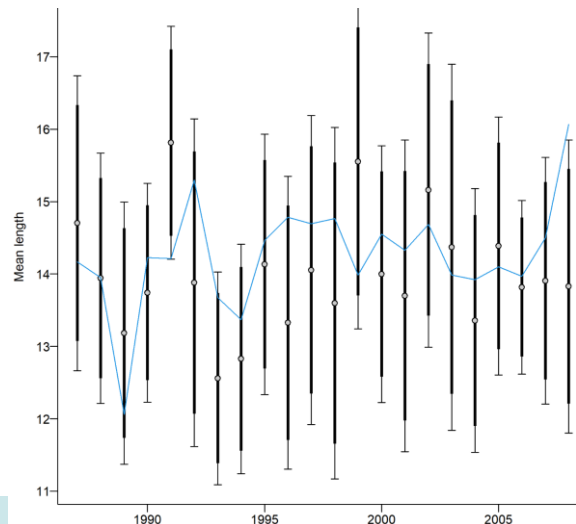
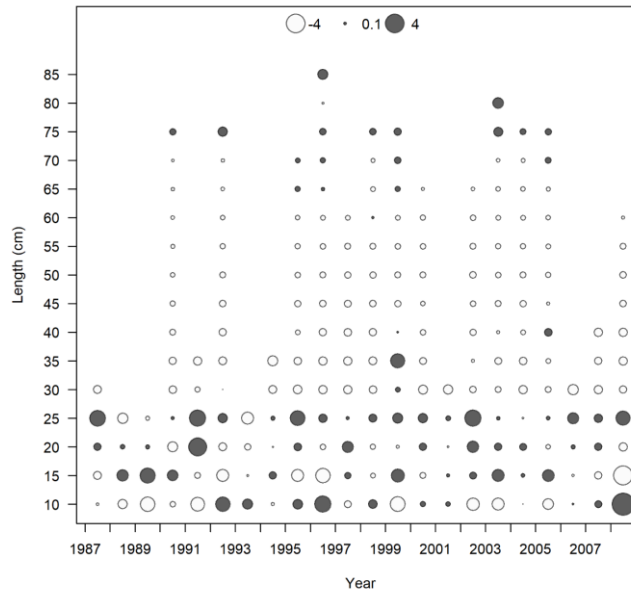
Summer Trawl (Early) Length Comp Fits

● = pos
○ = neg

Central

West

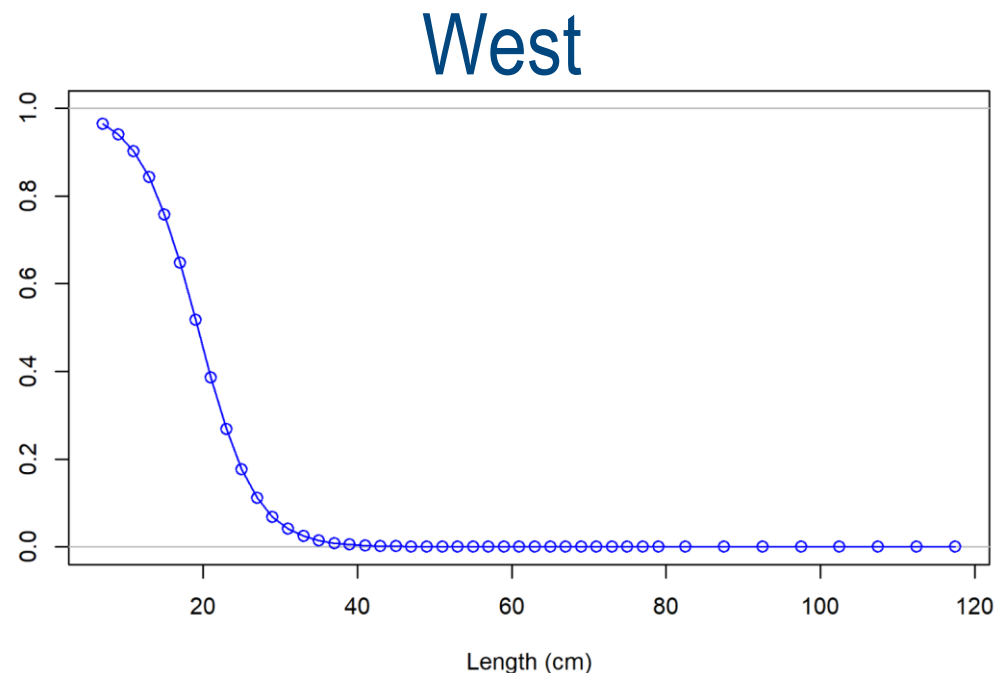
East



NOAA FISHERIES

Fall Trawl Early (Negative Slope Logistic Form)

- Slope constrained to be less than 0 in model specifications.



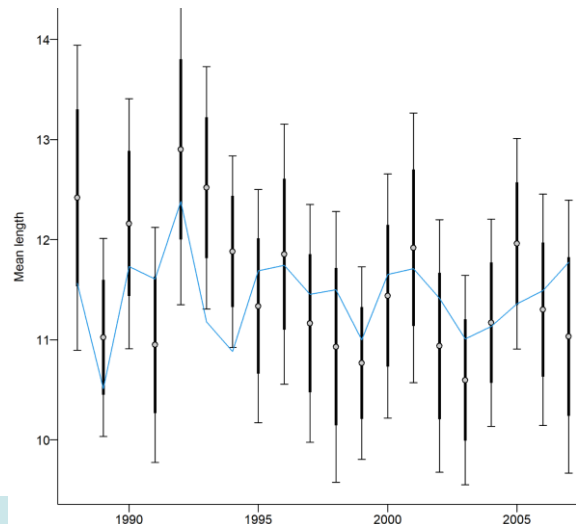
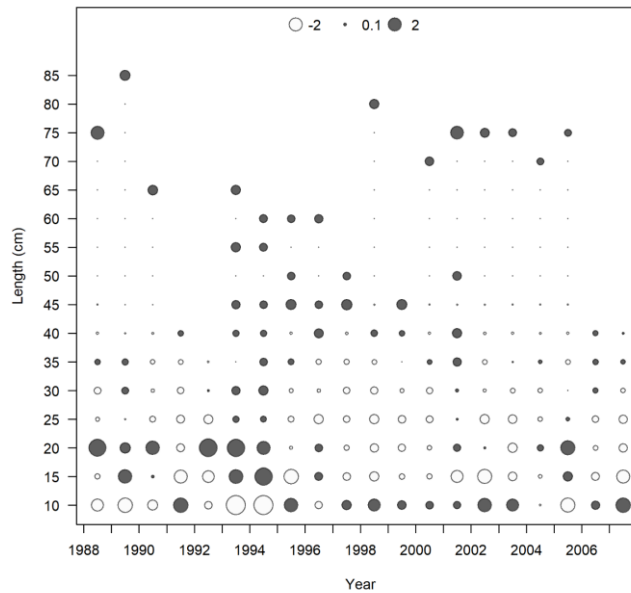
Fall Trawl (Early) Length Comp Fits

Central

West

East

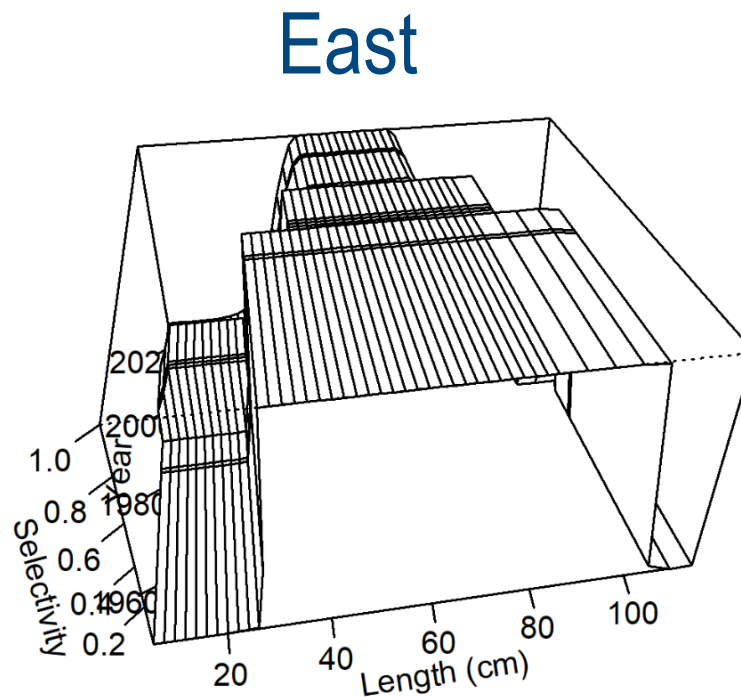
● = pos
○ = neg



NOAA FISHERIES

Comm. RFOP Survey (Double Normal Form)

- Mirrored to the commercial handline east fleet.



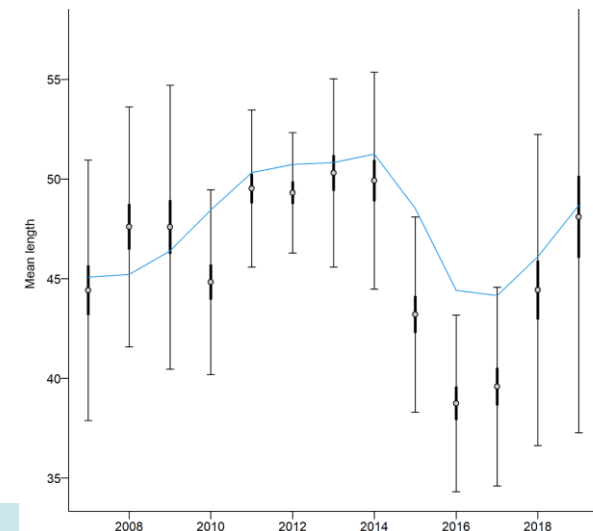
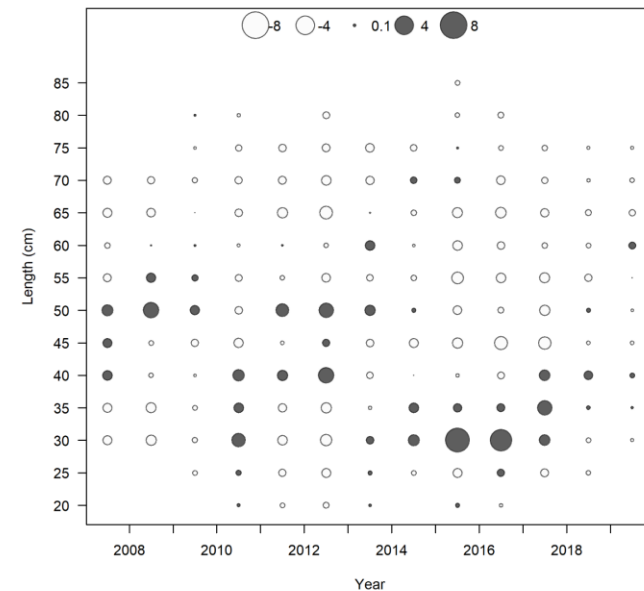
Comm. RFOP Survey Length Comp Fits

Central

West

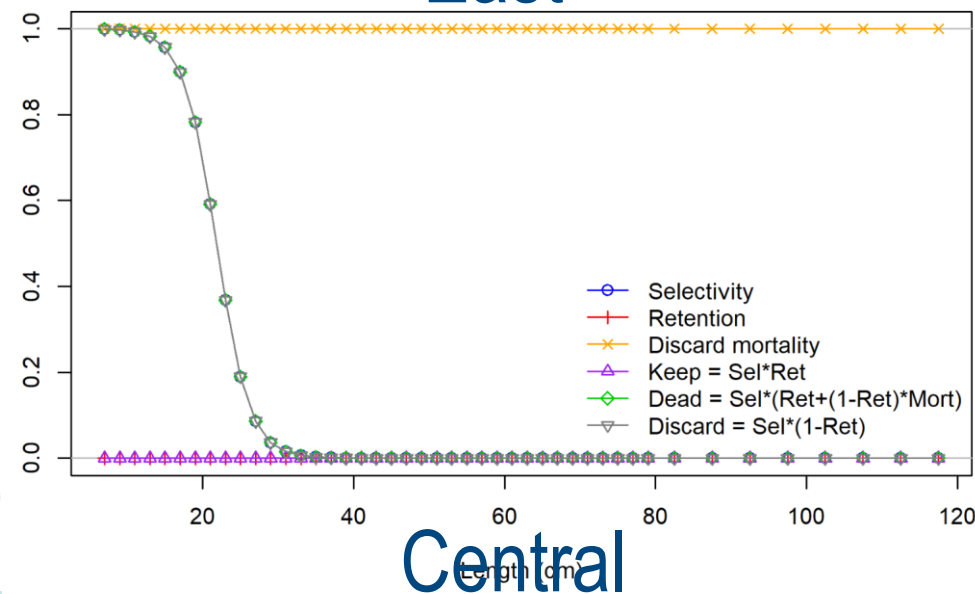
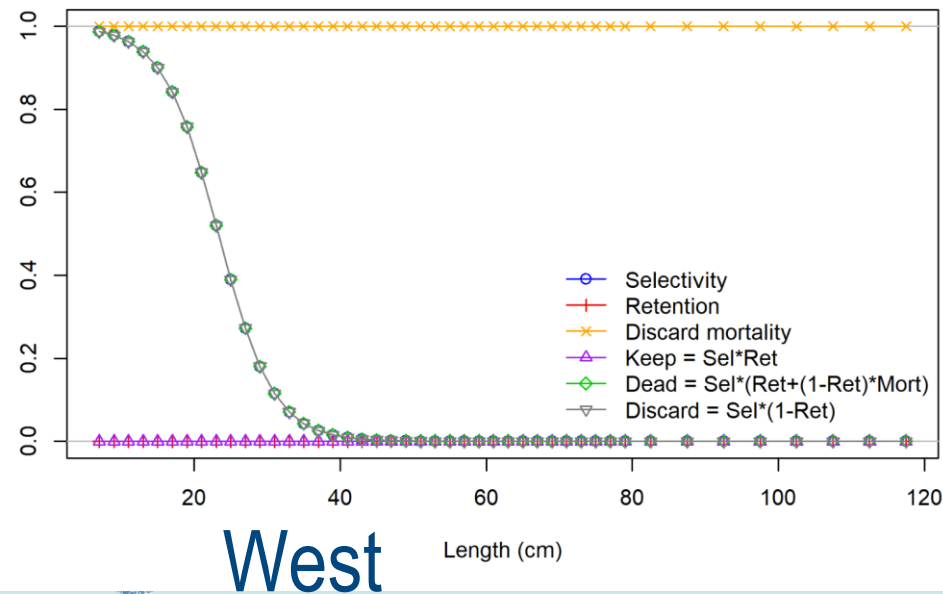
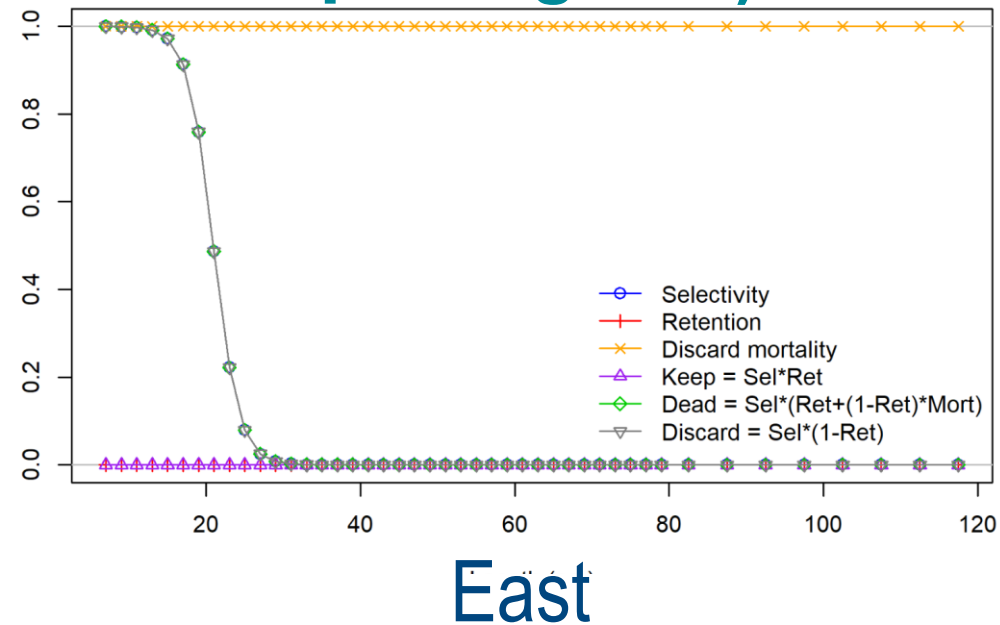
East

● = pos
○ = neg



Shrimp Bycatch (Negative Slope Logistic)

- Slope constrained to be less than 0 in model specifications.



