

# **Assessment of the Small Coastal Shark Complex 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

# Why a surplus production model?

---

- Stocks have been managed as a complex (SCS)
- Cannot use age-structured model for different species with different life history characteristics

# Assessments conducted

---

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

# Surplus production modeling approaches

---

## 1) Bayesian SPM (BSP)

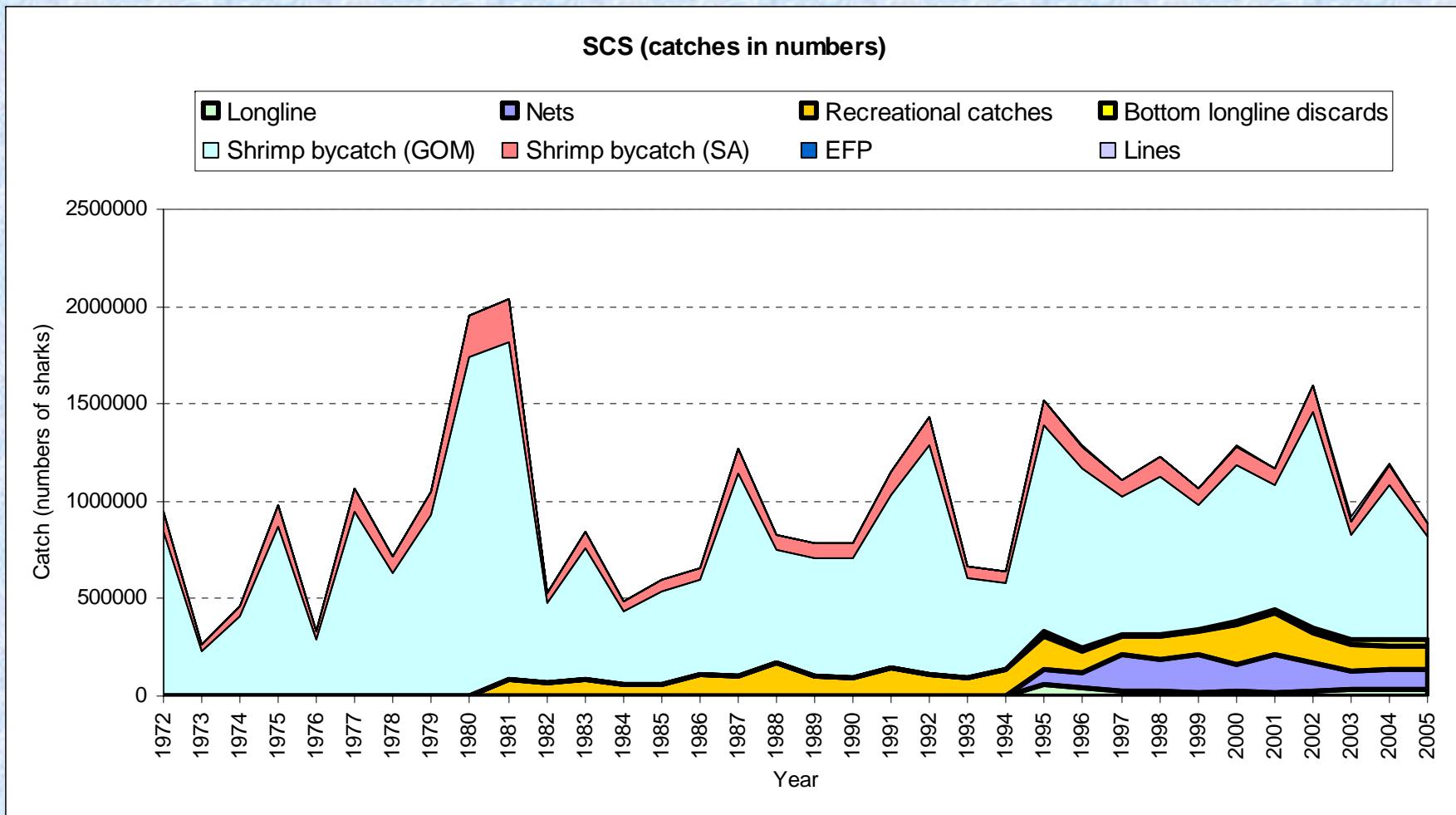
- Observation error in CPUE
- SIR algorithm for numerical integration
- Implemented in VB

## 2) State-space Bayesian SPM (WinBUGS)

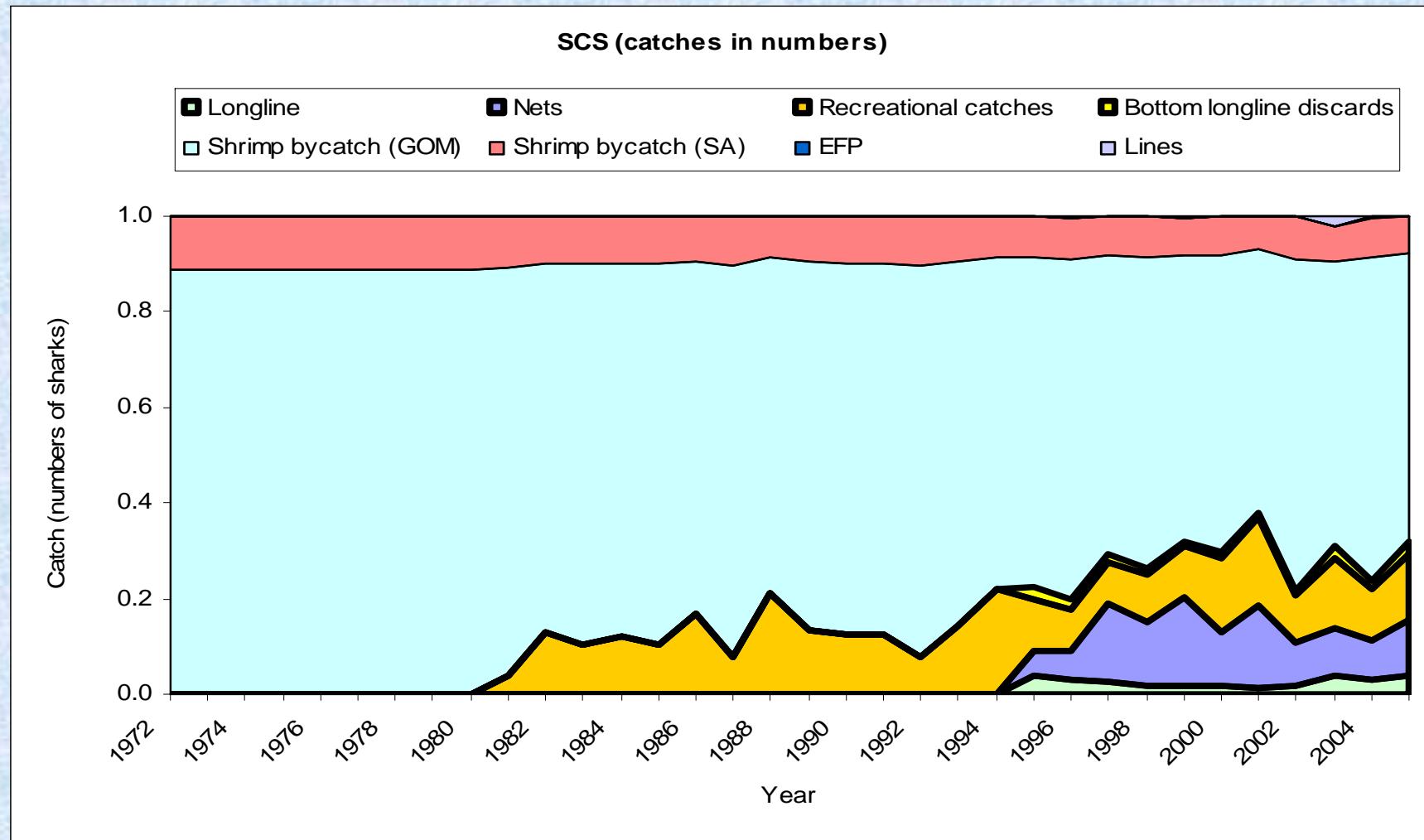
- Observation error in CPUE
- Process error in biomass (unobserved state)
- MCMC for numerical integration
- Implemented in WinBUGS

# SMALL COASTAL SHARK COMPLEX

# Total Catches: SCS complex



# Total Catches: SCS complex (relative)

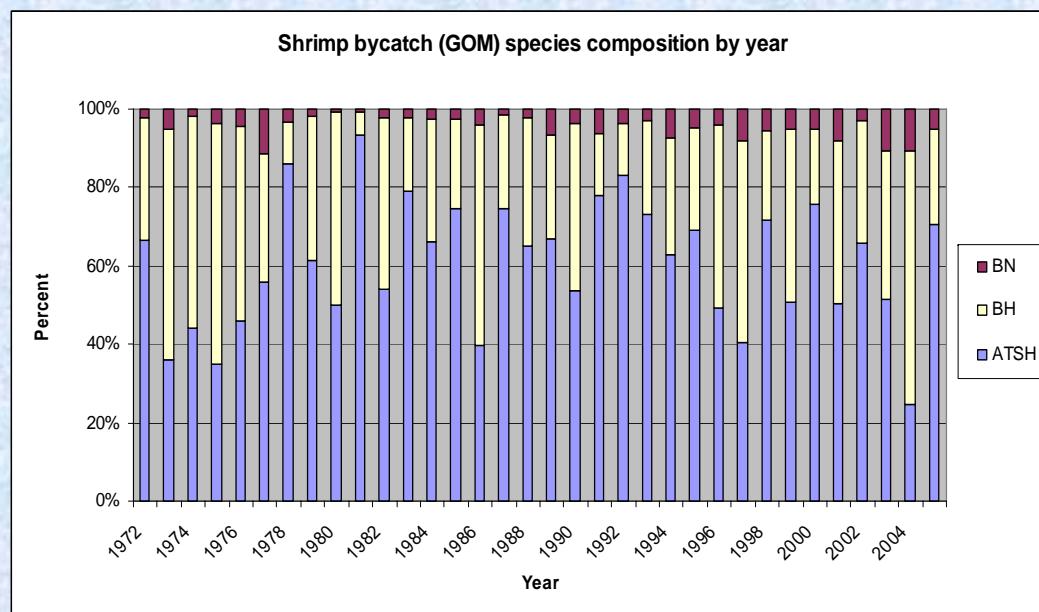
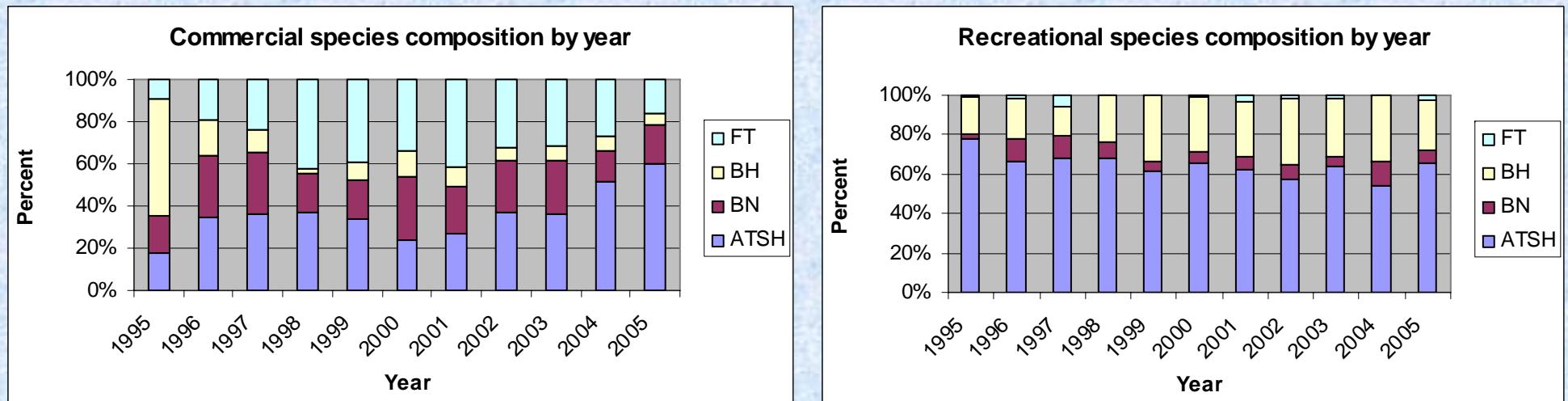


# Catches by sector: why numbers?

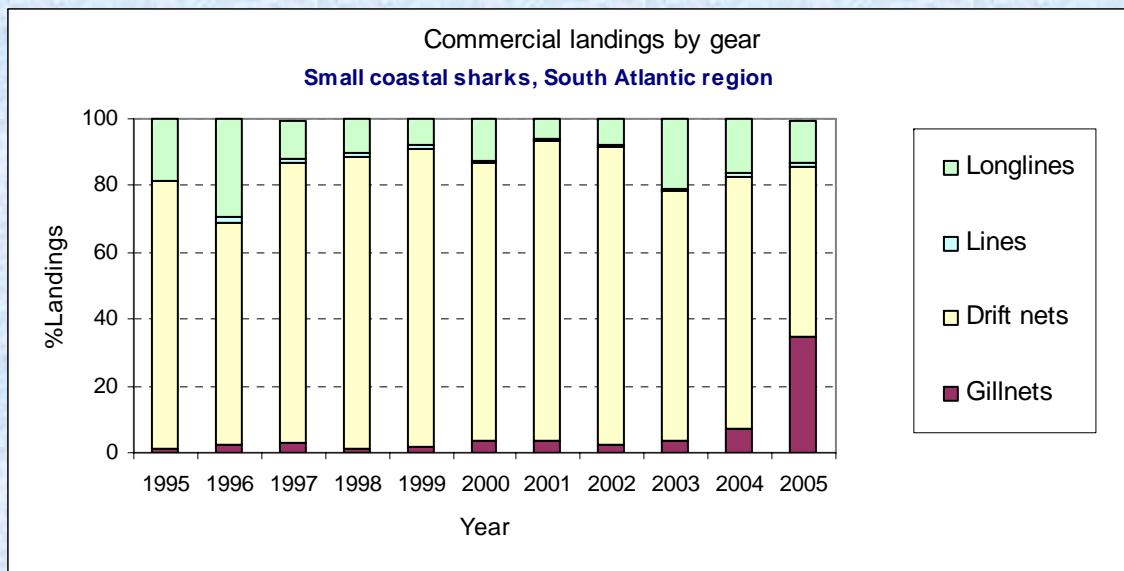
---

- 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)

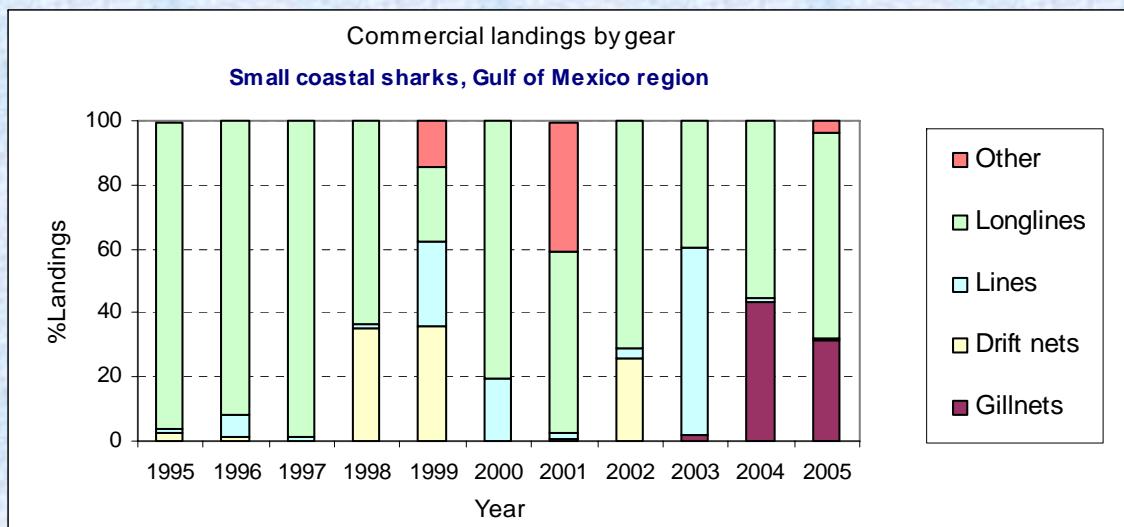
# Species composition of the SCS complex by sector



# Commercial landings of the SCS complex by region and gear type

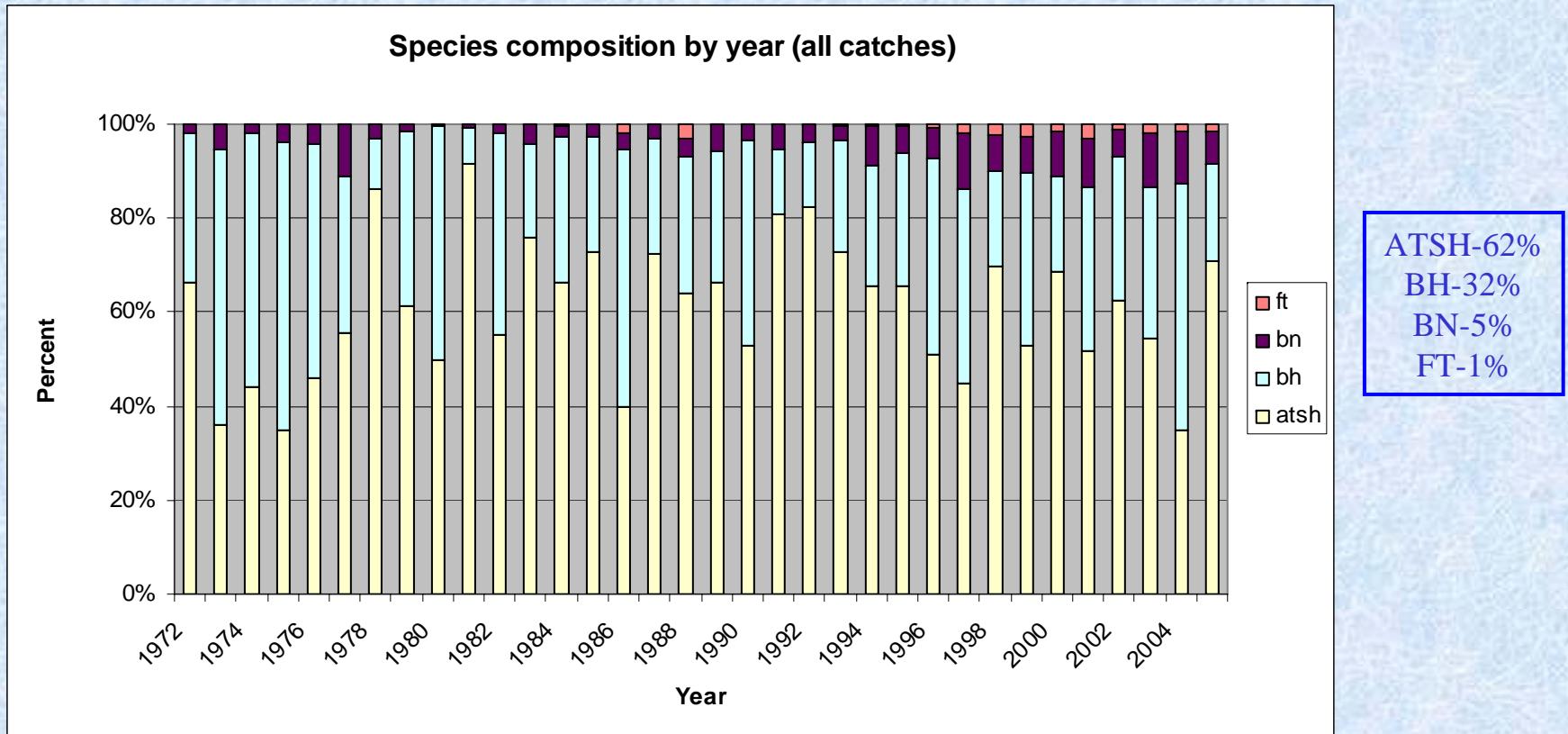


Region=SA	%landings (all years combined)
Gear	
Otter trawl	0.01
Gillnets	5.9
Drift nets	79.1
Lines	1.0
Longlines	13.9
Other	0.01
Unknown	0.04



Year	%landings	
	SA	GOM
1995	70.3	29.7
1996	92.5	7.5
1997	97.7	2.3
1998	97.0	3.0
1999	97.0	3.0
2000	96.8	3.2
2001	98.0	2.0
2002	89.4	10.6
2003	77.8	22.2
2004	74.2	25.8
2005	76.2	23.8

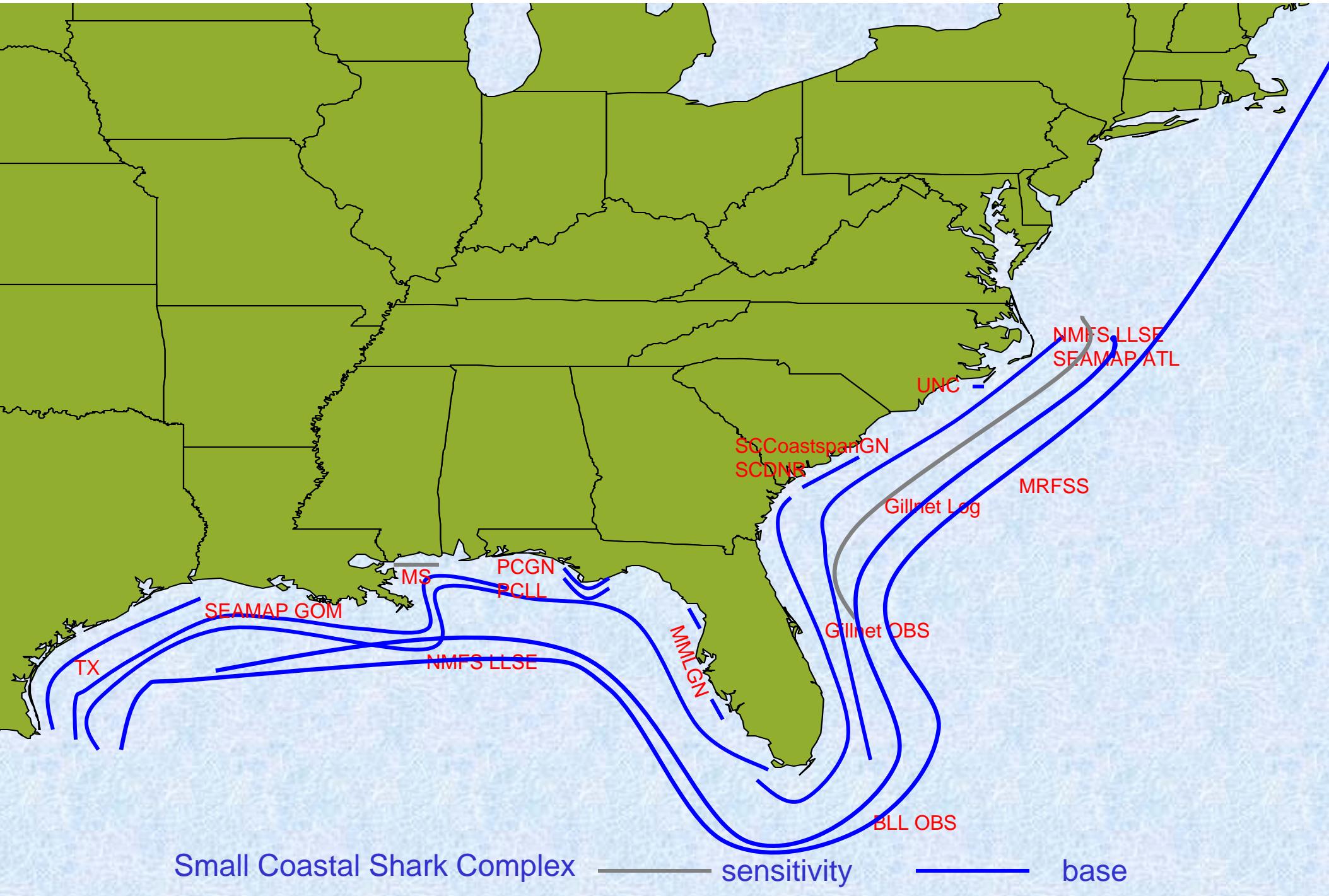
# Overall species composition of the SCS complex



# CPUE series: SCS complex -Baseline

---

- **FISHERY-DEPENDENT:** BLLOP, Gillnet Obs (2)
- **FISHERY-INDEPENDENT:** PC LL, PC Gillnet, SEAMAP-SA, TEXAS, NMFS LL SE, SC CoastsGN, SCDNR red drum, SEAMAP-GoM-Summer, SEAMAP-GoM-Fall, UNC, MML Gillnet (11)



