Science, Service, Stewardship

SEDAR 27 Gulf Menhaden: Beaufort Assessment Model

Amy M. Schueller

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Beaufort Assessment Model (BAM)

- Final base run configuration and results
- Sensitivity runs
- Monte Carlo bootstraps
- Benchmarks and stock status
- Comparison to surplus production

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Base run configuration

- 1948-2010 and ages 0-4+ (1948 is near start of fishery)
- Age-varying natural mortality scaled to empirical estimate
- Full maturity at age 2, 0% mature for ages 0 and 1
- Sex ratio assumed 1:1
- Input fecundity and weight at age over time
- Ageing error matrix based on an otolith:scale comparison
- Commercial reduction landings and age comps
- Seine index
- Gillnet index (LA only) and length comps

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Base run configuration

- Selectivity: age and time varying
  - Seine index (one block 1977-2010):
    - Assumed 1.0 for age 0 and 0.0 for all other ages
  - Gillnet index (one block 1986-2010):
    - Assumed 0.0 for age 0 and 1.0 for age 2
    - Ages 1, 3, and 4 were estimated with loose priors
  - Reduction (three blocks):
    - 1948-1963: average of selectivity from 1964-1966
    - 1964-1979: ages 1, 3, 4 estimated, assumed 0.0 for age 0 and 1.0 for age 1; loose prior used for ages 1, 3, 4
    - 1980-2010: estimated age 1, assumed 0.0 for age 0 and 1.0 for ages 2+

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Base run configuration

- Sample size was capped at 200 for age and length comps
  - Sample sizes under 100 for gillnet length comps were not fit
  - Sample sizes were set to 10 from 1964-1976 for age comps
- Beverton-Holt stock recruitment curve
- Estimating R0, h, and recruitment variability
  - Not estimating von Bertalanffy parameters
- Reweighted the data components (Francis 2011)
  - SDNRs near 1.0

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Base run configuration

- Re-weighted data components and then did a “sanity” check
  - Increased weight on seine index (base run w=1.0)
    - Beyond 1.0: poorer fit on landings without improved fit on index
  - Increased weight on gillnet index (base run w=1.0)
    - Beyond 1.0: improved fit of index but lost fits elsewhere
  - Reduced age composition weight (base run w=0.25)
    - Improved fit to landings without losing much fit to age comps
    - Didn’t affect other fits much
  - Reduced length composition weight (base run w=0.5)
    - If lower than 0.5: Noticeably poorer fit to length comps, h goes to upper bound, and F becomes unrealistically high (~30)

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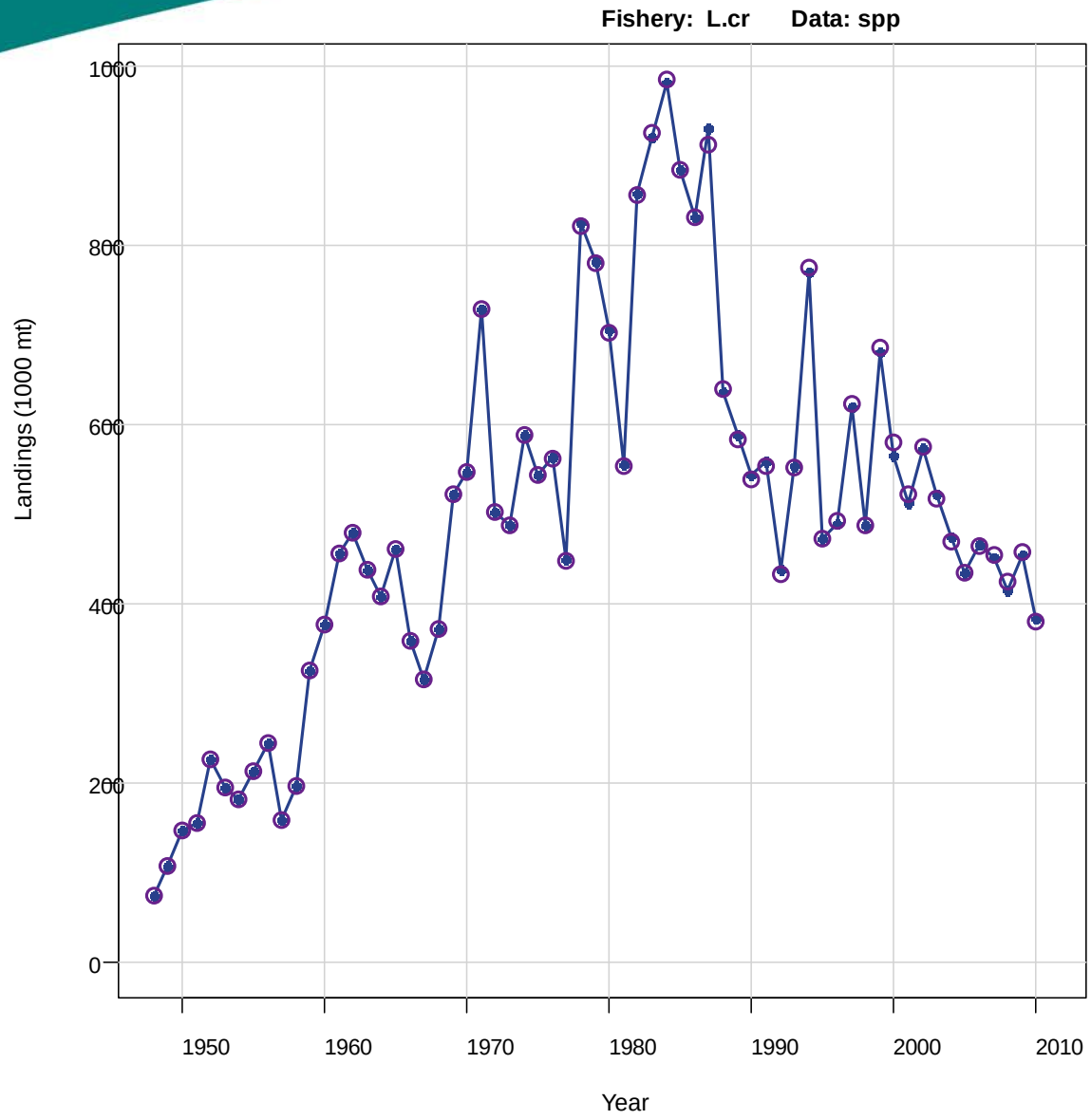
Base Run: landings



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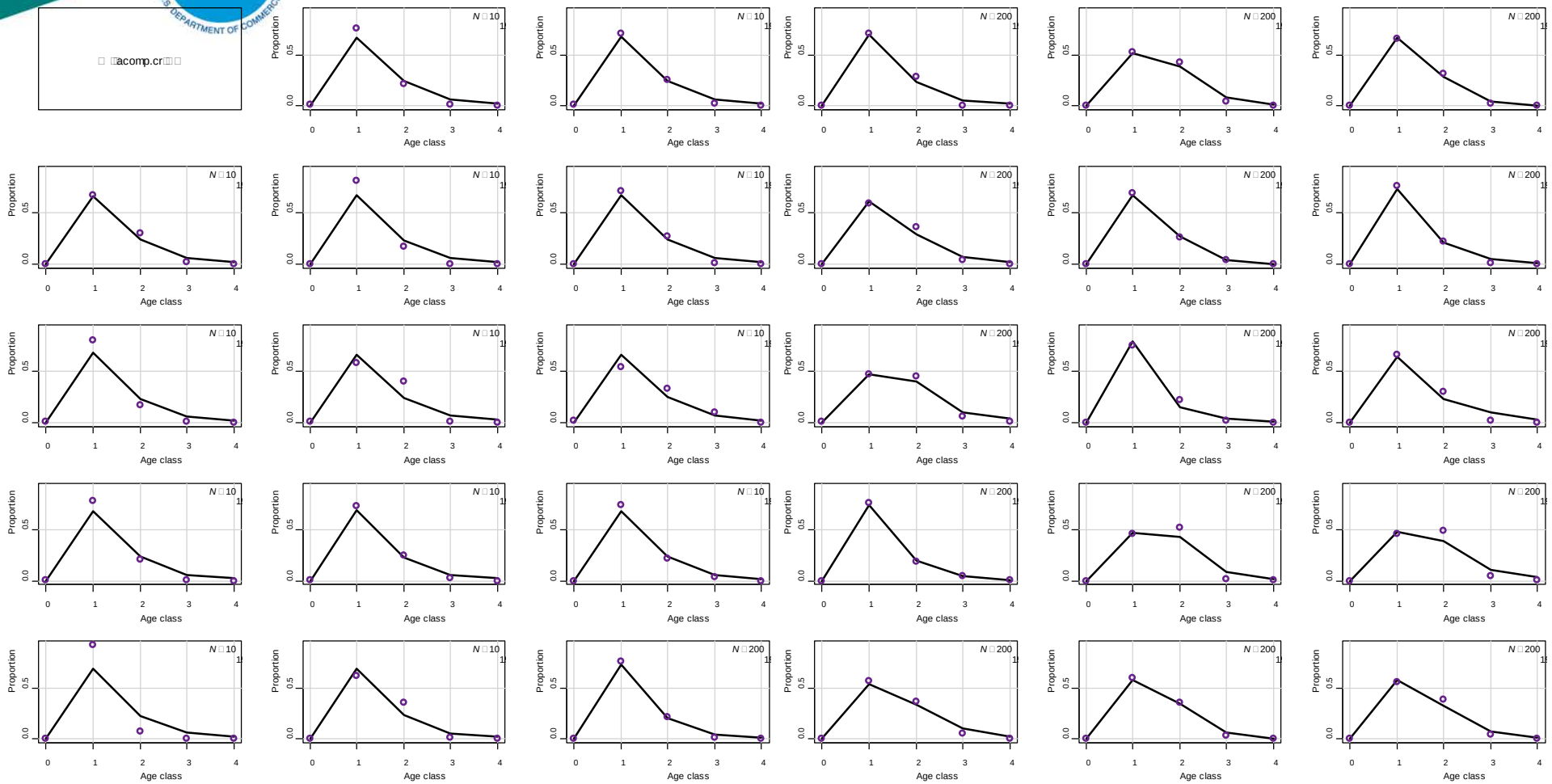
Base Run: age comps



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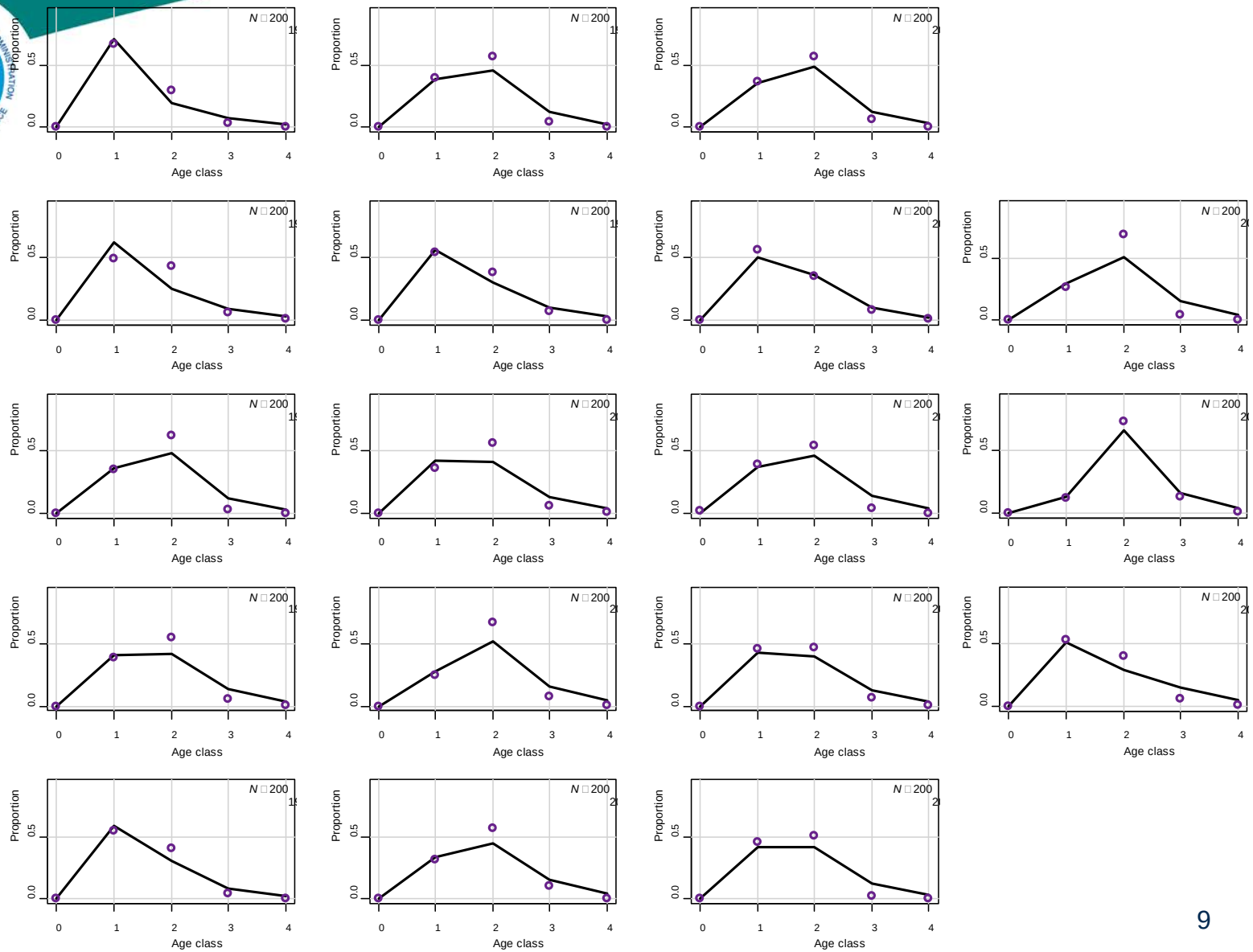
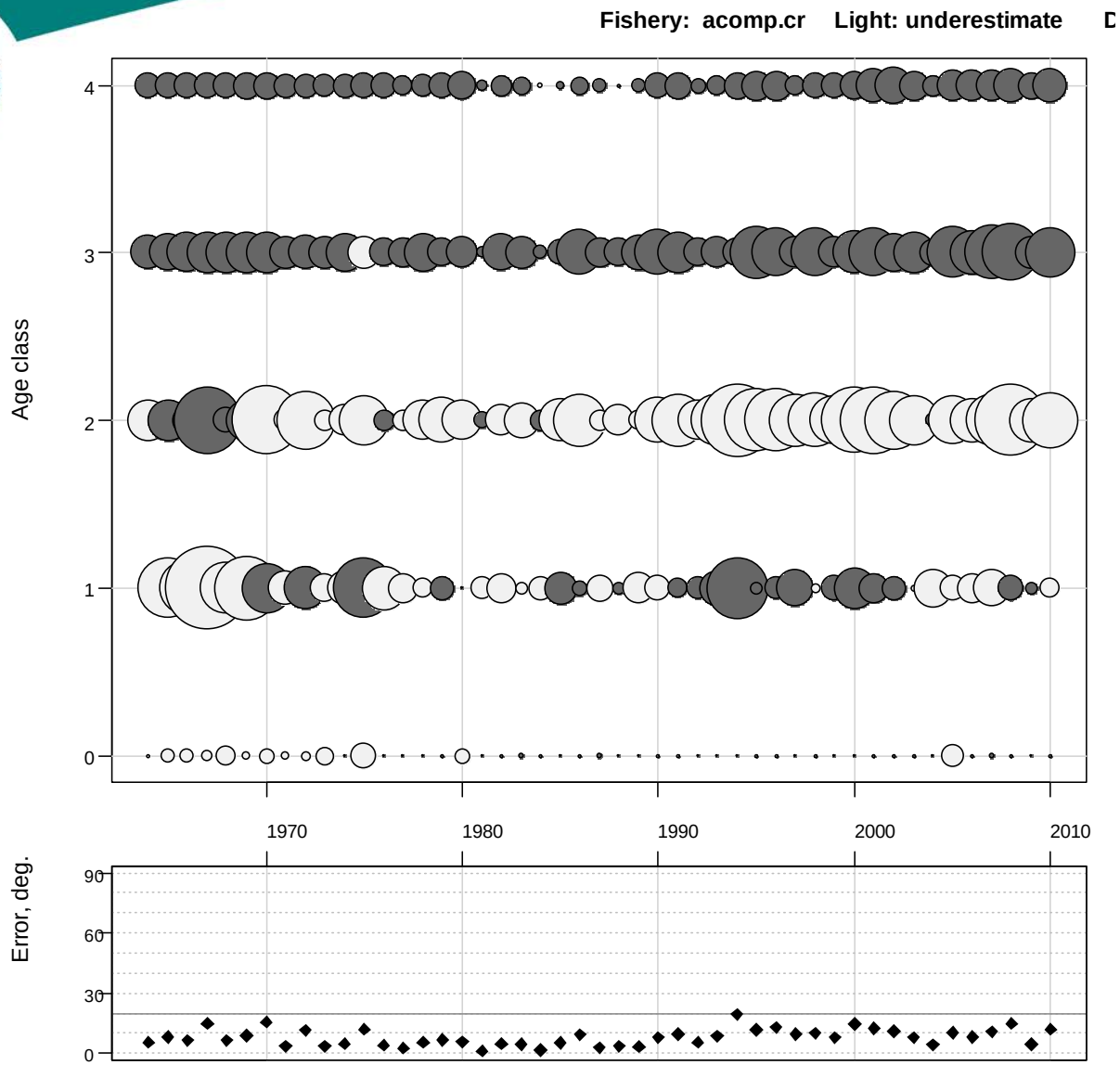
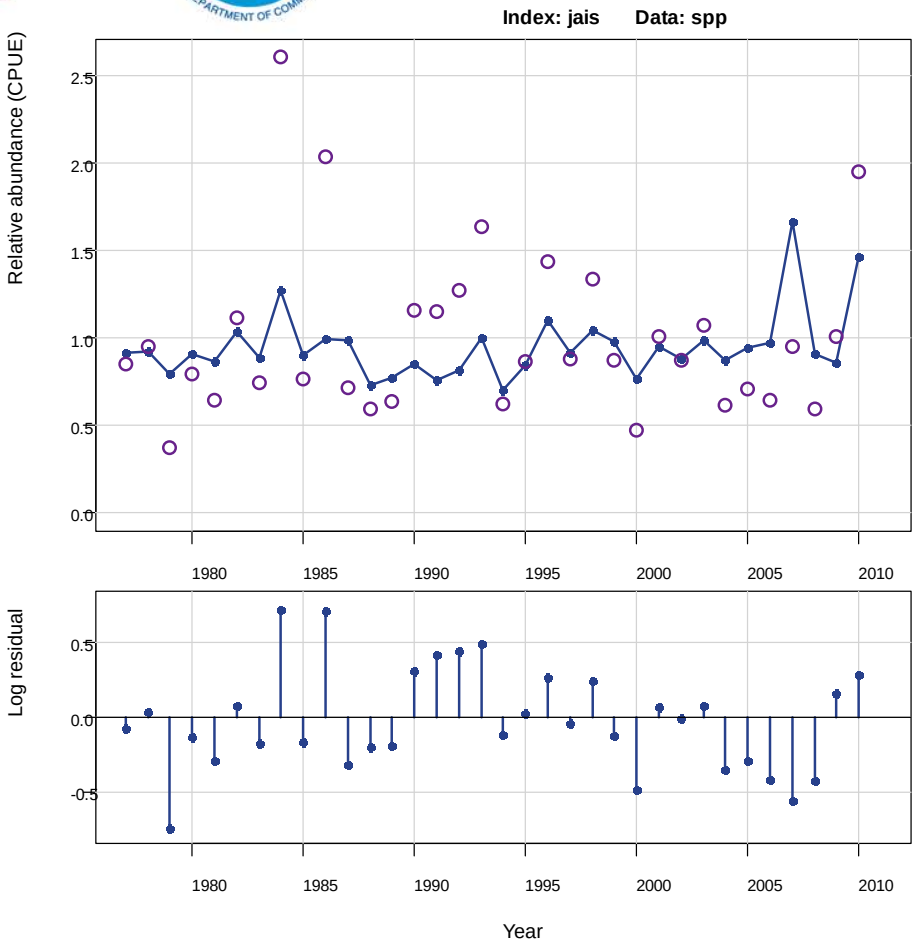
Base Run: age comps

