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Update on the Status of Spiny Dogfish in 2008 and Initial Evaluation of Alternative Harvest Strategies

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A. Catch and Survey Indices

1. This document summarizes the most recent information on spiny dogfish stock status using survey data from the spring 2008 NEFSC bottom trawl survey and catch data from 2007. Catch data include landings from US and Canadian commercial fisheries, and US recreational landings. Discard information includes discards from US commercial fisheries and US recreational fisheries. Estimates of dead discards are obtained by multiplying the total discards by the gear-specific discard mortality rates.

2. Total catch in 2007 was estimated to be 12,136 mt. Preliminary estimates of landings, discards and dead discards are provided below.

Gear (fraction dead)	Discard (mt)	Dead Discards (mt)	Landings (mt)
Otter Trawl (0.5)	8,115	4,058	
Sink gill net (0.30)	5,133	1,540	
Line Trawl + Scallop Dredge (0.1)	133.8	13.4	
Recreational Discards (0.2)	4,303.5	860.7	
Recreational Landings			37.1
US Landings			3,524
Canadian Landings			2,328
TOTAL (mt)	17,685	6,247	5,889

3. No new estimates of composition of the landings and discards by sex were computed for 2007. Instead the sex ratios were assumed to be the same as in the last peer-reviewed estimates in SARC 43.

4. Similarly, the selectivity pattern of the overall fishery for both males and females was assumed to be the same as in SARC 43.

5. Total dead discards declined rapidly from over 15,000 mt during the early 1990s to about 4,000 in 1998. Discards have been relatively stable since then with a modest increase in recent years to nearly 6,000 mt. (Fig. 1)

6. Swept area biomass estimates in the 2008 NEFSC spring bottom trawl survey increased to 657 k mt consistent with increases seen in 2006 and 2007 (Table 1). Swept area biomass estimates are based on the nominal footprint of 0.01 nm^2. A simple 3-year moving average of the female spawning stock biomass is 218 k mt which exceeds the biological reference point of 200 k mt based on this same nominal footprint. A more explicit treatment of the uncertainty in the biomass estimator is addressed later in the stochastic biomass and fishing section (See bullets B1 to B7)

7. The size composition of the female stock is summarized in Fig. 2 for 3-yr stanzas. The effects of the fishery through removal of large females is evident through 2002. Beginning about 1997 recruitment dropped rapidly. The consequences of the low recruitment since then are evident in the progressive decrease in the abundance of spiny dogfish less than 70 cm. Recruitment since 2003 has shown a modest increase but no cohorts in the 40 to 6 cm range are evident.

8. Biomass of the population in the 2006-2008 stanza are greater than would be expected in the 2003-2005 period. Trend relationships among size groups are addressed in bullets A10 and A12.

9. Male size frequency compositions (Fig. 3) do not show the effects of fishery changes as they constituted a very small fraction of landings. Trends in reduced pup production and subsequent reduction of male dogfish between 40 to 65 cm are evident. Such changes are consistent with the hypothesis of lower recruitment since 1997.

10. The relationships between trends in mature (≥80 cm) and immature (36-79 cm) components of the female dogfish are shown in Fig. 4. Lowess smoothes of the survey data suggest that the estimates in 2003-05 were low. The reduction in the immature female size range reflects both their growth into the mature stock and the reduction in recruitment.

11. Changes in recruitment are illustrated in Fig. 5. Interannual variations in abundance are high but patterns after 1997 show a marked decline.

12. No strong trends in abundance of large male dogfish (≥80 cm) are evident (Fig. 6 top) and total biomass of this component appears to be negligible. Male dogfish from 36 to 79 cm have increased steadily since 1980 from about 100 k mt to 300 k mt. (Fig. 6 bottom).

13. As a result of the reductions in mature females from harvest and limited removals of males, the sex ratio of mature male (≥60 cm) to mature female (≥80 cm) dogfish has

changed markedly (Fig. 7). Owing to their earlier maturation, and assuming comparable natural mortality rates between males and females, life history theory suggests that the expected ratio of mature males to females should be about 2:1. Current estimates of the ratio are in the neighborhood of 4:1

B. Stochastic Estimates of Biomass and Fishing Mortality

1. The simple arithmetic average of stock size does not incorporate sampling variations in the underlying survey data or uncertainty in the size of the footprint of the average trawl tow. A stochastic estimator of spawning stock biomass for female dogfish is described in SARC 43. Results of this estimator are depicted in Fig. 8.

2. The mean stochastic SSB estimate for 2008 of 194,616 mt represents an increase form 141,350 mt in 2007. Each estimate includes 3 years of data. The sharp increase is partially due to excluding the 2005 abundance value from the average in the 2008 estimate.

3. The incorporation of a larger average size trawl footprint reduces the target SSB level to 167,800 mt from 200,000 mt.

4. The uncertainty of spawning stock biomass estimate and its relationship to the target and threshold values is depicted in Fig. 8 (top). There is about a 75% probability that the current SSB in 2008 exceeds the target.

5. The cumulative distribution functions for SSB and exploitable biomass of male and female spiny dogfish (Fig. 8 bottom) illustrate the uncertainty in the estimates of biomass. The median total biomass estimate for spiny dogfish is slightly less than 600 k mt. Exploitable biomass is a function of the selectivity pattern in the fishery. Because the recent fishery harvests the largest fish in the population, the exploitable biomass is lower than the spawning stock biomass. Median exploitable biomass of male dogfish is about 300 k mt.

6. The estimator for fishing mortality is based on the ratio of total catch and swept area biomass. Ostensibly this assumes that the trawl is 100% efficient in capturing dogfish between the wings. Alternatively it implies that the trawl is about 50% efficient in capturing dogfish between the doors. An external mass balance model was first applied at SARC 43 and has been recently updated for a chapter in a forthcoming book on spiny dogfish (Gallucci et al. in press, AFS). The mass balance model supports the biomass estimates based on simple swept area concepts. However it is acknowledged that this is a source of uncertainty in the assessment and subject to change at a future benchmark assessment.

7. The derived sampling distribution of fishing mortality on the exploitable population is depicted in Fig. 9. Using the current selectivity pattern, the F on the exploitable female biomass is 0.11—well below the threshold F of 0.39 and the target F (0.284 which gives 1.5 pups per recruit). The 90% confidence interval is (0.08 to 0.154). The current F is roughly equal to the rebuild F=0.11.

8. The threshold biological reference points for fishing mortality is 0.39. This is uncharacteristically high for elasmobranch species but it is explained by the selectivity pattern of the fishery which harvests the largest fish in the population, thereby delaying

the force of mortality to older individuals. The ultimate measure of the effects of varying selectivity patterns are their consequences for net reproductive rate. For spiny dogfish, net reproductive rate is expressed as female pups per recruit. An infinite number of selectivity and fishing mortality rates can generate the same value of pups per recruit. One of the challenges that arises is that shifts in selection toward smaller fish, can rapidly change the estimates of derived full F and the associated biological reference points. As an example, increased harvesting of smaller fish in a directed fishery would shift the force of mortality to younger fish and decrease the biological reference point from 0.39 to much lower values.

9. Overall, the fishing mortality rates on spiny dogfish are very low. Fishing mortality rates on the total biomass are less than 3%.

10. It is important to recognize that the uncertainty in the estimate of F is a function of uncertainty in the survey density estimate, the variability in the footprint size, variability in the recreational catch, and variability in the discards by gear and sex.

C. Harvest Scenarios

1. The projection model for spiny dogfish was revised to incorporate the following changes
    a. A separate F for each sex. This was important because of the spatial segregation of the fishery and to accommodate options that might include changes that target male dogfish offshore.
    b. The model now summarizes landings, discard and catch for each sex. Discards are obtained by multiplying the catch by an average discard fraction by sex.
    c. The average discard fraction was estimated as the ratio of discards to catch in 2007.

2. Current stock status is consistent with projections made at SARC 43. (Fig. 10). Realized SSB estimates 2006, 2007 and 2008 are within the interquartile range of projections made in 2005 under the Frebuild scenario.

3. Six different projections were considered. Four of these are based on fishing mortality rates. The other two are based on fixed quotas. Projections were conducted for 30 years, but to improve readability, the results are only presented for 20 years, to 2027.

4. The F-based projections are based on a Status quo F (=2007), a previously derived Frebuild (=0.11) and the target and threshold Fs equal to the biological reference points (0.284 and 039 respectively).

5. The quota-based projections assume a continuation of the current magnitude of catch. (Quota=Status quo for 2007) and the current catch plus 5000 mt. Neither of these alternatives have any policy standing. They are simply used to illustrate the consequences of a constant catch scenario.

6. Each of the scenarios is summarized by a time series plot of SSB, the ratio of current stock size to the rebuilt status, and either catch or fishing mortality. For the F-based scenarios (Fig. 11-14) , box plots are used to summarize the distributions of total catch, landings, and discards. For quota-based projections (Fig. 15-16), box plots are used to illustrate the distribution of Fs arising from taking a fixed quota each year.

7. Each scenario is also summarized with a table that illustrates the30 year trend in average stock size, landings, and discards by sex. (Tables 2-7). The table also includes three ratio estimates of stock performance. The first is a measure of the average ratio of SSB to the reference SSB. The second and third represent the fraction of the simulations in which population size exceeds either the target or threshold SSB values.

8. All of the scenarios assume that survival of pups is at average longterm values (0.68 based on model described in SARC 19). All of the projections will be optimistic if this assumption is not true. Scenarios with alternative values of pup survival have not been run but it is safe to say that the long term population biomass will scale proportionally to the magnitude of pup survival. For example, a harvest rates that leads a longterm population size of 200 k mt when pup survival is 0 .68 would be 100 k mt if pup survival were 0.34.

9. A common feature of all the scenarios is an oscillation as the present population increases through growth and declines as the last decade's low recruitment feeds into the adult population. Only after the new recruits begin to contribute to the population does the population continue its rebuilding path.

10. F-Status quo Projection. Fig. 11 and Table 2 Under this scenario, F=0.11042 results in continued increase in SSB through 2011 followed by a gradual decline to below the target SSB by 2016. The population is predicted to begin increasing steadily after a low point in 2017. Based on the projections, the population is expected to remain above the threshold biomass level over the entire period. Landings would be expected to increase gradually over the projection period.

11. F-Rebuild Projection. Fig. 12 and Table 3. The F-rebuild scenario is essentially equal to the status quo. The only difference is that the fishing mortality rate on males is slightly higher. For the Frebuild, Ftarget and Fthreshold values, the male mortality rate was assumed to be 10% of the F on females. In this example the increase in F on males is about 30% higher than in the status quo F projection. (ie. 0.011 vs 0.00836).

12. F-target Projection. Fig. 13 and Table 4. The target F is expected to result in a PPR of 1.5. At the current selectivity pattern the target F is 0.284. Male F was assumed to be 10% of the female F or 0.0284. The population oscillations are more pronounced under this scenario as the population is fished down from its currently rebuilt status. Landings would exceed 12 k mt through 2012 but would fall rapidly to about 8.9 k mt in 2017. The population is expected to fall below the SSB threshold in that year because the low number of recruits have not yet been replaced by predicted recruits from 2007 to 2016. Longer term projections suggest that the oscillations would be expected to continue for several cycles before rebuilding.

13. F-threshold Projection. Fig. 14 and Table 5. A fishing mortality of 0.39 would rapidly fish down the reproductive stock to below rebuilt status by 2013 and induce longterm oscillations in the population. An overfished condition would likely occur by 2016; if the high rate of F continued the population would probably not return to rebuilt status over any reasonable forecast period.

14. Q Status Quo Projection Fig 15 and Table 6. In this scenario total landings would continue at about 5600 mt and the population would continue to rebuild. Fishing

mortality would continue to decline and remain well below the target and threshold F levels. The stock would remain above B target for the entire projection period.

15. Q Status Quo Projection Fig.16 and Table 7. In contrast to the status quo catch projection, the addition of 5,000 mt results in the stock falling below rebuilt status in 2015-2019 and much more variable fishing mortality rates. The likelihood of exceeding the threshold F is present but remote during those same years. The interquartile range of predicted Fs is predicted to remain below the target F.

Summary

The stochastic spawning stock biomass estimates for 2008 suggests that the spiny dogfish population exceeds the target biomass of 167.8 k mt. The average stochastic SSB estimate is 194.6 k mt and 75% of the computed values exceeded the target biomass. The 90% confidence interval for SSB in 2008 is 133 to 257 k mt.

The most recent stochastic estimate of fishing mortality for spiny dogfish stock indicates that *overfishing is not occurring* (probability that $F_{2006} < F_{threshold} \approx 100\%$). Total removals in 2007 were approximately *12,136 mt* corresponding to an F estimate of 0.1104 well below the overfishing threshold of F = 0.39 and essentially equivalent to $F_{rebuild} = 0.11$. Among the sources of removals, U.S. commercial landings comprised 3,524 mt, Canadian commercial landings were 2,328 mt, U.S. commercial discards were 6,247 mt, of which U.S. recreational dead discards were 861 mt.

The determination of rebuilt status is not without problems. The size frequency of the female population is concentrated between 75 and 95 cm with very few fish above 100 cm or below 70 cm. The low numbers of juvenile female and male dogfish imply that the population will oscillate over time. The decline will be induced by the sequence of poor recruits from the last ten years. In other words the recruitment deficit will have to be paid back.

SSB should increase again IF pup survival rates begin to increase. Recruitment in the past 5 years has been modest but well below expectations. The consequences of the skewed sex ratio of 4:1 for mature males to mature females has unknown implications for future reproductive success.

Distributional shifts and the influence of environmental correlates may have contributed to underestimates of biomass in 2003 - 2005. While measures of within-year sampling variability have remained fairly stable throughout the survey time series, inter-annual variability in survey-based biomass estimates require smoothing across years in order to characterize population trends.

