Assessment of the Small Coastal Shark Complex, Atlantic sharpnose, Bonnethead, Blacknose and Finetooth sharks using surplus production methods

E. Cortés

NOAA/NMFS/SEFSC
Panama City Laboratory
3500 Delwood Beach Road
Panama City, FL 32408, USA

This presentation

- Stock assessment modeling approaches
- Data inputs
- Baseline results
- Sensitivity analyses
- Discussion / Summary

Assessments conducted

- SCS: Atlantic sharpnose + Bonnethead + Blacknose + Finetooth (smalltail and angel shark not included)
- Atlantic sharpnose (*Rhizoprionodon terraenovae*)
- Bonnethead (*Sphyrna tiburo*)
- Blacknose (*Carcharhinus acronotus*)
- Finetooth (*Carcharhinus isodon*)

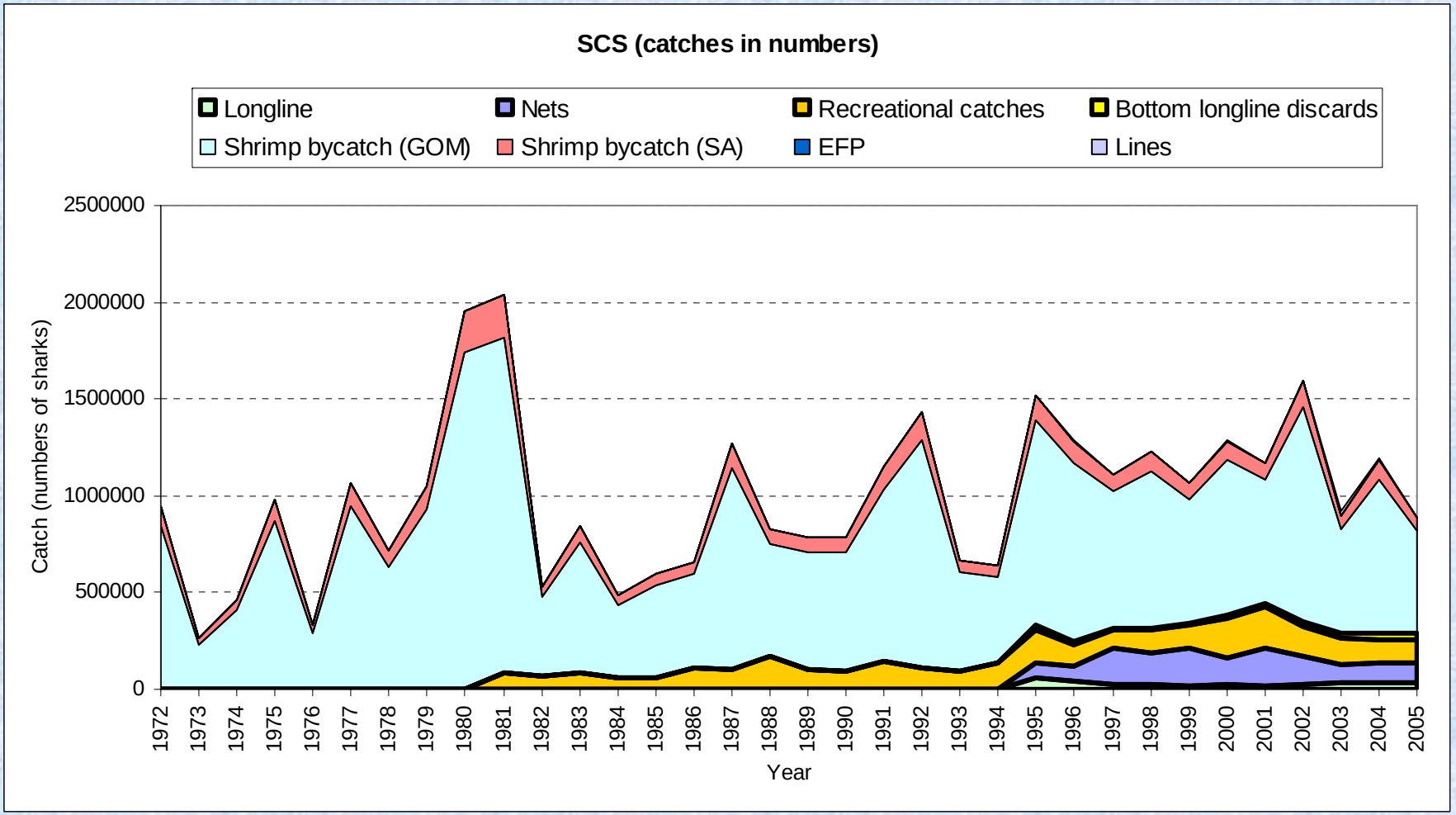
Surplus production modeling approaches

1) **Bayesian SPM (BSP)**
   - Observation error in CPUE
   - SIR algorithm for numerical integration
   - Implemented in VB

2) **State-space Bayesian SPM** (WinBUGS)
   - Observation error in CPUE
   - Process error in biomass (unobserved state)
   - MCMC for numerical integration
   - Implemented in WinBUGS

SMALL COASTAL SHARK COMPLEX

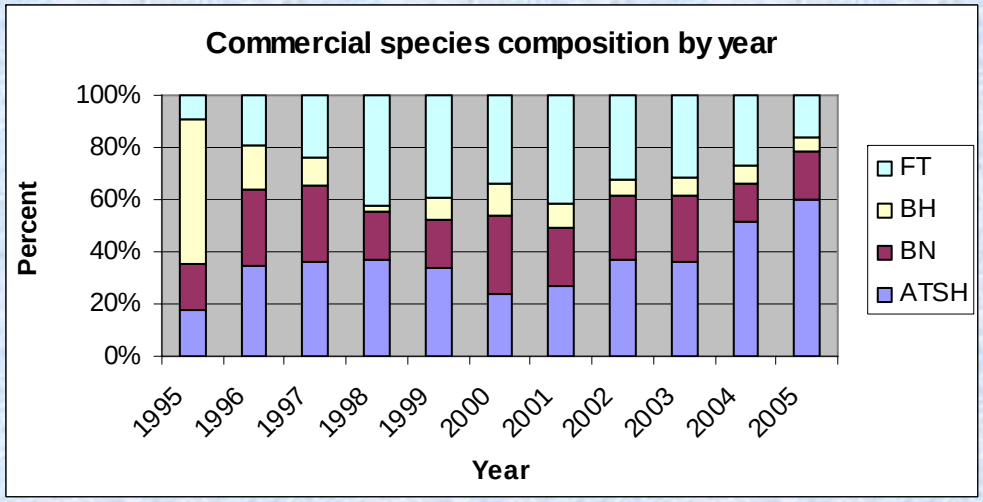
Total Catches: SCS complex

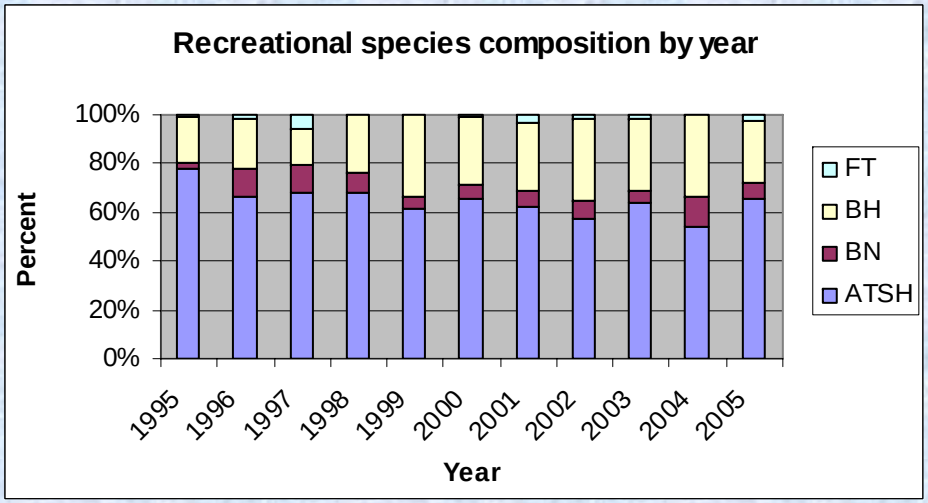


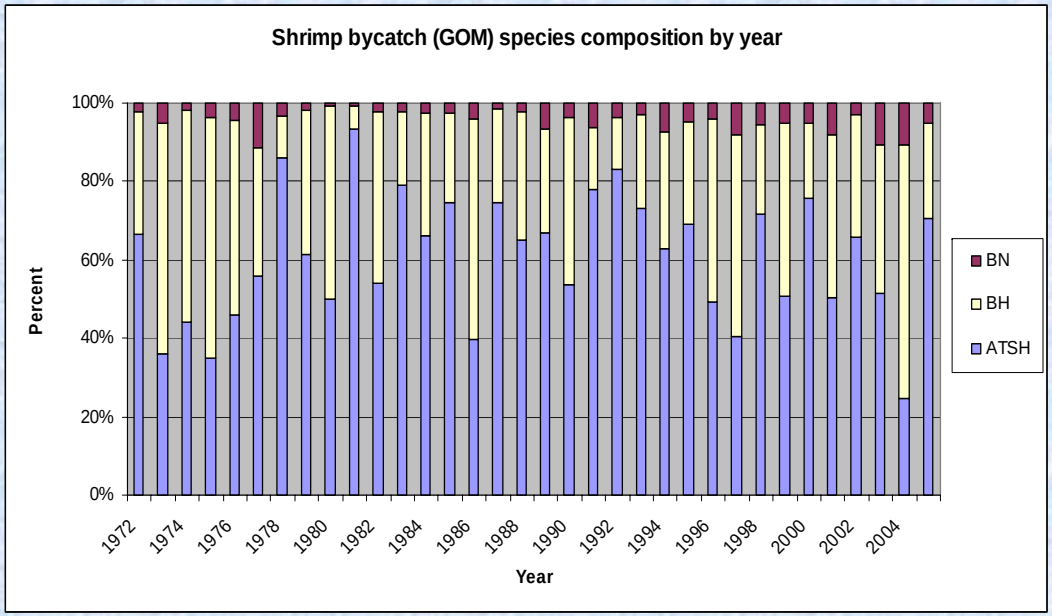
Catches by sector: why numbers?

- Commercial (in weight; use average weights from observer program to estimate numbers)
- Recreational (MRFSS + Headboat + TXPWD; in numbers)
- Bottom longline dead discards (discard rate from observer program applied to LL commercial landings)
- Shrimp trawl bycatch in the GOM (numbers)
- Shrimp trawl bycatch in the SA (a proportion of the GOM catches)
- EFP (exempted fishing permits; numbers)

Species composition of the SCS complex by sector





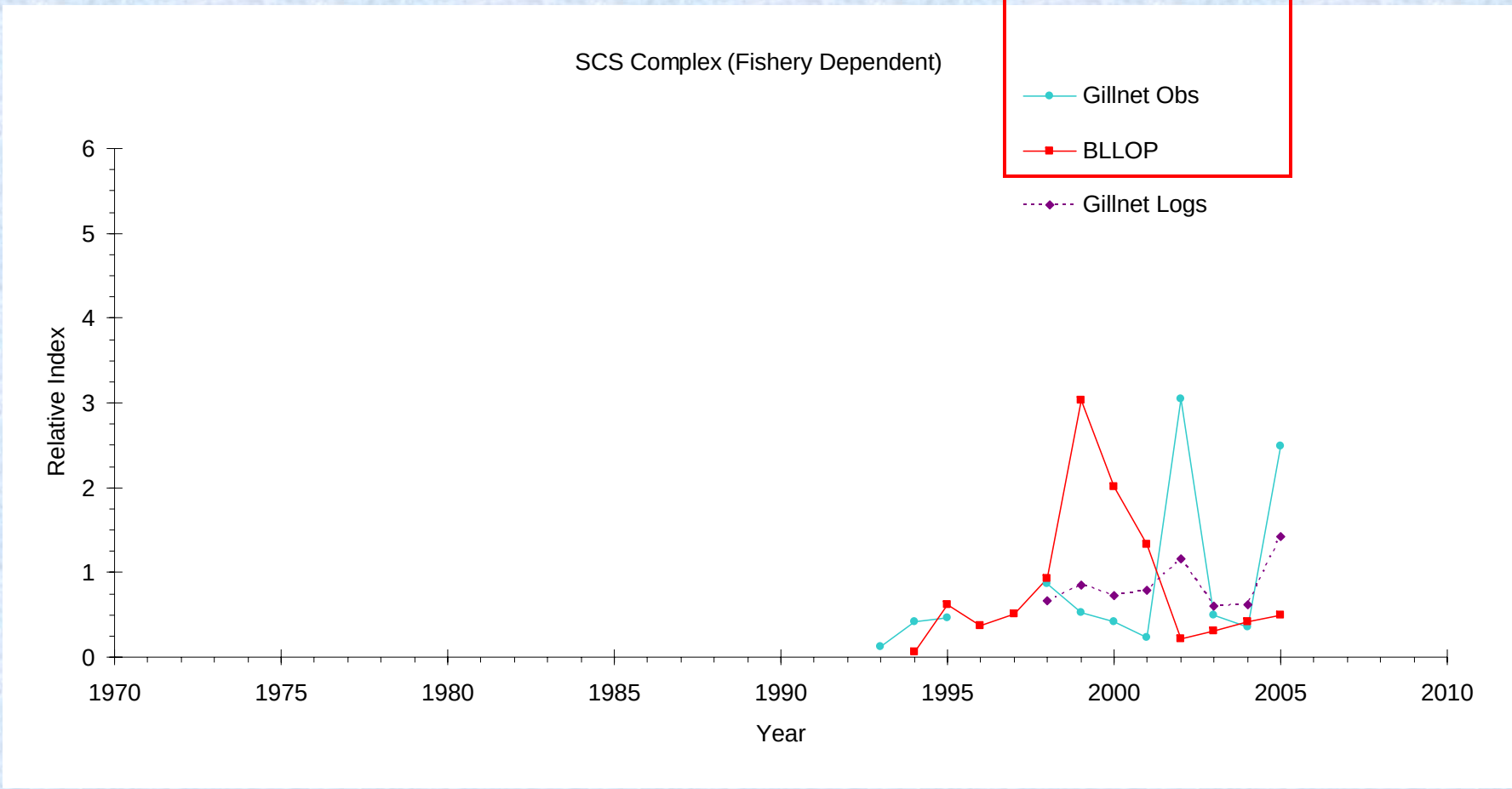


CPUE series: SCS complex -Baseline

- **FISHERY-DEPENDENT:** BLLOP, Gillnet Observer (2)
- **FISHERY-INDEPENDENT:** PC LL, PC Gillnet, SEAMAP-SA, TEXAS, NMFS LL SE, SC Coastspan GN, SCDNR red drum, SEAMAP-GOM-S, SEAMAP-GOM-F, UNC, MML Gillnet (11)

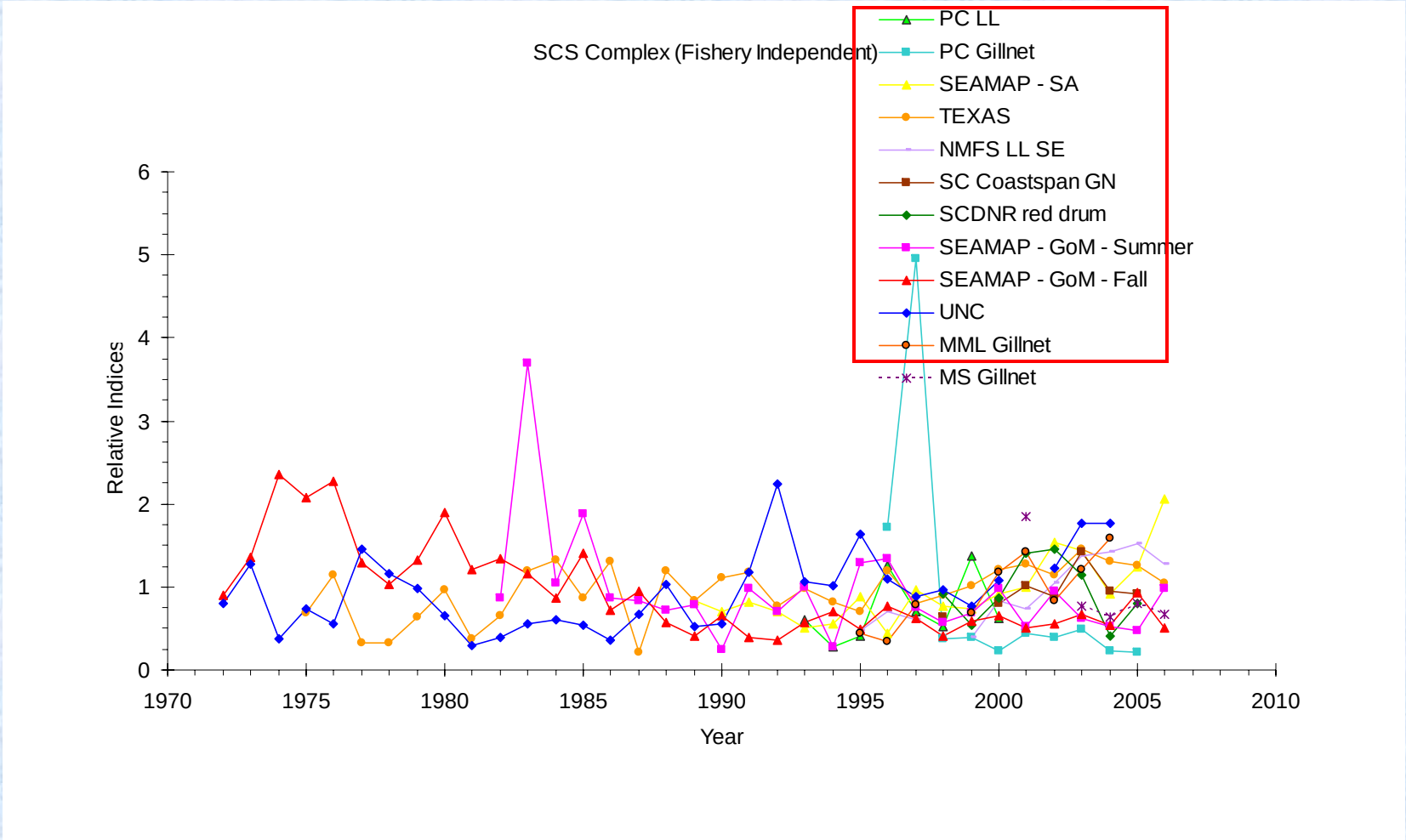
CPUE series: SCS complex-Baseline (F-D)

Baseline Indices



CPUE series: SCS complex-Baseline (F-I)

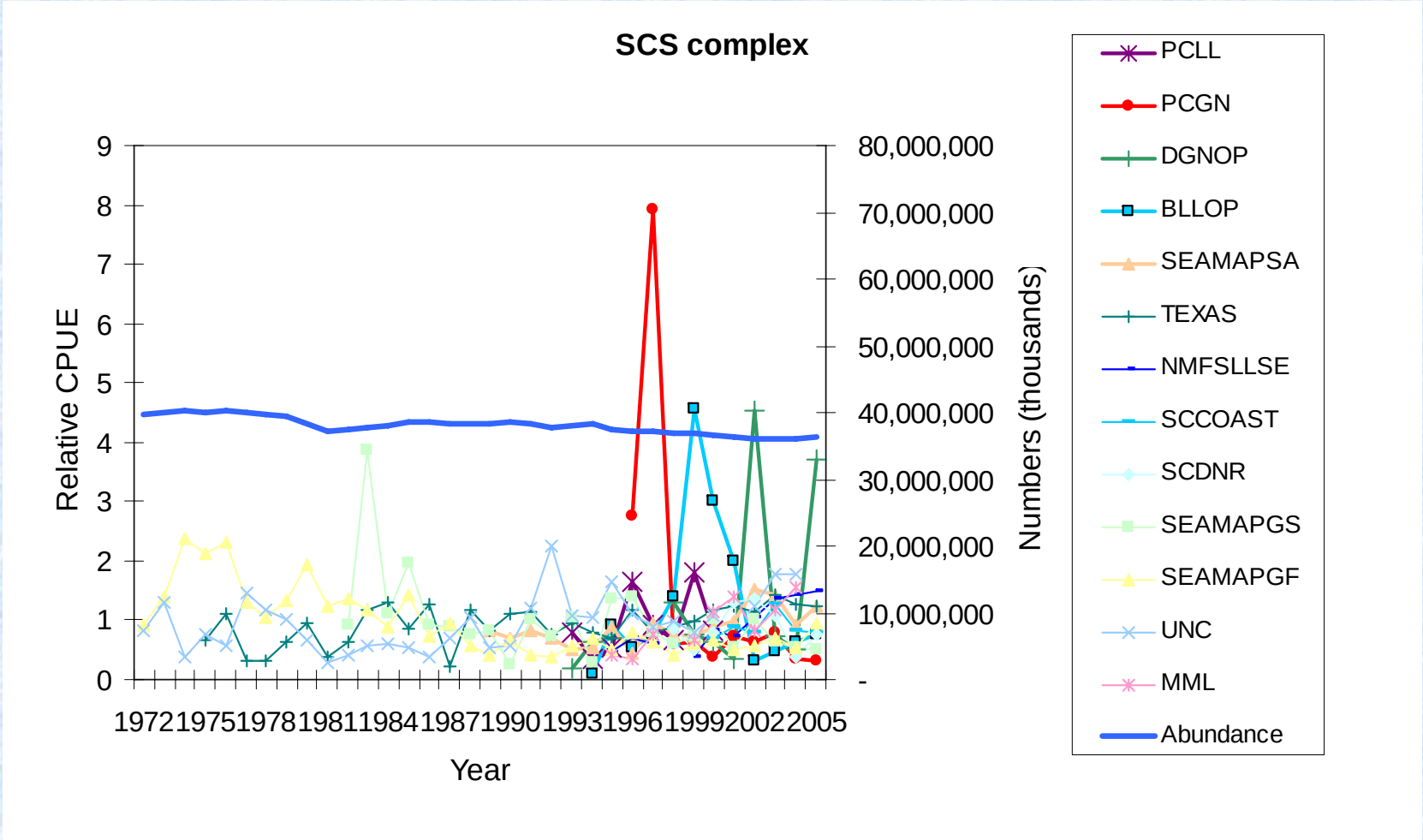
Baseline Indices



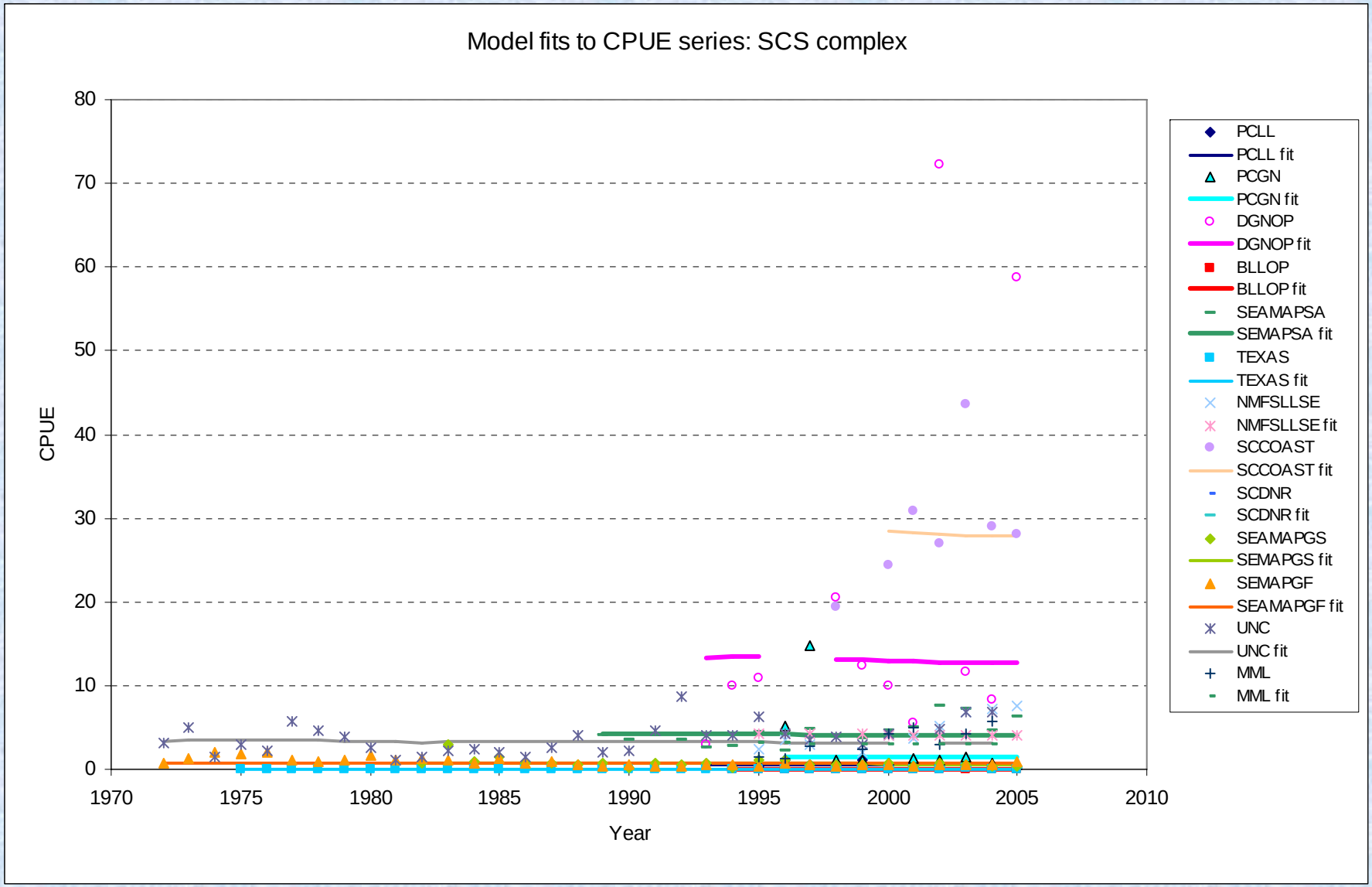
Inputs-Priors for SCS complex-Baseline

- Model starts in 1972 (first year of CPUE indices)
- Catch data available for 1972-2005
- 13 Indices available
- r ~ LN (0.17, 0.1, 0.001,2.0) ← Weighted mean
- K ~ U on log K (10^4-10^8)
- $N_{72/K}$ ~ LN (0.9, 0.2, 0.2, 1.1)

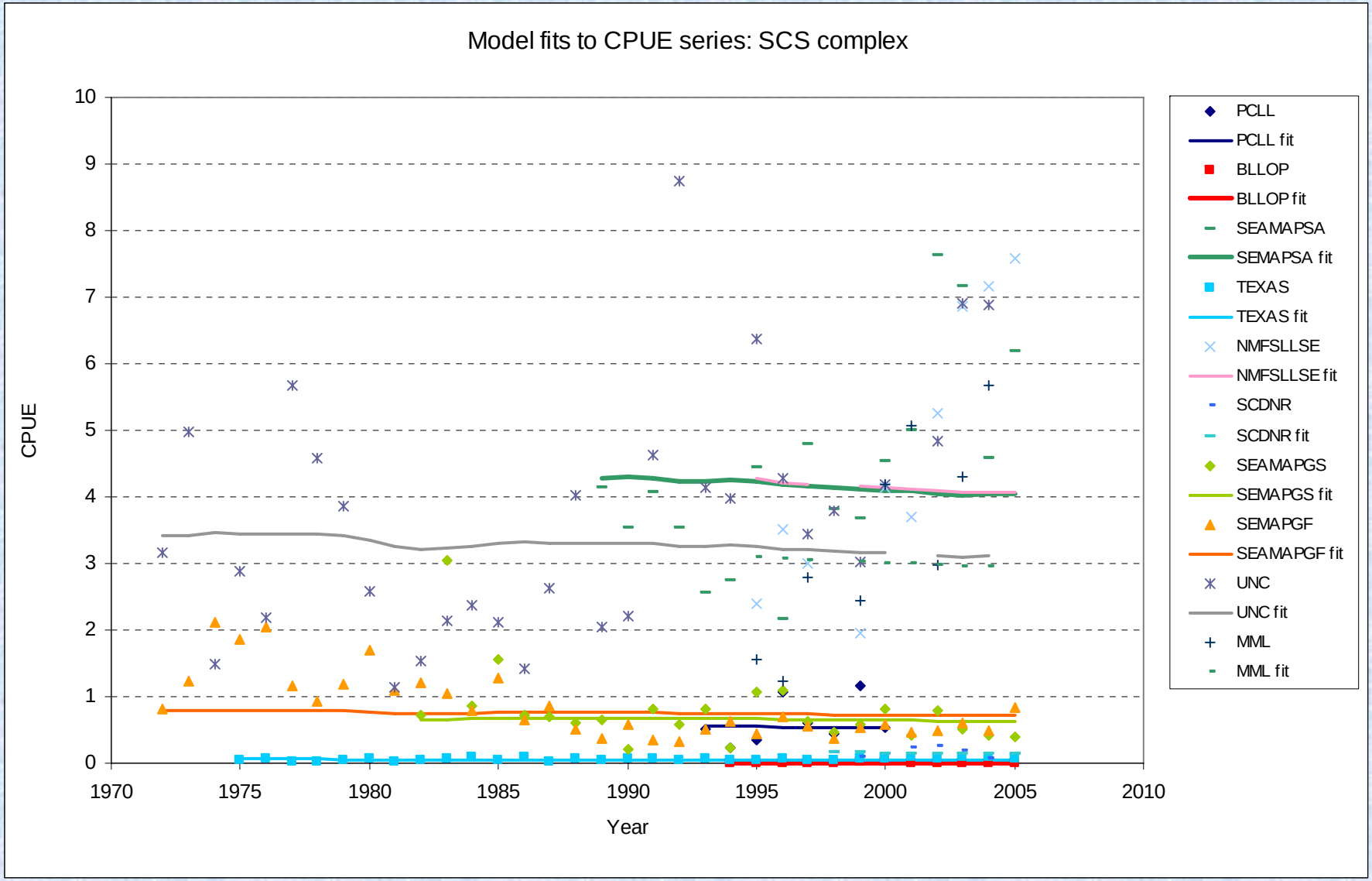
BSP results for SCS complex-Baseline: Predicted biomass trend at posterior mode of the BSP model fitted to catch and CPUE data



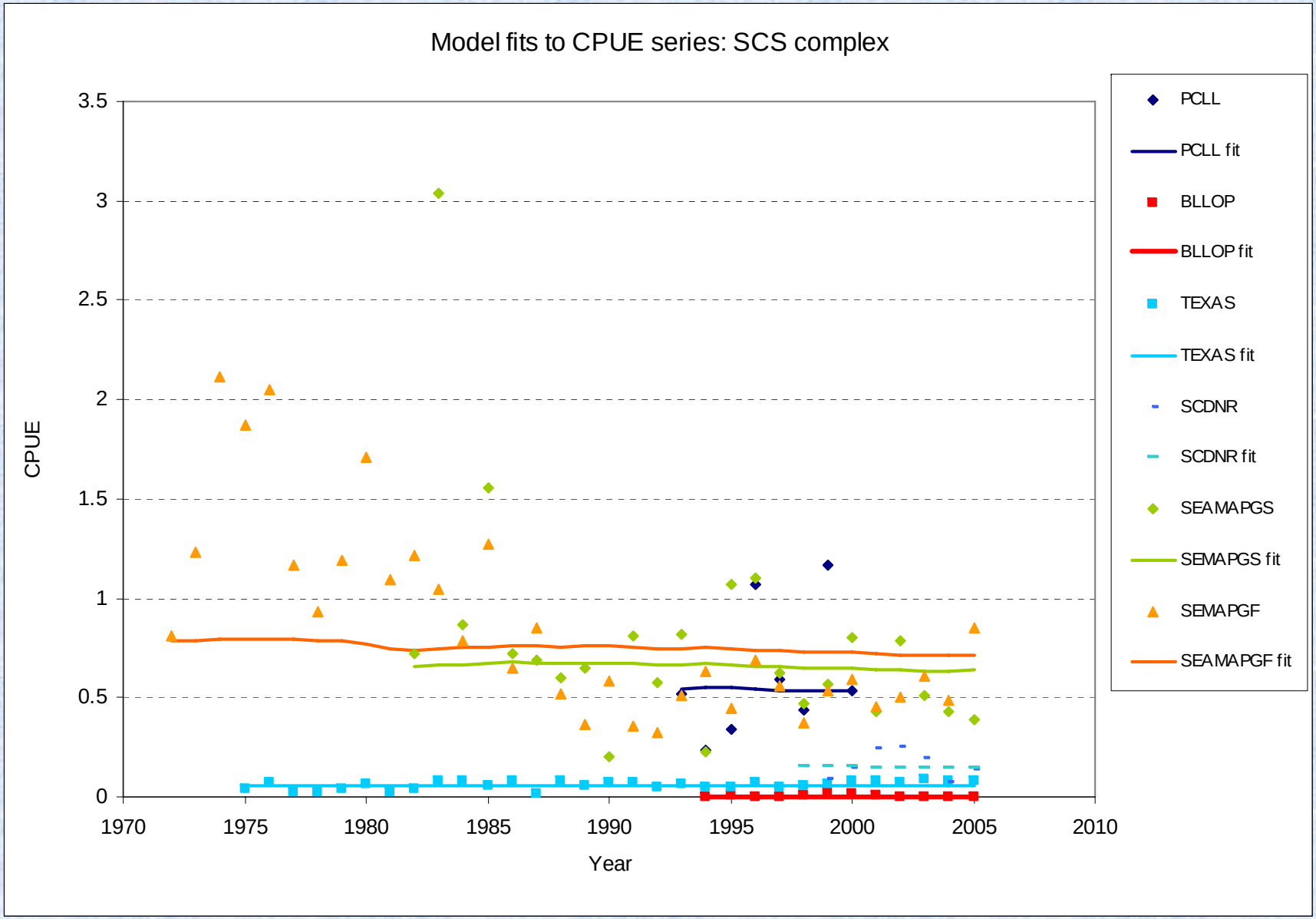
BSP results for SCS complex-Baseline: Model fits to the individual CPUE series



BSP results for SCS complex-Baseline: Model fits to the individual CPUE series (-SCCOAST, DGNOP and PCGN)

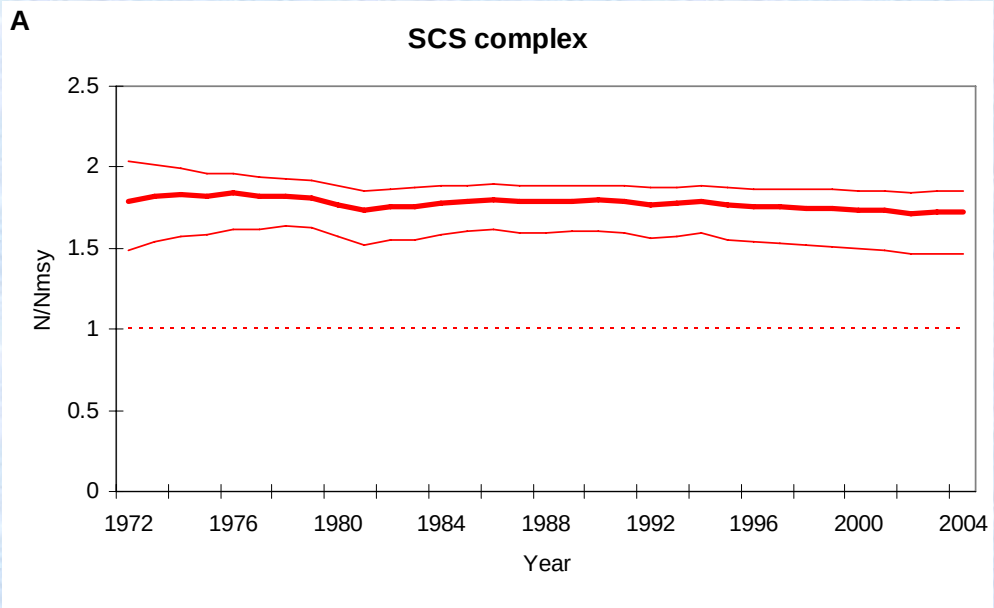


BSP results for SCS complex-Baseline: Model fits to the individual CPUE series (-SEAMAPSA, NMFSLLSE, UNC and MML)

