NOAA FISHERIES

Southeast Fisheries Science Center

Gulf Menhaden Assessment

November 6-7, 2018

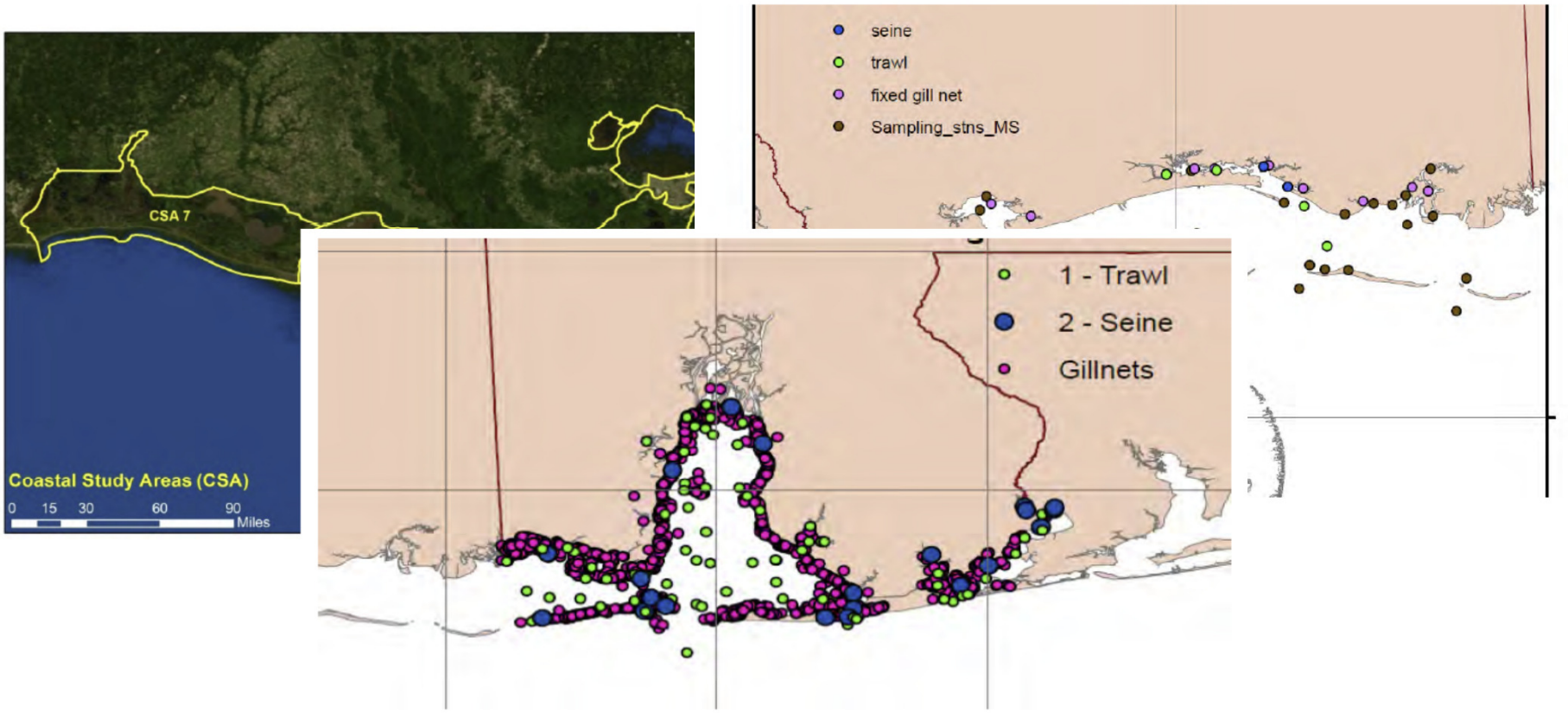
Review Workshop

Outline

- Data included (indices, then base run)
- Base run configuration
- Sensitivity analyses
- Monte Carlo bootstrap
- Projections
- Benchmarks

Indices

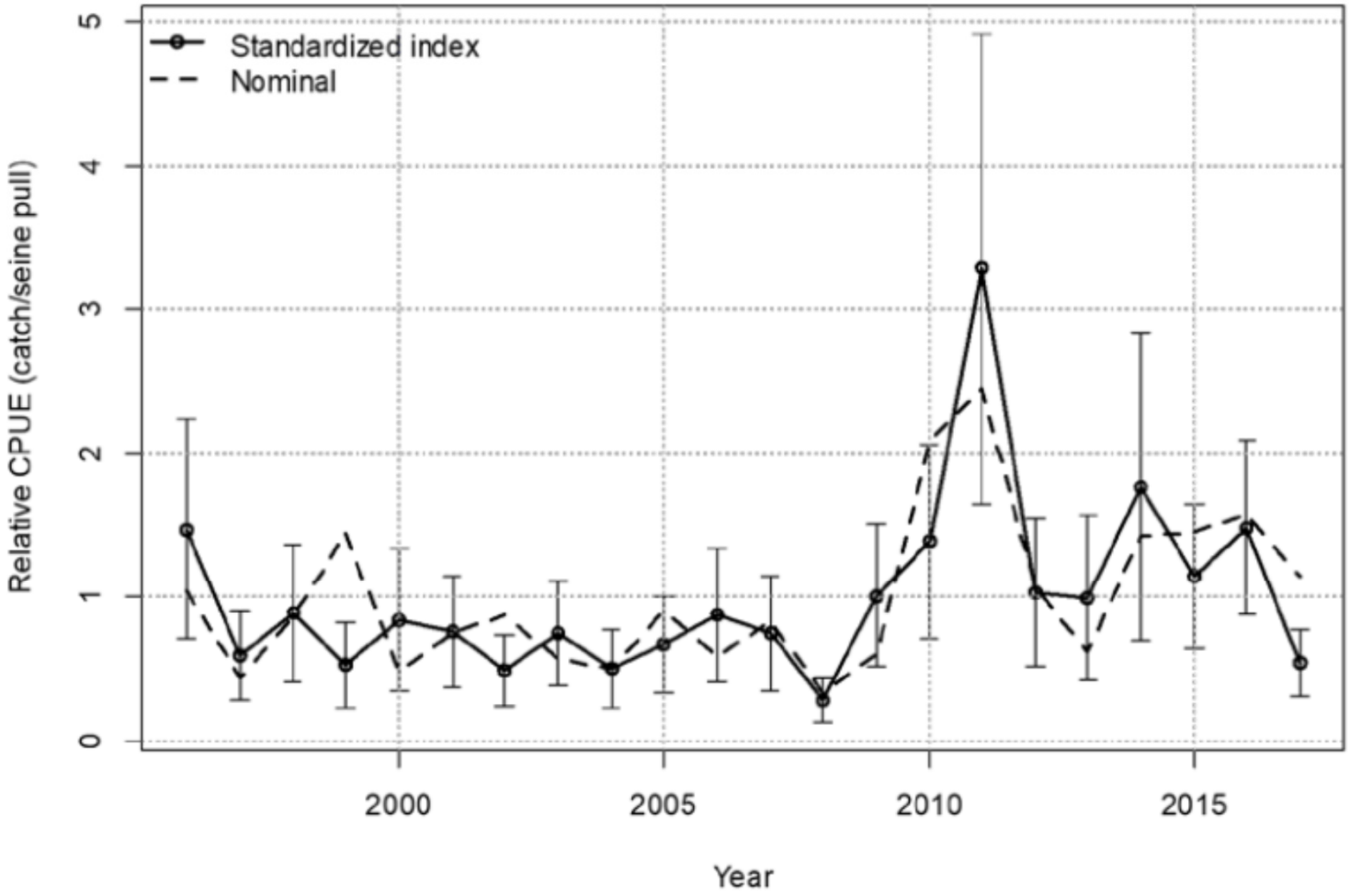
- Considered seine index data from Louisiana, Mississippi, and Alabama



Indices

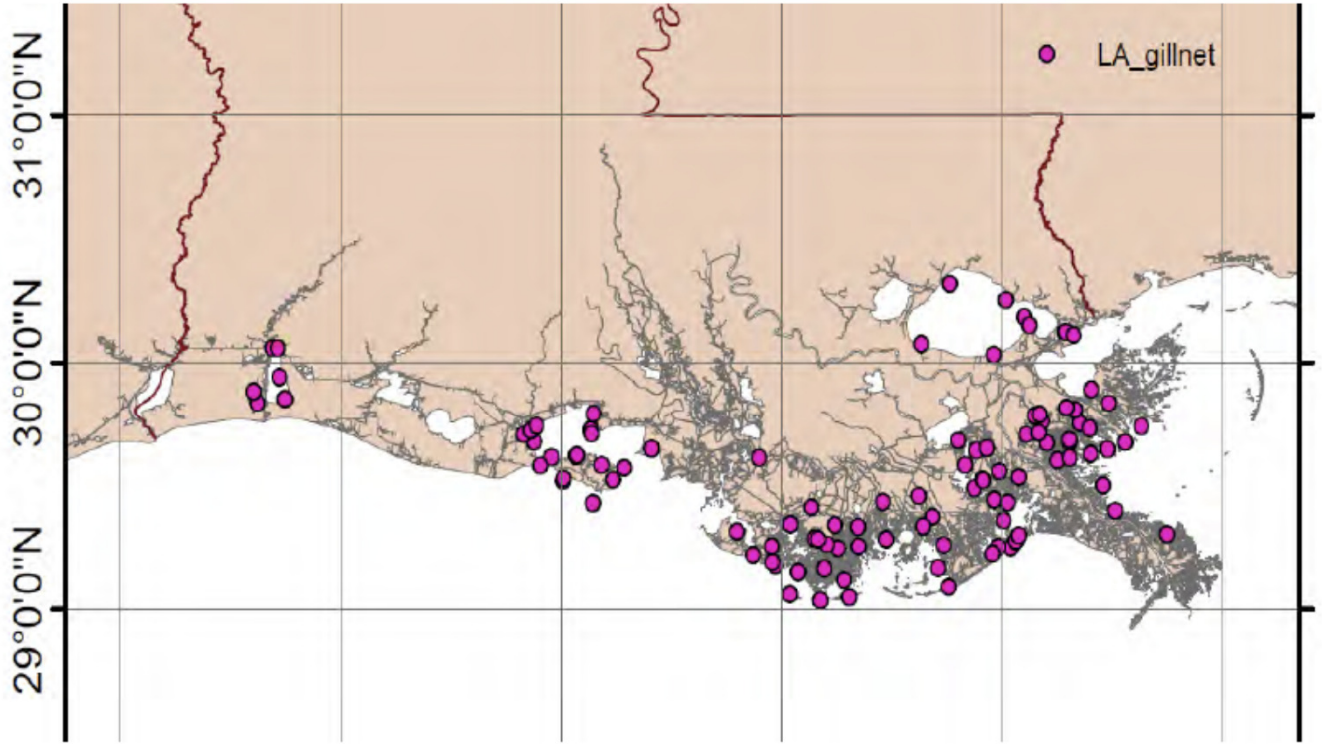
- Seine data included the months of January – June
  - Highest catches of age-0 individuals and consistent length compositions (< 100 mm FL)
- Data were combined and standardized using a delta-GLM model
  - Binomial and lognormal components included the following factors: year, state, month, temperature, and salinity

Indices


Standardized index
Nominal
Relative CPUE (catch/seine pull)
0
1
2
3
4
5
2000
2005
2010
2015
Year

Indices

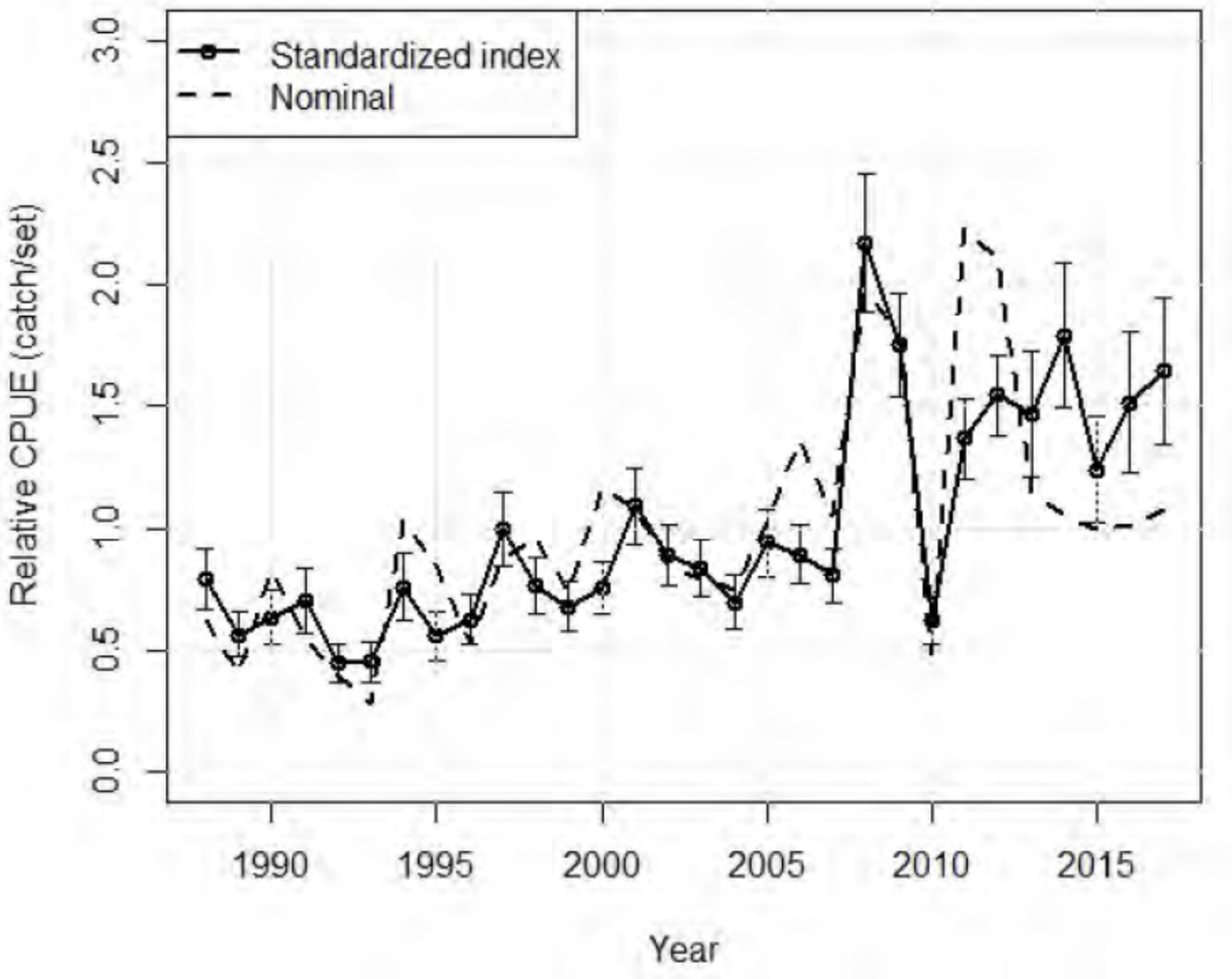
- Considered gill net data from Louisiana



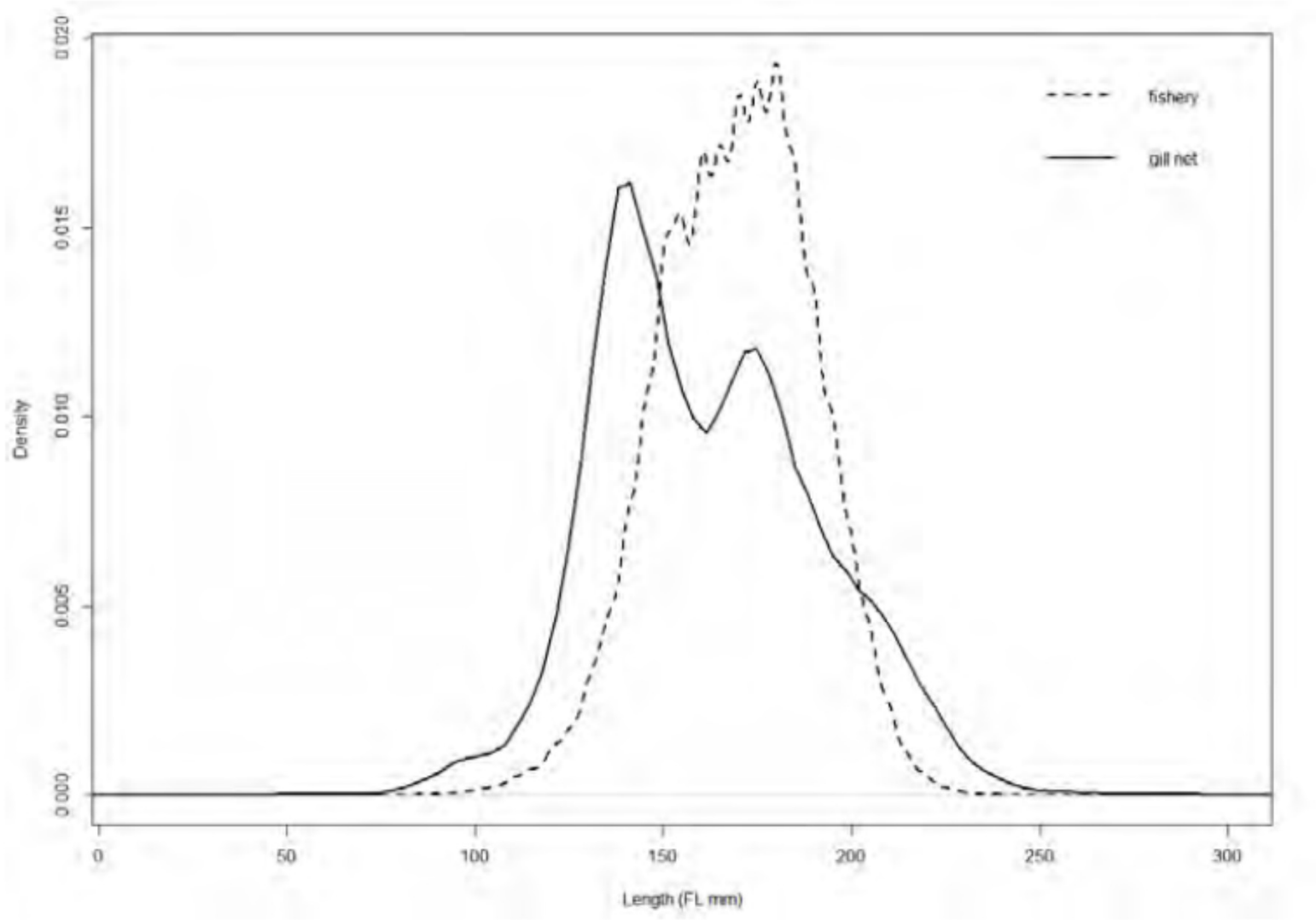
Indices

- Gill net data included the months of April – Sept
- Data were combined and standardized using a delta-GLM model
  - Binomial component included the following factors: year, month, temperature, salinity, mesh size, station, CSA
  - Lognormal component included all factors except month

Indices


Standardized index
Nominal
Relative CPUE (catch/set)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1990
1995
2000
2005
2010
2015
Year

Indices

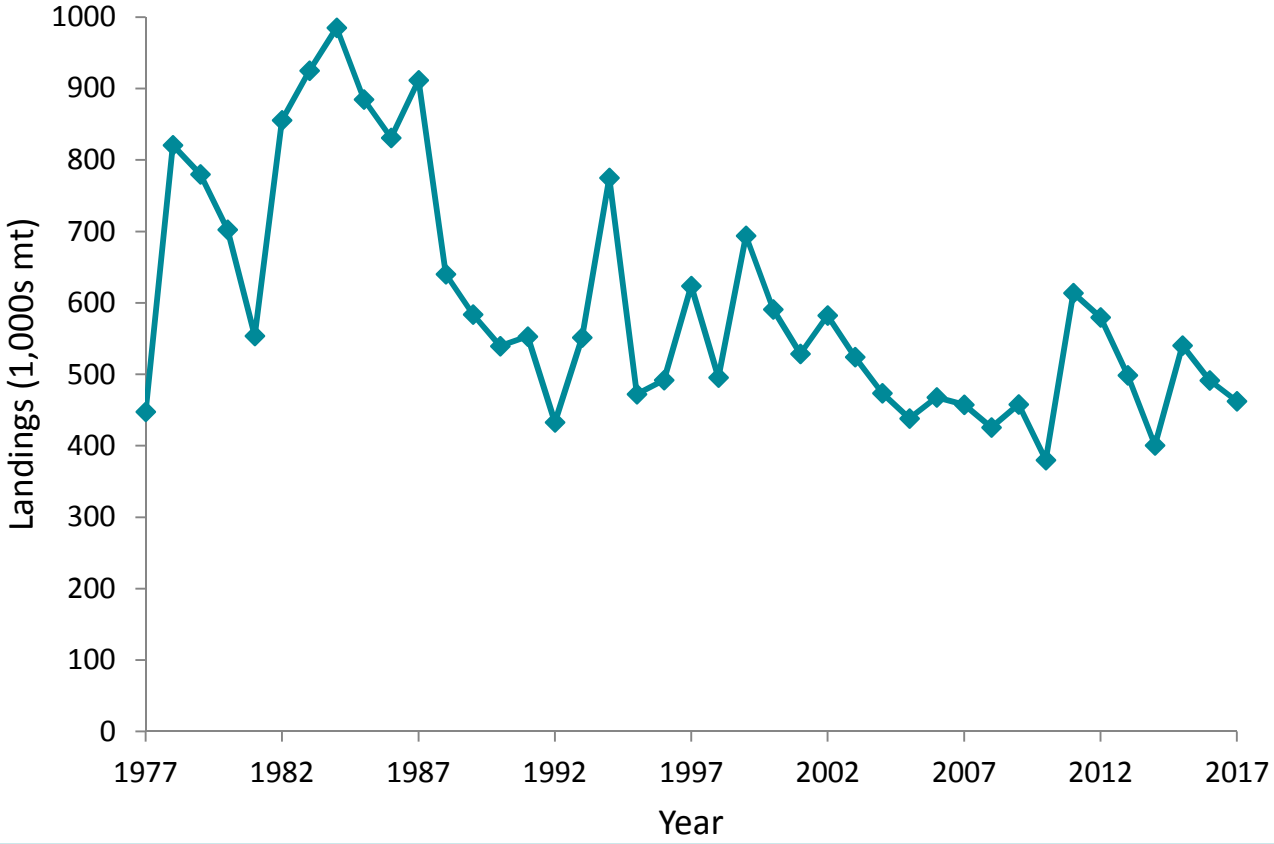

fishery
gill net
Density
0.020
0.015
0.010
0.005
0.000
0
50
100
150
200
250
300
Length (FL mm)

Data included in base run of model

- Commercial reduction landings
- Commercial reduction age compositions
- 2 indices – LA gill net and seine
- LA gill net length compositions
- Life history information
  - Lorenzen M scaled to tagging data
  - Weights at age for population and fishery
  - Fecundity, maturity, sex ratio

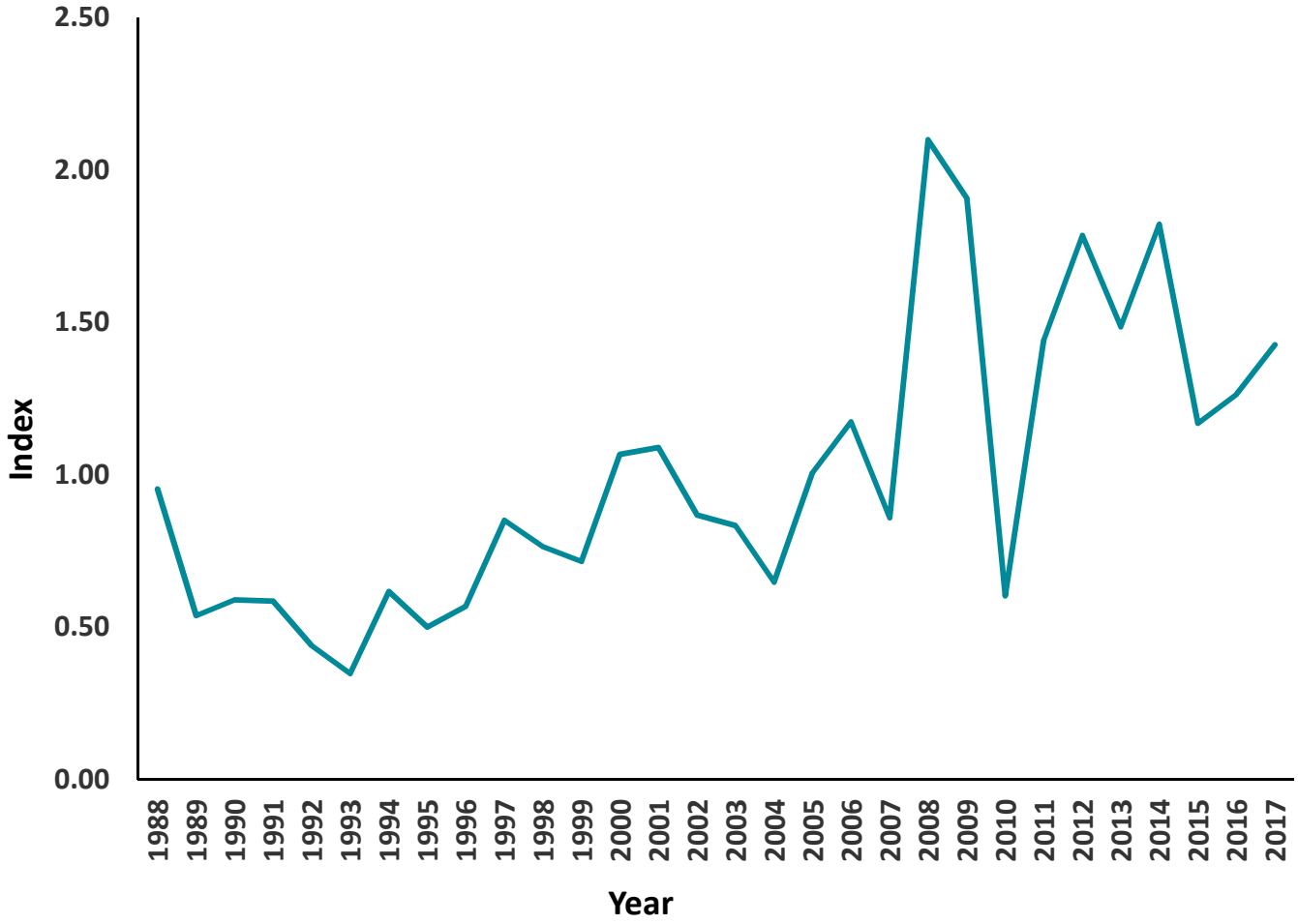
Data included

- Commercial reduction landings and age comps (includes bait and recreational)



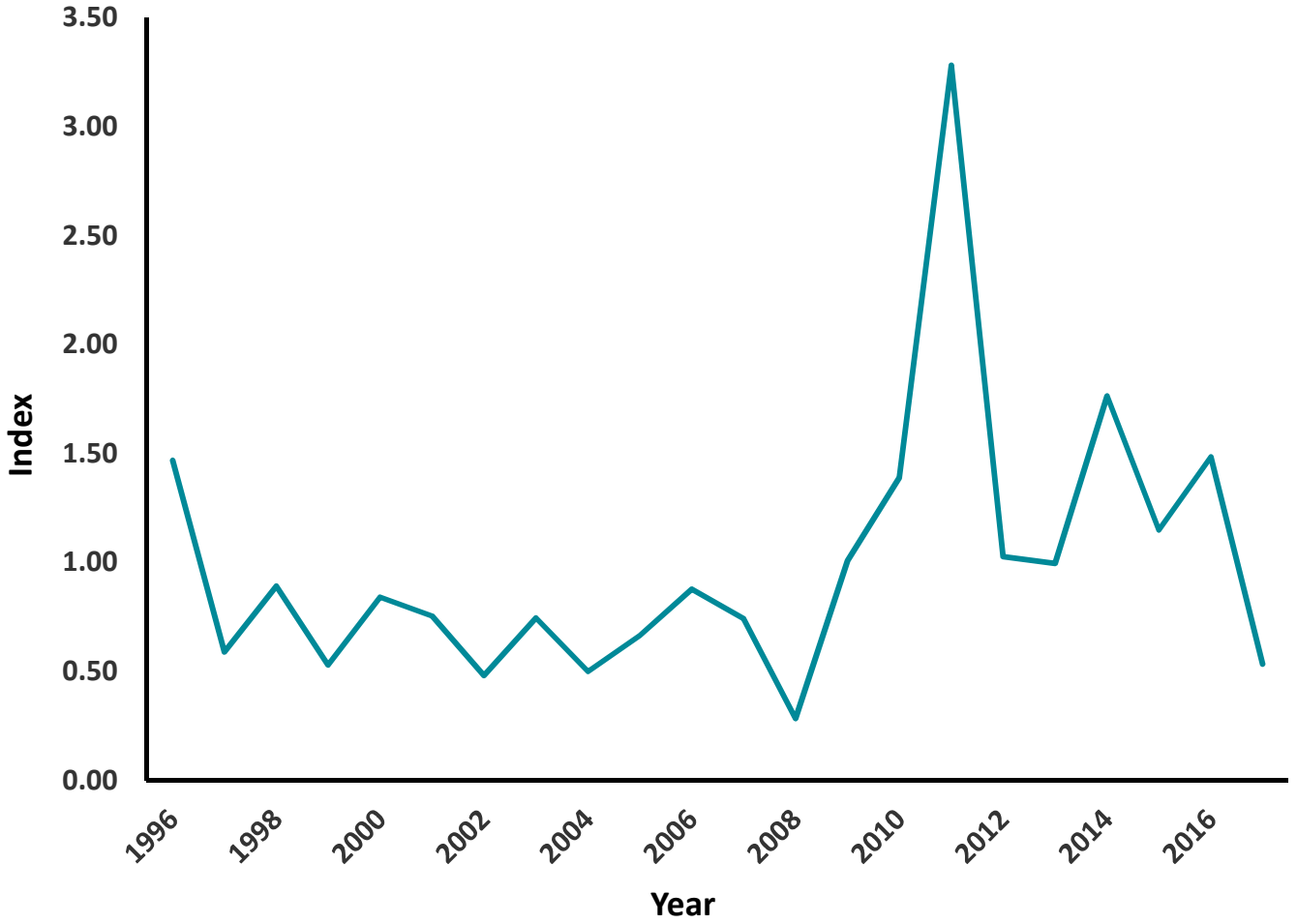
Data included

- Gill net index and length compositions



Data included

- Seine index



Data included

- Life history information
  - Lorenzen M scaled to tagging data
  - Weights at age for population and fishery
  - Brown-Peterson et al. (2017)
    - Fecundity: based on batches, duration, and size
    - Maturity: 80% age-1, 100% age-2+
    - Sex ratio: 1:1

Outline

- Data included
- Base run configuration
- Sensitivity analyses
- Monte Carlo bootstrap
- Projections
- Benchmarks

Model structure

- 1977-2017 (Jan 1 to Dec 31; annual time step)
- Ages 0 to 4+
- Landings data from 1977-2017
  - Age composition data 1977-2017
- LA gill net index 1988-2017 – July 1
  - Length composition data 1996-2017
- Seine (recruitment) index 1996-2017 – April 1

Model structure

- Fixed parameters
  - Linf, K, t0 – at 1997 to 2017 population parameter values
  - Steepness – at 0.99 based on likelihood profile
  - SD of Recruitment in log space (0.6)
  - Age based selectivity parameters
    - Reduction fishery - Age-0 fixed at 0.0, age-2 fixed at 1.0, and ages-3 and 4+ fixed at 0.87
    - Seine index – 1.0 for age-0 and 0.0 for ages-1+

Model structure

- Estimated parameters
  - CV of length at age
  - Log R0 (R0)
  - Dirichlet mulitinomial likelihood parameters
  - Age based selectivity parameters
    - Age-1 for 1977-1996 and 1997-2017
  - Logistic LA gill net selectivity
  - Catchability for each index
  - Average F

