SEDAR 47 Data and Assessment Methods: Structure of the catch-free assessment model, assumptions, and 2014 model estimates

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The Catch-Free Model (Porch et al. 2006)

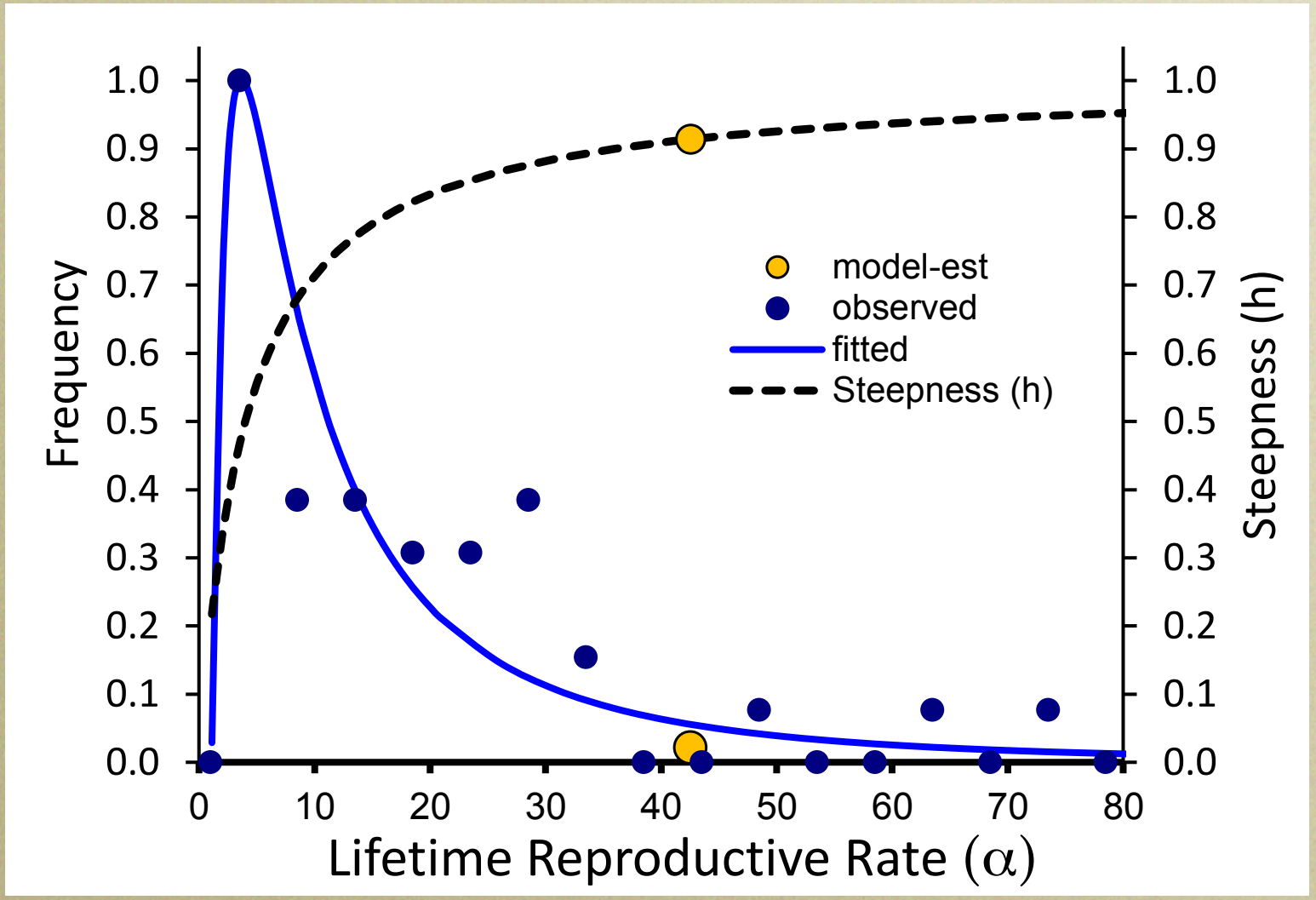
- A flexible framework for estimating stock status, reference points, and recovery times when catch data or other measures of absolute abundance may be unreliable.
  - age-structured production model made relative to a pre-exploitation time period.
  - incorporates information from meta-analyses from similar stocks or observations
  - Uses indices of relative abundance to guide population estimates
- Comprised of:
  - a population dynamics model
  - recruitment related to body size and with a random component,
  - Ricker or Beverton-Holt spawner-recruit functions using maximum lifetime reproductive rate (for Goliaths, α is a prior developed from Ran Myers data)
  - Yield-per-recruit estimates suitable for relative reference points

Lifetime Reproductive rate (α)

species	frequency	alpha	species	frequency	alpha
Bombay duck	1	2	striped bass	1	18.6
alewife	4	5.7	walleye pollock	2	9.5
shad	1	18.5	white croaker	1	26.1
Atl. Menhaden	1	24.8	Atlantic bluefin tuna	1	5.2
blueback herring	3	31.9	bigeye tuna	2	5.3
Gulf menhaden	1	5.3	chub mack	1	2.4
Atl Herring	18	22.1	Atlantic mack	2	31.8
Pacific sardine	2	12.7	southern bluefin	1	2.9
Blue whiting	2	10	yellowfin	1	9.3
Atlantic cod	21	26	New Zealand snapper	2	65.6
haddock	9	13	scup	1	74.6
hake	1	18	swordfish	1	30.1
Pacific hake	1	1.9	European flunder	1	5.3
pollock	5	18	Greenland halibut	3	29.3
silver hake	3	2.7	plaice	8	25.1
walleye pollock	2	5	yellowtail flounder	2	13
whiting	5	30.8	sole	7	28.7
black angler	1	6.7	northern pike	2	6.1
horse mack	2	12.1	Atka mack	1	12
Medit. horse mack	1	3.5	Pacific ocean perch	3	3
red snapper	1	47.8			