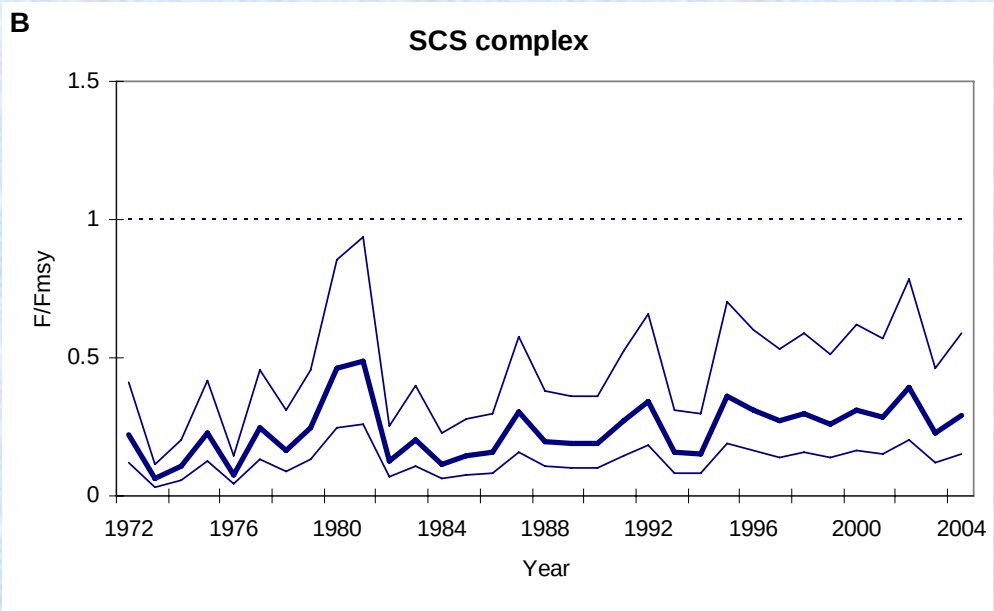


BSP results for SCS-Baseline:

BSP estimated relative abundance and fishing mortality rate trajectories



N/N_{MSY}

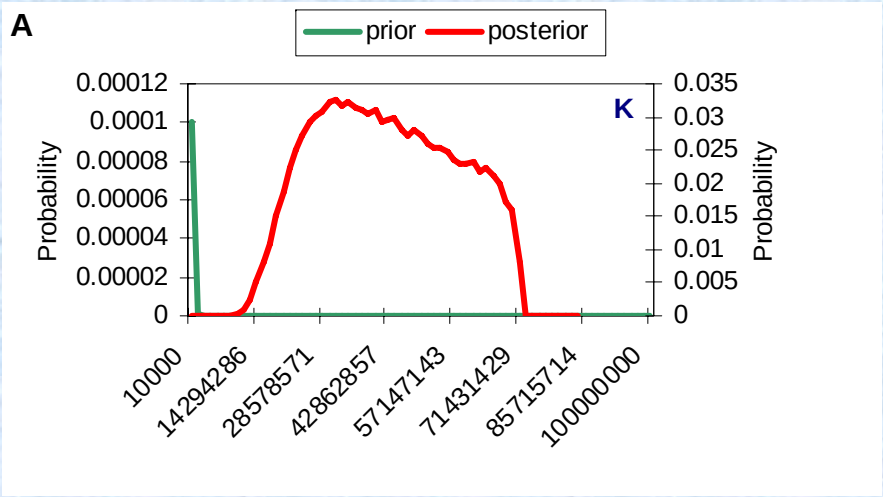


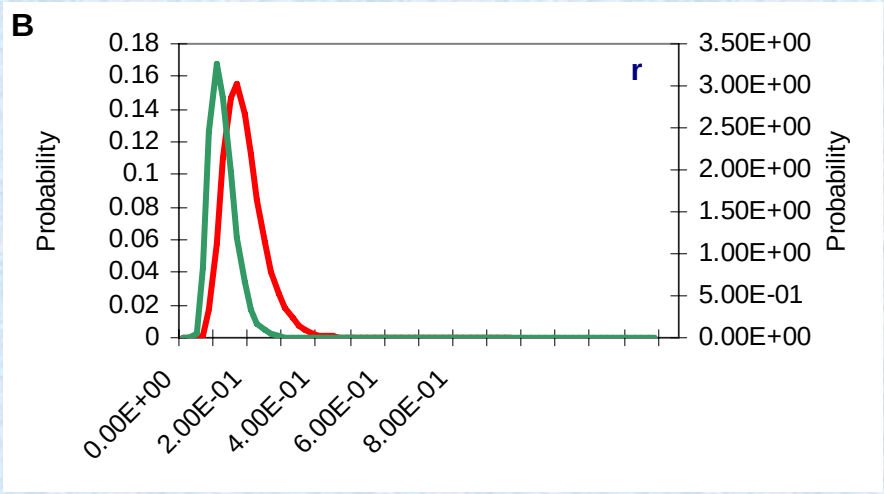
F/F_{MSY}

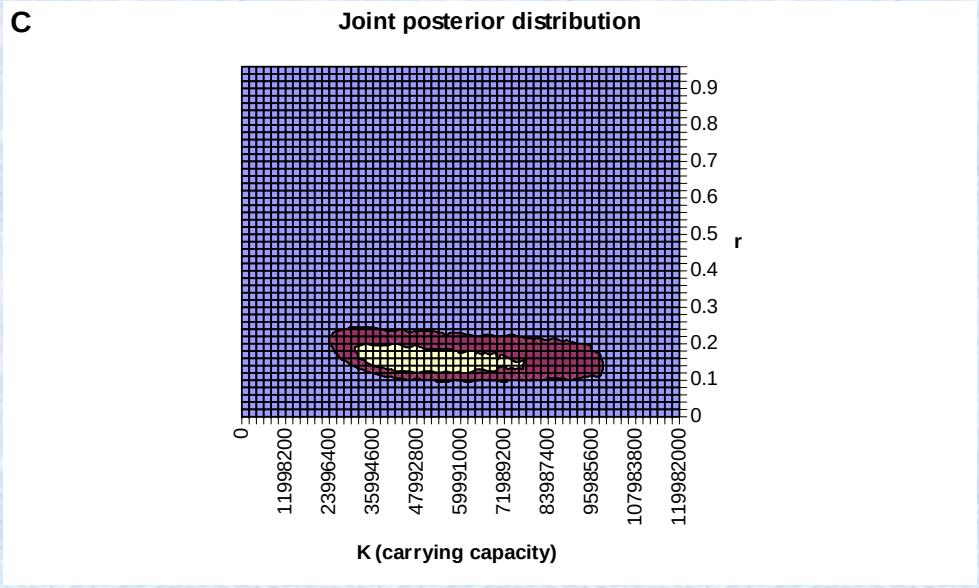
Expected values of the mean and CV of marginal posterior distributions from the BSP for SCS complex-Baseline

	SCS	
	EV	CV
Importance function	priors	
K	59566	0.35
r	0.181	0.32
MSY	2623	0.45
N_{2005}	51605	0.40
N_{2005}/K	**0.85**	0.09
N_{init}	53057	0.38
N_{2005}/N_{init}	0.97	0.13
C_{2005}/MSY	0.40	0.42
F_{2005}/F_{MSY}	**0.25**	0.55
N_{2005}/N_{MSY}	**1.69**	0.09
C_{2005}/repy	0.79	0.05
N_{MSY}	29783	0.35
F_{MSY}	0.091	
repy	1125	0.05
C_0		
Diagnostics		
CW (wt)	0.786	
CV (L*prior)	0.902	
CV (Wt) / CV (L*p)	0.87	
%maxpWt	0.002	

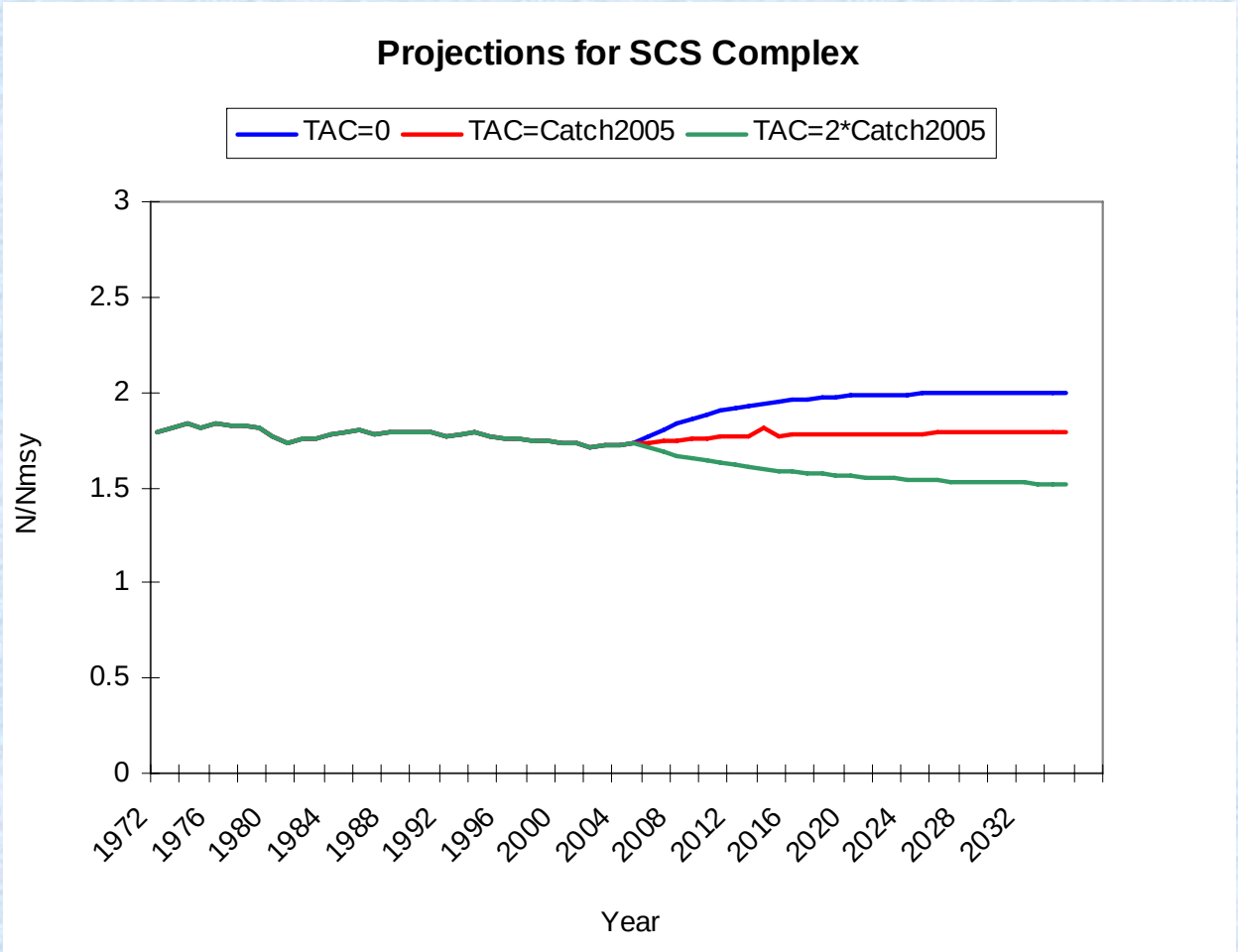
BSP results for SCS complex-Baseline: Prior and posterior pdfs for K and r, and joint posterior distribution for K and r







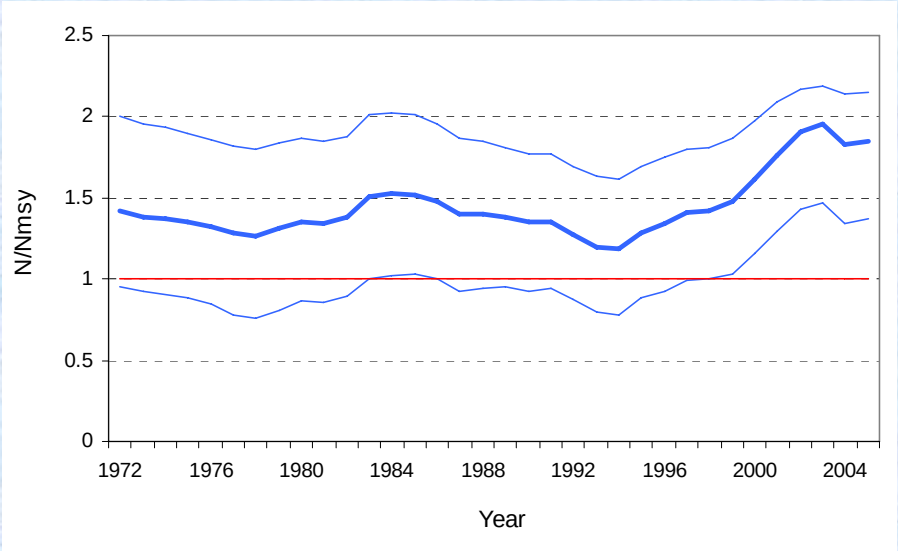
BSP results for SCS complex-Baseline: Projections



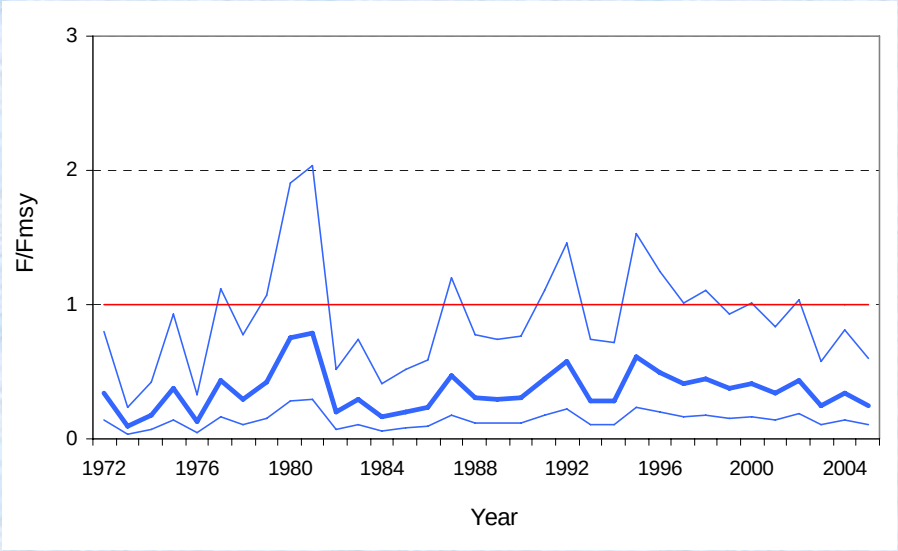
Sensitivity Analyses

- Alternative model (W; WinBUGS)
- Inverse CV weighting (WM)
- Extending catch series back to 1950 (AC)
- Including “sensitivity” CPUE series (ALL)

Results for SCS complex: Estimated biomass and relative biomass and fishing mortality rate trajectories of the **WinBUGS** SPM.

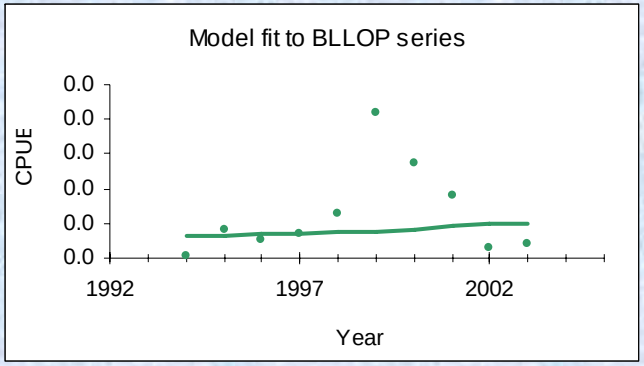


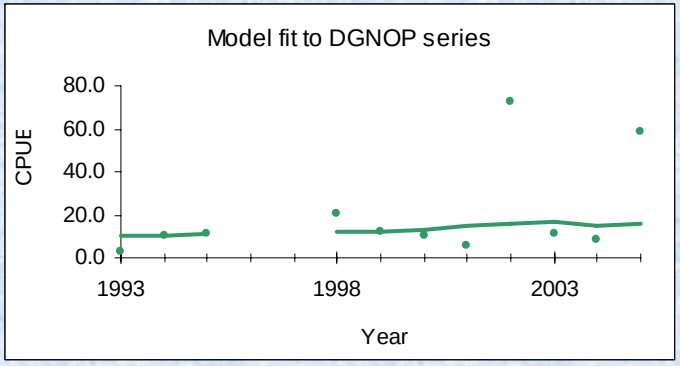
N/N_{MSY}

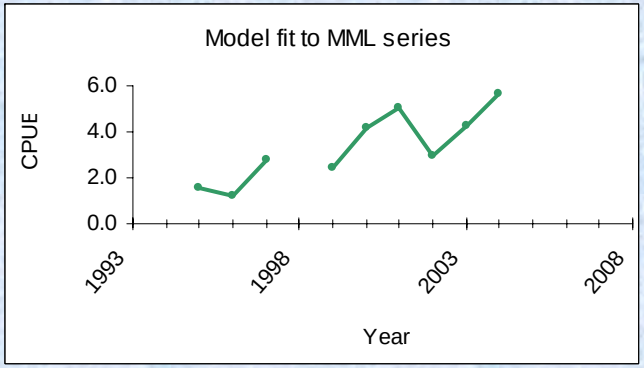


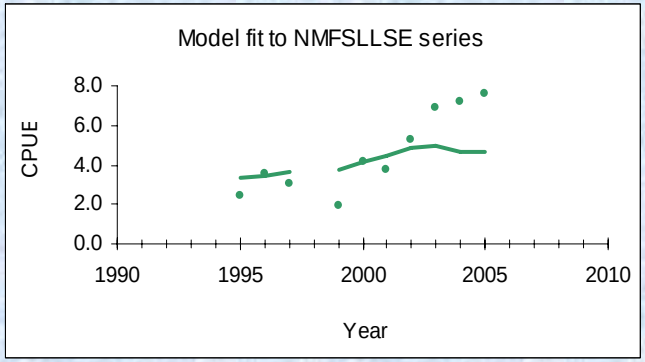
F/F_{MSY}

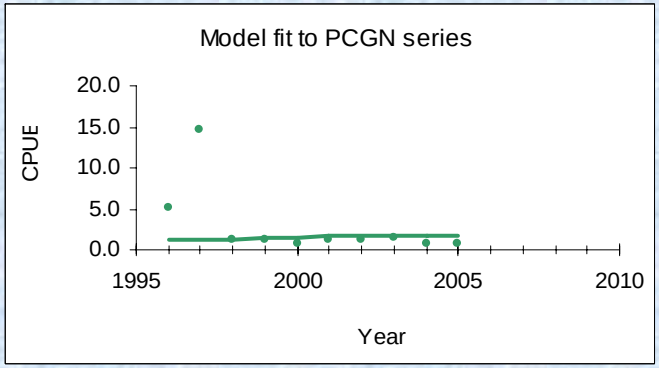
Results for SCS complex: WinBUGS SPM model fits to the CPUE series

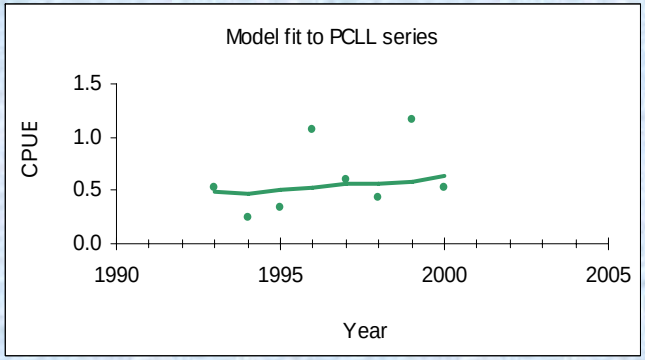


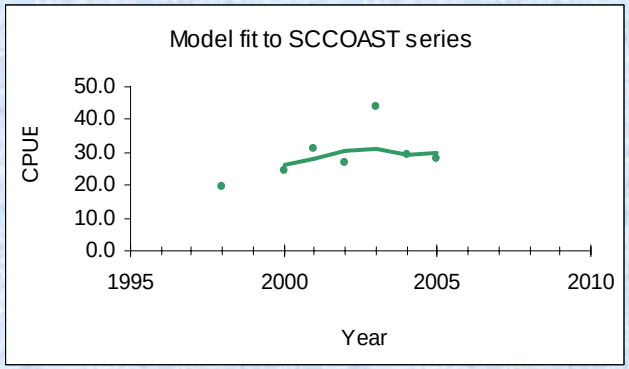


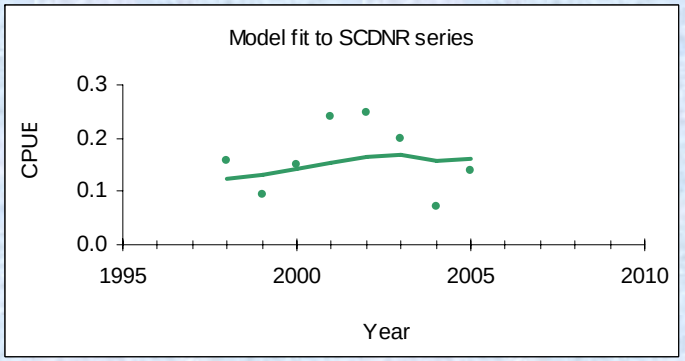


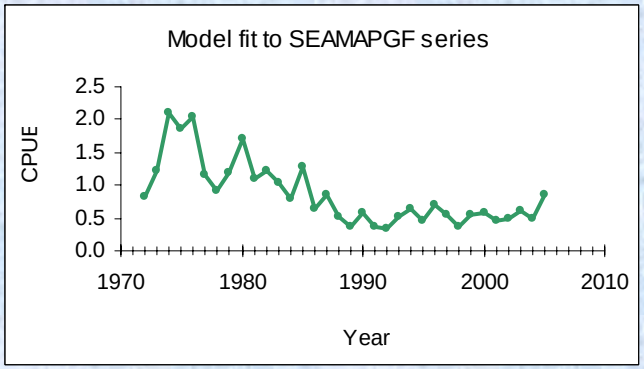




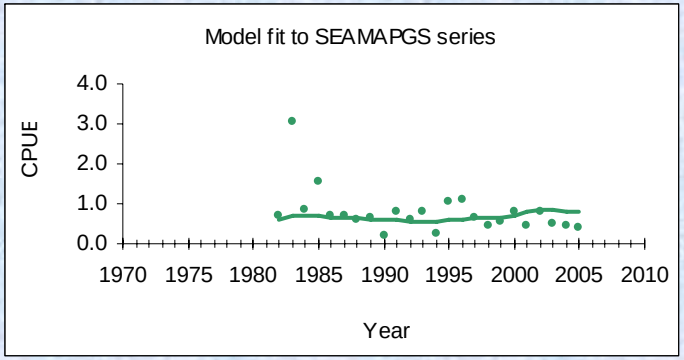


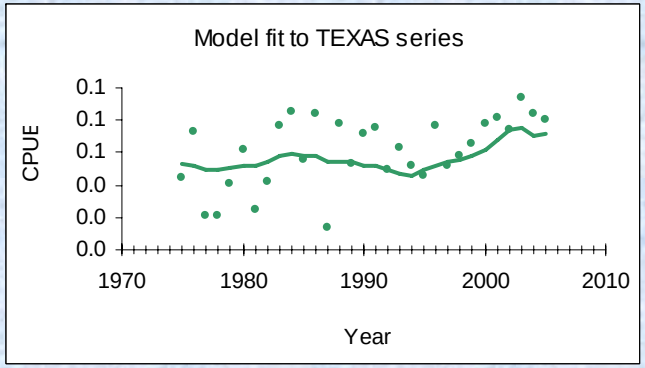


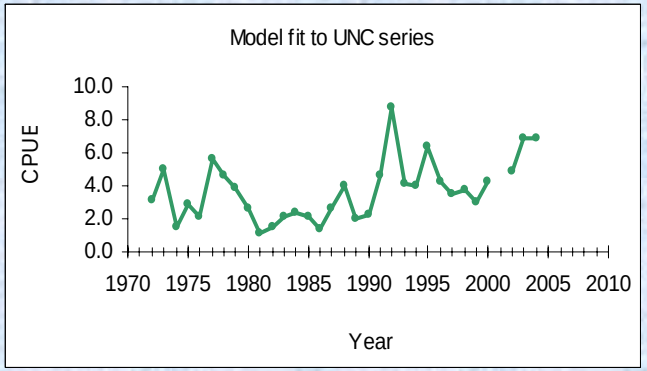


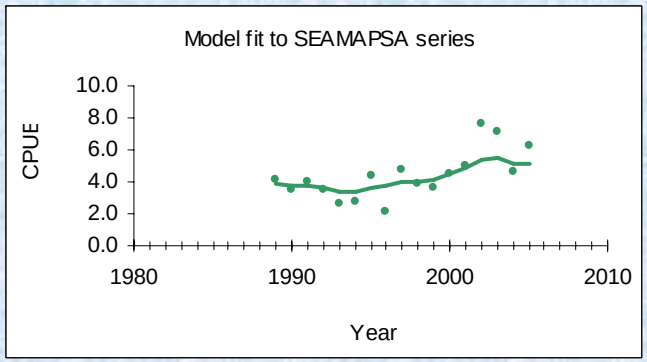


Results for SCS complex: WinBUGS SPM model fits to the CPUE series

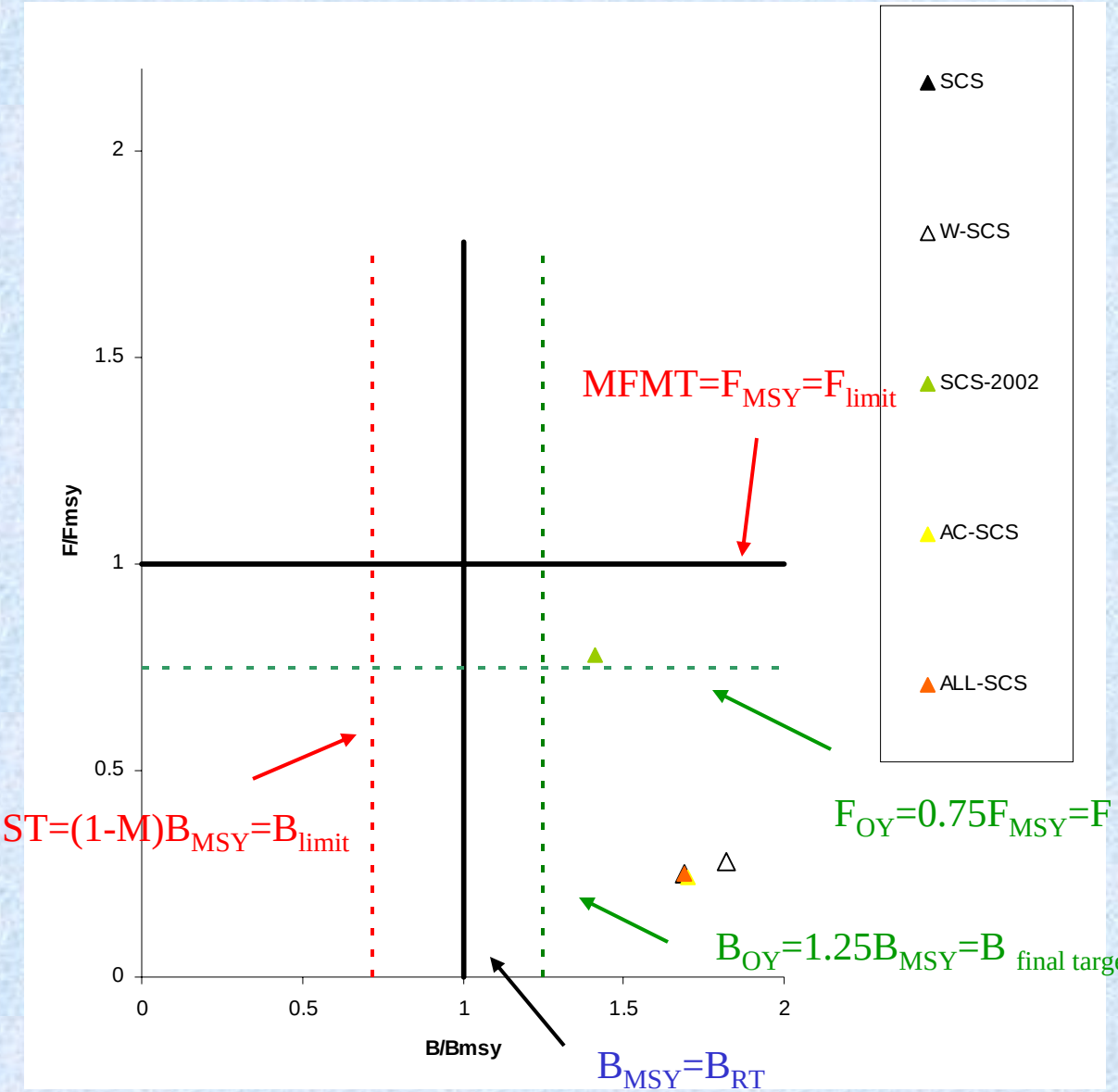






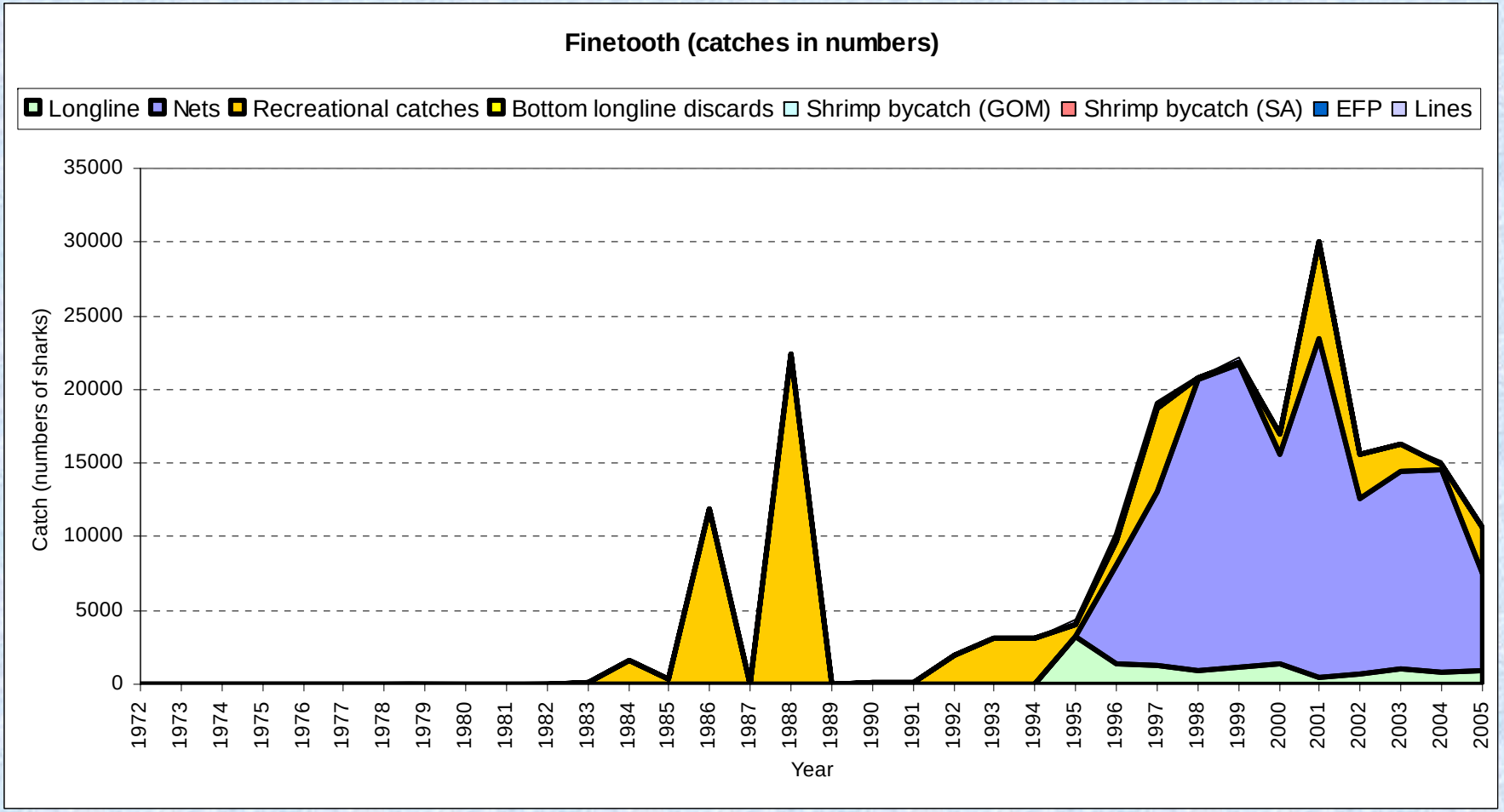


Results for SCS complex: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



FINETOOTH SHARK

Total Catches: Finetooth shark

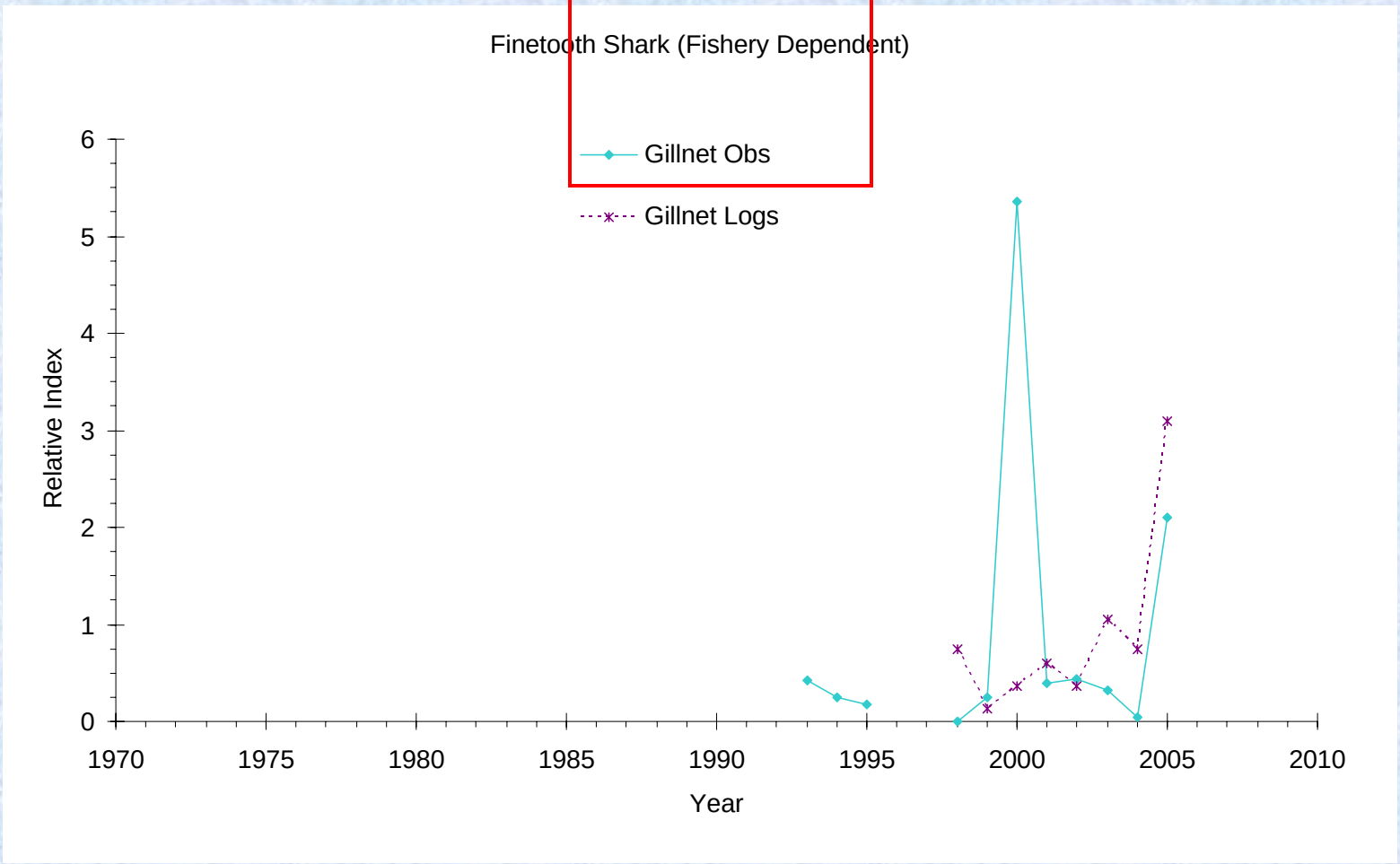


CPUE series: SCS complex -Baseline

- **FISHERY-DEPENDENT:** Gillnet Observer (1)
- **FISHERY-INDEPENDENT:** PC Gillnet, TEXAS, SC Coastspan GN (3)