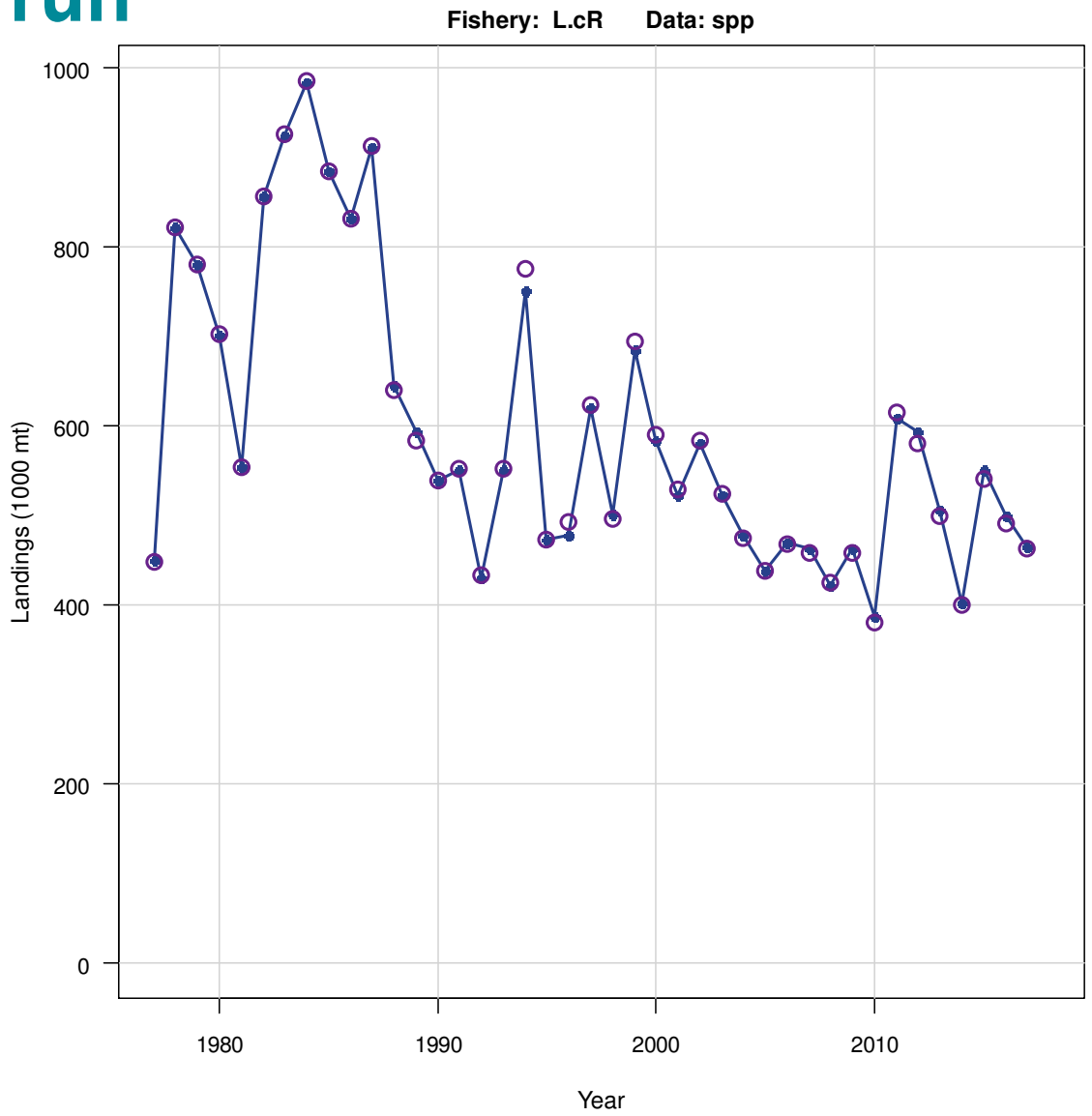
Model structure

- Estimated parameters
  - Annual deviations in F
  - Annual deviations in recruitment
  - Deviations in initial age structure

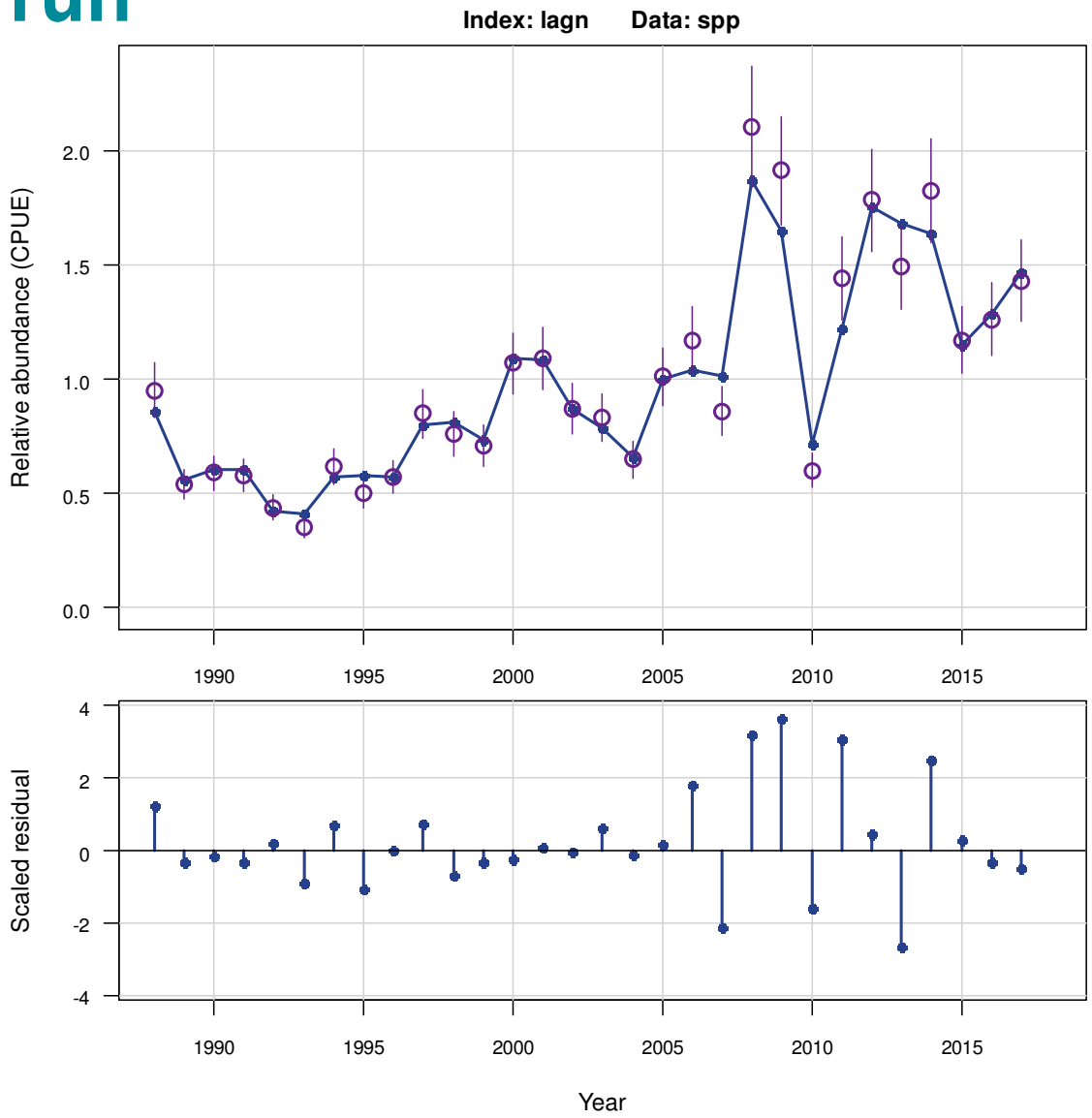
Model structure

- Likelihood distributions
  - Lognormal – indices, landings
  - Dirichlet multinomial – age compositions, length compositions
- Standard deviation of the normalized residuals (SDNR)
  - Upweighted gill net index such that both indices had SDNRs~1.5

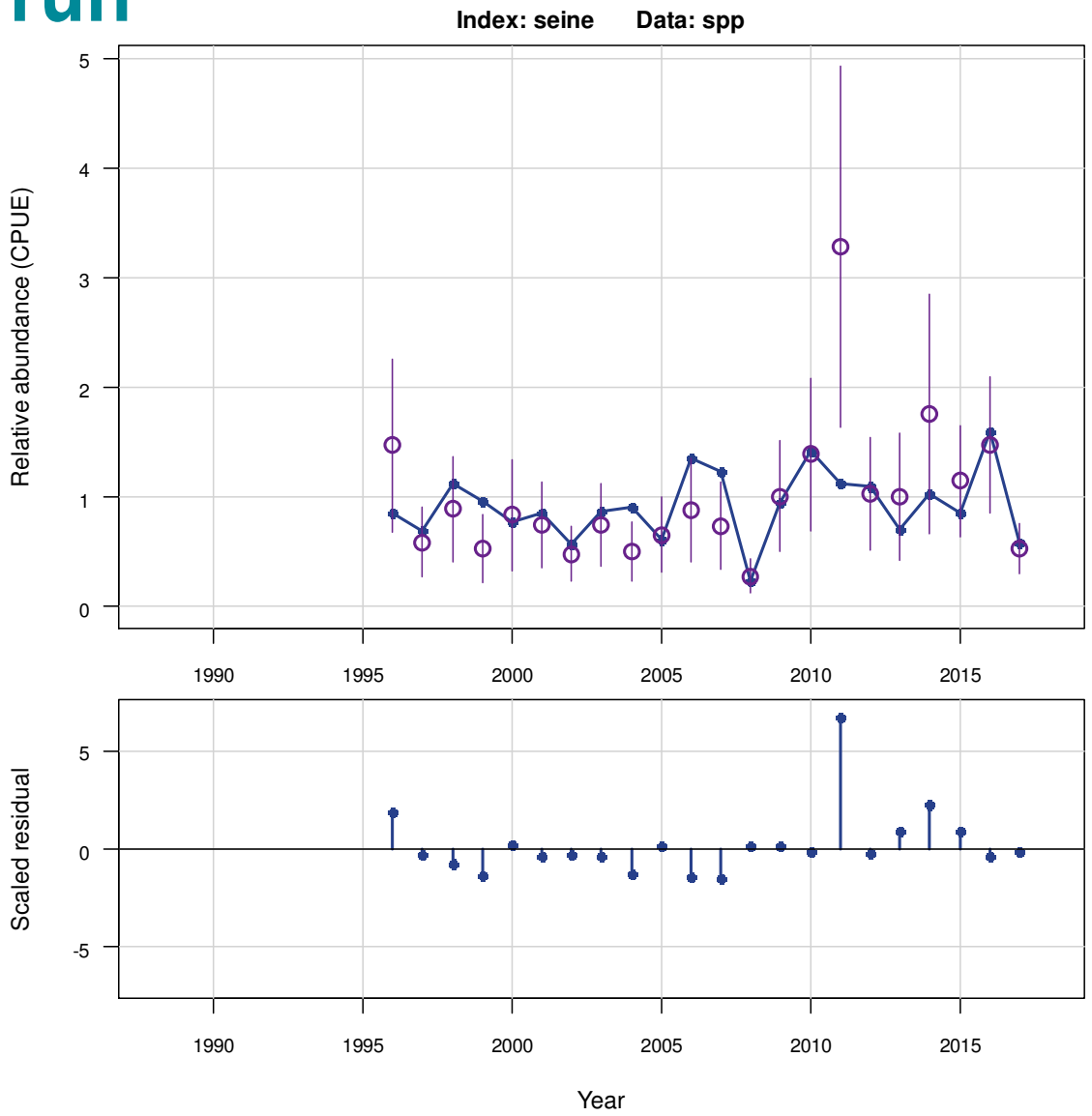
Base run


Fishery: L.cR Data: spp
Landings (1000 mt)
1000
800
600
400
200
0
1980
1990
2000
2010
Year

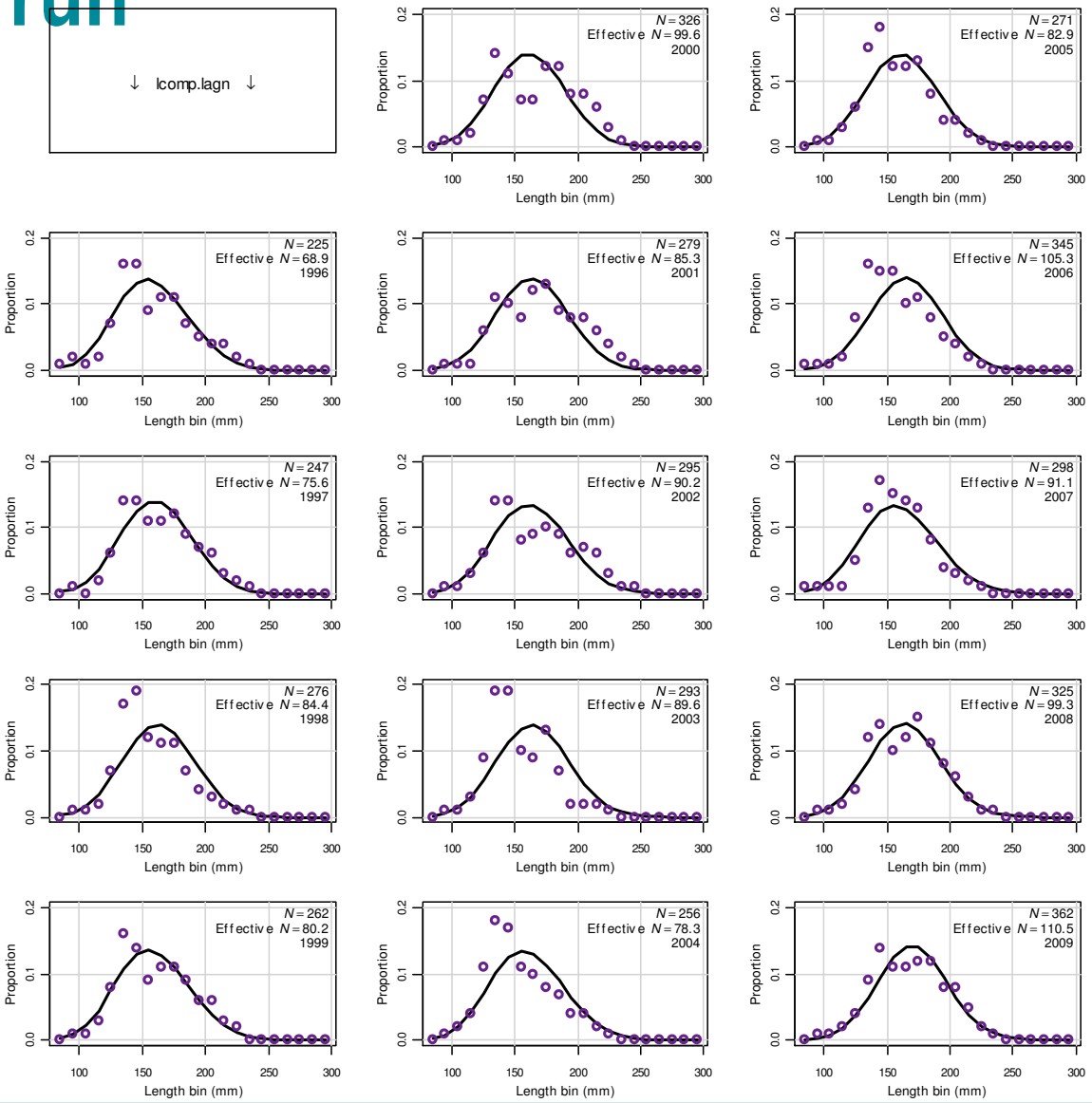
Base run


Index: lagn Data: spp
Relative abundance (CPUE)
2.0
1.5
1.0
0.5
0.0
1990
1995
2000
2005
2010
2015
Scaled residual
4
2
0
-2
-4
1990
1995
2000
2005
2010
2015
Year

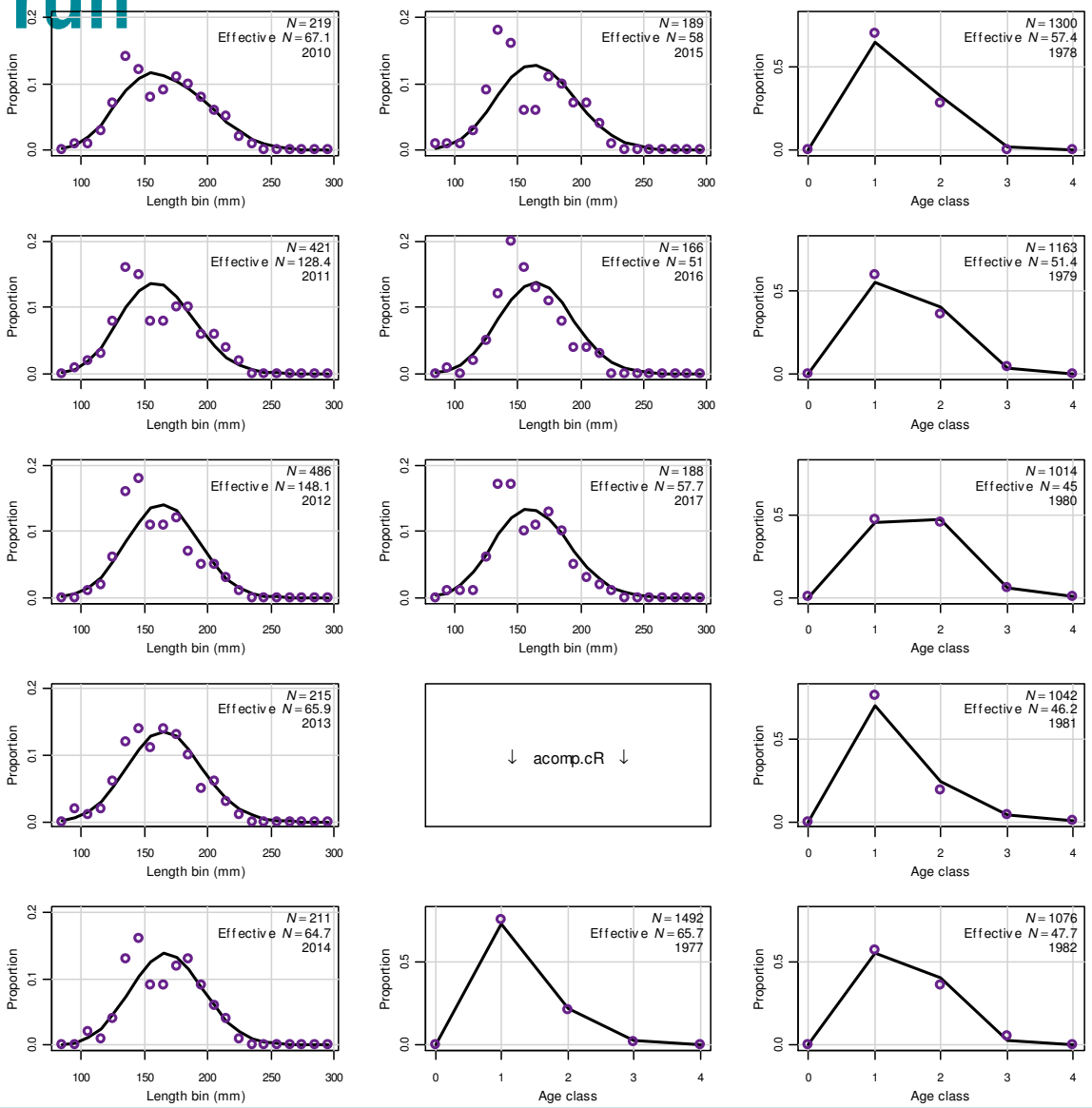
Base run


Index: seine Data: spp
Relative abundance (CPUE)
5
4
3
2
1
0
1990
1995
2000
2005
2010
2015
Scaled residual
5
0
-5
1990
1995
2000
2005
2010
2015
Year

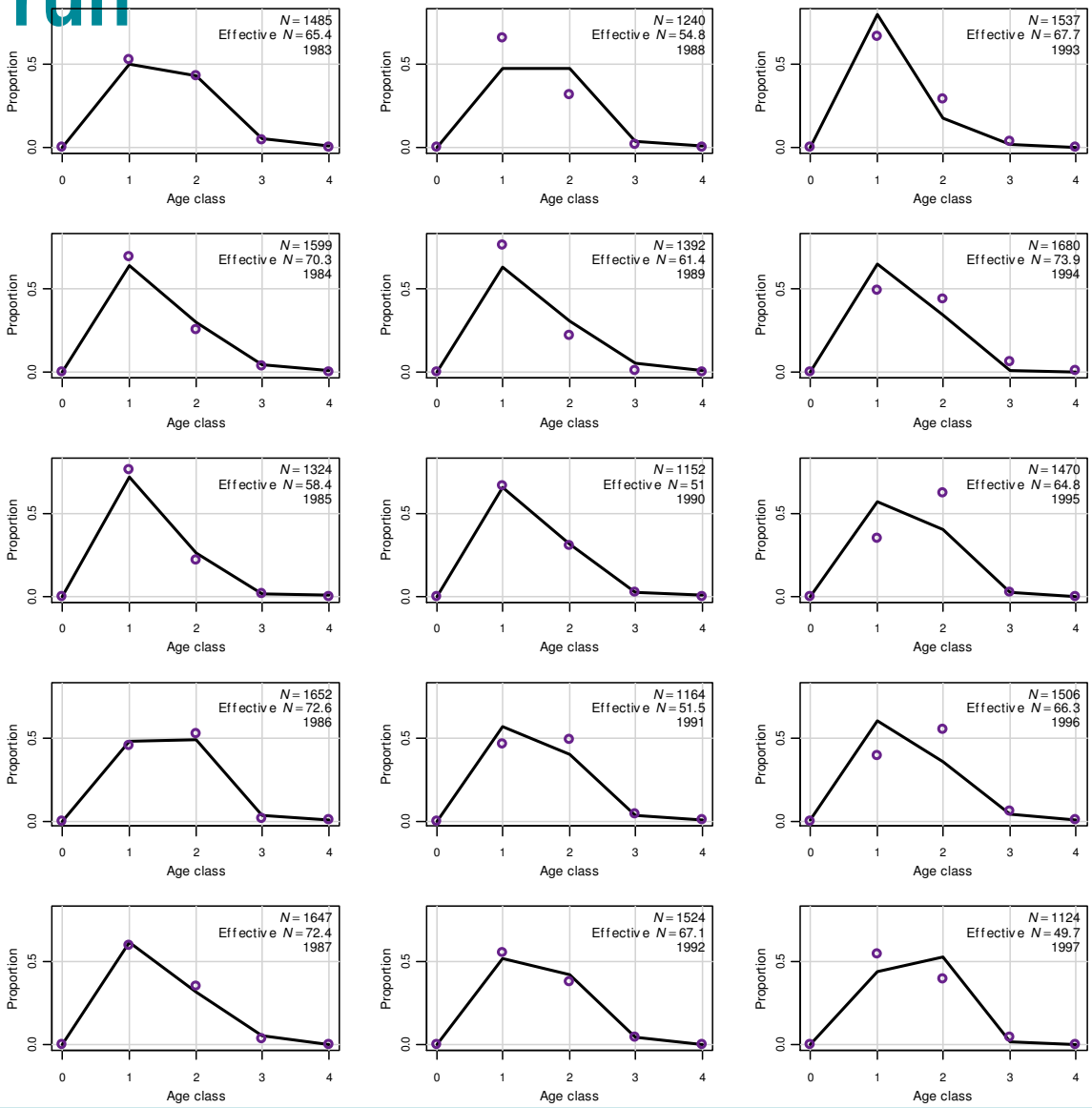
Base run


↓ lcomp.lagn ↓
N = 326
Effective N = 99.6
2000
N = 271
Effective N = 82.9
2005
N = 225
Effective N = 68.9
1996
N = 279
Effective N = 85.3
2001
N = 345
Effective N = 105.3
2006
N = 247
Effective N = 75.6
1997
N = 295
Effective N = 90.2
2002
N = 298
Effective N = 91.1
2007
N = 276
Effective N = 84.4
1998
N = 293
Effective N = 89.6
2003
N = 325
Effective N = 99.3
2008
N = 262
Effective N = 80.2
1999
N = 256
Effective N = 78.3
2004
N = 362
Effective N = 110.5
2009
Proportion
Length bin (mm)

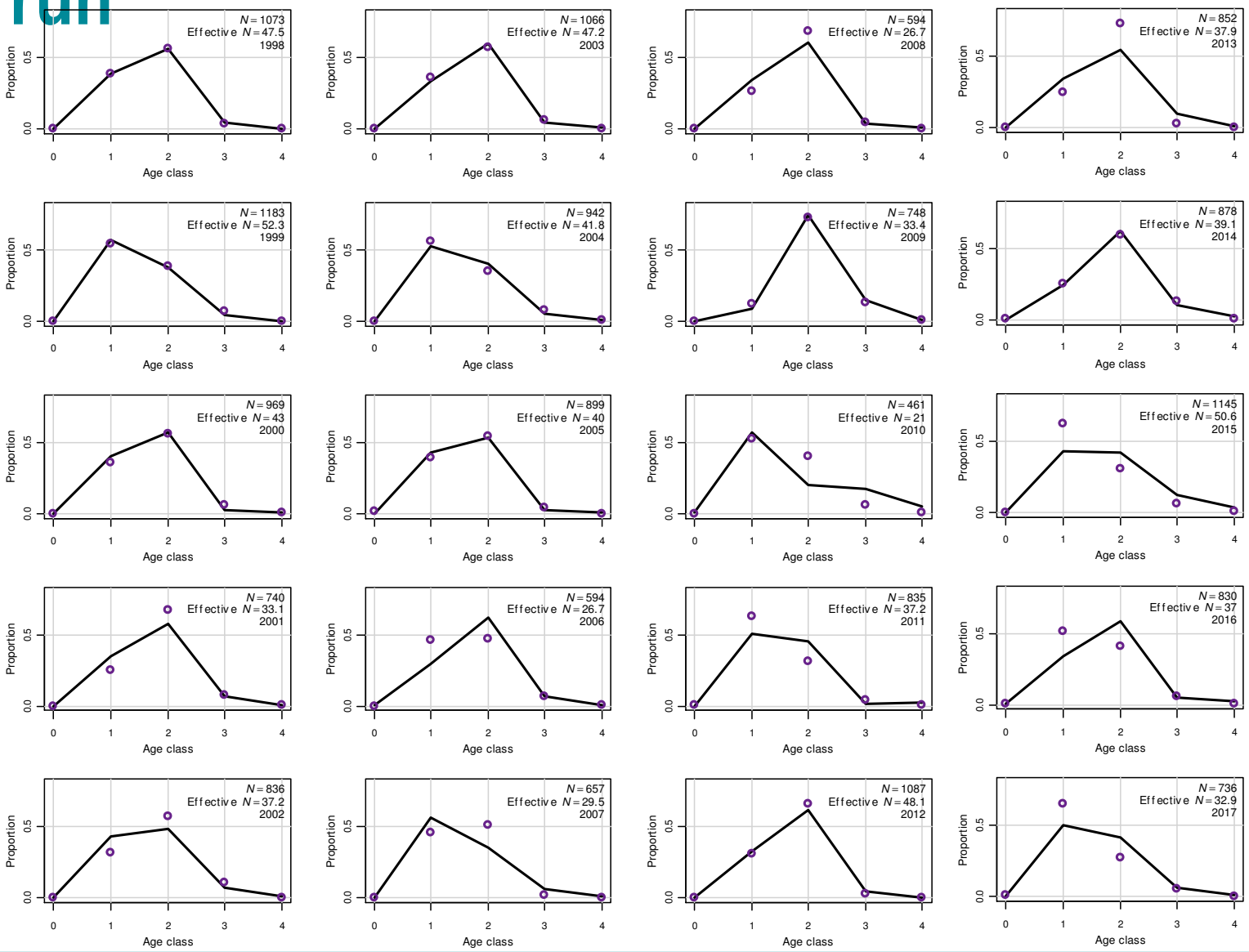
Base run


N = 219
Effective N = 67.1
2010
N = 189
Effective N = 58
2015
N = 1300
Effective N = 57.4
1978
N = 421
Effective N = 128.4
2011
N = 166
Effective N = 51
2016
N = 1163
Effective N = 51.4
1979
N = 486
Effective N = 148.1
2012
N = 188
Effective N = 57.7
2017
N = 1014
Effective N = 45
1980
N = 215
Effective N = 65.9
2013
↓ acomp.cR ↓
N = 1042
Effective N = 46.2
1981
N = 211
Effective N = 64.7
2014
N = 1492
Effective N = 65.7
1977
N = 1076
Effective N = 47.7
1982
Proportion
Length bin (mm)
Age class

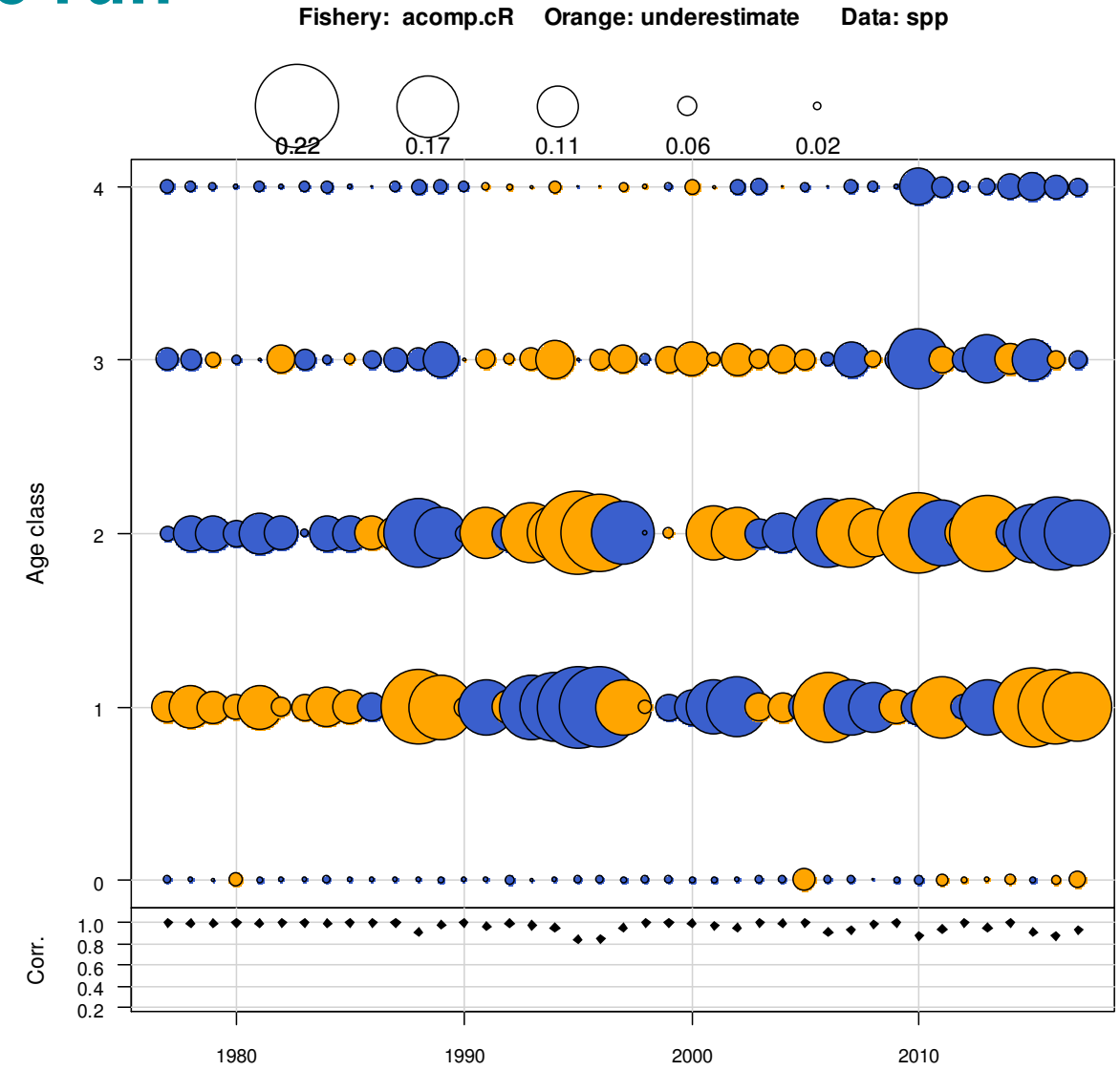
Base run


N = 1485
Effective N = 65.4
1983
N = 1240
Effective N = 54.8
1988
N = 1537
Effective N = 67.7
1993
N = 1599
Effective N = 70.3
1984
N = 1392
Effective N = 61.4
1989
N = 1680
Effective N = 73.9
1994
N = 1324
Effective N = 58.4
1985
N = 1152
Effective N = 51
1990
N = 1470
Effective N = 64.8
1995
N = 1652
Effective N = 72.6
1986
N = 1164
Effective N = 51.5
1991
N = 1506
Effective N = 66.3
1996
N = 1647
Effective N = 72.4
1987
N = 1524
Effective N = 67.1
1992
N = 1124
Effective N = 49.7
1997
Proportion
0.0
0.5
0
1
2
3
4
Age class

