

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



Photo by George Burgess

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Laboratory

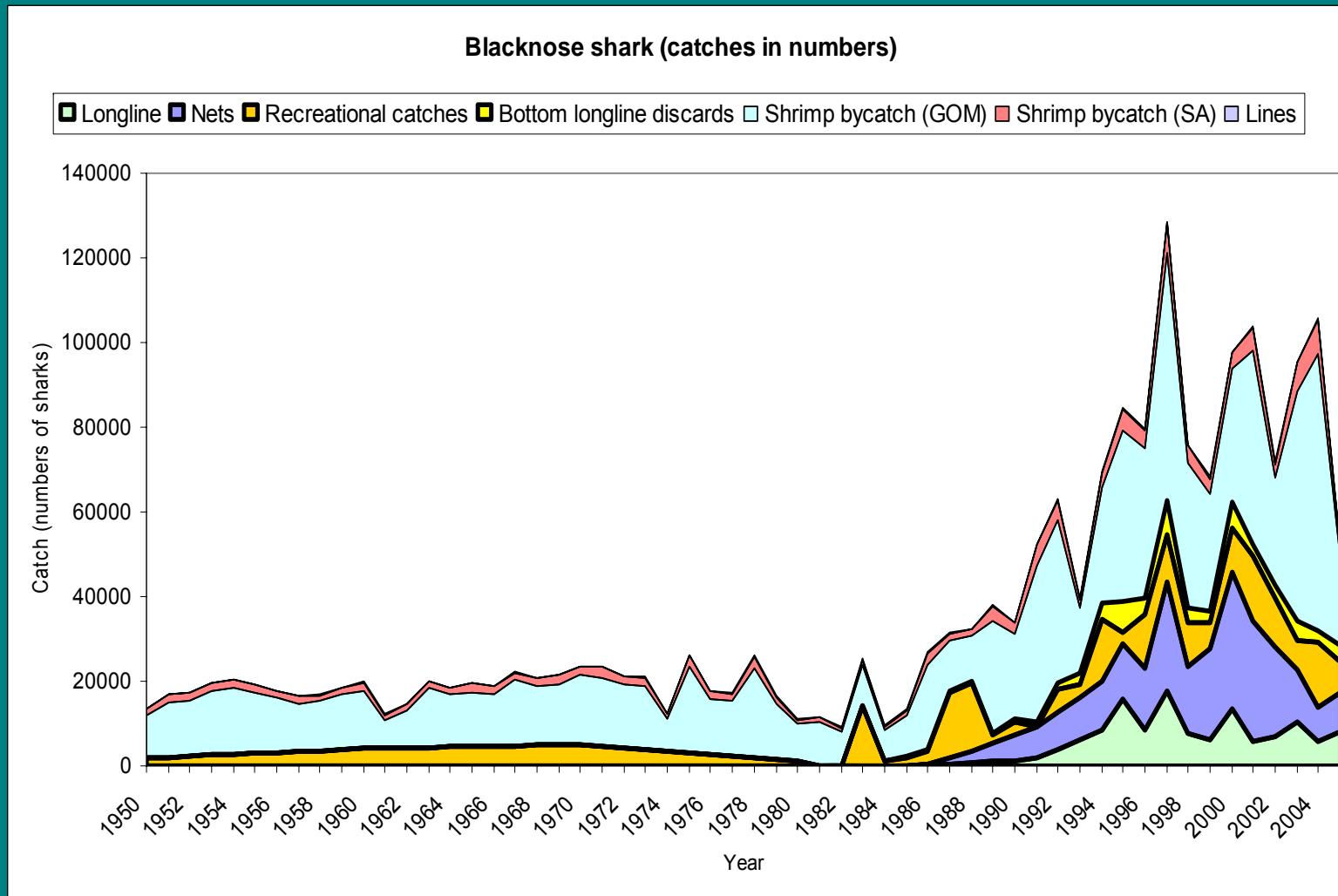
# OUTLINE

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

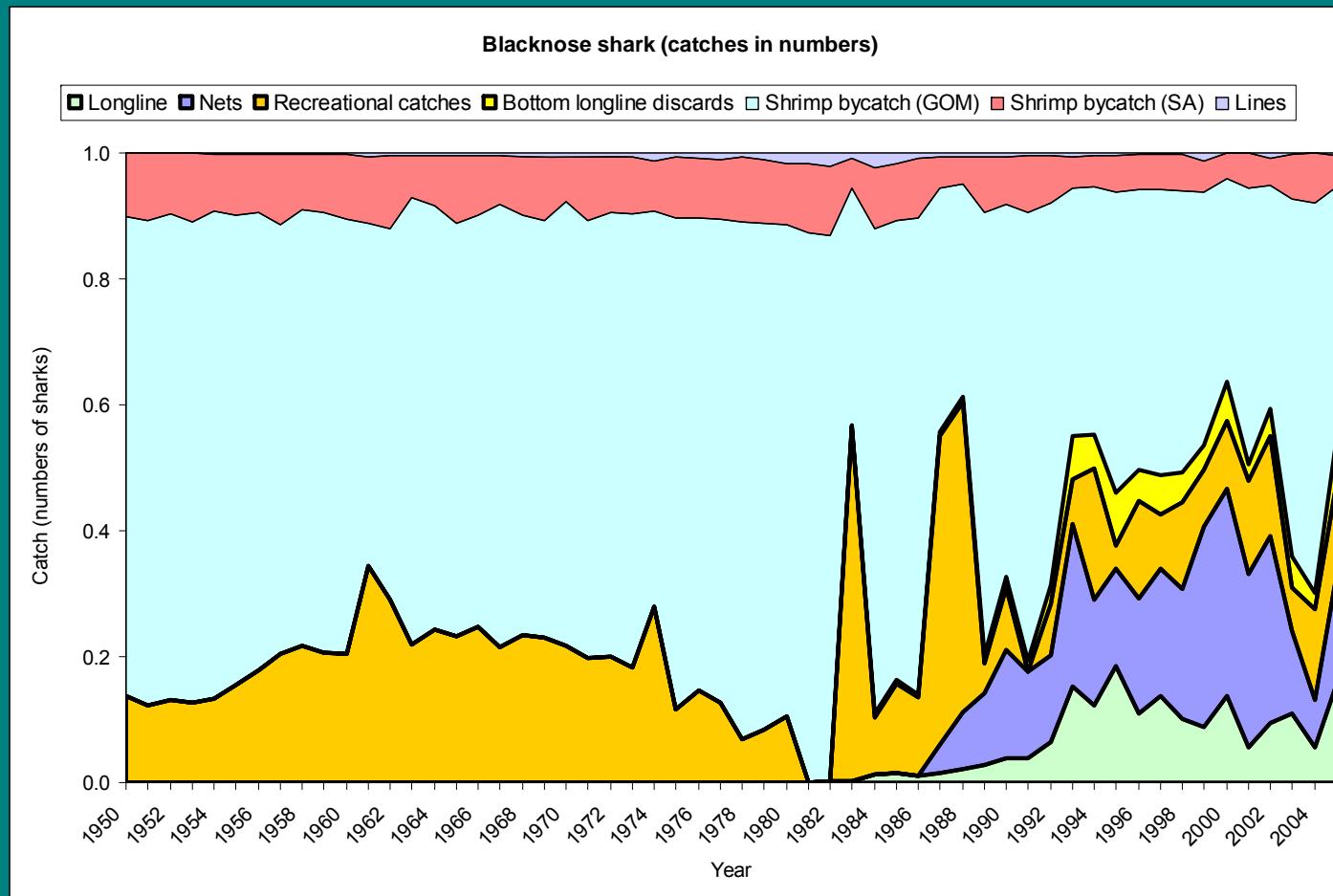
# 1a. Fishery Inputs

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

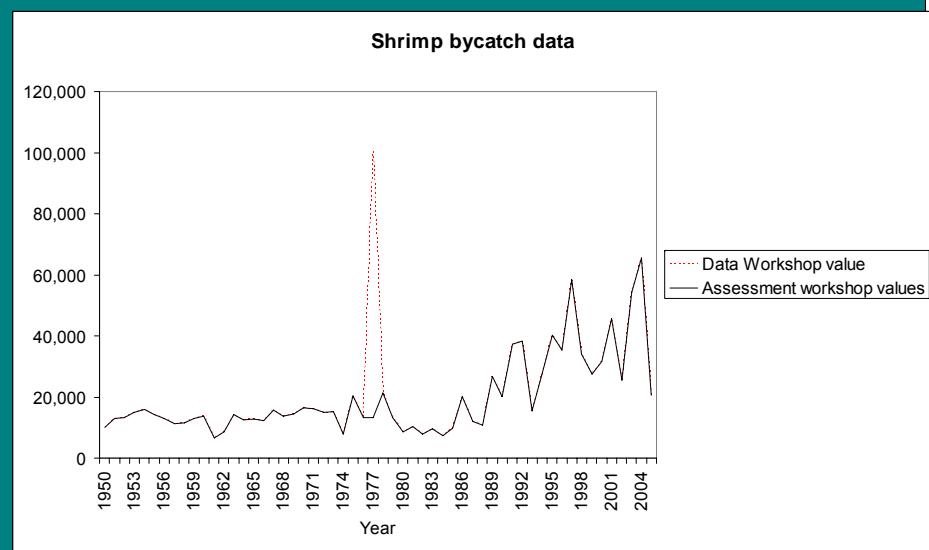
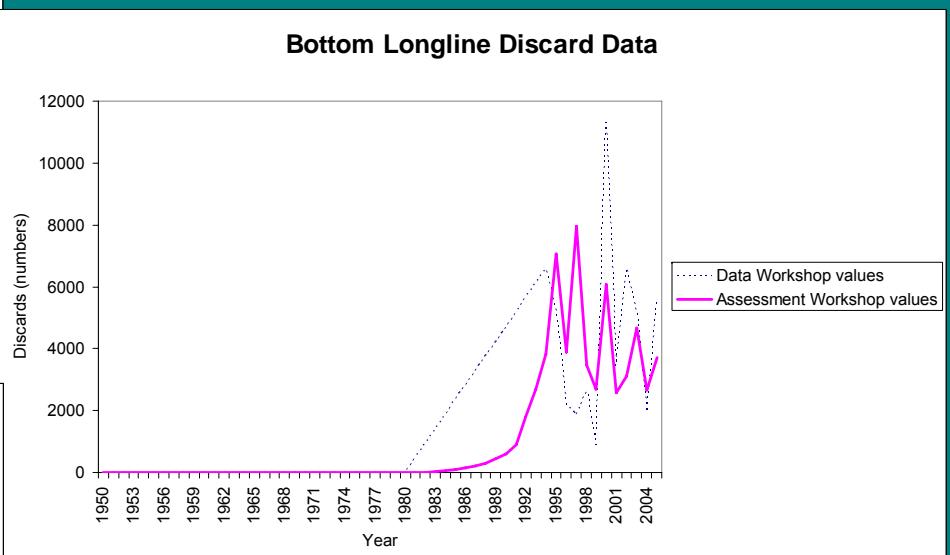
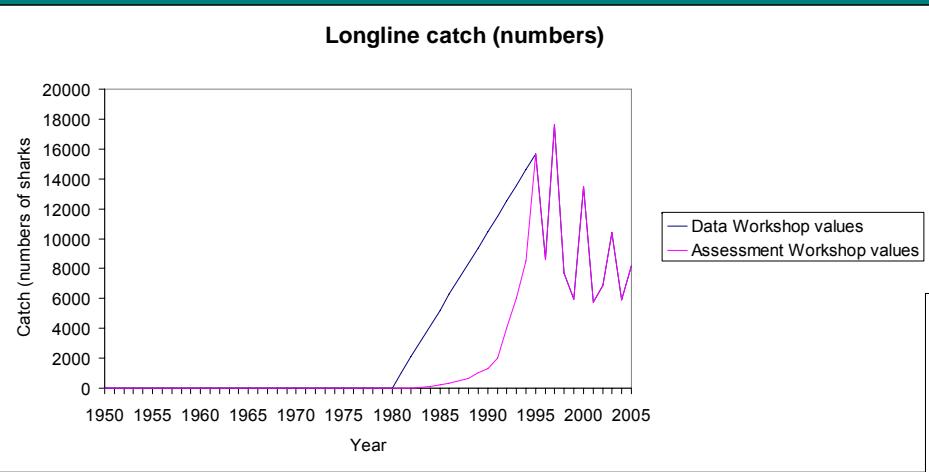
# Catches