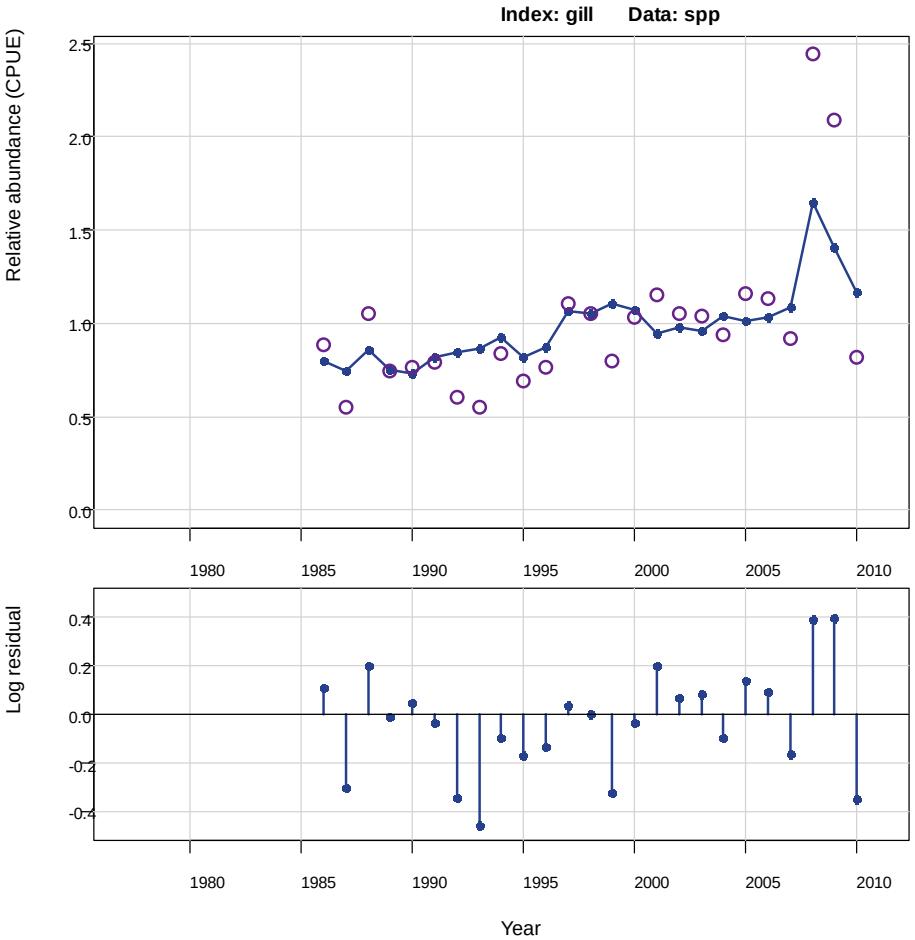


Base Run: age comps

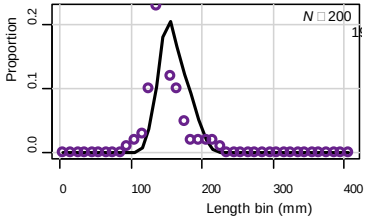


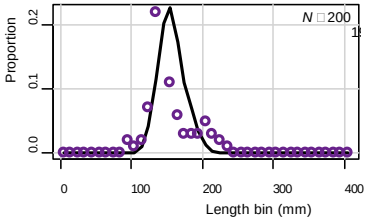
Base Run: indices

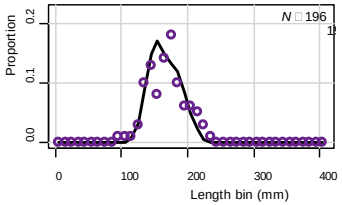


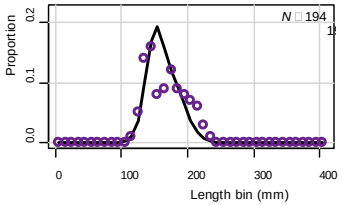


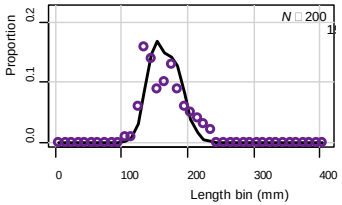
Base Run: length comps

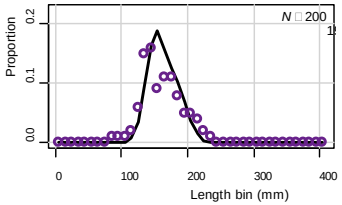


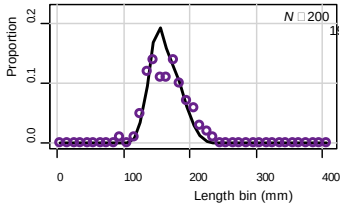


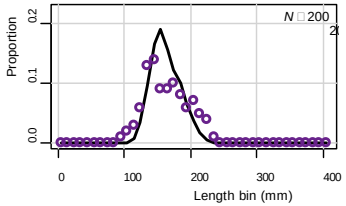


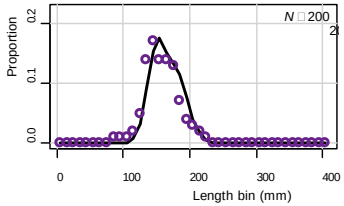


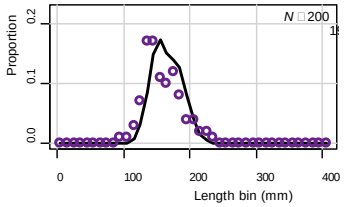


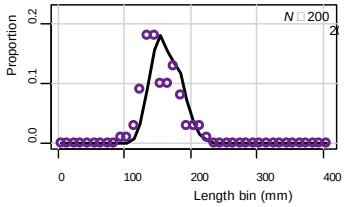


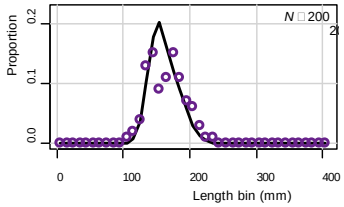


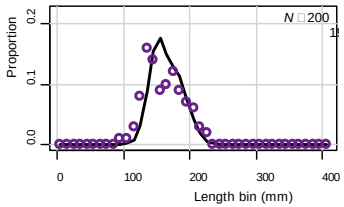


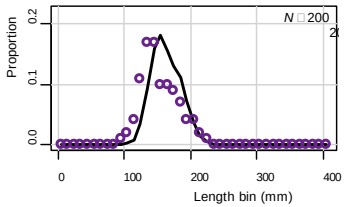


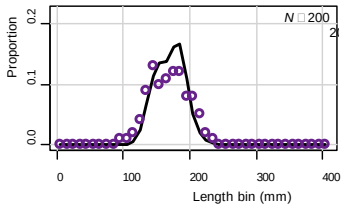


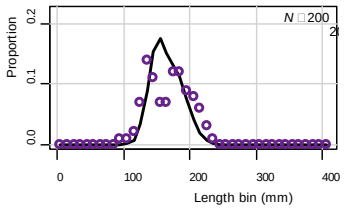


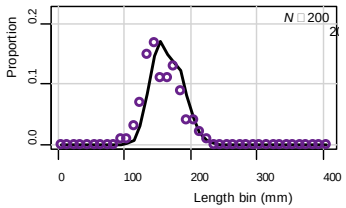


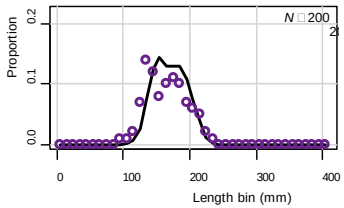


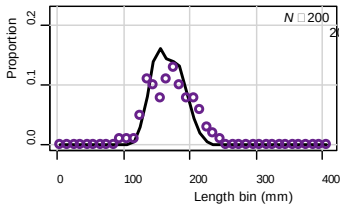


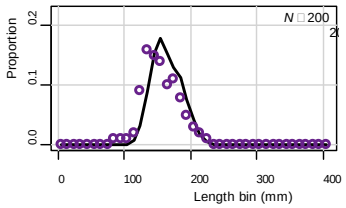




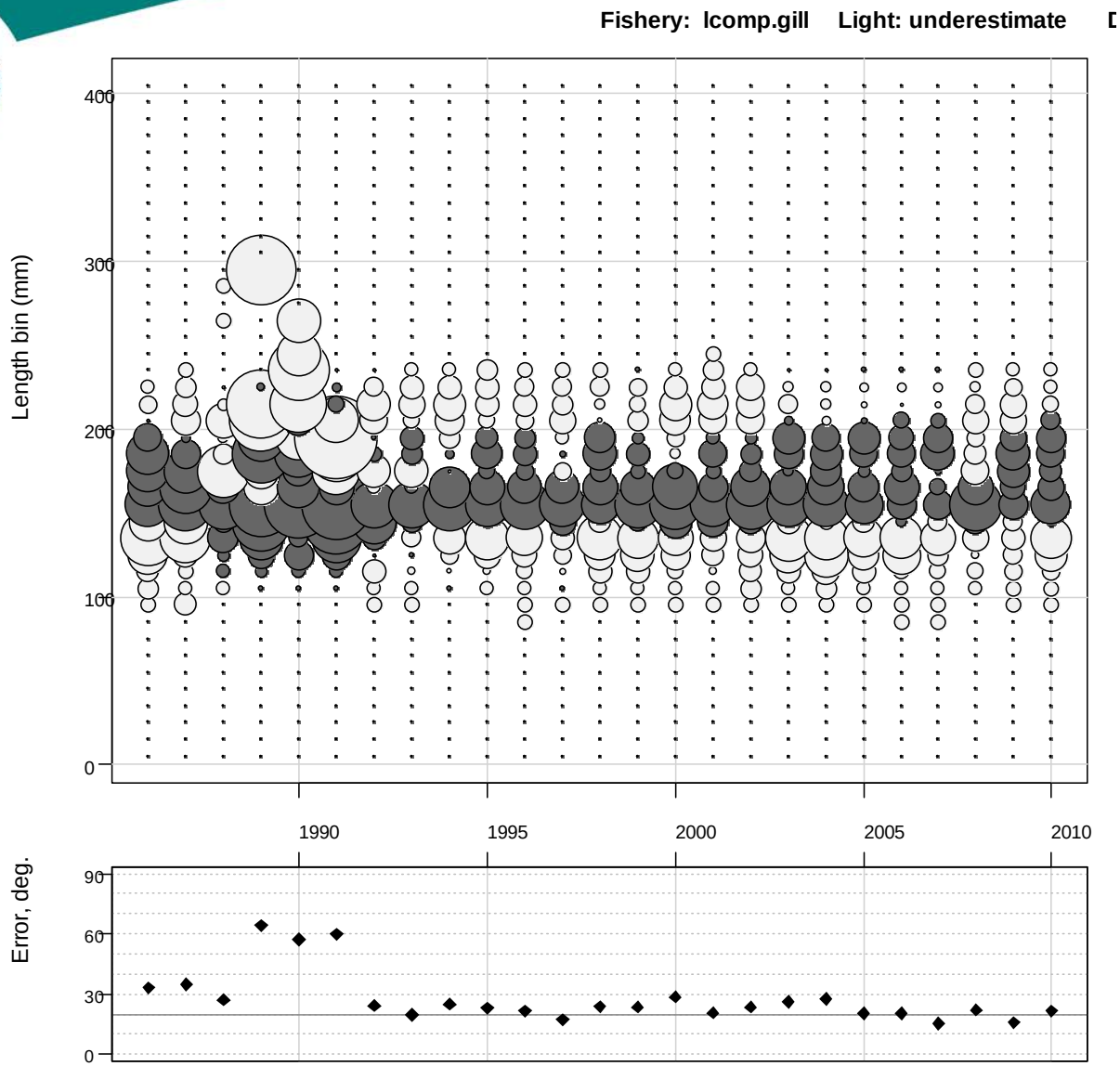




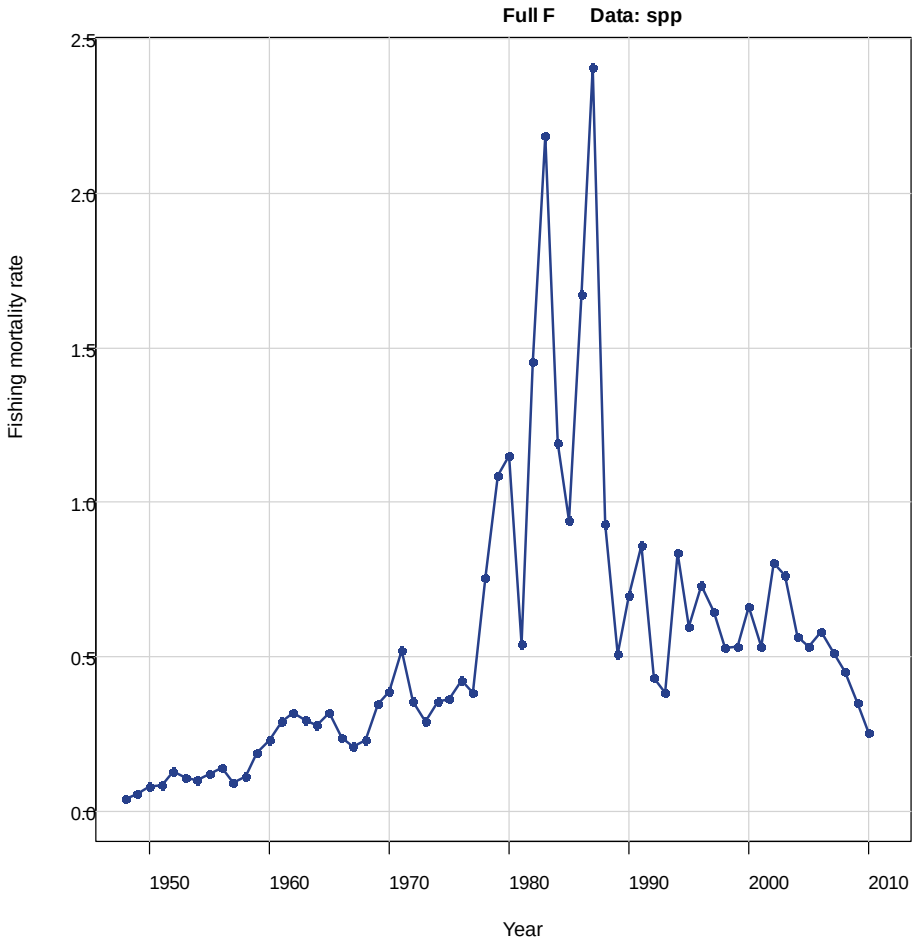