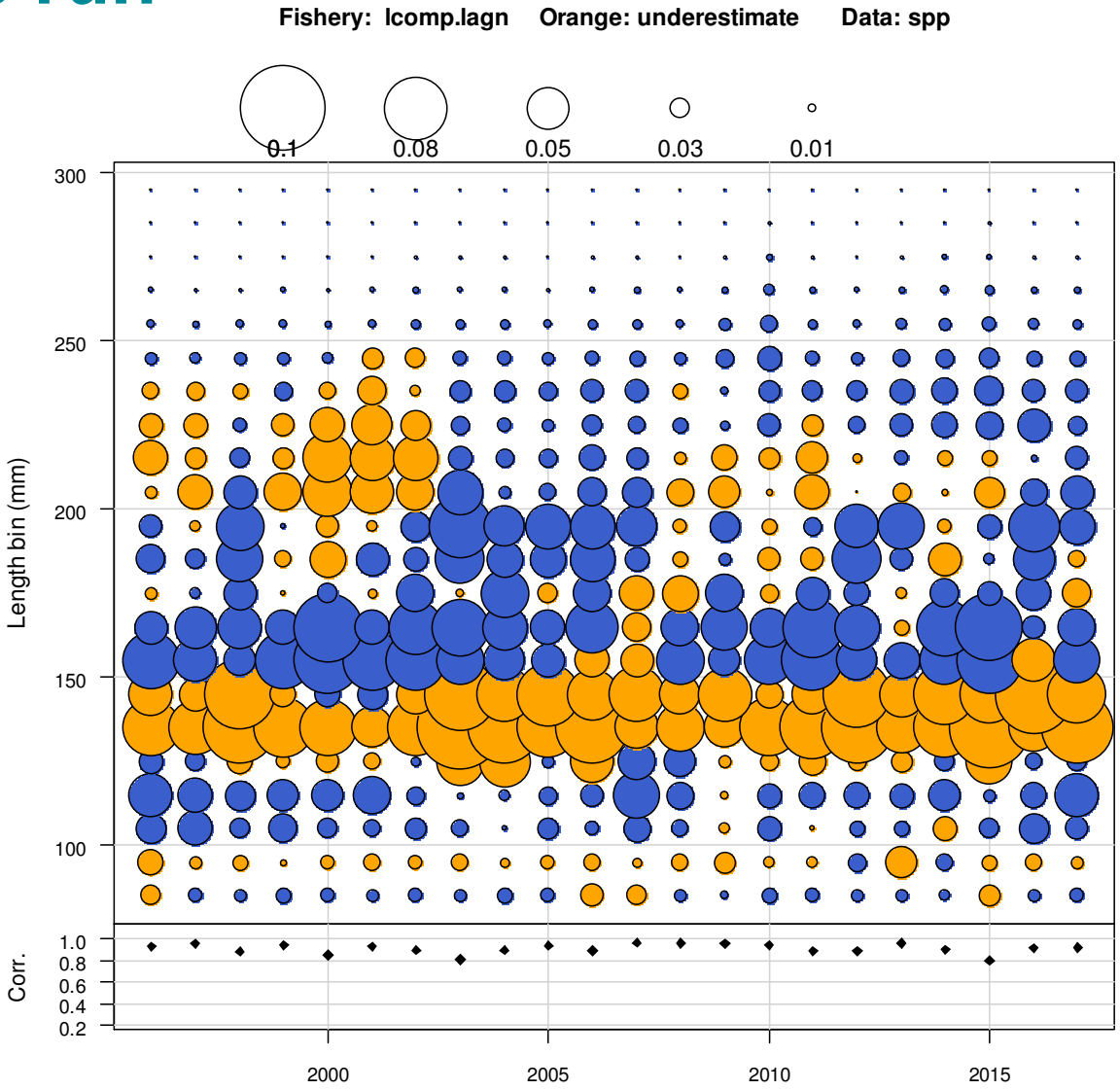
Base run


N = 1073
Effective N = 47.5
1998
N = 1066
Effective N = 47.2
2003
N = 594
Effective N = 26.7
2008
N = 852
Effective N = 37.9
2013
N = 1183
Effective N = 52.3
1999
N = 942
Effective N = 41.8
2004
N = 748
Effective N = 33.4
2009
N = 878
Effective N = 39.1
2014
N = 969
Effective N = 43
2000
N = 899
Effective N = 40
2005
N = 461
Effective N = 21
2010
N = 1145
Effective N = 50.6
2015
N = 740
Effective N = 33.1
2001
N = 594
Effective N = 26.7
2006
N = 835
Effective N = 37.2
2011
N = 830
Effective N = 37
2016
N = 836
Effective N = 37.2
2002
N = 657
Effective N = 29.5
2007
N = 1087
Effective N = 48.1
2012
N = 736
Effective N = 32.9
2017
Proportion
0.0
0.5
Age class
0
1
2
3
4

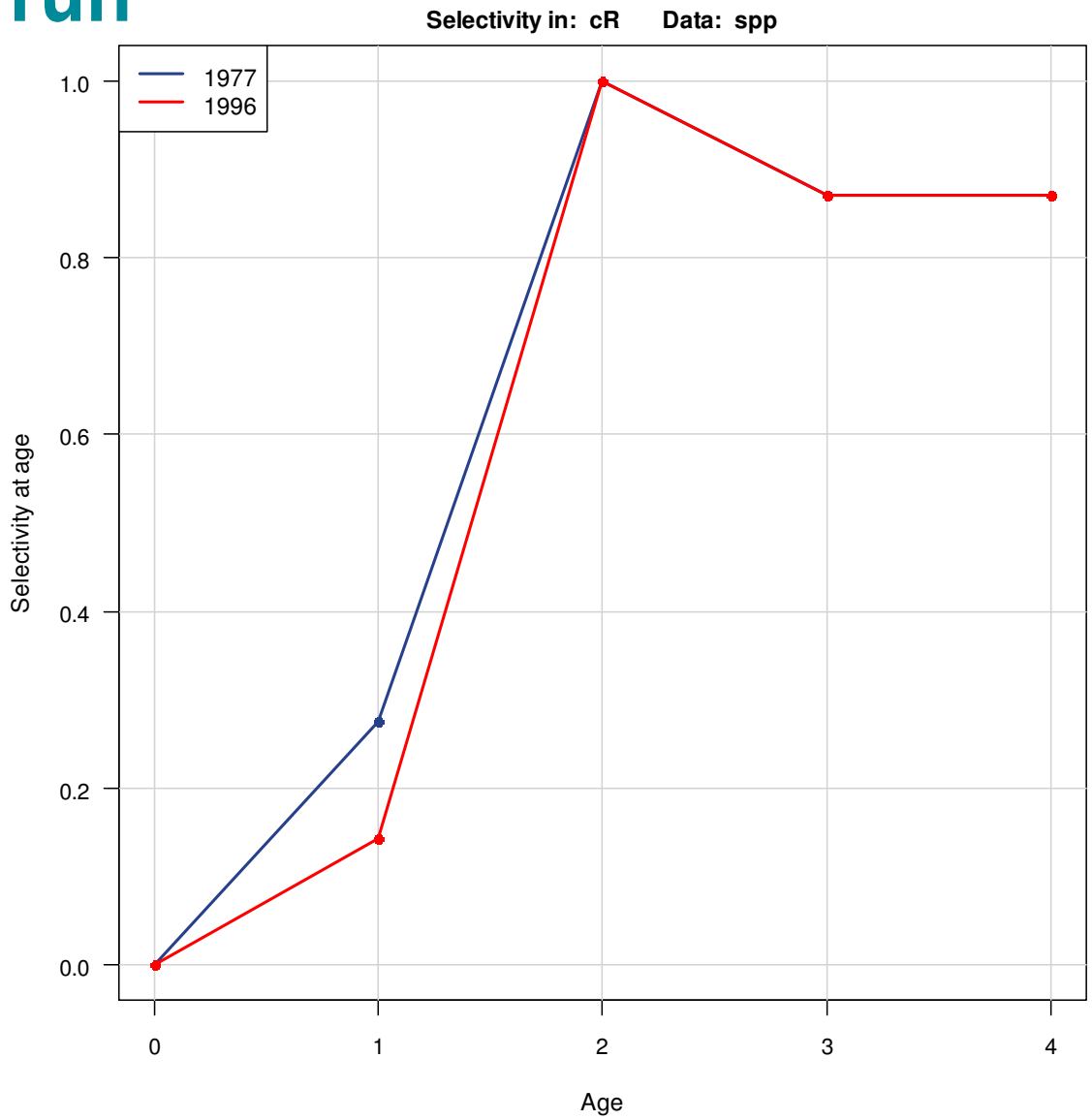
Base run


Fishery: acomp.cR Orange: underestimate Data: spp
0.22
0.17
0.11
0.06
0.02
Age class
4
3
2
1
0
Corr.
1.0
0.8
0.6
0.4
0.2
1980
1990
2000
2010

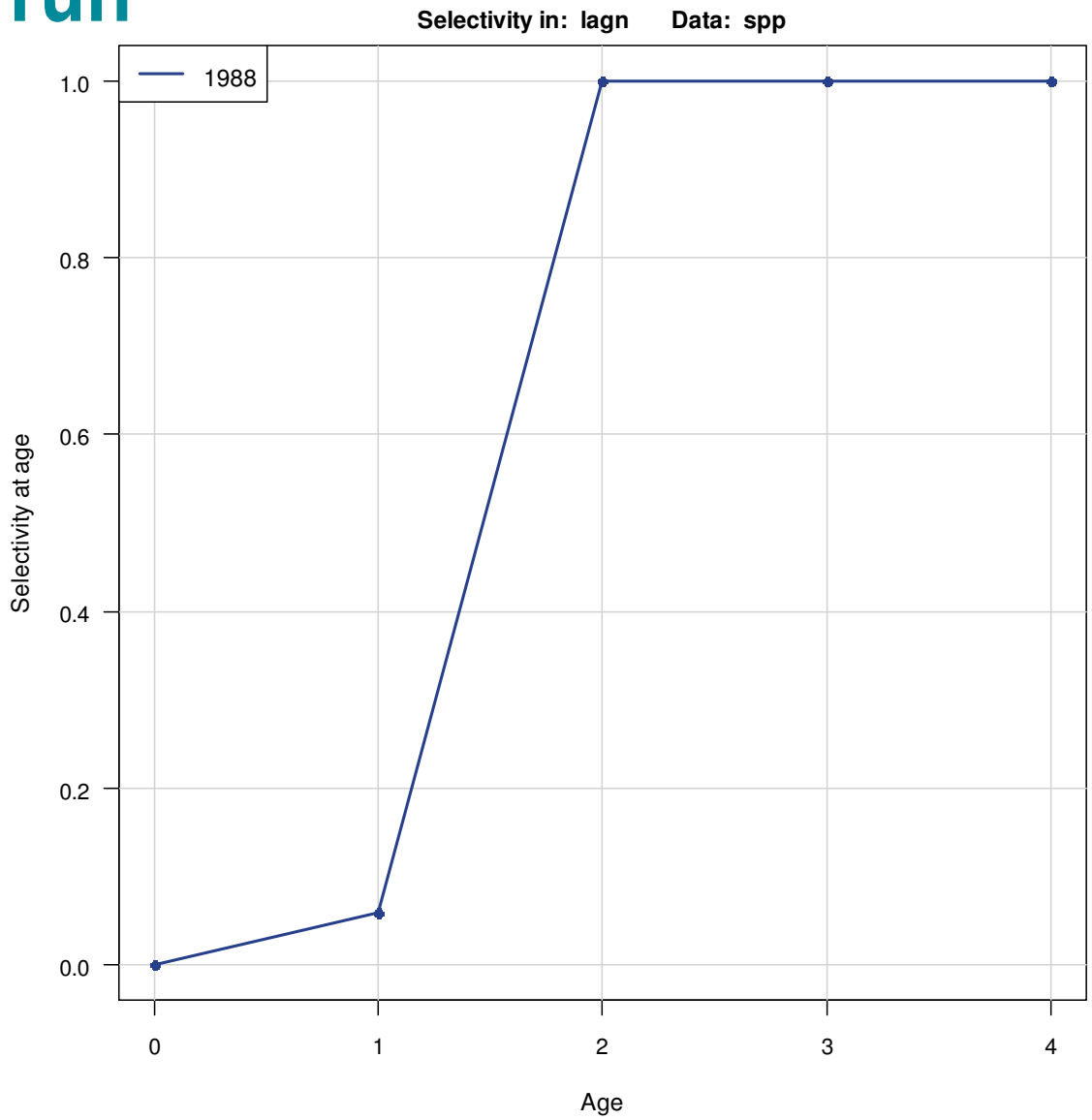
Base run


Fishery: lcomp.lagn Orange: underestimate Data: spp
0.1
0.08
0.05
0.03
0.01
Length bin (mm)
300
250
200
150
100
Corr.
1.0
0.8
0.6
0.4
0.2
2000
2005
2010
2015

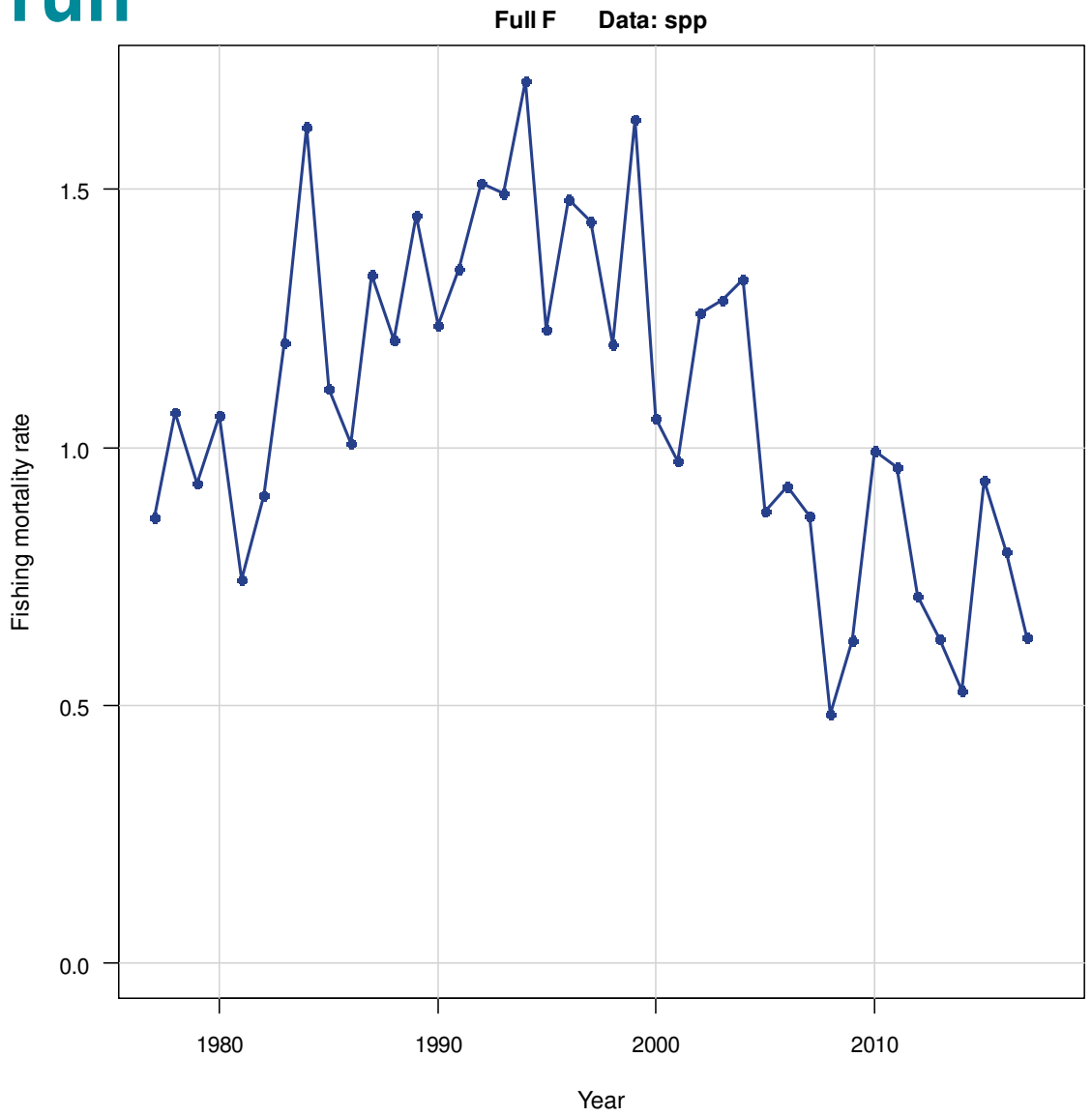
Base run


Selectivity in: cR Data: spp
1977
1996
1.0
0.8
0.6
0.4
0.2
0.0
Selectivity at age
0
1
2
3
4
Age

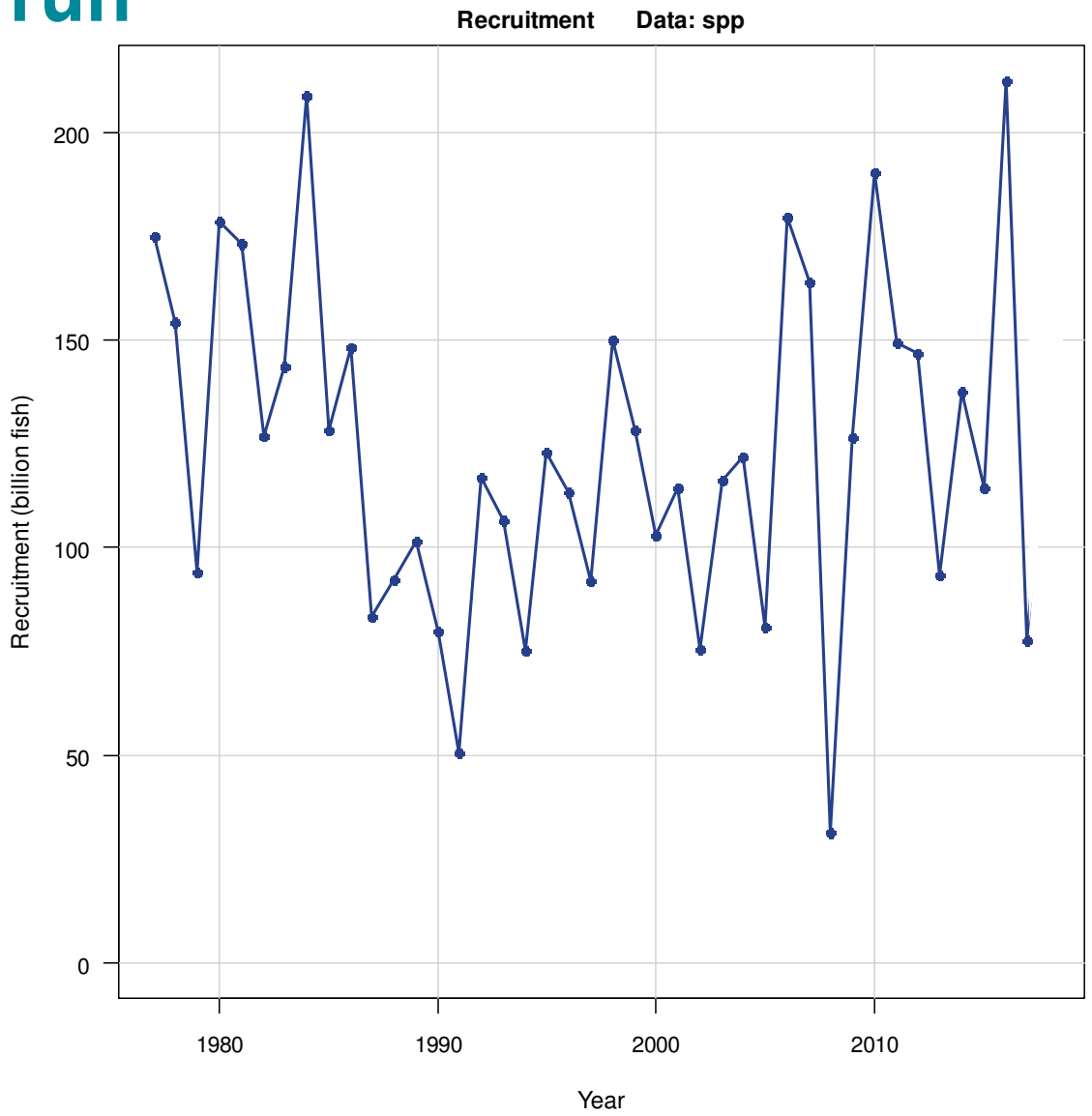
Base run


Selectivity in: lagn Data: spp
1988
1.0
0.8
0.6
0.4
0.2
0.0
Selectivity at age
0
1
2
3
4
Age

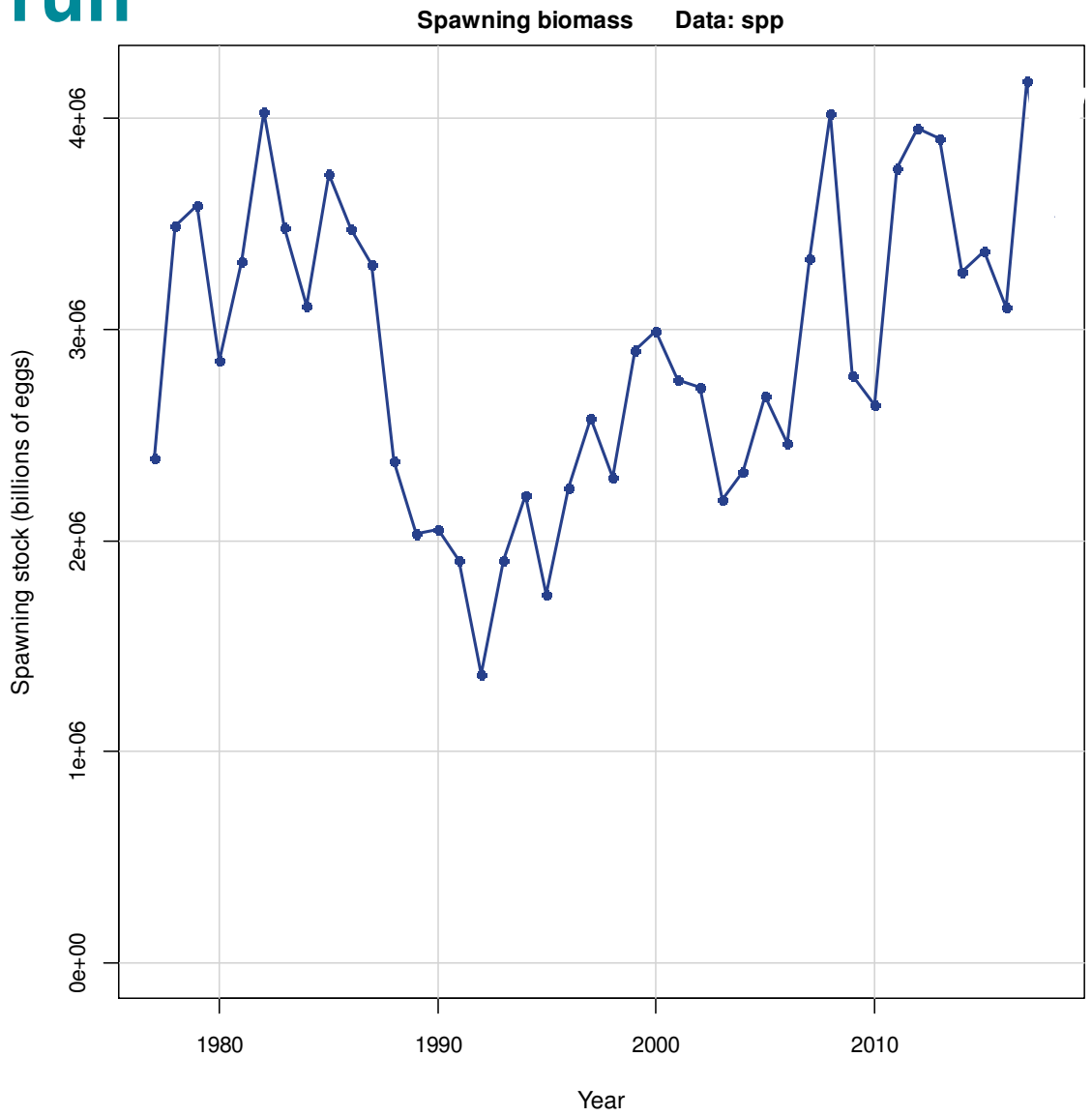
Base run


Full F
Data: spp
Fishing mortality rate
0.0
0.5
1.0
1.5
1980
1990
2000
2010
Year

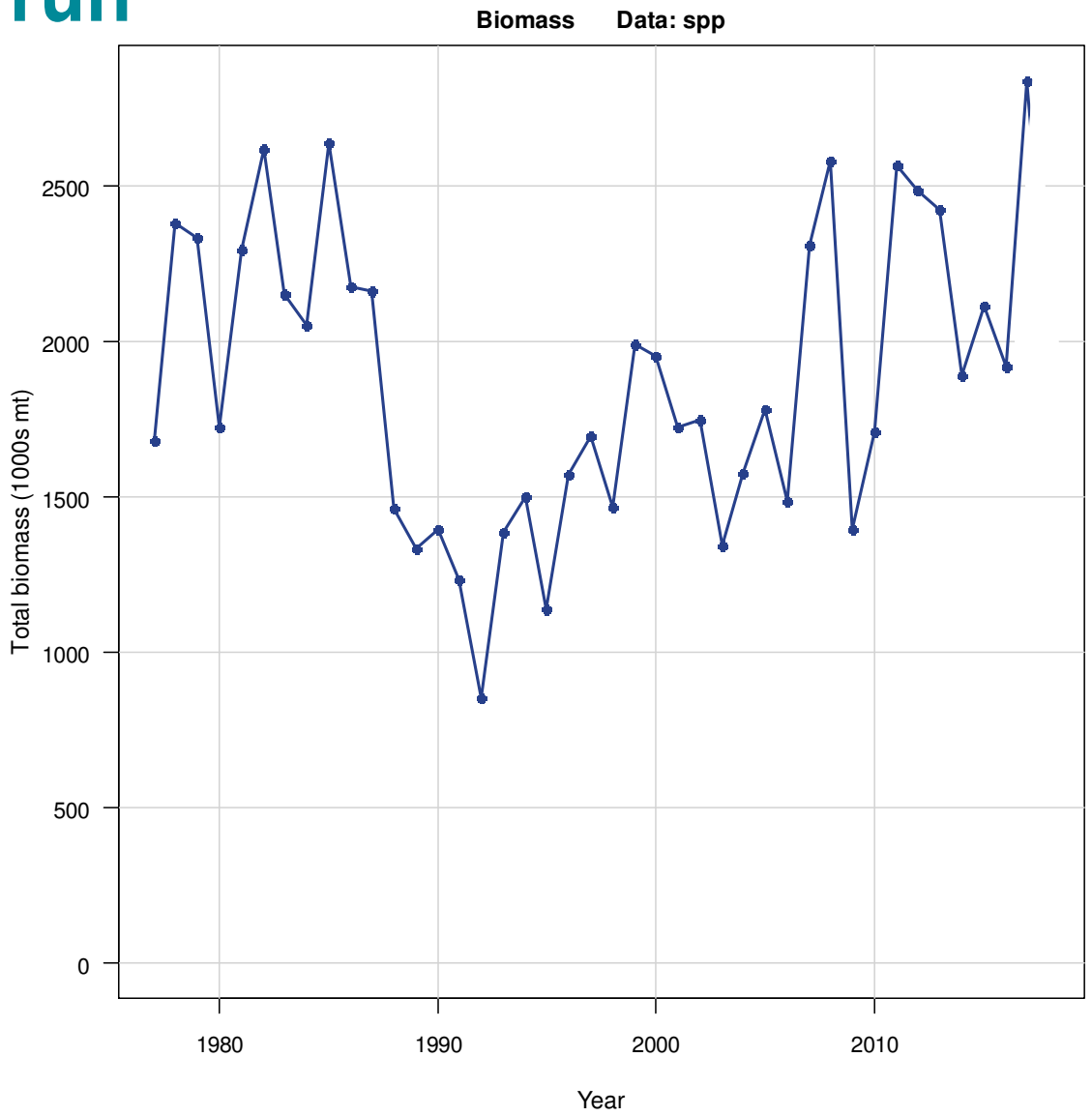
Base run


Recruitment Data: spp
Recruitment (billion fish)
200
150
100
50
0
1980
1990
2000
2010
Year

Base run


Spawning biomass Data: spp
Spawning stock (billions of eggs)
0e+00
1e+06
2e+06
3e+06
4e+06
1980
1990
2000
2010
Year

Base run

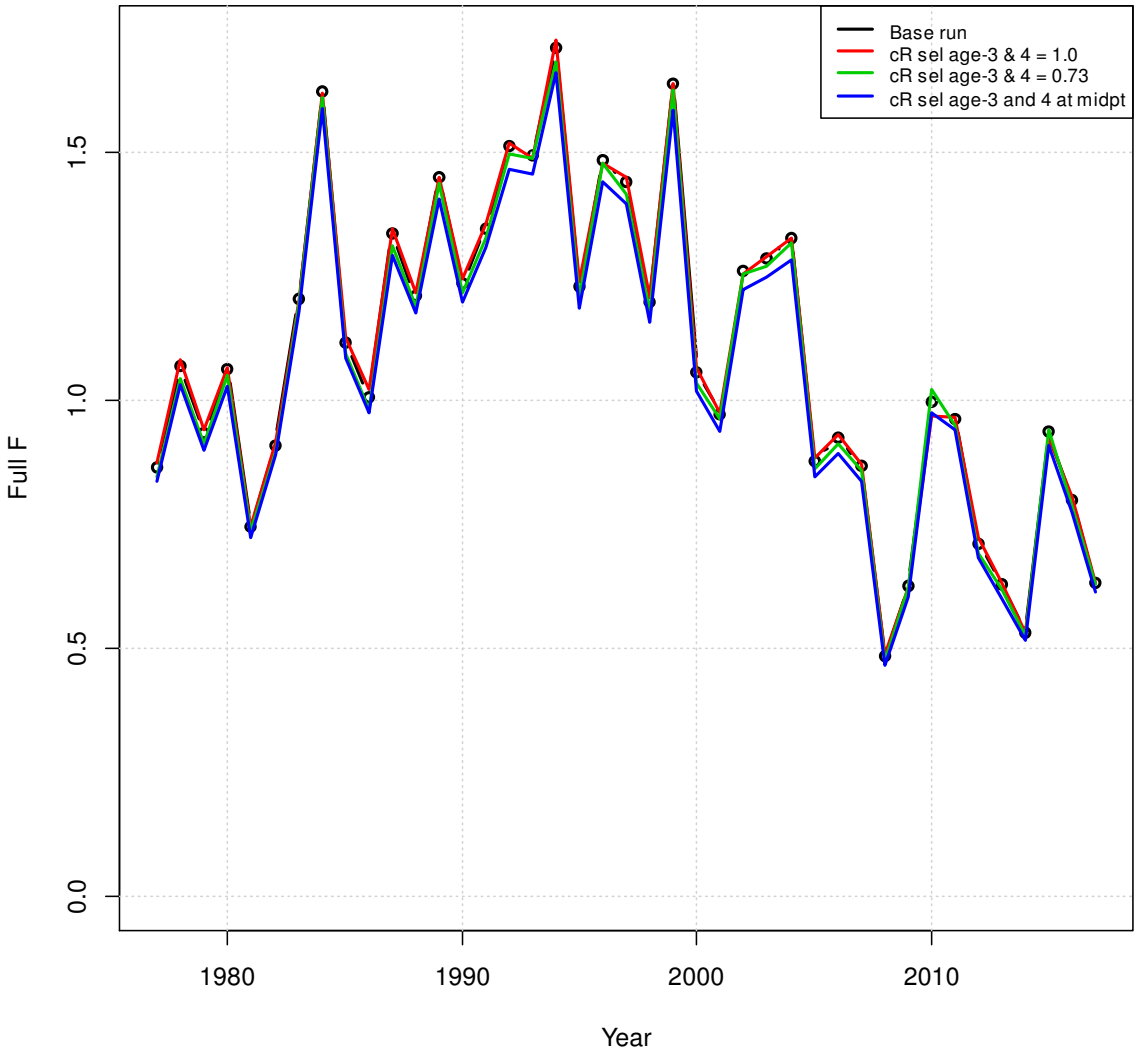

Biomass Data: spp
Total biomass (1000s mt)
2500
2000
1500
1000
500
0
1980
1990
2000
2010
Year

