B. SPINY DOGFISH ADVISORY REPORT

State of Stock: The spiny dogfish stock is overfished and overfishing is not occurring. Estimated fishing mortality in 2002 (F = 0.09) exceeds the rebuilding target (F = 0.03) by a factor of 3, and is near the overfishing threshold (F = 0.11). The female spawning portion of the biomass has declined by about 75% since 1988 and is at 29% of the biomass target. Estimates of the exploitable and total biomass in 2002 are about 140,000 mt and 371,000 mt, respectively, about half of the peak level observed in 1985 (Figure B5). Recent reductions in spawning stock biomass cannot be replaced quickly due to the reproductive biology of spiny dogfish, and the current low level of SSB is expected to result in low recruitment for the next several years. Recruitment estimates from 1997 to 2003 represent the seven lowest values in the entire series (Figure B3).

Management Advice: Given low current spawning biomass, poor recruitment and reduced pup survivorship, the SARC recommends total removals (landings, discards, Canadian catch) below those derived from the estimated rebuilding F (0.03). Targeting females should be avoided.

Forecast: Rebuilding of spiny dogfish populations will take at least 15 years under the most optimistic scenario (Figure B7). The low biomass of spawning females, high abundance of males, and the near absence of dogfish less than 50 cm will induce large oscillations in the stock regardless of management strategies. Biomass of males and immature females in the 36-70 cm range should decrease over the next decade as the small cohorts produced in the 1990s grow. Replacement of the spawning stock, i.e., accumulation of large females in the 100 cm range, could take another two decades. Forecasts of rebuilding which take into account the apparent lower survival of pups from smaller females indicate that rebuilding will not occur.

Projection Table for Scenarios, Spiny Dogfish

Scenario	Constant F 2004-2032	Year	SSB (mt)	Yield (mt)	Discard (mt)
RMP F	0.08	2003	57,608	2,290	8,692
		2004	91,077	7,790	8,597
		2012	81,105	7,727	6,539
		2022	120,140	9,086	6,230
		2032	128,266	9,528	6,781
Current F	0.09	2003	57,608	7,070	8,692
		2004	86,948	8,812	8,472
		2012	71,971	8,212	6,191
		2022	103,262	9,207	5,552
		2032	104,320	9,106	5,701
Rebuild F	0.03	2003	57,608	2,290	8,692
		2004	91,077	2,960	8,597
		2012	113,641	3,892	7,512
		2022	189,434	5,365	8,790
		2032	250,959	7,038	11,829
Zero F	0.00	2003	57,608	-	8,692
		2004	93,083	-	8,658
		2012	141,174	-	8,316
		2022	256,575	-	11,164
		2032	392,134	-	17,252
Constant Harvest 8.8 million lbs.		2003	57,608	7,252	8,692
		2004	86,842	7,252	8,467
		2012	90,693	7,253	6,746
		2022	135,518	7,253	6,764
		2032	161,989	7,254	8,091
Reduced Survival	0.09	2003	57,608	7,070	8,692
		2004	86,948	8,812	8,452
		2012	71,971	7,848	4,119
		2022	12,953	1,655	1,049
		2032	1,696	302	262

Landings and Status Table (weights in '000 mt, recruitment in millions): Spiny Dogfish

									1968-2002		
Year	1996	1997	1998	1999	2000	2001	2002	2003	Max	Min	Mean
USA commercial landings	27.2	18.4	20.6	14.9	9.3	2.3	2.2	-	27.2	<0.1	7.2
Foreign commercial landings	0.7	0.7	1.7	3.0	3.2	4.1	3.4	-	24.5	0.4	5.2
Discards, commercial[1]	14.1	6.3	4.3	3.7	3.7	7.0	5.0	-	47.3	3.7	16.7
USA recreational catch[2]	0.4	0.8	0.6	0.6	0.6	2.1	1.9	-	2.1	0.4	1.1
Total landings	28.3	19.8	23.0	18.5	13.0	8.5	7.5	-	28.3	1.5	13.1
Spring survey females[3]	60.5	44.9	15.5	32.5	29.2	19.8	32.2	29.7	89.2	1.6	46.4
F on female exploitable stock[4]	0.24	0.17	0.32	.24	.19	.08	.09		0.32	0.08	0.19
Swept Area Biomass Estimates[5]											
Total Stock (male+female)	521	489	406	358	343	337	371		665	337	473
Exploitable stock (male+female)	234	216	144	135	132	144	140		234	92	148
Female SSB[6]	114	91	52	53	62	65	58		270	52	128
Recruitment index[7]	33.9	1.8	2.9	1.0	3.1	1.3	1.9	5.3	128.4	1.0	29.5

