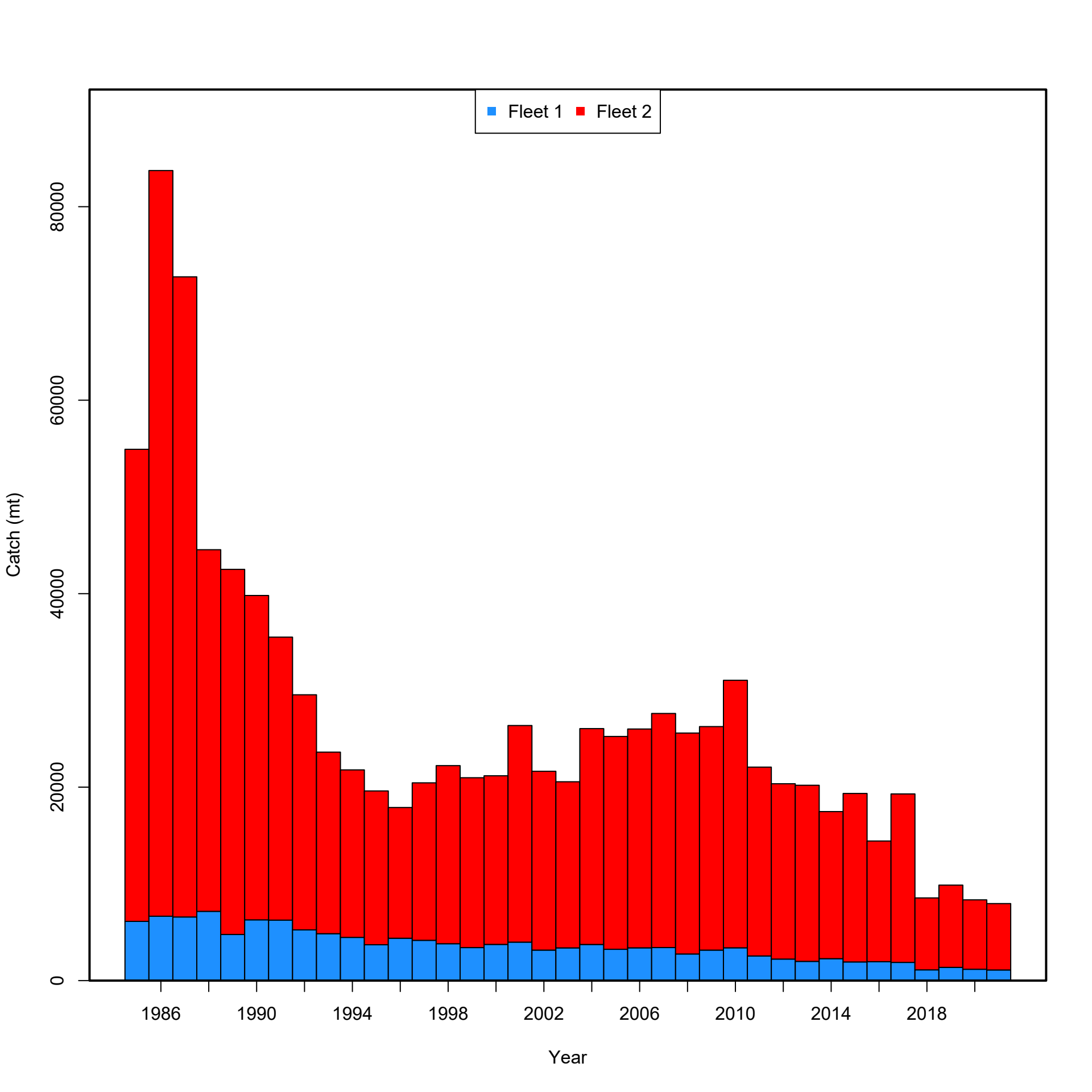
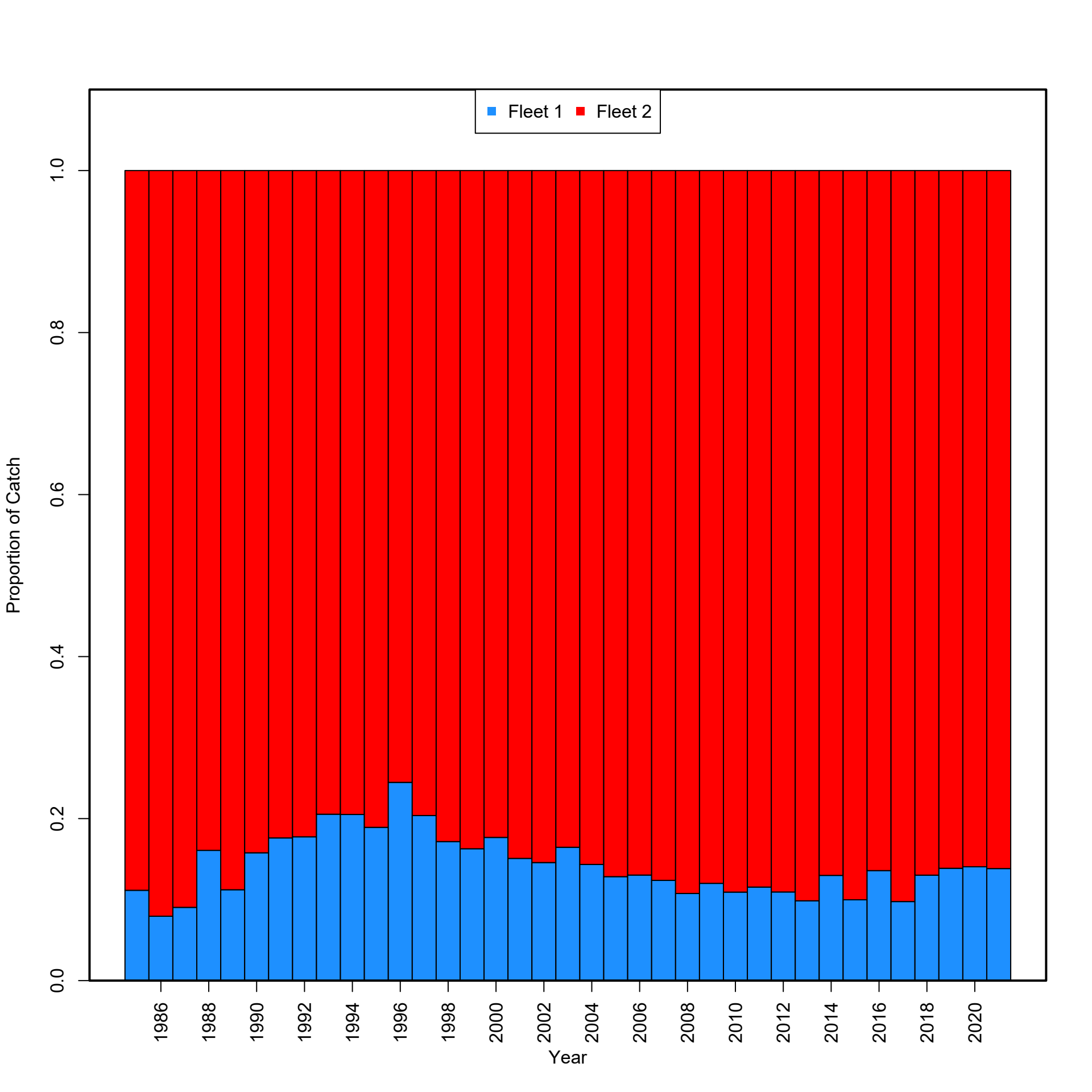
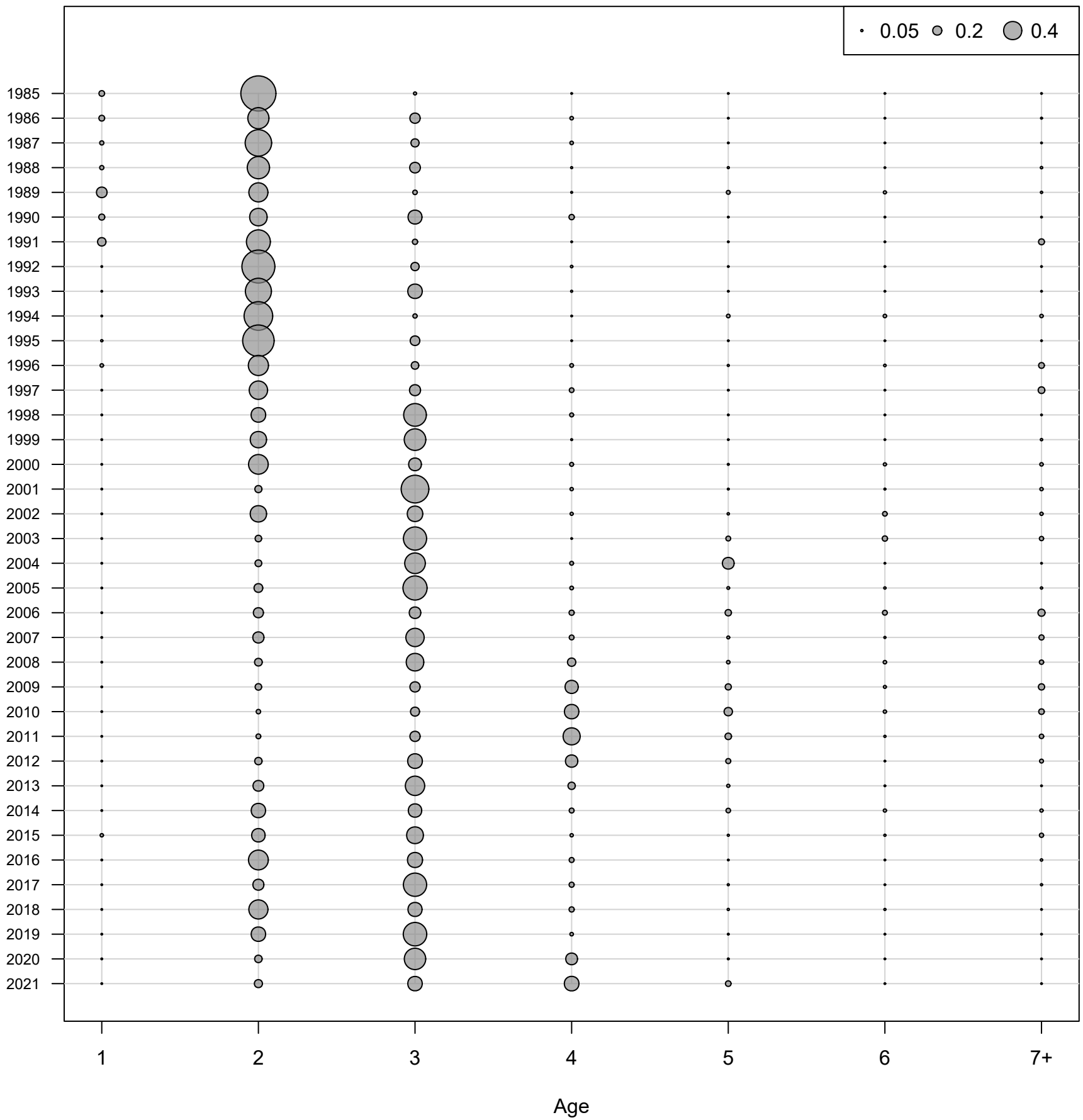
BF28W_M7ECOV

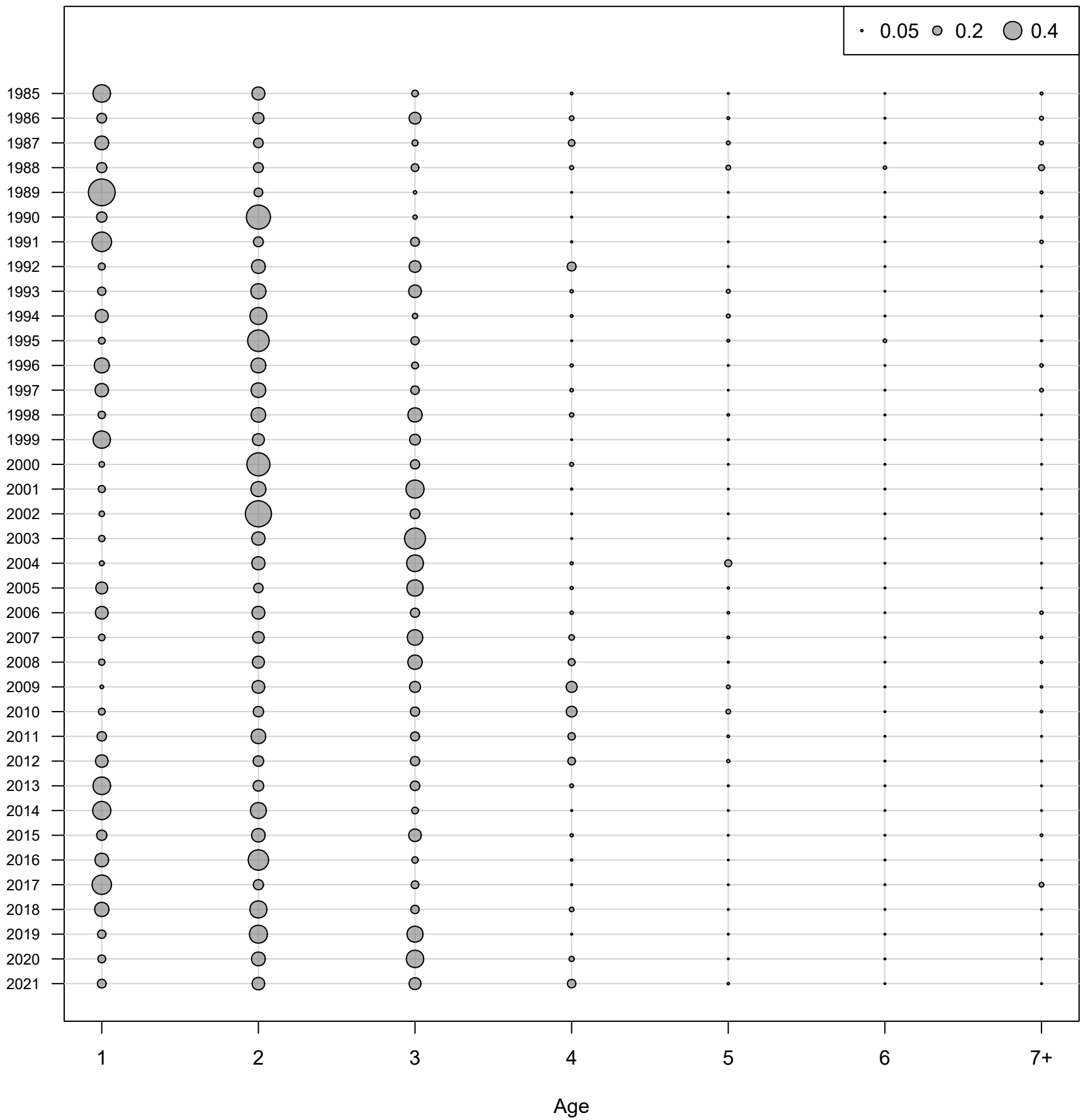
MRIP Forage Fish Index as an environmental covariate on catchability

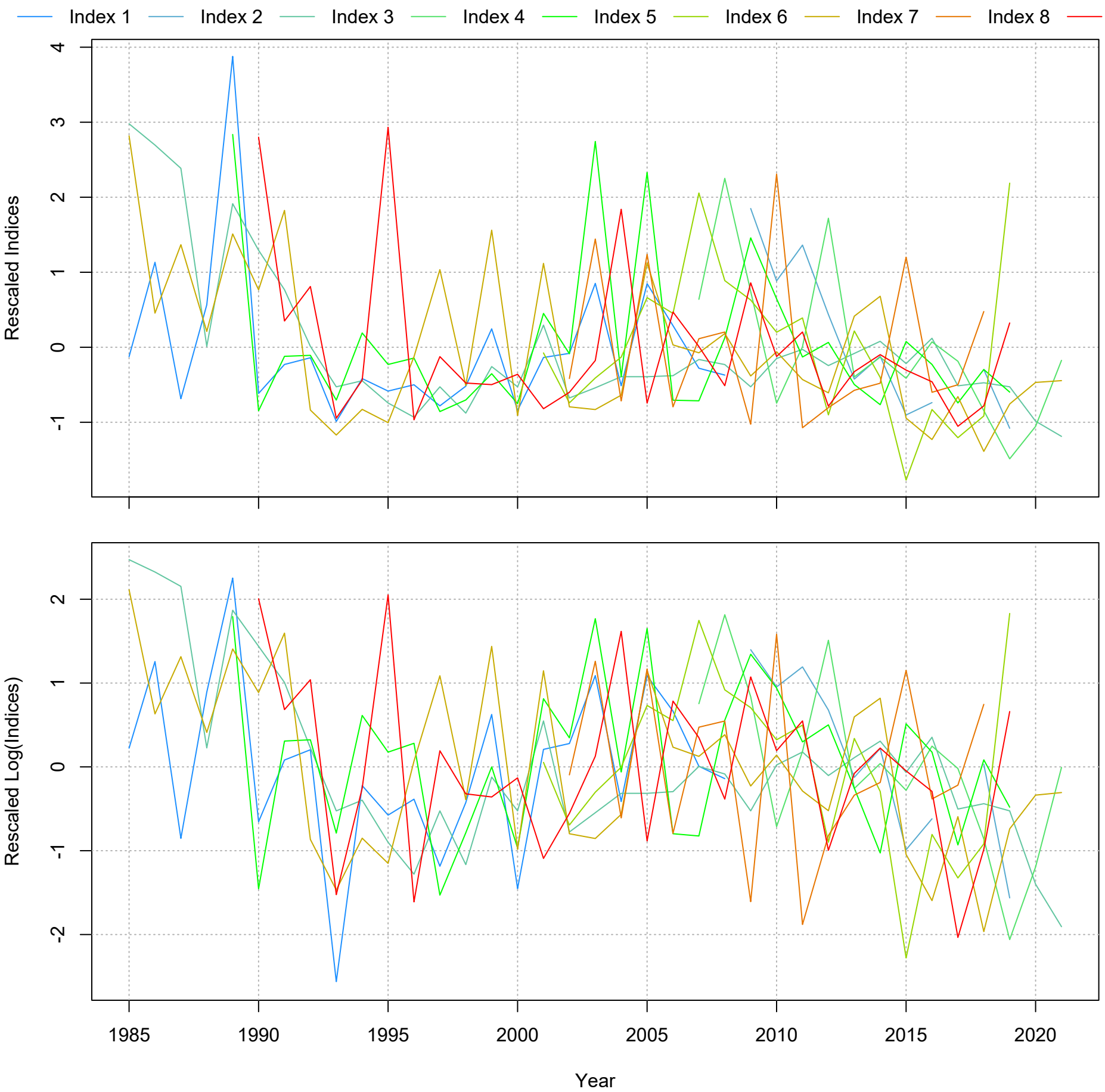
DATA PLOTS

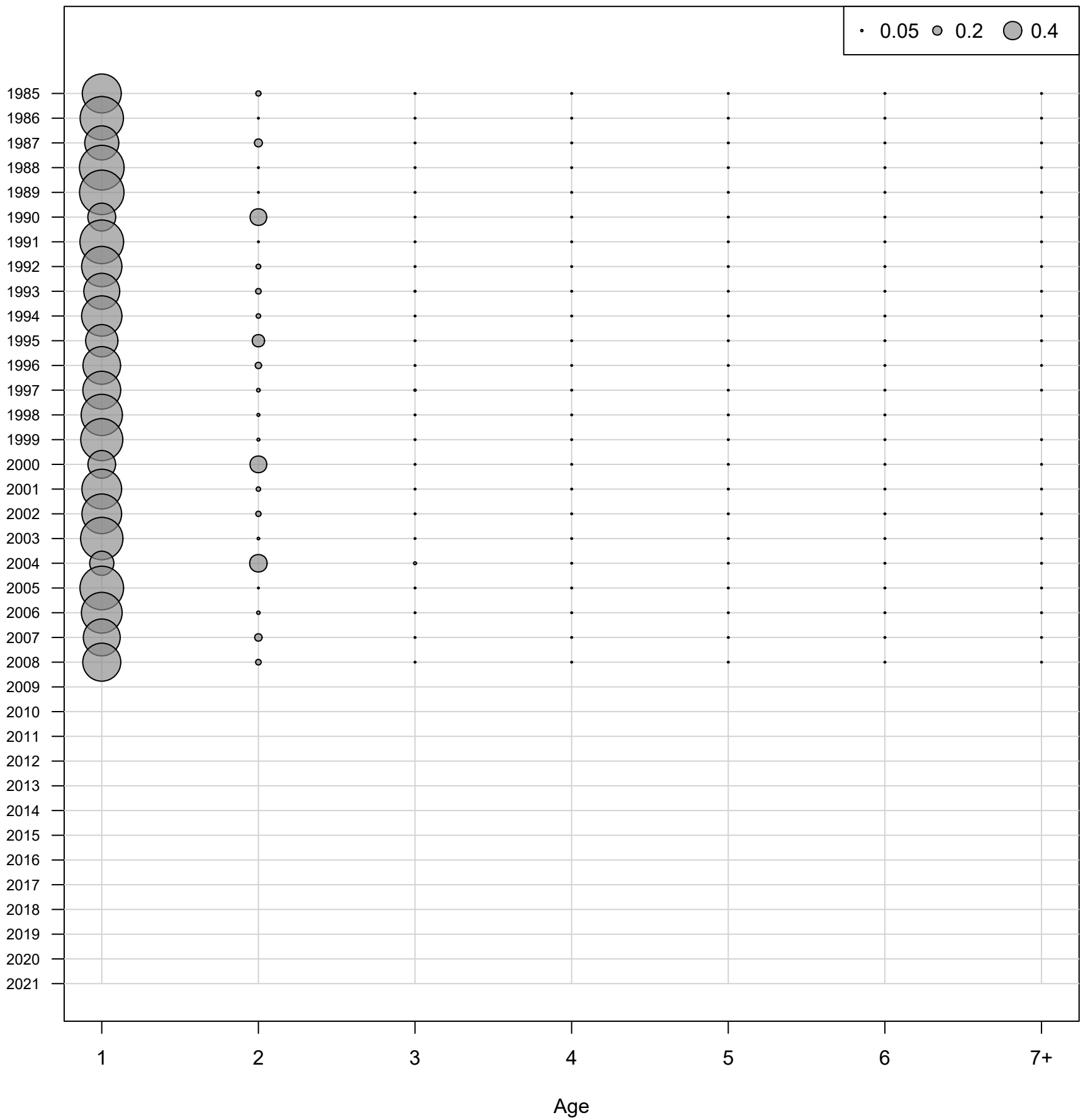

Fleet 1
Fleet 2
Catch (mt)
0
20000
40000
60000
80000
1986
1990
1994
1998
2002
2006
2010
2014
2018
Year

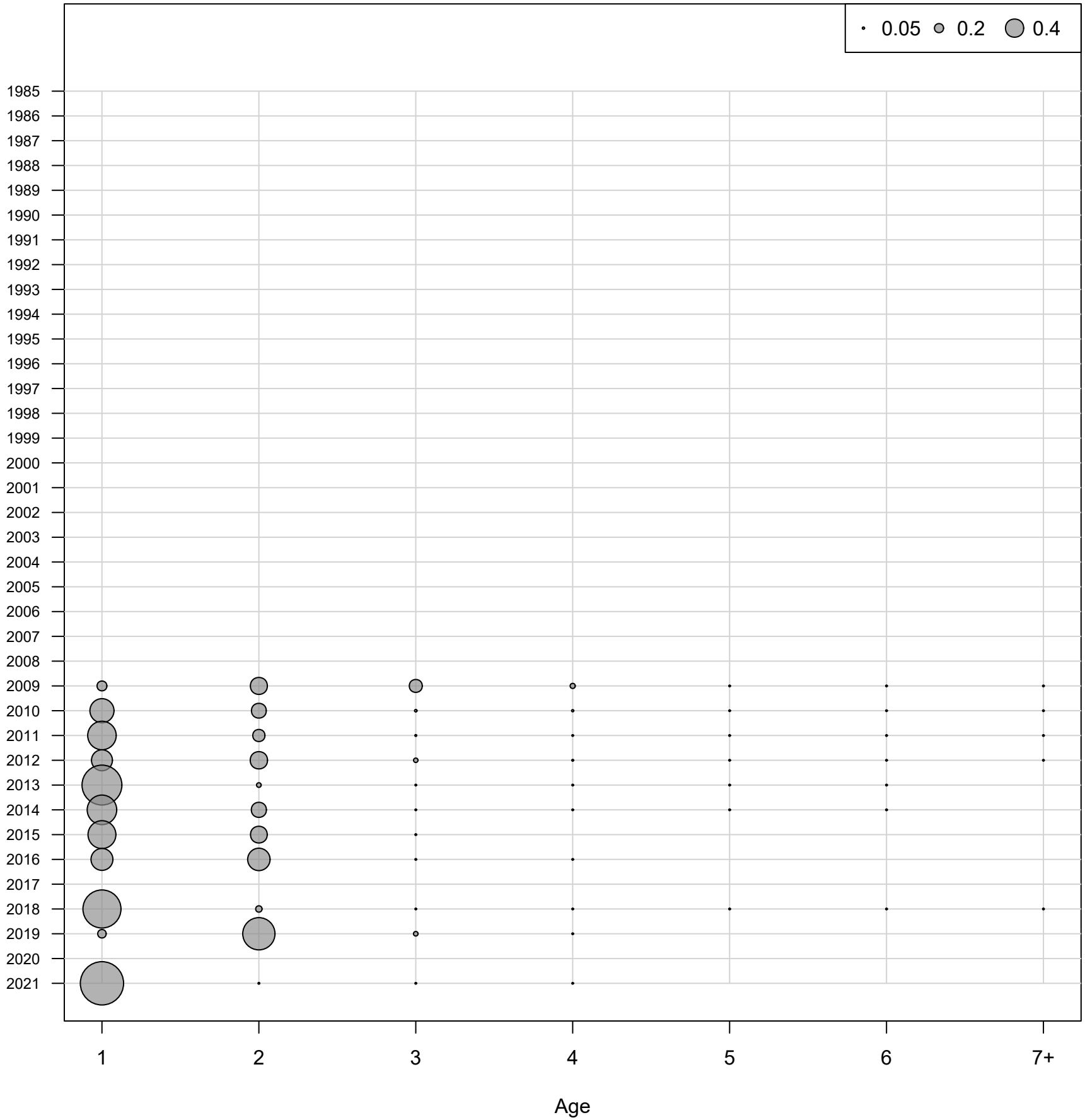

Fleet 1
Fleet 2
Proportion of Catch
0.0
0.2
0.4
0.6
0.8
1.0
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Year

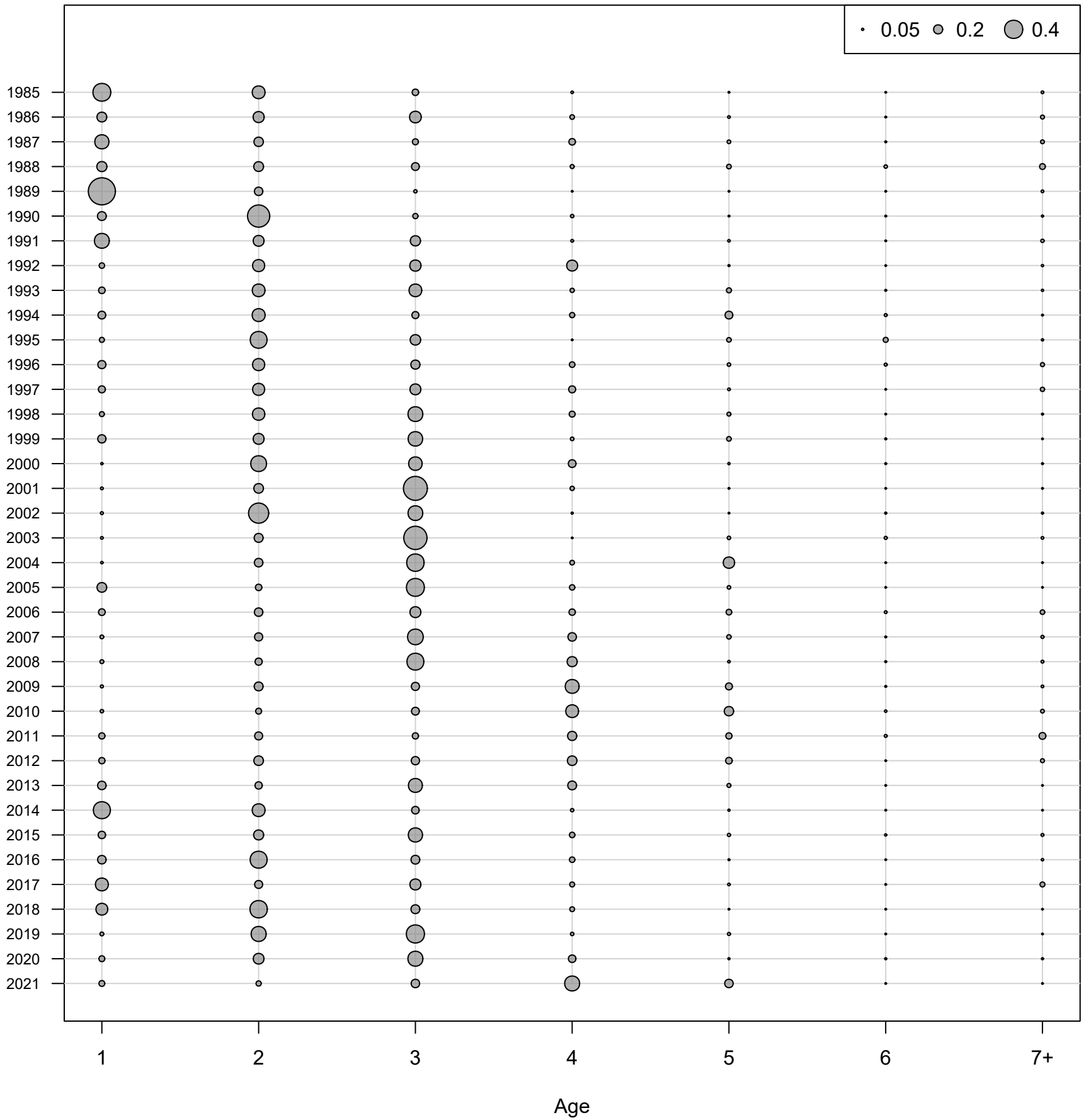

Age Comps for Catch for Fleet 1
0.05
0.2
0.4
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age


Age Comps for Catch for Fleet 2
0.05
0.2
0.4
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
1
2
3
4
5
6
7+
Age


Index 1
Index 2
Index 3
Index 4
Index 5
Index 6
Index 7
Index 8
Rescaled Indices
Rescaled Log(Indices)
Year
1985
1990
1995
2000
2005
2010
2015
2020


Age Comps for Index 1
0.05
0.2
0.4
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
1
2
3
4
5
6
7+
Age


Age Comps for Index 2
0.05
0.2
0.4
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
1
2
3
4
5
6
7+
Age


Age Comps for Index 3
0.05
0.2
0.4
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
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2012
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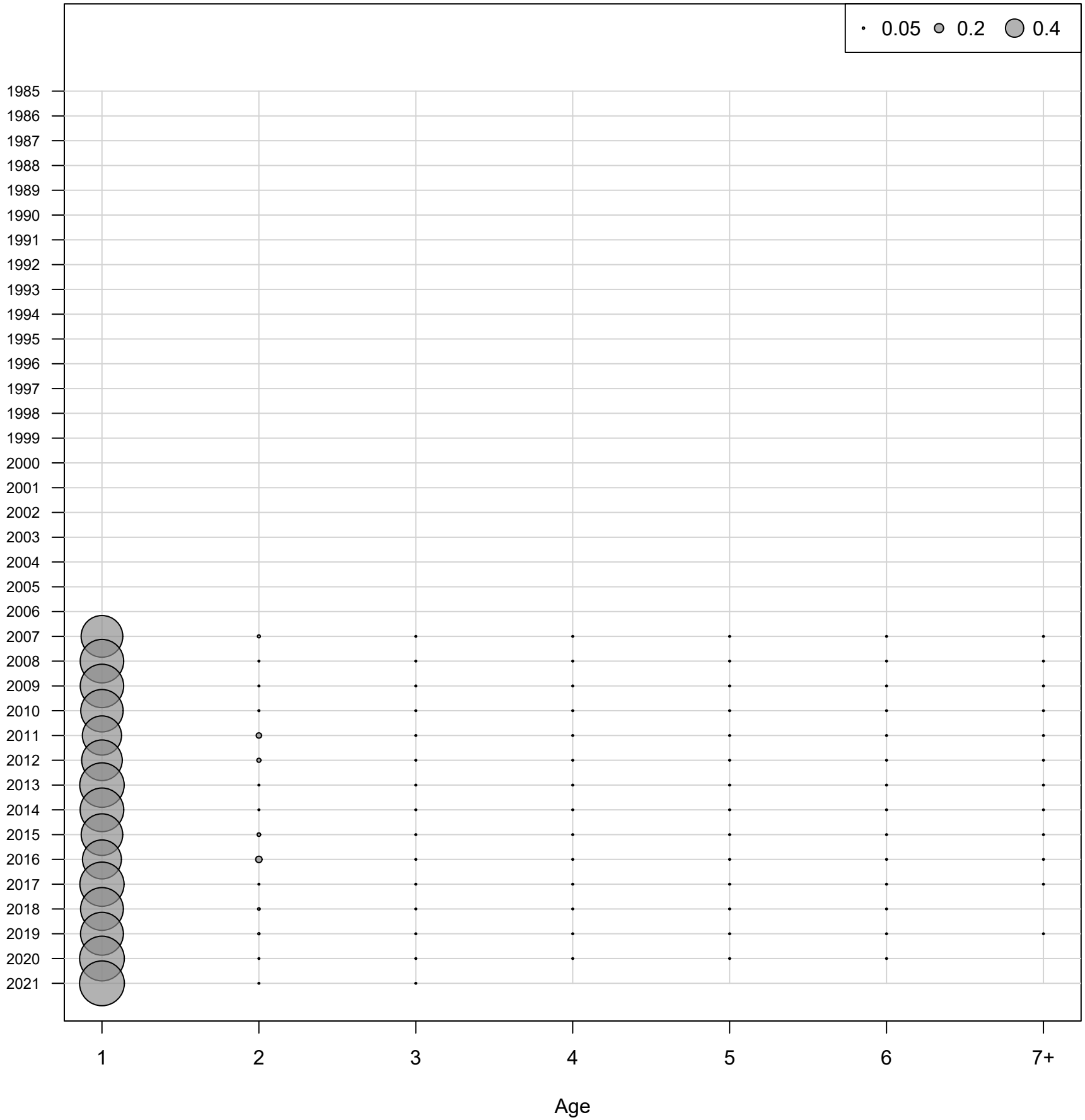
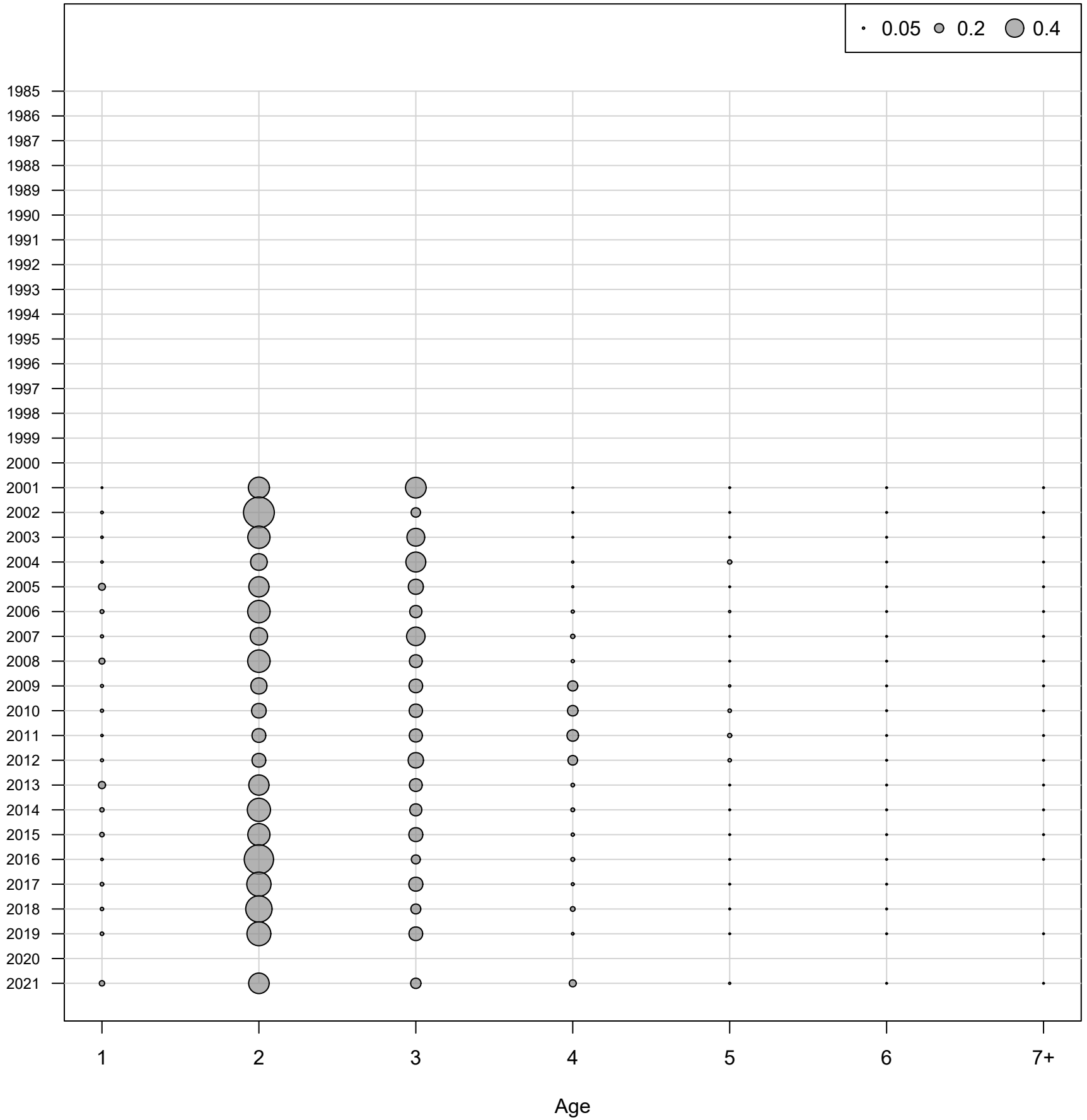
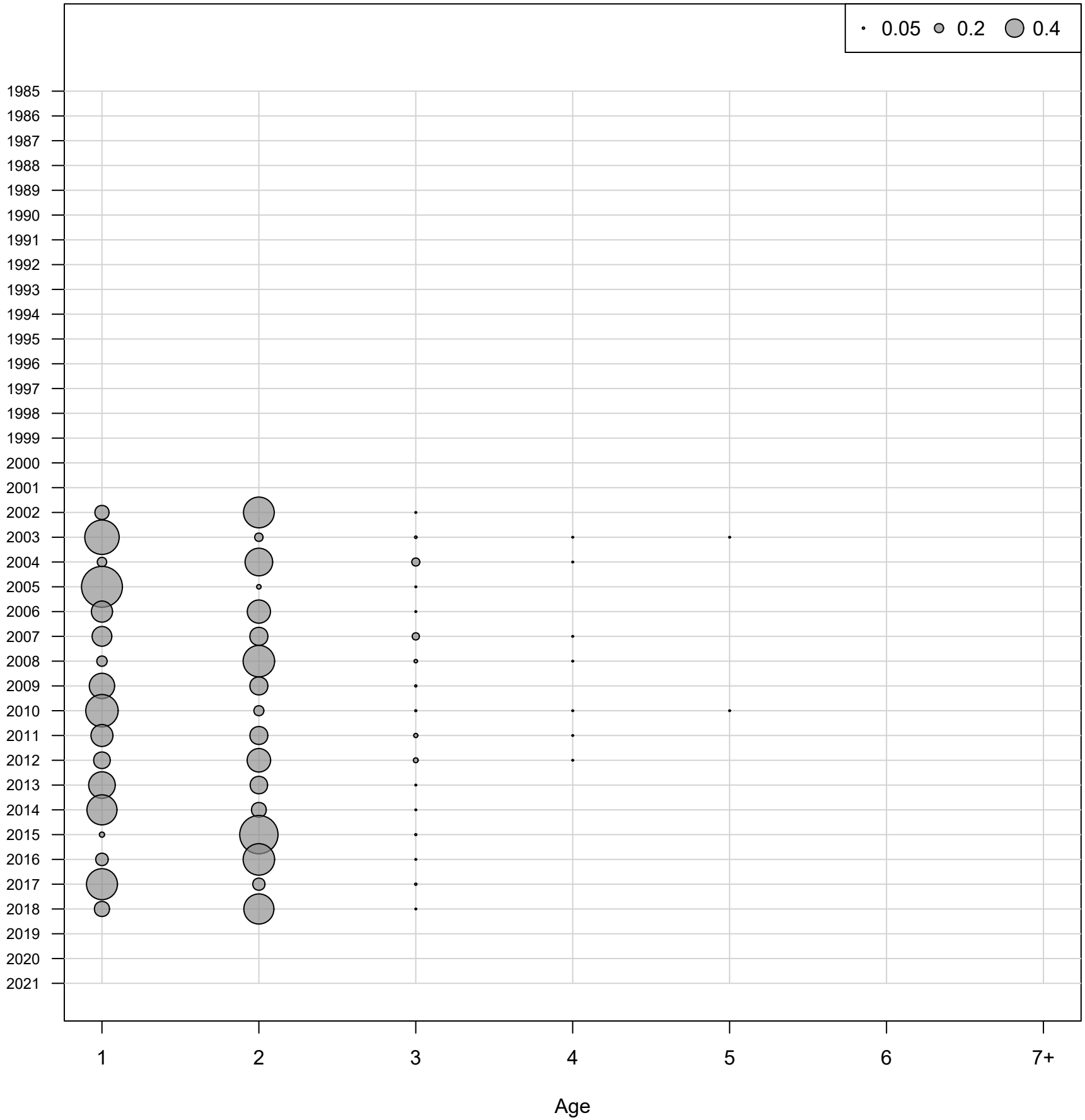
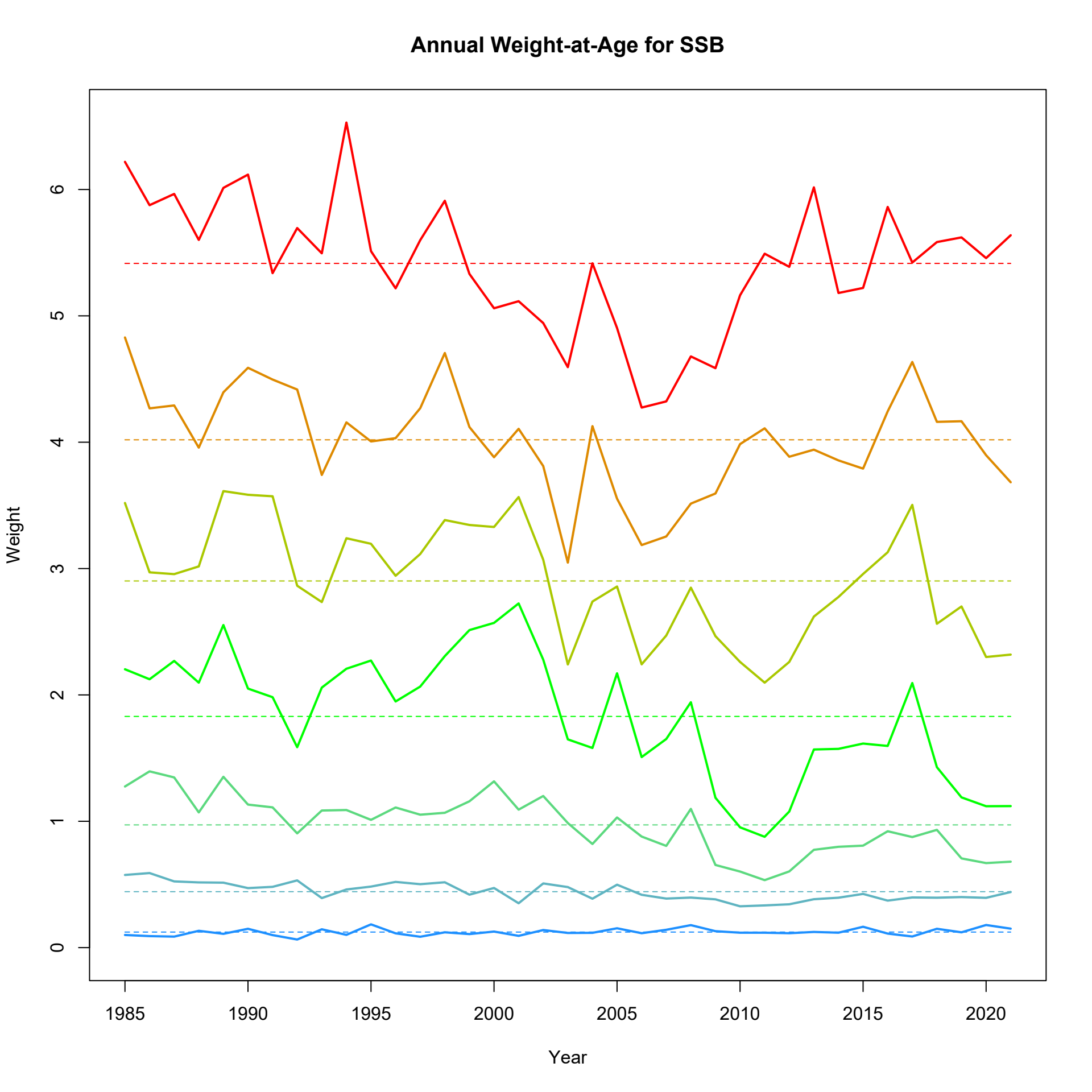
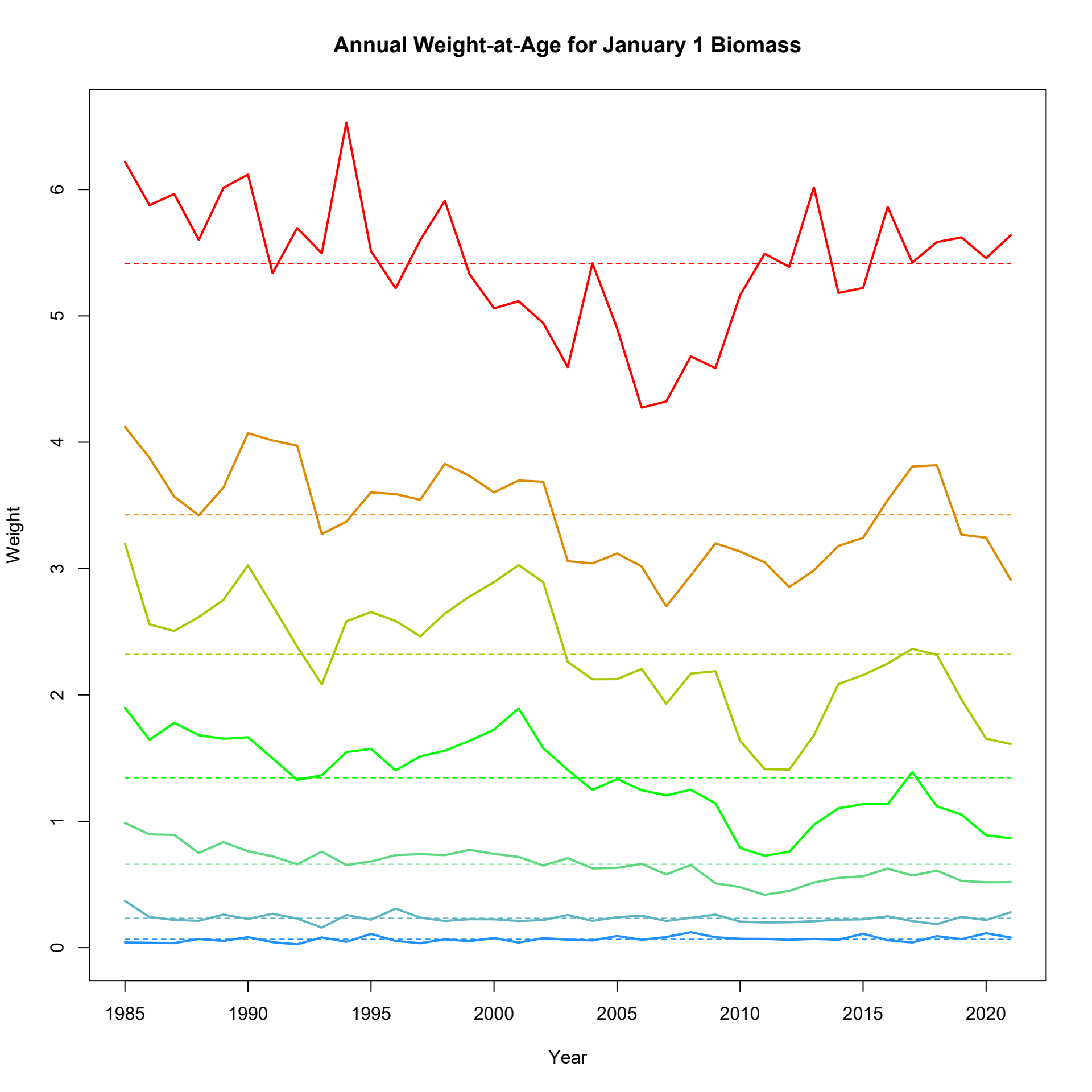
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age

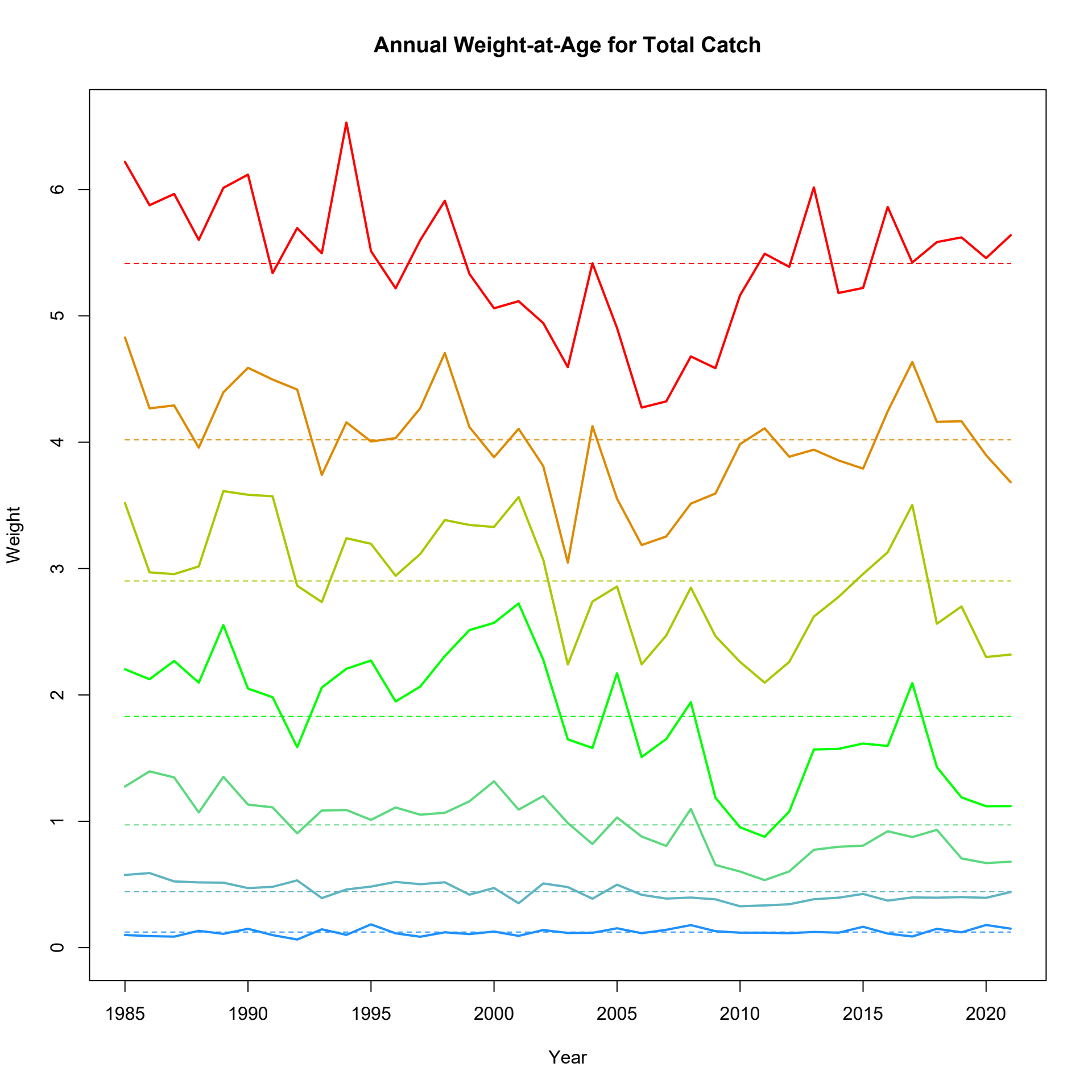

Age Comps for Index 4
0.05
0.2
0.4
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age


Age Comps for Index 6
0.05
0.2
0.4
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
1
2
3
4
5
6
7+
Age

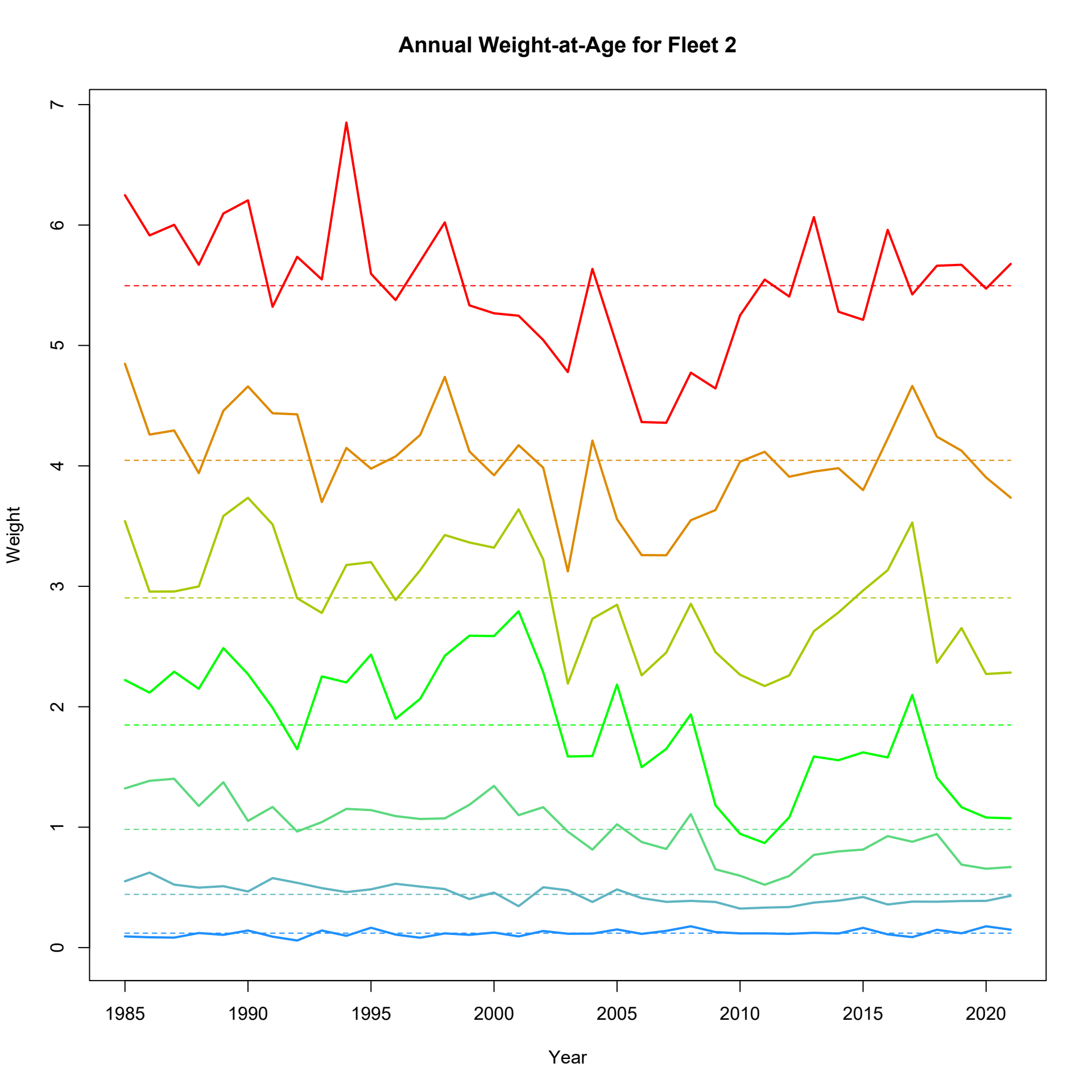

Age Comps for Index 8
0.05
0.2
0.4
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age

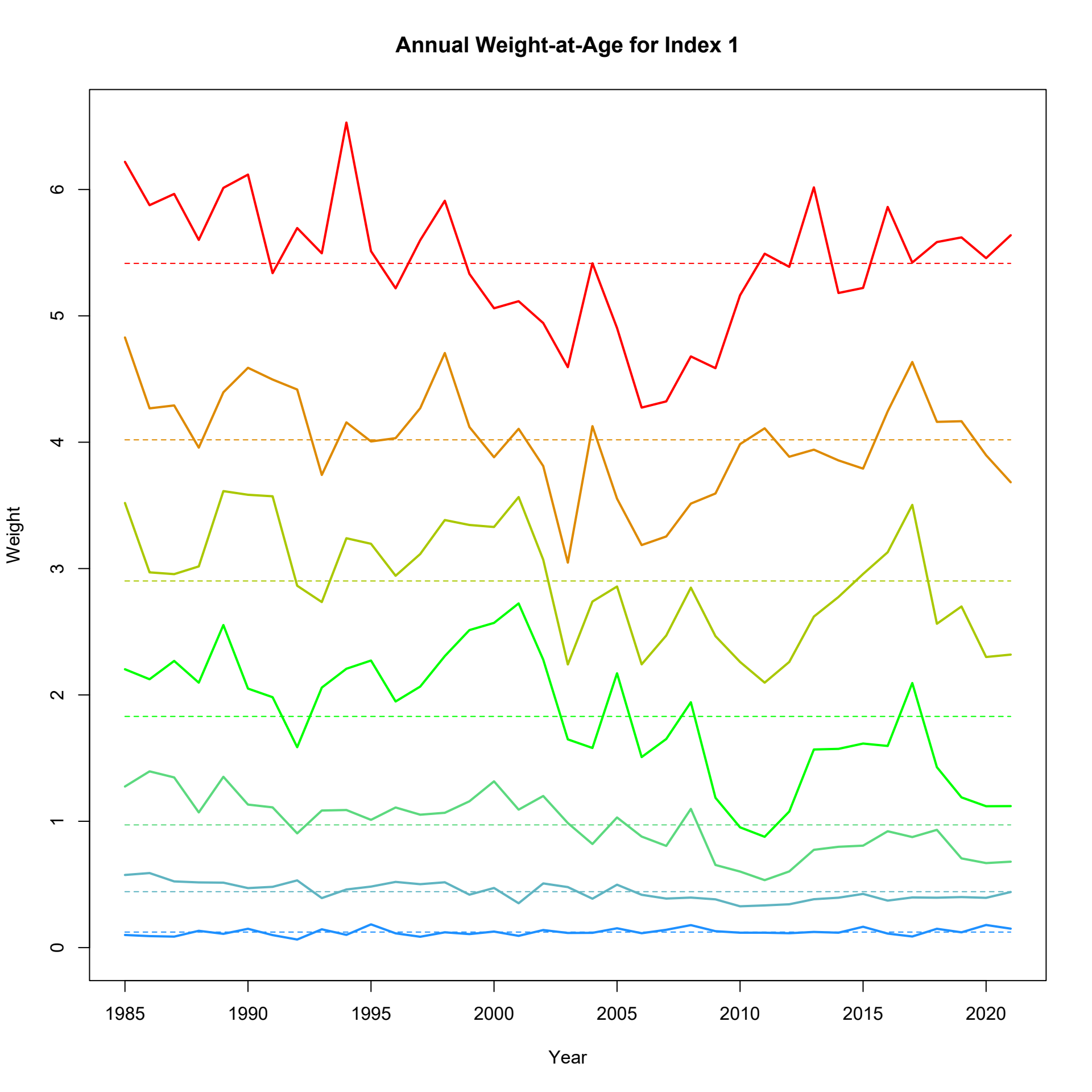

Annual Weight-at-Age for SSB
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

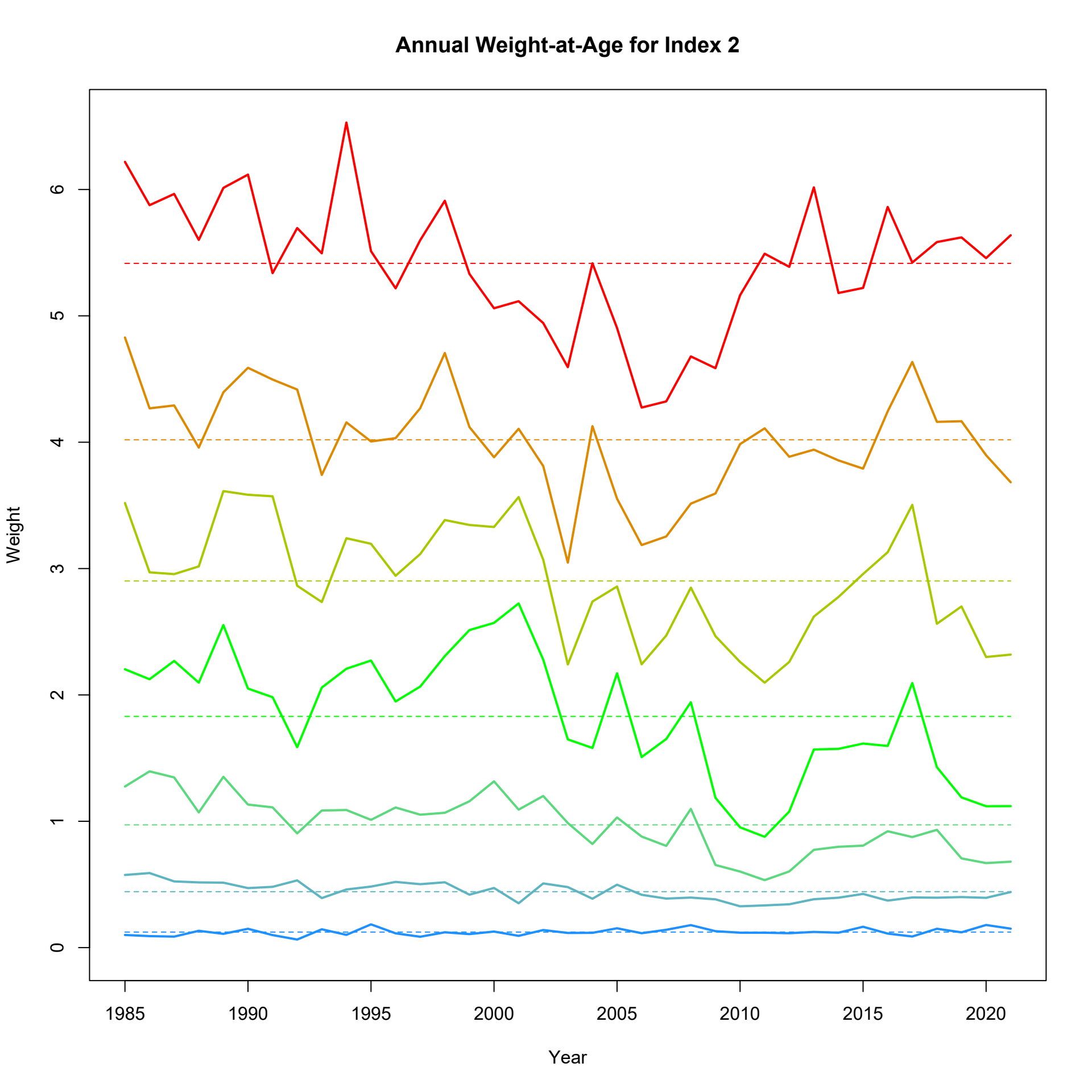

Annual Weight-at-Age for January 1 Biomass
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

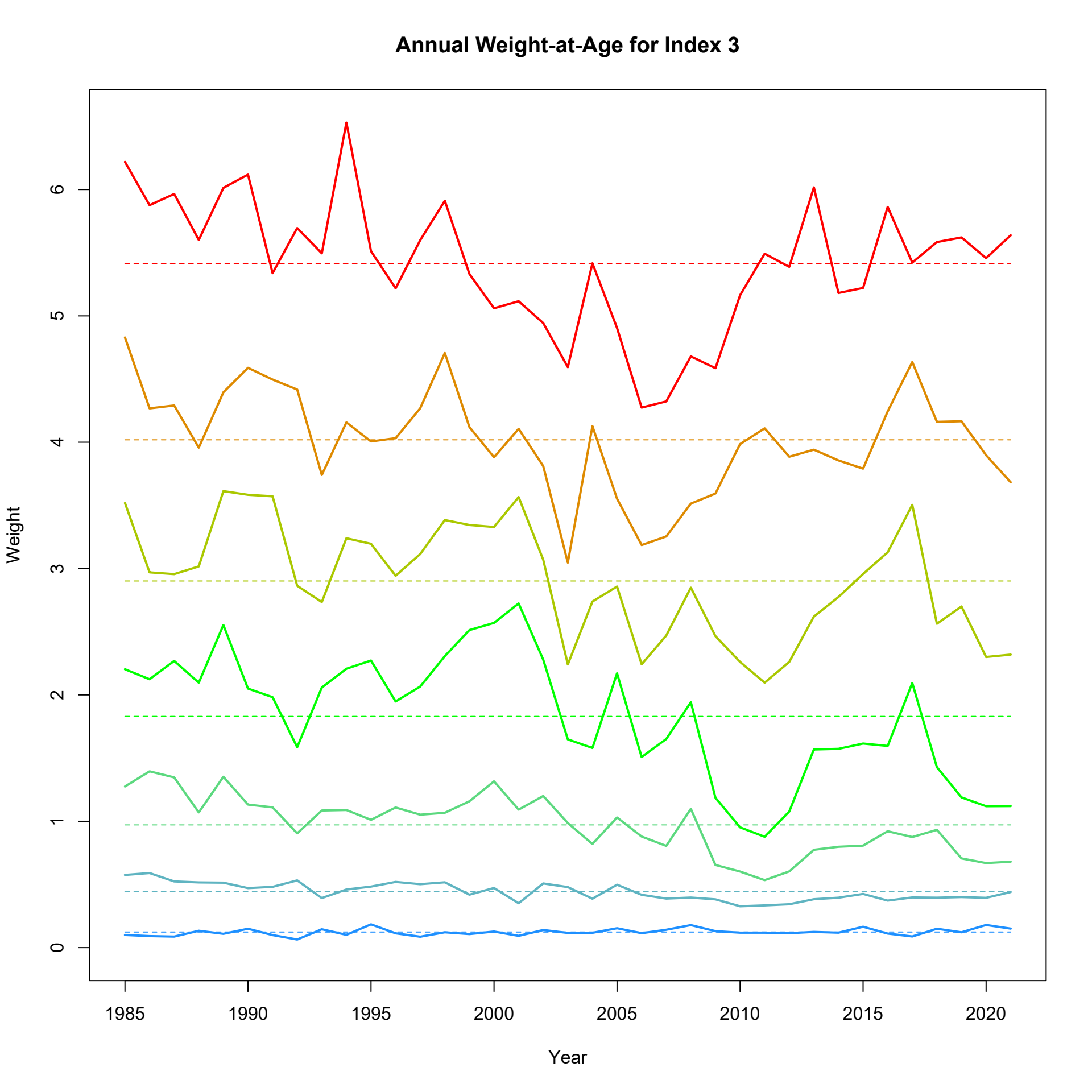

Annual Weight-at-Age for Total Catch
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

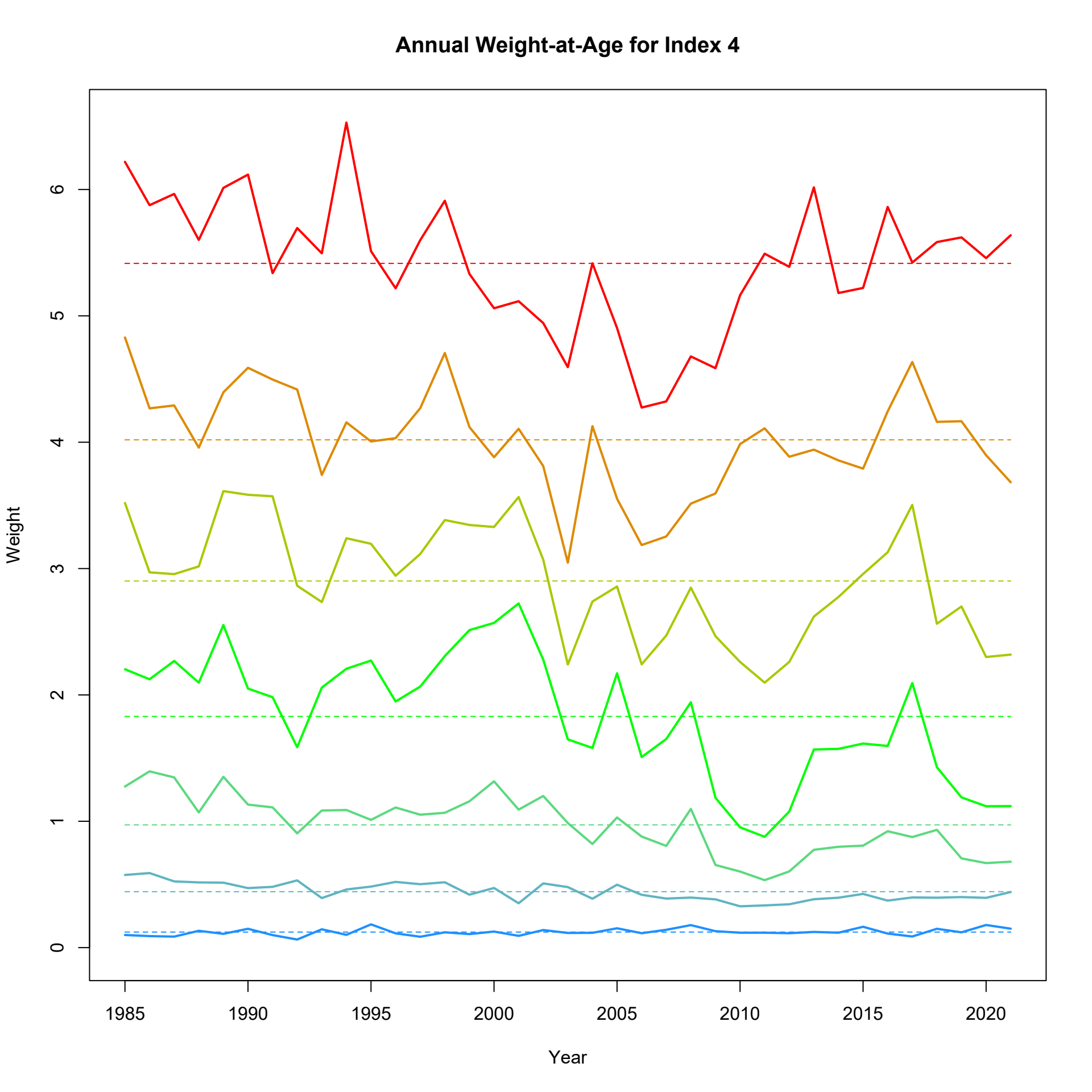
Annual Weight-at-Age for Fleet 1
Weight
0
1
2
3
4
5
1985
1990
1995
2000
2005
2010
2015
2020
Year

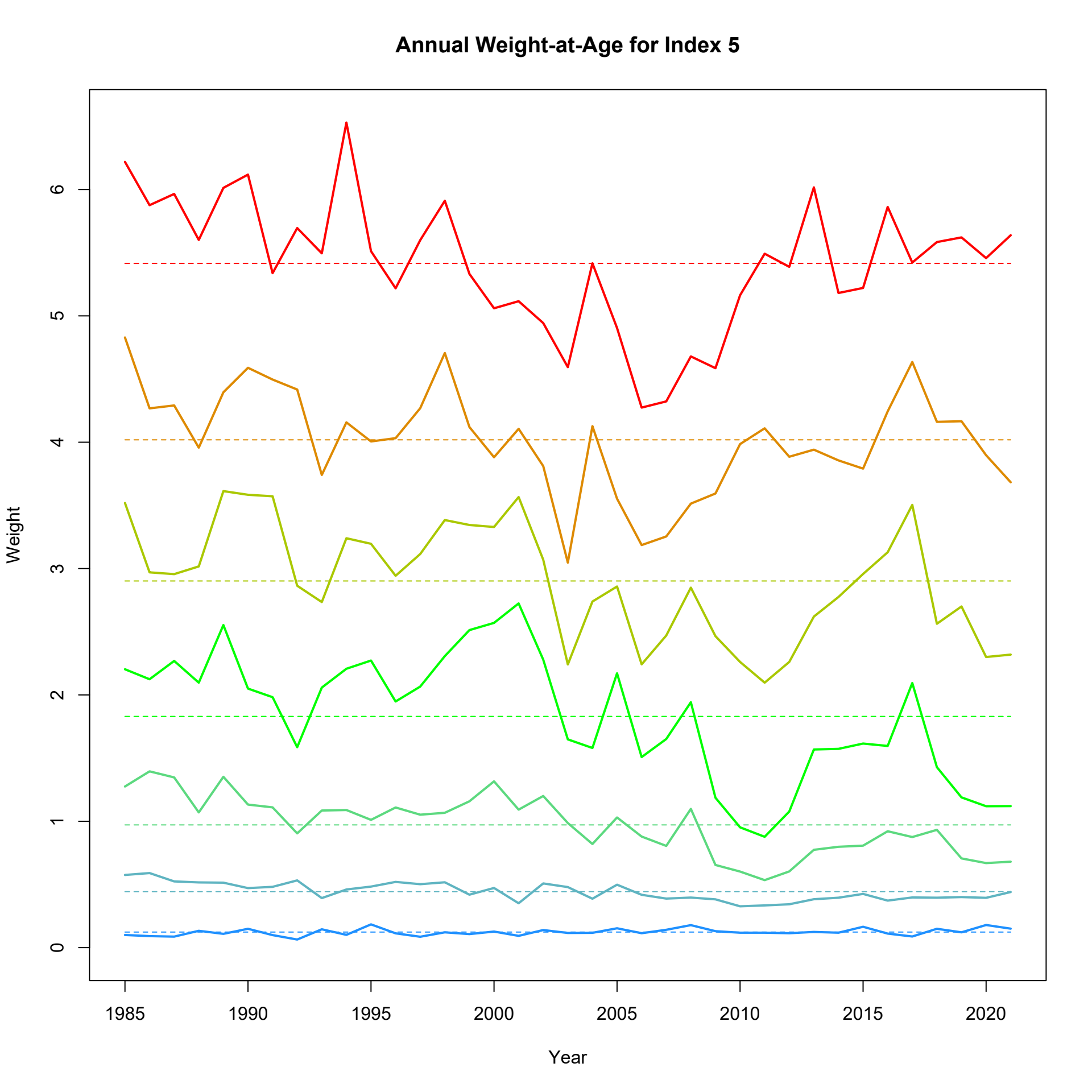

Annual Weight-at-Age for Fleet 2
Weight
0
1
2
3
4
5
6
7
1985
1990
1995
2000
2005
2010
2015
2020
Year

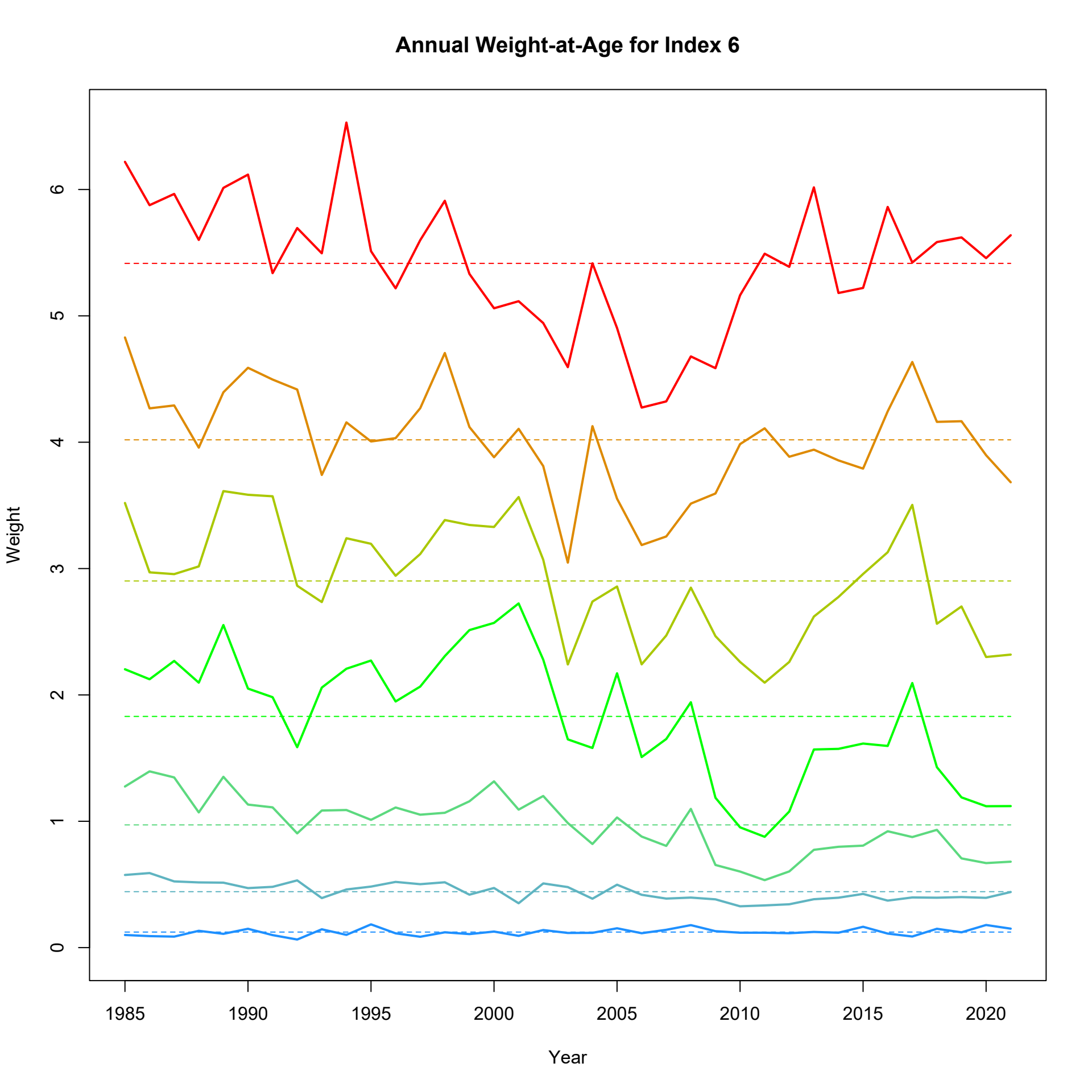

Annual Weight-at-Age for Index 1
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

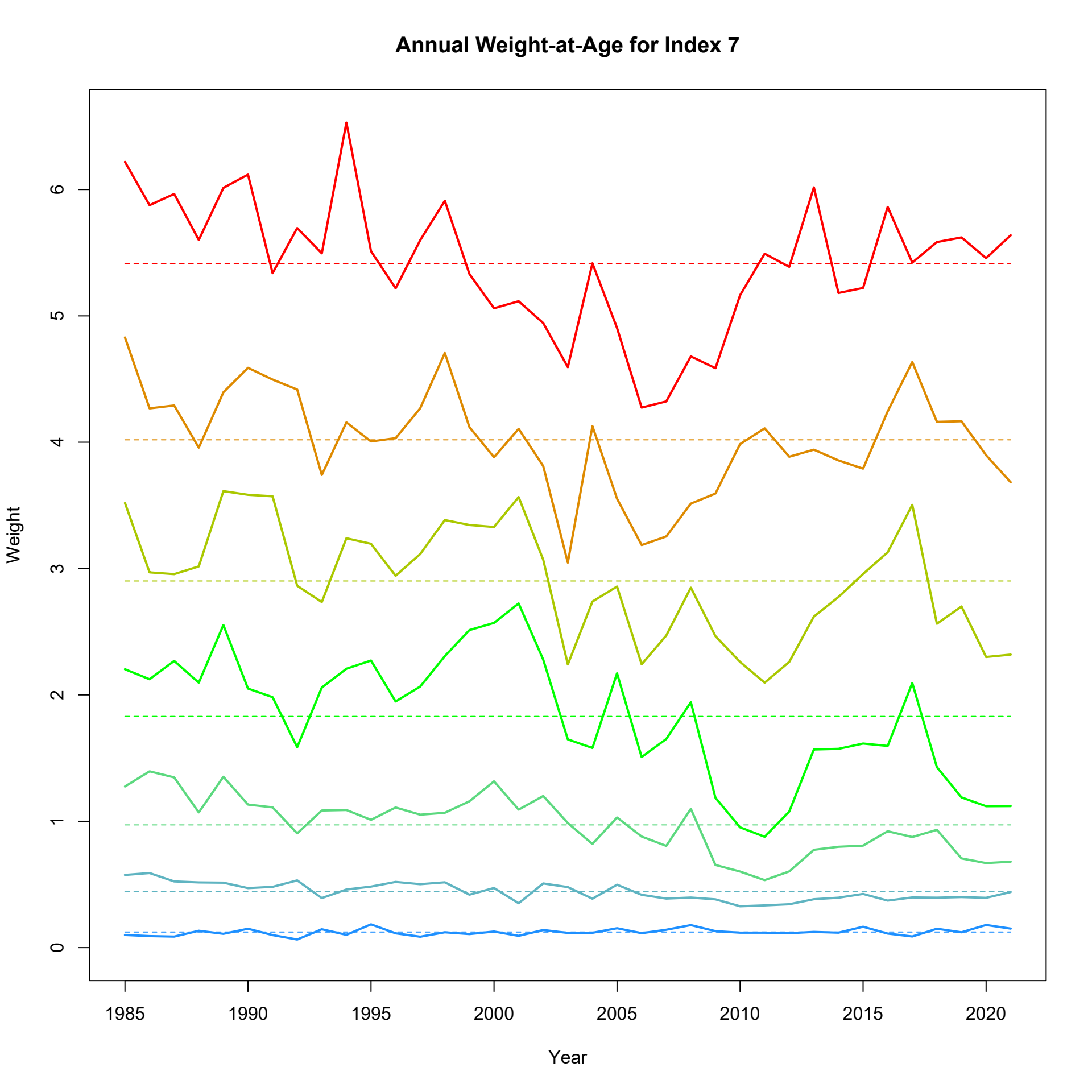

Annual Weight-at-Age for Index 2
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

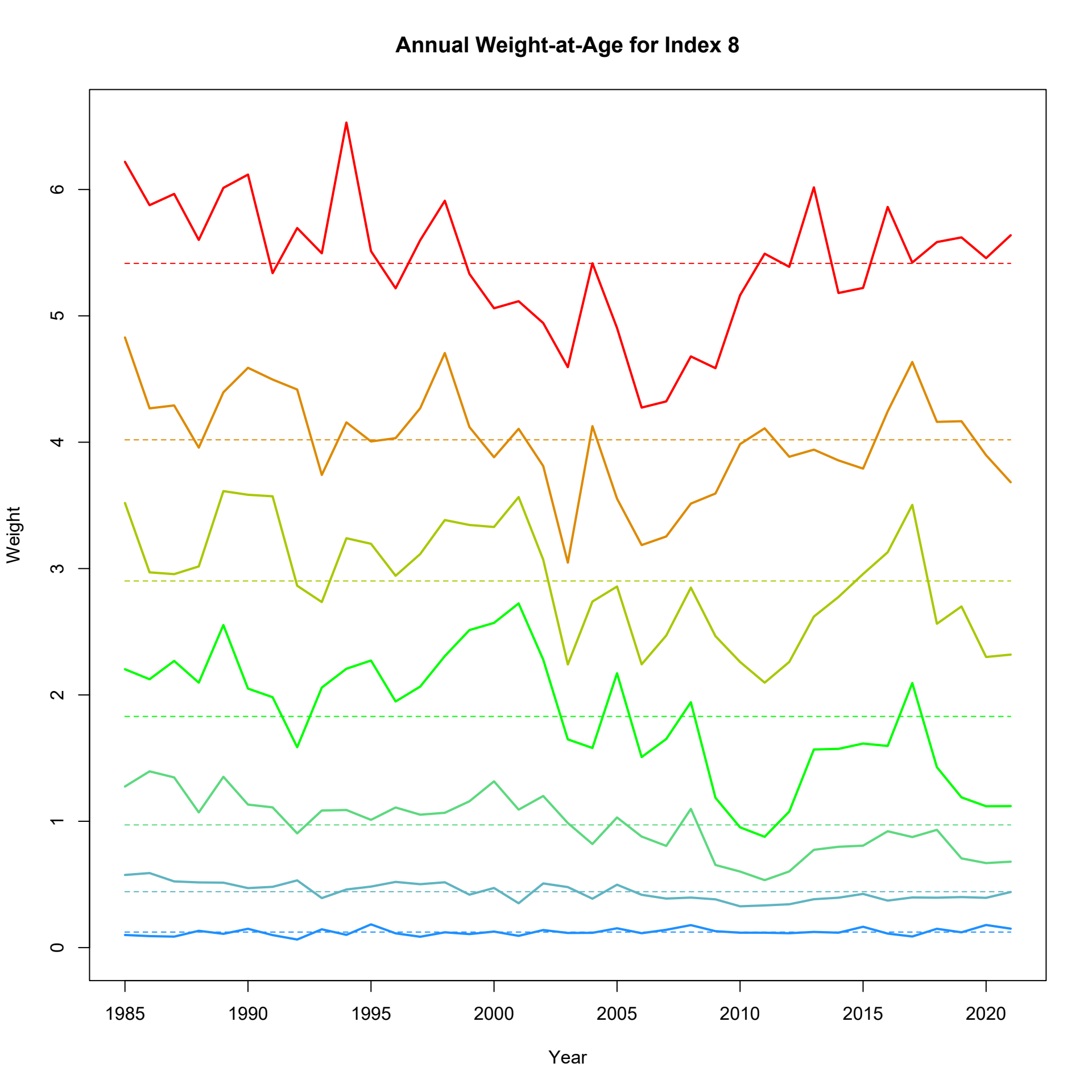

Annual Weight-at-Age for Index 3
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

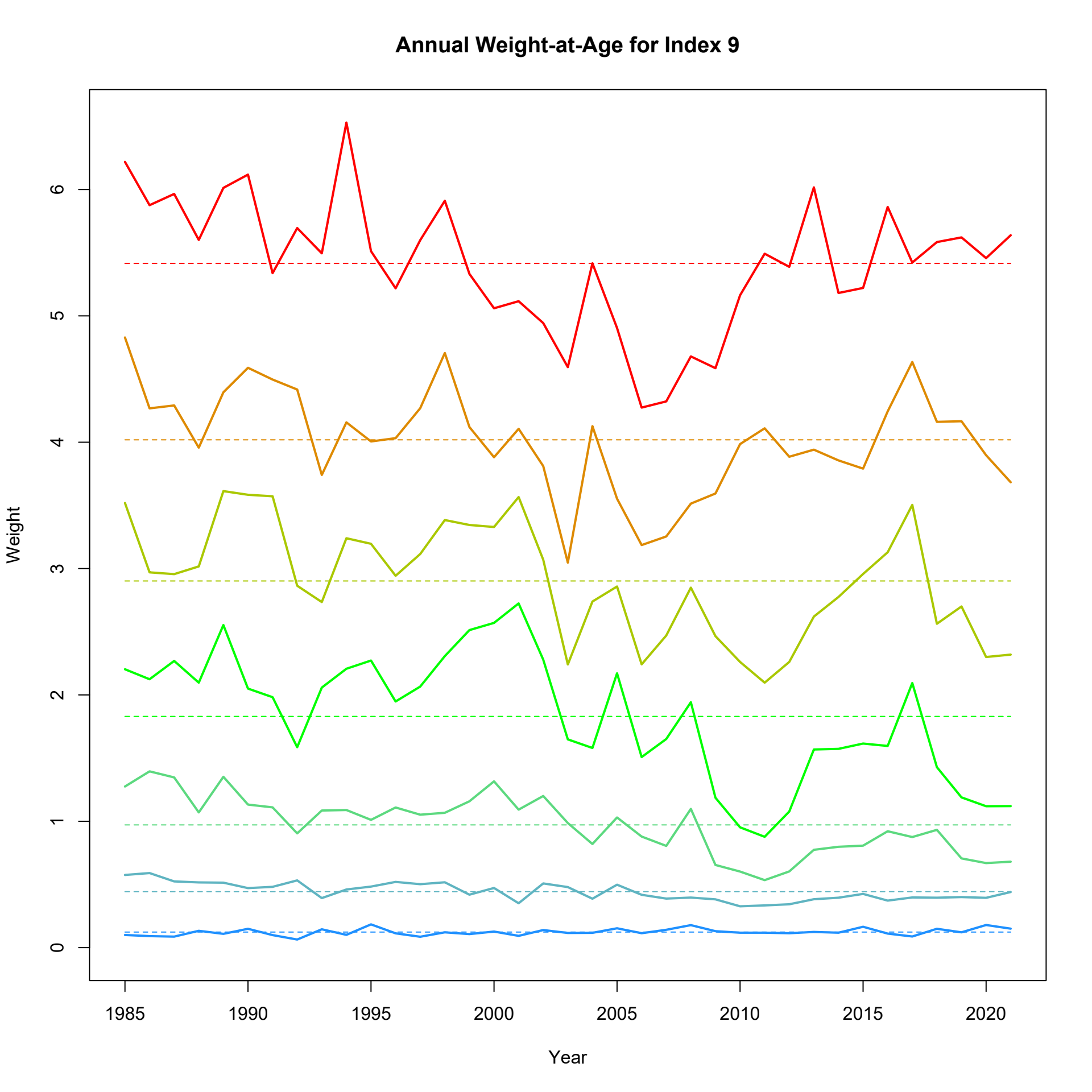

Annual Weight-at-Age for Index 4
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year

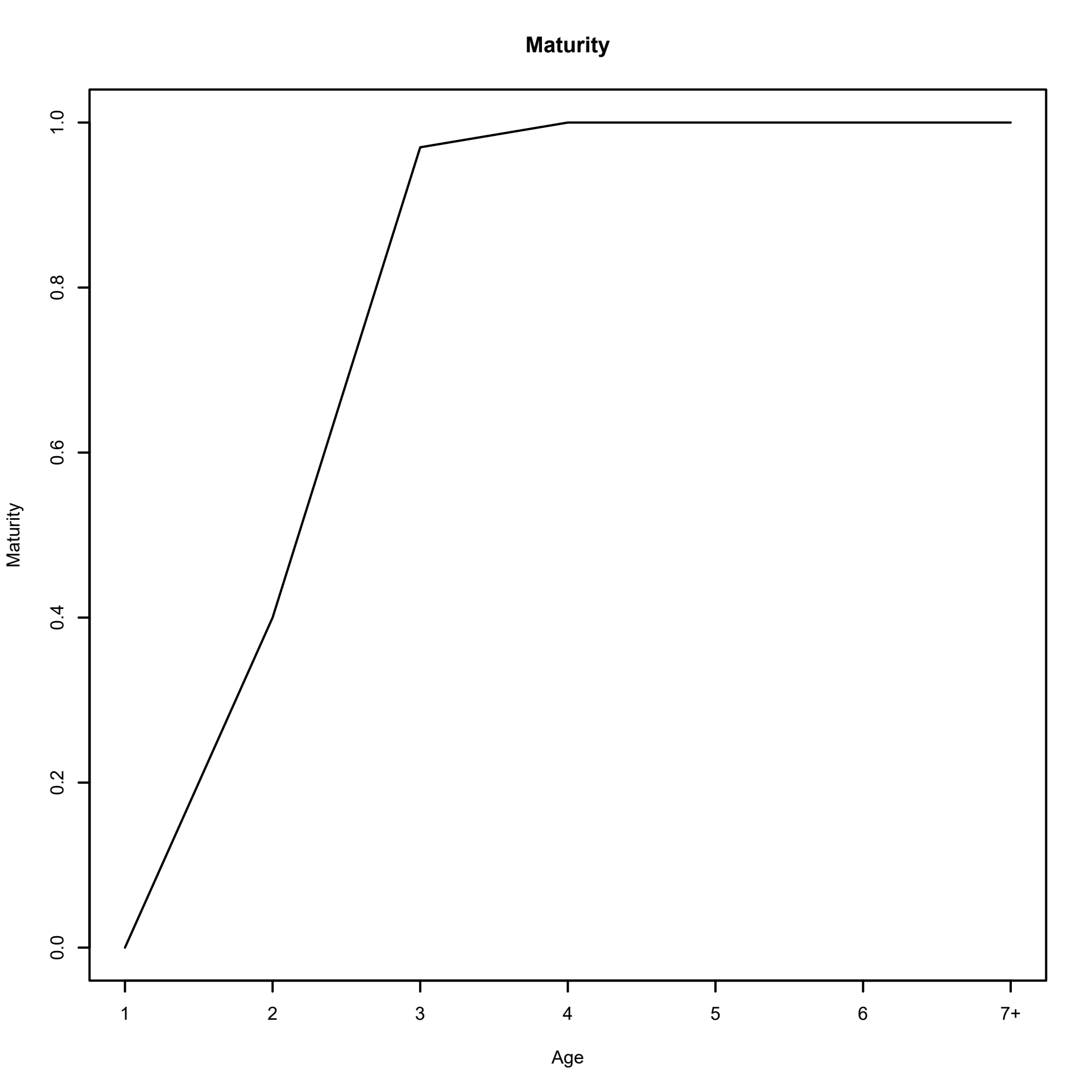

Annual Weight-at-Age for Index 5
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year


Annual Weight-at-Age for Index 6
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year


Annual Weight-at-Age for Index 7
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year


Annual Weight-at-Age for Index 8
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year


Annual Weight-at-Age for Index 9
Weight
0
1
2
3
4
5
6
1985
1990
1995
2000
2005
2010
2015
2020
Year


Maturity
Maturity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

BF28W_M7ECOV

MRIP Forage Fish Index as an environmental covariate on catchability

DIAGNOSTIC PLOTS

m7EM1_ar

Model years: 1985-2021

Projection years: none

Number of fleets: 2

Fleet Age Comp Models: Multinomial, Multinomial

Number of indices: 9

ɔ Models: Multinomial, Multinomial, Multinomial, Multinomial, Multinomial, Multinomial, Multinomial, Multinomial, Multinoı

Recruitment model: Random about mean

Environmental covariate 1: MRIPff modeled as AR1. Effects on q for index 3 estimated.