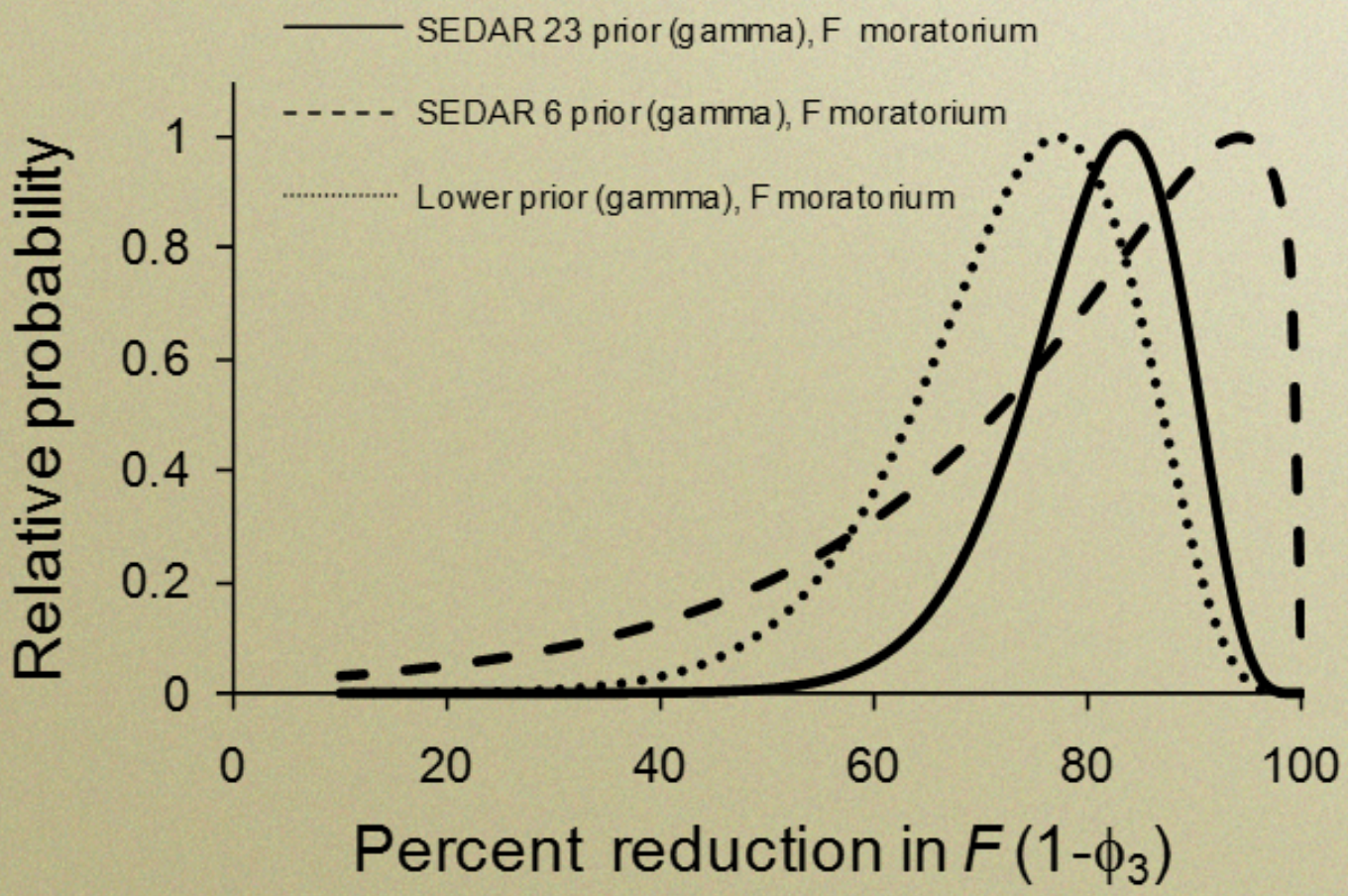
Meta-analysis of data from Myers, R. A., K.G. Bowen, and N.J. Barrowman. 1999. Maximum reproductive rate of fish at low population sizes. Can. J. Fish. Aquat. Sci. 56: 2404-2439.

Lifetime Reproductive rate (α)



Steepness = α / (4 + α)

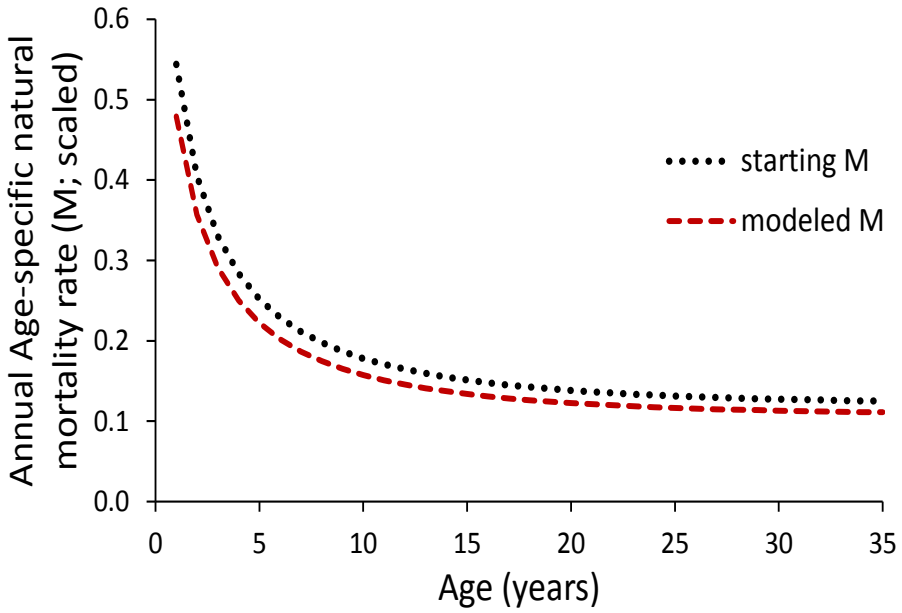
Data Inputs for the catch-free model



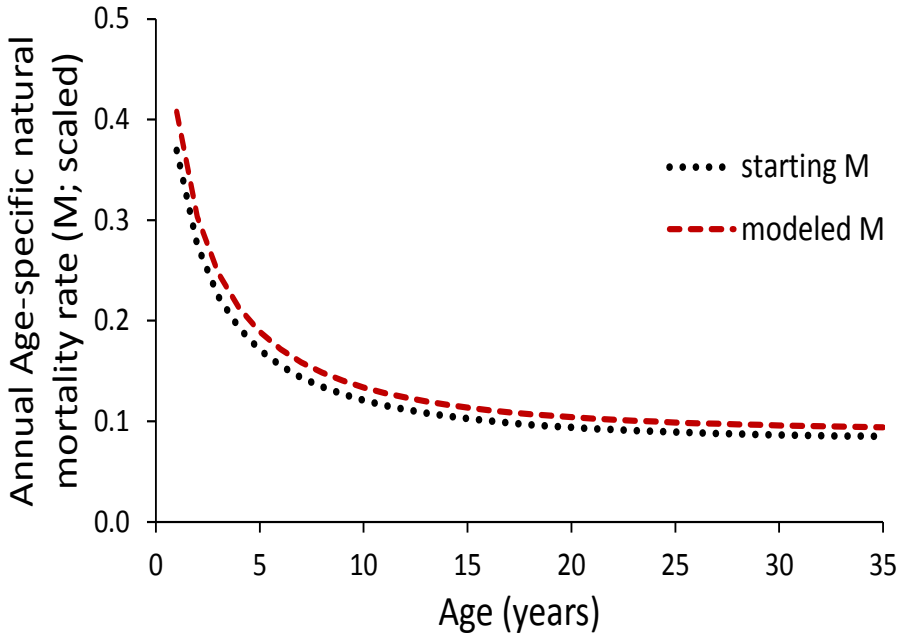
Age-Specific Natural Mortality (Lorenzen 1996, 2005)

- Scales natural mortality (M) using an empirical equation based on body weight, $M=aW^b$, where a=3, b= -0.288, and W is body weight in grams. This equation was for "natural waters", and there are choices in Lorenzen (1996) that could be used. The growth curve is used to estimate the total length at age, and the weight-length equation estimates the body weight at age.
- This relationship is re-scaled to the "Hoenig" estimate of M based on longevity.
- If the phase is turned on in the model, the age-specific M becomes a prior and will be estimated along with the other parameters that are active.
- For the SSRA model, M was calculated at Jan. 1 but was at mid-year for the catch-free model.

