SEDAR 22 YEG RW III:

III. SS3 Model set up and input decisions and scoping runs

February 12, 2011

Tampa, FL

SS3 model set up

- 1975-2009, Assume that stock is at virgin conditions in 1974, but recruitment deviations estimated 8 years prior
- 2 regions, recruitment partitioning estimated
- 4 ‘Fleets’ Comm HL (E,W), Comm LL (E, W)
- 4 ‘Indices’ Comm LL (E, W) , NMFS bottom longline (E, W)
- 4 sources of age and length composition CommHL,LL,NFMS trawl and NMFS bottom longline
- 2 sex model with hermaphroditism
- Symmetric. beta prior on steepness (between 0.4 and 0.99)
- Min and Max bounds for other parms
- Handline and Trawl selectivity modeled with double normal
- Longline and Longline survey modeled as logistic
- estimated growth for males and females and by region
- fixed length/wt parms, same for males and females
- Lorenzen M

3.2.1.2. Model configuration and equations: <u>Initial fishing mortality and Temporal domain</u>

<u>Initial fishing mortality</u>

-appears that the deep-water fishery generally began in the mid to late 1970's. Based on this input an

- initial equilibrium F of zero was assumed for all fleets, under the assumption that the population started in 1974 under close to virgin fishing conditions.

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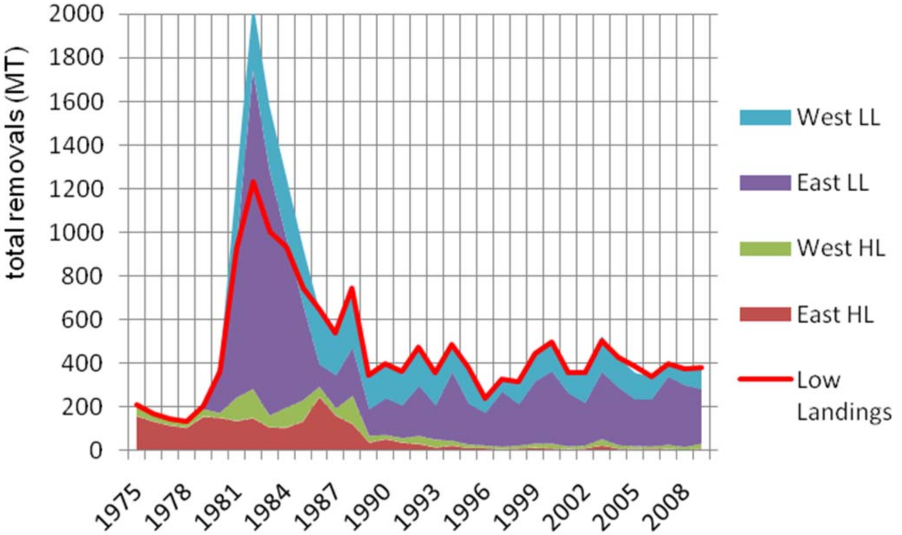
<u>Temporal domain:</u> 1974-2009 with early rec devs back 8 years



3.2.1.2. Model configuration and equations: <u>Spatial resolution</u>

FIGURE 1 MAJOR BOTTOM LONGLINE FISHING GROUNDS

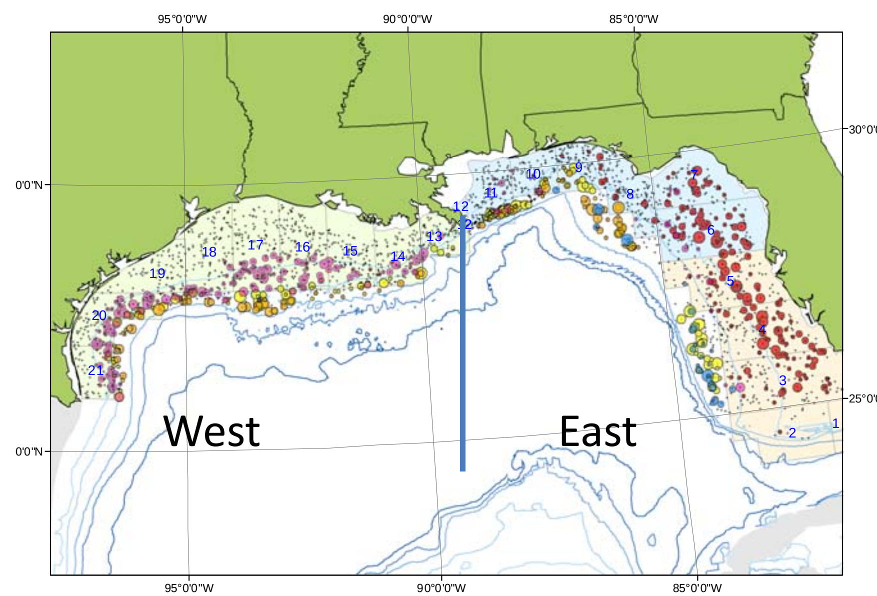
<u>Spatial resolution</u>

To ward against such serial depletion we desired to incorporate as much spatial resolution as possible while maintaining adequate sample sizes and balance.

Initially a 3 area-model was proposed, but this was condensed to a 2- area model due to mis-match of age/size samples and landings.

Eastern gulf is dominated by hard bottom habitats while the Western gulf is more mud.

Differences in growth E vs W

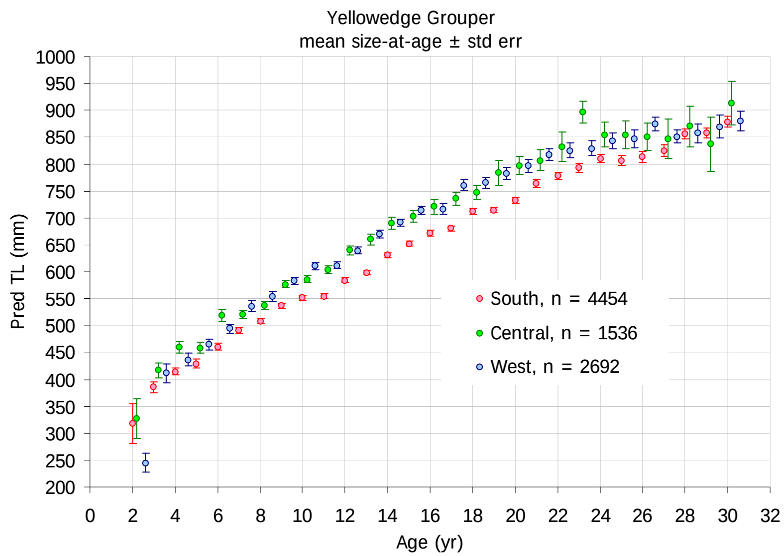


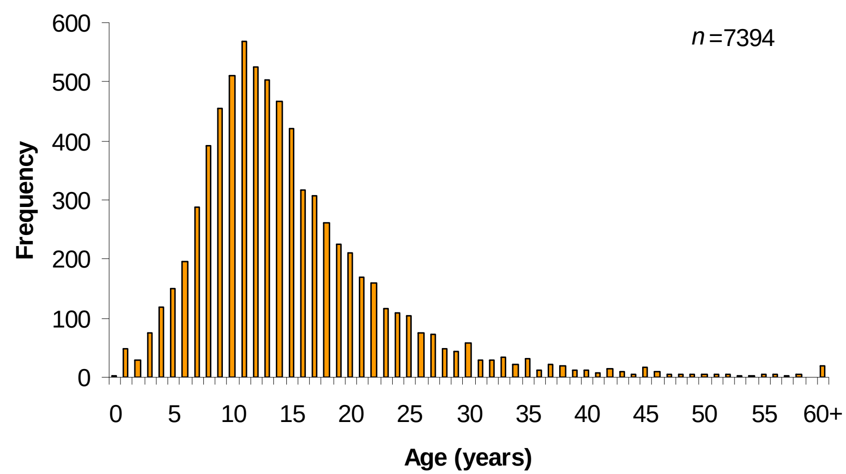
3.2.1.2. Model configuration and equations: Plus group decisions