# Catches



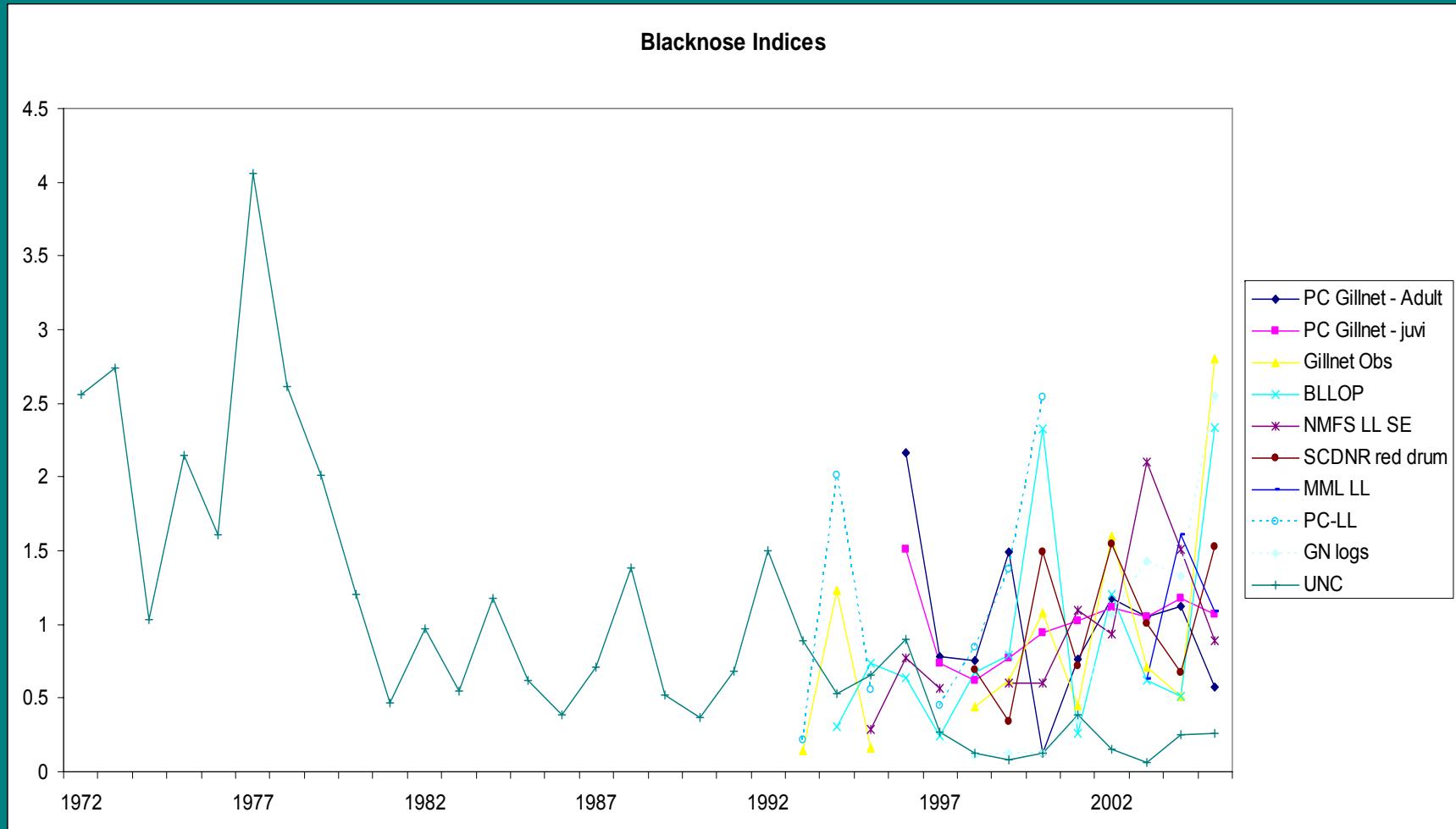
# Assessment Workshop data issues

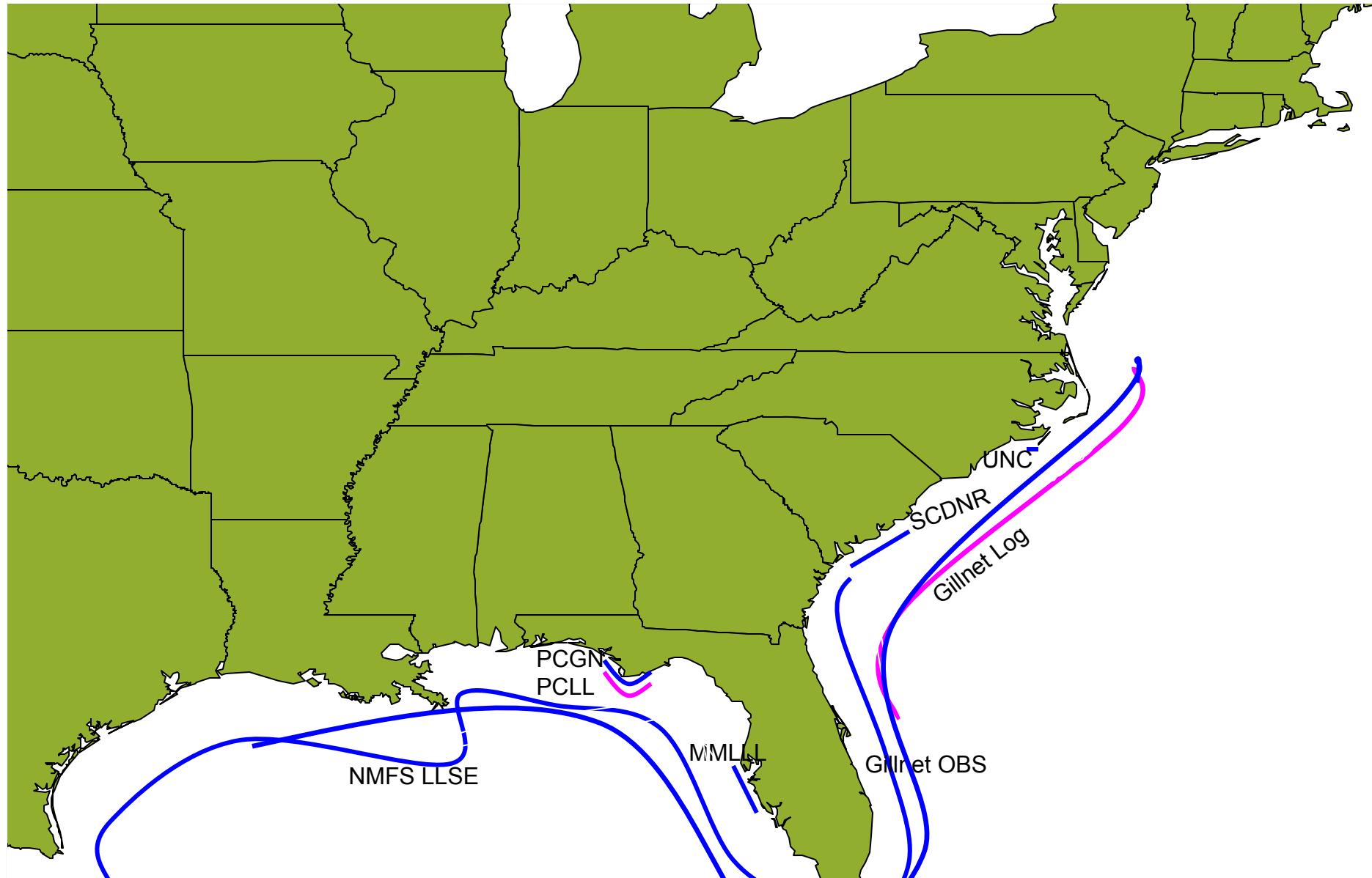


# 1a. Fishery Inputs

- 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

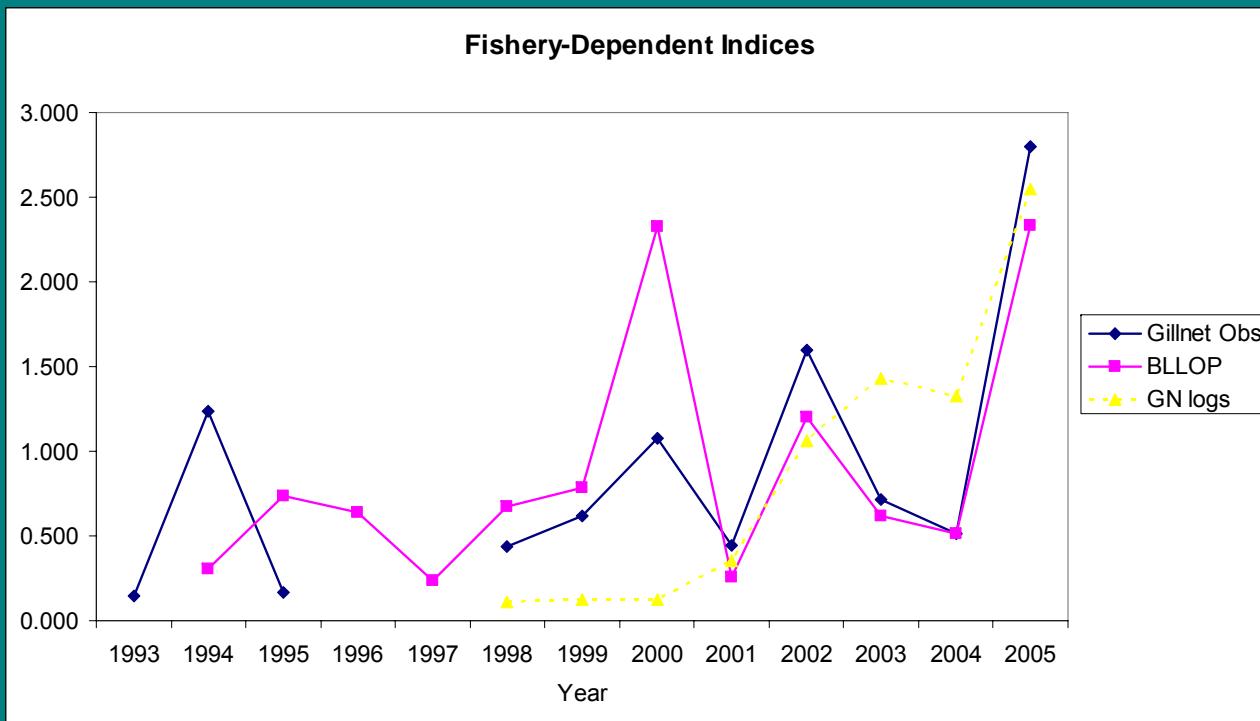


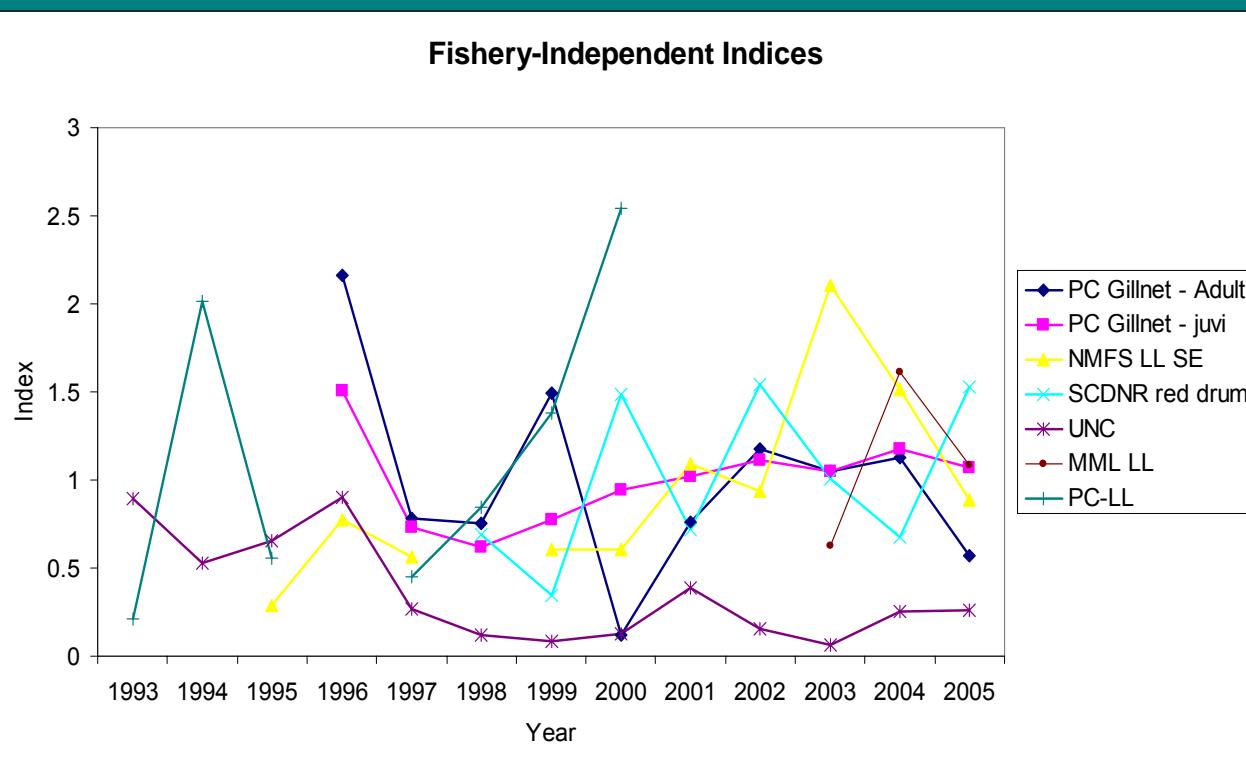
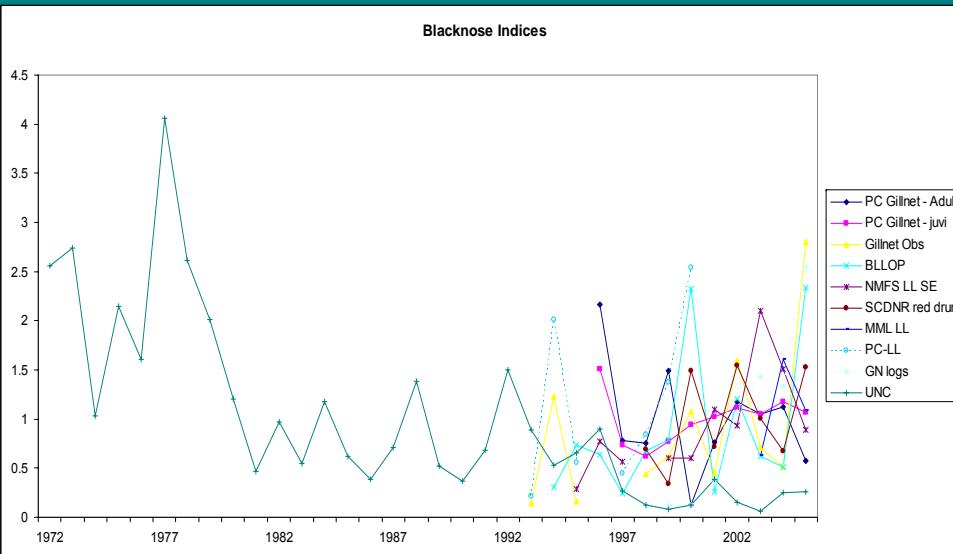


