Atlantic Sharpnose Shark Assessment

State-space, Age-structured Production Model (SPASM)

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Northeast Fishery Science Center
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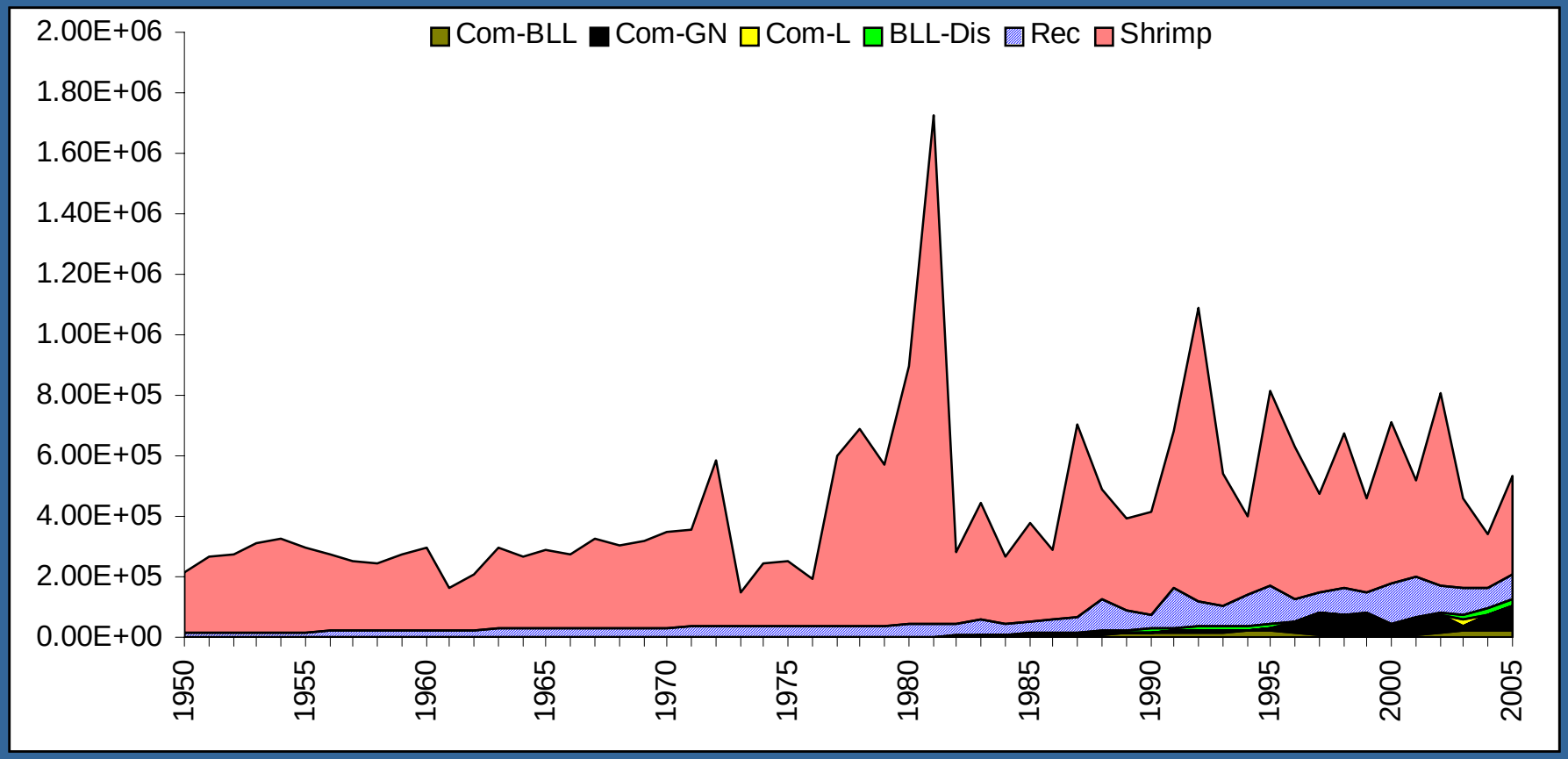
OUTLINE

1. Data Inputs
   a. Fishery
   b. Biology
2. Model Description
3. Base Model and Results
4. Sensitivity Cases

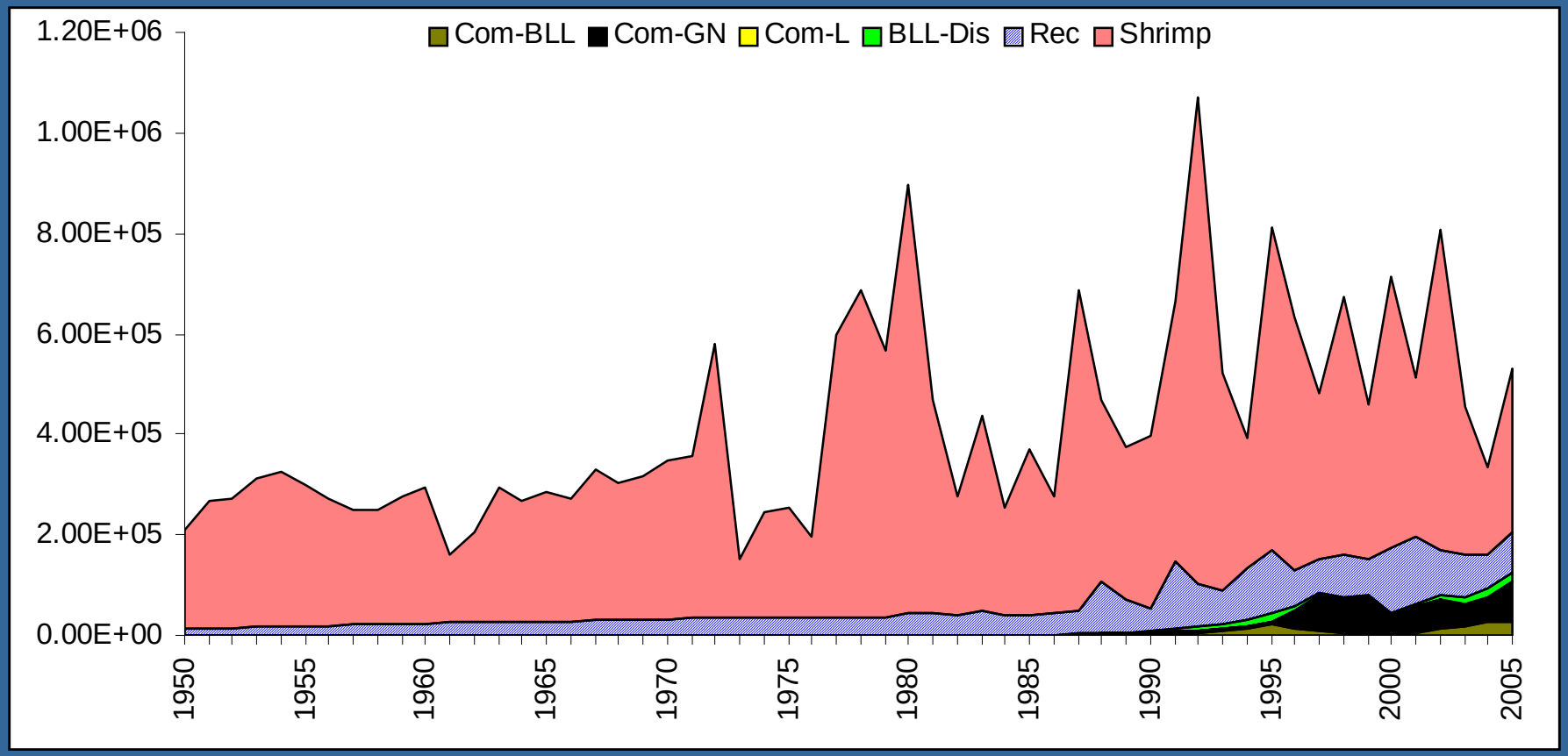
1a. Fishery Inputs

- Catch Series (1950-2005):
  - Commercial Lines
  - Commercial Gillnets
  - Commercial Bottom Longlines
  - Commercial Bottom Longline discards
  - Recreational
  - Shrimp Fishery discard

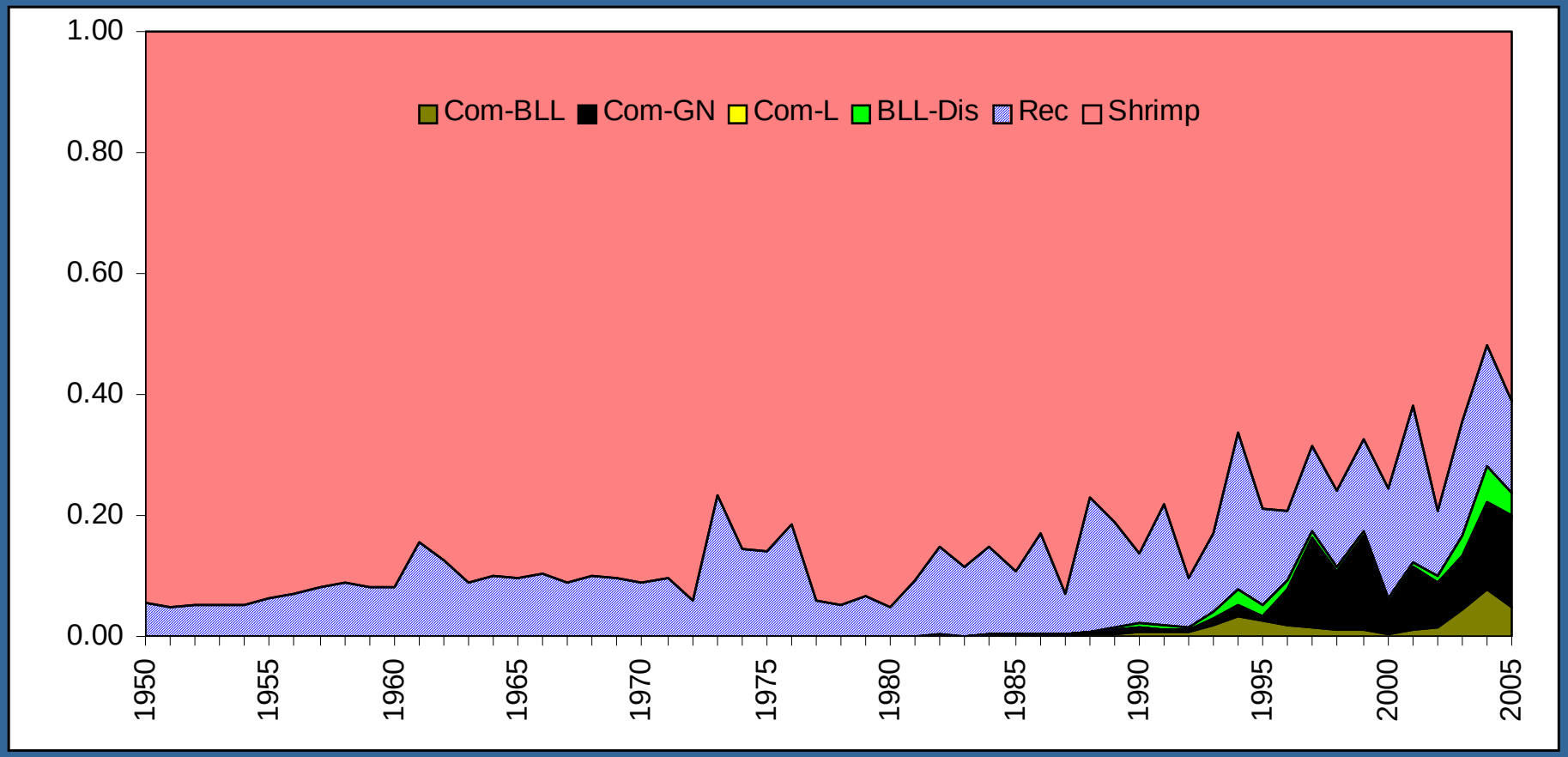
Catches - DW


Com-BLL
Com-GN
Com-L
BLL-Dis
Rec
Shrimp
2.00E+06
1.80E+06
1.60E+06
1.40E+06
1.20E+06
1.00E+06
8.00E+05
6.00E+05
4.00E+05
2.00E+05
0.00E+00
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