Age-Specific Natural Mortality



M=0.18 prior (black dotted line) and estimated (red dashed line)



M=0.12 prior (black dotted line) and estimated (red dashed line)

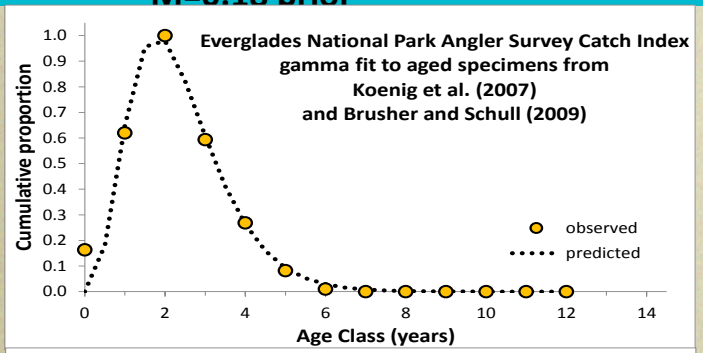
Fig. 7.5.1 a,b

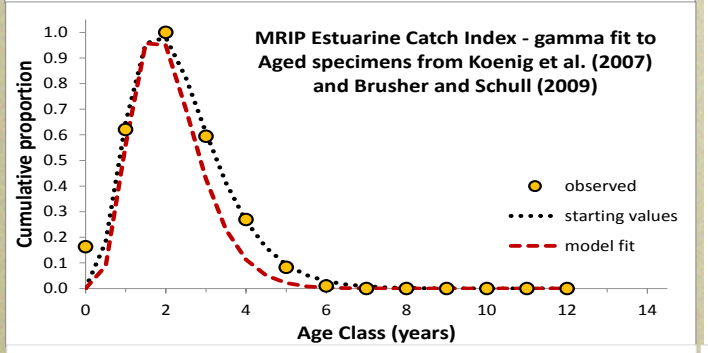
Selectivities / Vulnerabilities

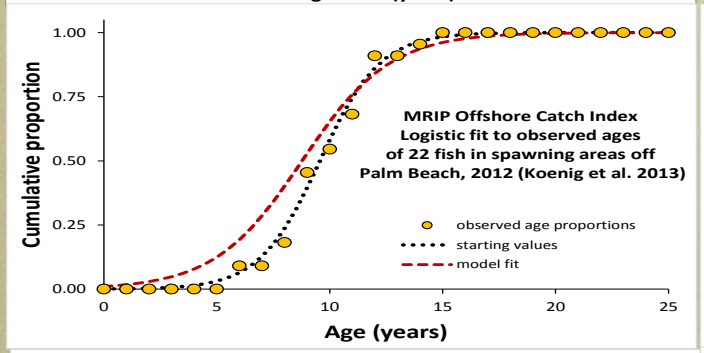
prior (black dotted line) and estimated (red dashed line)

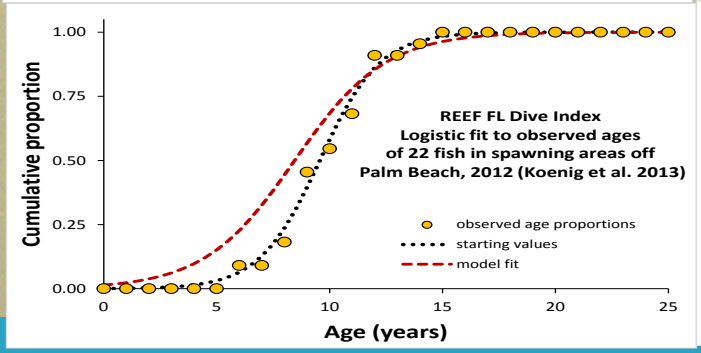
The selectivity for the Everglades was fixed in the model