Plus group decisions

The plus group was set at 40 for the purpose of the assessment as age and length composition information was relatively sparse with only 186 out of 8655 or 2.1% of all aged fish between 40-85 years old, growth was linear and size at age appears to approach the asymptotic L_{max} near age 40. Furthermore, there was little evidence of changes in selectivities from ages 39 to 40 and above.

Observed sizes at age





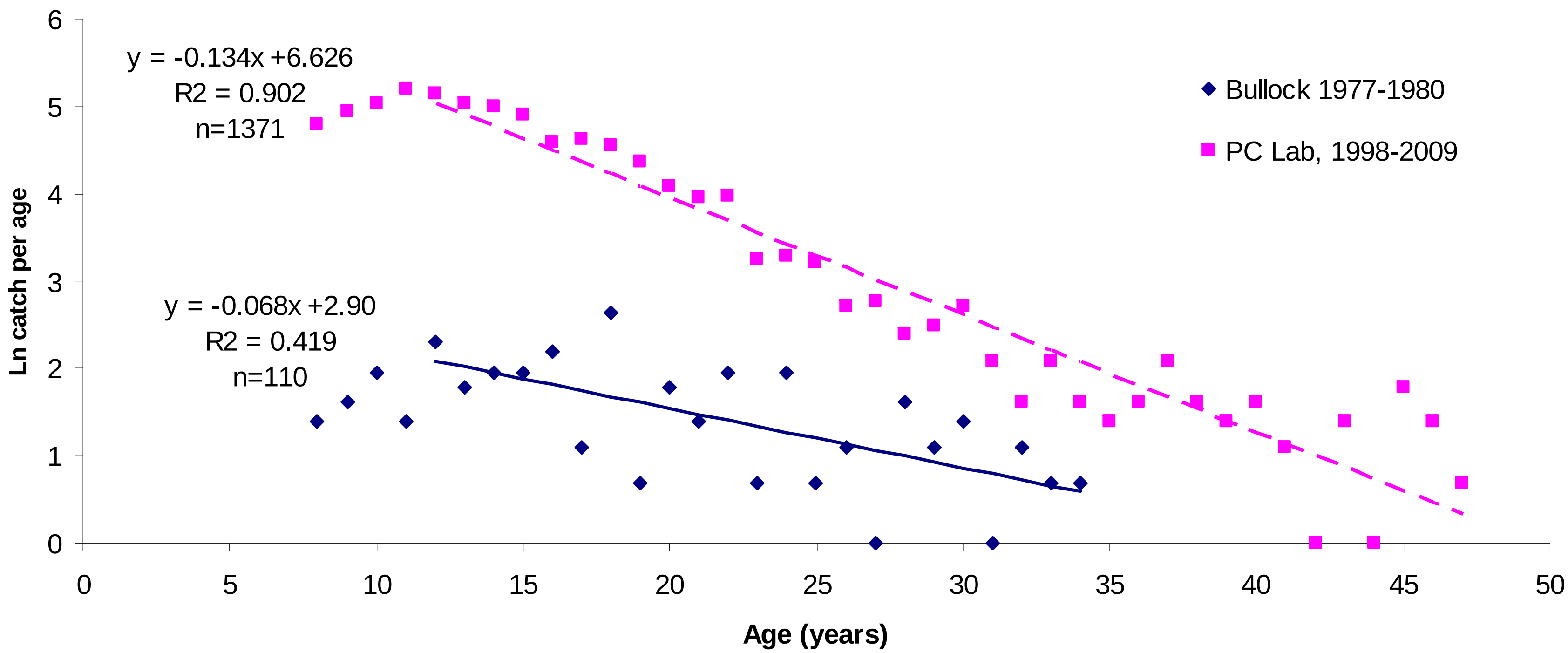
3.2.1.2. Model configuration and equations: Natural mortality

Natural mortality

Z from max age 56 using Hoenig equation (this is the max age from the 1977-1980 data)=0.074; from max age 85 Z=0.048

Catch curve Z from late 70's ~ 0.068-0.078

Recommended ranges 0.068-0.078; input as 0.073 (mean)



Grids 4 and 5 for both time periods

Ages 12-34 years (Bullock 1977-80) and 12-41 years (1998-2009)

3.2.1.2. Model configuration and equations: Natural mortality SCOPING RUN on target age

Natural mortality- TARGET M DETERMINATION

Initial Target M = 15

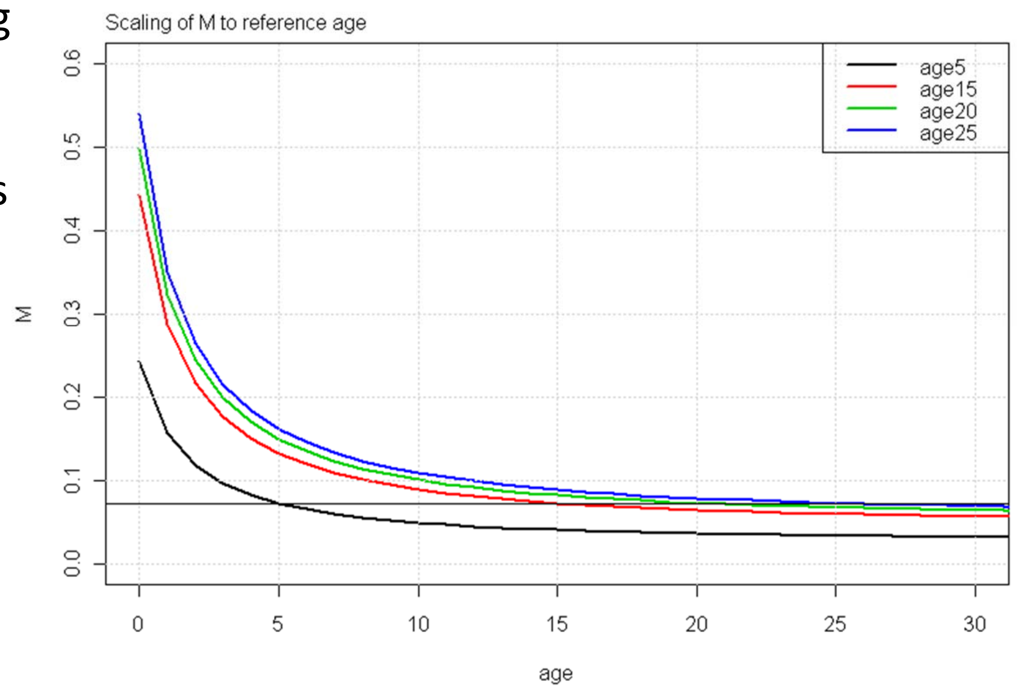
-As the reference age increases = a lower likelihood and better fit (Table 3.12)

- practical result is that of increasing the total mortality experienced, in the same manner as actually increasing or decreasing the reference M (Figure 3.10).