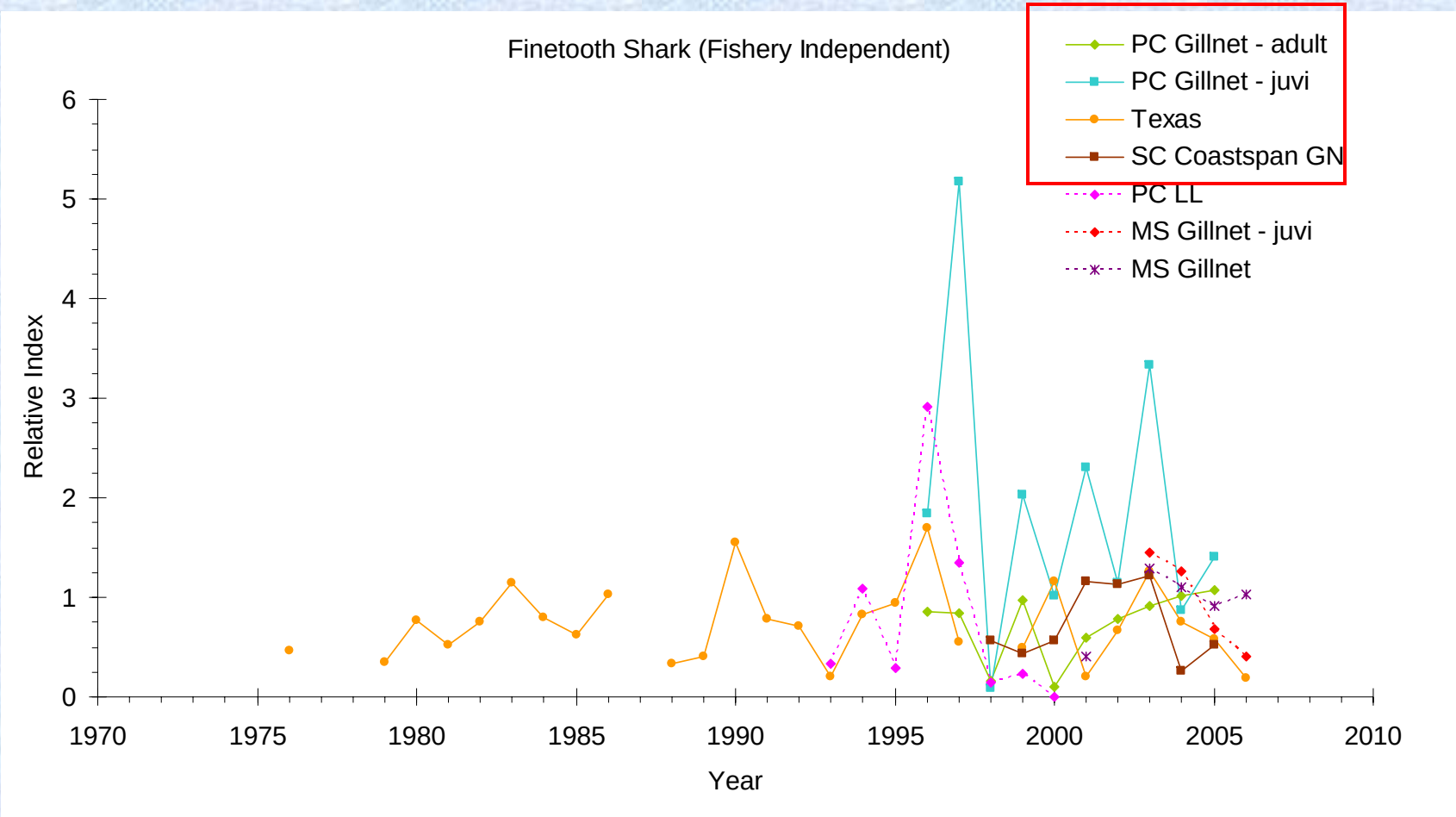
CPUE series: Finetooth shark-Baseline (F-D)

Baseline Index



CPUE series: Finetooth shark-Baseline (F-I)

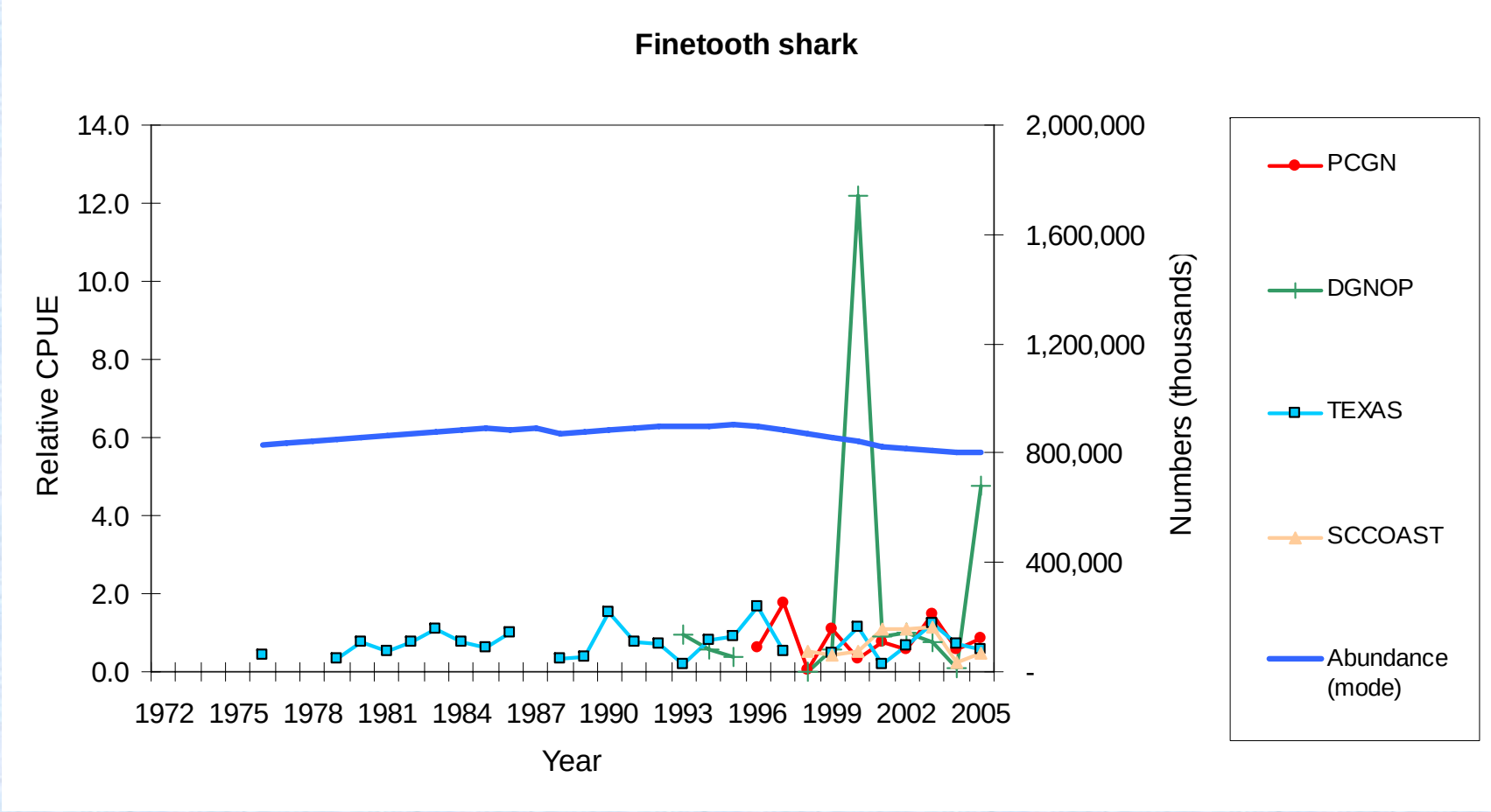
Baseline Indices



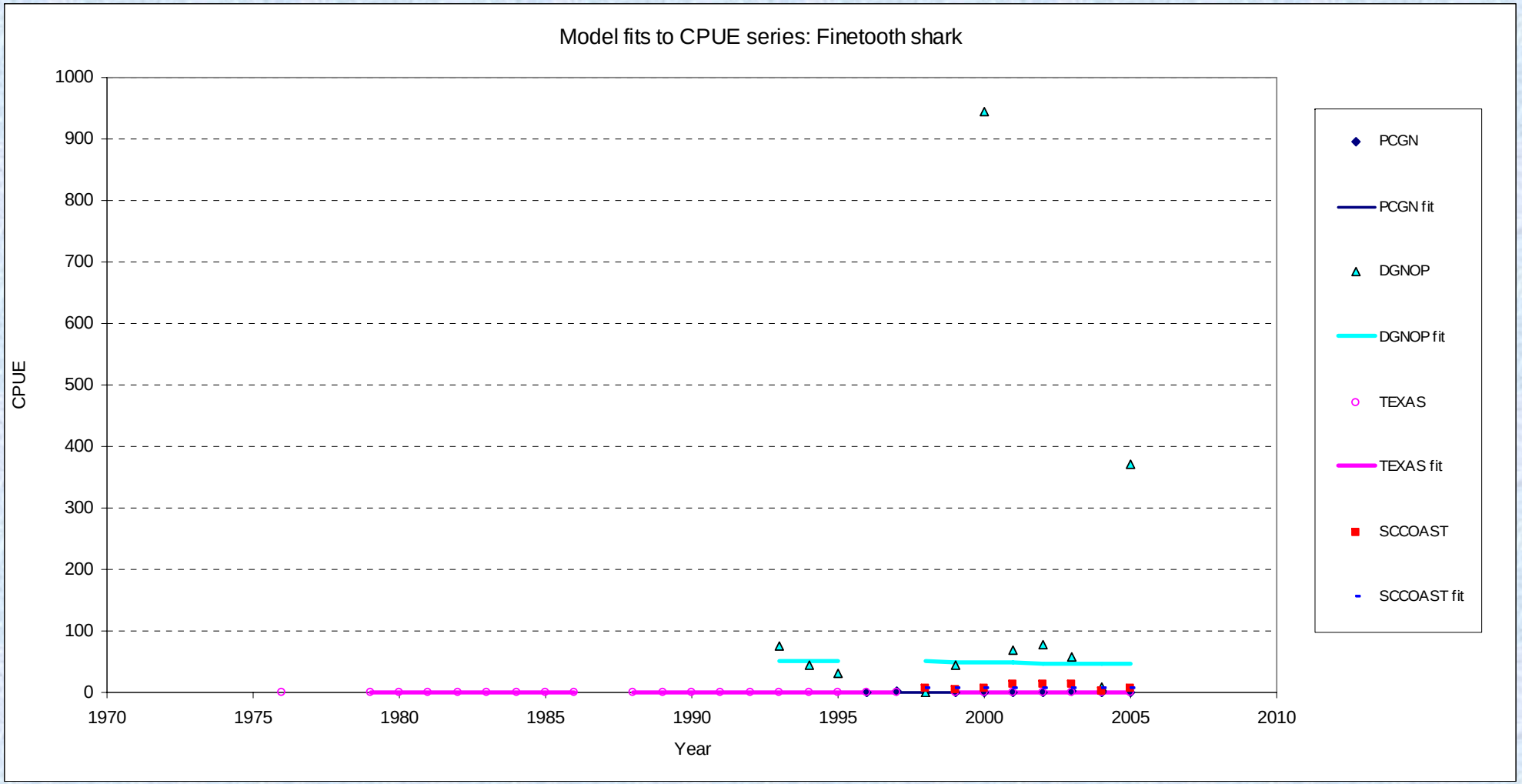
Inputs-Priors for Finetooth shark-Baseline

- Model starts in 1976 (first year of CPUE indices)
- Catch data available for 1983-2005
- 4 Indices available
- r ~ LN (0.06, 0.04, 0.001,2.0) ← 2002 assessment value
- K ~ U on log K (10^4-2x10^7)
- $N_{72/K}$ ~ LN (0.9, 0.2, 0.2, 1.1)
- C_0 ~ LN (2,774, 1) ← Mean (1983-1988)

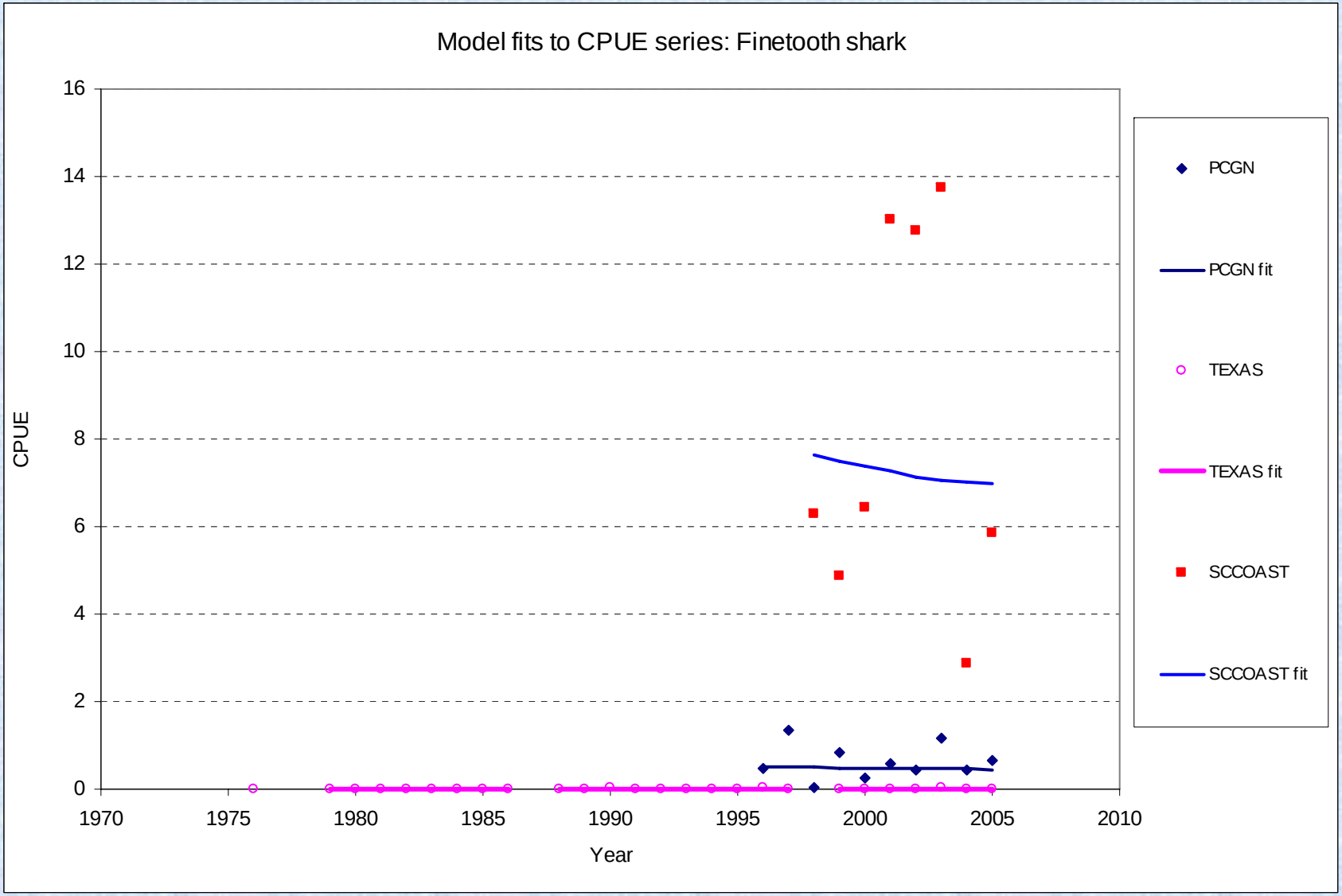
SPM results for Finetooth shark-Baseline: Predicted biomass trend at posterior mode of the BSP model fitted to catch and CPUE data



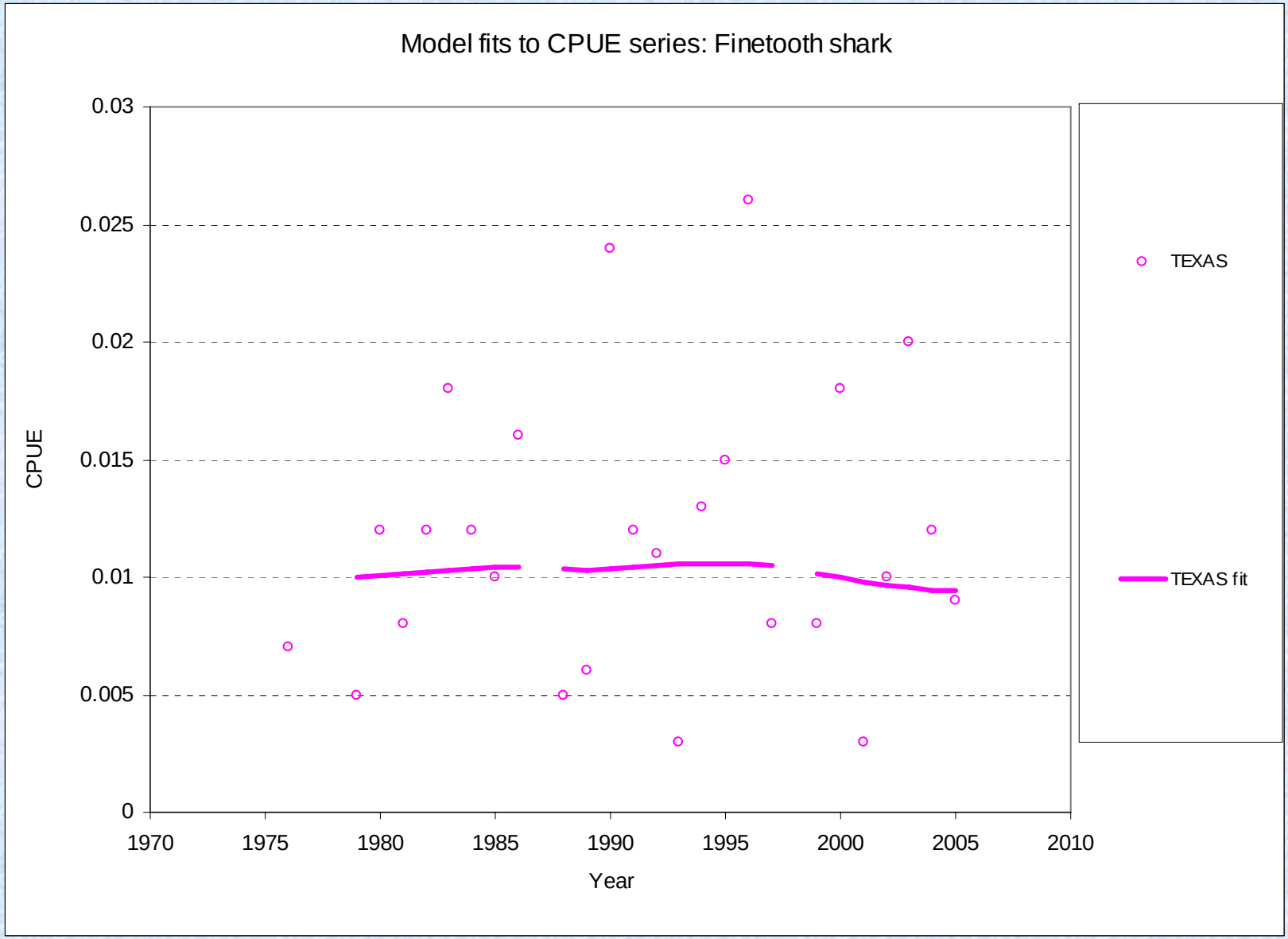
SPM results for Finetooth shark-Baseline: Model fits to the individual CPUE series



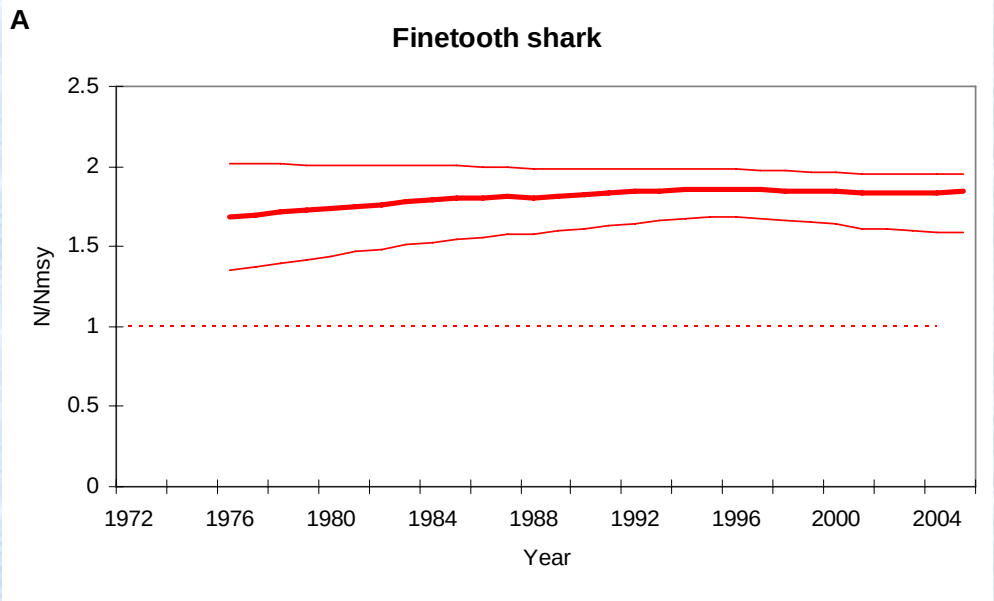
SPM results for Finetooth shark-Baseline: Model fits to the individual CPUE series (-DGNOP)



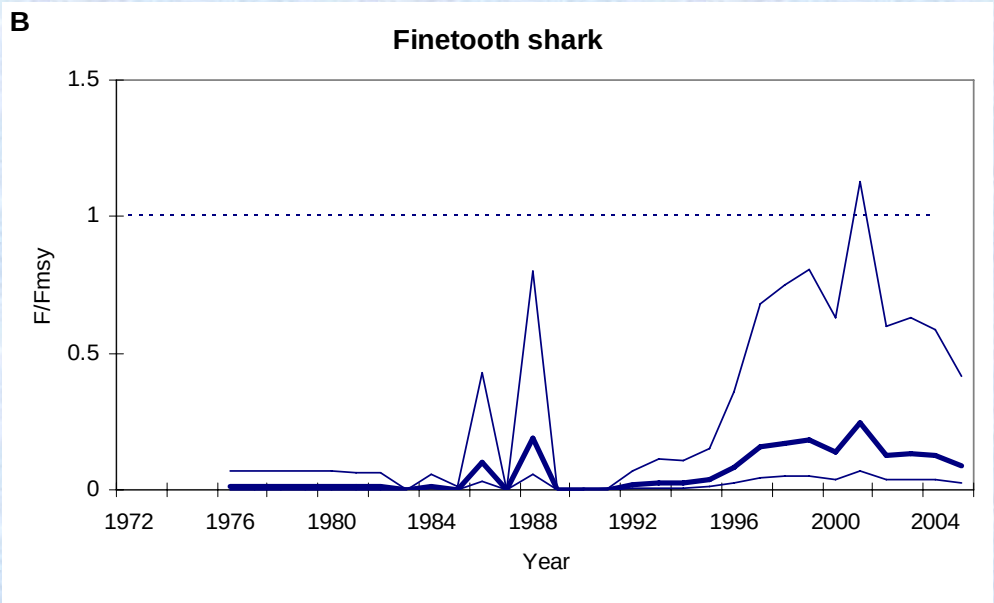
SPM results for Finetooth shark-Baseline: Model fits to the individual CPUE series (TEXAS only)



SPM results for Finetooth shark-Baseline: BSP estimated relative abundance and fishing mortality rate trajectories



N/N_{MSY}

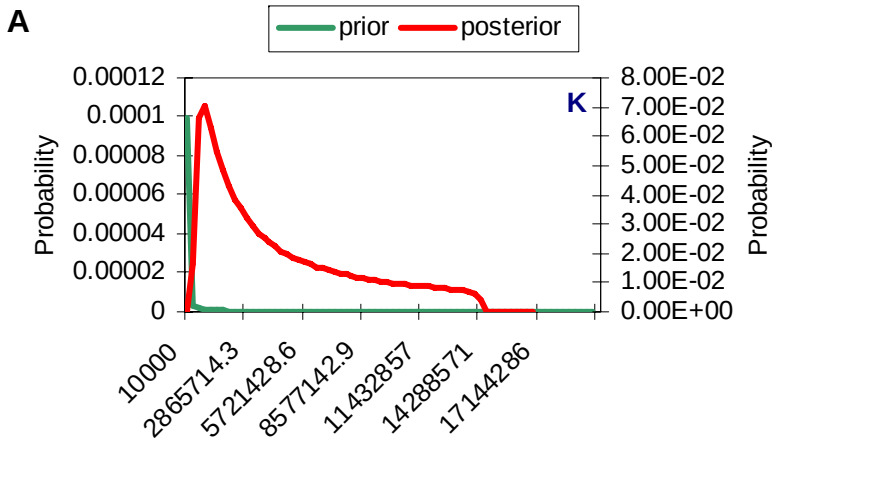


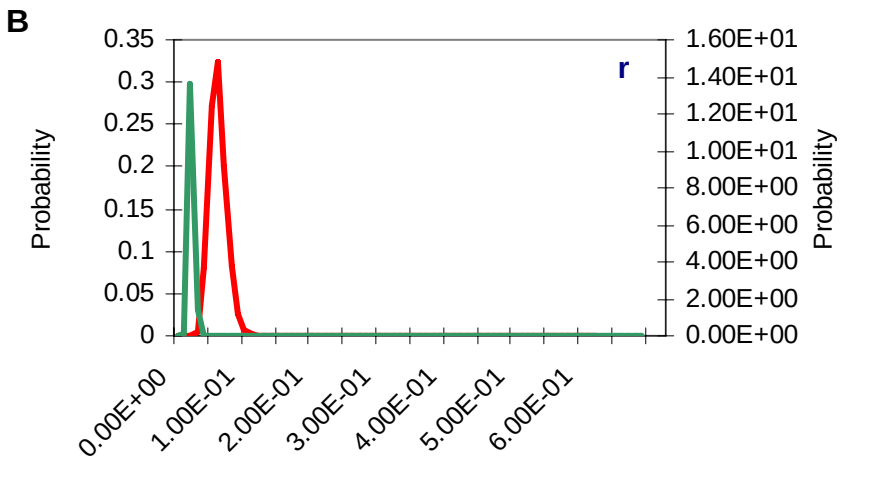
F/F_{MSY}

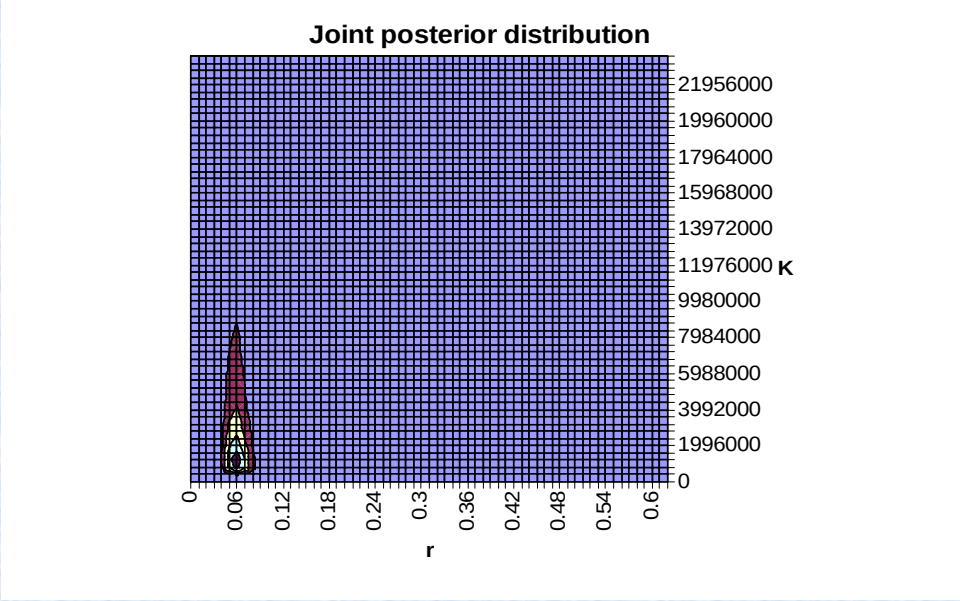
Expected values of the mean and CV of marginal posterior distributions from the SPM for Finetooth shark-Baseline

	Finetooth	
	EV	CV
Importance function	priors	
K	6397	0.82
r	0.060	0.20
MSY	96	0.86
N_{2005}	6000	0.84
N_{2005}/K	**0.90**	0.08
N_{init}	5380	0.84
N_{2005}/N_{init}	1.09	0.14
C_{2005}/MSY	0.27	1.08
F_{2005}/F_{MSY}	**0.17**	1.32
N_{2005}/N_{MSY}	**1.80**	0.09
C_{2005}/repy	0.78	81.34
N_{MSY}	3199	0.82
F_{MSY}	0.030	
repy	21	0.83
C_0	2	0.69
Diagnostics		
CW (wt)	0.609	
CV (L*prior)	1.163	
CV (Wt) / CV (L*p)	0.52	
%maxpWt	0.0004	

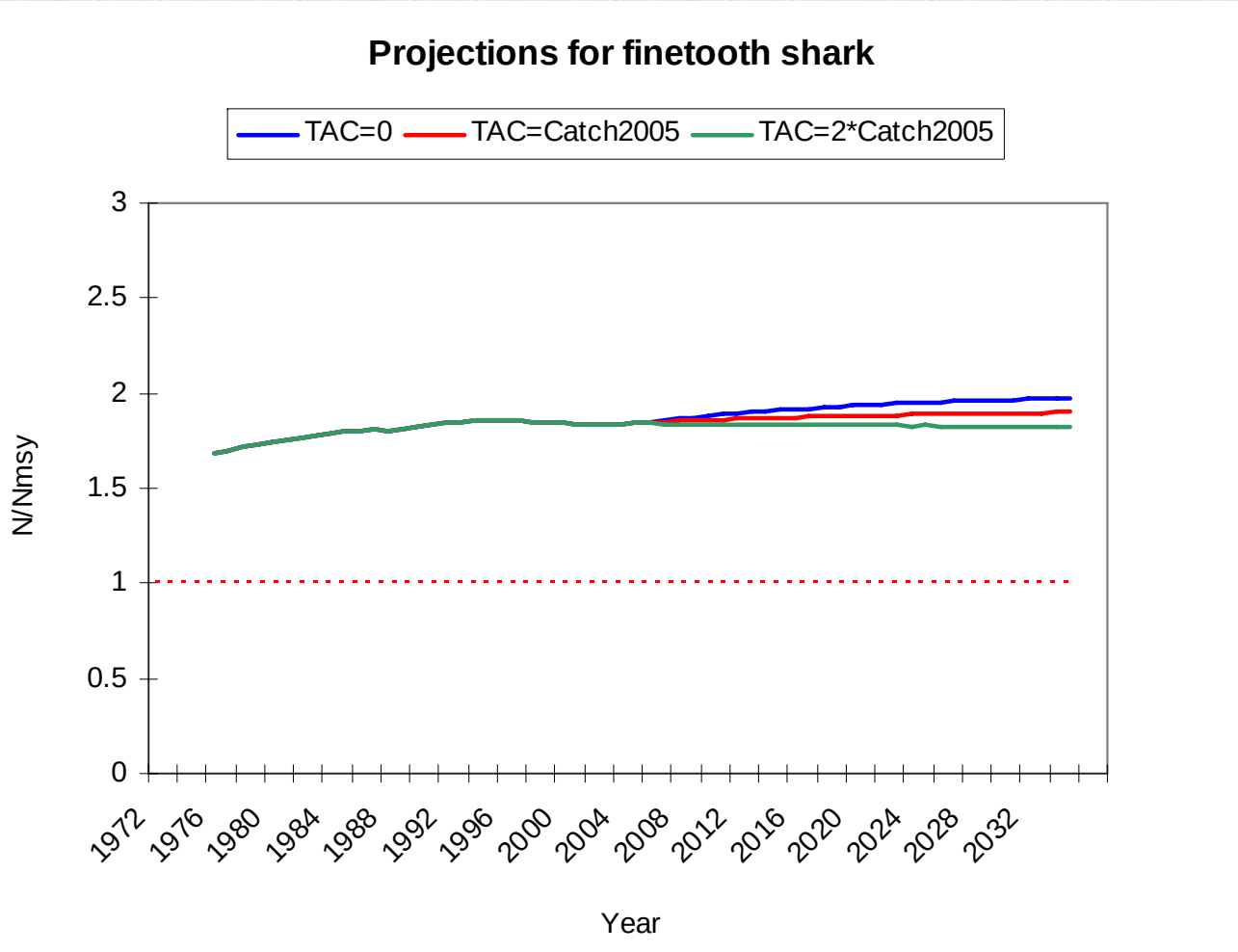
SPM results for Finetooth shark-Baseline: Prior and posterior pdfs for K and r, and joint posterior distribution for K and r







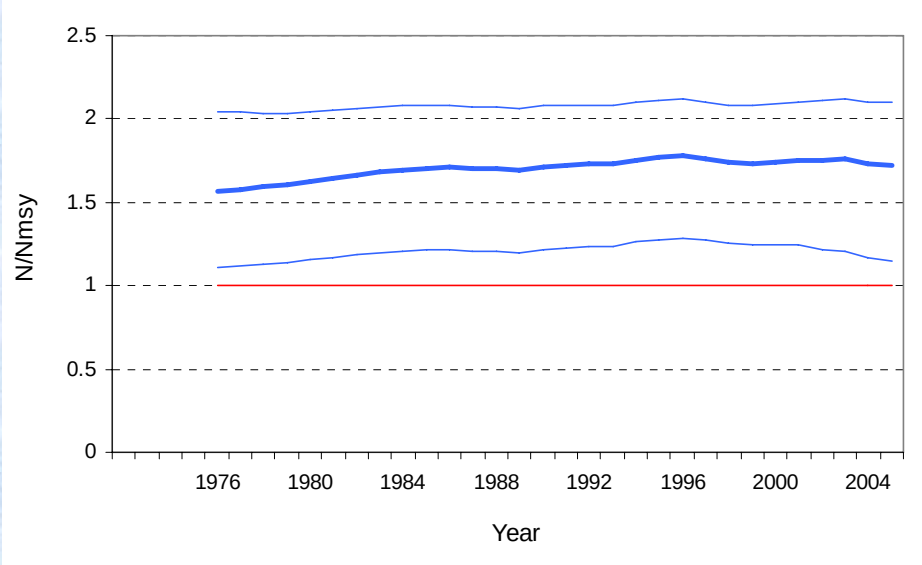
SPM results for Finetooth shark-Baseline: Projections



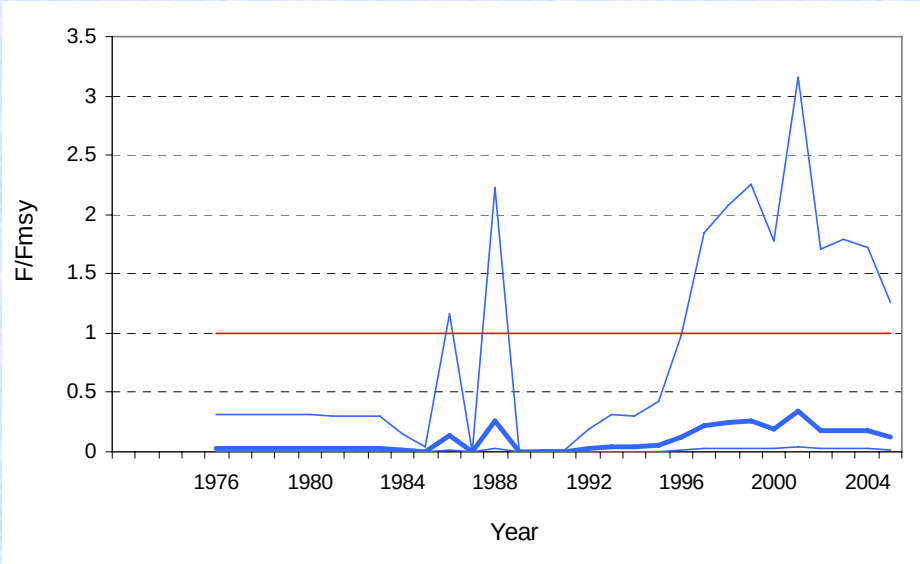
Sensitivity Analyses

- Alternative model (W; WinBUGS)
- Inverse CV weighting (WM)
- Extending catch series back to 1950 (AC)
- Including “sensitivity” CPUE series (ALL)
- Lowering value of r (mean=0.02)

Results for Finetooth shark: Estimated biomass and relative biomass and fishing mortality rate trajectories of the **WinBUGS** SPM.