Number of Selectivity blocks: 14

Age-specific, Age-specific, Age-specific, Age-specific, Age-specific, Logistic(+), Age-specific, Age-specific, Age-specific,

Fleet 1 Selectivity Blocks: c(1, 2)

Fleet 2 Selectivity Blocks: c(3, 4, 5)

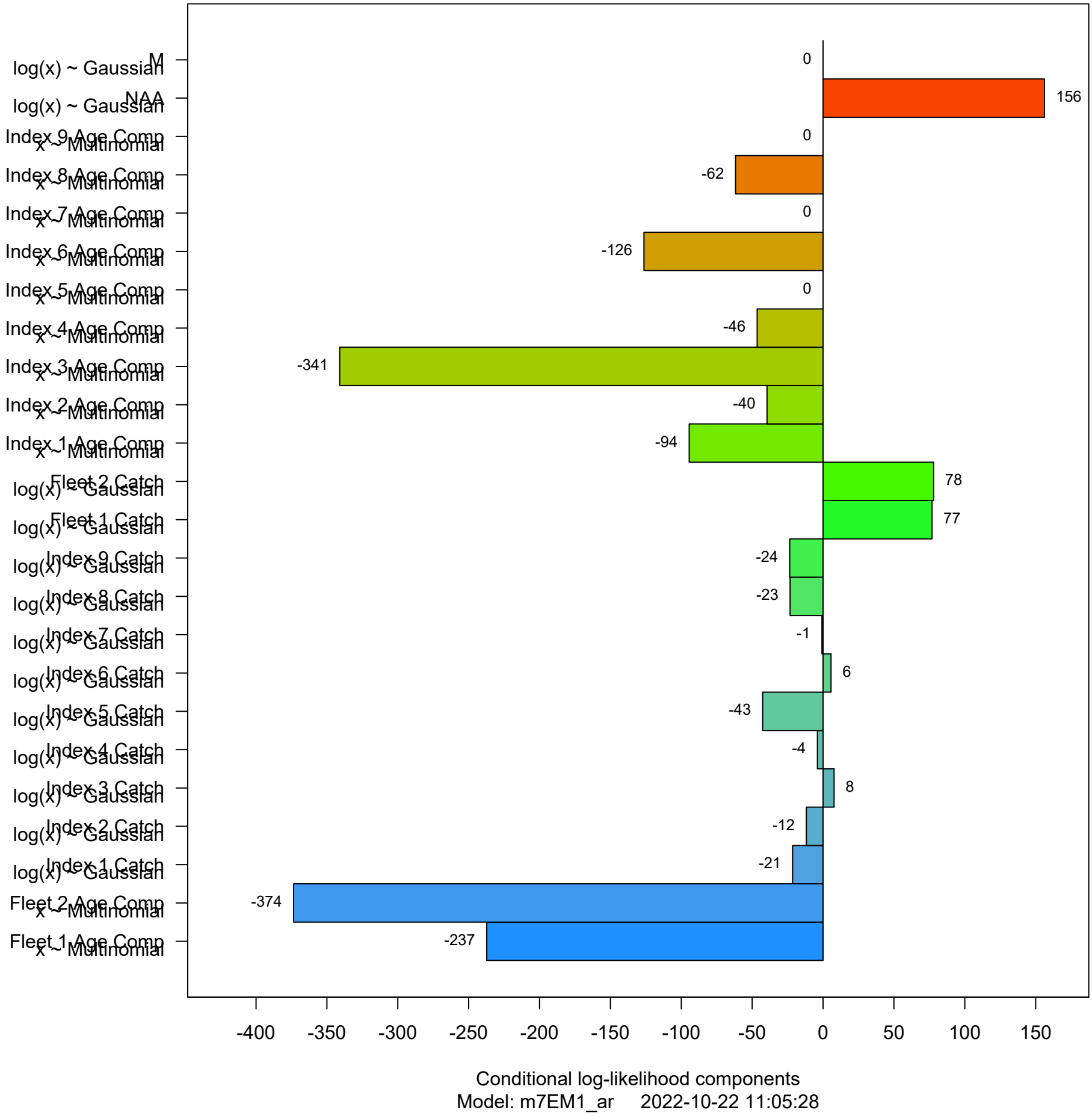
Index 1 Selectivity Blocks: 6

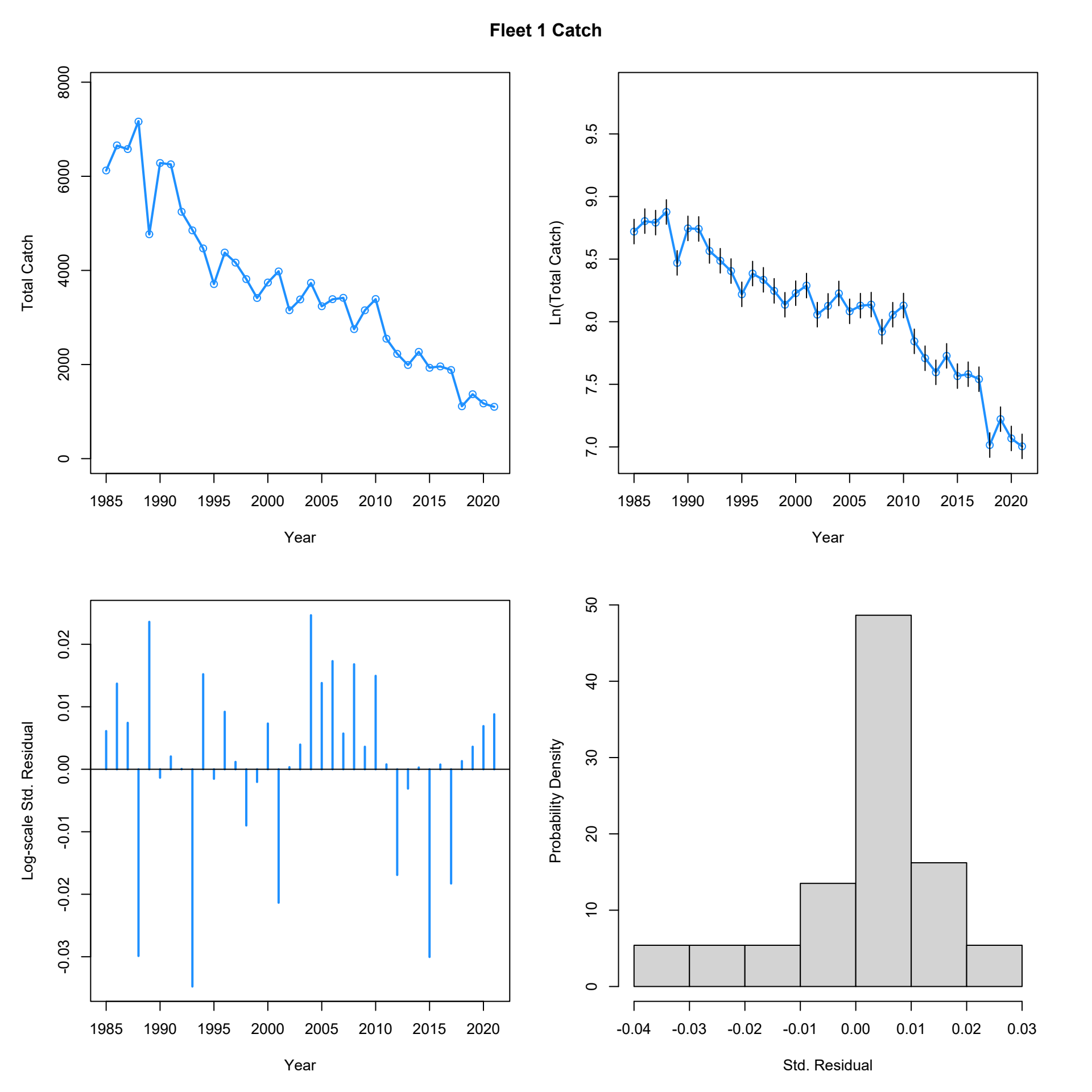
Index 2 Selectivity Blocks: 7

Index 3 Selectivity Blocks: 8

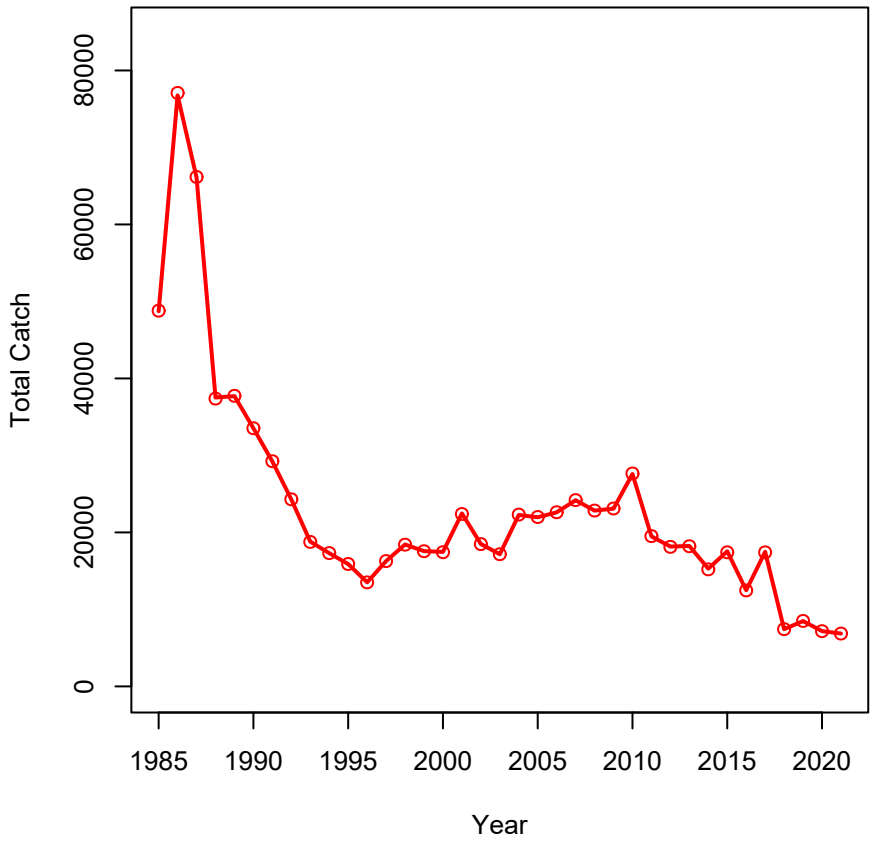
Index 4 Selectivity Blocks: 9

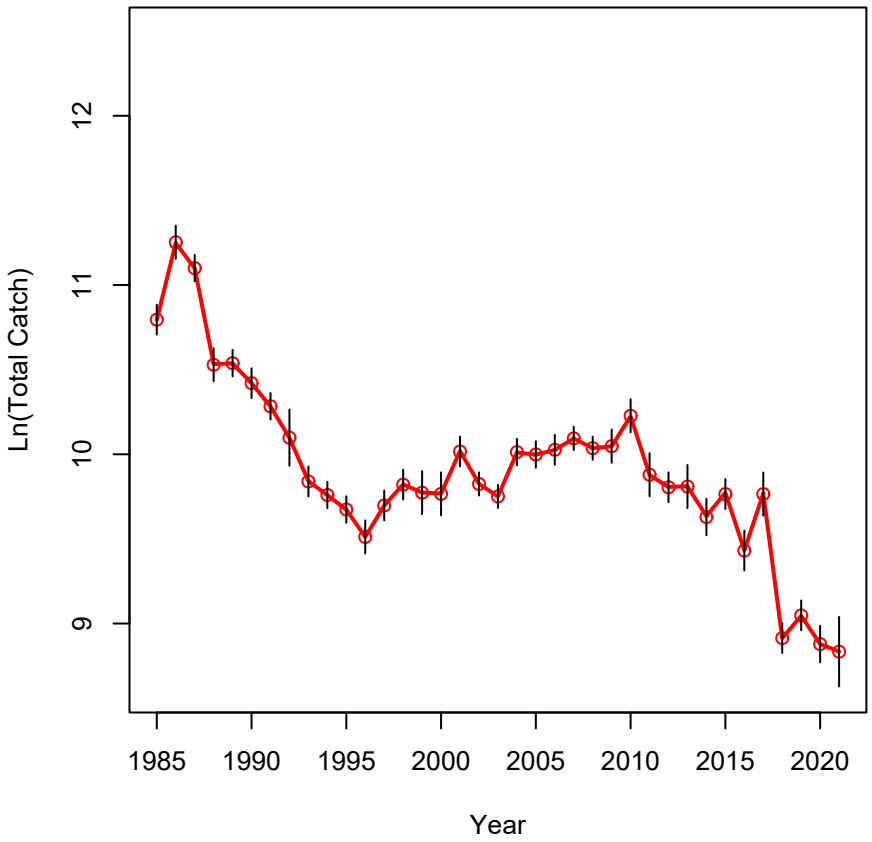
Index 5 Selectivity Blocks: 10

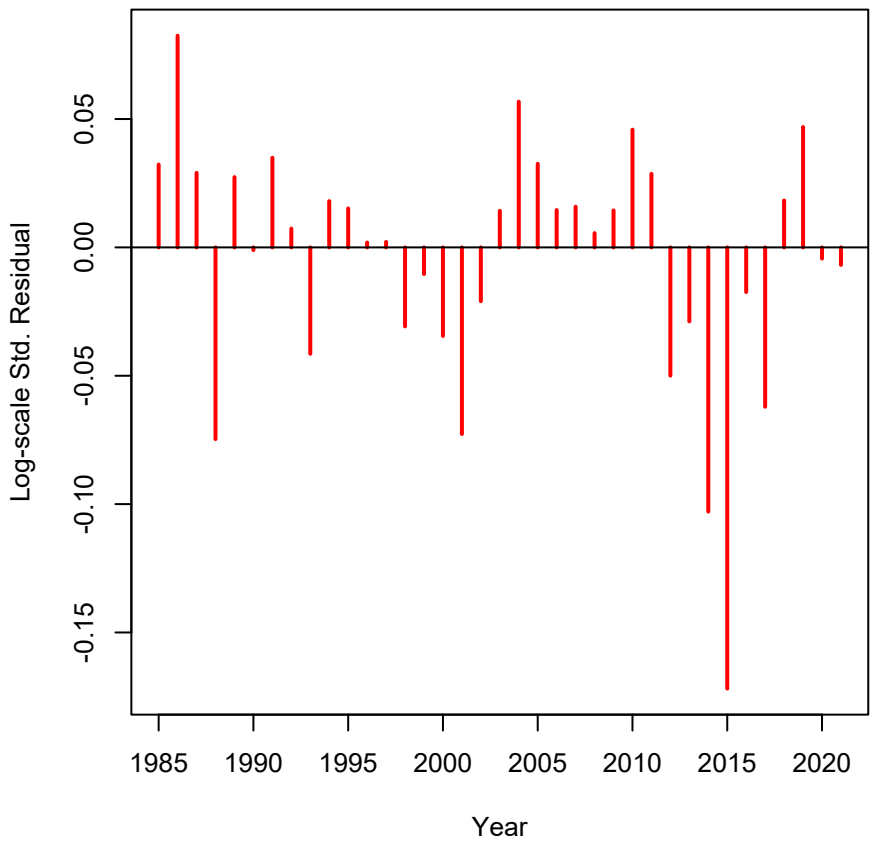

M
log(x) ~ Gaussian
NAA
log(x) ~ Gaussian
Index 9 Age Comp
x ~ Multinomial
Index 8 Age Comp
x ~ Multinomial
Index 7 Age Comp
x ~ Multinomial
Index 6 Age Comp
x ~ Multinomial
Index 5 Age Comp
x ~ Multinomial
Index 4 Age Comp
x ~ Multinomial
Index 3 Age Comp
x ~ Multinomial
Index 2 Age Comp
x ~ Multinomial
Index 1 Age Comp
x ~ Multinomial
Fleet 2 Catch
log(x) ~ Gaussian
Fleet 1 Catch
log(x) ~ Gaussian
Index 9 Catch
log(x) ~ Gaussian
Index 8 Catch
log(x) ~ Gaussian
Index 7 Catch
log(x) ~ Gaussian
Index 6 Catch
log(x) ~ Gaussian
Index 5 Catch
log(x) ~ Gaussian
Index 4 Catch
log(x) ~ Gaussian
Index 3 Catch
log(x) ~ Gaussian
Index 2 Catch
log(x) ~ Gaussian
Index 1 Catch
log(x) ~ Gaussian
Fleet 2 Age Comp
x ~ Multinomial
Fleet 1 Age Comp
x ~ Multinomial
0
156
0
-62
0
-126
0
-46
-341
-40
-94
78
77
-24
-23
-1
6
-43
-4
8
-12
-21
-374
-237
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
Conditional log-likelihood components
Model: m7EM1_ar 2022-10-22 11:05:28

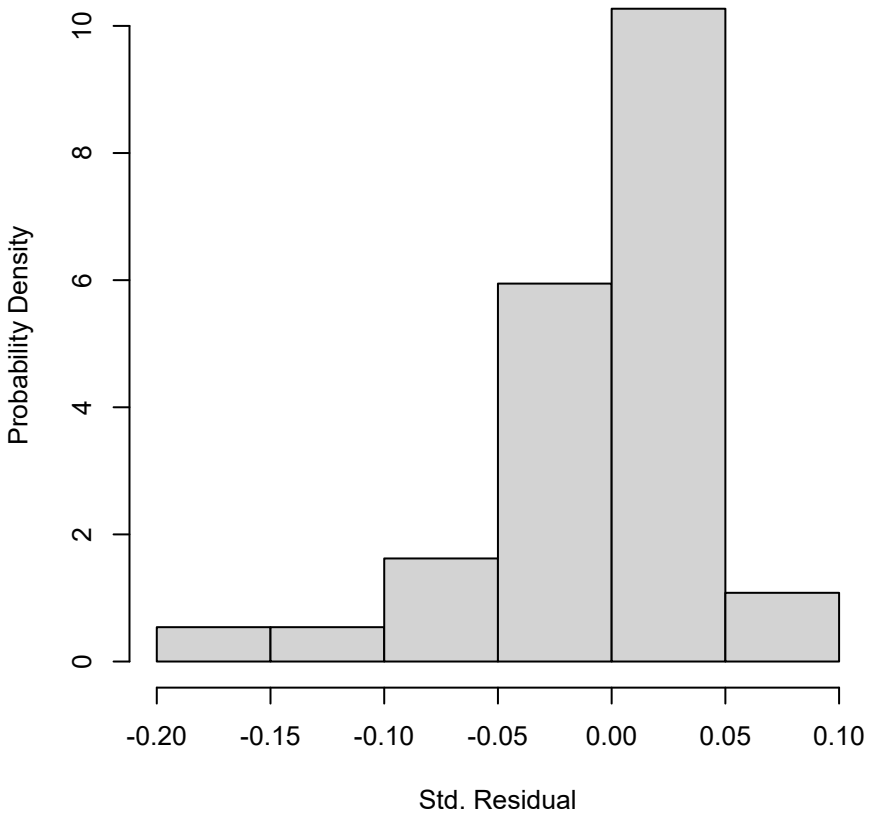

Fleet 1 Catch
Total Catch
0
2000
4000
6000
8000
1985
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Total Catch)
7.0
7.5
8.0
8.5
9.0
9.5
Year
Log-scale Std. Residual
-0.03
-0.02
-0.01
0.00
0.01
0.02
Year
Probability Density
0
10
20
30
40
50
-0.04
-0.03
-0.02
-0.01
0.00
0.01
0.02
0.03
Std. Residual

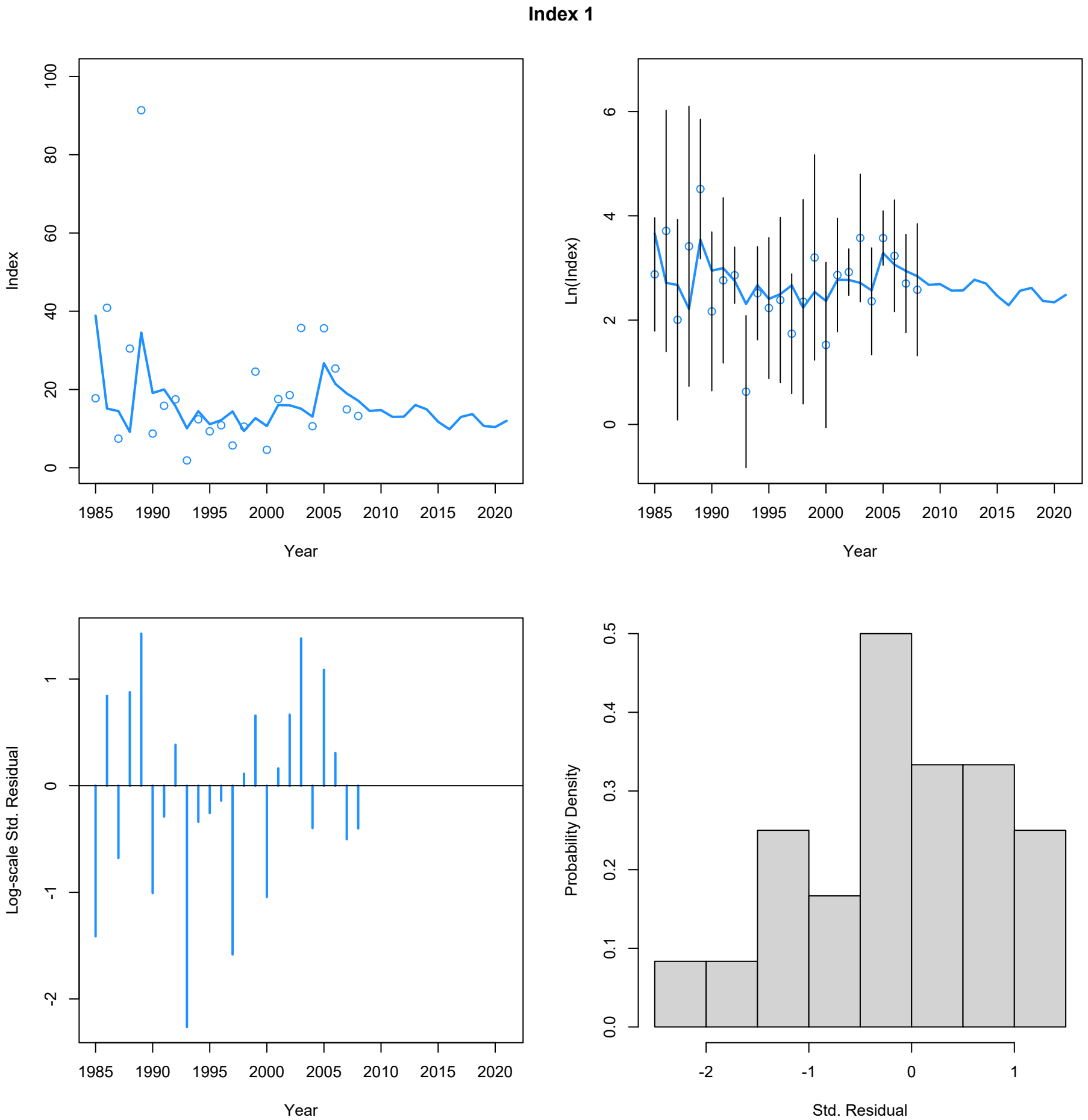
Fleet 2 Catch

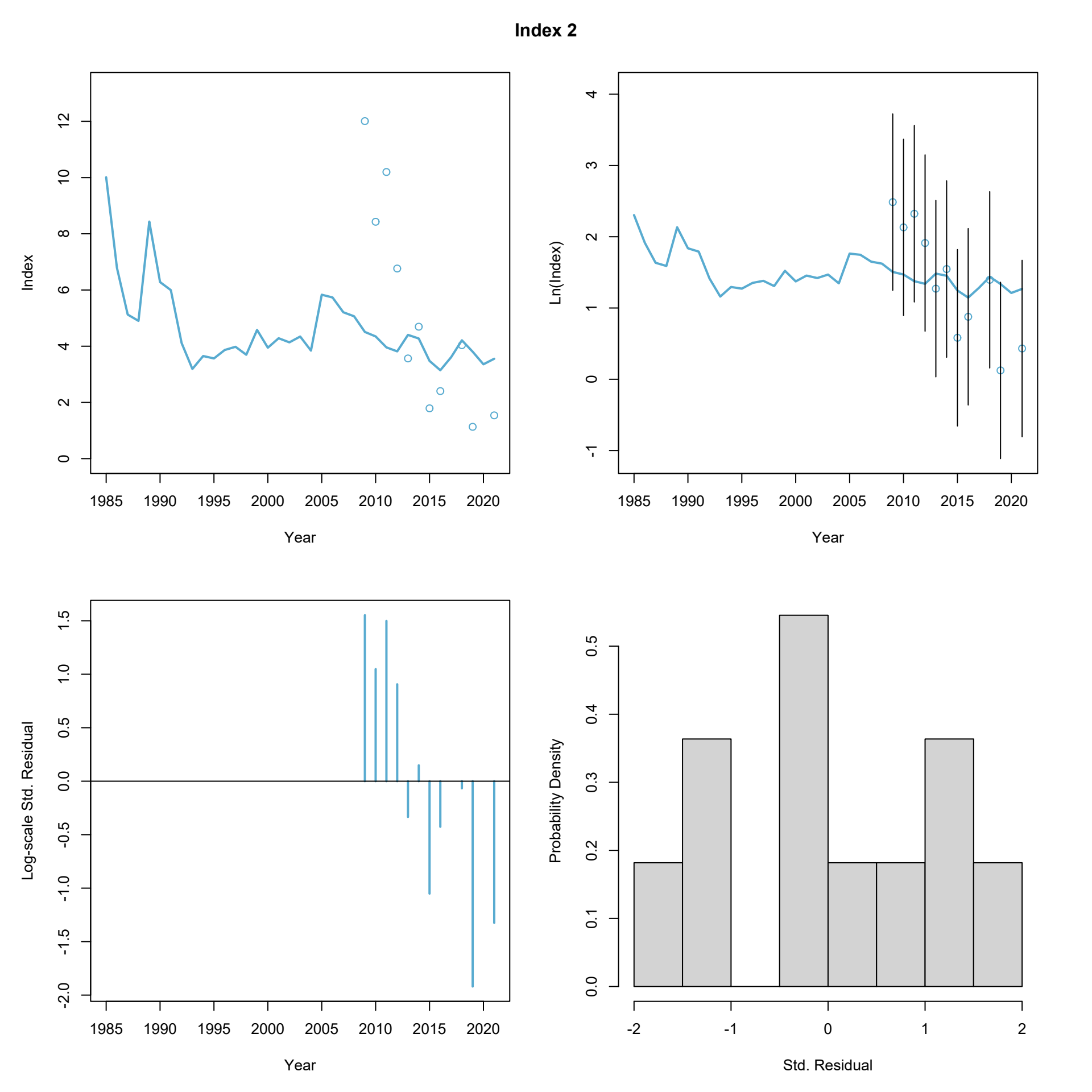


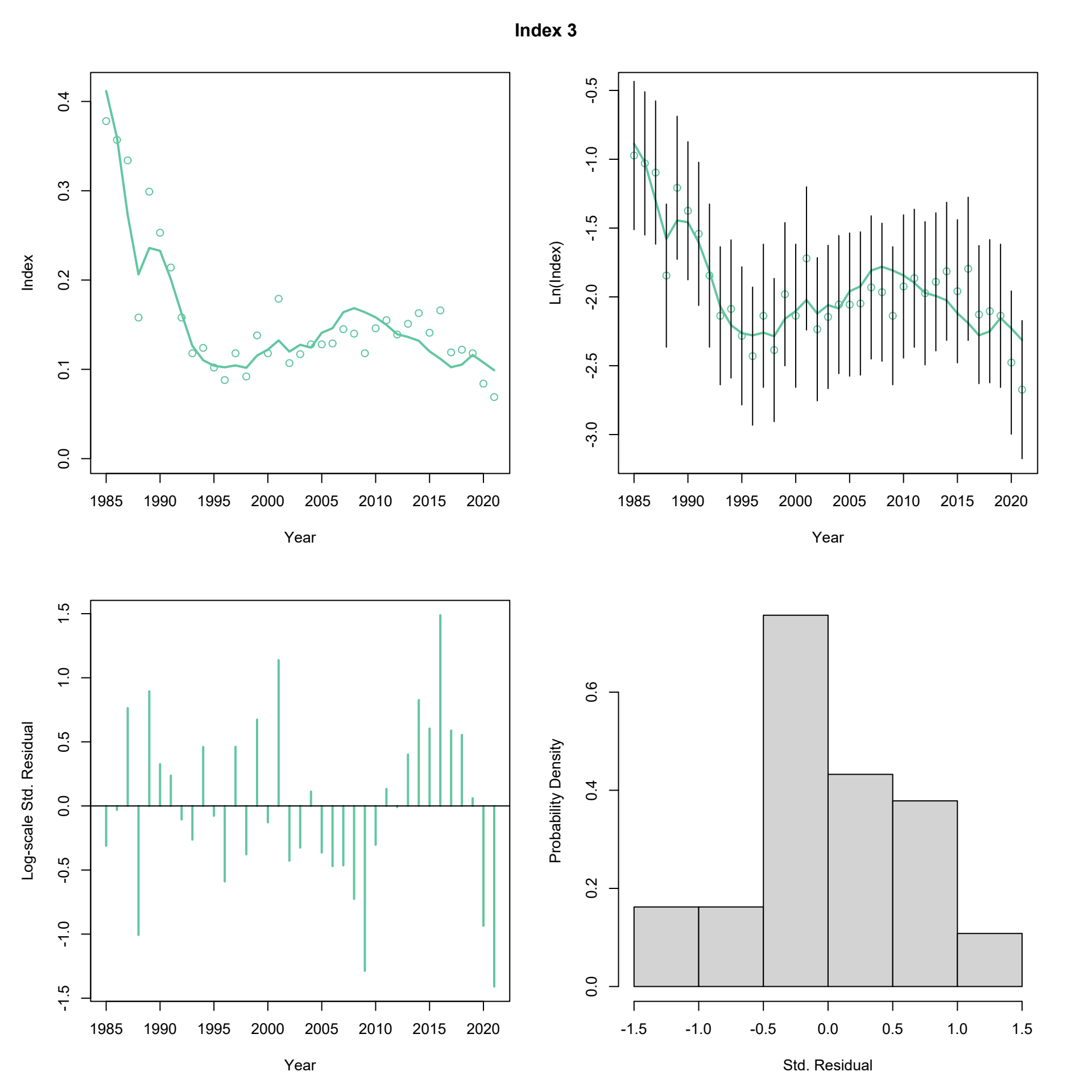


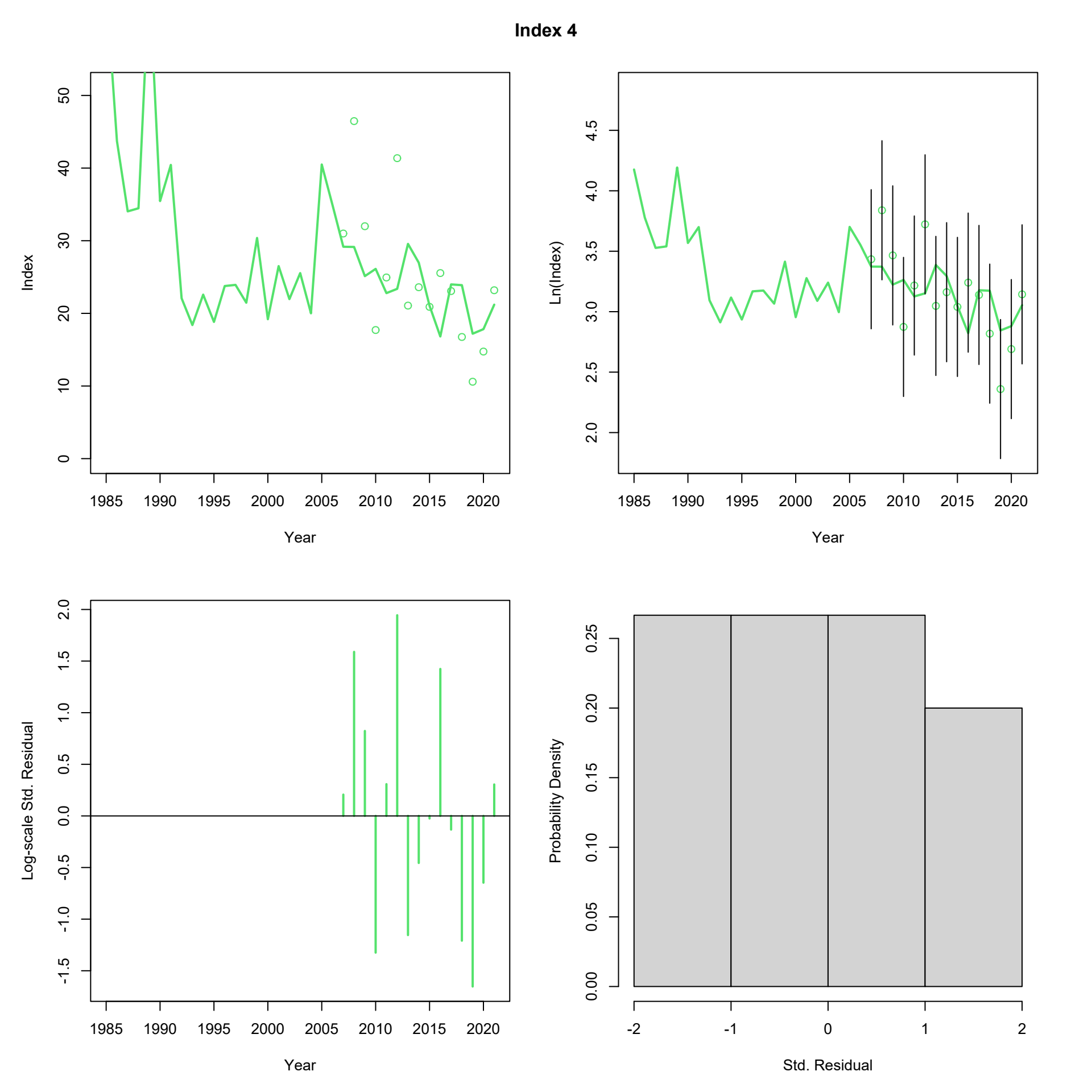




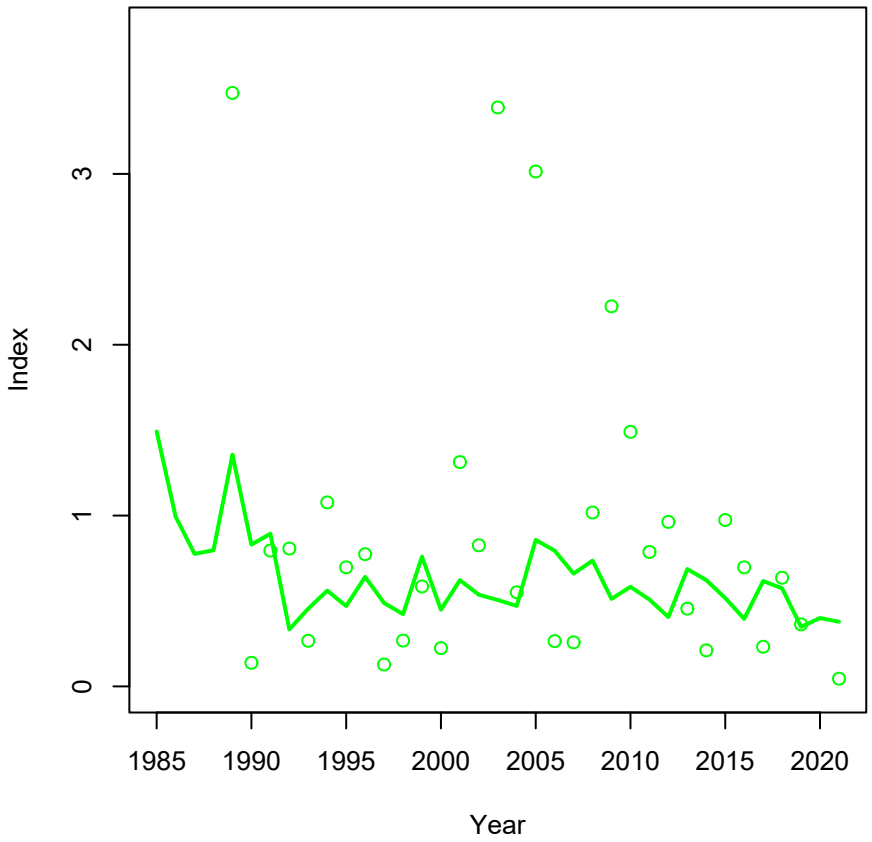

Index 1
Index
Year
Ln(Index)
Year
Log-scale Std. Residual
Year
Probability Density
Std. Residual

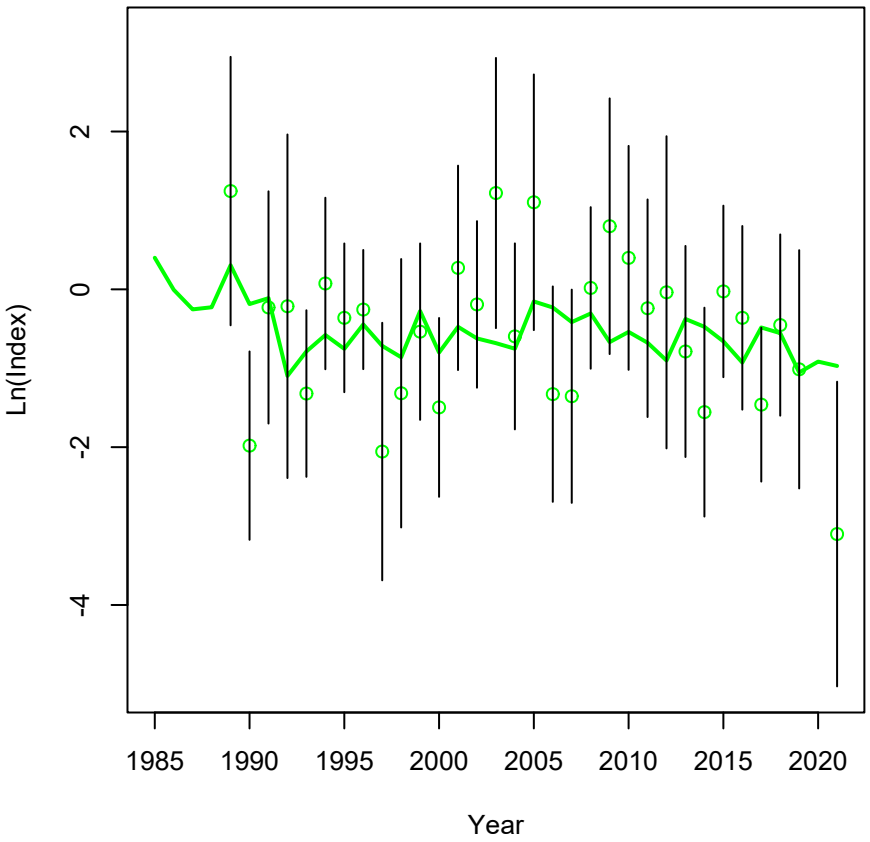

Index 2
Index
Year
Ln(Index)
Year
Log-scale Std. Residual
Year
Probability Density
Std. Residual

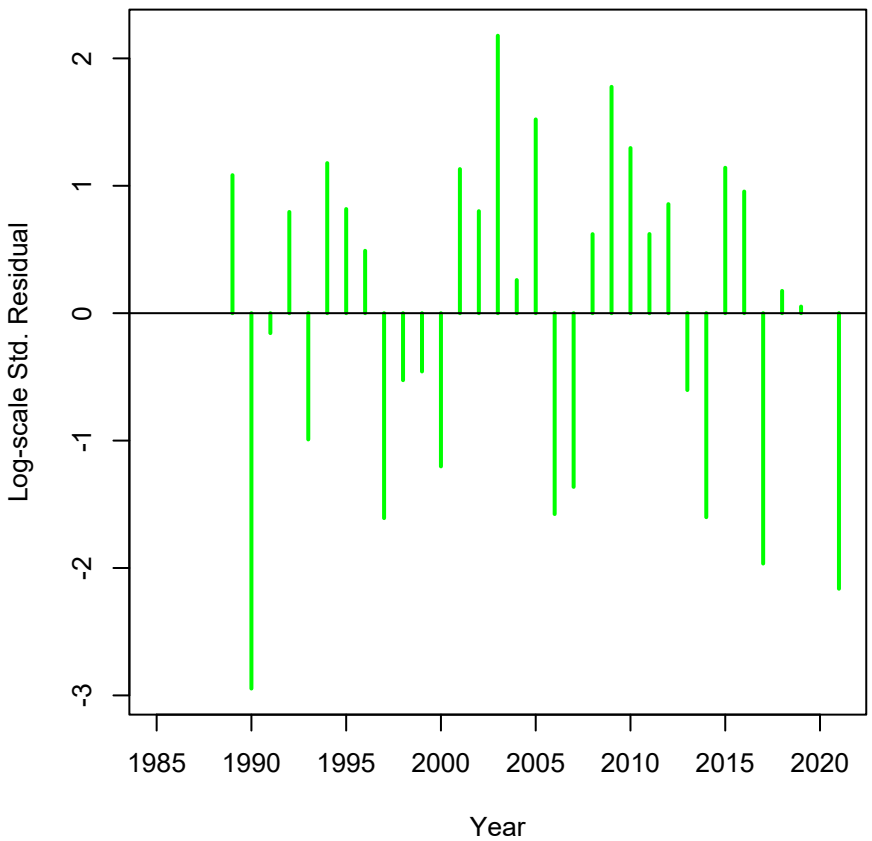

Index 3
Index
Year
Ln(Index)
Year
Log-scale Std. Residual
Year
Probability Density
Std. Residual

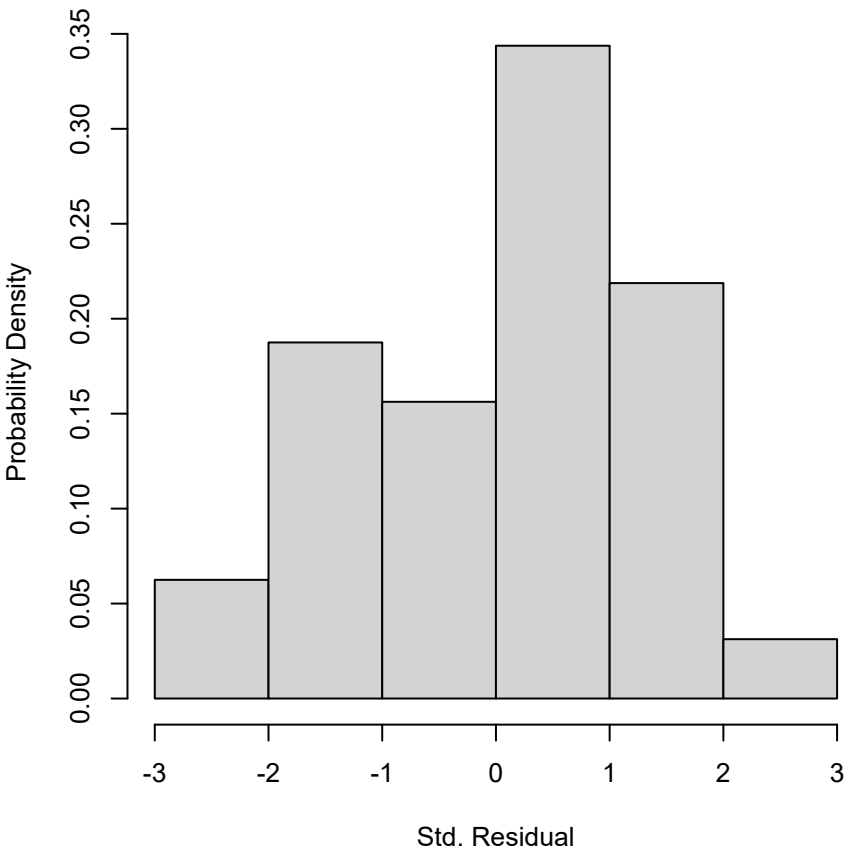

Index 4
Index
Year
Ln(Index)
Year
Log-scale Std. Residual
Year
Probability Density
Std. Residual

Index 5


Index
0
1
2
3
1985
1990
1995
2000
2005
2010
2015
2020
Year

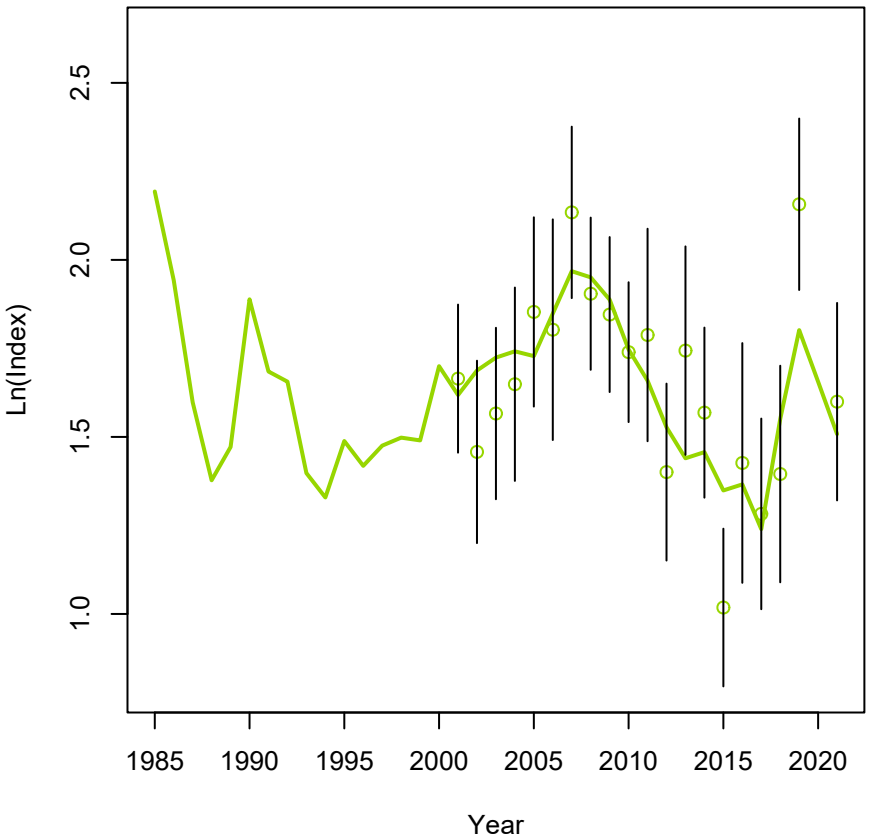

Ln(Index)
-4
-2
0
2
1985
1990
1995
2000
2005
2010
2015
2020
Year

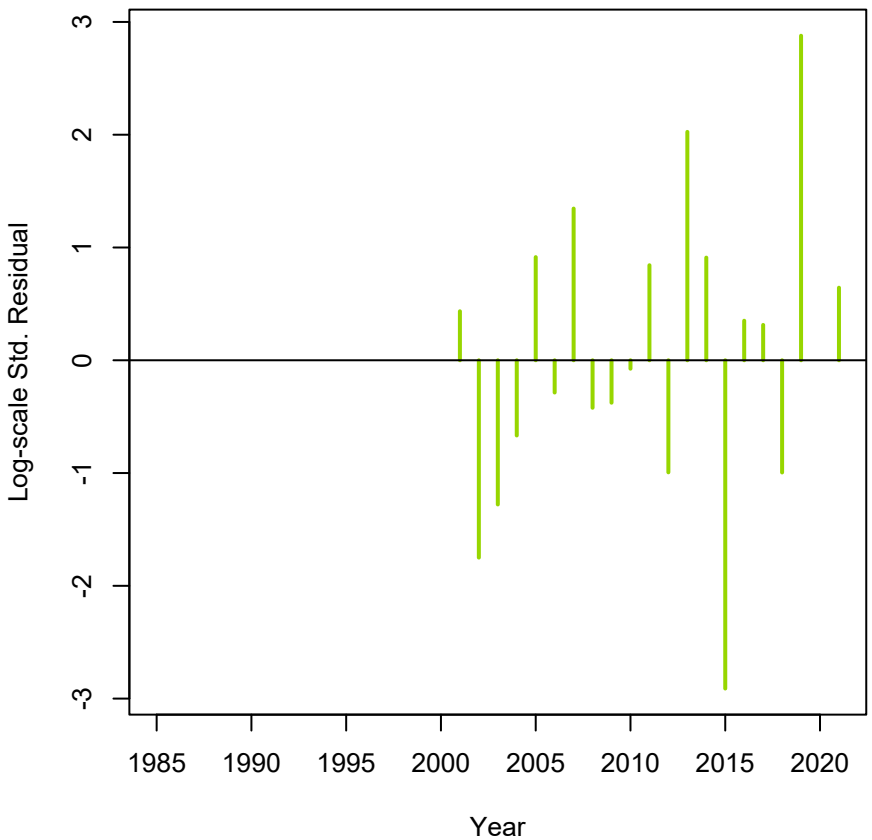

Log-scale Std. Residual
-3
-2
-1
0
1
2
1985
1990
1995
2000
2005
2010
2015
2020
Year

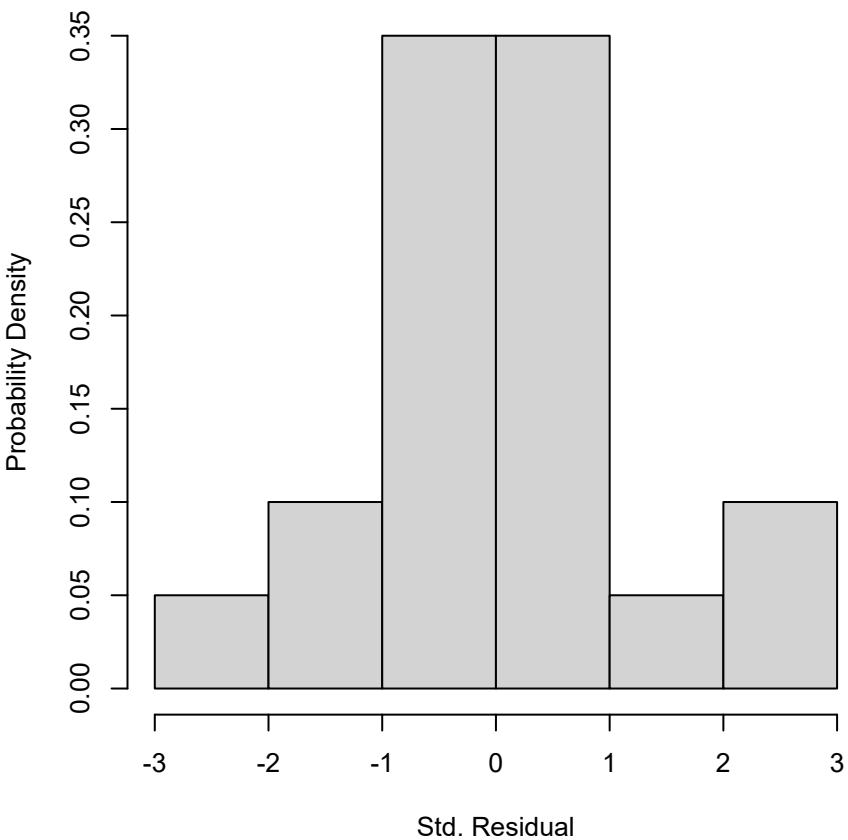

Probability Density
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
-3
-2
-1
0
1
2
3
Std. Residual

Index 6

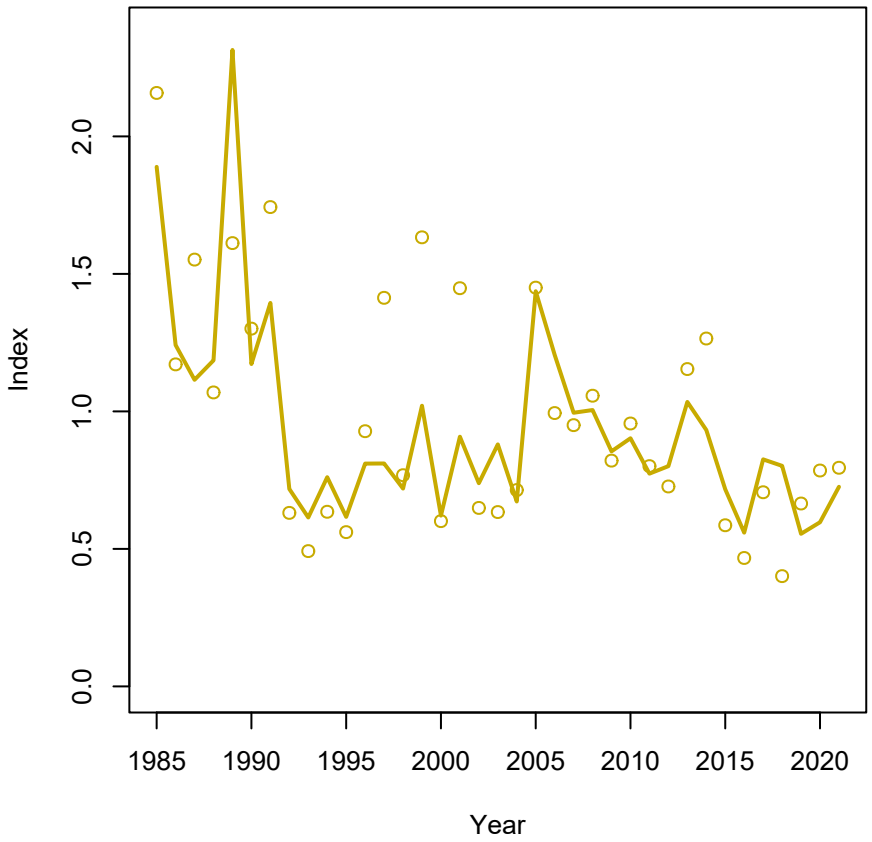
Index
0
2
4
6
8
1985
1990
1995
2000
2005
2010
2015
2020
Year

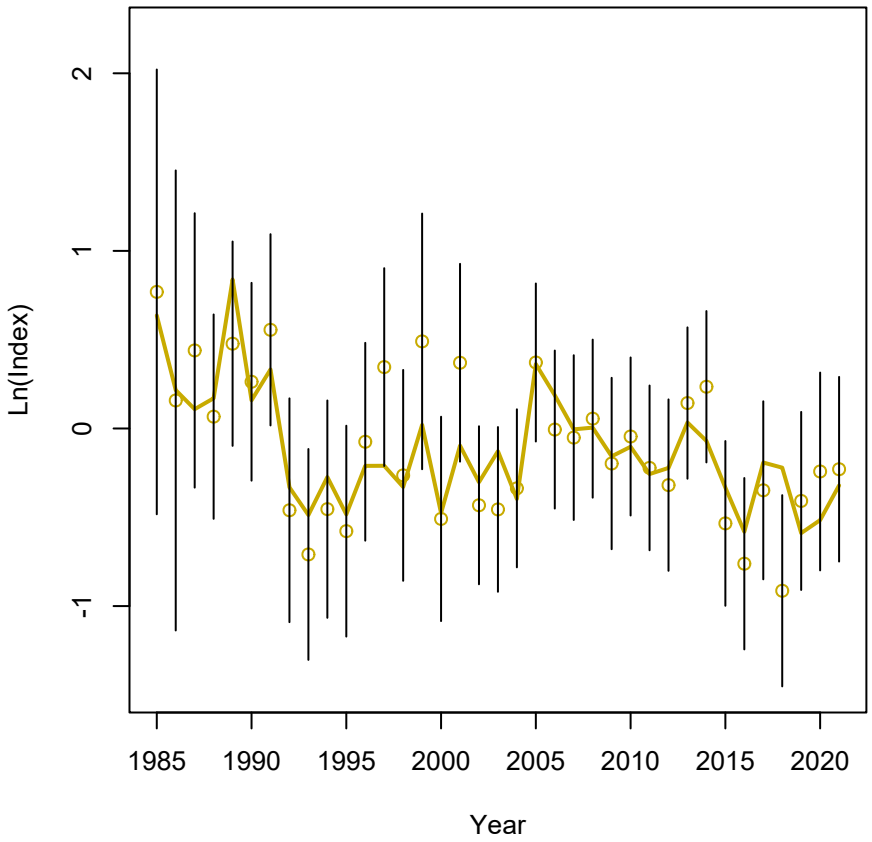

Ln(Index)
1.0
1.5
2.0
2.5
1985
1990
1995
2000
2005
2010
2015
2020
Year

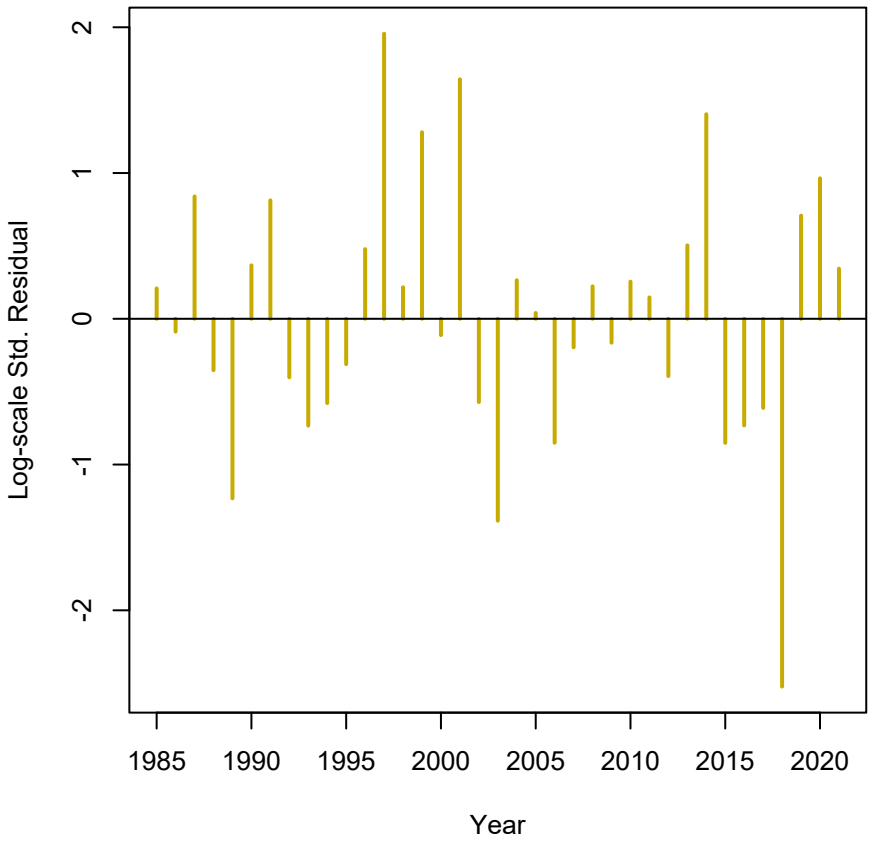

Log-scale Std. Residual
-3
-2
-1
0
1
2
3
1985
1990
1995
2000
2005
2010
2015
2020
Year

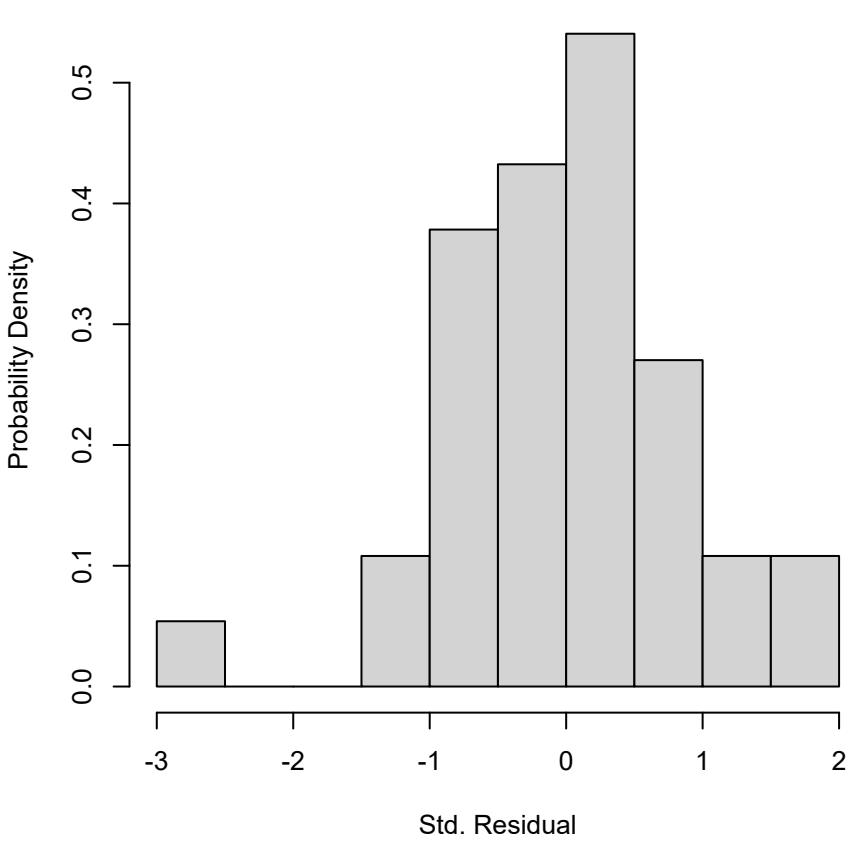

Probability Density
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
-3
-2
-1
0
1
2
3
Std. Residual

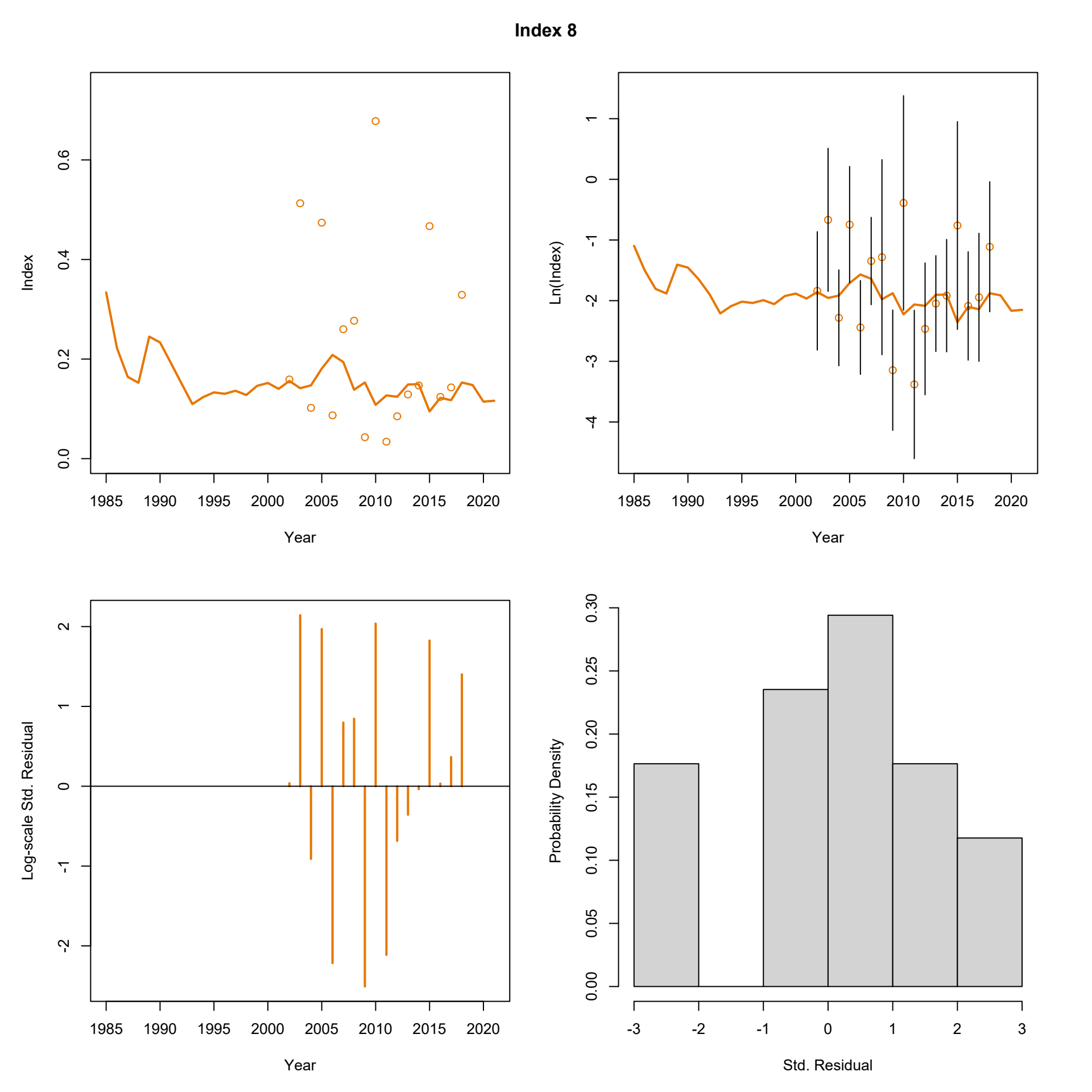
Index 7

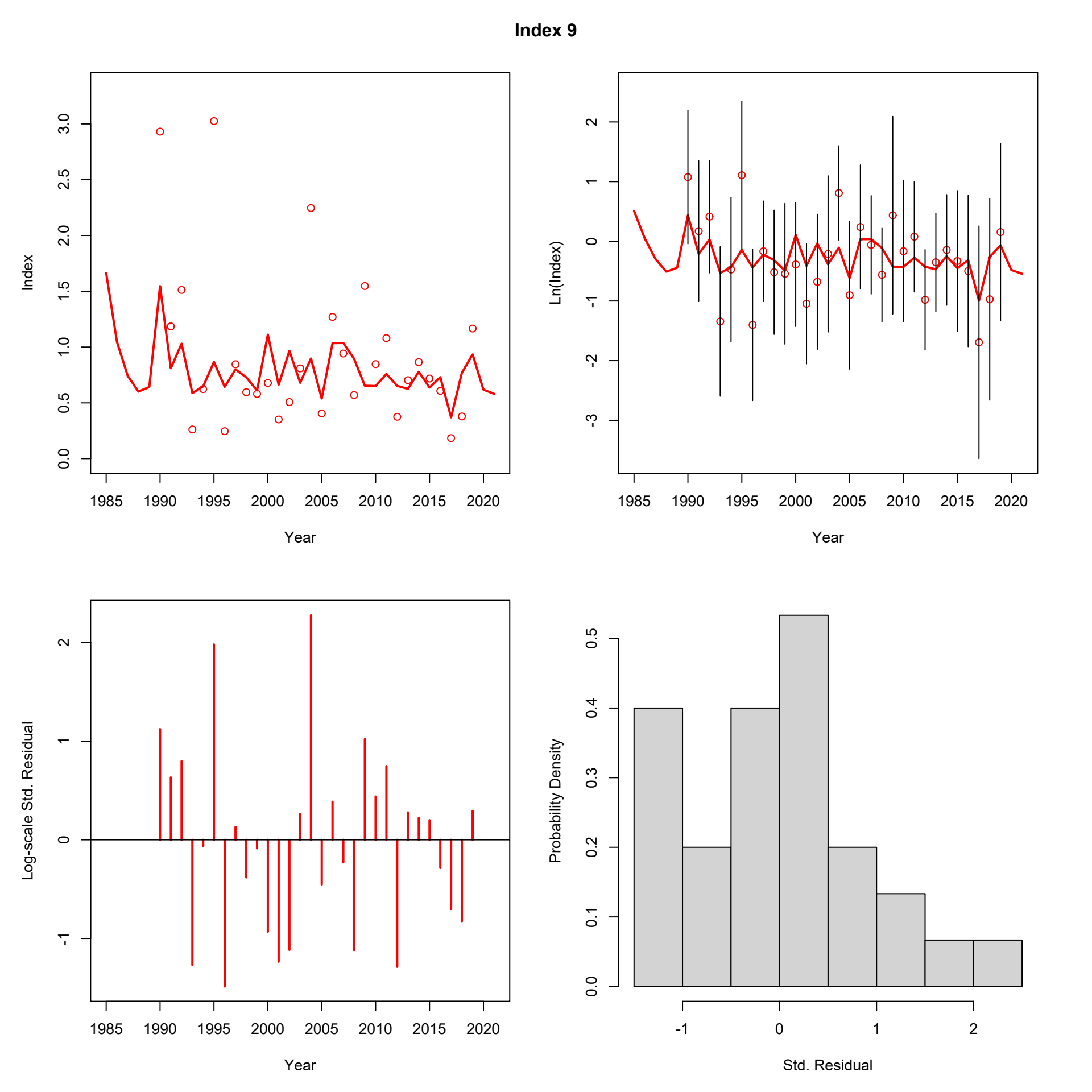

Index
0.0
0.5
1.0
1.5
2.0
1985
1990
1995
2000
2005
2010
2015
2020
Year

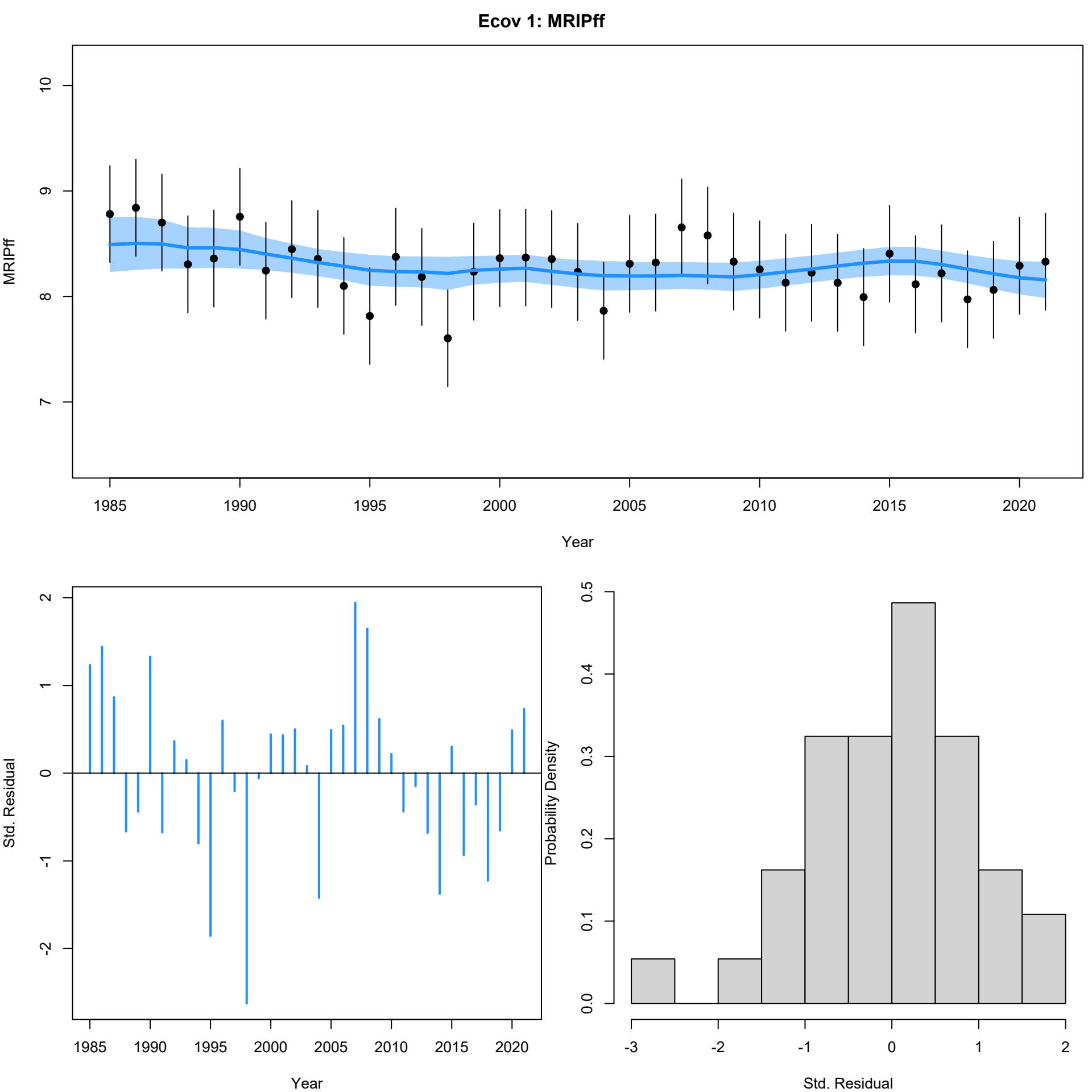

Ln(Index)
-1
0
1
2
1985
1990
1995
2000
2005
2010
2015
2020
Year

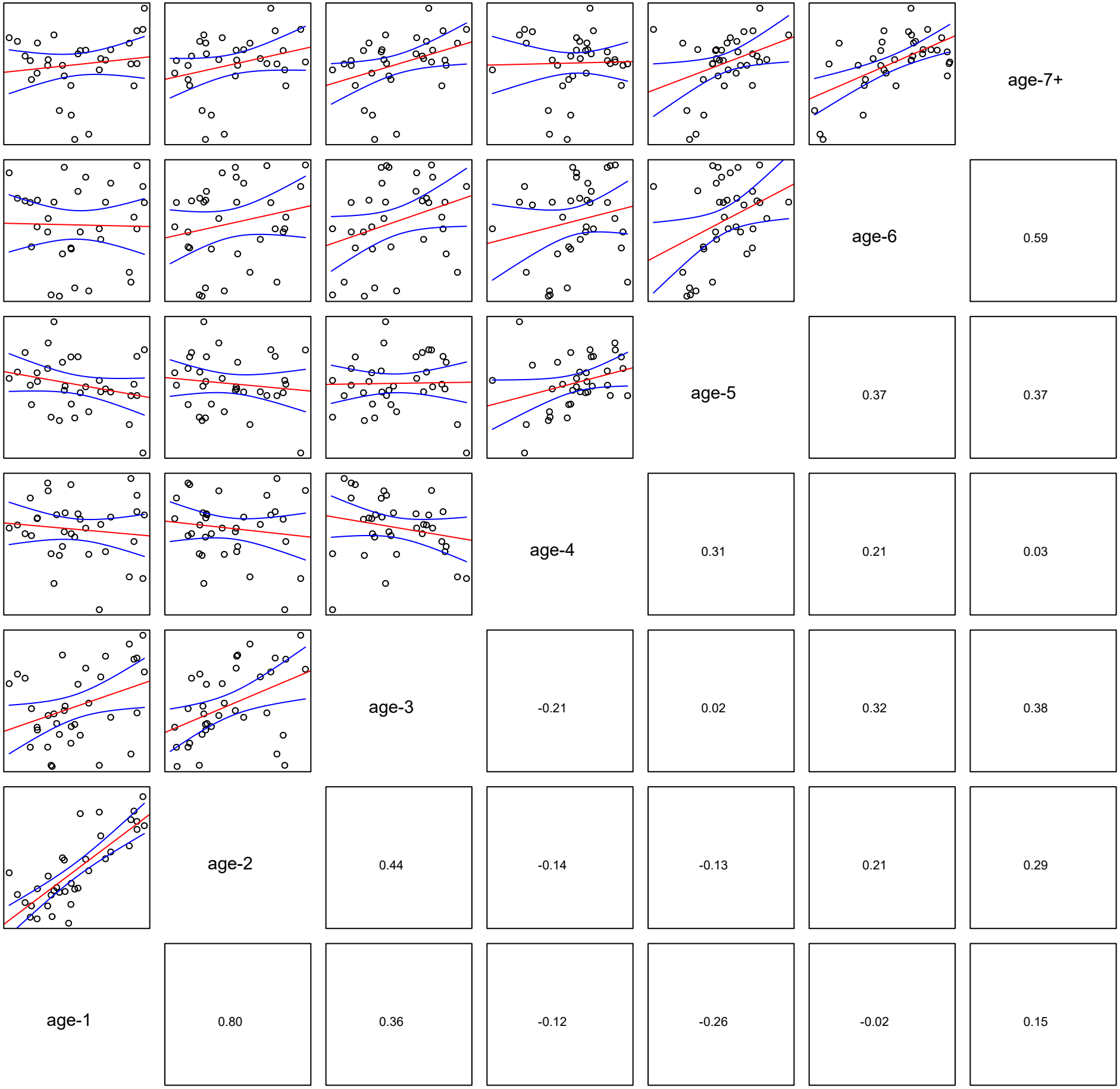

Log-scale Std. Residual
-2
-1
0
1
2
1985
1990
1995
2000
2005
2010
2015
2020
Year

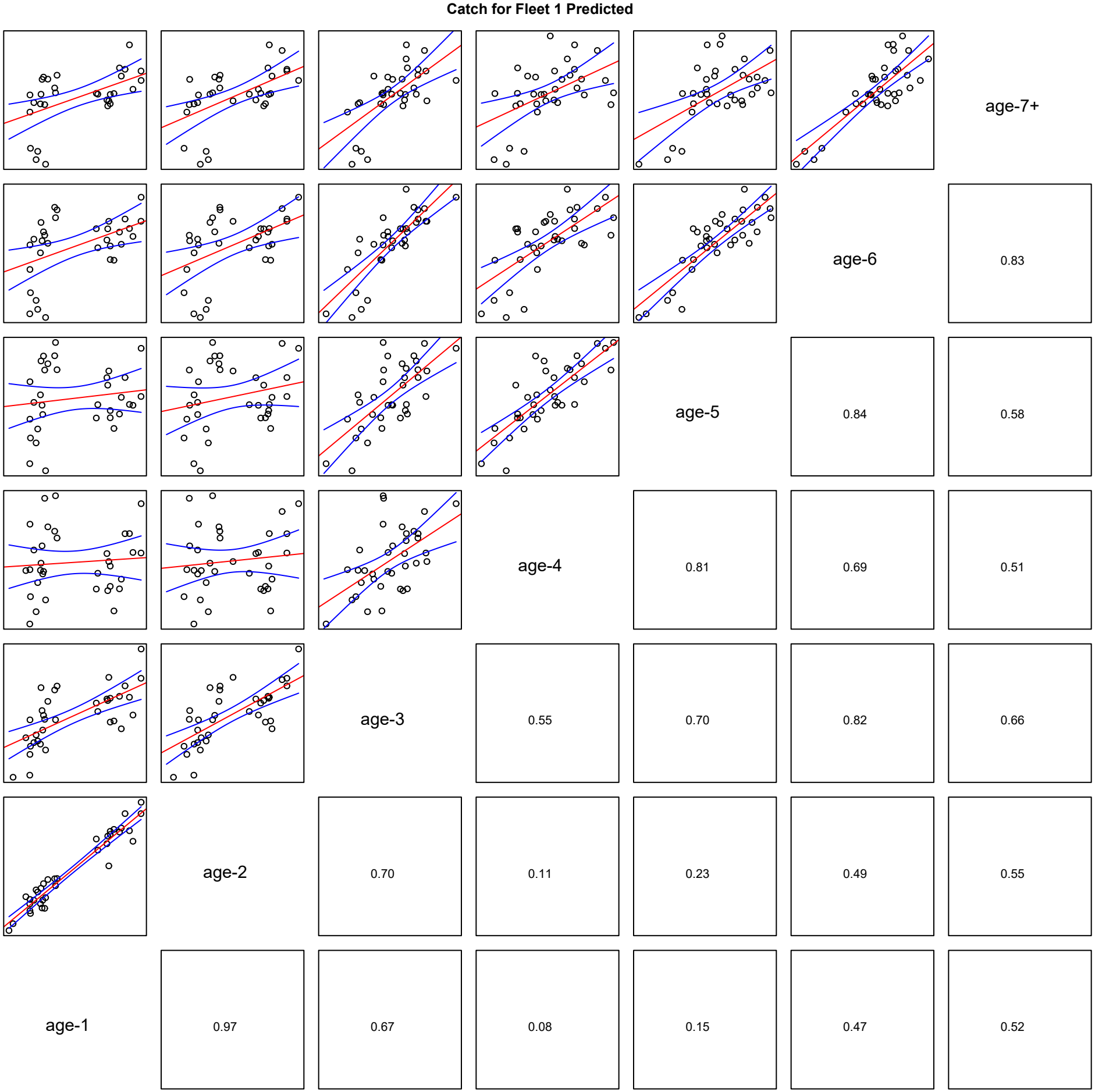

Probability Density
0.0
0.1
0.2
0.3
0.4
0.5
-3
-2
-1
0
1
2
Std. Residual

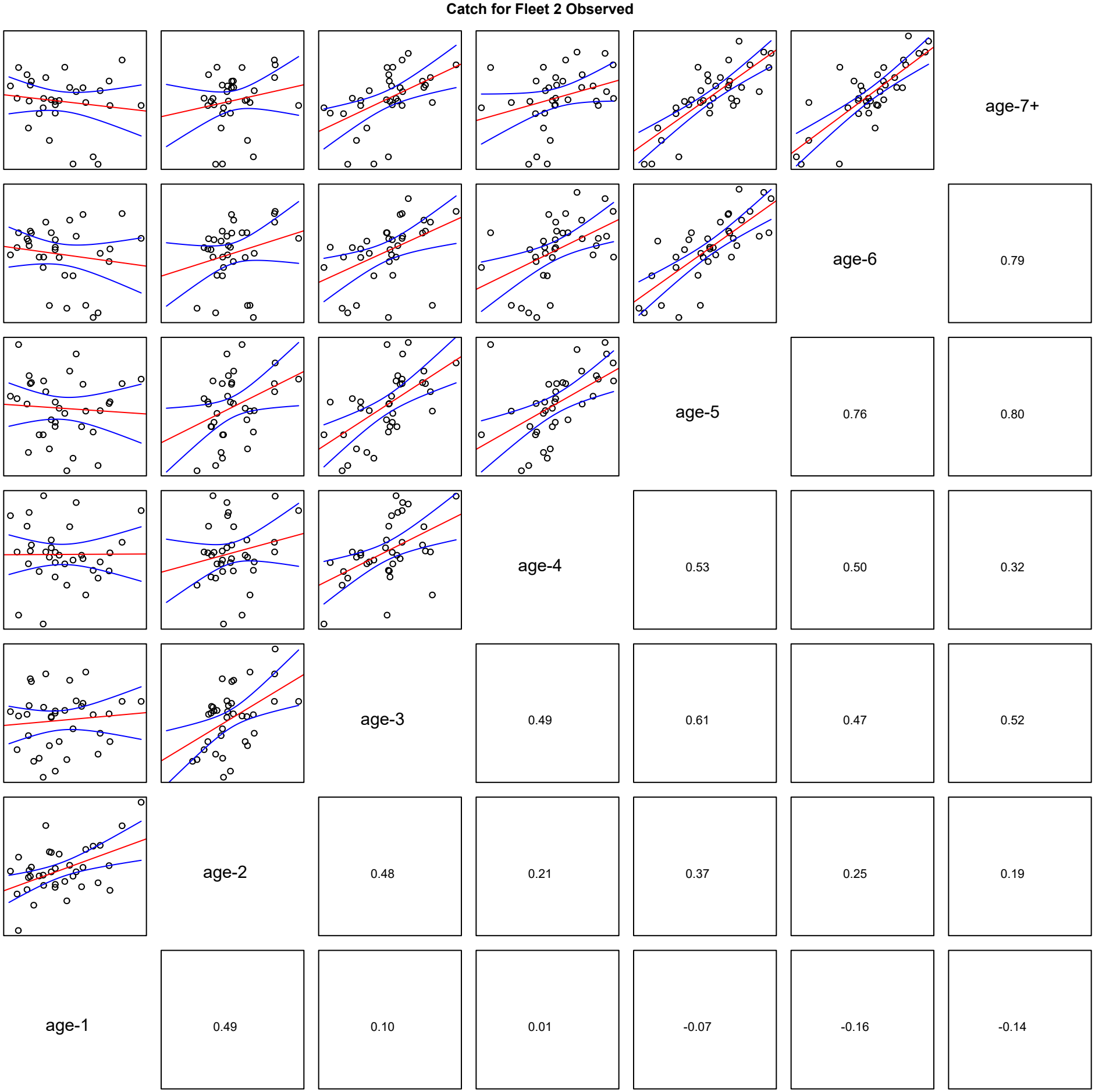

Index 8
Index
Year
Ln(Index)
Year
Log-scale Std. Residual
Year
Probability Density
Std. Residual

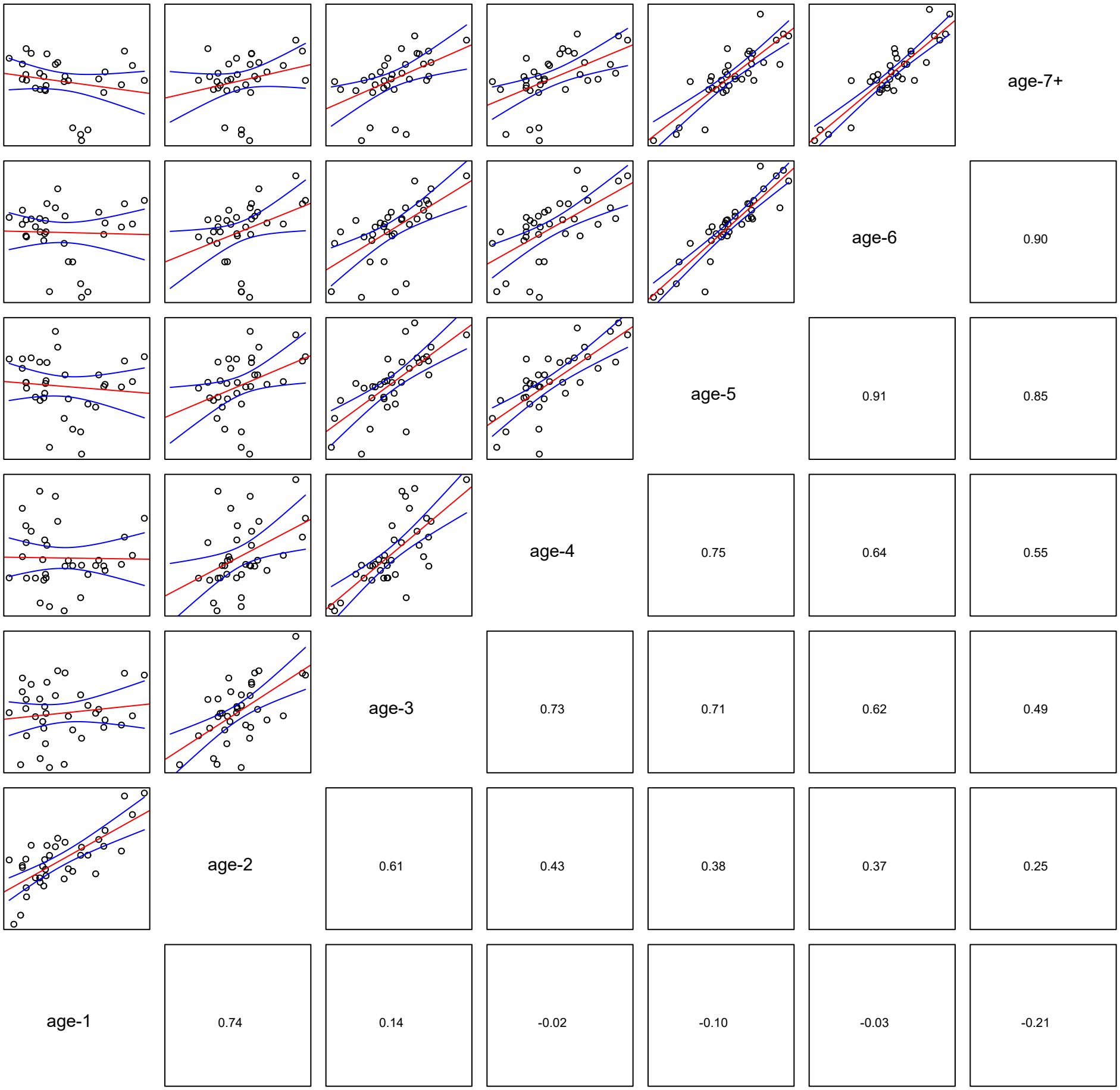

Index 9
Index
Year
Ln(Index)
Year
Log-scale Std. Residual
Year
Probability Density
Std. Residual

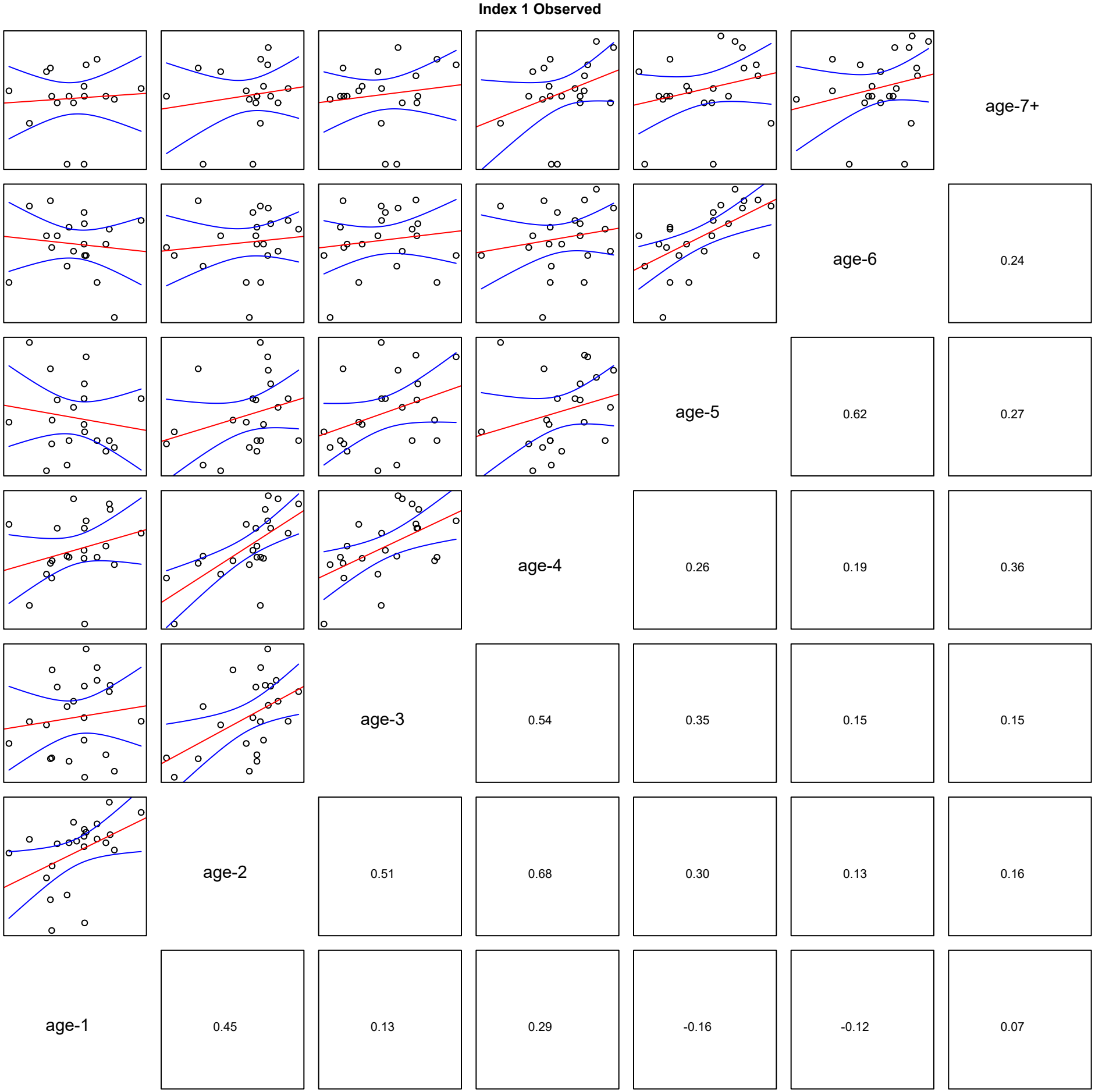

Ecov 1: MRIPff
MRIPff
10
9
8
7
1985
1990
1995
2000
2005
2010
2015
2020
Year
Std. Residual
2
1
0
-1
-2
1985
1990
1995
2000
2005
2010
2015
2020
Year
Probability Density
0.5
0.4
0.3
0.2
0.1
0.0
-3
-2
-1
0
1
2
Std. Residual

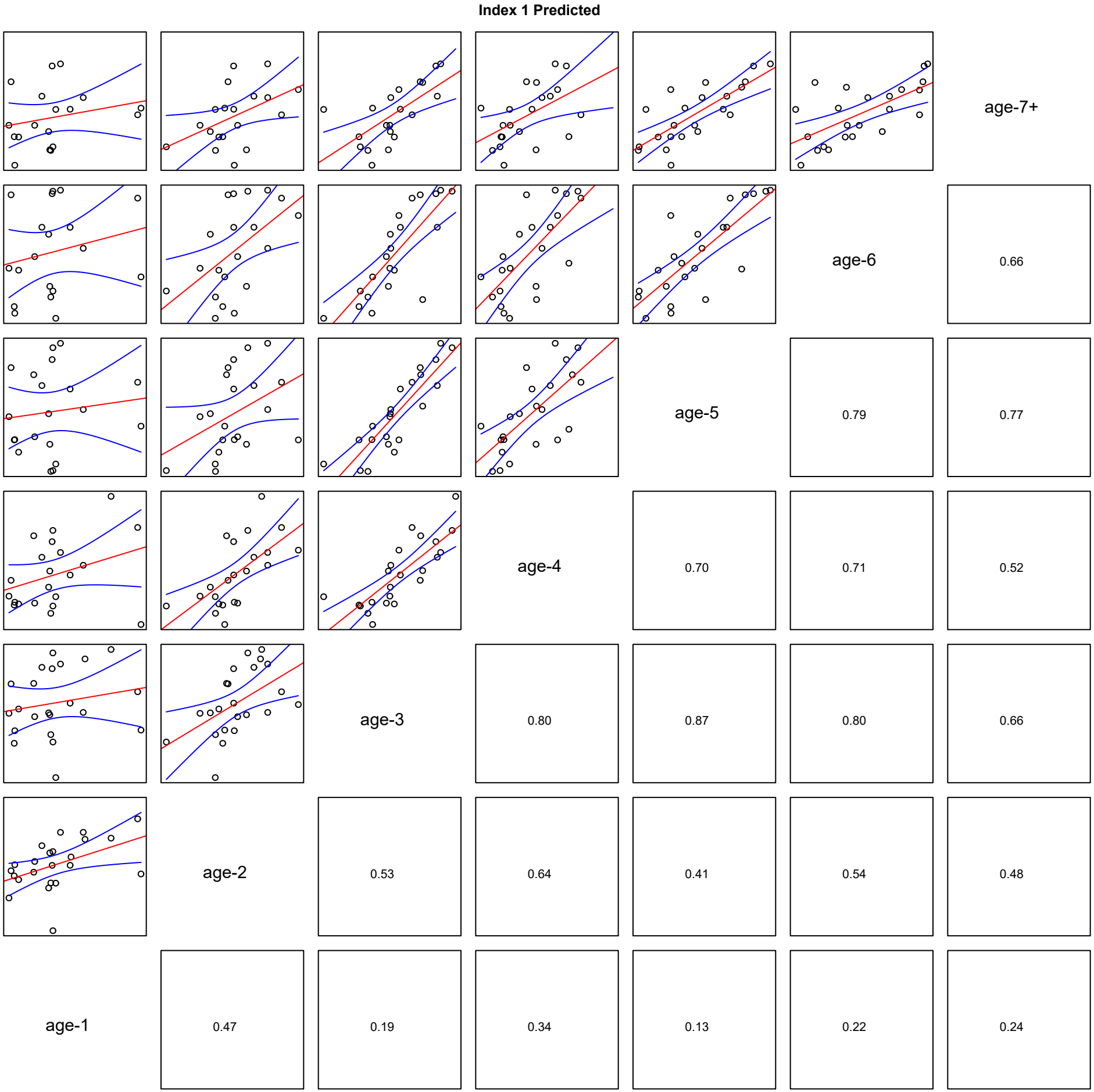

Catch for Fleet 1 Observed
age-7+
age-6
0.59
age-5
0.37
0.37
age-4
0.31
0.21
0.03
age-3
-0.21
0.02
0.32
0.38
age-2
0.44
-0.14
-0.13
0.21
0.29
age-1
0.80
0.36
-0.12
-0.26
-0.02
0.15

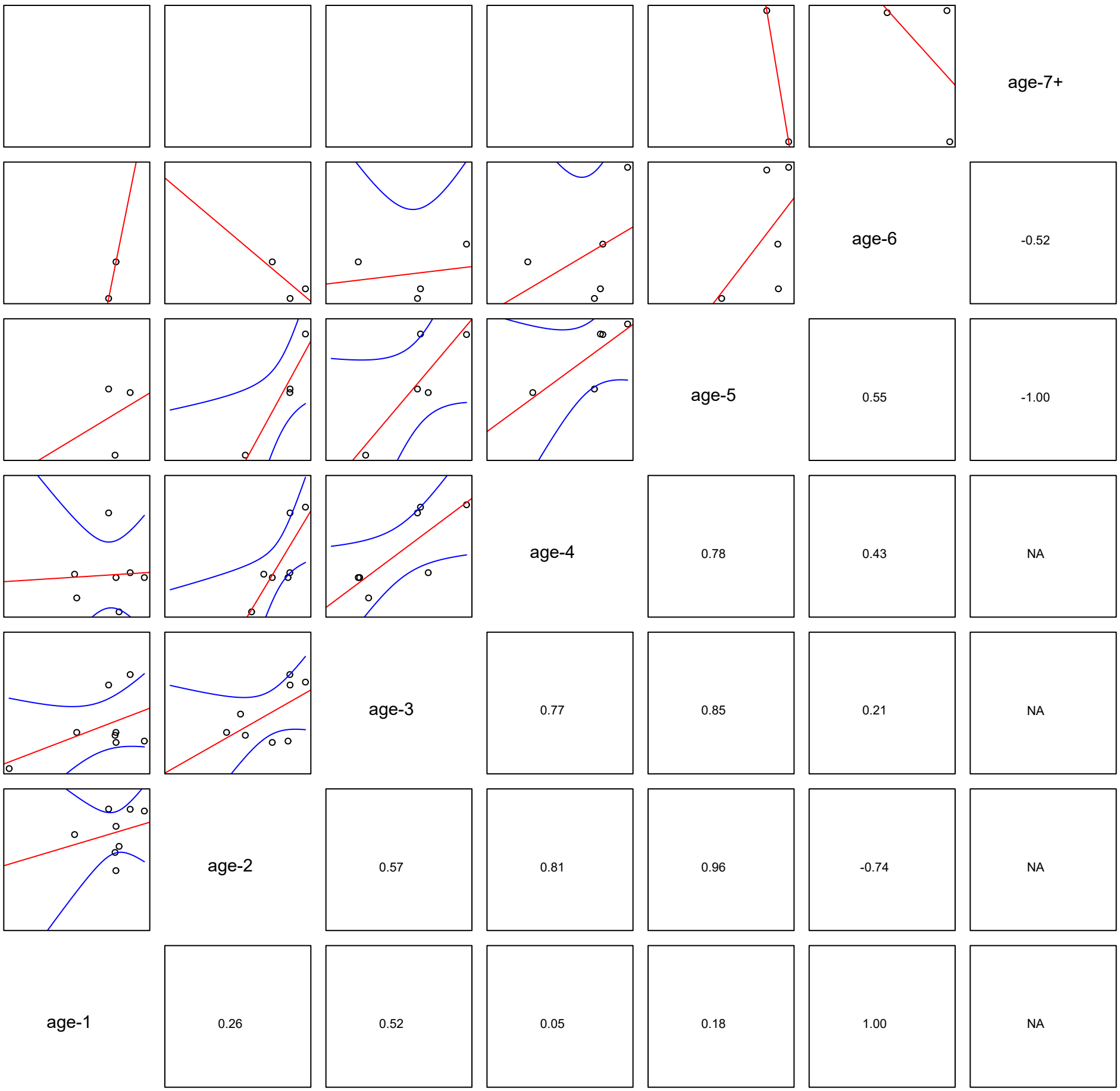

Catch for Fleet 1 Predicted
age-7+
age-6
0.83
age-5
0.84
0.58
age-4
0.81
0.69
0.51
age-3
0.55
0.70
0.82
0.66
age-2
0.70
0.11
0.23
0.49
0.55
age-1
0.97
0.67
0.08
0.15
0.47
0.52

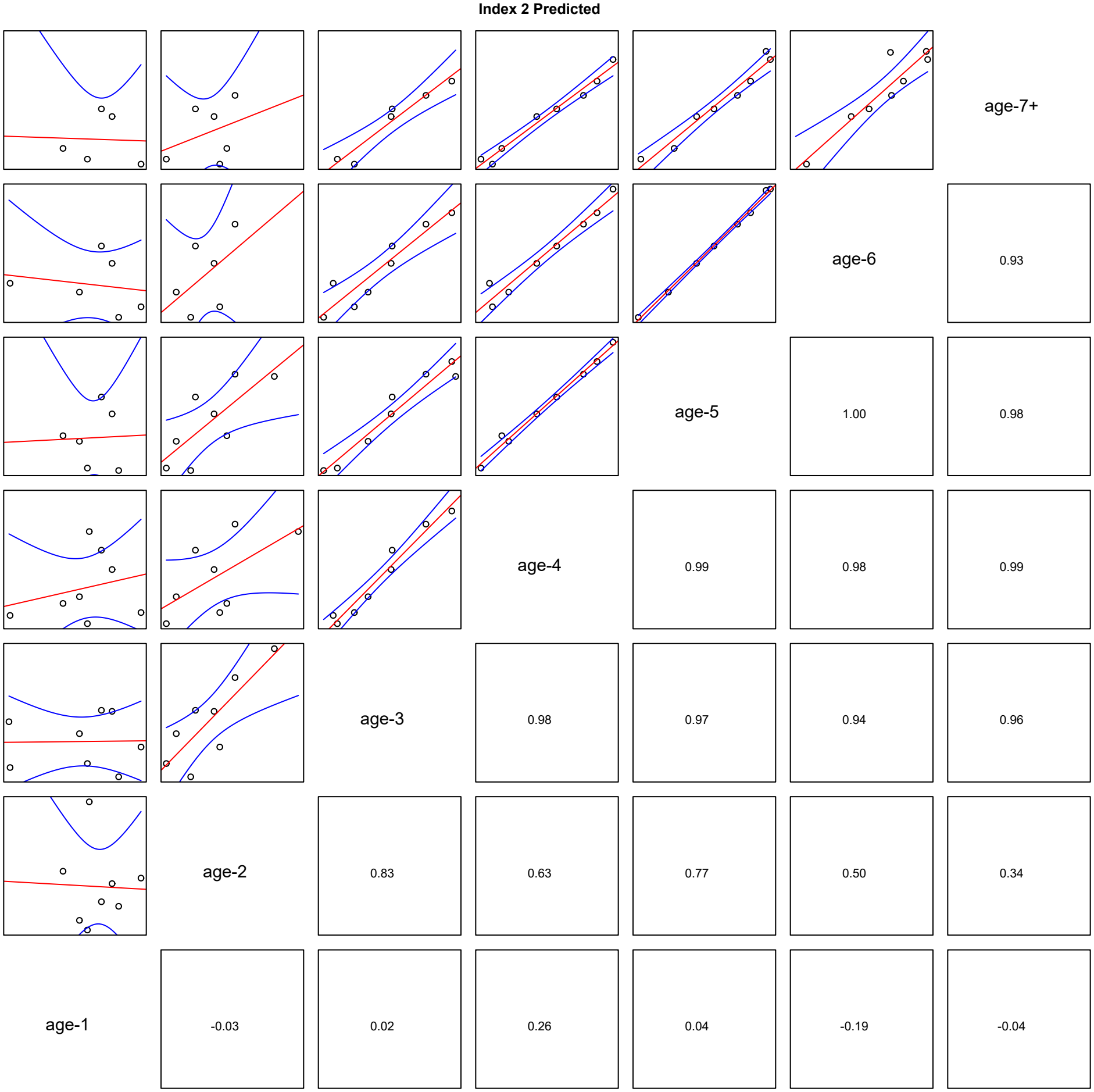

Catch for Fleet 2 Observed
age-7+
age-6
0.79
age-5
0.76
0.80
age-4
0.53
0.50
0.32
age-3
0.49
0.61
0.47
0.52
age-2
0.48
0.21
0.37
0.25
0.19
age-1
0.49
0.10
0.01
-0.07
-0.16
-0.14

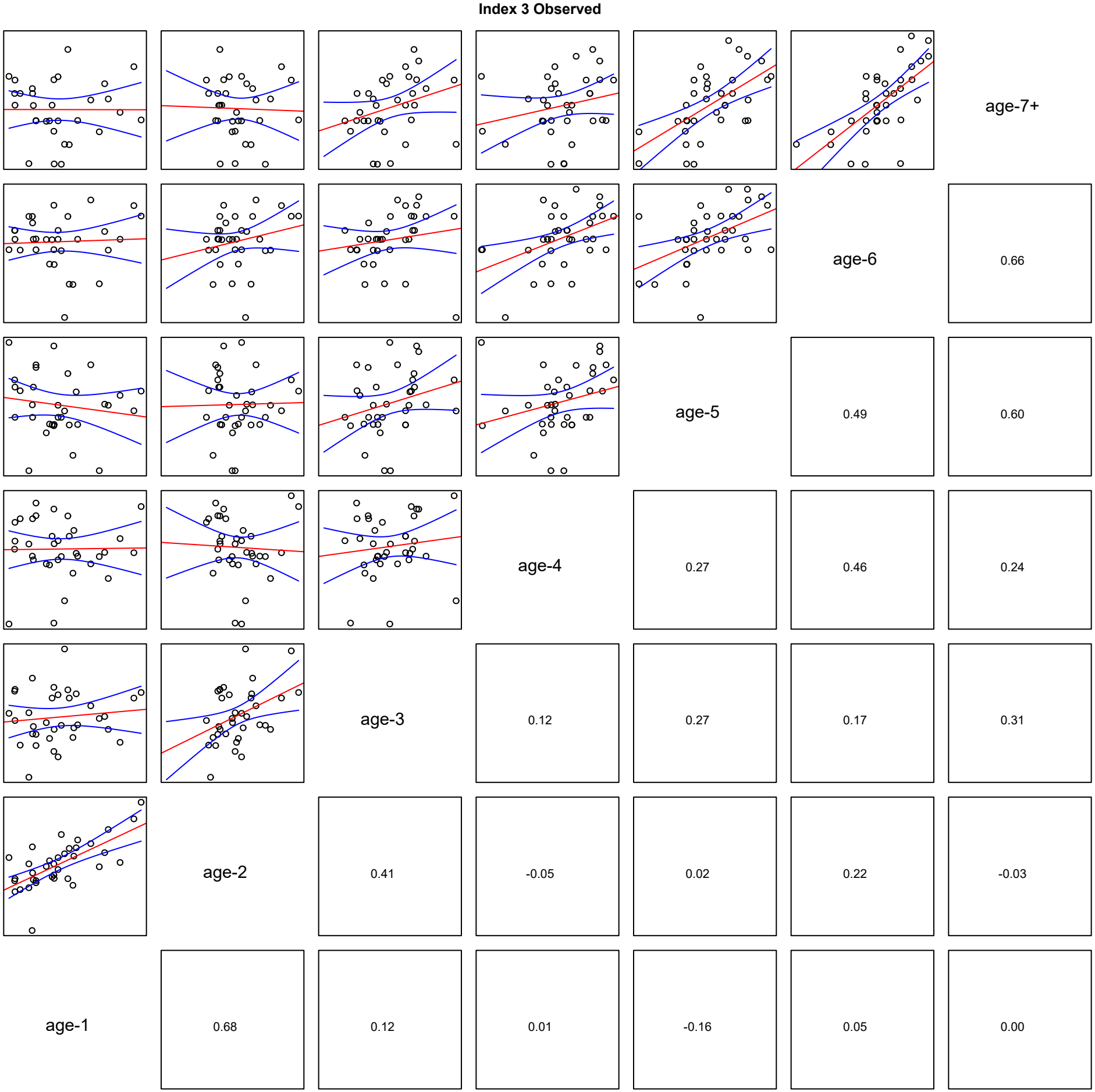

Catch for Fleet 2 Predicted
age-7+
age-6
0.90
age-5
0.91
0.85
age-4
0.75
0.64
0.55
age-3
0.73
0.71
0.62
0.49
age-2
0.61
0.43
0.38
0.37
0.25
age-1
0.74
0.14
-0.02
-0.10
-0.03
-0.21

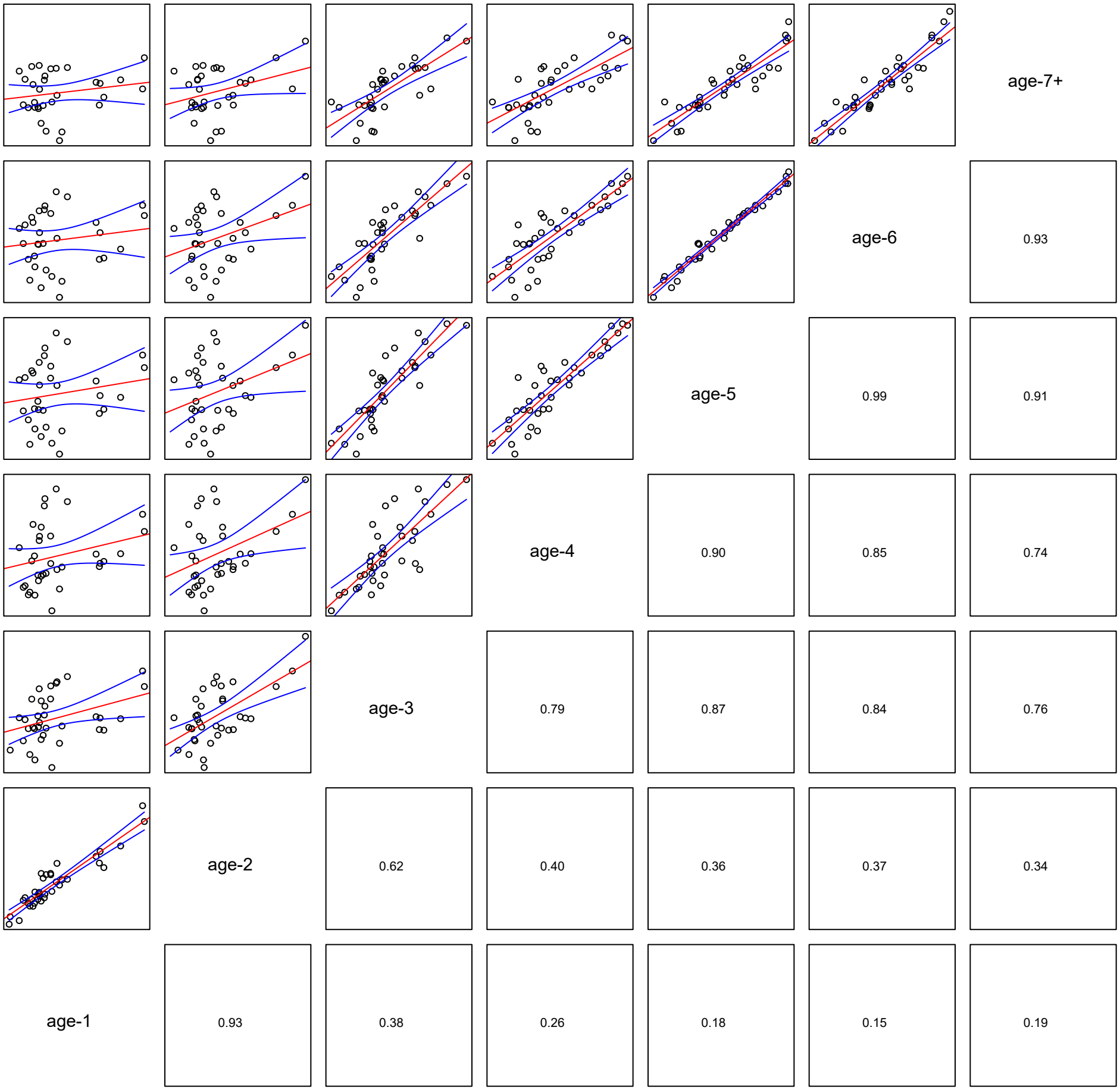

Index 1 Observed
age-7+
age-6
0.24
age-5
0.62
0.27
age-4
0.26
0.19
0.36
age-3
0.54
0.35
0.15
0.15
age-2
0.51
0.68
0.30
0.13
0.16
age-1
0.45
0.13
0.29
-0.16
-0.12
0.07


Index 1 Predicted
age-7+
age-6
0.66
age-5
0.79
0.77
age-4
0.70
0.71
0.52
age-3
0.80
0.87
0.80
0.66
age-2
0.53
0.64
0.41
0.54
0.48
age-1
0.47
0.19
0.34
0.13
0.22
0.24

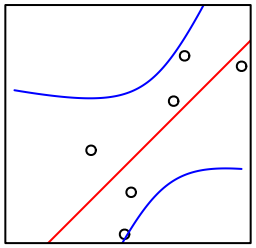

Index 2 Observed
age-7+
age-6
-0.52
age-5
0.55
-1.00
age-4
0.78
0.43
NA
age-3
0.77
0.85
0.21
NA
age-2
0.57
0.81
0.96
-0.74
NA
age-1
0.26
0.52
0.05
0.18
1.00
NA

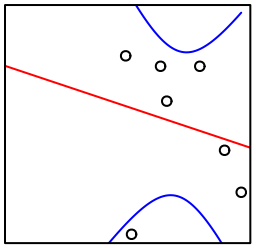

Index 2 Predicted
age-7+
age-6
0.93
age-5
1.00
0.98
age-4
0.99
0.98
0.99
age-3
0.98
0.97
0.94
0.96
age-2
0.83
0.63
0.77
0.50
0.34
age-1
-0.03
0.02
0.26
0.04
-0.19
-0.04

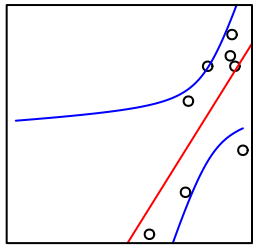

Index 3 Observed
age-7+
age-6
0.66
age-5
0.49
0.60
age-4
0.27
0.46
0.24
age-3
0.12
0.27
0.17
0.31
age-2
0.41
-0.05
0.02
0.22
-0.03
age-1
0.68
0.12
0.01
-0.16
0.05
0.00

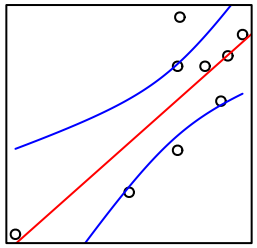

Index 3 Predicted
age-7+
age-6
0.93
age-5
0.99
0.91
age-4
0.90
0.85
0.74
age-3
0.79
0.87
0.84
0.76
age-2
0.62
0.40
0.36
0.37
0.34
age-1
0.93
0.38
0.26
0.18
0.15
0.19

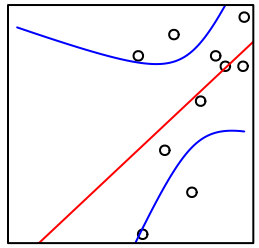
Index 4 Observed

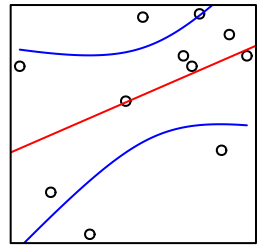




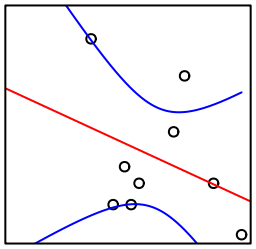


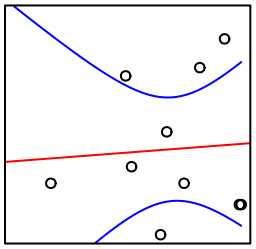


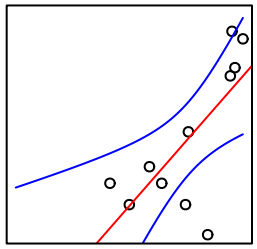


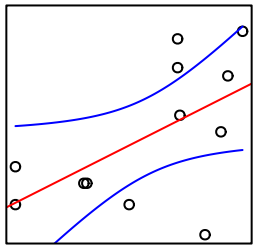


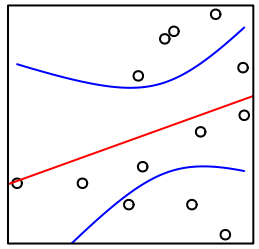
age-7+





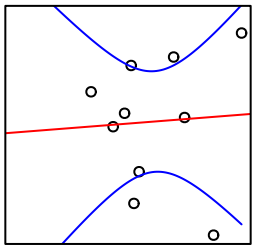


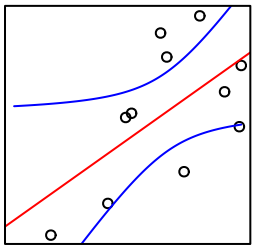


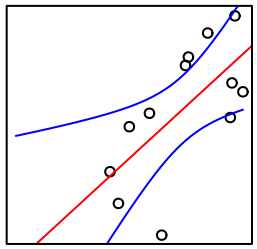


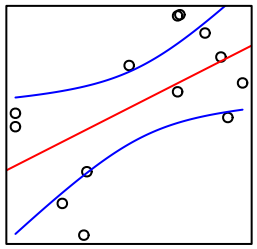
age-6

0.45









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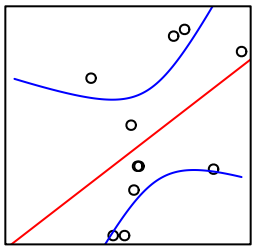
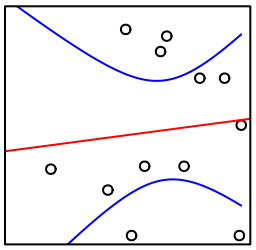
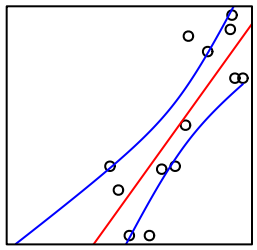
0.51







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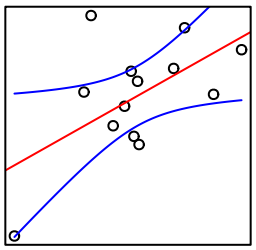

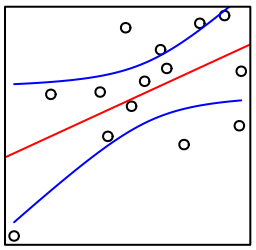

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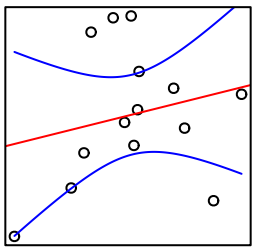

age-2

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age-1

0.22

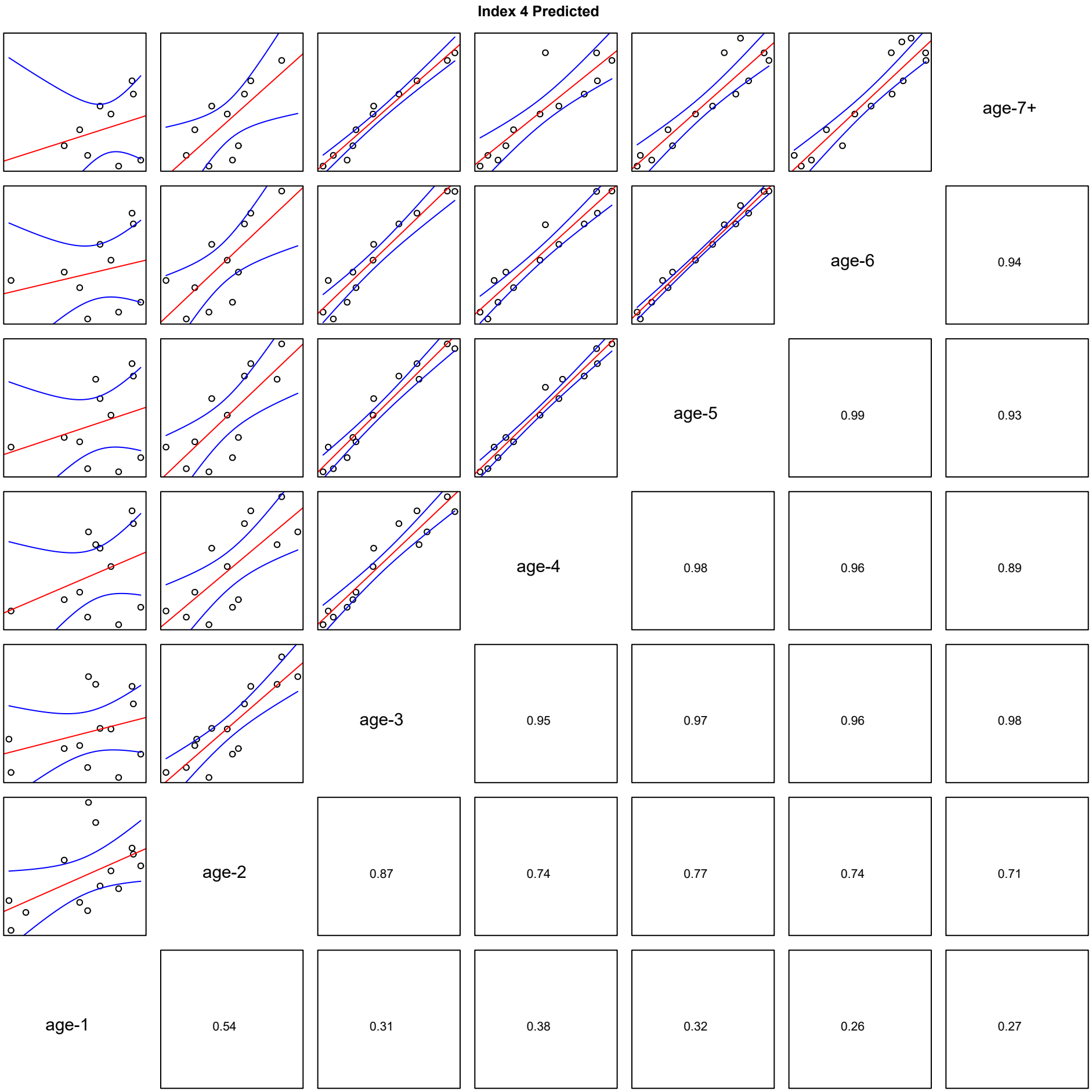
0.58

0.46

0.06

-0.36

0.75


Index 4 Predicted
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age-6
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age-5
0.99
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age-4
0.98
0.96
0.89
age-3
0.95
0.97
0.96
0.98
age-2
0.87
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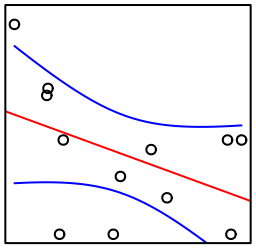
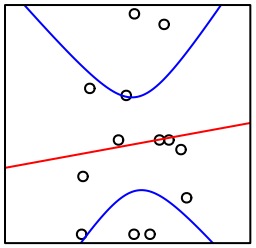
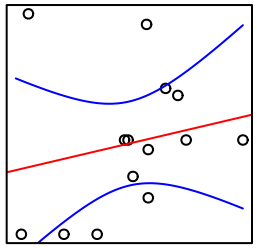
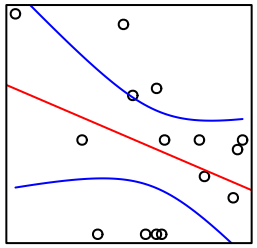
0.27