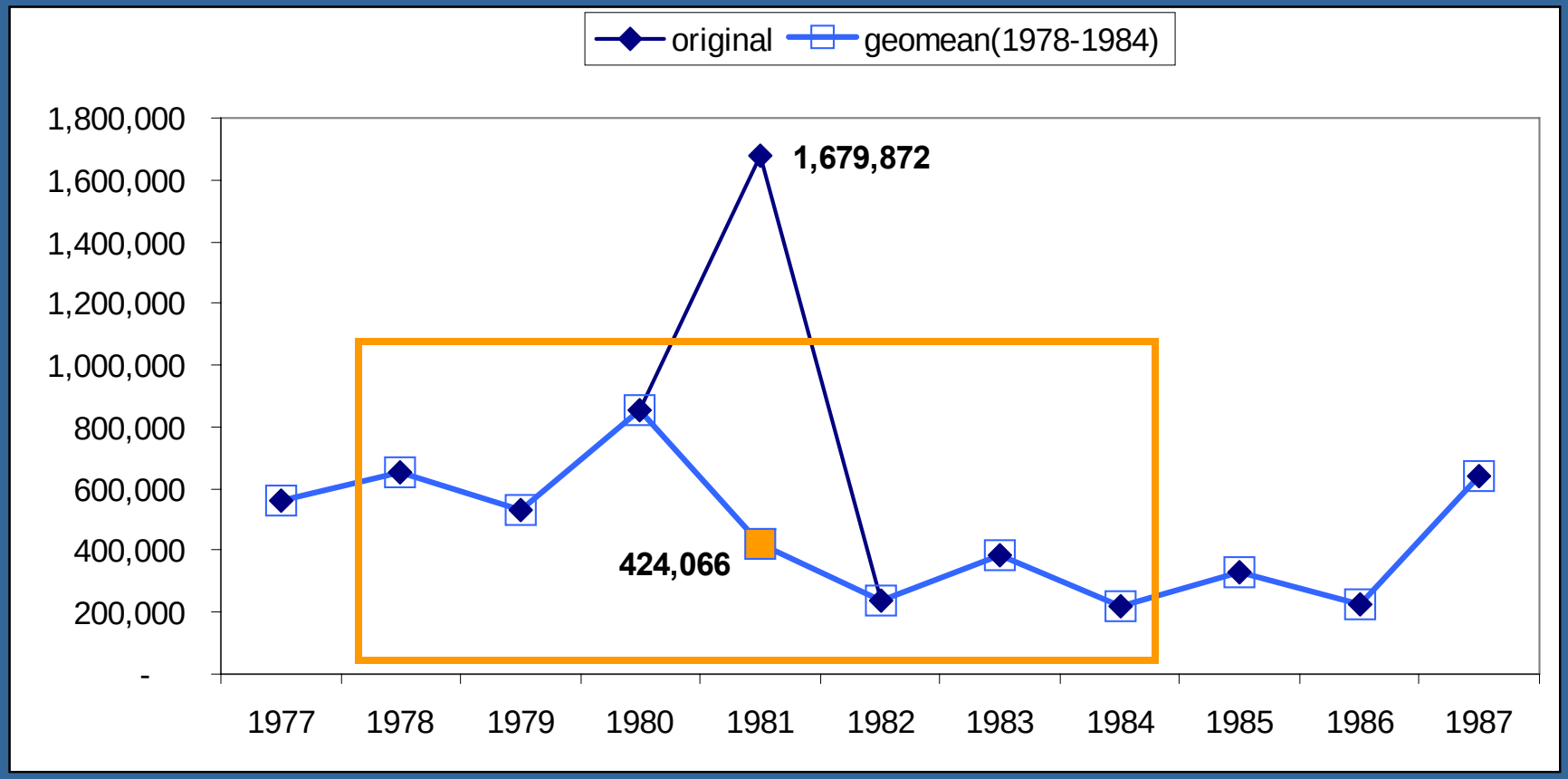
Catches – AW revised



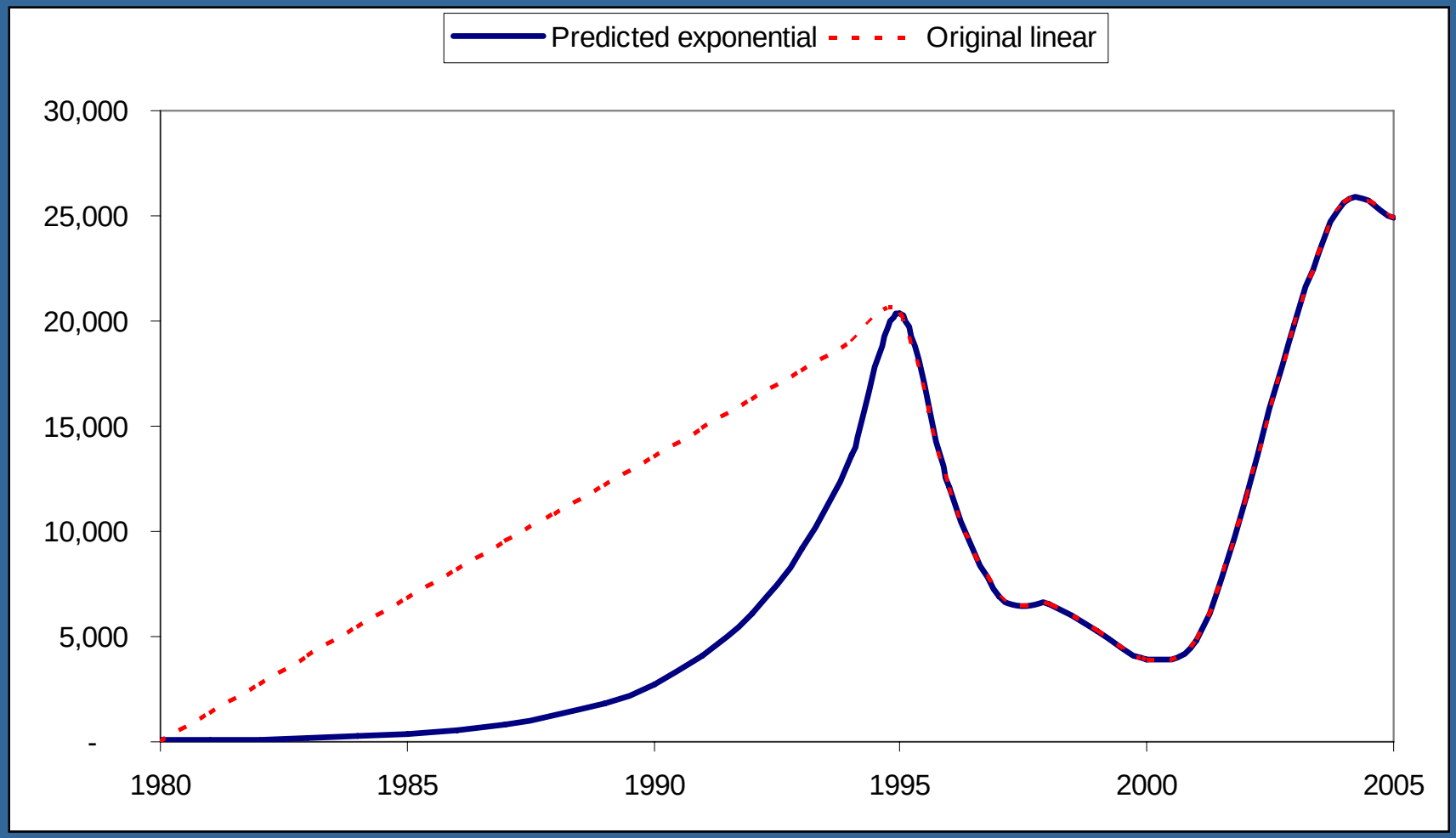
Catches – AW revised



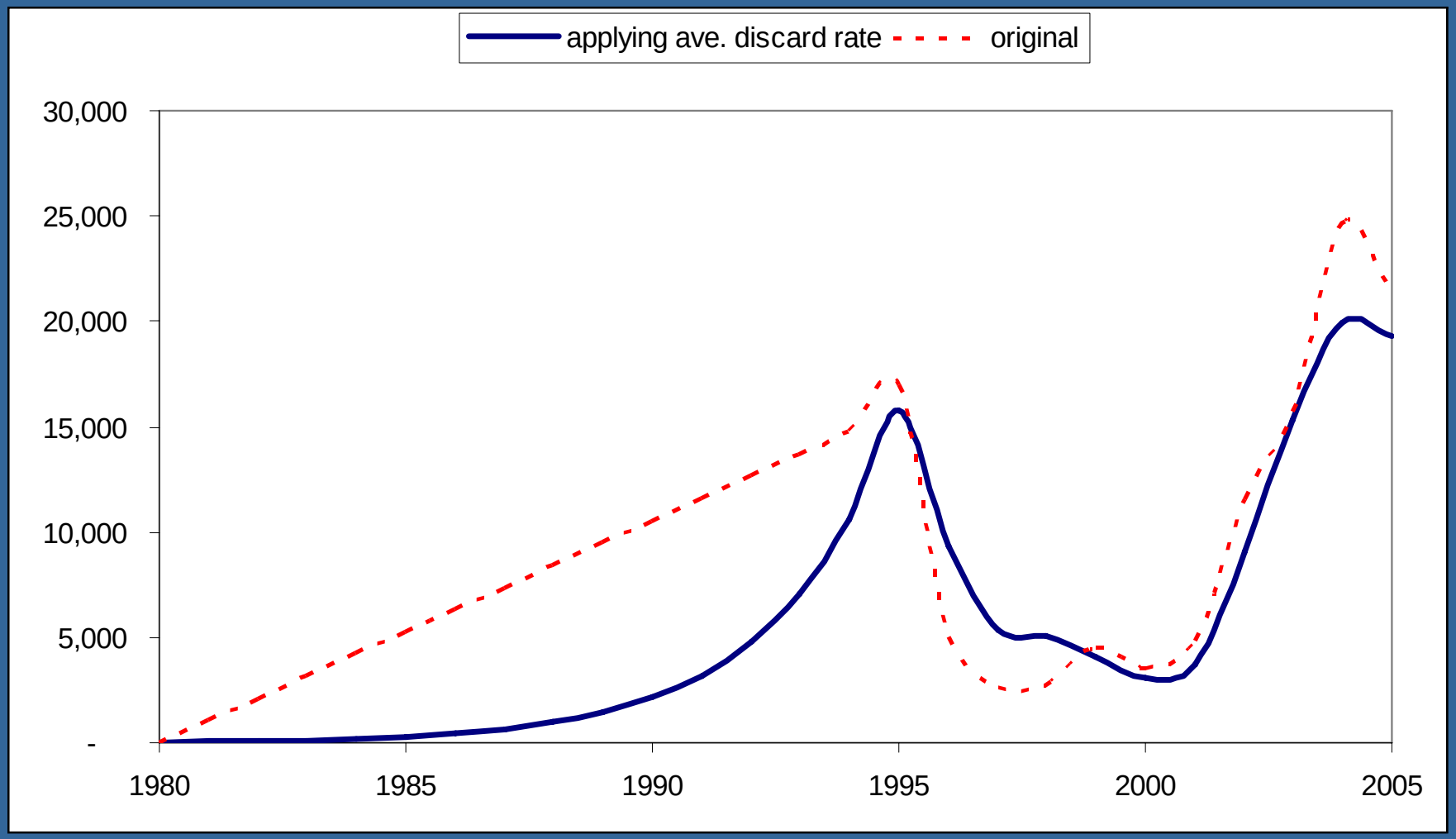
Revised Catches - Shrimp



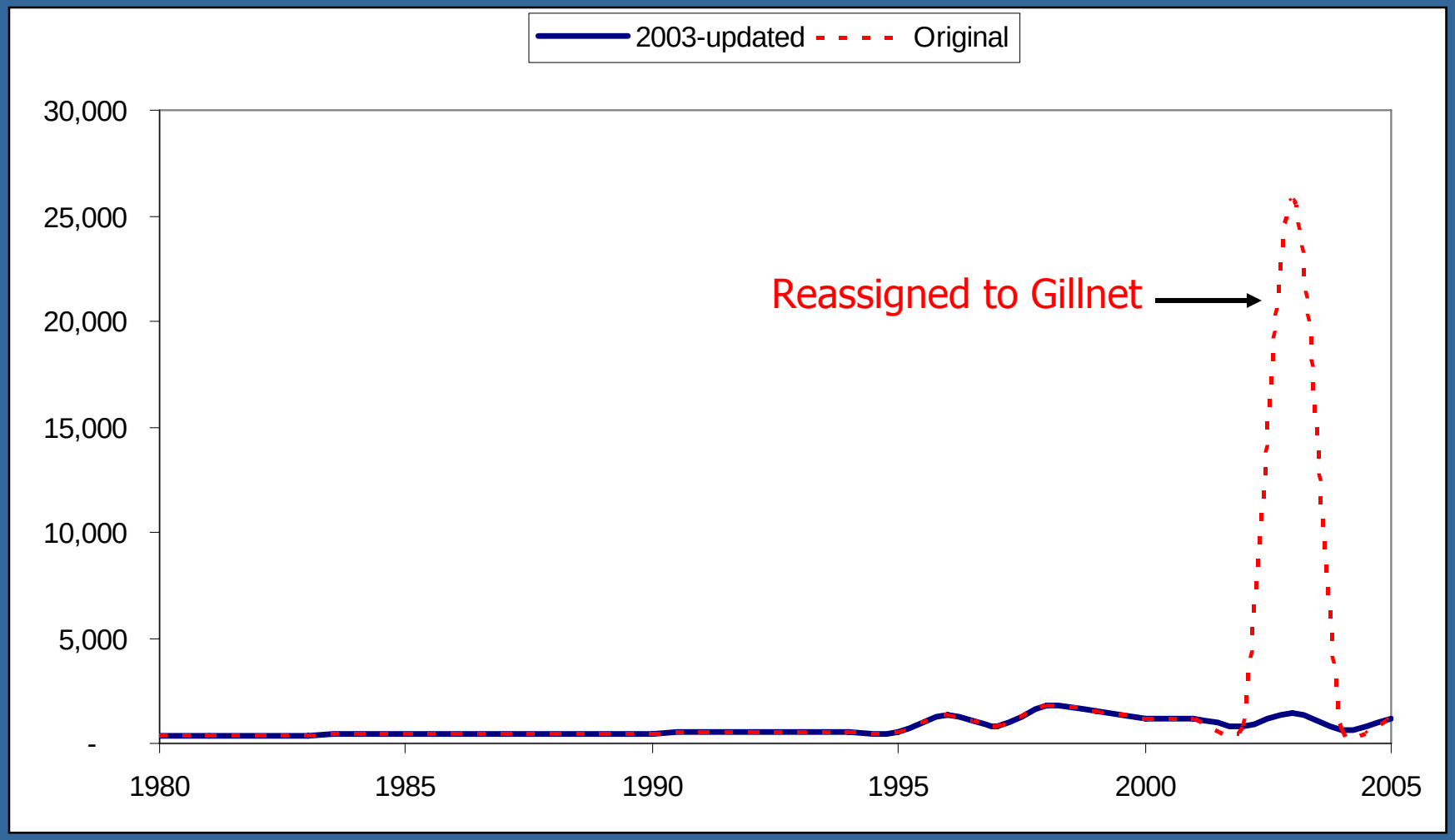
Revised Catches - BLL



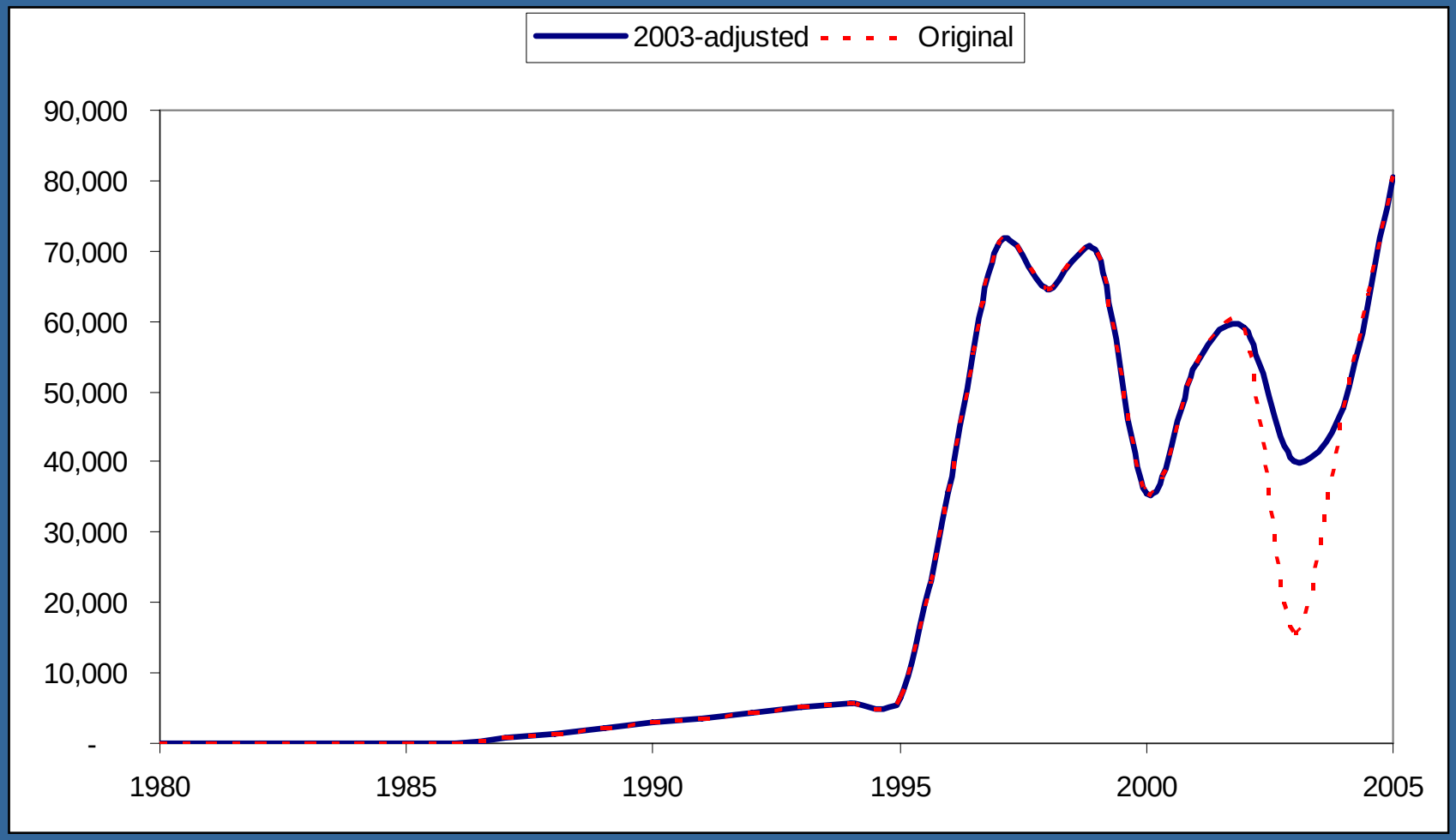
Revised Catches – BLL discards



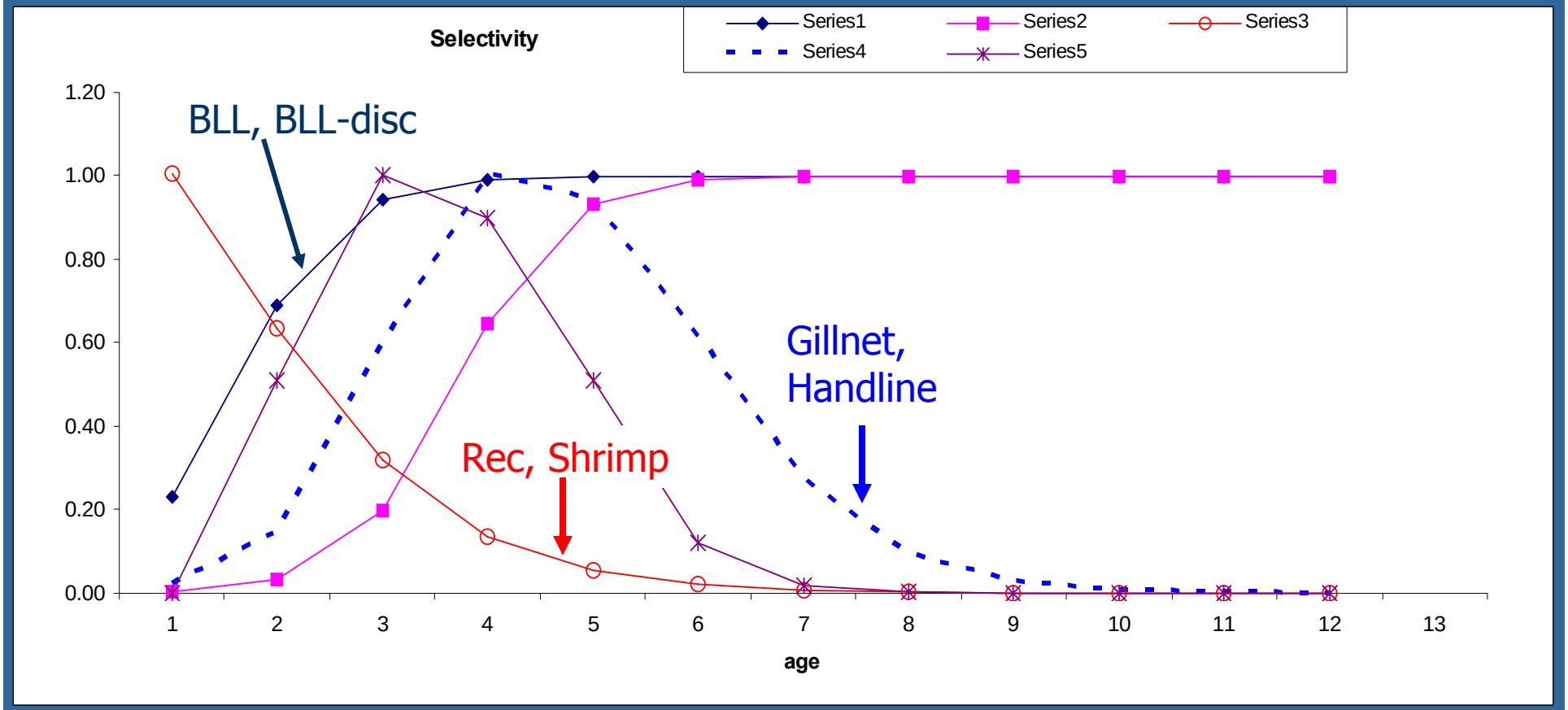
Revised Catches - Lines



Revised Catches - GN



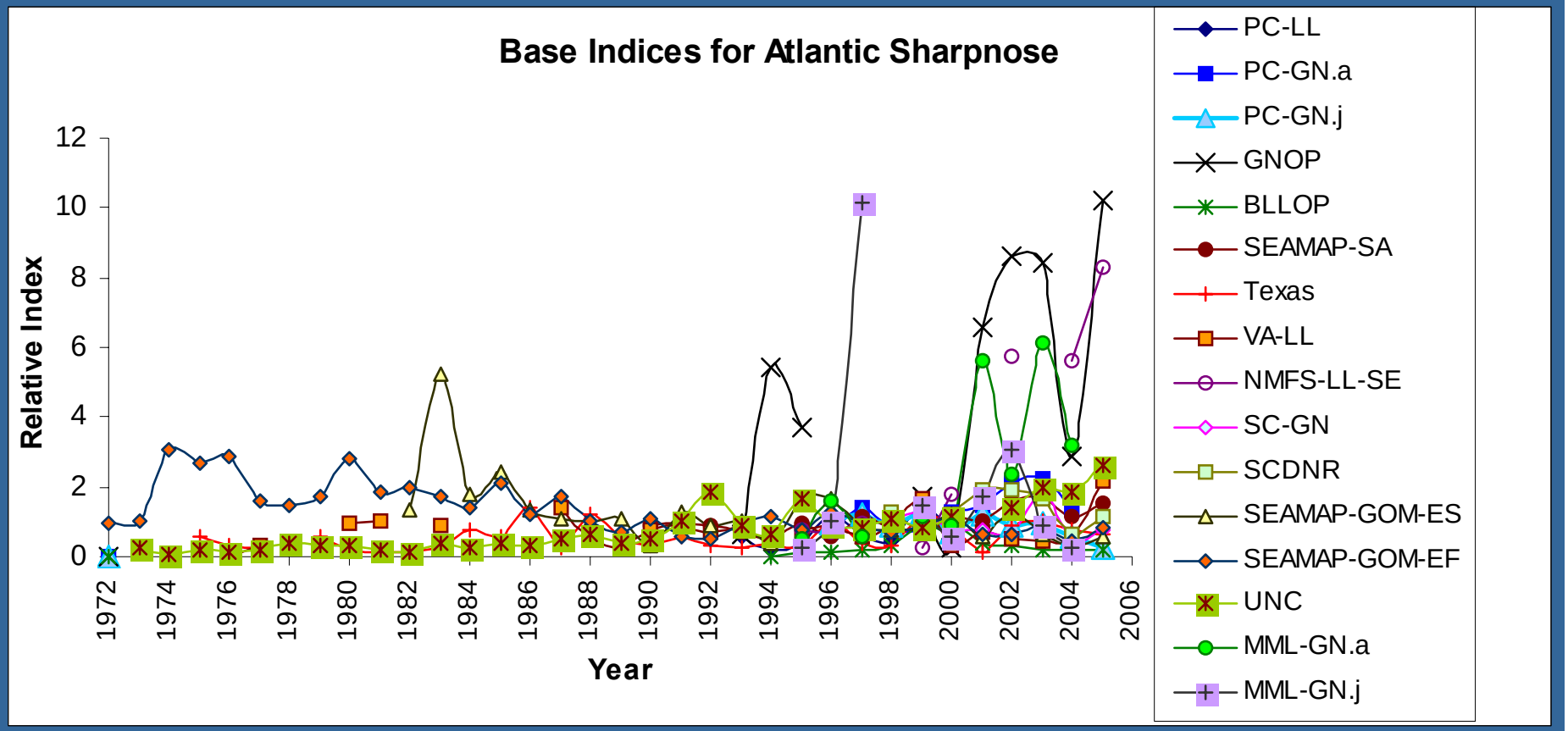
Selectivity - Catch



1a. Fishery Inputs

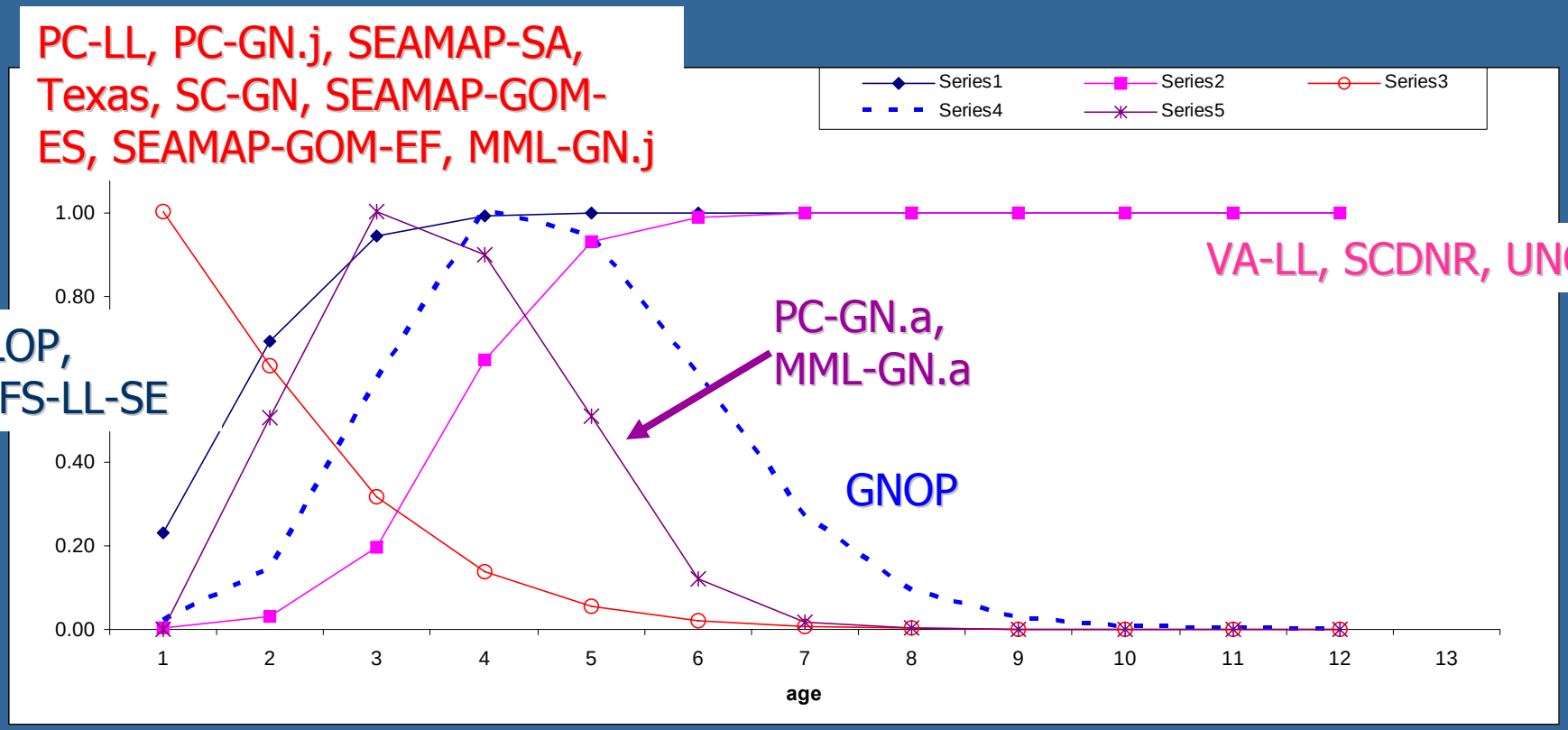
- Indices of Abundance:
  - BLLOP, NMFS-LL-SE
  - VA-LL, SCDNR, UNC
  - PC-LL, PC-GN.j, SEAMAP-SA, Texas, SC-GN, SEAMAP-GOM-ES, SEAMAP-GOM-EF, MML-GN.j
  - GNOP
  - PC-GN.a, MML-GN.a

INDICES


Base Indices for Atlantic Sharpnose
Relative Index
Year
0
2
4
6
8
10
12
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
PC-LL
PC-GN.a
PC-GN.j
GNOP
BLLOP
SEAMAP-SA
Texas
VA-LL
NMFS-LL-SE
SC-GN
SCDNR
SEAMAP-GOM-ES
SEAMAP-GOM-EF
UNC
MML-GN.a
MML-GN.j

NE Exp LL
VALL
UNC
NMFS LLSE
SCCoastalGN
SCDNR
SEAMAP ATL
Gillnet Log
PCGN
MS
PCLL
SEAMAP GOM
NMFS LLSE
Gillnet OBS
MML
TX
BLL OBS
Atlantic Sharpnose
sensitivity
base

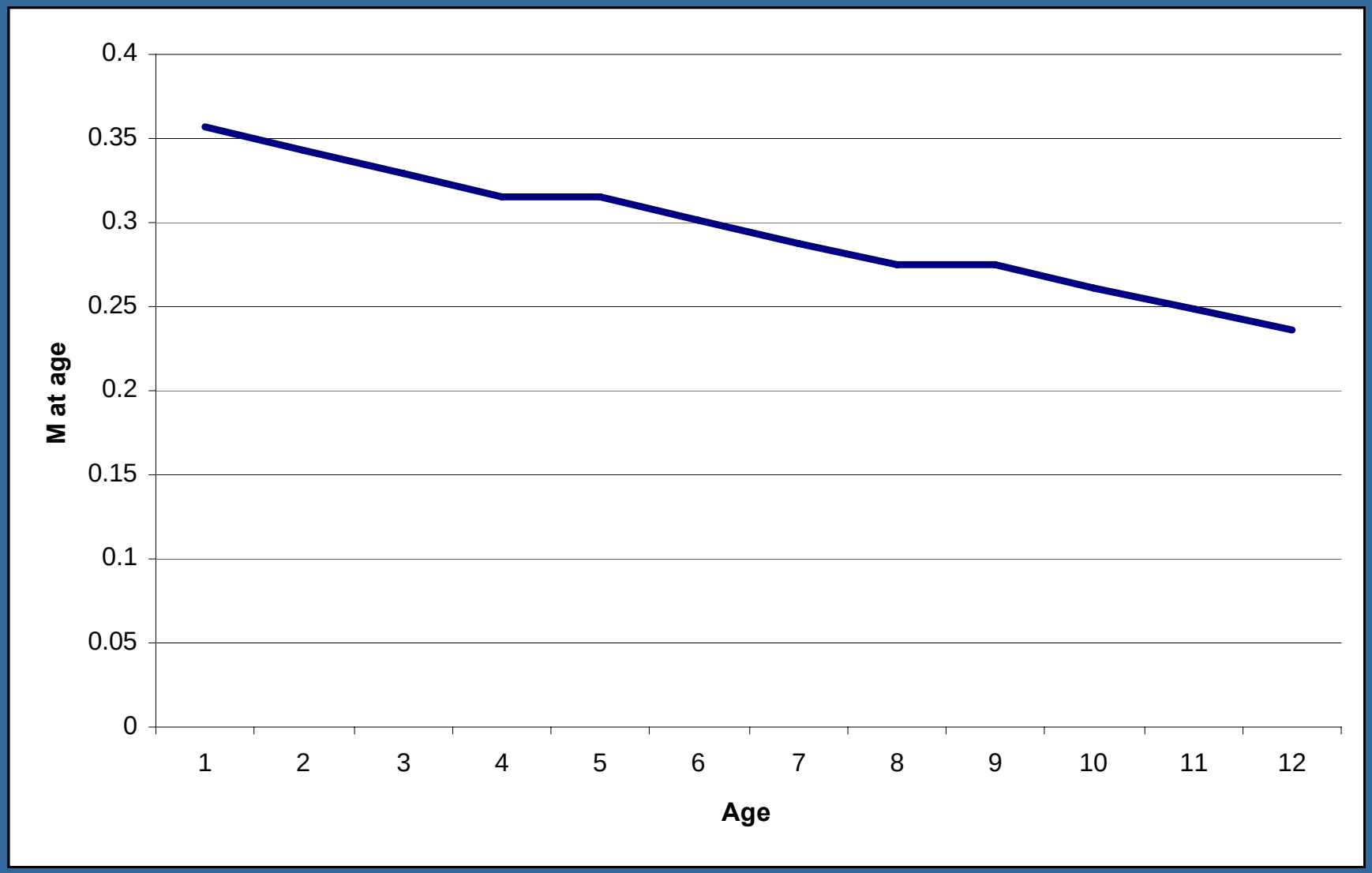
Selectivity - Indices



Biological Inputs – DW values

- Pup-production: 4.1 pups/female
- Natural Mortality: 0.24 → 0.36*
- Pup-Survival: LN(median=0.70, CV=0.3)
- Maturity: ~ (between ages 2 and 3)
- Steepness: ~ 0.3

Natural Mortality at age



* M alternatives

- Base model used max(Survival estimates)
  - Resulting steepness=0.43
- Alternative using min(Survival estimates)
  - Resulting steepness=0.13 → Untenable

Age	Base max(S)	min(S)
1	0.36	0.90
2	0.34	0.84
3	0.33	0.84
4	0.31	0.84
5	0.31	0.84
6	0.30	0.84
7	0.29	0.84
8	0.27	0.84
9	0.27	0.84
10	0.26	0.84
11	0.25	0.84
12	0.24	0.84

ȧ vs. Steepness (h)

- h can be defined in terms of ȧ :

$$h = \frac{\dot{a}}{\dot{a}+4}$$

Notation (Myers et al. 1999):

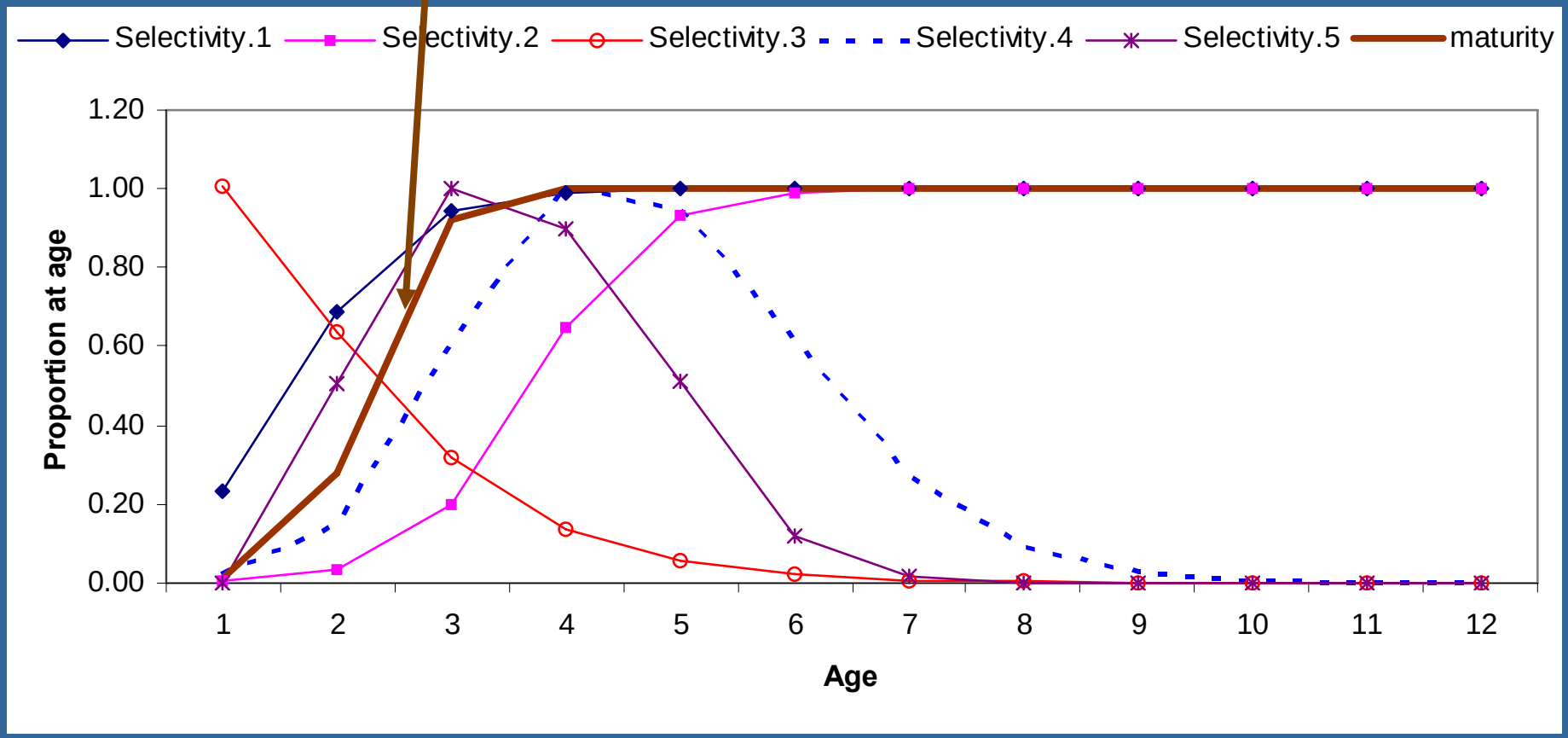
ȧ = maximum lifetime reproductive rate

= (slope at origin) x (virgin spawners per recruit)

= $b\varphi_0$ = pup.survival x φ_0 , where

$$\varphi_0 = \Sigma\, fec_{age} mat_{age} \Pi\, e^{-M_i}$$

Maturity at age



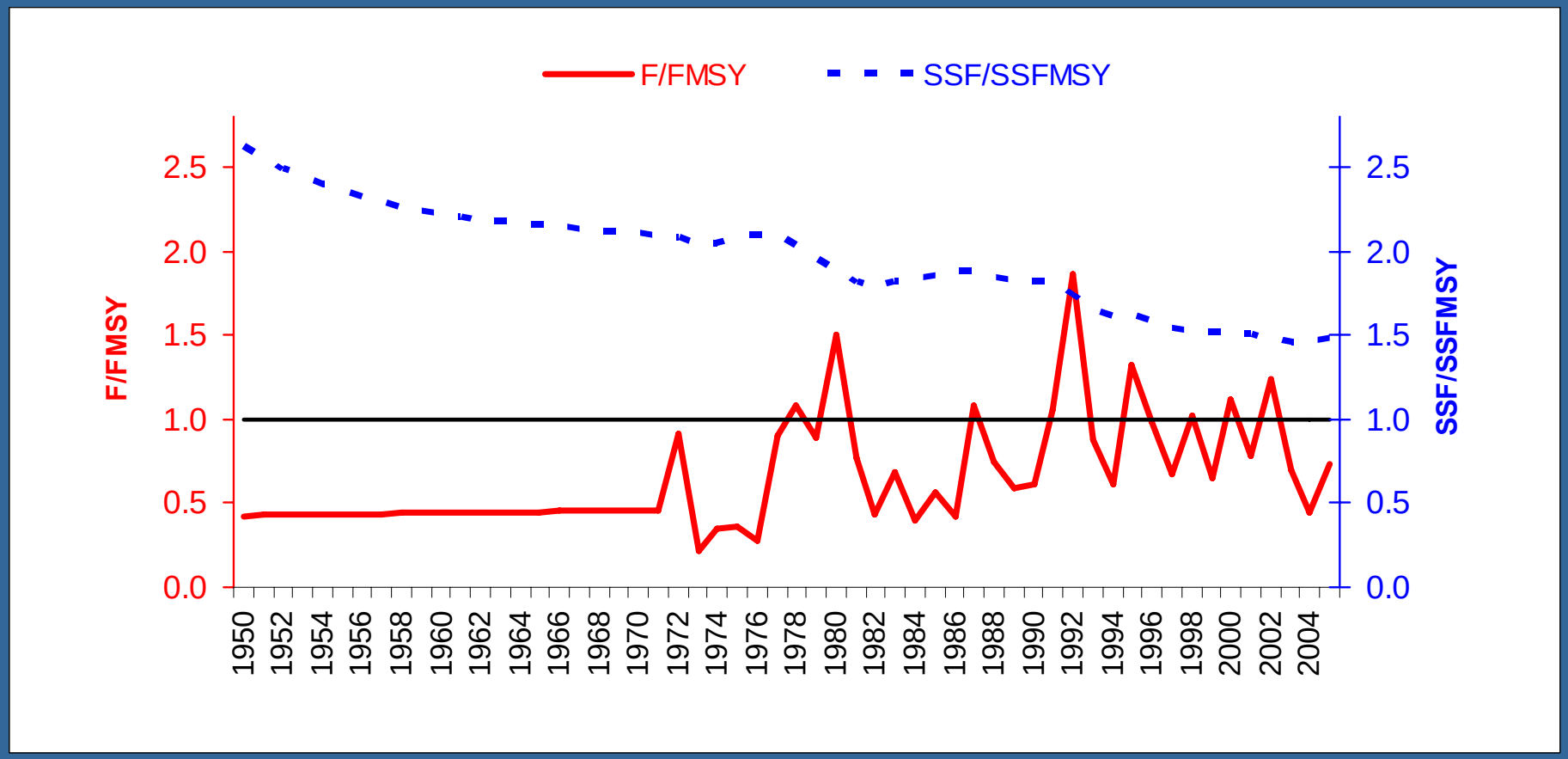
2. Model Description

- State-space Age-structured Production model
- ages 1-12 modeled, age 12 is a plus group
- Recruitment at age 1
- Beverton-Holt stock recruit function

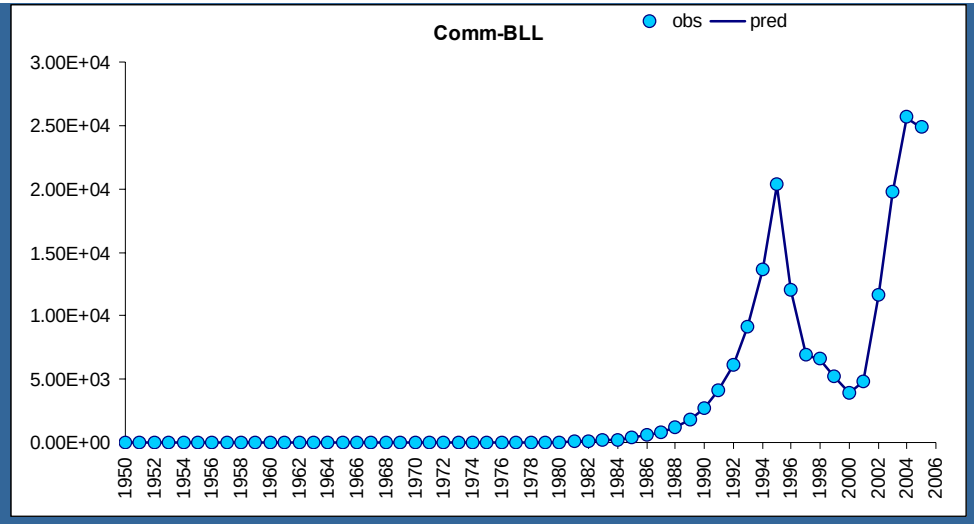
2. Model Description

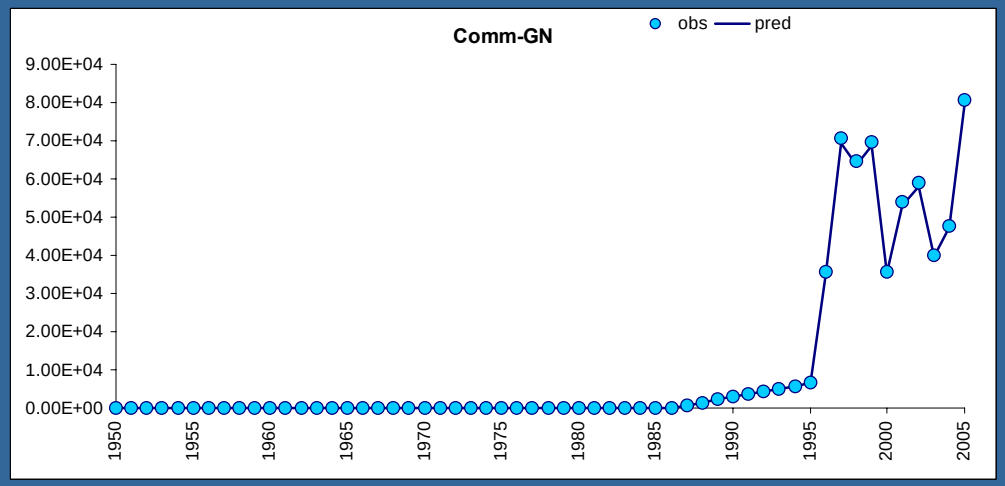
- Time series split into historic (1950-1971) and modern (1972-2005) period
- Estimated catch series begin in 1972 (shrimp bycatch); earliest index (SEAMAP) begins in 1972
- Historic Catches followed AW revisions for each series
- Historic catches were imputed for each series back to 1950; these were downweighted by ½ relative to estimated catches