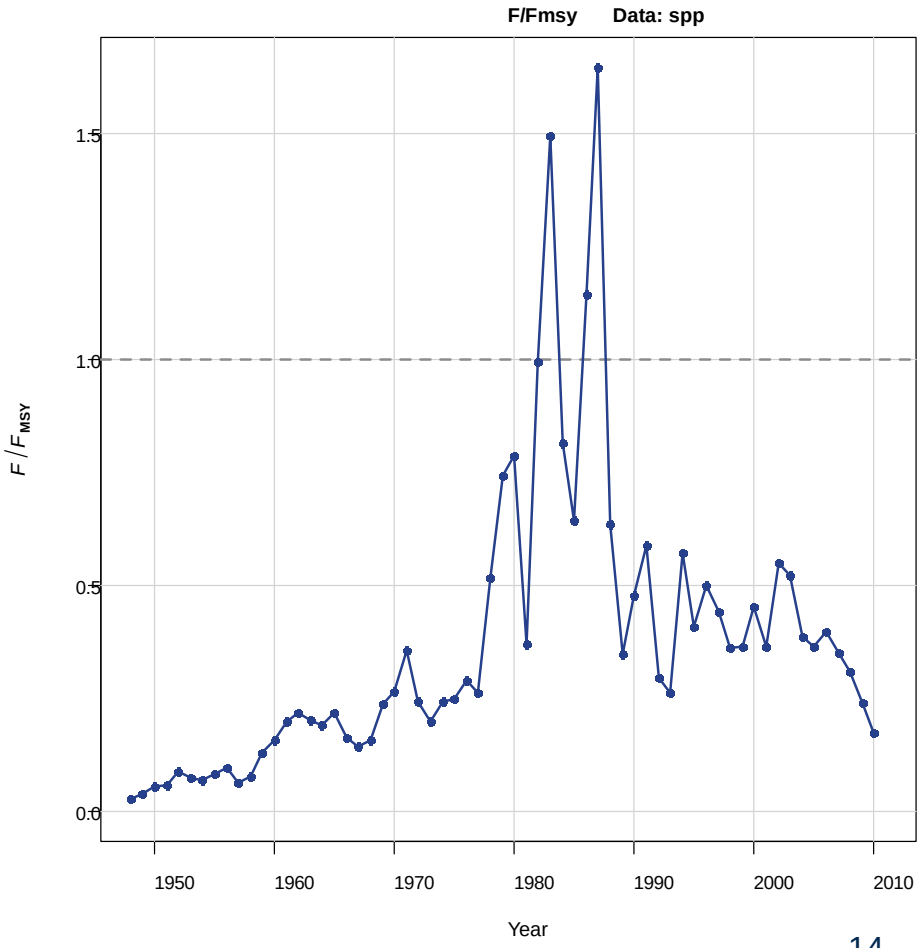


Base Run: length comps

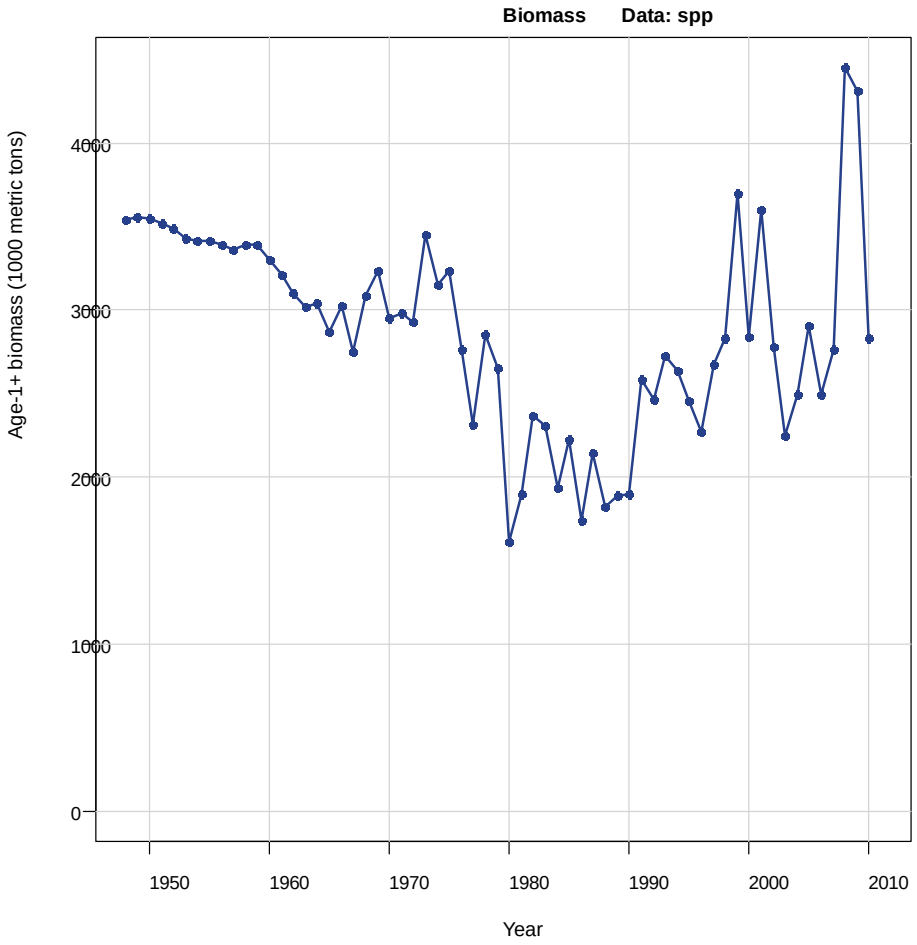


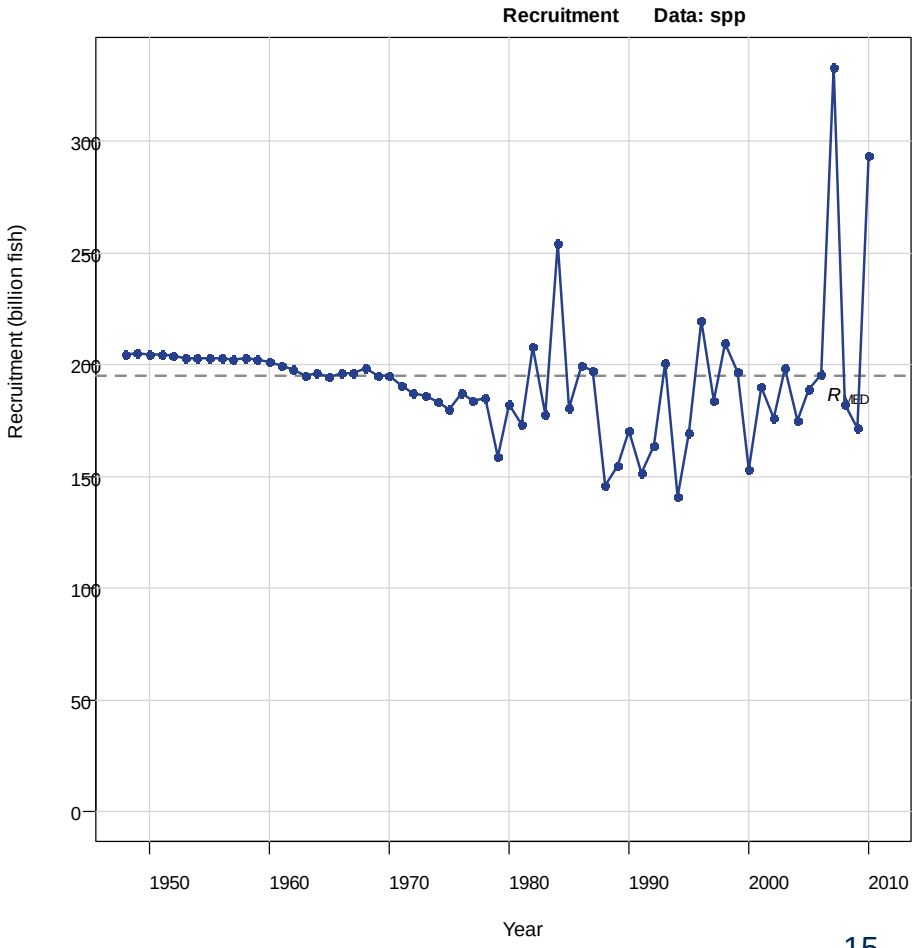
Base Run: full F and F/F_{MSY}



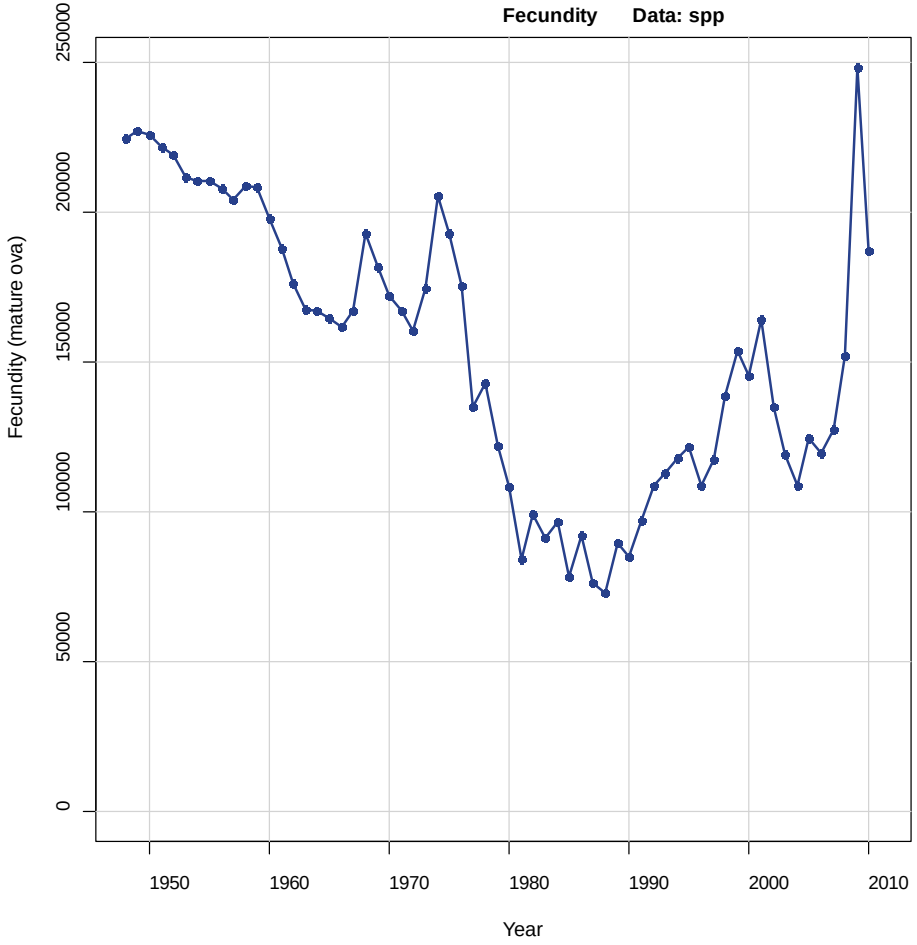


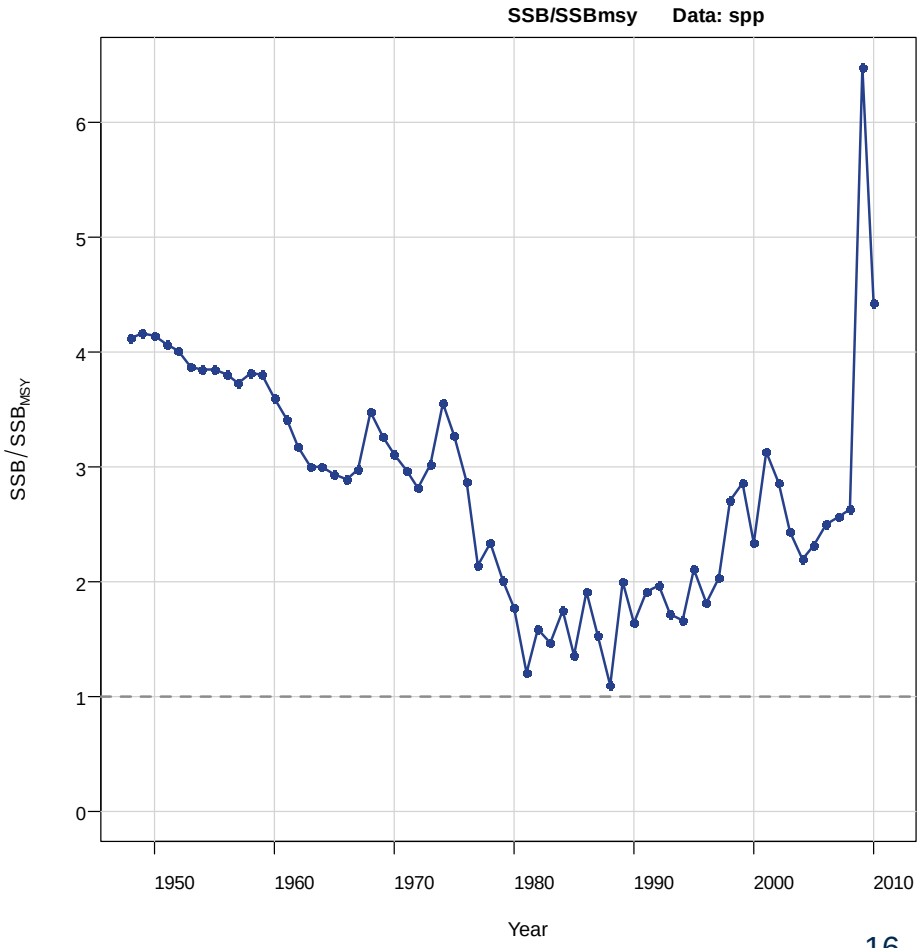
Base Run: Biomass and recruits





Base Run: Fecundity and SSB/SSB$_{MSY}$





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Beaufort Assessment Model (BAM)

- Final base run configuration and results
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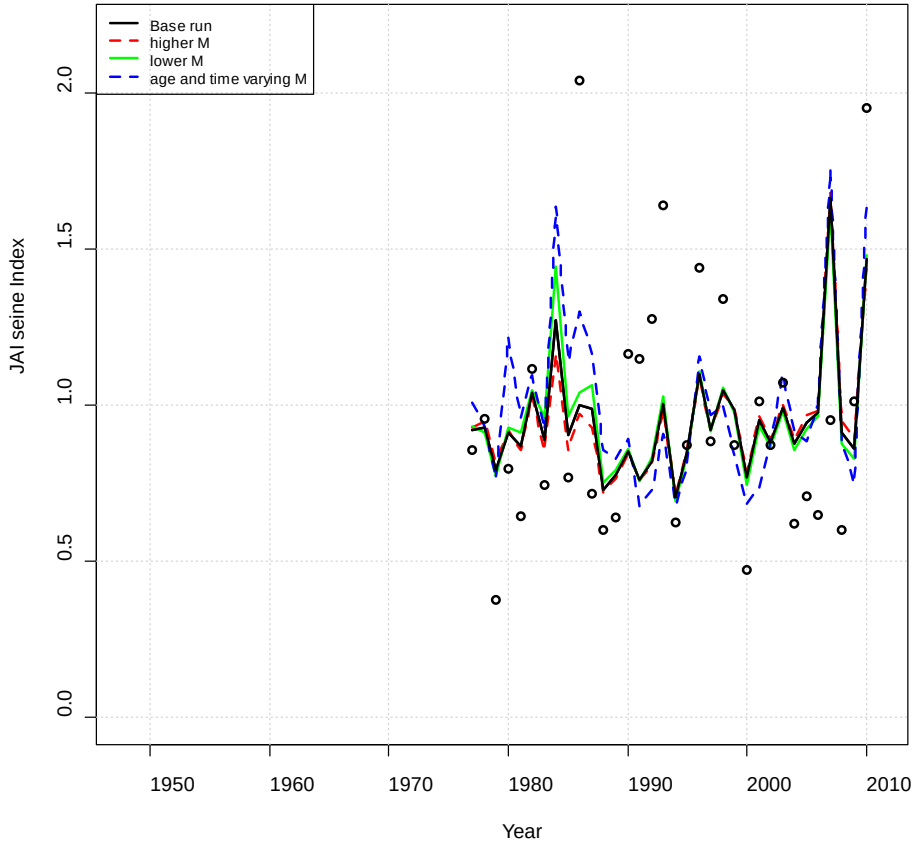
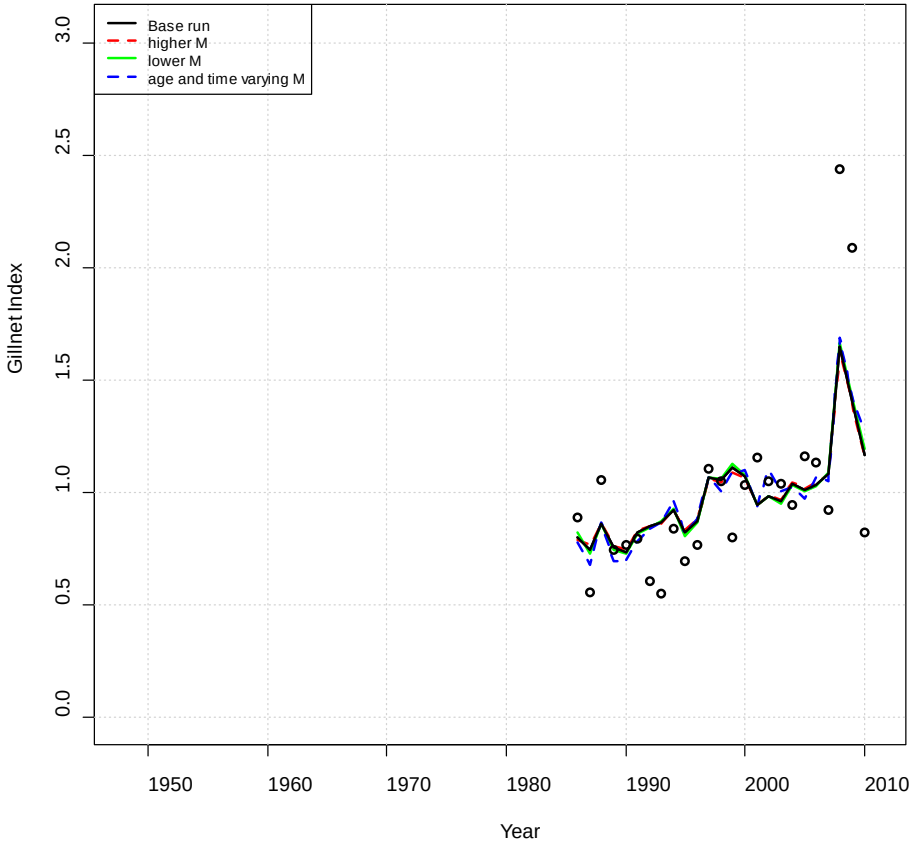
Sensitivity runs completed

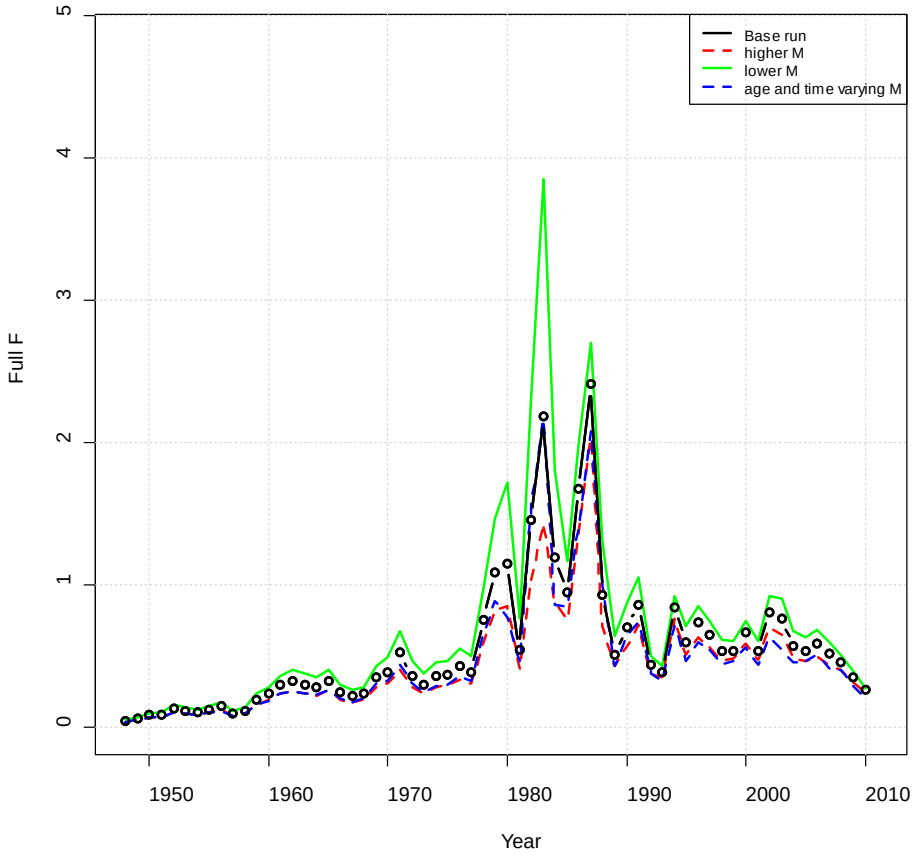
- Natural mortality
  - High M
  - Low M
  - Age and time varying M

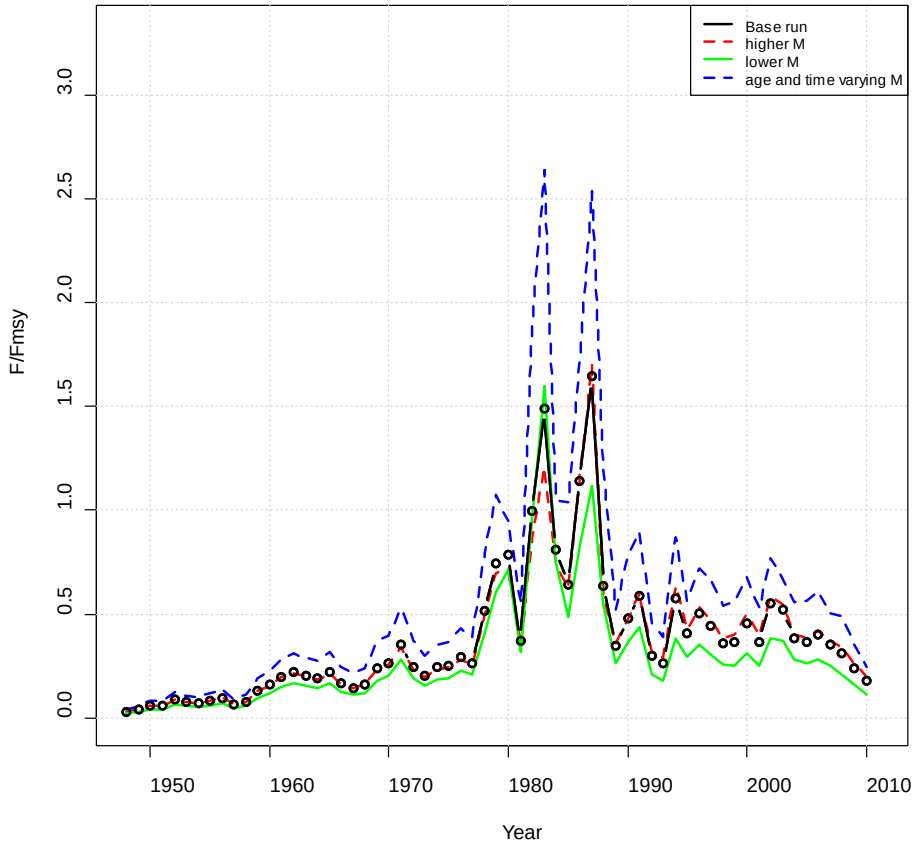
Natural mortality: index fits



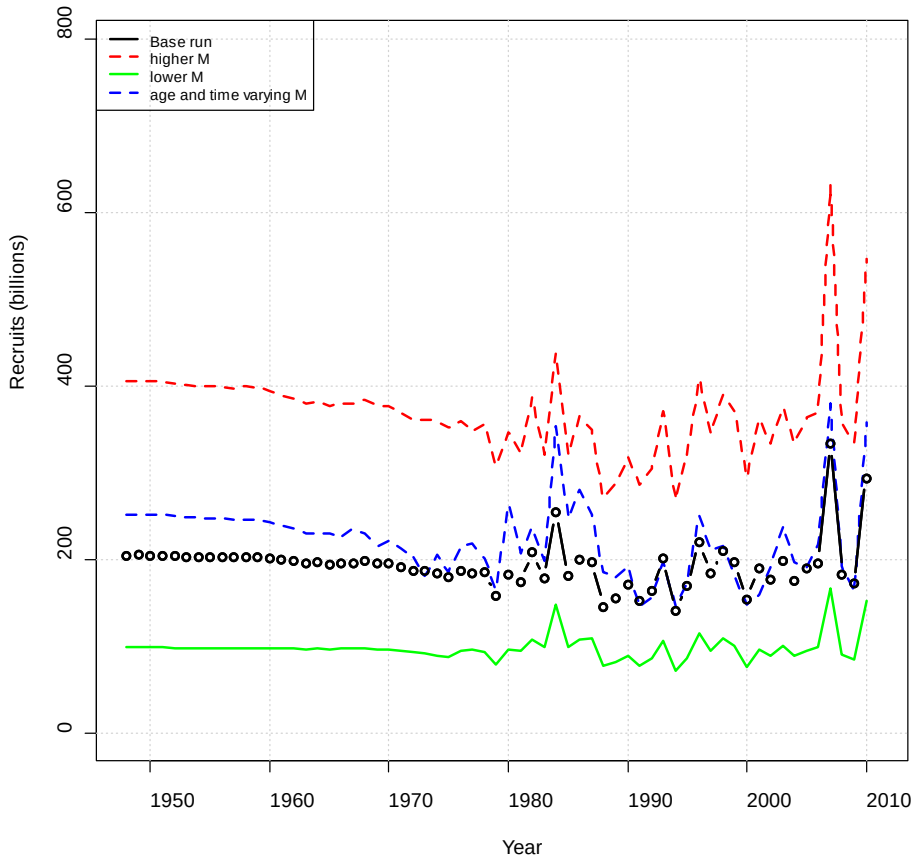


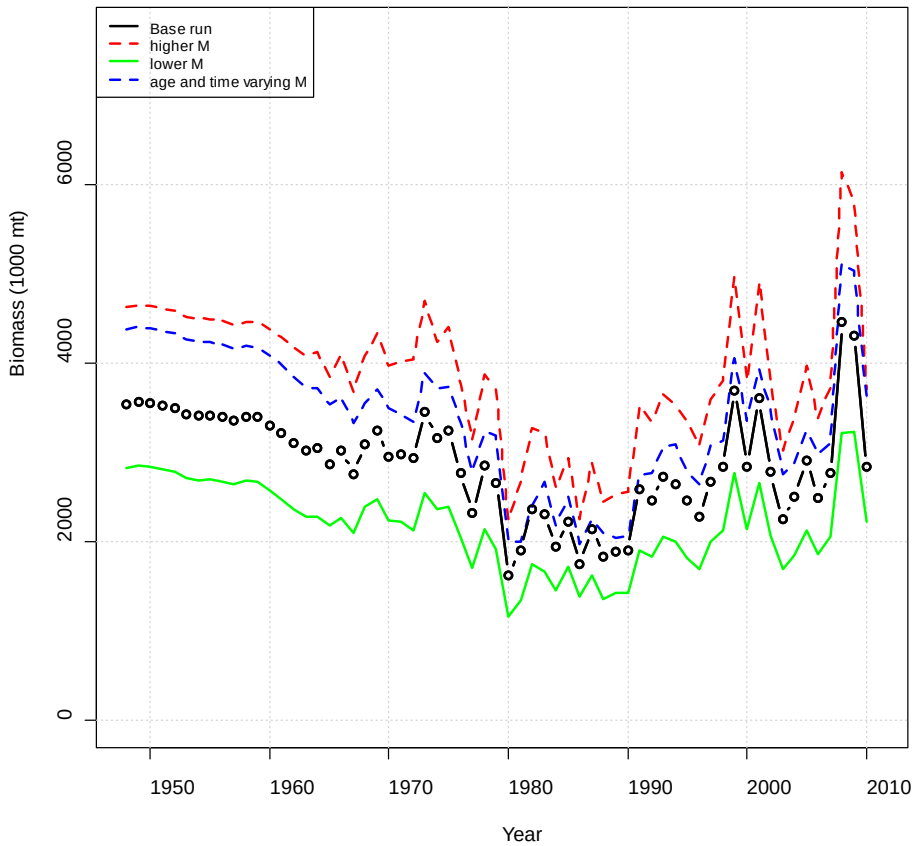
Natural mortality: F and F/F_{MSY}



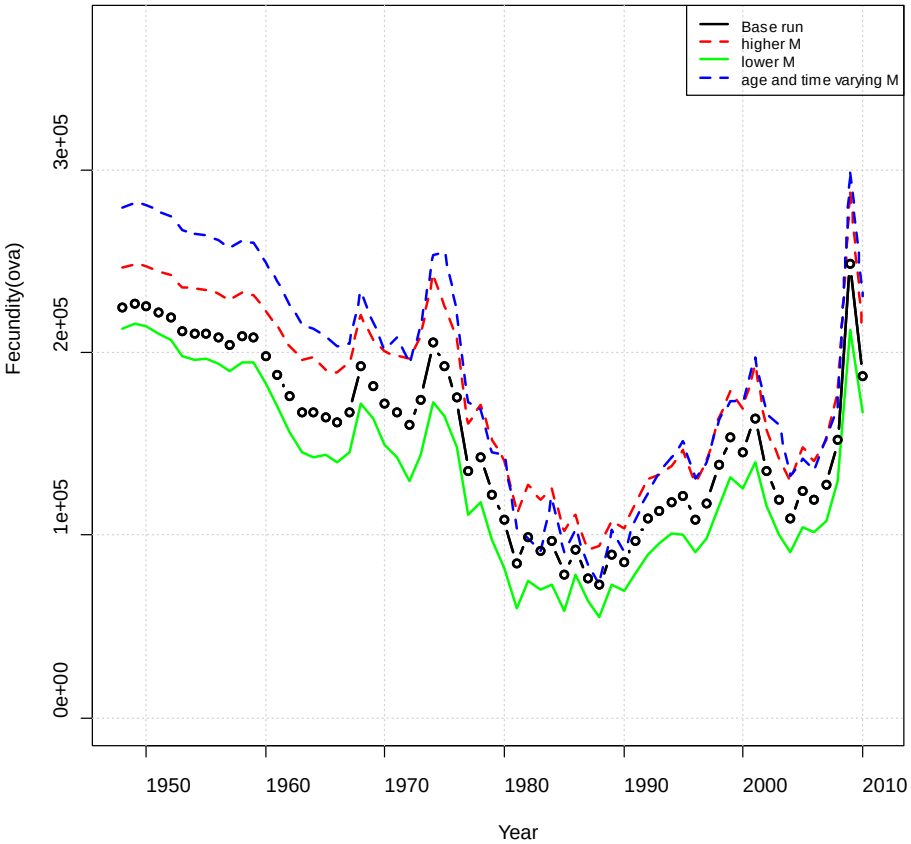


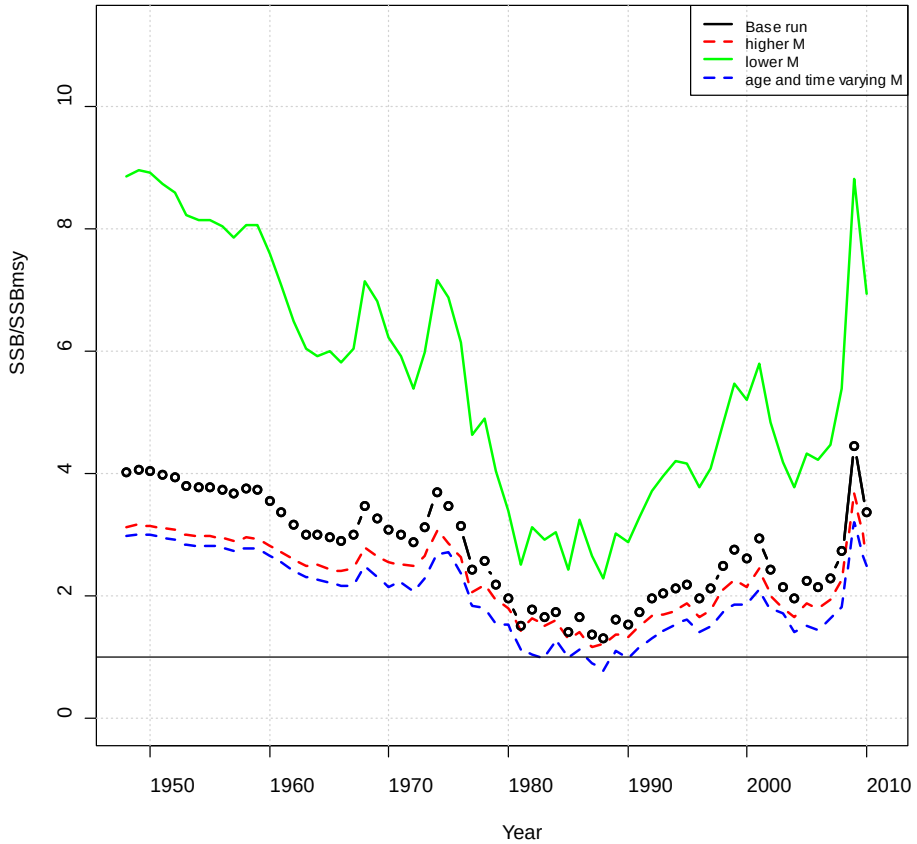
Natural mortality: recruitment and biomass