References

43rd Northeast Regional Stock Assessment Workshop (43rd SAW): 43rd SAW assessment report. US Dep Commer, Northeast Fish Sci Cent Ref Doc 06-25; 400 p.

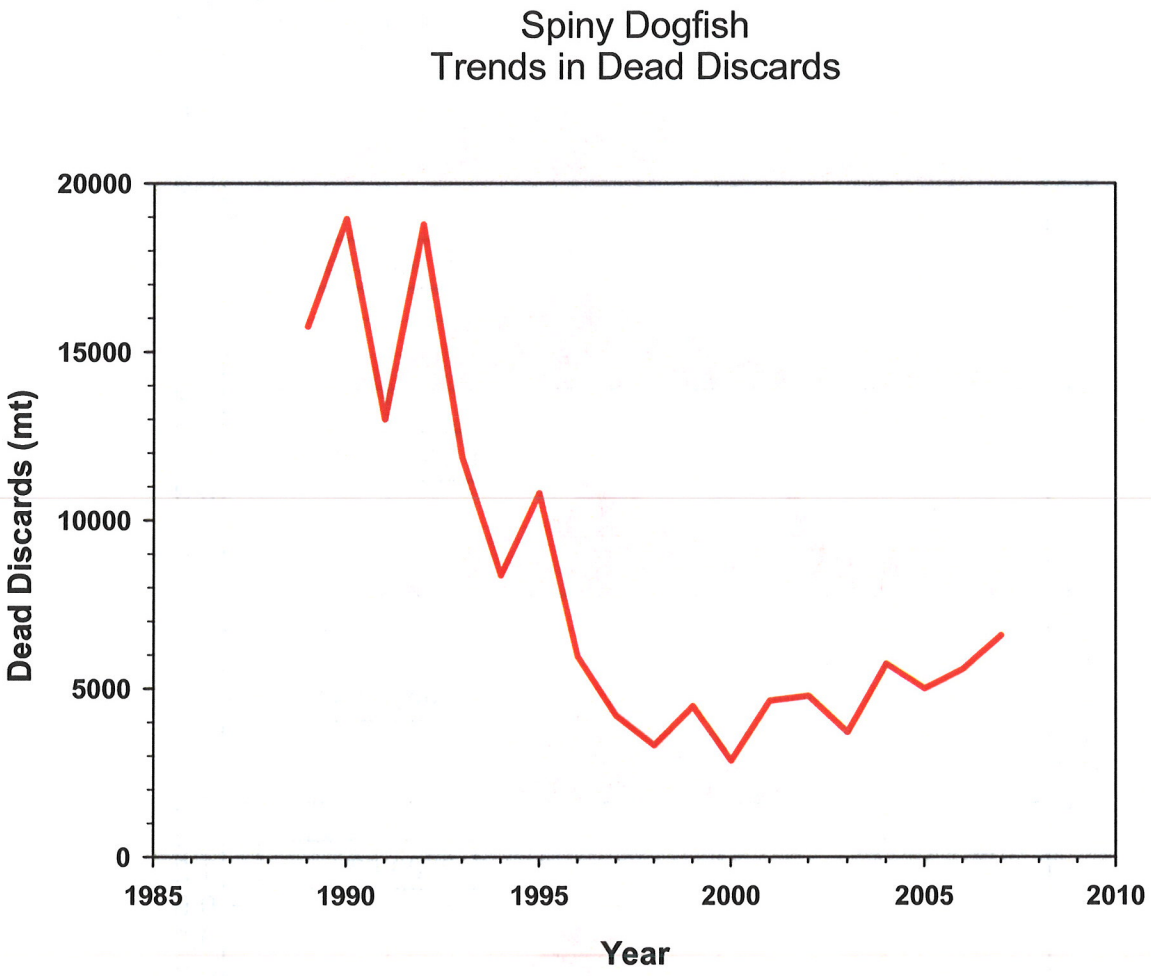


Fig. 1. Estimated dead discards (mt) 1989-2007. Discard estimates are multiplied by gear-specific mortality rates and summed over gears.

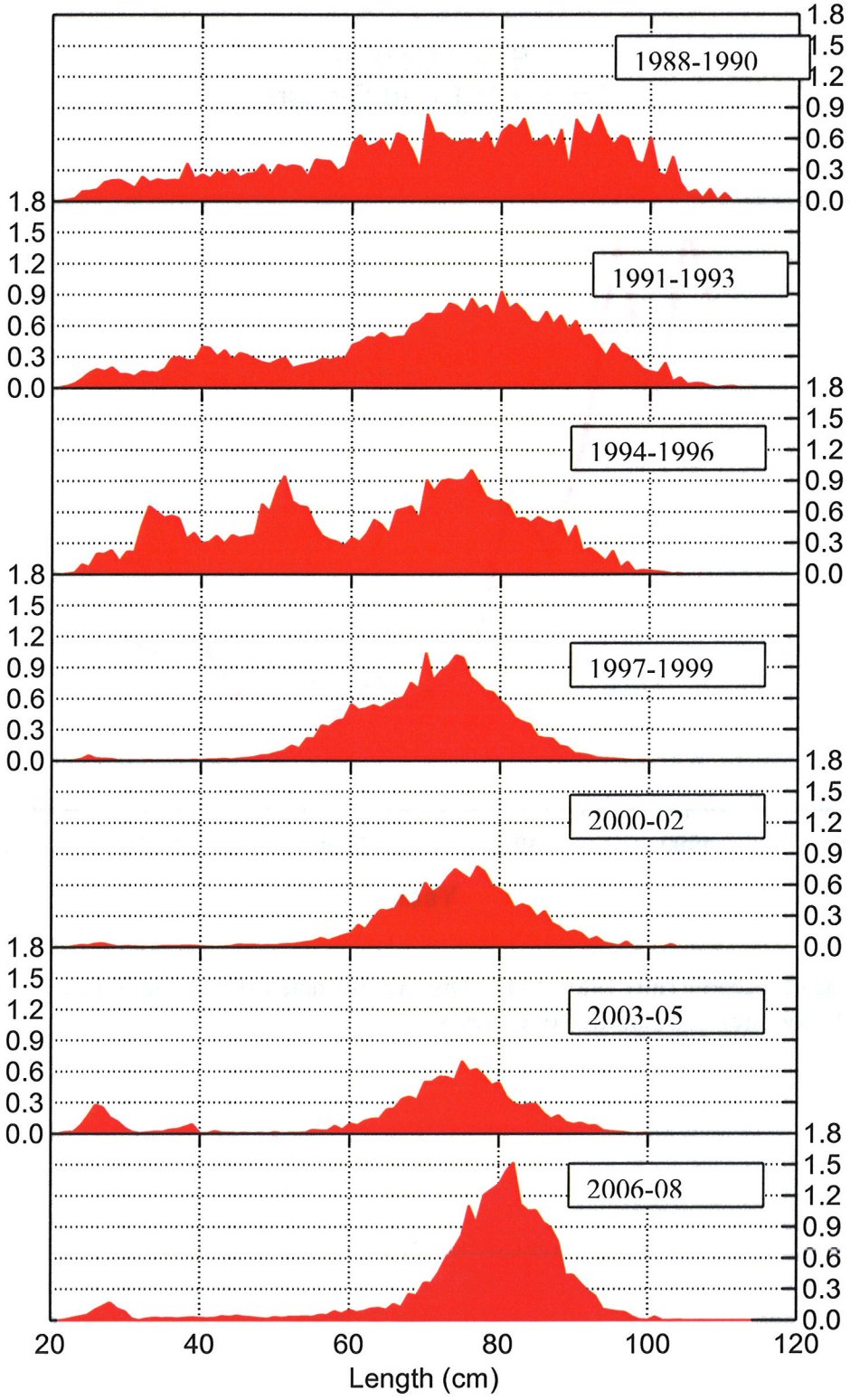


Fig. 2. **Number of female spiny dogfish per tow by 1 cm length class in NEFSC Spring Bottom Trawl Survey by 3-yr period, 1988-2008.**

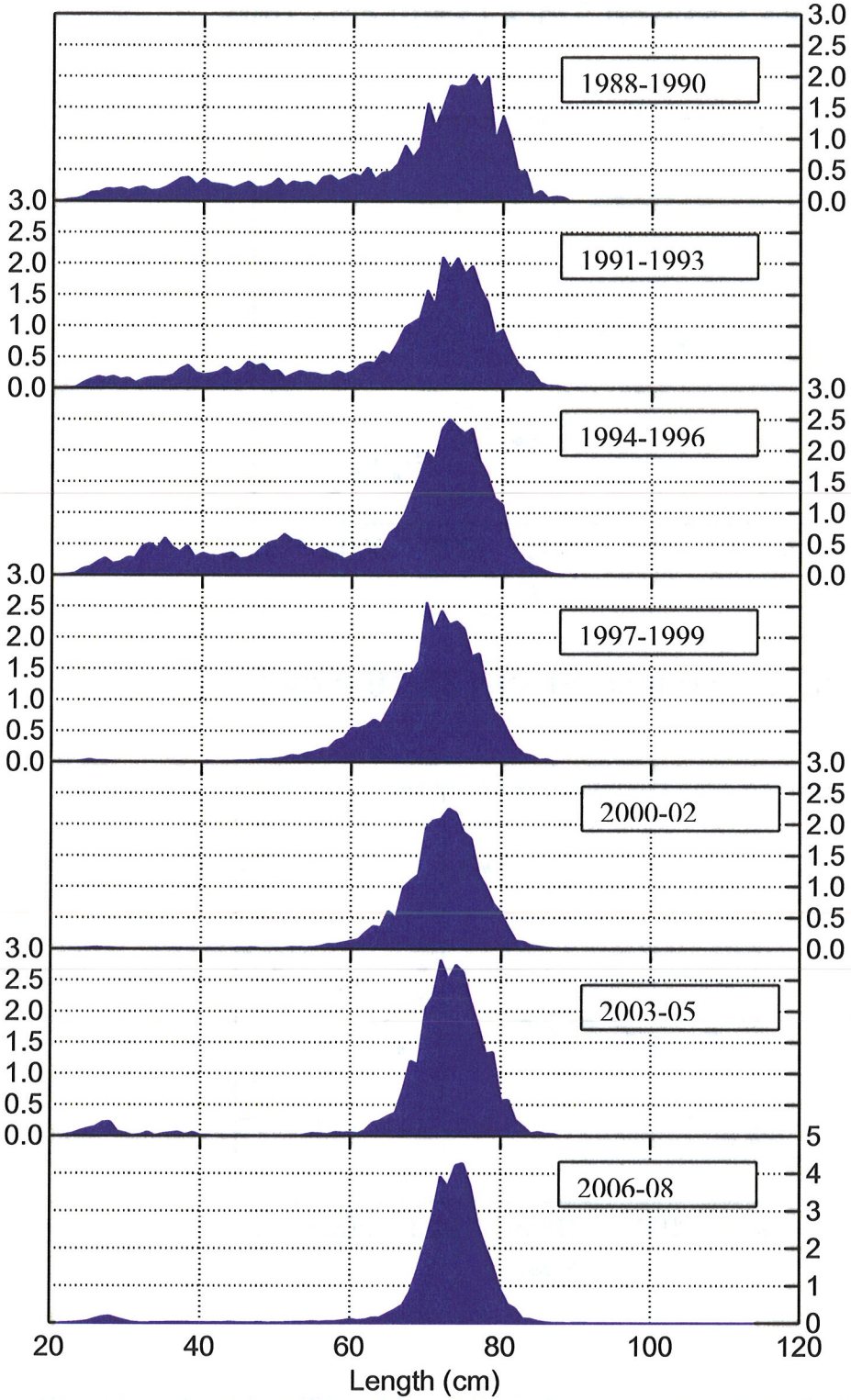
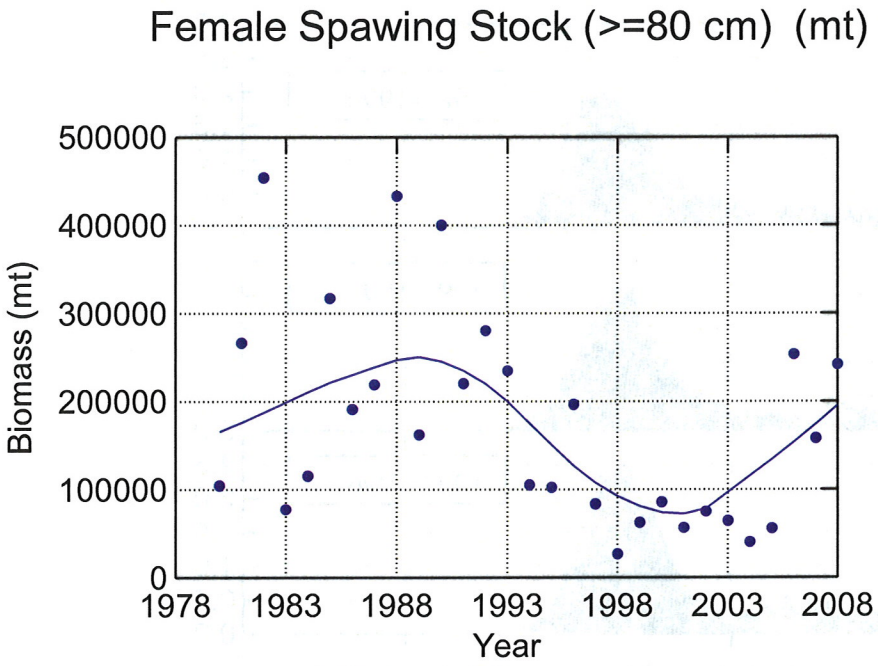


