Appendix 2
Model Structure

General Definitions	Symbol	Description/Definition
Year Index	y	y = {1982,..,2021} for catch. y = {1970,..,2021} for indices.
Age Index	a	a = {1,..,15+}
Fleet Index	f	f = {1: Chesapeake Bay, 2: Coast }
Indices Index:	t	t = {1,..,14}
Input Data	**Symbol**	**Description/Definition**
Observed Fleet Catch	$C_{f,y}$	Reported number of striped bass killed each year (y) by fleet (f)
Coefficient of Variation for Fleets	$CV_{f,y}$	Calculated from MRIP harvest and releases estimates with associated proportional standard errors (commercial harvest from census – no error)
Observed Fleet Age Compositions	$P_{f,y,a}$	Proportion-at-age (a) for each year (y) and fleet (f)
Observed Total Indices of Relative Abundance	$I_{t,y}$	Reported by various states. YOY and Age 1 Indices: 6 Indices with Age Composition: 8 (one fisheries-dependent, 7 fishery-independent)
Coefficient of Variation for Indices	$CV_{t,y}$	Calculated from indices and associated standard errors
Observed Age Compositions of Indices of Relative Abundance	$P_{t,y,a}$	Proportion-at-age (a) for each year (y) and index (t)
Effective Sample Size	$\hat{n}$	Starting Values from 2018 Benchmark Fleets: Bay – 68.4, Ocean – 71 Indices: NYOHS – 21.4, NJ Trawl – 5.2, MDSSN – 16.8, DESSN – 19.7, MRIP – 35.6, CTLIST – 12.4, DE30FT – 7.3, ChesMap – 10.7 The multiplier from equation 1.8 method of Francis (2011) is used to adjust the starting values.

Population Model	Symbol	Equation
Age-1 numbers	$\hat{N}_{y,1}$	$\hat{N}_{y,1} = \bar{N}_1 e^{\hat{\varepsilon}_y - 0.5\sigma_R^2}$ $\hat{\sigma}_R = \sqrt{\frac{\Sigma_y(\hat{\varepsilon}_y - \hat{\bar{\varepsilon}})^2}{n-1}}$ where ε_y are independent and identically distributed normal random variables with zero mean and constant variance and are constrained to sum to zero over all years
Abundance-at-Age	$\hat{N}_{y,a}$	First year (ages 2-A in 1970): $\hat{N}_{y,a} = \hat{N}_{y,a-1} \exp^{-\hat{F}_{1982,a-1} - M_{1982,a-1}}$ Rest of years (ages 2-15): $\hat{N}_{y,a} = \hat{N}_{y-1,a-1} \exp^{-\hat{F}_{y-1,a-1} - M_{y-1,a-1}}$
Plus-group abundance-at-age	$\hat{N}_{y,A}$	$\hat{N}_{y,A} = \hat{N}_{y-1,A-1} \exp^{-\hat{F}_{y-1,A-1} - M_{y-1,A-1}} + \hat{N}_{y-1,A} \exp^{-\hat{F}_{y-1,A} - M_{y-1,A}}$
Fishing Mortality	$\hat{F}_{f,y,a}$	$\hat{F}_{f,y,a} = \hat{F}_{f,y} \cdot \hat{s}_{f,a}$ where $F_{f,y}$ and $s_{f,a}$ are estimated parameters
Total Mortality	$\hat{Z}_{y,a}$	$Z_{y,a} = F_{y,a} + M_{y,a}$
Fleet Selectivity Time Blocks and Selectivity Equations	$\hat{s}_{f,a}$	Fleet 1 (Chespeake Bay): 1982-1984, 1985-1989, 1990-1995, 1996-2019, 2020-2021 $\hat{s}_a = \frac{1}{1-\hat{\gamma}} \cdot \left(\frac{1-\hat{\gamma}}{\hat{\gamma}}\right)^{\hat{\gamma}} \frac{\exp^{\hat{\alpha}\hat{\gamma}(\hat{\beta}-a)}}{1+\exp^{\hat{\alpha}(\hat{\beta}-a)}}$ Fleet 2 (Ocean): 1982-1984, 1985-1989,1990-1996,1997-2019, 2020-2021 $\hat{s}_a = \exp^{(-\exp^{-\hat{\beta}(a-\hat{\alpha})})}$
Predicted Catch-At-Age	$\hat{C}_{f,y,a}$	$\hat{C}_{f,y,a} = \frac{\hat{F}_{f,y,a}}{\hat{F}_{f,y,a} + M_{y,a}} \cdot (1 - \exp^{-\hat{F}_{y,a} - M_{y,a}}) \cdot \hat{N}_{y,a}$

Population Model	Symbol	Equation
Predicted Total Catch	$\hat{C}_{f,y}$	$\hat{C}_{f,y} = \sum_{a} \hat{C}_{f,y,a}$
Predicted Proportions of Catch-At-Age	$\hat{P}_{f,y,a}$	$\hat{P}_{f,y,a} = \frac{\hat{C}_{f,y,a}}{\sum_{a} \hat{C}_{f,y,a}}$
Predicted Aggregated Indices of Relative Abundance	$\hat{I}_{t,y,\sum a}$	$\hat{I}_{t,y,\Sigma a} = \hat{q}_t \cdot \sum_{a} \hat{N}_{y,a} \cdot \exp^{-p_t \cdot Z_{y,a}}$ where q_t is the estimated catchability coefficient of index t and p_t is the fraction of the year when the survey takes place.
Predicted Age-Specific Indices of Relative Abundance	$\hat{I}_{t,y,a}$	$\hat{I}_{t,y,a} = \hat{q}_t \cdot \hat{s}_{t,a} \cdot \hat{N}_{y,a} \cdot exp^{-p_t \cdot \hat{Z}_{y,a}}$ where $\hat{s}_{t,a}$ is the selectivity-at-age a for index t
Predicted Total Indices of Relative Abundance with Age Composition Data	$\hat{I}_{t,y}$	$\hat{I}_{t,y} = \hat{q}_t \sum_{a} \hat{s}_{t,a} \cdot \hat{N}_{y,a} \cdot \exp^{-p_t \cdot \hat{Z}_{y,a}}$
Predicted Age Composition of Survey	$\hat{U}_{t,y,a}$	$\hat{U}_{t,y,a} = \frac{\hat{I}_{t,y,a}}{\sum_{a} \hat{I}_{t,y,a}}$
Female Spawning Stock Biomass (metric tons)	SSB_y	$SSB_y = \sum_{a=1}^{A} N_{y,a} \cdot sr_a \cdot m_a \cdot w_{y,a} / 1000$ where sr_a is the female sex ratio at age a and m_a is female maturity at age a.

Likelihood	Symbol	Equation
Concentrated Lognormal Likelihood for Fleet Catch (F) and Indices of Relative Abundance (T)	$-L_F$; $-L_T$	$-L_F = 0.5 * \sum_f n_f * ln\left(\frac{\sum_f RSS_f}{\sum_f n_f}\right)$ $-L_T = 0.5 * \sum_t n_t * ln\left(\frac{\sum_t RSS_t}{\sum_t n_t}\right)$ where $RSS_f = \lambda_f \sum_y \left(\frac{ln(C_{f,y} + 0.00001) - ln(\hat{C}_{f,y} + 0.00001)}{\delta_f \cdot CV_{f,y}}\right)^2$ $RSS_t = \lambda_t \sum_y \left(\frac{ln(I_{t,y} + 0.00001) - ln(\hat{I}_{t,y} + 0.00001)}{\delta_t \cdot CV_{t,y}}\right)^2$ *ln* is the natural log. $CV_{f,y}$ and $CV_{t,y}$ are the annual coefficient of variation for the observed total catch (f) and index (t) in year *y*, δ_f and δ_t is the CV weights for total catch *f* and index *t* , and λ_t and λ_f are relative weights.
Multinomial fleet catch (FC) and index (TC) age compositions	$-L_{FC}$; $-L_{TC}$	$-L_{FC} = \lambda_f \sum_y -n_{f,y} \sum_a P_{f,y,a} \cdot ln(\hat{P}_{f,y,a} + 0.0000001)$ $-L_{TC} = \lambda_t \sum_y -n_{t,y} \sum_a U_{t,y,a} \cdot ln(\hat{U}_{t,y,a} + 0.0000001)$ where λ_f and λ_t are a user-defined weighting factors and n_y are the effective sample sizes.
Constraints Added To Total Likelihood	P_{n1}, P_{rdev}, P_{fadd}	$P_{n1} = \lambda_{n1}(\hat{N}_{y,1} - N^e_{y,1})^2$ - forces $N_{1,1}$ to follow S-R curve $P_{rdev} = \lambda_R \sum_y log_e(\hat{\sigma}_R) + \frac{\hat{\varepsilon}_y^2}{2\hat{\sigma}_R^2}$ - for bias correction to constrain deviations $P_{f_{add}} = \begin{cases} \text{phase} < 3, & 10 \cdot \sum_y (F_{f,y} - 0.15)^2 \\ \text{phase} \geq 3, & 0.000001 \cdot \sum_y (F_{f,y} - 0.15)^2 \end{cases}$ - avoid small F values at start

Diagnostics	Symbol	Equation
Standardized residuals (lognormal – catch and surveys)	$r_{f,y,a}$ or $r_{t,y,a}$	$r_{t,y} = \frac{\ln I_{t,y} - \widehat{\ln I_{t,y}}}{\sqrt{\ln((\delta_t CV_{t,y})^2 + 1)}}$ $r_{f,y} = \frac{\ln C_{f,y} - \widehat{\ln C_{f,y}}}{\sqrt{\ln(CV_{f,y}^2 + 1)}}$
Standardized residuals (age compositions – catch and surveys)	$ra_{f,y,a}$ or $ra_{t,y,a}$	$ra_{f,y,a} = \frac{P_{f,y,a} - \hat{P}_{f,y,a}}{\sqrt{\frac{\hat{P}_{f,y,a}(1-\hat{P}_{f,y,a})}{\hat{\hat{n}}_f}}}$ $ra_{t,y,a} = \frac{P_{t,y,a} - \hat{P}_{t,y,a}}{\sqrt{\frac{\hat{P}_{t,y,a}(1-\hat{P}_{t,y,a})}{\hat{\hat{n}}_t}}}$
Root mean square error	$RMSE$	Total catch $RMSE_f = \sqrt{\frac{\sum_y r_{f,y}^2}{n_f}}$ Index $RMSE_t = \sqrt{\frac{\sum_y r_{t,y}^2}{n_t}}$

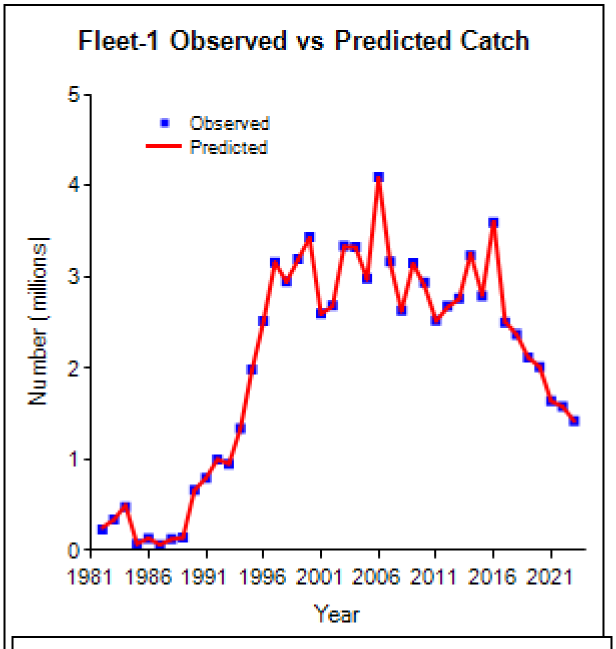
Appendix 3
Diagnostic plots, detailed results, and projections for the base model and sensitivity run

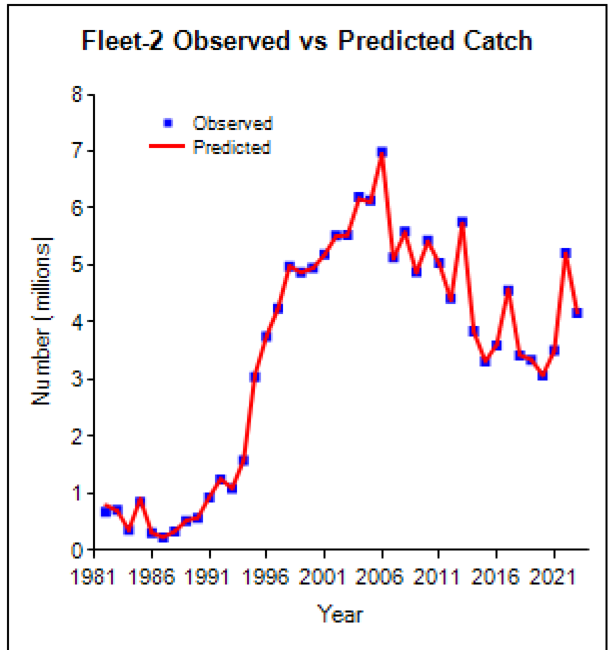
Base Run

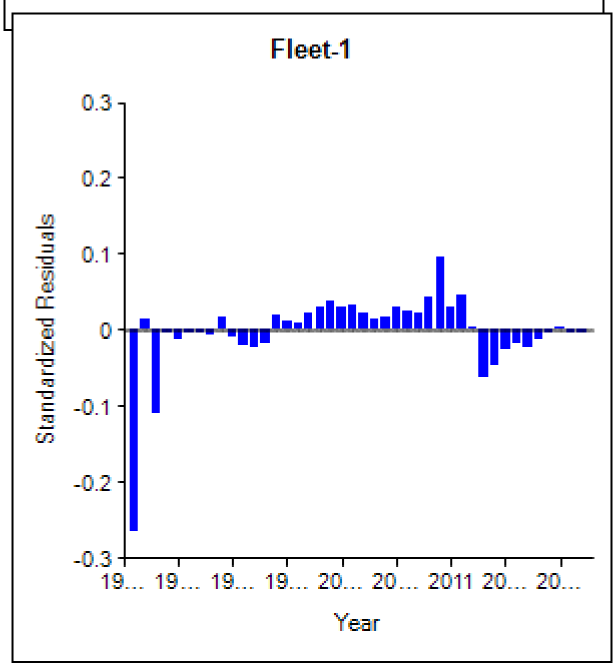
Run configuration:

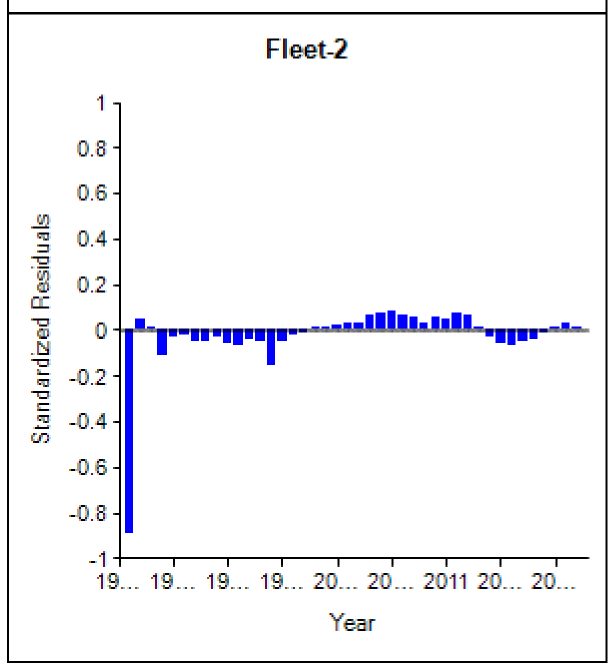
Bay and Ocean fleets: 2020-2023 selectivity block (no separate 2023 block)

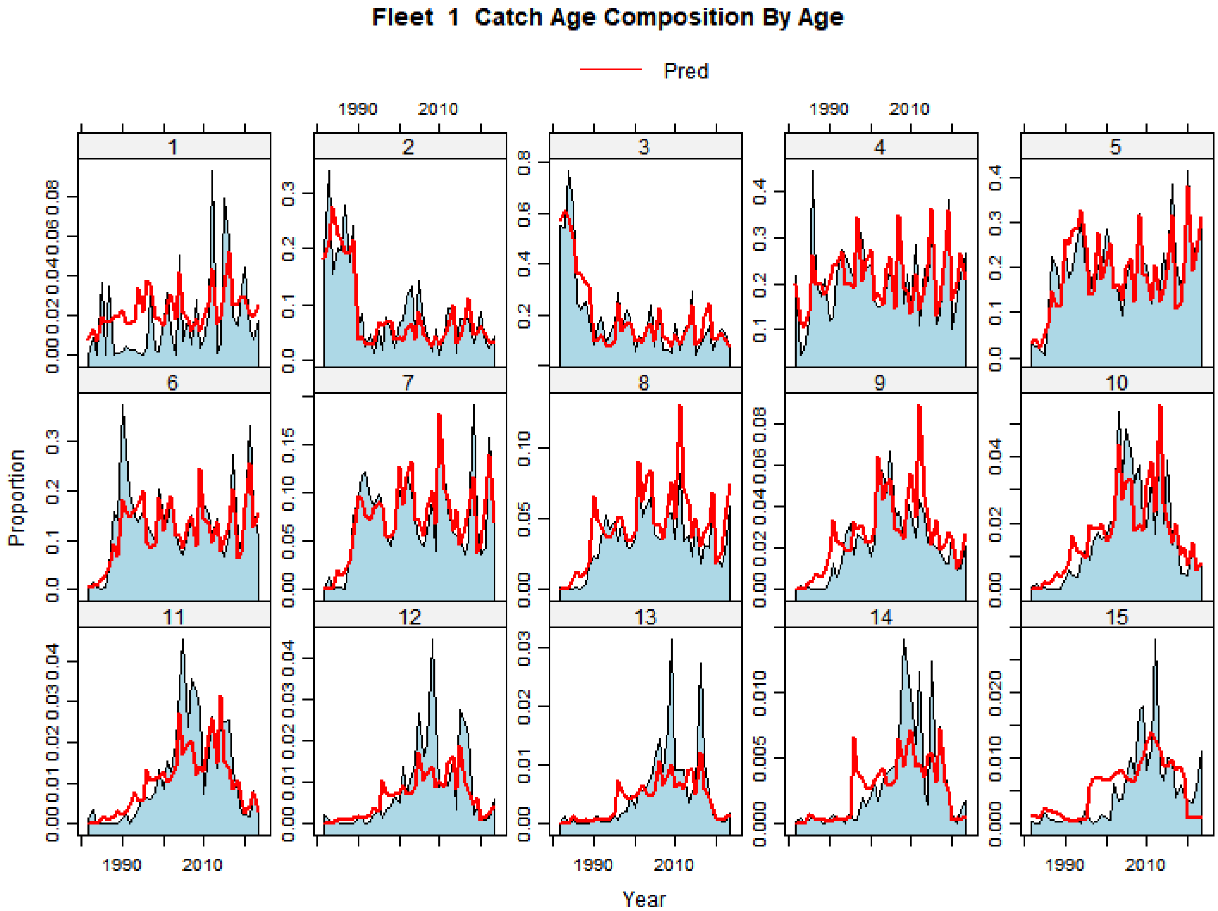
Diagnostic Plots

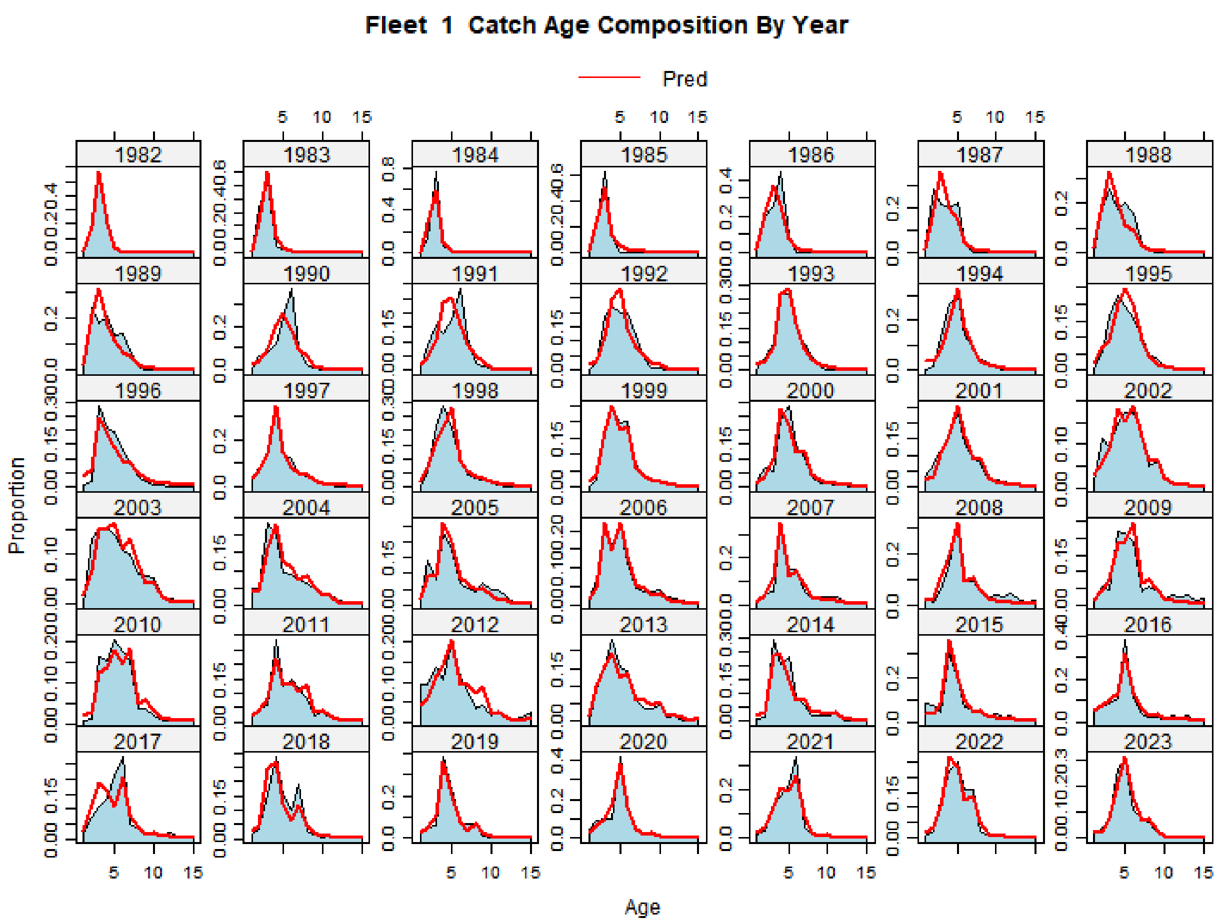




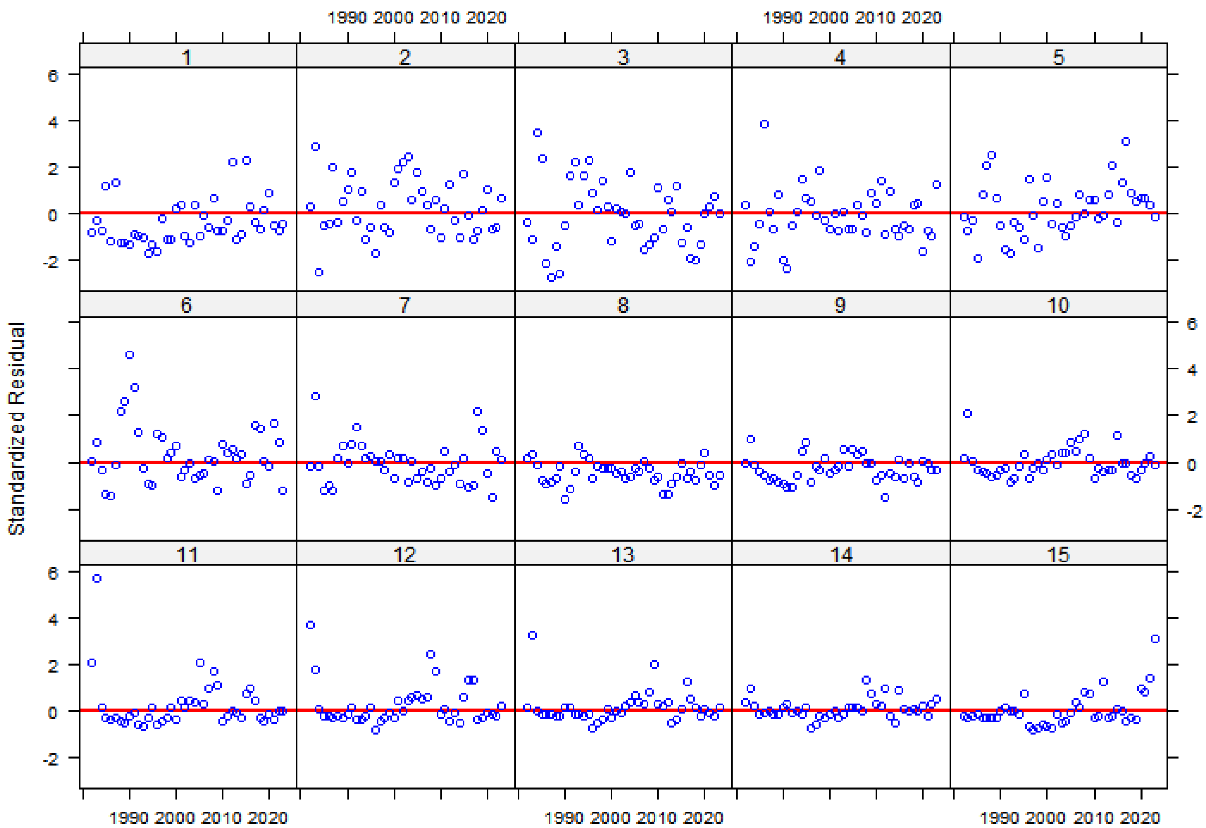




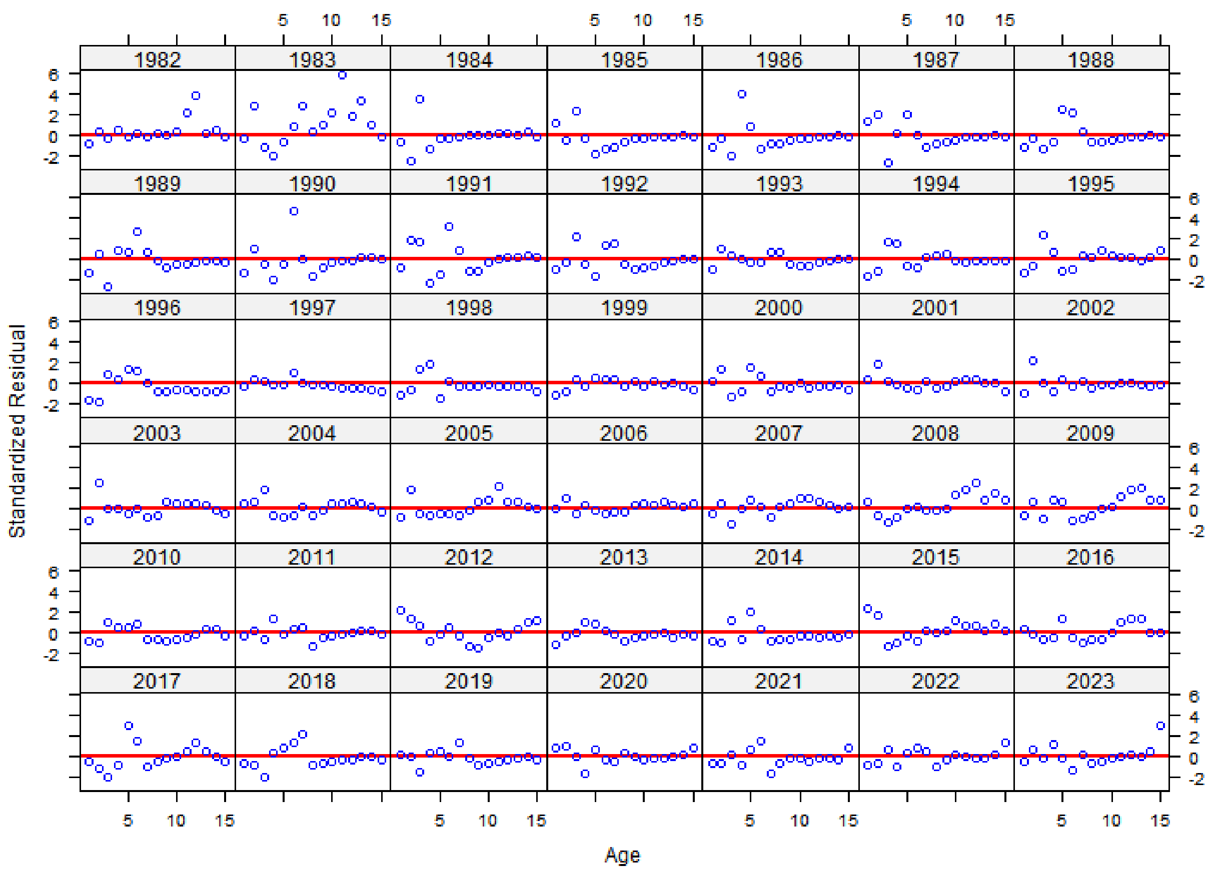

Fleet 1 Catch Age Composition By Age
Pred
Proportion
Year
1990
2010

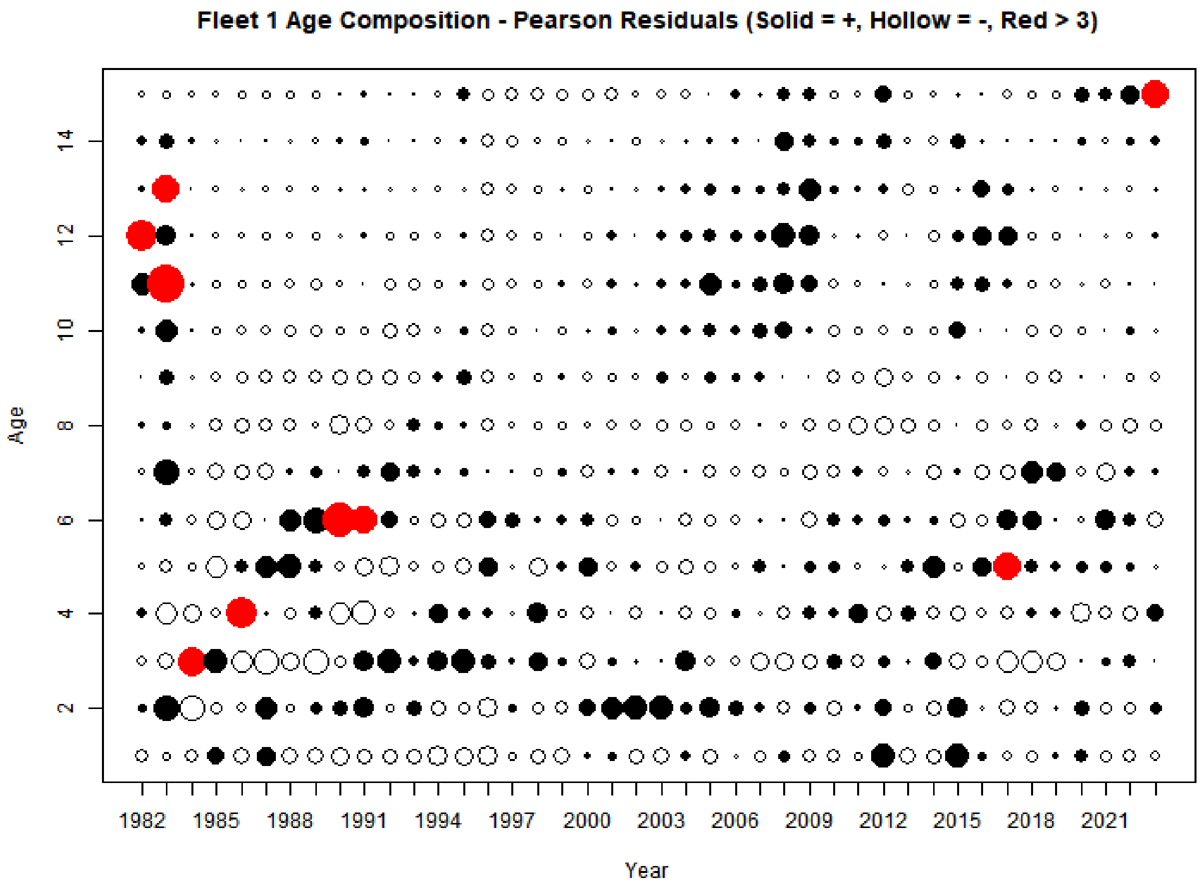

Fleet 1 Catch Age Composition By Year
Pred
Proportion
Age

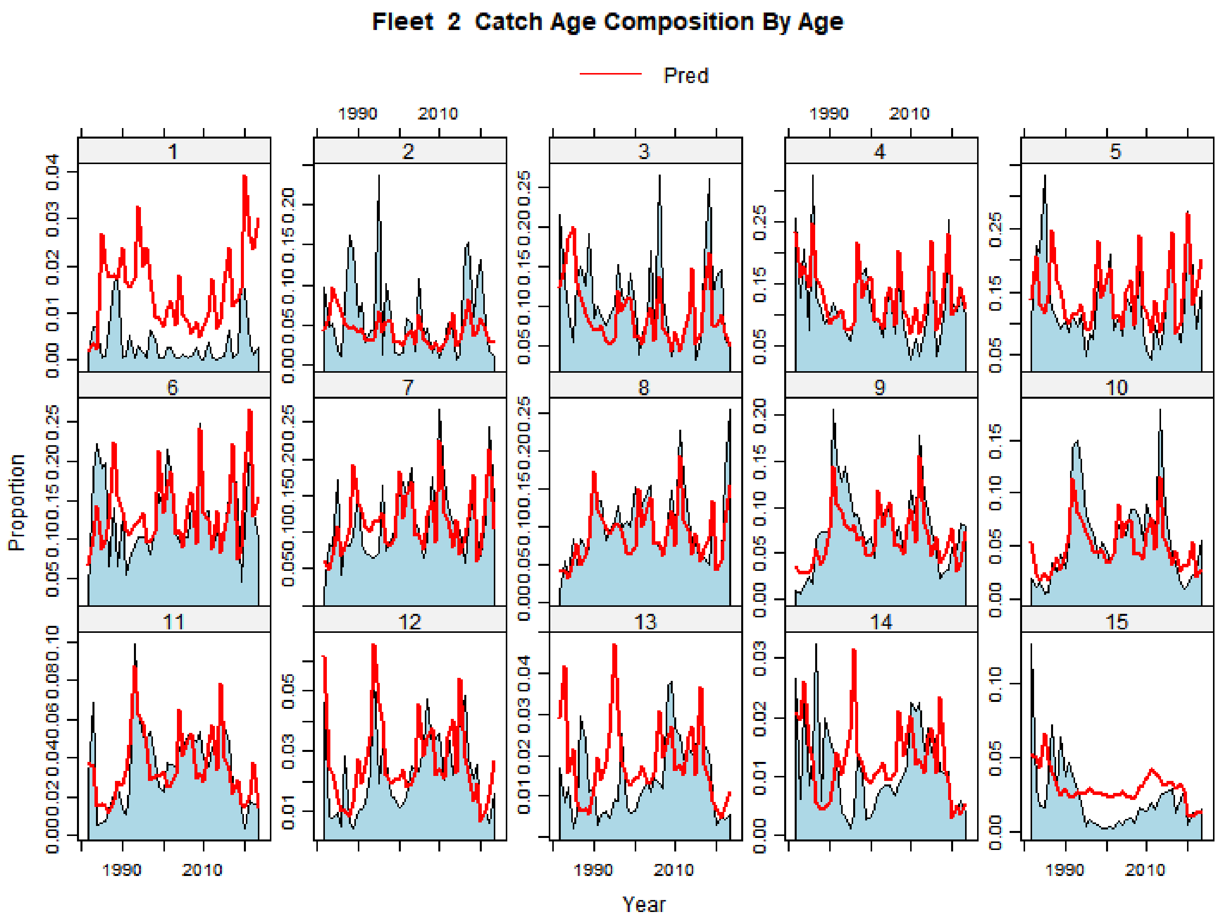
Fleet 1 Residuals of Age Composition By Age

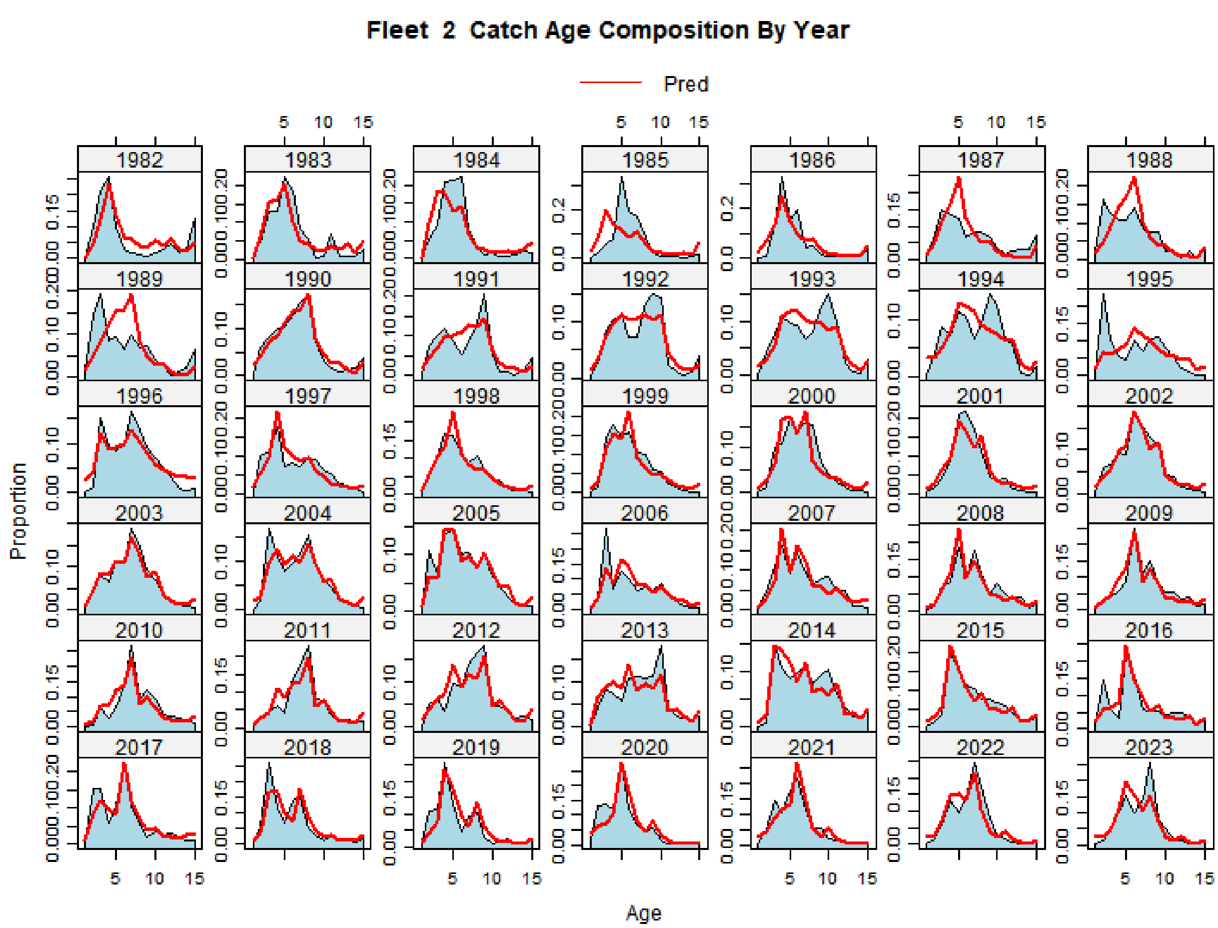


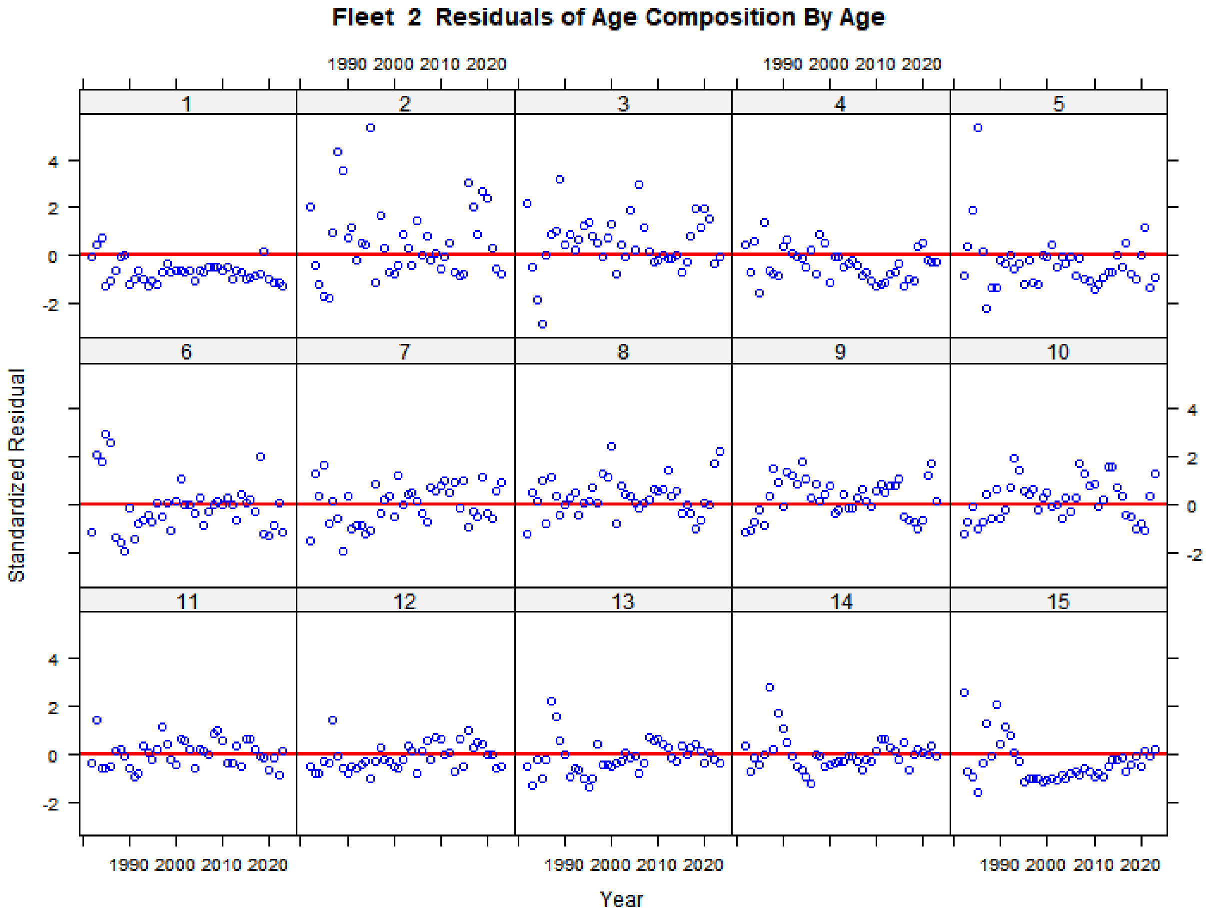
Fleet 1 Residuals of Age Composition By Year



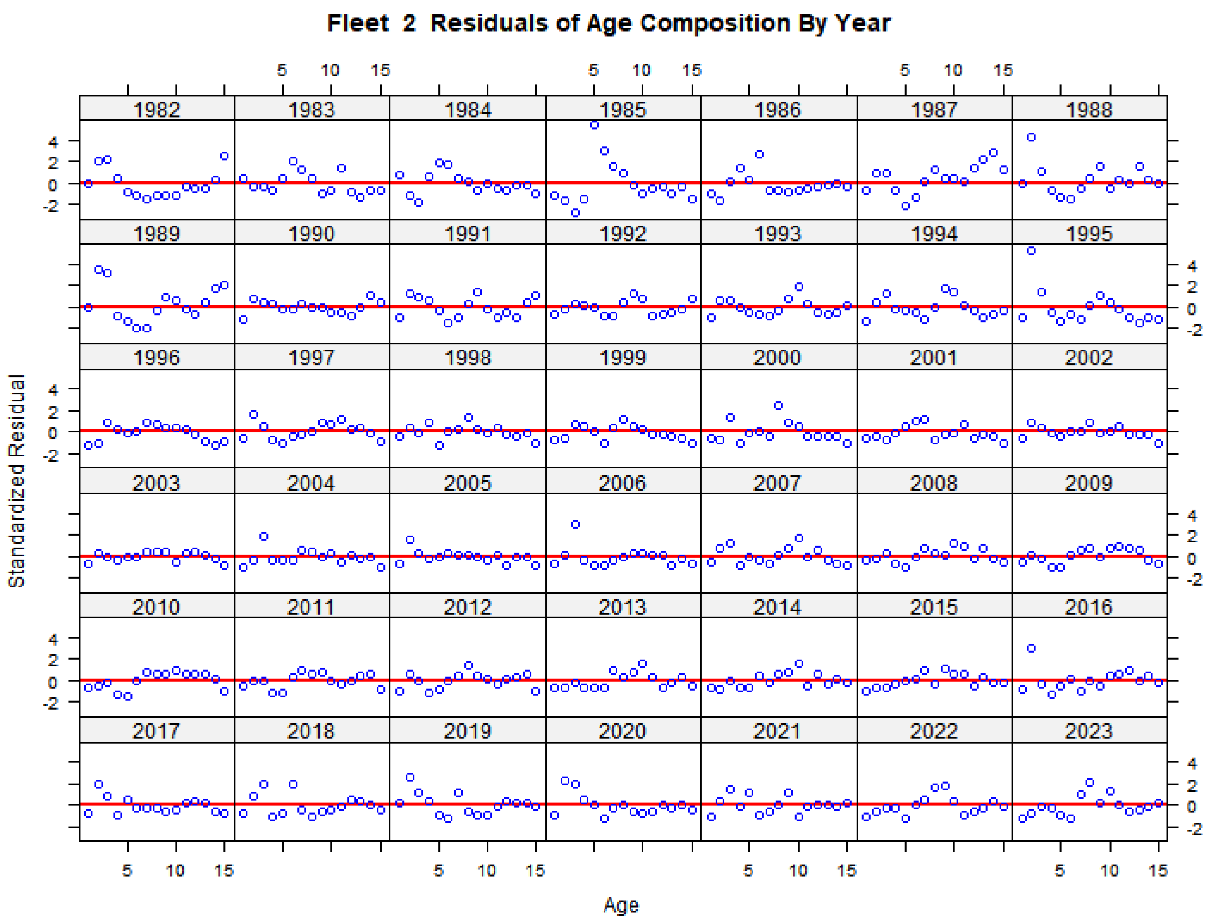

Fleet 1 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021


Fleet 2 Catch Age Composition By Age
Pred
Proportion
Year

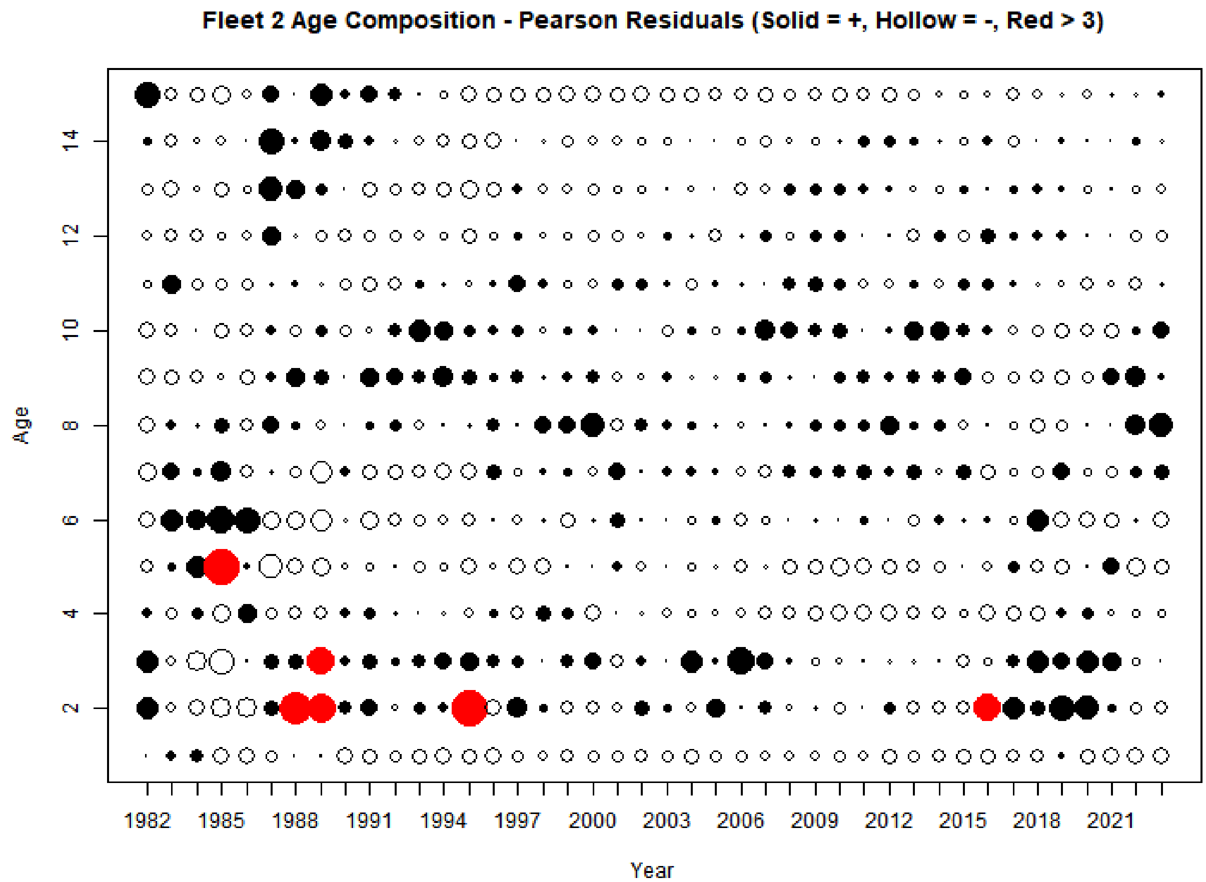

Fleet 2 Catch Age Composition By Year
Pred
Proportion
Age



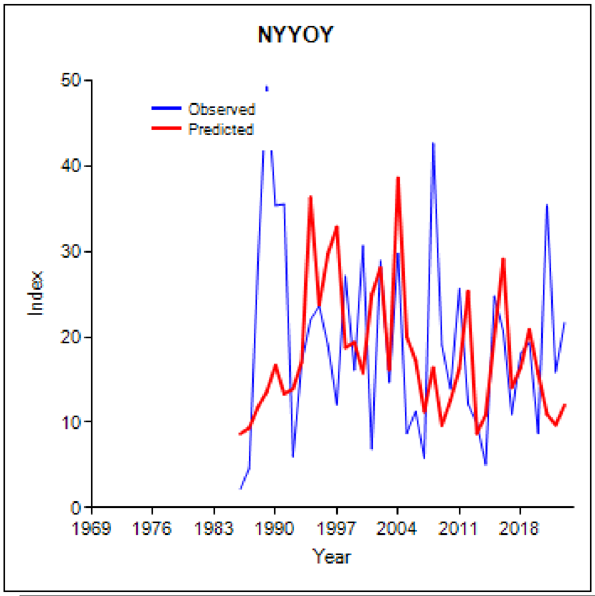
Fleet 2 Residuals of Age Composition By Age
Standardized Residual
Year

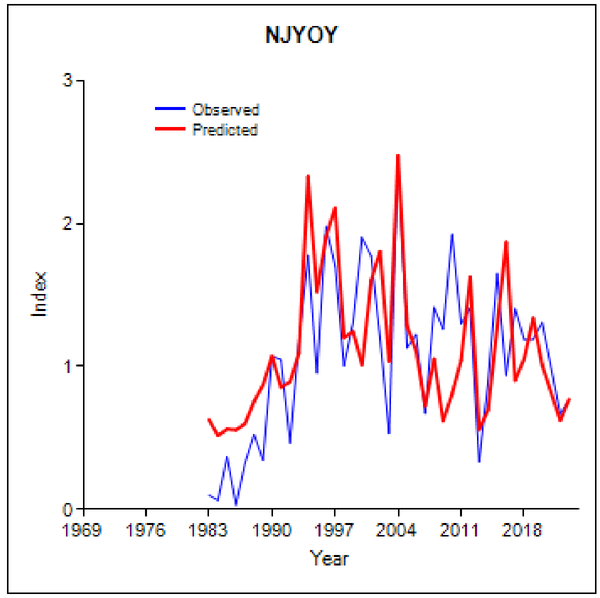


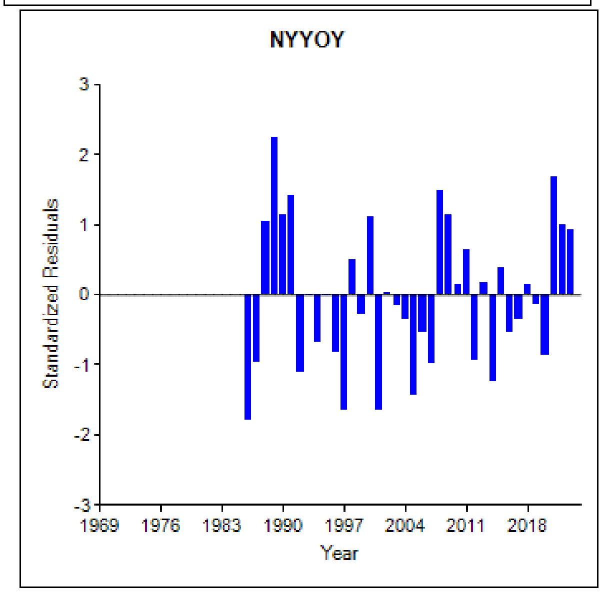
Fleet 2 Residuals of Age Composition By Year
Standardized Residual
Age

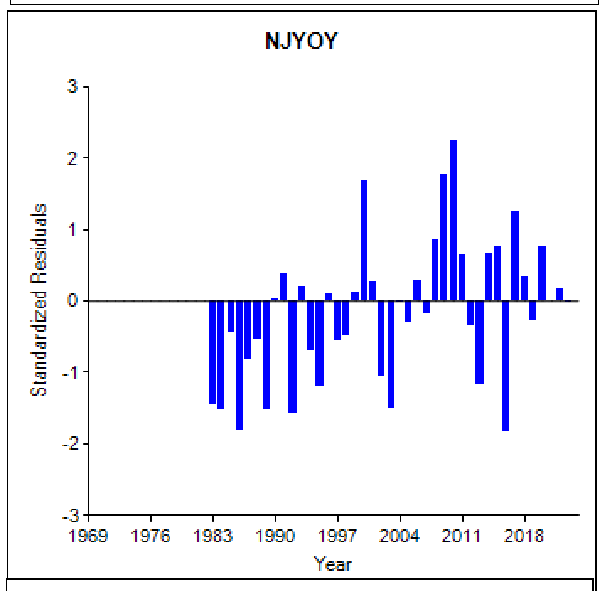


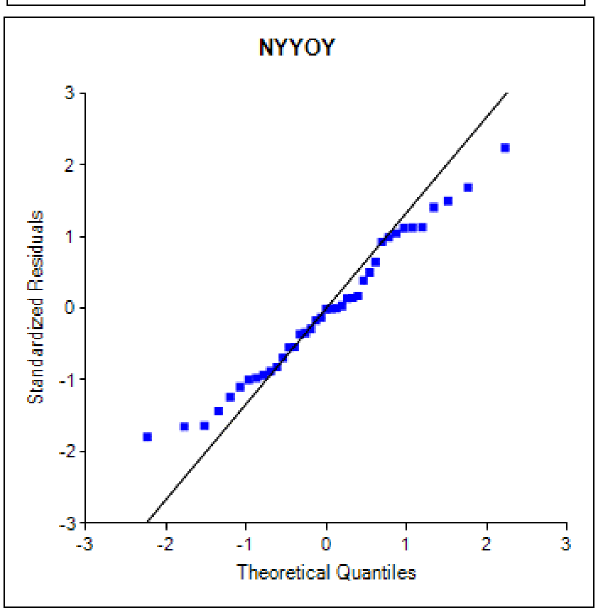
Fleet 2 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

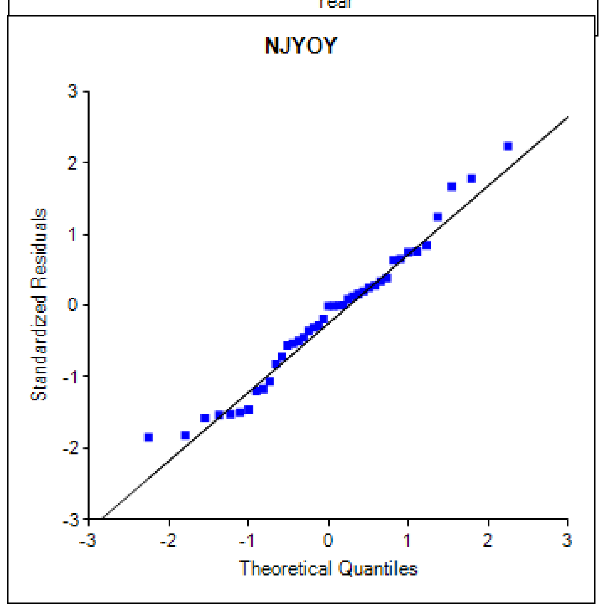

NYYOY
Observed
Predicted
Index
Year
0
10
20
30
40
50
1969 1976 1983 1990 1997 2004 2011 2018

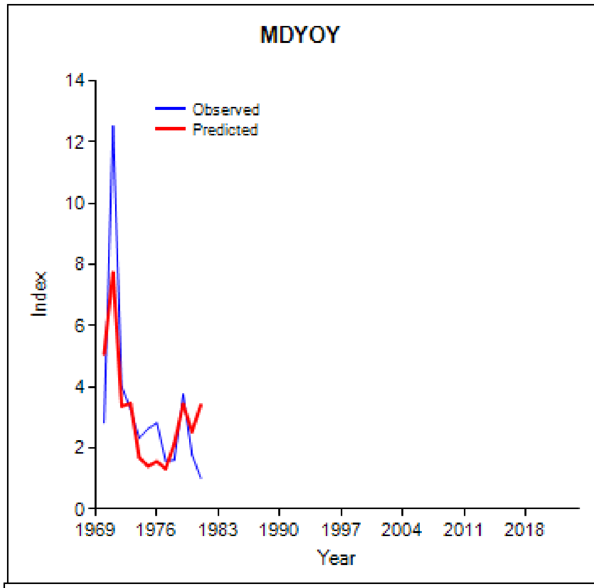

NJYOY
Observed
Predicted
Index
Year
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

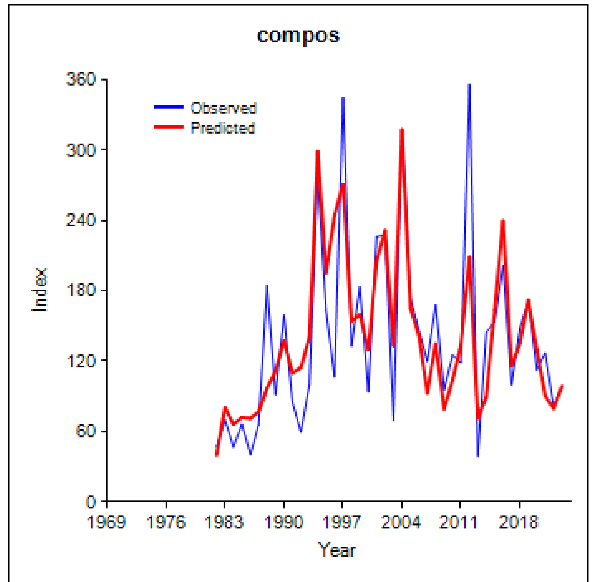

NYYOY
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

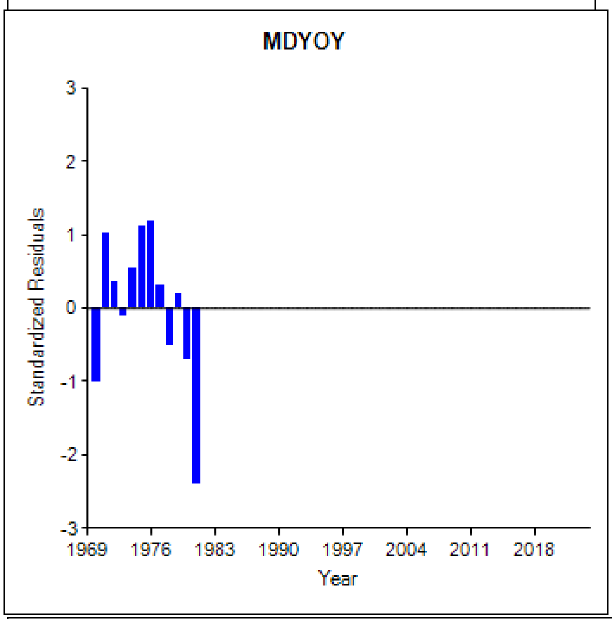

NJYOY
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

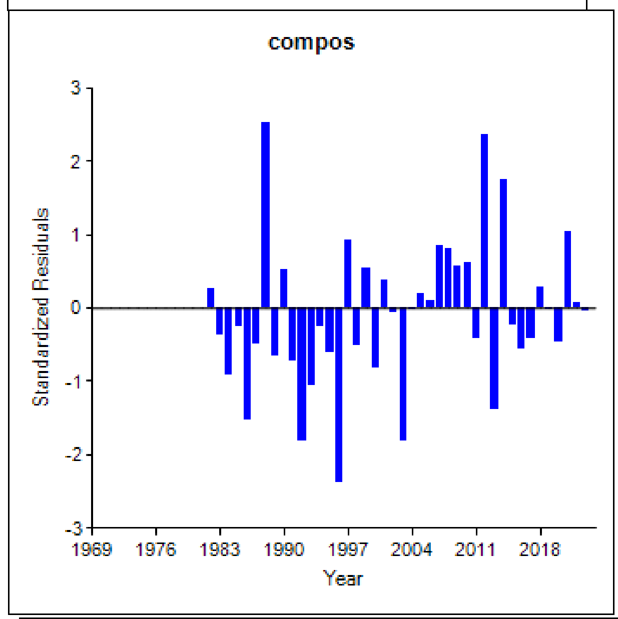

NYYOY
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3

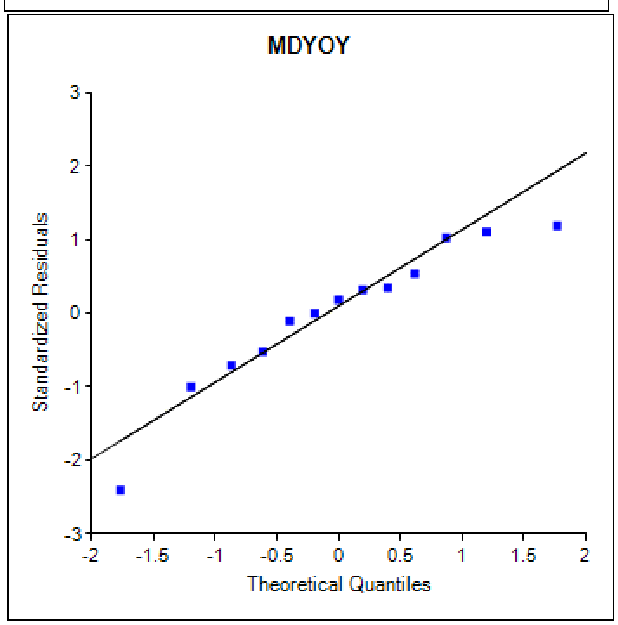

NJYOY
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3

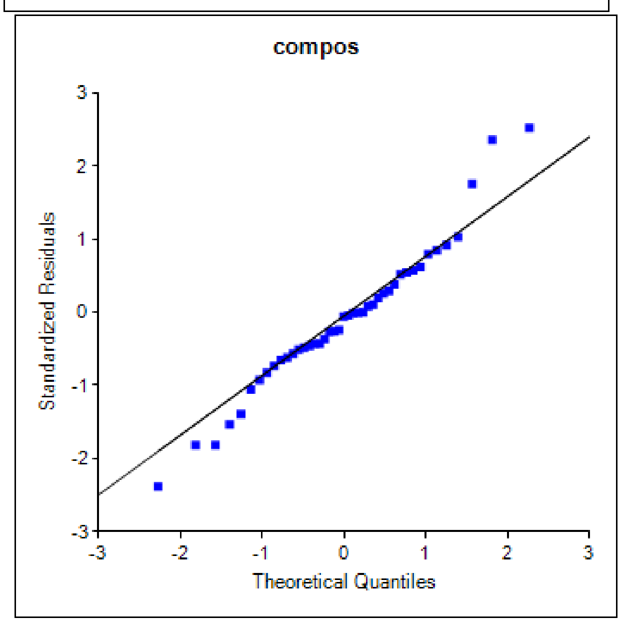

MDYOY
Observed
Predicted
Index
0
2
4
6
8
10
12
14
1969 1976 1983 1990 1997 2004 2011 2018
Year

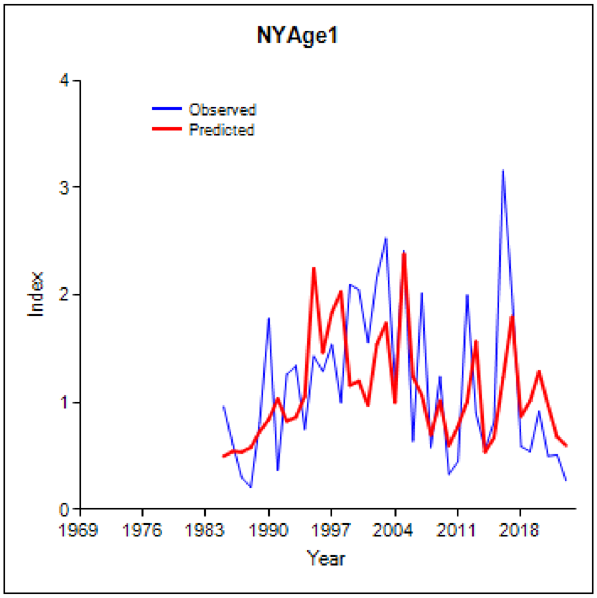
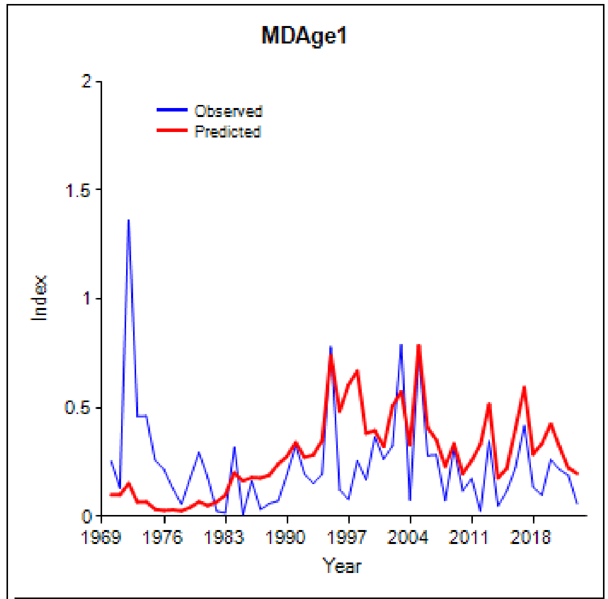
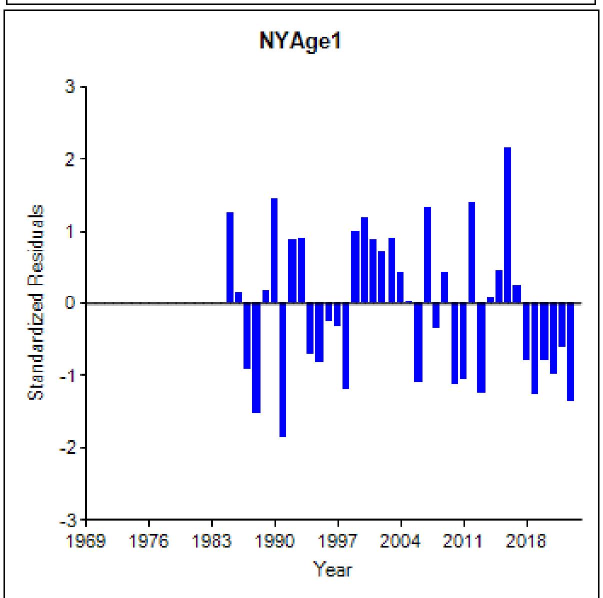
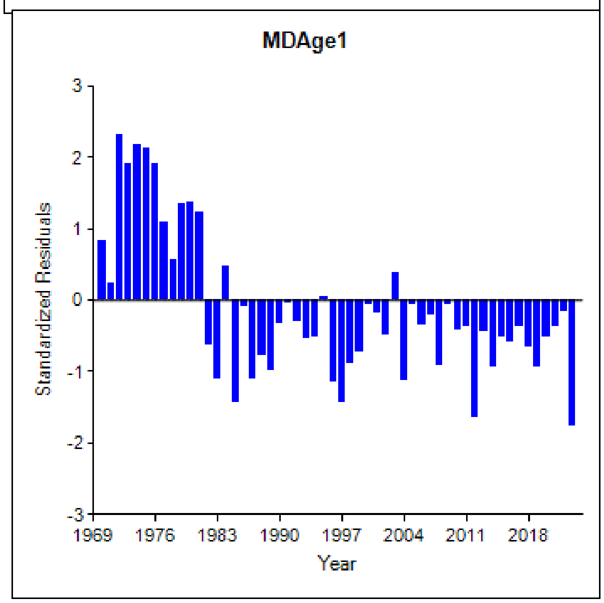
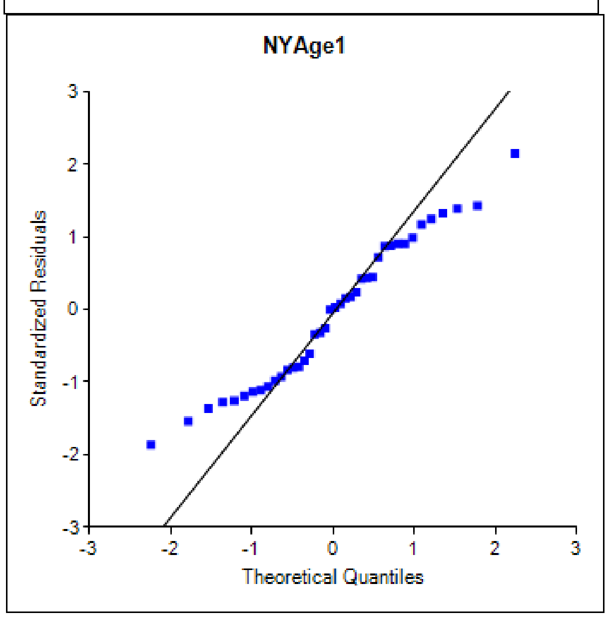
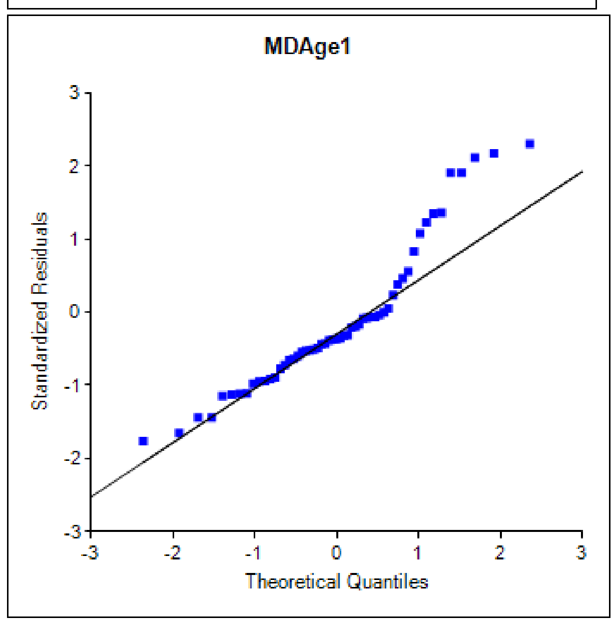

compos
Observed
Predicted
Index
0
60
120
180
240
300
360
1969 1976 1983 1990 1997 2004 2011 2018
Year

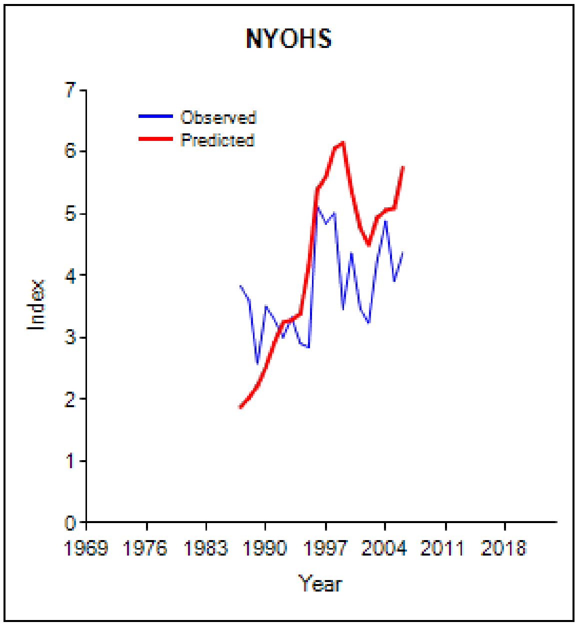

MDYOY
Standardized Residuals
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018
Year

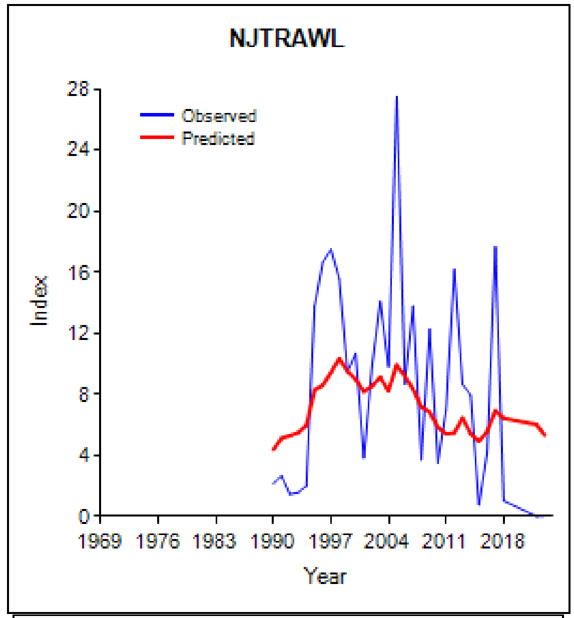

compos
Standardized Residuals
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018
Year

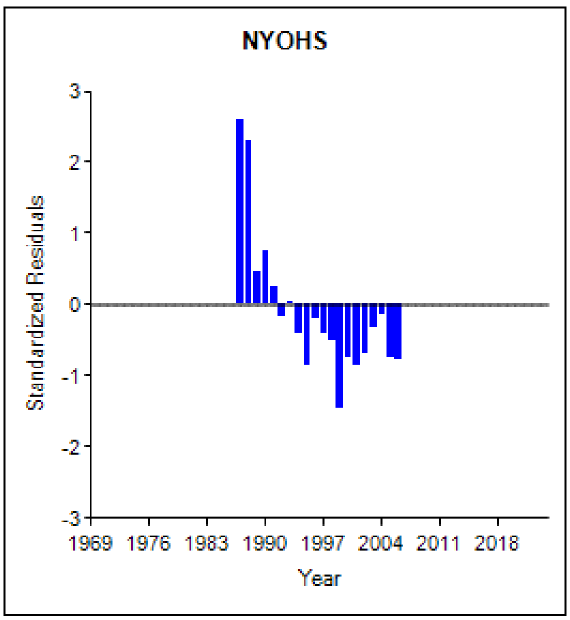

MDYOY
Standardized Residuals
-3
-2
-1
0
1
2
3
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
Theoretical Quantiles

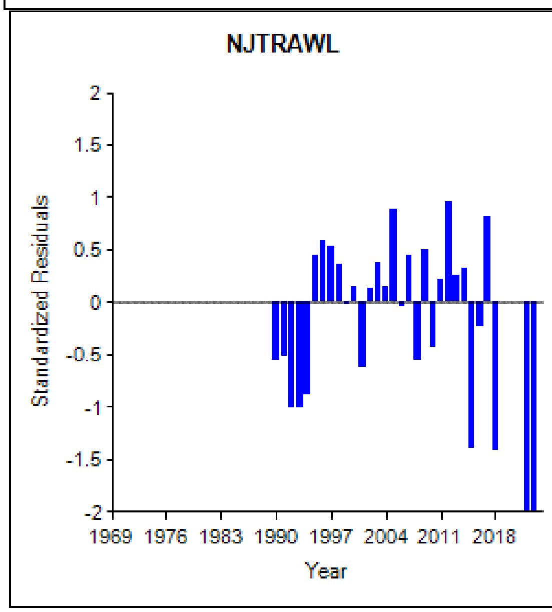

compos
Standardized Residuals
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3
Theoretical Quantiles

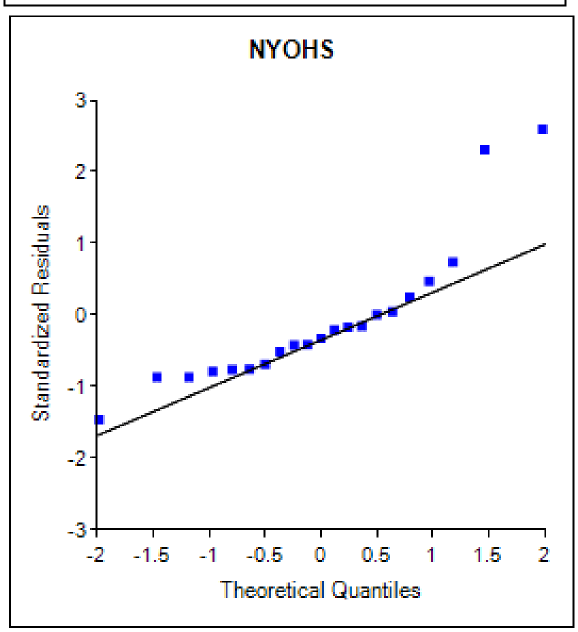

NYAge1
Observed
Predicted
Index
Year
0
1
2
3
4
1969
1976
1983
1990
1997
2004
2011
2018

MDAge1
Observed
Predicted
Index
Year
0
0.5
1
1.5
2
1969
1976
1983
1990
1997
2004
2011
2018

NYAge1
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969
1976
1983
1990
1997
2004
2011
2018

MDAge1
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969
1976
1983
1990
1997
2004
2011
2018

NYAge1
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3

MDAge1
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3

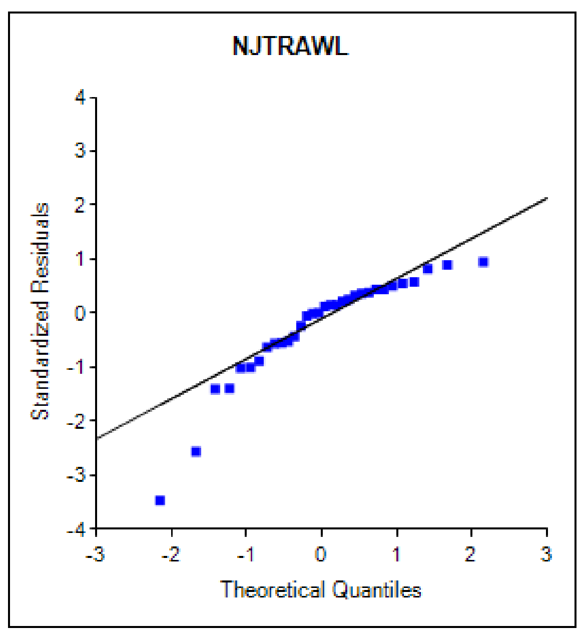

NYOHS
Observed
Predicted
Index
Year
0 1 2 3 4 5 6 7
1969 1976 1983 1990 1997 2004 2011 2018

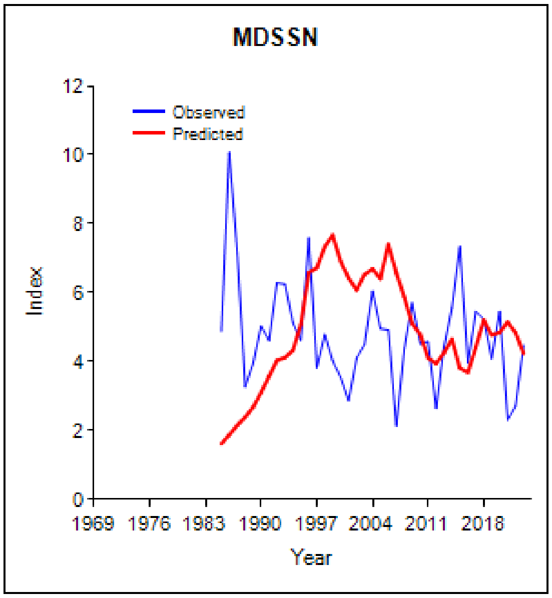

NJTRAWL
Observed
Predicted
Index
Year
0 4 8 12 16 20 24 28
1969 1976 1983 1990 1997 2004 2011 2018

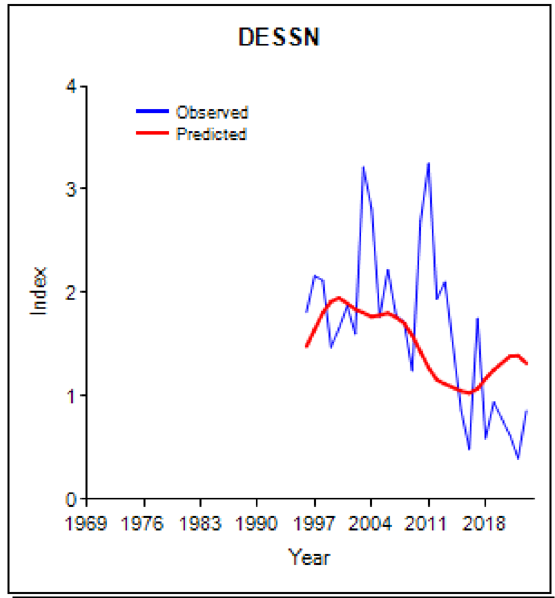

NYOHS
Standardized Residuals
Year
-3 -2 -1 0 1 2 3
1969 1976 1983 1990 1997 2004 2011 2018

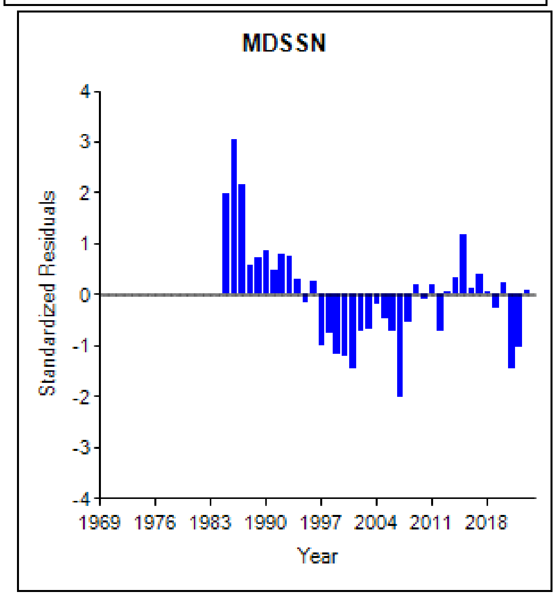

NJTRAWL
Standardized Residuals
Year
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
1969 1976 1983 1990 1997 2004 2011 2018

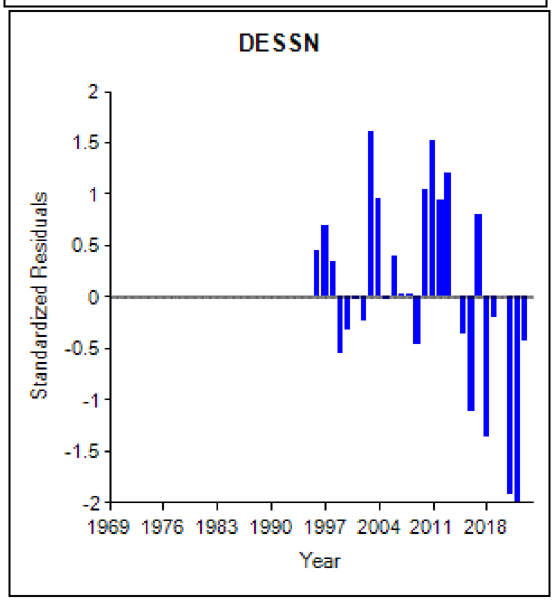

NYOHS
Standardized Residuals
Theoretical Quantiles
-3 -2 -1 0 1 2 3
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2

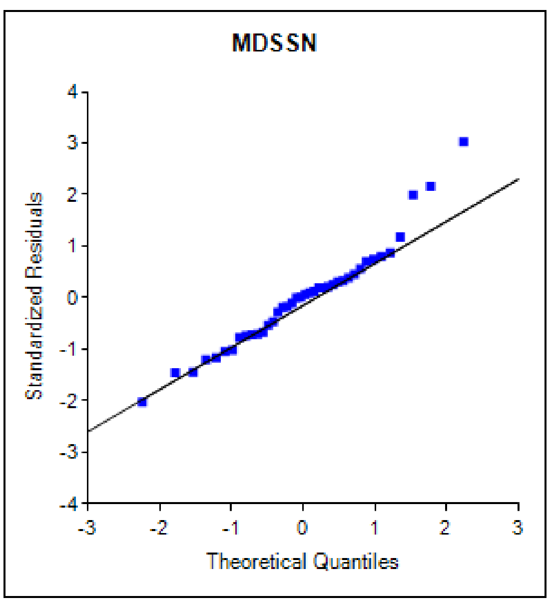

NJTRAWL
Standardized Residuals
Theoretical Quantiles
-4 -3 -2 -1 0 1 2 3 4
-3 -2 -1 0 1 2 3

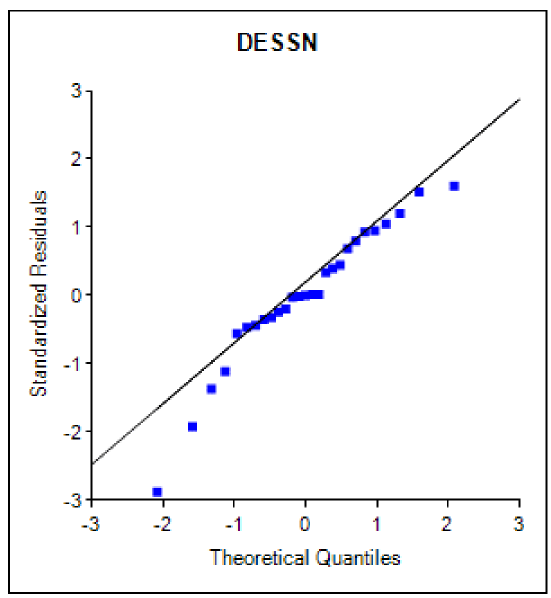

MDSSN
Observed
Predicted
Index
Year

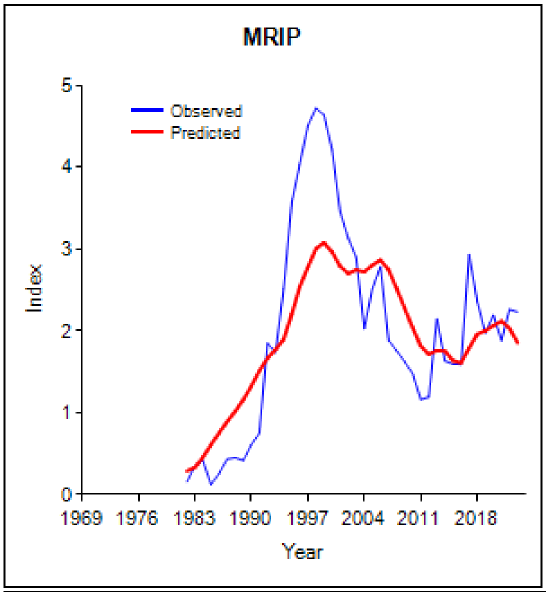

DESSN
Observed
Predicted
Index
Year

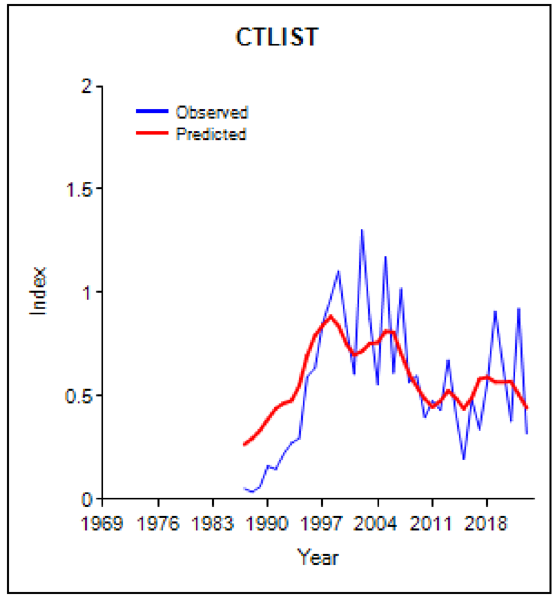

MDSSN
Standardized Residuals
Year

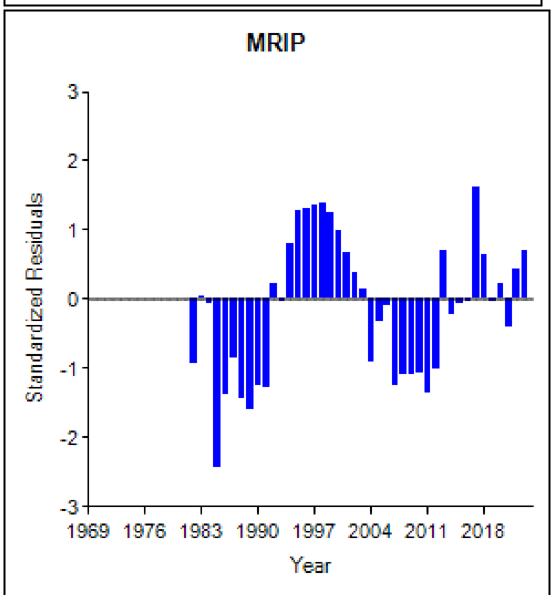

DESSN
Standardized Residuals
Year

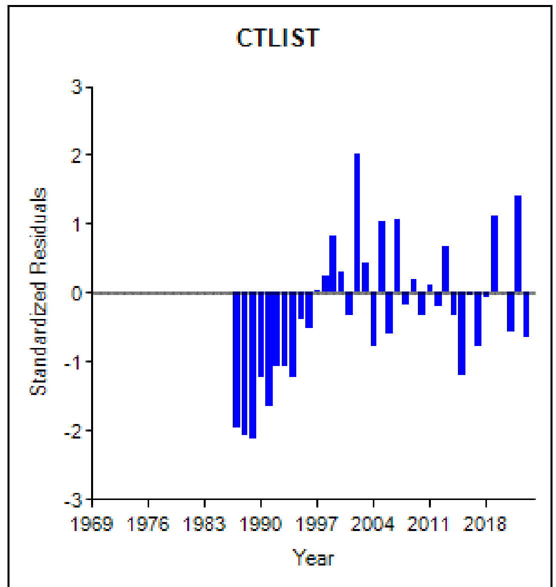

MDSSN
Standardized Residuals
Theoretical Quantiles

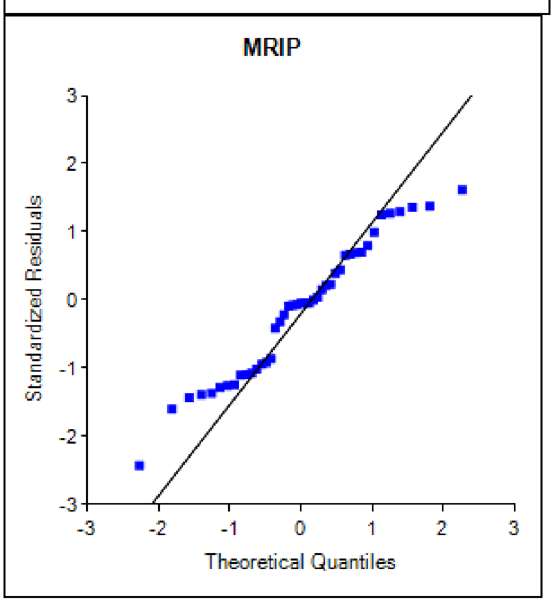

DESSN
Standardized Residuals
Theoretical Quantiles

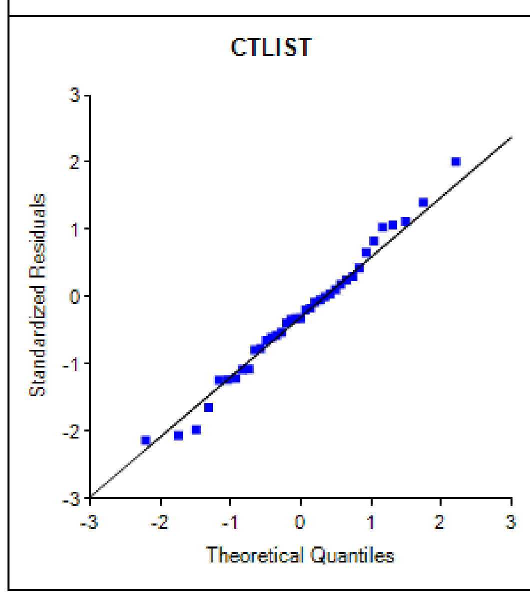

MRIP
Observed
Predicted
Index
Year
0
1
2
3
4
5
1969
1976
1983
1990
1997
2004
2011
2018

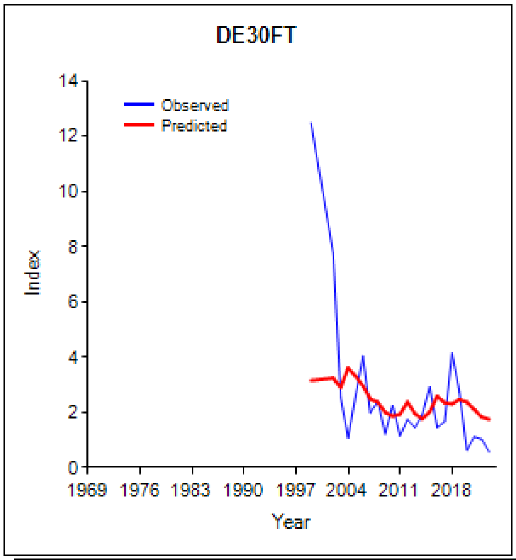

CTLIST
Observed
Predicted
Index
Year
0
0.5
1
1.5
2
1969
1976
1983
1990
1997
2004
2011
2018

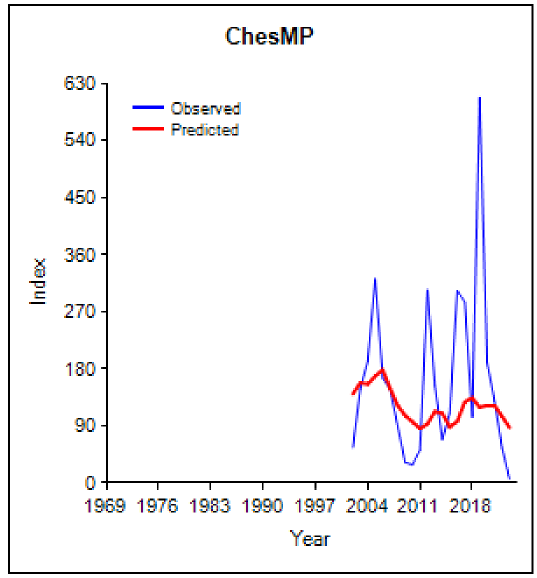

MRIP
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969
1976
1983
1990
1997
2004
2011
2018

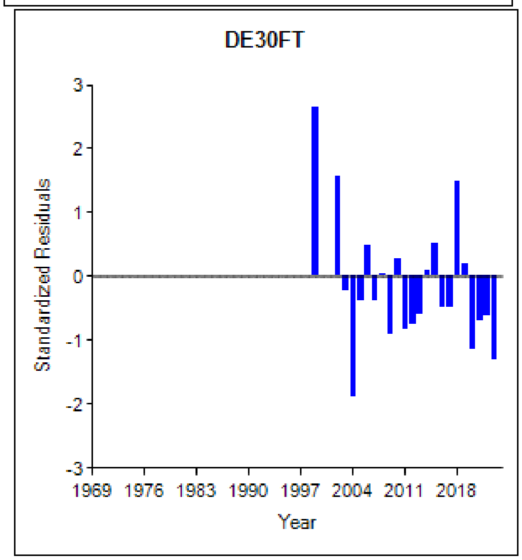

CTLIST
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969
1976
1983
1990
1997
2004
2011
2018