# CPUE series: Species composition of SCS complex

## ■ FISHERY-DEPENDENT:

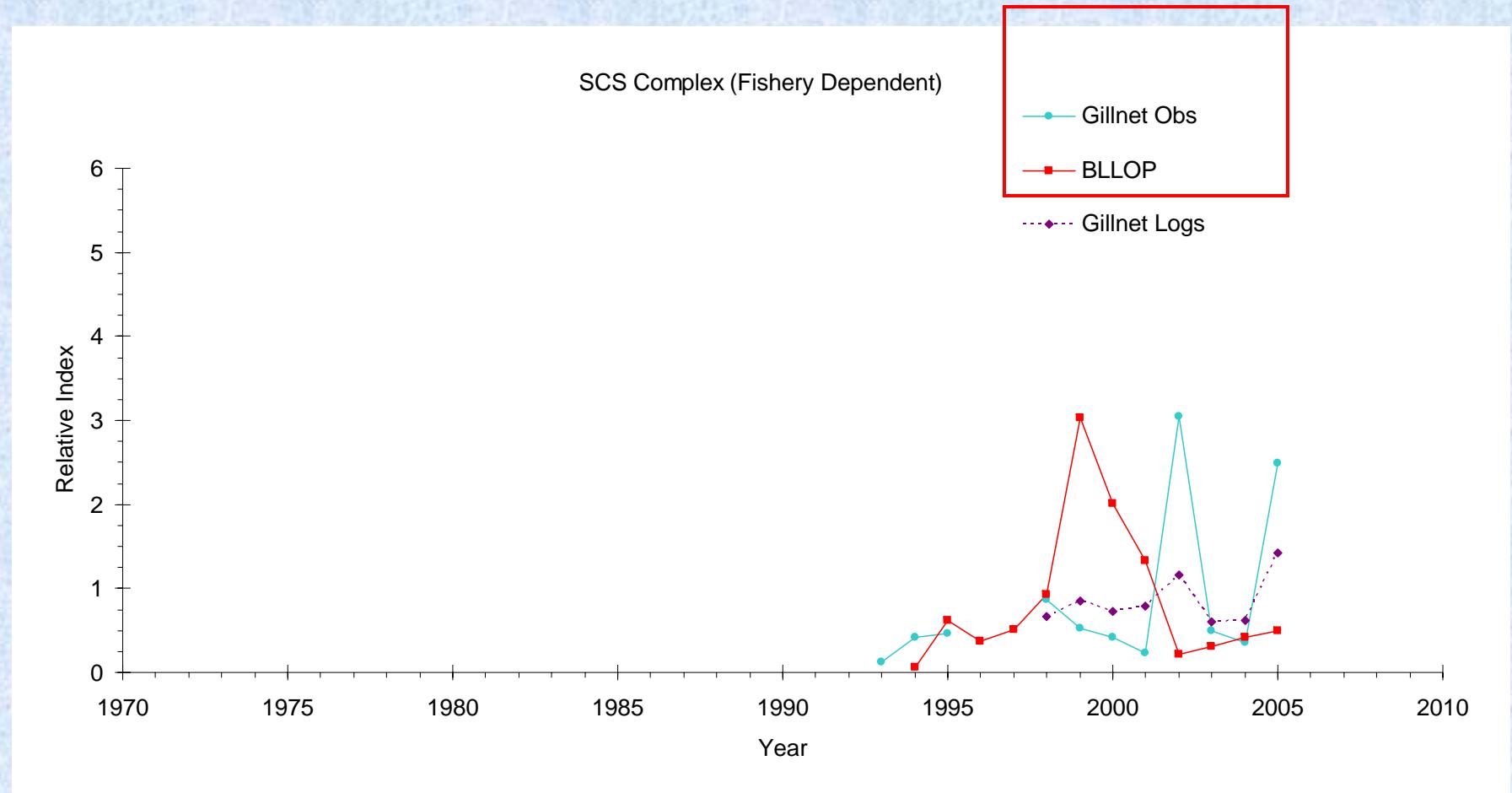
- BLLOP (ATSH+BN)
- Gillnet Obs (variable, but **41-88%ATSH**, 4-20% BN, **1-50%BH**,1-12%FT)

## ■ FISHERY-INDEPENDENT:

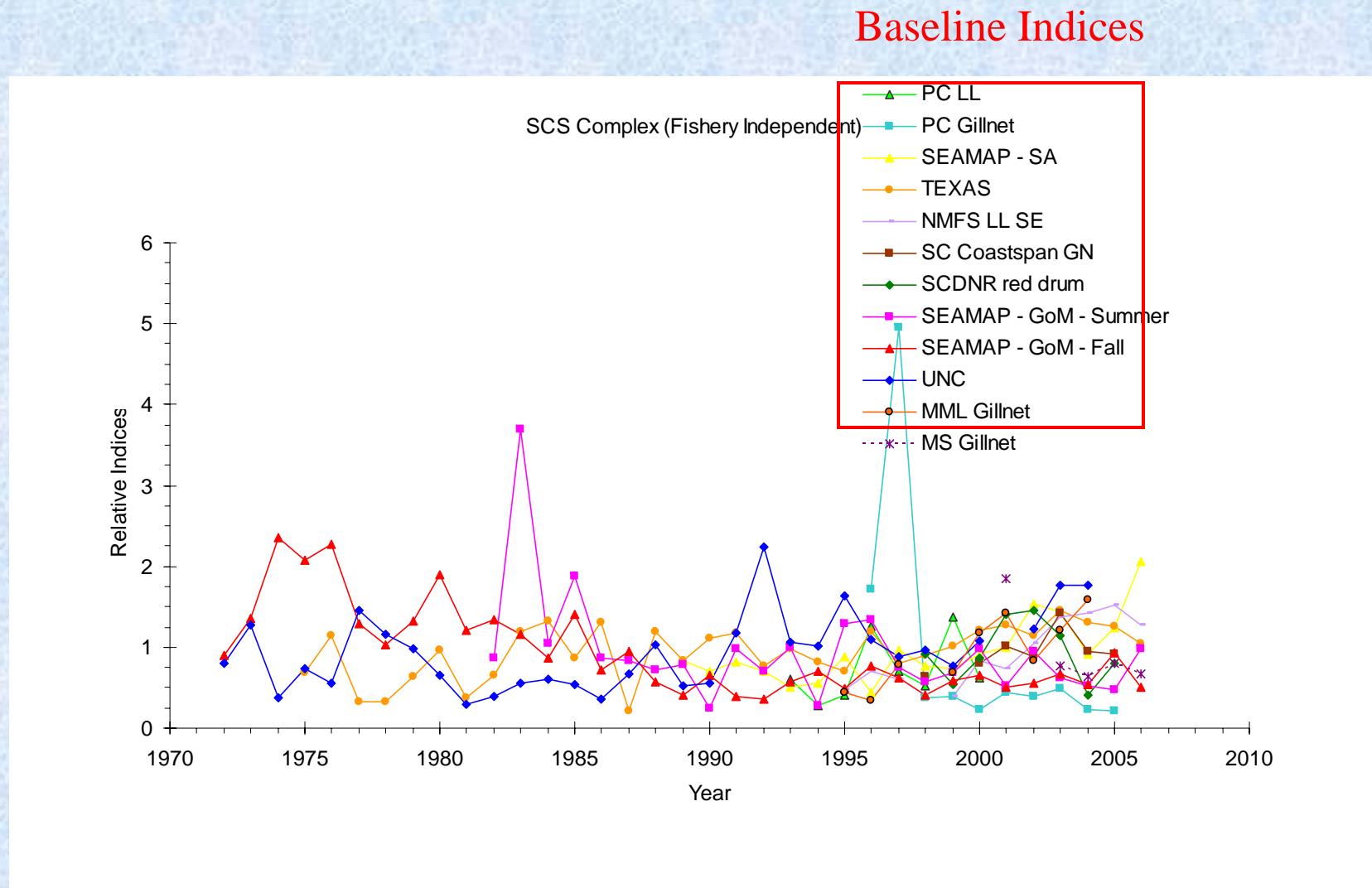
- PC LL (**ATSH mostly**)
- PC Gillnet (na)
- SEAMAP-SA (**71% ATSH, 28%BH**)
- TEXAS (**67%BH, 20%ATSH**, 13%FT)
- NMFS LL SE (**84%ATSH,15%BN**)
- SC Coastspan GN (**37%ATSH,38%BH,26%FT,1%BN**)
- SCDNR red drum LL (**87%ATSH, 1%BH**, 1%FT,11%BN)
- SEAMAP-GoM-Summer (**90%ATSH,5%BH,5%BN**)
- SEAMAP-GoM-Fall (**71%ATSH,25%BH,5%BN**)
- UNC (**67%ATSH,28%BN,4%FT**)
- MML Gillnet (**ATSH+BH**)

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

## Baseline Indices



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

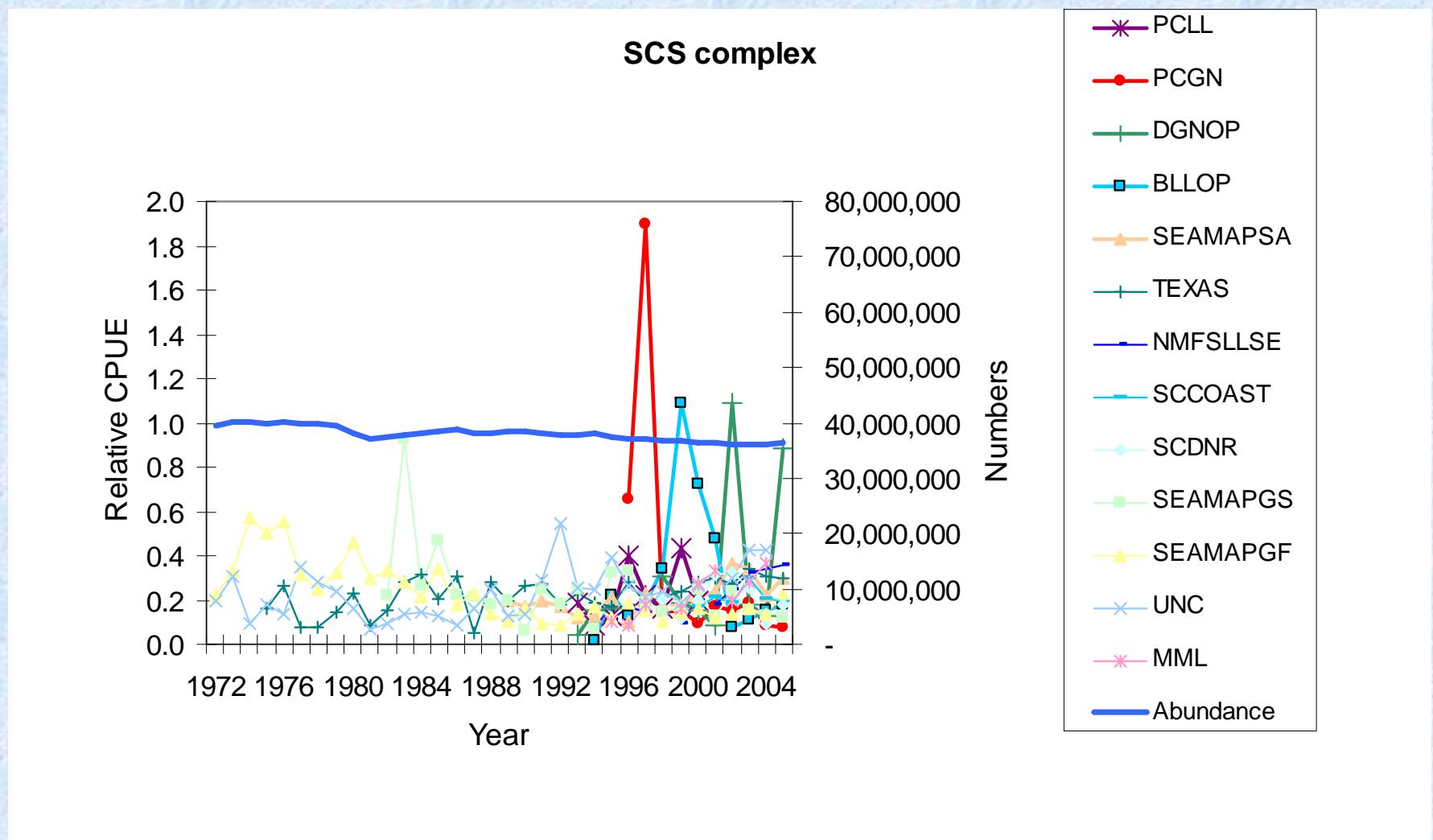


# Inputs-Priors for SCS complex-Baseline

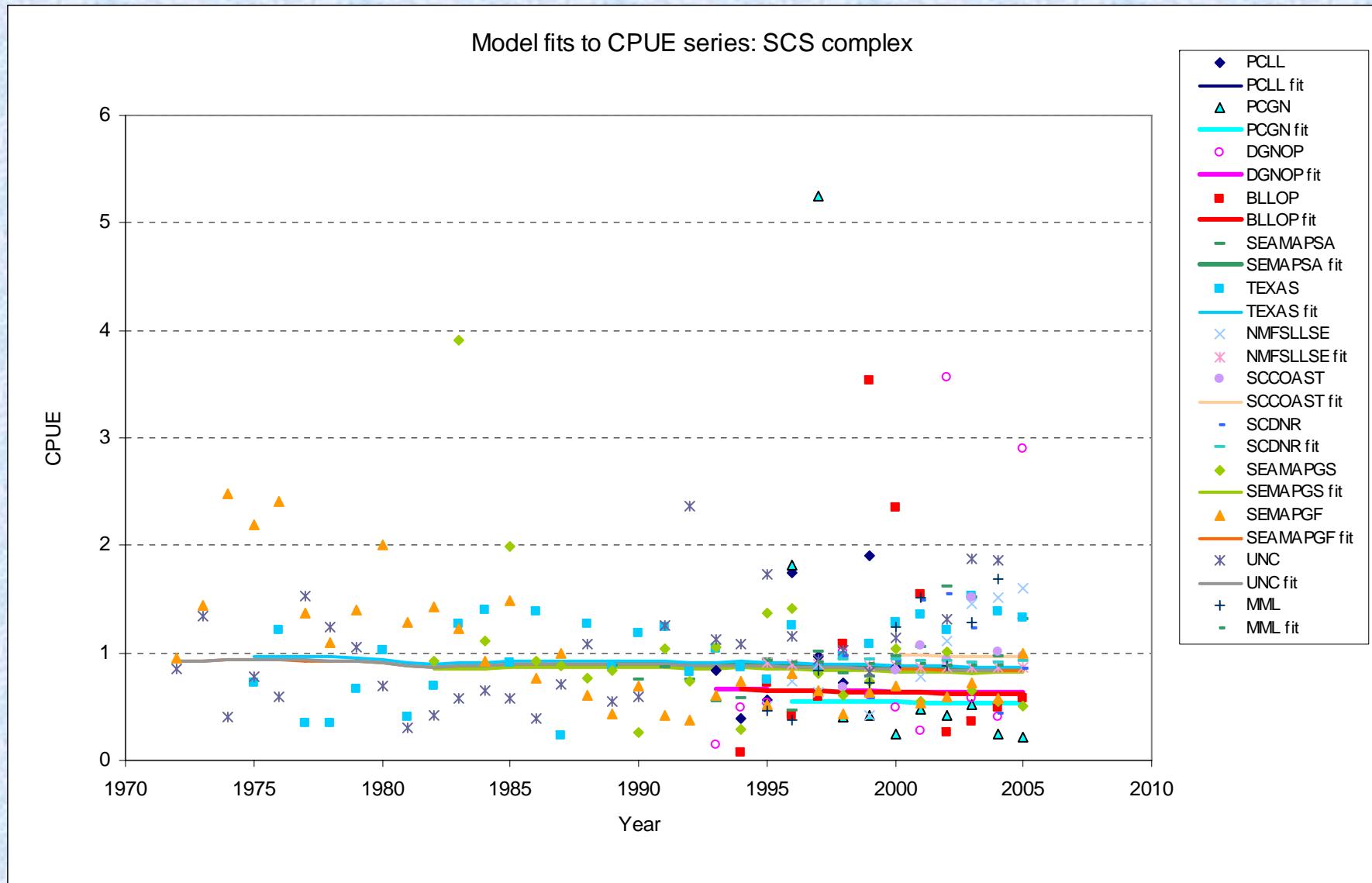
---

- Model starts in 1972 (first year of CPUE indices)
- Catch data available for 1972-2005
- 13 Indices available
- $r \sim LN(0.17, 0.32, 0.001, 2.0)$   Weighted mean
- $K \sim U \text{ on } \log K (10^4 - 10^8)$
- $N_{72/K} \sim LN(0.9, 0.2, 0.2, 1.1)$

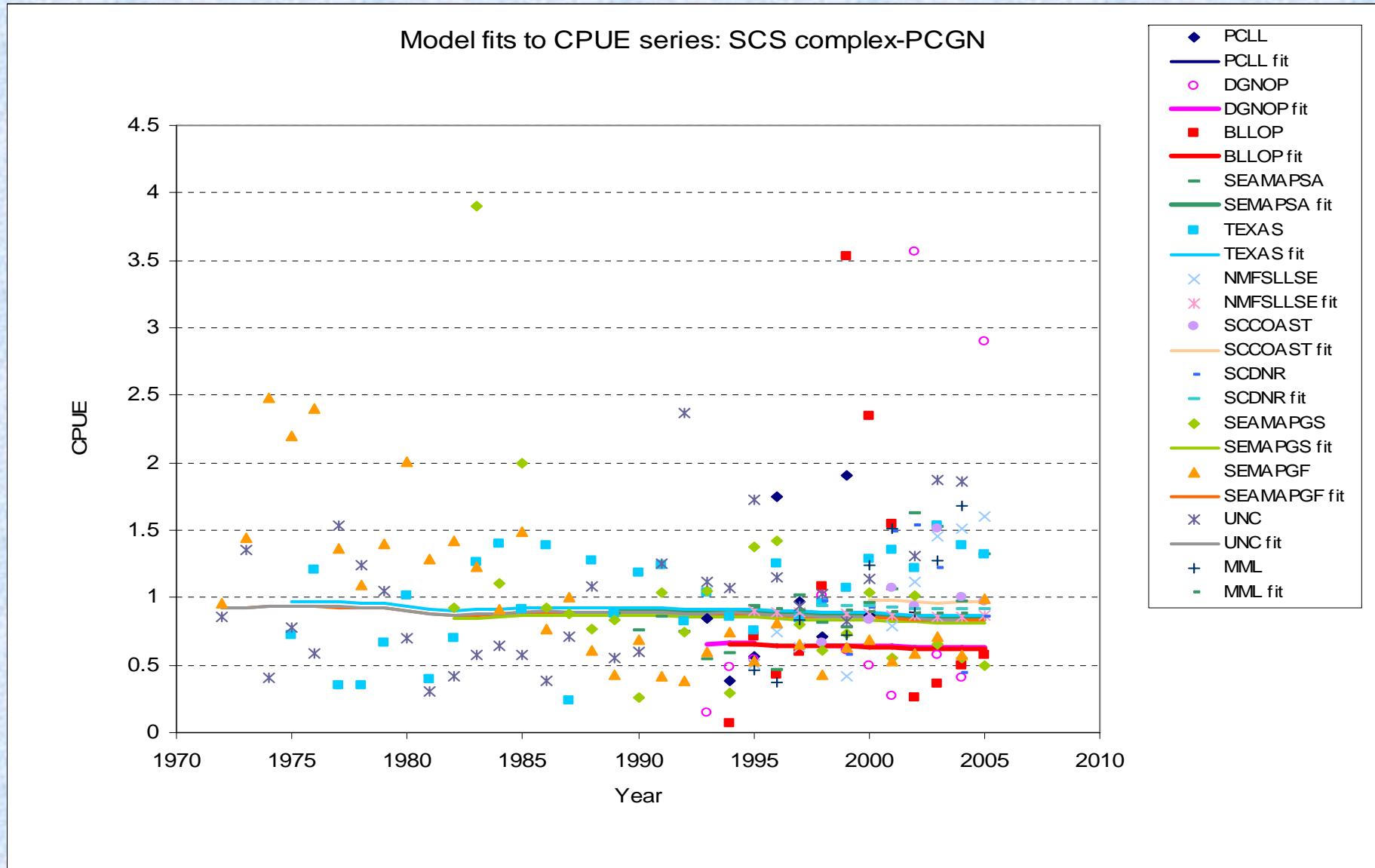
# BSP results for SCS complex-Baseline: Predicted abundance trend at posterior mode of the BSP model fitted to catch and CPUE data



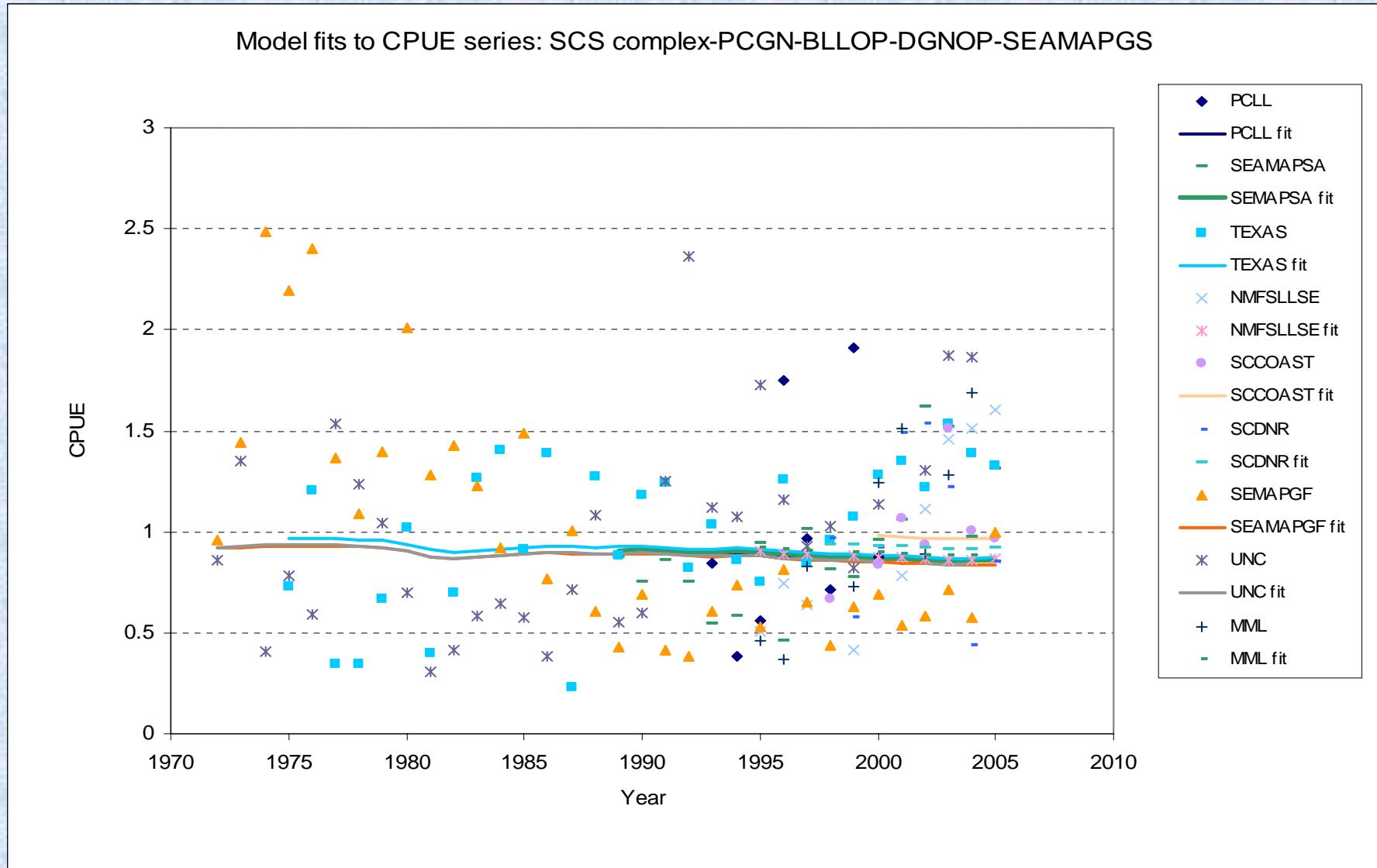
# BSP results for SCS complex-Baseline: Model fits to the individual CPUE series