Fig. 3. **Number of male spiny dogfish per tow by 1 cm length class in NEFSC Spring Bottom Trawl Survey by 3-yr period, 1988-2008. Not the scale change for 2006-08.**



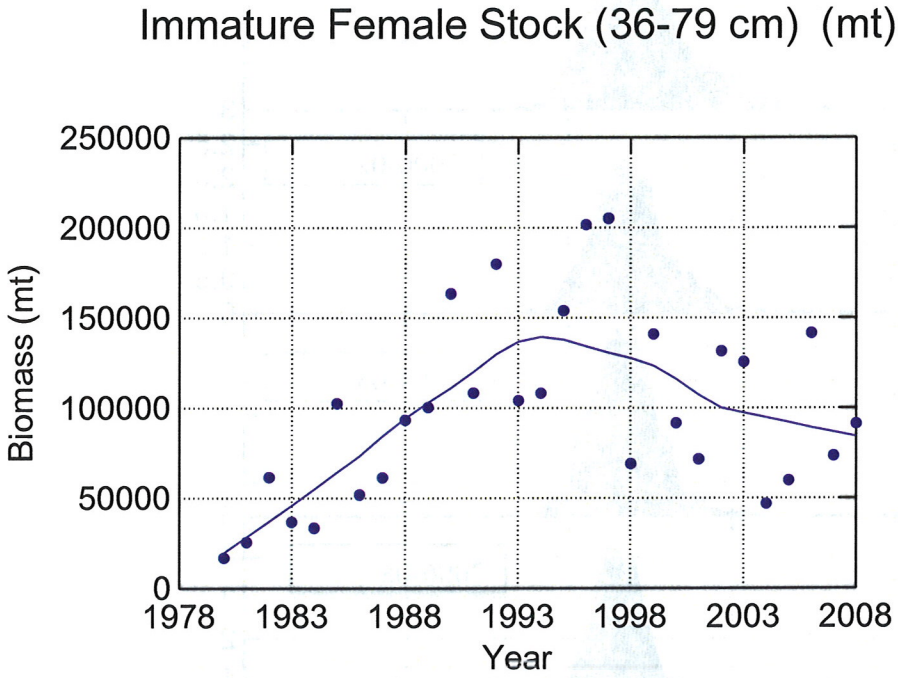


Fig. 4 **Swept area biomass of female dogfish 80 cm and greater (top) and biomass of female dogfish 36-79 cm (bottom), based on NEFSC Spring Bottom Trawl Survey, 1980-2008.**

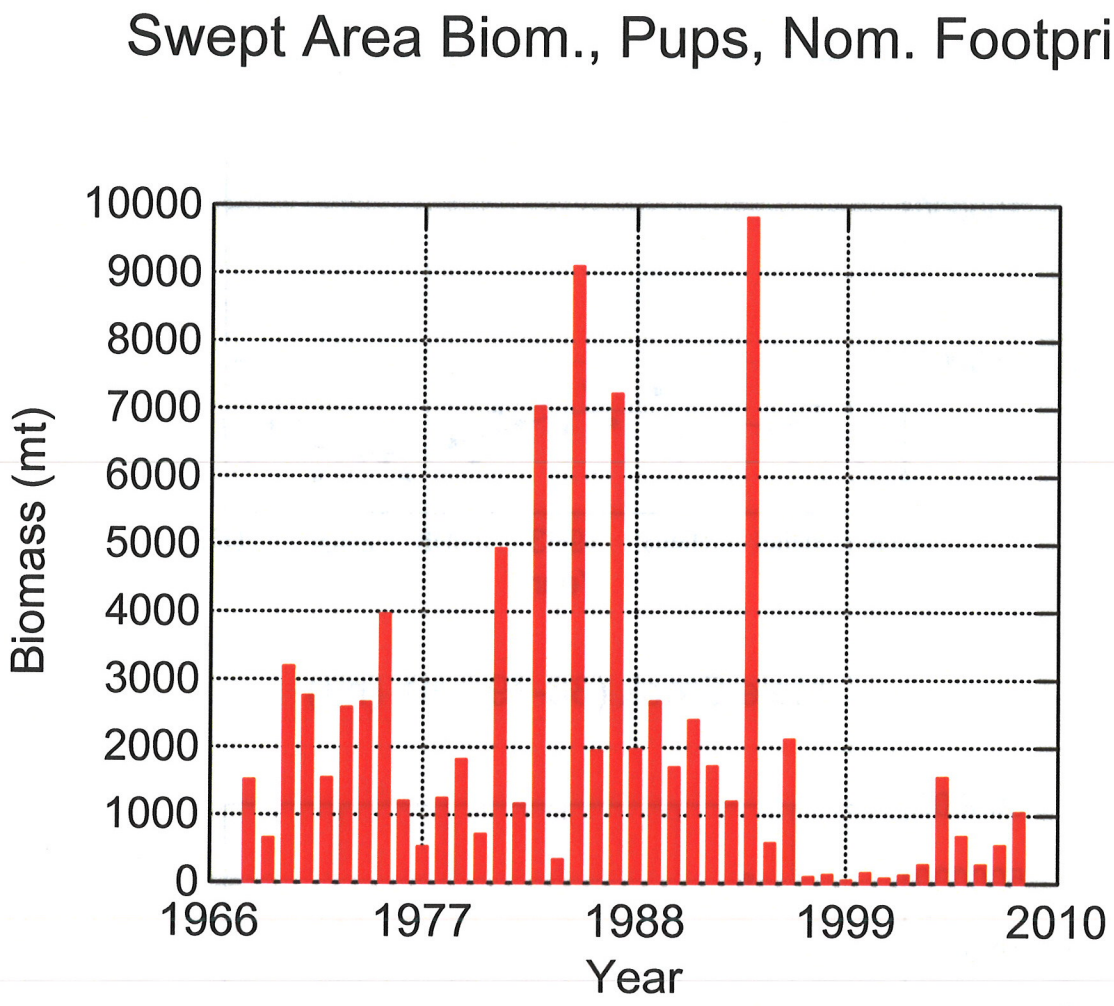


Fig. 5 **Swept area biomass of spiny dogfish recruits (< 1 yr old and < 36 cm TL), based on NEFSC Spring Bottom Trawl Survey, 1968-2008. both sexes combined.**

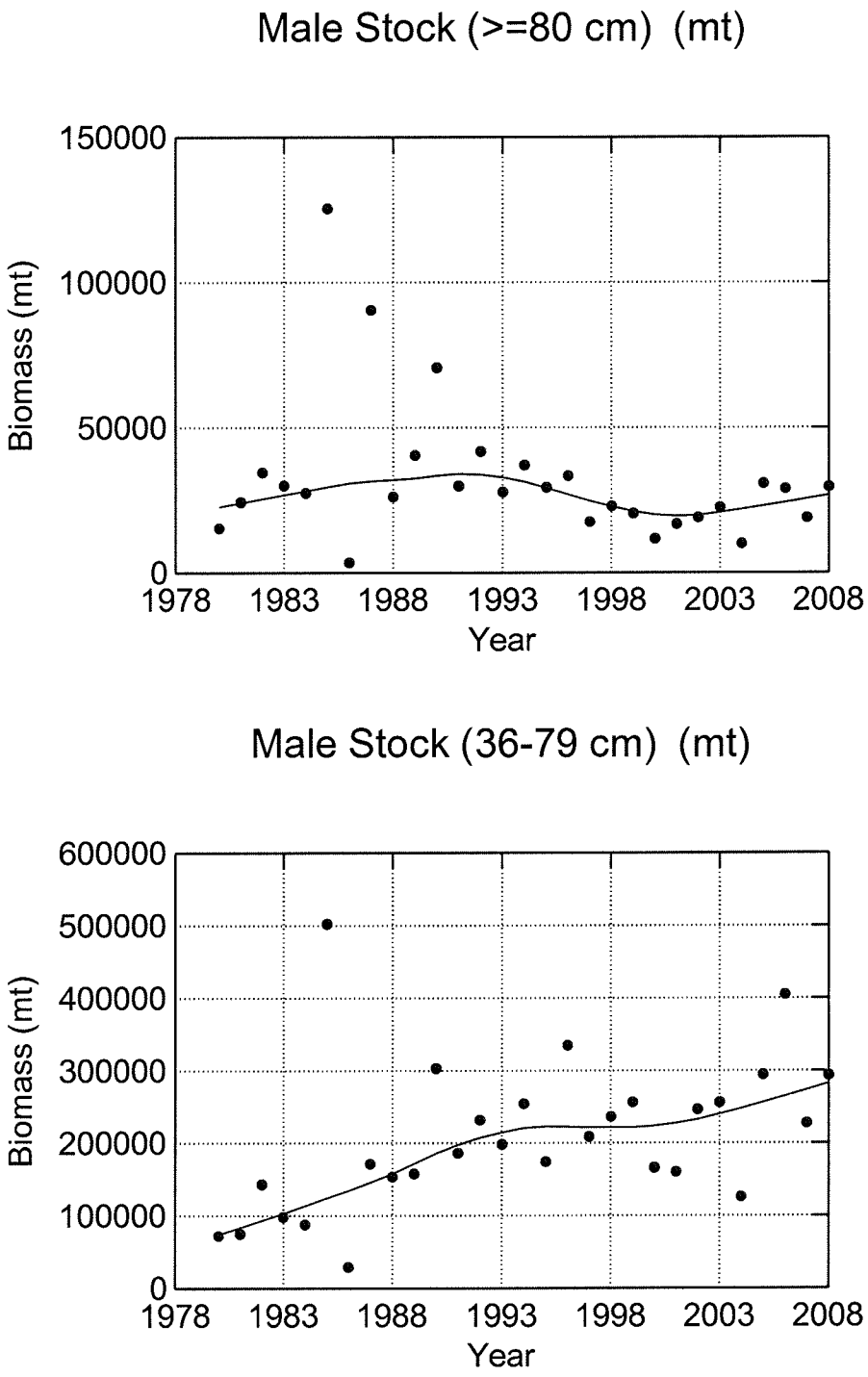


Fig. 6. **Swept area biomass of male dogfish 80 cm and greater (top) and biomass of male dogfish 36-79 cm (bottom), based on NEFSC Spring Bottom Trawl Survey, 1980-2008.**

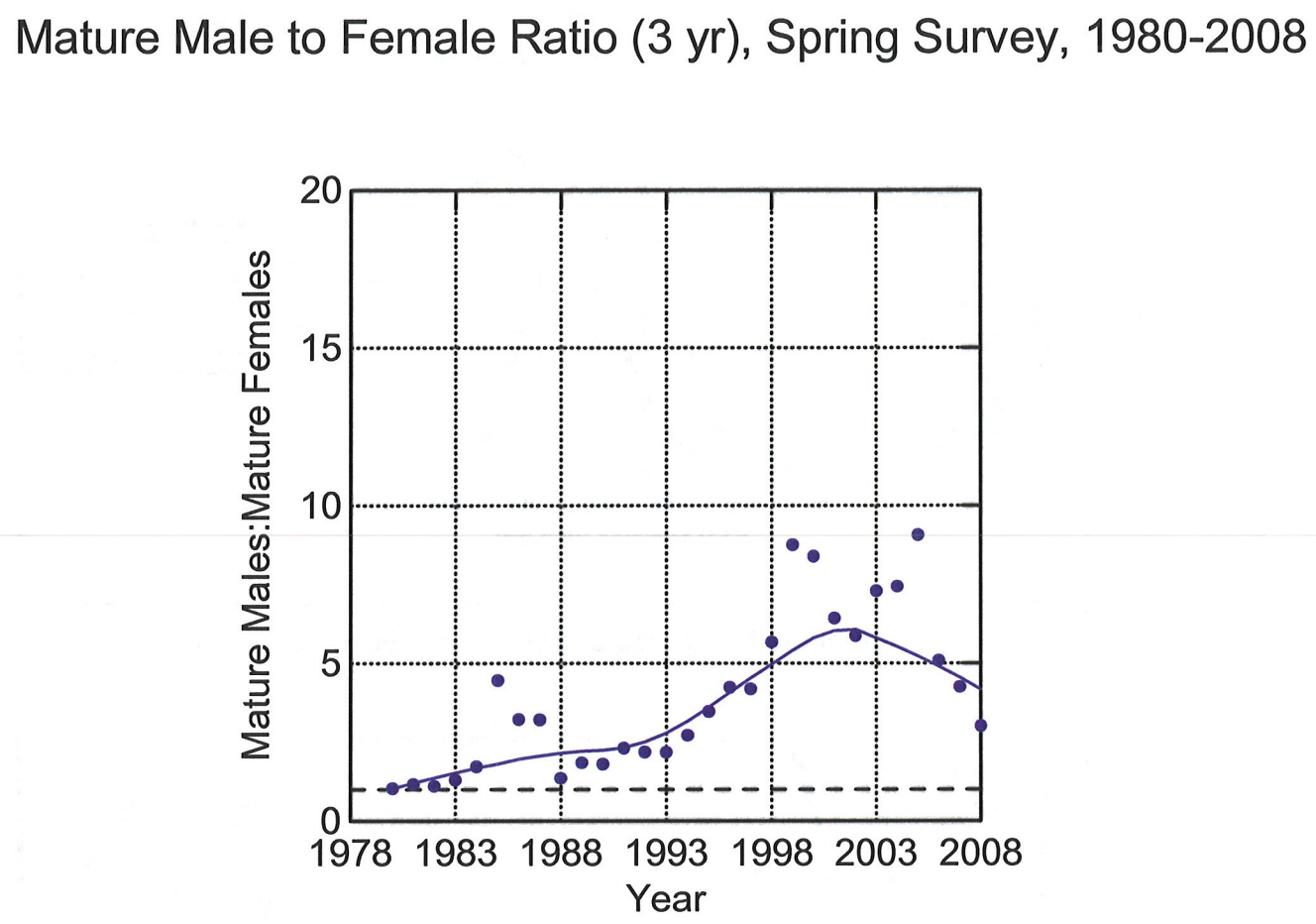
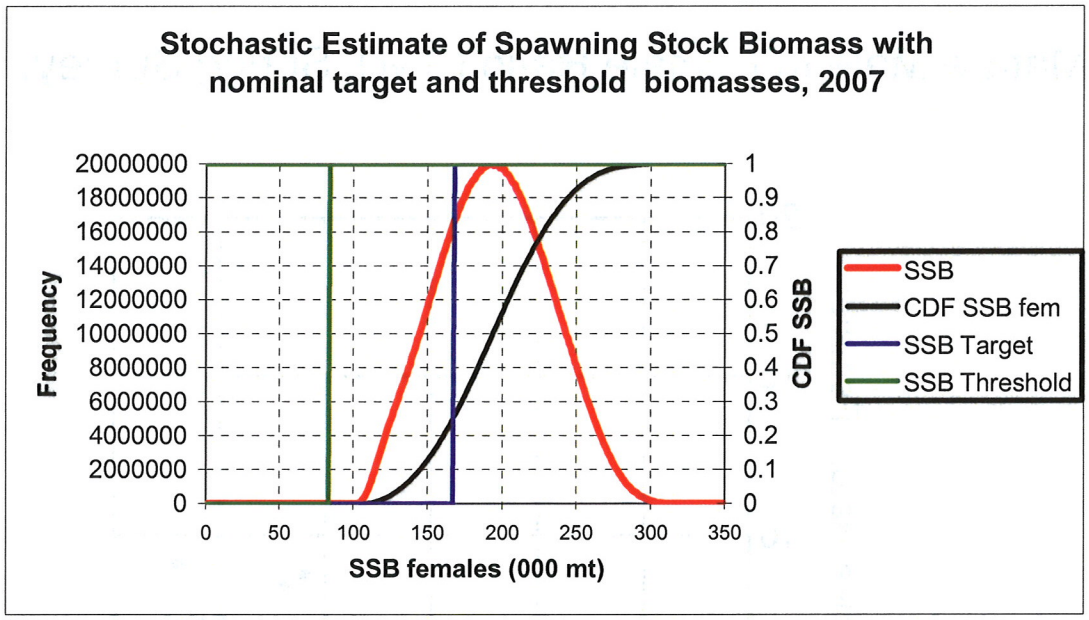