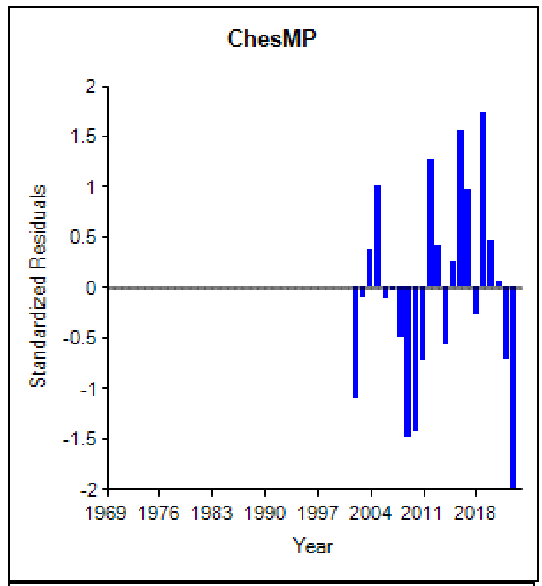

MRIP
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3

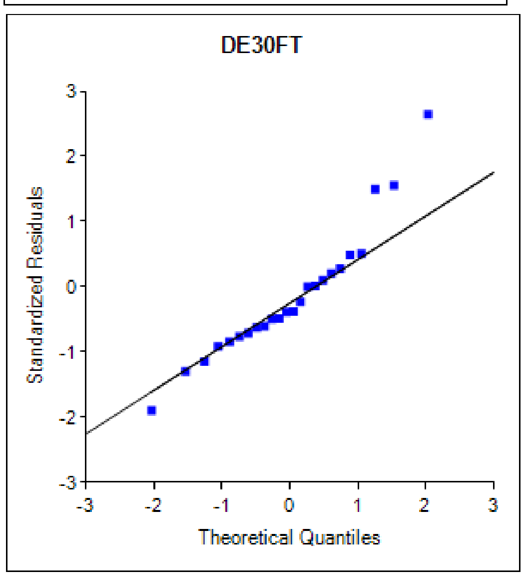

CTLIST
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3

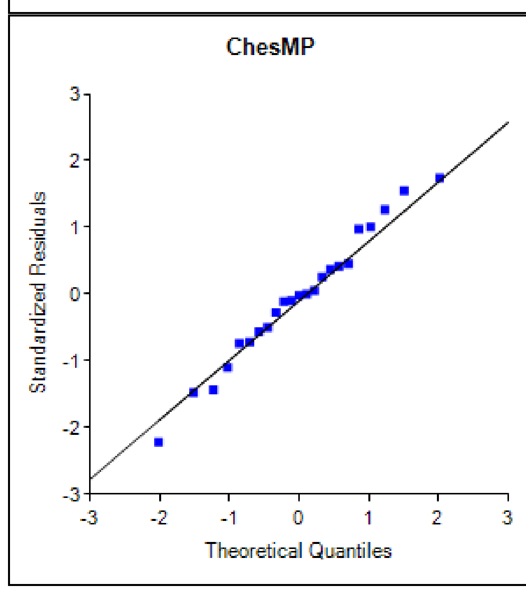

DE30FT
Observed
Predicted
Index
Year
0
2
4
6
8
10
12
14
1969 1976 1983 1990 1997 2004 2011 2018


ChesMP
Observed
Predicted
Index
Year
0
90
180
270
360
450
540
630
1969 1976 1983 1990 1997 2004 2011 2018

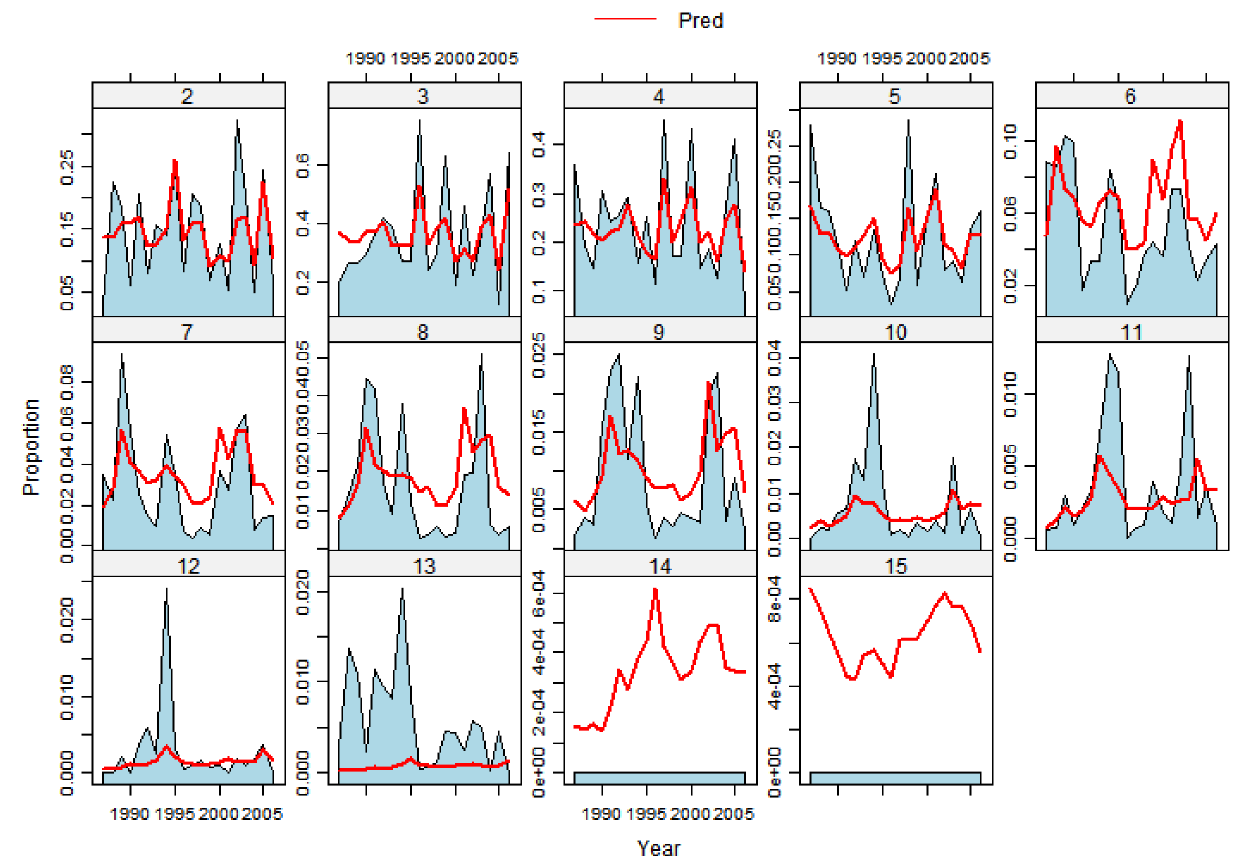

DE30FT
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018


ChesMP
Standardized Residuals
Year
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
1969 1976 1983 1990 1997 2004 2011 2018

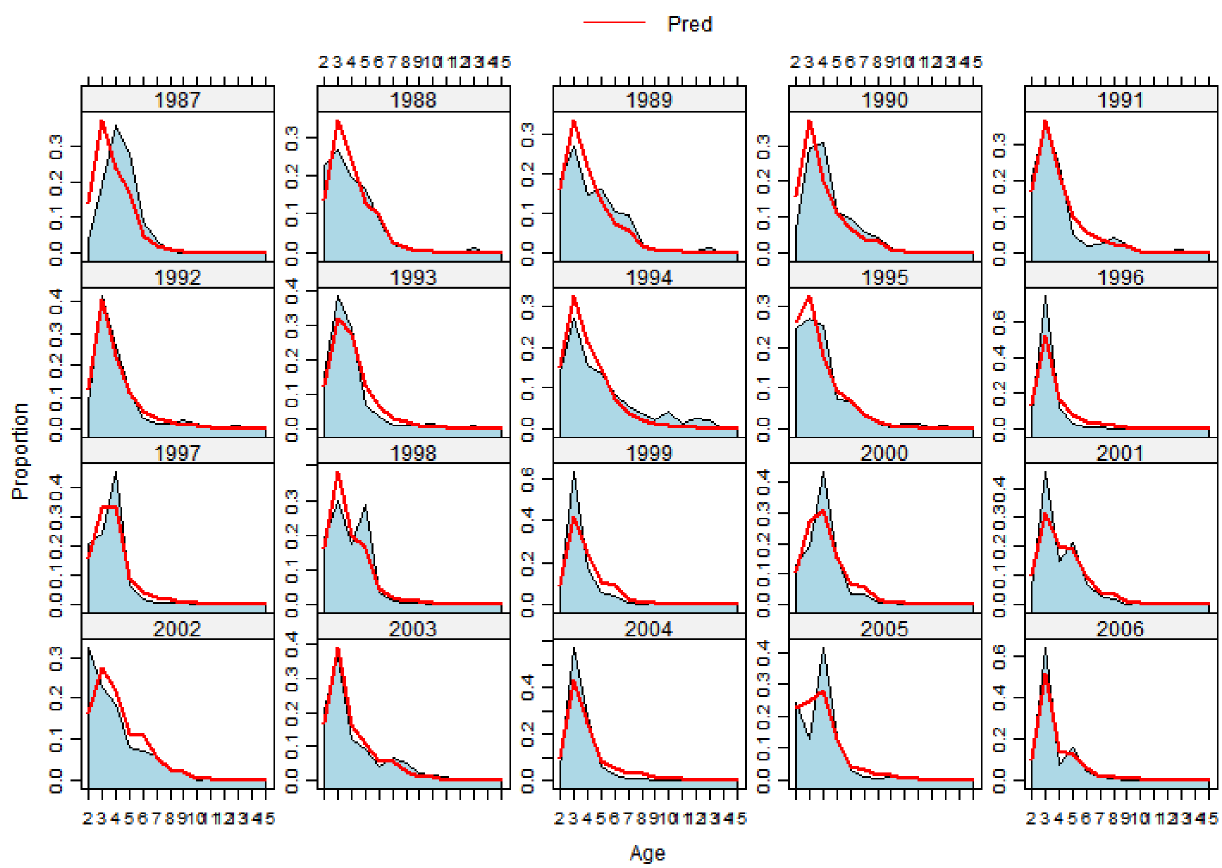

DE30FT
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3

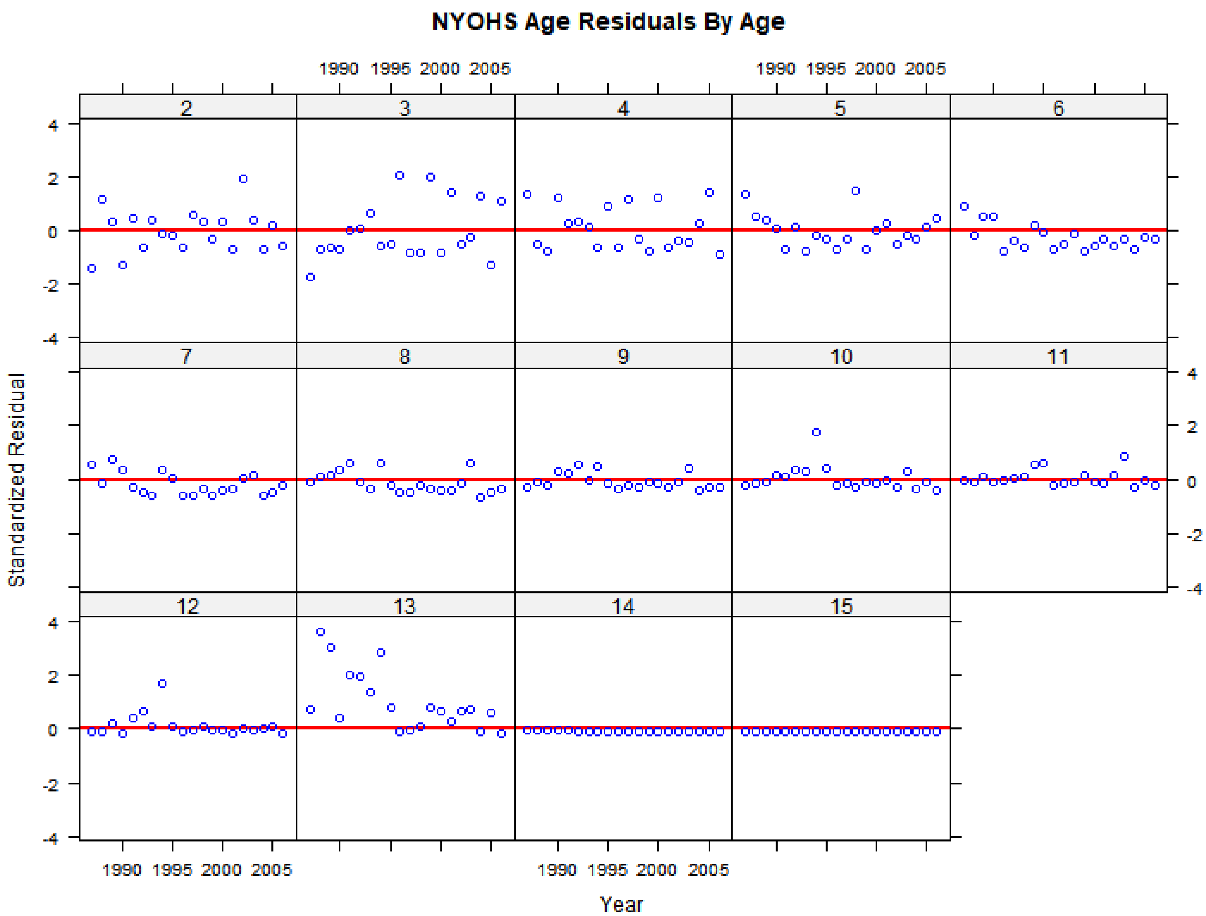

ChesMP
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3

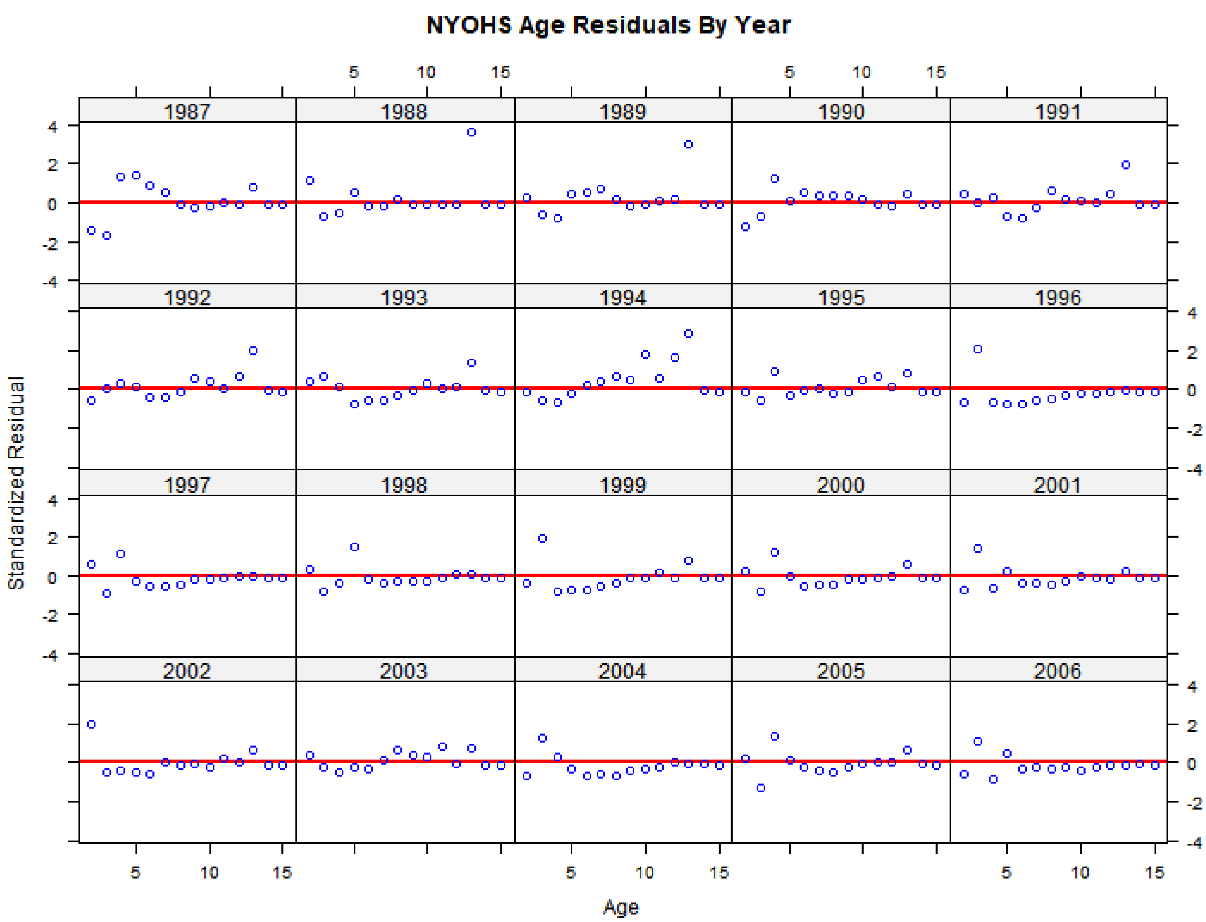
NYOHS Age Composition By Age

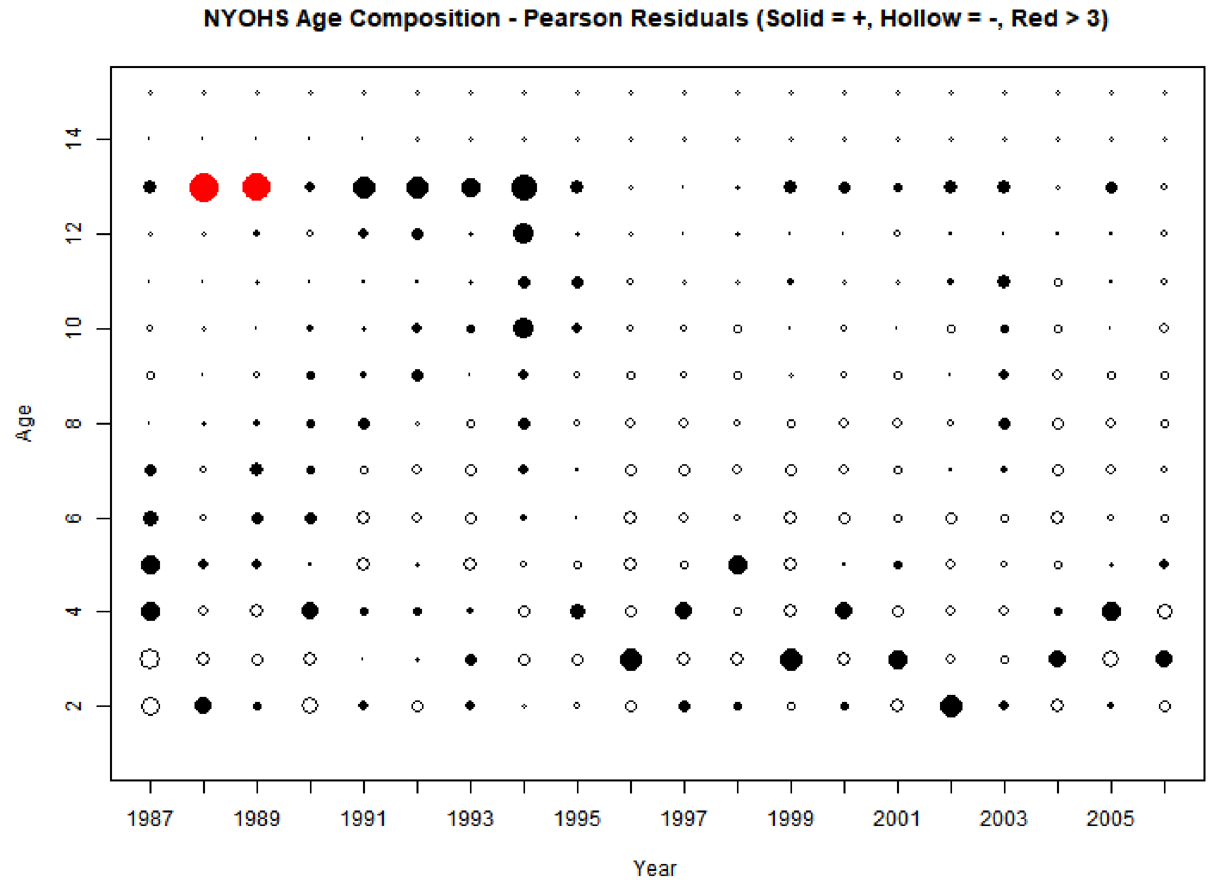


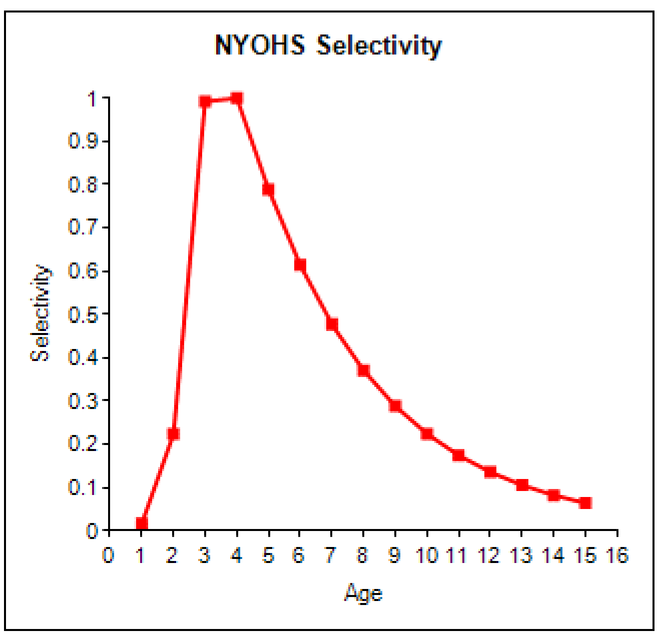
NYOHS Age Composition By Year

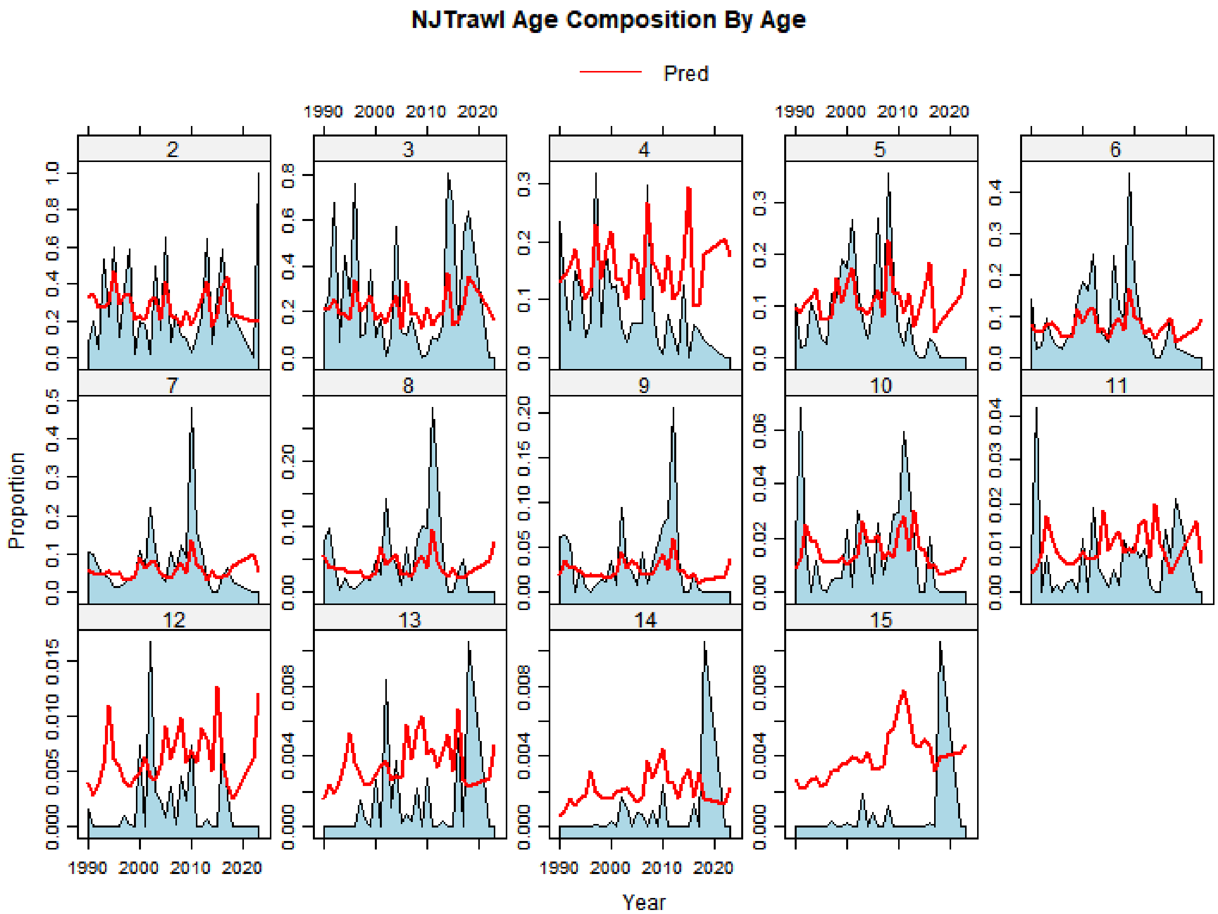


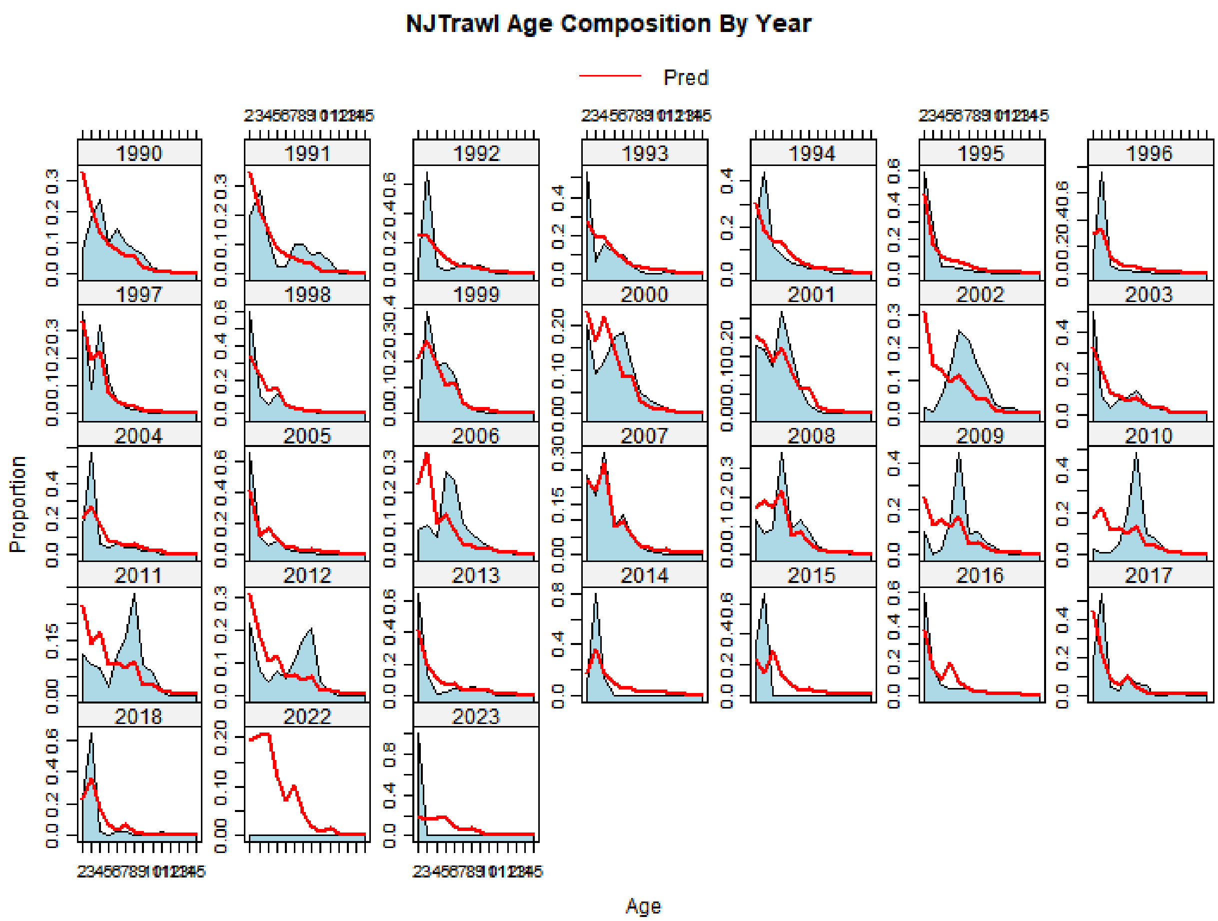

NYOHS Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15

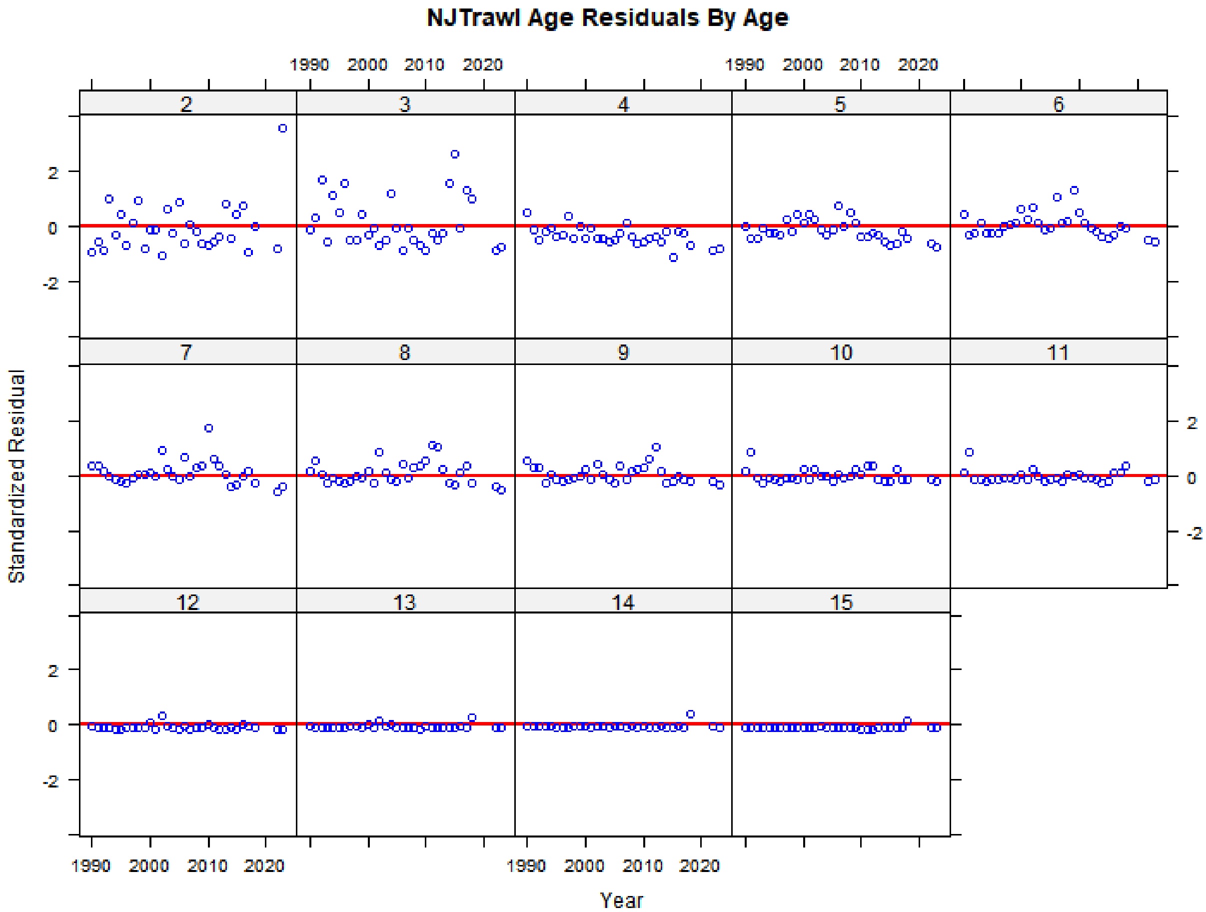

NYOHS Age Residuals By Year
Standardized Residual
Age
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

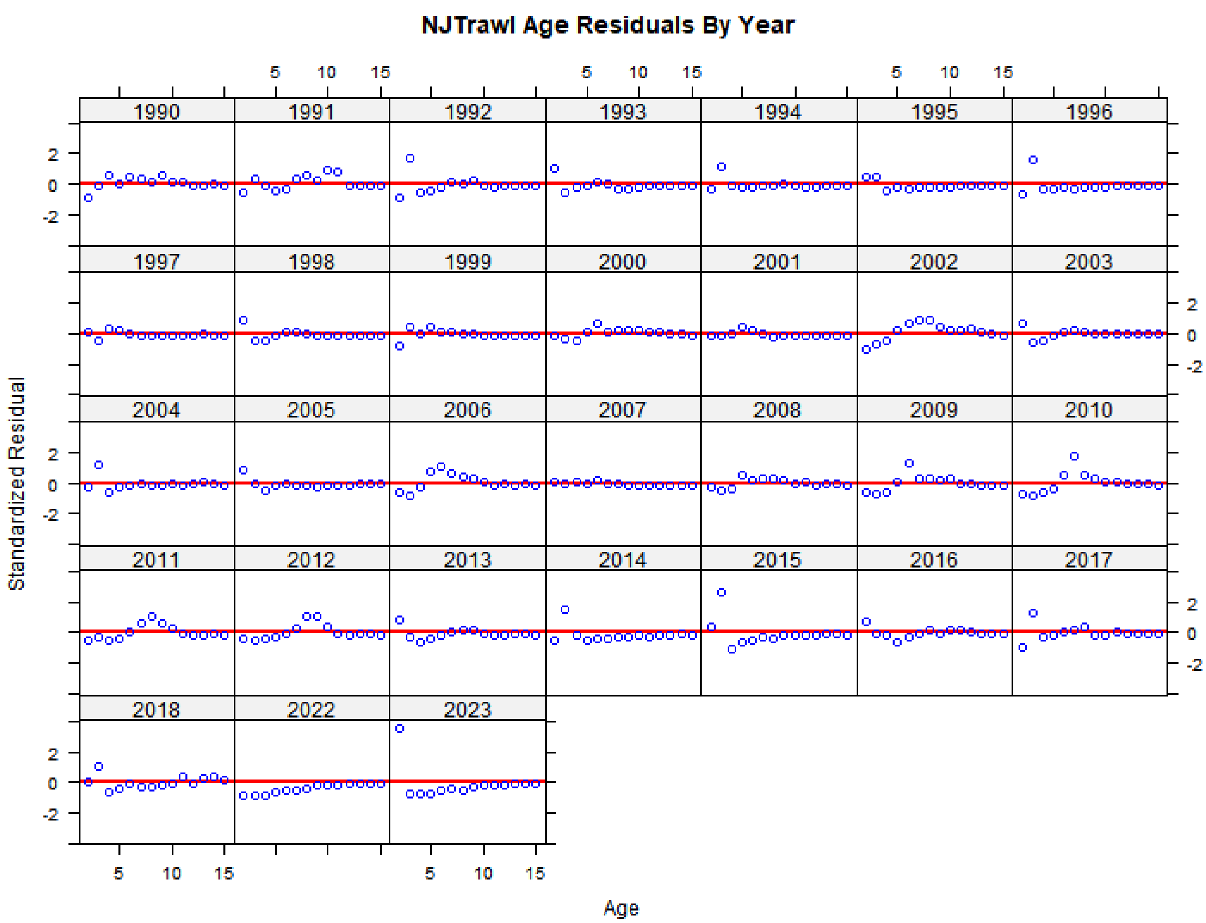

NYOHS Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

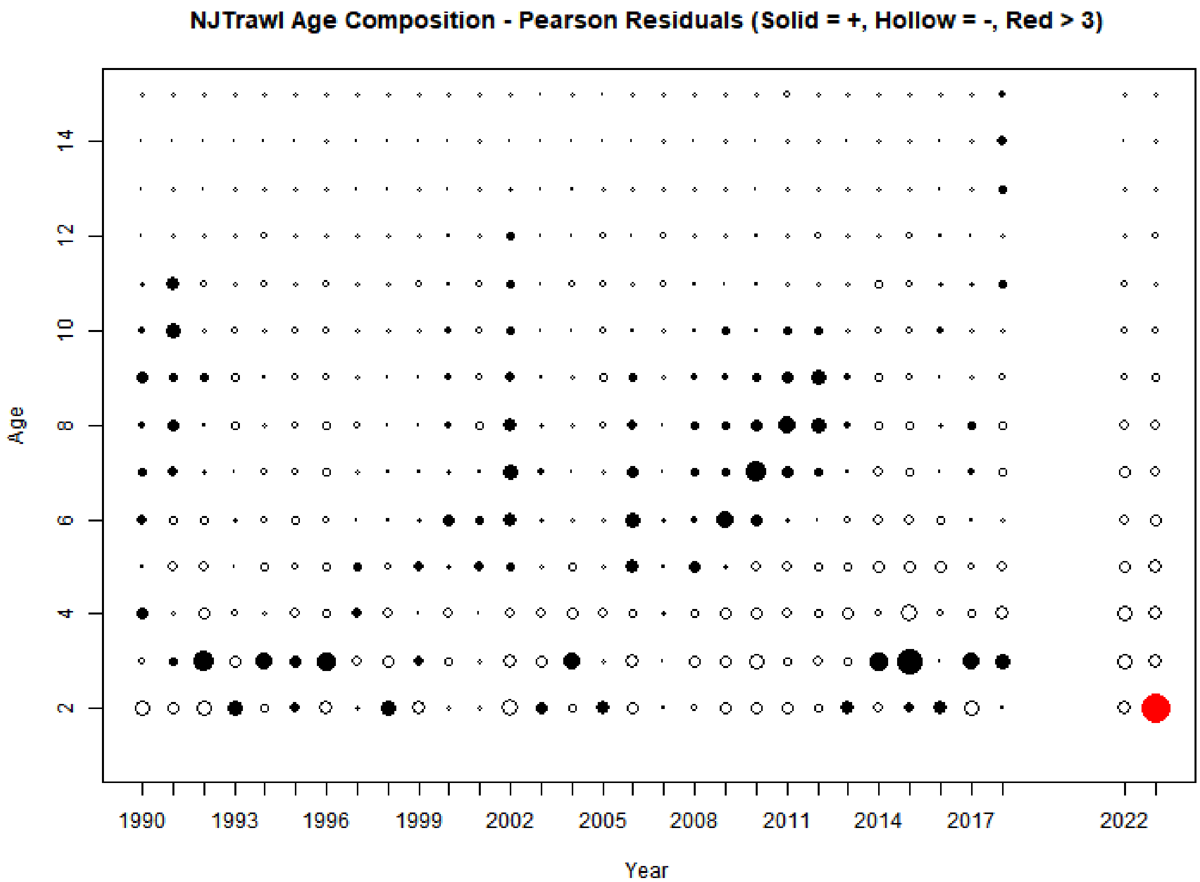

NYOHS Selectivity
Selectivity
Age

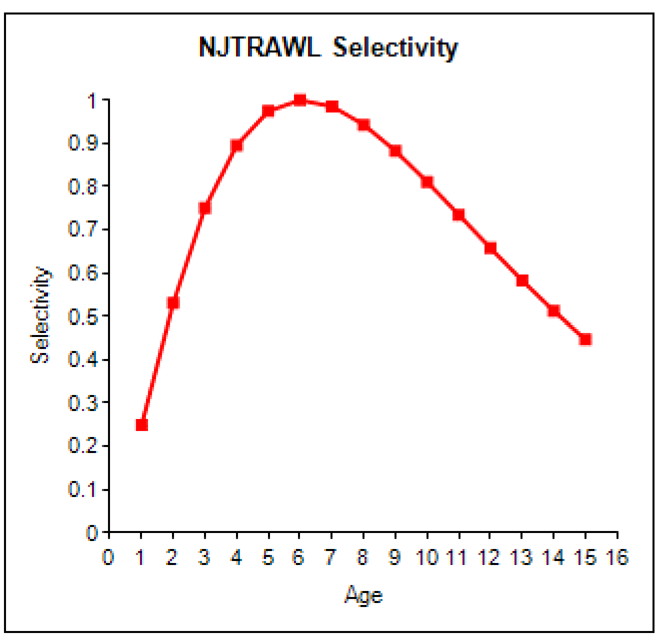

NJTrawl Age Composition By Age
Pred
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Proportion
Year
1990 2000 2010 2020

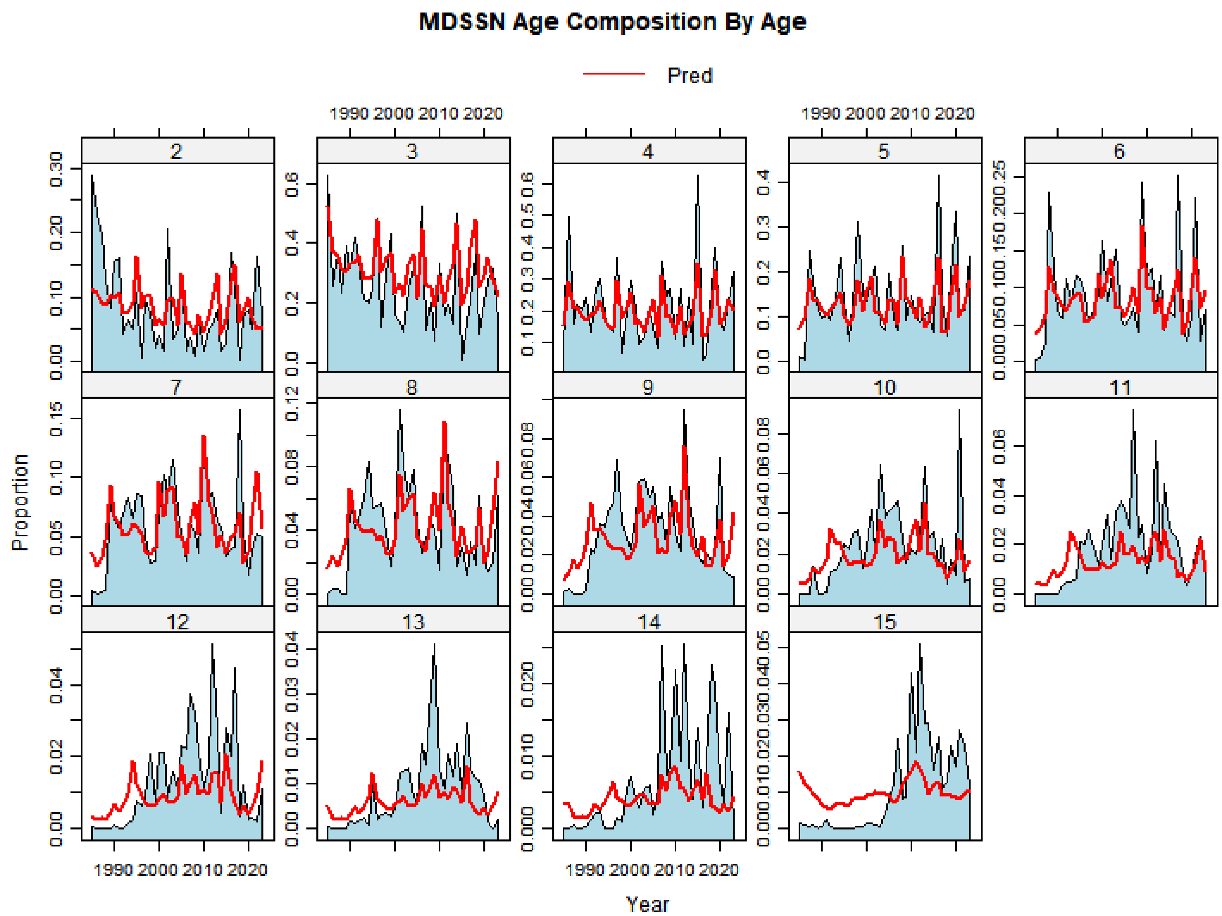

NJTrawl Age Composition By Year
Pred
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2022
2023
Proportion
Age

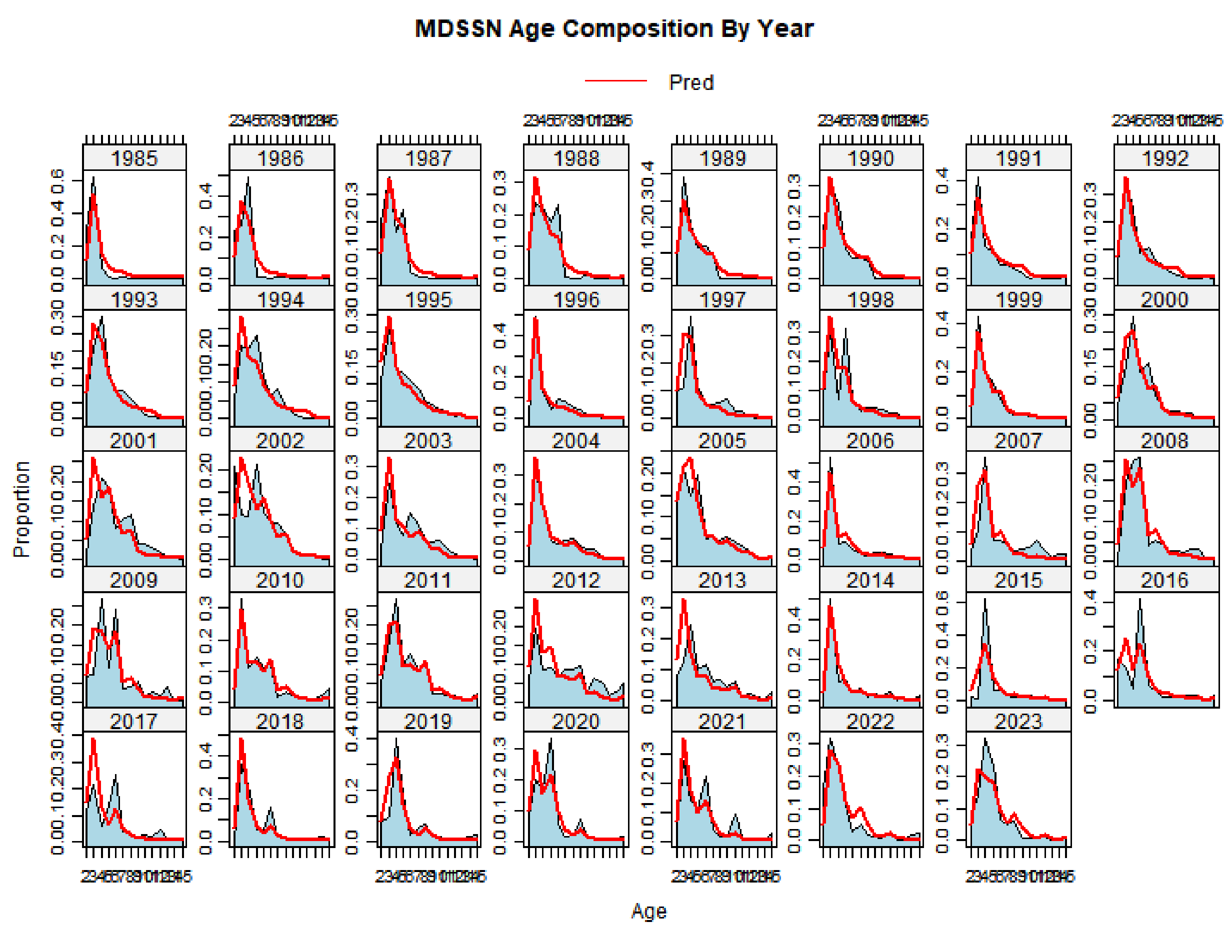

NJTrawl Age Residuals By Age
Standardized Residual
Year

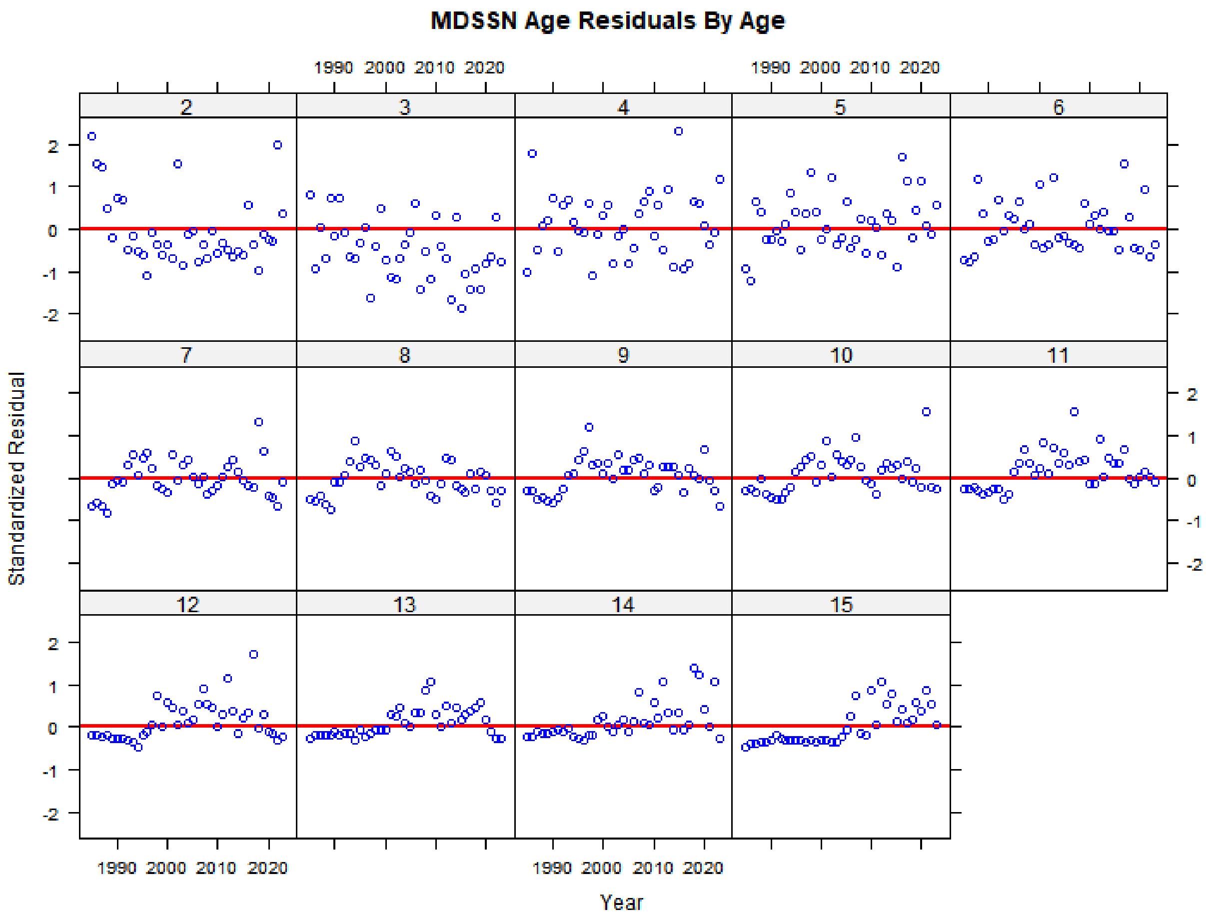

NJTrawl Age Residuals By Year
Standardized Residual
Age

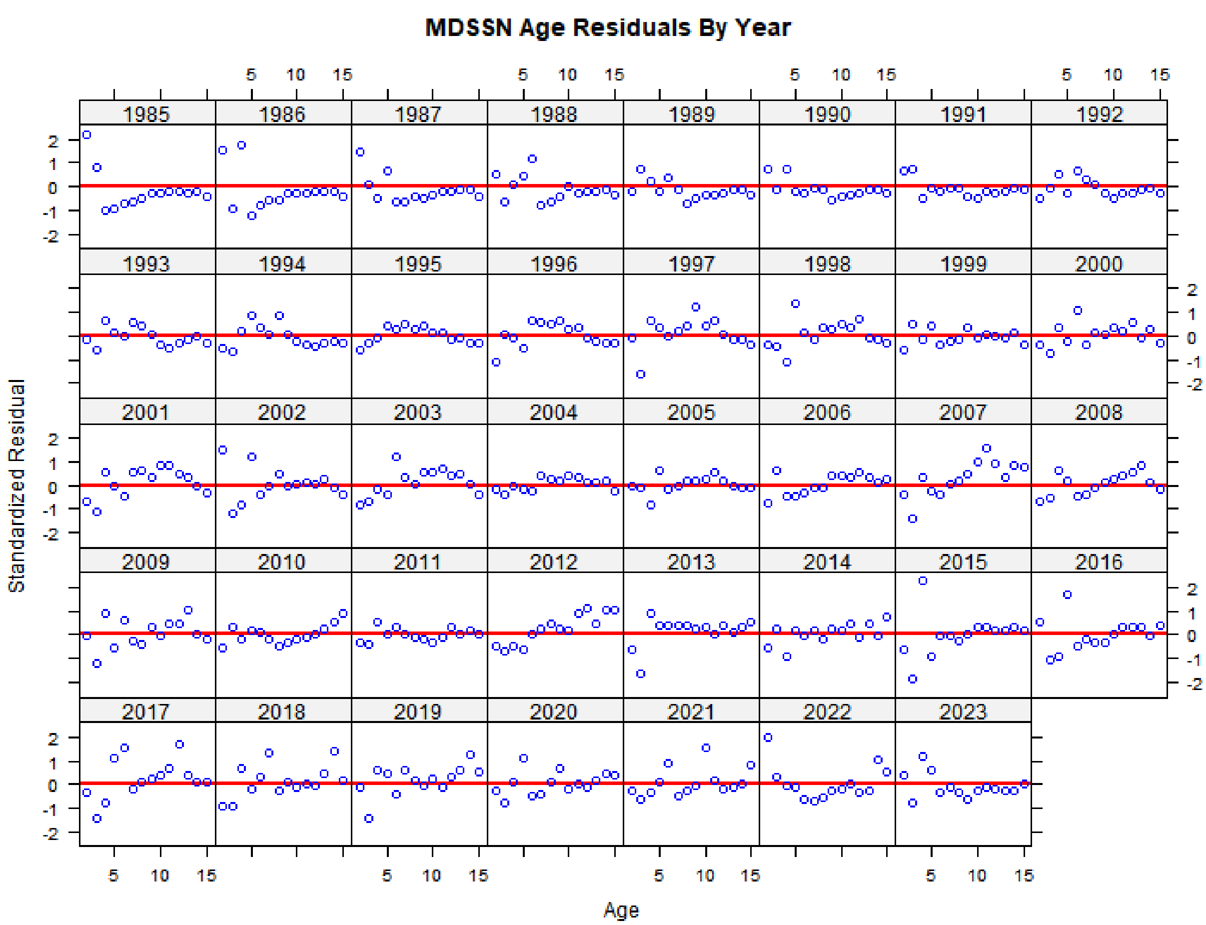

NJTrawl Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2022

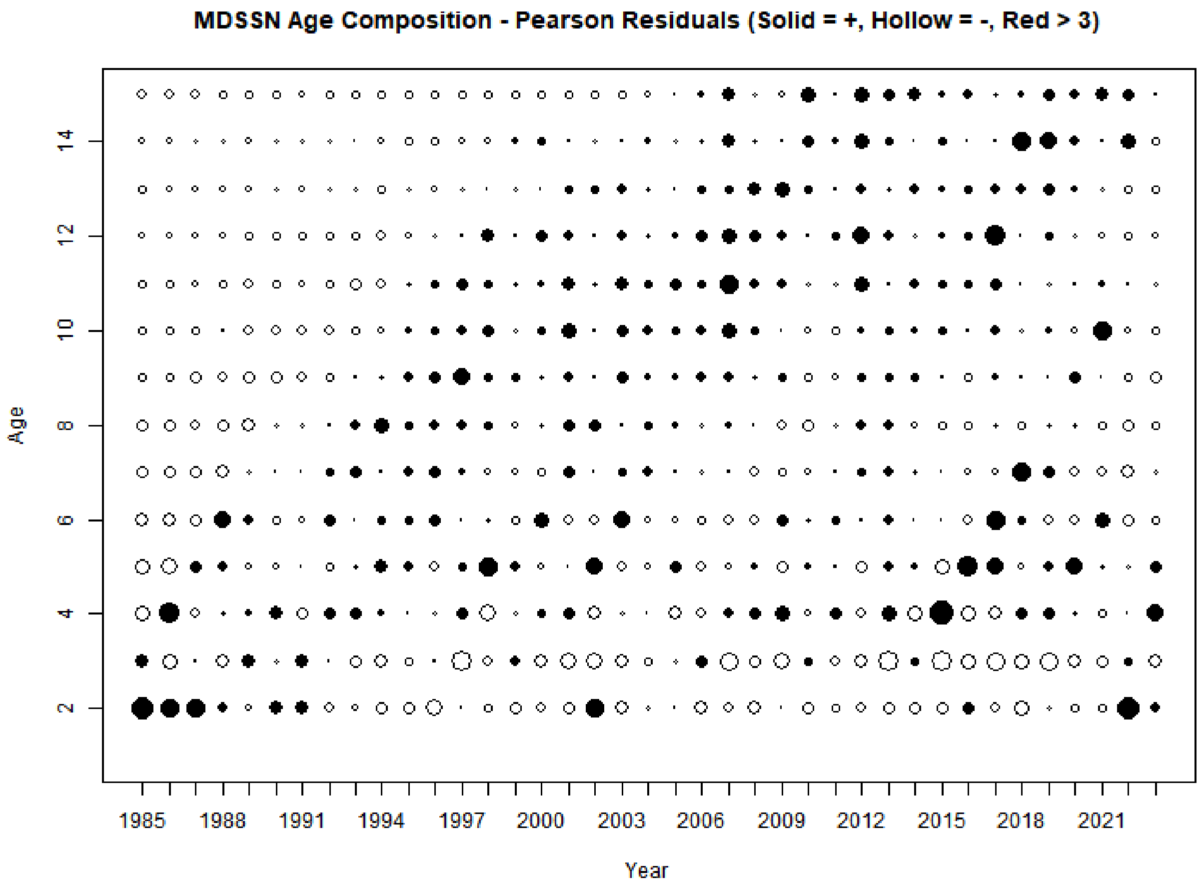

NJTRAWL Selectivity
Selectivity
Age

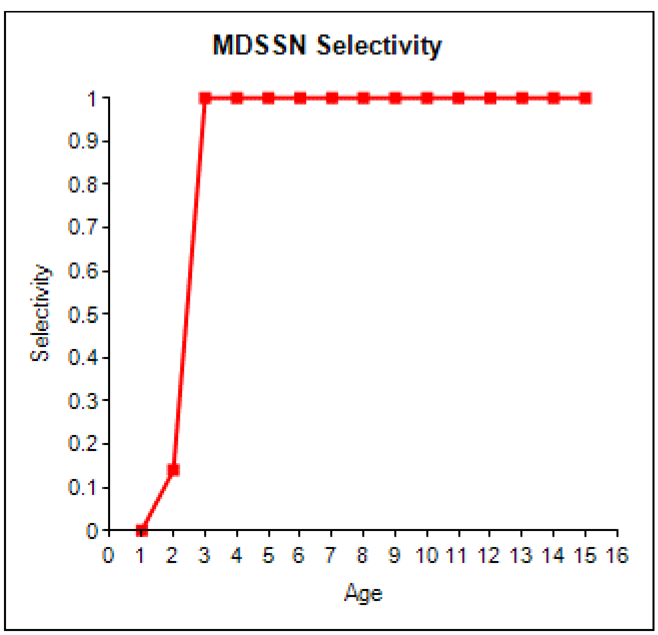

MDSSN Age Composition By Age
Pred
Proportion
Year

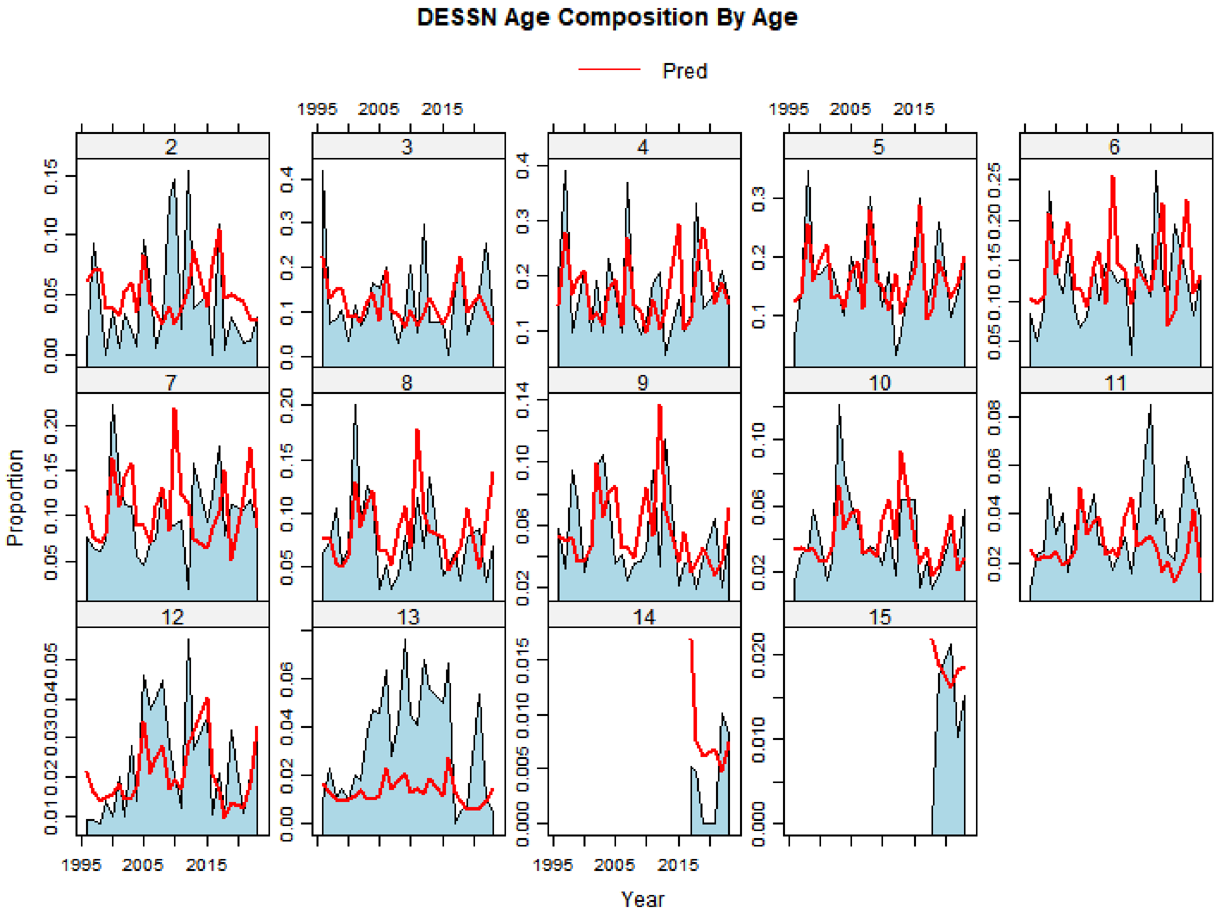

MDSSN Age Composition By Year
Pred
Proportion
Age

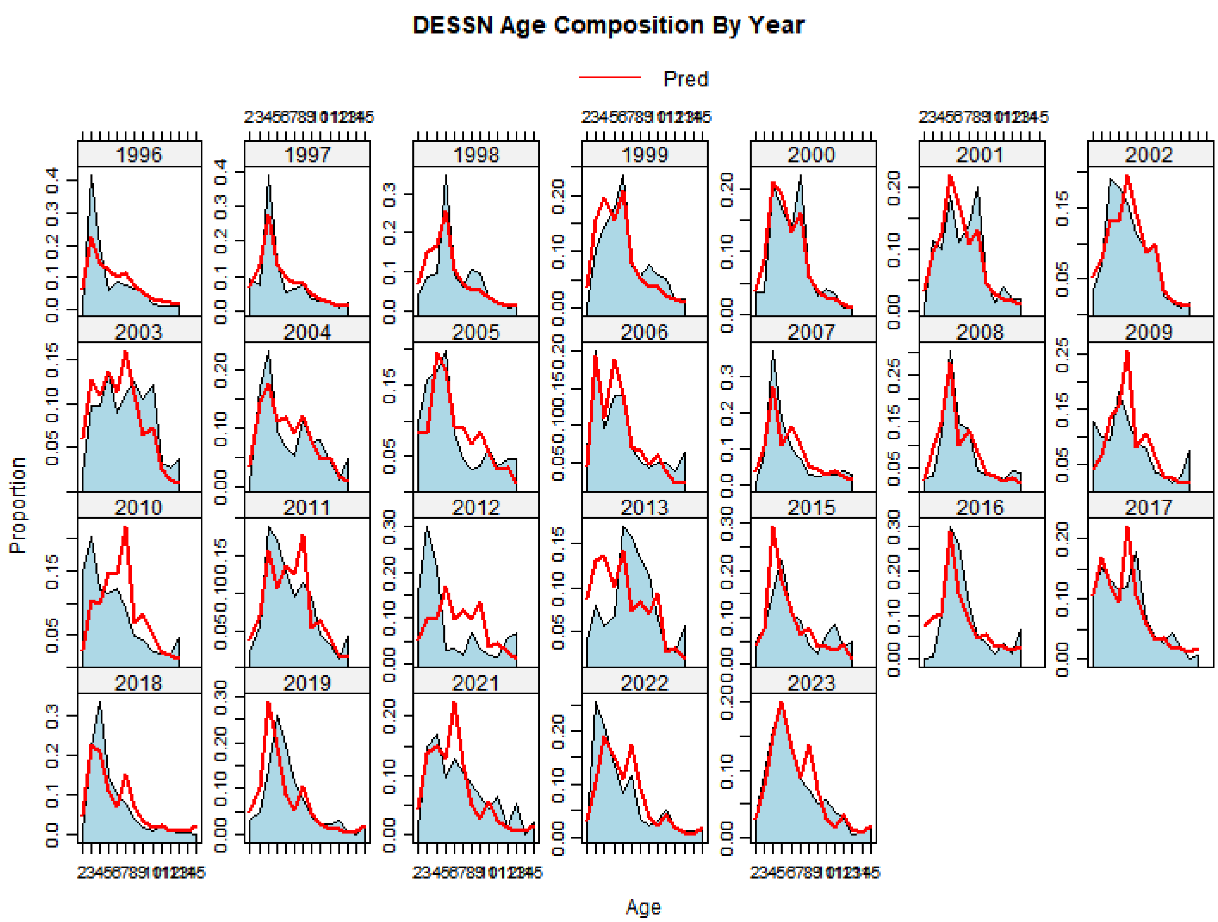

MDSSN Age Residuals By Age
Standardized Residual
Year

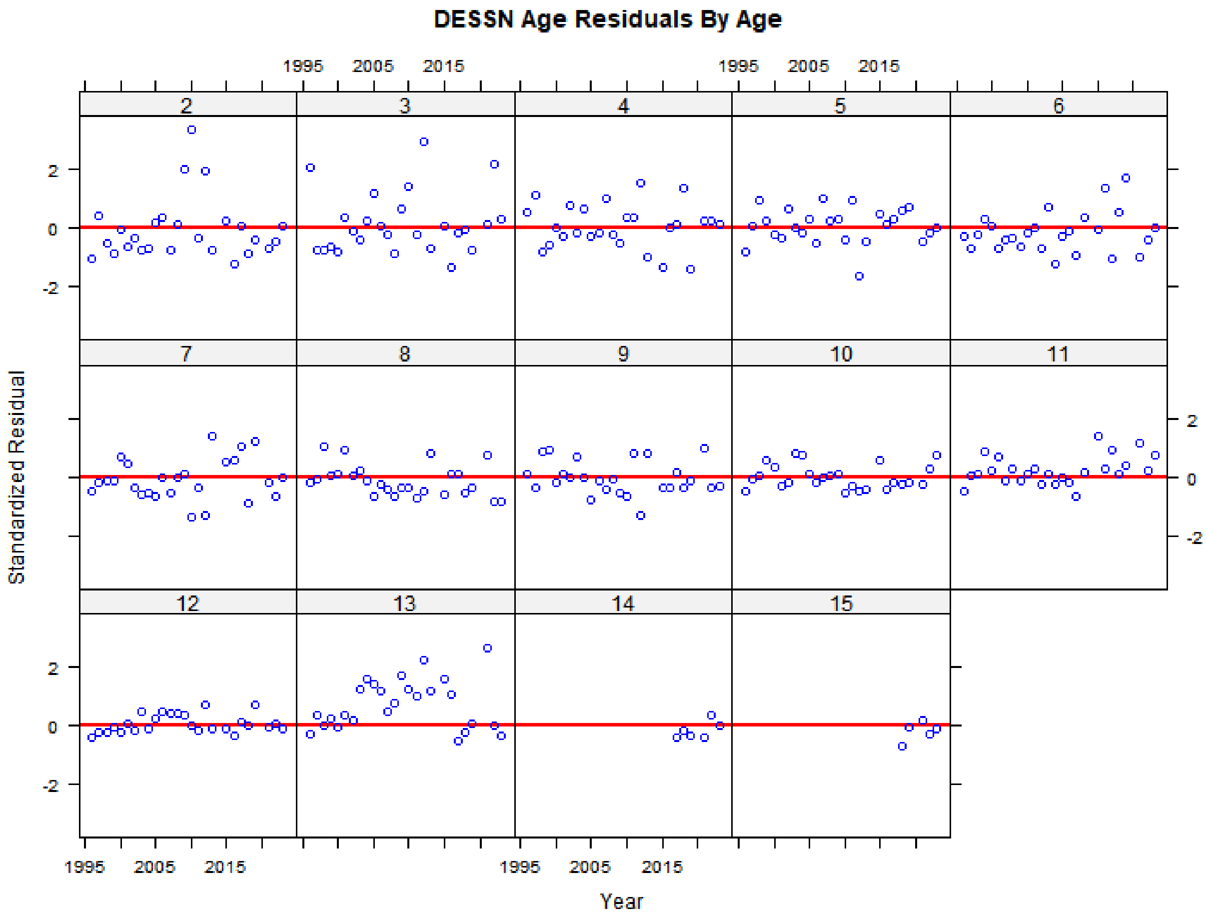

MDSSN Age Residuals By Year
Standardized Residual
Age

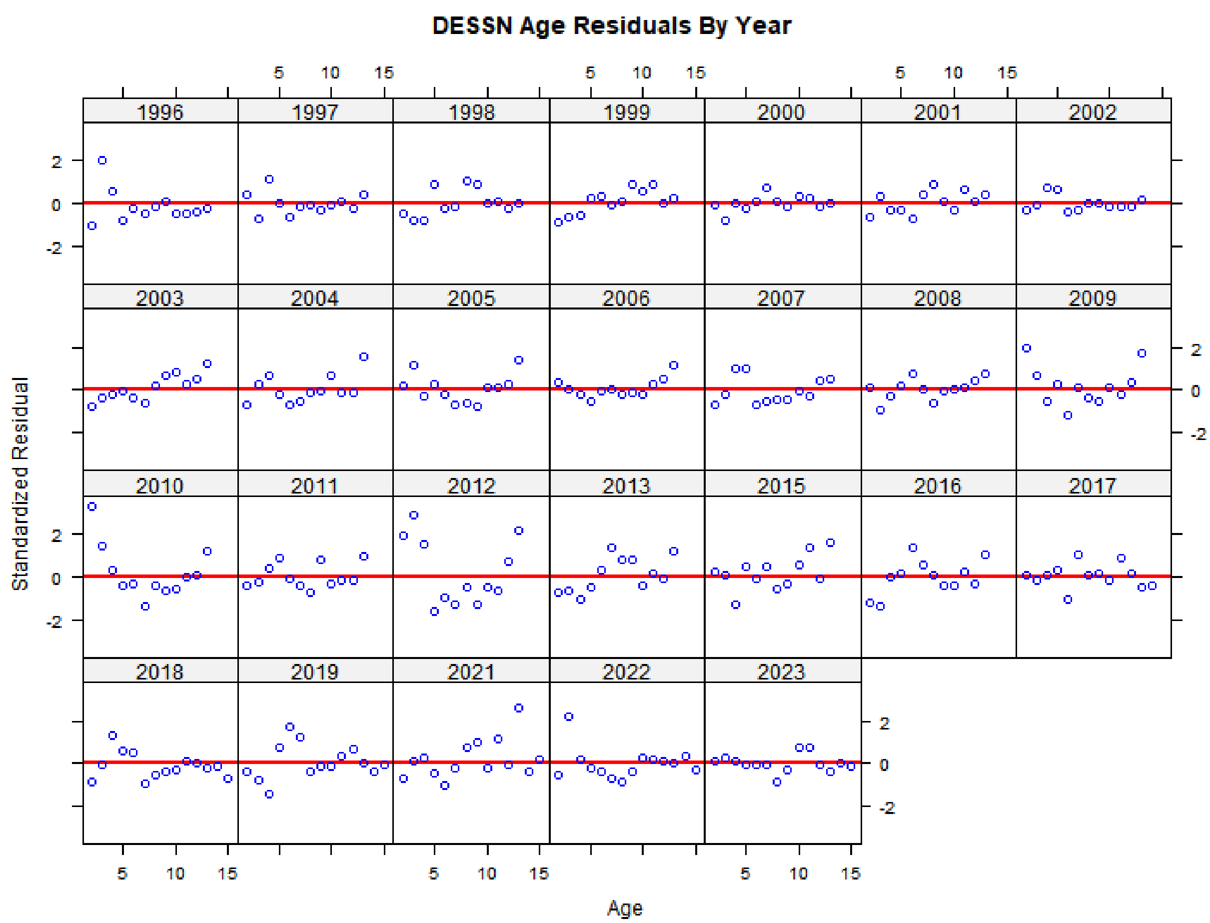

MDSSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

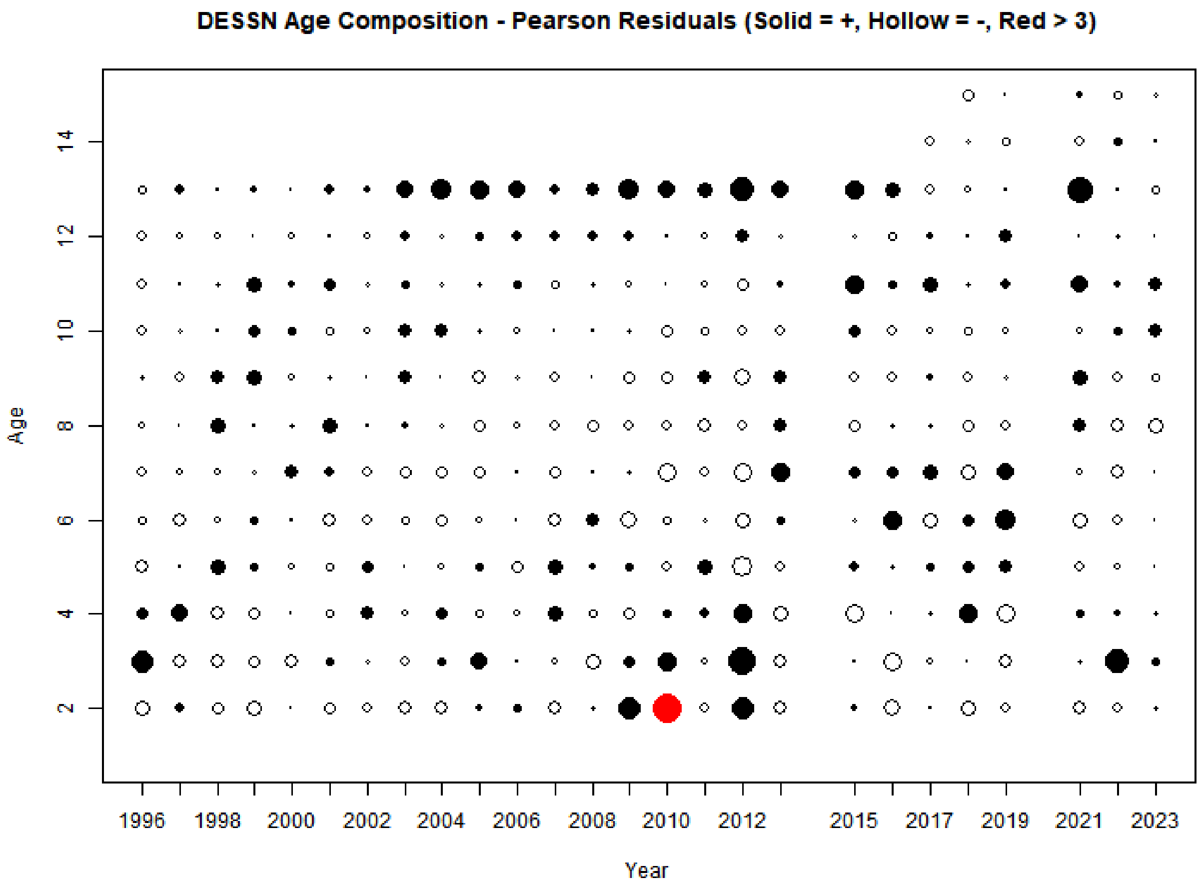

MDSSN Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Age
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

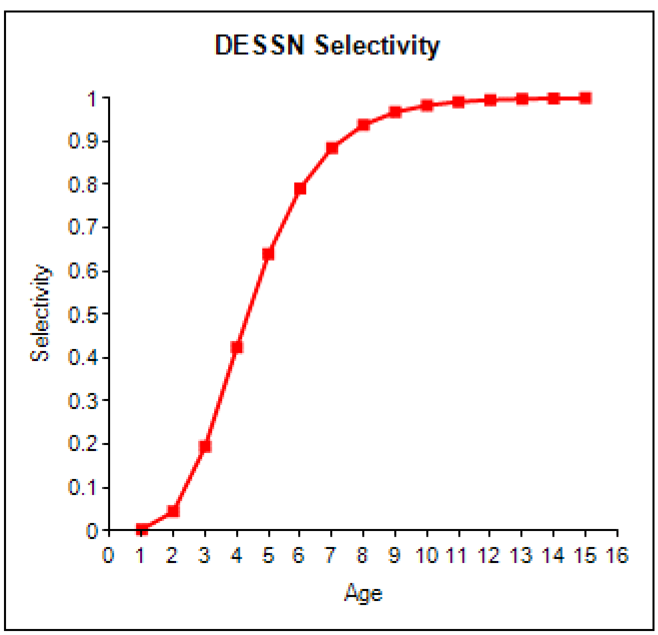

DESSN Age Composition By Age
Pred
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Proportion
Year
1995
2005
2015


DESSN Age Composition By Year
Pred
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2015
2016
2017
2018
2019
2021
2022
2023
Proportion
Age

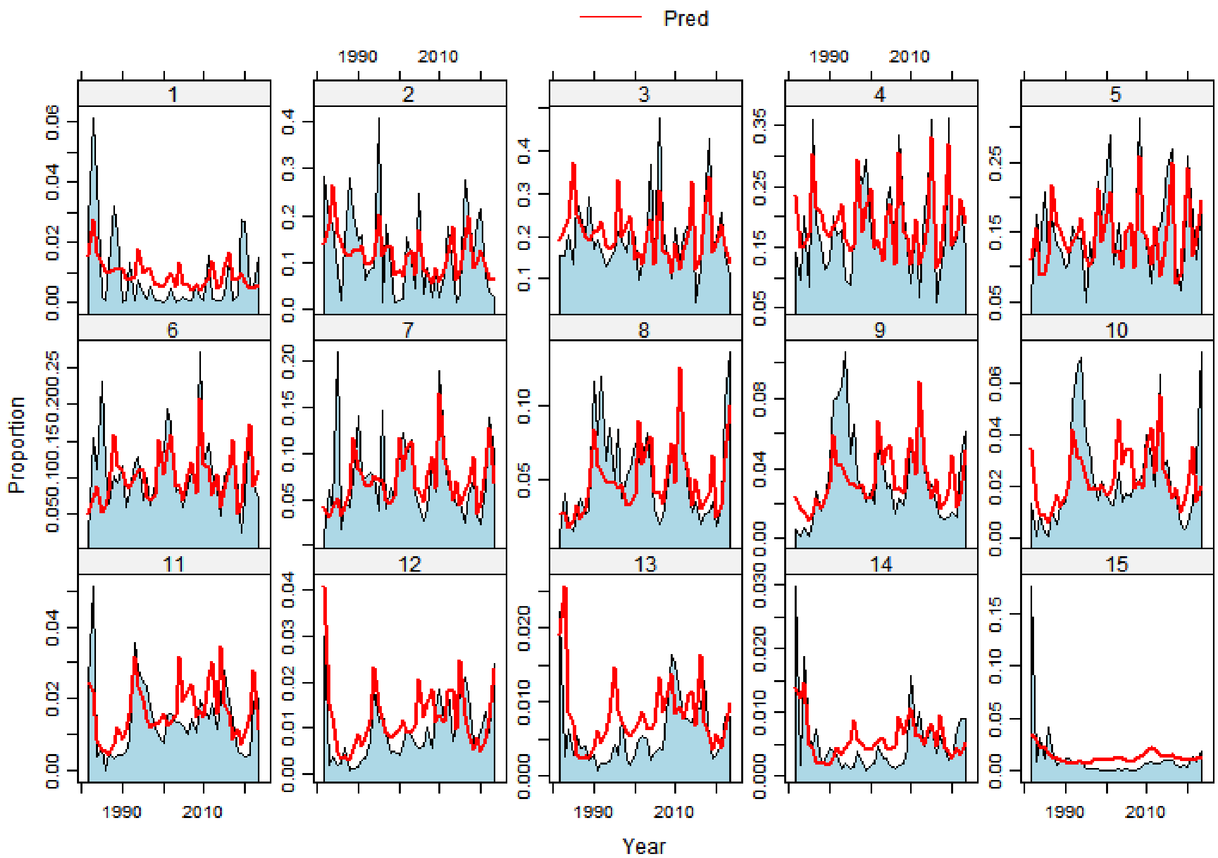

DESSN Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1995
2005
2015


DESSN Age Residuals By Year
Standardized Residual
Age
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2015
2016
2017
2018
2019
2021
2022
2023

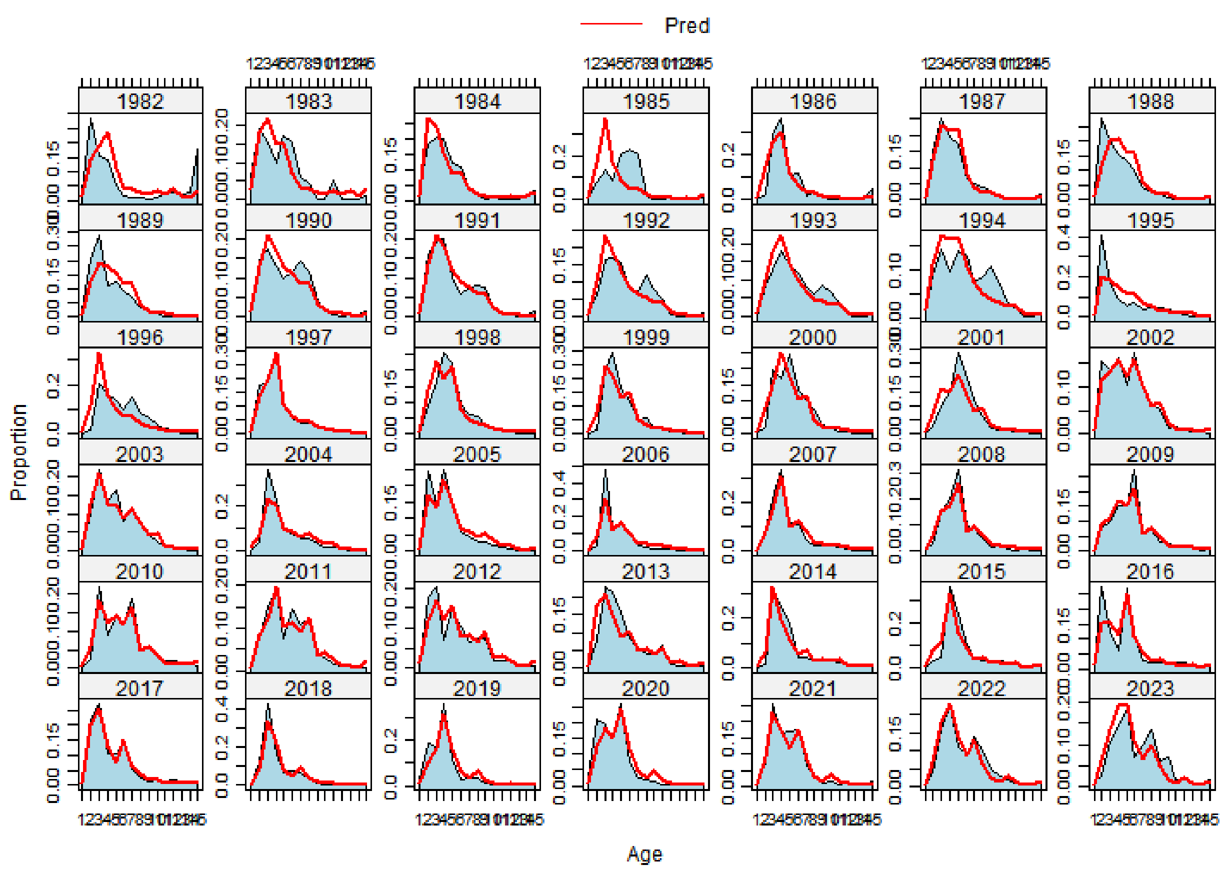

DESSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1996
1998
2000
2002
2004
2006
2008
2010
2012
2015
2017
2019
2021
2023
Year