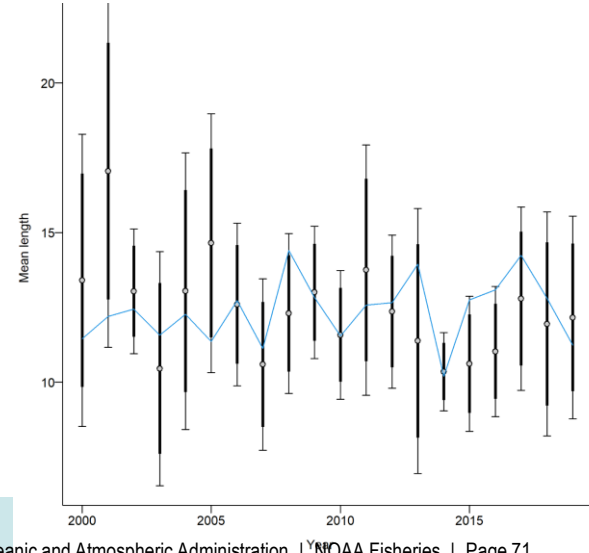
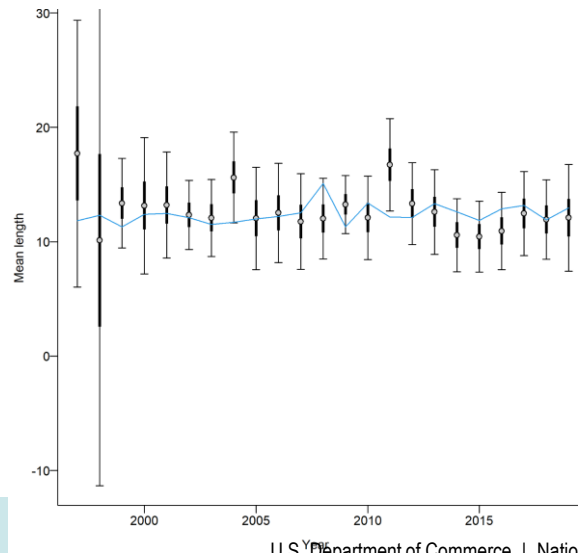
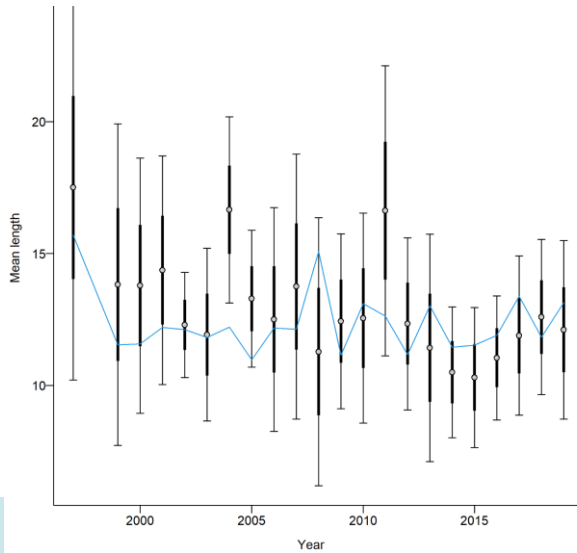
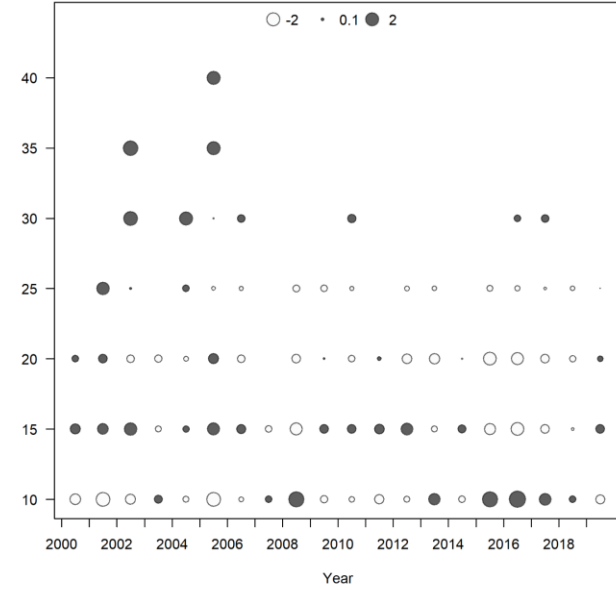
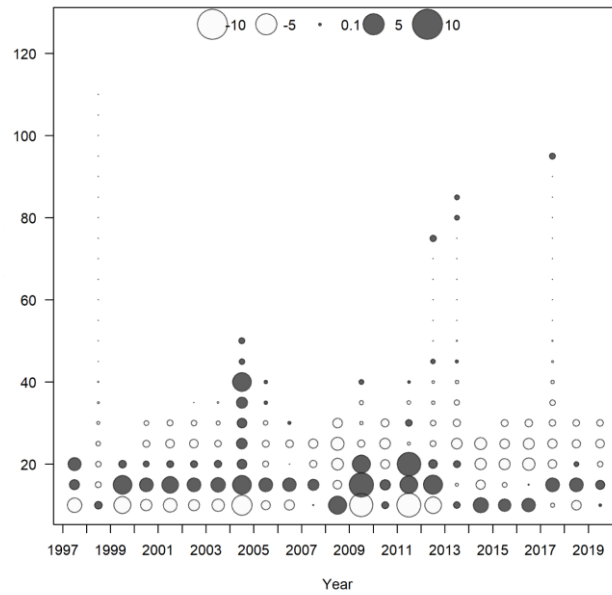
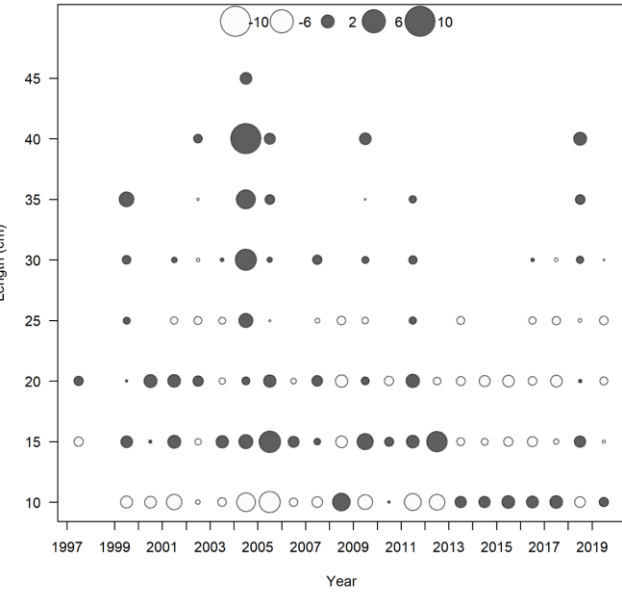
Shrimp Bycatch Length Comp Fits

● = pos
○ = neg

Central

West

East



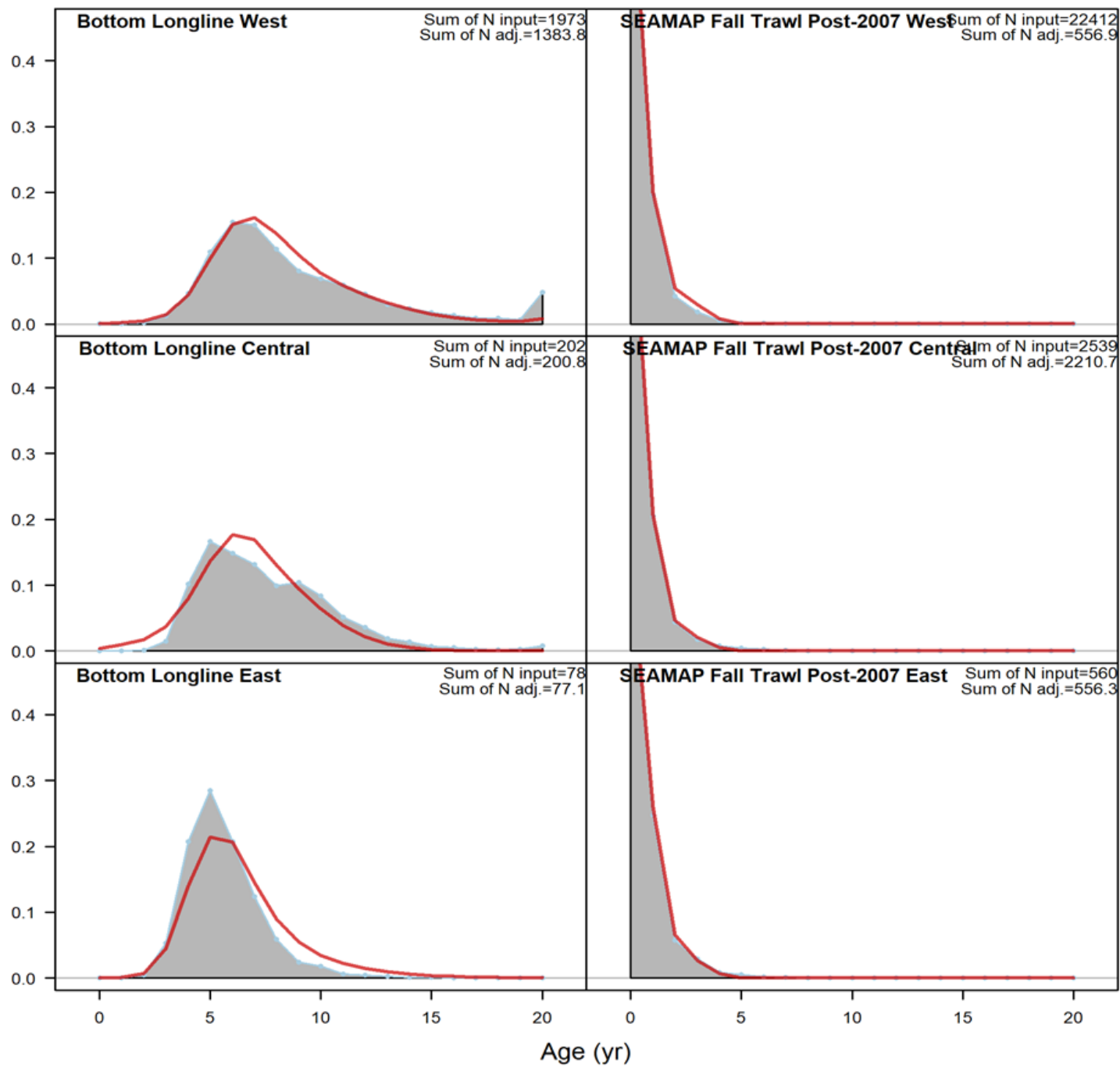
Questions about Fits to Length Composition?



Model Fits

Age Based Selectivity and Composition

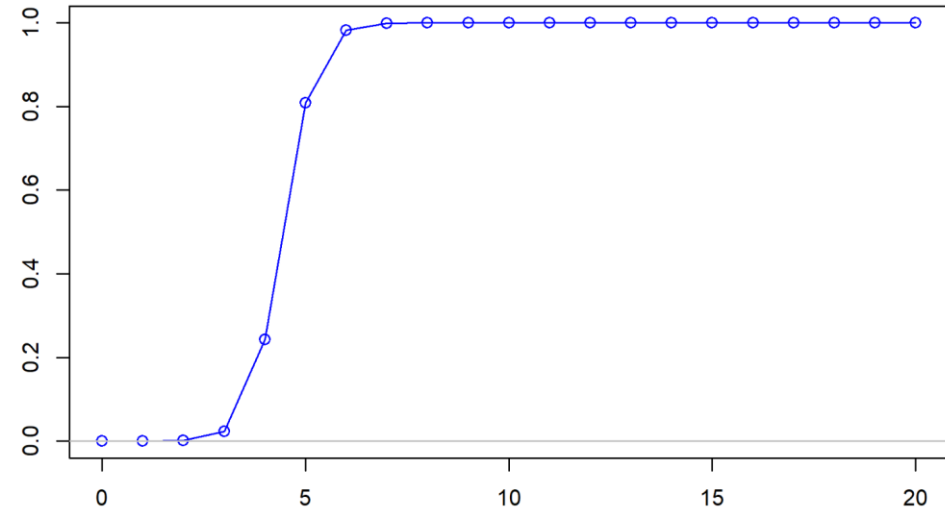




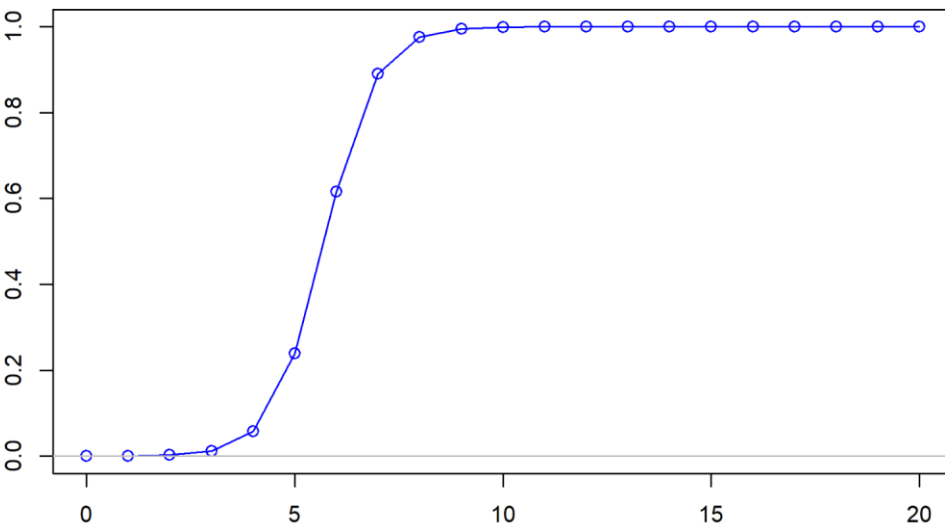
Fleet	Ln(Theta)
BLL_W	0.841
BLL_C	5
BLL_E	4.259
FALLLATE_W	-3.69
FALLLATE_C	1.902
FALLLATE_E	5

Bottom Longline Survey (Logistic Form)

- All parameters estimated.

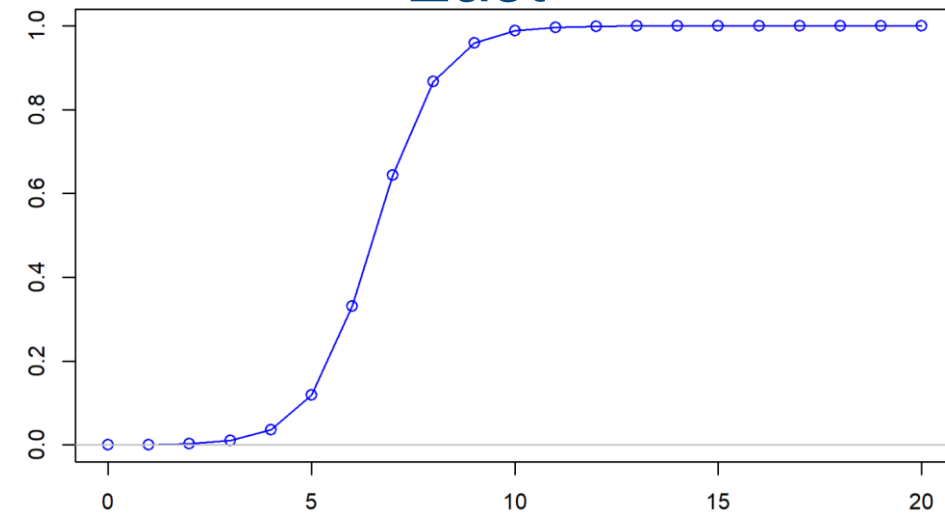


East



West

Age (yr)



Central

Age (yr)

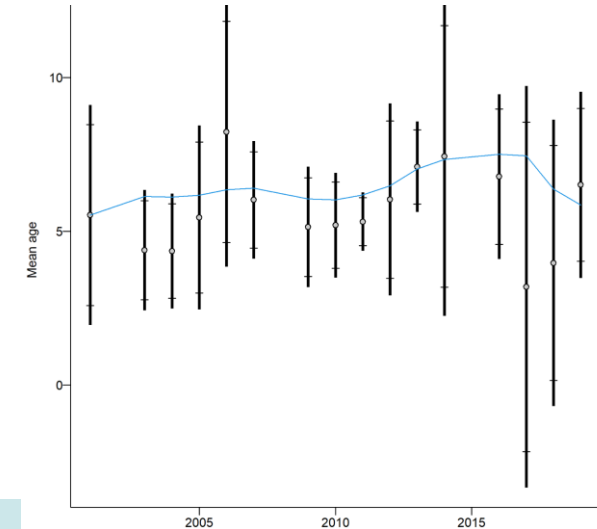
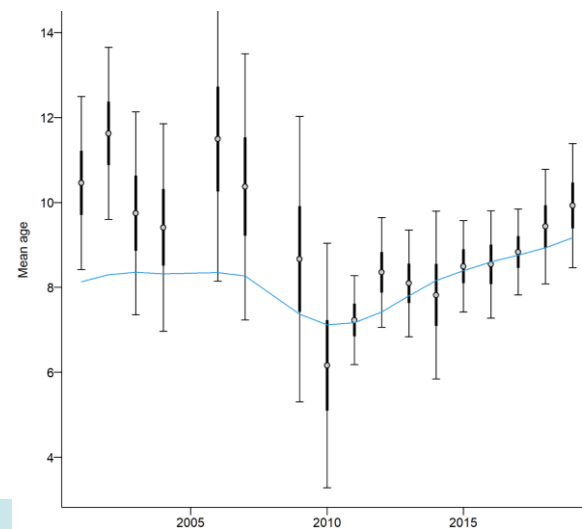
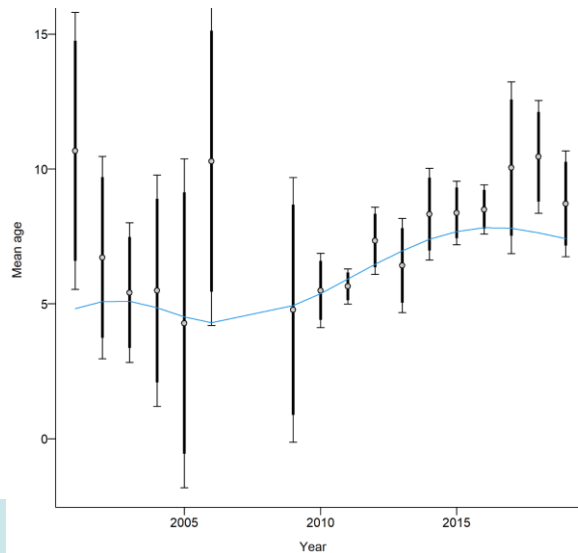
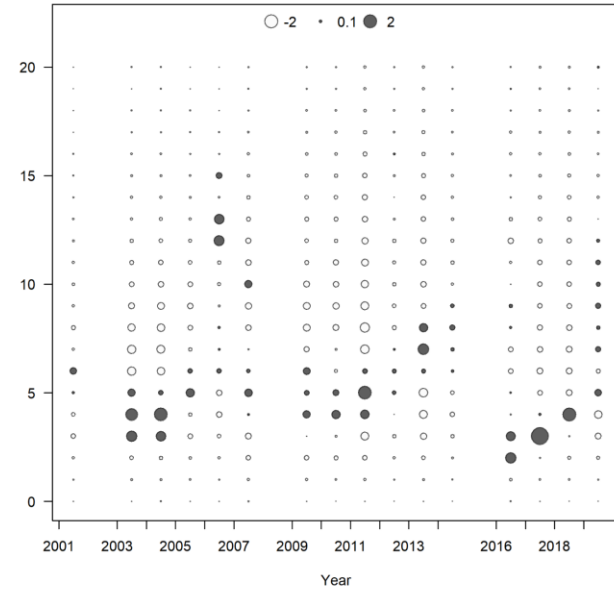
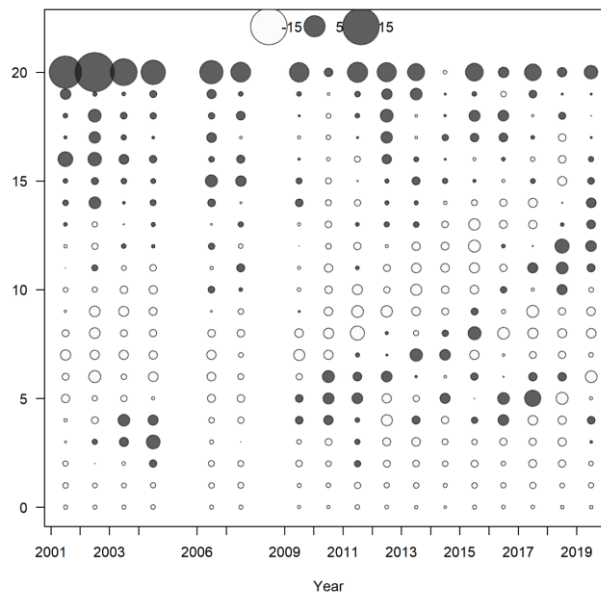
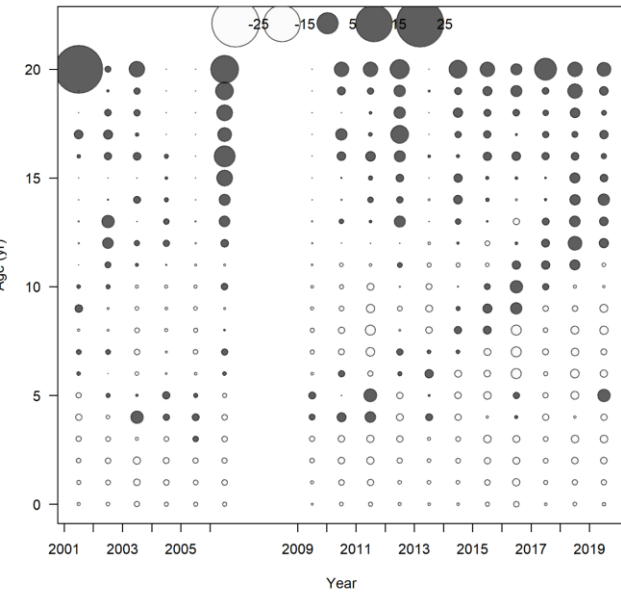
Bottom Longline Survey Age Comp Fits