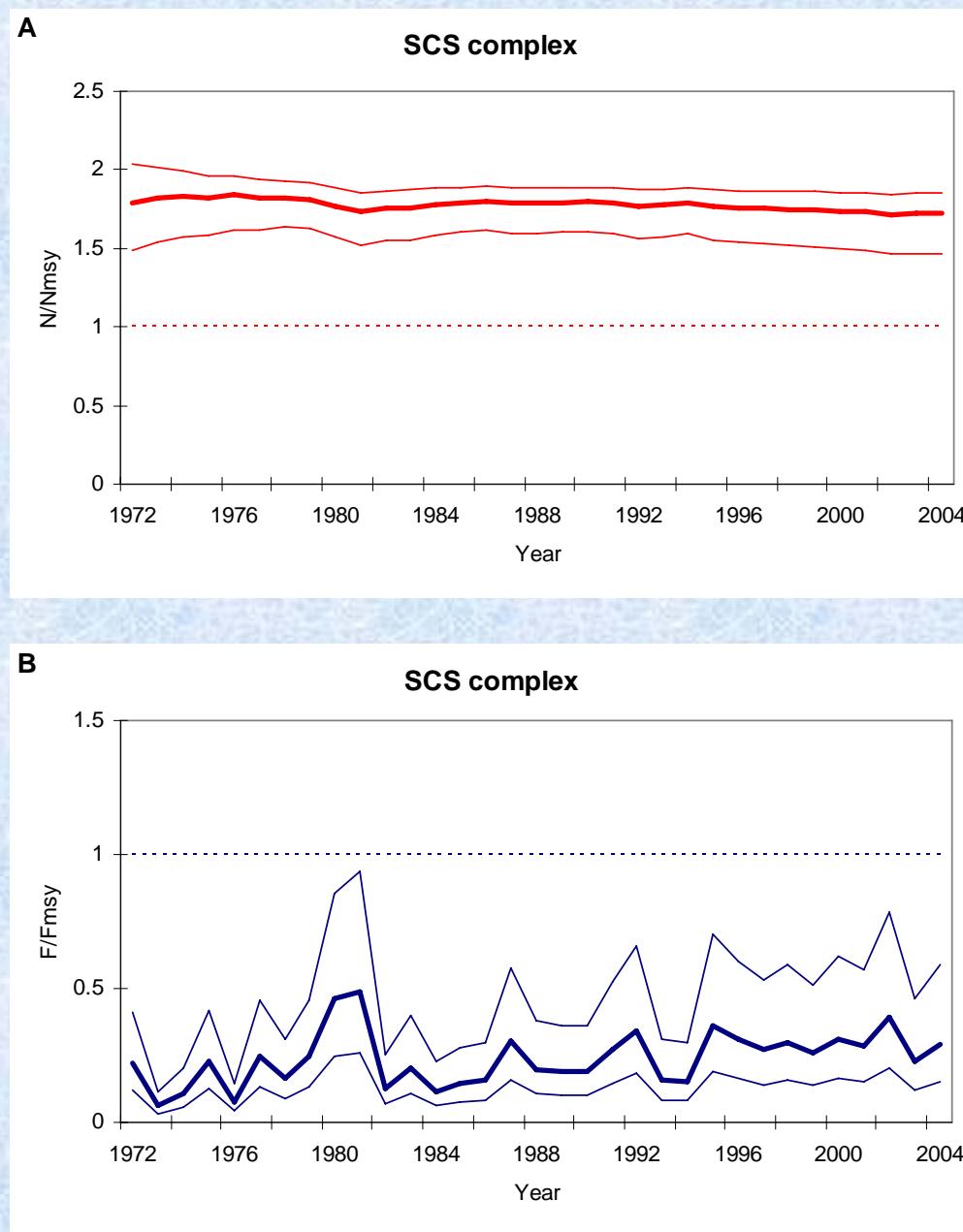
# BSP results for SCS complex-Baseline: Model fits to the individual CPUE series (-PCGN)



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



**BSP results  
for SCS-  
Baseline:  
BSP  
estimated  
median  
relative  
abundance  
and fishing  
mortality  
rate  
trajectories  
(with 80%  
credibility  
intervals )**



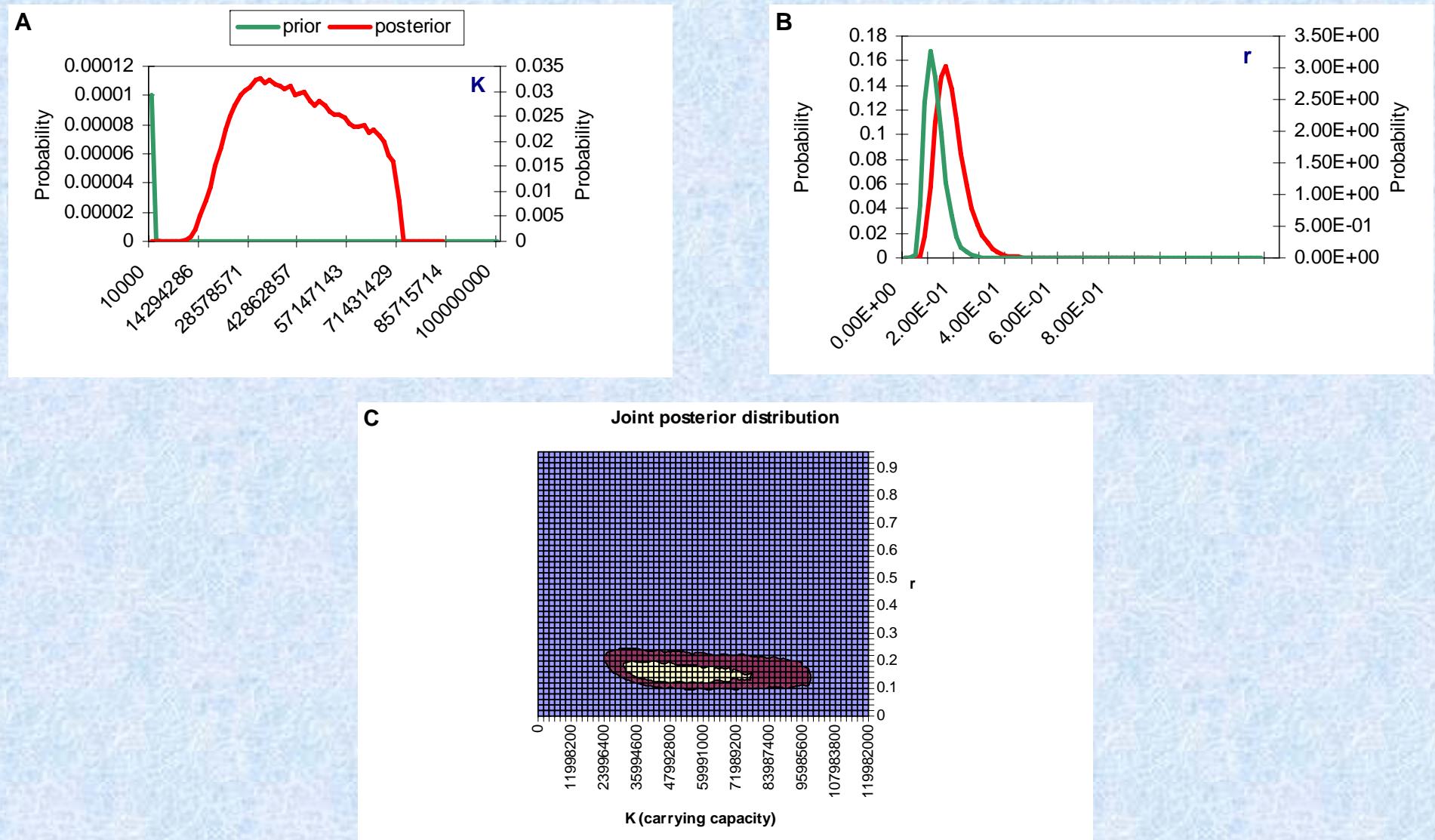
$N/N_{MSY}$

$F/F_{MSY}$

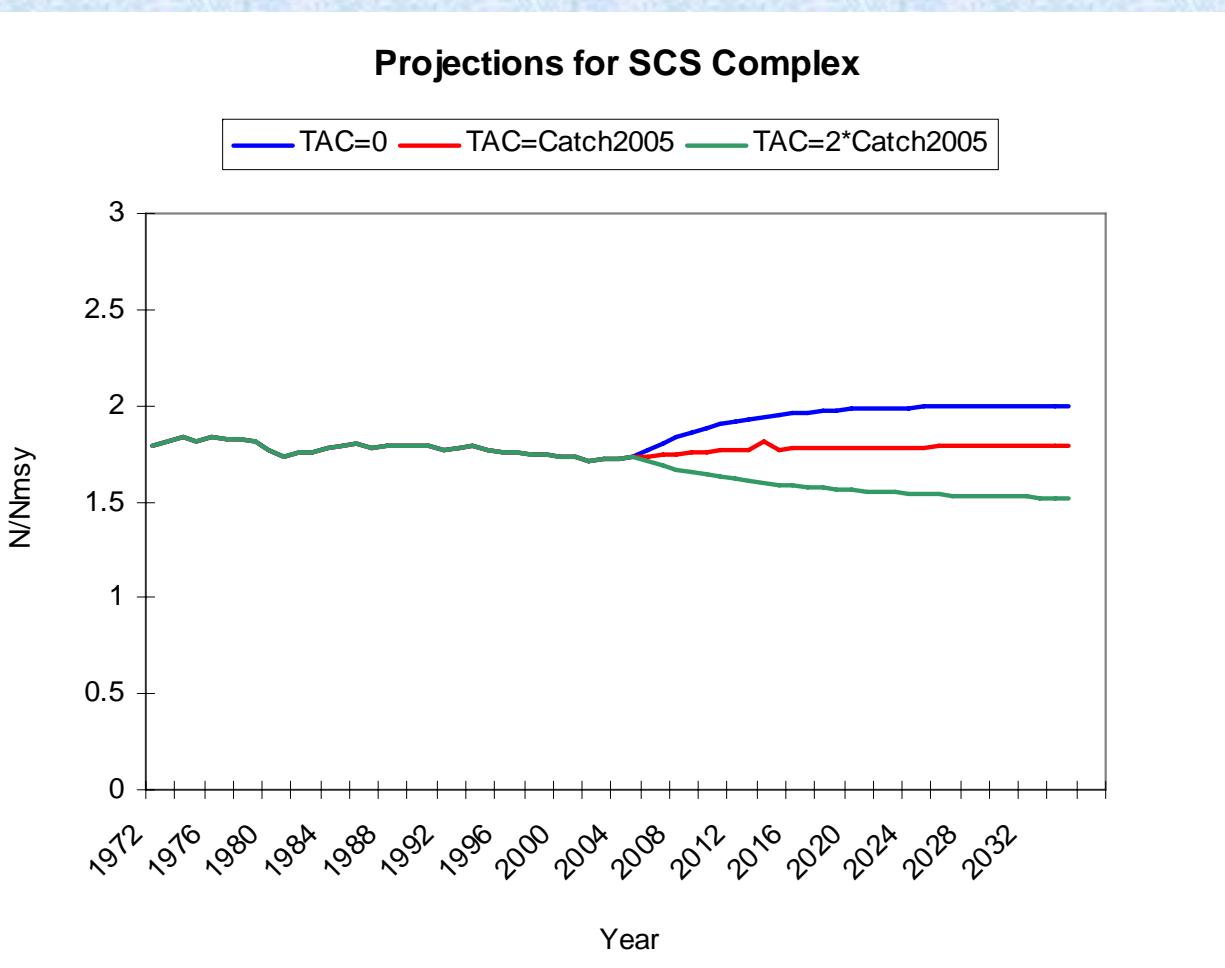
## Expected values of the mean and CV of marginal posterior distributions from the BSP for SCS complex-Baseline

	SCS	
	EV	CV
Importance function	priors	
K	59566	0.35
r	0.181	0.32
MSY	2623	0.45
N <sub>2005</sub>	51605	0.40
$N_{2005}/K$	<b>0.85</b>	0.09
N <sub>init</sub>	53057	0.38
N <sub>2005</sub> /N <sub>init</sub>	0.97	0.13
C <sub>2005</sub> /MSY	0.40	0.42
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.25</b>	0.55
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.69</b>	0.09
C <sub>2005</sub> /rep <sub>y</sub>	0.79	0.05
N <sub>MSY</sub>	29783	0.35
F <sub>MSY</sub>	0.091	
rep <sub>y</sub>	1125	0.05
C <sub>0</sub>		
<b>Diagnostics</b>		
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

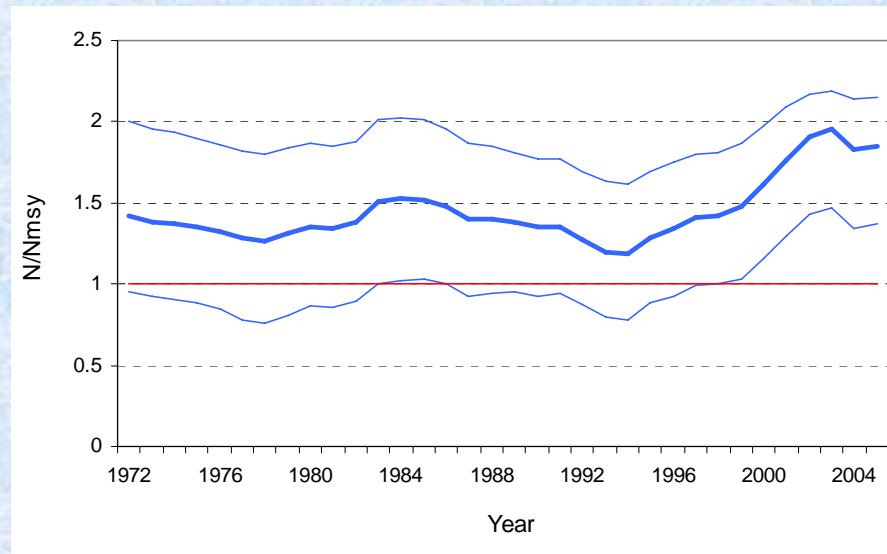


# Sensitivity Analyses

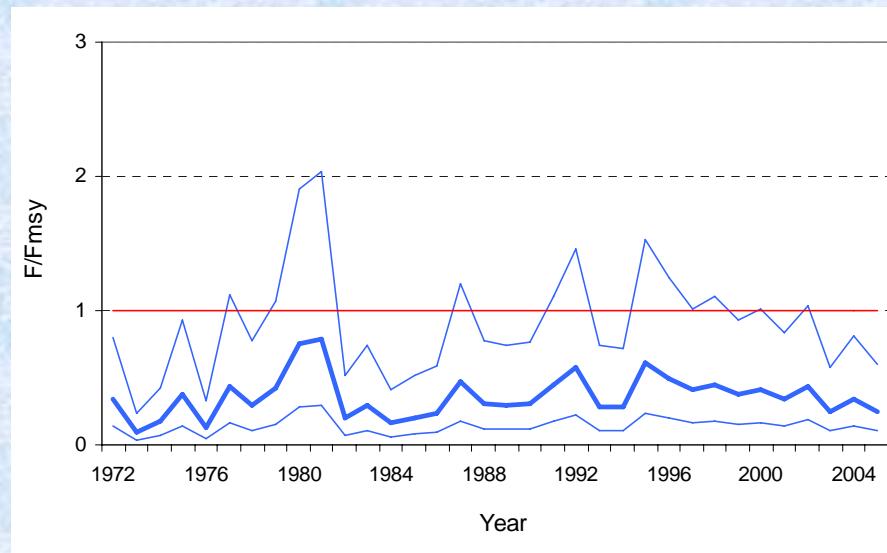
---

- Alternative model (W; WinBUGS)
- Inverse CV weighting (WM; had to remove Gillnet Obs CPUE series)
- Extending catch series back to 1950 (AC)
- Including “sensitivity” CPUE series (ALL: added MS Gillnet and Gillnet Logbook series)

## Results for SCS complex: Estimated median relative abundance and fishing mortality rate trajectories of the WinBUGS SPM (with 95% credibility intervals )

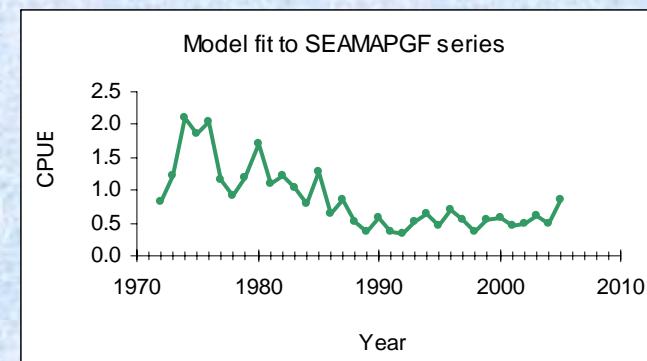
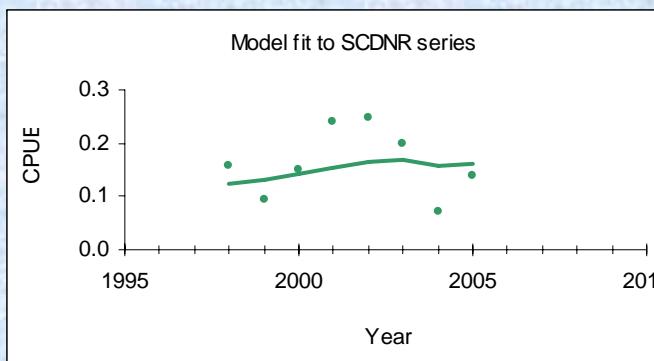
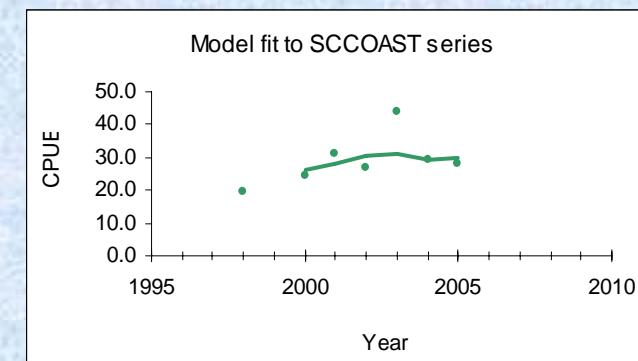
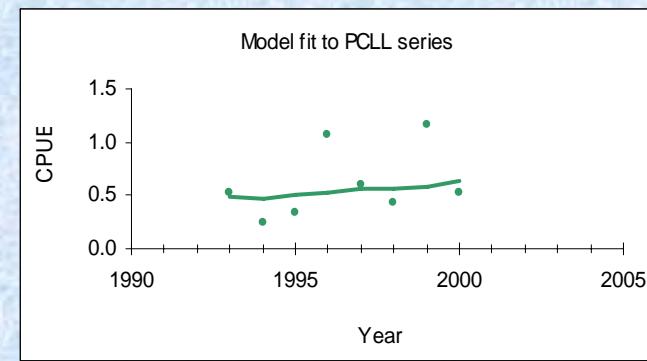
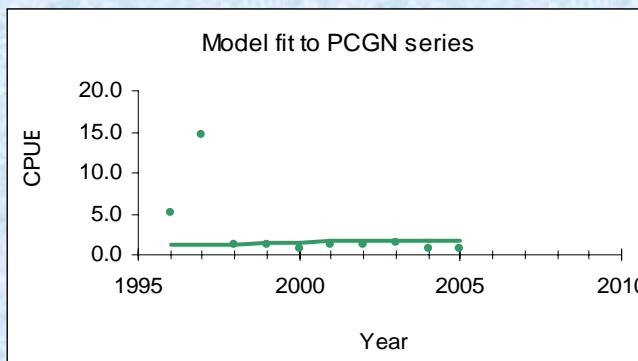
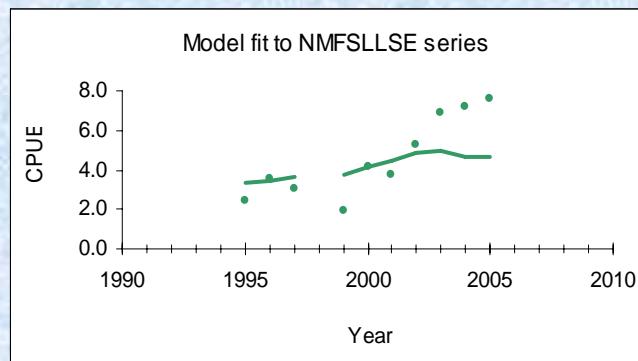
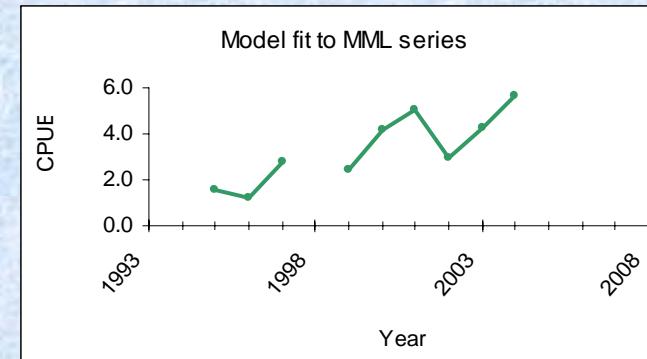
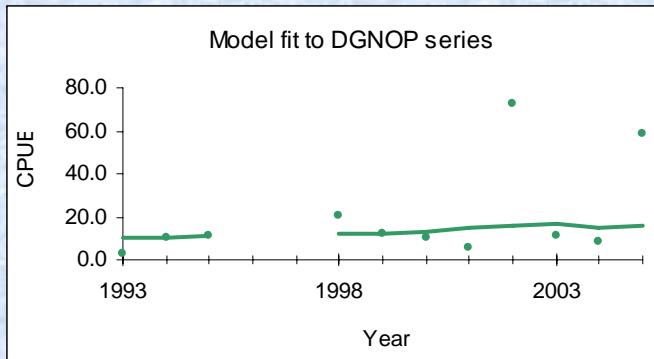
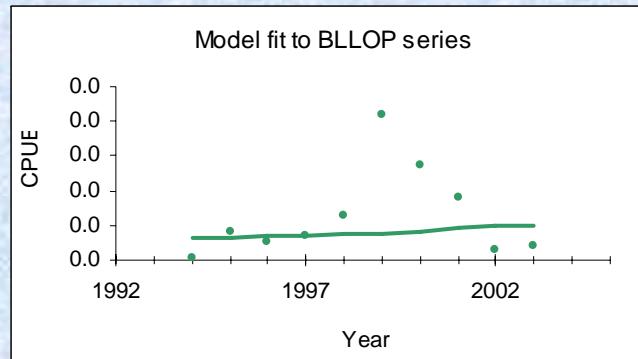


$N/N_{MSY}$

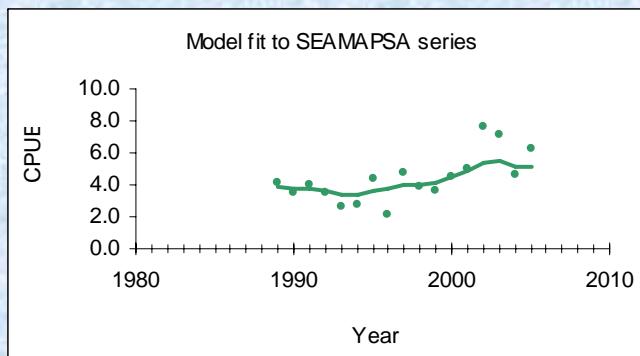
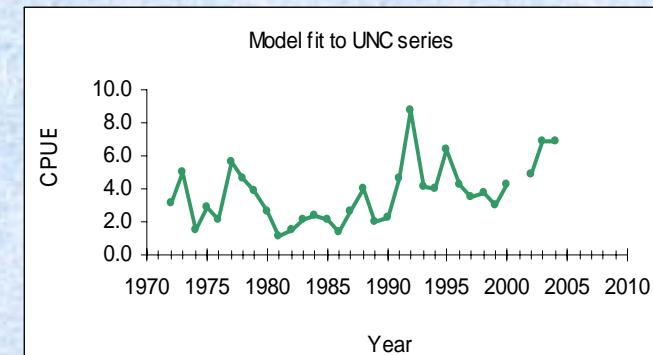
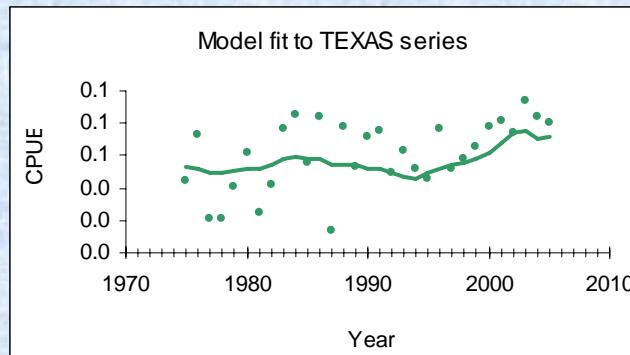
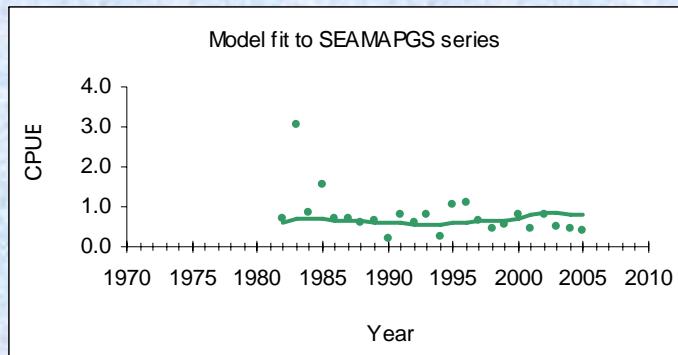