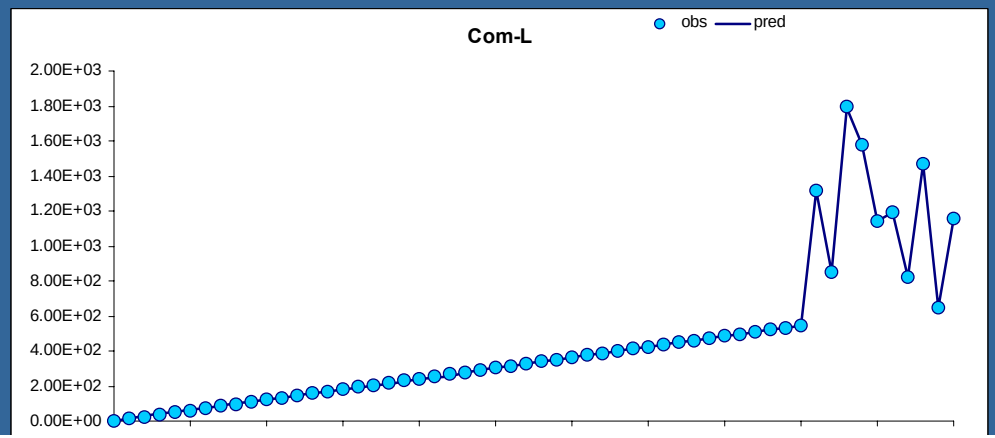
Base Model Results



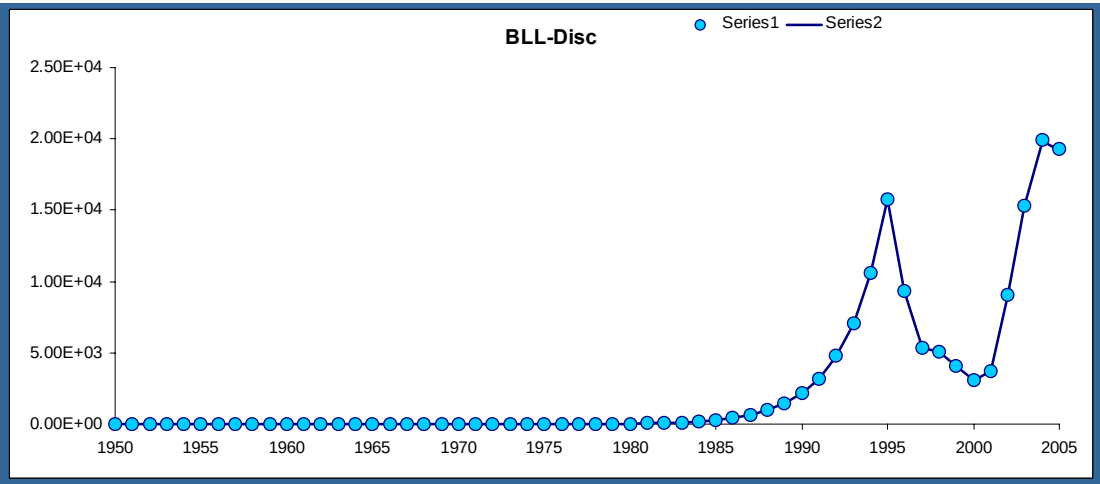
Catches imputed through 1994



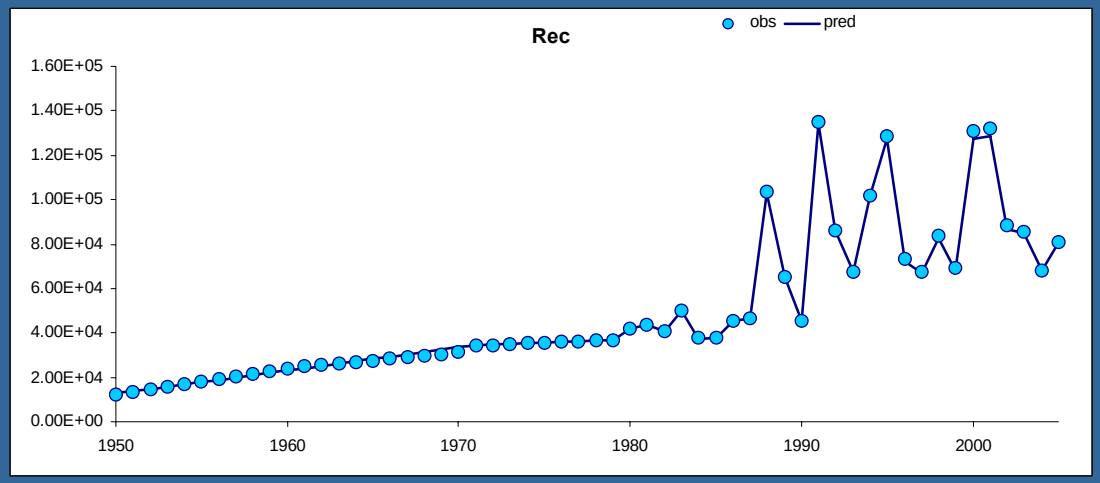




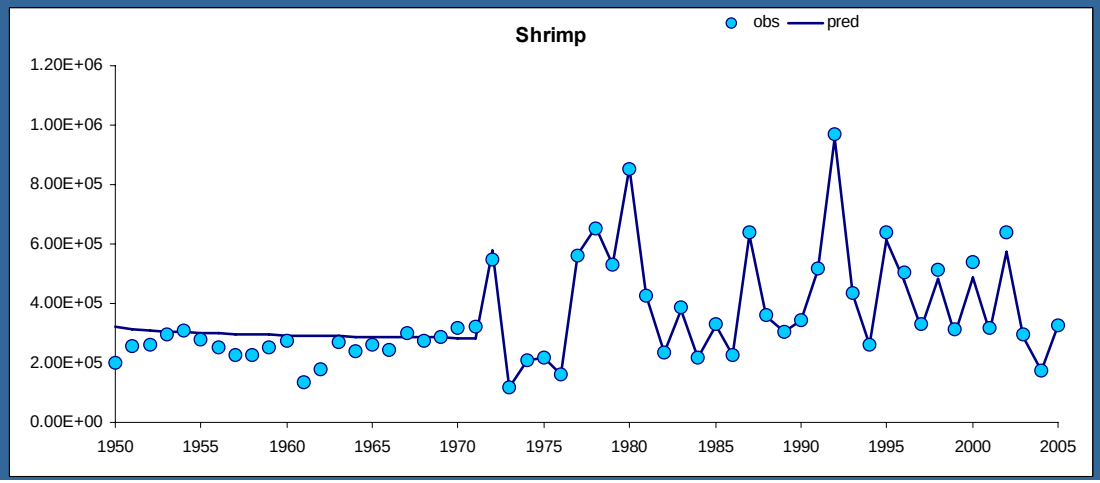
Catches imputed through 1994

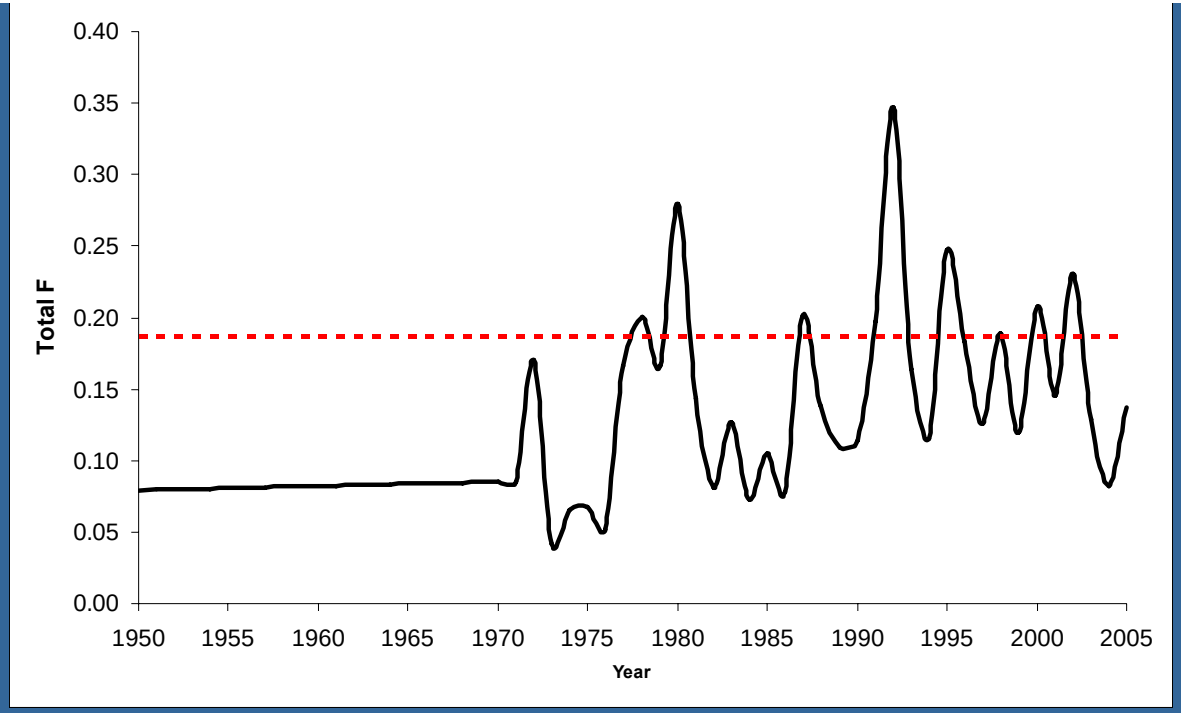


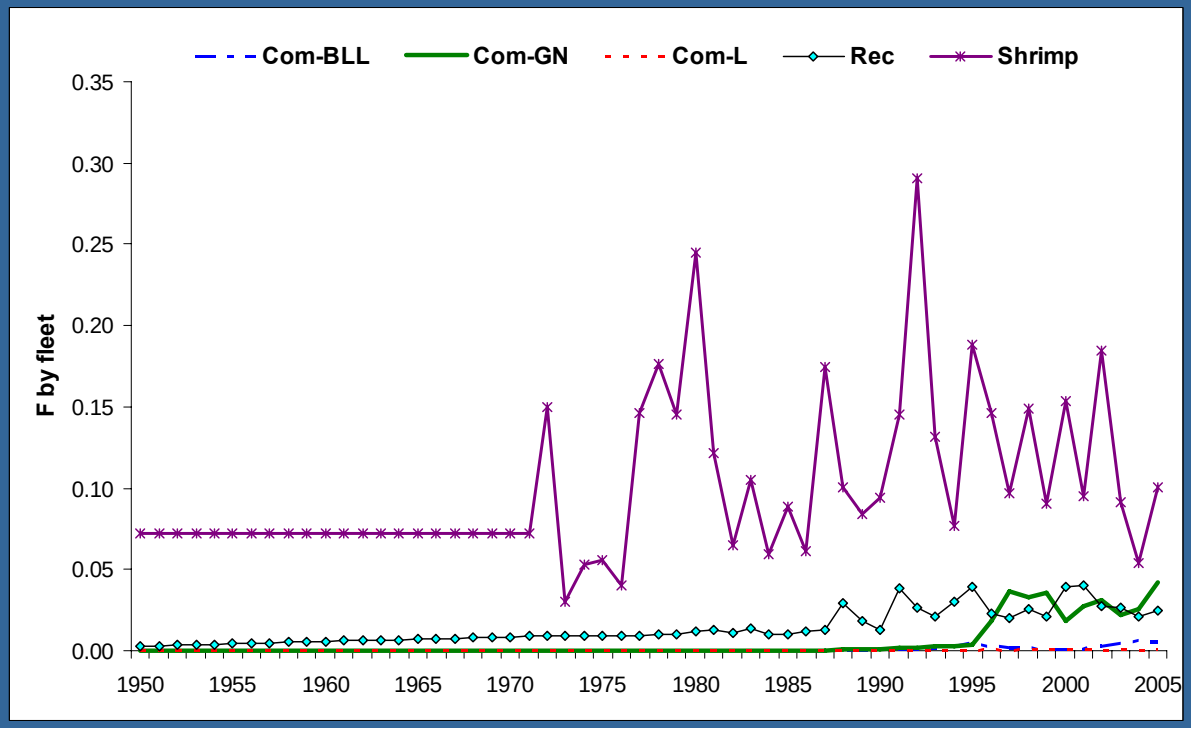
Catches imputed through 1979

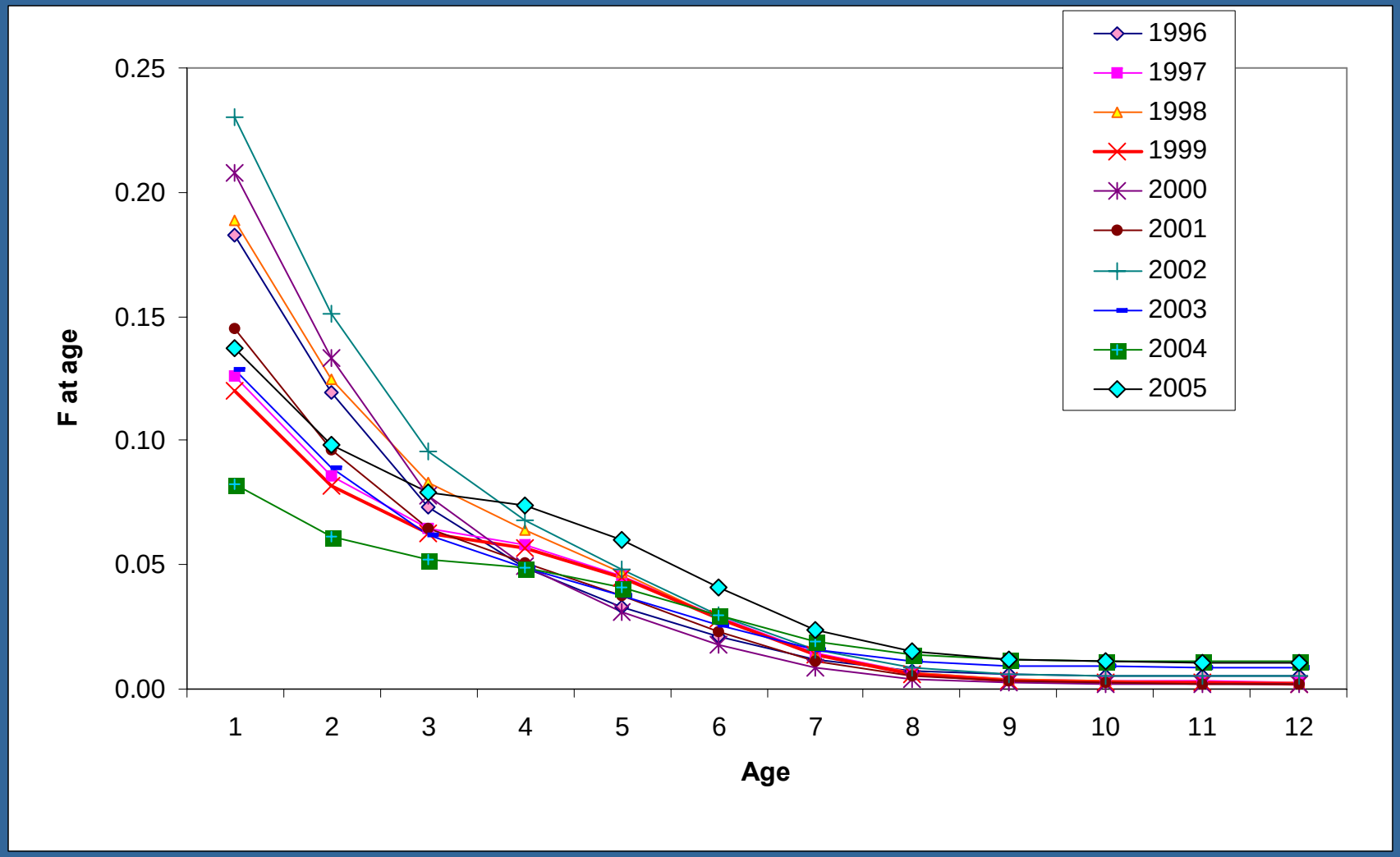


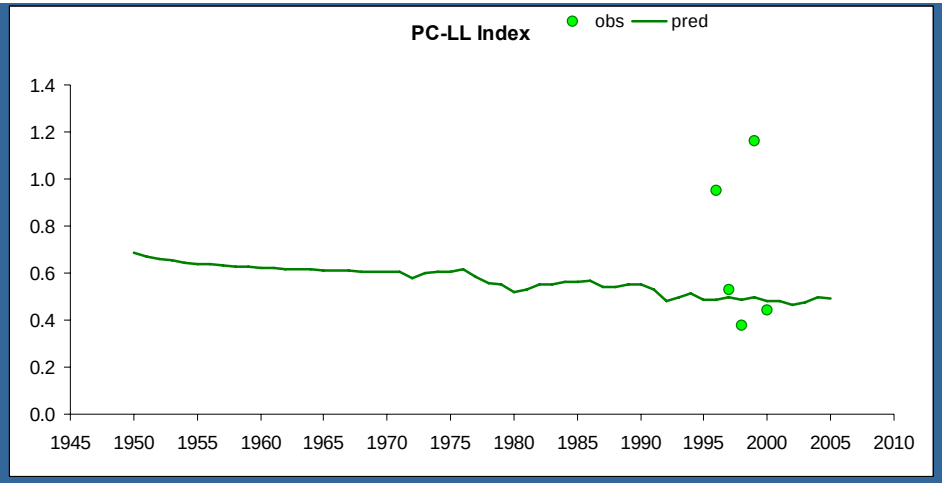
Catches imputed through 1971

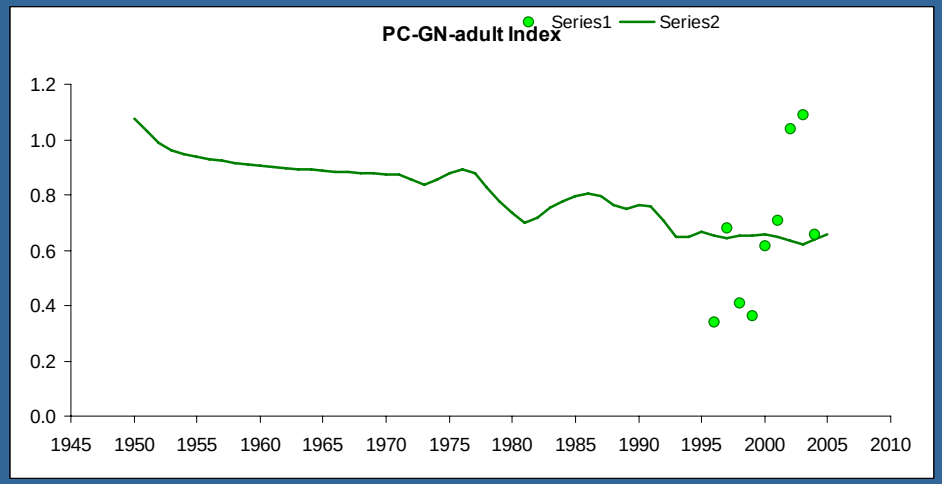


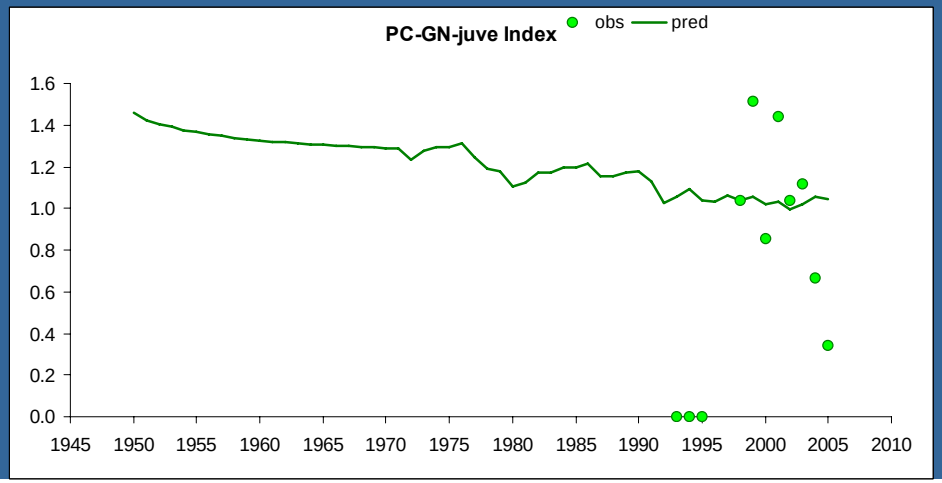

Total F
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

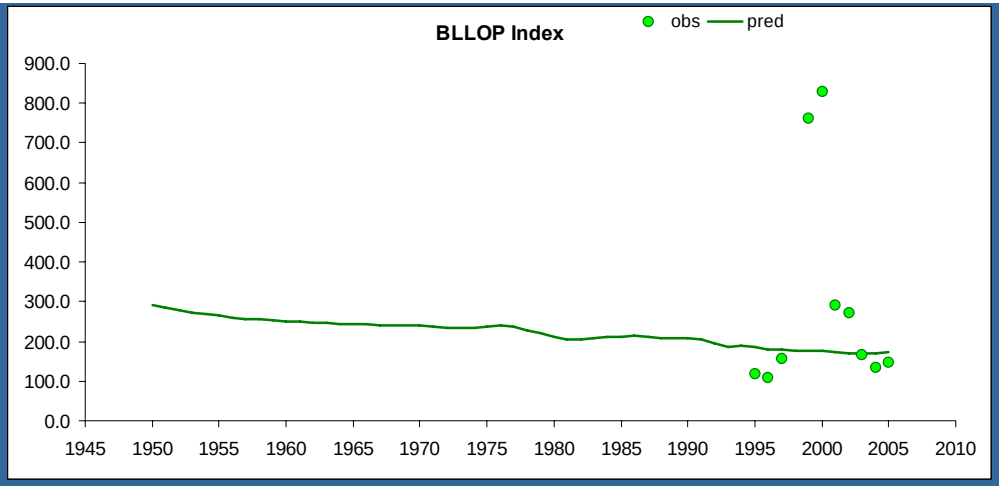

Com-BLL
Com-GN
Com-L
Rec
Shrimp
F by fleet
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

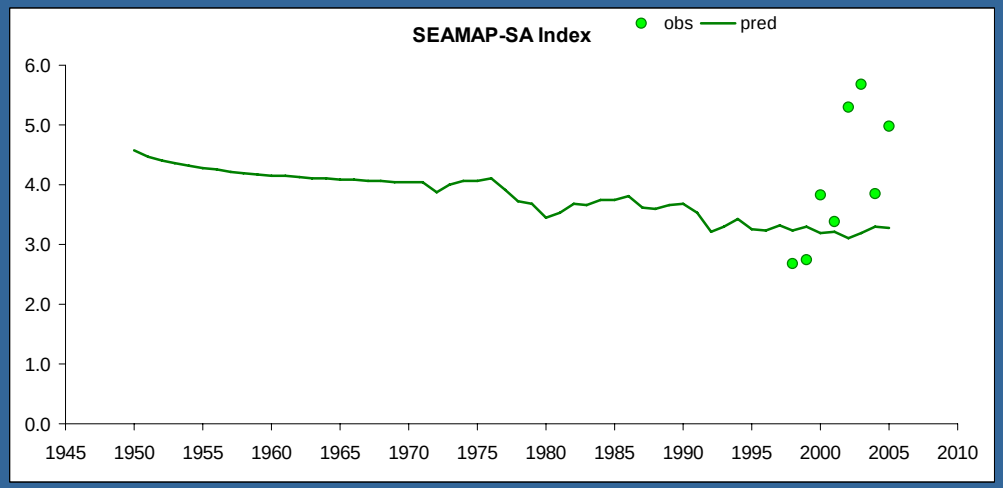

0.25
0.20
0.15
0.10
0.05
0.00
F at age
1
2
3
4
5
6
7
8
9
10
11
12
Age
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

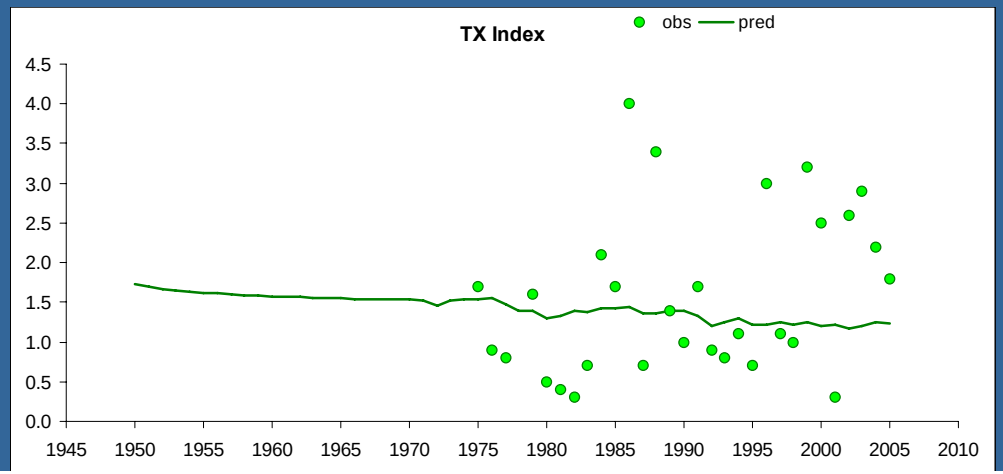

PC-LL Index
obs
pred
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

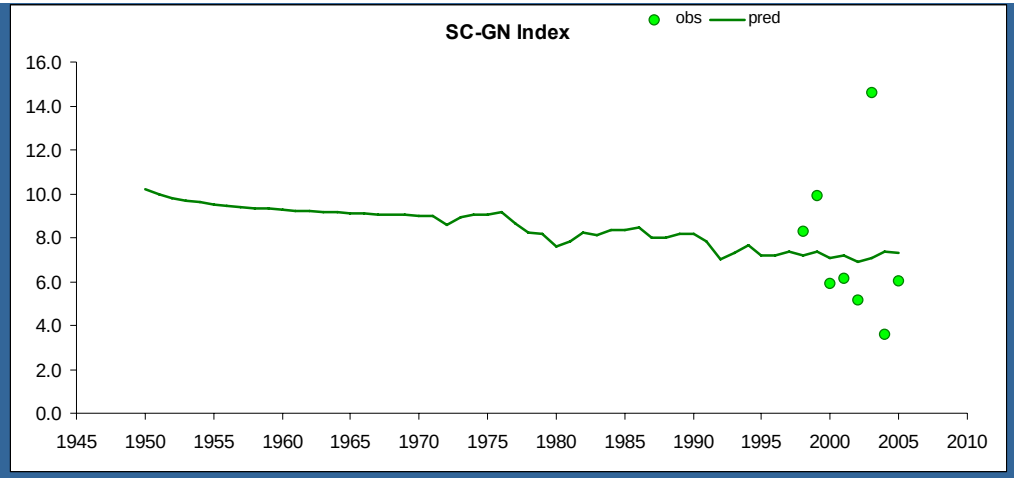

PC-GN-adult Index
Series1
Series2
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