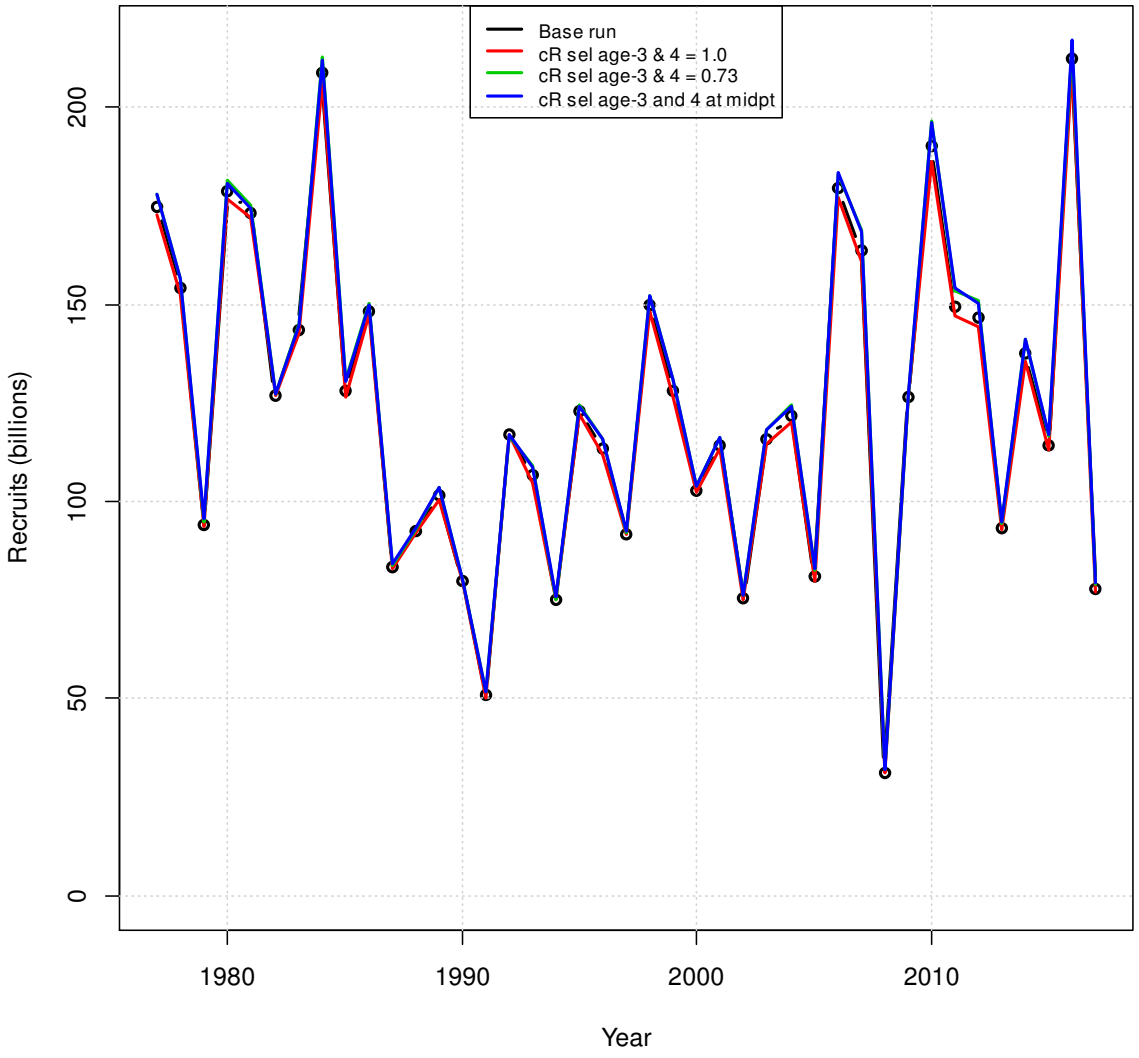
Outline

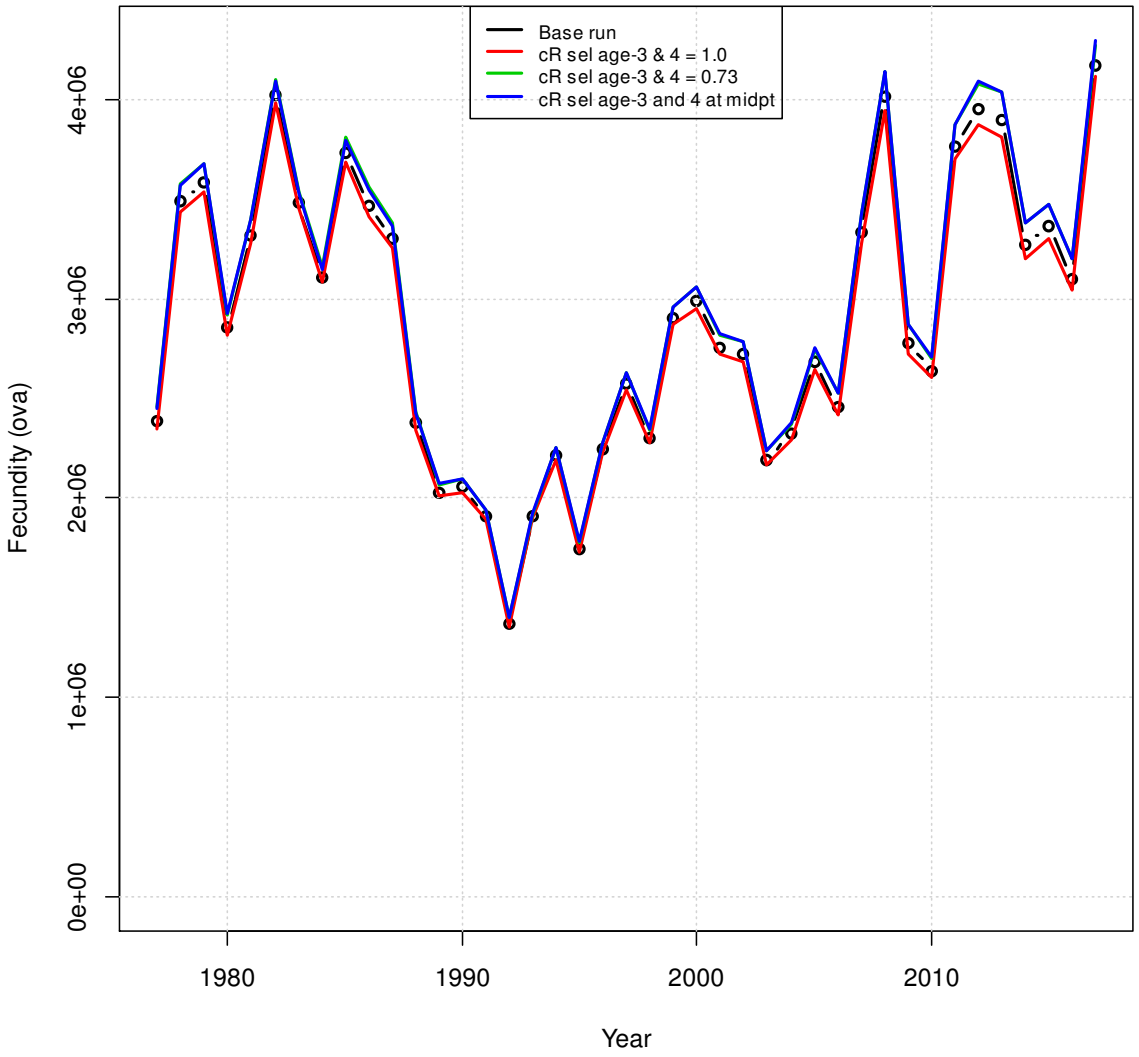
- Data included
- Base run configuration
- Sensitivity analyses
- Monte Carlo bootstrap
- Projections
- Benchmarks

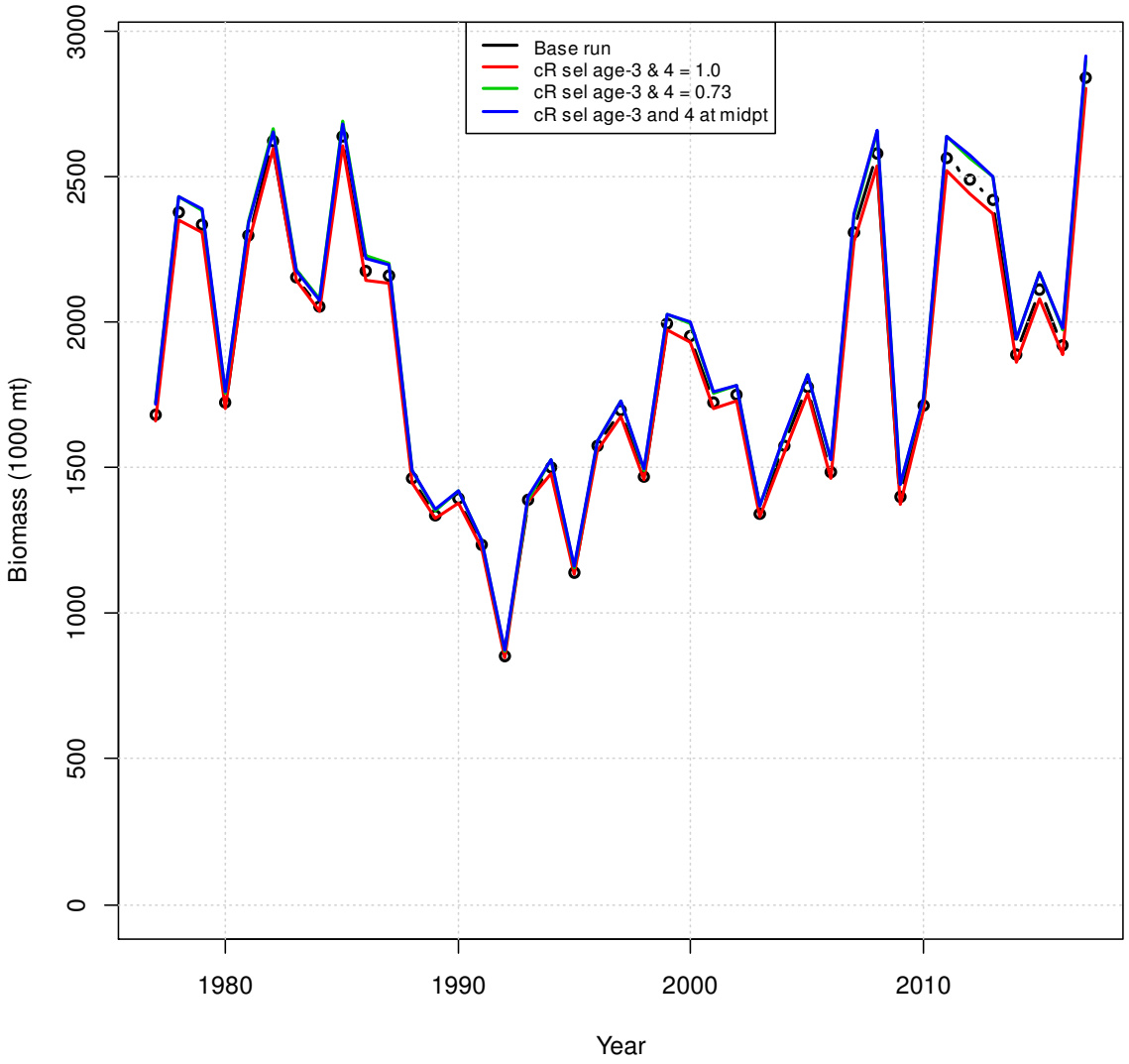
Sensitivity analyses

- Selectivity of cR
  - Flat topped (age-3 and -4 set to 1.0)
  - Age-3 and -4 set at 0.73 (based on like prof)
  - Age-3 and -4 each at the midpoint of the likelihood prof


Base run
cR sel age-3 & 4 = 1.0
cR sel age-3 & 4 = 0.73
cR sel age-3 and 4 at midpt
Full F
0.0
0.5
1.0
1.5
1980
1990
2000
2010
Year

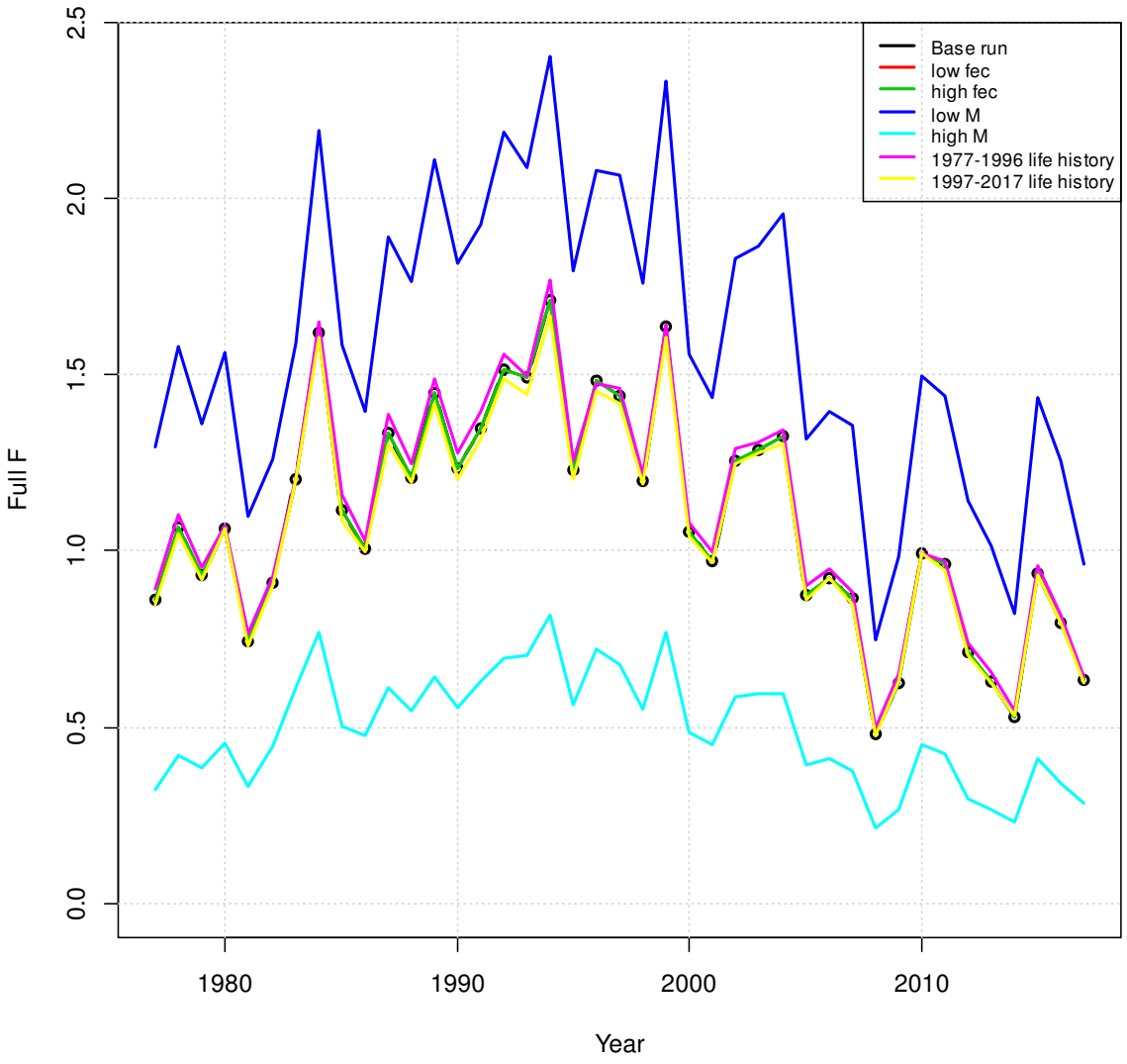

Base run
cR sel age-3 & 4 = 1.0
cR sel age-3 & 4 = 0.73
cR sel age-3 and 4 at midpt
Recruits (billions)
0
50
100
150
200
1980
1990
2000
2010
Year

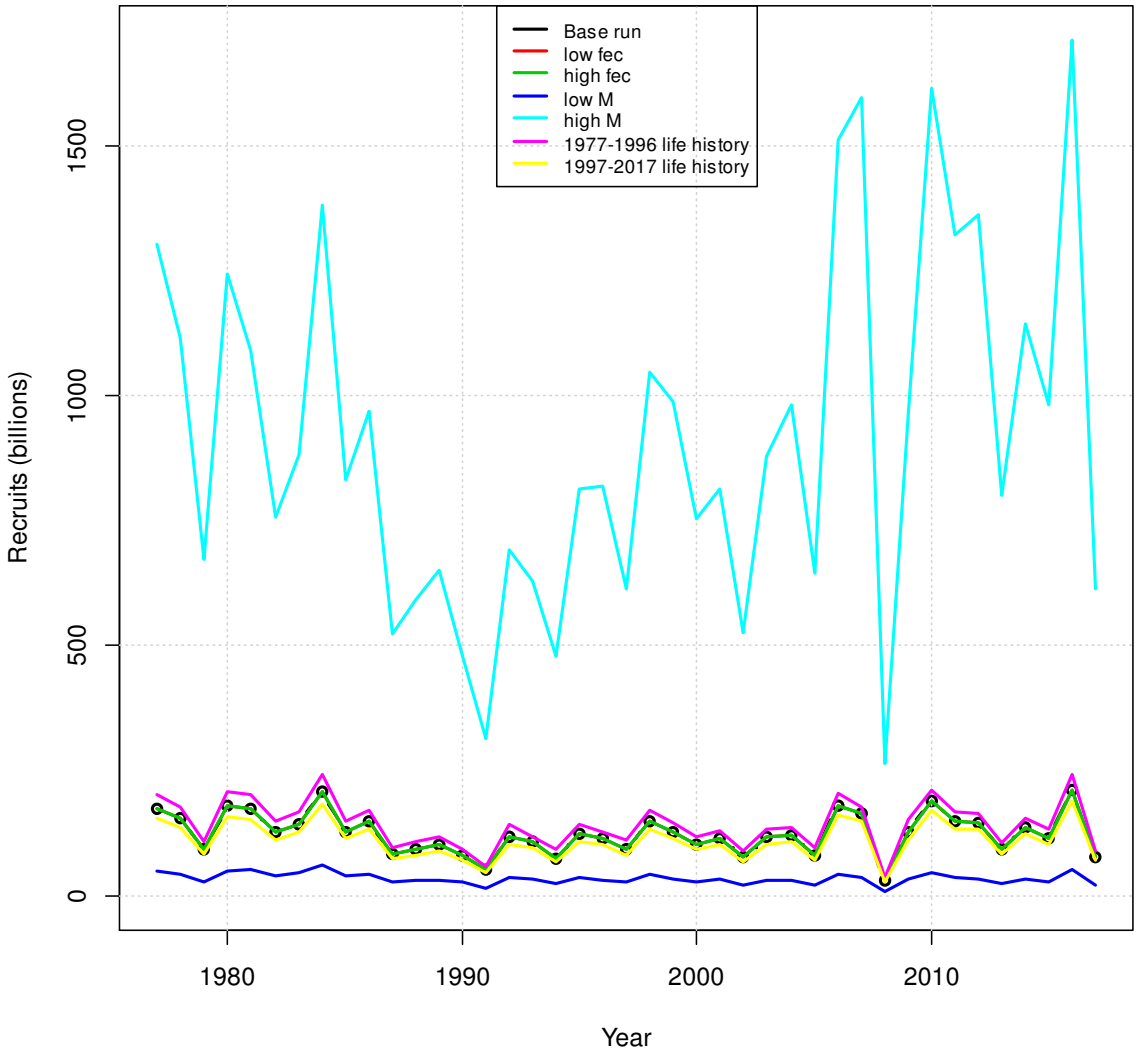

Base run
cR sel age-3 & 4 = 1.0
cR sel age-3 & 4 = 0.73
cR sel age-3 and 4 at midpt
Fecundity (ova)
0e+00
1e+06
2e+06
3e+06
4e+06
1980
1990
2000
2010
Year

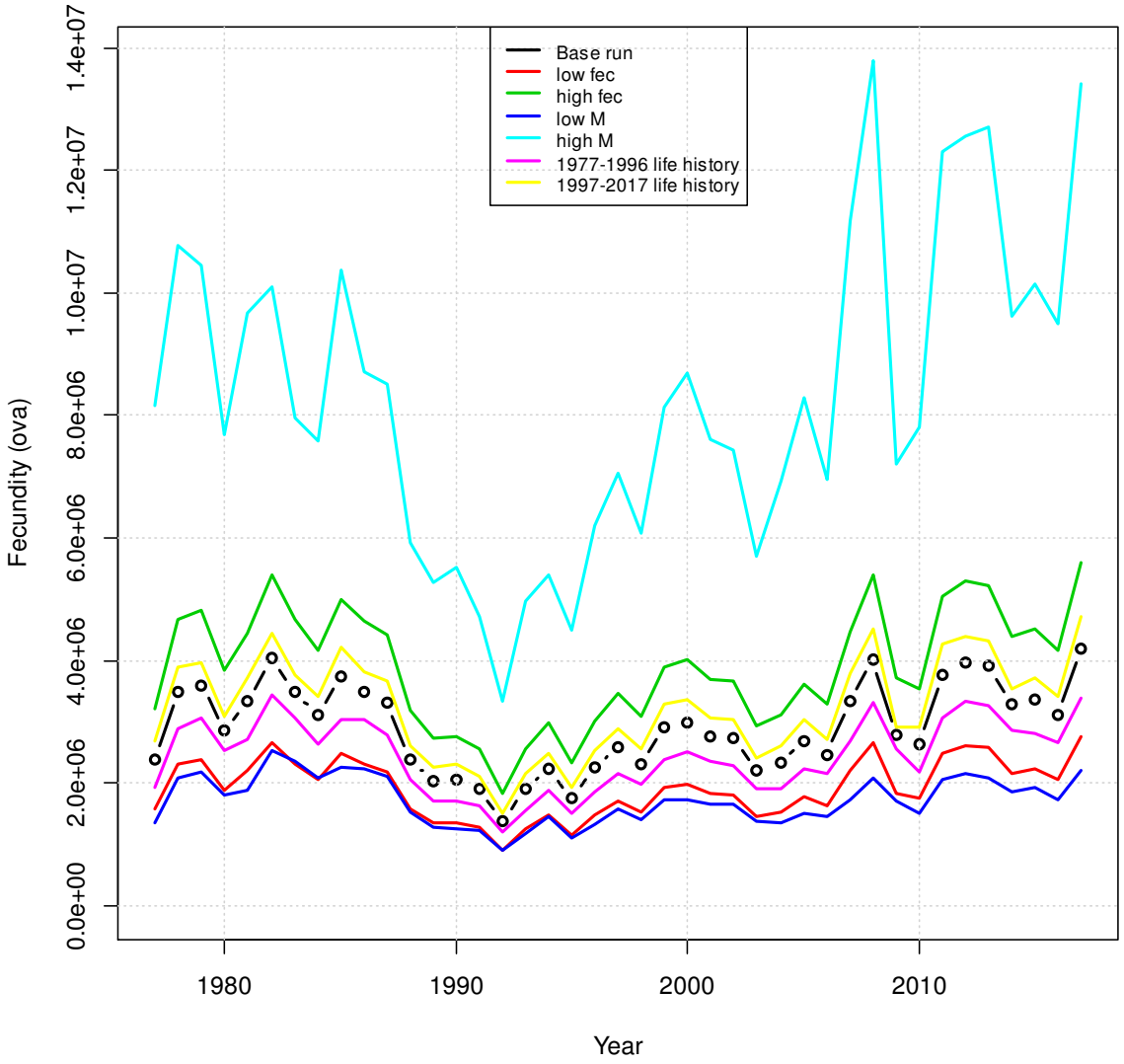

Base run
cR sel age-3 & 4 = 1.0
cR sel age-3 & 4 = 0.73
cR sel age-3 and 4 at midpt
Biomass (1000 mt)
0
500
1000
1500
2000
2500
3000
1980
1990
2000
2010
Year

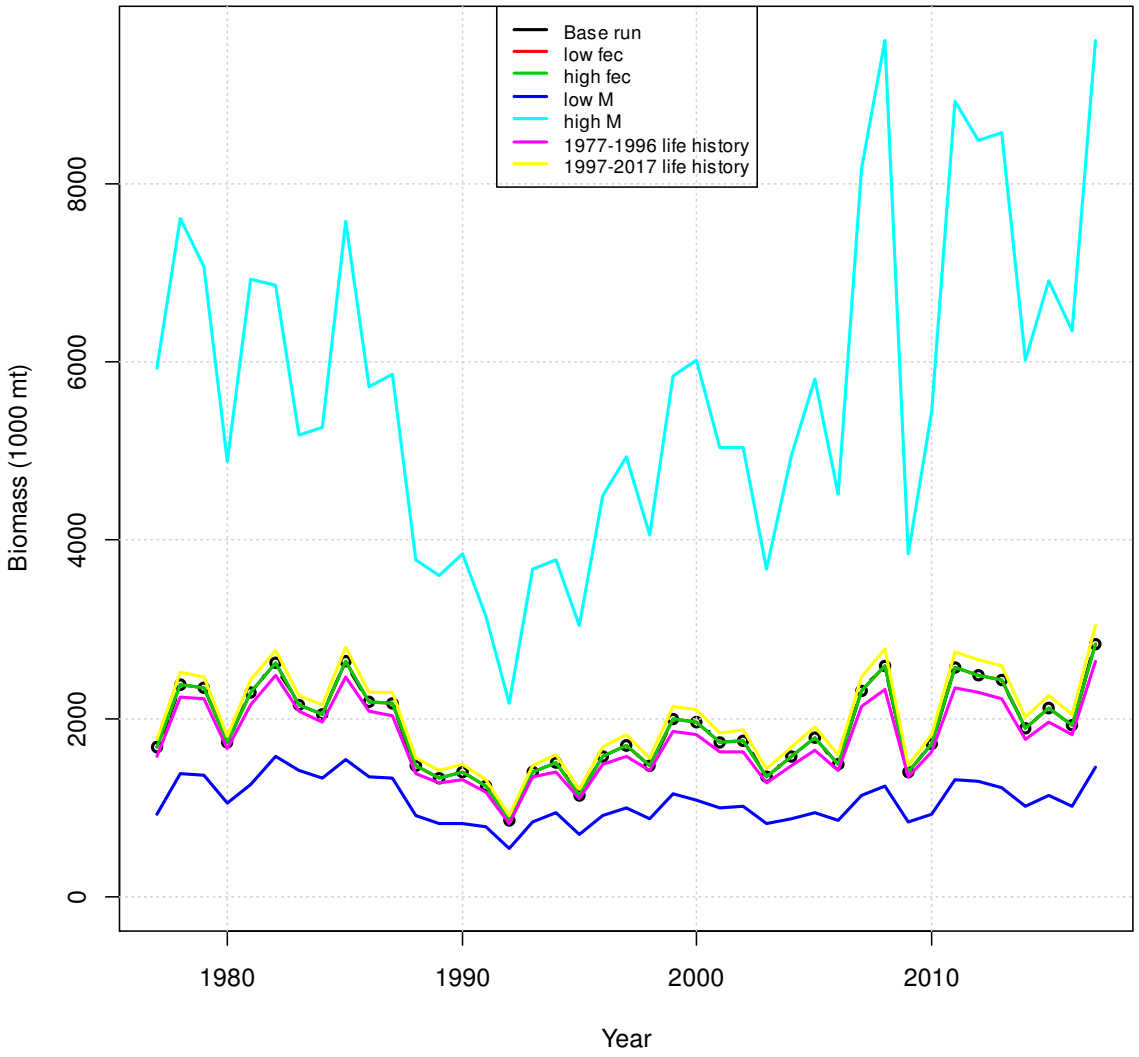
Sensitivity analyses

- Low and high fecundity vectors
- Low and high M
- Life history
  - 1977-1996 growth cover 1977-2107 years
  - 1997-2017 growth cover 1977-2017 years


Base run
low fec
high fec
low M
high M
1977-1996 life history
1997-2017 life history
Full F
0.0
0.5
1.0
1.5
2.0
2.5
1980
1990
2000
2010
Year

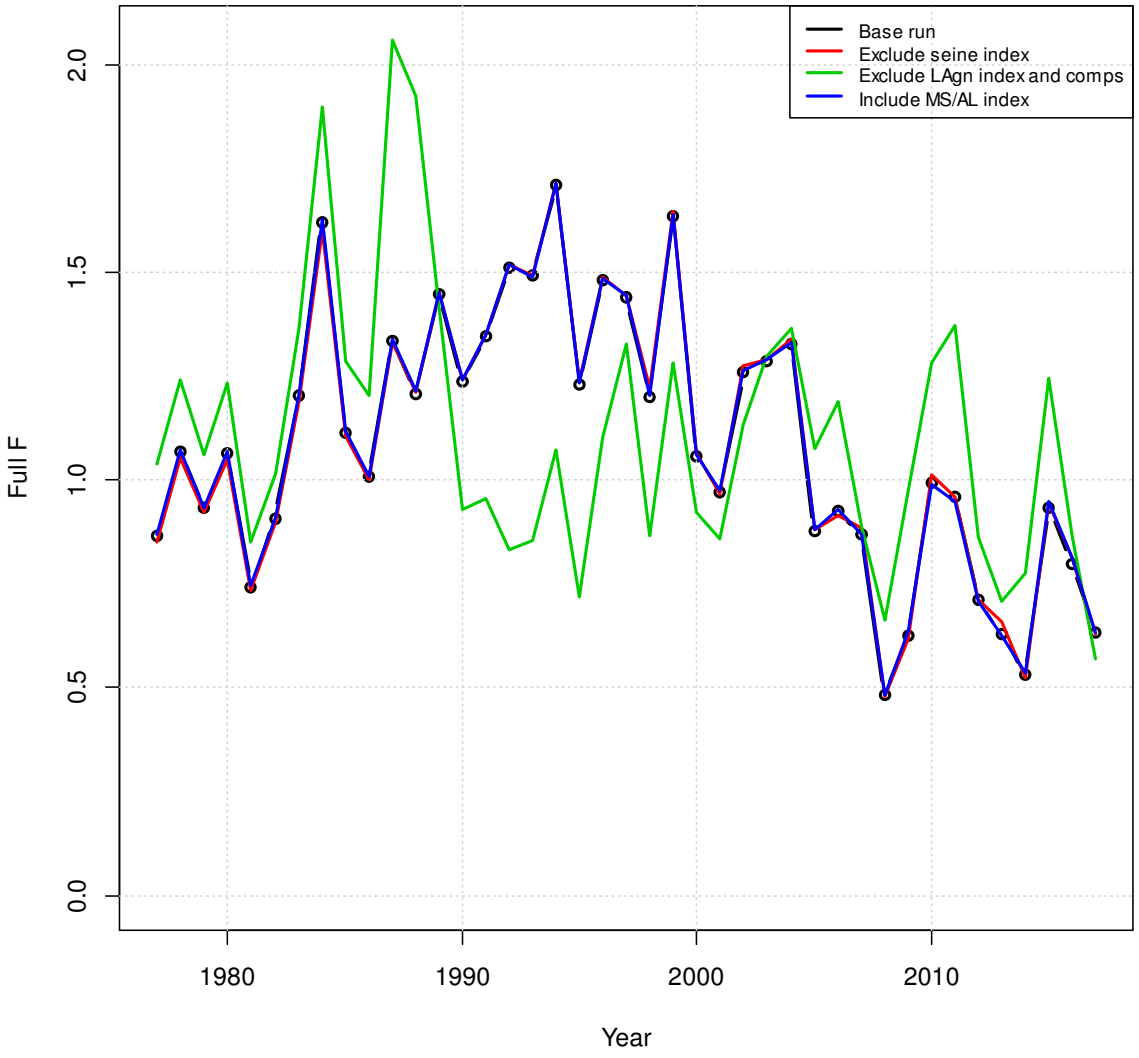

Base run
low fec
high fec
low M
high M
1977-1996 life history
1997-2017 life history
Recruits (billions)
0
500
1000
1500
1980
1990
2000
2010
Year

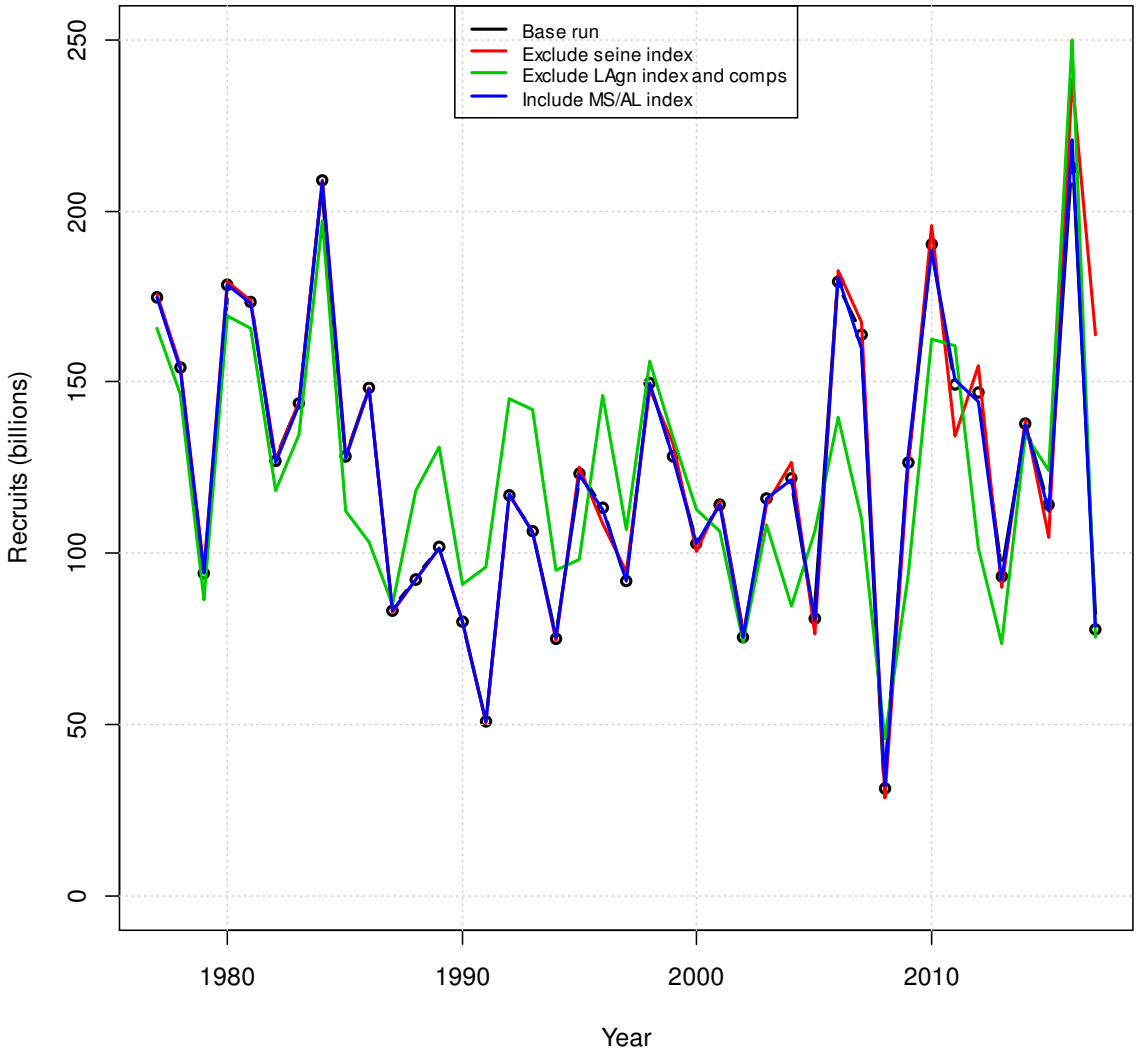

Base run
low fec
high fec
low M
high M
1977-1996 life history
1997-2017 life history
Fecundity (ova)
0.0e+00
2.0e+06
4.0e+06
6.0e+06
8.0e+06
1.0e+07
1.2e+07
1.4e+07
1980
1990
2000
2010
Year

