

Blacknose Shark Assessment State-space, Age-structured Production Model



Photo by George Burgess

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Laboratory

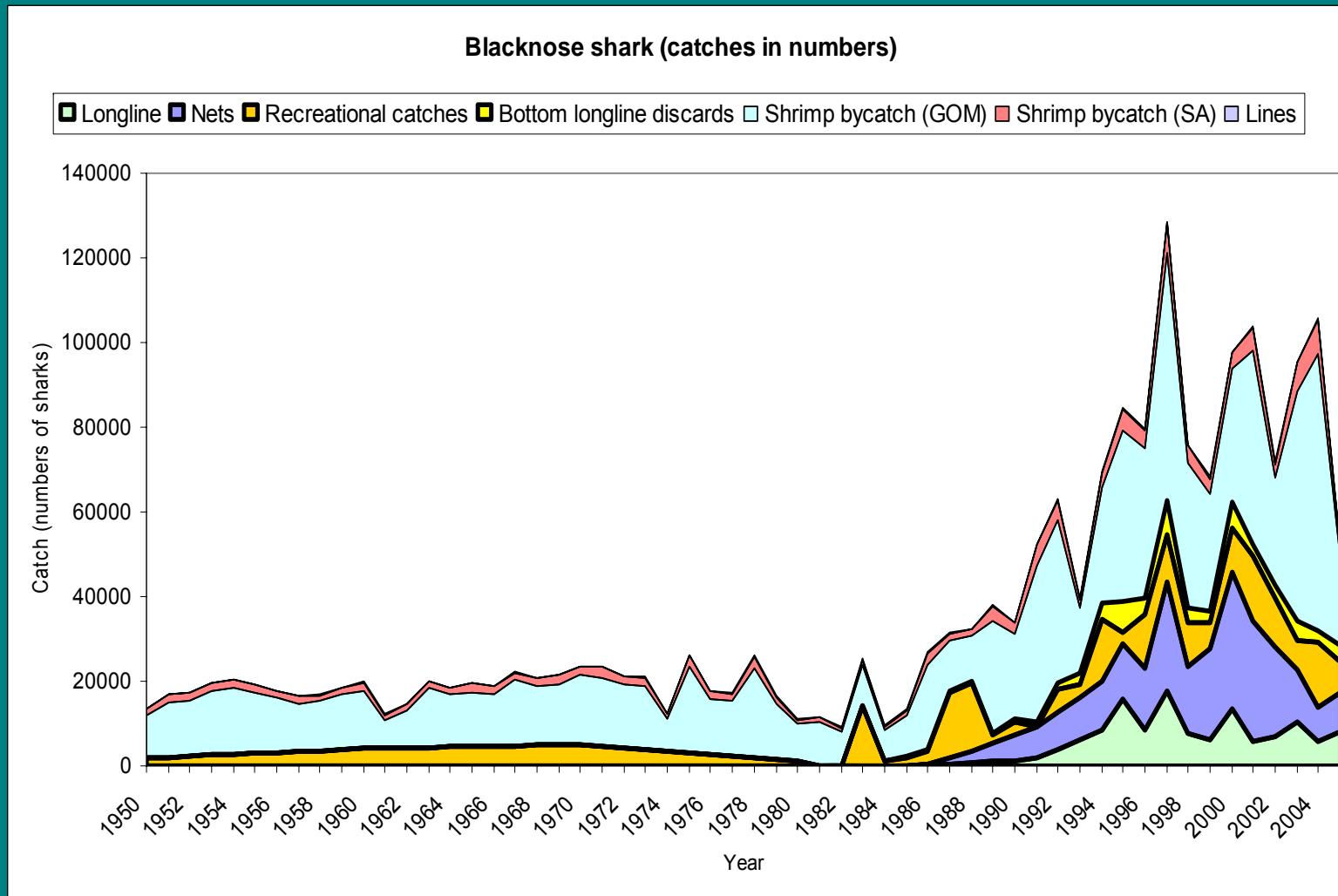
OUTLINE

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 - a. Fishery
 - b. Biology
2. Model Description
3. Base Model and Results
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4. Sensitivity Cases
5. Summary of all Results

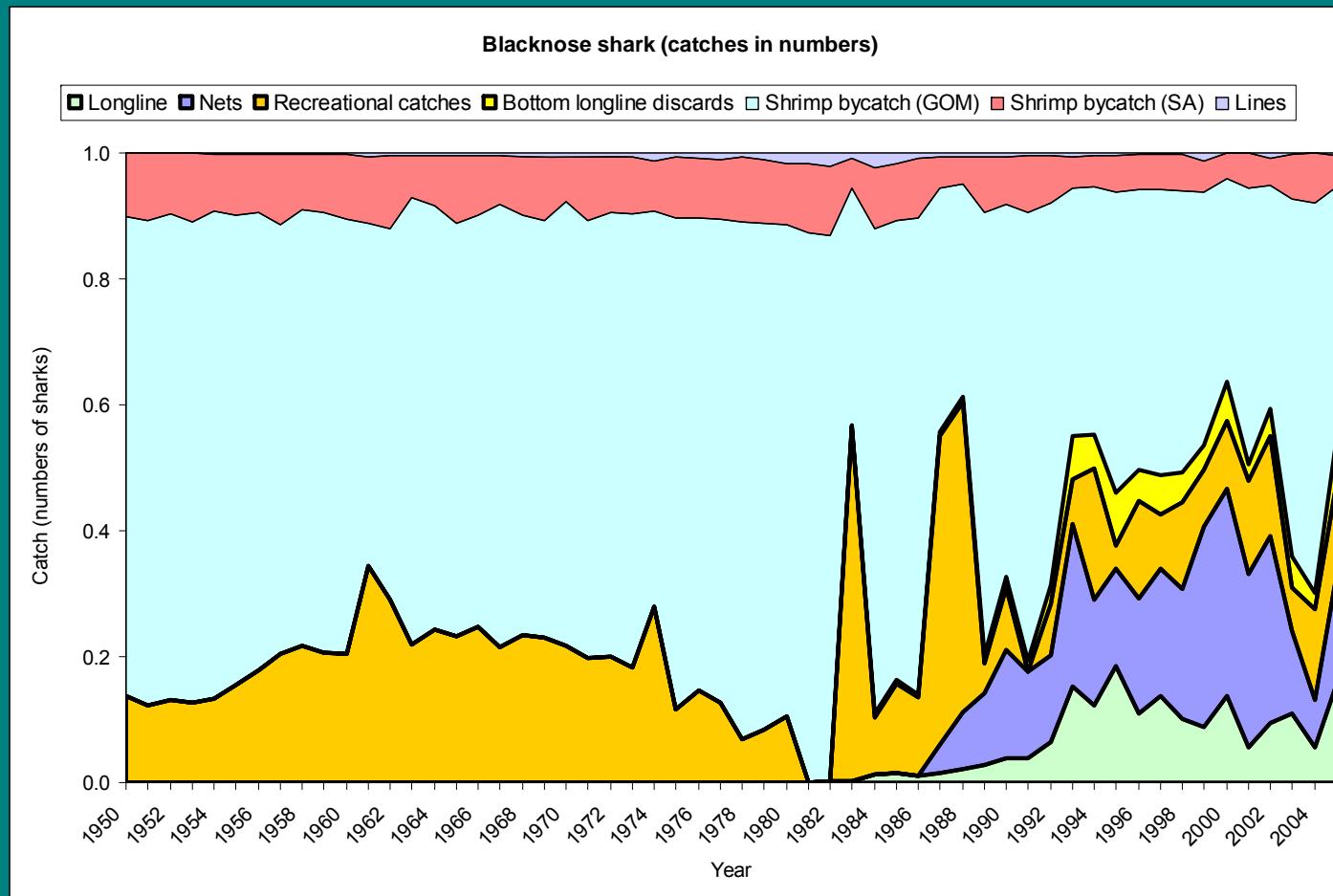
1a. Fishery Inputs

- Catch Series:
 - Commercial
 - Longline
 - Gillnet
 - Handline
 - BLL-discards
 - Recreational
 - Shrimp Bycatch

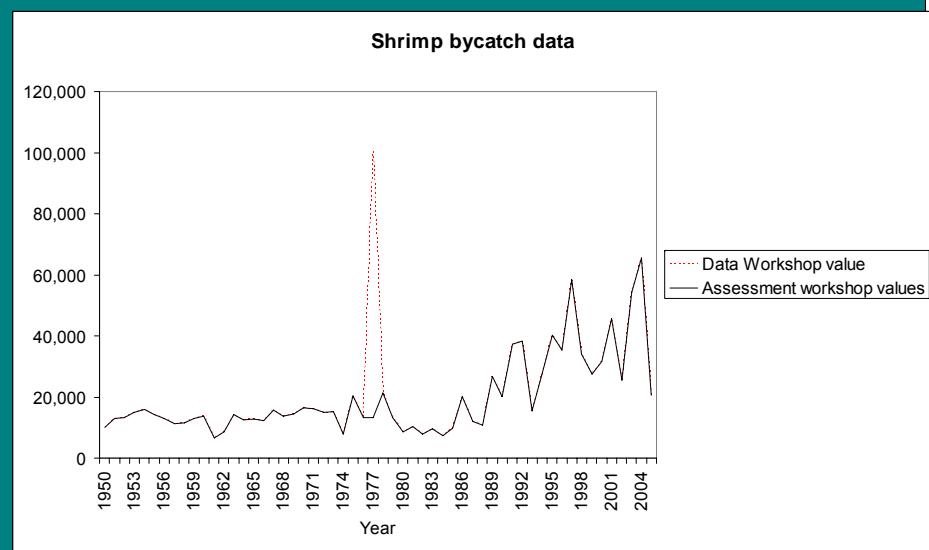
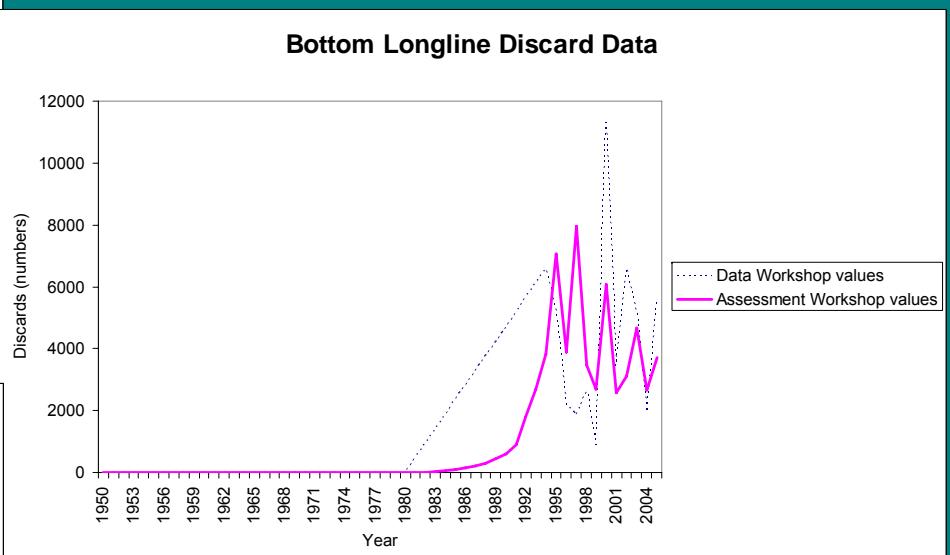
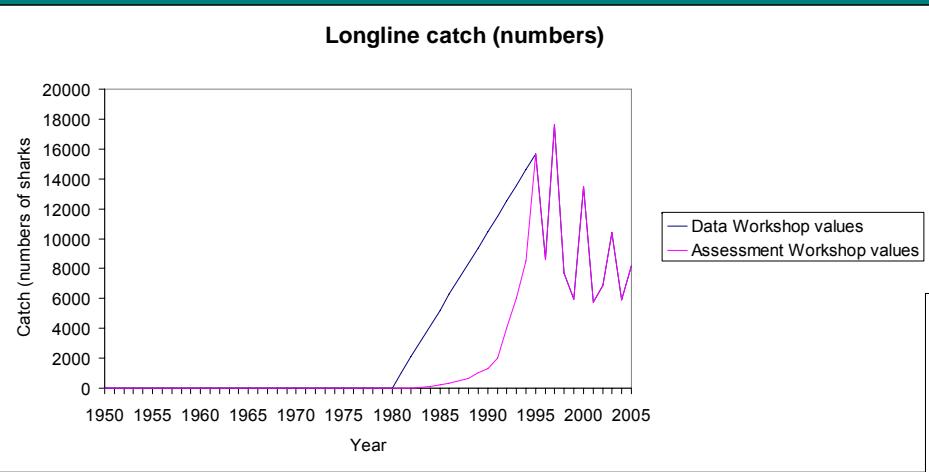
Catches