- Given the direct scaling of M which occurs with different reference ages, this uncertainty in the reference age will likely be very similar to the sensitivity runs that scale the actual value of M.

SCOPING RUN RESULTS

Target age	5	10	15	25
likelihood	13847	13485	13437	13416

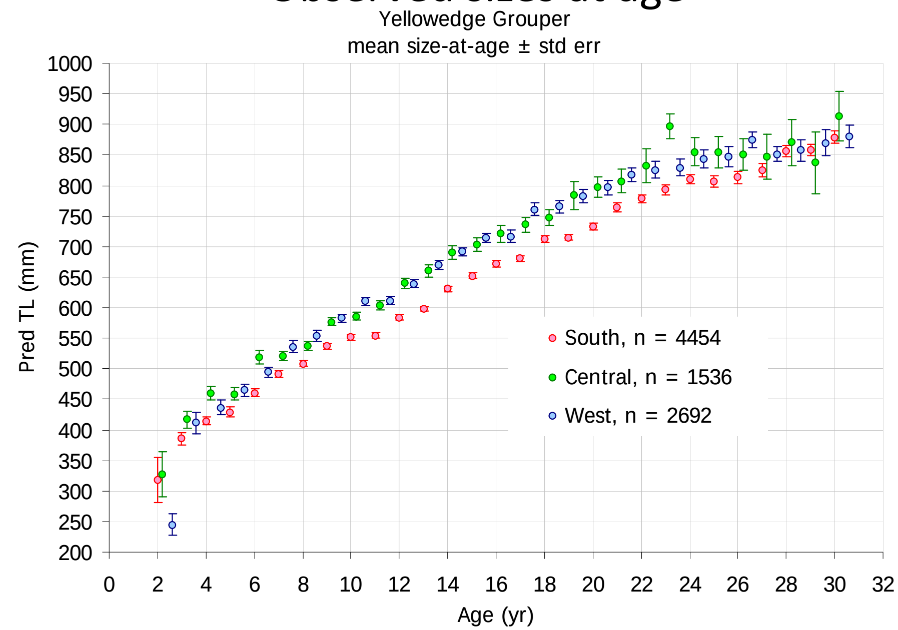


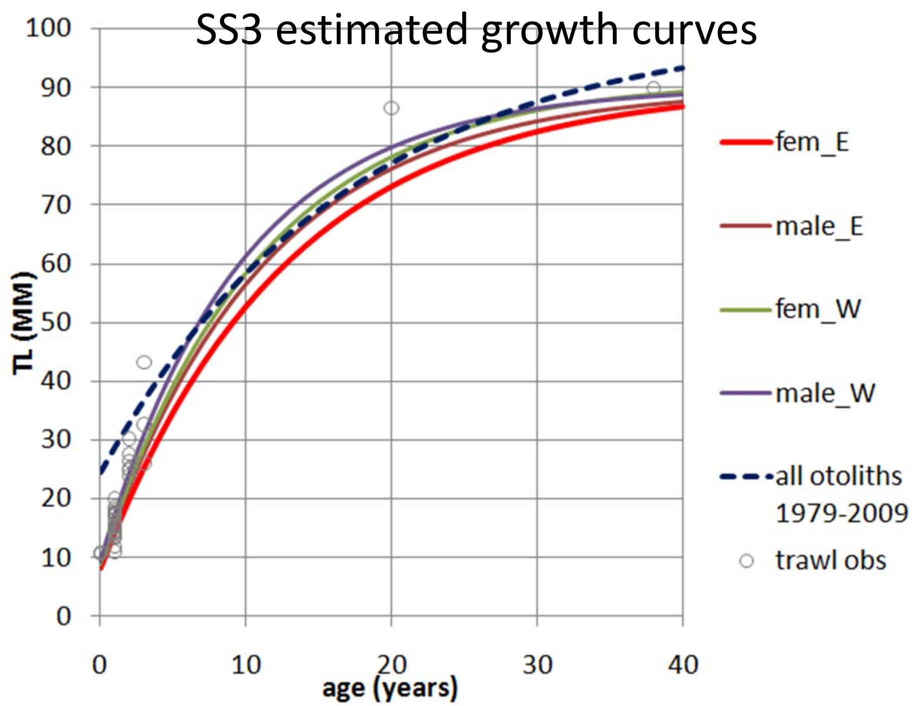
3.2.1.2. Model configuration and equations: Growth modeling

Growth modeling

- Estimated separately for each region and for each sex.
- three parameter (L_{min}, L_{max} and K) Von Bertalannfy .
- Lmin fixed at the mean value (5 cm) from the separately 3-parameter growth curves.
-Fixed CVs of 0.1626 and 0.1165 used for young (age<= 0) and old (age>= age at L_{max}).
- Because of selectivity effects upon observed size at age, curve departs that obtained from observed otos.