DESSN Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Age

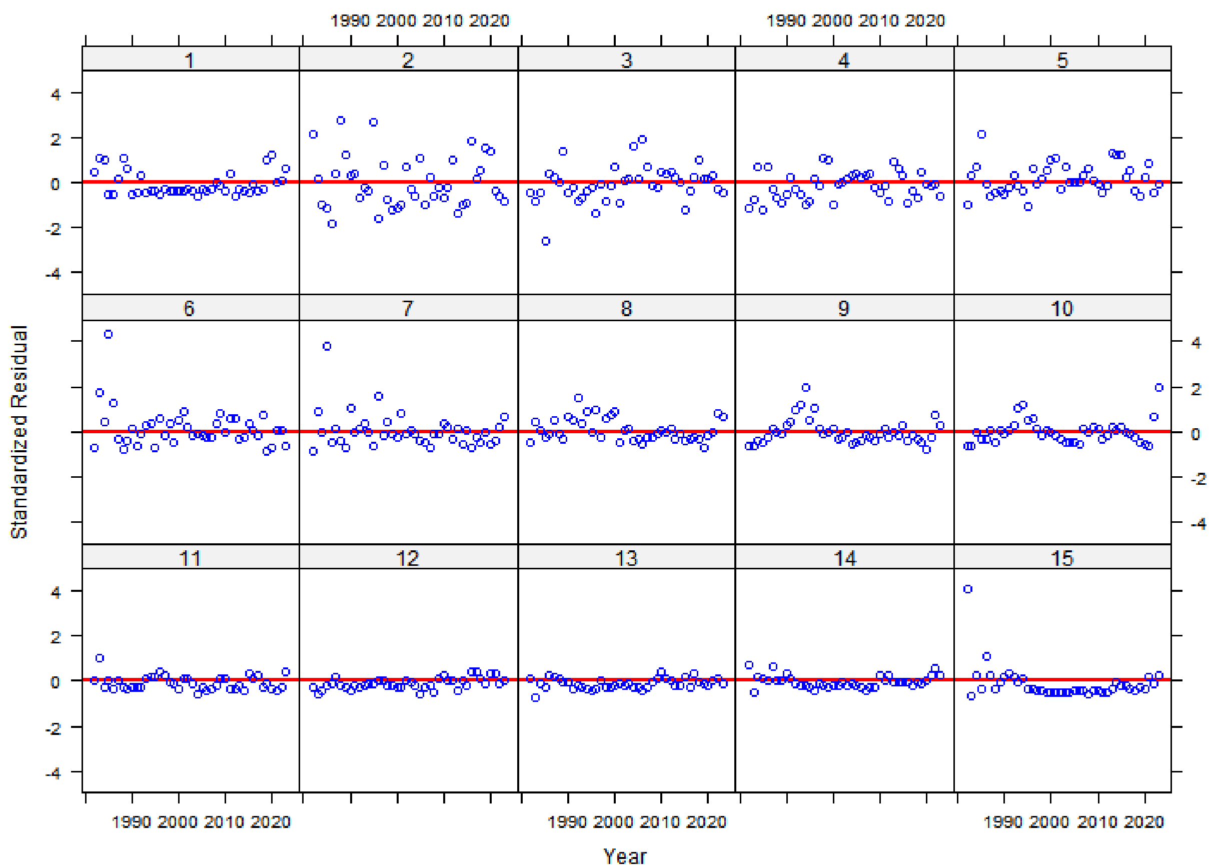
MRIP Age Composition By Age



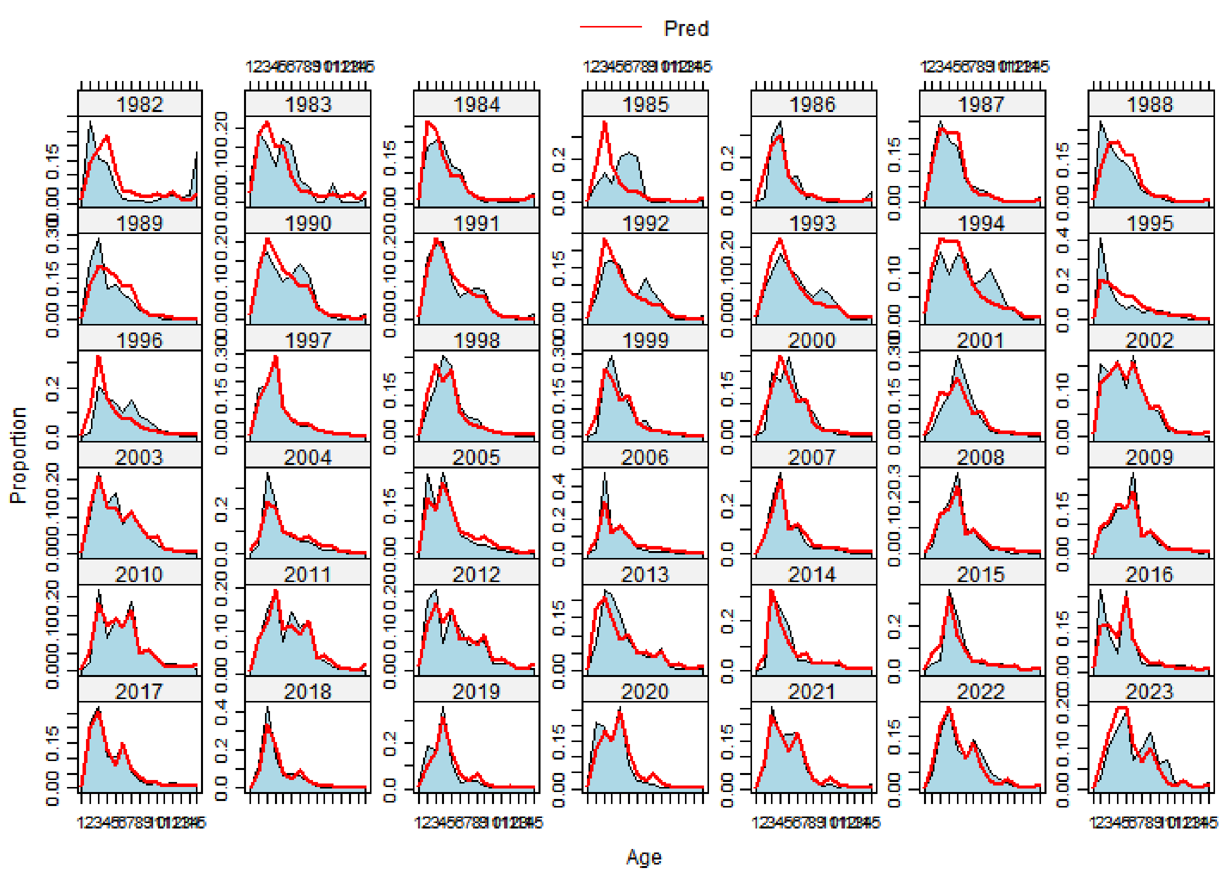
MRIP Age Composition By Year

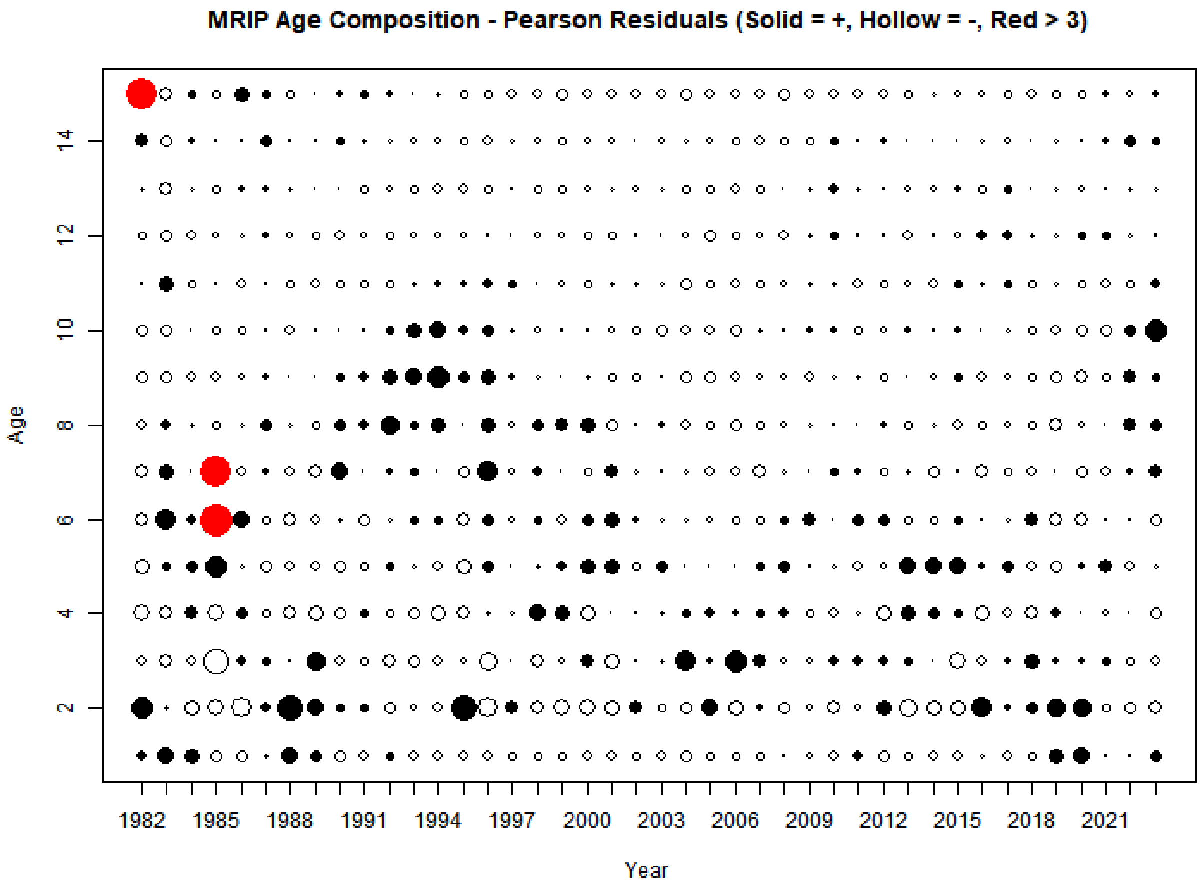


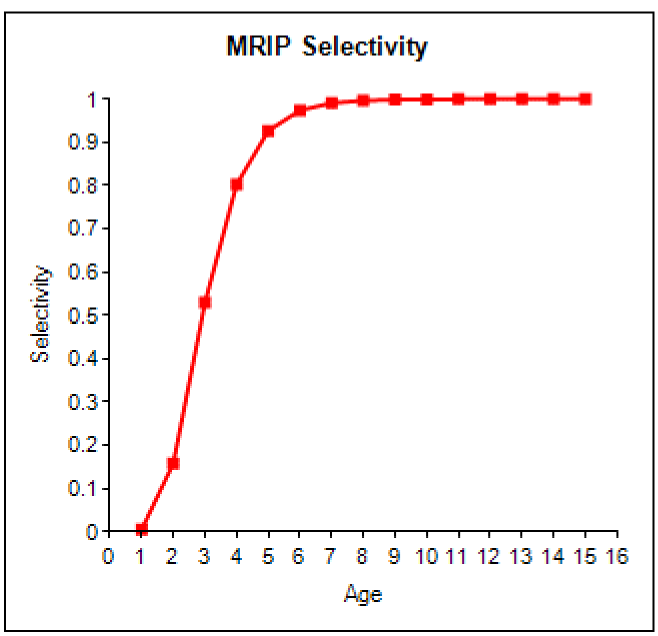
MRIP Age Residuals By Age



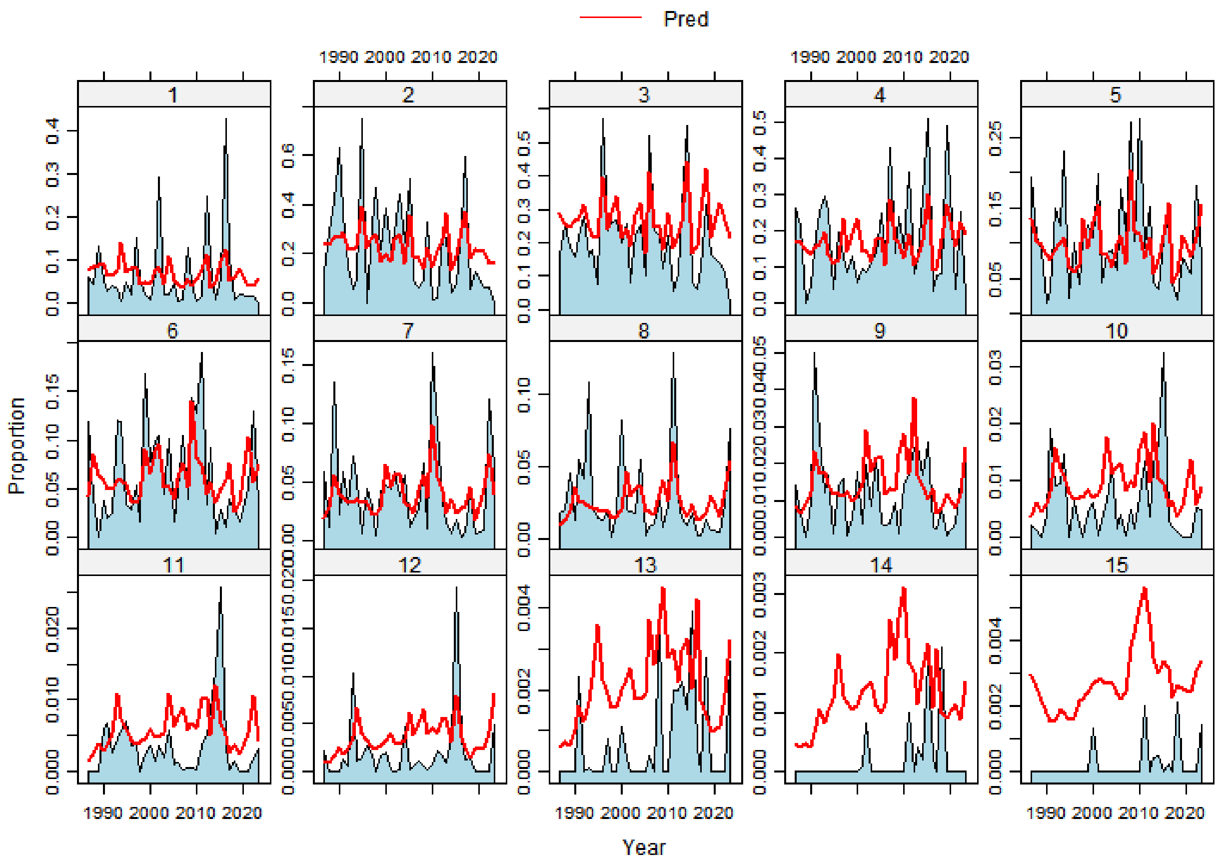
MRIP Age Composition By Year



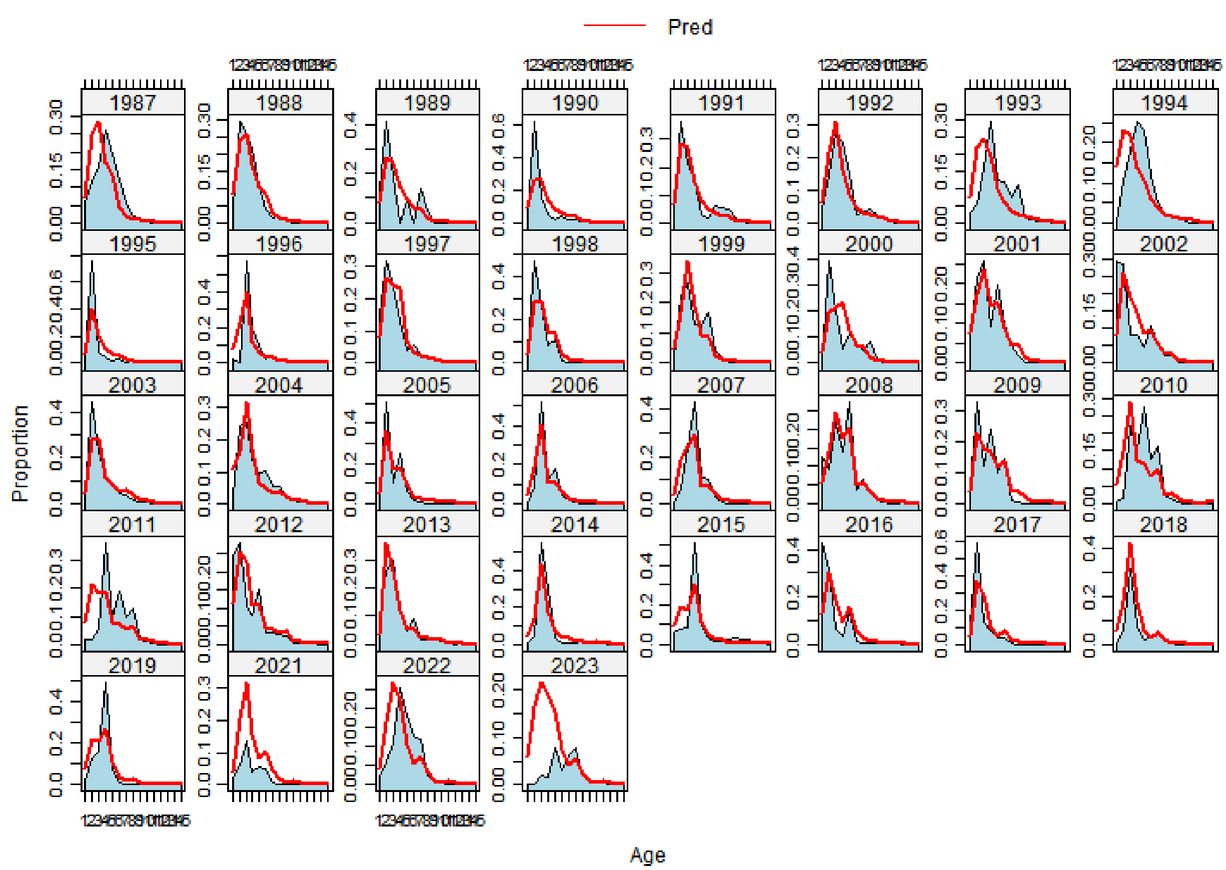

MRIP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2
4
6
8
10
12
14

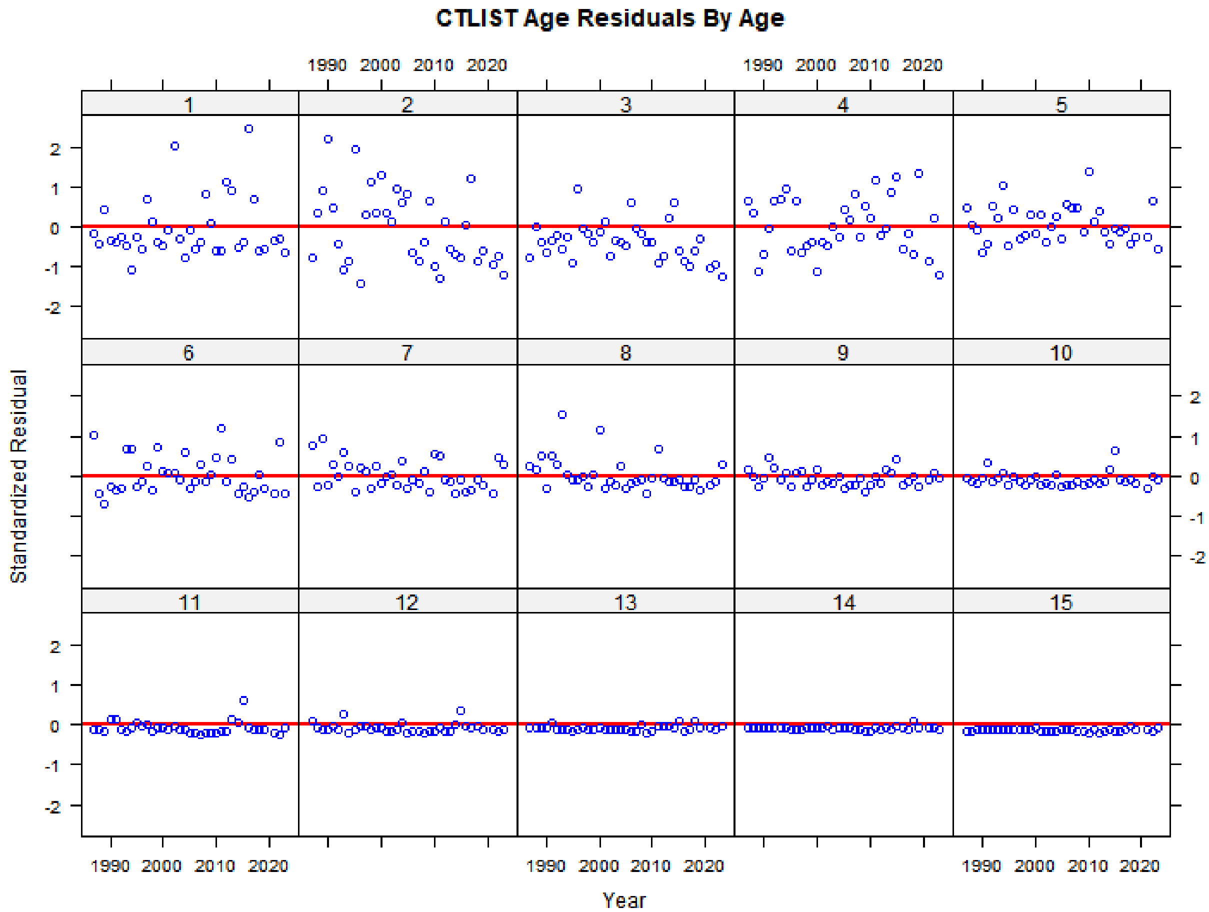

MRIP Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

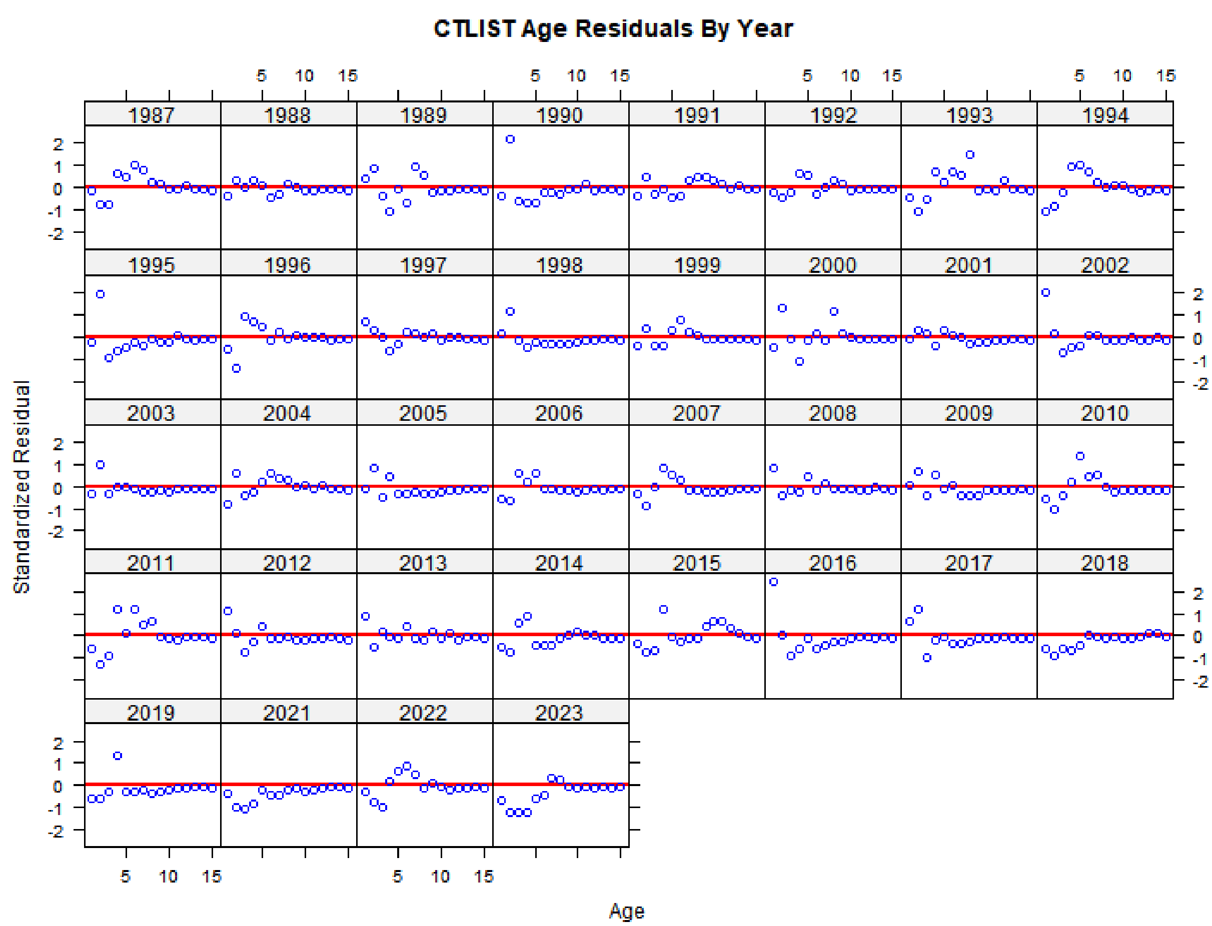
CTLIST Age Composition By Age

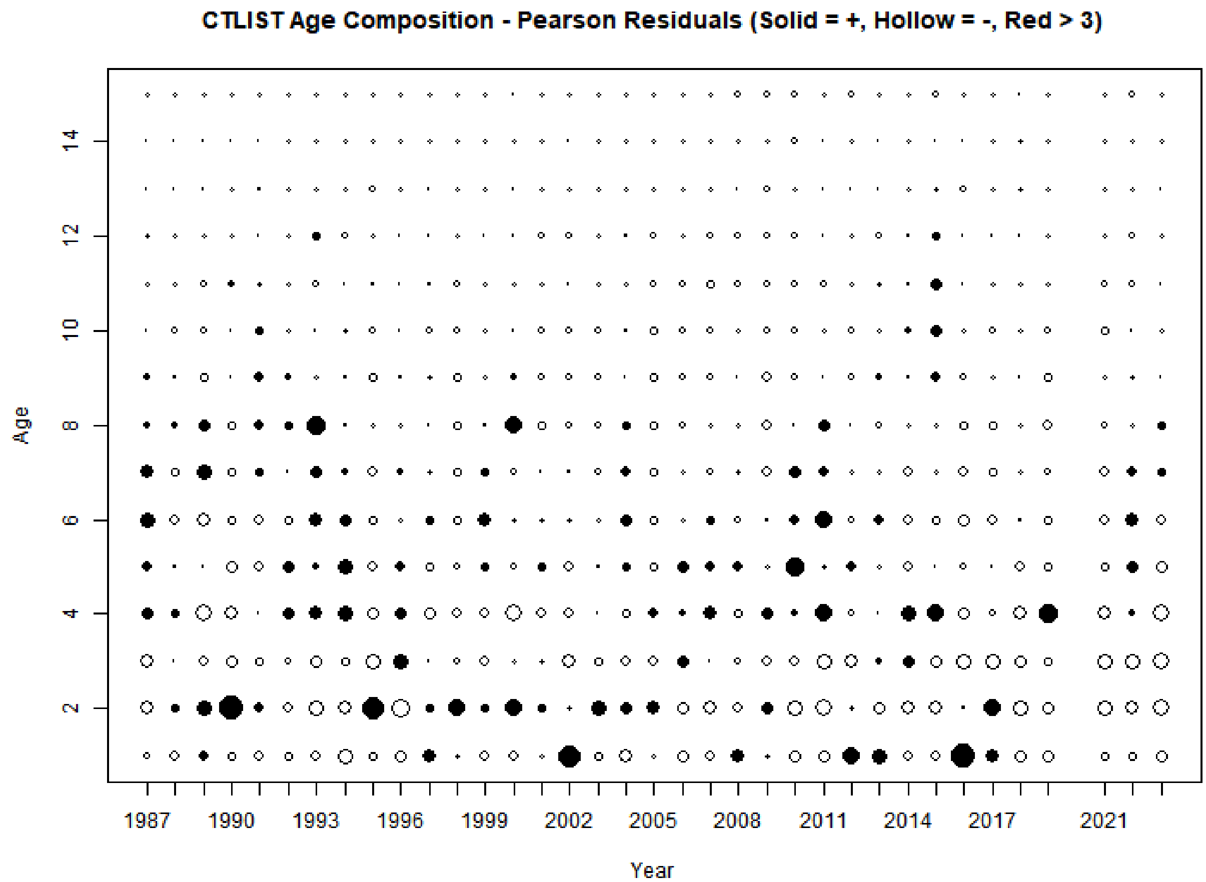


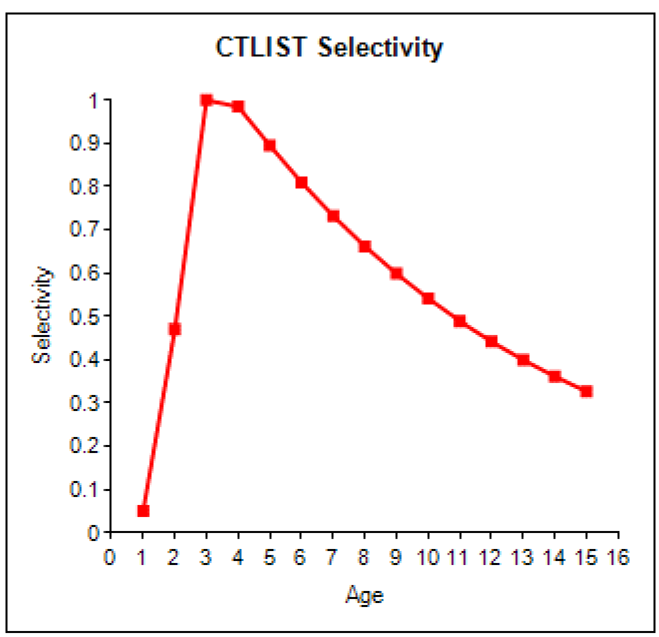
CTLIST Age Composition By Year



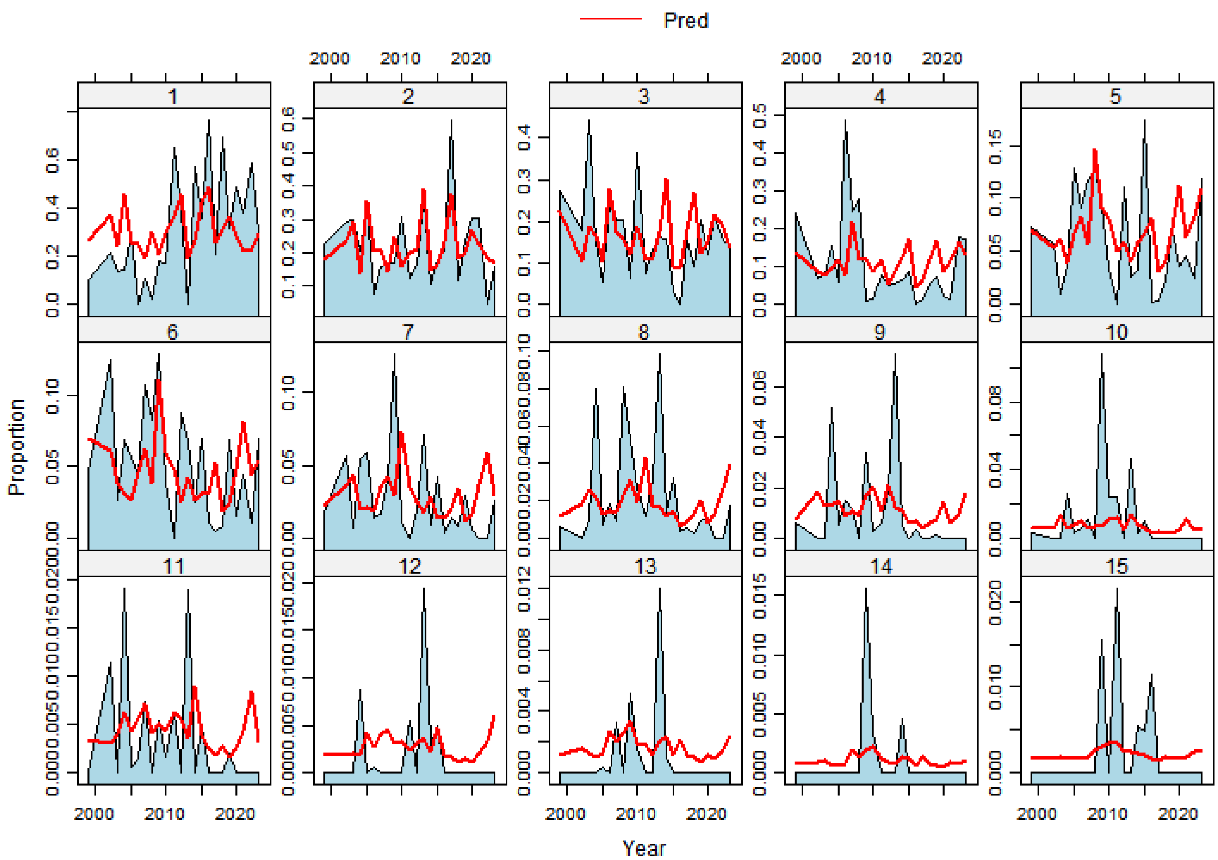

CTLIST Age Residuals By Age
Standardized Residual
Year


CTLIST Age Residuals By Year
Standardized Residual
Age

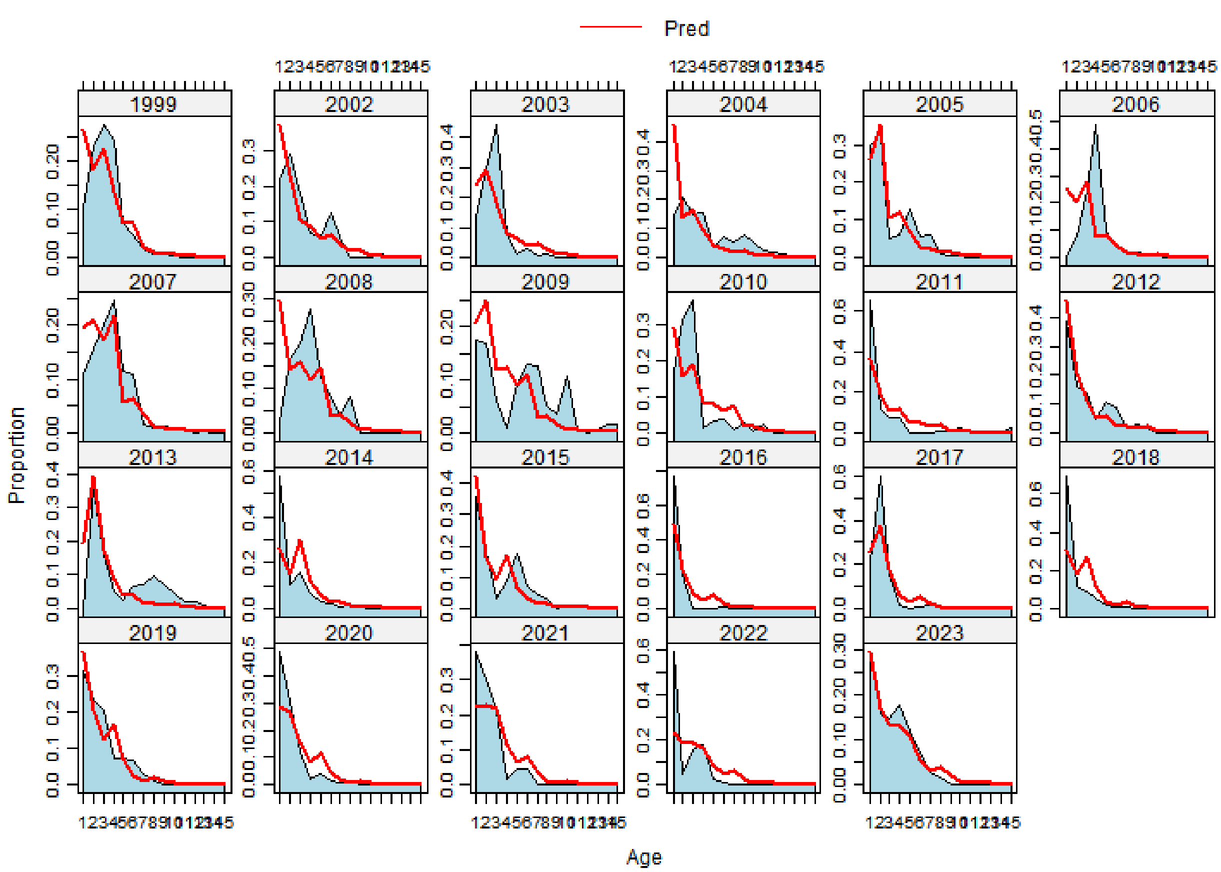

CTLIST Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2021

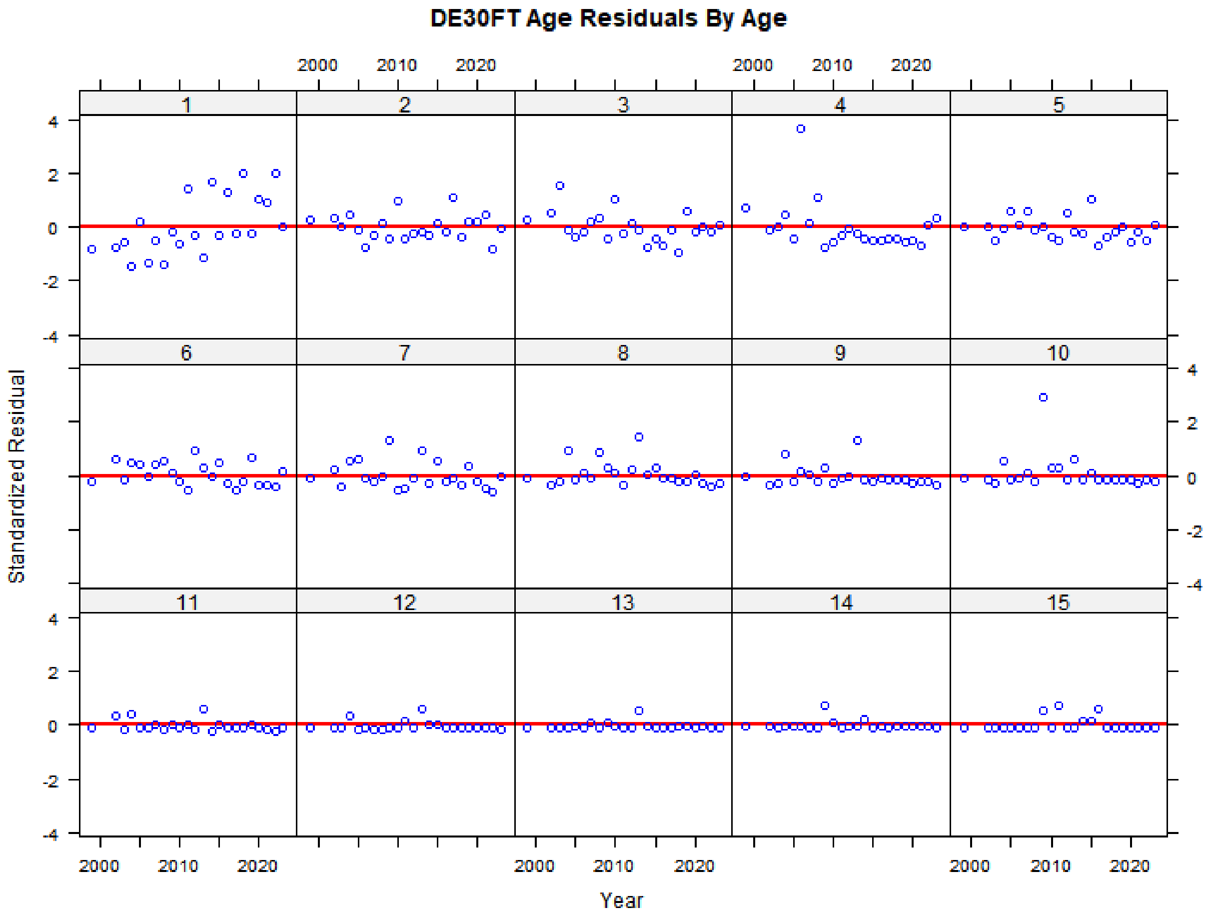

CTLIST Selectivity
Selectivity
Age

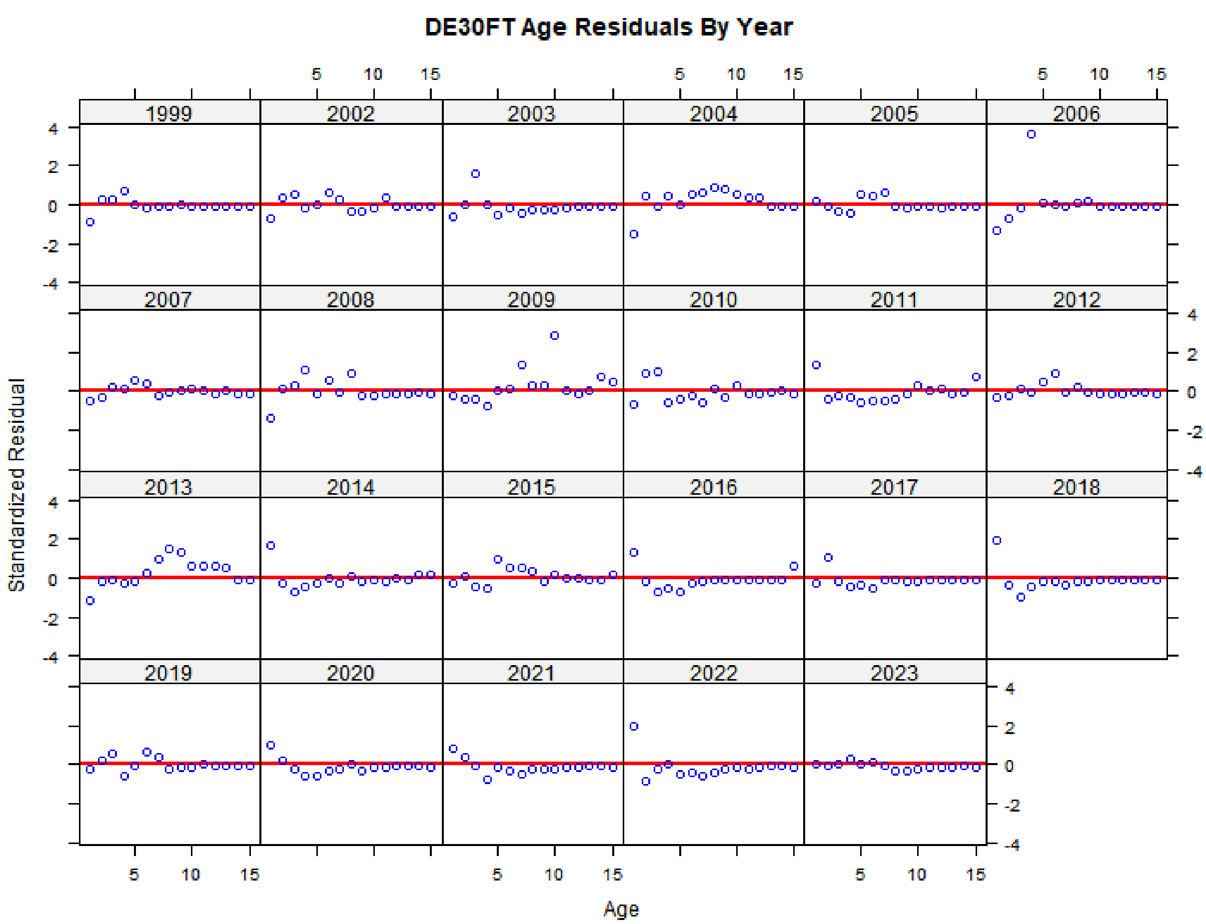
DE30FT Age Composition By Age

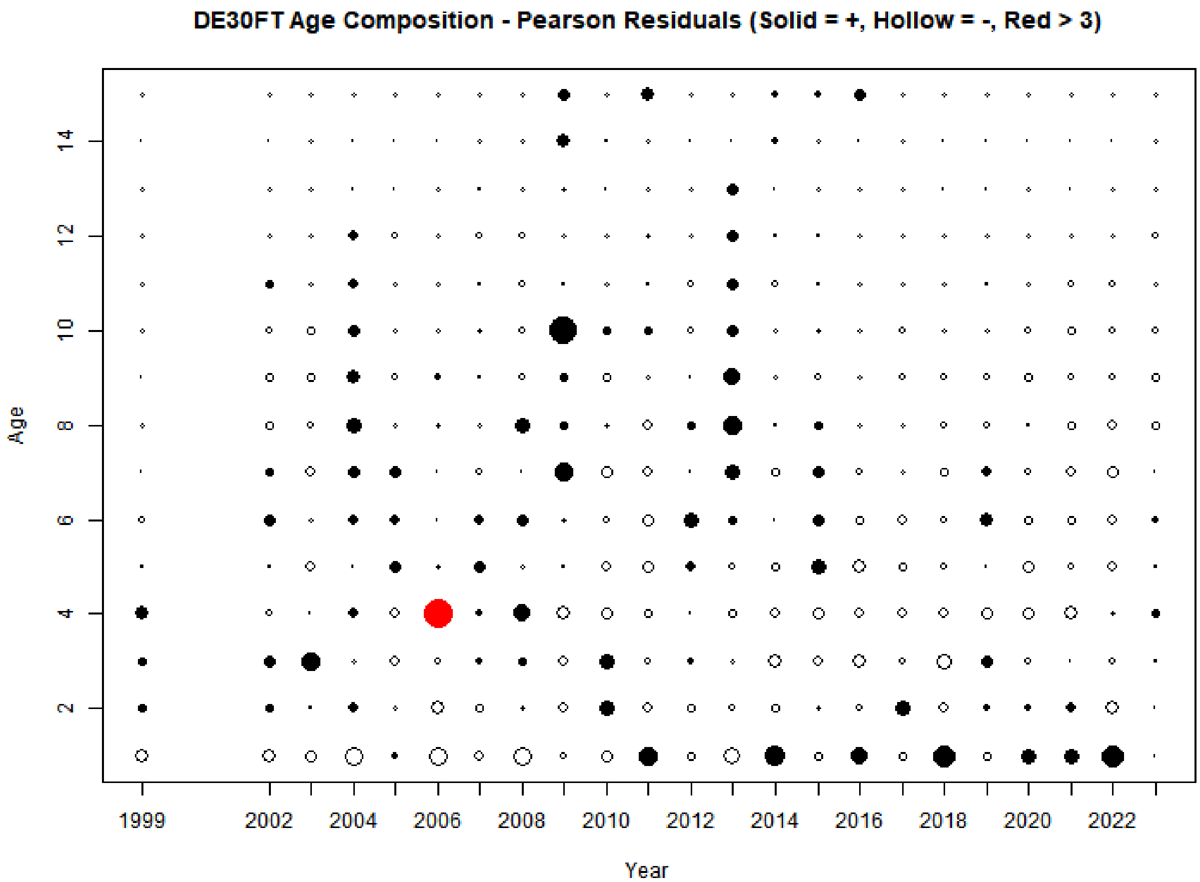


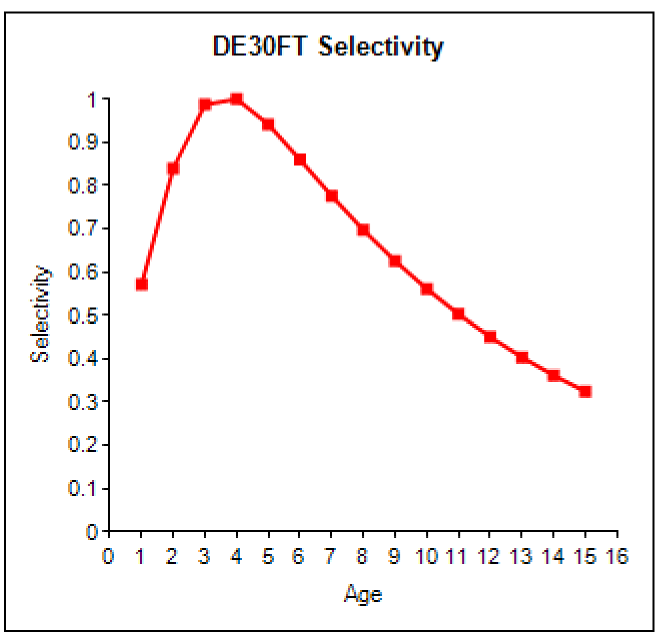
DE30FT Age Composition By Year

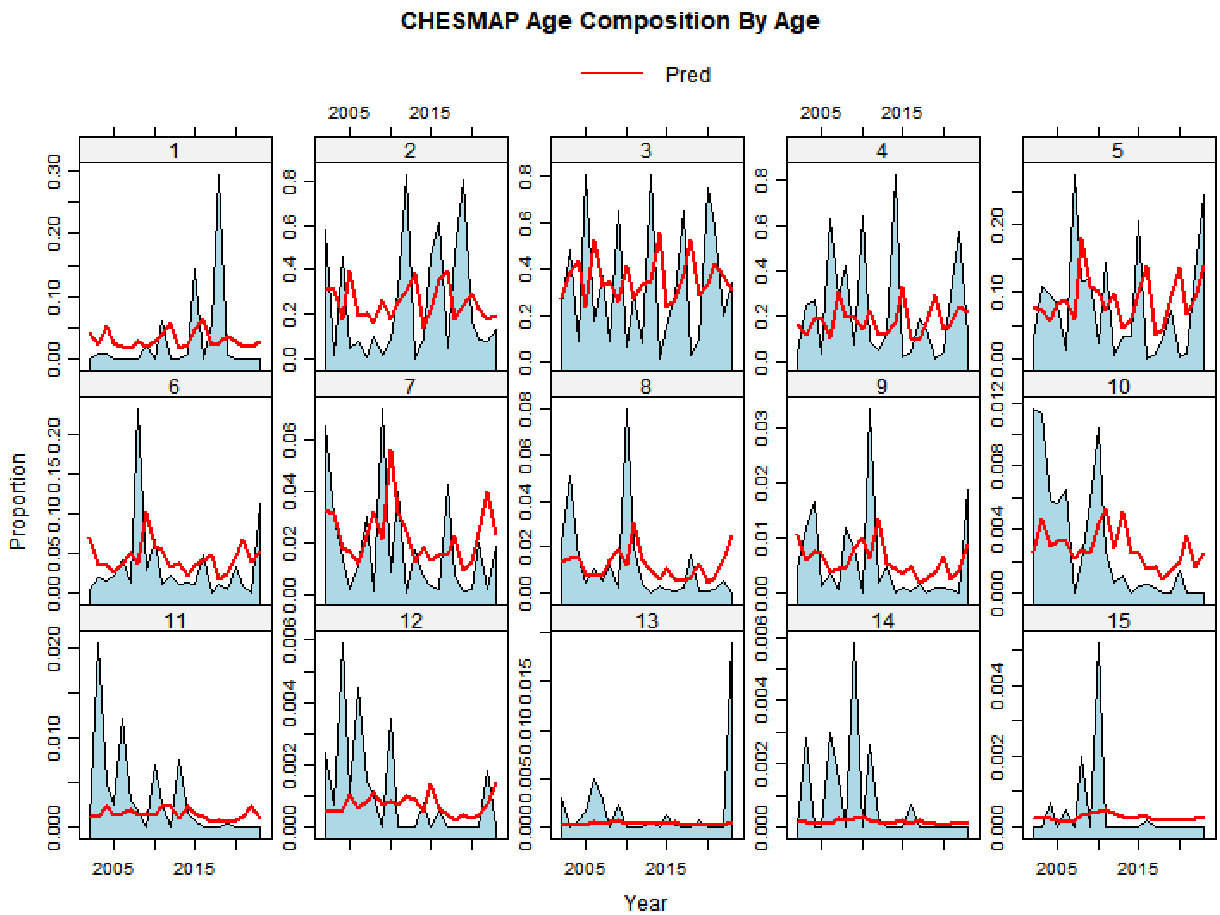


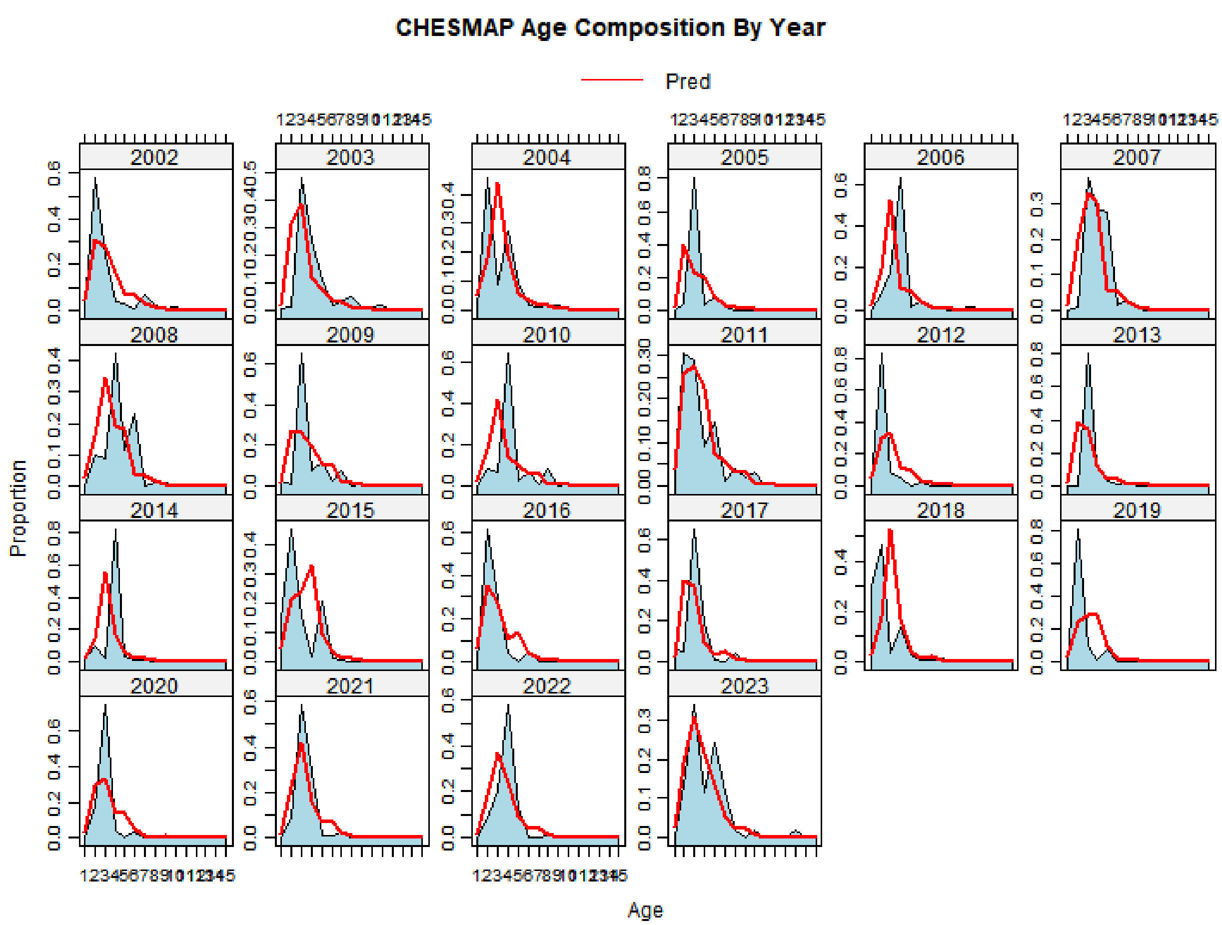

DE30FT Age Residuals By Age
Standardized Residual
Year
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
2000
2010
2020
4
2
0
-2
-4


DE30FT Age Residuals By Year
Standardized Residual
Age
1999
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
5
10
15
4
2
0
-2
-4

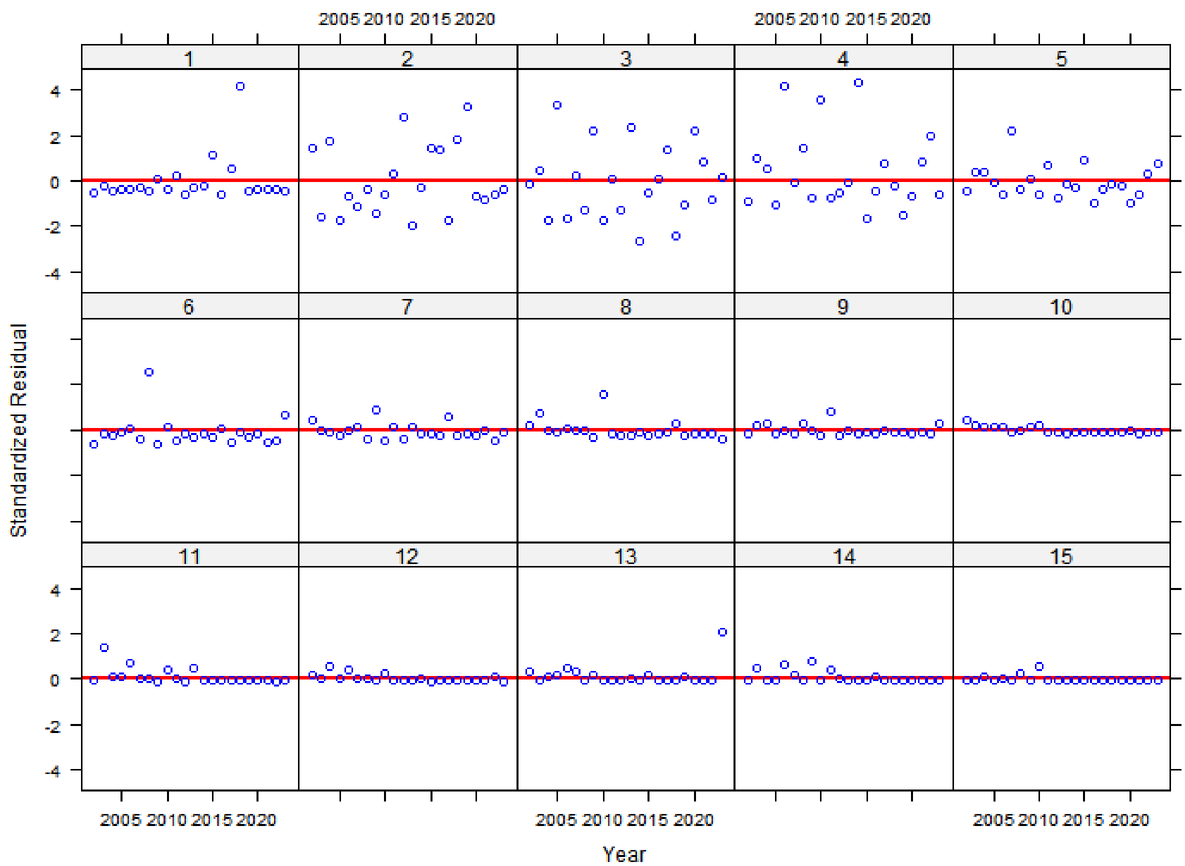

DE30FT Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2
4
6
8
10
12
14
1999
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022


DE30FT Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

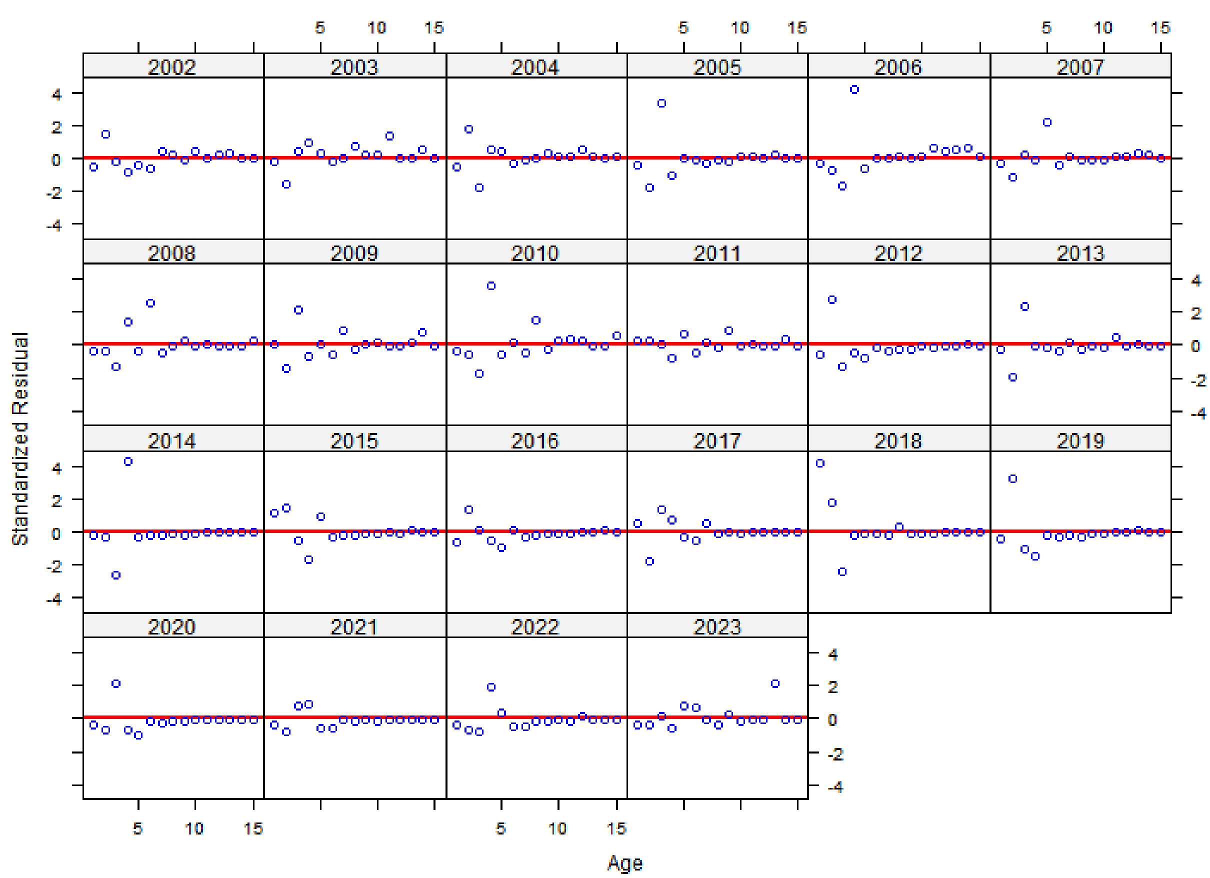

CHESMAP Age Composition By Age
Pred
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
2005
2015
Proportion
Year

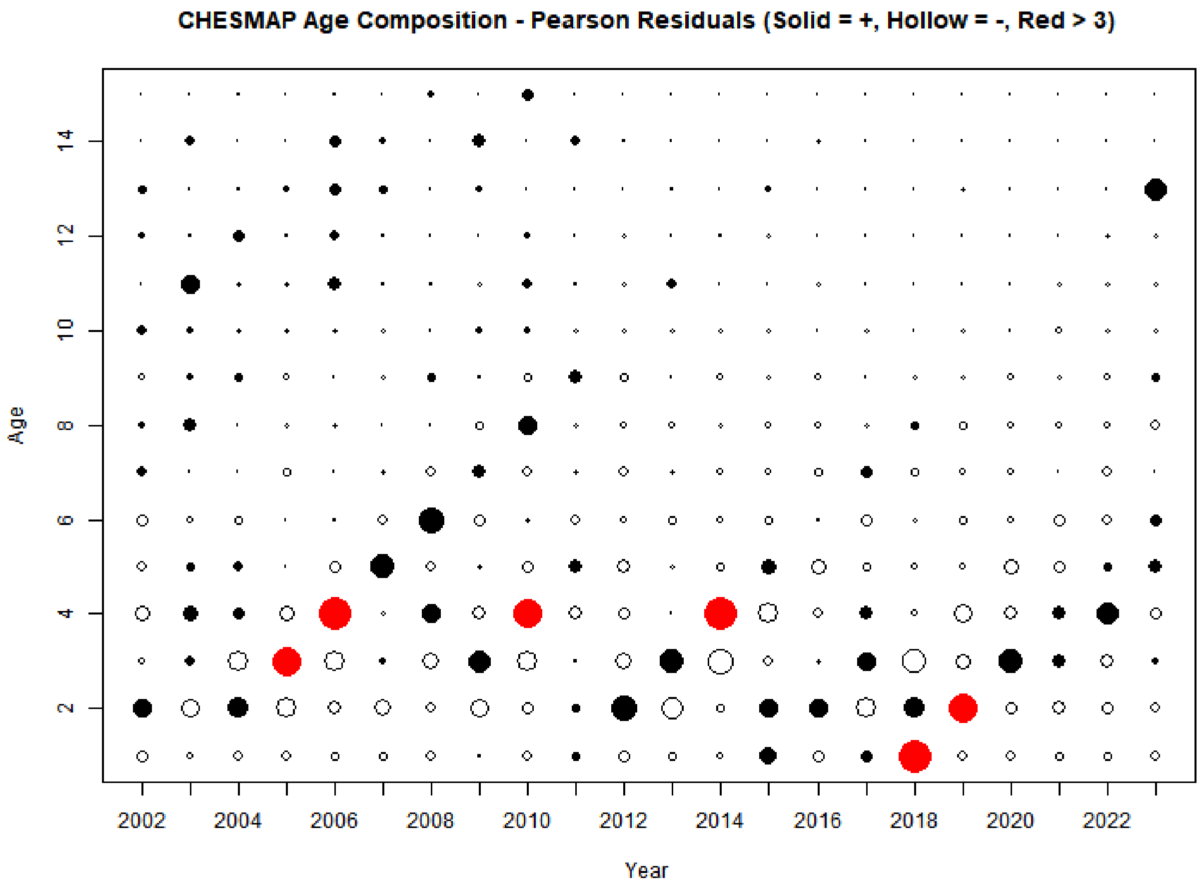

CHESMAP Age Composition By Year
Pred
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Proportion
Age

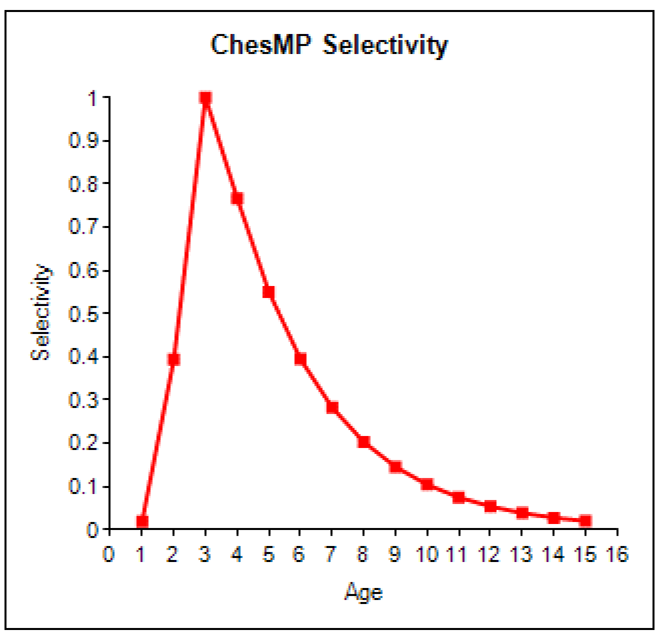
CHESMAP Age Residuals By Age



CHESMAP Age Residuals By Year




CHESMAP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2
4
6
8
10
12
14


ChesMP Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Results and Projections

Table X2. Comparison of RMSE, CV weights and effective sample sizes from the 2024 Base and 2024 Alternate Assessment.

2024 Base Update Assessment

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	38	1.00932	2.97	
NJYOY	40	1.01128	1.63	
MDYOY	12	1.0054	1.96	
compos	42	1.01242	1.00	
NYAge1	39	1.00882	1.19	
MDAge1	54	1.00057	3.25	
NYOHS	20	0.996985	2.55	21.34
NJTRAWL	31	0.999935	5.85	2.98
MDSSN	39	1.00736	2.40	15.57
DESSN	26	1.00552	1.42	19.45
MRIP	42	0.994992	2.27	27.47
CTLIST	36	1.00365	3.05	7.22
DE30FT	23	0.998003	0.85	5.62
ChesMP	22	0.995453	3.40	6.10

2024 Alternate Run

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	38	1.01062	2.97	
NJYOY	40	1.00465	1.63	
MDYOY	12	0.99246	1.92	
compos	42	1.002	1	
NYAge1	39	1.00667	1.19	
MDAge1	54	0.998896	3.25	
NYOHS	20	0.989164	2.55	21.31
NJTRAWL	31	1.00093	5.85	2.99
MDSSN	39	1.00337	2.4	15.61
DESSN	26	1.0164	1.42	19.39
MRIP	42	0.995036	2.25	27.82
CTLIST	36	1.00515	3.05	7.21
DE30FT	23	1.00116	0.85	5.44
ChesMP	22	0.992707	3.4	6.04

Table X3. Summary of likelihood component values.

	Likelihood Weight	RSS
Fleet 1 Total Catch:	2	0.216277
Fleet 2 Total Catch:	2	1.80129
Aggregate Abundance Indices		
NYYOY	1	30.7946
NJYOY	1	32.1672
MDYOY	1	10.3112
Composite	1	40.0734
NYAge1	1	34.3205
MDAge1	1	26.5649
Age Comp Abundance Indices		
NYOHS	1	18.6032
NJTrawl	1	6.56288
MDSSN	1	33.5359
DESSN	1	23.7251
MRIP	1	36.8262
CTLIST	1	29.1962
DE30FT	1	18.6787
CHESMAP	1	13.862
Total RSS		357.24
No. of Obs		548
Conc. Likel.		-117.236
Age Composition Data		
Fleet 1 Age Comp	1	7028.36
Fleet 2 Age Comp	1	6137.48
NYOHS	1	710.515
NJTrawl	1	169.297
MDSSN	1	1243.94
DESSN	1	1155.37
MRIP	1	2516.32
CTLIST	1	463.009
DE30FT	1	234.301
CHESMAP	1	233.231
Recr Devs	1	41.6345
Total Likelihood		19743.3
AIC		39882.5

Table X4. Estimates of Bay and Ocean fully-recruited fishing mortality and total fully-recruited fishing mortality with associated standard errors.

	Bay			Ocean			Total		
	Fully-recruited			Fully-recruited			Fully-recruited		
Year	F	SD	CV	F	SD	CV	F	SD	CV
1982	0.059	0.014	0.240	0.182	0.003	0.019	0.183	0.030	0.161
1983	0.063	0.029	0.461	0.147	0.012	0.084	0.148	0.040	0.269
1984	0.060	0.008	0.132	0.061	0.004	0.060	0.073	0.014	0.189
1985	0.004	0.040	11.075	0.196	0.016	0.082	0.196	0.071	0.364
1986	0.006	0.013	2.259	0.053	0.004	0.072	0.054	0.014	0.262
1987	0.002	0.012	4.844	0.031	0.015	0.494	0.031	0.007	0.216
1988	0.004	0.001	0.132	0.036	0.005	0.125	0.037	0.008	0.213
1989	0.005	0.071	15.619	0.047	0.018	0.371	0.048	0.009	0.191
1990	0.040	0.002	0.048	0.064	0.004	0.059	0.065	0.012	0.180
1991	0.044	0.014	0.319	0.091	0.013	0.148	0.092	0.016	0.175
1992	0.049	0.001	0.013	0.109	0.003	0.027	0.111	0.019	0.171
1993	0.042	0.007	0.161	0.086	0.015	0.173	0.087	0.014	0.159
1994	0.054	0.001	0.017	0.112	0.004	0.036	0.113	0.017	0.151
1995	0.079	0.008	0.099	0.204	0.013	0.064	0.206	0.033	0.159
1996	0.055	0.001	0.018	0.236	0.007	0.028	0.265	0.038	0.142
1997	0.059	0.009	0.154	0.164	0.016	0.097	0.200	0.014	0.068
1998	0.052	0.005	0.103	0.178	0.005	0.026	0.208	0.015	0.072
1999	0.053	0.012	0.217	0.163	0.016	0.100	0.194	0.013	0.069
2000	0.057	0.007	0.122	0.160	0.006	0.040	0.194	0.013	0.067
2001	0.045	0.016	0.350	0.166	0.017	0.100	0.192	0.013	0.066
2002	0.050	0.005	0.102	0.178	0.006	0.031	0.207	0.013	0.065
2003	0.065	0.019	0.290	0.184	0.025	0.134	0.222	0.014	0.061
2004	0.063	0.004	0.062	0.210	0.008	0.039	0.247	0.017	0.069
2005	0.056	0.014	0.246	0.211	0.020	0.094	0.244	0.017	0.068
2006	0.077	0.005	0.060	0.244	0.006	0.024	0.289	0.019	0.065
2007	0.058	0.017	0.291	0.181	0.018	0.098	0.216	0.014	0.067
2008	0.051	0.006	0.124	0.200	0.009	0.044	0.229	0.016	0.069
2009	0.068	0.033	0.478	0.183	0.020	0.111	0.224	0.014	0.064
2010	0.072	0.004	0.049	0.221	0.006	0.029	0.263	0.017	0.066
2011	0.070	0.036	0.522	0.228	0.026	0.114	0.268	0.018	0.065
2012	0.080	0.003	0.040	0.218	0.005	0.023	0.266	0.019	0.070
2013	0.087	0.012	0.140	0.314	0.019	0.062	0.364	0.027	0.074
2014	0.100	0.003	0.027	0.224	0.004	0.017	0.286	0.022	0.077
2015	0.084	0.014	0.163	0.197	0.018	0.090	0.248	0.020	0.082
2016	0.112	0.003	0.024	0.217	0.005	0.025	0.287	0.024	0.082
2017	0.079	0.012	0.158	0.275	0.018	0.065	0.321	0.029	0.090
2018	0.066	0.003	0.049	0.196	0.005	0.024	0.235	0.021	0.090
2019	0.053	0.012	0.223	0.177	0.018	0.103	0.208	0.019	0.092
2020	0.061	0.002	0.039	0.110	0.005	0.047	0.154	0.015	0.098
2021	0.051	0.012	0.224	0.120	0.027	0.228	0.156	0.020	0.131
2022	0.051	0.003	0.055	0.180	0.005	0.027	0.216	0.029	0.136
2023	0.049	0.012	0.246	0.149	0.022	0.151	0.183	0.024	0.133

Table X4 cont.

Year	Recruitment	SD	CV
1982	38296700	3654460	0.095
1983	77301100	6167490	0.080
1984	63603600	5047760	0.079
1985	69323200	5215200	0.075
1986	68551600	5141120	0.075
1987	73855100	5382970	0.073
1988	93137700	6438600	0.069
1989	107221000	7324070	0.068
1990	131811000	8541010	0.065
1991	105317000	7693570	0.073
1992	109903000	8167730	0.074
1993	134808000	9302590	0.069
1994	286886000	14658400	0.051
1995	187595000	11521500	0.061
1996	234759000	13265600	0.057
1997	259536000	13803100	0.053
1998	148101000	9952600	0.067
1999	153117000	9938990	0.065
2000	124771000	8982140	0.072
2001	196937000	11333500	0.058
2002	222073000	11997600	0.054
2003	127874000	8798540	0.069
2004	304610000	13910500	0.046
2005	158237000	9633660	0.061
2006	136369000	8712020	0.064
2007	89174400	6734280	0.076
2008	129419000	8190850	0.063
2009	76363900	6033890	0.079
2010	99619400	7126830	0.072
2011	128567000	8405000	0.065
2012	200280000	11453200	0.057
2013	68928800	6110650	0.089
2014	85838800	6954950	0.081
2015	157070000	11041100	0.070
2016	229985000	15528700	0.068
2017	111203000	9427490	0.085
2018	129634000	11108600	0.086
2019	164809000	14493500	0.088
2020	124284000	12813500	0.103
2021	86716700	11651300	0.134
2022	76653000	10730500	0.140
2023	94898600	15356800	0.162

Catch Selectivity Parameters

Bay

	Estimate	SD	CV
1982-1984			
α	-5.449	0.188	0.03
β	2.554	0.041	0.02
ϒ	0.831	0.020	0.02
1985-1989			
α	-3.934	0.473	0.12
β	2.286	0.085	0.04
ϒ	0.959	0.013	0.01
1990-1995			
α	-2.062	0.096	0.05
β	4.470	0.180	0.04
ϒ	0.815	0.032	0.04
1996-2019			
α	-1.815	0.063	0.03
β	3.623	0.084	0.02
ϒ	0.962	0.009	0.01
2020-2023			
α	-1.745	0.109	0.06
β	4.471	0.220	0.05
ϒ	0.805	0.039	0.05

Ocean

	Estimate	SD	CV
1982-1984			
α	3.481	0.205	0.06
β	0.836	0.094	0.11
1985-1989			
α	4.951	0.448	0.09
β	0.446	0.052	0.12
1990-1996			
α	6.257	0.570	0.09
β	0.340	0.037	0.11
1997-2019			
α	4.807	0.175	0.04
β	0.464	0.025	0.05
2020-2023			
α	-1.167	0.136	0.12
β	5.069	0.717	0.14
ϒ	0.936	0.070	0.07

Survey Selectivity Parameters

NYOHS	Estimate	SD	CV
α	-3.027	0.511	0.17
β	2.620	0.154	0.06
ϒ	0.917	0.026	0.03
NJ Trawl			
α	1.434	0.739	0.51
β	0.236	0.156	0.66
MDSSN			
s_2	0.140	0.021	0.15
DE SSN			
α	3.763	0.237	0.06
β	0.647	0.087	0.13
MRIP			
α	2.576	0.076	0.03
β	1.064	0.064	0.06
CTLIST			
α	-2.805	0.393	0.14
β	2.163	0.160	0.07
ϒ	0.964	0.017	0.02
DE30FT			
α	-0.993	0.736	0.74
β	1.495	1.239	0.83
ϒ	0.890	0.162	0.18
ChesMap			
α	-3.659	0.598	0.16
β	2.282	0.139	0.06
ϒ	0.909	0.027	0.03

Catchability Coefficients

Survey	Estimate	SD	CV
NYYOY	1.27E-07	1.24E-08	0.10
NJYOY	8.13E-09	4.94E-10	0.06
MDYOY	1.32E-07	2.02E-08	0.15
compos	1.04E-06	4.62E-08	0.04
NYAge1	2.42E-08	1.77E-09	0.07
MDAge1	8.00E-09	1.31E-09	0.16
NYOHS	8.78E-08	8.11E-09	0.09
NJTRAWL	9.26E-08	2.70E-08	0.29
MDSSN	7.60E-08	6.35E-09	0.08
DESSN	4.14E-08	5.39E-09	0.13
MRIP	4.32E-08	2.92E-09	0.07
CTLIST	7.90E-09	7.35E-10	0.09
DE30FT	2.63E-08	4.53E-09	0.17
ChesMP	2.43E-06	4.34E-07	0.18

Table X5. Region-specific and total fishing mortality-at-age, 1982-2021

Bay Fishing Mortality-At-Age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0076	0.0595	0.0257	0.0102	0.0041	0.0016	0.0006	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1983	0.0001	0.0081	0.0634	0.0274	0.0109	0.0043	0.0017	0.0007	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0014
1984	0.0001	0.0076	0.0598	0.0259	0.0103	0.0041	0.0016	0.0006	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1985	0.0000	0.0011	0.0036	0.0032	0.0028	0.0023	0.0020	0.0017	0.0014	0.0012	0.0010	0.0009	0.0008	0.0006	0.0005
1986	0.0001	0.0018	0.0059	0.0053	0.0045	0.0038	0.0033	0.0028	0.0024	0.0020	0.0017	0.0015	0.0012	0.0010	0.0009
1987	0.0000	0.0008	0.0024	0.0022	0.0019	0.0016	0.0014	0.0012	0.0010	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004
1988	0.0000	0.0014	0.0045	0.0040	0.0034	0.0029	0.0025	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008	0.0007
1989	0.0000	0.0014	0.0046	0.0041	0.0035	0.0030	0.0025	0.0022	0.0018	0.0016	0.0013	0.0011	0.0010	0.0008	0.0007
1990	0.0002	0.0010	0.0053	0.0215	0.0399	0.0349	0.0247	0.0169	0.0116	0.0079	0.0054	0.0037	0.0025	0.0017	0.0012
1991	0.0002	0.0011	0.0058	0.0236	0.0439	0.0384	0.0272	0.0186	0.0127	0.0087	0.0059	0.0040	0.0028	0.0019	0.0013
1992	0.0002	0.0013	0.0065	0.0265	0.0492	0.0430	0.0305	0.0209	0.0143	0.0097	0.0067	0.0045	0.0031	0.0021	0.0014
1993	0.0002	0.0011	0.0055	0.0225	0.0417	0.0365	0.0258	0.0177	0.0121	0.0083	0.0056	0.0039	0.0026	0.0018	0.0012
1994	0.0003	0.0014	0.0072	0.0292	0.0543	0.0475	0.0336	0.0230	0.0157	0.0107	0.0073	0.0050	0.0034	0.0023	0.0016
1995	0.0004	0.0020	0.0104	0.0423	0.0787	0.0688	0.0487	0.0334	0.0228	0.0156	0.0106	0.0073	0.0050	0.0034	0.0023
1996	0.0007	0.0036	0.0166	0.0421	0.0547	0.0545	0.0515	0.0482	0.0450	0.0420	0.0393	0.0367	0.0342	0.0320	0.0299
1997	0.0007	0.0039	0.0180	0.0456	0.0593	0.0591	0.0558	0.0522	0.0488	0.0455	0.0425	0.0397	0.0371	0.0346	0.0324
1998	0.0006	0.0034	0.0156	0.0397	0.0515	0.0514	0.0485	0.0454	0.0424	0.0396	0.0370	0.0345	0.0323	0.0301	0.0281
1999	0.0006	0.0035	0.0161	0.0409	0.0531	0.0530	0.0500	0.0468	0.0437	0.0408	0.0381	0.0356	0.0333	0.0311	0.0290
2000	0.0007	0.0038	0.0172	0.0439	0.0569	0.0568	0.0536	0.0502	0.0469	0.0438	0.0409	0.0382	0.0356	0.0333	0.0311
2001	0.0006	0.0030	0.0138	0.0350	0.0454	0.0453	0.0428	0.0400	0.0374	0.0349	0.0326	0.0305	0.0285	0.0266	0.0248
2002	0.0006	0.0033	0.0151	0.0384	0.0498	0.0497	0.0469	0.0439	0.0410	0.0383	0.0358	0.0334	0.0312	0.0291	0.0272
2003	0.0008	0.0043	0.0196	0.0499	0.0647	0.0645	0.0609	0.0570	0.0533	0.0497	0.0465	0.0434	0.0405	0.0378	0.0353
2004	0.0008	0.0042	0.0191	0.0486	0.0631	0.0629	0.0594	0.0556	0.0519	0.0485	0.0453	0.0423	0.0395	0.0369	0.0344
2005	0.0007	0.0037	0.0169	0.0430	0.0558	0.0557	0.0526	0.0492	0.0459	0.0429	0.0401	0.0374	0.0349	0.0326	0.0305
2006	0.0009	0.0051	0.0232	0.0590	0.0765	0.0763	0.0721	0.0674	0.0630	0.0588	0.0549	0.0513	0.0479	0.0447	0.0418
2007	0.0007	0.0039	0.0176	0.0448	0.0581	0.0579	0.0547	0.0512	0.0478	0.0447	0.0417	0.0390	0.0364	0.0340	0.0317
2008	0.0006	0.0034	0.0154	0.0391	0.0507	0.0506	0.0478	0.0447	0.0418	0.0390	0.0364	0.0340	0.0318	0.0297	0.0277
2009	0.0008	0.0045	0.0206	0.0525	0.0681	0.0679	0.0641	0.0600	0.0561	0.0524	0.0489	0.0457	0.0426	0.0398	0.0372
2010	0.0009	0.0048	0.0217	0.0552	0.0717	0.0715	0.0675	0.0632	0.0590	0.0551	0.0515	0.0481	0.0449	0.0419	0.0391
2011	0.0008	0.0046	0.0211	0.0536	0.0696	0.0695	0.0656	0.0614	0.0573	0.0535	0.0500	0.0467	0.0436	0.0407	0.0380
2012	0.0010	0.0053	0.0243	0.0618	0.0802	0.0800	0.0755	0.0706	0.0660	0.0616	0.0576	0.0538	0.0502	0.0469	0.0438
2013	0.0011	0.0058	0.0265	0.0673	0.0874	0.0871	0.0823	0.0770	0.0719	0.0672	0.0627	0.0586	0.0547	0.0511	0.0477
2014	0.0012	0.0067	0.0304	0.0774	0.1005	0.1002	0.0946	0.0885	0.0827	0.0772	0.0721	0.0673	0.0629	0.0587	0.0548
2015	0.0010	0.0055	0.0253	0.0643	0.0835	0.0833	0.0787	0.0736	0.0687	0.0642	0.0600	0.0560	0.0523	0.0488	0.0456
2016	0.0014	0.0075	0.0341	0.0866	0.1124	0.1121	0.1059	0.0991	0.0925	0.0864	0.0807	0.0754	0.0704	0.0657	0.0614
2017	0.0010	0.0052	0.0238	0.0605	0.0786	0.0783	0.0740	0.0692	0.0646	0.0604	0.0564	0.0527	0.0492	0.0459	0.0429
2018	0.0008	0.0044	0.0200	0.0508	0.0660	0.0658	0.0621	0.0581	0.0543	0.0507	0.0474	0.0442	0.0413	0.0386	0.0360
2019	0.0006	0.0035	0.0160	0.0407	0.0528	0.0527	0.0497	0.0465	0.0435	0.0406	0.0379	0.0354	0.0331	0.0309	0.0288
2020	0.0008	0.0031	0.0120	0.0366	0.0610	0.0567	0.0426	0.0306	0.0218	0.0155	0.0111	0.0079	0.0056	0.0040	0.0028
2021	0.0007	0.0026	0.0101	0.0309	0.0515	0.0478	0.0360	0.0259	0.0184	0.0131	0.0093	0.0066	0.0047	0.0034	0.0024
2022	0.0007	0.0026	0.0101	0.0307	0.0513	0.0476	0.0358	0.0257	0.0184	0.0131	0.0093	0.0066	0.0047	0.0034	0.0024
2023	0.0006	0.0025	0.0096	0.0293	0.0488	0.0454	0.0341	0.0245	0.0175	0.0124	0.0089	0.0063	0.0045	0.0032	0.0023

Table X5 cont.

Ocean Fishing Mortality-At-Age

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0058	0.0407	0.0950	0.1371	0.1608	0.1722	0.1775	0.1798	0.1808	0.1812	0.1814	0.1815	0.1815	0.1816
1983	0.0001	0.0047	0.0329	0.0768	0.1109	0.1300	0.1393	0.1436	0.1454	0.1462	0.1466	0.1468	0.1468	0.1468	0.1469
1984	0.0000	0.0019	0.0136	0.0318	0.0459	0.0538	0.0576	0.0594	0.0601	0.0605	0.0606	0.0607	0.0607	0.0607	0.0607
1985	0.0006	0.0047	0.0182	0.0429	0.0745	0.1059	0.1327	0.1533	0.1681	0.1783	0.1852	0.1897	0.1927	0.1946	0.1958
1986	0.0002	0.0013	0.0049	0.0116	0.0201	0.0286	0.0359	0.0414	0.0454	0.0482	0.0500	0.0513	0.0521	0.0526	0.0529
1987	0.0001	0.0008	0.0029	0.0068	0.0118	0.0168	0.0211	0.0243	0.0267	0.0283	0.0294	0.0301	0.0306	0.0309	0.0311
1988	0.0001	0.0009	0.0034	0.0080	0.0138	0.0196	0.0246	0.0284	0.0312	0.0330	0.0343	0.0352	0.0357	0.0361	0.0363
1989	0.0001	0.0012	0.0044	0.0104	0.0180	0.0256	0.0321	0.0371	0.0407	0.0432	0.0448	0.0459	0.0466	0.0471	0.0474
1990	0.0002	0.0010	0.0033	0.0078	0.0145	0.0225	0.0308	0.0386	0.0452	0.0506	0.0549	0.0582	0.0606	0.0624	0.0637
1991	0.0002	0.0014	0.0046	0.0111	0.0206	0.0320	0.0439	0.0549	0.0644	0.0721	0.0782	0.0828	0.0863	0.0888	0.0907
1992	0.0003	0.0016	0.0056	0.0134	0.0248	0.0386	0.0529	0.0661	0.0776	0.0869	0.0942	0.0998	0.1039	0.1070	0.1092
1993	0.0002	0.0013	0.0044	0.0105	0.0195	0.0303	0.0415	0.0519	0.0609	0.0682	0.0740	0.0783	0.0816	0.0840	0.0858
1994	0.0003	0.0017	0.0057	0.0137	0.0254	0.0395	0.0541	0.0677	0.0794	0.0889	0.0964	0.1021	0.1064	0.1095	0.1118
1995	0.0006	0.0031	0.0104	0.0249	0.0463	0.0720	0.0986	0.1233	0.1446	0.1619	0.1755	0.1859	0.1937	0.1994	0.2036
1996	0.0006	0.0035	0.0121	0.0288	0.0535	0.0832	0.1140	0.1426	0.1672	0.1873	0.2031	0.2151	0.2241	0.2307	0.2355
1997	0.0005	0.0042	0.0164	0.0387	0.0665	0.0934	0.1156	0.1322	0.1438	0.1516	0.1568	0.1601	0.1622	0.1636	0.1644
1998	0.0005	0.0045	0.0178	0.0420	0.0720	0.1012	0.1252	0.1432	0.1558	0.1643	0.1699	0.1735	0.1758	0.1772	0.1781
1999	0.0005	0.0041	0.0162	0.0384	0.0659	0.0925	0.1146	0.1310	0.1425	0.1503	0.1554	0.1587	0.1608	0.1621	0.1630
2000	0.0005	0.0041	0.0159	0.0376	0.0645	0.0906	0.1122	0.1283	0.1396	0.1472	0.1522	0.1554	0.1575	0.1588	0.1596
2001	0.0005	0.0042	0.0165	0.0390	0.0670	0.0941	0.1165	0.1332	0.1449	0.1528	0.1580	0.1613	0.1635	0.1648	0.1657
2002	0.0005	0.0045	0.0178	0.0420	0.0721	0.1013	0.1253	0.1433	0.1560	0.1644	0.1700	0.1736	0.1759	0.1774	0.1783
2003	0.0005	0.0047	0.0183	0.0432	0.0742	0.1043	0.1291	0.1476	0.1606	0.1693	0.1751	0.1788	0.1812	0.1827	0.1836
2004	0.0006	0.0053	0.0210	0.0495	0.0850	0.1194	0.1478	0.1690	0.1838	0.1938	0.2004	0.2046	0.2074	0.2091	0.2102
2005	0.0006	0.0054	0.0211	0.0498	0.0855	0.1201	0.1486	0.1700	0.1849	0.1950	0.2016	0.2058	0.2086	0.2103	0.2114
2006	0.0007	0.0062	0.0243	0.0575	0.0987	0.1387	0.1717	0.1963	0.2136	0.2252	0.2328	0.2378	0.2409	0.2429	0.2442
2007	0.0005	0.0046	0.0181	0.0427	0.0733	0.1030	0.1275	0.1458	0.1586	0.1673	0.1729	0.1766	0.1789	0.1804	0.1813
2008	0.0006	0.0051	0.0199	0.0471	0.0808	0.1135	0.1405	0.1607	0.1749	0.1844	0.1906	0.1947	0.1972	0.1989	0.1999
2009	0.0005	0.0046	0.0182	0.0431	0.0740	0.1039	0.1286	0.1471	0.1600	0.1687	0.1745	0.1781	0.1805	0.1820	0.1829
2010	0.0006	0.0056	0.0220	0.0520	0.0893	0.1254	0.1553	0.1775	0.1932	0.2037	0.2106	0.2150	0.2179	0.2197	0.2208
2011	0.0007	0.0058	0.0227	0.0536	0.0920	0.1292	0.1600	0.1829	0.1990	0.2099	0.2170	0.2216	0.2245	0.2264	0.2276
2012	0.0006	0.0055	0.0218	0.0515	0.0883	0.1241	0.1536	0.1756	0.1911	0.2015	0.2083	0.2127	0.2155	0.2173	0.2184
2013	0.0009	0.0080	0.0313	0.0738	0.1268	0.1781	0.2204	0.2521	0.2743	0.2892	0.2990	0.3053	0.3093	0.3119	0.3135
2014	0.0006	0.0057	0.0223	0.0527	0.0905	0.1271	0.1573	0.1799	0.1958	0.2064	0.2134	0.2179	0.2208	0.2226	0.2238
2015	0.0006	0.0050	0.0196	0.0463	0.0795	0.1117	0.1383	0.1582	0.1721	0.1814	0.1876	0.1915	0.1941	0.1957	0.1967
2016	0.0006	0.0055	0.0216	0.0510	0.0876	0.1230	0.1523	0.1742	0.1895	0.1998	0.2066	0.2109	0.2137	0.2155	0.2166
2017	0.0008	0.0070	0.0274	0.0648	0.1113	0.1563	0.1935	0.2213	0.2407	0.2538	0.2624	0.2680	0.2715	0.2738	0.2752
2018	0.0006	0.0050	0.0196	0.0463	0.0794	0.1115	0.1381	0.1579	0.1718	0.1812	0.1873	0.1913	0.1938	0.1954	0.1964
2019	0.0005	0.0045	0.0177	0.0417	0.0717	0.1006	0.1246	0.1425	0.1550	0.1635	0.1690	0.1726	0.1749	0.1763	0.1772
2020	0.0016	0.0047	0.0134	0.0337	0.0674	0.0975	0.1096	0.1089	0.1033	0.0966	0.0899	0.0835	0.0776	0.0720	0.0669
2021	0.0018	0.0052	0.0146	0.0369	0.0738	0.1068	0.1200	0.1192	0.1132	0.1058	0.0985	0.0915	0.0850	0.0789	0.0732
2022	0.0027	0.0078	0.0220	0.0556	0.1110	0.1606	0.1805	0.1793	0.1702	0.1591	0.1481	0.1376	0.1278	0.1186	0.1101
2023	0.0022	0.0064	0.0181	0.0458	0.0914	0.1323	0.1487	0.1477	0.1402	0.1311	0.1220	0.1133	0.1053	0.0977	0.0907

Table X5 cont.

Total Fishing Mortality-At-Age

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0002	0.0133	0.1002	0.1207	0.1473	0.1648	0.1739	0.1781	0.1800	0.1809	0.1813	0.1814	0.1815	0.1816	0.1829
1983	0.0001	0.0127	0.0963	0.1042	0.1218	0.1344	0.1410	0.1442	0.1457	0.1463	0.1466	0.1468	0.1468	0.1469	0.1483
1984	0.0001	0.0095	0.0734	0.0576	0.0561	0.0579	0.0592	0.0600	0.0604	0.0606	0.0607	0.0607	0.0607	0.0607	0.0621
1985	0.0006	0.0058	0.0218	0.0462	0.0772	0.1082	0.1347	0.1550	0.1695	0.1795	0.1862	0.1906	0.1934	0.1952	0.1964
1986	0.0002	0.0031	0.0108	0.0169	0.0246	0.0324	0.0391	0.0442	0.0478	0.0502	0.0517	0.0527	0.0533	0.0536	0.0538
1987	0.0001	0.0015	0.0053	0.0090	0.0137	0.0184	0.0224	0.0255	0.0277	0.0291	0.0301	0.0307	0.0311	0.0313	0.0315
1988	0.0002	0.0023	0.0079	0.0120	0.0172	0.0225	0.0271	0.0305	0.0329	0.0346	0.0356	0.0363	0.0366	0.0369	0.0370
1989	0.0002	0.0025	0.0090	0.0145	0.0215	0.0286	0.0347	0.0393	0.0425	0.0447	0.0461	0.0470	0.0476	0.0479	0.0481
1990	0.0004	0.0020	0.0085	0.0293	0.0544	0.0574	0.0555	0.0555	0.0568	0.0585	0.0603	0.0618	0.0631	0.0641	0.0648
1991	0.0005	0.0025	0.0104	0.0347	0.0645	0.0704	0.0710	0.0735	0.0771	0.0808	0.0841	0.0868	0.0890	0.0907	0.0920
1992	0.0005	0.0029	0.0121	0.0399	0.0741	0.0817	0.0833	0.0870	0.0918	0.0966	0.1008	0.1043	0.1070	0.1091	0.1107
1993	0.0004	0.0024	0.0099	0.0329	0.0612	0.0668	0.0673	0.0696	0.0730	0.0765	0.0796	0.0822	0.0842	0.0858	0.0870
1994	0.0006	0.0031	0.0129	0.0429	0.0797	0.0870	0.0877	0.0907	0.0951	0.0997	0.1037	0.1071	0.1098	0.1118	0.1134
1995	0.0009	0.0051	0.0208	0.0672	0.1250	0.1407	0.1472	0.1567	0.1674	0.1775	0.1862	0.1932	0.1987	0.2028	0.2059
1996	0.0013	0.0072	0.0286	0.0709	0.1082	0.1378	0.1655	0.1908	0.2122	0.2293	0.2423	0.2517	0.2583	0.2626	0.2654
1997	0.0012	0.0081	0.0343	0.0844	0.1257	0.1525	0.1714	0.1844	0.1926	0.1972	0.1993	0.1998	0.1993	0.1982	0.1968
1998	0.0011	0.0079	0.0334	0.0817	0.1236	0.1526	0.1738	0.1886	0.1982	0.2039	0.2069	0.2080	0.2080	0.2073	0.2063
1999	0.0011	0.0077	0.0323	0.0793	0.1190	0.1455	0.1646	0.1778	0.1863	0.1911	0.1935	0.1943	0.1940	0.1932	0.1920
2000	0.0012	0.0078	0.0332	0.0814	0.1215	0.1474	0.1658	0.1785	0.1865	0.1910	0.1930	0.1936	0.1931	0.1920	0.1907
2001	0.0010	0.0072	0.0303	0.0740	0.1124	0.1394	0.1593	0.1732	0.1823	0.1877	0.1906	0.1918	0.1919	0.1914	0.1905
2002	0.0011	0.0078	0.0329	0.0804	0.1219	0.1509	0.1722	0.1872	0.1969	0.2027	0.2058	0.2070	0.2071	0.2065	0.2055
2003	0.0013	0.0090	0.0379	0.0931	0.1390	0.1688	0.1900	0.2046	0.2139	0.2191	0.2215	0.2222	0.2217	0.2205	0.2189
2004	0.0014	0.0095	0.0401	0.0981	0.1481	0.1823	0.2072	0.2245	0.2358	0.2423	0.2457	0.2469	0.2468	0.2460	0.2446
2005	0.0013	0.0091	0.0380	0.0928	0.1413	0.1757	0.2012	0.2191	0.2308	0.2379	0.2416	0.2433	0.2435	0.2429	0.2419
2006	0.0016	0.0113	0.0475	0.1165	0.1753	0.2150	0.2437	0.2637	0.2766	0.2840	0.2878	0.2891	0.2888	0.2877	0.2860
2007	0.0012	0.0085	0.0357	0.0875	0.1314	0.1609	0.1822	0.1970	0.2064	0.2119	0.2146	0.2155	0.2153	0.2144	0.2131
2008	0.0012	0.0084	0.0353	0.0862	0.1316	0.1641	0.1883	0.2054	0.2166	0.2234	0.2270	0.2287	0.2290	0.2285	0.2276
2009	0.0014	0.0092	0.0389	0.0956	0.1421	0.1718	0.1928	0.2071	0.2161	0.2211	0.2233	0.2238	0.2231	0.2218	0.2201
2010	0.0015	0.0104	0.0437	0.1072	0.1610	0.1969	0.2228	0.2407	0.2522	0.2588	0.2620	0.2631	0.2628	0.2616	0.2600
2011	0.0015	0.0104	0.0438	0.1072	0.1616	0.1987	0.2256	0.2443	0.2564	0.2634	0.2670	0.2683	0.2681	0.2671	0.2656
2012	0.0016	0.0109	0.0461	0.1132	0.1685	0.2040	0.2291	0.2463	0.2571	0.2631	0.2659	0.2665	0.2657	0.2642	0.2622
2013	0.0020	0.0138	0.0577	0.1412	0.2142	0.2652	0.3027	0.3291	0.3462	0.3563	0.3617	0.3639	0.3640	0.3630	0.3612
2014	0.0019	0.0123	0.0527	0.1301	0.1909	0.2273	0.2519	0.2684	0.2784	0.2836	0.2855	0.2853	0.2837	0.2814	0.2786
2015	0.0016	0.0105	0.0449	0.1107	0.1631	0.1950	0.2169	0.2317	0.2408	0.2456	0.2475	0.2475	0.2464	0.2445	0.2423
2016	0.0020	0.0130	0.0556	0.1376	0.2000	0.2351	0.2582	0.2732	0.2820	0.2862	0.2873	0.2863	0.2841	0.2812	0.2780
2017	0.0017	0.0122	0.0512	0.1253	0.1898	0.2346	0.2674	0.2905	0.3054	0.3142	0.3188	0.3206	0.3207	0.3197	0.3181
2018	0.0014	0.0094	0.0396	0.0971	0.1454	0.1773	0.2002	0.2160	0.2261	0.2319	0.2346	0.2355	0.2351	0.2340	0.2324
2019	0.0012	0.0080	0.0337	0.0824	0.1245	0.1533	0.1743	0.1890	0.1985	0.2041	0.2069	0.2080	0.2079	0.2072	0.2061
2020	0.0024	0.0079	0.0254	0.0703	0.1284	0.1542	0.1522	0.1395	0.1252	0.1122	0.1010	0.0914	0.0832	0.0760	0.0697
2021	0.0024	0.0078	0.0247	0.0678	0.1252	0.1546	0.1560	0.1451	0.1316	0.1189	0.1078	0.0981	0.0897	0.0822	0.0756
2022	0.0033	0.0104	0.0321	0.0863	0.1622	0.2082	0.2163	0.2050	0.1885	0.1722	0.1574	0.1442	0.1325	0.1220	0.1125
2023	0.0028	0.0089	0.0277	0.0750	0.1402	0.1777	0.1828	0.1722	0.1577	0.1435	0.1308	0.1196	0.1097	0.1009	0.0930

Table X6. Estimates of age-specific population abundance, 1982-2023

	Age																
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	8+
1982	38,296,700	8,340,660	3,115,980	2,426,610	963,810	401,321	330,477	216,139	186,669	274,688	192,524	317,028	149,222	107,118	271,568	55,590,514	1,714,956
1983	77,301,100	12,369,200	4,169,560	1,797,470	1,546,240	647,793	281,447	239,054	155,683	134,197	197,304	138,235	227,592	107,118	271,568	99,583,561	1,470,751
1984	63,603,600	24,967,300	6,187,210	2,414,570	1,164,360	1,066,130	468,347	210,378	178,120	115,831	99,780	146,659	102,739	169,141	281,139	101,175,304	1,303,787
1985	69,323,200	20,543,900	12,528,700	3,665,860	1,638,700	857,300	832,081	379,925	170,528	144,325	93,837	80,826	118,796	83,219	364,422	110,825,618	1,435,877
1986	68,551,600	22,380,000	10,347,300	7,816,770	2,516,570	1,181,390	636,221	625,945	280,064	123,888	103,808	67,044	57,496	84,268	316,665	115,089,028	1,659,177
1987	73,855,100	22,139,800	11,303,200	6,526,960	5,525,510	1,912,230	945,774	526,600	515,473	229,810	101,413	84,844	54,743	46,919	327,025	124,095,401	1,886,827
1988	93,137,700	23,854,900	11,199,600	7,168,980	4,650,280	4,244,760	1,552,510	795,995	441,849	431,571	192,121	84,700	70,817	45,675	311,899	148,183,357	2,374,627
1989	107,221,000	30,082,100	12,058,200	7,085,350	5,092,510	3,559,770	3,431,990	1,300,570	664,531	367,979	358,835	159,575	70,306	58,760	296,602	171,808,078	3,277,158
1990	131,811,000	34,629,800	15,201,400	7,619,980	5,020,450	3,881,590	2,860,740	2,853,350	1,076,320	548,160	302,872	294,925	131,036	57,700	291,511	206,580,834	5,555,874
1991	105,317,000	42,563,900	17,509,300	9,610,570	5,320,270	3,703,030	3,030,900	2,329,310	2,323,360	875,273	444,983	245,433	238,626	105,888	281,733	193,899,576	6,844,606
1992	109,903,000	34,005,600	21,510,000	11,048,600	6,673,720	3,884,710	2,854,100	2,429,860	1,862,780	1,851,380	694,893	352,112	193,677	187,896	304,426	197,756,754	7,877,024
1993	134,808,000	35,483,600	17,177,800	13,550,600	7,632,850	4,826,460	2,960,610	2,260,120	1,917,080	1,462,640	1,446,750	540,734	273,050	149,781	379,574	224,869,649	8,429,729
1994	286,886,000	43,528,800	17,934,200	10,845,200	9,426,270	5,591,480	3,733,410	2,382,280	1,814,440	1,533,890	1,166,220	1,149,960	428,695	216,031	417,795	387,054,671	9,109,311
1995	187,595,000	92,621,500	21,984,800	11,289,000	7,469,600	6,778,730	4,238,710	2,943,530	1,872,610	1,420,010	1,195,010	904,883	889,256	330,622	487,318	342,020,579	10,043,239
1996	234,759,000	60,543,300	46,685,800	13,729,600	7,588,290	5,134,020	4,869,770	3,148,820	2,166,160	1,363,390	1,023,450	853,845	642,024	627,496	573,716	383,708,681	10,398,901
1997	259,536,000	75,736,800	30,453,100	28,928,700	9,194,840	5,303,680	3,699,220	3,552,200	2,239,550	1,507,950	933,003	691,345	571,367	426,812	794,049	423,568,616	10,716,276
1998	148,101,000	83,739,100	38,059,900	18,762,400	19,115,000	6,314,940	3,765,770	2,682,500	2,542,610	1,589,960	1,065,640	657,939	487,280	402,920	862,693	328,149,652	10,291,542
1999	153,117,000	47,787,400	42,088,100	23,471,800	12,431,100	13,156,400	4,483,340	2,724,240	1,911,960	1,794,920	1,116,050	745,814	459,946	340,639	885,983	306,514,692	9,979,552
2000	124,771,000	49,407,000	24,025,200	25,982,800	15,587,900	8,595,090	9,406,450	3,273,240	1,962,810	1,365,980	1,276,130	791,583	528,578	326,059	871,073	268,170,893	10,395,453
2001	196,937,000	40,258,900	24,835,300	14,819,600	17,218,600	10,751,400	6,133,630	6,859,180	2,356,830	1,402,040	971,340	905,555	561,425	375,065	851,196	325,237,061	14,282,631
2002	222,073,000	63,551,900	20,249,200	15,363,400	9,894,030	11,983,900	7,734,110	4,502,030	4,964,740	1,690,470	1,000,200	690,961	643,403	398,847	872,159	365,612,350	14,762,810
2003	127,874,000	71,657,000	31,945,400	12,494,100	10,192,300	6,821,200	8,521,970	5,603,520	3,213,330	3,509,300	1,188,020	700,782	483,519	450,197	890,486	285,545,124	16,039,154
2004	304,610,000	41,253,500	35,979,100	19,611,800	8,183,900	6,908,030	4,764,720	6,065,590	3,930,510	2,233,230	2,426,230	819,350	483,009	333,429	926,560	438,528,958	17,217,908
2005	158,237,000	98,264,700	20,701,700	22,040,600	12,782,000	5,496,480	4,760,860	3,333,710	4,170,720	2,672,520	1,508,510	1,633,380	550,916	324,795	848,863	337,326,754	15,043,414
2006	136,369,000	51,050,300	49,333,200	12,708,200	14,441,600	8,643,100	3,812,990	3,351,020	2,304,740	2,849,820	1,813,320	1,019,680	1,102,310	371,699	792,924	289,963,903	13,605,513
2007	89,174,400	43,980,000	25,573,000	29,996,600	8,131,870	9,439,080	5,764,880	2,572,010	2,215,620	1,504,410	1,846,370	1,170,450	657,328	710,764	752,687	223,489,469	11,429,639
2008	129,419,000	28,771,100	22,093,400	15,734,700	19,759,200	5,553,150	6,645,480	4,135,400	1,817,940	1,551,300	1,047,590	1,282,230	812,096	456,184	1,017,250	240,096,020	12,119,990
2009	76,363,900	41,756,900	14,453,400	13,598,900	10,378,100	13,491,400	3,897,170	4,738,050	2,898,430	1,259,980	1,067,930	718,532	878,045	555,924	1,009,760	187,066,421	13,126,651
2010	99,619,400	24,634,800	20,961,800	8,864,620	8,885,580	7,011,960	9,395,570	2,766,250	3,315,250	2,009,910	869,367	735,198	494,433	604,596	1,080,680	191,249,414	11,875,684
2011	128,567,000	32,132,100	12,351,800	12,794,000	5,724,910	5,891,090	4,762,210	6,471,910	1,871,580	2,217,460	1,335,500	575,780	486,408	327,226	1,117,810	216,626,784	14,403,674
2012	200,280,000	41,469,200	16,110,300	7,538,550	8,262,610	3,793,100	3,993,930	3,271,220	4,363,080	1,246,620	1,466,630	880,152	378,977	320,202	953,348	294,327,919	12,880,229
2013	68,928,800	64,593,800	20,782,000	9,810,020	4,839,520	5,437,030	2,557,870	2,733,820	2,200,970	2,904,070	824,754	967,648	580,355	250,074	842,900	188,253,631	11,304,591
2014	85,838,800	22,222,800	32,277,300	12,508,100	6,124,220	3,042,450	3,448,870	1,626,560	1,693,240	1,340,080	1,750,270	494,423	578,823	347,095	655,249	173,948,280	8,485,740
2015	157,070,000	27,677,400	11,120,300	19,523,800	7,895,460	3,940,520	2,004,520	2,307,400	1,070,410	1,103,200	868,587	1,132,320	319,941	375,144	652,306	237,061,308	7,829,308
2016	229,985,000	50,659,100	13,874,900	6,779,290	12,565,700	5,223,860	2,681,360	1,388,840	1,575,220	724,153	742,744	583,678	760,896	215,246	693,483	328,453,470	6,684,260
2017	111,203,000	74,145,700	25,334,400	8,368,210	4,247,160	8,012,180	3,414,780	1,782,770	909,619	1,022,650	468,159	479,672	377,310	492,949	591,874	240,850,433	6,125,003
2018	129,634,000	35,859,800	37,108,200	15,347,400	5,307,490	2,735,810	5,240,150	2,249,410	1,147,640	576,892	642,876	292,950	299,608	235,655	678,816	237,356,697	6,123,847
2019	164,809,000	41,819,100	17,997,900	22,743,500	10,012,800	3,574,150	1,894,770	3,691,900	1,559,920	787,898	393,781	437,601	199,243	203,851	623,609	270,749,023	7,897,803
2020	124,284,000	53,177,800	21,017,400	11,096,100	15,057,100	6,885,270	2,535,560	1,369,940	2,630,370	1,100,920	552,977	275,583	305,924	139,297	579,418	241,007,659	6,954,429
2021	86,716,700	40,051,700	26,729,600	13,065,800	7,435,710	10,313,700	4,880,090	1,874,220	1,025,570	1,997,590	847,029	430,241	216,477	242,295	576,241	196,402,963	7,209,663
2022	76,653,000	27,944,400	20,132,600	16,627,000	8,777,720	5,109,230	7,307,150	3,593,770	1,395,330	773,887	1,526,580	654,555	335,705	170,342	651,928	171,653,197	9,102,097
2023	94,898,600	24,679,400	14,010,100	12,431,900	10,965,600	5,812,440	3,430,900	5,066,100	2,519,770	994,613	560,736	1,122,630	487,738	253,097	631,181	177,864,805	11,635,865

Table X7. Estimates of female spawning stock biomass, 1982-2023.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	0	0	0	139	357	406	892	836	890	2,001	1,864	3,141	1,838	1,474	4,345	18,183.4
1983	0	0	0	97	546	535	610	844	765	877	1,642	1,319	2,572	1,398	4,054	15,259.6
1984	0	0	0	142	439	903	1,236	733	946	734	747	1,588	1,190	2,252	4,393	15,302.9
1985	0	0	0	255	555	777	2,144	1,376	909	902	722	737	1,346	1,038	5,128	15,889.3
1986	0	0	0	642	934	924	1,426	2,144	1,271	675	717	561	544	890	3,606	14,335.3
1987	0	0	0	509	2,293	1,460	1,917	1,632	2,324	1,246	668	721	523	498	4,043	17,832.9
1988	0	0	0	547	2,206	4,154	3,573	2,396	1,885	2,107	1,385	753	695	495	3,865	24,060.2
1989	0	0	0	555	2,342	4,024	9,970	5,070	3,144	2,454	2,571	1,384	731	659	3,781	36,685.0
1990	0	0	0	574	1,945	3,839	7,989	11,305	5,224	2,857	2,105	2,447	1,192	584	3,173	43,233.3
1991	0	0	0	743	2,188	2,971	7,980	8,643	12,225	4,637	3,364	1,814	2,217	1,073	3,249	51,103.9
1992	0	0	0	806	2,931	3,571	7,259	9,135	10,208	12,346	5,432	3,737	2,179	2,444	4,937	64,984.7
1993	0	0	0	1,016	3,225	4,438	7,703	8,904	10,674	9,828	11,892	5,200	3,163	1,929	5,443	73,415.9
1994	0	0	0	879	4,092	5,027	9,844	9,420	9,965	9,842	9,672	10,910	4,689	2,646	5,775	82,759.6
1995	0	0	0	963	3,244	6,300	11,777	11,589	10,775	10,129	8,017	7,972	9,037	3,712	5,997	89,513.4
1996	0	0	0	1,159	3,691	5,563	15,528	14,055	13,072	10,120	8,305	7,223	6,729	7,259	7,534	100,240.4
1997	0	0	0	2,604	4,085	5,070	9,576	12,853	12,553	11,404	8,062	6,255	6,237	5,294	11,374	95,367.1
1998	0	0	0	1,169	7,296	4,979	9,508	9,658	13,221	9,485	7,636	5,882	4,847	4,562	10,785	89,027.4
1999	0	0	0	1,345	3,782	8,700	8,371	9,075	9,937	11,685	8,157	6,223	4,805	4,023	12,441	88,543.2
2000	0	0	0	1,467	4,693	5,905	18,824	10,121	10,521	8,400	10,412	7,280	5,860	4,194	13,428	101,106.2
2001	0	0	0	962	5,688	8,342	13,167	21,784	11,659	9,173	7,161	7,071	5,498	4,164	10,229	104,898.3
2002	0	0	0	896	3,387	9,394	17,445	15,469	23,482	10,502	7,748	5,912	6,368	4,587	11,888	117,078.5
2003	0	0	0	678	3,381	5,357	18,761	18,557	15,644	20,705	8,672	5,898	4,784	5,082	11,409	118,926.8
2004	0	0	0	1,049	2,867	5,315	10,573	19,852	18,775	13,074	16,958	6,564	4,597	3,596	11,341	114,561.9
2005	0	0	0	1,272	4,188	4,463	10,571	11,682	20,661	15,781	10,836	13,995	5,467	3,667	11,206	113,787.1
2006	0	0	0	682	4,468	6,140	7,986	11,263	12,050	17,312	13,086	8,385	11,163	4,267	10,538	107,340.6
2007	0	0	0	1,441	2,535	7,003	12,783	8,484	11,756	9,721	14,460	10,269	6,981	8,699	10,897	105,029.4
2008	0	0	0	843	6,188	4,593	16,971	14,403	9,413	10,485	8,178	11,235	8,561	5,500	13,949	110,318.3
2009	0	0	0	739	3,065	10,765	9,392	17,701	15,444	8,045	8,186	6,097	8,945	6,471	13,349	108,198.2
2010	0	0	0	480	2,681	5,493	21,452	9,300	16,605	12,771	6,617	5,992	4,886	6,836	13,939	107,052.7
2011	0	0	0	758	1,734	4,381	10,584	21,232	9,299	13,616	9,474	5,028	4,844	3,755	14,918	99,622.6
2012	0	0	0	464	2,844	2,939	9,231	11,766	21,995	8,280	11,164	7,759	4,055	3,876	13,531	97,903.2
2013	0	0	0	521	1,673	4,465	5,644	9,203	11,534	17,893	6,482	8,677	6,214	3,063	11,985	87,352.8
2014	0	0	0	614	1,946	2,326	7,919	5,413	8,996	9,075	13,434	4,961	6,779	4,693	10,728	76,881.8
2015	0	0	0	1,115	2,754	3,464	4,728	8,197	5,696	7,077	6,755	10,380	3,549	4,698	9,107	67,520.2
2016	0	0	0	325	4,153	4,413	6,828	5,227	8,579	5,167	6,124	5,556	8,892	2,867	11,079	69,211.1
2017	0	0	0	462	1,467	6,360	8,086	6,136	4,652	7,084	3,918	4,550	4,373	6,579	8,769	62,435.9
2018	0	0	0	824	1,721	2,414	11,216	7,612	6,465	4,062	5,707	3,185	3,505	3,013	11,084	60,808.2
2019	0	0	0	1,199	3,163	2,746	4,354	13,766	8,865	5,681	3,464	4,563	2,617	2,720	9,407	62,544.0
2020	0	0	0	680	4,704	4,878	5,894	5,326	14,420	8,035	5,001	2,943	3,744	1,824	8,471	65,920.7
2021	0	0	0	751	2,624	6,967	10,210	6,357	4,888	13,744	5,178	4,279	2,727	3,188	8,877	69,791.5
2022	0	0	0	1,091	3,169	4,691	16,560	11,572	7,346	4,766	12,719	5,946	4,005	2,161	9,865	83,892.4
2023	0	0	0	844	4,153	5,059	8,491	16,700	12,354	5,919	4,780	10,799	5,570	3,289	8,576	86,535.7

Table x8. Estimate of total female spawning stock biomass with associated standard errors and coefficients of variation.