Catches



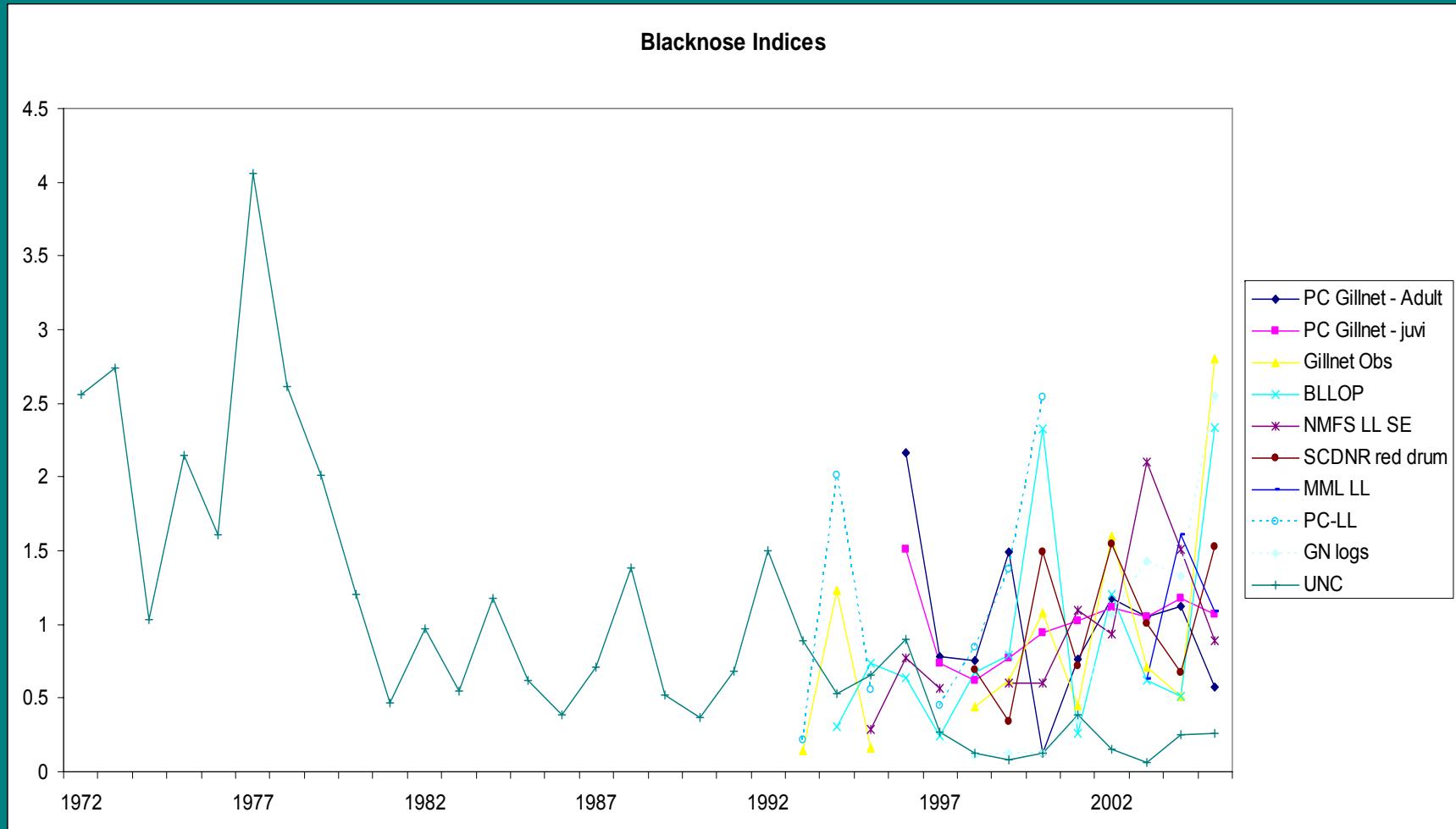
Assessment Workshop data issues

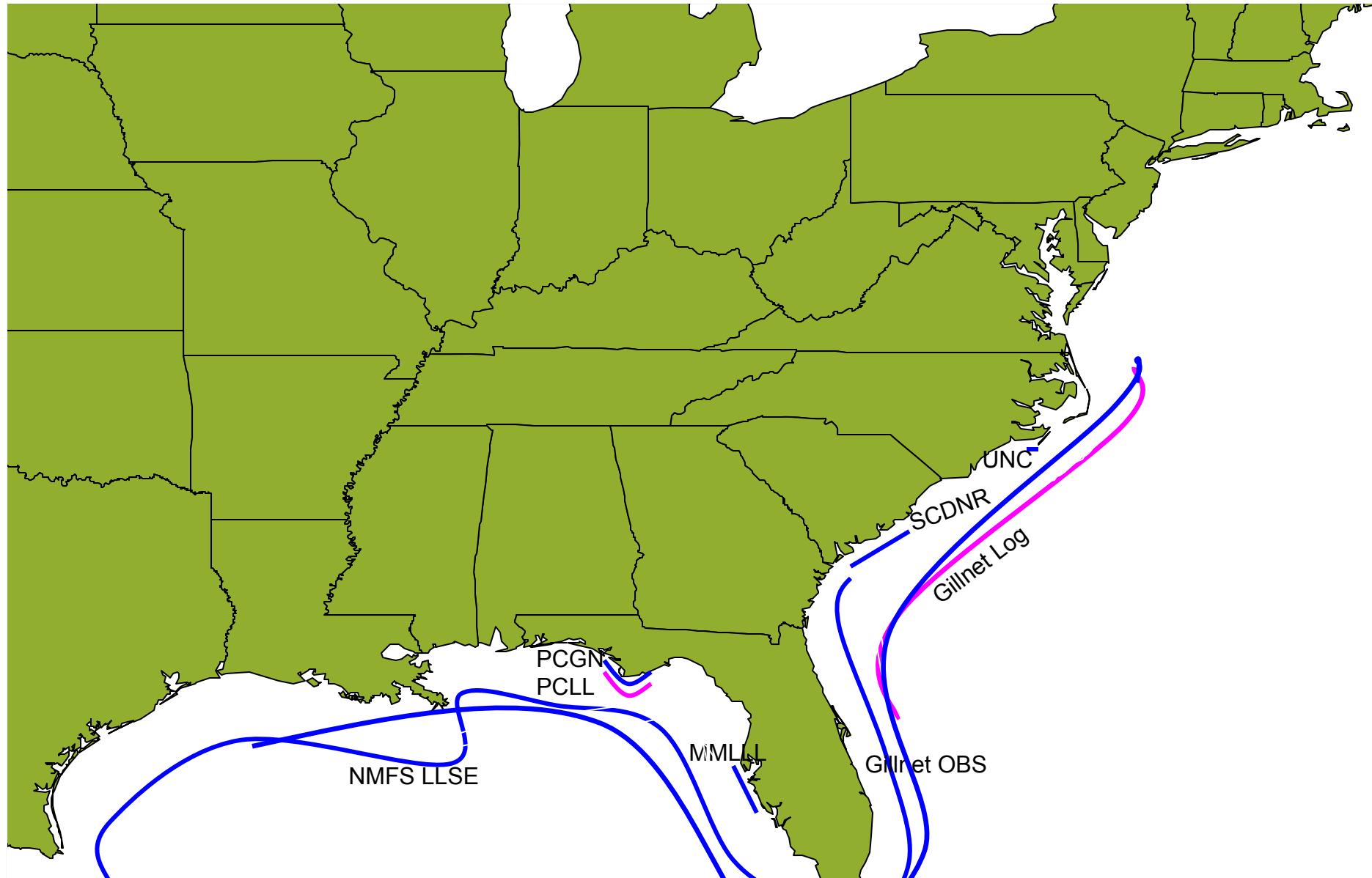


1a. Fishery Inputs

- Indices of Abundance
 - PC Gillnet (adult)
 - PC Gillnet (juvenile)
 - Gillnet Observer
 - Bottom Longline Observer Program
 - NMFS Longline SE
 - South Carolina DNR red drum survey
 - Mote Marine Lab longline
 - University of North Carolina survey
 - PC longline
 - Gillnet logbook

INDICES

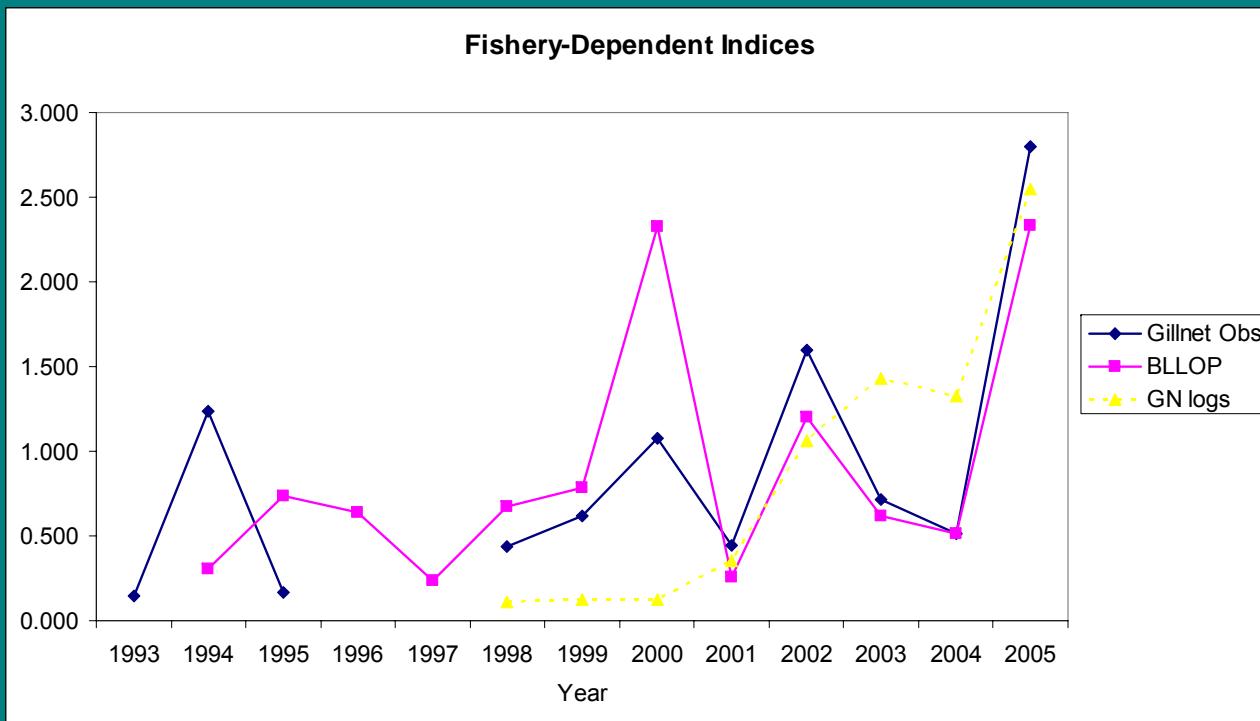


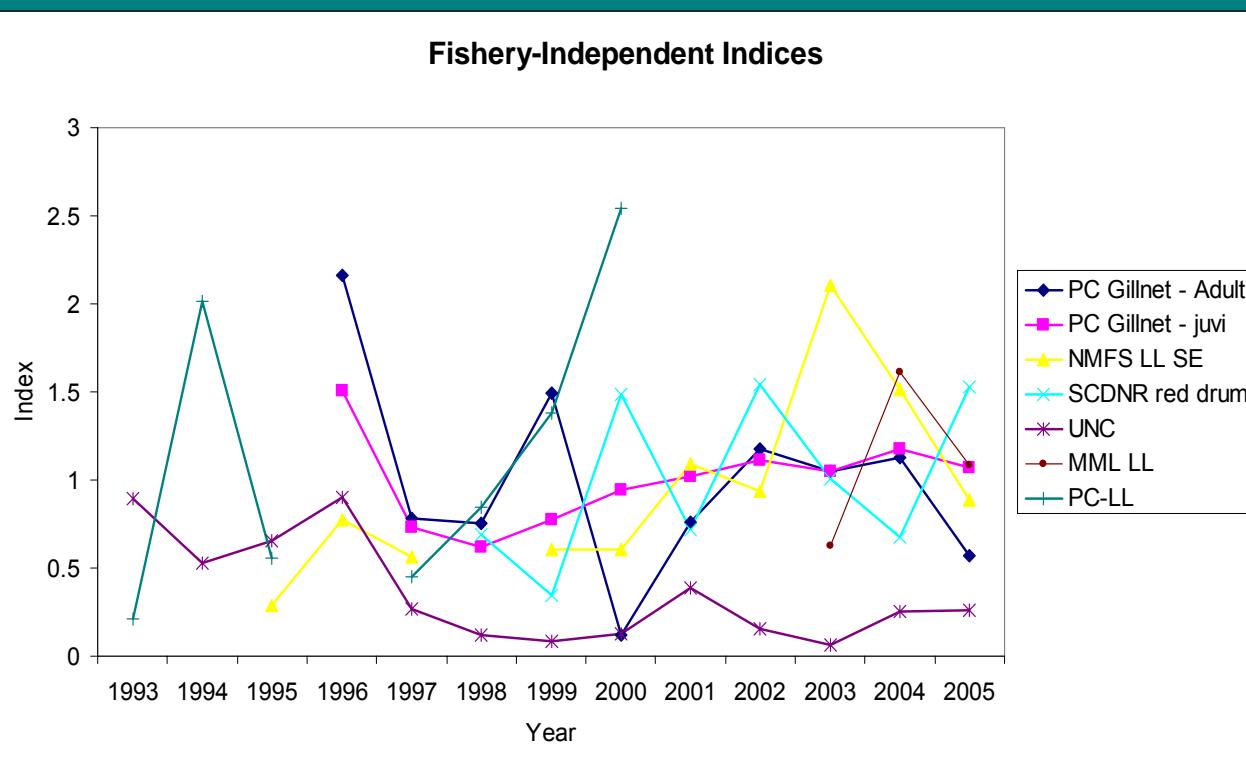
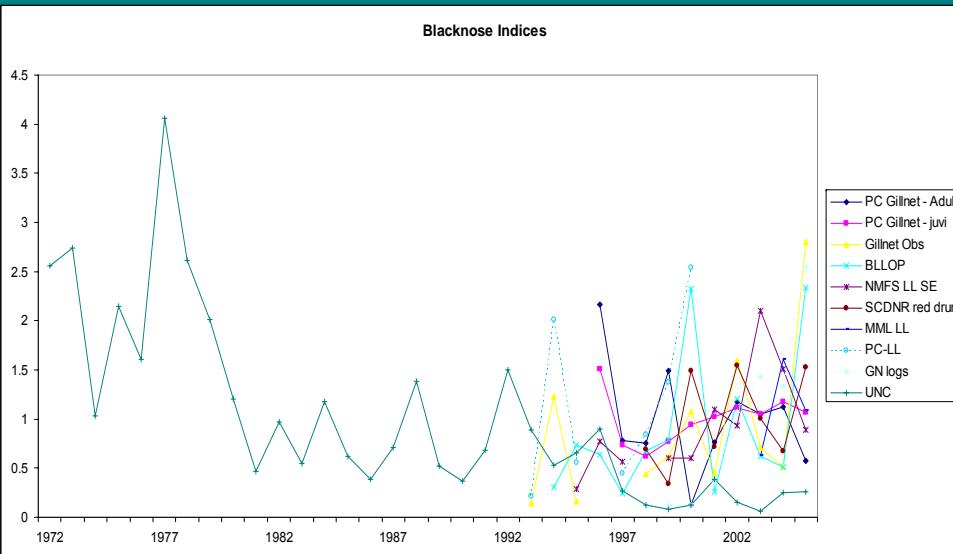


Blacknose

sensitivity

base

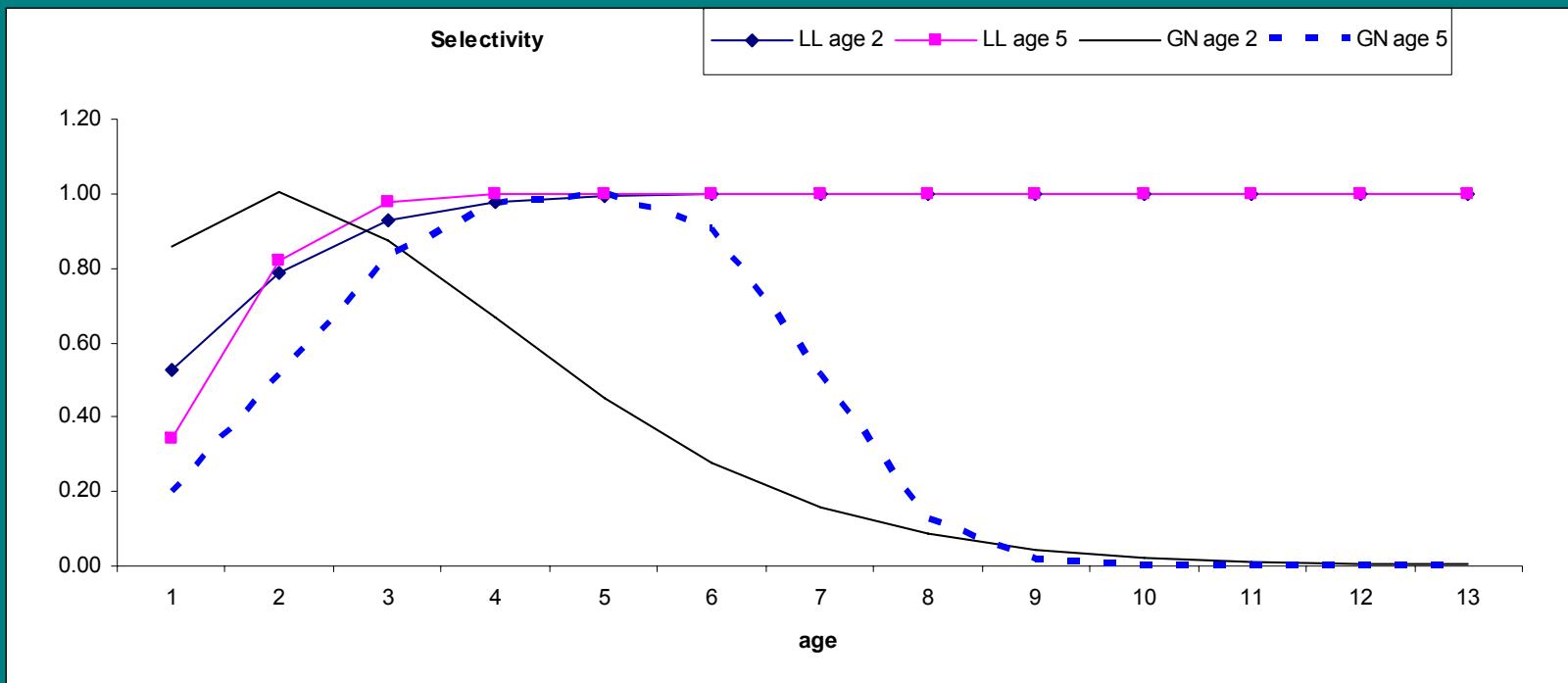




1a. Fishery Inputs

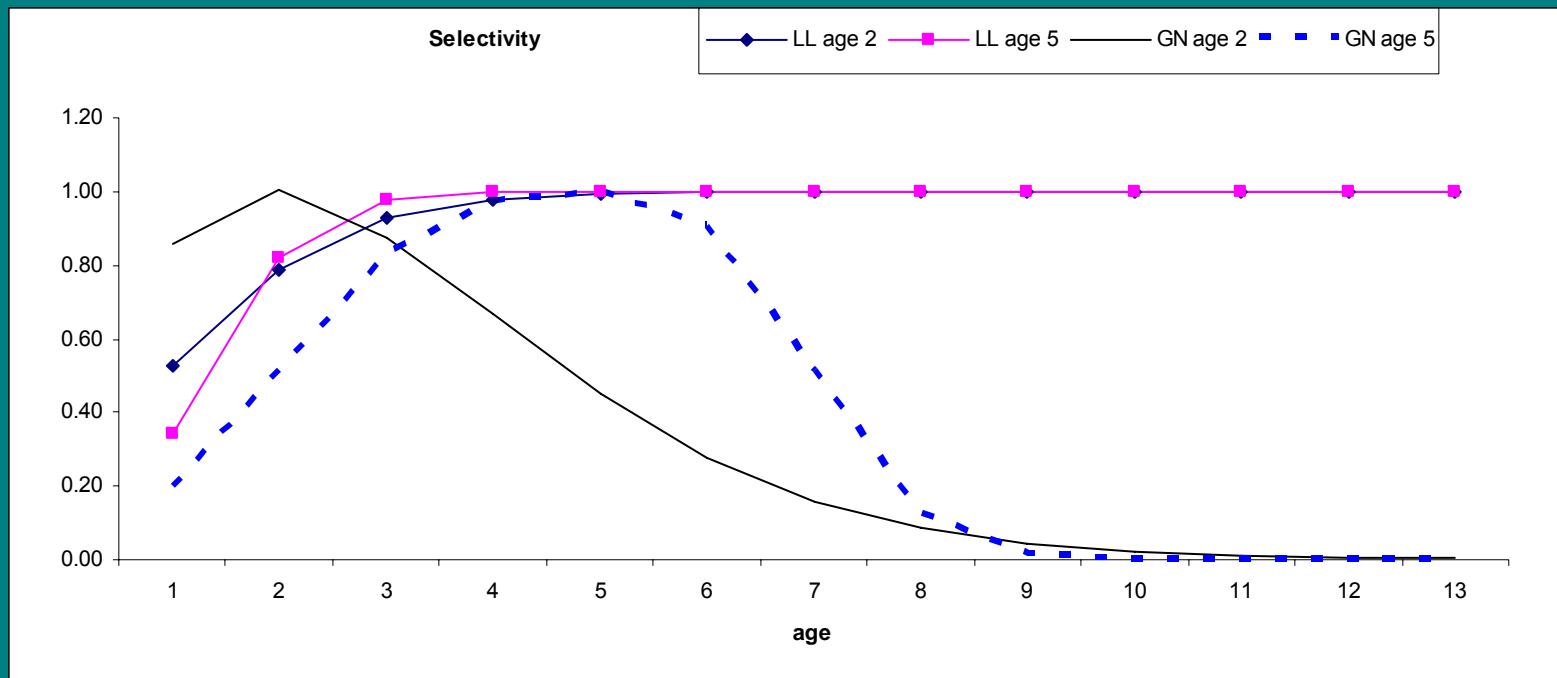
- Selectivity for catches
- Selectivity for indices