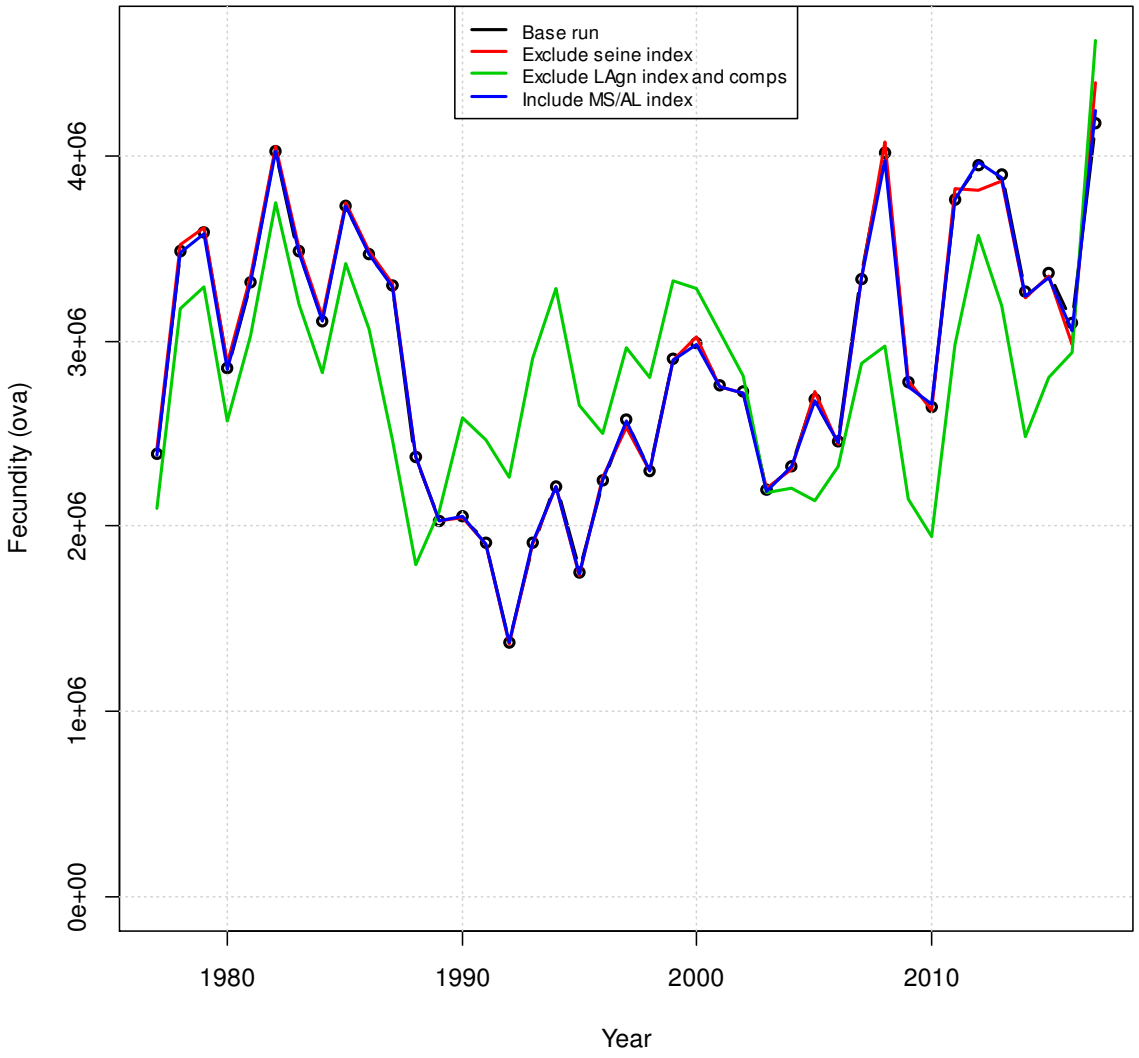

Base run
low fec
high fec
low M
high M
1977-1996 life history
1997-2017 life history
Biomass (1000 mt)
0
2000
4000
6000
8000
1980
1990
2000
2010
Year

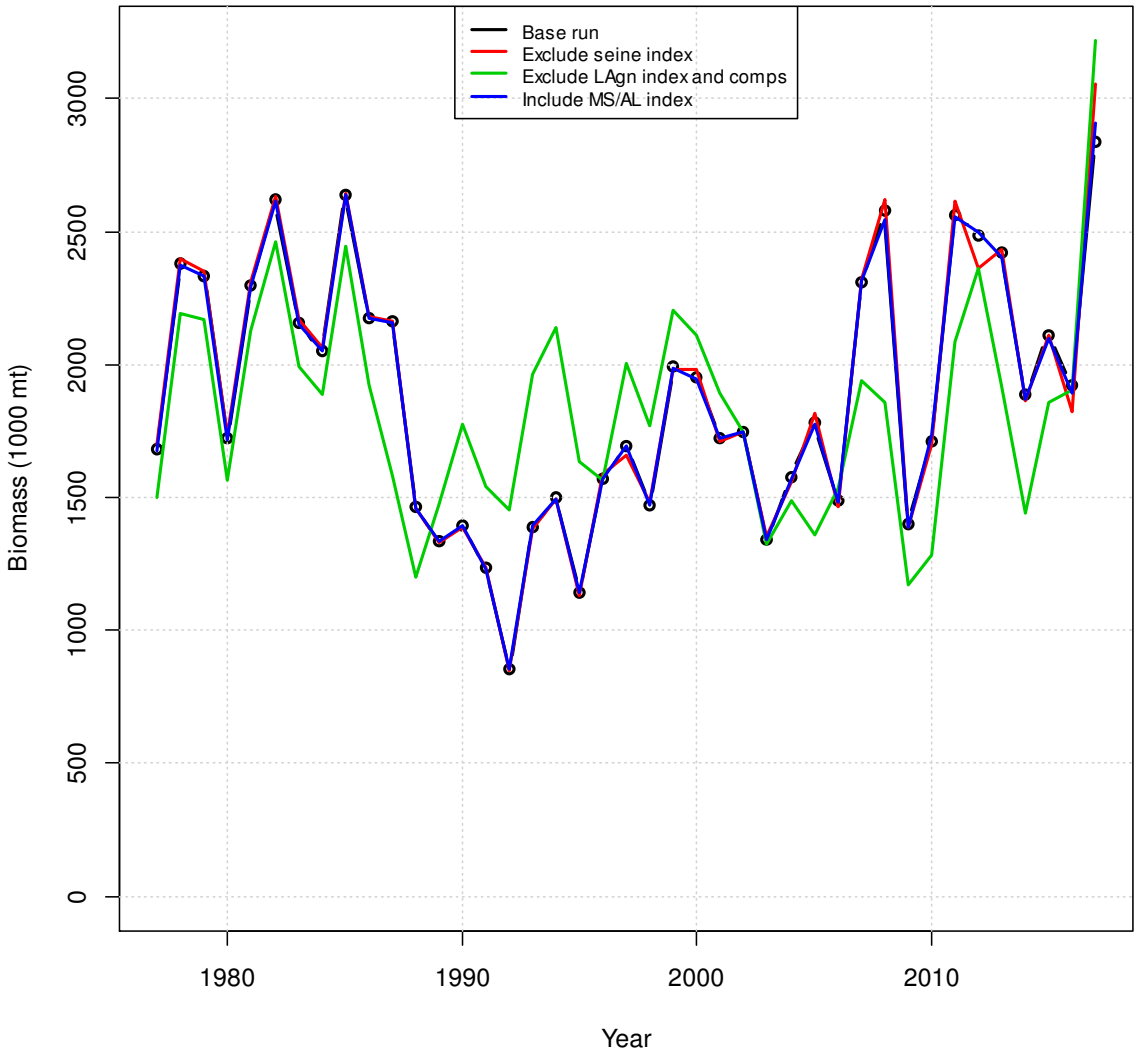
Sensitivity analyses

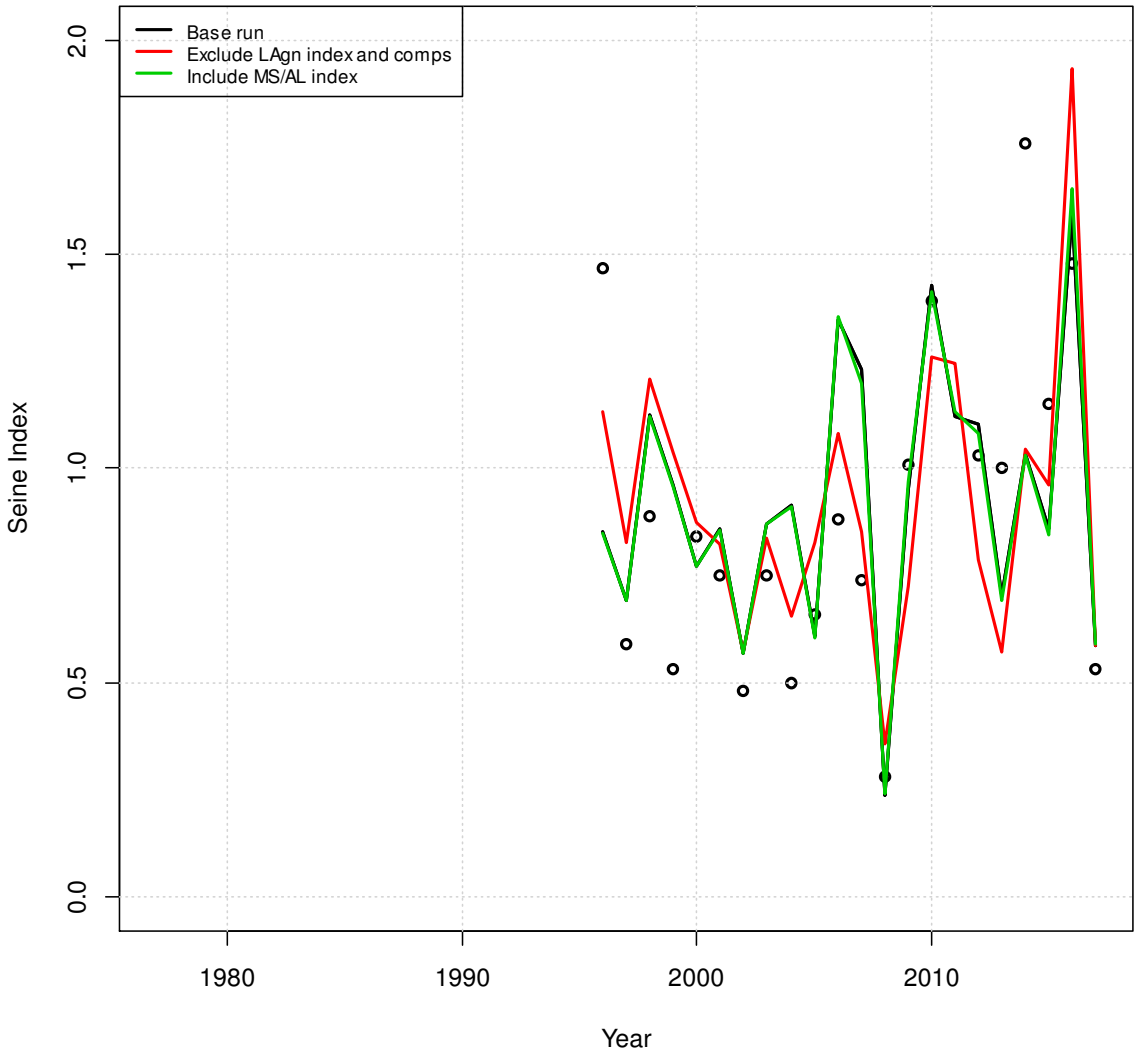
- Exclude seine index
- Exclude LA gill net index and composition data
- Include MS/AL gill net index and composition data


Base run
Exclude seine index
Exclude LAgn index and comps
Include MS/AL index
Full F
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010
Year


Base run
Exclude seine index
Exclude LAgn index and comps
Include MS/AL index
Recruits (billions)
0
50
100
150
200
250
1980
1990
2000
2010
Year

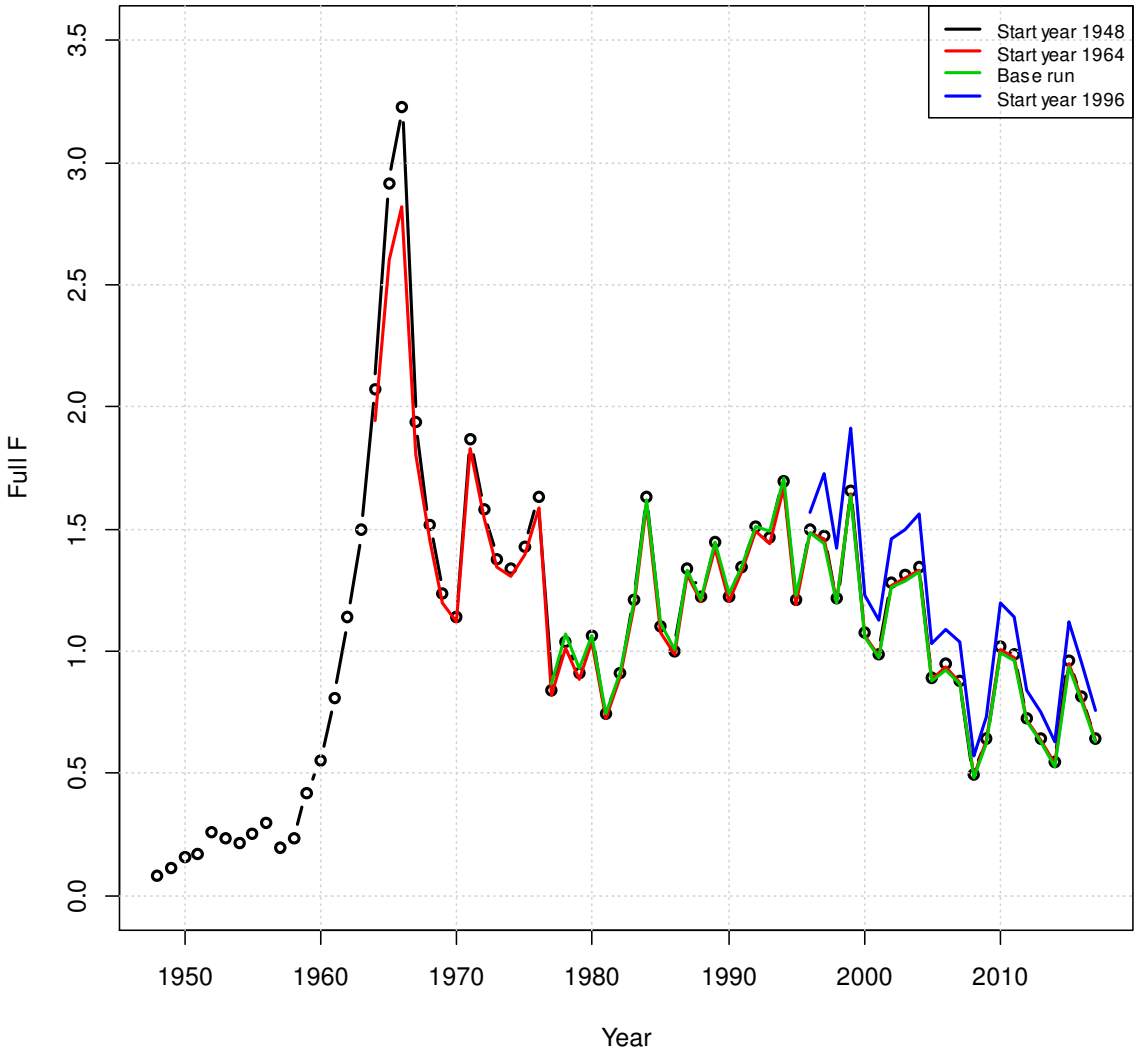

Base run
Exclude seine index
Exclude LAgn index and comps
Include MS/AL index
Fecundity (ova)
0e+00
1e+06
2e+06
3e+06
4e+06
1980
1990
2000
2010
Year

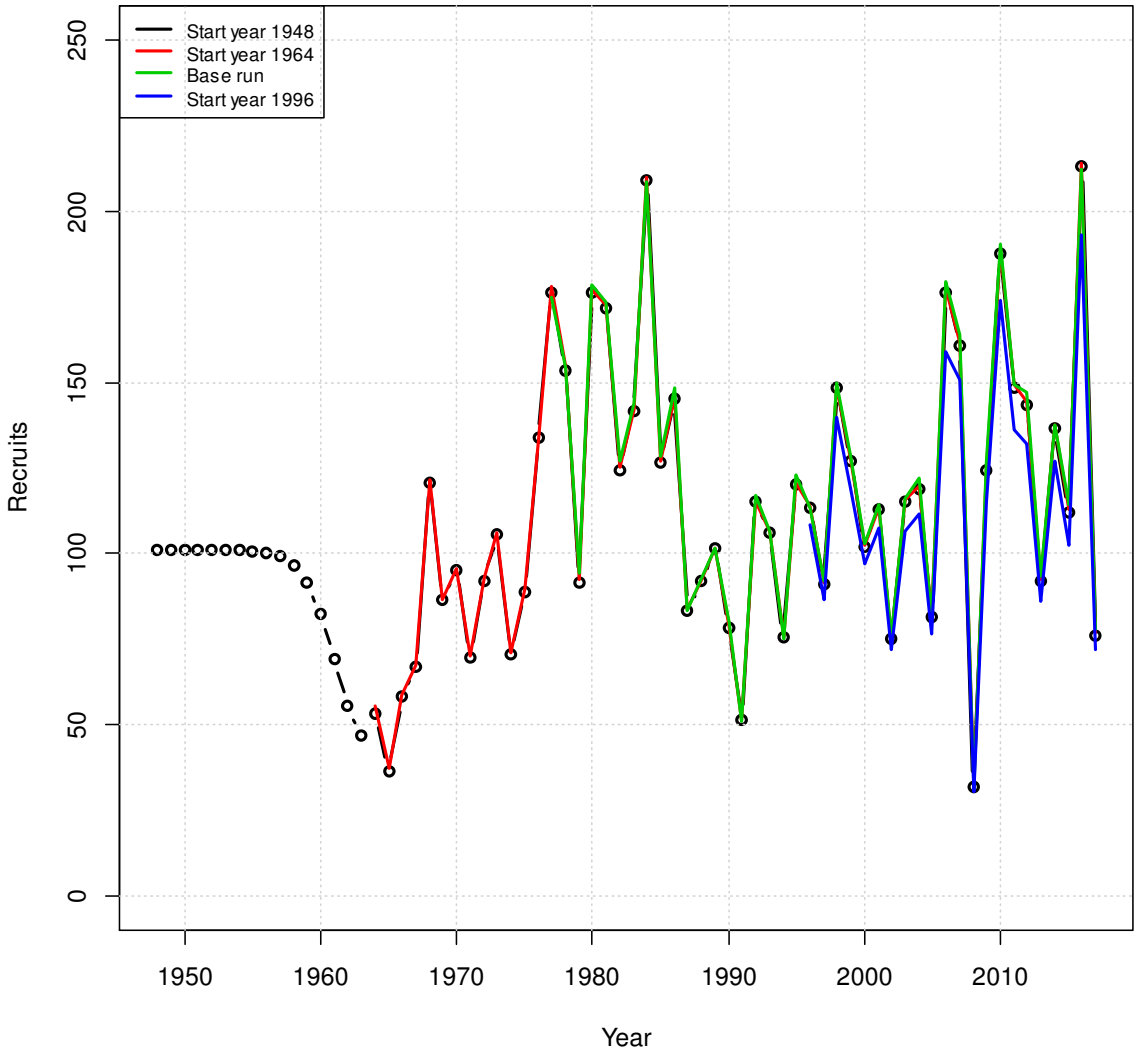

Base run
Exclude seine index
Exclude LAgn index and comps
Include MS/AL index
Biomass (1000 mt)
0
500
1000
1500
2000
2500
3000
1980
1990
2000
2010
Year

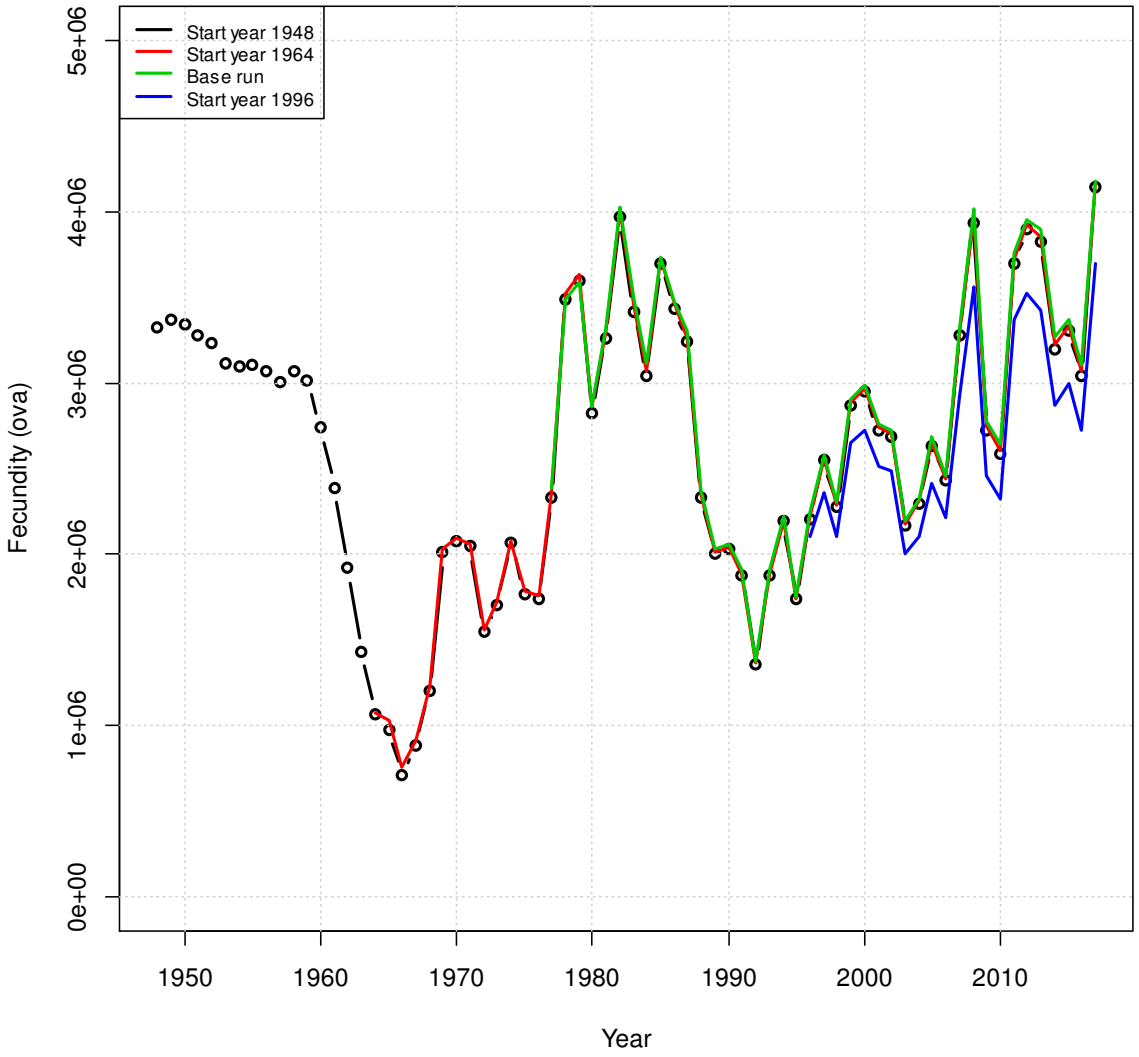

Base run
Exclude LAgn index and comps
Include MS/AL index
Seine Index
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010
Year

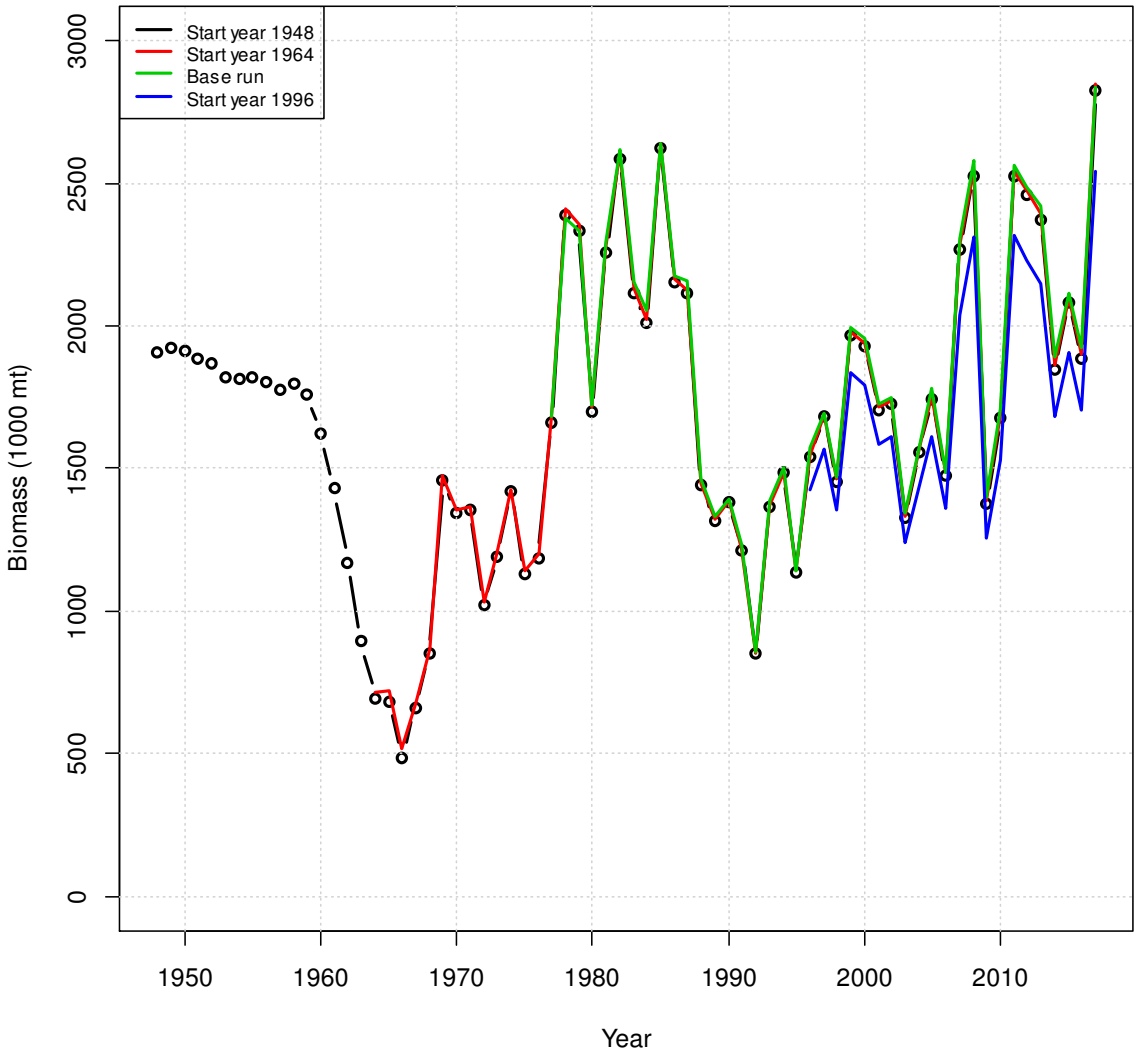
Sensitivity analyses

- Start year of model = 1948
- Start year of model = 1964
- Start year of model = 1996


Start year 1948
Start year 1964
Base run
Start year 1996
Full F
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1950
1960
1970
1980
1990
2000
2010
Year

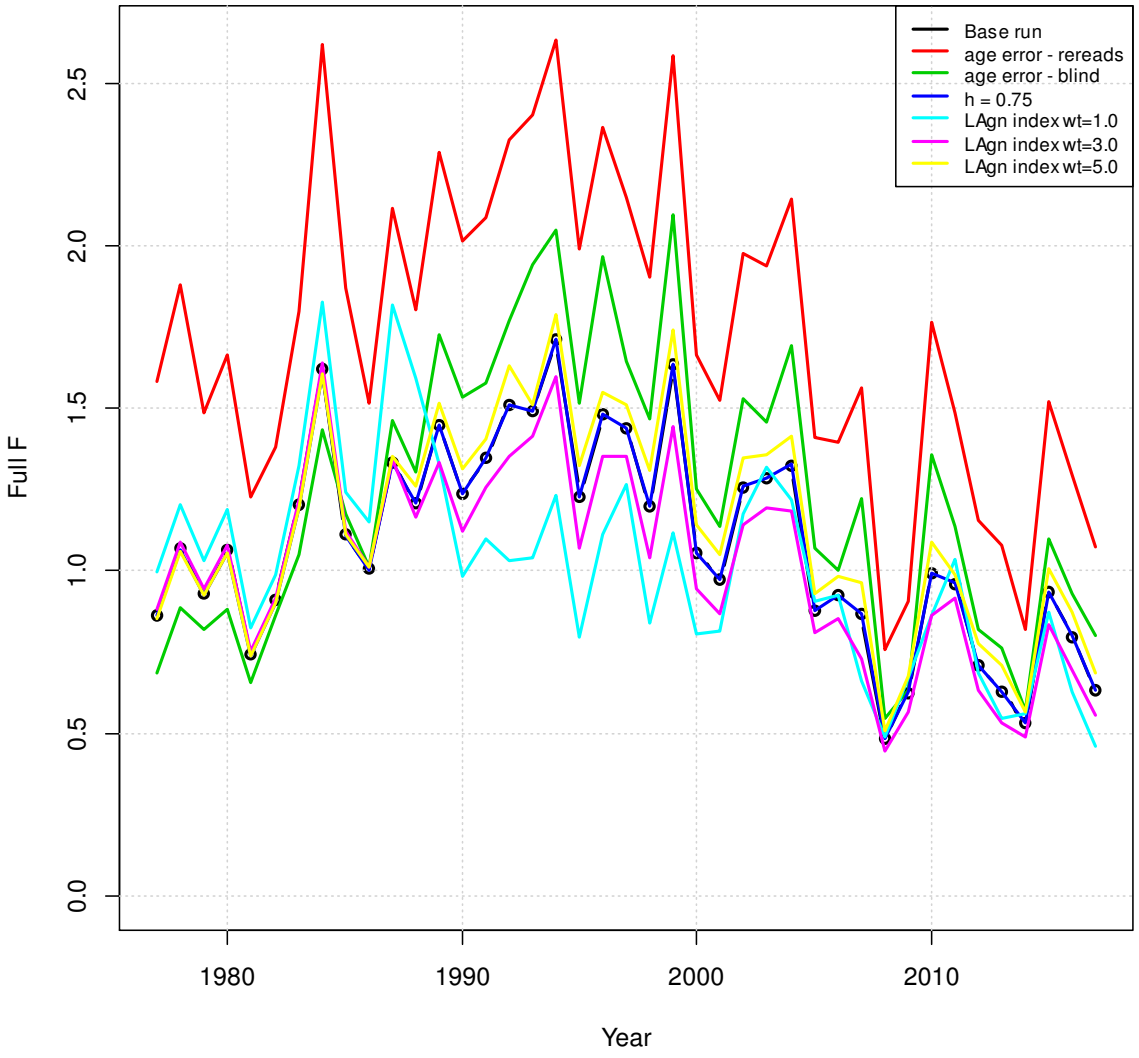

Start year 1948
Start year 1964
Base run
Start year 1996
Recruits
0
50
100
150
200
250
1950
1960
1970
1980
1990
2000
2010
Year