Blacknose

sensitivity

base

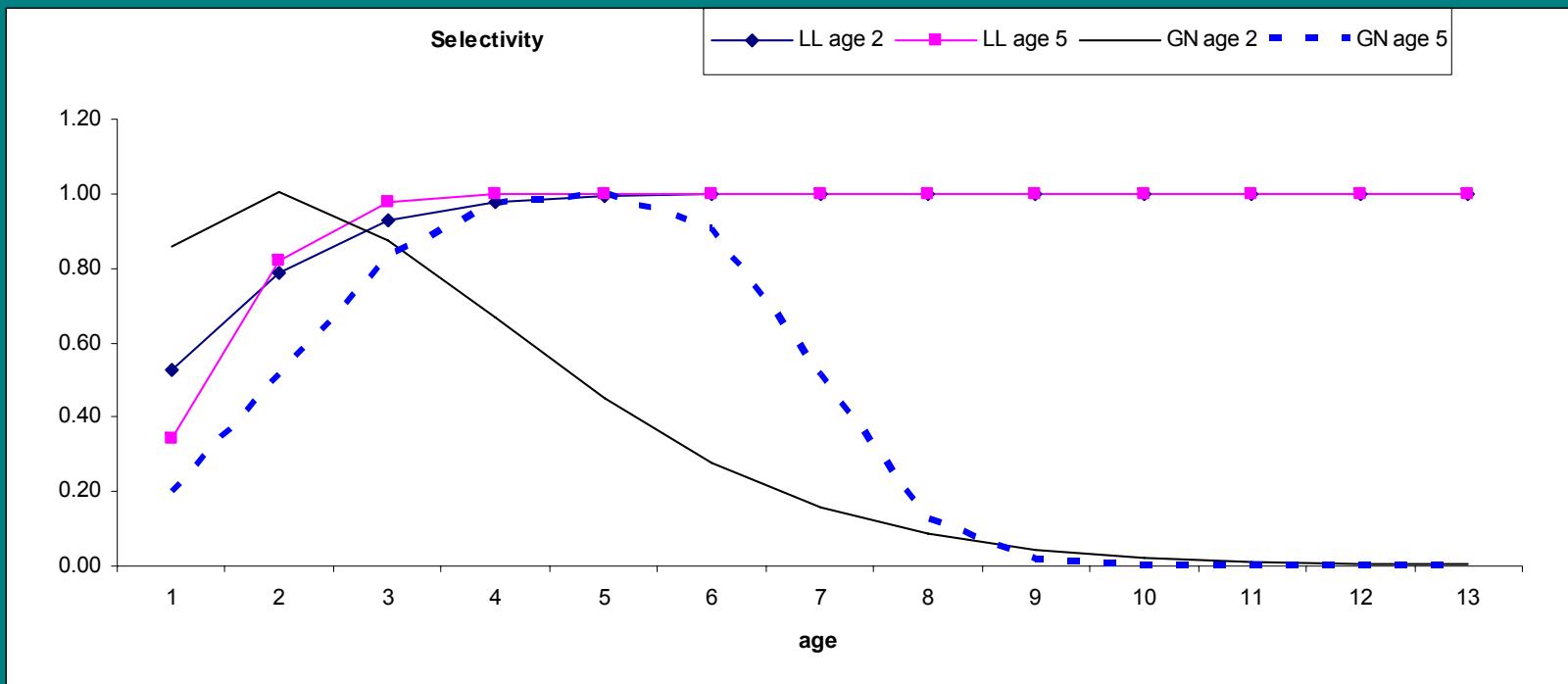




# 1a. Fishery Inputs

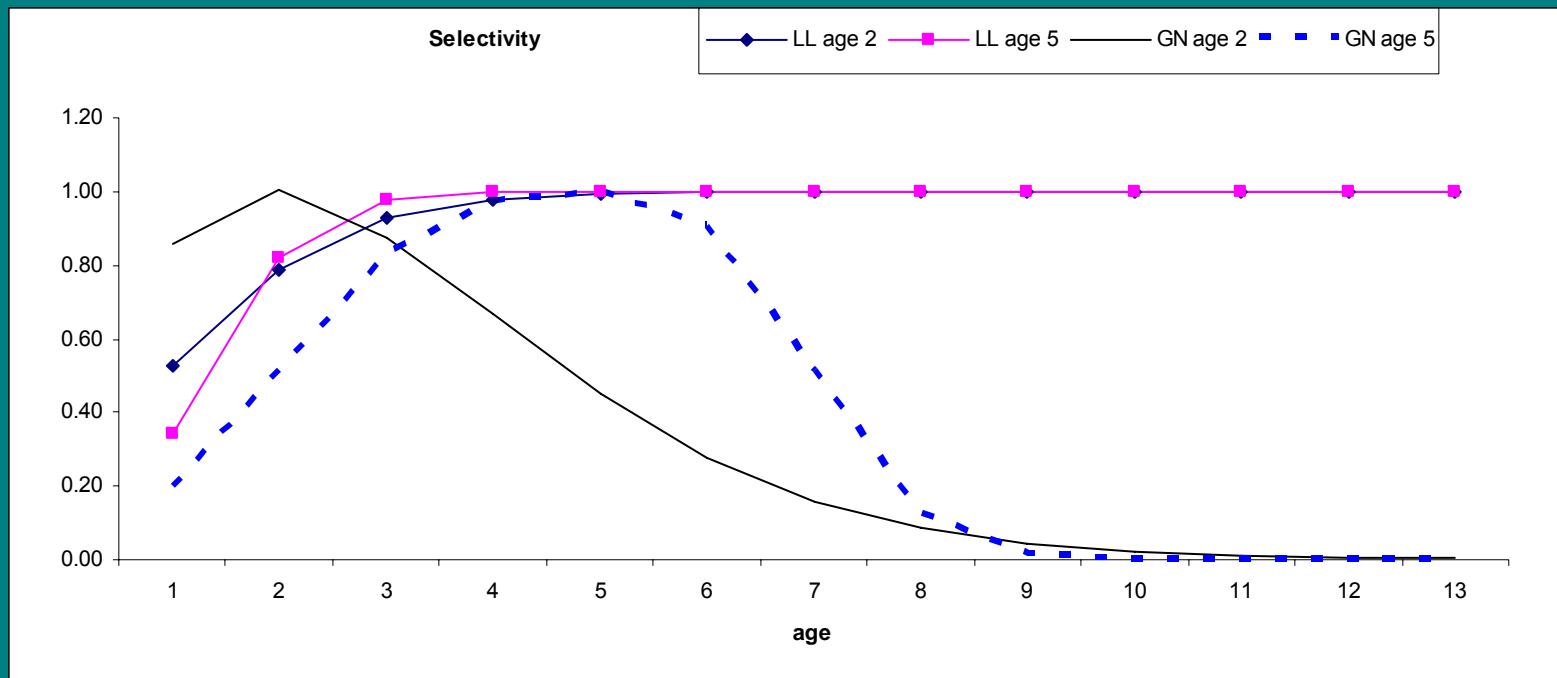
- Selectivity for catches
- Selectivity for indices

# Selectivity of the catch



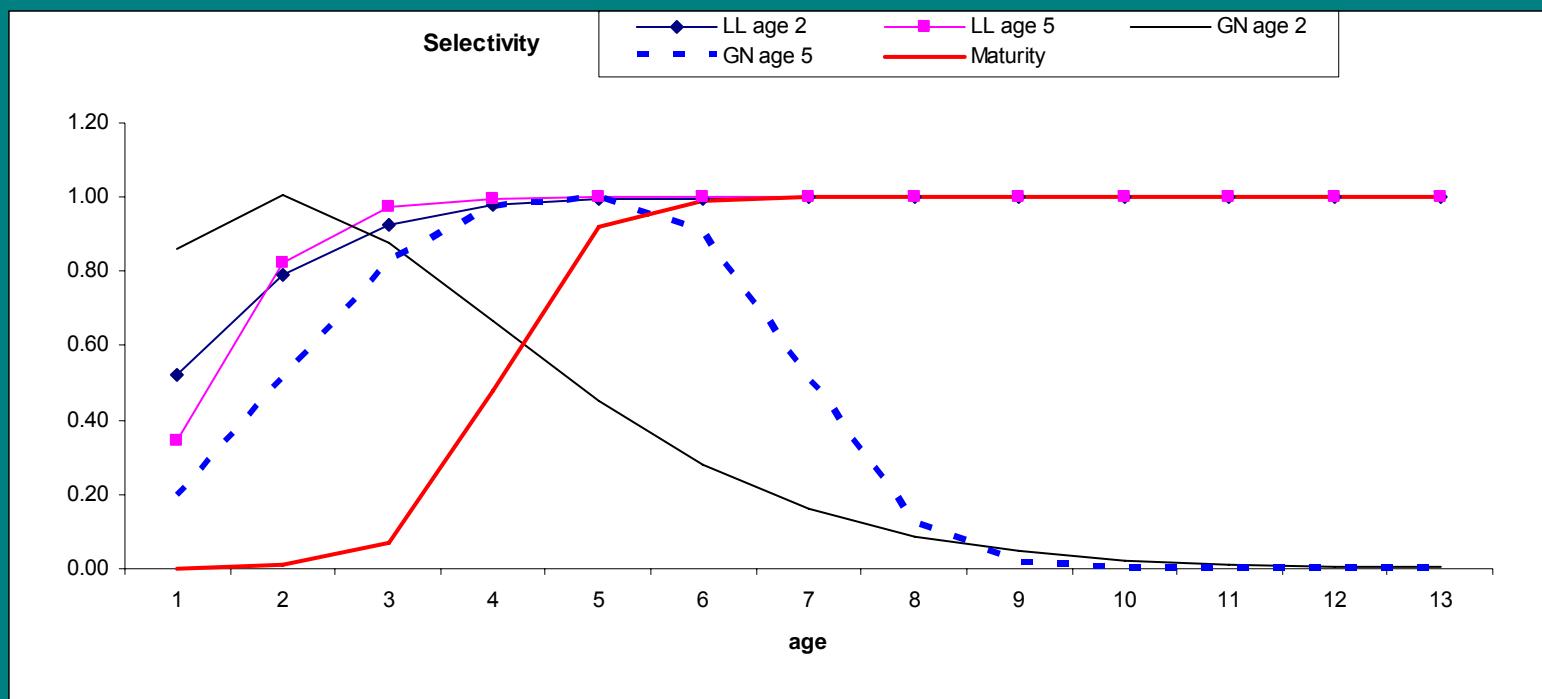
- The longline, lines, recreational, and longline bycatch series used selectivity 1
- The gillnet and shrimp bycatch series used selectivity 3

# 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

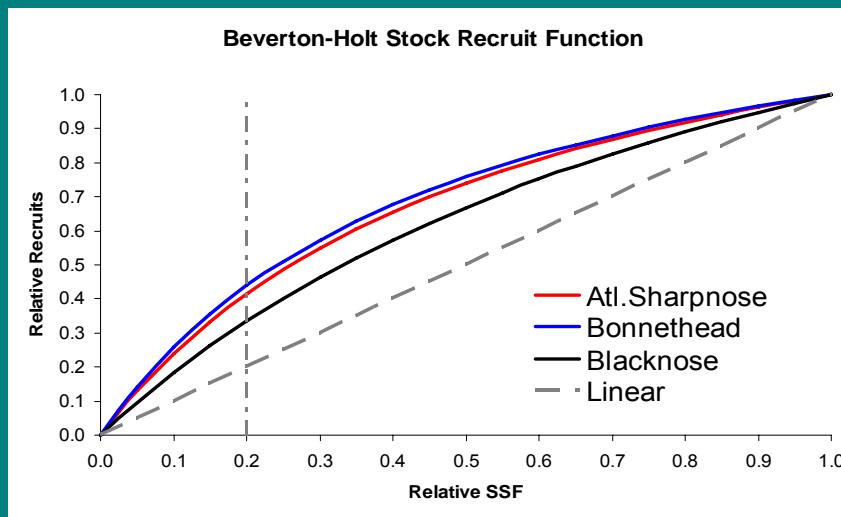
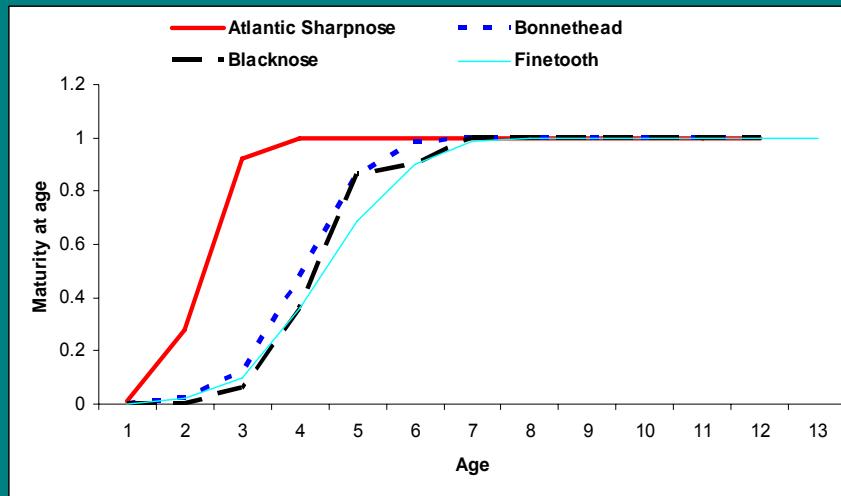


# Selectivity Derivations

- 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
$L_\infty$	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 ( $\alpha$ )

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

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

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

- 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

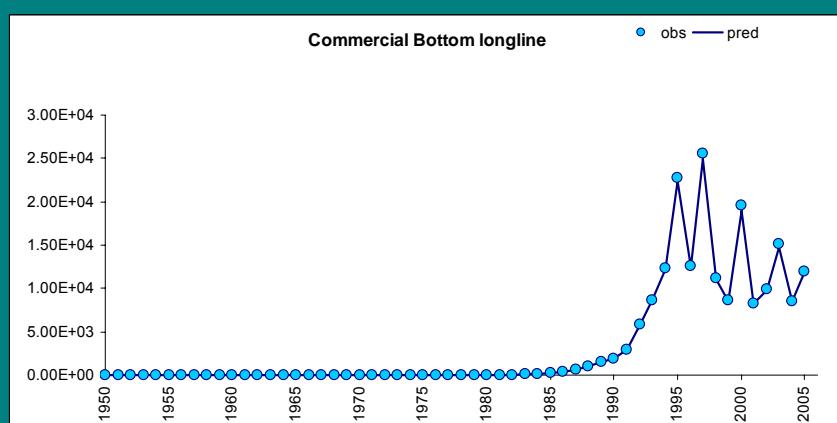
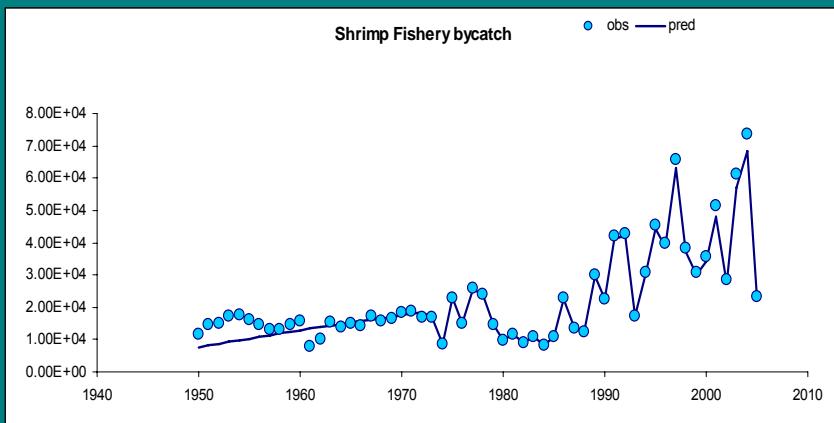
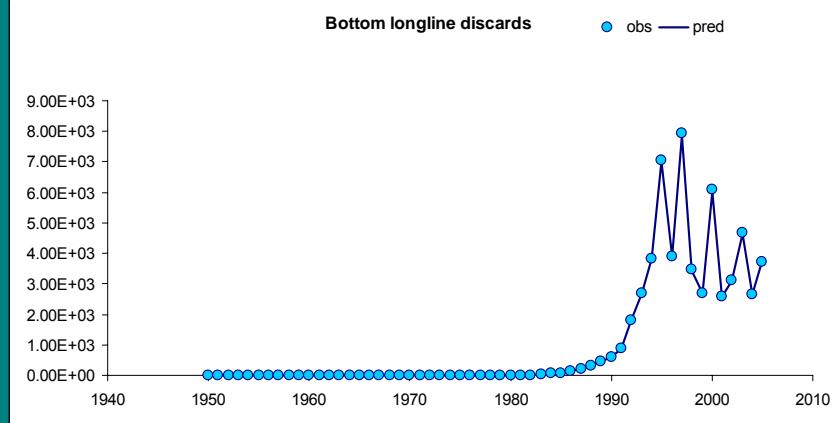
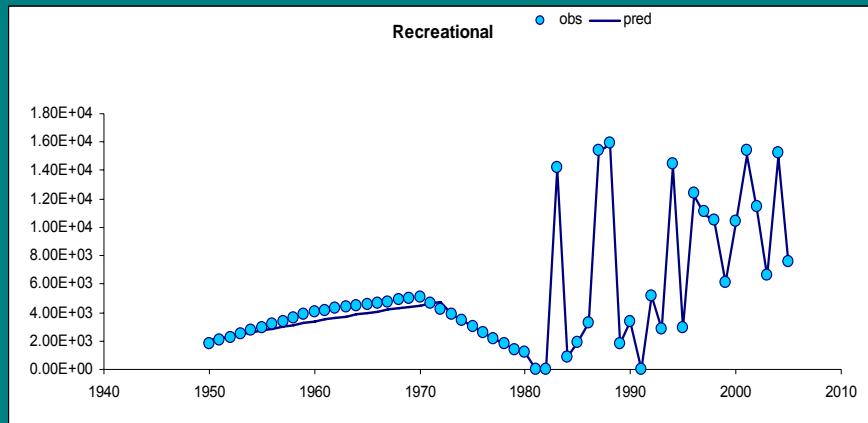
### 3. Base Model and Results

Blacknose	BASE	
	Estimate	CV
$\text{SSF}_{2005}/\text{SSF}_{\text{MSY}}$	0.48	0.67
$F_{2005}/F_{\text{MSY}}$	3.77	0.83
$N_{2005}/N_{\text{MSY}}$	0.48	-
MSY	89,415	-
$\text{SPR}_{\text{MSY}}$	0.71	0.38
$F_{\text{MSY}}$	0.07	-
$\text{SSF}_{\text{MSY}}$	349,060	-
$N_{\text{MSY}}$	570,753	-
$F_{2005}$	0.24	0.83
$\text{SSF}_{2005}$	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	-