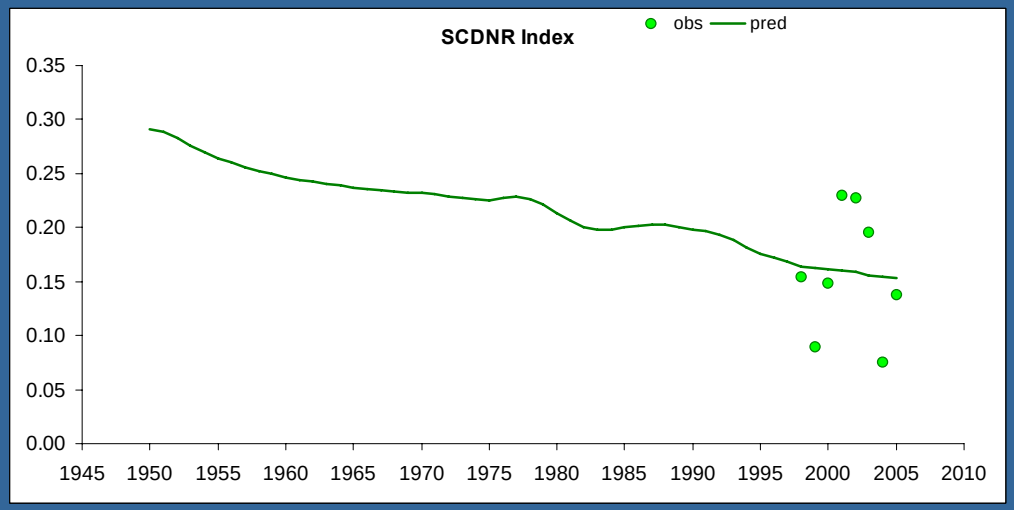

PC-GN-juve Index
obs
pred
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

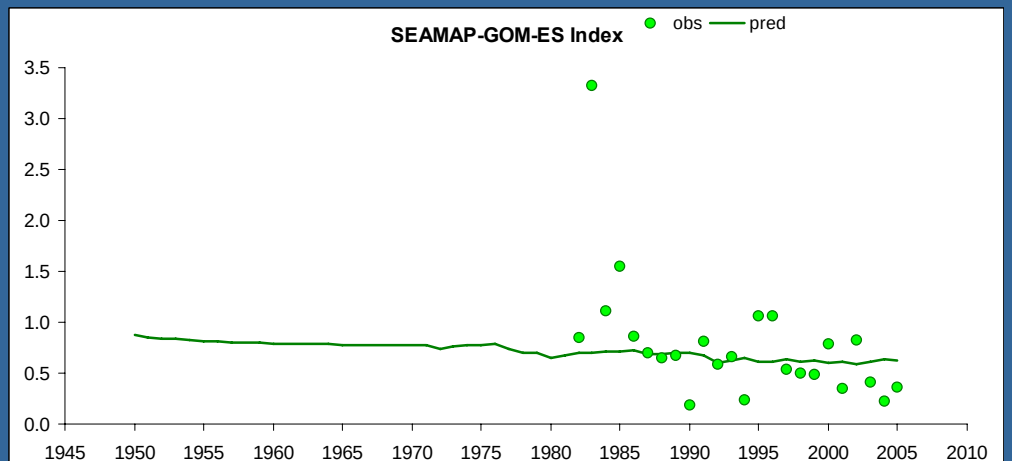

BLLOP Index
obs
pred
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

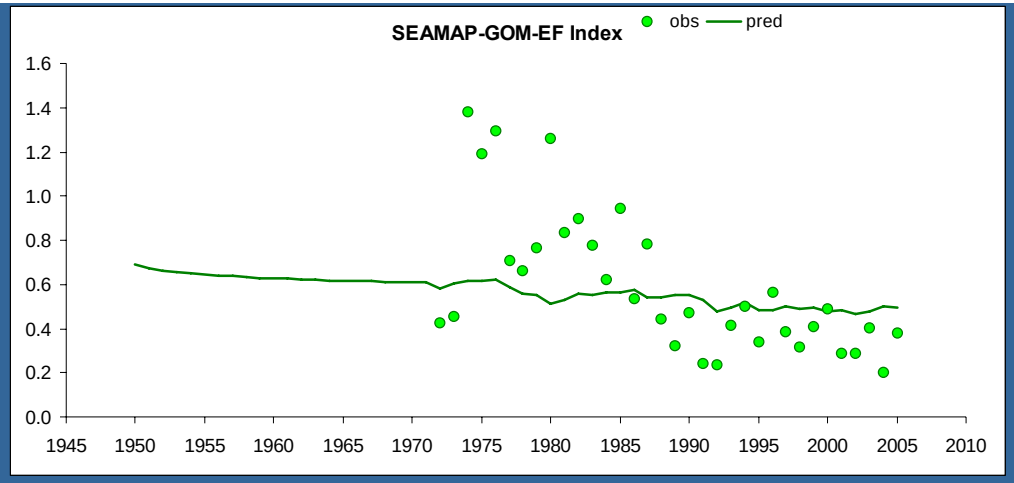

SEAMAP-SA Index
obs
pred
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

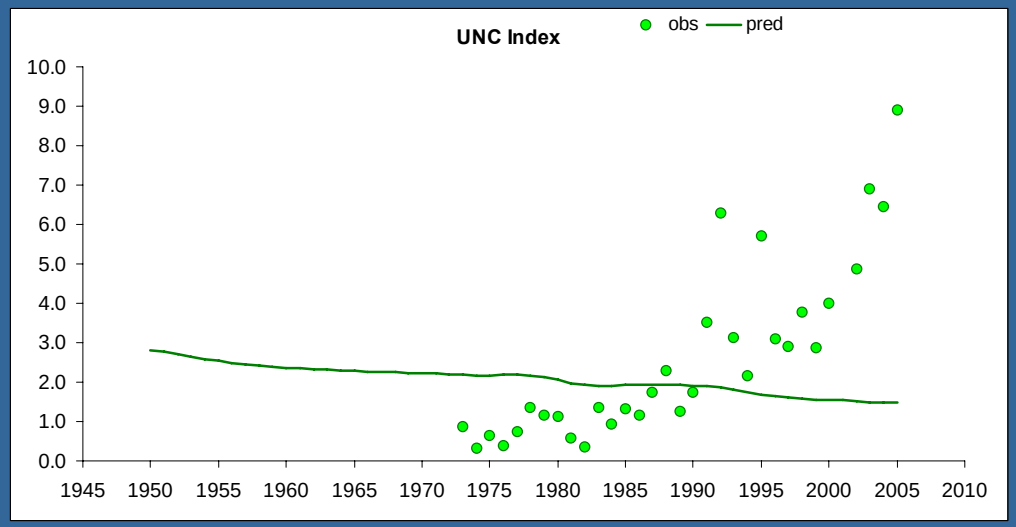

TX Index
obs
pred
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

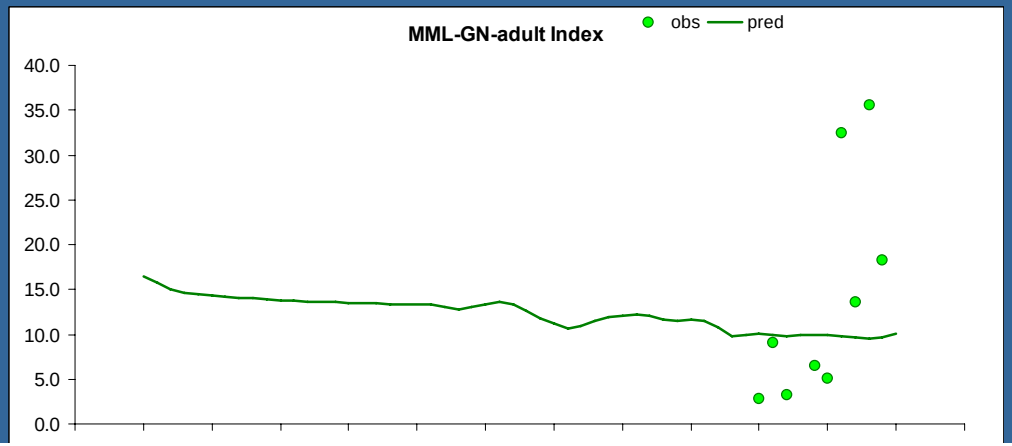

SC-GN Index
obs
pred
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

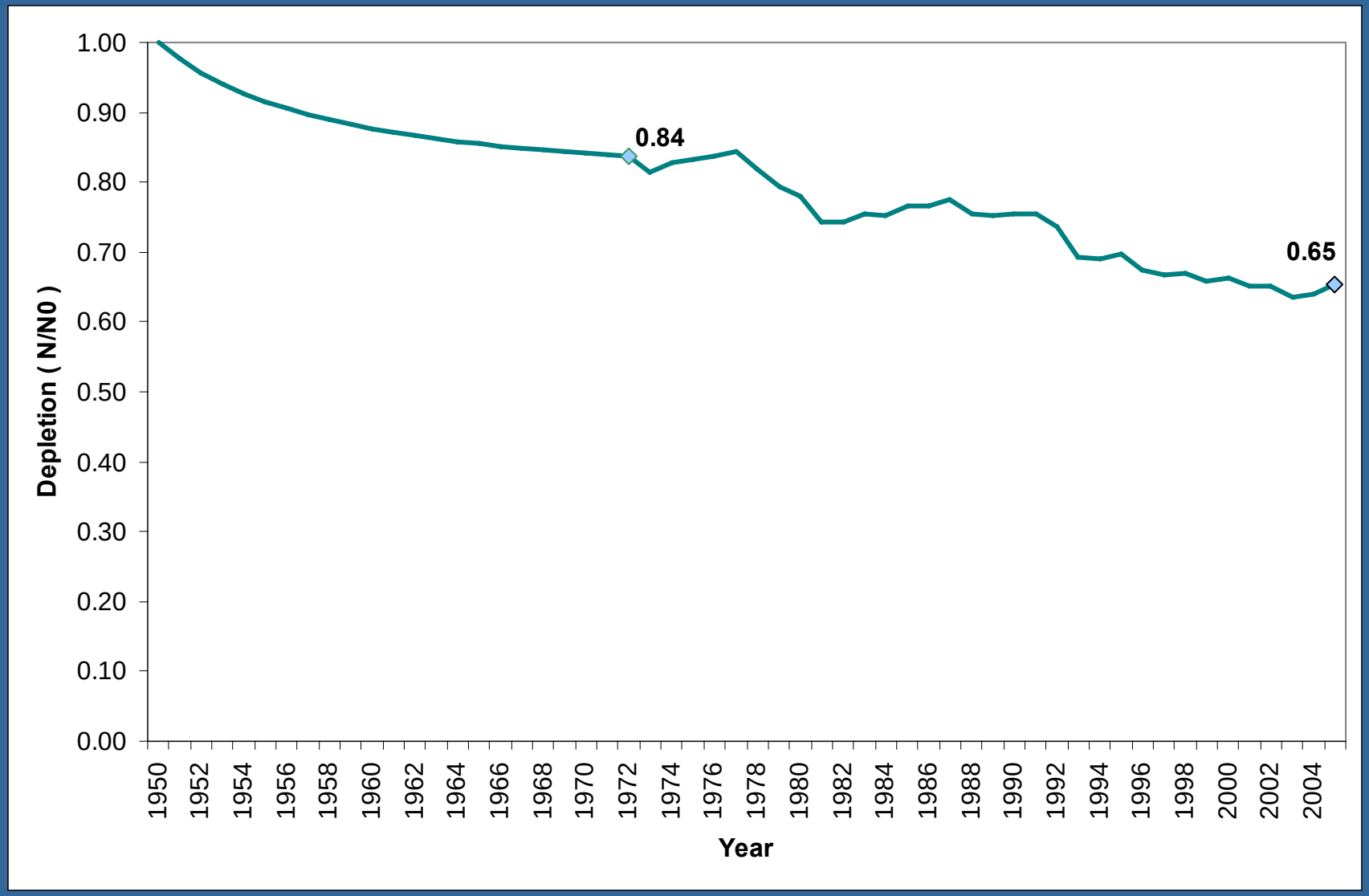

SCDNR Index
obs
pred
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

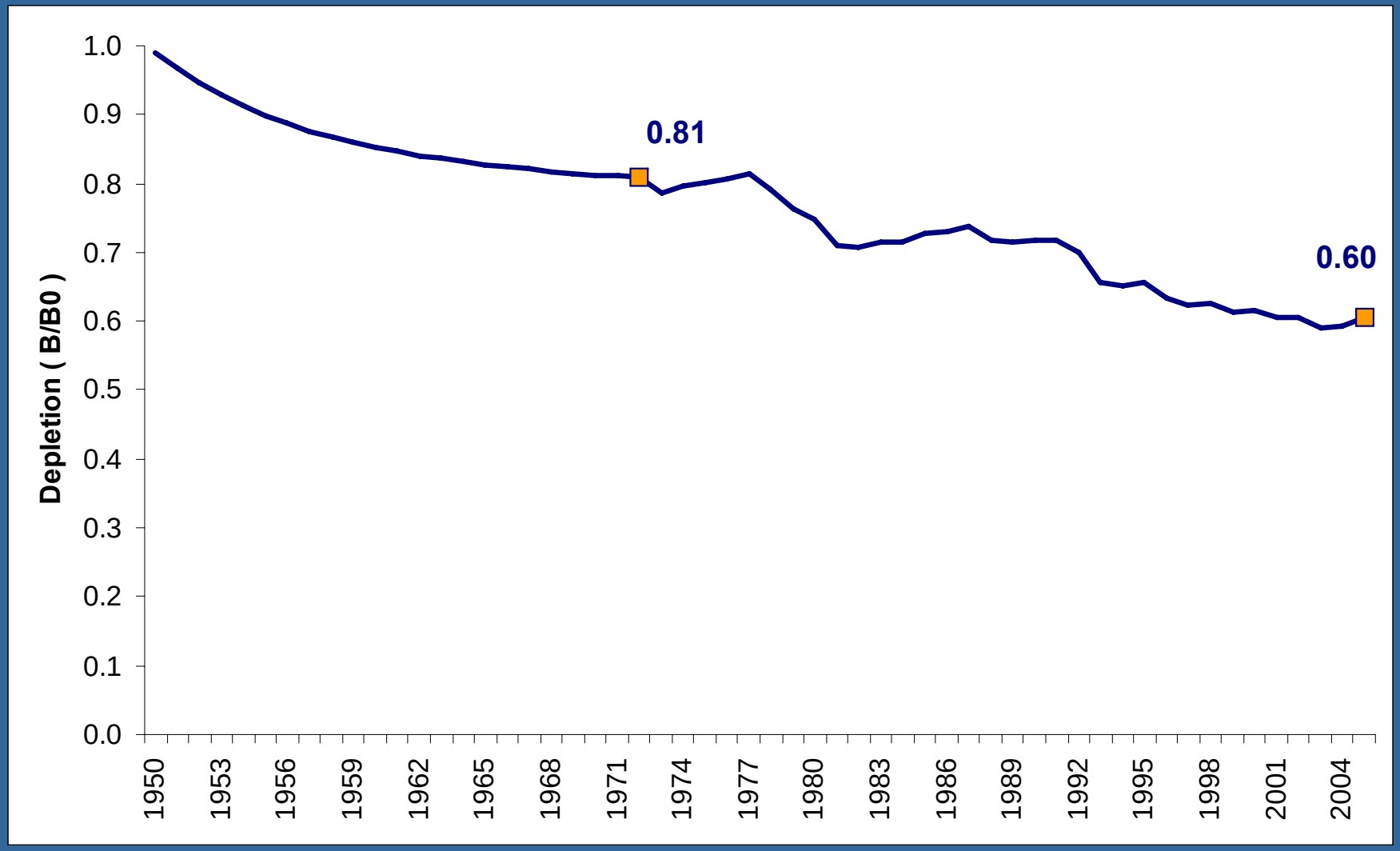

SEAMAP-GOM-ES Index
obs
pred
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

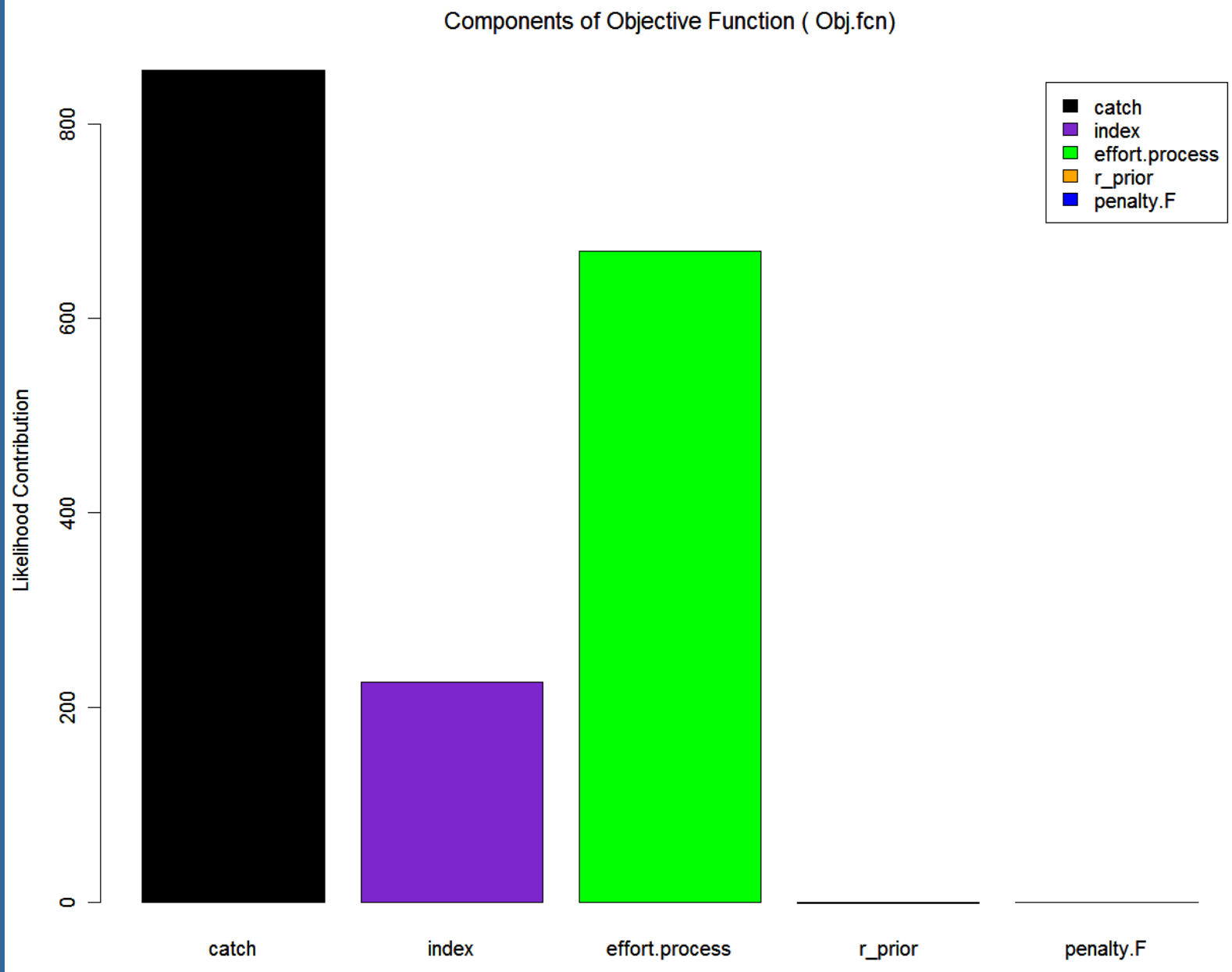

SEAMAP-GOM-EF Index
obs
pred
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

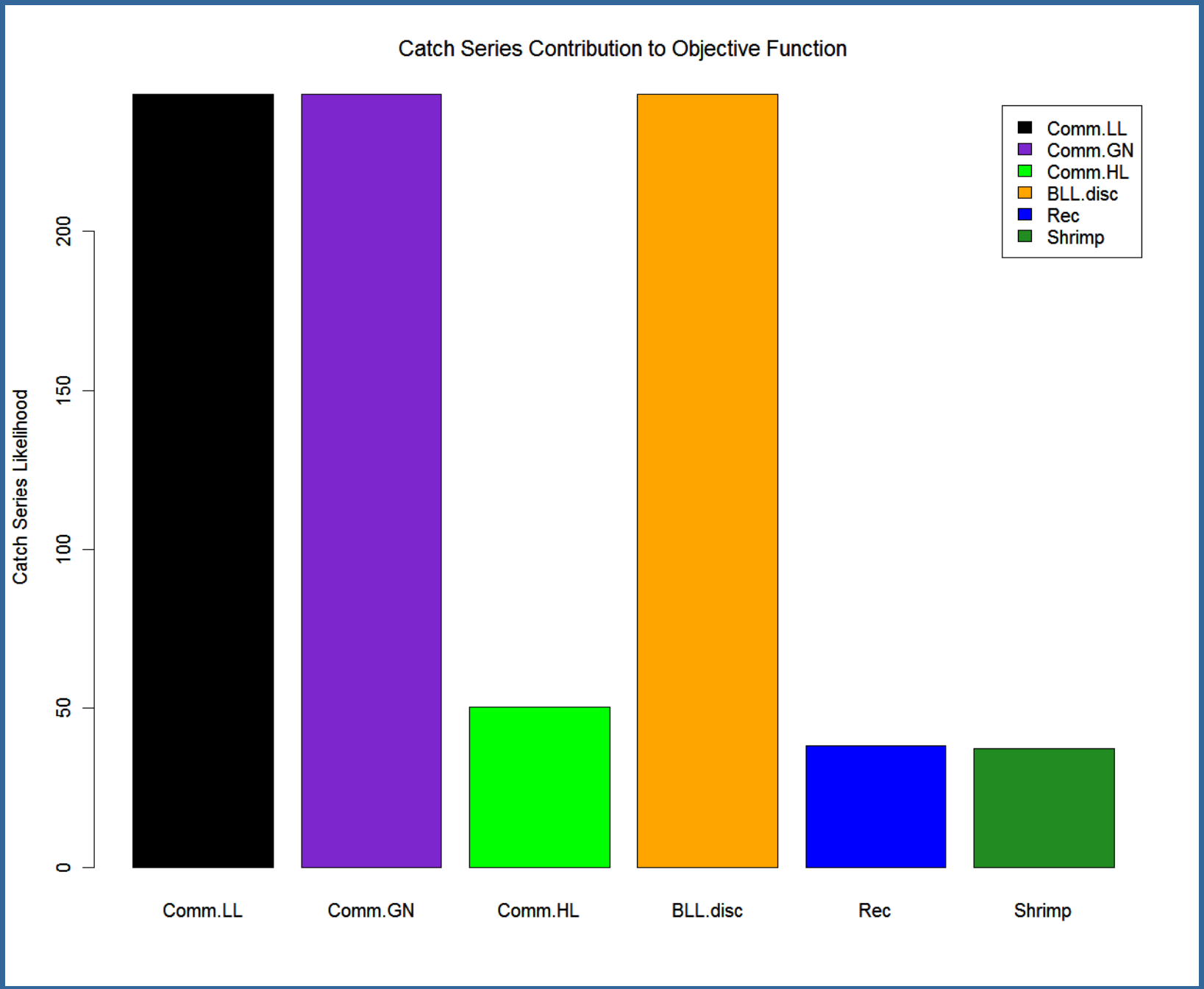

UNC Index
obs
pred
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

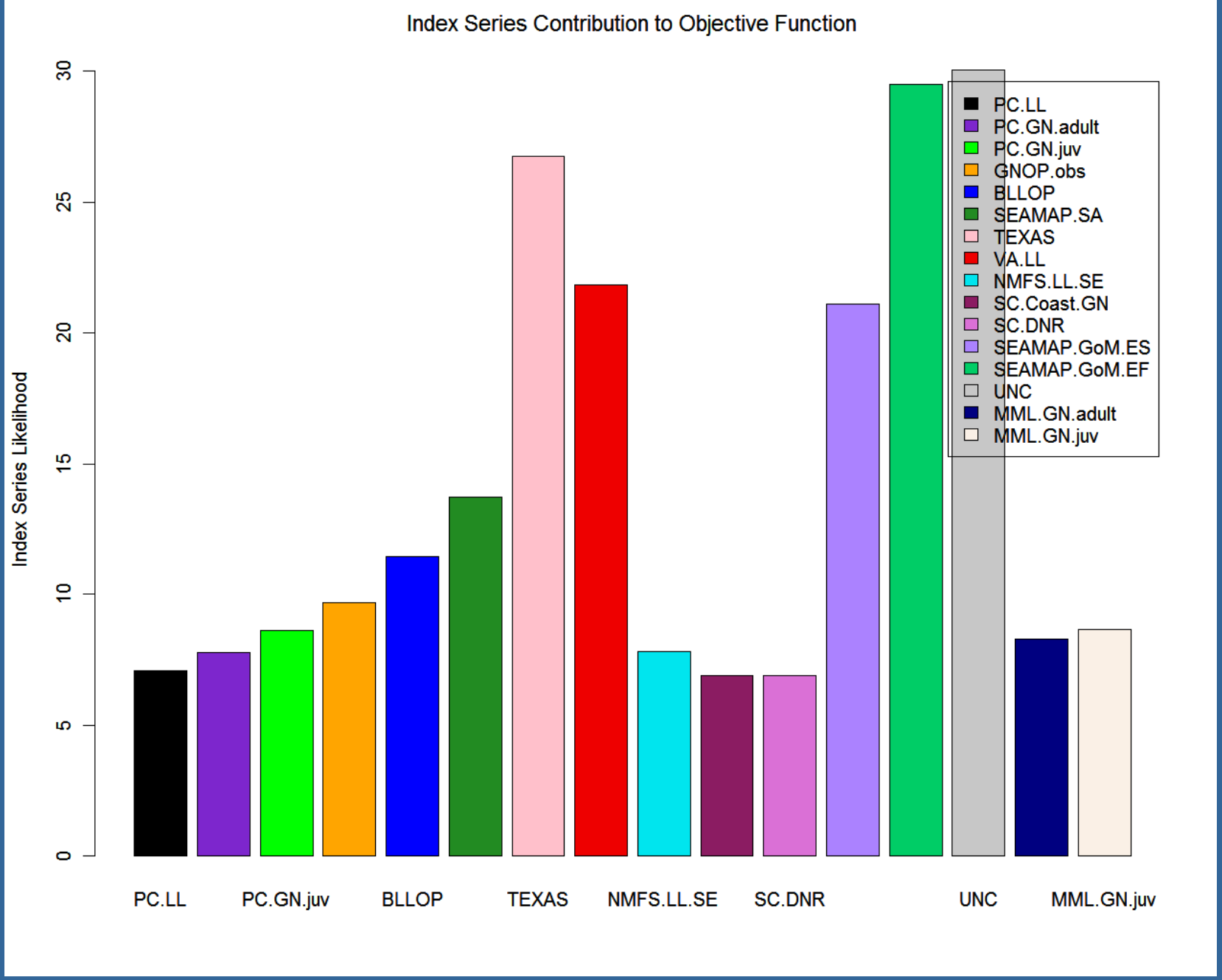

MML-GN-adult Index
obs
pred
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Depletion (N/N0)
0.84
0.65
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year


Depletion (B/B0)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.81
0.60
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004

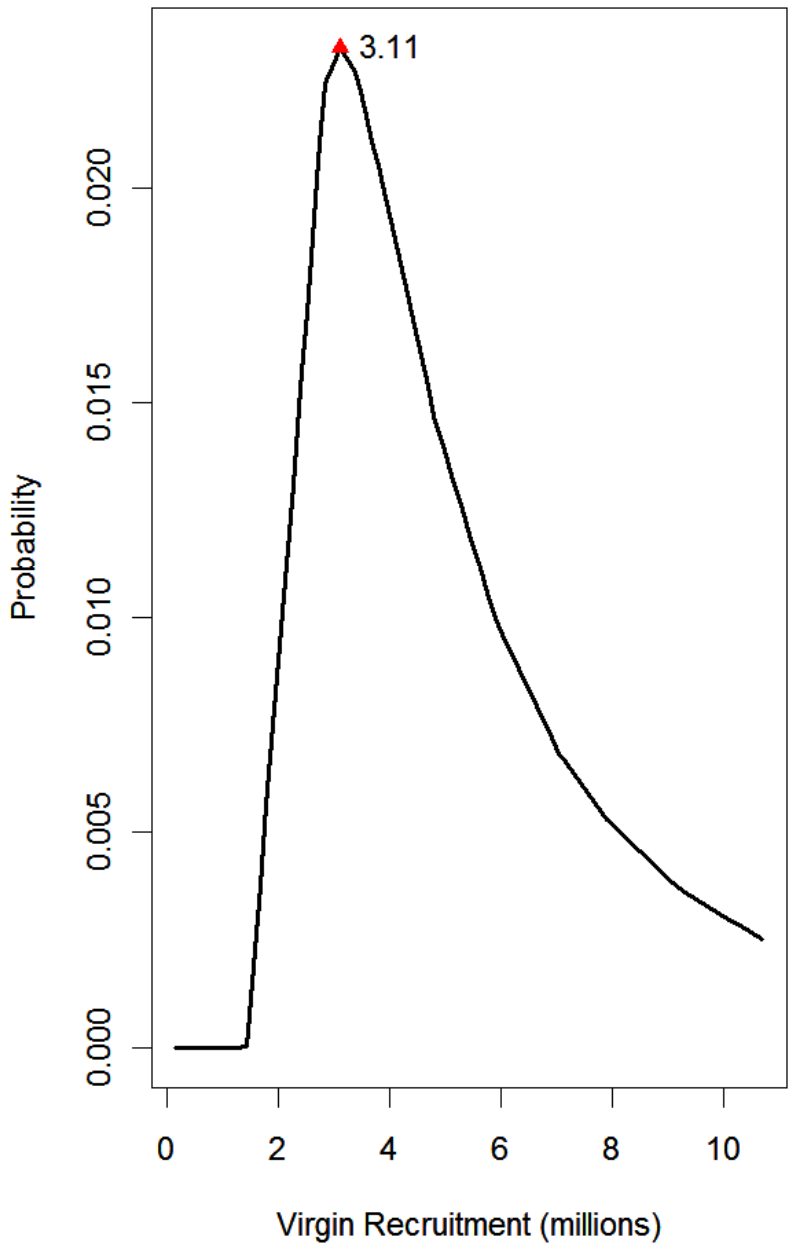

Components of Objective Function (Obj.fcn)
Likelihood Contribution
0
200
400
600
800
catch
index
effort.process
r_prior
penalty.F
catch
index
effort.process
r_prior
penalty.F