M=0.18 prior

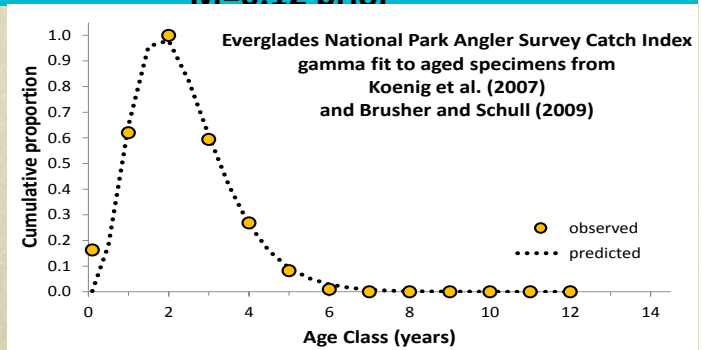


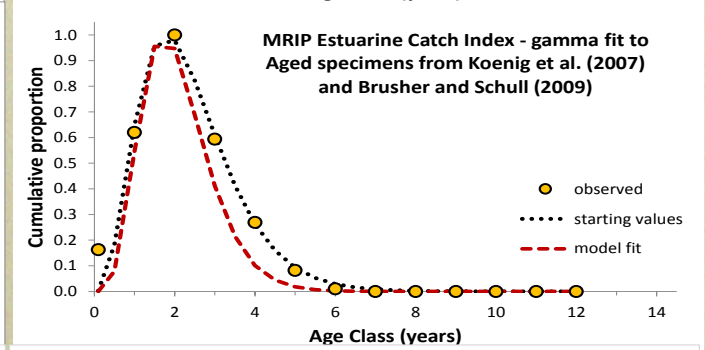


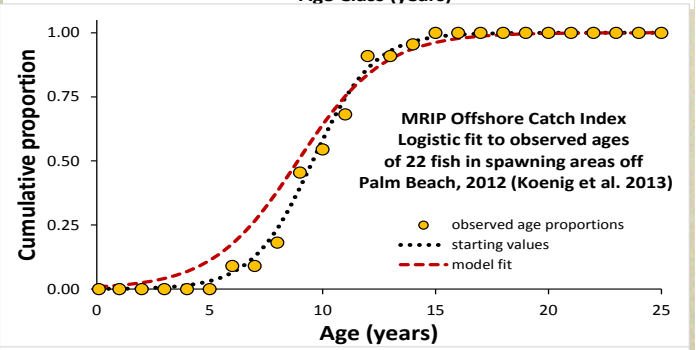




M=0.12 prior







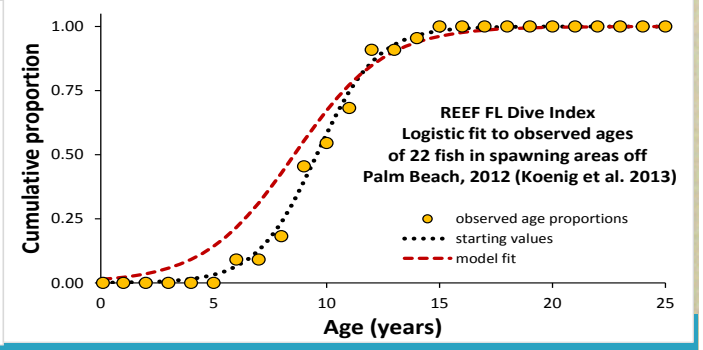
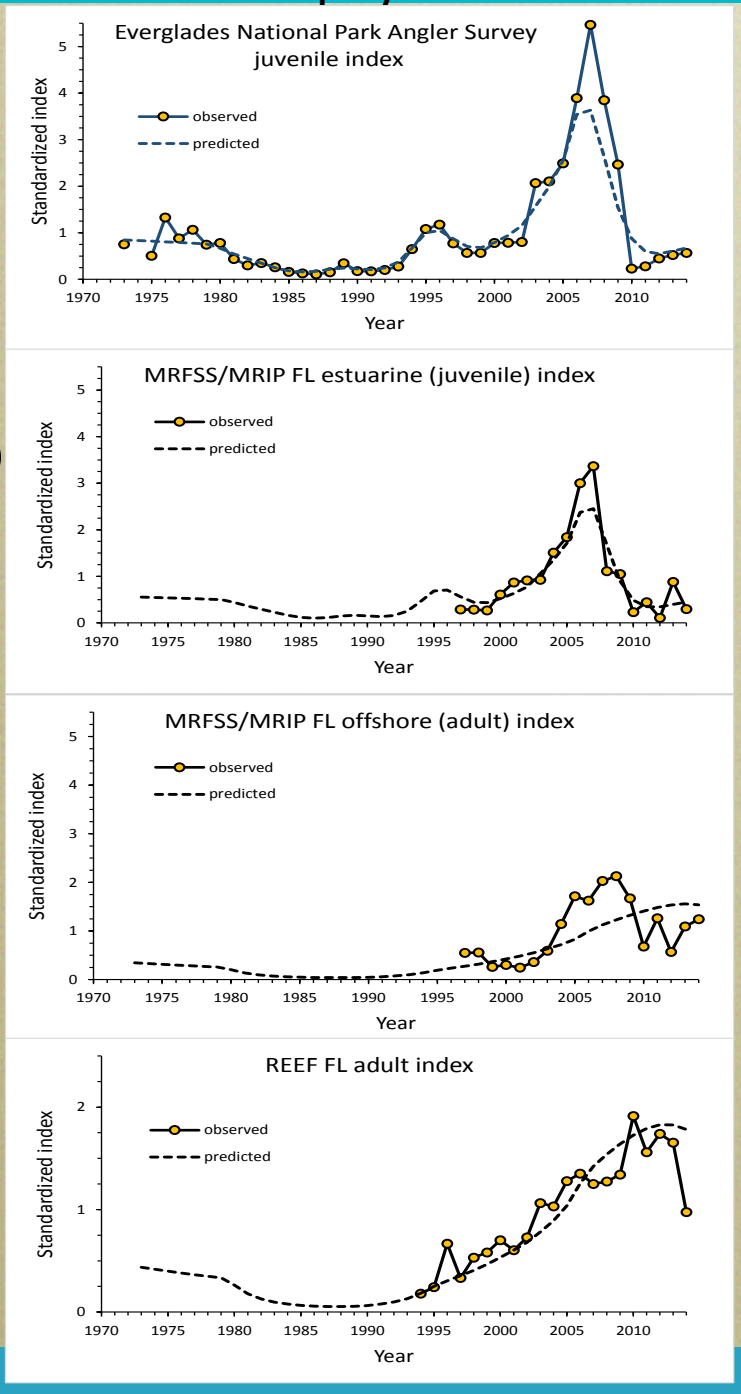


Fig. 7.5.4

Index fits, estuarine (juveniles) and offshore (adults)



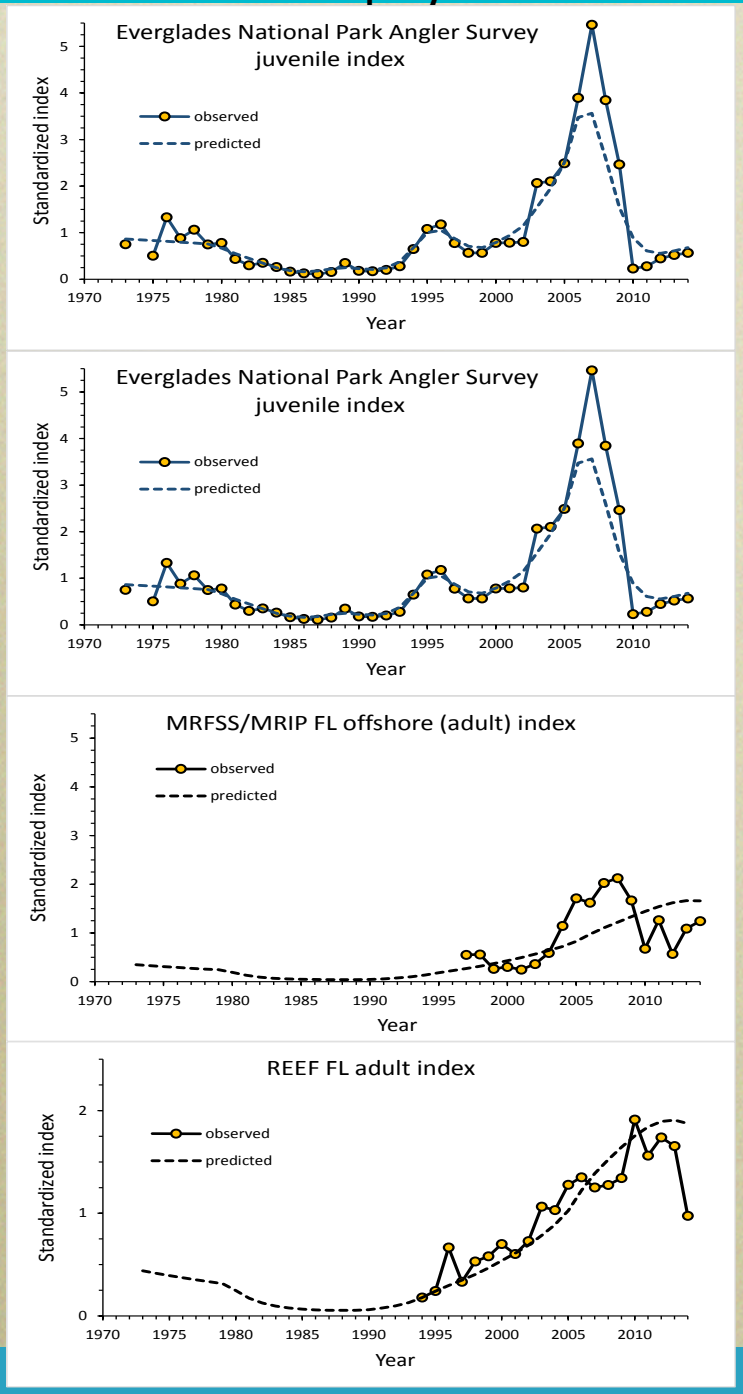


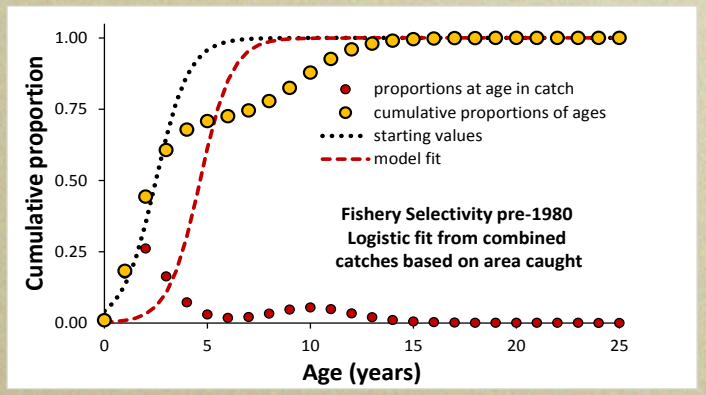
Fig. 7.5.2

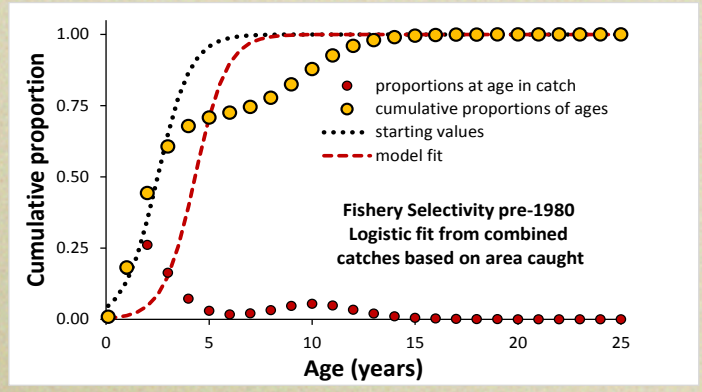
Estimated fishery removals in the catch-free model