Selectivity of the catch



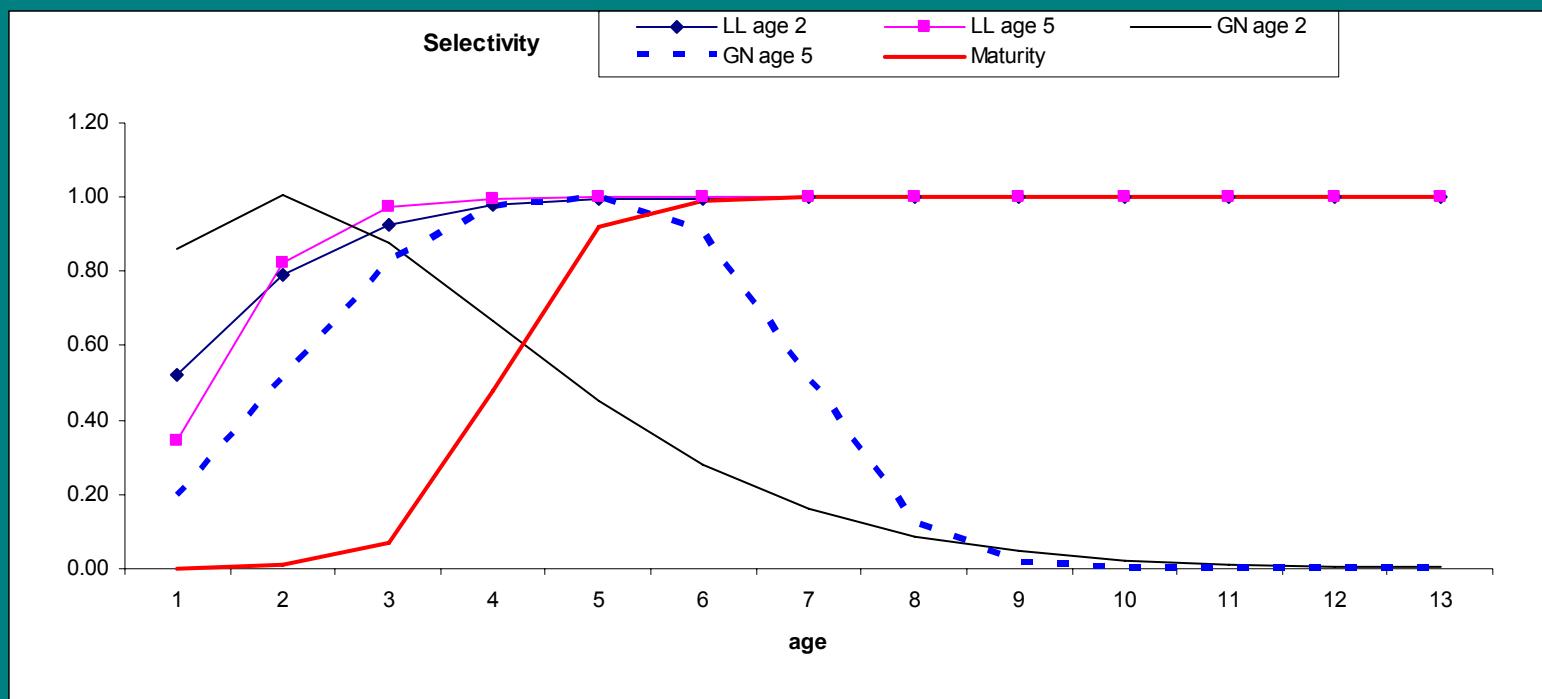
- The longline, lines, recreational, and longline bycatch series used selectivity 1
- The gillnet and shrimp bycatch series used selectivity 3

Selectivity of the surveys



- BLLOP, NMFS LL-SE, SCDNR, PC-LL used 1
GNOP and GN logs used 2
PC-GN adult, PC-GN juvenile used 3
UNC and MML used 4

Selectivities as they relate to maturity ogive

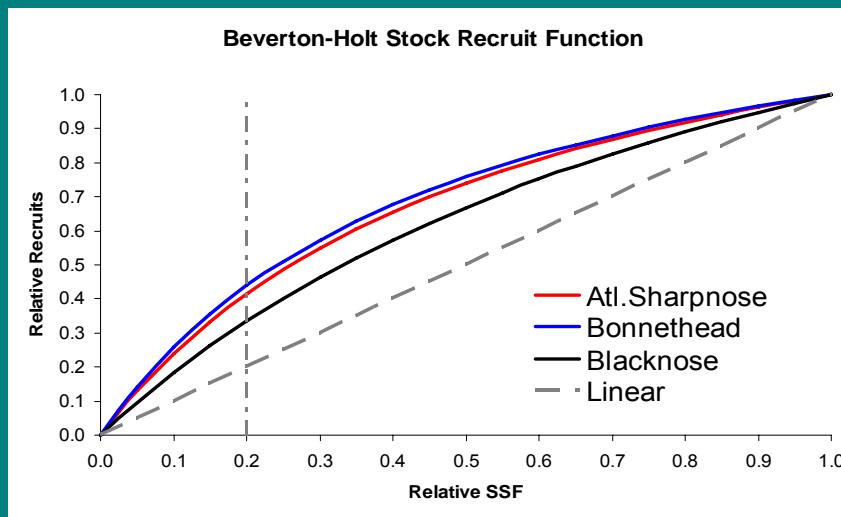
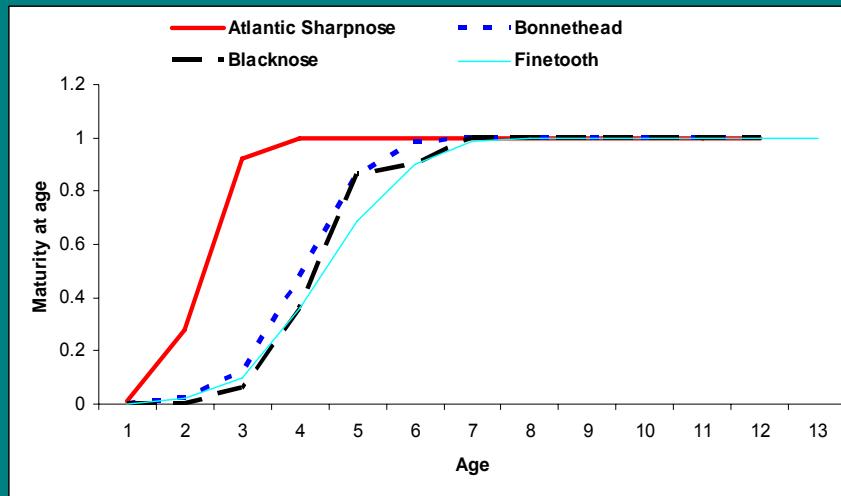


Selectivity Derivations

- SEDAR 13-AW-02 working document
- Calculated selectivity at age from age frequencies. Age-length keys were used to calculate the age-frequencies.

1b. Biological Inputs

- Comparing all species' maturity ogives
- Comparing stock-recruitment relationships



1b. Biological Inputs – DW values

Parameter	Value
L_∞	104.3 (cm FL)
K	0.3
t_0	-1.71
a	1.65E-6
b	3.34
Pup Survival	0.72
Virgin Recruitment (R_0)	[1.0E+4, 1.0E+10]

Steepness – Max. Repro Rate (α)

- $\alpha = \text{pup.survival} \times \text{virgin.spawners.per.recruit}$

$\alpha = \text{pup.survival} \times$

$$\varphi_0 = \sum_{age} fec_{age} \cdot mat_{age} \prod_{j=1}^{age-1} e^{-M_j}$$

- Steepness = $\alpha / (\alpha+4)$

1a. Biological Inputs

Age	M	Female Maturity	Pups-per-Female
1	0.33	0	1.65
2	0.28	0.07	1.65
3	0.26	0.10	1.65
4	0.25	0.48	1.65
5	0.25	0.92	1.65
6	0.24	0.99	1.65
7	0.24	1	1.65
8	0.24	1	1.65
9	0.24	1	1.65
10	0.24	1	1.65
11	0.24	1	1.65
12	0.24	1	1.65
13	0.22	1	1.65

2. Model Description

- Historical period 1950-1971, reconstructed catches were used for the recreational and shrimp fisheries.
- Catch series begin in 1972 (Shrimp bycatch) and 1981 (Recreational); earliest index (UNC) begins in 1972

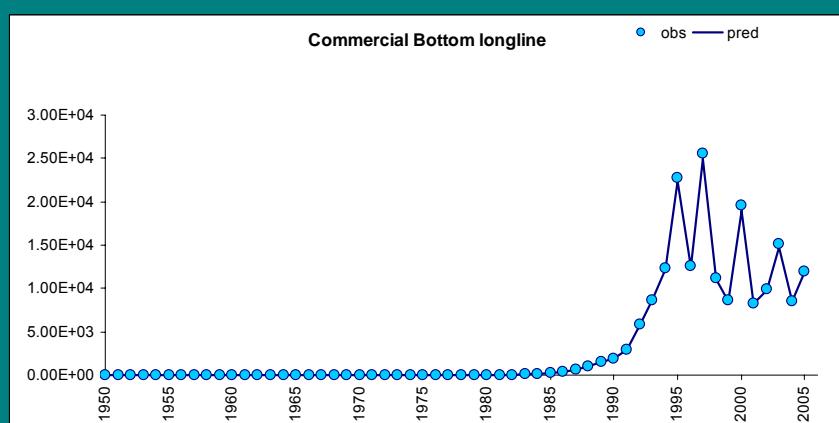
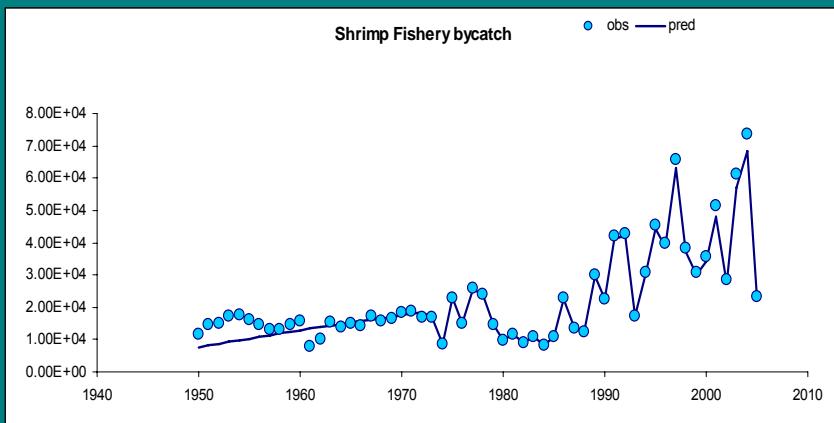
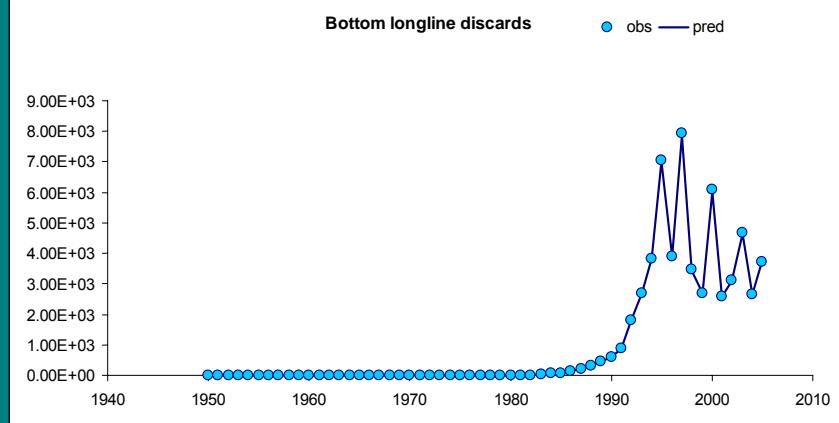
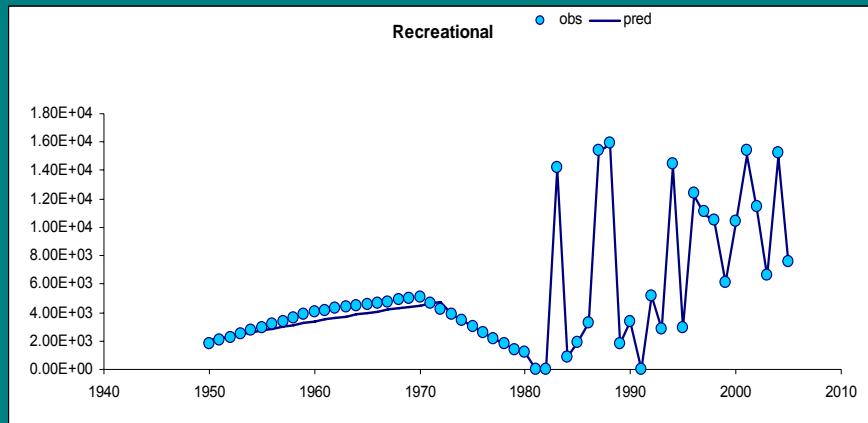
3. Base Model and Results

Blacknose	BASE	
	Estimate	CV
$\text{SSF}_{2005}/\text{SSF}_{\text{MSY}}$	0.48	0.67
F_{2005}/F_{MSY}	3.77	0.83
N_{2005}/N_{MSY}	0.48	-
MSY	89,415	-
SPR_{MSY}	0.71	0.38
F_{MSY}	0.07	-
SSF_{MSY}	349,060	-
N_{MSY}	570,753	-
F_{2005}	0.24	0.83
SSF_{2005}	168,140	0.75
N_{2005}	349,308	-
$\text{SSF}_{2005}/\text{SSF}_0$	0.2	0.65
B_{2005}/B_0	0.24	-
R0	317,590	0.19
Pup-survival	0.78	0.23
alpha	2.02	-
steepness	0.336	-