● = pos
○ = neg

Central

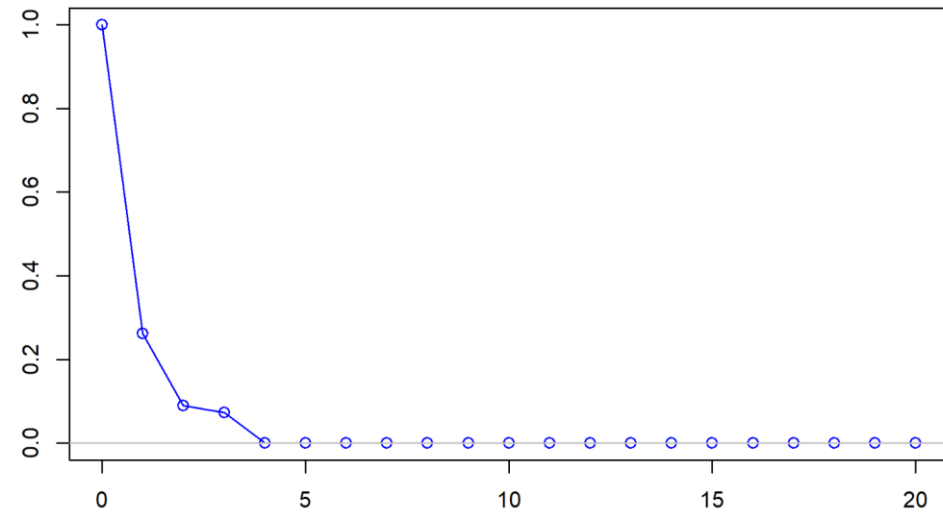
West

East

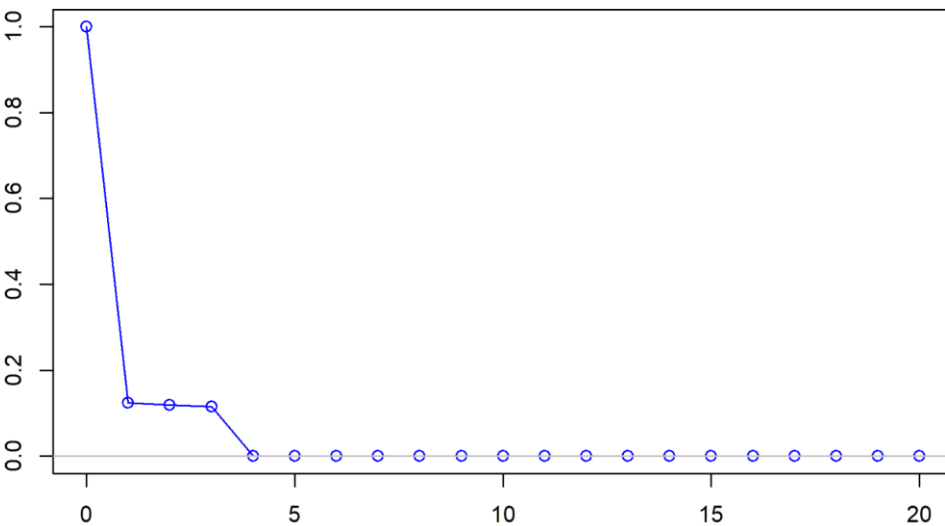


Fall Trawl Late (Empirical Random Walk Form)

- Estimated for ages 0-4
- Fixed at 0 for ages 5+

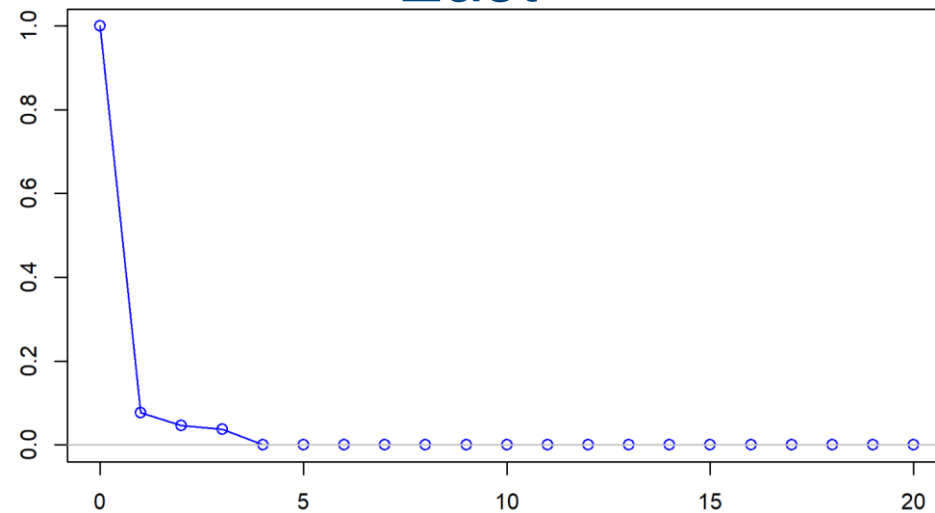


East



West

Age (yr)



Central

Age (yr)

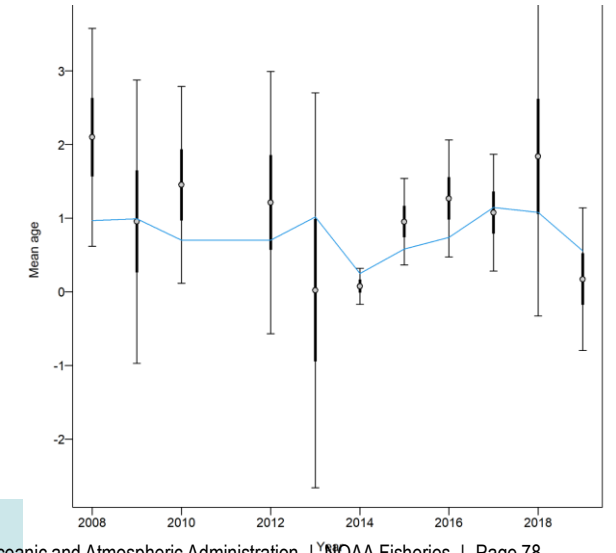
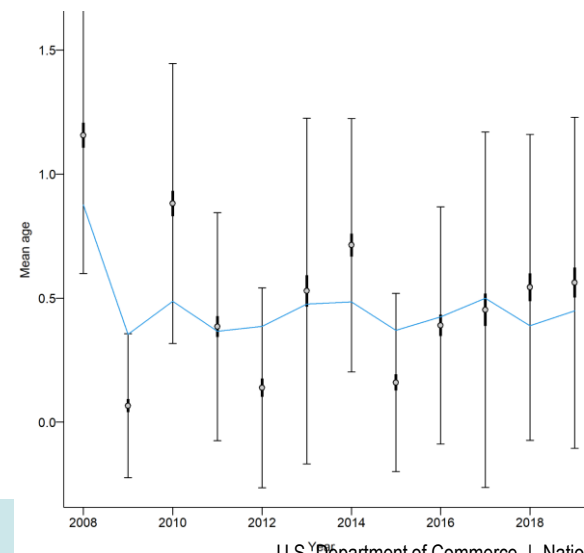
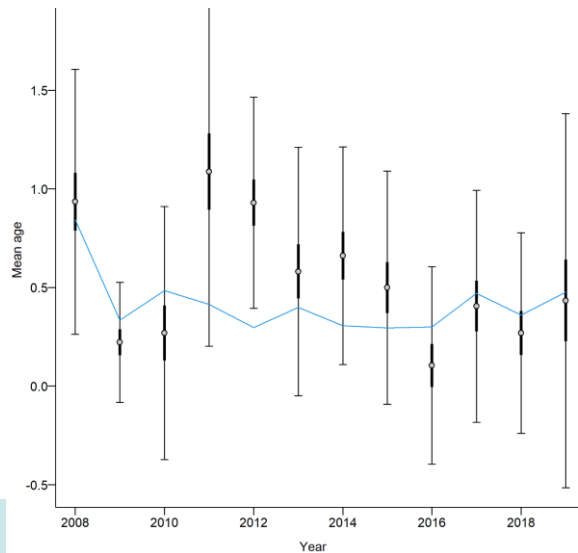
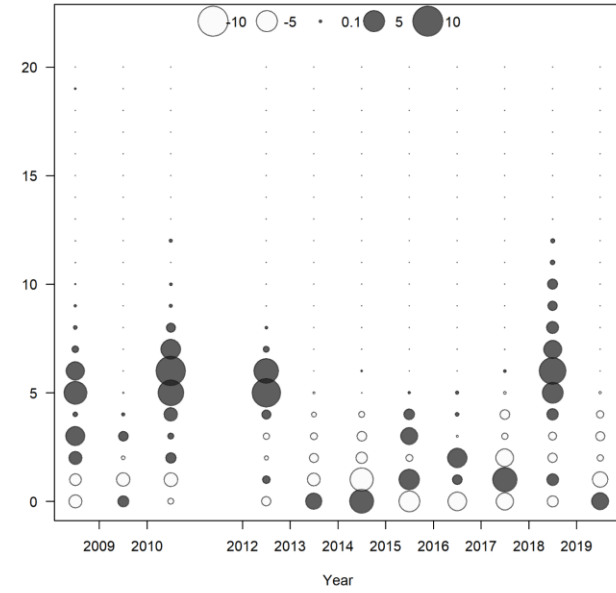
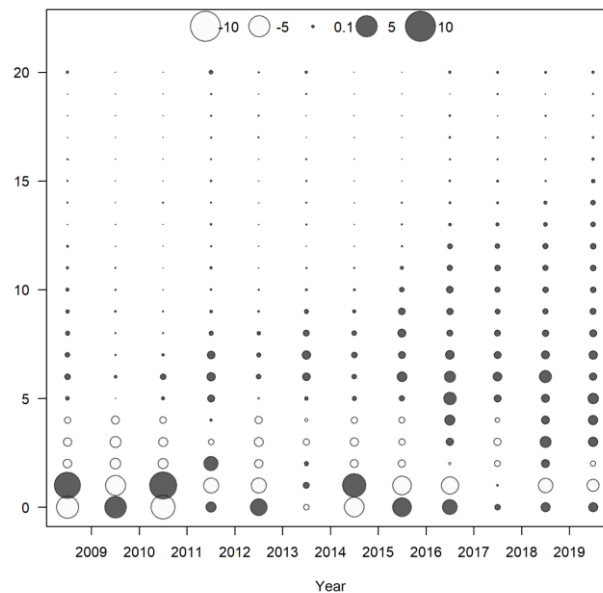
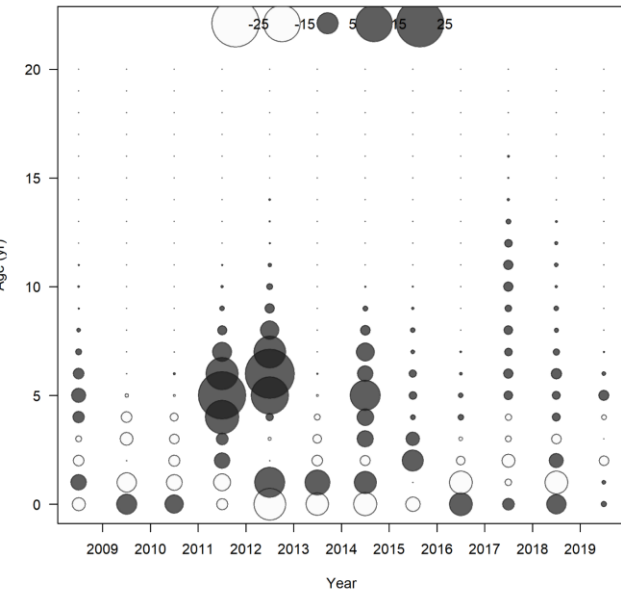
Fall Trawl Late Length Comp Fits

● = pos
○ = neg

Central

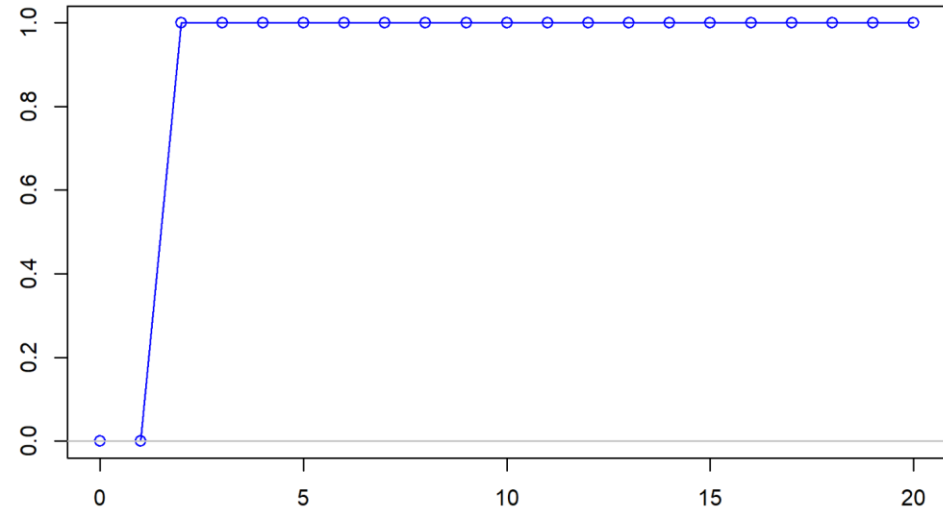
West

East

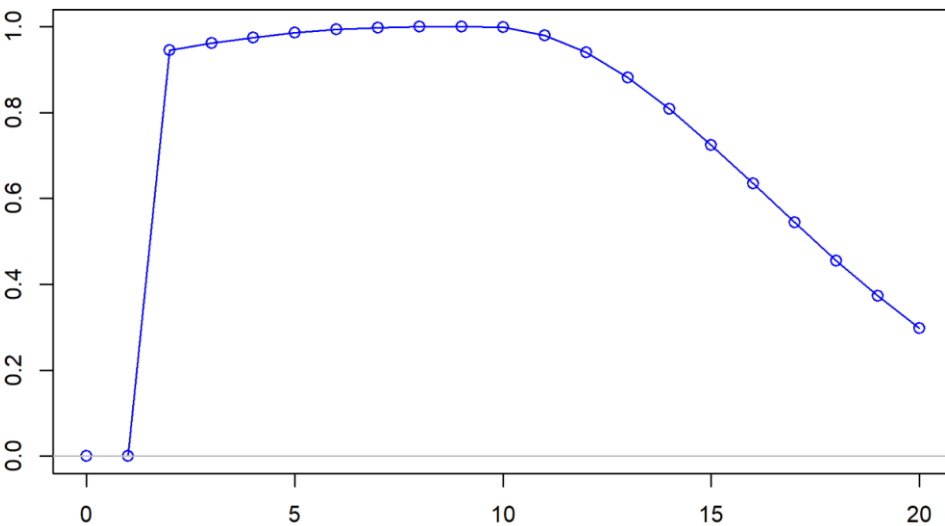


GRSC (Double Normal or Fixed Form)

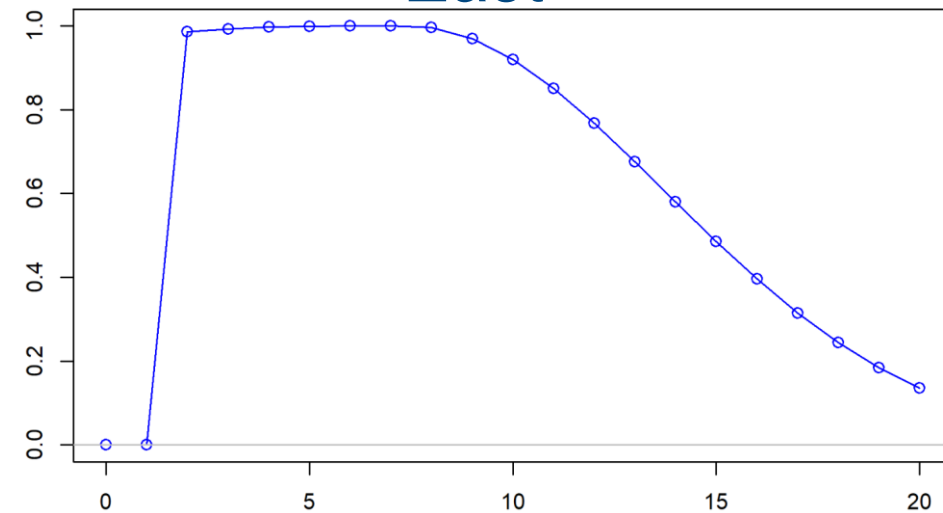
- East fixed at 100% selectivity for ages 2+
- For W & C ages 0 and 1 Fixed at 0% selectivity



East



West



Central

Age (yr)

Age (yr)