Observed sizes at age

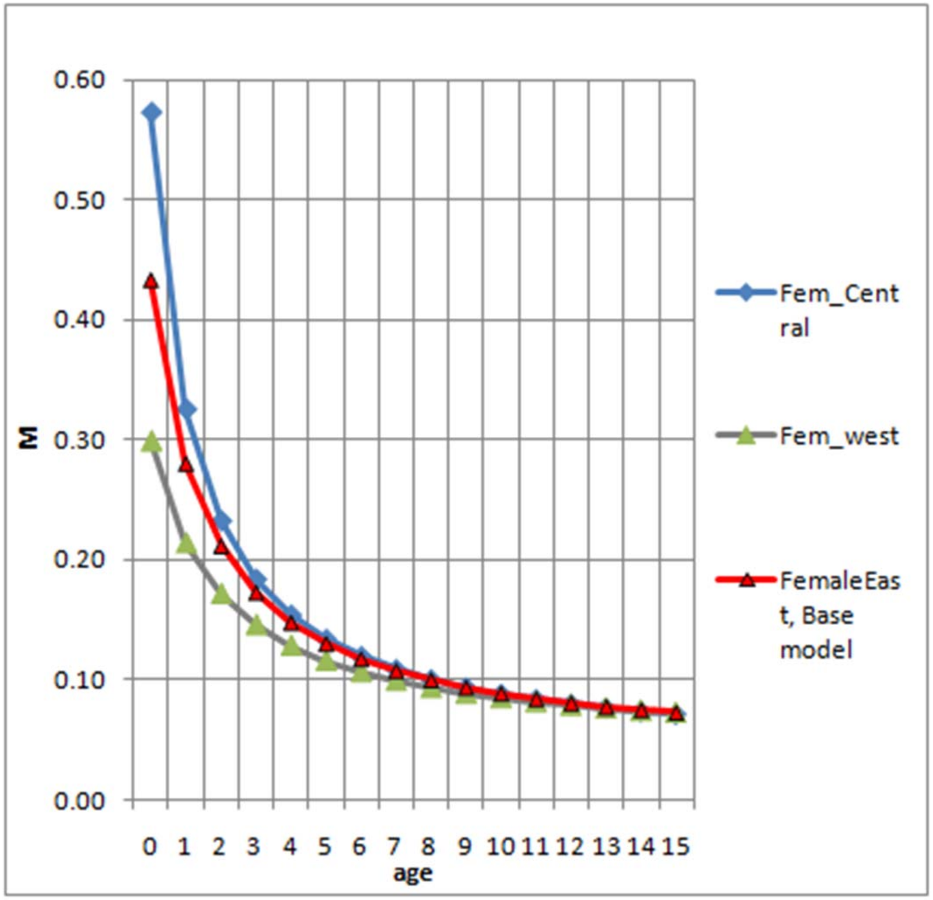




3.2.1.2. Model configuration and equations: Interplay between growth modeling and M

Growth modeling and M

- Estimating a separate Lmin for each region and sex means that age 0 and age 1 M can vary quite substantially, resulting in very different results based upon poorly estimated Lmin.
- Expedient solution was to fix Lmin to the mean of the separately estimated values . When estimated



3.2.1.2. Model configuration and equations: <u>Maturity, fecundity and length-weight relationships</u>

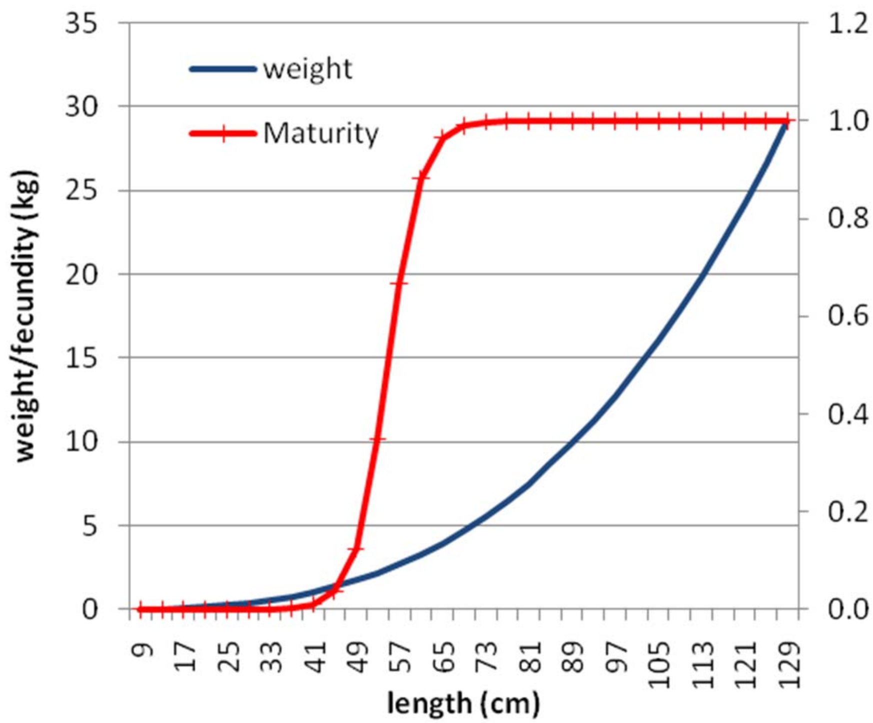
<u>Maturity, fecundity and length-weight relationships</u>

-fixed length-weight relationships were used to obtain biomass and fecundity .

-Fecundity was assumed to be proportional to weight.

- <u>Total SSB was used as the fecundity proxy, based upon the potential for male sperm limitation</u>

-Maturity was input as fixed slope and size of inflection parameters of a logistic function of length.



3.2.1.2. Model configuration and equations: <u>Stock recruitment</u>

$$R = R_0 \frac{4h\, S/S_0}{1-h+(5h-1)\, S/S_0}$$

Where *R0* is virgin recruitment
h is steepness
S0 is virgin SSB
S is stock size in a given year

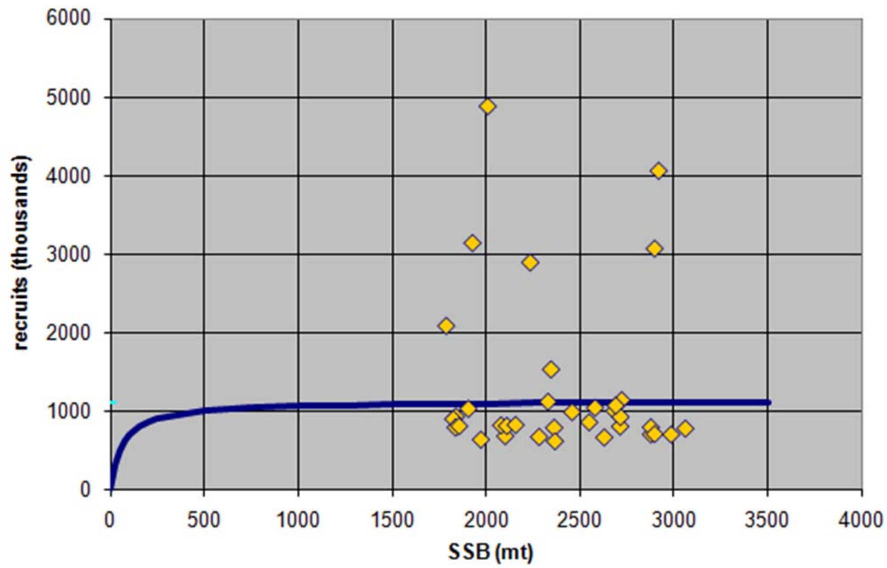
<u>Stock recruitment</u>

Beverton-Holt stock recruitment relationship was fit within SS3.

- SSB assumed to be the males and females
- Recruits allocated to both regions based upon an estimated fraction.