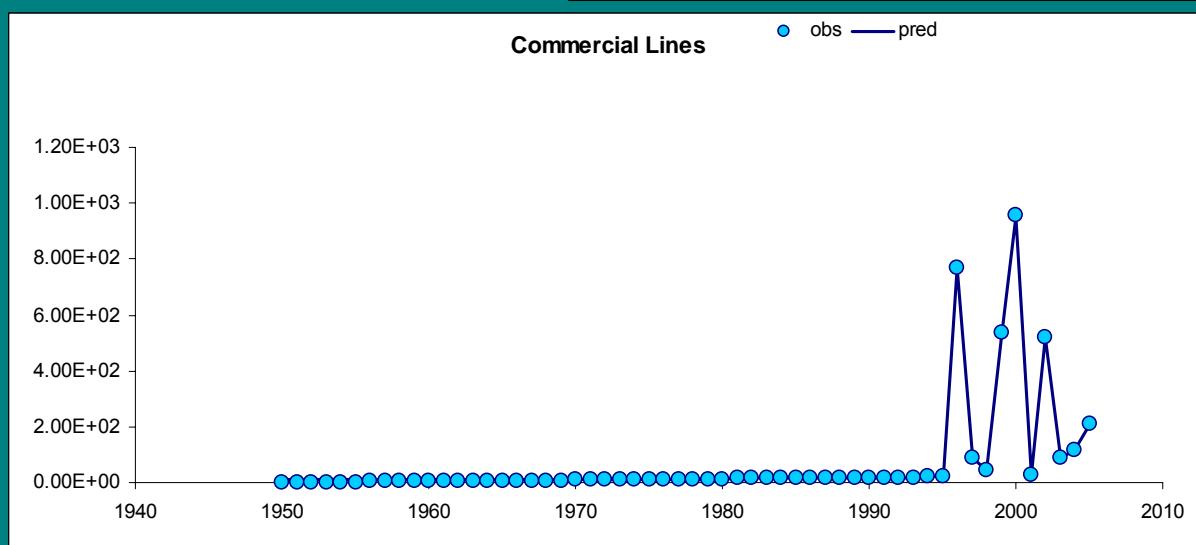
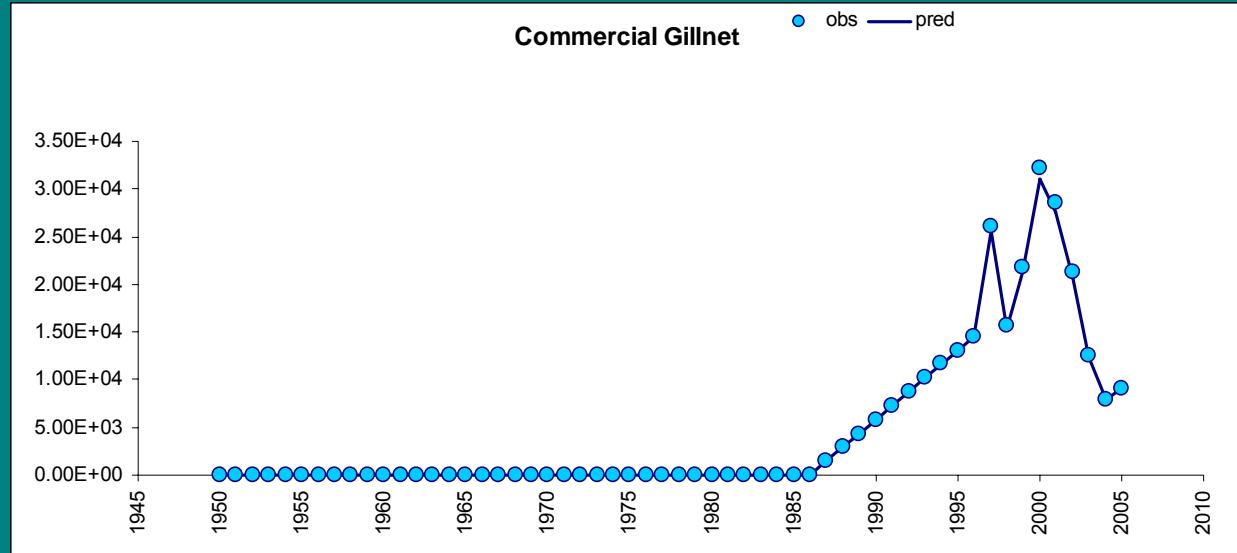
3. Base Model and Results

- $\text{SSF}_{2005}/\text{SSF}_{\text{MSY}} = 0.48 \rightarrow \text{overfished}$
- $F_{2005}/F_{\text{MSY}} = 3.77 \rightarrow \text{overfishing}$
- Steepness = 0.34
- $\text{SPR}_{\text{MSY}} = 0.71$
- $F_{\text{MSY}} = 0.07$

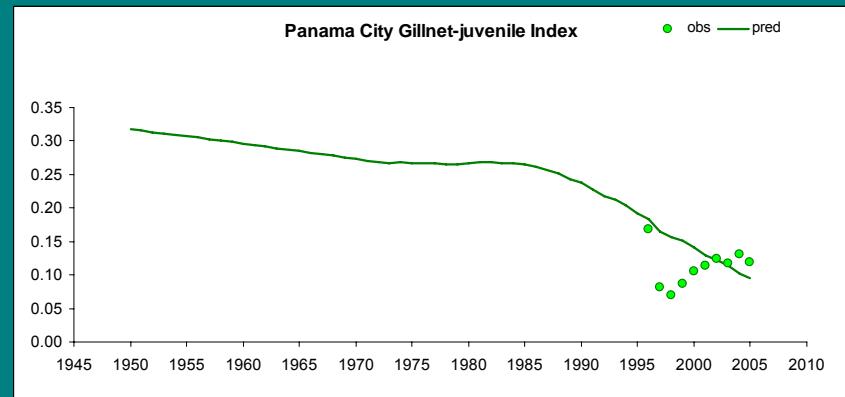
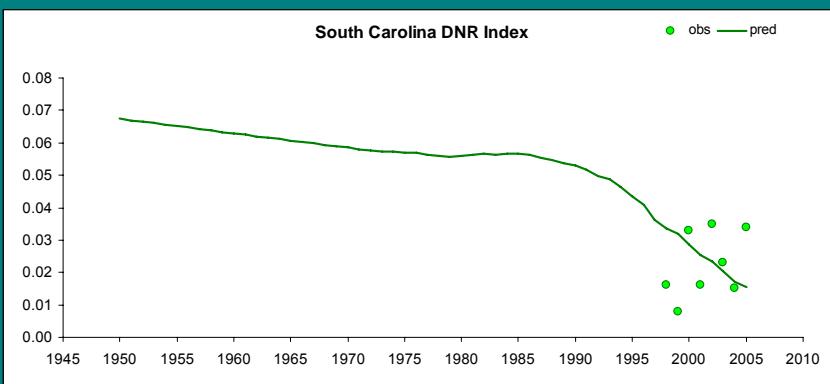
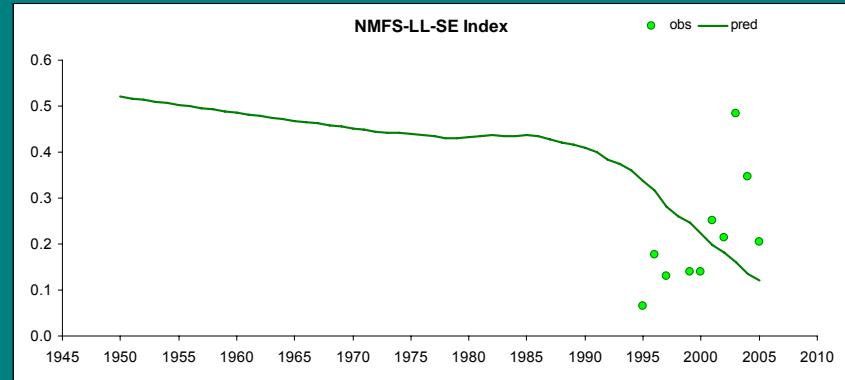
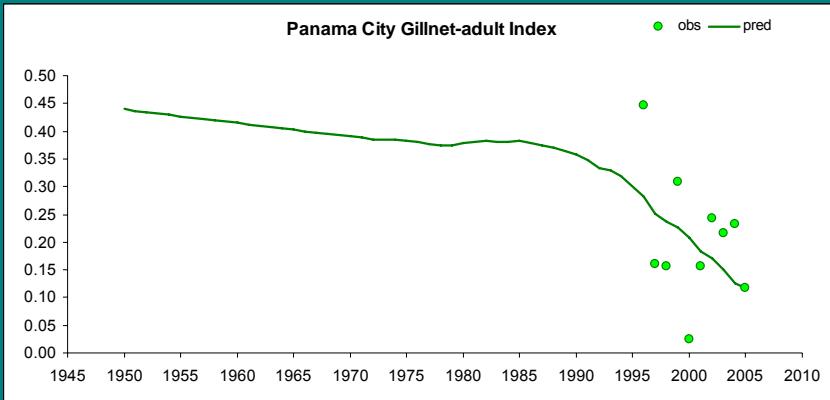
Model fit to catches



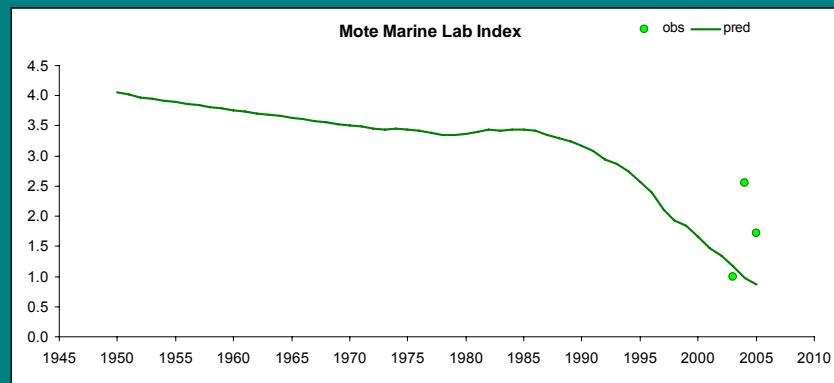
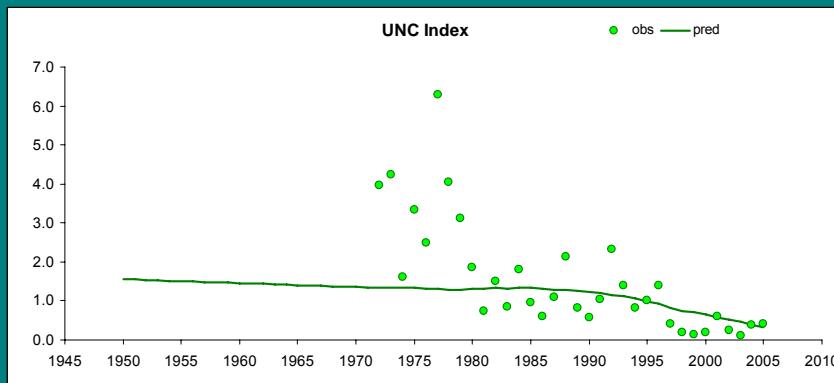
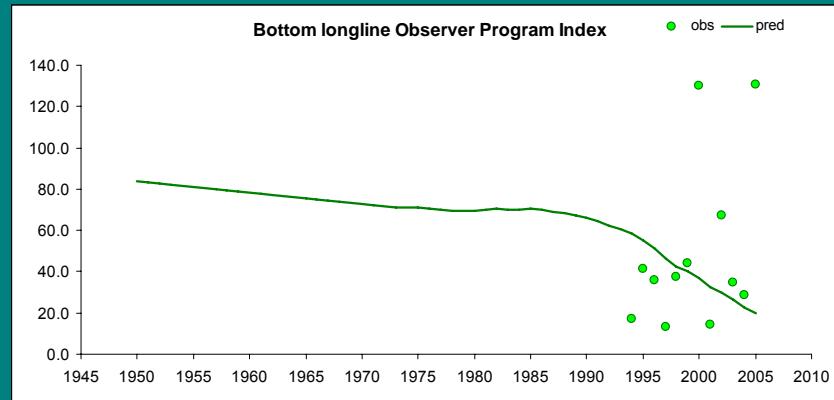
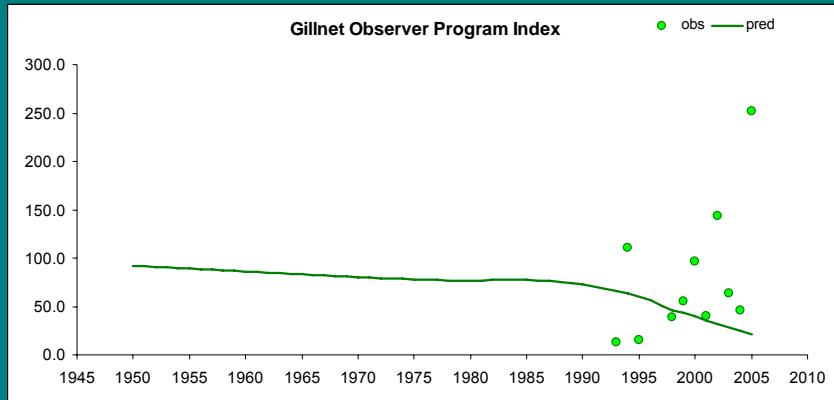
Catches continued...



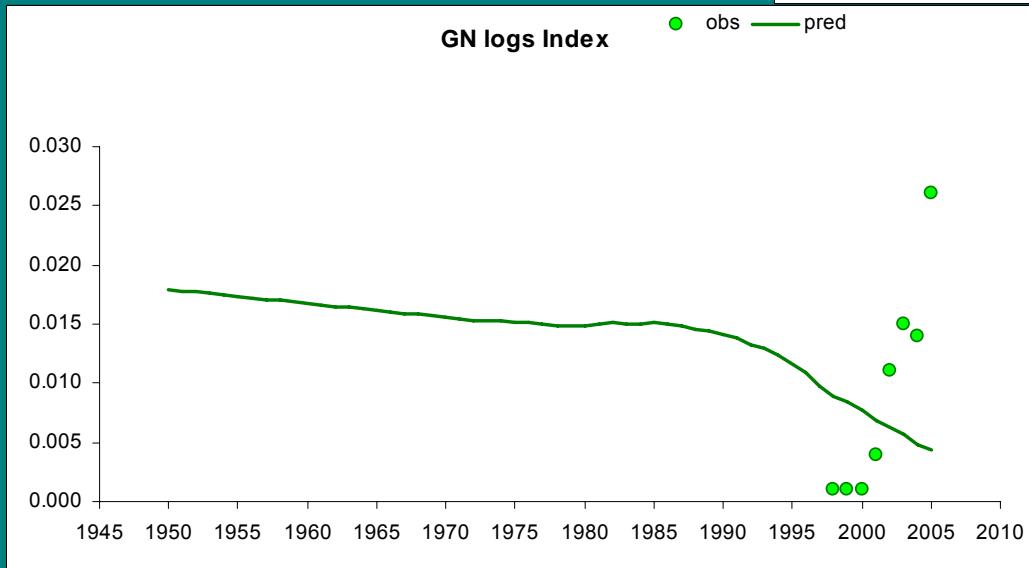
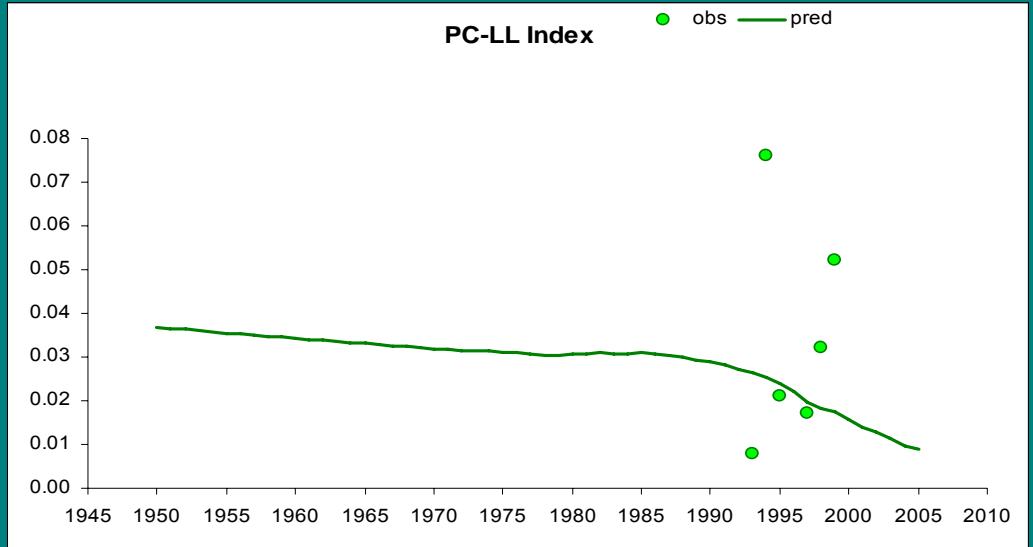
Model fit to indices