Natural mortality: fecundity and SSB/SSB$_{MSY}$





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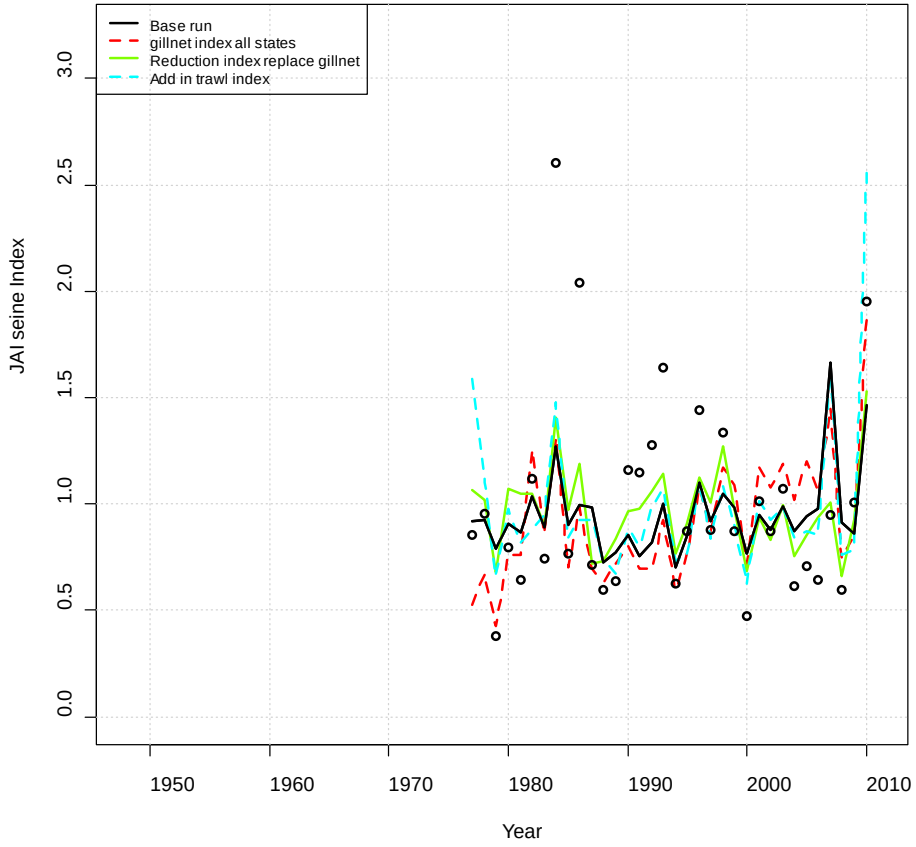
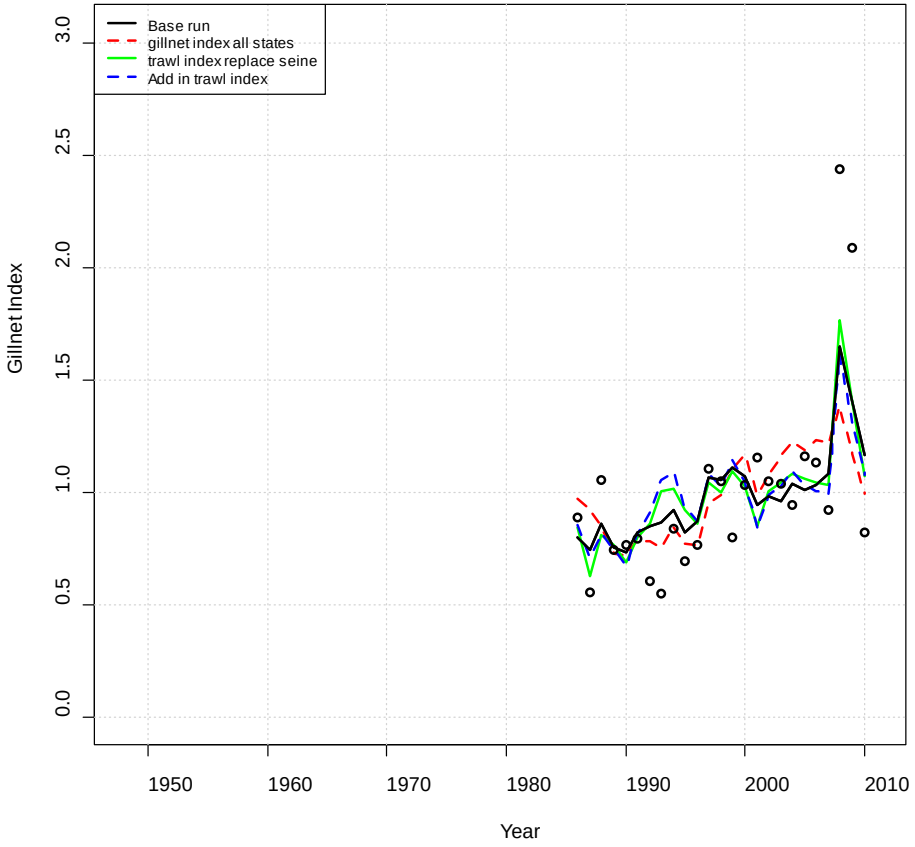
Sensitivity runs completed

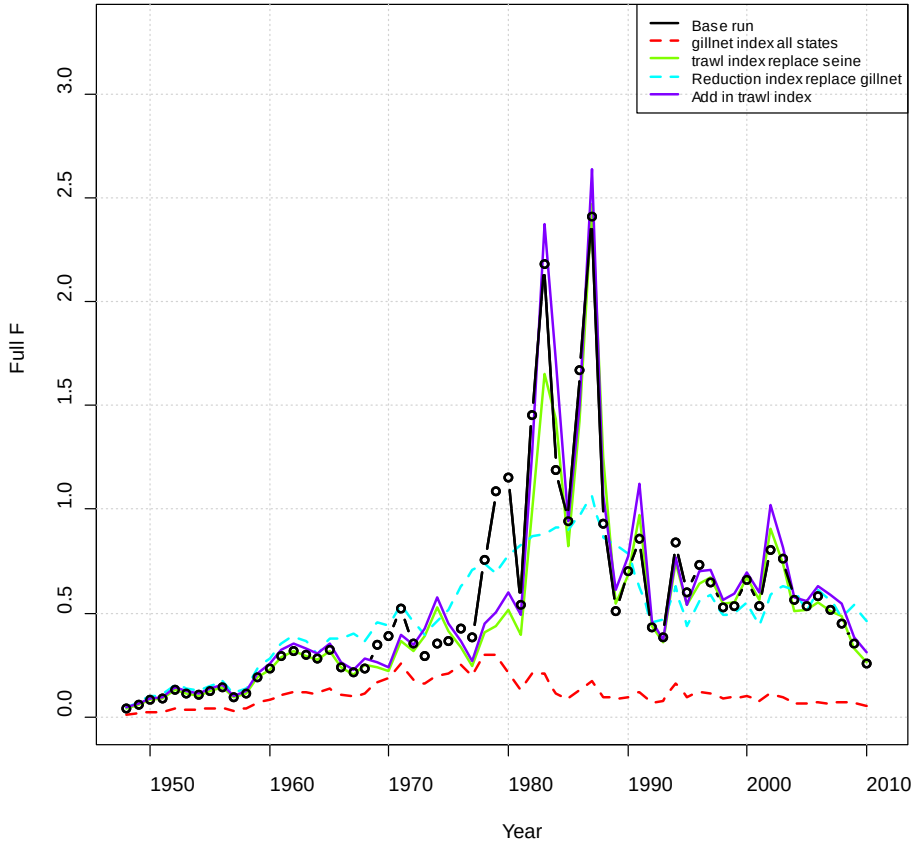
- Natural mortality
  - High M
  - Low M
  - Age and time varying M
- Index
  - Gillnet index including all states
  - Trawl index replace seine index
  - Reduction index replace gillnet index
  - Add in trawl index