[1] Total discard mortality in trawl, gill net and hook fisheries, 1989-2002, assuming 75% gillnet, 50% trawl and 25% hook discard mortality.
[2] Includes all landed and released recreational catch assuming 100% discard mortality, 1981-2002.
[3] Raw spring survey average weight (kg) per tow, 1981-2003
[4] Stochastic estimator of F on female exploitable stock, 1990-2002, minimum footprint assumption.
[5] Stochastic estimates of biomass, 1990-2002, for total, exploitable and female spawning stock, minimum footprint assumption.
[6] Individuals >=80 cm.
[7] NEFSC spring survey, expanded number of individuals <35 cm (millions).

Species Distribution and Stock Identification: Spiny dogfish are distributed in the Northwest Atlantic between Labrador and Florida, are most abundant between Nova Scotia and Cape Hatteras, and are considered to be a unit stock in NAFO Subareas 2-6. Seasonal migrations occur northward in spring/summer and southward in autumn/winter. Analysis of spatial and temporal abundance patterns from NEFSC spring and autumn and Canadian summer research vessel survey catches suggests that the spring survey provides a valid abundance measure for the entire stock.

Tagging studies and research surveys conducted in North Carolina waters by East Carolina University (ECU) suggest that spiny dogfish found south of Cape Hatteras during the winter comprise a minor component of the stock north of Cape Hatteras, as defined above. Tag returns from the ECU studies were mainly from North Carolina waters in winter and Massachusetts waters in summer. Few ECU tags were recovered in Canadian waters. Further study of dogfish stock structure is needed.

Catches: Dogfish landings were dominated by foreign catches from 1966 to 1977, peaking in 1974 at about 25,000 mt (Figure B2). US commercial landings dominated the catch from 1979 to 2000, peaking in 1996 at about 28,000 mt. Total landings have declined steadily since 1998 and were sharply lower in 2001 and 2002. In the last two years, the Canadian catches are the largest proportion of estimated landings and recreational catches are, for the first time, a significant proportion of total landings (Figure B2).

Quantitative estimates of discards are available for 1990-2002, and have ranged from 3,700 to 47,000 mt. Estimated discard mortalities during 1990-1991 of about 47,000 mt indicate total catch mortality in those years of about 60,000 mt, and suggest that total catch mortality in previous years may have been much higher than reported landings. However, discard mortality is applied to all size classes and both sexes whereas the landings are concentrated on mature females. Discards have declined significantly in recent years, most likely due to effort restrictions on other species.

Data and Assessment: Spiny dogfish were last assessed in March 1998 (SAW 26). The current assessment updates the findings of the SAW 18 (June 1994) and SAW 26, and incorporates new estimates of stock biomass and fishing mortality. Estimates of means and variances of discarded catch have been included in assessment models for the first time. Since age compositions of the landings and discards are not available, the analytical models are length-based. Indices of abundance were derived from research vessel survey catch per tow. New biological data on the relationship between maternal size, and numbers and size of pups were incorporated. Natural mortality (M) was estimated to be 0.092 based on an assumed longevity of 50 years. Estimates of biomass and fishing mortality were derived from a stochastic length-based, survey swept-area method using data from the commercial fishery and NEFSC trawl surveys. Fishing mortality estimates based on the Beverton-Holt model and NEFSC spring survey data were also computed over an assumed range of sizes at entry and natural mortality rates. A size- and sex-structured equilibrium life history model incorporating known biological parameters was used to estimate yield per recruit and female pups per female recruit corresponding to varying levels of F and minimum size at entry to the fishery. A stochastic, length-based projection model was developed to predict yield, population sizes and rebuilding times under alternative management scenarios. Selectivity patterns for exploited female and male dogfish were developed.

Biological Reference Points: Reference points established in the MAFMC/NEFMC Spiny Dogfish Fishery Management Plan (1999) include a B_{TARGET} of 180,000 mt, a $B_{THRESHOLD}$ of 100,000 mt, an $F_{THRESHOLD}$ of F=0.11 and an F_{TARGET} of F=0.08, all in terms of adult (>= 80 cm) female biomass. The B_{TARGET} reference point was subsequently disapproved. The biomass target in the ASMFC FMP is determined from the trawl survey results and is currently 167,000 mt. These reference points were neither updated nor re-estimated by the current assessment.