M = 0.18 per year

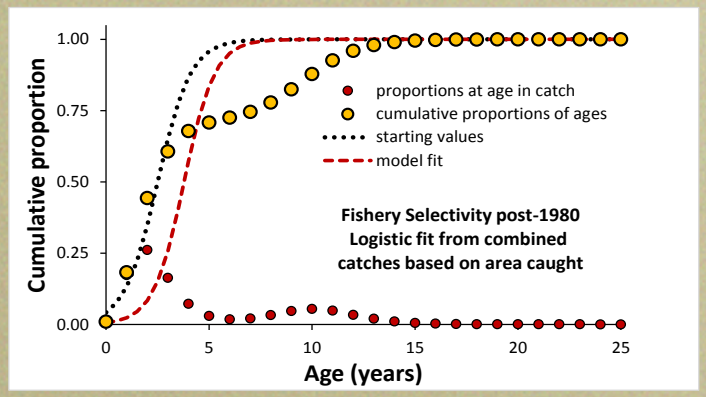
M = 0.12 per year

Pre-1980





Post-1980



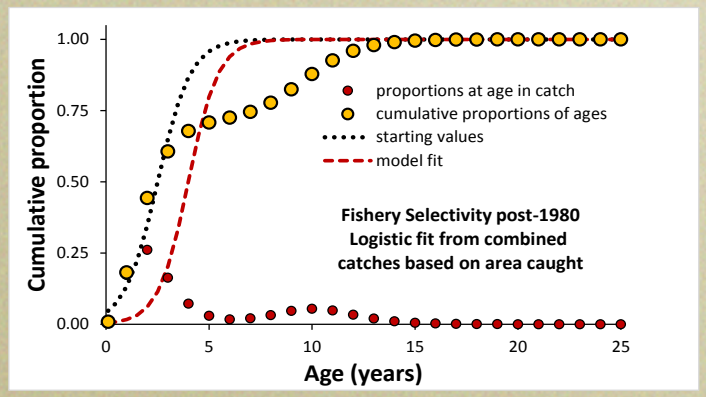
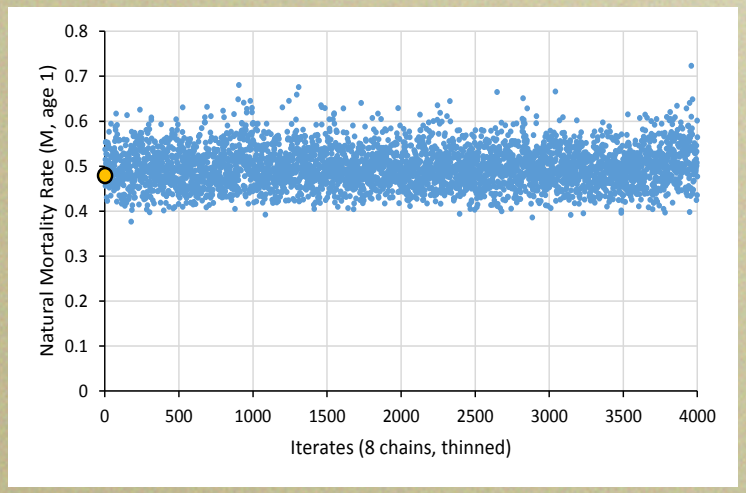


Fig. 7.5.2

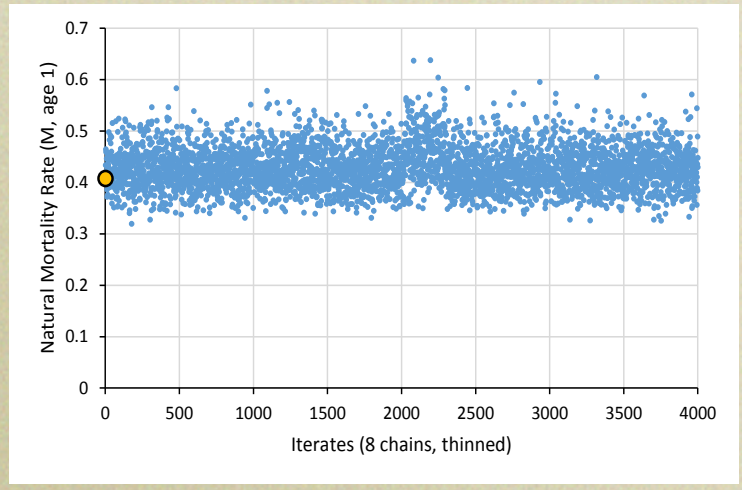
MCMC estimates - chains

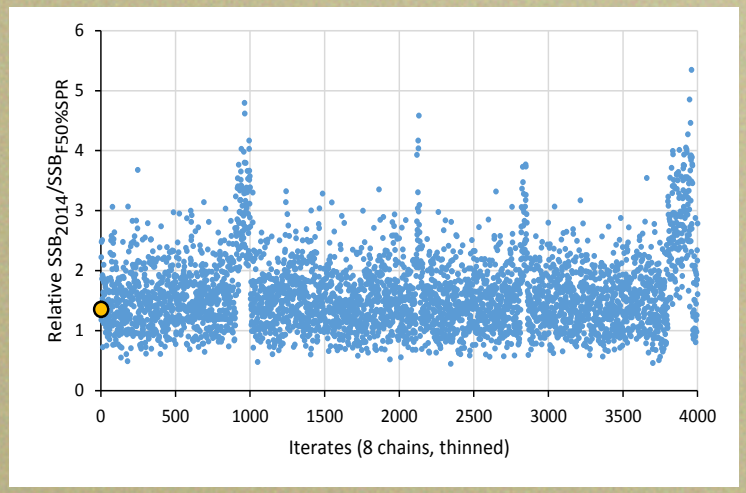
M = 0.18 per year



Natural Mortality, Age 1

M = 0.12 per year





SSB-ratio

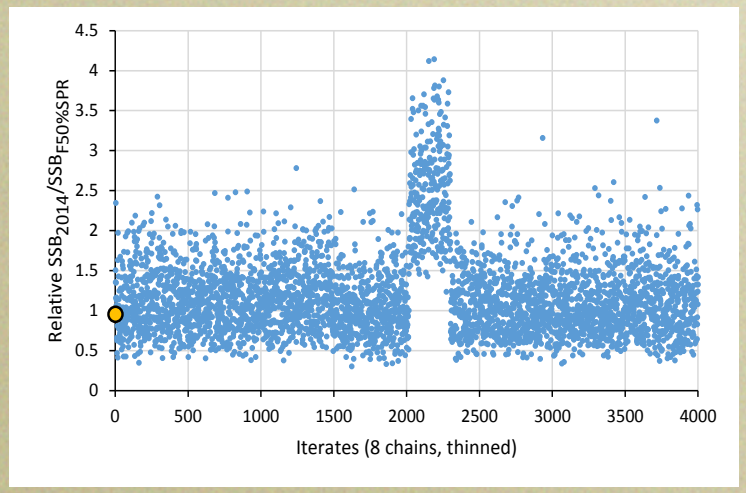
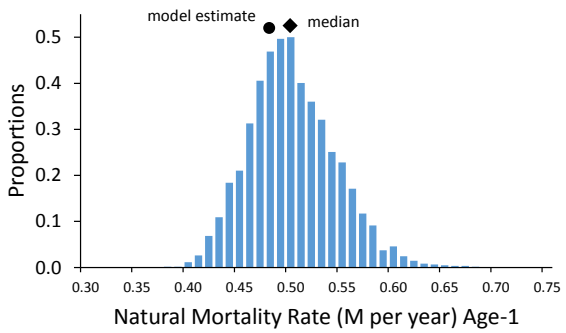