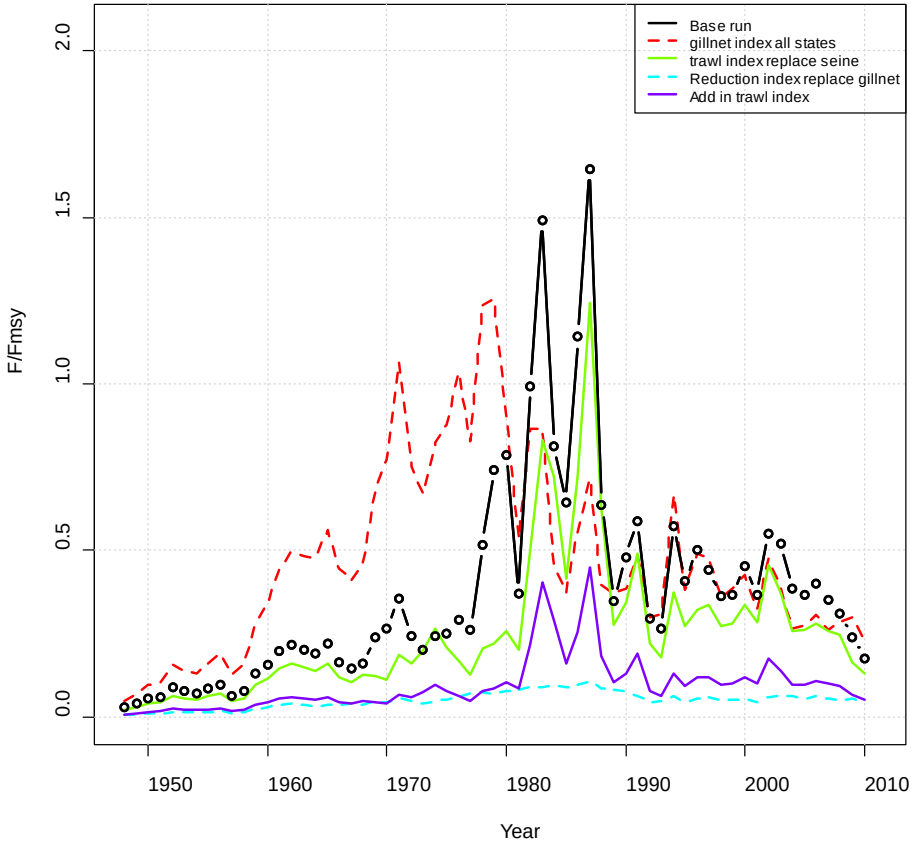
Index: index fits



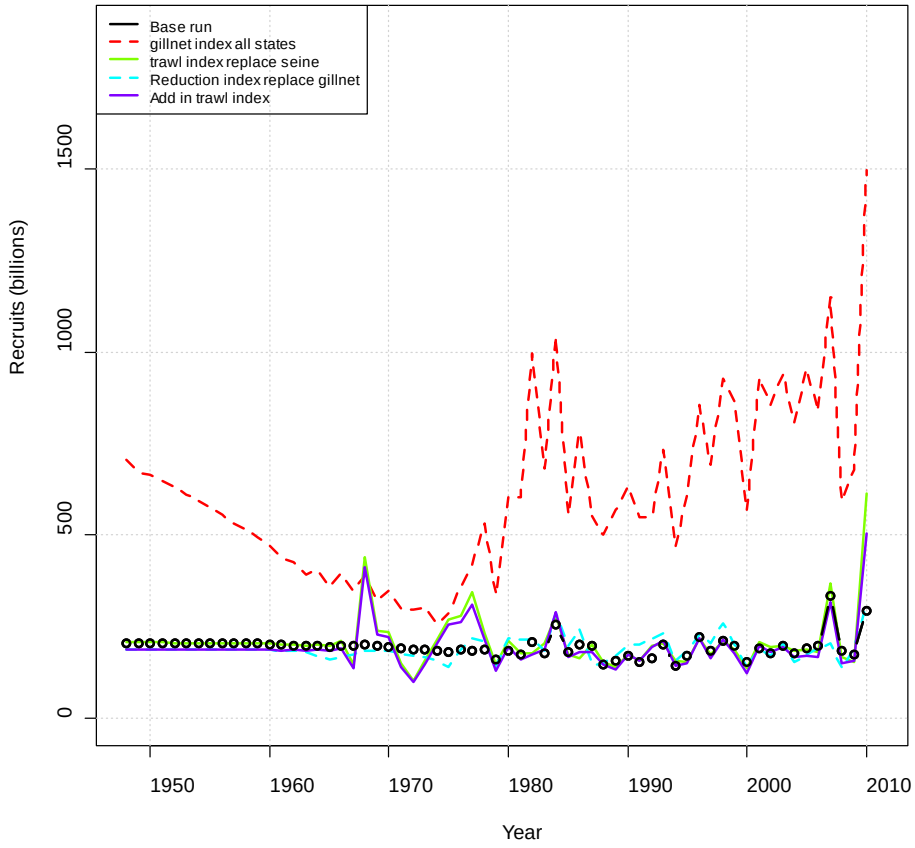


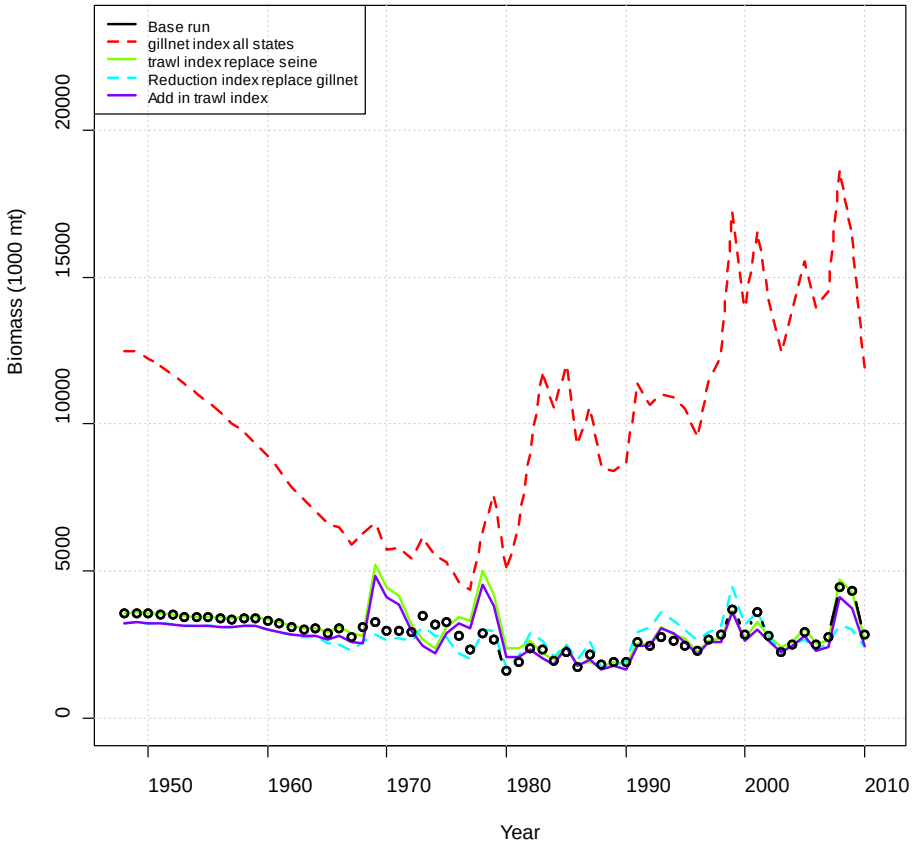
Index: F and F/F_{MSY}



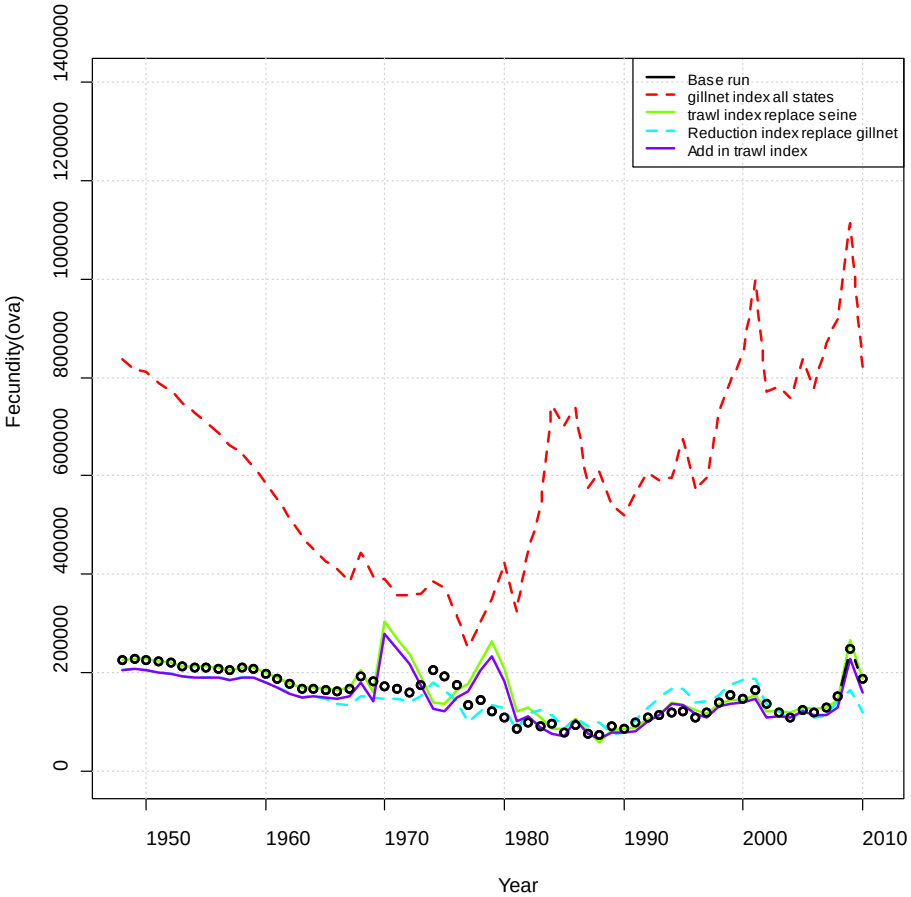


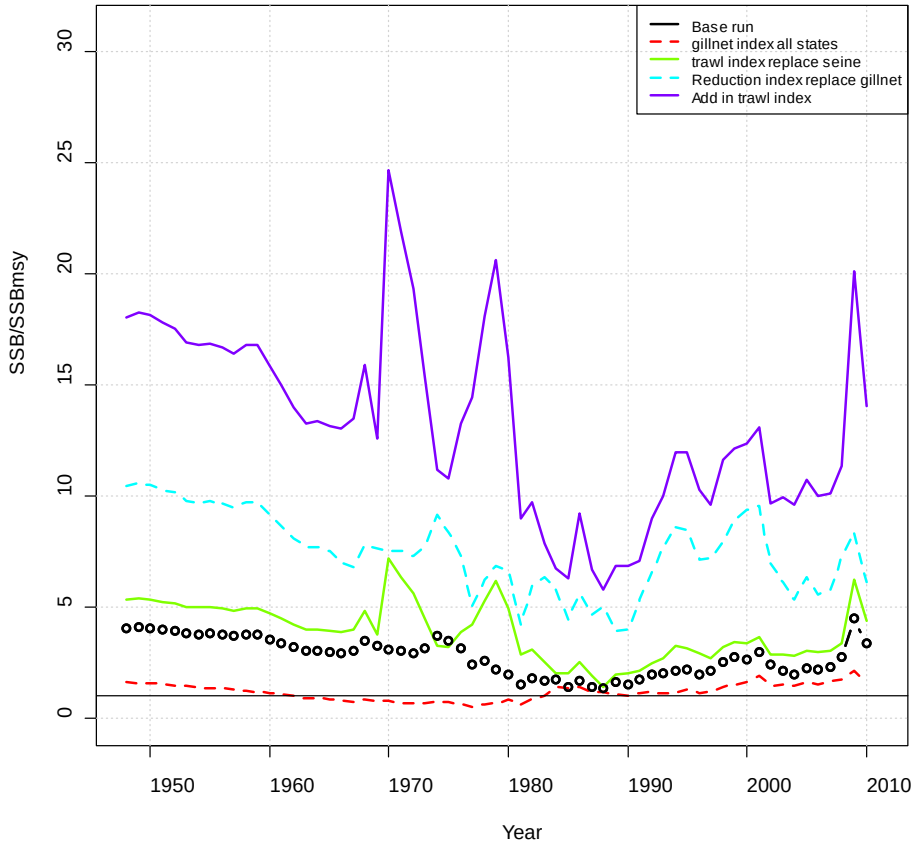
Index: recruitment and biomass





Index: fecundity and SSB/SSB$_{MSY}$





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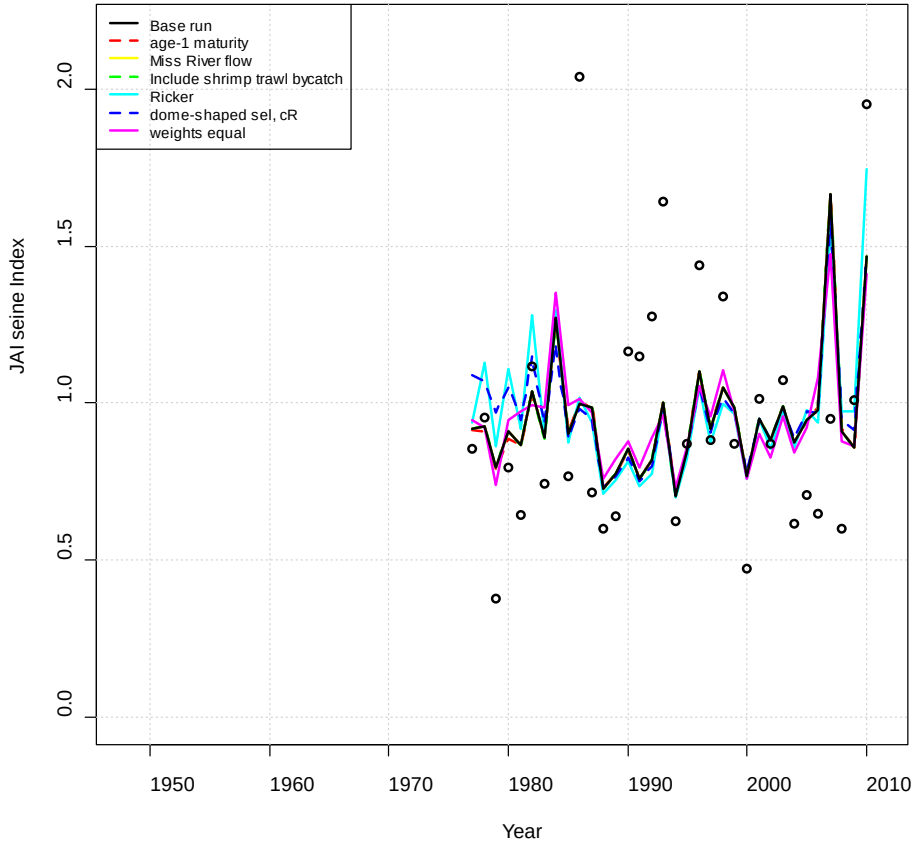
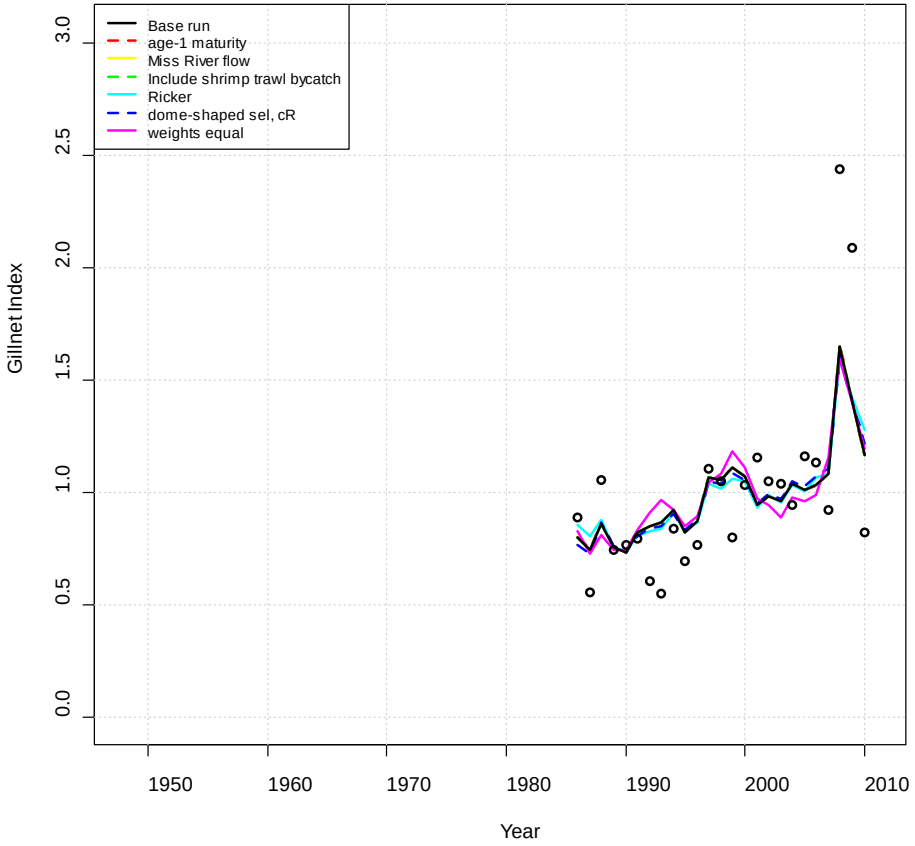
Sensitivity runs completed

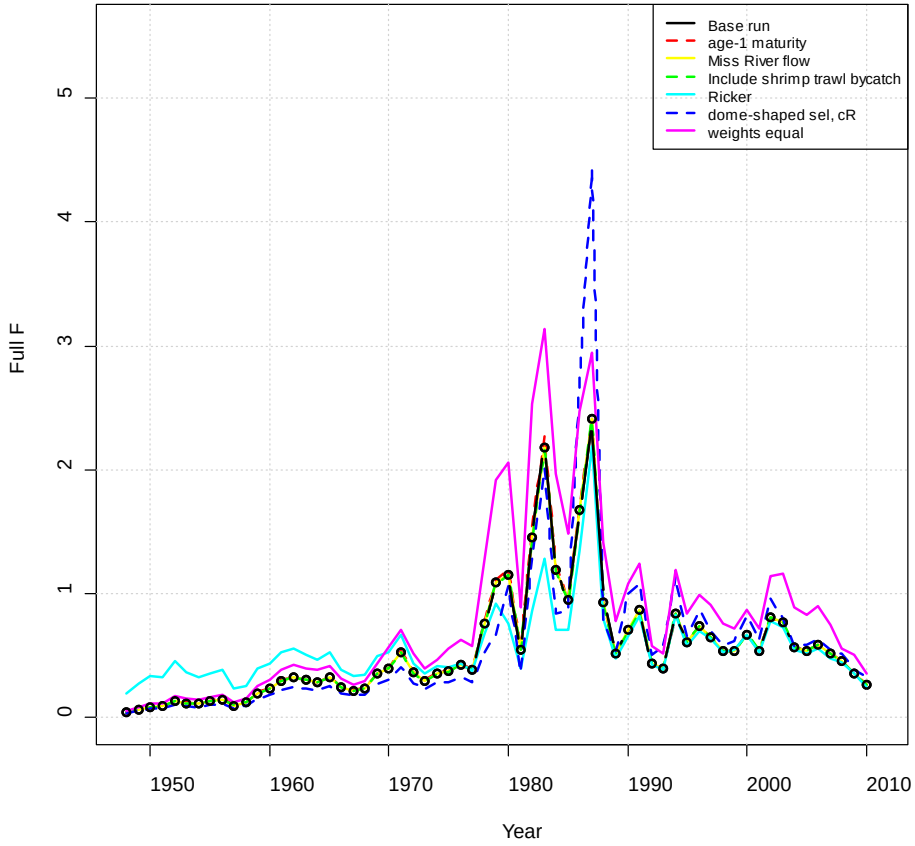
- Natural mortality
  - High M
  - Low M
  - Age and time varying M
- Index
  - Gillnet index including all states
  - Trawl index replace seine index
  - Reduction index replace gillnet index
  - Add in trawl index
- Others
  - Age 1 maturity
  - Mississippi River flow
  - Shrimp trawl bycatch
  - Ricker
  - Dome-shaped selectivity for reduction fishery
  - Weights equal