Model fit to indices



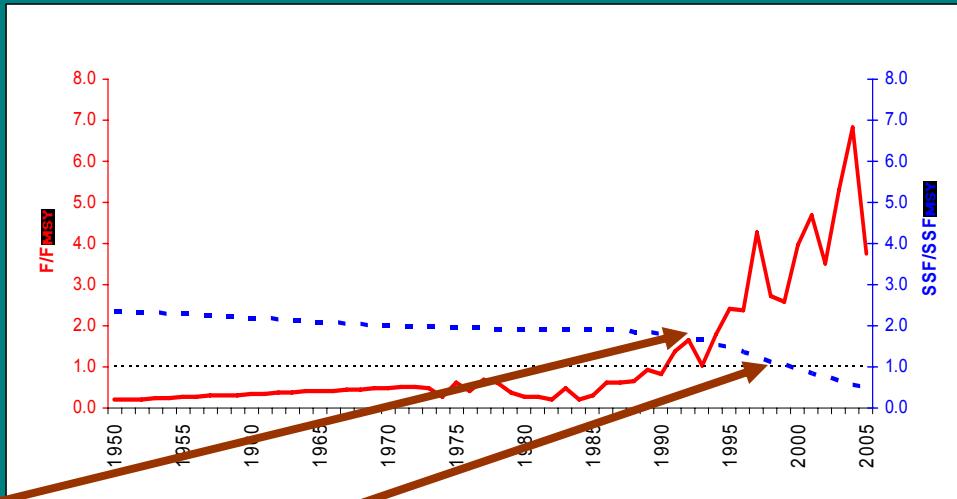
Model fit to sensitivity indices



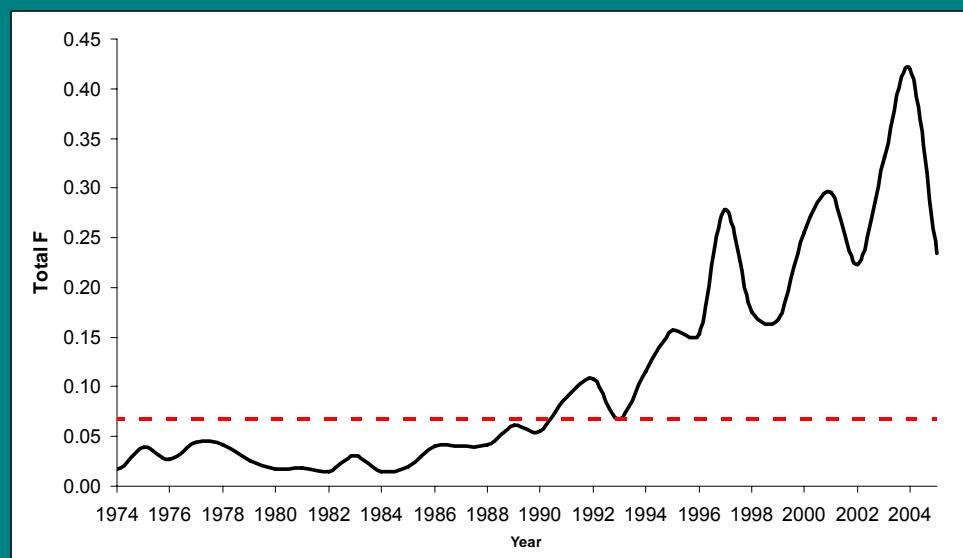
Steep decline
from 1993 to
current

Overfished
from 2000

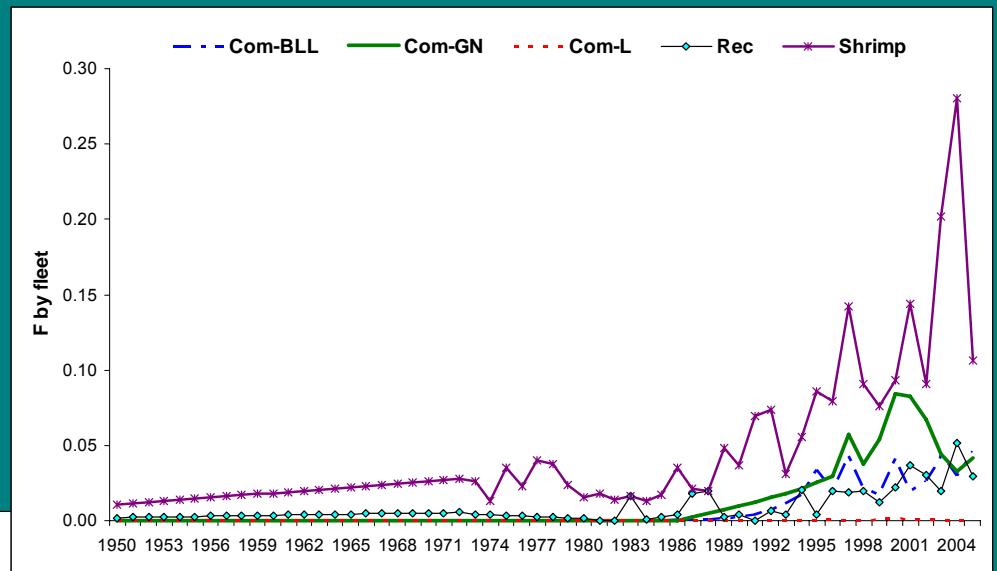
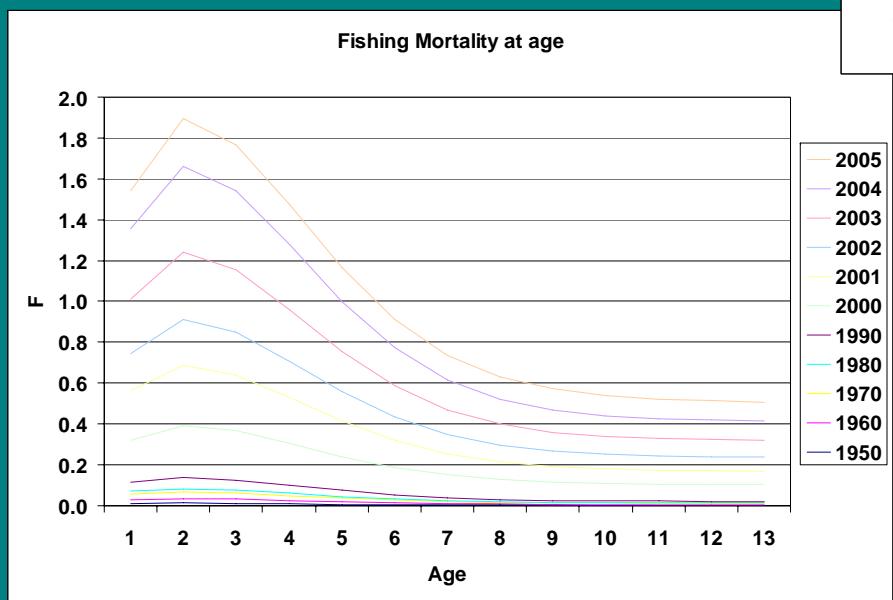
Total F and F_{MSY}



F/F_{MSY} and
 SSF/SSF_{MSY}

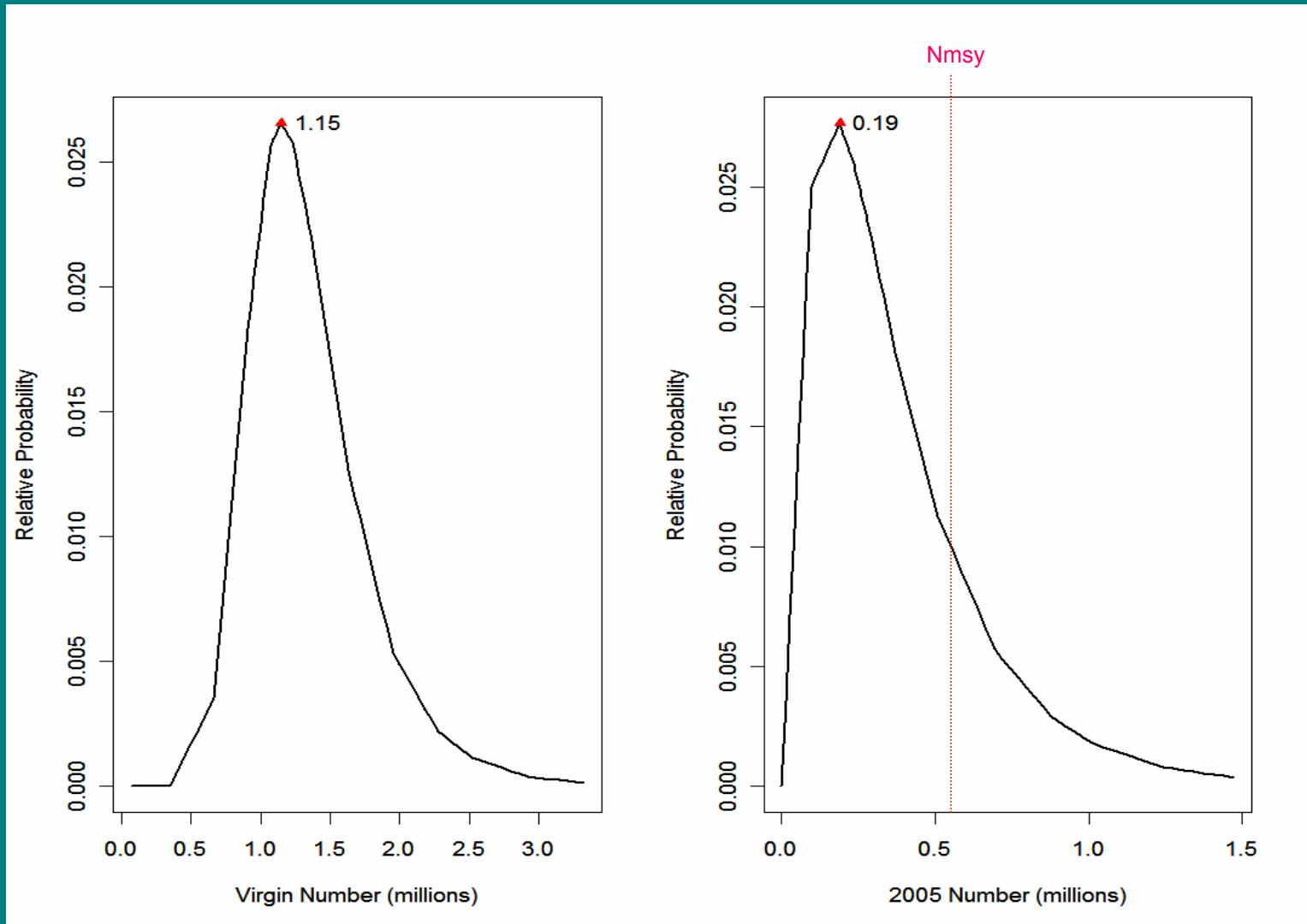


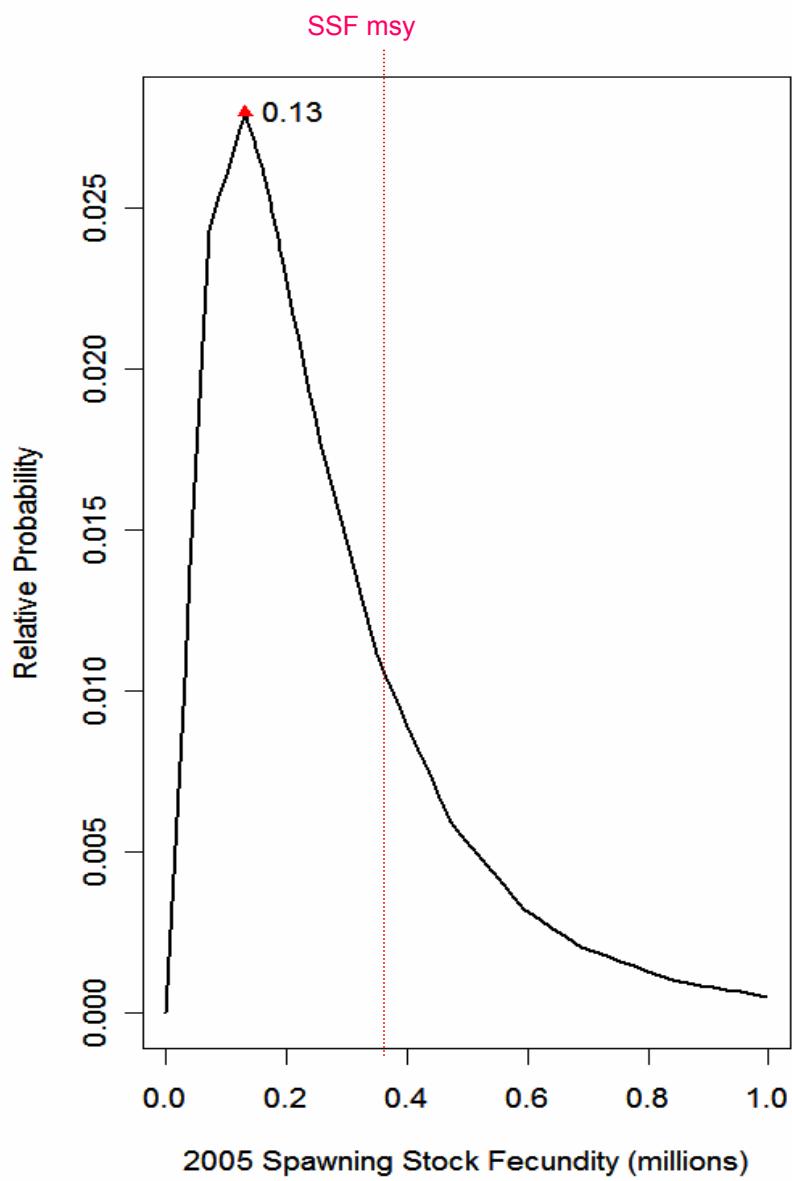
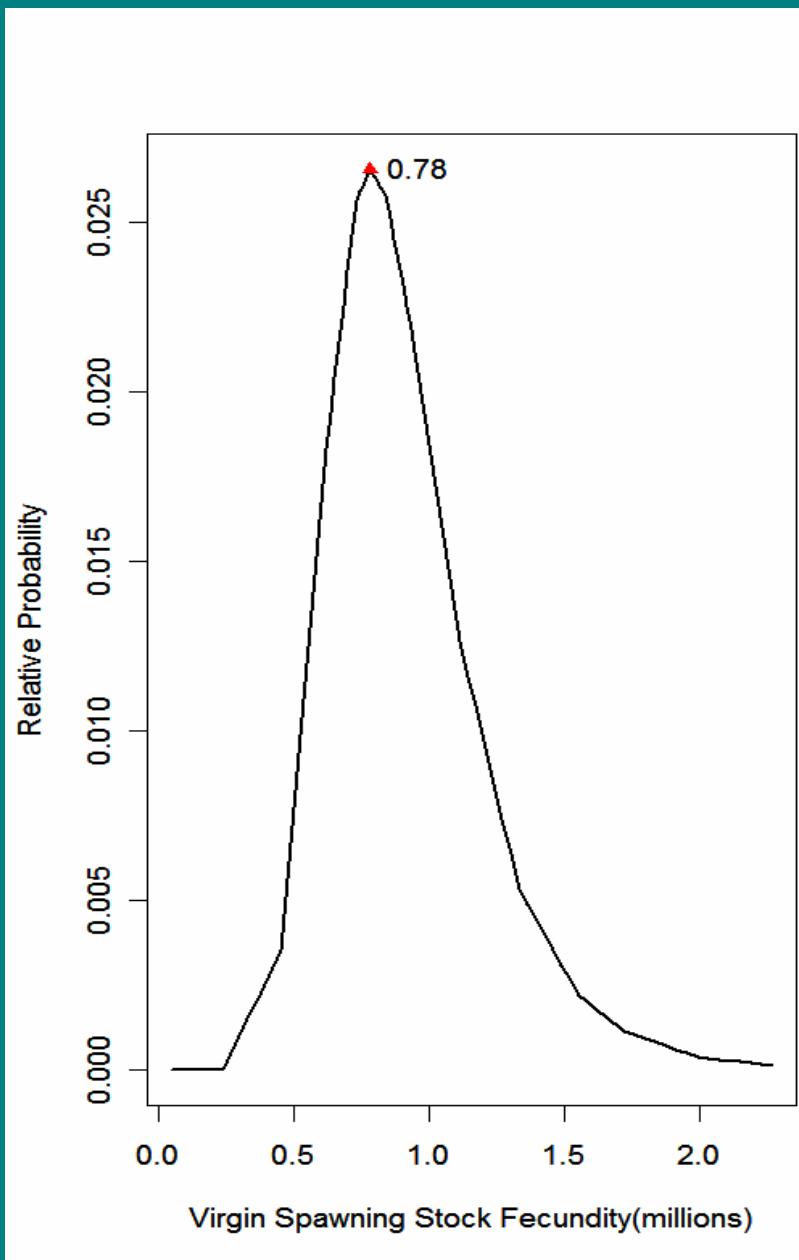
Fishing mortality by fleet and by age