$F/F_{MSY}$

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



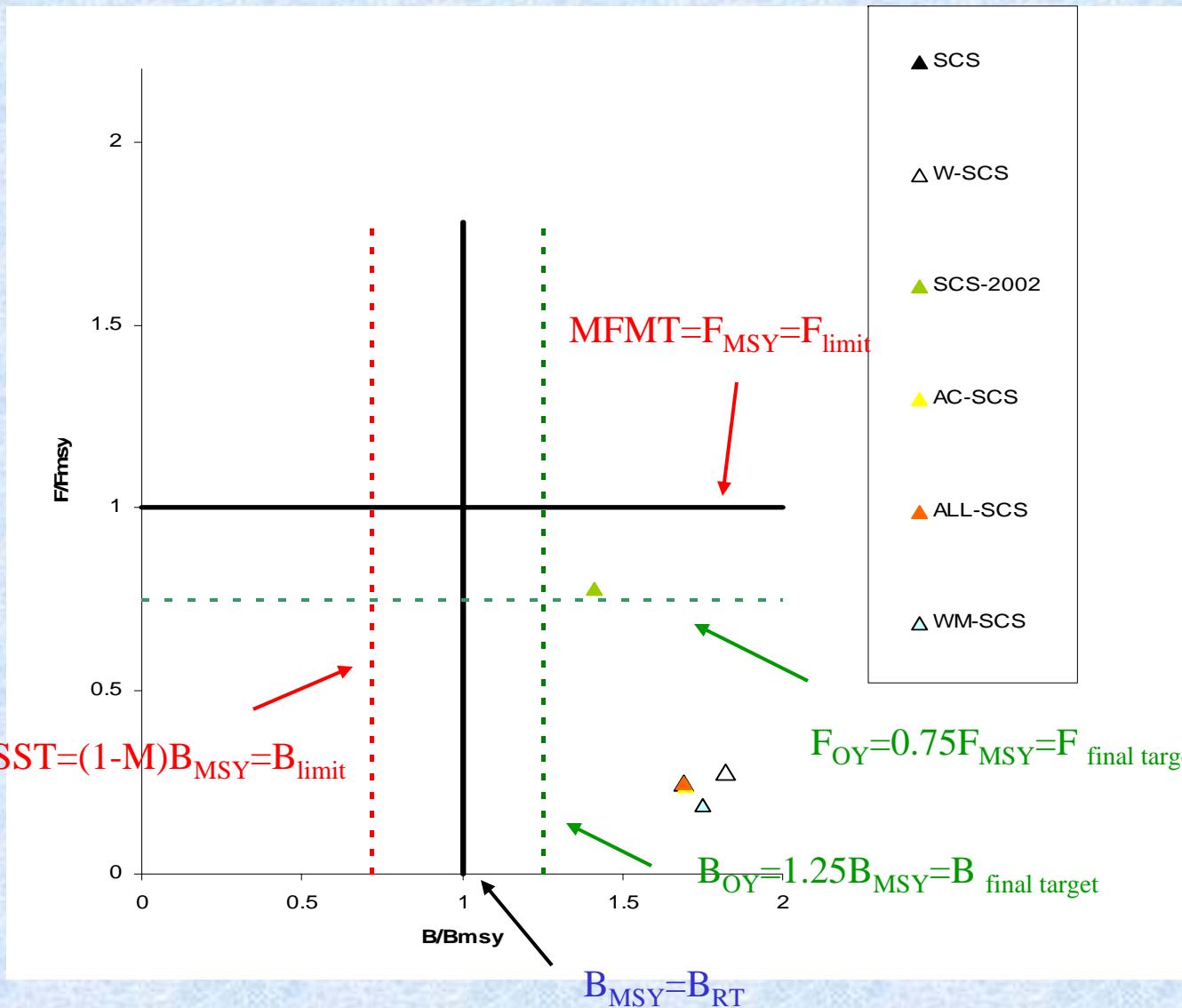
# Results for SCS complex: WinBUGS SPM model fits to the CPUE series



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

	Inverse CV		Alternative catch		All cpue series	
	EV	CV	EV	CV	EV	CV
Importance functi	priors		priors		priors	
K	72665	0.25	60082	0.35	59511	0.35
r	0.172	0.32	0.184	0.32	0.181	0.32
MSY	3056	0.36	2695	0.44	2621	0.45
N <sub>2005</sub>	64118	0.27	52193	0.40	51548	0.41
<b>N<sub>2005</sub>/K</b>	<b>0.88</b>	0.06	<b>0.85</b>	0.09	<b>0.85</b>	0.09
N <sub>init</sub>	51453	0.31	51785	0.38	53006	0.38
N <sub>2005</sub> /N <sub>init</sub>	1.28	0.18	1.00	0.17	0.97	0.13
C <sub>2005</sub> /MSY	0.33	0.34	0.39	0.41	0.41	0.42
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.19</b>	0.42	<b>0.24</b>	0.54	<b>0.25</b>	0.55
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.75</b>	0.06	<b>1.70</b>	0.09	<b>1.69</b>	0.09
C <sub>2005</sub> /repy	0.75	0.04	0.77	0.04	0.79	0.05
N <sub>MSY</sub>	36332	0.25	30041	0.35	29756	0.35
F <sub>MSY</sub>	0.086		0.092		0.090	
repy	1184	0.05	1146	0.04	1125	0.05
C <sub>0</sub>						
<b>Diagnostics</b>						
CW (wt)	3.986		0.635		0.785	
CV (L*prior)	1.566		0.797		0.902	
CV (Wt) / CV (L*p)	<b>2.55</b>		0.797		0.869	
%maxpWt	0.259		0.001		0.002	

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



# Conclusions

---

- Complex dominated by Atlantic sharpnose and bonnethead sharks (94% of all catches; mostly from shrimp trawl)
- Status of complex (not overfished, no overfishing) consistent with those of Atlantic sharpnose and bonnethead sharks using various stock assessment methods

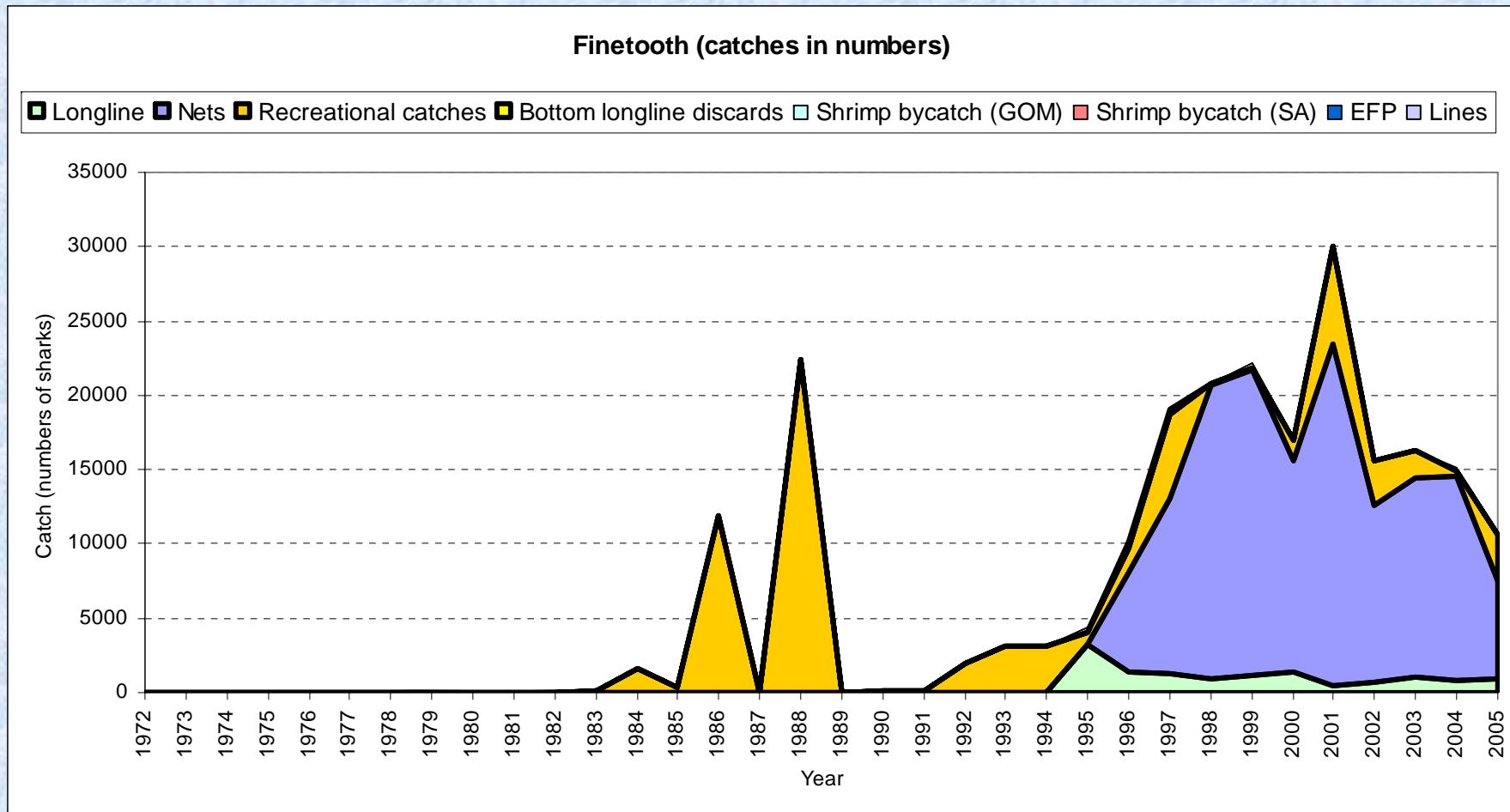
# FINETOOTH SHARK

# Why a surplus production model?

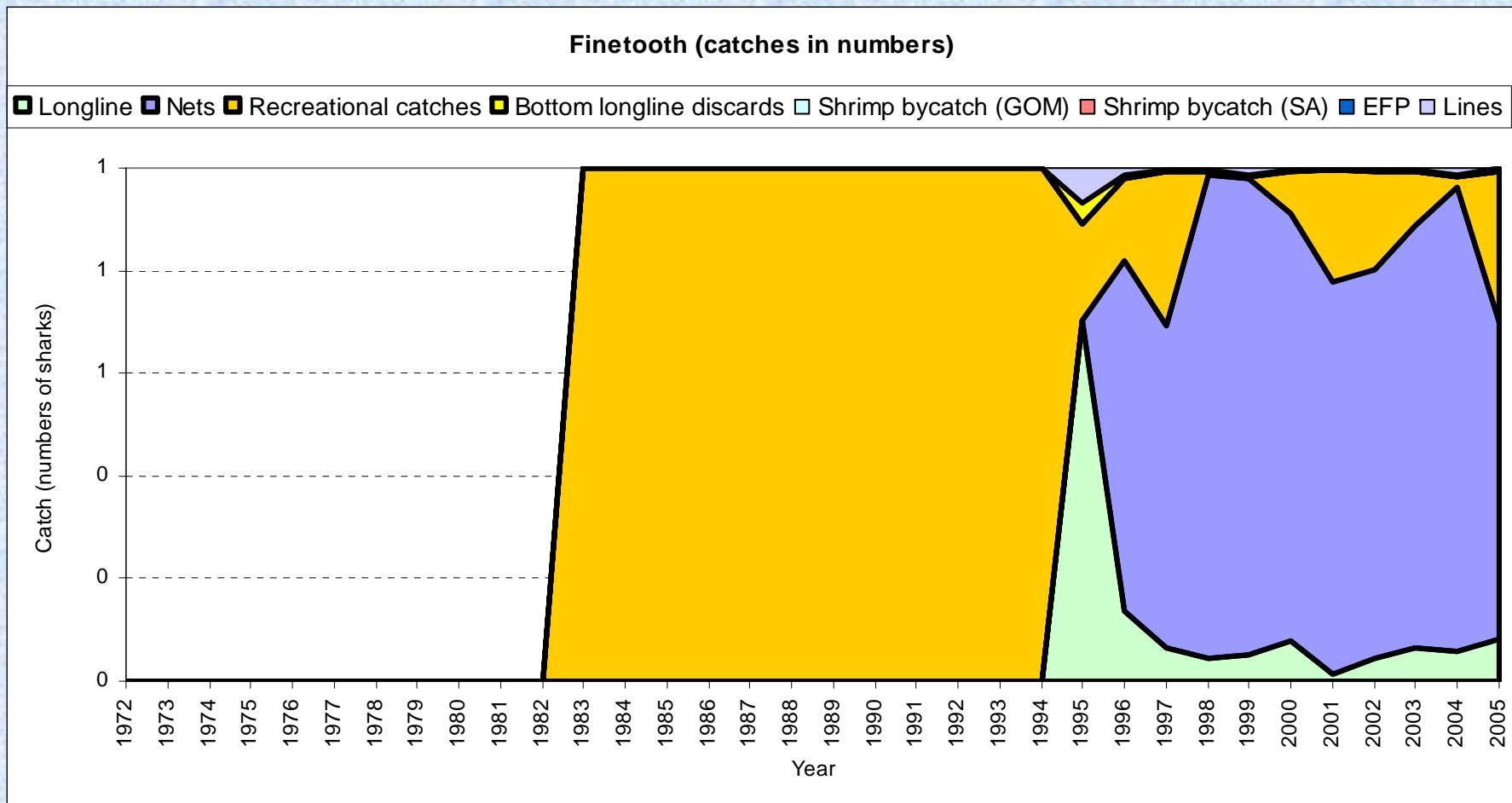
---

- Data-poor (sketchy catch and CPUE data) and poor data (life history)

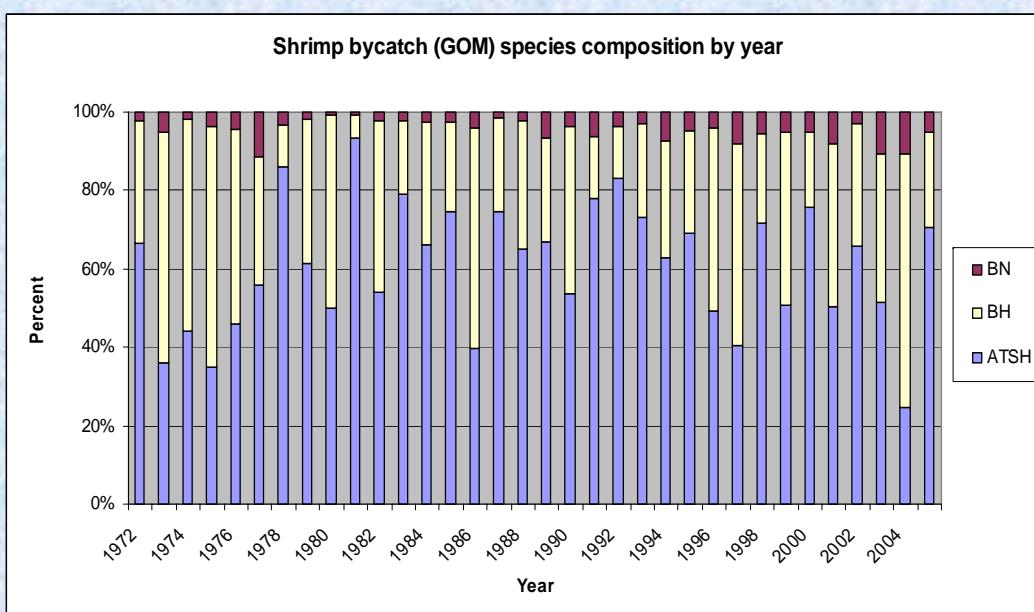
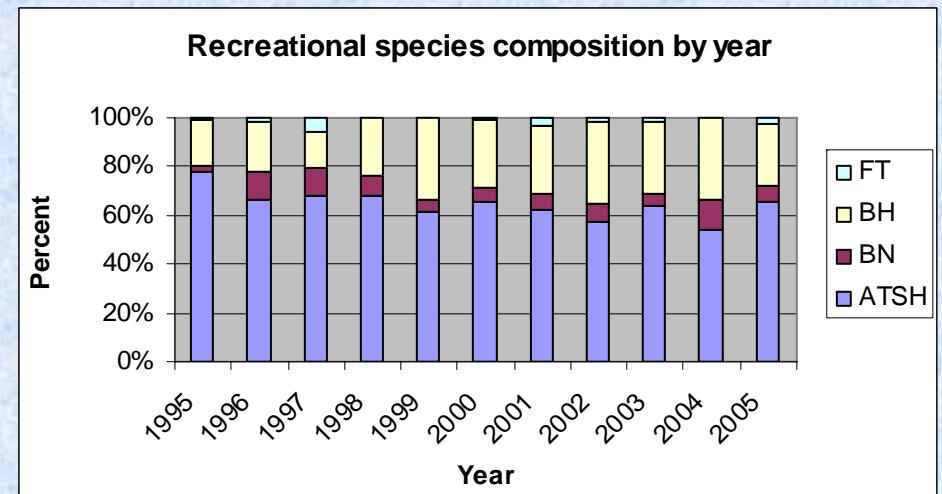
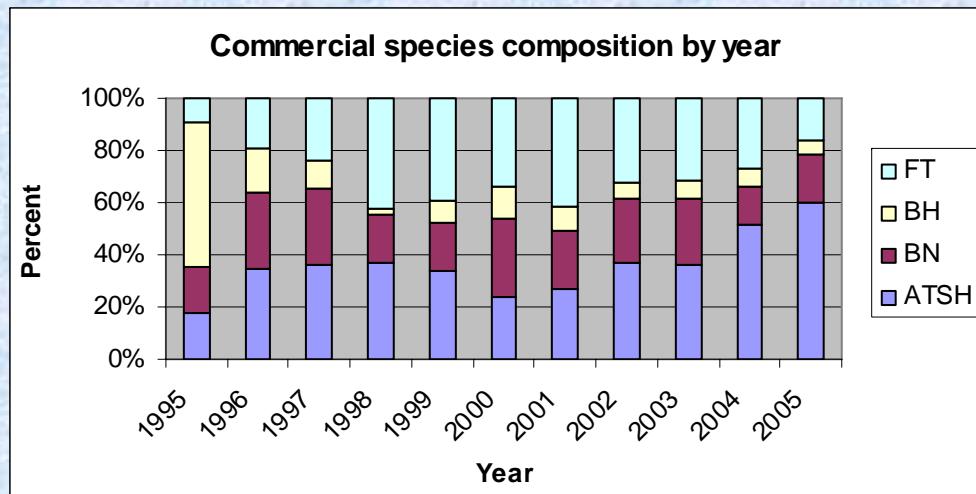
# Total Catches: Finetooth shark



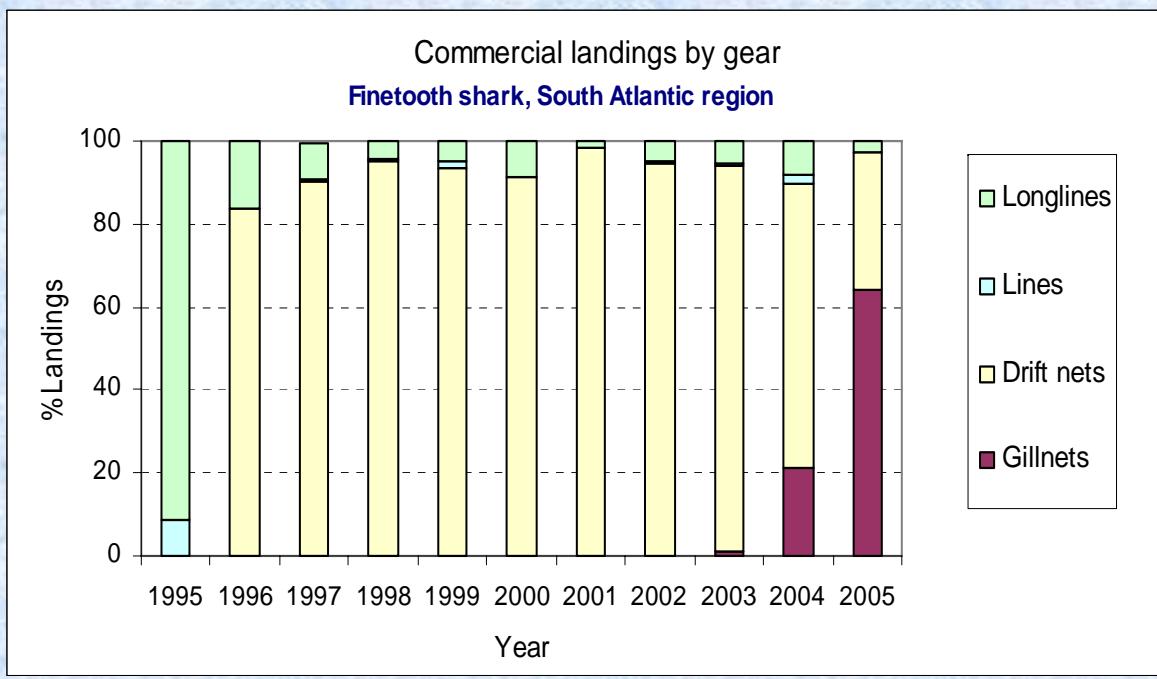
# Total Catches: Finetooth shark (relative)



# Species composition of the SCS complex by sector



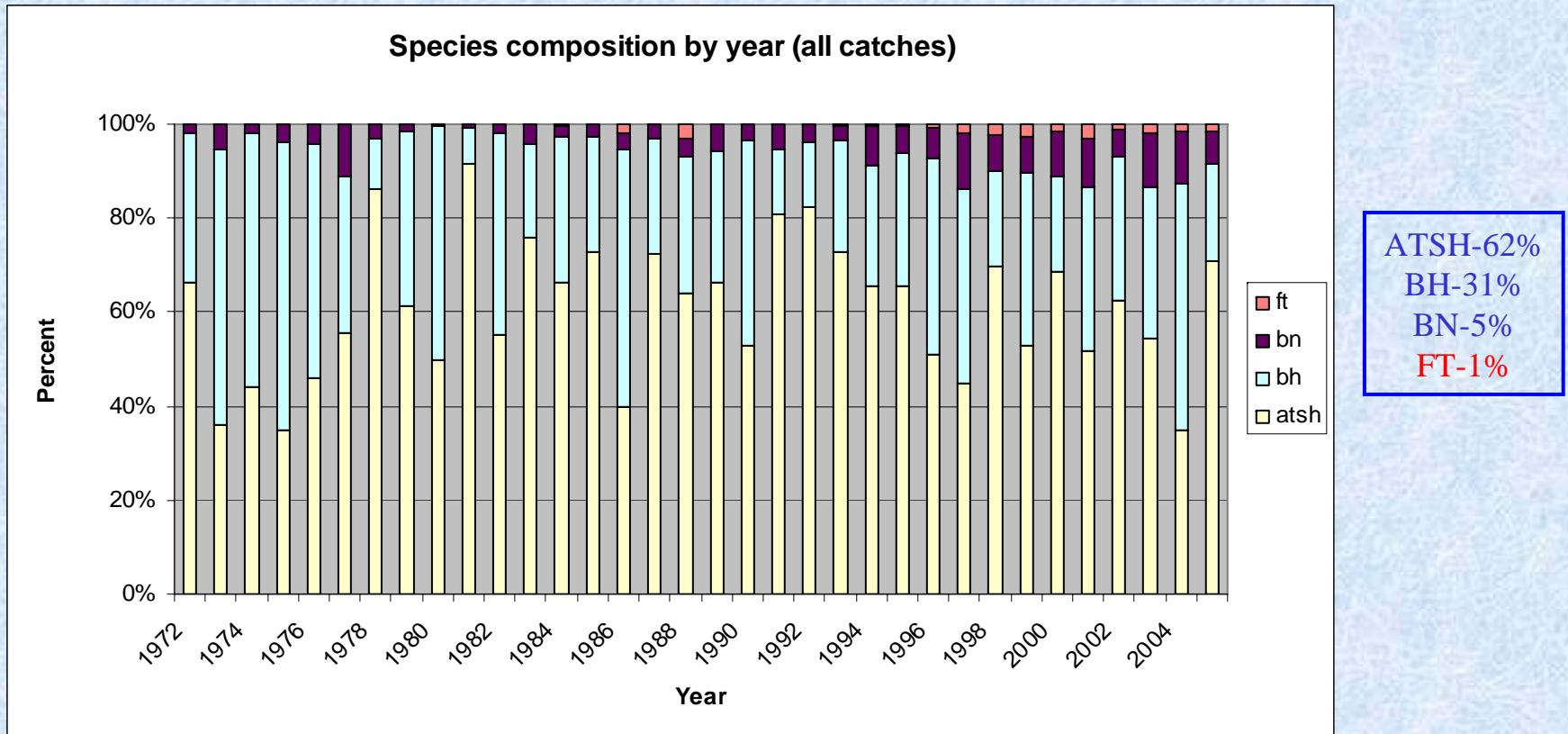
# Commercial landings of Finetooth sharks by region and gear type