Fig. 7. Ratio of number of mature male (>60 cm) to mature female (>80 cm) spiny dogfish in NEFSC Spring Bottom Trawl Surveys, 1980-2008. Line represents LOWESS smooth with tension =0.5.



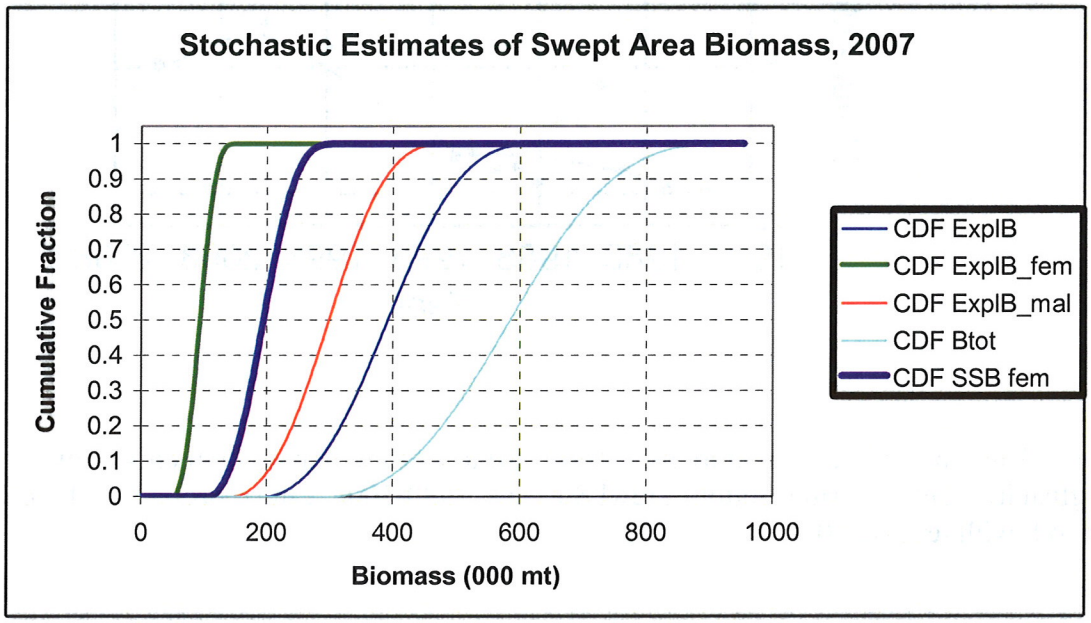
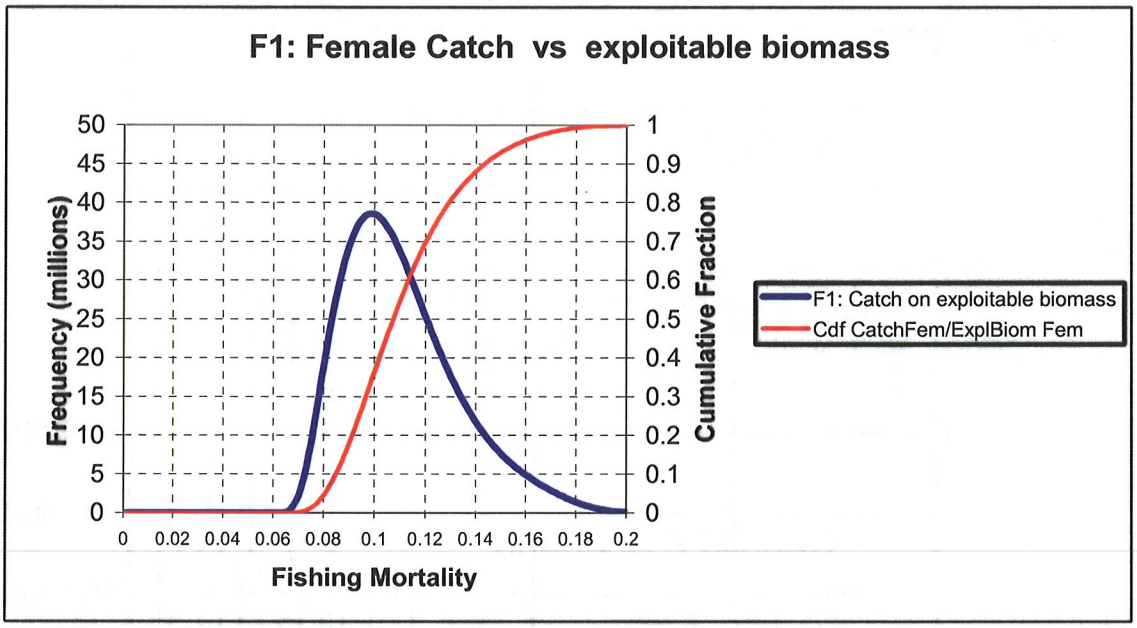


Fig 8. Estimates of female spawning stock biomass (top) and cumulative distribution functions for exploitable male and female biomass of spiny dogfish, for the 2006-2008 survey period.



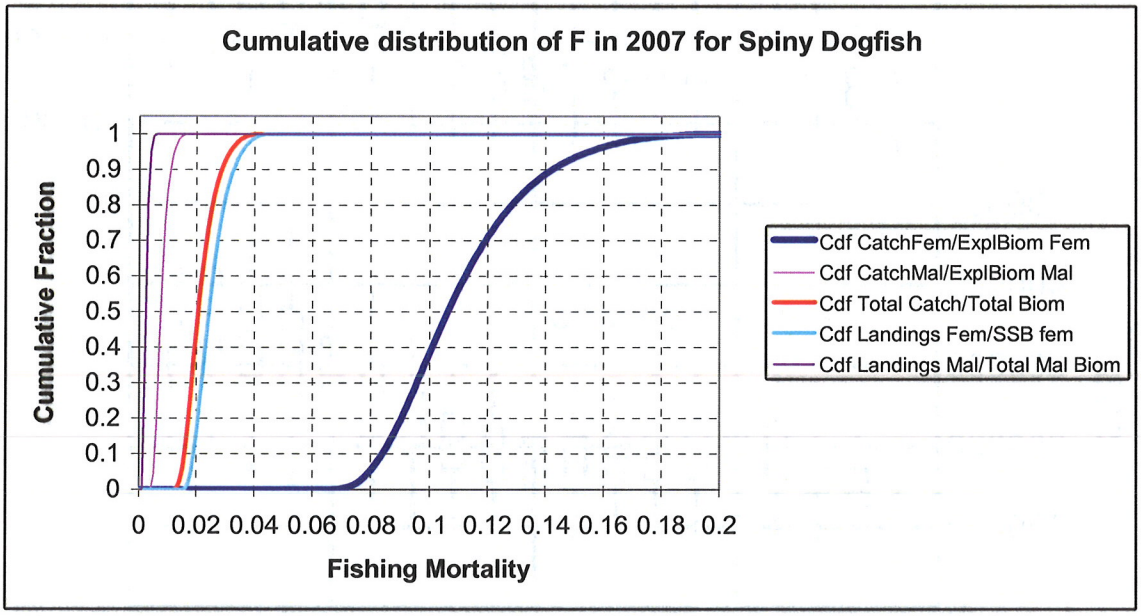


Fig. 9. Stochastic estimates of fishing mortality on spiny dogfish, 2007

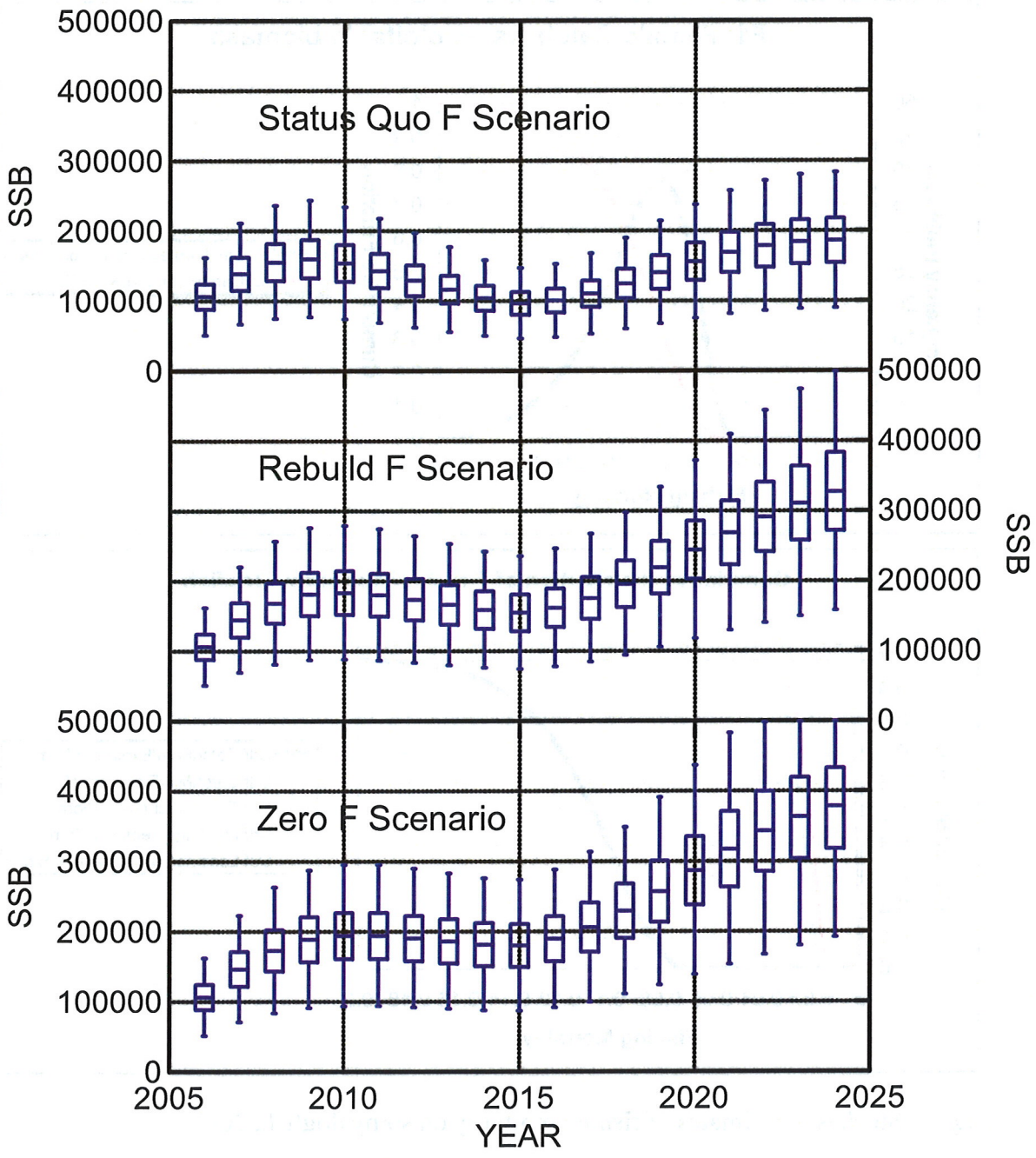


Fig. 10. **(Formerly Fig. 11. SARC 43, 2006.) Spiny dogfish spawning stock projections, 2006-2024, for three alternative scenarios: Status quo (full F=0.128), Rebuild F (0.03), and Zero F. Boxes represent interquartile ranges.**