Year	Total	SE	CV
1982	18,183	2,616	0.144
1983	15,260	2,314	0.152
1984	15,303	2,308	0.151
1985	15,889	2,234	0.141
1986	14,335	1,905	0.133
1987	17,833	2,097	0.118
1988	24,060	2,377	0.099
1989	36,685	3,104	0.085
1990	43,233	3,296	0.076
1991	51,104	3,701	0.072
1992	64,985	4,700	0.072
1993	73,416	5,099	0.069
1994	82,760	5,430	0.066
1995	89,513	5,595	0.062
1996	100,240	6,380	0.064
1997	95,367	6,515	0.068
1998	89,027	5,639	0.063
1999	88,543	5,610	0.063
2000	101,106	6,067	0.060
2001	104,898	5,742	0.055
2002	117,078	6,351	0.054
2003	118,927	6,451	0.054
2004	114,562	6,391	0.056
2005	113,787	6,596	0.058
2006	107,340	6,452	0.060
2007	105,029	6,530	0.062
2008	110,318	6,475	0.059
2009	108,198	6,214	0.057
2010	107,053	6,046	0.056
2011	99,623	5,914	0.059
2012	97,903	6,148	0.063
2013	87,353	5,977	0.068
2014	76,882	6,046	0.079
2015	67,520	5,519	0.082
2016	69,211	5,925	0.086
2017	62,436	5,676	0.091
2018	60,808	5,963	0.098
2019	62,544	6,198	0.099
2020	65,921	6,516	0.099
2021	69,792	6,982	0.100
2022	83,892	8,420	0.100
2023	86,536	9,309	0.108

Table x9 . Estimates of exploitable biomass, 1982-2023.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	2,420	4,405	3,030	3,012	2,000	1,501	1,515	1,228	1,013	2,271	2,120	3,381	1,940	1,527	4,649	36,012
1983	8,926	3,307	3,234	2,197	2,954	1,828	1,058	1,216	918	951	1,798	1,464	2,677	1,471	4,323	38,323
1984	9,575	8,649	5,965	2,980	2,227	3,022	1,913	971	1,072	791	824	1,614	1,191	2,279	4,644	47,716
1985	1,349	7,861	10,039	6,140	3,087	2,654	3,395	1,999	1,055	1,024	784	766	1,462	1,100	5,495	48,210
1986	4,092	4,139	9,107	12,526	5,065	3,088	2,396	3,117	1,526	795	789	609	588	963	3,809	52,610
1987	6,925	7,269	10,133	10,685	13,535	5,095	3,174	2,279	2,722	1,366	698	739	534	502	4,261	69,914
1988	17,645	10,177	10,307	11,978	11,932	13,457	5,543	3,279	2,202	2,404	1,434	761	719	506	4,077	96,420
1989	7,274	15,259	12,705	11,097	12,535	13,383	15,946	6,794	3,541	2,482	2,544	1,459	758	670	3,992	110,437
1990	3,110	13,068	14,787	12,051	11,493	13,288	13,492	16,142	6,414	3,292	2,434	2,657	1,266	626	3,355	117,474
1991	12,201	11,547	18,761	15,116	12,330	10,107	13,009	12,258	14,416	5,220	3,344	1,929	2,287	1,095	3,446	137,067
1992	3,987	12,945	23,614	17,433	16,480	12,046	11,249	12,823	11,671	13,434	5,426	3,820	2,049	2,340	5,245	154,561
1993	2,437	9,782	16,332	21,879	17,648	15,308	12,426	12,367	12,231	10,921	12,750	5,544	3,367	2,036	5,770	160,797
1994	40,316	11,801	20,325	18,453	22,449	17,410	15,700	12,996	11,696	11,160	10,296	11,607	4,855	2,753	6,137	217,954
1995	27,125	37,964	26,175	21,668	18,481	21,863	18,393	16,238	12,572	11,022	9,022	8,805	9,625	3,967	6,433	249,353
1996	15,618	32,828	47,358	24,298	20,136	18,166	23,518	19,475	15,025	11,150	9,295	7,466	6,903	7,499	8,130	266,864
1997	13,863	22,314	33,897	55,012	23,477	18,186	16,702	20,219	15,492	12,761	8,922	6,750	6,366	5,465	12,189	271,614
1998	38,022	26,494	32,829	25,941	44,971	18,182	15,559	13,553	14,951	10,936	8,989	6,517	5,129	4,913	11,569	278,555
1999	100,793	28,312	38,911	30,855	21,867	31,266	14,115	13,232	11,650	13,133	8,723	6,491	4,936	4,091	13,325	341,699
2000	45,554	28,851	23,905	32,963	26,188	19,841	29,393	13,537	11,738	9,498	11,136	7,633	5,880	4,250	14,381	284,748
2001	22,637	15,096	19,492	20,561	30,823	27,135	20,796	30,311	13,410	10,434	7,756	8,120	5,928	4,557	10,955	248,011
2002	11,918	14,154	12,851	19,980	19,325	31,719	28,540	21,392	27,315	11,722	8,417	6,345	6,290	4,651	12,751	237,371
2003	7,039	19,228	17,786	15,220	18,577	18,016	30,723	26,156	18,579	23,123	9,523	6,478	4,994	5,368	12,253	233,063
2004	47,517	7,494	25,543	23,205	15,095	18,070	17,343	27,926	22,082	14,718	18,620	7,178	4,810	3,796	12,212	265,608
2005	12,032	33,323	12,697	25,869	22,534	15,399	17,165	16,109	23,953	17,680	11,742	14,773	5,565	3,765	12,062	244,670
2006	15,355	11,347	31,396	15,765	25,892	21,549	13,429	15,847	14,168	19,595	14,262	9,120	11,713	4,472	11,394	235,302
2007	4,204	12,655	15,284	30,781	13,692	23,154	20,027	11,625	13,452	10,903	15,401	10,907	7,028	8,878	11,697	209,688
2008	15,817	6,103	15,281	18,243	32,957	14,990	26,166	20,153	10,846	11,703	8,892	12,313	8,863	5,788	14,994	223,109
2009	12,100	15,067	9,840	16,468	17,196	35,798	15,383	25,510	17,833	9,061	9,110	6,703	9,270	6,813	14,339	220,490
2010	8,841	10,510	17,390	10,683	14,884	17,757	35,216	13,379	19,889	14,571	7,239	6,601	5,067	7,199	15,032	204,257
2011	16,598	9,268	10,539	16,782	9,614	14,585	17,623	30,290	10,816	15,247	10,577	5,448	4,955	3,906	16,097	192,343
2012	6,474	12,849	11,675	9,935	15,601	9,671	14,770	16,062	25,330	9,098	12,115	8,132	4,168	3,990	14,596	174,464
2013	7,698	12,789	14,107	11,624	9,423	15,160	9,383	13,262	13,804	20,453	7,235	9,406	6,519	3,232	13,057	167,149
2014	54,674	7,184	21,315	13,811	10,587	8,032	13,118	7,619	10,306	10,064	14,563	5,192	6,872	4,765	11,591	199,693
2015	13,915	10,433	7,910	23,225	14,069	11,189	7,500	11,387	6,506	8,088	7,545	11,132	3,818	5,061	9,804	151,582
2016	23,268	12,866	6,599	7,270	23,341	15,230	11,317	7,295	9,984	5,710	6,523	5,852	9,049	2,913	11,970	159,185
2017	13,932	21,180	17,104	9,319	7,493	21,376	13,298	8,953	5,651	7,955	4,373	4,995	4,569	6,959	9,511	156,668
2018	20,188	12,622	25,451	18,562	9,698	8,168	18,766	10,885	7,242	4,362	6,127	3,294	3,584	3,185	11,920	164,056
2019	19,877	15,467	14,761	26,449	17,126	9,178	7,312	18,207	9,847	6,375	3,779	4,907	2,728	2,843	10,090	168,946
2020	32,140	17,637	15,947	14,986	25,571	16,805	9,425	7,069	17,069	8,962	5,322	3,084	3,851	1,960	8,964	188,790
2021	5,098	15,860	19,423	16,242	14,388	24,272	16,300	8,999	6,123	15,055	6,282	4,642	2,804	3,330	9,398	168,215
2022	7,116	6,845	15,373	22,218	17,029	15,375	25,345	16,171	8,360	5,094	13,779	5,605	4,061	2,314	10,483	175,169
2023	29,297	7,682	11,252	18,245	23,408	17,128	14,286	24,161	14,238	6,843	5,002	11,518	5,836	3,453	9,095	201,445

Table X10. Reference points and probability of female spawning stock biomass being greater or equal to the SSB target and SSBthreshold over a six-year projection under the current fully-recruited 2023 F, Ftarget and Fthreshold.

	Reference Points	
	SSB	F
Target	111,891.8	0.1707
Threshold	89,513.4	0.2064
Current	86,535.7	0.1828

	Current F		Ftarget		Fthreshold	
Year	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget
2023	0.333	0.001	0.334	0.000	0.328	0.000
2024	0.756	0.016	0.771	0.018	0.756	0.016
2025	0.880	0.459	0.910	0.062	0.820	0.031
2026	0.913	0.073	0.952	0.111	0.802	0.029
2027	0.915	0.077	0.960	0.141	0.745	0.021
2028	0.894	0.066	0.958	0.138	0.632	0.011
2029	0.854	0.051	0.951	0.131	0.533	0.007

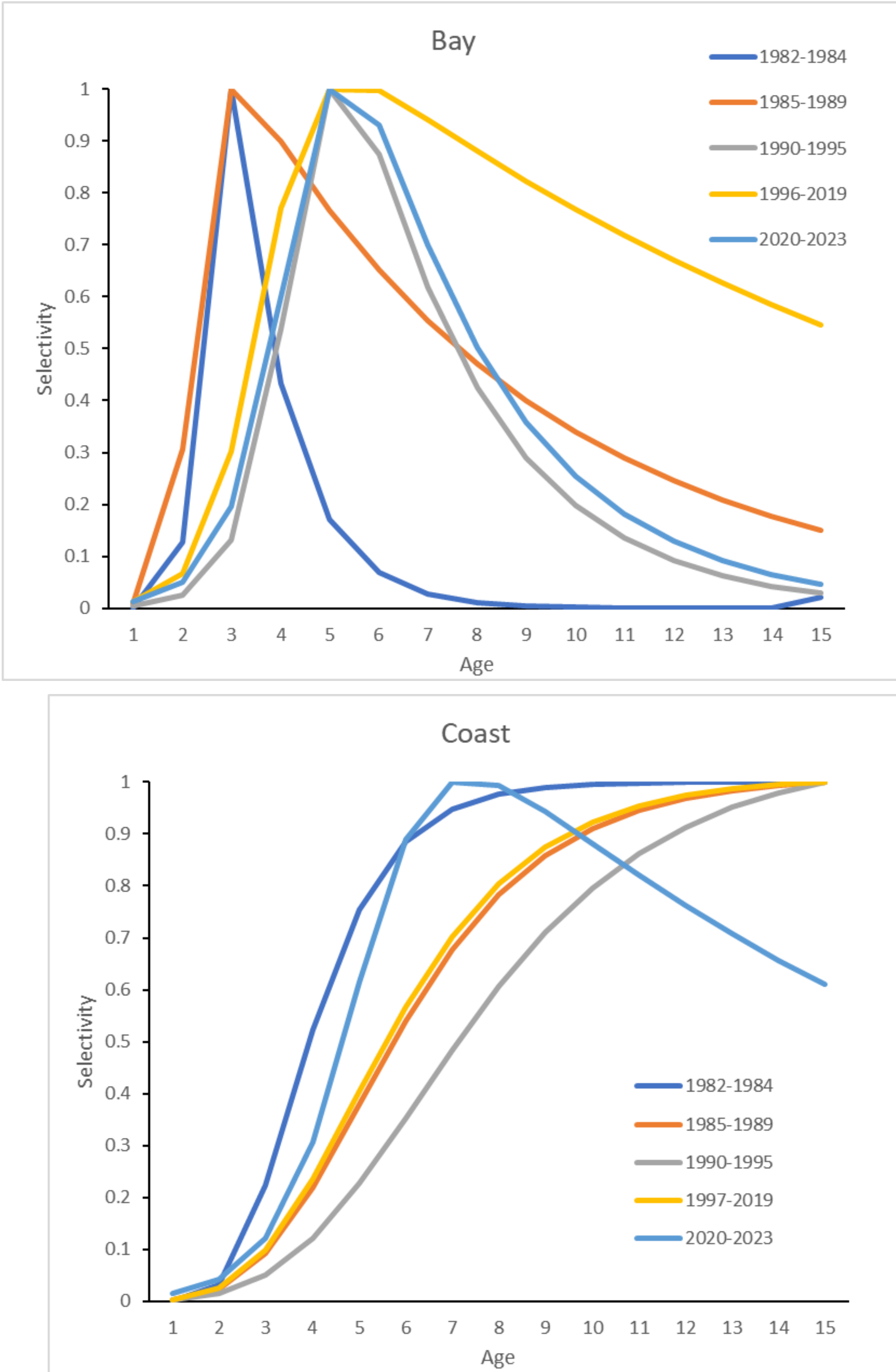


Figure 1. Estimates of selectivity patterns for the five Bay and Ocean time blocks.

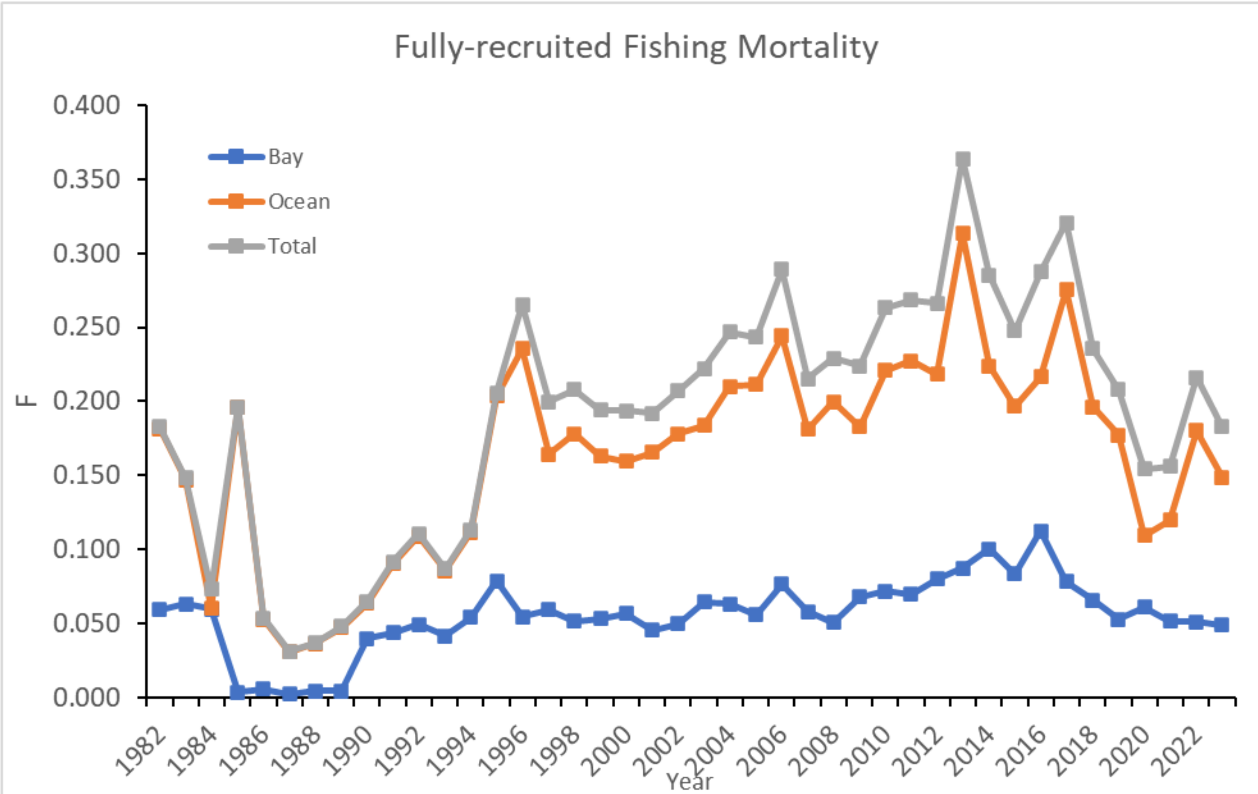


Figure 2. Estimates of region-specific and total fully-recruited fishing mortality in the Bay and Ocean, 1982-2023.

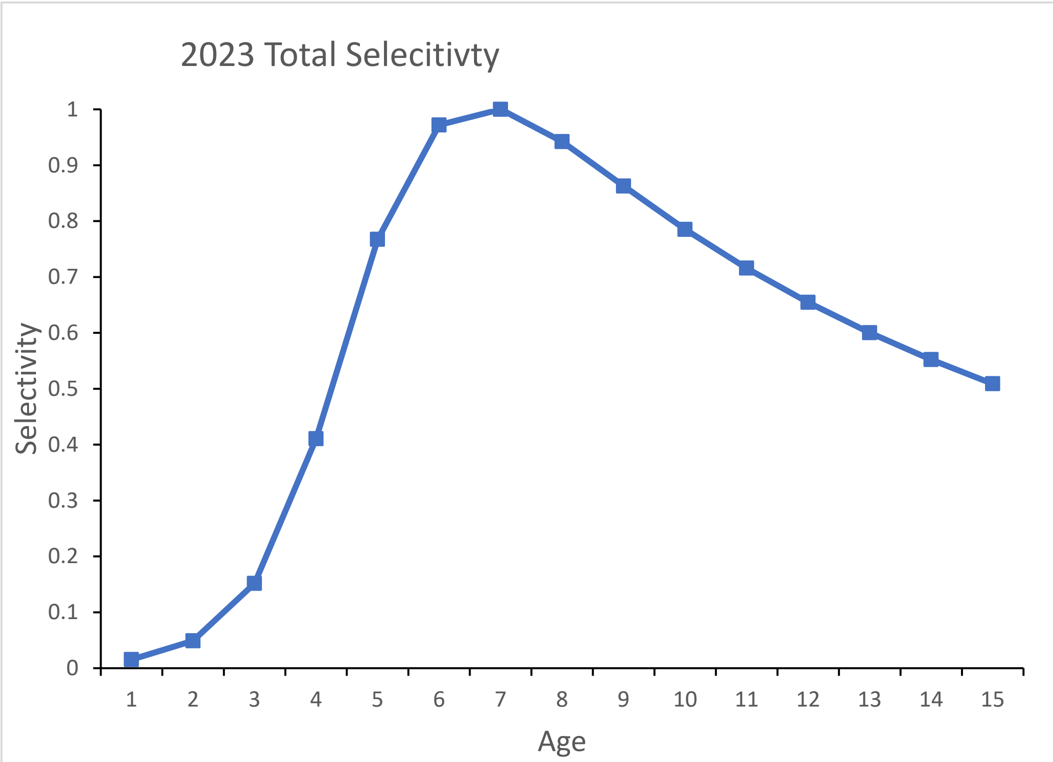


Figure 3. Total selectivity pattern for 2023 (Bay and Ocean combined) derived from total fishing mortality-at-age.

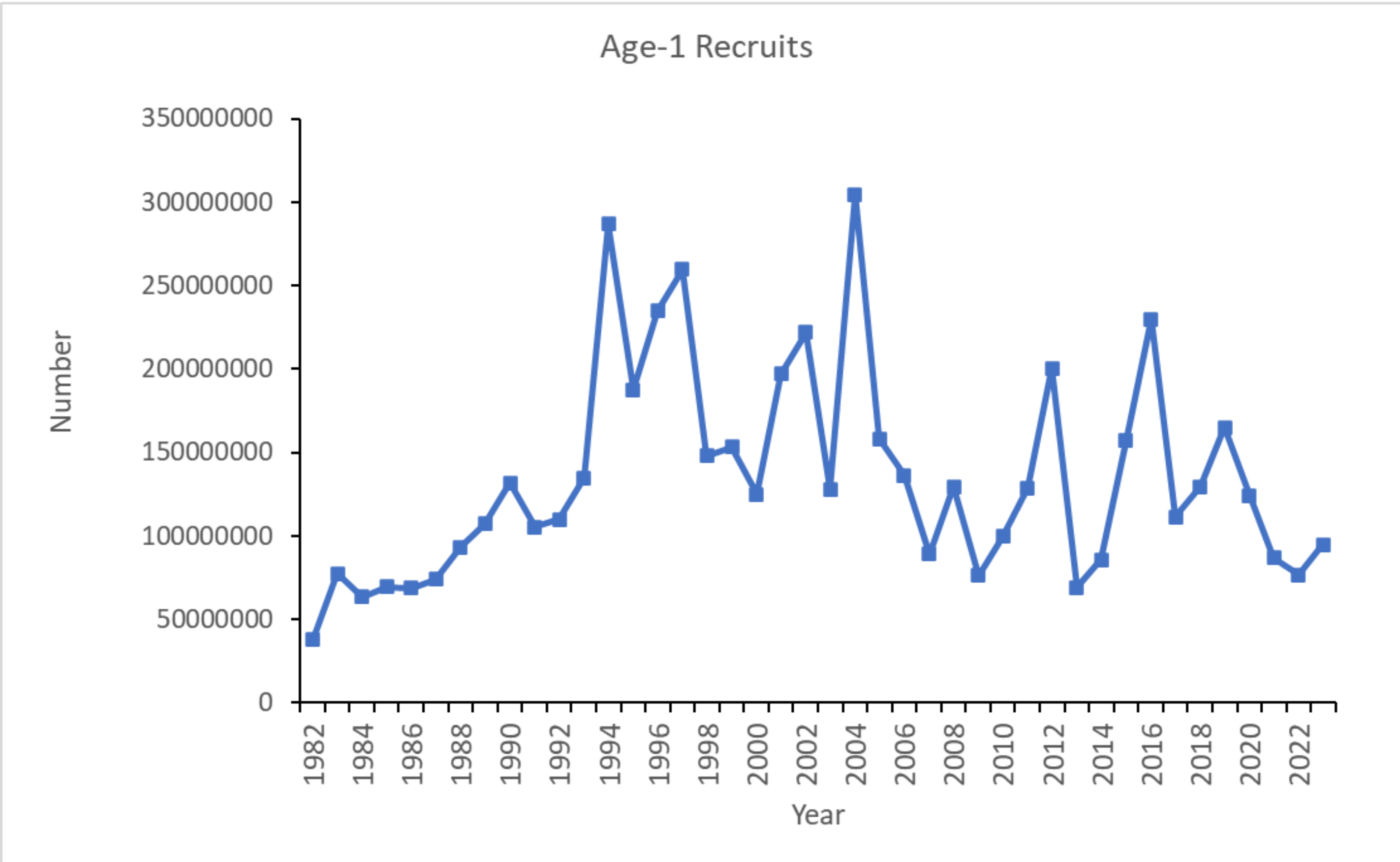


Figure 4. Estimates of recruit (age-1) abundance, 1982-2023.

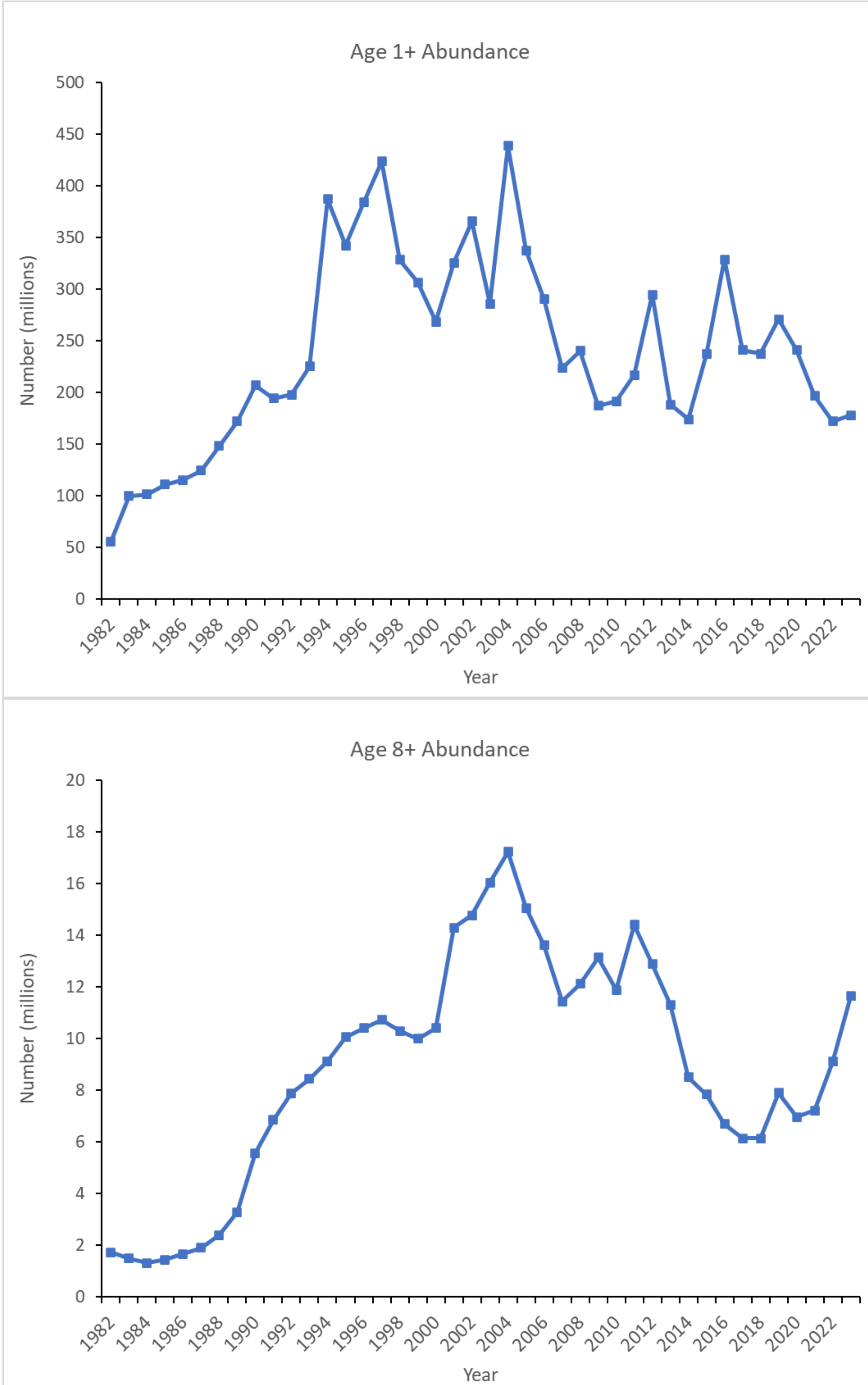


Figure 5. Estimates of total (top) and age-8 + (bottom) abundance from the updated stock assessment, 1982-2023.

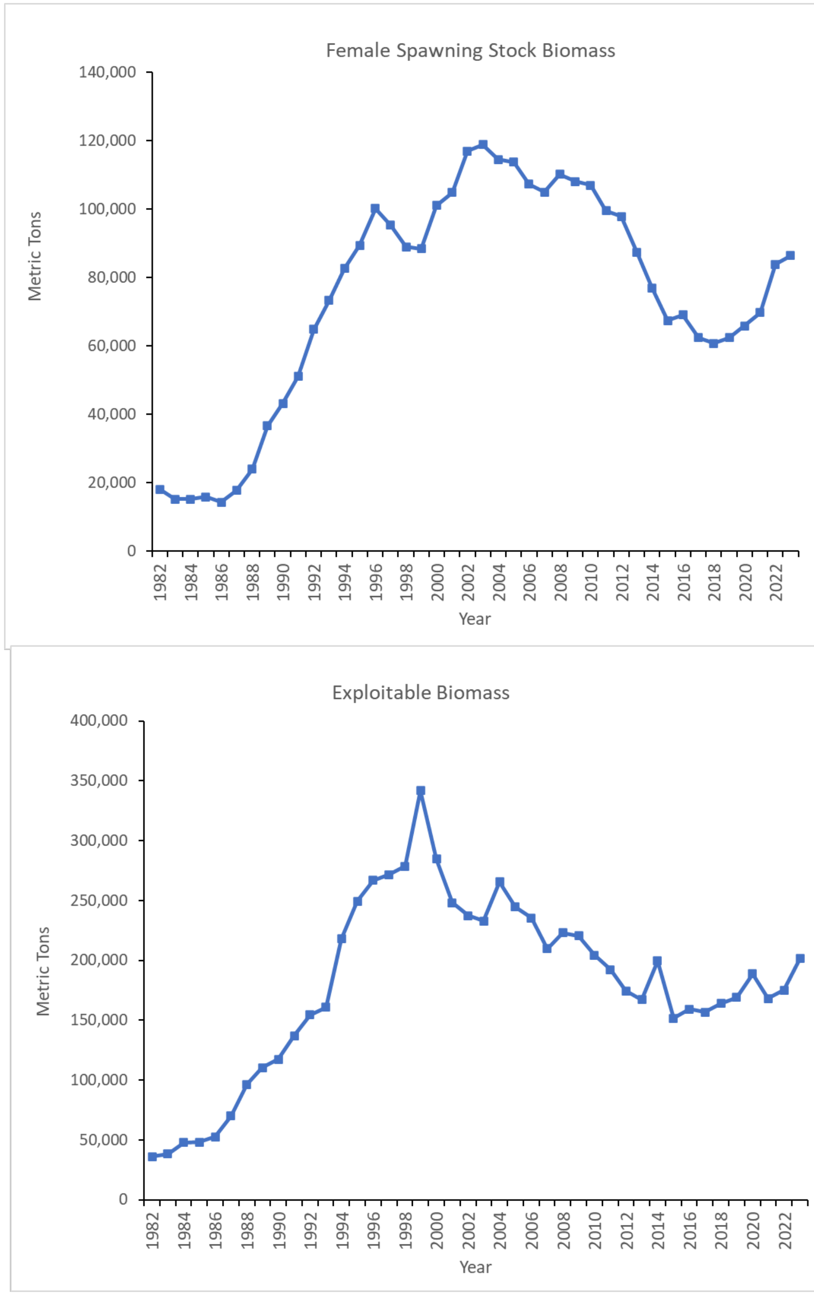


Figure 6. Estimates of female spawning stock biomass (top) and exploitable biomass (bottom), 1982-2023

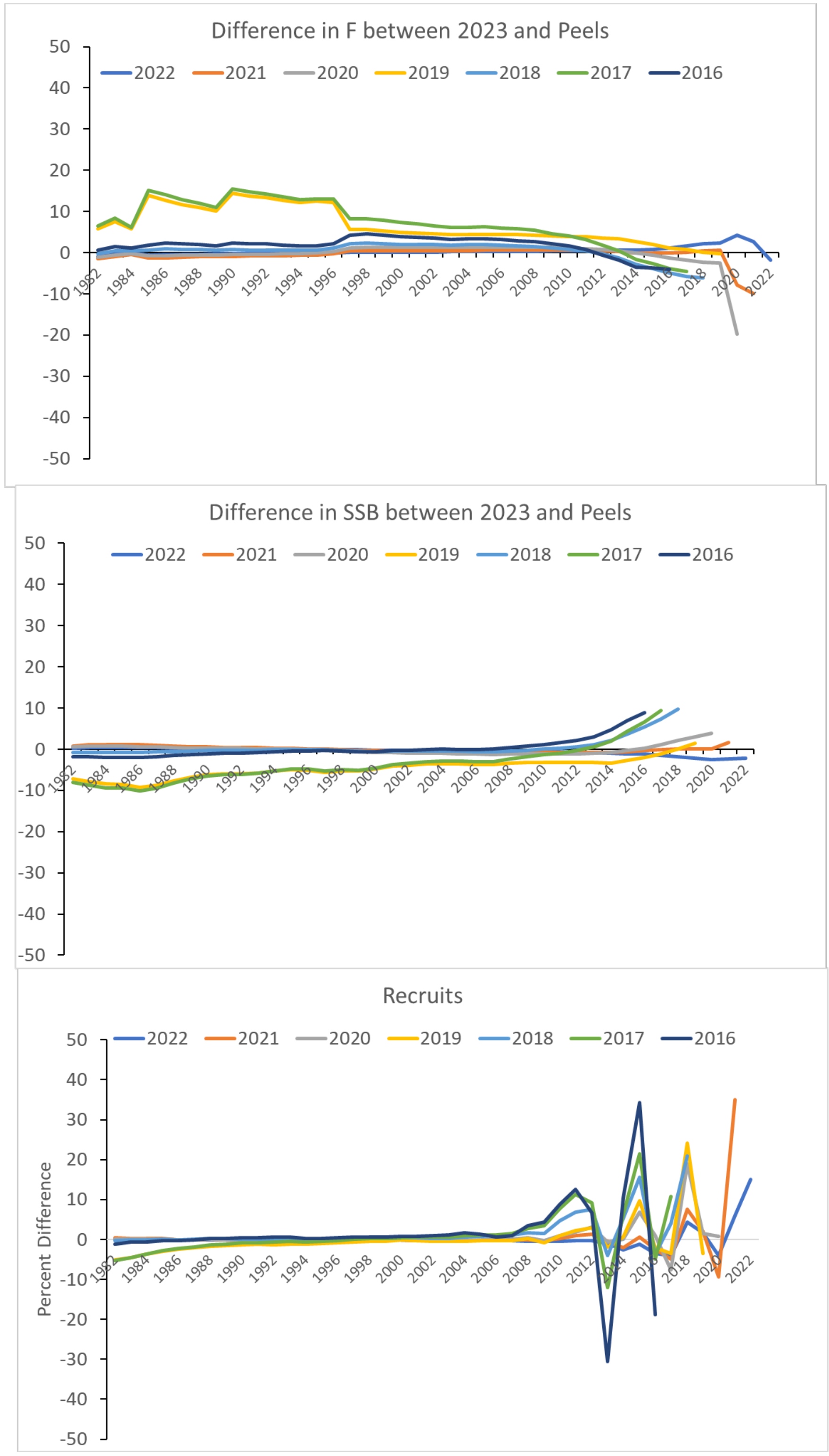


Figure 7. Retrospective plots of seven-year peels for fishing mortality, female spawning stock biomass and recruitment.

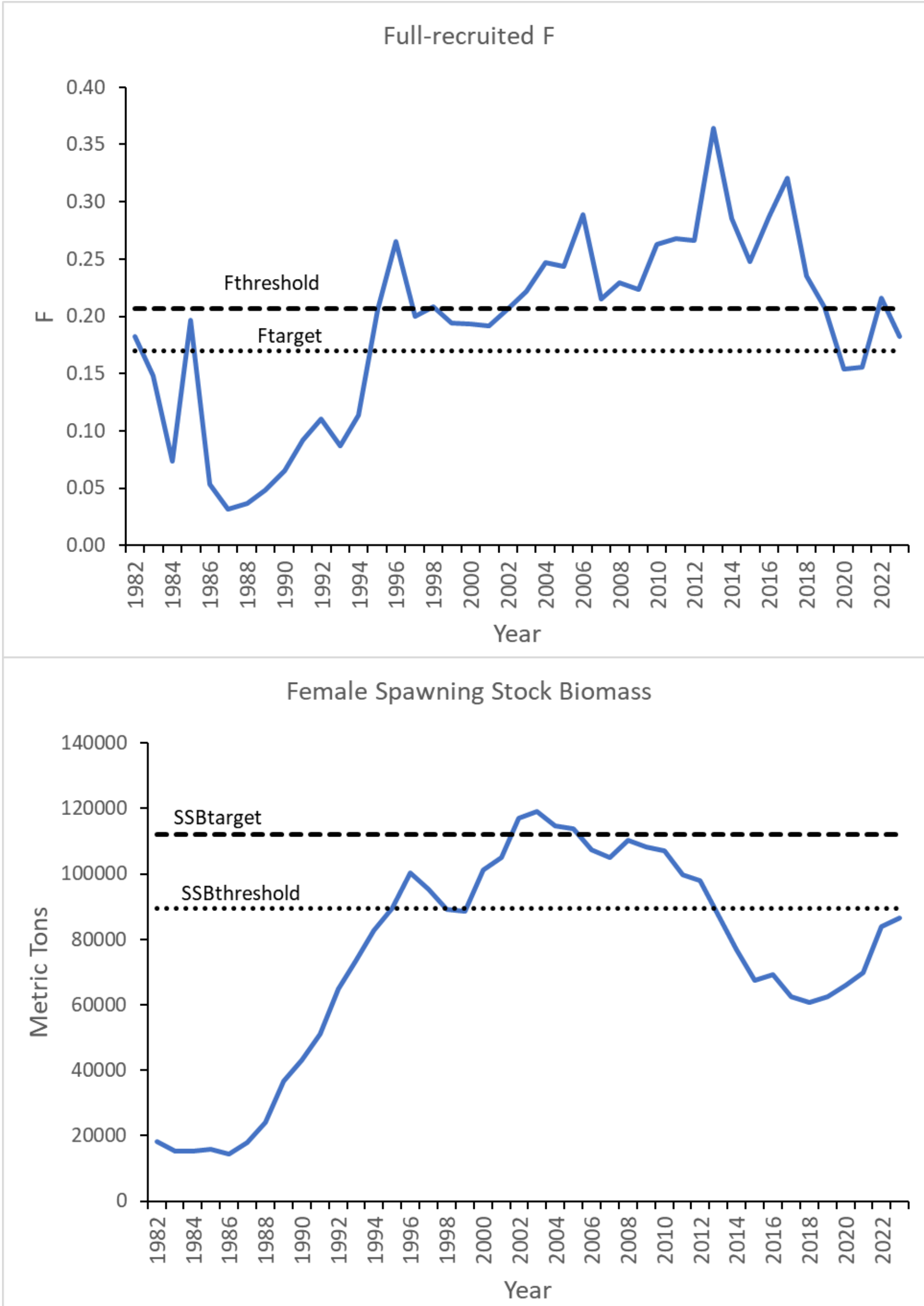


Figure 13. Comparison of SSB and F estimates to SSB and F reference points.

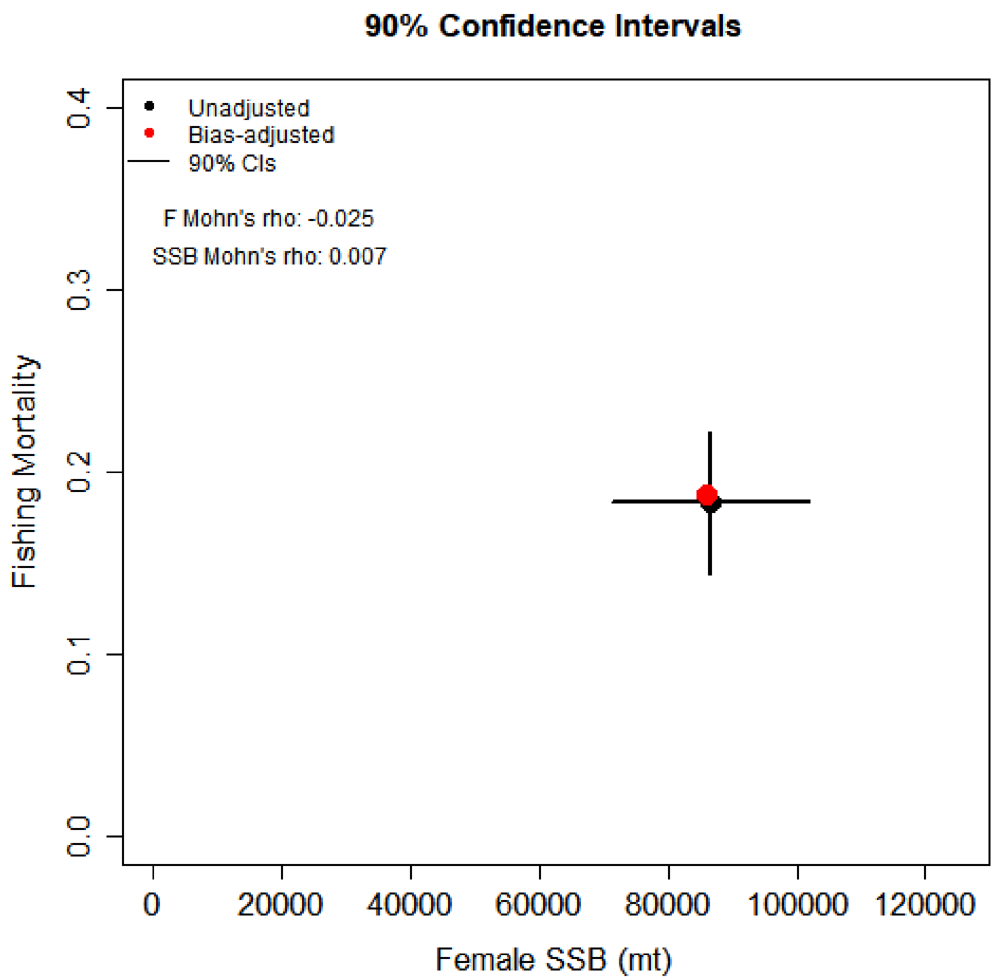


Figure 14. Plot comparing the 2023 bias-corrected F and female SSB values the uncorrected F and SSB estimates and their associated 90% confidence intervals. Because the retrospective adjusted values fall within the 90% confidence intervals, bias-correction is not needed.

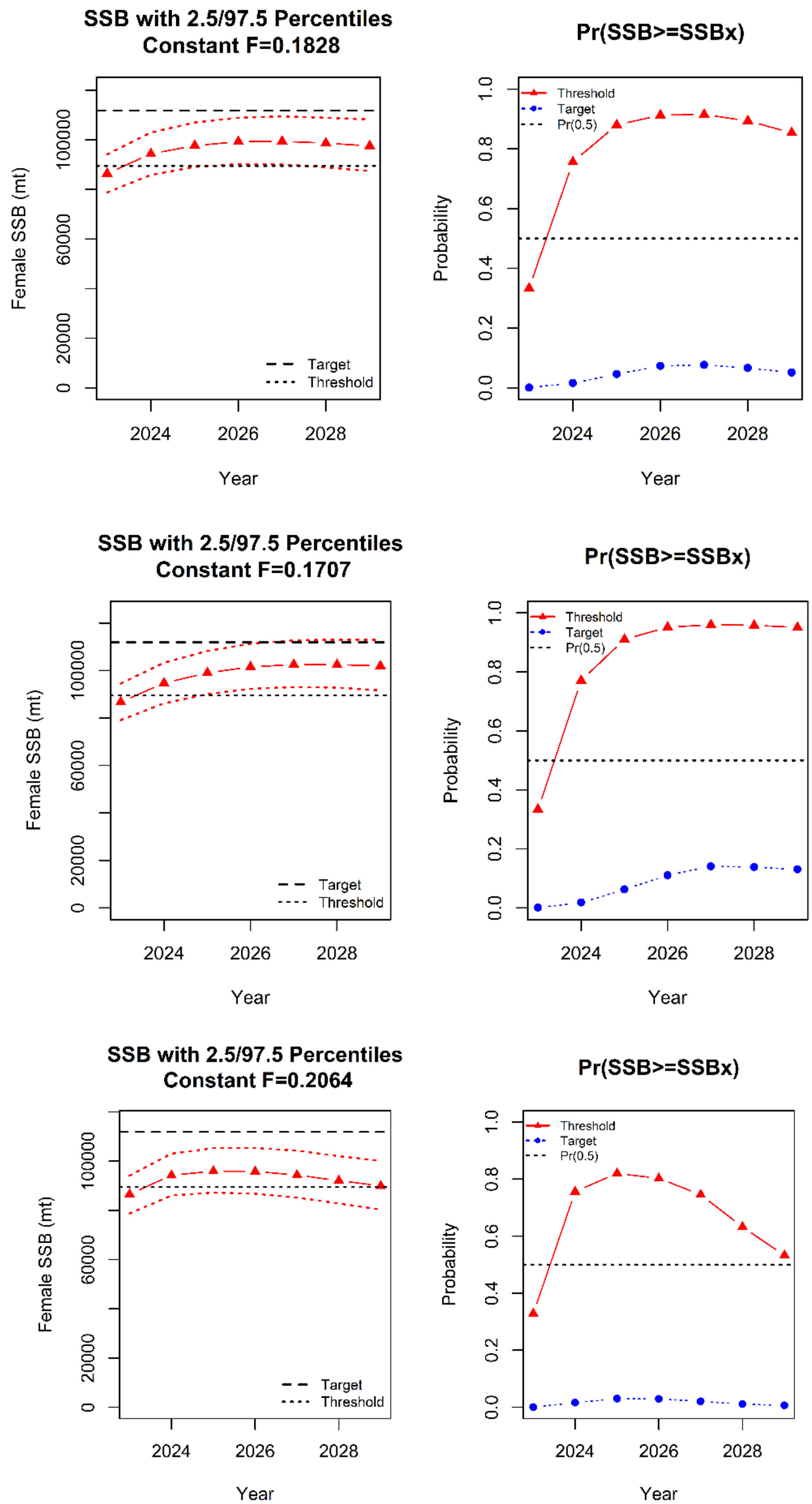


Figure 15. Projections of female spawning stock biomass through 2029 under current, target and threshold fishing mortality (left) and the probability of female SSB being above the target and threshold values of 111,891 and 89513 metric tons, respectively, over time (right).

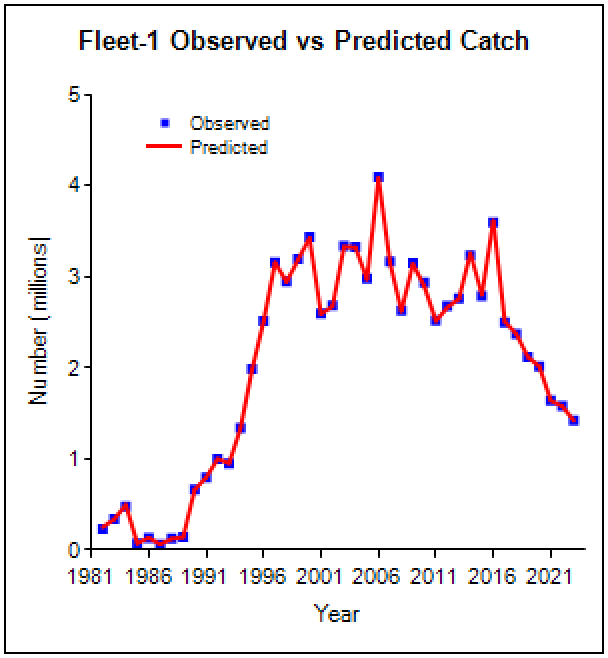
Sensitivity Run

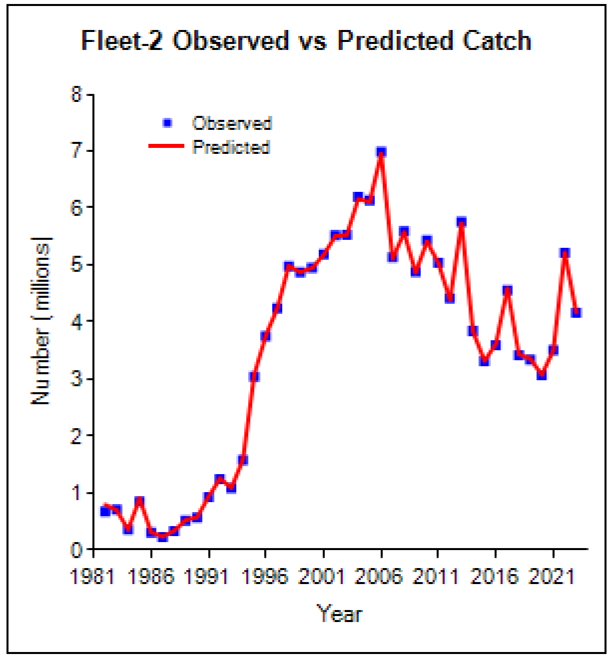
Model configuration:

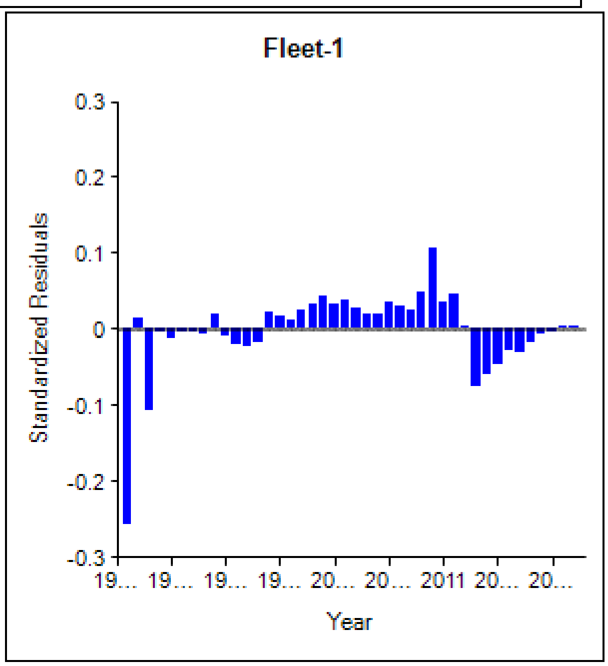
Ocean recent selectivity blocks: 2020-2022, 2023 (new blocks in 2020 and 2023)

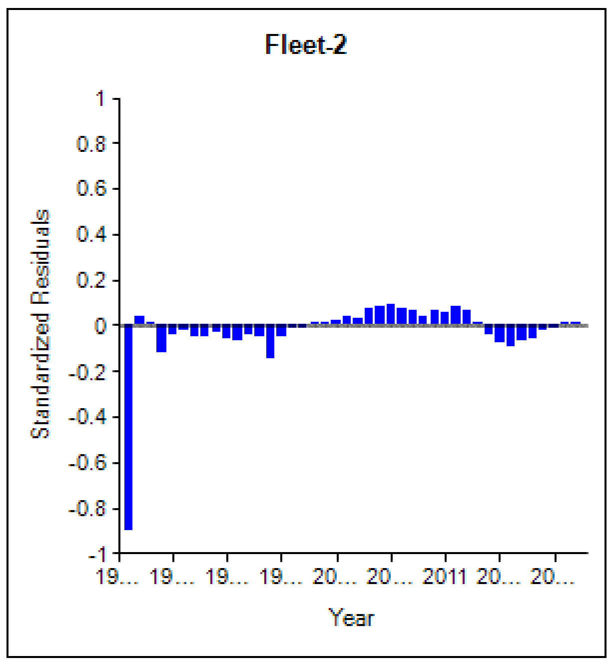
Bay recent selectivity blocks: 1996-2022, 2023 (new block in 2023 only)

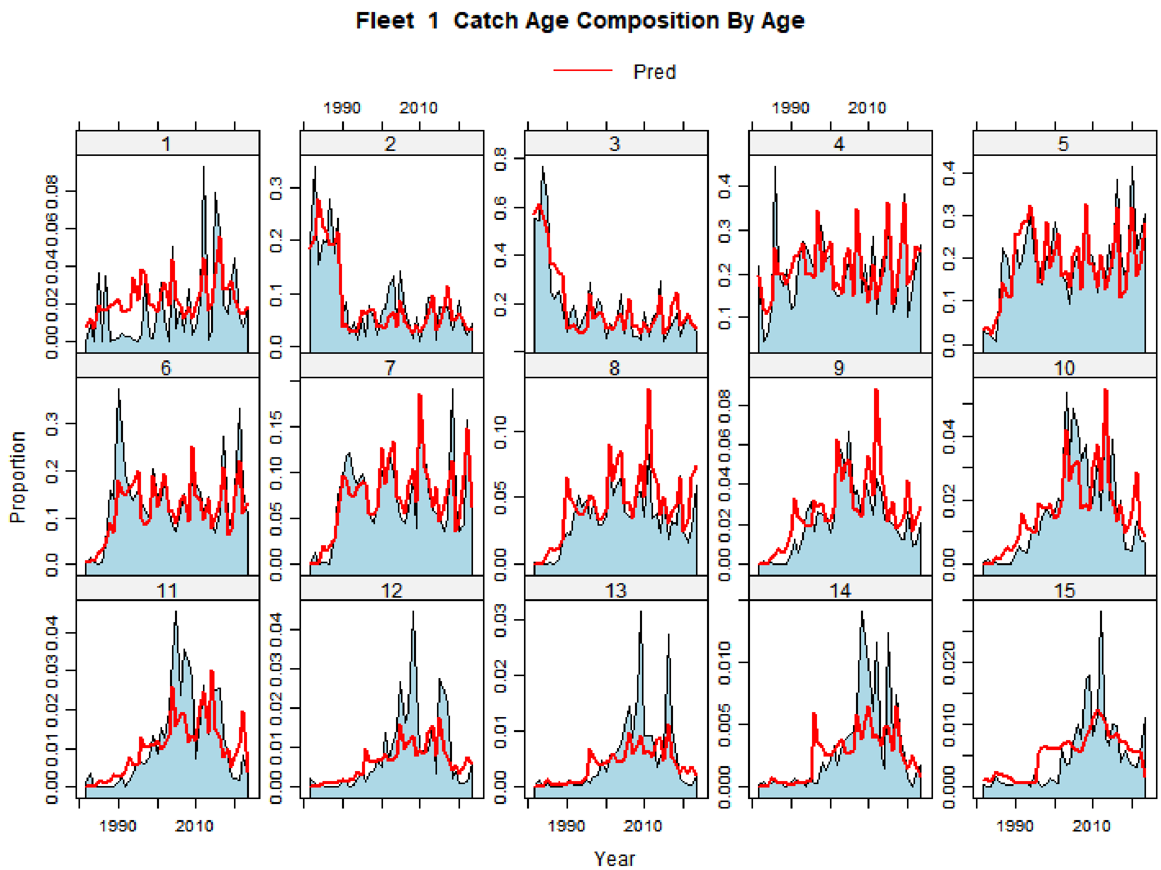
Diagnostics

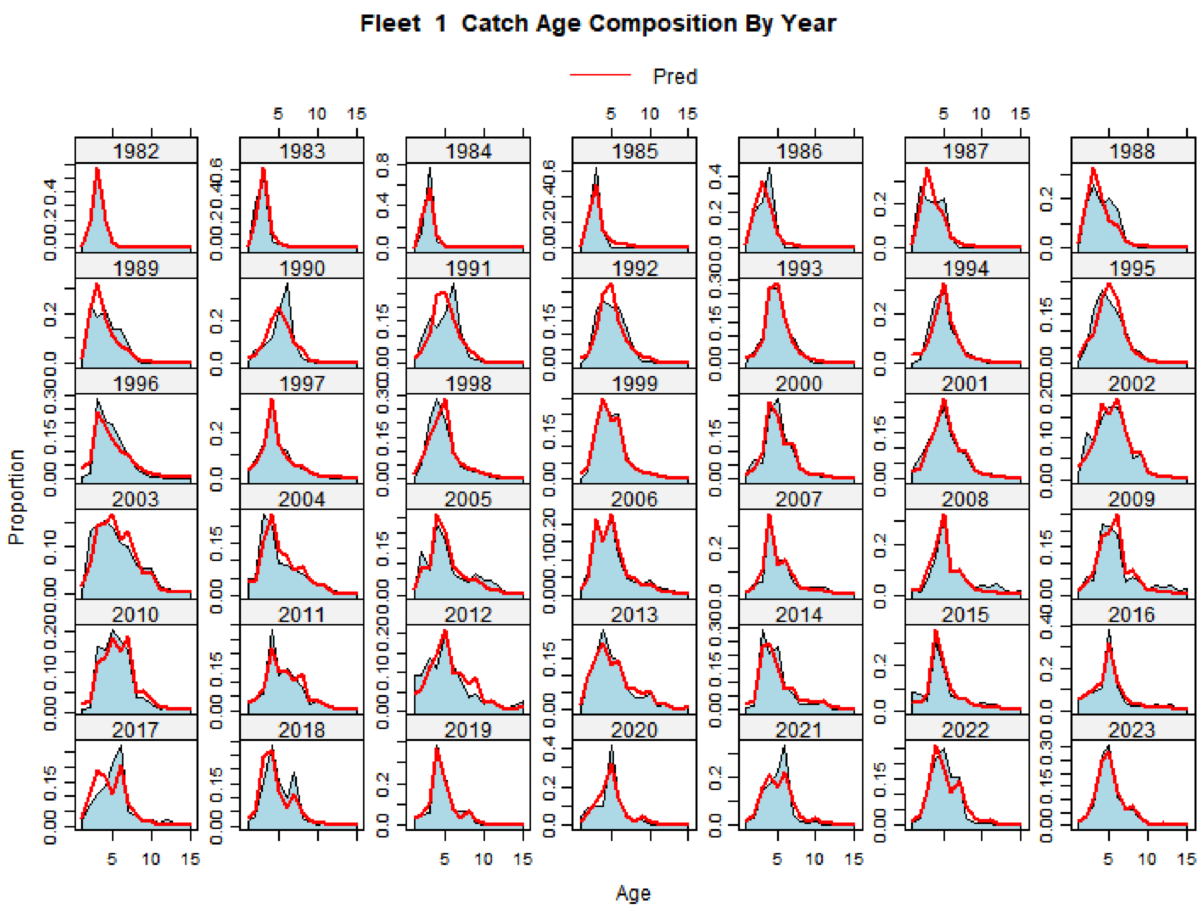


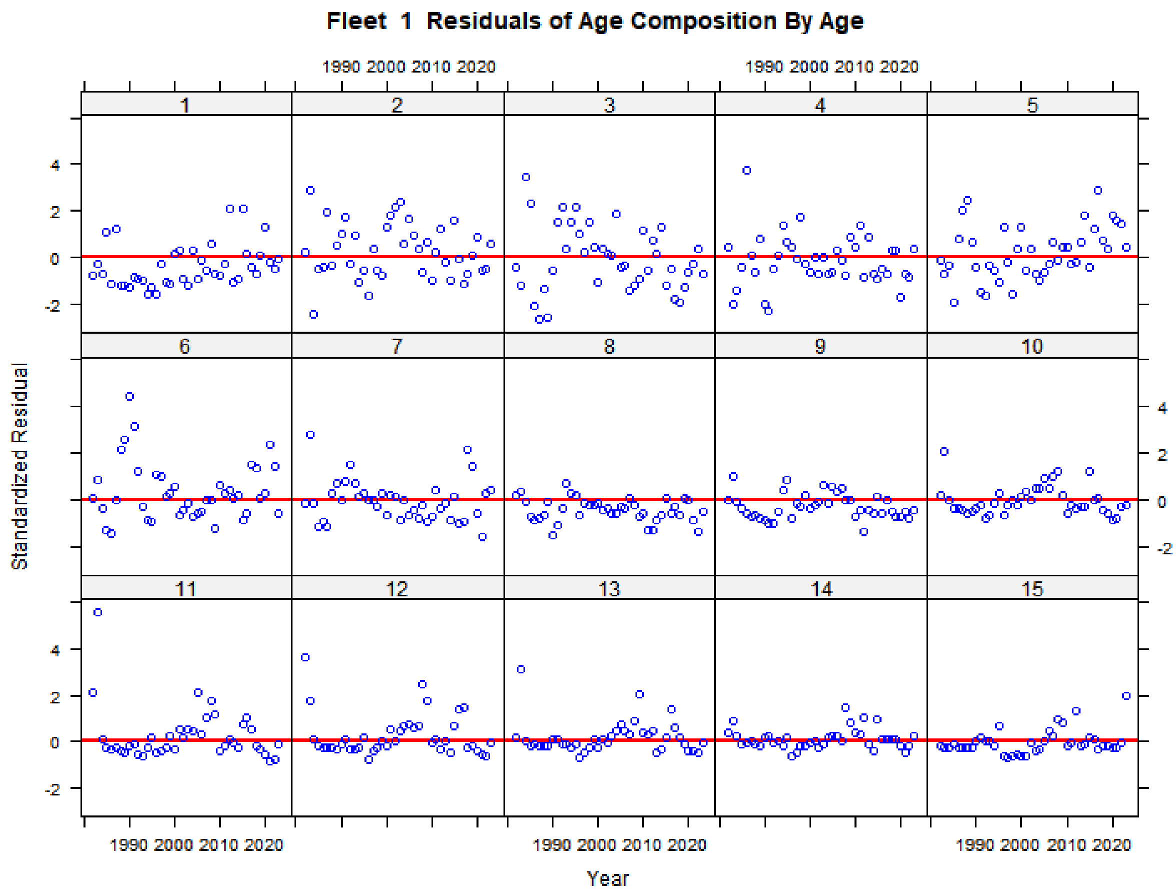


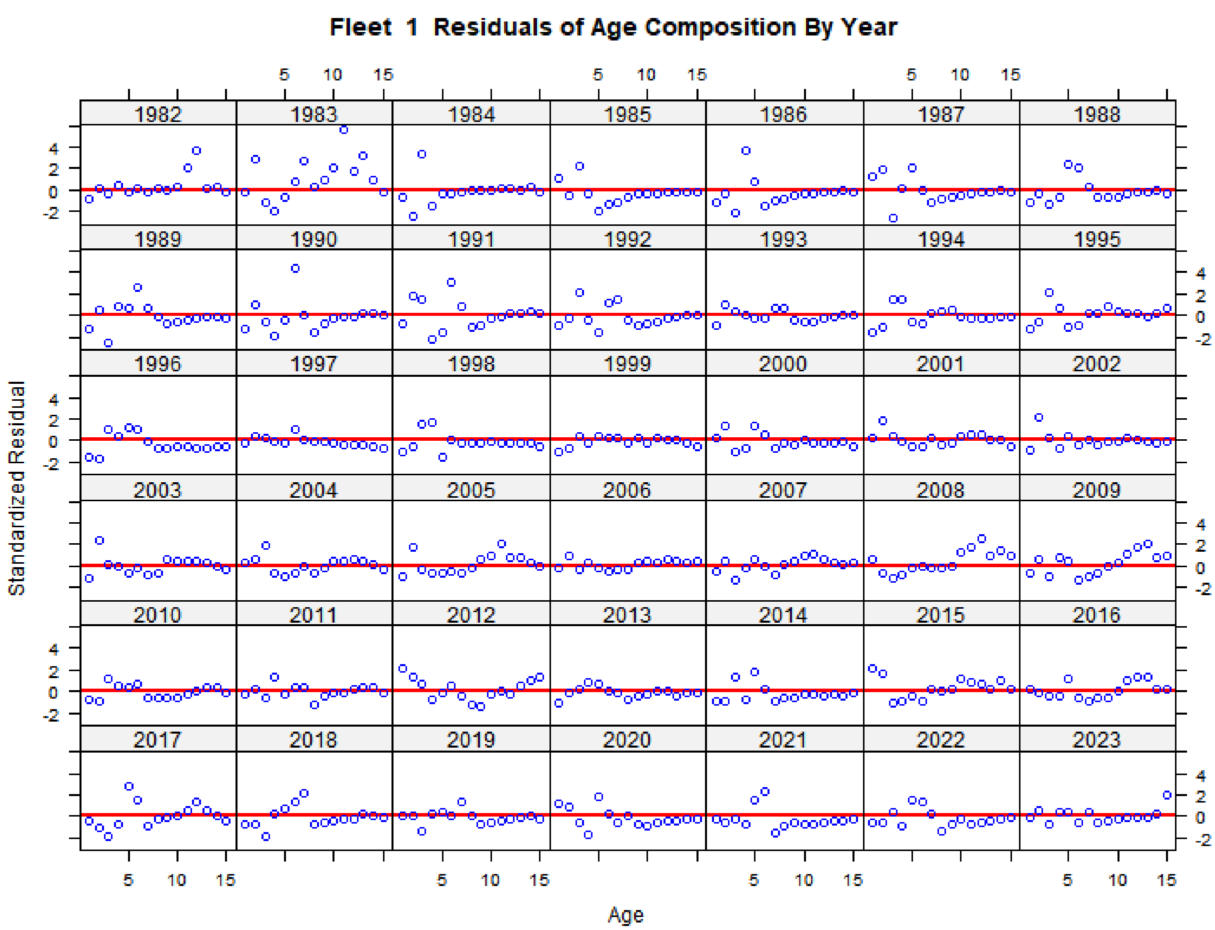


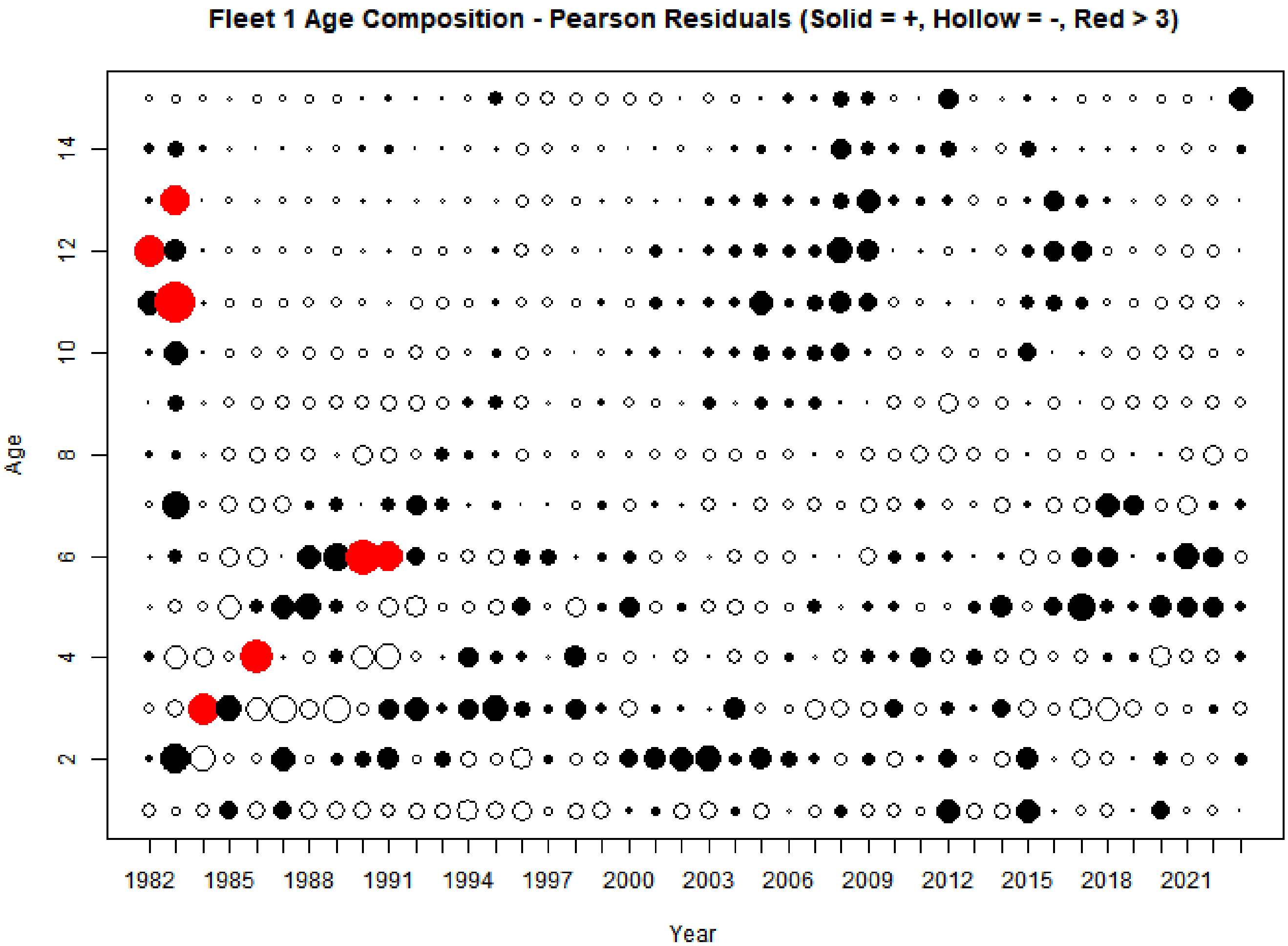


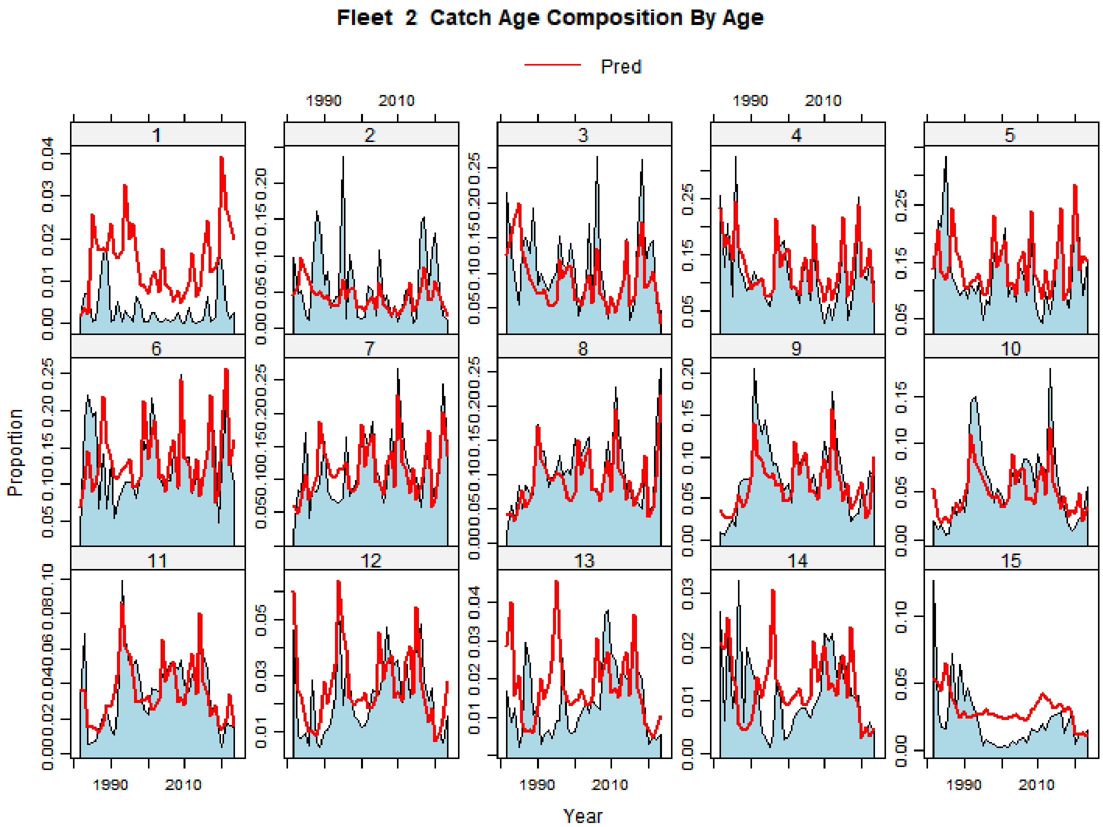

Fleet 1 Catch Age Composition By Age
Pred
Proportion
Year
1990
2010

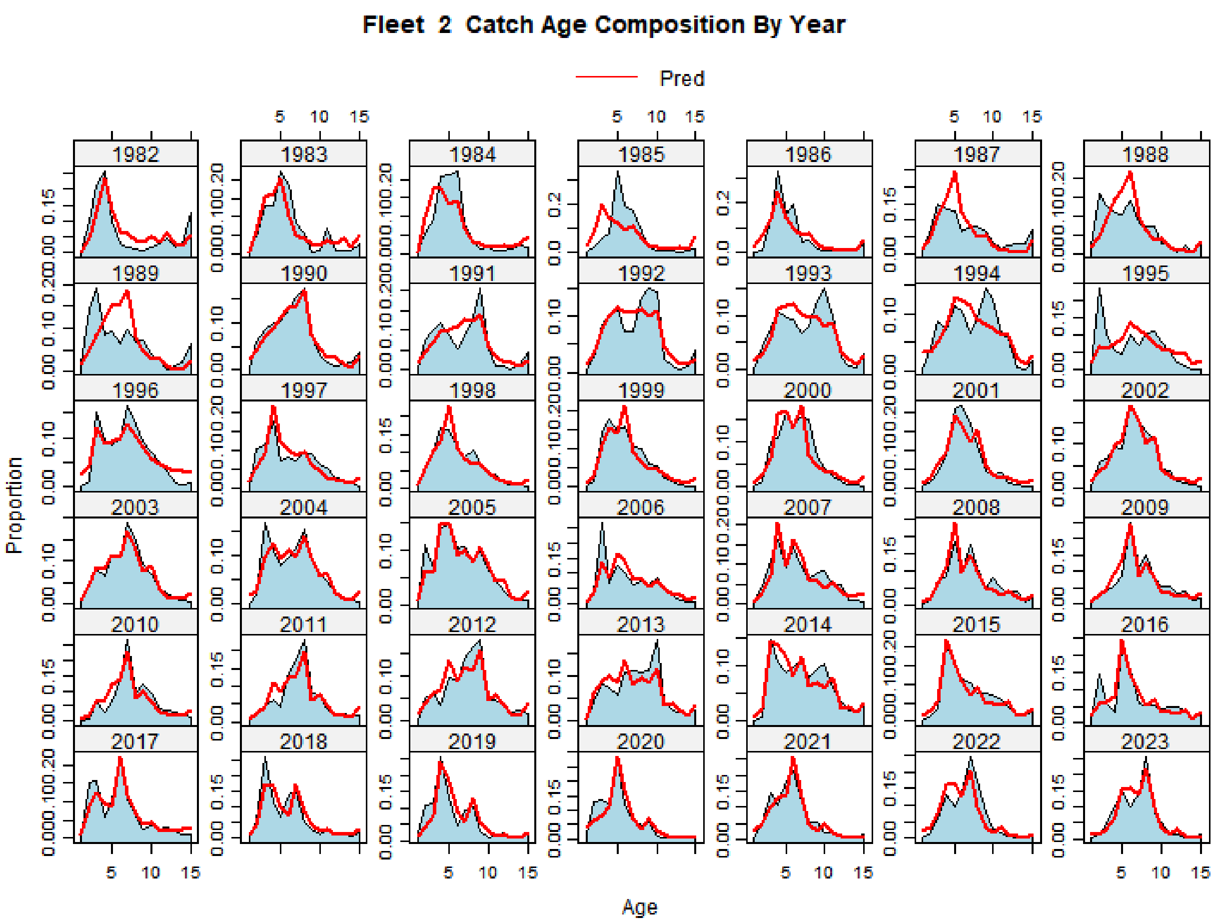

Fleet 1 Catch Age Composition By Year
Pred
Proportion
Age
5
10
15


Fleet 1 Residuals of Age Composition By Age
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Standardized Residual
Year
1990 2000 2010 2020

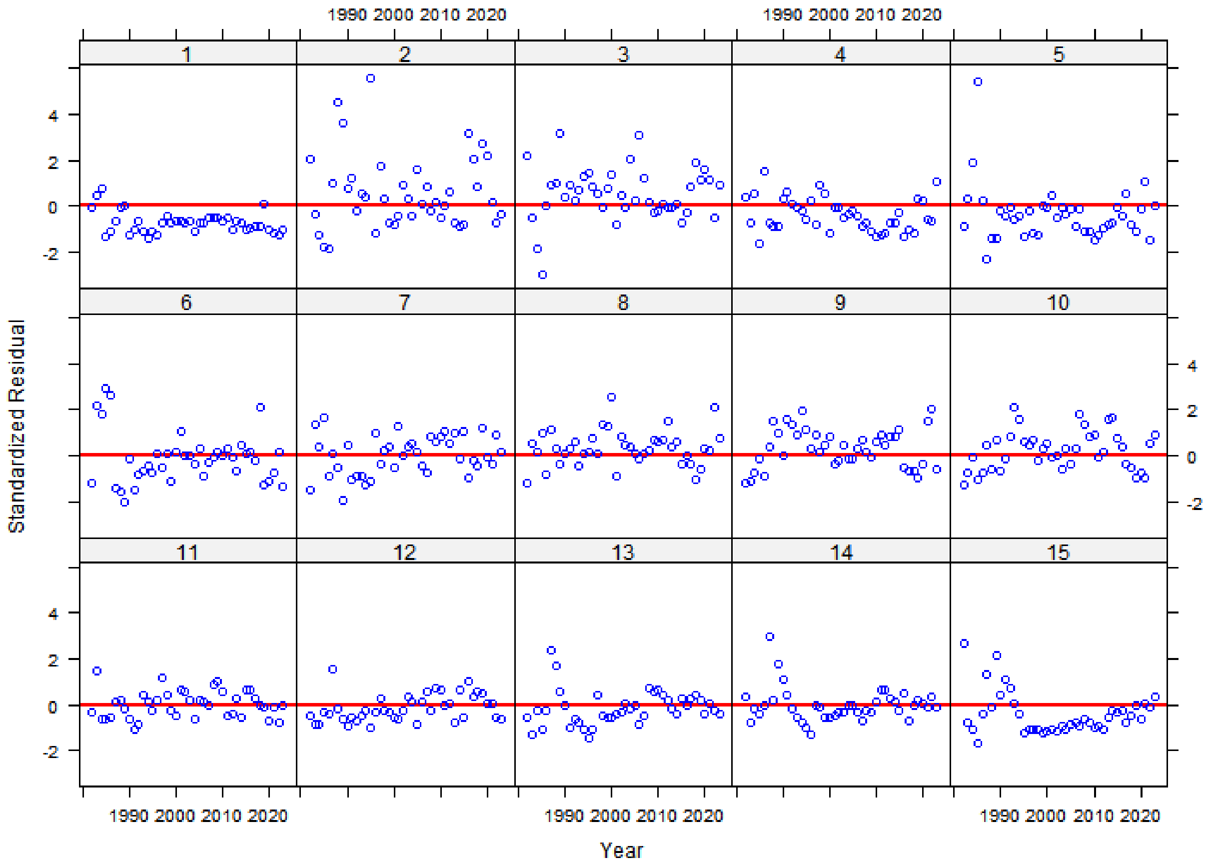

Fleet 1 Residuals of Age Composition By Year
1982 1983 1984 1985 1986 1987 1988
1989 1990 1991 1992 1993 1994 1995
1996 1997 1998 1999 2000 2001 2002
2003 2004 2005 2006 2007 2008 2009
2010 2011 2012 2013 2014 2015 2016
2017 2018 2019 2020 2021 2022 2023
Standardized Residual
Age


Fleet 1 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

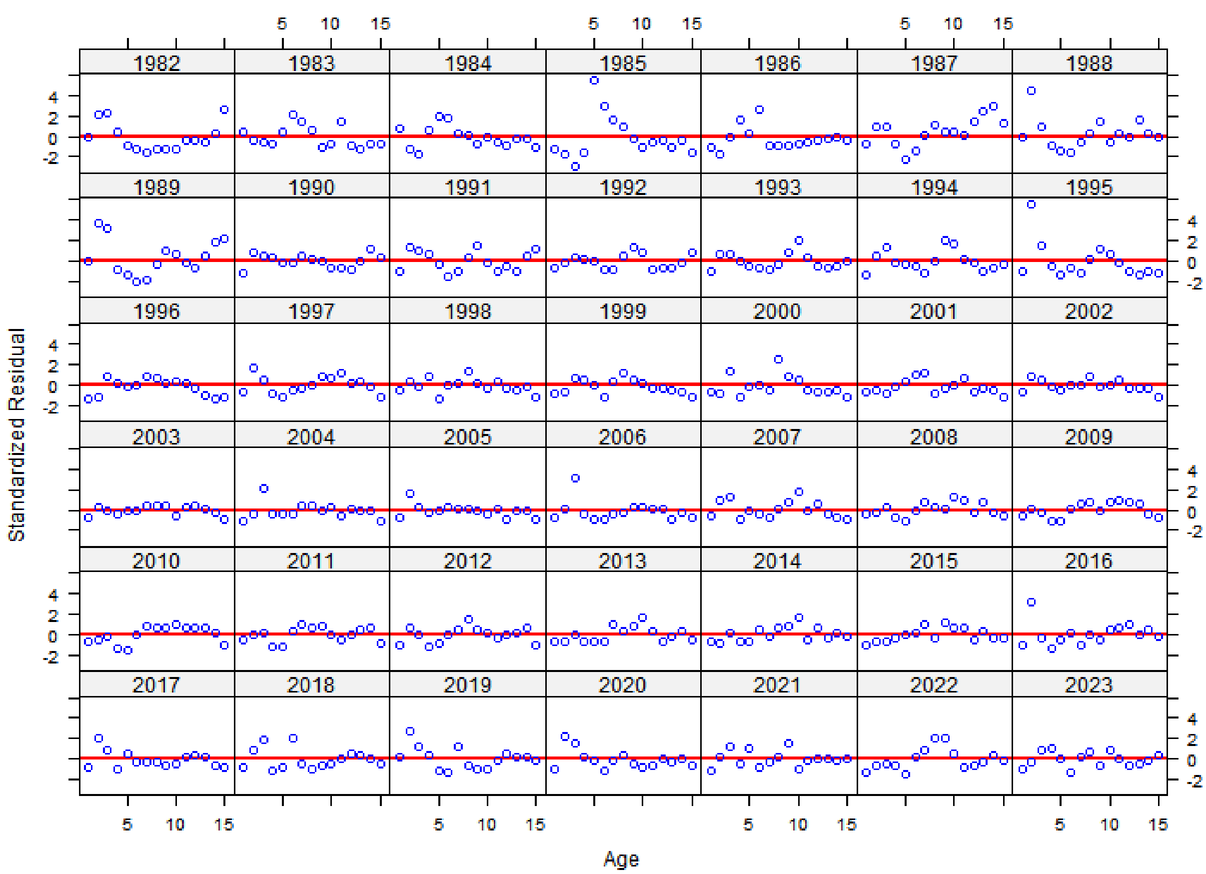

Fleet 2 Catch Age Composition By Age
Pred
Proportion
Year

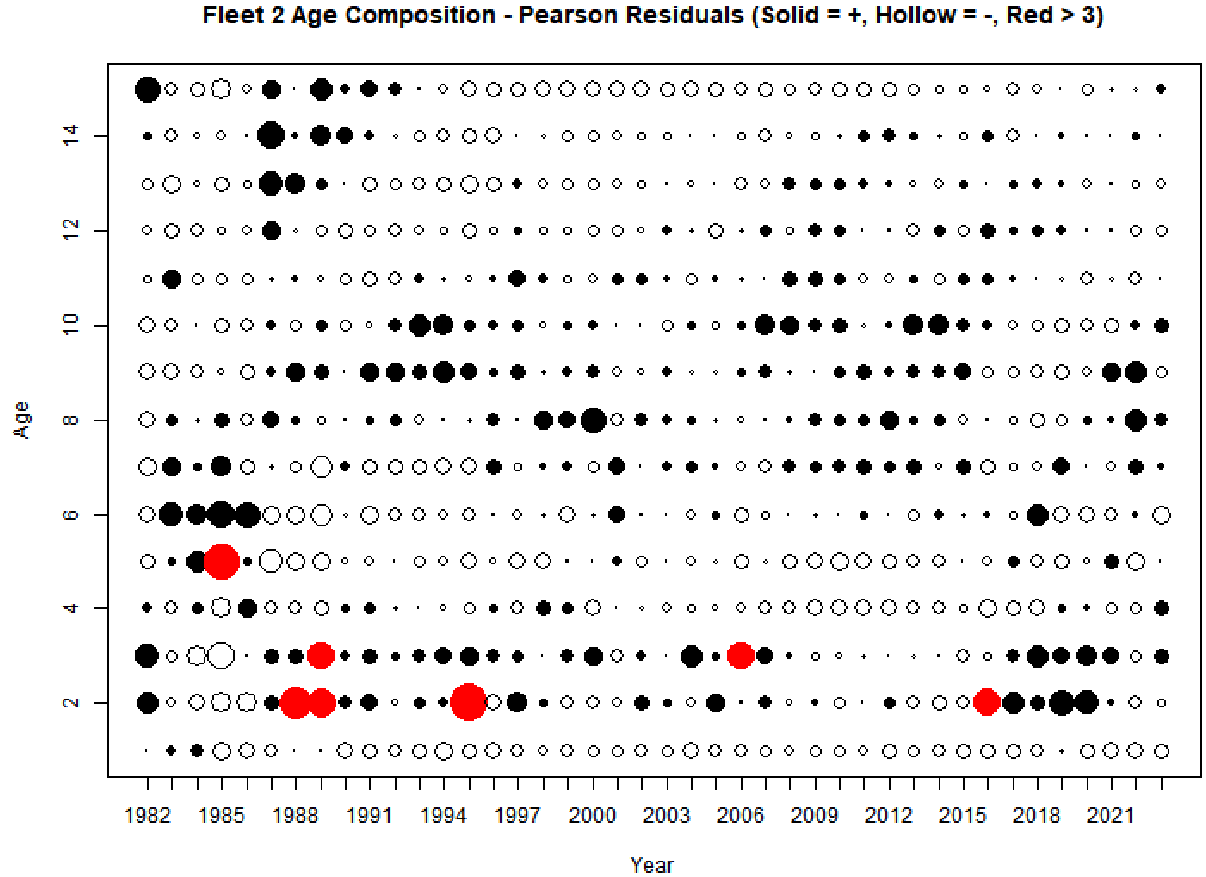

Fleet 2 Catch Age Composition By Year
Pred
Proportion
Age

Fleet 2 Residuals of Age Composition By Age

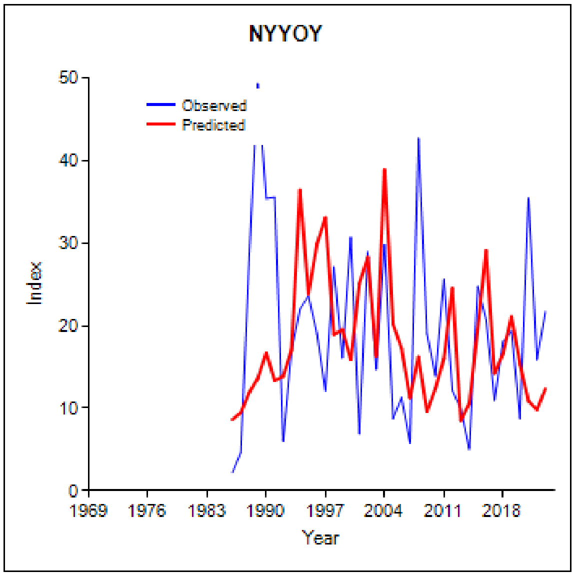


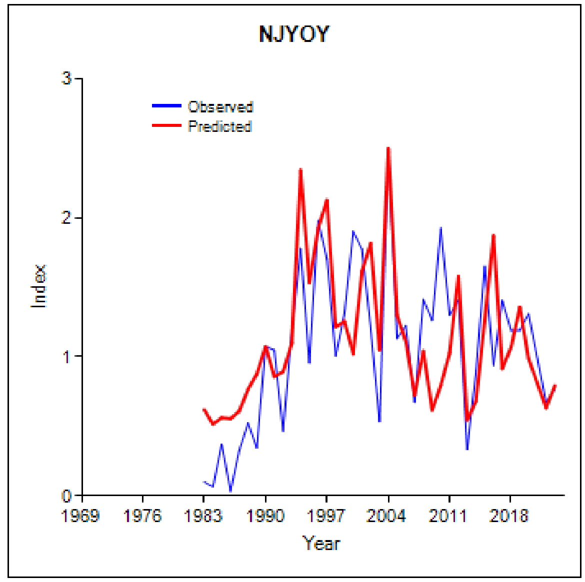
Fleet 2 Residuals of Age Composition By Year