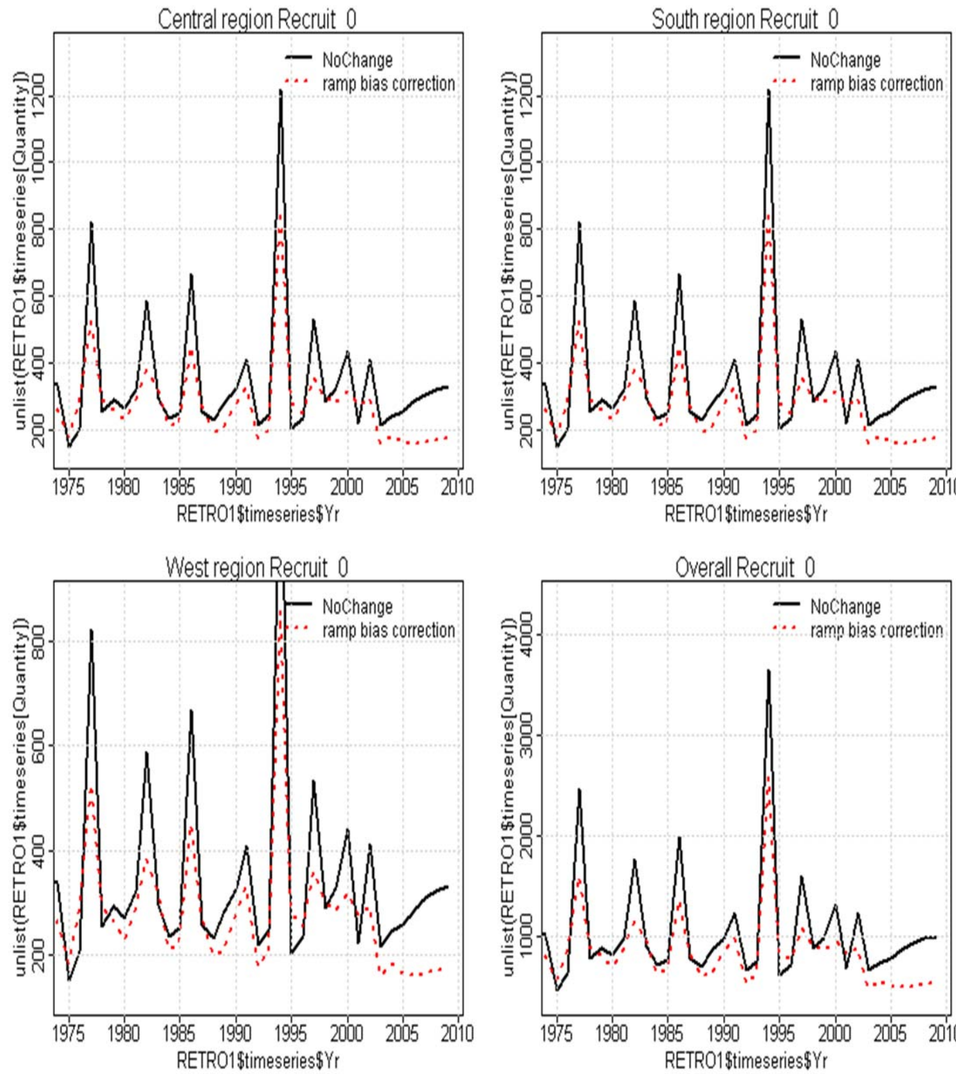
- Two parameters of the stock recruitment relationship estimated; R_0 or the virgin recruitment level and steepness.

- A third parameter, sigmaR or the standard deviation in recruitment was input as a fixed value



3.2.1.2. Model configuration and equations: <u>recruitment deviations</u>

Older model run comparison between no bias correction and ramped bias correction



<u>recruitment deviations</u>

-Bias-correction necessary due to estimating the recruitments on the log scale.

-Recommendation is to use a bias correction less than 1, to estimate it as follows and to ramp up and down the correction depending upon the amount of information in the data.

- Where there is information, use full bias correction, where no info, use less.

- practical result appear that the lower the bias correction, the higher the mean recruitment

3.2.1.2. Model configuration and equations: <u>recruitment deviations</u>

<u>recruitment deviations</u>

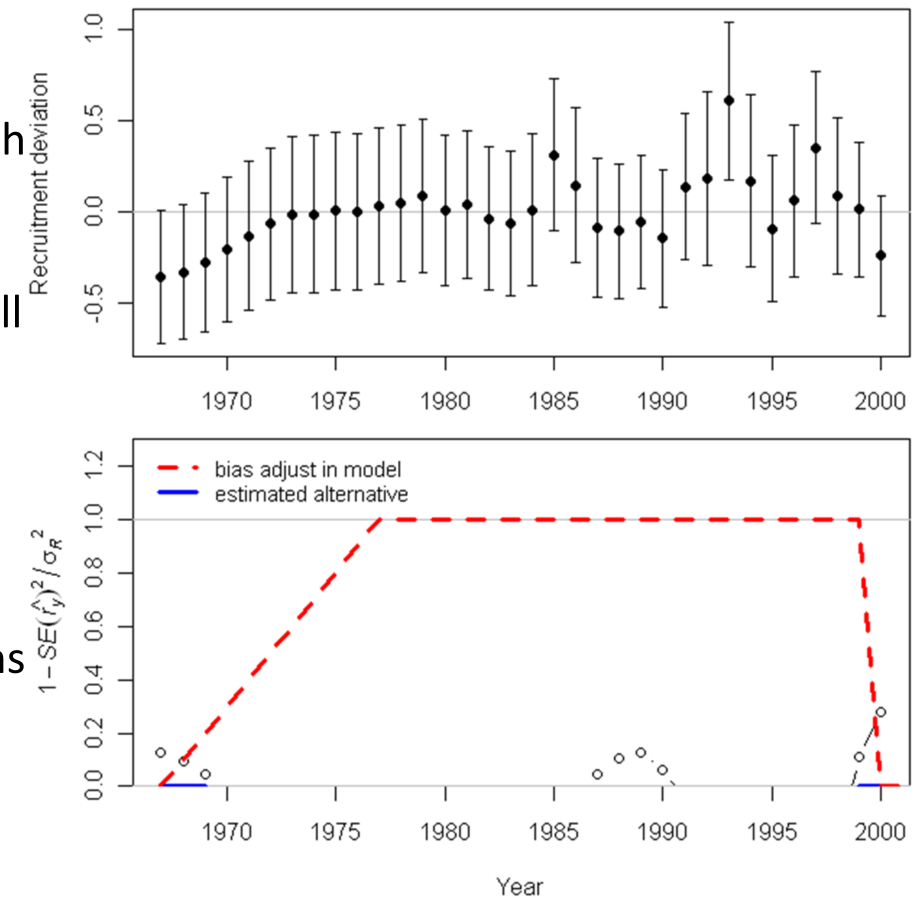
- begin in 1967 because the initial age and length contain signals of rec. several years prior.

- End in 2000, last year that reliable age or length comp give information on rec devs.

- bias adjustment initiated in 1967 ramped to full value of 1 in 1977, kept at 1 until 1999, ramped down to zero in 2000.

-No forecast rec devs estimated.

- Settings come primarily from recommendations of Rick Methot



3.2.1.2. Model configuration and equations: Modeling conditional age at length

Modeling conditional age at length

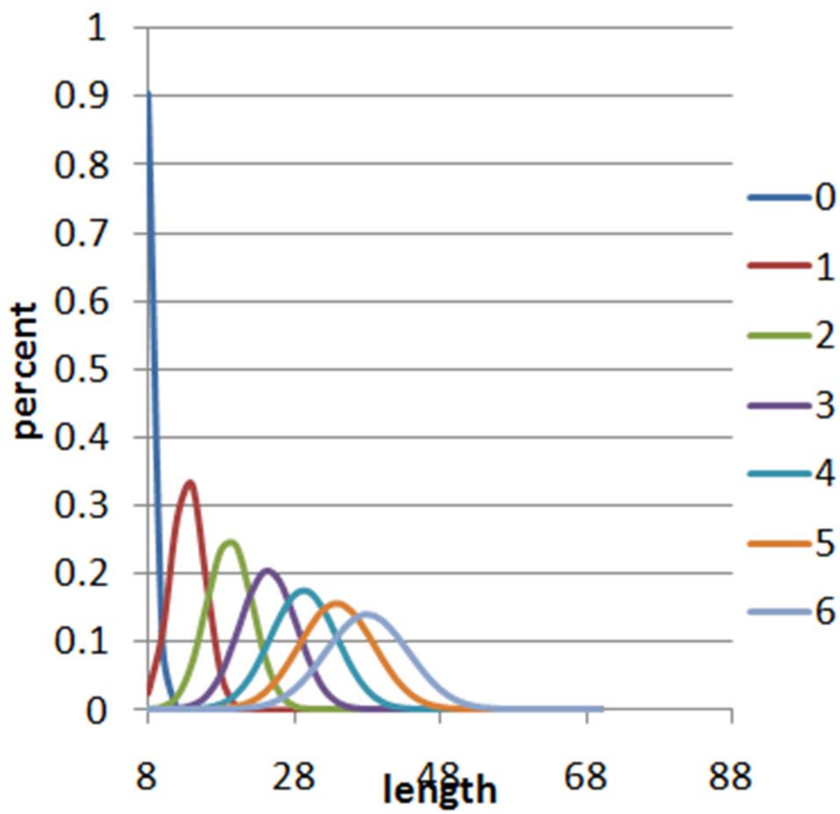
- similar to age length key where a distribution of ages is input for a given length bin.