Gear	(all years combined)
Other nets	0.004
Otter trawl	0.03
Gillnets	7.9
Drift nets	76.5
Lines	1.4
Longlines	14.2
Other	0.004

Year	SA	GOM
1995	100.0	0.0
1996	98.3	1.7
1997	99.4	0.6
1998	99.8	0.2
1999	98.7	1.3
2000	100.0	0.0
2001	99.8	0.2
2002	99.4	0.6
2003	98.1	1.9
2004	60.1	39.9
2005	90.3	9.7

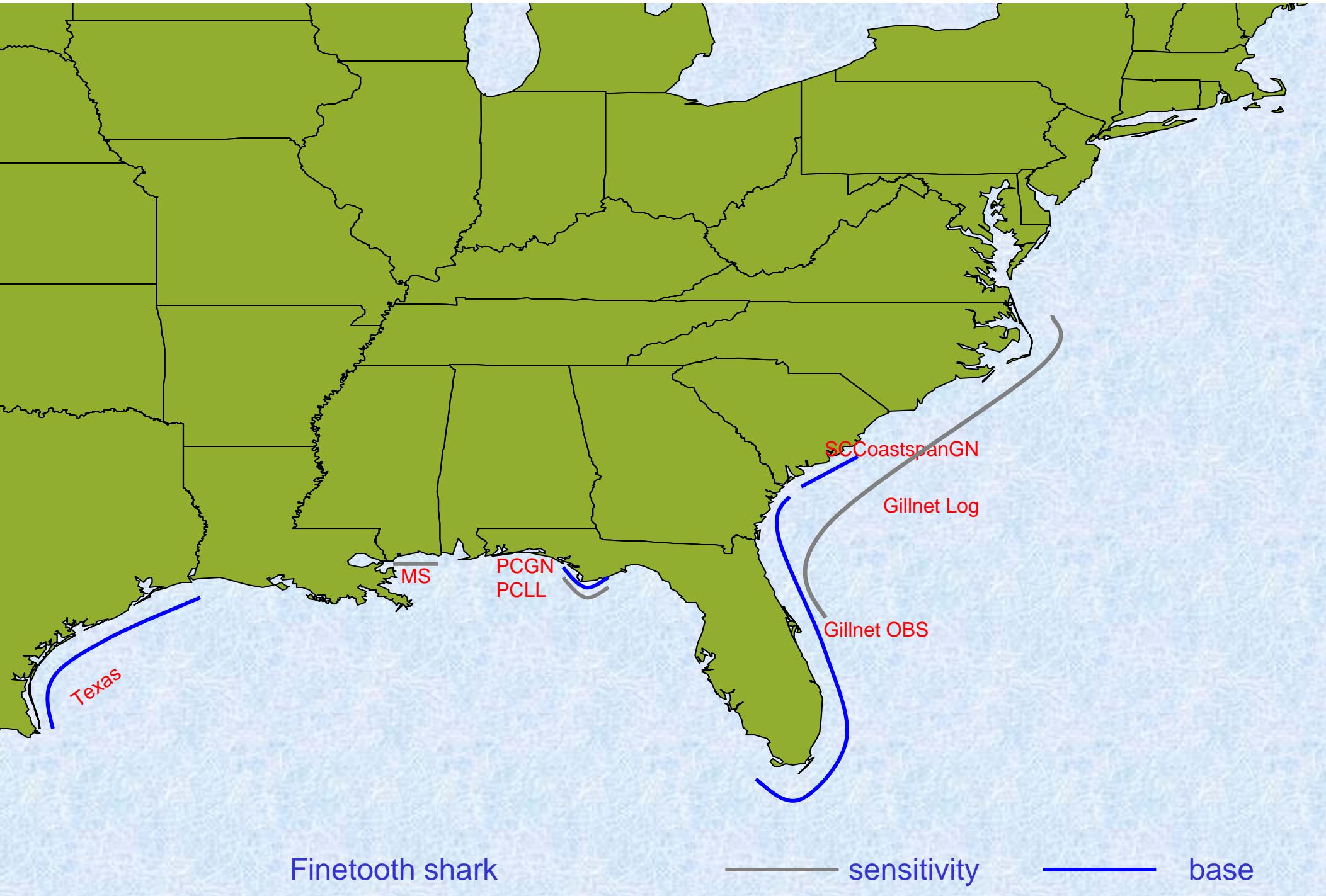
# Overall species composition of the SCS complex



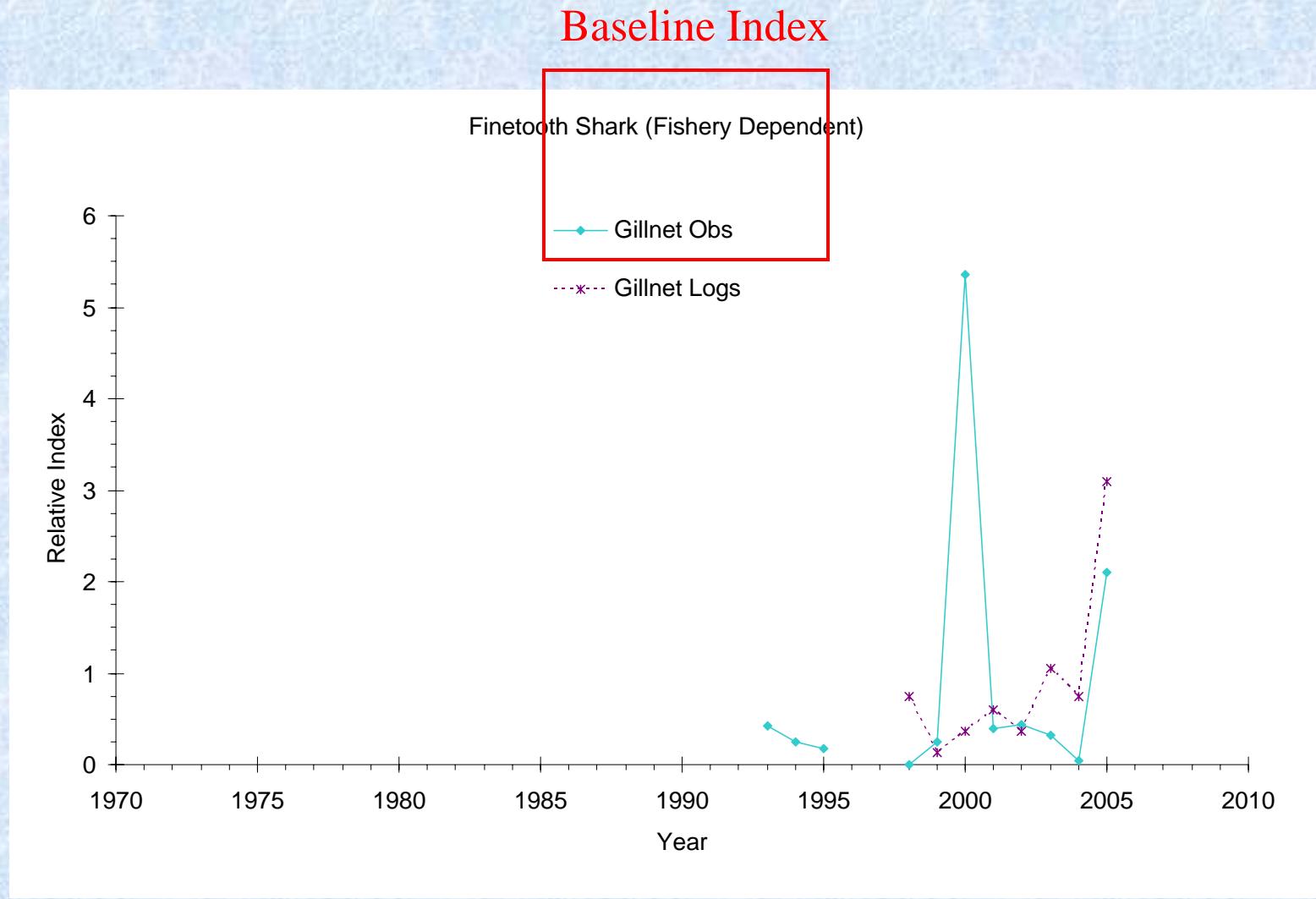
# CPUE series: SCS complex -Baseline

---

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

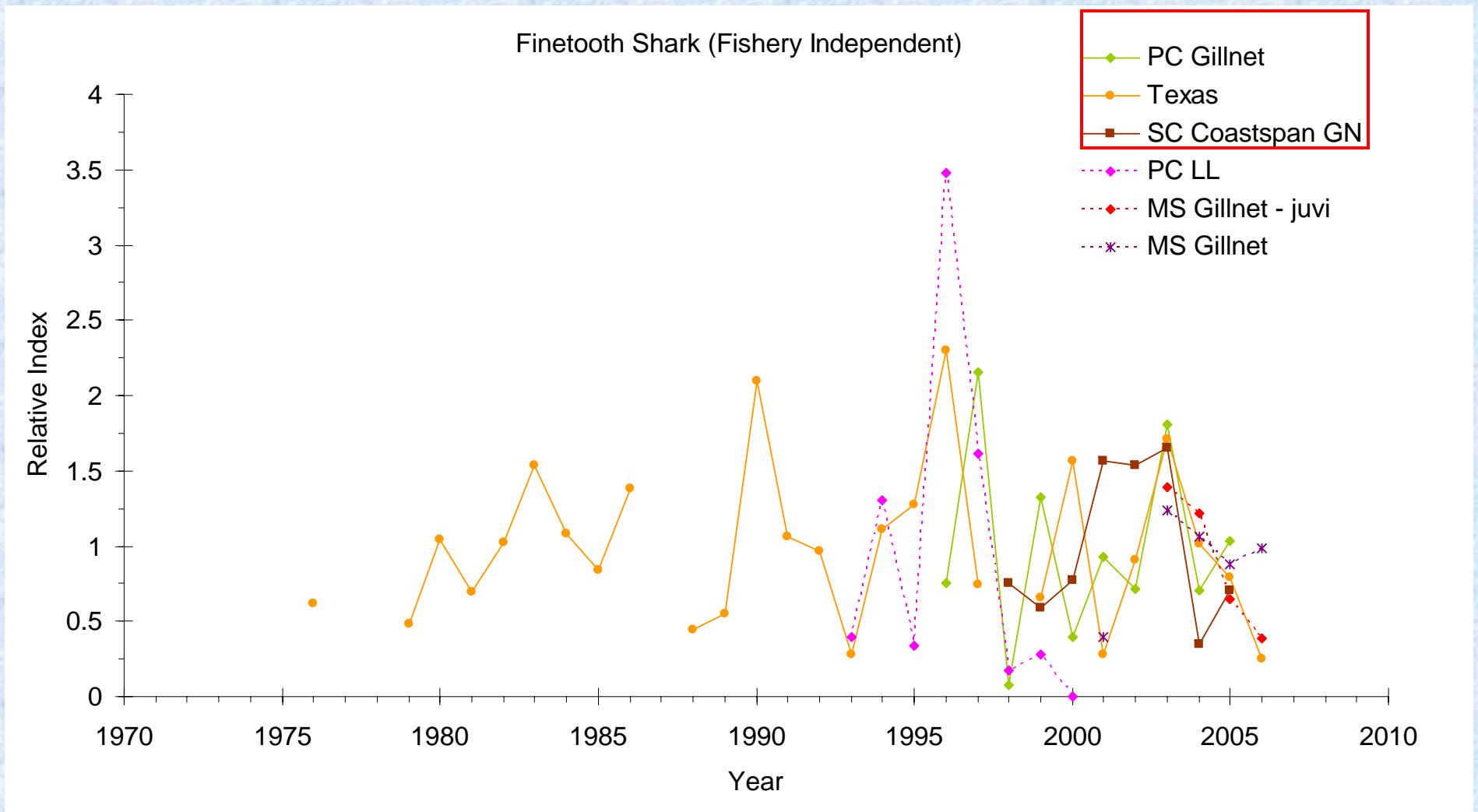


# CPUE series: Finetooth shark-Baseline (F-D)



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

## Baseline Indices

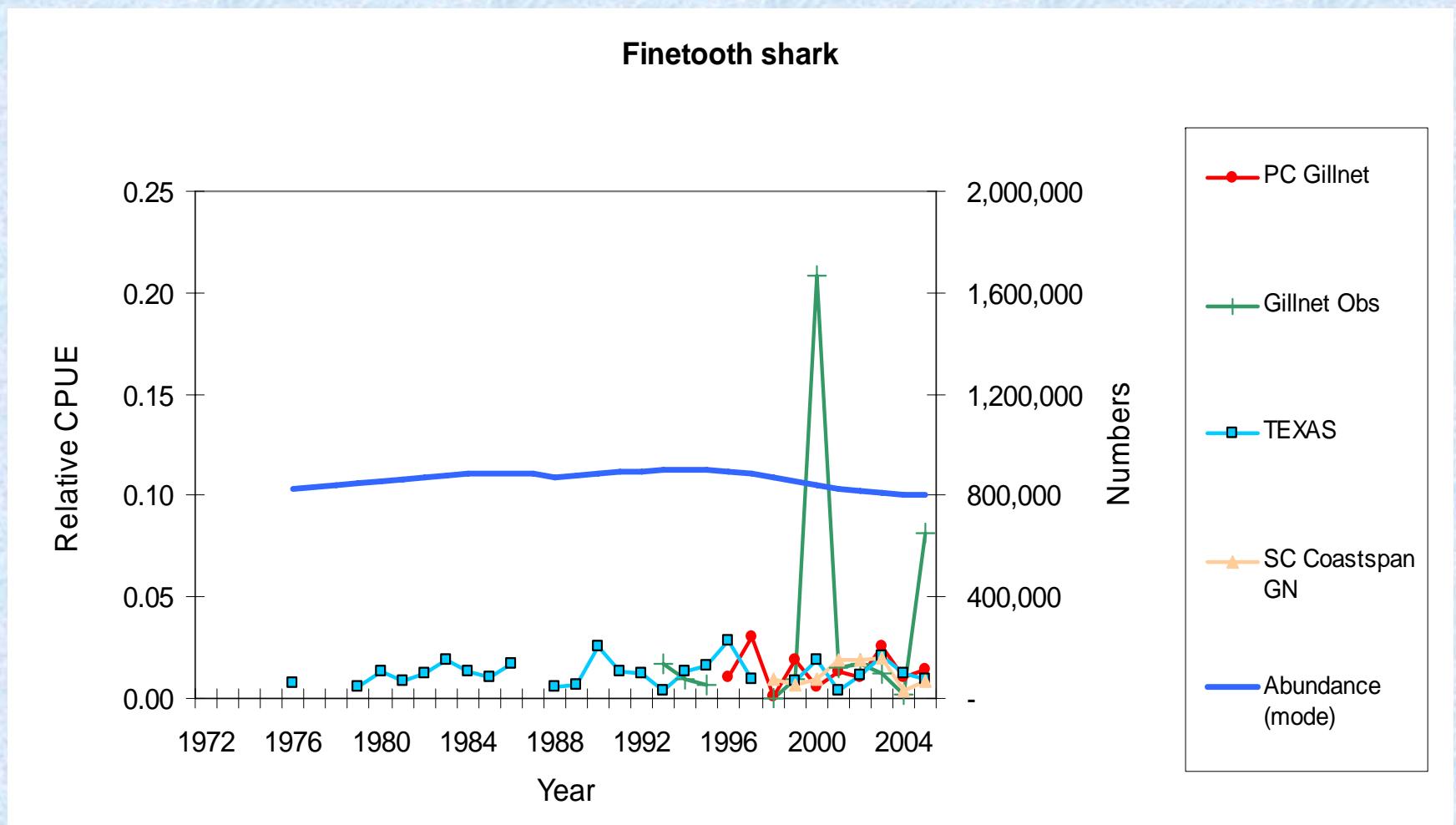


# Inputs-Priors for Finetooth shark-Baseline

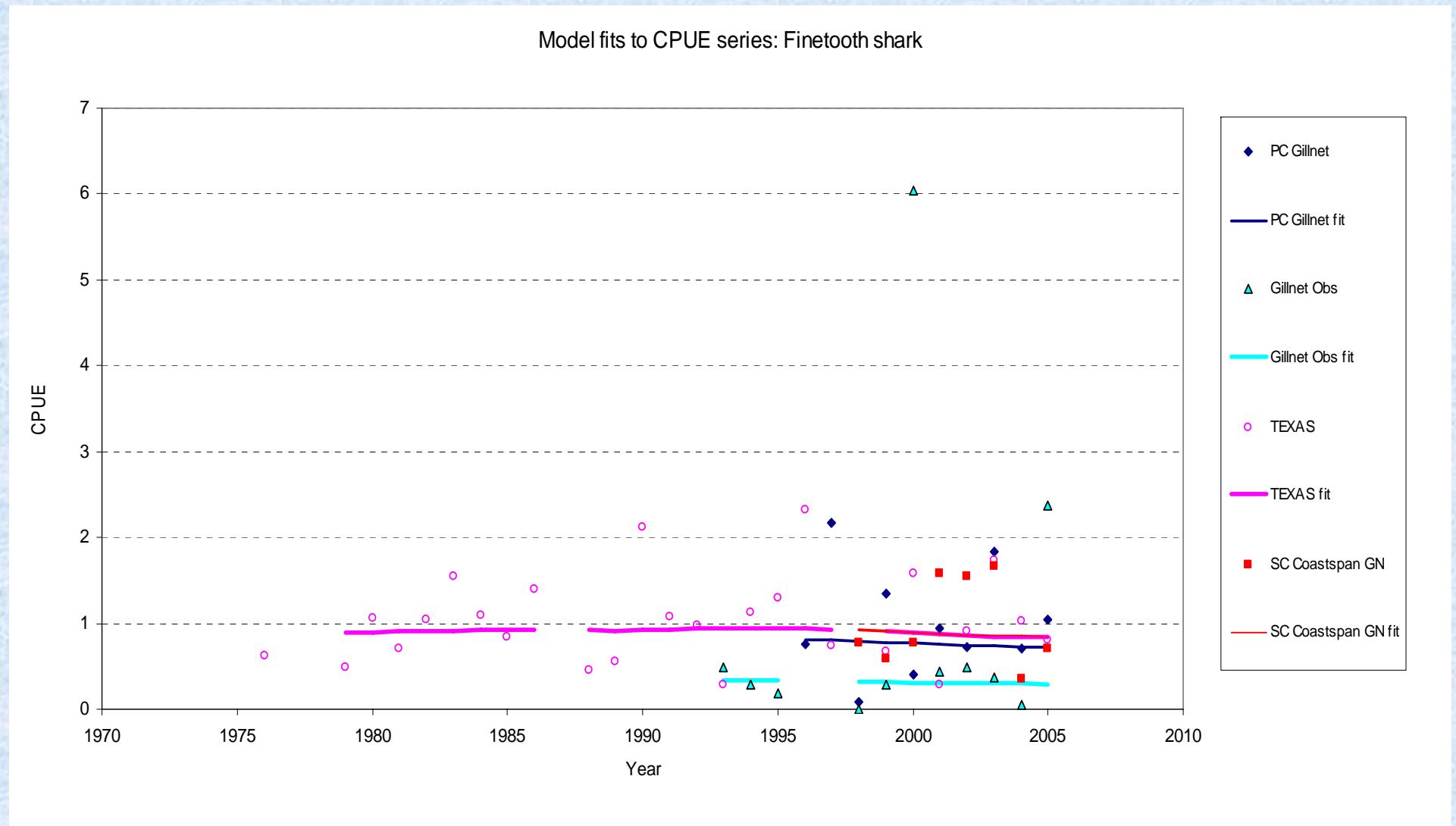
---

- Model starts in 1976 (first year of CPUE indices)
- Catch data available for 1983-2005
- 4 indices available
- $r \sim LN(0.06, 0.04, 0.001, 2.0)$  ← 2002 assessment value
- $K \sim U$  on  $\log K (10^4 - 2 \times 10^7)$
- $N_{72/K} \sim LN(0.9, 0.2, 0.2, 1.1)$
- $C_0 \sim LN(2774, 1)$  ← Mean (1983-1988)

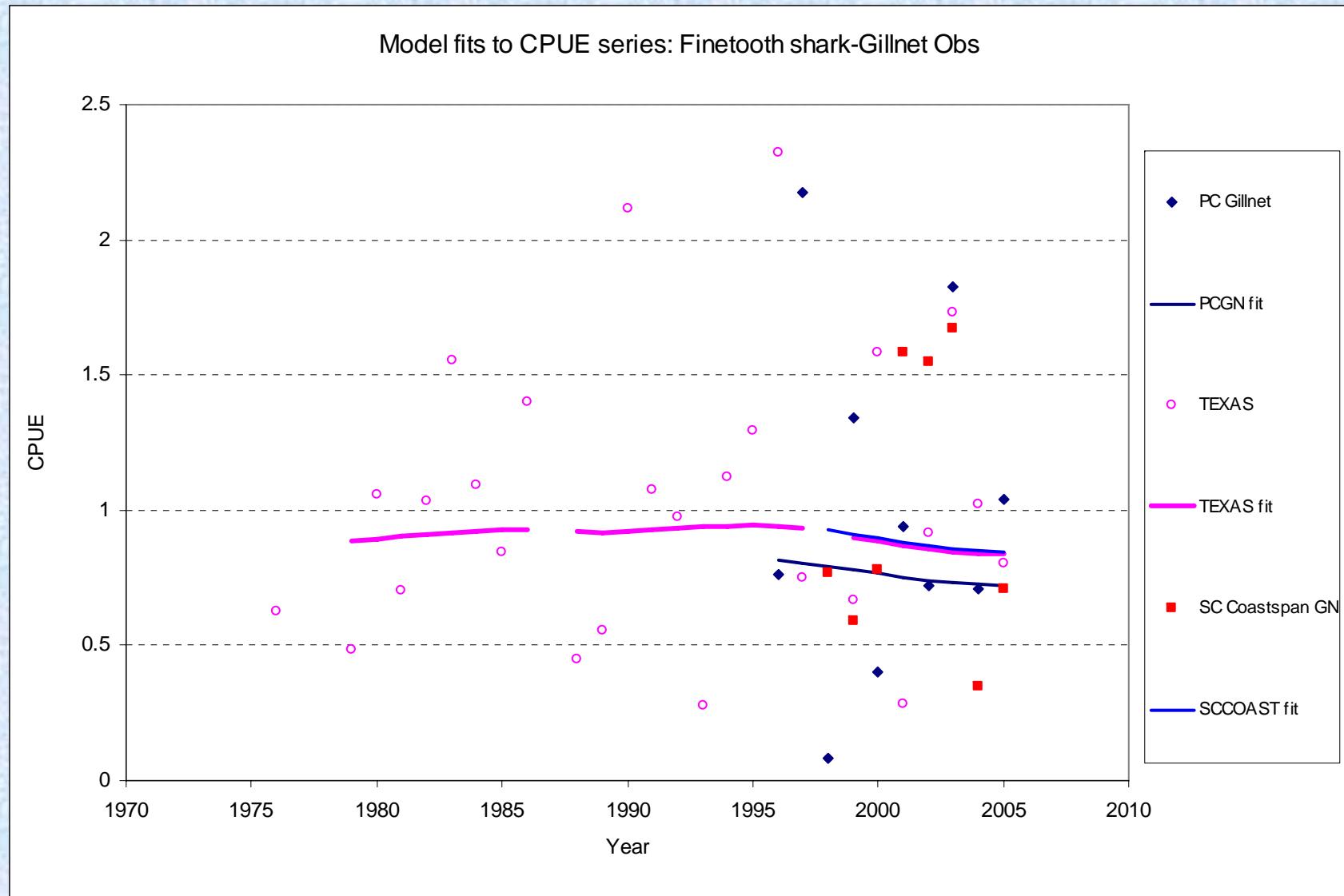
# SPM results for Finetooth shark-Baseline: Predicted abundance trend at posterior mode of the BSP model fitted to catch and CPUE data