Fishing Mortality: F on the female exploitable stock varied between 0.1 and 0.3 between 1990 and 2000 (Figure B1). Despite the much lower level of landings, fishing mortality rates in 2001-2002 remain high (F_{2001} = 0.08; F_{2002} = 0.09), relative to the rebuilding target (0.03).

Recruitment: Annual pup production is low (4-9 pups per litter) and directly related to the number and size structure of spawning females. Recruitment estimates from 1997 to 2003 represent the seven lowest values in the entire series (Figure B3).

Stock Biomass: Research vessel abundance and biomass survey indices increased from the early 1970s through 1992 (Figure B5), and then declined by 33% during 1992-2002 (600,000 mt to 400,000 mt). Most of this change in overall abundance has been driven by the removal of dogfish greater than 80 cm (Figure B5). Swept-area estimates of the spawning (female) biomass (defined as >=80 cm fish) increased six-fold from about 50,000 mt in 1968 to 295,000 mt in 1989 and have declined to about 50,000 mt in 1998 and remained relatively constant since (Figure B1). Owing to the high proportion of females in the landings, estimated minimum biomass of females >=80 cm has declined more sharply than the combined male-female >=80-cm biomass. Length-frequency data from both the US commercial landings and six separate research vessel survey catches indicate a pronounced and consistent decrease in average length of mature females in recent years (Figure B6). Changes in the overall size composition of the stock since the onset of the intensive fishery (Figure B6) suggest marked changes in present and future reproductive potential.

Special Comments: The low abundance of pups in the spring survey, first noted in the SARC 26 assessment, has continued for seven consecutive years through the spring 2003 NMFS trawl survey. Declines in the abundance of dogfish less than 60 cm suggest that the estimates of low pup production are not artifacts of reduced availability to the gear. Average size of pups in the survey has declined, consistent with newly developed data on the reduced average size of pups produced by smaller females. Spawning potential will decline as these weak year classes reach maturity. In the long term projection, which accounts for the apparent lower survival of pups from smaller females, the lower spawning potential leads to stock collapse under current fishing mortality rates (Figure B7).

The current Federal FMP fails to specify either a biomass rebuilding goal or a relevant time frame for rebuilding, as required by the SFA. The SARC recommends SSB_{MAX} as a biomass target, currently estimated as 190,000 mt (swept area biomass assuming nominal footprint of 0.012 nm^2) of mature female biomass (Figure B4).

Coordinated assessment and management of this resource by the US and Canada is strongly recommended. Recent increases in Canadian landings may compromise the pace of rebuilding that would otherwise be achieved via catch reductions in the US. Continued harvesting at rates in excess of the $F_{REBUILD}$ (0.03) of large spiny dogfish in the US and Canadian fisheries, given recent poor recruitment, poses a substantial risk to the spawning stock of spiny dogfish.

Sources of Information: Bowman, R., R. Eppi, and M. Grosslein. 1984. Diet and consumption of spiny dogfish in the northwest Atlantic. ICES CM 1984/G:27; Link, J.S., L. P. Garrison, and F.P. Almeida. 2002. Ecological interactions between elasmobranchs and groundfish species of the Northeastern U.S. continental shelf. N. Am. J. Fish. Mgmt. 22: 500-562; MAFMC, NEFMC. 1999. Spiny Dogfish Fishery Management Plan. MAFMC, Dover DE, March, 292 pp., apps; NEFSC 1994. Report of the 18th Stock Assessment Workshop/Stock Assessment Review Committee, NEFSC CRD 94-22; NEFSC 1998. Report of the 26th Northeast Regional Stock Assessment Workshop (26th SAW). Stock Assessment Review Committee (SARC) Consensus Review of Assessments. CRD 98-03; Rago, P. J., Sosebee, K.A., Brodziak, J.K.T., Murawski, S.A. and Anderson, E.D.. 1998. Implications of recent increases in catches on the dynamics of Northwest Atlantic spiny dogfish (*Squalus acanthias*). Fisheries Research 39:165-181.