- avoids double use of fish for both age and size

- Contains more detailed information on the variance of size-at-age and provides better ability to estimate growth parameters and

-age composition need not be selected completely at random.

- age composition data was input in this manner with ages assigned to 2 cm length bins with the length bins ranging from 8 to 128 cm and the ages from 1-40 where 40 represents a plus group age.



3.2.1.2. Model configuration and equations: <u>Selectivity modeling</u>

Selectivity modeling

- selectivity modeled on length, mirrored East and West, with a fleet

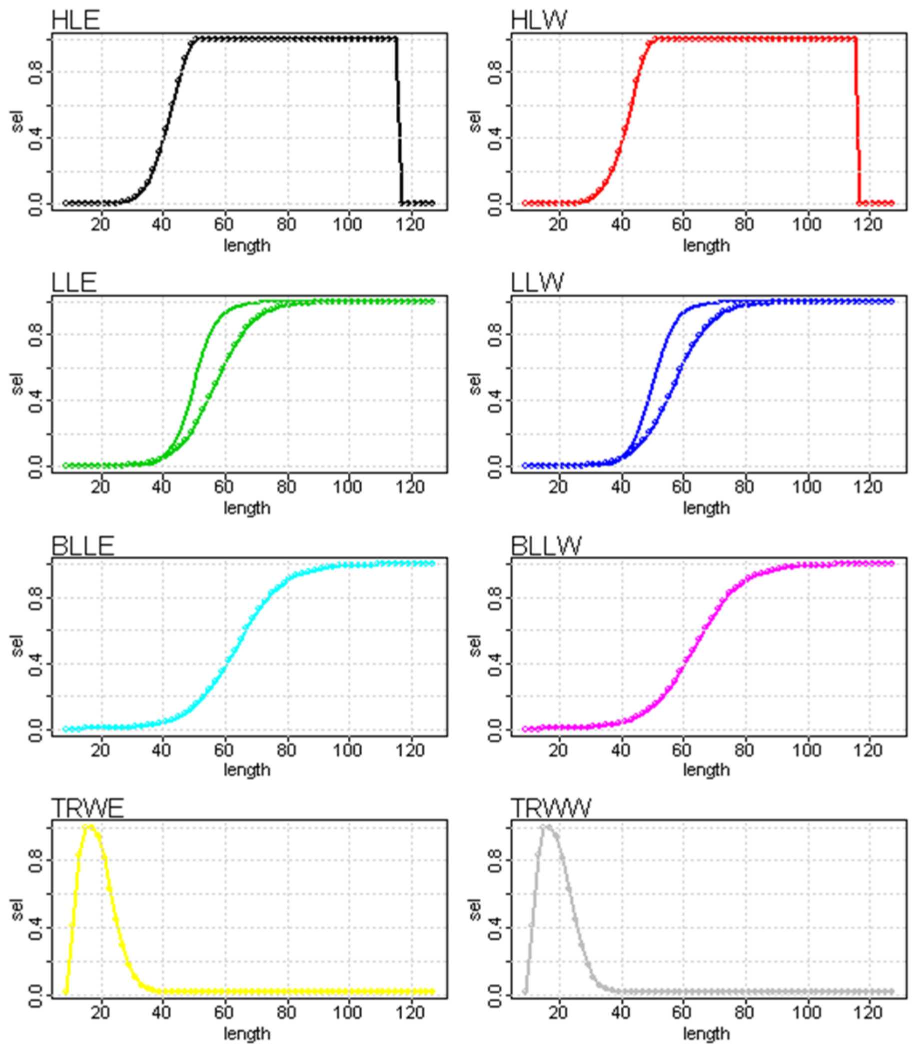
- handline and the NMFS trawl selectivity were modeled with 6 parameter double normal functions

- commercial longline and the NMFS bottom longline modeled with a 2-parameter logistic .

- No prior distributions used other than for the time block estimates (symmetric beta distribution bounded between -15 and 1 on a log scale).

- Comm longline selectivity modeled with two time blocks: 1975-1985 and 1986-2009.

-Age-based selectivities were not estimated. The 'realized' selectivity for a fish of a given age was then assumed to be only a function of its size.

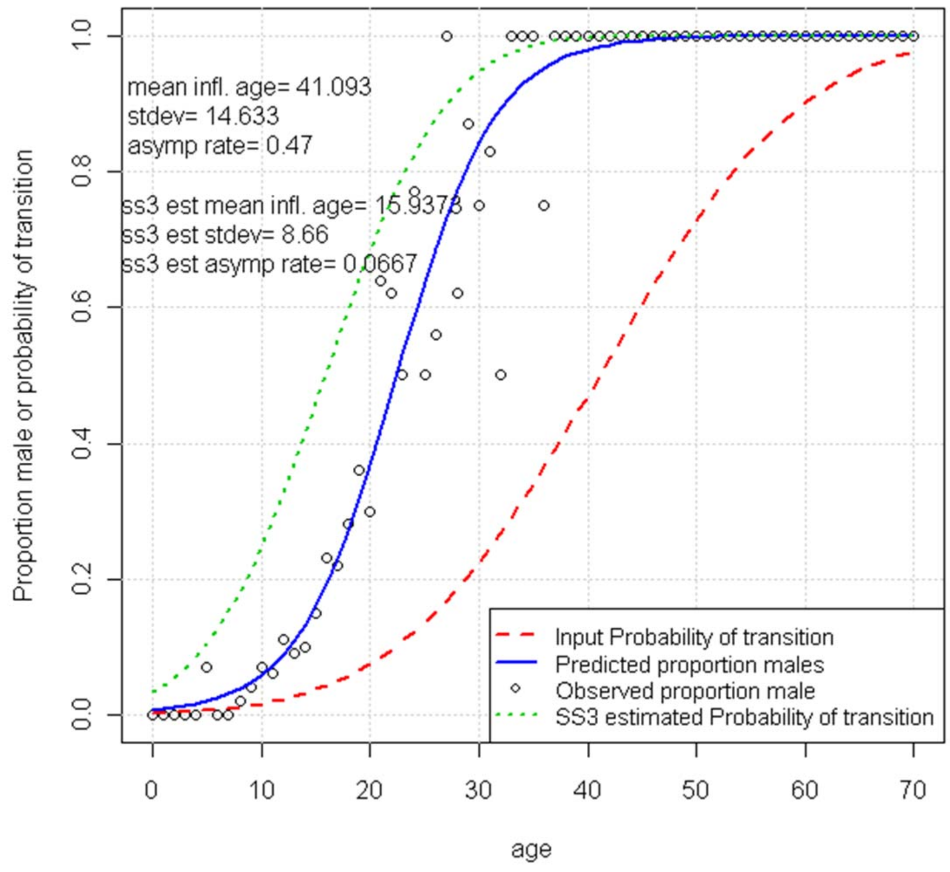


3.2.1.2. *Model configuration and equations:* *Hermaphroditism*

Hermaphroditism

-Within SS3, sex change is modeled with 3 parameters (inflection age, standard deviation and an asymptotic rate) that define a cumulative normal distribution for the probability of transition of females to males as a function of age.