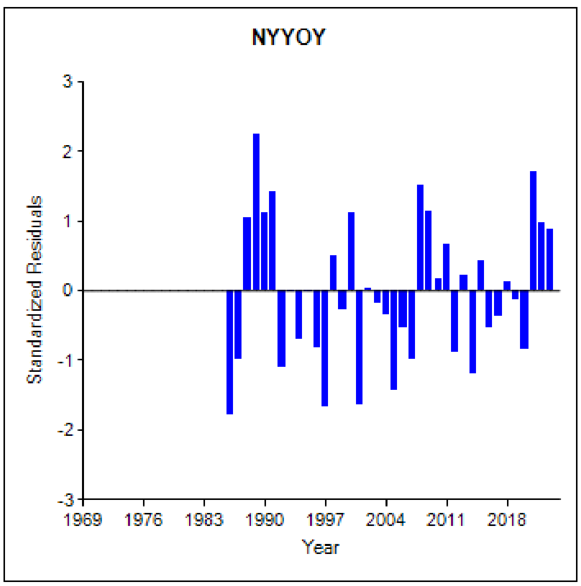


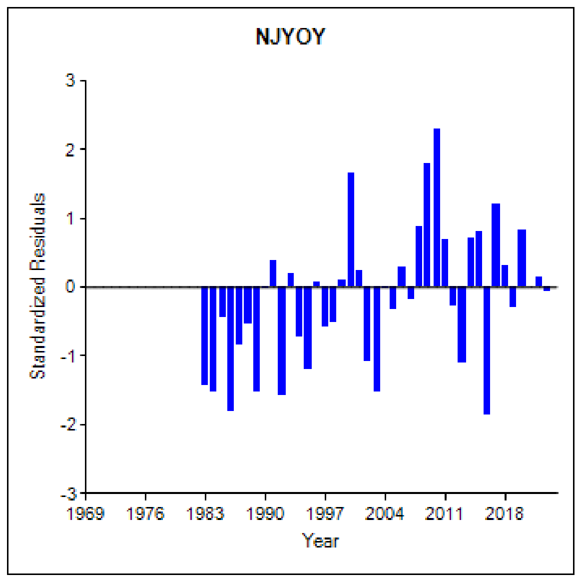


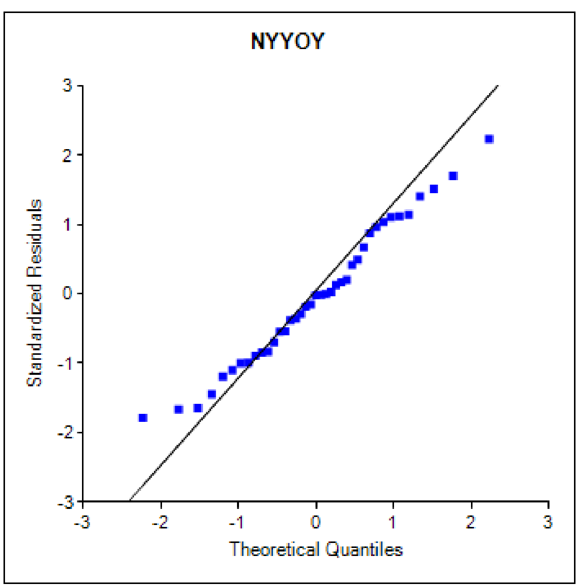
Fleet 2 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
Year

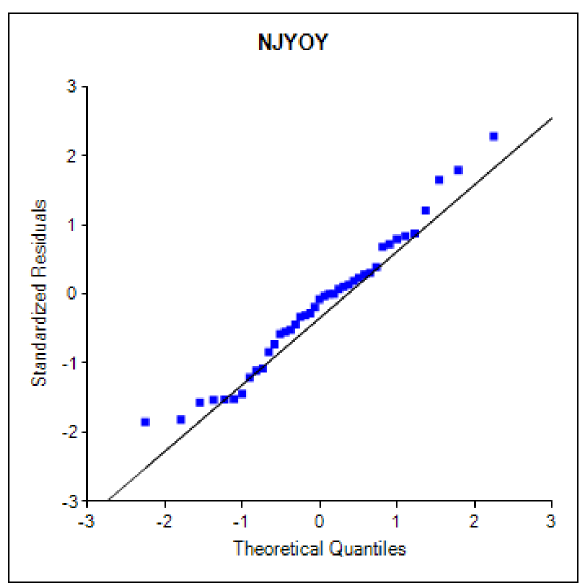

NYYOY
Observed
Predicted
Index
Year

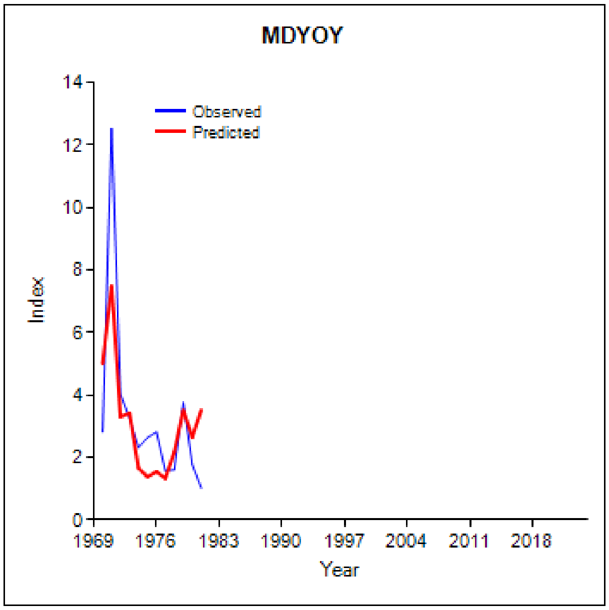

NJYOY
Observed
Predicted
Index
Year

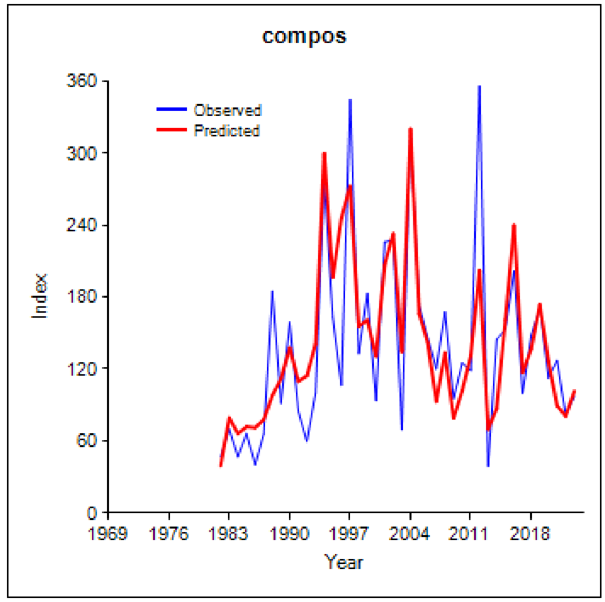

NYYOY
Standardized Residuals
Year

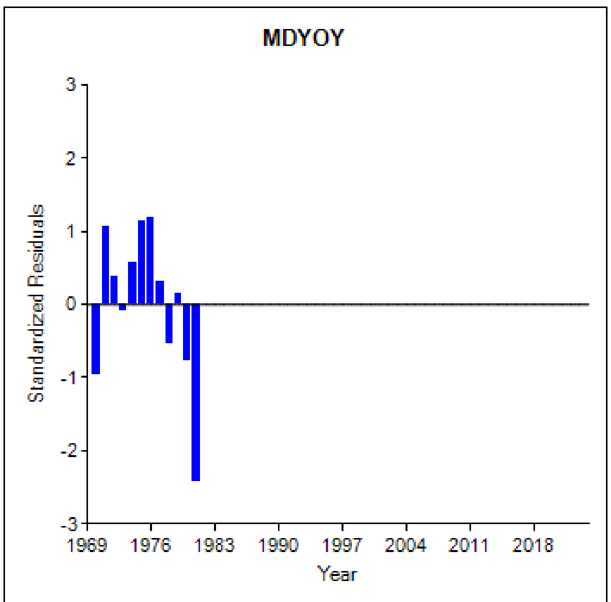

NJYOY
Standardized Residuals
Year

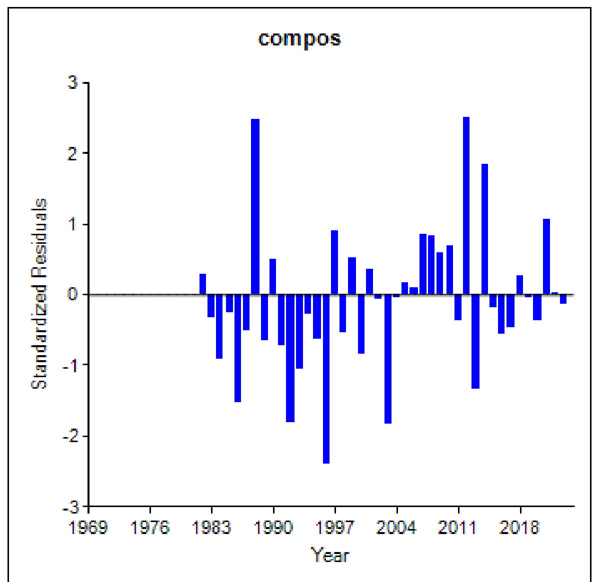

NYYOY
Standardized Residuals
Theoretical Quantiles

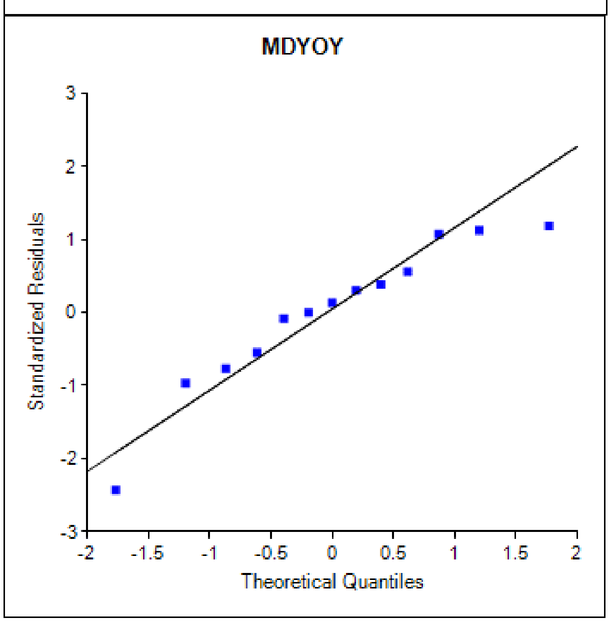

NJYOY
Standardized Residuals
Theoretical Quantiles

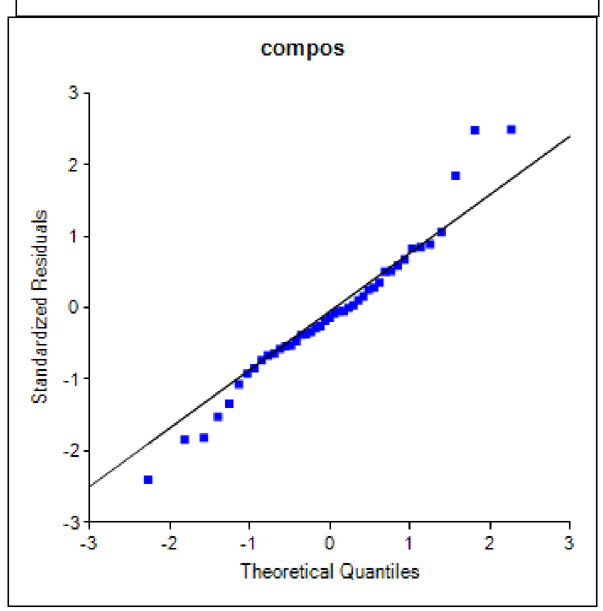

MDYOY
Observed
Predicted
Index
Year

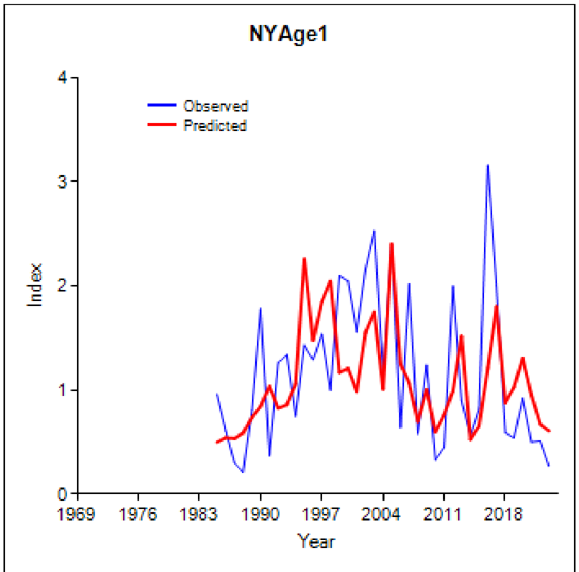

compos
Observed
Predicted
Index
Year

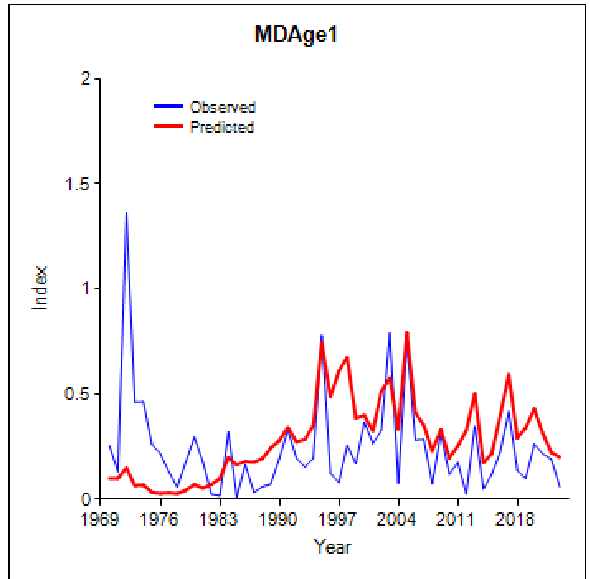

MDYOY
Standardized Residuals
Year

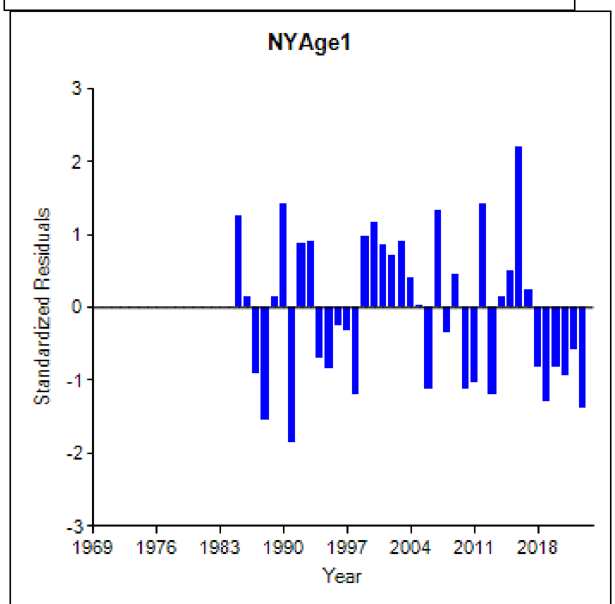

compos
Standardized Residuals
Year

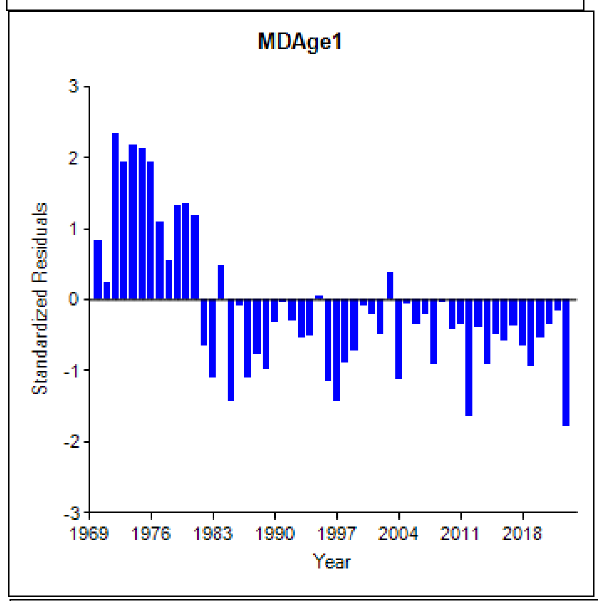

MDYOY
Standardized Residuals
Theoretical Quantiles

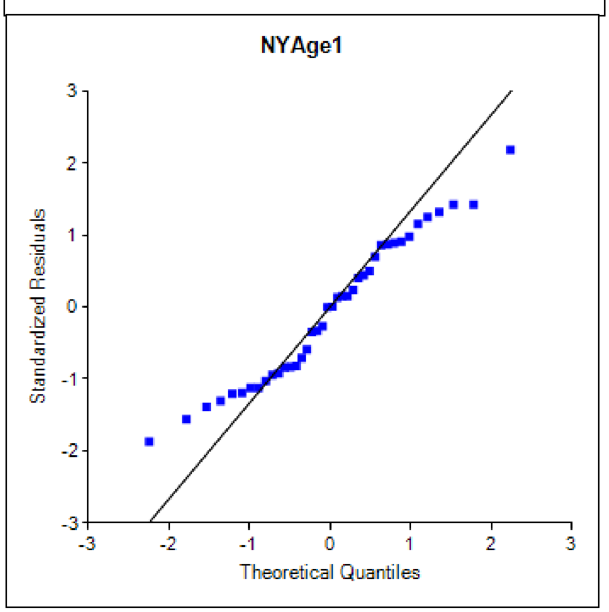

compos
Standardized Residuals
Theoretical Quantiles

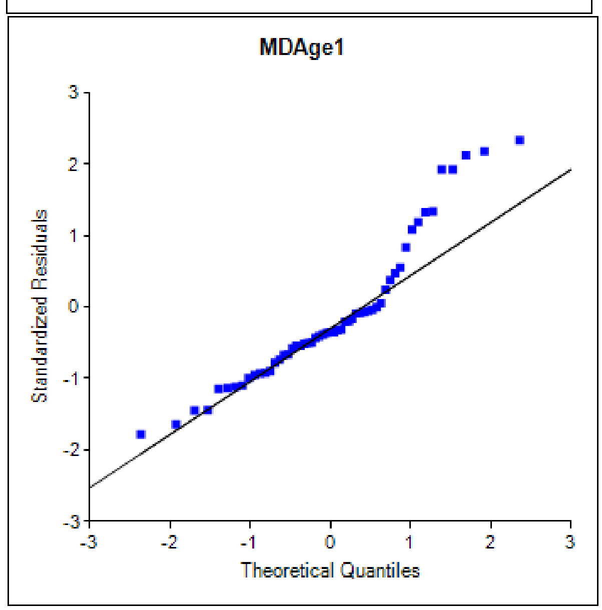

NYAge1
Observed
Predicted
Index
Year
0
1
2
3
4
1969 1976 1983 1990 1997 2004 2011 2018

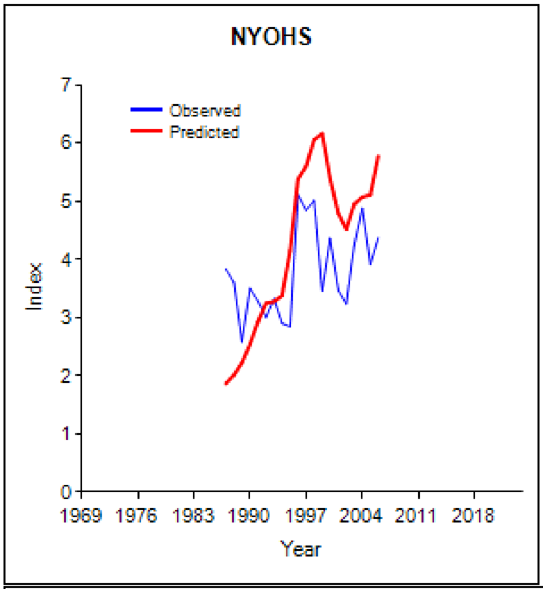

MDAge1
Observed
Predicted
Index
Year
0
0.5
1
1.5
2
1969 1976 1983 1990 1997 2004 2011 2018

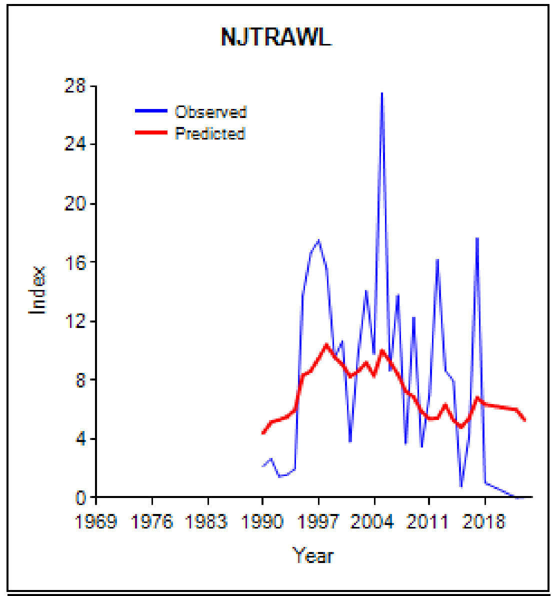

NYAge1
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

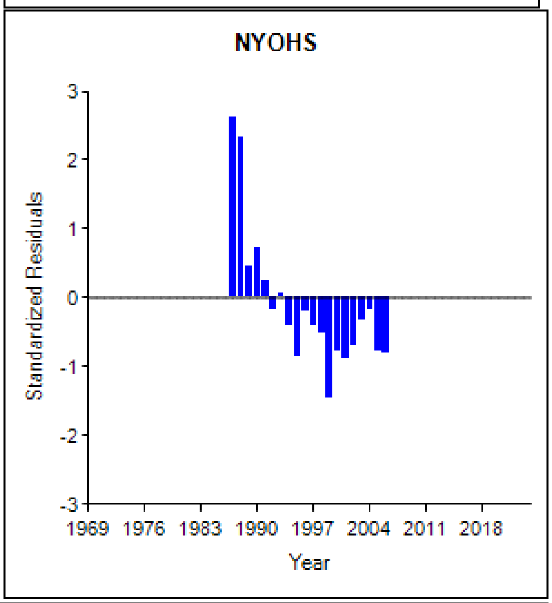

MDAge1
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

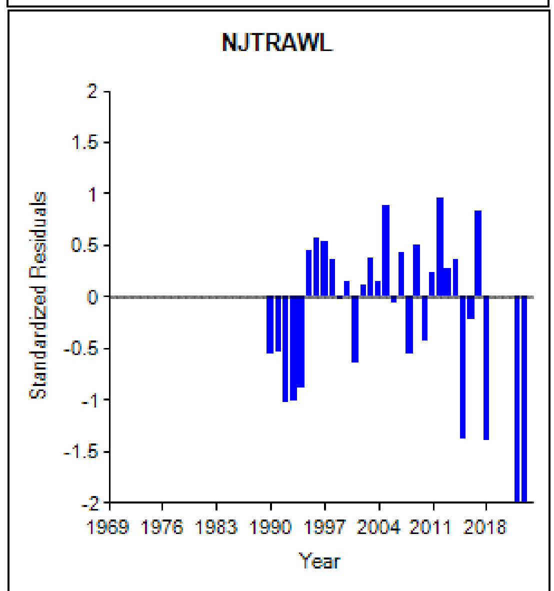

NYAge1
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3

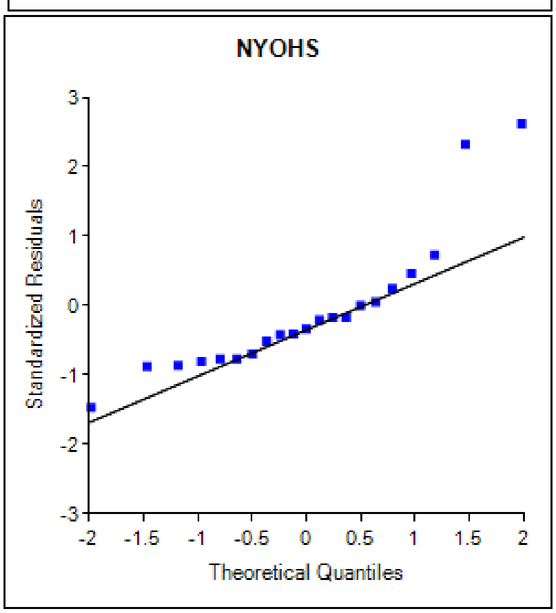

MDAge1
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3

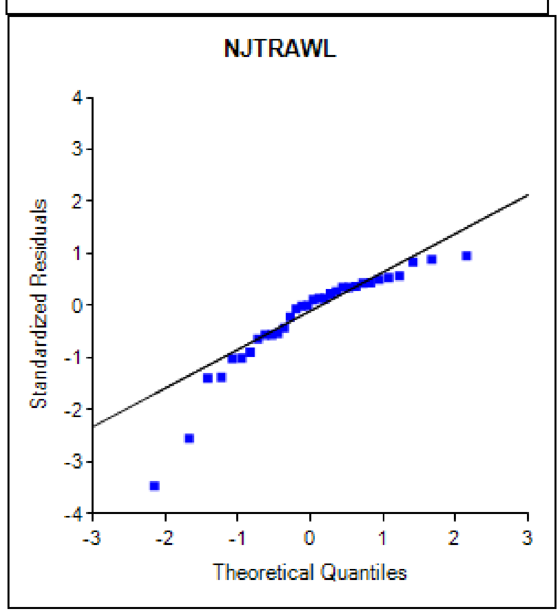

NYOHS
Observed
Predicted
Index
Year
1969 1976 1983 1990 1997 2004 2011 2018

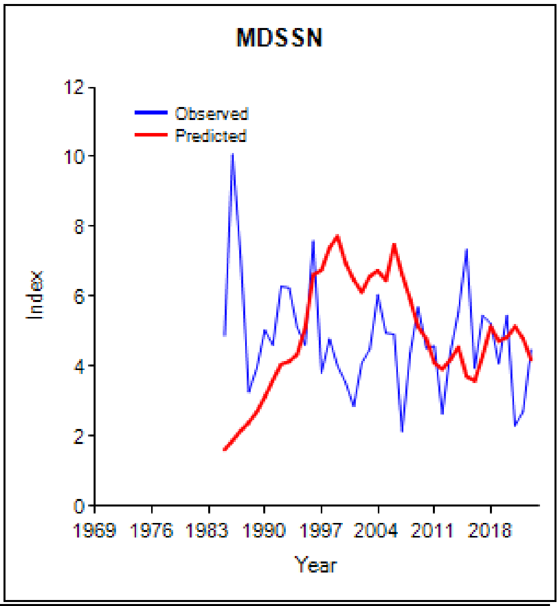

NJTRAWL
Observed
Predicted
Index
Year
1969 1976 1983 1990 1997 2004 2011 2018

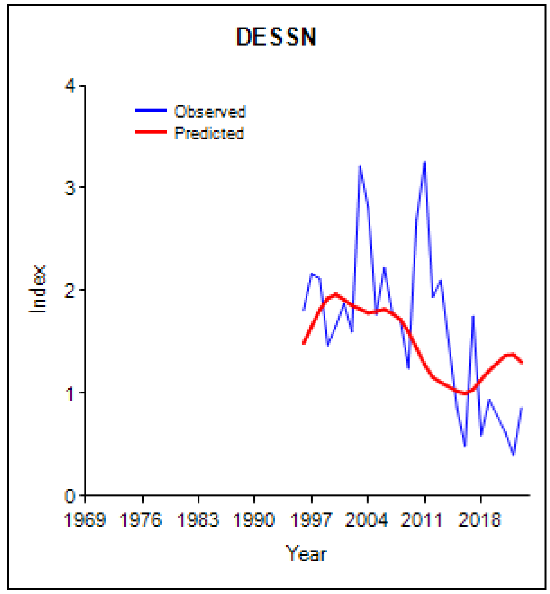

NYOHS
Standardized Residuals
Year
1969 1976 1983 1990 1997 2004 2011 2018

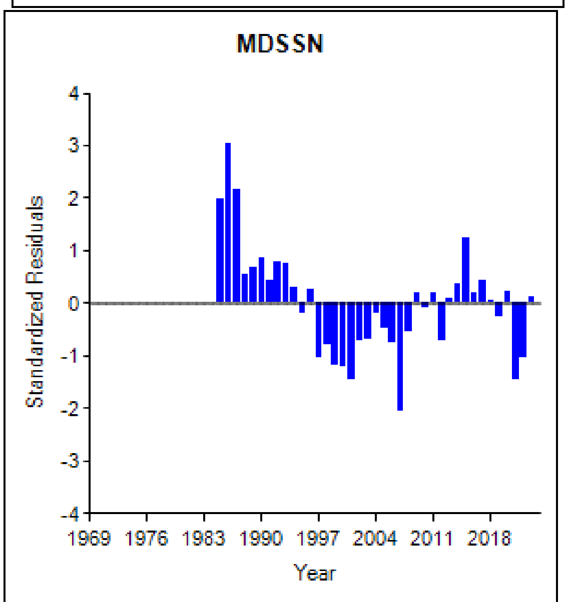

NJTRAWL
Standardized Residuals
Year
1969 1976 1983 1990 1997 2004 2011 2018

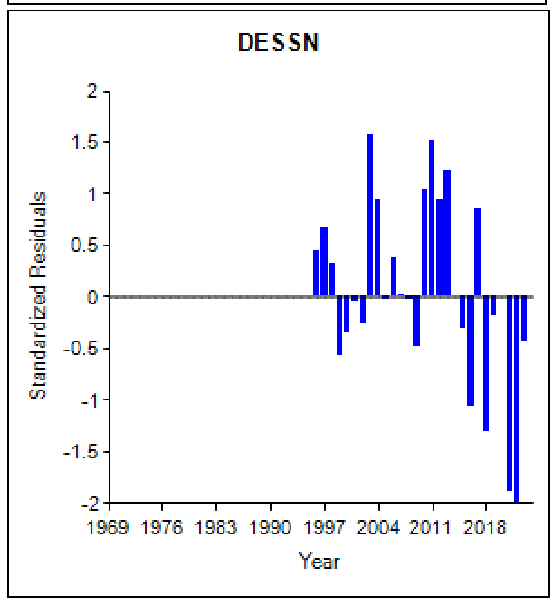

NYOHS
Standardized Residuals
Theoretical Quantiles

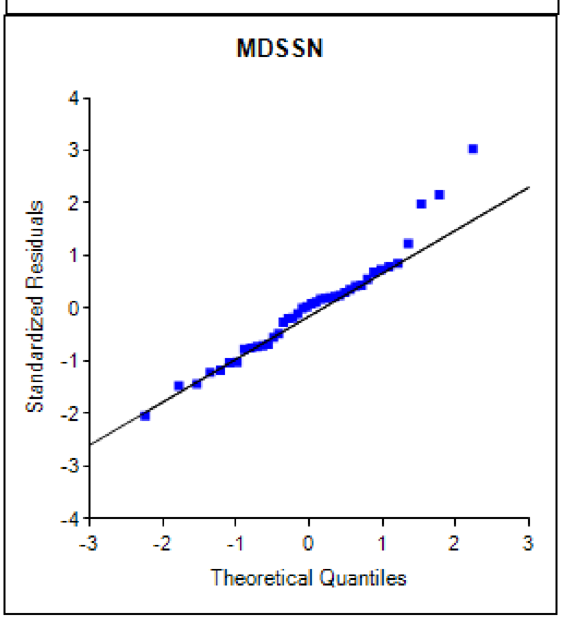

NJTRAWL
Standardized Residuals
Theoretical Quantiles

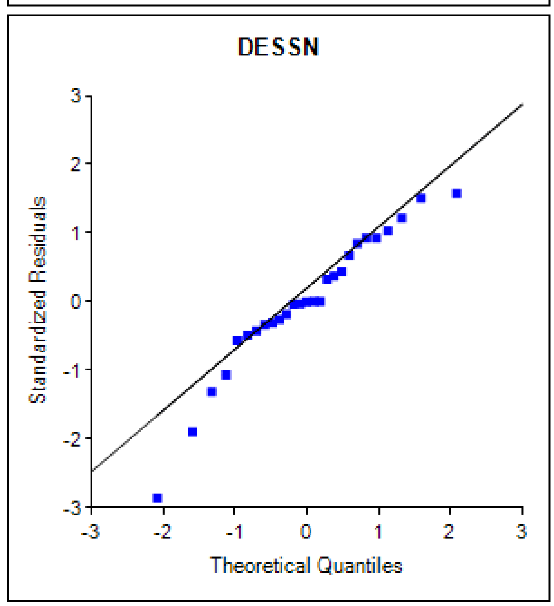

MDSSN
Observed
Predicted
Index
Year
0 2 4 6 8 10 12
1969 1976 1983 1990 1997 2004 2011 2018

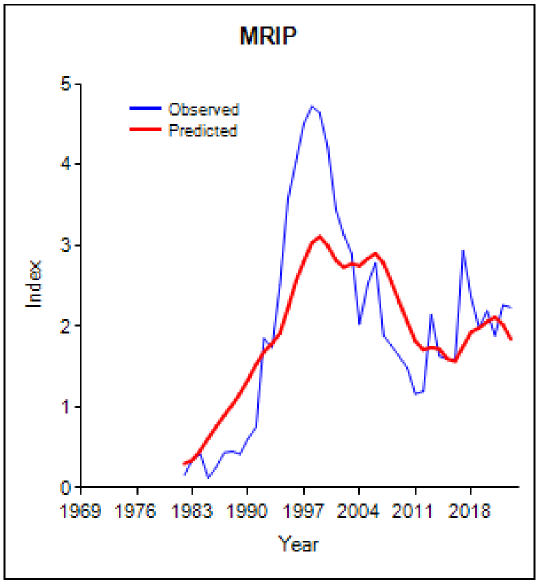

DESSN
Observed
Predicted
Index
Year
0 1 2 3 4
1969 1976 1983 1990 1997 2004 2011 2018

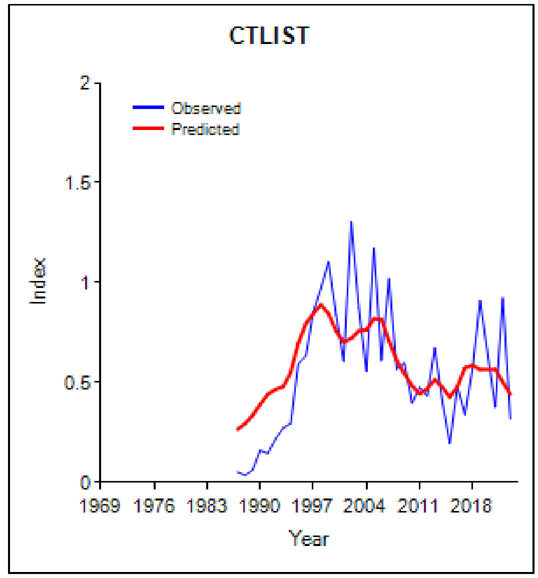

MDSSN
Standardized Residuals
Year
-4 -3 -2 -1 0 1 2 3 4
1969 1976 1983 1990 1997 2004 2011 2018

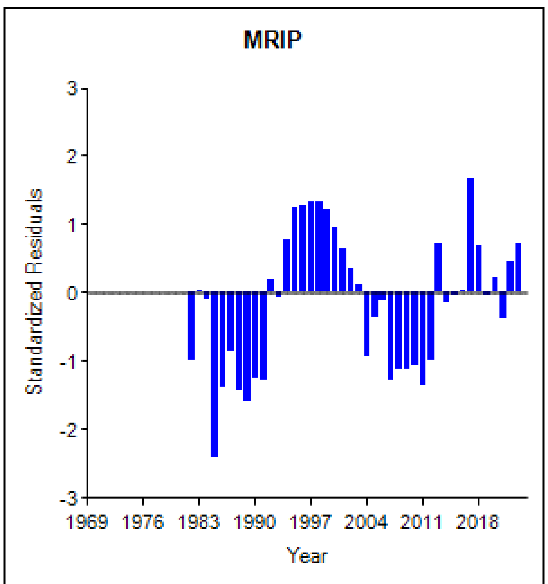

DESSN
Standardized Residuals
Year
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
1969 1976 1983 1990 1997 2004 2011 2018

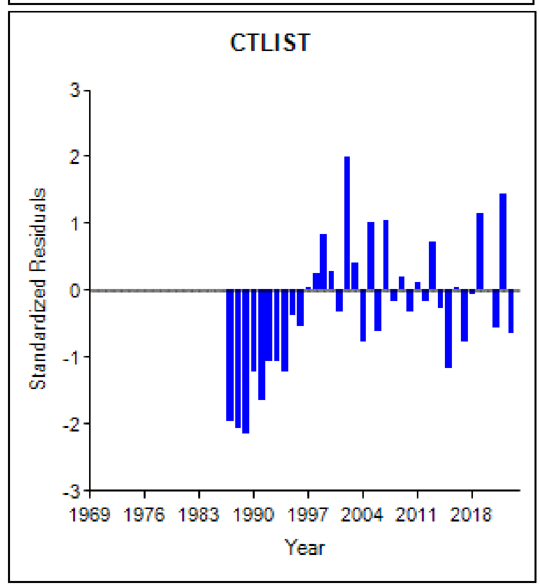

MDSSN
Standardized Residuals
Theoretical Quantiles
-4 -3 -2 -1 0 1 2 3 4
-3 -2 -1 0 1 2 3

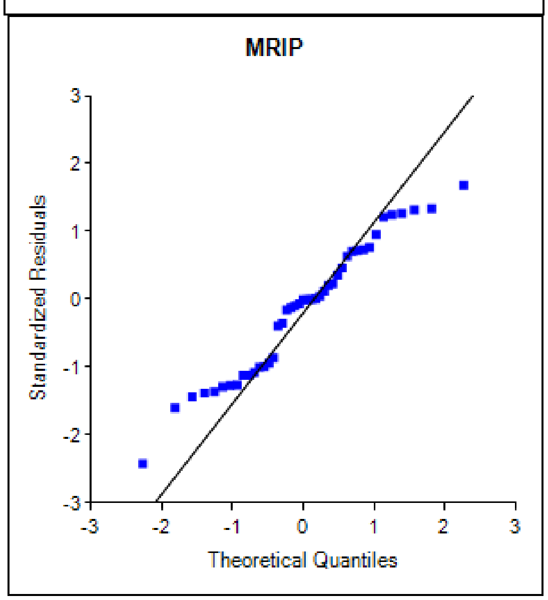

DESSN
Standardized Residuals
Theoretical Quantiles
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3

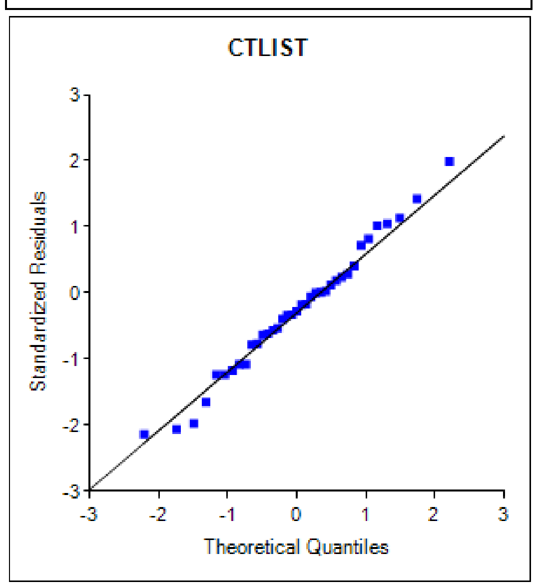

MRIP
Observed
Predicted
Index
Year
0
1
2
3
4
5
1969 1976 1983 1990 1997 2004 2011 2018

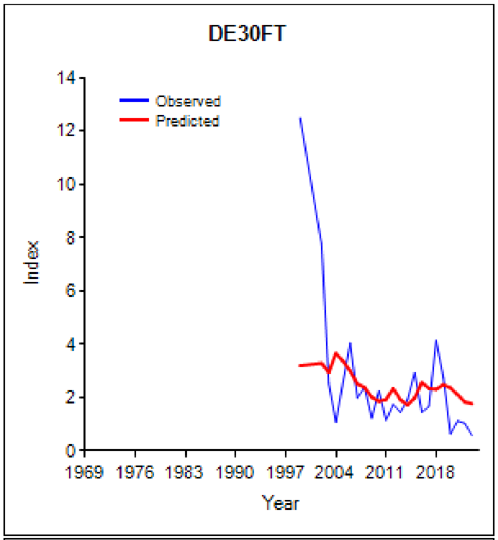

CTLIST
Observed
Predicted
Index
Year
0
0.5
1
1.5
2
1969 1976 1983 1990 1997 2004 2011 2018

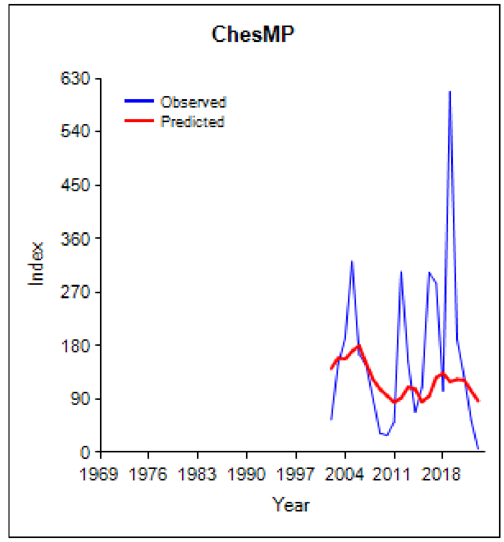

MRIP
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

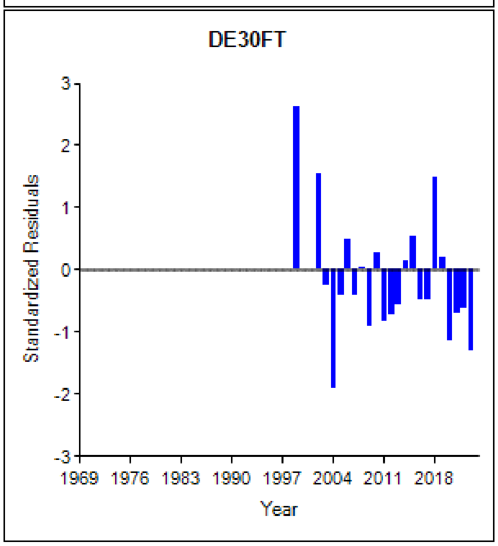

CTLIST
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

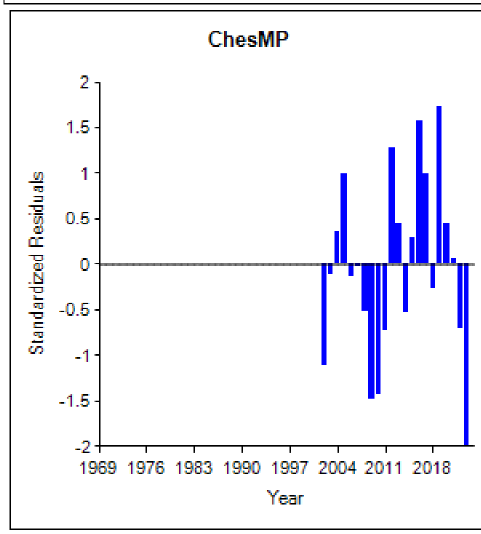

MRIP
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3

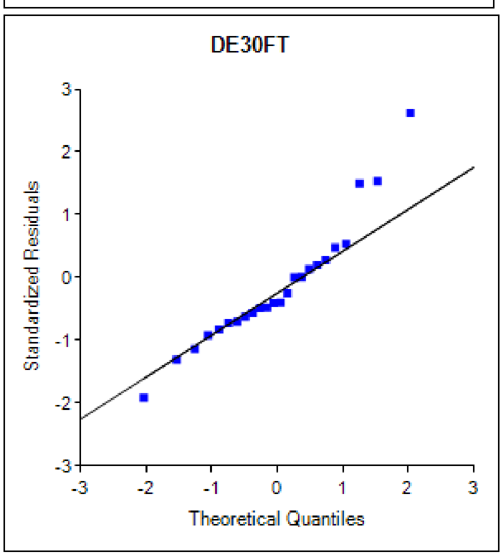

CTLIST
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3

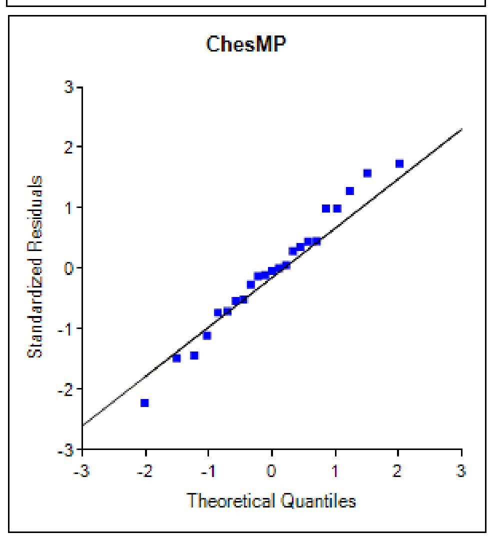

DE30FT
Observed
Predicted
Index
Year

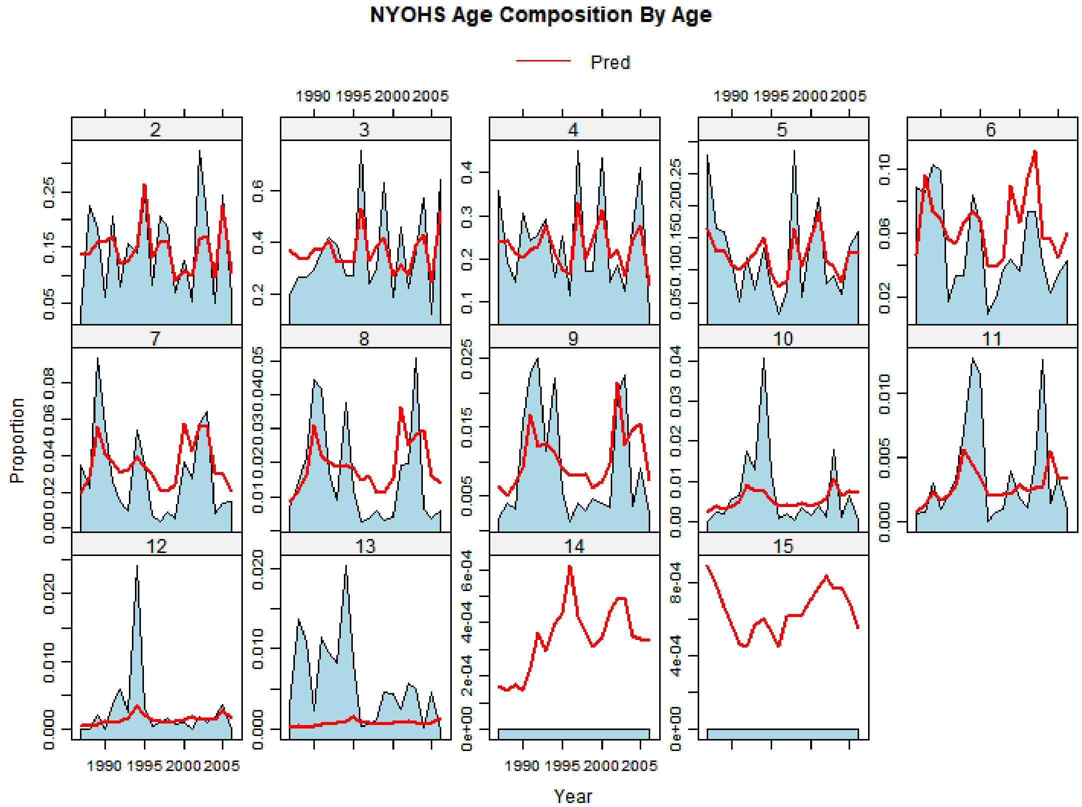

ChesMP
Observed
Predicted
Index
Year

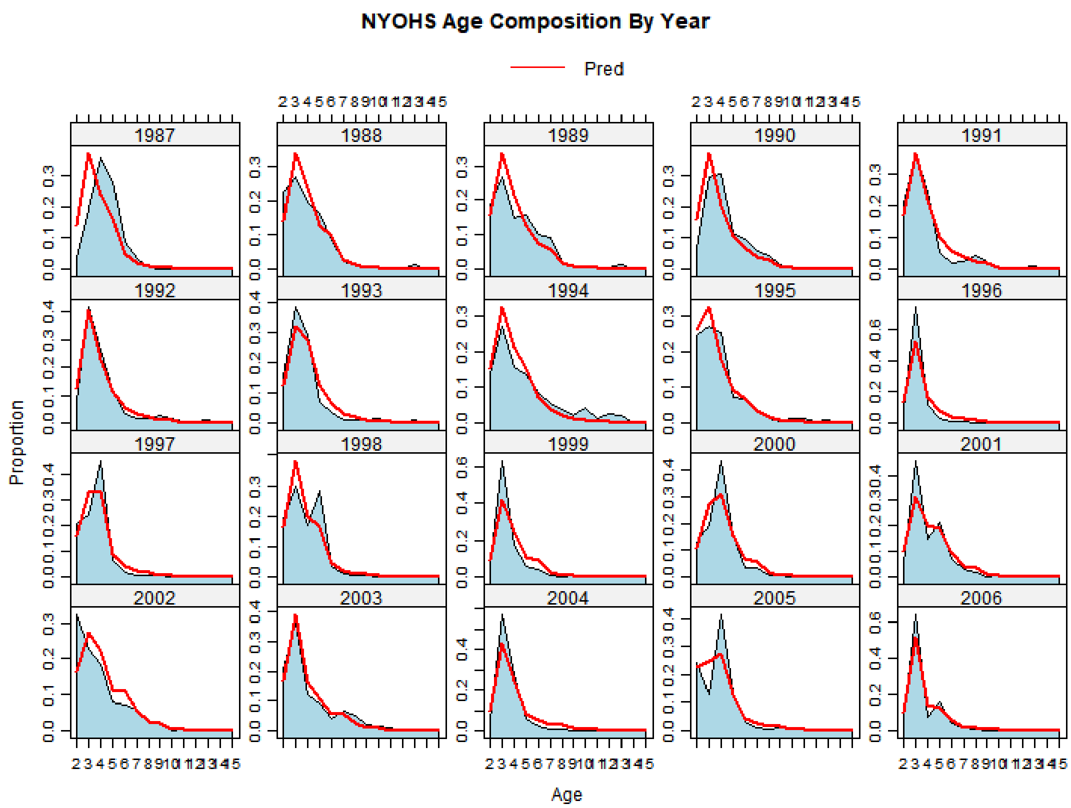

DE30FT
Standardized Residuals
Year

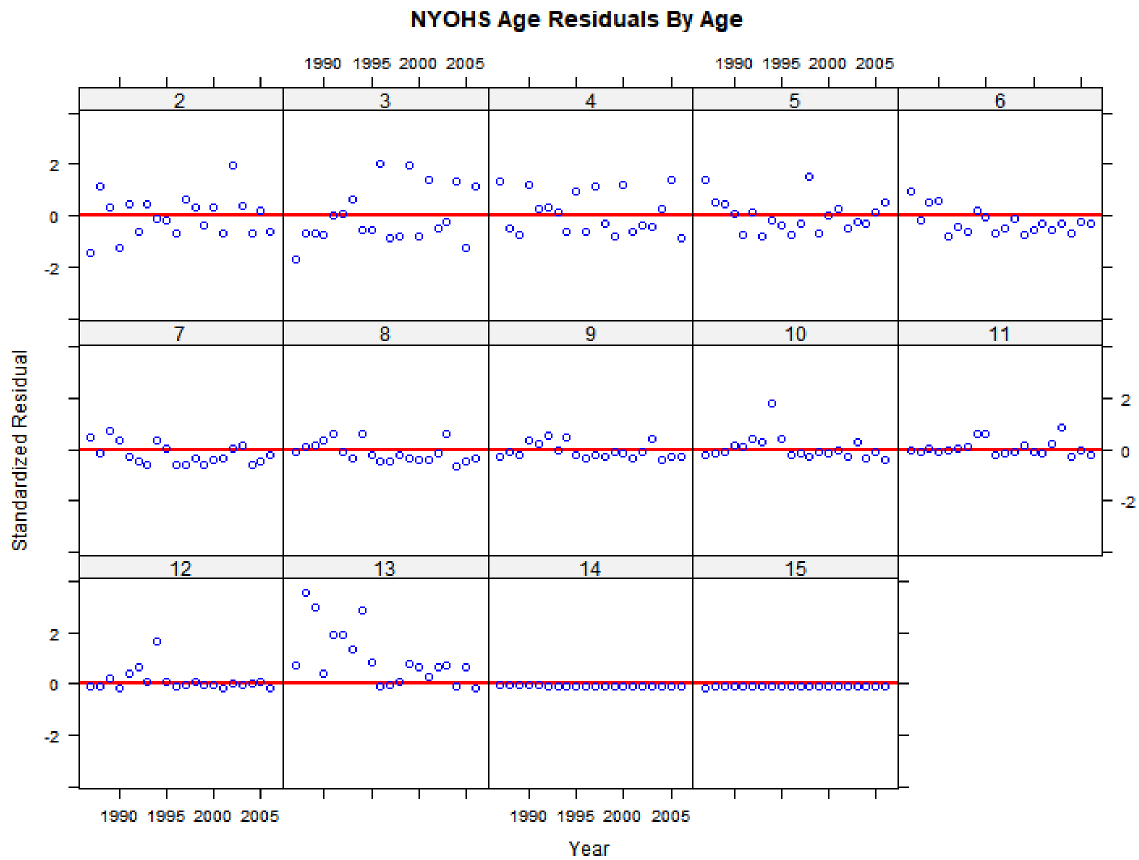

ChesMP
Standardized Residuals
Year

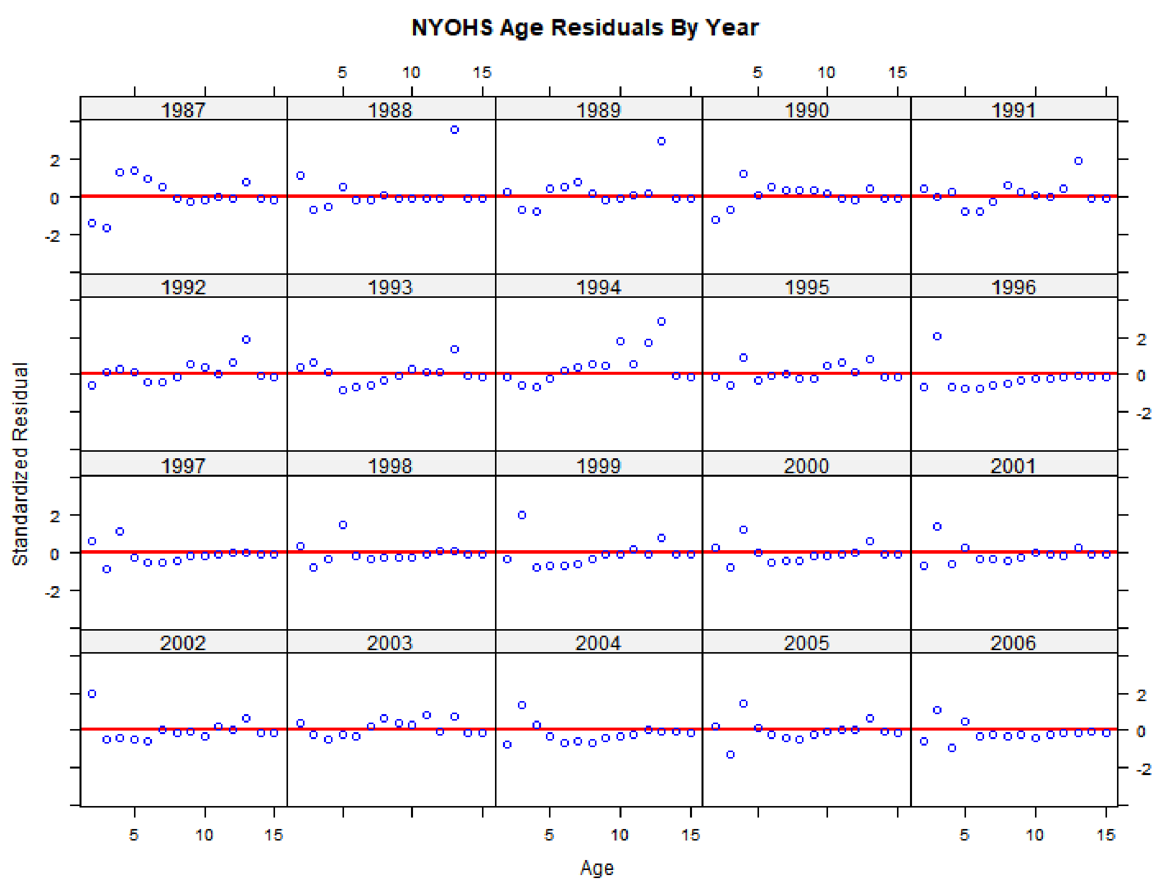

DE30FT
Standardized Residuals
Theoretical Quantiles

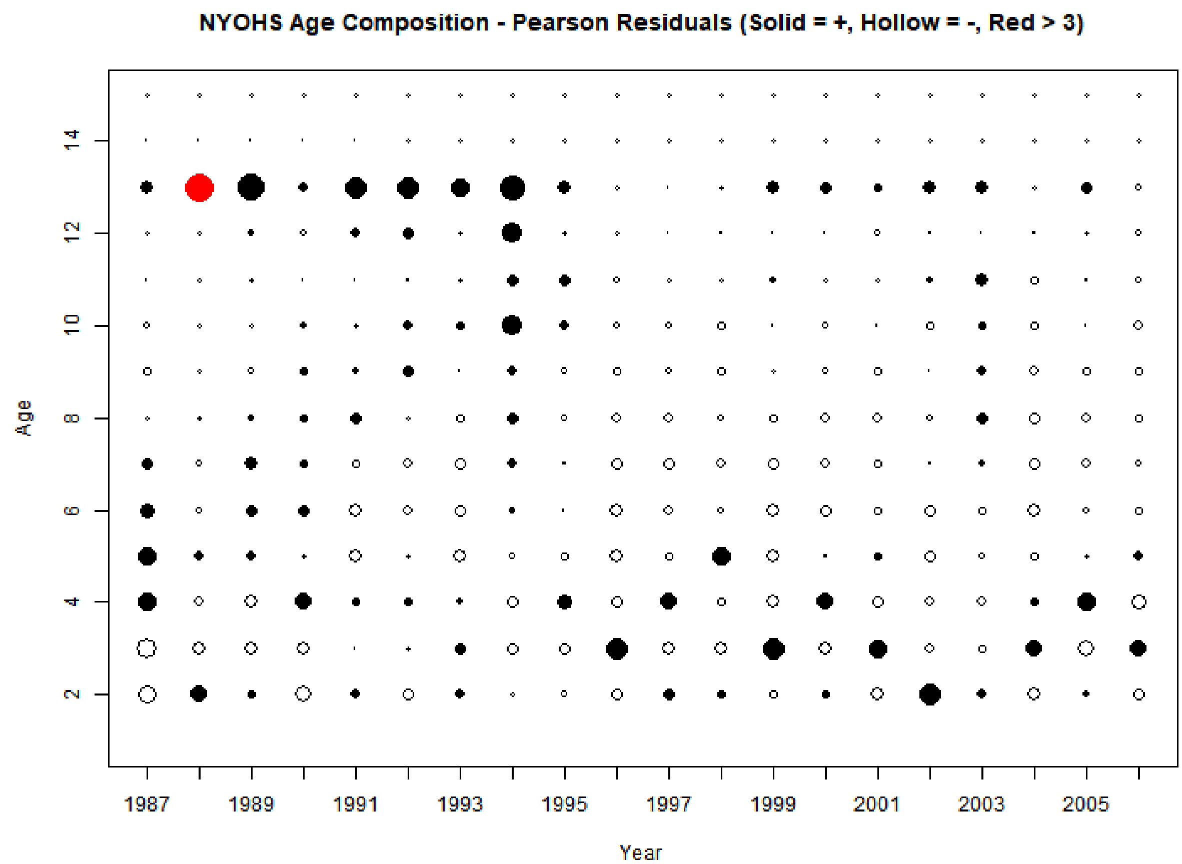

ChesMP
Standardized Residuals
Theoretical Quantiles


NYOHS Age Composition By Age
Pred
Proportion
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990 1995 2000 2005

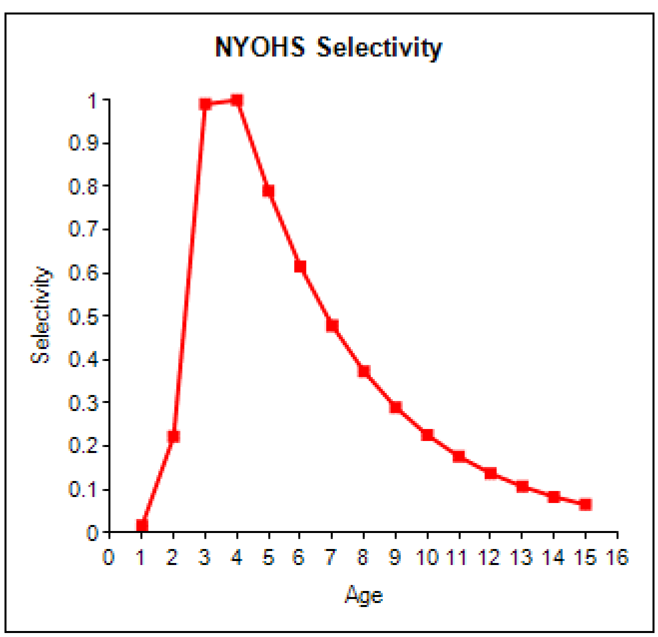

NYOHS Age Composition By Year
Pred
Proportion
Age
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006


NYOHS Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15


NYOHS Age Residuals By Year
Standardized Residual
Age
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

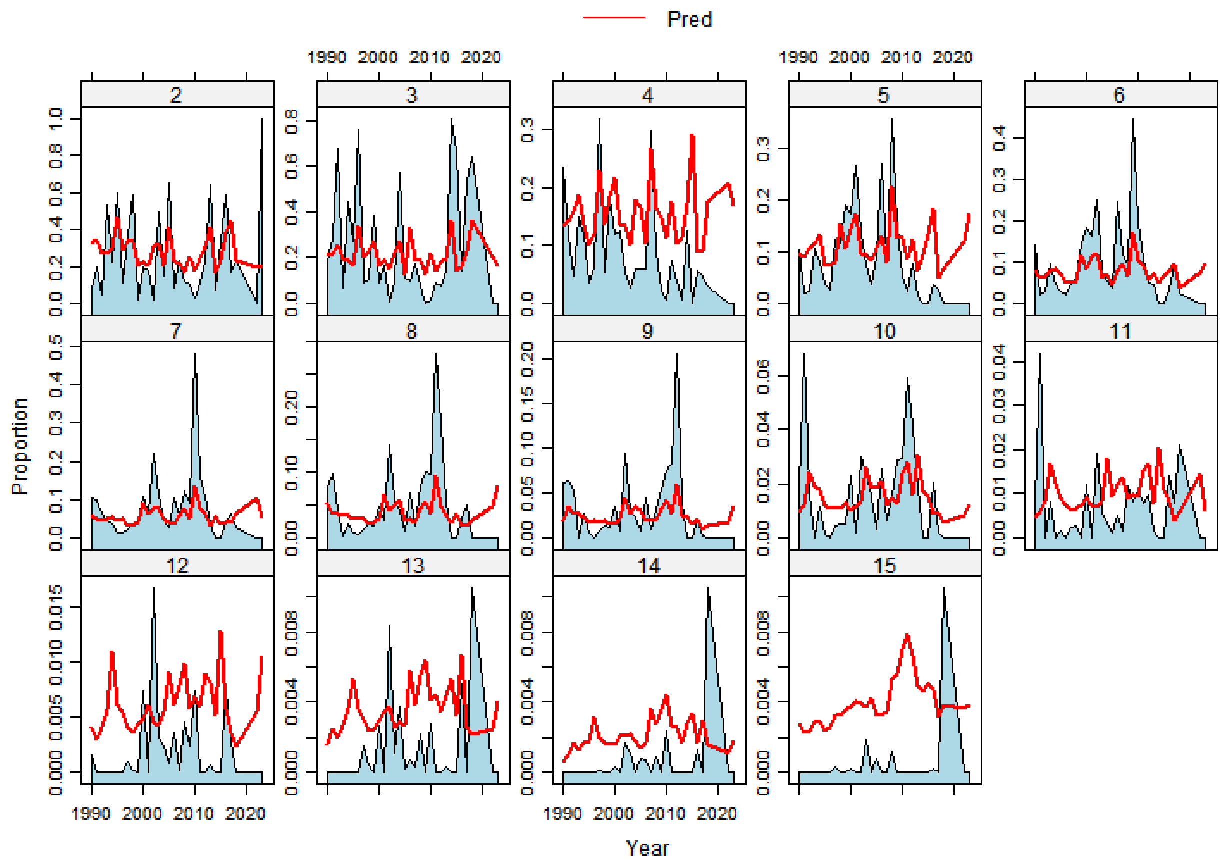


NYOHS Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2
4
6
8
10
12
14
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

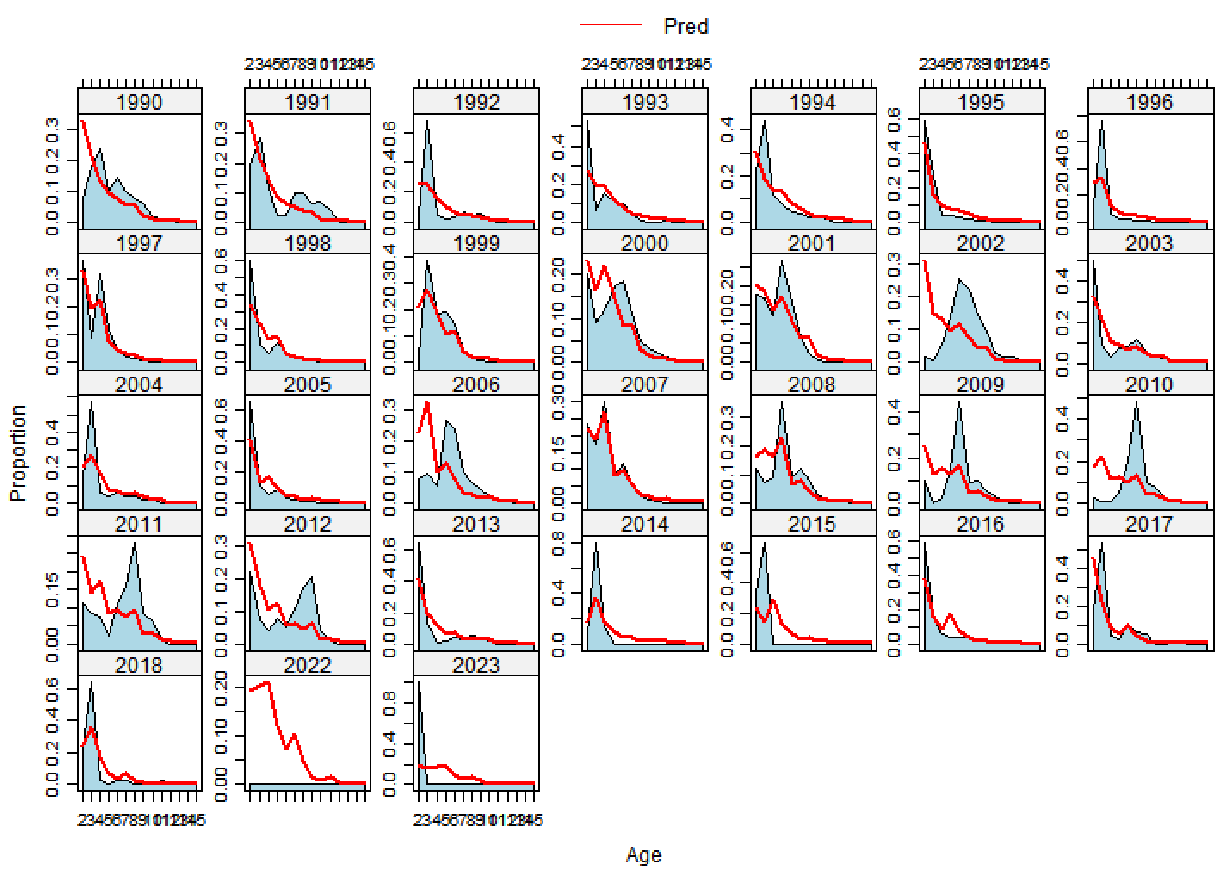


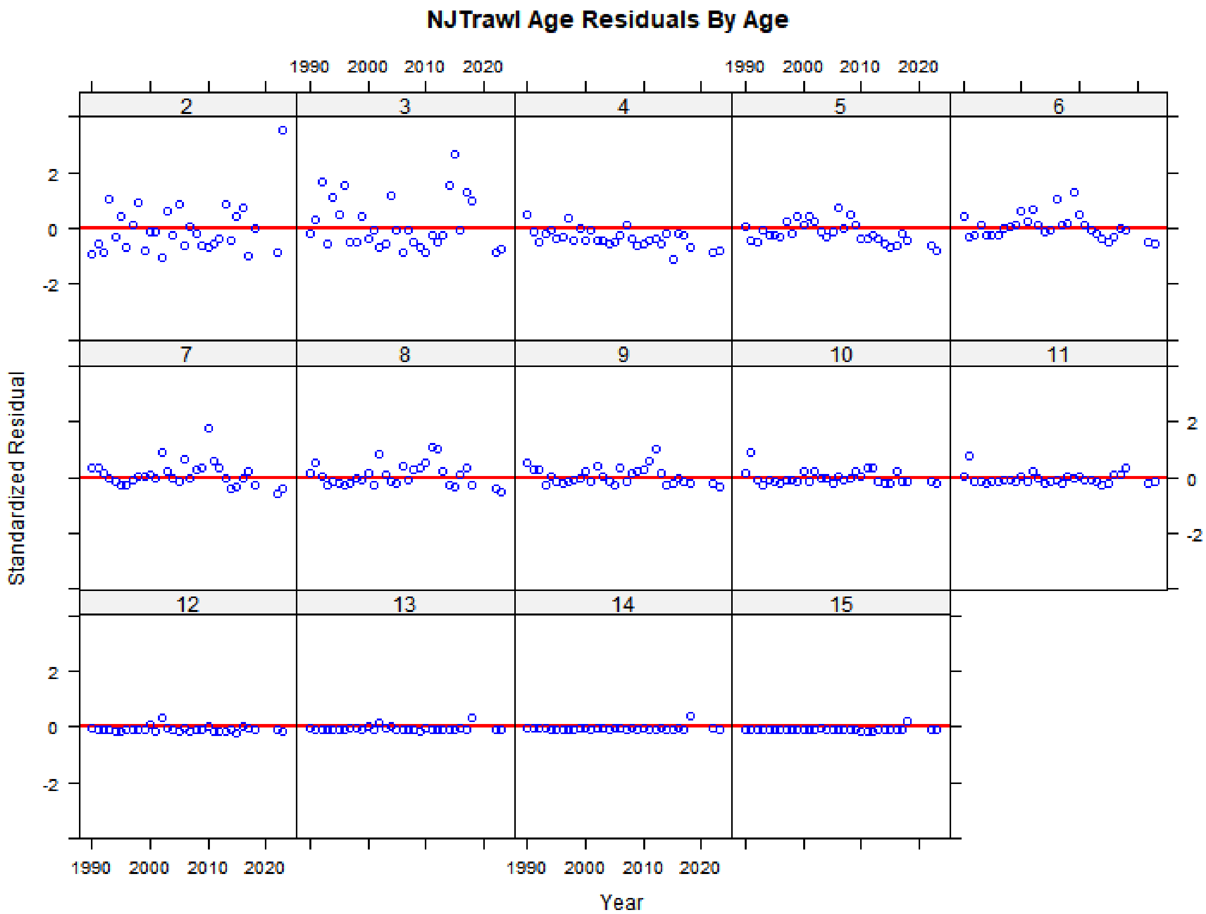
NYOHS Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

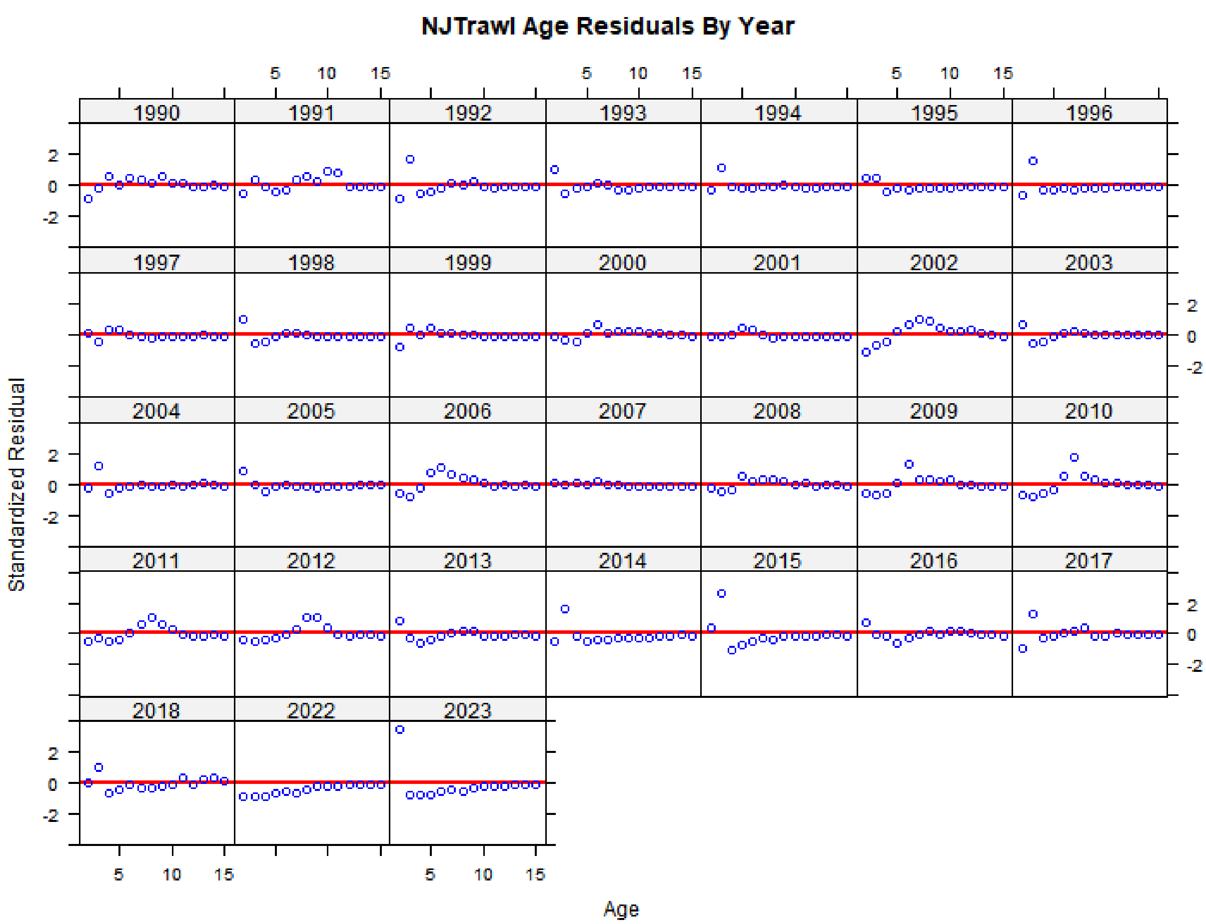
NJTrawl Age Composition By Age

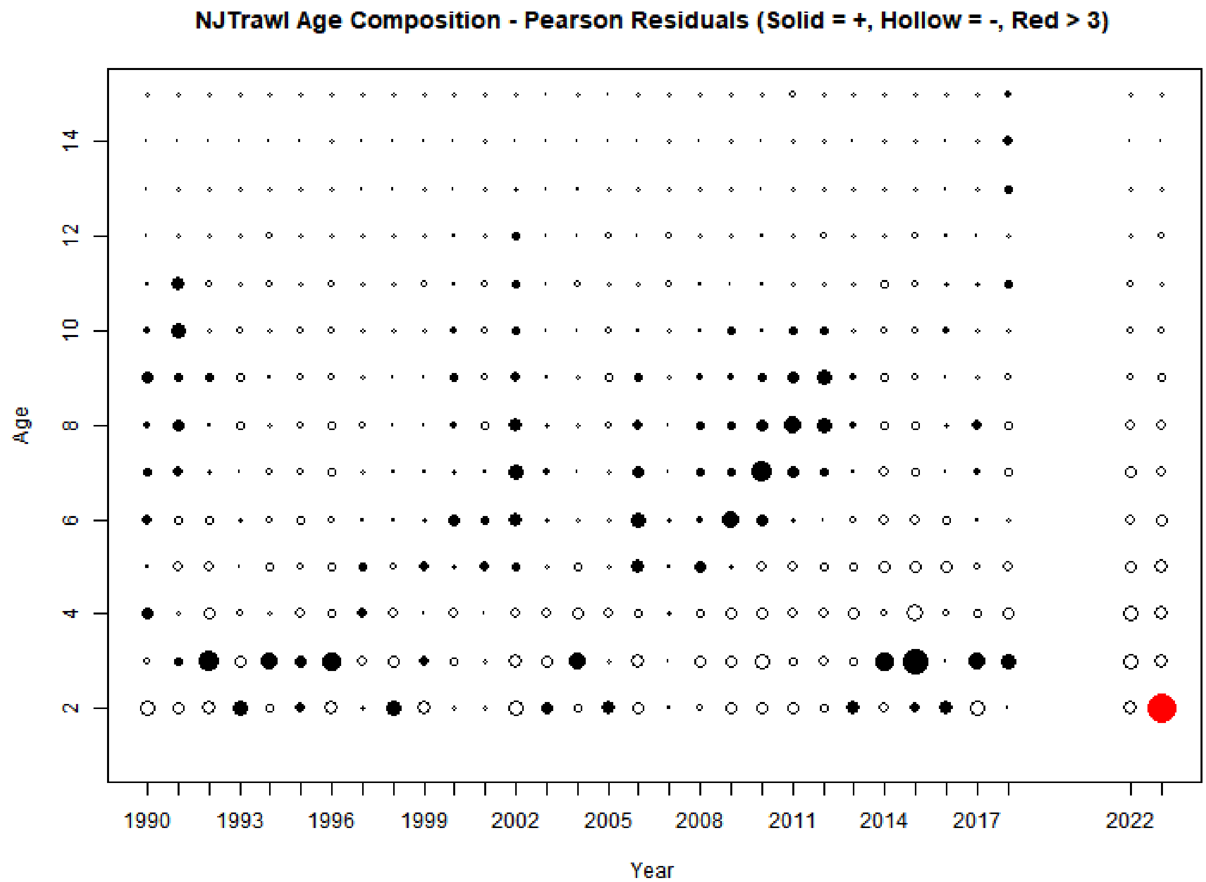


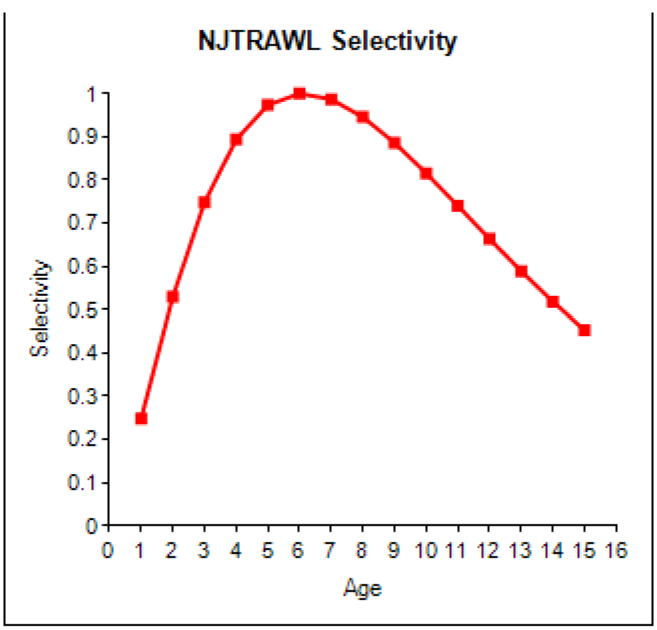
NJTrawl Age Composition By Year

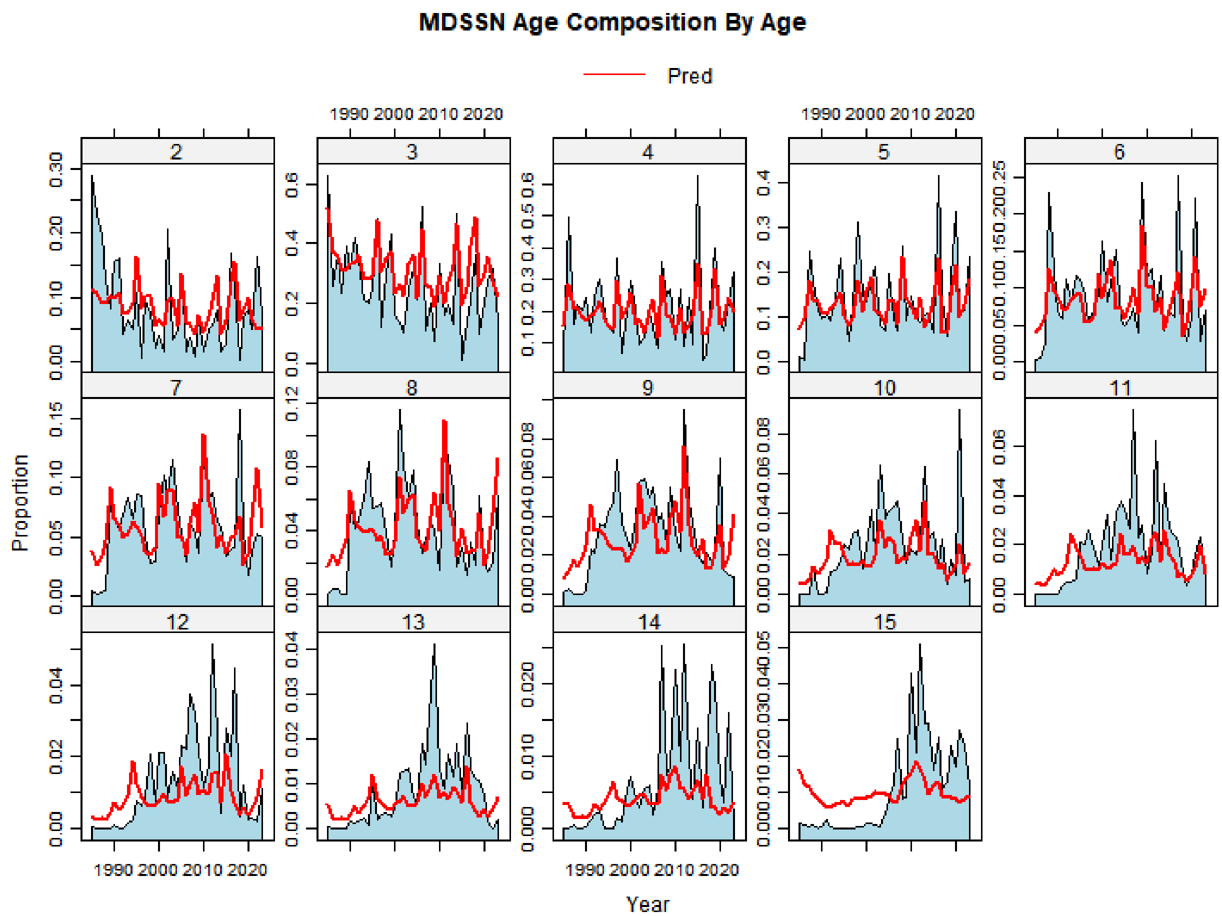


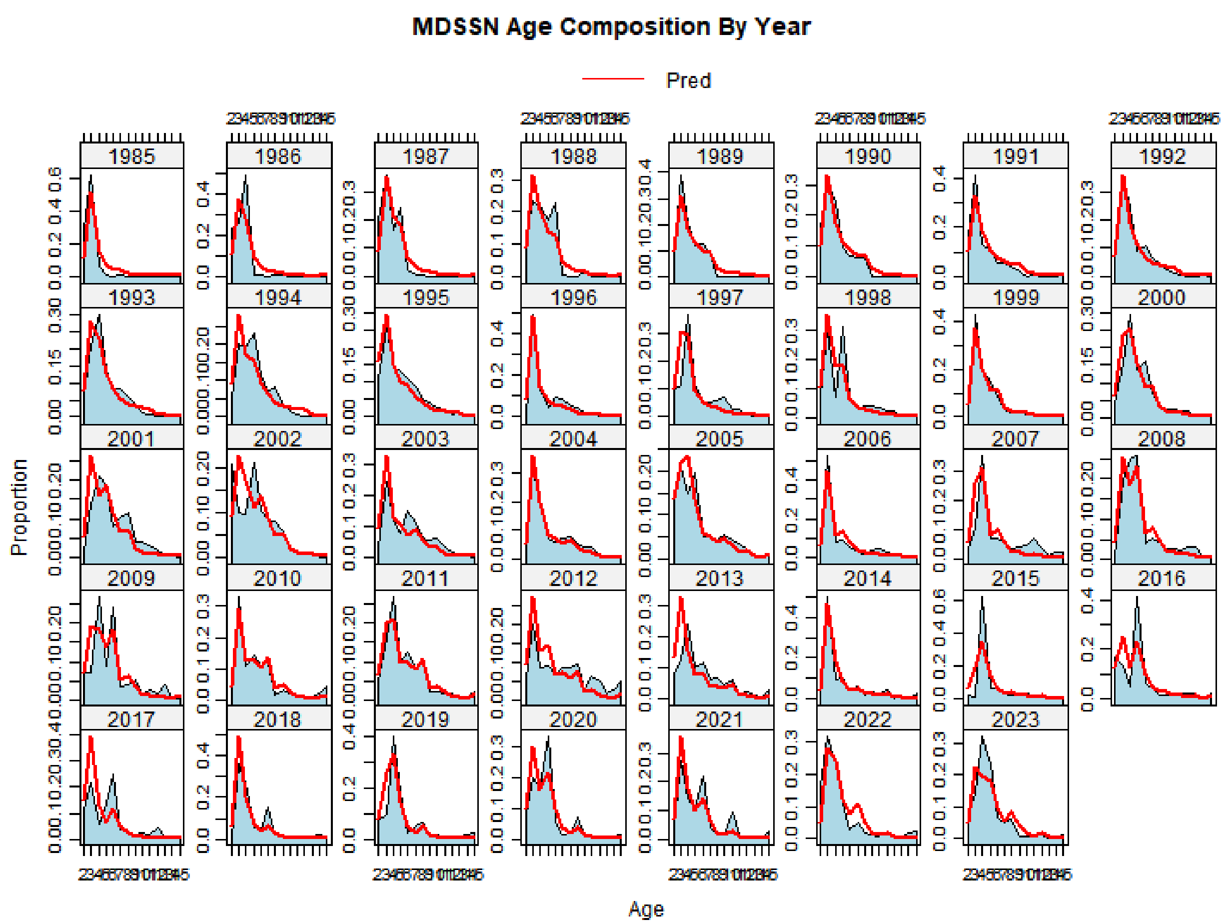

NJTrawl Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990
2000
2010
2020

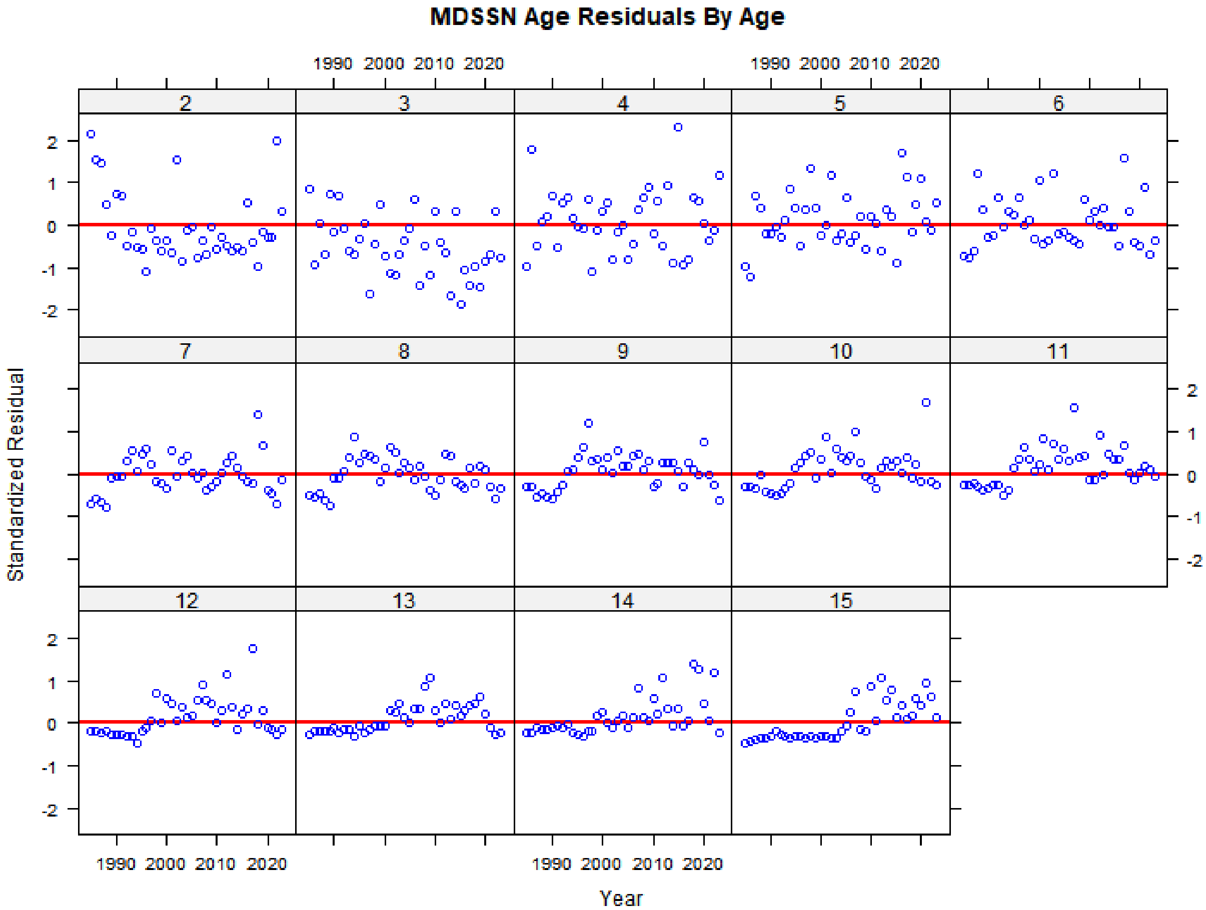

NJTrawl Age Residuals By Year
Standardized Residual
Age
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2022
2023

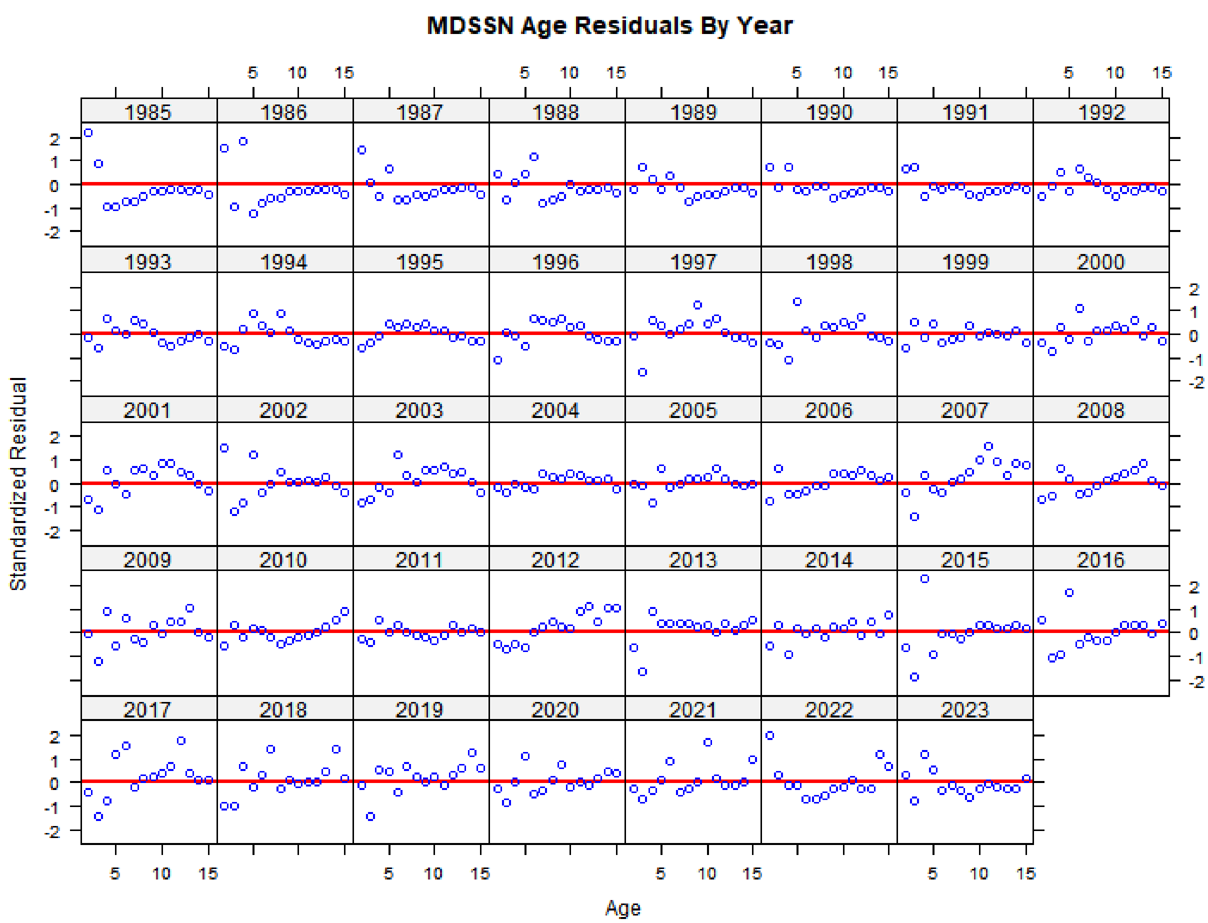

NJTrawl Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2022
Year

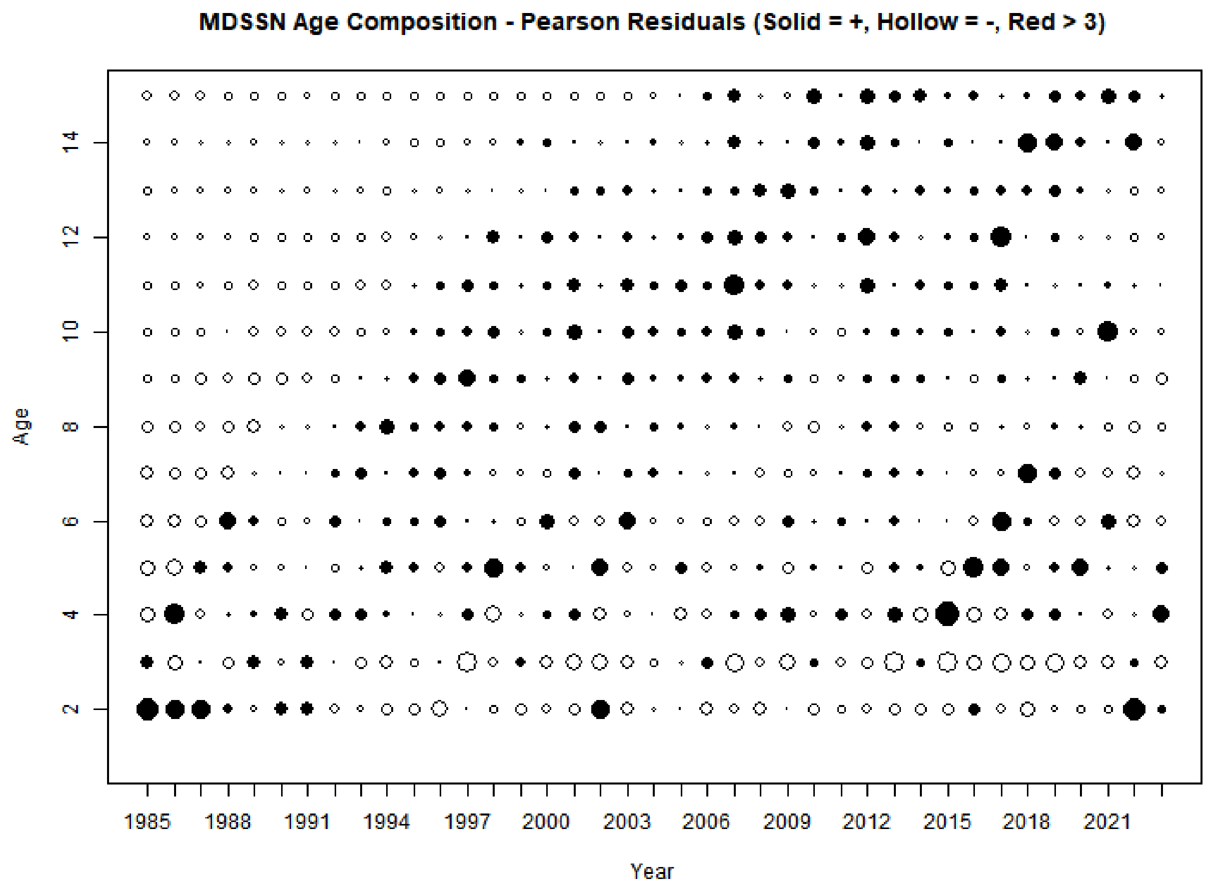

NJTRAWL Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

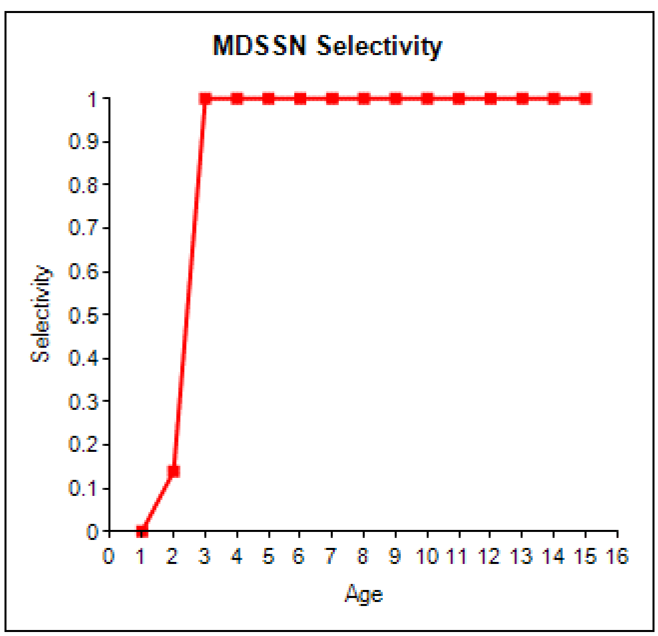

MDSSN Age Composition By Age
Pred
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Proportion
Year