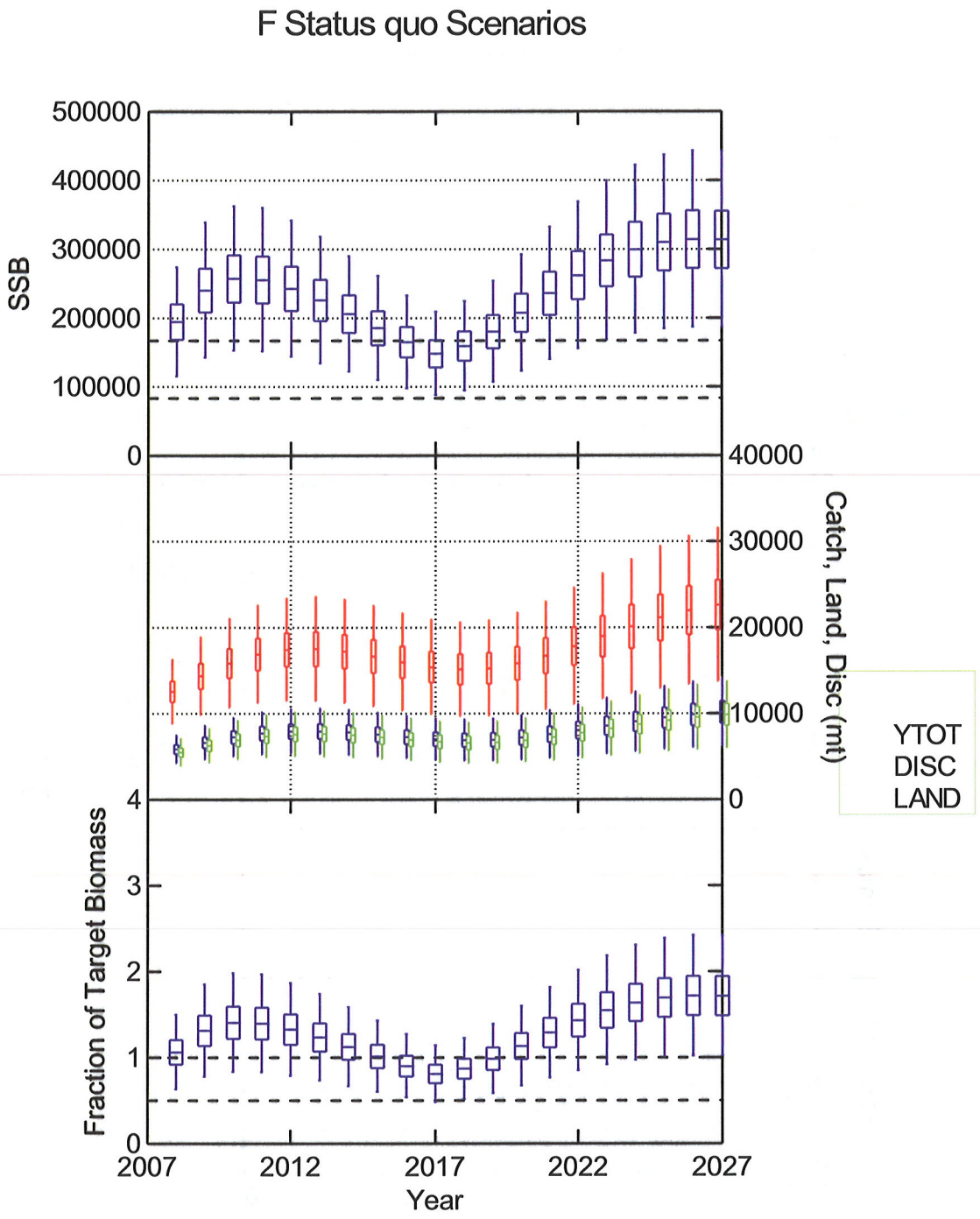


Fig 11. Predicted spawning stock biomass, catch, landings, discards, and ratio of SSB(t) to target biomass (167.5 k mt), 2008-2027 based on constant F harvest policy = F status quo. See Table 2

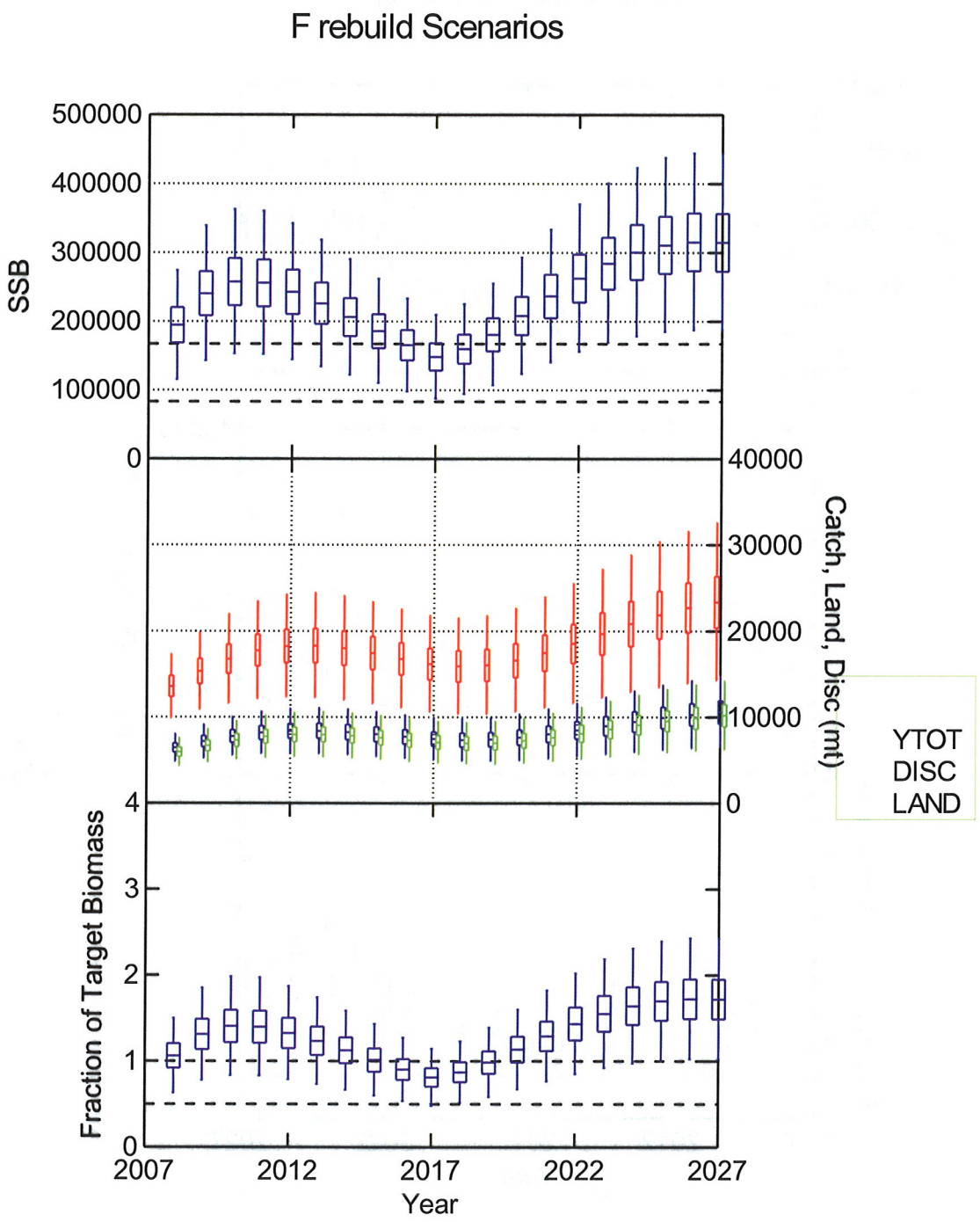


Fig 12. Predicted spawning stock biomass, catch, landings, discards, and ratio of SSB(t) to target biomass (167.5 k mt), 2008-2027 based on constant F harvest policy = F rebuild, See Table 3 .

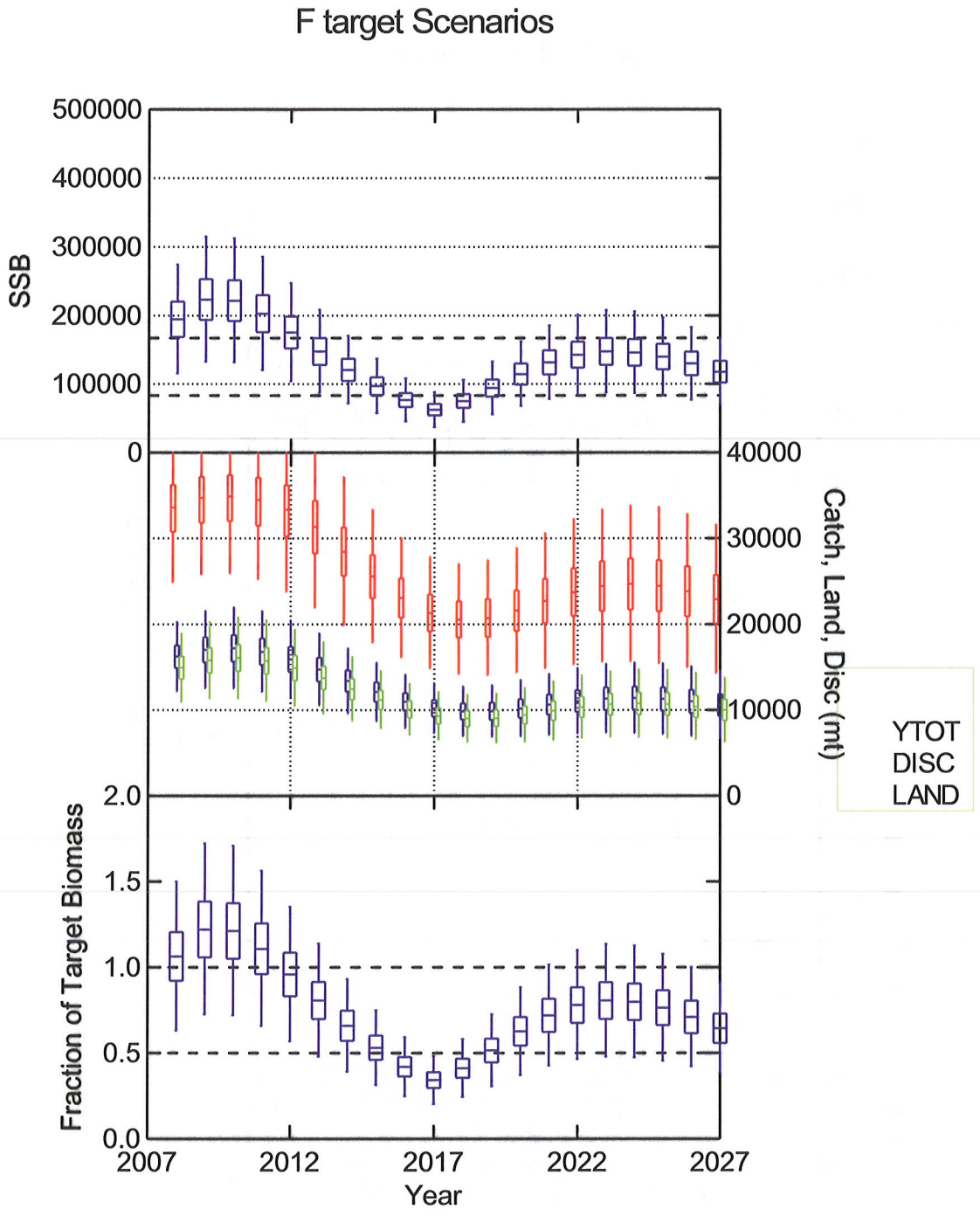


Fig 13. Predicted spawning stock biomass, catch, landings, discards, and ratio of SSB(t) to target biomass (167.5 k mt), 2008-2027 based on constant F harvest policy = Ftarget=0.284. See Table 4.