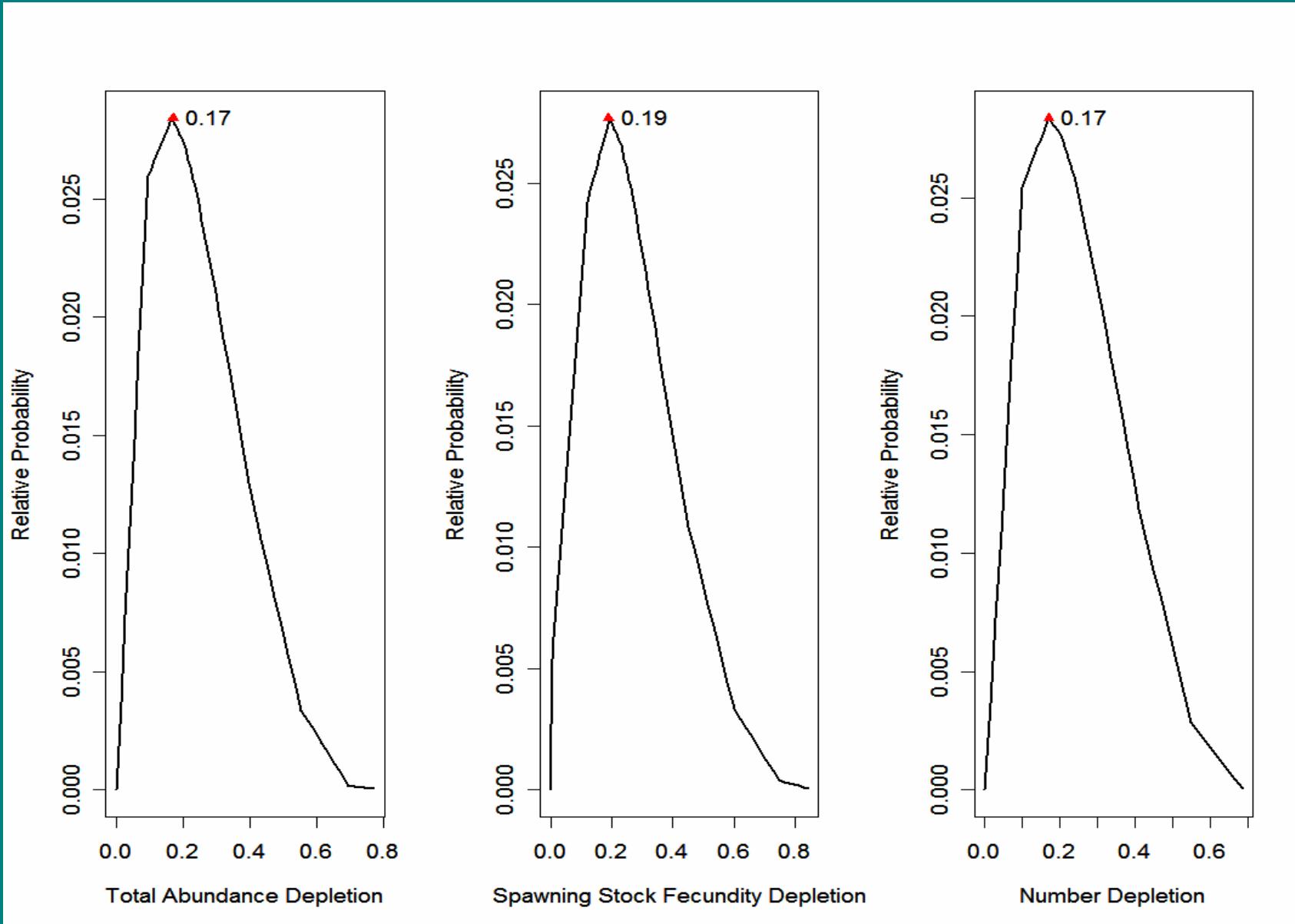


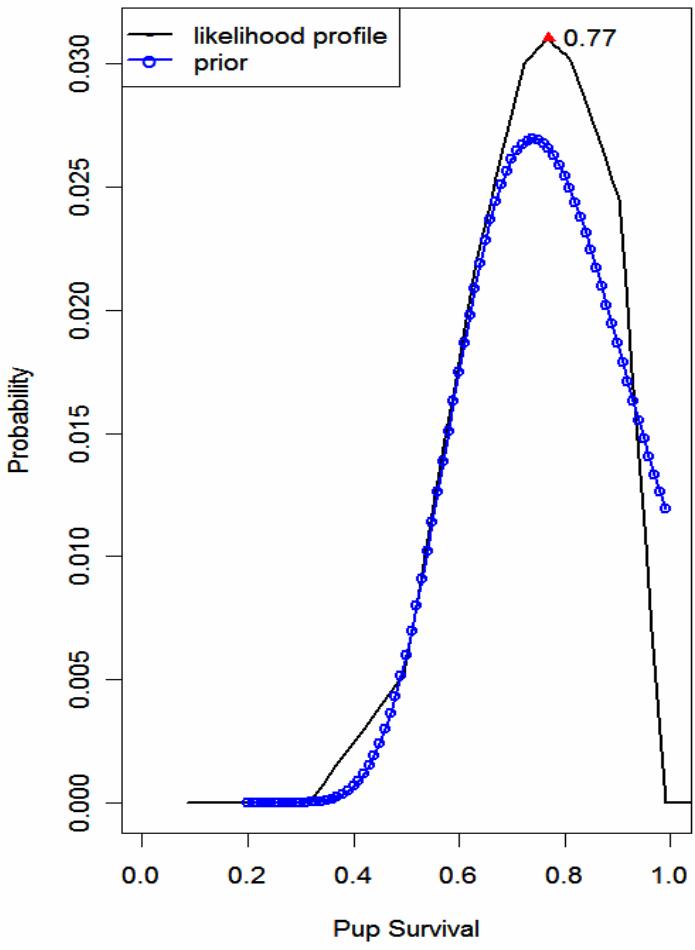
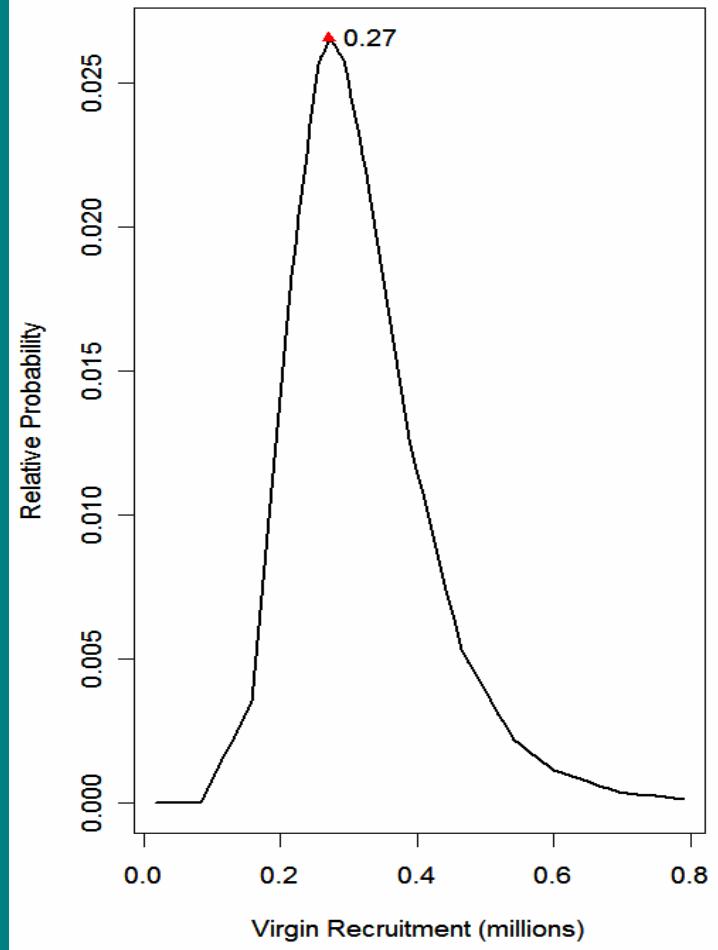
Uncertainty

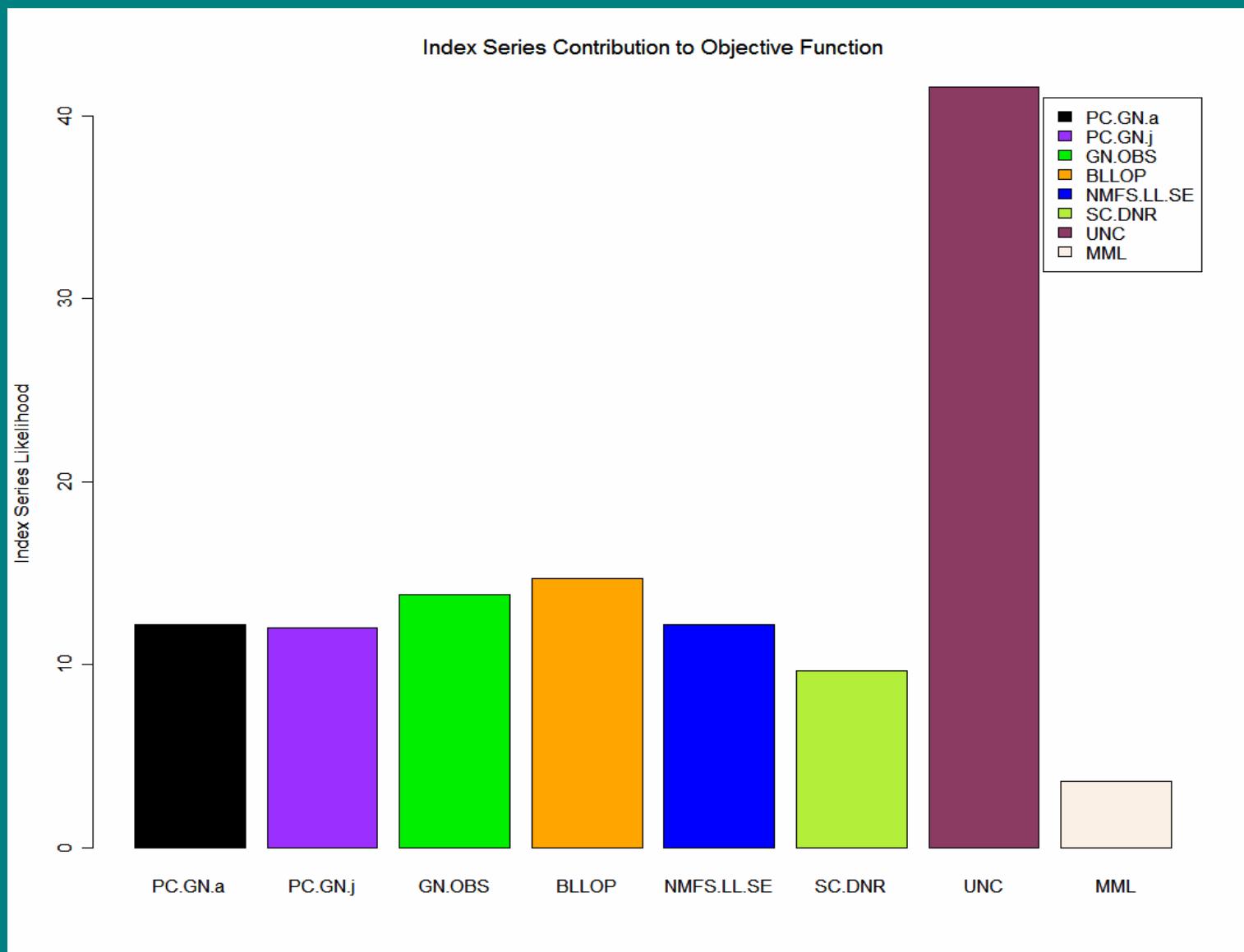
- Likelihood profiling option in ADMB to estimate posterior distributions for parameters

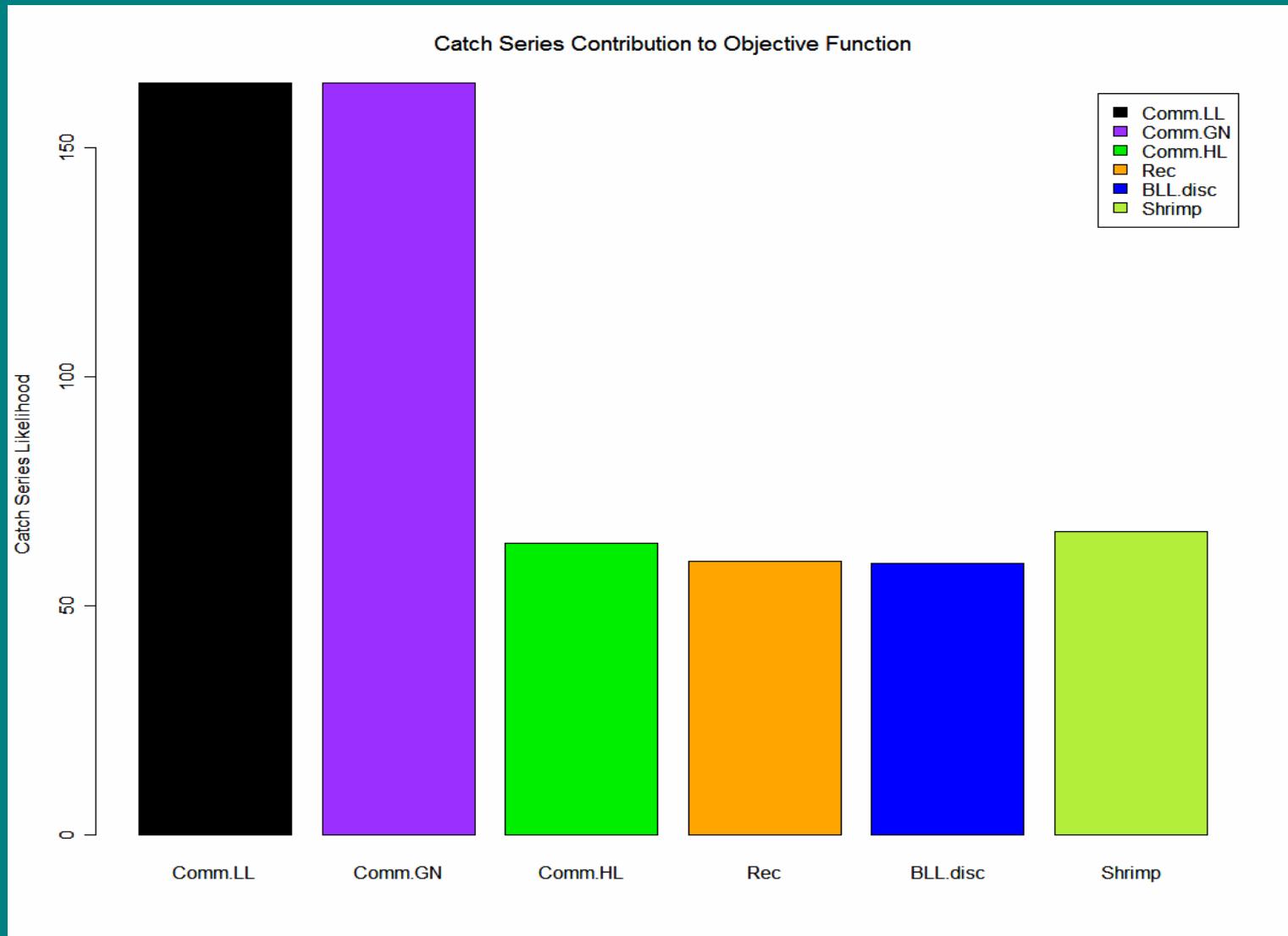






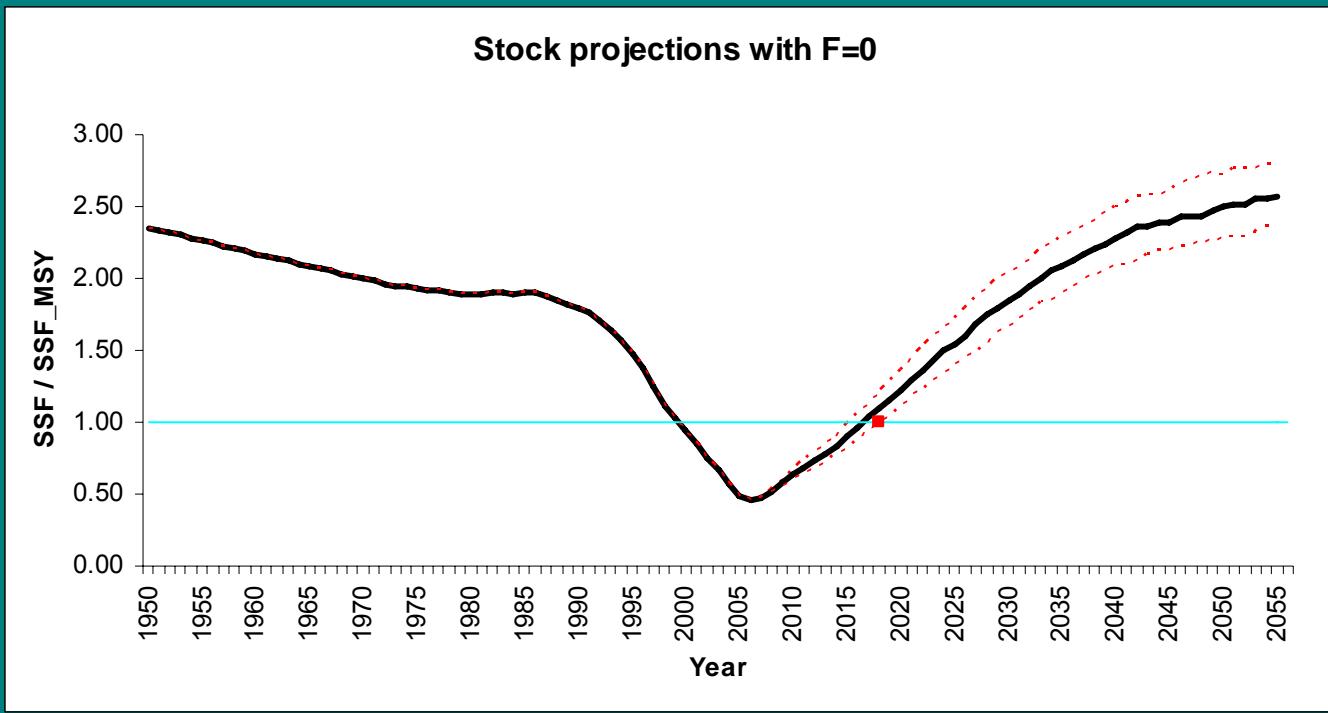






3. Base Model and Results

Given the status is overfished with overfishing,
we need to carry out a rebuilding analysis...