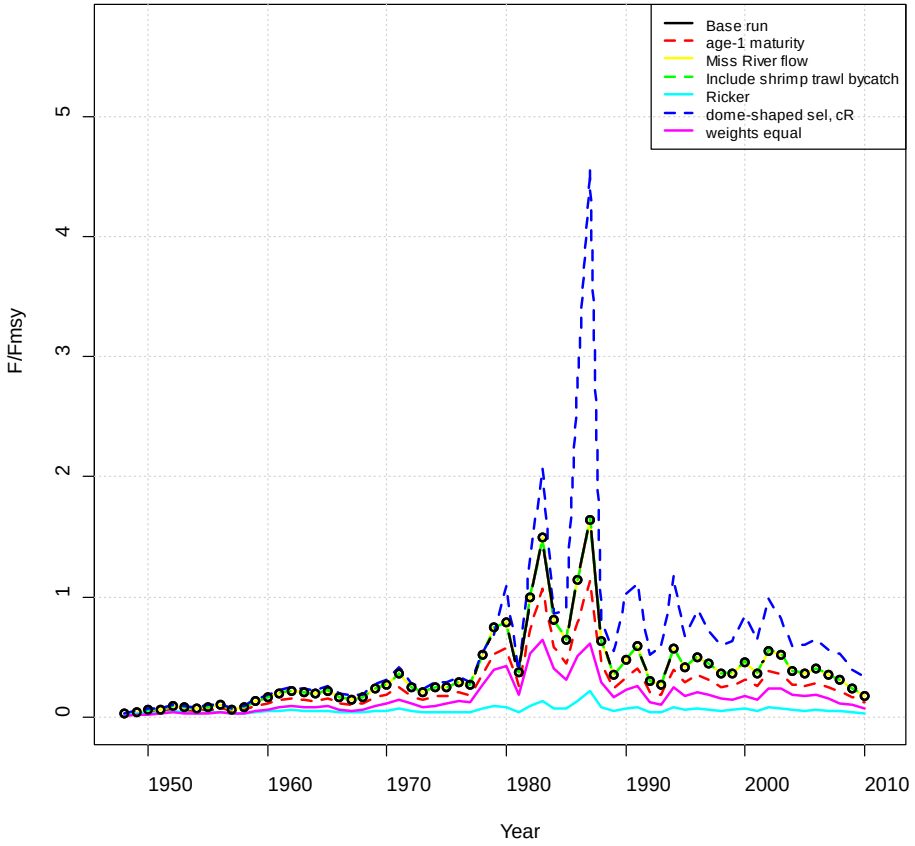
Others: index fits



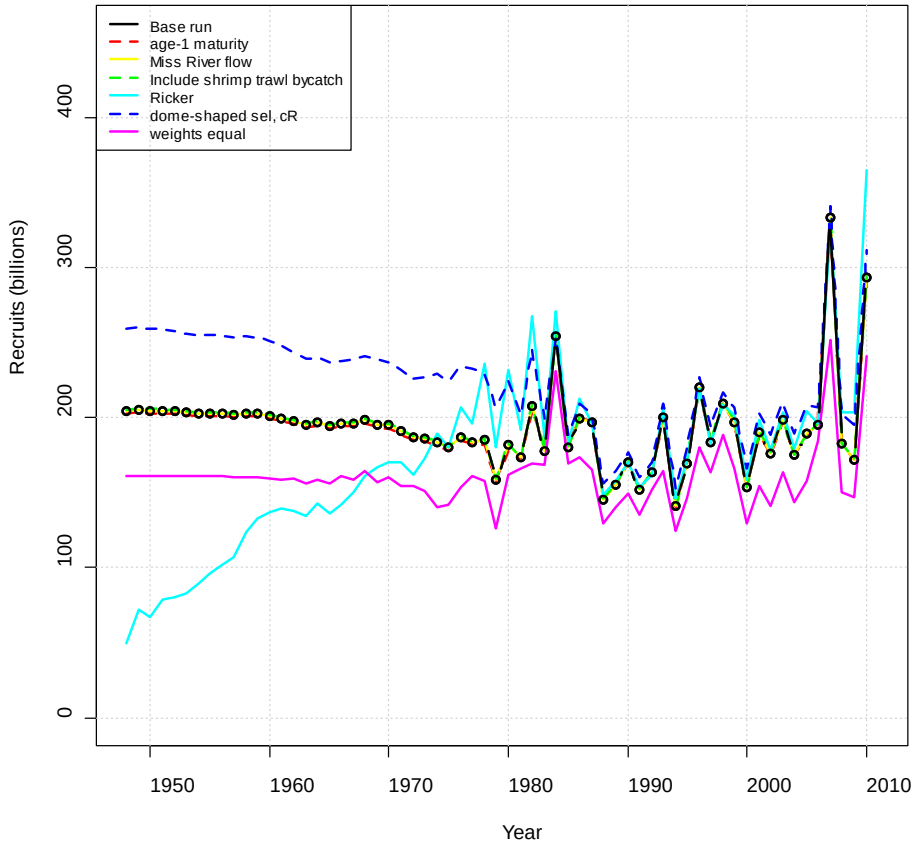


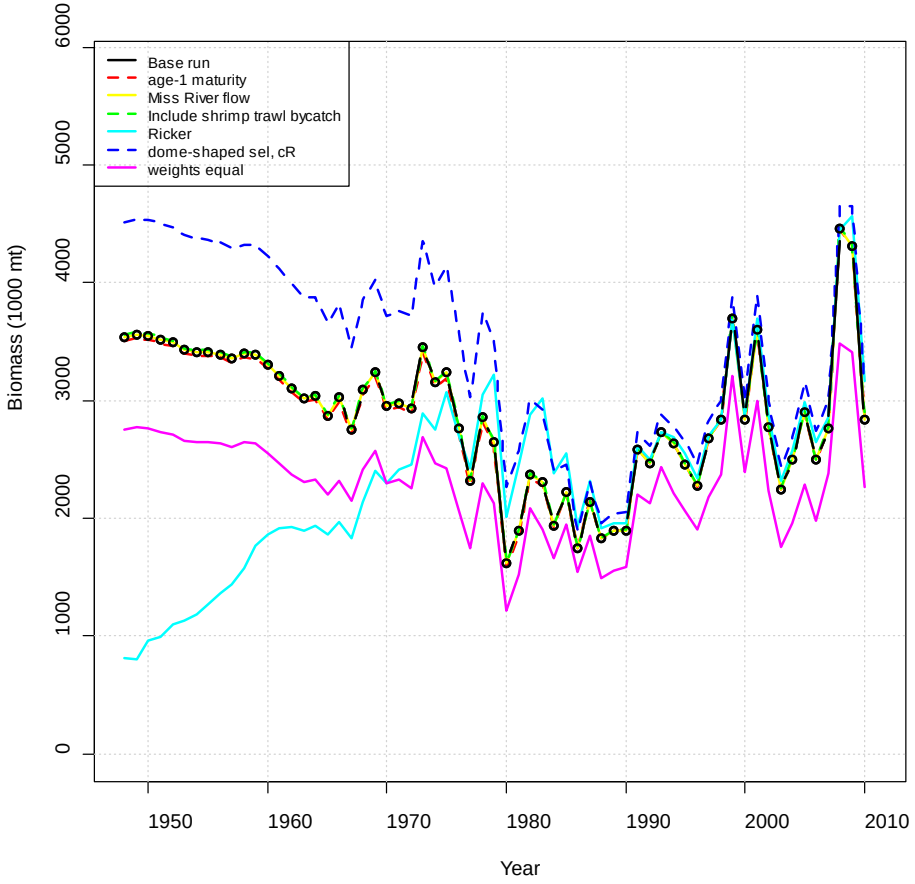
Others: F and F/F_{MSY}



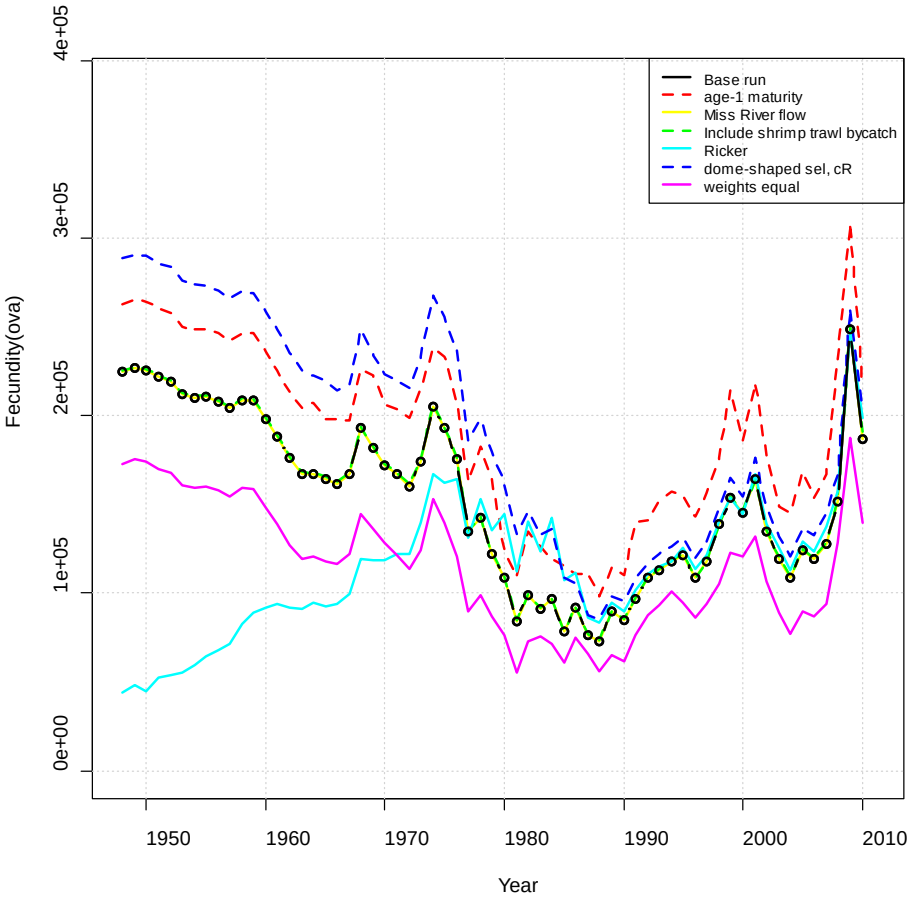


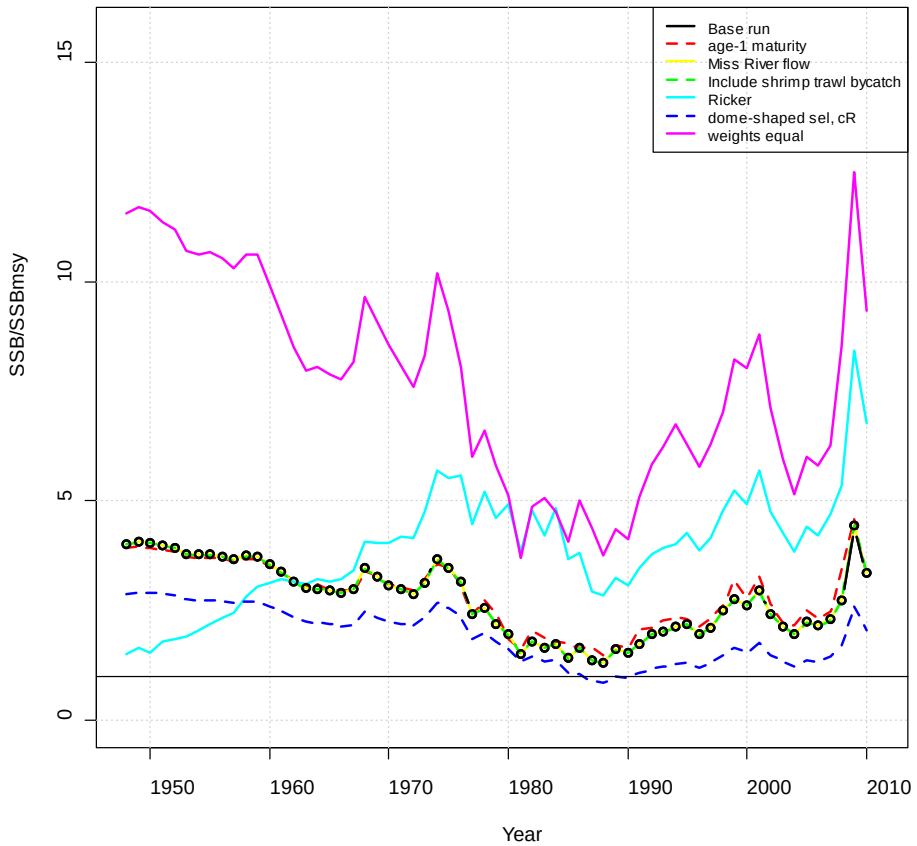
Others: recruitment and biomass





Others: fecundity and SSB/SSB_{MSY}





NOAA FISHERIES SERVICE

Sensitivity runs completed

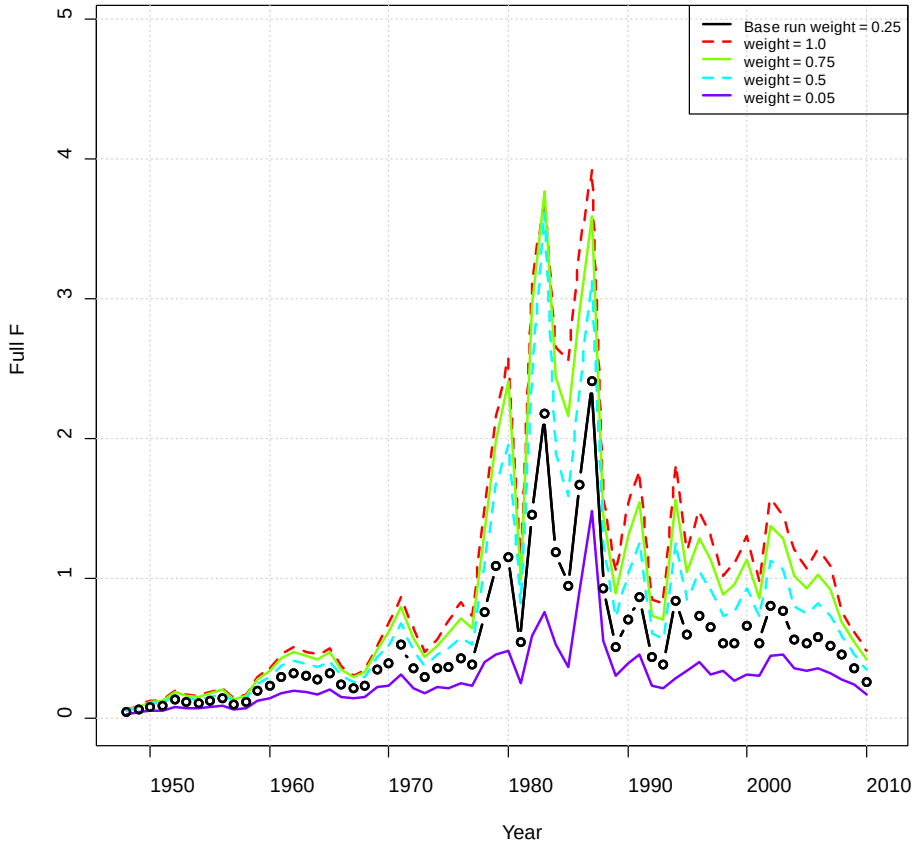
- Natural mortality
  - High M
  - Low M
  - Age and time varying M
- Index
  - Gillnet index including all states
  - Trawl index replace seine index
  - Reduction index replace gillnet index
  - Add in trawl index
- Others
  - Age 1 maturity
  - Mississippi River flow
  - Shrimp trawl bycatch
  - Ricker
  - Dome-shaped selectivity for reduction fishery
  - Weights equal
- Age composition weights

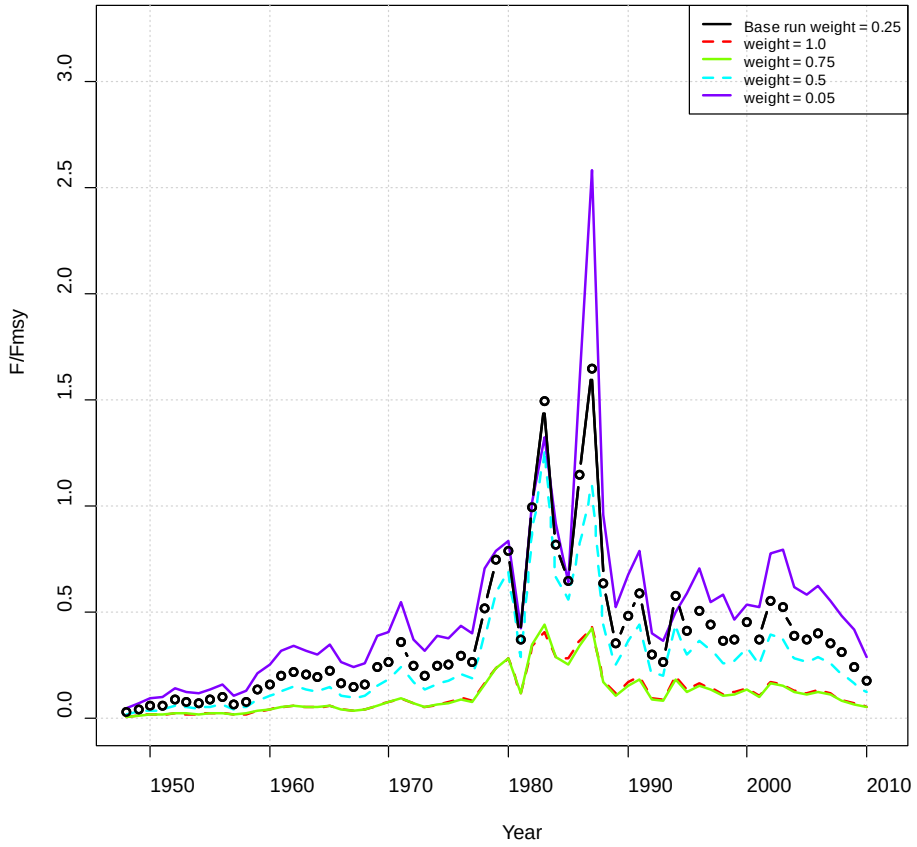
NOAA FISHERIES SERVICE

Sensitivity runs: Age comp weight

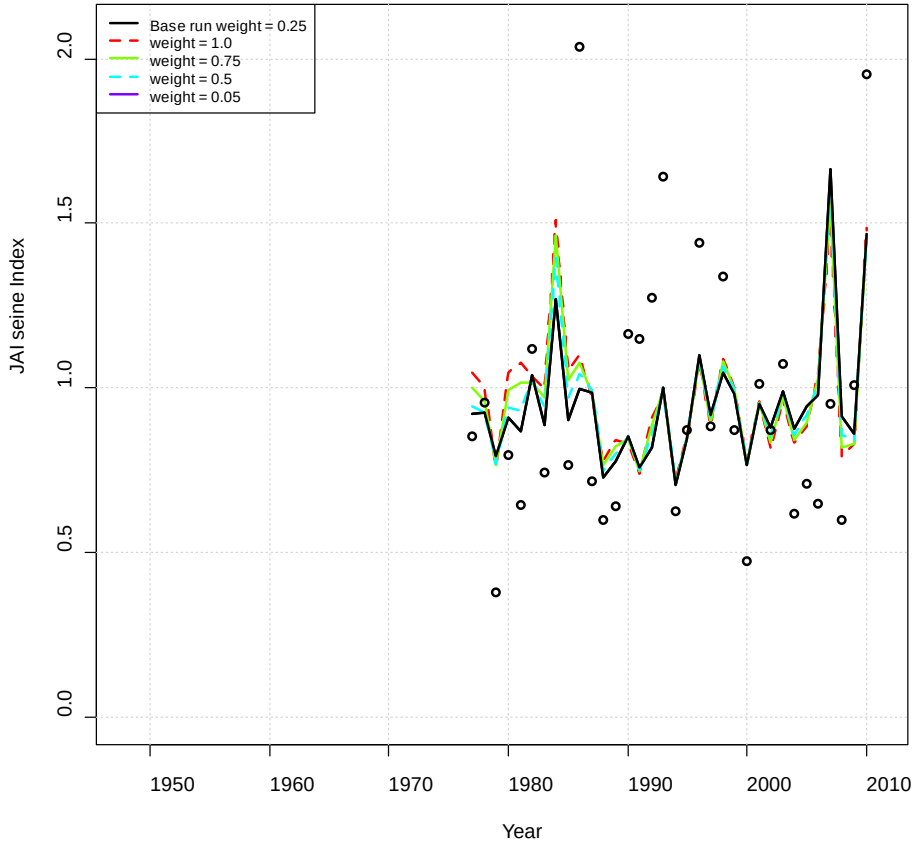
- Ran series of sensitivity runs on age composition weight
  - Base run w = 0.25
  - w = 1.0
  - w = 0.75
  - w = 0.50
  - w = 0.05
- Base run weight allowed most other data sources to fit better (smaller likelihood components)
- Once reached w = 0.05, Hessian problems

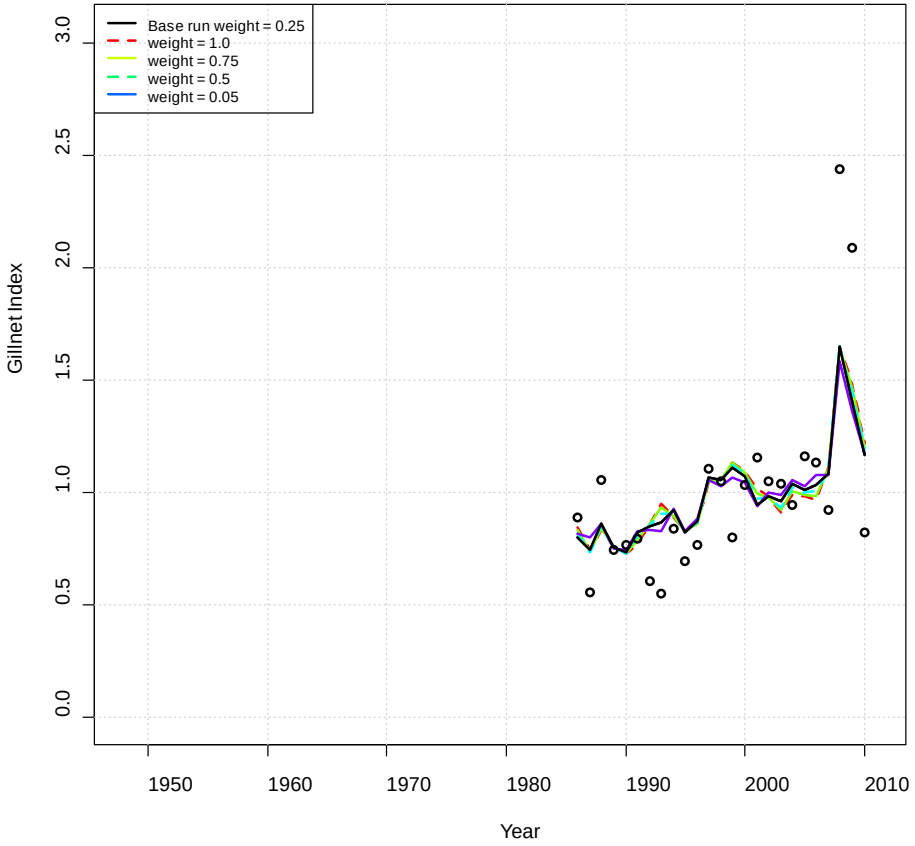
Age comp weight: F and F/F_{MSY}





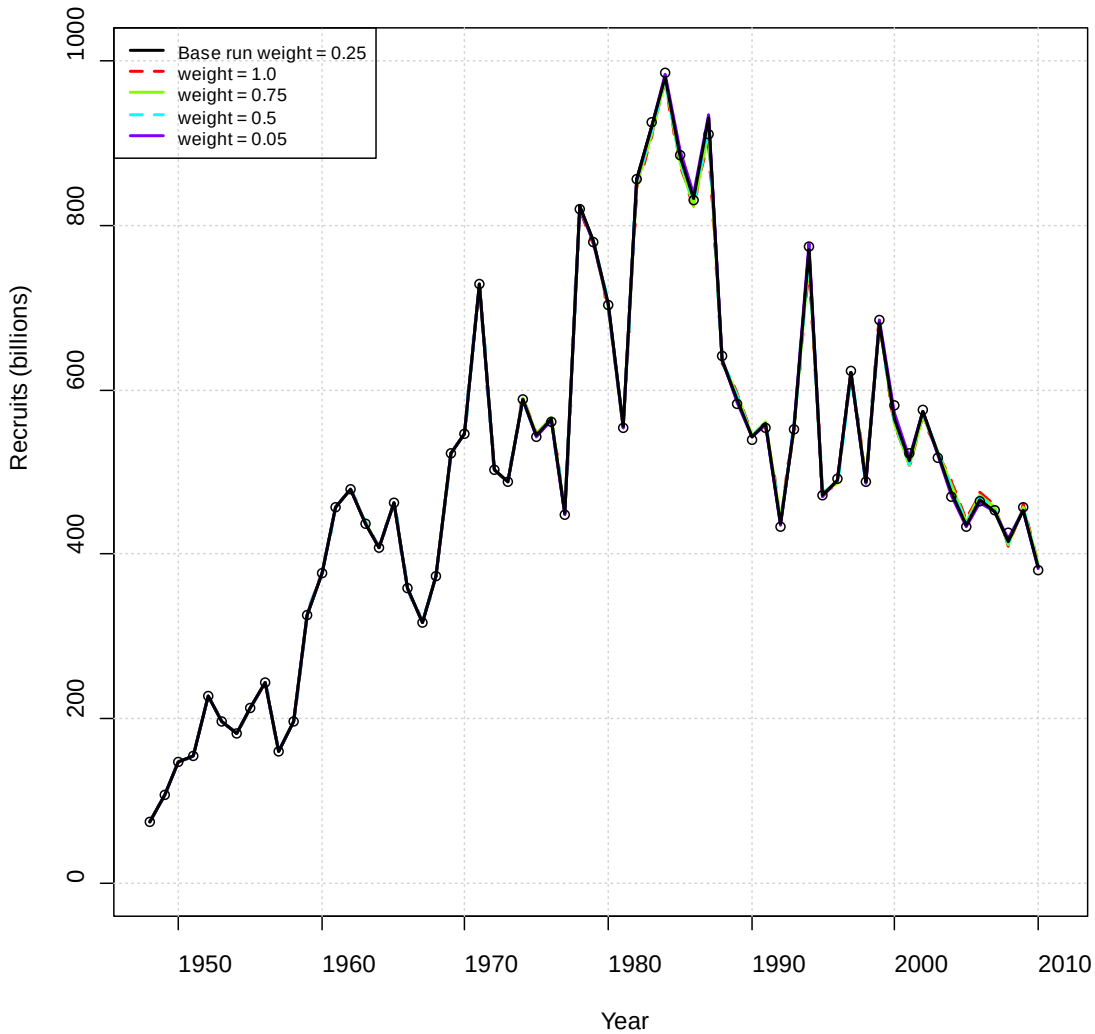
Age comp weight: index fits





NOAA FISHERIES SERVICE

Age comp weight: landings fit



NOAA FISHERIES SERVICE

Sensitivity runs completed

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  - Age and time varying M
- Index
  - Gillnet index including all states
  - Trawl index replace seine index
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  - Add in trawl index
- Others
  - Age 1 maturity
  - Mississippi River flow
  - Shrimp trawl bycatch
  - Ricker
  - Dome-shaped selectivity for reduction fishery
  - Weights equal
- Age composition weights
- Retrospective

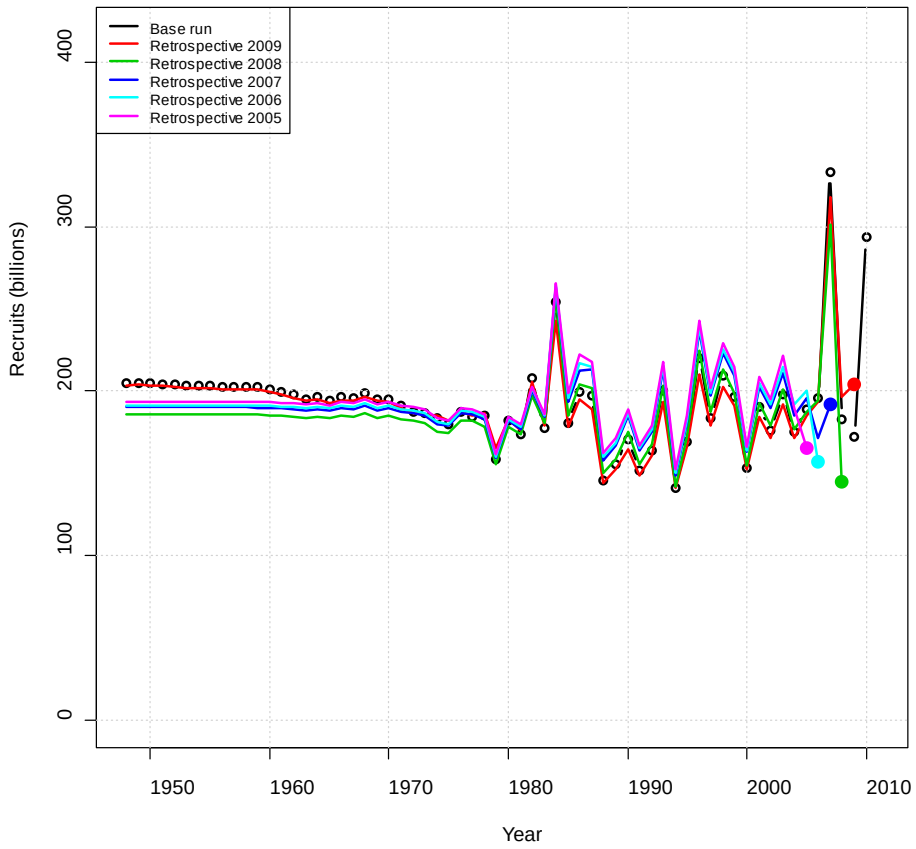
NOAA FISHERIES SERVICE

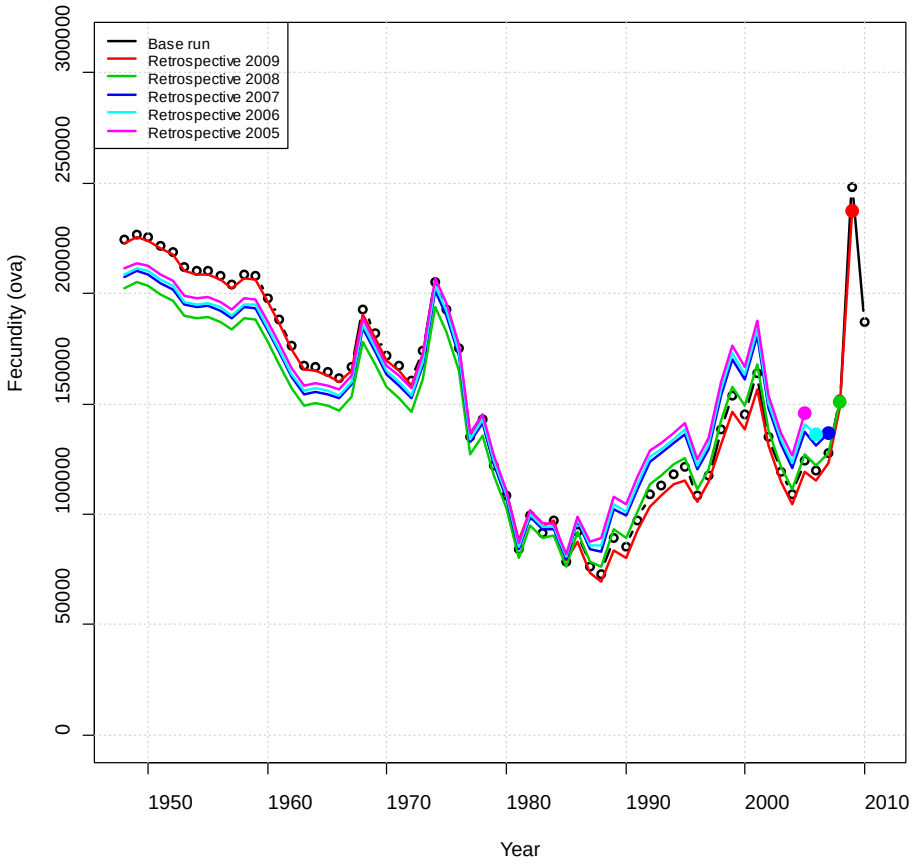
Retrospective runs:

- Fixed recruitment variability to base run value
- Used a prior on steepness

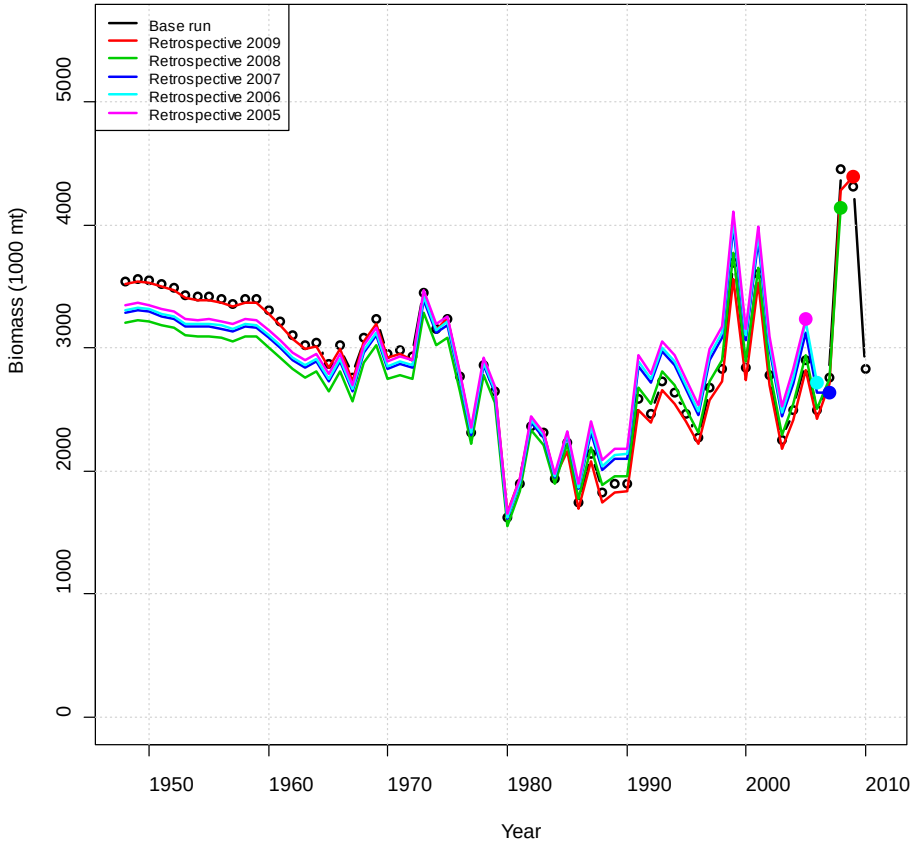
- End result was
  - Steepness estimated but at a higher value than in model ending in 2010
  - Could not estimated F_{MSY} for some years, estimated high for other years