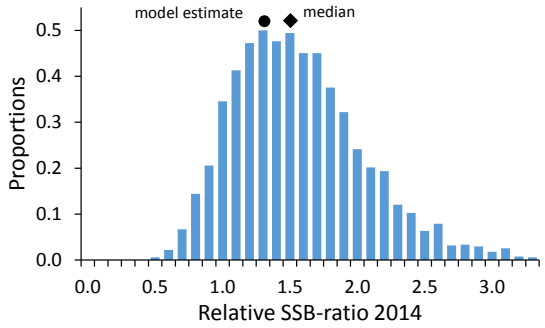
Fig. 7.5.8

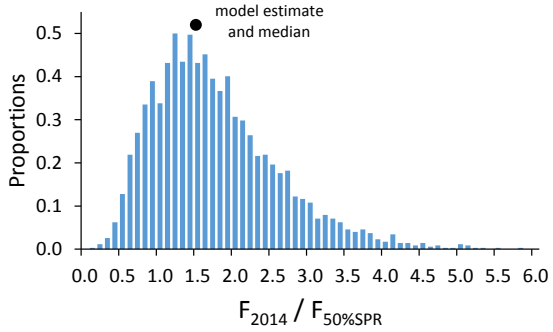
MCMC estimates

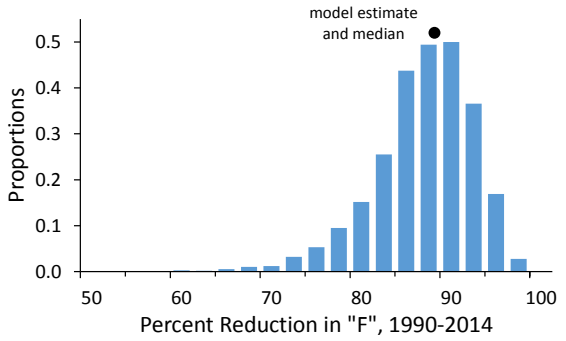
distributions of some parameters

M=0.18 prior

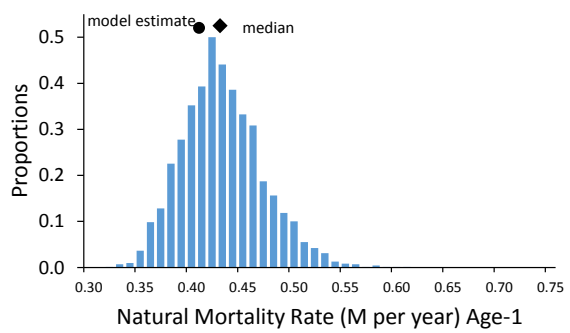


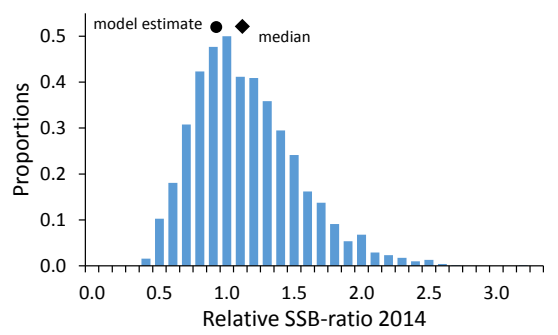


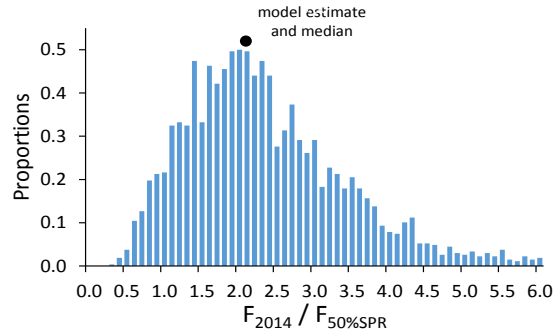