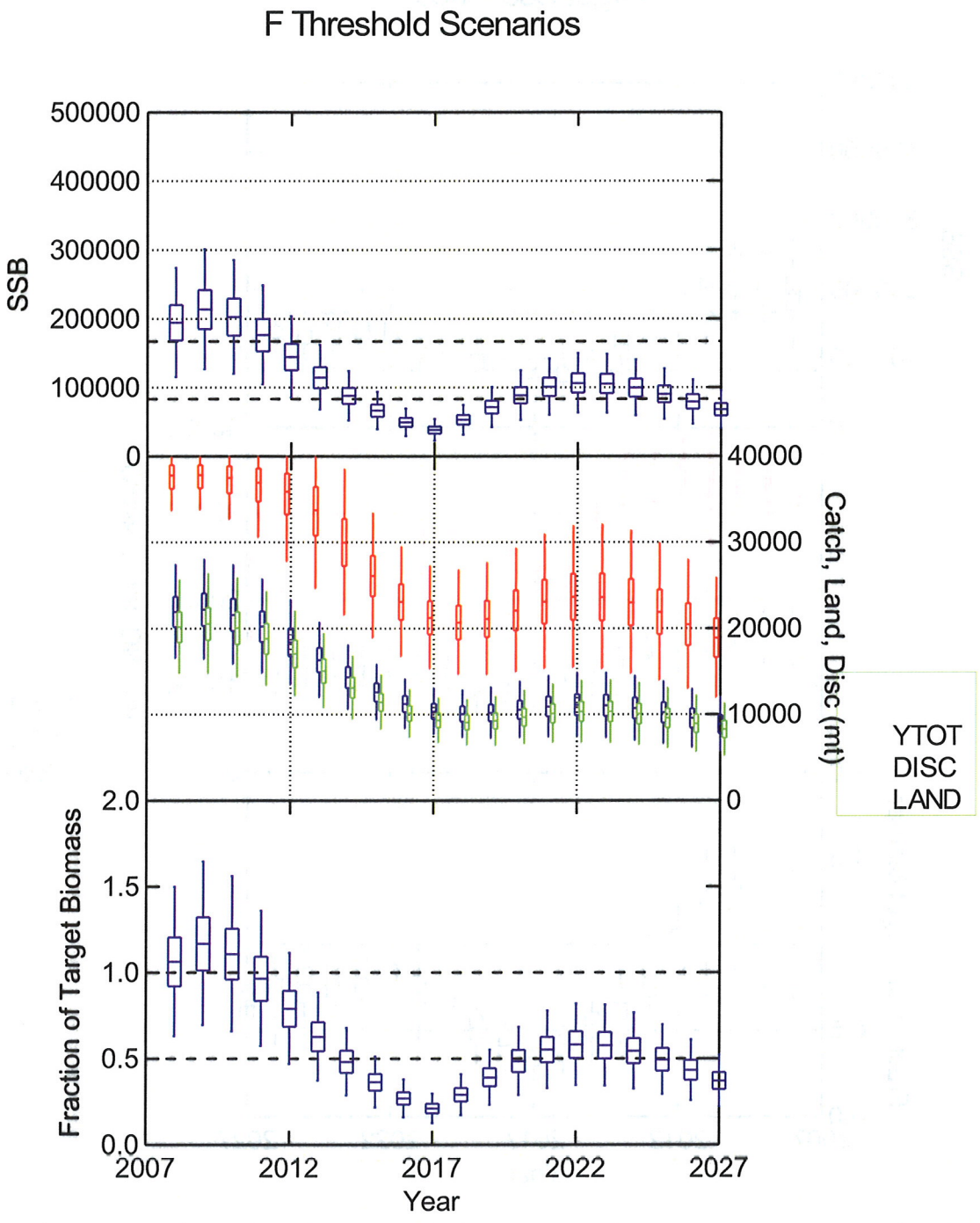


Fig 14. Predicted spawning stock biomass, catch, landings, discards, and ratio of SSB(t) to target biomass (167.5 k mt), 2008-2027 based on constant F harvest policy = Fthreshold=0.39, See Table 5.

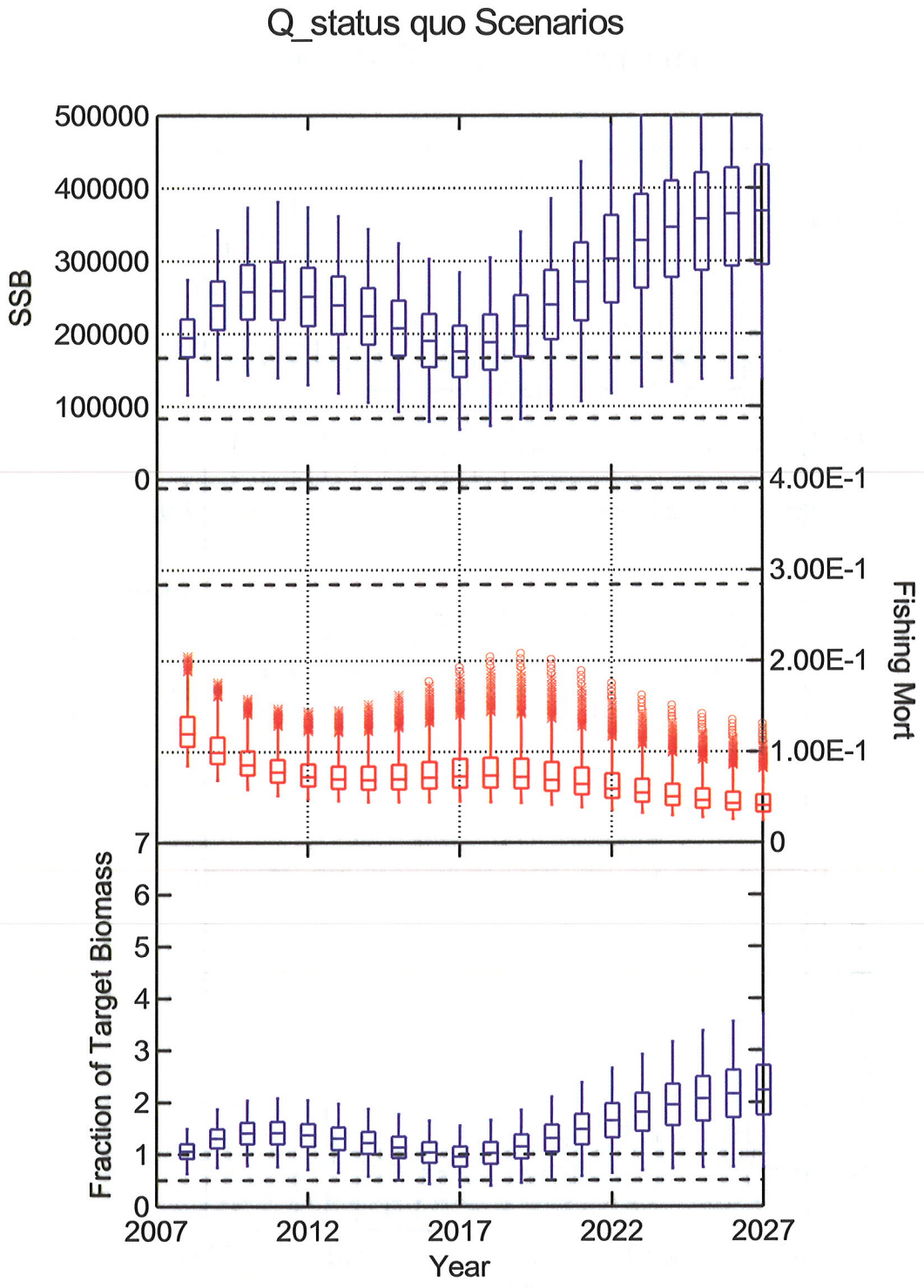


Fig 15. Predicted spawning stock biomass, fishing mortality rate, and ratio of SSB(t) to target biomass (167.5 k mt), 2008-2027 based on constant quota harvest policy = 2007 total catch, See Table 6. Dashed lines represent target and threshold BRPa.

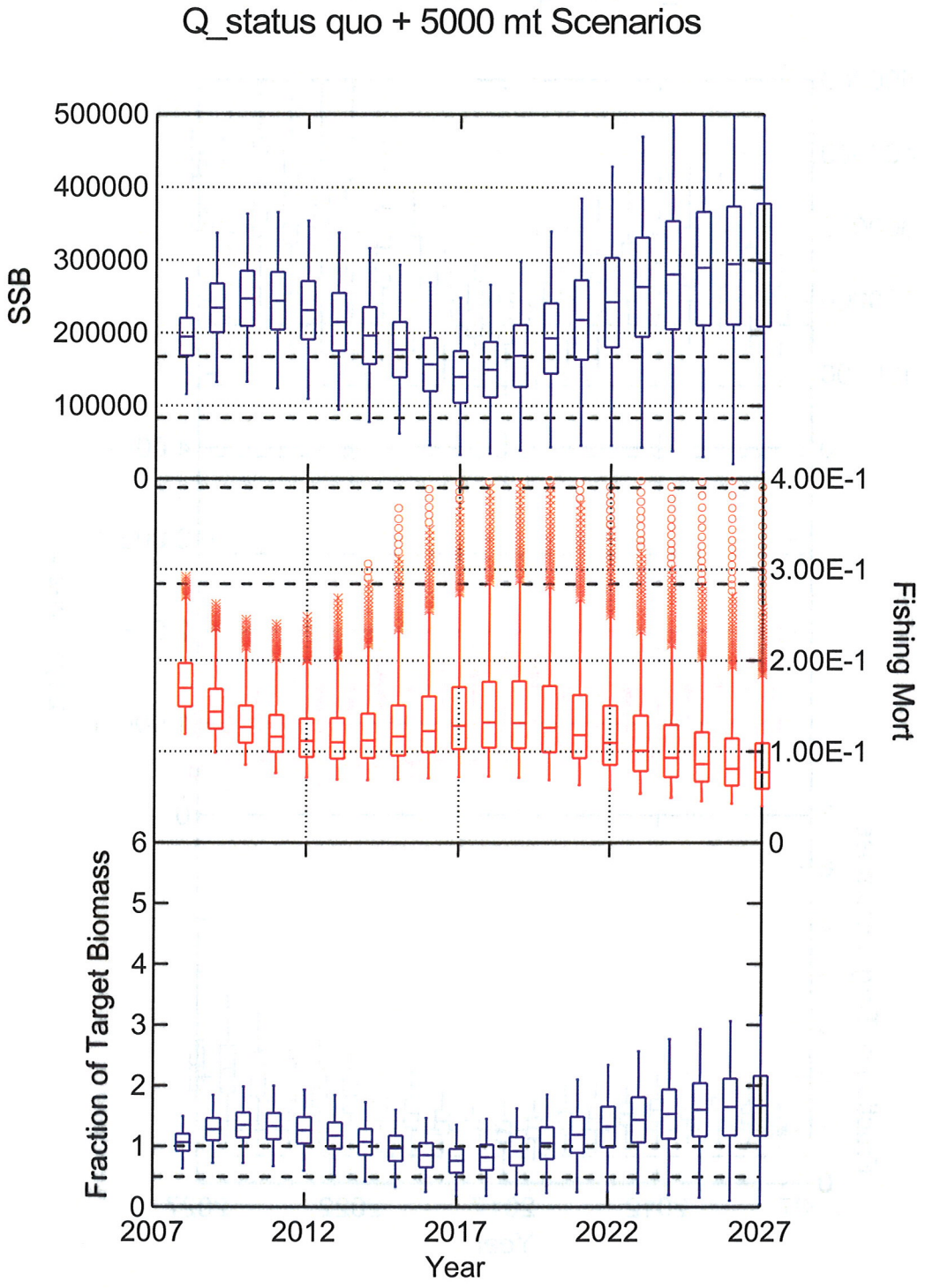


Fig 16. Predicted spawning stock biomass, fishing mortality rate, and ratio of SSB(t) to target biomass (167.5 k mt), 2008-2027 based on constant quota harvest policy = 2007 total catch PLUS 5,000 mt. See Table 7. Dashed lines represent target and threshold BRP.

Table 1. Biomass estimates for spiny dogfish (thousands of metric tons) based on area swept by NEFSC trawl during spring surveys, 1968-2008. Estimates based on nominal survey trawl footprint of 0.01 nm^2.

Year	Lengths >= 80 cm			Lengths 36 to 79 cm			Length <= 35 cm			All Lengths	3-pt avg
	Females	Males	Total	Females	Males	Total	Females	Males	Total		Fem SSB
1968			41.4			110.4			1.52	153.3	
1969			27.4			69.3			0.66	97.3	
1970			36.7			33.0			3.19	72.9	
1971			103.8			27.6			2.76	134.2	
1972			126.6			145.9			1.55	274.1	
1973			178.7			165.3			2.58	346.5	
1974			221.9			179.6			2.66	404.1	
1975			105.1			125.0			3.97	234.0	
1976			96.3			120.8			1.20	218.3	
1977			77.3			68.0			0.53	145.9	
1978			87.4			131.2			1.24	219.8	
1979			52.3			18.6			1.82	72.7	
1980	104.7	15.3	168.1	16.8	72.2	123.5	0.32	0.39	0.84	292.4	104.7
1981	266.5	24.4	293.8	25.5	75.1	100.6	2.14	2.80	5.06	399.5	185.6
1982	454.0	34.6	488.6	61.6	143.3	204.9	0.48	0.69	1.17	694.6	275.1
1983	77.7	30.1	107.8	36.7	98.5	135.3	3.09	3.95	7.03	250.1	266.1
1984	115.6	27.5	143.1	33.4	88.0	121.4	0.14	0.21	0.35	264.9	215.8
1985	317.0	125.5	442.6	102.5	502.5	605.0	4.01	5.10	9.10	1056.7	170.1
1986	191.3	3.5	194.8	51.9	29.6	81.5	0.84	1.11	1.96	278.2	208.0
1987	219.1	90.5	309.6	61.5	171.7	233.1	2.46	4.76	7.22	550.0	242.5
1988	433.1	26.2	459.4	93.3	153.6	247.0	0.89	1.09	1.98	708.4	281.2
1989	162.1	40.5	202.6	100.4	158.2	258.6	1.14	1.54	2.68	463.9	271.5
1990	400.3	70.7	471.0	163.5	303.1	466.6	0.68	1.03	1.71	939.3	331.8
1991	220.4	30.0	250.3	108.4	186.3	294.7	0.98	1.43	2.41	547.4	260.9
1992	280.5	41.9	322.4	179.9	231.9	411.8	0.73	1.00	1.73	735.9	300.4
1993	234.6	27.8	262.5	104.1	198.5	302.6	0.55	0.65	1.21	566.3	245.2
1994	105.3	37.1	142.4	108.3	254.2	362.5	4.28	5.54	9.82	514.8	206.8
1995	102.4	29.5	131.9	154.0	174.5	328.5	0.25	0.35	0.59	460.9	147.5
1996	196.5	33.4	229.9	201.7	334.8	536.4	0.98	1.14	2.12	768.5	134.7
1997	83.7	17.5	101.2	205.2	209.1	414.3	0.05	0.05	0.10	515.5	127.5
1998	26.7	22.9	49.7	69.0	236.4	305.4	0.05	0.08	0.13	355.2	102.3
1999	62.7	20.4	83.1	140.8	256.4	397.2	0.02	0.03	0.05	480.4	57.7
2000	85.8	11.7	97.5	91.5	166.2	257.7	0.07	0.09	0.16	355.4	58.4
2001	56.7	16.7	73.4	71.4	160.5	231.9	0.04	0.03	0.07	305.4	68.4
2002	75.2	19.0	94.2	131.5	246.3	377.8	0.06	0.06	0.12	472.1	72.5
2003	64.5	22.5	87.1	125.5	256.3	381.8	0.13	0.14	0.27	469.1	65.5
2004	40.4	10.0	50.3	46.9	126.2	173.1	0.66	0.91	1.56	225.0	60.0
2005	55.8	30.8	86.6	59.8	294.7	354.5	0.28	0.42	0.69	441.9	53.6
2006	253.4	29.0	282.5	141.6	406.5	548.1	0.10	0.17	0.27	830.8	116.6
2007	158.0	18.9	176.9	73.6	227.6	301.1	0.23	0.32	0.56	478.6	155.8
2008	241.7	29.6	271.4	91.2	293.7	385.0	0.47	0.59	1.05	657.4	217.7

Notes: Total equals sum of males and females plus unsexed dogfish. Data for dogfish prior to 1980 are currently not available by sex.