Questions about Fits to Age Composition



Model Fits

Length Based Retention Functions

Retention Functions Setup Refresher

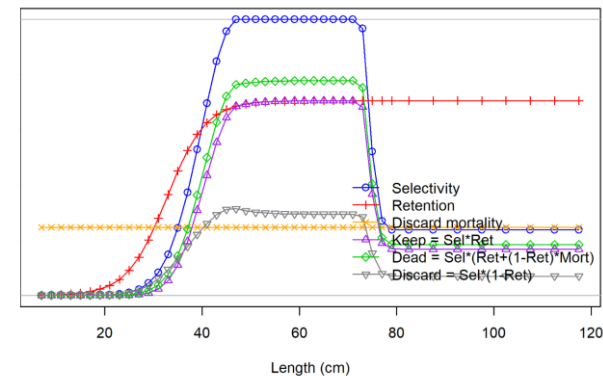
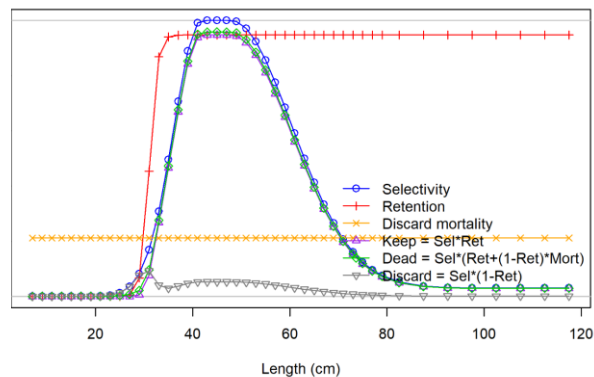
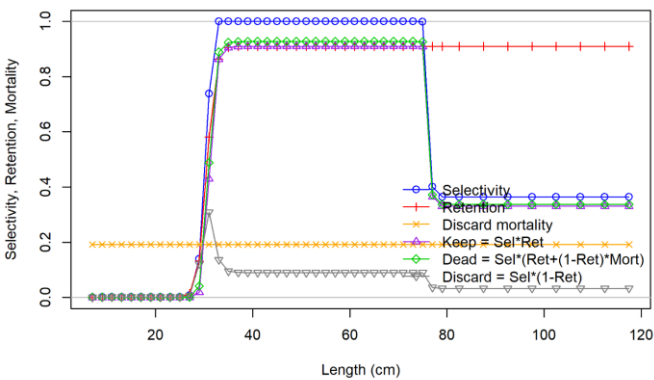
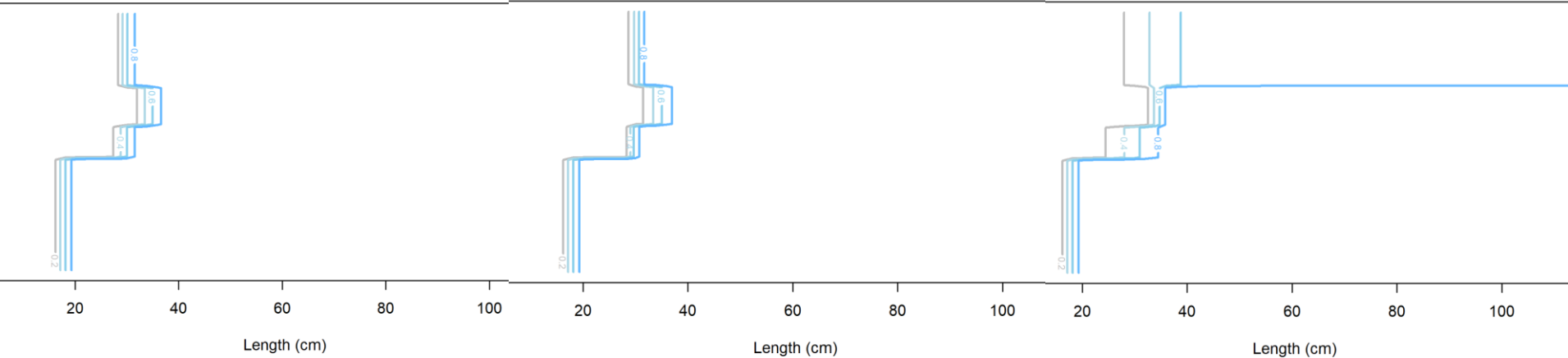
- All 4 parameter logistic form with the slope, inflection and asymptote parameters considered.
- When no discard composition data was available inflections were fixed at the minimum size.
- Base slope was fixed at “knife-edged” while all other slopes were estimated to accommodate sublegal fish occurring in the retained composition
- Asymptote fixed at 1 except for 2007-present where it was estimated

Commercial Handline Retention

Central

West

East



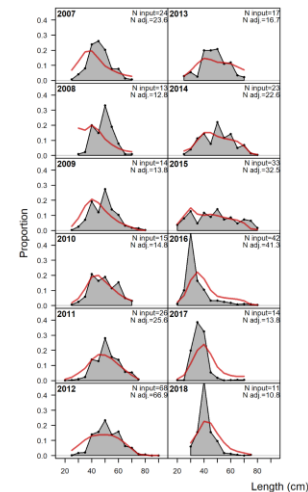
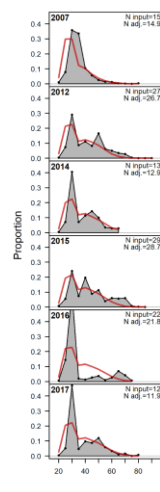
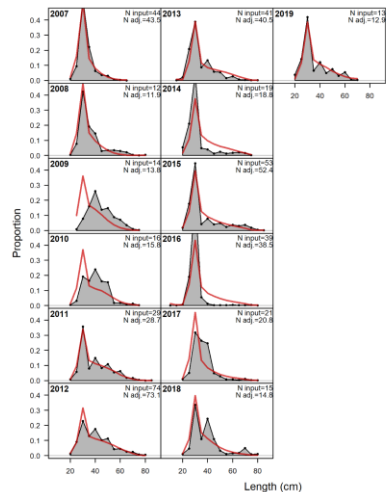
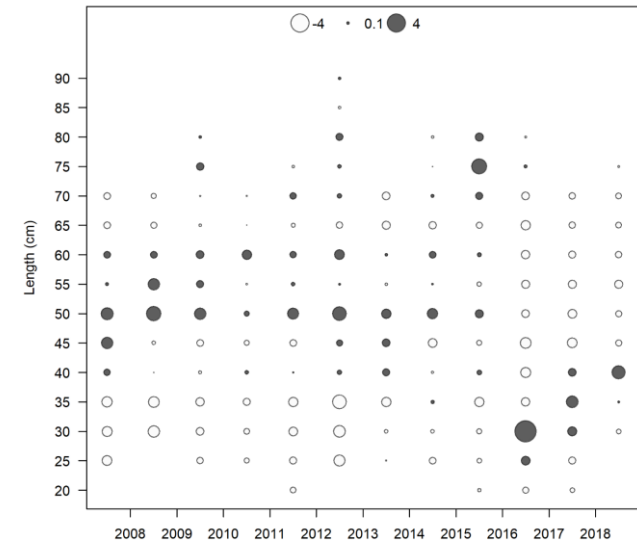
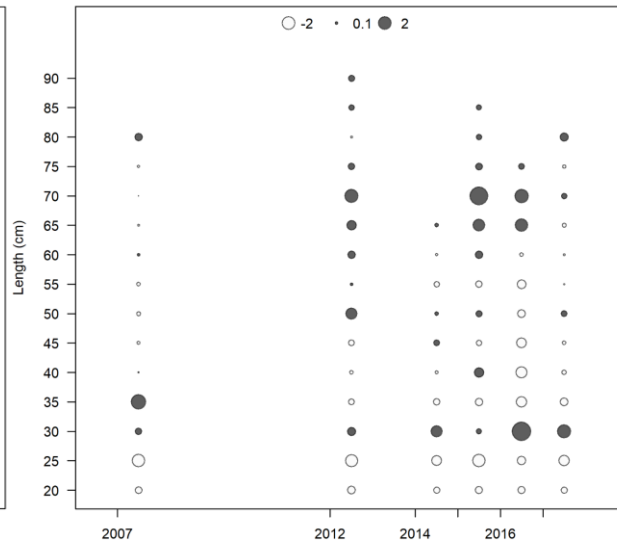
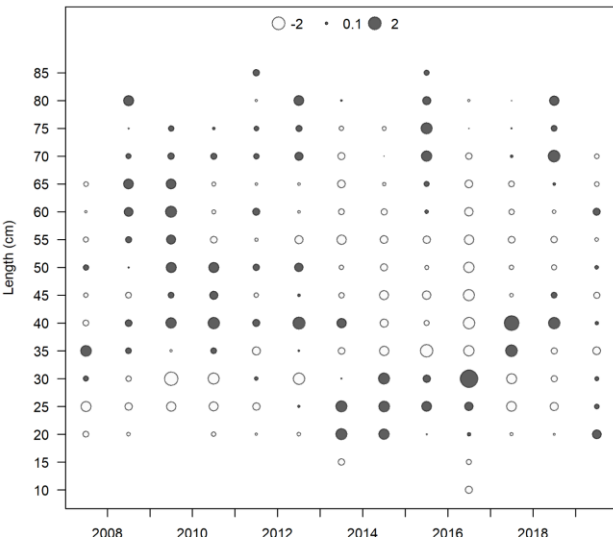
Commercial Handline Discard Comp

● = pos
○ = neg

Central

West

East

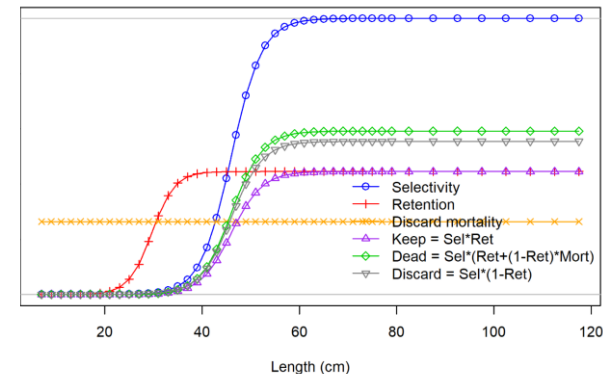
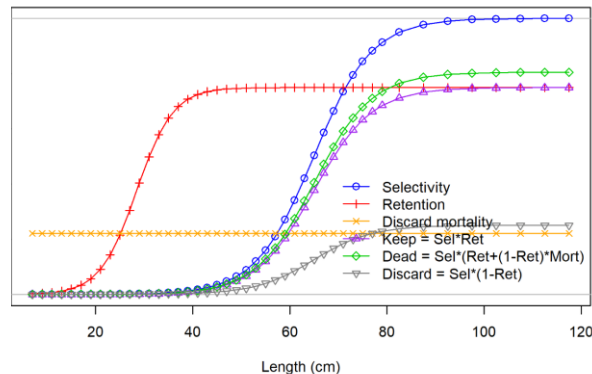
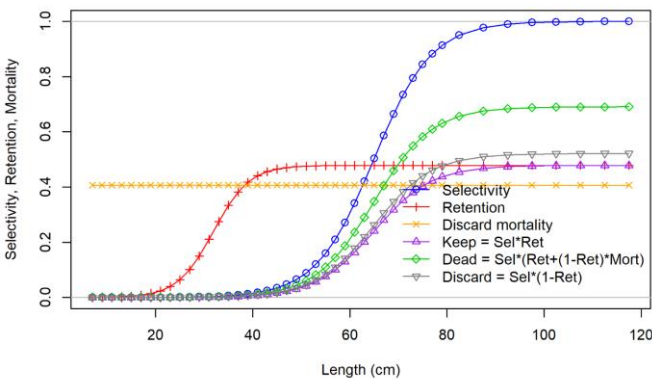
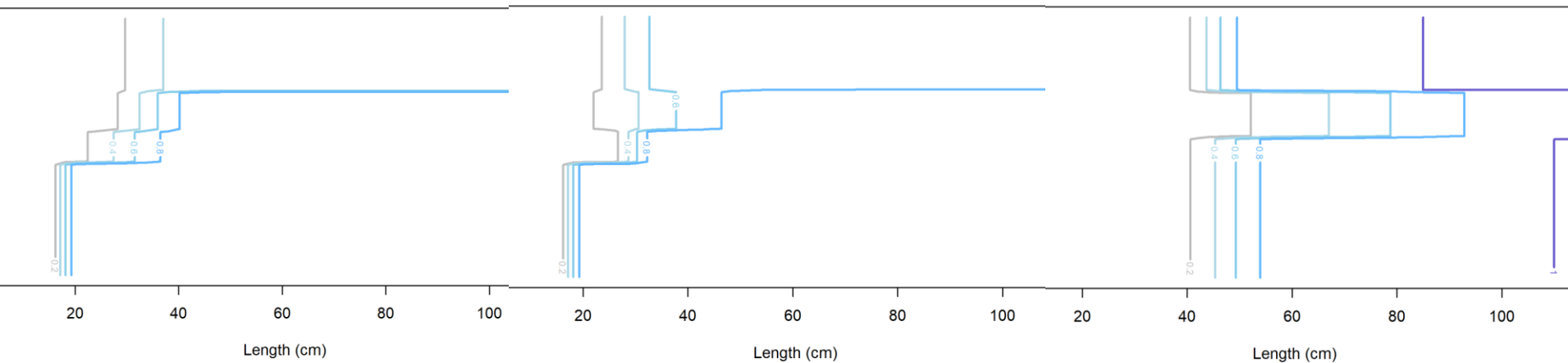


Commercial Longline Retention

Central

West

East

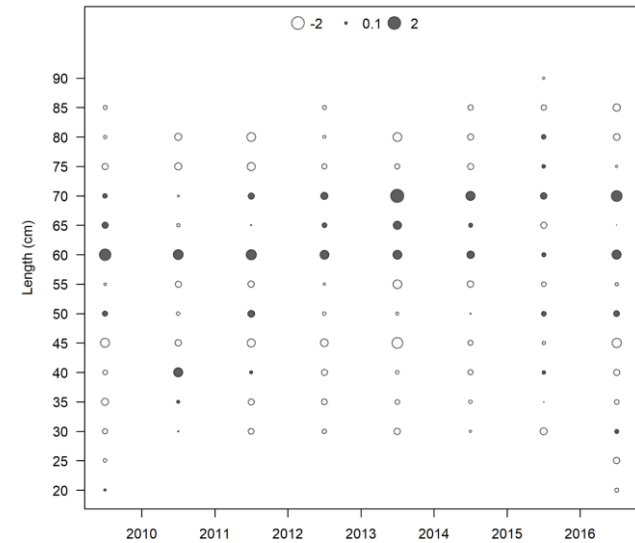
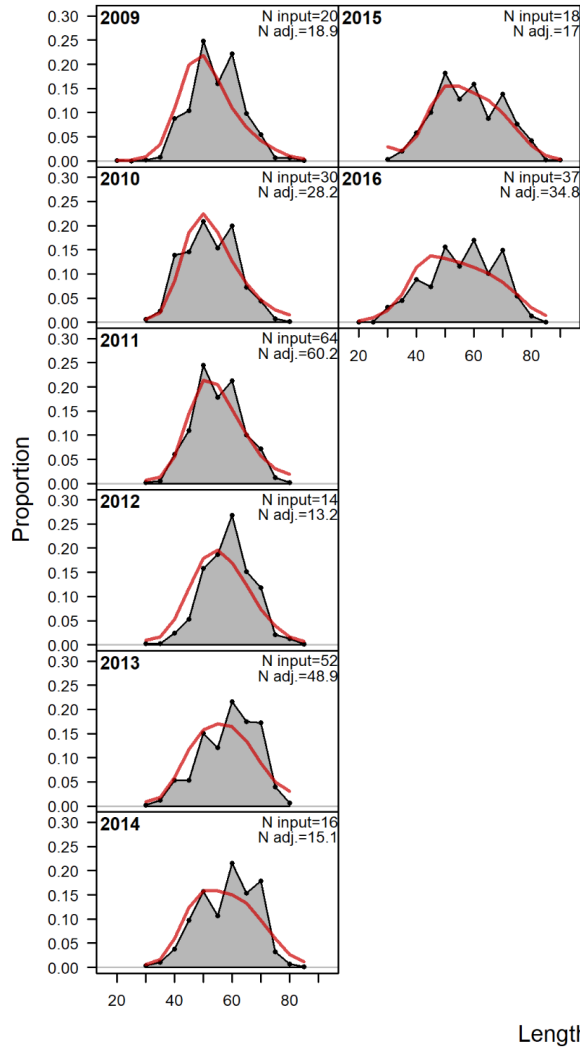


Magnitude of estimated regulatory discards exceeded expectations but supported by composition

Commercial Longline Discard Comp

● = pos
○ = neg

East

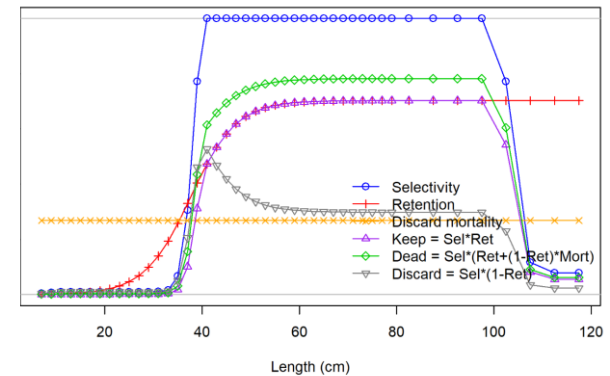
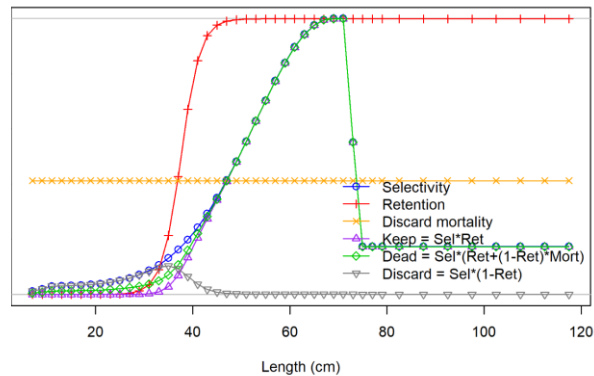
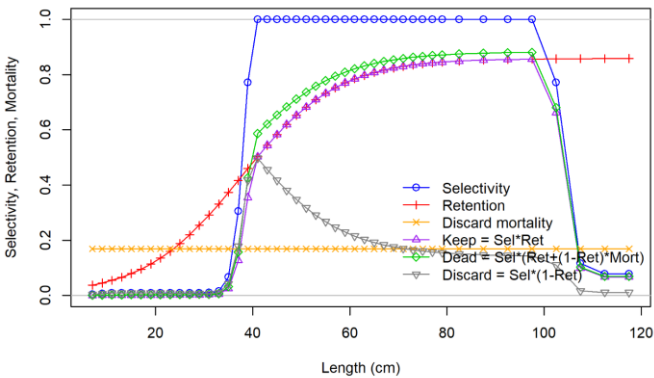
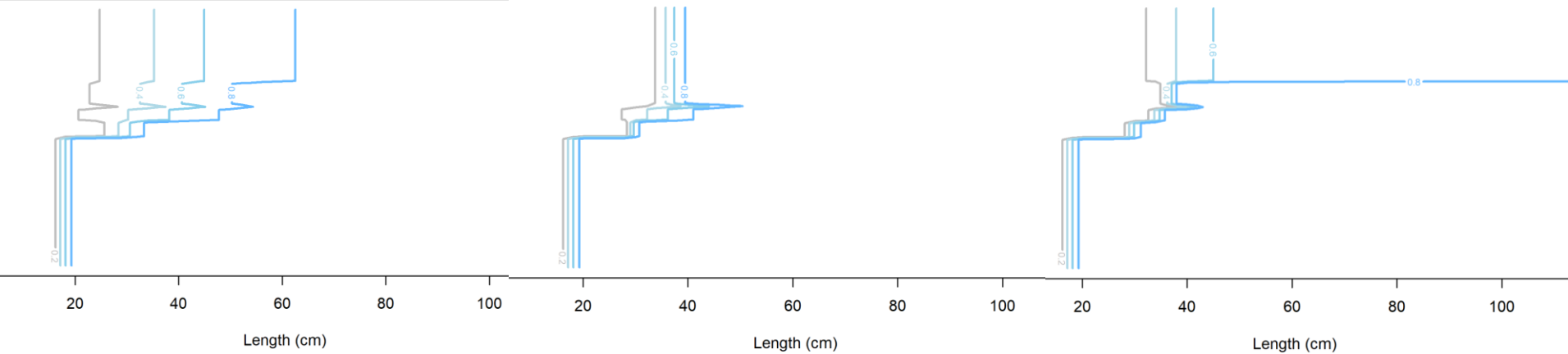