Retrospective: recruitment and fecundity

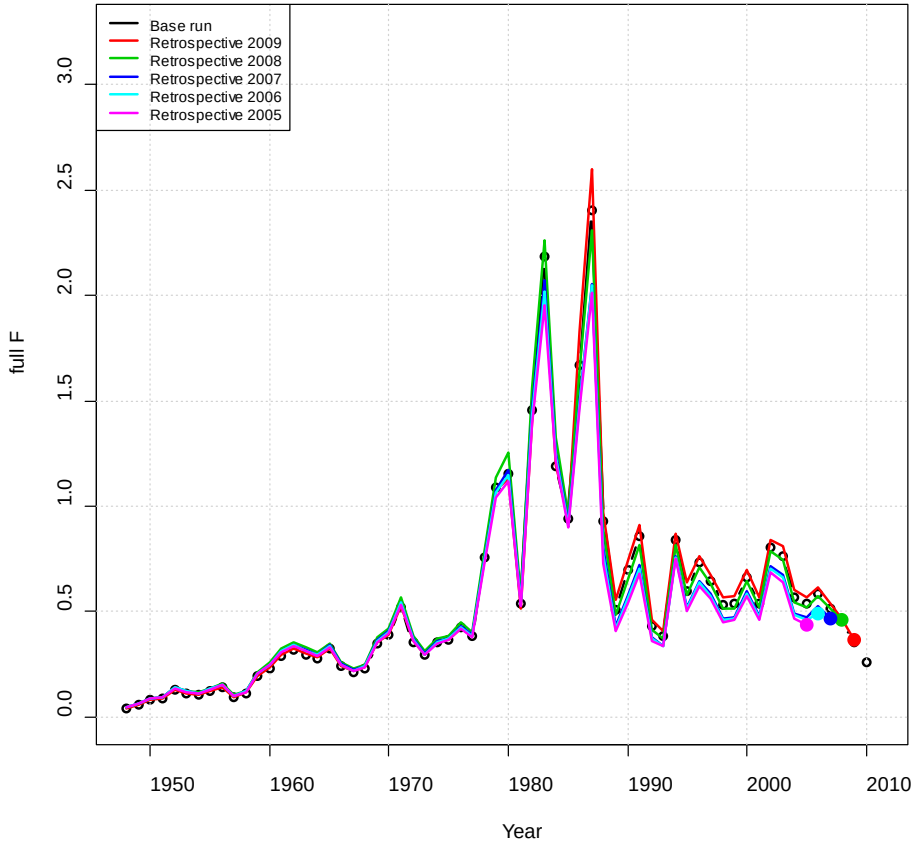


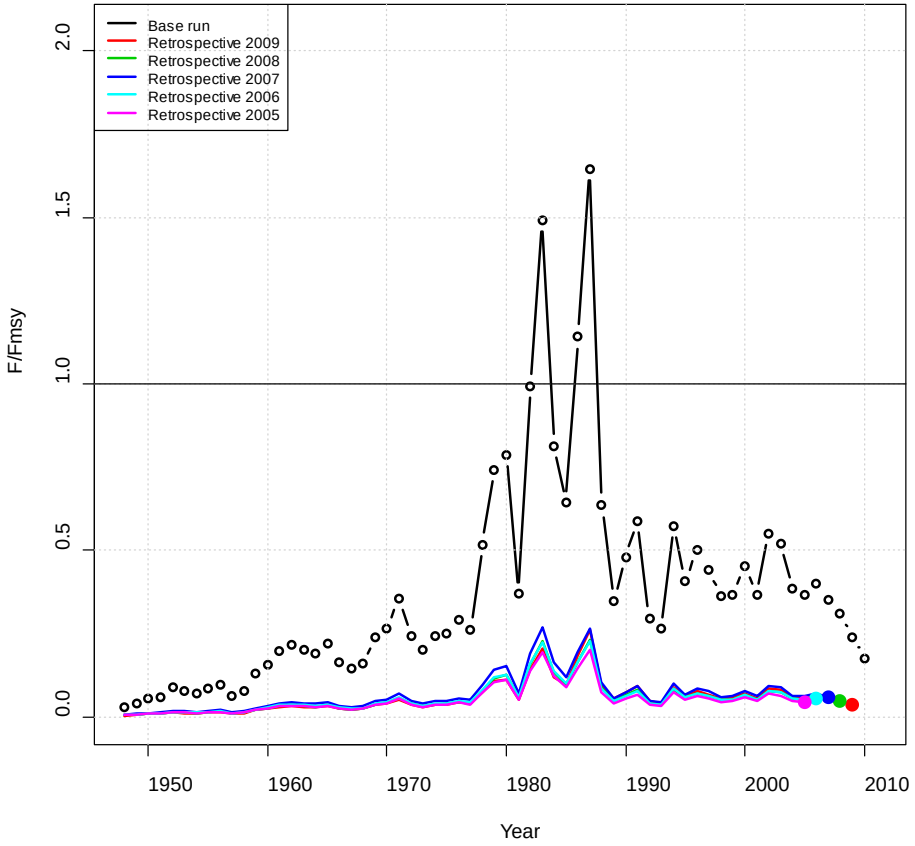


Retrospective: biomass



Natural mortality: F and F/F_{MSY}





NOAA FISHERIES SERVICE

Beaufort Assessment Model (BAM)

- Final base run configuration and results
- Sensitivity runs
- Monte Carlo bootstraps
- Benchmarks and stock status
- Comparison to surplus production

NOAA FISHERIES SERVICE

Monte Carlo Bootstraps (4,000 total)

- Uncertainty currently included:
  - Landings
    - Multiplicative lognormal error with a bias correction
    - Landings*[exp(x)-(σ^2/2)]
    - Where x ~ N(0, σ^2) and σ=(log(1.0+CV^2))^0.5
  - Age comps
    - Distributes number of fish sampled based on probability observed and recreates age comps for each year
  - Length comps
    - Distributes number of fish sampled based on probability observed and recreates length comps for each year

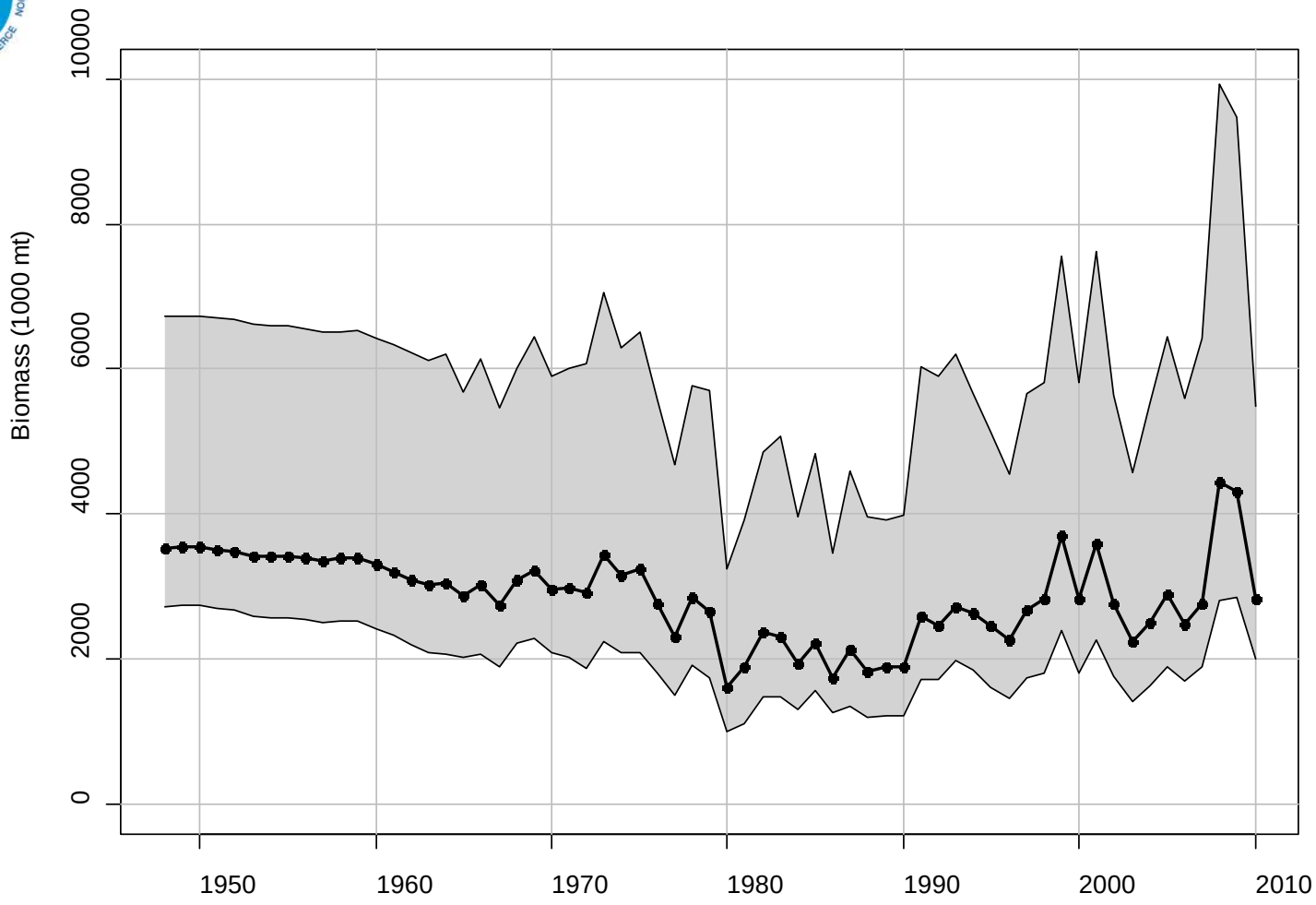
NOAA FISHERIES SERVICE

Monte Carlo Bootstraps

- Uncertainty currently included:
  - Gillnet and seine indices
    - Multiplicative lognormal error using CVs
  - Maturity at age-1
    - Triangular distribution with range of 0 to 0.25 and mode of 0
  - Natural mortality
    - Normal with a mean of 1.10 and StDev of 0.18
    - Age 2 scaled to randomly chosen value
- MCB runs were culled if F_{MSY} could not be estimated (15% of runs)