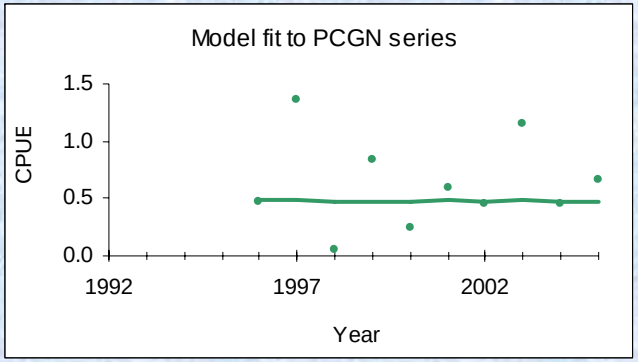


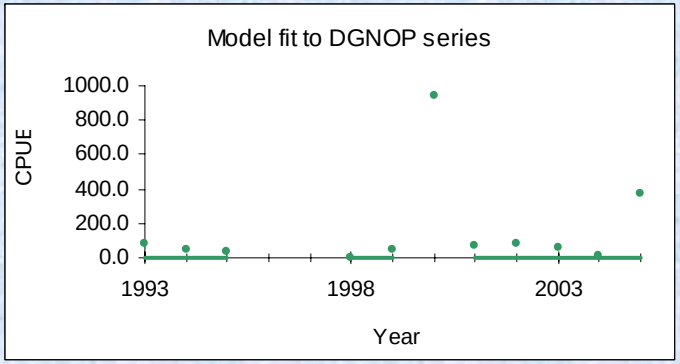
N/N_{MSY}

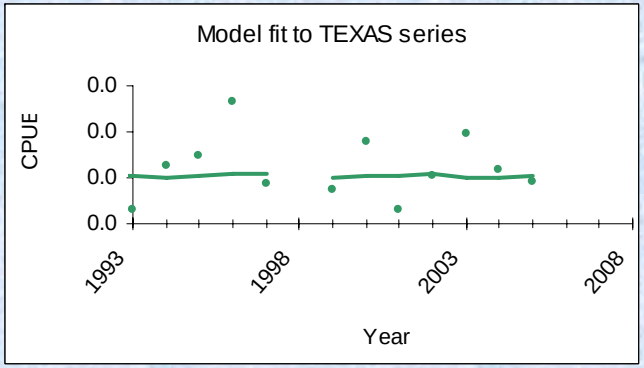


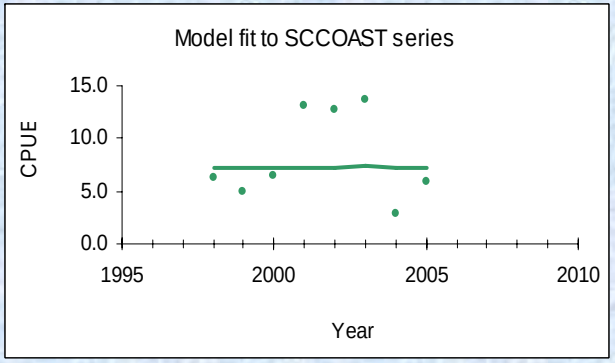
F/F_{MSY}

Results for Finetooth shark: WinBUGS SPM model fits to the CPUE series

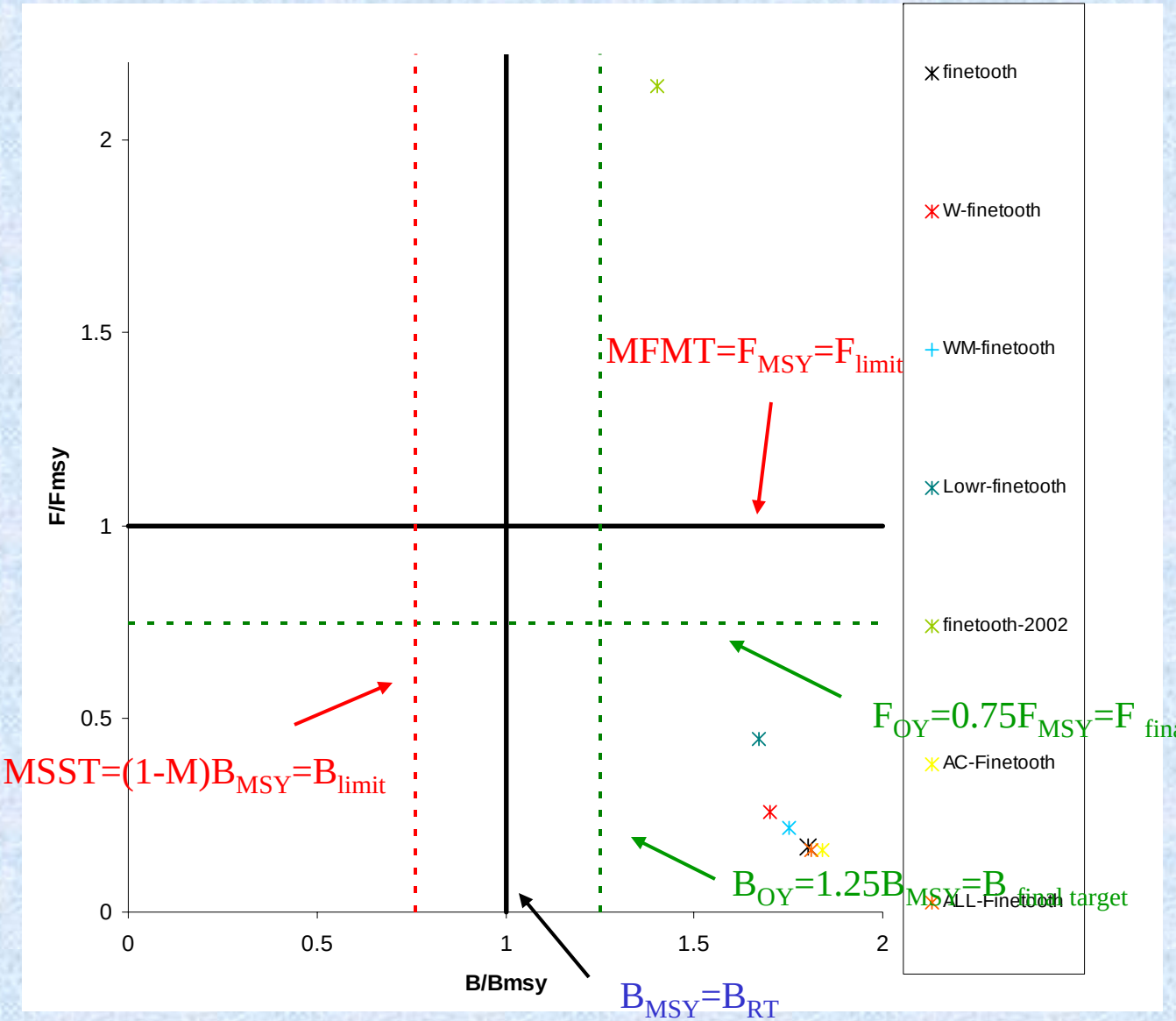






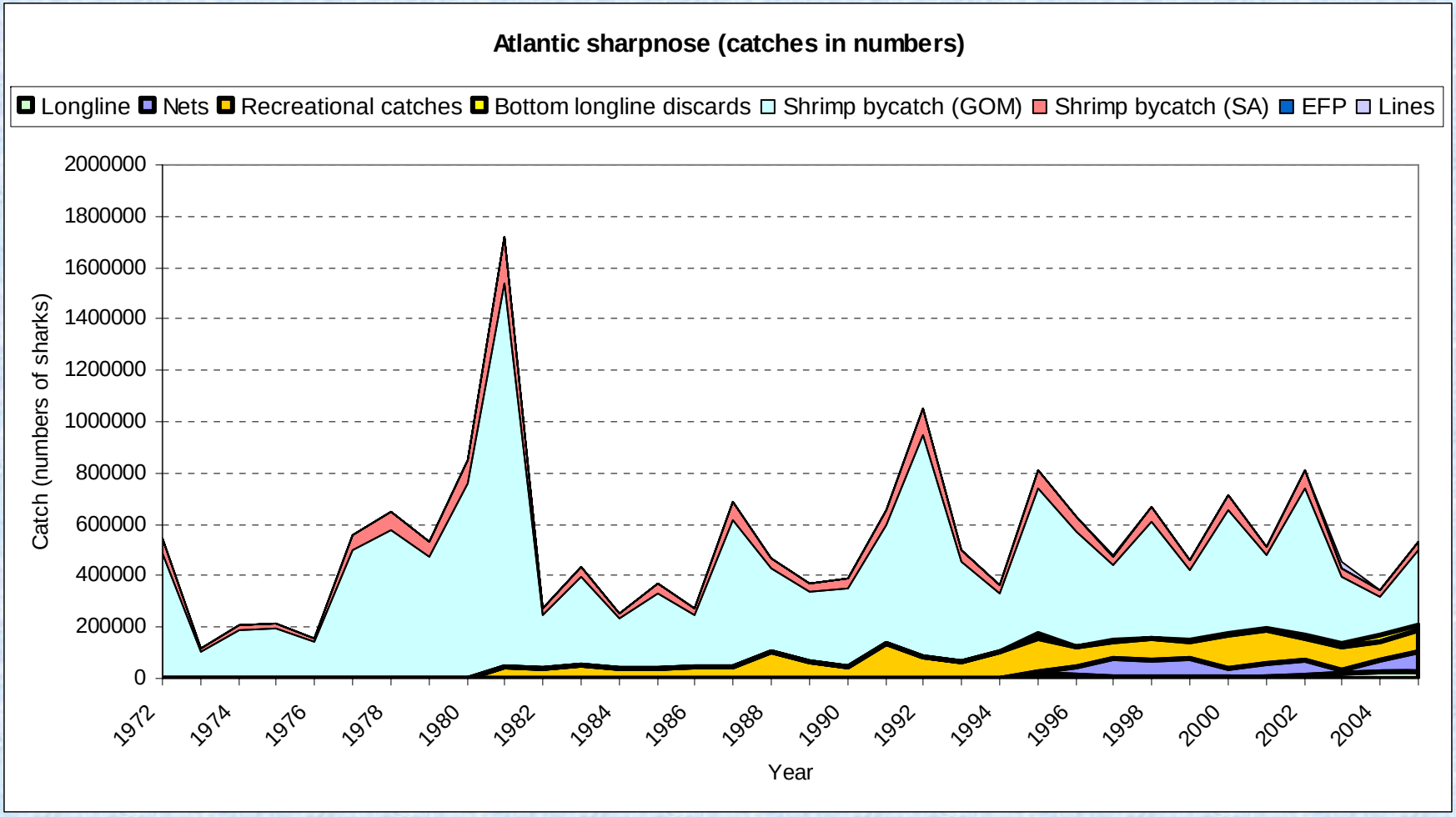


Results for Finetooth shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



ATLANTIC SHARPNOSE SHARK

Total Catches: Atlantic sharpnose shark

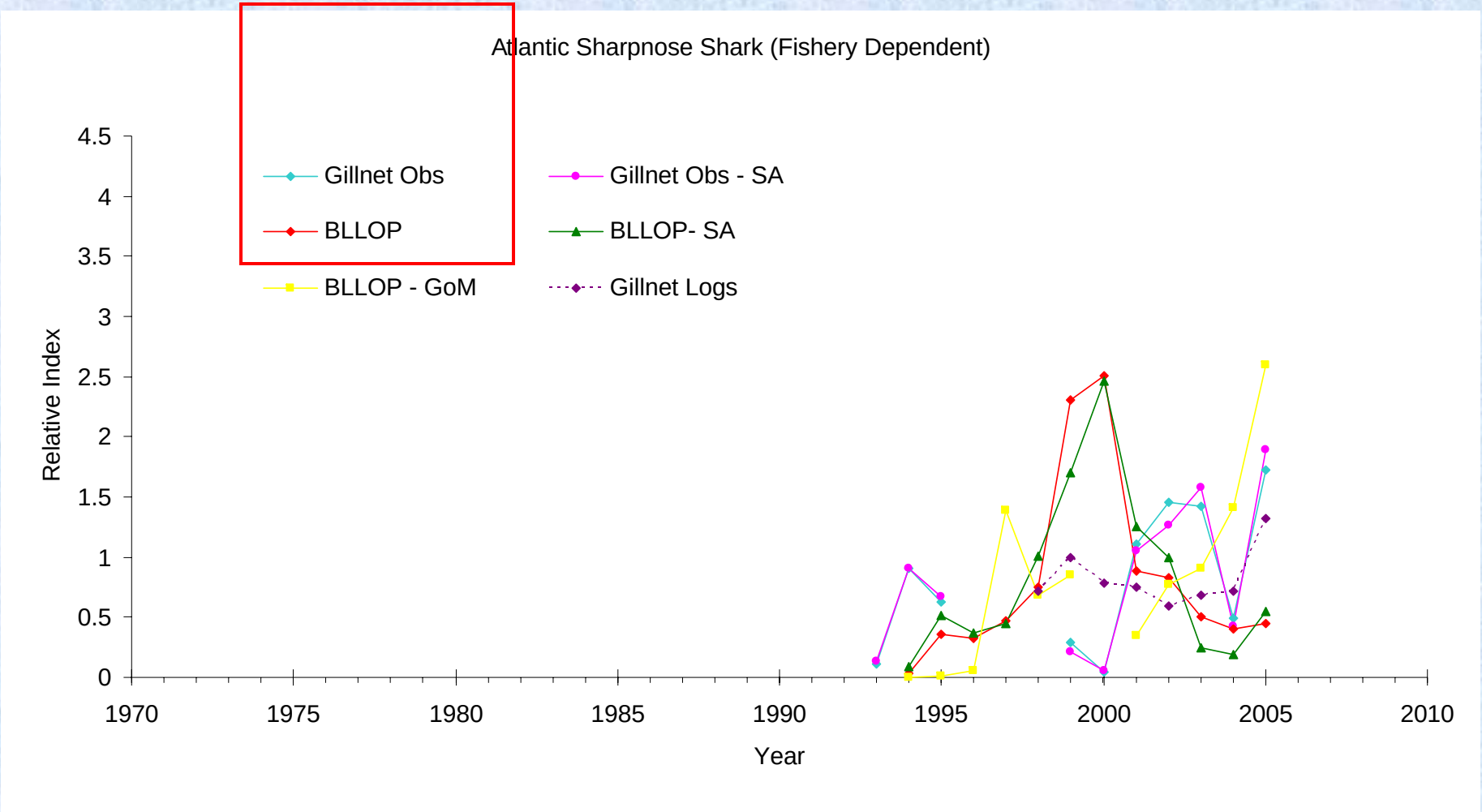


CPUE series: Atlantic sharpnose shark -Baseline

- **FISHERY-DEPENDENT:** Gillnet Observer, BLLOP (2)
- **FISHERY-INDEPENDENT:** PC LL, PC Gillnet, SEAMAP-SA, TEXAS, VA LL, NMFS LLSE, SC Coastspan, SCDNR, SEAMAP-GOM-S, SEAMAP-GOM-F, UNC, MML-Ad, MML-Juv (13)

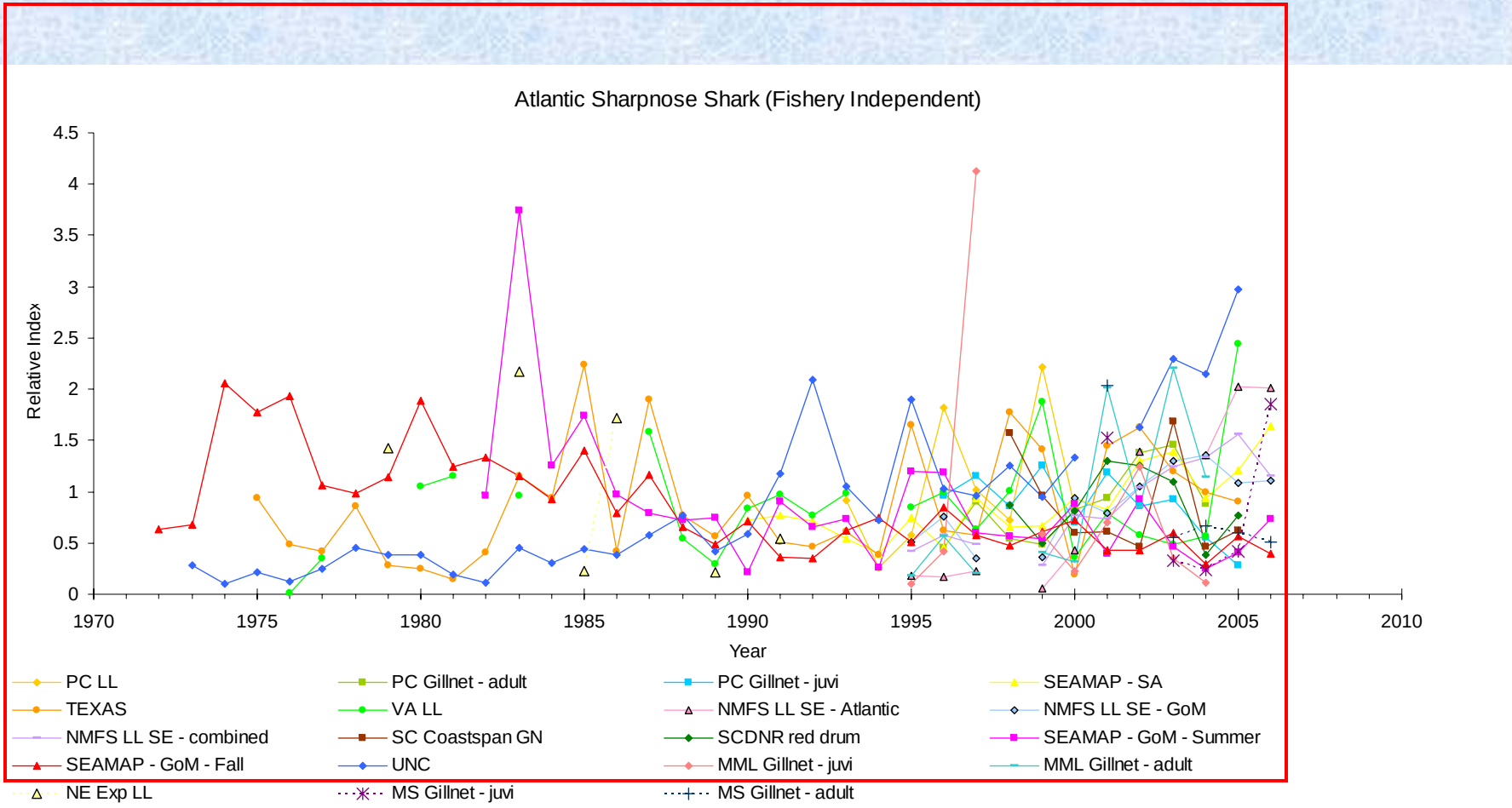
CPUE series: Atlantic sharpnose shark-Baseline (F-D)

Baseline Indices



CPUE series: Atlantic sharpnose shark-Baseline (F-I)

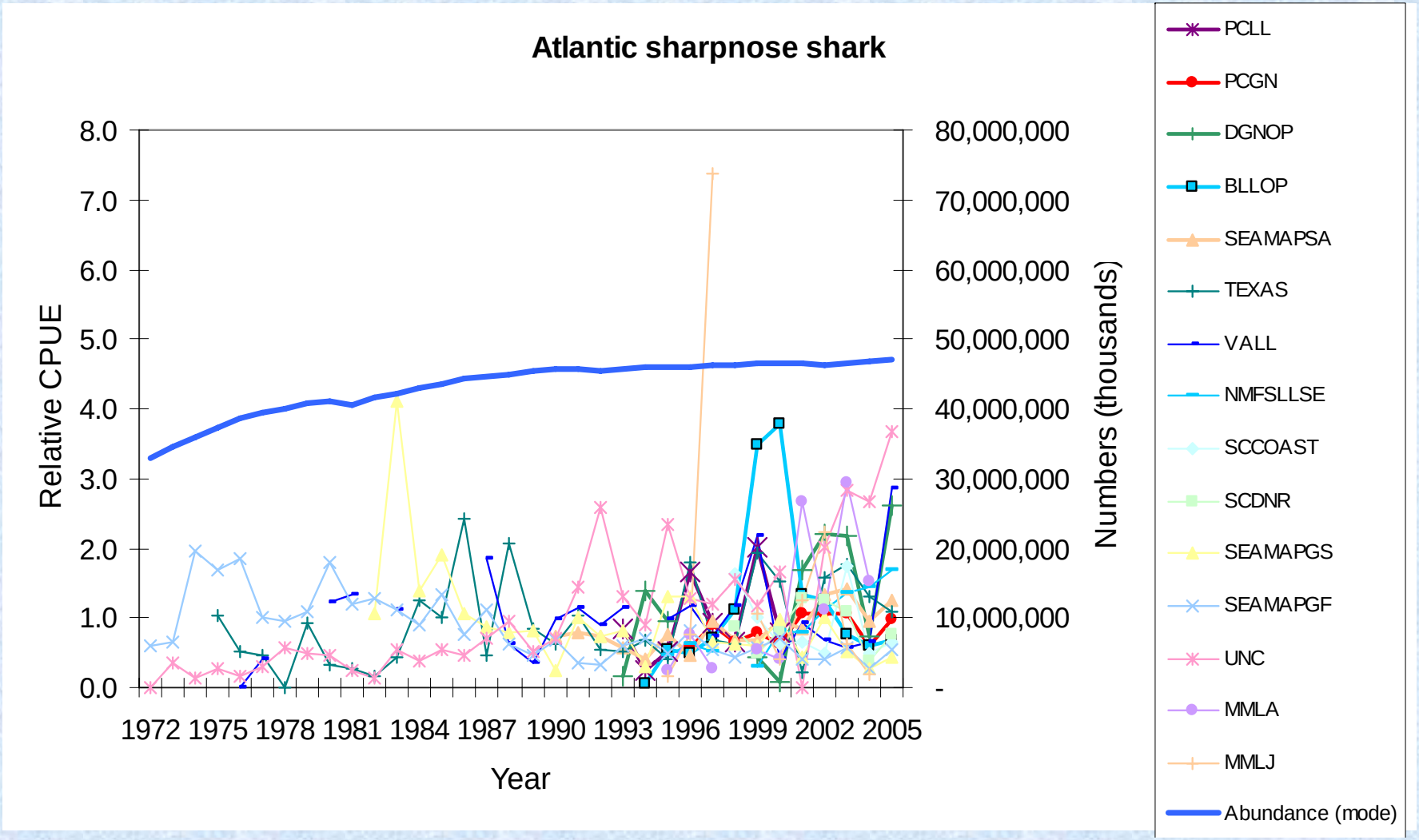
Baseline Indices



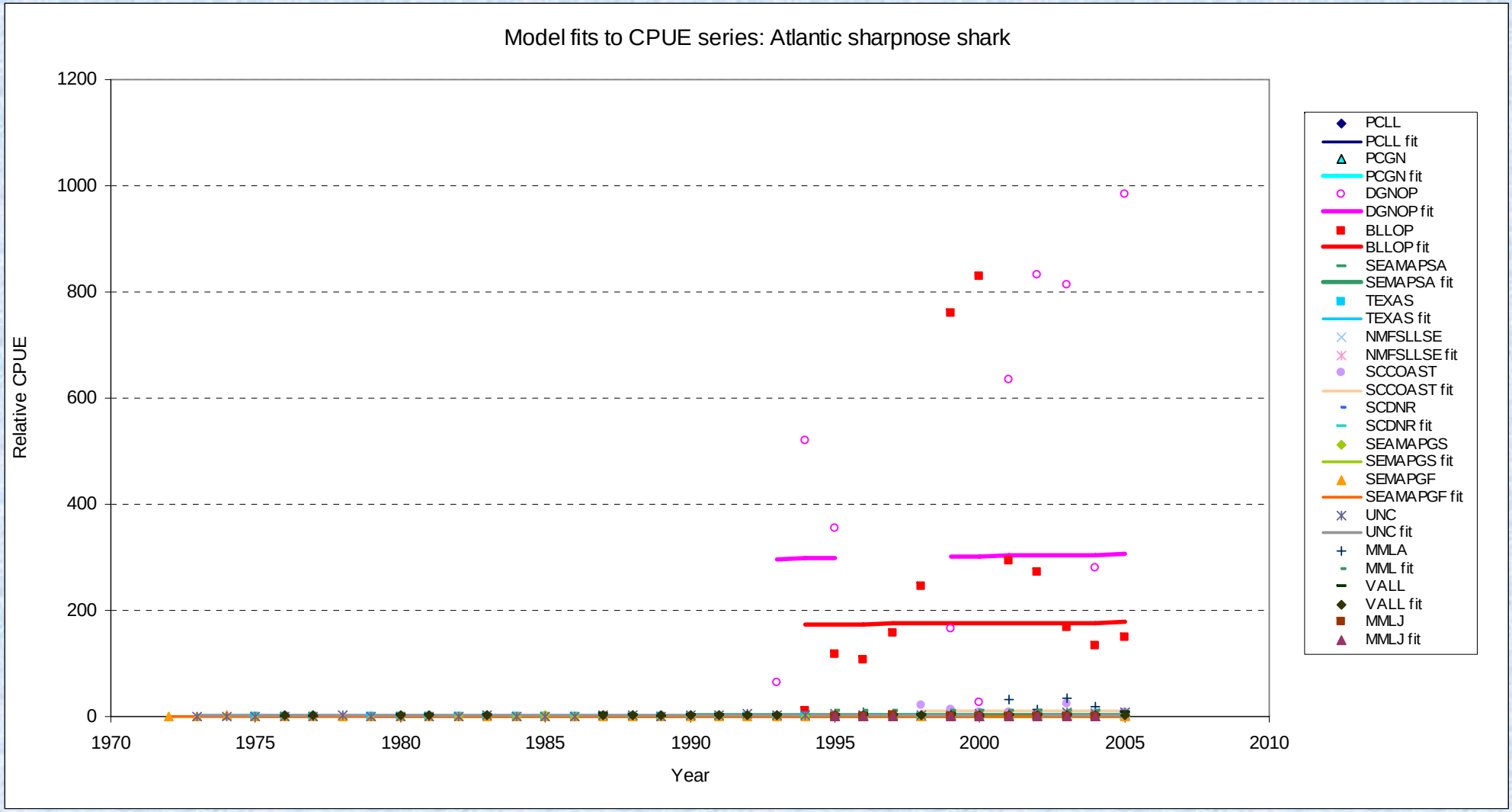
Inputs-Priors for Atlantic sharpnose shark-Baseline

- Model starts in 1972 (first year of CPUE indices)
- Catch data available for 1972-2005
- 15 Indices available
- r ~ LN (0.165, 0.08, 0.001,2.0)
- K ~ U on log K (10^4-10^8)
- $N_{72/K}$ ~ LN (0.9, 0.2, 0.2, 1.1)

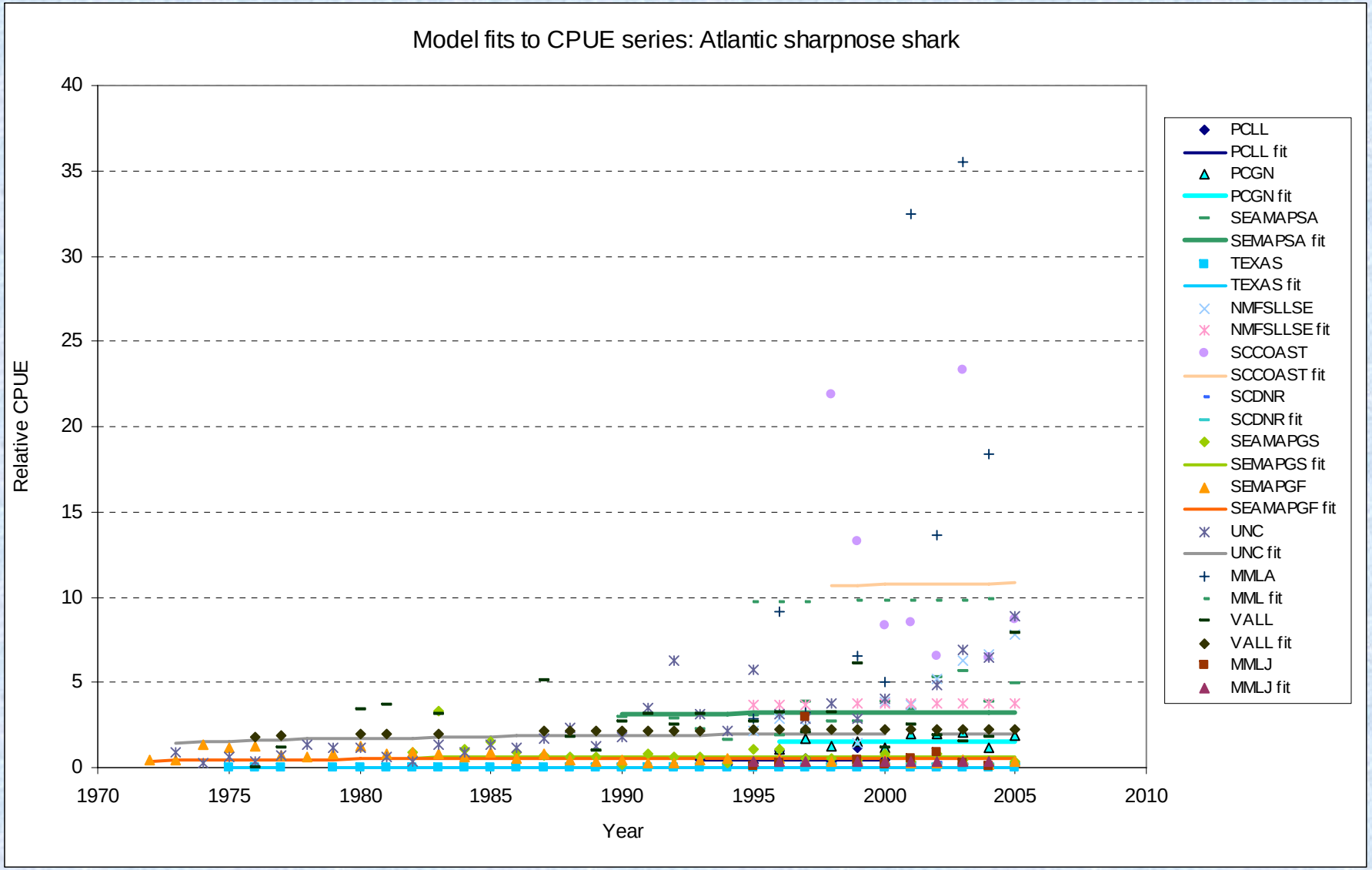
SPM results for Atlantic sharpnose shark-Baseline: Predicted biomass trend at posterior mode of the BSP model fitted to catch and CPUE data