Recreational Charter Boat Retention

Central

West

East

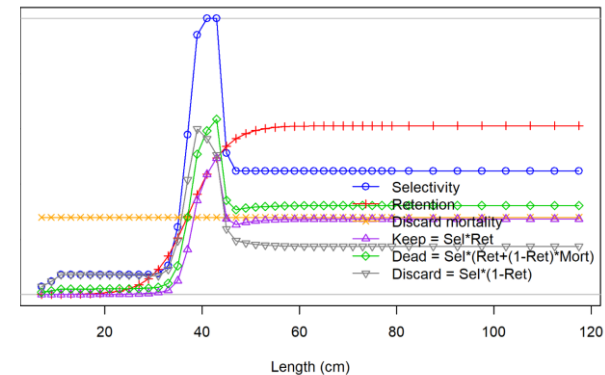
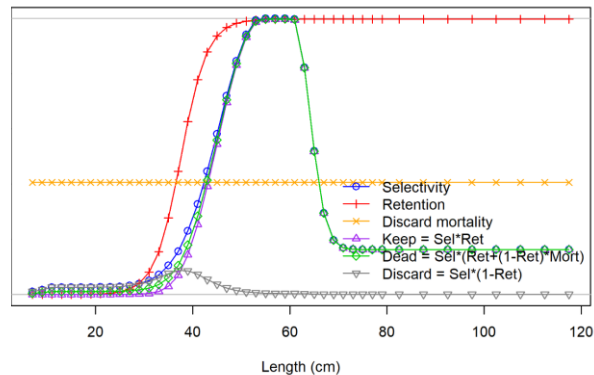
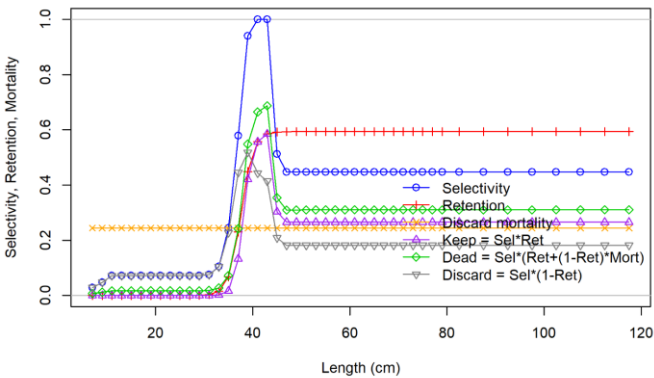
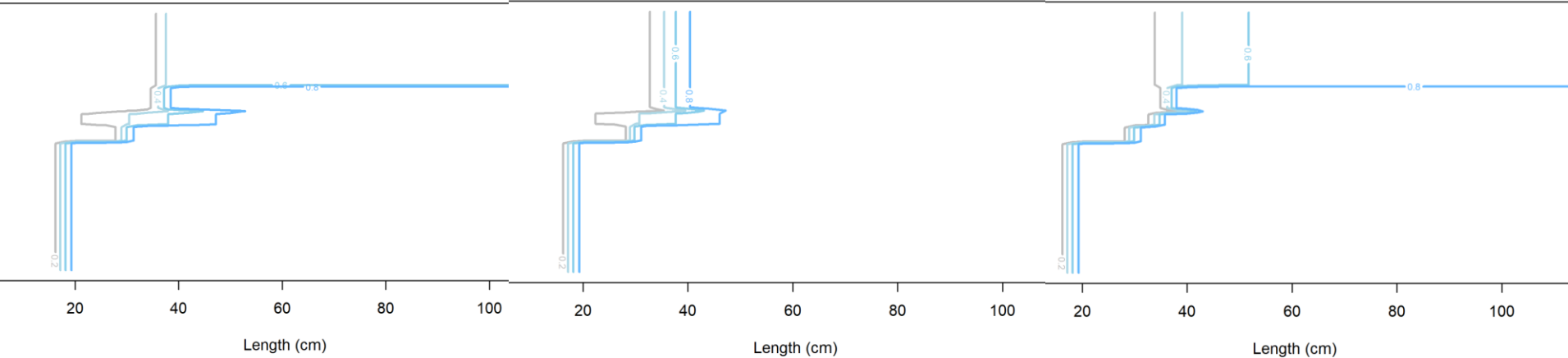


Recreational Headboat Retention

Central

West

East

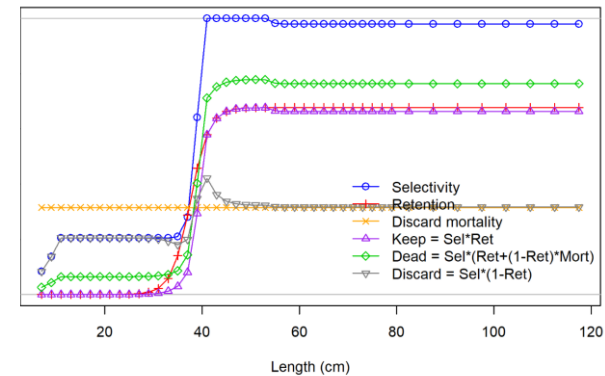
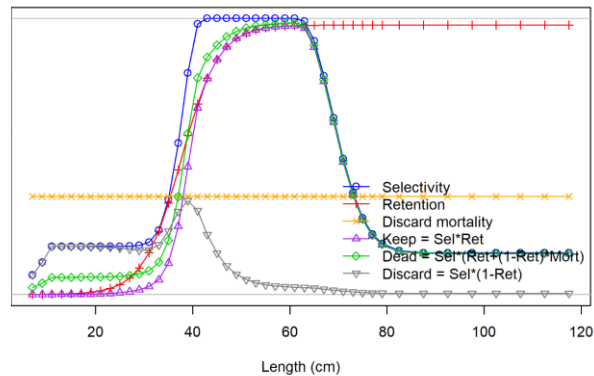
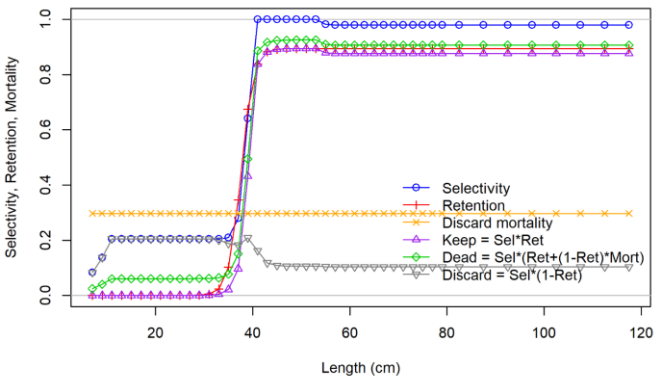
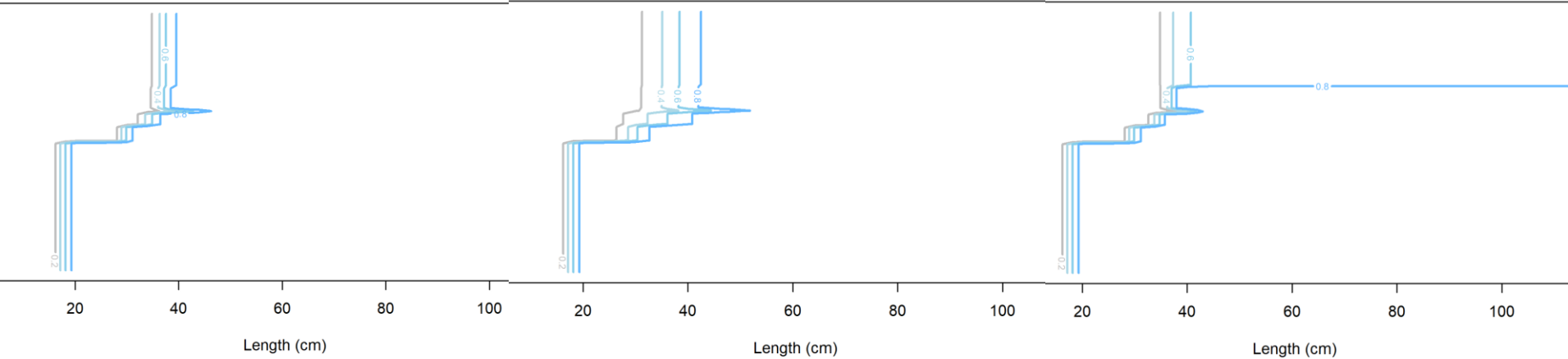


Recreational Private Boat Retention

Central

West

East



Retention Summary

- In general retention functions with estimated parameters followed reasonable and predictable forms.
- For recreational fleets, model estimated significant regulatory discarding for all east fleets and the central headboat fleet; however, these estimates are not currently supported by discard composition.
- Regulatory discards of commercially caught fish was more prevalent in the east and in the Longline fleets were lack of IFQ may be a driving factor.
- Estimates of asymptote parameters could benefit from increased discard composition collection or informative priors derived from independent studies.

Questions about Retention Functions and Discard Composition

Model Fits

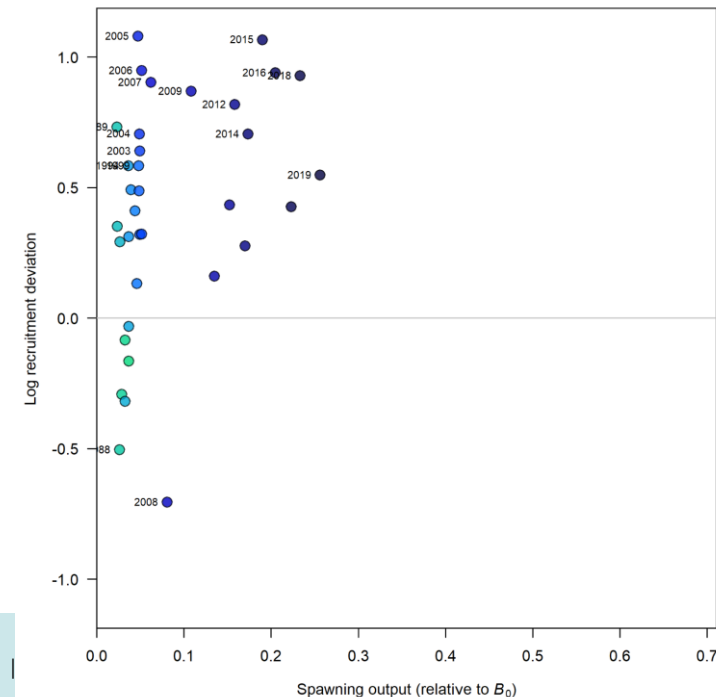
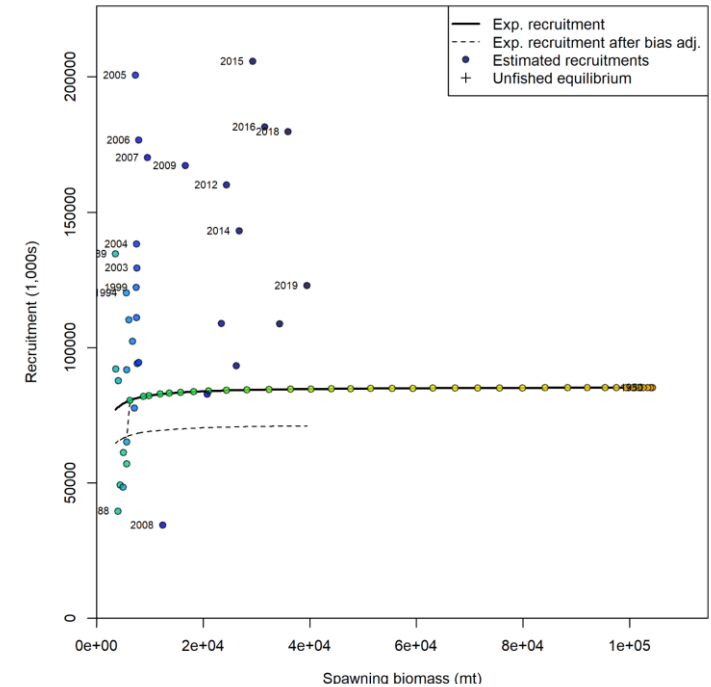
Model Derived Quantities

Model Fits

Stock Recruit and Apportionment

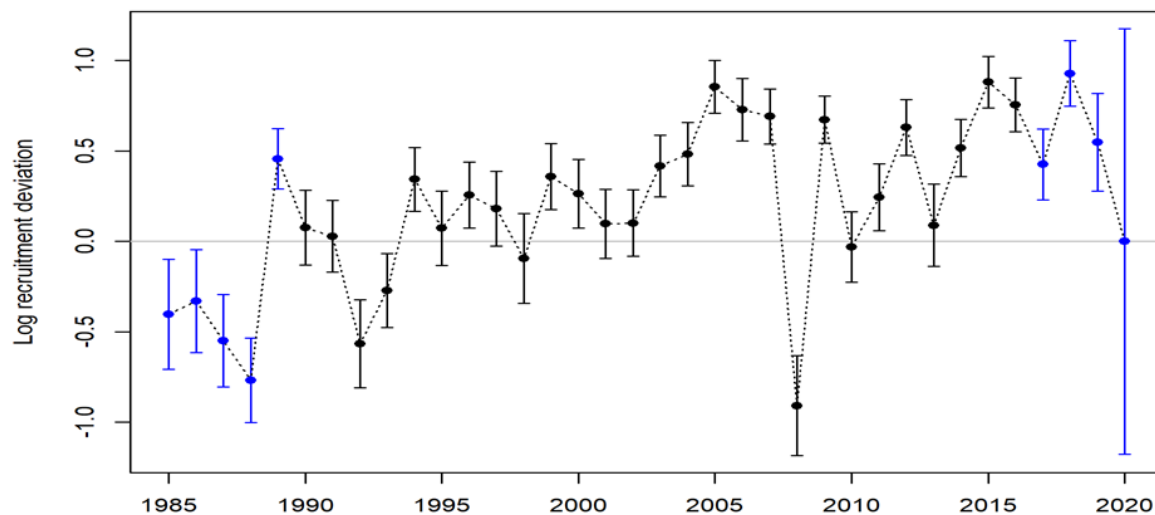
Stock Recruitment

- Model essentially estimates average recruitment.
- Deviations have become increasingly positive with time.

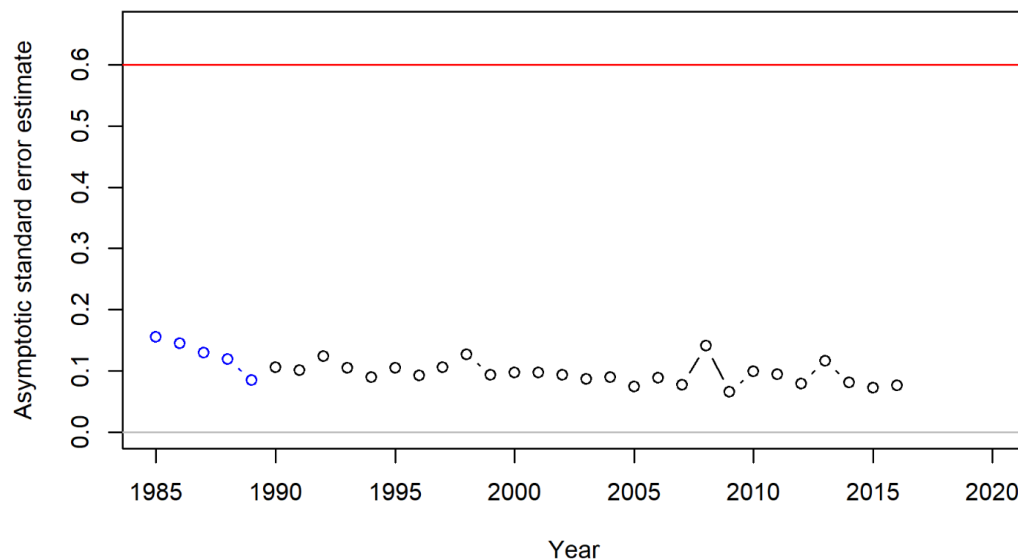


Recruitment

- Upward trend in recruitment deviations.
- Generally well estimated with the exception of the earliest and terminal years.

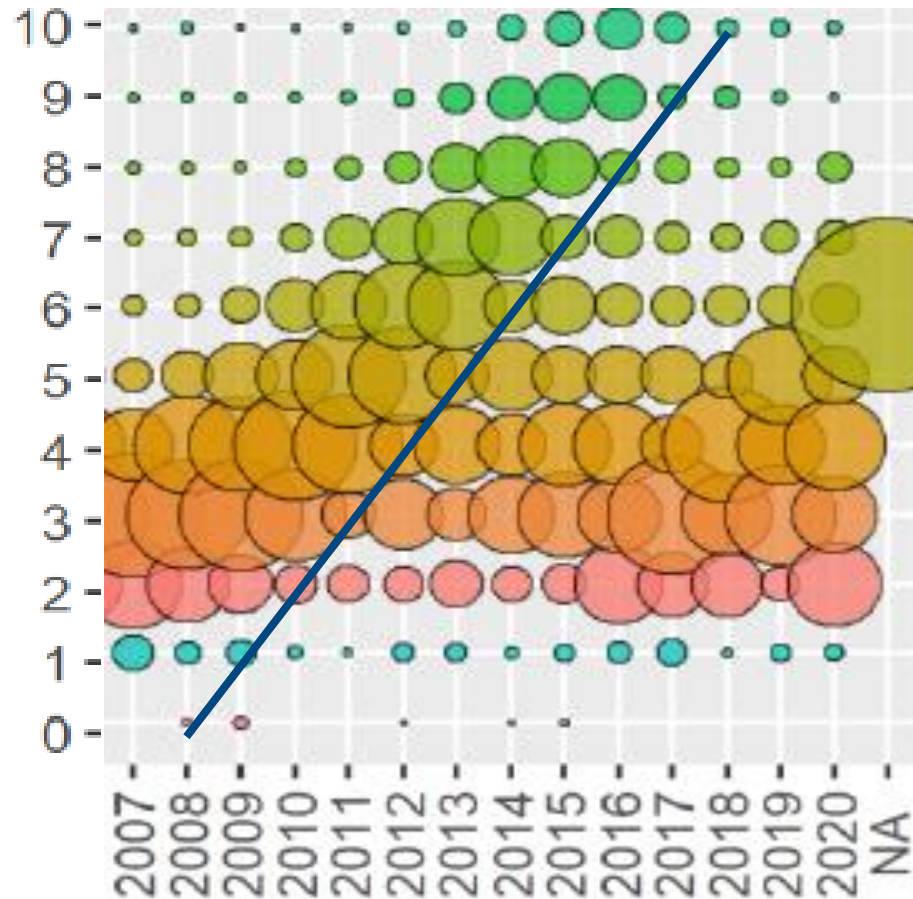


Recruitment deviation variance

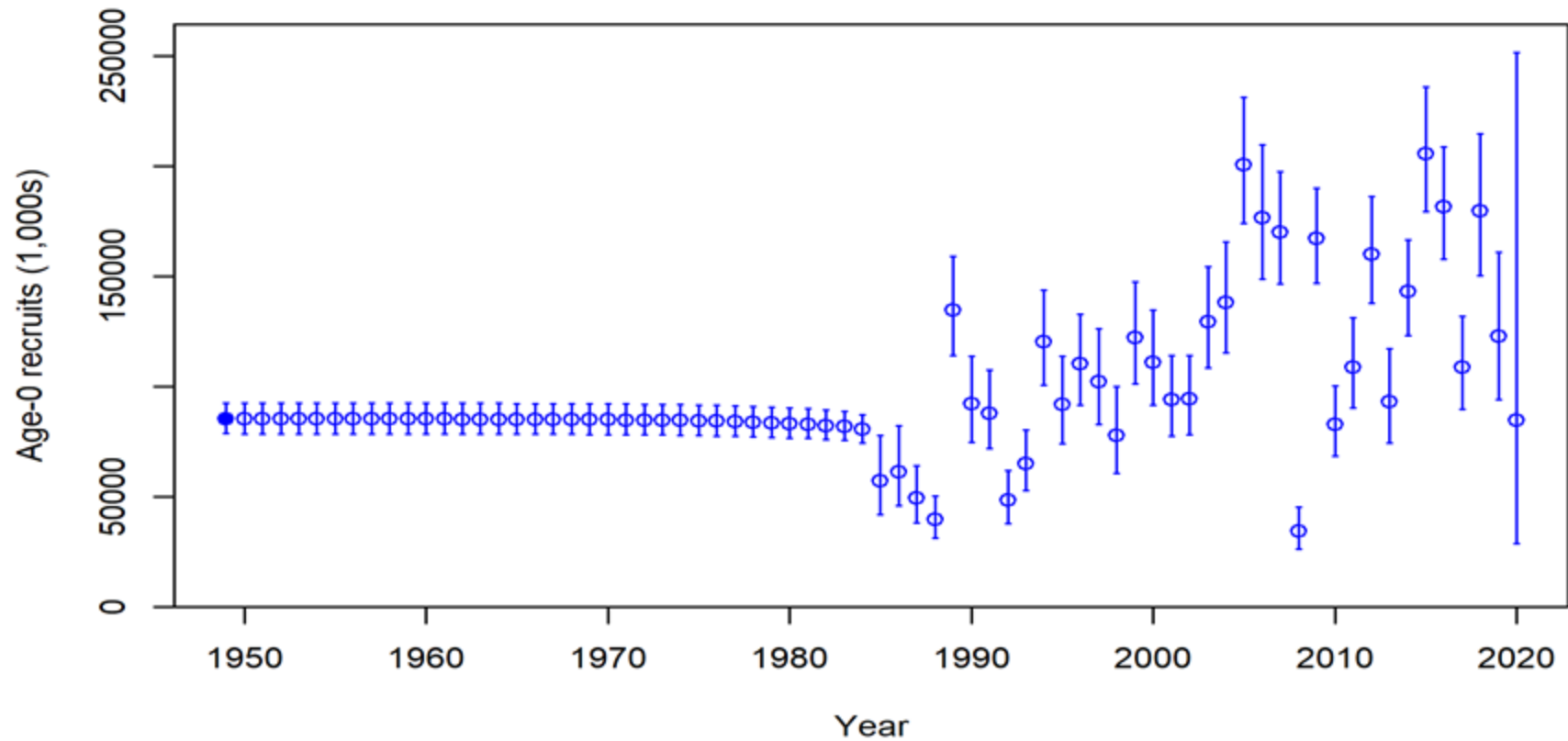


2008 Recruitment

Evidence of poor recruitment seen across assessment areas (Central Shown).