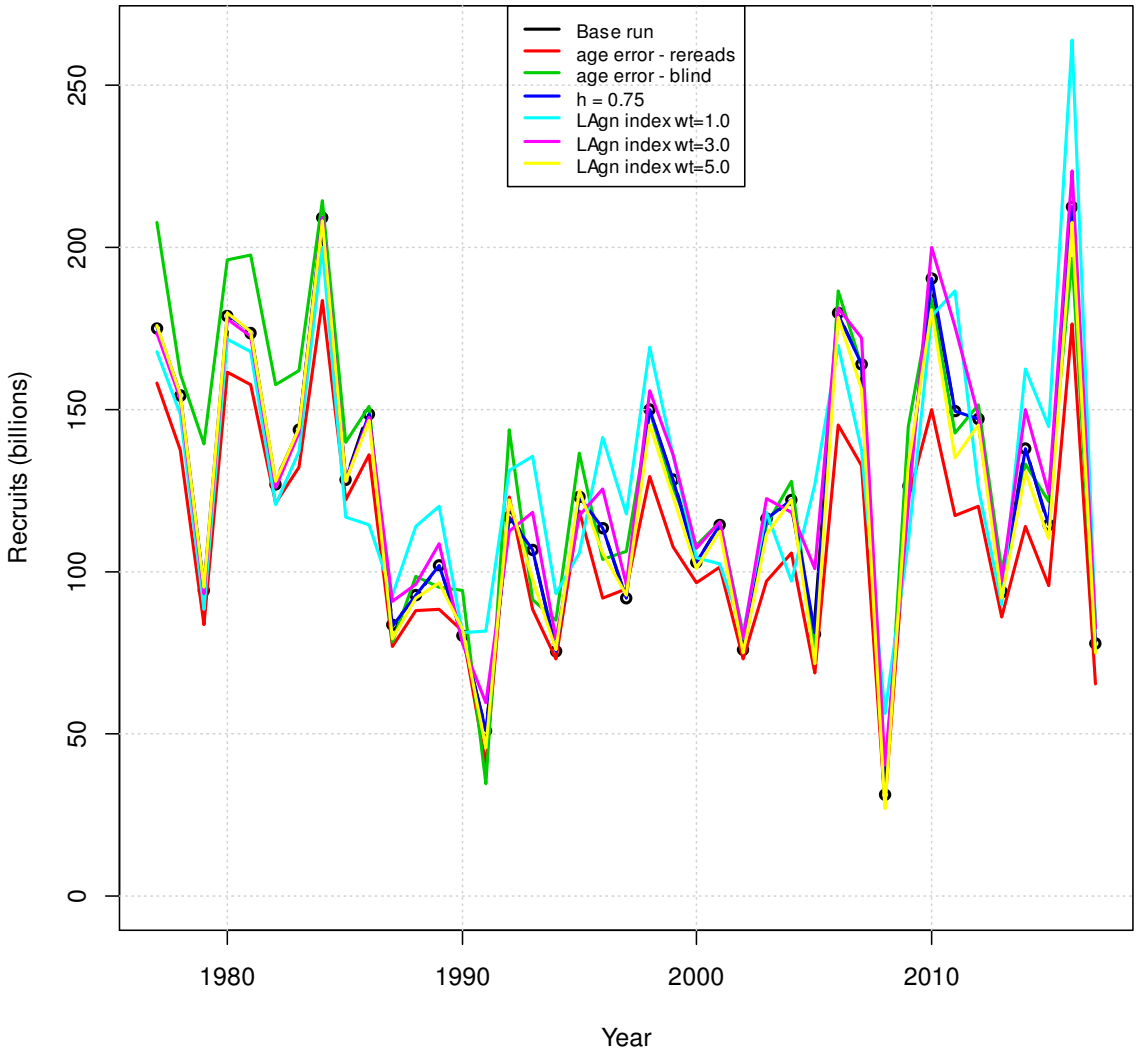

Start year 1948
Start year 1964
Base run
Start year 1996
Fecundity (ova)
0e+00
1e+06
2e+06
3e+06
4e+06
5e+06
1950
1960
1970
1980
1990
2000
2010
Year

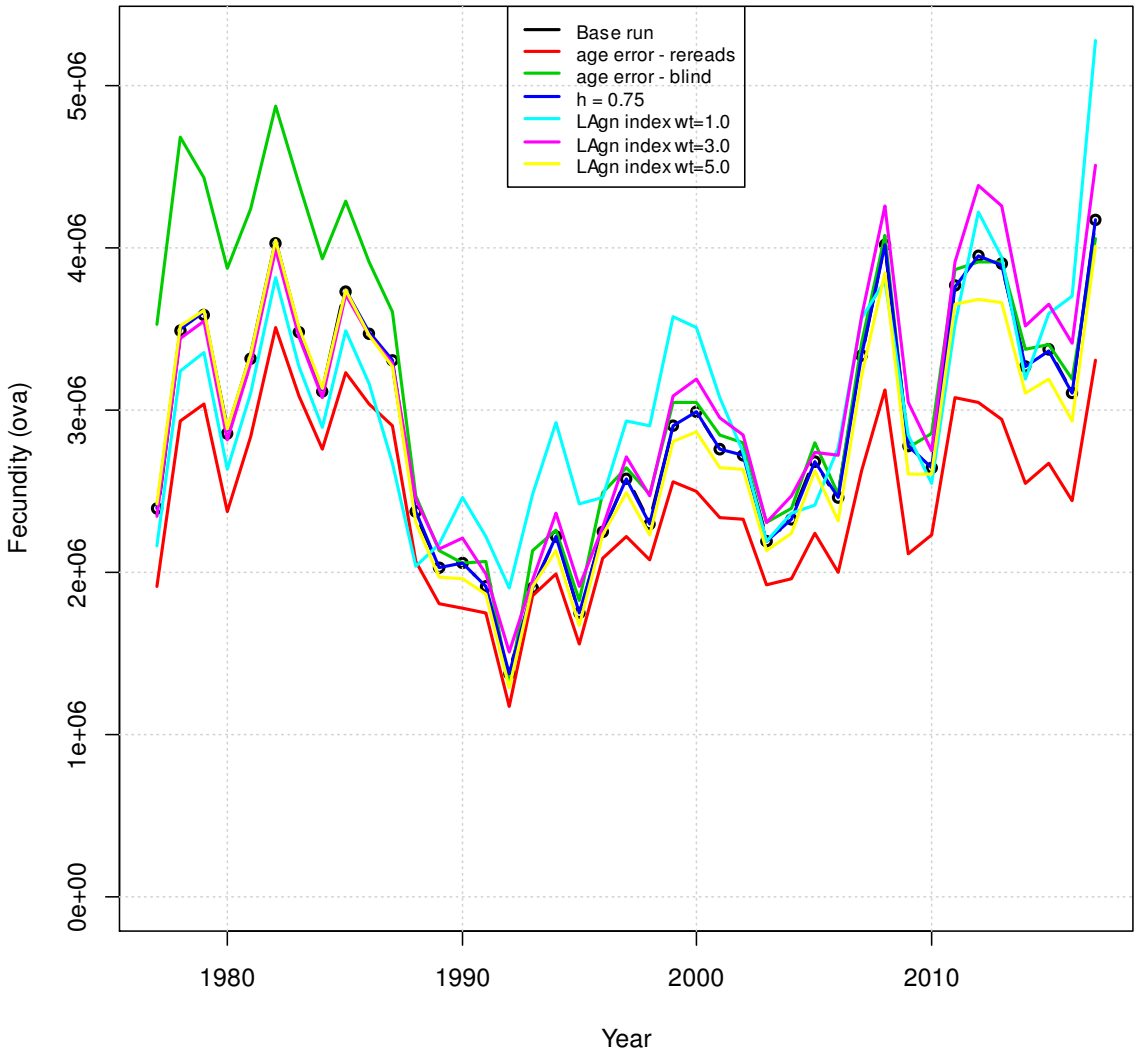

Start year 1948
Start year 1964
Base run
Start year 1996
Biomass (1000 mt)
0
500
1000
1500
2000
2500
3000
1950
1960
1970
1980
1990
2000
2010
Year

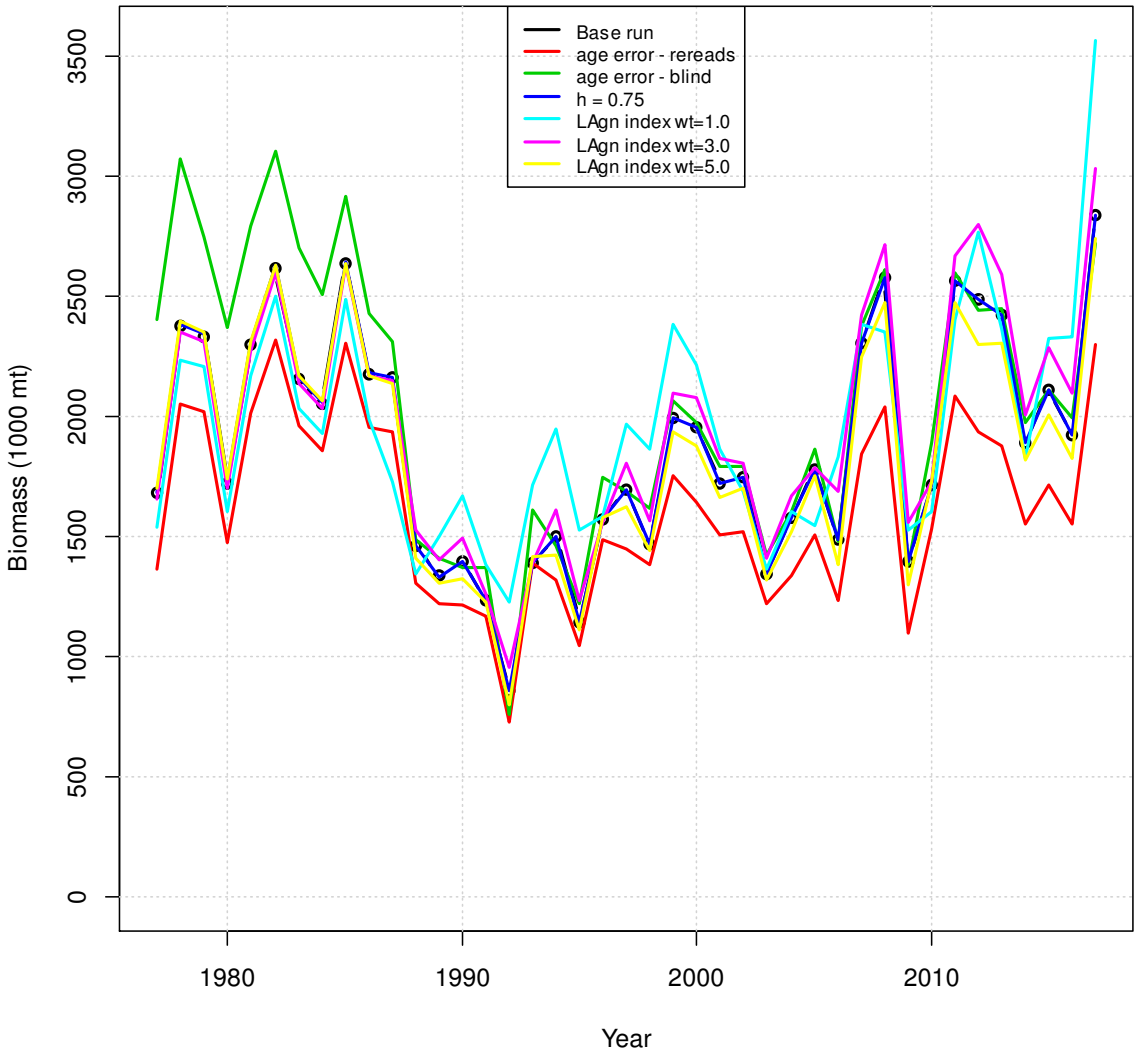
Sensitivity analyses

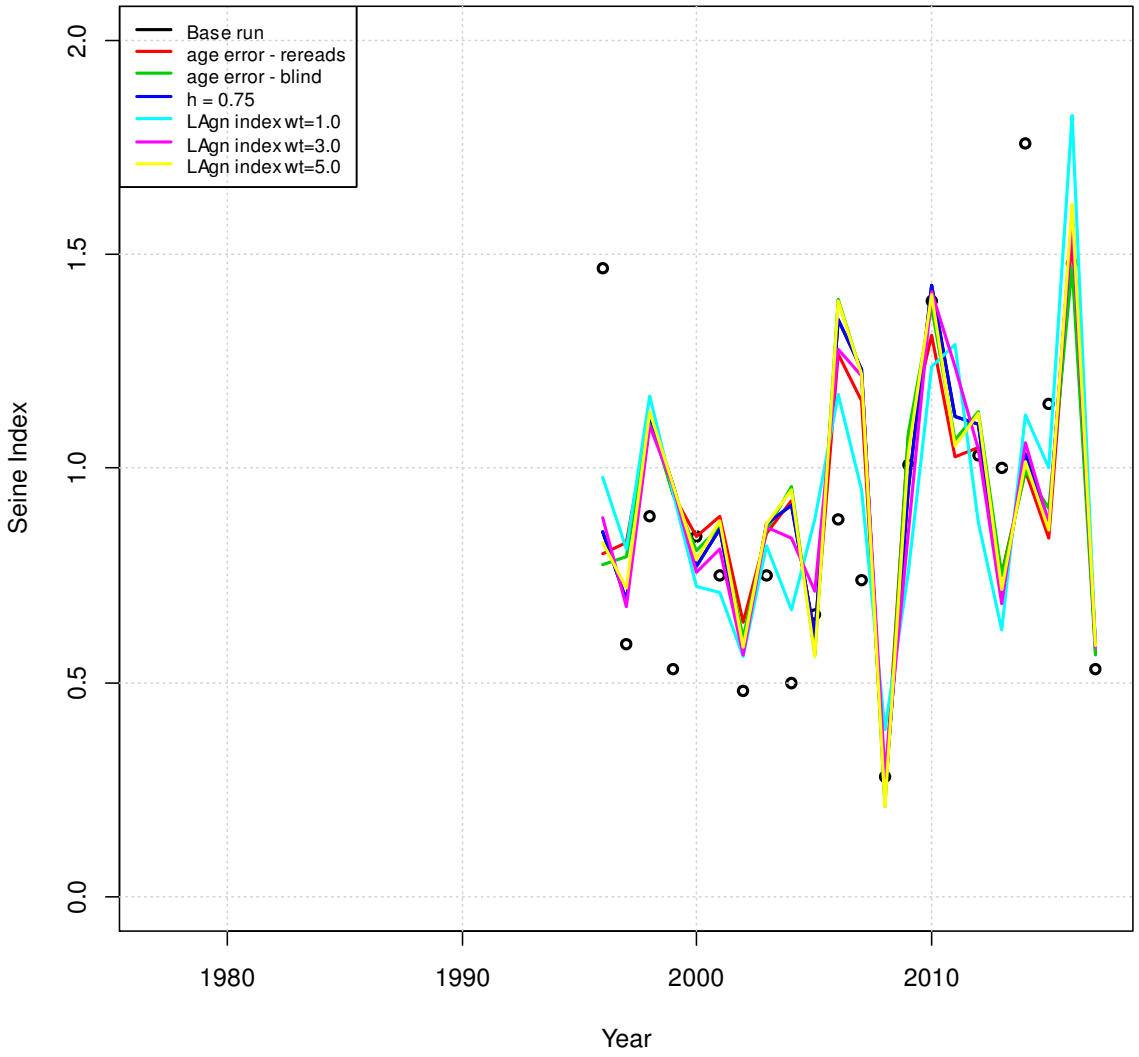
- Ageing error (2) – Ethel, Amanda/Kasea
- Steepness – 0.75
- Weight of 1.0, 3.0, and 5.0 on gill net index likelihood

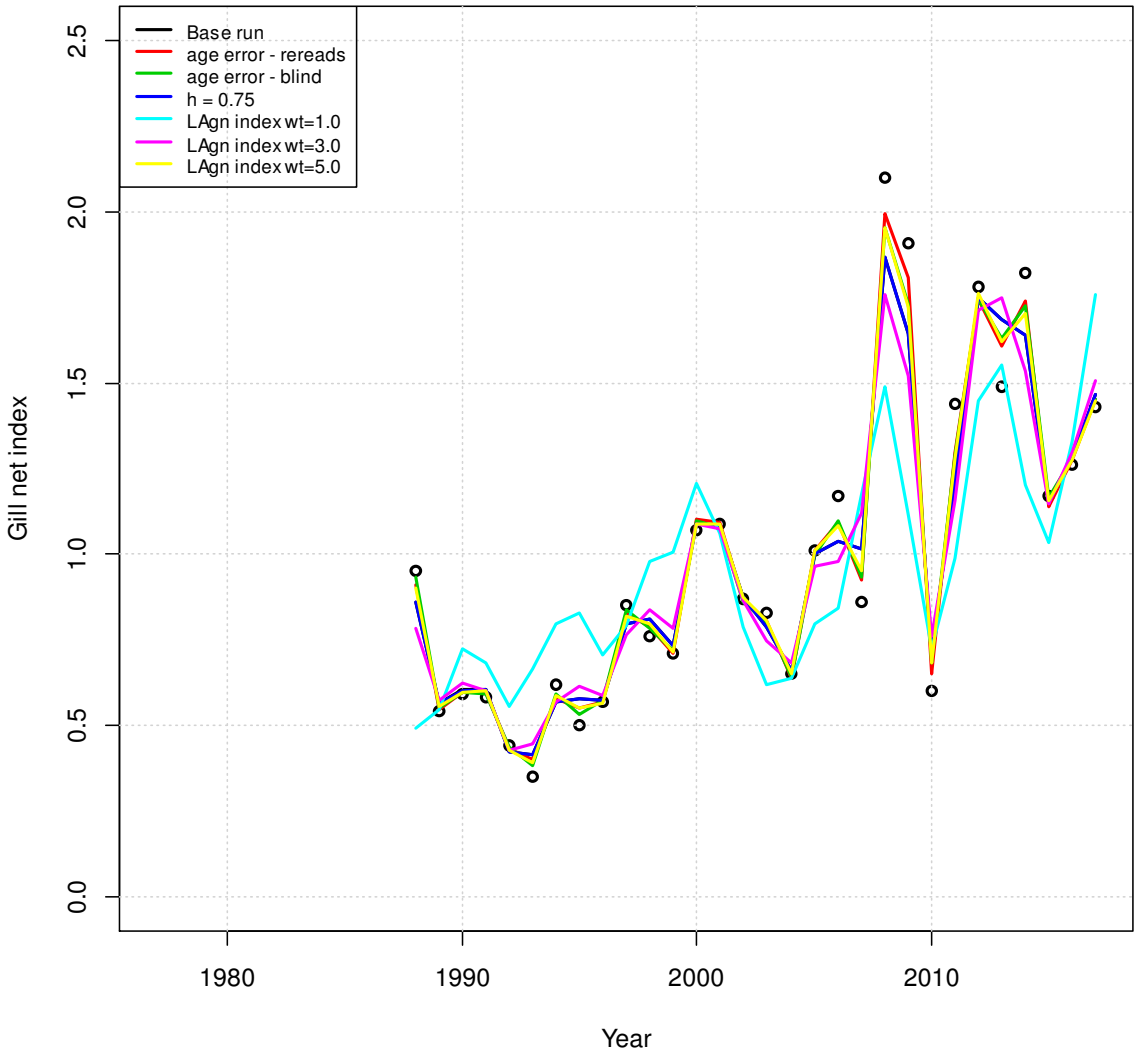

Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
Full F
0.0
0.5
1.0
1.5
2.0
2.5
1980
1990
2000
2010
Year


Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
Recruits (billions)
0
50
100
150
200
250
1980
1990
2000
2010
Year


Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
Fecundity (ova)
0e+00
1e+06
2e+06
3e+06
4e+06
5e+06
1980
1990
2000
2010
Year

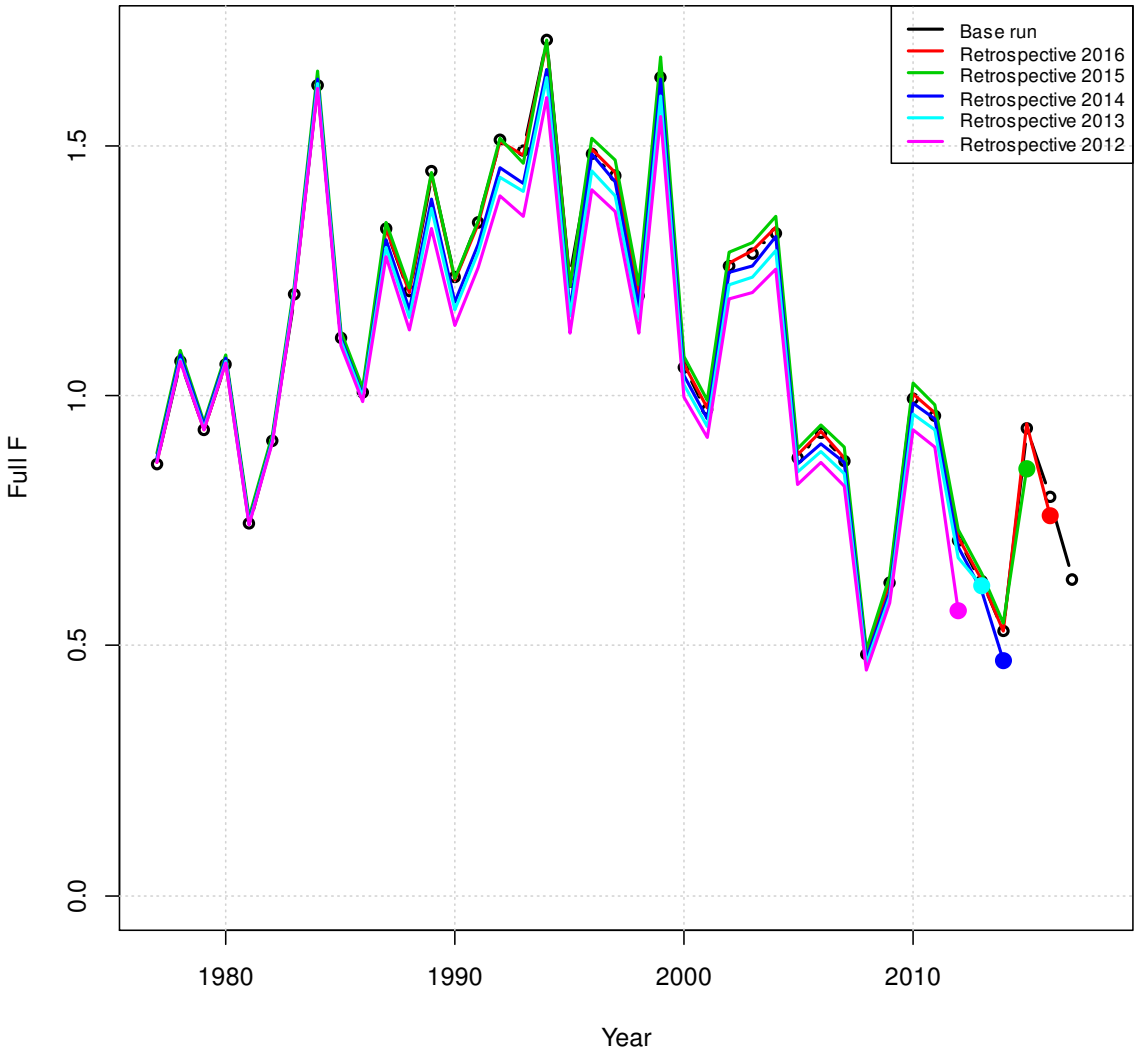

Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
Biomass (1000 mt)
0
500
1000
1500
2000
2500
3000
3500
1980
1990
2000
2010
Year

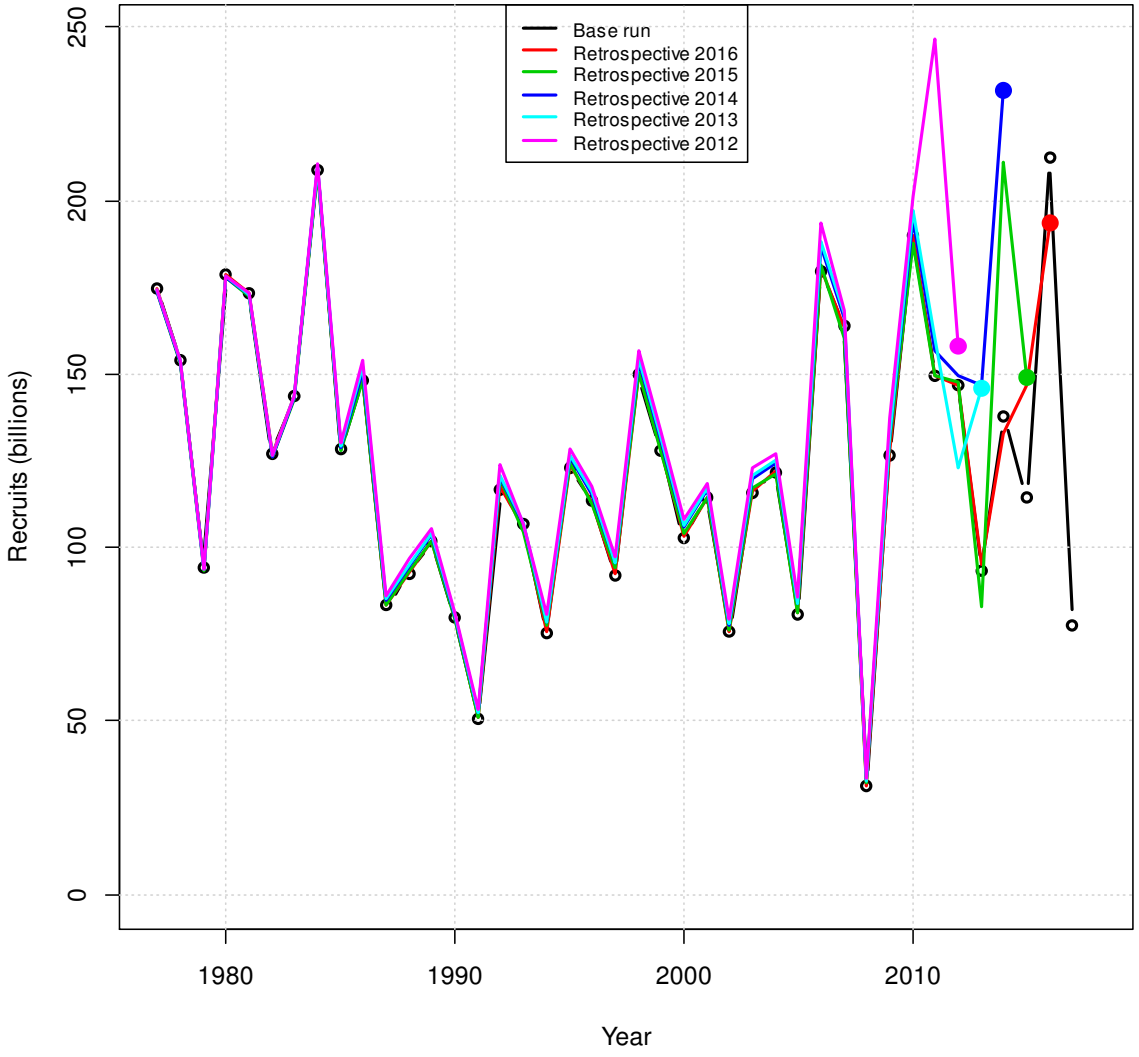

Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
Seine Index
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010
Year

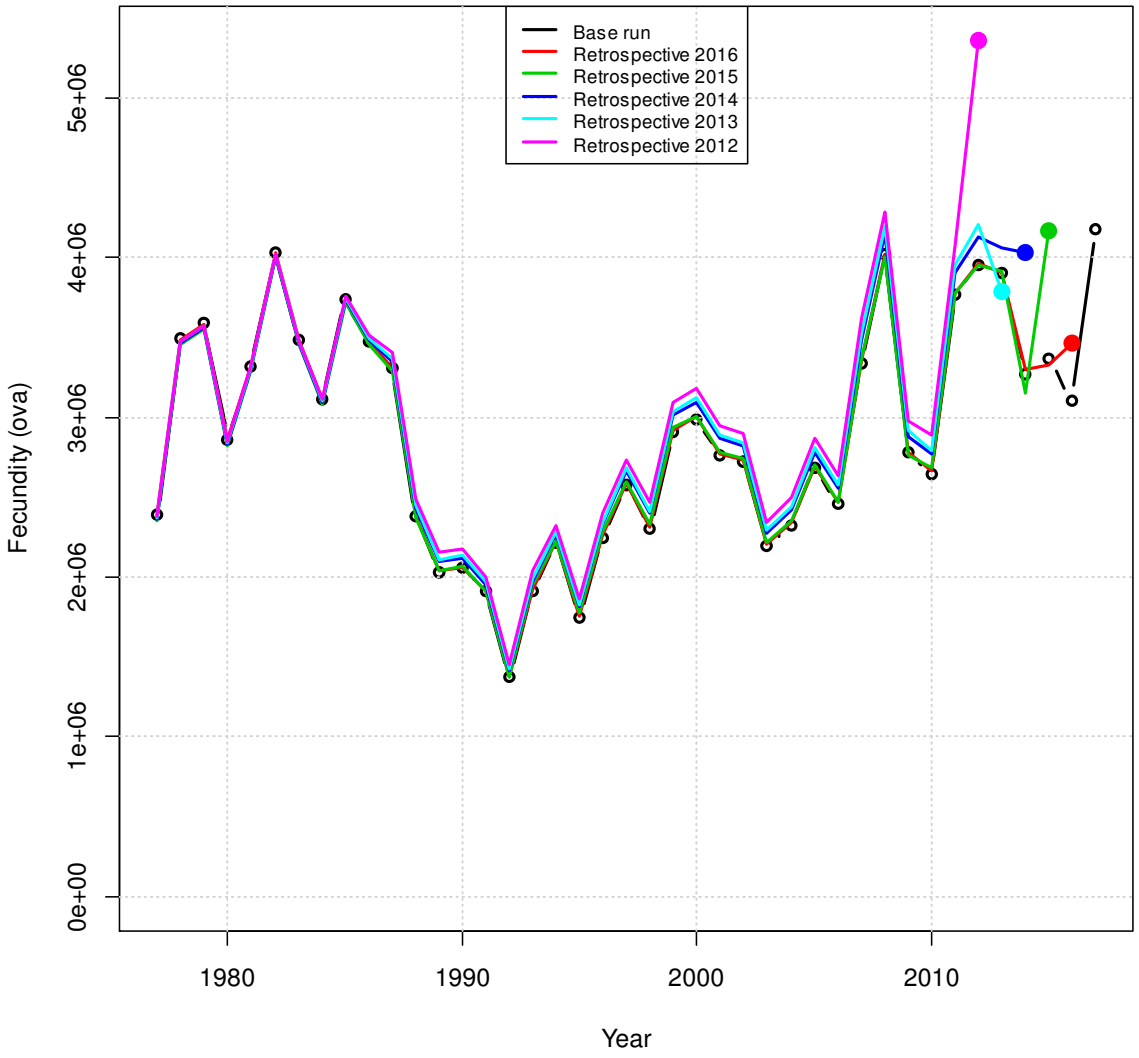

Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
Gill net index
0.0
0.5
1.0
1.5
2.0
2.5
1980
1990
2000
2010
Year

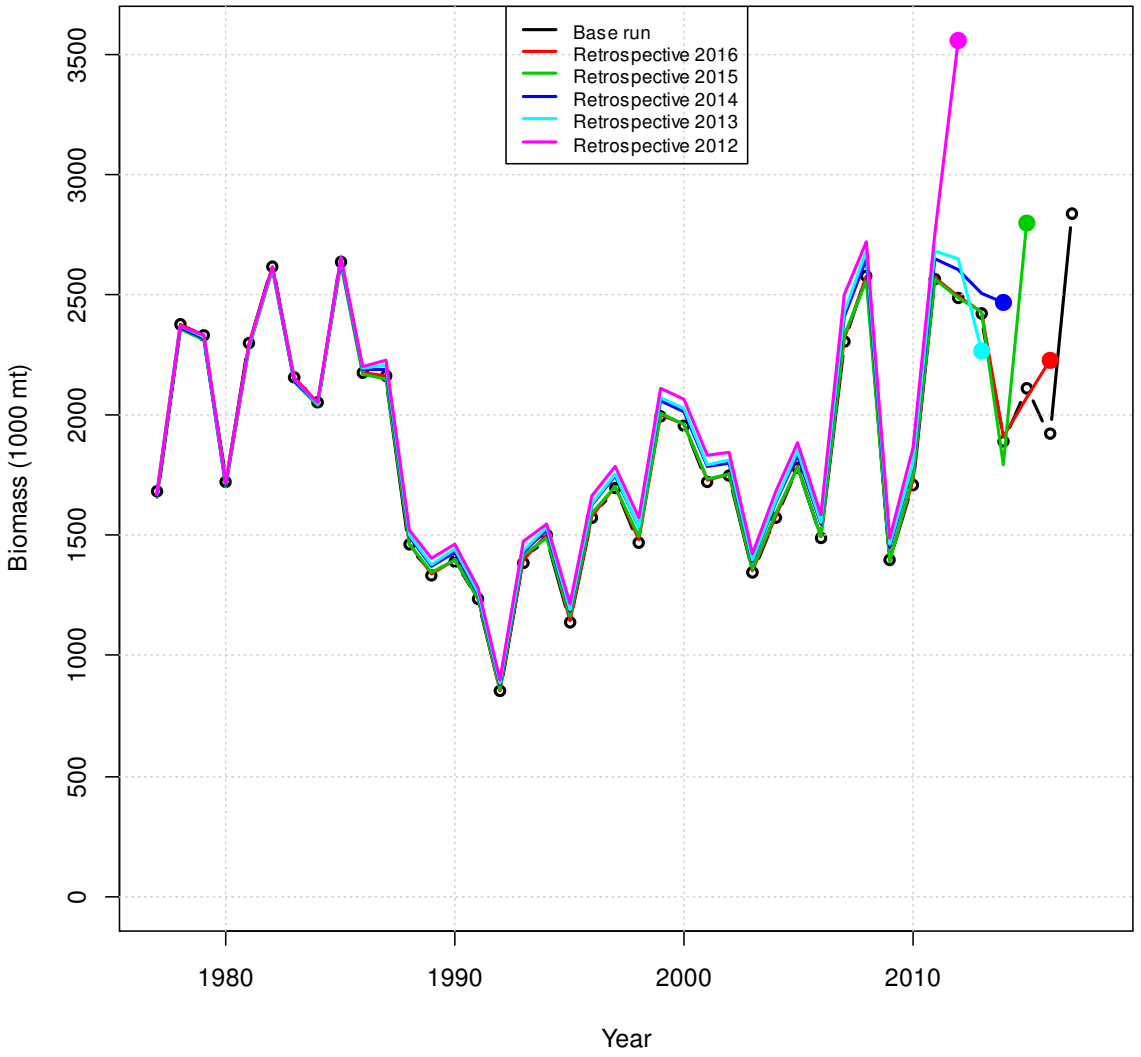
Sensitivity analyses

- Retrospective


Base run
Retrospective 2016
Retrospective 2015
Retrospective 2014
Retrospective 2013
Retrospective 2012
Full F
0.0
0.5
1.0
1.5
1980
1990
2000
2010
Year