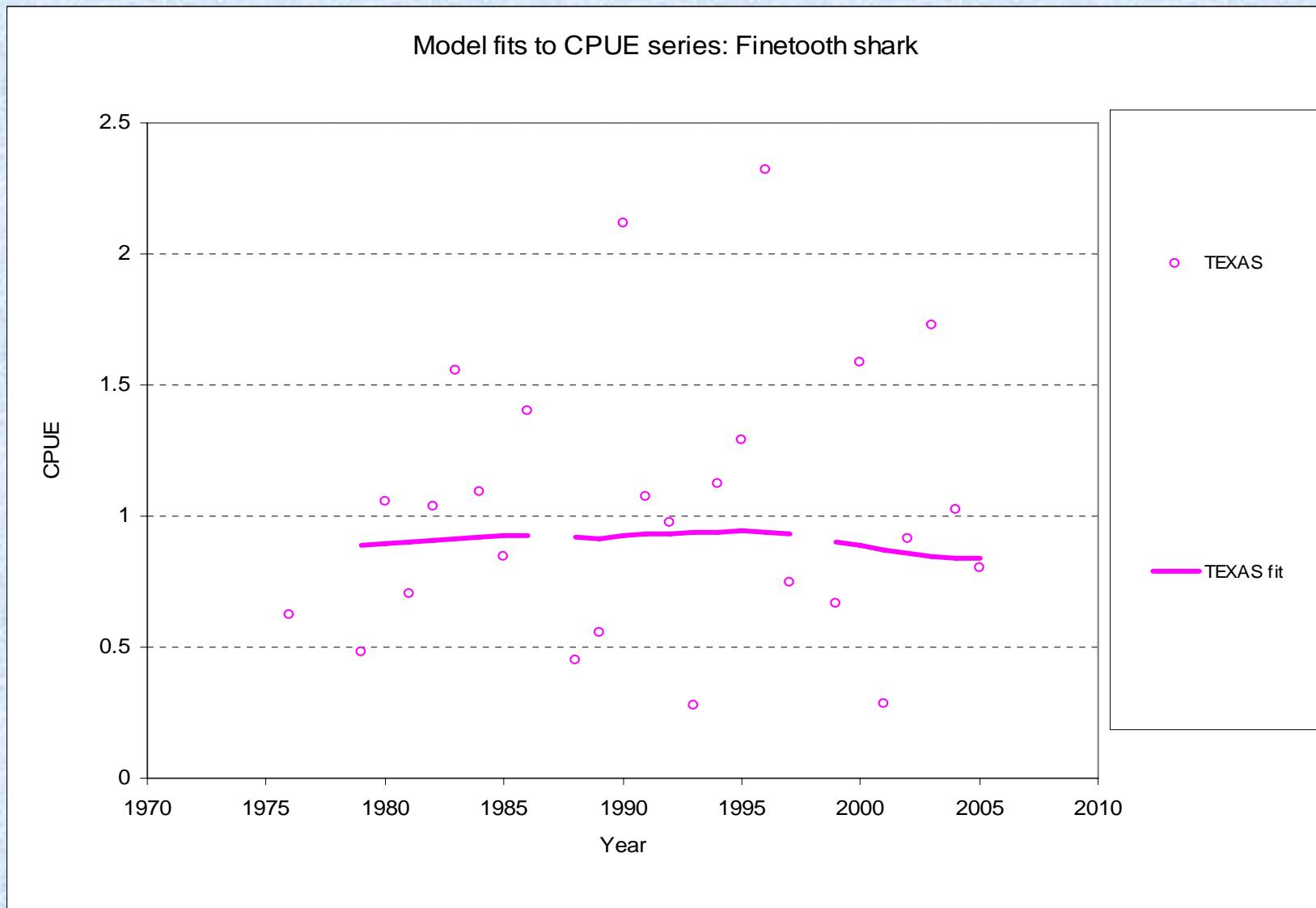
## SPM results for Finetooth shark-Baseline: Model fits to the individual CPUE series



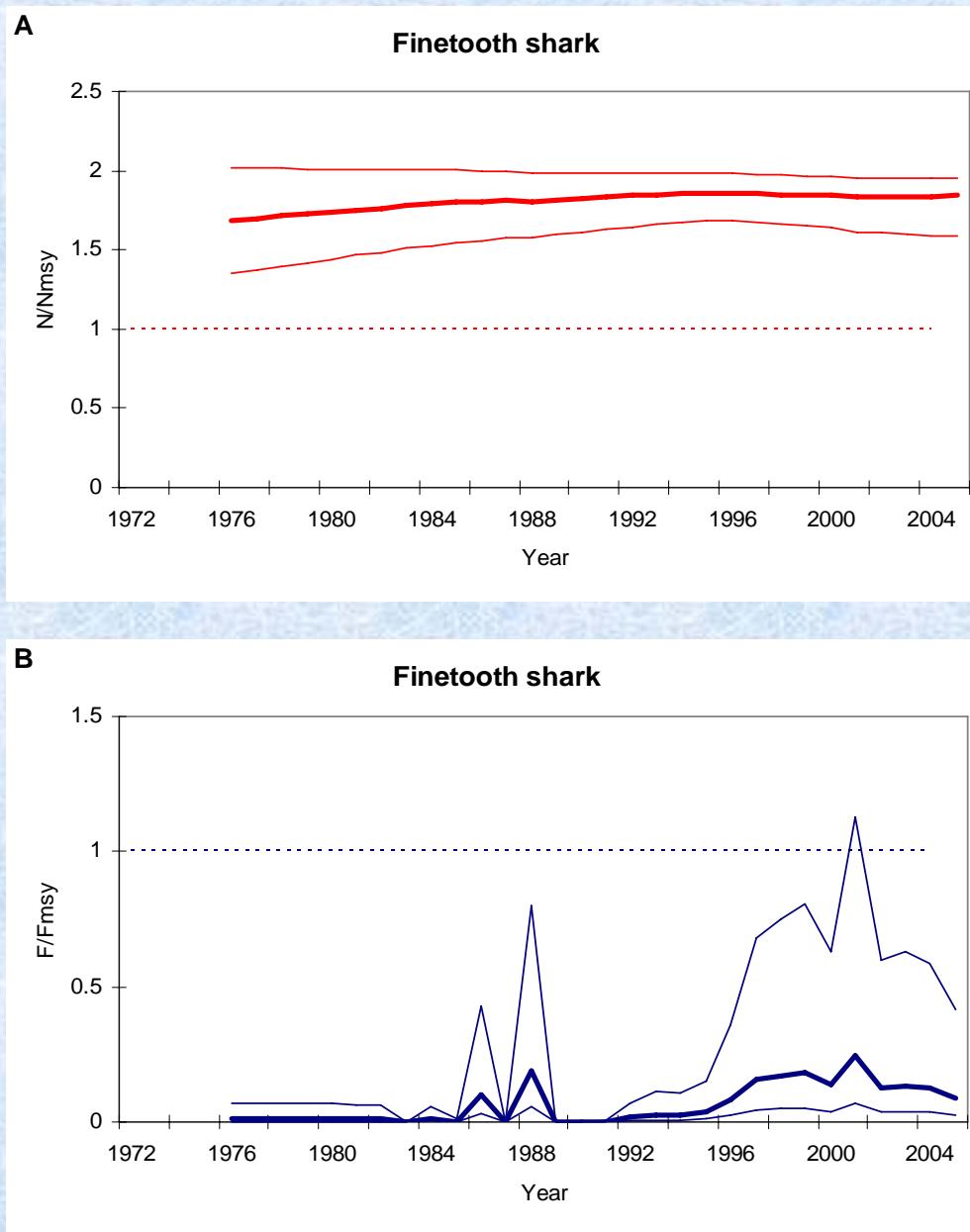
## SPM results for Finetooth shark-Baseline: Model fits to the individual CPUE series (-Gillnet Obs)



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



**SPM**  
**results for**  
**Finetooth**  
**shark-**  
**Baseline:**  
BSP  
estimated  
median  
relative  
abundance  
and fishing  
mortality  
rate  
trajectories  
(with 80%  
credibility  
intervals)



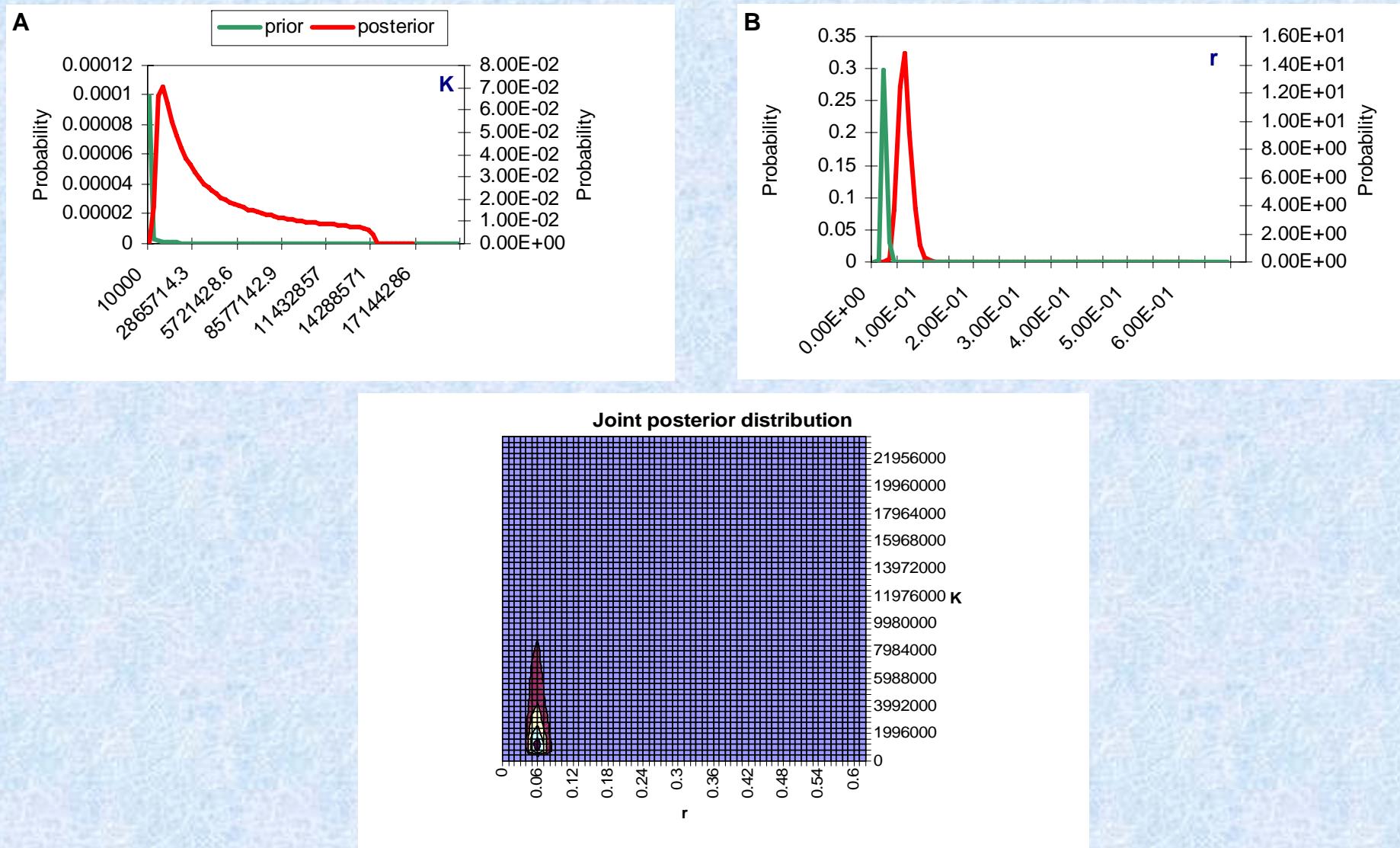
$N/N_{MSY}$

$F/F_{MSY}$

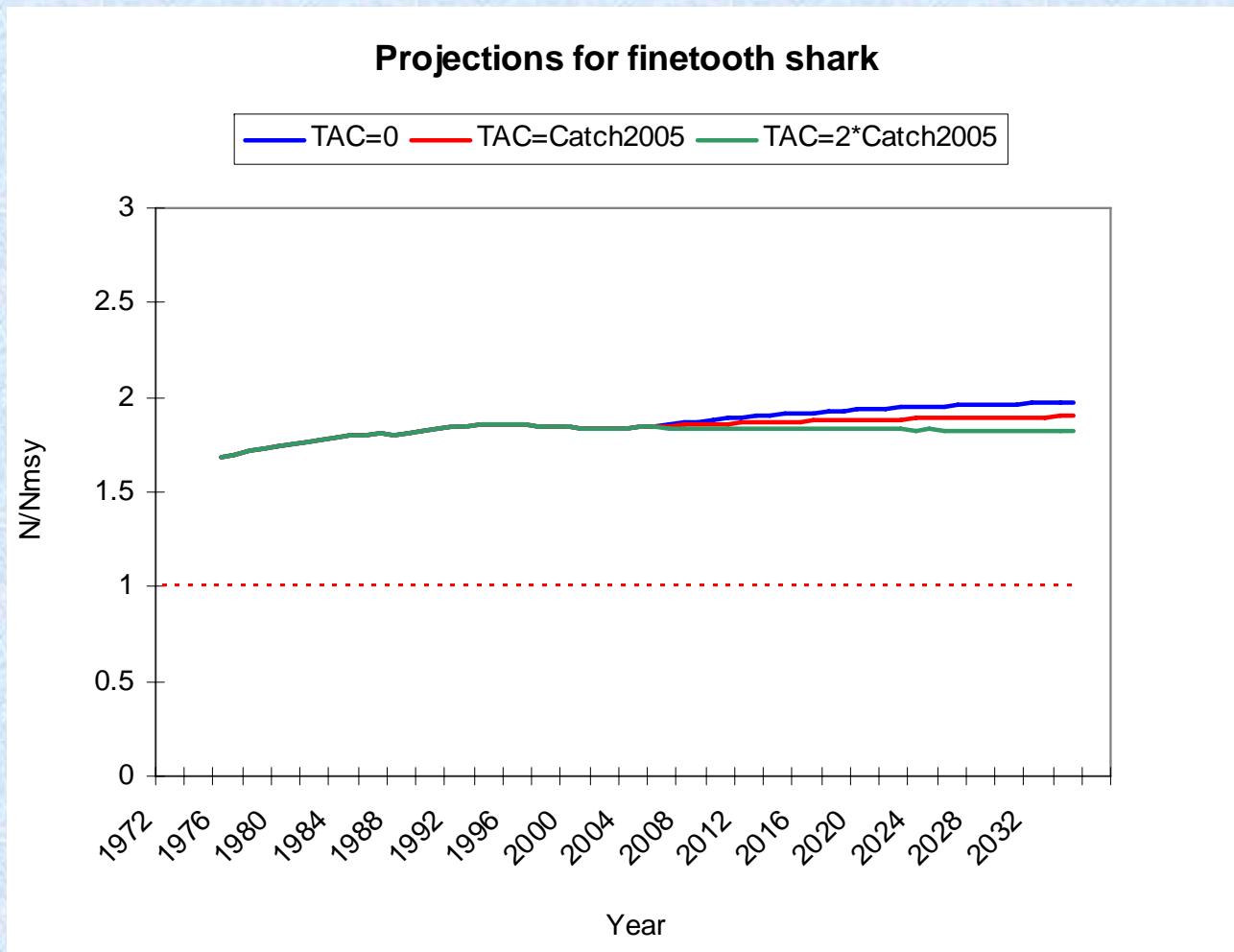
# Expected values of the mean and CV of marginal posterior distributions from the SPM for Finetooth shark-Baseline

	Finetooth	
	EV	CV
Importance function	priors	
K	6397	0.82
r	0.060	0.20
MSY	96	0.86
N <sub>2005</sub>	6000	0.84
N <sub>2005</sub> /K	<b>0.90</b>	0.08
N <sub>init</sub>	5380	0.84
N <sub>2005</sub> /N <sub>init</sub>	1.09	0.14
C <sub>2005</sub> /MSY	0.27	1.08
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.17</b>	1.32
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.80</b>	0.09
C <sub>2005</sub> /repy	0.78	81.34
N <sub>MSY</sub>	3199	0.82
F <sub>MSY</sub>	0.030	
repy	21	0.83
C <sub>0</sub>	2	0.69
<b>Diagnostics</b>		
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

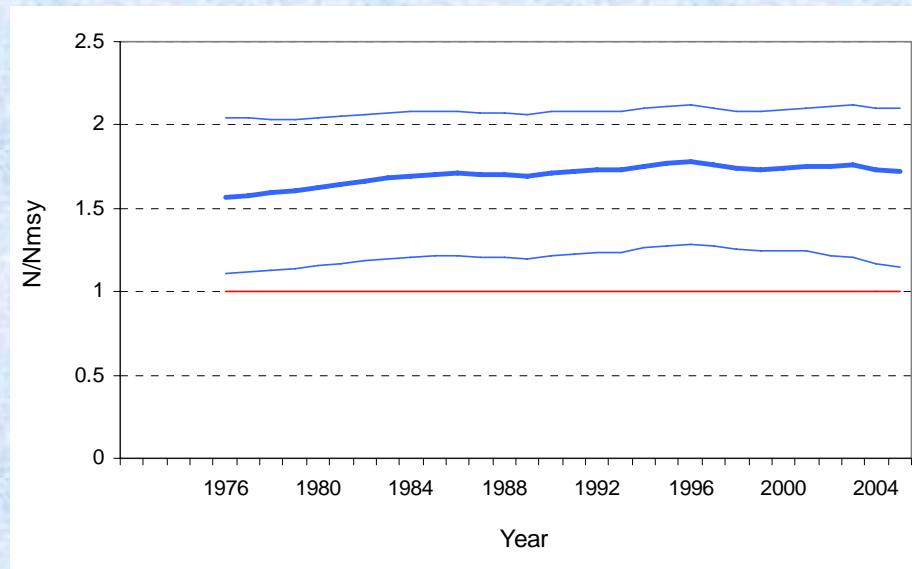


# Sensitivity Analyses

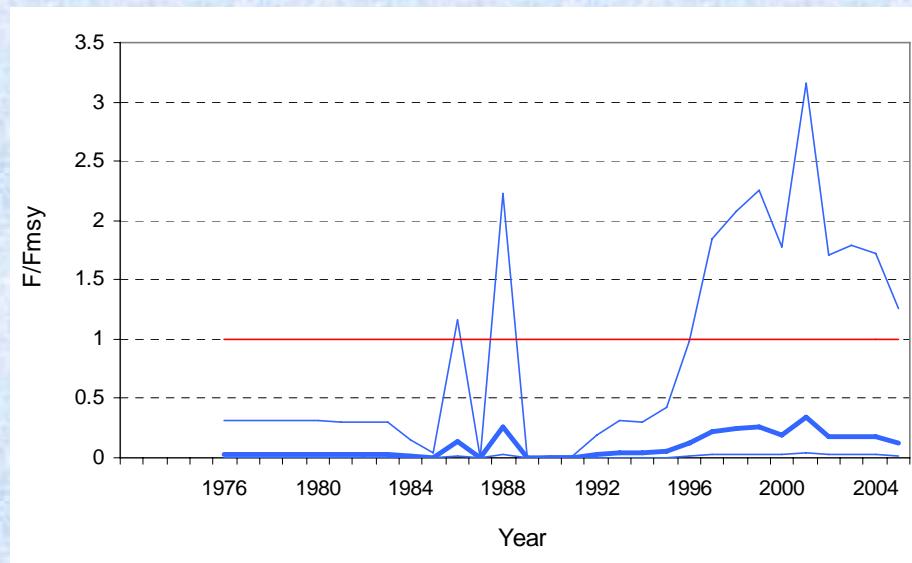
---

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

## Results for Finetooth shark: Estimated median relative abundance and fishing mortality rate trajectories of the WinBUGS SPM (with 95% credibility intervals )

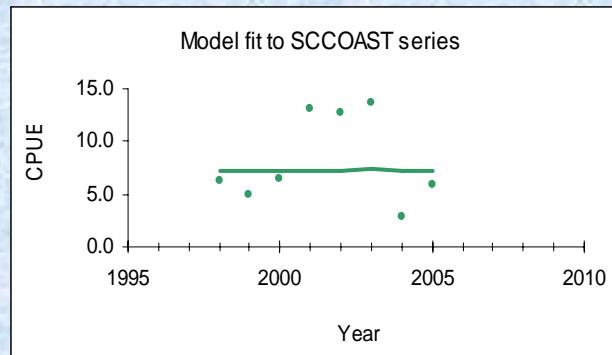
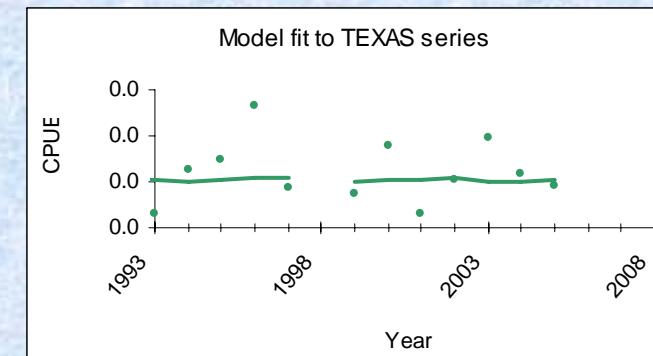
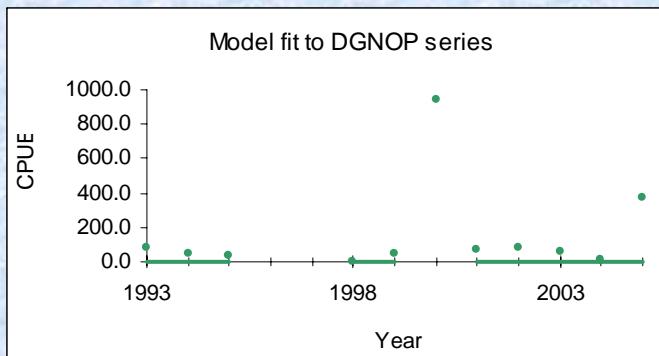
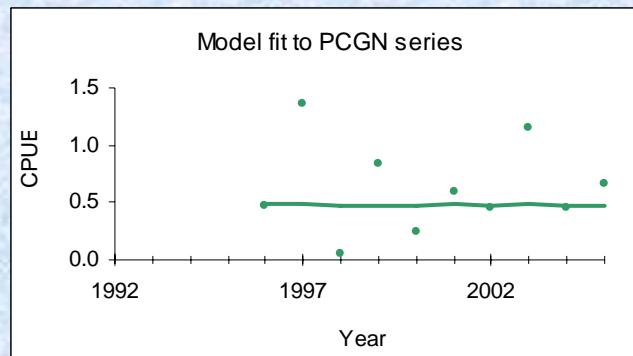


$N/N_{MSY}$



$F/F_{MSY}$

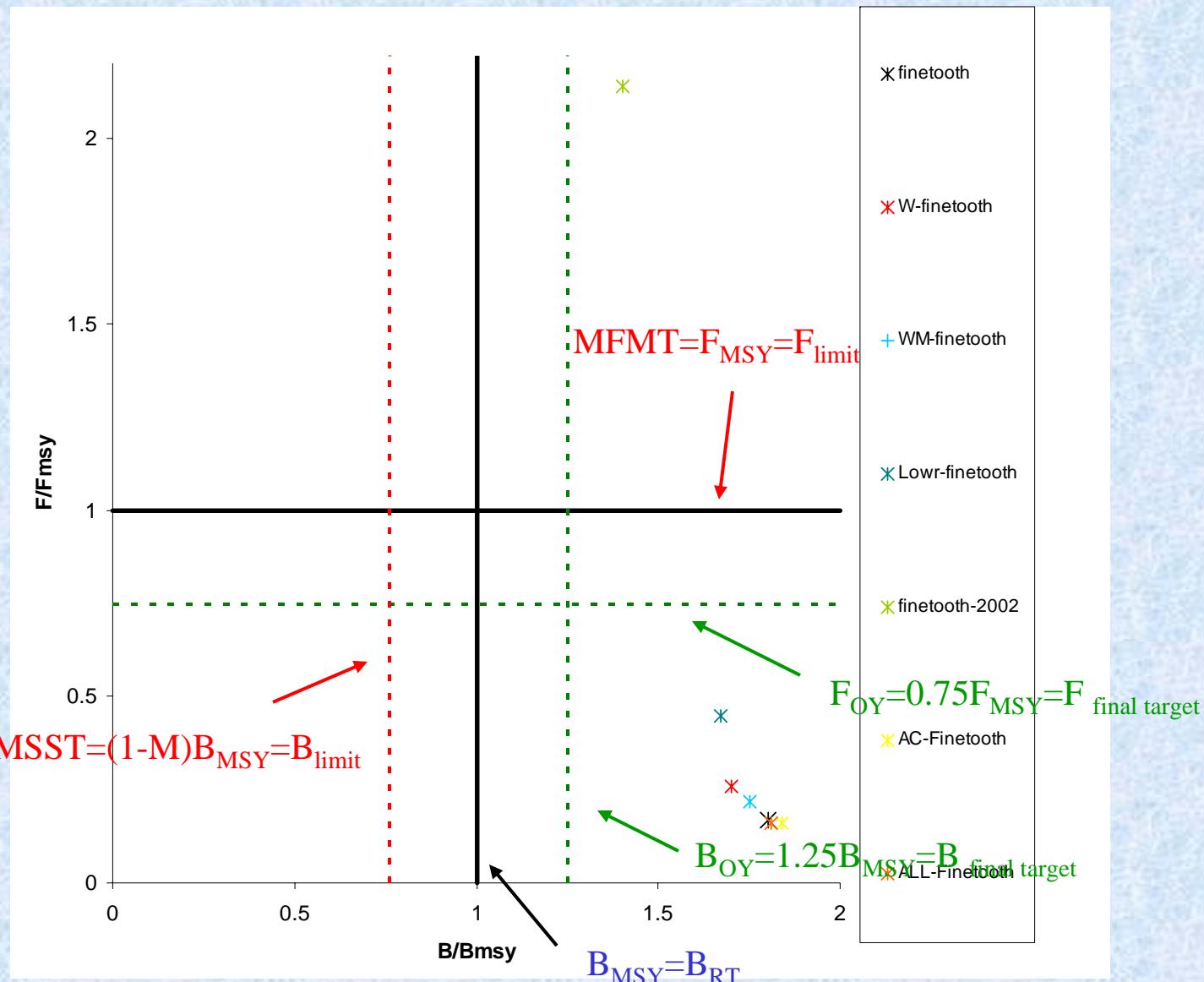
# Results for Finetooth shark: WinBUGS SPM model fits to the CPUE series