MDSSN Age Composition By Year
Pred
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Proportion
Age

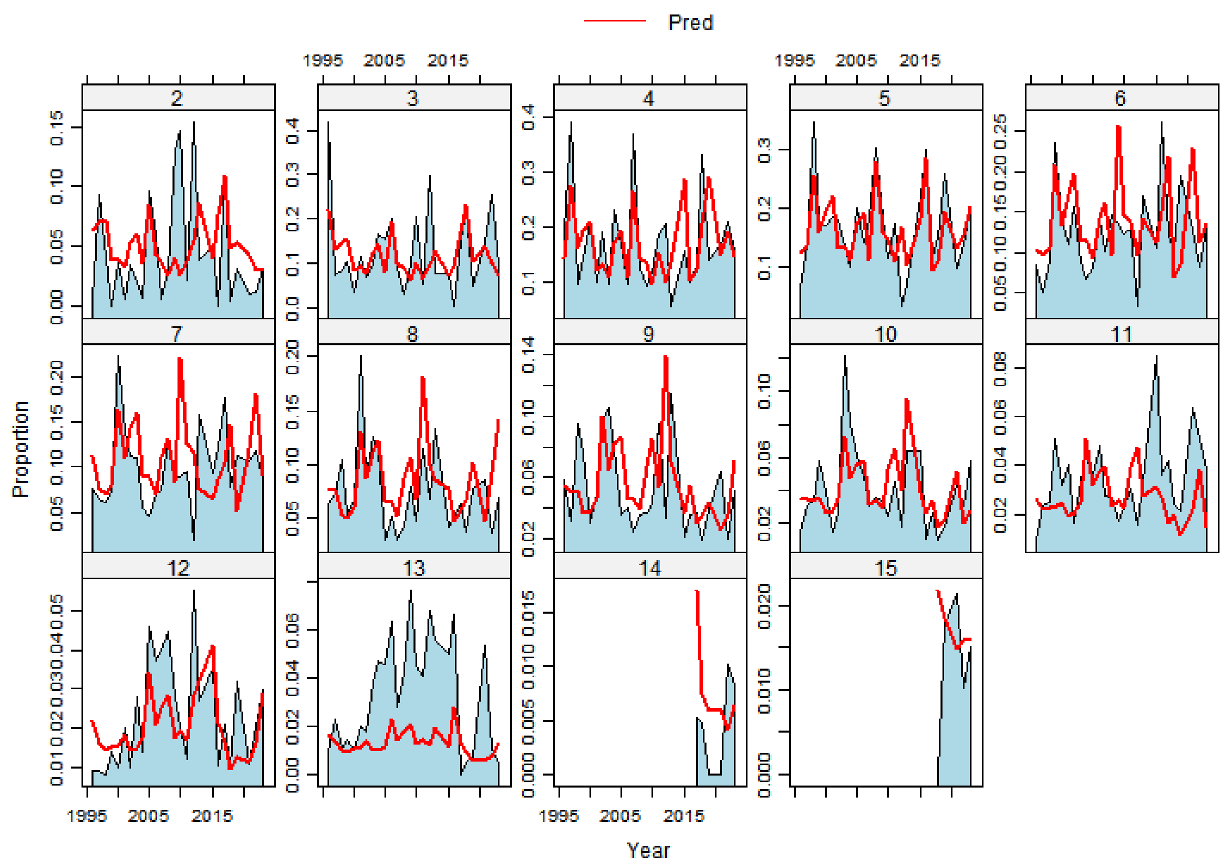

MDSSN Age Residuals By Age
Standardized Residual
Year


MDSSN Age Residuals By Year
Standardized Residual
Age

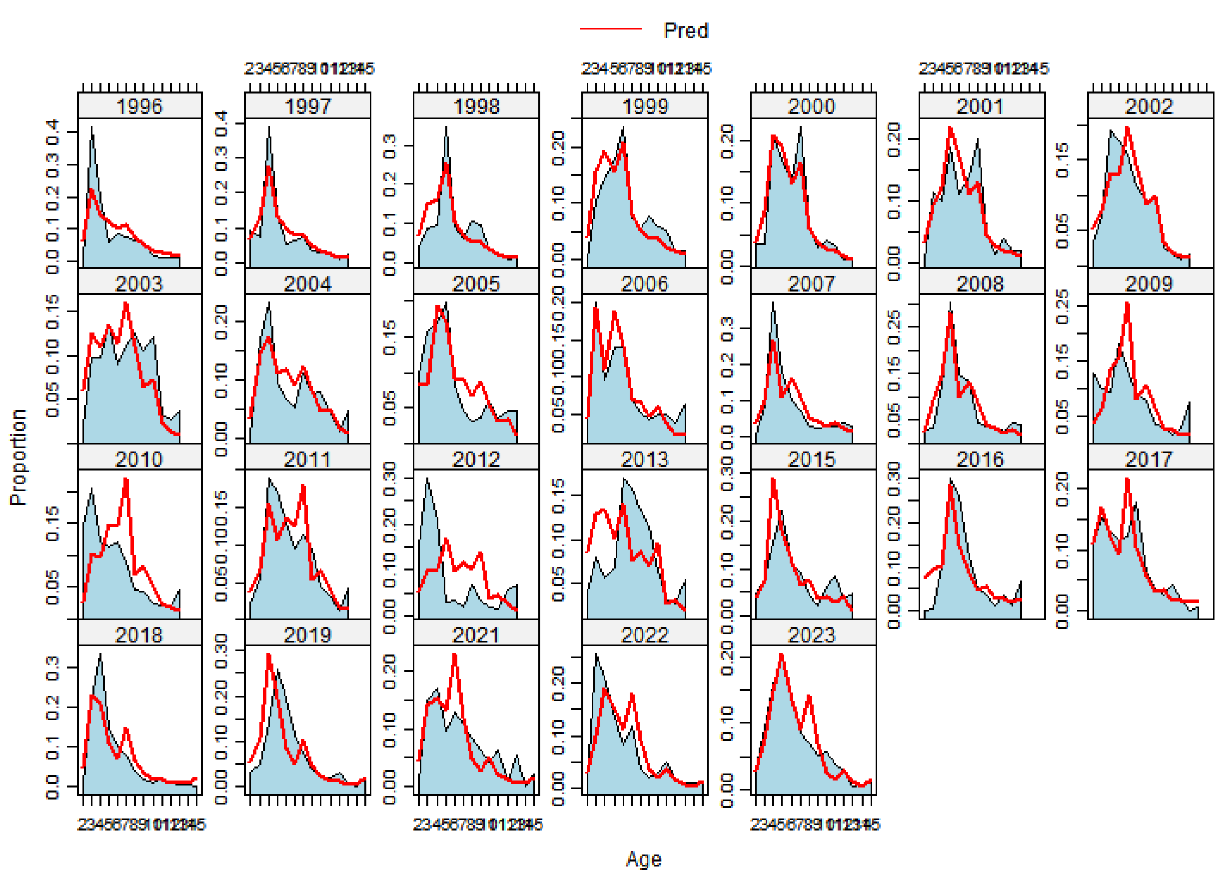

MDSSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

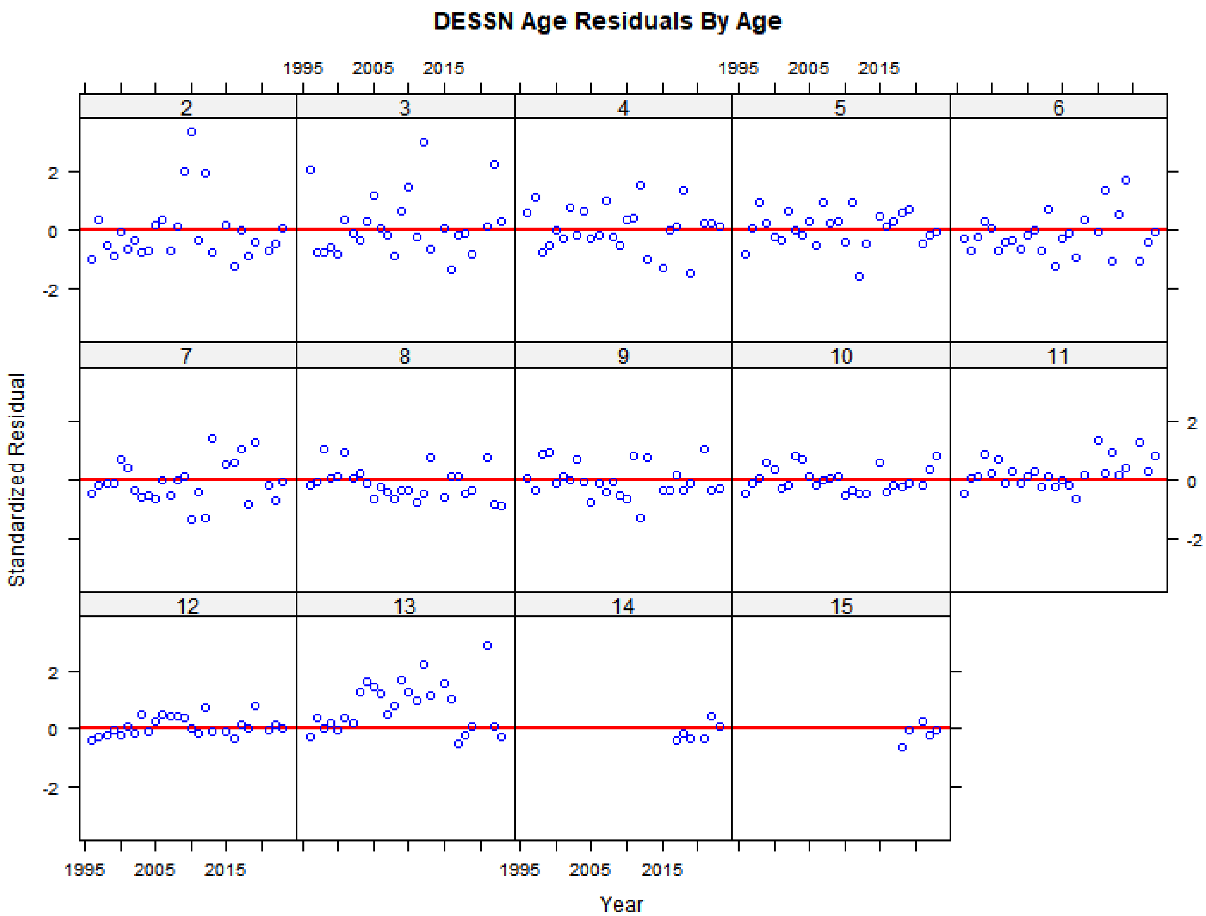

MDSSN Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Age
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

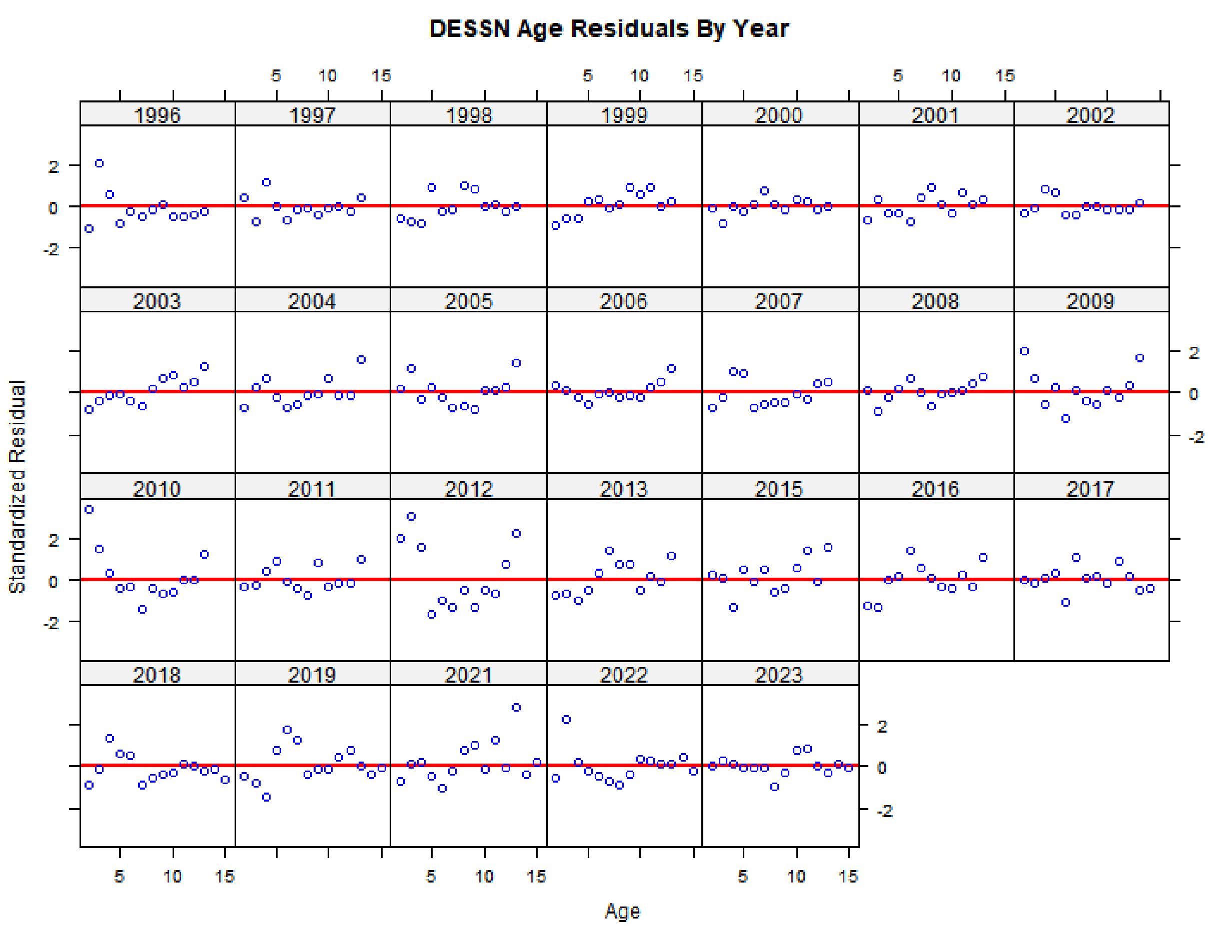
DESSN Age Composition By Age

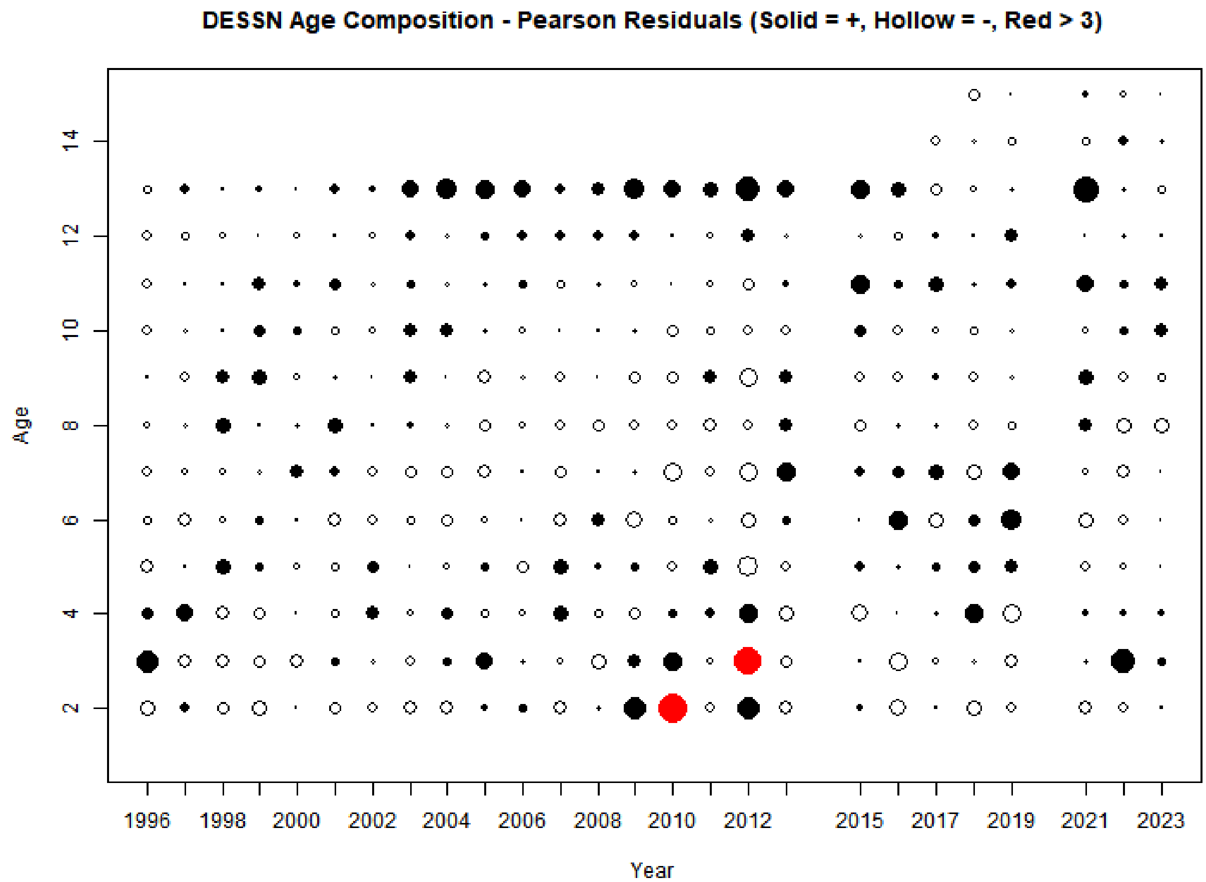


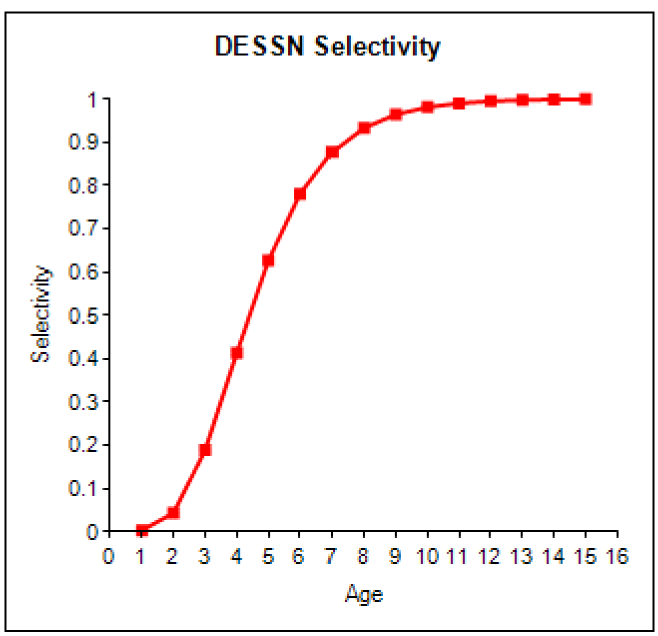
DESSN Age Composition By Year



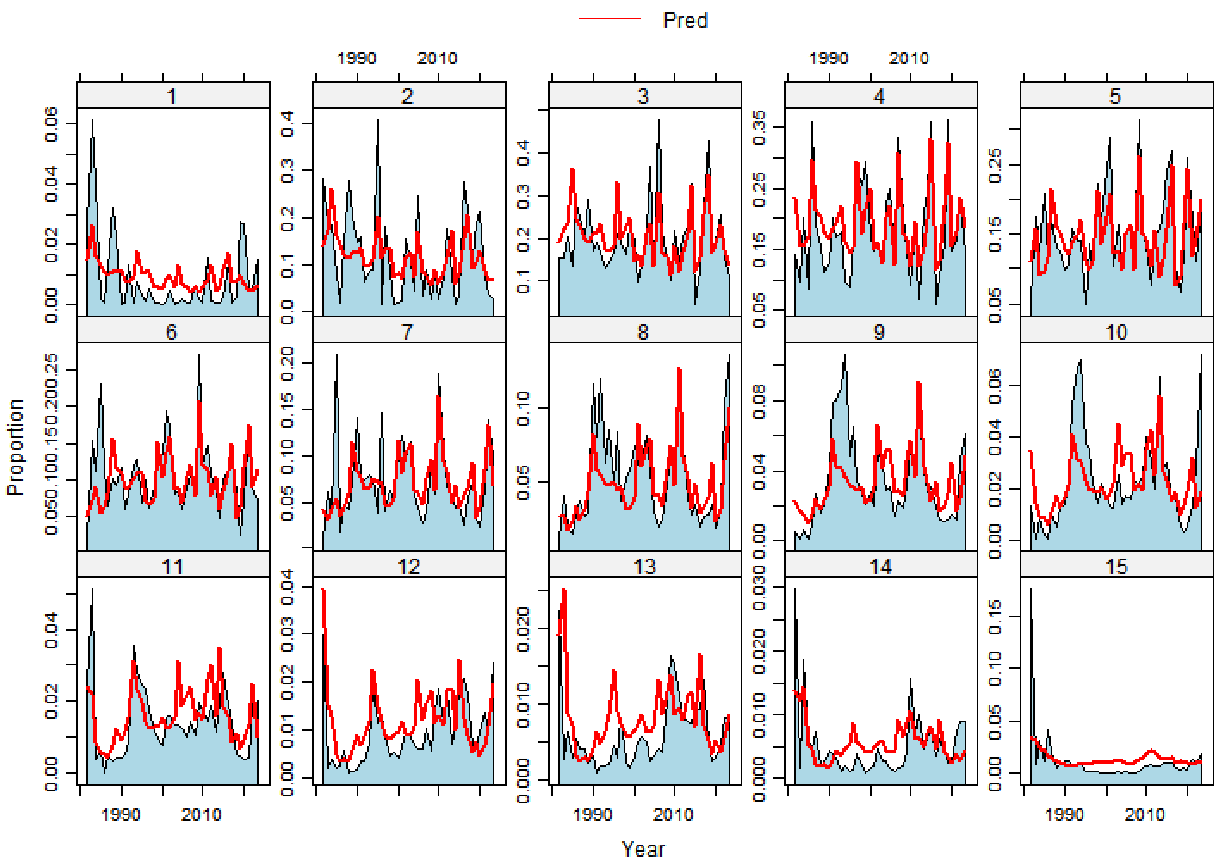

DESSN Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1995
2005
2015
2
0
-2


DESSN Age Residuals By Year
Standardized Residual
Age
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2015
2016
2017
2018
2019
2021
2022
2023
5
10
15
2
0
-2

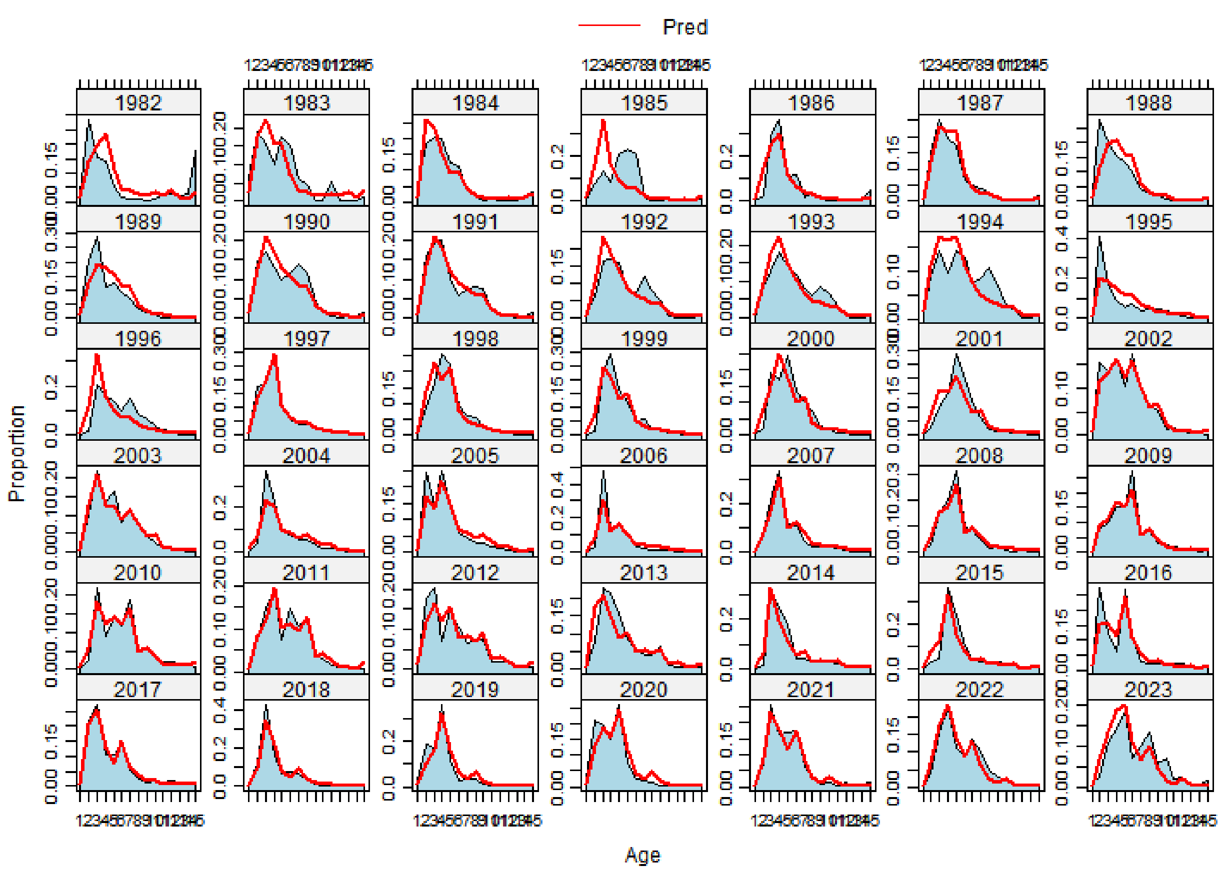

DESSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1996
1998
2000
2002
2004
2006
2008
2010
2012
2015
2017
2019
2021
2023
2
4
6
8
10
12
14

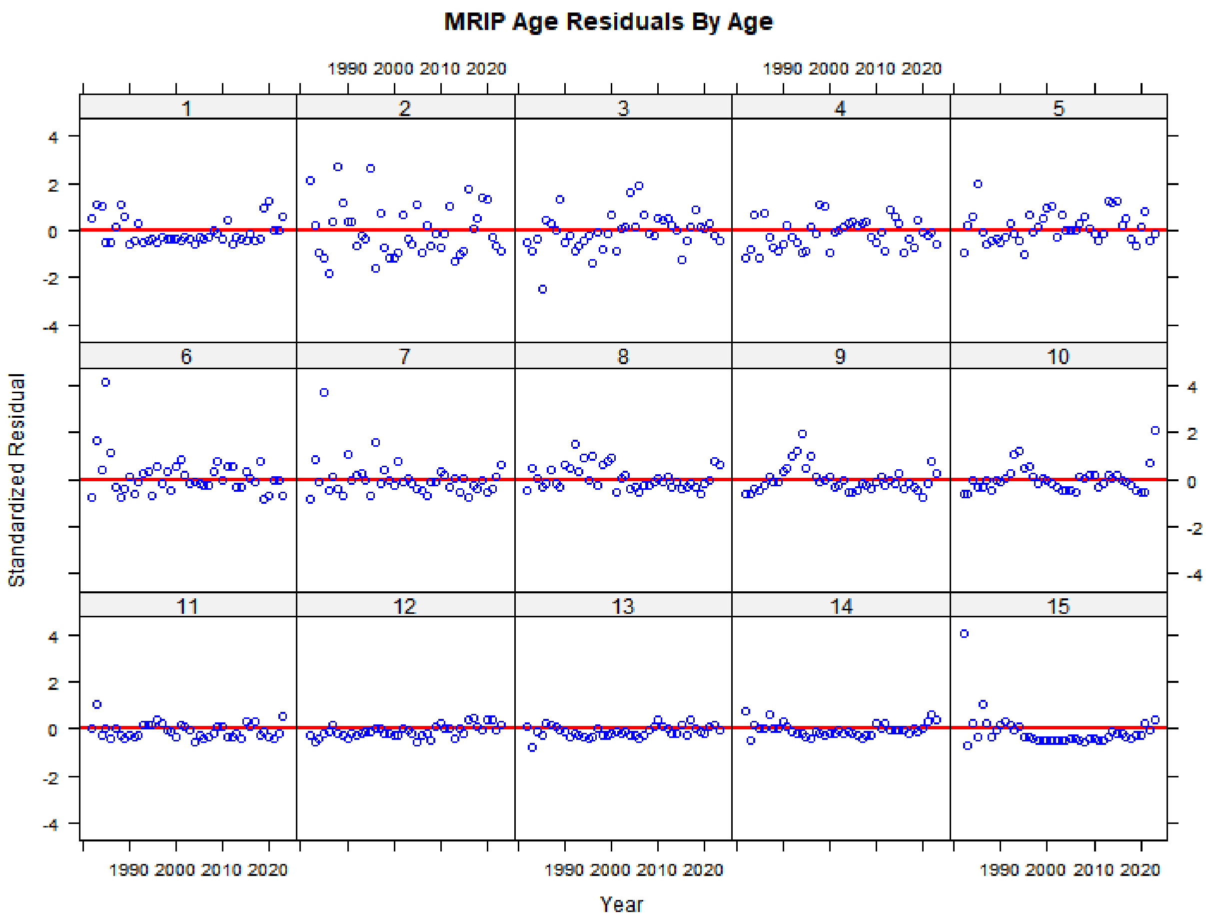

DESSN Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

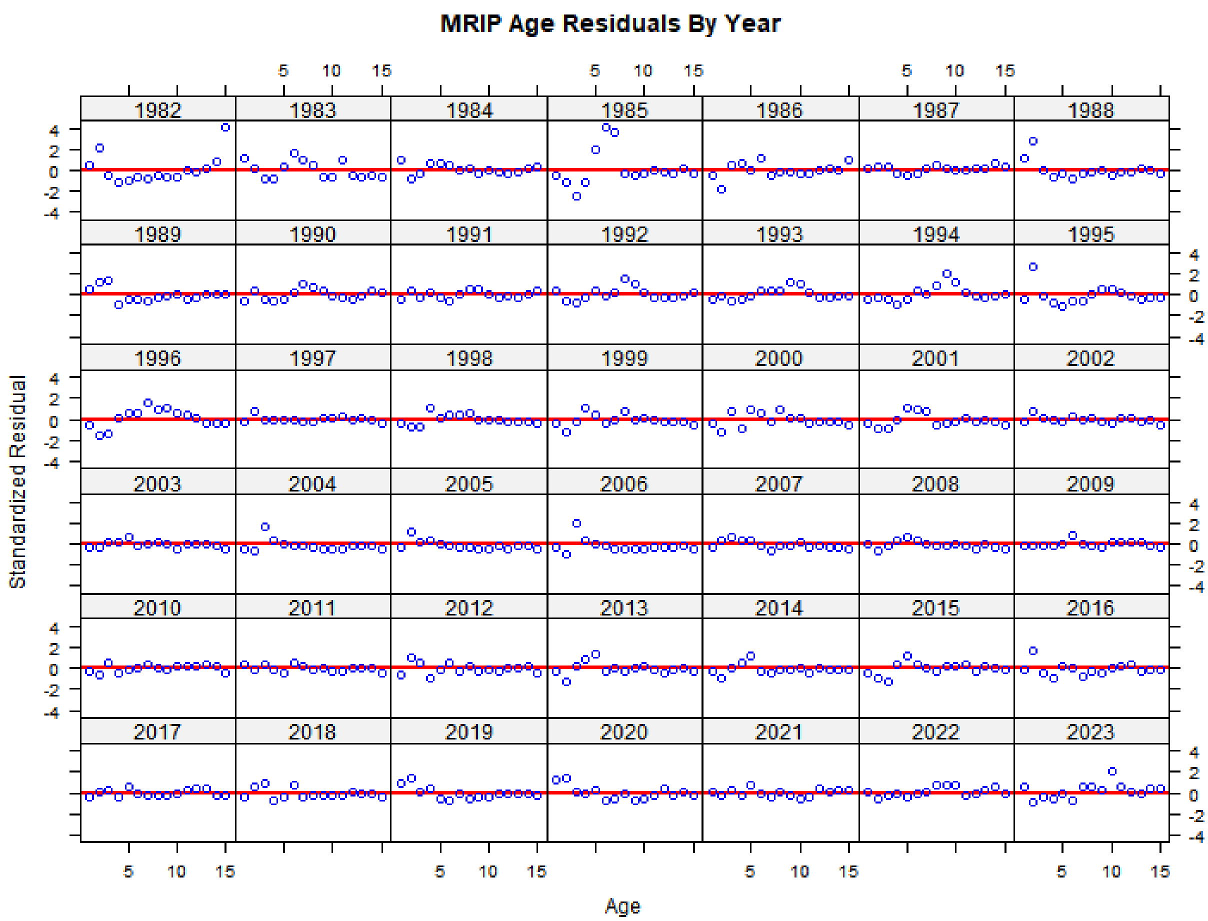
MRIP Age Composition By Age

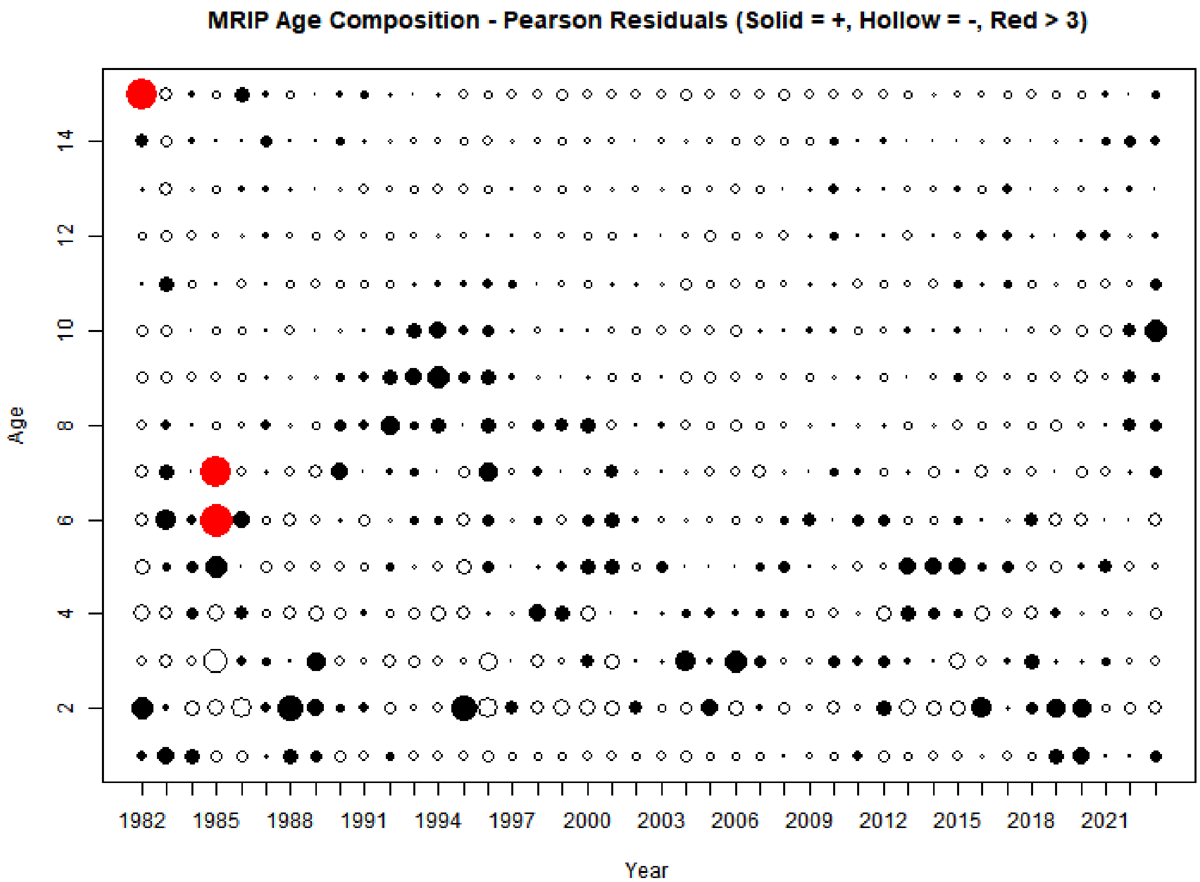


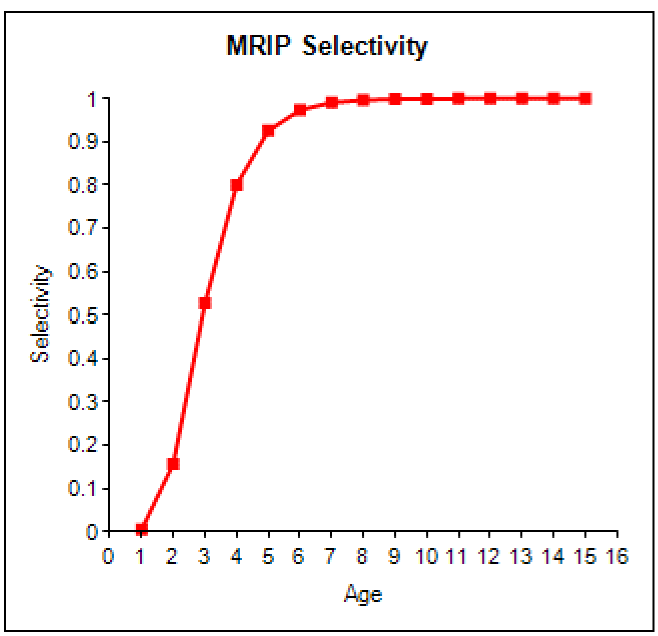
MRIP Age Composition By Year



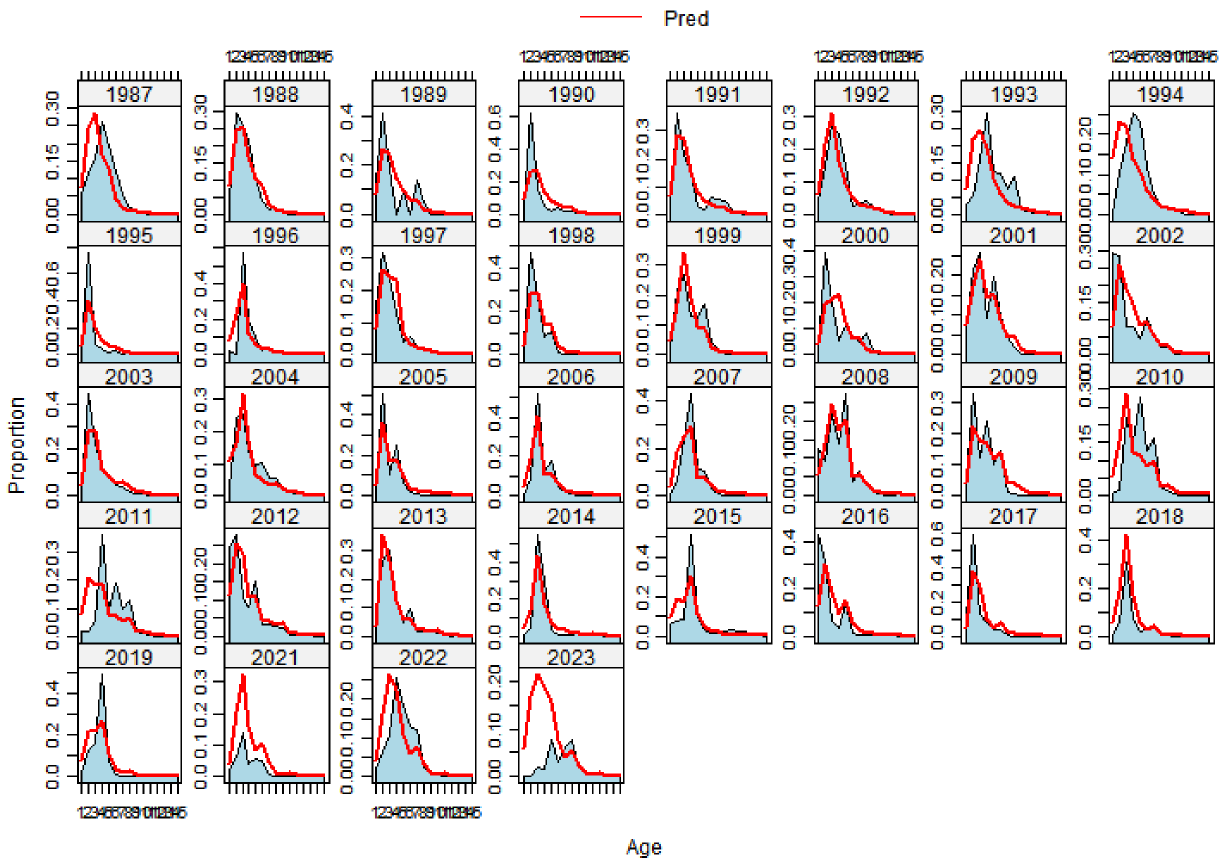

MRIP Age Residuals By Age
Standardized Residual
Year
1990 2000 2010 2020
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


MRIP Age Residuals By Year
Standardized Residual
Age
1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

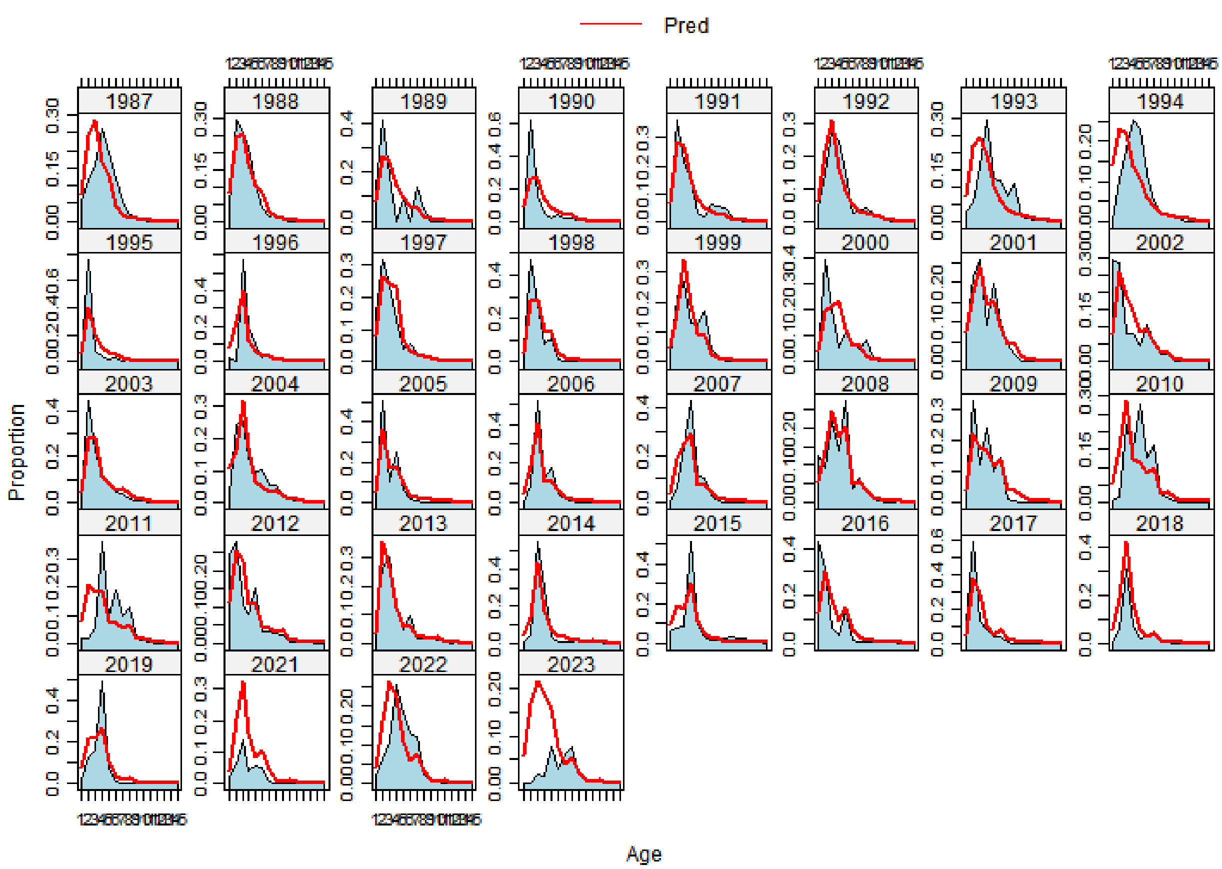

MRIP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
Year

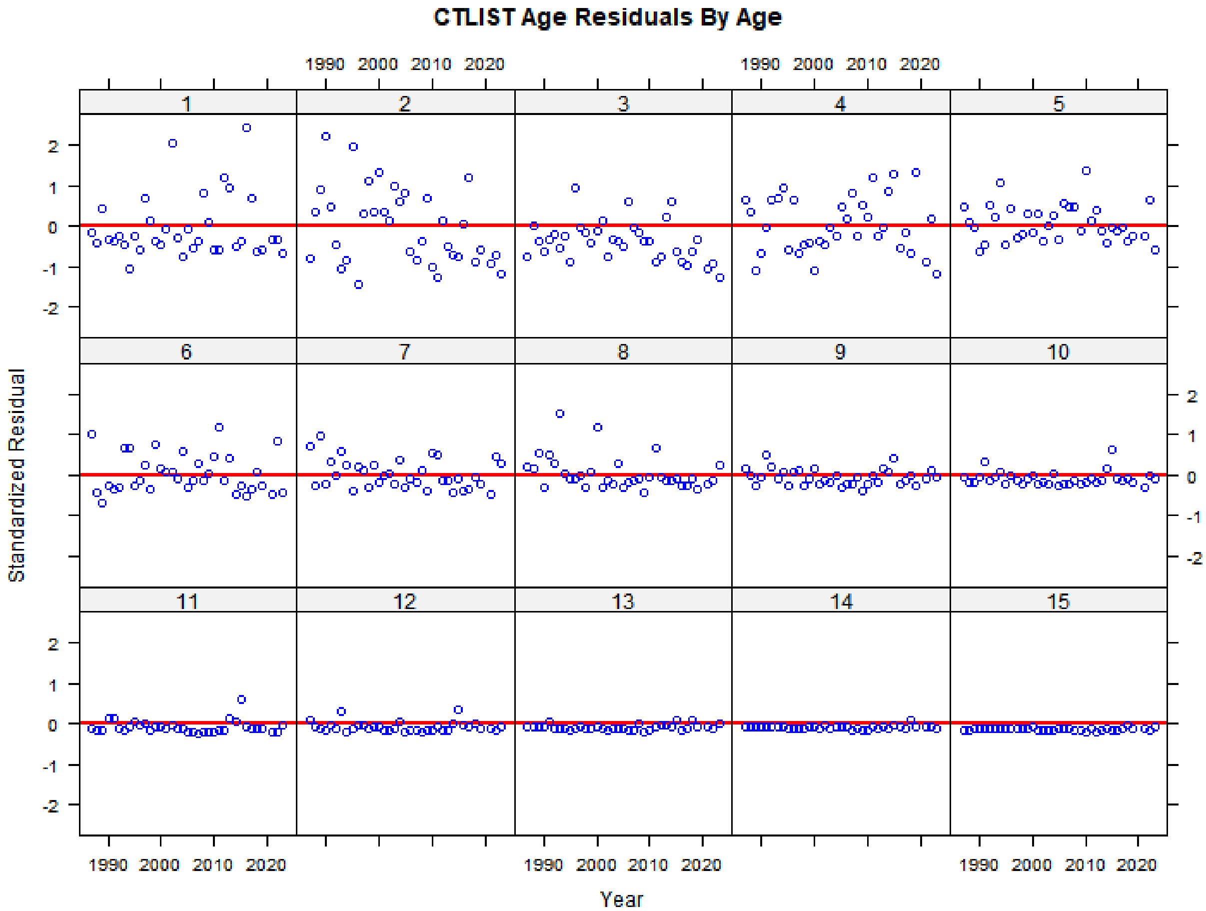

MRIP Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

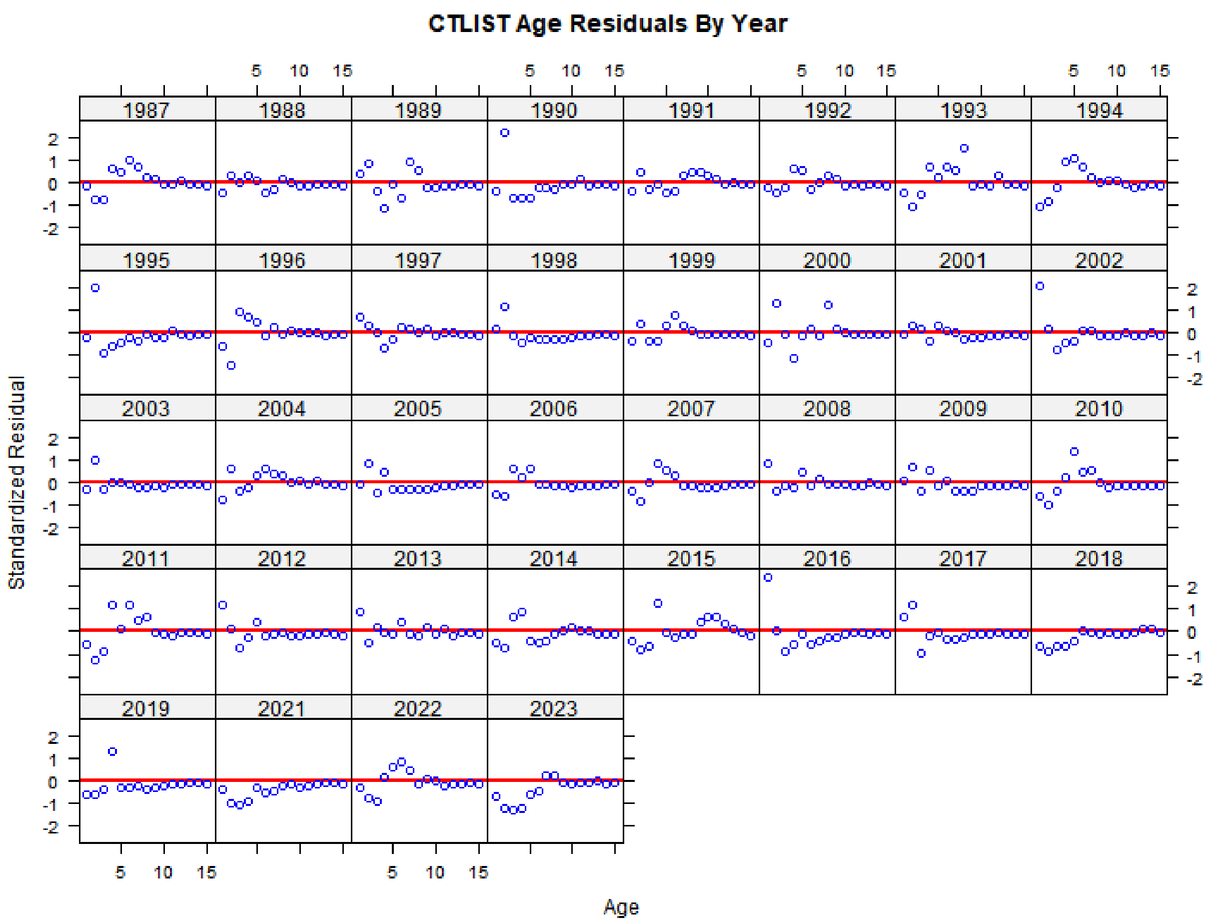
CTLIST Age Composition By Year

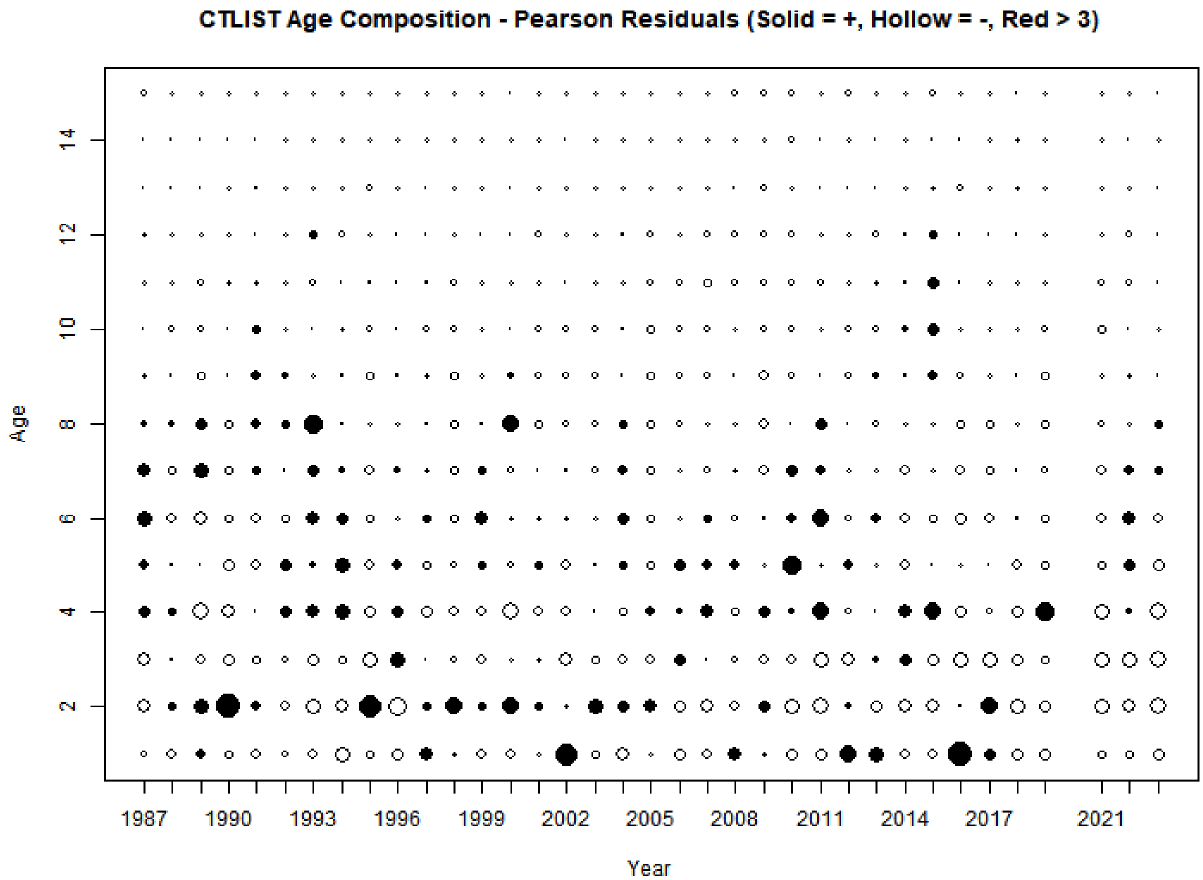


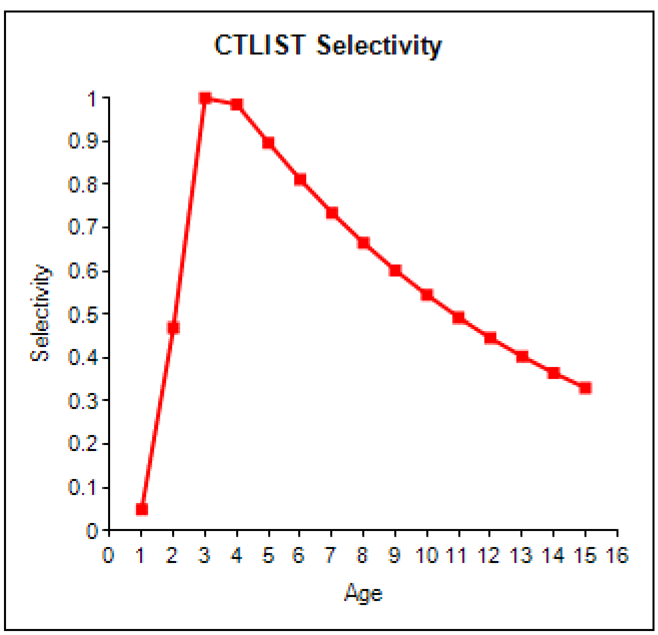
CTLIST Age Composition By Year

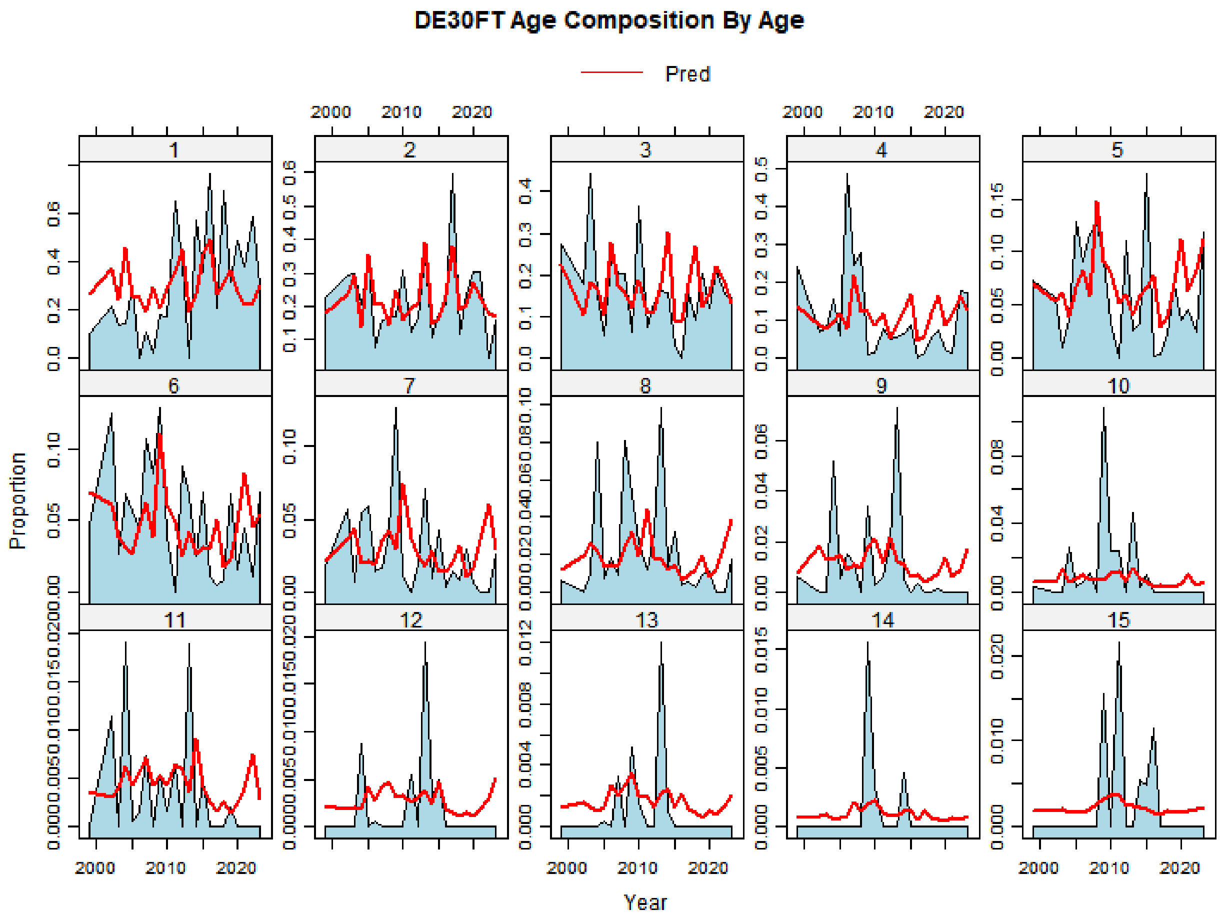


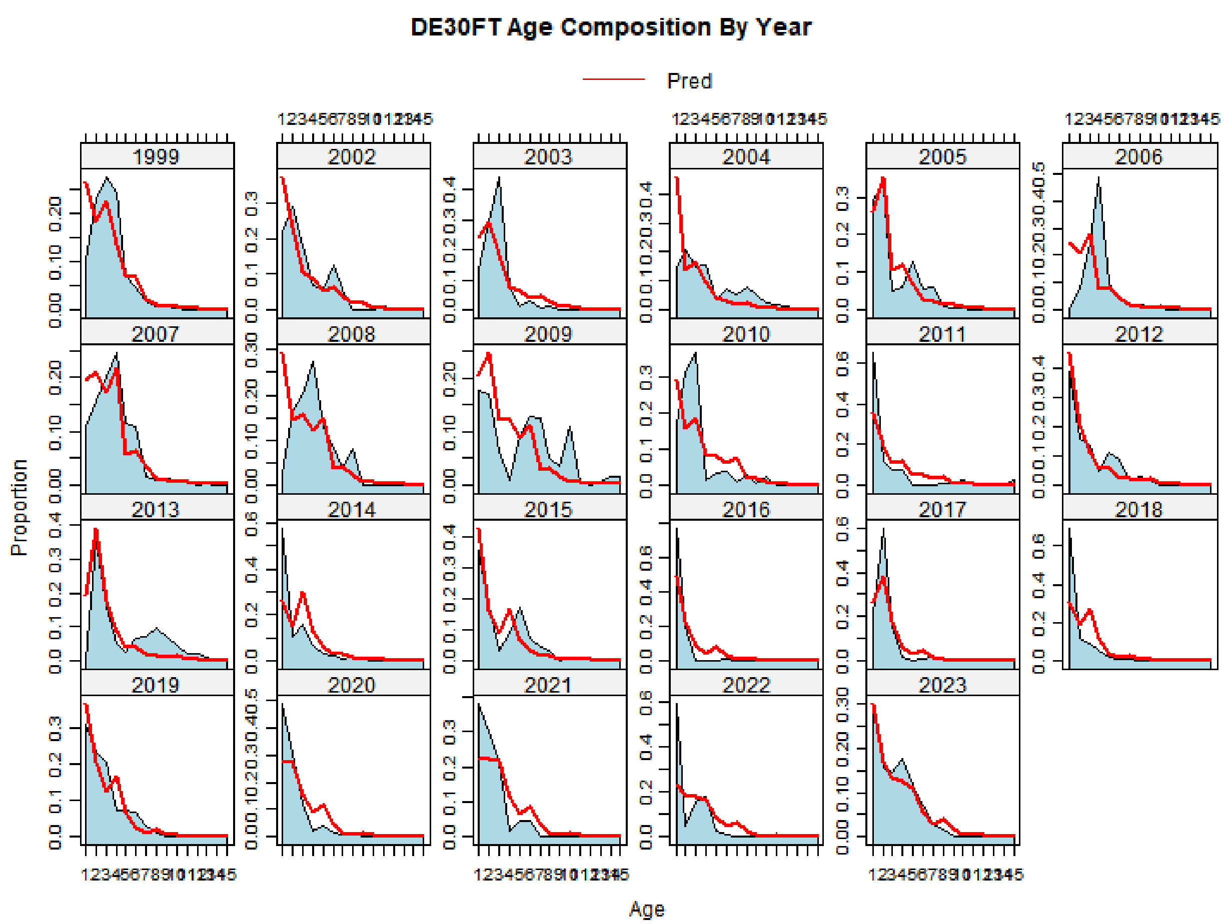

CTLIST Age Residuals By Age
Standardized Residual
Year
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


CTLIST Age Residuals By Year
Standardized Residual
Age
1987 1988 1989 1990 1991 1992 1993 1994
1995 1996 1997 1998 1999 2000 2001 2002
2003 2004 2005 2006 2007 2008 2009 2010
2011 2012 2013 2014 2015 2016 2017 2018
2019 2021 2022 2023

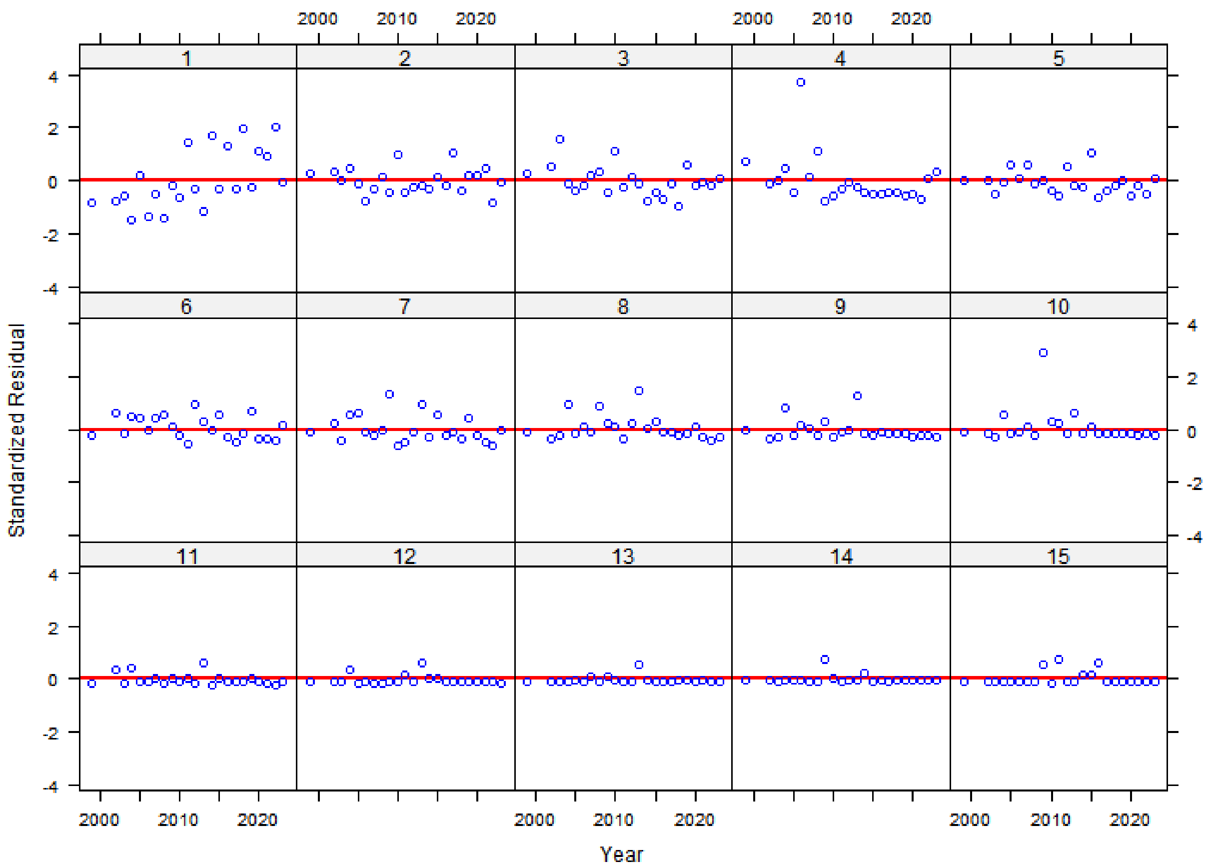

CTLIST Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2
4
6
8
10
12
14
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2021


CTLIST Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

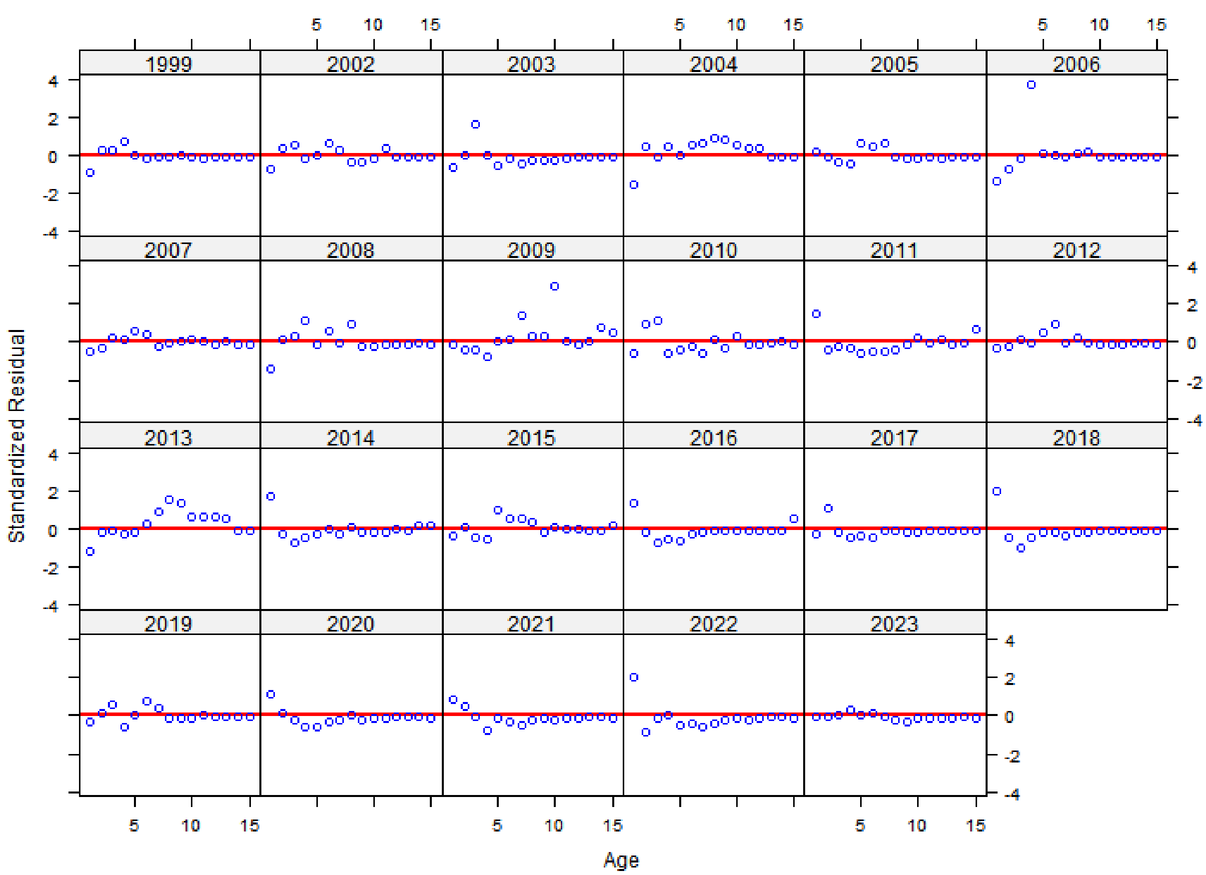

DE30FT Age Composition By Age
Pred
Proportion
Year

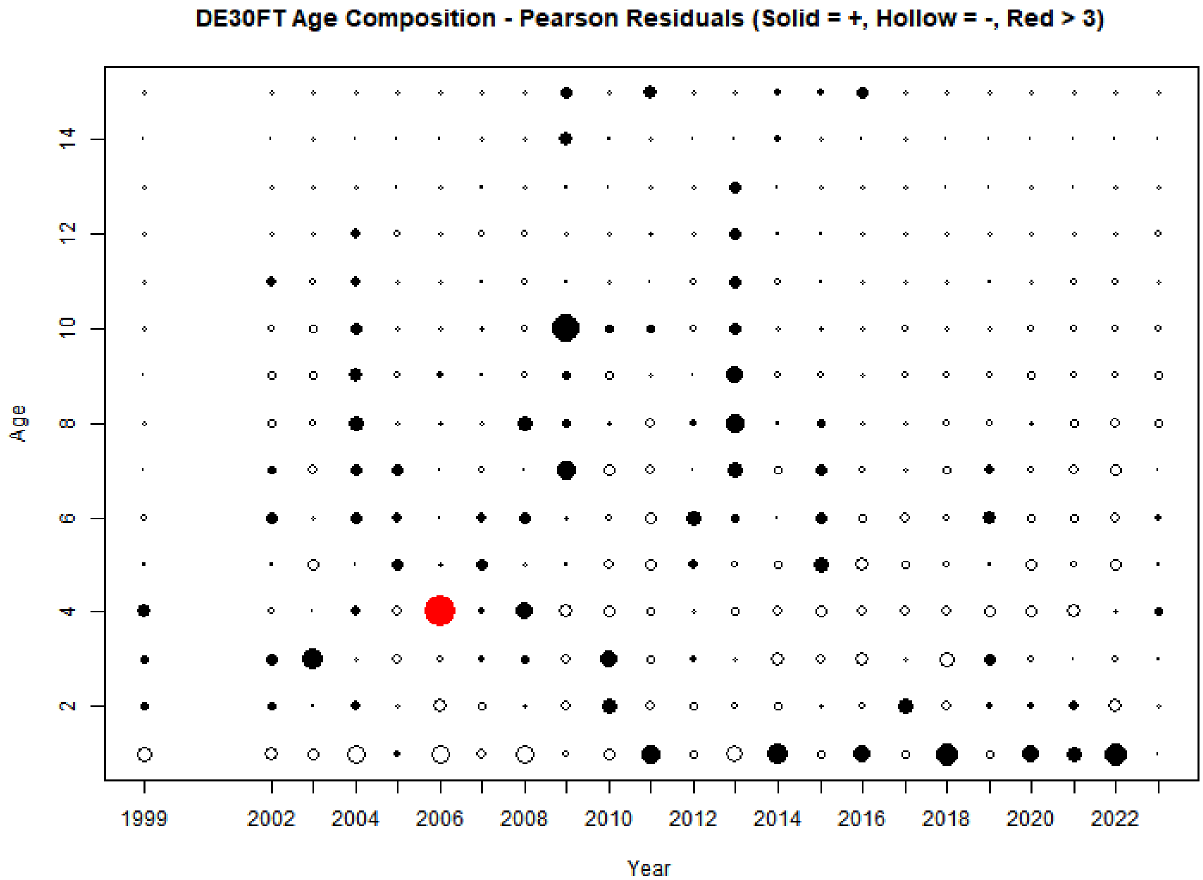

DE30FT Age Composition By Year
Pred
Proportion
Age

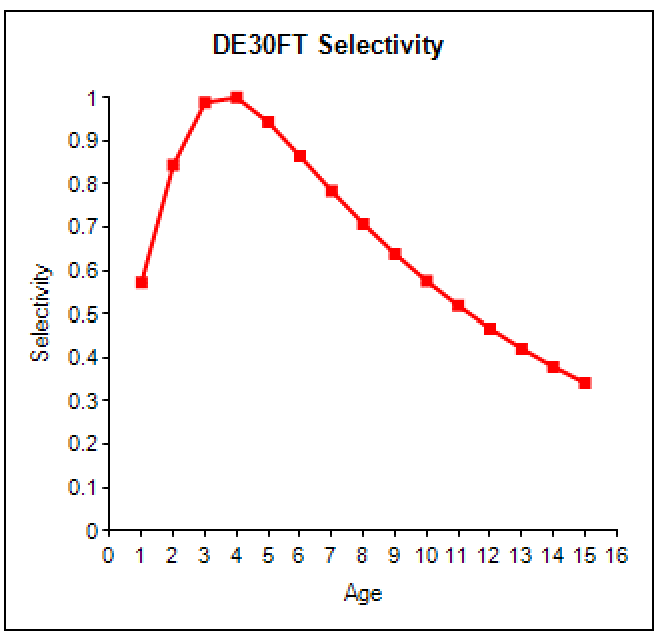
DE30FT Age Residuals By Age



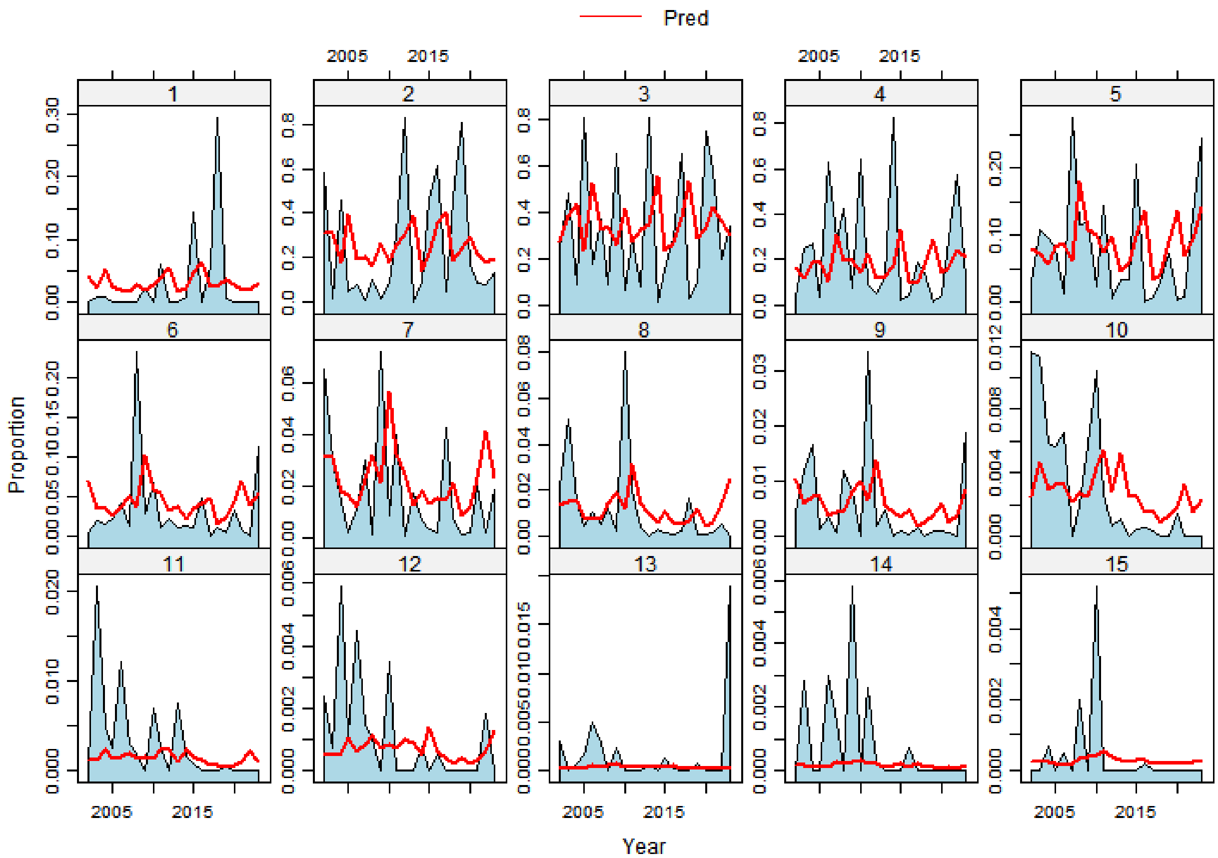
DE30FT Age Residuals By Year



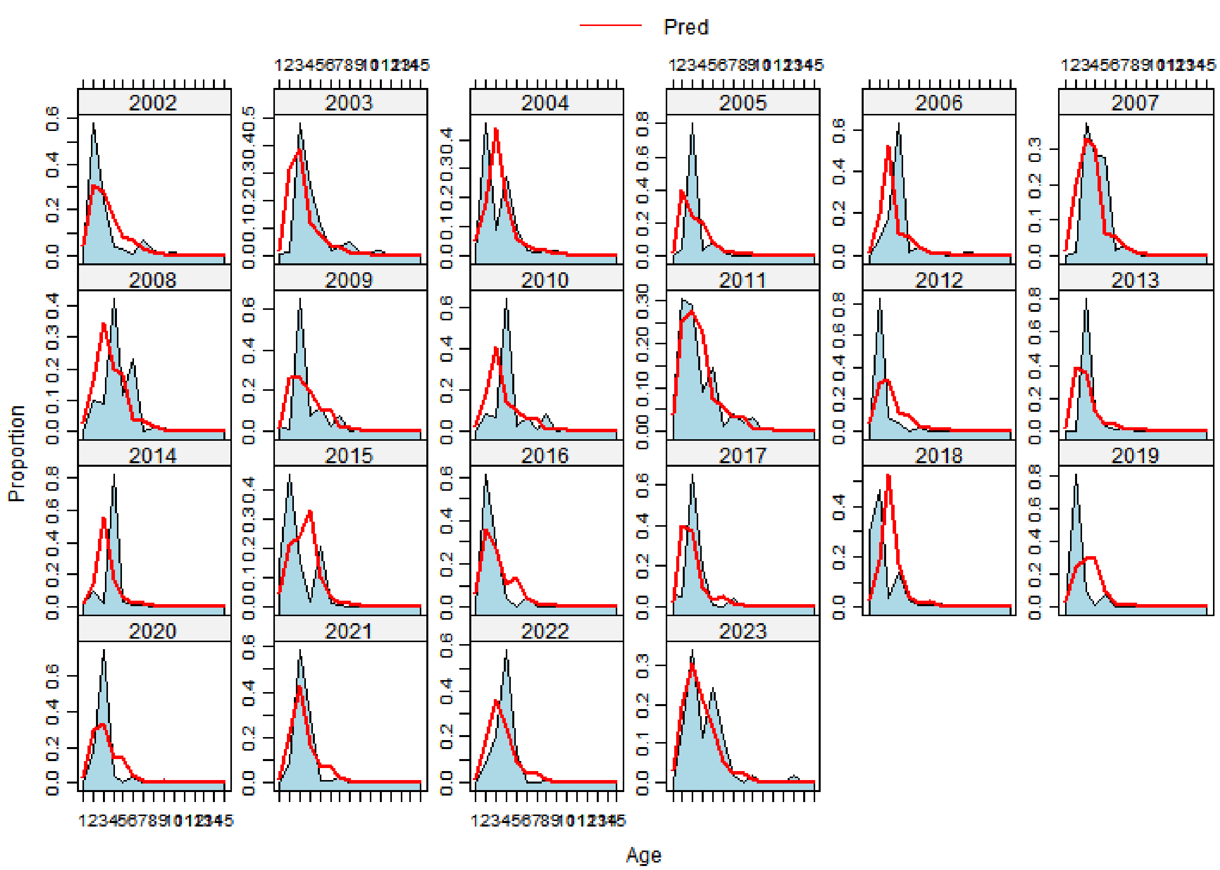

DE30FT Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1999
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

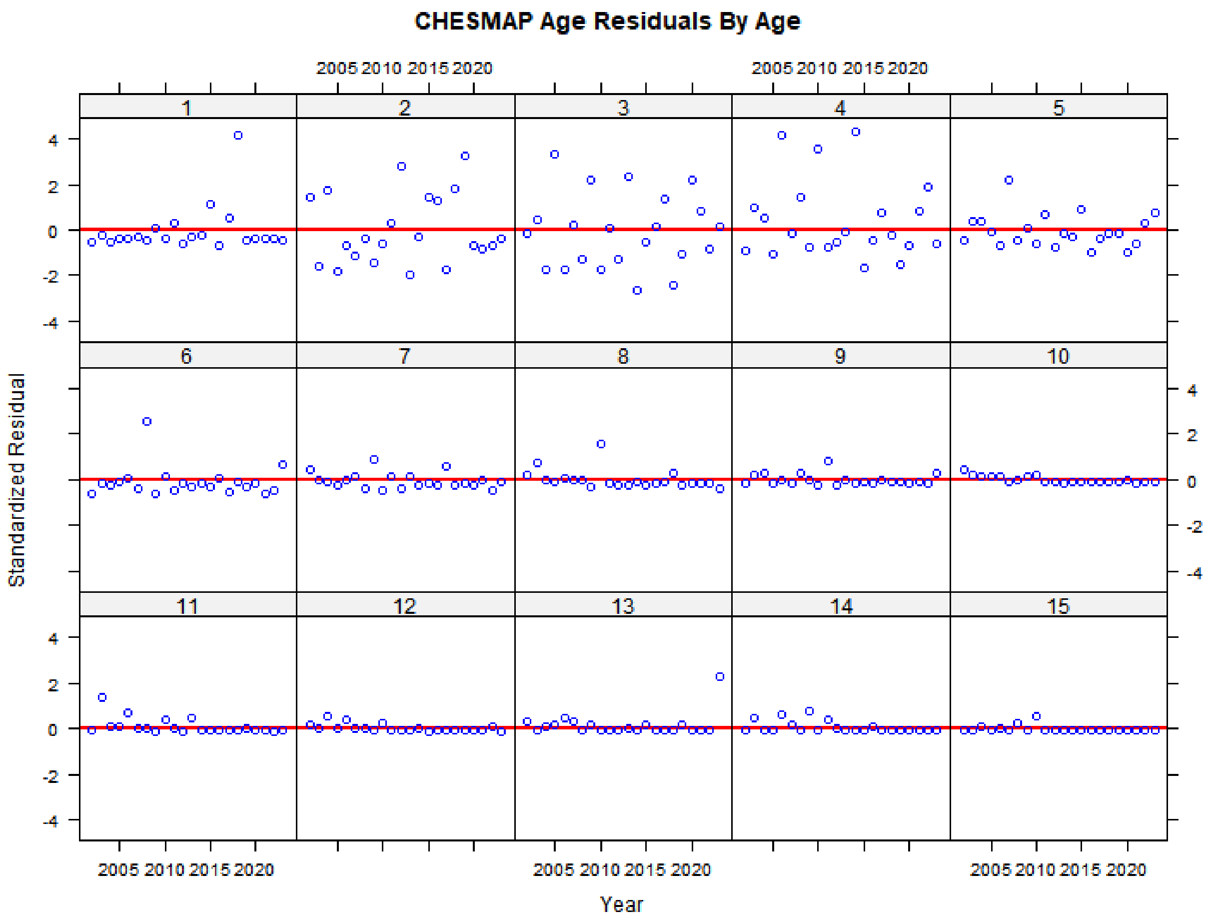

DE30FT Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Age
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

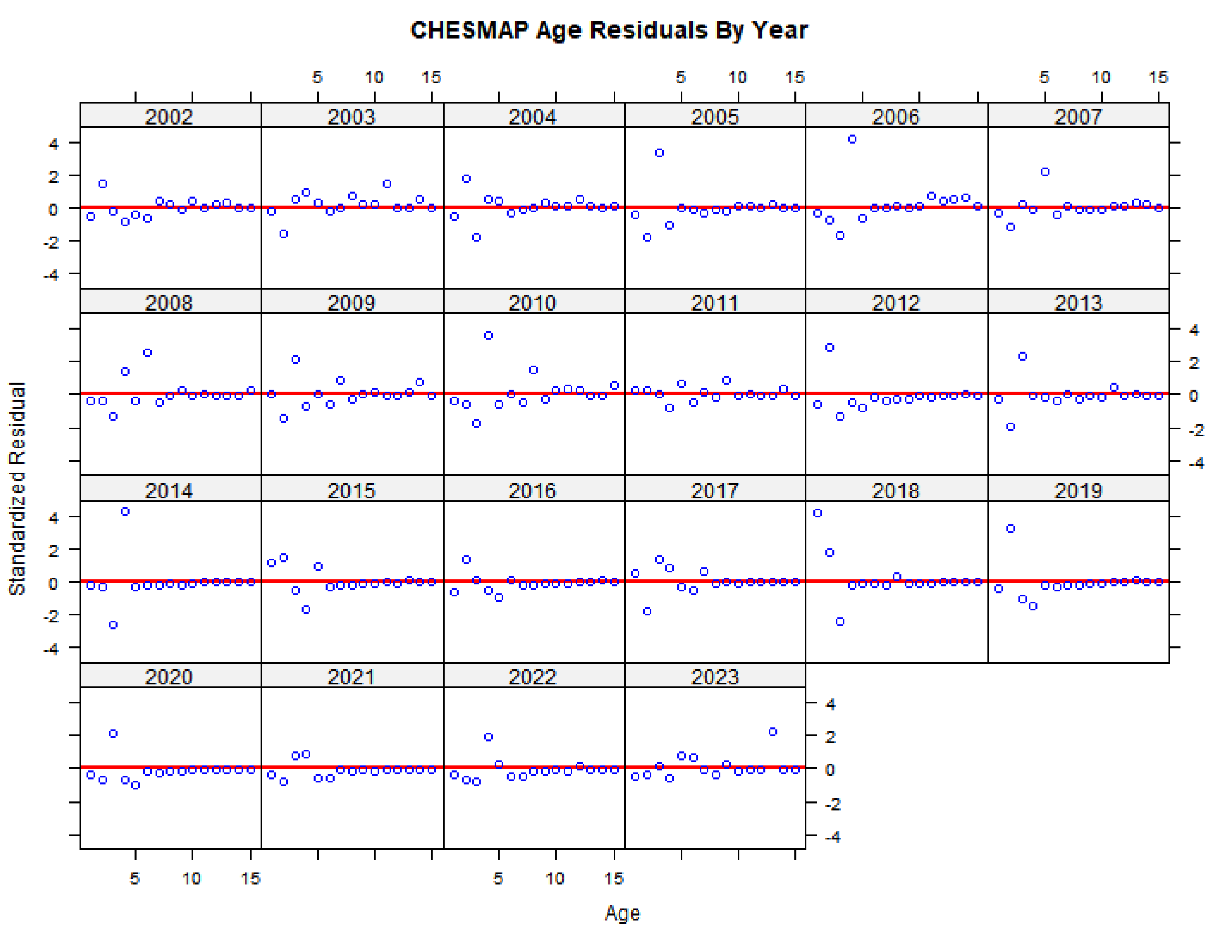
CHESMAP Age Composition By Age

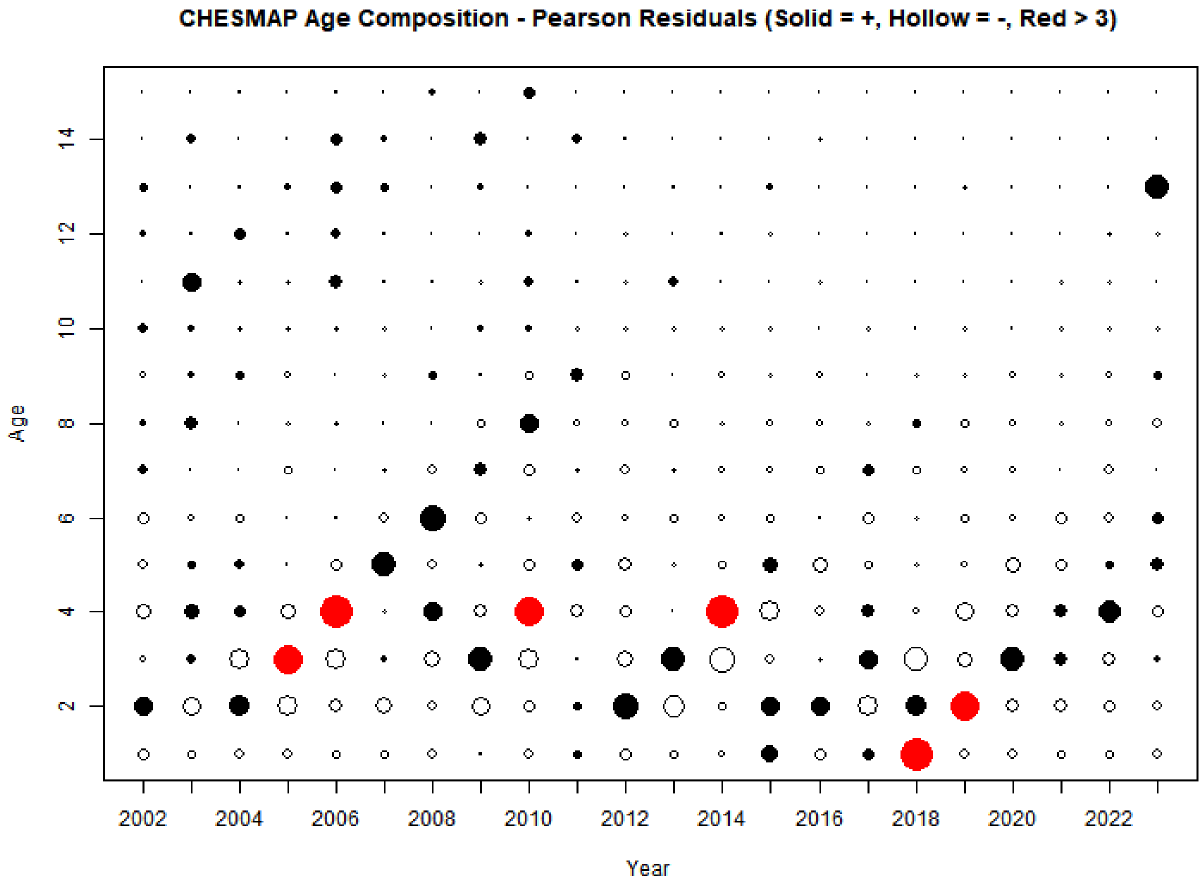


CHESMAP Age Composition By Year

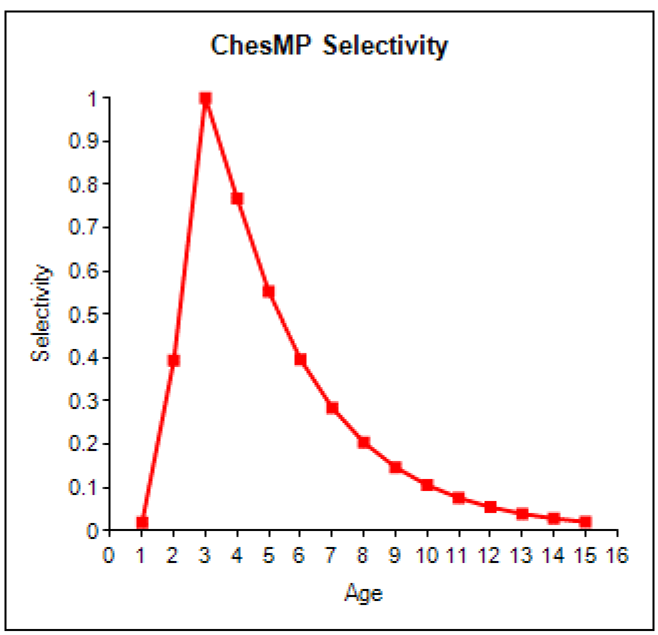



CHESMAP Age Residuals By Age
Standardized Residual
Year
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
2005 2010 2015 2020


CHESMAP Age Residuals By Year
Standardized Residual
Age
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



CHESMAP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2
4
6
8
10
12
14



ChesMP Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Results and Projections

Table X2. Comparison of RMSE, CV weights and effective sample sizes from the 2018 benchmark and 2022 update assessments.