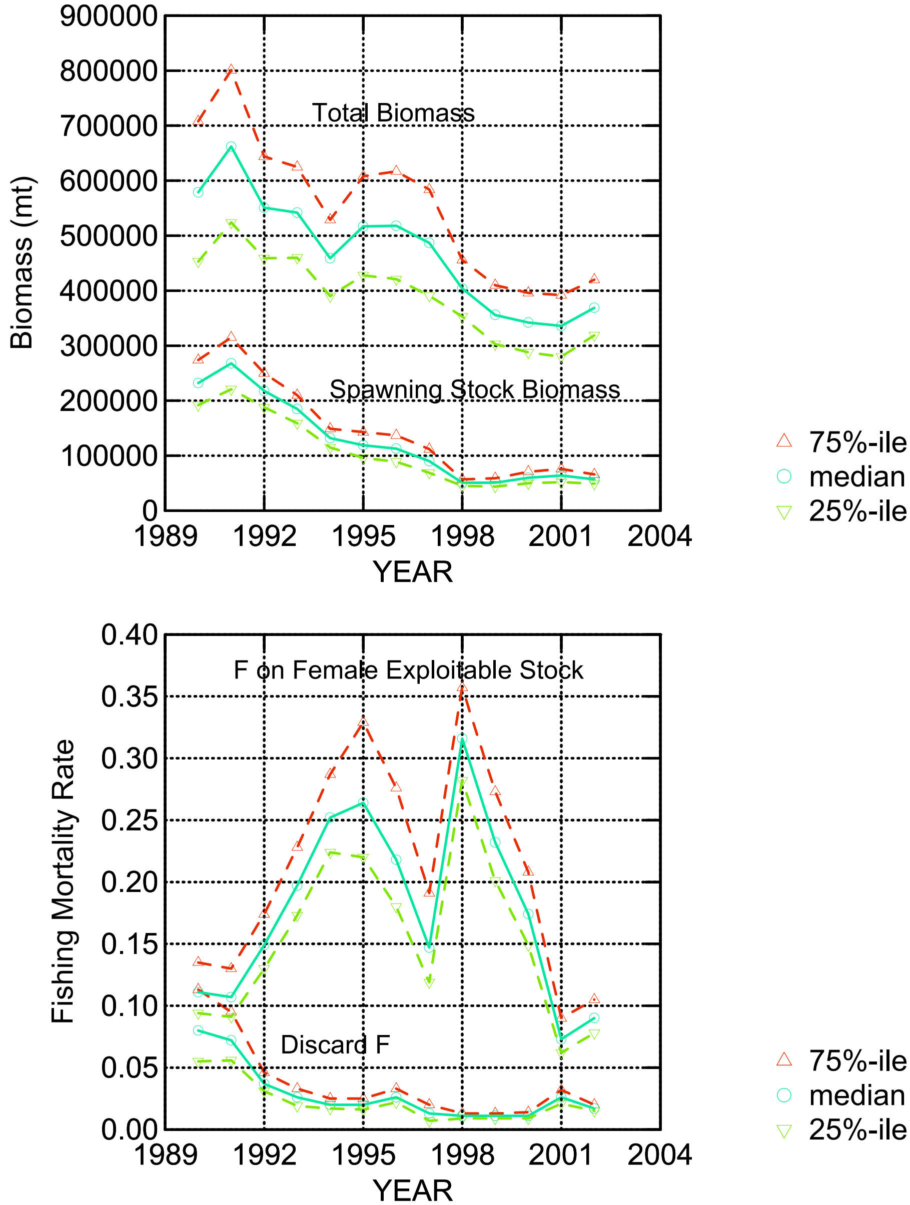

Fig. B.1 Summary of stochastic estimates of biomass and F with interquartile range, 1990-2002