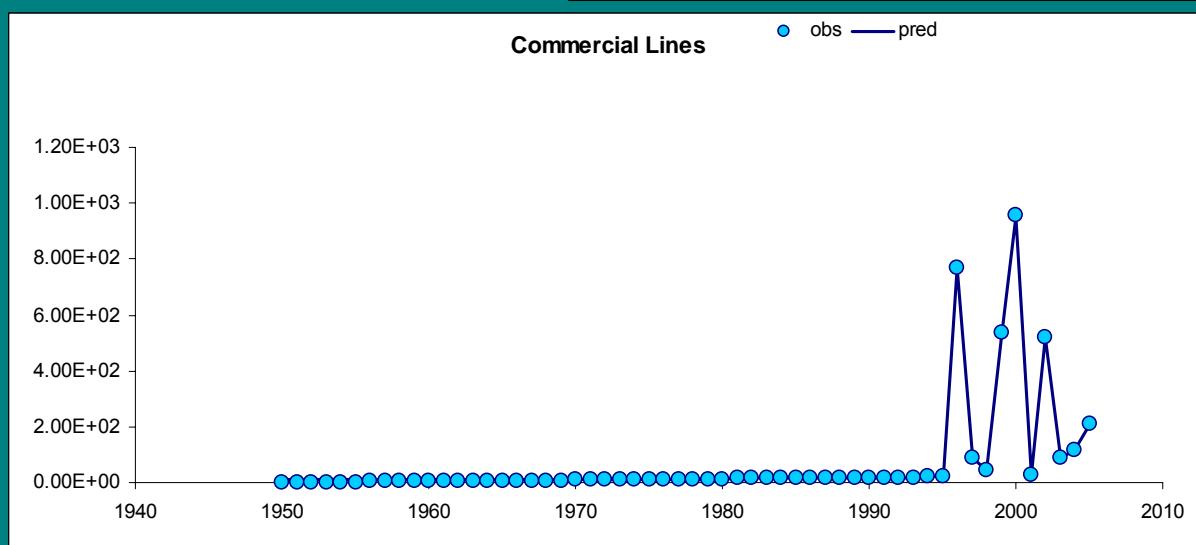
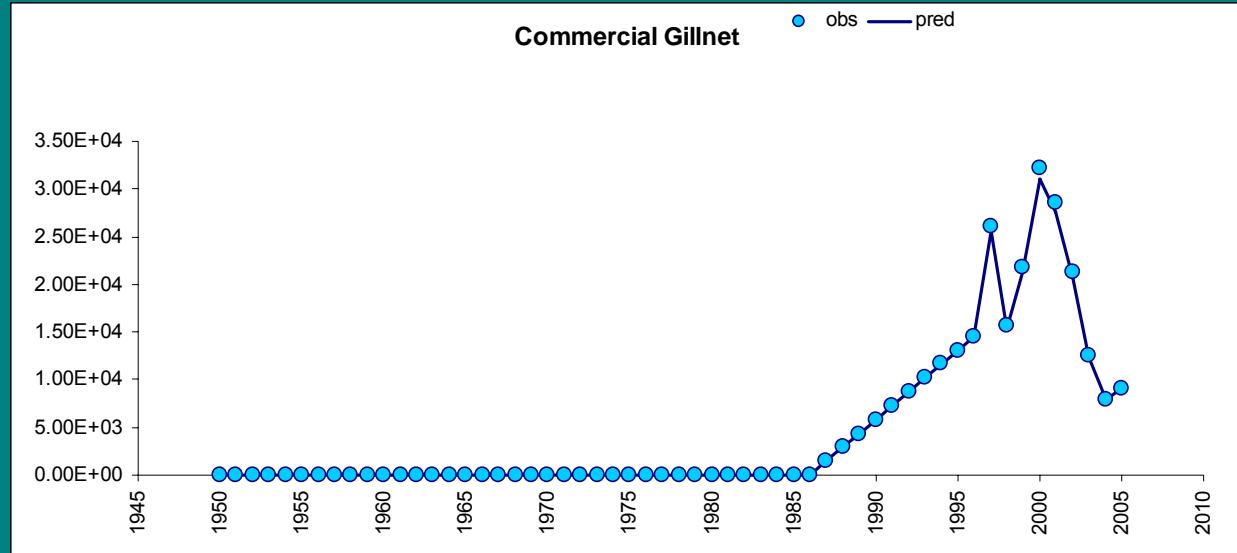
### 3. Base Model and Results

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

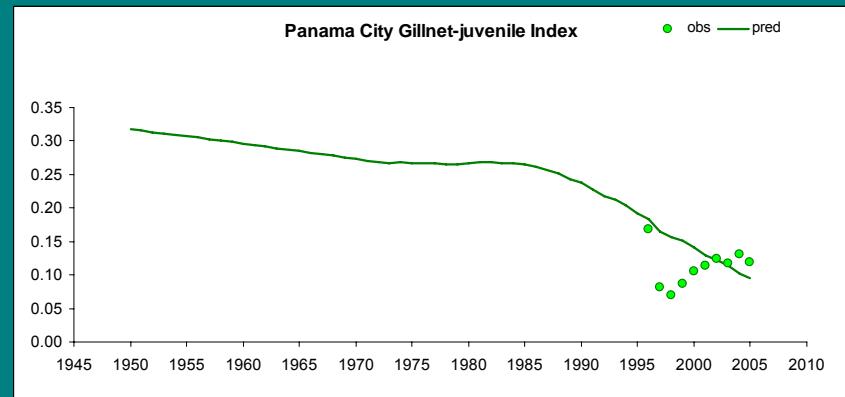
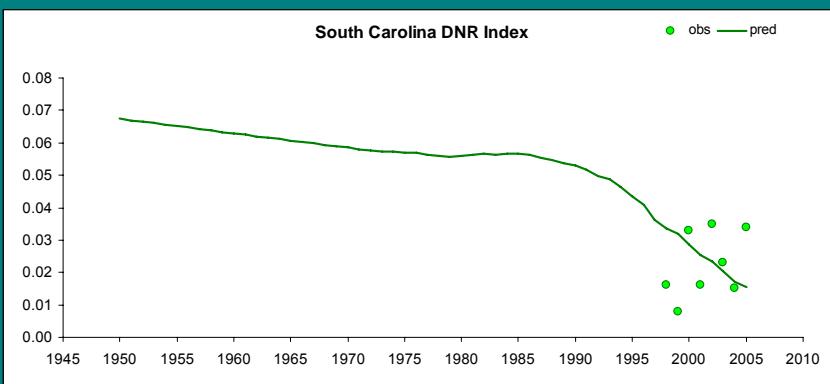
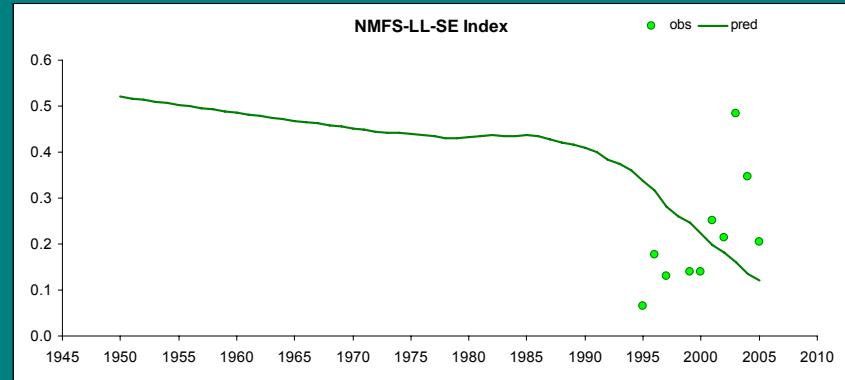
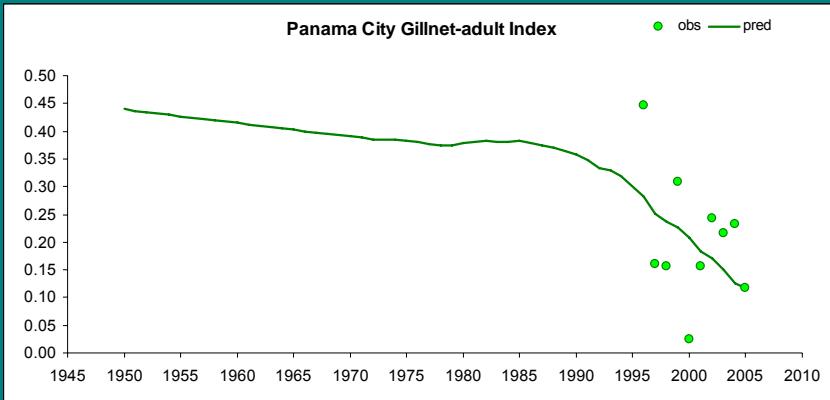
# Model fit to catches



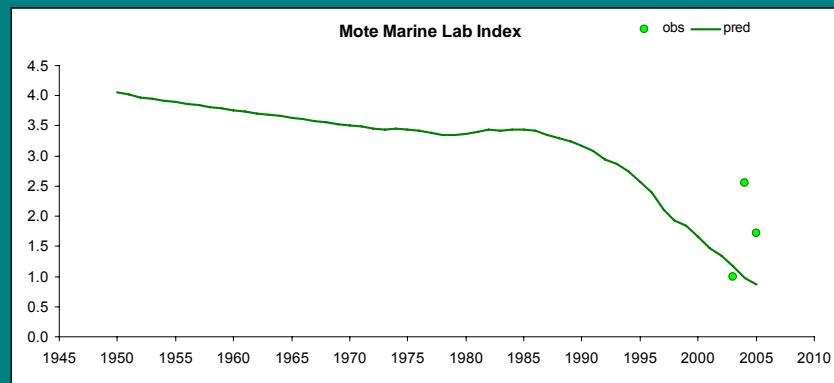
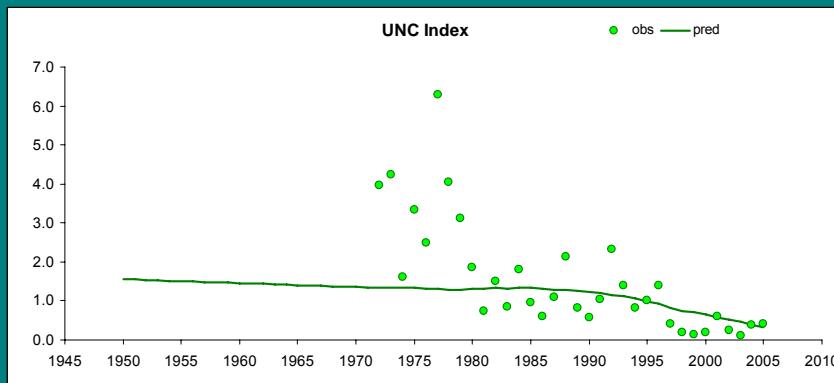
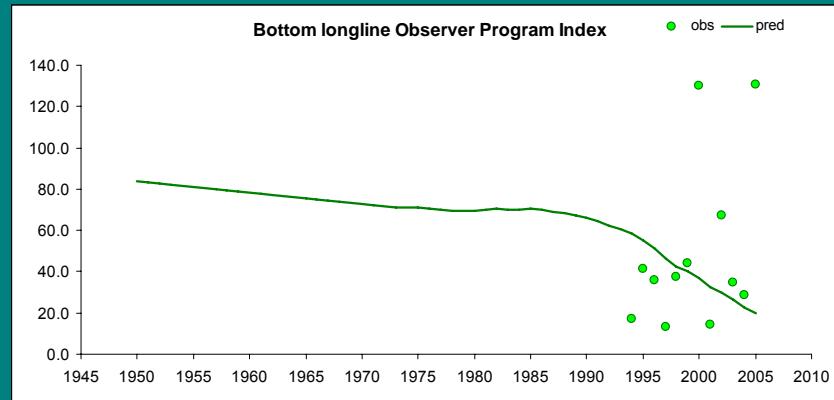
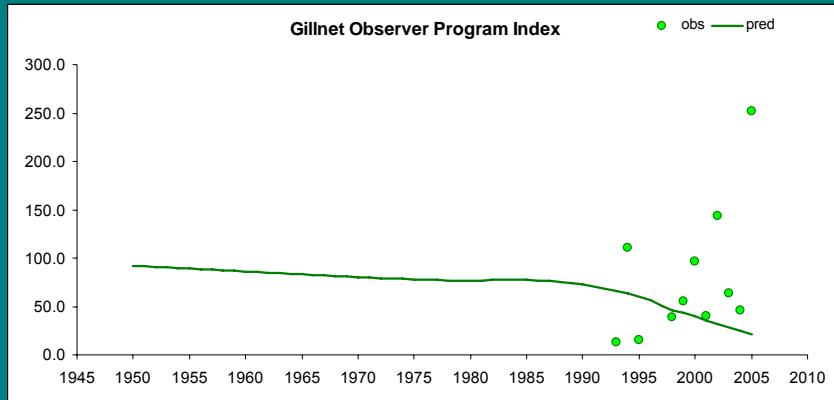
# Catches continued...



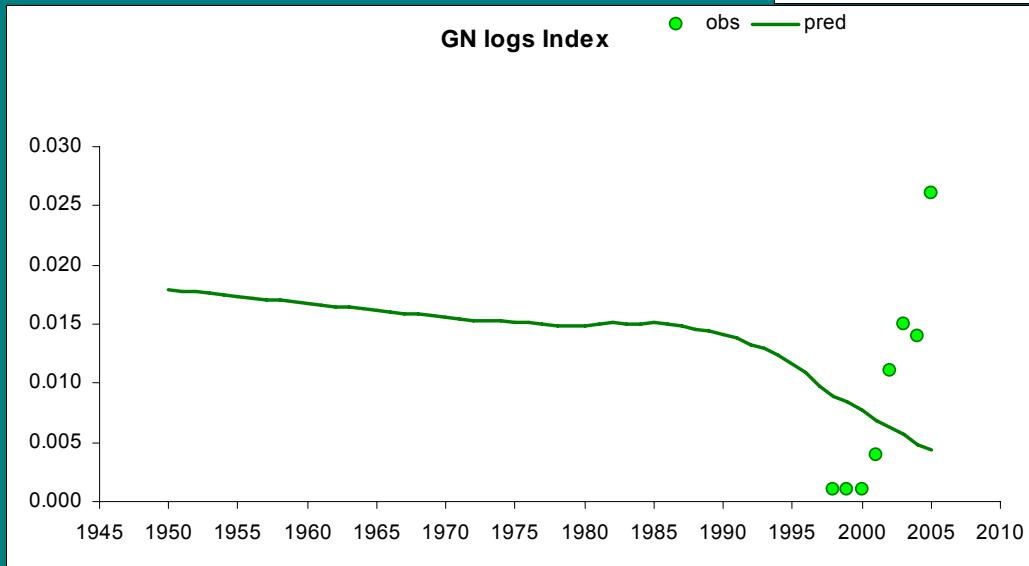
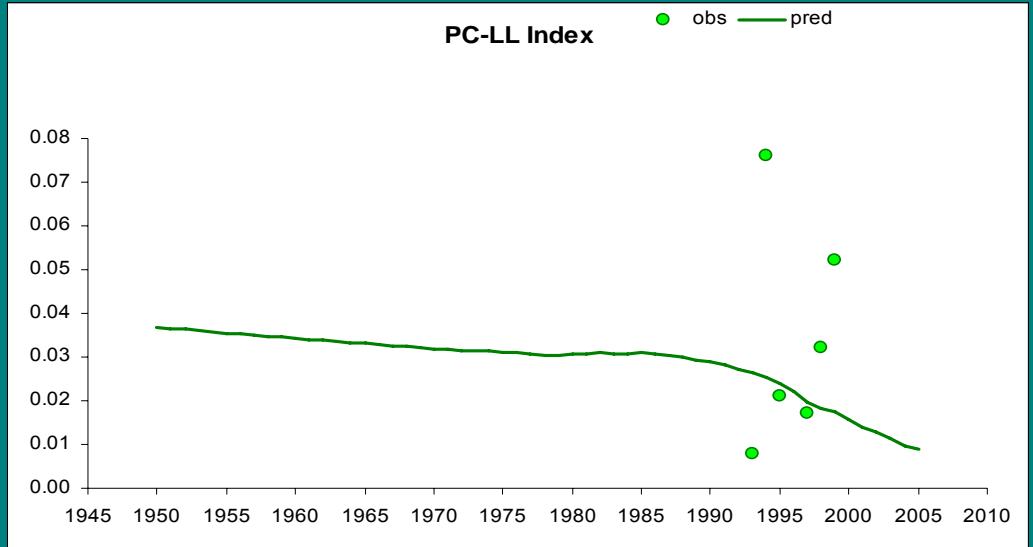
# Model fit to indices