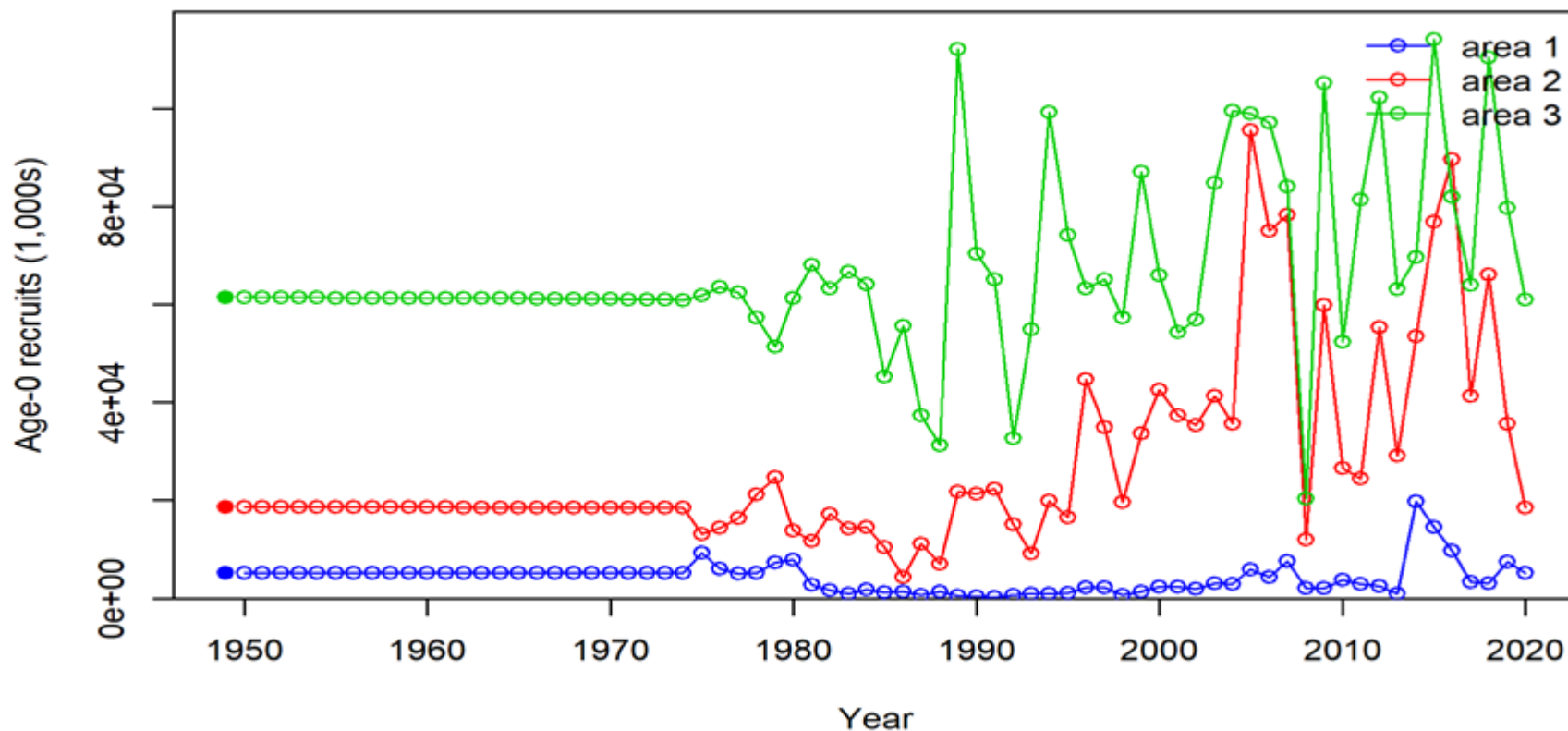


Recruits



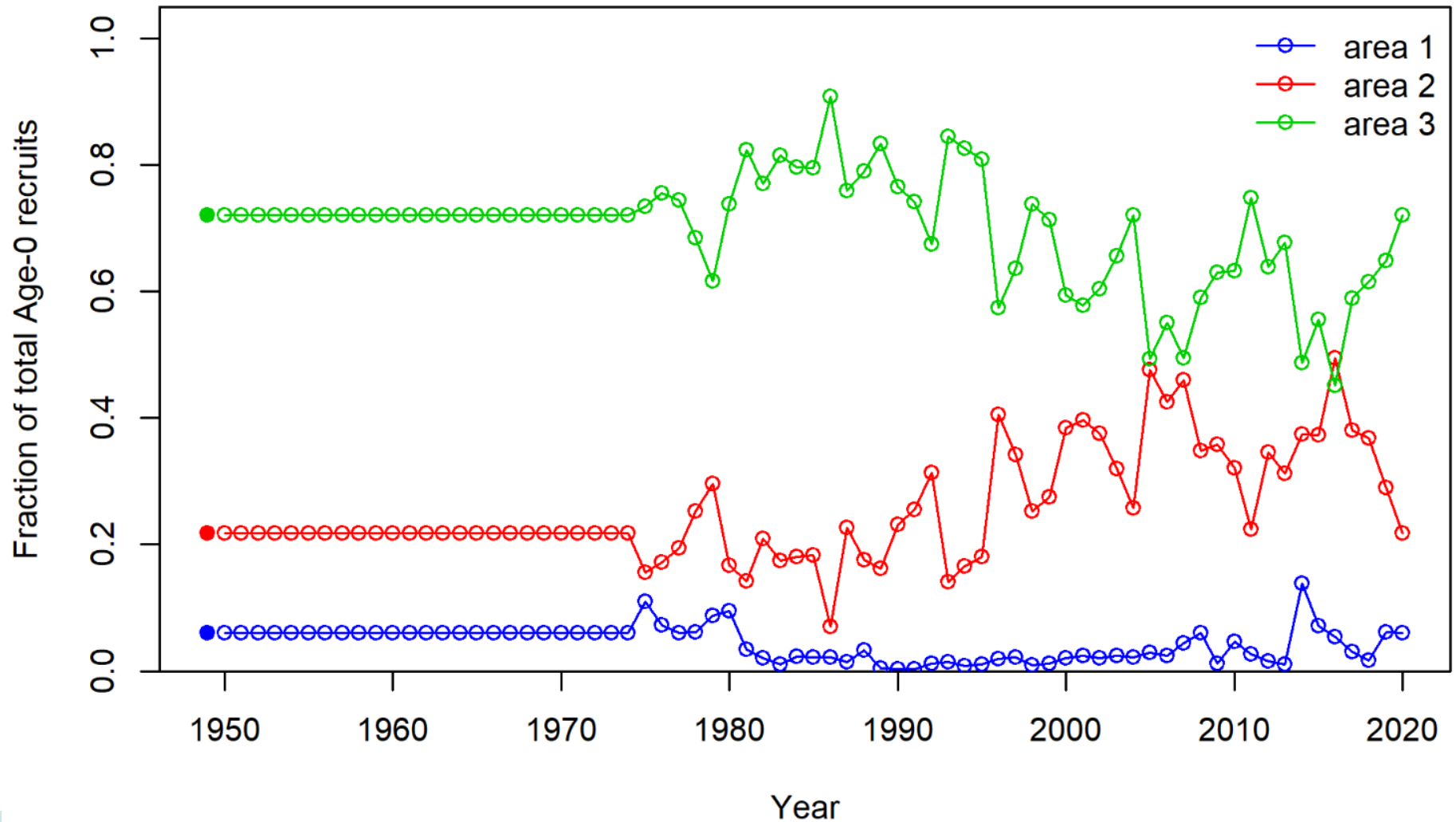
Recruits by area

Area 1 = East
Area 2 = Central
Area 3 = West



Apportionment

Area 1 = East
Area 2 = Central
Area 3 = West



Questions about Stock Recruitment and Apportionment

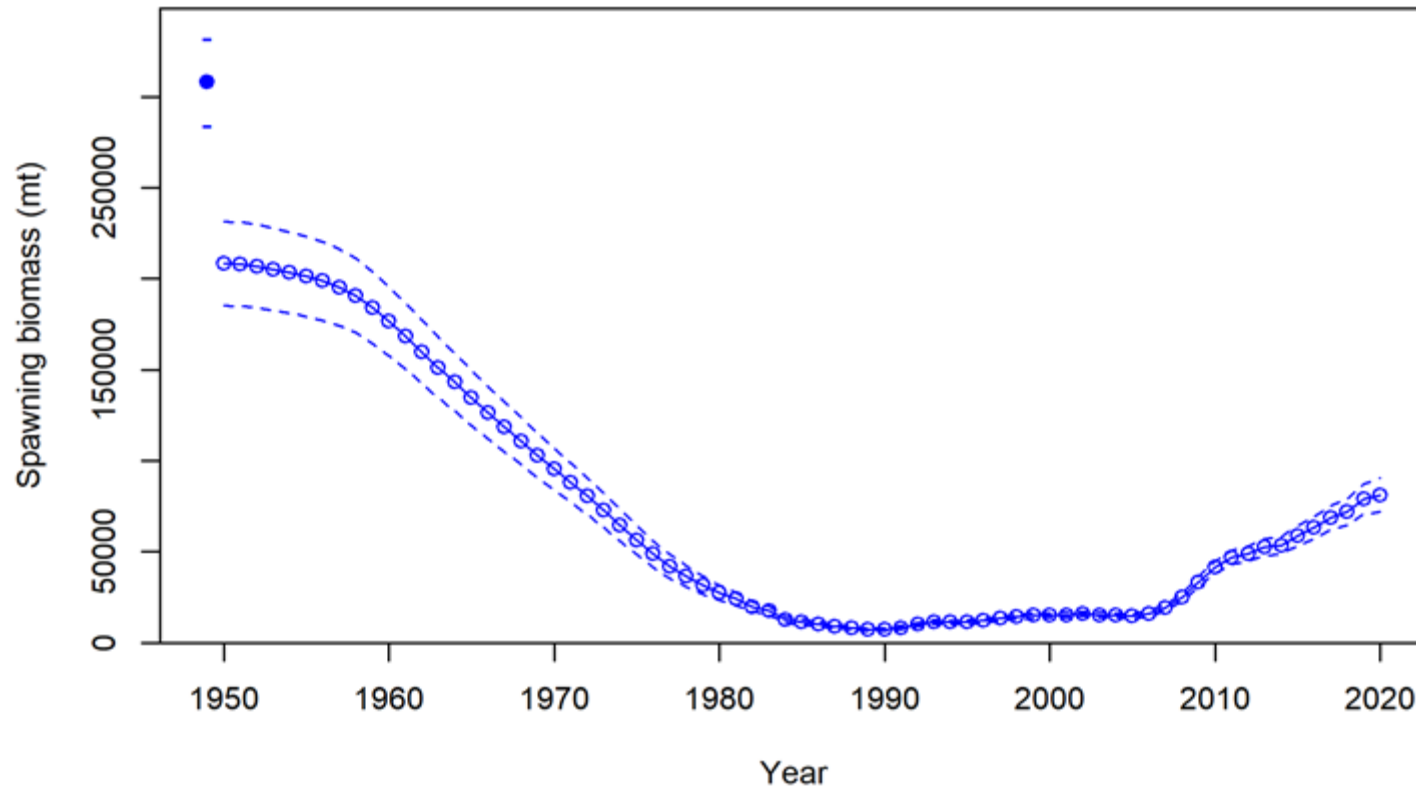


Model Fits

Biomass and Fishing Mortality

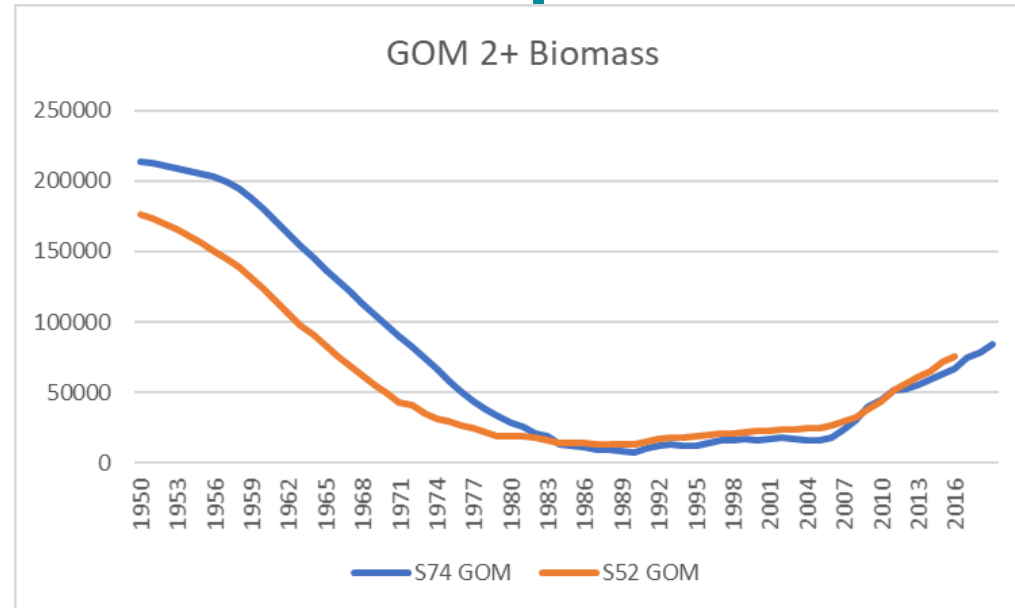


Spawning Biomass Gulf wide



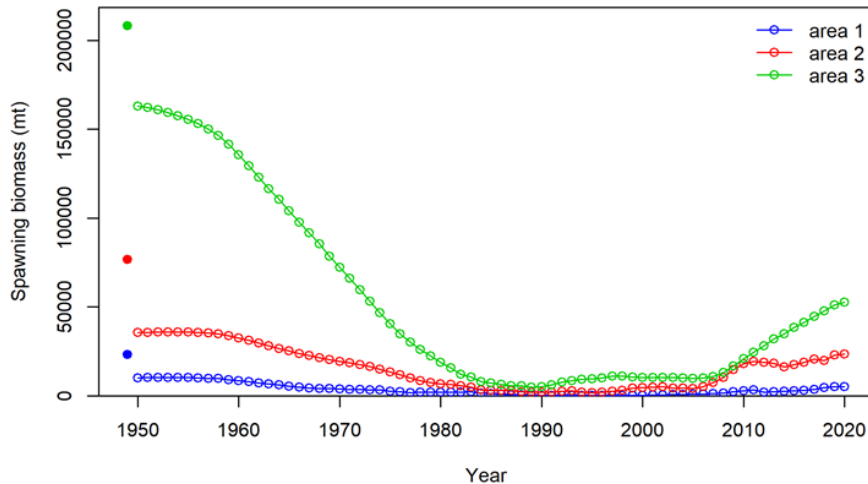
Spawning Biomass Gulf wide Comparison

- Similar biomass and depletion trajectories between current and past assessment
- Initial differences likely due to change of start year between models