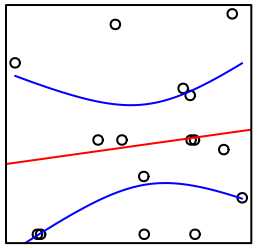
Index 6 Observed

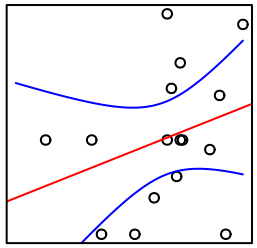












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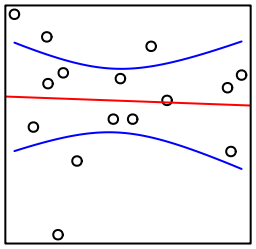

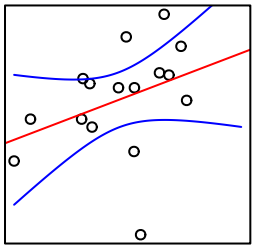

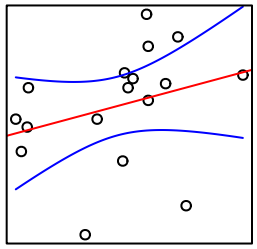

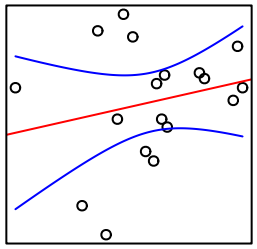

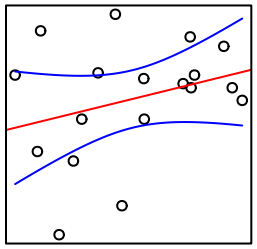

age-6

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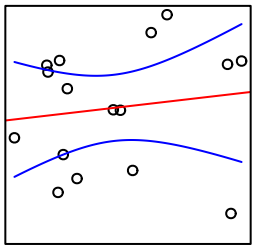

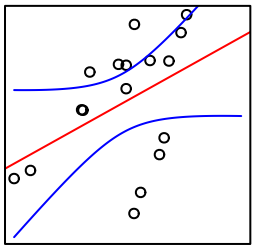

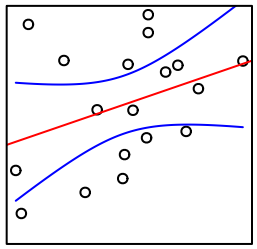

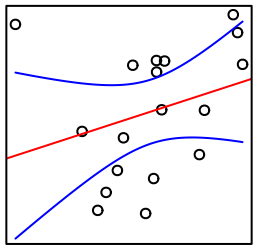

age-5

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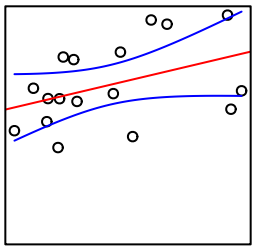
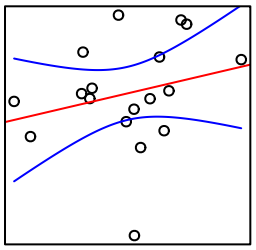
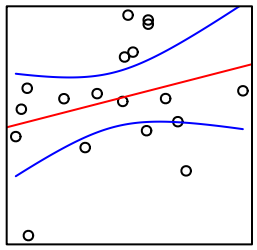
0.14







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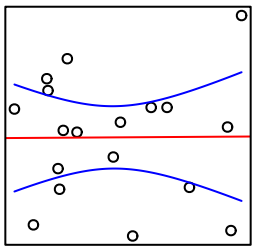
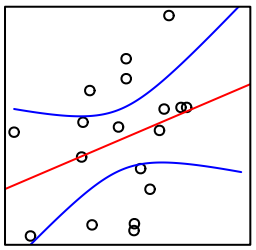
0.23

-0.37





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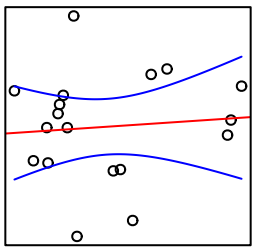
0.36

0.30

0.20



age-2

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0.25

0.44

0.36

0.09

age-1

0.09

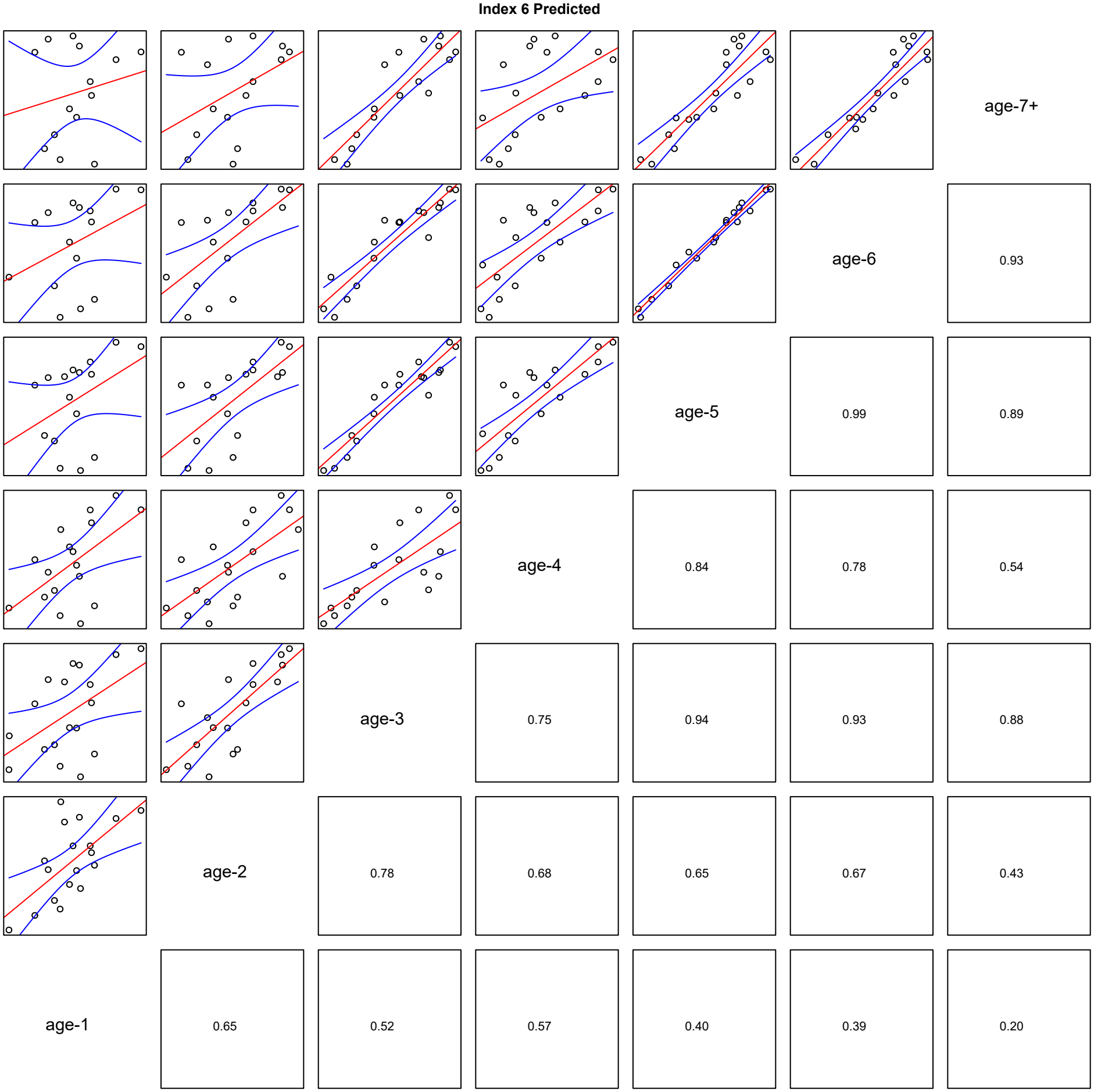
0.01

0.42

0.14

-0.05

-0.45


Index 6 Predicted
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age-6
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age-5
0.99
0.89
age-4
0.84
0.78
0.54
age-3
0.75
0.94
0.93
0.88
age-2
0.78
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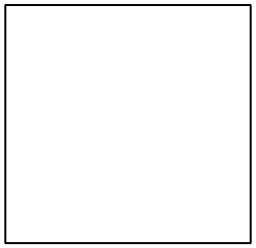
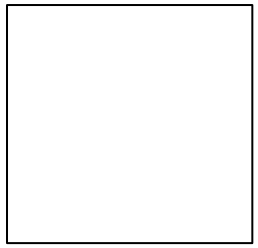
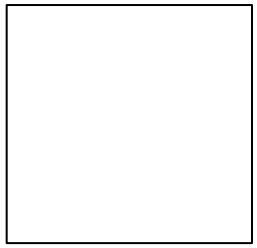
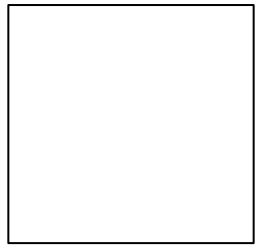
0.43
age-1
0.65
0.52
0.57
0.40
0.39
0.20

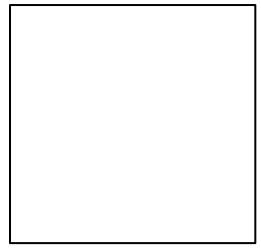
Index 8 Observed

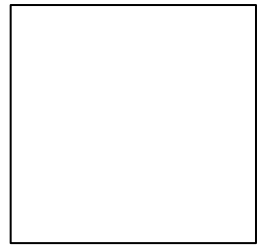




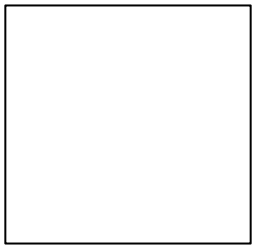


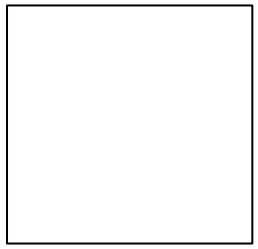


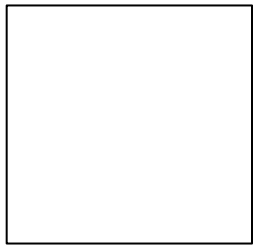


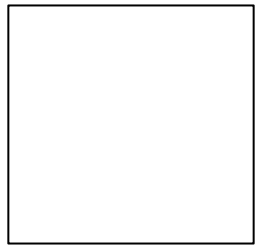


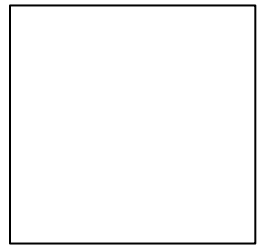
age-7+











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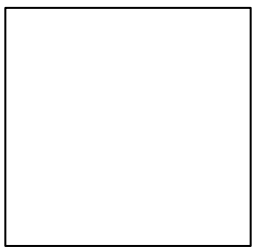

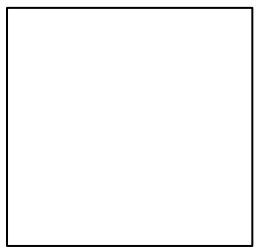

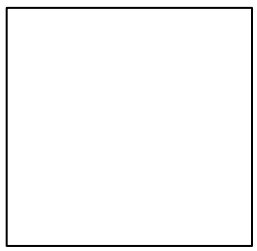

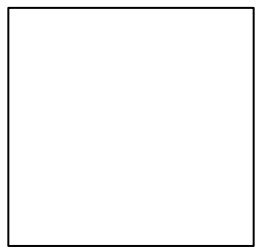

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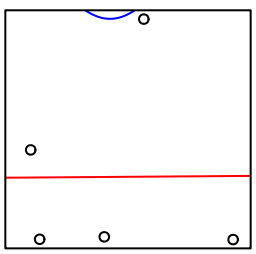

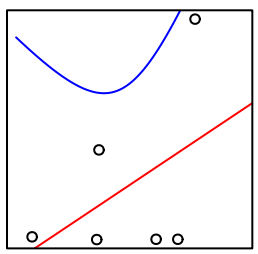

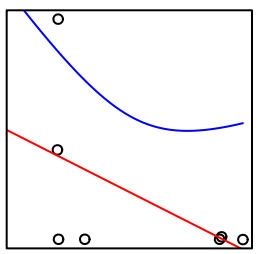

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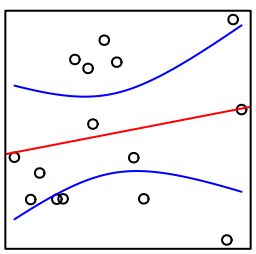

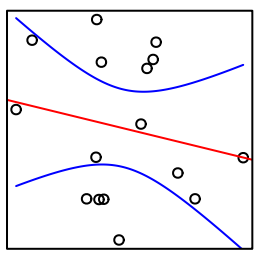

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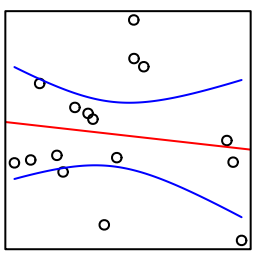
NA

NA



age-2

-0.20

0.46

NA

NA

NA

age-1

-0.14

0.20

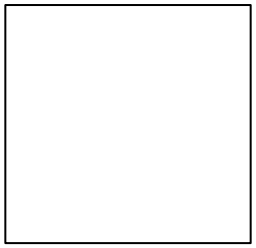
0.01

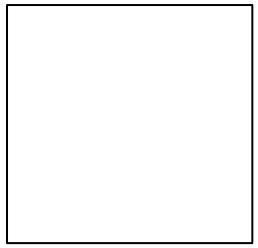
NA

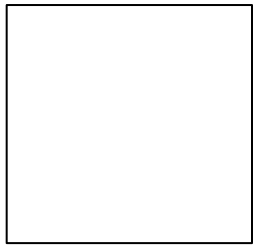
NA

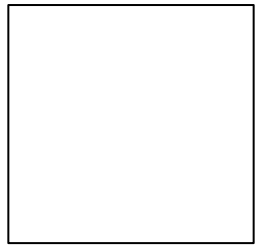
NA

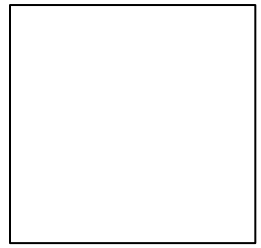
Index 8 Predicted

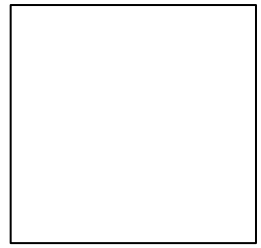




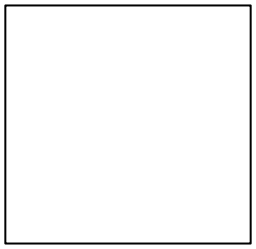


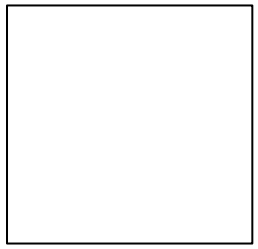


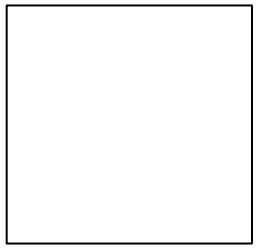


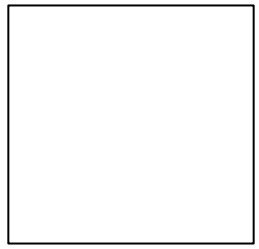


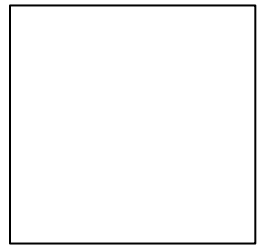
age-7+











age-6

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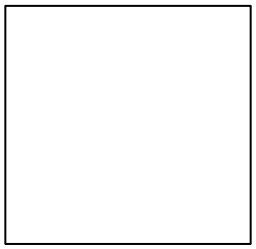
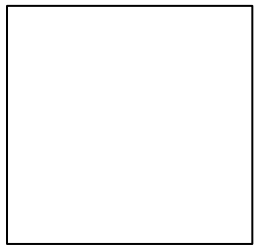
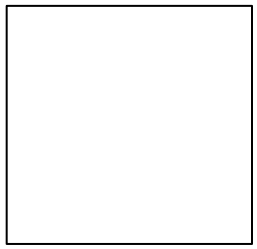
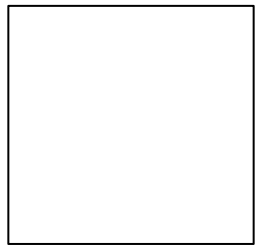




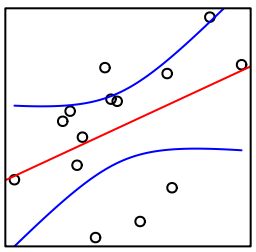


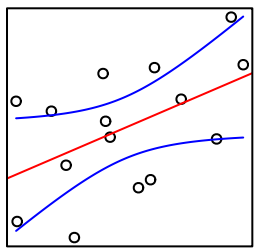


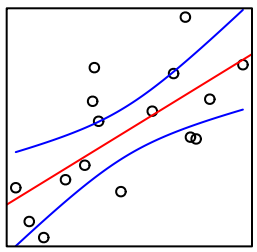
age-5

NA

NA





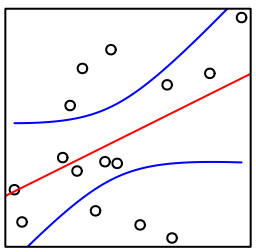


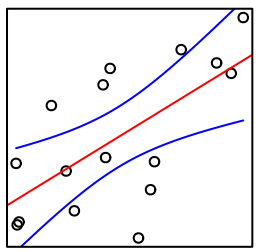
age-4

NA

NA

NA





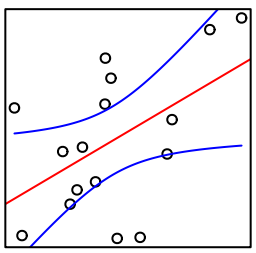
age-3

0.69

NA

NA

NA



age-2

0.65

0.51

NA

NA

NA

age-1

0.51

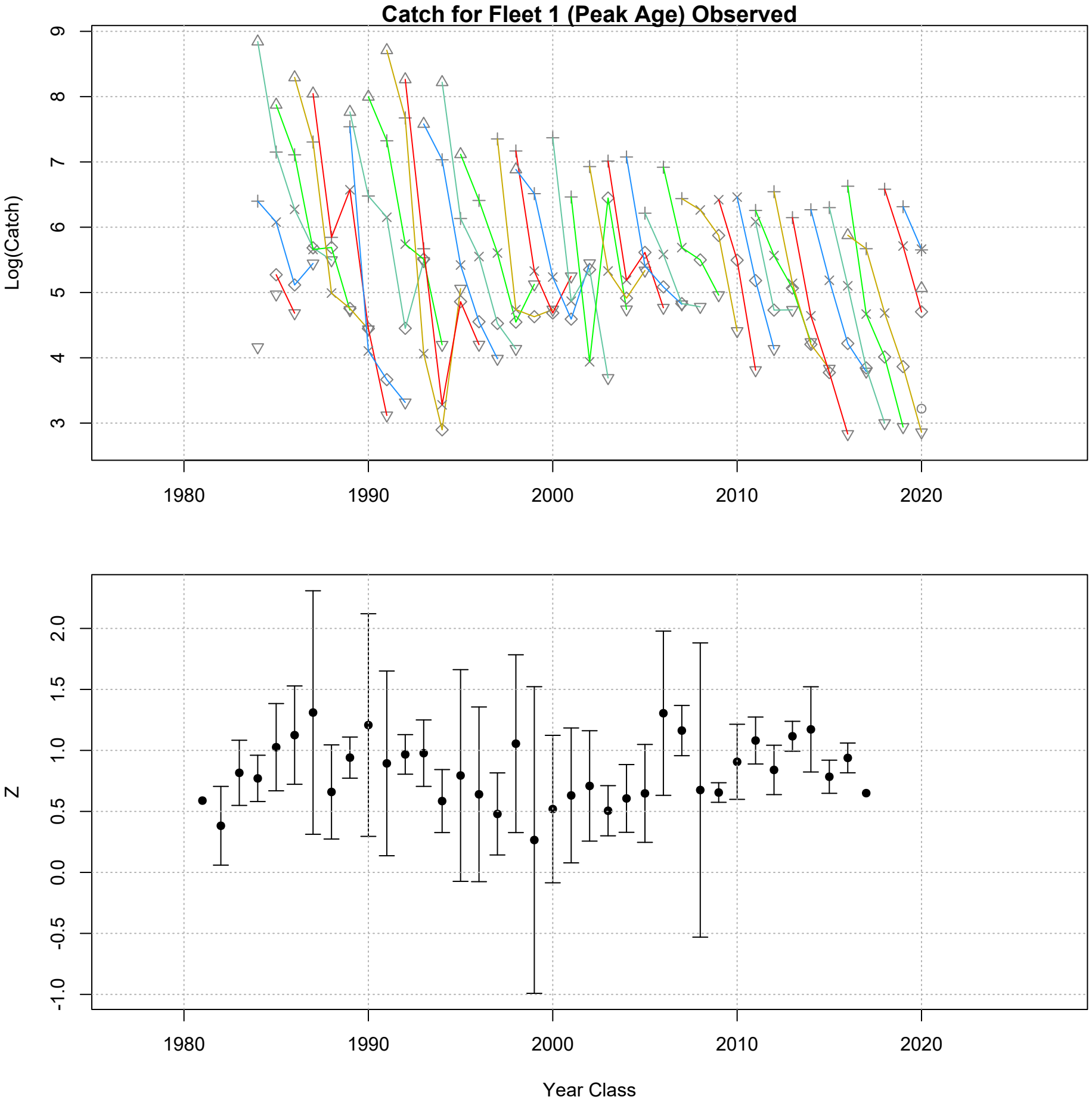
0.45

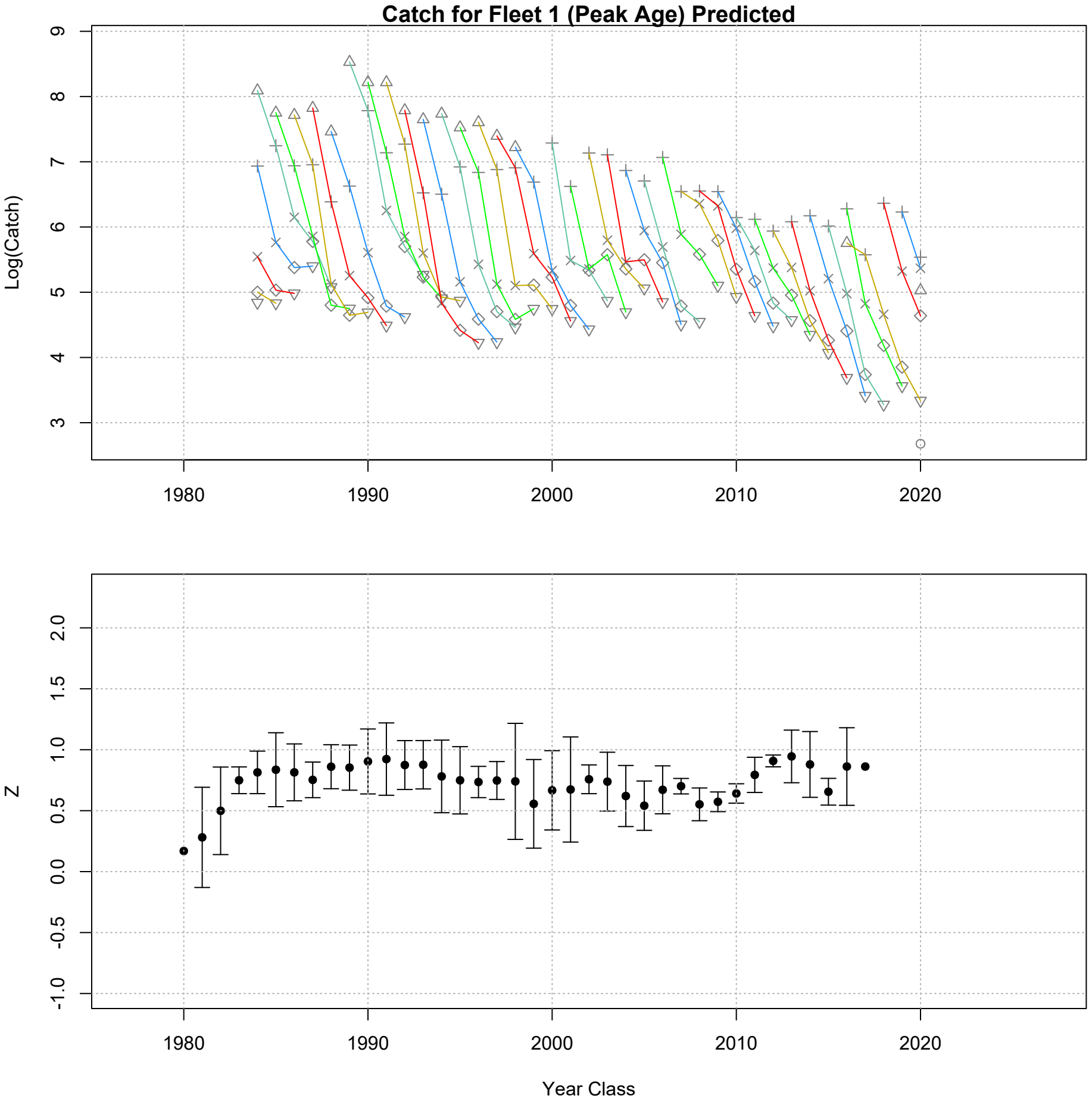
0.45

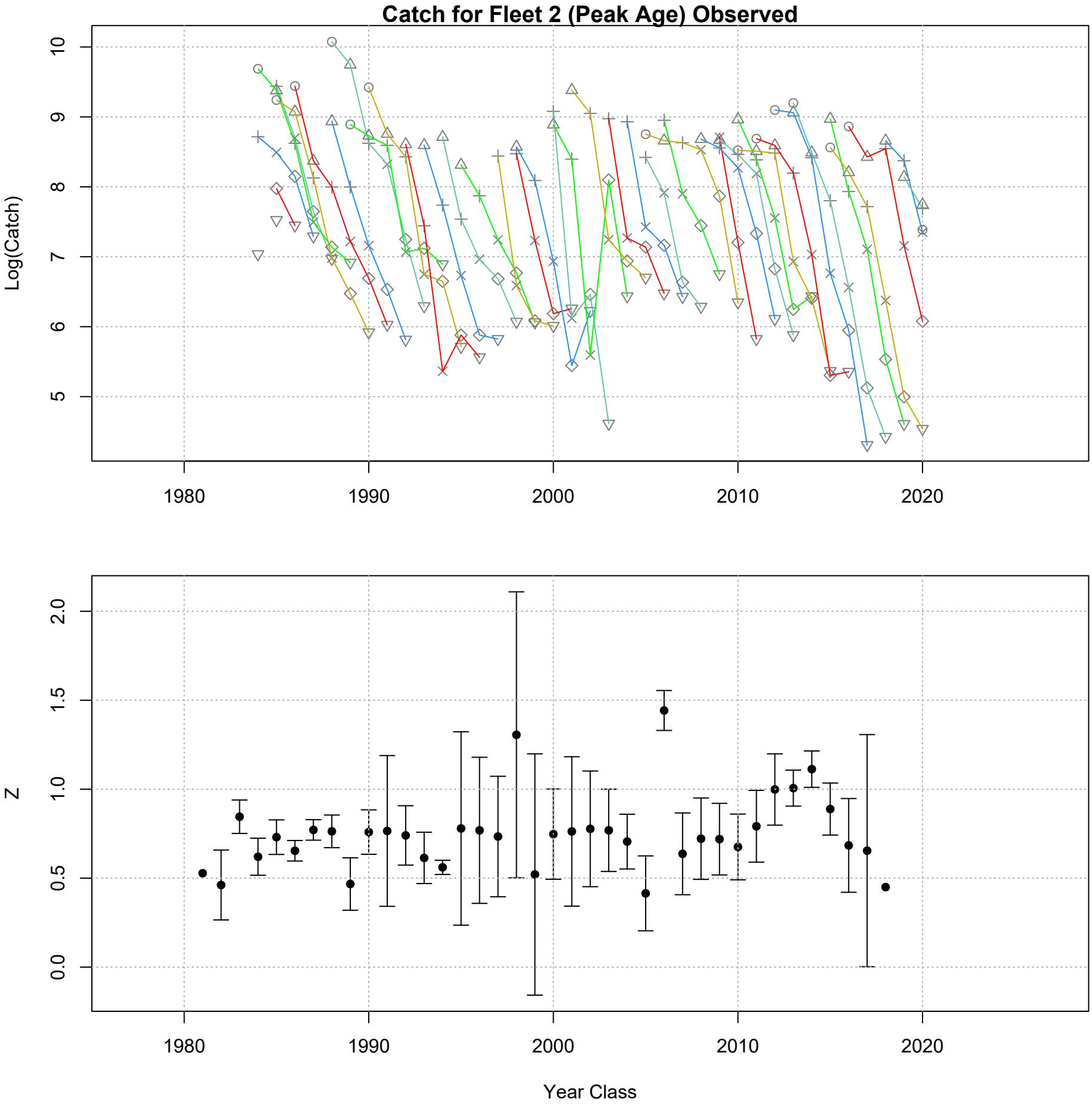
NA

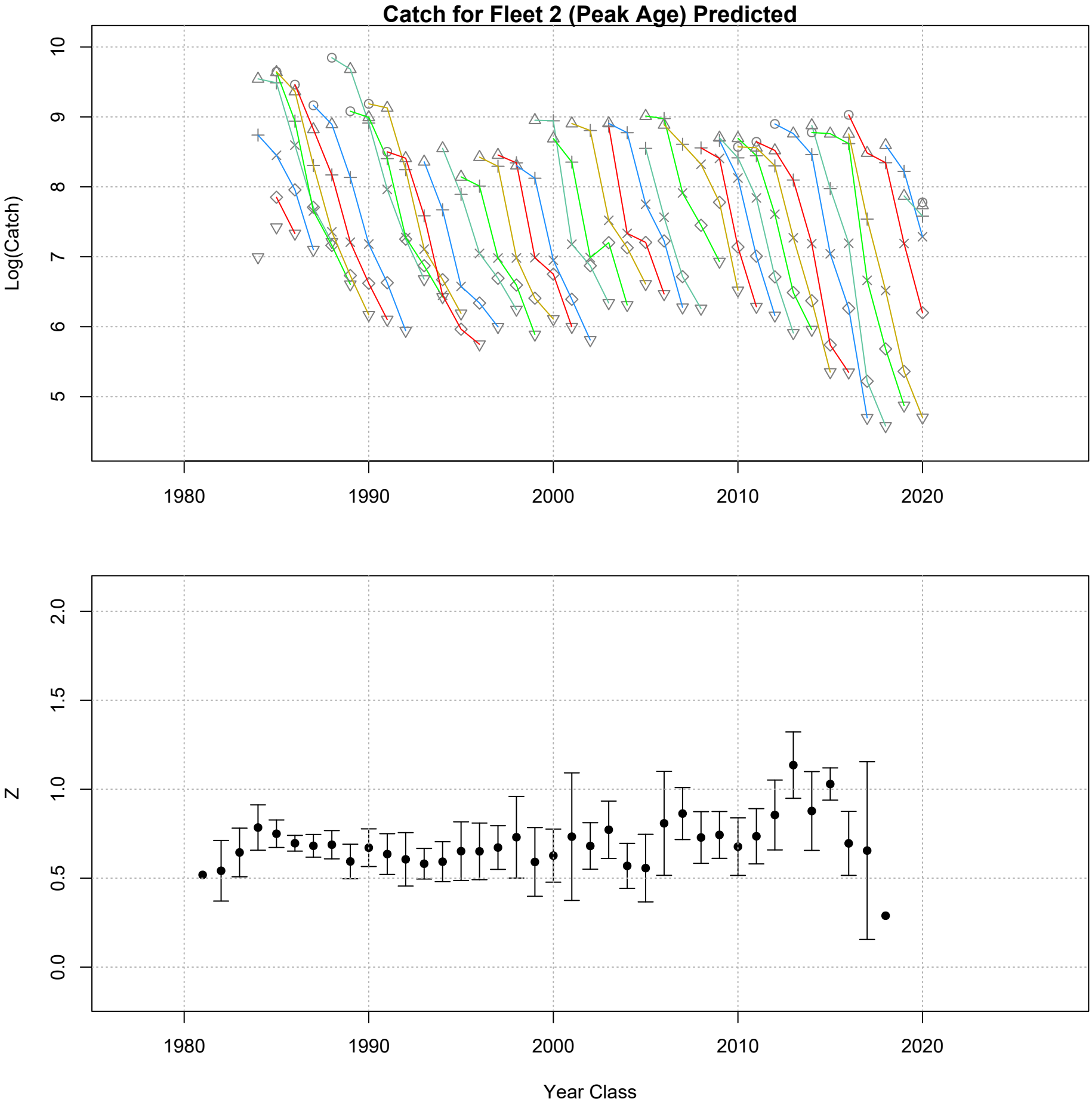
NA

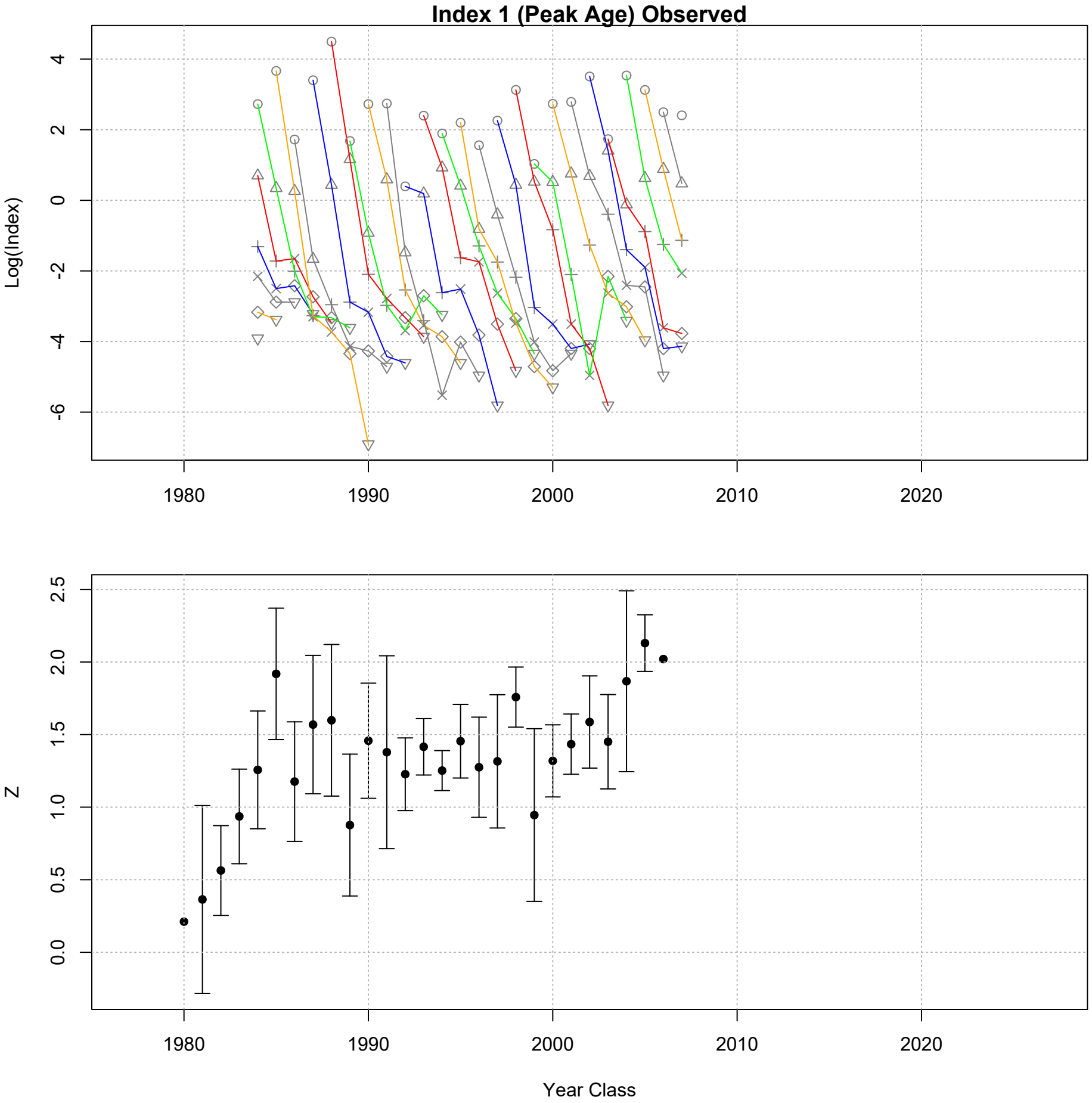
NA

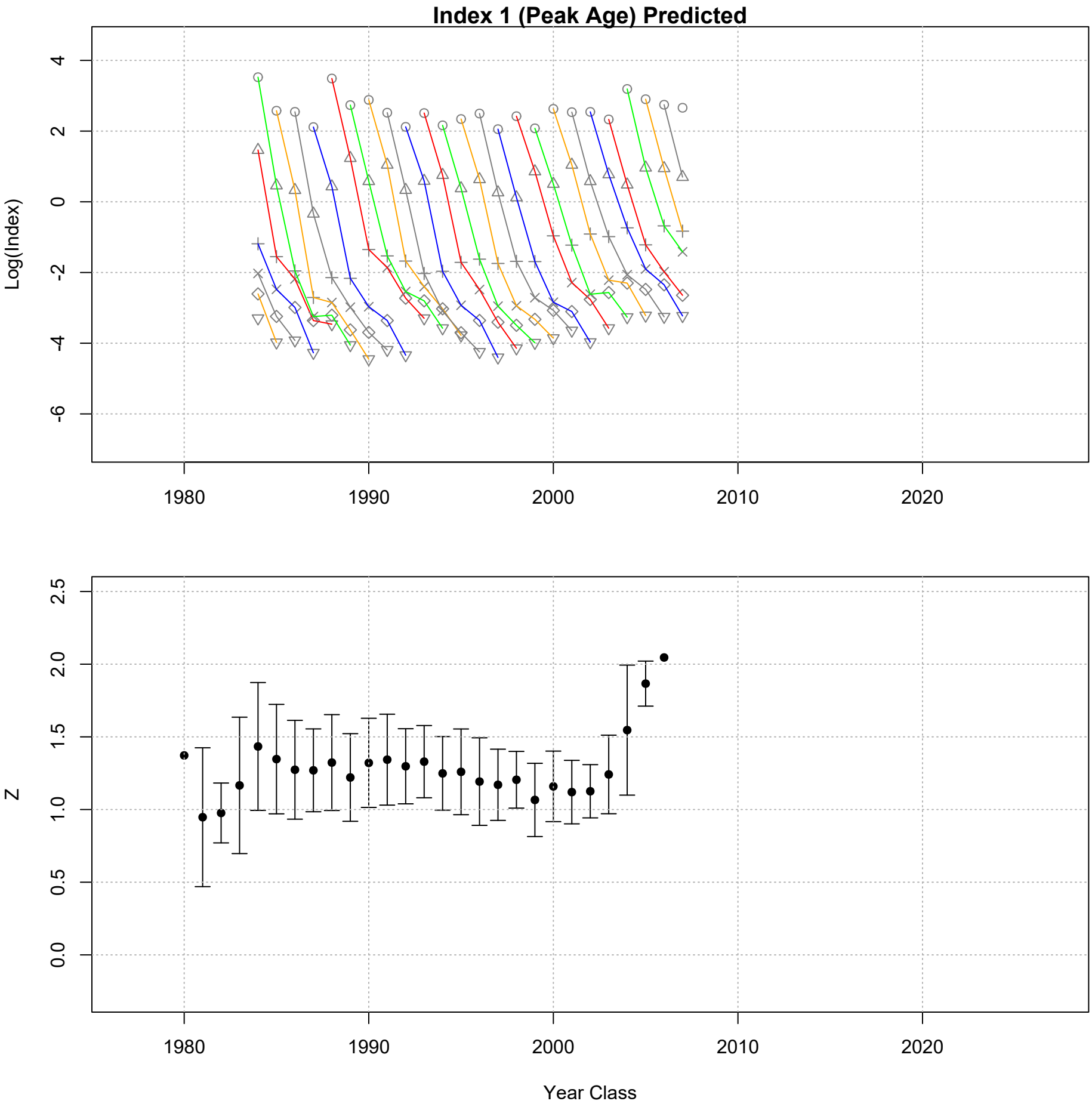

Catch for Fleet 1 (Peak Age) Observed
Log(Catch)
3
4
5
6
7
8
9
1980
1990
2000
2010
2020
Z
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010
2020
Year Class

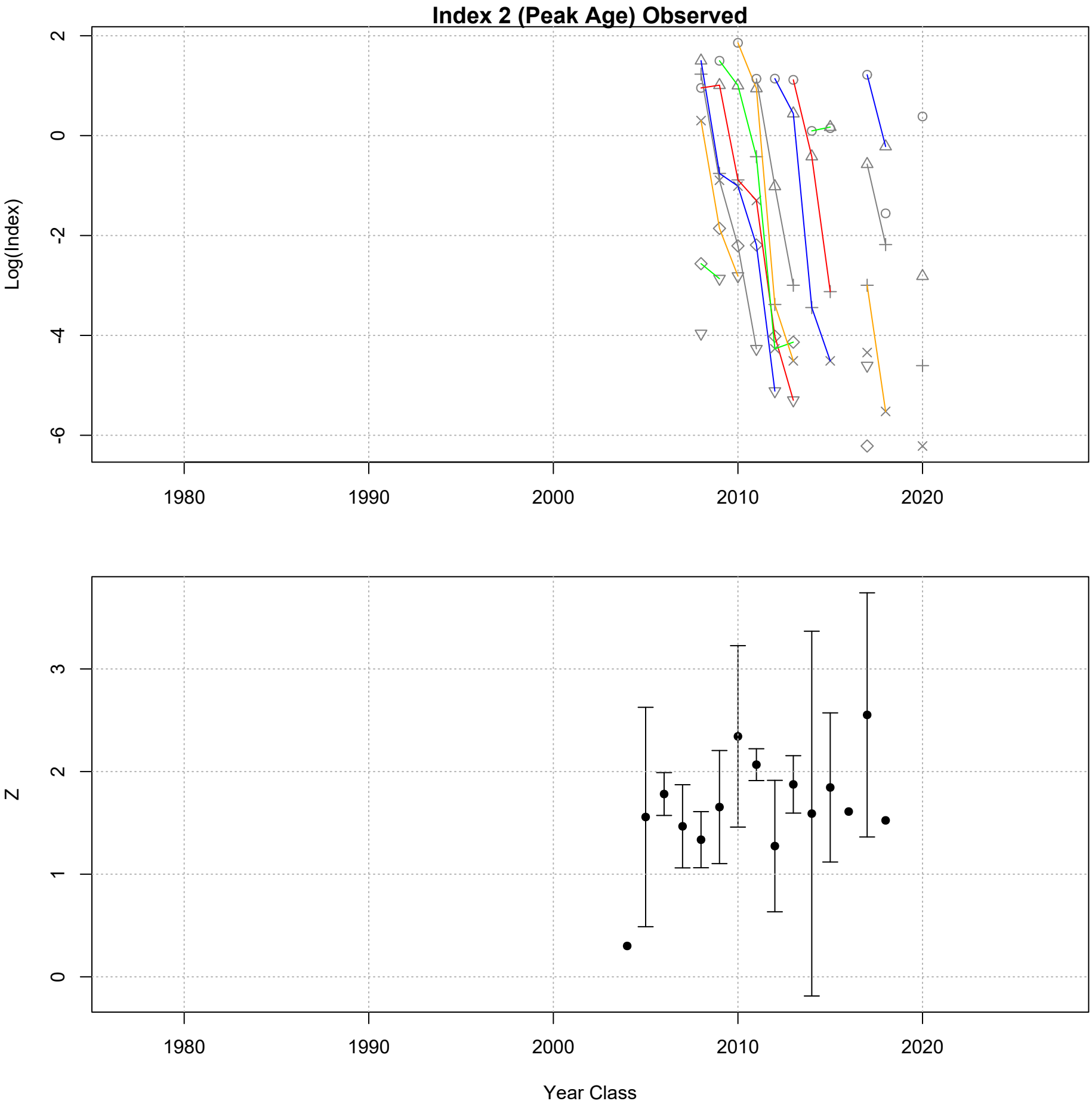

Catch for Fleet 1 (Peak Age) Predicted
Log(Catch)
9
8
7
6
5
4
3
1980
1990
2000
2010
2020
Z
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1980
1990
2000
2010
2020
Year Class

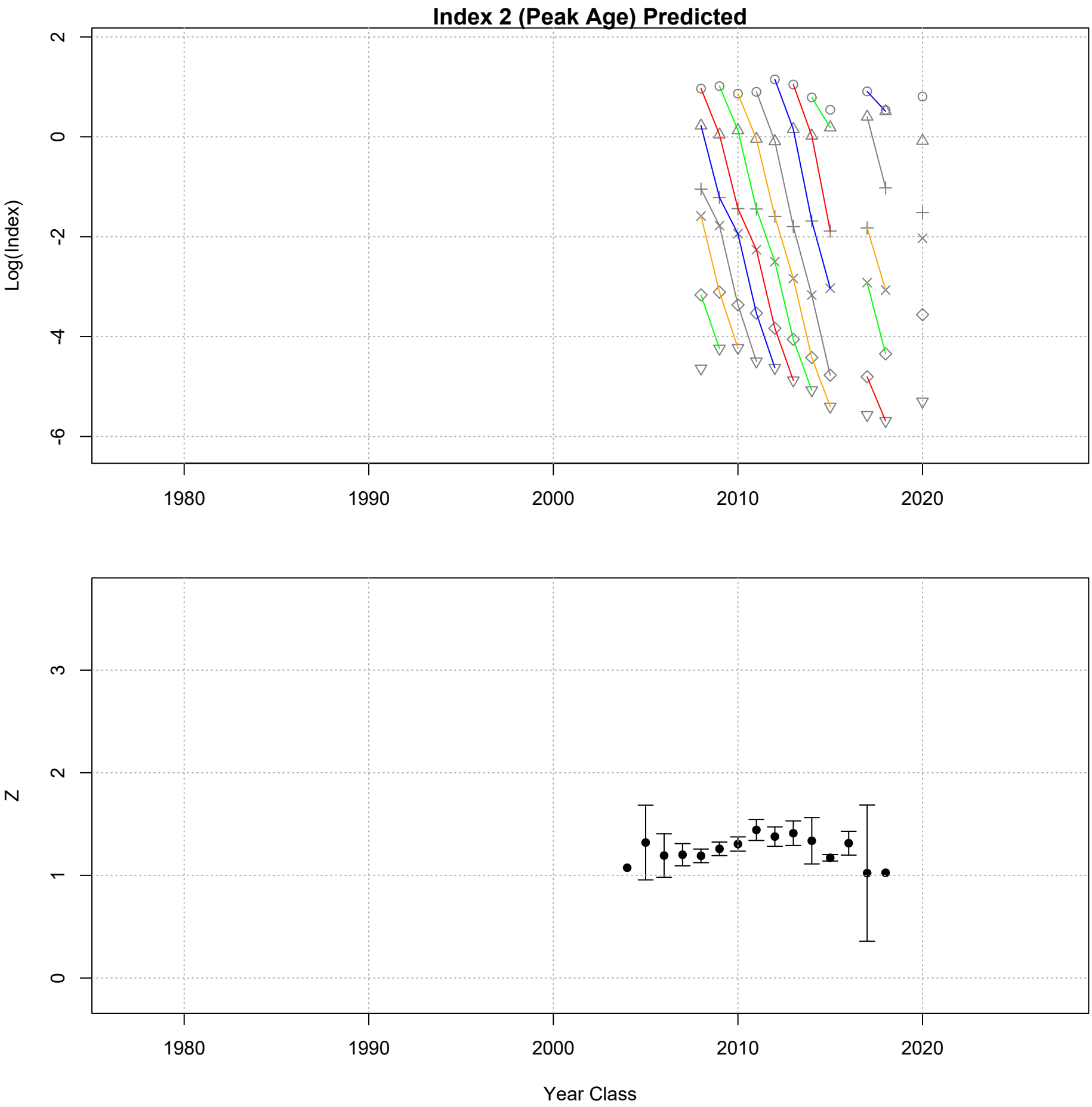

Catch for Fleet 2 (Peak Age) Observed
Log(Catch)
10
9
8
7
6
5
1980
1990
2000
2010
2020
Z
2.0
1.5
1.0
0.5
0.0
1980
1990
2000
2010
2020
Year Class

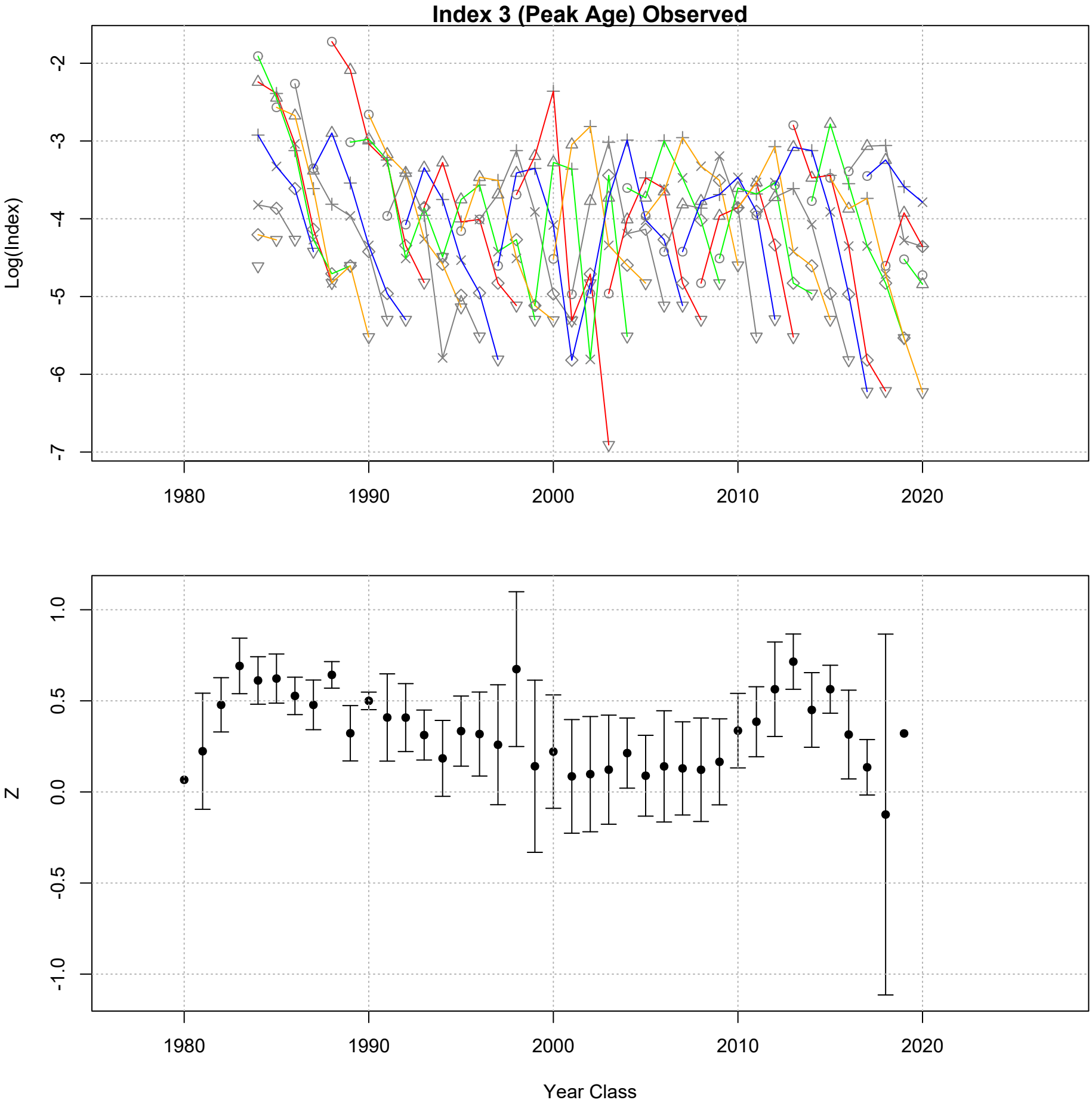

Catch for Fleet 2 (Peak Age) Predicted
Log(Catch)
10
9
8
7
6
5
1980
1990
2000
2010
2020
Z
2.0
1.5
1.0
0.5
0.0
1980
1990
2000
2010
2020
Year Class

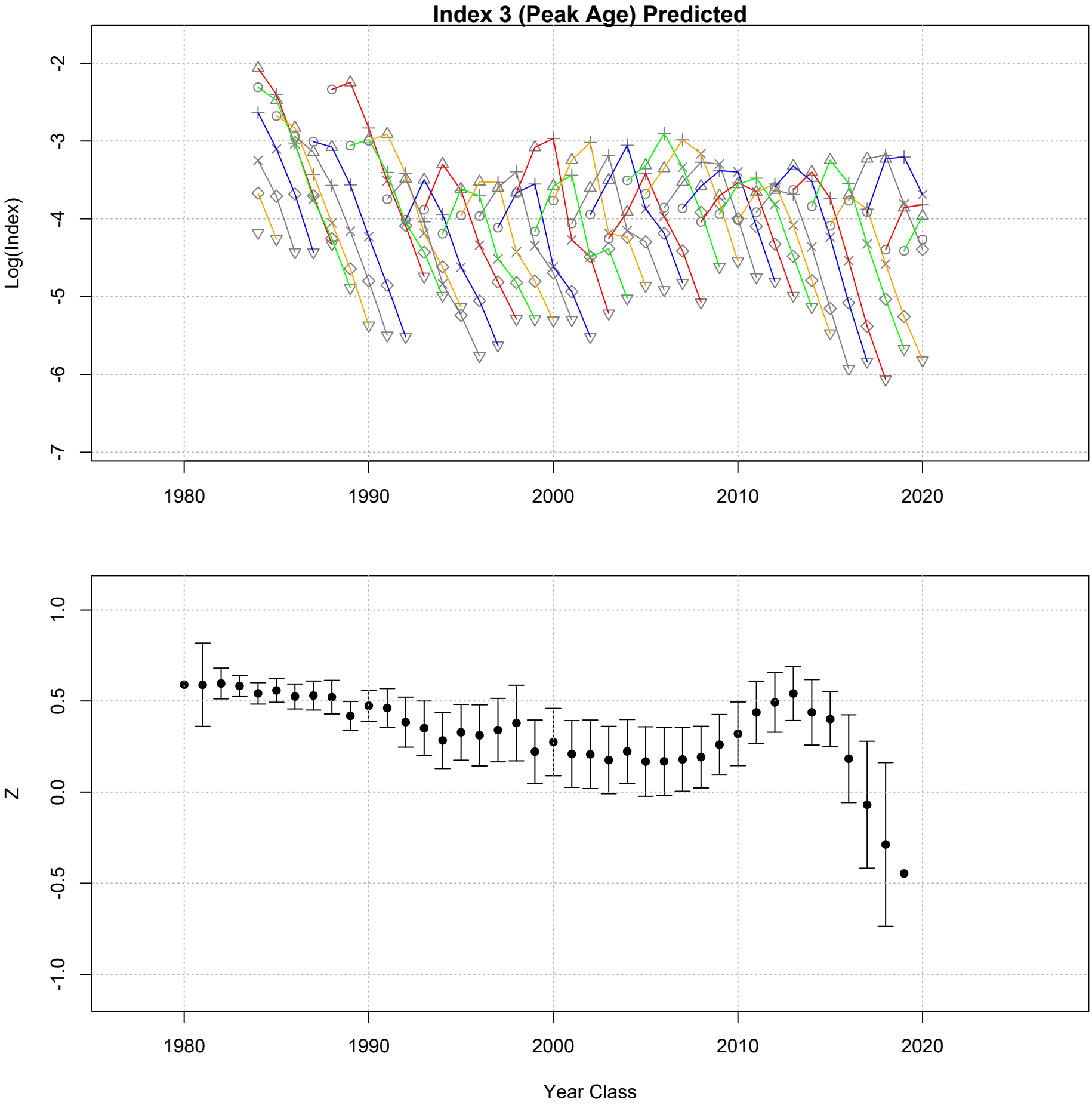

Index 1 (Peak Age) Observed
Log(Index)
4
2
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
2.5
2.0
1.5
1.0
0.5
0.0
1980
1990
2000
2010
2020
Year Class

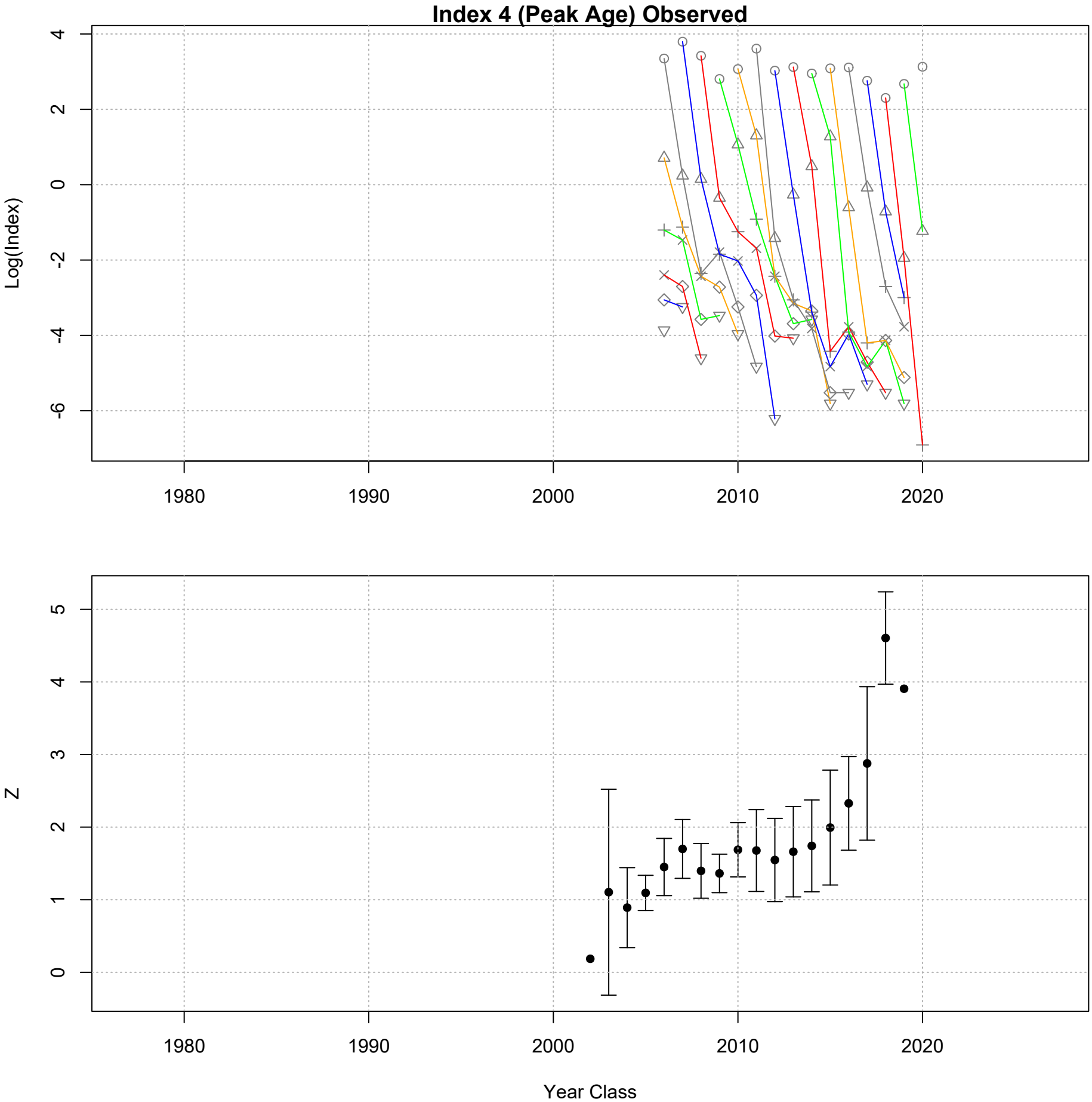

Index 1 (Peak Age) Predicted
Log(Index)
4
2
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
2.5
2.0
1.5
1.0
0.5
0.0
1980
1990
2000
2010
2020
Year Class

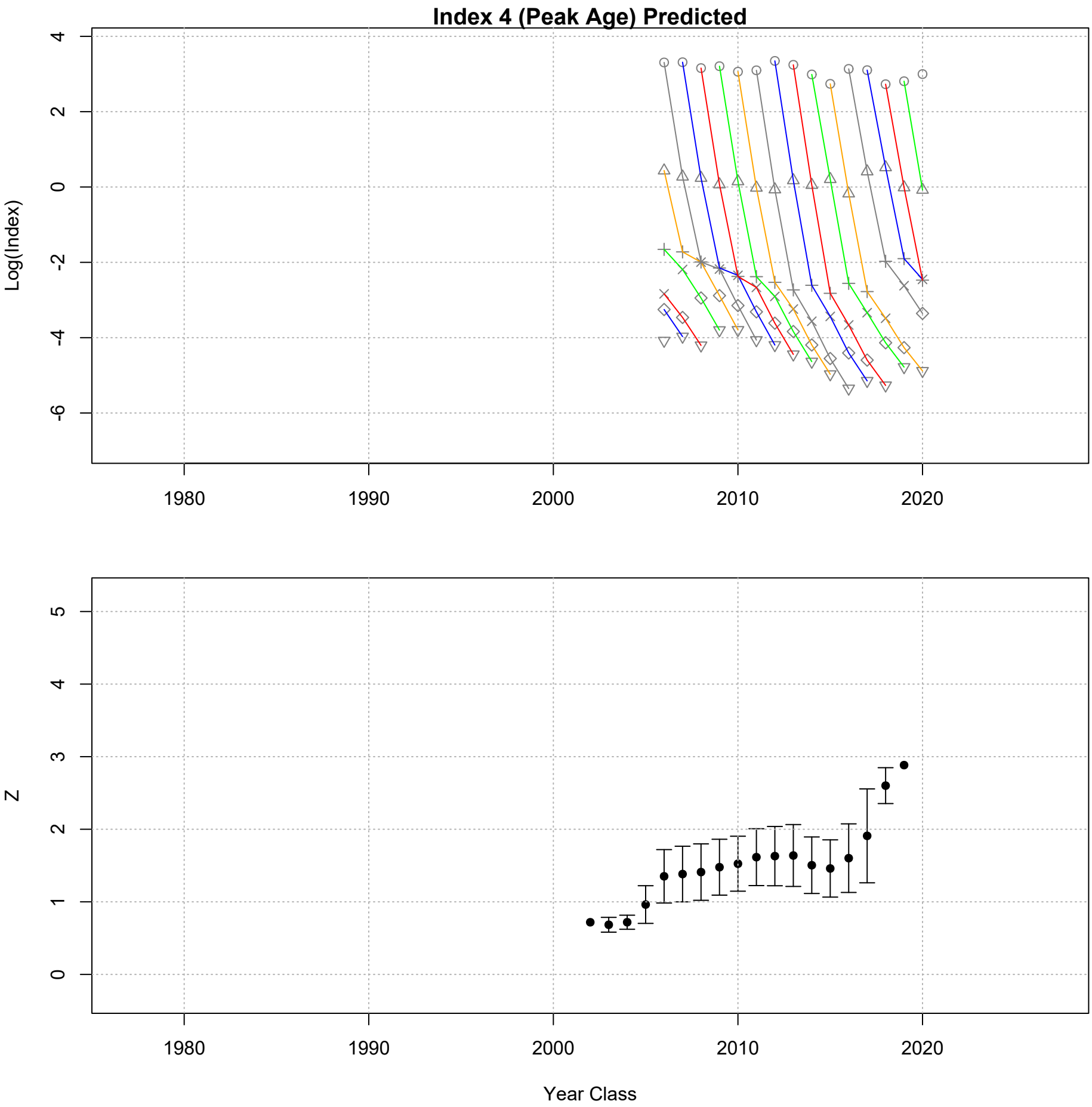

Index 2 (Peak Age) Observed
Log(Index)
2
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
3
2
1
0
1980
1990
2000
2010
2020
Year Class

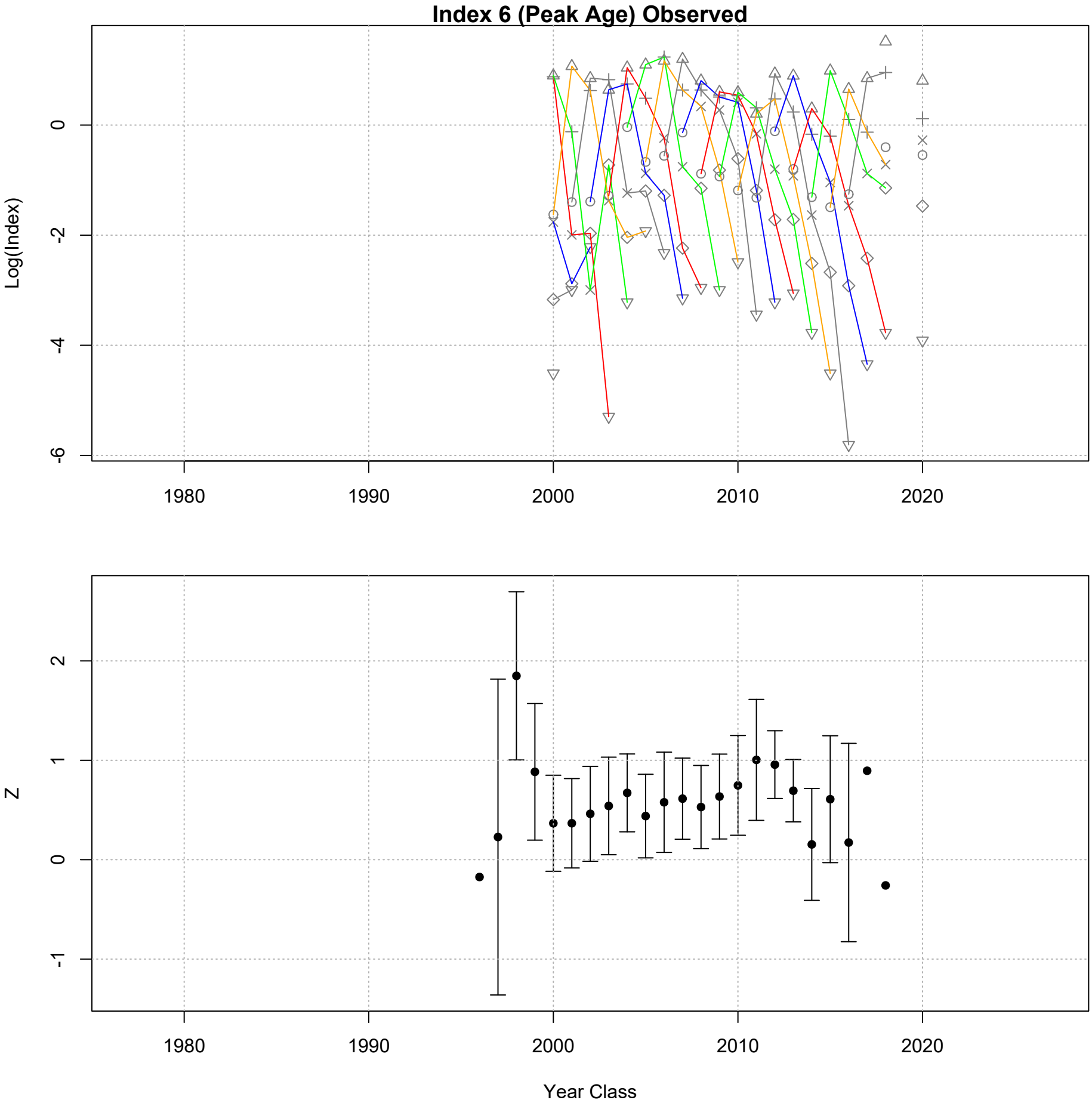

Index 2 (Peak Age) Predicted
Log(Index)
2
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
3
2
1
0
1980
1990
2000
2010
2020
Year Class

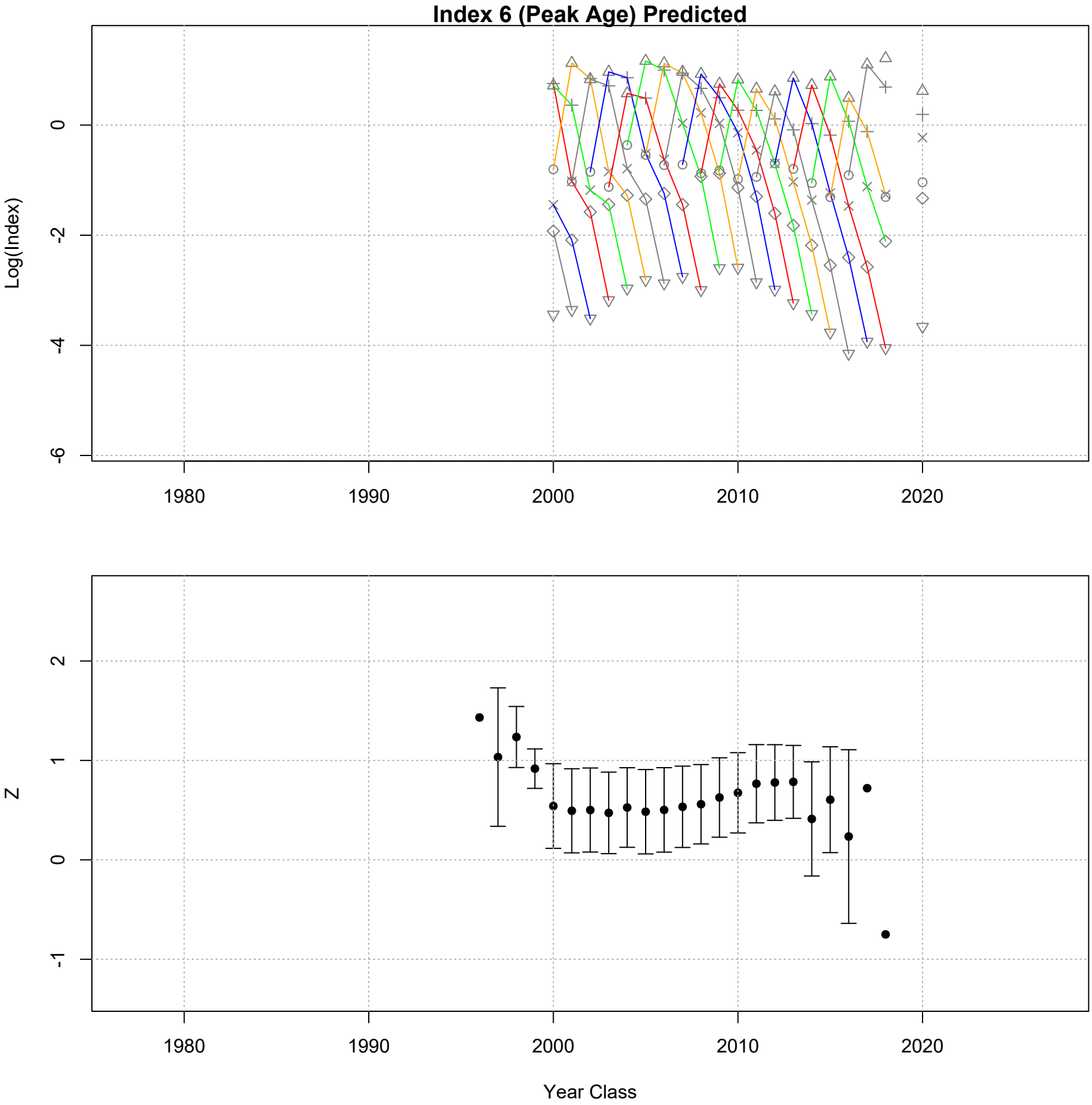

Index 3 (Peak Age) Observed
Log(Index)
-2
-3
-4
-5
-6
-7
1980
1990
2000
2010
2020
Z
1.0
0.5
0.0
-0.5
-1.0
1980
1990
2000
2010
2020
Year Class

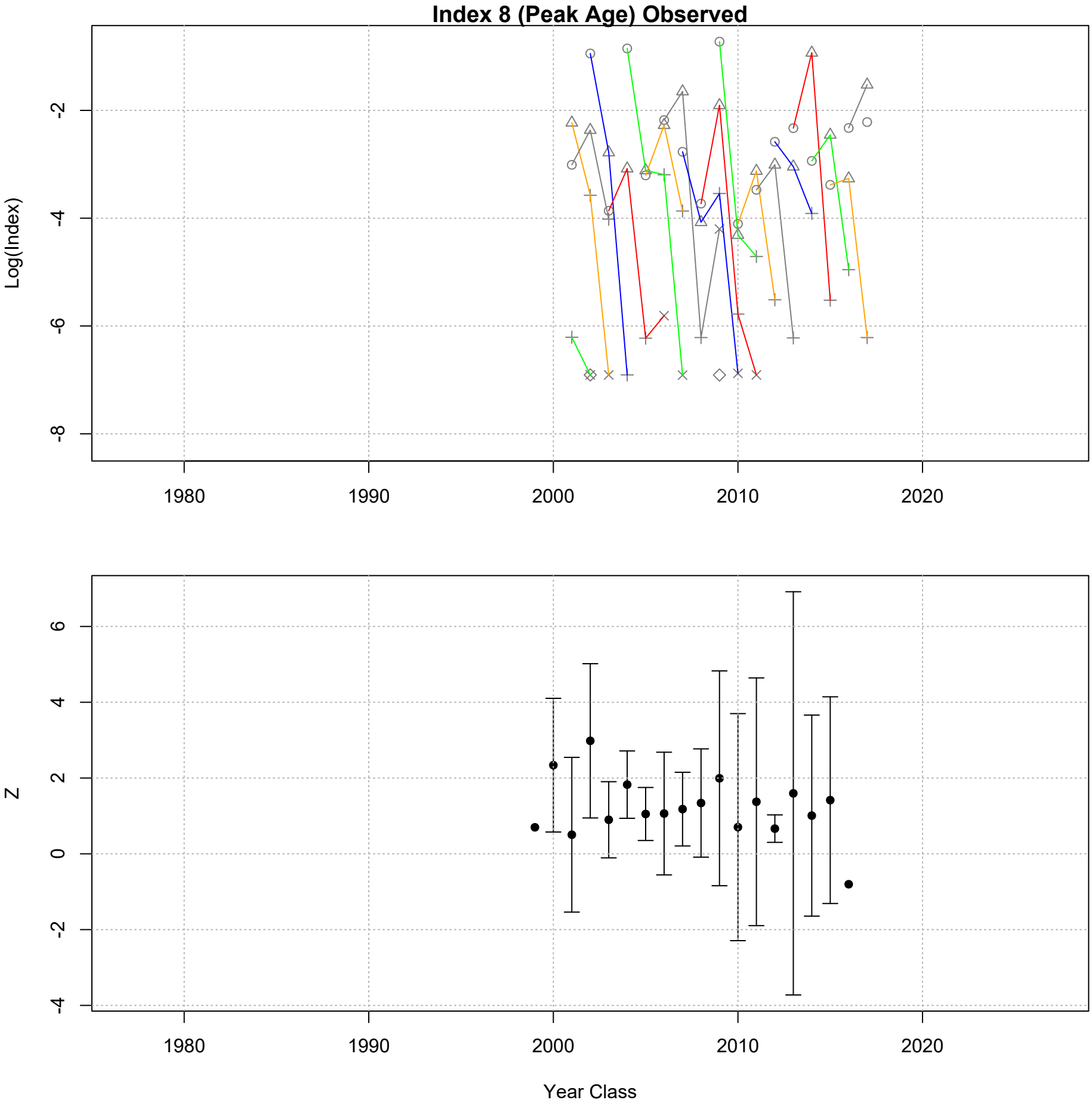

Index 3 (Peak Age) Predicted
Log(Index)
-2
-3
-4
-5
-6
-7
1980
1990
2000
2010
2020
Z
1.0
0.5
0.0
-0.5
-1.0
1980
1990
2000
2010
2020
Year Class

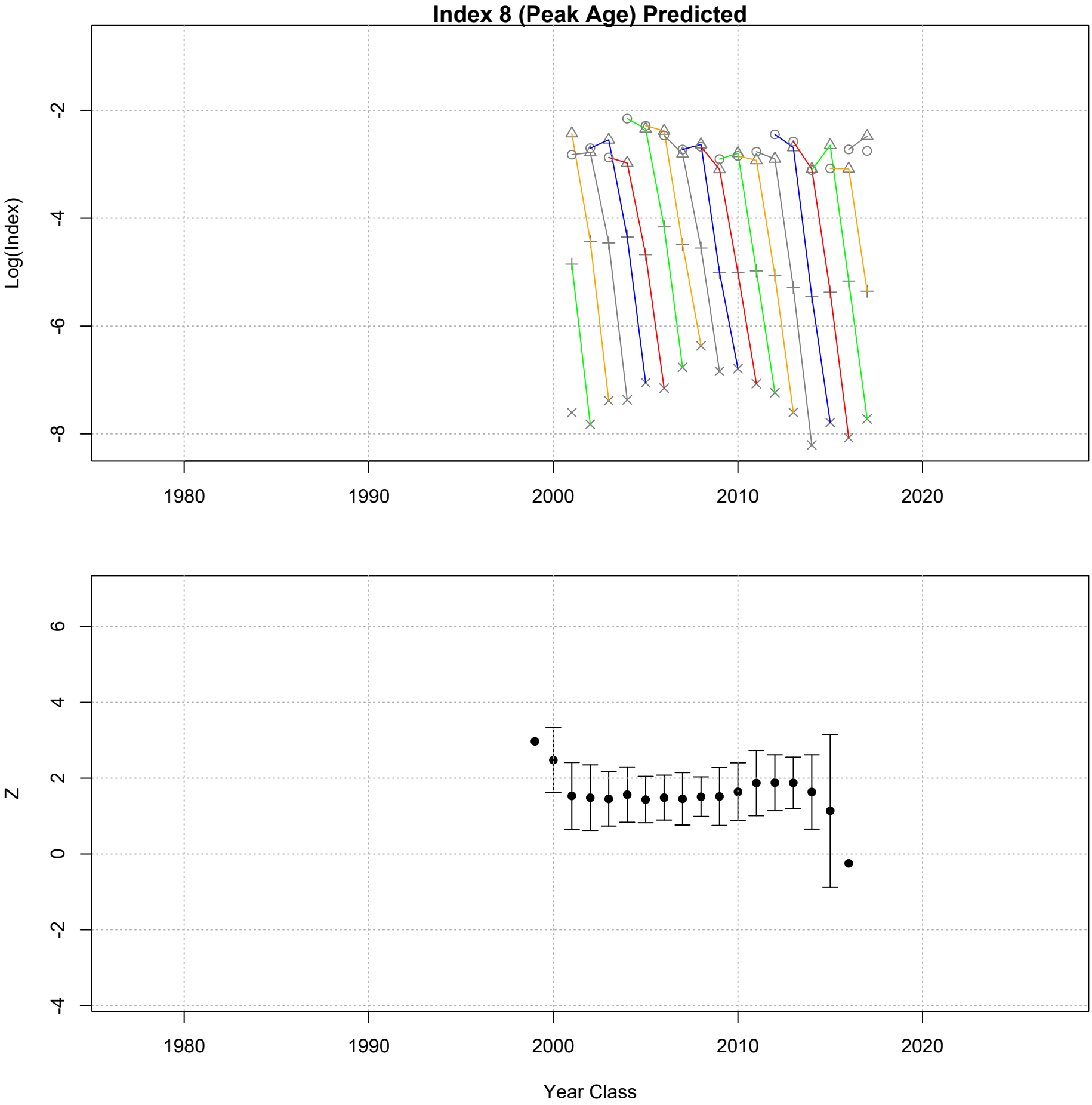

Index 4 (Peak Age) Observed
Log(Index)
4
2
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
5
4
3
2
1
0
1980
1990
2000
2010
2020
Year Class

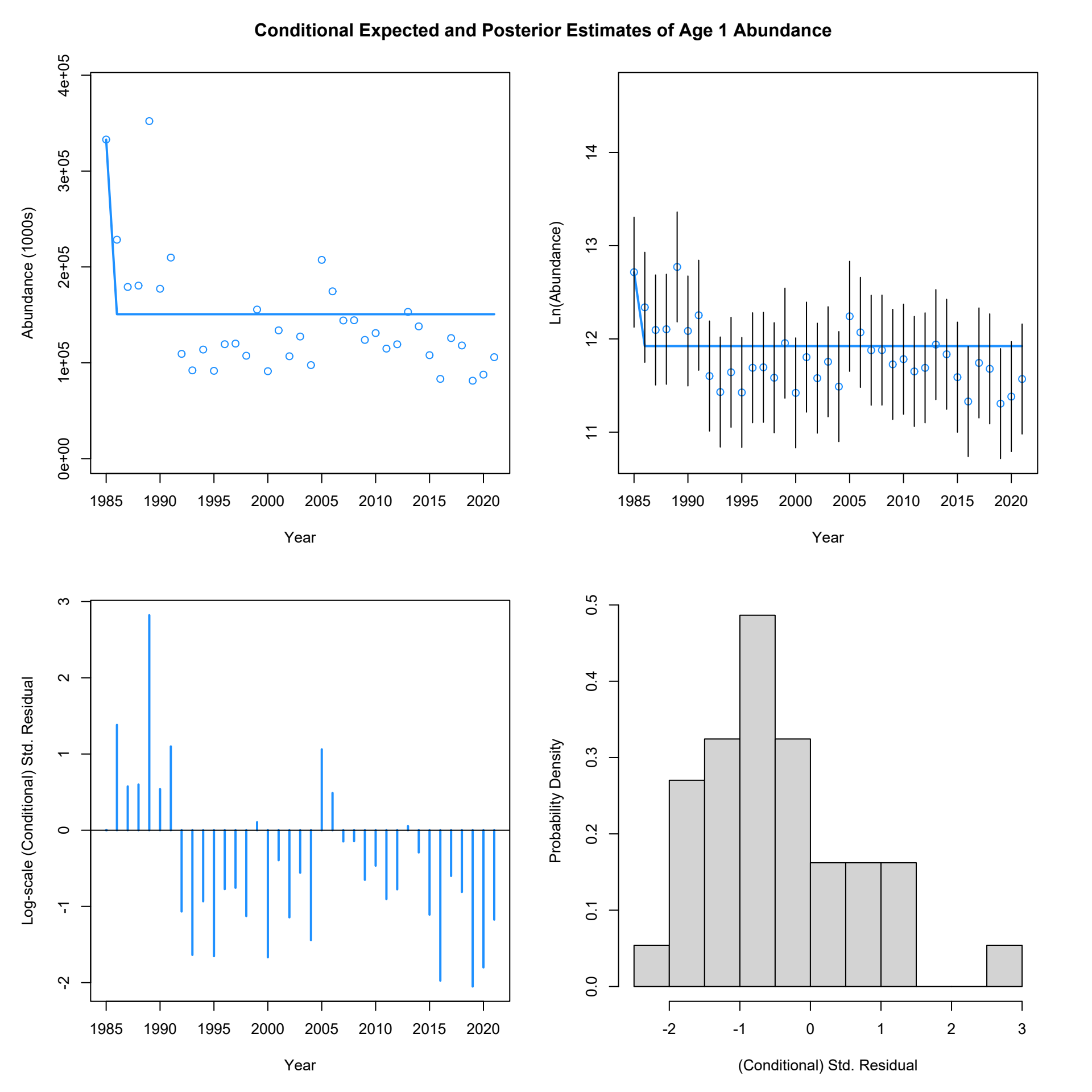

Index 4 (Peak Age) Predicted
Log(Index)
4
2
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
5
4
3
2
1
0
1980
1990
2000
2010
2020
Year Class


Index 6 (Peak Age) Observed
Log(Index)
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
2
1
0
-1
1980
1990
2000
2010
2020
Year Class

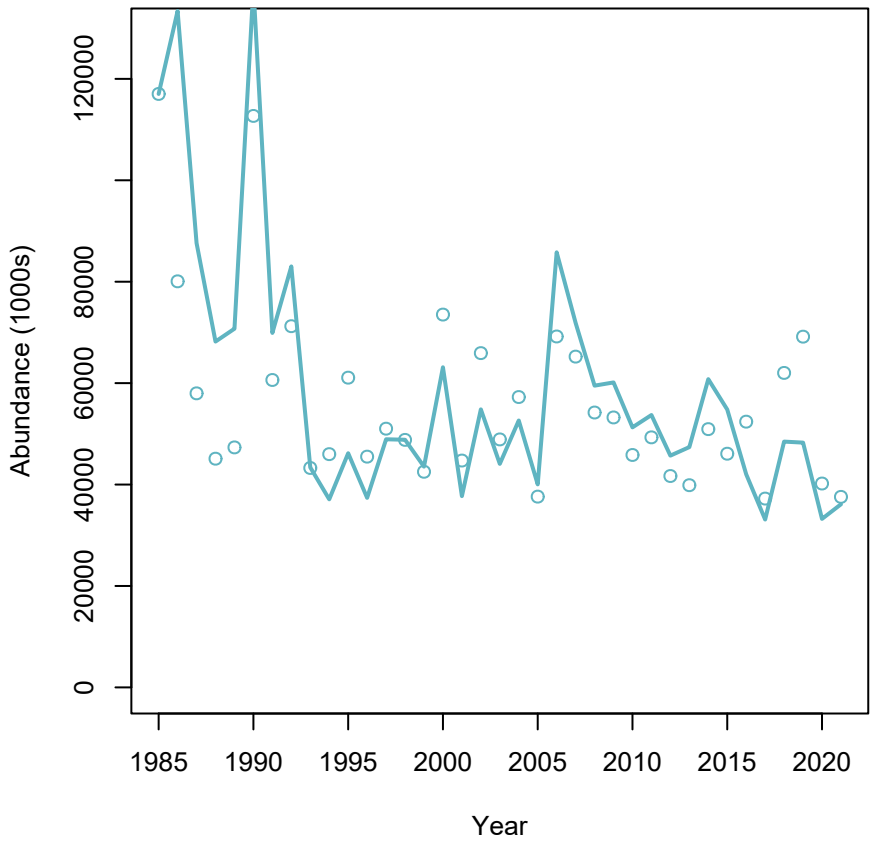

Index 6 (Peak Age) Predicted
Log(Index)
0
-2
-4
-6
1980
1990
2000
2010
2020
Z
2
1
0
-1
1980
1990
2000
2010
2020
Year Class

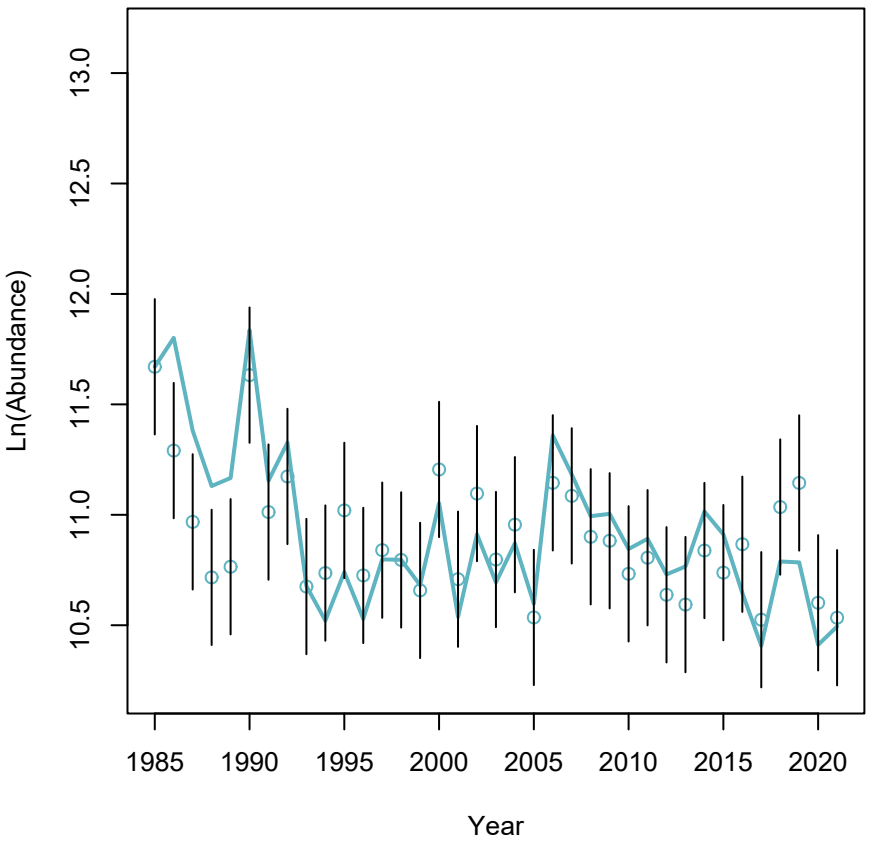

Index 8 (Peak Age) Observed
Log(Index)
-2
-4
-6
-8
1980
1990
2000
2010
2020
Z
6
4
2
0
-2
-4
1980
1990
2000
2010
2020
Year Class

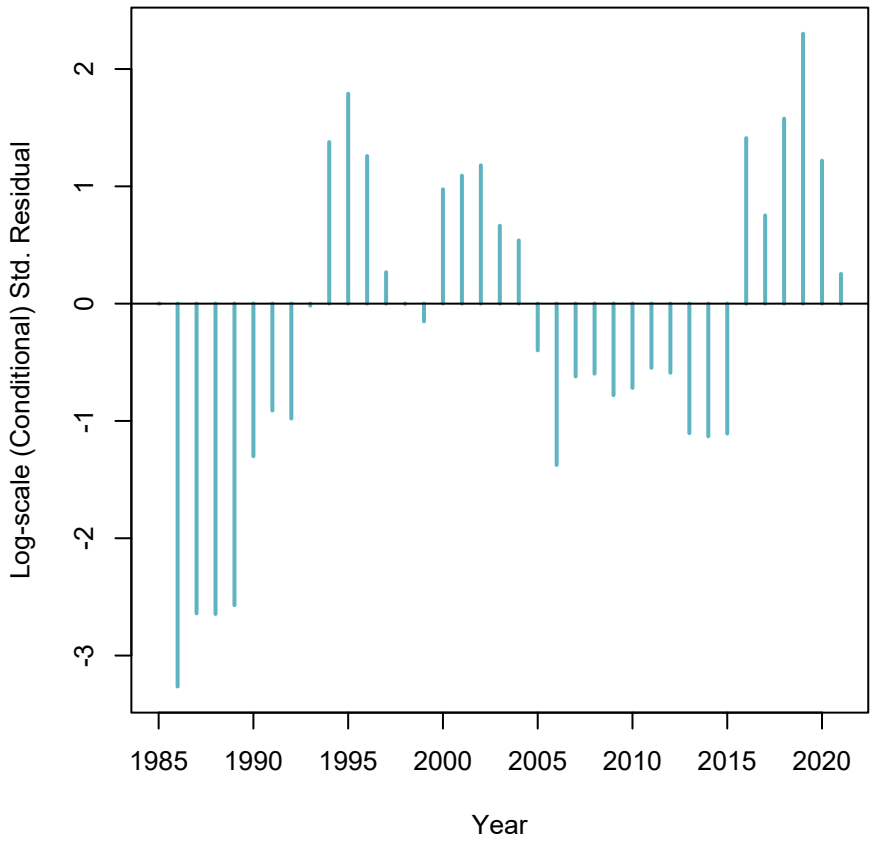

Index 8 (Peak Age) Predicted
Log(Index)
-2
-4
-6
-8
1980
1990
2000
2010
2020
Z
6
4
2
0
-2
-4
1980
1990
2000
2010
2020
Year Class

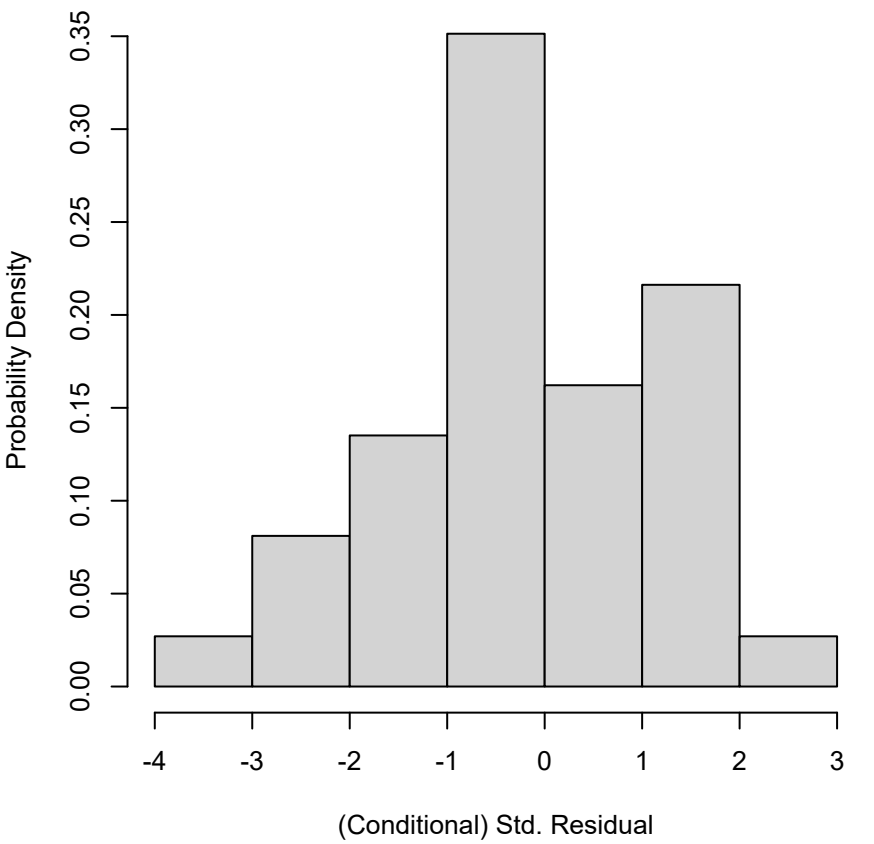

Conditional Expected and Posterior Estimates of Age 1 Abundance
Abundance (1000s)
0e+00
1e+05
2e+05
3e+05
4e+05
1985
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Abundance)
11
12
13
14
Log-scale (Conditional) Std. Residual
-2
-1
0
1
2
3
Probability Density
0.0
0.1
0.2
0.3
0.4
0.5
(Conditional) Std. Residual

Conditional Expected and Posterior Estimates of Age 2 Abundance

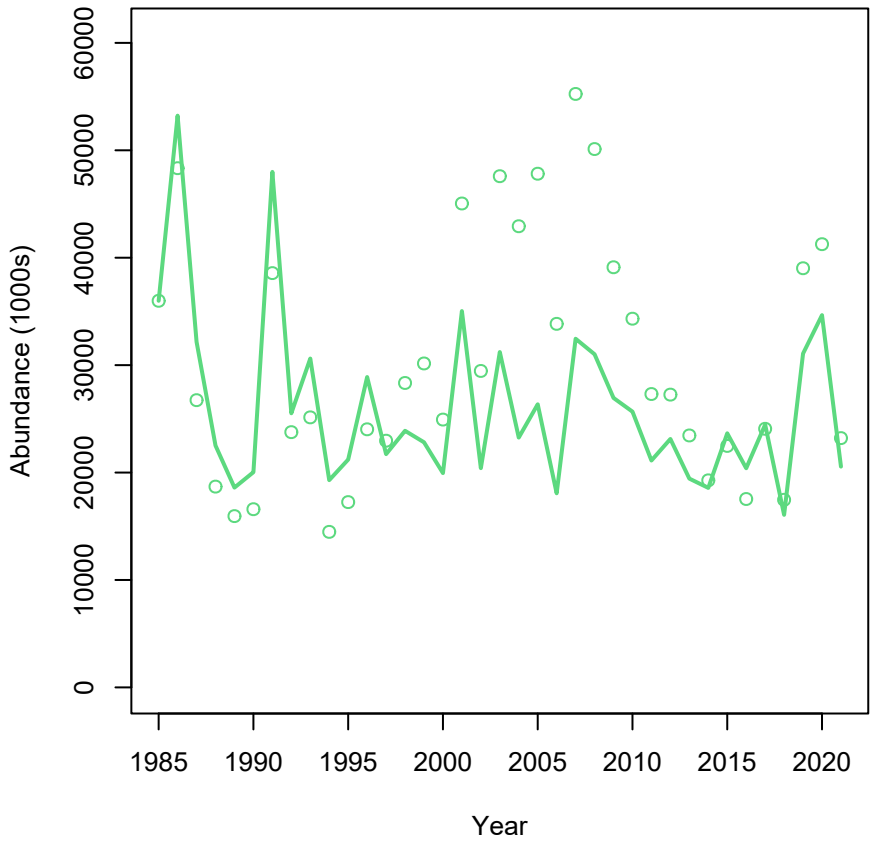


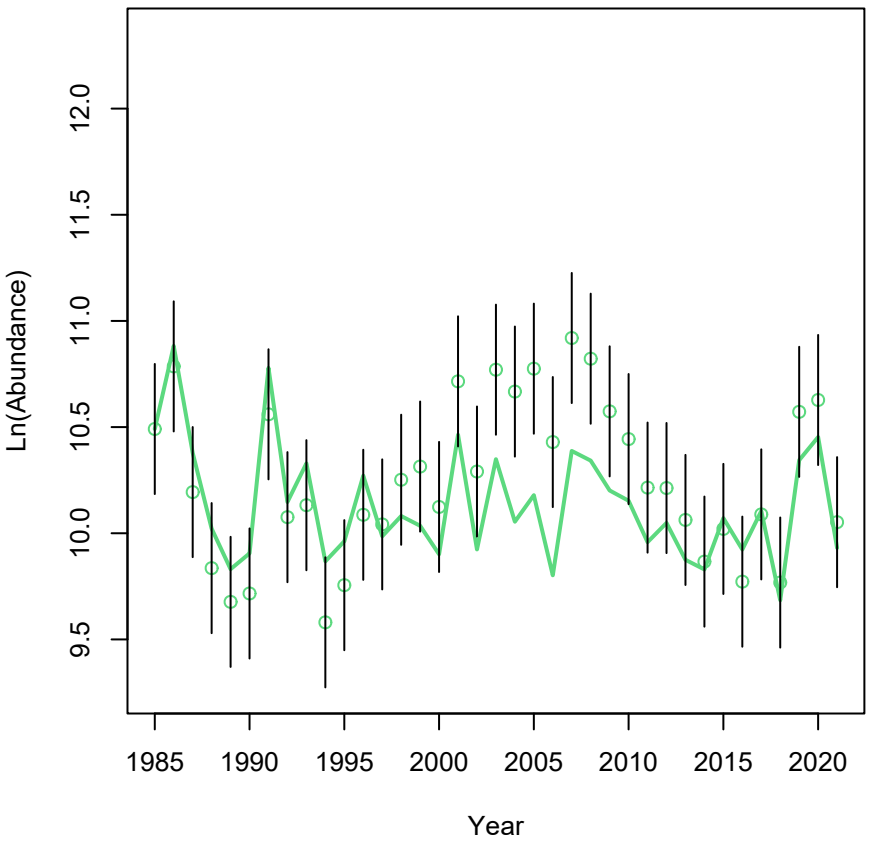


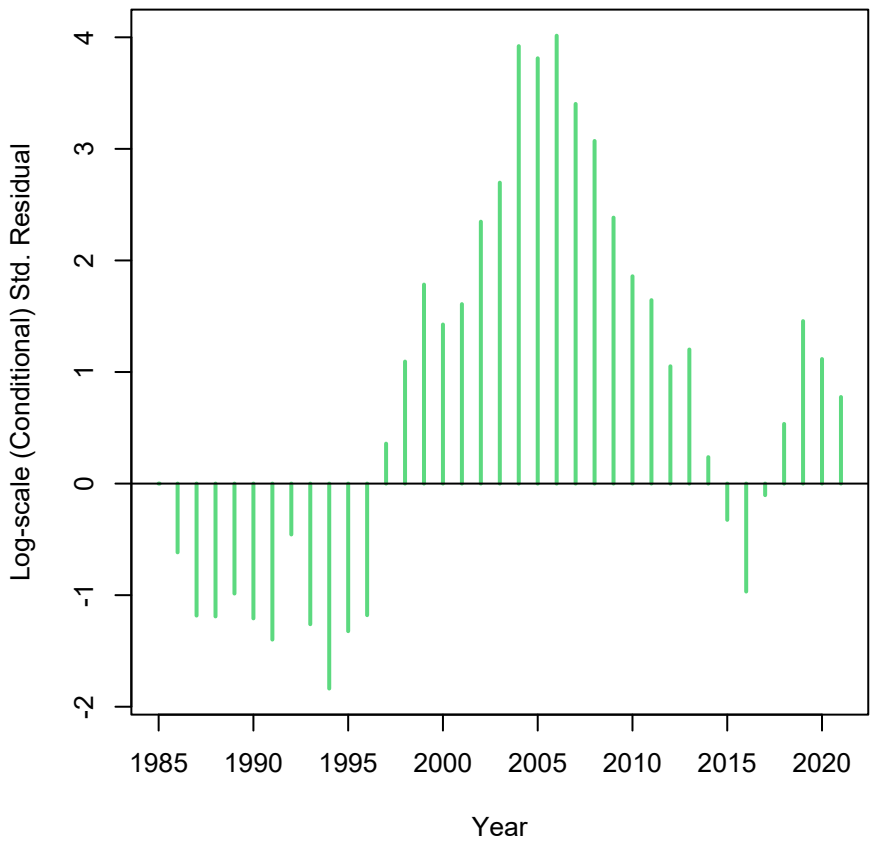


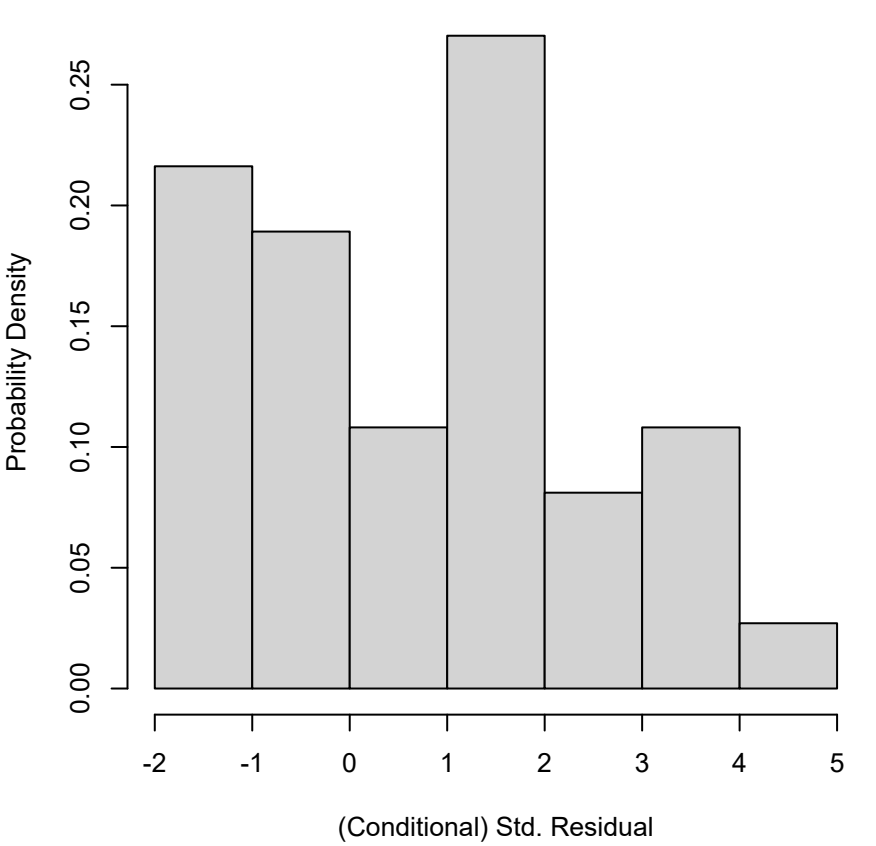


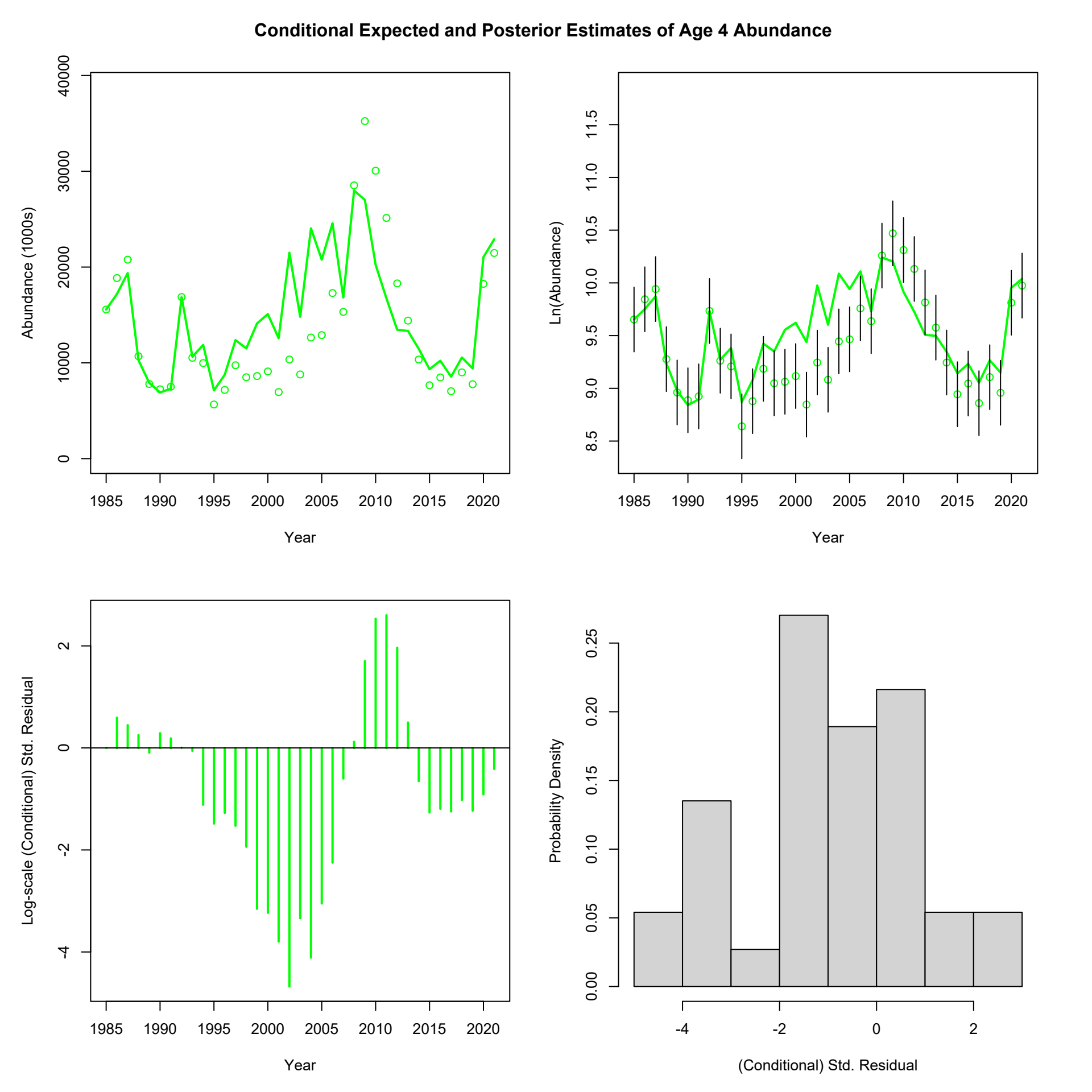
Conditional Expected and Posterior Estimates of Age 3 Abundance