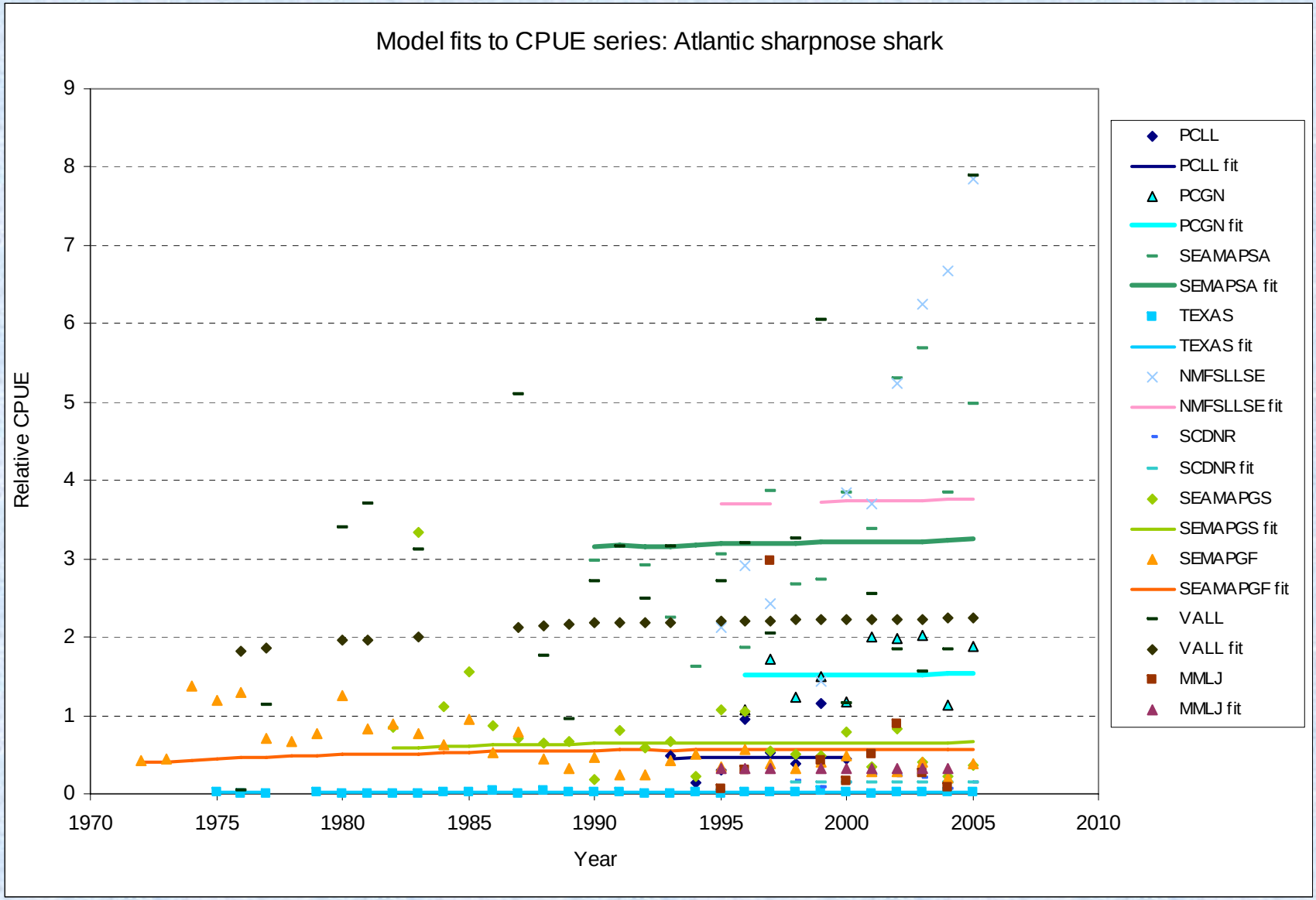
SPM results for Atlantic sharpnose shark-Baseline: Model fits to the individual CPUE series



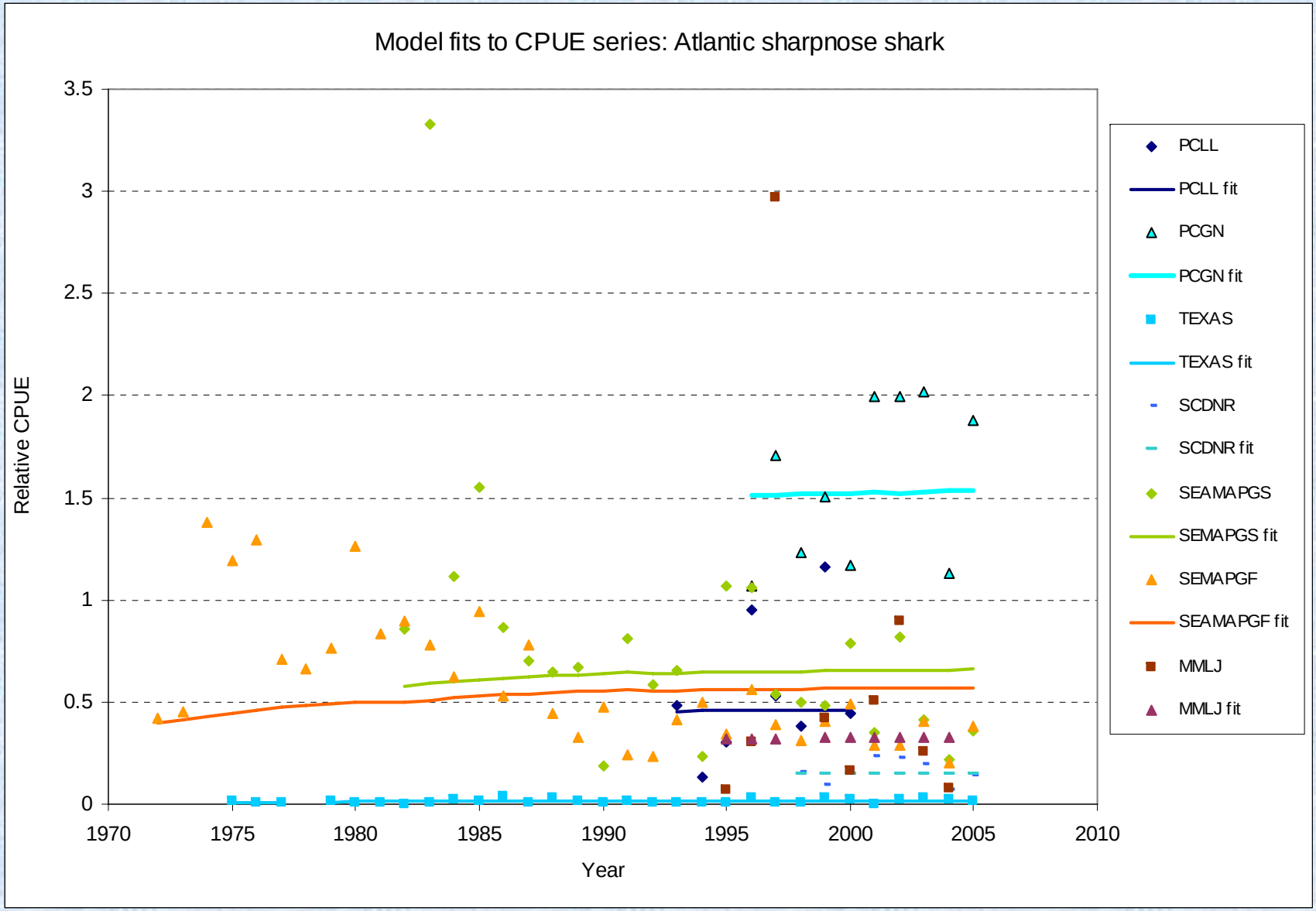
SPM results for Atlantic sharpnose shark-Baseline: Model fits to the individual CPUE series (-DGNOP, BLLOP)



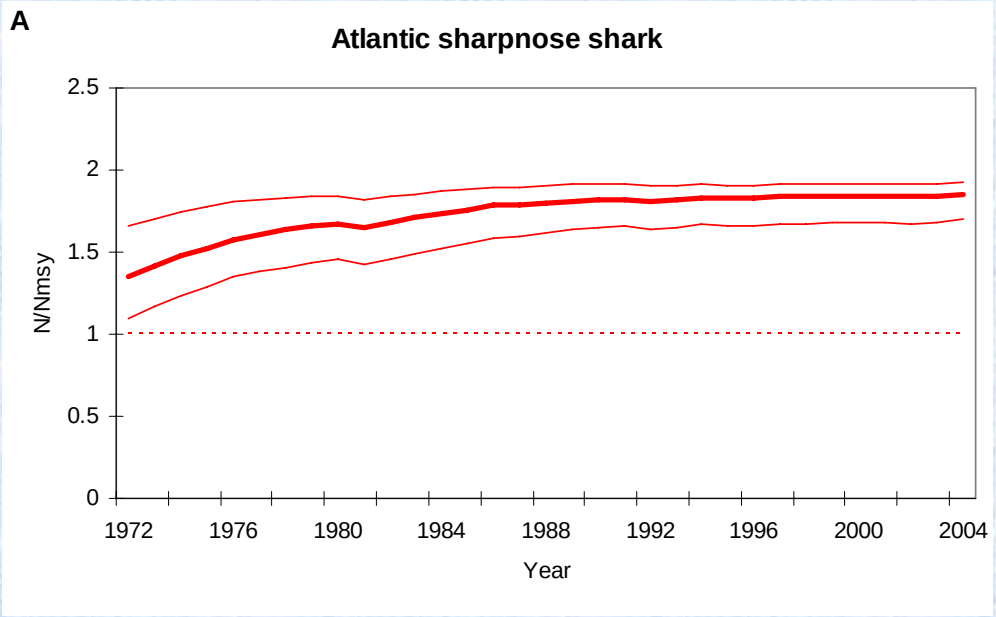
SPM results for Atlantic sharpnose shark-Baseline: Model fits to the individual CPUE series (-SCCOAST, MMLA, UNC)



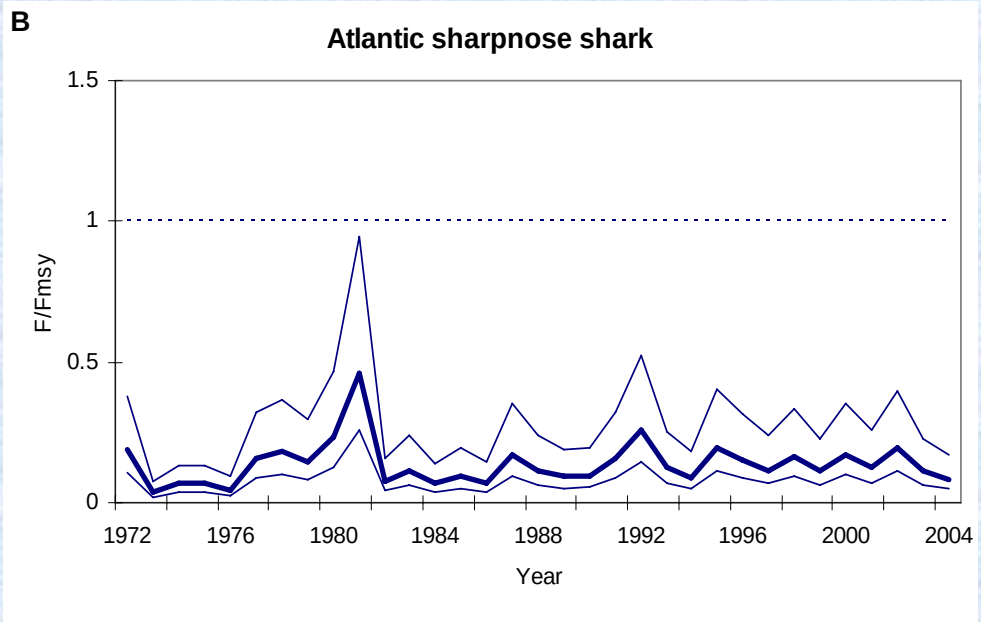
SPM results for Atlantic sharpnose shark-Baseline: Model fits to the individual CPUE series (-SEAMAPSA, VALL, NMFSLLSE)



SPM results for Atlantic sharpnose shark-Baseline: BSP estimated relative abundance and fishing mortality rate trajectories



N/N_{MSY}

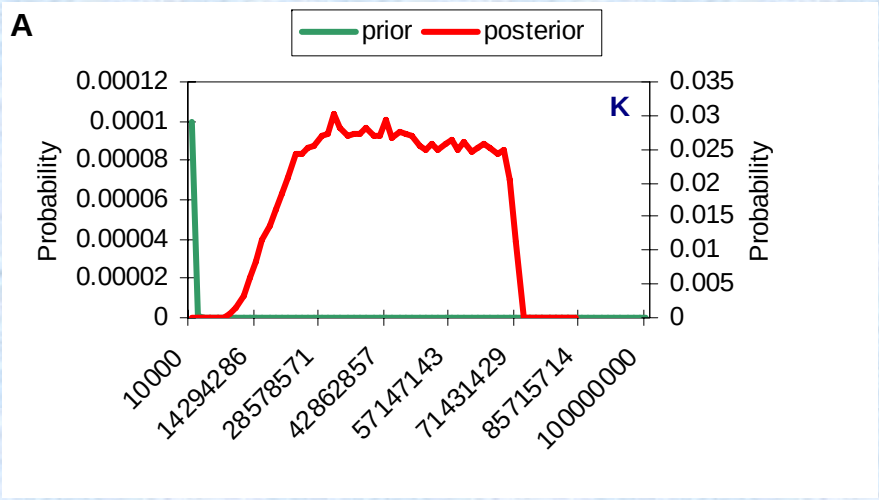


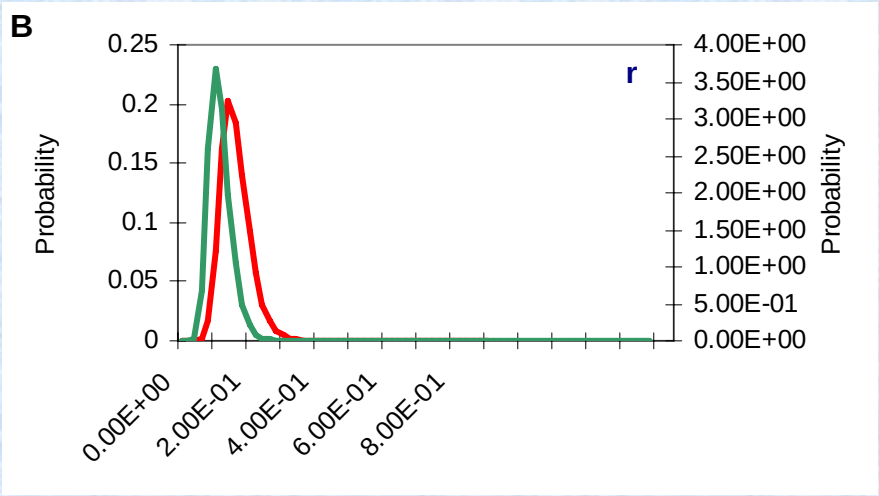
F/F_{MSY}

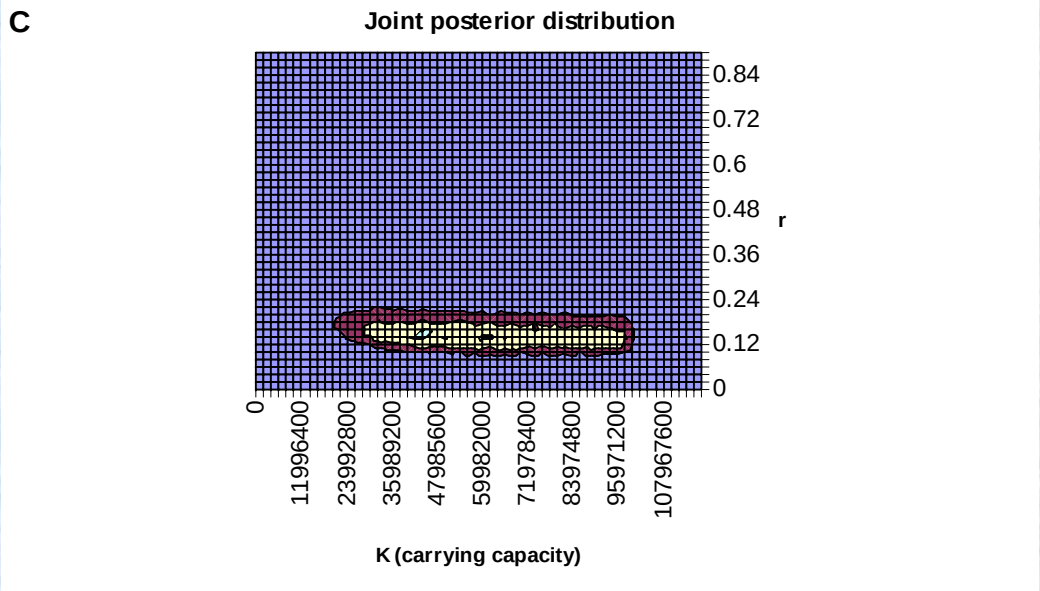
Expected values of the mean and CV of marginal posterior distributions from the SPM for Atlantic sharpnose shark-Baseline

	Atl. Sharpnose	
	EV	CV
Importance function	priors	
K	60833	0.36
r	0.160	0.27
MSY	2389	0.43
N_{2005}	56389	0.39
N_{2005}/K	**0.91**	0.05
N_{init}	41778	0.41
N_{2005}/N_{init}	1.37	0.15
C_{2005}/MSY	0.27	0.46
F_{2005}/F_{MSY}	**0.15**	0.54
N_{2005}/N_{MSY}	**1.83**	0.05
C_{2005}/repy	0.90	0.08
N_{MSY}	30416	0.36
F_{MSY}	0.080	
repy	597	0.10
C_0		
Diagnostics		
CW (wt)	3.182	
CV (L*prior)	0.000	
CV (Wt) / CV (L*p)	n/a	
%maxpWt	0.070	

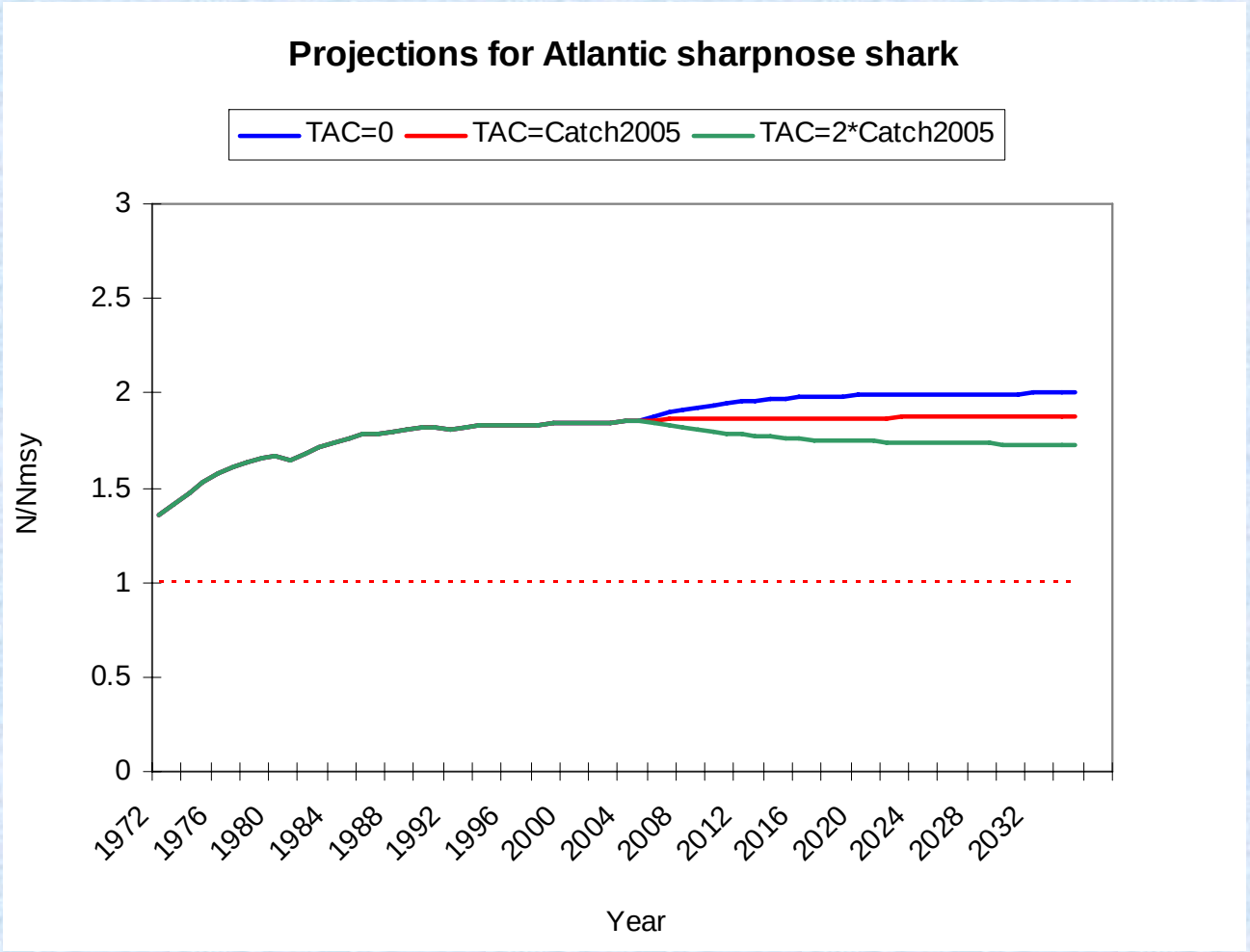
SPM results for Atlantic sharpnose shark-Baseline: Prior and posterior pdfs for K and r, and joint posterior distribution for K and r







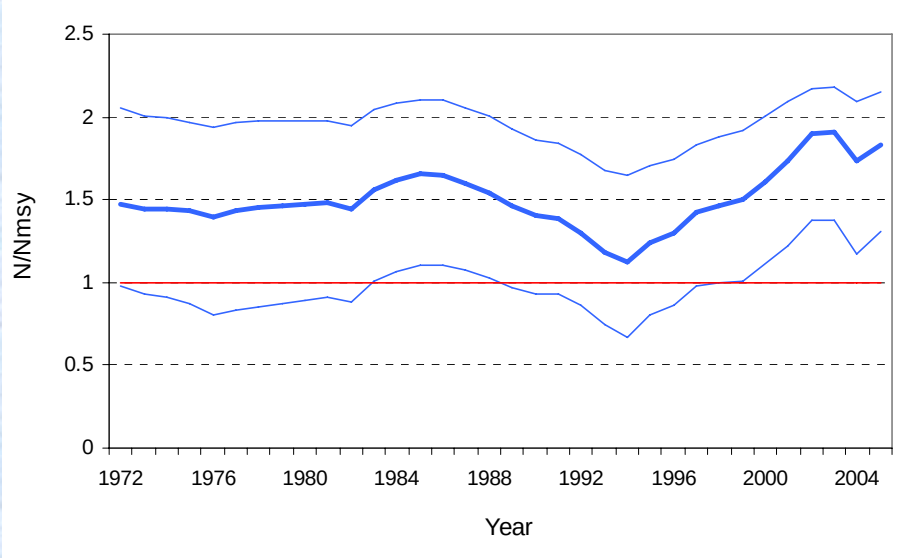
SPM results for Atlantic sharpnose shark-Baseline: Projections



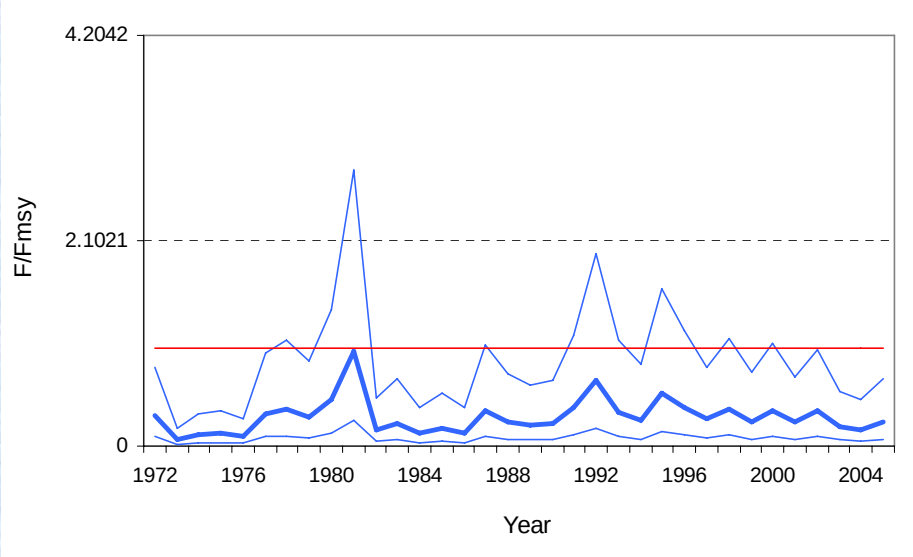
Sensitivity Analyses

- Alternative model (W; WinBUGS)
- Inverse CV weighting (WM)
- Extending catch series back to 1950 (AC)
- Including “sensitivity” CPUE series (ALL)
- Considering separate stocks (GOM or SA)

Results for Atlantic sharpnose shark: Estimated biomass and relative biomass and fishing mortality rate trajectories of the **WinBUGS** SPM.

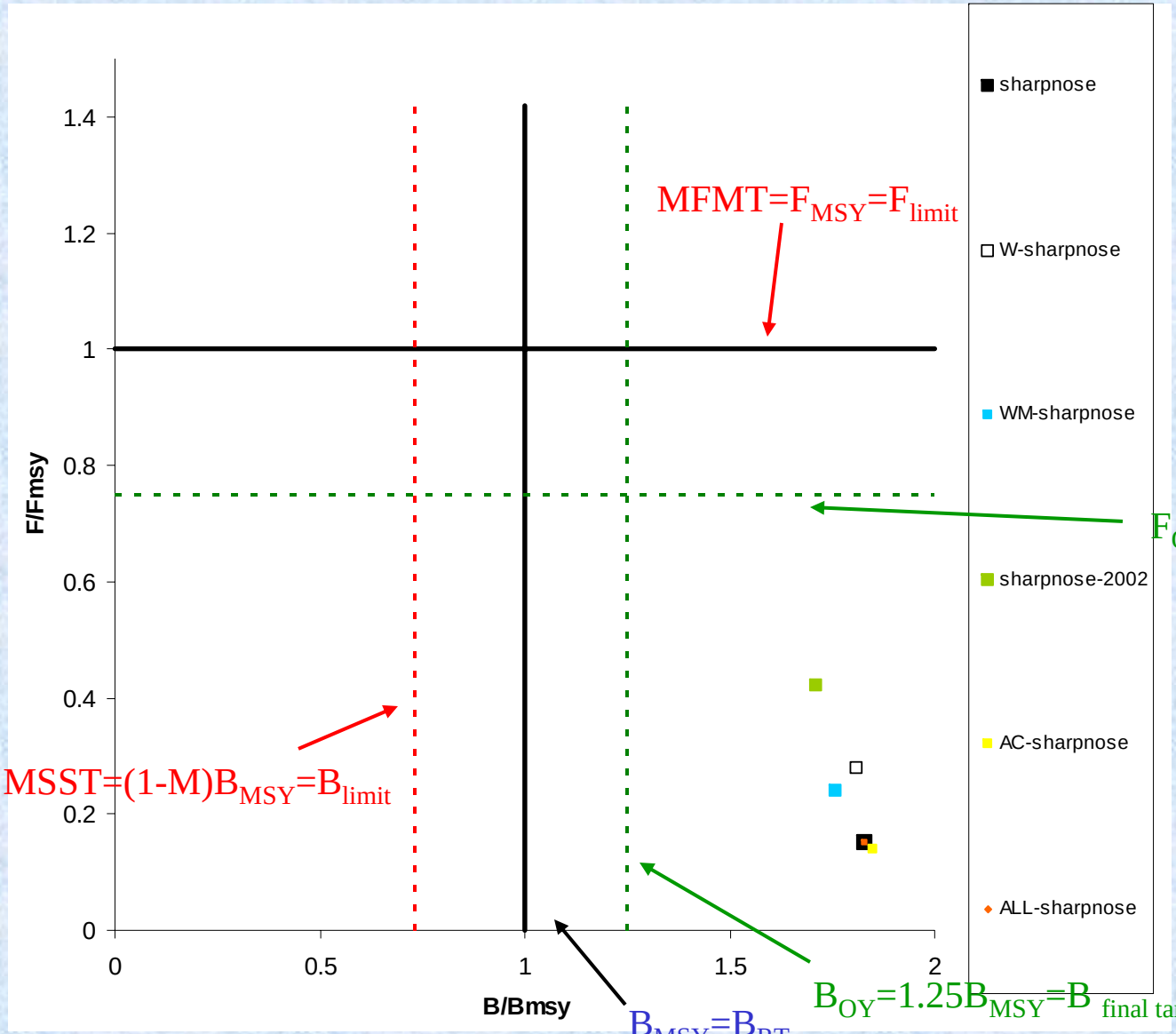


N/N_{MSY}



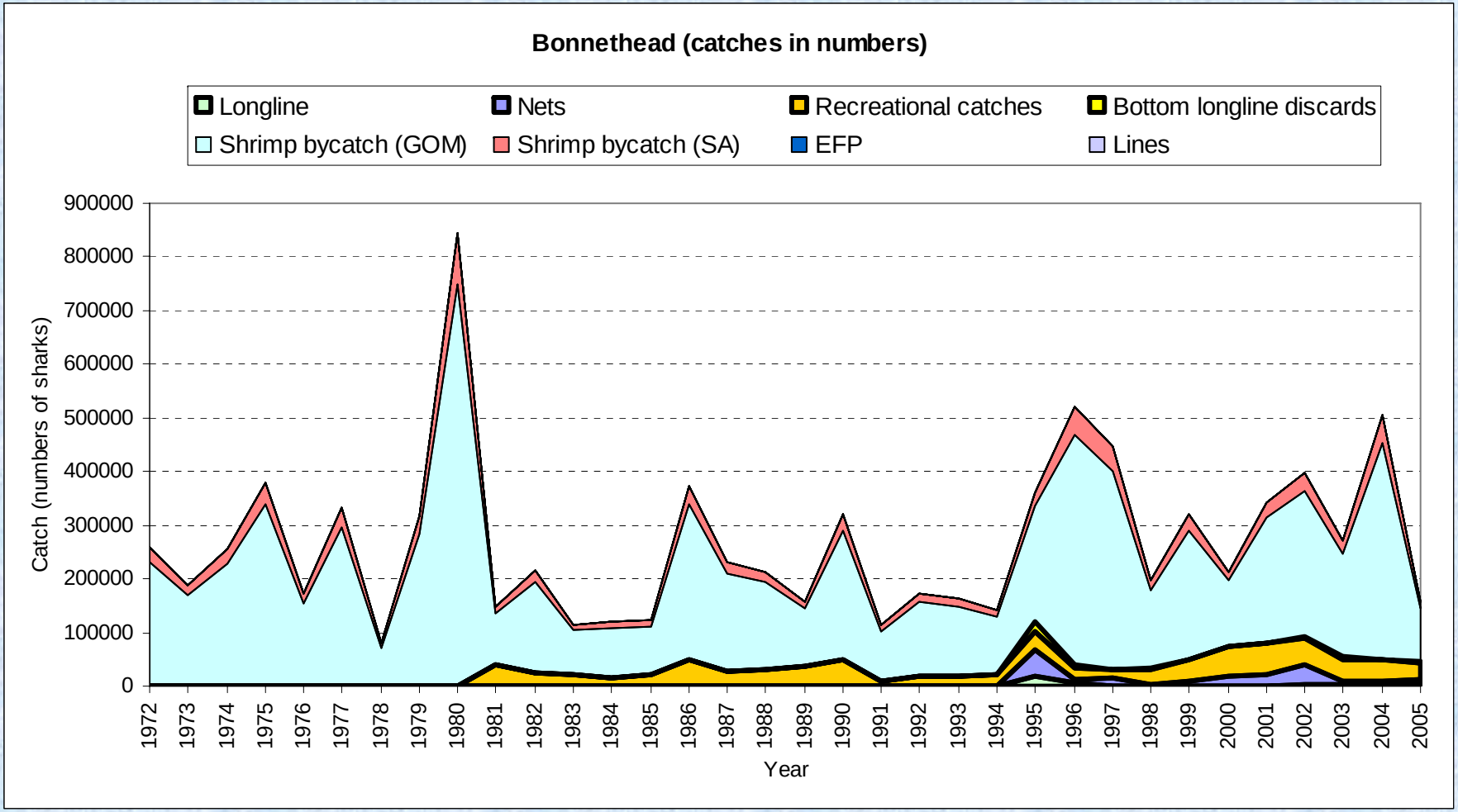
F/F_{MSY}

Results for Atlantic sharpnose shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



BONNETHEAD SHARK

Total Catches: Bonnethead shark

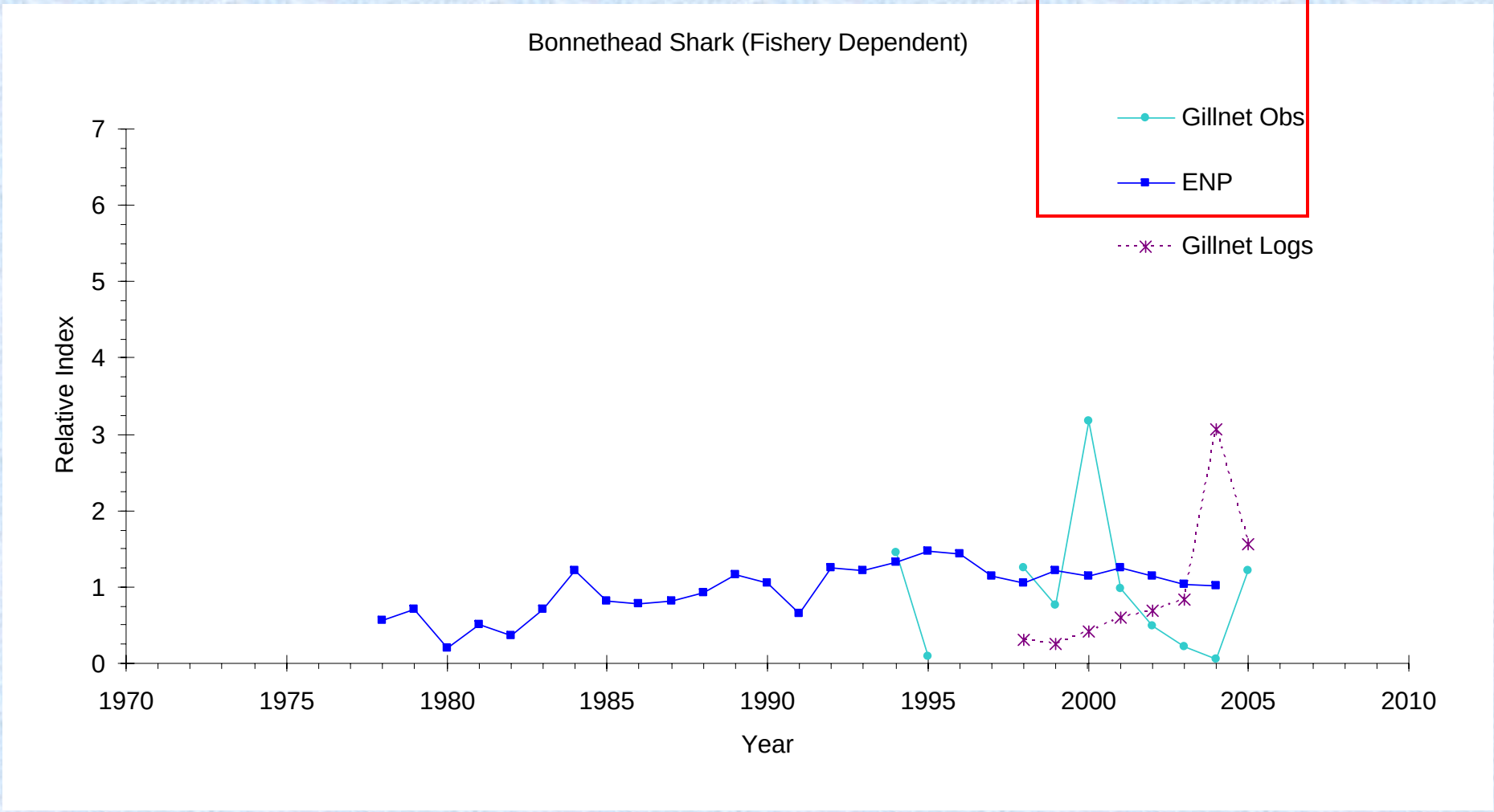


CPUE series: Bonnethead shark -Baseline

- **FISHERY-DEPENDENT:** Gillnet Observer, ENP (2)
- **FISHERY-INDEPENDENT:** PC Gillnet, SEAMAP-SA, TEXAS, SC Coastspan, SEAMAP-GOM-S, SEAMAP-GOM-F, MML-Ad, MML-Juv (8)