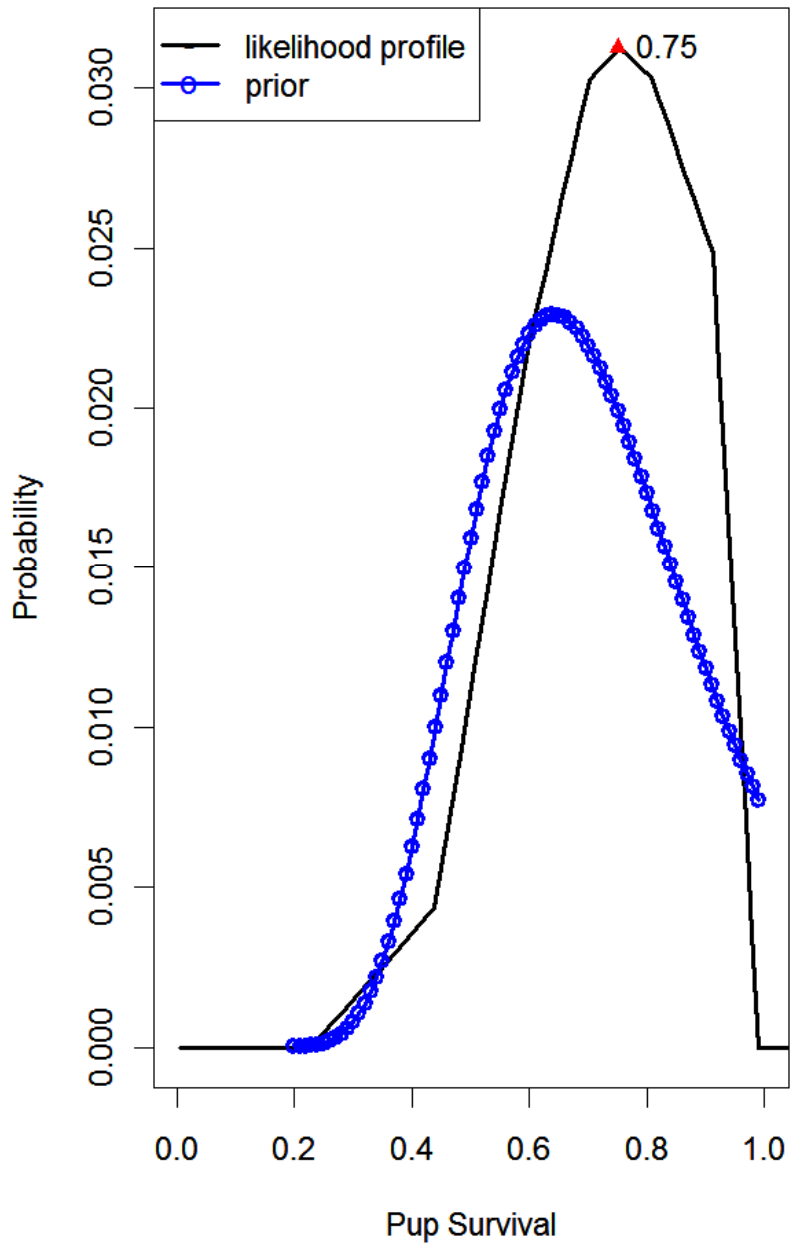

Catch Series Contribution to Objective Function
Catch Series Likelihood
0
50
100
150
200
Comm.LL
Comm.GN
Comm.HL
BLL.disc
Rec
Shrimp
Comm.LL
Comm.GN
Comm.HL
BLL.disc
Rec
Shrimp

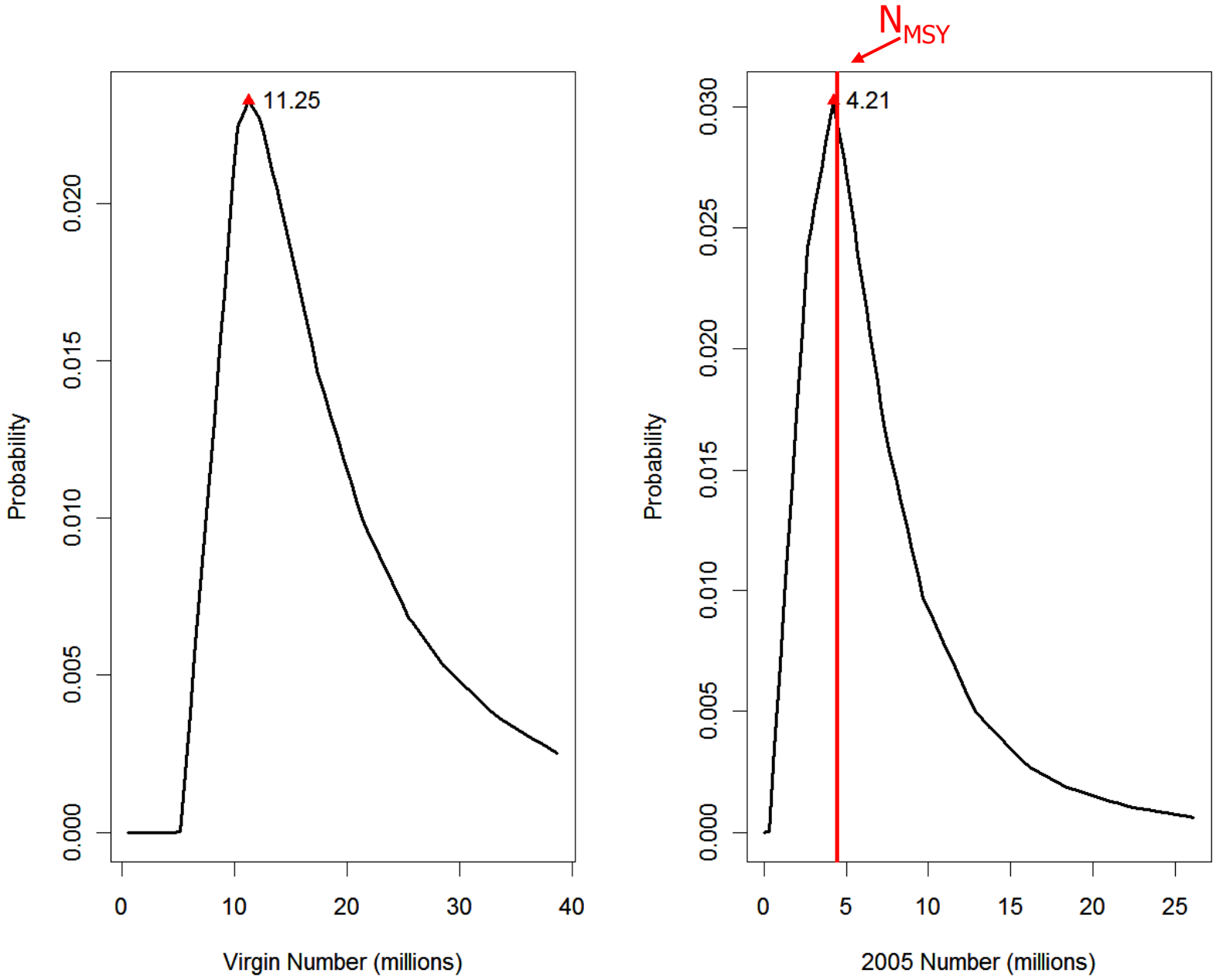

Index Series Contribution to Objective Function
Index Series Likelihood
0
5
10
15
20
25
30
PC.LL
PC.GN.juv
BLLOP
TEXAS
NMFS.LL.SE
SC.DNR
UNC
MML.GN.juv
PC.LL
PC.GN.adult
PC.GN.juv
GNOP.obs
BLLOP
SEAMAP.SA
TEXAS
VA.LL
NMFS.LL.SE
SC.Coast.GN
SC.DNR
SEAMAP.GoM.ES
SEAMAP.GoM.EF
UNC
MML.GN.adult
MML.GN.juv

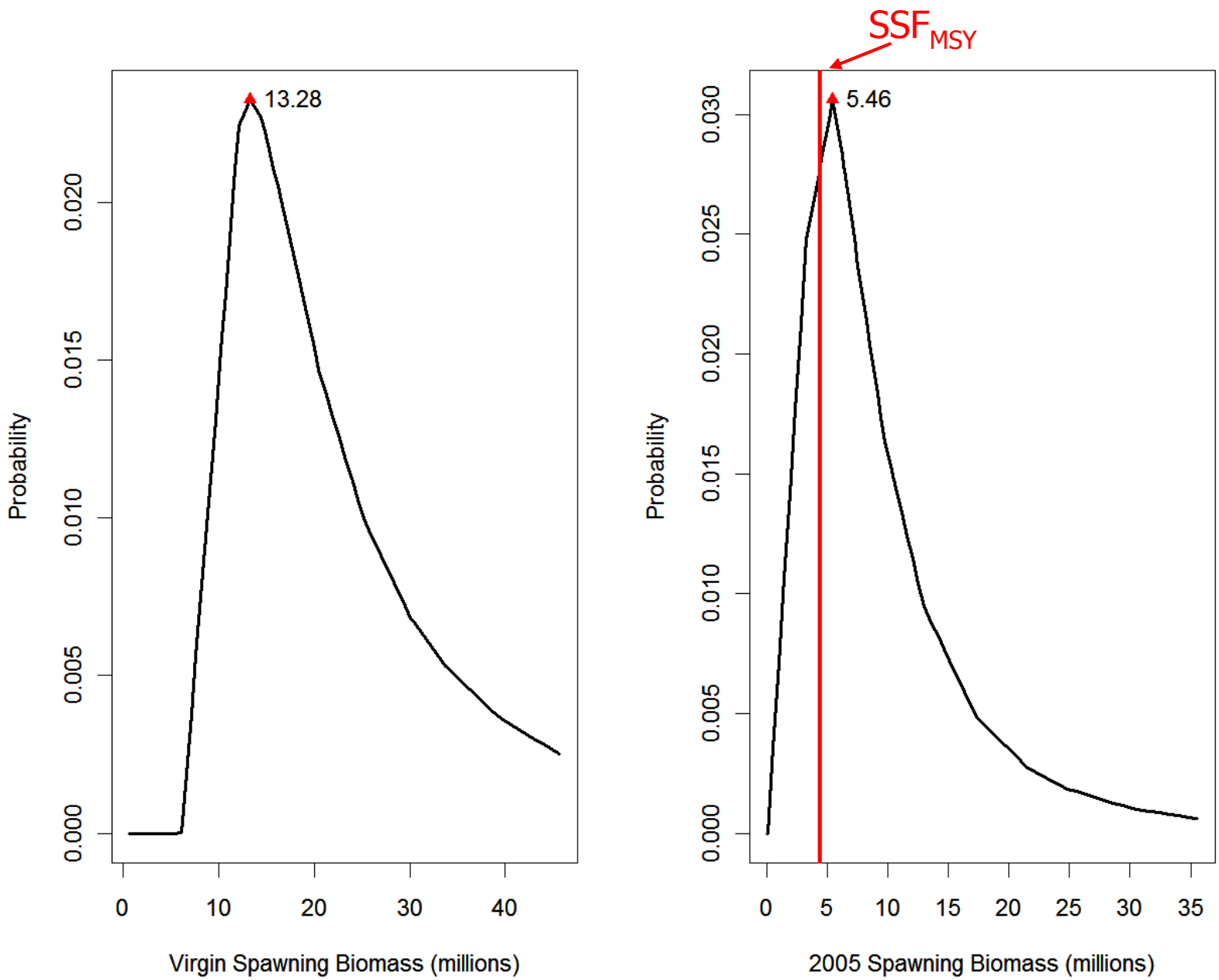
Model Uncertainty

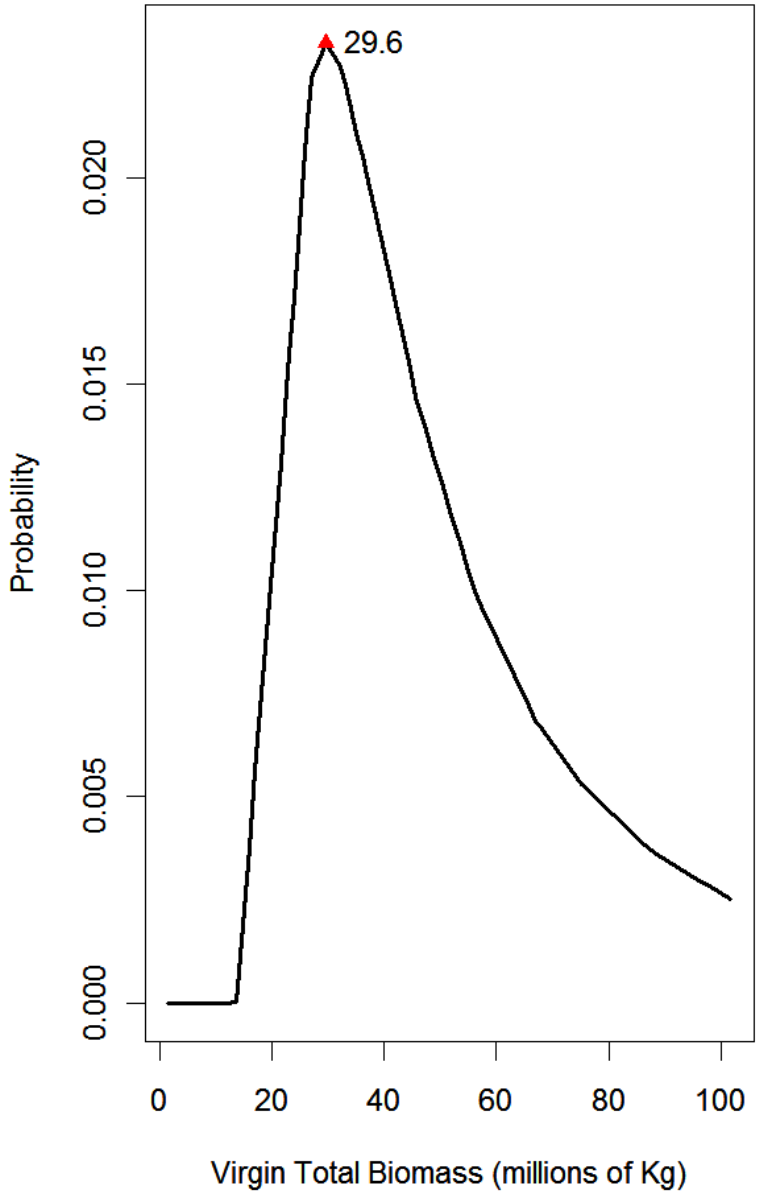
- Likelihood profiling option in AD Model Builder

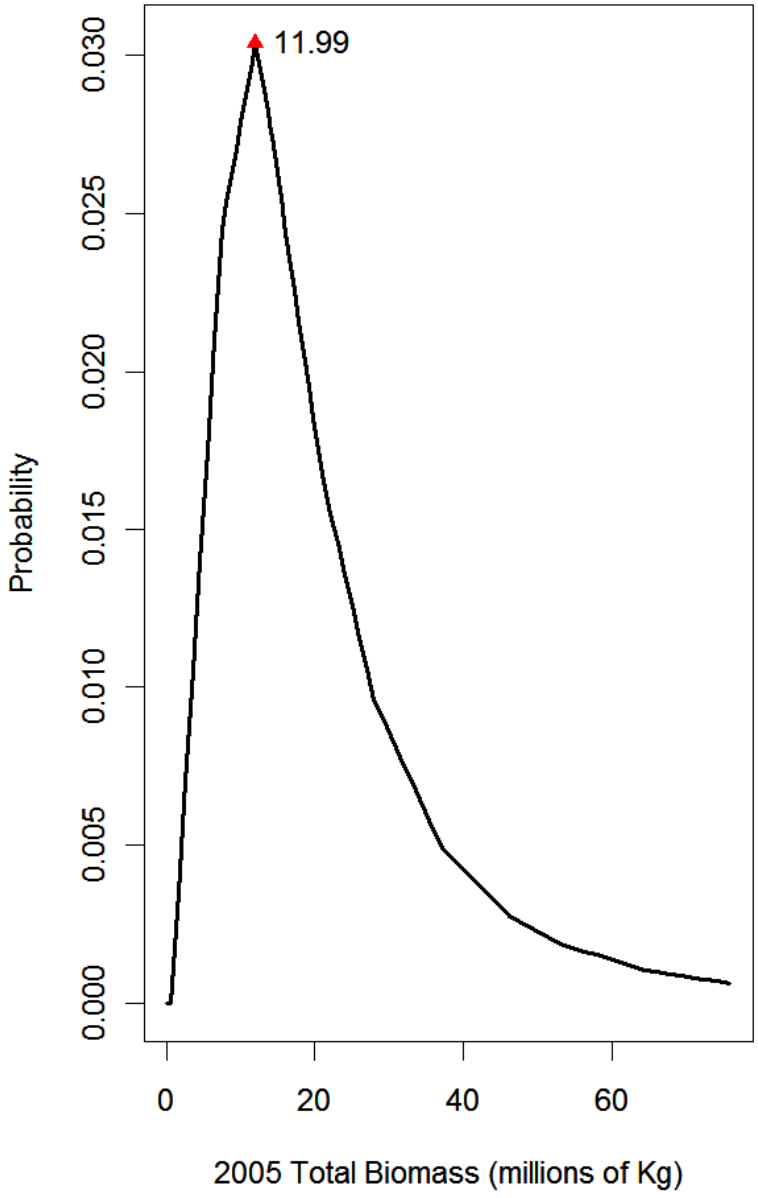

3.11
Probability
0.000
0.005
0.010
0.015
0.020
0
2
4
6
8
10
Virgin Recruitment (millions)

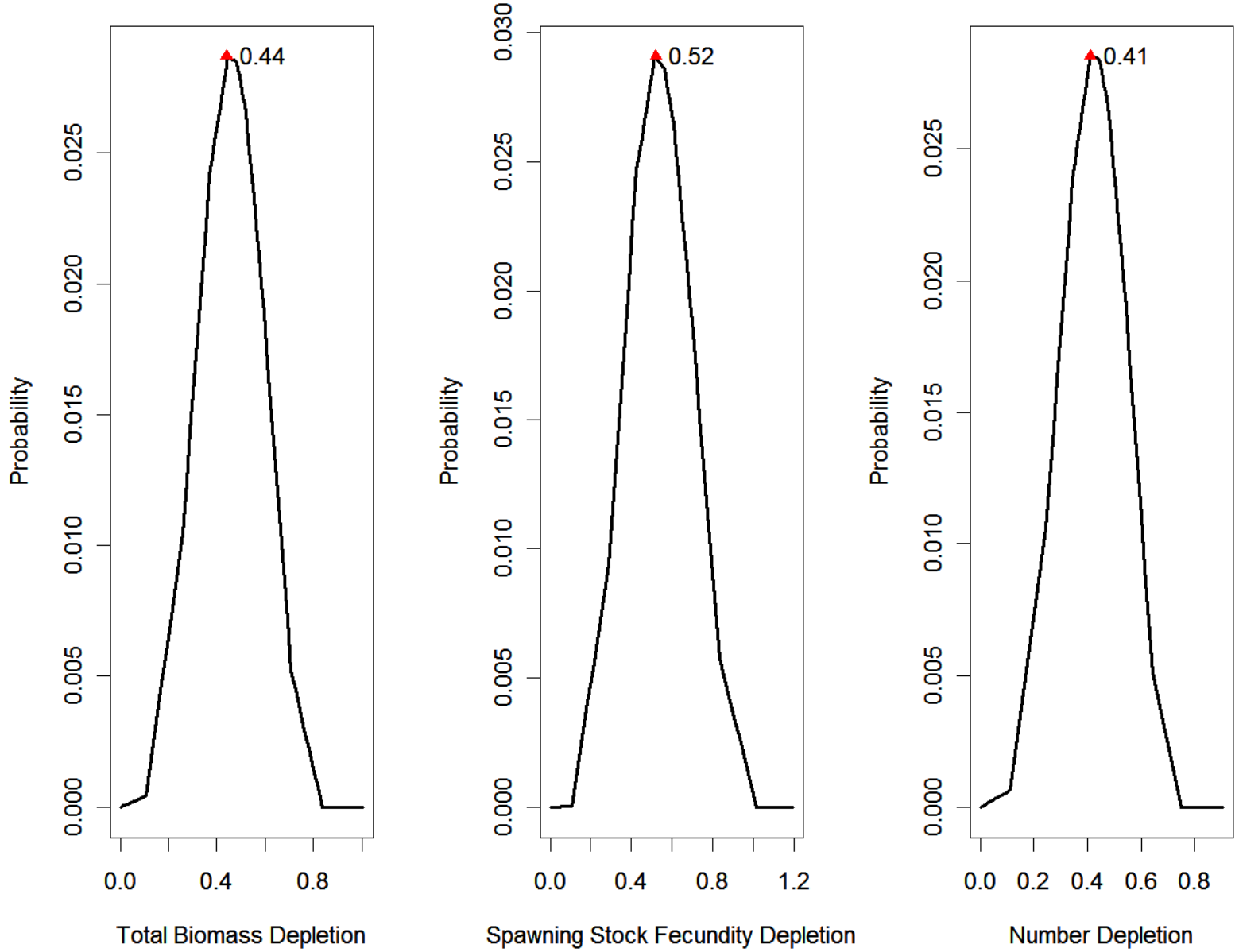

likelihood profile
prior
0.75
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.0
0.2
0.4
0.6
0.8
1.0
Pup Survival

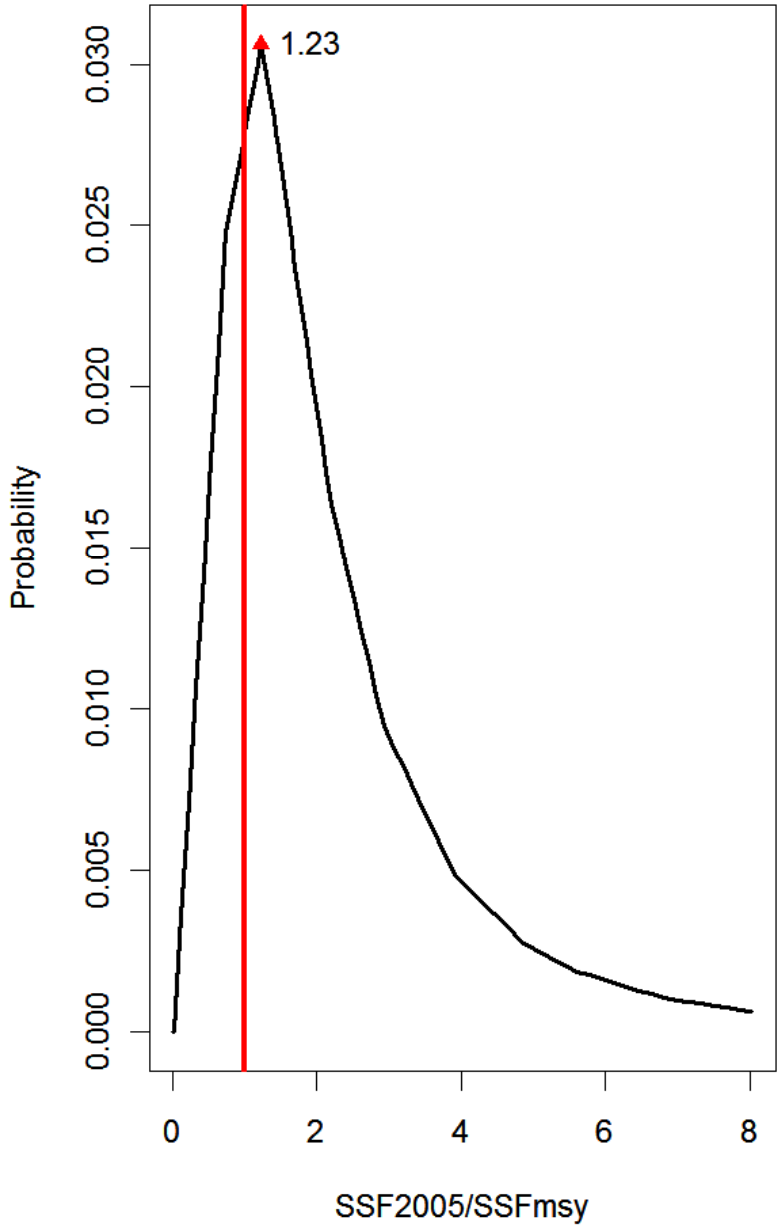

11.25
Probability
0.000
0.005
0.010
0.015
0.020
0
10
20
30
40
Virgin Number (millions)
N MSY
4.21
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0
5
10
15
20
25
2005 Number (millions)

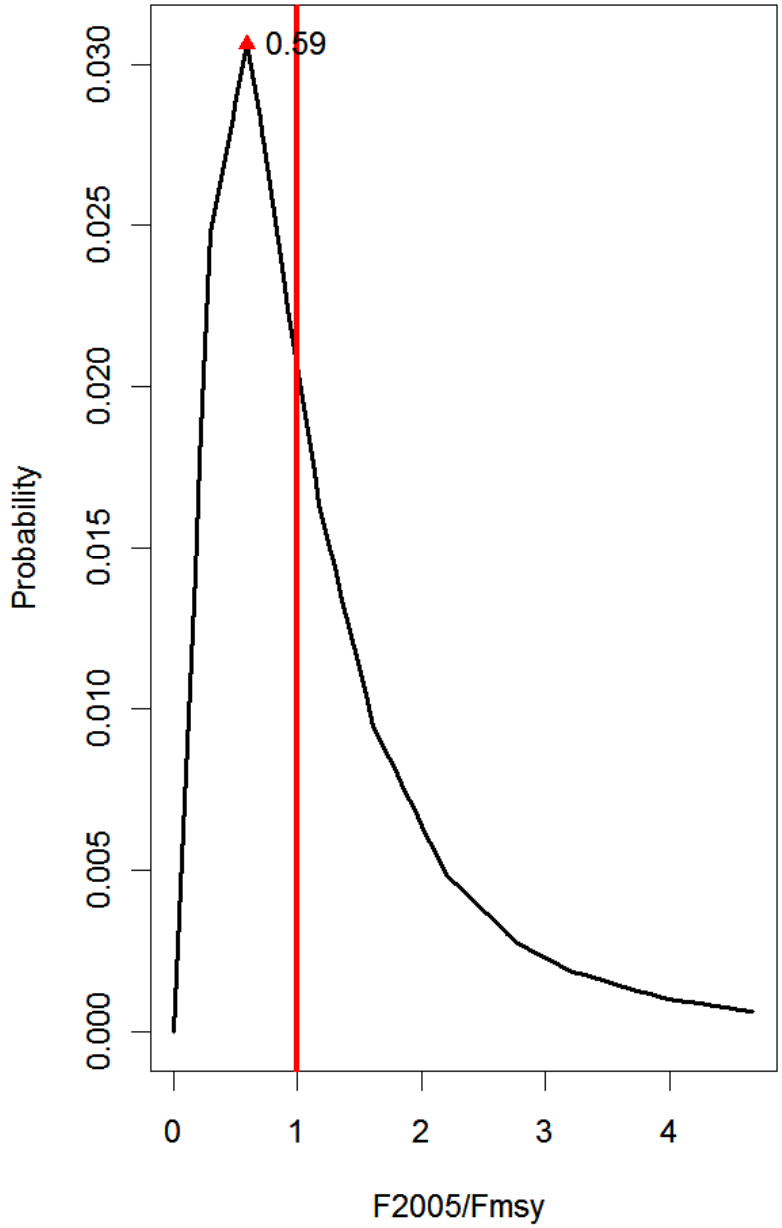

13.28
Probability
0.000
0.005
0.010
0.015
0.020
0
10
20
30
40
Virgin Spawning Biomass (millions)
SSF MSY
5.46
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0
5
10
15
20
25
30
35
2005 Spawning Biomass (millions)