- Initially the three input parameters were estimated externally from the observed sex ratios but then were estimated within the assessment model from sex-specific age and length composition data.
- However the numbers of



3.2.2.1. Sensitivity analyses on inputs (scoping and profiling for stp, Ro, etc)

Sigma R

-Ideally want sigR to be slightly higher than the RMSE of the rec deviations.

- Values of sigma R above 0.3 all lead to estimated RMSE > sigma R.

- In these cases, the input value of sigma R creates recruitment variability not observed in data.

- Rather little information in the data on recruitment variability as when estimated sigmaR is 0.

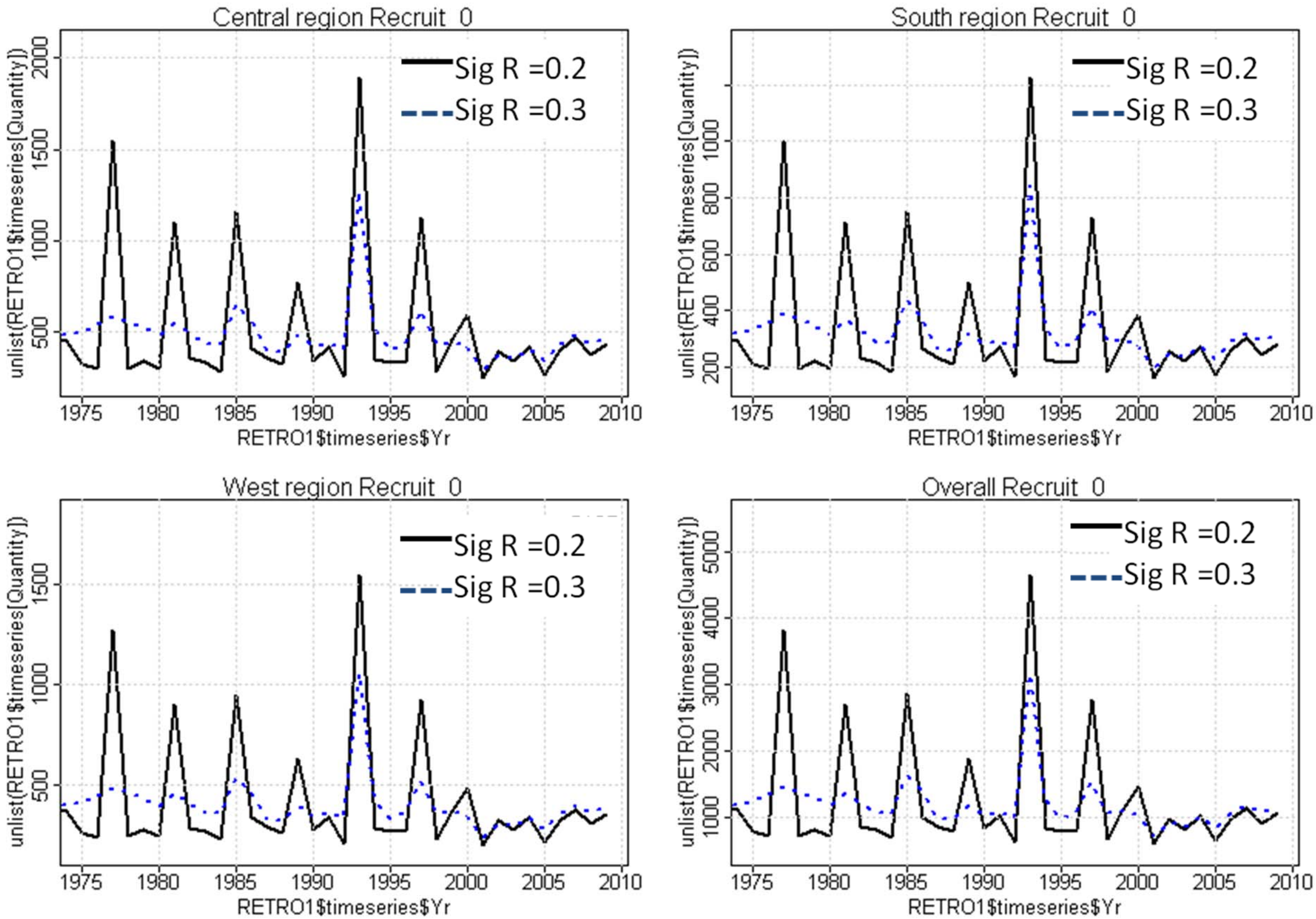
- Methot and Taylor (unpublished ms) recommend that sigmaR >= RMSE.

Input sigma R	Estimated Root Mean Square Error (RMSE) of recruitment deviations	RMSE / sigmaR
estimated	0	0
0.1	0.082	0.677
0.2	0.186	0.867
0.3	0.344	1.312
0.4	0.547	1.868
0.5	0.779	2.429
0.6	0.893	2.217
0.8	1.189	2.21
0.9	1.189	2.21