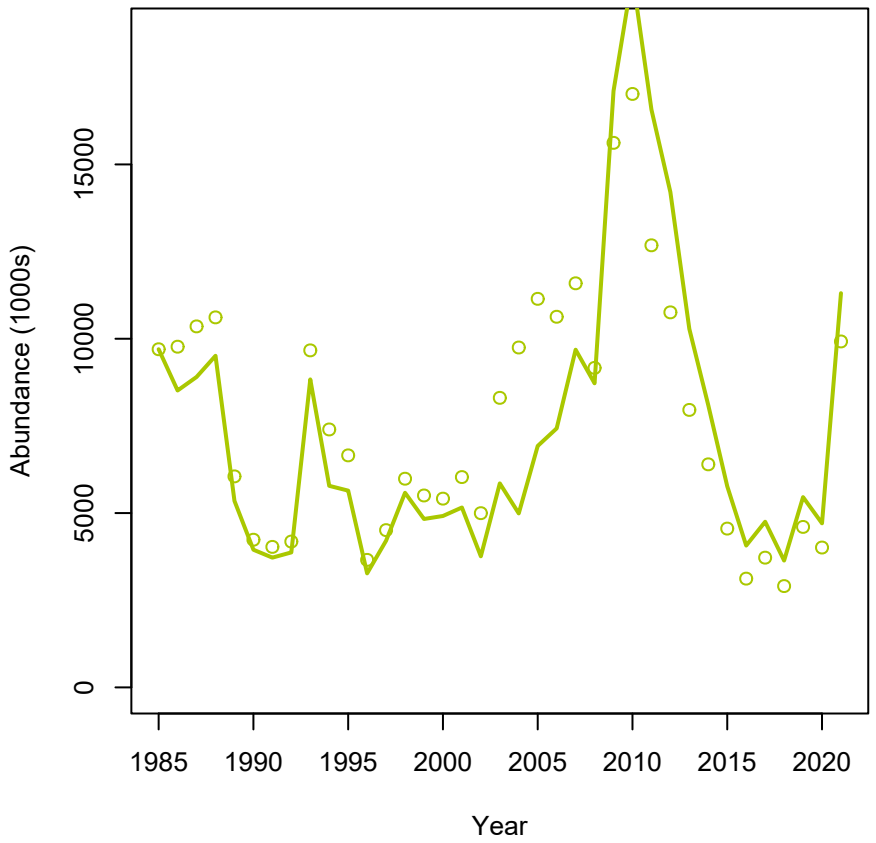


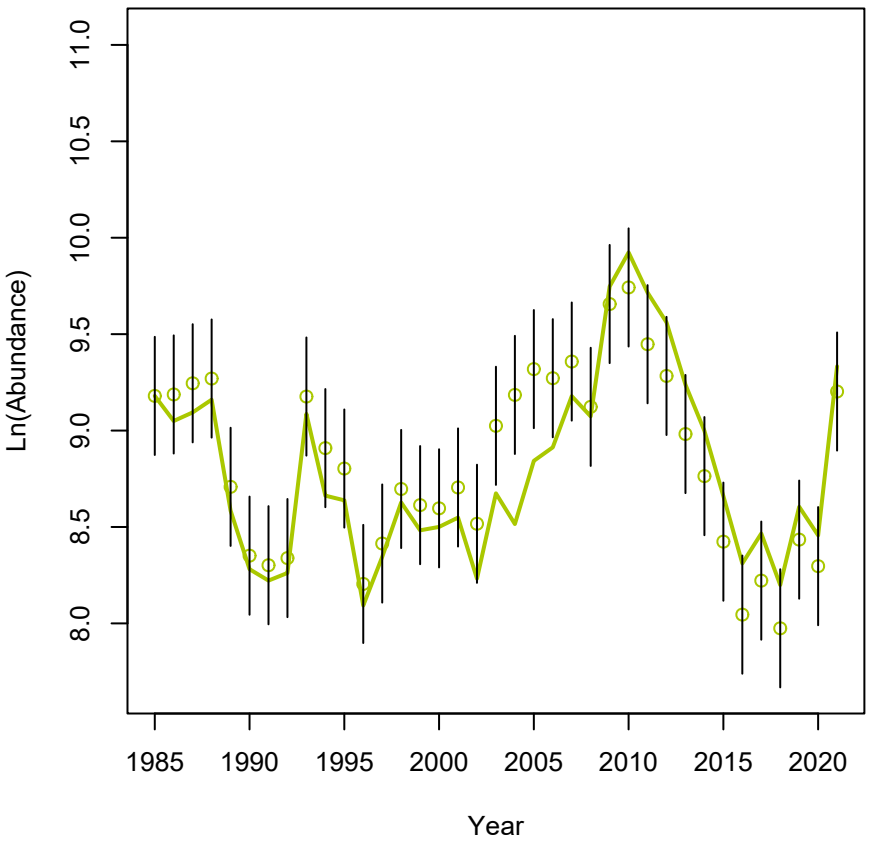


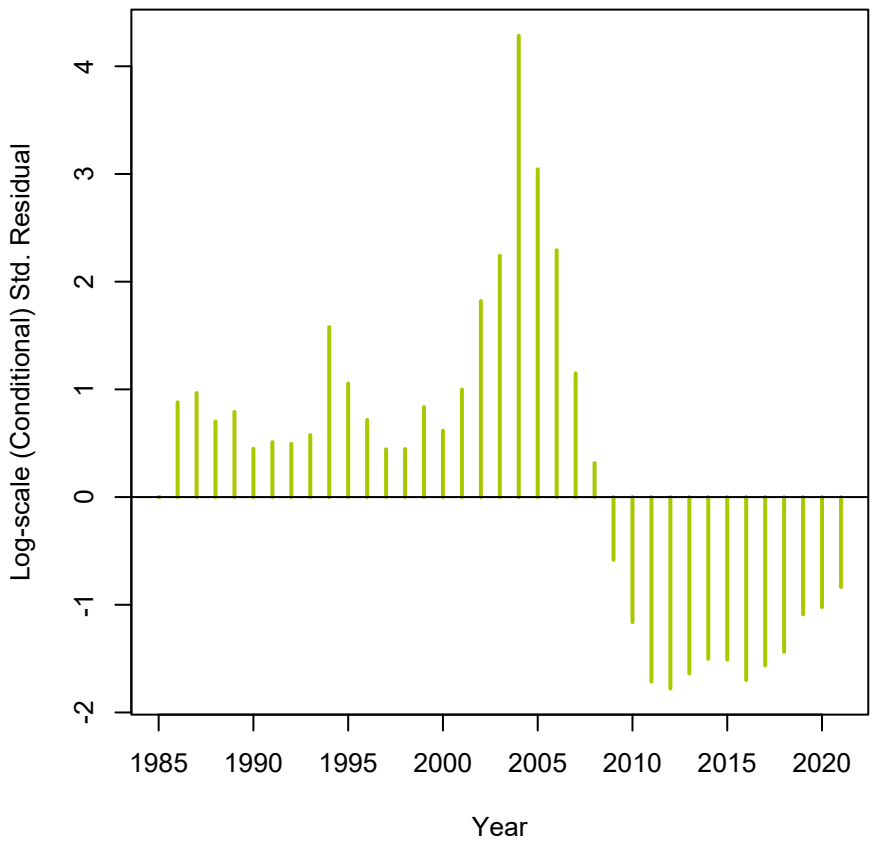


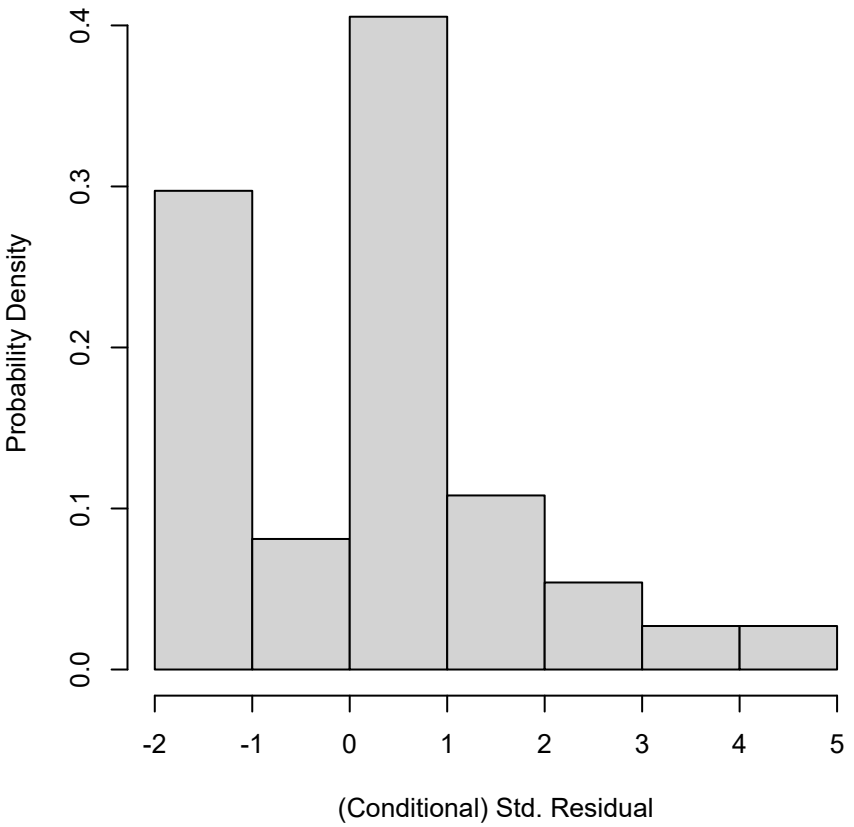

Conditional Expected and Posterior Estimates of Age 4 Abundance
Abundance (1000s)
0
10000
20000
30000
40000
1985
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Abundance)
8.5
9.0
9.5
10.0
10.5
11.0
11.5
Year
Log-scale (Conditional) Std. Residual
-4
-2
0
2
Year
Probability Density
0.00
0.05
0.10
0.15
0.20
0.25
-4
-2
0
2
(Conditional) Std. Residual

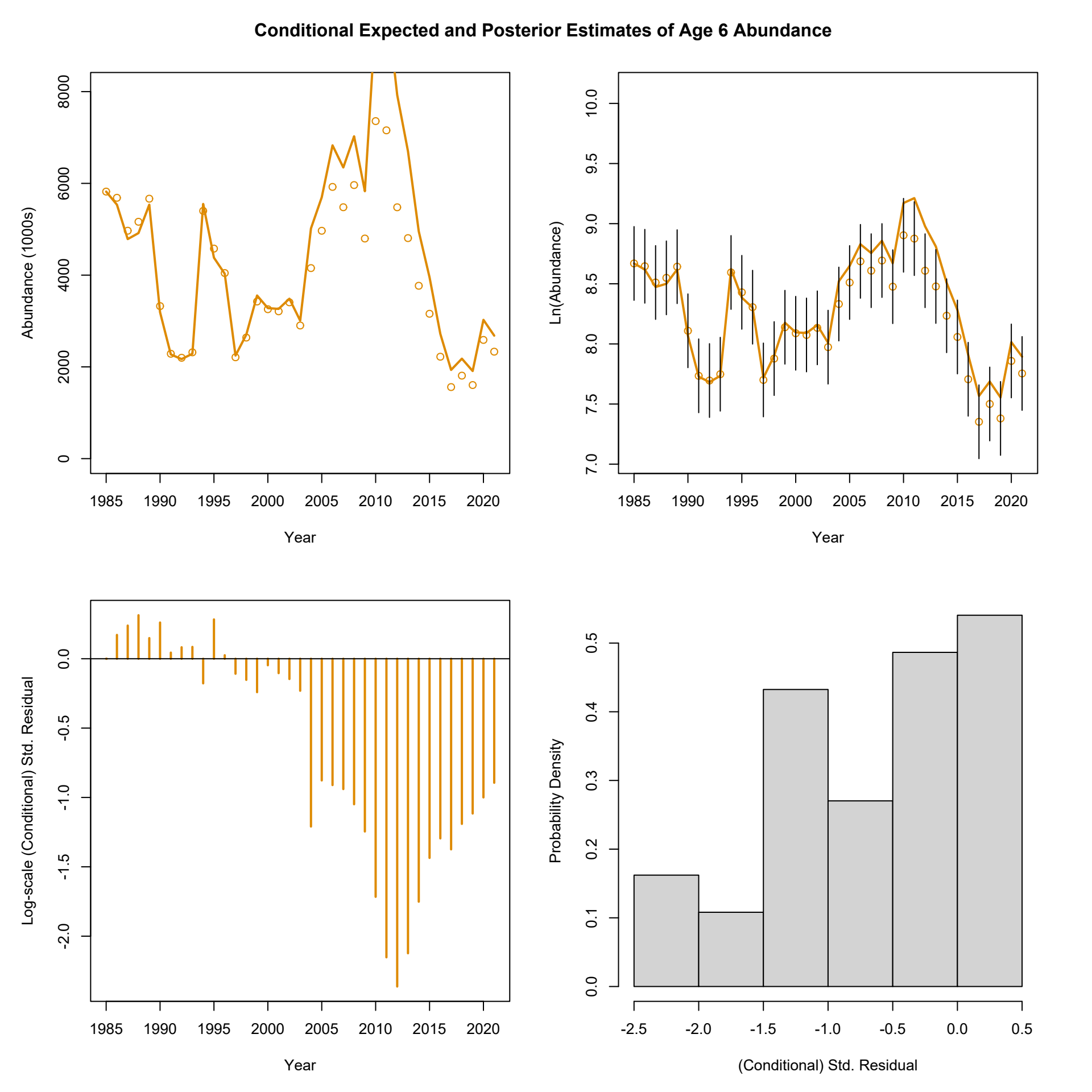
Conditional Expected and Posterior Estimates of Age 5 Abundance



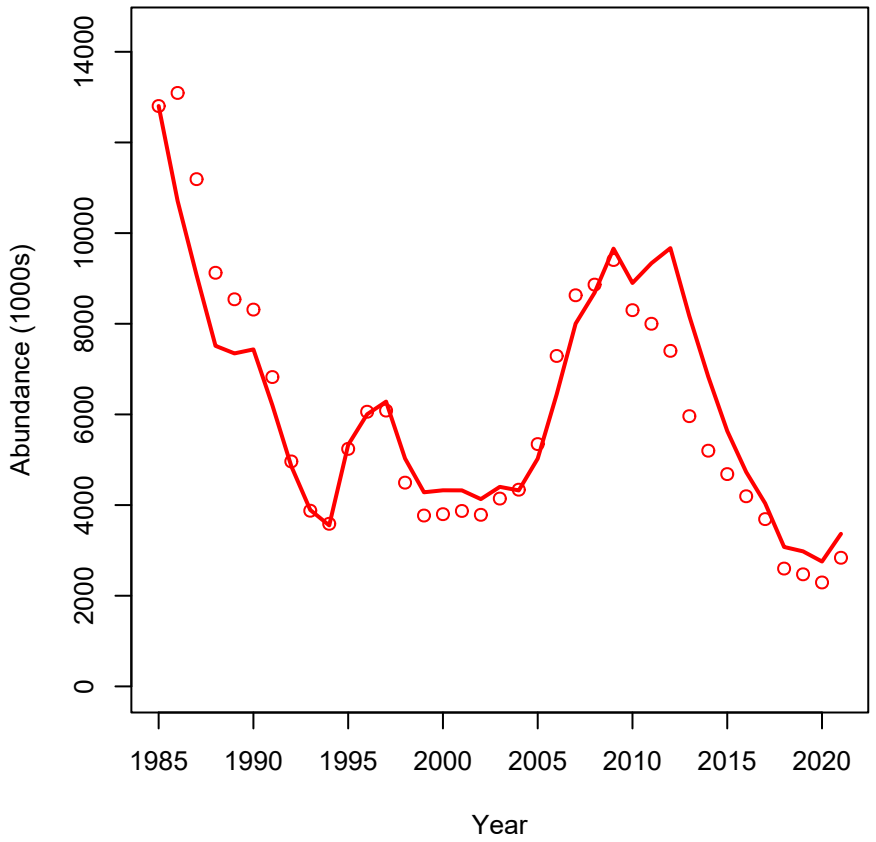


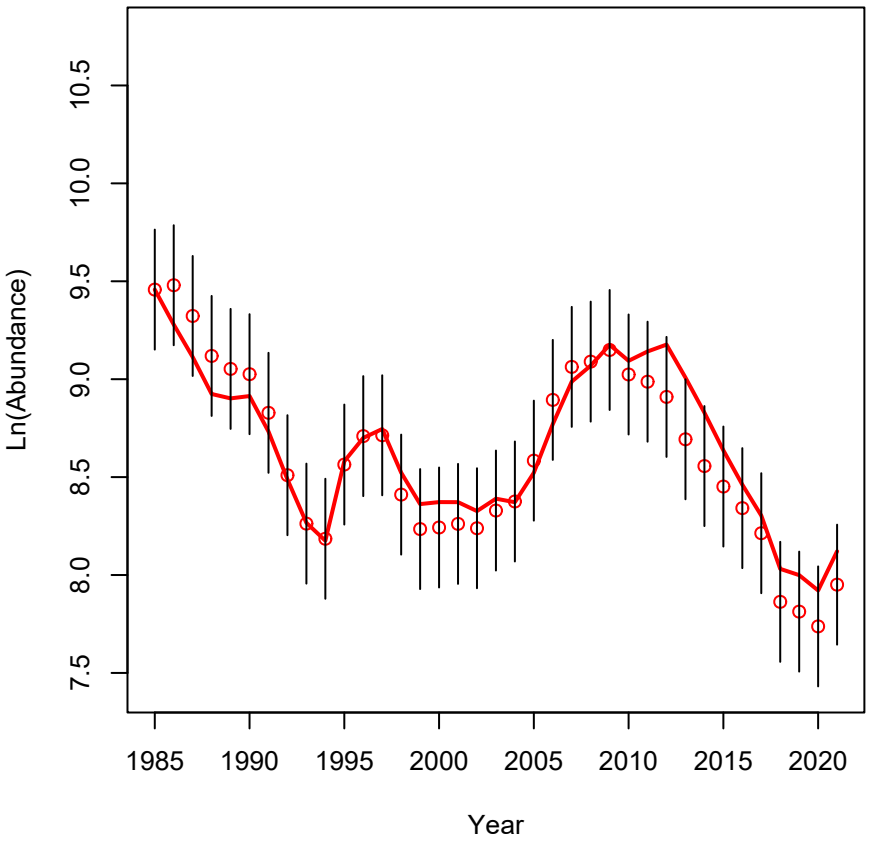


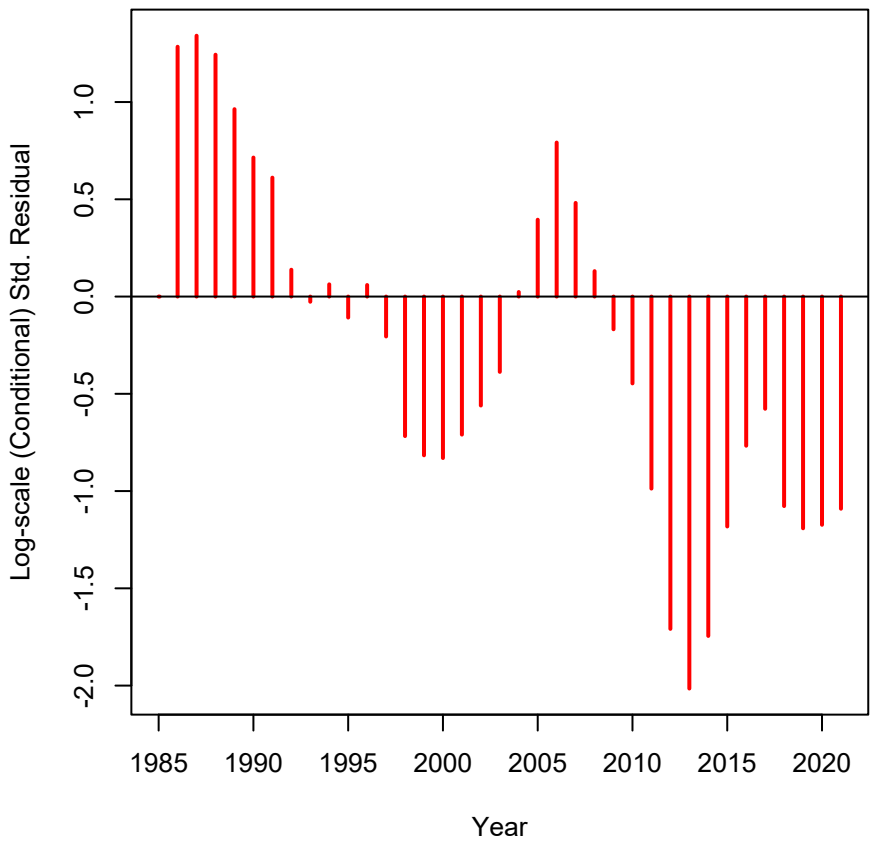


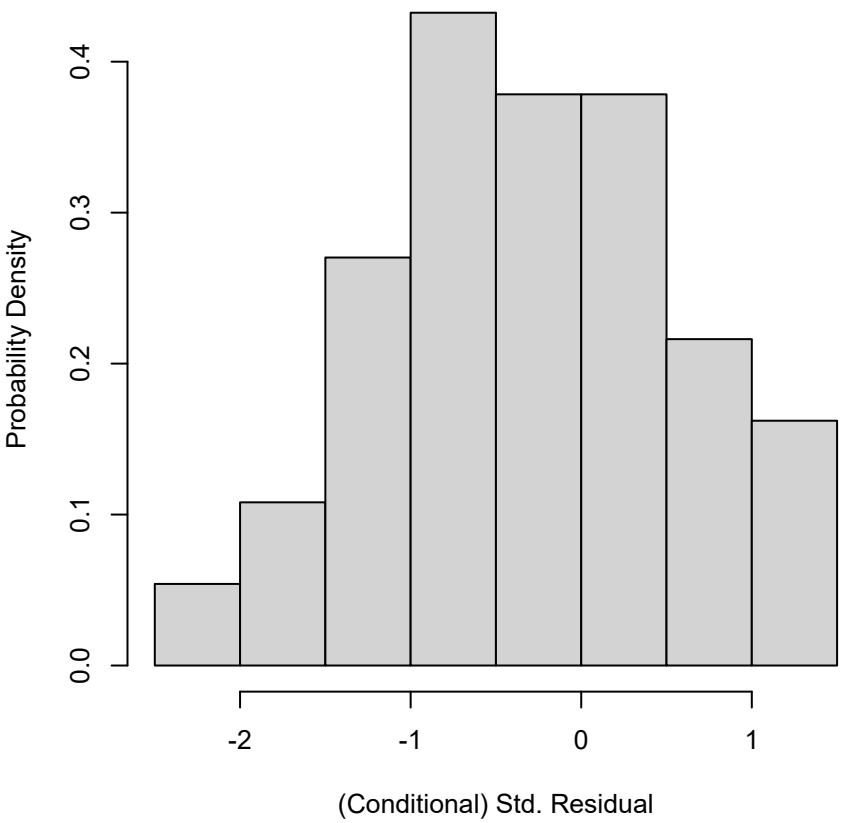

Conditional Expected and Posterior Estimates of Age 6 Abundance
Abundance (1000s)
0
2000
4000
6000
8000
1985
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Abundance)
7.0
7.5
8.0
8.5
9.0
9.5
10.0
Year
Log-scale (Conditional) Std. Residual
-2.0
-1.5
-1.0
-0.5
0.0
Year
Probability Density
0.0
0.1
0.2
0.3
0.4
0.5
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
(Conditional) Std. Residual

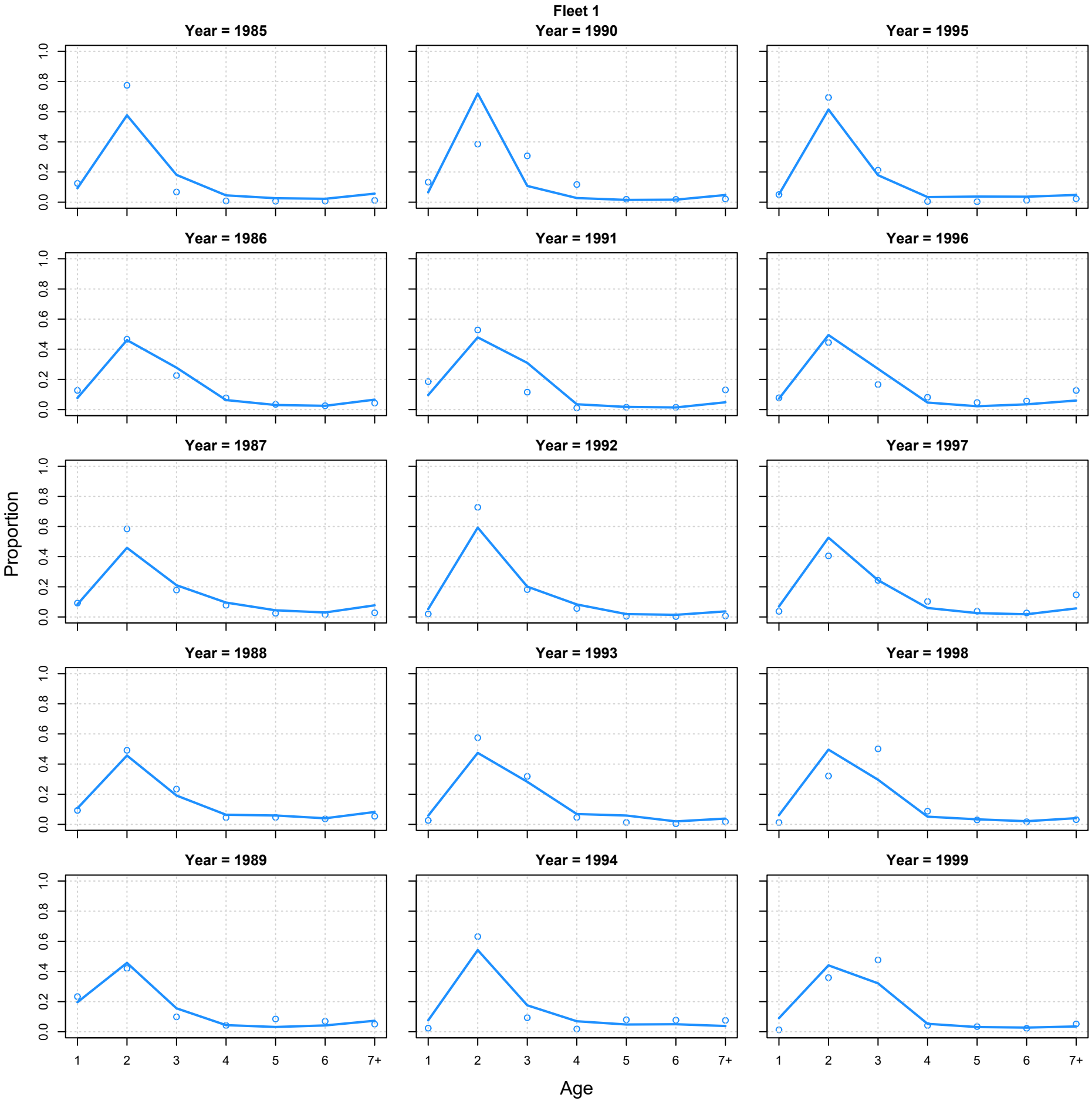
Conditional Expected and Posterior Estimates of Age 7 Abundance

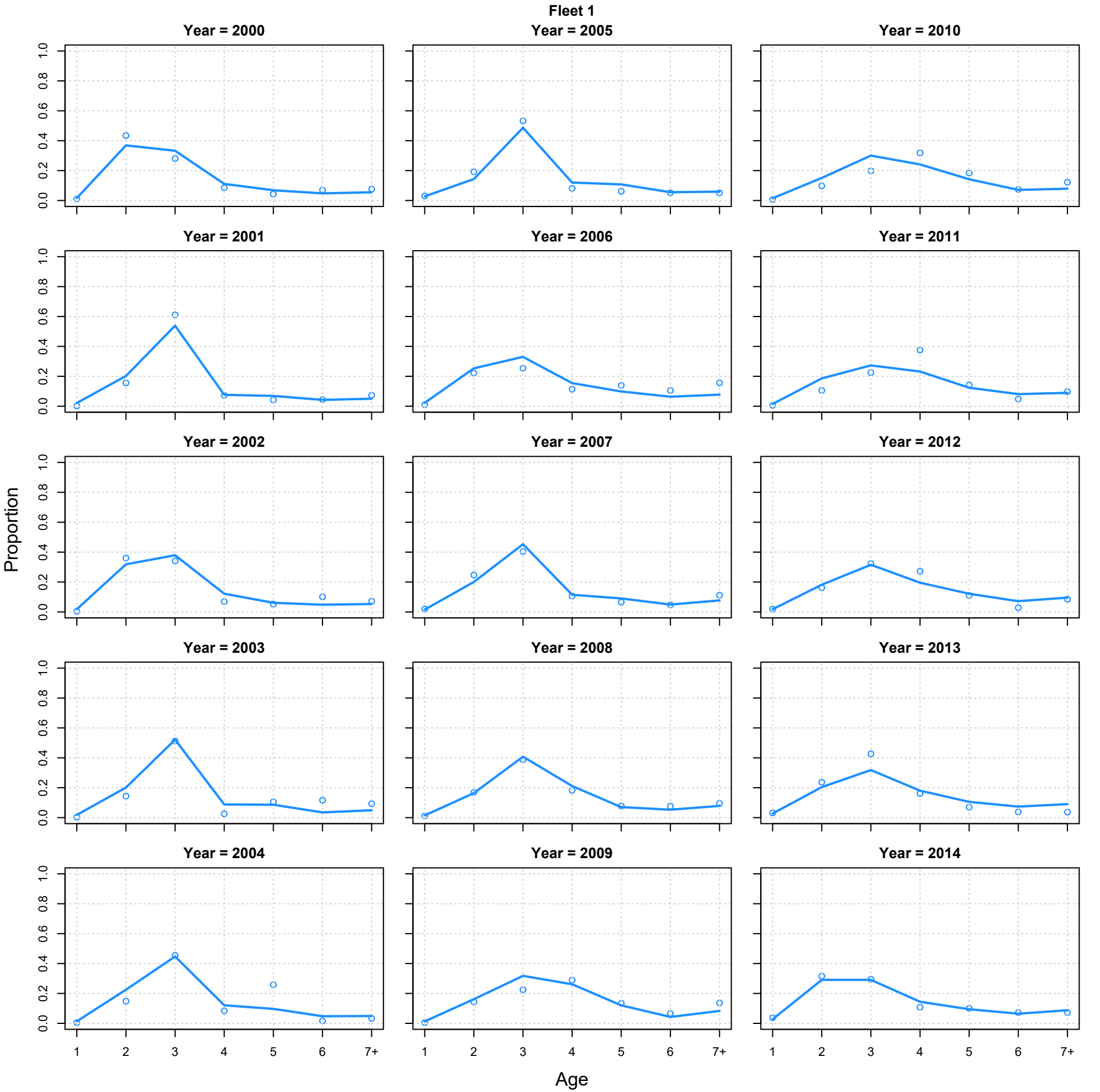


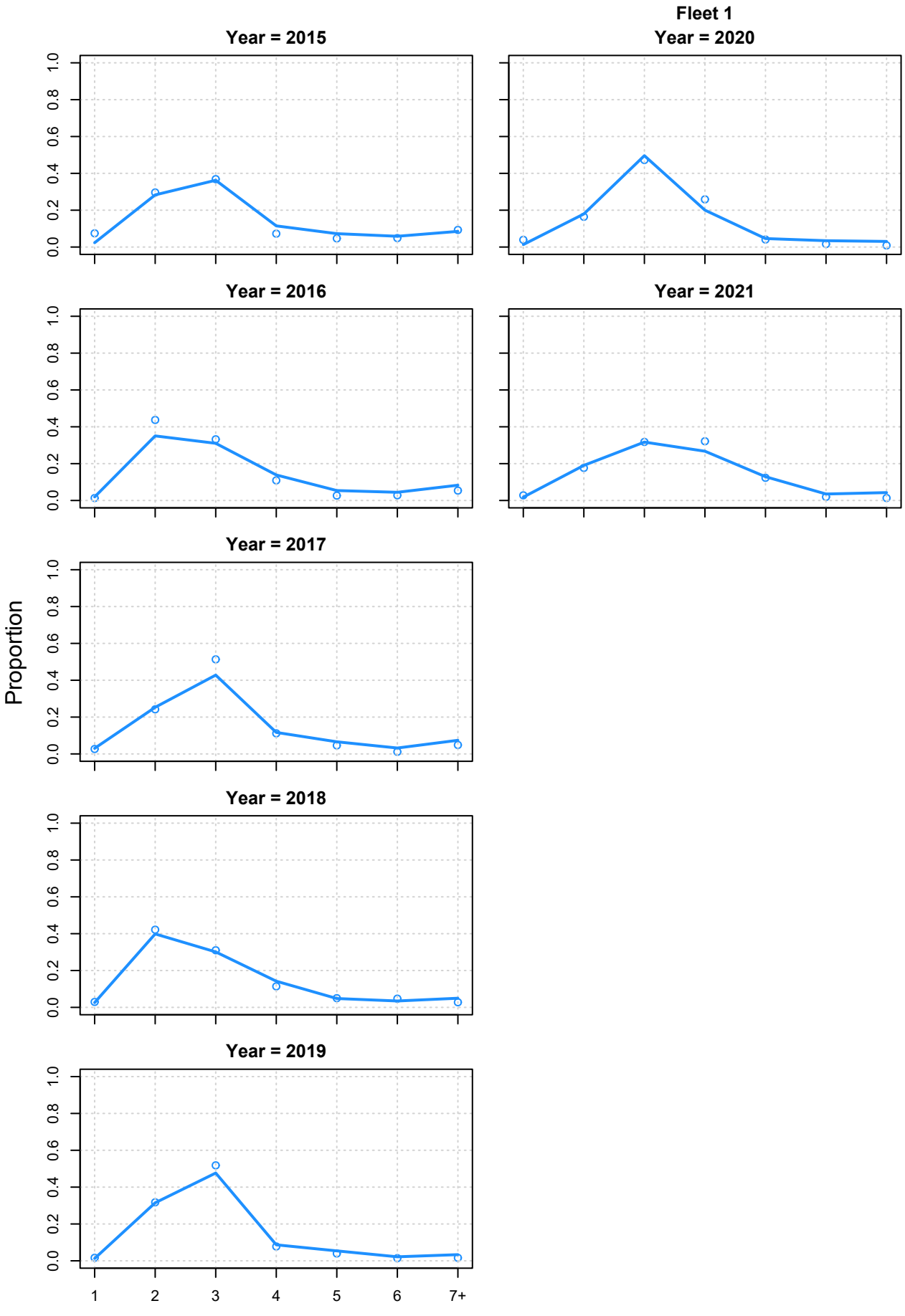


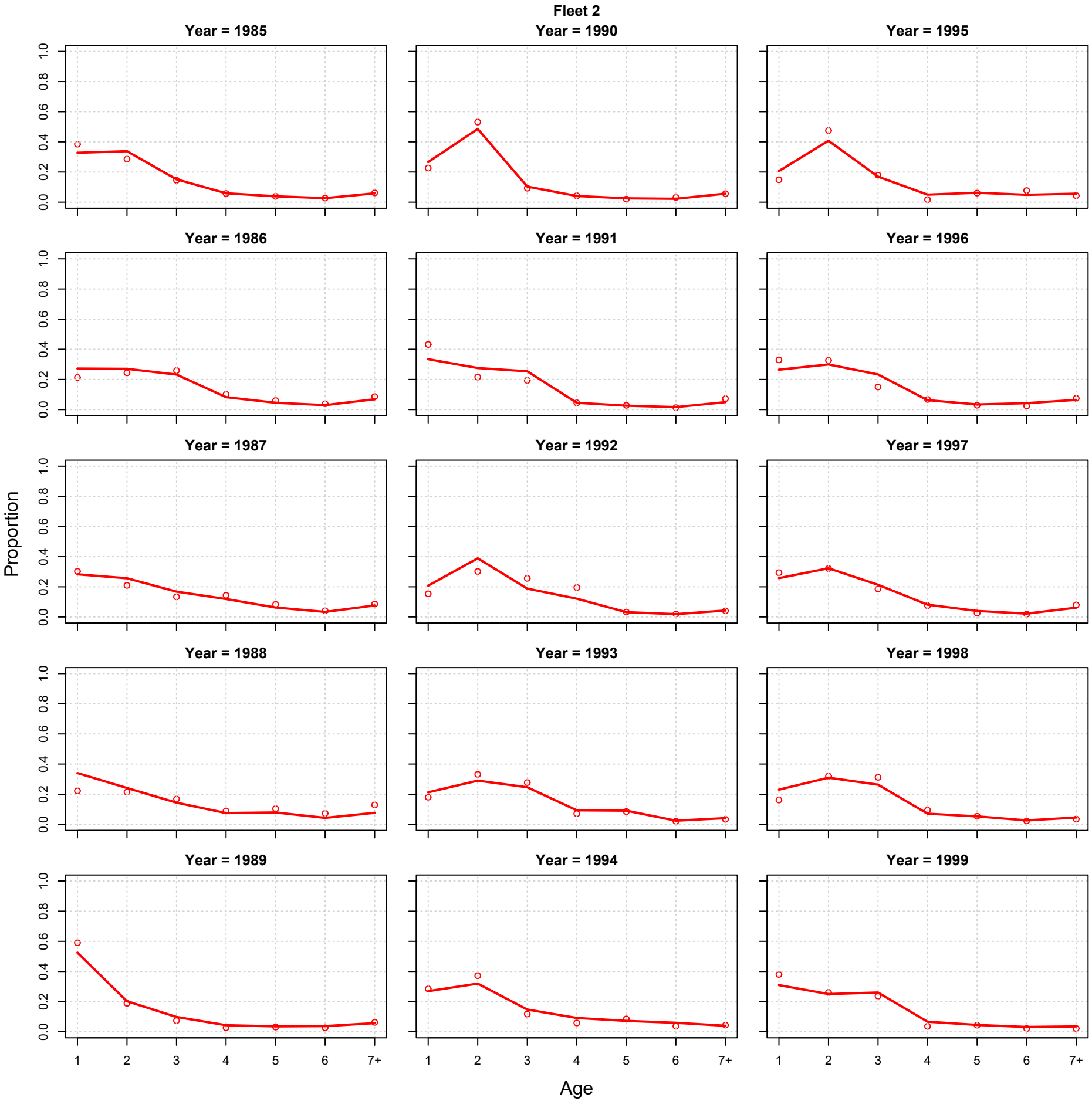


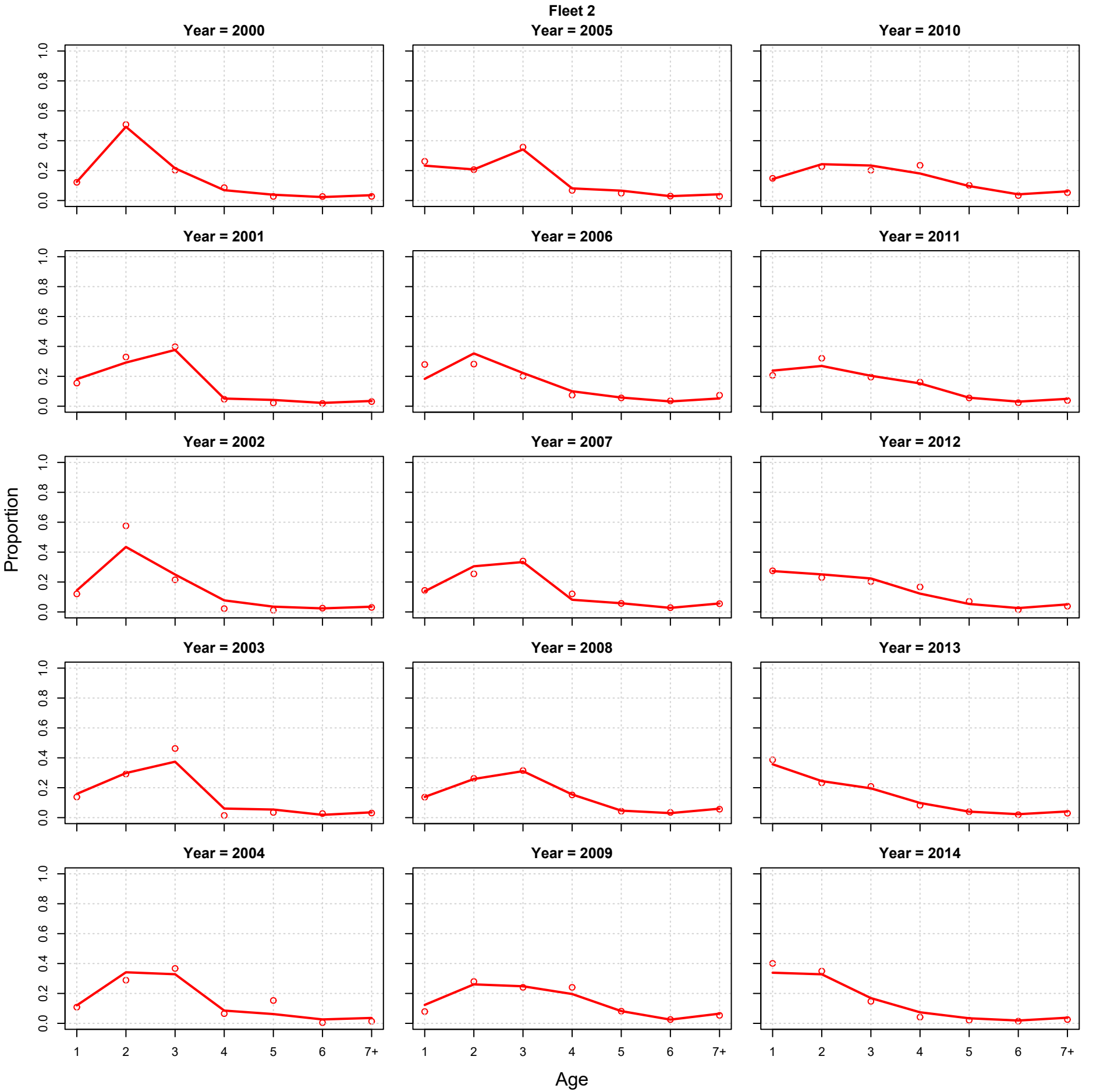


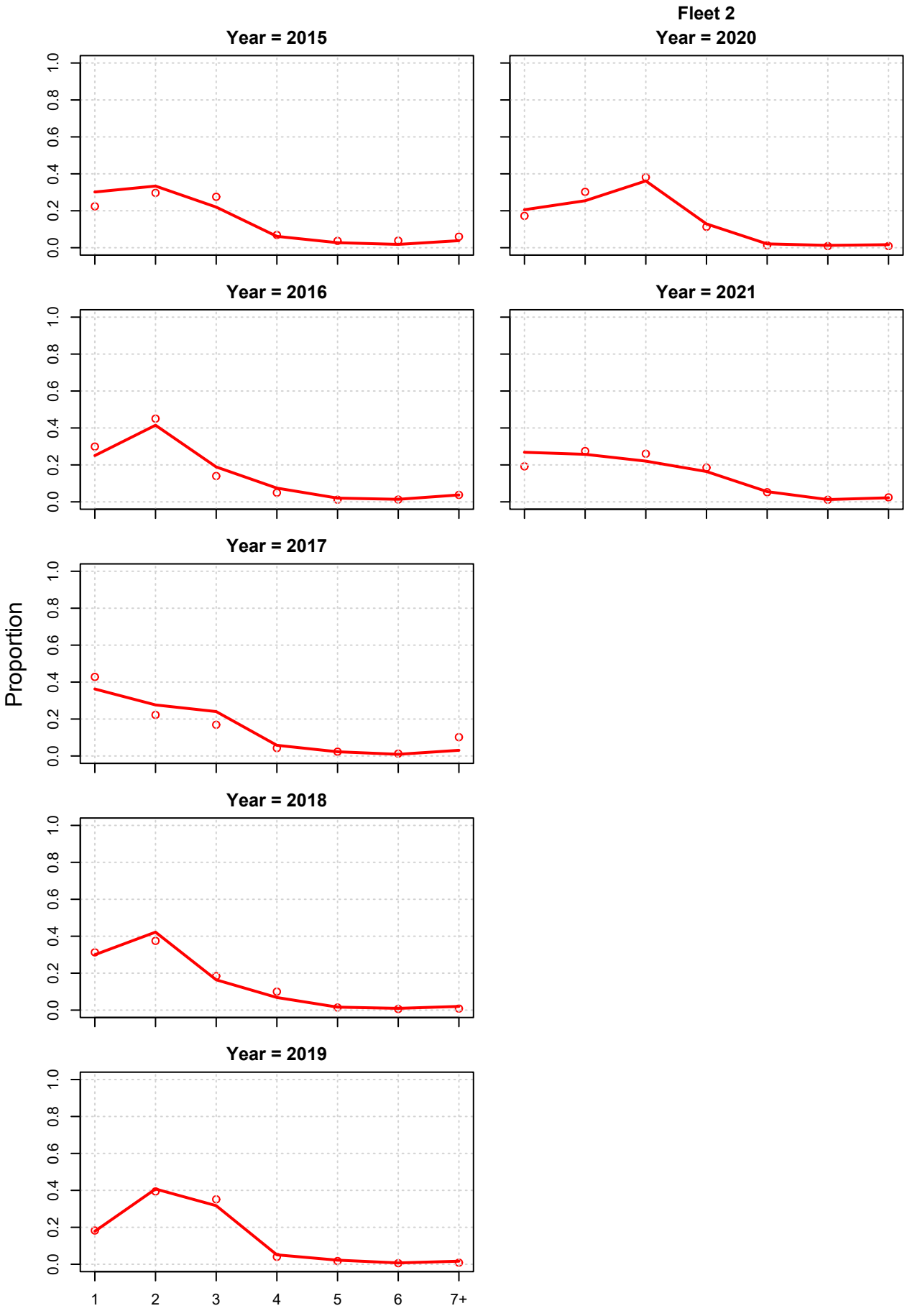

Fleet 1
Year = 1985
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

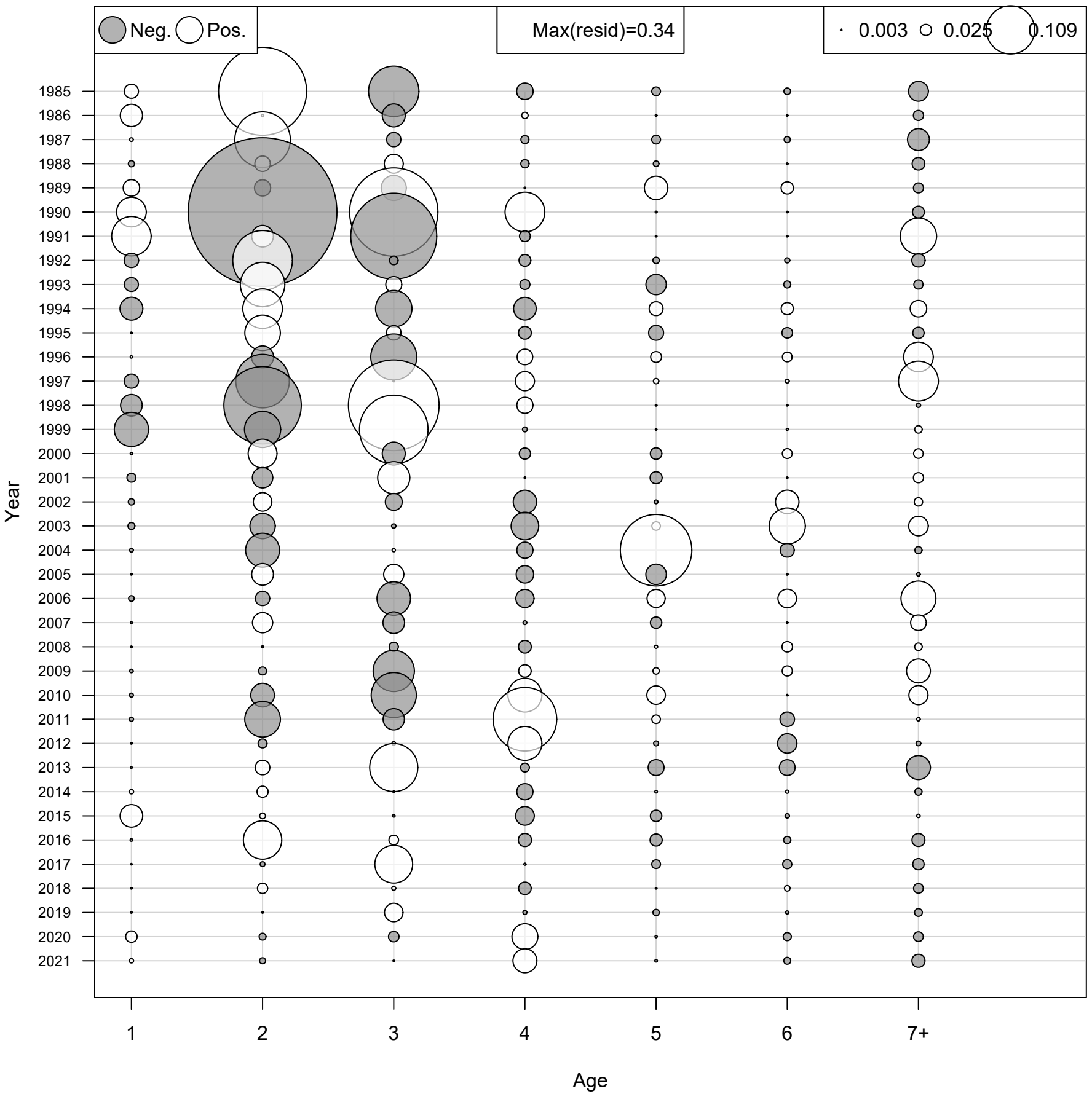

Fleet 1
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

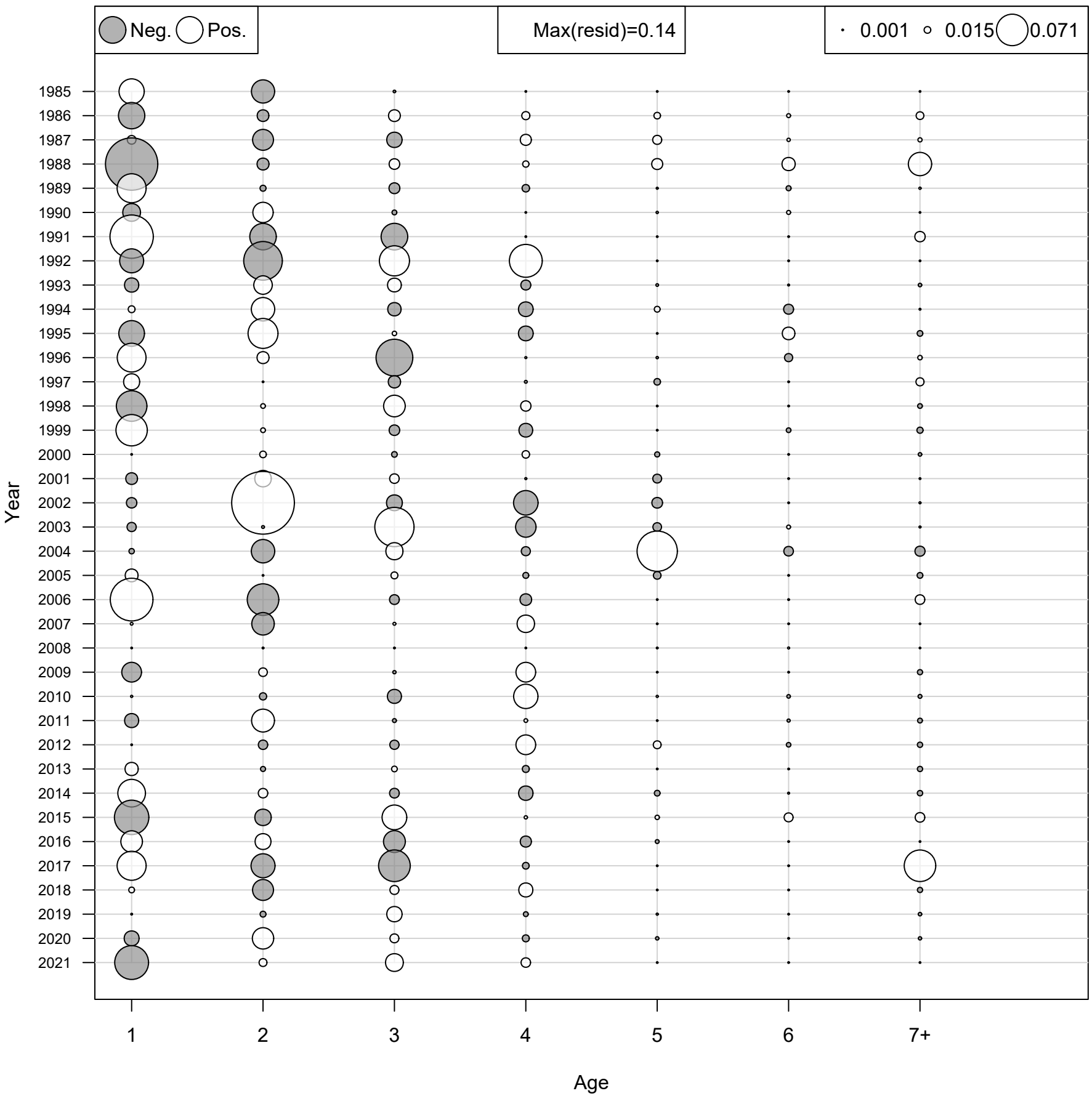

Fleet 1
Year = 2015
Year = 2020
Year = 2016
Year = 2021
Year = 2017
Year = 2018
Year = 2019
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

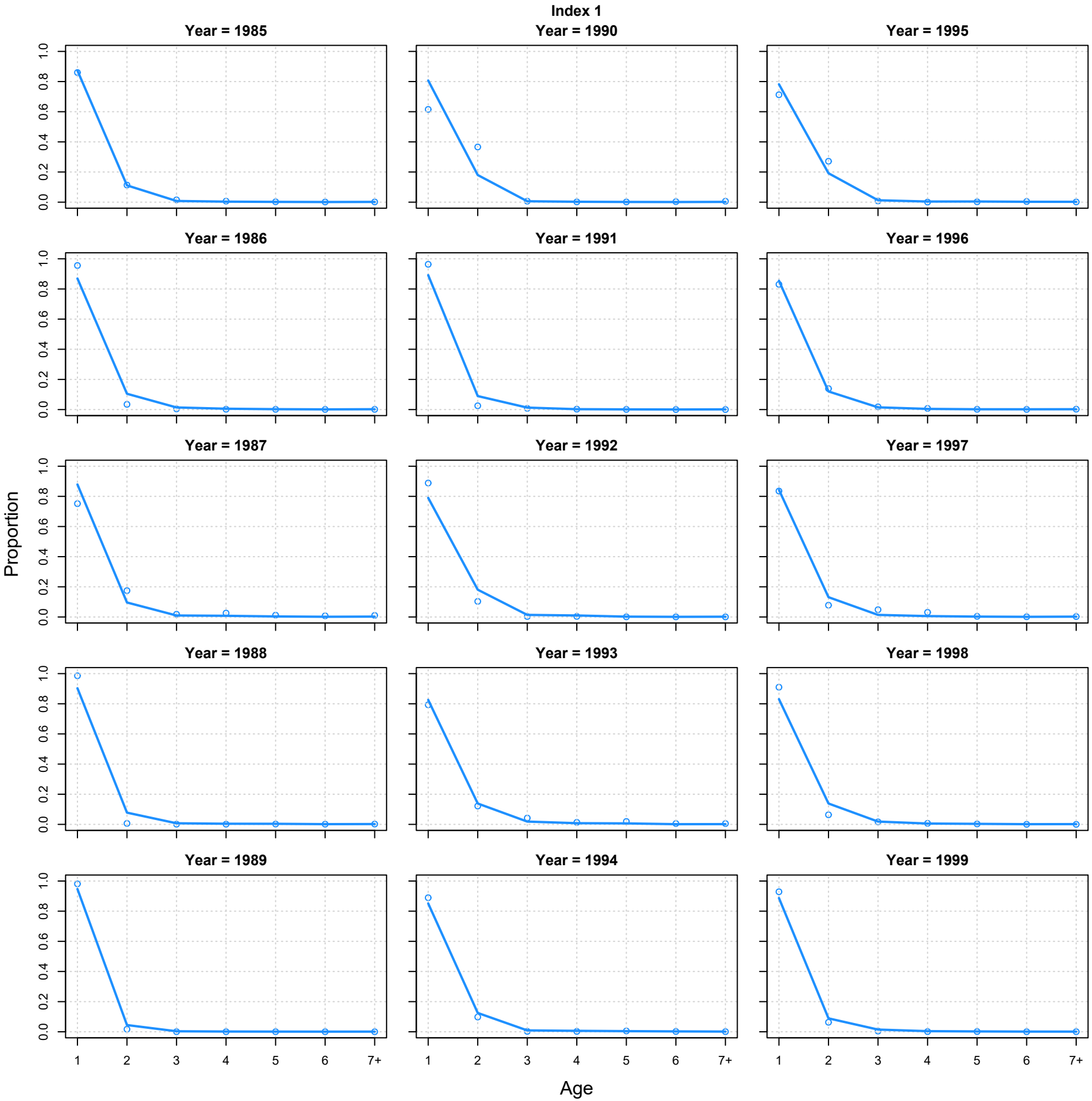

Fleet 2
Year = 1985
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

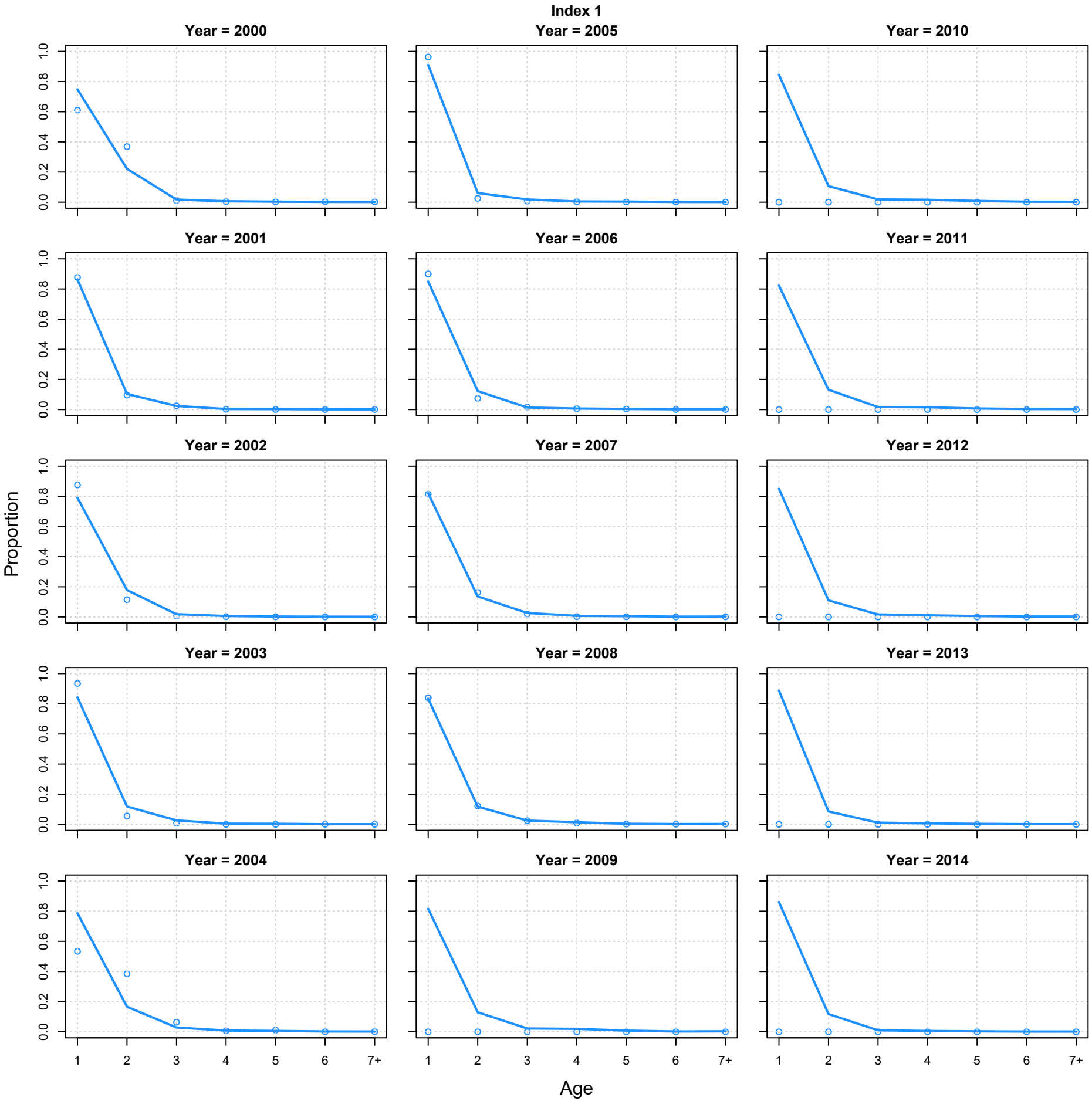

Fleet 2
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

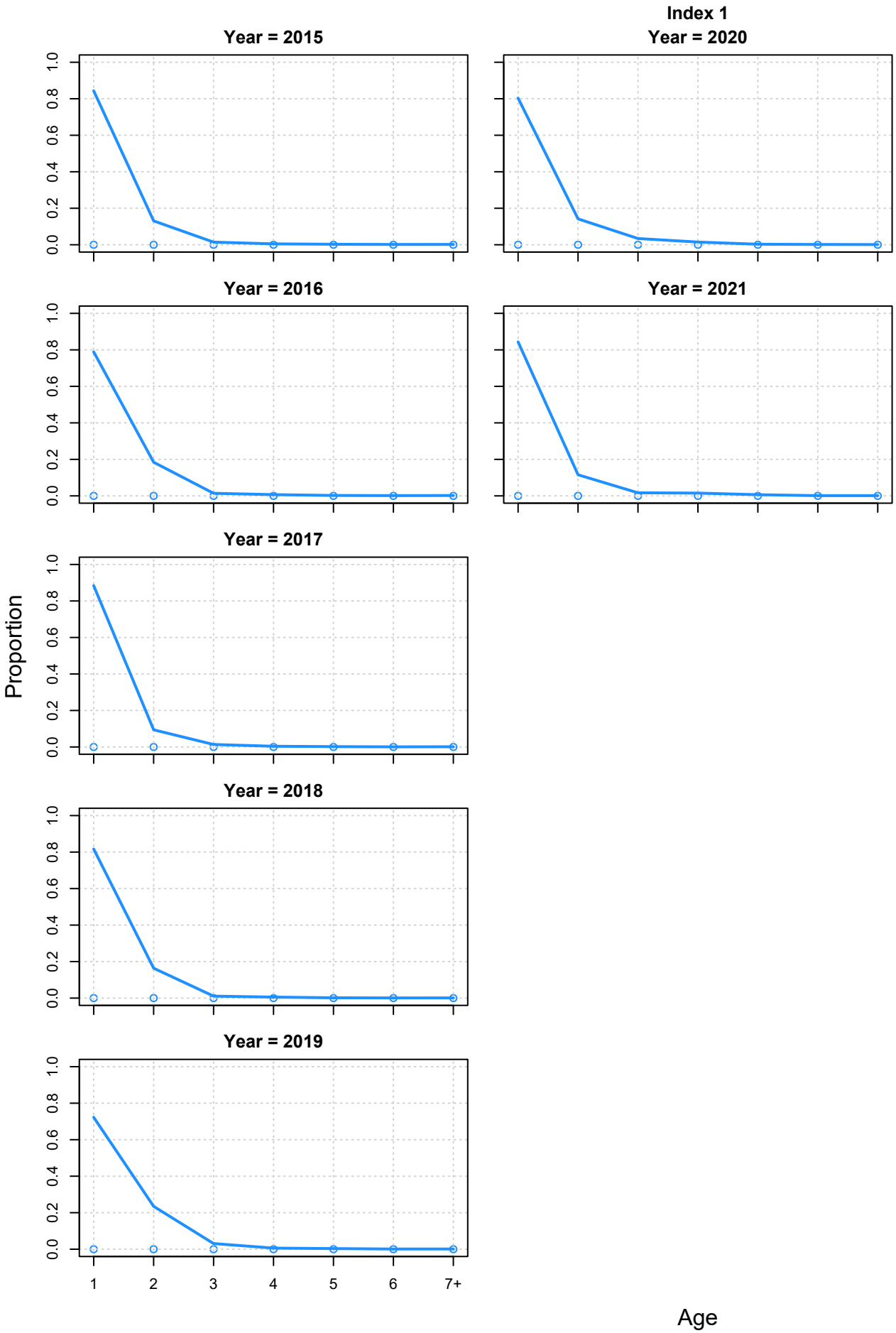

Fleet 2
Year = 2015
Year = 2020
Year = 2016
Year = 2021
Year = 2017
Year = 2018
Year = 2019
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

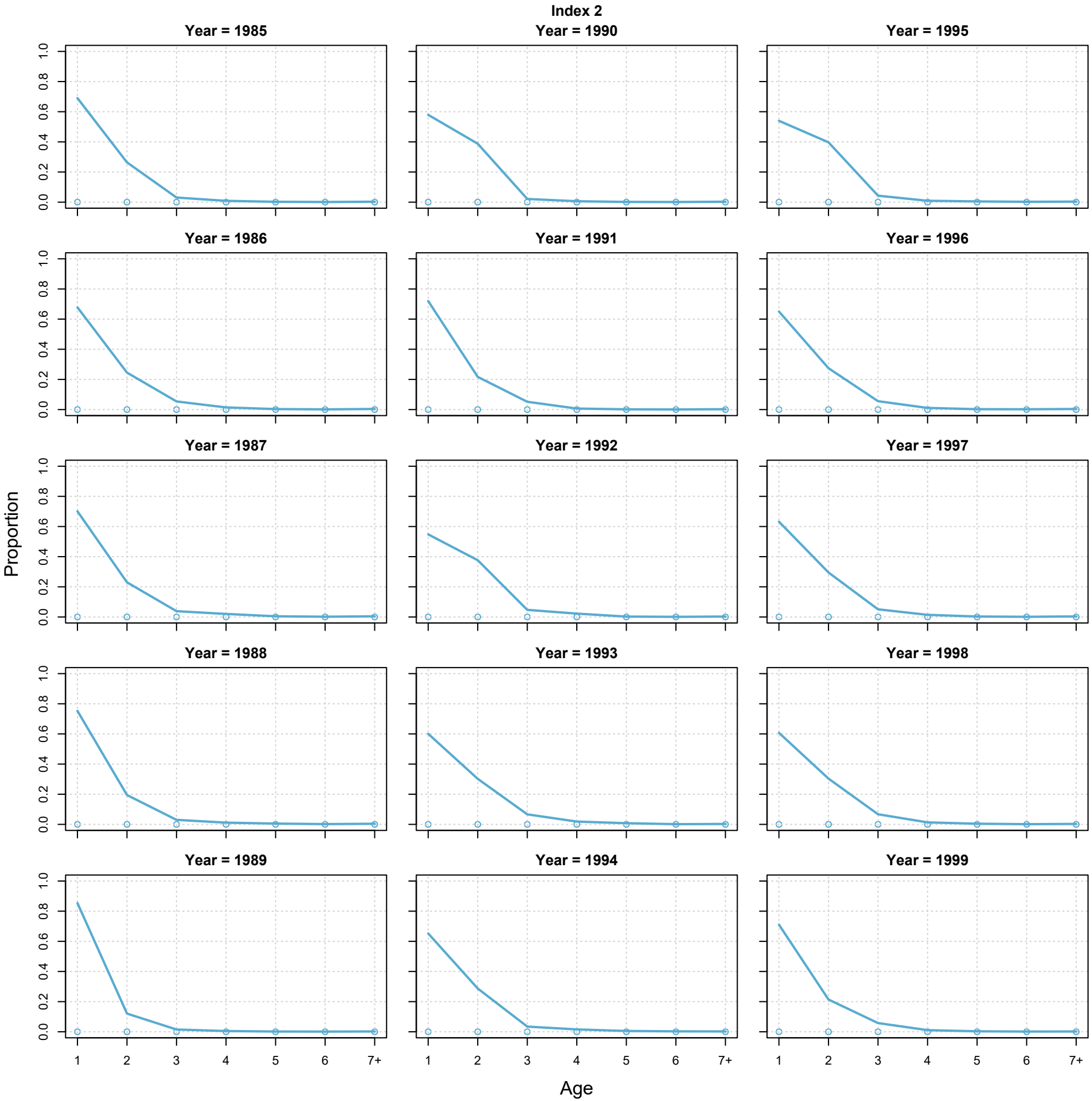

Age Comp Residuals (Observed-Predicted) for Fleet 1
Neg.
Pos.
Max(resid)=0.34
0.003
0.025
0.109
Year
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age

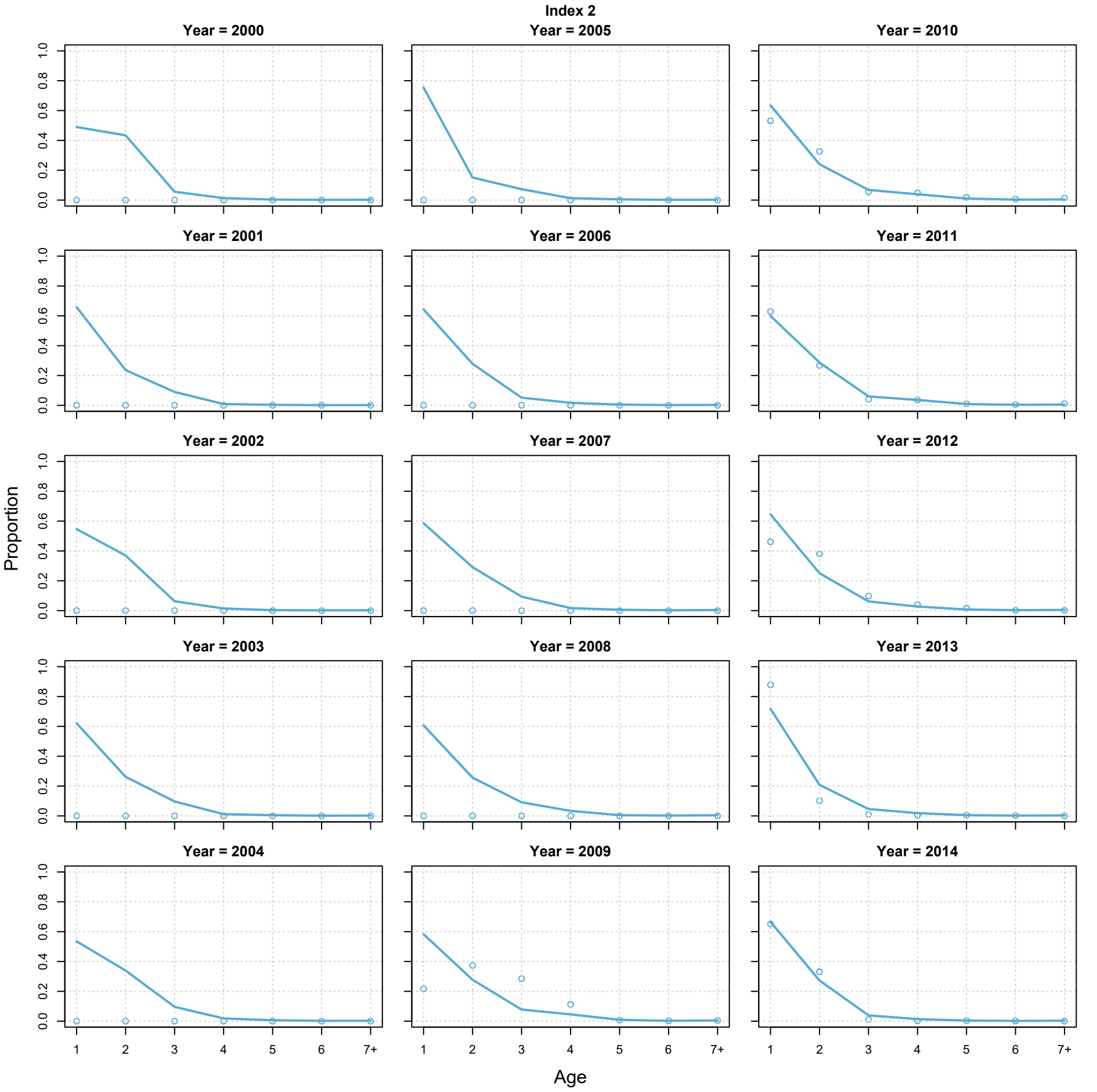

Age Comp Residuals (Observed-Predicted) for Fleet 2
Neg.
Pos.
Max(resid)=0.14
0.001
0.015
0.071
Year
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age

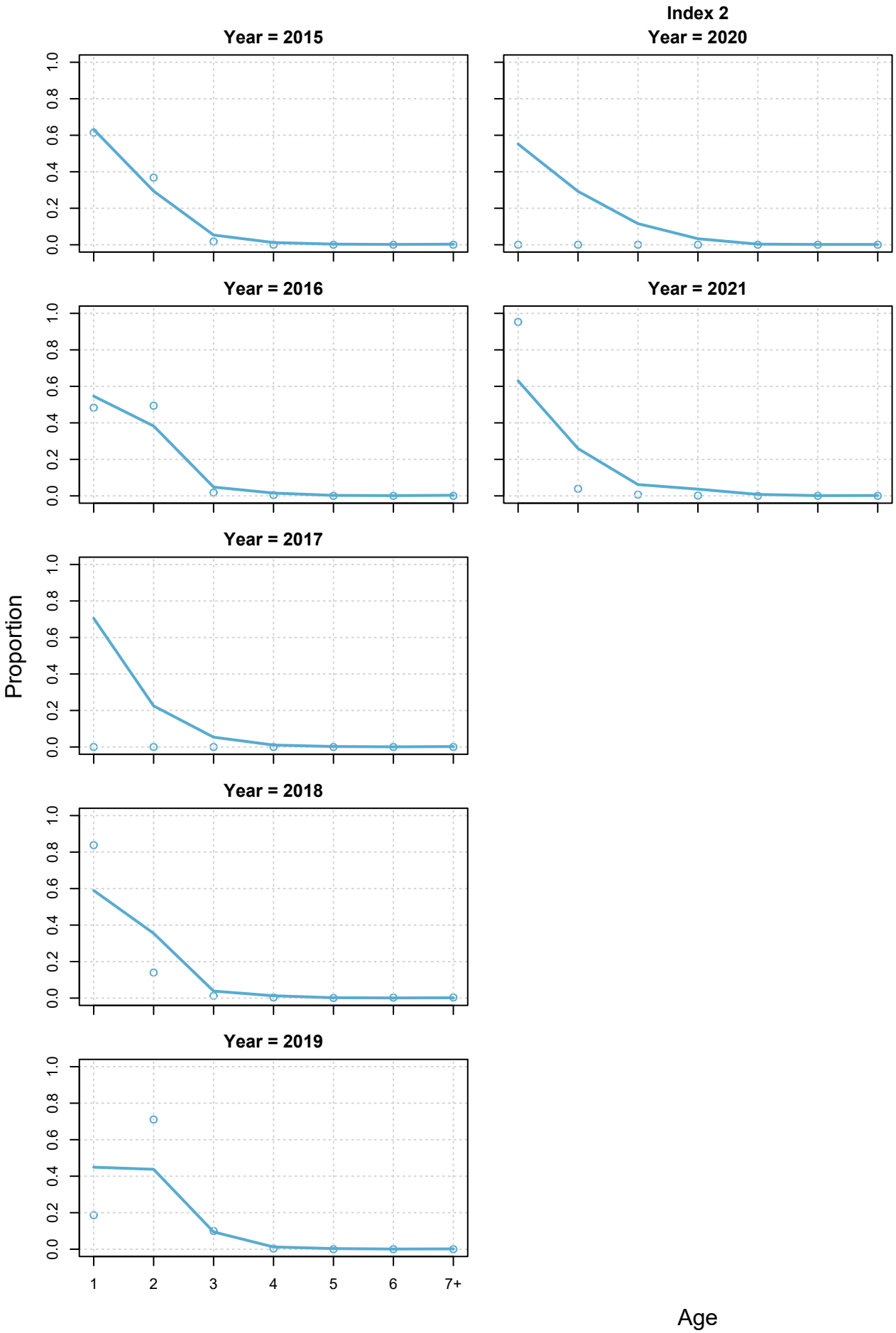

Index 1
Year = 1985
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age

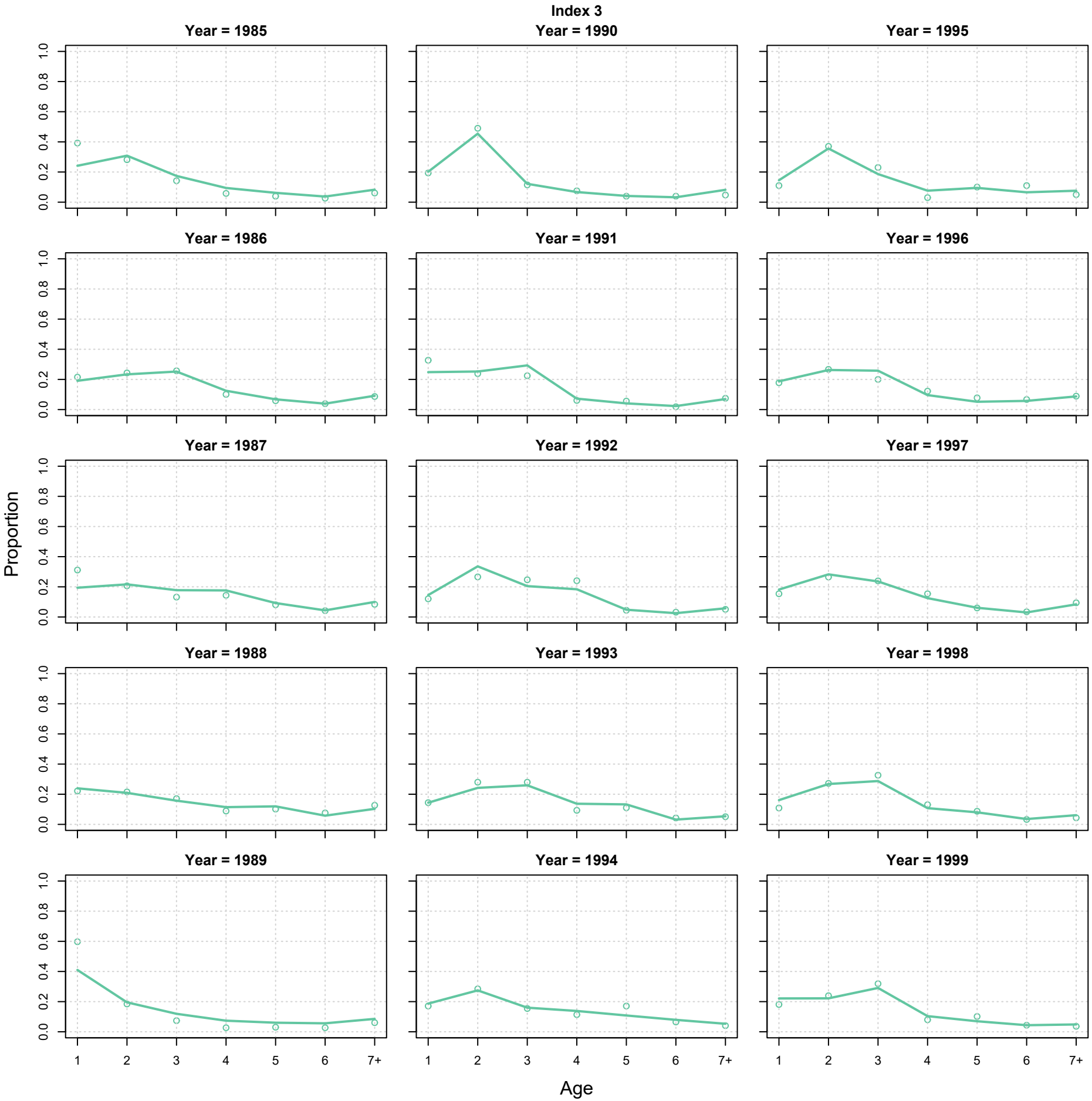

Index 1
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 1
Year = 2015
Year = 2020
Year = 2016
Year = 2021
Year = 2017
Year = 2018
Year = 2019
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 2
Year = 1985
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 2
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 2
Year = 2015
Year = 2020
Year = 2016
Year = 2021
Year = 2017
Year = 2018
Year = 2019
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 3
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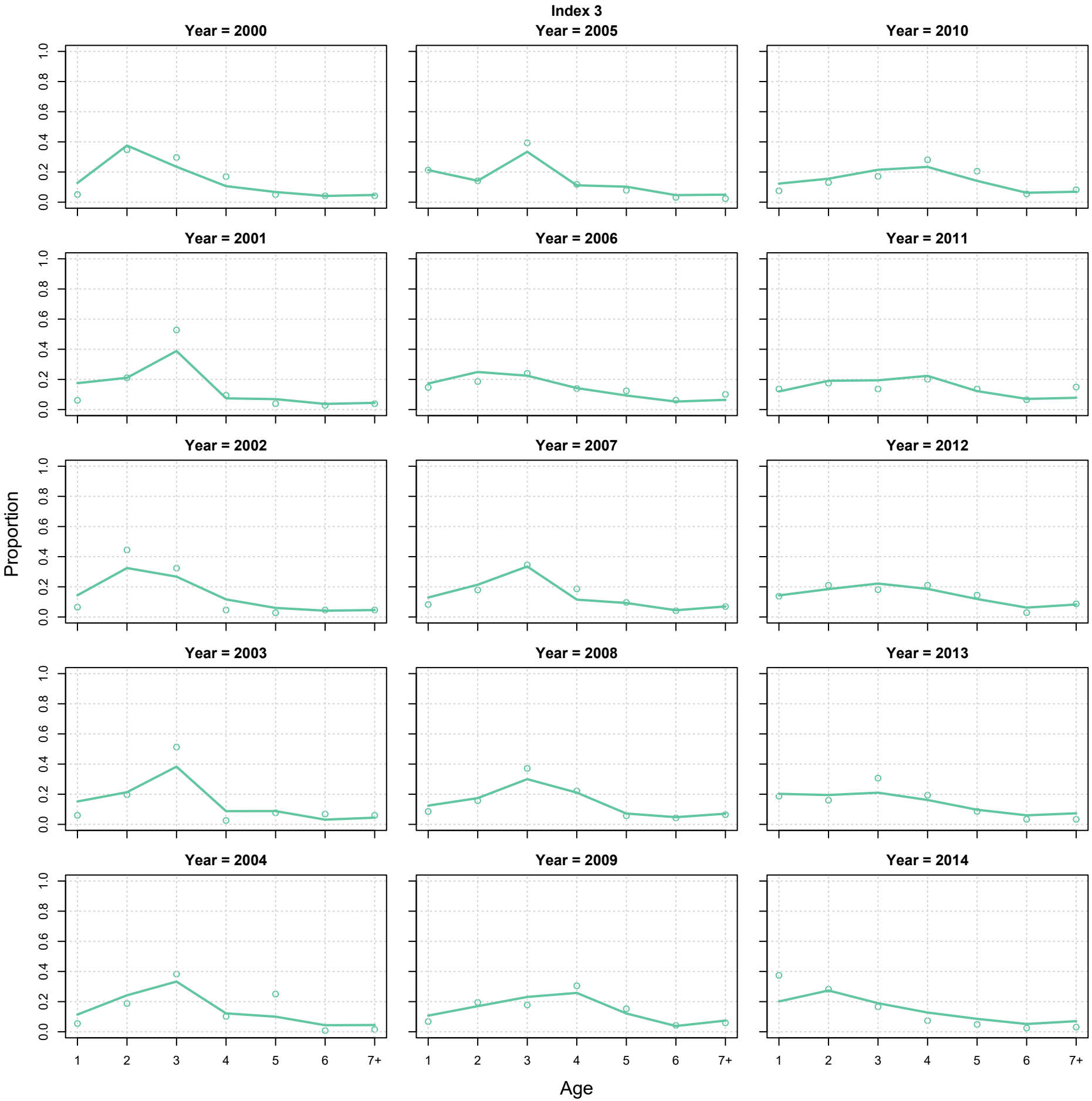
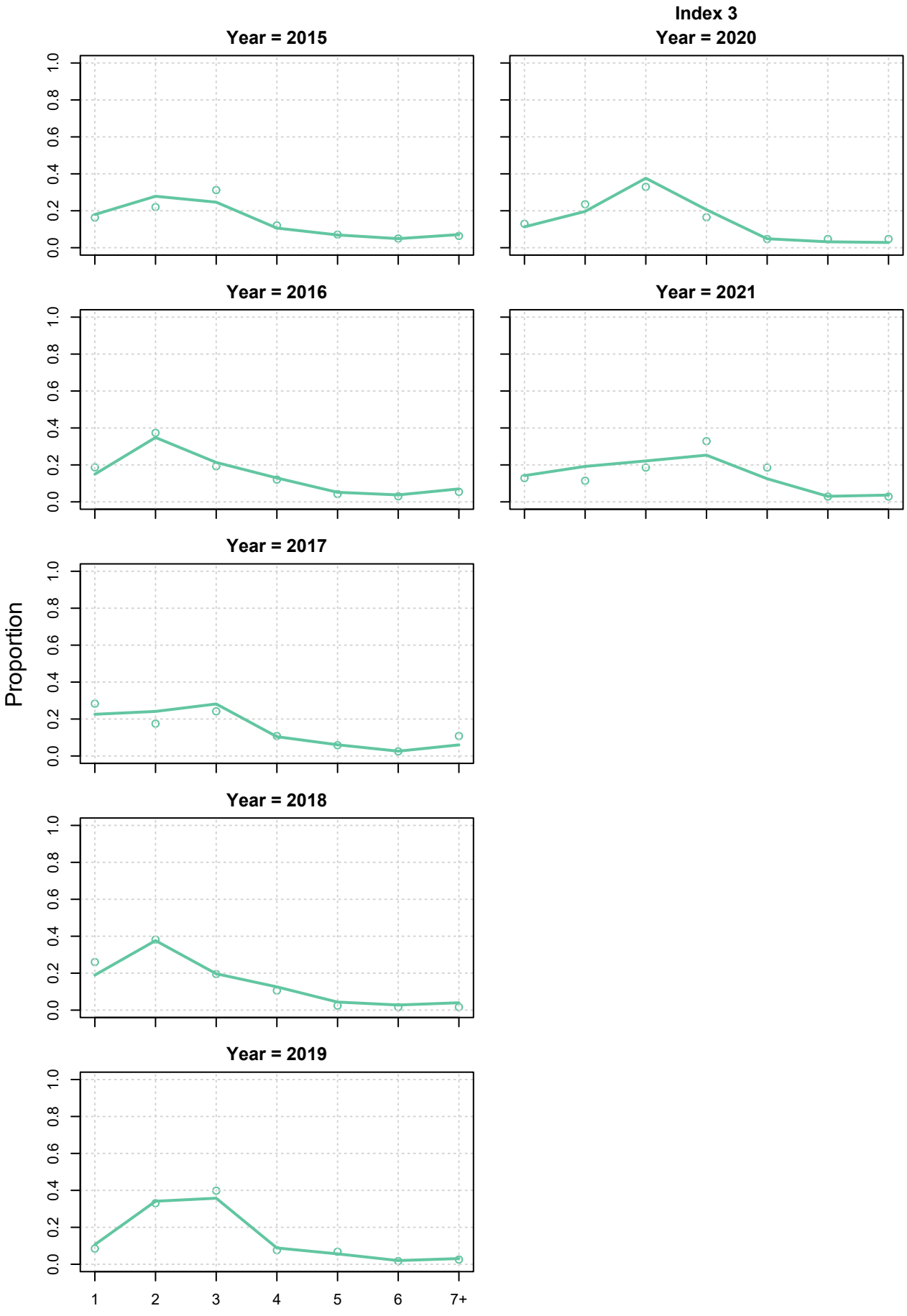
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 3
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 3
Year = 2015
Year = 2020
Year = 2016
Year = 2021
Year = 2017
Year = 2018
Year = 2019
Proportion
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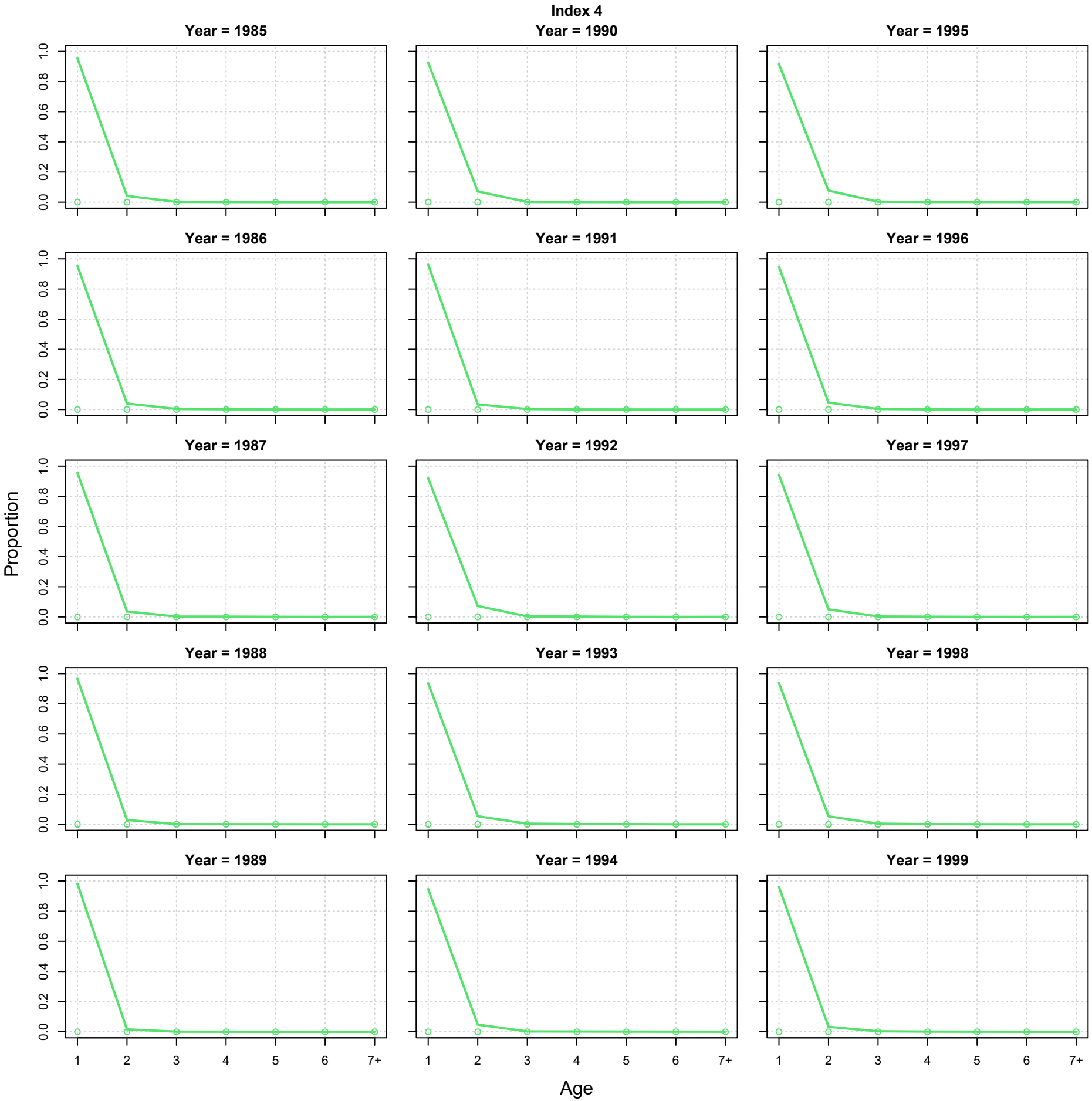
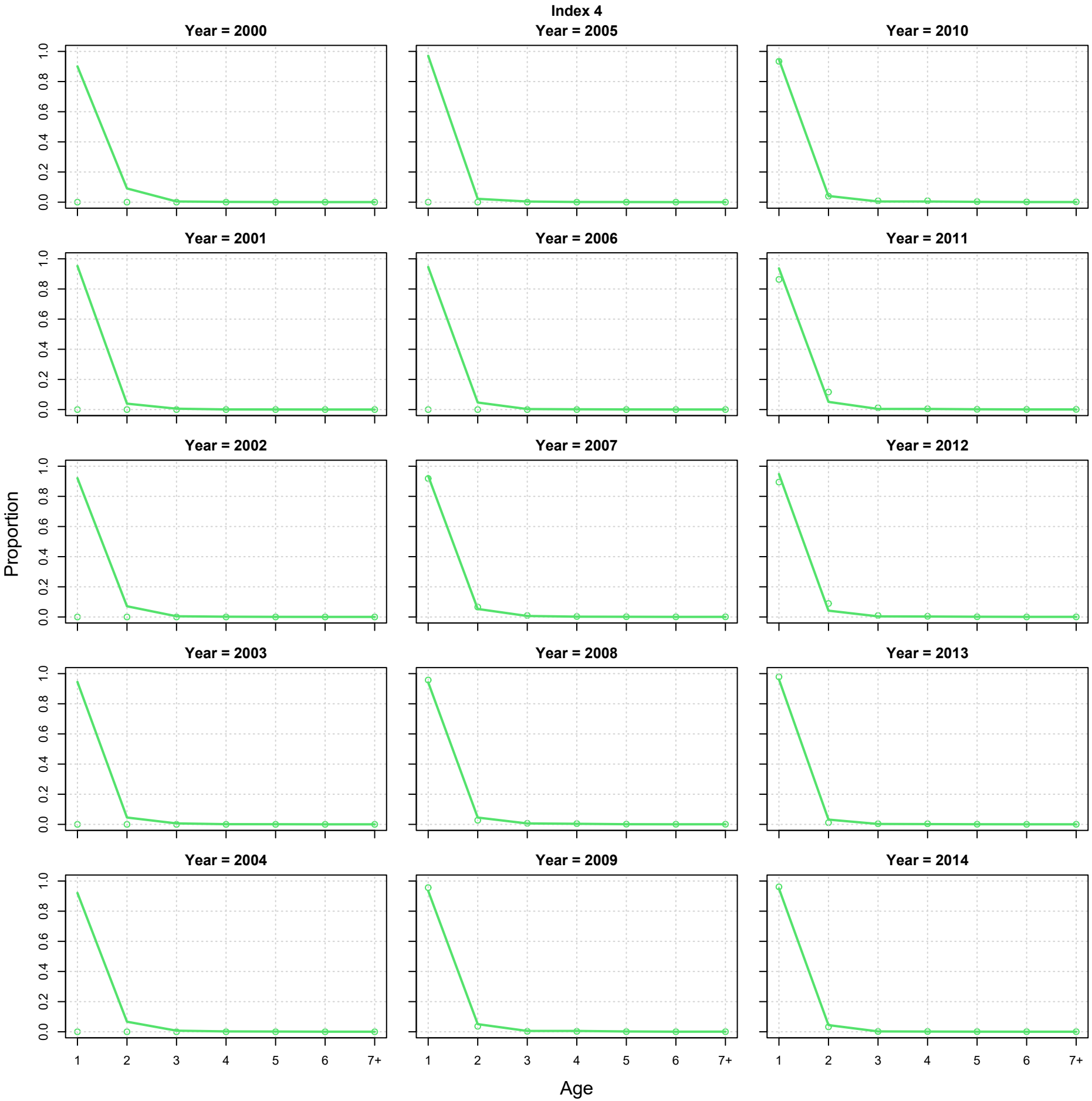
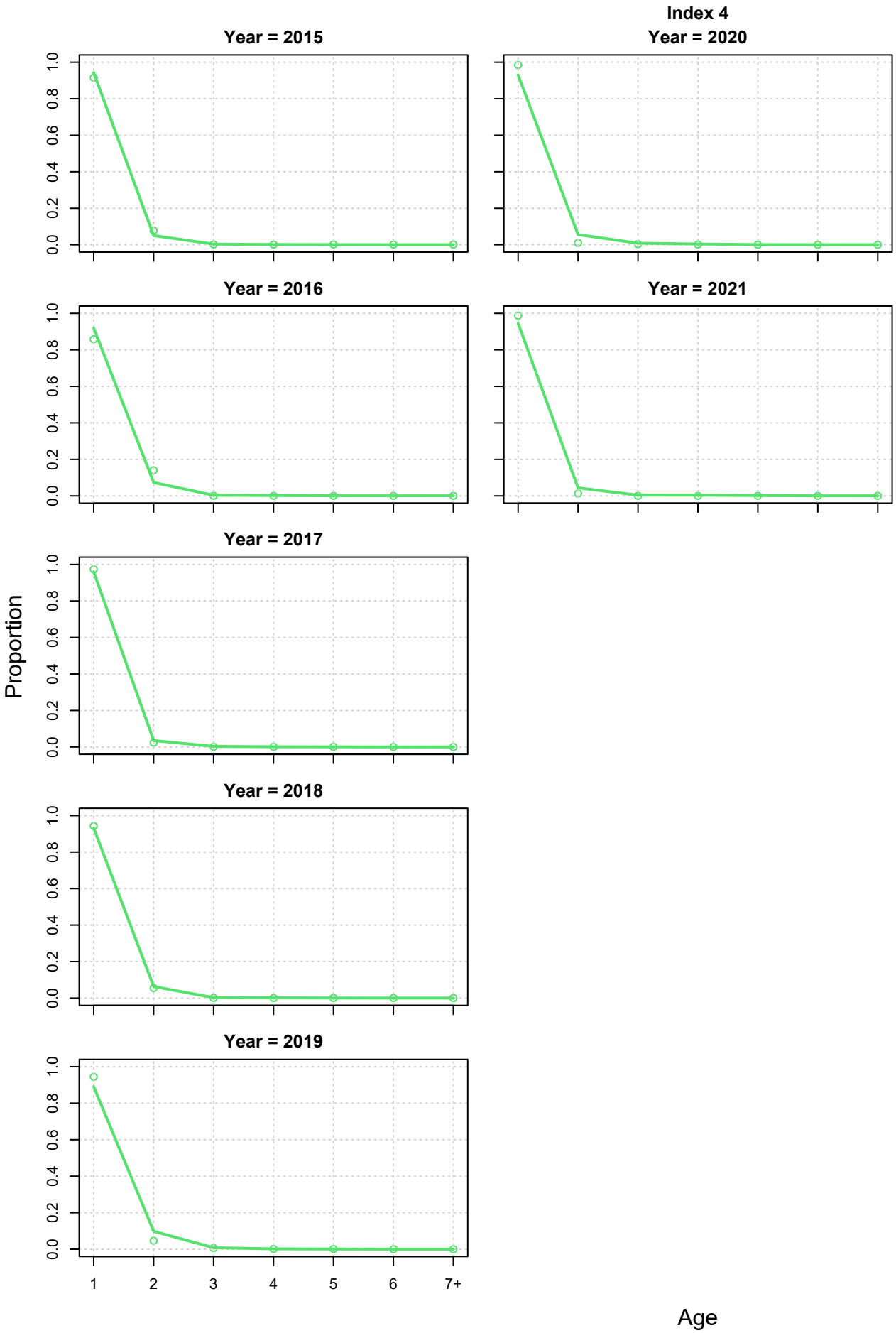
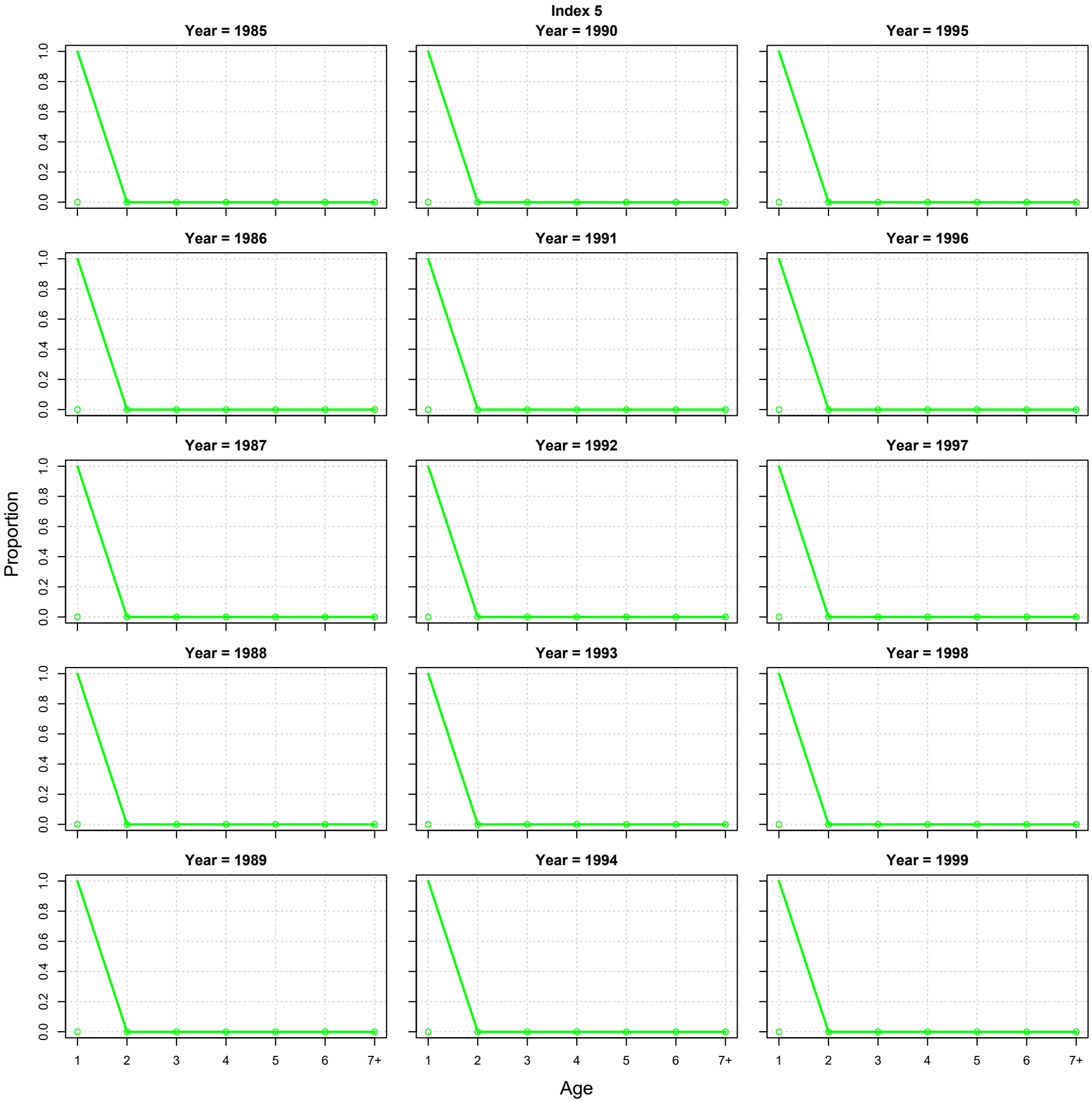
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 4
Year = 1985
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 4
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 4
Year = 2015
Year = 2020
Year = 2016
Year = 2021
Year = 2017
Year = 2018
Year = 2019
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7+
Age