29.6
Probability
0.000
0.005
0.010
0.015
0.020
0
20
40
60
80
100
Virgin Total Biomass (millions of Kg)


11.99
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0
20
40
60
2005 Total Biomass (millions of Kg)


0.44
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.0
0.4
0.8
Total Biomass Depletion
0.52
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.0
0.4
0.8
1.2
Spawning Stock Fecundity Depletion
0.41
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.0
0.2
0.4
0.6
0.8
Number Depletion


1.23
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0
2
4
6
8
SSF2005/SSFmsy


0.59
Probability
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0
1
2
3
4
F2005/Fmsy

Sensitivity Runs

- S1 : base inputs with inverse CV weights
- S2 : separate assessment for Gulf and Atlantic (assumes 2 stocks)
- S3 : using base <u>and</u> sensitivity indices
- S4 : Split SEAMAP into 2 separate indices

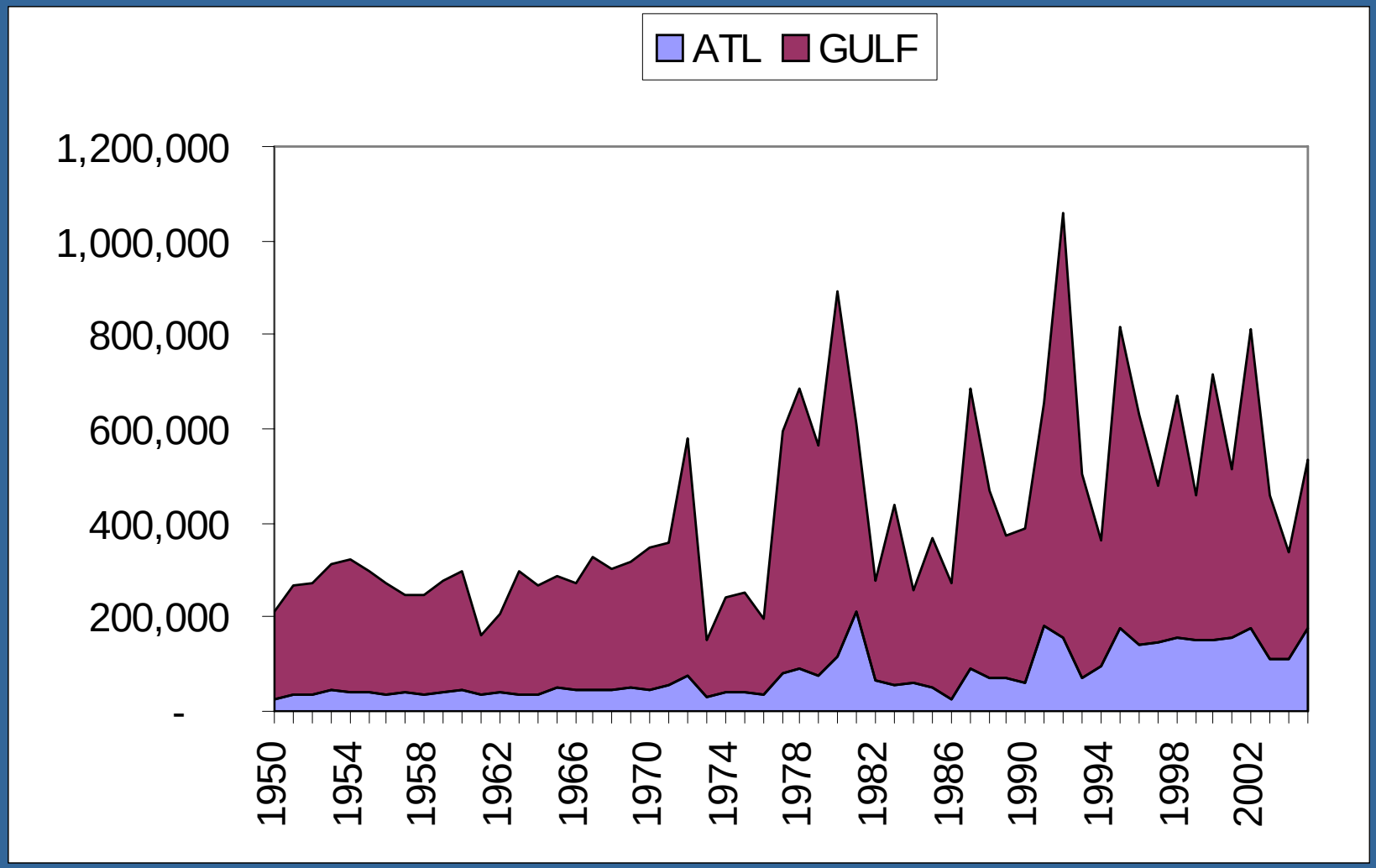
Sensitivity Results

- S1 : base inputs with inverse CV weights
- S2 : separate assessment for Gulf and Atlantic (assumes 2 stocks)
- S3 : using base <u>and</u> sensitivity indices
- S4 : Split SEAMAP into 2 separate indices

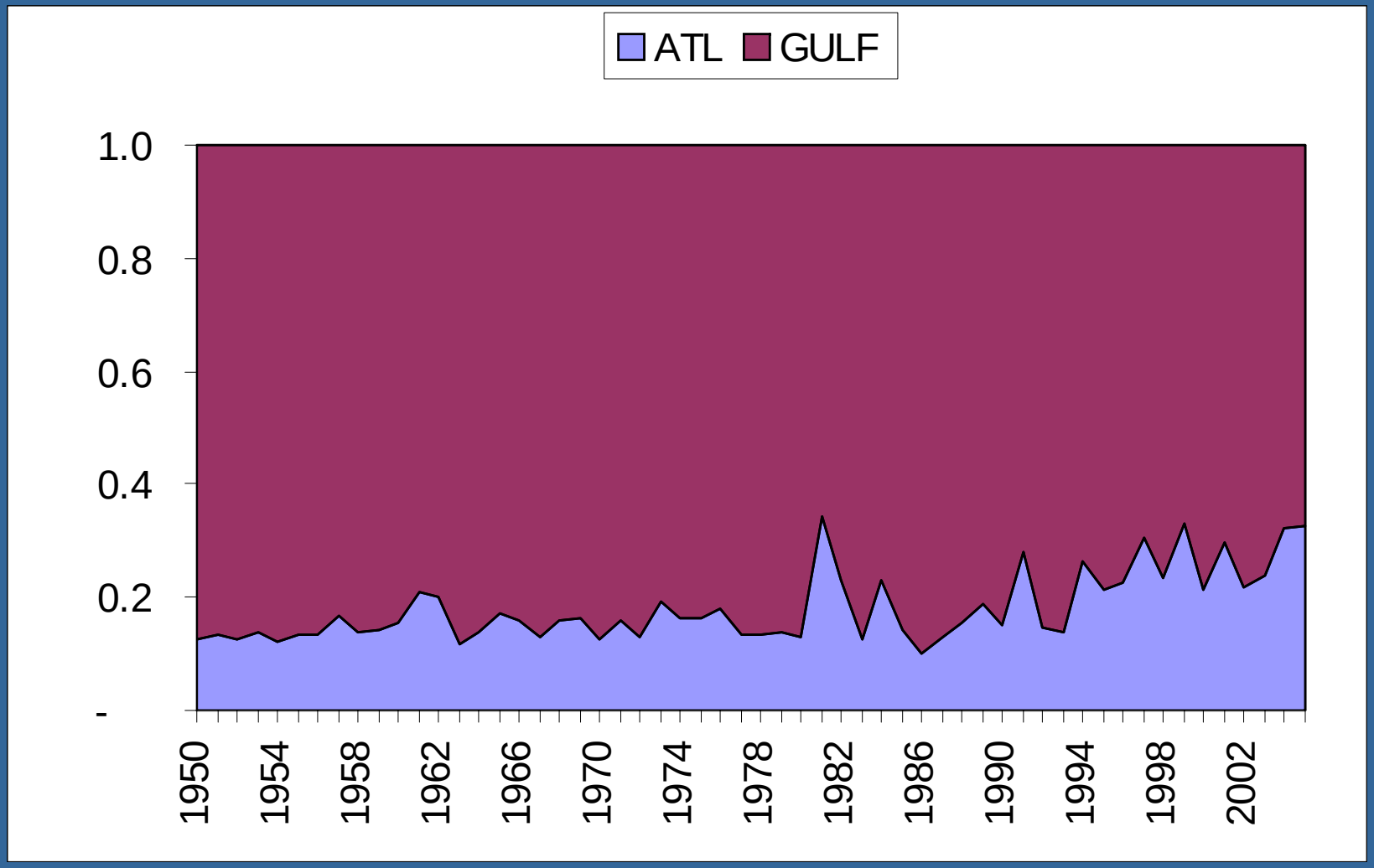
= converged

= no convergence

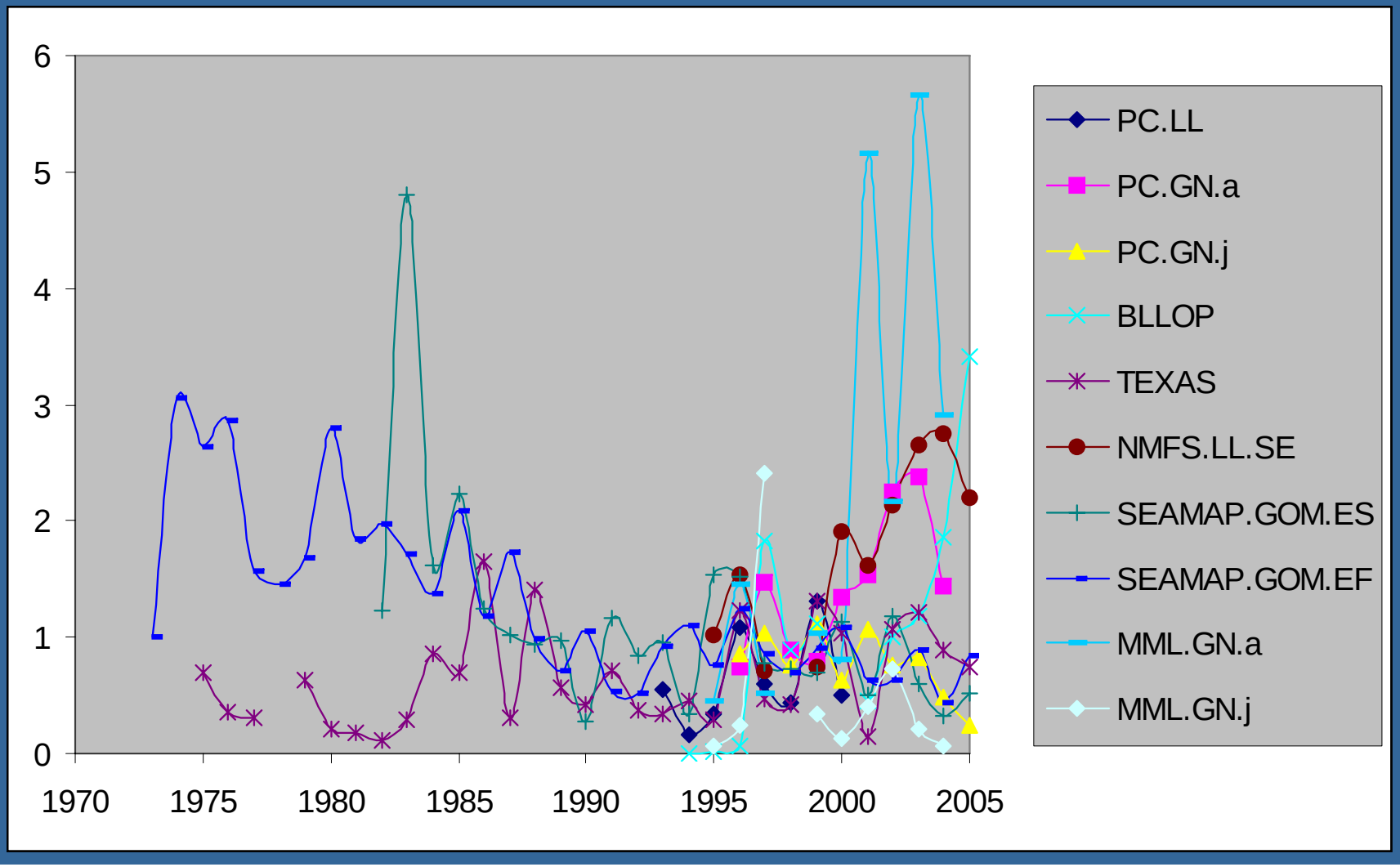
Gulf + Atlantic Landings



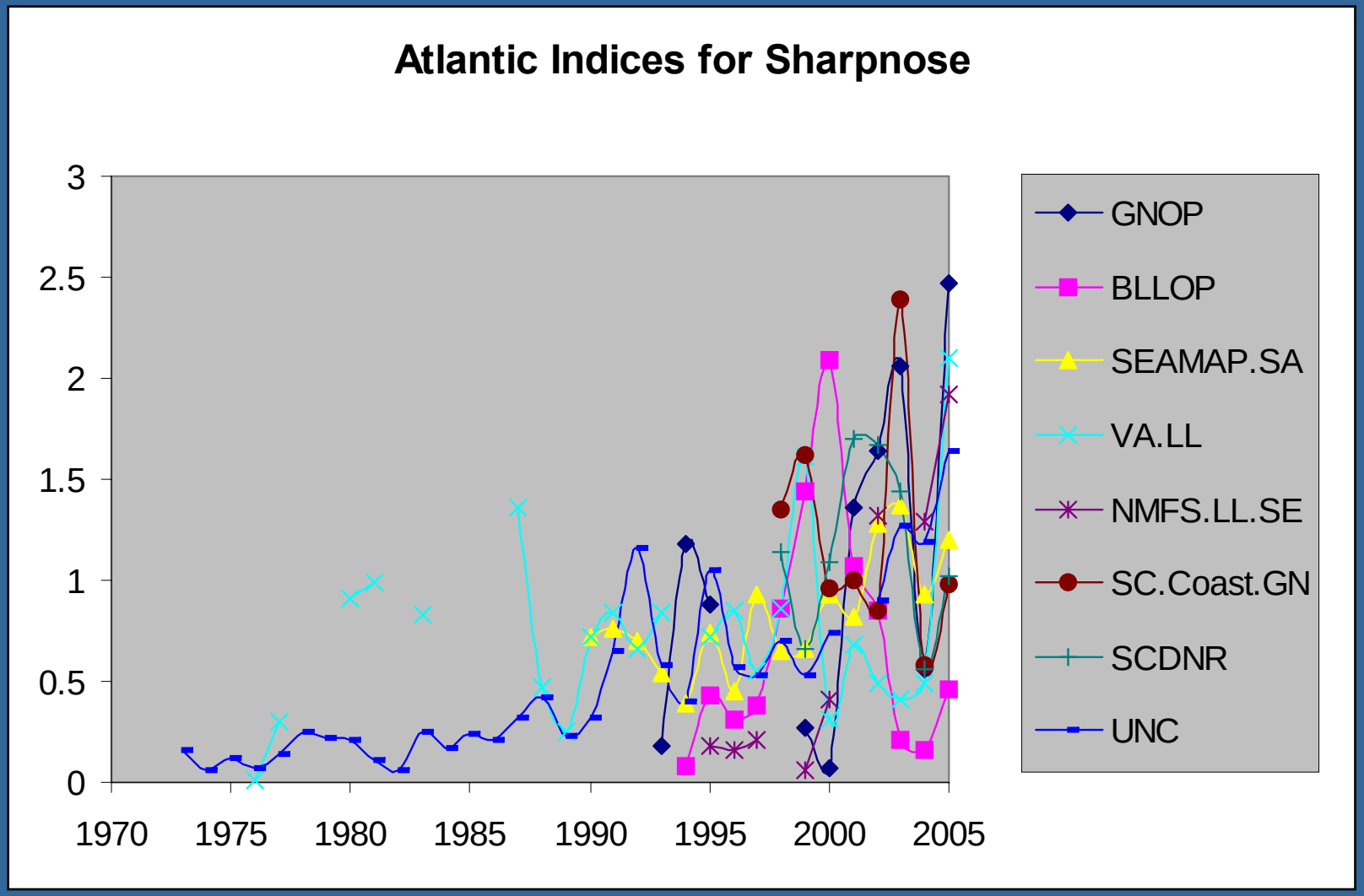
Gulf + Atlantic Landings

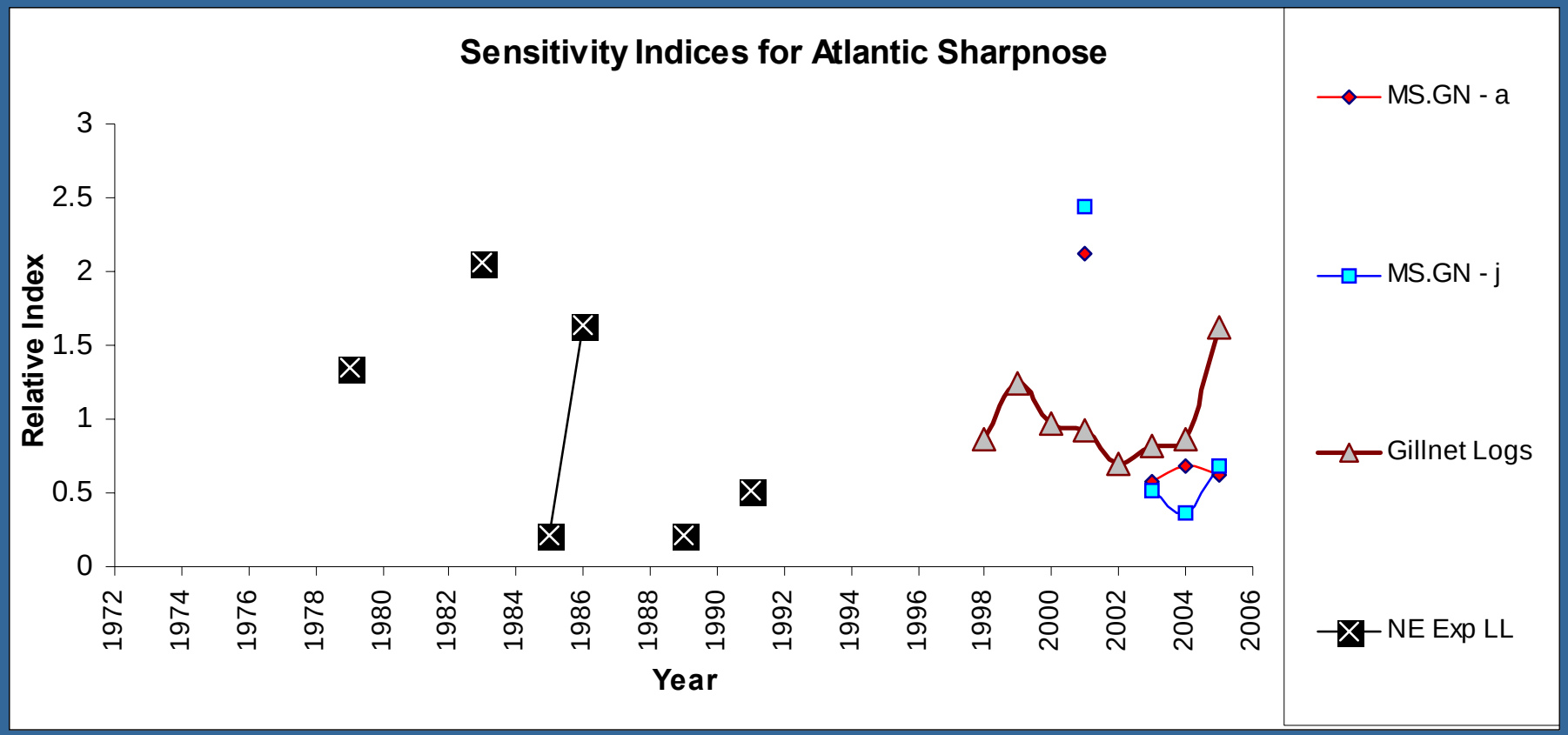


S2: Gulf Indices



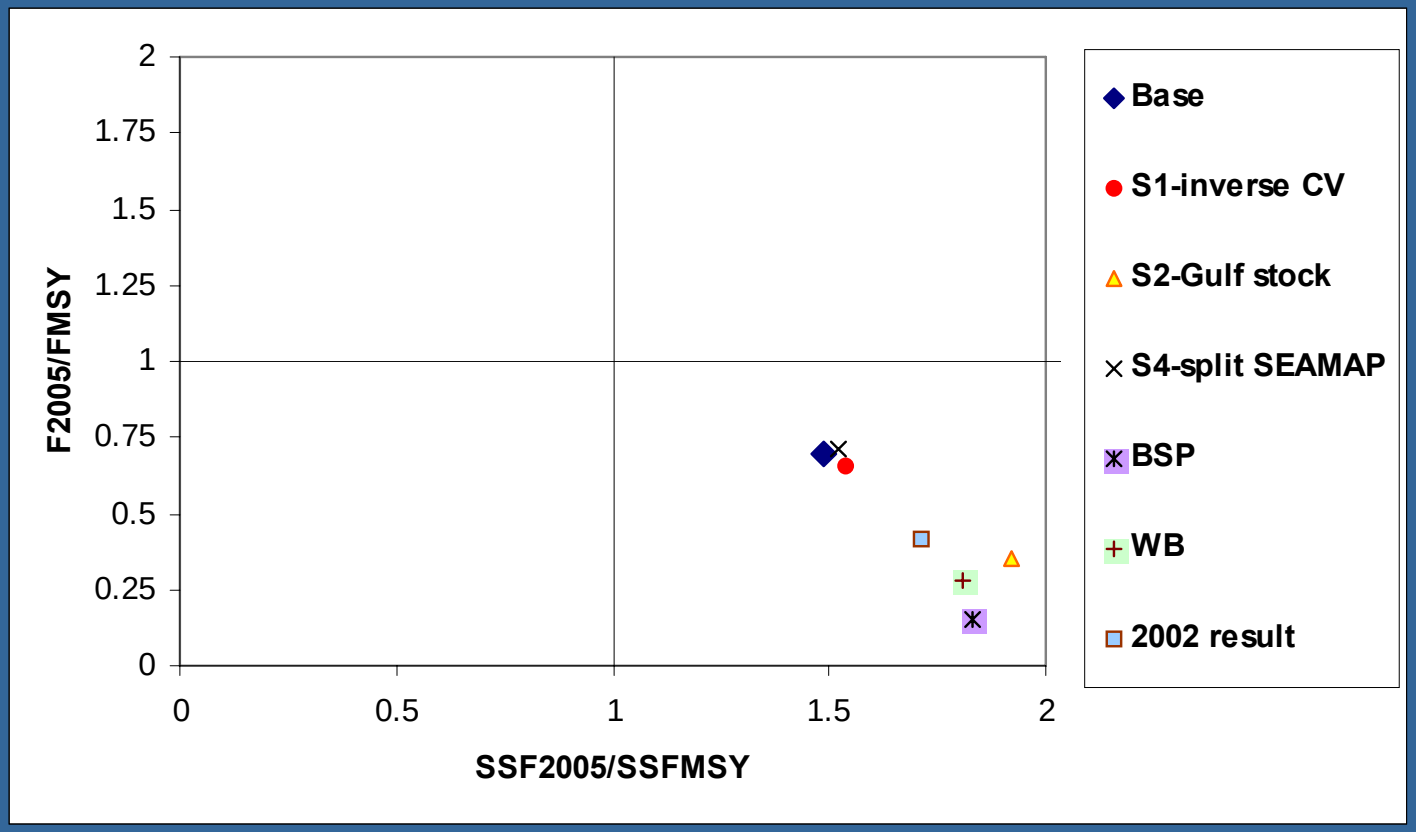
S2: Atlantic Indices




Sensitivity Indices for Atlantic Sharpnose
Relative Index
3
2.5
2
1.5
1
0.5
0
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Year
MS.GN - a
MS.GN - j
Gillnet Logs
NE Exp LL

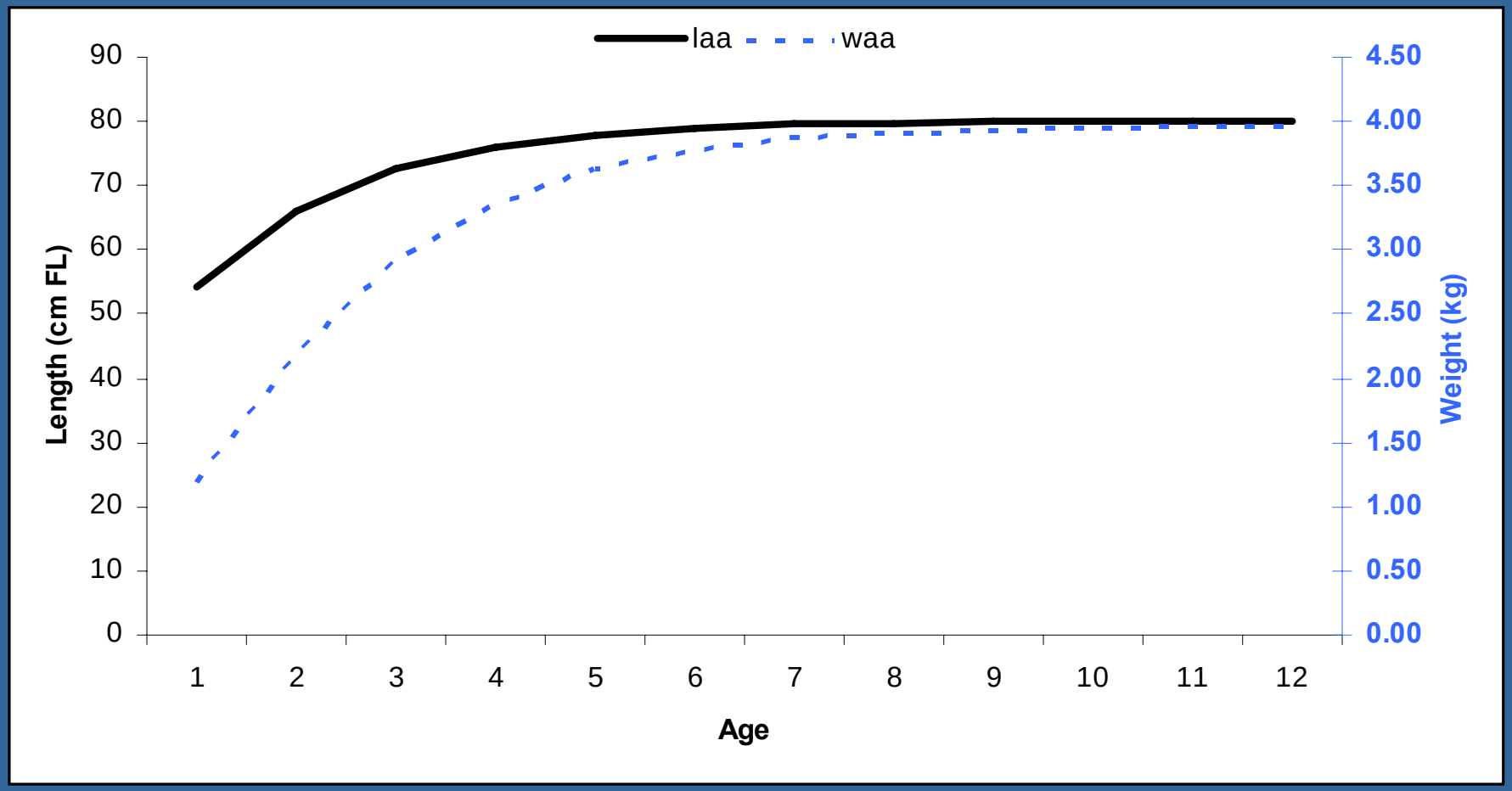
	AW Catches		Inverse CV		Gulf Stock		Seamap Split	
	Base		S1		S2		S4	
Parameter	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV
SSF_{2005}/SSF_{MSY}	**1.47**	0.45	1.56	0.42	1.26	0.45	1.52	0.44
F_{2005}/F_{MSY}	**0.74**	0.79	0.66	0.76	0.81	0.78	0.71	0.78
N_{2005}/N_{MSY}	**1.34**	--	1.41	--	1.18	--	1.37	--
MSY	**1.21E+06**	--	1.28E+06	--	8.60E+05	--	1.24E+06	--
SPR_{MSY}	**0.60**	0.11	0.60	0.11	0.58	0.11	0.59	0.11
F_{MSY}	**0.19**	--	0.19	--	0.25	--	0.19	--
SSF_{MSY}	**4.43E+06**	--	4.67E+06	--	2.63E+06	--	4.43E+06	--
N_{MSY}	**4.45E+06**	--	4.69E+06	--	2.65E+06	--	4.47E+06	--
F2005	**0.14**	0.79	0.12	0.76	0.20	0.23	0.13	0.78
SSF2005	**6.53E+06**	0.66	7.30E+06	0.61	3.33E+06	0.29	6.72E+06	0.65
N2005	**5.96E+06**	--	6.59E+06	--	3.12E+06	--	6.11E+06	--
SSF2005/SSF0	**0.56**	0.32	0.59	0.29	0.47	0.68	0.57	0.31
B2005/B0	**0.48**	0.31	0.51	0.27	0.40	0.26	0.49	0.29
R0	**3.11E+06**	0.36	3.29E+06	0.35	1.91E+06	0.16	3.13E+06	0.36
Pup-survival	**0.75**	0.28	0.76	0.28	0.81	0.16	0.77	0.28
alpha	**2.84**	--	2.85	--	3.03	--	2.88	--
steepness	**0.41**	--	0.42	--	0.43	--	0.42	--