# Model fit to indices



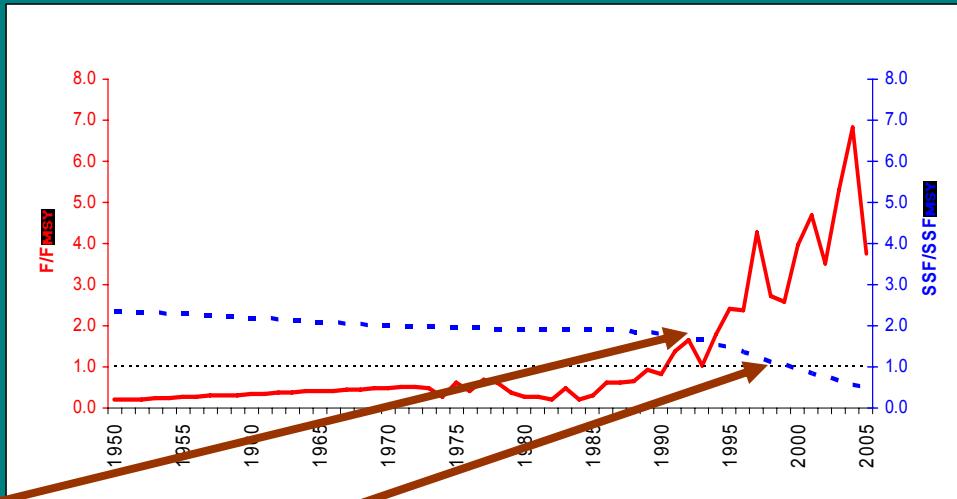
# Model fit to sensitivity indices



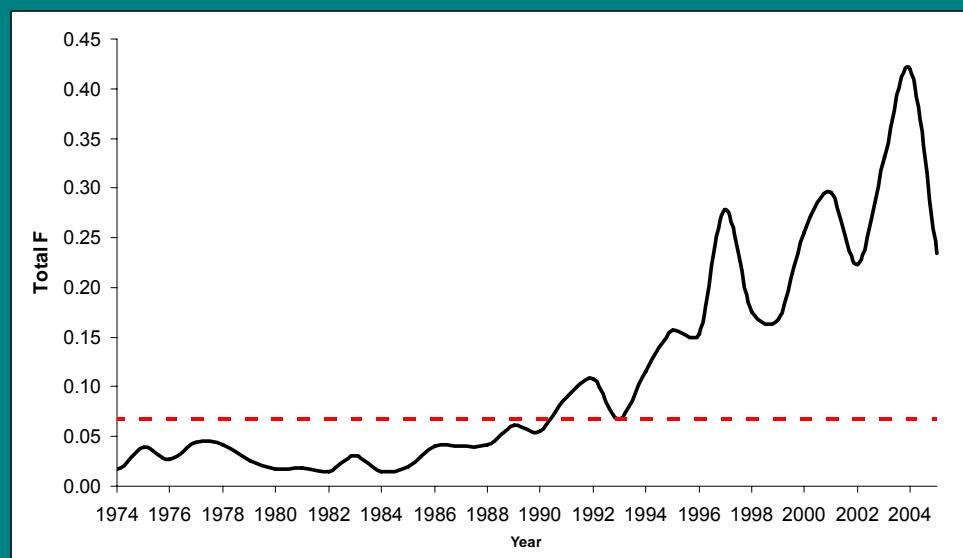
Steep decline  
from 1993 to  
current

Overfished  
from 2000

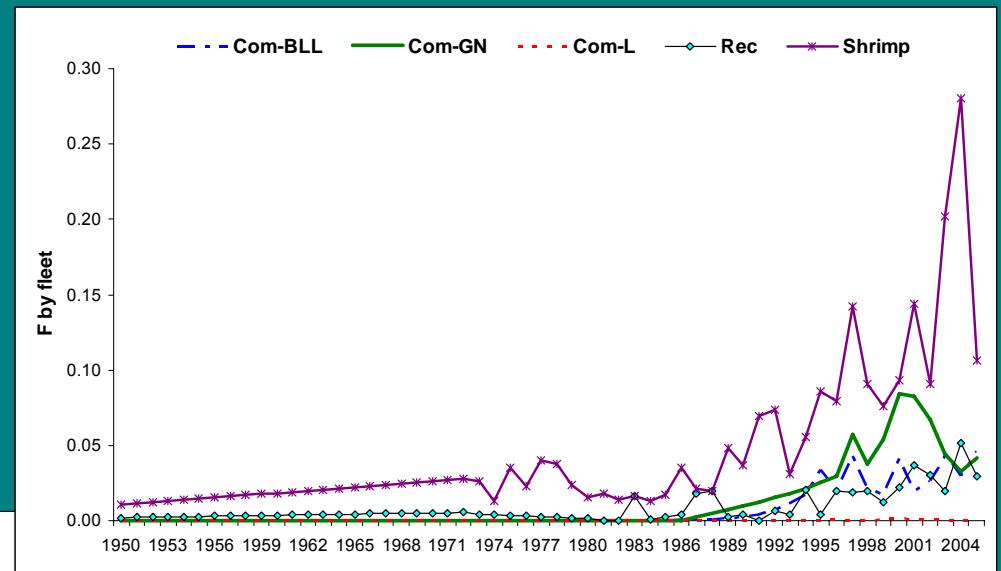
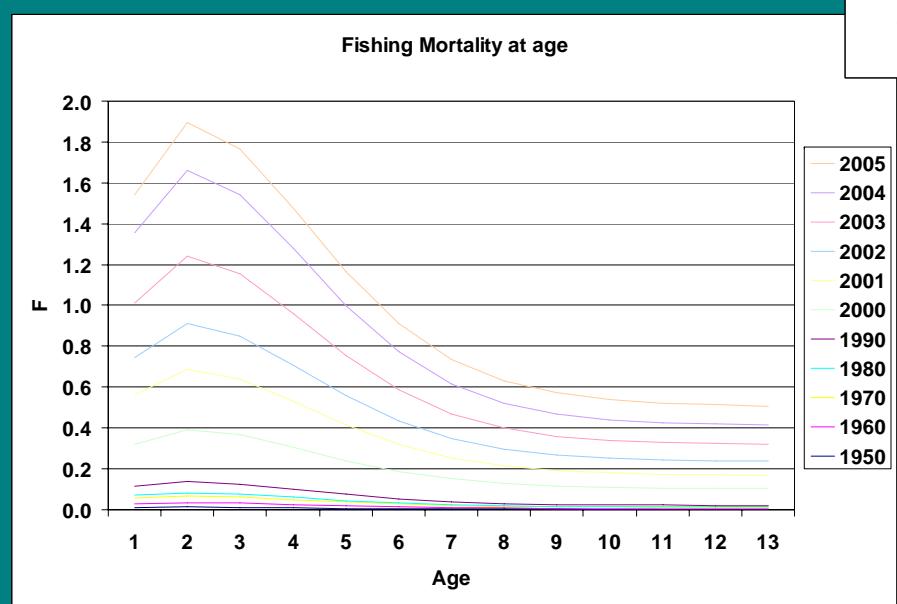
Total F and  $F_{MSY}$



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

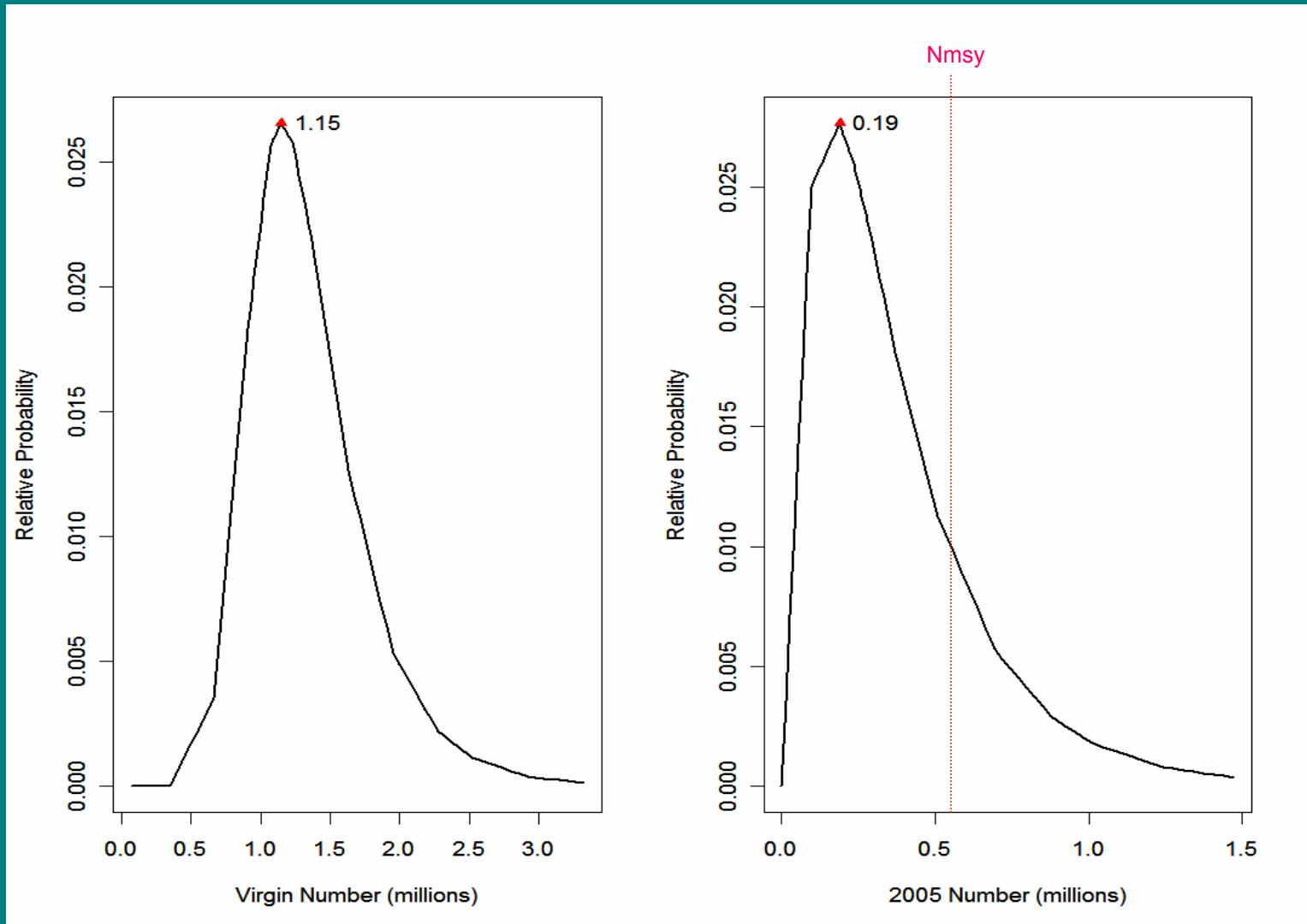


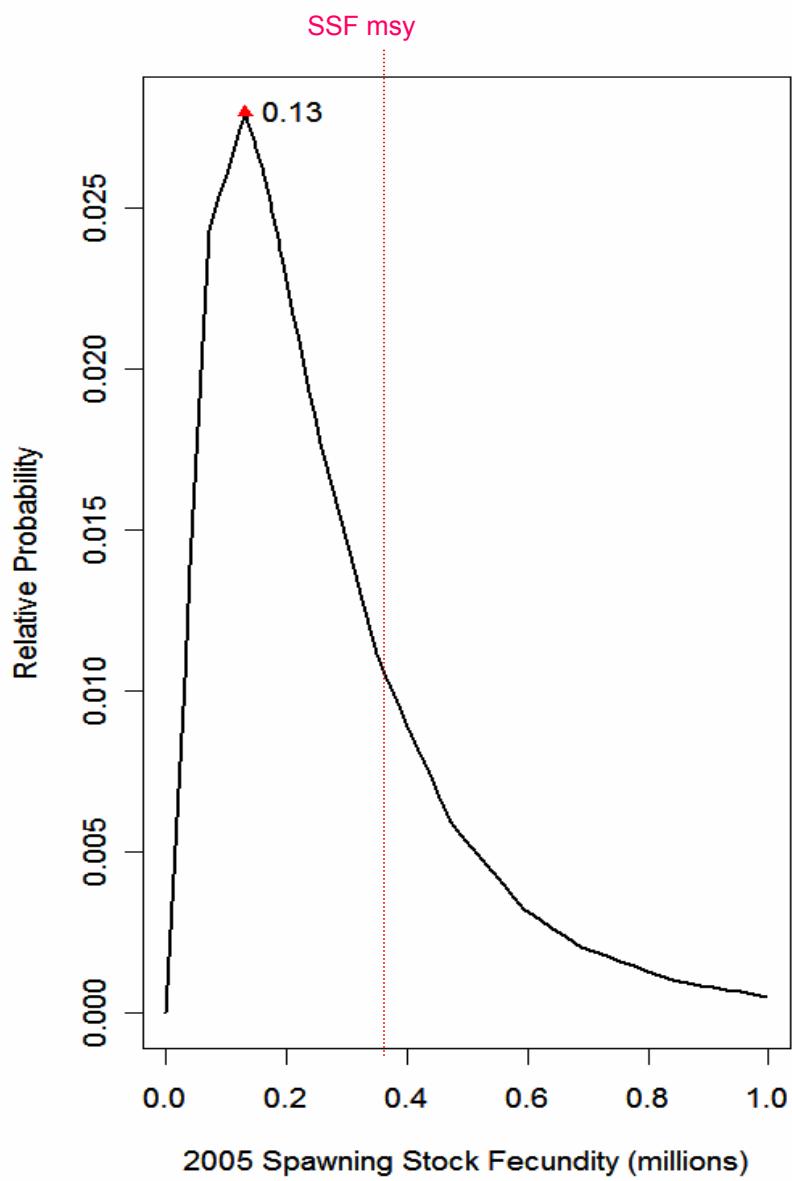
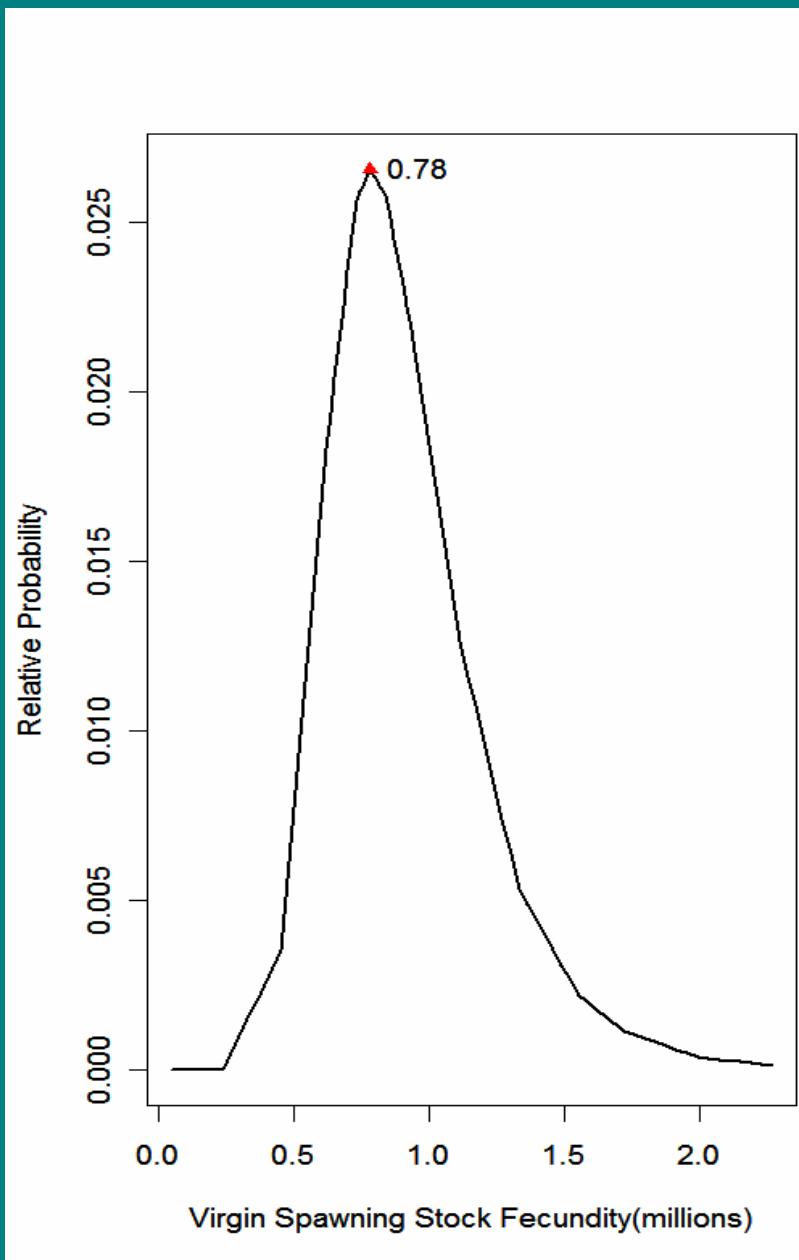
# Fishing mortality by fleet and by age