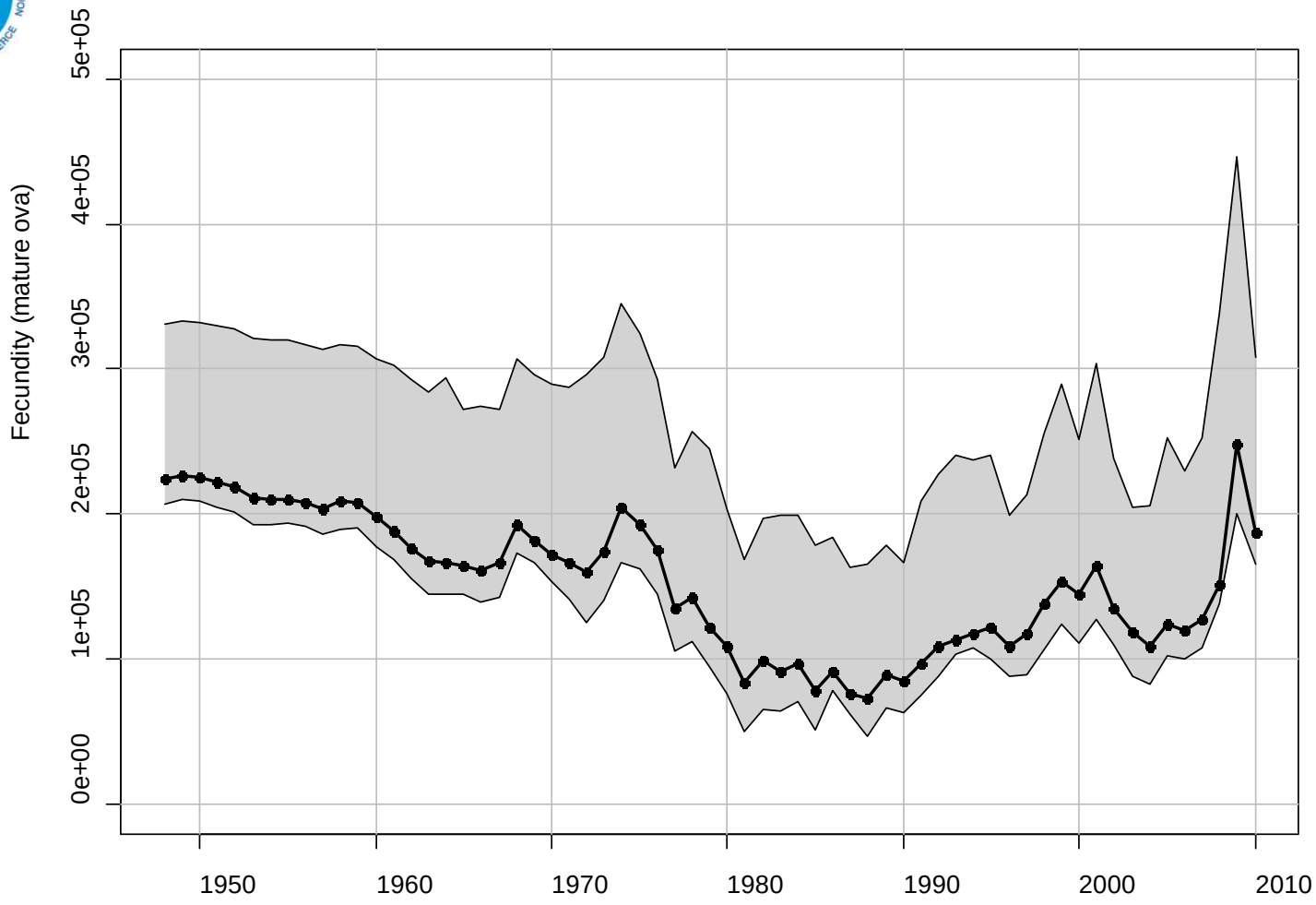
NOAA FISHERIES SERVICE

MCB: Biomass



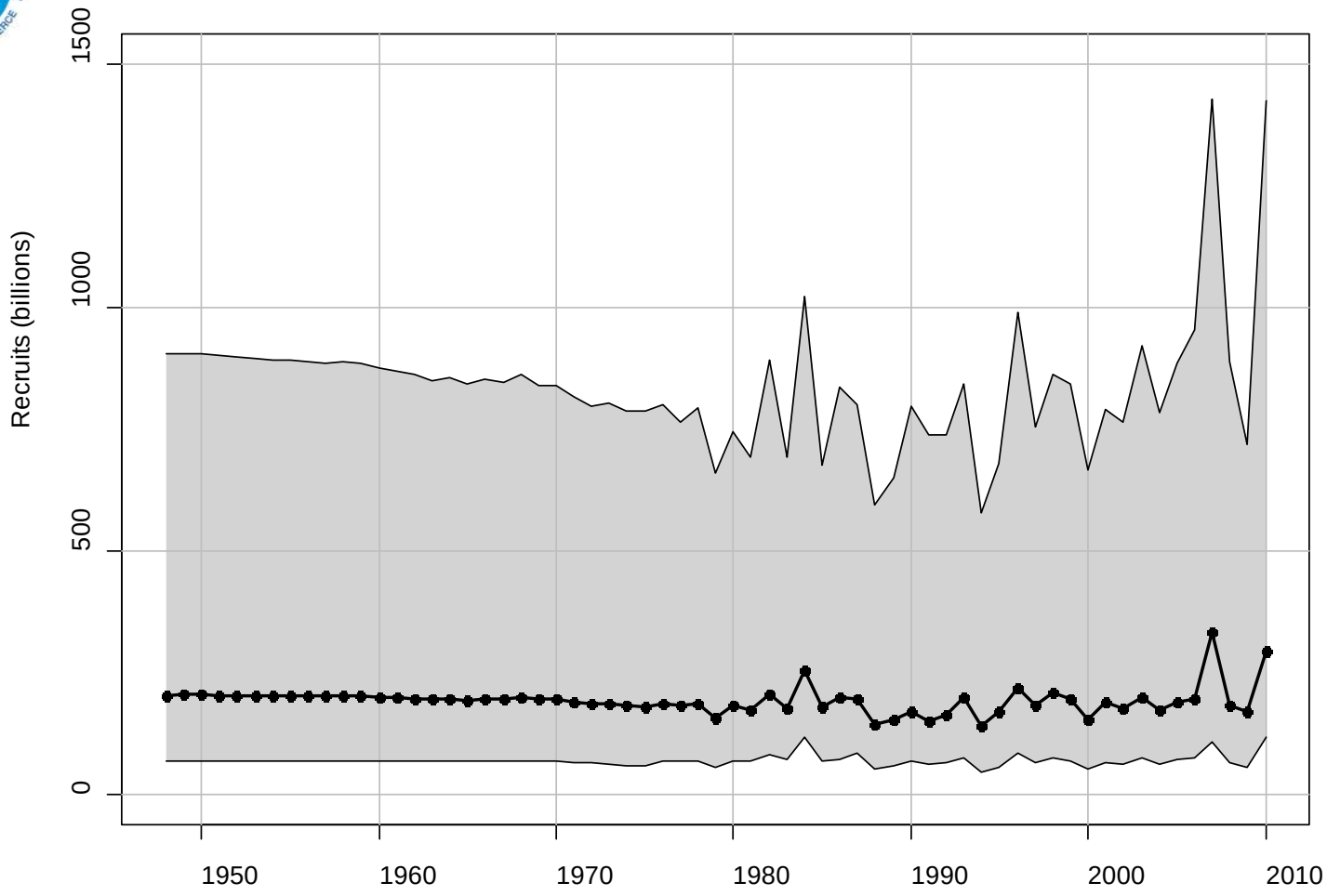
NOAA FISHERIES SERVICE

MCB: Fecundity



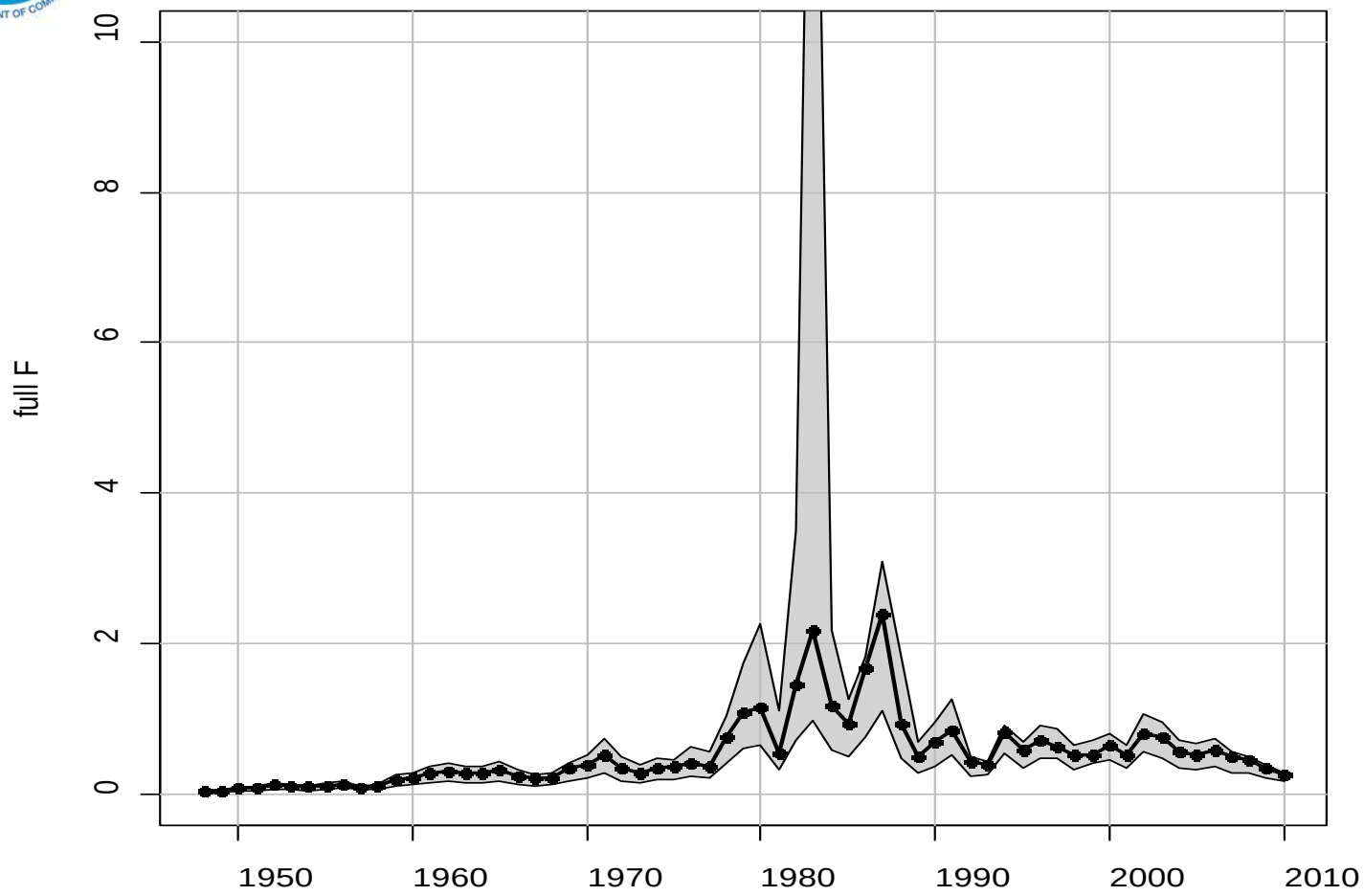
NOAA FISHERIES SERVICE

MCB: Recruitment



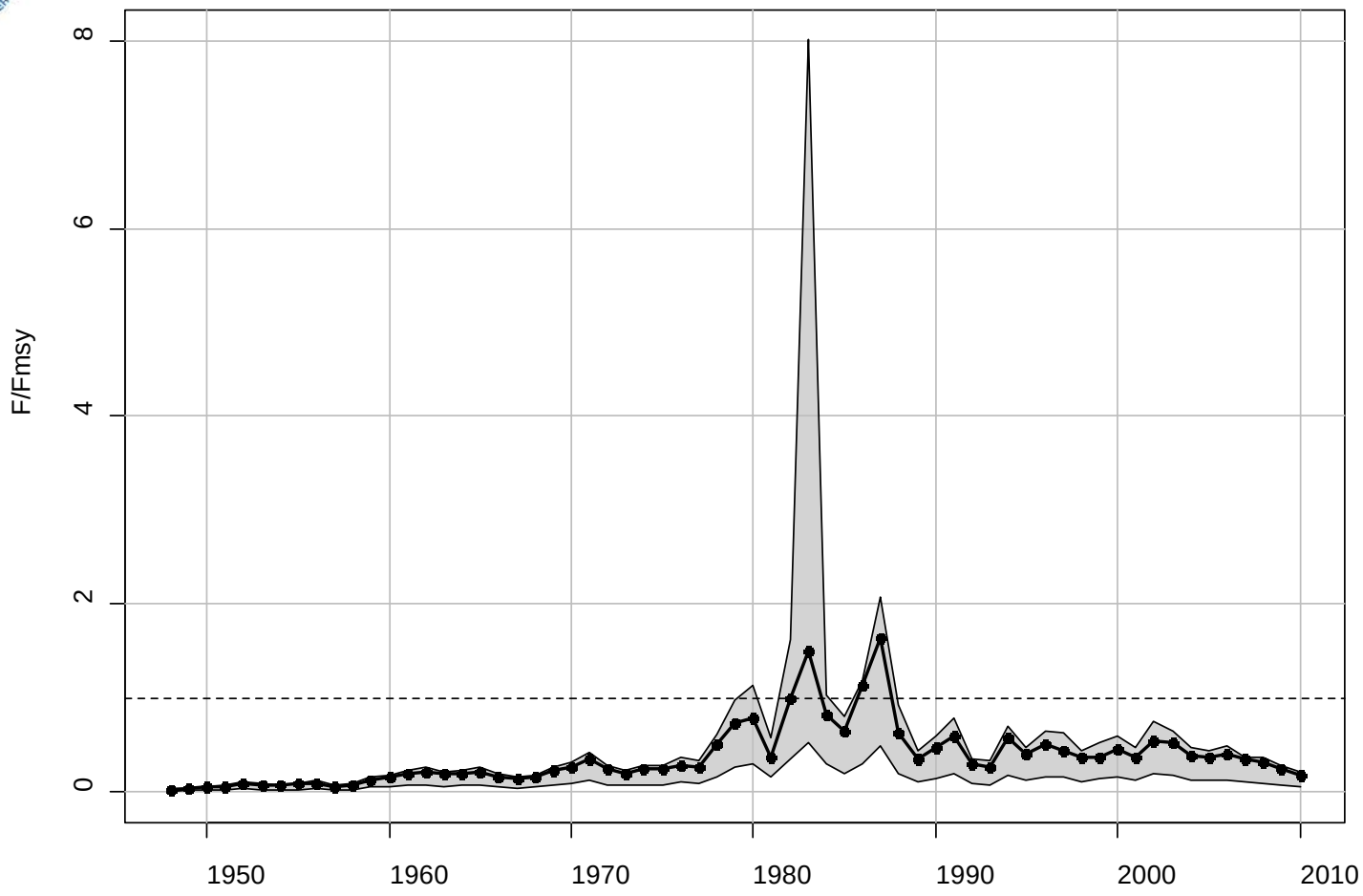
NOAA FISHERIES SERVICE

MCB: Age 2+ F



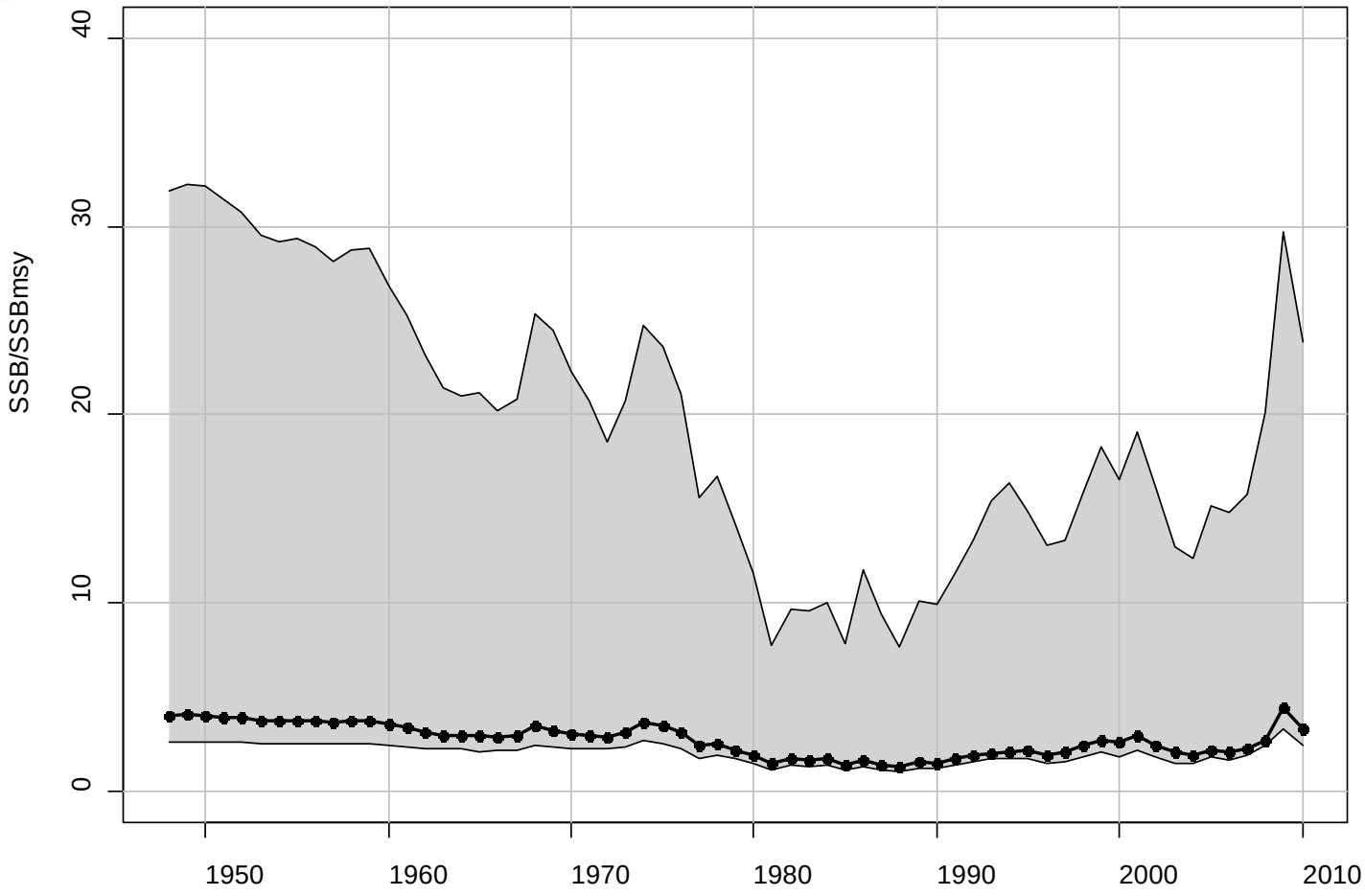
NOAA FISHERIES SERVICE

MCB: F/Fmsy

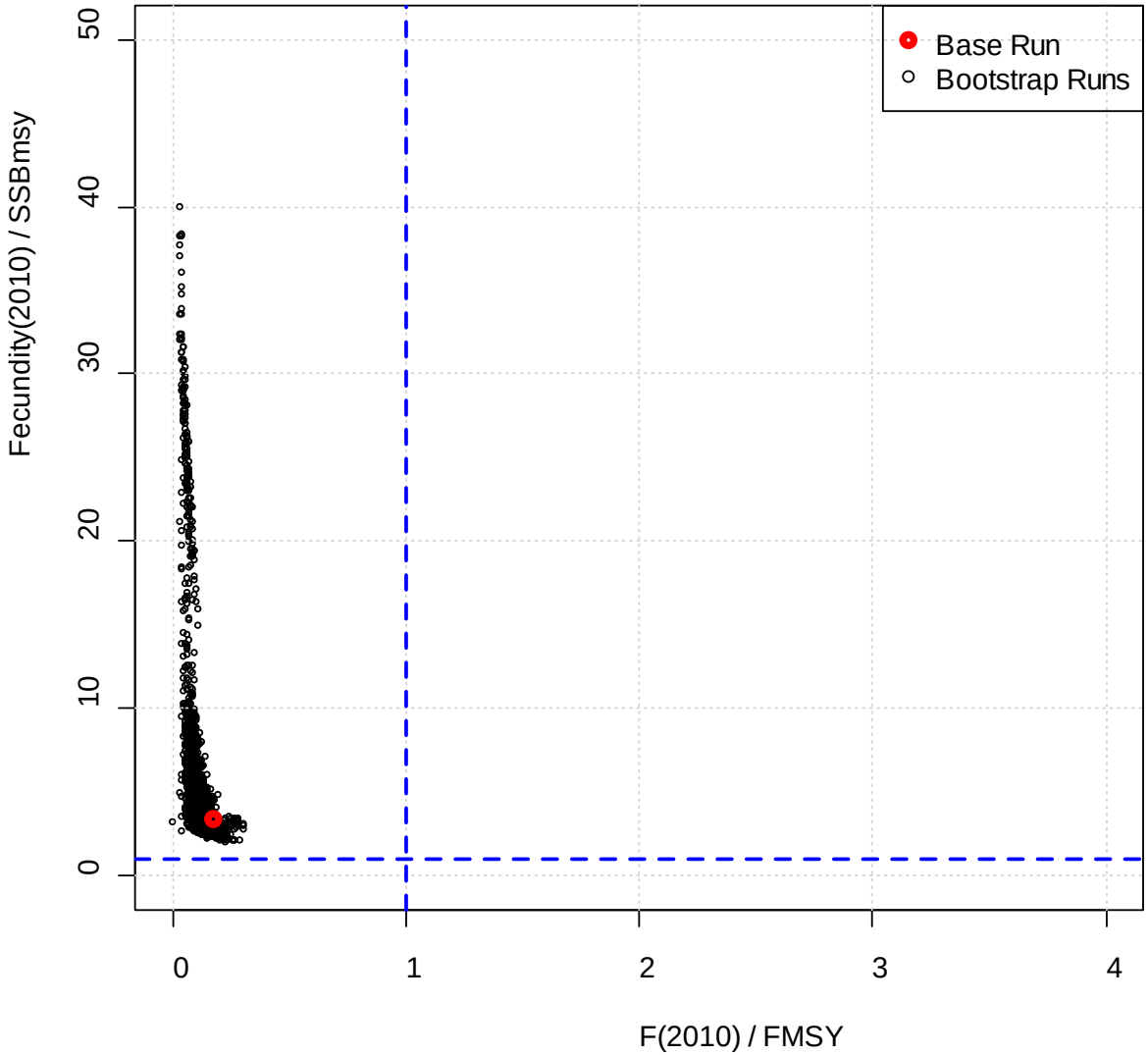


NOAA FISHERIES SERVICE

MCB: SSB/SSBmsy



MCB: Reference points



Beaufort Assessment Model (BAM)

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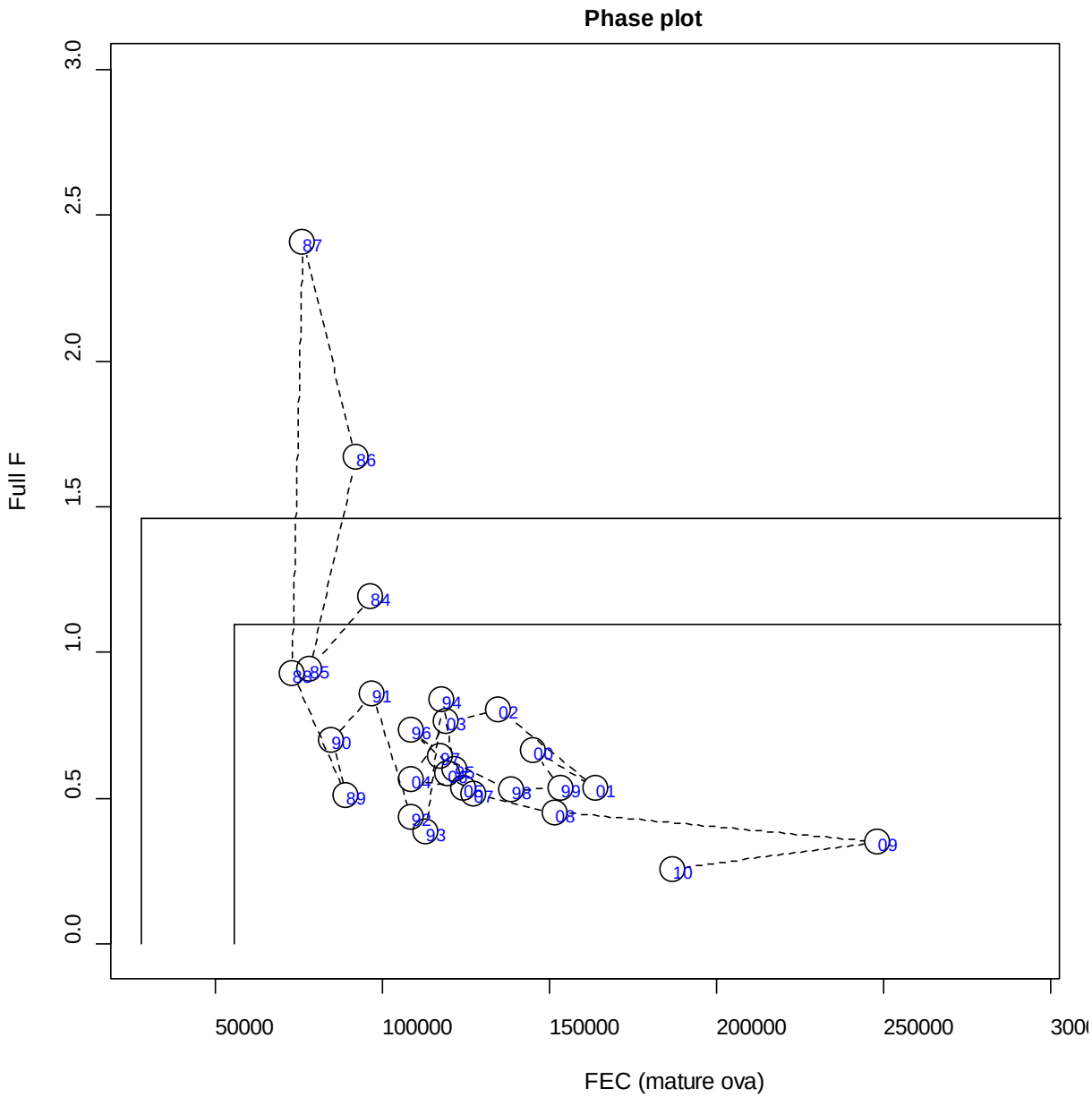
Benchmarks and stock status

- Proposed MSY based benchmarks
  - Well defined stock recruitment curve with parameters, including h, estimated
  - National standard
- Stock status is consistent among base run, sensitivity runs, and MCB runs
- Stock status
  - Not overfished with respect to limit
    - Target: $SSB_{2010}/SSB_{MSY} = 3.35$
  - Overfishing is not occurring
    - Geometric mean of last 3 years of $F/F_{MSY} = 0.23$

Phase plot



Phase plot
Full F
FEC (mature ova)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
50000
100000
150000
200000
250000
87
86
84
85
91
94
02
03
96
90
00
97
04
98
99
01
89
08
92
93
09
10

Beaufort Assessment Model (BAM)

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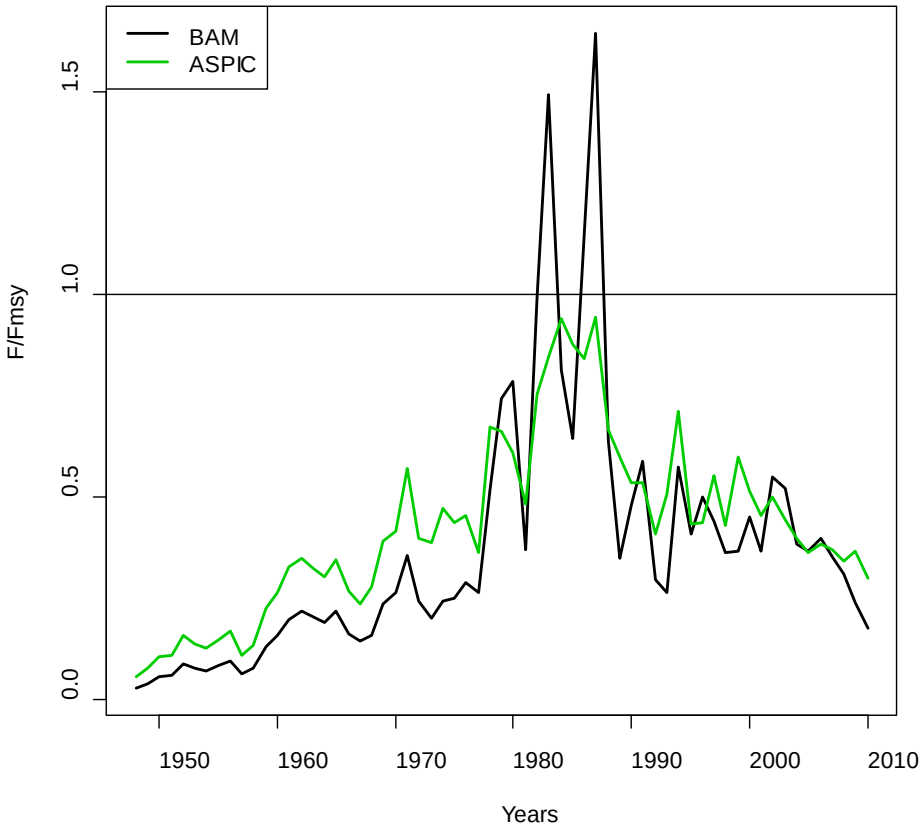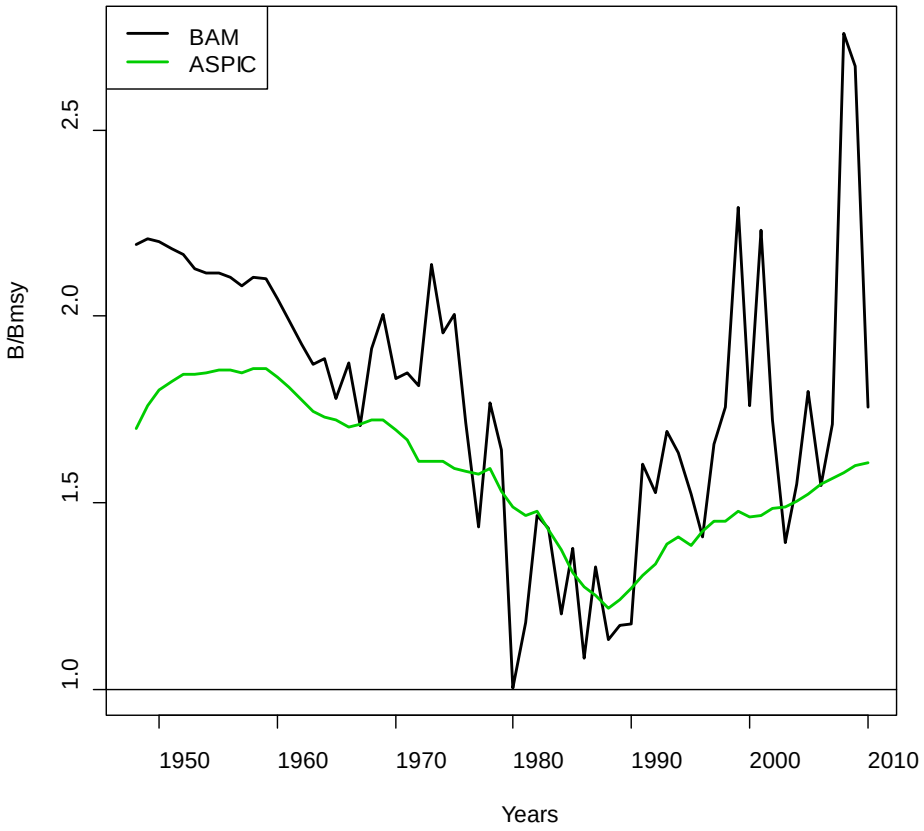
Comparison to surplus production