# Expected values of the mean and CV of marginal posterior distributions from the BSP for Finetooth shark-Sensitivities

	Inverse CV		Alternative catch		All cpue series		Lower r	
	EV	CV	EV	CV	EV	CV	EV	CV
Importance function	priors		priors		priors		priors	
K	5950	0.88	6466	0.81	6518	0.81	6949	0.76
r	0.061	0.20	0.060	0.20	0.060	0.20	0.020	0.20
MSY	91	0.92	97	0.85	97	0.85	35	0.80
N <sub>2005</sub>	5496	0.91	6217	0.84	6113	0.83	6031	0.79
$N_{2005}/K$	<b>0.87</b>	0.12	<b>0.92</b>	0.08	<b>0.90</b>	0.08	<b>0.83</b>	0.13
N <sub>init</sub>	4692	0.91	5494	0.83	5469	0.83	5836	0.78
N <sub>2005</sub> /N <sub>init</sub>	1.13	0.17	1.11	0.17	1.10	0.14	1.00	0.10
C <sub>2005</sub> /MSY	0.33	1.15	0.26	1.05	0.26	1.06	0.67	1.04
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.22</b>	1.60	<b>0.16</b>	1.29	<b>0.16</b>	1.27	<b>0.45</b>	1.26
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.75</b>	0.12	<b>1.84</b>	0.08	<b>1.81</b>	0.08	<b>1.67</b>	0.13
C <sub>2005</sub> /rep <sub>y</sub>	0.71	59.22	0.87	0.29	0.76	82.85	1.18	68.60
N <sub>MSY</sub>	2974	0.88	3233	0.81	3259	0.81	3474	0.76
F <sub>MSY</sub>	0.031		0.030		0.030		0.010	
rep <sub>y</sub>	24	0.84	13	0.37	22	0.83	15	0.99
C <sub>0</sub>	1.7	0.69			2.0	0.69	1.7	0.69
<b>Diagnostics</b>								
CW (wt)	0.823		0.558		0.637		0.654	
CV (L*prior)	1.207		0.944		1.167		1.124	
CV (Wt) / CV (L*p)	0.682		0.591		0.546		0.582	
%maxpWt	0.002		0.000		0.001		0.001	

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



# Conclusions

---

- Represent only 1% of total SCS catches (mostly caught in gillnets)
- Only 4 CPUE series available and none shows a clear trend: model interprets this as little depletion
- Species is closer to other large coastal sharks in life history traits
- Results to be viewed cautiously

# ADDITIONAL SLIDES

---

# 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 Coastsnap GN, SCDNR red drum, SEAMAP-GOM-S, SEAMAP-GOM-F, UNC, MML Gillnet (13)

→ 5 series in common, 8 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

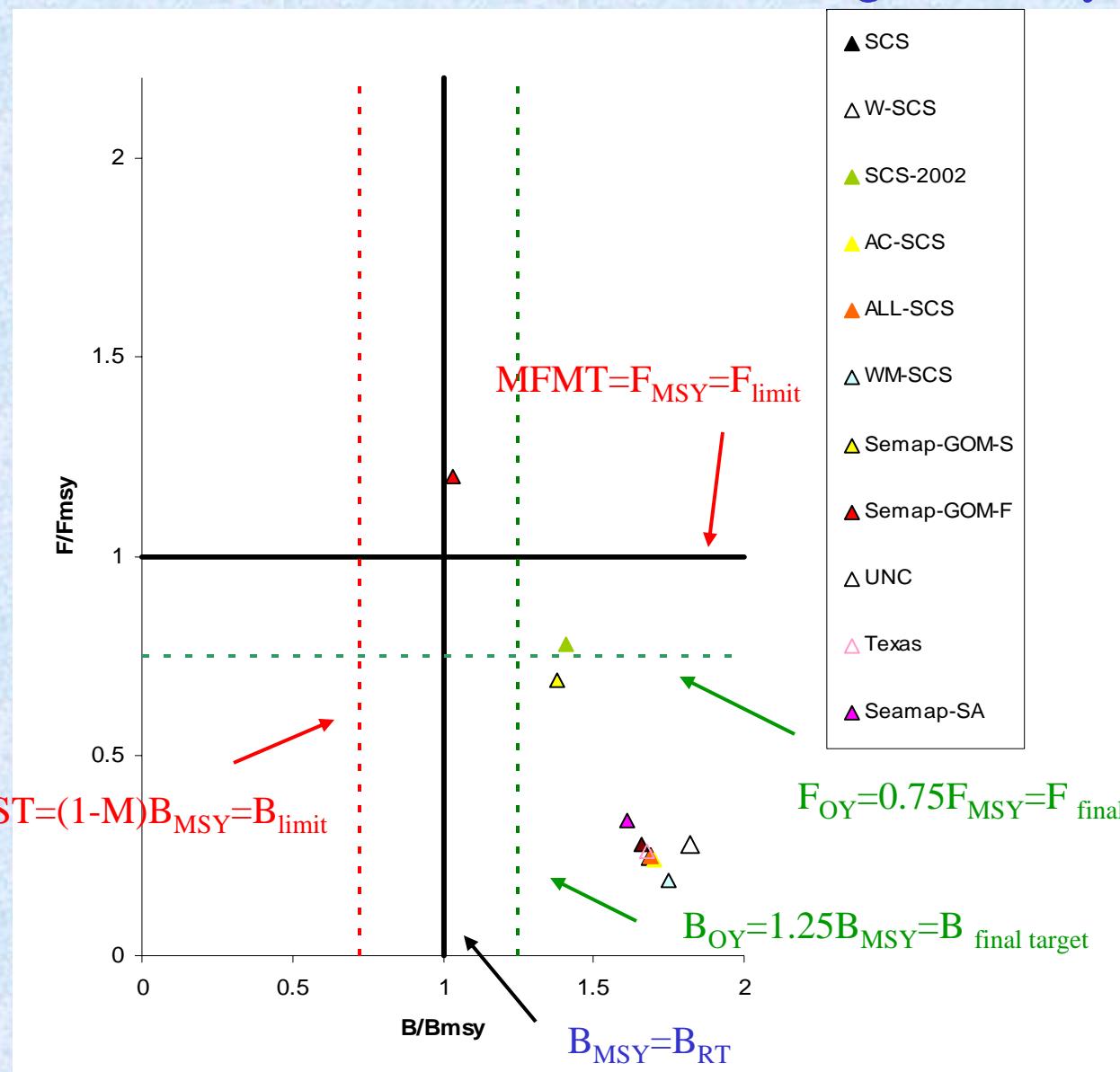
# Expected values of the mean and CV of marginal posterior distributions from the BSP for SCS complex-Sensitivities to individual CPUE series

	baseline		seamap-gom-S		seamap-gom-F		UNC		Texas		Seamap-SA	
	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
Importance function	priors		priors		priors		priors		priors		priors	
K	59566	0.35	43487	0.52	29506	0.51	57029	0.39	59347	0.37	53417	0.42
r	0.181	0.32	0.171	0.33	0.158	0.32	0.182	0.32	0.182	0.32	0.179	0.32
MSY	2623	0.45	1831	0.64	1124	0.61	2506	0.47	2624	0.46	2335	0.52
N <sub>2005</sub>	51605	0.40	33614	0.72	17457	0.93	48892	0.45	51310	0.43	44983	0.51
N <sub>2005</sub> /K	<b>0.85</b>	0.09	<b>0.69</b>	0.30	<b>0.52</b>	0.39	<b>0.83</b>	0.12	<b>0.84</b>	0.11	<b>0.80</b>	0.16
N <sub>init</sub>	53057	0.38	37466	0.55	26475	0.56	46815	0.43	48199	0.41	45256	0.45
N <sub>2005</sub> /N <sub>init</sub>	0.97	0.13	0.82	0.32	0.58	0.37	1.04	0.17	1.06	0.18	0.97	0.21
C <sub>2005</sub> /MSY	0.40	0.42	0.66	0.50	0.93	0.31	0.43	0.44	0.41	0.44	0.48	0.48
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.25</b>	0.55	<b>0.69</b>	1.19	<b>1.20</b>	0.75	<b>0.28</b>	0.64	<b>0.26</b>	0.63	<b>0.34</b>	0.81
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.69</b>	0.09	<b>1.38</b>	0.30	<b>1.03</b>	0.39	<b>1.66</b>	0.12	<b>1.68</b>	0.11	<b>1.61</b>	0.16
C <sub>2005</sub> /rep	0.79	0.05	0.92	0.31	1.10	0.31	0.78	0.06	0.78	0.06	0.81	0.11
N <sub>MSY</sub>	29783	0.35	21744	0.52	14753	0.51	28515	0.39	29674	0.37	26708	0.42
F <sub>MSY</sub>	0.091		0.086		0.079		0.091		0.091		0.090	
rep	1125	0.05	1009	0.18	861	0.23	1129	0.05	1135	0.05	1104	0.08
C <sub>0</sub>												
<b>Diagnostics</b>												
CW (wt)	0.786		0.335		1.475		0.645		0.753		0.394	
CV (L*prior)	0.902		1.011		1.973		0.776		0.785		0.664	
CV (Wt) / CV (L*p)	0.87		0.33		0.75		0.83		0.96		0.59	
%maxpWt	0.002		0.001		0.006		0.003		0.004		0.001	

# Expected values of the mean and CV of marginal posterior distributions from the BSP for SCS complex-Sensitivities to assumptions about r and K

	baseline		larger SD for r		K ~ U (K)		larger SD for r, r halved		larger SD for r, K halved	
	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
Importance function	priors		priors		priors		priors		priors	
K	59566	0.35	58243	0.40	66788	0.30	66167	0.32	33290	0.32
r	0.181	0.32	0.279	0.90	0.176	0.32	0.159	0.92	0.383	0.75
MSY	2623	0.45	3491	0.93	2898	0.43	2290	0.84	2833	0.71
N <sub>2005</sub>	51605	0.40	49987	0.44	58793	0.34	53194	0.36	27844	0.35
N <sub>2005</sub> /K	<b>0.85</b>	0.09	<b>0.85</b>	0.11	<b>0.87</b>	0.08	<b>0.80</b>	0.13	<b>0.84</b>	0.12
N <sub>init</sub>	53057	0.38	51510	0.42	59671	0.33	57264	0.35	29249	0.34
N <sub>2005</sub> /N <sub>init</sub>	0.97	0.13	0.97	0.13	0.98	0.13	0.93	0.14	0.96	0.13
C <sub>2005</sub> /MSY	0.40	0.42	0.41	0.63	0.36	0.42	0.57	0.62	0.43	0.49
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.25</b>	0.55	<b>0.26</b>	0.80	<b>0.22</b>	0.55	<b>0.39</b>	0.80	<b>0.28</b>	0.65
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.69</b>	0.09	<b>1.70</b>	0.11	<b>1.73</b>	0.08	<b>1.60</b>	0.13	<b>1.67</b>	0.12
C <sub>2005</sub> /rep <sub>y</sub>	0.79	0.05	0.81	0.16	0.78	0.05	0.90	0.29	0.78	0.08
N <sub>MSY</sub>	29783	0.35	29121	0.40	33394	0.30	33083	0.32	16645	0.32
F <sub>MSY</sub>	0.091		0.140		0.088		0.079		0.191	
rep <sub>y</sub>	1125	0.05	1111	0.11	1129	0.05	1032	0.16	1144	0.08
C <sub>0</sub>										
<b>Diagnostics</b>										
CW (wt)	0.786		0.884		0.604		1.157		1.157	
CV (L*prior)	0.902		1.086		0.815		1.326		1.317	
CV (Wt) / CV (L*p)	0.87		0.81		0.74		0.87		0.88	
%maxpWt	0.002		0.002		0.0003		0.004		0.005	

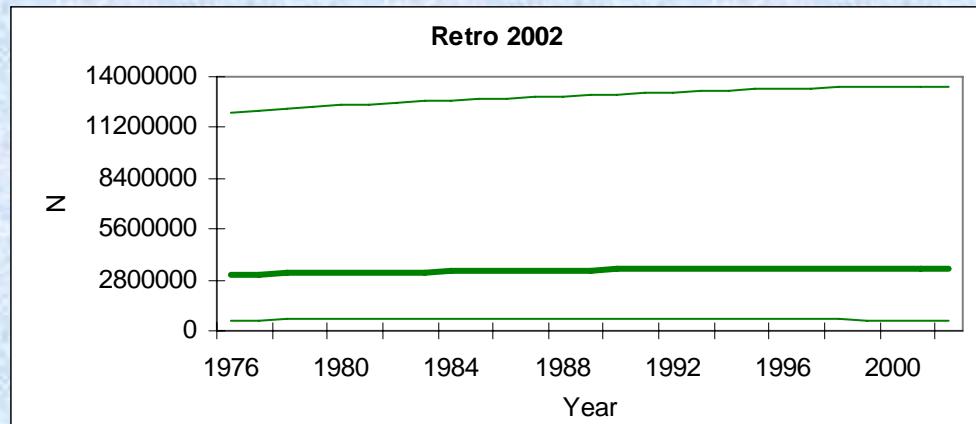
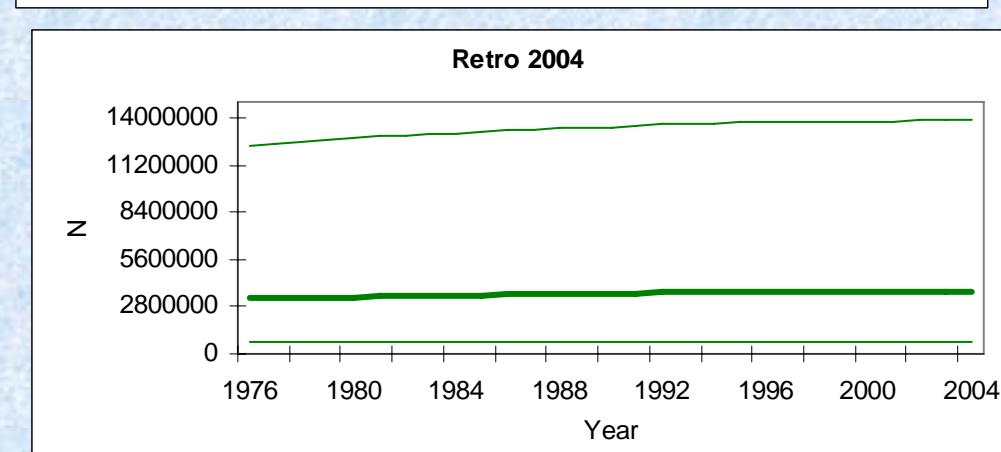
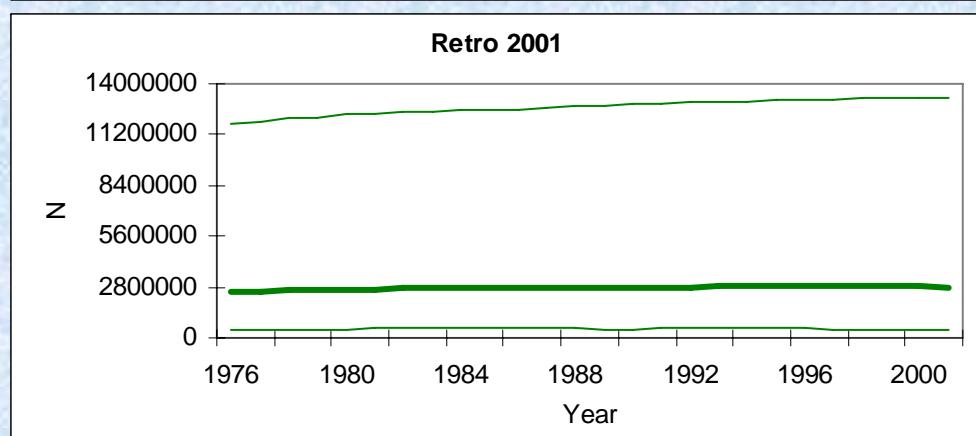
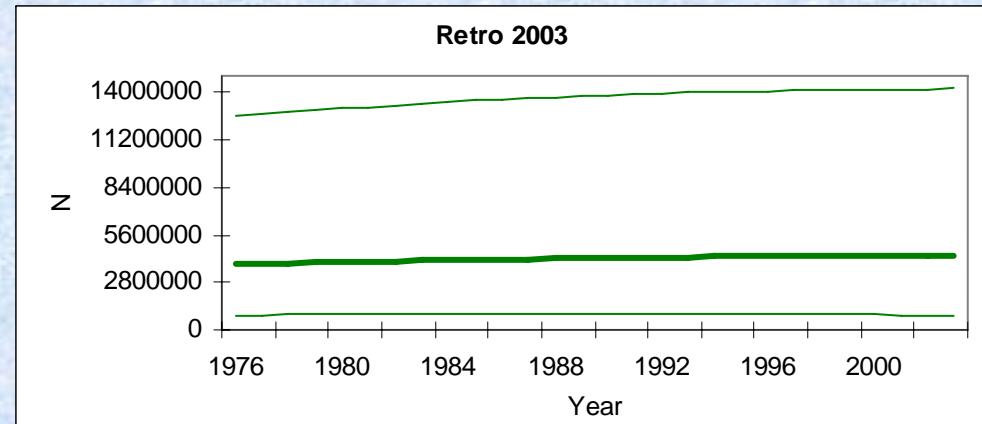
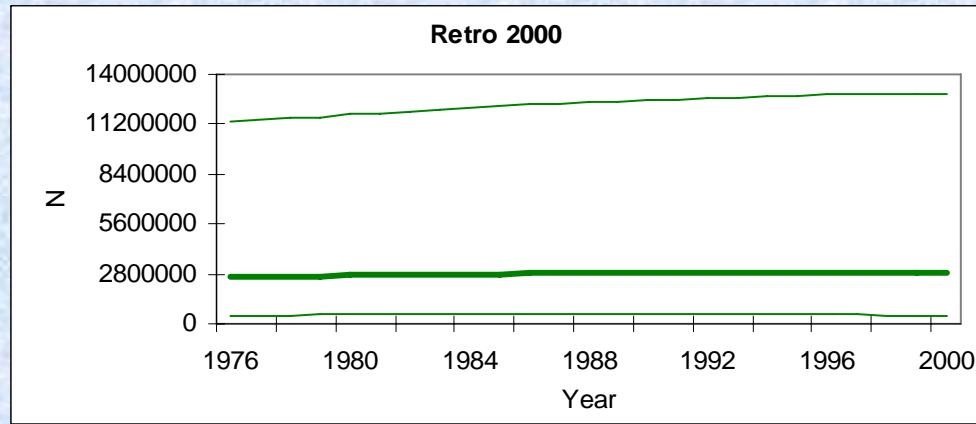
## Results for SCS complex: Biological reference points (phase plot of relative biomass vs. relative fishing mortality)



# Expected values of the mean and CV of marginal posterior distributions from the BSP for Finetooth shark-Retrospective analyses

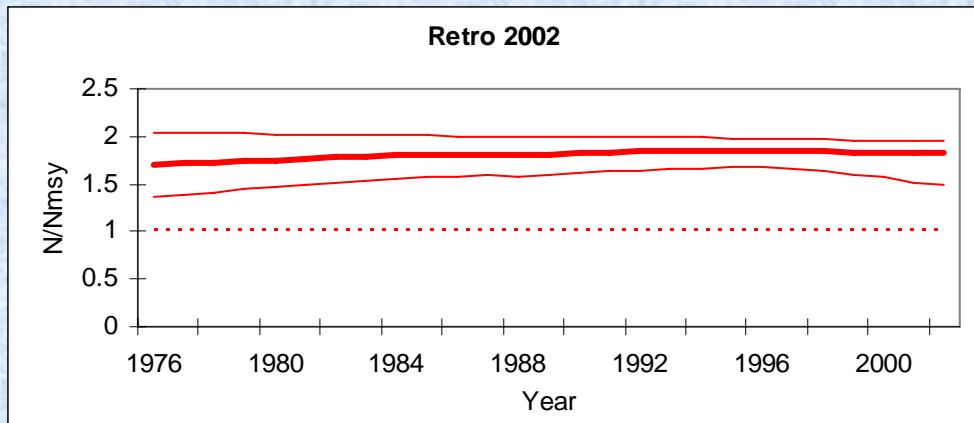
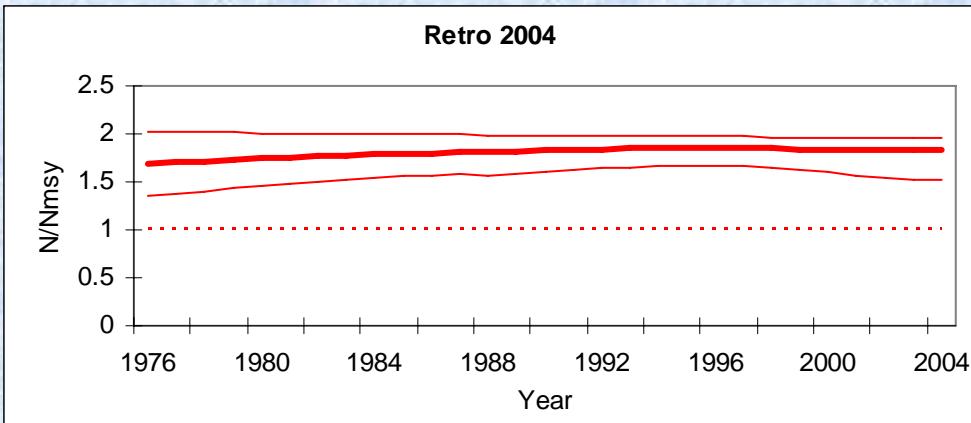
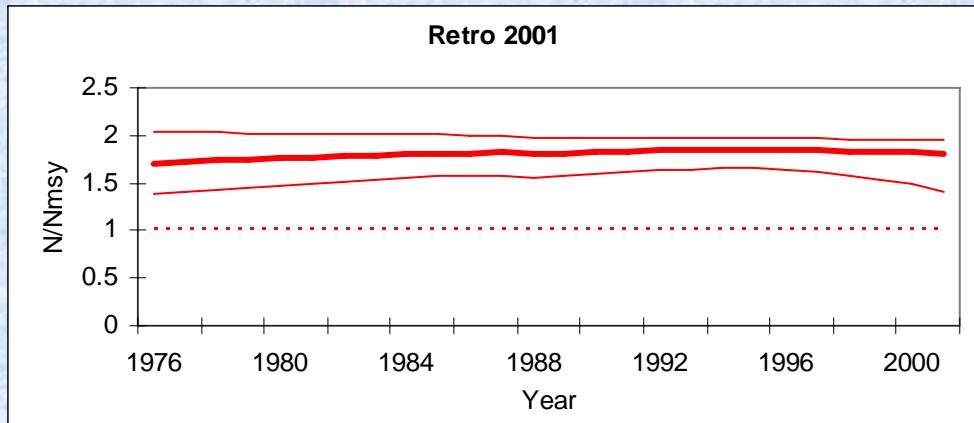
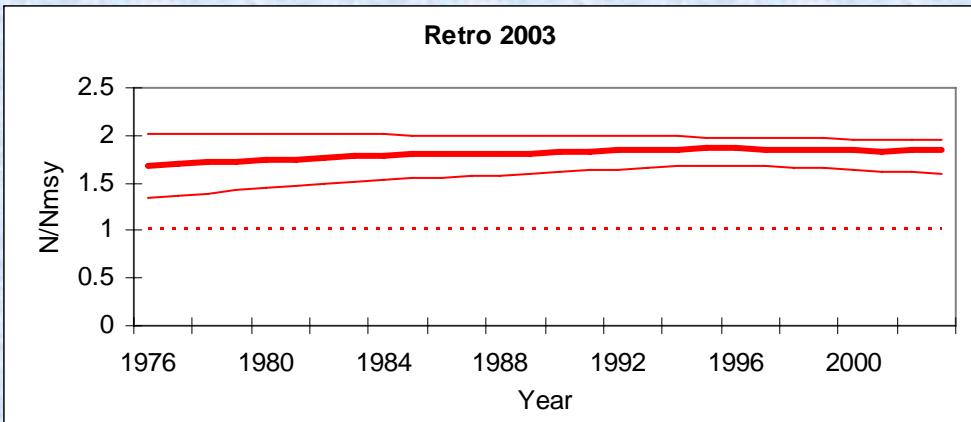
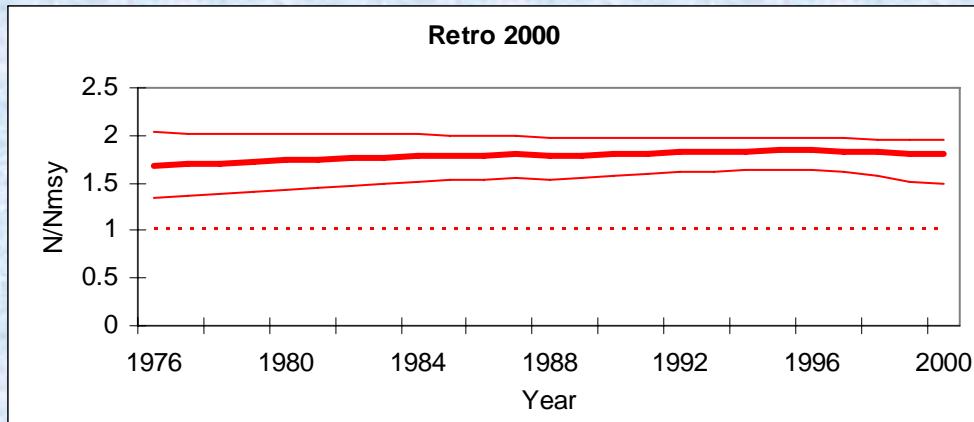
	baseline		Retrospective 2000		Retrospective 2001		Retrospective 2002		Retrospective 2003		Retrospective 2004	
	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV	EV	CV
Importance function	priors		priors		priors		priors		priors		priors	
K	6397	0.82	5308	0.98	5180	0.99	5631	0.92	6351	0.83	5852	0.89
r	0.060	0.20	0.060	0.20	0.060	0.20	0.060	0.20	0.060	0.20	0.060	0.20
MSY	96	0.86	80	1.01	78	1.03	85	0.96	95	0.87	88	0.93
N <sub>2005</sub>	6000	0.84	4945	1.00	4827	1.02	5260	0.95	5938	0.85	5473	0.92
N <sub>2005</sub> /K	<b>0.90</b>	0.08	<b>0.88</b>	0.11	<b>0.87</b>	0.13	<b>0.88</b>	0.11	<b>0.90</b>	0.09	<b>0.89</b>	0.11
N <sub>init</sub>	5380	0.84	4471	1.00	4418	1.01	4792	0.94	5339	0.85	4952	0.91
N <sub>2005</sub> /N <sub>init</sub>	1.09	0.14	1.06	0.15	1.04	0.17	1.06	0.15	1.09	0.14	1.07	0.15
C <sub>2005</sub> /MSY	0.27	1.08	0.74	1.23	1.32	1.19	0.55	1.15	0.43	1.12	0.47	1.11
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.17</b>	1.32	<b>0.50</b>	1.61	<b>0.94</b>	1.63	<b>0.37</b>	1.49	<b>0.27</b>	1.37	<b>0.31</b>	1.42
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.80</b>	0.09	<b>1.76</b>	0.11	<b>1.74</b>	0.13	<b>1.77</b>	0.11	<b>1.80</b>	0.09	<b>1.77</b>	0.11
C <sub>2005</sub> /rep <sub>y</sub>	0.78	81.34	1.84	84.33	3.43	67.64	1.97	208.51	1.25	68.20	1.40	74.01
N <sub>MSY</sub>	3199	0.82	2654	0.98	2590	0.99	2815	0.92	3176	0.83	2926	0.89
F <sub>MSY</sub>	0.030		0.030		0.030		0.030		0.030		0.030	
rep <sub>y</sub>	21	0.83	19	1.11	17	1.08	19	0.97	21	0.90	20	0.88
C <sub>0</sub>	1.7	0.69	1.7	0.69	1.7	0.69	1.7	0.69	1.7	0.69	1.7	0.69
<b>Diagnostics</b>												
CW (wt)	0.609		0.489		0.422		0.495		0.618		0.516	
CV (L*prior)	1.163		1.250		1.270		1.220		1.160		1.202	
CV (Wt) / CV (L*p)	0.52		0.39		0.33		0.41		0.53		0.43	
%maxpWt	0.0004		0.0003		0.0003		0.0003		0.0004		0.0004	