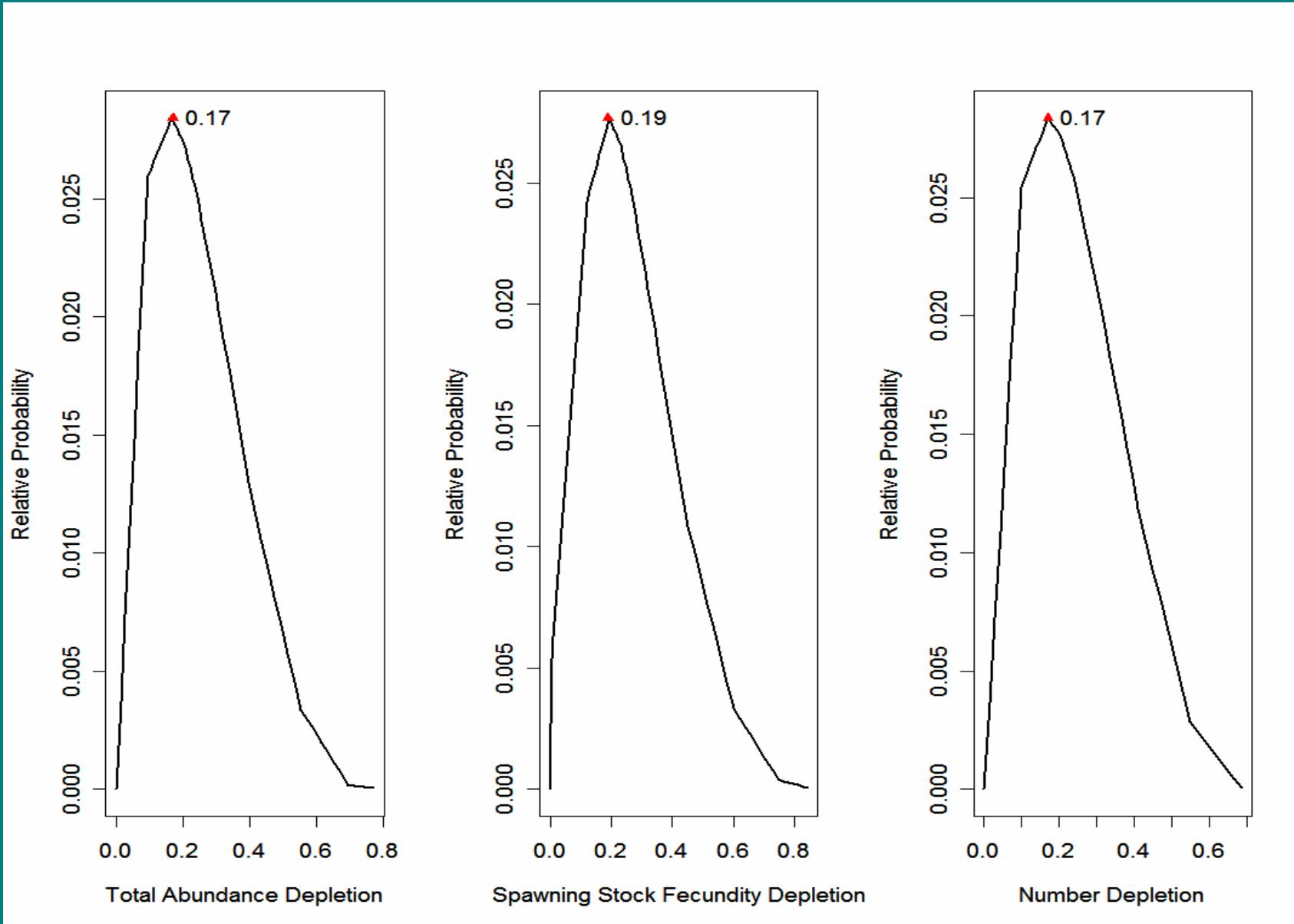


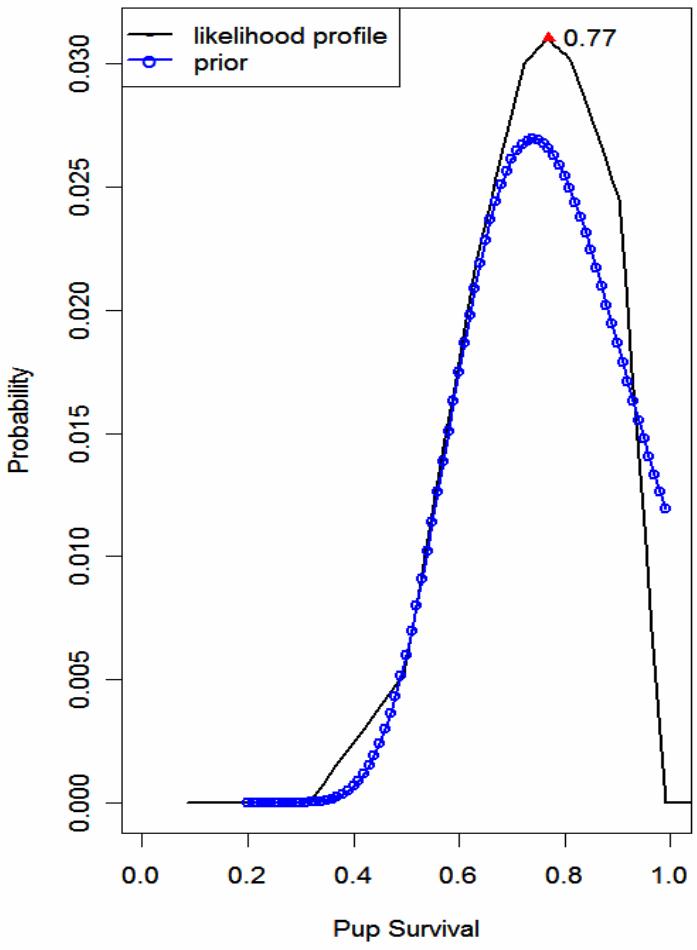
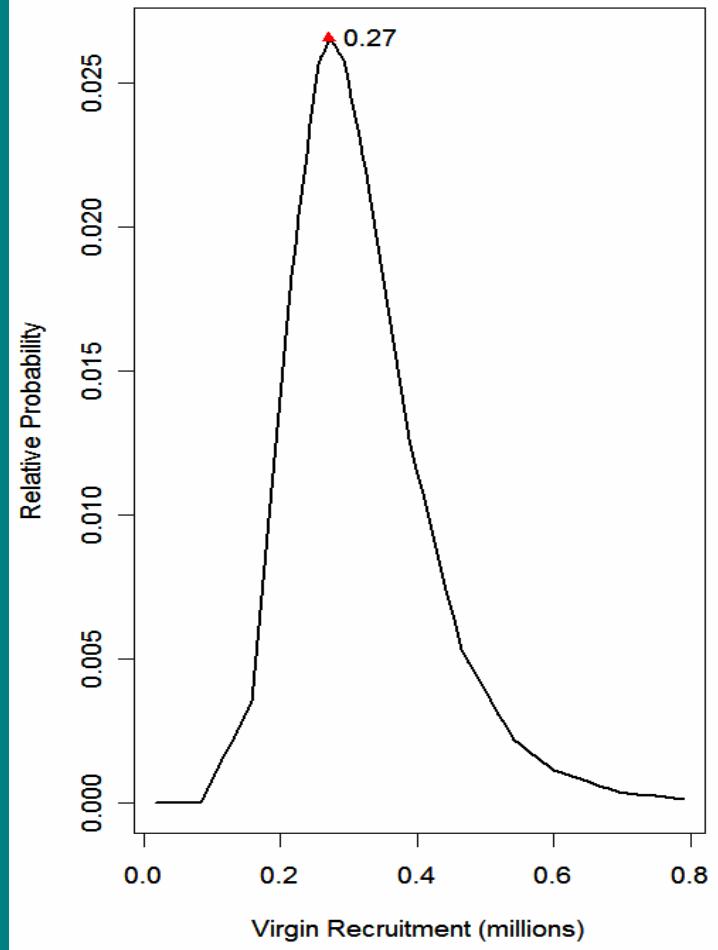
# Uncertainty

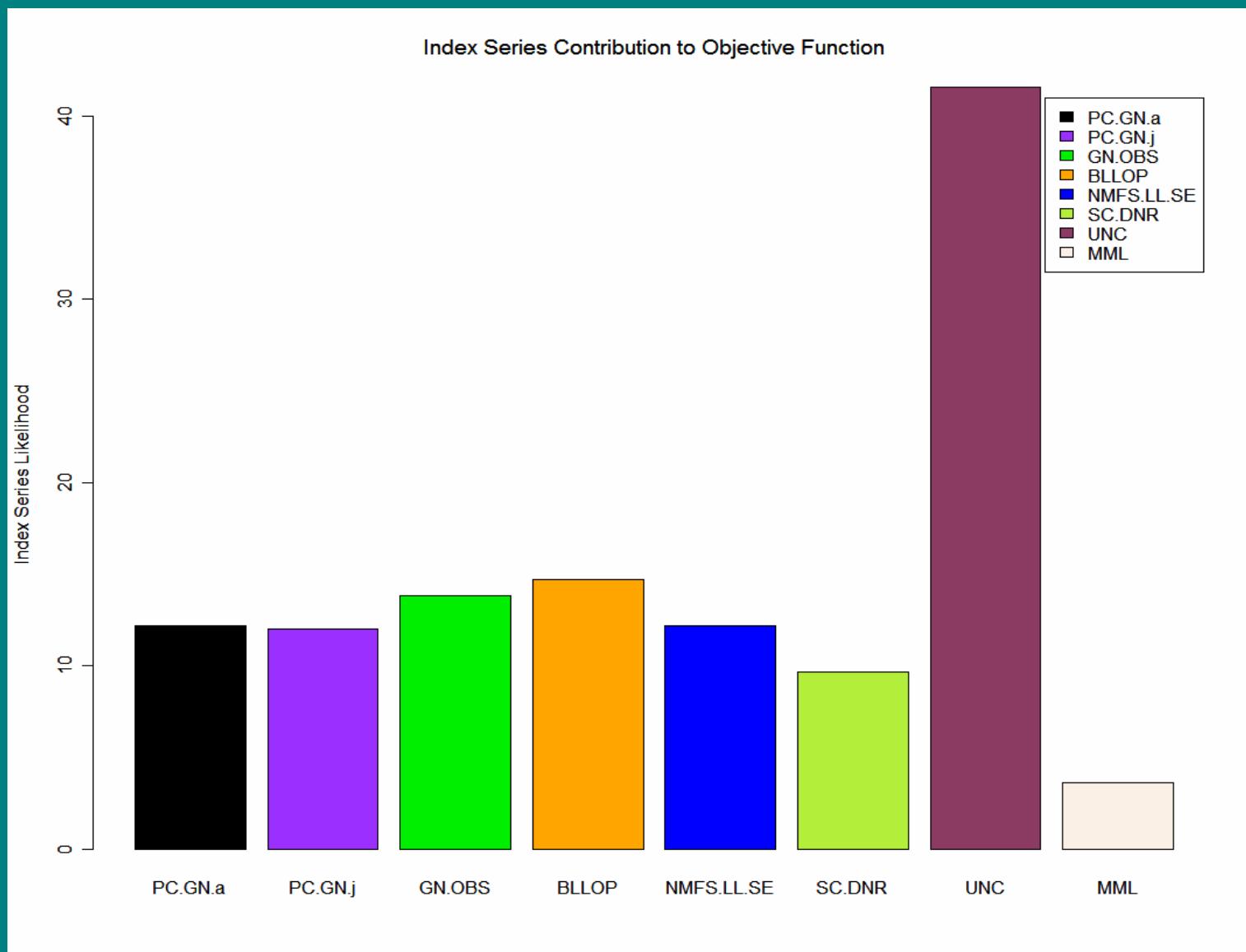
- Likelihood profiling option in ADMB to estimate posterior distributions for parameters