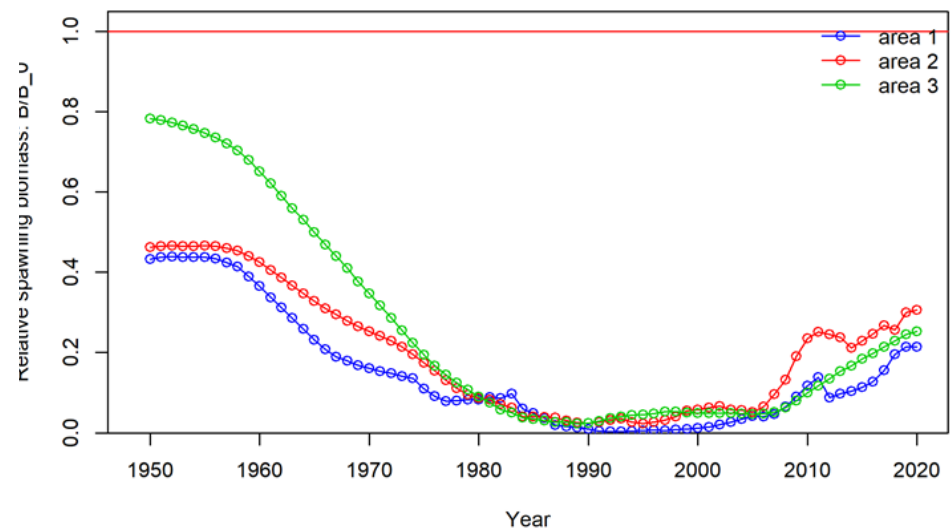


By Area Spawning Biomass and Relative Biomass

SSB



SSB/SSB0



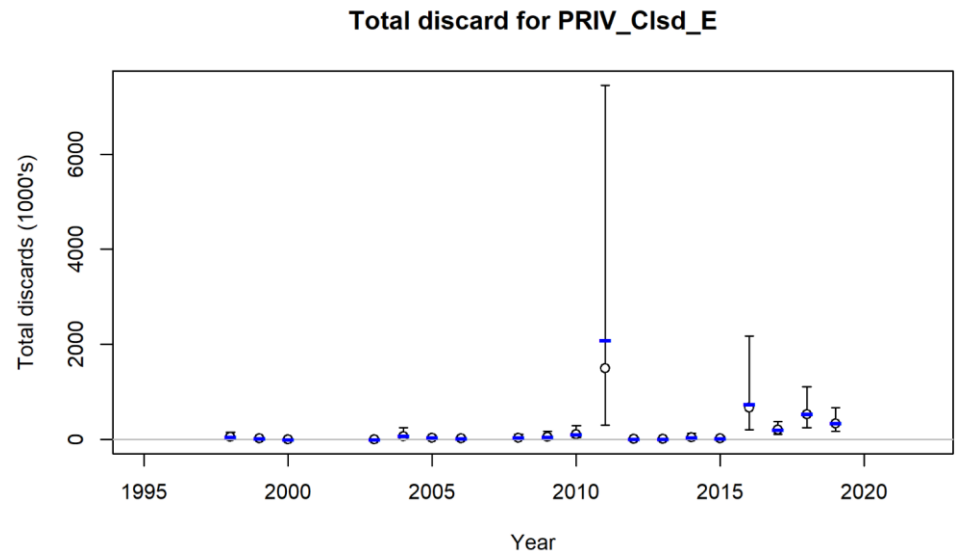
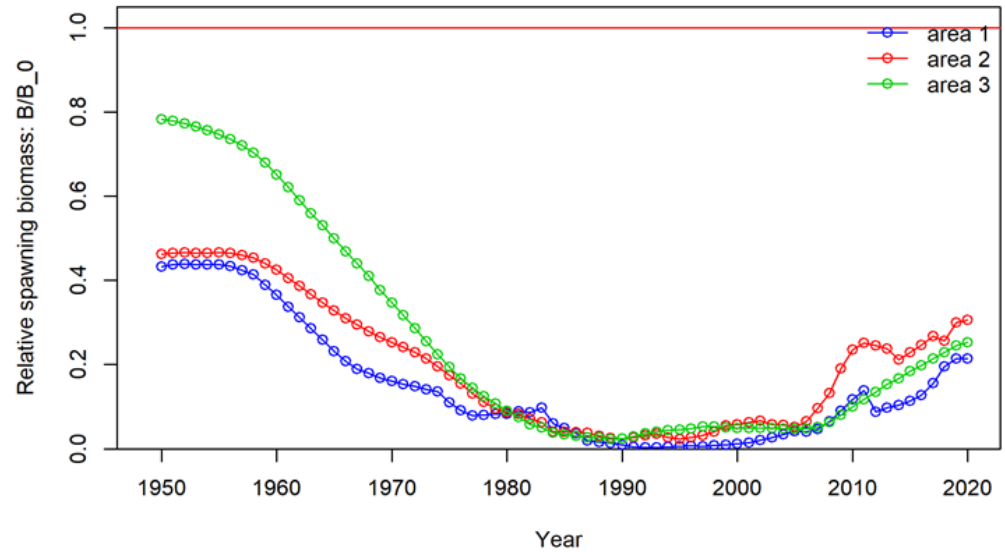
Area 1 = East

Area 2 = Central

Area 3 = West

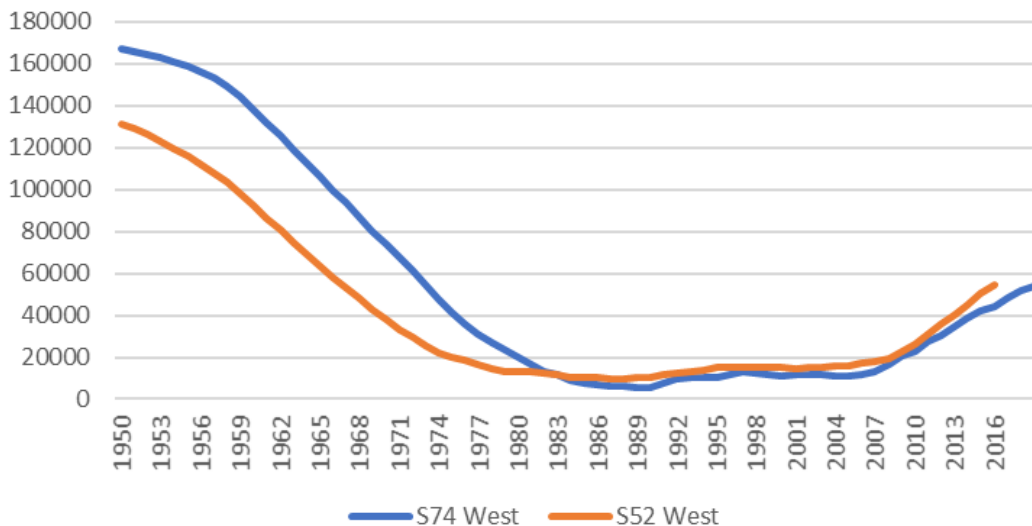
East Area Trend

Steep decline from
2011 to 2012
associated with
highly uncertain
private discards for
2011 which resulted
in a very high
estimate of fishing
mortality rate

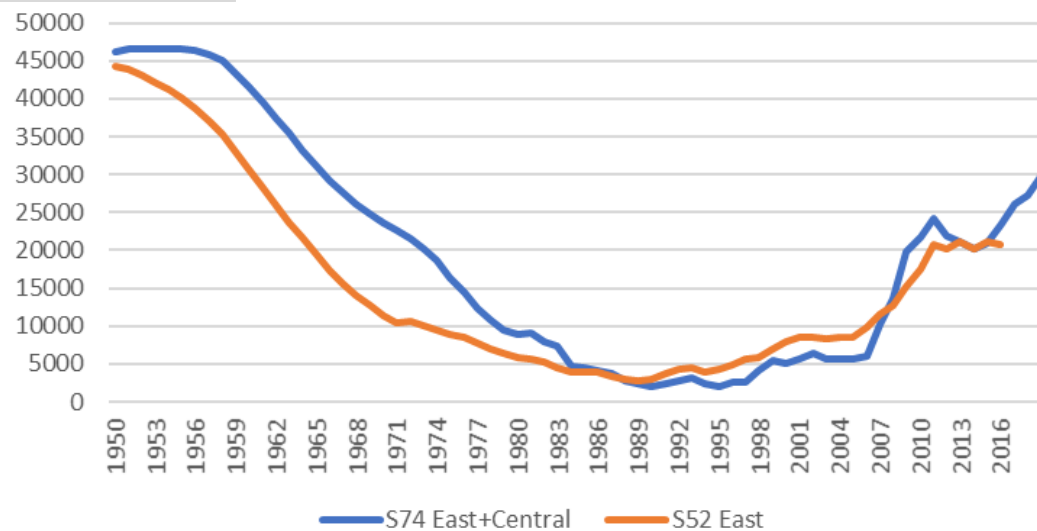


Area-specific SSB Comparisons

West GOM 2+ Biomass

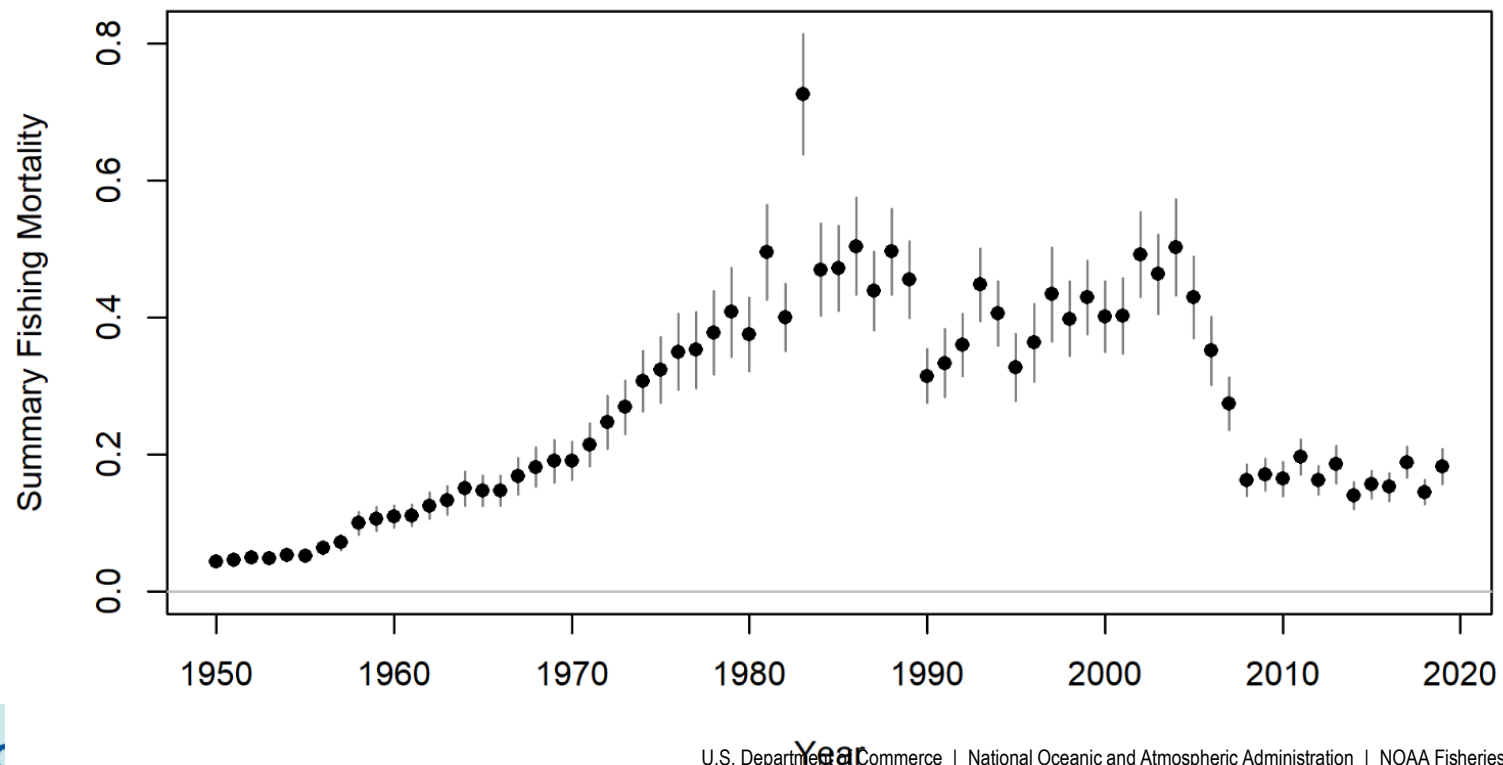


East GOM 2+ Biomass

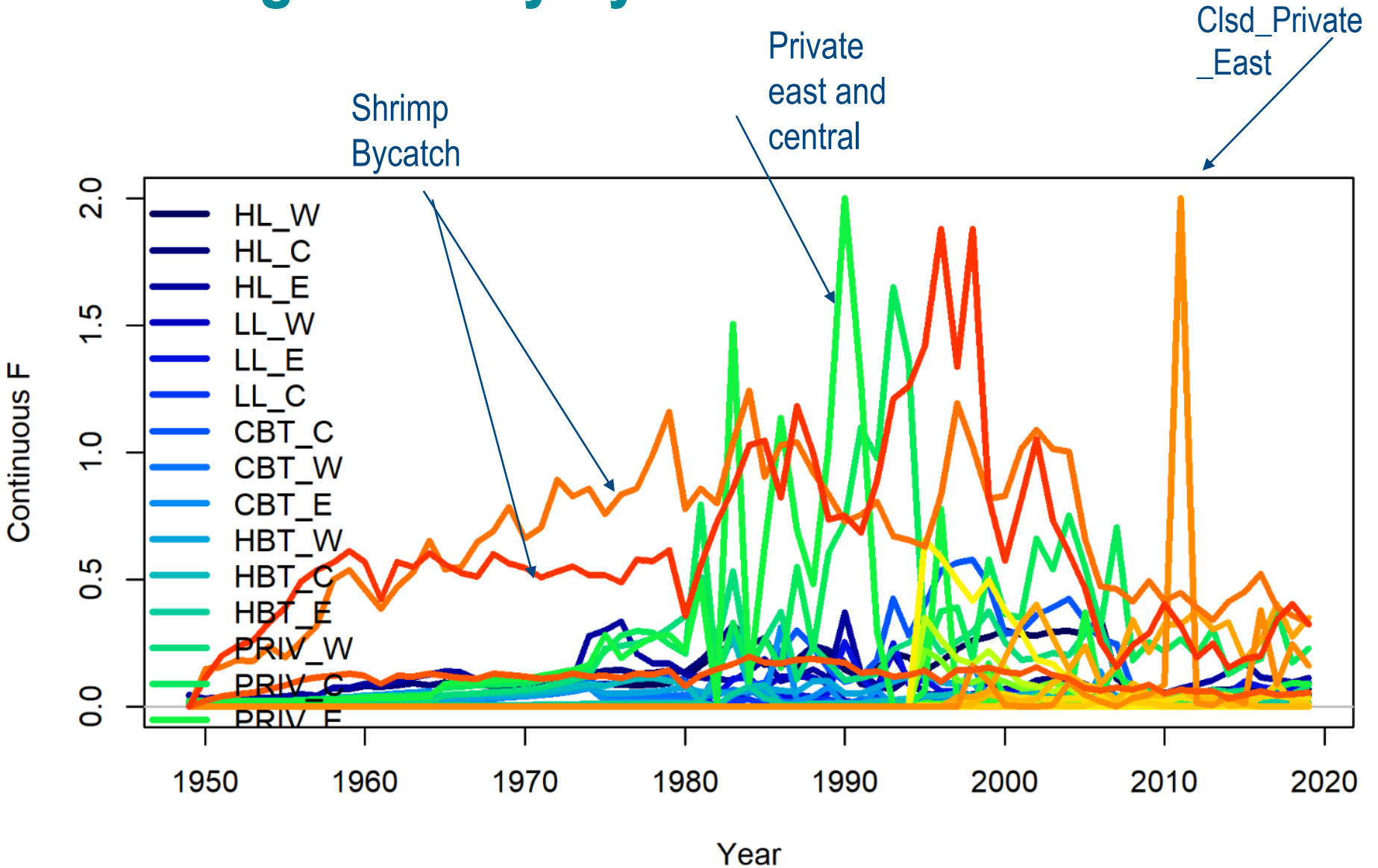


Age 2+ Exploitation

Reasonable exploitation rates through time given history of fishing. '81 and '83 estimates tied to highly uncertain recreational landings

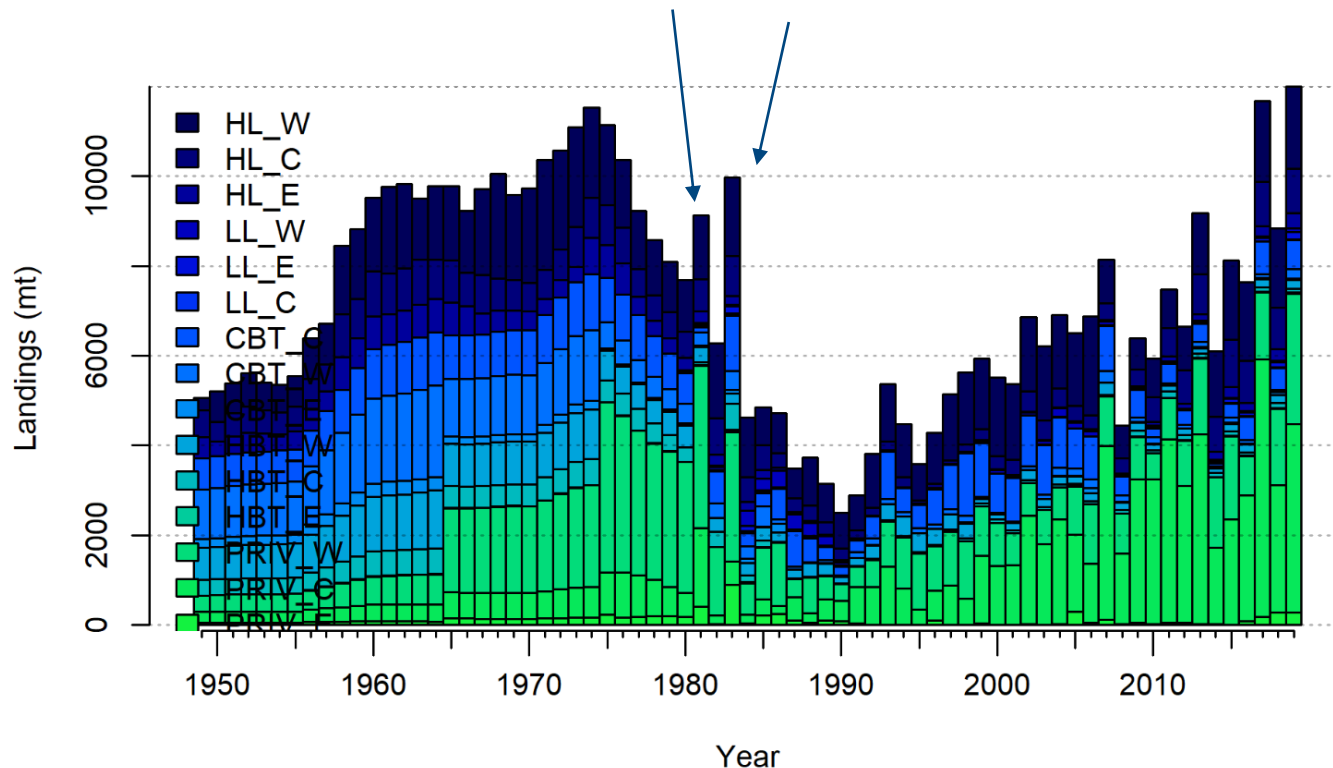


Fishing Mortality by Fleet



Age 2+ Exploitation

Recreational '81 and '83 estimates should be re-evaluated and potentially smoothed over



Questions about Biomass and Fishing Mortality



Outline

- Data Review
 - Stock Definition
 - Life History
 - Data
 - Removals
 - Indices
 - Compositions
- Statistical Catch-at-age Model
 - Base Model Setup
 - Model Fits
 - Sensitivities

Sensitivities - Dynamic Maturity

Based on suggestions from the LHWG time varying maturity sensitivities were conducted.