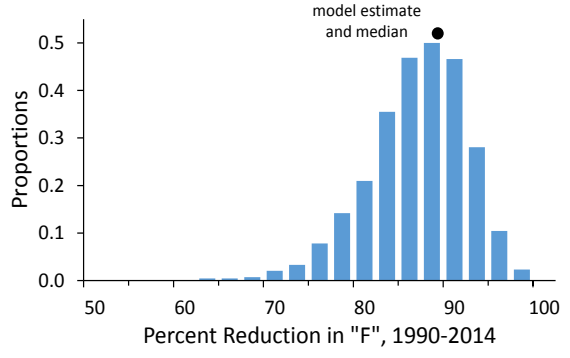


M=0.12 prior

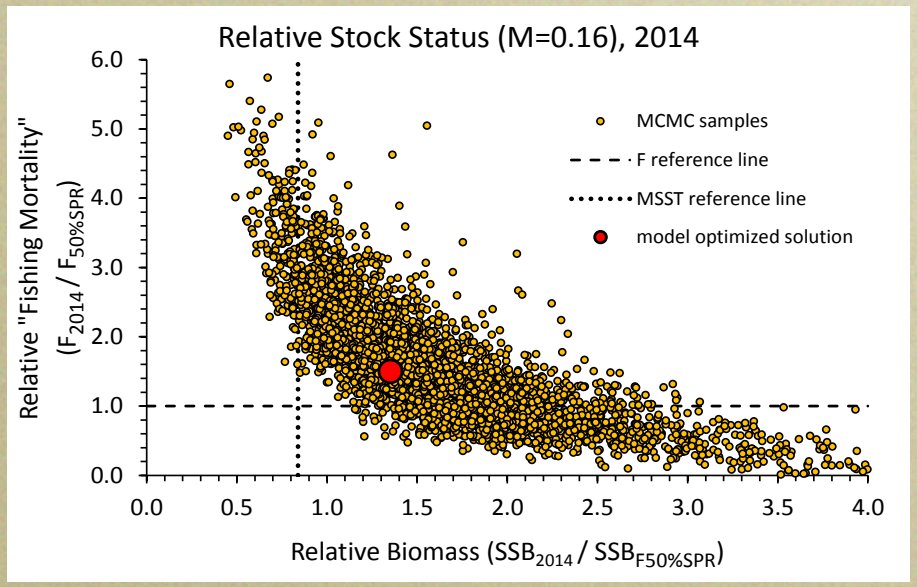


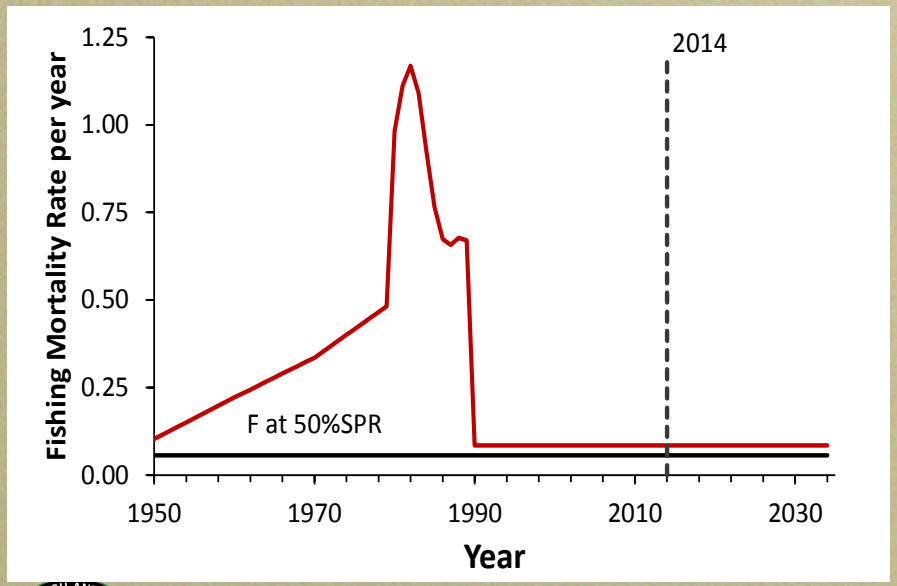




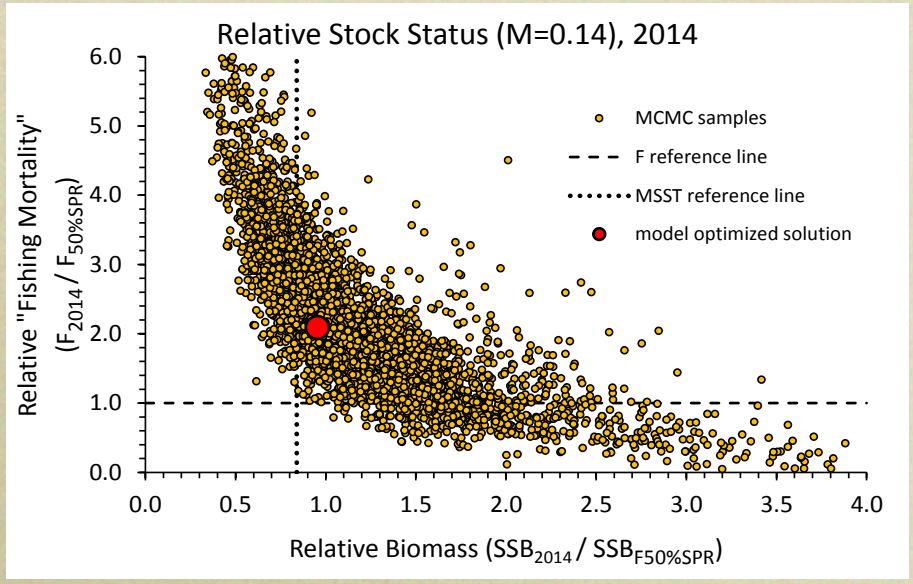


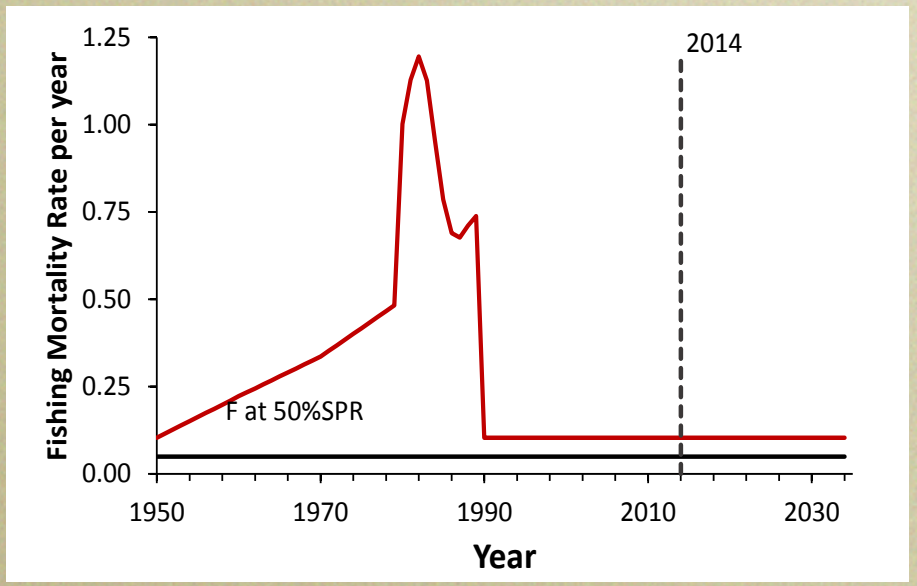
M=0.18 prior)





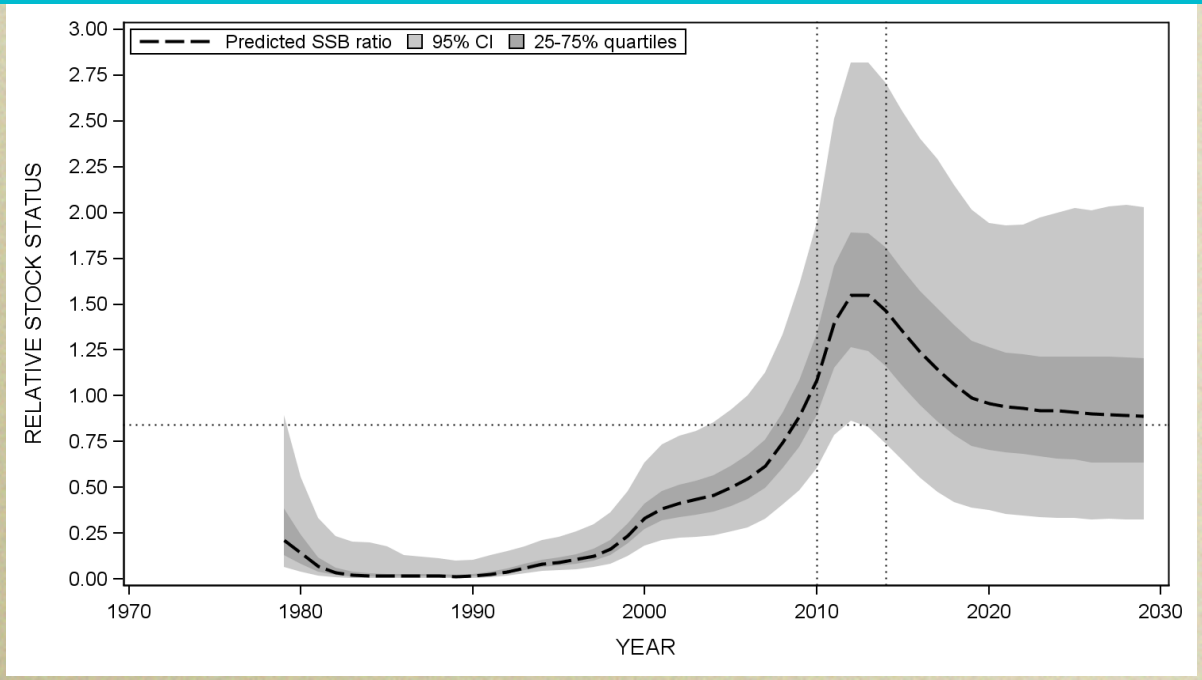
M=0.12 prior)