Index 5
Year = 1985
Year = 1990
Year = 1995
Year = 1986
Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
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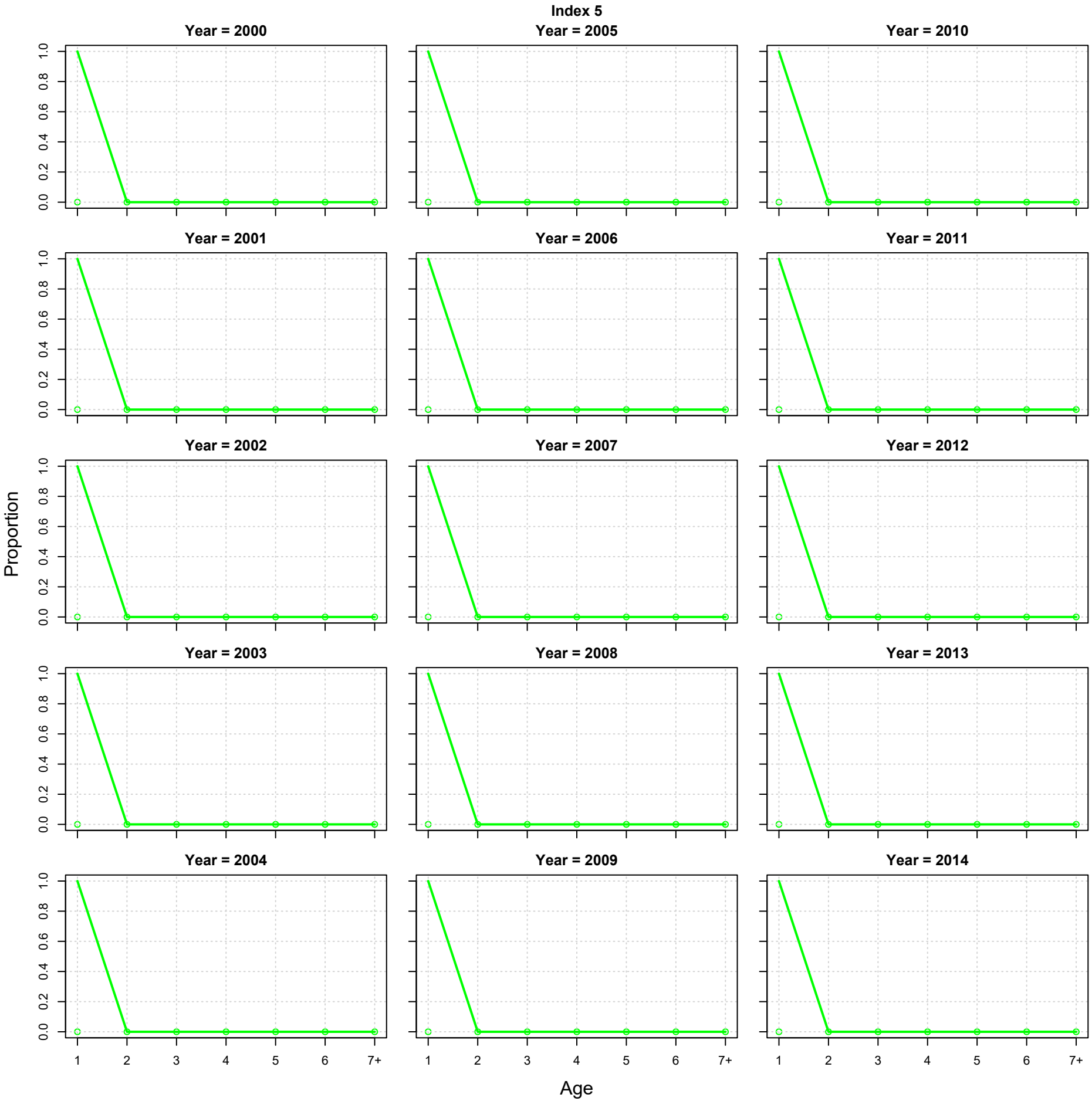
6
7+
Age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Year = 2006
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Year = 2002
Year = 2007
Year = 2012
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Proportion
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0.4
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0.8
1.0
1
2
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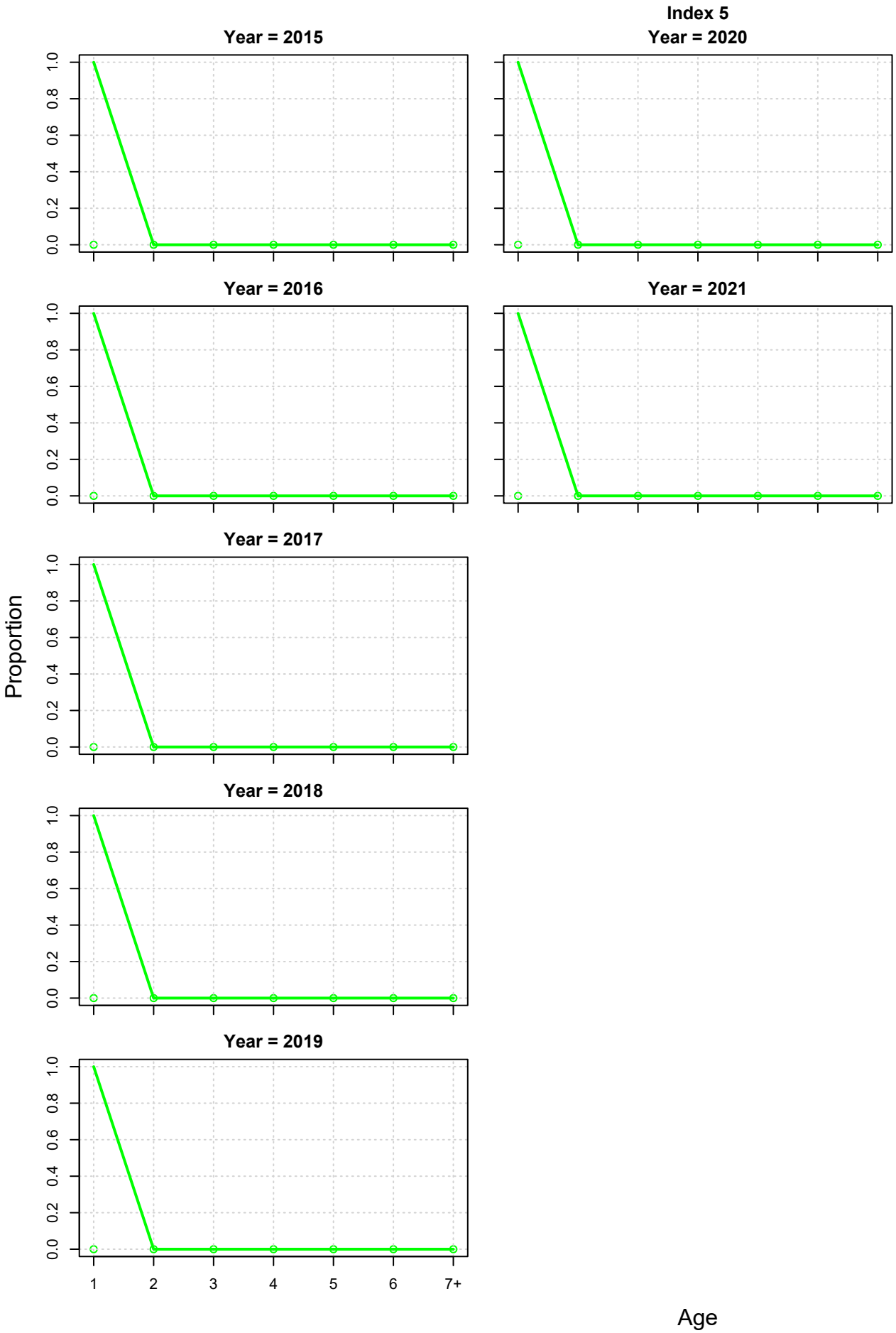
7+
Age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Year = 2019
Proportion
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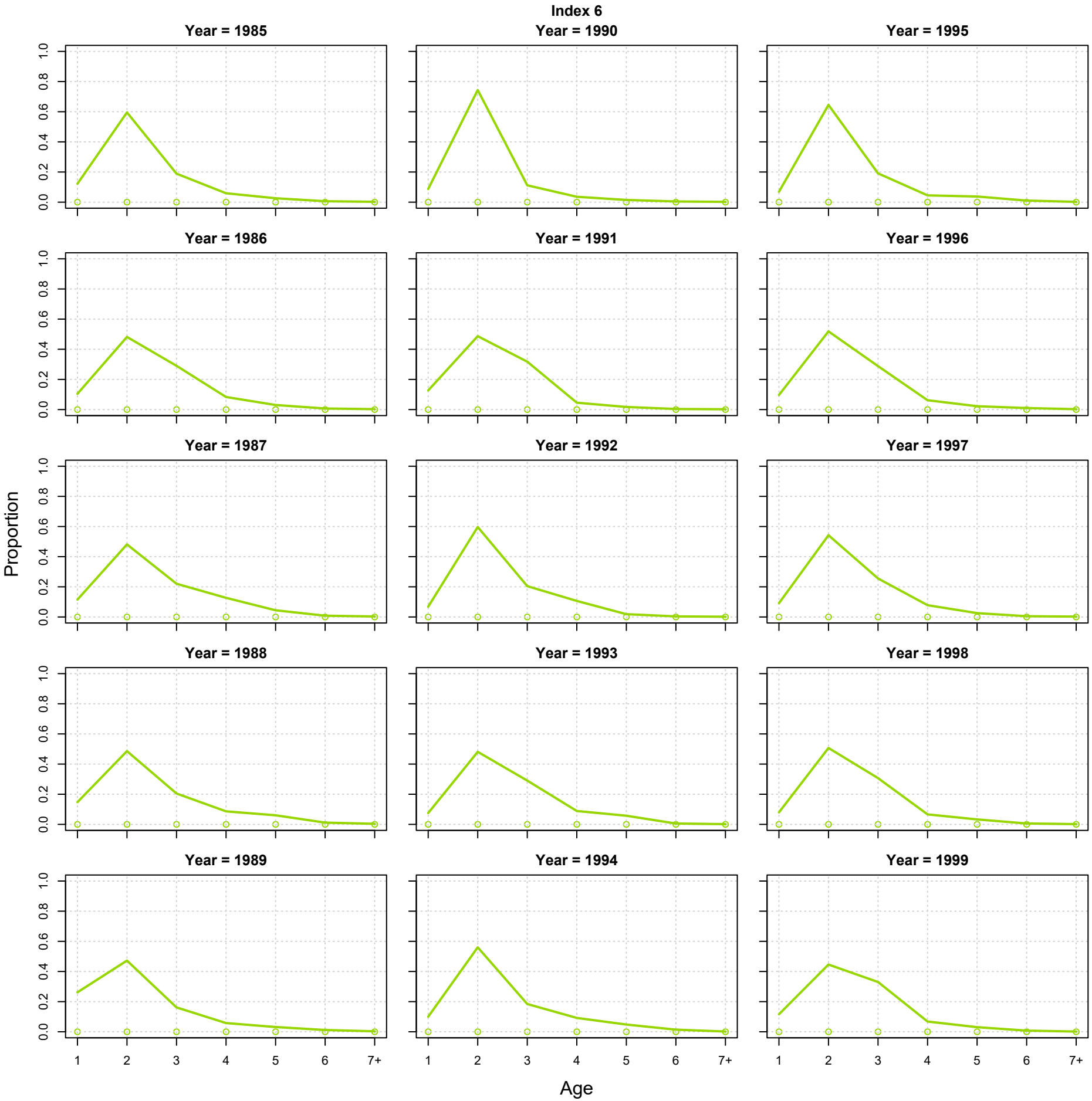
Age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Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
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0.4
0.6
0.8
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1
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4
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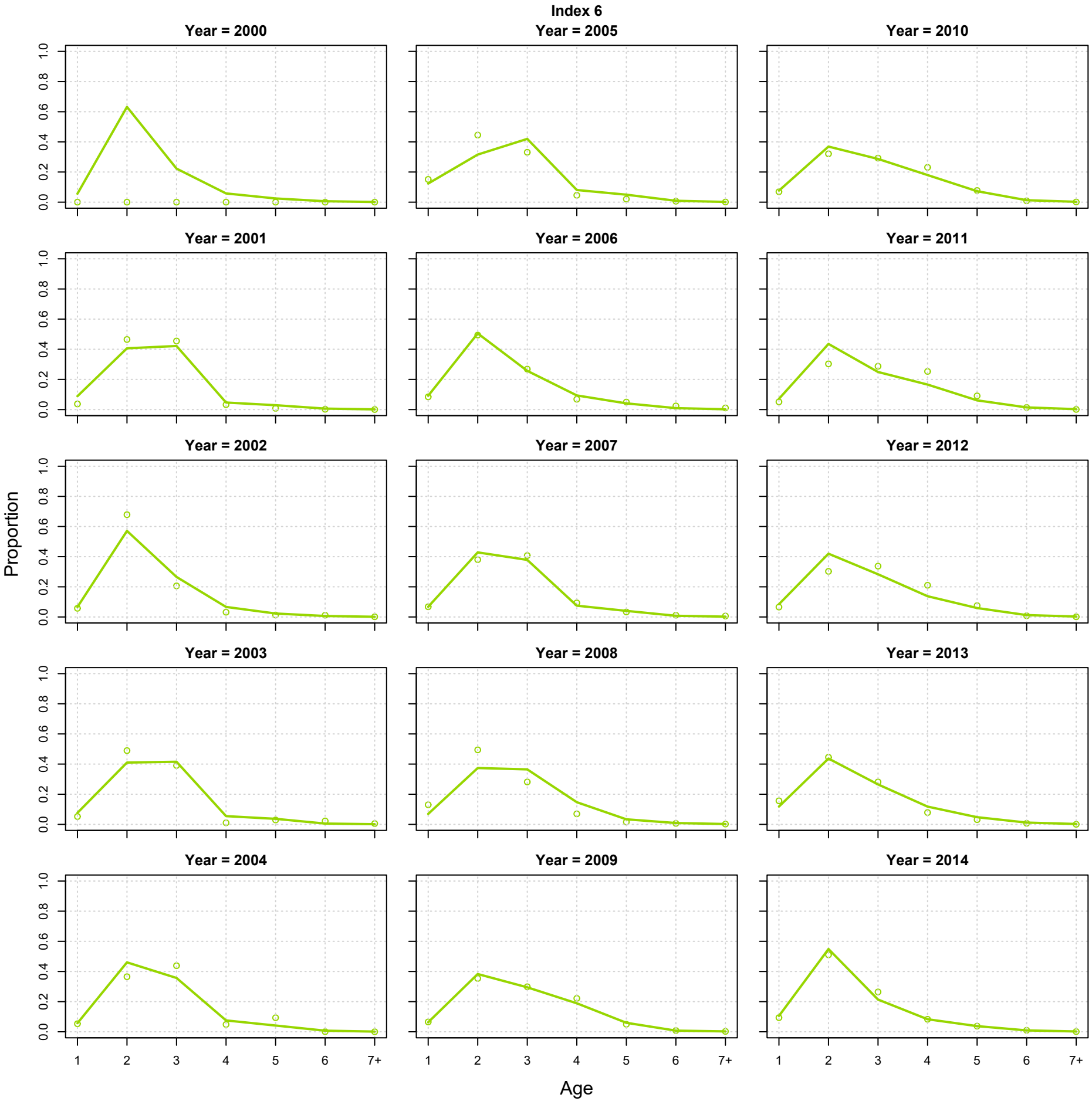
6
7+
Age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Year = 2003
Year = 2008
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Year = 2009
Year = 2014
Proportion
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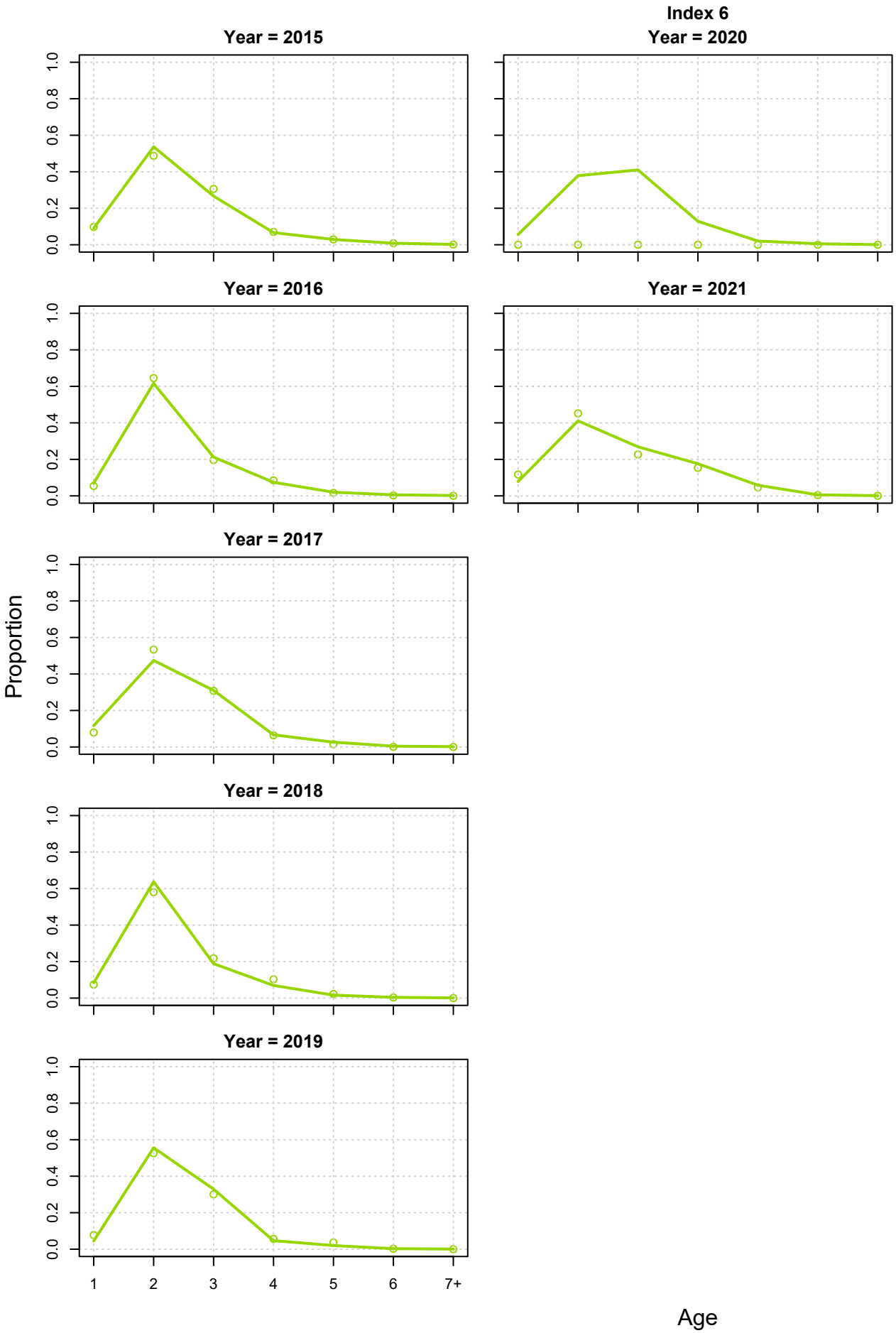
Age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Year = 2019
Proportion
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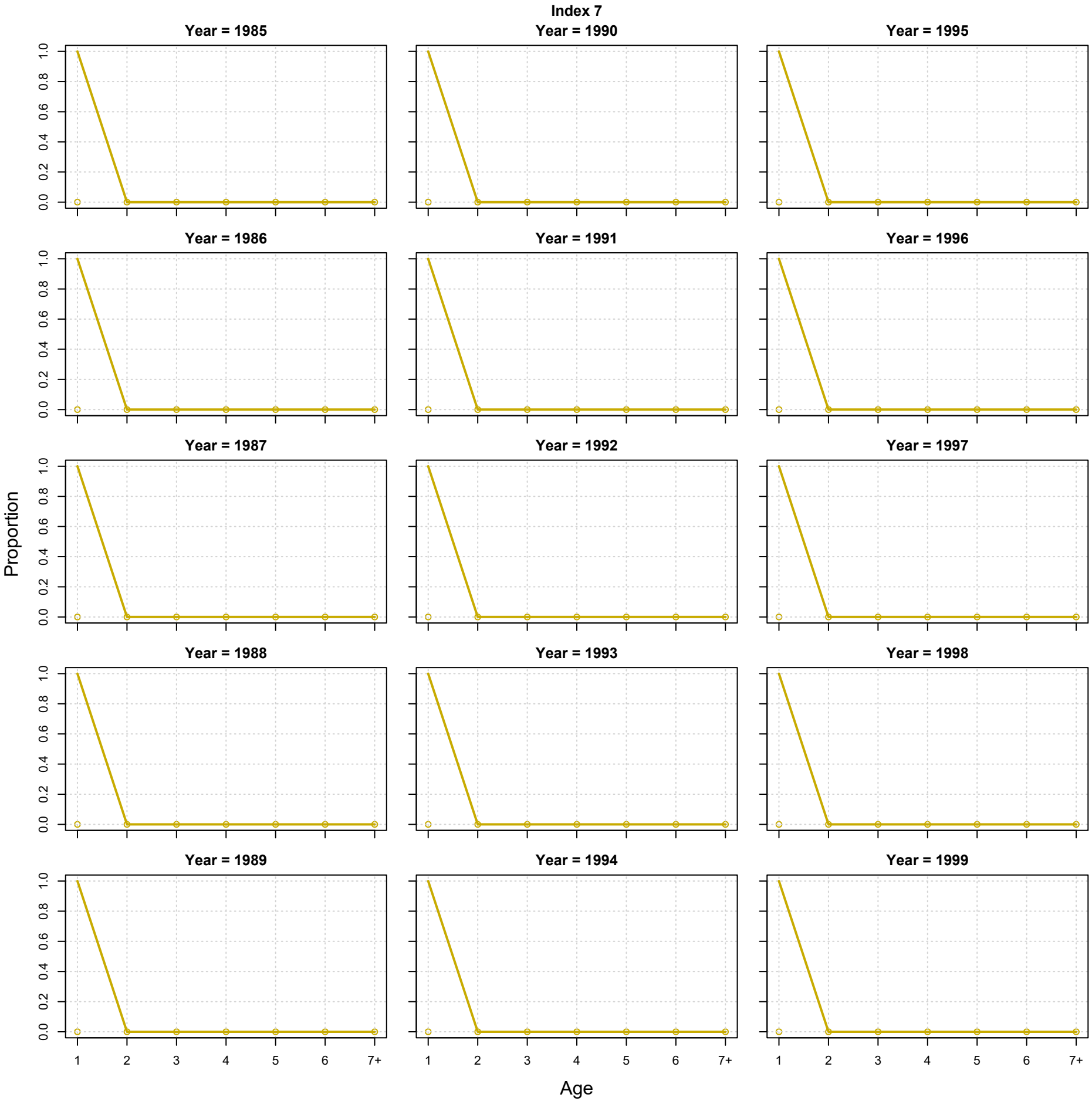
Age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Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
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0.4
0.6
0.8
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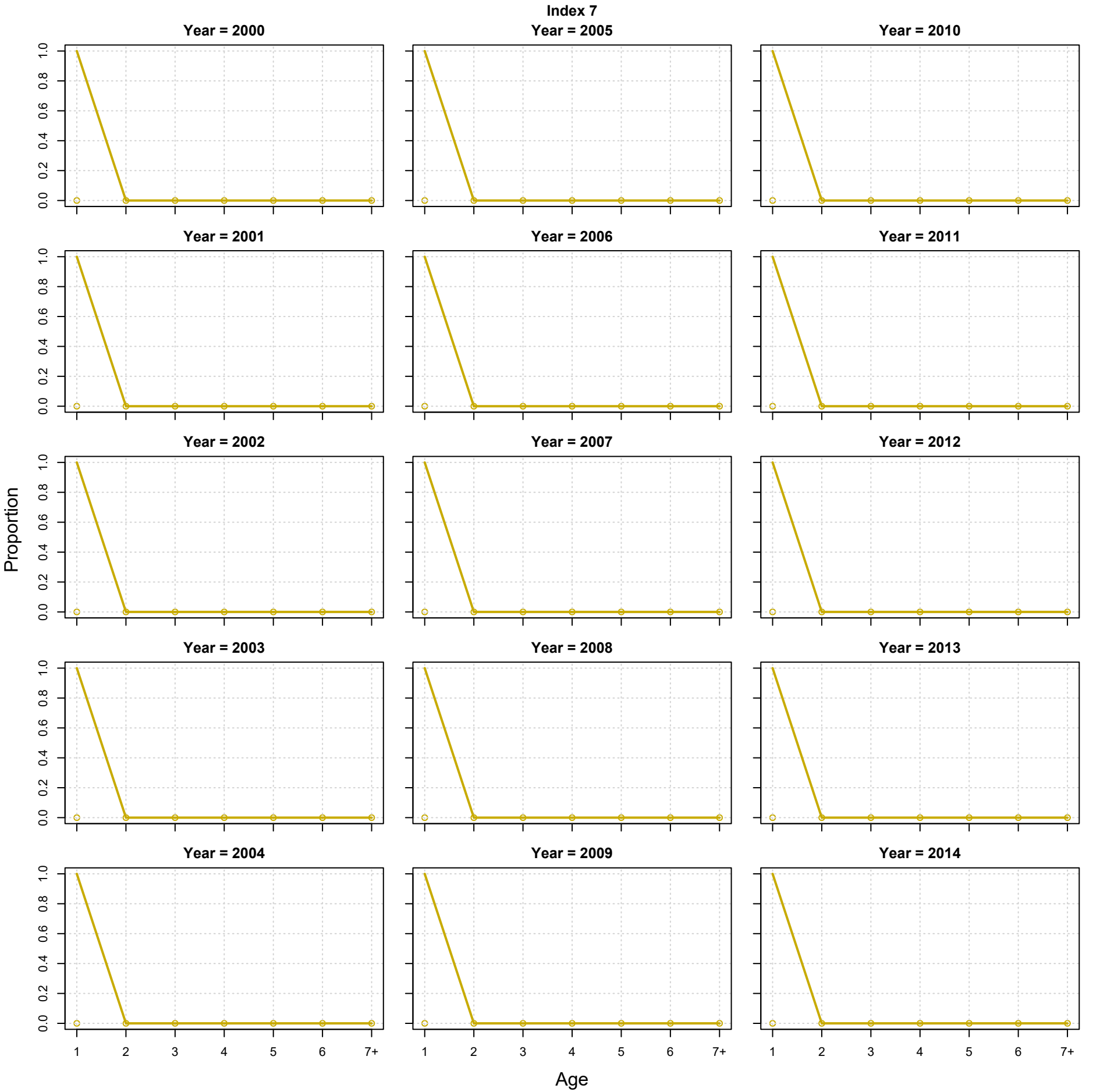
7+
Age


Index 7
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Year = 2008
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Year = 2009
Year = 2014
Proportion
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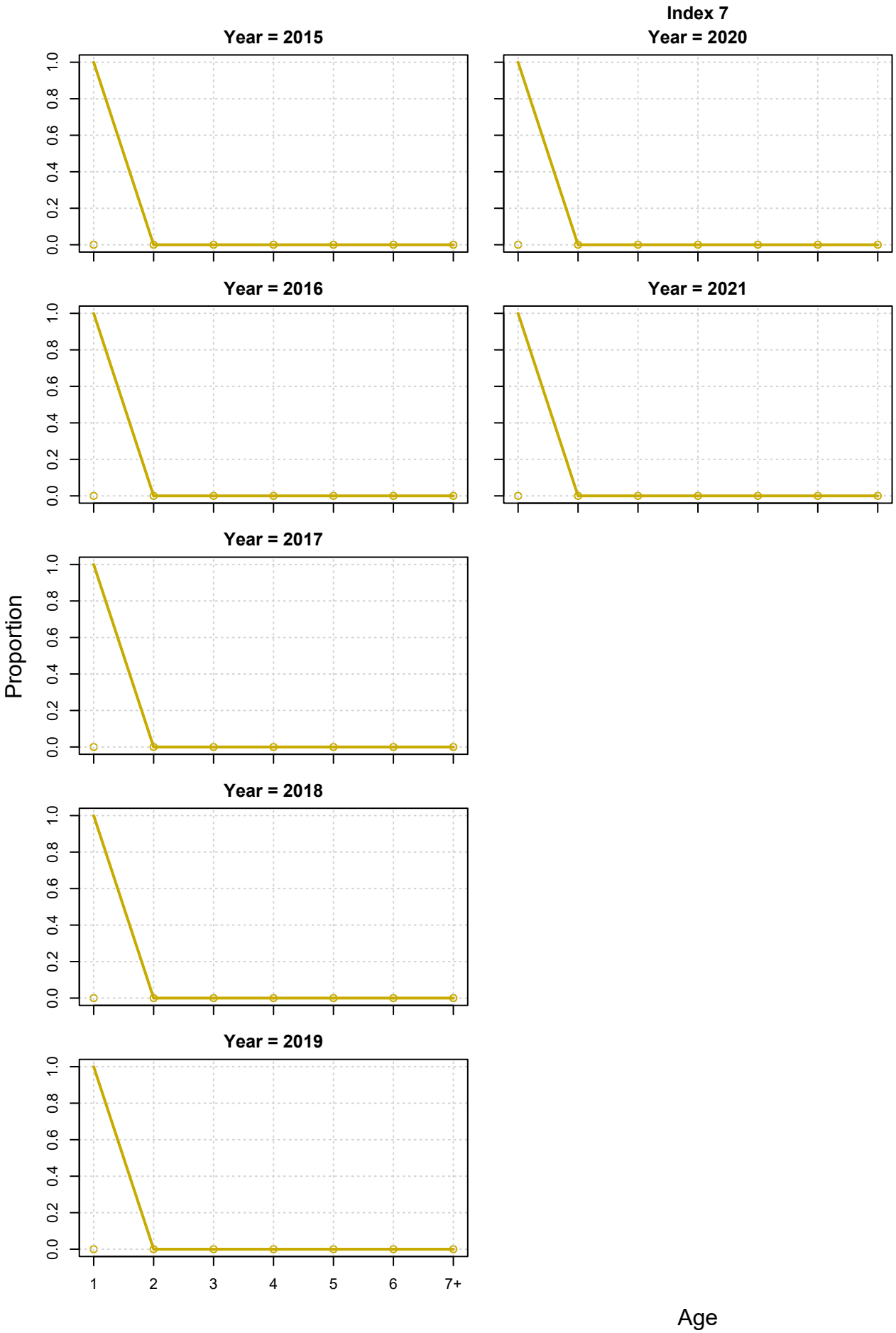
Age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Year = 2019
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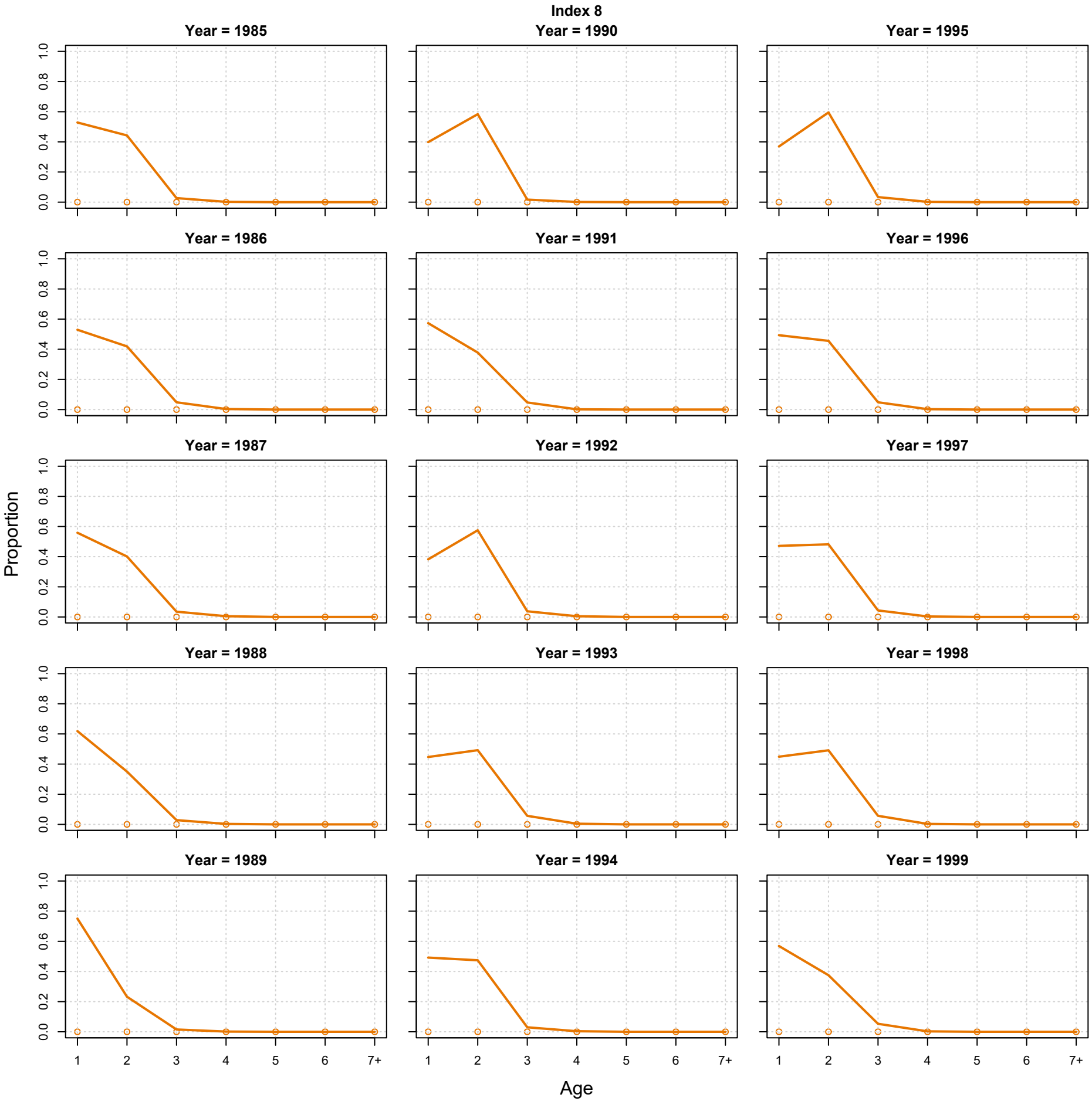
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Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
Year = 1998
Year = 1989
Year = 1994
Year = 1999
Proportion
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0.4
0.6
0.8
1.0
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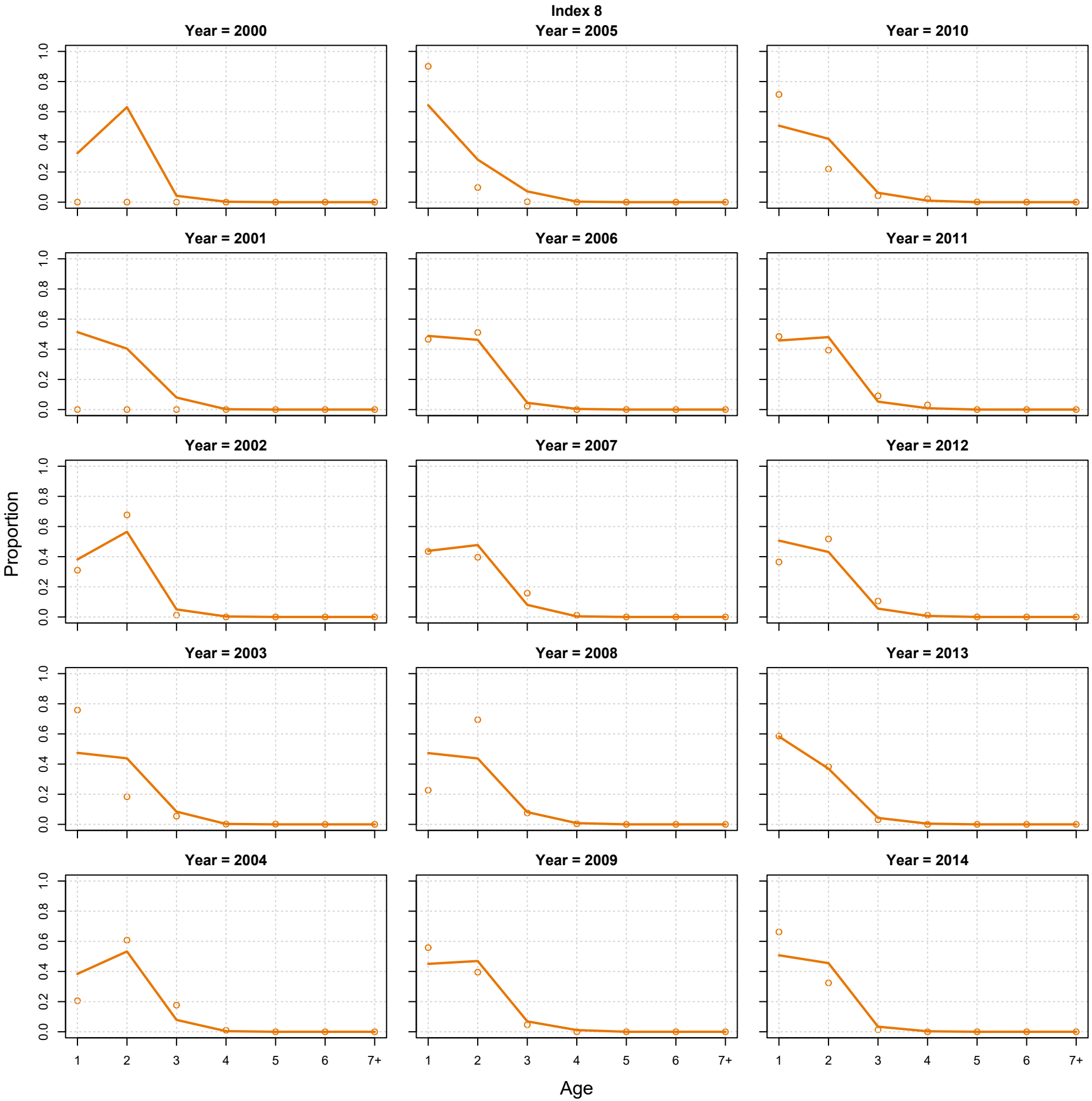
5
6
7+
Age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Year = 2007
Year = 2012
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Year = 2009
Year = 2014
Proportion
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0.8
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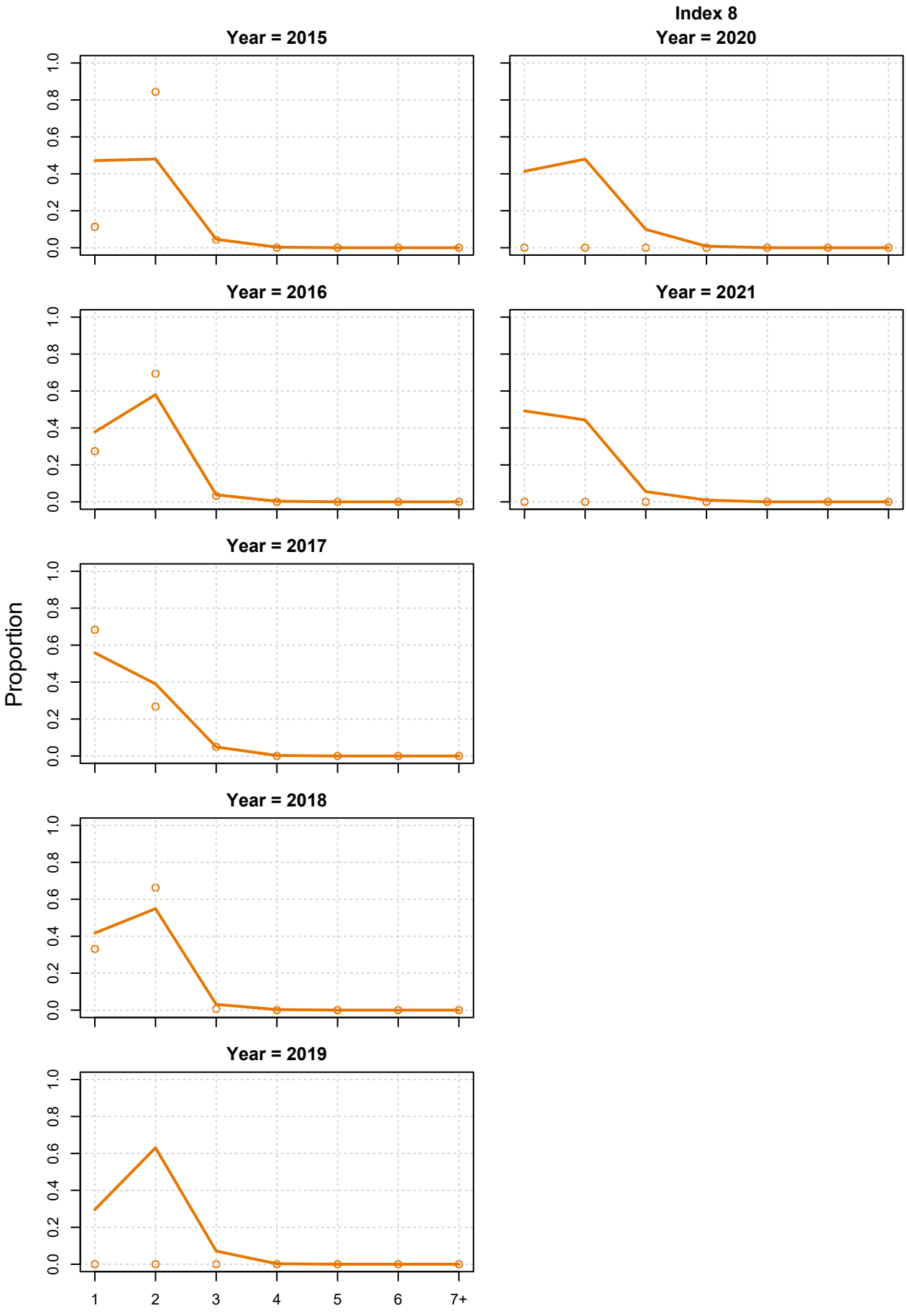
7+
Age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Year = 2018
Year = 2019
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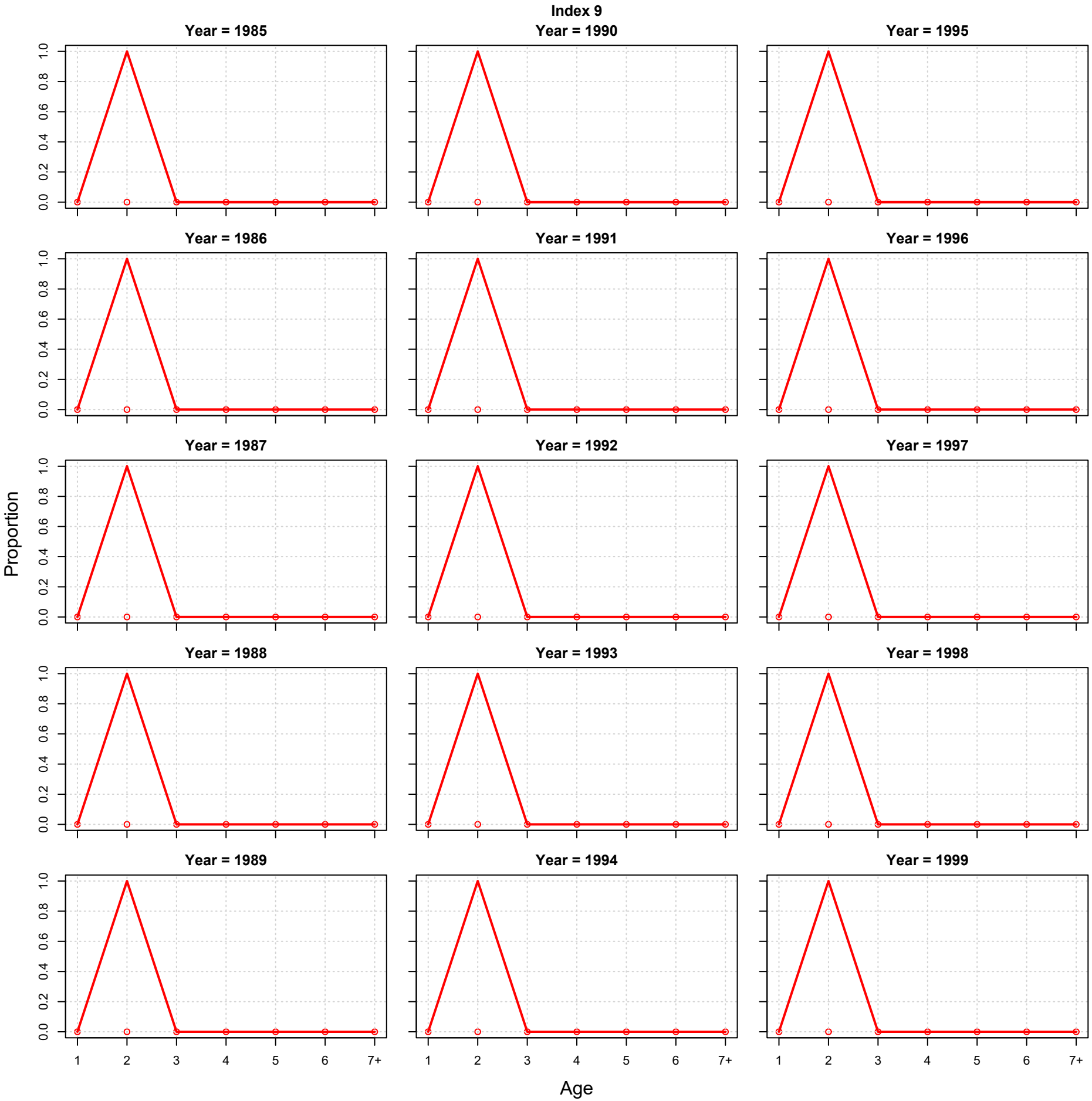
7+
Age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Year = 1991
Year = 1996
Year = 1987
Year = 1992
Year = 1997
Year = 1988
Year = 1993
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Year = 1989
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Year = 1999
Proportion
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0.8
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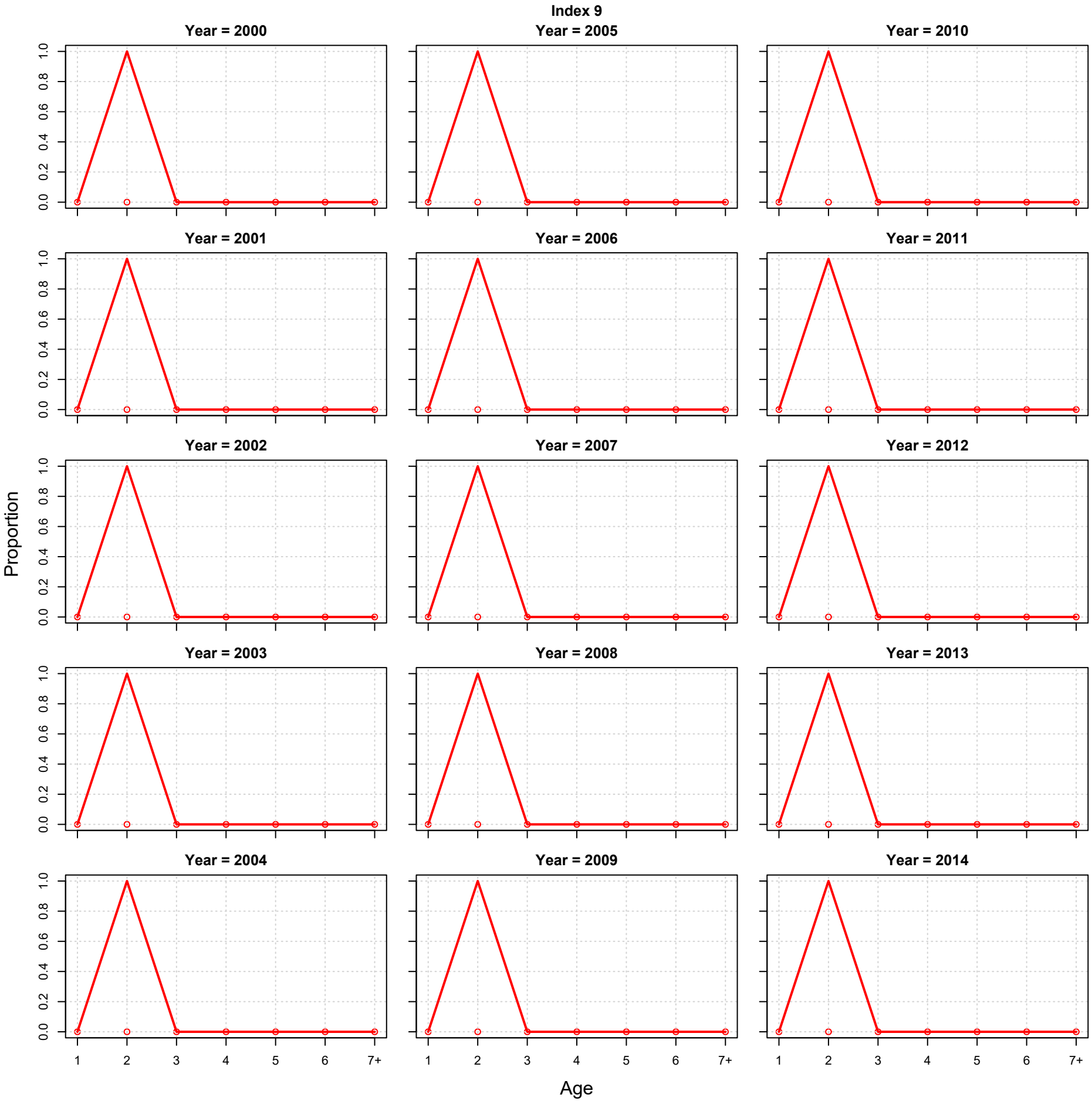
Age


Index 9
Year = 2000
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Year = 2003
Year = 2008
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Year = 2014
Proportion
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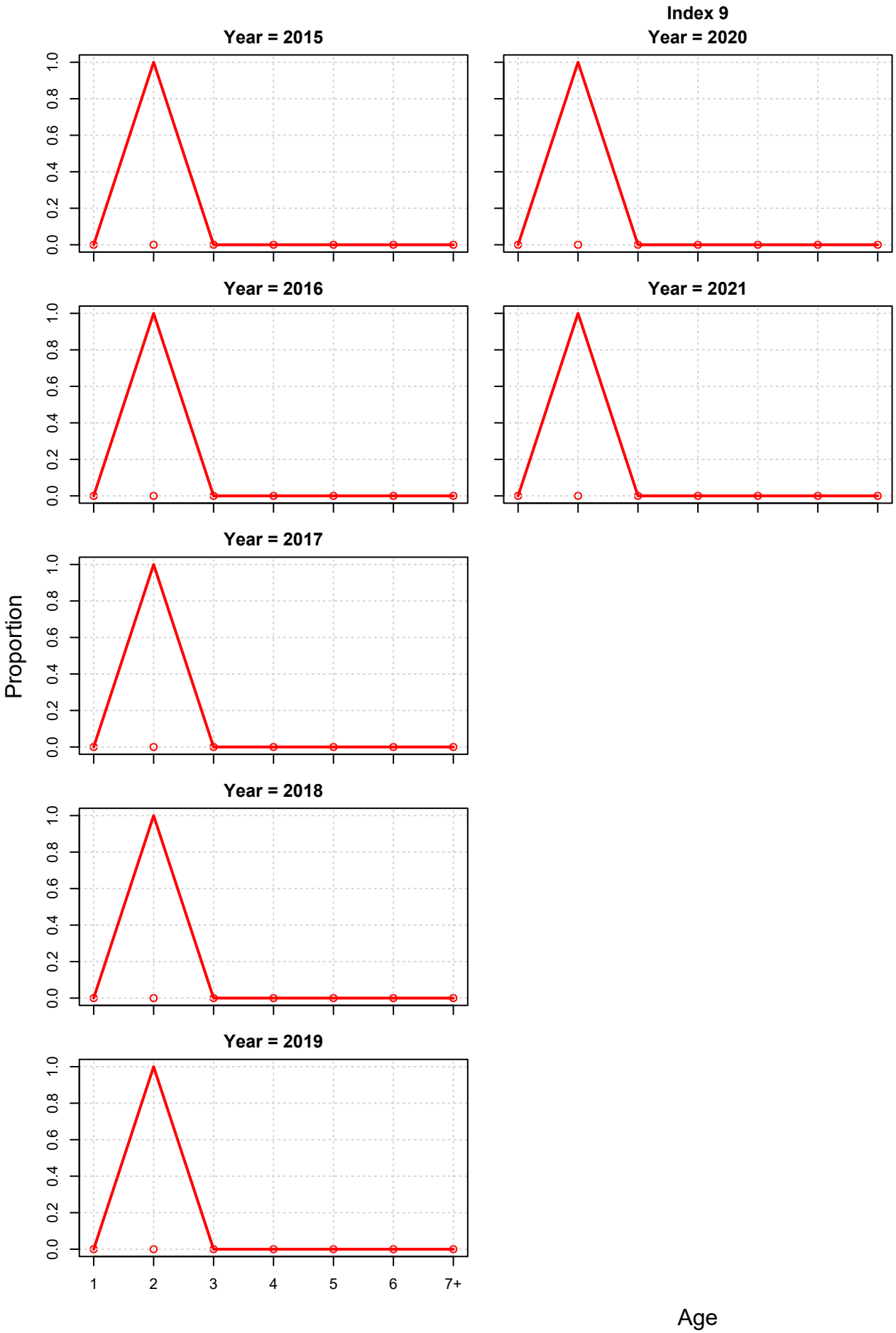
7+
Age


Index 9
Year = 2015
Year = 2020
Year = 2016
Year = 2021
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Year = 2018
Year = 2019
Proportion
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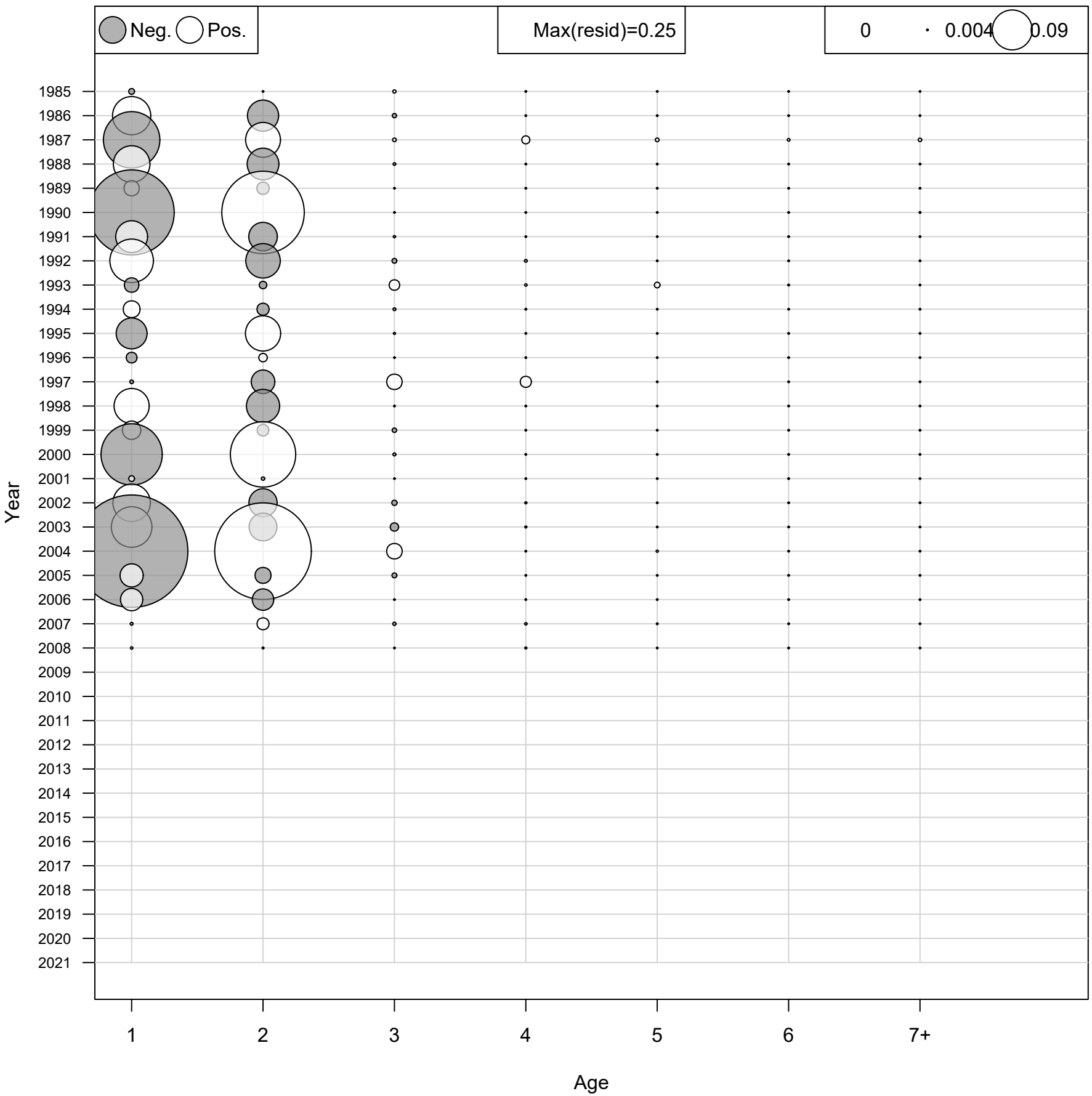
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 1
Neg.
Pos.
Max(resid)=0.25
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0.004
0.09
Year
1985
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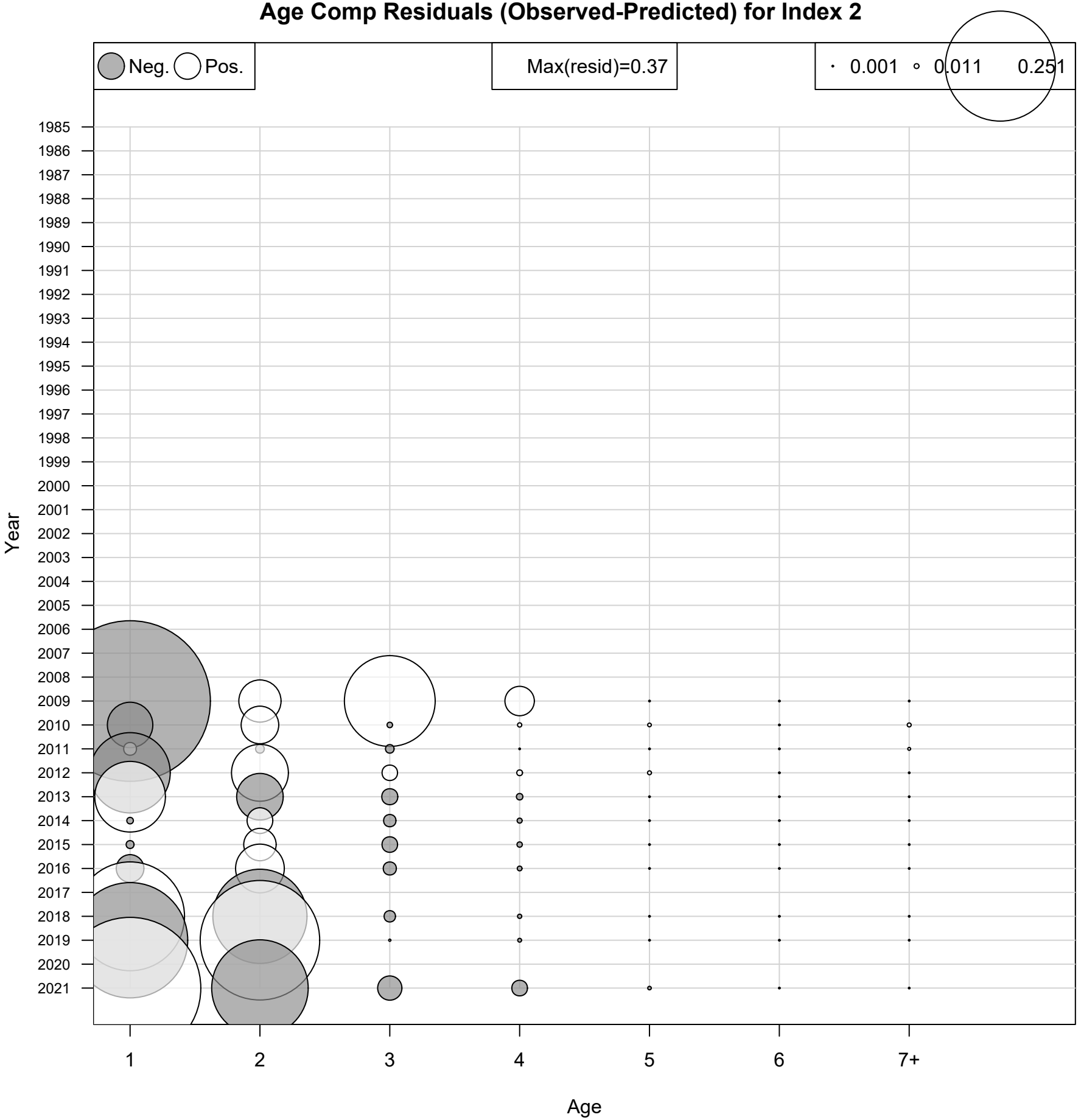
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 2
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Pos.
Max(resid)=0.37
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Year
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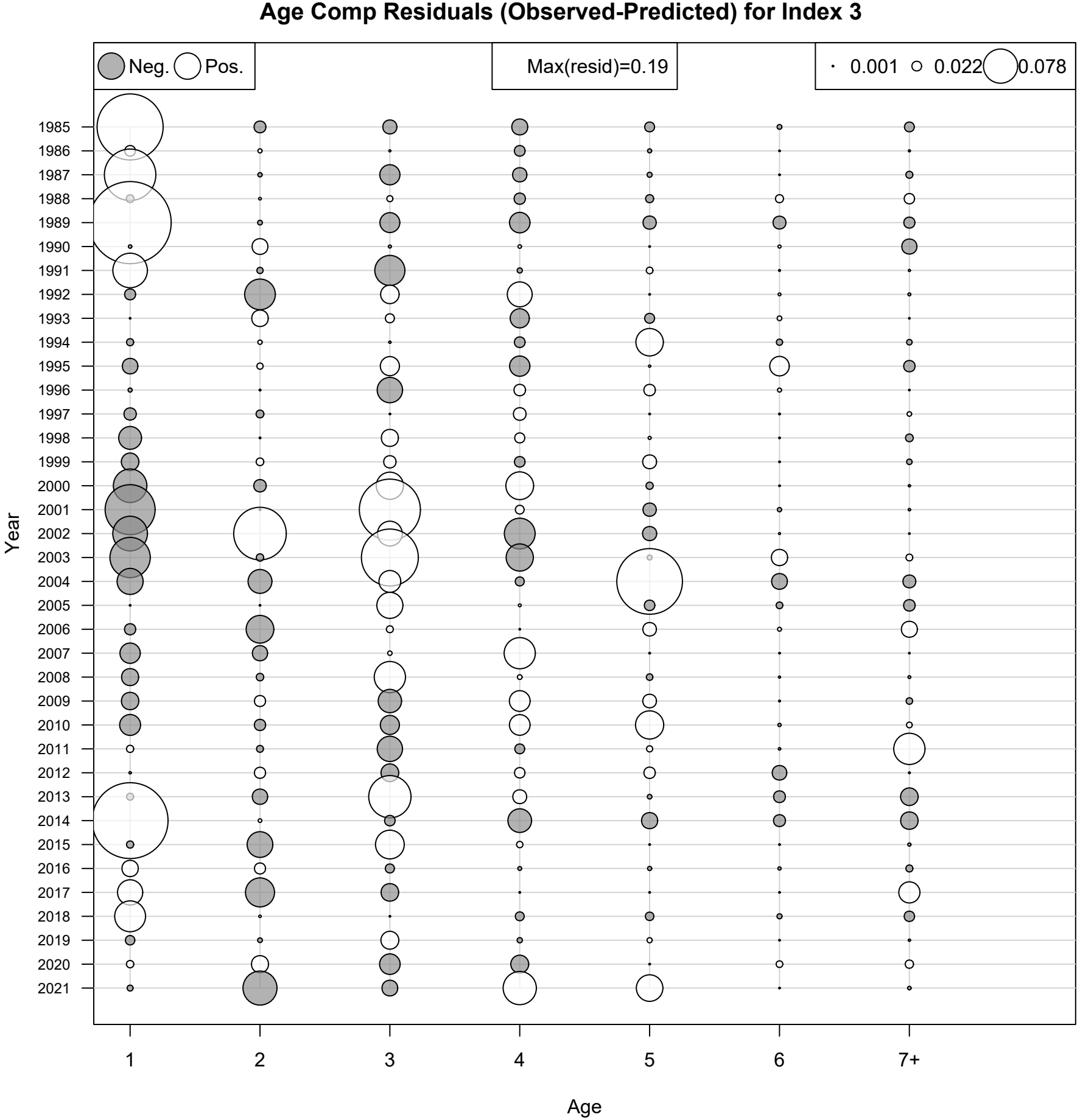
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 3
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Pos.
Max(resid)=0.19
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Year
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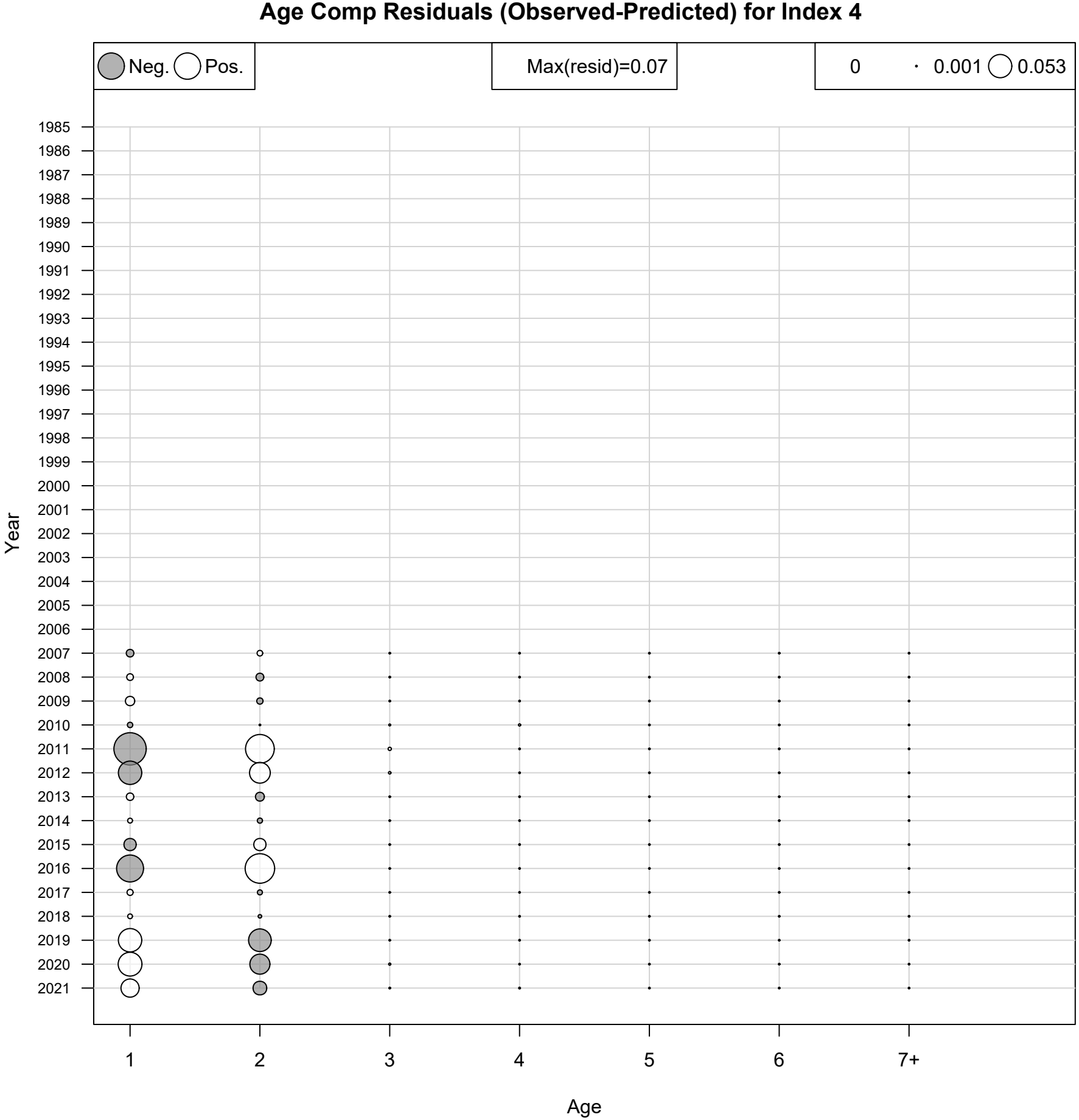
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 4
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Max(resid)=0.07
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Year
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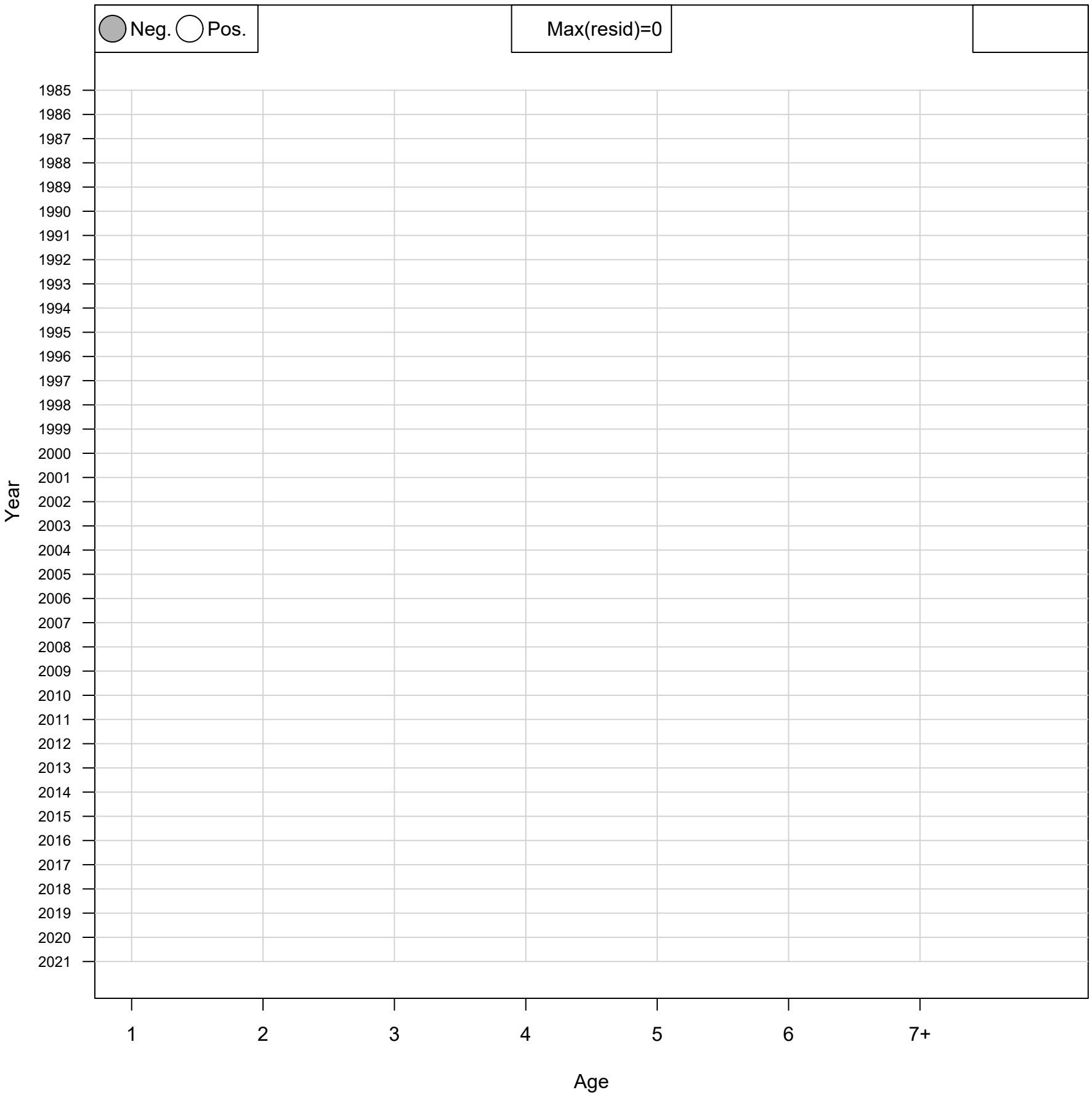
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 5
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Pos.
Max(resid)=0
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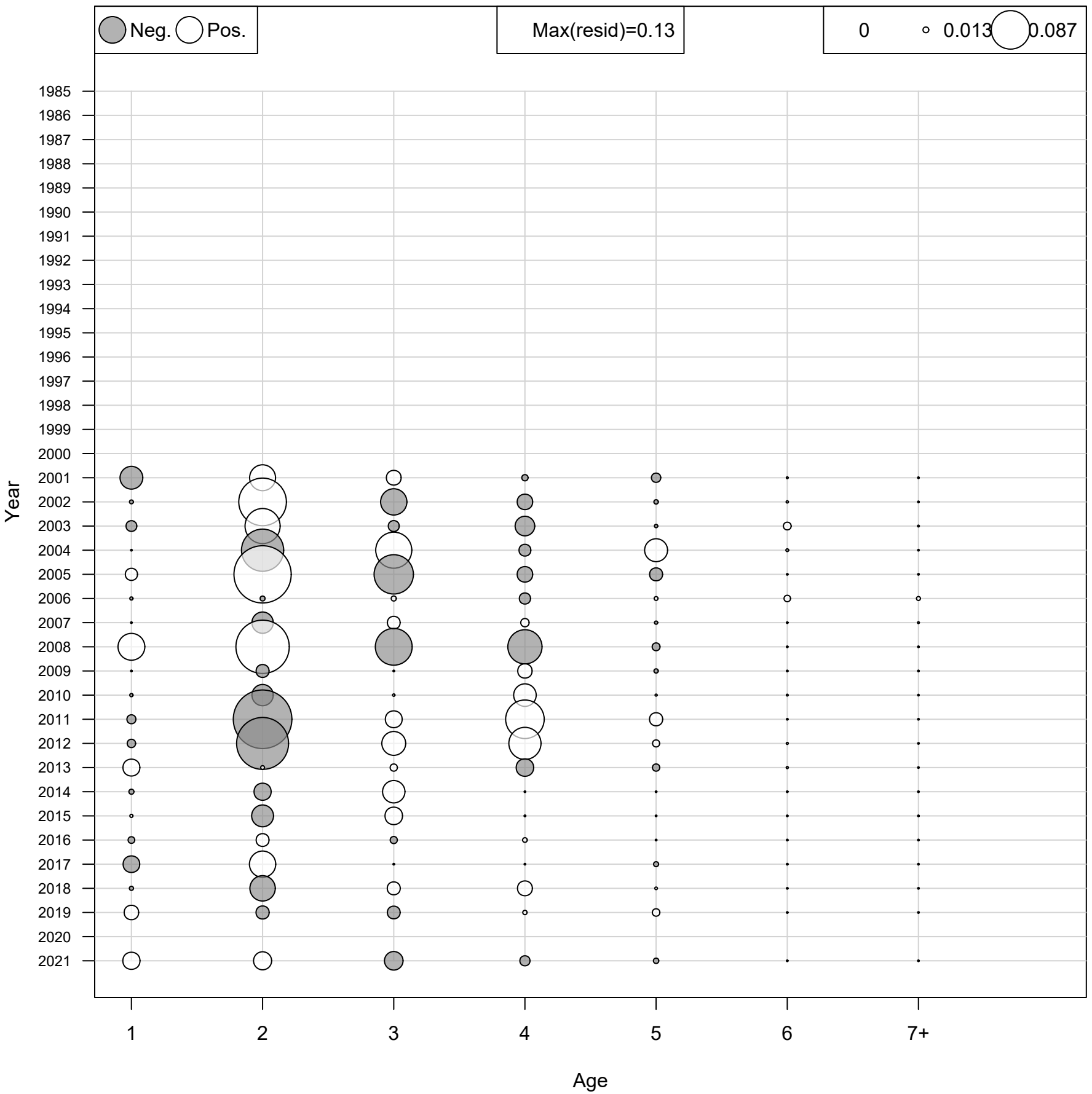
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 6
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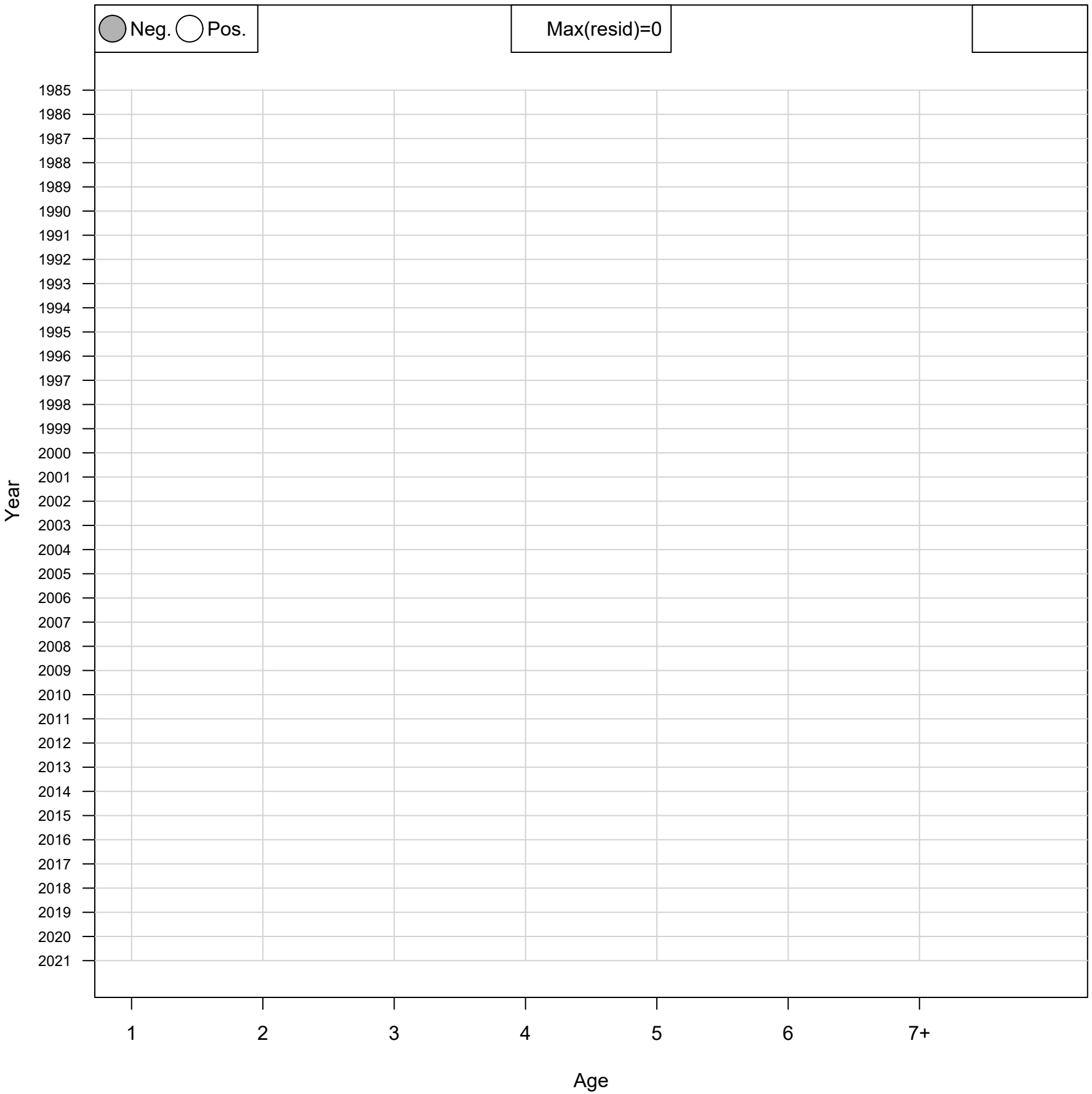
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 7
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Max(resid)=0
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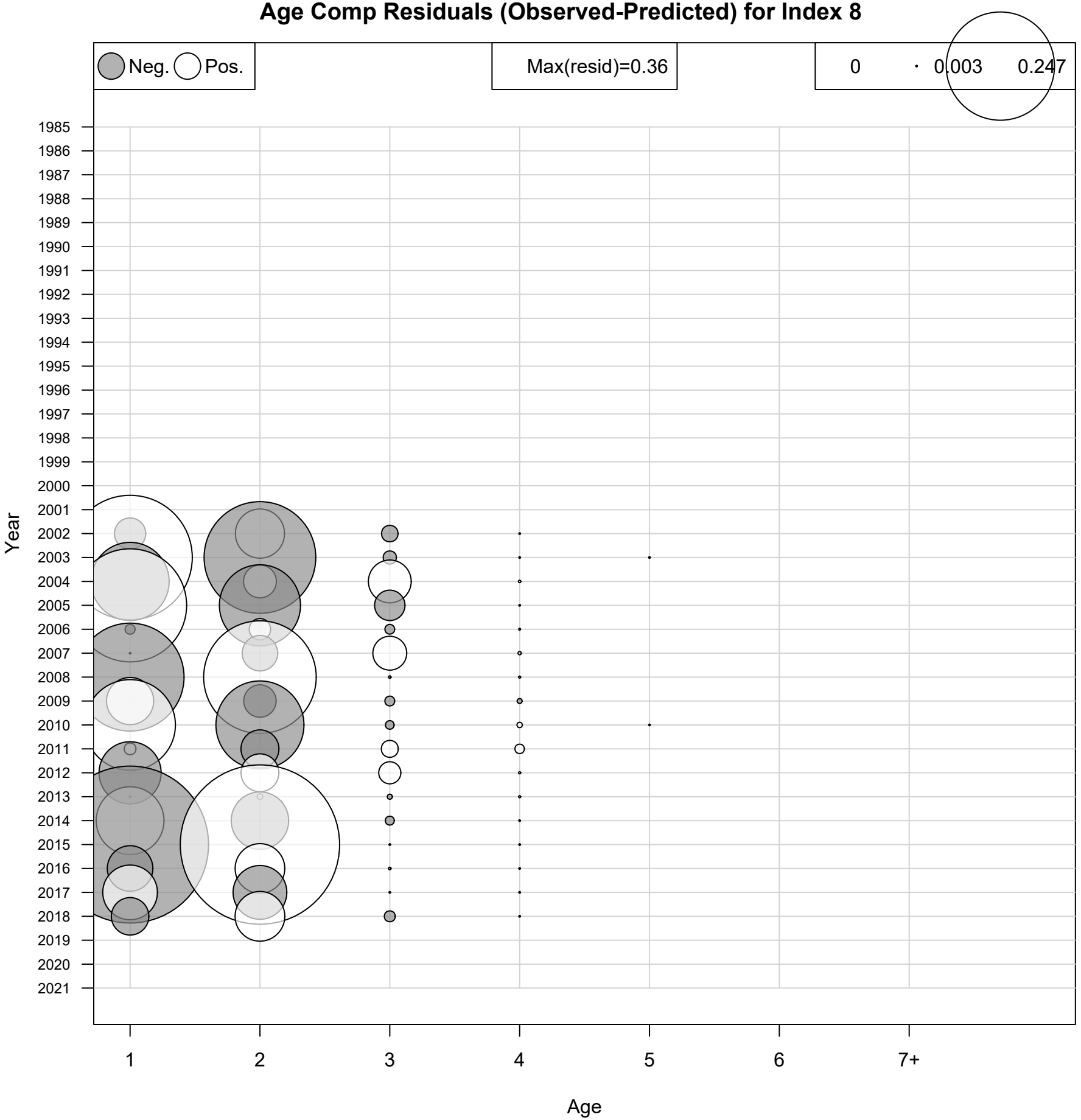
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 8
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Year
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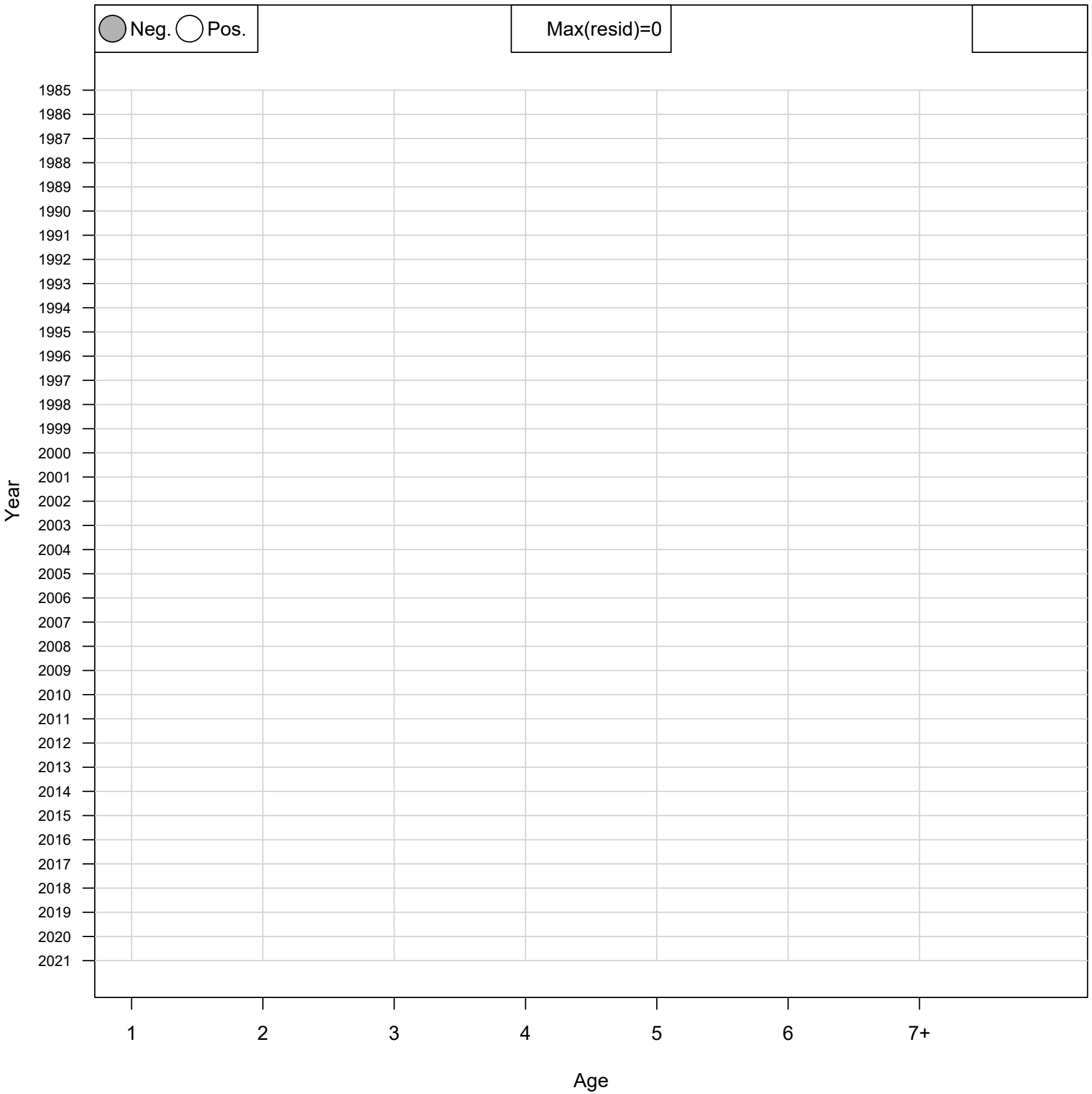
7+
Age


Age Comp Residuals (Observed-Predicted) for Index 9
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Max(resid)=0
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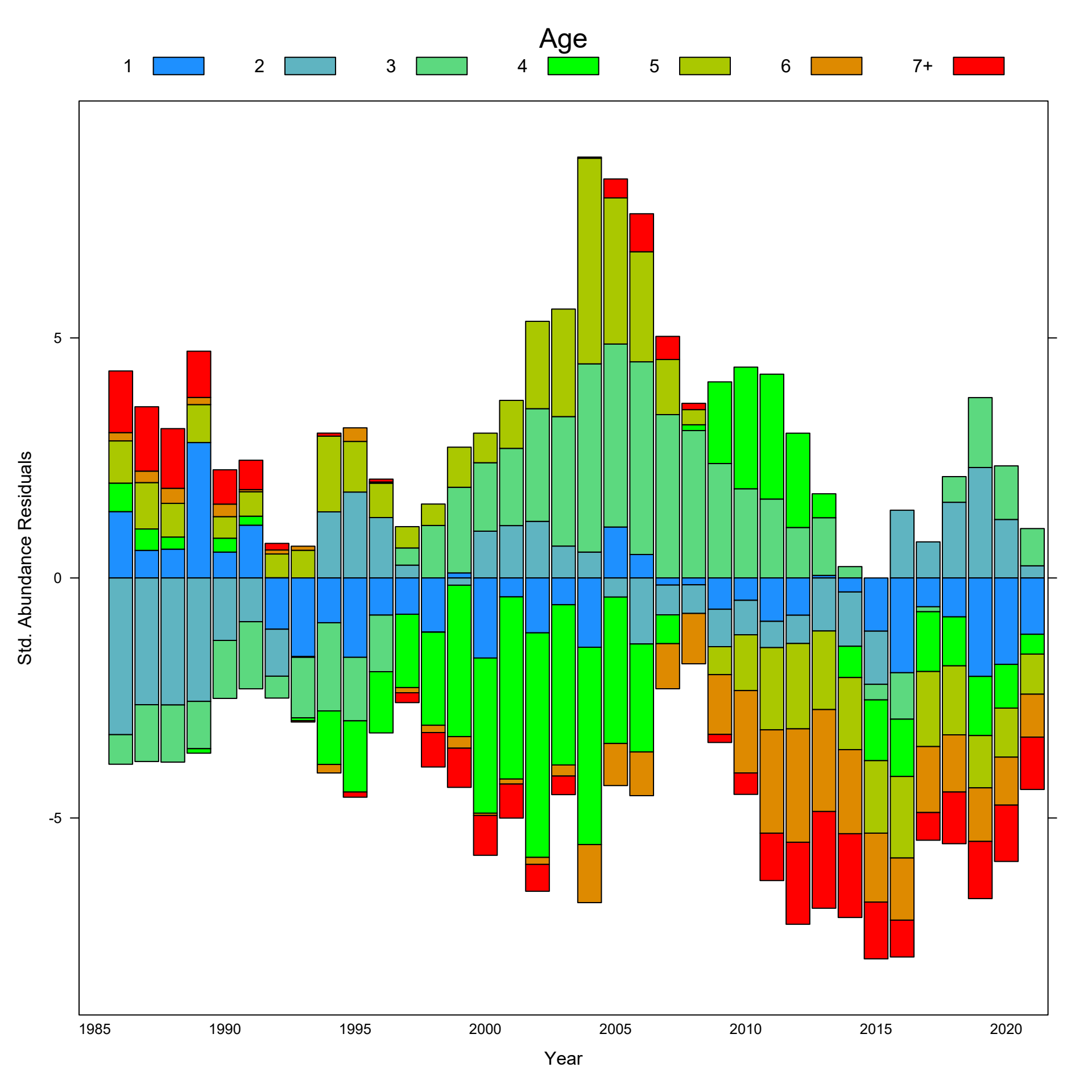
7+
Age


Age
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Std. Abundance Residuals
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1985
1990
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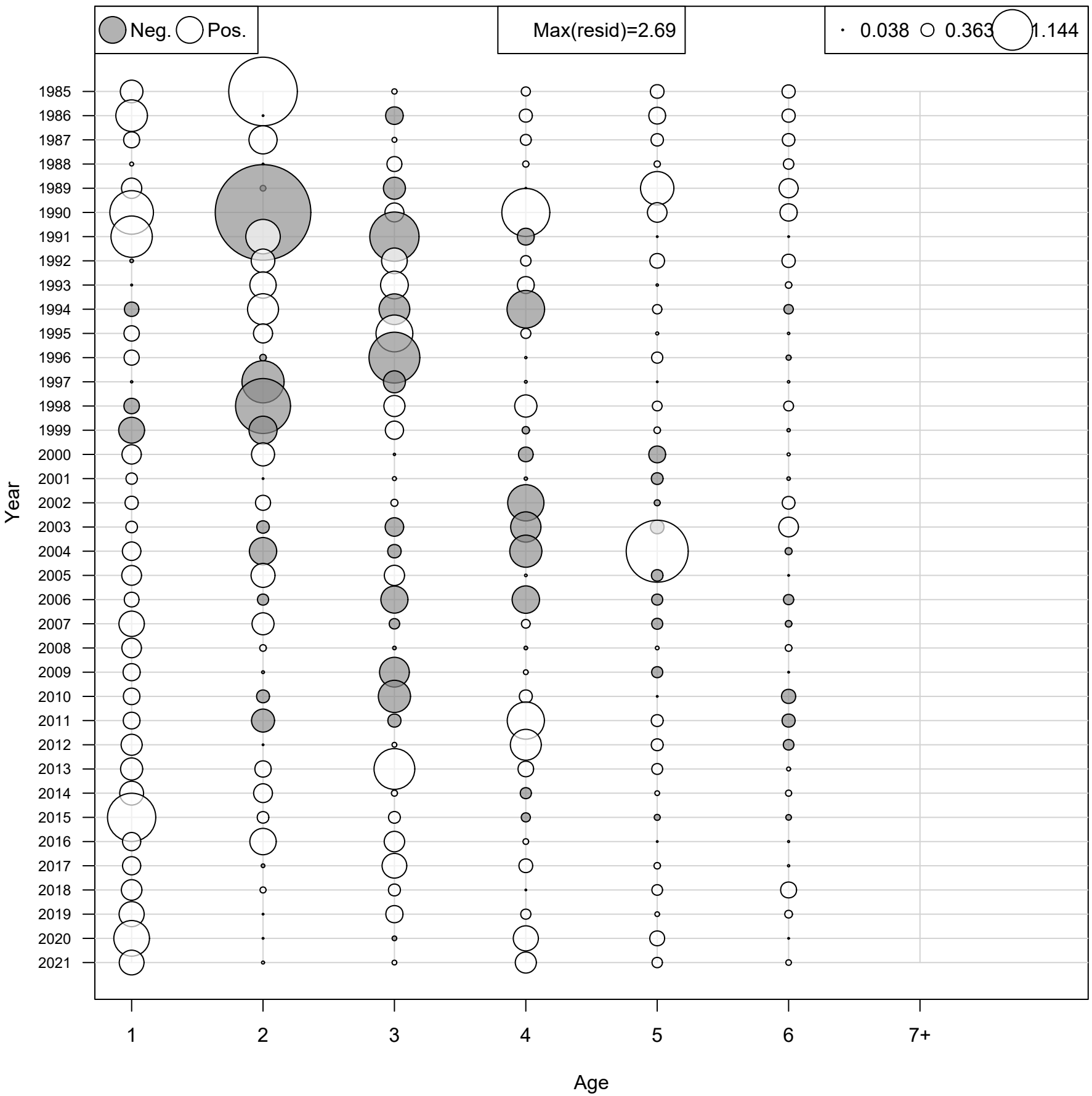
2010
2015
2020
Year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Neg.
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Max(resid)=2.69
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0.363
1.144
Year
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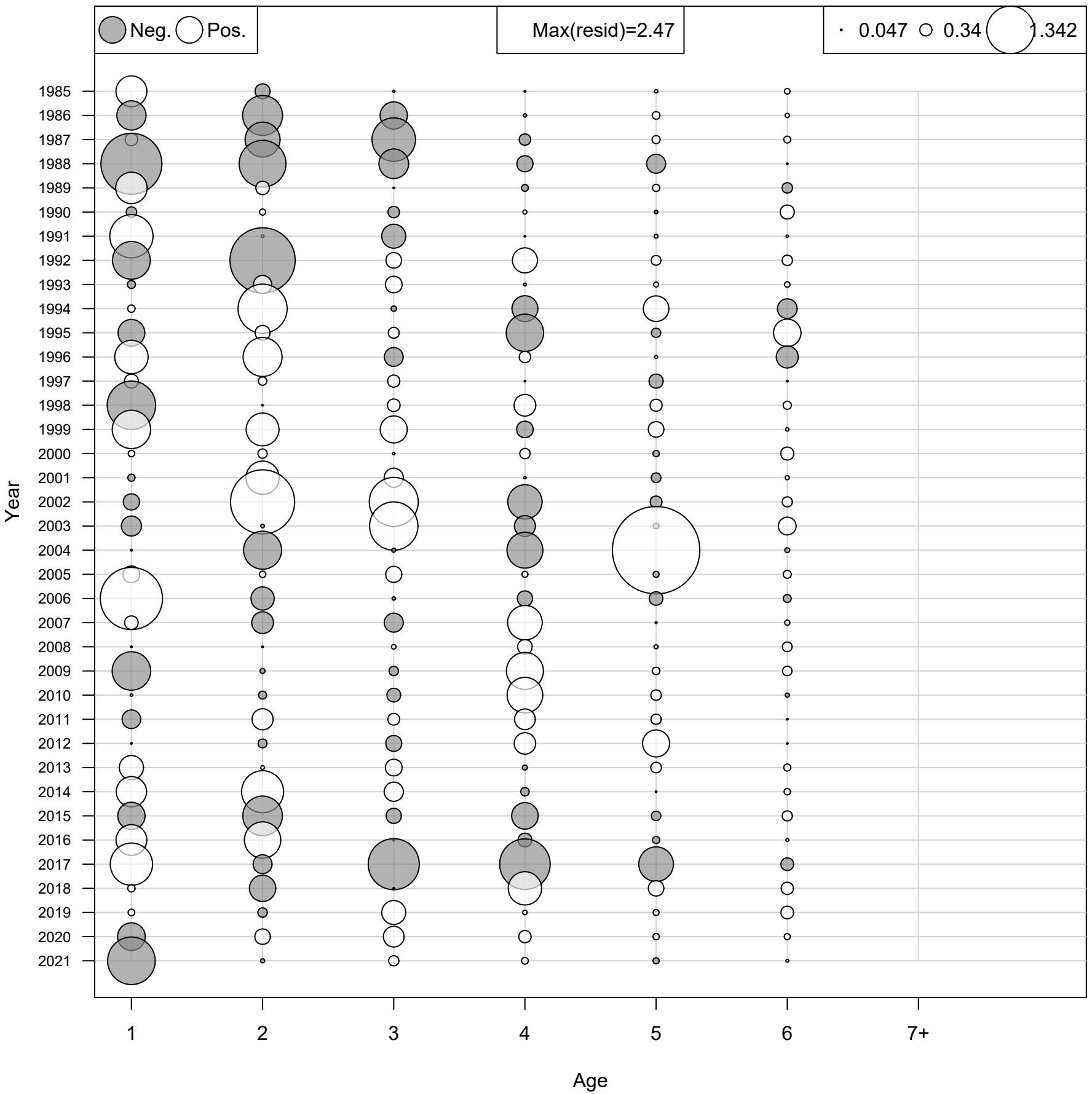
7+
Age


Age Comp OSA Quantile Residuals for Fleet 2
Neg.
Pos.
Max(resid)=2.47
0.047
0.34
1.342
Year
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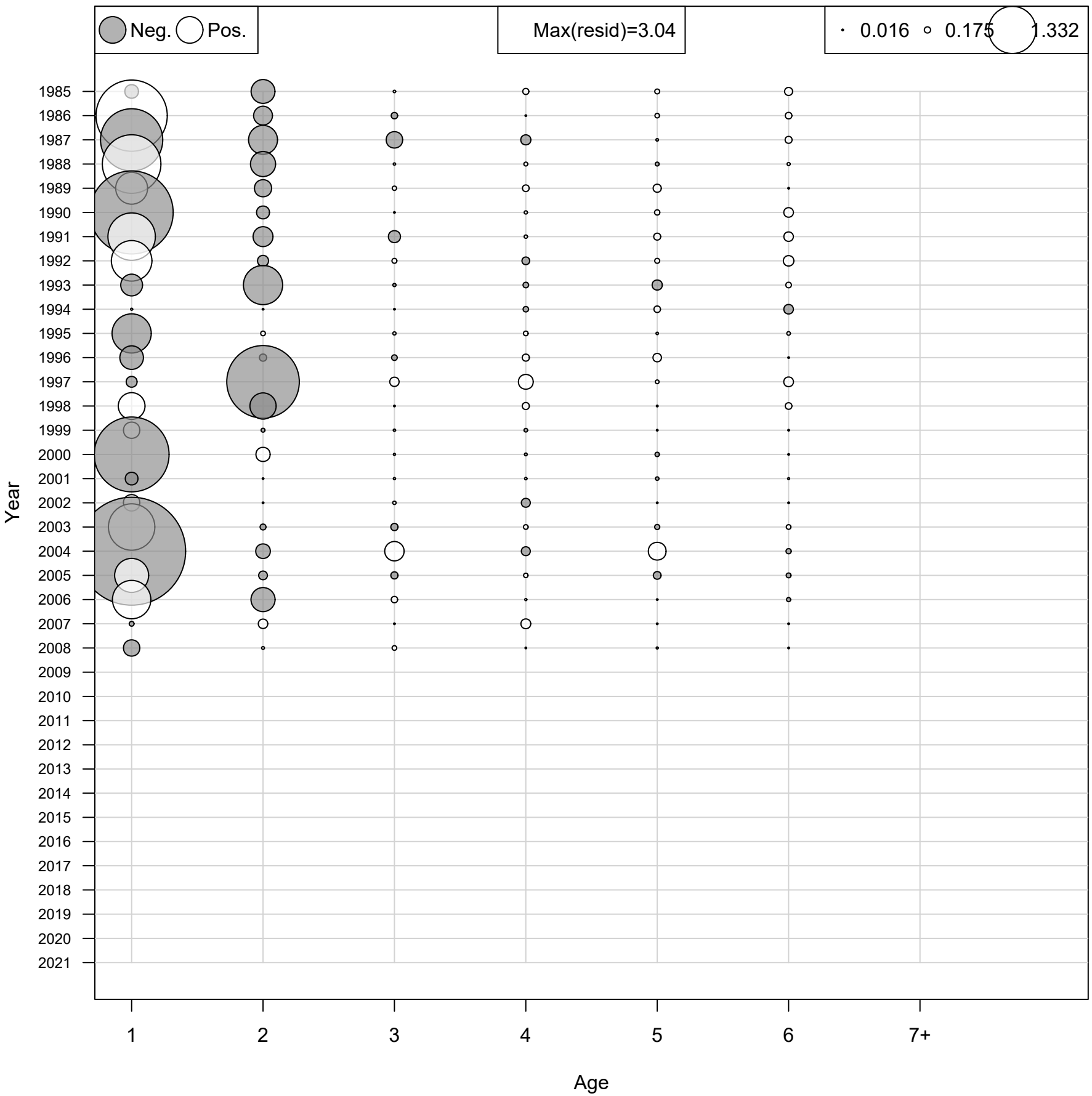
Age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Max(resid)=3.04
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0.175
1.332
Year
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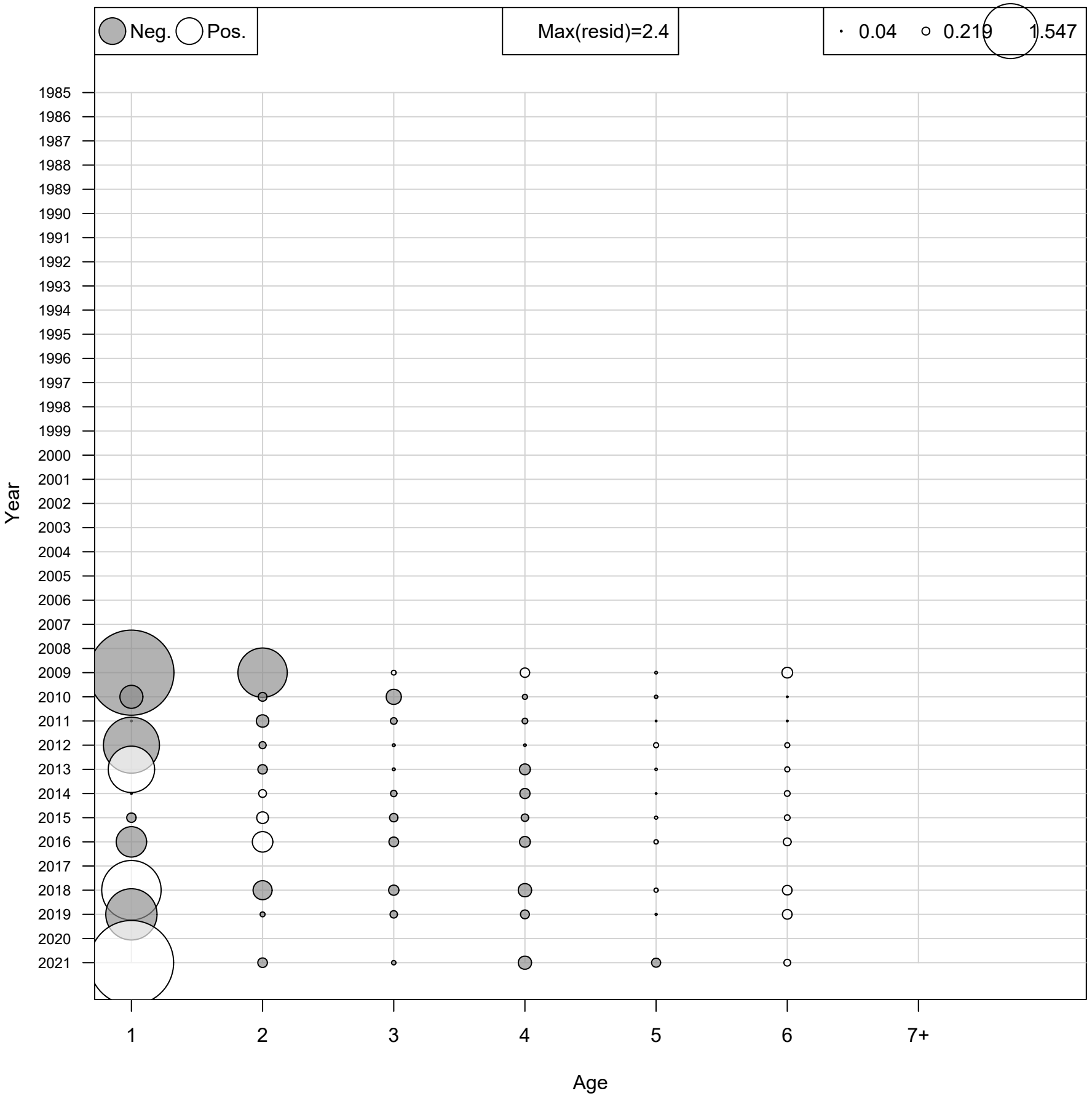
7+
Age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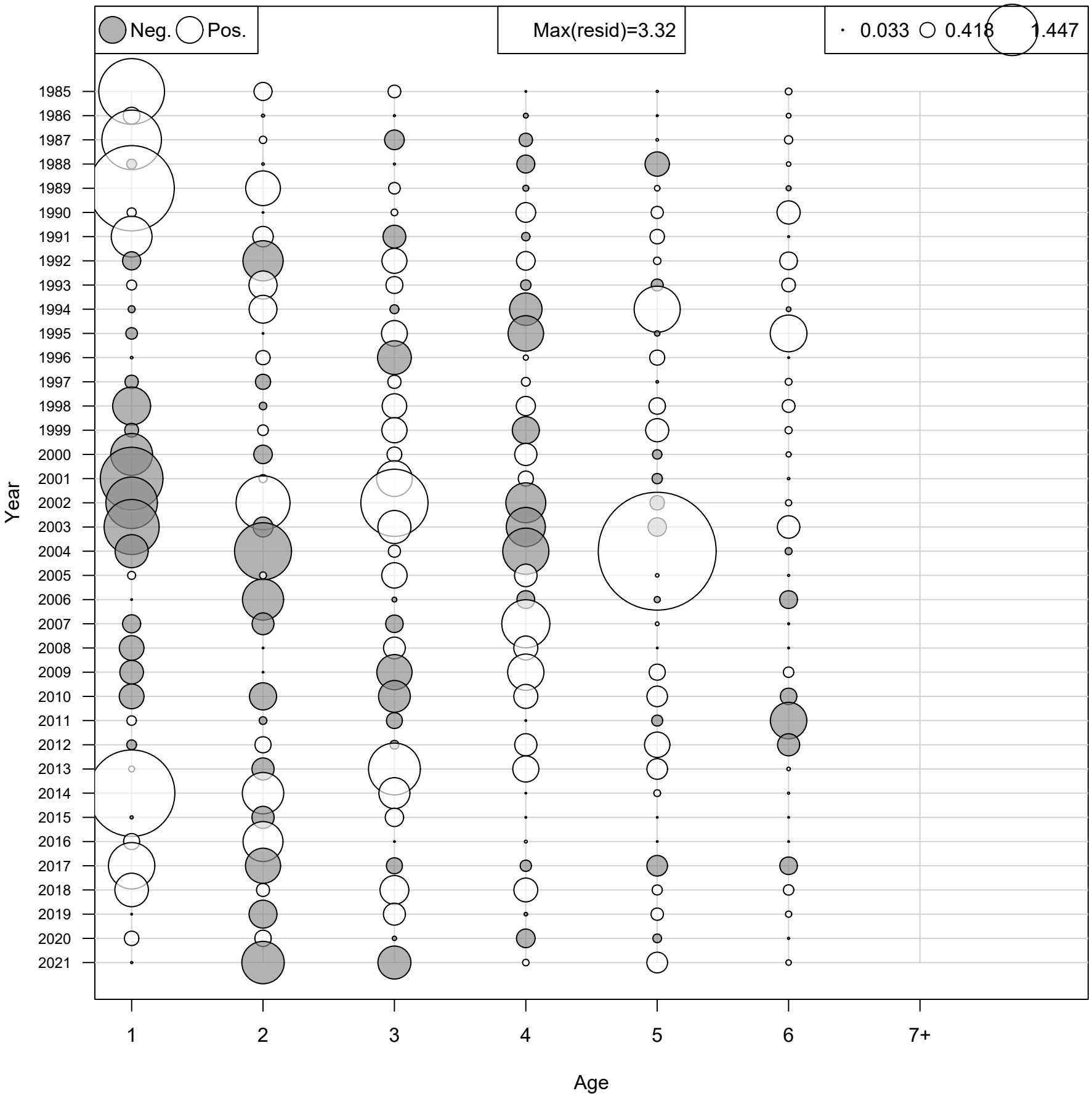
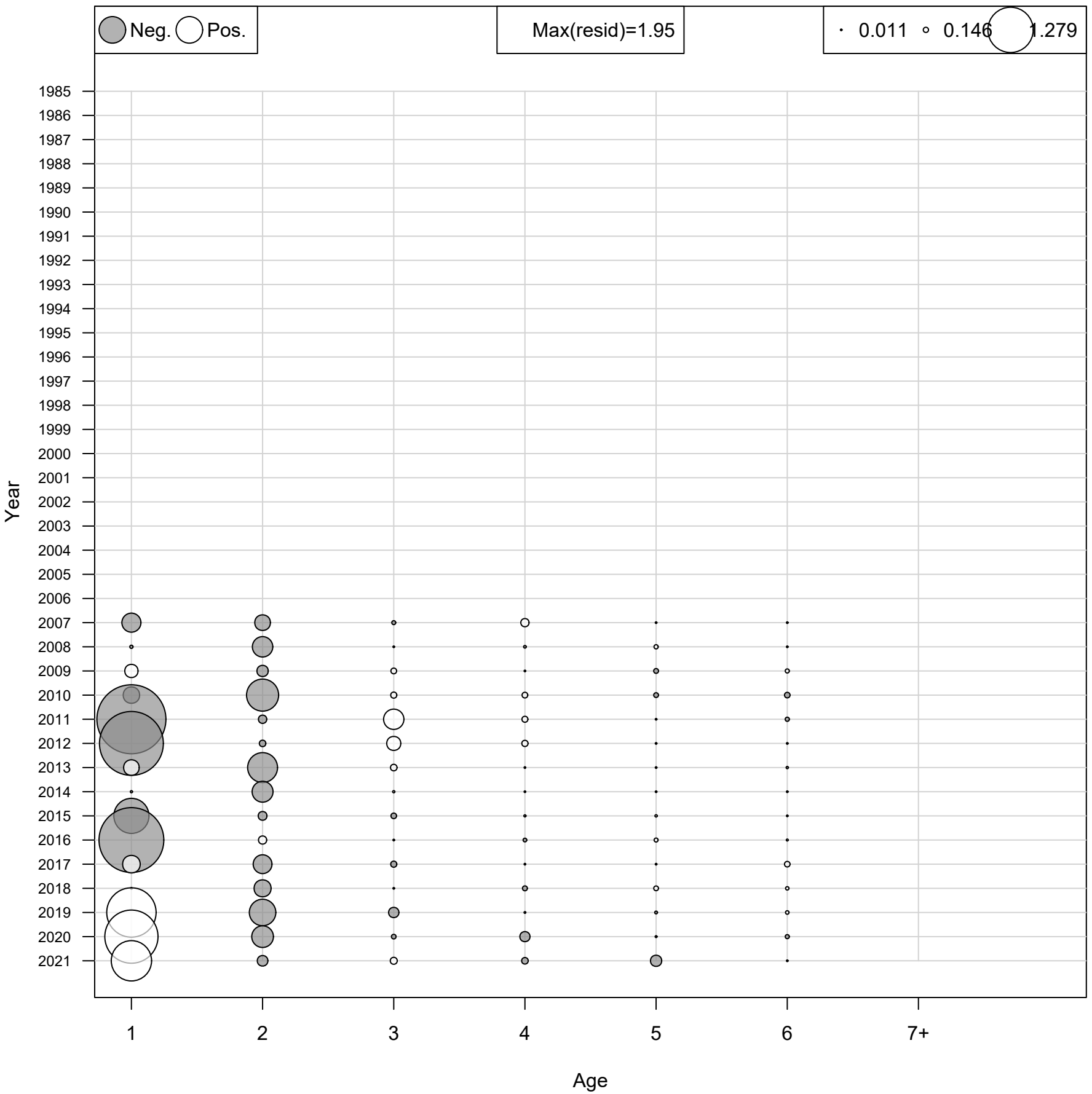
7+
Age


Age Comp OSA Quantile Residuals for Index 3
Neg.
Pos.
Max(resid)=3.32
0.033
0.418
1.447
Year
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
1
2
3
4
5
6
7+
Age