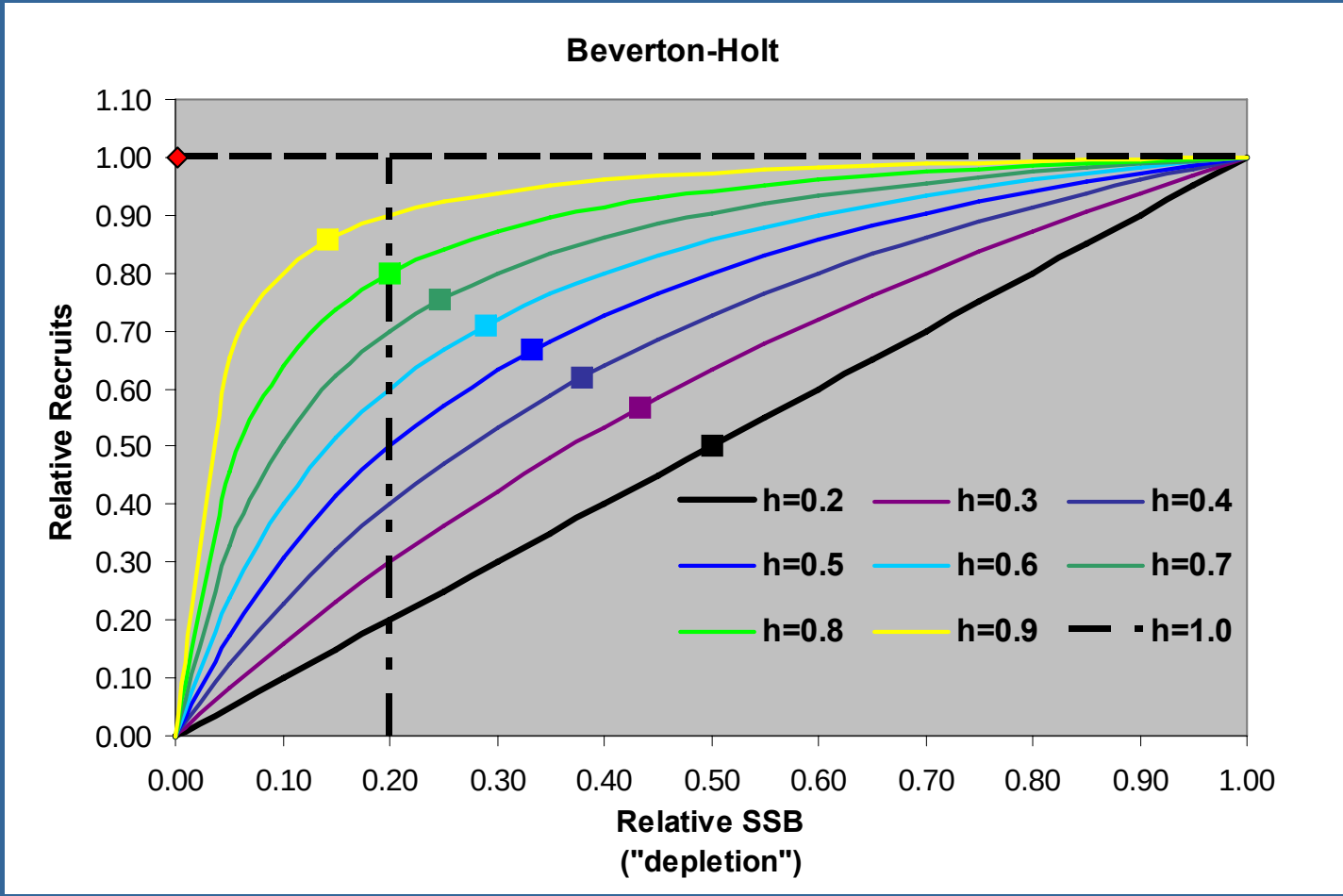
Atlantic Sharpnose Conclusions



- Not overfished
- No overfishing

Extra slides


laa
waa
Length (cm FL)
Weight (kg)
Age
0
10
20
30
40
50
60
70
80
90
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
1
2
3
4
5
6
7
8
9
10
11
12

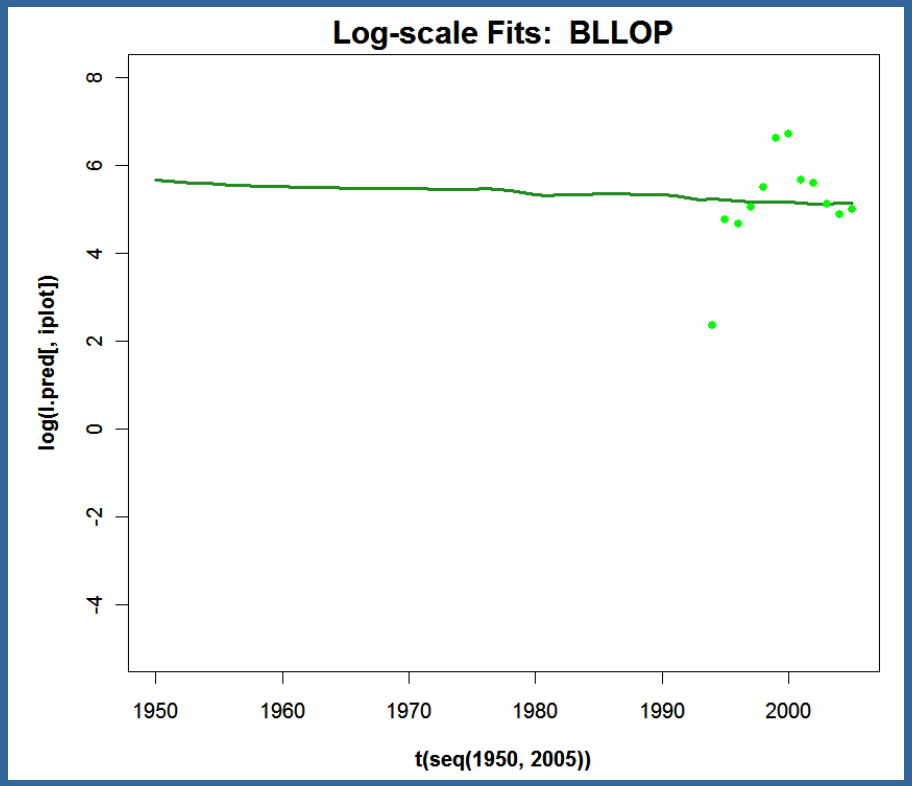


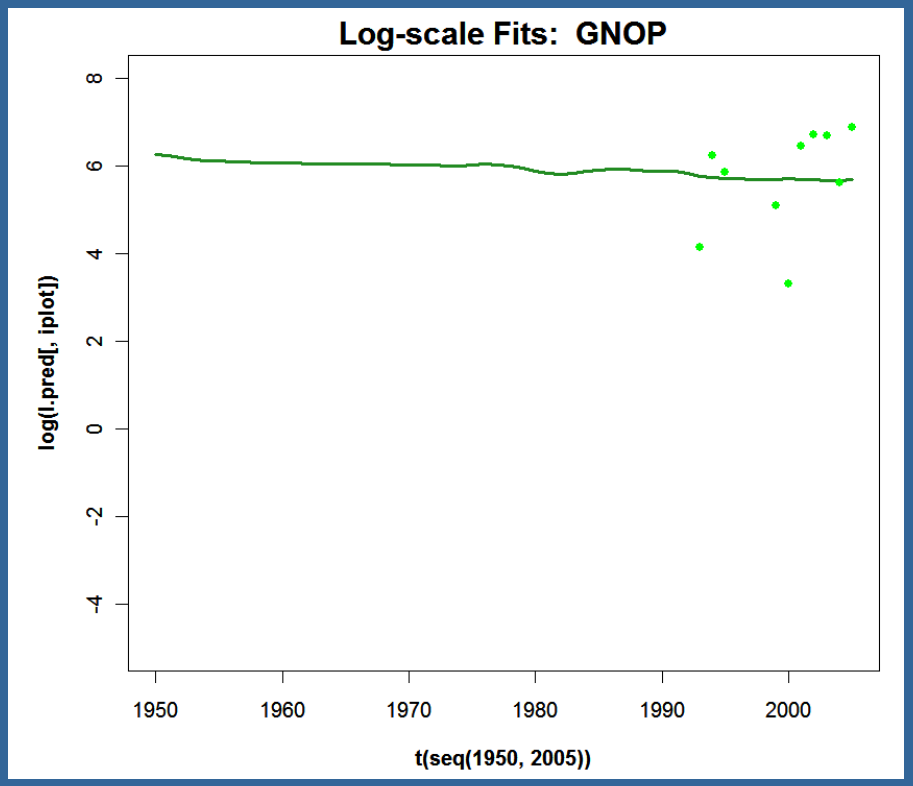
h	alpha
0.2	1.00
0.3	1.71
0.4	2.67
0.5	4.00
0.6	6.00
0.7	9.33
0.8	16.00
0.9	36.00
1.0	∞

RW Requests

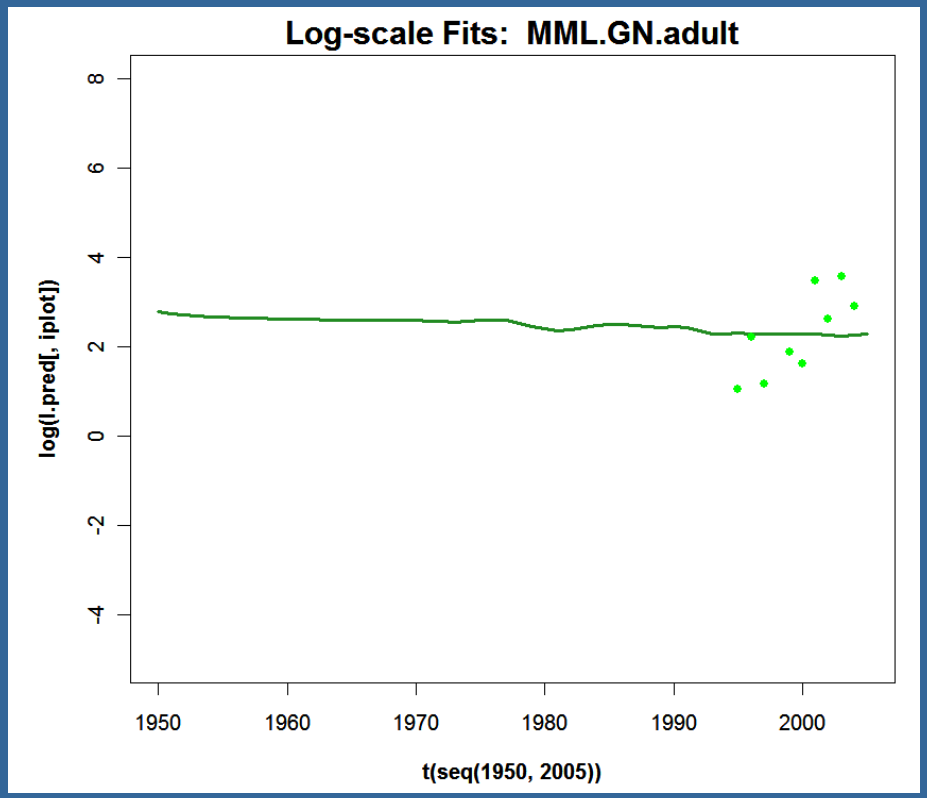
1. Log-scale fits, Log-scale residuals
2. Run with $C_{VAR}=I_{VAR}$

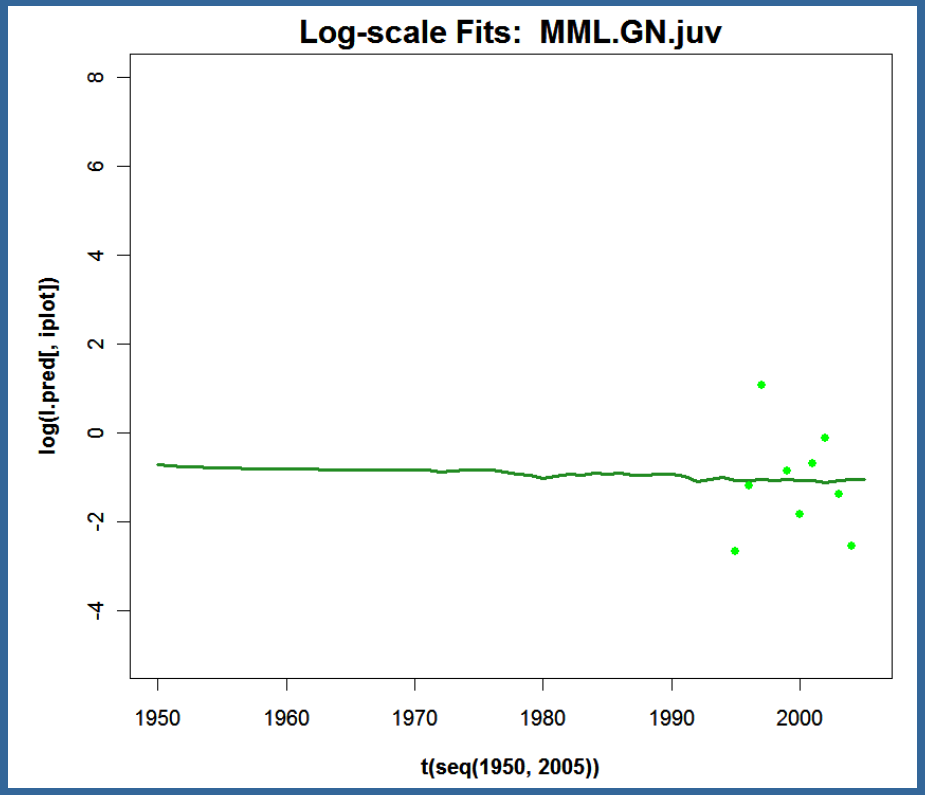
Log-scale residuals, fits (BASE)



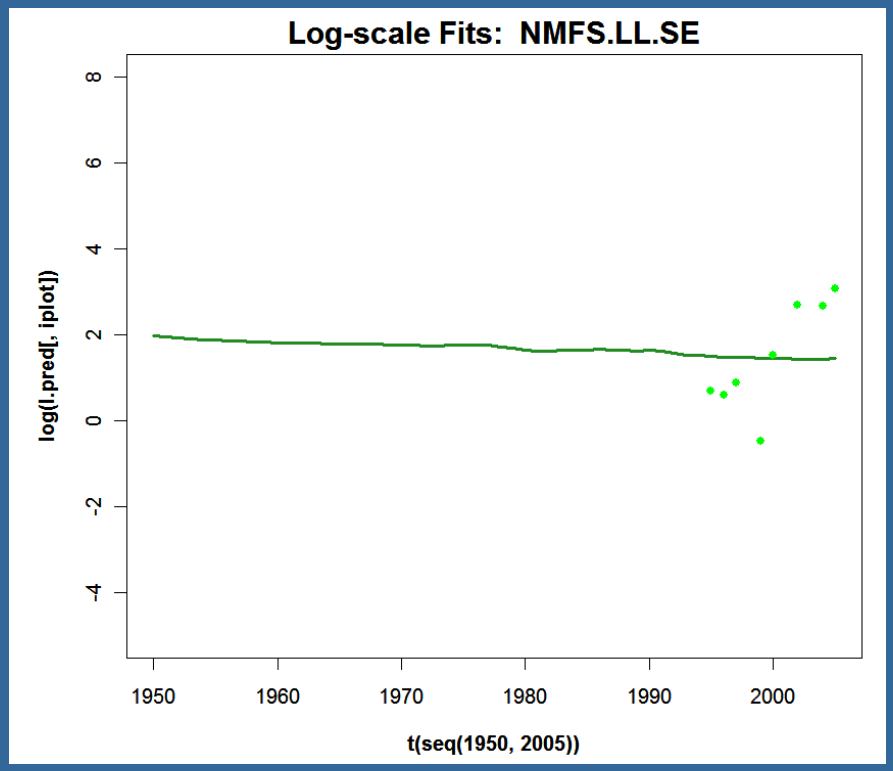


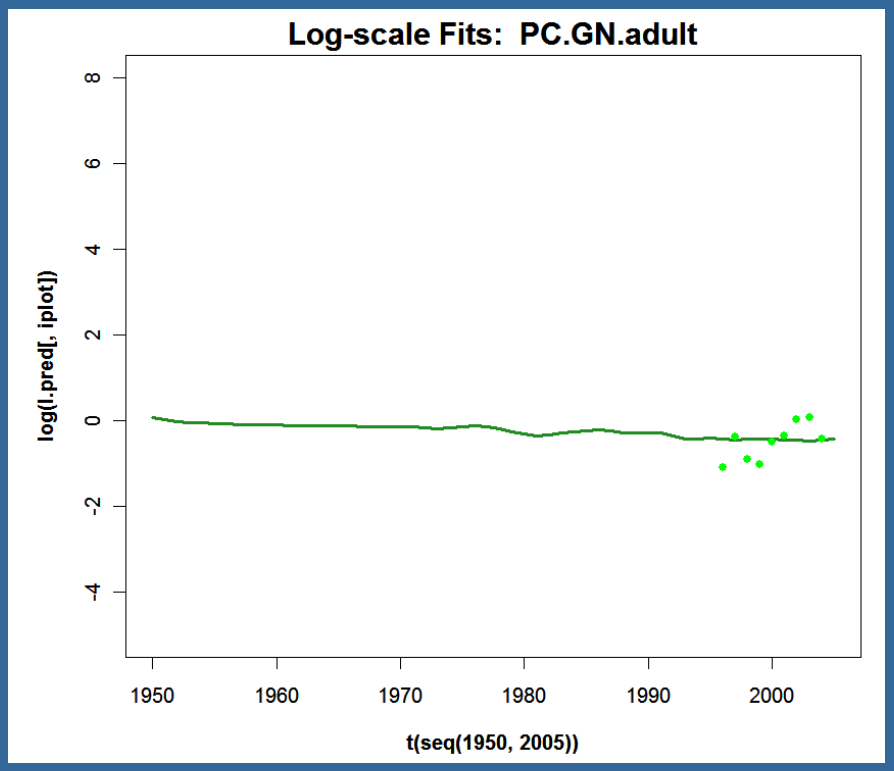
Log-scale residuals, fits (BASE)



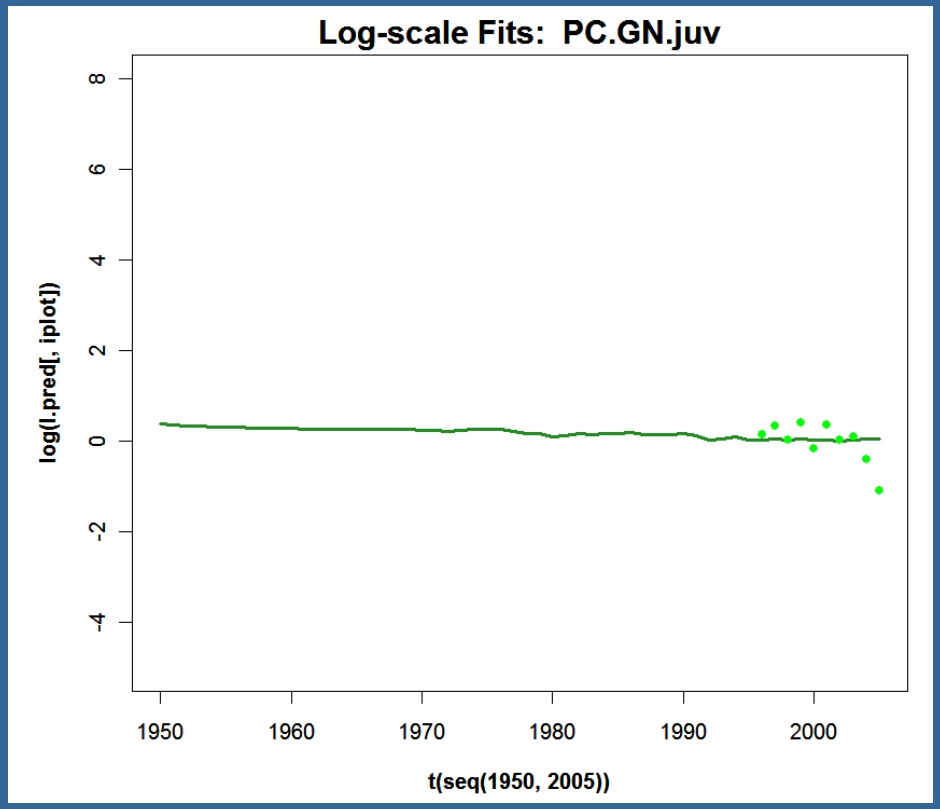


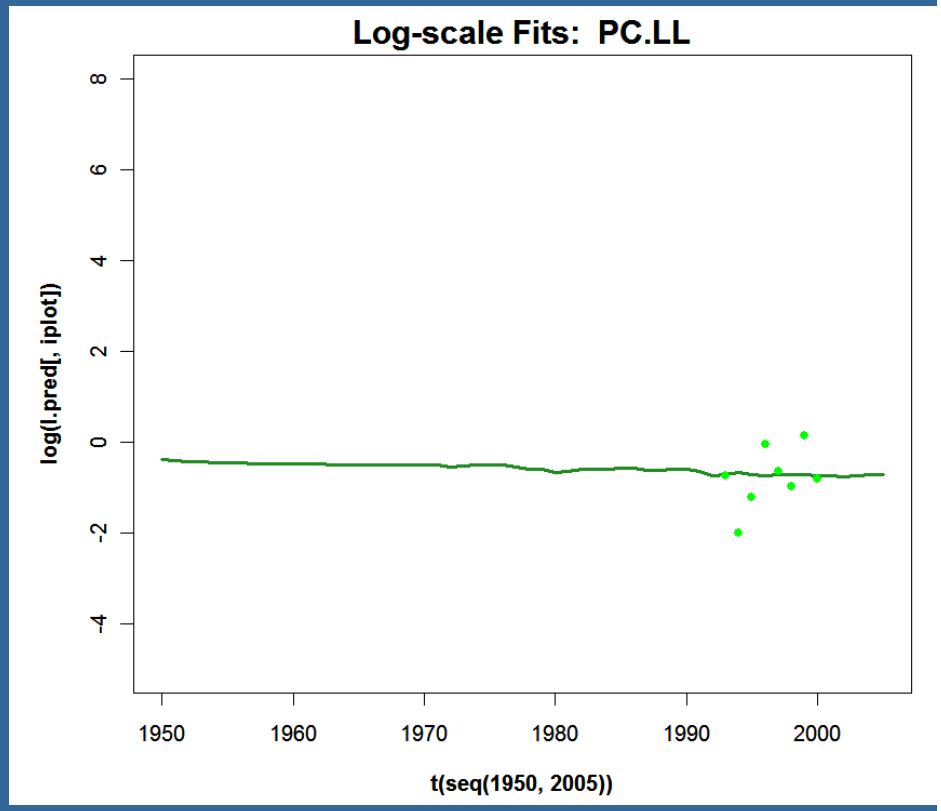
Log-scale residuals, fits (BASE)



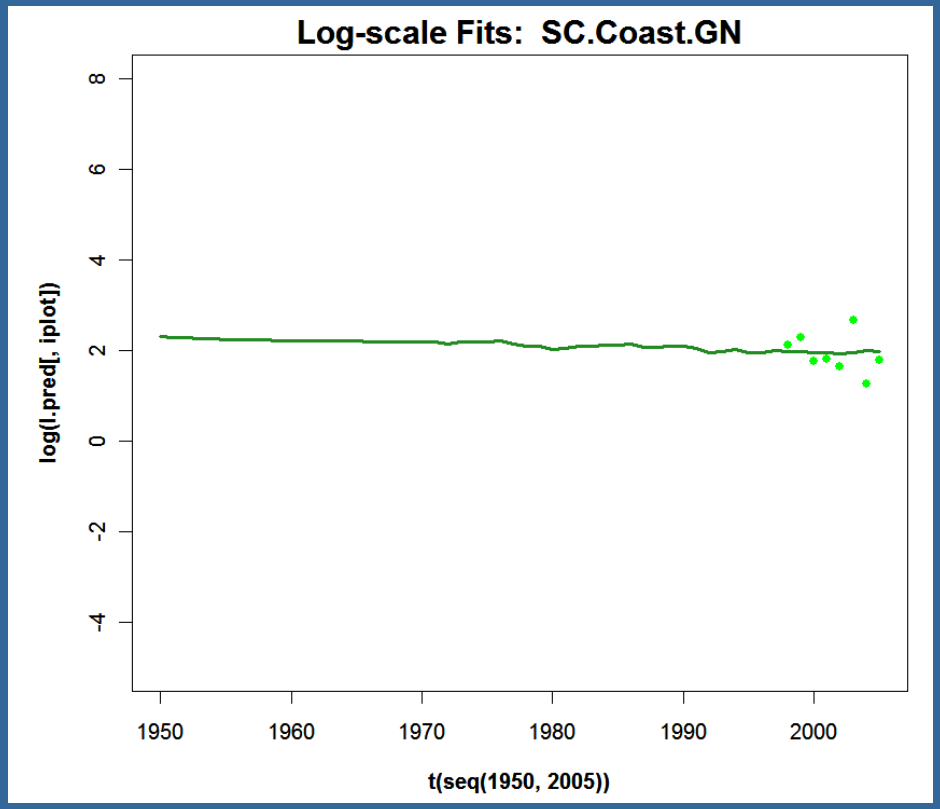


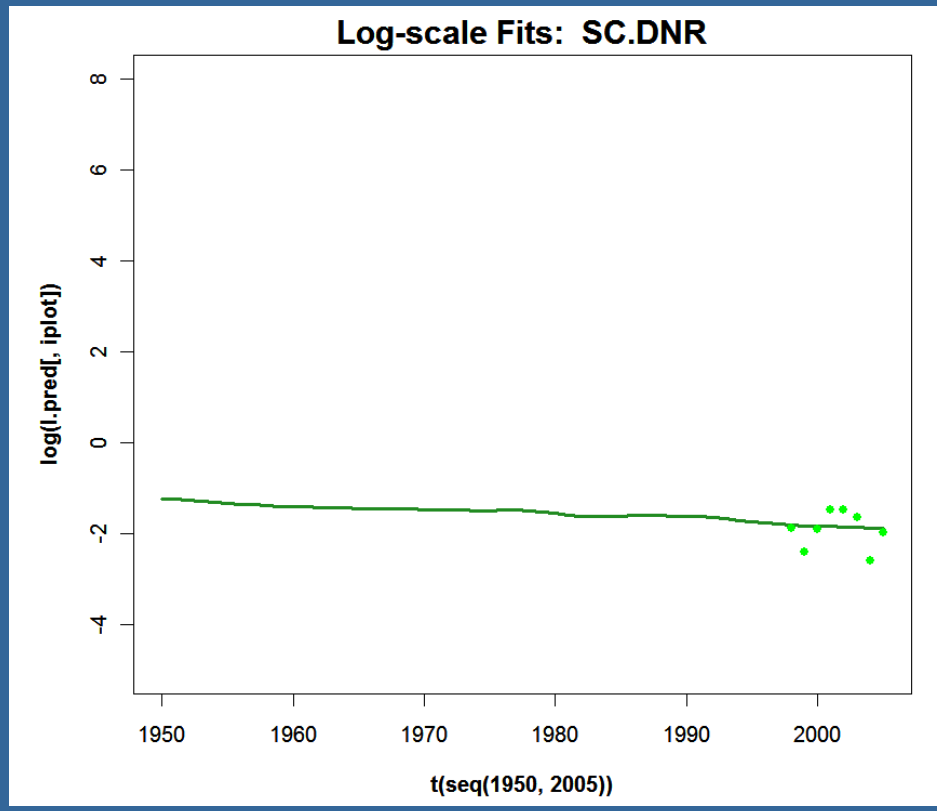
Log-scale residuals, fits (BASE)