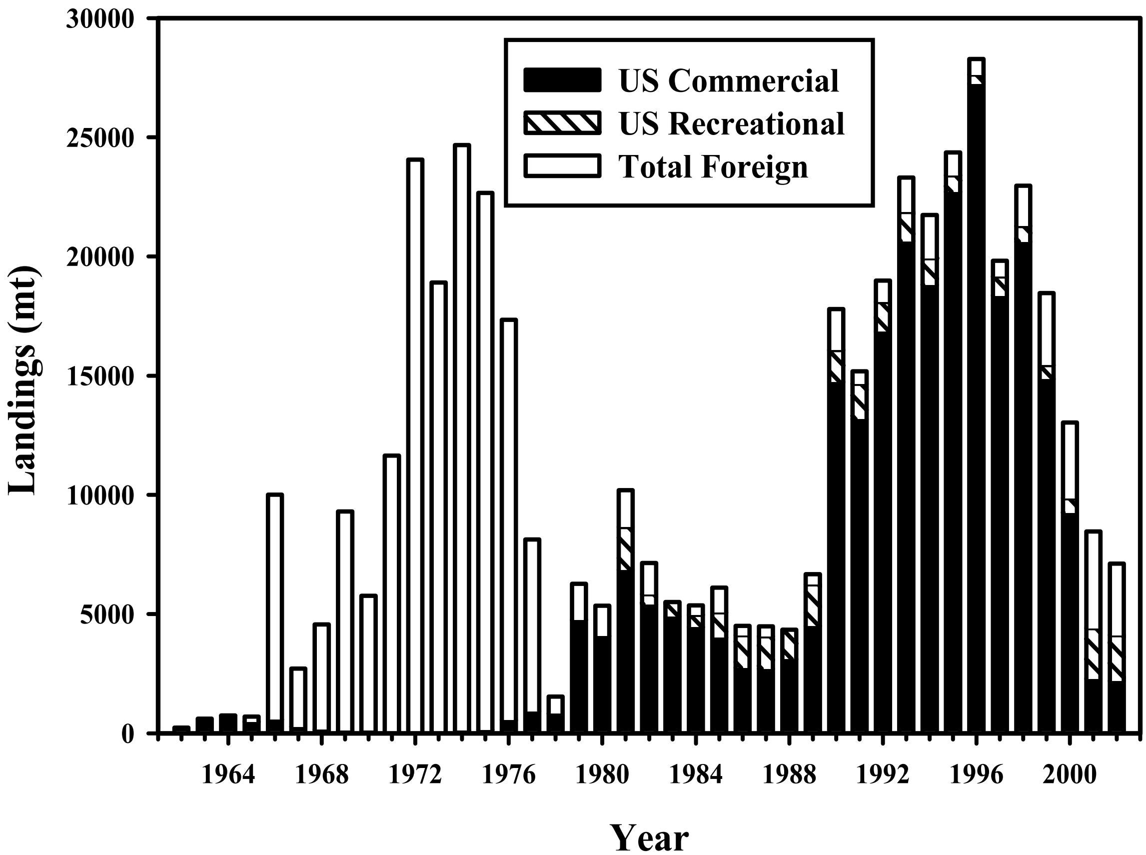

Figure B.2. Commercial landings (metric tons) and recreational catch of spiny dogfish from NAFO subareas 2-6, 1962-2002.

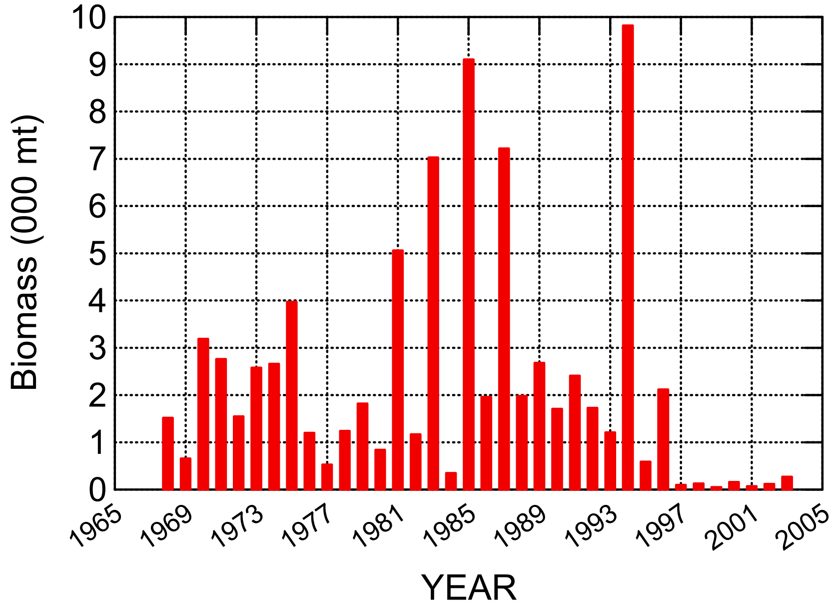

Fig. B.3 Swept area estimate of dogfish biomass (000 mt) recruits in spring R/V trawl survey, 1968-2003. Recruits defined as individuals less than 36 cm.