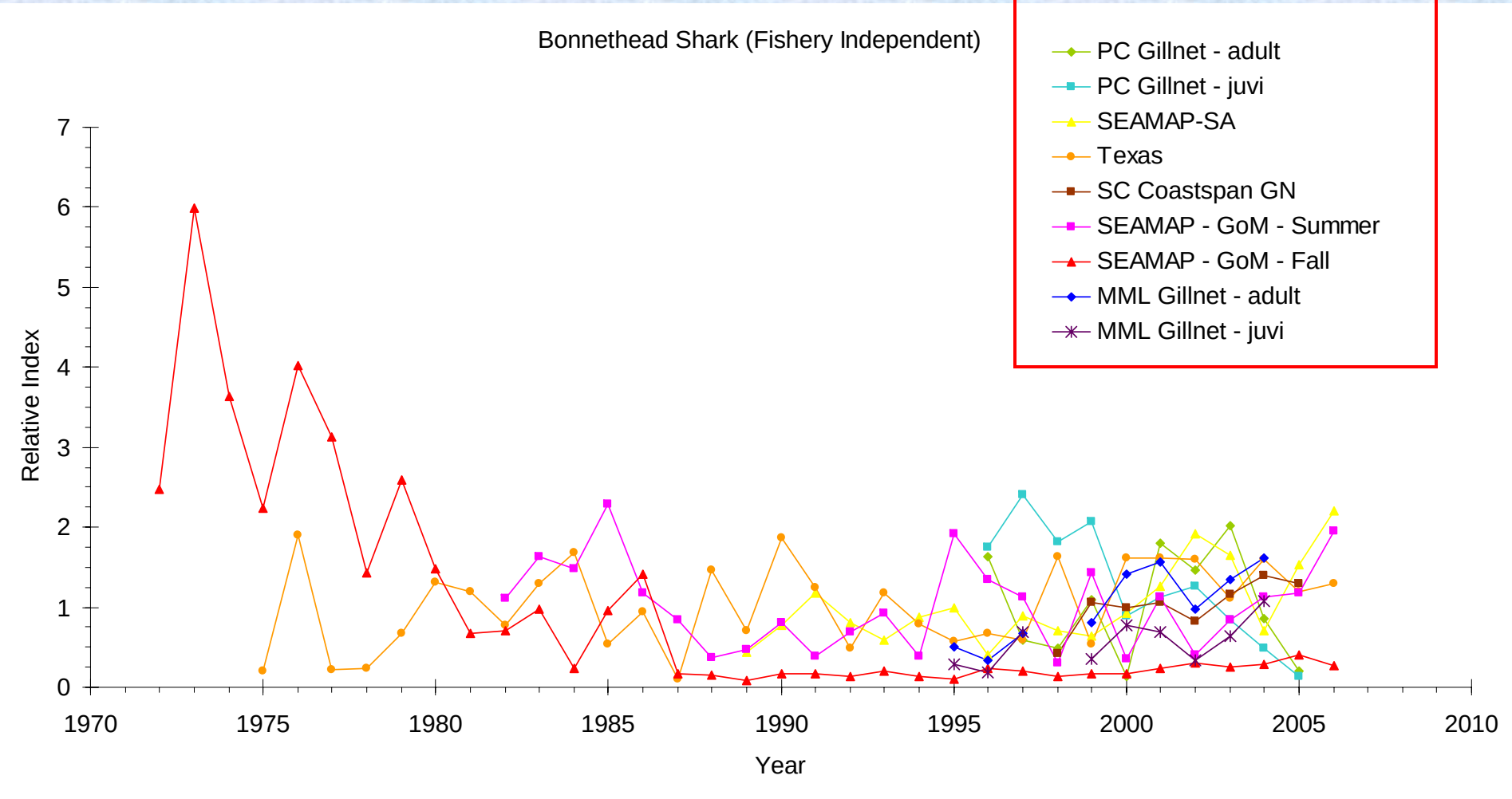
CPUE series: Bonnethead shark-Baseline (F-D)

Baseline Indices



CPUE series: Bonnethead shark-Baseline (F-I)

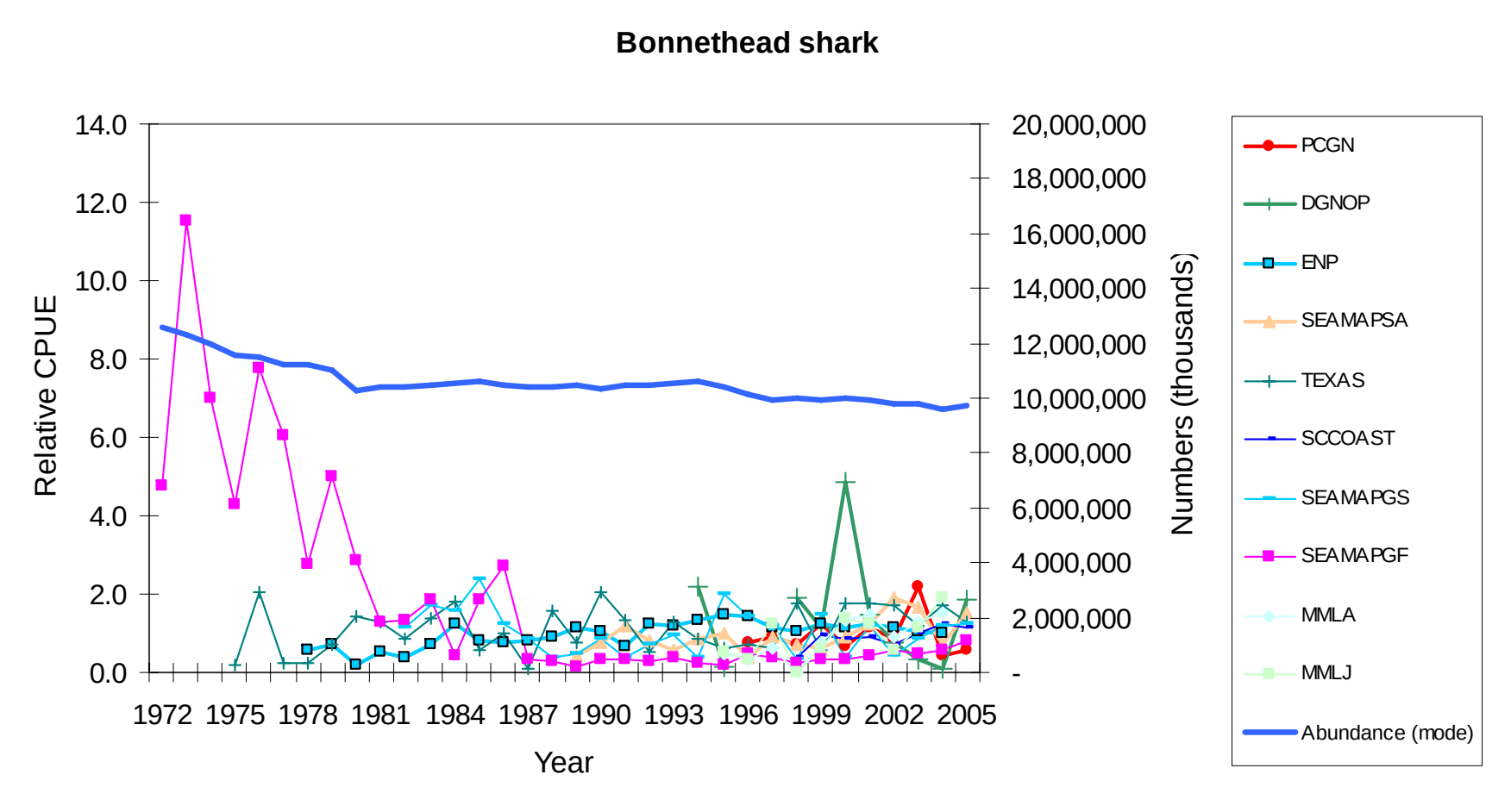
Baseline Indices



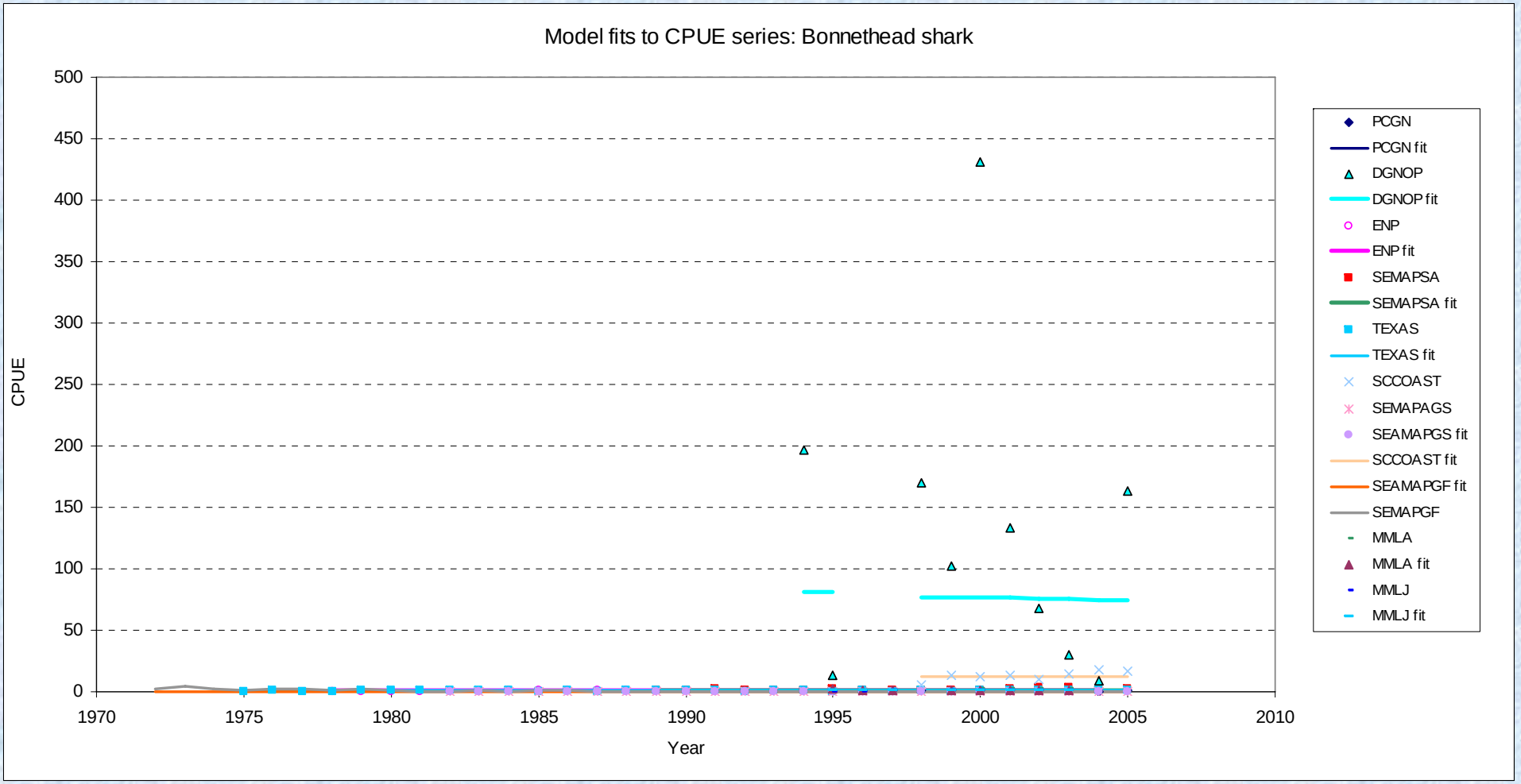
Inputs-Priors for Bonnethead shark-Baseline

- Model starts in 1972 (first year of CPUE indices)
- Catch data available for 1972-2005
- 10 Indices available
- r ~ LN (0.205, 0.08, 0.001,2.0)
- K ~ U on log K (10^4-10^8)
- $N_{72/K}$ ~ LN (0.9, 0.2, 0.2, 1.1)

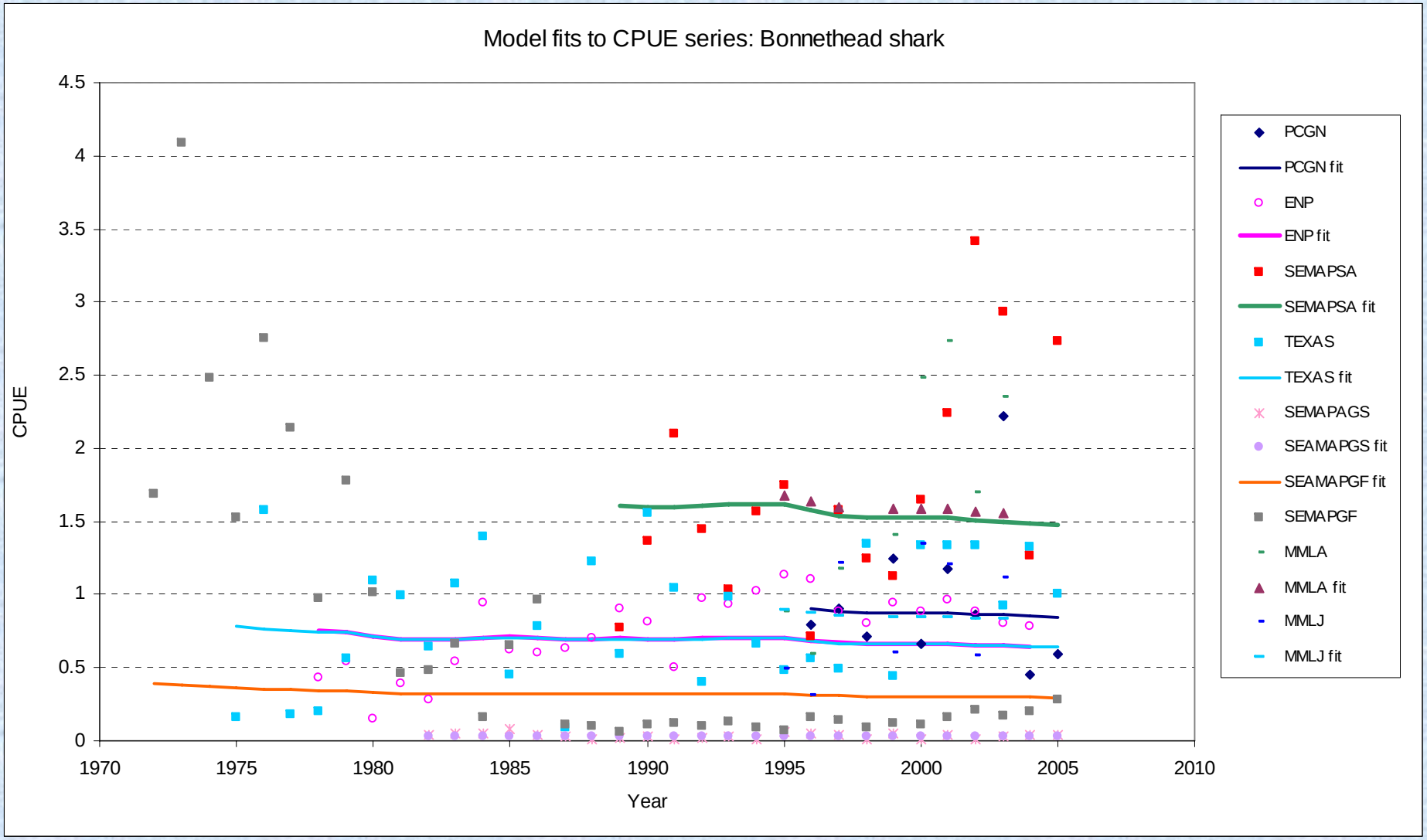
SPM results for Bonnethead shark-Baseline: Predicted biomass trend at posterior mode of the BSP model fitted to catch and CPUE data



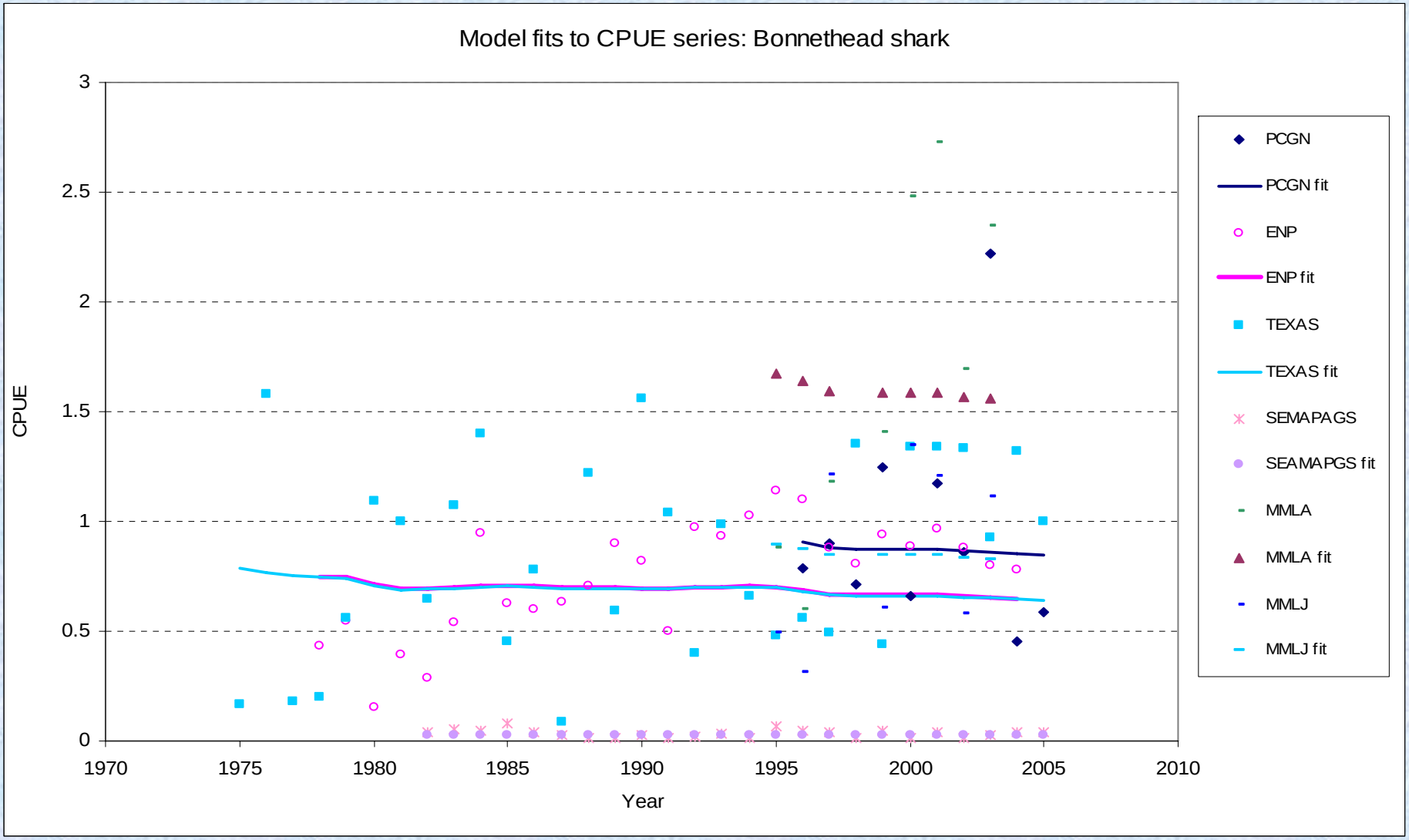
SPM results for Bonnethead shark-Baseline: Model fits to the individual CPUE series



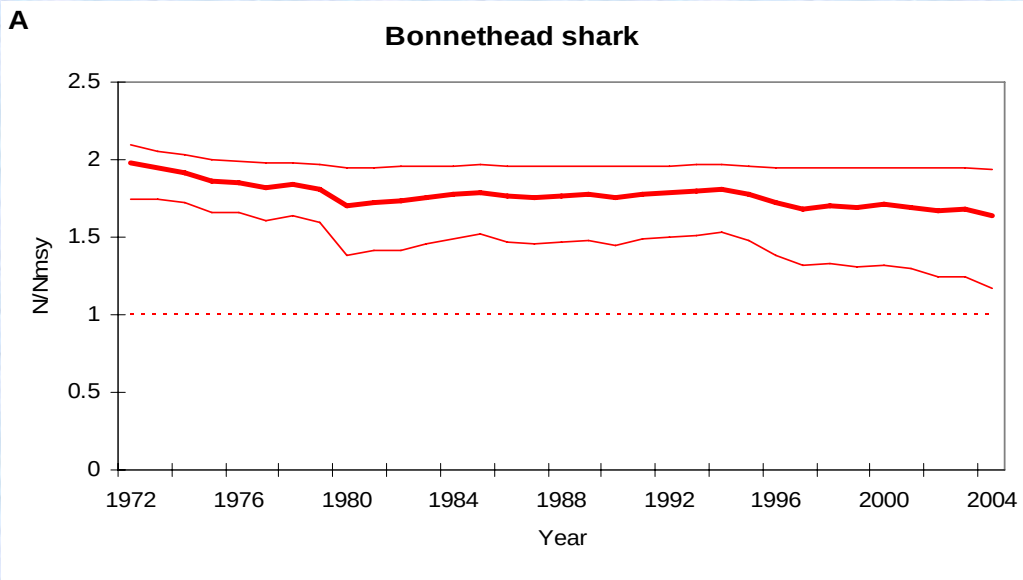
SPM results for Bonnethead shark-Baseline: Model fits to the individual CPUE series (-DGNOP, SCCOAST)



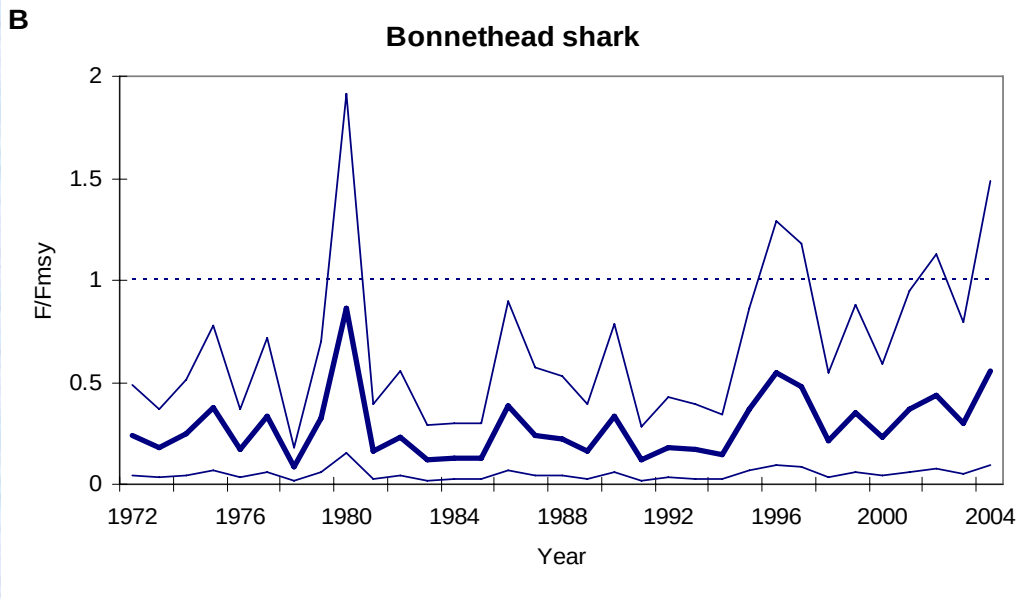
SPM results for Bonnethead shark-Baseline: Model fits to the individual CPUE series (-SEAMAPGF, SEAMAPSA)



SPM results for Bonnethead shark- Baseline: BSP estimated relative abundance and fishing mortality rate trajectories



N/N_{MSY}

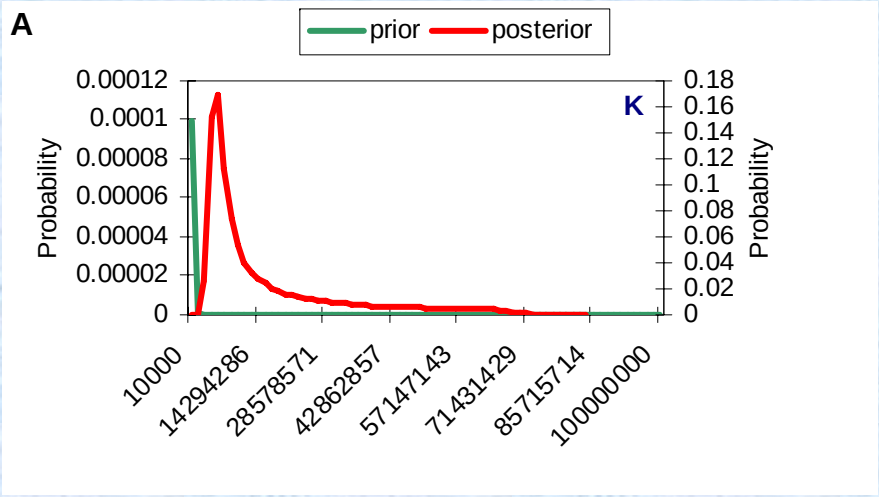


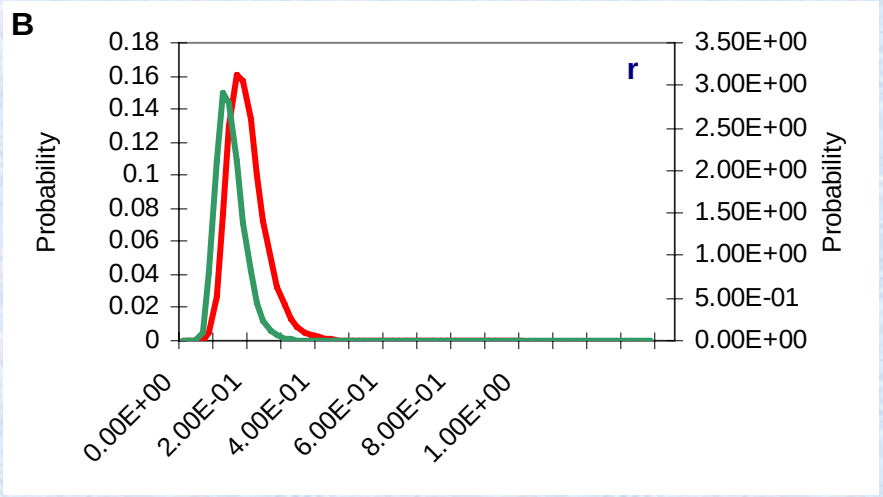
F/F_{MSY}

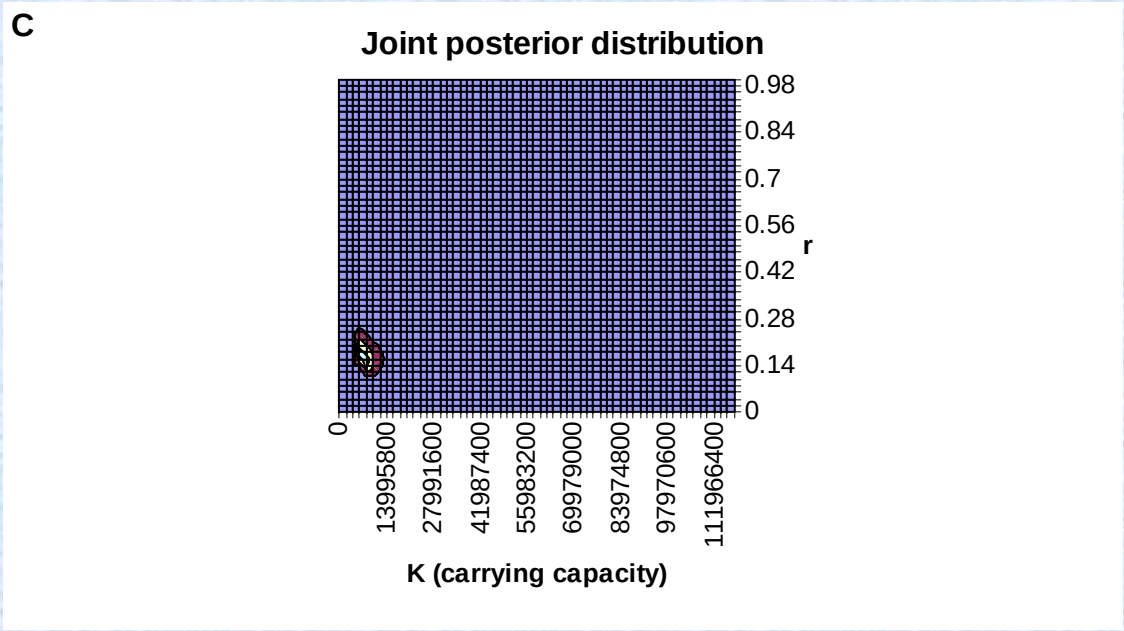
Expected values of the mean and CV of marginal posterior distributions from the SPM for Bonnethead shark-Baseline

	Bonnethead	
	EV	CV
Importance function	priors	
K	21708	0.98
r	0.191	0.29
MSY	1058	1.11
N_{2005}	19631	1.09
N_{2005}/K	**0.81**	0.18
N_{init}	21433	0.99
N_{2005}/N_{init}	0.83	0.17
C_{2005}/MSY	0.31	0.64
F_{2005}/F_{MSY}	**0.22**	0.83
N_{2005}/N_{MSY}	**1.61**	0.18
C_{2005}/repy	0.52	0.13
N_{MSY}	10854	0.98
F_{MSY}	0.096	
repy	309	0.11
C_0		
Diagnostics		
CW (wt)	1.819	
CV (L*prior)	2.390	
CV (Wt) / CV (L*p)	0.76	
%maxpWt	0.008	

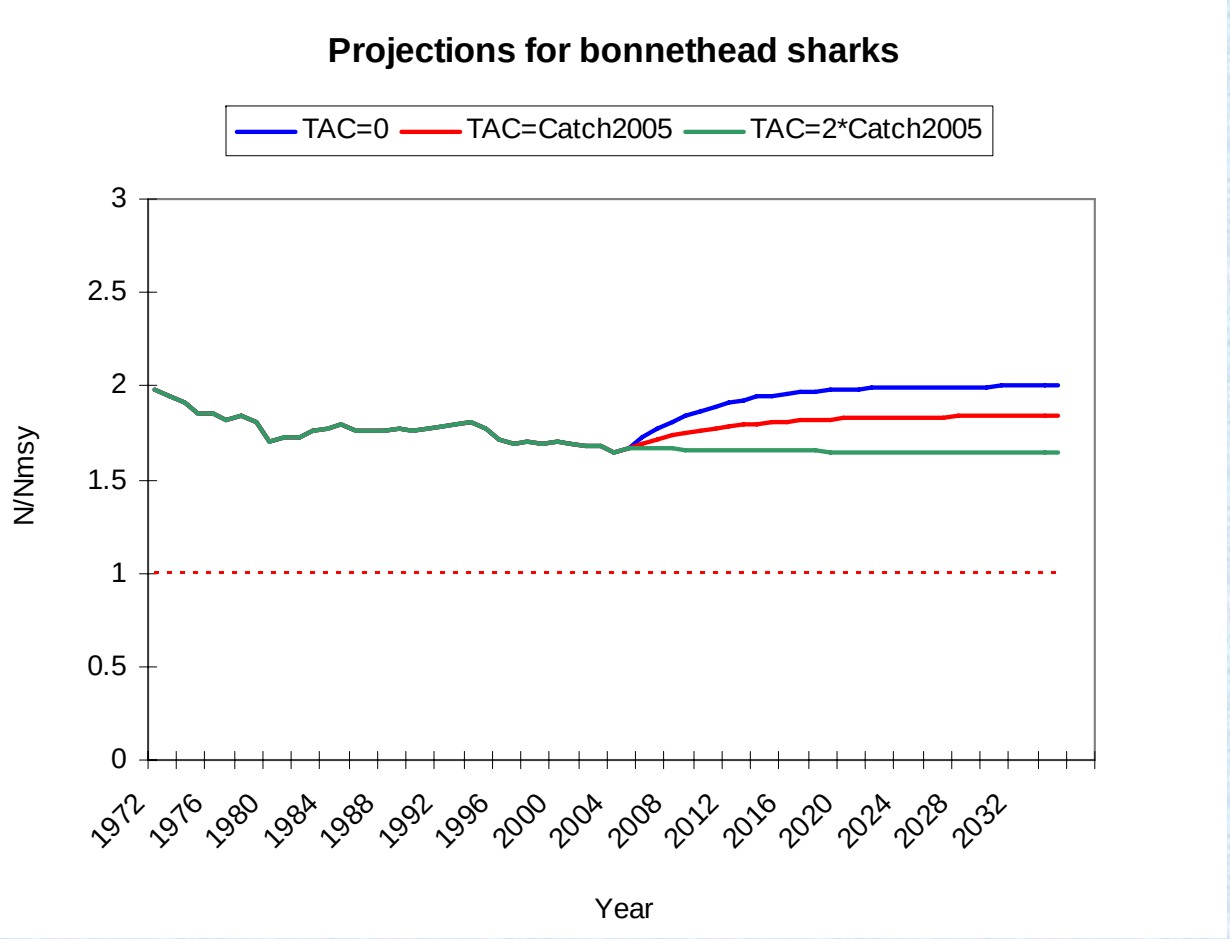
SPM results for Bonnethead shark-Baseline: Prior and posterior pdfs for K and r, and joint posterior distribution for K and r







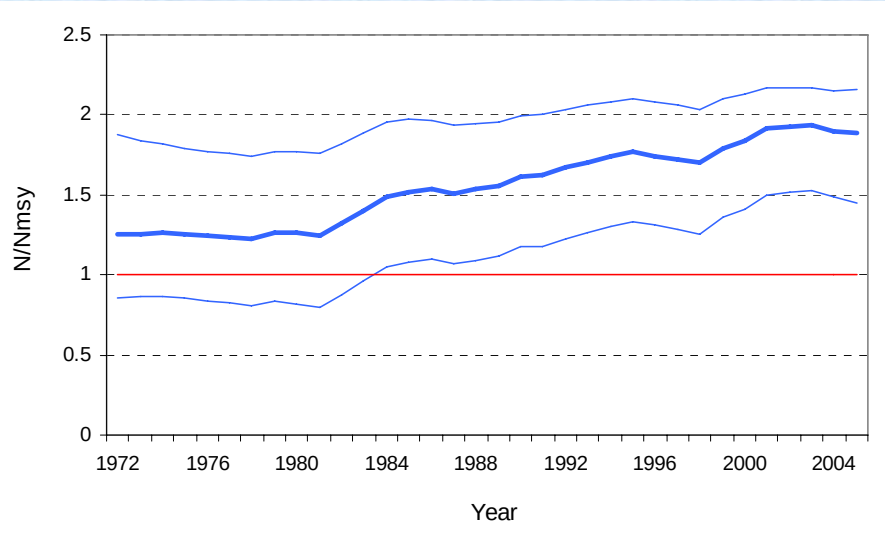
SPM results for Bonnethead shark-Baseline: Projections



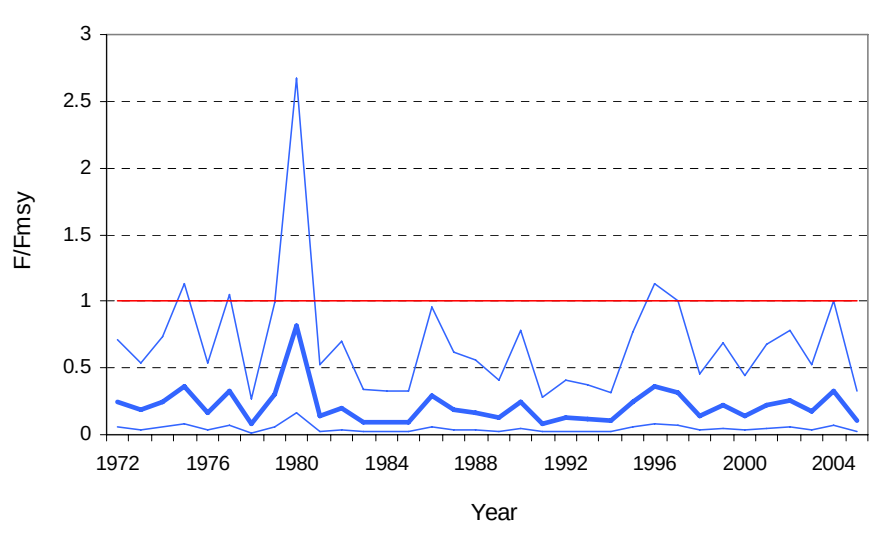
Sensitivity Analyses

- Alternative model (W; WinBUGS)
- Inverse CV weighting (WM)
- Extending catch series back to 1950 (AC)
- Including “sensitivity” CPUE series (ALL)

Results for Bonnethead shark: Estimated biomass and relative biomass and fishing mortality rate trajectories of the **WinBUGS** SPM.