Age Comp OSA Quantile Residuals for Index 4
Neg.
Pos.
Max(resid)=1.95
0.011
0.146
1.279
Year
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
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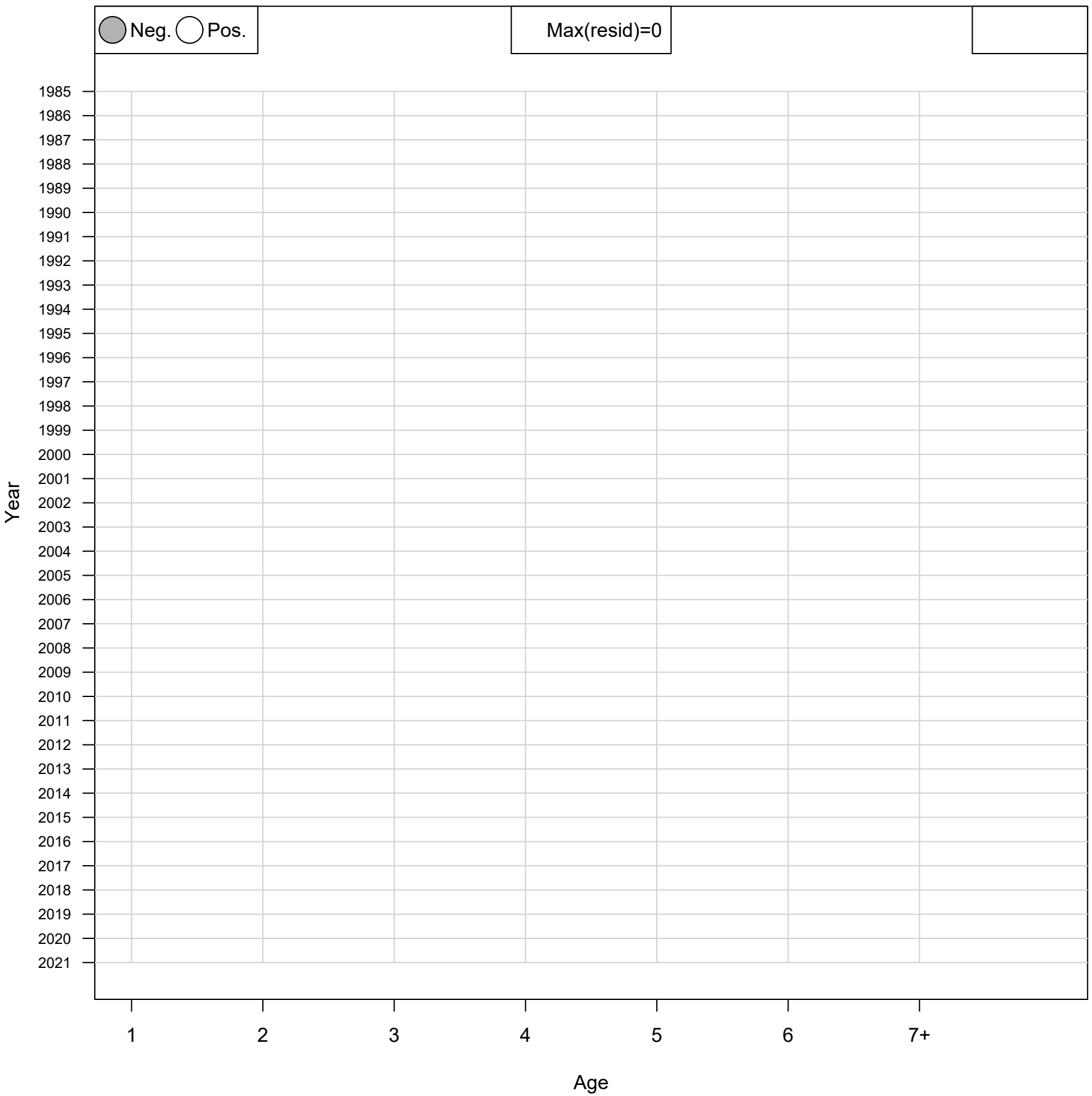
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age


Age Comp OSA Quantile Residuals for Index 5
Neg.
Pos.
Max(resid)=0
Year
1985
1986
1987
1988
1989
1990
1991
1992
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1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
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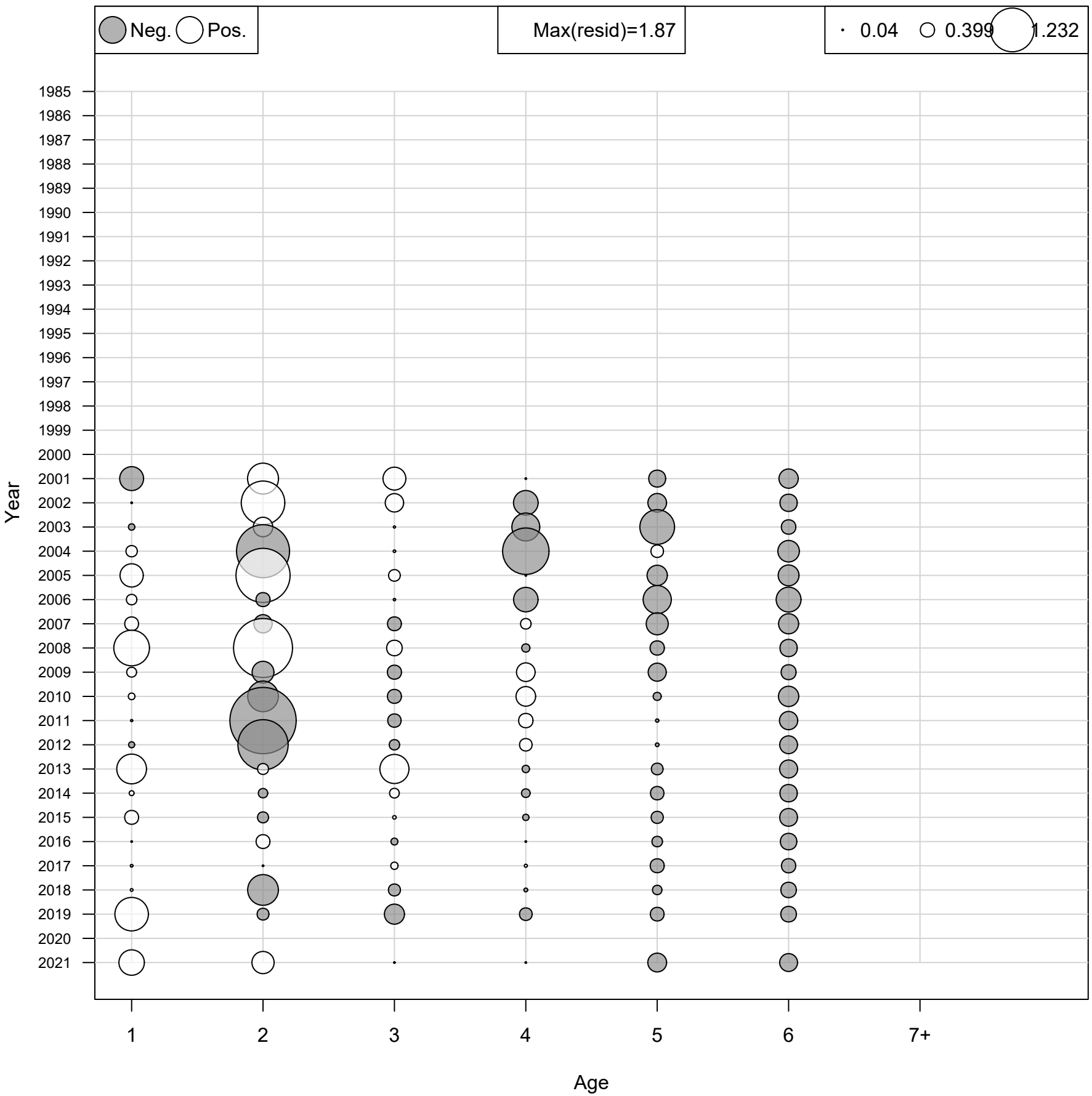
2014
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age


Age Comp OSA Quantile Residuals for Index 6
Neg.
Pos.
Max(resid)=1.87
0.04
0.399
1.232
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
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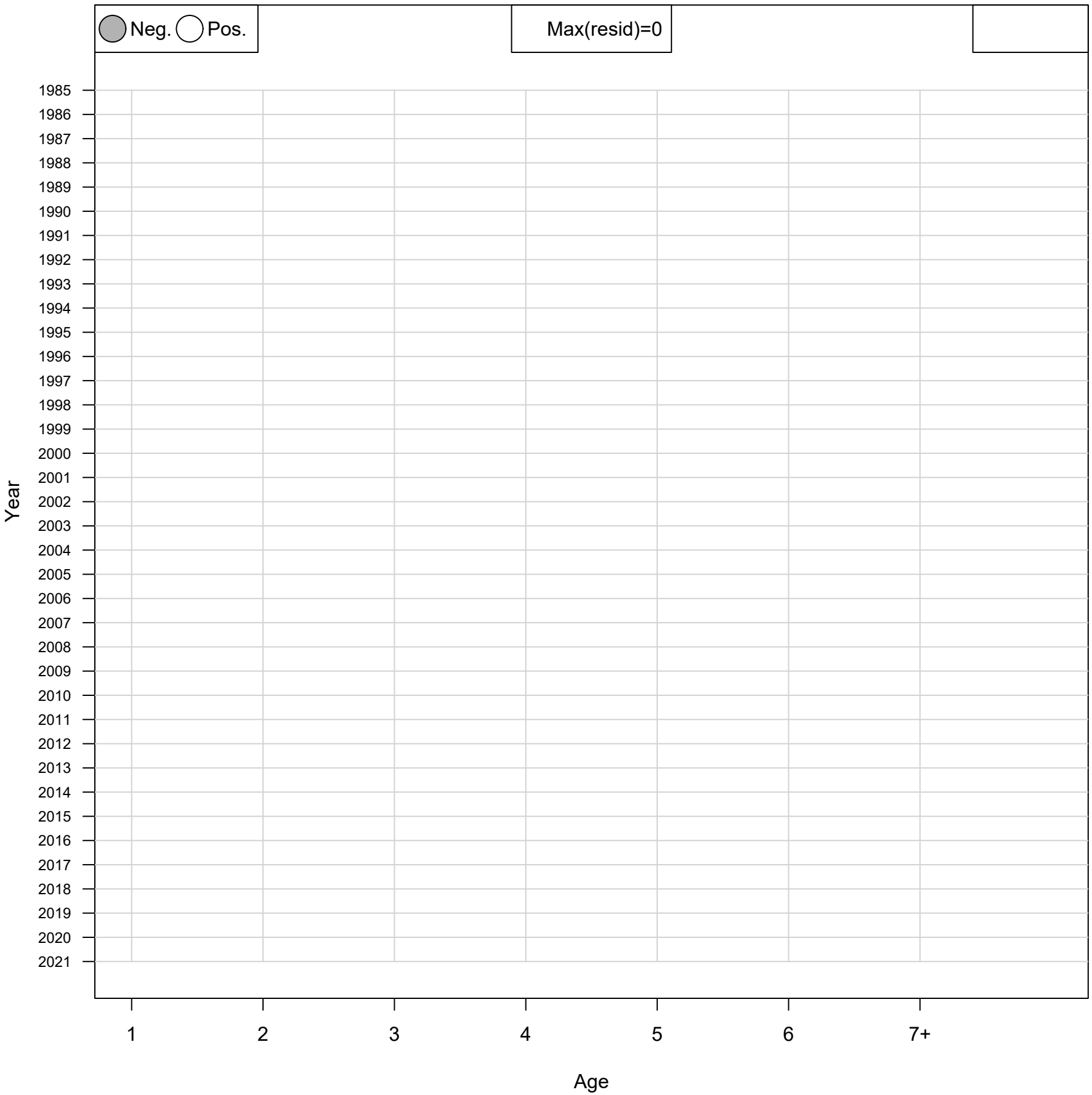
2015
2016
2017
2018
2019
2020
2021
Year
1
2
3
4
5
6
7+
Age


Age Comp OSA Quantile Residuals for Index 7
Neg.
Pos.
Max(resid)=0
Year
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
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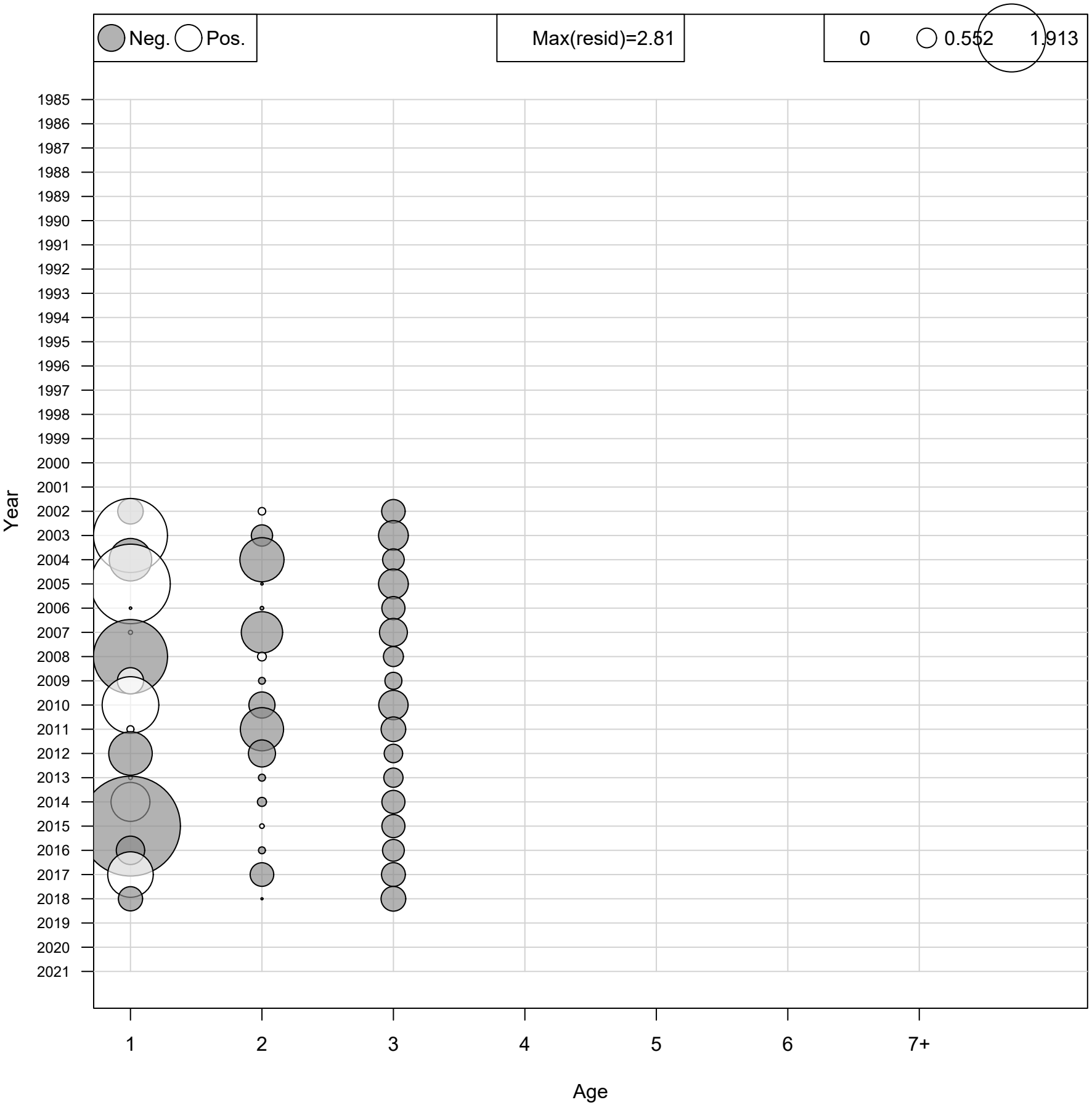
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age


Age Comp OSA Quantile Residuals for Index 8
Neg.
Pos.
Max(resid)=2.81
0
0.552
1.913
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
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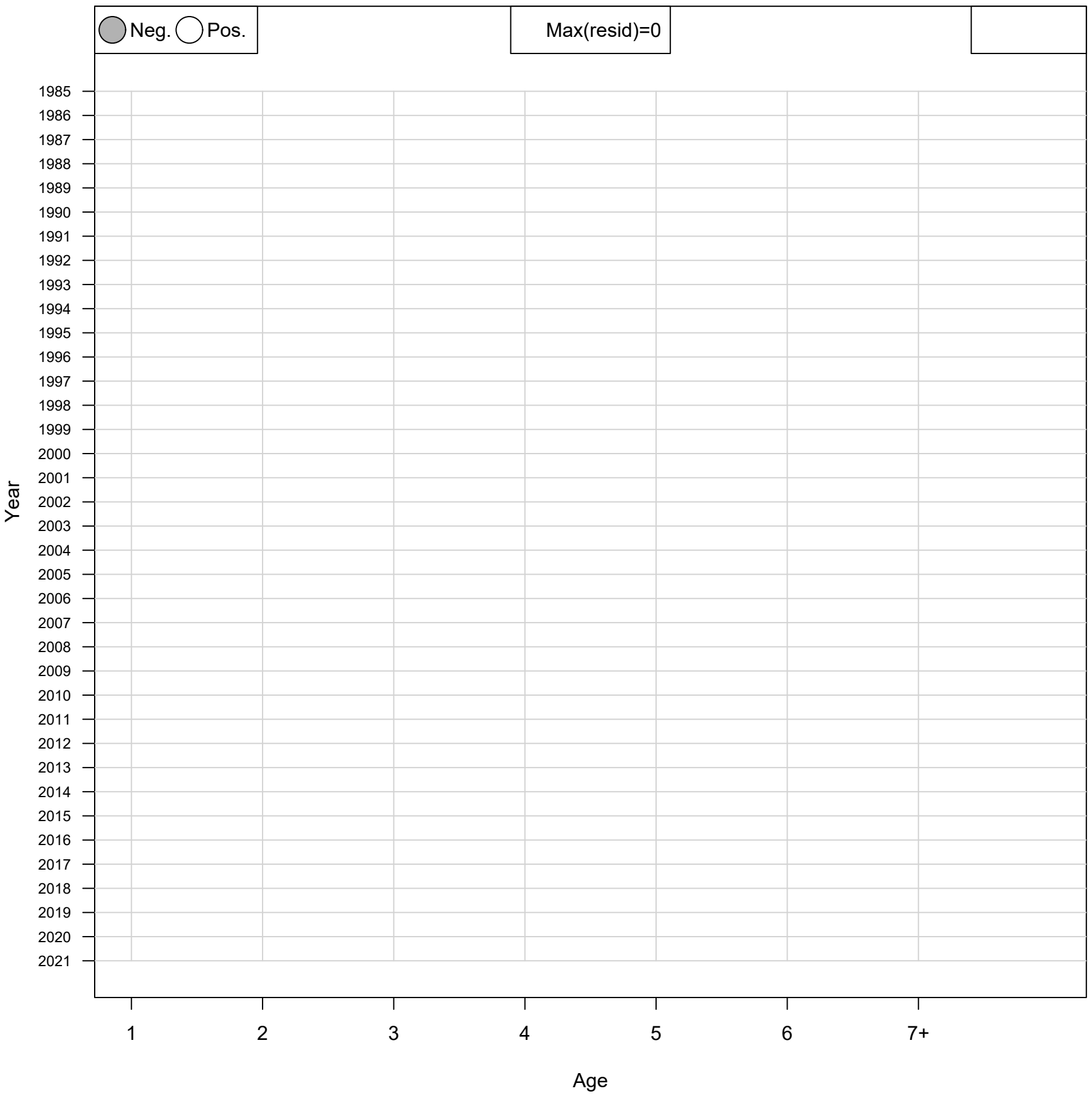
2015
2016
2017
2018
2019
2020
2021
Year
1
2
3
4
5
6
7+
Age


Age Comp OSA Quantile Residuals for Index 9
Neg.
Pos.
Max(resid)=0
Year
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
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2010
2011
2012
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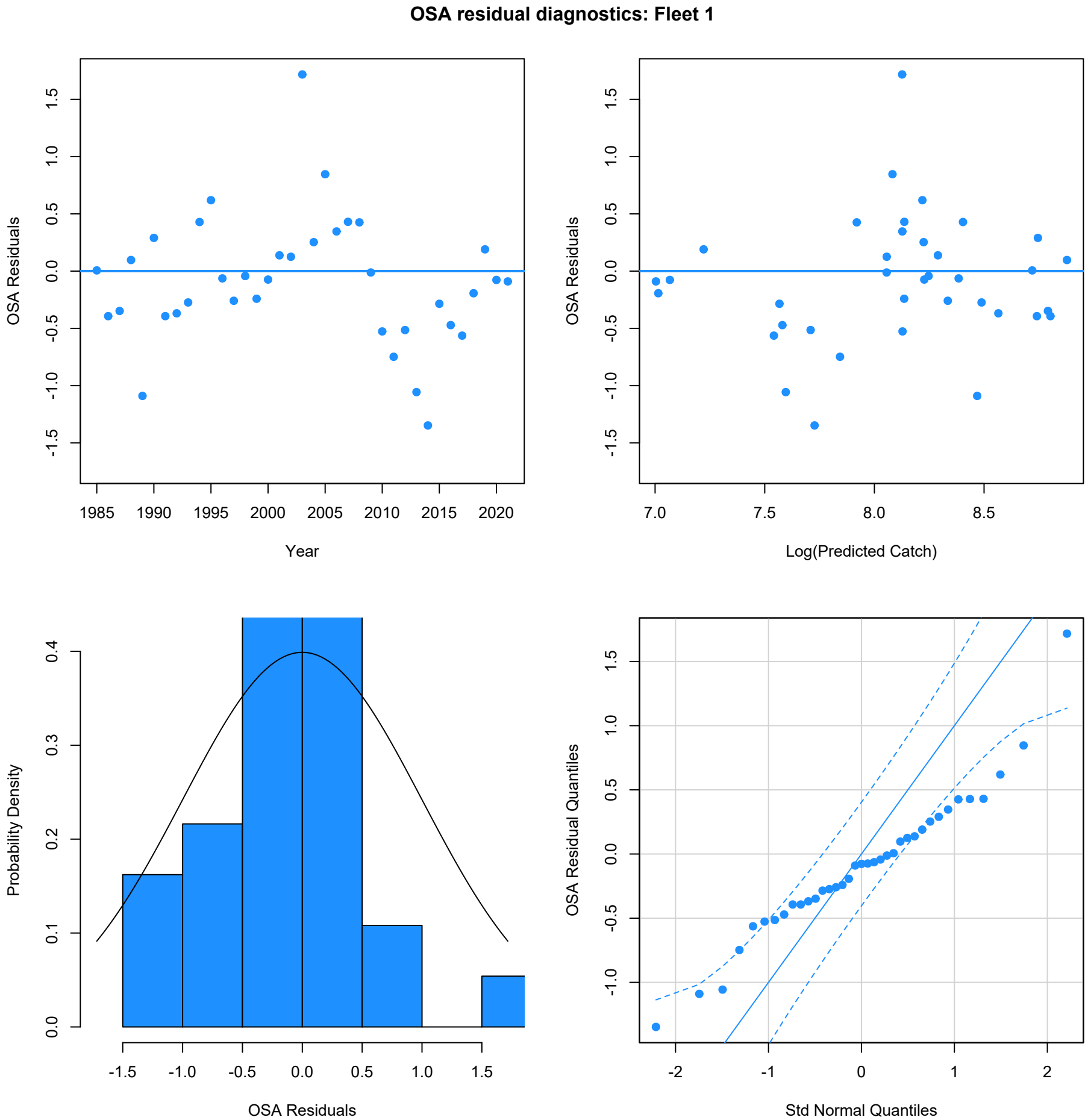
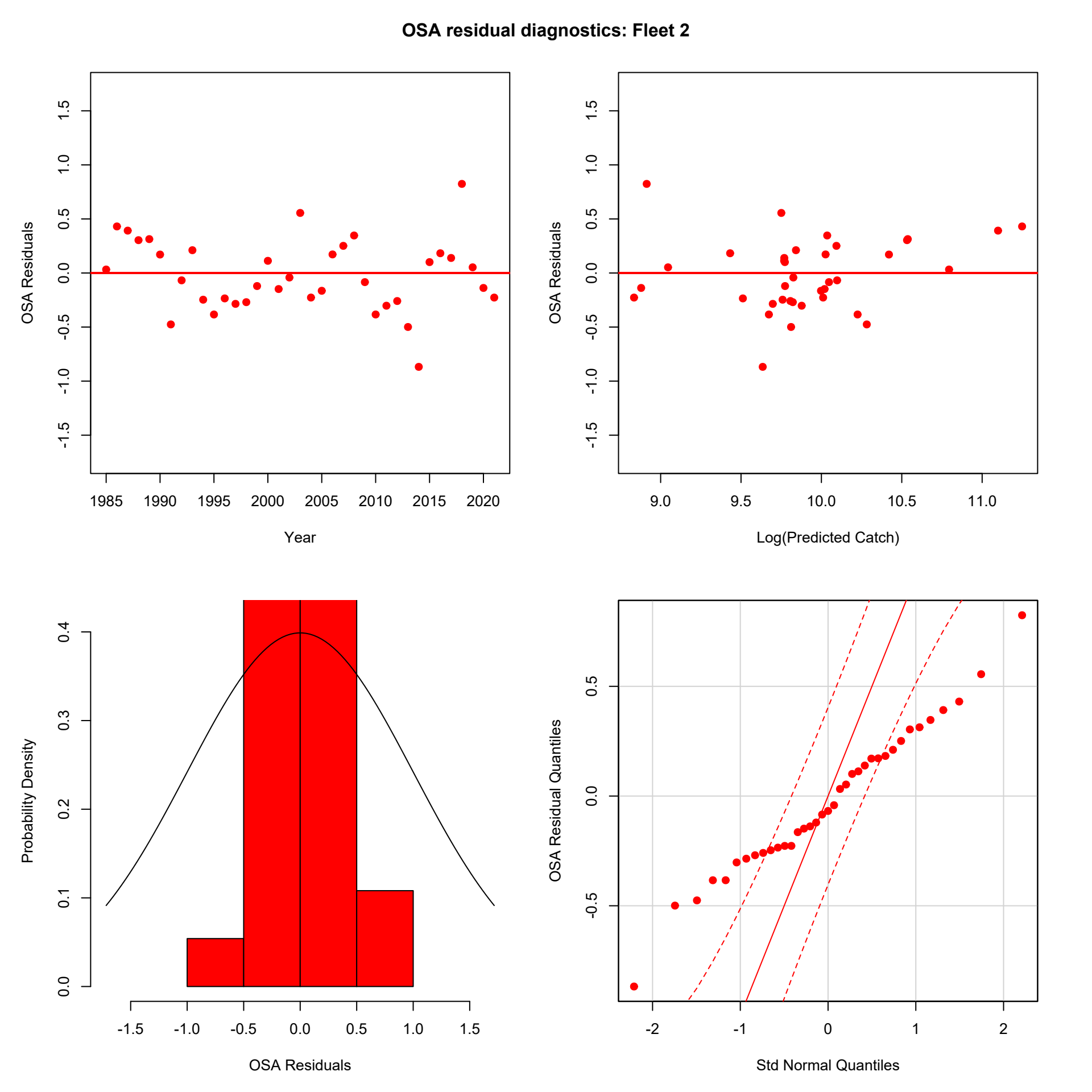
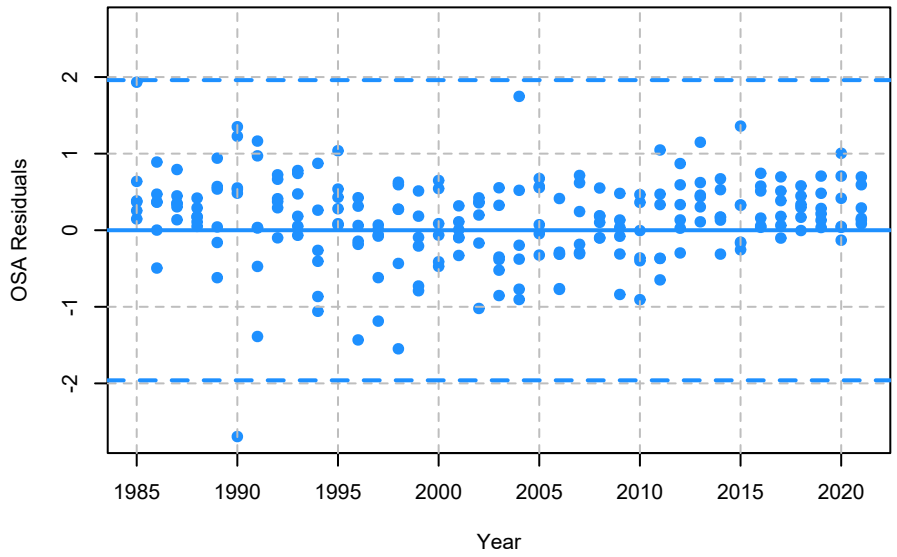
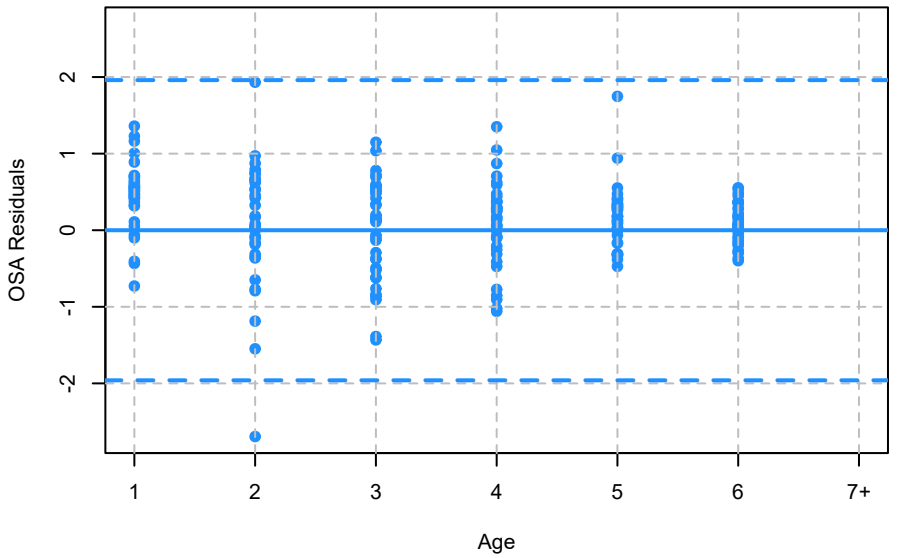
2015
2016
2017
2018
2019
2020
2021
1
2
3
4
5
6
7+
Age

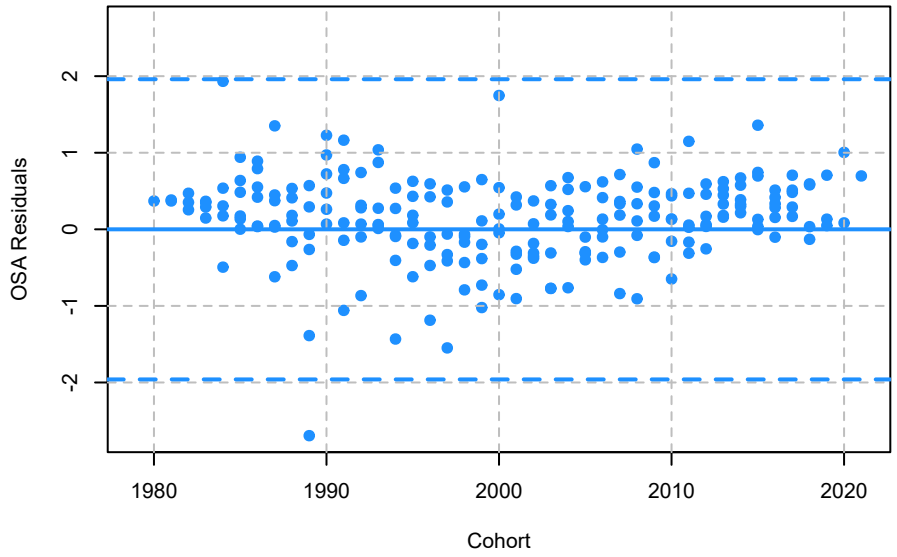

OSA residual diagnostics: Fleet 1
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
OSA Residuals
Log(Predicted Catch)
7.0
7.5
8.0
8.5
Probability Density
OSA Residuals
0.0
0.1
0.2
0.3
0.4
OSA Residual Quantiles
Std Normal Quantiles
-2
-1
0
1
2

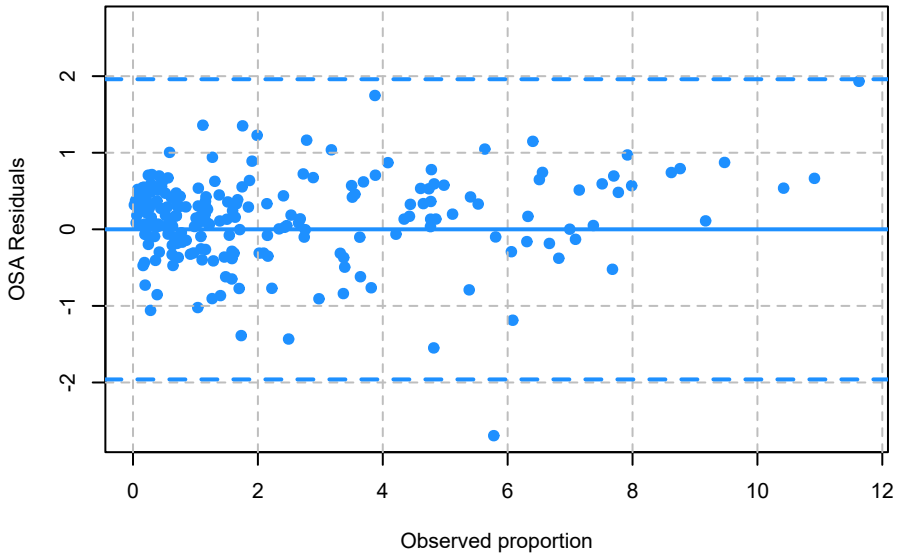

OSA residual diagnostics: Fleet 2
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
OSA Residuals
Log(Predicted Catch)
9.0
9.5
10.0
10.5
11.0
Probability Density
OSA Residuals
0.0
0.1
0.2
0.3
0.4
OSA Residual Quantiles
Std Normal Quantiles
-2
-1
0
1
2

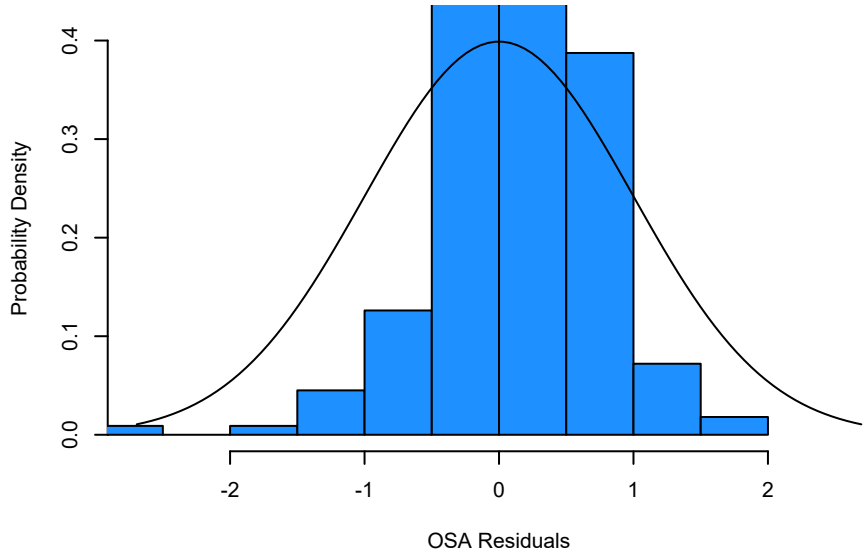
age composition OSA residual diagnostics: Fleet 1

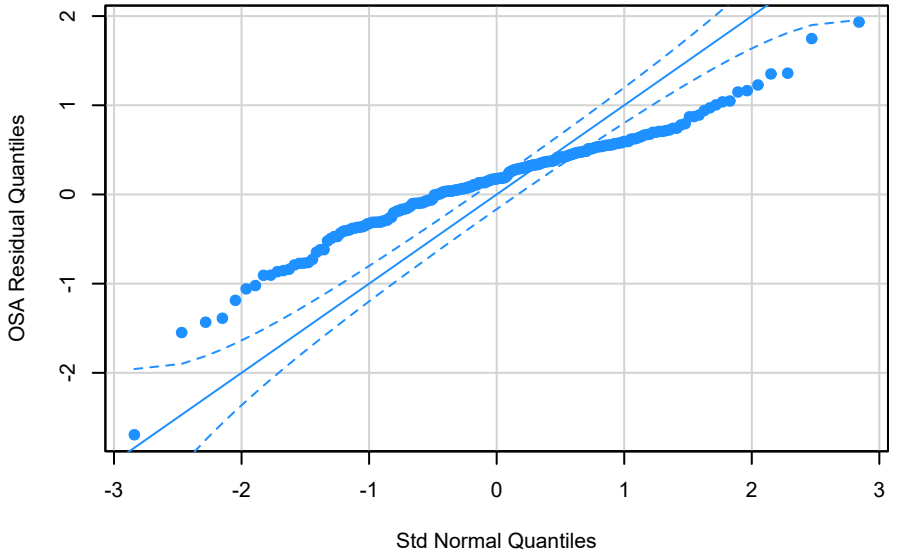




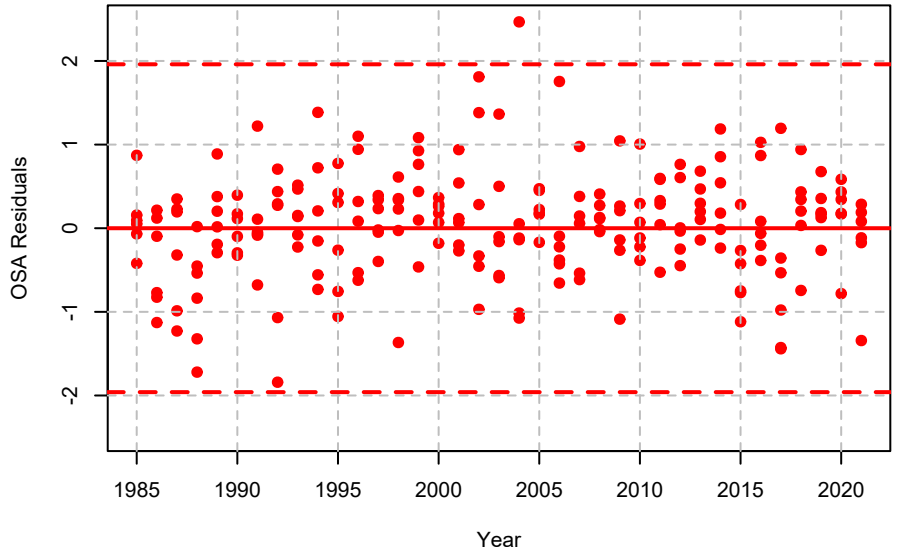


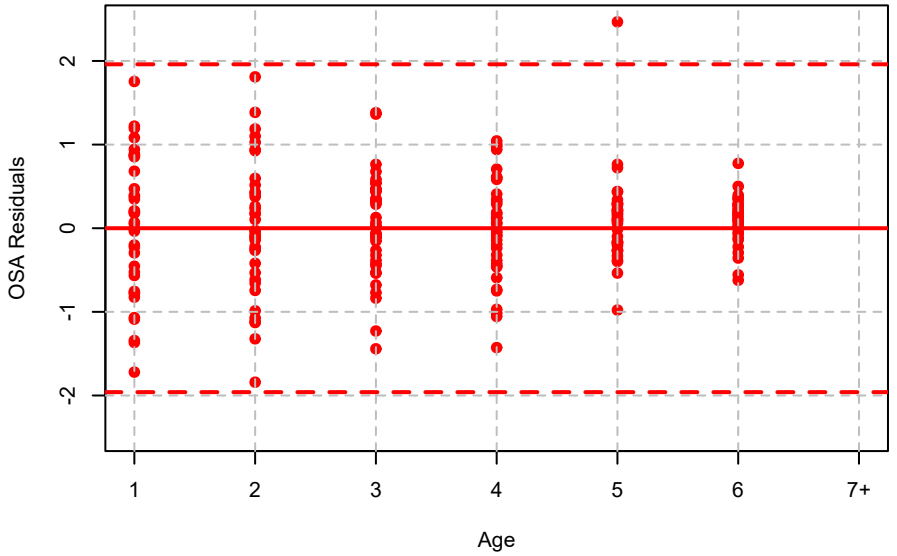


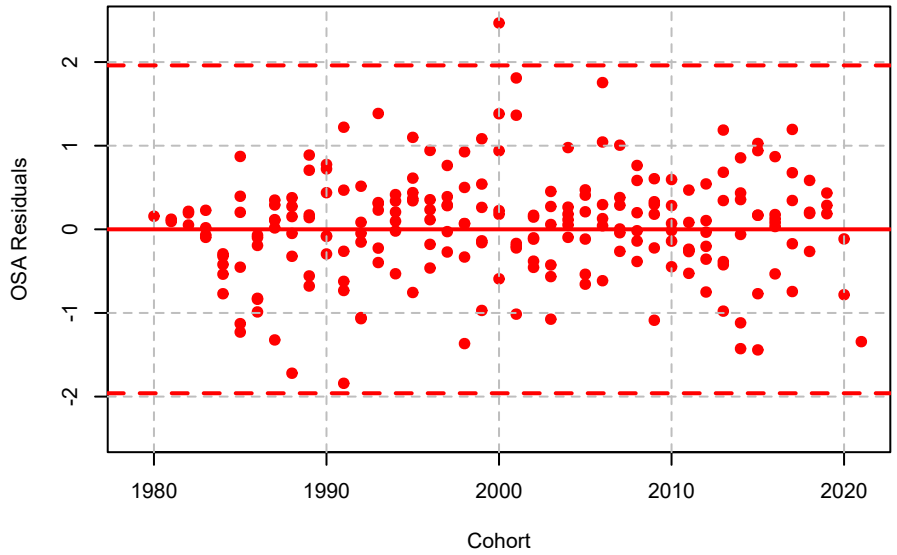


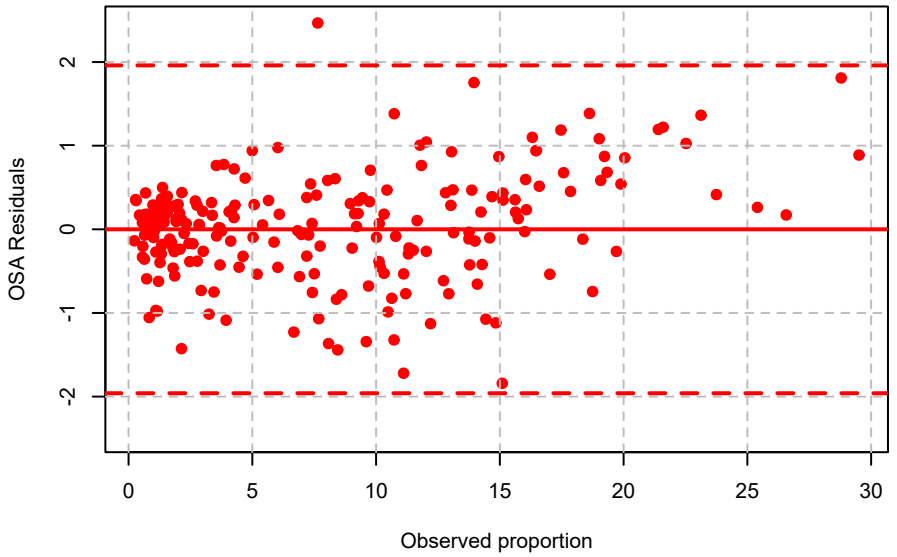


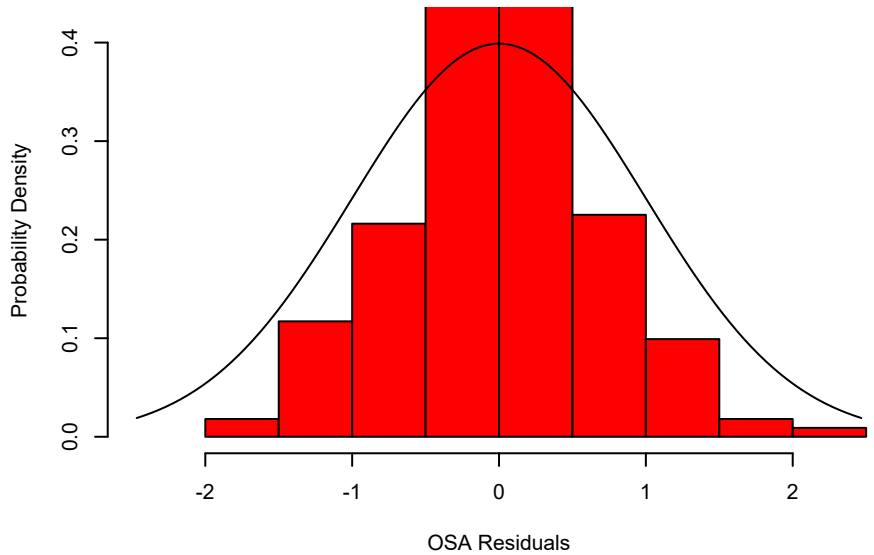
age composition OSA residual diagnostics: Fleet 2

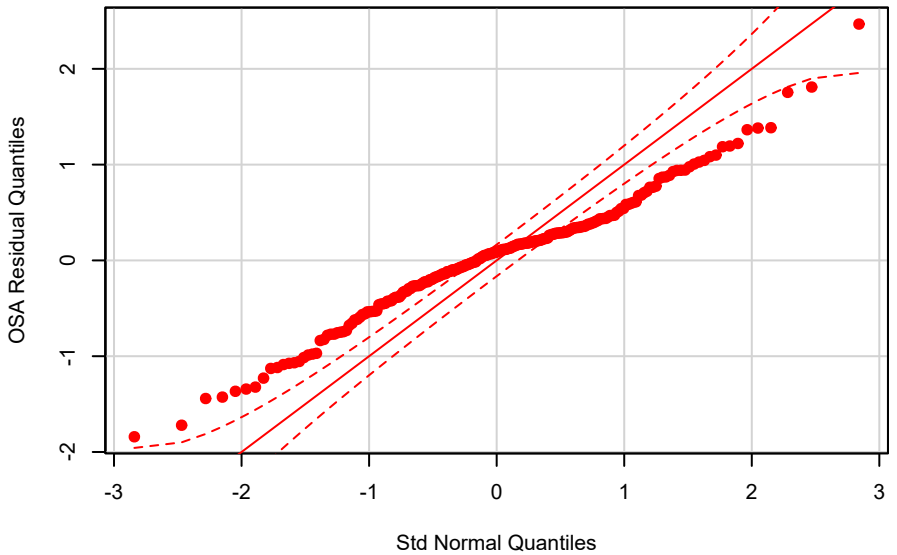


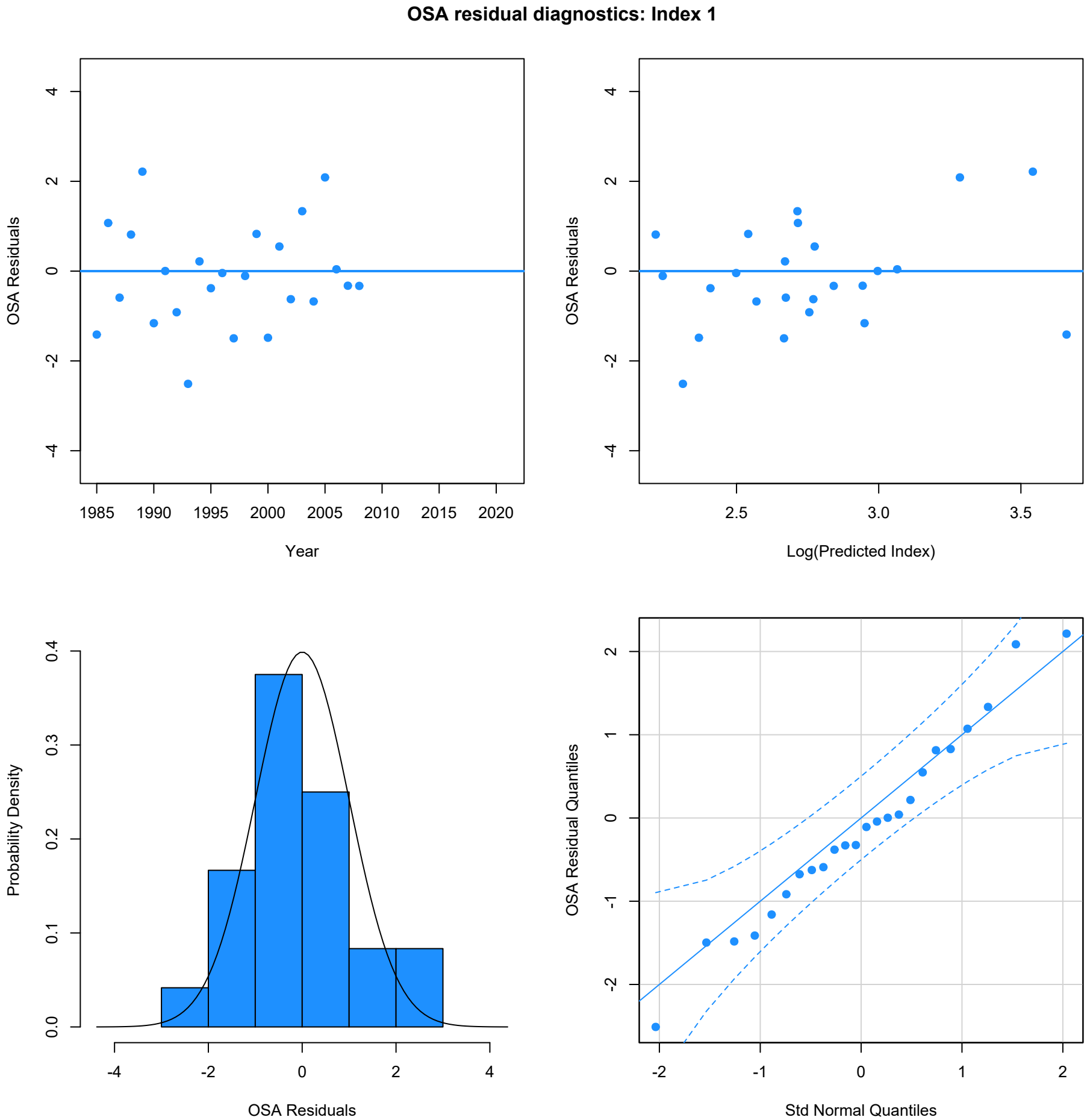


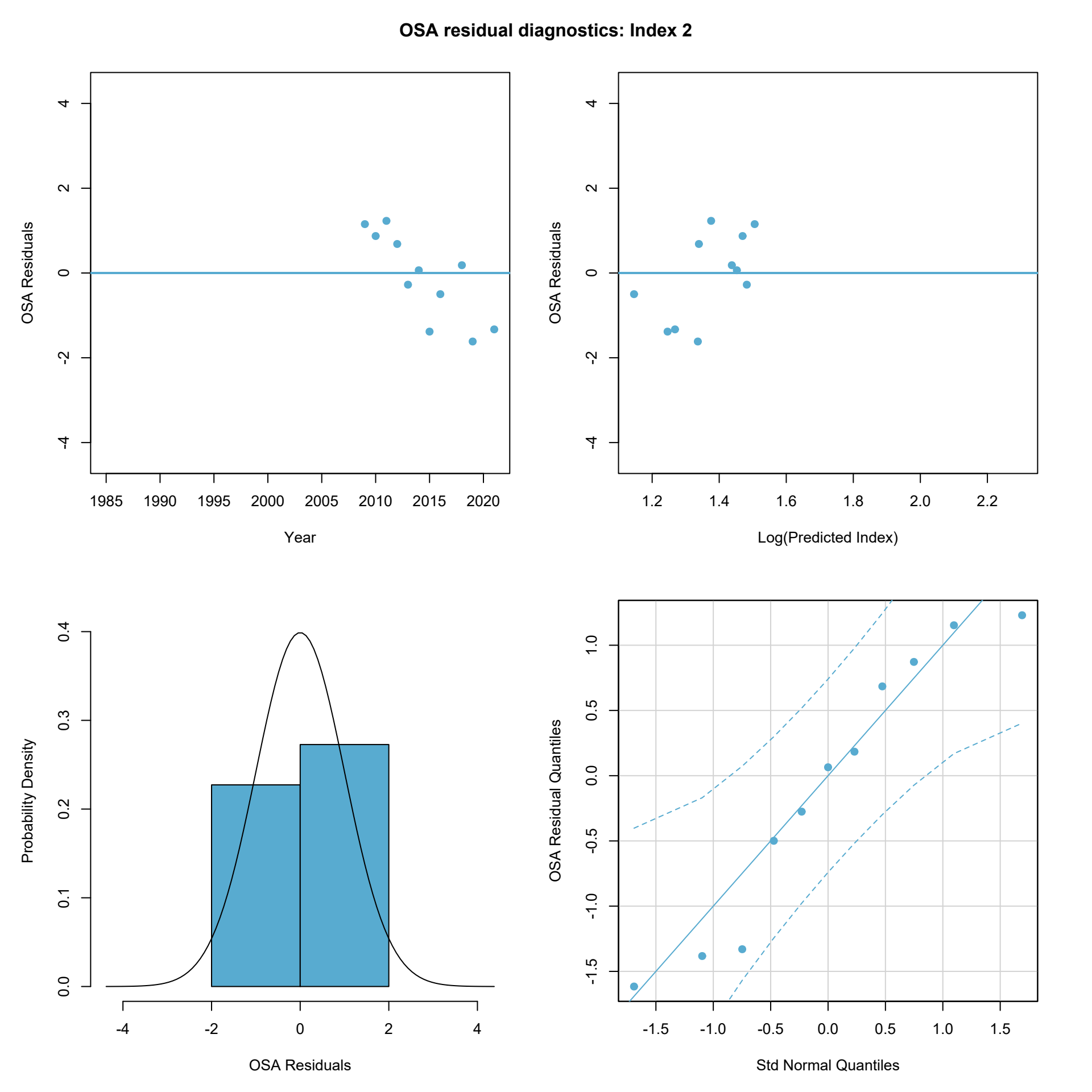


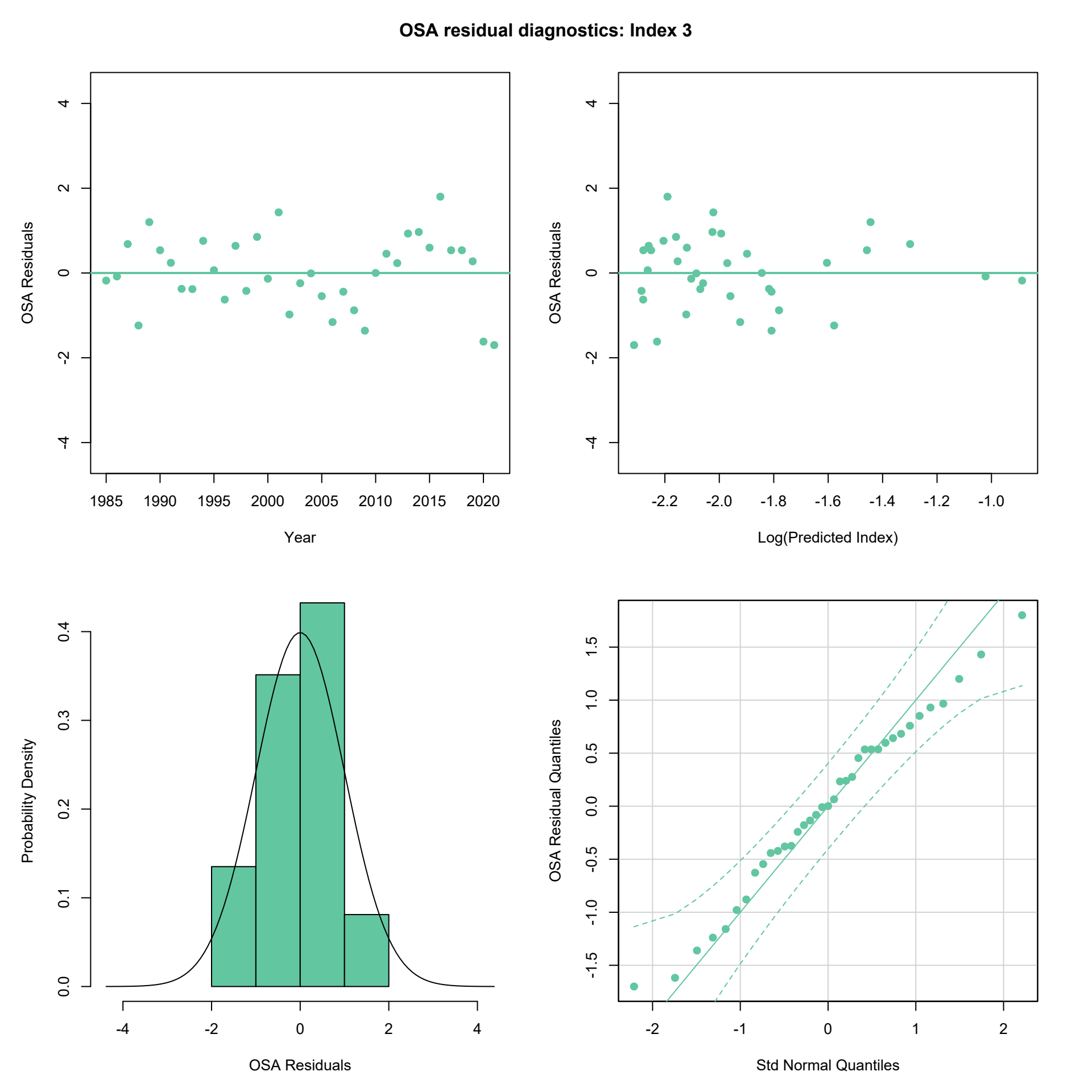


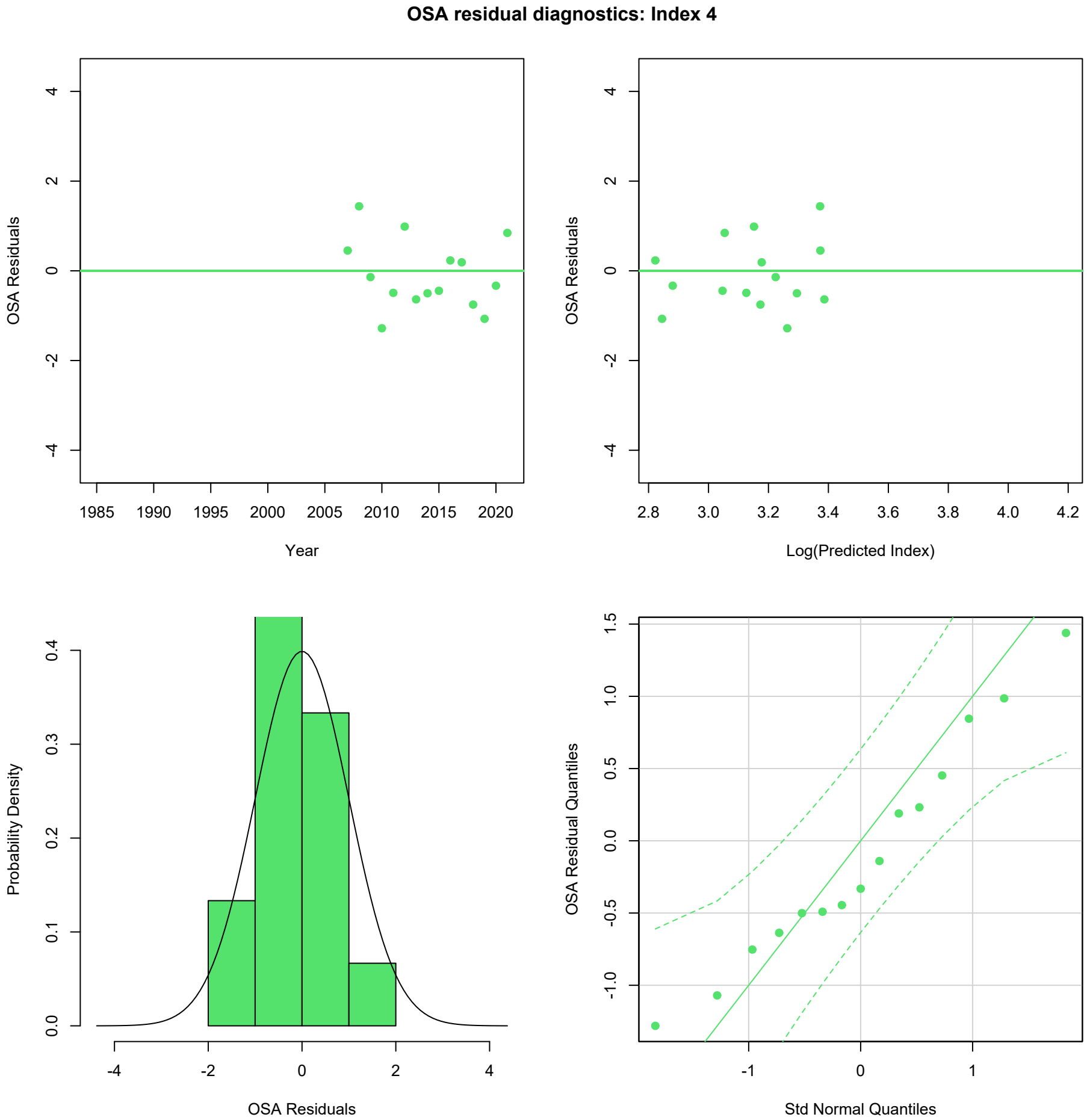


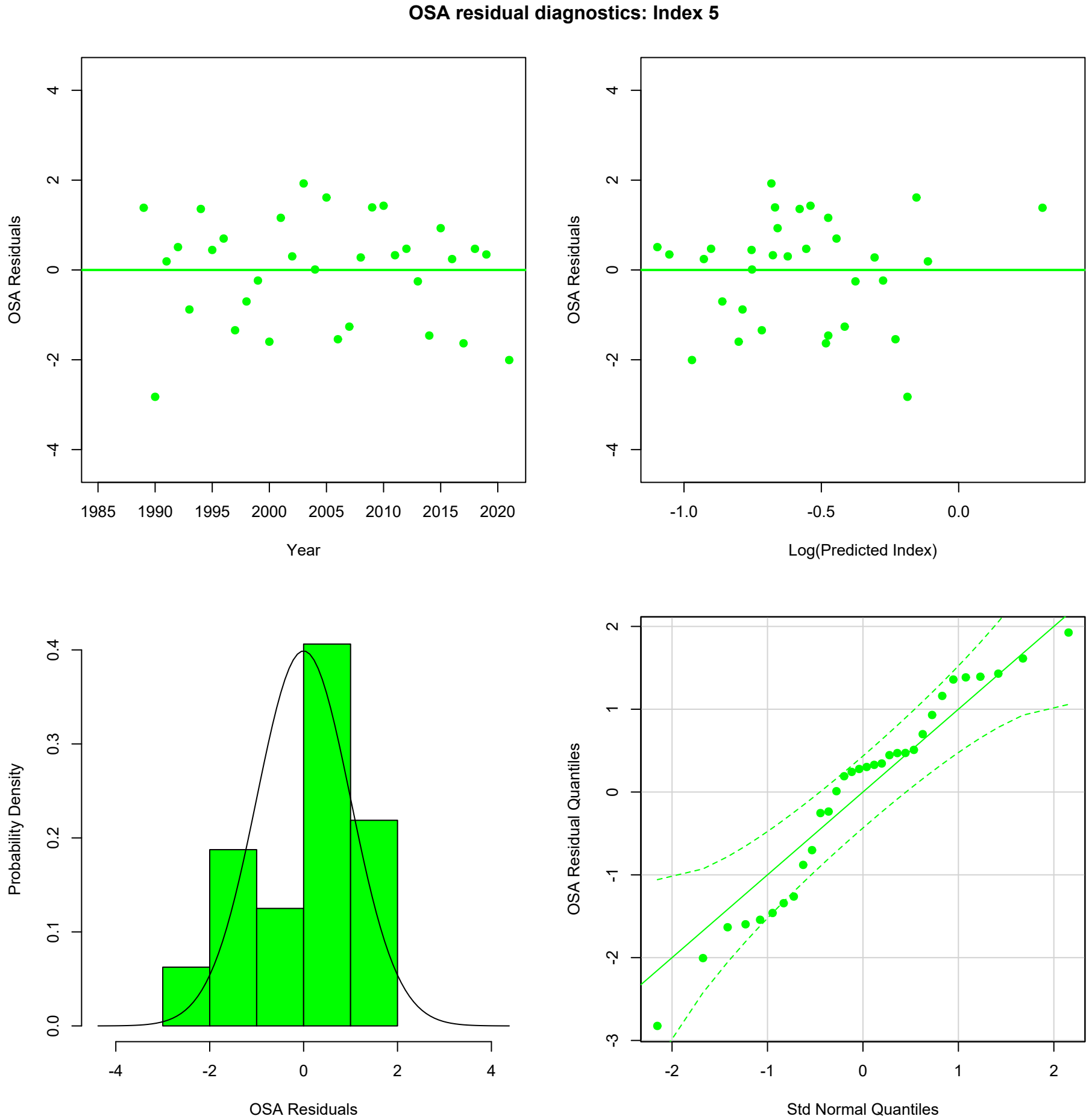


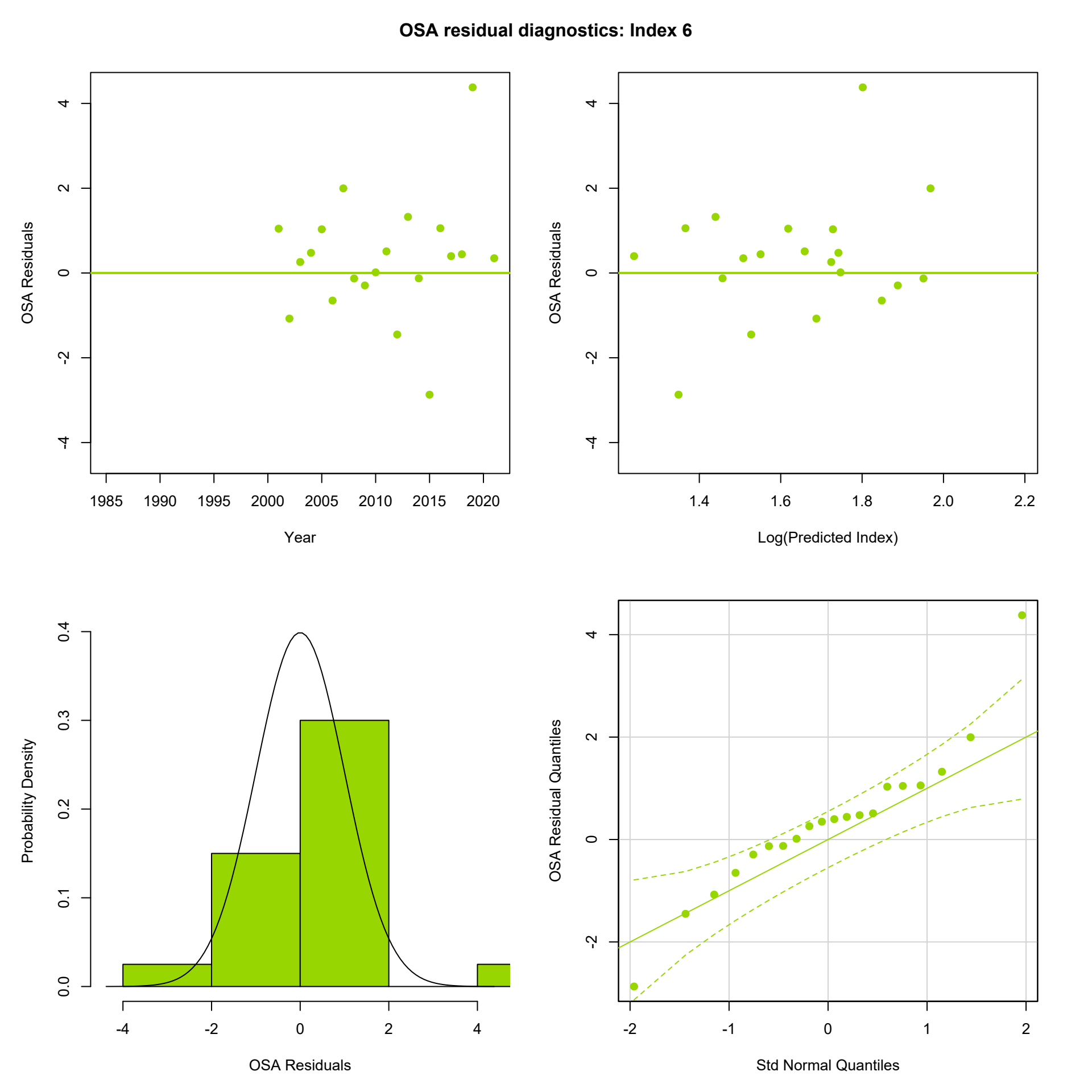

OSA residual diagnostics: Index 1
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Log(Predicted Index)
2.5
3.0
3.5
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

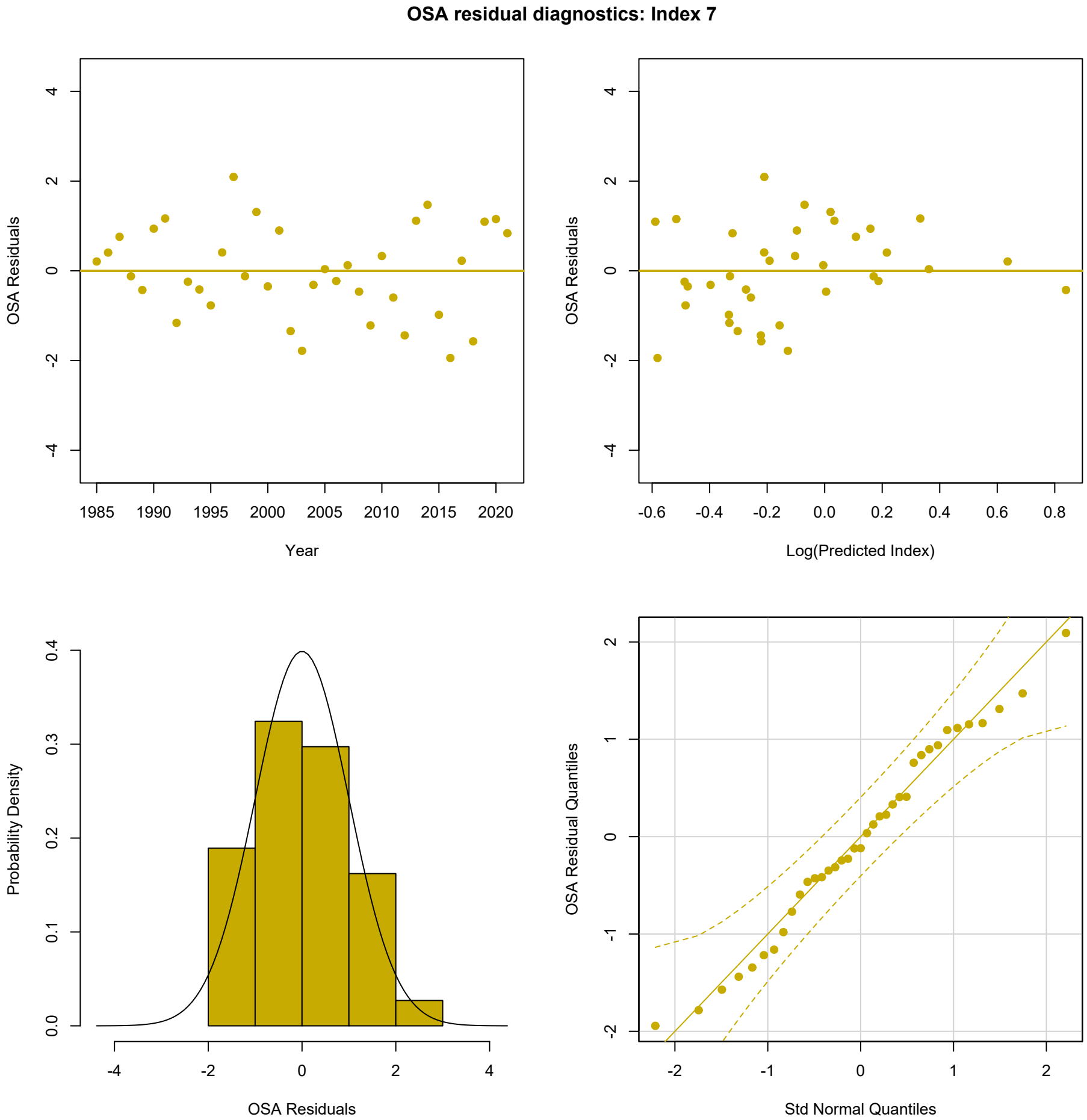

OSA residual diagnostics: Index 2
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
Log(Predicted Index)
1.2
1.4
1.6
1.8
2.0
2.2
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

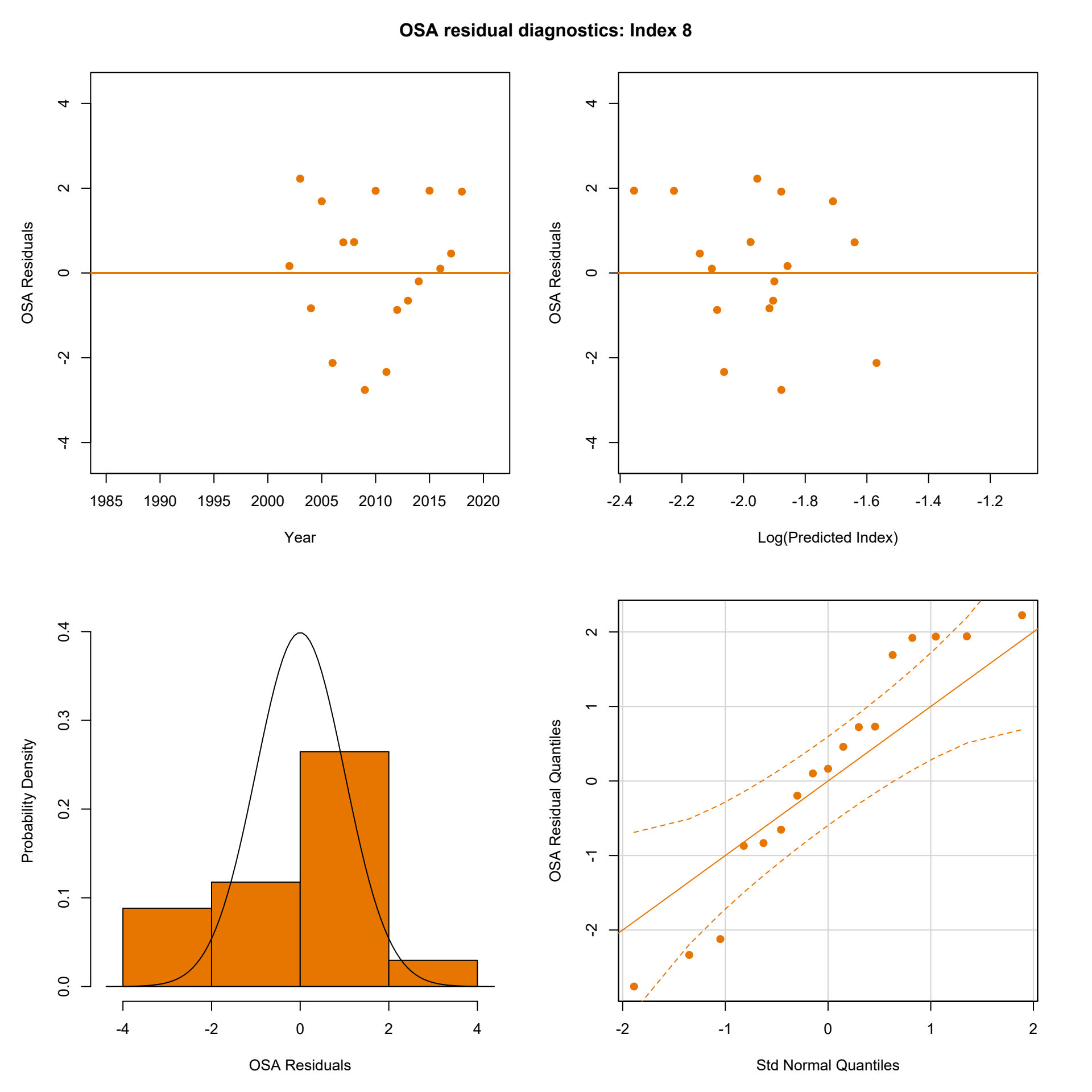

OSA residual diagnostics: Index 3
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Log(Predicted Index)
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

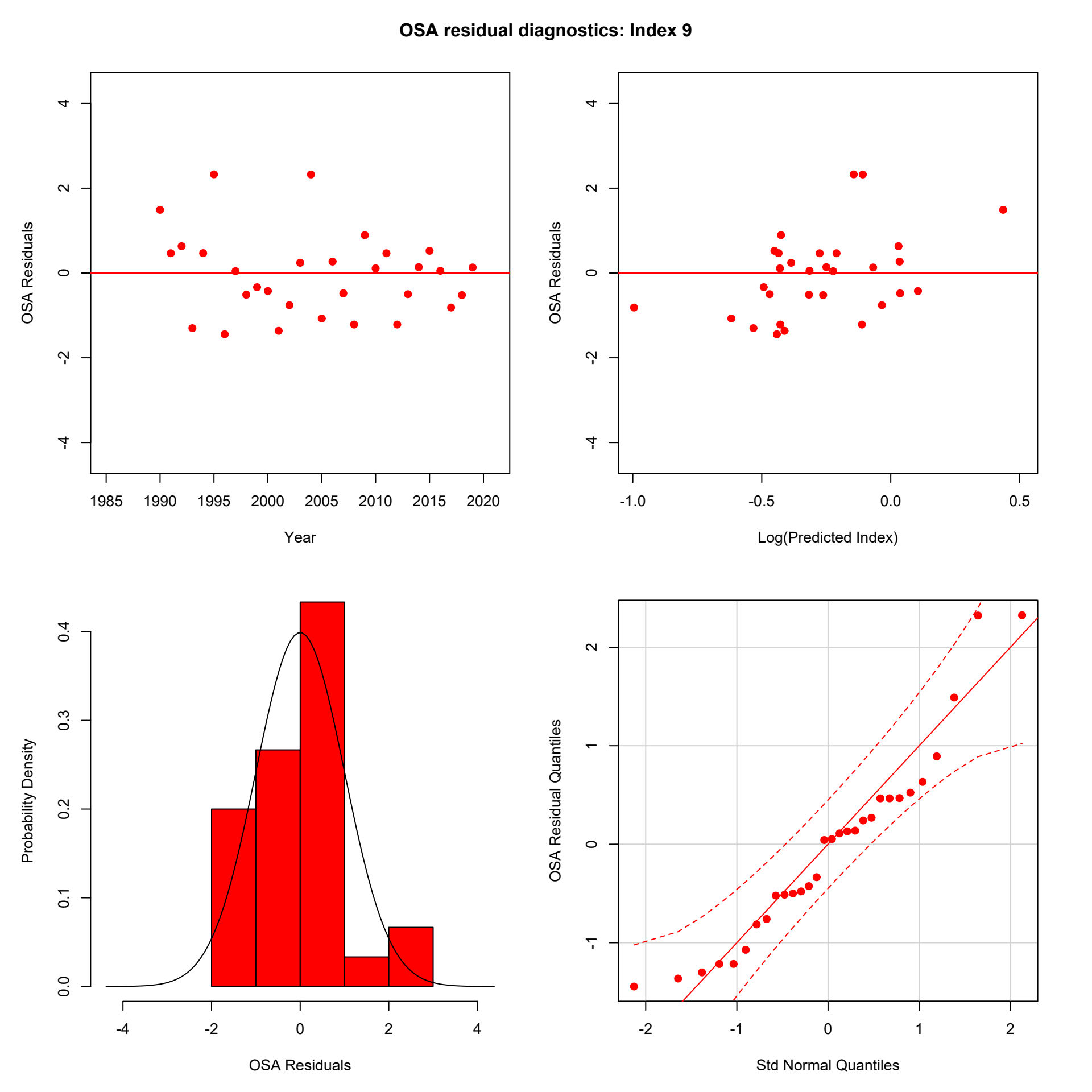

OSA residual diagnostics: Index 4
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Log(Predicted Index)
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles


OSA residual diagnostics: Index 5
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Log(Predicted Index)
-1.0
-0.5
0.0
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

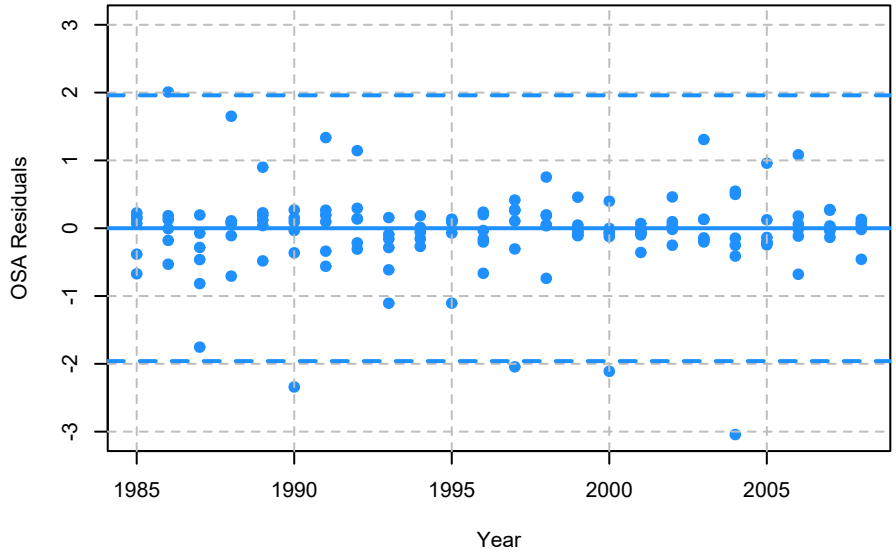

OSA residual diagnostics: Index 6
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
Log(Predicted Index)
1.4
1.6
1.8
2.0
2.2
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

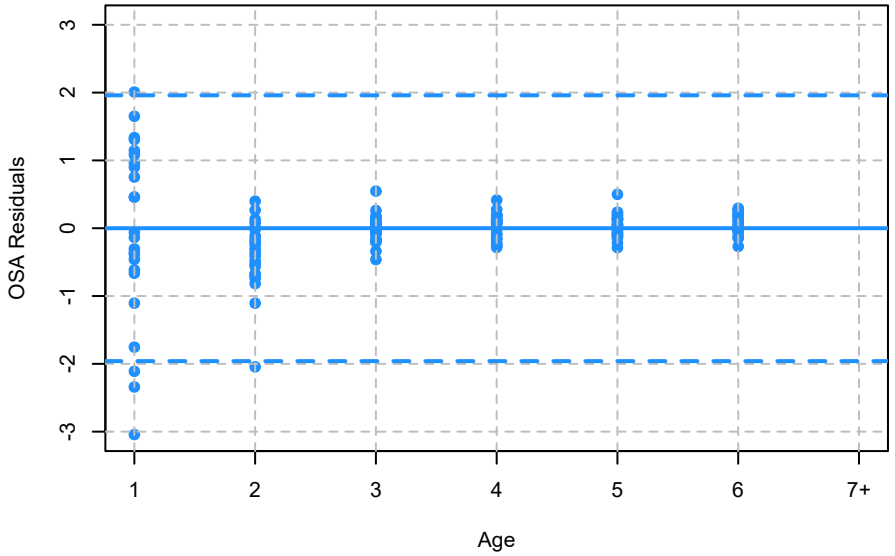

OSA residual diagnostics: Index 7
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Log(Predicted Index)
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

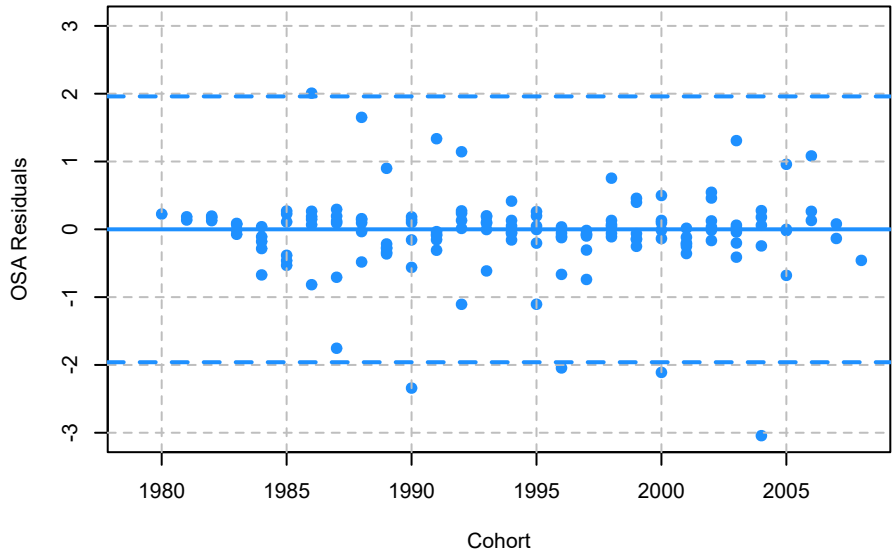

OSA residual diagnostics: Index 8
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Log(Predicted Index)
-2.4
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

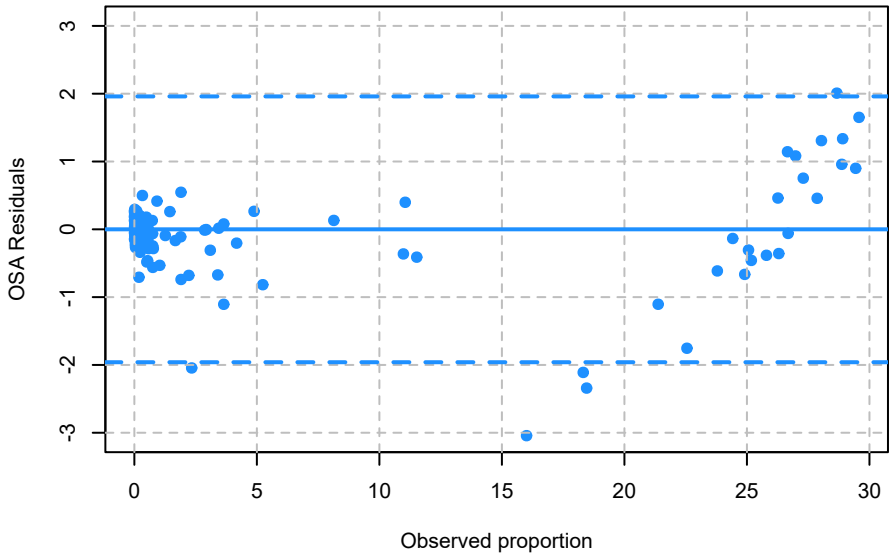

OSA residual diagnostics: Index 9
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
-4
-2
0
2
4
OSA Residuals
Log(Predicted Index)
-1.0
-0.5
0.0
0.5
Probability Density
OSA Residuals
0.0
0.1
0.2
0.3
0.4
OSA Residual Quantiles
Std Normal Quantiles
-2
-1
0
1
2

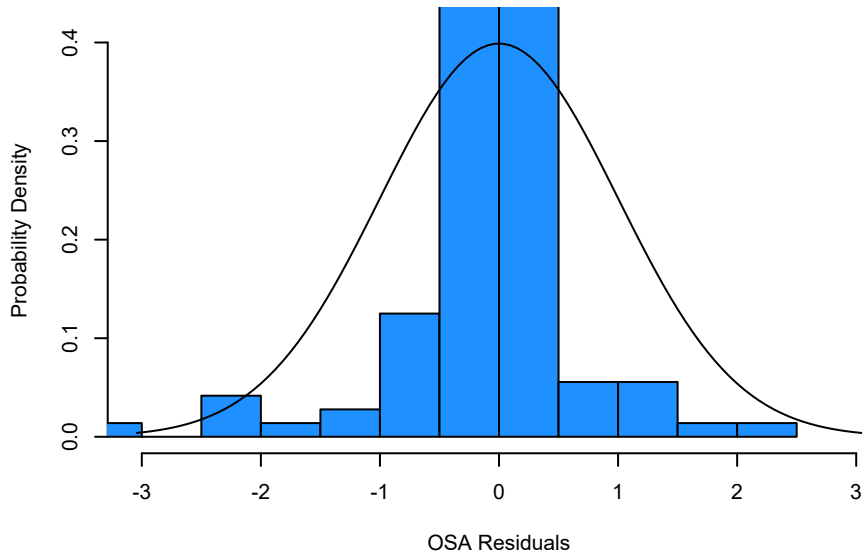
age composition OSA residual diagnostics: Index 1

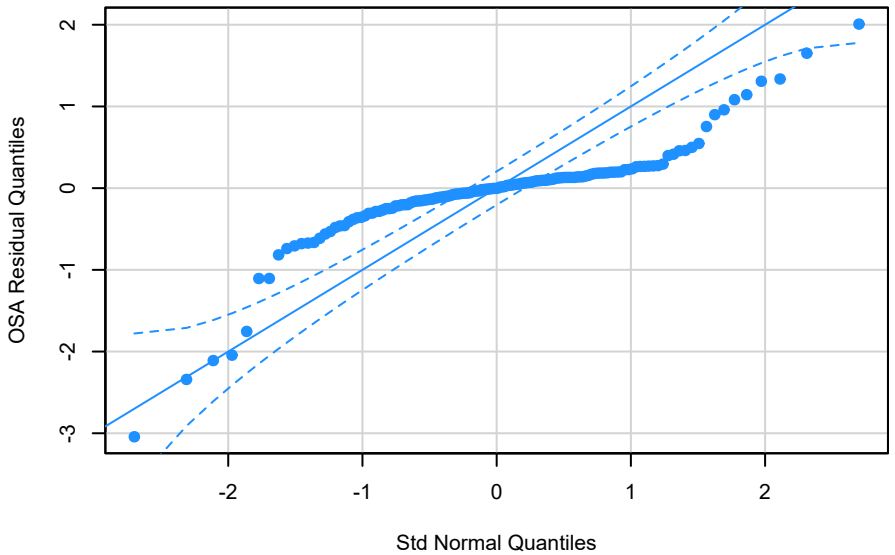




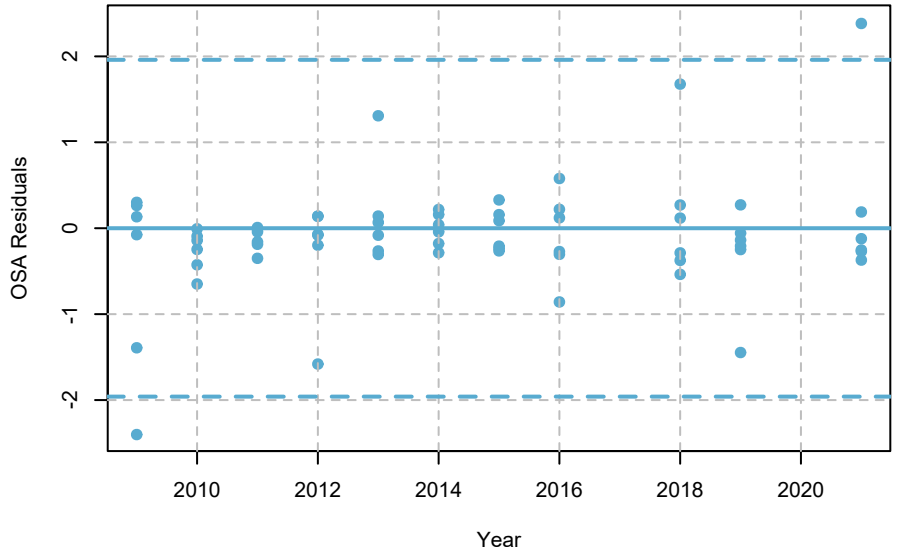


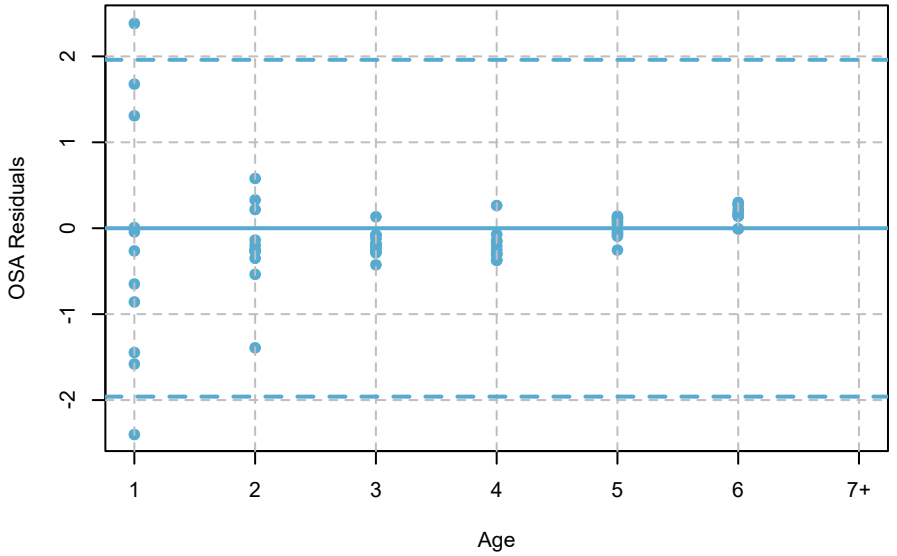


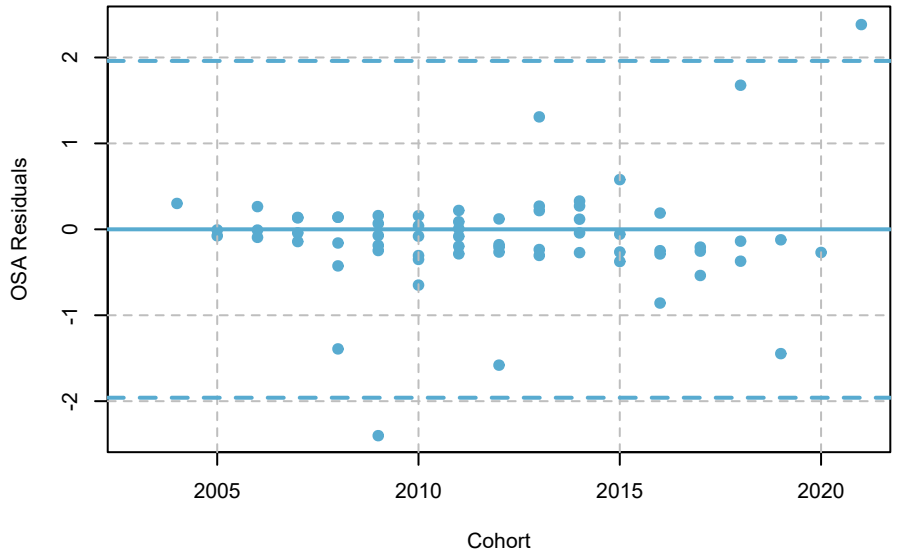


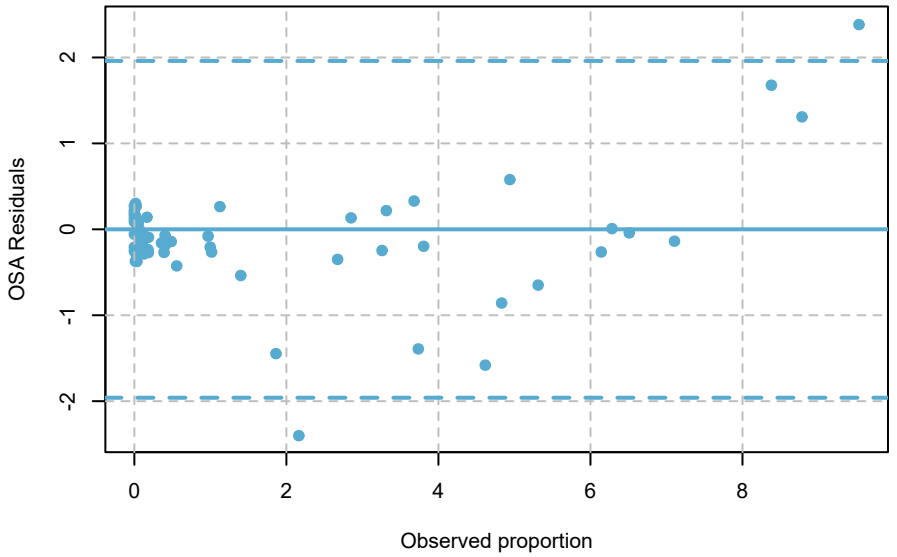


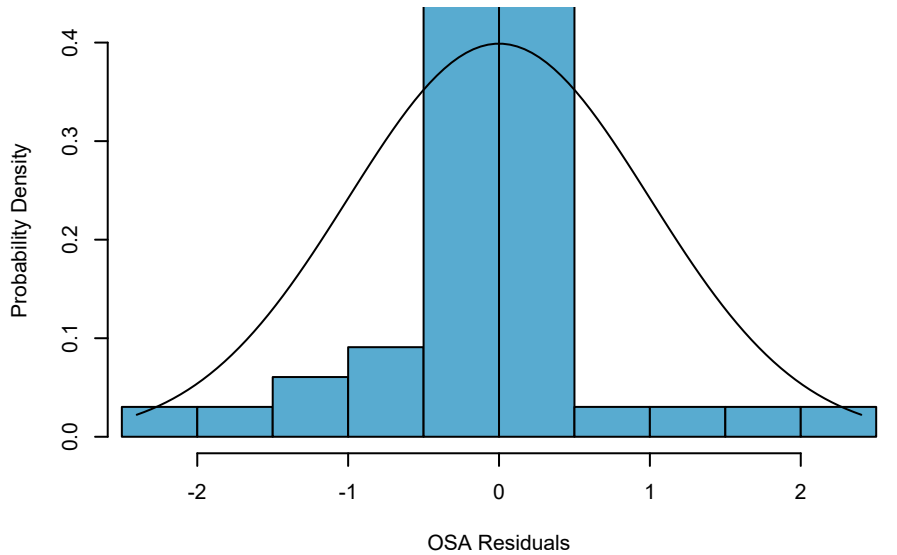
age composition OSA residual diagnostics: Index 2

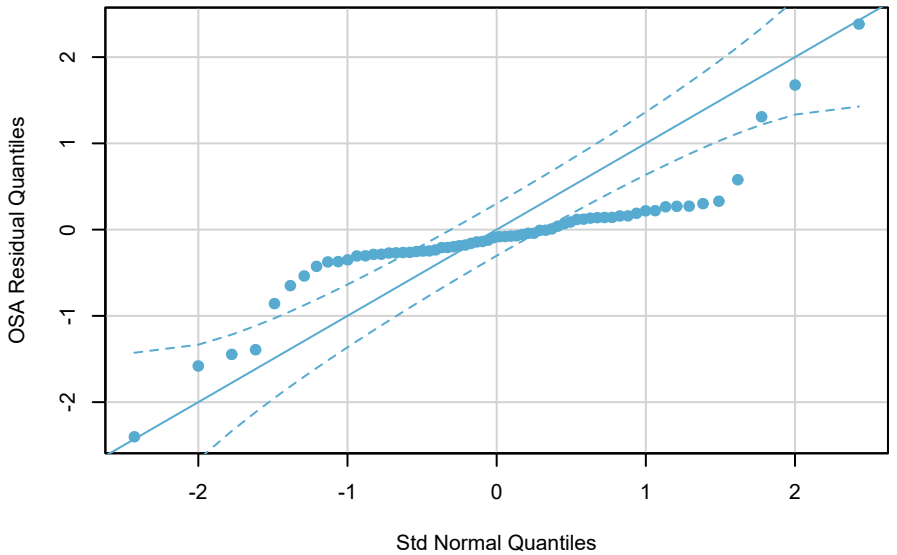




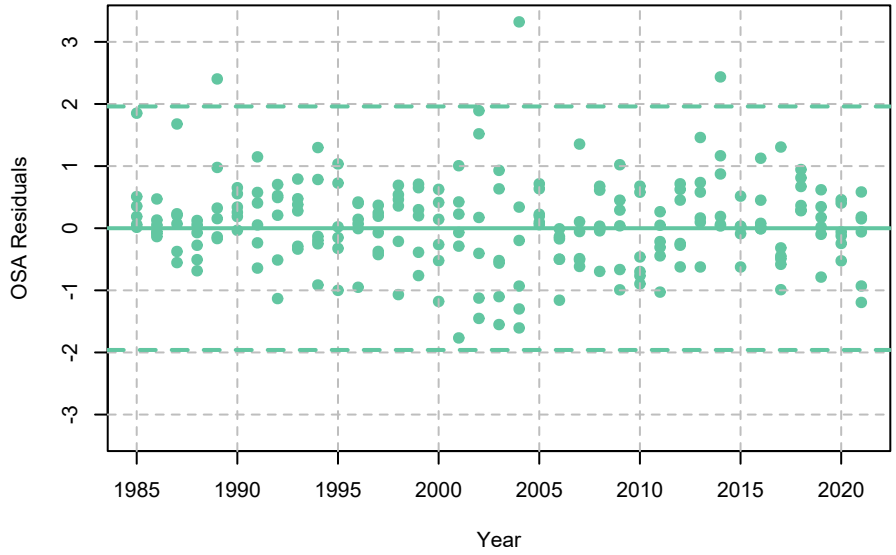


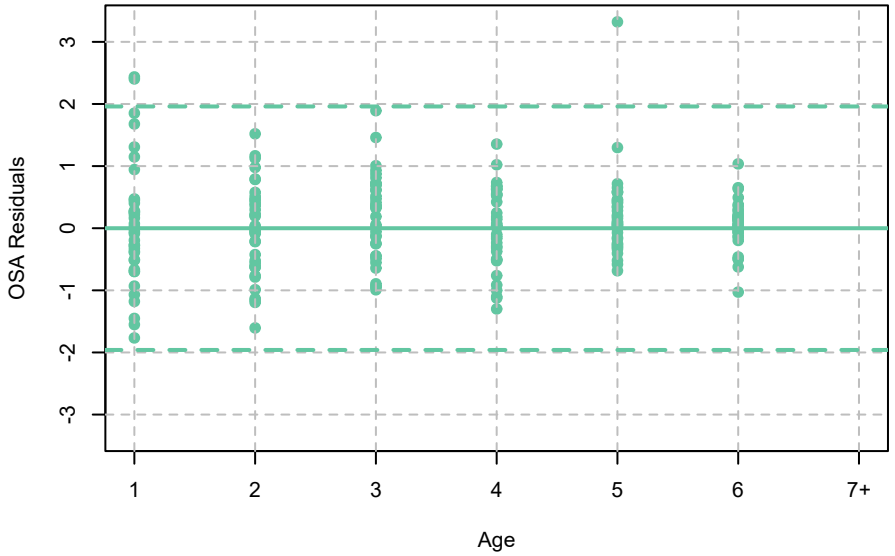


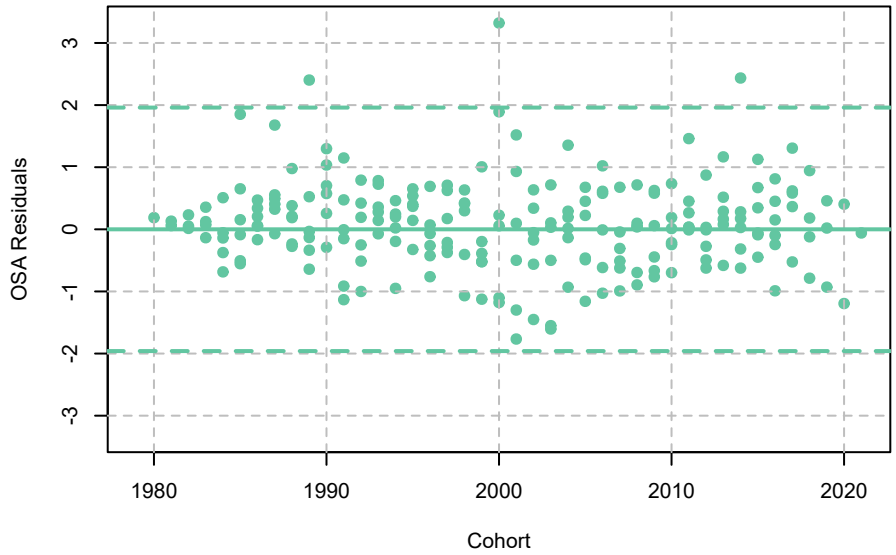


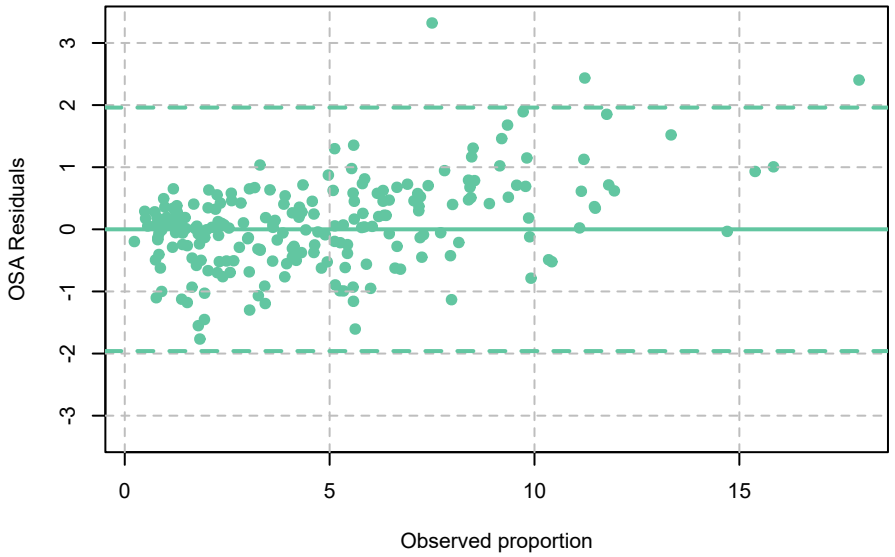


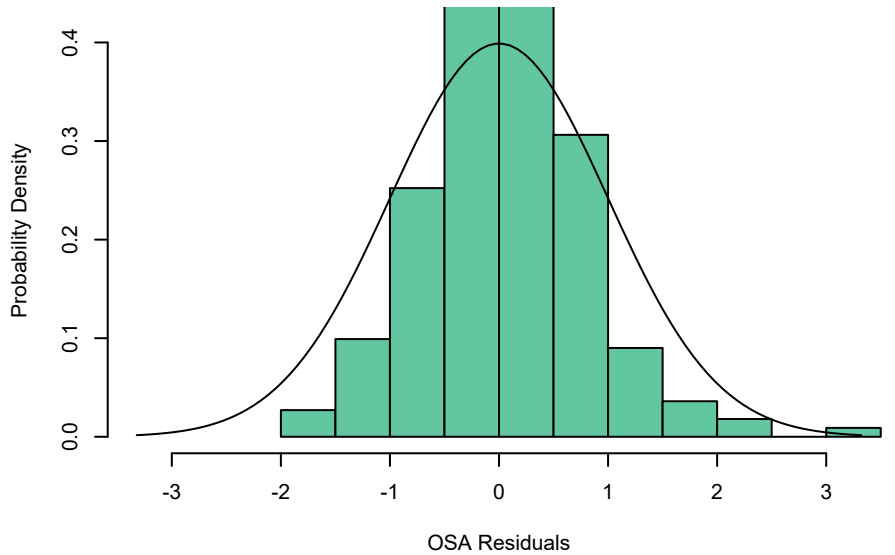
age composition OSA residual diagnostics: Index 3