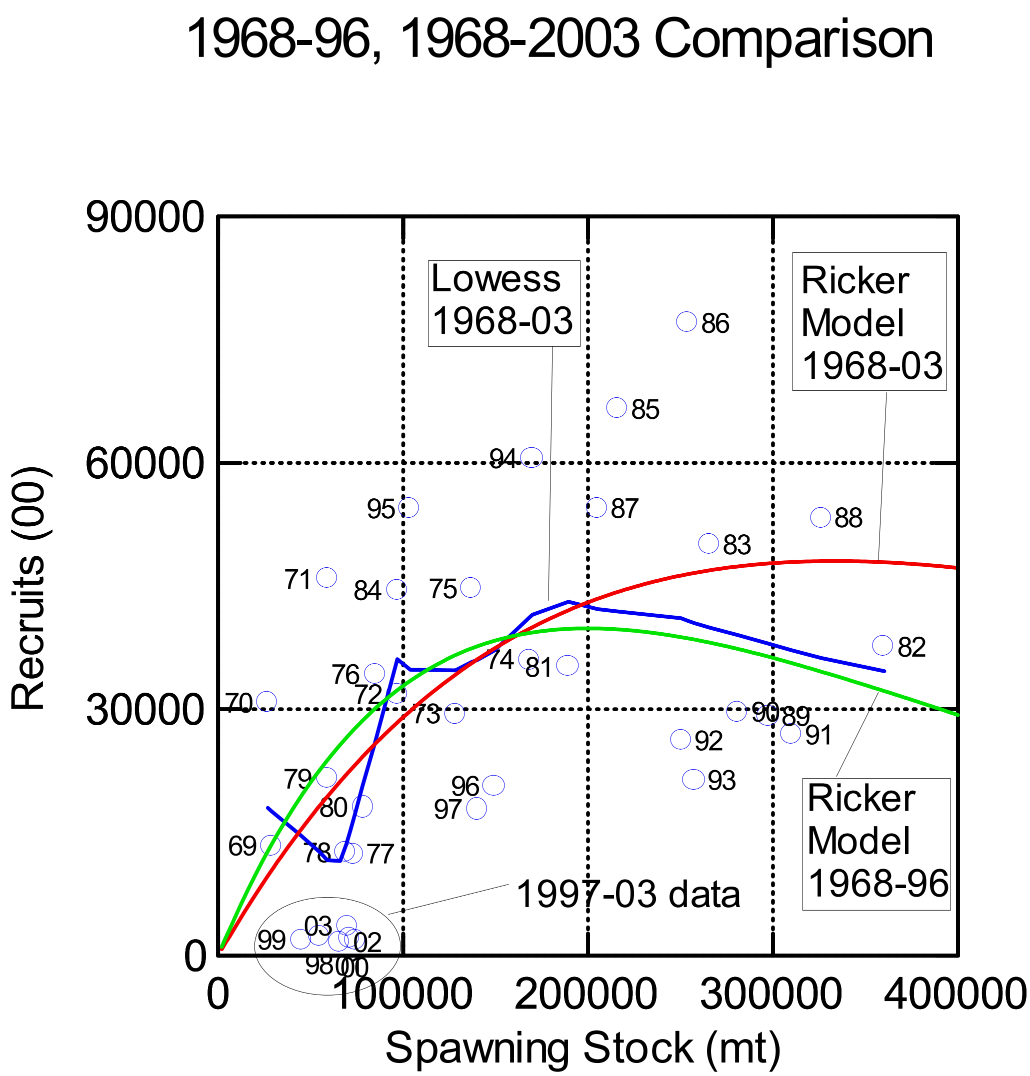

Figure B.4 Comparison of parametric and nonparametric S-R curves for spiny dogfish for 1968-1996 and 1968-2003. Point estimates of SSB_{max} based on nominal footprint of 0.01 nm^2 and unscaled NEFSC spring trawl survey catch rates. Nonparametric models based on Lowess smooths with tension = 0.6.