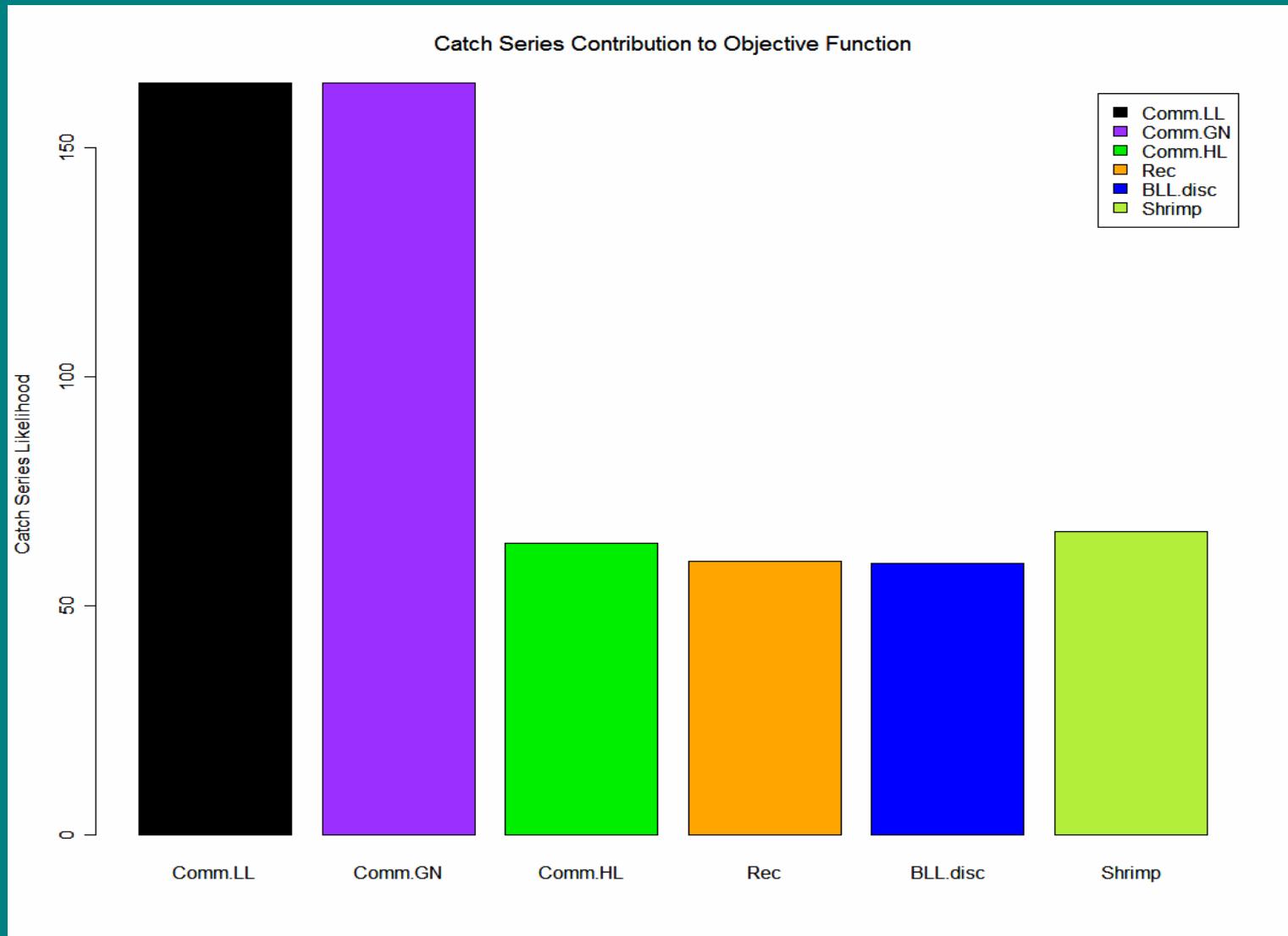






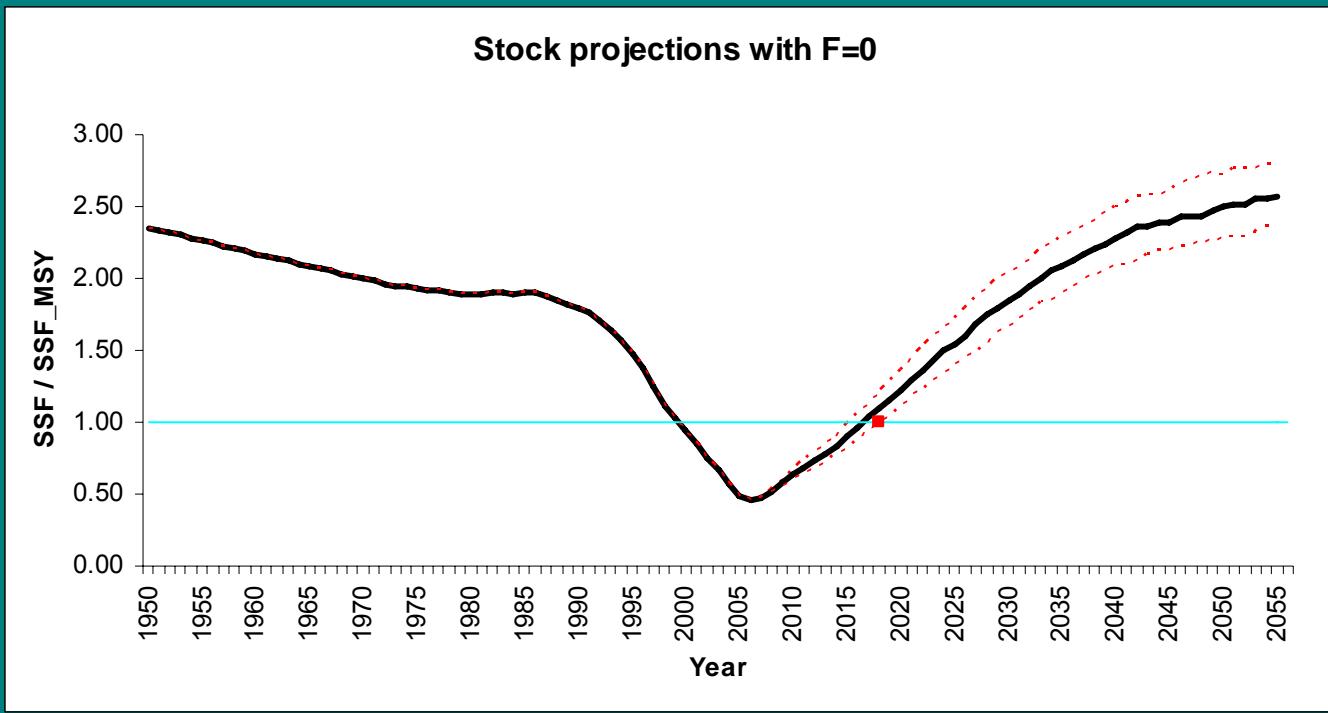






### 3. Base Model and Results

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

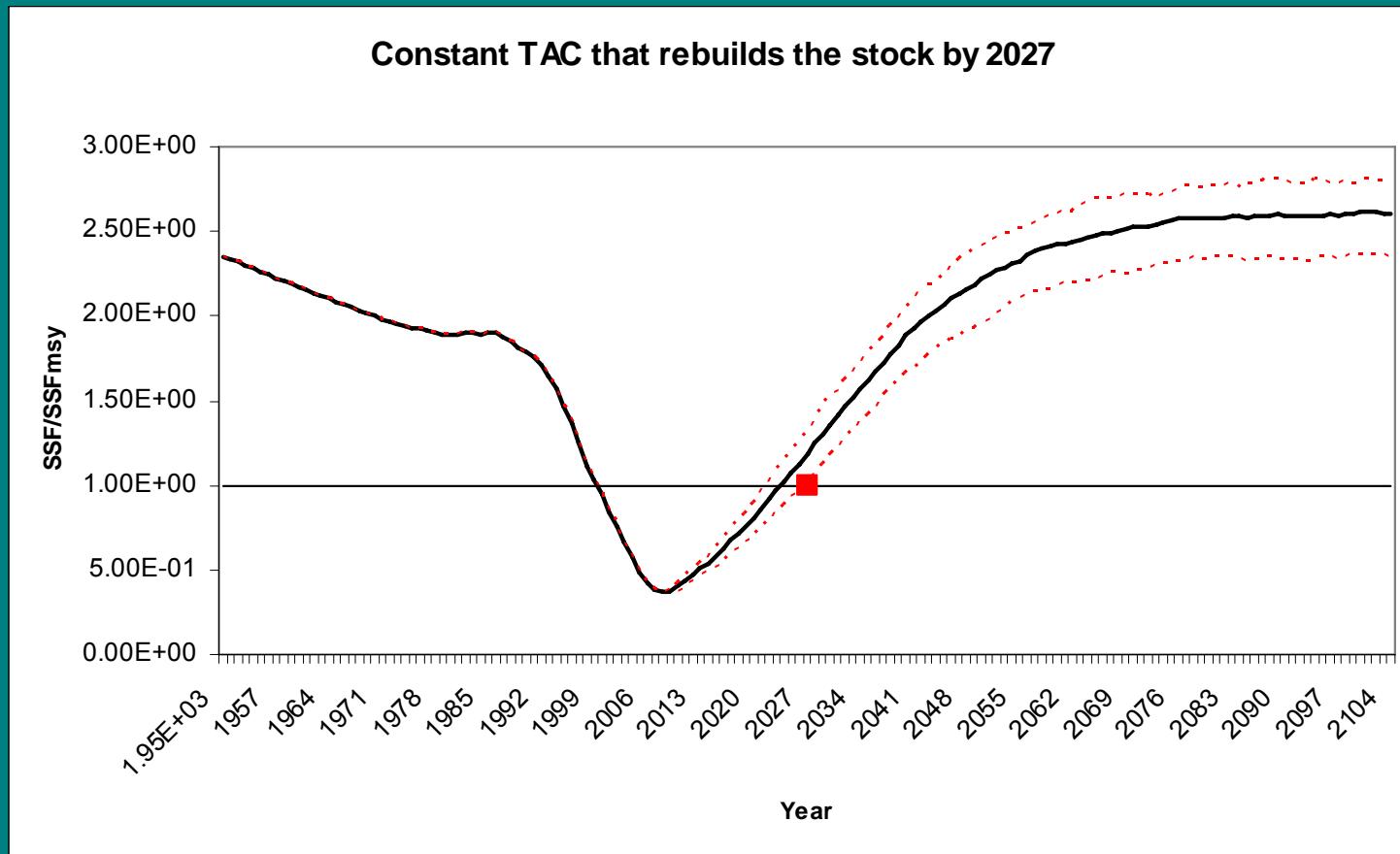
$$GenTime = \frac{\sum_i if_i \prod_{j=1}^{i-1} s_j}{\sum_i f_i \prod_{j=1}^{i-1} s_j}$$

$i$  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

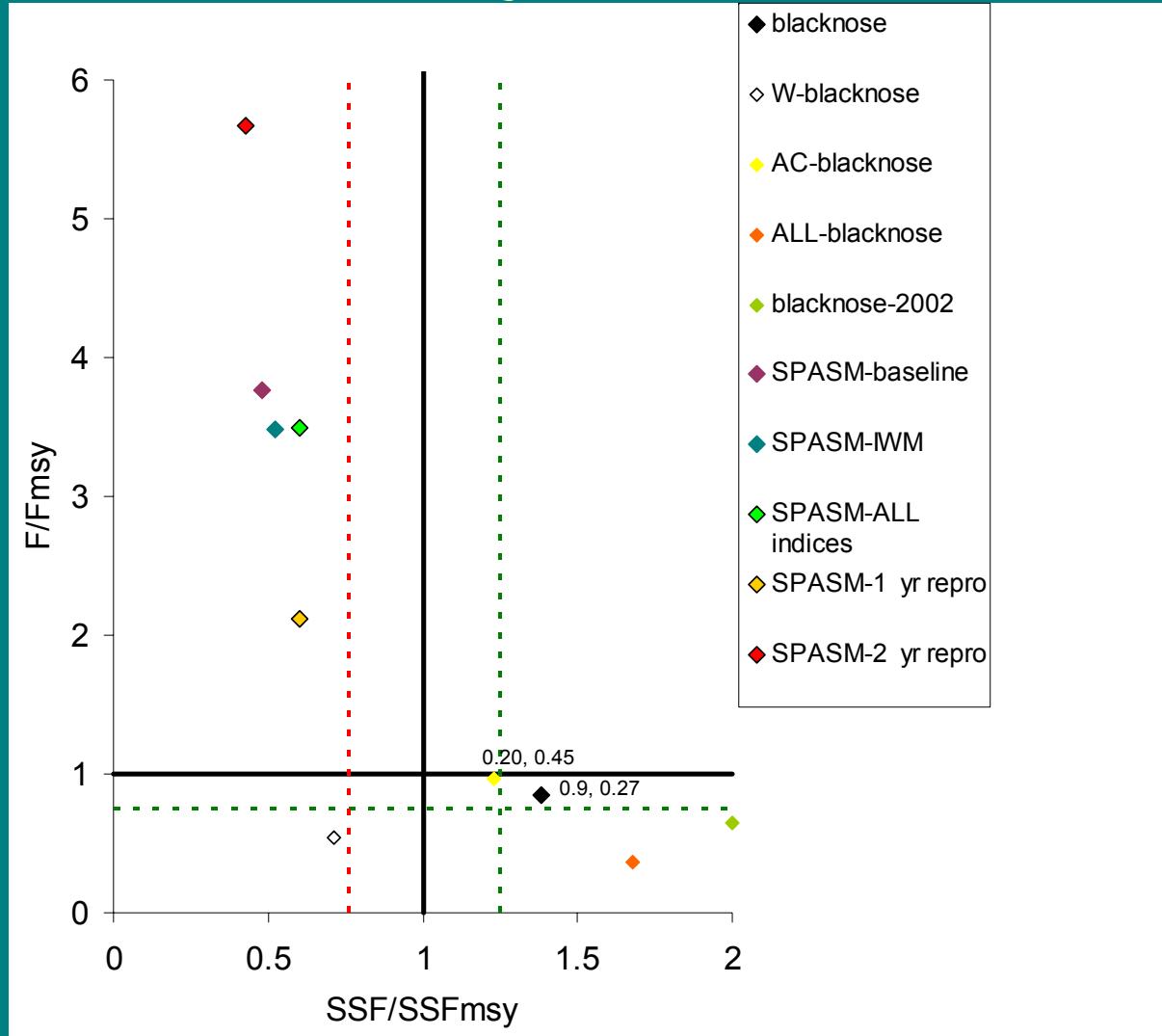


## 4. Sensitivity Analyses

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

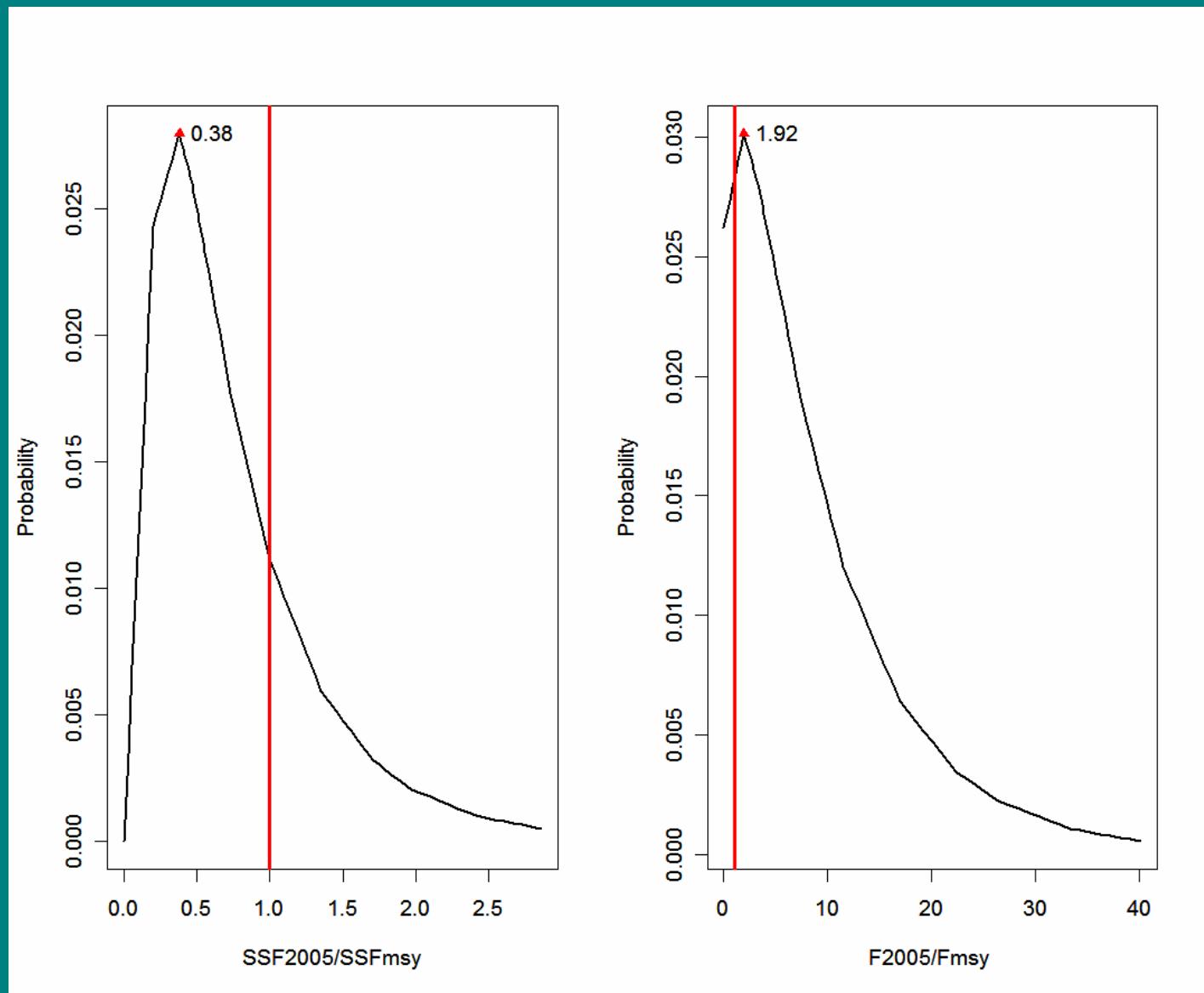
Blacknose	S1		S2		S3		S4	
	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV
$\text{SSF}_{2005}/\text{SSF}_{\text{MSY}}$	0.52	0.59	0.6	0.73	0.601	0.66	0.43	0.65
$F_{2005}/F_{\text{MSY}}$	3.48	0.81	3.49	0.76	2.12	0.8	5.68	0.85
$N_{2005}/N_{\text{MSY}}$	0.48	-	0.51	-	0.52	-	0.30	-
MSY	99,876	-	99,236	-	91,681	-	88,911	-
$\text{SPR}_{\text{MSY}}$	0.71	0.39	0.7	0.04	0.54	0.28	0.64	0.45
$F_{\text{MSY}}$	0.07	-	0.07	-	0.11	-	0.05	-
$\text{SSF}_{\text{MSY}}$	347,930	-	343,050	-	434,590	-	108,920	-
$N_{\text{MSY}}$	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
$\text{SSF}_{2005}$	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