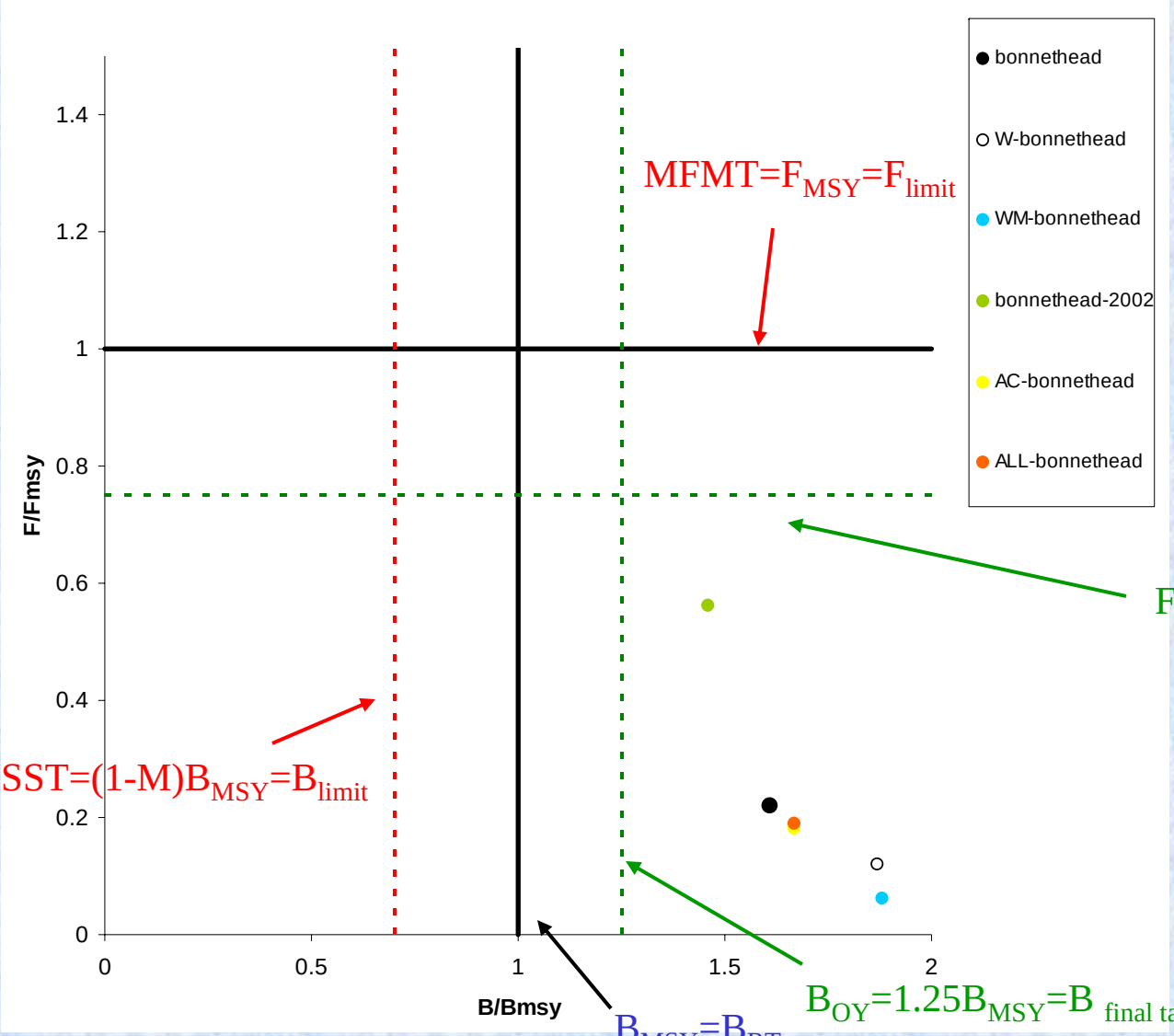


N/N_{MSY}



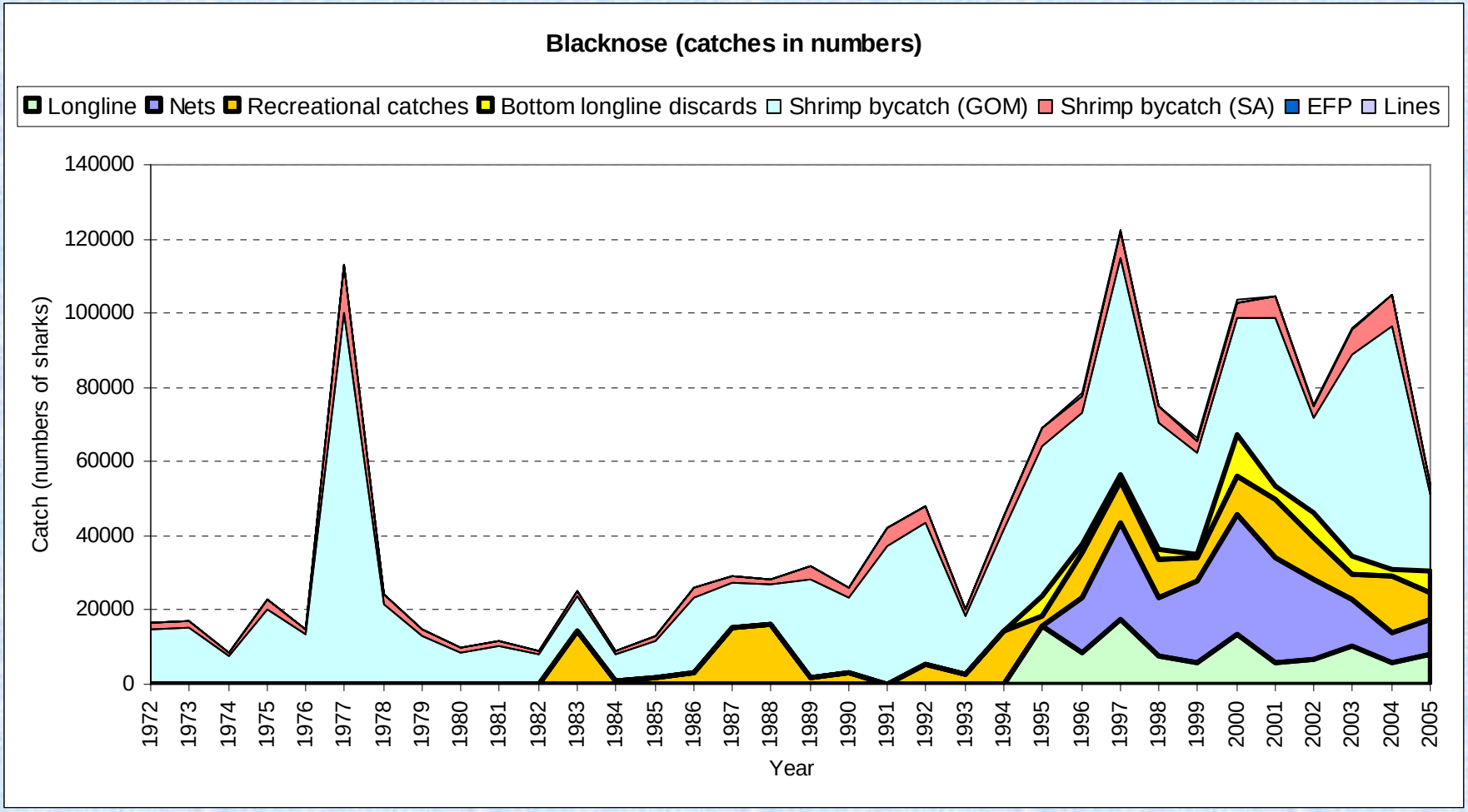
F/F_{MSY}

Results for Bonnethead shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



BLACKNOSE SHARK

Total Catches: Blacknose shark

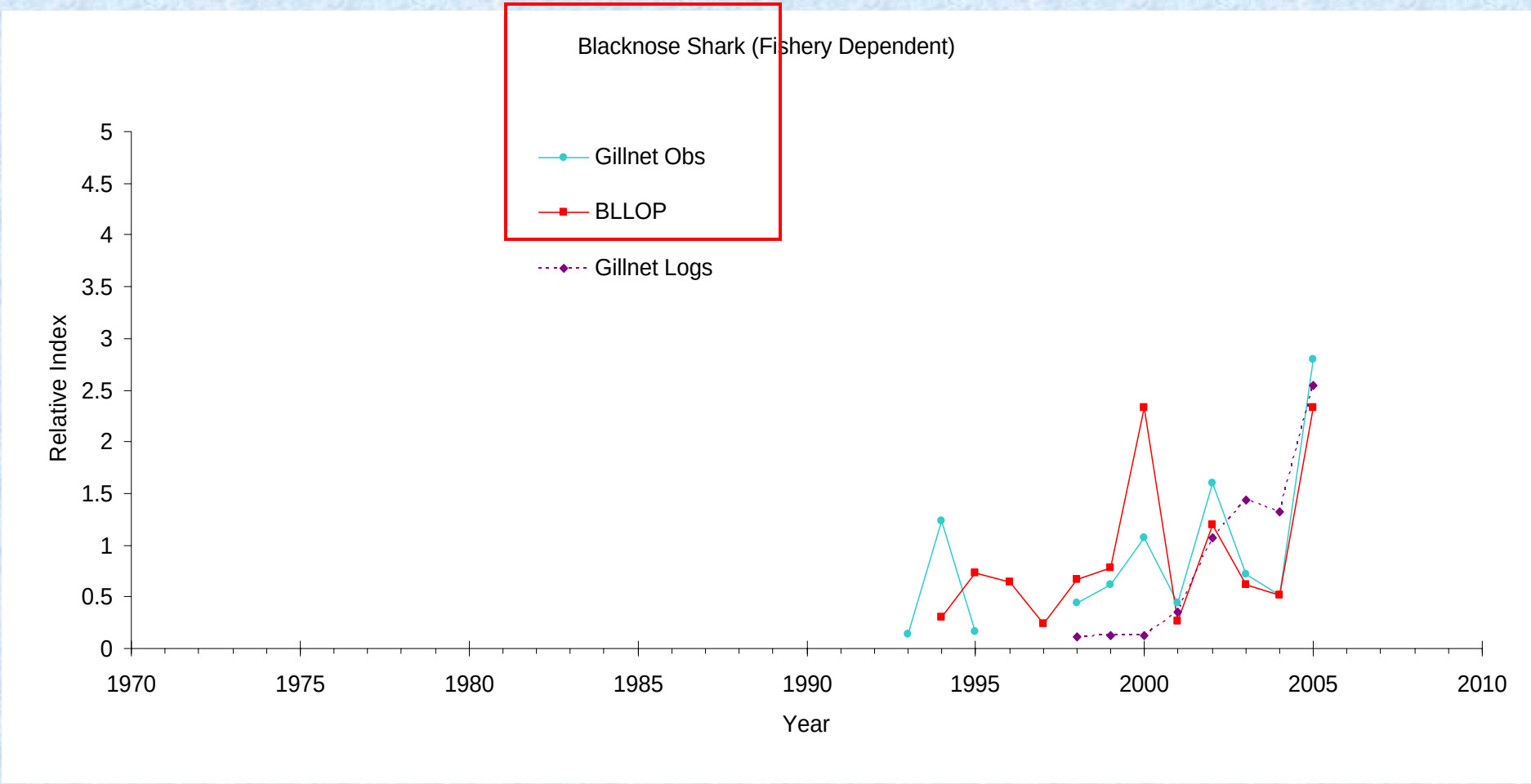


CPUE series: Blacknose shark -Baseline

- **FISHERY-DEPENDENT:** Gillnet Observer, BLLOP (2)
- **FISHERY-INDEPENDENT:** PC Gillnet, SCDNR, NMFSLLSE, UNC, MML (5)

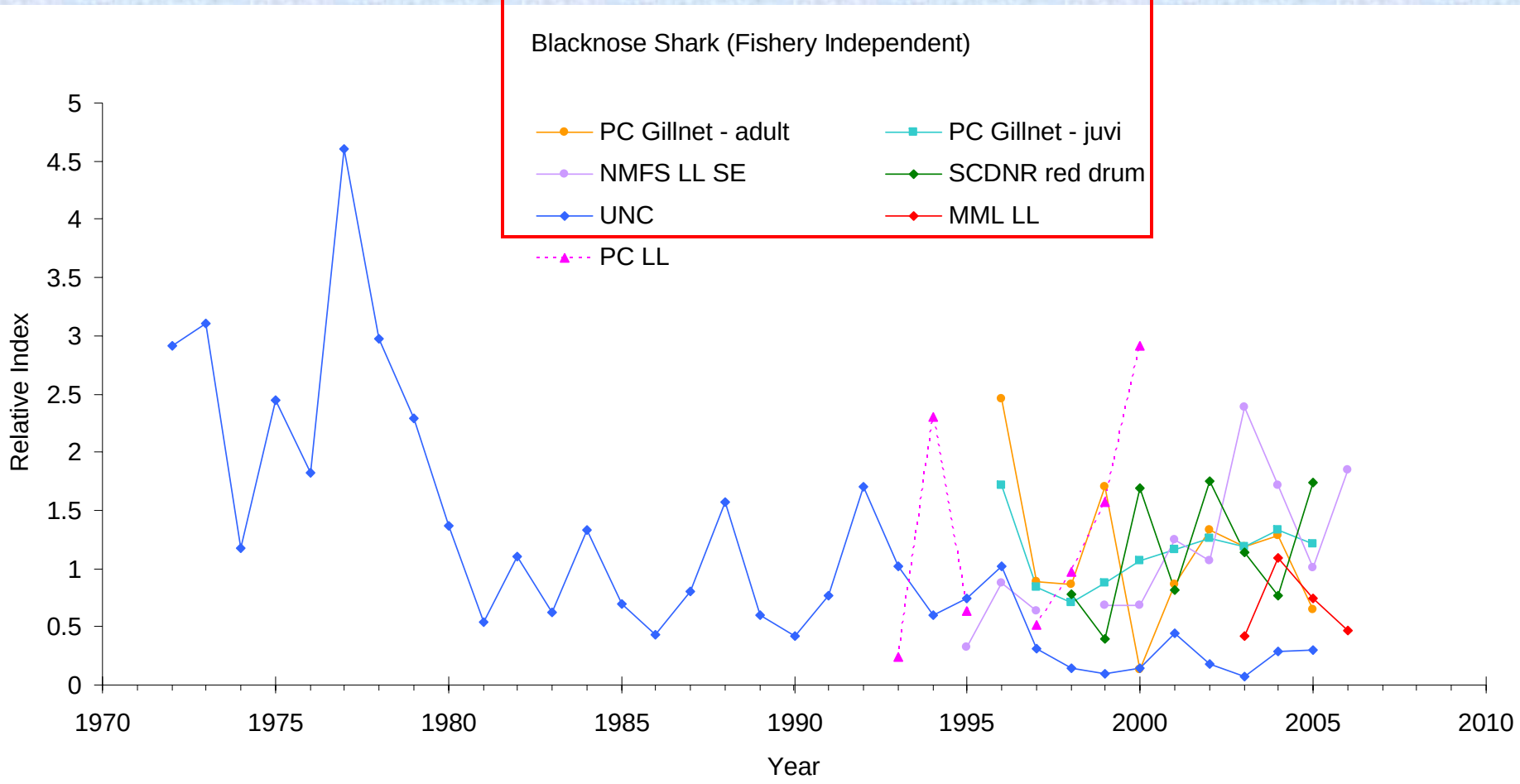
CPUE series: Blacknose shark-Baseline (F-D)

Baseline Indices



CPUE series: Blacknose shark-Baseline (F-I)

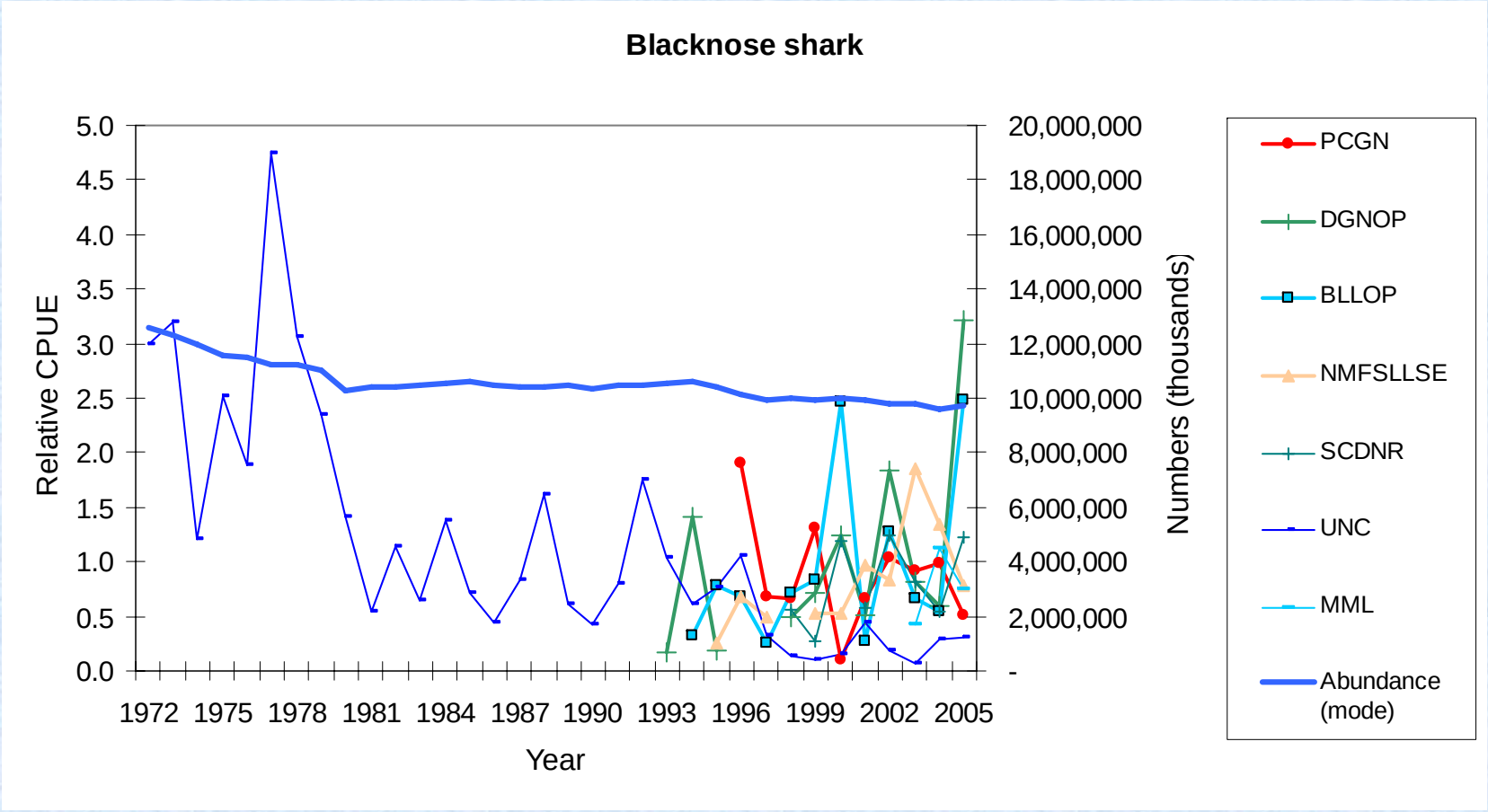
Baseline Indices



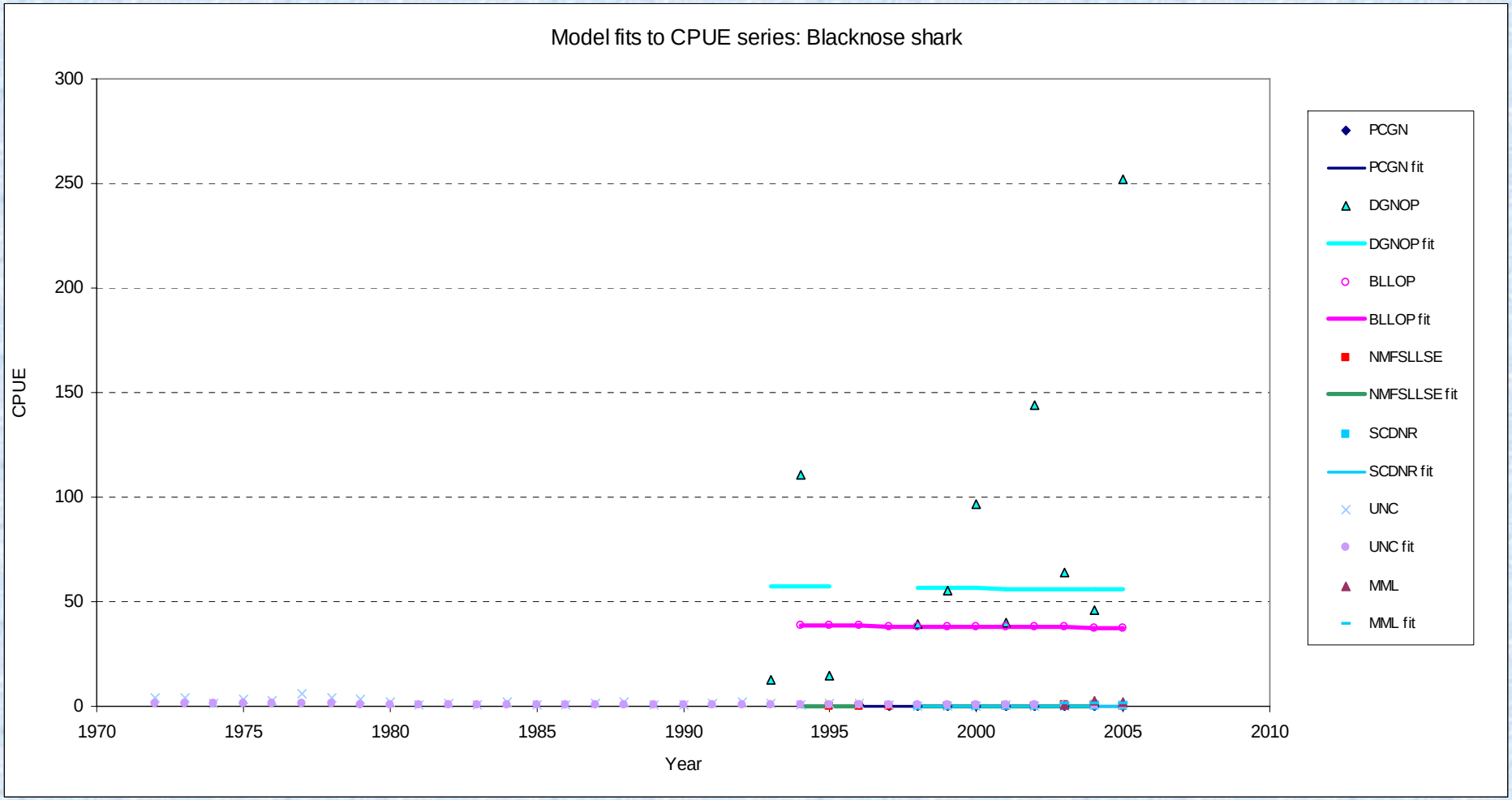
Inputs-Priors for Blacknose shark-Baseline

- Model starts in 1972 (first year of CPUE indices)
- Catch data available for 1972-2005
- 7 Indices available
- r ~ LN (0. 084, 0.06, 0.001,2.0)
- K ~ U on log K (10^4-10^8)
- $N_{72/K}$ ~ LN (0.9, 0.2, 0.2, 1.1)

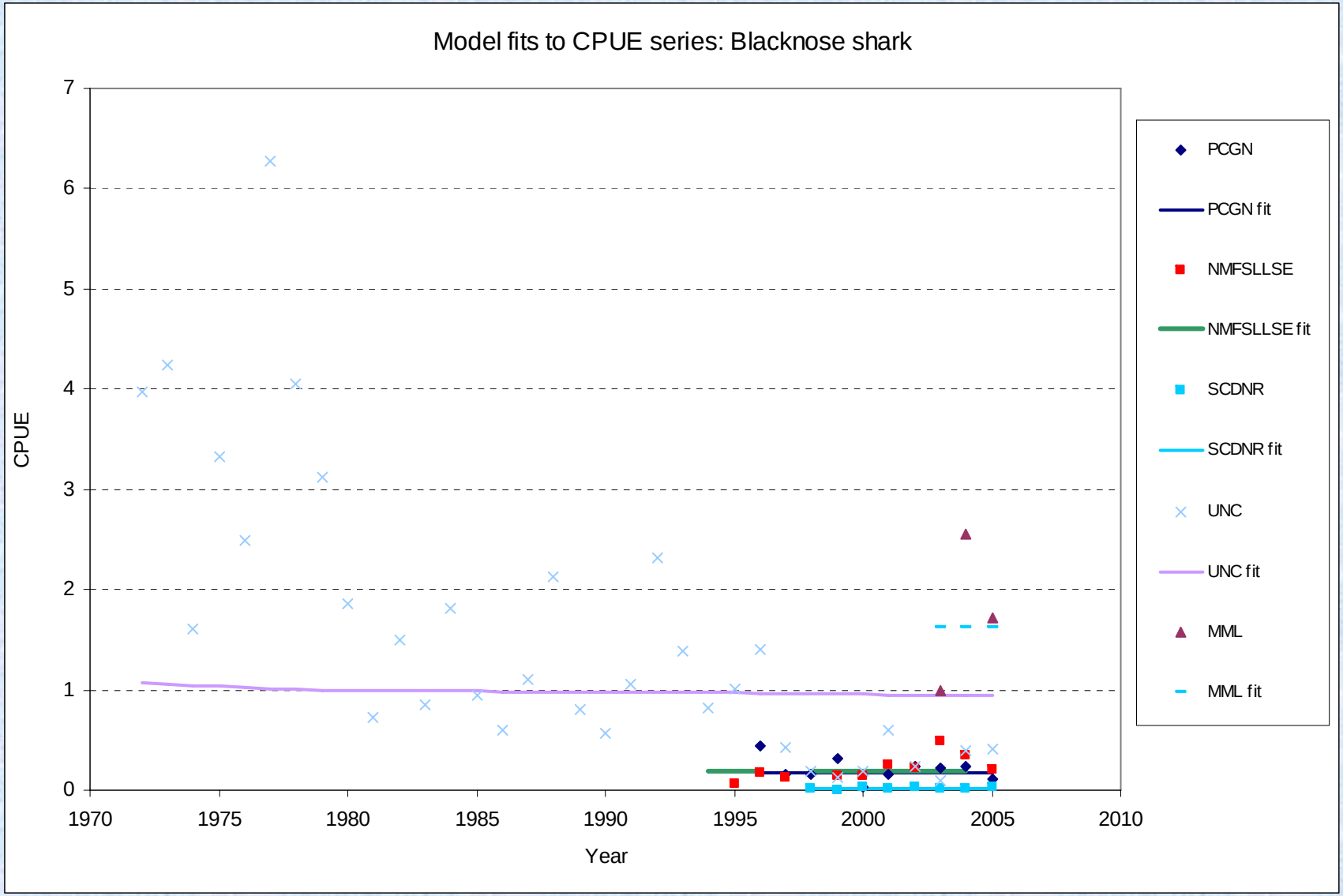
SPM results for Blacknose shark-Baseline: Predicted biomass trend at posterior mode of the BSP model fitted to catch and CPUE data



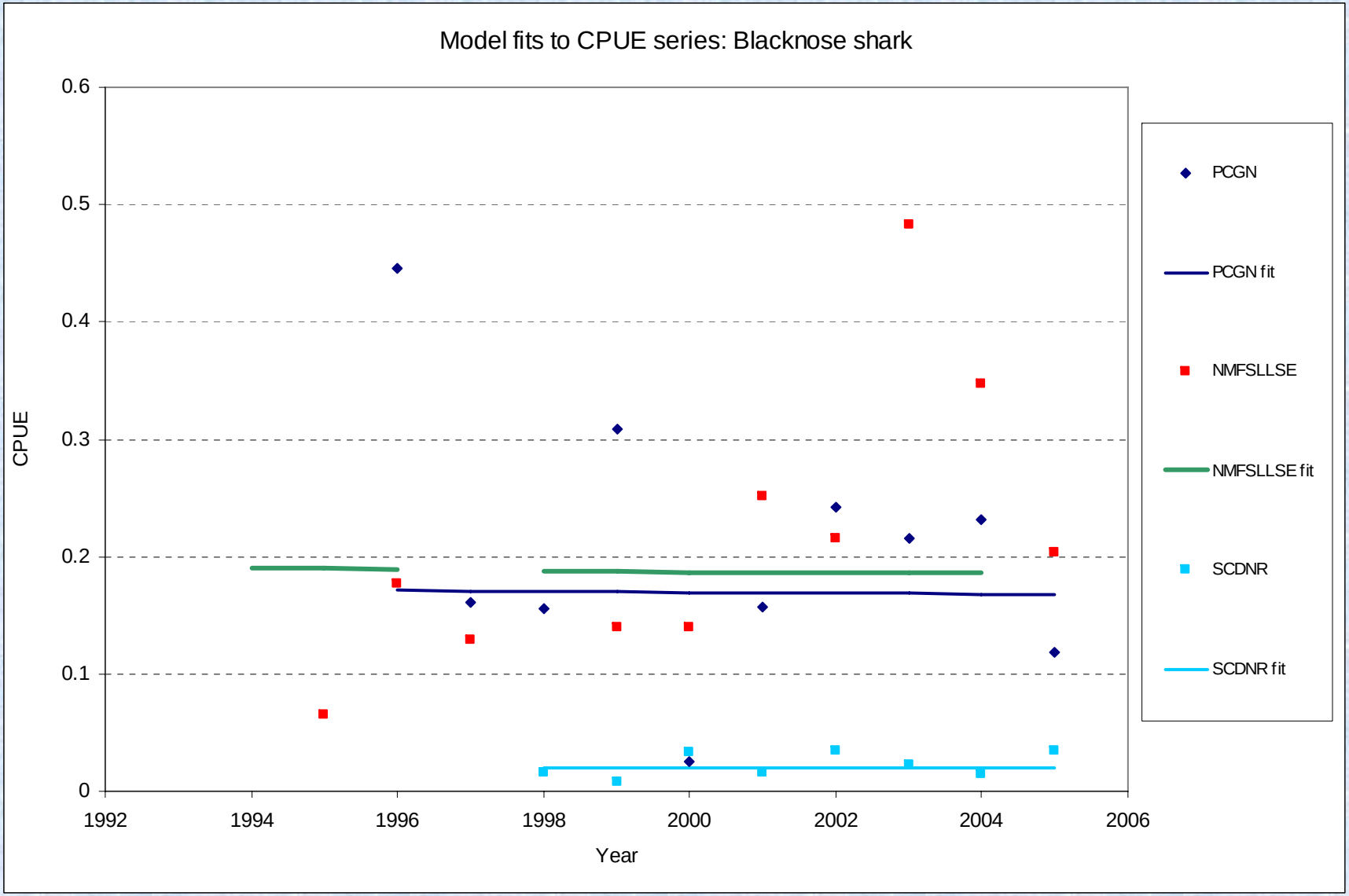
SPM results for Blacknose shark-Baseline: Model fits to the individual CPUE series



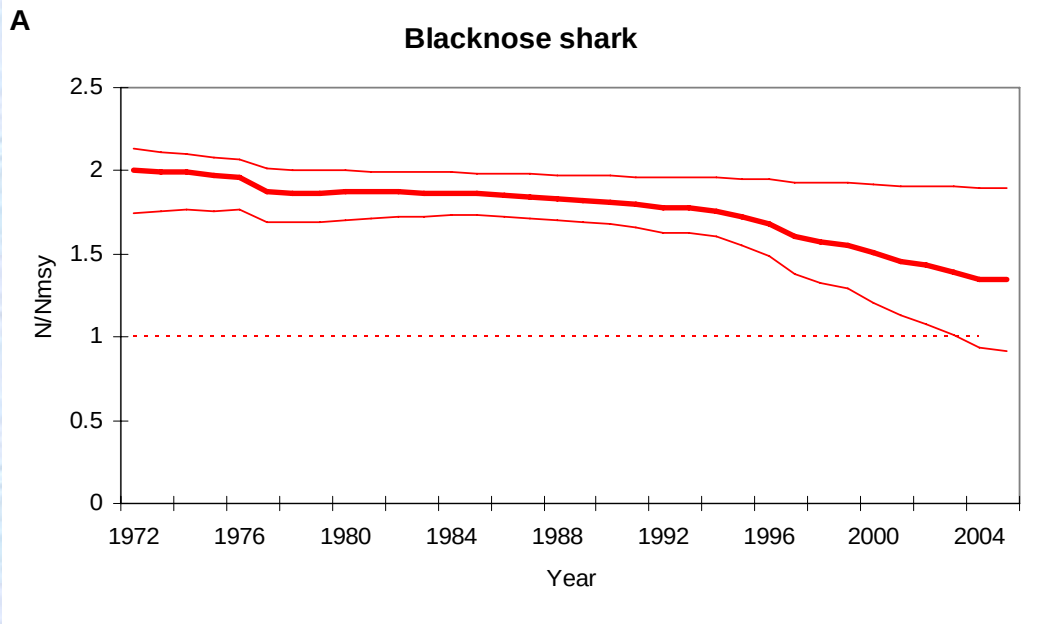
SPM results for Blacknose shark-Baseline: Model fits to the individual CPUE series (-DGNOP, BLLOP)



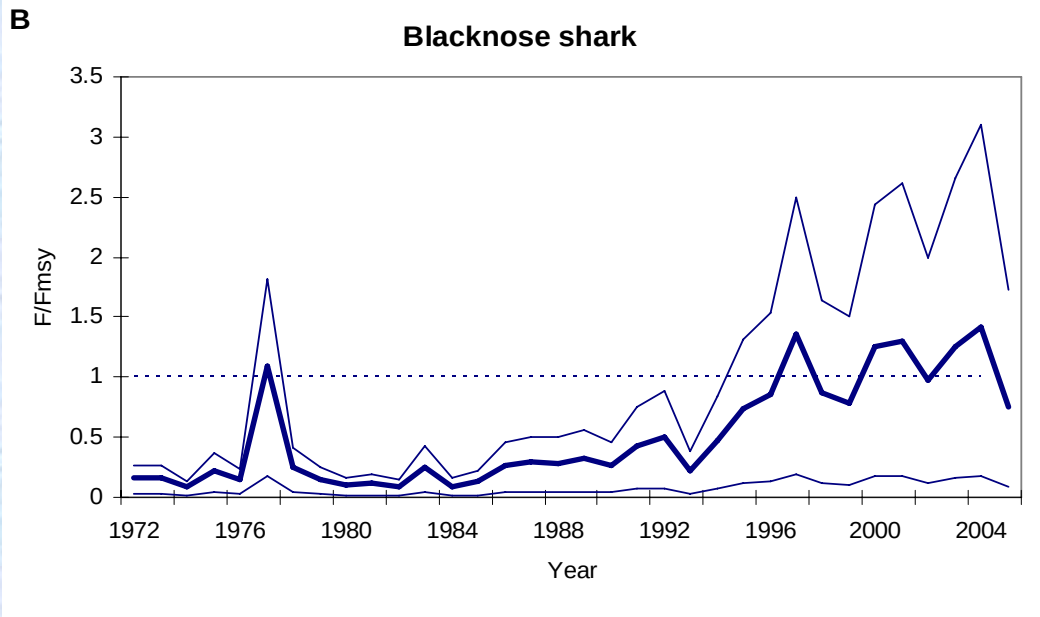
SPM results for Blacknose shark-Baseline: Model fits to the individual CPUE series (-UNC, MML)