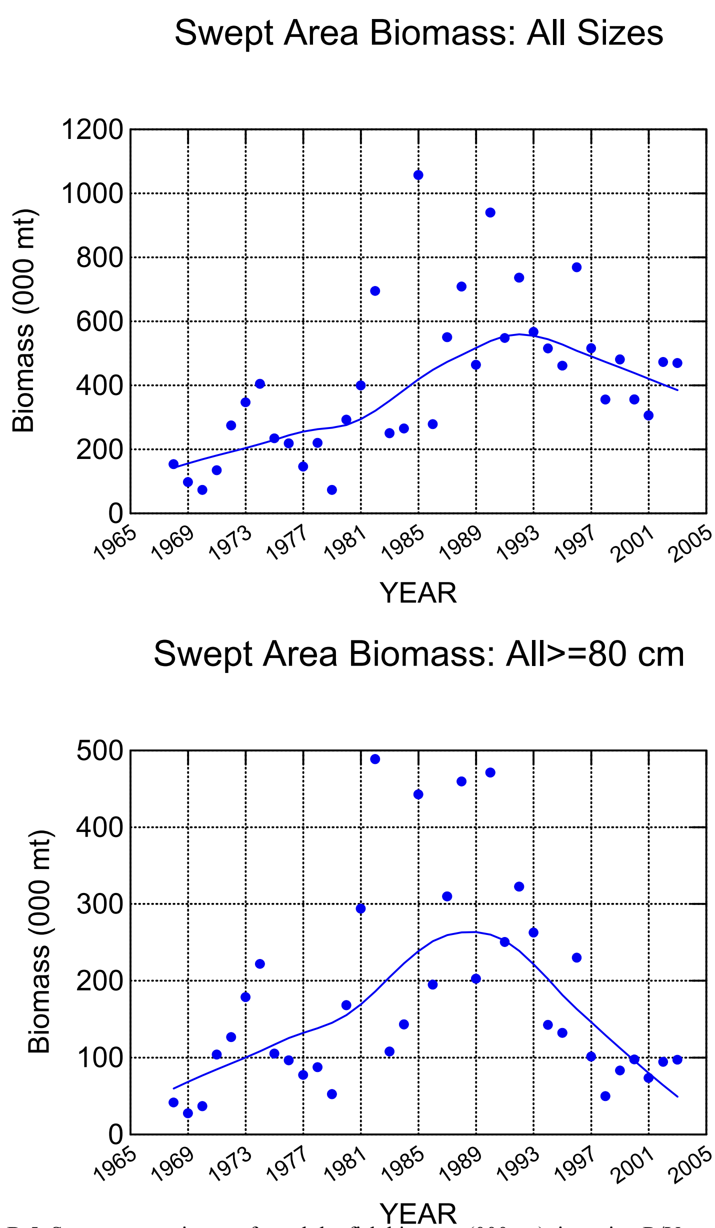

Fig. B.5 Swept area estimate of total dogfish biomass (000 mt) in spring R/V trawl survey, 1968-2003. Line represents Lowess smooth with tension factor = 0.5.