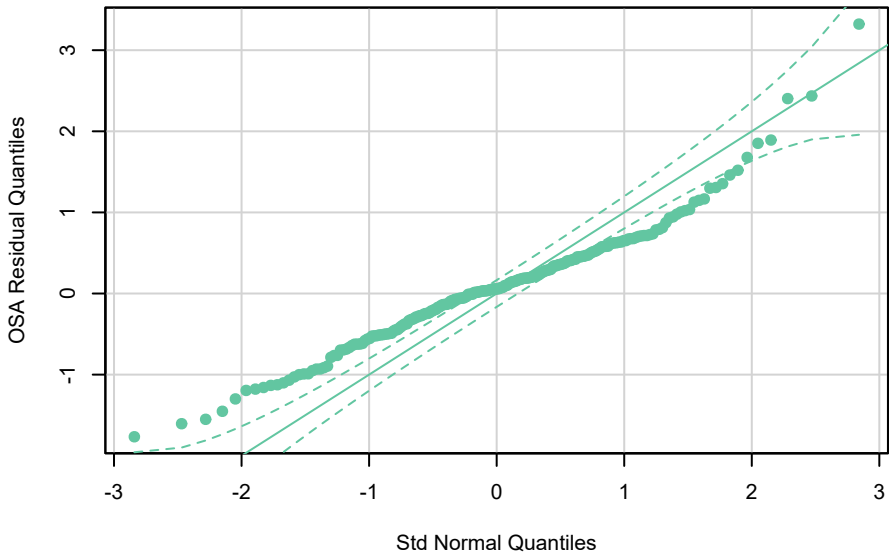




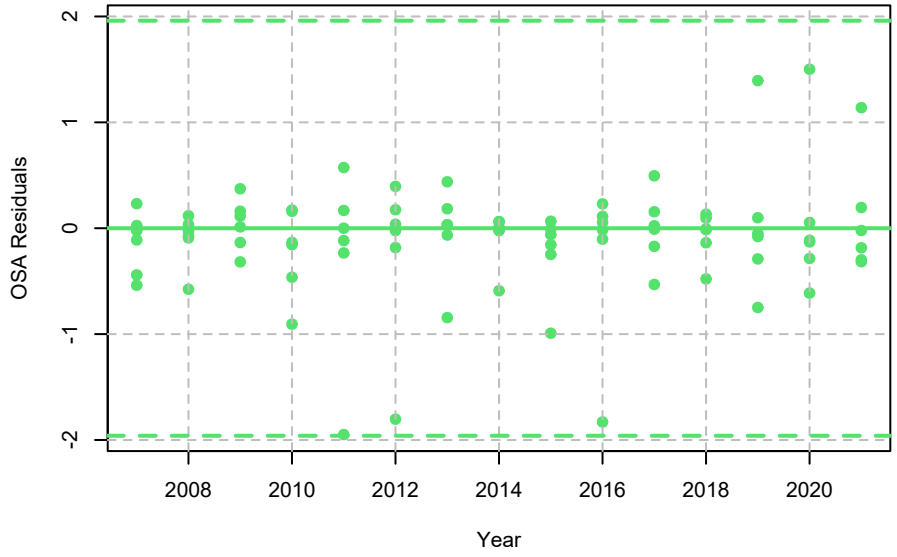


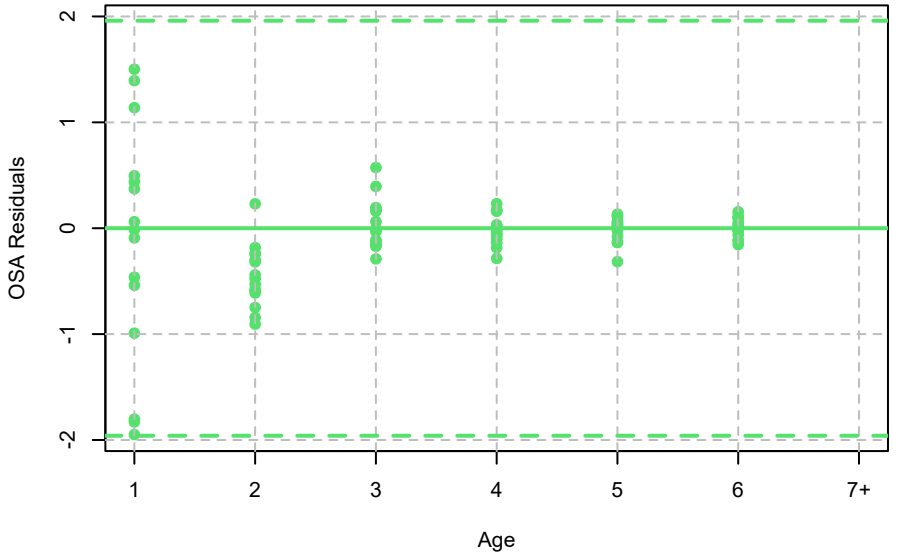


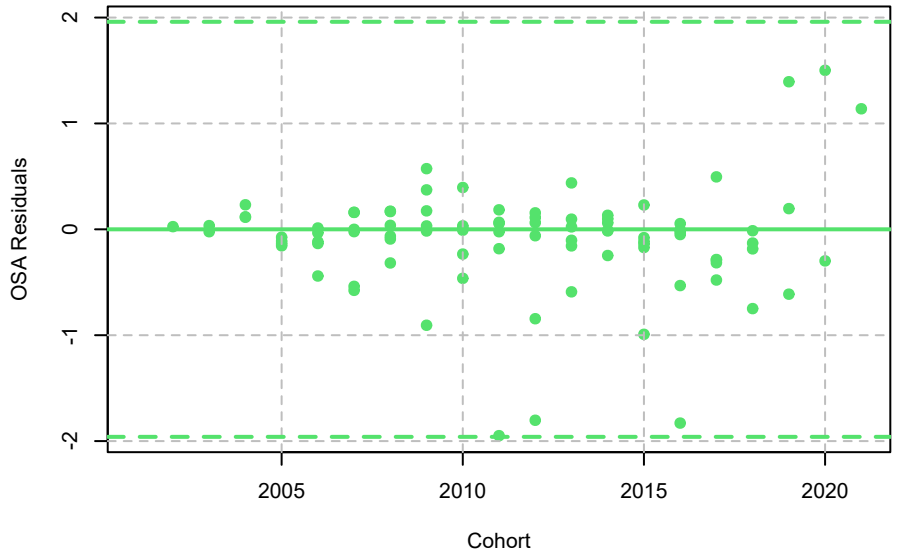


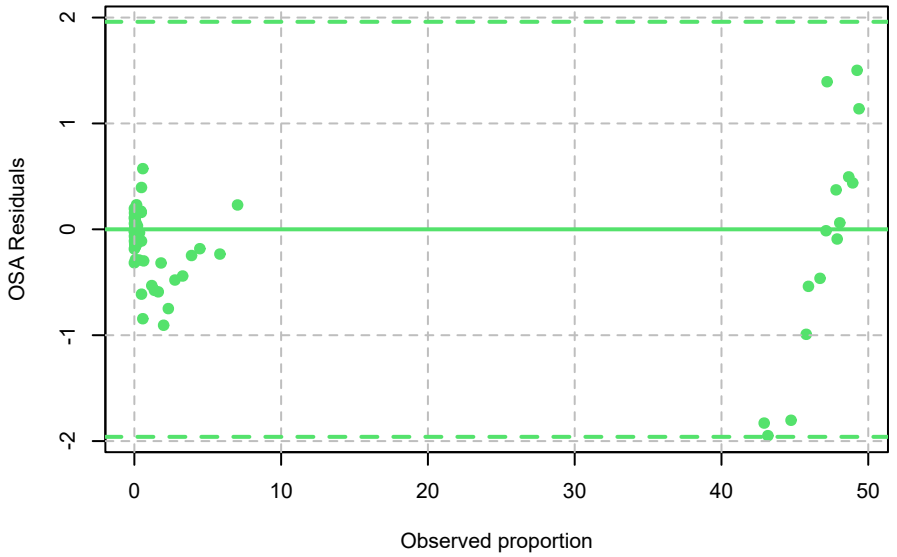


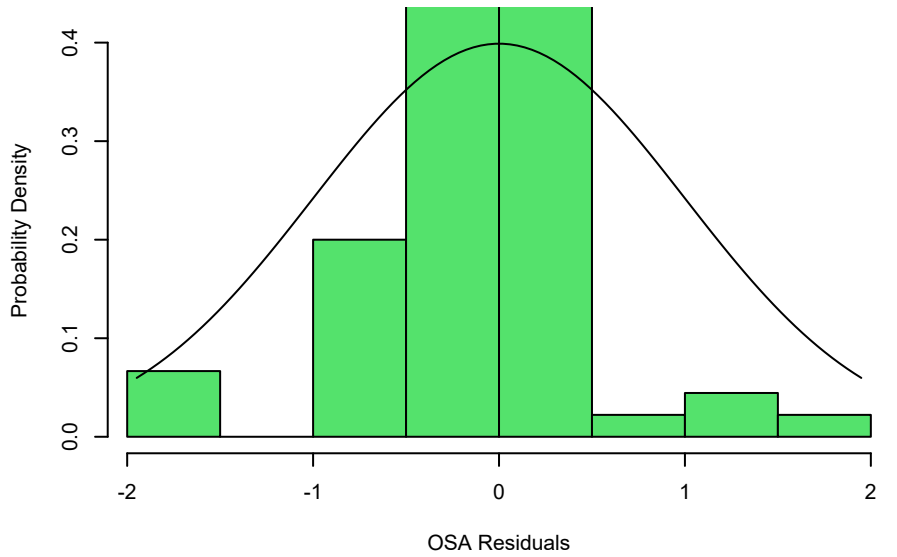
age composition OSA residual diagnostics: Index 4

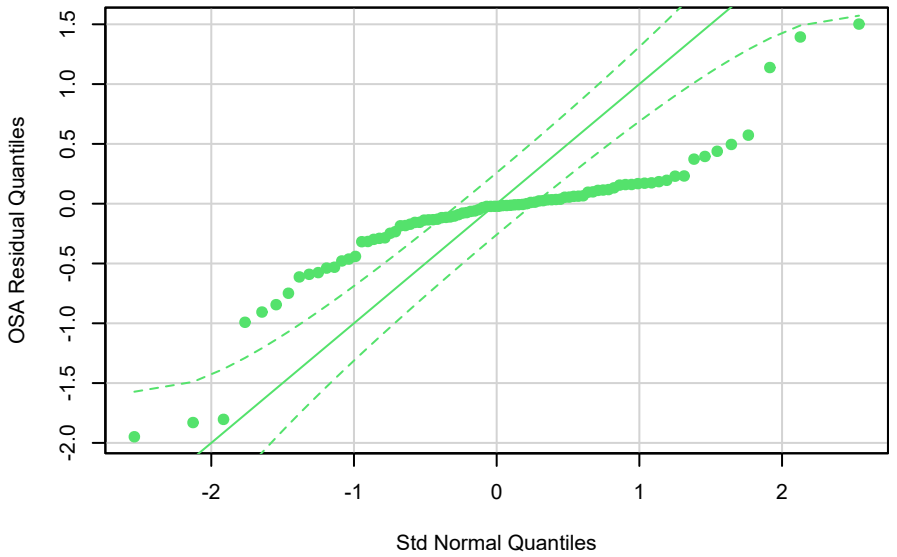




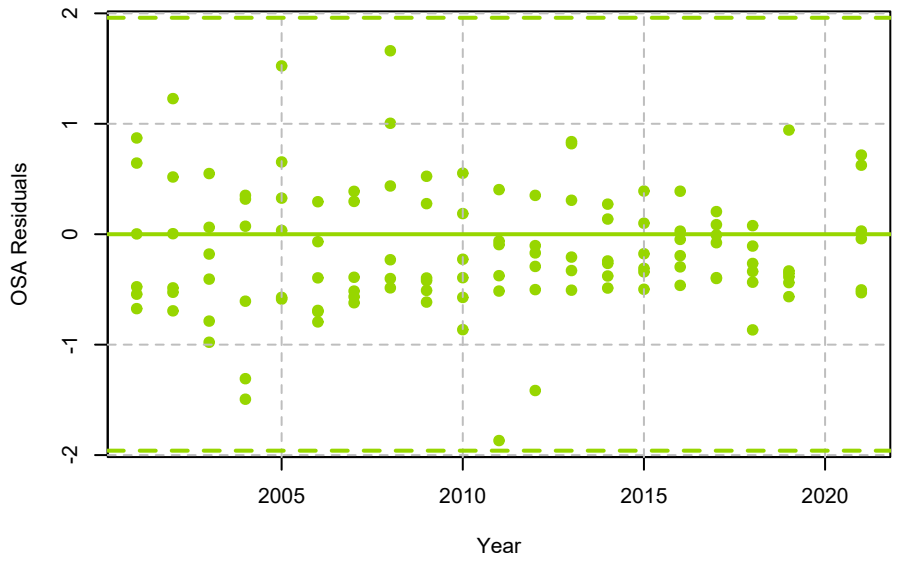


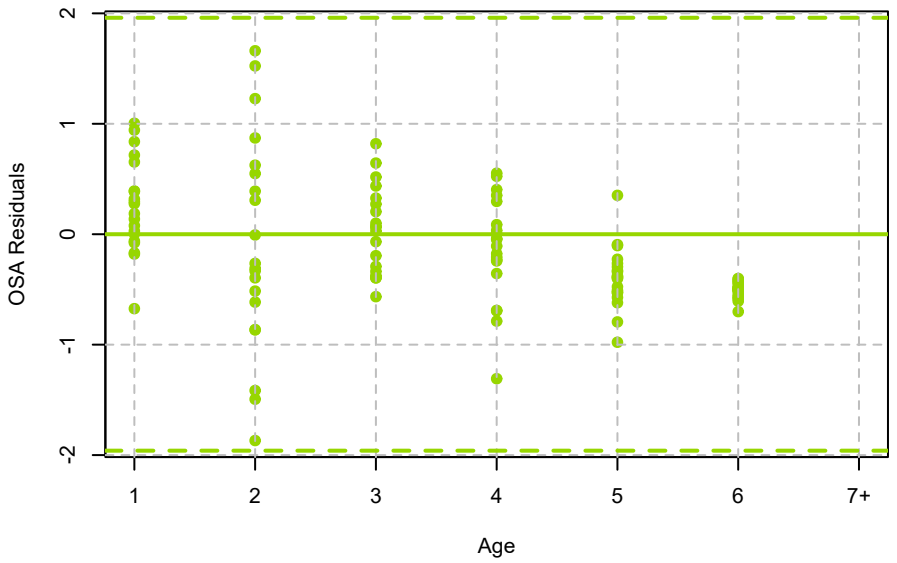


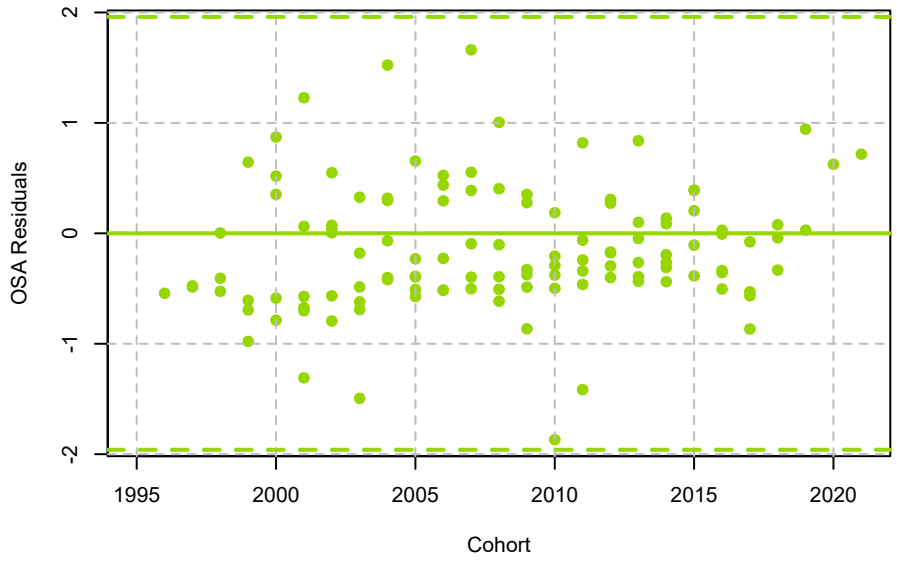


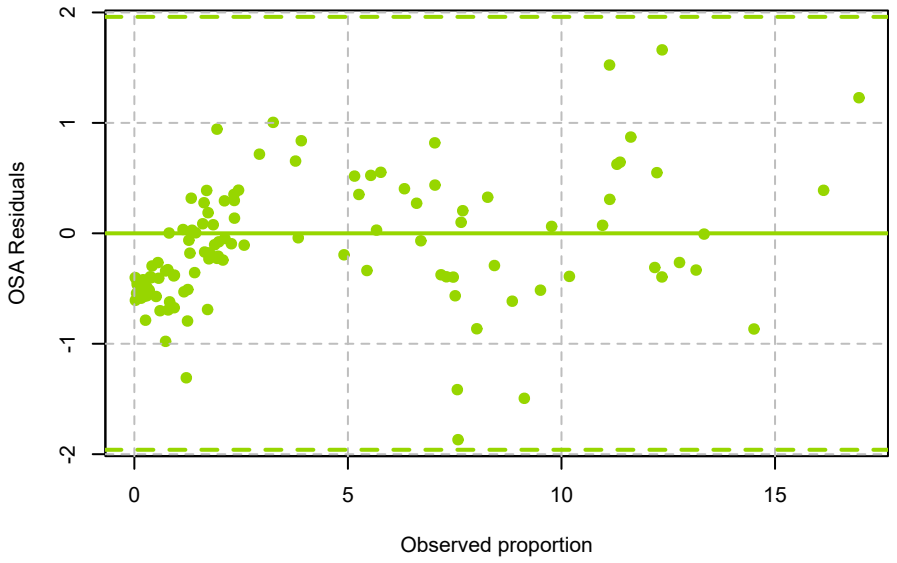


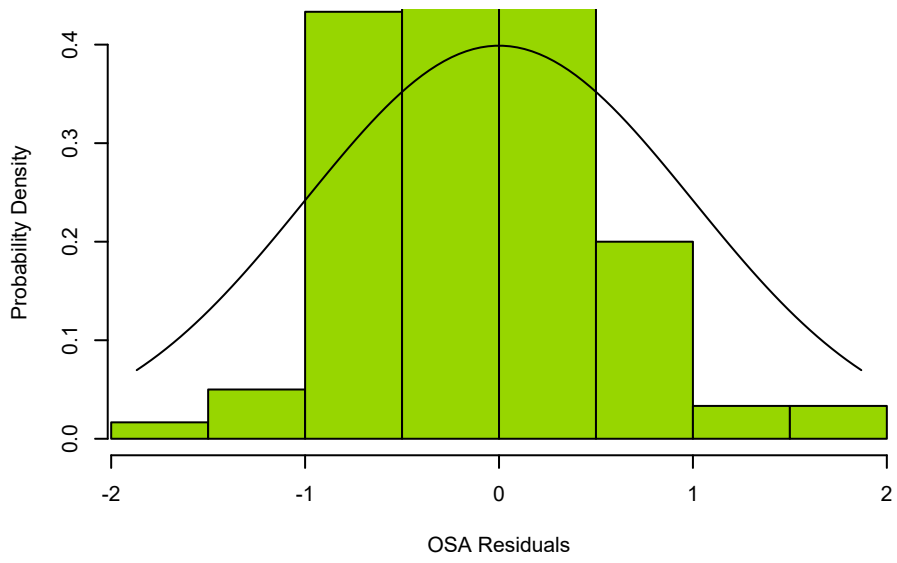
age composition OSA residual diagnostics: Index 6

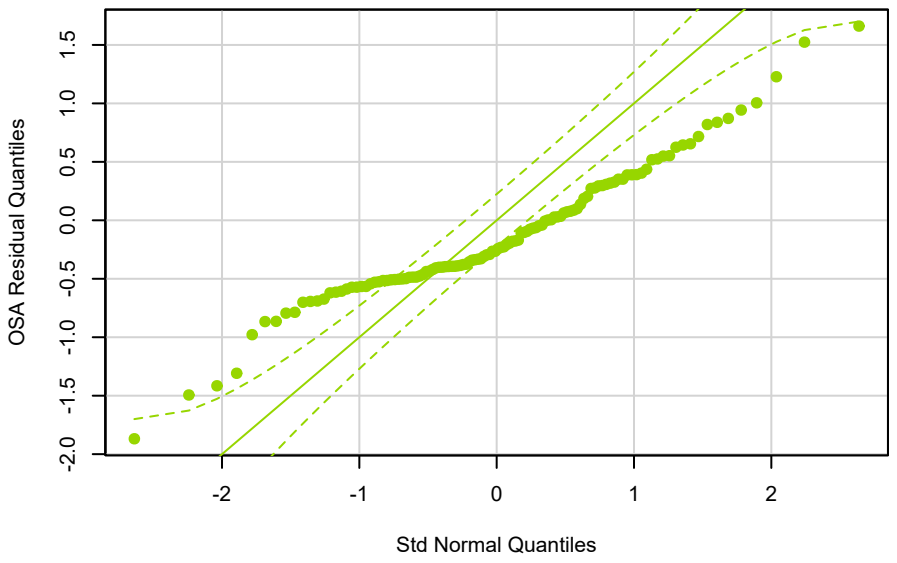




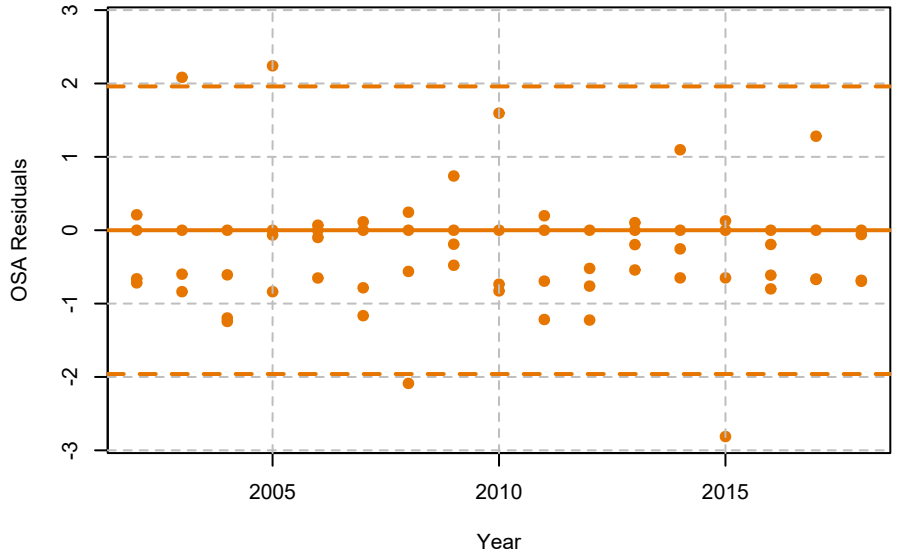


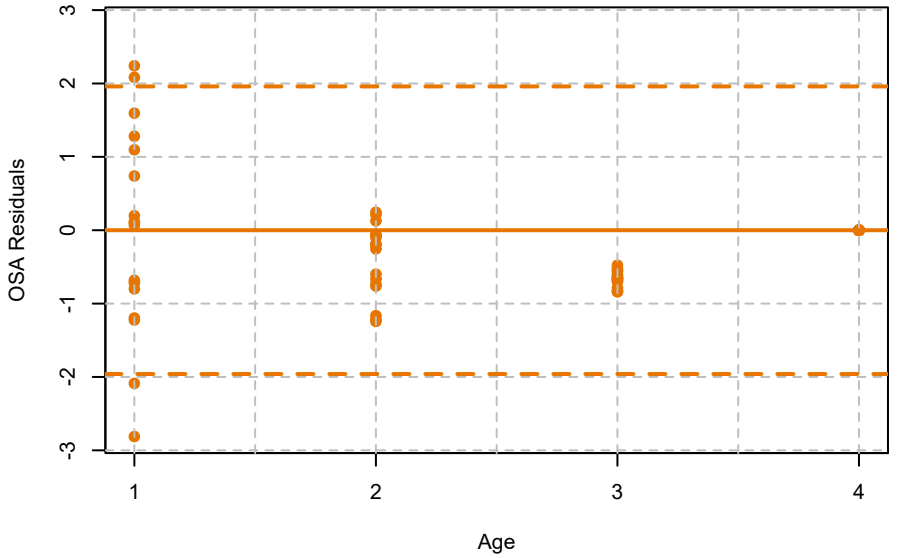


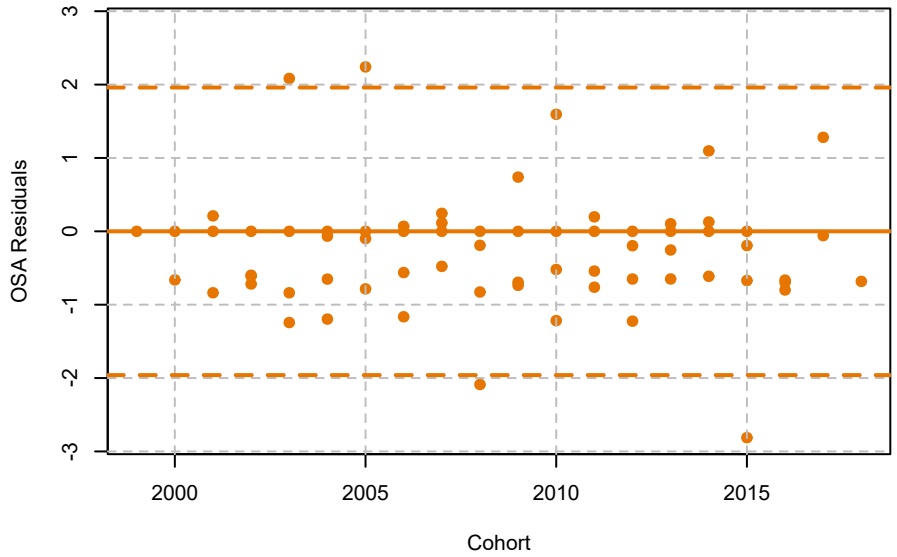


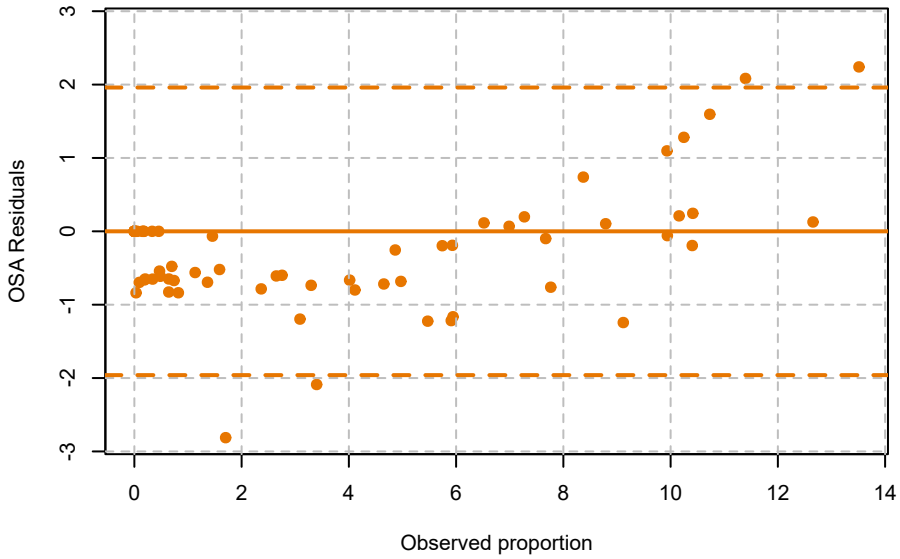


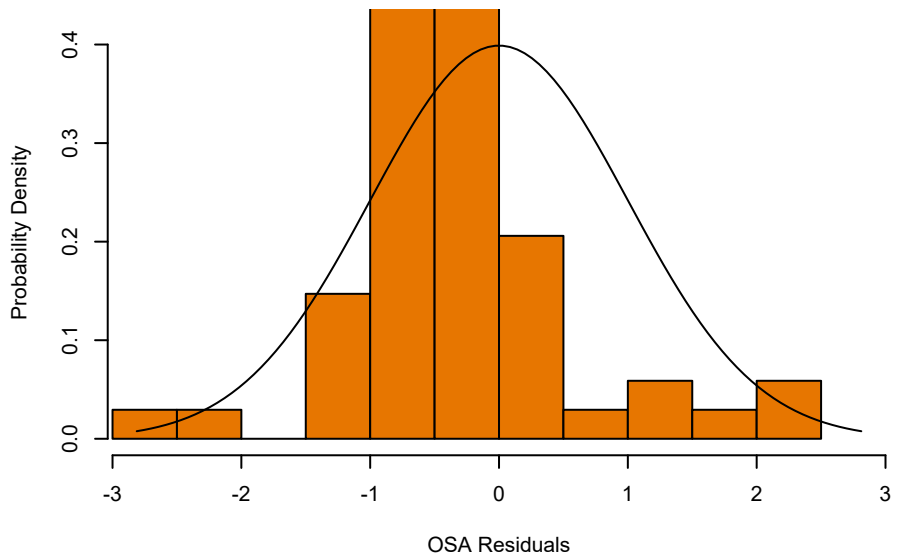
age composition OSA residual diagnostics: Index 8

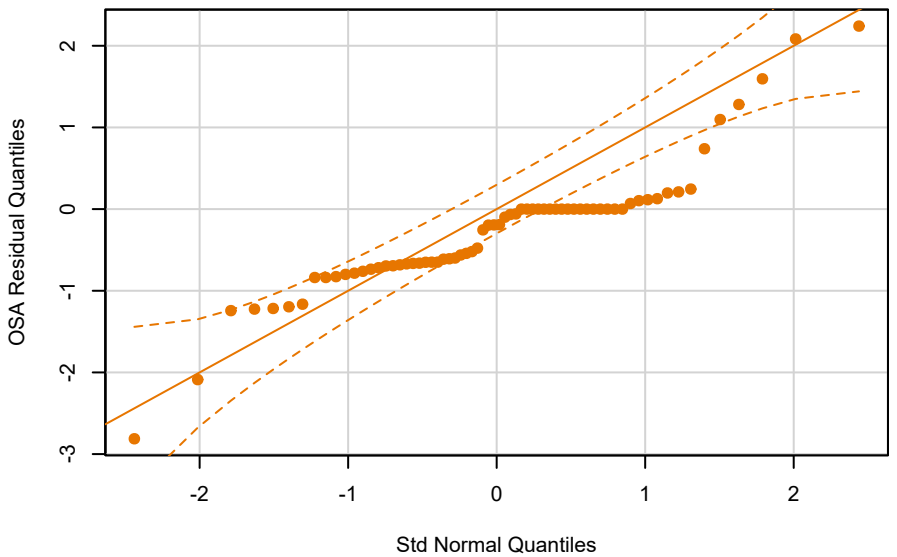


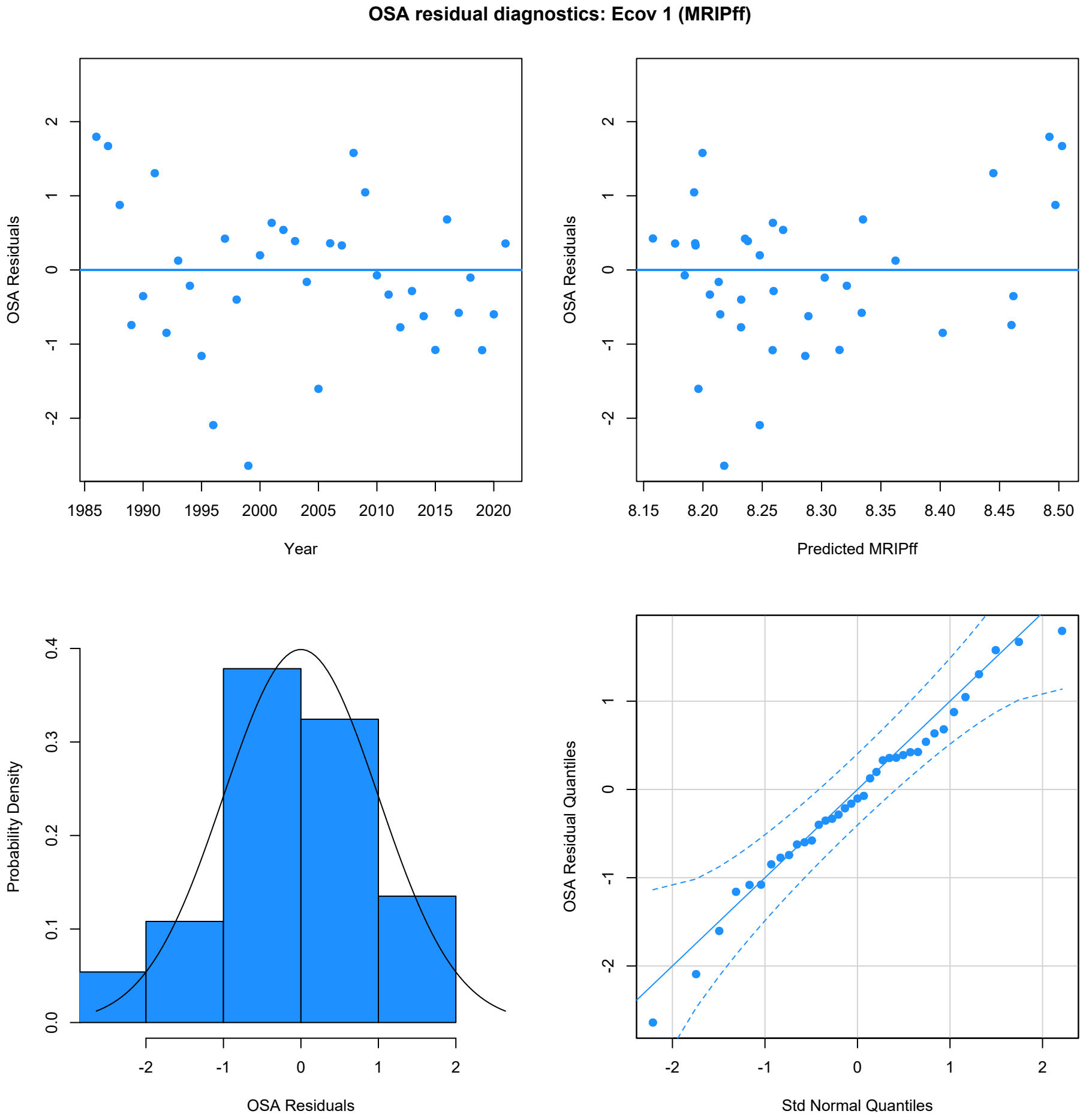


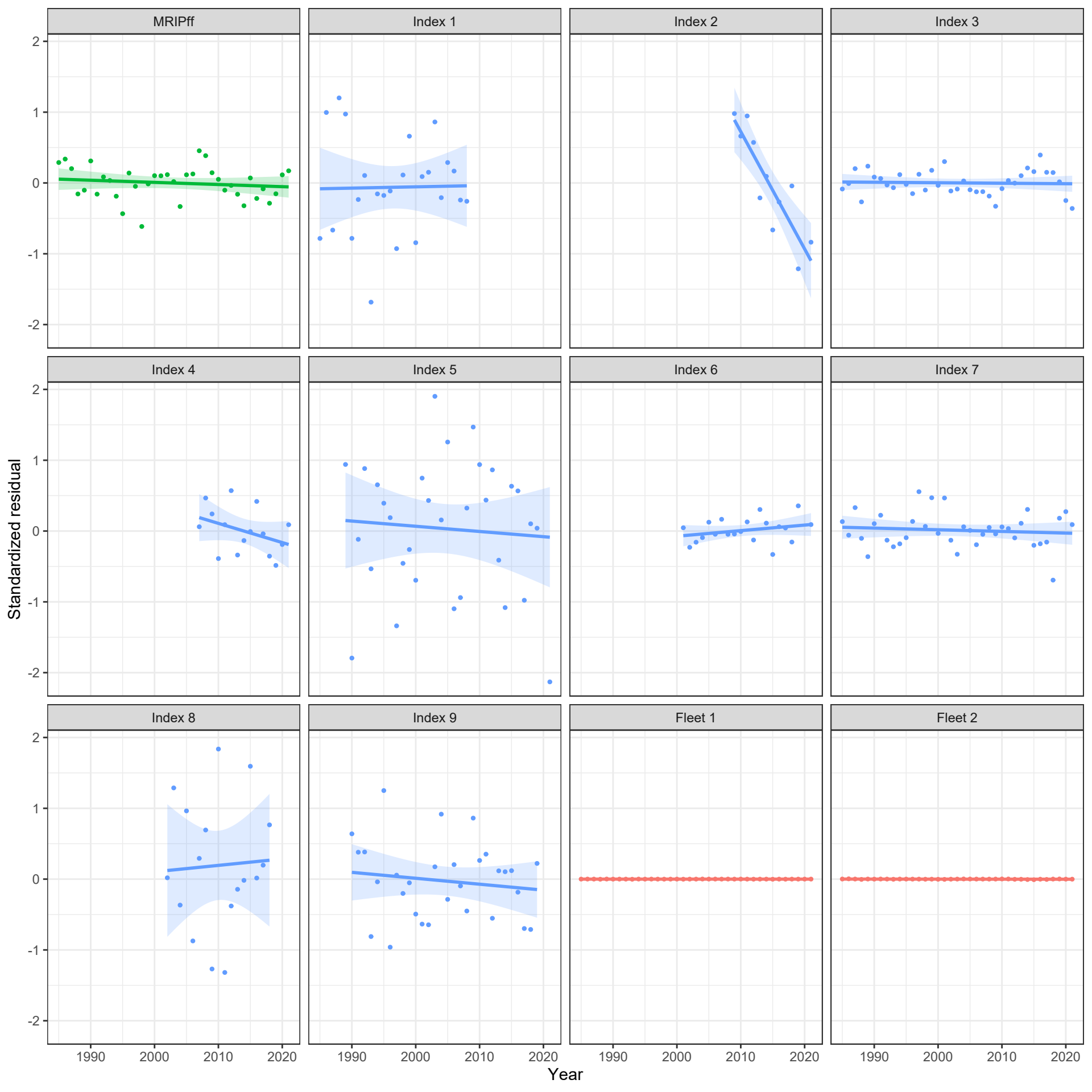








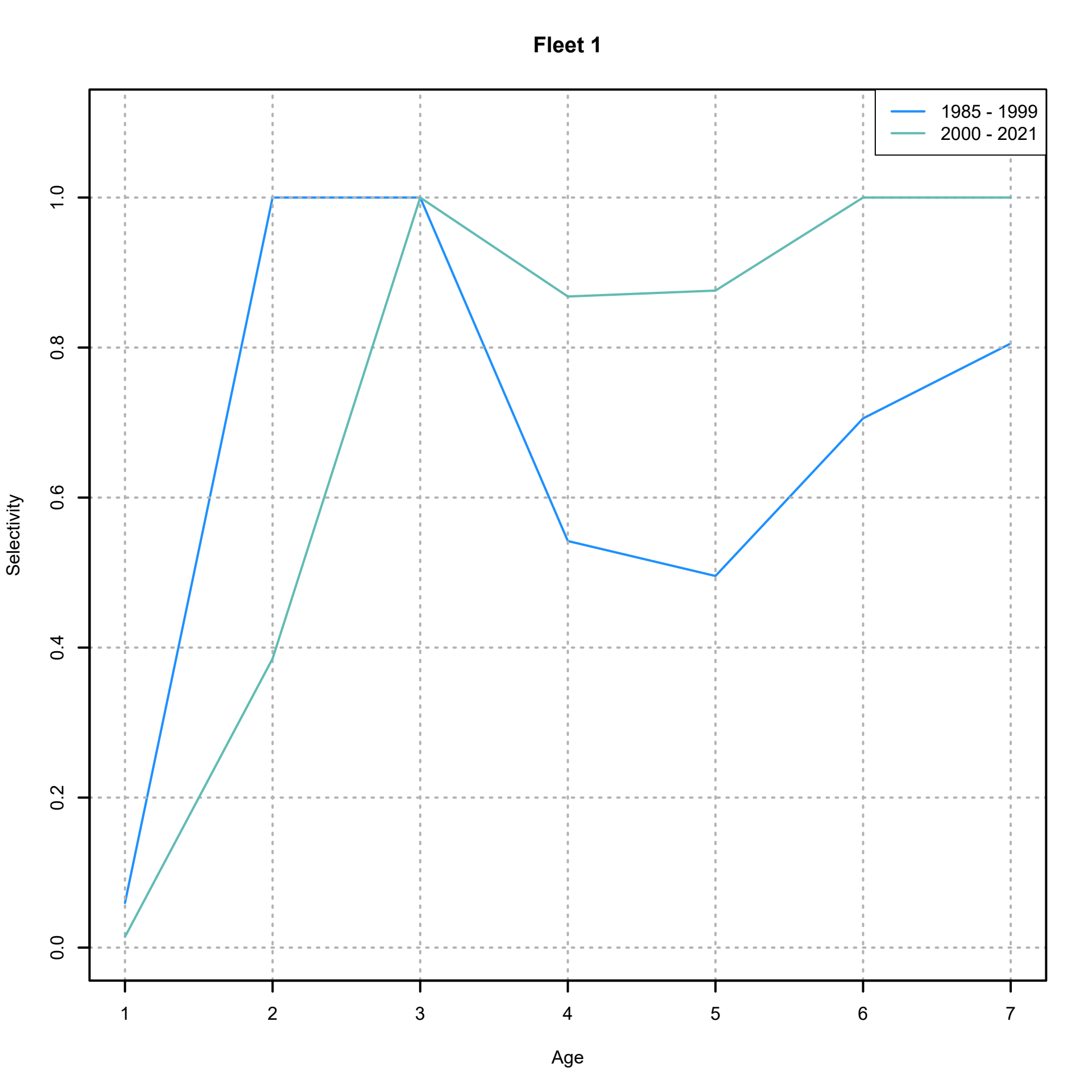

OSA residual diagnostics: Ecov 1 (MRIPff)
OSA Residuals
Year
1985
1990
1995
2000
2005
2010
2015
2020
OSA Residuals
Predicted MRIPff
8.15
8.20
8.25
8.30
8.35
8.40
8.45
8.50
Probability Density
OSA Residuals
OSA Residual Quantiles
Std Normal Quantiles

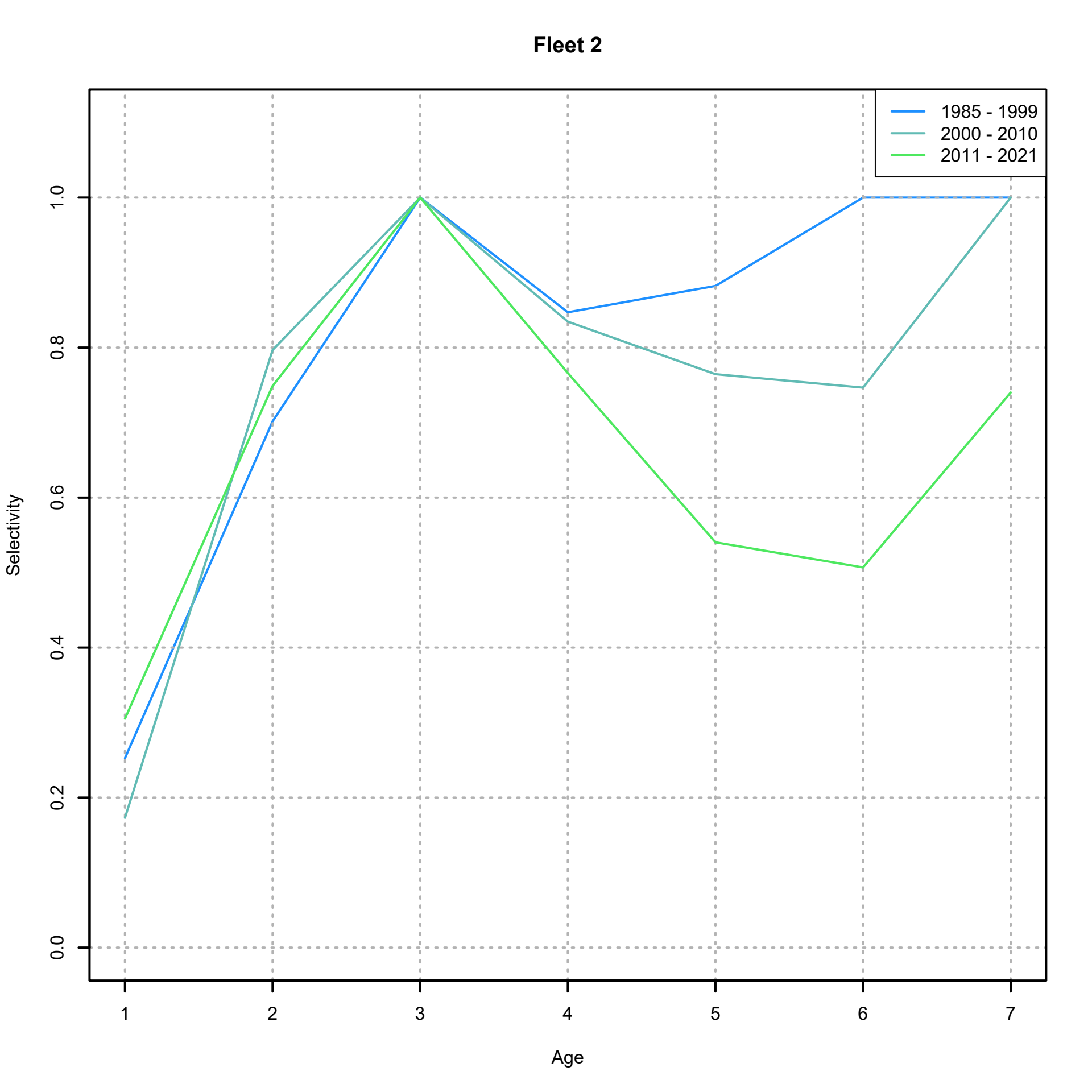

MRIPff
Index 1
Index 2
Index 3
Index 4
Index 5
Index 6
Index 7
Index 8
Index 9
Fleet 1
Fleet 2
Standardized residual
Year
2
1
0
-1
-2
1990
2000
2010
2020

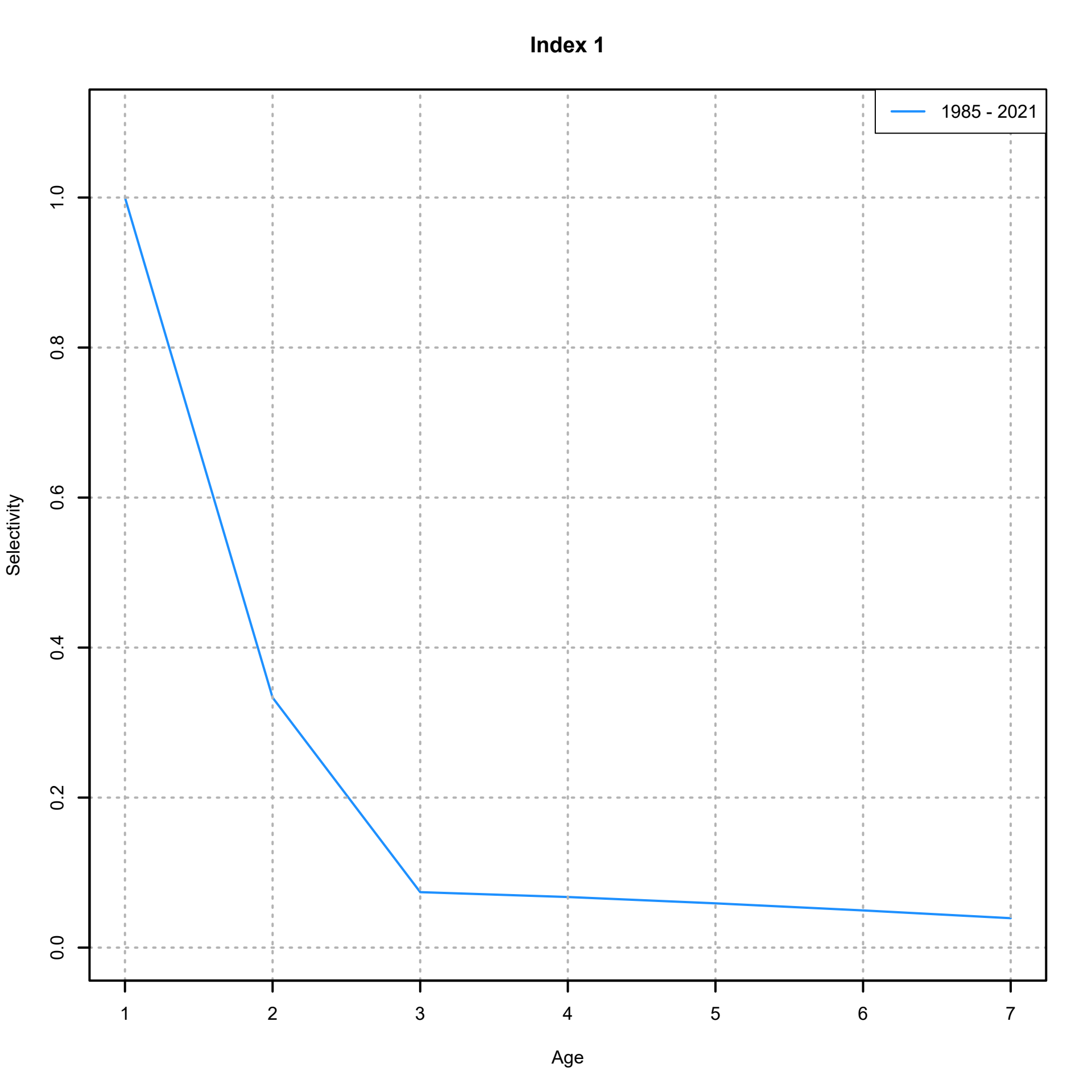
BF28W_M7ECOV

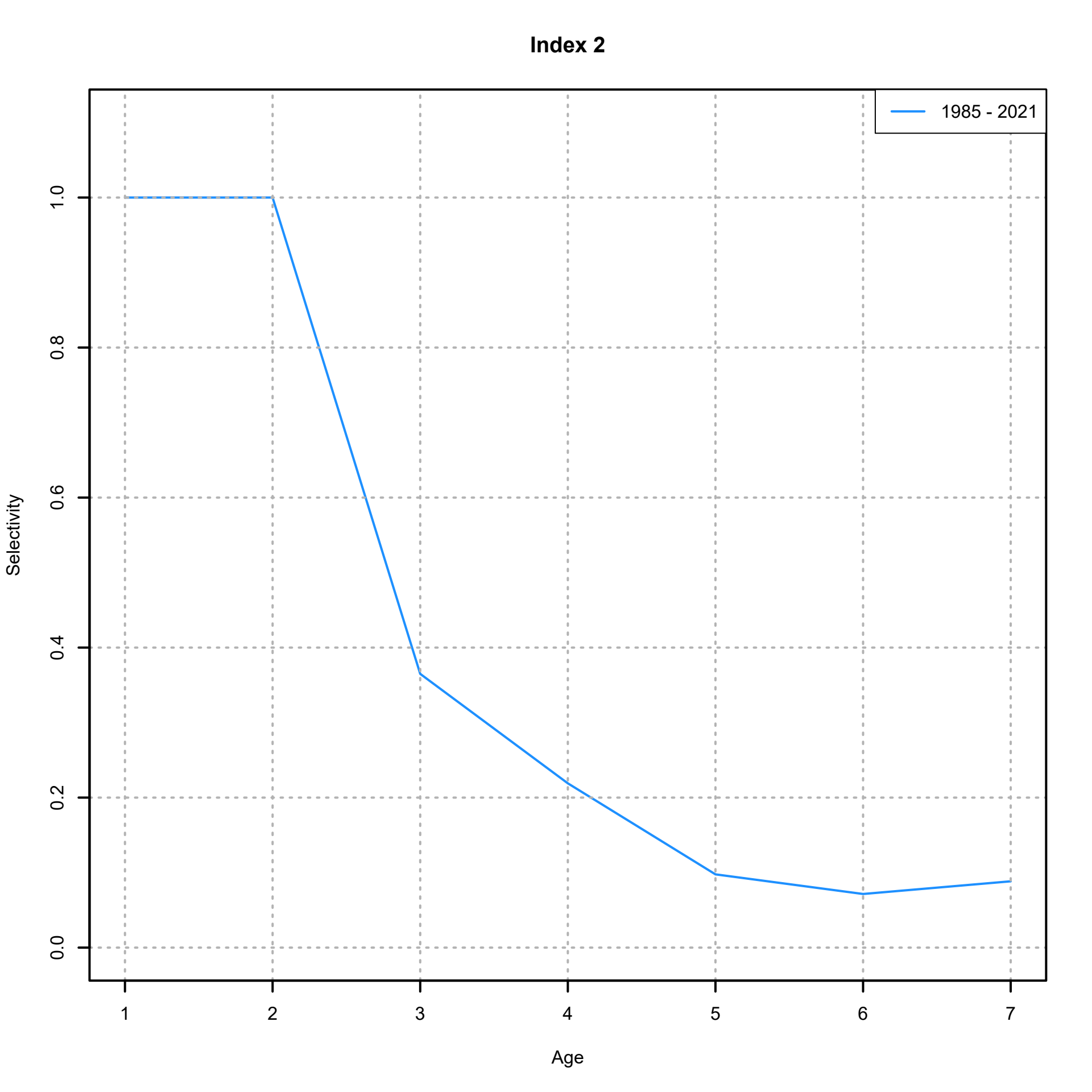
MRIP Forage Fish Index as an environmental covariate on catchability

RESULTS PLOTS


Fleet 1
1985 - 1999
2000 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age


Fleet 2
1985 - 1999
2000 - 2010
2011 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age


Index 1
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age


Index 2
1985 - 2021
Selectivity
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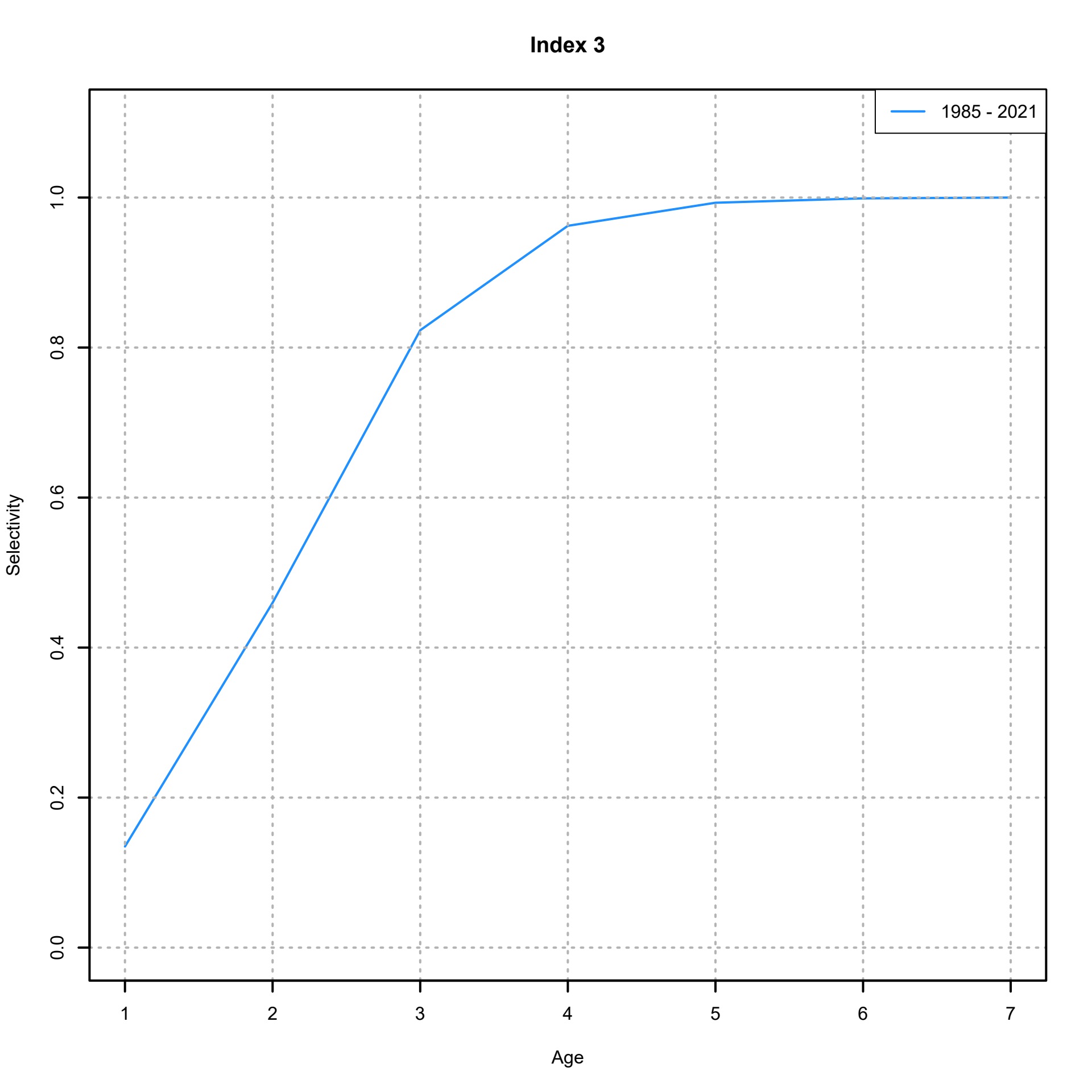
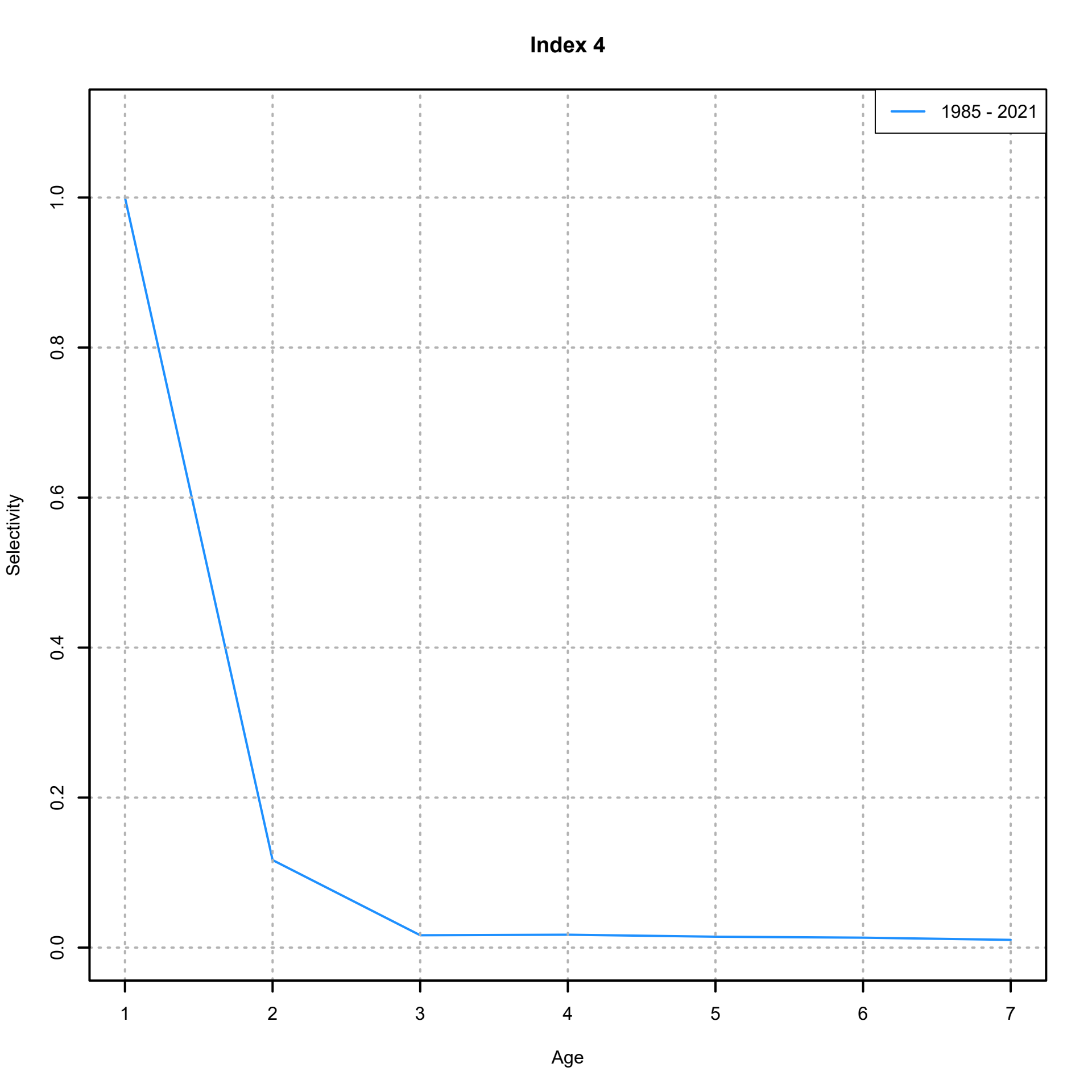
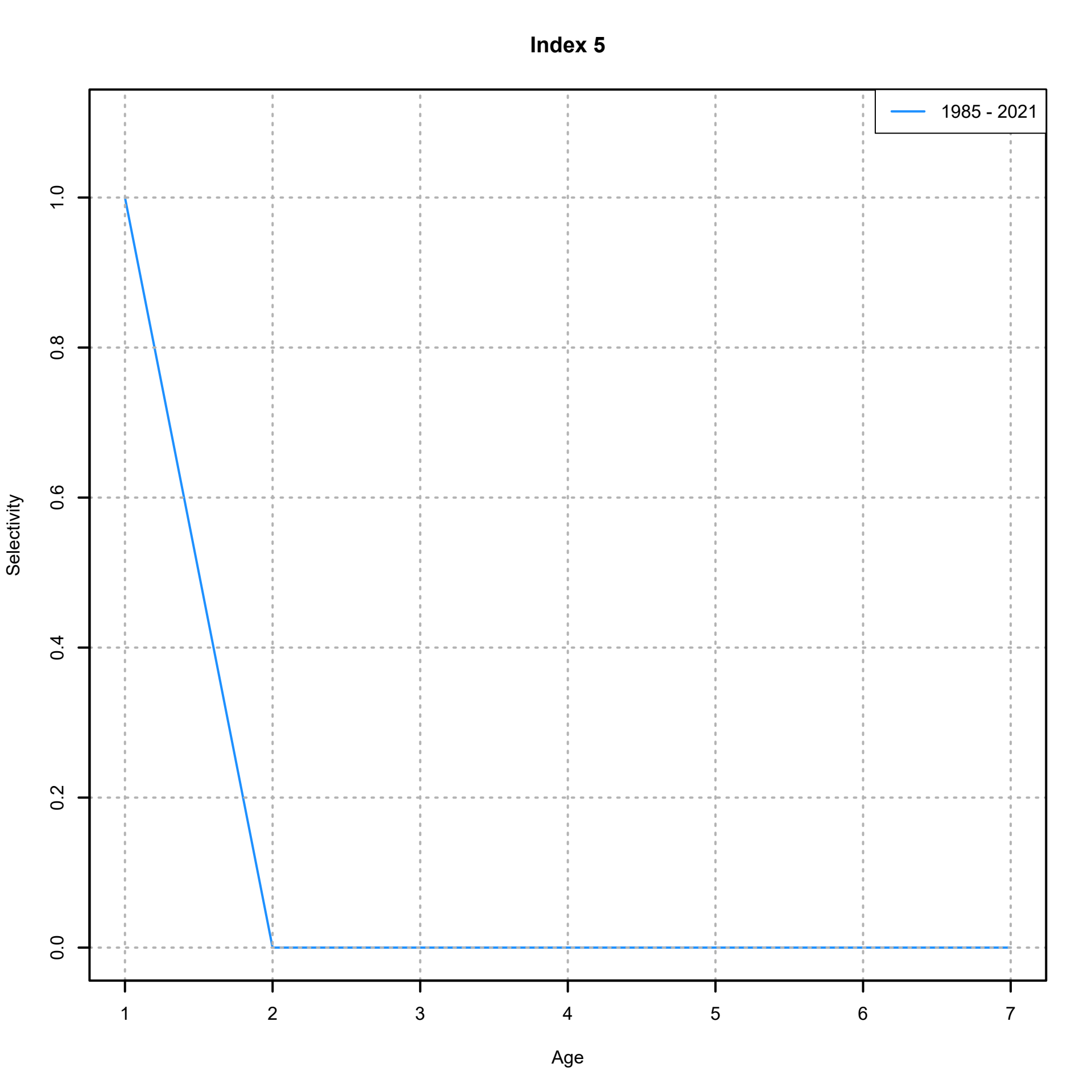
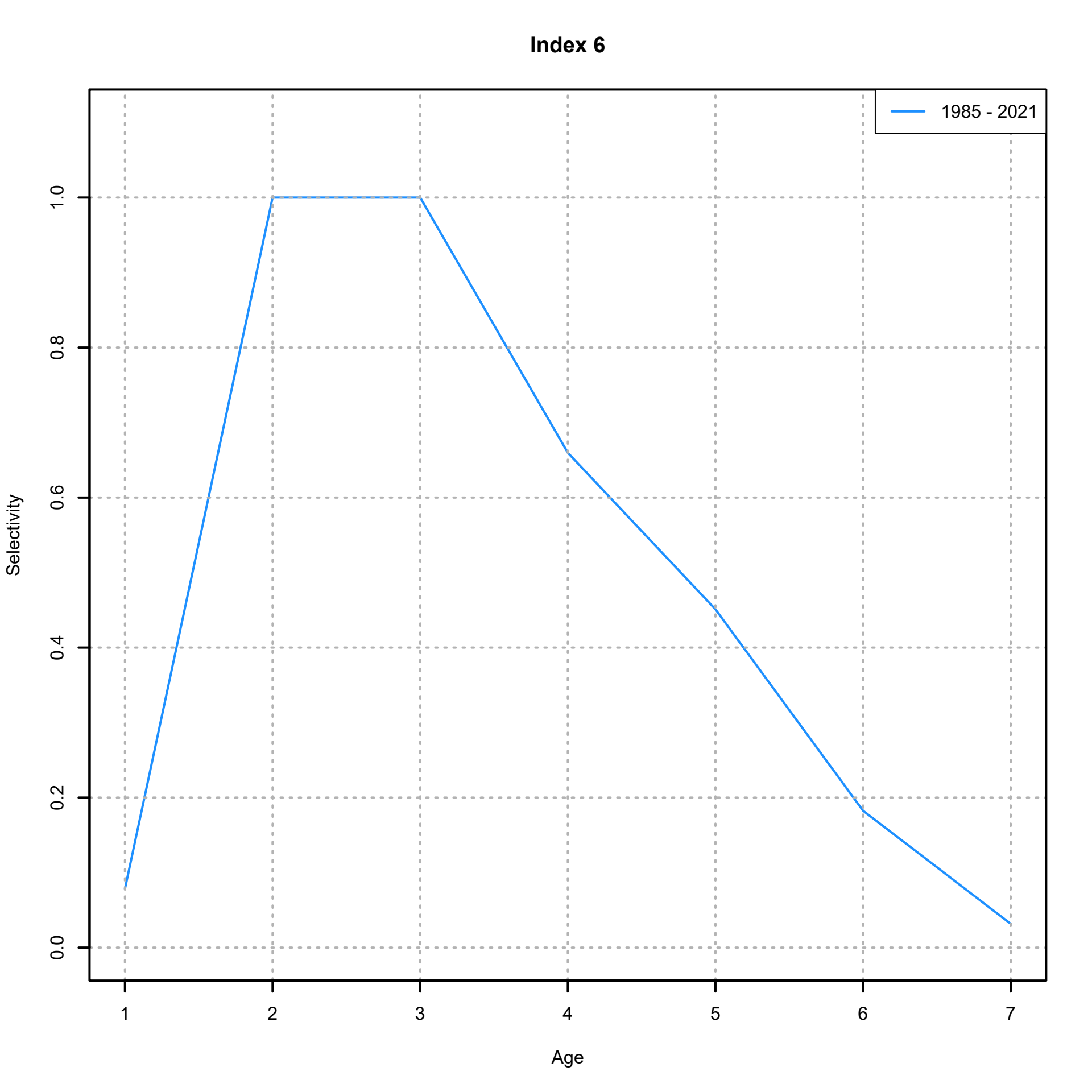
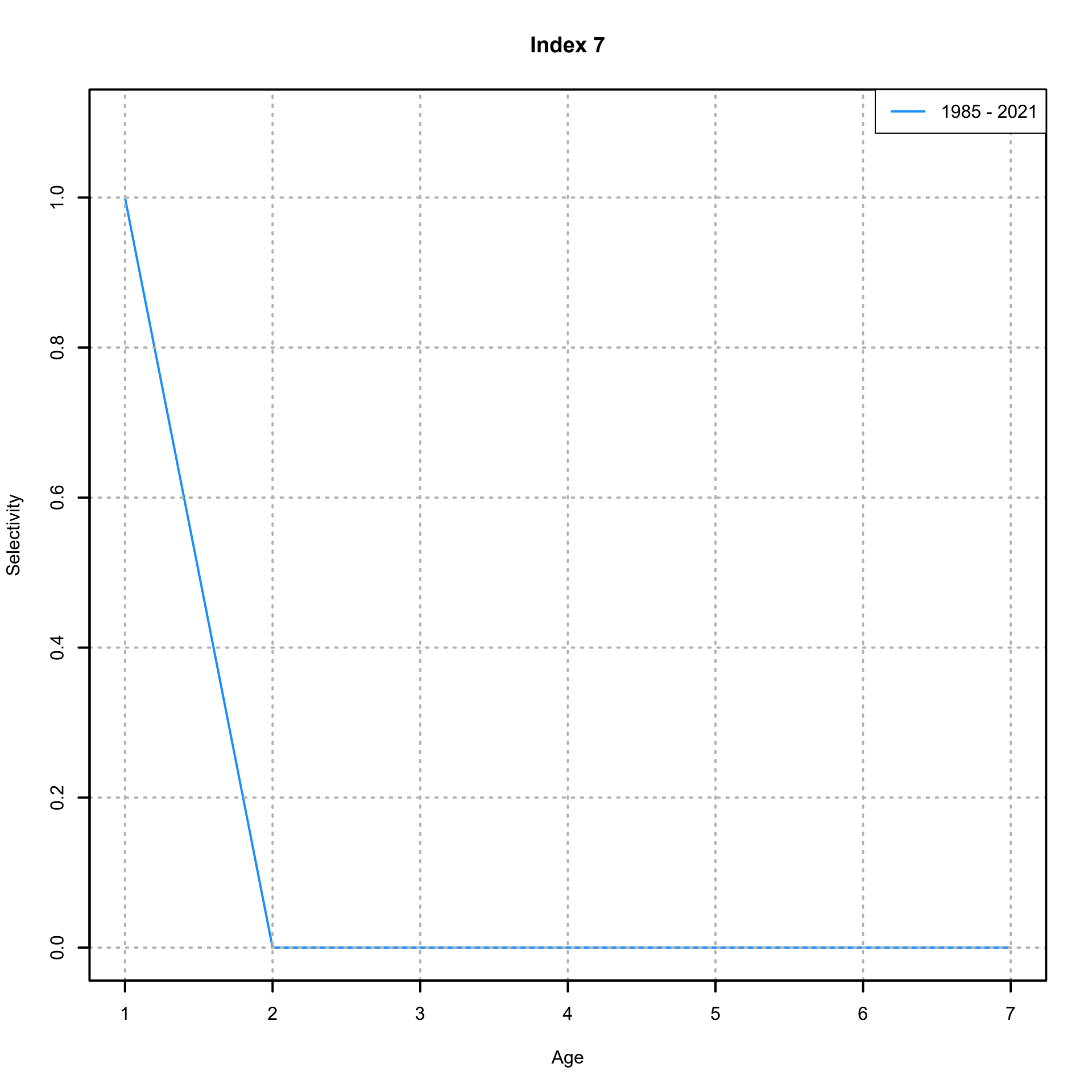
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

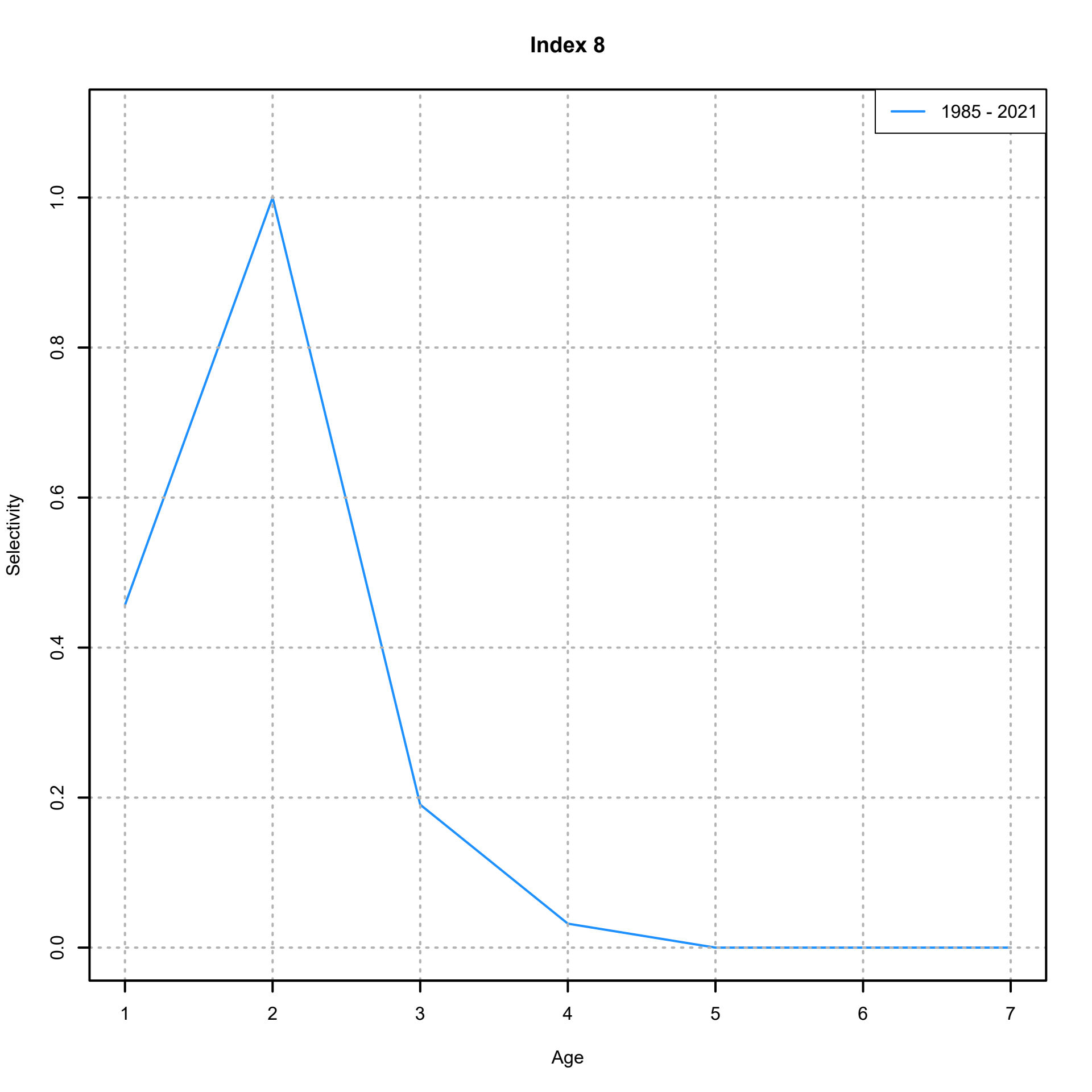

Index 3
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

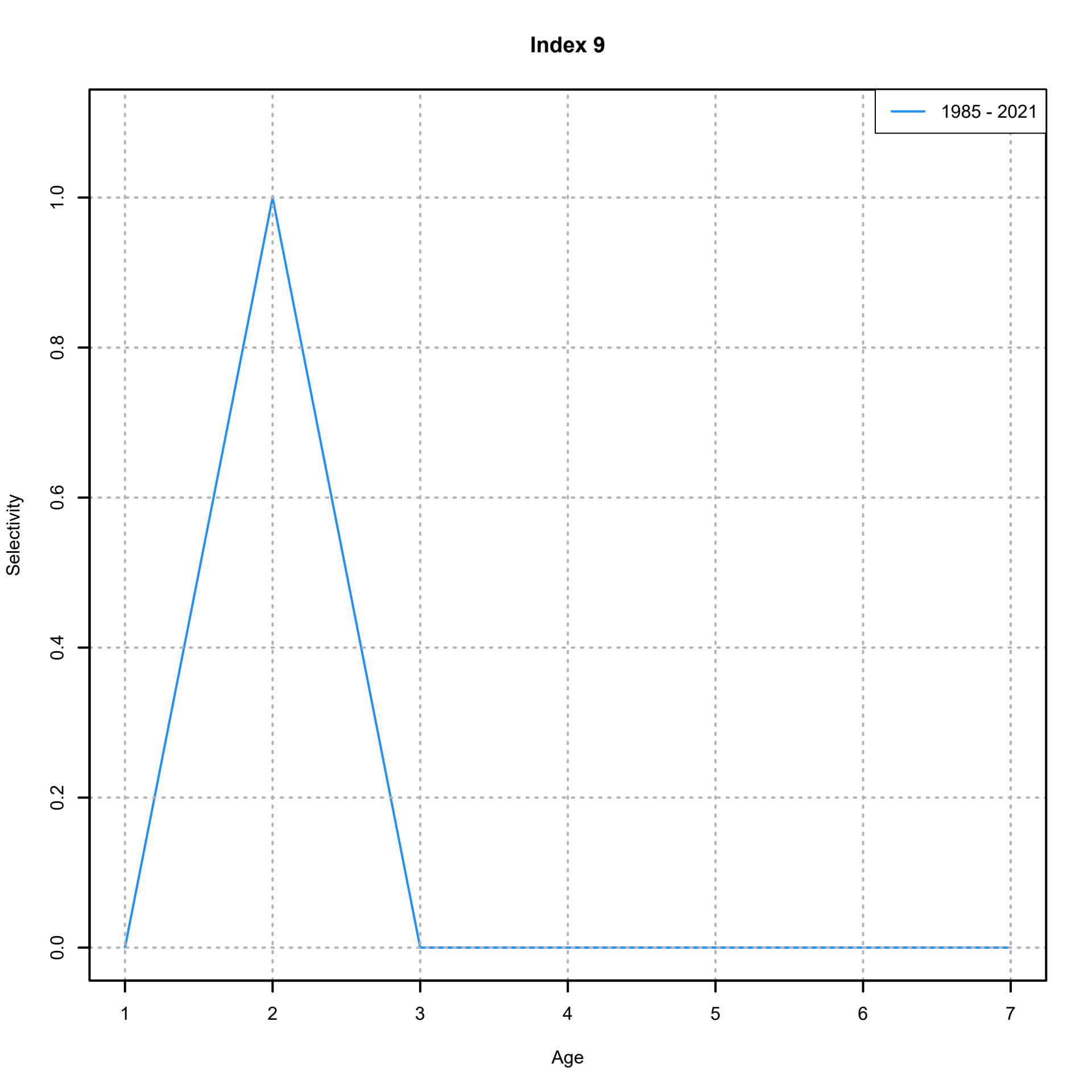

Index 4
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

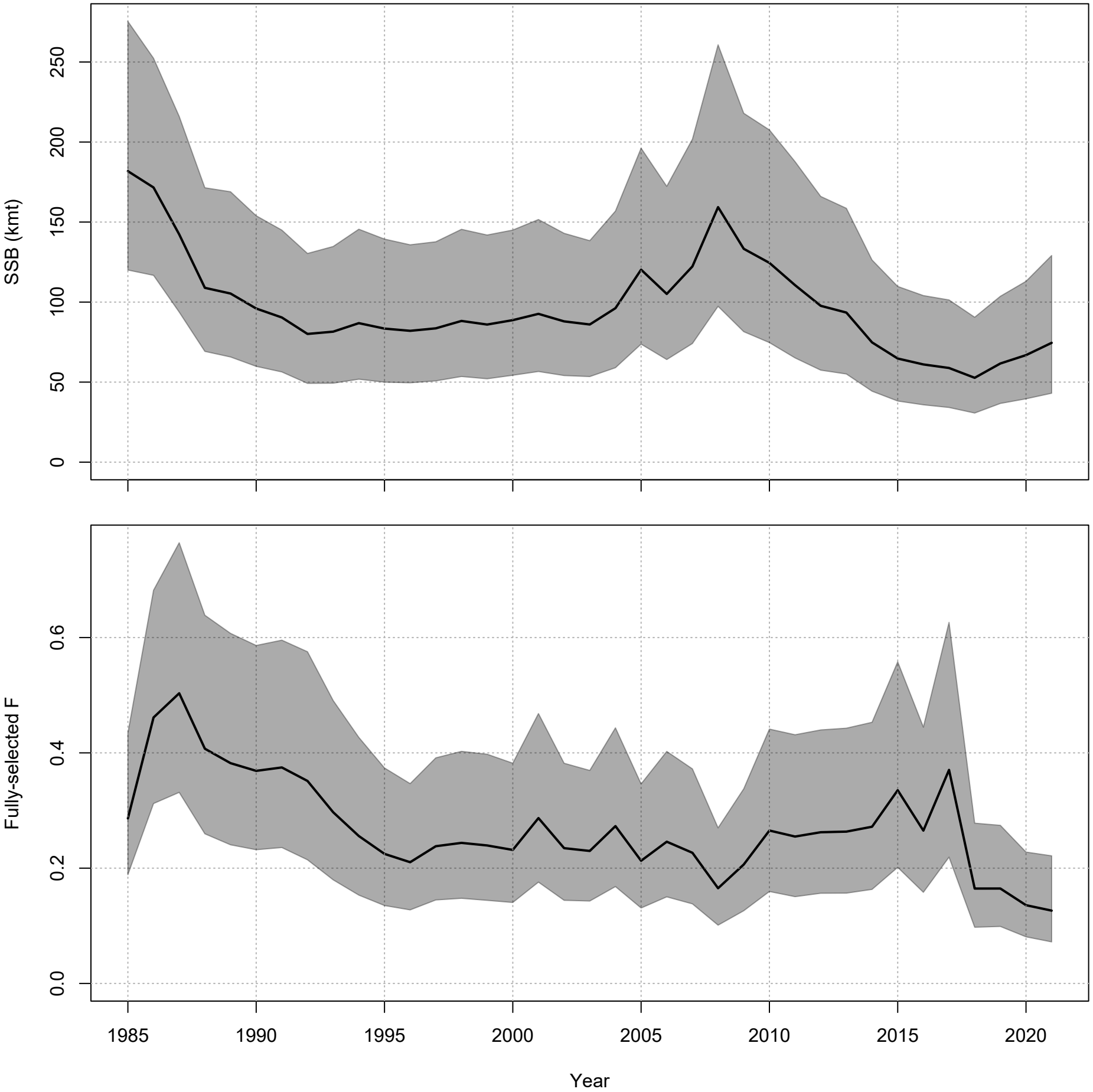

Index 5
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

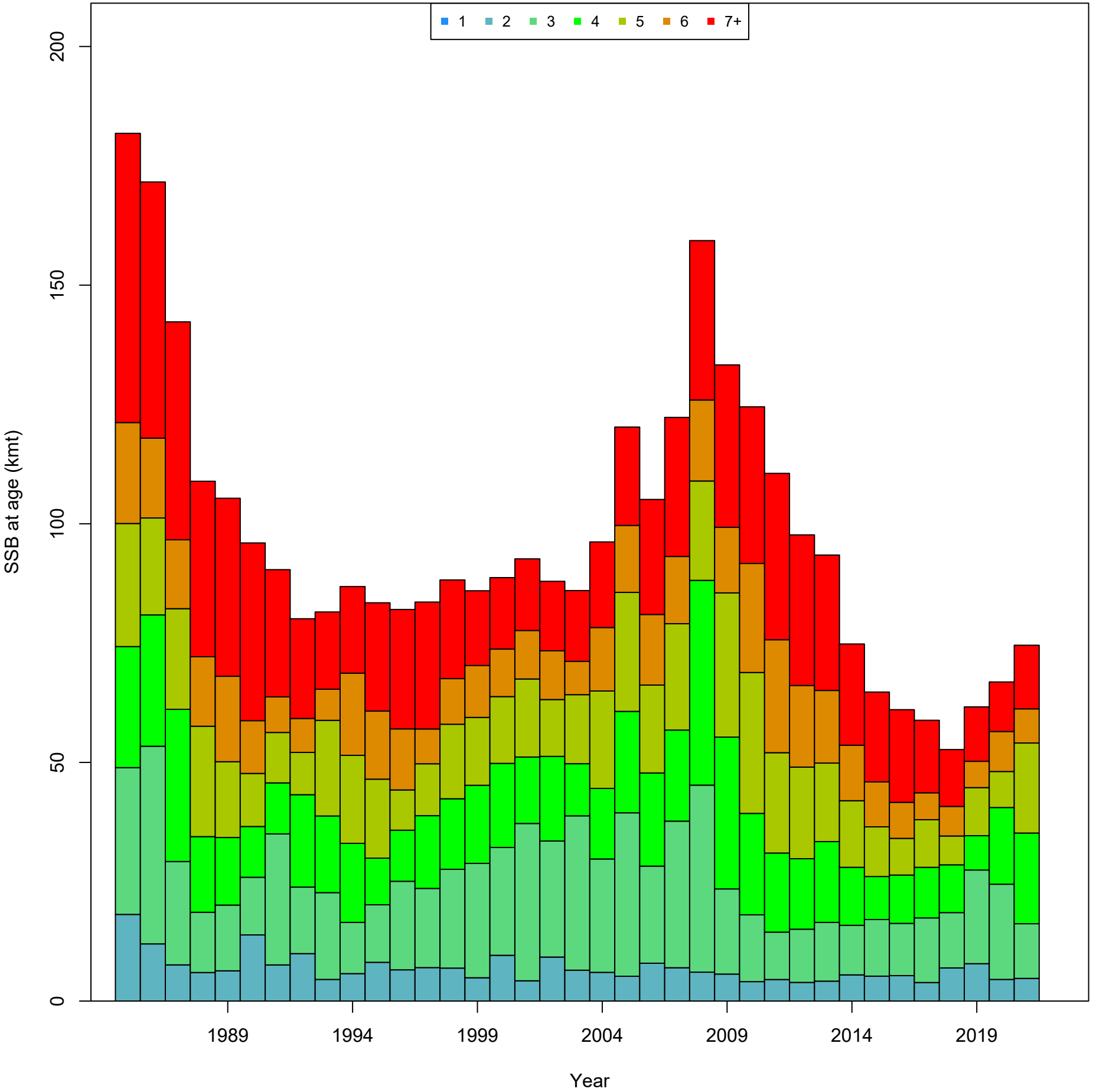

Index 6
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

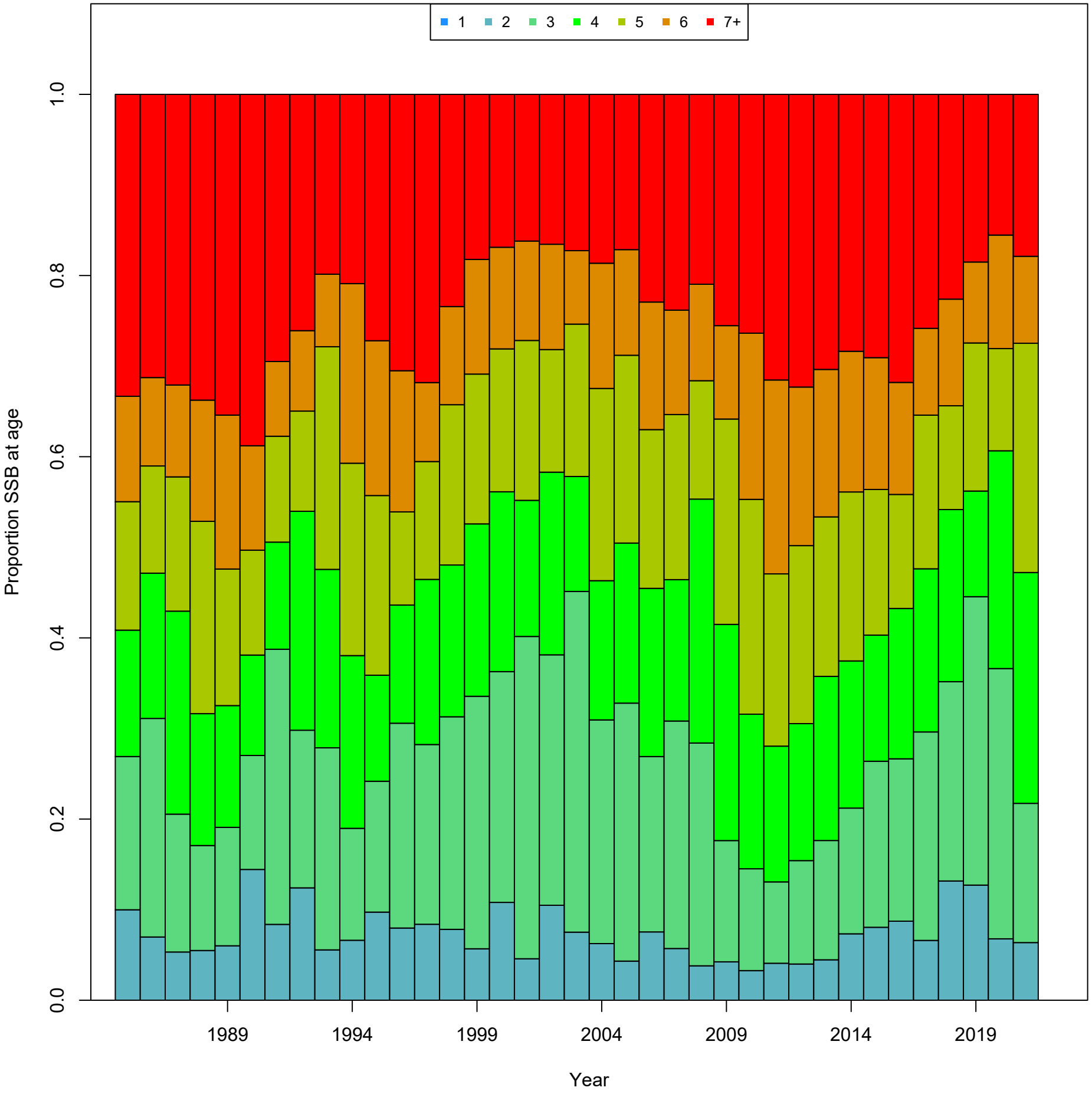

Index 7
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

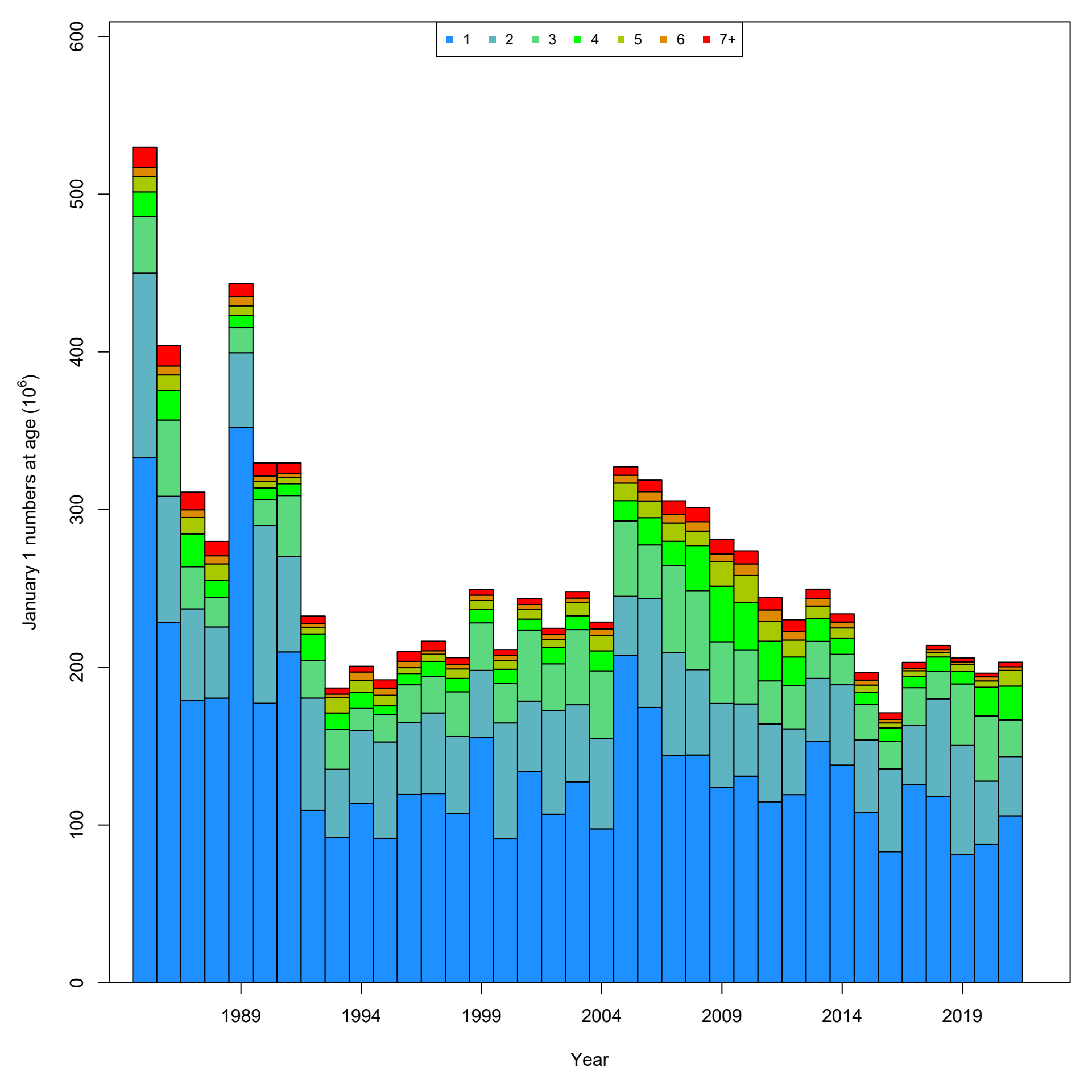

Index 8
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

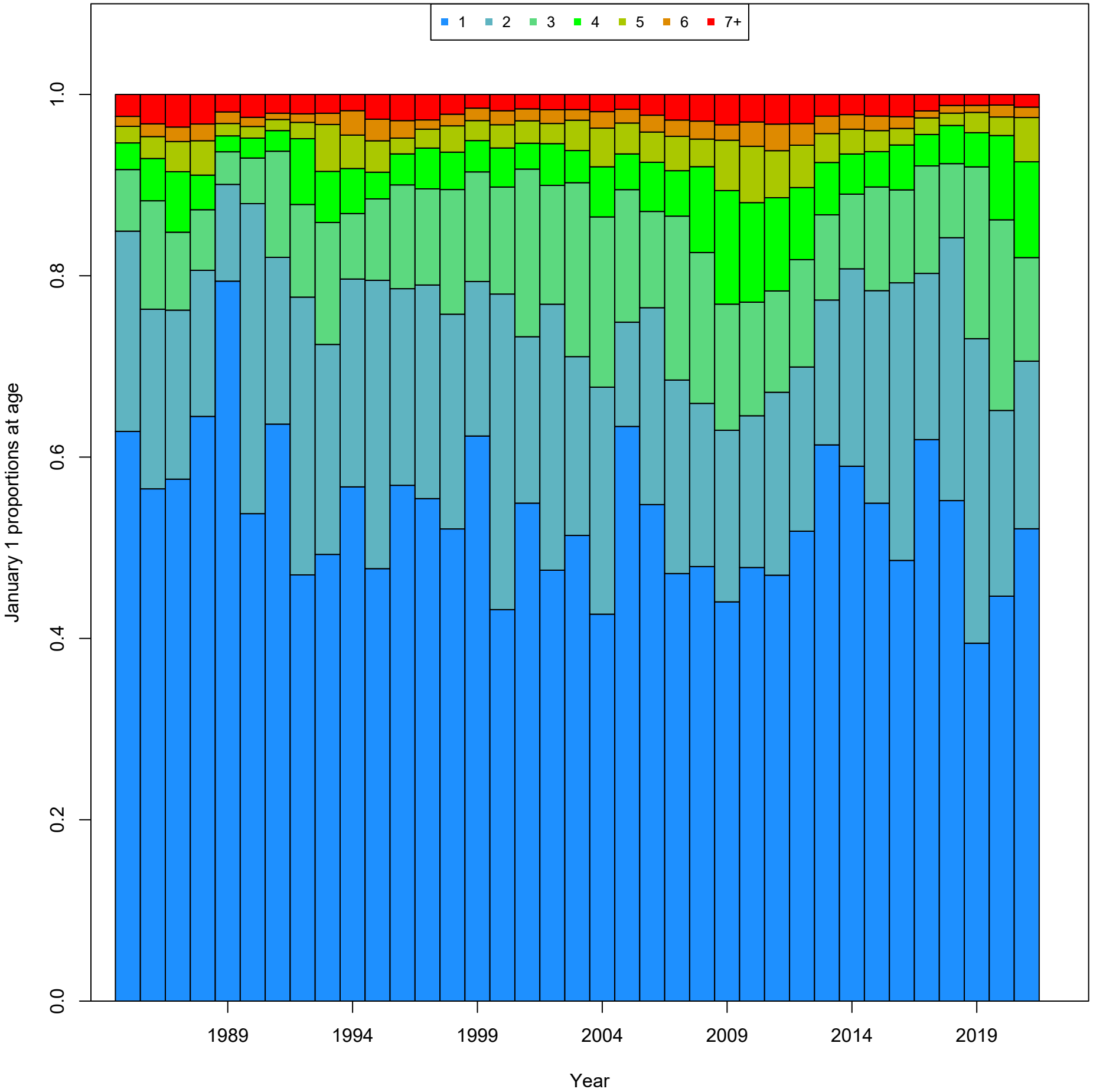

Index 9
1985 - 2021
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Age

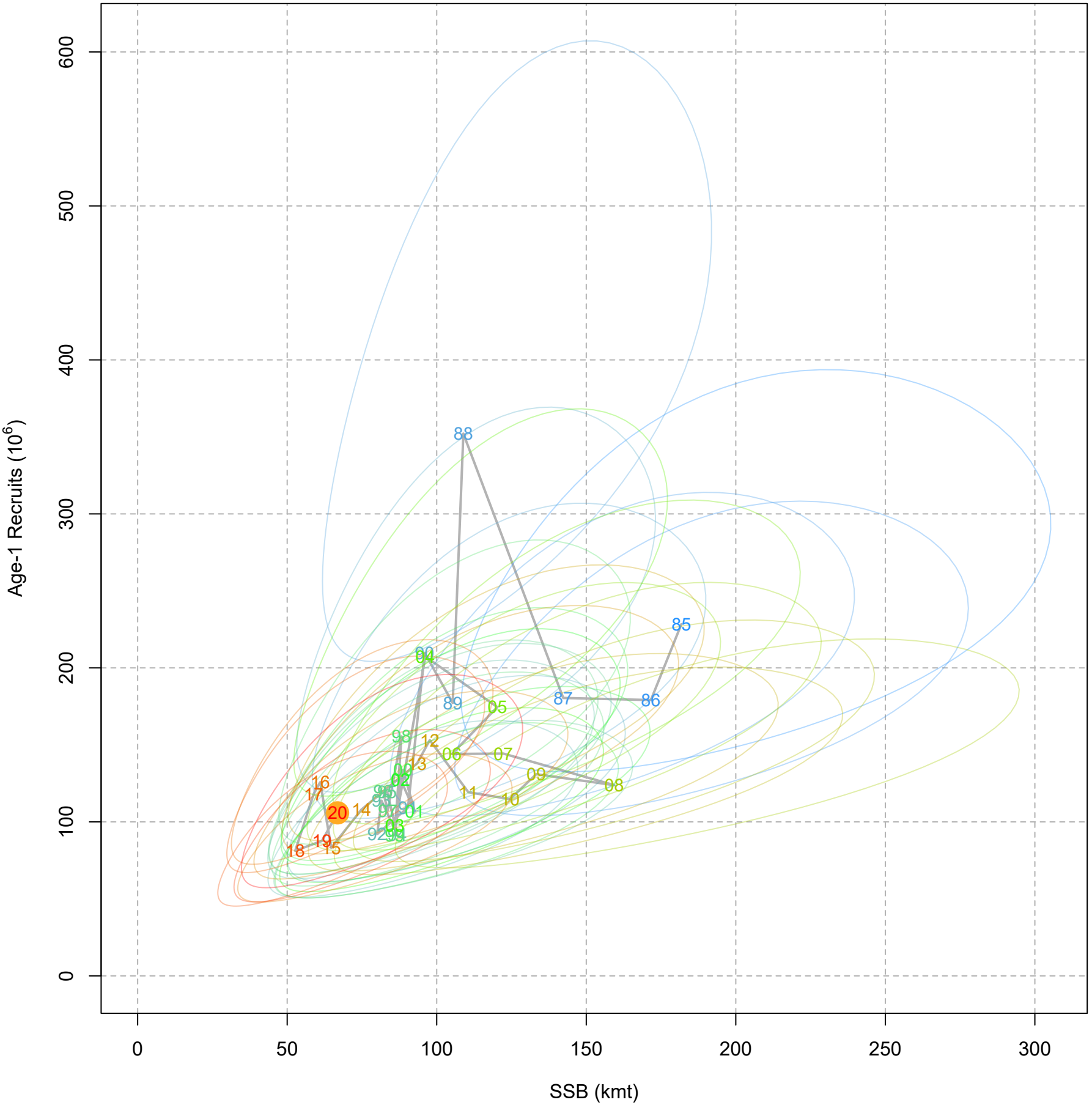

SSB (kmt)
0
50
100
150
200
250
Fully-selected F
0.0
0.2
0.4
0.6
1985
1990
1995
2000
2005
2010
2015
2020
Year


1
2
3
4
5
6
7+
SSB at age (kmt)
0
50
100
150
200
1989
1994
1999
2004
2009
2014
2019
Year

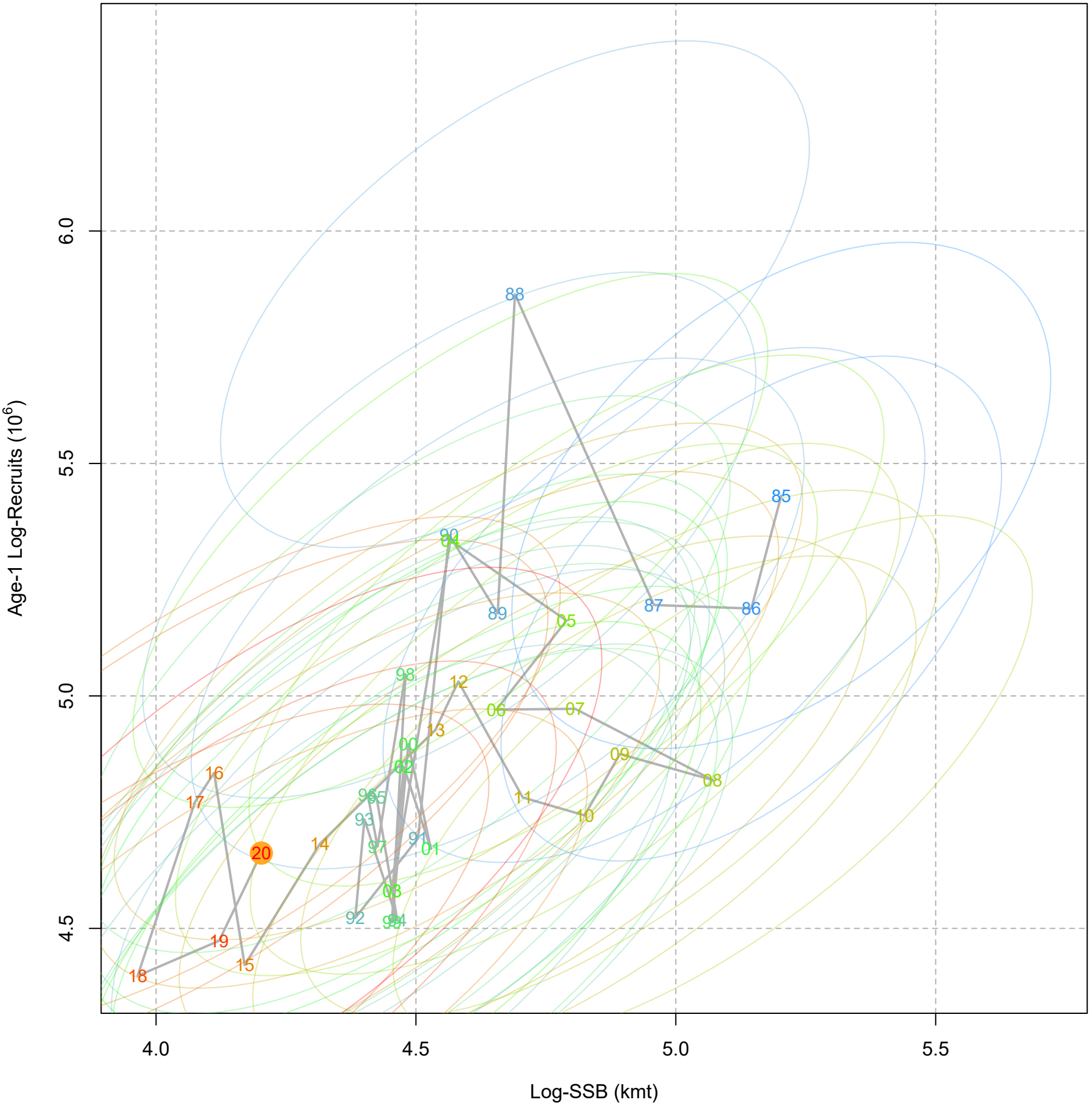

1
2
3
4
5
6
7+
Proportion SSB at age
0.0
0.2
0.4
0.6
0.8
1.0
1989
1994
1999
2004
2009
2014
2019
Year

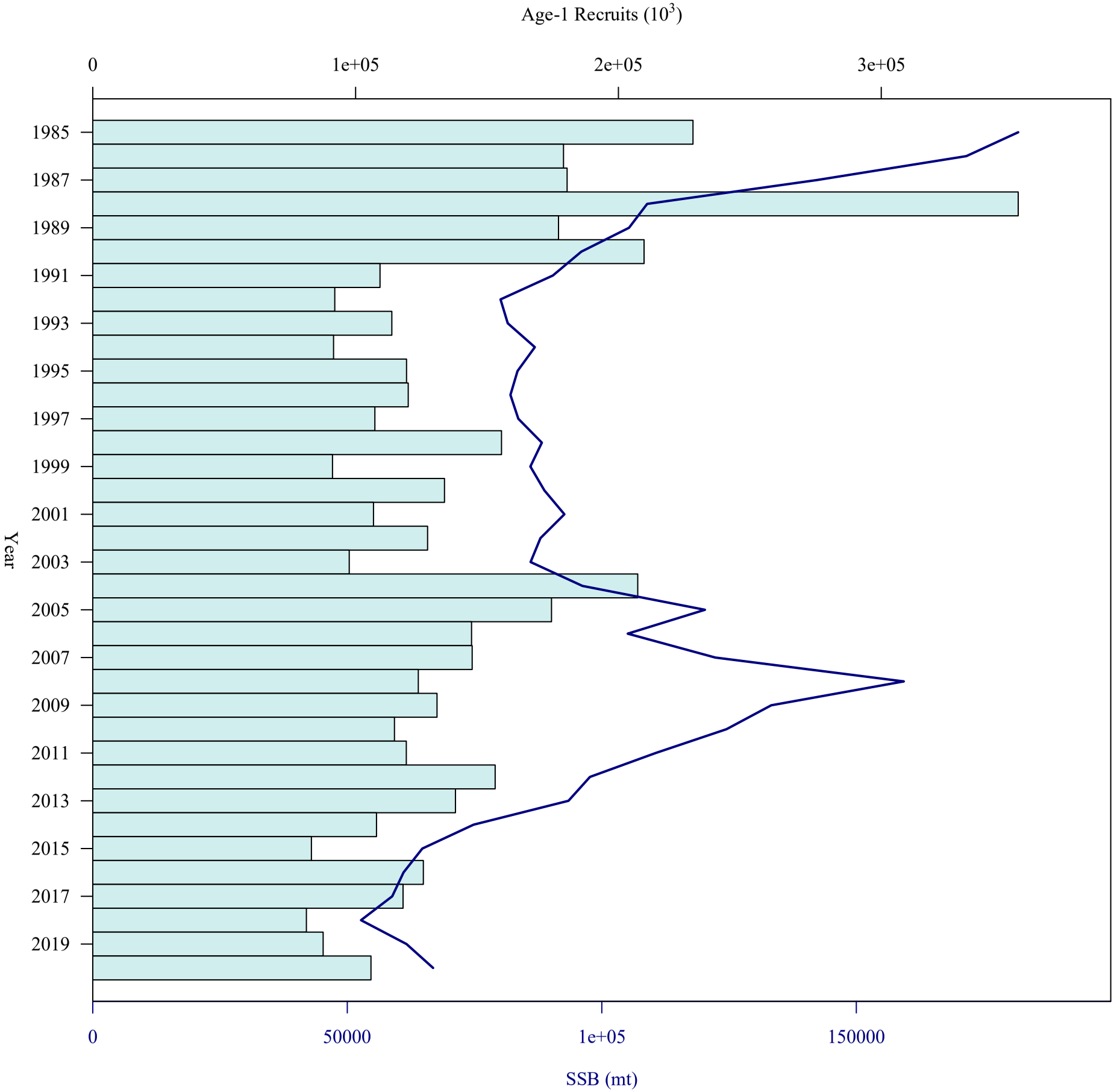

1
2
3
4
5
6
7+
0
100
200
300
400
500
600
January 1 numbers at age (10^6)
1989
1994
1999
2004
2009
2014
2019
Year