Base run
Retrospective 2016
Retrospective 2015
Retrospective 2014
Retrospective 2013
Retrospective 2012
Recruits (billions)
0
50
100
150
200
250
1980
1990
2000
2010
Year


Base run
Retrospective 2016
Retrospective 2015
Retrospective 2014
Retrospective 2013
Retrospective 2012
Fecundity (ova)
0e+00
1e+06
2e+06
3e+06
4e+06
5e+06
1980
1990
2000
2010
Year


Base run
Retrospective 2016
Retrospective 2015
Retrospective 2014
Retrospective 2013
Retrospective 2012
Biomass (1000 mt)
0
500
1000
1500
2000
2500
3000
3500
1980
1990
2000
2010
Year

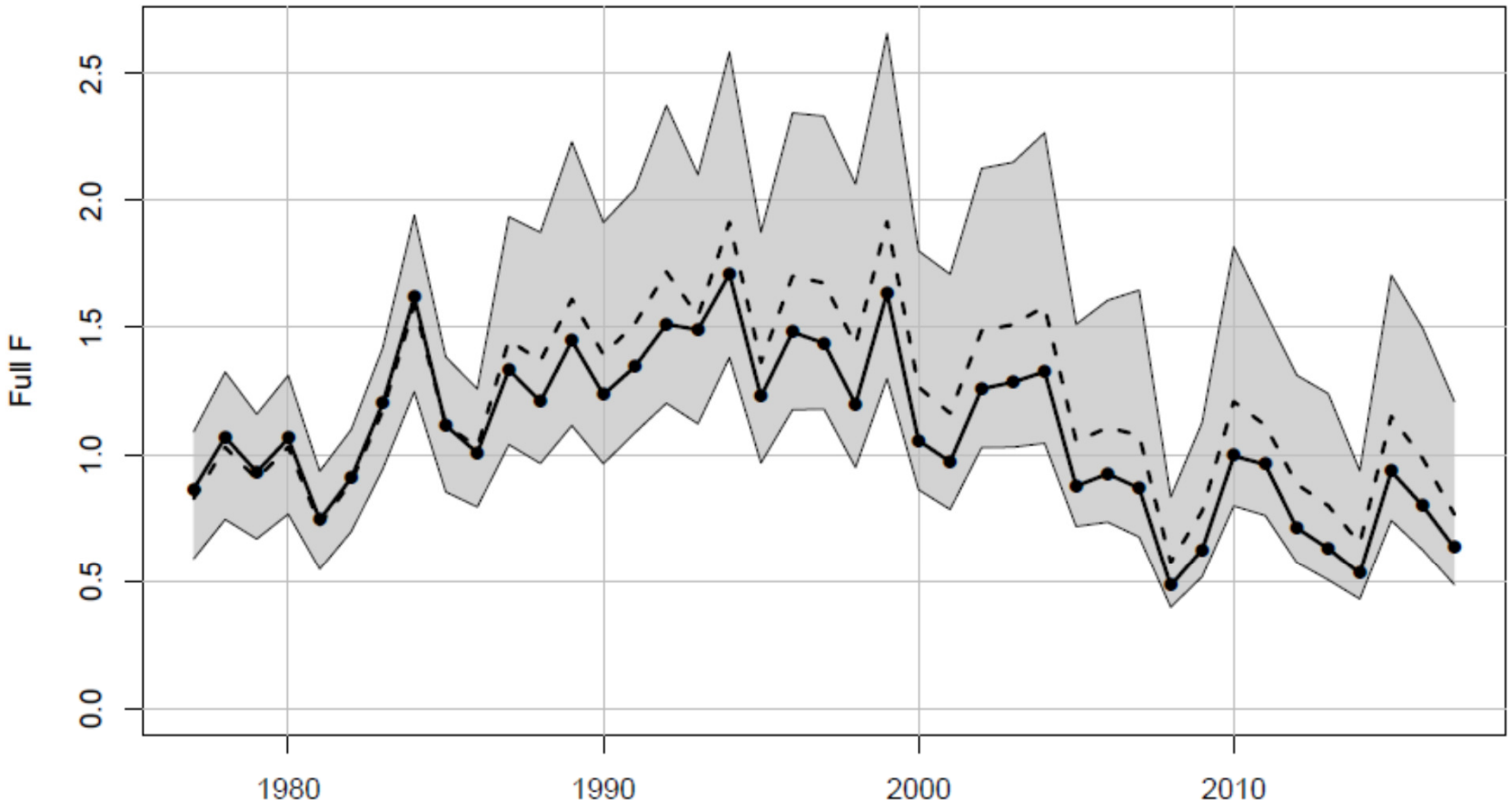
Outline

- Data included
- Base run configuration
- Sensitivity analyses
- Monte Carlo bootstrap
- Projections
- Benchmarks

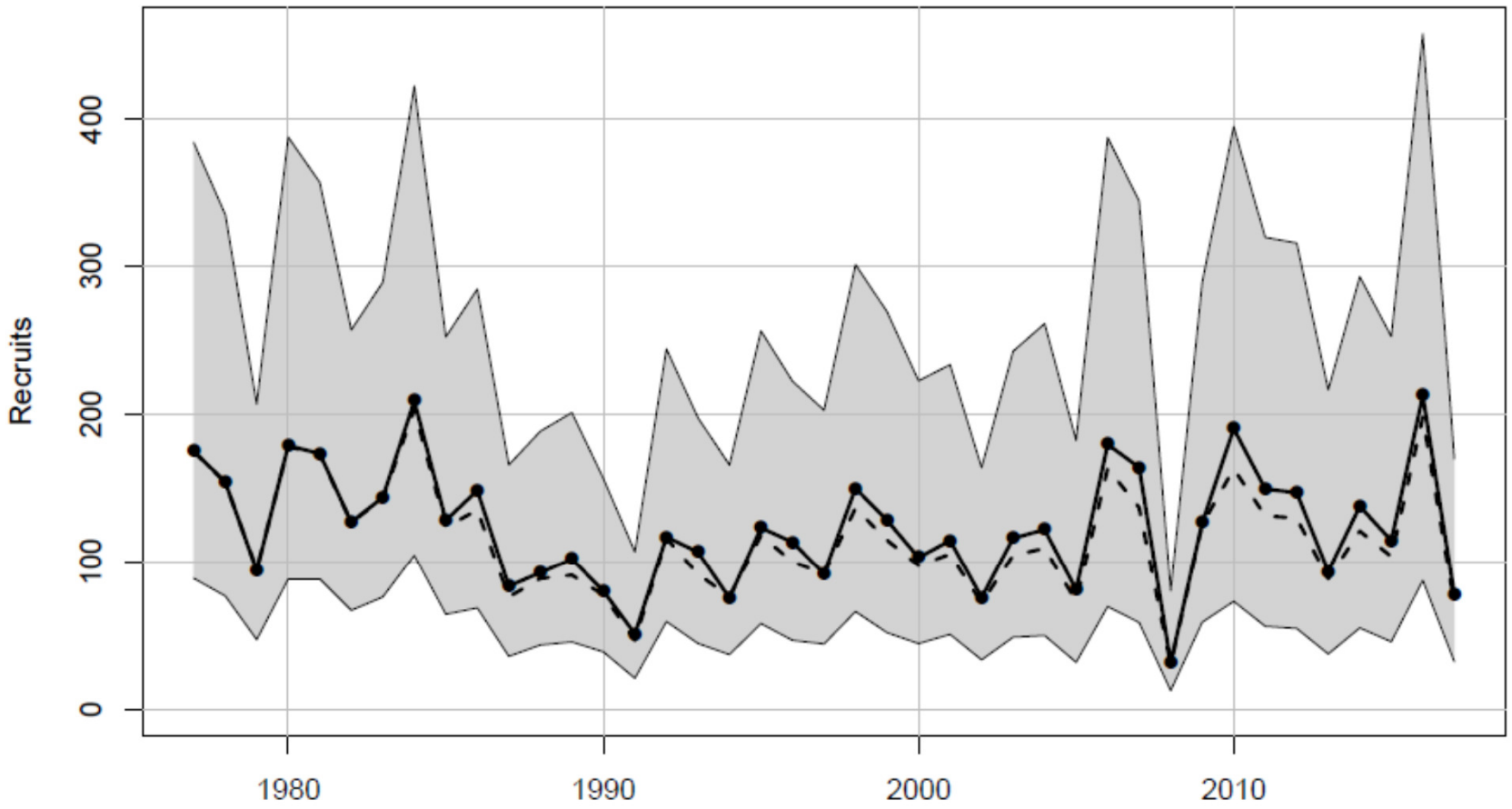
Monte Carlo bootstrap configuration

- Include uncertainty in:
  - Landings
  - Indices
  - Composition data
  - Age-3 and 4 cR sel
    - uniform [0.68, 0.95]
  - M
    - M at age-2 [0.69, 1.51], scaled Lorenzen

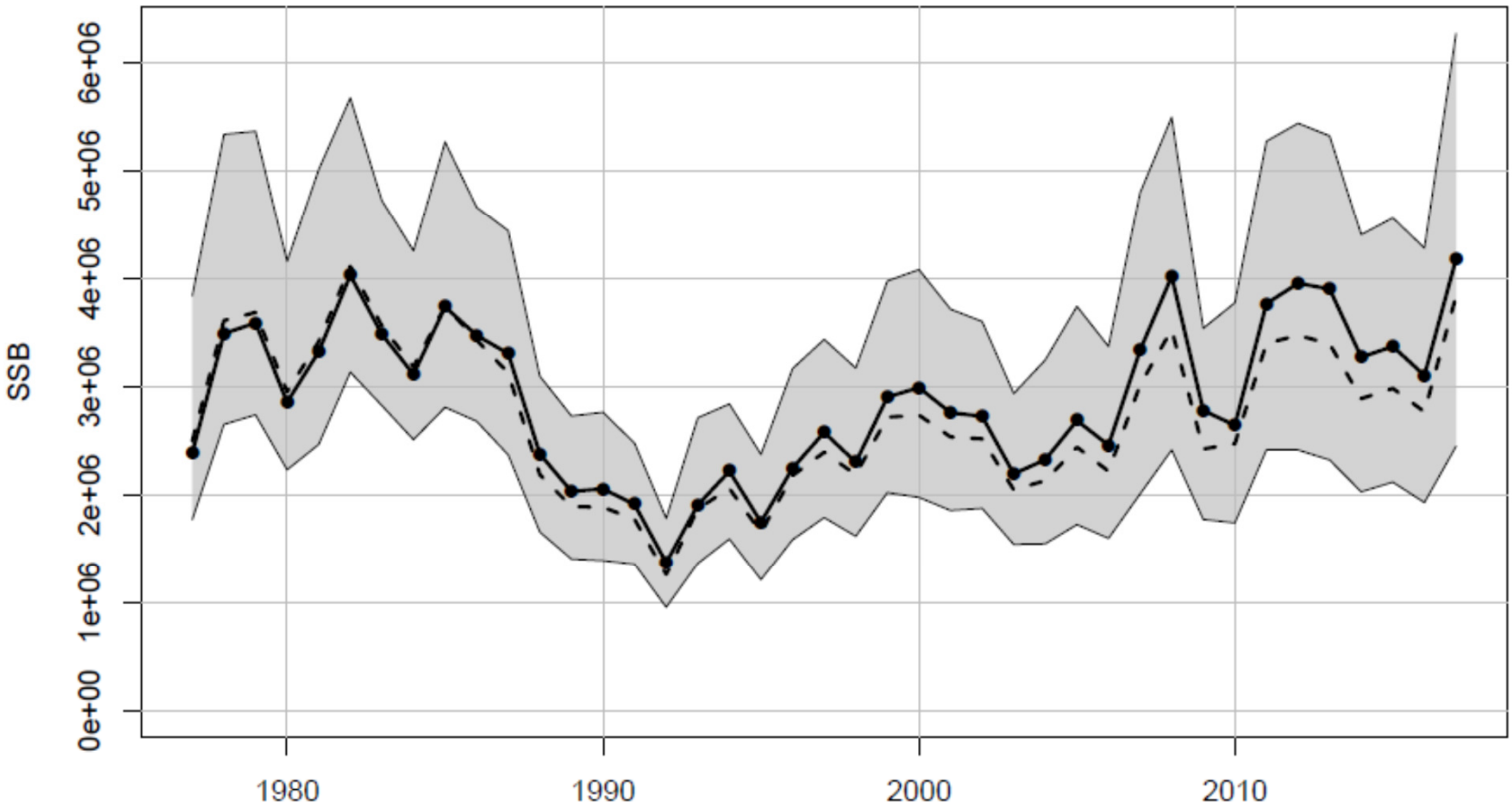
Monte Carlo bootstrap



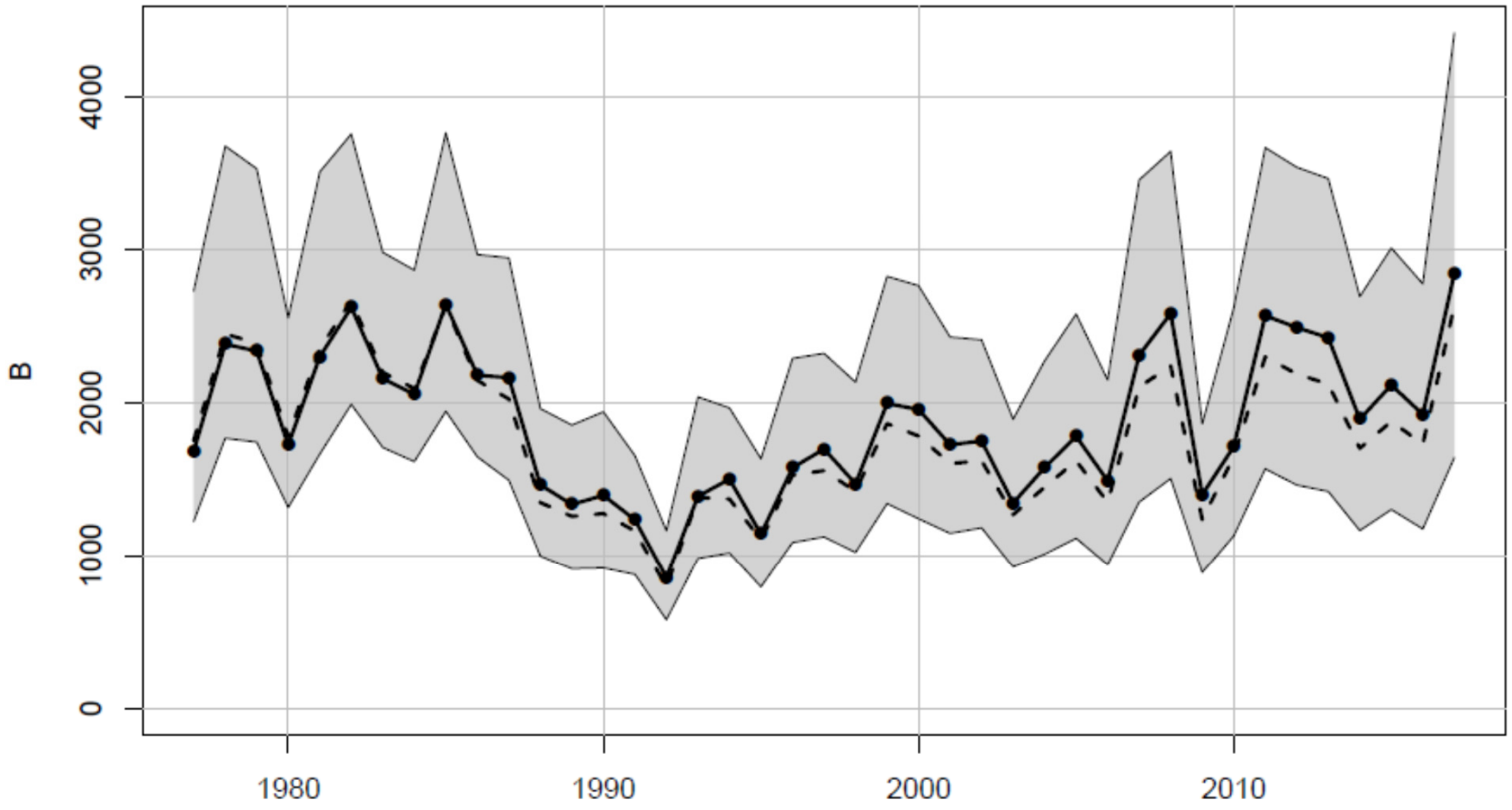
Monte Carlo bootstrap



Monte Carlo bootstrap



Monte Carlo bootstrap



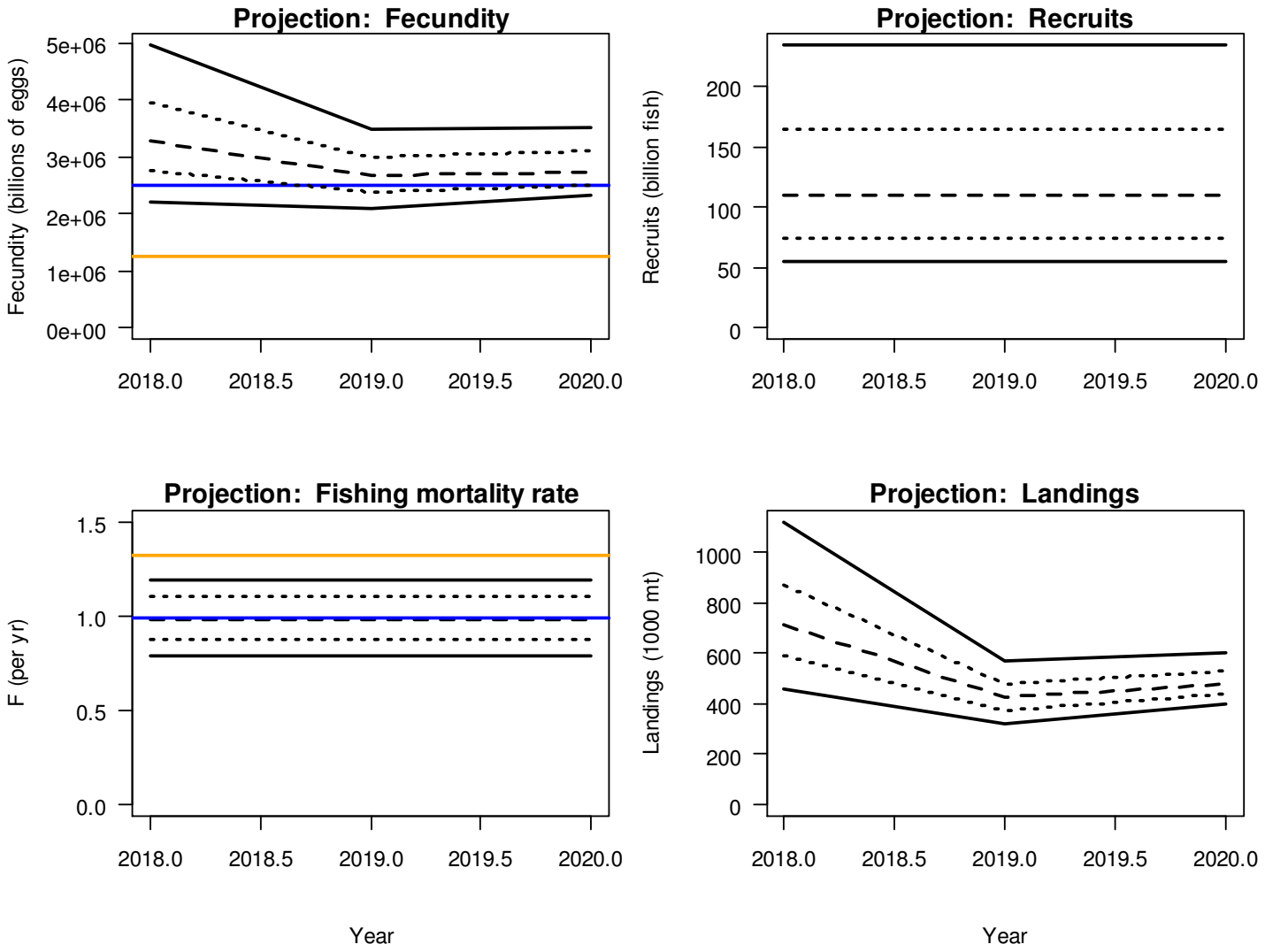
Outline

- Data included
- Base run configuration
- Sensitivity analyses
- Monte Carlo bootstrap
- Projections
- Benchmarks

Projections

- Project 3 years
- Use uncertainty as described in MCB runs
- Project F at F=0.75M
- Recruitment
  - Reflecting recent recruitment dynamics
    - Use devs and median from 1996 to 2017 (seine index)

Projections



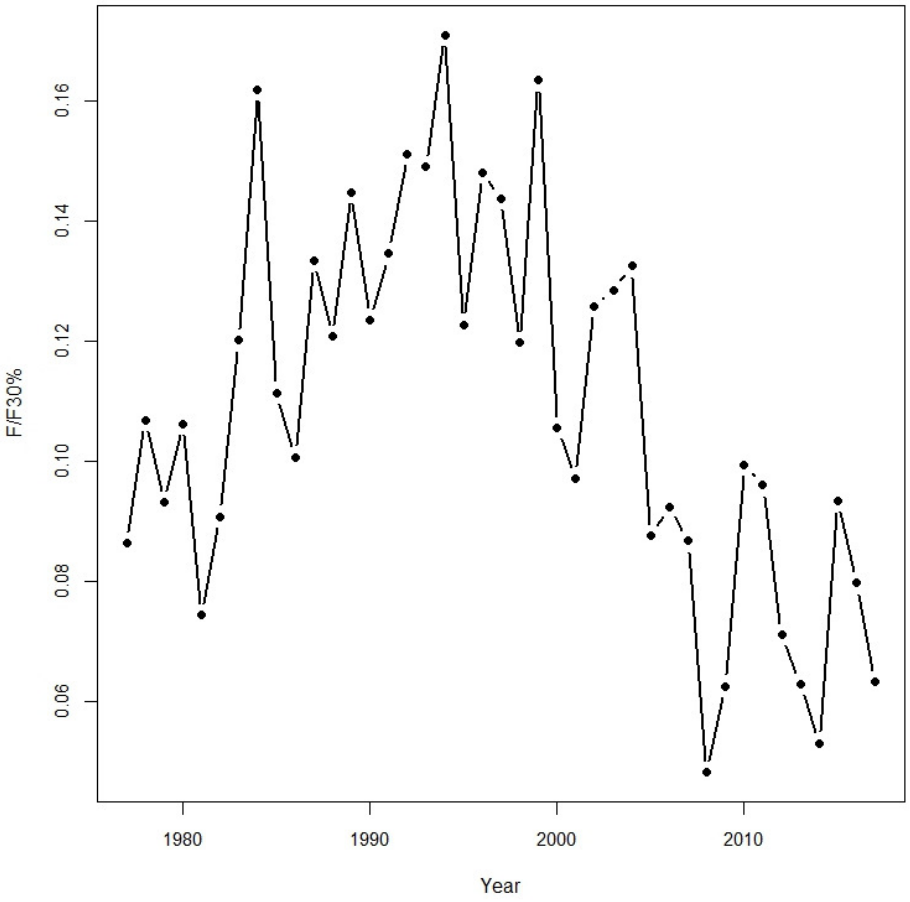
Outline

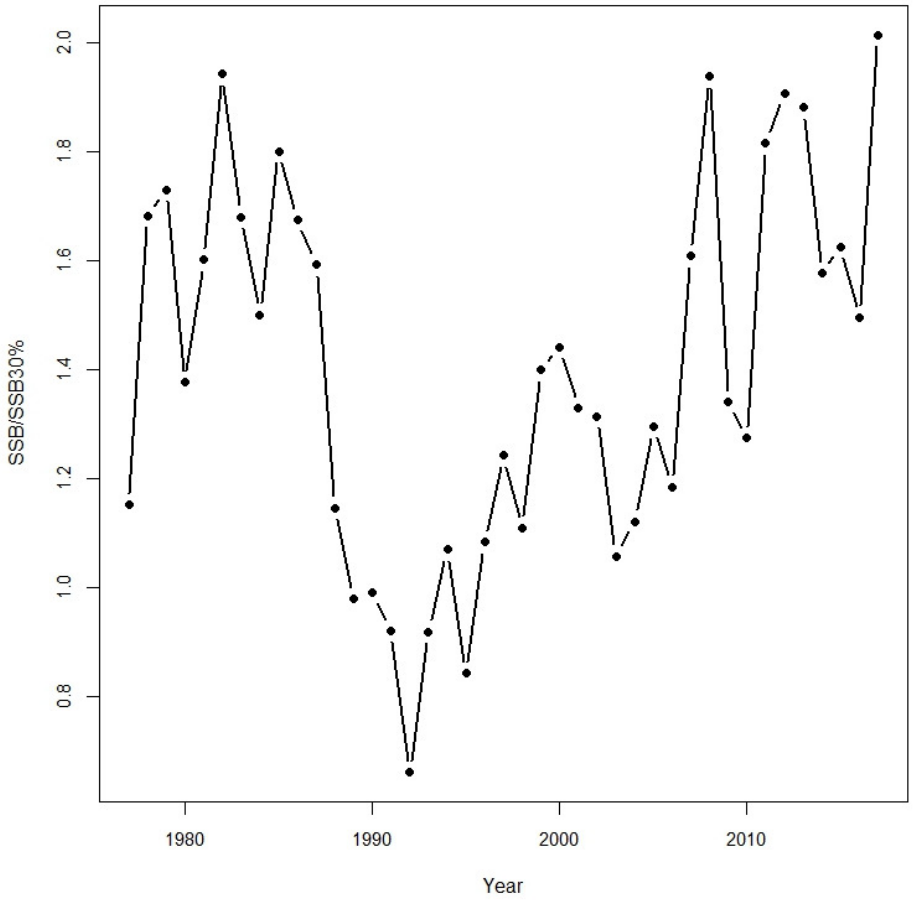
- Data included
- Base run configuration
- Sensitivity analyses
- Monte Carlo bootstrap
- Projections
- Benchmarks

Benchmarks

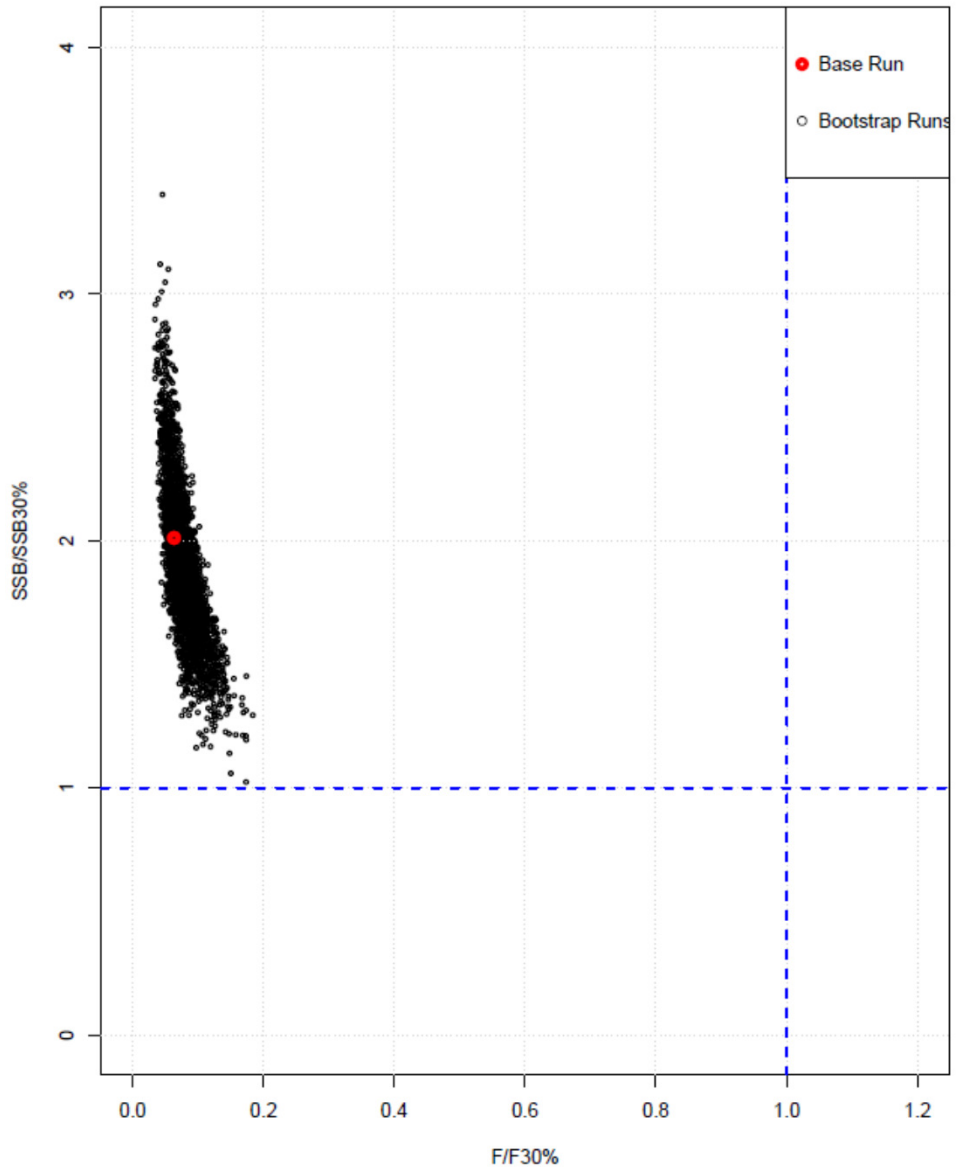
- MSY based benchmarks are not estimable
- FMP has SPR based benchmarks
  - $F_{30\%}$, $F_{35\%}$, $SSB_{30\%}$, and $SSB_{35\%}$
  - Under these options, overfishing is not occurring and not overfished
  - **But, value for threshold is maximum F value explored, or > 10.0**

Benchmarks


F/F30%
0.06
0.08
0.10
0.12
0.14
0.16
1980
1990
2000
2010
Year


SSB/SSB30%
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1980
1990
2000
2010
Year