1. Using separate parameter blocks for changes in A_{50} and A_{slope} over three time periods.

Year	Parameter	East	Central	West
1970	M_{A50}	1.49	1.49	1.71
	M Slope $_{A50}$	-2.39	-2.39	-1.99
1991	M_{A50}	1.39	1.39	1.51
	M Slope $_{A50}$	-3.61	-3.61	-3.21
2009	M_{A50}	1.49	1.49	1.71
	M Slope $_{A50}$	-2.39	-2.39	-1.99

2. A_{50} and A_{slope} as functions of Spawning Stock Biomass (i.e., fish mature at younger ages when stock sizes are low)

$$P_y = P_{base} + P_t * E_y$$

Where:

y = year

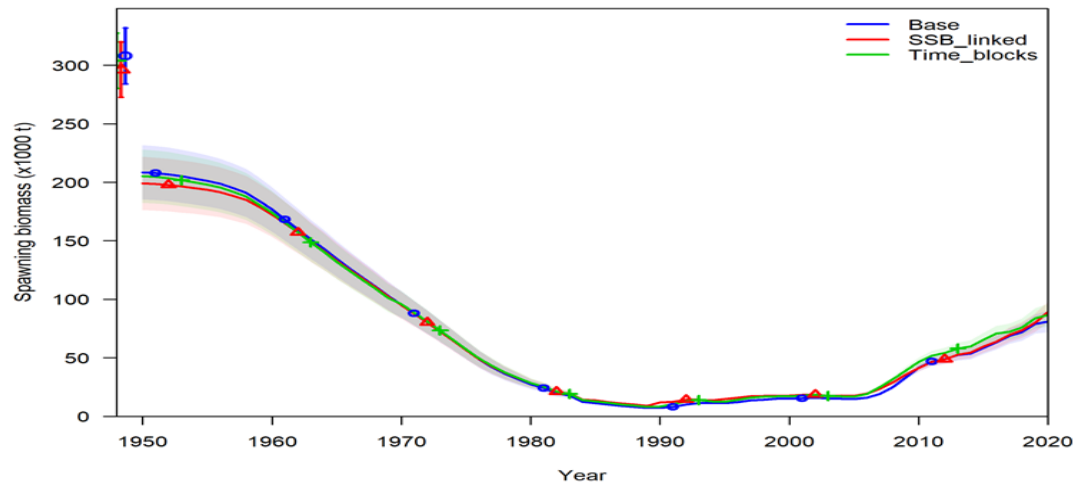
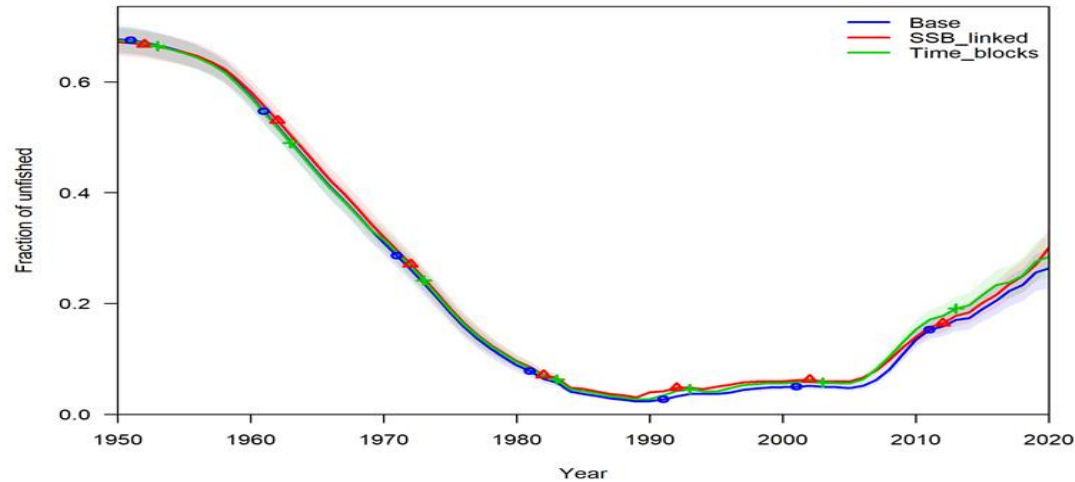
P_y = Maturity slope or A_{50} in year, y

P_{base} = Base Maturity slope or A_{50} (1950)

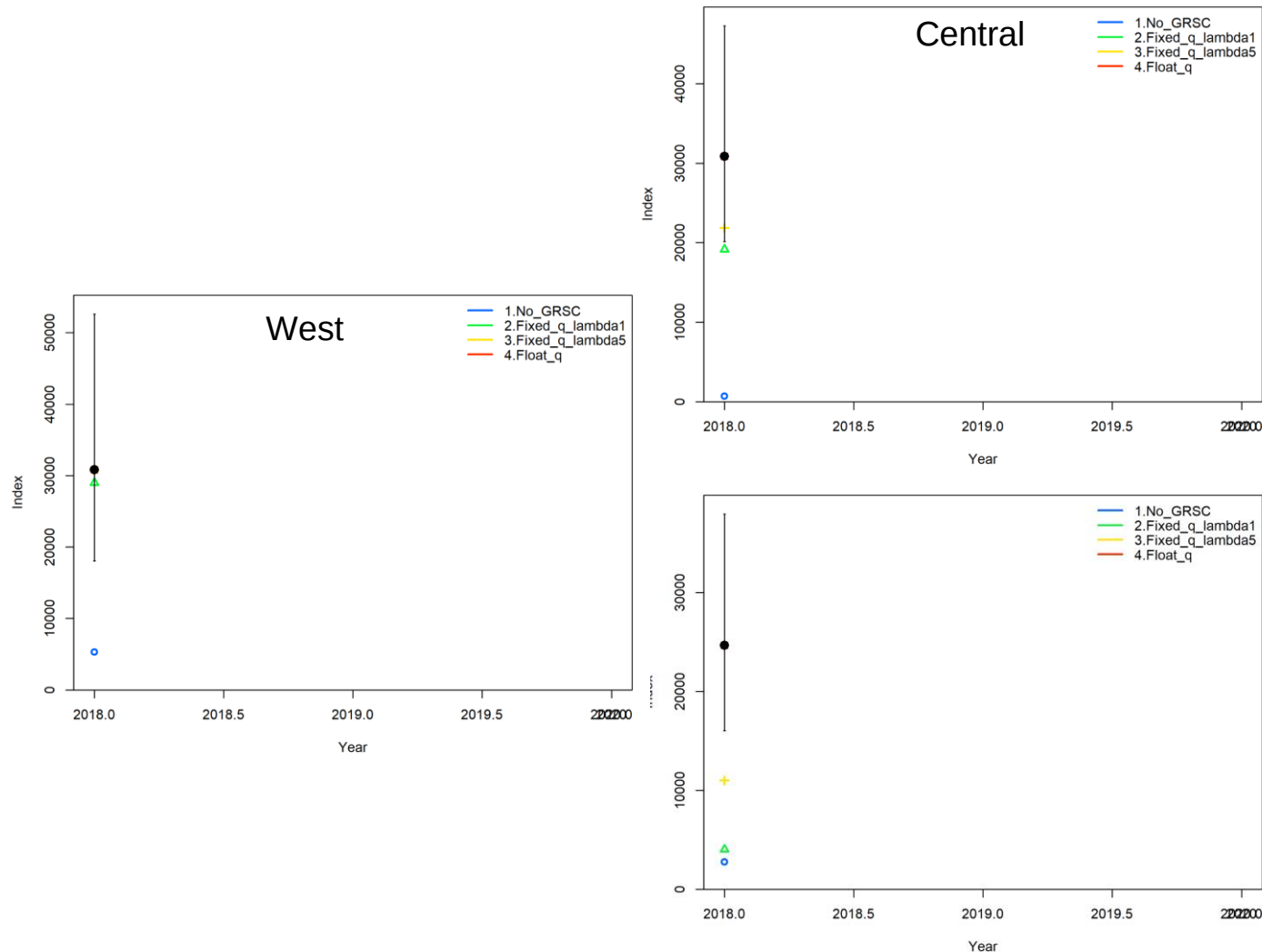
P_t = Scaling parameter (i.e., effect size)

E_y = $\text{Log}(\text{SSB}_y / \text{SSB}_0)$ in year, y

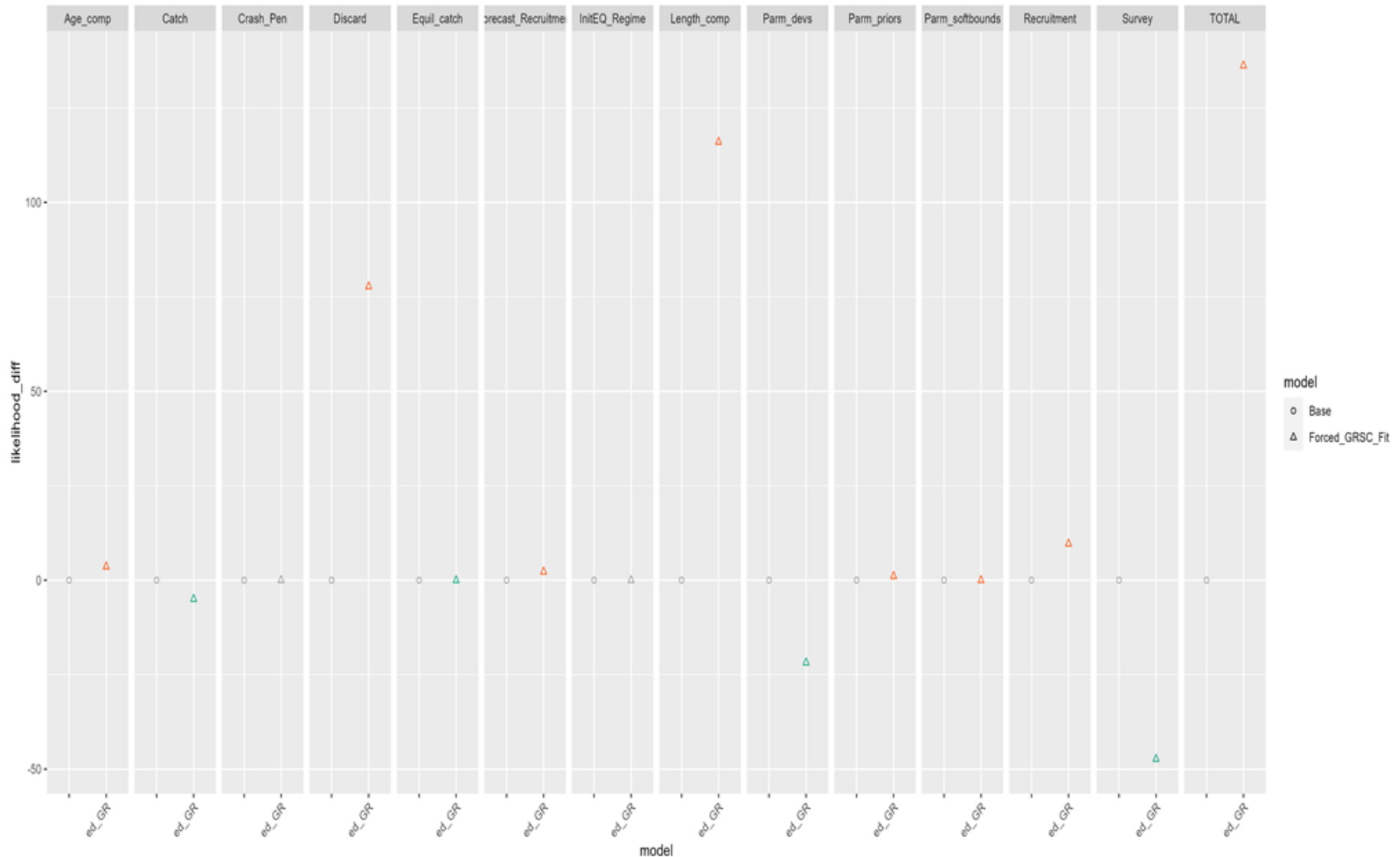
Sensitivities - Dynamic Maturity



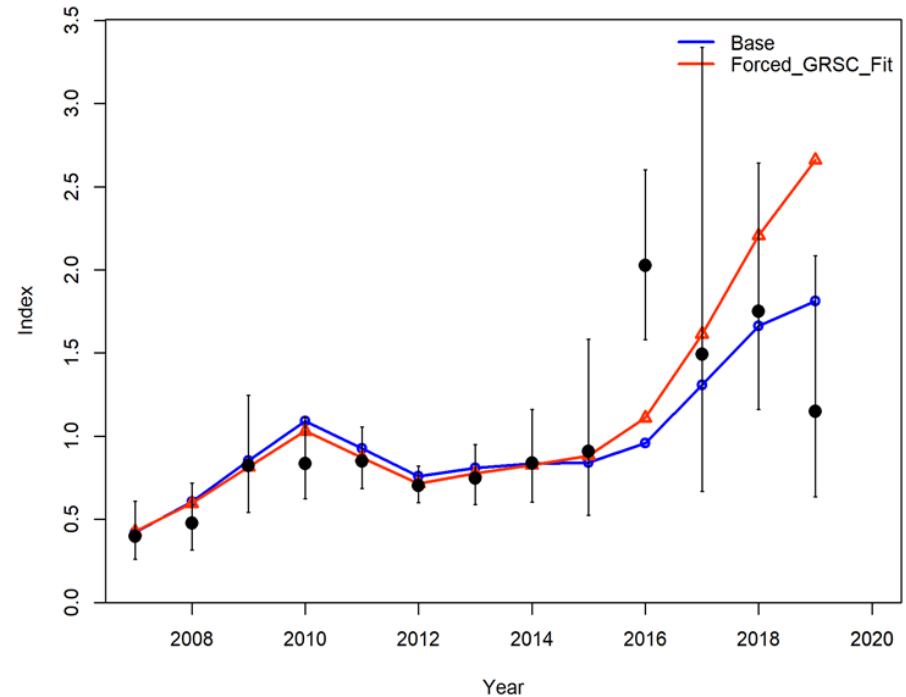
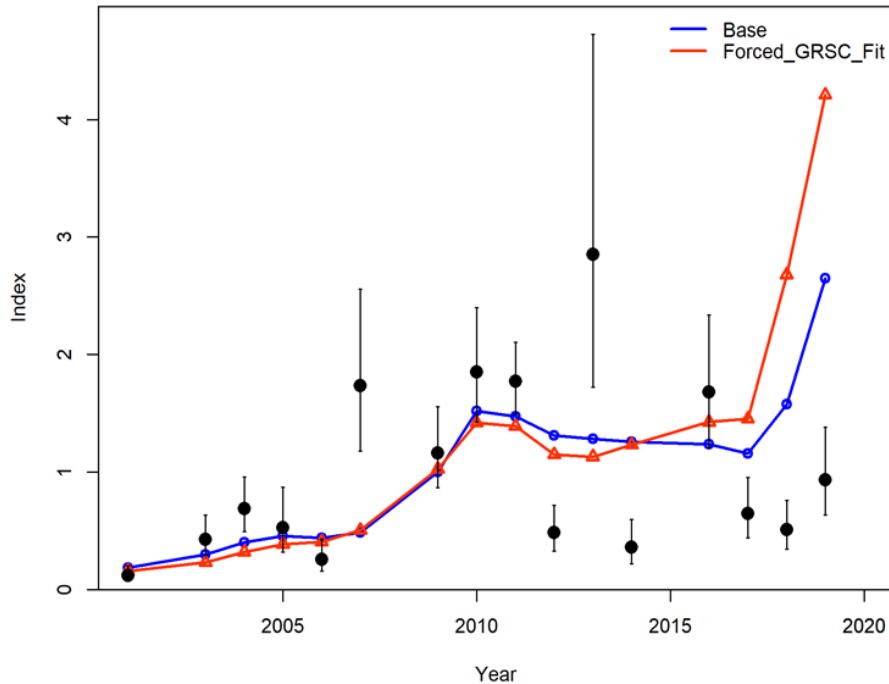
Sensitivities - GRSC - Catchability Coefficient (Q)



Sensitivities - GRSC - Weighting



Sensitivities - GRSC - Weighting

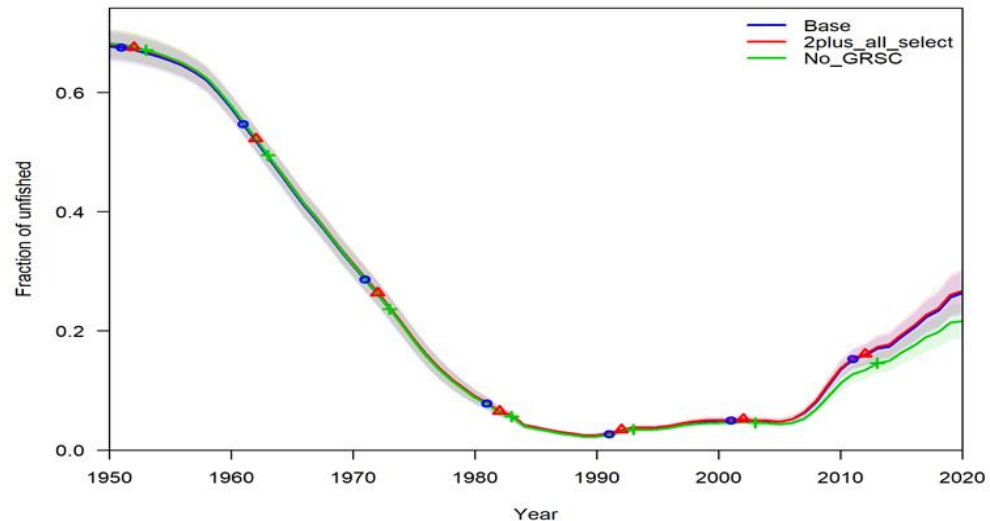
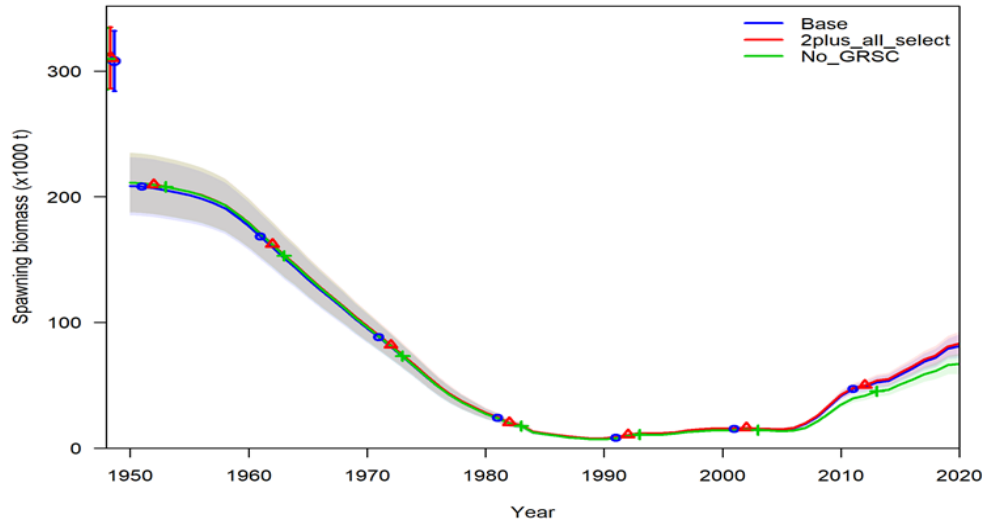


Sensitivities - GRSC - Selectivity

Due to concerns surrounding GRSC length comp data, two sensitivities were conducted.

1. No GRSC estimates used in the model.
2. GRSC estimates are included in the assessment model and the selectivity is assumed to be 100% of all fish age-2+.

Sensitivities - GRSC - Selectivity



Operational Assessment Considerations

Operational Assessment

- Data will be updated and recompiled following best practices determined during the research track
- Diagnostic analyses to be considered
 - Jitter analysis
 - Residual analysis
 - Runs test
 - Profile analysis of SR parameters
 - Retrospective analysis
 - Hindcasting

Operational Assessment

- Once model is finalized
 - Projections will be conducted in order to establish biological reference points, estimate stock status and project yield.
- Sensitivity analysis will be considered and conducted as necessary



Questions?

Thank you!