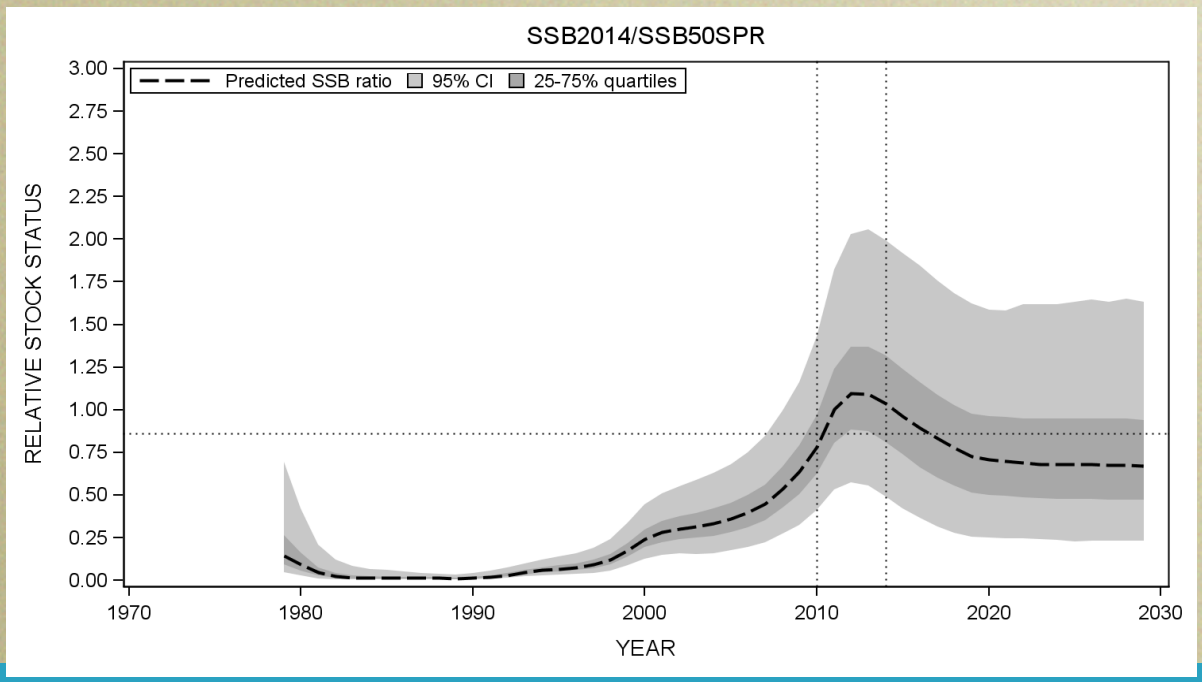


M=0.18 per year

Relative stock status under two different levels of natural mortality, "$F_{current}$" for projections

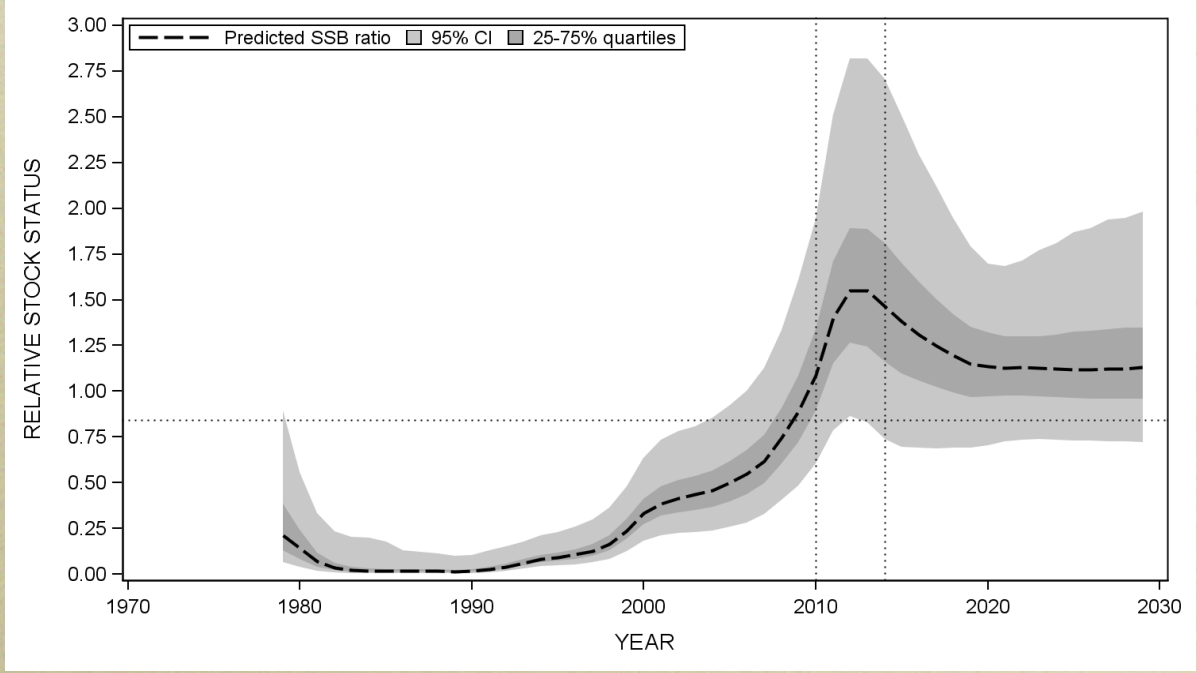


M=0.12 per year

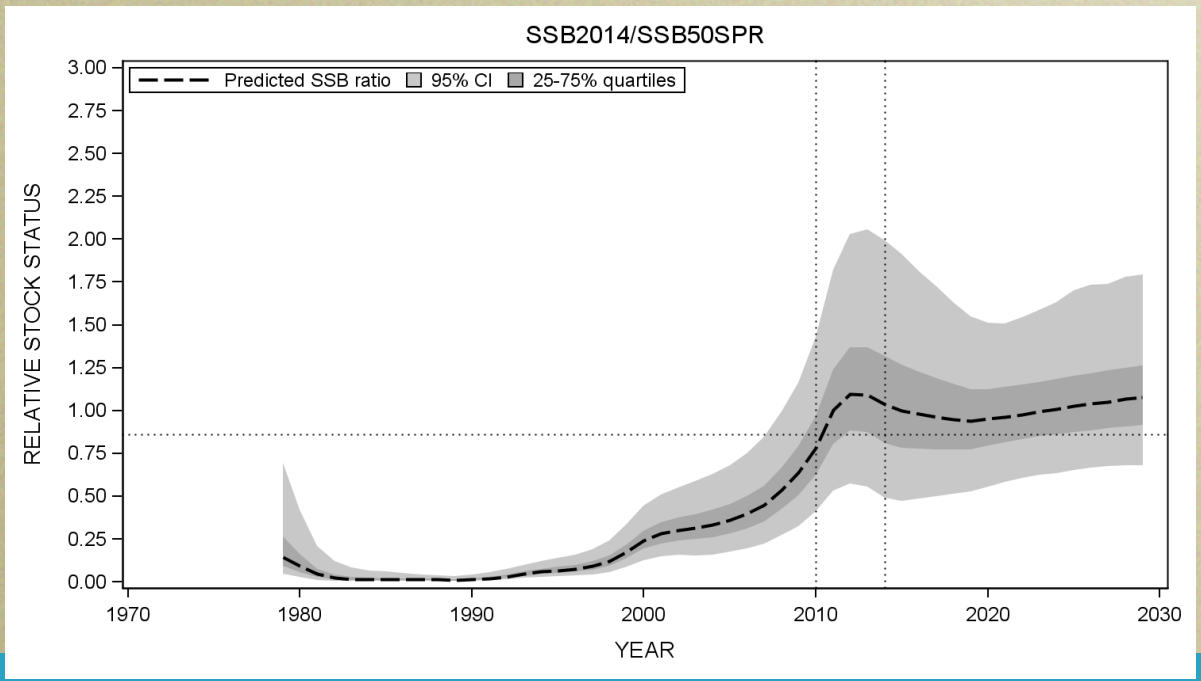


M=0.18 per year

Relative stock status under two different levels of natural mortality, "$F_{50\%SPR}$" for projections



M=0.12 per year



M=0.18 per year

Relative stock status under two different levels of natural mortality, "$F_{geometric}$" from the SSRA for projections

M=0.12 per year