Entries in the above table are based on a nominal trawl survey footprint of 0.01 nm^2. A simple 3-yr moving average is used to estimate female SSB. The biological reference point for this estimate of stock size is 200,000 mt.

Table 2. Summary of stochastic projections for spiny dogfish under a constant F harvest strategy equal to F2008_status quo=0.11 for 2008 to 2037. Table entries are means of predicted values

Scenario = FstatusQuo

	Average												
Year	F on females	F on males	SSB (mt)	Total Catch (mt)	Total Landing (mt)	Female Landings (mt)	Male Landings (mt)	Total Discards (mt)	Female Discards (mt)	Male Discards (mt)	SSB(t)/ SSB_target	Probabilty (SSB>SSB_target)	Probabilty (SSB> SSB_thresh)
2008	0.110	0.008	194,577	12,542	6,681	5,200	1,480	5,862	3,995	1,867	1.064	0.618	1
2009	0.110	0.008	240,326	14,352	7,718	6,289	1,429	6,634	4,831	1,803	1.314	0.892	1.000
2010	0.110	0.008	257,225	15,846	8,581	7,216	1,365	7,265	5,543	1,723	1.407	0.938	1.000
2011	0.110	0.008	255,578	16,886	9,187	7,884	1,303	7,699	6,056	1,643	1.398	0.934	1.000
2012	0.110	0.008	242,619	17,417	9,499	8,240	1,260	7,918	6,329	1,589	1.327	0.900	1.000
2013	0.110	0.008	225,837	17,504	9,555	8,322	1,234	7,948	6,392	1,556	1.235	0.834	1.000
2014	0.110	0.008	205,884	17,208	9,391	8,169	1,222	7,817	6,275	1,542	1.126	0.714	1.000
2015	0.110	0.008	185,533	16,655	9,079	7,859	1,220	7,576	6,037	1,539	1.015	0.528	1.000
2016	0.110	0.008	165,142	15,986	8,701	7,482	1,219	7,285	5,747	1,538	0.903	0.294	1.000
2017	0.110	0.008	148,286	15,400	8,370	7,153	1,217	7,030	5,495	1,535	0.811	0.114	0.994
2018	0.110	0.008	159,350	15,133	8,220	7,007	1,213	6,913	5,382	1,531	0.871	0.226	1.000
2019	0.110	0.008	180,361	15,263	8,295	7,087	1,208	6,968	5,443	1,524	0.986	0.472	1.000
2020	0.110	0.008	207,556	15,830	8,618	7,417	1,201	7,212	5,697	1,515	1.135	0.726	1.000
2021	0.110	0.008	235,995	16,725	9,127	7,935	1,192	7,598	6,095	1,503	1.291	0.878	1.000
2022	0.110	0.008	261,975	17,813	9,745	8,564	1,181	8,068	6,578	1,490	1.433	0.948	1.000
2023	0.110	0.008	283,596	18,972	10,403	9,230	1,173	8,569	7,090	1,479	1.551	0.980	1.000
2024	0.110	0.008	299,689	20,112	11,049	9,880	1,169	9,064	7,589	1,475	1.639	0.994	1.000
2025	0.110	0.008	310,037	21,154	11,637	10,465	1,172	9,517	8,038	1,479	1.695	1.000	1.000
2026	0.110	0.008	314,415	21,991	12,107	10,923	1,184	9,884	8,390	1,493	1.719	1.000	1.000
2027	0.110	0.008	313,788	22,635	12,466	11,262	1,204	10,169	8,651	1,518	1.716	1.000	1.000
2028	0.110	0.008	311,892	23,131	12,739	11,509	1,230	10,392	8,840	1,552	1.706	1.000	1.000
2029	0.110	0.008	311,589	23,549	12,966	11,704	1,262	10,583	8,990	1,592	1.704	1.000	1.000
2030	0.110	0.008	315,062	23,972	13,196	11,898	1,298	10,776	9,139	1,637	1.723	1.000	1.000
2031	0.110	0.008	322,972	24,475	13,470	12,135	1,335	11,005	9,321	1,684	1.766	1.000	1.000
2032	0.110	0.008	335,593	25,112	13,819	12,446	1,373	11,293	9,560	1,732	1.835	1.000	1.000
2033	0.110	0.008	352,126	25,912	14,261	12,850	1,411	11,651	9,871	1,780	1.926	1.000	1.000
2034	0.110	0.008	371,671	26,877	14,797	13,348	1,448	12,080	10,253	1,827	2.032	1.000	1.000
2035	0.110	0.008	392,595	27,977	15,408	13,922	1,486	12,569	10,694	1,874	2.147	1.000	1.000
2036	0.110	0.008	413,356	29,172	16,073	14,549	1,524	13,099	11,176	1,923	2.260	1.000	1.000
2037	0.110	0.008	432,643	30,417	16,767	15,202	1,565	13,651	11,677	1,974	2.366	1.000	1.000
Average	0.110	0.008	274,909	20,201	11,064	9,772	1,293	9,136	7,506	1,631	1.503	0.833	1.000
Ave '08-17	0.110	0.008	212,101	15,980	8,676	7,381	1,295	7,303	5,670	1,634	1.160	0.677	0.999
Ave '18-27	0.110	0.008	256,676	18,563	10,167	8,977	1,190	8,396	6,895	1,501	0.000	0.000	0.000
Ave '28-37	0.110	0.008	355,950	26,059	14,350	12,956	1,393	11,710	9,952	1,758	0.000	0.000	0.000
Formula	*A*	*B*	*C*	*D=E+H*	*E=F+G*	*F*	*G*	*H=I+J*	*I*	*J*	*K*	*L*	*M*

Table 3. Summary of stochastic projections for spiny dogfish under a constant F harvest strategy equal to Frebuild=0.11 for 2008 to 2037. Table entries are means of predicted values

Scenario = Frebuild

	Average												
Year	F on females	F on males	SSB (mt)	Total Catch (mt)	Total Landing (mt)	Female Landings (mt)	Male Landings (mt)	Total Discards (mt)	Female Discards (mt)	Male Discards (mt)	SSB(t)/ SSB_target	Probabilty (SSB>SSB_target)	Probabilty (SSB> SSB_thresh)
2008	0.110	0.011	194,577	13,562	7,127	5,181	1,946	6,435	3,980	2,455	1.064	0.618	1
2009	0.110	0.011	240,369	15,318	8,141	6,267	1,874	7,178	4,814	2,364	1.314	0.894	1.000
2010	0.110	0.011	257,319	16,754	8,977	7,192	1,786	7,777	5,524	2,253	1.407	0.938	1.000
2011	0.110	0.011	255,723	17,739	9,559	7,860	1,699	8,181	6,037	2,143	1.398	0.936	1.000
2012	0.110	0.011	242,813	18,234	9,855	8,216	1,639	8,379	6,311	2,068	1.328	0.900	1.000
2013	0.110	0.011	226,074	18,298	9,902	8,300	1,602	8,396	6,376	2,021	1.236	0.836	1.000
2014	0.110	0.011	206,156	17,992	9,734	8,150	1,584	8,258	6,260	1,998	1.127	0.716	1.000
2015	0.110	0.011	185,831	17,437	9,421	7,843	1,578	8,016	6,024	1,991	1.016	0.532	1.000
2016	0.110	0.011	165,456	16,766	9,043	7,469	1,574	7,723	5,737	1,986	0.905	0.298	1.000
2017	0.110	0.011	148,608	16,177	8,711	7,142	1,570	7,466	5,486	1,980	0.813	0.116	0.994
2018	0.110	0.011	159,680	15,905	8,559	6,996	1,563	7,346	5,374	1,972	0.873	0.230	1.000
2019	0.110	0.011	180,706	16,027	8,631	7,077	1,554	7,396	5,436	1,960	0.988	0.476	1.000
2020	0.110	0.011	207,927	16,584	8,949	7,406	1,543	7,635	5,689	1,947	1.137	0.728	1.000
2021	0.110	0.011	236,406	17,467	9,452	7,923	1,529	8,015	6,086	1,929	1.293	0.880	1.000
2022	0.110	0.011	262,439	18,542	10,065	8,551	1,514	8,478	6,568	1,909	1.435	0.948	1.000
2023	0.110	0.011	284,122	19,691	10,718	9,217	1,501	8,973	7,080	1,894	1.554	0.980	1.000
2024	0.110	0.011	300,283	20,826	11,361	9,866	1,495	9,465	7,578	1,886	1.642	0.994	1.000
2025	0.110	0.011	310,702	21,868	11,950	10,451	1,499	9,918	8,028	1,890	1.699	1.000	1.000
2026	0.110	0.011	315,150	22,712	12,423	10,911	1,513	10,289	8,381	1,908	1.723	1.000	1.000
2027	0.110	0.011	314,589	23,370	12,789	11,251	1,538	10,582	8,642	1,940	1.720	1.000	1.000
2028	0.110	0.011	312,755	23,886	13,071	11,499	1,571	10,815	8,833	1,982	1.710	1.000	1.000
2029	0.110	0.011	312,510	24,328	13,309	11,697	1,612	11,019	8,985	2,034	1.709	1.000	1.000
2030	0.110	0.011	316,038	24,777	13,550	11,892	1,658	11,227	9,135	2,092	1.728	1.000	1.000
2031	0.110	0.011	324,005	25,307	13,837	12,131	1,706	11,470	9,318	2,152	1.772	1.000	1.000
2032	0.110	0.011	336,688	25,971	14,199	12,444	1,755	11,772	9,558	2,214	1.841	1.000	1.000
2033	0.110	0.011	353,290	26,797	14,652	12,849	1,803	12,145	9,869	2,275	1.932	1.000	1.000
2034	0.110	0.011	372,915	27,788	15,199	13,348	1,851	12,589	10,253	2,336	2.039	1.000	1.000
2035	0.110	0.011	393,929	28,913	15,822	13,923	1,900	13,091	10,694	2,396	2.154	1.000	1.000
2036	0.110	0.011	414,791	30,134	16,499	14,551	1,949	13,635	11,177	2,458	2.268	1.000	1.000
2037	0.110	0.011	434,186	31,408	17,205	15,205	2,001	14,203	11,679	2,524	2.374	1.000	1.000
Average	0.110	0.011	275,534	21,019	11,424	9,760	1,664	9,596	7,497	2,099	1.507	0.834	1.000
Ave '08-17	0.110	0.011	212,292	16,828	9,047	7,362	1,685	7,781	5,655	2,126	1.161	0.678	0.999
Ave '18-27	0.110	0.011	257,200	19,299	10,490	8,965	1,525	8,810	6,886	1,923	0.000	0.000	0.000
Ave '28-37	0.110	0.011	357,111	26,931	14,734	12,954	1,781	12,196	9,950	2,246	0.000	0.000	0.000
Formula	*A*	*B*	*C*	*D=E+H*	*E=F+G*	*F*	*G*	*H=I+J*	*I*	*J*	*K*	*L*	*M*

Table 4. Summary of stochastic projections for spiny dogfish under a constant F harvest strategy equal to Ftarget=0.284 for 2008 to 2037. Table entries are means of predicted values