Benchmarks

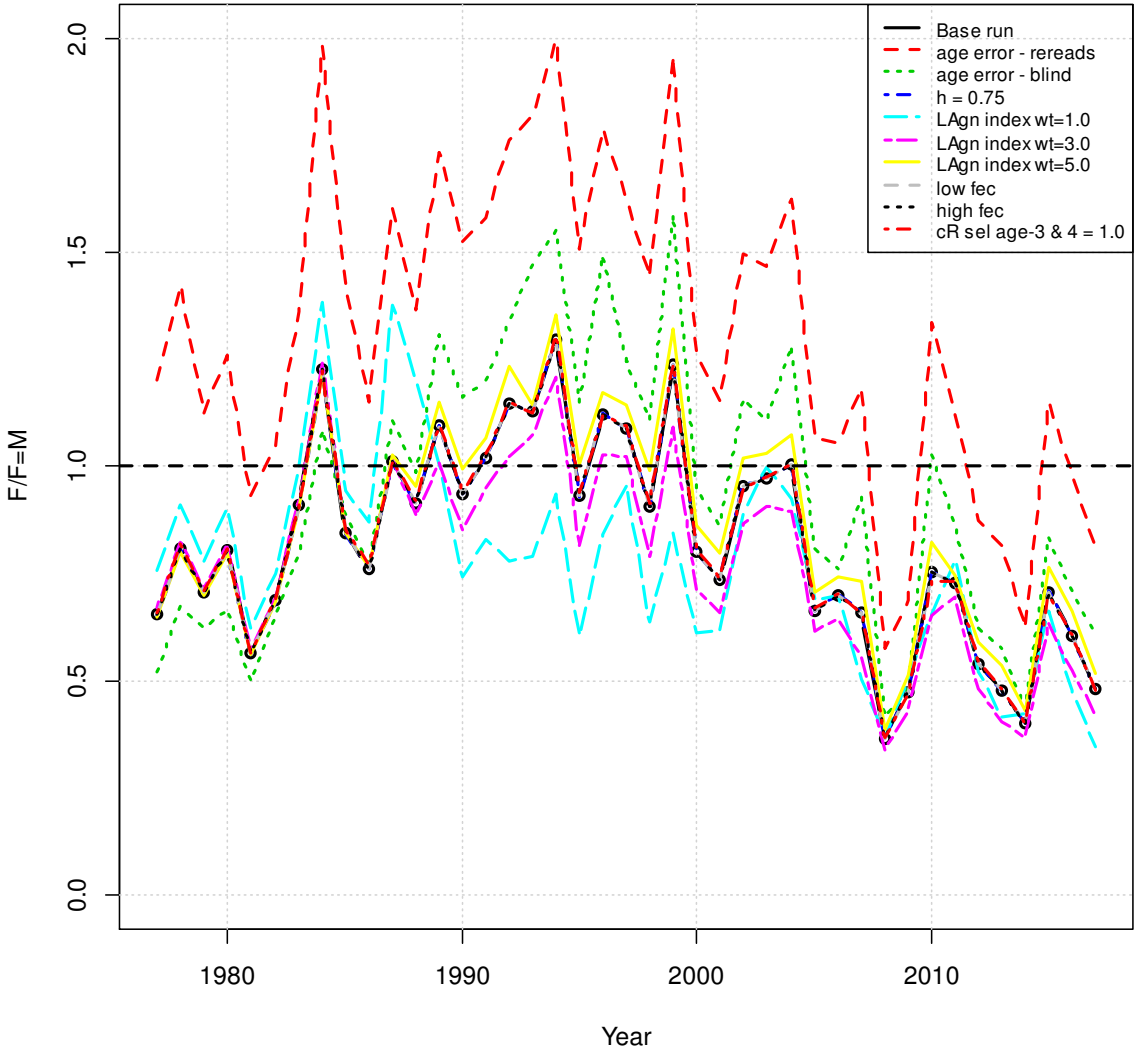

Base Run
Bootstrap Runs
SSB/SSB30%
F/F30%
0
1
2
3
4
0.0
0.2
0.4
0.6
0.8
1.0
1.2

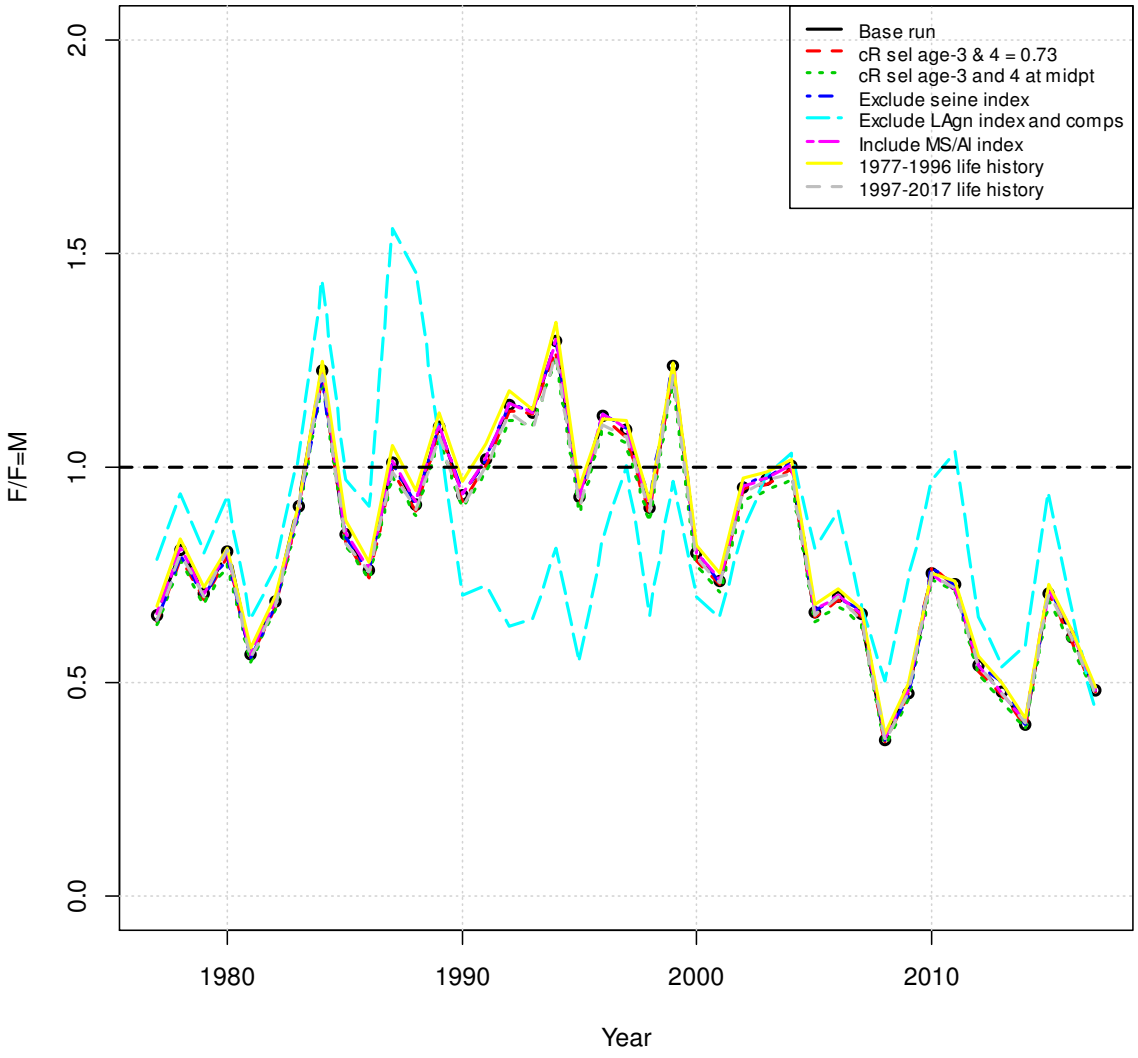
Benchmarks

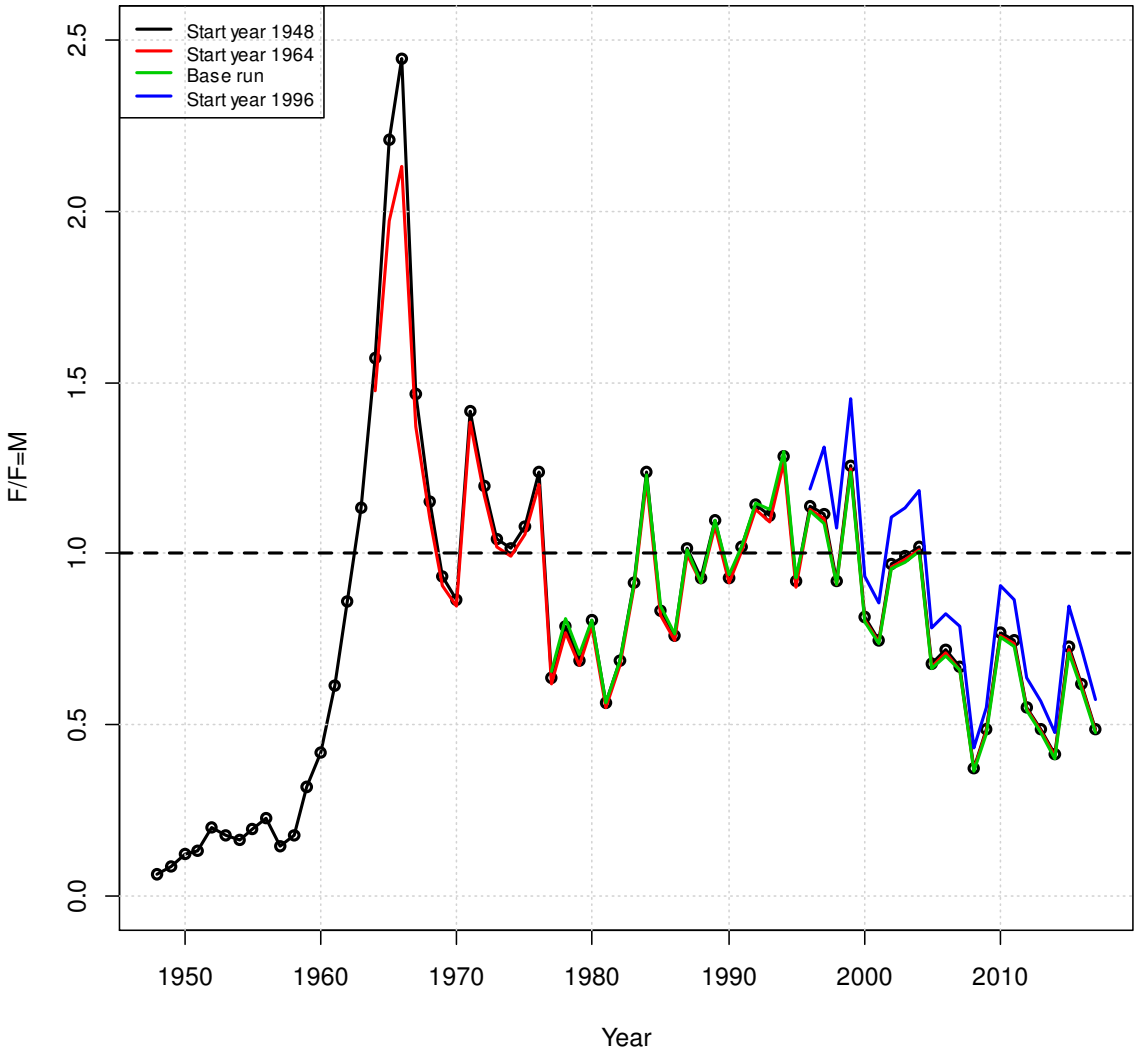
- Assessment panel discussed
  - Historical perspective
    - Target close to recent years
    - Threshold during higher years in 1980s and 1990s
  - Natural mortality based
    - Target as 75% of M
    - Threshold as M
    - M as geometric mean of ages-0 to -2

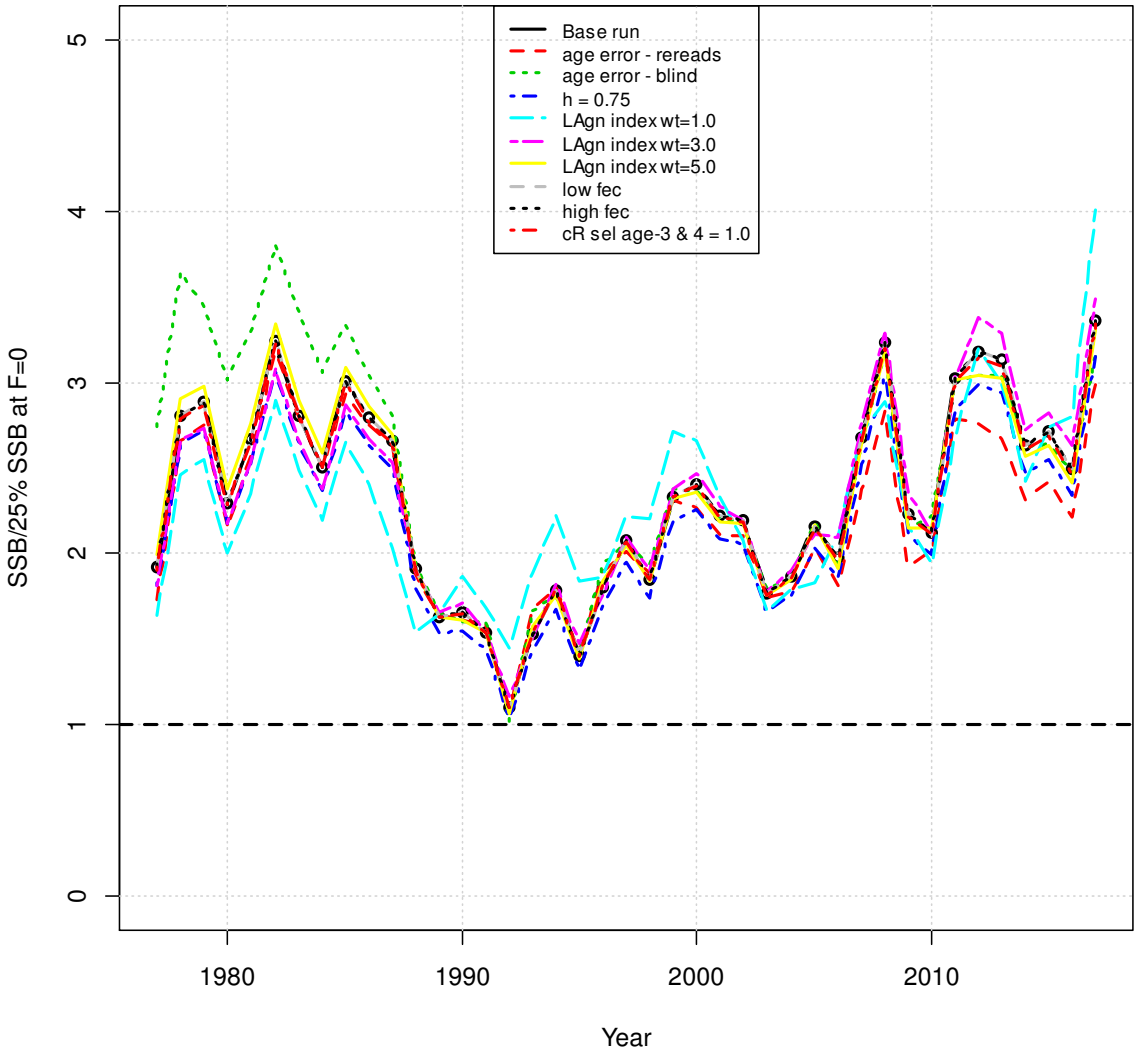
Benchmarks

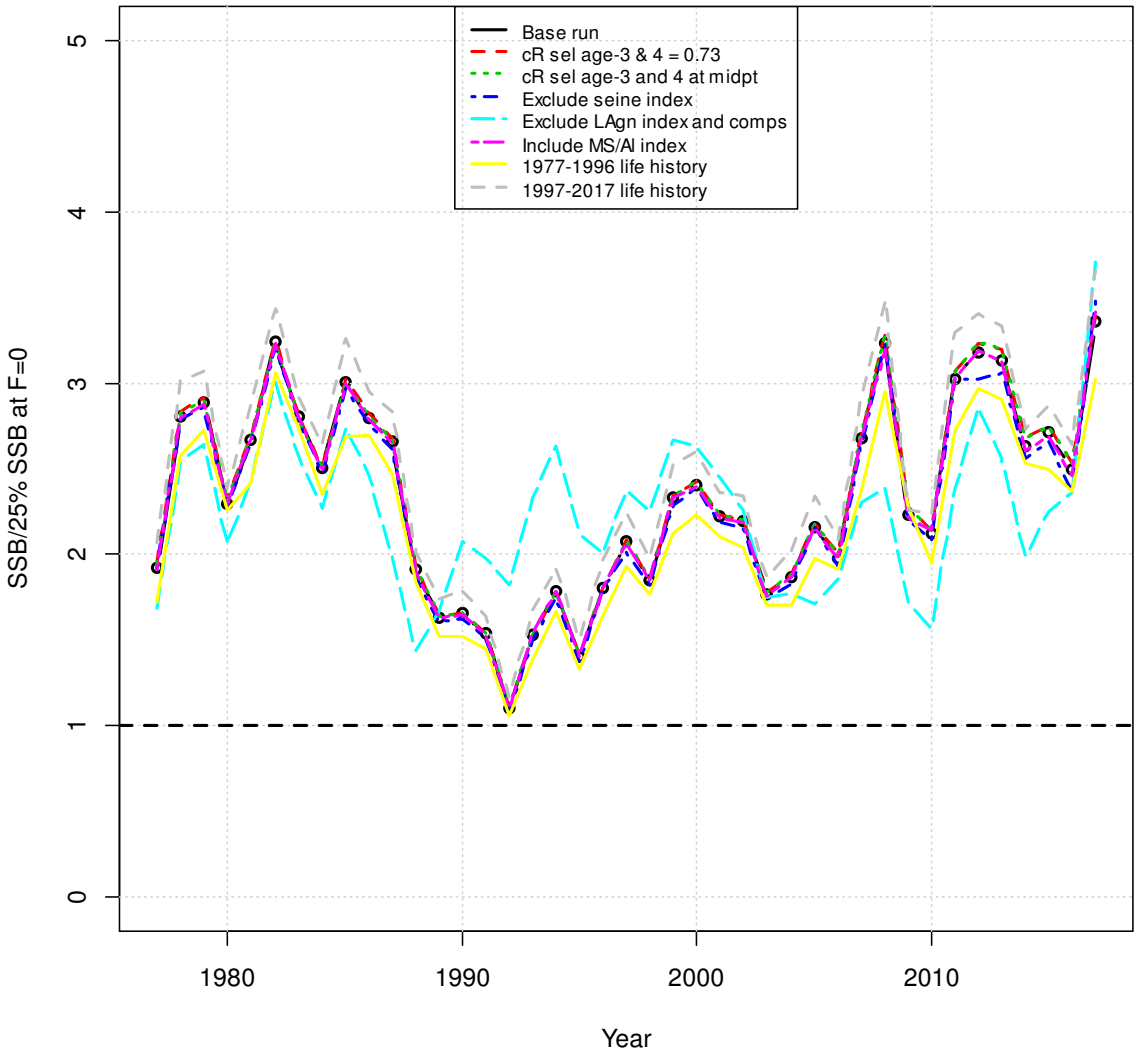
- F threshold and target
  - 1.32 and 0.99
  - Associated SSB is 3212045 and 3408847 (less than 1 SD apart)
  - TAC is 717,000 and 623,000
- SSB threshold and target
  - 25% and 50% of SSB when F=0
  - 1244281 and 2488562
  - Associated F is > 10 and 4.71

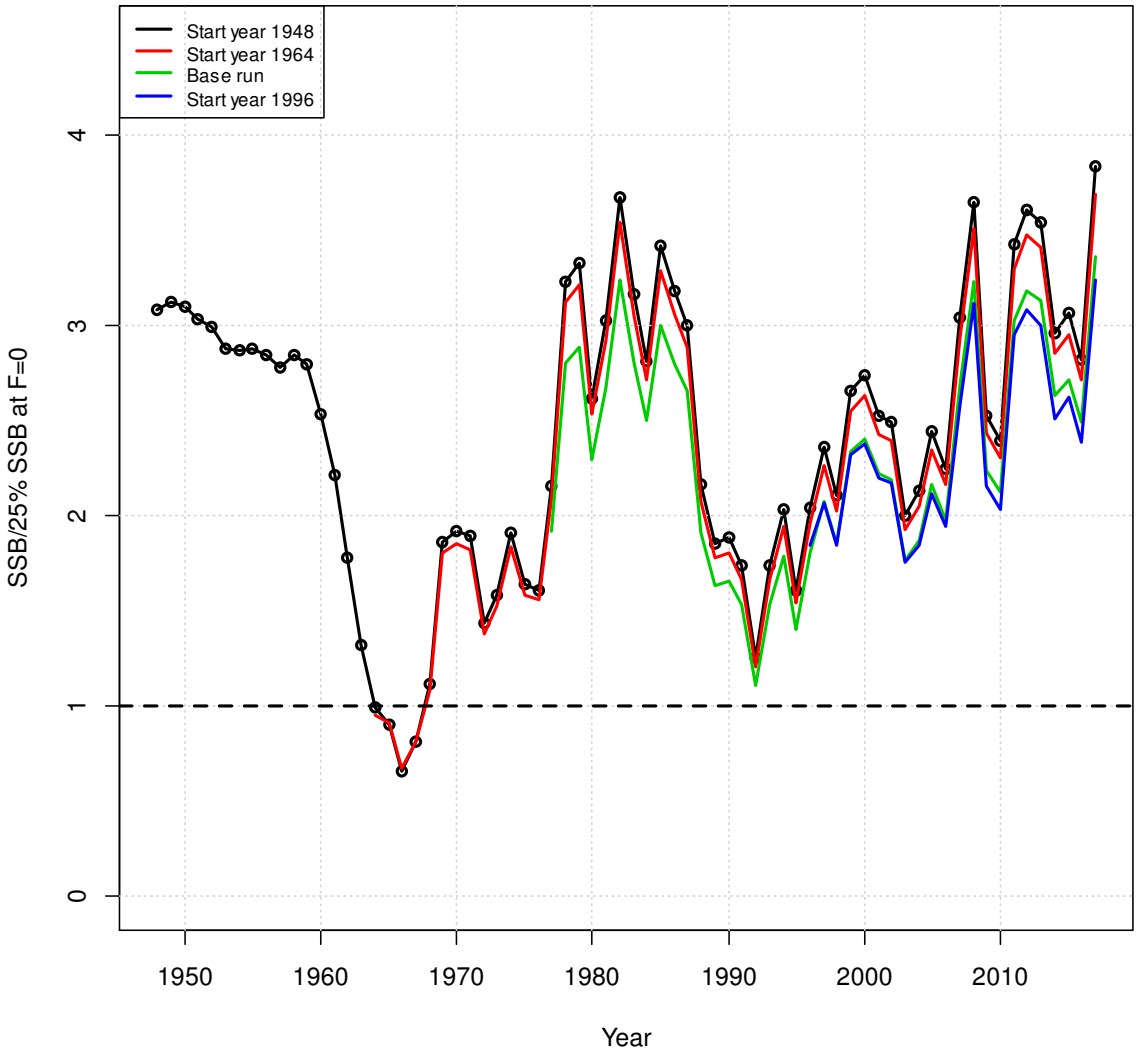

Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
low fec
high fec
cR sel age-3 & 4 = 1.0
F/F=M
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010
Year

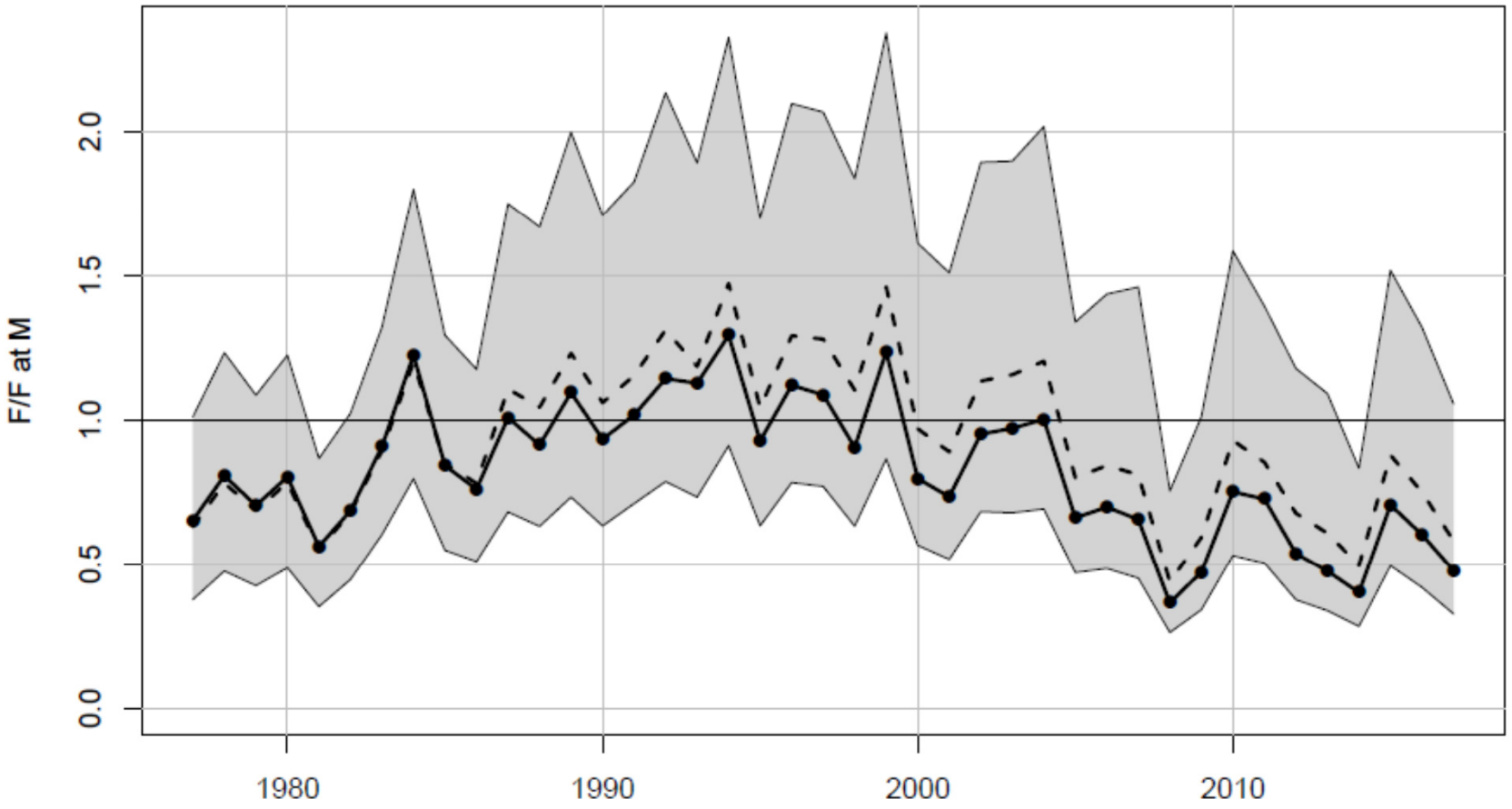

Base run
cR sel age-3 & 4 = 0.73
cR sel age-3 and 4 at midpt
Exclude seine index
Exclude LAgn index and comps
Include MS/AI index
1977-1996 life history
1997-2017 life history
F/F=M
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010
Year

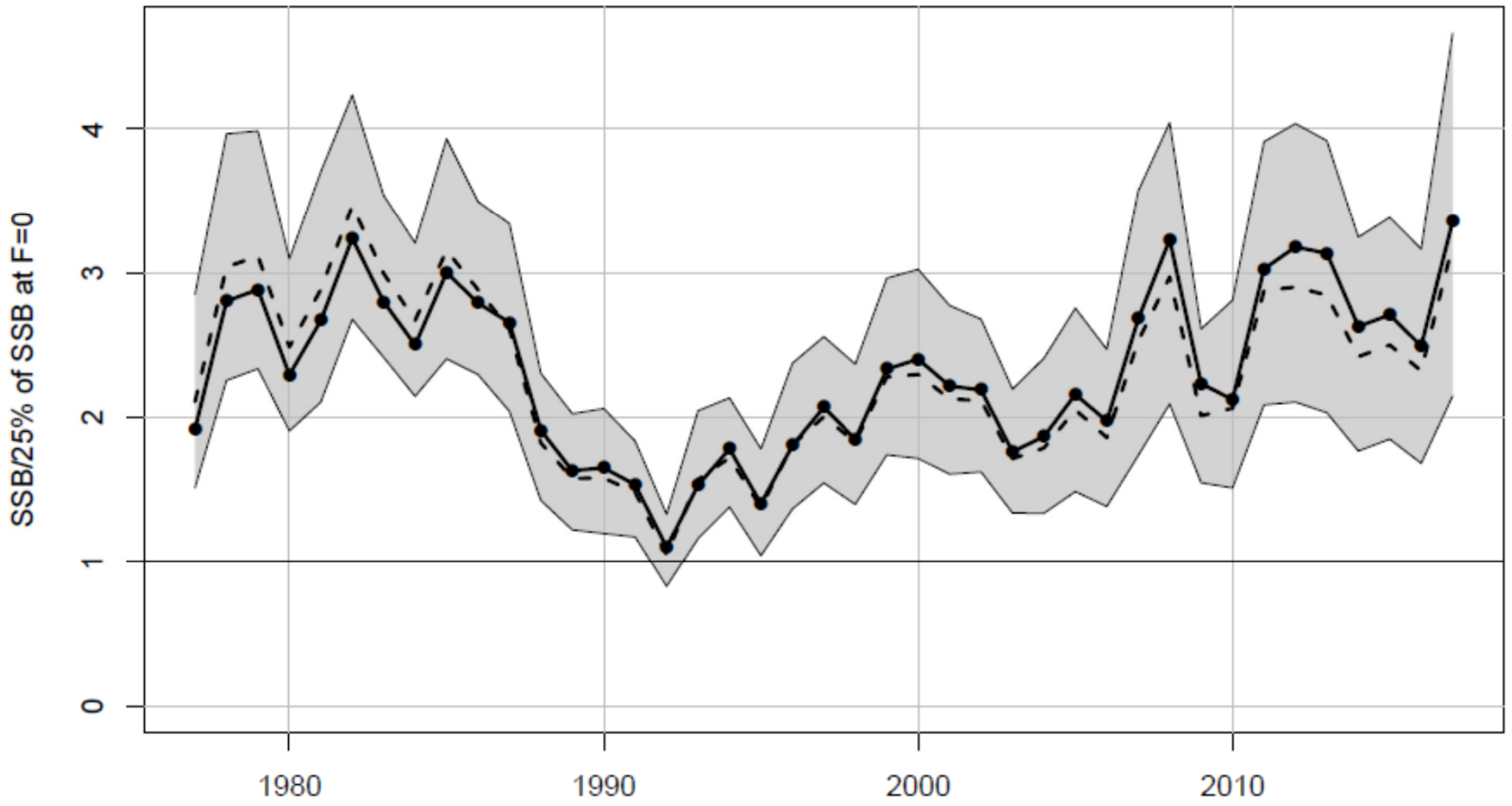

Start year 1948
Start year 1964
Base run
Start year 1996
F/F=M
0.0
0.5
1.0
1.5
2.0
2.5
1950
1960
1970
1980
1990
2000
2010
Year

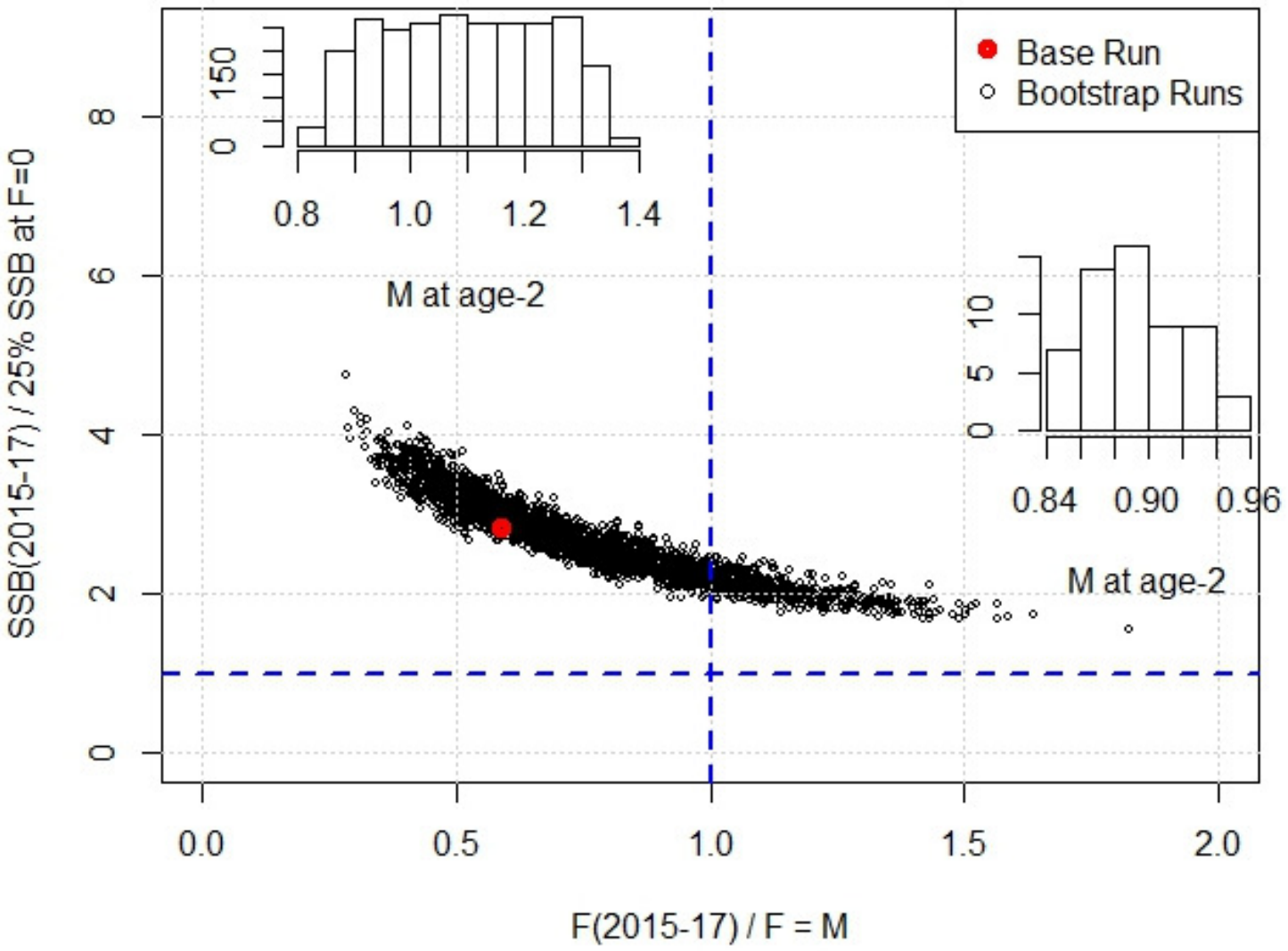

Base run
age error - rereads
age error - blind
h = 0.75
LAgn index wt=1.0
LAgn index wt=3.0
LAgn index wt=5.0
low fec
high fec
cR sel age-3 & 4 = 1.0
SSB/25% SSB at F=0
0
1
2
3
4
5
1980
1990
2000
2010
Year


Base run
cR sel age-3 & 4 = 0.73
cR sel age-3 and 4 at midpt
Exclude seine index
Exclude LAgn index and comps
Include MS/AI index
1977-1996 life history
1997-2017 life history
SSB/25% SSB at F=0
0
1
2
3
4
5
1980
1990
2000
2010
Year


Start year 1948
Start year 1964
Base run
Start year 1996
SSB/25% SSB at F=0
0
1
2
3
4
1950
1960
1970
1980
1990
2000
2010
Year


F/F at M
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010


SSB/25% of SSB at F=0
0
1
2
3
4
1980
1990
2000
2010


Base Run
Bootstrap Runs
SSB(2015-17) / 25% SSB at F=0
F(2015-17) / F = M
M at age-2
M at age-2
0
150
0.8
1.0
1.2
1.4
0
5
10
0.84
0.90
0.96
0.0
0.5
1.0
1.5
2.0
0
2
4
6
8

Stock status

- Consistent status across base run, sensitivities, and most MCBs
  - Overfishing is not occurring
  - Not overfished
- Recommend that goals and objectives for fishery are fully discussed and defined