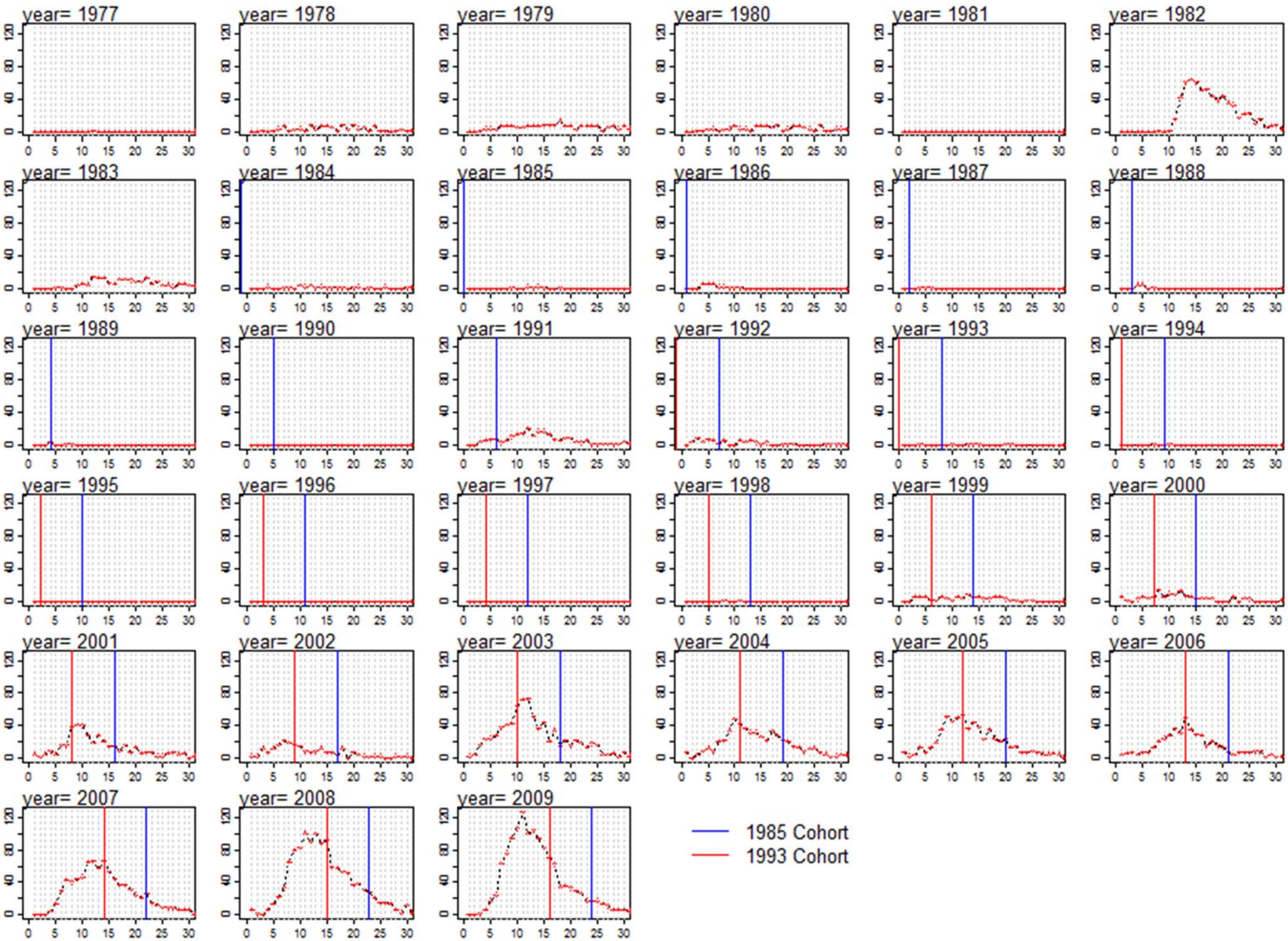
3.2.2.1. Sensitivity analyses on inputs (scoping and profiling for stp, Ro, etc)

<u>Sigma R</u>

Older version of recruitment deviation estimates



Limited evidence of recruitments



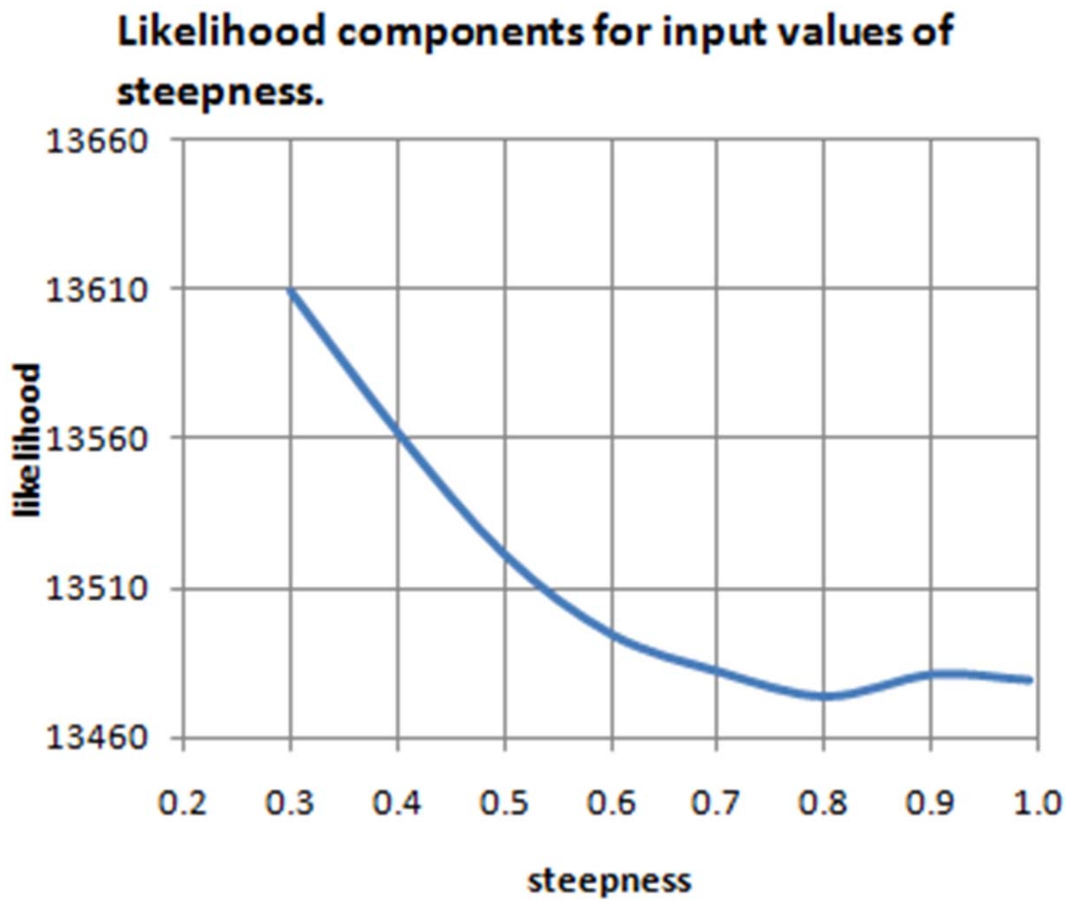
3.2.2.1. Sensitivity analyses on inputs (scoping and profiling for stp, Ro, etc)

<u>*Steepness*</u>

-determine the estimability of the steepness parameter.

- without strong contrast in spawning stock and clear recruitment signals, it may be difficult to estimate steepness.

- model tends to estimate very high values of steepness; very little contrast between values of 0.7 and 0.99.



Likelihood profile for steepness

likelihood	Stp0.3	Stp0.4	Stp0.5	Stp0.6	Stp0.7	Stp0.8	Stp0.9	Stp0.99
TOTAL	13609.3	13562.2	13521.3	13494.7	13482.3	13474	13481.4	13479.5
Catch	0	0	0	0	0	0	0	0
Equil_catch	0	0	0	0	0	0	0	0
Survey	30.87	14.64	3.01	-7.49	-14.2	-18.86	-20.61	-24.14
Length_comp	4181.65	4186.01	4199.5	4194.03	4196.46	4197.63	4222.6	4201.41
Age_comp	9355.17	9341.17	9326.8	9326.98	9323.69	9321.47	9305.02	9317.05
Recruitment	38.33	4.11	-10.82	-20.68	-25.32	-28.11	-28.62	-31.06
Forecast_Rec	0	0	0	0	0	0	0	0
Parm_priors	3.25	16.22	2.78	1.85	1.63	1.9	2.97	16.23