MSY ~ 87,000 sharks

C_{2005} ~ 55,000 sharks

Generation Time

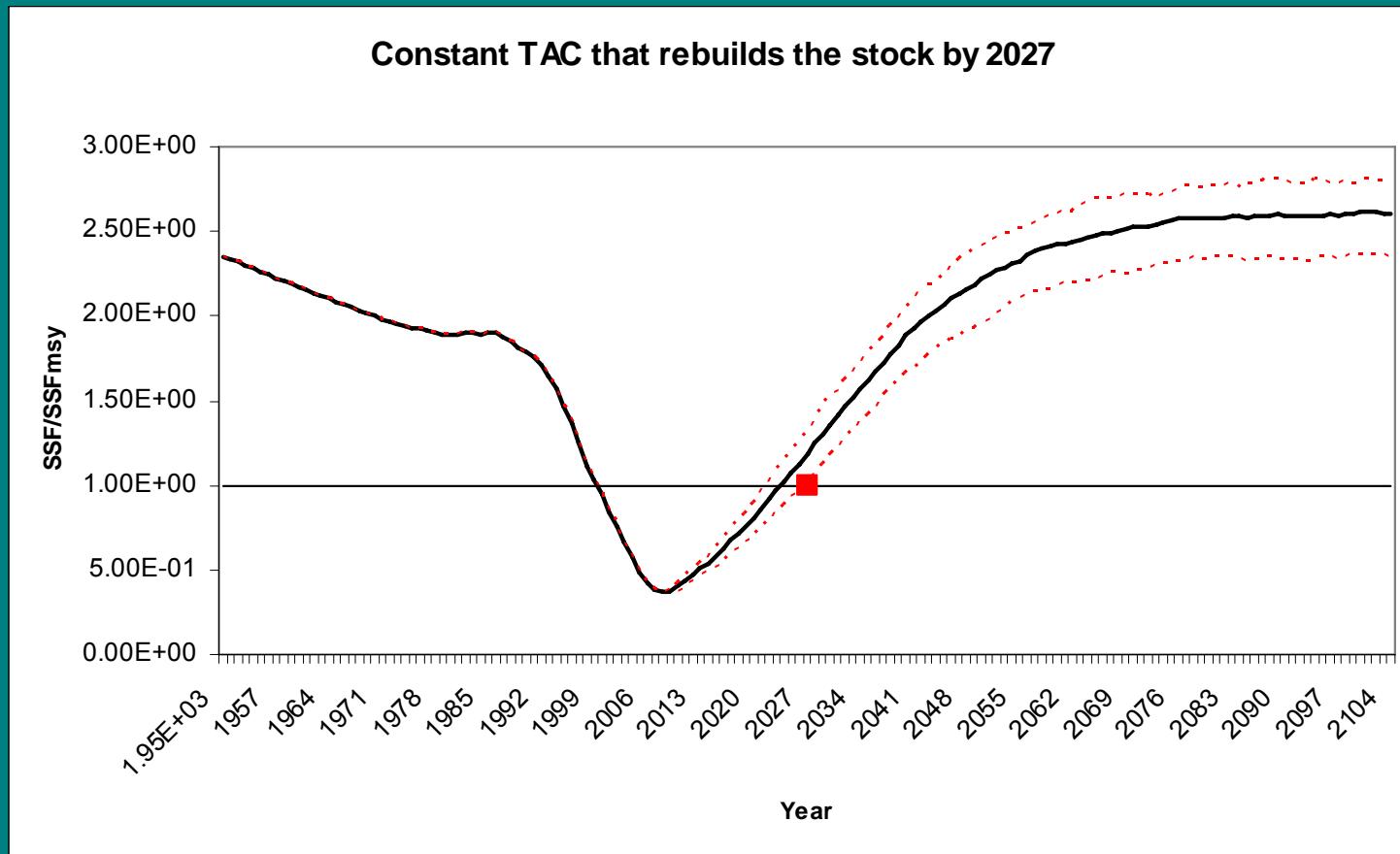
$$GenTime = \frac{\sum_i if_i \prod_{j=1}^{i-1} s_j}{\sum_i f_i \prod_{j=1}^{i-1} s_j}$$

i is age, f_i is the product of (fecundity at age) x (maturity at age), and s_j is survival at age.

Rebuilding timeline

- With $F=0$, the stock rebuilds by 2019
- Add a generation time = 8 years
- What is the harvest allowed in order to rebuild by $2019+8 = 2027$?

19,200 individuals per year allow for rebuilding by 2027

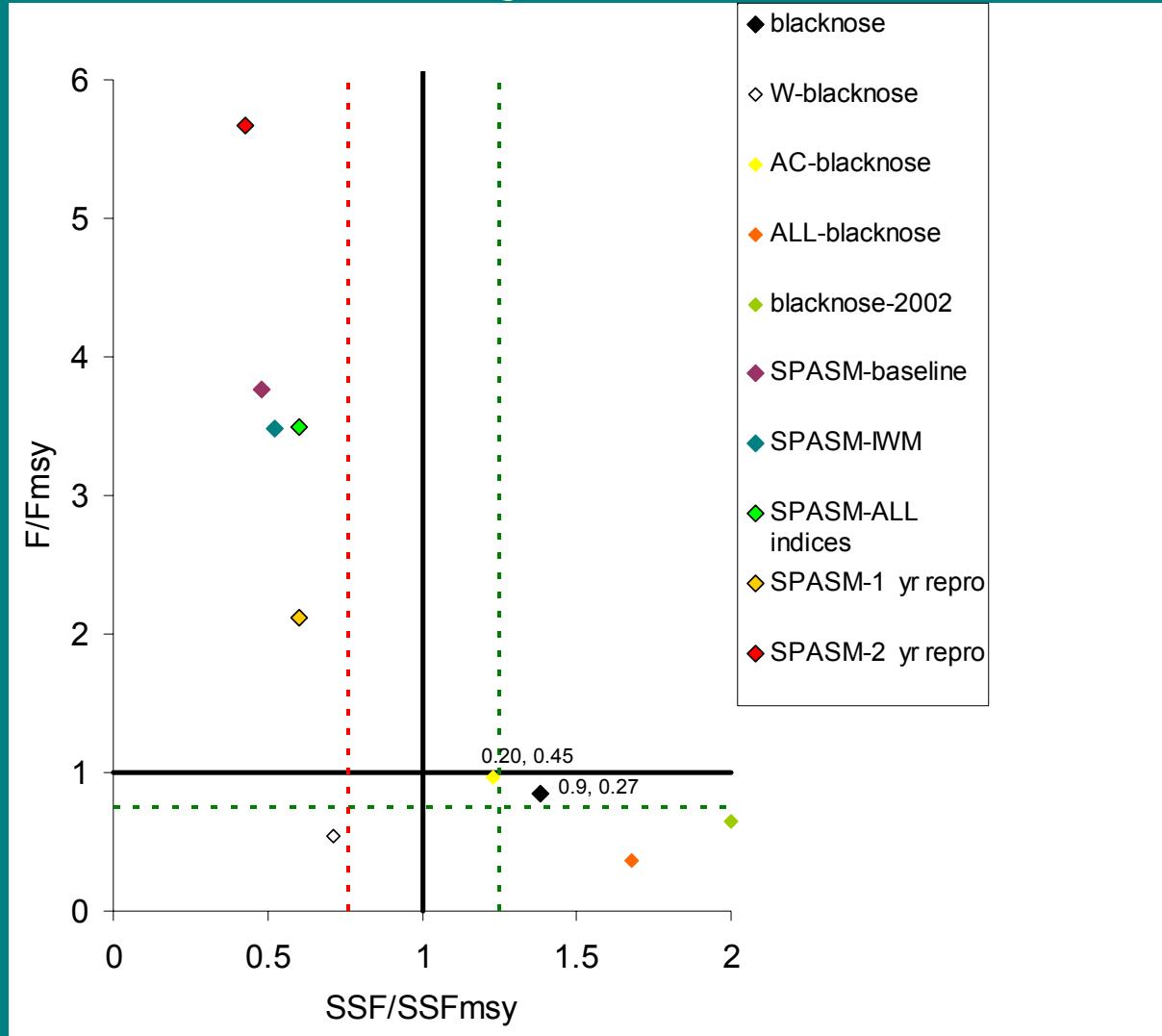


4. Sensitivity Analyses

- S-1: inverse CV weighting of indices
- S-2: all indices used
- S-3: 1-year reproductive cycle
- S-4: 2-year reproductive cycle

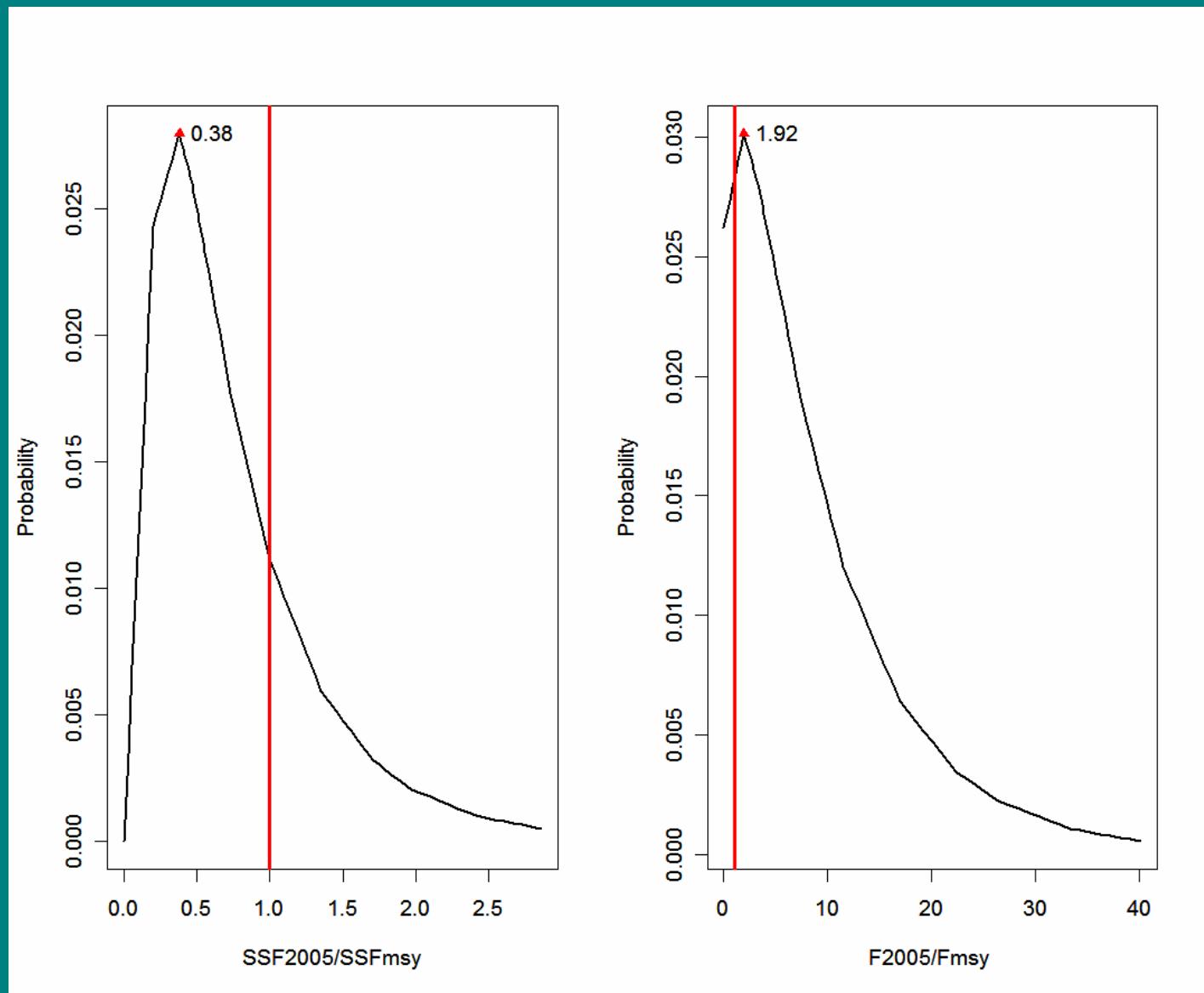
Blacknose	S1		S2		S3		S4	
	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV
$\text{SSF}_{2005}/\text{SSF}_{\text{MSY}}$	0.52	0.59	0.6	0.73	0.601	0.66	0.43	0.65
F_{2005}/F_{MSY}	3.48	0.81	3.49	0.76	2.12	0.8	5.68	0.85
N_{2005}/N_{MSY}	0.48	-	0.51	-	0.52	-	0.30	-
MSY	99,876	-	99,236	-	91,681	-	88,911	-
SPR_{MSY}	0.71	0.39	0.7	0.04	0.54	0.28	0.64	0.45
F_{MSY}	0.07	-	0.07	-	0.11	-	0.05	-
SSF_{MSY}	347,930	-	343,050	-	434,590	-	108,920	-
N_{MSY}	569,595	-	564,628	-	522,800	-	603,536	-
F_{2005}	0.23	0.16	0.23	0.76	0.23	0.8	0.26	0.85
SSF_{2005}	179,870	0.77	204,720	0.71	261,240	0.82	133,250	0.78
N_{2005}	293,540	-	286,486	-	290,138	-	180,370	-
$\text{SSF}_{2005}/\text{SSF}_0$	0.22	0	0.21	0.58	0.22	0.23	0.19	0.49
B_{2005}/B_0	0.25	0.68	0.25	0.66	0.28	0.67	0.22	0.70
R0	321,470	0.19	316,810	0.18	265,620	0.19	358,870	0.2
Pup-survival	0.78	0.23	0.79	0.23	0.75	0.24	0.81	0.22
alpha	2.02	-	2.05	-	3.43	-	0.72	-
steepness	0.34	-	0.339	-	0.46	-	0.28	-