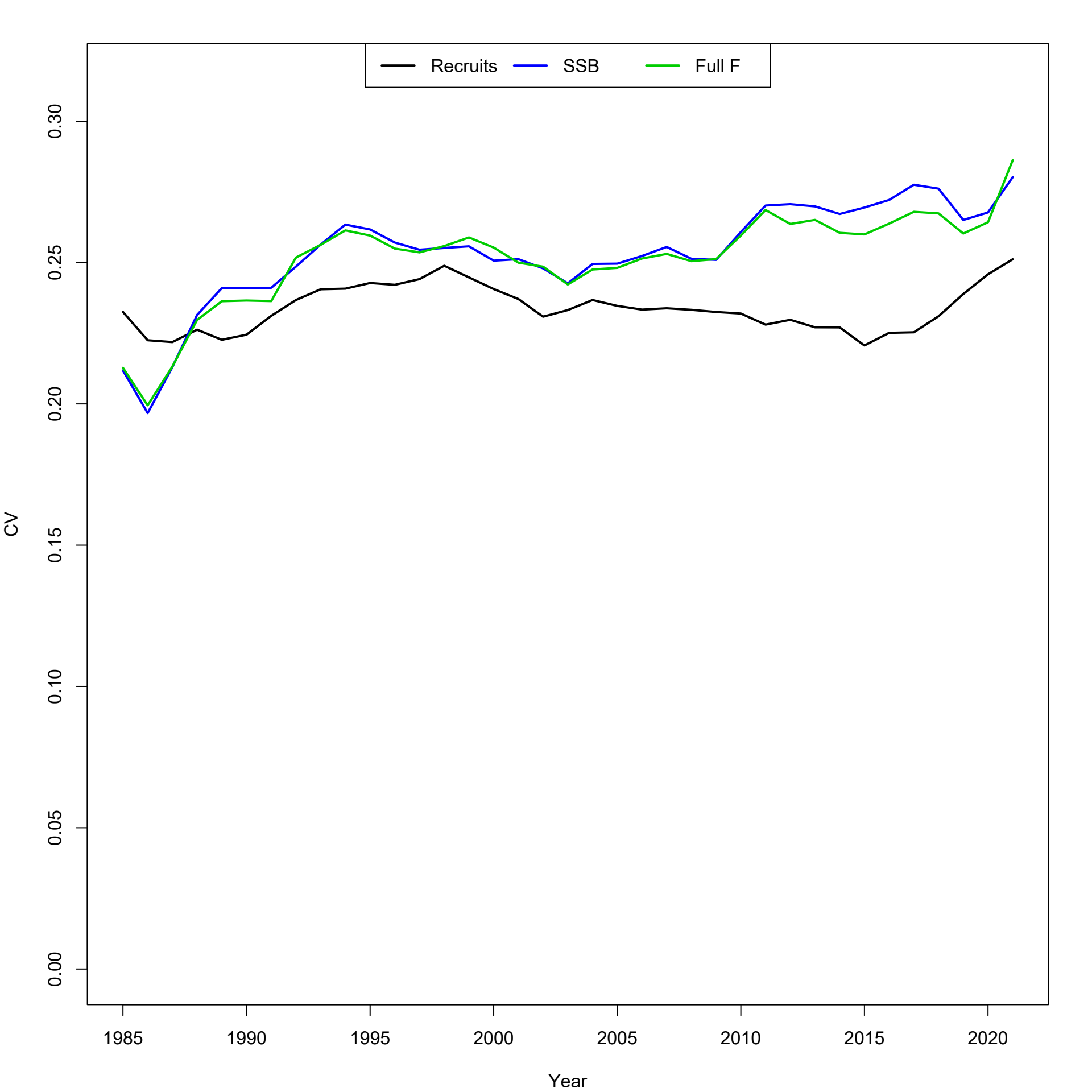

1
2
3
4
5
6
7+
January 1 proportions at age
0.0
0.2
0.4
0.6
0.8
1.0
1989
1994
1999
2004
2009
2014
2019
Year

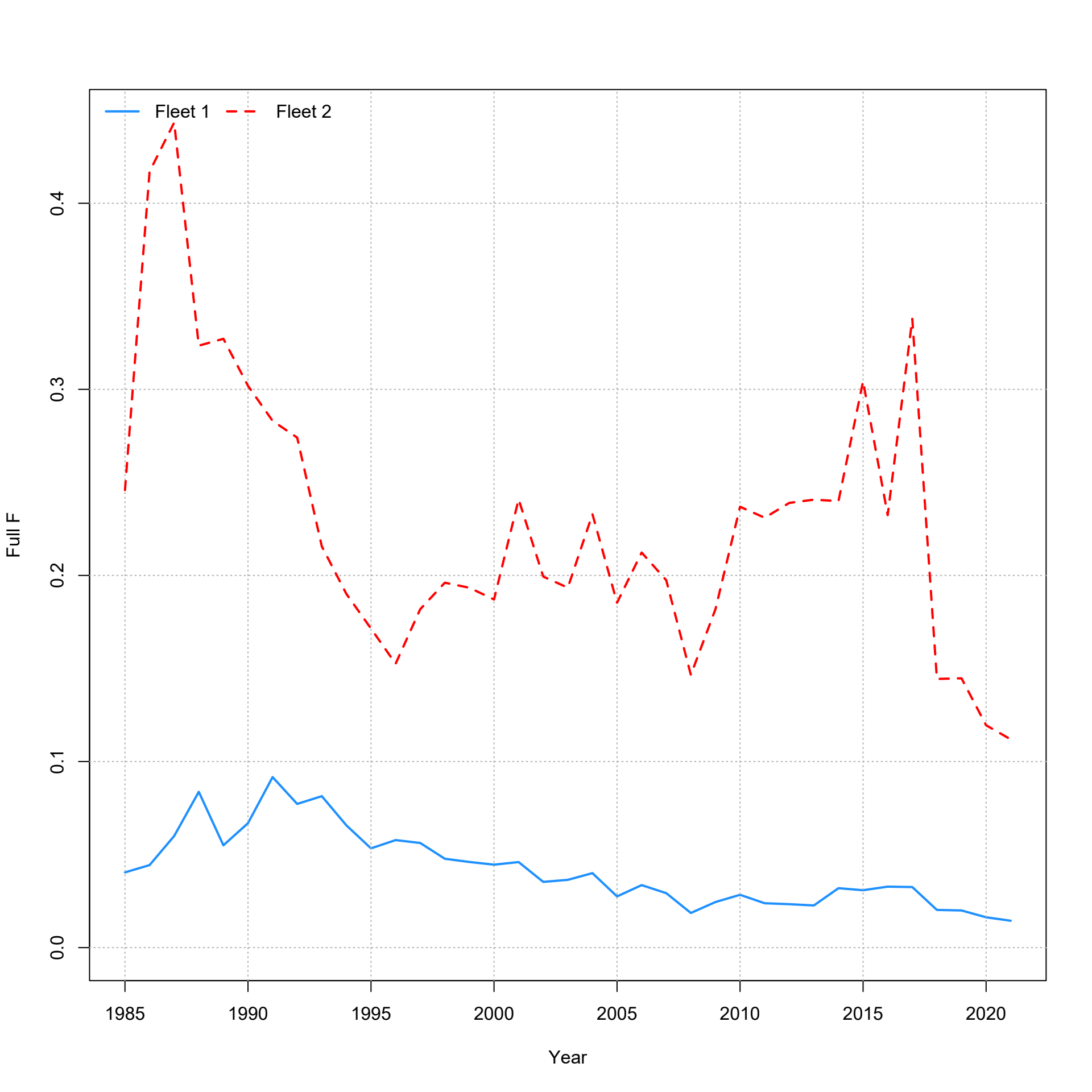


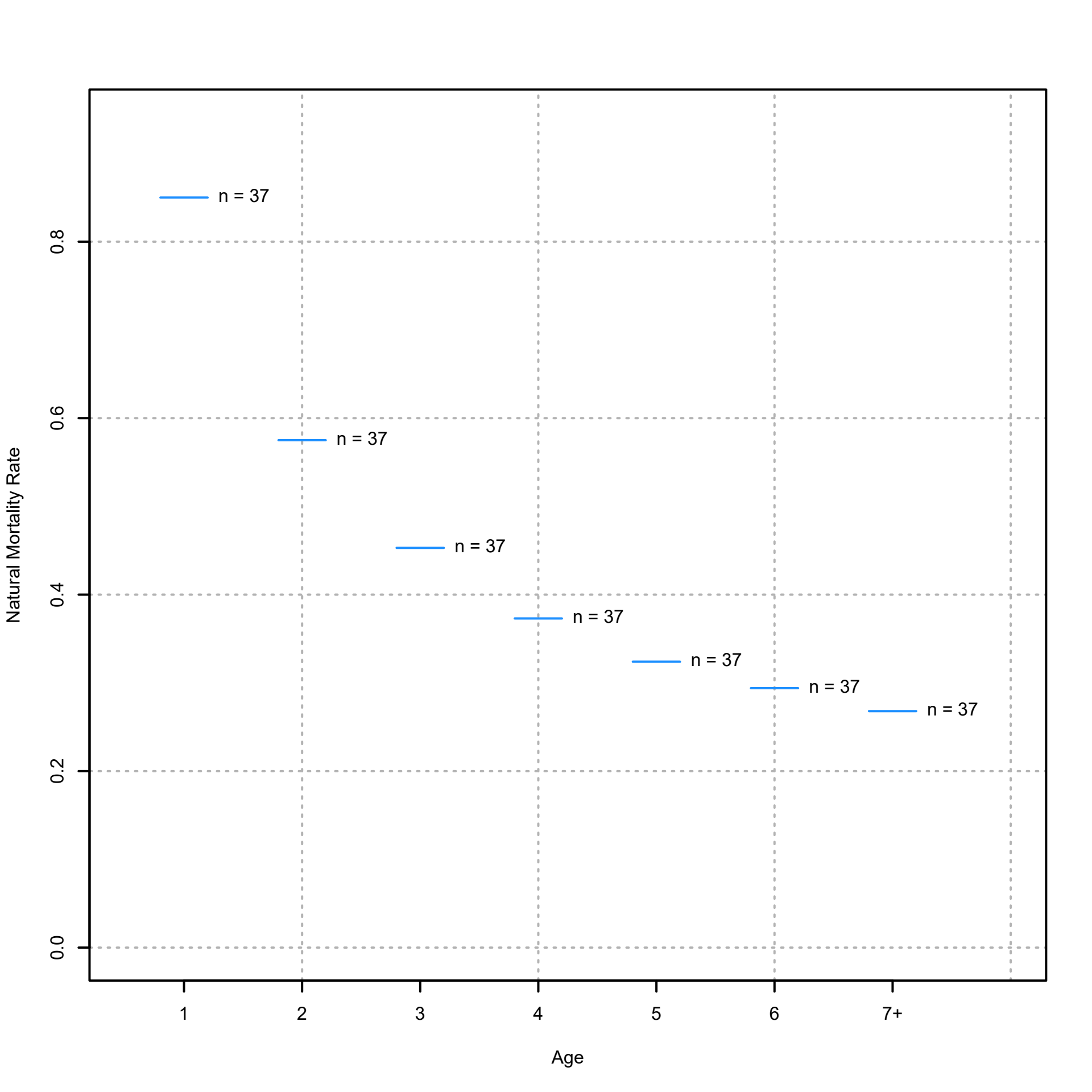
Age-1 Recruits (10^6)
SSB (kmt)
0
100
200
300
400
500
600
0
50
100
150
200
250
300
88
85
86
87
89
90
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19
20

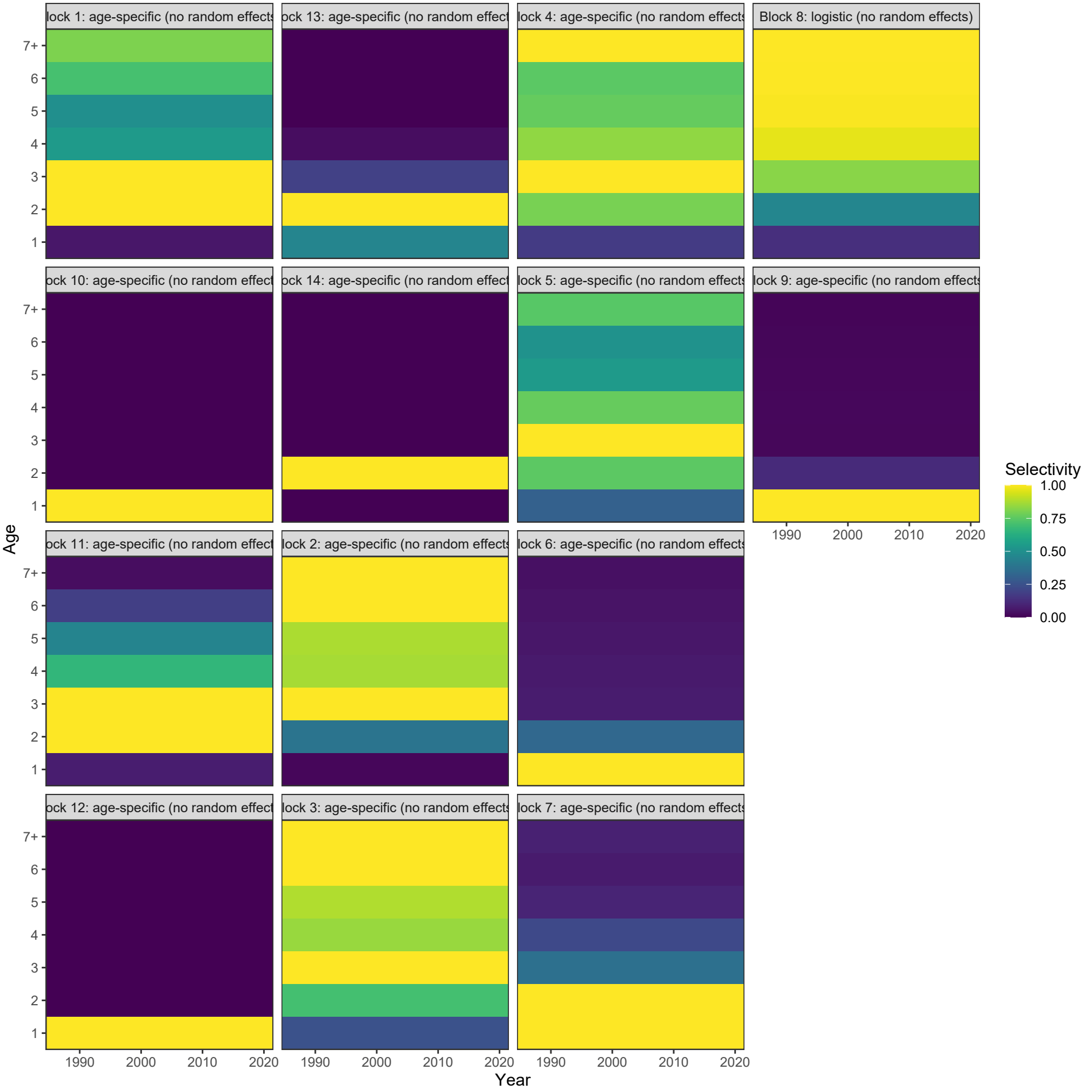

Age-1 Log-Recruits (10^6)
6.0
5.5
5.0
4.5
4.0
4.5
5.0
5.5
Log-SSB (kmt)
88
85
80
04
89
87
86
05
98
12
06
07
13
00
09
02
08
96
95
11
93
10
14
97
91
01
20
03
92
94
16
17
19
15
18

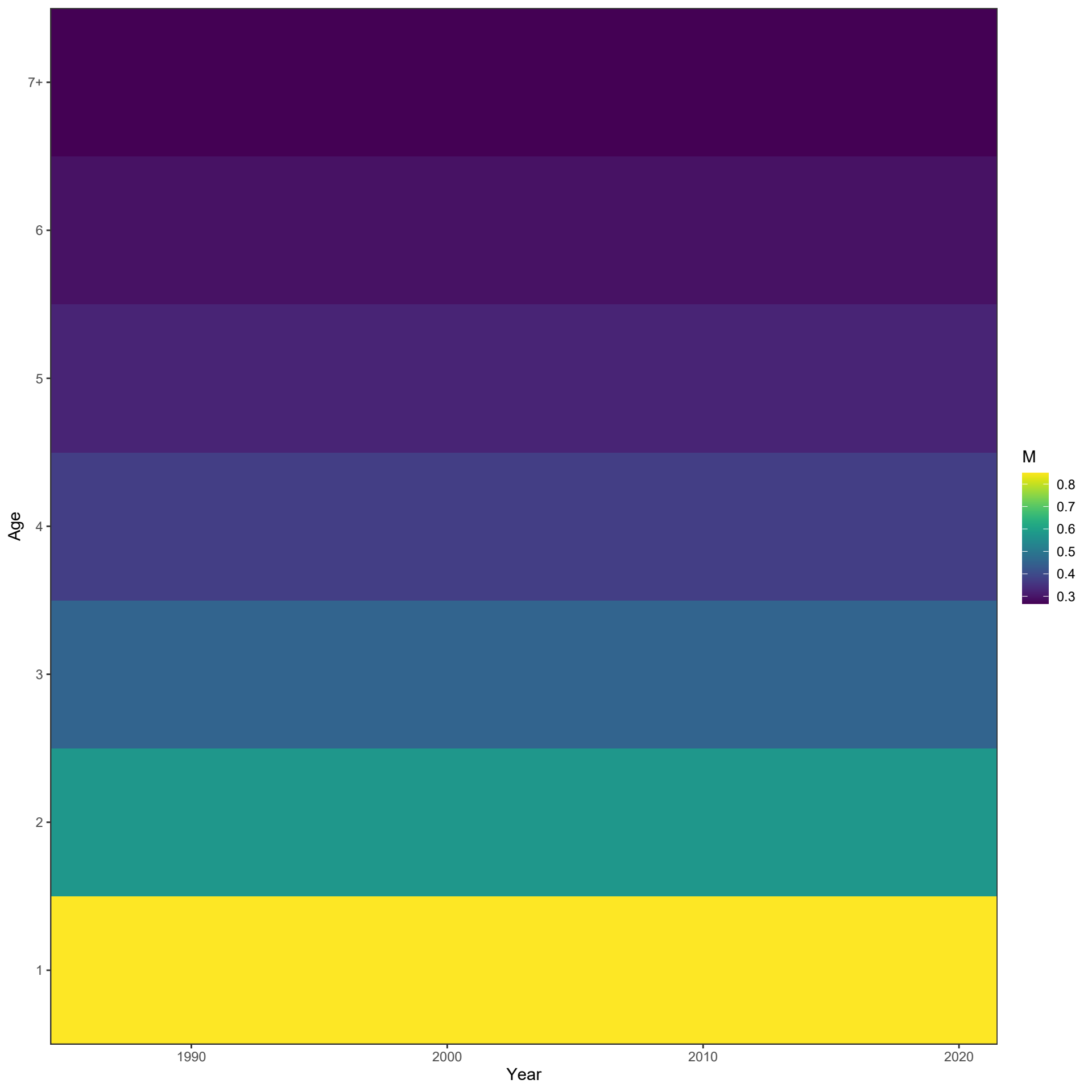

Age-1 Recruits (10^3)
0
1e+05
2e+05
3e+05
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
0
50000
1e+05
150000
SSB (mt)

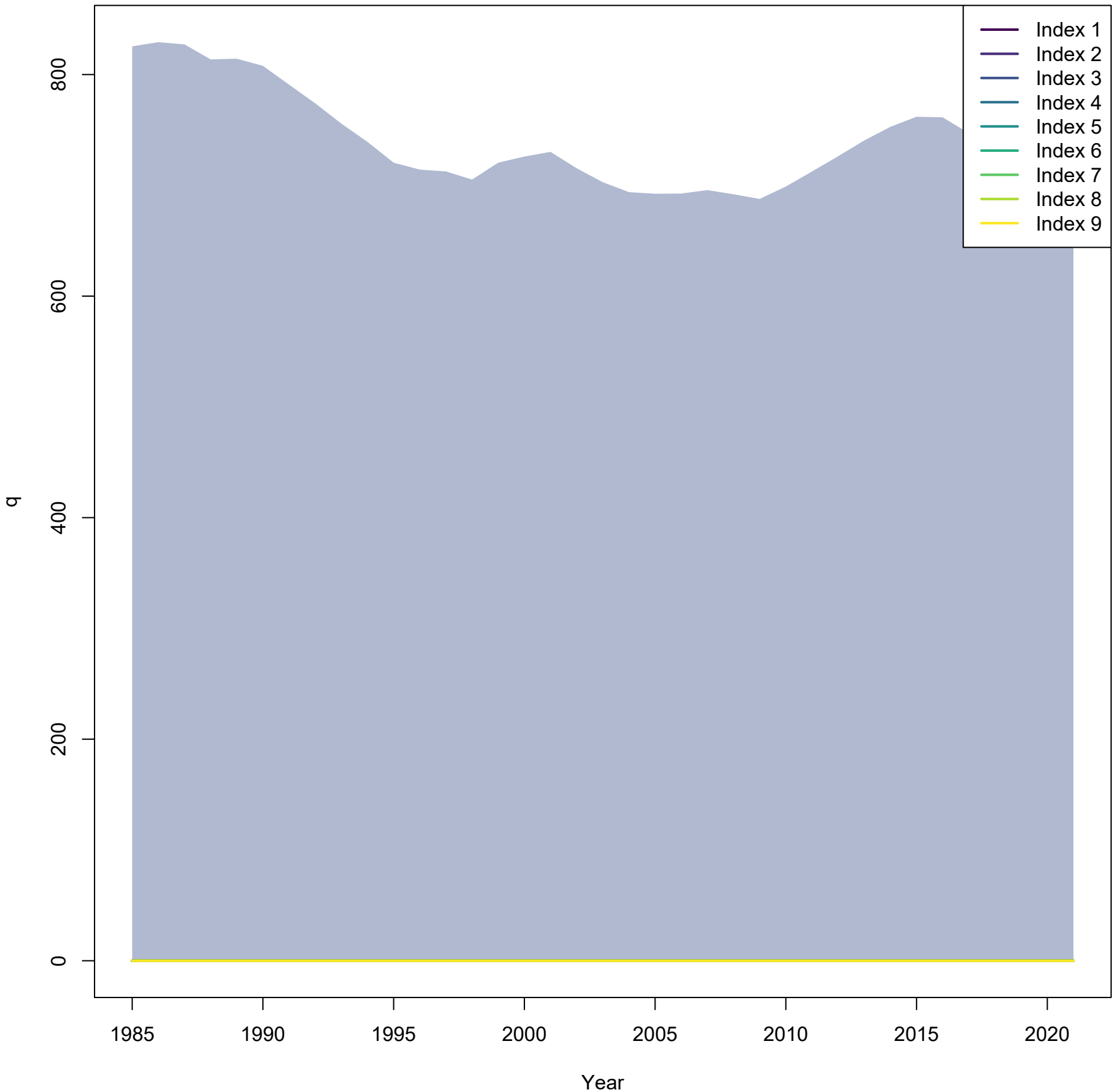

Recruits
SSB
Full F
CV
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1985
1990
1995
2000
2005
2010
2015
2020
Year

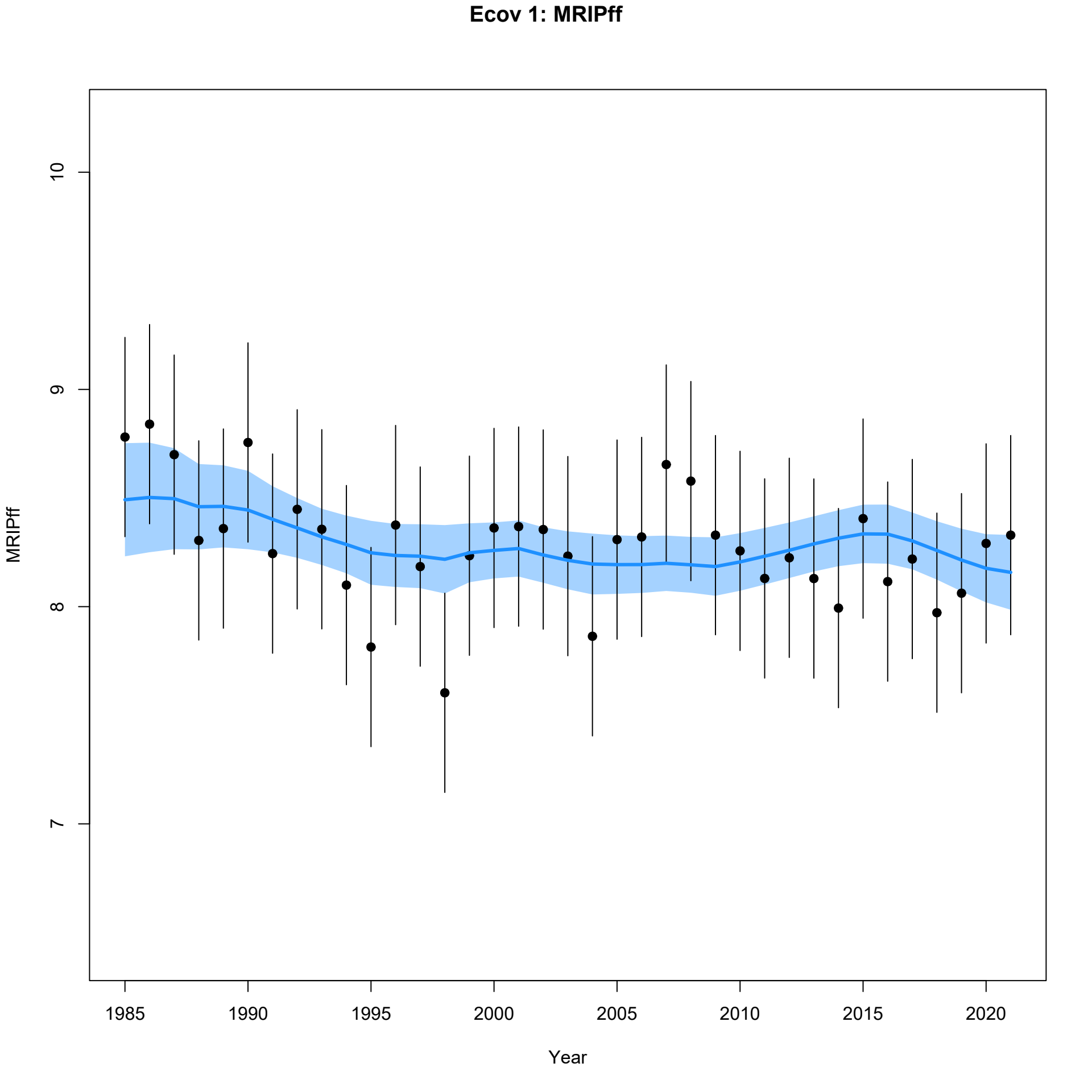

Fleet 1
Fleet 2
Full F
0.0
0.1
0.2
0.3
0.4
1985
1990
1995
2000
2005
2010
2015
2020
Year

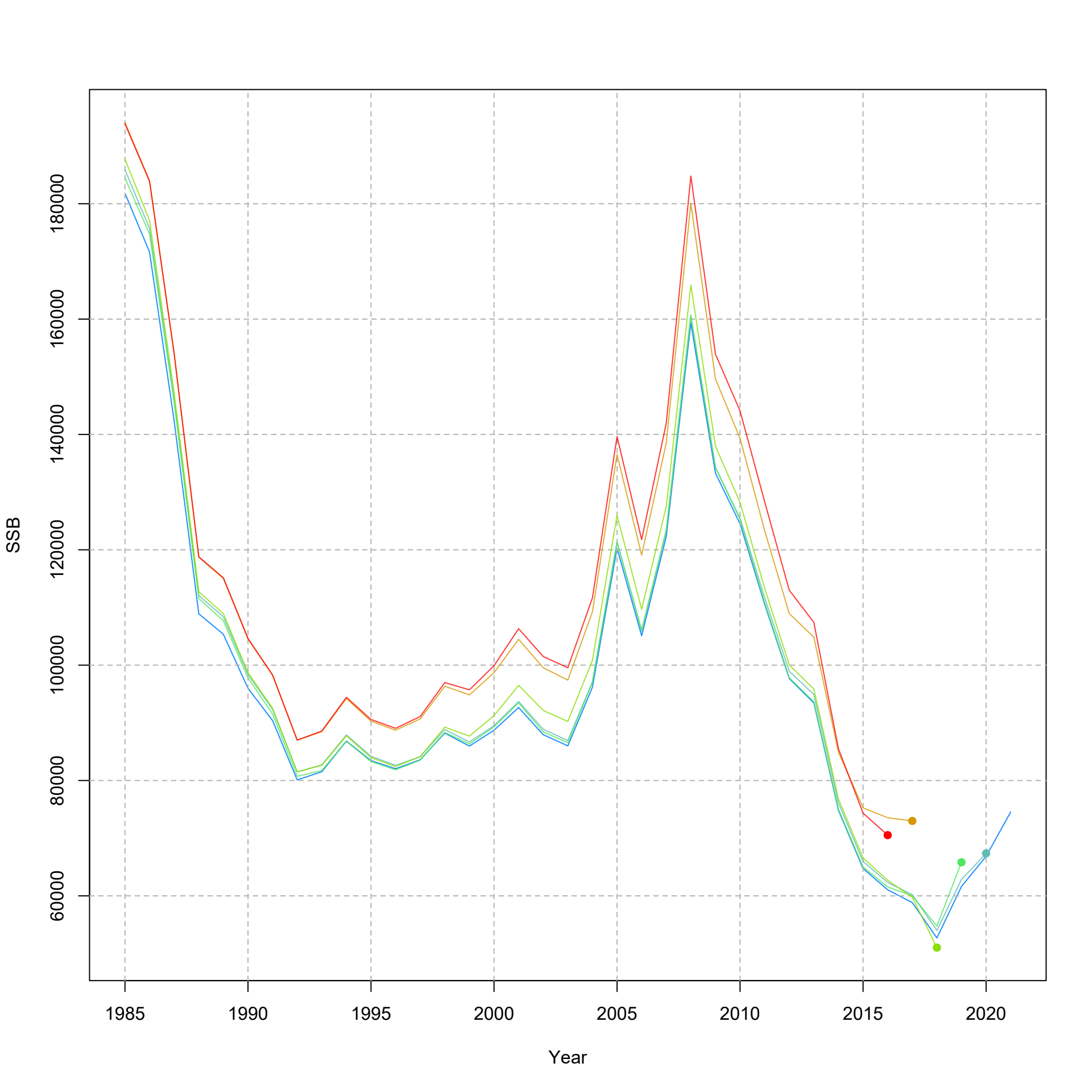

n = 37
n = 37
n = 37
n = 37
n = 37
n = 37
n = 37
0.0
0.2
0.4
0.6
0.8
Natural Mortality Rate
1
2
3
4
5
6
7+
Age

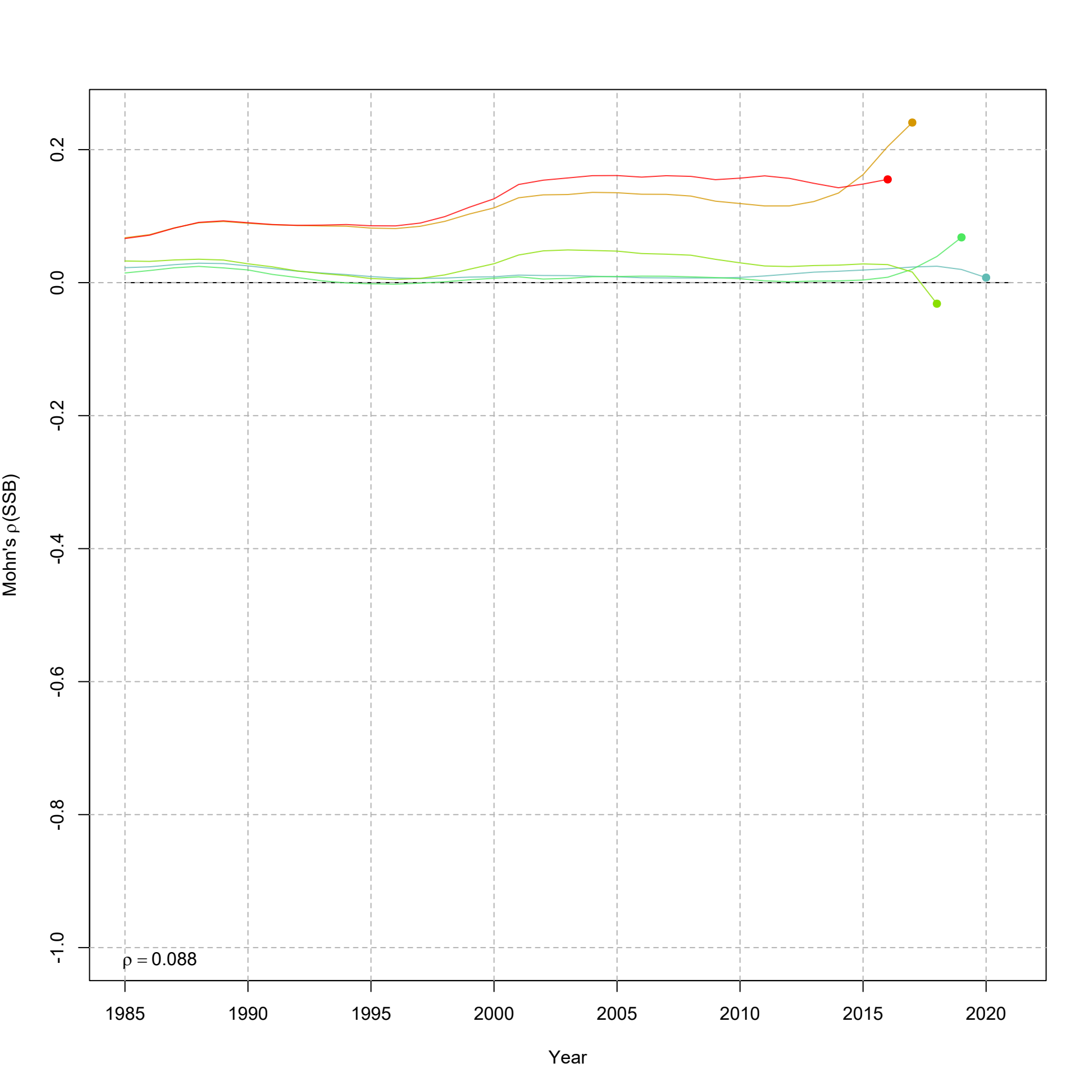

lock 1: age-specific (no random effects
ock 13: age-specific (no random effect
lock 4: age-specific (no random effects
Block 8: logistic (no random effects)
ock 10: age-specific (no random effect
ock 14: age-specific (no random effect
lock 5: age-specific (no random effects
lock 9: age-specific (no random effects
ock 11: age-specific (no random effect
lock 2: age-specific (no random effects
lock 6: age-specific (no random effects
ock 12: age-specific (no random effect
lock 3: age-specific (no random effects
lock 7: age-specific (no random effects
Age
7+
6
5
4
3
2
1
1990
2000
2010
2020
Year
Selectivity
1.00
0.75
0.50
0.25
0.00

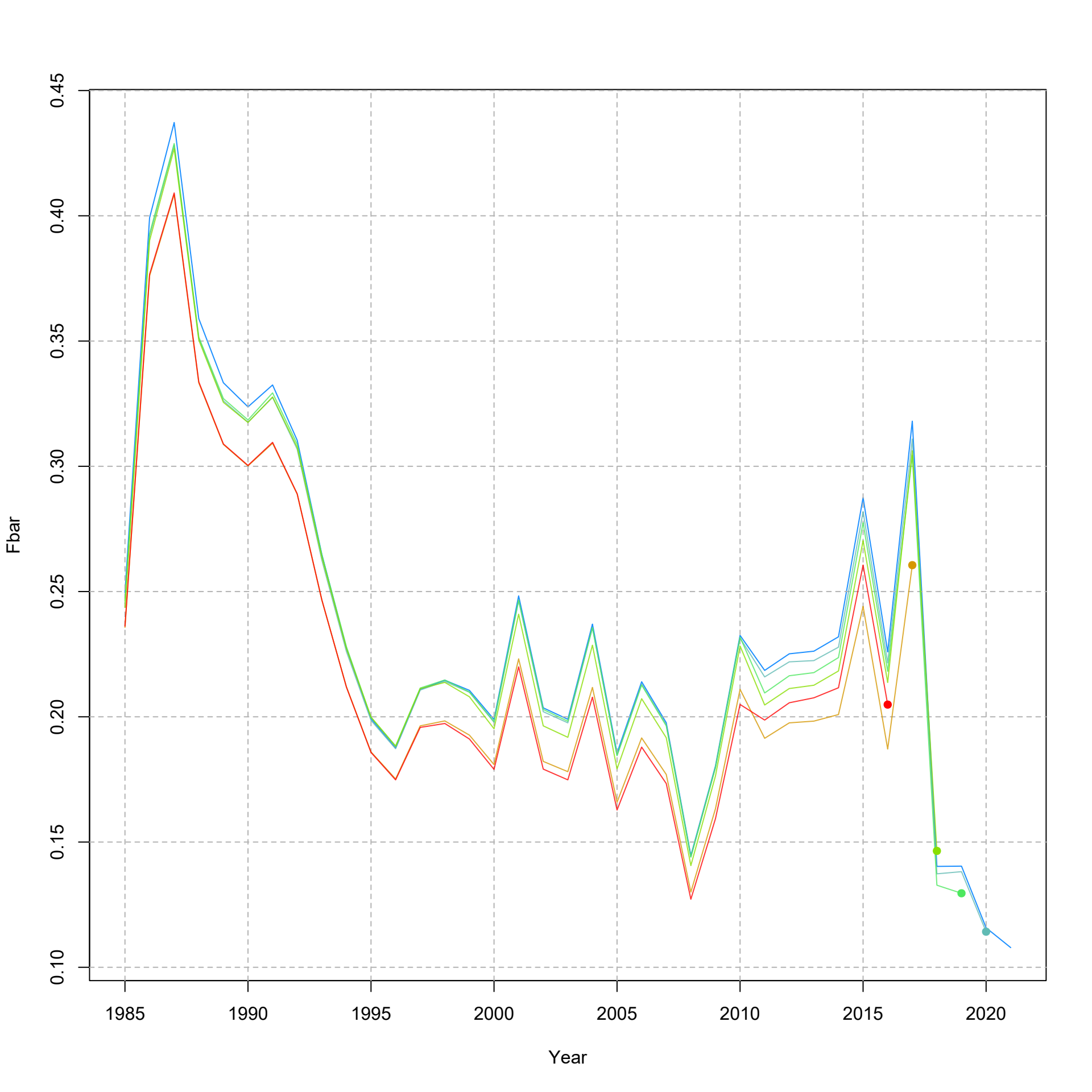

7+
6
5
4
3
2
1
Age
1990
2000
2010
2020
Year
M
0.8
0.7
0.6
0.5
0.4
0.3

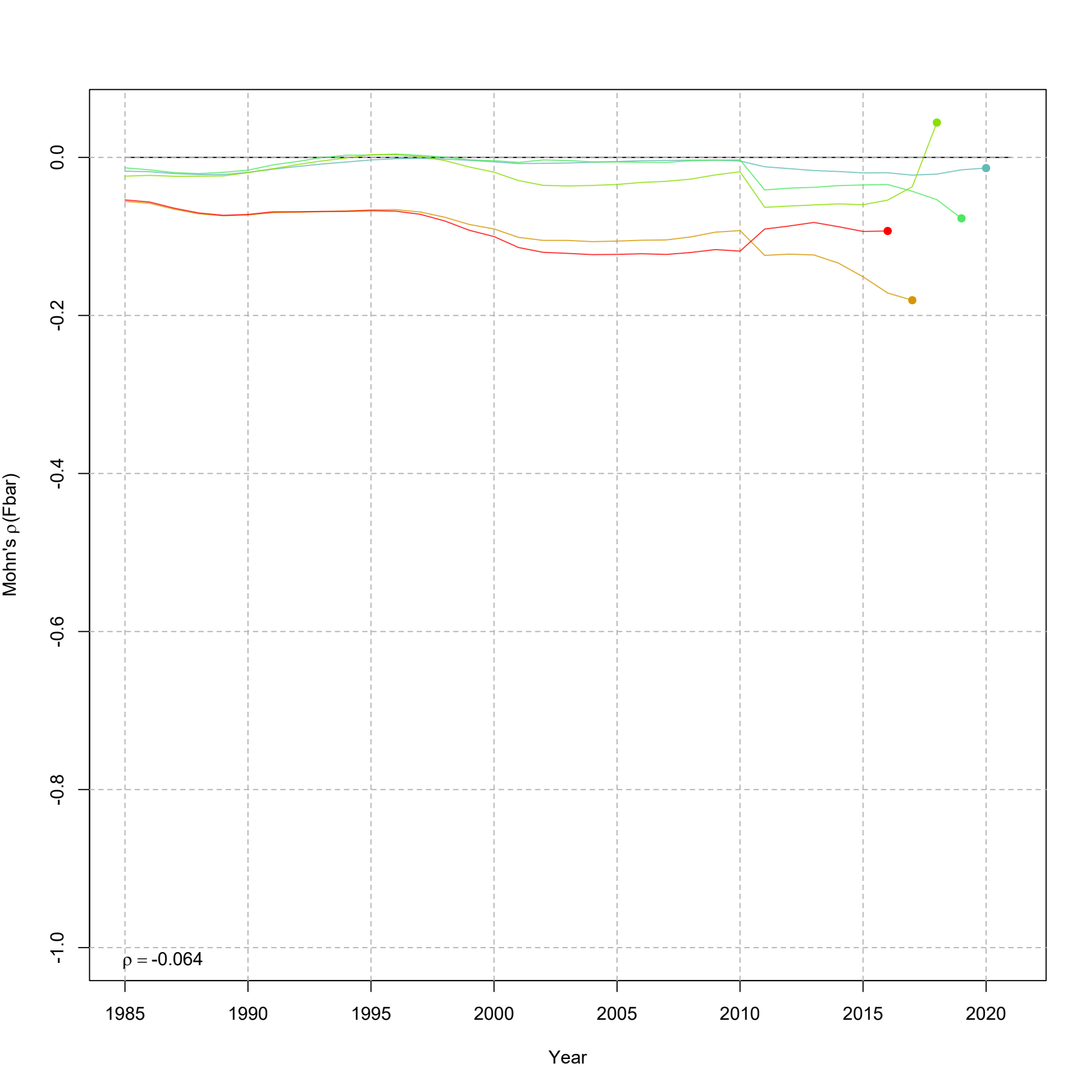

Index 1
Index 2
Index 3
Index 4
Index 5
Index 6
Index 7
Index 8
Index 9
q
0
200
400
600
800
1985
1990
1995
2000
2005
2010
2015
2020
Year

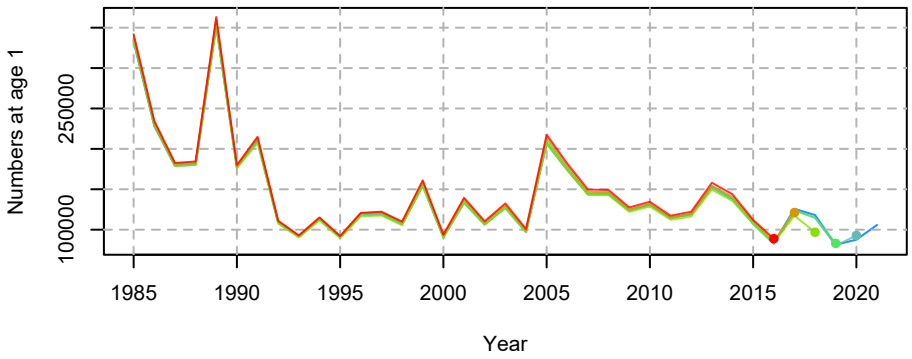

Ecov 1: MRIPff
MRIPff
10
9
8
7
1985
1990
1995
2000
2005
2010
2015
2020
Year

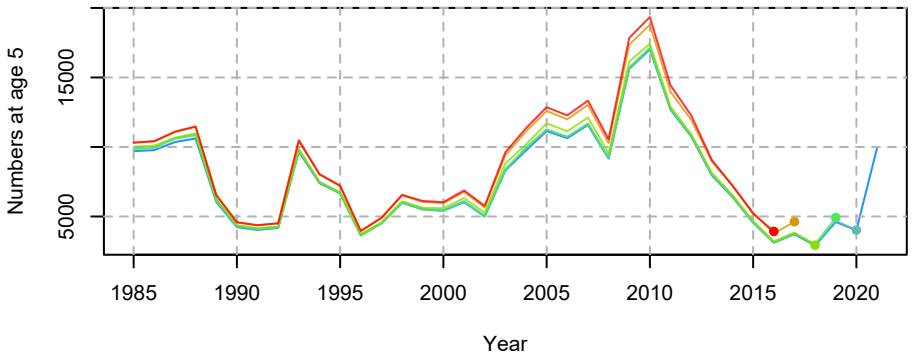

SSB
60000
80000
100000
120000
140000
160000
180000
1985
1990
1995
2000
2005
2010
2015
2020
Year

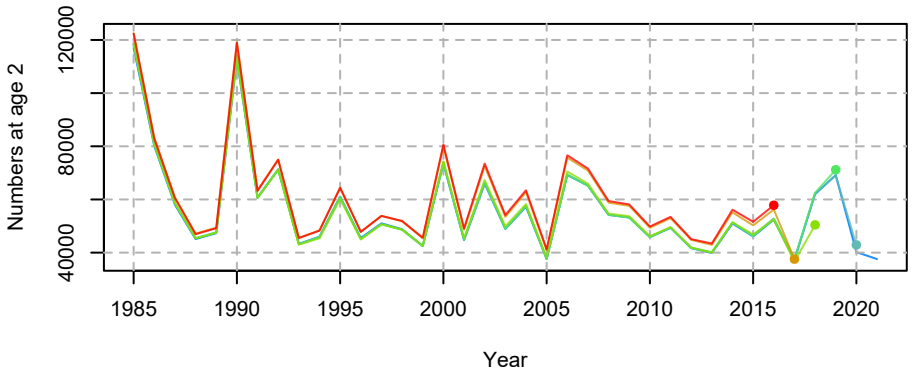

0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Mohn's ρ(SSB)
ρ = 0.088
1985
1990
1995
2000
2005
2010
2015
2020
Year

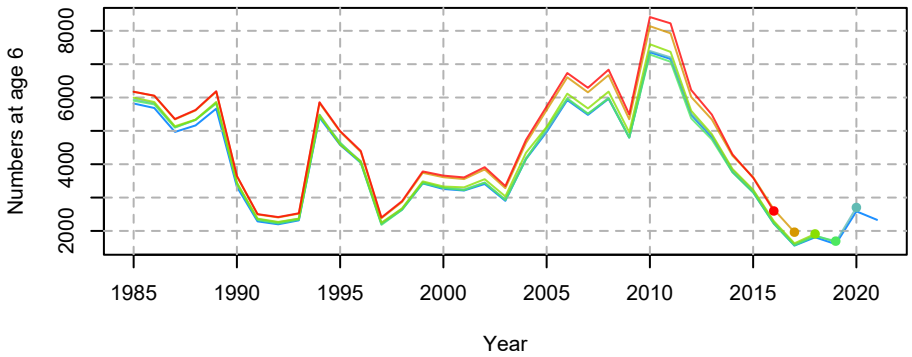

0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
Fbar
1985
1990
1995
2000
2005
2010
2015
2020
Year

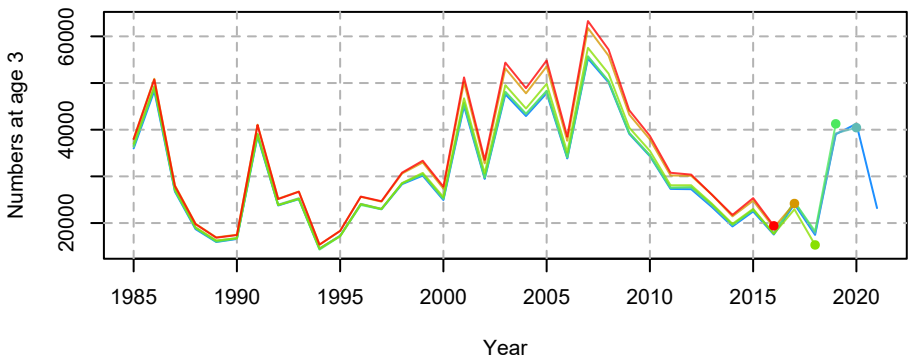

0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Mohn's ρ(Fbar)
ρ = -0.064
1985
1990
1995
2000
2005
2010
2015
2020
Year

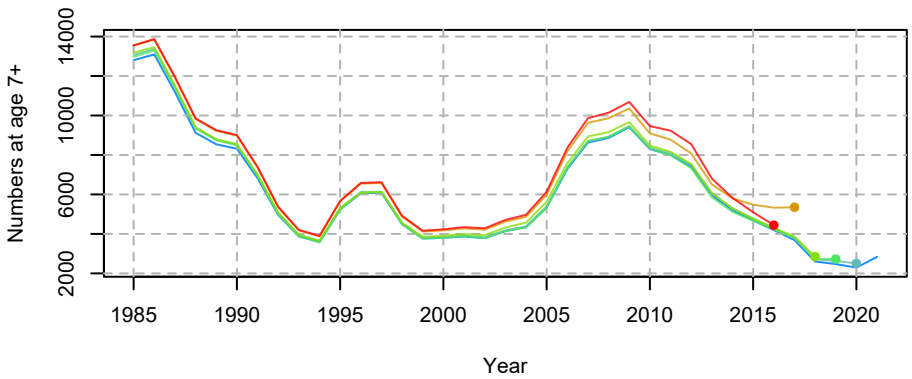

Numbers at age 1
100000
250000
1985
1990
1995
2000
2005
2010
2015
2020
Year

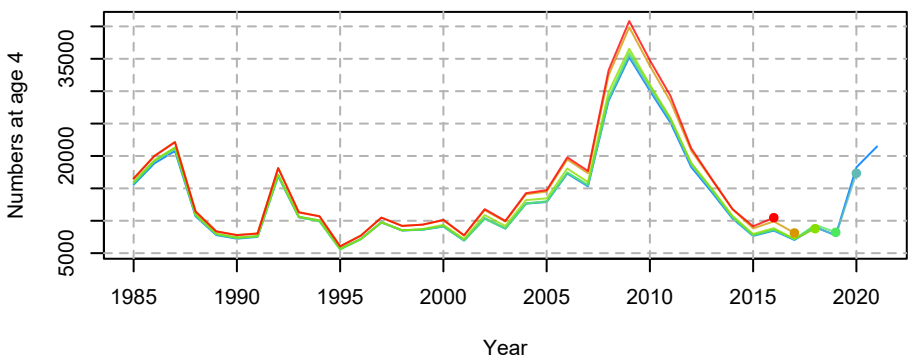

Numbers at age 5
5000
15000
1985
1990
1995
2000
2005
2010
2015
2020
Year

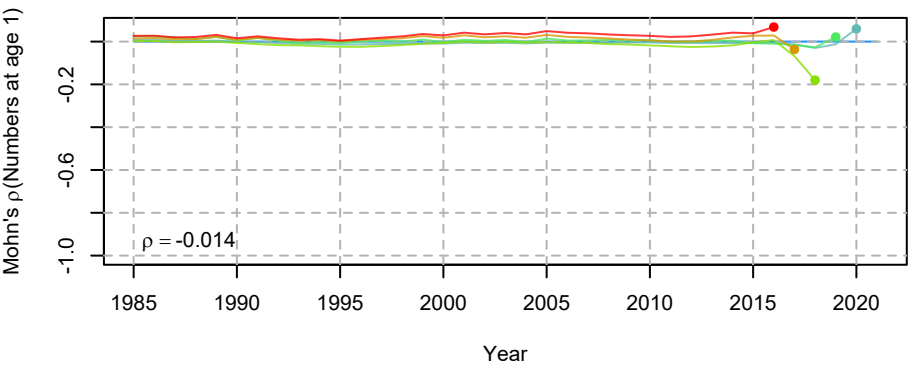

Numbers at age 2
40000
80000
120000
1985
1990
1995
2000
2005
2010
2015
2020
Year

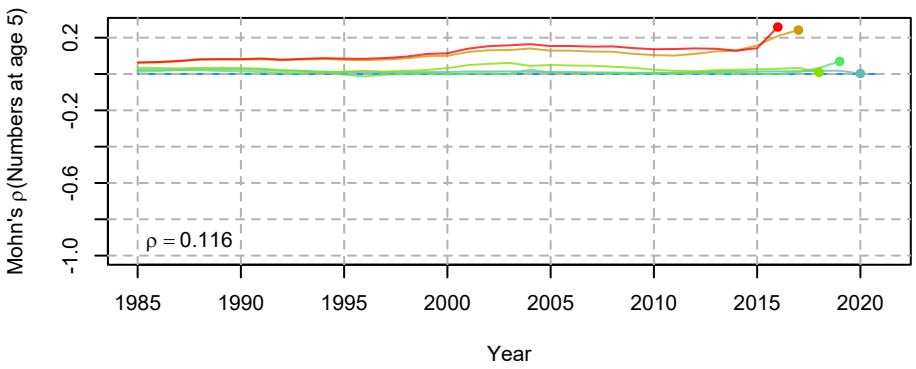

Numbers at age 6
2000
4000
6000
8000
1985
1990
1995
2000
2005
2010
2015
2020
Year

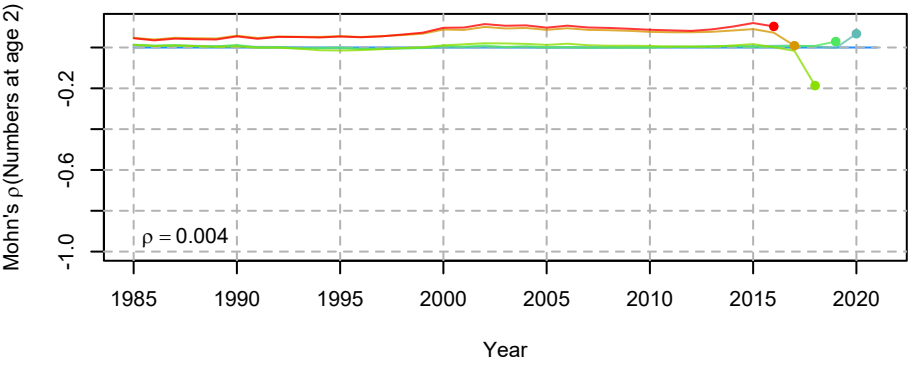

Numbers at age 3
20000
40000
60000
1985
1990
1995
2000
2005
2010
2015
2020
Year

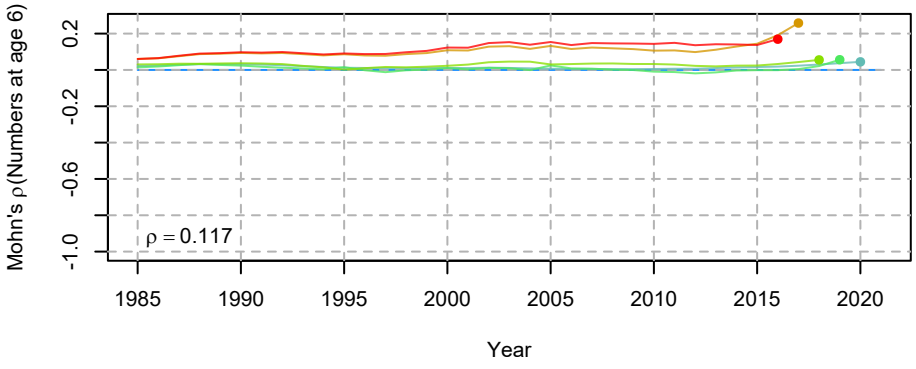

Numbers at age 7+
2000
6000
10000
14000
1985
1990
1995
2000
2005
2010
2015
2020
Year

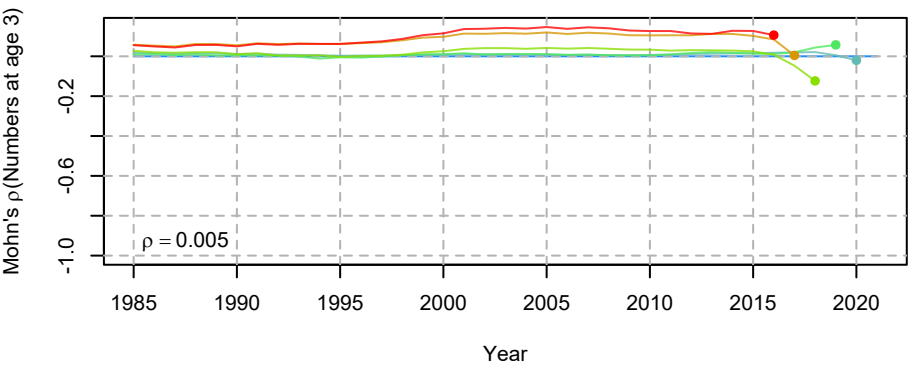

Numbers at age 4
5000
20000
35000
1985
1990
1995
2000
2005
2010
2015
2020
Year

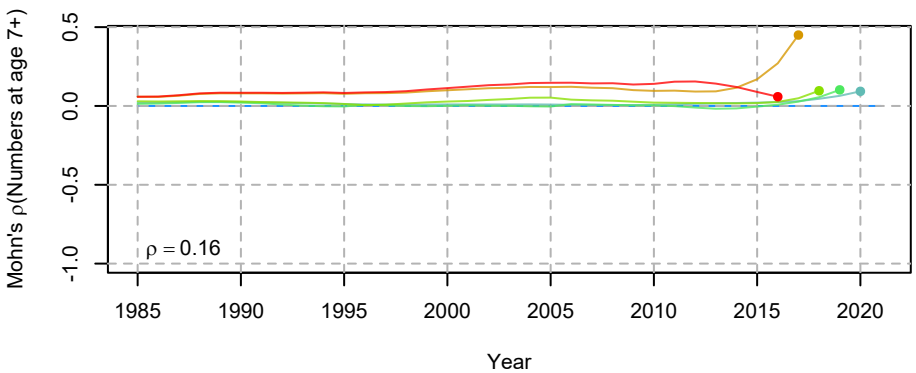

Mohn's ρ(Numbers at age 1)
-1.0
-0.6
-0.2
ρ = -0.014
1985
1990
1995
2000
2005
2010
2015
2020
Year

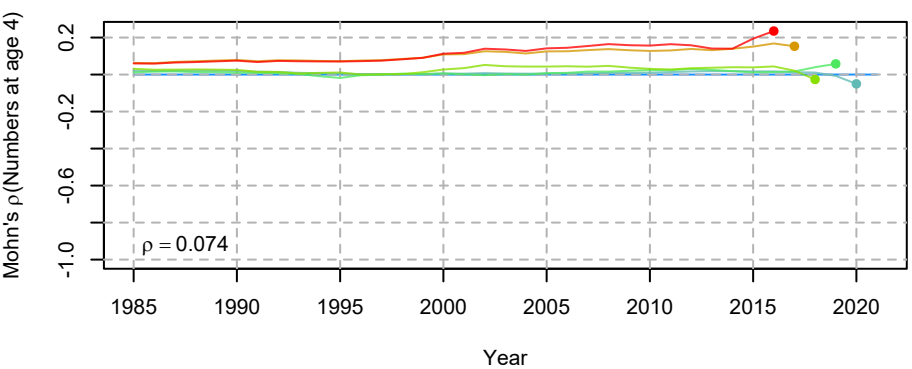

Mohn's ρ(Numbers at age 5)
-1.0
-0.6
-0.2
0.2
ρ = 0.116
1985
1990
1995
2000
2005
2010
2015
2020
Year

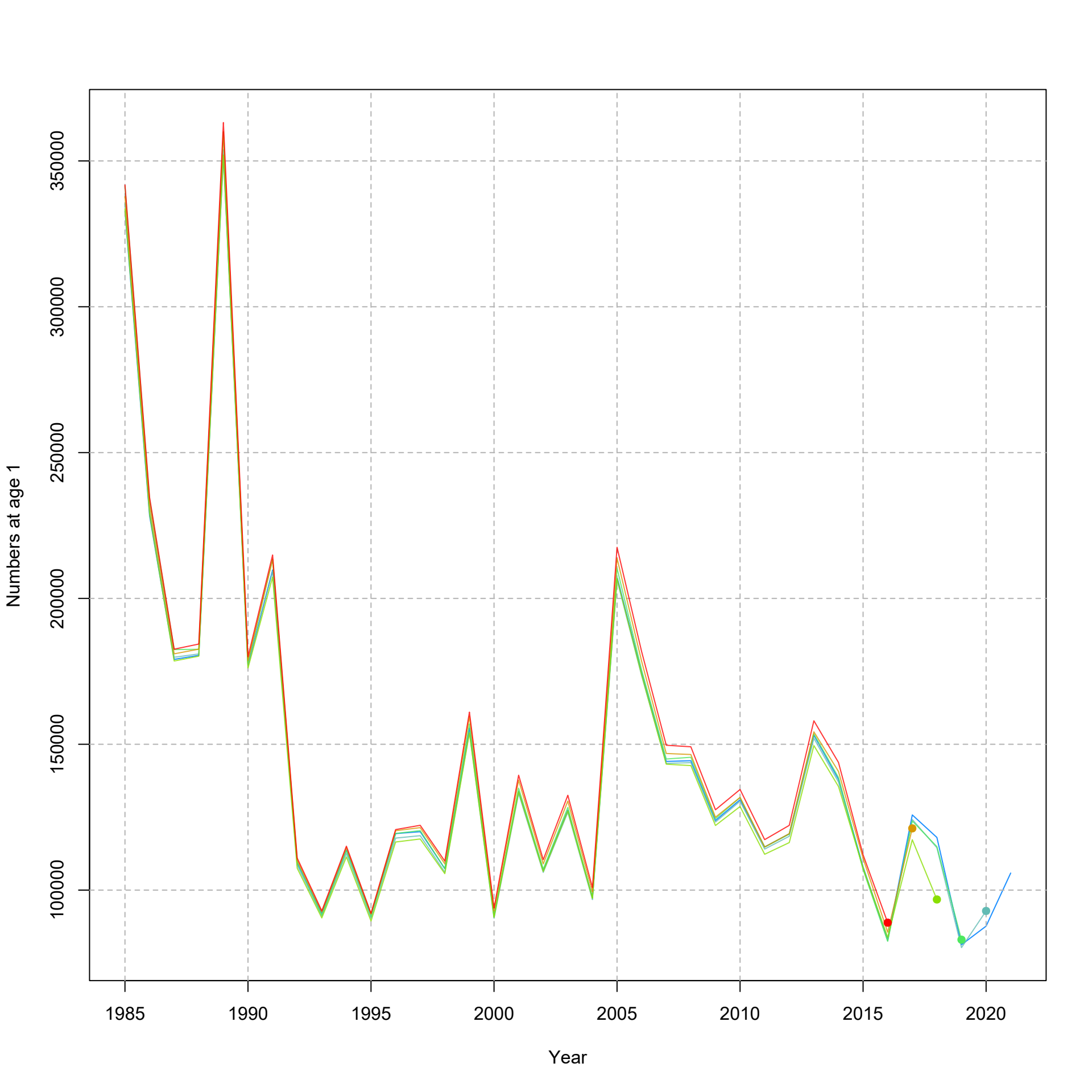

Mohn's ρ(Numbers at age 2)
-1.0
-0.6
-0.2
ρ = 0.004
1985
1990
1995
2000
2005
2010
2015
2020
Year

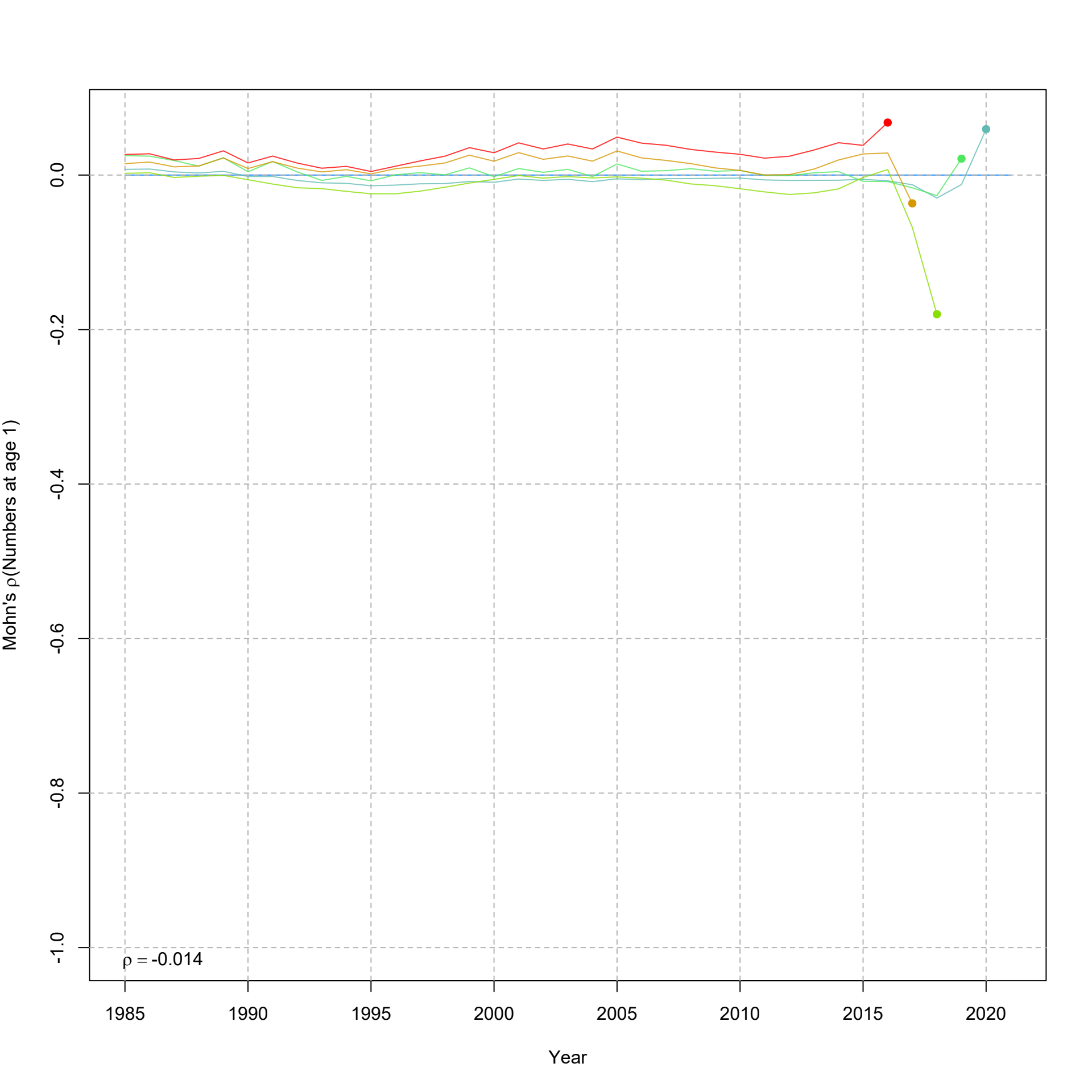

Mohn's ρ(Numbers at age 6)
-1.0
-0.6
-0.2
0.2
ρ = 0.117
1985
1990
1995
2000
2005
2010
2015
2020
Year


Mohn's ρ(Numbers at age 3)
-1.0
-0.6
-0.2
ρ = 0.005
1985
1990
1995
2000
2005
2010
2015
2020
Year


Mohn's ρ(Numbers at age 7+)
-1.0
-0.5
0.0
0.5
ρ = 0.16
1985
1990
1995
2000
2005
2010
2015
2020
Year


Mohn's ρ(Numbers at age 4)
-1.0
-0.6
-0.2
0.2
ρ = 0.074
1985
1990
1995
2000
2005
2010
2015
2020
Year

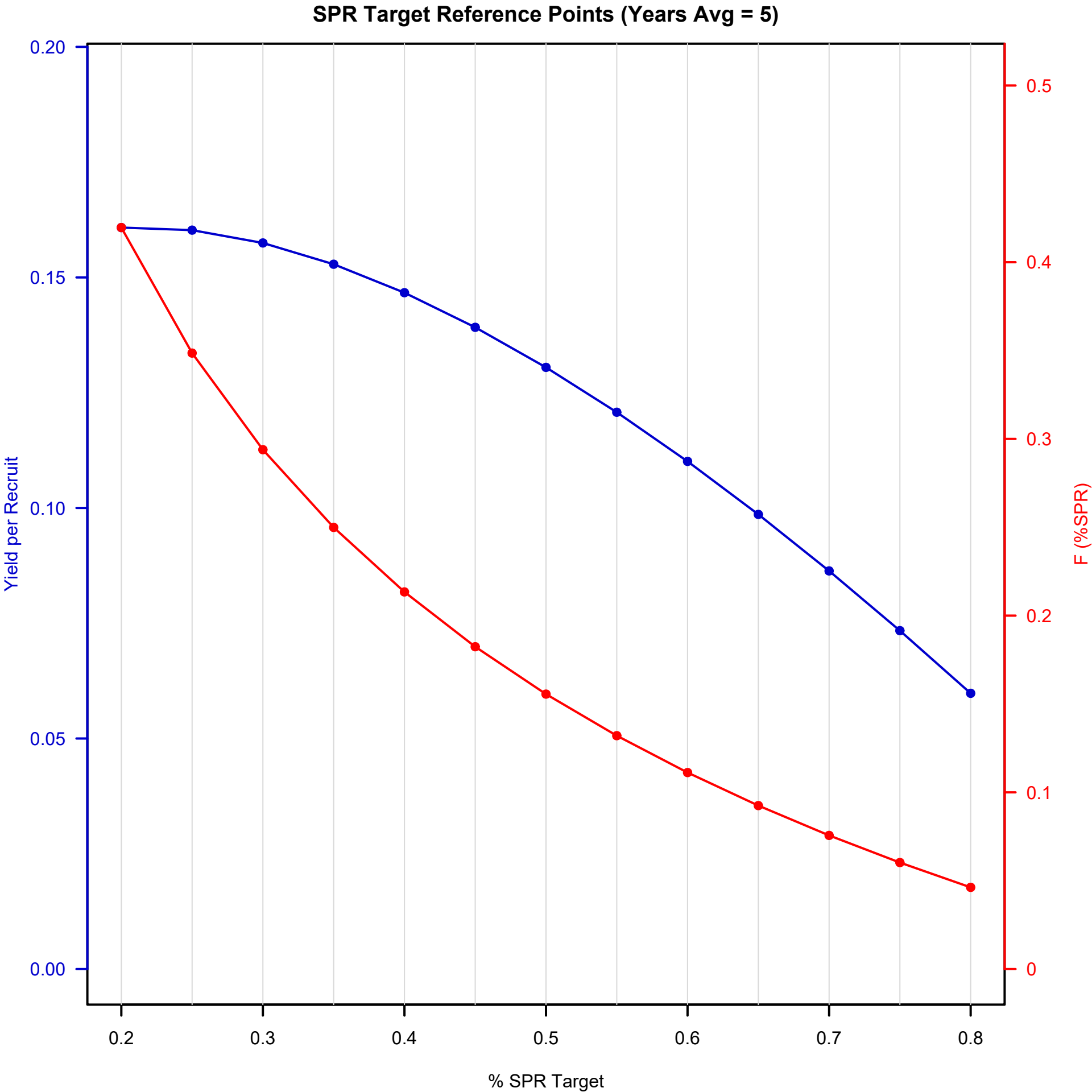

Numbers at age 1
100000
150000
200000
250000
300000
350000
1985
1990
1995
2000
2005
2010
2015
2020
Year


Mohn's ρ(Numbers at age 1)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
ρ = -0.014
1985
1990
1995
2000
2005
2010
2015
2020
Year

BF28W_M7ECOV

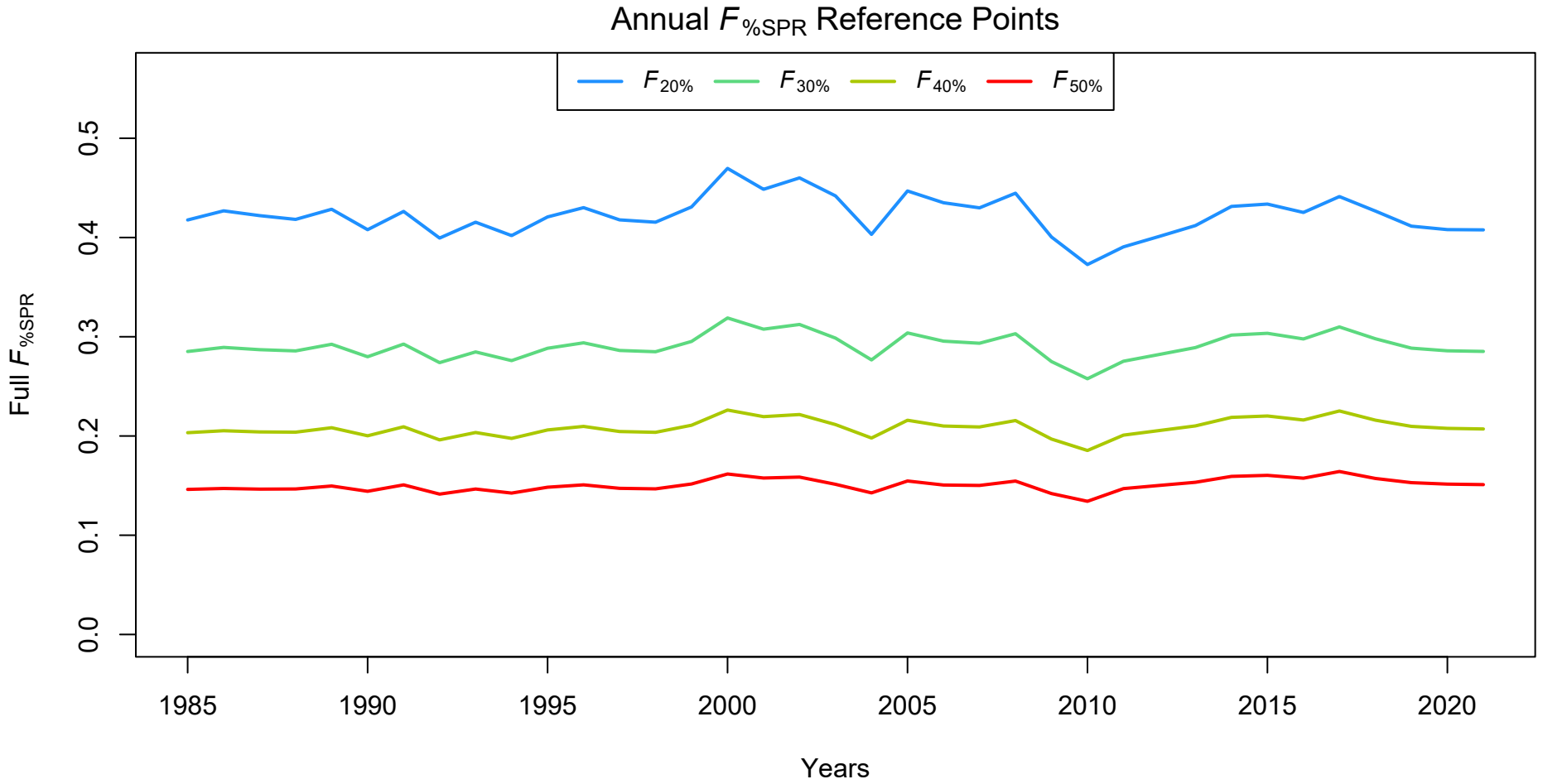
MRIP Forage Fish Index as an environmental covariate on catchability

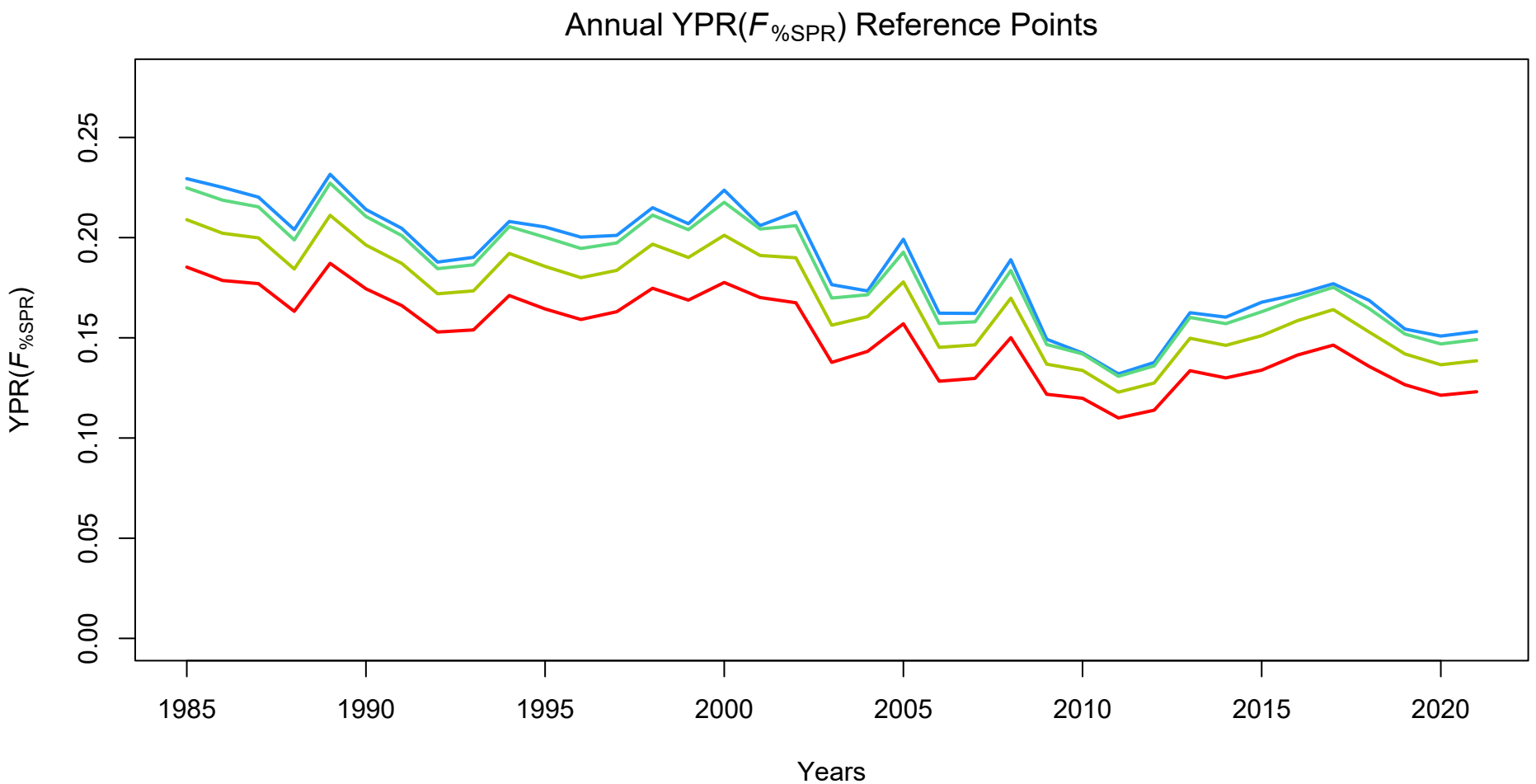
REFERENCE POINT PLOTS

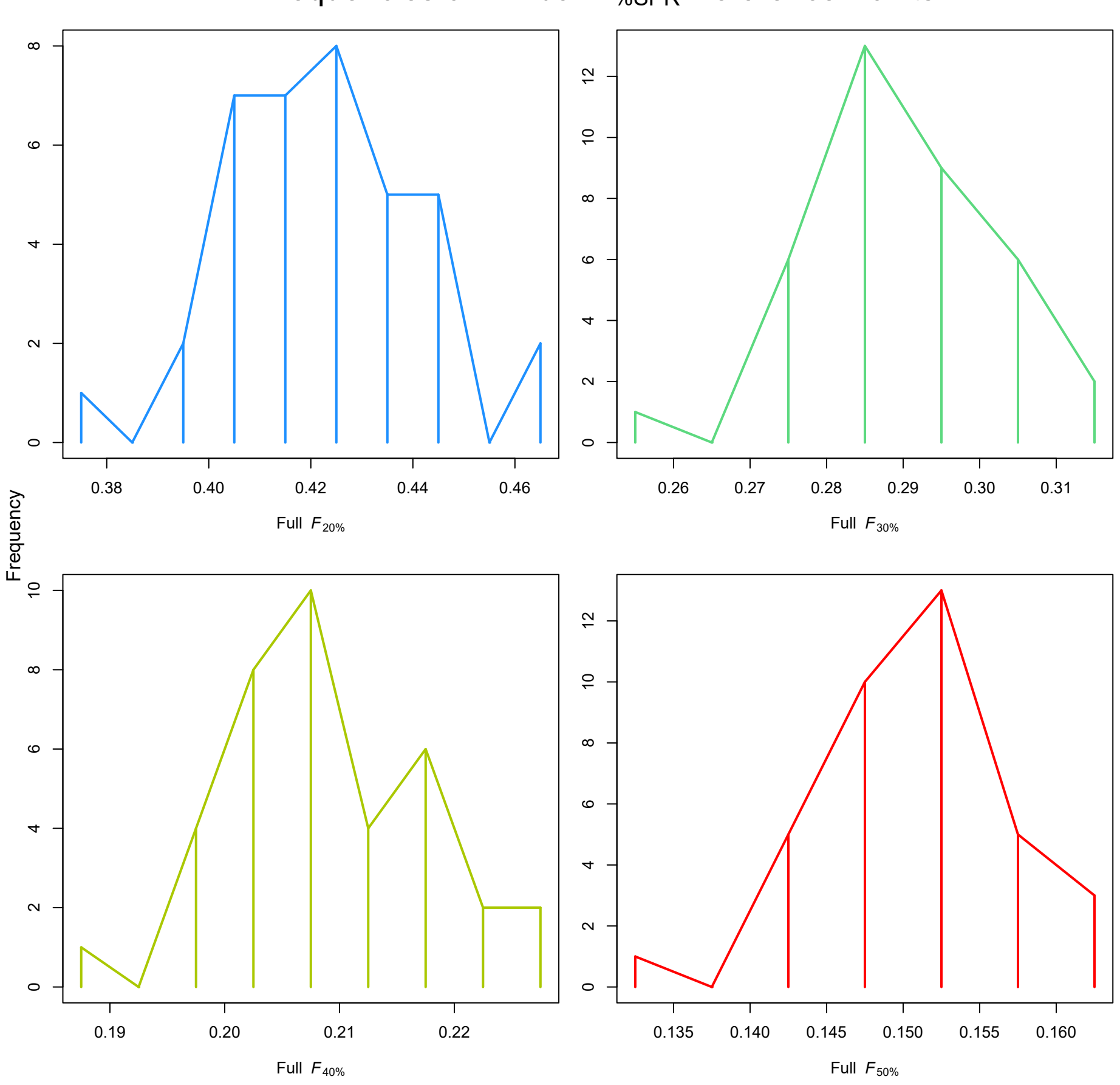

SPR Target Reference Points (Years Avg = 5)
Yield per Recruit
F (%SPR)
% SPR Target
0.20
0.15
0.10
0.05
0.00
0.5
0.4
0.3
0.2
0.1
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8

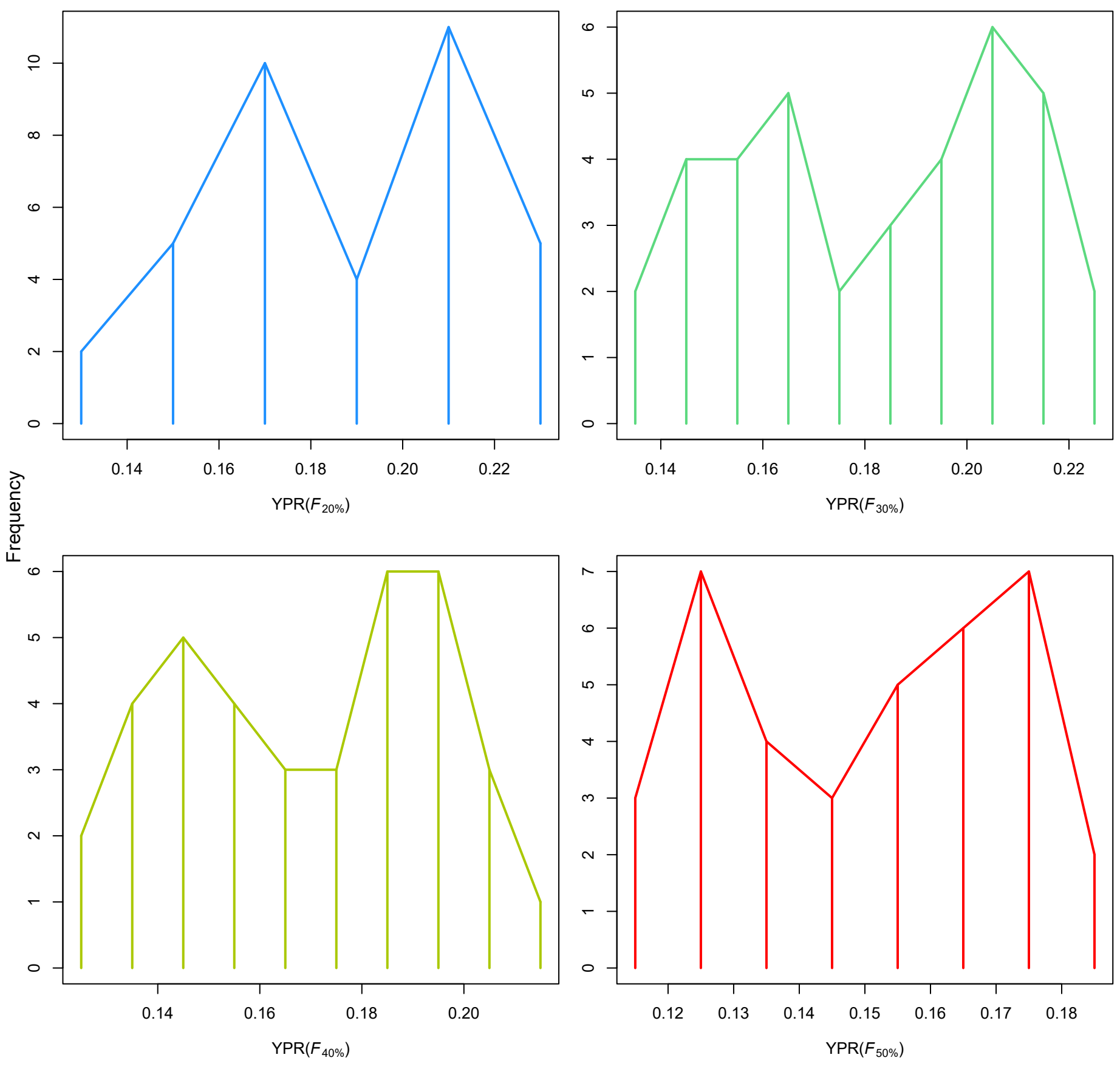
SPR Target Reference Points (Years Avg = 5)

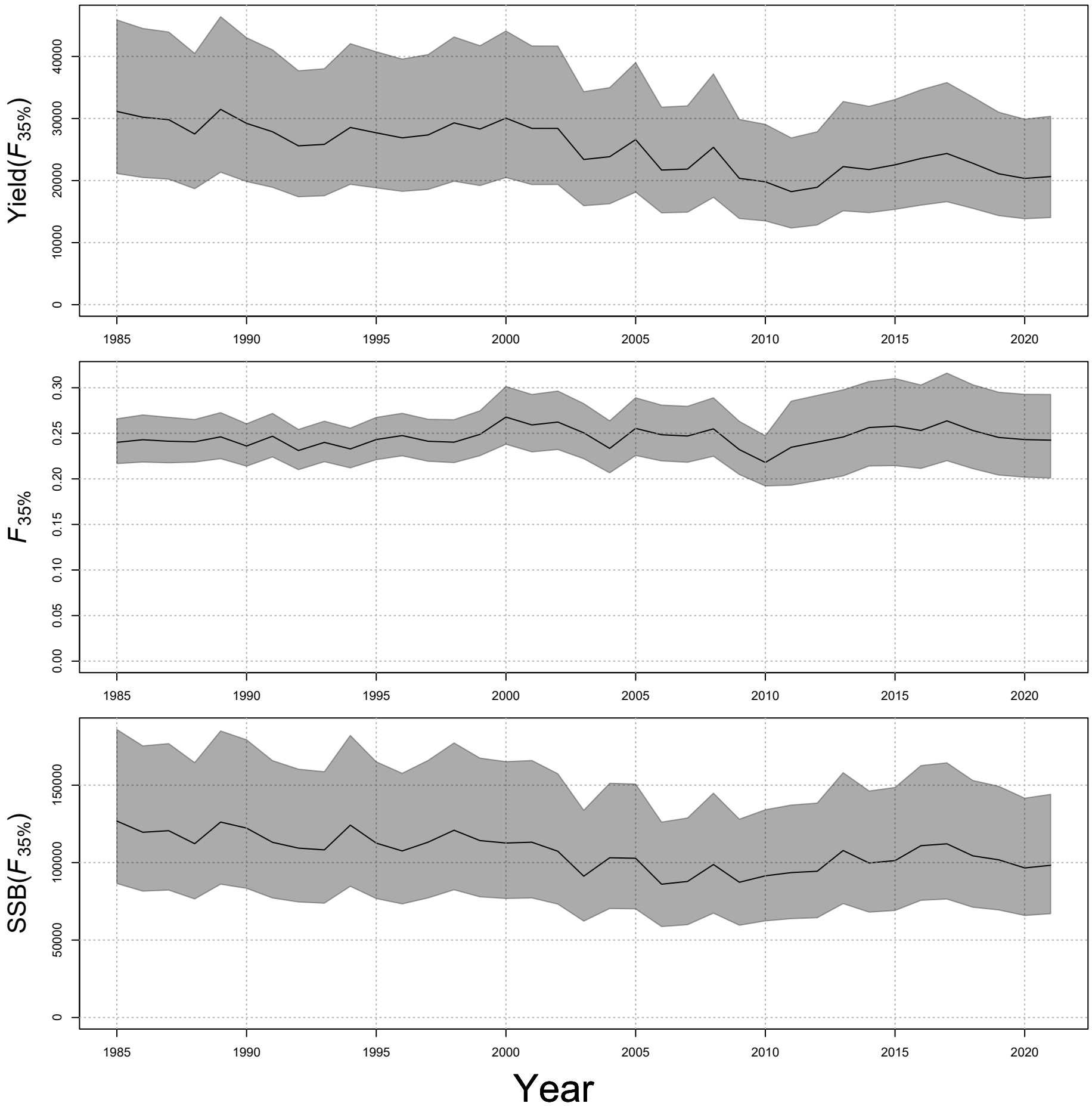
% SPR	F(%SPR)	YPR
0.2	0.4196	0.1608
0.25	0.3486	0.1603
0.3	0.2939	0.1575
0.35	0.2499	0.1529
0.4	0.2134	0.1467
0.45	0.1824	0.1392
0.5	0.1556	0.1305
0.55	0.1321	0.1208
0.6	0.1112	0.1101
0.65	0.0925	0.0986
0.7	0.0756	0.0863
0.75	0.0603	0.0734
0.8	0.0462	0.0598

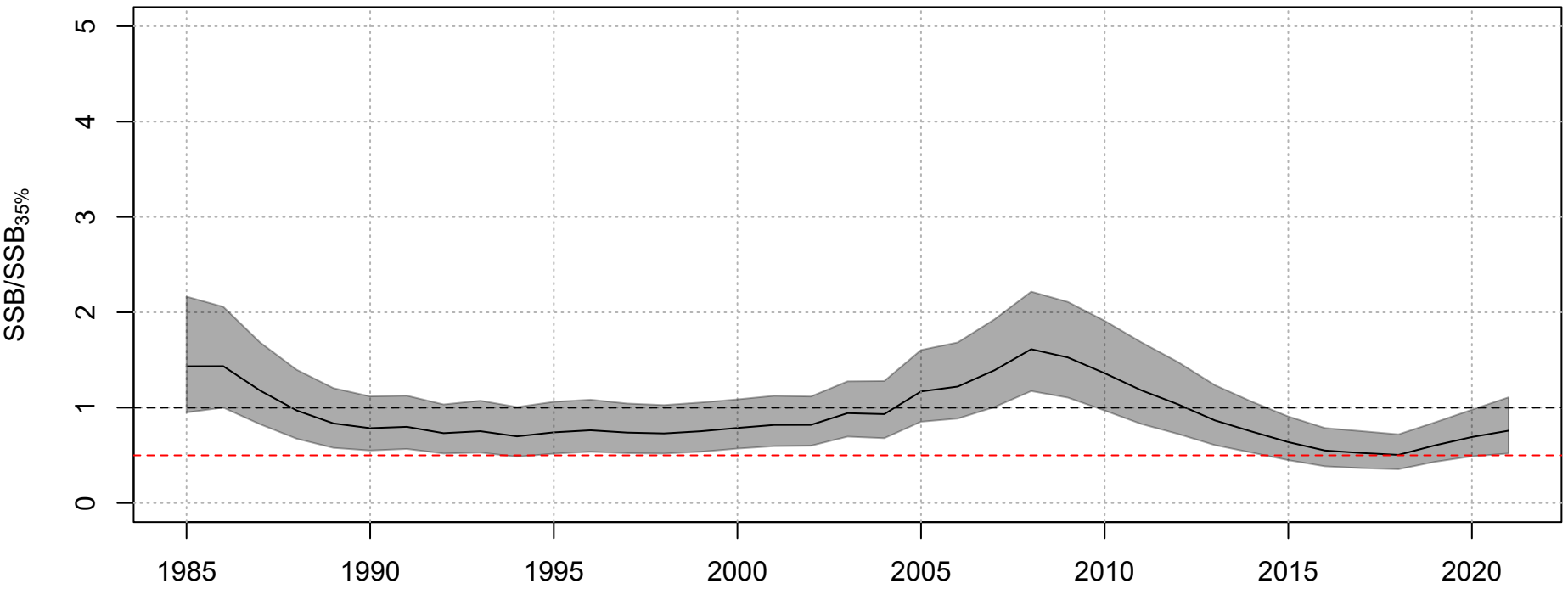

Annual $F_{\%SPR}$ Reference Points
$F_{20\%}$
$F_{30\%}$
$F_{40\%}$
$F_{50\%}$
Full $F_{\%SPR}$
0.0
0.1
0.2
0.3
0.4
0.5
1985
1990
1995
2000
2005
2010
2015
2020
Years

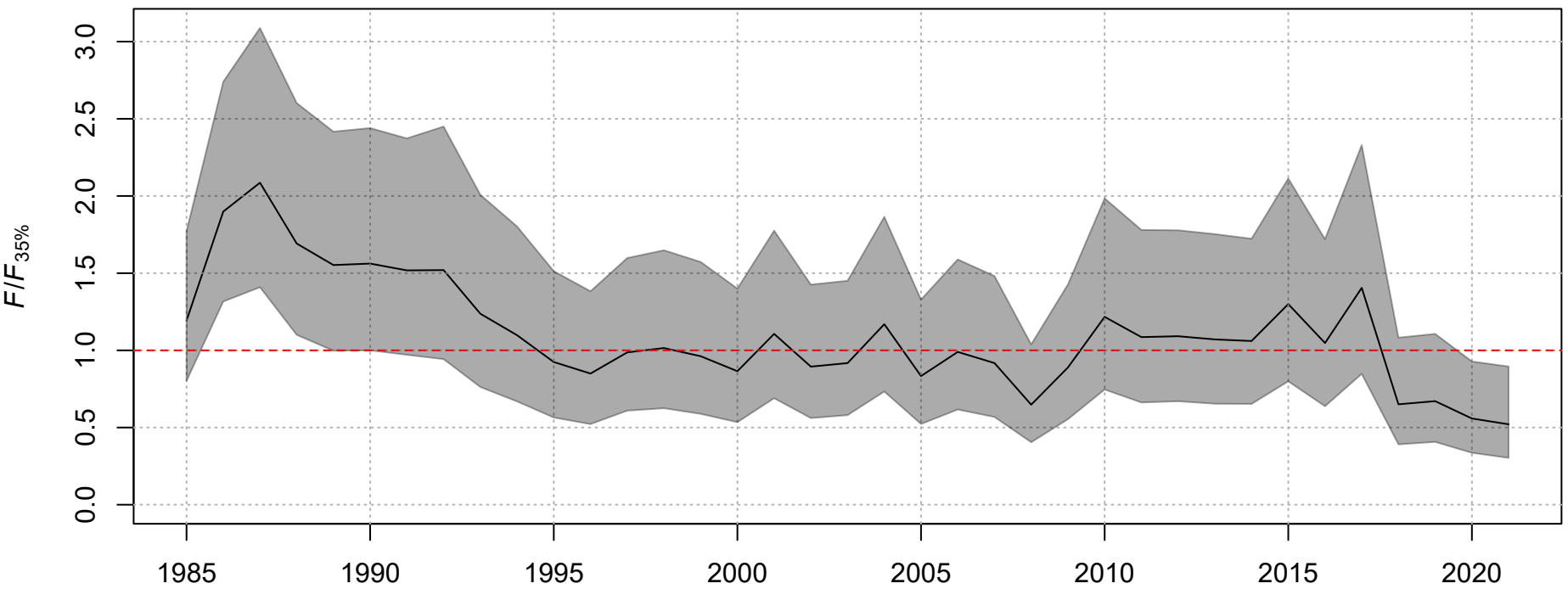

Annual YPR($F_{\%SPR}$) Reference Points
YPR($F_{\%SPR}$)
0.00
0.05
0.10
0.15
0.20
0.25
1985
1990
1995
2000
2005
2010
2015
2020
Years

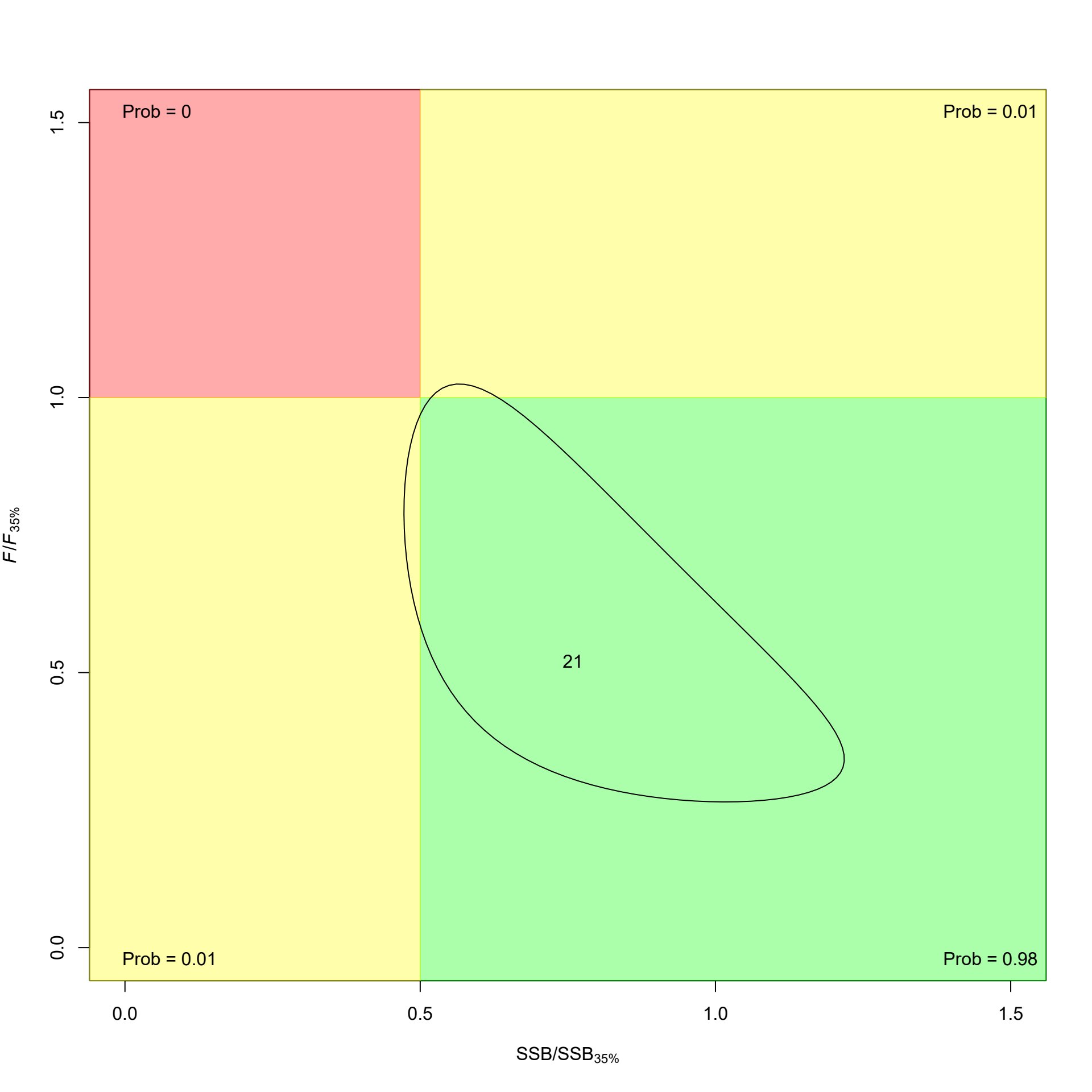

Frequencies of Annual $F_{\%SPR}$ Reference Points
Frequency
Full $F_{20\%}$
Full $F_{30\%}$
Full $F_{40\%}$
Full $F_{50\%}$

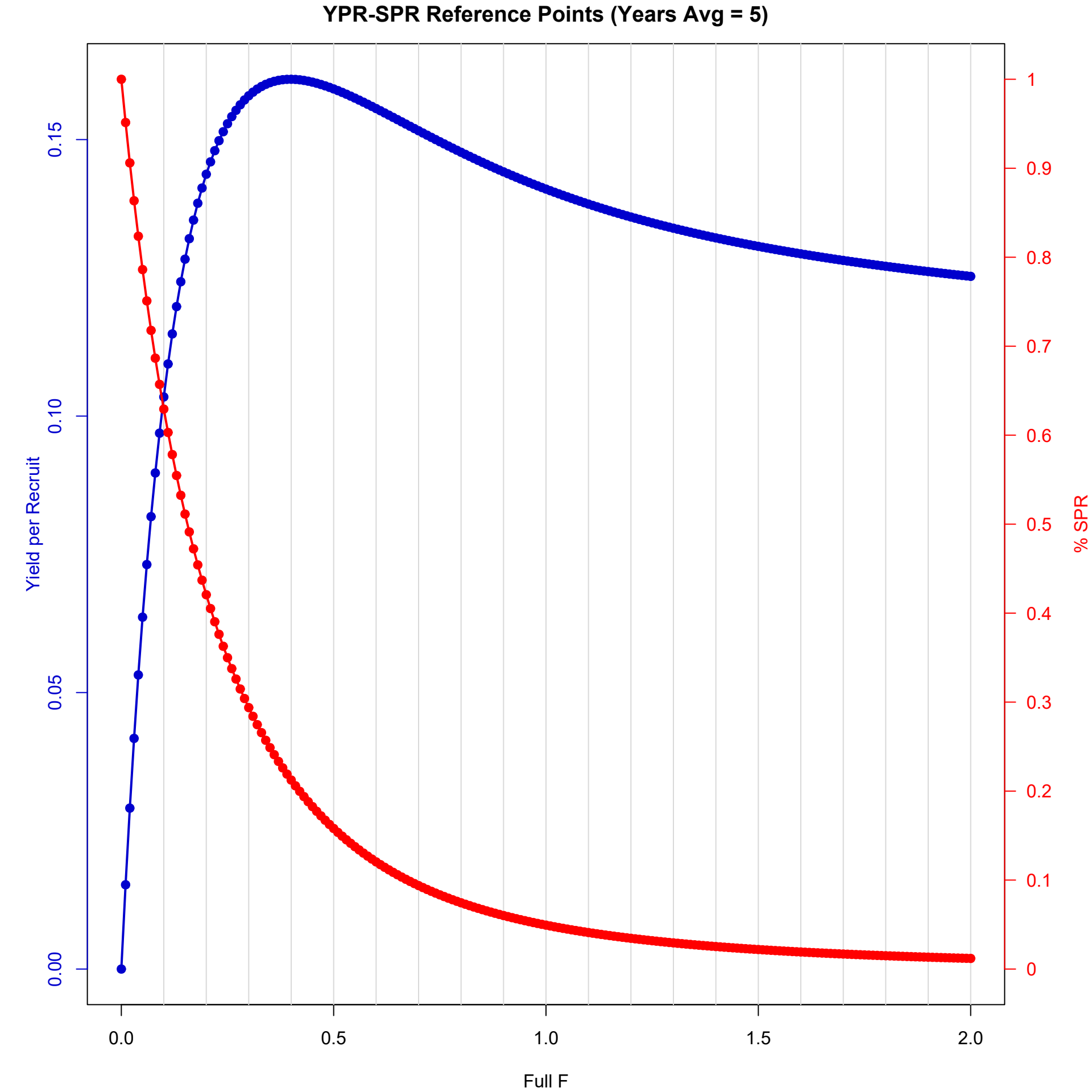

Frequencies of Annual YPR($F_{\%SPR}$) Reference Points
Frequency
YPR($F_{20\%}$)
YPR($F_{30\%}$)
YPR($F_{40\%}$)
YPR($F_{50\%}$)


Yield($F_{35\%}$)
0
10000
20000
30000
40000
1985
1990
1995
2000
2005
2010
2015
2020
$F_{35\%}$
0.00
0.05
0.10
0.15
0.20
0.25
0.30
SSB($F_{35\%}$)
50000
100000
150000
Year


SSB/SSB35%
0
1
2
3
4
5
1985
1990
1995
2000
2005
2010
2015
2020


F/F35%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1985
1990
1995
2000
2005
2010
2015
2020


Prob = 0
Prob = 0.01
Prob = 0.01
Prob = 0.98
21
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
F/F35%
SSB/SSB35%


YPR-SPR Reference Points (Years Avg = 5)
Yield per Recruit
% SPR
Full F
0.00
0.05
0.10
0.15
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.0
0.5
1.0
1.5
2.0

YPR-SPR Reference Points (Years Avg = 5)

F	YPR	SPR	F	YPR	SPR	F	YPR	SPR
0	0	1	0.35	0.1603	0.2488	0.7	0.1516	0.0938
0.01	0.0152	0.9514	0.36	0.1605	0.2409	0.71	0.1512	0.0916
0.02	0.0291	0.906	0.37	0.1607	0.2334	0.72	0.1508	0.0894
0.03	0.0417	0.8635	0.38	0.1608	0.2261	0.73	0.1504	0.0874
0.04	0.0532	0.8236	0.39	0.1609	0.2191	0.74	0.15	0.0853
0.05	0.0636	0.7861	0.4	0.1609	0.2124	0.75	0.1496	0.0834
0.06	0.0732	0.7509	0.41	0.1609	0.206	0.76	0.1492	0.0815
0.07	0.0818	0.7178	0.42	0.1608	0.1998	0.77	0.1488	0.0797
0.08	0.0897	0.6866	0.43	0.1607	0.1938	0.78	0.1485	0.0779
0.09	0.0969	0.6571	0.44	0.1606	0.1881	0.79	0.1481	0.0762
0.1	0.1035	0.6293	0.45	0.1604	0.1826	0.8	0.1477	0.0745
0.11	0.1094	0.603	0.46	0.1602	0.1773	0.81	0.1473	0.0728
0.12	0.1149	0.5782	0.47	0.16	0.1722	0.82	0.147	0.0713
0.13	0.1198	0.5547	0.48	0.1597	0.1673	0.83	0.1466	0.0697
0.14	0.1243	0.5324	0.49	0.1594	0.1625	0.84	0.1462	0.0682
0.15	0.1284	0.5113	0.5	0.1592	0.158	0.85	0.1459	0.0668
0.16	0.1321	0.4913	0.51	0.1589	0.1536	0.86	0.1455	0.0654
0.17	0.1354	0.4723	0.52	0.1585	0.1494	0.87	0.1452	0.064
0.18	0.1385	0.4542	0.53	0.1582	0.1453	0.88	0.1448	0.0627
0.19	0.1412	0.437	0.54	0.1579	0.1413	0.89	0.1445	0.0614
0.2	0.1437	0.4207	0.55	0.1575	0.1375	0.9	0.1442	0.0602
0.21	0.146	0.4051	0.56	0.1571	0.1339	0.91	0.1438	0.0589
0.22	0.148	0.3903	0.57	0.1568	0.1303	0.92	0.1435	0.0577
0.23	0.1498	0.3762	0.58	0.1564	0.1269	0.93	0.1432	0.0566
0.24	0.1514	0.3627	0.59	0.156	0.1236	0.94	0.1429	0.0555
0.25	0.1529	0.3499	0.6	0.1556	0.1204	0.95	0.1426	0.0544
0.26	0.1542	0.3376	0.61	0.1552	0.1173	0.96	0.1422	0.0533
0.27	0.1553	0.3259	0.62	0.1548	0.1144	0.97	0.1419	0.0523
0.28	0.1563	0.3147	0.63	0.1544	0.1115	0.98	0.1416	0.0513
0.29	0.1572	0.3041	0.64	0.154	0.1087	0.99	0.1413	0.0503
0.3	0.1579	0.2938	0.65	0.1536	0.106	1	0.141	0.0493
0.31	0.1586	0.284	0.66	0.1532	0.1034	1.01	0.1408	0.0484
0.32	0.1591	0.2747	0.67	0.1528	0.1009	1.02	0.1405	0.0475
0.33	0.1596	0.2657	0.68	0.1524	0.0984	1.03	0.1402	0.0466
0.34	0.16	0.2571	0.69	0.152	0.0961	1.04	0.1399	0.0458