SPM results for Blacknose shark-Baseline: BSP estimated relative abundance and fishing mortality rate trajectories



N/N_{MSY}

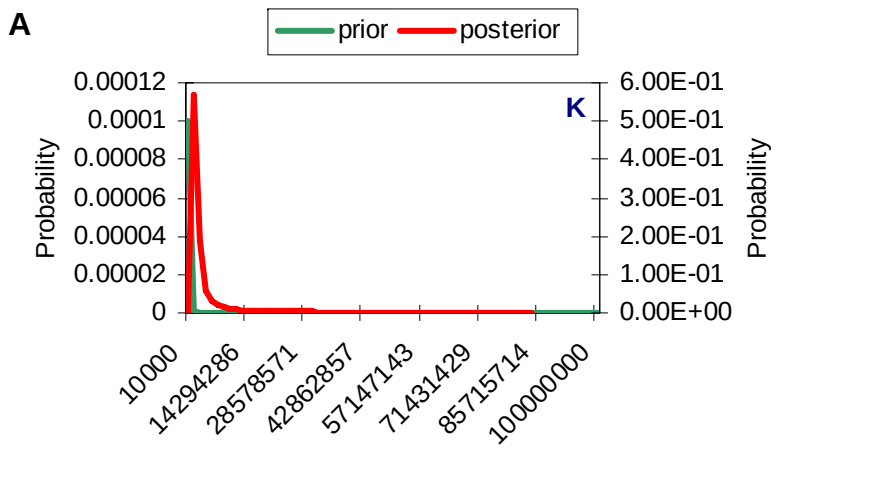


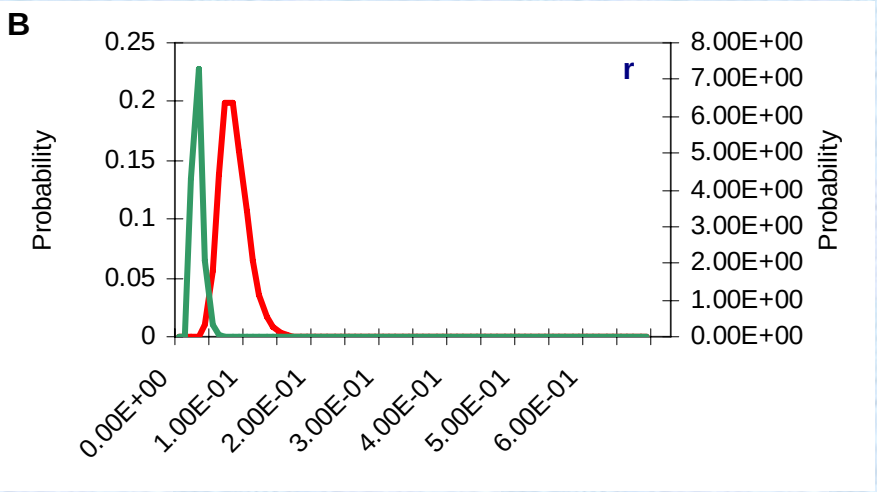
F/F_{MSY}

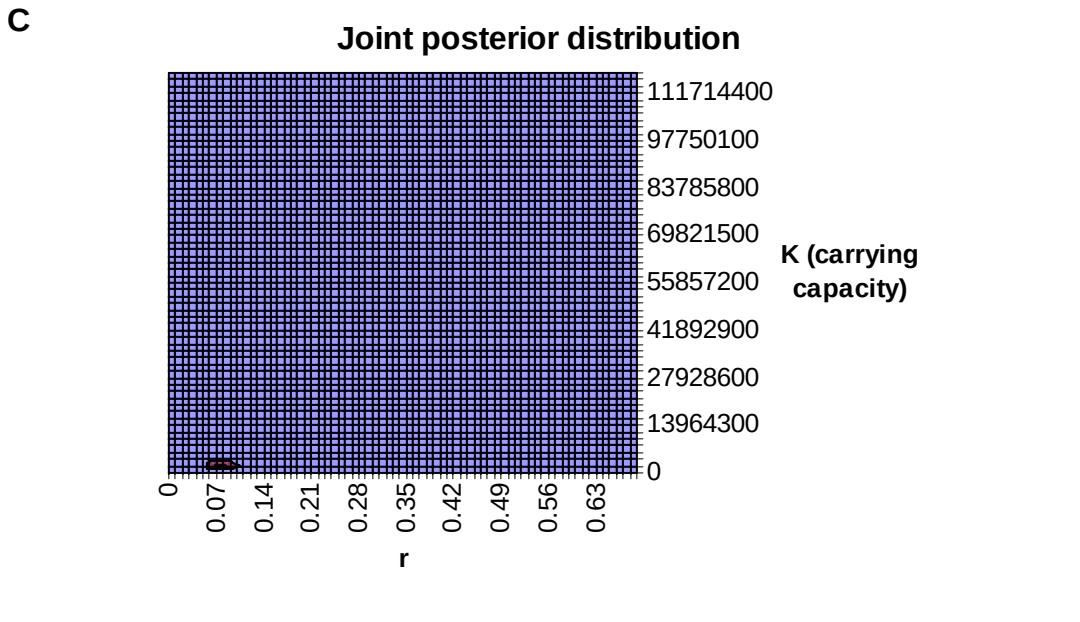
Expected values of the mean and CV of marginal posterior distributions from the SPM for Blacknose shark-Baseline

	Blacknose	
	EV	CV
Importance function	priors	
K	7529	1.88
r	0.080	0.25
MSY	155	1.98
N_{2005}	6654	2.13
N_{2005}/K	**0.69**	0.26
N_{init}	7522	1.89
N_{2005}/N_{init}	0.70	0.26
C_{2005}/MSY	0.95	0.56
F_{2005}/F_{MSY}	**0.85**	0.78
N_{2005}/N_{MSY}	**1.38**	0.26
C_{2005}/repy	1.22	2.27
N_{MSY}	3764	1.88
F_{MSY}	0.040	
repy	47	0.28
C_0		
Diagnostics		
CW (wt)	2.412	
CV (L*prior)	3.060	
CV (Wt) / CV (L*p)	0.79	
%maxpWt	0.006	

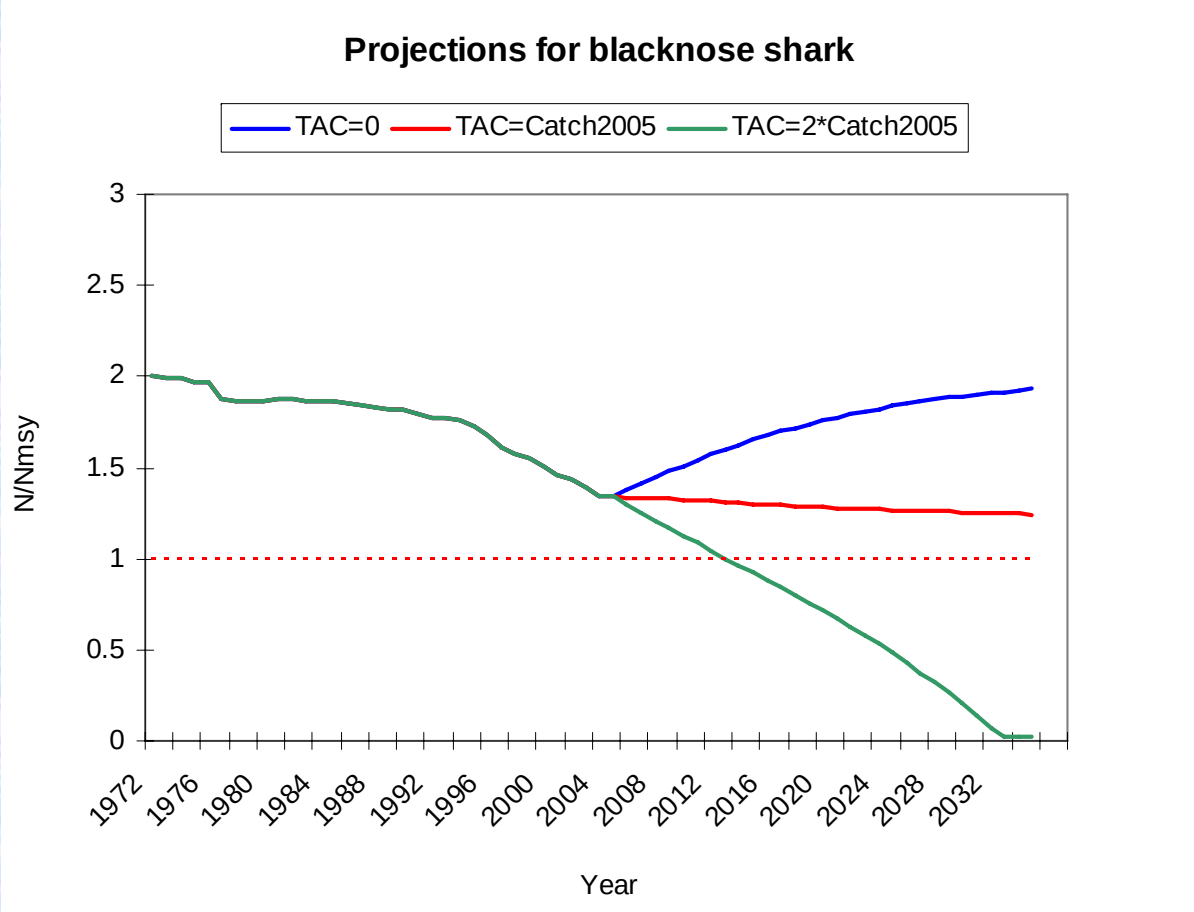
SPM results for Blacknose shark-Baseline: Prior and posterior pdfs for K and r, and joint posterior distribution for K and r







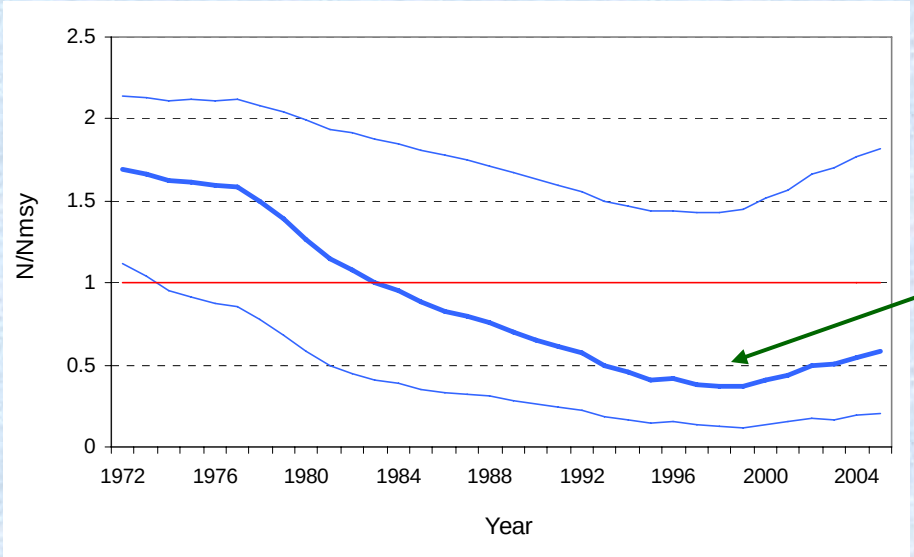
SPM results for Blacknose shark-Baseline: Projections



Sensitivity Analyses

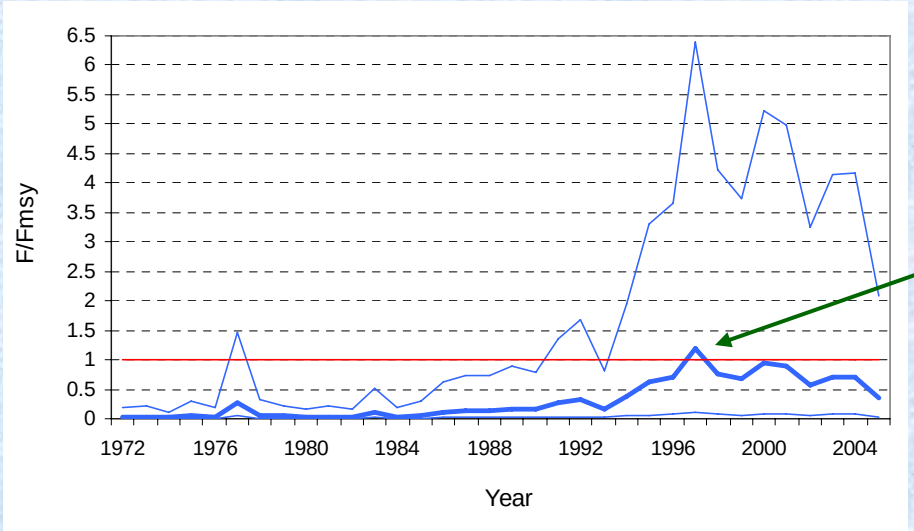
- Alternative model (W; WinBUGS)
- Inverse CV weighting (WM)
- Extending catch series back to 1950 (AC)
- Including “sensitivity” CPUE series (ALL)

Results for Blacknose shark: Estimated biomass and relative biomass and fishing mortality rate trajectories of the **WinBUGS** SPM.



N/N_{MSY}

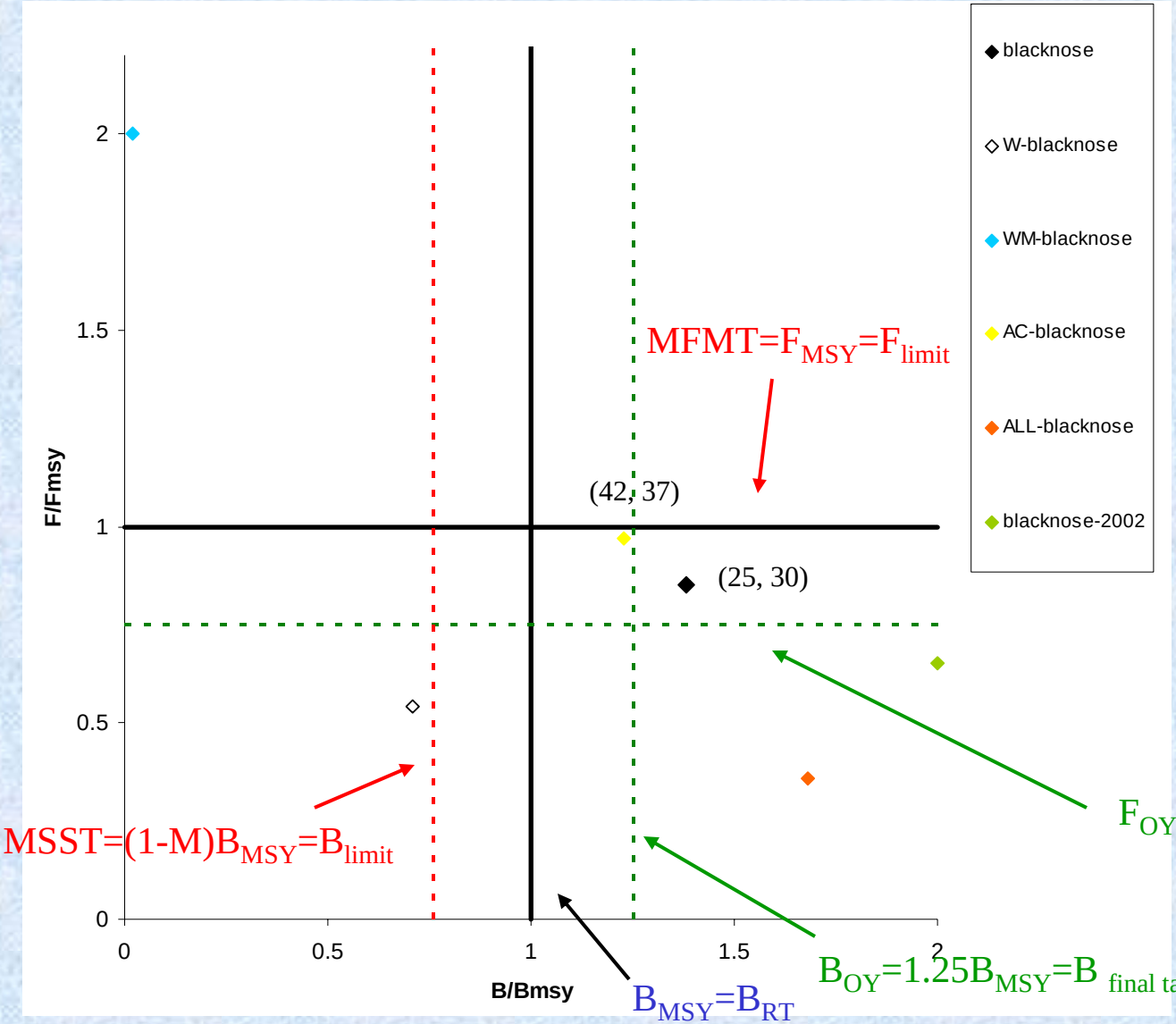
Overfished since 1984



F/F_{MSY}

Overfishing in 1997

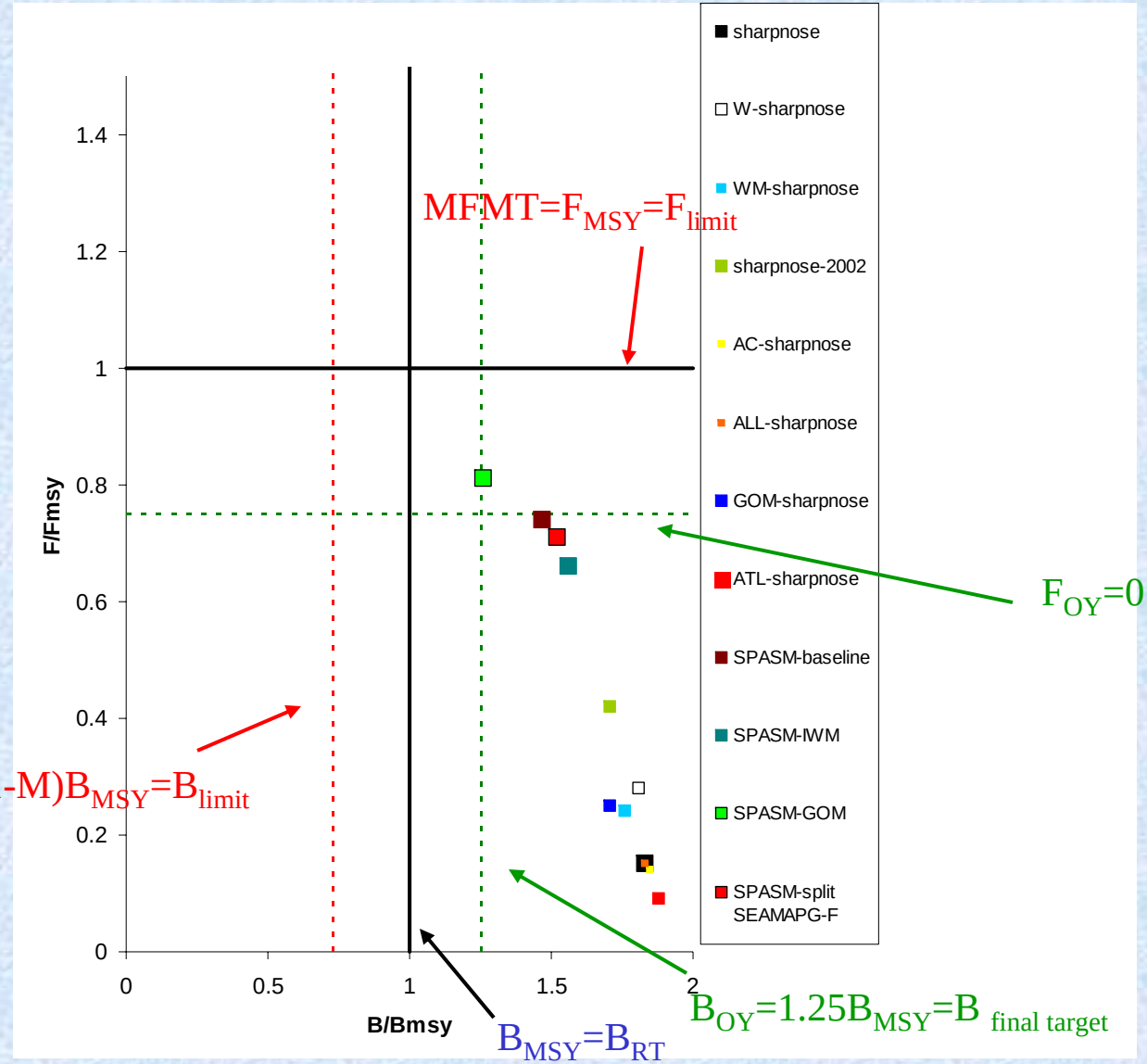
Results for Blacknose shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



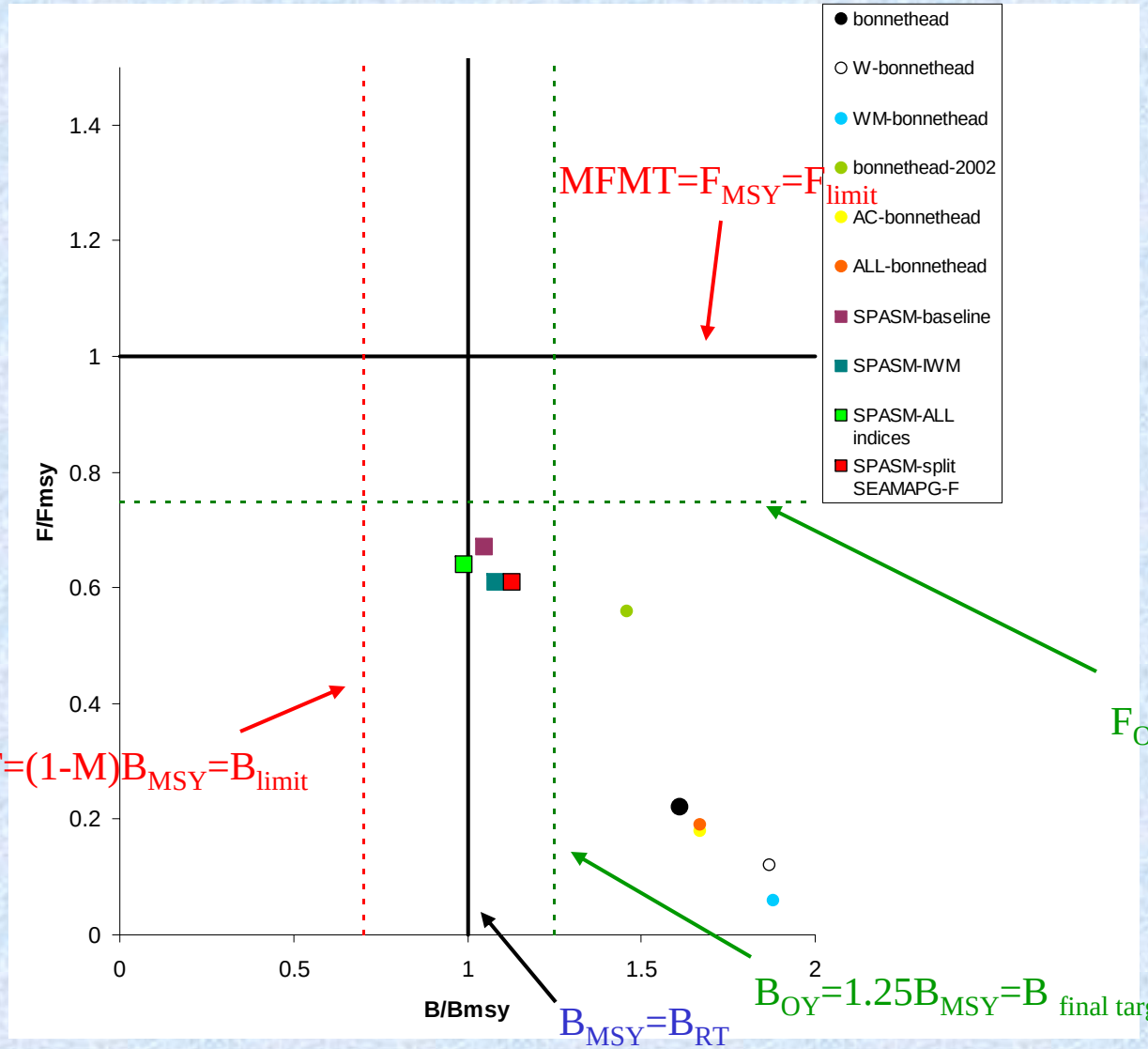
Additional slides

- Stock-recruitment curve; position of inflection point

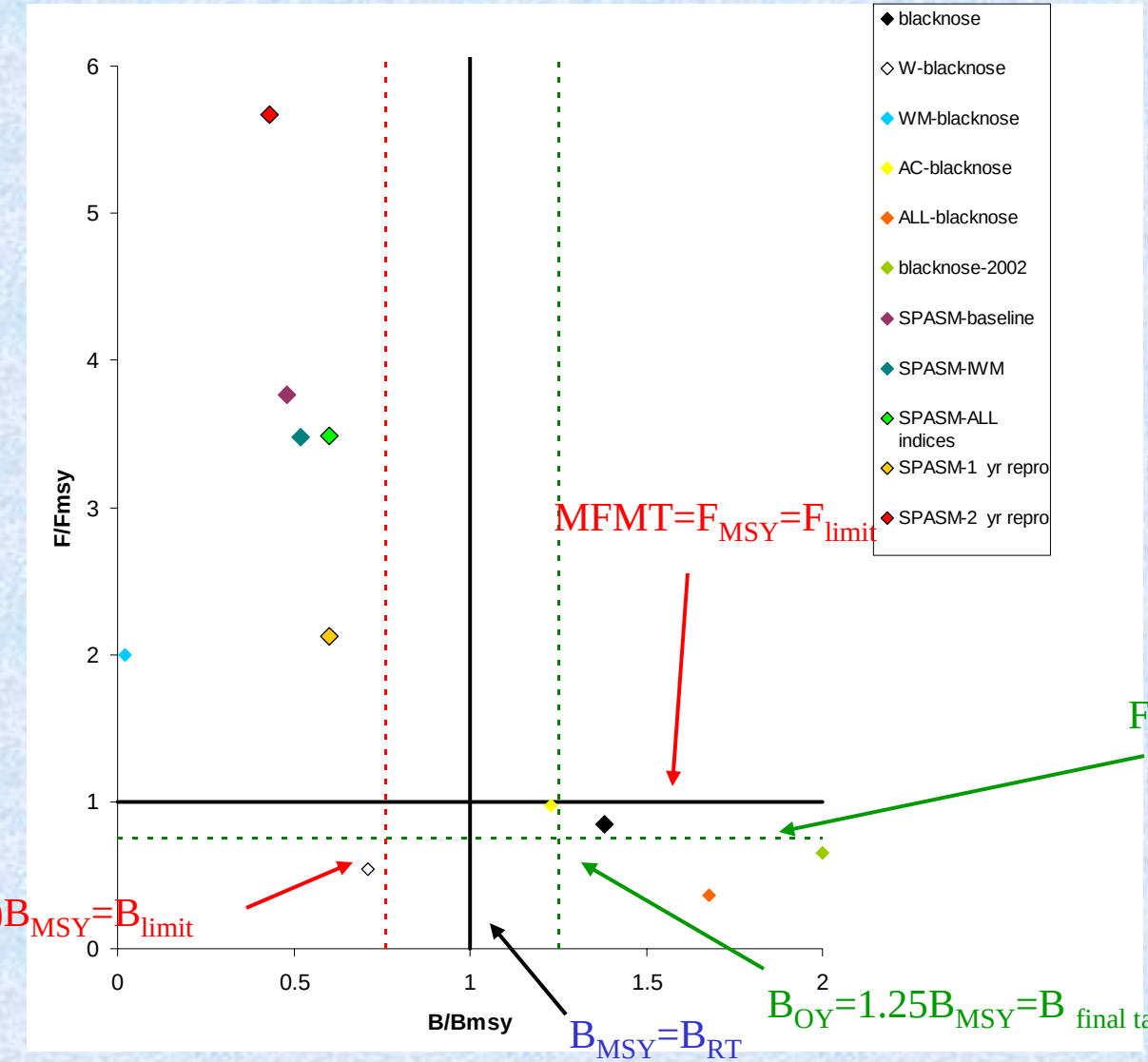
ALL Results for Atlantic sharpnose shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



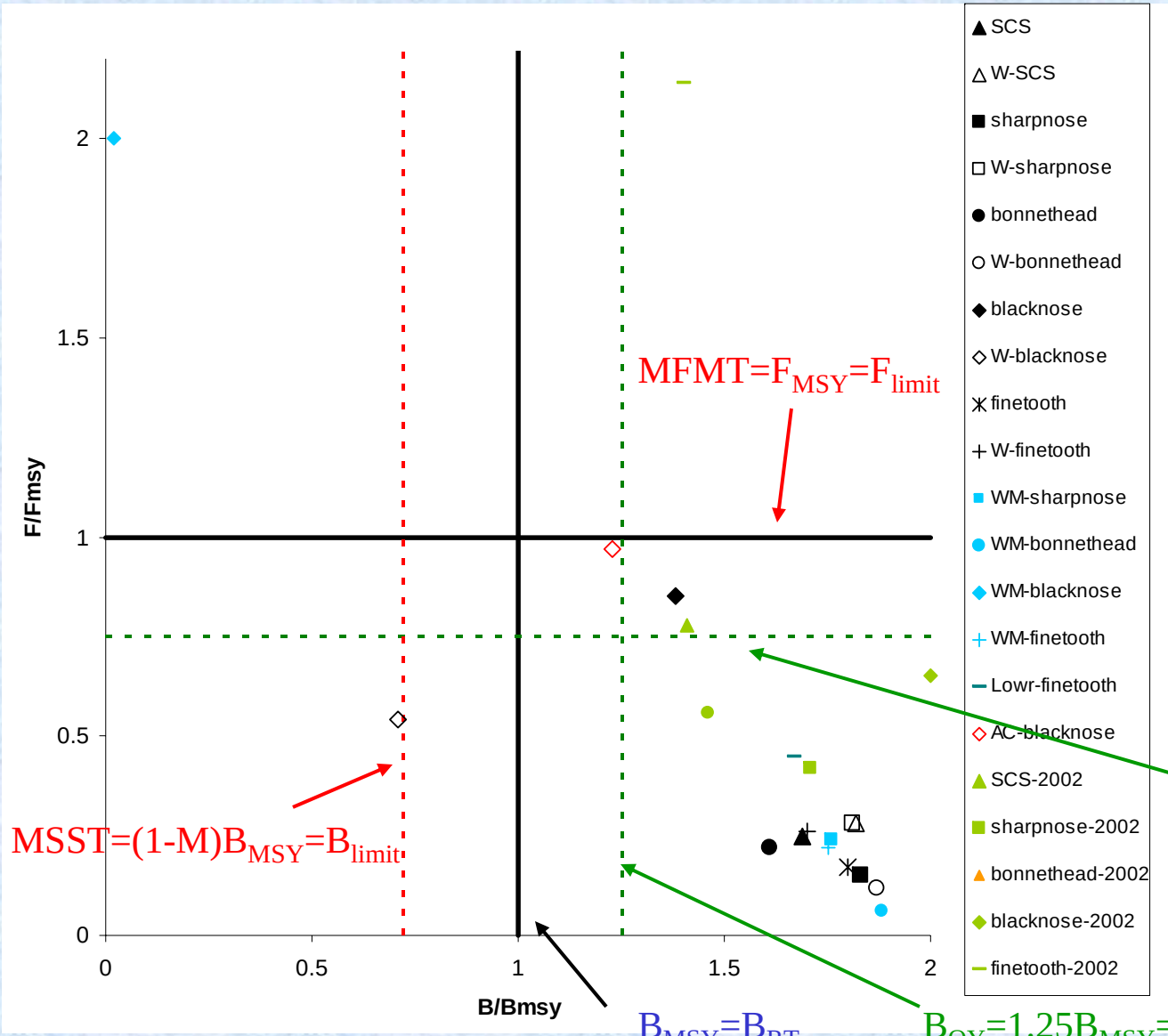
ALL Results for Bonnethead shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



ALL Results for Blacknose shark: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



Results for all (SCS complex + species): Biological reference points (phase plo of relative biomass vs. relative fishing mortality)



CPUE series: SCS complex - 2007 vs. 2002

- **2002:** SEAMAP-GOM-F, SCDNR, Rec, PC LL, PC Gillnet, Gillnet Observer, SEAMAP-SA, VA LL, NEFSC-Trawl (9)
- **2007:** BLLOP, Gillnet Observer, PC LL, PC Gillnet, SEAMAP-SA, TEXAS, NMFS LL SE, SC Coastspan GN, SCDNR red drum, SEAMAP-GOM-S, SEAMAP-GOM-F, UNC, MML Gillnet (13)

→ 4 series in common, 9 new series

CPUE series: Atlantic sharpnose - 2007 vs. 2002

- **2002:** SEAMAP-GOM-F, SCDNR, NMFS LL NE, Rec, NMFS LL SE-ATL, NMFS LL SE-EGM, NMFS LL SE-WGM, PC LL, PC Gillnet, Gillnet Observer, SEAMAP-SA, VA LL, NEFSC-Trawl (13)

- **2007:** Gillnet Observer, BLLOP, PC LL, PC Gillnet, SEAMAP-SA, TEXAS, VA LL, NMFS LLSE, SC Coastspan, SCDNR, SEAMAP-GOM-S, SEAMAP-GOM-F, UNC, MML-Ad, MML-Juv (15)

→ 7 series in common, 8 new series

CPUE series: Bonnethead - 2007 vs. 2002

- **2002:** Rec, PC Gillnet, Gillnet Observer, SEAMAP-SA (4)
- **2007:** Gillnet Observer, ENP, PC Gillnet, SEAMAP-SA, TEXAS, SC Coastspan, SEAMAP-GOM-S, SEAMAP-GOM-F, MML-Ad, MML-Juv (10)

→ 3 series in common, 7 new series

CPUE series: Blacknose - 2007 vs. 2002

- **2002:** Rec, NMFS LL SE-EGM, NMFS LL SE-WGM, PC LL, PC Gillnet, Gillnet Observer (6)
- **2007:** Gillnet Observer, BLLOP, PC Gillnet, SCDNR, NMFS LL SE, UNC, MML (7)

→ 2 series in common, 5 new series

CPUE series: Finetooth - 2007 vs. 2002

- **2002:** Rec, NMFS LL SE-WGM, PC LL, PC Gillnet, Gillnet Observer (5)
- **2007:** Gillnet Observer, PC Gillnet, TEXAS, SC Coastspan (4)

→ 2 series in common, 2 new series