5. Summary of all Results

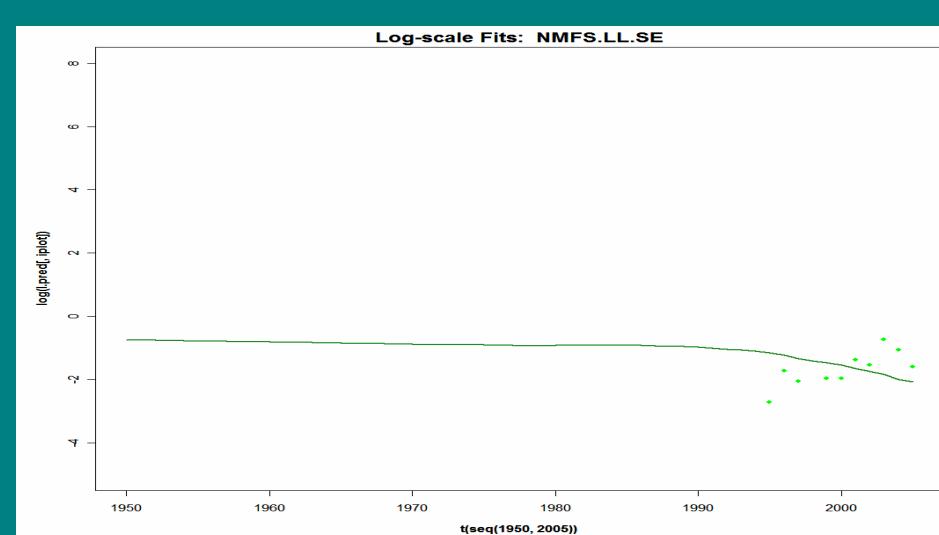
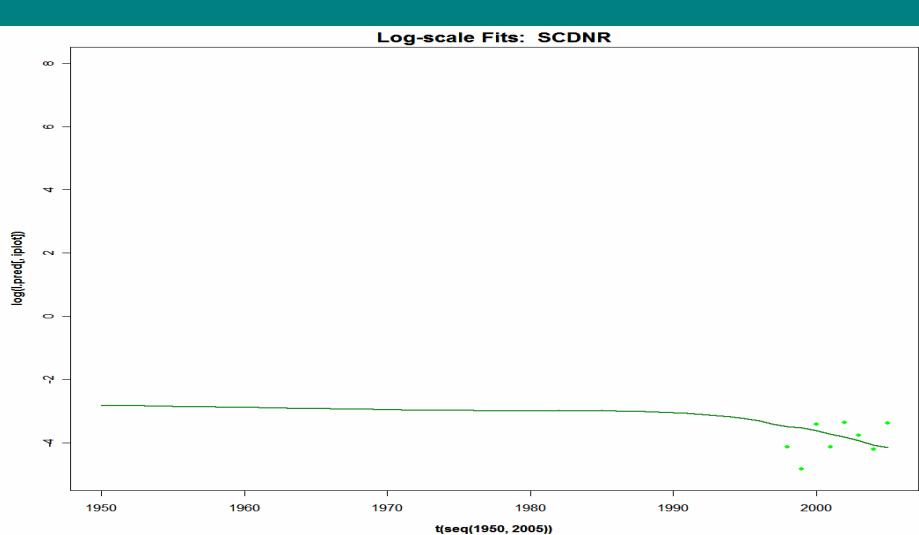
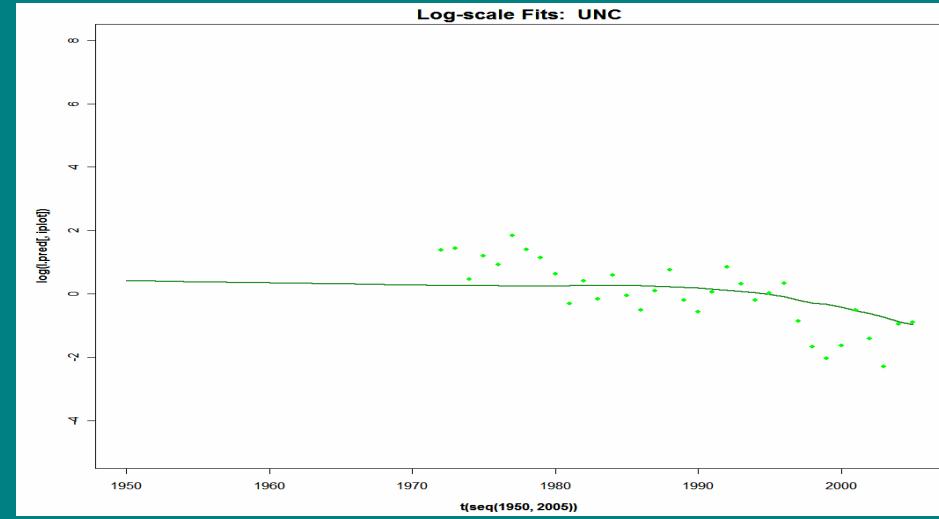
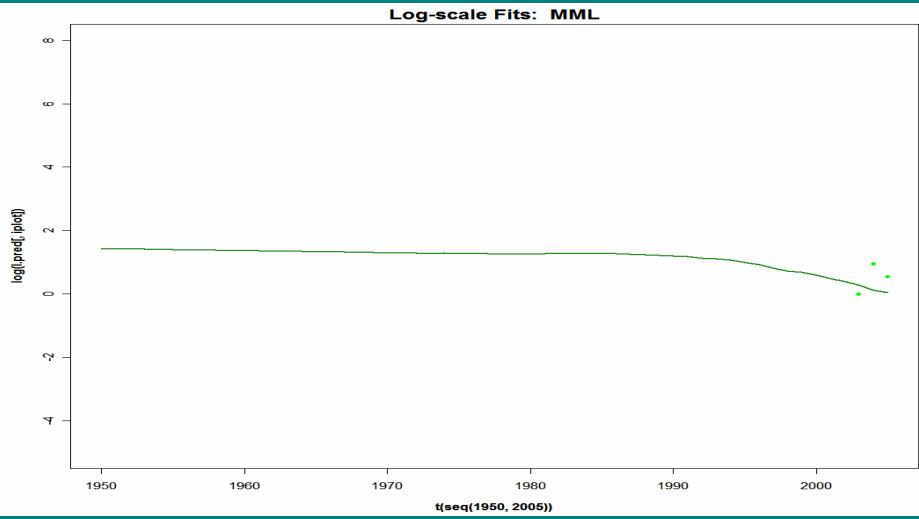


Lack of continuity analysis

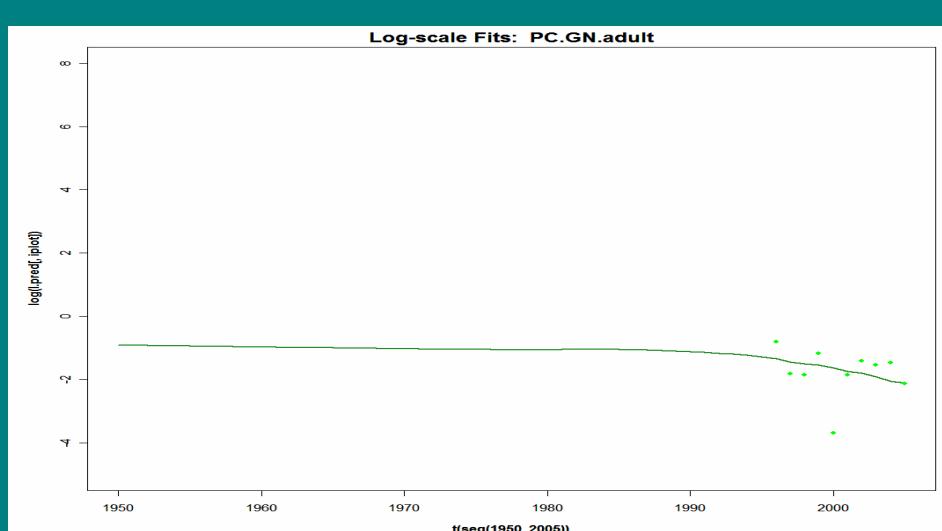
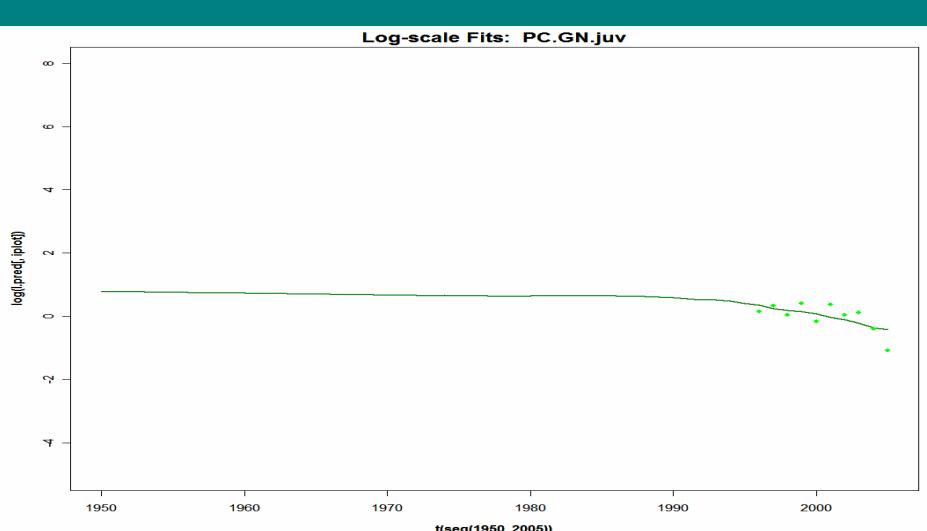
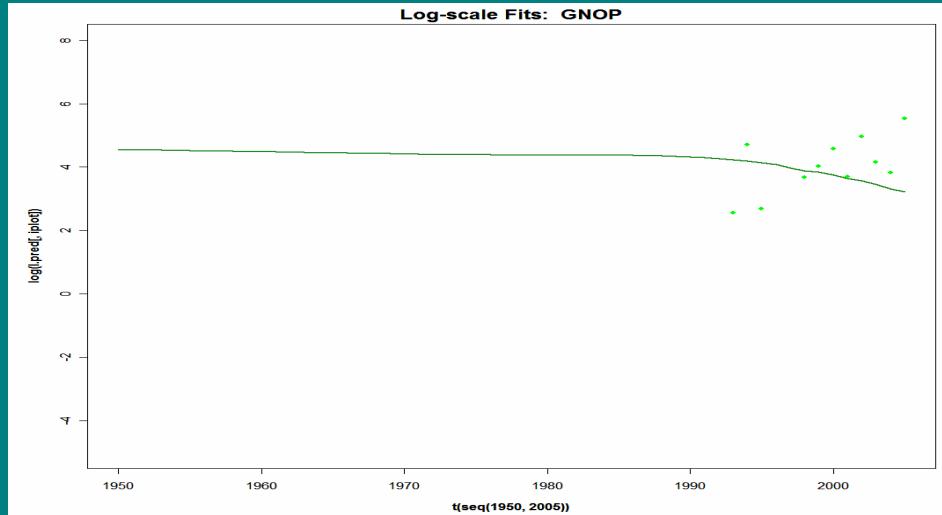
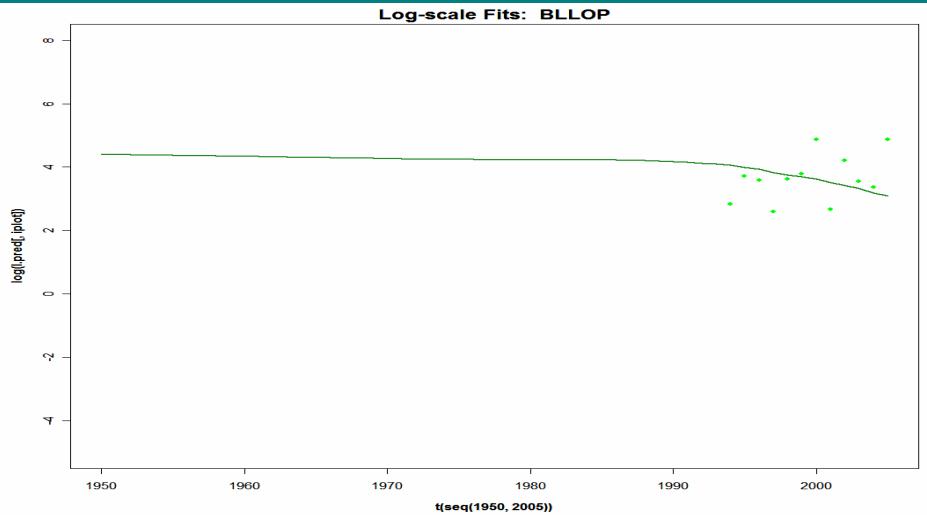
- Indices were not consistent between the 2002 assessment and the current assessment:
 - GNOP is the only series consistent between assessments with additional years of data (2 yrs)



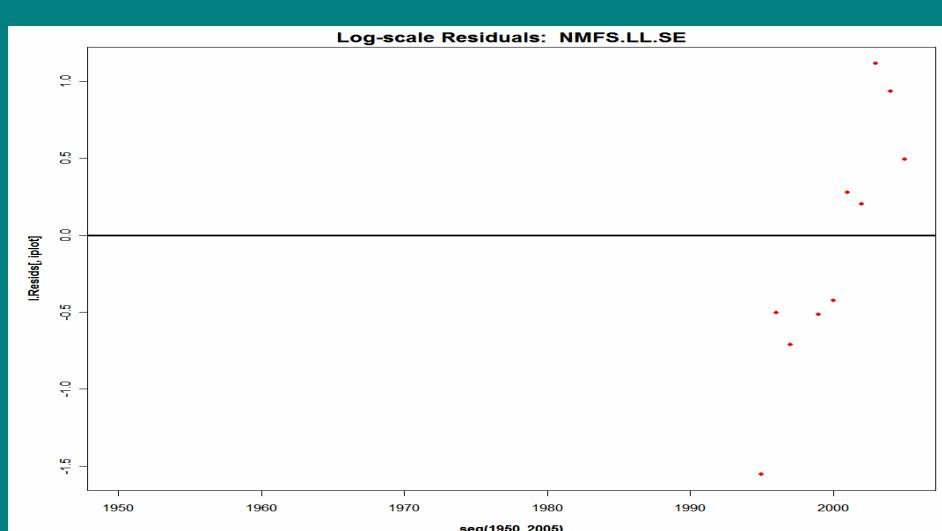
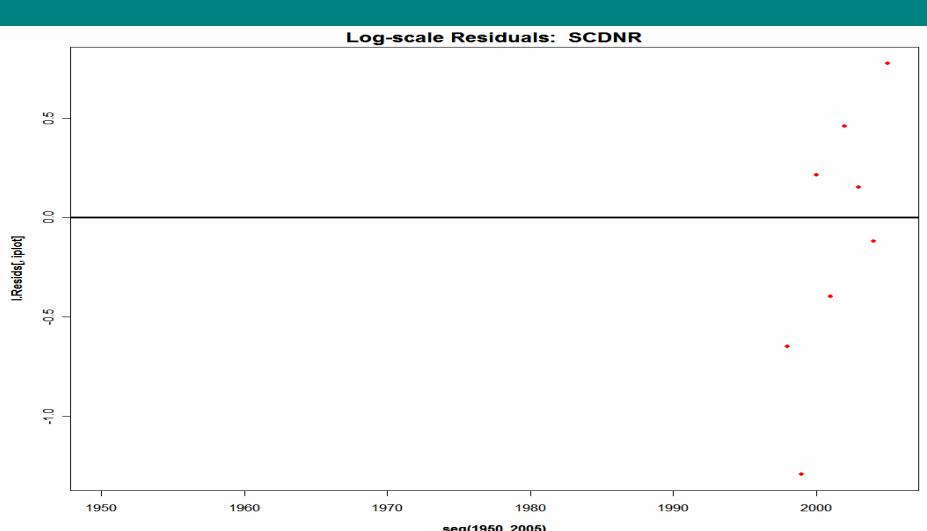
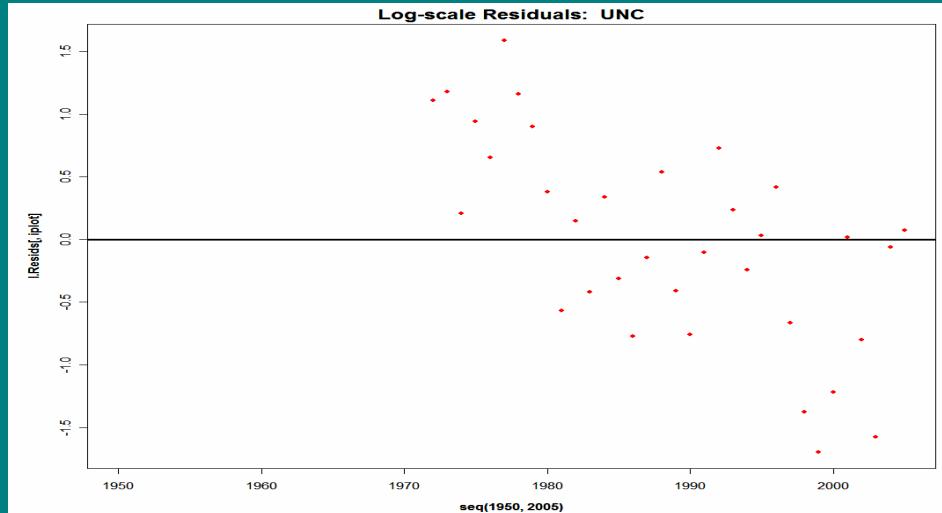
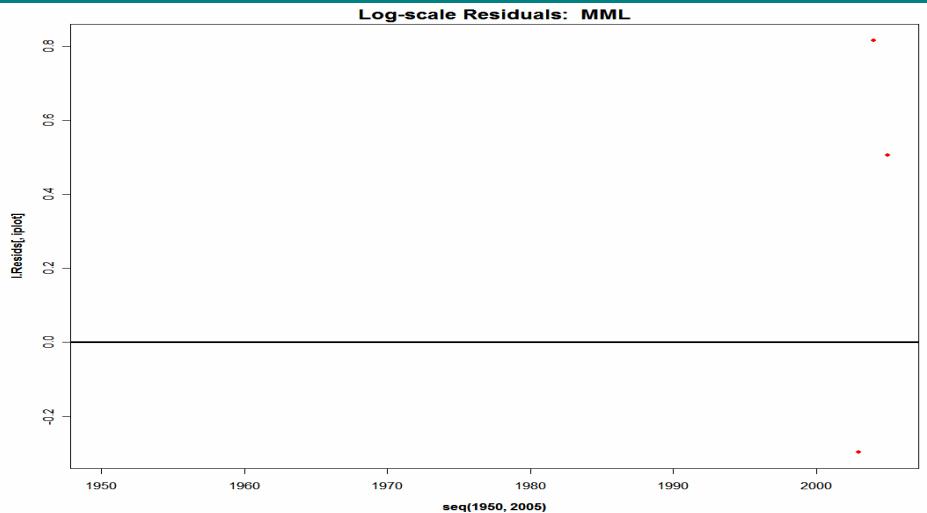
New fits with equal weighting



New fits with equal weighting



Residuals



Residuals