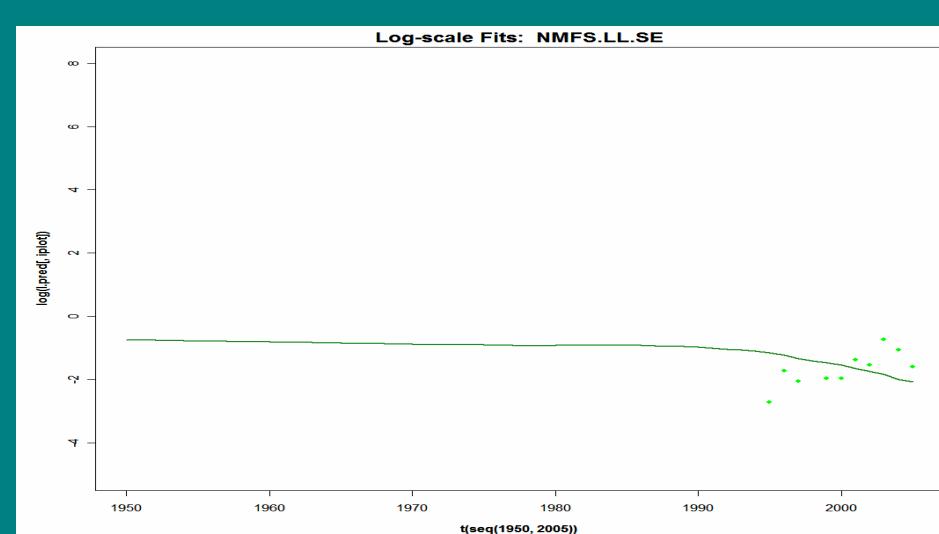
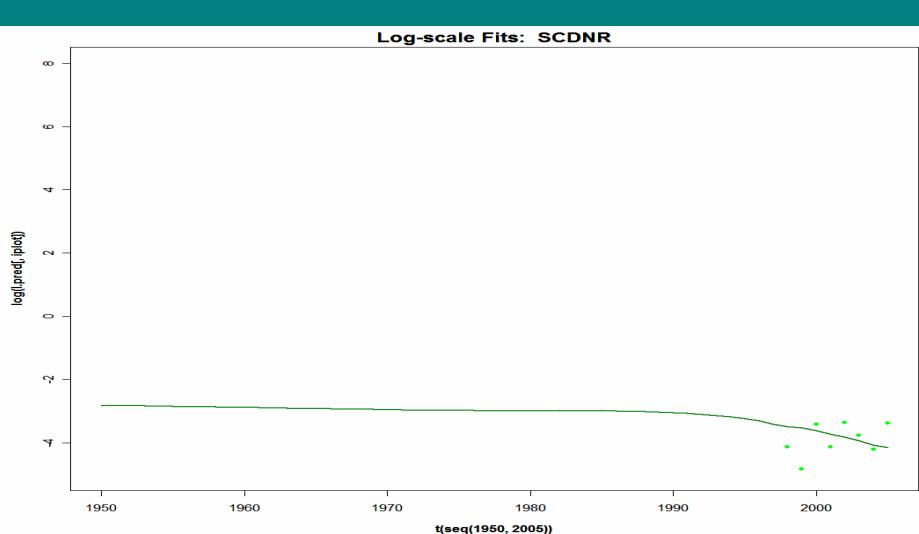
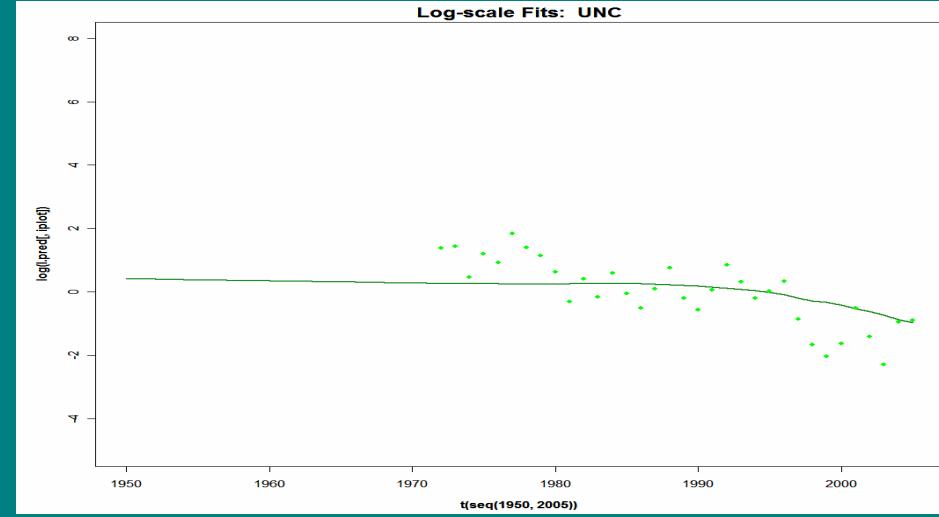
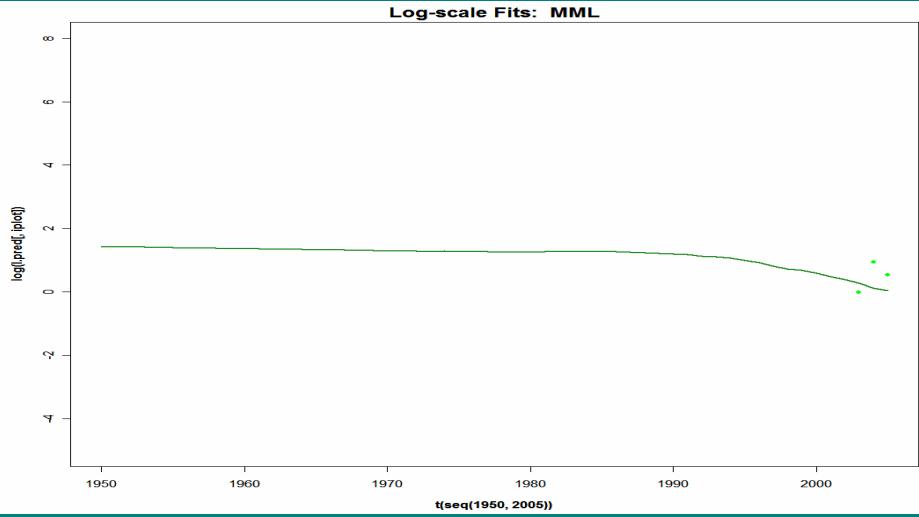


# Lack of continuity analysis

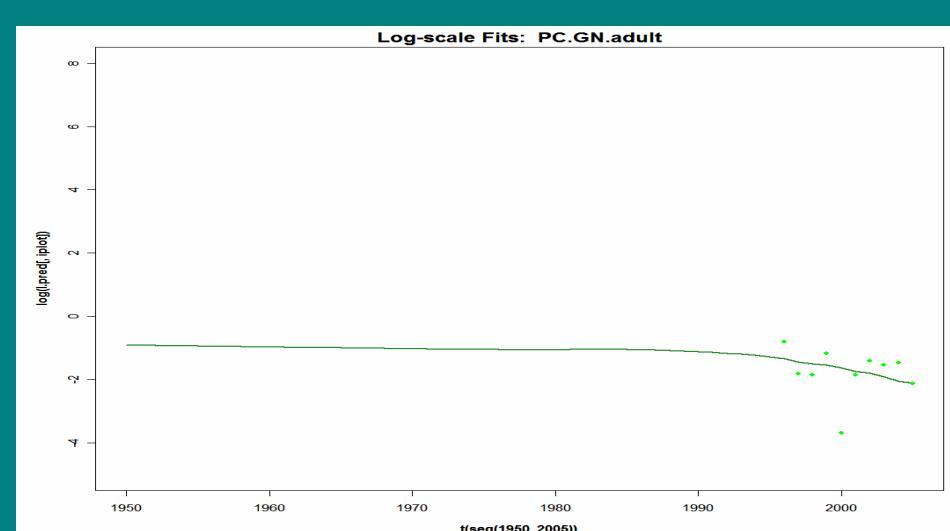
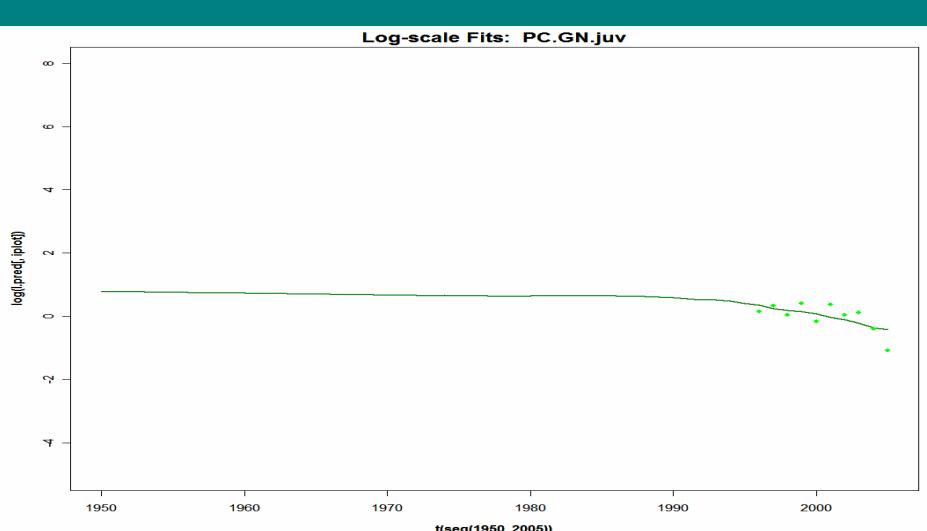
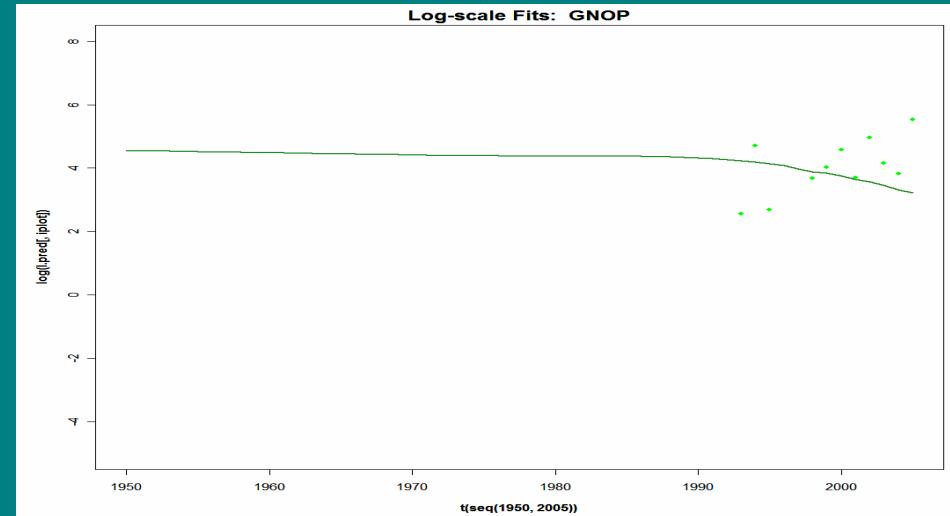
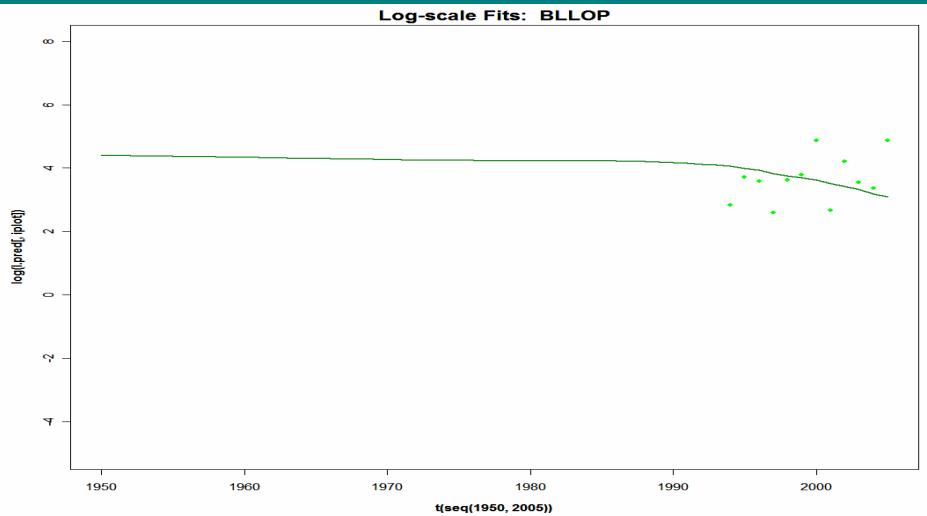
- Indices were not consistent between the 2002 assessment and the current assessment:
  - GNOP is the only series consistent between assessments with additional years of data (2 yrs)



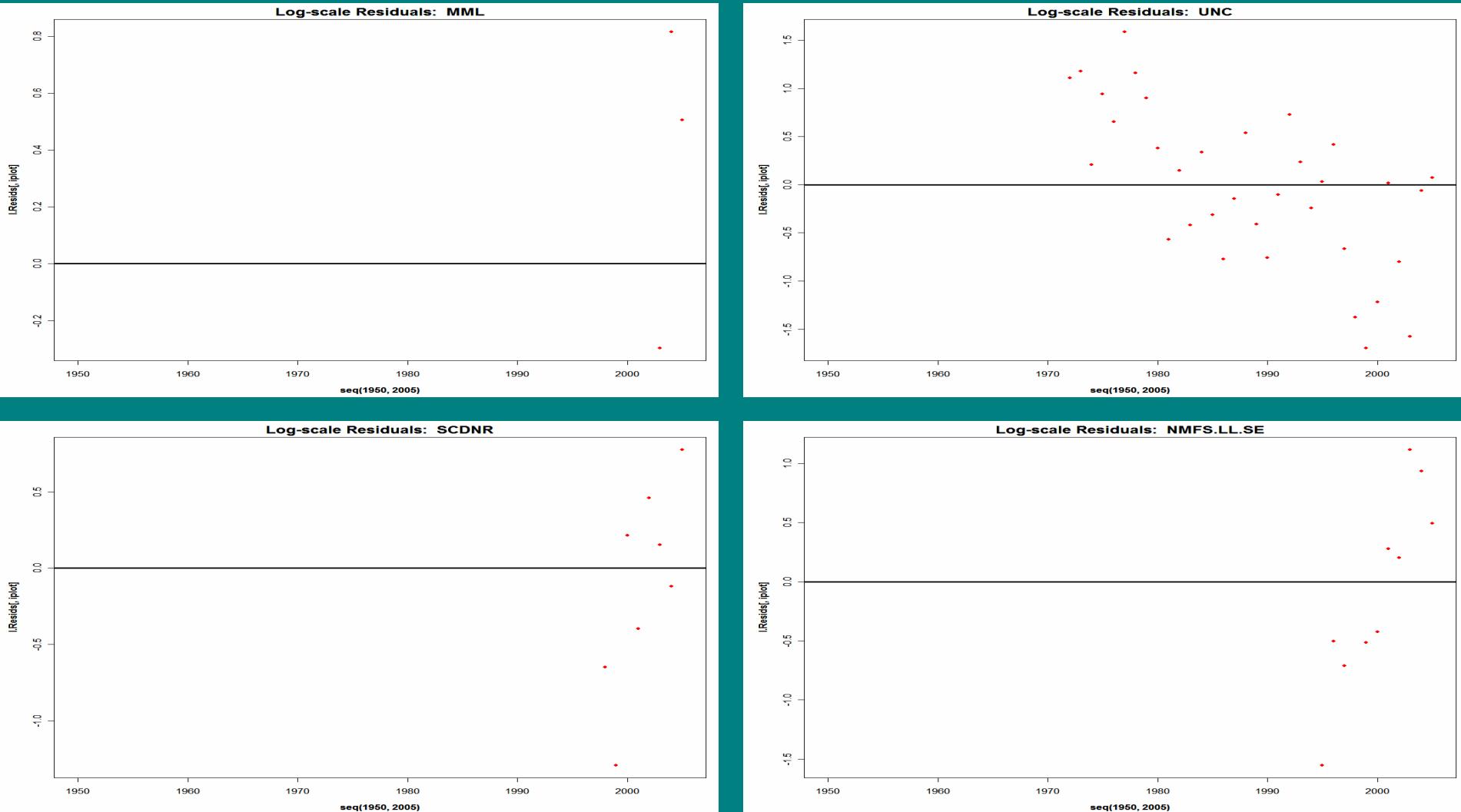
# New fits with equal weighting



# New fits with equal weighting



# Residuals



# Residuals