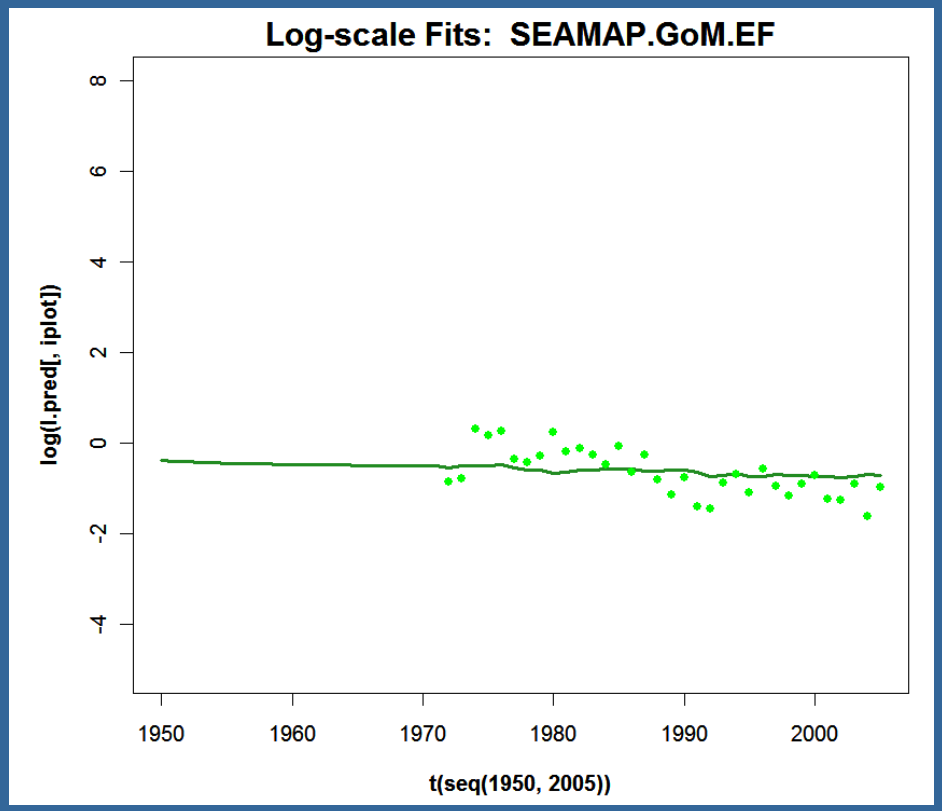


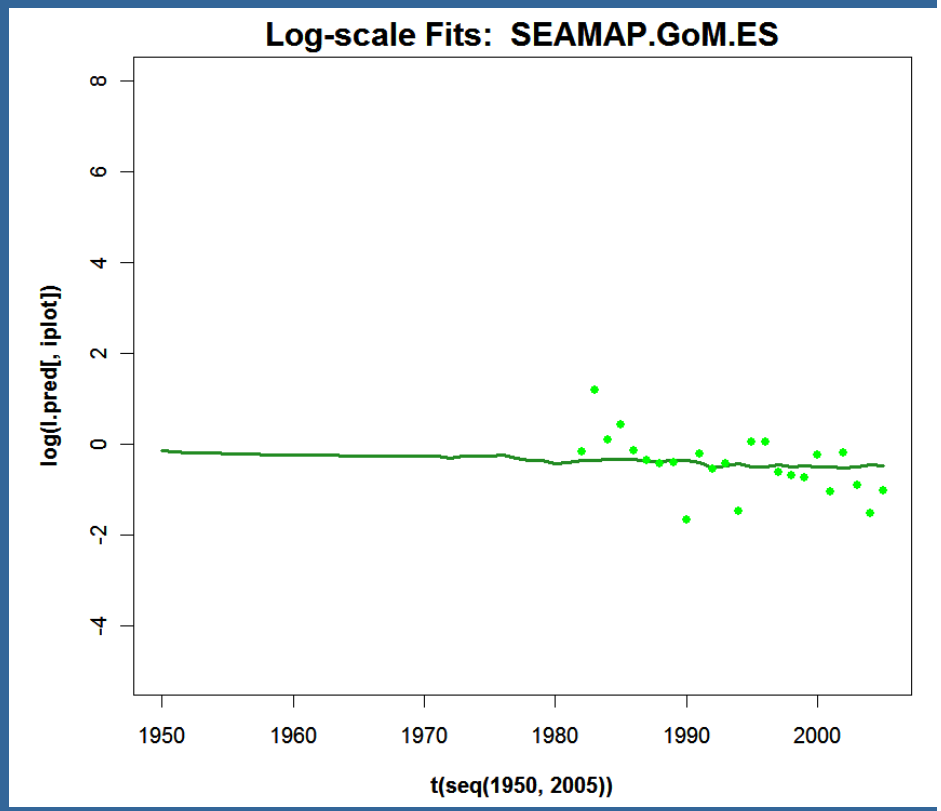
Log-scale residuals, fits (BASE)



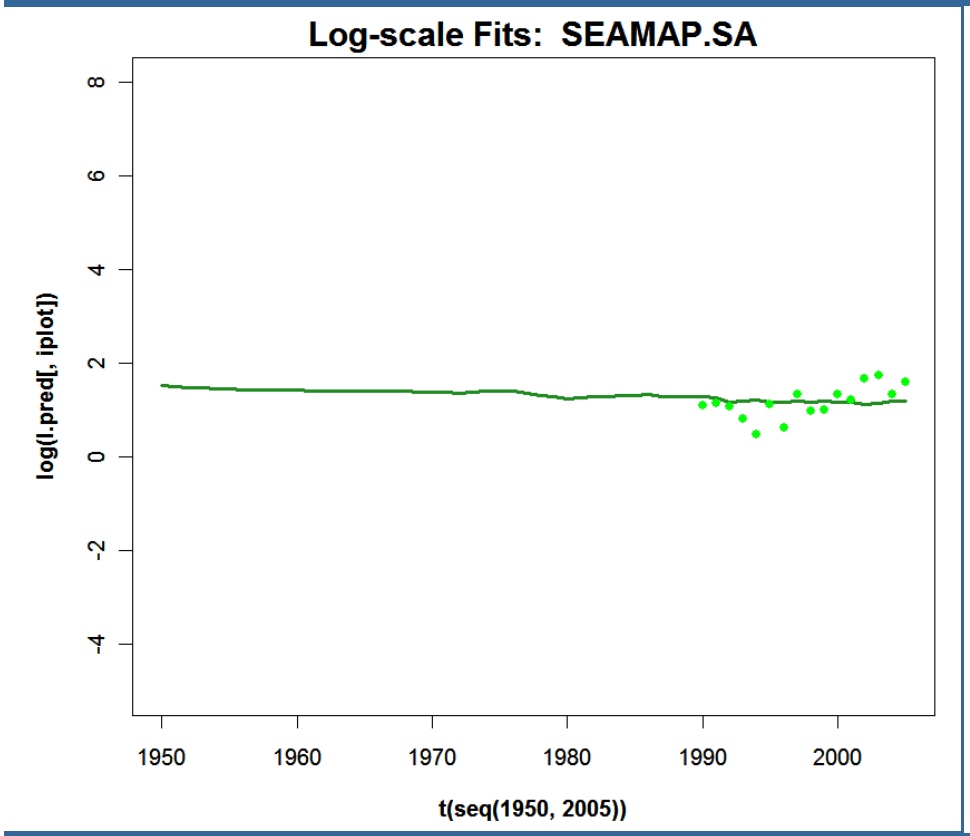


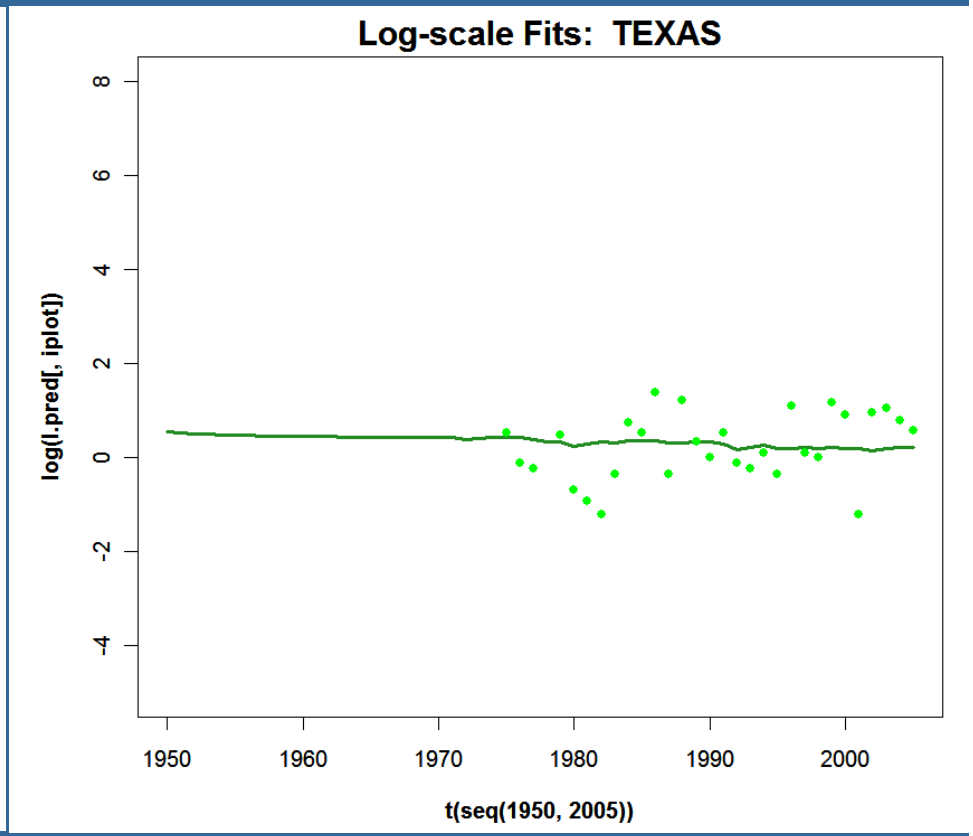
Log-scale residuals, fits (BASE)



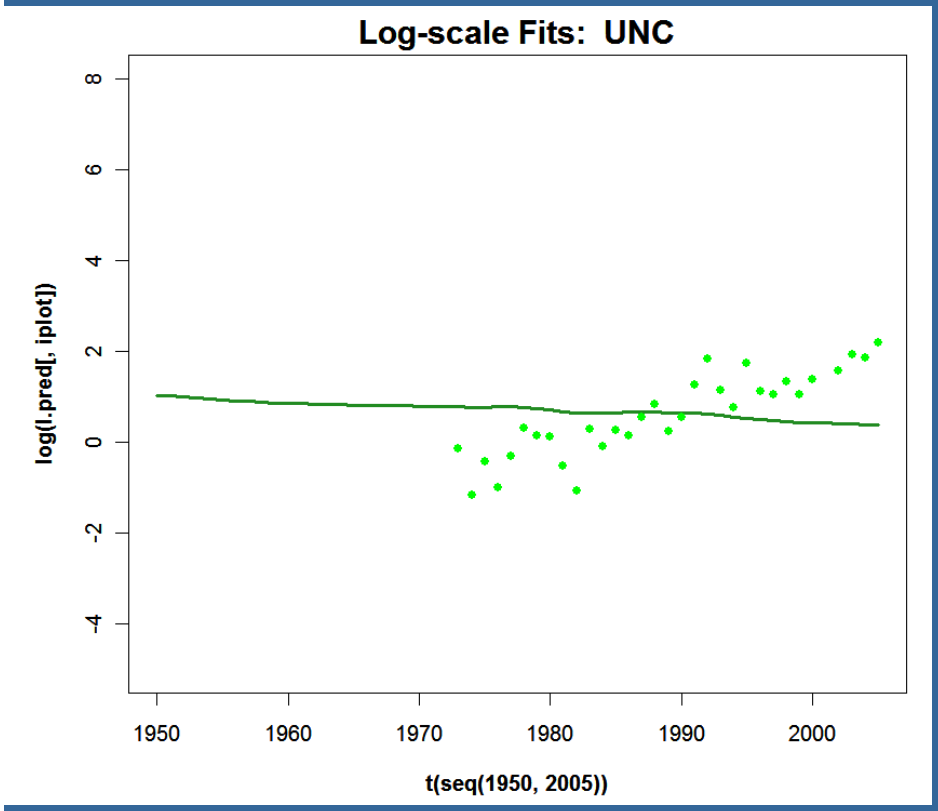


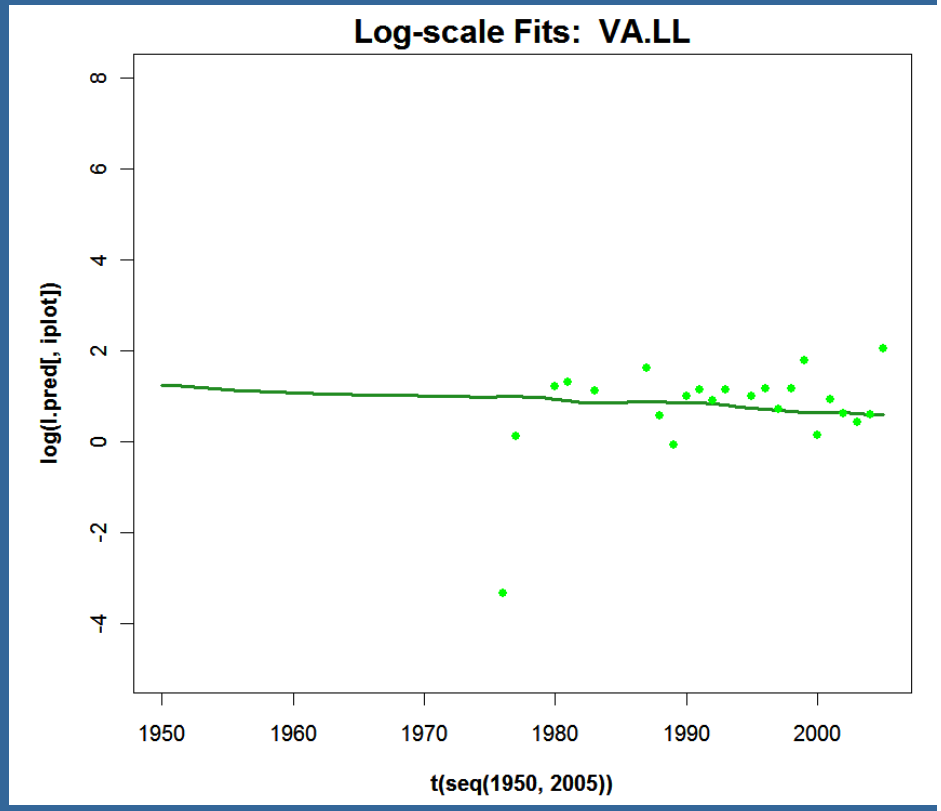
Log-scale residuals, fits (BASE)





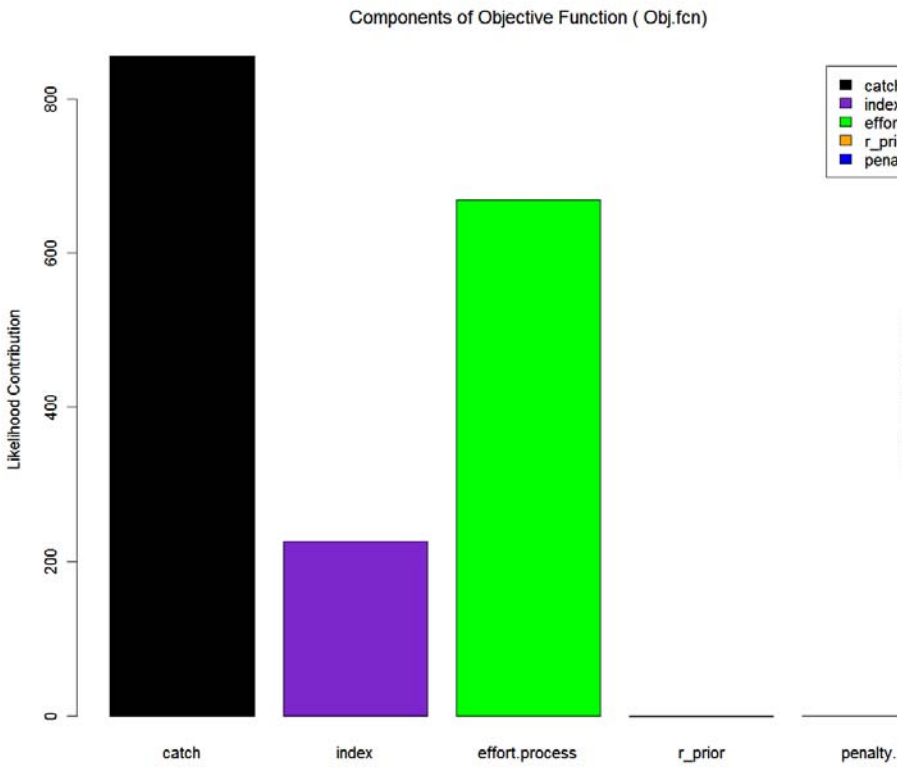
Log-scale residuals, fits (BASE)



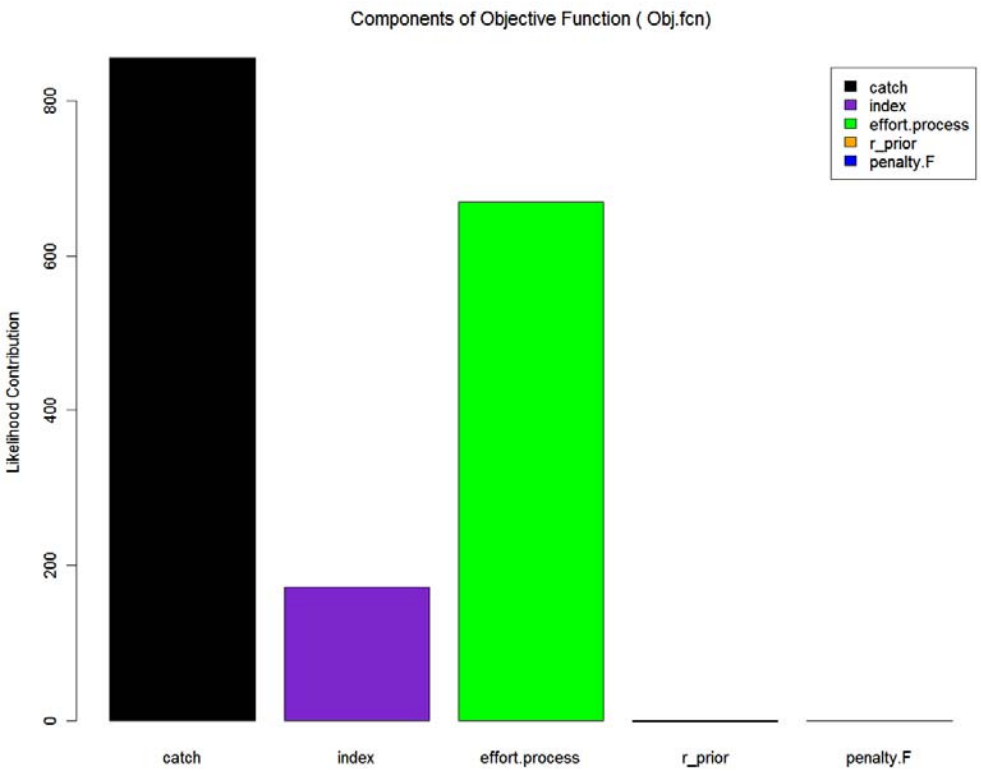


	Base		Cvar = Ivar	
Parameter	**Estimate**	**CV**	**Estimate**	**CV**
SSF_{2005}/SSF_{MSY}	**1.47**	0.45	1.56	0.42
F_{2005}/F_{MSY}	**0.74**	0.79	0.66	0.76
N_{2005}/N_{MSY}	**1.34**	--	1.41	--
MSY	**1.21E+06**	--	1.28E+06	--
SPR_{MSY}	**0.6**	0.11	0.6	0.11
F_{MSY}	**0.19**	--	0.19	--
SSF_{MSY}	**4.43E+06**	--	4.67E+06	--
N_{MSY}	**4.45E+06**	--	4.69E+06	--
F2005	**0.14**	0.79	0.12	0.76
SSF2005	**6.53E+06**	0.66	7.30E+06	0.61
N2005	**5.96E+06**	--	6.59E+06	--
SSF2005/SSF0	**0.56**	0.32	0.59	0.29
B2005/B0	**0.48**	0.31	0.51	0.27
R0	**3.11E+06**	0.36	3.29E+06	0.35
Pup-survival	**0.75**	0.28	0.76	0.28
alpha	**2.84**	--	2.85	--
steepness	**0.41**	--	0.42	--

Base model

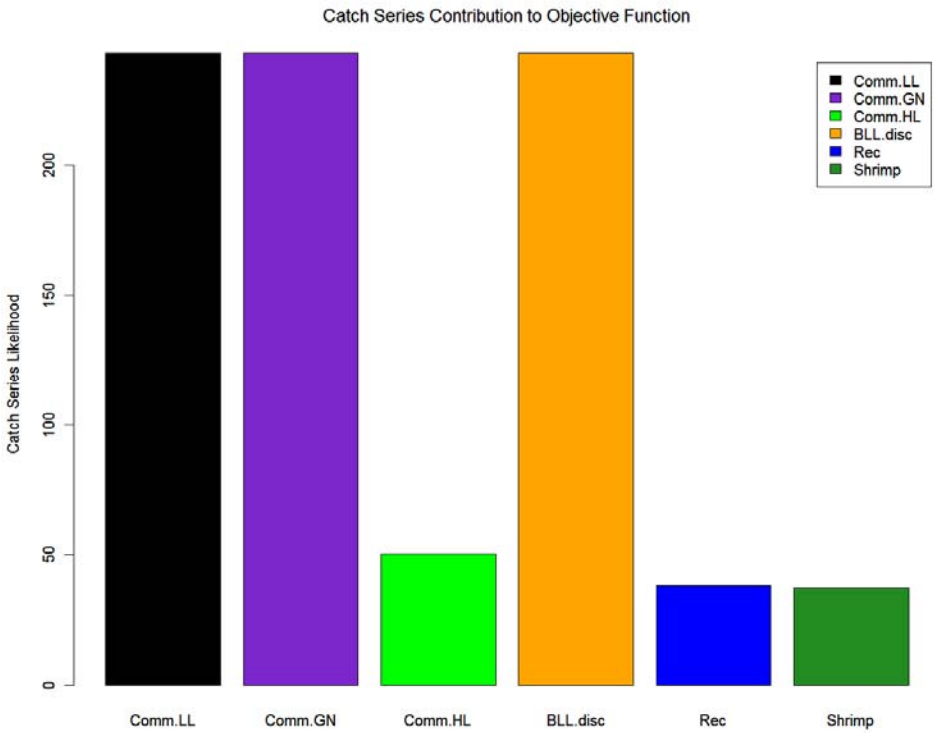


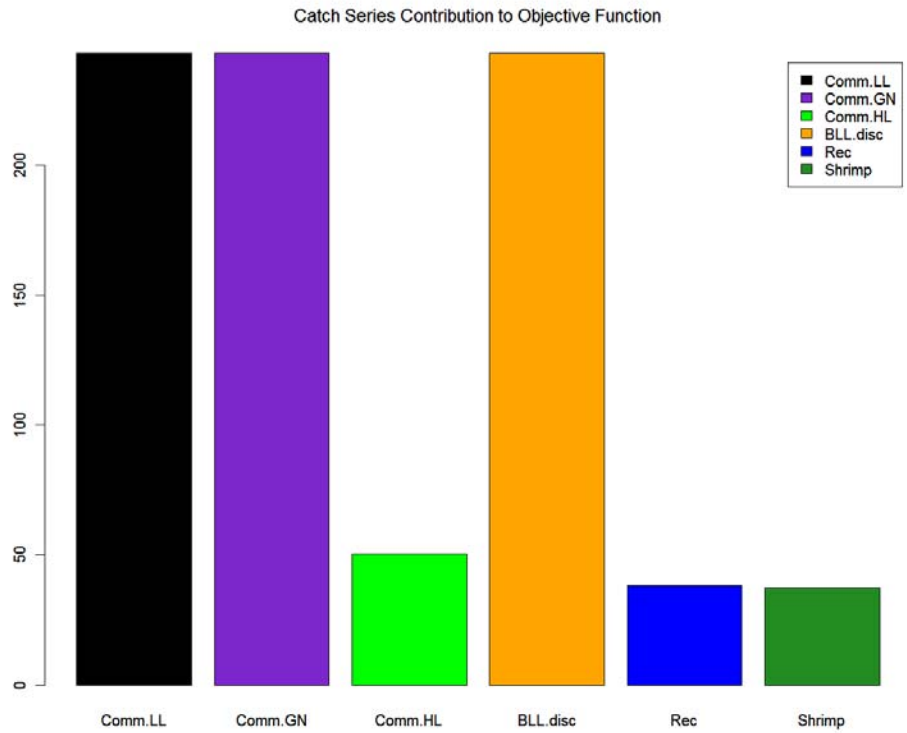
Cvar = Ivar

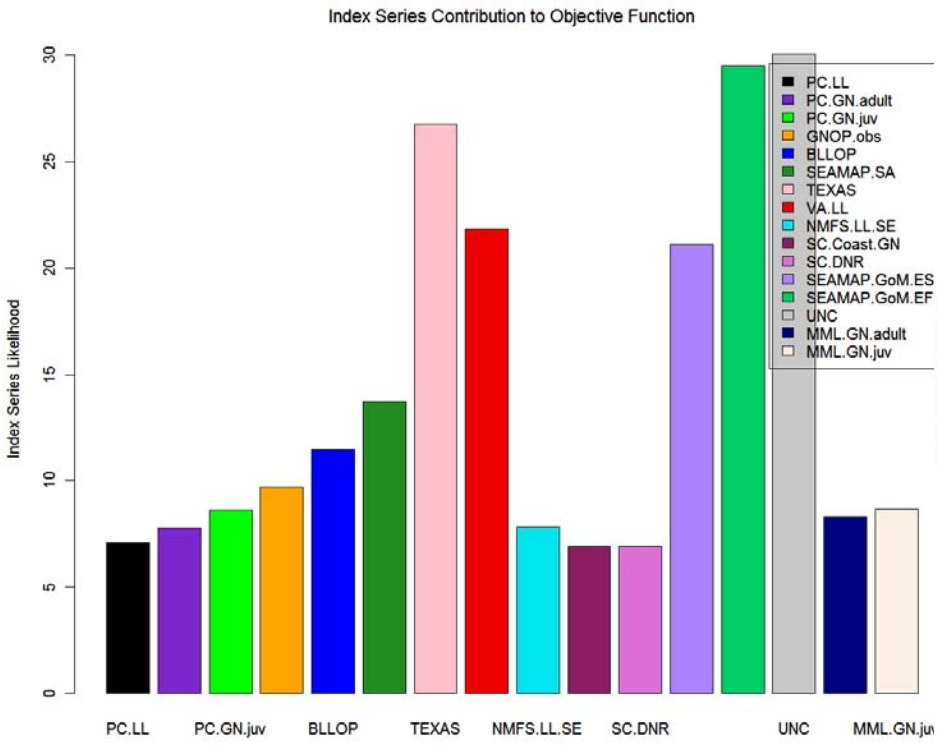
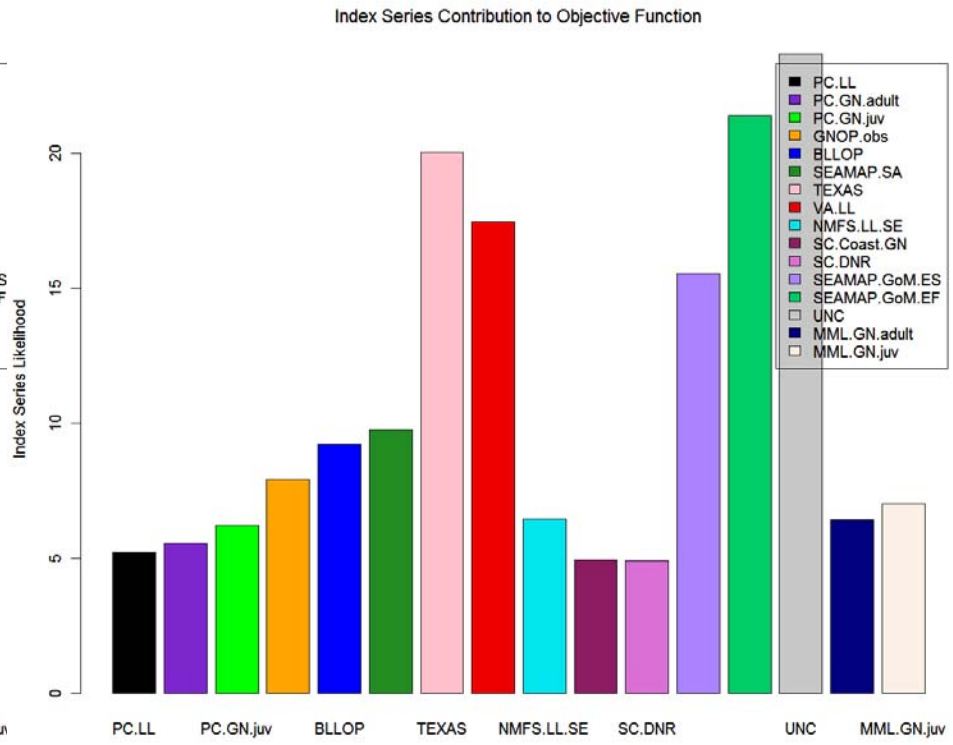


Base model

Cvar = Ivar





Base model

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