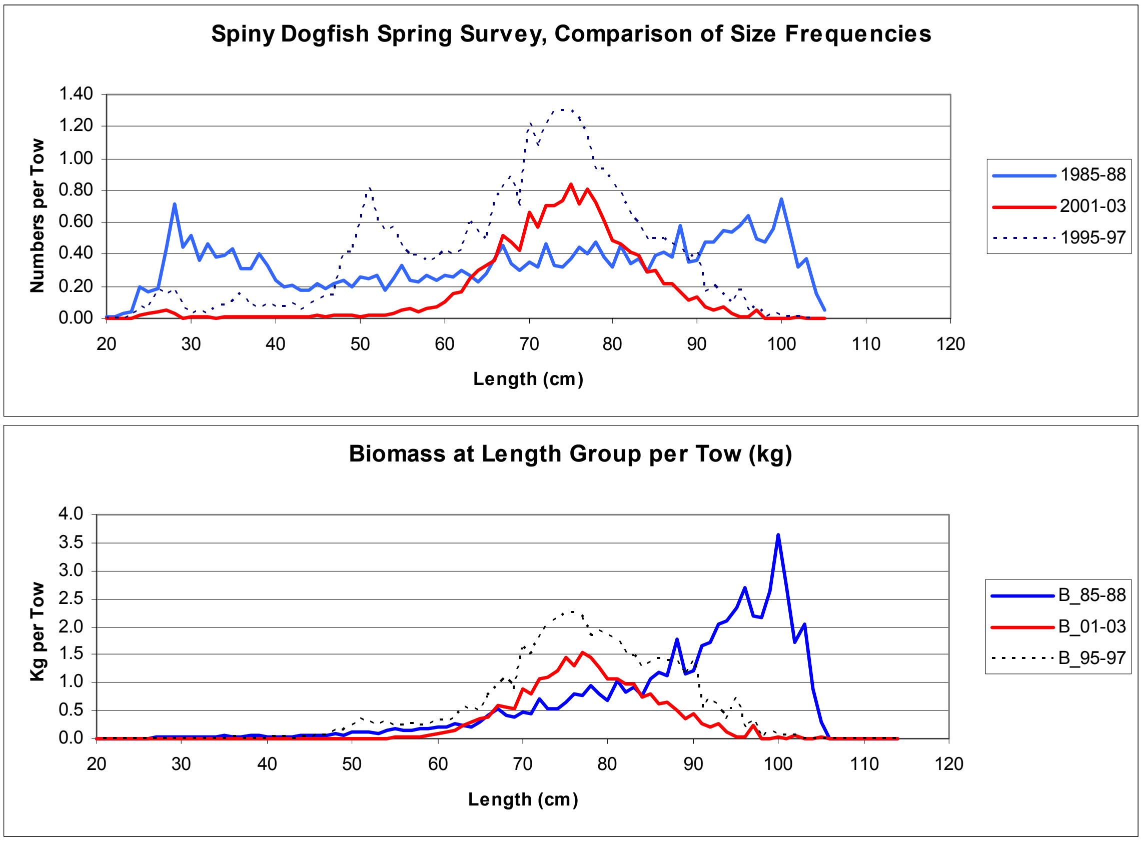

Fig. B.6. Comparison of length frequency distributions and biomass at length in the NEFSC R/V spring trawl survey for three time periods.

Figure B7. Yield and biomass, long-term projections, spiny dogfish. Scenarios include F = 0.08, as called for in the current FMP; F_{SQ}, a continuation of current F (0.09); a constant harvest strategy of 8.8 million pounds annually; application of $F_{REBUILD}$ (F=0.03); and 'Reduced So', a scenario formally accounting for lower survival of smaller pups under status quo F (0.09).

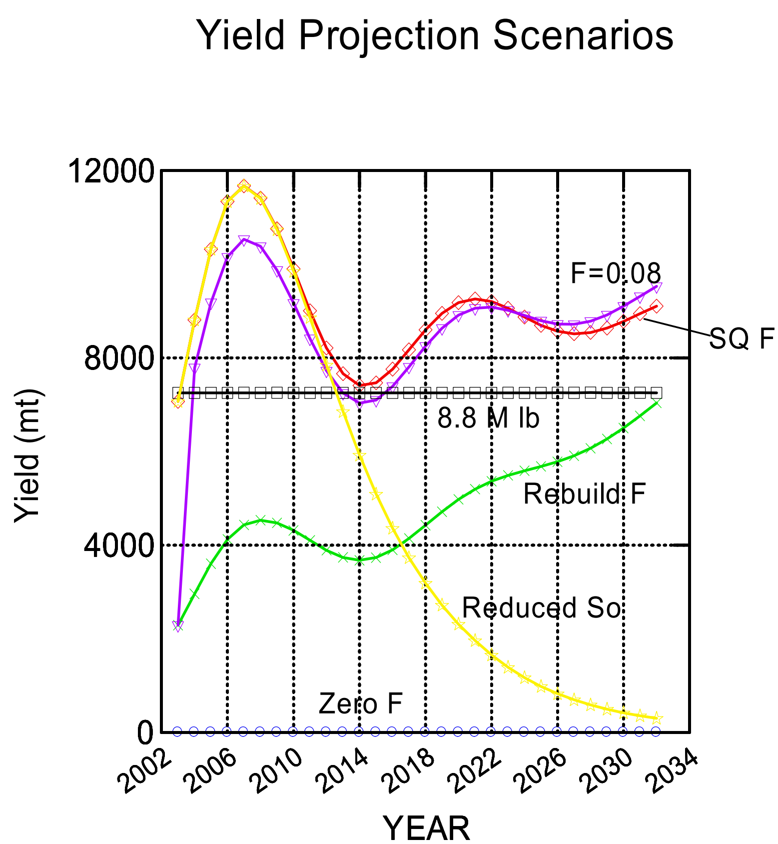

Figure B7 (continued). Yield and biomass, long-term projections, spiny dogfish. Scenarios include F = 0.08, as called for in the current FMP; F_{SQ}, a continuation of current F (0.09); a constant harvest strategy of 8.8 million pounds annually; application of $F_{REBUILD}$ (F=0.03); and 'Reduced So', a scenario formally accounting for lower survival of smaller pups under status quo F (0.09).