2024 Update Assessment

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	38	1.00932	2.97	
NJYOY	40	1.01128	1.63	
MDYOY	12	1.0054	1.96	
compos	42	1.01242	1.00	
NYAge1	39	1.00882	1.19	
MDAge1	54	1.00057	3.25	
NYOHS	20	0.996985	2.55	21.34
NJTRAWL	31	0.999935	5.85	2.98
MDSSN	39	1.00736	2.40	15.57
DESSN	26	1.00552	1.42	19.45
MRIP	42	0.994992	2.27	27.47
CTLIST	36	1.00365	3.05	7.22
DE30FT	23	0.998003	0.85	5.62
ChesMP	22	0.995453	3.40	6.10

2022 Update

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	36	0.990985	2.97	
NJYOY	38	1.00901	1.73	
MDYOY	12	1.00507	2.11	
compos	40	1.00575	0.96	
NYAge1	37	1.00193	1.19	
MDAge1	52	0.998121	3.25	
NYOHS	20	0.996071	2.65	21.80
NJTRAWL	29	1.00117	2.95	5.66
MDSSN	37	0.998646	2.50	14.95
DESSN	24	1.00934	1.17	18.55
MRIP	40	1.00898	2.27	29.64
CTLIST	34	0.996705	3.00	12.93
DE30FT	21	1.00132	0.85	5.81
ChesMP	17	1.00111	2.45	15.10

Table X3. Summary of likelihood component values.

	Likelihood Weight	RSS
Fleet 1 Total Catch:	2	0.231403
Fleet 2 Total Catch:	2	1.85817
Aggregate Abundance Indices		
NYYOY	1	30.7183
NJYOY	1	32.6827
MDYOY	1	10.5312
Composite	1	40.9288
NYAge1	1	34.4667
MDAge1	1	26.6986
Age Comp Abundance Indices		
NYOHS	1	18.9014
NJTrawl	1	6.55357
MDSSN	1	33.8027
DESSN	1	23.2213
MRIP	1	36.7523
CTLIST	1	29.0973
DE30FT	1	18.5411
CHESMAP	1	13.9466
Total RSS		358.932
No. of Obs		548
Conc. Likel.		-115.941
Age Composition Data		
Fleet 1 Age Comp	1	6468.26
Fleet 2 Age Comp	1	6799.73
NYOHS	1	711.306
NJTrawl	1	168.126
MDSSN	1	1241.94
DESSN	1	1159.93
MRIP	1	2483.06
CTLIST	1	463.211
DE30FT	1	241.603
CHESMAP	1	235.109
Recr Devs	1	41.5586
Total Likelihood		19825.3
AIC		40052.7

Table X4. Estimates of Bay and Ocean fully-recruited fishing mortality and total fully-recruited fishing mortality with associated standard errors.

	Bay			Ocean			Total		
	Fully-recruited			Fully-recruited			Fully-recruited		
Year	F	SD	CV	F	SD	CV	F	SD	CV
1982	0.057	0.014	0.240	0.179	0.004	0.020	0.180	0.029	0.161
1983	0.062	0.029	0.463	0.144	0.012	0.085	0.145	0.039	0.269
1984	0.060	0.008	0.128	0.060	0.004	0.062	0.074	0.014	0.190
1985	0.004	0.039	10.655	0.190	0.016	0.085	0.190	0.069	0.360
1986	0.006	0.013	2.250	0.051	0.004	0.076	0.052	0.013	0.256
1987	0.002	0.012	4.653	0.030	0.015	0.506	0.031	0.006	0.208
1988	0.005	0.001	0.132	0.036	0.005	0.131	0.036	0.007	0.207
1989	0.005	0.068	14.825	0.046	0.018	0.377	0.047	0.009	0.185
1990	0.040	0.002	0.049	0.063	0.004	0.061	0.064	0.011	0.174
1991	0.044	0.013	0.301	0.090	0.013	0.148	0.091	0.015	0.169
1992	0.049	0.001	0.013	0.109	0.003	0.028	0.110	0.018	0.166
1993	0.042	0.006	0.152	0.085	0.015	0.173	0.086	0.013	0.153
1994	0.055	0.001	0.018	0.111	0.004	0.037	0.113	0.016	0.145
1995	0.079	0.007	0.094	0.202	0.013	0.064	0.205	0.031	0.154
1996	0.057	0.001	0.018	0.234	0.007	0.029	0.261	0.036	0.137
1997	0.061	0.009	0.141	0.167	0.016	0.095	0.201	0.013	0.067
1998	0.053	0.005	0.101	0.181	0.005	0.026	0.209	0.014	0.068
1999	0.055	0.011	0.202	0.166	0.016	0.098	0.195	0.013	0.068
2000	0.059	0.007	0.120	0.162	0.007	0.041	0.194	0.013	0.066
2001	0.047	0.015	0.328	0.168	0.017	0.099	0.192	0.012	0.063
2002	0.051	0.005	0.101	0.181	0.006	0.031	0.208	0.013	0.061
2003	0.067	0.018	0.270	0.186	0.025	0.133	0.222	0.013	0.060
2004	0.065	0.004	0.061	0.213	0.009	0.040	0.248	0.017	0.068
2005	0.058	0.013	0.228	0.215	0.020	0.094	0.244	0.016	0.067
2006	0.079	0.005	0.059	0.248	0.006	0.025	0.290	0.018	0.064
2007	0.060	0.016	0.270	0.184	0.018	0.100	0.216	0.014	0.065
2008	0.052	0.006	0.123	0.203	0.009	0.045	0.229	0.016	0.068
2009	0.070	0.031	0.446	0.186	0.021	0.114	0.224	0.014	0.063
2010	0.074	0.004	0.049	0.224	0.007	0.031	0.264	0.017	0.065
2011	0.072	0.035	0.478	0.232	0.027	0.117	0.270	0.017	0.064
2012	0.084	0.003	0.040	0.224	0.005	0.024	0.269	0.018	0.068
2013	0.093	0.012	0.132	0.324	0.020	0.063	0.372	0.026	0.070
2014	0.107	0.003	0.026	0.233	0.004	0.017	0.294	0.022	0.075
2015	0.089	0.014	0.152	0.207	0.018	0.089	0.256	0.020	0.078
2016	0.120	0.003	0.023	0.229	0.004	0.017	0.299	0.024	0.081
2017	0.084	0.012	0.147	0.293	0.017	0.056	0.337	0.029	0.087
2018	0.071	0.003	0.047	0.209	0.003	0.015	0.246	0.022	0.090
2019	0.056	0.012	0.211	0.187	0.017	0.090	0.216	0.020	0.092
2020	0.052	0.002	0.047	0.103	0.003	0.033	0.151	0.018	0.122
2021	0.042	0.012	0.276	0.114	0.025	0.221	0.152	0.018	0.122
2022	0.041	0.003	0.071	0.170	0.006	0.038	0.207	0.027	0.131
2023	0.044	0.012	0.273	0.212	0.047	0.221	0.237	0.049	0.205

Table X4 cont.

Year	Recruitment	SD	CV
1982	37,364,100	3,561,750	0.095
1983	75,602,800	6,004,810	0.079
1984	62,859,700	4,971,380	0.079
1985	68,479,300	5,140,620	0.075
1986	67,611,600	5,071,660	0.075
1987	74,169,300	5,384,940	0.073
1988	93,300,800	6,426,560	0.069
1989	106,655,000	7,274,910	0.068
1990	130,941,000	8,472,950	0.065
1991	104,485,000	7,631,770	0.073
1992	108,762,000	8,080,020	0.074
1993	133,935,000	9,225,910	0.069
1994	285,297,000	14,524,200	0.051
1995	186,734,000	11,447,800	0.061
1996	234,018,000	13,186,100	0.056
1997	258,960,000	13,727,900	0.053
1998	148,052,000	9,929,320	0.067
1999	152,875,000	9,909,210	0.065
2000	124,486,000	8,956,900	0.072
2001	196,467,000	11,283,100	0.057
2002	221,336,000	11,926,200	0.054
2003	127,967,000	8,776,480	0.069
2004	304,432,000	13,794,500	0.045
2005	158,153,000	9,576,770	0.061
2006	135,236,000	8,615,300	0.064
2007	88,441,000	6,659,590	0.075
2008	126,912,000	8,010,310	0.063
2009	75,196,700	5,917,220	0.079
2010	96,903,000	6,899,820	0.071
2011	125,307,000	8,087,160	0.065
2012	192,360,000	10,784,700	0.056
2013	66,597,300	5,843,220	0.088
2014	82,938,200	6,642,880	0.080
2015	153,154,000	10,612,200	0.069
2016	228,067,000	15,322,400	0.067
2017	111,488,000	9,507,160	0.085
2018	130,105,000	11,341,500	0.087
2019	165,265,000	14,827,500	0.090
2020	120,143,000	12,559,800	0.105
2021	85,158,100	11,605,200	0.136
2022	76,967,300	10,874,800	0.141
2023	96,681,400	16,032,400	0.166

Catch Selectivity Parameters

Bay

	Estimate	SD	CV
1982-1984			
α	-5.451	0.197	0.04
β	2.551	0.043	0.02
ϒ	0.830	0.020	0.02
1985-1989			
α	-3.922	0.496	0.13
β	2.292	0.090	0.04
ϒ	0.958	0.013	0.01
1990-1995			
α	-2.060	0.101	0.05
β	4.468	0.188	0.04
ϒ	0.816	0.033	0.04
1996-2022			
α	-1.783	0.059	0.03
β	3.710	0.085	0.02
ϒ	0.953	0.010	0.01
2023			
α	-1.985	0.318	0.16
β	3.801	0.377	0.10
ϒ	0.888	0.054	0.06

Ocean

	Estimate	SD	CV
1982-1984			
α	3.484	0.194	0.06
β	0.820	0.086	0.10
1985-1989			
α	4.713	0.383	0.08
β	0.473	0.051	0.11
1990-1996			
α	6.186	0.508	0.08
β	0.345	0.034	0.10
1997-2019			
α	4.932	0.170	0.03
β	0.450	0.022	0.05
2020-2022			
α	-1.196	0.173	0.14
β	4.656	0.722	0.16
ϒ	0.970	0.065	0.07
2023			
α	-1.160	0.179	0.15
β	6.232	1.050	0.17
ϒ	0.884	0.128	0.14

Survey Selectivity Parameters

NYOHS	Estimate	SD	CV
α	-3.025	0.511	-0.17
β	2.620	0.154	0.06
ϒ	0.917	0.026	0.03
NJ Trawl			
α	1.43E+00	7.41E-01	0.52
β	2.34E-01	1.57E-01	0.67
MDSSN			
[illegible]	0.14	0.02	0.14
DE SSN			
α	3.80E+00	2.44E-01	0.06
β	6.35E-01	8.62E-02	0.14
MRIP			
α	2.58E+00	7.63E-02	0.03
β	1.06E+00	6.42E-02	0.06
CTLIST			
α	-2.806	0.393	-0.14
β	2.163	0.160	0.07
ϒ	0.964	0.017	0.02
DE30FT			
α	-1.011	0.755	-0.75
β	1.445	1.173	0.81
ϒ	0.897	0.153	0.17
ChesMap			
α	-3.661	0.595	-0.16
β	2.281	0.138	0.06
ϒ	0.909	0.027	0.03

Catchability Coefficients

Survey	Estimate	SD	CV
Y	1.28E-07	1.26E-08	0.10
Y	8.21E-09	4.98E-10	0.06
)Y	1.32E-07	2.06E-08	0.16
os	1.05E-06	4.65E-08	0.04
e1	2.45E-08	1.79E-09	0.07
;e1	8.07E-09	1.33E-09	0.16
IS	8.83E-08	8.15E-09	0.09
\WL	9.38E-08	2.74E-08	0.29
;N	7.70E-08	6.42E-09	0.08
N	4.26E-08	5.60E-09	0.13
	4.39E-08	2.97E-09	0.07
T	7.97E-09	7.41E-10	0.09
-T	2.66E-08	4.56E-09	0.17
MP	2.46E-06	4.39E-07	0.18

Table X5. Region-specific and total fishing mortality-at-age, 1982-2021

Bay Fishing Mortality-At-Age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0075	0.0574	0.0246	0.0098	0.0039	0.0015	0.0006	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0012
1983	0.0001	0.0081	0.0620	0.0266	0.0105	0.0042	0.0017	0.0007	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1984	0.0001	0.0079	0.0605	0.0260	0.0103	0.0041	0.0016	0.0006	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1985	0.0000	0.0011	0.0037	0.0033	0.0028	0.0024	0.0020	0.0017	0.0014	0.0012	0.0010	0.0009	0.0007	0.0006	0.0005
1986	0.0001	0.0018	0.0060	0.0054	0.0046	0.0039	0.0033	0.0028	0.0024	0.0020	0.0017	0.0014	0.0012	0.0010	0.0009
1987	0.0000	0.0008	0.0025	0.0022	0.0019	0.0016	0.0014	0.0012	0.0010	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004
1988	0.0000	0.0014	0.0046	0.0041	0.0035	0.0029	0.0025	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008	0.0007
1989	0.0000	0.0014	0.0046	0.0042	0.0035	0.0030	0.0025	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008	0.0007
1990	0.0002	0.0010	0.0053	0.0216	0.0402	0.0352	0.0249	0.0171	0.0117	0.0080	0.0055	0.0038	0.0026	0.0018	0.0012
1991	0.0002	0.0011	0.0058	0.0237	0.0440	0.0385	0.0273	0.0188	0.0129	0.0088	0.0060	0.0041	0.0028	0.0019	0.0013
1992	0.0002	0.0013	0.0065	0.0266	0.0494	0.0432	0.0307	0.0211	0.0144	0.0099	0.0067	0.0046	0.0032	0.0022	0.0015
1993	0.0002	0.0011	0.0055	0.0226	0.0419	0.0367	0.0260	0.0179	0.0122	0.0084	0.0057	0.0039	0.0027	0.0018	0.0013
1994	0.0003	0.0014	0.0072	0.0294	0.0546	0.0478	0.0339	0.0233	0.0159	0.0109	0.0075	0.0051	0.0035	0.0024	0.0016
1995	0.0004	0.0020	0.0105	0.0427	0.0792	0.0693	0.0492	0.0338	0.0231	0.0158	0.0108	0.0074	0.0051	0.0035	0.0024
1996	0.0007	0.0036	0.0162	0.0426	0.0568	0.0566	0.0528	0.0486	0.0448	0.0412	0.0379	0.0349	0.0321	0.0295	0.0271
1997	0.0008	0.0039	0.0175	0.0460	0.0614	0.0611	0.0570	0.0525	0.0484	0.0445	0.0409	0.0377	0.0346	0.0319	0.0293
1998	0.0007	0.0034	0.0152	0.0398	0.0532	0.0529	0.0494	0.0455	0.0419	0.0386	0.0355	0.0326	0.0300	0.0276	0.0254
1999	0.0007	0.0035	0.0157	0.0411	0.0548	0.0546	0.0509	0.0469	0.0432	0.0397	0.0366	0.0336	0.0309	0.0285	0.0262
2000	0.0007	0.0038	0.0167	0.0439	0.0586	0.0583	0.0544	0.0501	0.0461	0.0425	0.0391	0.0359	0.0331	0.0304	0.0280
2001	0.0006	0.0030	0.0133	0.0349	0.0466	0.0464	0.0433	0.0399	0.0368	0.0338	0.0311	0.0286	0.0263	0.0242	0.0223
2002	0.0006	0.0033	0.0146	0.0384	0.0512	0.0510	0.0476	0.0439	0.0404	0.0371	0.0342	0.0314	0.0289	0.0266	0.0245
2003	0.0008	0.0043	0.0191	0.0501	0.0668	0.0665	0.0621	0.0572	0.0527	0.0485	0.0446	0.0410	0.0377	0.0347	0.0319
2004	0.0008	0.0042	0.0187	0.0489	0.0652	0.0649	0.0606	0.0559	0.0514	0.0473	0.0435	0.0400	0.0368	0.0339	0.0312
2005	0.0007	0.0037	0.0165	0.0431	0.0575	0.0573	0.0534	0.0493	0.0454	0.0417	0.0384	0.0353	0.0325	0.0299	0.0275
2006	0.0010	0.0051	0.0226	0.0592	0.0790	0.0787	0.0734	0.0677	0.0623	0.0573	0.0527	0.0485	0.0446	0.0410	0.0377
2007	0.0007	0.0038	0.0171	0.0449	0.0599	0.0596	0.0556	0.0513	0.0472	0.0434	0.0399	0.0368	0.0338	0.0311	0.0286
2008	0.0006	0.0033	0.0149	0.0390	0.0521	0.0518	0.0484	0.0446	0.0410	0.0378	0.0347	0.0320	0.0294	0.0270	0.0249
2009	0.0009	0.0045	0.0200	0.0525	0.0700	0.0697	0.0650	0.0600	0.0552	0.0508	0.0467	0.0430	0.0395	0.0364	0.0335
2010	0.0009	0.0047	0.0212	0.0555	0.0741	0.0738	0.0688	0.0634	0.0584	0.0537	0.0494	0.0455	0.0418	0.0385	0.0354
2011	0.0009	0.0046	0.0207	0.0543	0.0725	0.0722	0.0673	0.0621	0.0571	0.0526	0.0483	0.0445	0.0409	0.0376	0.0346
2012	0.0010	0.0054	0.0240	0.0629	0.0840	0.0836	0.0780	0.0719	0.0662	0.0609	0.0560	0.0515	0.0474	0.0436	0.0401
2013	0.0011	0.0059	0.0265	0.0693	0.0926	0.0921	0.0859	0.0793	0.0729	0.0671	0.0617	0.0568	0.0522	0.0481	0.0442
2014	0.0013	0.0069	0.0307	0.0805	0.1075	0.1070	0.0998	0.0920	0.0847	0.0779	0.0717	0.0660	0.0607	0.0558	0.0513
2015	0.0011	0.0057	0.0255	0.0669	0.0893	0.0889	0.0829	0.0764	0.0703	0.0647	0.0595	0.0548	0.0504	0.0464	0.0426
2016	0.0015	0.0077	0.0344	0.0900	0.1202	0.1196	0.1116	0.1029	0.0947	0.0871	0.0801	0.0737	0.0678	0.0624	0.0574
2017	0.0010	0.0054	0.0241	0.0632	0.0844	0.0840	0.0784	0.0723	0.0665	0.0612	0.0563	0.0518	0.0477	0.0438	0.0403
2018	0.0009	0.0045	0.0202	0.0529	0.0706	0.0703	0.0656	0.0605	0.0557	0.0512	0.0471	0.0433	0.0399	0.0367	0.0337
2019	0.0007	0.0036	0.0159	0.0418	0.0557	0.0555	0.0518	0.0477	0.0439	0.0404	0.0372	0.0342	0.0315	0.0289	0.0266
2020	0.0006	0.0033	0.0148	0.0387	0.0517	0.0515	0.0480	0.0443	0.0407	0.0375	0.0345	0.0317	0.0292	0.0268	0.0247
2021	0.0005	0.0027	0.0119	0.0312	0.0417	0.0415	0.0387	0.0357	0.0329	0.0302	0.0278	0.0256	0.0235	0.0217	0.0199
2022	0.0005	0.0026	0.0116	0.0304	0.0406	0.0405	0.0377	0.0348	0.0320	0.0295	0.0271	0.0249	0.0229	0.0211	0.0194
2023	0.0005	0.0025	0.0127	0.0358	0.0440	0.0380	0.0308	0.0247	0.0198	0.0159	0.0127	0.0102	0.0082	0.0066	0.0053

Table X5 cont.

Ocean Fishing Mortality-At-Age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0058	0.0402	0.0933	0.1347	0.1580	0.1695	0.1747	0.1770	0.1781	0.1785	0.1787	0.1788	0.1788	0.1788
1983	0.0001	0.0047	0.0324	0.0751	0.1085	0.1273	0.1365	0.1408	0.1426	0.1435	0.1438	0.1440	0.1440	0.1441	0.1441
1984	0.0000	0.0020	0.0135	0.0313	0.0451	0.0530	0.0568	0.0586	0.0593	0.0597	0.0598	0.0599	0.0599	0.0599	0.0599
1985	0.0006	0.0048	0.0185	0.0434	0.0748	0.1055	0.1312	0.1507	0.1646	0.1740	0.1803	0.1843	0.1870	0.1887	0.1898
1986	0.0002	0.0013	0.0050	0.0118	0.0202	0.0286	0.0355	0.0408	0.0446	0.0471	0.0488	0.0499	0.0506	0.0511	0.0514
1987	0.0001	0.0008	0.0030	0.0069	0.0119	0.0168	0.0210	0.0241	0.0263	0.0278	0.0288	0.0294	0.0299	0.0301	0.0303
1988	0.0001	0.0009	0.0035	0.0081	0.0140	0.0197	0.0246	0.0282	0.0308	0.0326	0.0337	0.0345	0.0350	0.0353	0.0355
1989	0.0001	0.0012	0.0045	0.0106	0.0183	0.0258	0.0321	0.0369	0.0403	0.0426	0.0441	0.0451	0.0458	0.0462	0.0465
1990	0.0002	0.0010	0.0033	0.0079	0.0147	0.0227	0.0310	0.0387	0.0453	0.0506	0.0547	0.0579	0.0602	0.0619	0.0632
1991	0.0002	0.0014	0.0047	0.0113	0.0209	0.0324	0.0442	0.0551	0.0645	0.0721	0.0780	0.0824	0.0858	0.0882	0.0900
1992	0.0003	0.0017	0.0057	0.0136	0.0252	0.0391	0.0533	0.0665	0.0777	0.0869	0.0940	0.0994	0.1034	0.1064	0.1085
1993	0.0002	0.0013	0.0045	0.0107	0.0198	0.0307	0.0419	0.0522	0.0611	0.0682	0.0738	0.0781	0.0812	0.0836	0.0852
1994	0.0003	0.0017	0.0058	0.0139	0.0258	0.0400	0.0546	0.0681	0.0796	0.0890	0.0963	0.1018	0.1059	0.1090	0.1112
1995	0.0006	0.0031	0.0106	0.0253	0.0470	0.0728	0.0994	0.1240	0.1450	0.1620	0.1753	0.1854	0.1929	0.1984	0.2024
1996	0.0006	0.0036	0.0123	0.0293	0.0543	0.0843	0.1150	0.1434	0.1677	0.1874	0.2028	0.2145	0.2231	0.2295	0.2341
1997	0.0005	0.0042	0.0164	0.0389	0.0669	0.0943	0.1170	0.1340	0.1460	0.1541	0.1594	0.1629	0.1651	0.1665	0.1674
1998	0.0005	0.0045	0.0178	0.0421	0.0725	0.1022	0.1268	0.1452	0.1582	0.1670	0.1728	0.1765	0.1789	0.1804	0.1814
1999	0.0005	0.0041	0.0162	0.0385	0.0663	0.0934	0.1159	0.1328	0.1447	0.1527	0.1580	0.1614	0.1636	0.1650	0.1658
2000	0.0005	0.0040	0.0159	0.0377	0.0649	0.0914	0.1134	0.1299	0.1416	0.1494	0.1546	0.1579	0.1600	0.1614	0.1623
2001	0.0005	0.0042	0.0165	0.0391	0.0673	0.0948	0.1177	0.1348	0.1468	0.1550	0.1603	0.1638	0.1660	0.1674	0.1683
2002	0.0005	0.0045	0.0177	0.0420	0.0724	0.1020	0.1266	0.1450	0.1579	0.1667	0.1724	0.1762	0.1785	0.1801	0.1810
2003	0.0005	0.0046	0.0183	0.0433	0.0746	0.1050	0.1303	0.1493	0.1626	0.1716	0.1775	0.1814	0.1838	0.1854	0.1864
2004	0.0006	0.0053	0.0209	0.0495	0.0853	0.1202	0.1491	0.1708	0.1860	0.1964	0.2031	0.2075	0.2103	0.2121	0.2133
2005	0.0006	0.0053	0.0210	0.0498	0.0858	0.1209	0.1500	0.1718	0.1872	0.1975	0.2044	0.2088	0.2116	0.2134	0.2145
2006	0.0007	0.0062	0.0243	0.0575	0.0991	0.1396	0.1732	0.1985	0.2162	0.2282	0.2360	0.2411	0.2444	0.2465	0.2478
2007	0.0005	0.0046	0.0180	0.0427	0.0736	0.1037	0.1286	0.1473	0.1605	0.1694	0.1752	0.1790	0.1815	0.1830	0.1840
2008	0.0006	0.0050	0.0198	0.0471	0.0811	0.1142	0.1417	0.1623	0.1768	0.1866	0.1931	0.1972	0.1999	0.2016	0.2027
2009	0.0005	0.0046	0.0182	0.0431	0.0742	0.1046	0.1297	0.1486	0.1619	0.1709	0.1768	0.1806	0.1830	0.1846	0.1856
2010	0.0006	0.0056	0.0220	0.0521	0.0897	0.1264	0.1568	0.1796	0.1957	0.2065	0.2137	0.2183	0.2212	0.2231	0.2243
2011	0.0007	0.0058	0.0227	0.0538	0.0928	0.1306	0.1621	0.1857	0.2023	0.2135	0.2209	0.2256	0.2287	0.2306	0.2319
2012	0.0006	0.0056	0.0219	0.0519	0.0895	0.1260	0.1564	0.1791	0.1952	0.2060	0.2131	0.2177	0.2206	0.2225	0.2237
2013	0.0009	0.0081	0.0317	0.0752	0.1295	0.1824	0.2263	0.2593	0.2824	0.2981	0.3084	0.3150	0.3193	0.3220	0.3237
2014	0.0007	0.0058	0.0228	0.0542	0.0933	0.1315	0.1631	0.1869	0.2036	0.2148	0.2223	0.2271	0.2301	0.2321	0.2333
2015	0.0006	0.0051	0.0202	0.0480	0.0827	0.1165	0.1445	0.1656	0.1804	0.1903	0.1969	0.2012	0.2039	0.2056	0.2067
2016	0.0007	0.0057	0.0225	0.0532	0.0917	0.1292	0.1603	0.1836	0.2000	0.2111	0.2184	0.2231	0.2262	0.2281	0.2293
2017	0.0008	0.0073	0.0287	0.0680	0.1171	0.1649	0.2046	0.2344	0.2554	0.2695	0.2788	0.2848	0.2887	0.2912	0.2927
2018	0.0006	0.0052	0.0204	0.0484	0.0835	0.1175	0.1459	0.1671	0.1820	0.1921	0.1987	0.2030	0.2058	0.2075	0.2086
2019	0.0005	0.0047	0.0183	0.0435	0.0749	0.1055	0.1309	0.1500	0.1634	0.1724	0.1784	0.1822	0.1847	0.1863	0.1873
2020	0.0017	0.0052	0.0152	0.0380	0.0704	0.0941	0.1028	0.1034	0.1010	0.0979	0.0946	0.0914	0.0882	0.0852	0.0822
2021	0.0018	0.0057	0.0167	0.0417	0.0774	0.1034	0.1130	0.1136	0.1111	0.1076	0.1040	0.1004	0.0970	0.0936	0.0904
2022	0.0028	0.0086	0.0251	0.0625	0.1159	0.1549	0.1693	0.1702	0.1664	0.1612	0.1558	0.1504	0.1452	0.1402	0.1353
2023	0.0014	0.0039	0.0108	0.0287	0.0694	0.1360	0.1945	0.2124	0.2014	0.1808	0.1594	0.1397	0.1222	0.1068	0.0933

Table X5 cont.

Total Fishing Mortality-At-Age

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0002	0.0133	0.0976	0.1179	0.1444	0.1619	0.1710	0.1753	0.1773	0.1782	0.1785	0.1787	0.1788	0.1788	0.1801
1983	0.0002	0.0127	0.0944	0.1018	0.1190	0.1315	0.1382	0.1414	0.1429	0.1436	0.1439	0.1440	0.1441	0.1441	0.1454
1984	0.0001	0.0098	0.0739	0.0572	0.0554	0.0570	0.0584	0.0592	0.0596	0.0598	0.0599	0.0599	0.0599	0.0600	0.0613
1985	0.0006	0.0059	0.0221	0.0467	0.0775	0.1078	0.1332	0.1524	0.1660	0.1752	0.1813	0.1852	0.1877	0.1893	0.1903
1986	0.0002	0.0031	0.0110	0.0171	0.0248	0.0324	0.0388	0.0436	0.0469	0.0491	0.0505	0.0514	0.0518	0.0521	0.0523
1987	0.0001	0.0015	0.0054	0.0092	0.0138	0.0185	0.0223	0.0252	0.0273	0.0286	0.0295	0.0300	0.0304	0.0306	0.0307
1988	0.0002	0.0023	0.0080	0.0122	0.0175	0.0227	0.0270	0.0303	0.0326	0.0341	0.0350	0.0356	0.0359	0.0361	0.0362
1989	0.0002	0.0026	0.0091	0.0148	0.0218	0.0288	0.0347	0.0390	0.0421	0.0441	0.0454	0.0462	0.0467	0.0470	0.0471
1990	0.0004	0.0020	0.0086	0.0295	0.0548	0.0579	0.0560	0.0558	0.0570	0.0586	0.0602	0.0616	0.0628	0.0637	0.0644
1991	0.0005	0.0025	0.0105	0.0350	0.0649	0.0709	0.0715	0.0739	0.0773	0.0808	0.0840	0.0866	0.0886	0.0902	0.0913
1992	0.0005	0.0029	0.0122	0.0402	0.0746	0.0823	0.0840	0.0875	0.0921	0.0967	0.1007	0.1040	0.1066	0.1085	0.1100
1993	0.0004	0.0024	0.0100	0.0332	0.0617	0.0673	0.0679	0.0701	0.0733	0.0766	0.0796	0.0820	0.0839	0.0854	0.0865
1994	0.0006	0.0031	0.0130	0.0433	0.0804	0.0878	0.0885	0.0914	0.0956	0.0999	0.1037	0.1069	0.1094	0.1113	0.1128
1995	0.0009	0.0051	0.0211	0.0680	0.1262	0.1422	0.1486	0.1578	0.1681	0.1779	0.1861	0.1928	0.1980	0.2019	0.2048
1996	0.0013	0.0072	0.0285	0.0718	0.1112	0.1408	0.1678	0.1921	0.2125	0.2286	0.2407	0.2493	0.2552	0.2590	0.2613
1997	0.0012	0.0081	0.0339	0.0848	0.1283	0.1554	0.1740	0.1866	0.1944	0.1986	0.2003	0.2005	0.1997	0.1983	0.1967
1998	0.0012	0.0079	0.0330	0.0820	0.1257	0.1551	0.1762	0.1908	0.2001	0.2055	0.2082	0.2091	0.2089	0.2080	0.2068
1999	0.0011	0.0076	0.0319	0.0796	0.1211	0.1480	0.1668	0.1797	0.1879	0.1924	0.1945	0.1950	0.1945	0.1934	0.1920
2000	0.0012	0.0078	0.0326	0.0815	0.1235	0.1497	0.1678	0.1801	0.1877	0.1919	0.1936	0.1938	0.1931	0.1918	0.1902
2001	0.0010	0.0072	0.0298	0.0740	0.1140	0.1413	0.1610	0.1747	0.1836	0.1888	0.1914	0.1924	0.1923	0.1916	0.1906
2002	0.0011	0.0078	0.0324	0.0804	0.1236	0.1530	0.1741	0.1888	0.1983	0.2038	0.2066	0.2076	0.2075	0.2067	0.2055
2003	0.0013	0.0089	0.0374	0.0933	0.1414	0.1715	0.1924	0.2065	0.2153	0.2201	0.2221	0.2224	0.2216	0.2201	0.2183
2004	0.0014	0.0095	0.0395	0.0984	0.1505	0.1851	0.2097	0.2266	0.2374	0.2436	0.2466	0.2475	0.2472	0.2460	0.2444
2005	0.0013	0.0090	0.0375	0.0929	0.1434	0.1782	0.2034	0.2211	0.2325	0.2393	0.2427	0.2441	0.2441	0.2433	0.2420
2006	0.0017	0.0112	0.0469	0.1167	0.1781	0.2183	0.2466	0.2661	0.2784	0.2854	0.2887	0.2896	0.2890	0.2875	0.2856
2007	0.0013	0.0084	0.0351	0.0876	0.1335	0.1633	0.1842	0.1986	0.2077	0.2128	0.2152	0.2158	0.2153	0.2141	0.2126
2008	0.0012	0.0084	0.0347	0.0861	0.1332	0.1660	0.1901	0.2069	0.2179	0.2244	0.2278	0.2292	0.2293	0.2287	0.2276
2009	0.0014	0.0091	0.0382	0.0956	0.1443	0.1743	0.1948	0.2086	0.2171	0.2217	0.2235	0.2236	0.2226	0.2210	0.2191
2010	0.0015	0.0103	0.0431	0.1076	0.1638	0.2001	0.2256	0.2431	0.2541	0.2602	0.2631	0.2637	0.2631	0.2616	0.2597
2011	0.0015	0.0104	0.0434	0.1081	0.1652	0.2028	0.2294	0.2478	0.2594	0.2660	0.2692	0.2701	0.2696	0.2683	0.2665
2012	0.0017	0.0109	0.0459	0.1148	0.1734	0.2096	0.2344	0.2510	0.2613	0.2668	0.2691	0.2692	0.2680	0.2661	0.2638
2013	0.0020	0.0140	0.0582	0.1445	0.2220	0.2745	0.3123	0.3385	0.3554	0.3652	0.3701	0.3718	0.3715	0.3701	0.3680
2014	0.0020	0.0127	0.0536	0.1347	0.2008	0.2385	0.2629	0.2789	0.2883	0.2928	0.2939	0.2930	0.2908	0.2879	0.2847
2015	0.0017	0.0109	0.0458	0.1149	0.1719	0.2053	0.2274	0.2420	0.2507	0.2551	0.2564	0.2559	0.2543	0.2520	0.2494
2016	0.0021	0.0134	0.0568	0.1433	0.2119	0.2488	0.2719	0.2865	0.2947	0.2982	0.2985	0.2969	0.2940	0.2905	0.2867
2017	0.0019	0.0127	0.0528	0.1312	0.2015	0.2490	0.2830	0.3067	0.3219	0.3307	0.3351	0.3366	0.3364	0.3350	0.3330
2018	0.0015	0.0097	0.0406	0.1014	0.1541	0.1879	0.2114	0.2276	0.2377	0.2433	0.2458	0.2464	0.2456	0.2442	0.2424
2019	0.0012	0.0082	0.0343	0.0852	0.1306	0.1610	0.1827	0.1977	0.2073	0.2128	0.2156	0.2164	0.2162	0.2152	0.2139
2020	0.0023	0.0085	0.0300	0.0767	0.1221	0.1456	0.1508	0.1476	0.1418	0.1354	0.1291	0.1231	0.1174	0.1120	0.1069
2021	0.0024	0.0084	0.0287	0.0730	0.1191	0.1450	0.1517	0.1493	0.1439	0.1379	0.1318	0.1260	0.1205	0.1153	0.1103
2022	0.0033	0.0112	0.0367	0.0930	0.1565	0.1954	0.2070	0.2050	0.1984	0.1907	0.1829	0.1754	0.1682	0.1613	0.1547
2023	0.0019	0.0065	0.0235	0.0645	0.1134	0.1740	0.2253	0.2371	0.2212	0.1967	0.1721	0.1499	0.1303	0.1133	0.0986

Table X6. Estimates of age-specific population abundance, 1982-2021

	Age																
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	8+
1982	37,364,100	8,588,370	3,226,070	2,476,530	984,780	404,374	330,079	213,479	185,704	275,932	192,122	313,355	151,055	108,728	278,367	55,093,045	1,718,742
1983	75,602,800	12,068,000	4,293,690	1,865,850	1,582,410	663,821	284,418	239,450	154,199	133,873	198,742	138,323	225,568	108,728	278,367	97,838,239	1,477,250
1984	62,859,700	24,418,600	6,036,480	2,491,240	1,211,610	1,094,090	481,314	213,208	178,921	115,049	99,817	148,139	103,090	168,103	288,191	99,907,552	1,314,518
1985	68,479,300	20,303,500	12,250,200	3,574,720	1,691,400	892,742	854,611	390,767	172,963	145,090	93,277	80,920	120,090	83,569	369,578	109,502,727	1,456,254
1986	67,611,600	22,107,700	10,225,700	7,640,310	2,452,660	1,218,990	662,796	643,827	288,791	126,101	104,810	66,973	57,873	85,672	322,502	113,616,305	1,696,549
1987	74,169,300	21,836,200	11,165,400	6,448,960	5,399,460	1,863,340	975,896	548,761	530,513	237,174	103,335	85,769	54,759	47,295	333,442	123,799,604	1,941,048
1988	93,300,800	23,956,400	11,045,800	7,080,820	4,594,000	4,147,350	1,512,740	821,426	460,560	444,341	198,380	86,357	71,638	45,722	317,811	148,084,146	2,446,236
1989	106,655,000	30,134,800	12,109,200	6,987,030	5,028,780	3,515,920	3,352,810	1,267,300	685,903	383,703	369,638	164,873	71,731	59,485	301,786	171,087,958	3,304,418
1990	130,941,000	34,446,800	15,227,600	7,650,960	4,949,430	3,831,890	2,824,960	2,787,500	1,049,010	566,020	315,996	304,018	135,495	58,921	296,639	205,386,239	5,513,599
1991	104,485,000	42,283,100	17,416,500	9,626,300	5,340,420	3,648,980	2,990,600	2,299,140	2,268,960	852,882	459,454	256,089	246,034	109,526	286,987	192,569,972	6,779,072
1992	108,762,000	33,736,700	21,367,700	10,989,000	6,682,810	3,897,720	2,810,970	2,396,330	1,837,910	1,807,590	677,075	363,605	202,143	193,811	311,598	196,036,962	7,790,062
1993	133,935,000	35,115,100	17,041,600	13,459,400	7,589,240	4,830,600	2,968,700	2,224,620	1,889,700	1,442,670	1,412,390	526,927	282,048	156,400	389,927	223,264,322	8,324,682
1994	285,297,000	43,246,700	17,747,600	10,758,100	9,360,100	5,556,950	3,734,550	2,387,510	1,785,150	1,511,540	1,150,150	1,122,690	417,829	223,222	431,404	384,730,495	9,029,495
1995	186,734,000	92,108,400	21,841,600	11,169,900	7,406,490	6,726,490	4,209,160	2,942,140	1,875,510	1,396,460	1,177,330	892,402	868,332	322,356	503,596	340,174,166	9,978,126
1996	234,018,000	60,265,400	46,424,800	13,636,700	7,502,680	5,084,410	4,825,430	3,122,640	2,162,740	1,364,470	1,006,110	841,231	633,409	613,151	579,924	382,081,095	10,323,675
1997	258,960,000	75,495,500	30,311,800	28,770,400	9,124,160	5,228,440	3,652,350	3,511,810	2,218,020	1,505,120	934,388	680,720	564,275	422,380	791,697	422,171,060	10,628,410
1998	148,052,000	83,550,900	37,939,400	18,683,000	19,001,600	6,250,310	3,701,530	2,641,650	2,508,220	1,571,870	1,062,170	658,237	479,458	397,761	857,909	327,356,015	10,177,275
1999	152,875,000	47,770,300	41,994,900	23,406,800	12,374,800	13,050,100	4,426,050	2,671,330	1,878,780	1,767,290	1,101,560	742,368	459,644	334,876	878,539	305,732,337	9,834,387
2000	124,486,000	49,327,600	24,017,400	25,936,300	15,540,800	8,538,000	9,307,430	3,224,210	1,921,000	1,340,130	1,254,870	780,533	525,764	325,695	861,605	267,387,337	10,233,807
2001	196,467,000	40,166,100	24,796,600	14,822,600	17,186,200	10,697,600	6,078,890	6,773,450	2,317,780	1,370,470	952,107	889,963	553,441	373,069	844,523	324,289,793	14,074,803
2002	221,336,000	63,399,200	20,203,500	15,346,600	9,895,990	11,942,900	7,681,040	4,454,190	4,895,320	1,660,330	976,643	676,713	631,928	393,004	865,851	364,359,209	14,553,979
2003	127,967,000	71,418,000	31,870,300	12,472,000	10,180,700	6,810,750	8,475,350	5,554,690	3,174,080	3,455,590	1,165,570	683,709	473,270	442,005	881,917	285,024,931	15,830,831
2004	304,432,000	41,282,400	35,860,800	19,576,300	8,167,420	6,883,390	4,744,390	6,018,290	3,888,990	2,202,830	2,386,730	803,399	471,137	326,394	915,468	437,959,938	17,013,238
2005	158,153,000	98,204,900	20,717,200	21,979,700	12,755,300	5,471,910	4,730,500	3,311,210	4,129,550	2,639,810	1,486,030	1,605,270	539,860	316,713	836,755	336,877,708	14,865,198
2006	135,236,000	51,022,000	49,305,900	12,724,200	14,399,600	8,607,120	3,786,610	3,322,170	2,284,690	2,816,970	1,788,640	1,003,380	1,082,440	364,028	779,111	288,522,859	13,441,429
2007	88,441,000	43,613,400	25,560,400	29,999,900	8,139,960	9,384,600	5,722,040	2,546,890	2,191,350	1,488,530	1,822,530	1,153,420	646,466	697,828	739,045	222,147,359	11,286,059
2008	126,912,000	28,533,800	21,910,400	15,735,400	19,759,200	5,547,320	6,591,680	4,096,400	1,797,270	1,532,390	1,035,610	1,264,970	800,086	448,662	999,156	236,964,344	11,974,544
2009	75,196,700	40,947,600	14,335,200	13,493,800	10,379,600	13,470,000	3,885,600	4,691,510	2,866,800	1,244,090	1,053,860	709,776	865,771	547,530	992,185	184,680,022	12,971,522
2010	96,903,000	24,257,700	20,557,000	8,798,030	8,816,910	6,997,620	9,357,590	2,752,480	3,277,760	1,985,960	857,921	725,405	488,521	596,480	1,063,820	187,436,197	11,748,347
2011	125,307,000	31,255,000	12,163,300	12,554,200	5,679,980	5,829,110	4,737,180	6,427,480	1,857,870	2,188,230	1,317,670	567,614	479,621	323,219	1,101,440	211,788,914	14,263,144
2012	192,360,000	40,416,400	15,670,500	7,426,080	8,100,520	3,749,890	3,935,670	3,241,530	4,318,180	1,233,720	1,443,490	866,465	372,911	315,259	938,971	284,389,586	12,730,526
2013	66,597,300	62,036,200	20,253,000	9,543,610	4,759,560	5,304,120	2,514,580	2,679,760	2,170,600	2,861,980	813,181	949,314	569,765	245,504	828,725	182,127,199	11,118,829
2014	82,938,200	21,469,400	30,992,700	12,184,300	5,938,020	2,968,680	3,333,300	1,583,840	1,644,160	1,309,510	1,709,760	483,413	563,369	338,219	639,654	168,096,525	8,271,925
2015	153,154,000	26,739,200	10,739,800	18,731,000	7,655,810	3,783,210	1,934,150	2,205,700	1,031,450	1,060,750	841,052	1,096,820	310,403	362,540	632,440	230,278,325	7,541,155
2016	228,067,000	49,391,300	13,400,400	6,541,700	12,005,000	5,020,460	2,547,850	1,326,140	1,490,430	690,928	707,461	560,155	730,875	207,182	666,741	323,353,622	6,379,912
2017	111,488,000	73,518,300	24,689,800	8,072,670	4,075,320	7,564,400	3,237,260	1,670,930	857,067	955,370	441,338	451,755	358,299	468,845	564,197	238,413,551	5,767,801
2018	130,105,000	35,947,600	36,776,500	14,933,400	5,090,040	2,594,660	4,876,880	2,099,530	1,058,330	534,662	590,752	271,701	277,691	220,307	636,724	236,013,777	5,689,697
2019	165,265,000	41,967,500	18,035,800	22,516,400	9,701,210	3,398,080	1,778,200	3,397,620	1,439,300	718,223	360,807	397,648	182,792	186,956	578,611	269,924,147	7,261,957
2020	120,143,000	53,321,800	21,087,400	11,112,700	14,865,000	6,630,030	2,392,210	1,274,980	2,399,780	1,006,890	499,670	250,332	275,651	126,746	531,867	235,918,056	6,365,916
2021	85,158,100	38,720,900	26,784,800	13,048,600	7,399,390	10,246,600	4,740,090	1,770,770	946,785	1,792,490	756,905	377,985	190,510	210,977	508,908	192,653,810	6,555,330
2022	76,967,300	27,444,300	19,452,800	16,596,400	8,720,710	5,115,800	7,330,100	3,505,450	1,312,700	705,664	1,344,130	571,010	286,811	145,358	554,104	170,052,637	8,425,227
2023	96,681,400	24,782,200	13,749,300	11,957,000	10,872,400	5,807,770	3,479,720	5,129,420	2,458,020	926,552	501,940	963,536	412,419	208,649	515,022	178,445,348	11,115,558

Table X7. Estimates of female spawning stock biomass, 1982-2023.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	0.0	0.0	0.0	142.0	365.4	409.4	891.1	825.6	886.1	2,010.4	1,860.7	3,105.7	1,861.0	1,496.7	4,454.6	18,308.5
1983	0.0	0.0	0.0	100.3	558.8	548.4	616.4	845.9	758.0	875.4	1,654.2	1,320.5	2,550.2	1,419.7	4,156.7	15,404.5
1984	0.0	0.0	0.0	147.0	457.3	926.4	1,270.7	742.6	950.2	728.9	747.4	1,603.8	1,194.6	2,238.1	4,503.3	15,510.3
1985	0.0	0.0	0.0	249.0	572.5	808.9	2,202.7	1,415.2	921.9	907.7	718.3	738.3	1,361.3	1,043.0	5,204.1	16,142.8
1986	0.0	0.0	0.0	627.8	910.6	953.3	1,486.0	2,205.4	1,310.8	687.1	723.5	561.0	547.9	905.0	3,673.1	14,591.5
1987	0.0	0.0	0.0	502.6	2,241.1	1,422.8	1,977.9	1,700.8	2,392.1	1,285.9	681.0	728.4	522.7	501.7	4,122.3	18,079.2
1988	0.0	0.0	0.0	539.9	2,179.3	4,058.2	3,481.6	2,472.2	1,964.7	2,169.3	1,430.1	768.1	703.3	495.5	3,938.9	24,201.0
1989	0.0	0.0	0.0	547.2	2,313.0	3,974.6	9,739.7	4,940.8	3,245.1	2,559.1	2,648.3	1,429.6	745.6	667.4	3,847.7	36,658.0
1990	0.0	0.0	0.0	576.5	1,917.6	3,789.9	7,889.0	11,043.2	5,091.2	2,950.0	2,195.9	2,522.9	1,232.7	595.9	3,228.6	43,033.1
1991	0.0	0.0	0.0	743.8	2,195.9	2,927.9	7,873.4	8,530.3	11,938.2	4,518.8	3,473.2	1,892.8	2,285.9	1,110.4	3,310.0	50,800.7
1992	0.0	0.0	0.0	801.6	2,934.7	3,582.7	7,148.7	9,008.8	10,071.3	12,053.6	5,293.0	3,859.0	2,274.1	2,521.3	5,053.7	64,602.5
1993	0.0	0.0	0.0	1,009.2	3,206.0	4,441.8	7,723.6	8,763.3	10,521.6	9,694.1	11,610.1	5,067.5	3,267.3	2,014.1	5,592.1	72,910.8
1994	0.0	0.0	0.0	871.8	4,062.9	4,995.6	9,846.1	9,439.7	9,804.0	9,698.6	9,538.2	10,651.2	4,569.9	2,734.1	5,963.6	82,175.8
1995	0.0	0.0	0.0	952.5	3,215.8	6,250.9	11,693.7	11,582.6	10,790.7	9,960.9	7,898.8	7,862.8	8,824.6	3,619.8	6,198.2	88,851.2
1996	0.0	0.0	0.0	1,151.4	3,648.4	5,508.0	15,383.4	13,936.6	13,051.0	10,128.6	8,165.6	7,118.3	6,641.2	7,095.5	7,619.0	99,447.0
1997	0.0	0.0	0.0	2,589.7	4,052.5	4,996.3	9,452.3	12,703.9	12,430.5	11,381.0	8,073.1	6,158.8	6,159.8	5,238.5	11,340.4	94,576.7
1998	0.0	0.0	0.0	1,164.0	7,251.0	4,927.2	9,343.1	9,508.8	13,039.2	9,375.6	7,609.6	5,883.8	4,769.0	4,503.7	10,724.9	88,099.9
1999	0.0	0.0	0.0	1,340.9	3,763.8	8,627.5	8,262.0	8,897.5	9,763.0	11,503.8	8,049.9	6,194.1	4,801.3	3,955.2	12,335.9	87,495.0
2000	0.0	0.0	0.0	1,464.5	4,678.3	5,864.2	18,622.0	9,967.9	10,295.7	8,240.1	10,237.9	7,178.6	5,829.2	4,189.1	13,283.0	99,850.5
2001	0.0	0.0	0.0	962.3	5,676.3	8,298.9	13,047.0	21,508.7	11,464.5	8,965.6	7,018.2	6,948.6	5,419.6	4,142.0	10,148.8	103,600.5
2002	0.0	0.0	0.0	895.4	3,387.6	9,359.6	17,321.8	15,302.2	23,150.9	10,313.1	7,564.8	5,789.9	6,254.2	4,519.6	11,802.3	115,661.3
2003	0.0	0.0	0.0	677.3	3,375.9	5,347.1	18,653.5	18,391.8	15,450.6	20,386.1	8,507.7	5,754.1	4,682.8	4,989.4	11,299.7	117,516.0
2004	0.0	0.0	0.0	1,047.1	2,860.8	5,294.6	10,524.9	19,693.5	18,573.9	12,893.9	16,680.8	6,435.4	4,483.7	3,520.5	11,205.9	113,215.0
2005	0.0	0.0	0.0	1,268.1	4,177.9	4,442.2	10,501.5	11,600.4	20,454.0	15,585.5	10,672.8	13,753.4	5,356.9	3,575.1	11,045.5	112,433.3
2006	0.0	0.0	0.0	683.1	4,453.6	6,112.7	7,928.6	11,163.5	11,942.5	17,109.8	12,906.5	8,250.7	10,961.6	4,179.1	10,355.2	106,046.9
2007	0.0	0.0	0.0	1,441.6	2,536.7	6,960.5	12,685.4	8,400.0	11,626.0	9,617.5	14,272.8	10,119.2	6,865.7	8,541.0	10,700.2	103,766.5
2008	0.0	0.0	0.0	843.1	6,187.0	4,587.4	16,830.6	14,265.2	9,304.3	10,356.3	8,083.4	11,082.9	8,434.5	5,409.3	13,700.9	109,084.9
2009	0.0	0.0	0.0	733.0	3,064.9	10,744.7	9,362.1	17,524.2	15,274.3	7,943.4	8,077.6	6,022.5	8,820.9	6,373.8	13,118.1	107,059.4
2010	0.0	0.0	0.0	476.2	2,659.8	5,480.1	21,359.5	9,252.0	16,413.7	12,616.6	6,529.6	5,911.7	4,827.8	6,743.9	13,722.0	105,992.8
2011	0.0	0.0	0.0	743.2	1,719.7	4,333.3	10,524.1	21,079.2	9,227.6	13,433.0	9,345.8	4,956.1	4,775.4	3,709.0	14,697.7	98,544.1
2012	0.0	0.0	0.0	457.1	2,786.5	2,903.9	9,091.2	11,653.4	21,759.0	8,190.9	10,984.5	7,636.2	3,989.1	3,815.7	13,325.2	96,592.6
2013	0.0	0.0	0.0	506.7	1,643.7	4,352.2	5,542.8	9,012.1	11,364.4	17,617.7	6,385.6	8,506.0	6,096.1	3,004.7	11,775.6	85,807.5
2014	0.0	0.0	0.0	597.5	1,884.5	2,267.1	7,644.9	5,265.4	8,726.4	8,859.6	13,111.7	4,846.8	6,593.1	4,569.5	10,466.8	74,833.3
2015	0.0	0.0	0.0	1,068.9	2,667.6	3,322.6	4,557.5	7,827.3	5,483.3	6,798.1	6,534.9	10,046.6	3,440.8	4,537.0	8,823.7	65,108.1
2016	0.0	0.0	0.0	313.4	3,963.2	4,235.7	6,478.9	4,984.0	8,107.3	4,924.4	5,826.7	5,326.4	8,533.0	2,756.8	10,642.6	66,092.4
2017	0.0	0.0	0.0	445.0	1,406.0	5,996.2	7,653.5	5,741.3	4,376.0	6,607.5	3,688.0	4,278.1	4,146.6	6,247.6	8,346.1	58,932.0
2018	0.0	0.0	0.0	801.6	1,649.1	2,287.1	10,427.1	7,096.9	5,954.6	3,760.5	5,238.2	2,950.9	3,245.4	2,813.7	10,386.1	56,611.0
2019	0.0	0.0	0.0	1,187.0	3,062.5	2,608.5	4,082.7	12,657.6	8,172.5	5,174.1	3,171.1	4,142.5	2,398.8	2,492.5	8,721.2	57,871.0
2020	0.0	0.0	0.0	680.4	4,646.6	4,701.2	5,561.3	4,953.1	13,133.7	7,331.8	4,506.5	2,664.9	3,362.3	1,653.9	7,747.4	60,943.1
2021	0.0	0.0	0.0	749.8	2,613.1	6,928.7	9,921.4	6,003.7	4,507.4	12,309.2	4,616.4	3,748.5	2,392.2	2,767.1	7,812.8	64,370.2
2022	0.0	0.0	0.0	1,088.0	3,150.1	4,703.4	16,627.5	11,287.4	6,904.6	4,338.2	11,170.6	5,171.3	3,409.7	1,836.5	8,349.5	78,036.8
2023	0.0	0.0	0.0	812.7	4,129.0	5,057.2	8,575.3	16,799.3	11,975.3	5,484.7	4,261.4	9,240.8	4,700.0	2,708.4	6,993.8	80,738.0

Table x8. Estimate of total female spawning stock biomass with associated standard errors and coefficients of variation.

Year	Total	SE	CV
1982	18,308.5	2,575.7	0.141
1983	15,404.4	2,285.6	0.148
1984	15,510.3	2,286.7	0.147
1985	16,142.8	2,221.6	0.138
1986	14,591.5	1,899.4	0.130
1987	18,079.2	2,093.3	0.116
1988	24,201.0	2,368.9	0.098
1989	36,658.0	3,084.6	0.084
1990	43,033.1	3,264.2	0.076
1991	50,800.7	3,659.9	0.072
1992	64,602.5	4,647.2	0.072
1993	72,910.7	5,027.9	0.069
1994	82,175.7	5,342.5	0.065
1995	88,851.2	5,491.2	0.062
1996	99,447.0	6,244.7	0.063
1997	94,576.7	6,356.5	0.067
1998	88,099.9	5,493.2	0.062
1999	87,495.0	5,457.6	0.062
2000	99,850.6	5,896.1	0.059
2001	103,601.0	5,575.4	0.054
2002	115,661.0	6,163.8	0.053
2003	117,516.0	6,258.5	0.053
2004	113,215.0	6,196.8	0.055
2005	112,433.0	6,387.2	0.057
2006	106,047.0	6,239.6	0.059
2007	103,766.0	6,304.1	0.061
2008	109,085.0	6,239.6	0.057
2009	107,059.0	5,976.9	0.056
2010	105,993.0	5,802.6	0.055
2011	98,544.2	5,661.3	0.057
2012	96,592.7	5,868.2	0.061
2013	85,807.5	5,684.1	0.066
2014	74,833.3	5,719.4	0.076
2015	65,108.1	5,188.6	0.080
2016	66,092.5	5,535.9	0.084
2017	58,932.0	5,264.8	0.089
2018	56,611.0	5,485.0	0.097
2019	57,871.0	5,674.1	0.098
2020	60,943.1	5,955.9	0.098
2021	64,370.1	6,342.3	0.099
2022	78,036.8	7,687.2	0.099
2023	80,738.0	8,574.5	0.106

Table x9 . Estimates of exploitable biomass, 1982-2021.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	2,362	4,535	3,137	3,074	2,044	1,512	1,513	1,213	1,007	2,281	2,115	3,342	1,964	1,550	4,766	36,416
1983	8,730	3,227	3,330	2,280	3,023	1,873	1,069	1,218	910	949	1,811	1,465	2,653	1,493	4,432	38,463
1984	9,463	8,459	5,820	3,074	2,317	3,101	1,966	984	1,077	786	824	1,630	1,195	2,265	4,761	47,722
1985	1,333	7,769	9,815	5,987	3,186	2,764	3,487	2,056	1,070	1,030	780	767	1,478	1,105	5,573	48,199
1986	4,036	4,088	9,000	12,244	4,936	3,186	2,496	3,206	1,574	810	796	608	592	979	3,880	52,431
1987	6,954	7,169	10,010	10,557	13,226	4,965	3,275	2,374	2,801	1,409	711	747	534	506	4,345	69,583
1988	17,676	10,220	10,166	11,831	11,787	13,148	5,401	3,384	2,295	2,475	1,480	776	728	506	4,154	96,027
1989	7,235	15,286	12,759	10,943	12,378	13,218	15,578	6,620	3,655	2,588	2,620	1,507	773	678	4,062	109,900
1990	3,089	12,999	14,812	12,100	11,330	13,118	13,323	15,770	6,251	3,399	2,539	2,739	1,309	639	3,414	116,832
1991	12,105	11,471	18,662	15,141	12,377	9,959	12,836	12,099	14,079	5,087	3,453	2,012	2,358	1,133	3,510	136,281
1992	3,945	12,842	23,458	17,339	16,502	12,086	11,079	12,646	11,515	13,116	5,287	3,944	2,139	2,414	5,369	153,682
1993	2,421	9,681	16,202	21,731	17,548	15,321	12,460	12,172	12,056	10,772	12,447	5,403	3,478	2,126	5,927	159,745
1994	40,093	11,725	20,114	18,305	22,291	17,303	15,705	13,025	11,507	10,998	10,154	11,332	4,732	2,845	6,337	216,463
1995	27,000	37,753	26,004	21,440	18,325	21,695	18,265	16,230	12,592	10,839	8,889	8,683	9,399	3,868	6,647	247,630
1996	15,569	32,677	47,093	24,133	19,909	17,991	23,304	19,313	15,001	11,159	9,138	7,356	6,810	7,327	8,218	264,997
1997	13,833	22,242	33,740	54,711	23,297	17,928	16,490	19,989	15,343	12,737	8,935	6,647	6,287	5,408	12,153	269,739
1998	38,009	26,434	32,725	25,831	44,704	17,996	15,294	13,347	14,749	10,812	8,960	6,520	5,047	4,851	11,505	276,783
1999	100,633	28,302	38,824	30,769	21,768	31,013	13,935	12,975	11,448	12,931	8,610	6,461	4,933	4,022	13,213	339,836
2000	45,450	28,805	23,897	32,904	26,109	19,710	29,083	13,334	11,488	9,318	10,950	7,527	5,849	4,245	14,225	282,893
2001	22,583	15,061	19,462	20,566	30,765	26,999	20,610	29,932	13,187	10,199	7,602	7,981	5,844	4,532	10,869	246,193
2002	11,878	14,120	12,823	19,958	19,329	31,611	28,345	21,165	26,933	11,513	8,218	6,215	6,178	4,583	12,659	235,526
2003	7,044	19,164	17,745	15,193	18,556	17,989	30,555	25,928	18,352	22,769	9,343	6,320	4,888	5,270	12,135	231,250
2004	47,490	7,499	25,459	23,163	15,064	18,005	17,269	27,708	21,849	14,517	18,317	7,039	4,692	3,716	12,066	263,852
2005	12,025	33,303	12,707	25,798	22,487	15,330	17,056	16,000	23,717	17,464	11,567	14,519	5,453	3,672	11,890	242,988
2006	15,227	11,340	31,378	15,785	25,817	21,459	13,336	15,710	14,044	19,369	14,068	8,974	11,501	4,380	11,196	233,585
2007	4,169	12,550	15,277	30,785	13,706	23,020	19,878	11,512	13,305	10,788	15,203	10,748	6,912	8,717	11,485	208,051
2008	15,511	6,053	15,155	18,244	32,957	14,975	25,954	19,963	10,722	11,560	8,790	12,147	8,732	5,693	14,728	221,183
2009	11,915	14,775	9,760	16,340	17,199	35,742	15,337	25,259	17,638	8,947	8,990	6,621	9,140	6,710	14,089	218,462
2010	8,600	10,349	17,054	10,603	14,769	17,720	35,073	13,313	19,664	14,397	7,144	6,513	5,006	7,102	14,798	202,105
2011	16,177	9,015	10,378	16,467	9,538	14,431	17,530	30,082	10,737	15,046	10,436	5,371	4,886	3,858	15,861	189,813
2012	6,218	12,523	11,357	9,787	15,295	9,560	14,554	15,916	25,069	9,004	11,924	8,005	4,101	3,928	14,376	171,617
2013	7,437	12,283	13,748	11,308	9,267	14,789	9,224	12,999	13,614	20,157	7,133	9,228	6,400	3,173	12,837	163,596
2014	52,826	6,940	20,467	13,454	10,265	7,837	12,678	7,419	10,007	9,834	14,226	5,077	6,688	4,643	11,316	193,678
2015	13,568	10,080	7,640	22,282	13,642	10,742	7,237	10,885	6,269	7,777	7,305	10,783	3,705	4,891	9,506	146,310
2016	23,074	12,544	6,373	7,015	22,299	14,637	10,753	6,965	9,446	5,448	6,213	5,616	8,692	2,804	11,508	153,388
2017	13,968	21,001	16,669	8,990	7,190	20,181	12,606	8,392	5,325	7,431	4,122	4,704	4,339	6,619	9,067	150,603
2018	20,262	12,653	25,223	18,061	9,301	7,747	17,465	10,159	6,679	4,042	5,631	3,055	3,322	2,978	11,181	157,760
2019	19,932	15,522	14,792	26,185	16,593	8,726	6,862	16,756	9,086	5,812	3,463	4,459	2,503	2,607	9,362	162,658
2020	31,069	17,685	16,000	15,008	25,245	16,182	8,892	6,579	15,573	8,196	4,809	2,801	3,470	1,784	8,228	181,521
2021	5,006	15,333	19,463	16,221	14,317	24,114	15,832	8,503	5,653	13,509	5,613	4,078	2,467	2,900	8,300	161,310
2022	7,146	6,722	14,854	22,177	16,919	15,395	25,425	15,773	7,865	4,645	12,132	4,890	3,470	1,975	8,910	168,297
2023	29,847	7,714	11,042	17,548	23,209	17,115	14,489	24,463	13,889	6,375	4,478	9,885	4,935	2,846	7,421	195,258

Table X10. Reference points and probability of female spawning stock biomass being greater or equal to the SSB target and SSBthreshold over a ten-year projection under the current fully-recruited 2023 F, Ftarget and Fthreshold.

Reference Points

	SSB	F
Target	111064.0	0.193
Threshold	88851.2	0.235
Current	80738.0	0.237

	Current F		Ftarget		Fthreshold	
Year	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget
2023	0.111	0.000	0.114	0.000	0.109	0.000
2024	0.353	0.001	0.363	0.001	0.352	0.001
2025	0.430	0.004	0.607	0.012	0.432	0.004
2026	0.430	0.005	0.722	0.030	0.437	0.007
2027	0.356	0.004	0.767	0.046	0.388	0.005
2028	0.294	0.003	0.777	0.051	0.318	0.003
2029	0.247	0.002	0.774	0.057	0.269	0.003

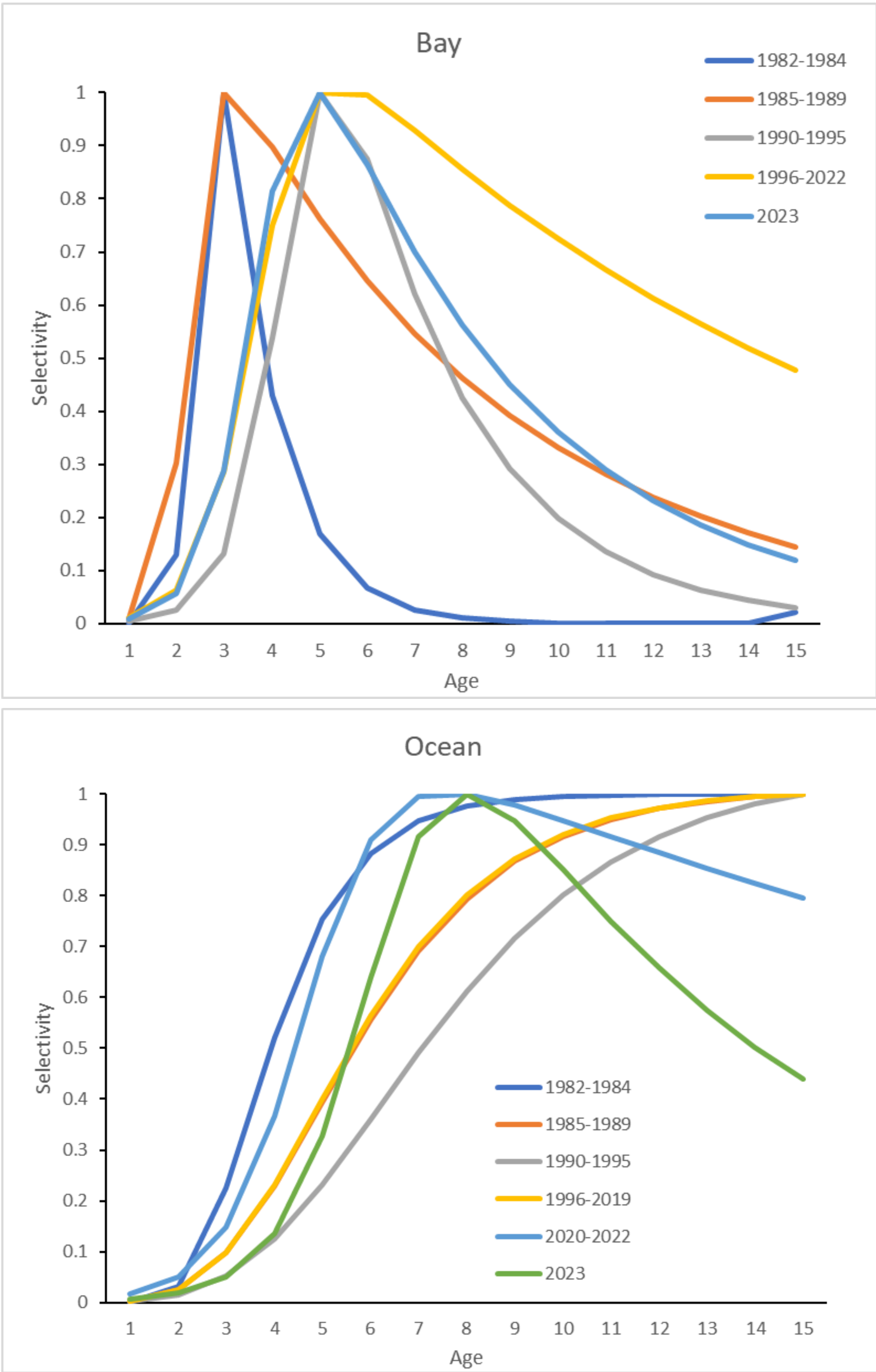


Figure 1. Estimates of selectivity patterns for the five Bay and Ocean time blocks.

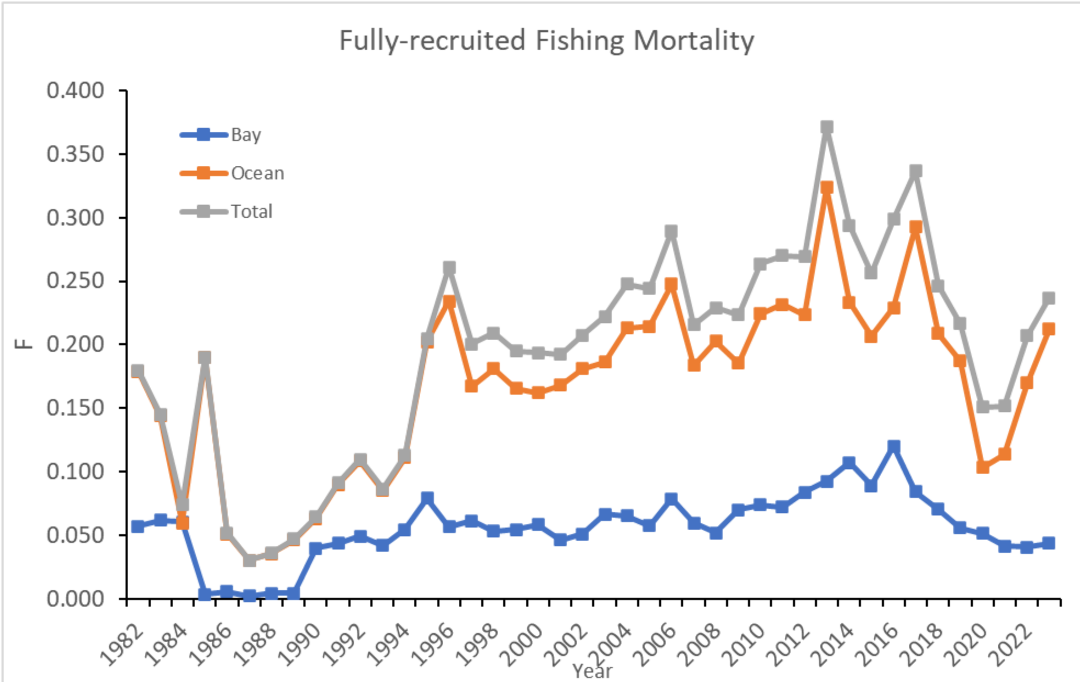


Figure 2. Estimates of region-specific and total fully-recruited fishing mortality in the Bay and Ocean, 1982-2023.

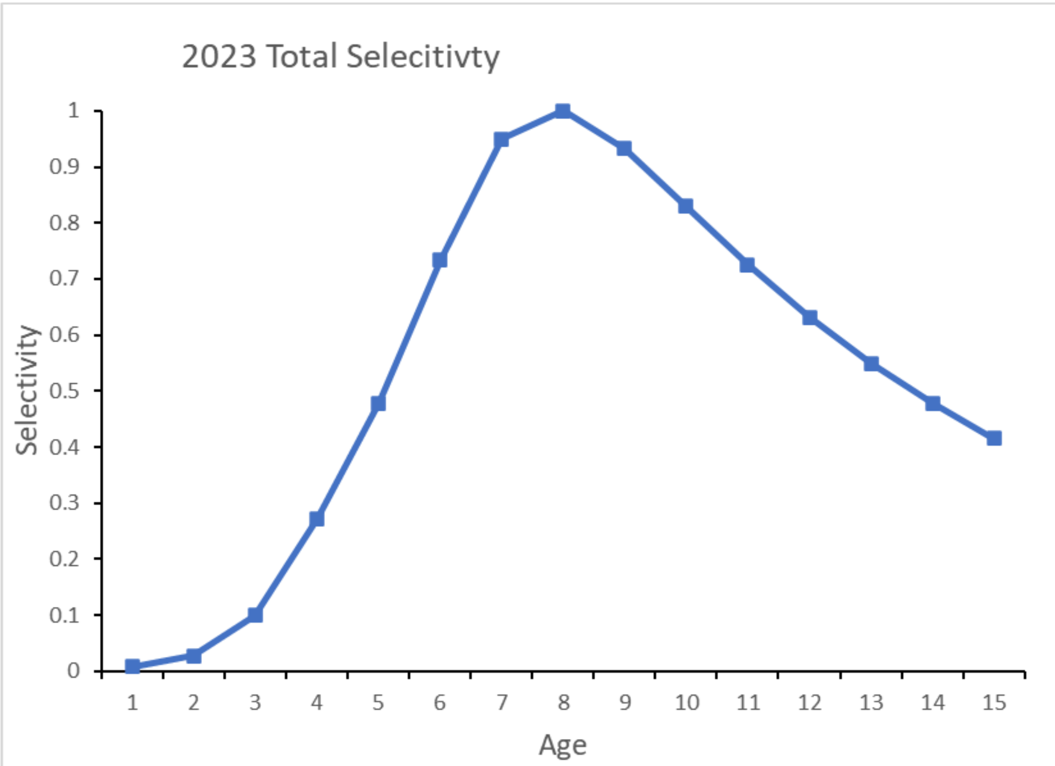


Figure 3. Total selectivity pattern for 2023 (Bay and Ocean combined) derived from total fishing mortality-at-age.

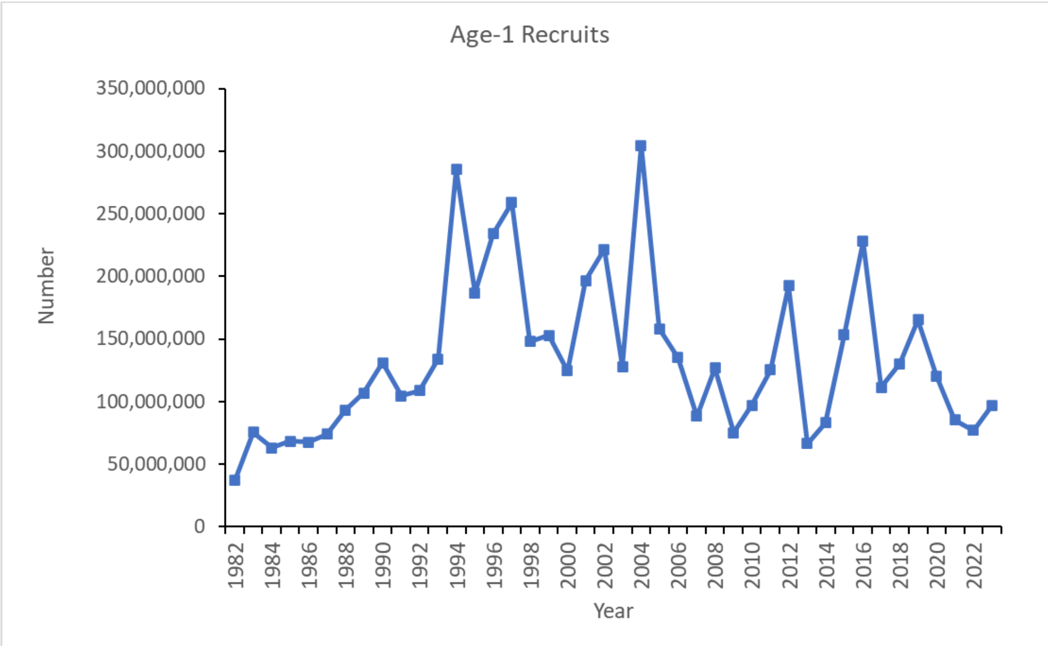


Figure 4. Estimates of recruit (age-1) abundance, 1982-2023.

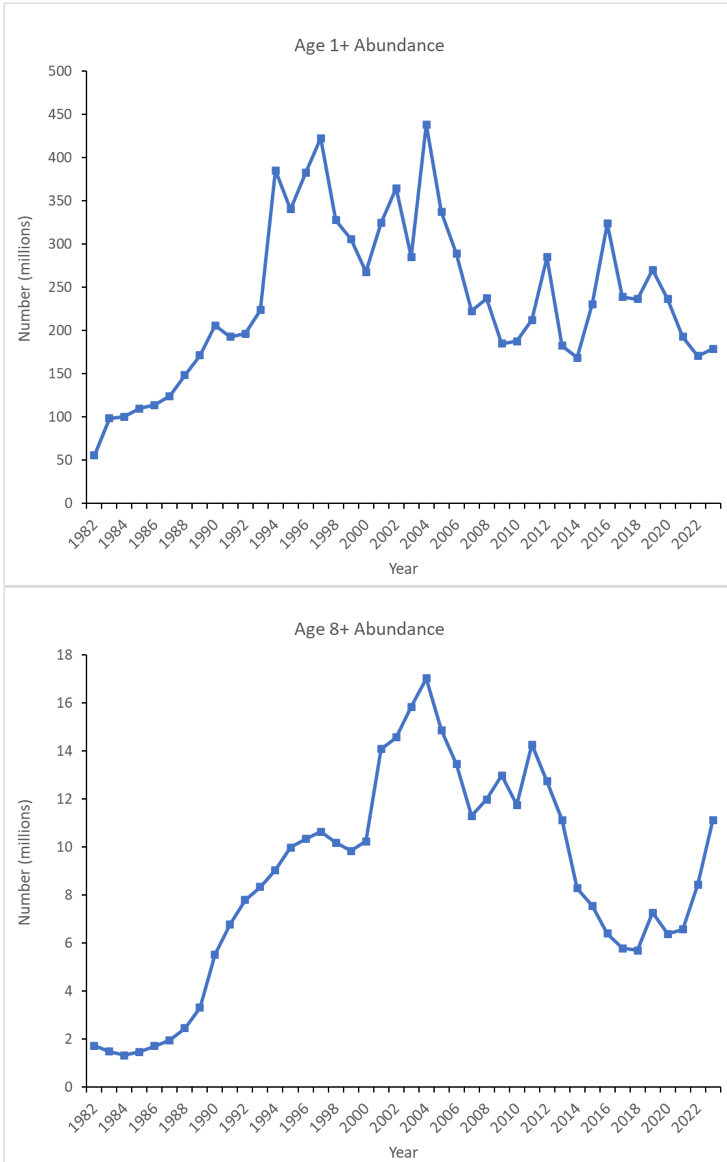


Figure 5. Estimates of total (top) and age-8 + (bottom) abundance from the updated stock assessment, 1982-2023.

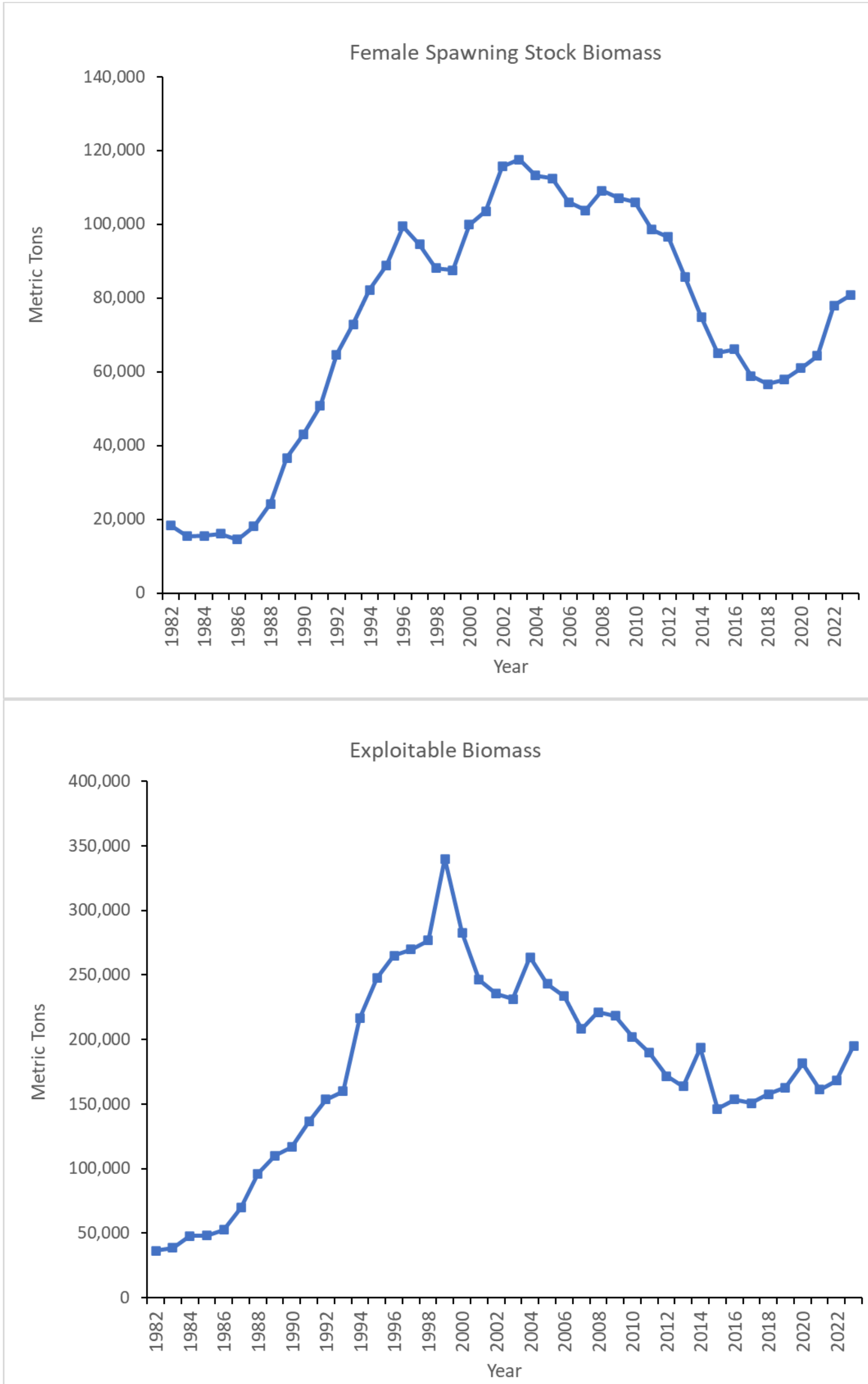


Figure 6. Estimates of female spawning stock biomass (top) and exploitable biomass (bottom), 1982-2023

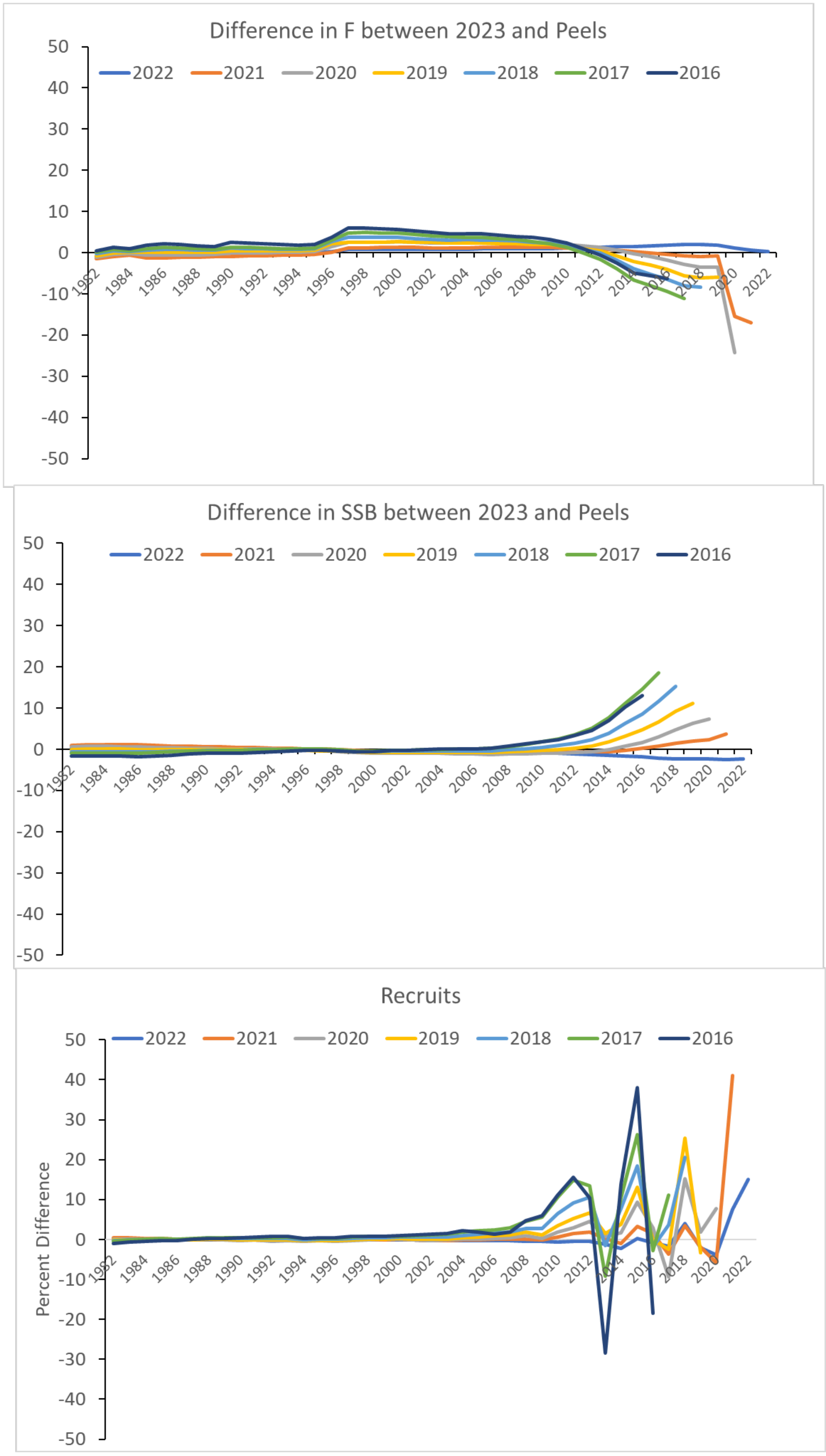


Figure 7. Retrospective plots of seven-year peels for fishing mortality, female spawning stock biomass and recruitment.

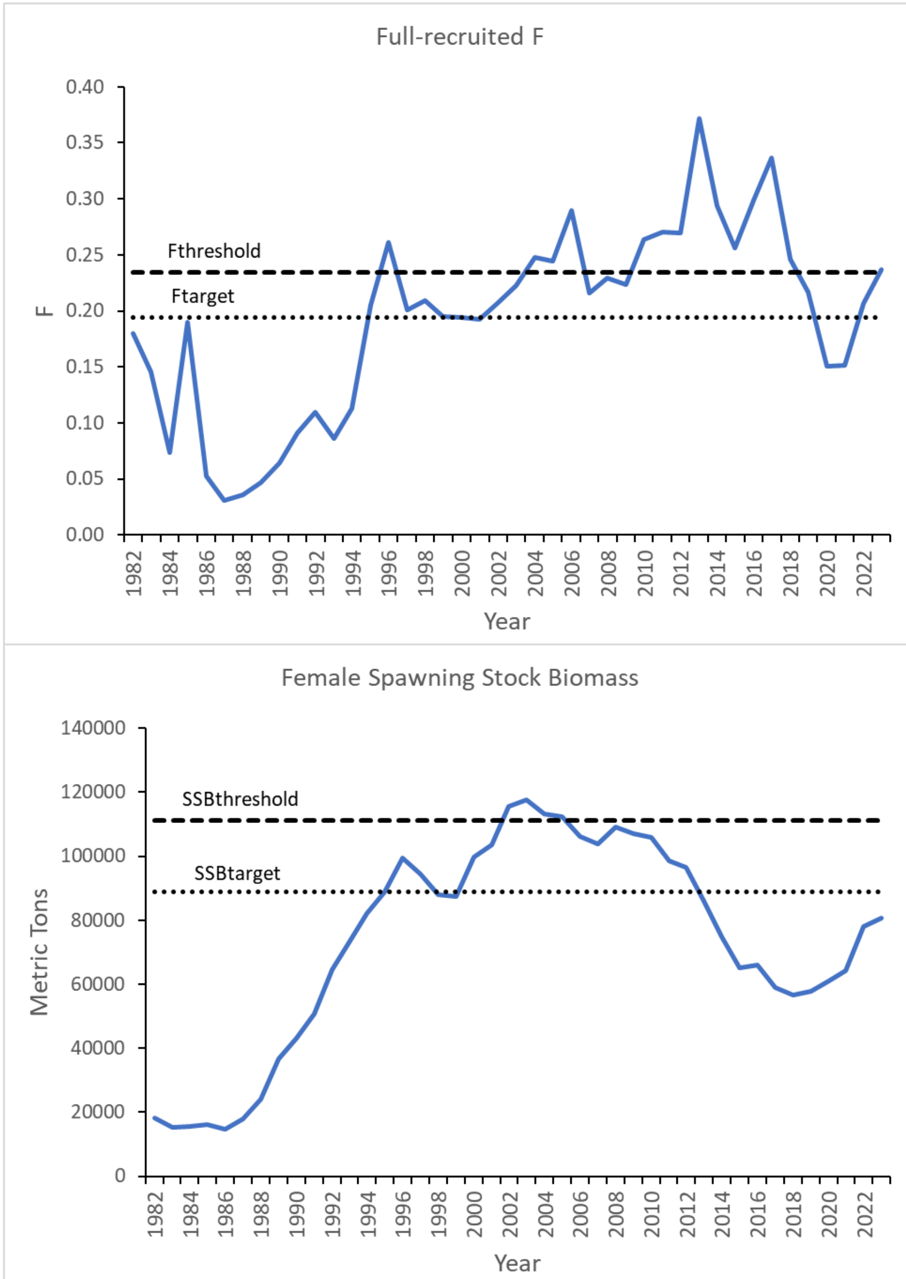


Figure 13. Comparison of SSB and F estimates to SSB and F reference points.

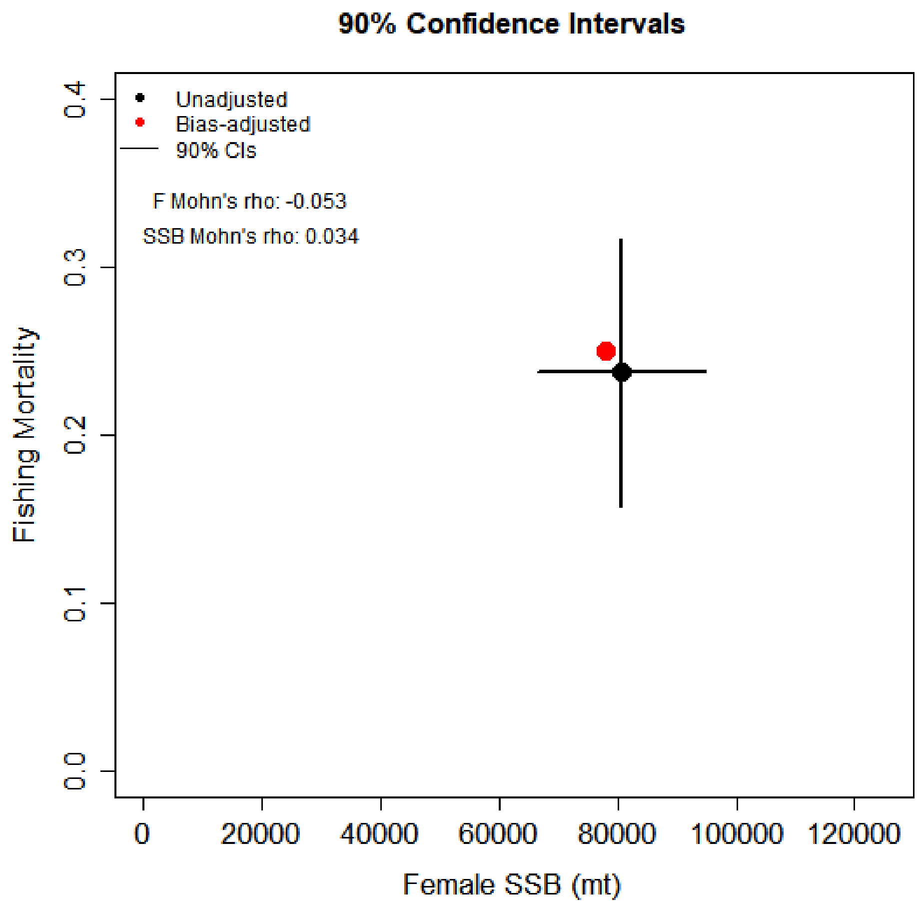


Figure 14. Plot comparing the 2023 bias-corrected F and female SSB values the uncorrected F and SSB estimates and their associated 90% confidence intervals. Because the retrospective adjusted values fall within the 90% confidence intervals, bias-correction is not needed.

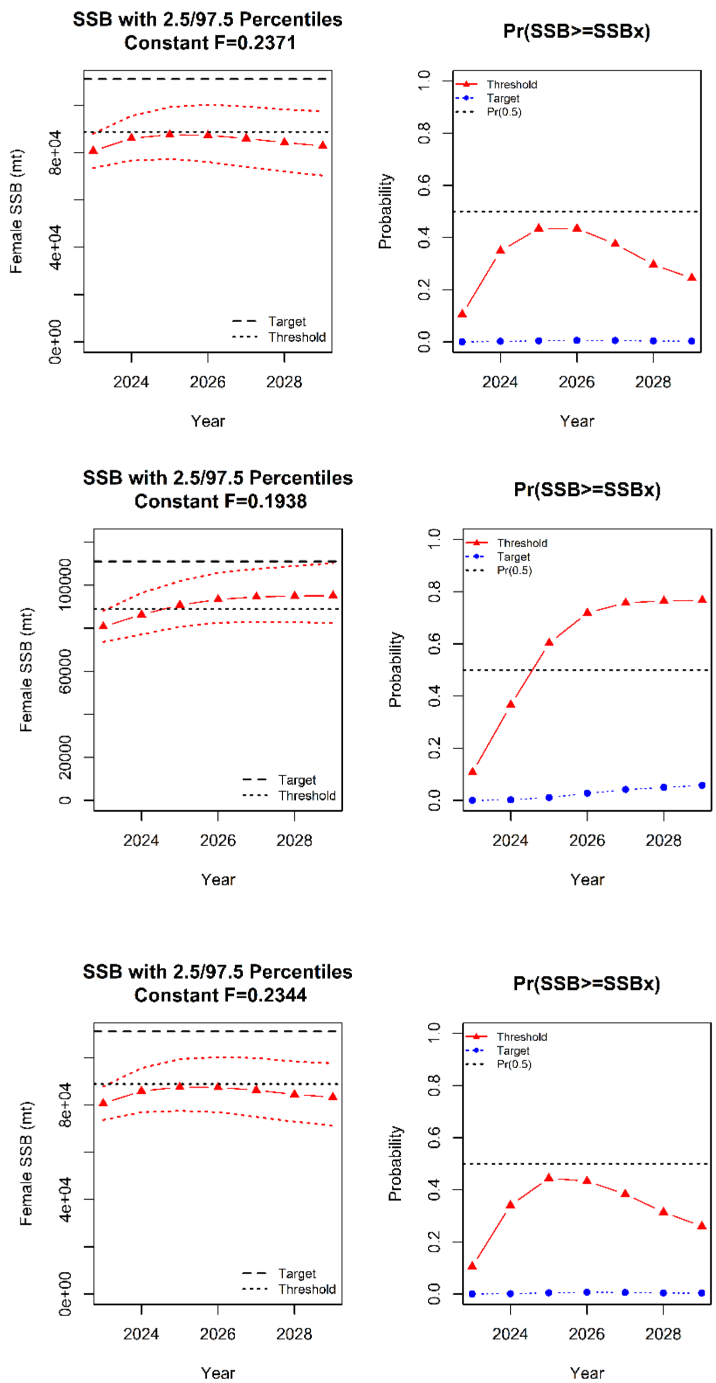


Figure 15. Projections of female spawning stock biomass through 2029 under current, target and threshold fishing mortality (left) and the probability of female SSB being above the target and threshold values of 111,064 and 88,851 metric tons, respectively, over time (right).