# SPM results for Finetooth shark: retrospective analyses (medians with 80% credibility interval)



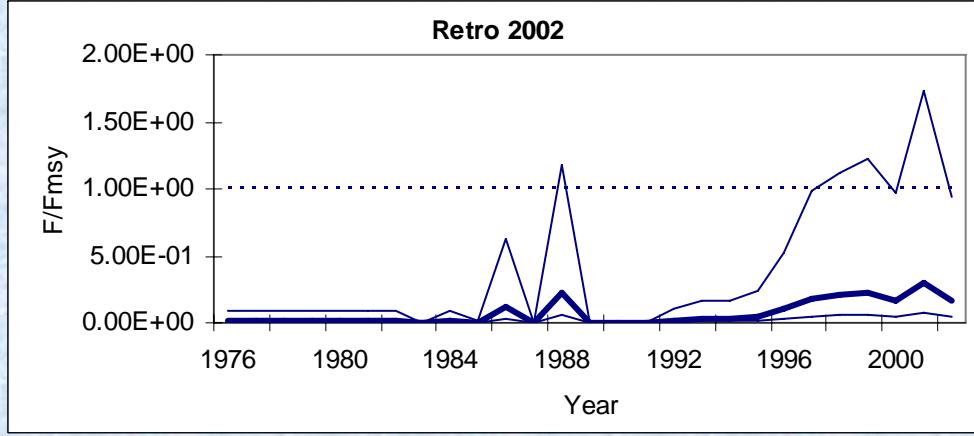
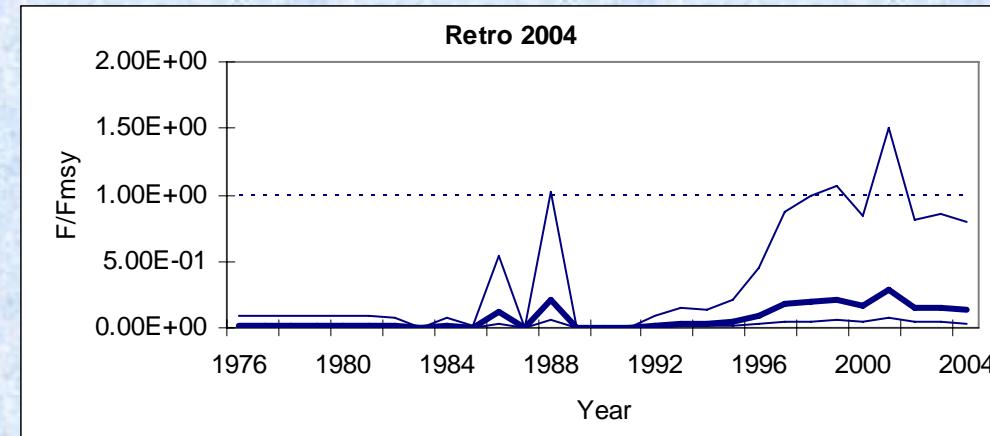
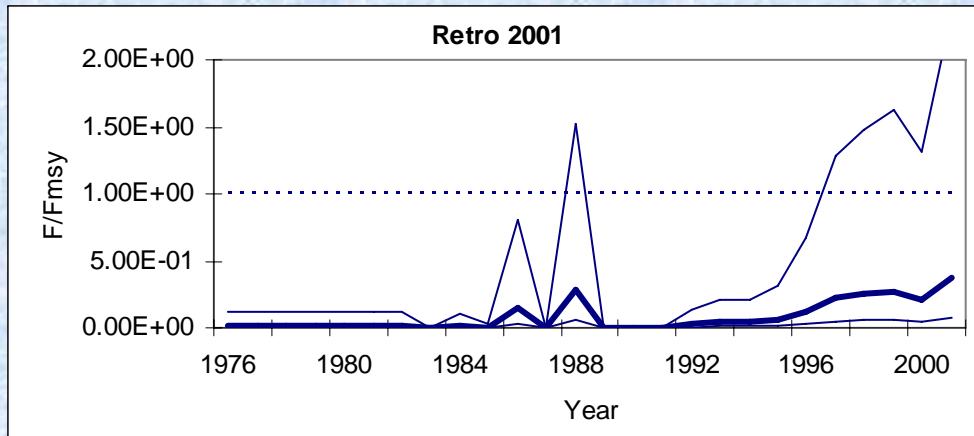
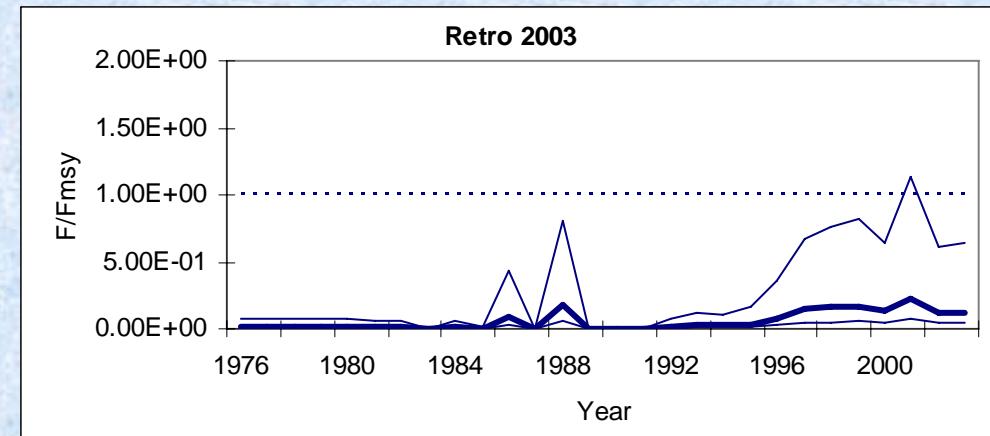
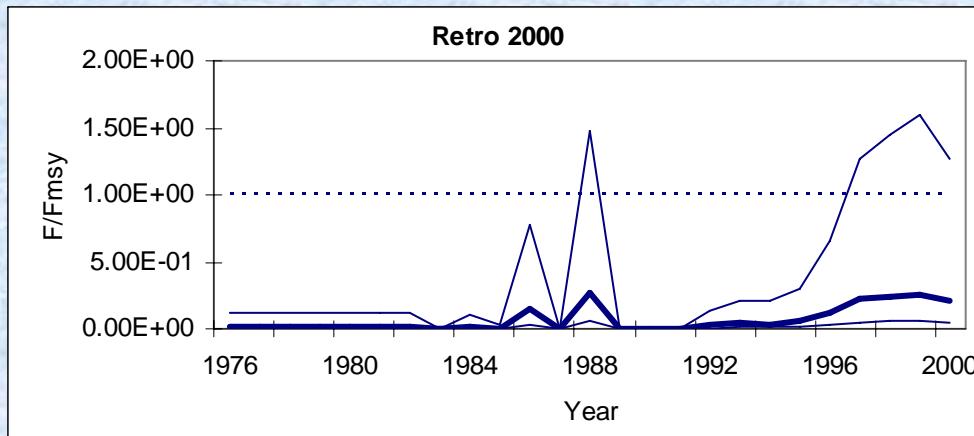
N

# SPM results for Finetooth shark: retrospective analyses (medians with 80% credibility interval)



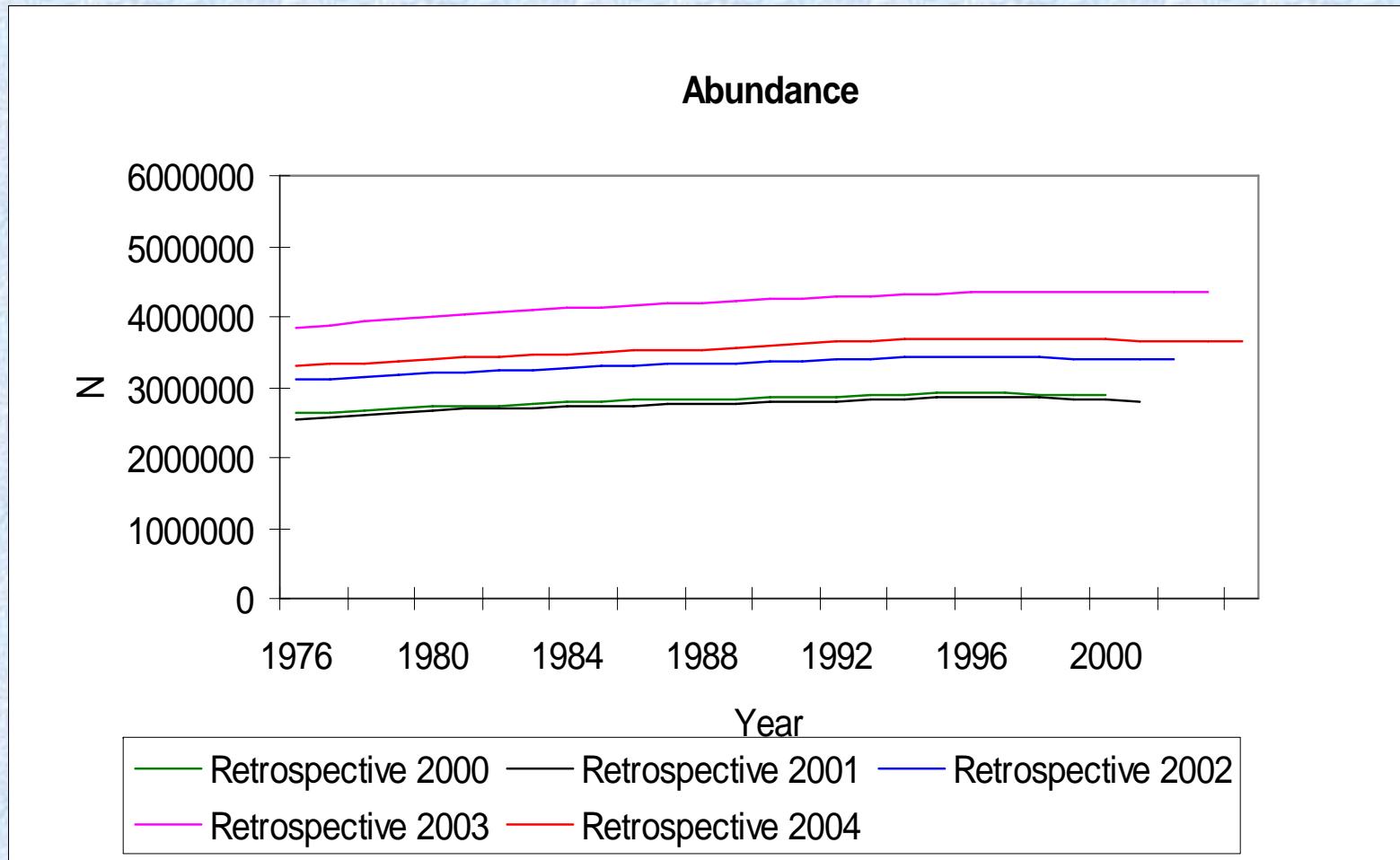
N/Nmsy

## SPM results for Finetooth shark: retrospective analyses (medians with 80% credibility interval)

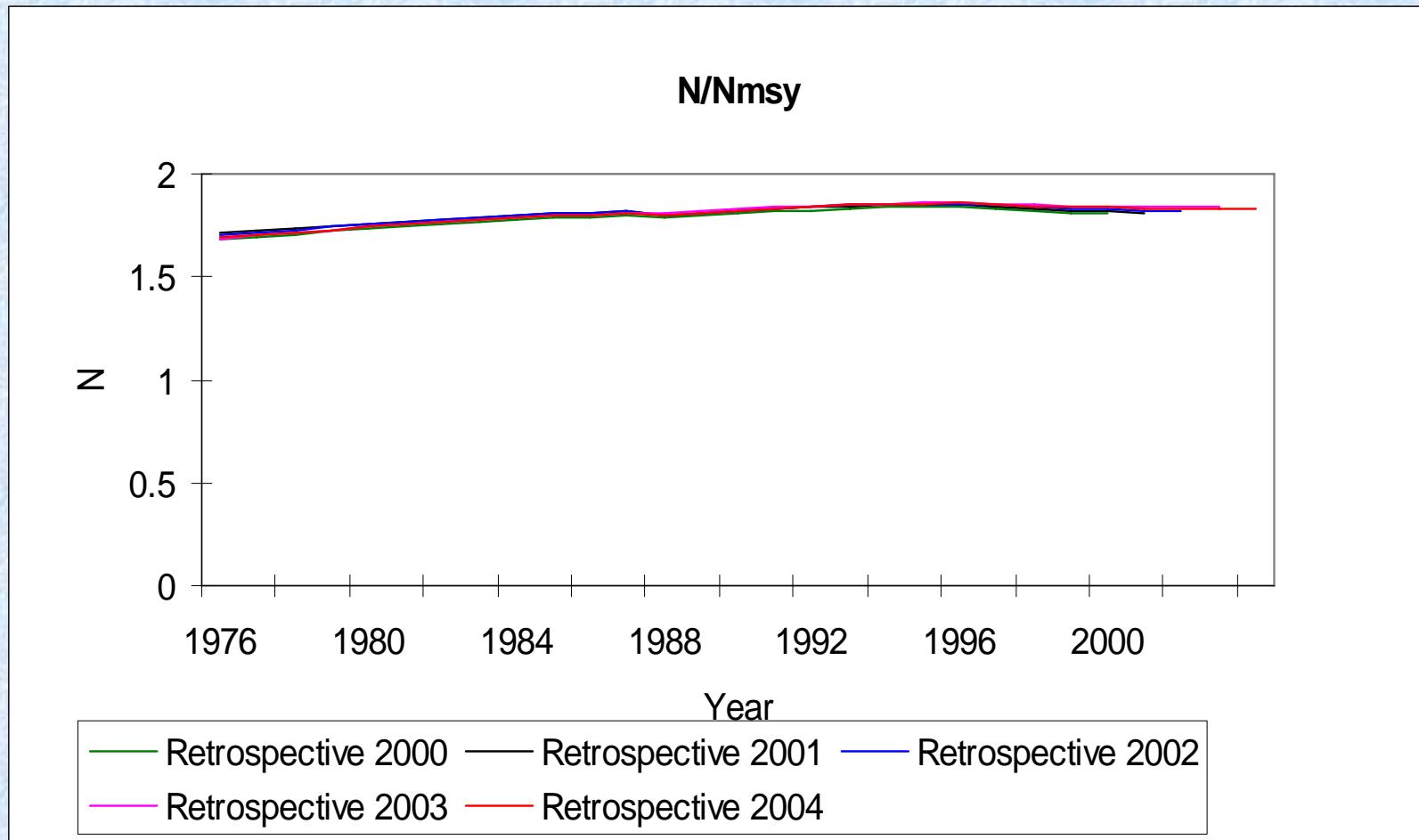


$F/F_{\text{msy}}$

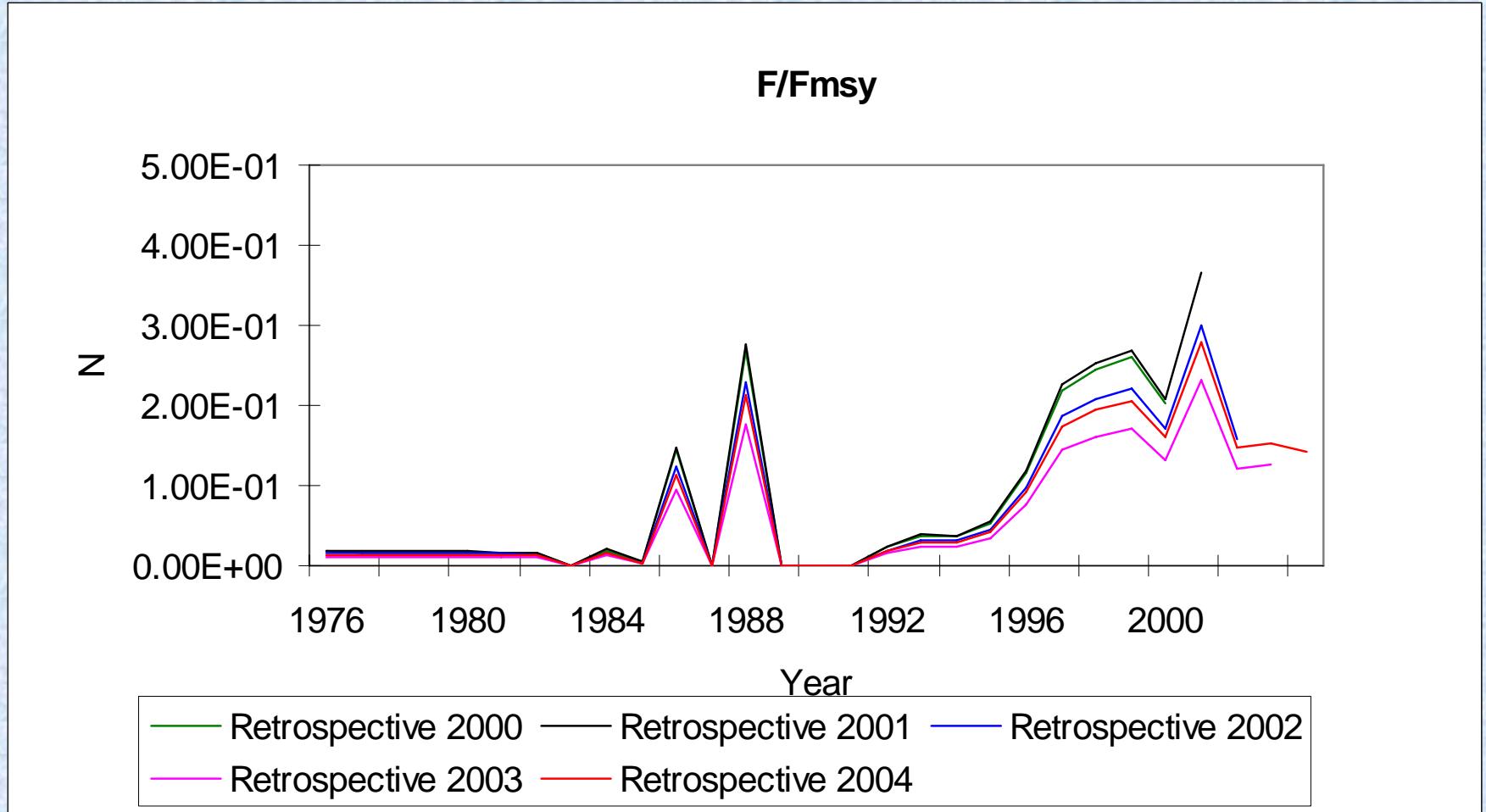
## SPM results for Finetooth shark: retrospective analyses, Abundance trajectories



## SPM results for Finetooth shark: retrospective analyses, Relative abundance trajectories



## SPM results for Finetooth shark: retrospective analyses, Relative fishing mortality trajectory



# Expected values of the mean and CV of marginal posterior distributions from the BSP for Finetooth shark-Sensitivity to prior for r

	baseline		r prior multivariate t		r prior uniform <sup>1</sup>	
	EV	CV	EV	CV	EV	CV
Importance function	priors		multivar			
K	6397	0.82	2031	1.10	4455	1.11
r	0.060	0.20	0.213	0.63	0.271	0.52
MSY	96	0.86	96	1.23	285	1.37
N <sub>2005</sub>	6000	0.84	1908	1.15	4227	1.13
N <sub>2005</sub> /K	<b>0.90</b>	0.08	<b>0.91</b>	0.09	<b>0.92</b>	0.11
N <sub>init</sub>	5380	0.84	1755	1.10	3564	
N <sub>2005</sub> /N <sub>init</sub>	1.09	0.14	1.07	0.14	1.19	
C <sub>2005</sub> /MSY	0.27	1.08	0.35	2.86	0.04	
F <sub>2005</sub> /F <sub>MSY</sub>	<b>0.17</b>	1.32	<b>0.22</b>	3.49	<b>0.12</b>	1.96
N <sub>2005</sub> /N <sub>MSY</sub>	<b>1.80</b>	0.09	<b>1.82</b>	0.09	<b>1.83</b>	0.11
C <sub>2005</sub> /rep <sub>y</sub>	0.78	81.34	0.83	21.89		
N <sub>MSY</sub>	3199	0.82	1015	1.10	2228	
F <sub>MSY</sub>	0.030		0.107		0.135	
rep <sub>y</sub>	21	0.83	15	0.30		
C <sub>0</sub>	1.7	0.69	1.6	0.63	2.5	0.57
<b>Diagnostics</b>						
CW (wt)	0.609		2.611		satisfactory	
CV (L*prior)	1.163		0.729			
CV (Wt) / CV (L*p)	0.52		<b>3.583</b>			
%maxpWt	0.0004		0.034			

N<sub>init</sub> is initial abundance (for the first year of the model), rep<sub>y</sub> is replacement yield

<sup>1</sup> Using WinBUGS

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