Appendix 4: Hybrid Selectivity and Projections

Gary Nelson

2024-10-04

Method

1) Combine state ALK keys that have been expanded to the total number across each component (Rec Harvest, Rec Dead Releases, Comm Harvest). Dead Commercial Discards are included by using the ALK of the Comm Harvest.
2) Within an age, calculate the fraction that each length interval of each component comprises of the summed total of all components
3) Within an age, multiply step 2 fractions for each length interval of each component by the age-specific F
4) Apply the new slot to recreational harvest component, make lengths outside slot zero, but transfer F*0.09 to the Rec Dead Releases
5) Sum the age-specific Fs across components, standardize new F vector to one (F/max(F))

Load Functions

```
library(readxl)
library(writexl)
library(fishmethods)
library(kableExtra)
```

Constant_F_projection Code

```
Constant_F_Projections <-function(maxage=max_age,M=Nat_Mortality,sex=female_sex_fraction,
                          fmat=female_mature_fraction,Nages_base=N2024,
                          Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                          avgwgt=average_wgt,
                          cursel=select_current,avgselect=current_select,
                          recruits=recruits_series,
                          curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                          Fcur=F2024,FcurCV=F_current_CV,Fcur_bias=F_bias,
                          Fproj=F2024,
                          SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                          SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                          pyears=6,nsims=5000,usebias=1,
```

```
                        catch_current=pcatch){
if(usebias==1){
  Nages<-Nages_base
  F_base<-Fcur
}
if(usebias==2){
  Nages<-Nages_base
  Nages$N<-Nages$N*(1-Nbias)
  F_base<-Fcur*(1-F_bias)
}
if(length(Fproj)==1) F_p<-c(F_base,rep(Fproj,pyears-1))    #F to project
if(length(Fproj)>1){
  F_p<-c(F_base,Fproj)    #F to project
  if(length(F_p)!=pyears) stop("Number of pyears does not equal the number of Fs (Fcur+Fproj)")
}
F_CV<-FcurCV
F_SD<-F_base*F_CV
recruits_short<-recruits[recruits$year>=recruit_start_year &
                           recruits$year<=recruit_end_year,2]
N<-matrix(0,nrow=pyears,ncol=maxage)
SSB<-matrix(0,nrow=pyears,ncol=maxage)
catch<-matrix(0,nrow=pyears,ncol=maxage)
SSBout<-matrix(0,nrow=nsims,ncol=pyears)
catchout<-matrix(0,nrow=nsims,ncol=pyears)

#!!! Begin projections !!!#
for(nrep in 1:nsims){
  F_proj<-rnorm(length(F_p),mean=F_p,sd=F_p*F_CV)
  F_proj<-ifelse(F_proj<0,0,F_proj)
  # generate January 1 abundance and SSB estimates in current year
    for(a in 1:maxage){
    N[1,a]<-rnorm(1,mean=Nages[a,1],sd=Nages[a,2]*Nages[a,1])
    #calculate F given catch
    SSB[1,a]<-N[1,a]*exp(-(pF*cursel[a]*F_proj[1])-(M[a]*pM))*sex[a]*fmat[a]*
      curwgt[a]/1000 #metric tons
    }
  catch[1,1]<-catch_current

  for(i in 2:as.numeric(pyears)){
      for(a in 1:maxage){
        if(a==1) N[i,1]<-sample(recruits_short,1,replace=FALSE)
        if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-F_proj[i-1]*avgselect[a-1]-M[a-1])
        if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-F_proj[i-1]*avgselect[a-1]-M[a-1])+
            N[i-1,a]*exp(-F_proj[i-1]*avgselect[a]-M[a]) #plus group calculation
        if(N[i,a]<0) N[i,a]<-0
        catch[i,a]<-(avgselect[a]*F_proj[i])/(avgselect[a]*F_proj[i]+M[a])*
          (1-exp(-(avgselect[a]*F_proj[i])-(M[a])))*N[i,a]
      }
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*F_proj[i])-(M[a]*pM))*
          sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }

  SSBout[nrep,]<-rowSums(SSB)
```

```
  catchout[nrep,]<-rowSums(catch)
}
SSBprob_threshold<-NULL
for(i in 1:pyears) SSBprob_threshold[i]<-pgen(SSBout[,i],limit=SSBthreshold,
                          limSD=SSBthreshold*SSBthresholdCV,dist=1,comp=4)
#Plot results
SSBmed<-apply(SSBout,2,median)
SSBpercent<-apply(SSBout,2,function(x){quantile(x,prob=c(0.025,0.975))})
SSBmean<-apply(SSBout,2,mean)
SSBSE<-apply(SSBout,2,sd)
SSBLCI<-SSBmean-SSBSE*1.96
SSBUCI<-SSBmean+SSBSE*1.96
catchmed<-apply(catchout,2,median)
catchpercent<-apply(catchout,2,function(x){quantile(x,prob=c(0.025,0.975))})
catchmean<-apply(catchout,2,mean)
catchSE<-apply(catchout,2,sd)
catchLCI<-catchmean-catchSE*1.96
catchUCI<-catchmean+catchSE*1.96
SSBprob_target<-NULL
for(i in 1:pyears) SSBprob_target[i]<-pgen(SSBout[,i],limit=SSBtarget,
                                    limSD=SSBtarget*SSBtargetCV,dist=1,comp=4)

yrs<-seq(as.Date(paste(curyear,"/01/01",sep="")),by="1 year", length.out=pyears)
 outtables<-list(type="Constant_F_Projections",SSBthreshold=SSBthreshold,
          SSBtarget=SSBtarget,Fproj=Fproj,SSBmed=SSBmed,SSBpercentiles=SSBpercent,
          SSBmean=SSBmean,SSBSE=SSBSE,SSBLCI=SSBLCI,SSBUCI=SSBUCI,
          catchmed=catchmed, catchpercentiles=catchpercent,catchmean=catchmean,
          catchSE=catchSE,catchLCI=catchLCI,catchUCI=catchUCI,
          SSBprob_threshold=SSBprob_threshold,SSBprob_target=SSBprob_target,
          axis_yrs=yrs)
 return(outtables)
}
```

Plot Function

```
Plot_Projection_Results<-function(results=NULL,export_as_tif=FALSE,
                    tiff_attributes=list(name="C:/temp/outs.tif",width=16,height=12,
                                     zoom=12,pointsize=10,units="cm")){

    word.tif = function(filename="C:/Temp/Word_Figure_%03d.tif", zoom=12, width=16,
                        height=12, pointsize=10,units="cm", ...) {
      if (!grepl("[.]ti[f]+$", filename, ignore.case=TRUE))
      filename = paste0(filename,".tif")
      tiff(filename=filename, compression="lzw", res=96*zoom,
       width=width, height=height, units=units, pointsize=pointsize,...)}

  if(results$type=="Constant_Catch_Projections_1"){
    if(results$trajectory_target_label %in% c("Ftarget","Fthreshold")){
      if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                       width=tiff_attributes$width,
                                       height=tiff_attributes$height,
```

```
                                    zoom=tiff_attributes$zoom,
                                    pointsize=tiff_attributes$pointsize,
                                    units=tiff_attributes$units)

      par(mfrow=c(1,2),mai=c(0.8,0.8,0.6,0.6))
      plot(results$results$FM~results$results$year, main="",type="o",pch=16,
      ylim=c(min(results$results$FM),max(results$results$FM)*1.05),
      ylab="Fishing Mortality",xlab="Year")
      abline(h=results$trajectory_target,lty=3)
      temp<-paste(results$conditions[1]," = ",round(results$constant_catch,0),
                  " fish",sep="")
      mtext(text=temp,side=3,line=1,at=max(results$results$year)+2)
      text(x=results$results$year[2],y=results$trajectory_target*1.01,
           labels=results$trajectory_target_label,cex=0.7)
      plot(results$results$SSB~results$results$year, main="",type="o",pch=16,
           ylim=c(min(results$results$SSB),max(results$results$SSB)*1.05),
           ylab="Spawning Stock Biomass",xlab="Year")

    if(export_as_tif==TRUE) dev.off()
  }
  if(results$trajectory_target_label %in% c("SSBtarget","SSBthreshold")){
    if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                    width=tiff_attributes$width,
                                    height=tiff_attributes$height,
                                    zoom=tiff_attributes$zoom,
                                    pointsize=tiff_attributes$pointsize,
                                    units=tiff_attributes$units)

    par(mfrow=c(1,2),mai=c(0.8,0.8,0.6,0.6))
    plot(results$results$FM~results$results$year, main="",type="o",pch=16,
         ylim=c(min(results$results$FM),max(results$results$FM)*1.05),
         ylab="Fishing Mortality",xlab="Year")
    abline(h=results$trajectory_value,lty=3)
    temp<-paste(results$conditions[1]," = ",round(results$constant_catch,0),
                " fish",sep="")
    mtext(text=temp,side=3,line=1,at=max(results$results$year)+2)
      plot(results$results$SSB~results$results$year, main="",type="o",pch=16,
         ylim=c(min(results$results$SSB),max(results$results$SSB)*1.05),
         ylab="Spawning Stock Biomass",xlab="Year")
             abline(h=results$trajectory_target,lty=3)
          text(x=results$results$year[2],y=results$trajectory_target*1.01,
               labels=results$trajectory_target_label,cex=0.7)
   if(export_as_tif==TRUE) dev.off()
 }
}#Constant_Catch_Projections_1

if(results$type=="Constant_Catch_Projections_2"){
  if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                  width=tiff_attributes$width,
                                  height=tiff_attributes$height,
                                  zoom=tiff_attributes$zoom,
                                  pointsize=tiff_attributes$pointsize,
                                  units=tiff_attributes$units)
```

```
    par(mfrow=c(2,2),mai=c(0.7,0.7,0.5,0.4))
    plot(results$results$Fmed~results$results$year, main="",type="o",pch=16,
        ylim=c(0,max(results$results$F97_5)*1.10),ylab="Fishing Mortality",xlab="Years")
    lines(results$results$F2_5~results$results$year,lty=3,lwd=1.5)
    lines(results$results$F97_5~results$results$year,lty=3,lwd=1.5)
    abline(h=results$Ftarget,col="red",lwd=1.5)
    abline(h=results$Fthreshold,lty=2,col="blue",lwd=1.5)
    legend("bottomright",legend=c("Target","Threshold"),col=c("red","blue"),
           lty=c(1,2),bty="n",cex=0.7)
    mtext(text=paste("Constant Catch = ",round(results$results$catch[1],0),
                     " fish",sep=""),side=3,line=1, at=max(results$results$year)+2)

    plot(results$results$Prob_F_greater_Ftarget~results$results$year, main="",
         type="o",pch=16,
         ylim=c(0,1),ylab="Pr(F>Fx)",xlab="Year",col="red")
    lines(results$results$Prob_F_greater_Fthreshold~results$results$year,col="blue")
    points(results$results$Prob_F_greater_Fthreshold~results$results$year,
           col="blue",pch=16)
    legend("topleft",legend=c("F Target","F Threshold"),col=c("red","blue"),
           lty=c(1,2),pch=c(16,16),bty="n",cex=0.7,lwd=1.5)

    plot(results$results$SSBmed~results$results$year, main="",type="o",pch=16,
         ylim=c(min(results$results$SSB2_5,SSB_threshold)*0.95,
                max(results$results$SSB97_5,SSB_target)*1.10),
         ylab="Spawning Stock Biomass",
         xlab="Years")
    lines(results$results$SSB2_5~results$results$year,lty=3,lwd=1.5)
    lines(results$results$SSB97_5~results$results$year,lty=3,lwd=1.5)
    abline(h=results$SSBtarget,col="red",lwd=1.5)
    abline(h=results$SSBthreshold,col="blue",lty=2,lwd=1.5)
    legend("topleft",legend=c("SSB Target","SSB Threshold"),col=c("red","blue"),
           bty="n",pch=c(16,16),lty=c(1,2),cex=0.7)

    plot(results$results$Prob_SSB_less_SSBtarget~results$results$year, main="",
         type="o",pch=16,
         ylim=c(0,1),ylab="Pr(SSB<SSBx)",xlab="Year",col="red")
    lines(results$results$Prob_SSB_less_SSBthreshold~results$results$year,col="blue")
    points(results$results$Prob_SSB_less_SSBthreshold~results$results$year,
           col="blue",pch=16)
    legend("topright",legend=c("SSB Target","SSB Threshold"),col=c("red","blue"),
           bty="n",pch=c(16,NA),lty=c(1,1),cex=0.7)

    if(export_as_tif==TRUE) dev.off()
 }

 if(results$type=="Constant_F_Projections"){
   if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                   width=tiff_attributes$width,
                                   height=tiff_attributes$height,
                                   zoom=tiff_attributes$zoom,
                                   pointsize=tiff_attributes$pointsize,
                                   units=tiff_attributes$units)
```

```
    par(mfrow=c(1,2))
    if(length(results$Fproj)==1) mainlabel<-paste("SSB with 2.5/97.5 Percentiles","\n Constant F=",
                    round(results$Fproj,4),sep="")

    if(length(results$Fproj)>1){
        fslabels<-paste(as.character(round(results$Fproj,4)),collapse=" ")
        mainlabel<-paste("SSB with 2.5/97.5 Percentiles", "\n F=",fslabels,sep="")

    }

    plot(y=results$SSBmed,x=results$axis_yrs,type="b",col="red",

        main=mainlabel,

         xlab="Year",ylim=c(0,max(results$SSBpercent)*1.10),pch=17,
         ylab="Female SSB (mt)")
    lines(results$SSBpercent[1,]~results$axis_yrs,col="red",lty=3,lwd=1.5)
    lines(results$SSBpercent[2,]~results$axis_yrs,col="red",lty=3,lwd=1.5)
    abline(h=results$SSBthreshold,lty=3,lwd=1.5)
    abline(h=results$SSBtarget,lty=2,lwd=1.5)
    legend("bottomright",legend=c("Target","Threshold"),lwd=1.5,lty=c(2,3),bty="n",
           cex=0.8)
    plot(results$SSBprob_threshold~results$axis_yrs,type="b",col="red",
         main="Pr(SSB>=SSBx)",pch=17,
         xlab="Year",ylim=c(0,1),ylab="Probability")
    abline(h=0.5,lty=3,lwd=1.5)

    par(new=TRUE)
     plot(results$SSBprob_target~results$axis_yrs,type="b",col="blue",lty=3,pch=16,
         xlab="",ylim=c(0,1),ylab="")
    legend("topleft",legend=c("Threshold","Target","Pr(0.5)"),
           col=c("red","blue","black"),pch=c(17,16,NA),lty=c(1,3,3),bty="n",
           cex=0.7,lwd=1.5)
    if(export_as_tif==TRUE) dev.off()
  }#Constant F
}#function
```

Constant_Catch_Projections Function

```
Constant_Catch_Projections<-function(maxage=max_age,M=Nat_Mortality,
                  sex=female_sex_fraction,fmat=female_mature_fraction,
                  Nages_base=N_at_age_estimates,Nbias=N_bias,pF=F_fraction,
                  pM=M_fraction,curwgt=wgt_current,avgwgt=average_wgt,
                  cursel=select_current,avgselect=average_select,
                  recruits=recruits_series,curyear=2023,recruit_start_year=2008,
                  recruit_end_year=2023,Fcur=F_current,FcurCV1=F_current_CV,
                  Fcur_bias=F_bias,total_current_catch=sum(catch_at_age_current),
                  SSBthreshold=SSB_threshold, SSBthresholdCV=SSB_threshold_CV,
                  SSBtarget=SSB_target, SSBtargetCV=SSB_target_CV,
                  Ftarget=F_target, FtargetCV=F_target_CV,
                  Fthreshold=F_threshold,FthresholdCV=F_threshold_CV,
```

```
                   solve_catch=2,
                   objective_function_value_solve_catch_1=2,
                   pyears=7,nsims=5000,Nerr=1,Ferr=1,usebias=1,
                   rcentral=1){
  pcatch<-NULL
  if(usebias==1) {
    Fuse<-Fcur
    Nages<-Nages_base
  }
  if(usebias==2){
    Nages$N<-Nages_base$N*(1-Nbias)
    Fuse<-Fcur*(1-Fcur_bias)
  }
  recruits_short<-recruits[recruits$year>=recruit_start_year &
                              recruits$year<=recruit_end_year,2]
  if(solve_catch==1){#solve for catch
    #storage matrices
    parm<-total_current_catch
    getsolution<-function(parm){
      N<-matrix(0,nrow=pyears,ncol=maxage)
      SSB<-matrix(0,nrow=pyears,ncol=maxage)
      prob<-matrix(0,nrow=pyears,ncol=1)
      SSBout<<-matrix(0,nrow=1,ncol=pyears)
      Fout<<-matrix(0,nrow=1,ncol=pyears)
      for(a in 1:maxage){
        N[1,a]<-Nages[a,1]
        Fran<-Fuse
        #SSB metric tons
        SSB[1,a]<-N[1,a]*exp(-(pF*cursel[a]*Fran)-(M[a]*pM))*sex[a]*fmat[a]*
          curwgt[a]/1000
      }
      Fout[1,1]<-Fran
      # January 1 abundance for years > current
      for(i in 2:as.numeric(pyears)){
        if(i==2){
          for(a in 1:maxage){
            if(a==1){
              if(rcentral==1) N[i,1]<-mean(recruits_short) else
                N[i,1]<-median(recruits_short)
            }
            if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*cursel[a-1]-M[a-1])
            if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*cursel[a-1]-M[a-1])+
                N[i-1,a]*exp(-Fout[1,i-1]*cursel[a]-M[a]) #plus group calculation
            if(N[i,a]<0) N[i,a]<-0
          }
          # solve for F given total_current_catch
          Nin<-N[i,]
          solveF1<-function(x){
            for(a in 1:maxage){
              pcatch[a]<-(avgselect[a]*x)/(avgselect[a]*x+M[a])*
                (1-exp(-avgselect[a]*x-M[a]))*Nin[a]
            }
            (log(sum(pcatch))-log(parm))^2
```

```r
      }
      outs<-optimize(solveF1,interval=c(0.001,2))
      Fout[1,i]<-outs$minimum
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout[1,i])-
                        (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }
    if(i>2){
      for(a in 1:maxage){
        if(a==1){
          if(rcentral==1) N[i,1]<-mean(recruits_short) else
            N[i,1]<-median(recruits_short)
        }
        if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*avgselect[a-1]-M[a-1])
        if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*avgselect[a-1]-M[a-1])+
            N[i-1,a]*exp(-Fout[1,i-1]*avgselect[a]-M[a]) #plus group calculation
        if(N[i,a]<0) N[i,a]<-0
      }
      # solve for F given total_current_catch
      Nin<-N[i,]
      solveF1<-function(x){
        for(a in 1:maxage){
          pcatch[a]<-(avgselect[a]*x)/(avgselect[a]*x+M[a])*
            (1-exp(-avgselect[a]*x-M[a]))*Nin[a]
        }
        (log(sum(pcatch))-log(parm))^2
      }
      outs<-optimize(solveF1,interval=c(0.001,2))
      Fout[1,i]<-outs$minimum
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout[1,i])-
                          (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }
  }
  SSBout[1,]<<-rowSums(SSB)
  Fout2<<-Fout[1,]
  if(objective_function_value_solve_catch_1==1)
    return((Ftarget-Fout[1,pyears])^2)
  if(objective_function_value_solve_catch_1==2)
    return((Fthreshold-Fout[1,pyears])^2)
  if(objective_function_value_solve_catch_1==3)
    return((SSBtarget-SSBout[1,pyears])^2)
  if(objective_function_value_solve_catch_1==4)
    return((SSBthreshold-SSBout[1,pyears])^2)
}#getsolution
results<-optimize(getsolution,c(1,total_current_catch*10))
constcatch<-round(results$minimum,1)
labs<-NULL
if(objective_function_value_solve_catch_1==1) {outparm<-Ftarget;labs<-"Ftarget"}
if(objective_function_value_solve_catch_1==2)
  {outparm<-Fthreshold;labs<-"Fthreshold"}
if(objective_function_value_solve_catch_1==3)
  {outparm<-SSBtarget;labs<-"SSBtarget"}
if(objective_function_value_solve_catch_1==4)
  {outparm<-SSBthreshold;labs<-"SSBthreshold"}
```

```
  dataset<-data.frame(year=c(curyear:c(curyear+pyears-1)),SSB=SSBout[1,],FM=Fout2)
  condata<-paste("Constant catch to obtain ",paste(labs," (",outparm,")",sep=""),
            " by year ",c(curyear+pyears-1),sep="")
  condata1<-paste("Recruit values from ",recruit_start_year,
                  " to ", recruit_end_year,sep="")
  condata2<-ifelse(usebias==1,"N & F not bias-corrected","N & F bias-corrected")
  condata3<-ifelse(rcentral==1,"Mean recruits used","Median recruits used")
  cons<-c(condata,condata1,condata2,condata3)


  outpt<-list(type="Constant_Catch_Projections_1",trajectory_target=outparm,
              trajectory_target_label=labs,conditions=cons,
              constant_catch=constcatch,results=dataset)
  return(outpt)
}#solve_catch==1

if(solve_catch==2){
  #storage matrices
  N<-matrix(0,nrow=pyears,ncol=maxage)
  SSB<-matrix(0,nrow=pyears,ncol=maxage)
  prob<-matrix(0,nrow=pyears,ncol=1)
  SSBout1<-matrix(0,nrow=nsims,ncol=pyears)
  Fout1<-matrix(0,nrow=nsims,ncol=pyears)

  for(nrep in 1:nsims){
    for(a in 1:maxage){
      if(Nerr==1) N[1,a]<-Nages[a,1]
      if(Nerr==2) N[1,a]<-rnorm(1,mean=Nages[a,1],sd=Nages[a,2]*Nages[a,1])

      if(Ferr==1) Fran<-Fuse
      if(Ferr==2) Fran<-rnorm(1,mean=Fuse,sd=Fuse*FcurCV)
      #calculate F given catch
      SSB[1,a]<-N[1,a]*exp(-(pF*cursel[a]*Fran)-(M[a]*pM))*sex[a]*fmat[a]*
        curwgt[a]/1000 #metric tons
    }
    Fout1[nrep,1]<-Fran
    # January 1 abundance for years > 2014
    for(i in 2:as.numeric(pyears)){
      if(i==2){
        for(a in 1:maxage){
          if(a==1){
            N[i,1]<-sample(recruits_short,1,replace=FALSE)
          }
          if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*cursel[a-1]-M[a-1])
          if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*cursel[a-1]-M[a-1])+
              N[i-1,a]*exp(-Fout1[nrep,i-1]*cursel[a]-M[a]) #plus group calculation
          if(N[i,a]<0) N[i,a]<-0
        }
        # solve for F given total_current_catch
        Nin<-N[i,]
        solveF2<-function(x){
          for(a in 1:maxage){
            pcatch[a]<-(avgselect[a]*x)/(avgselect[a]*x+M[a])*(1-exp(-avgselect[a]*
```

```
                                x-M[a]))*Nin[a]
        }
        (log(sum(pcatch))-log(total_current_catch))^2
      }
      outs<-optimize(solveF2,interval=c(0.001,2))
      Fout1[nrep,i]<-outs$minimum
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout1[nrep,i])-
                  (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }
    if(i>2){
      for(a in 1:maxage){
        if(a==1){
          N[i,1]<-sample(recruits_short,1,replace=FALSE)
        }
        if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*
                                              avgselect[a-1]-M[a-1])
        #plusgrp
        if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*avgselect[a-1]-
                       M[a-1])+N[i-1,a]*exp(-Fout1[nrep,i-1]*avgselect[a]-M[a])
        if(N[i,a]<0) N[i,a]<-0
      }
      # solve for F given total_current_catch
      Nin<-N[i,]
      outs<-optimize(solveF2,interval=c(0.001,2))
      Fout1[nrep,i]<-outs$minimum
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout1[nrep,i])-
                      (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }
  }
  SSBout1[nrep,]<-rowSums(SSB)
}#nrep
Fprob_target<-NULL
for(i in 1:pyears) Fprob_target[i]<-pgen(Fout1[,i],limit=Ftarget,
                                limSD=Ftarget*FtargetCV,dist=1,comp=4)
SSBprob_target<-NULL
for(i in 1:pyears) SSBprob_target[i]<-pgen(SSBout1[,i],limit=SSBtarget,
                                limSD=SSBtarget*SSBtargetCV,dist=1,comp=2)

Fprob_threshold<-NULL
for(i in 1:pyears) Fprob_threshold[i]<-pgen(Fout1[,i],limit=Fthreshold,
                                limSD=Fthreshold*FthresholdCV,dist=1,comp=4)
SSBprob_threshold<-NULL
for(i in 1:pyears) SSBprob_threshold[i]<-pgen(SSBout1[,i],limit=SSBthreshold,
                                limSD=SSBthreshold*SSBthresholdCV,dist=1,comp=2)

#Plot results
SSBmed<-apply(SSBout1,2,median)
SSBpercent<-as.data.frame(t(apply(SSBout1,2,function(x){quantile(x,
                                     prob=c(0.025,0.975))})))

Fmed<-apply(Fout1,2,median)
Fpercent<-as.data.frame(t(apply(Fout1,2,function(x){quantile(x,
                                     prob=c(0.025,0.975))})))
```

```
    dataout<-data.frame(year=c(curyear:(curyear+pyears-1)),
                        catch=total_current_catch,Fmed=Fmed,
                        F2_5=Fpercent[,1],F97_5=Fpercent[,2],
                        Prob_F_greater_Ftarget=Fprob_target,
                        Prob_F_greater_Fthreshold=Fprob_threshold,
                        SSBmed=SSBmed,SSB2_5=SSBpercent[,1],
                        SSB97_5=SSBpercent[,2],
                        Prob_SSB_less_SSBtarget=SSBprob_target,
                        Prob_SSB_less_SSBthreshold=SSBprob_threshold)

    if(Ferr==1) errorF<-"Off" else errorF<-"On"
    if(Nerr==1) errorN<-"Off" else errorN<-"On"
    if(usebias==1) bias_on<-"No" else bias_on<-"Yes"
    conout<-paste("F error: ",errorF,", N error: ",errorN,
                  ", F & N Bias-Corrected?: ",bias_on,sep="")
    outpt<-list(type="Constant_Catch_Projections_2",Ftarget=Ftarget,
                Fthreshold=Fthreshold,SSBtarget=SSBtarget,
                SSBthreshold=SSBthreshold,
                condition=conout,results=dataout)
    return(outpt)
  }#solve_catch==2
}#function
```

Data

```
maxage<-15
# Natural Mortality-at-age
Nat_Mortality<-M<-c(1.13,0.68,0.45,0.33,0.25,0.19,0.15,0.15,0.15,0.15,0.15,0.15,0.15,
                0.15,0.15)

# Female Sex proportions-at-age
female_sex_fraction<-c(0.53,0.56,0.56,0.52,0.57,0.65,0.73,0.81,0.88,0.92,0.95,0.97,
                       1.00,1.00,1.00)

#Female maturity
female_mature_fraction<-c(0,0,0,0.09,0.32,0.45,0.84,0.89,1,1,1,1,1,1,1)

# Proportion F and M for SSB calculations
F_fraction<-0.1
M_fraction<-0.33
maxage<-max_age<-15


# SSB rivard wgts  #2024

# Average of 2019-2023
average_wgt<-c(0.170912897,0.417823556,0.927379714,1.458463863,2.071445994,2.897995624,
            3.990014283,5.182445546,6.319665235,7.741211998,9.069336065,10.90477891,
            13.0331813,13.87866685,15.67380948)
```

```r
# All recruits 1982-2023
recruits_series<-data.frame(year=1982:2023,
            recr=c(37364100,75602800,62859700,68479300,67611600,74169300,93300800,
                   106655000,130941000,104485000,108762000,133935000,285297000,
                   186734000,234018000,258960000,148052000,152875000,
                   124486000,196467000,221336000,127967000,304432000,158153000,
                   135236000,88441000,126912000,75196700,96903000,125307000,
                   192360000,66597300,82938200,153154000,228067000,111488000,
                   130105000,165265000,120143000,85158100,76967300,96681400))
```

Bay - New Selectivity

```r
dir<-getwd()
bayfile<-paste(dir,"/BAYALKS_2021.xlsx",sep="") # data 2021 only
MD_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

bayfile<-paste(dir,"/BAYALKS_2020.xlsx",sep="") # data 2020 only
MD_Bay_R_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2020 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2020 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

bayfile<-paste(dir,"/BAYALKS_2021.xlsx",sep="") # data 2021 only
MD_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

bayfile<-paste(dir,"/BAYALKS_2022.xlsx",sep="") # data 2022 only
MD_Bay_R_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2022 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2022 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2022<-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

Bay_Rec_Har<-MD_Bay_R_Har_2020[,c(2:16)]+VA_Bay_R_Har_2020[,c(2:16)]+
  MD_Bay_R_Har_2021[,c(2:16)]+ VA_Bay_R_Har_2021[,c(2:16)]+
```

```
  MD_Bay_R_Har_2022[,c(2:16)]+ VA_Bay_R_Har_2022[,c(2:16)]
Bay_Rec_Har[is.na(Bay_Rec_Har)]<-0

Bay_Comm_Har<-MD_Bay_Comm_Har_2020[,c(2:16)]+VA_Bay_Comm_Har_2020[,c(2:16)]+
  PRFC_Comm_Har_2020[,c(2:16)]+MD_Bay_Comm_Har_2021[,c(2:16)]+
  VA_Bay_Comm_Har_2021[,c(2:16)]+PRFC_Comm_Har_2021[,c(2:16)]+
  MD_Bay_Comm_Har_2022[,c(2:16)]+VA_Bay_Comm_Har_2022[,c(2:16)]+
  PRFC_Comm_Har_2022[,c(2:16)]
Bay_Comm_Har[is.na(Bay_Comm_Har)]<-0

Bay_Rec_Dead_Rel<-MD_Bay_R_DR_2020[,c(2:16)]+VA_Bay_R_DR_2020[,c(2:16)]+
  MD_Bay_R_DR_2021[,c(2:16)]+VA_Bay_R_DR_2021[,c(2:16)]+
  MD_Bay_R_DR_2022[,c(2:16)]+VA_Bay_R_DR_2022[,c(2:16)]
Bay_Rec_Dead_Rel[is.na(Bay_Rec_Dead_Rel)]<-0

#Comm Dead Discards
Bay_Comm_DD_2020<-c(0,58,1862,6633,17003,8297,2237,944,2775,736,160,39,13,23,427)
Bay_Comm_DD_2021<-c(0,201,7015,14559,15476,29719,5787,1421,1138,2102,155,0,112,0,157)
Bay_Comm_DD_2022<-c(0,12,2410,10018,7896,5568,9263,2878,565,523,1118,387,64,190,606)
Bay_Comm_DD<-Bay_Comm_DD_2020+Bay_Comm_DD_2021+Bay_Comm_DD_2022

#Don't have ALK for commercial discards
Bay_Comm_Dead_Dis<-as.matrix(Bay_Comm_Har)
for(cc in 1:ncol(Bay_Comm_Dead_Dis)){
  Bay_Comm_Dead_Dis[,cc]<-Bay_Comm_Dead_Dis[,cc]/sum(Bay_Comm_Dead_Dis[,cc])*
    Bay_Comm_DD[cc]
}
Bay_Comm_Dead_Dis[is.nan(Bay_Comm_Dead_Dis)]<-0

Bay_Rec_Har_Prop<-as.matrix(Bay_Rec_Har)
Bay_Rec_Har_Prop[is.nan(Bay_Rec_Har_Prop)]<-0
Bay_Rec_Dead_Rel_Prop<-as.matrix(Bay_Rec_Dead_Rel)
Bay_Rec_Dead_Rel[is.nan(Bay_Rec_Dead_Rel_Prop)]<-0
Bay_Comm_Har_Prop<-as.matrix(Bay_Comm_Har)
Bay_Comm_Har_Prop[is.nan(Bay_Comm_Har_Prop)]<-0
Bay_Comm_Dead_Dis_Prop<-as.matrix(Bay_Comm_Dead_Dis)
Bay_Comm_Dead_Dis_Prop[is.nan(Bay_Comm_Dead_Dis_Prop)]<-0


bayF2020<-c(0.00063,0.00331,0.01478,0.03872,0.05169,0.05146,0.048,0.04426,0.04074,
            0.03748,0.03448,0.03172,0.02918,0.02684,0.02469)

bayF2021<-c(0.000506789,0.00266759,0.011922,0.0312385,0.041701,0.0415123,0.038724,
            0.0357083,0.0328629,0.0302343,0.0278144,0.0255879,0.0235397,0.0216553,
            0.0199219)

bayF2022<-c(0.000493889,0.00259968,0.0116186,0.0304433,0.0406395,0.0404556,0.0377383,
            0.0347993,0.0320264,0.0294647,0.0271064,0.0249366,0.0229405,0.0211041,
            0.0194147)


bayFavg<-exp((log(bayF2020)+log(bayF2021)+log(bayF2022))/3)
```

```r
for(cc in 1:ncol(Bay_Comm_Dead_Dis)){
  coltotal<-sum(Bay_Rec_Har[,cc],Bay_Rec_Dead_Rel[,cc],Bay_Comm_Har[,cc],
                Bay_Comm_Dead_Dis[,cc])
  Bay_Rec_Har_Prop[,cc]<-Bay_Rec_Har[,cc]/coltotal*bayFavg[cc]
  Bay_Rec_Har_Prop[is.nan(Bay_Rec_Har_Prop)]<-0
  Bay_Rec_Dead_Rel_Prop[,cc]<-Bay_Rec_Dead_Rel[,cc]/coltotal*bayFavg[cc]
  Bay_Rec_Dead_Rel_Prop[is.nan(Bay_Rec_Dead_Rel_Prop)]<-0
  Bay_Comm_Har_Prop[,cc]<-Bay_Comm_Har[,cc]/coltotal*bayFavg[cc]
  Bay_Comm_Har_Prop[is.nan(Bay_Comm_Har_Prop)]<-0
  Bay_Comm_Dead_Dis_Prop[,cc]<-Bay_Comm_Dead_Dis[,cc]/coltotal*bayFavg[cc]
  Bay_Comm_Dead_Dis_Prop[is.nan(Bay_Comm_Dead_Dis_Prop)]<-0
}

#New Bay Regulations
new_Bay_slot<-c(19,24)

new_Bay_Rec_Har_Prop<-Bay_Rec_Har_Prop
new_Bay_Rec_Dead_Rel_Prop<-Bay_Rec_Dead_Rel_Prop

newbelow<-new_Bay_Rec_Har_Prop[1:c(new_Bay_slot[1]-1),]
newabove<-new_Bay_Rec_Har_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Har_Prop),]

newbelow_adjusted<-newbelow*0.09
newabove_adjusted<-newabove*0.09

new_Bay_Rec_Har_Prop[1:c(new_Bay_slot[1]-1),]<-0
new_Bay_Rec_Har_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Har_Prop),]<-0

#Add to Releases
new_Bay_Rec_Dead_Rel_Prop[1:c(new_Bay_slot[1]-1),]<-
  Bay_Rec_Dead_Rel_Prop[1:c(new_Bay_slot[1]-1),]+
  newbelow_adjusted
new_Bay_Rec_Dead_Rel_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Dead_Rel_Prop),]<-
  new_Bay_Rec_Dead_Rel_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Dead_Rel_Prop),]+
  newabove_adjusted

#Get New F trajectory
newBayF<-vector()
for(cc in 1:ncol(Bay_Comm_Har_Prop)){
newBayF[cc]<-sum(Bay_Comm_Har_Prop[,cc],Bay_Comm_Dead_Dis_Prop[,cc],
    new_Bay_Rec_Har_Prop[,cc],new_Bay_Rec_Dead_Rel_Prop[,cc])
}
newBayF[is.nan(newBayF)]<-0
new_bay_select<-newBayF/max(newBayF)
```

Coast - New Selectivity

```r
dir<-getwd()
#--------------------2020
cstfile<-paste(dir,"/CSTALKS_2020.xlsx",sep="")
ME_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Harvest"))
```

```r
ME_R_Har_2020[is.na(ME_R_Har_2020)]<-0
NH_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Harvest"))
NH_R_Har_2020[is.na(NH_R_Har_2020)]<-0
MA_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Harvest"))
MA_R_Har_2020[is.na(MA_R_Har_2020)]<-0
RI_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Harvest"))
RI_R_Har_2020[is.na(RI_R_Har_2020)]<-0
CT_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Harvest"))
CT_R_Har_2020[is.na(CT_R_Har_2020)]<-0
NY_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Harvest"))
NY_R_Har_2020[is.na(NY_R_Har_2020)]<-0
NJ_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Harvest"))
NJ_R_Har_2020[is.na(NJ_R_Har_2020)]<-0
DE_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Harvest"))
DE_R_Har_2020[is.na(DE_R_Har_2020)]<-0
MD_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Harvest"))
MD_R_Har_2020[is.na(MD_R_Har_2020)]<-0
VA_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Harvest"))
VA_R_Har_2020[is.na(VA_R_Har_2020)]<-0

#rec releases
ME_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Dead Rel"))
ME_R_Dead_Rel_2020[is.na(ME_R_Dead_Rel_2020)]<-0
NH_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Dead Rel"))
NH_R_Dead_Rel_2020[is.na(NH_R_Dead_Rel_2020)]<-0
MA_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Dead Rel"))
MA_R_Dead_Rel_2020[is.na(MA_R_Dead_Rel_2020)]<-0
RI_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Dead Rel"))
RI_R_Dead_Rel_2020[is.na(RI_R_Dead_Rel_2020)]<-0
CT_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Dead Rel"))
CT_R_Dead_Rel_2020[is.na(CT_R_Dead_Rel_2020)]<-0
NY_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Dead Rel"))
NY_R_Dead_Rel_2020[is.na(NY_R_Dead_Rel_2020)]<-0
NJ_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Dead Rel"))
NJ_R_Dead_Rel_2020[is.na(NJ_R_Dead_Rel_2020)]<-0
DE_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Dead Rel"))
DE_R_Dead_Rel_2020[is.na(DE_R_Dead_Rel_2020)]<-0
MD_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Dead Rel"))
MD_R_Dead_Rel_2020[is.na(MD_R_Dead_Rel_2020)]<-0
VA_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Dead Rel"))
VA_R_Dead_Rel_2020[is.na(VA_R_Dead_Rel_2020)]<-0
NC_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NC Ocean Rec Dead Rel"))
NC_R_Dead_Rel_2020[is.na(NC_R_Dead_Rel_2020)]<-0

#com harvest
MA_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MA Comm Harvest"))
MA_R_Comm_Har_2020[is.na(MA_R_Comm_Har_2020)]<-0
RI_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="RI Comm Harvest"))
RI_R_Comm_Har_2020[is.na(RI_R_Comm_Har_2020)]<-0
NY_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NY Comm Harvest"))
NY_R_Comm_Har_2020[is.na(NY_R_Comm_Har_2020)]<-0
DE_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="DE Comm Harvest"))
DE_R_Comm_Har_2020[is.na(DE_R_Comm_Har_2020)]<-0
```

```
MD_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Comm Harvest"))
MD_R_Comm_Har_2020[is.na(MD_R_Comm_Har_2020)]<-0
VA_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Comm Harvest"))
VA_R_Comm_Har_2020[is.na(VA_R_Comm_Har_2020)]<-0


#2021
cstfile<-paste(dir,"/CSTALKS_2021.xlsx",sep="")
ME_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Harvest"))
ME_R_Har_2021[is.na(ME_R_Har_2021)]<-0
NH_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Harvest"))
NH_R_Har_2021[is.na(NH_R_Har_2021)]<-0
MA_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Harvest"))
MA_R_Har_2021[is.na(MA_R_Har_2021)]<-0
RI_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Harvest"))
RI_R_Har_2021[is.na(RI_R_Har_2021)]<-0
CT_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Harvest"))
CT_R_Har_2021[is.na(CT_R_Har_2021)]<-0
NY_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Harvest"))
NY_R_Har_2021[is.na(NY_R_Har_2021)]<-0
NJ_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Harvest"))
NJ_R_Har_2021[is.na(NJ_R_Har_2021)]<-0
DE_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Harvest"))
DE_R_Har_2021[is.na(DE_R_Har_2021)]<-0
MD_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Harvest"))
MD_R_Har_2021[is.na(MD_R_Har_2021)]<-0
VA_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Harvest"))
VA_R_Har_2021[is.na(VA_R_Har_2021)]<-0

#rec releases
ME_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Dead Rel"))
ME_R_Dead_Rel_2021[is.na(ME_R_Dead_Rel_2021)]<-0
NH_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Dead Rel"))
NH_R_Dead_Rel_2021[is.na(NH_R_Dead_Rel_2021)]<-0
MA_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Dead Rel"))
MA_R_Dead_Rel_2021[is.na(MA_R_Dead_Rel_2021)]<-0
RI_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Dead Rel"))
RI_R_Dead_Rel_2021[is.na(RI_R_Dead_Rel_2021)]<-0
CT_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Dead Rel"))
CT_R_Dead_Rel_2021[is.na(CT_R_Dead_Rel_2021)]<-0
NY_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Dead Rel"))
NY_R_Dead_Rel_2021[is.na(NY_R_Dead_Rel_2021)]<-0
NJ_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Dead Rel"))
NJ_R_Dead_Rel_2021[is.na(NJ_R_Dead_Rel_2021)]<-0
DE_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Dead Rel"))
DE_R_Dead_Rel_2021[is.na(DE_R_Dead_Rel_2021)]<-0
MD_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Dead Rel"))
MD_R_Dead_Rel_2021[is.na(MD_R_Dead_Rel_2021)]<-0
VA_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Dead Rel"))
VA_R_Dead_Rel_2021[is.na(VA_R_Dead_Rel_2021)]<-0
NC_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NC Ocean Rec Dead Rel"))
NC_R_Dead_Rel_2021[is.na(NC_R_Dead_Rel_2021)]<-0
```

```r
#com harvest
MA_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MA Comm Harvest"))
MA_R_Comm_Har_2021[is.na(MA_R_Comm_Har_2021)]<-0
RI_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="RI Comm Harvest"))
RI_R_Comm_Har_2021[is.na(RI_R_Comm_Har_2021)]<-0
NY_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NY Comm Harvest"))
NY_R_Comm_Har_2021[is.na(NY_R_Comm_Har_2021)]<-0
DE_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="DE Comm Harvest"))
DE_R_Comm_Har_2021[is.na(DE_R_Comm_Har_2021)]<-0
MD_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Comm Harvest"))
MD_R_Comm_Har_2021[is.na(MD_R_Comm_Har_2021)]<-0
VA_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Comm Harvest"))
VA_R_Comm_Har_2021[is.na(VA_R_Comm_Har_2021)]<-0

#2022

cstfile<-paste(dir,"/CSTALKS_2022.xlsx",sep="")
ME_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Harvest"))
ME_R_Har_2022[is.na(ME_R_Har_2022)]<-0
NH_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Harvest"))
NH_R_Har_2022[is.na(NH_R_Har_2022)]<-0
MA_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Harvest"))
MA_R_Har_2022[is.na(MA_R_Har_2022)]<-0
RI_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Harvest"))
RI_R_Har_2022[is.na(RI_R_Har_2022)]<-0
CT_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Harvest"))
CT_R_Har_2022[is.na(CT_R_Har_2022)]<-0
NY_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Harvest"))
NY_R_Har_2022[is.na(NY_R_Har_2022)]<-0
NJ_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Harvest"))
NJ_R_Har_2022[is.na(NJ_R_Har_2022)]<-0
DE_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Harvest"))
DE_R_Har_2022[is.na(DE_R_Har_2022)]<-0
MD_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Harvest"))
MD_R_Har_2022[is.na(MD_R_Har_2022)]<-0
VA_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Harvest"))
VA_R_Har_2022[is.na(VA_R_Har_2022)]<-0

#rec releases
ME_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Dead Rel"))
ME_R_Dead_Rel_2022[is.na(ME_R_Dead_Rel_2022)]<-0
NH_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Dead Rel"))
NH_R_Dead_Rel_2022[is.na(NH_R_Dead_Rel_2022)]<-0
MA_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Dead Rel"))
MA_R_Dead_Rel_2022[is.na(MA_R_Dead_Rel_2022)]<-0
RI_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Dead Rel"))
RI_R_Dead_Rel_2022[is.na(RI_R_Dead_Rel_2022)]<-0
CT_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Dead Rel"))
CT_R_Dead_Rel_2022[is.na(CT_R_Dead_Rel_2022)]<-0
NY_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Dead Rel"))
NY_R_Dead_Rel_2022[is.na(NY_R_Dead_Rel_2022)]<-0
NJ_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Dead Rel"))
NJ_R_Dead_Rel_2022[is.na(NJ_R_Dead_Rel_2022)]<-0
```

```r
DE_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Dead Rel"))
DE_R_Dead_Rel_2022[is.na(DE_R_Dead_Rel_2022)]<-0
MD_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Dead Rel"))
MD_R_Dead_Rel_2022[is.na(MD_R_Dead_Rel_2022)]<-0
VA_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Dead Rel"))
VA_R_Dead_Rel_2022[is.na(VA_R_Dead_Rel_2022)]<-0
NC_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NC Ocean Rec Dead Rel"))
NC_R_Dead_Rel_2022[is.na(NC_R_Dead_Rel_2022)]<-0

#com harvest
MA_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MA Comm Harvest"))
MA_R_Comm_Har_2022[is.na(MA_R_Comm_Har_2022)]<-0
RI_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="RI Comm Harvest"))
RI_R_Comm_Har_2022[is.na(RI_R_Comm_Har_2022)]<-0
NY_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NY Comm Harvest"))
NY_R_Comm_Har_2022[is.na(NY_R_Comm_Har_2022)]<-0
DE_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="DE Comm Harvest"))
DE_R_Comm_Har_2022[is.na(DE_R_Comm_Har_2022)]<-0
MD_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Comm Harvest"))
MD_R_Comm_Har_2022[is.na(MD_R_Comm_Har_2022)]<-0
VA_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Comm Harvest"))
VA_R_Comm_Har_2022[is.na(VA_R_Comm_Har_2022)]<-0

CST_Rec_Har<-ME_R_Har_2021[,c(2:16)]+NH_R_Har_2021[,c(2:16)]+MA_R_Har_2021[,c(2:16)]+
  RI_R_Har_2021[,c(2:16)]+CT_R_Har_2021[,c(2:16)]+NY_R_Har_2021[,c(2:16)]+
  DE_R_Har_2021[,c(2:16)]+MD_R_Har_2021[,c(2:16)]+VA_R_Har_2021[,c(2:16)]+
  ME_R_Har_2020[,c(2:16)]+NH_R_Har_2020[,c(2:16)]+MA_R_Har_2020[,c(2:16)]+
  RI_R_Har_2020[,c(2:16)]+CT_R_Har_2020[,c(2:16)]+NY_R_Har_2020[,c(2:16)]+
  DE_R_Har_2020[,c(2:16)]+MD_R_Har_2020[,c(2:16)]+VA_R_Har_2020[,c(2:16)]+
  ME_R_Har_2022[,c(2:16)]+NH_R_Har_2022[,c(2:16)]+MA_R_Har_2022[,c(2:16)]+
  RI_R_Har_2022[,c(2:16)]+CT_R_Har_2022[,c(2:16)]+NY_R_Har_2022[,c(2:16)]+
  DE_R_Har_2022[,c(2:16)]+MD_R_Har_2022[,c(2:16)]+VA_R_Har_2022[,c(2:16)]

CST_Rec_Dead_Rel<-ME_R_Dead_Rel_2020[,c(2:16)]+NH_R_Dead_Rel_2020[,c(2:16)]+
  MA_R_Dead_Rel_2020[,c(2:16)]+RI_R_Dead_Rel_2020[,c(2:16)]+
  CT_R_Dead_Rel_2020[,c(2:16)]+NY_R_Dead_Rel_2020[,c(2:16)]+
  DE_R_Dead_Rel_2020[,c(2:16)]+MD_R_Dead_Rel_2020[,c(2:16)]+
  VA_R_Dead_Rel_2020[,c(2:16)]+NC_R_Dead_Rel_2020[,c(2:16)]+
  ME_R_Dead_Rel_2021[,c(2:16)]+NH_R_Dead_Rel_2021[,c(2:16)]+
  MA_R_Dead_Rel_2021[,c(2:16)]+RI_R_Dead_Rel_2021[,c(2:16)]+
  CT_R_Dead_Rel_2021[,c(2:16)]+NY_R_Dead_Rel_2021[,c(2:16)]+
  DE_R_Dead_Rel_2021[,c(2:16)]+MD_R_Dead_Rel_2021[,c(2:16)]+
  VA_R_Dead_Rel_2021[,c(2:16)]+NC_R_Dead_Rel_2021[,c(2:16)]+
  ME_R_Dead_Rel_2022[,c(2:16)]+NH_R_Dead_Rel_2022[,c(2:16)]+
  MA_R_Dead_Rel_2022[,c(2:16)]+RI_R_Dead_Rel_2022[,c(2:16)]+
  CT_R_Dead_Rel_2022[,c(2:16)]+NY_R_Dead_Rel_2022[,c(2:16)]+
  DE_R_Dead_Rel_2022[,c(2:16)]+MD_R_Dead_Rel_2022[,c(2:16)]+
  VA_R_Dead_Rel_2022[,c(2:16)]+NC_R_Dead_Rel_2022[,c(2:16)]

CST_Comm_Har<-MA_R_Comm_Har_2020[,c(2:16)]+RI_R_Comm_Har_2020[,c(2:16)]+
  NY_R_Comm_Har_2020[,c(2:16)]+DE_R_Comm_Har_2020[,c(2:16)]+
  MD_R_Comm_Har_2020[,c(2:16)]+VA_R_Comm_Har_2020[,c(2:16)]+
  MA_R_Comm_Har_2021[,c(2:16)]+RI_R_Comm_Har_2021[,c(2:16)]+
```

```
  NY_R_Comm_Har_2021[,c(2:16)]+DE_R_Comm_Har_2021[,c(2:16)]+
  MD_R_Comm_Har_2021[,c(2:16)]+VA_R_Comm_Har_2021[,c(2:16)]+
  MA_R_Comm_Har_2022[,c(2:16)]+RI_R_Comm_Har_2022[,c(2:16)]+
  NY_R_Comm_Har_2022[,c(2:16)]+DE_R_Comm_Har_2022[,c(2:16)]+
  MD_R_Comm_Har_2022[,c(2:16)]+VA_R_Comm_Har_2022[,c(2:16)]

#Dead discards at age - from 2024 update
CST_Comm_DD_2020<-c(0,130,315,945,3810,4369,2443,1989,1378,576,419,928,321,550,984)
CST_Comm_DD_2021<-c(0,64,215,512,1408,3423,2060,1152,506,1360,334,146,65,117,281)
CST_Comm_DD_2022<-c(0,2,35,235,351,727,964,326,122,94,131,53,22,14,52)


CST_Comm_DD<-CST_Comm_DD_2020+CST_Comm_DD_2021+CST_Comm_DD_2022

CST_Comm_Dead_Dis<-as.matrix(CST_Comm_Har)
for(cc in 1:ncol(CST_Comm_Dead_Dis)){
  CST_Comm_Dead_Dis[,cc]<-CST_Comm_Dead_Dis[,cc]/sum(CST_Comm_Dead_Dis[,cc])*
    CST_Comm_DD[cc]
}
CST_Comm_Dead_Dis[is.nan(CST_Comm_Dead_Dis)]<-0

CST_Rec_Har_Prop<-as.matrix(CST_Rec_Har)
CST_Rec_Har_Prop[is.nan(CST_Rec_Har_Prop)]<-0
CST_Rec_Dead_Rel_Prop<-as.matrix(CST_Rec_Dead_Rel)
CST_Rec_Dead_Rel[is.nan(CST_Rec_Dead_Rel_Prop)]<-0
CST_Comm_Har_Prop<-as.matrix(CST_Comm_Har)
CST_Comm_Har_Prop[is.nan(CST_Comm_Har_Prop)]<-0

CST_Comm_Dead_Dis_Prop<-as.matrix(CST_Comm_Dead_Dis)
CST_Comm_Dead_Dis_Prop[is.nan(CST_Comm_Dead_Dis_Prop)]<-0

CSTF2020<-c(0.00168,0.0052,0.01522,0.03797,0.07037,0.0941,0.1028,0.10335,0.10103,
            0.0979,0.09462,0.09137,0.08821,0.08515,0.08219)

CSTF2021<-c(0.00184,0.00572,0.01673,0.04174,0.07736,0.10344,0.11301,0.11362,0.11107,
            0.10763,0.10402,0.10044,0.09697,0.09361,0.09036)

CSTF2022<-c(0.00276,0.00857,0.02505,0.06252,0.11586,0.15492,0.16926,0.17016,0.16635,
            0.16119,0.15578,0.15043,0.14523,0.14019,0.13533)

CSTFavg<-exp((log(CSTF2020)+log(CSTF2021)+log(CSTF2022))/3)


for(cc in 1:ncol(CST_Comm_Dead_Dis)){
  coltotal<-sum(CST_Rec_Har[,cc],CST_Rec_Dead_Rel[,cc],CST_Comm_Har[,cc],
                CST_Comm_Dead_Dis[,cc])
  CST_Rec_Har_Prop[,cc]<-CST_Rec_Har[,cc]/coltotal*CSTFavg[cc]
  CST_Rec_Har_Prop[is.nan(CST_Rec_Har_Prop)]<-0
  CST_Rec_Dead_Rel_Prop[,cc]<-CST_Rec_Dead_Rel[,cc]/coltotal*CSTFavg[cc]
  CST_Rec_Dead_Rel_Prop[is.nan(CST_Rec_Dead_Rel_Prop)]<-0
  CST_Comm_Har_Prop[,cc]<-CST_Comm_Har[,cc]/coltotal*CSTFavg[cc]
  CST_Comm_Har_Prop[is.nan(CST_Comm_Har_Prop)]<-0
  CST_Comm_Dead_Dis_Prop[,cc]<-CST_Comm_Dead_Dis[,cc]/coltotal*CSTFavg[cc]
```

```
  CST_Comm_Dead_Dis_Prop[is.nan(CST_Comm_Dead_Dis_Prop)]<-0
}

#New Regulations
cstslot<-c(28,31)

new_CST_Rec_Har_Prop<-CST_Rec_Har_Prop
new_CST_Rec_Dead_Rel_Prop<-CST_Rec_Dead_Rel_Prop

newbelow<-new_CST_Rec_Har_Prop[1:c(cstslot[1]-1),]
newabove<-new_CST_Rec_Har_Prop[c(cstslot[2]+1):nrow(CST_Rec_Har_Prop),]

newbelow_adjusted<-newbelow*0.09
newabove_adjusted<-newabove*0.09

new_CST_Rec_Har_Prop[1:c(cstslot[1]-1),]<-0
new_CST_Rec_Har_Prop[c(cstslot[2]+1):nrow(CST_Rec_Har_Prop),]<-0

#Add to Releases
new_CST_Rec_Dead_Rel_Prop[1:c(cstslot[1]-1),]<-
  CST_Rec_Dead_Rel_Prop[1:c(cstslot[1]-1),]+newbelow_adjusted
new_CST_Rec_Dead_Rel_Prop[c(cstslot[2]+1):nrow(CST_Rec_Dead_Rel_Prop),]<-
  new_CST_Rec_Dead_Rel_Prop[c(cstslot[2]+1):nrow(CST_Rec_Dead_Rel_Prop),]+
  newabove_adjusted

#Get New F trajectory
newCSTF<-vector()
for(cc in 1:ncol(CST_Comm_Har_Prop)){
  newCSTF[cc]<-sum(CST_Comm_Har_Prop[,cc],CST_Comm_Dead_Dis_Prop[,cc],
      new_CST_Rec_Har_Prop[,cc],new_CST_Rec_Dead_Rel_Prop[,cc])
}

newCSTF[is.nan(newCSTF)]<-0
new_CST_select<-newCSTF/max(newCSTF)
```

New combined Selectivity

```
# 2024 selectivity (from total F)
comb_select_2024<-newBayF+newCSTF
comb_select_2024<-comb_select_2024/max(comb_select_2024)
CombF<-CSTFavg+bayFavg #2020-2022
```

Calculate Numbers-at-age for 2024

```
#Jan-1
N2023<-data.frame(N=c(96681400,24782200,13749300,11957000,10872400,5807770,3479720,
                      5129420,2458020,926552,501940,963536,412419,208649,515022))
```

```r
catch_2023<-data.frame(removals=c(35504.03,111866.23,299326.95,799575.80,
                  1066841.90,567243.77,695959.36,1145467.72,357229.05,236550.82,
                  70131.97,73326.67,26013.12,19799.25,77273.11))

#Predict Age1 in 2024 from MD YOY Index for 2023
# All recruits 1982-2023
recruits_series<-data.frame(year=1982:2023,
            recr=c(37364100,75602800,62859700,68479300,67611600,74169300,93300800,
                   106655000,130941000,104485000,108762000,133935000,285297000,
                   186734000,234018000,258960000,148052000,152875000,
                   124486000,196467000,221336000,127967000,304432000,158153000,
                   135236000,88441000,126912000,75196700,96903000,125307000,
                   192360000,66597300,82938200,153154000,228067000,111488000,
                   130105000,165265000,120143000,85158100,76967300,96681400))
MDYOYlag<-c(0.59,3.57,0.61,1.64,0.91,1.34,1.46,0.73,4.87,1.03,1.52,2.34,13.97,6.40,
            4.41,17.61,3.91,5.50,5.34,7.42,12.57,2.20,10.83,4.85,6.91,
            1.78,5.12,1.26,3.92,2.54,9.57,0.49,3.42,4.06,10.67,1.25,5.88,6.96,1.95,
            1.12,1.65,1.78,0.57)

#Determine Age 1 versus MD YOY relationship
datar<-data.frame(year=1982:2024,age1=c(recruits_series$recr,NA),index=MDYOYlag)
tempdata<-datar[datar$year<2024,]
age1YOY_model<-lm(age1~index, data=tempdata)

# Predict age 1 for 2024
predicted_age1_2024<-as.numeric(predict(age1YOY_model,newdata=
                        data.frame(index=datar[datar$year==2024,3])))

N2024<-N2023
for(a in 1:maxage){
  if(a==1) N2024[1,1]<-predicted_age1_2024
  if(a>1 & a<maxage) N2024[a,1]<-N2023[a-1,1]*exp(-M[a-1])-catch_2023[a-1,1]*
       exp(-M[a-1]/2)
  if(a==maxage) N2024[a,1]<-N2023[a-1,1]*exp(-M[a-1])-catch_2023[a-1,1]*
      exp(-M[a-1]/2)+N2023[a,1]*exp(-M[a])-catch_2023[a,1]*exp(-M[a]/2)#plus group
   if(N2024[a,1]<0) N2024[a,1]<-0
}


N2024$CV<-c(0.166,0.141,0.137,0.107,0.098,0.102,0.107,0.107,0.121,0.135,
                0.149,0.149,0.171,0.193,0.247)
N2024
```

```
##              N    CV
## 1  80936272.2 0.166
## 2  31211128.4 0.141
## 3  12475460.6 0.137
## 4   8527923.3 0.107
## 5   7918215.8 0.098
## 6   7525949.0 0.102
## 7   4286952.3 0.107
## 8   2349351.0 0.107
## 9   3352232.5 0.121
```

```
## 10  1784220.5 0.135
## 11   578032.2 0.149
## 12   366959.3 0.149
## 13   761294.8 0.171
## 14   330838.8 0.193
## 15   532811.2 0.247
```

Reference Points

```r
# Reference Points from one block model
SSB_threshold<-89213.4
SSB_threshold_CV<-0.062
SSB_target<-SSB_threshold*1.25
SSB_target_CV<-SSB_threshold_CV
F_threshold<-0.2064
F_threshold_CV<-0.133
F_target<-0.1707
F_target_CV<-0.133
SSB_2023<-86535.7
F_2023<-0.1828

Nbias<-c(0.052569183,0.018336967,0.022521635,0.0262269,0.027848943,0.035054616,
         0.047813092,0.053597387,0.051212845,0.048280795,0.044594976,
         0.040305708,0.035191998,0.029222708,0.010445624)#old

# Bias in F from retrospective analysis
F_bias<--0.053#old
```

Catch Number Scenarios

```r
catch_scenario_1<-5862189
catch_scenario_2<-3890793
```

Projections: Catch Scenario 1 (High 2024 Catch)

Solve for F given total catch

```r
   pcatch<-vector()
   solveF1<-function(x){
            for(a in 1:maxage){
              pcatch[a]<-(comb_select_2024[a]*x)/(comb_select_2024[a]*x+M[a])*
                (1-exp(-comb_select_2024[a]*x-M[a]))*N2024[a,1]
            }
            (log(sum(pcatch))-log(catch_scenario_1))^2
       }
```

```
    outs1<-optimize(solveF1,interval=c(0.00001,5))
    F2024_scen_1<-outs1$minimum
```

Projection to 2034 using F2024_scen_1 in year 1 and the same after 2024

```
cF_current_1<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_1,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_1,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_current_1
```

Projection F in year 1 is F2024_scen_1 and Ftarget thereafter

```
cF_target_1<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_1,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F_target,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_target_1
```

Solve for catch needed to achieve F target by 2025

```
ftarget_2025_1<-Constant_Catch_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
                        Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                        avgwgt=average_wgt,cursel=comb_select_2024,
```

```
                          avgselect=comb_select_2024,recruits=recruits_series,
                          curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                          Fcur=F2024_scen_1,FcurCV1=F_target_CV,Fcur_bias=F_bias,
                          total_current_catch=catch_scenario_1,
                          SSBthreshold=SSB_threshold, SSBthresholdCV=SSB_threshold_CV,
                           SSBtarget=SSB_target, SSBtargetCV=SSB_target_CV,
                           Ftarget=F_target, FtargetCV=F_target_CV,
                           Fthreshold=F_threshold,FthresholdCV=F_threshold_CV,
                           solve_catch=1,
                           objective_function_value_solve_catch_1=1,
                           pyears=2,nsims=5000,Nerr=2,Ferr=2,usebias=1,
                           rcentral=1)
#ftarget_2025_1
```

Solve for F needed to achieve rebuilding with 50% probability of SSB being above SSBtarget by 2029

```
cF_Frebuild_1<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                     sex=female_sex_fraction,
                     fmat=female_mature_fraction,Nages_base=N2024,
                     Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                     avgwgt=average_wgt,
                     cursel=comb_select_2024,avgselect=comb_select_2024,
                     recruits=recruits_series,
                     curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                     Fcur=F2024_scen_1,FcurCV=0.133,Fcur_bias=F_bias,
                     Fproj=0.111,
                     SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                     SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                     pyears=6,nsims=10000,usebias=1,
                     catch_current=catch_scenario_1)
#cF_Frebuild_1
```

Projections: Catch Scenario 2 (Low 2024 Catch)

Solve for F given total catch

```
   pcatch<-vector()
   solveF1<-function(x){
            for(a in 1:maxage){
              pcatch[a]<-(comb_select_2024[a]*x)/(comb_select_2024[a]*x+M[a])*
                (1-exp(-comb_select_2024[a]*x-M[a]))*N2024[a,1]
            }
            (log(sum(pcatch))-log(catch_scenario_2))^2
        }

    outs2<-optimize(solveF1,interval=c(0.00001,5))
    F2024_scen_2<-outs2$minimum
```

Projection to 2034 using F2024 in year 1 and the same thereafter

```
cF_current_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_2,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_current_2
```

Projection constant F in year 1 and F target thereafter

```
cF_target_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F_target,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
#cF_target_2
```

Solve for catch needed to achieve F target by 2025

```
ftarget_2025_2<-Constant_Catch_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
                        Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                        avgwgt=average_wgt,cursel=comb_select_2024,
                        avgselect=comb_select_2024,recruits=recruits_series,
                        curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                        Fcur=F2024_scen_2,FcurCV1=F_target_CV,Fcur_bias=F_bias,
                        total_current_catch=catch_scenario_2,
                        SSBthreshold=SSB_threshold, SSBthresholdCV=SSB_threshold_CV,
```

```
                             SSBtarget=SSB_target, SSBtargetCV=SSB_target_CV,
                             Ftarget=F_target, FtargetCV=F_target_CV,
                             Fthreshold=F_threshold,FthresholdCV=F_threshold_CV,
                             solve_catch=1,
                             objective_function_value_solve_catch_1=1,
                             pyears=2,nsims=5000,Nerr=2,Ferr=2,usebias=1,
                             rcentral=1)
#ftarget_2025_2
```

Solve for F needed to achieve rebuilding with 50% probability of SSB being above SSBtarget by 2029

```
cF_Frebuild_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
                        Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                        avgwgt=average_wgt,
                        cursel=comb_select_2024,avgselect=comb_select_2024,
                        recruits=recruits_series,
                        curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                        Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                        Fproj=0.126,
                        SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                        SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                        pyears=6,nsims=10000,usebias=1,
                        catch_current=catch_scenario_2)
#cF_Frebuild_2
```

```
F2024_scen_3 <- F2024_scen_2 * (1+0.387)

cF_2022pInc_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
                        Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                        avgwgt=average_wgt,
                        cursel=comb_select_2024,avgselect=comb_select_2024,
                        recruits=recruits_series,
                        curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                        Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                        Fproj=F2024_scen_3,
                        SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                        SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                        pyears=11,nsims=5000,usebias=1,
                        catch_current=catch_scenario_2)
#cF_2022pInc_2
```

```
F2024_scen_4 <- F2024_scen_2 * (1+0.172)

cF_2023pInc_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
```

```
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_4,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
#cF_2023pInc_2
```

Additional Projection with variable Fs

Altered Projection Code

```
varFs<-c(F2024_scen_4,0.126,0.126,0.126,0.126)
cf_scen_2_var_Fs2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=varFs,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=6,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
```

Tables

Table 1: 2024 Assessment Reference Points

SSB.Refs	SSB	F.Refs	F
Target	111,516.8	Target	0.1707
Threshold	89,213.4	Threshold	0.2064
2023	86,535.7	2023	0.1828

Table 2: Catch and 2024 F Estimates

Catch	Removals	F
Scenario 1	5,862,189	0.1950
Scenario 2	3,890,793	0.1264

Table 3: Projection Results using F2024 in All Years

	Scenario 1				Scenario 2			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.195	5,862,189	0.325	0.001	0.126	5,862,189	0.370	0.001
2025	0.195	5,423,865	0.528	0.004	0.126	3,751,468	0.819	0.024
2026	0.195	5,134,366	0.599	0.006	0.126	3,658,378	0.969	0.134
2027	0.195	5,144,004	0.578	0.006	0.126	3,707,293	0.994	0.297
2028	0.195	5,318,206	0.458	0.003	0.126	3,873,952	0.998	0.434
2029	0.195	5,541,406	0.331	0.001	0.126	4,051,657	0.999	0.503
2030	0.195	5,684,011	0.238	0.001	0.126	4,198,552	0.999	0.561
2031	0.195	5,758,484	0.200	0.001	0.126	4,282,790	0.999	0.631
2032	0.195	5,825,179	0.186	0.001	0.126	4,339,902	0.999	0.676
2033	0.195	5,844,425	0.200	0.002	0.126	4,382,267	0.999	0.725
2034	0.195	5,862,793	0.217	0.003	0.126	4,425,940	0.999	0.763

Table 4: Projection Results for 2024 F and Ftarget

	Scenario 1				Scenario 2			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.195	5,862,189	0.337	0.000	0.126	3,890,793	0.356	0.001
2025	0.171	4,782,921	0.545	0.004	0.171	4,977,582	0.792	0.020
2026	0.171	4,601,902	0.700	0.012	0.171	4,743,436	0.898	0.055
2027	0.171	4,636,210	0.761	0.020	0.171	4,743,985	0.923	0.074
2028	0.171	4,841,601	0.749	0.019	0.171	4,918,083	0.904	0.062
2029	0.171	5,061,695	0.691	0.015	0.171	5,085,327	0.853	0.041
2030	0.171	5,218,784	0.634	0.013	0.171	5,248,565	0.796	0.032
2031	0.171	5,288,331	0.607	0.016	0.171	5,332,686	0.755	0.032
2032	0.171	5,344,185	0.606	0.021	0.171	5,378,087	0.711	0.037
2033	0.171	5,363,981	0.611	0.037	0.171	5,390,770	0.692	0.049
2034	0.171	5,404,582	0.631	0.053	0.171	5,430,432	0.696	0.064

Table 5: Catch To Reach Ftarget by 2025

	Scenario 1		Scenario 2	
Year	F	Catch	F	Catch
2024	0.195	5,862,189	0.126	3,890,793
2025	0.171	4,786,429	0.171	4,983,814

Table 6: F needed to rebuild SSB by 2029

	Scenario 1				Scenario 2			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.195	5,862,189	0.338	0.001	0.126	3,890,793	0.363	0.001
2025	0.111	3,171,196	0.563	0.004	0.126	3,735,471	0.810	0.024
2026	0.111	3,159,998	0.894	0.052	0.126	3,641,580	0.966	0.133
2027	0.111	3,249,542	0.980	0.196	0.126	3,700,575	0.993	0.304
2028	0.111	3,430,020	0.996	0.361	0.126	3,871,423	0.998	0.428
2029	0.111	3,629,865	0.999	0.517	0.126	4,052,648	0.999	0.504

Table 7: Projection Results if F Increases in 2025

	F Increases by Same Percent as in 2023				F Increases by Same Percent as in 2022			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.126	3,890,793	0.365	0.001	0.126	3,890,793	0.368	0.001
2025	0.148	4,368,599	0.804	0.021	0.175	5,103,863	0.800	0.021
2026	0.148	4,207,073	0.938	0.087	0.175	4,853,542	0.888	0.051
2027	0.148	4,228,542	0.974	0.159	0.175	4,830,779	0.908	0.064
2028	0.148	4,410,957	0.979	0.192	0.175	5,016,984	0.876	0.050
2029	0.148	4,613,175	0.980	0.201	0.175	5,195,578	0.812	0.033
2030	0.148	4,747,809	0.975	0.195	0.175	5,344,763	0.733	0.022
2031	0.148	4,811,663	0.970	0.220	0.175	5,416,288	0.679	0.025
2032	0.148	4,853,165	0.962	0.249	0.175	5,451,445	0.623	0.028
2033	0.148	4,884,653	0.958	0.293	0.175	5,459,675	0.603	0.037
2034	0.148	4,937,977	0.957	0.334	0.175	5,492,176	0.599	0.047

Table 8: Projection results if F increases in 2025 only due to 2018 YC

	F = 0.126 after 2026			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.126	3,890,793	0.360	0.001
2025	0.148	4,361,188	0.808	0.022
2026	0.126	3,595,776	0.942	0.087
2027	0.126	3,678,054	0.988	0.230
2028	0.126	3,857,024	0.995	0.355
2029	0.126	4,054,539	0.998	0.416

Figures

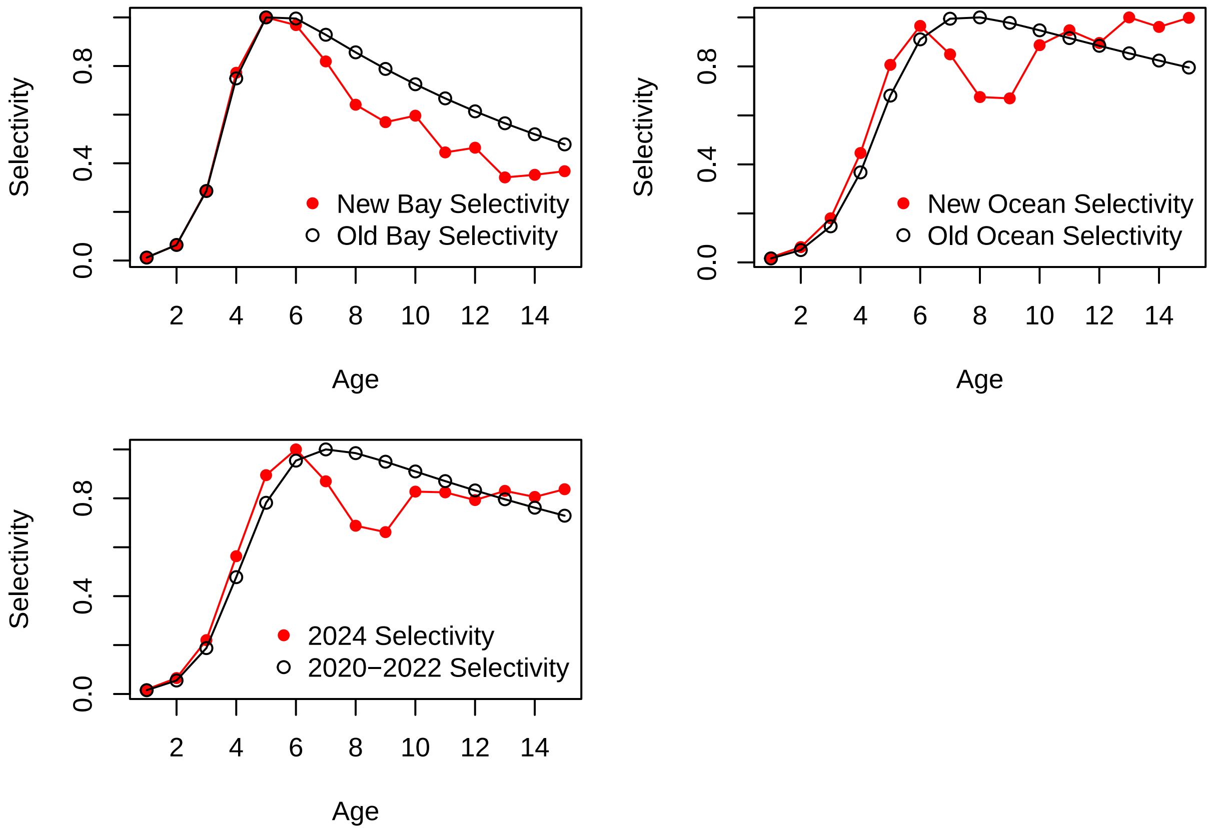


Figure 1. Plots of New Selectivities for Bay, Ocean and Combined.

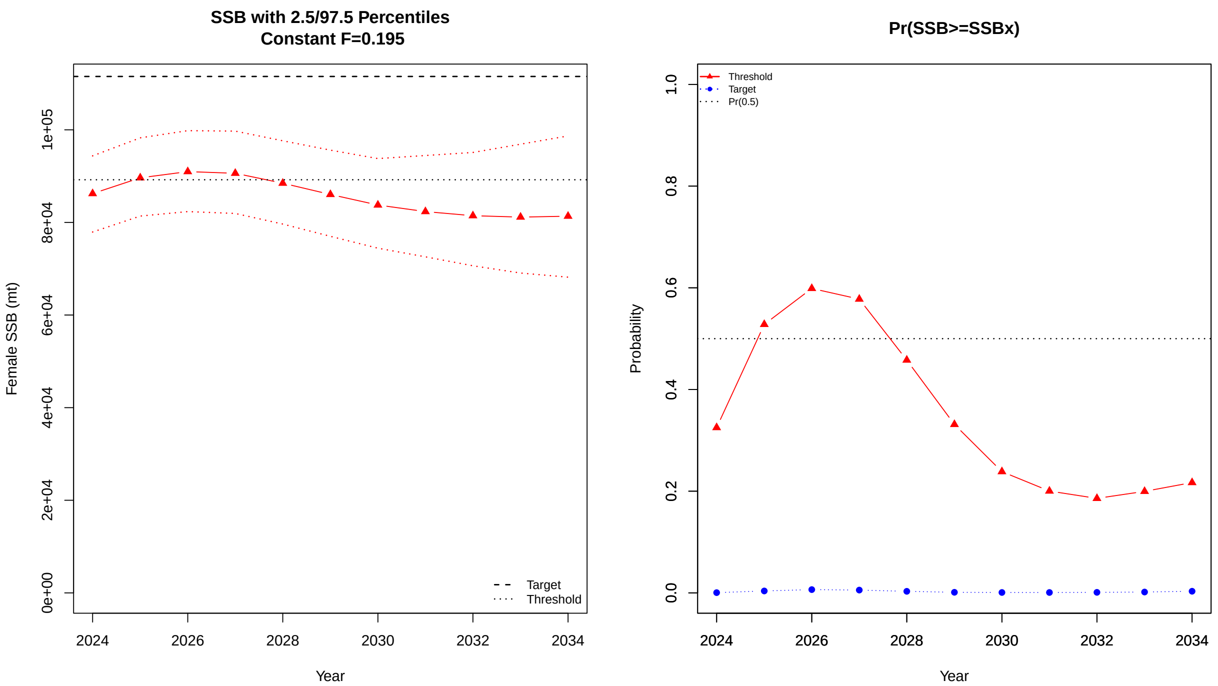


Figure 2. Projections of SSB and probabilities of SSB being >= SSB threshold and SSB target through 2034 under constant F=F2024 for catch scenario 1 .

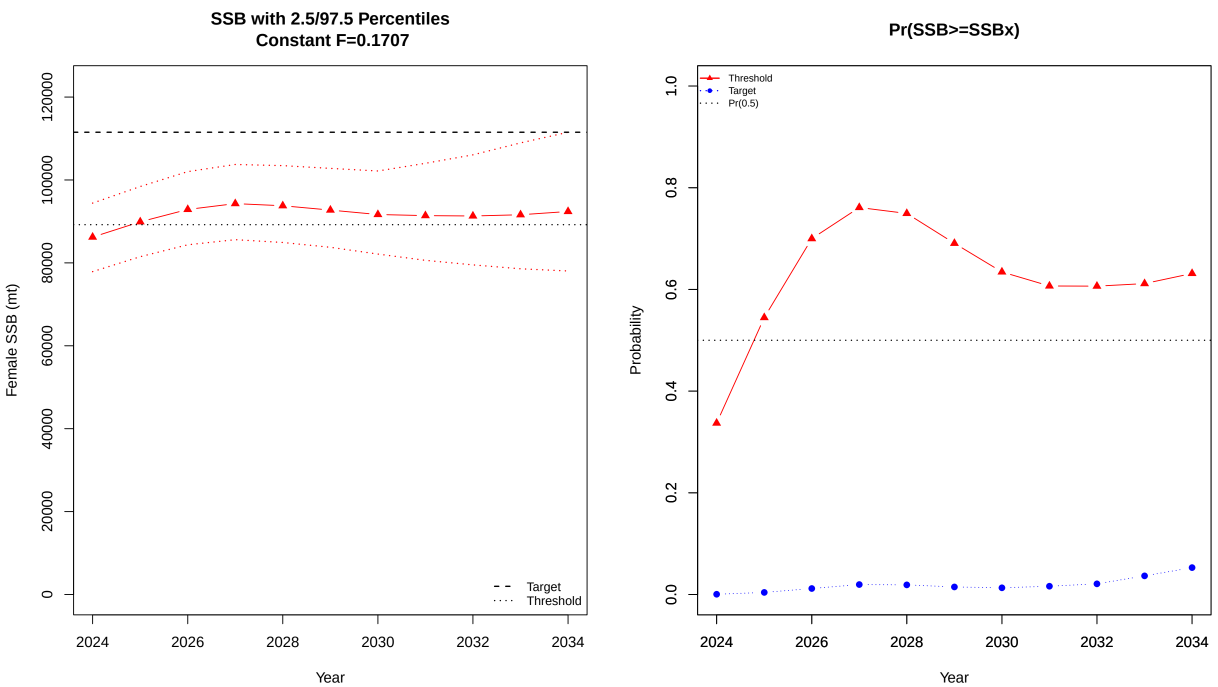


Figure 3. Projection through 2034 of SSB and probabilities of SSB being >= SSB threshold and SSB target under F2024 in 2024 and F-target thereafter for catch scenario 1 .

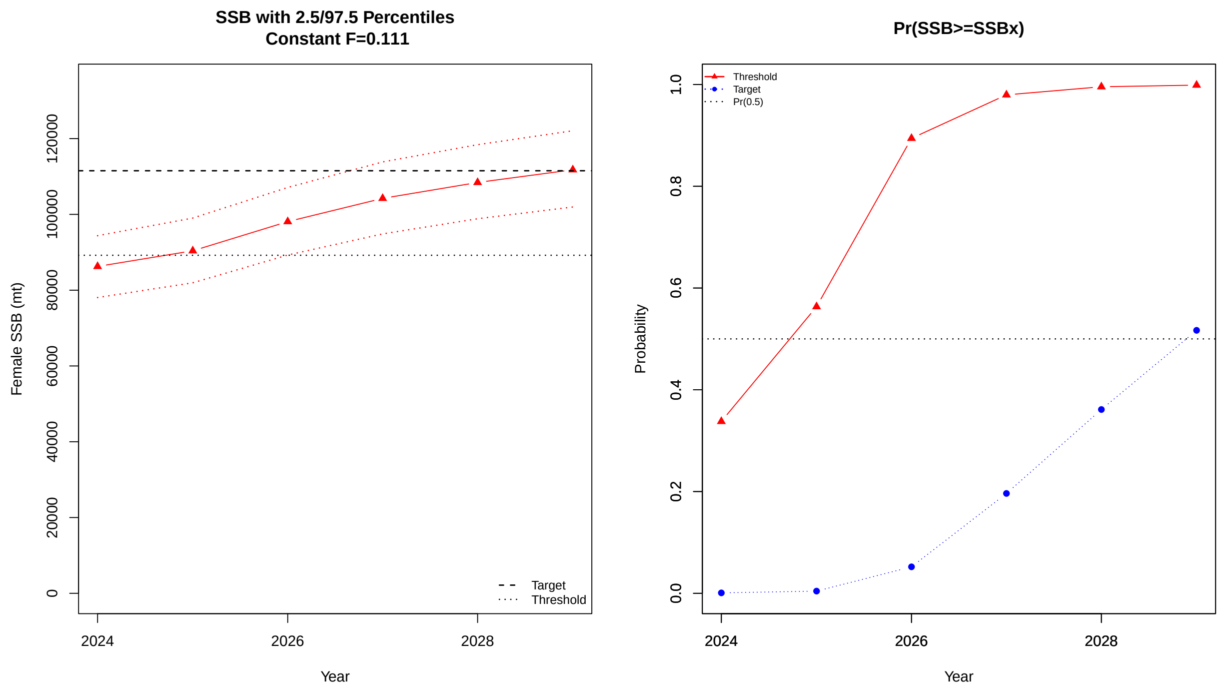


Figure 4. F needed to rebuild SSB with 50% probability that is SSB >= SSB target under catch scenario 1.

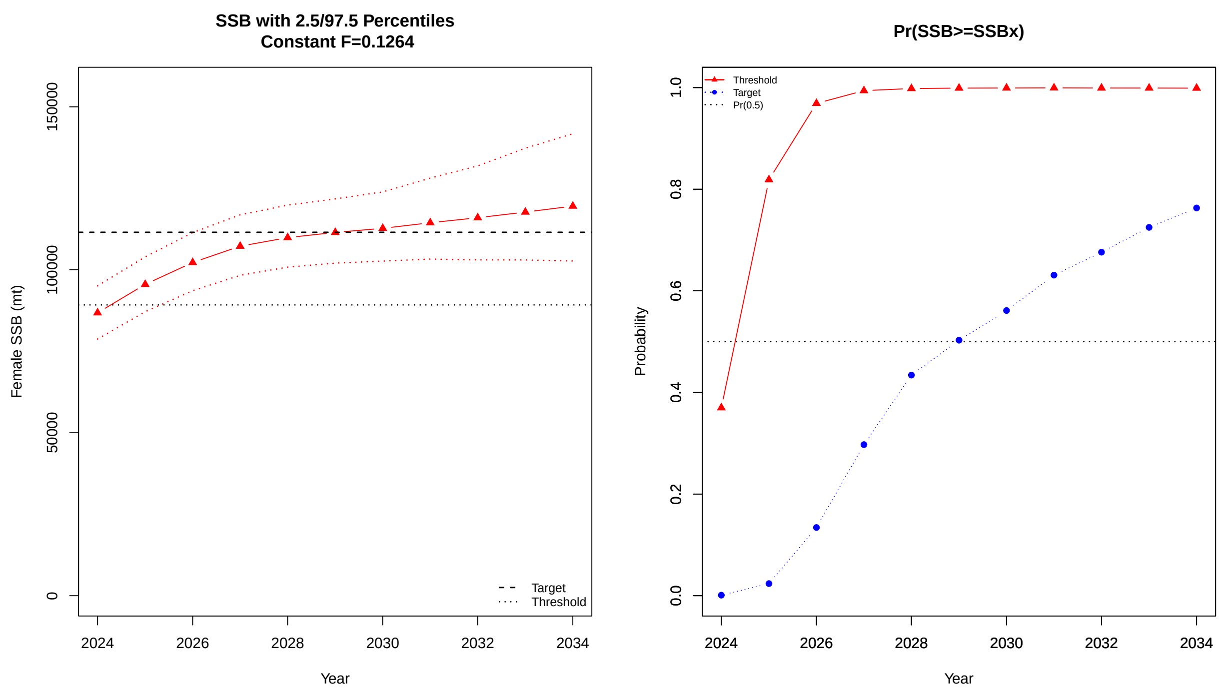


Figure 5. Projections of SSB and probabilities of SSB being >= SSB threshold and SSB target through 2034 under constant F=F2024 for catch scenario 2 .

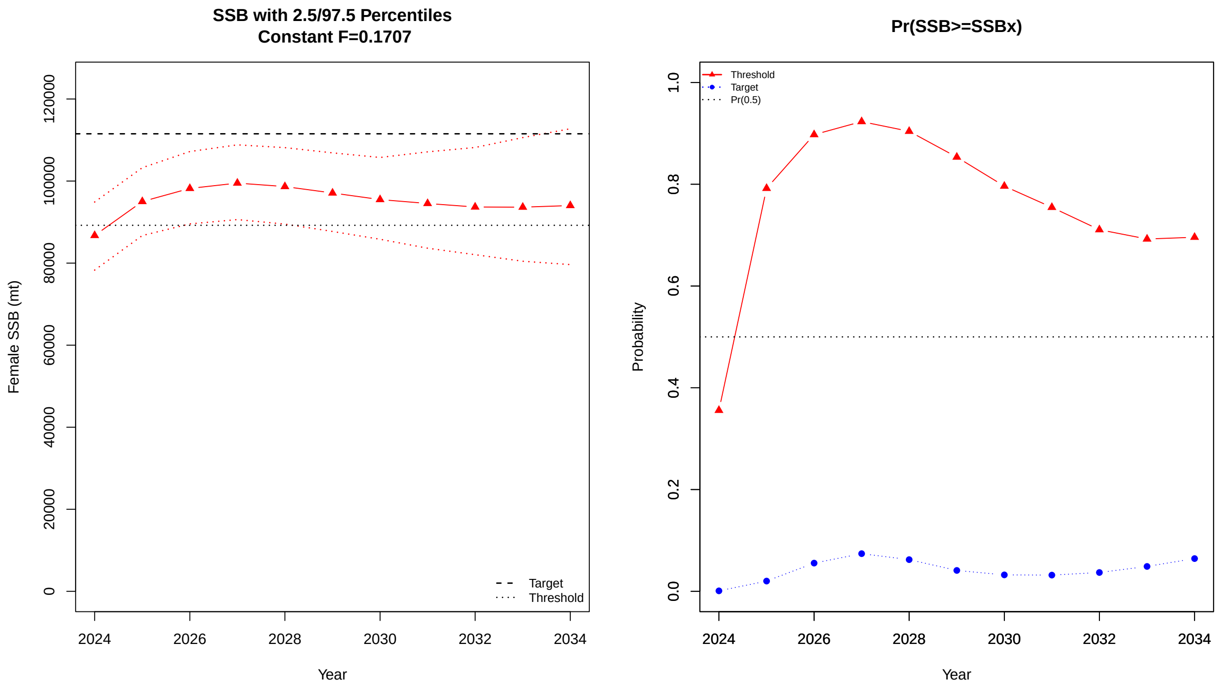


Figure 6. Projection through 2034 of SSB and probabilities of SSB being >= SSB threshold and SSB target under F2024 in 2024 and F-target thereafter for catch scenario 2.

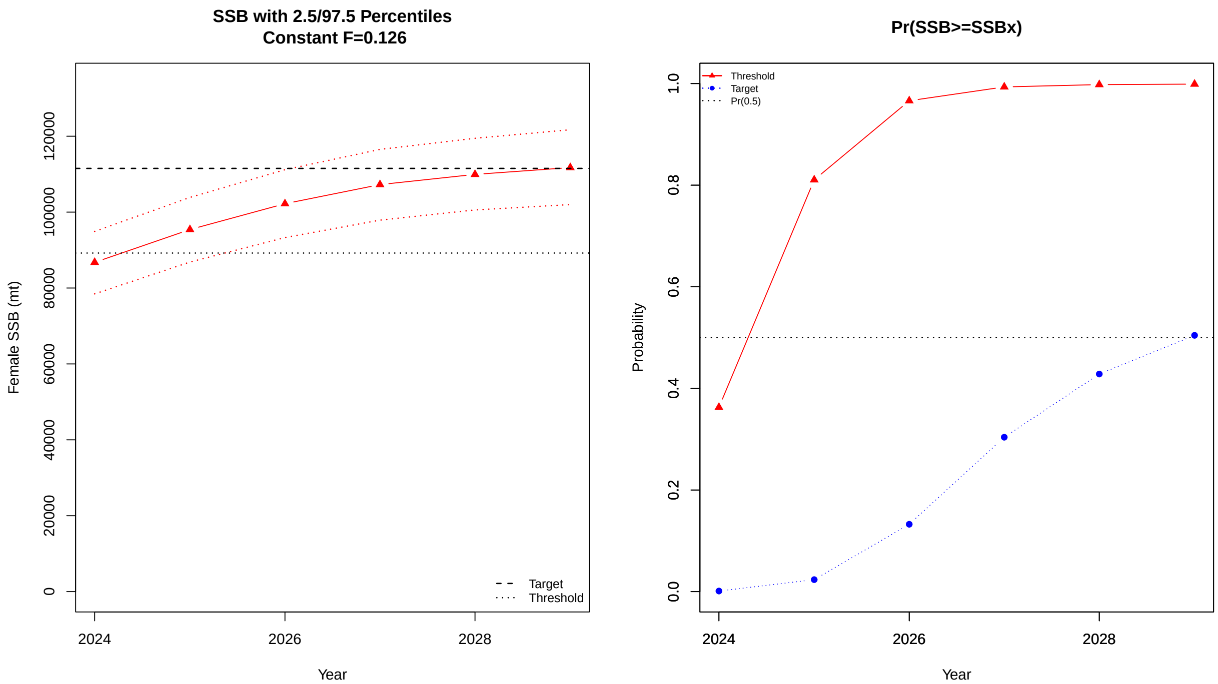


Figure 7. F needed to rebuild SSB with 50% probability that is SSB >= SSB target under catch scenario 2.

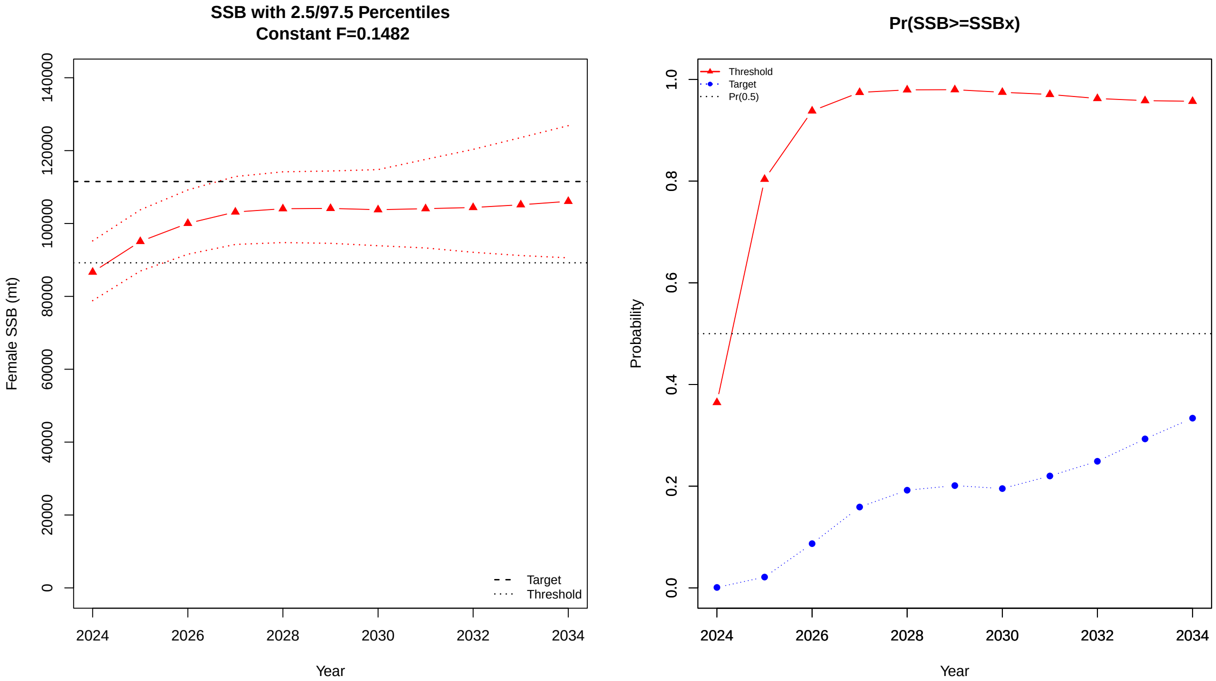


Figure 8. Constant F=F 2025, where F 2025 increases from F 2024 at the same rate seen from 2021 to 2023 under the 28-31" slot

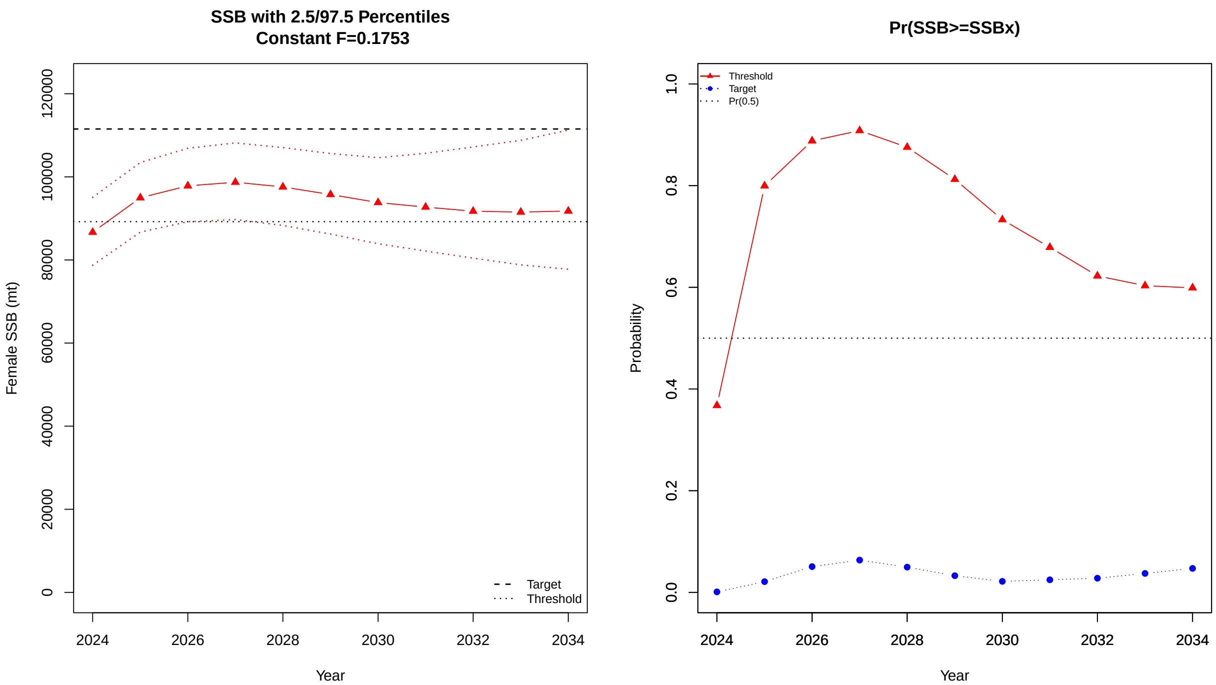


Figure 9. Constant F=F 2025, where F 2025 increases from F 2024 at the same rate seen from 2021 to 2022 when the 2015 year-class turned seven.

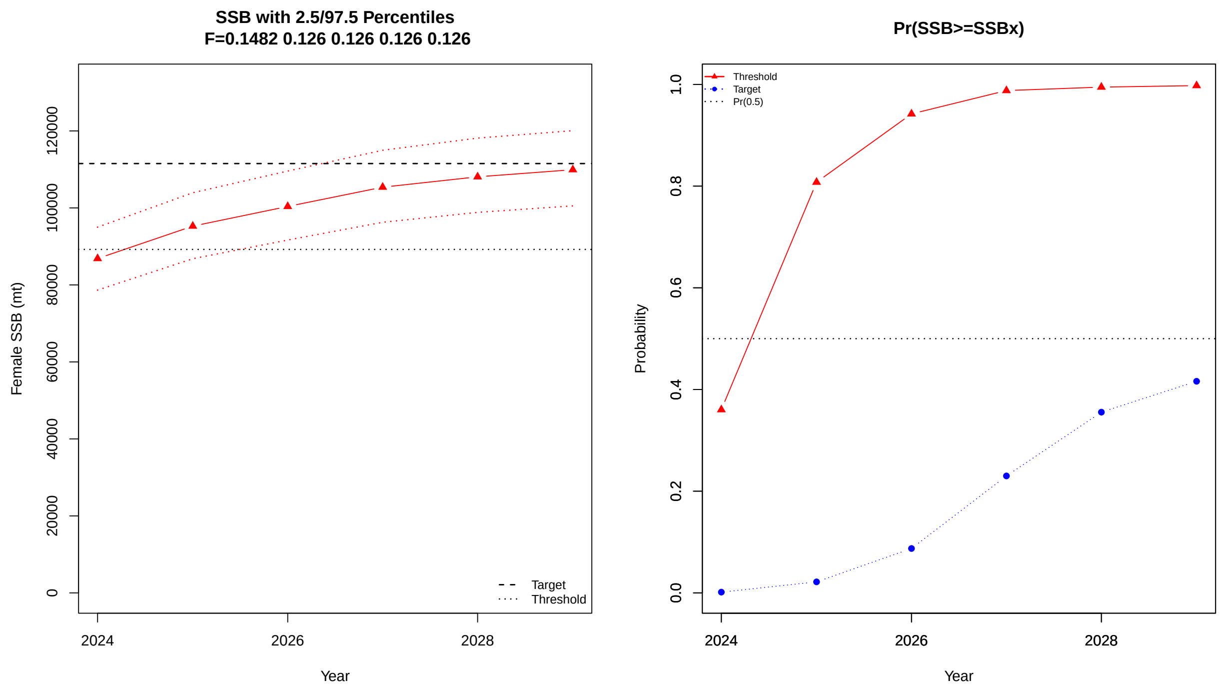


Figure 10. F increases in 2025 only as 2018 Year-class moves through slot. F after 2025 at F=F 2024=0.126