Scenario = Ftarget

	Average												
Year	F on females	F on males	SSB (mt)	Total Catch (mt)	Total Landing (mt)	Female Landings (mt)	Male Landings (mt)	Total Discards (mt)	Female Discards (mt)	Male Discards (mt)	SSB(t)/ SSB_target	Probabilty (SSB>SSB_target)	Probabilty (SSB> SSB_thresh)
2008	0.284	0.028	194,577	34,127	17,911	12,930	4,982	16,216	9,932	6,284	1.064	0.618	1
2009	0.284	0.028	223,337	36,124	19,116	14,402	4,714	17,009	11,063	5,946	1.221	0.822	1.000
2010	0.284	0.028	221,653	36,767	19,562	15,147	4,415	17,205	11,635	5,569	1.212	0.814	1.000
2011	0.284	0.028	202,710	36,013	19,215	15,085	4,130	16,797	11,587	5,210	1.109	0.688	1.000
2012	0.284	0.028	175,386	34,104	18,195	14,276	3,919	15,910	10,965	4,944	0.959	0.414	1.000
2013	0.284	0.028	147,684	31,452	16,739	12,976	3,762	14,714	9,967	4,746	0.808	0.108	0.994
2014	0.284	0.028	120,768	28,468	15,083	11,437	3,646	13,385	8,785	4,600	0.660	0.000	0.906
2015	0.284	0.028	97,203	25,564	13,467	9,917	3,550	12,096	7,617	4,479	0.532	0.000	0.636
2016	0.284	0.028	76,944	23,058	12,079	8,632	3,447	10,979	6,630	4,349	0.421	0.000	0.186
2017	0.284	0.028	62,657	21,307	11,120	7,785	3,335	10,187	5,980	4,207	0.343	0.000	0.000
2018	0.284	0.028	75,356	20,564	10,734	7,522	3,212	9,830	5,778	4,052	0.412	0.000	0.152
2019	0.284	0.028	94,318	20,716	10,857	7,776	3,081	9,860	5,973	3,887	0.516	0.000	0.582
2020	0.284	0.028	114,678	21,577	11,382	8,436	2,945	10,196	6,480	3,715	0.627	0.000	0.862
2021	0.284	0.028	131,736	22,709	12,060	9,255	2,806	10,648	7,109	3,539	0.720	0.008	0.956
2022	0.284	0.028	142,819	23,735	12,679	10,009	2,670	11,056	7,688	3,368	0.781	0.070	0.984
2023	0.284	0.028	147,495	24,430	13,106	10,559	2,547	11,324	8,111	3,213	0.807	0.106	0.992
2024	0.284	0.028	146,123	24,685	13,279	10,835	2,444	11,406	8,323	3,083	0.799	0.094	0.990
2025	0.284	0.028	139,899	24,479	13,185	10,822	2,363	11,294	8,313	2,981	0.765	0.050	0.978
2026	0.284	0.028	129,964	23,827	12,833	10,529	2,304	10,994	8,087	2,907	0.711	0.002	0.950
2027	0.284	0.028	117,980	22,897	12,318	10,055	2,263	10,579	7,724	2,855	0.645	0.000	0.886
2028	0.284	0.028	107,476	21,886	11,754	9,520	2,234	10,131	7,313	2,818	0.588	0.000	0.790
2029	0.284	0.028	100,447	20,975	11,246	9,036	2,210	9,729	6,941	2,789	0.549	0.000	0.692
2030	0.284	0.028	97,880	20,308	10,875	8,688	2,187	9,433	6,673	2,759	0.535	0.000	0.648
2031	0.284	0.028	99,110	19,946	10,678	8,517	2,161	9,268	6,542	2,726	0.542	0.000	0.670
2032	0.284	0.028	103,180	19,881	10,650	8,519	2,130	9,231	6,544	2,687	0.564	0.000	0.734
2033	0.284	0.028	108,557	20,041	10,750	8,656	2,094	9,291	6,649	2,642	0.594	0.000	0.802
2034	0.284	0.028	113,978	20,329	10,924	8,870	2,055	9,405	6,813	2,592	0.623	0.000	0.856
2035	0.284	0.028	118,247	20,637	11,110	9,095	2,015	9,528	6,986	2,542	0.647	0.000	0.888
2036	0.284	0.028	120,555	20,870	11,252	9,274	1,977	9,618	7,124	2,494	0.659	0.000	0.904
2037	0.284	0.028	120,532	20,964	11,314	9,370	1,944	9,650	7,197	2,453	0.659	0.000	0.904
Average	0.284	0.028	128,442	24,748	13,182	10,264	2,918	11,566	7,884	3,681	0.702	0.126	0.798
Ave '08-17	0.284	0.028	152,292	30,698	16,249	12,259	3,990	14,450	9,416	5,034	0.833	0.346	0.772
Ave '18-27	0.284	0.028	124,037	22,962	12,243	9,580	2,663	10,719	7,359	3,360	0.000	0.000	0.000
Ave '28-37	0.284	0.028	108,996	20,584	11,055	8,954	2,101	9,528	6,878	2,650	0.000	0.000	0.000
Formula	*A*	*B*	*C*	*D=E+H*	*E=F+G*	*F*	*G*	*H=I+J*	*I*	*J*	*K*	*L*	*M*

Table 5. Summary of stochastic projections for spiny dogfish under a constant F harvest strategy equal to Fthreshold=0.39 for 2008 to 2037. Table entries are means of predicted values

Scenario = Fthreshold

	Average												
Year	F on females	F on males	SSB (mt)	Total Catch (mt)	Total Landing (mt)	Female Landings (mt)	Male Landings (mt)	Total Discards (mt)	Female Discards (mt)	Male Discards (mt)	SSB(t)/ SSB_target	Probabilty (SSB>SSB_target)	Probabilty (SSB> SSB_thresh)
2008	0.390	0.039	194,577	46,152	24,203	17,398	6,805	21,949	13,364	8,585	1.064	0.618	1
2009	0.390	0.039	213,624	47,021	24,816	18,444	6,372	22,205	14,167	8,038	1.168	0.768	1.000
2010	0.390	0.039	202,658	45,927	24,327	18,422	5,905	21,600	14,150	7,449	1.108	0.688	1.000
2011	0.390	0.039	176,490	43,076	22,837	17,370	5,467	20,239	13,342	6,897	0.965	0.428	1.000
2012	0.390	0.039	144,624	39,036	20,644	15,508	5,136	18,392	11,912	6,480	0.791	0.082	0.988
2013	0.390	0.039	114,903	34,476	18,137	13,259	4,878	16,339	10,185	6,154	0.628	0.000	0.864
2014	0.390	0.039	88,236	29,999	15,663	10,993	4,671	14,336	8,444	5,892	0.483	0.000	0.450
2015	0.390	0.039	66,590	26,099	13,509	9,023	4,486	12,590	6,931	5,660	0.364	0.000	0.020
2016	0.390	0.039	49,358	23,079	11,855	7,566	4,290	11,223	5,811	5,412	0.270	0.000	0.000
2017	0.390	0.039	38,509	21,236	10,872	6,791	4,081	10,364	5,216	5,148	0.211	0.000	0.000
2018	0.390	0.039	53,205	20,685	10,622	6,762	3,859	10,063	5,194	4,869	0.291	0.000	0.000
2019	0.390	0.039	71,606	21,094	10,916	7,284	3,632	10,177	5,595	4,582	0.392	0.000	0.084
2020	0.390	0.039	88,854	22,089	11,543	8,137	3,405	10,546	6,250	4,296	0.486	0.000	0.464
2021	0.390	0.039	100,988	23,080	12,166	8,985	3,181	10,914	6,902	4,012	0.552	0.000	0.700
2022	0.390	0.039	106,365	23,649	12,547	9,578	2,969	11,102	7,357	3,745	0.582	0.000	0.776
2023	0.390	0.039	105,538	23,628	12,587	9,807	2,780	11,040	7,533	3,507	0.577	0.000	0.766
2024	0.390	0.039	99,668	23,009	12,282	9,660	2,621	10,727	7,420	3,307	0.545	0.000	0.680
2025	0.390	0.039	90,447	21,897	11,689	9,196	2,493	10,208	7,064	3,144	0.495	0.000	0.500
2026	0.390	0.039	79,299	20,437	10,891	8,500	2,391	9,546	6,529	3,016	0.434	0.000	0.238
2027	0.390	0.039	67,790	18,879	10,033	7,723	2,310	8,846	5,932	2,914	0.371	0.000	0.032
2028	0.390	0.039	58,899	17,453	9,246	7,006	2,240	8,207	5,382	2,825	0.322	0.000	0.000
2029	0.390	0.039	53,857	16,329	8,629	6,455	2,174	7,701	4,958	2,742	0.295	0.000	0.000
2030	0.390	0.039	52,878	15,594	8,232	6,124	2,107	7,363	4,704	2,658	0.289	0.000	0.000
2031	0.390	0.039	54,757	15,231	8,046	6,009	2,037	7,185	4,616	2,570	0.299	0.000	0.000
2032	0.390	0.039	58,235	15,147	8,019	6,057	1,962	7,128	4,653	2,475	0.318	0.000	0.000
2033	0.390	0.039	61,847	15,210	8,077	6,192	1,884	7,134	4,757	2,377	0.338	0.000	0.000
2034	0.390	0.039	64,589	15,287	8,142	6,336	1,806	7,145	4,867	2,279	0.353	0.000	0.004
2035	0.390	0.039	65,750	15,270	8,153	6,422	1,731	7,117	4,933	2,184	0.360	0.000	0.012
2036	0.390	0.039	65,038	15,092	8,072	6,409	1,663	7,020	4,923	2,097	0.356	0.000	0.008
2037	0.390	0.039	62,542	14,734	7,886	6,284	1,602	6,848	4,827	2,021	0.342	0.000	0.000
Average	0.390	0.039	91,724	24,330	12,821	9,457	3,365	11,508	7,264	4,245	0.502	0.086	0.353
Ave '08-17	0.390	0.039	128,957	35,610	18,686	13,477	5,209	16,924	10,352	6,571	0.705	0.258	0.632
Ave '18-27	0.390	0.039	86,376	21,845	11,527	8,563	2,964	10,317	6,578	3,739	0.000	0.000	0.000
Ave '28-37	0.390	0.039	59,839	15,535	8,250	6,330	1,921	7,285	4,862	2,423	0.000	0.000	0.000
Formula	*A*	*B*	*C*	*D=E+H*	*E=F+G*	*F*	*G*	*H=I+J*	*I*	*J*	*K*	*L*	*M*

Table 6. Summary of stochastic projections for spiny dogfish under a constant quota harvest strategy equal to current catch for 2008 to 2037. Table entries are means of predicted values.

Scenario = QstatusQuo

	Average												
Year	F on females	F on males	SSB (mt)	Total Catch (mt)	Total Landing (mt)	Female Landings (mt)	Male Landings (mt)	Total Discards (mt)	Female Discards (mt)	Male Discards (mt)	SSB(t)/ SSB_target	Probabilty (SSB>SSB_target)	Probabilty (SSB> SSB_thresh)
2008	0.125	0.006	194,577	12,515	6,765	5,644	1,122	5,750	4,335	1,415	1.064	0.618	1
2009	0.104	0.006	239,348	12,433	6,729	5,644	1,085	5,704	4,335	1,369	1.309	0.876	1.000
2010	0.090	0.007	257,609	12,600	6,803	5,644	1,159	5,797	4,335	1,462	1.409	0.918	1.000
2011	0.081	0.007	259,312	12,482	6,750	5,644	1,107	5,731	4,335	1,396	1.418	0.912	1.000
2012	0.076	0.007	250,925	12,403	6,716	5,644	1,071	5,687	4,336	1,352	1.372	0.880	1.000
2013	0.074	0.007	239,180	12,487	6,753	5,644	1,109	5,734	4,335	1,398	1.308	0.832	1.000
2014	0.074	0.008	224,062	12,489	6,754	5,644	1,110	5,736	4,335	1,400	1.225	0.762	1.000
2015	0.075	0.008	207,843	12,476	6,748	5,643	1,105	5,728	4,335	1,394	1.137	0.670	1.000
2016	0.078	0.008	190,549	12,483	6,751	5,644	1,107	5,732	4,335	1,397	1.042	0.556	0.984
2017	0.080	0.008	175,699	12,482	6,750	5,644	1,107	5,731	4,335	1,396	0.961	0.446	0.960
2018	0.081	0.008	188,409	12,482	6,751	5,644	1,107	5,731	4,335	1,396	1.030	0.538	0.974
2019	0.080	0.008	210,755	12,481	6,750	5,644	1,107	5,731	4,335	1,396	1.153	0.672	0.990
2020	0.077	0.008	239,844	12,486	6,752	5,645	1,108	5,733	4,336	1,397	1.312	0.792	1.000
2021	0.072	0.008	271,544	12,485	6,752	5,645	1,107	5,733	4,336	1,397	1.485	0.872	1.000
2022	0.066	0.008	302,725	12,483	6,751	5,645	1,107	5,732	4,336	1,396	1.655	0.918	1.000
2023	0.061	0.008	331,693	12,483	6,751	5,645	1,107	5,732	4,336	1,396	1.814	0.944	1.000
2024	0.056	0.008	357,228	12,481	6,750	5,643	1,107	5,731	4,335	1,396	1.953	0.958	1.000
2025	0.052	0.008	378,807	12,483	6,751	5,644	1,107	5,732	4,335	1,397	2.071	0.966	1.000
2026	0.048	0.007	395,621	12,481	6,750	5,643	1,107	5,731	4,335	1,396	2.163	0.970	1.000
2027	0.046	0.007	408,114	12,481	6,750	5,644	1,106	5,731	4,335	1,396	2.232	0.972	1.000
2028	0.044	0.007	419,702	12,481	6,750	5,644	1,106	5,731	4,335	1,396	2.295	0.972	1.000
2029	0.042	0.007	433,062	12,483	6,751	5,645	1,107	5,732	4,336	1,396	2.368	0.972	1.000
2030	0.040	0.007	450,365	12,481	6,750	5,644	1,106	5,731	4,336	1,395	2.463	0.976	1.000
2031	0.038	0.006	472,548	12,483	6,751	5,645	1,107	5,732	4,336	1,396	2.584	0.978	1.000
2032	0.036	0.006	500,398	12,482	6,751	5,643	1,107	5,732	4,335	1,397	2.736	0.982	1.000
2033	0.034	0.006	533,731	12,480	6,750	5,644	1,106	5,730	4,335	1,395	2.919	0.988	1.000
2034	0.032	0.006	572,309	12,483	6,752	5,645	1,106	5,732	4,336	1,395	3.130	0.992	1.000
2035	0.030	0.006	614,814	12,480	6,749	5,643	1,107	5,731	4,334	1,396	3.362	0.996	1.000
2036	0.028	0.005	659,975	12,484	6,751	5,644	1,108	5,732	4,335	1,397	3.609	0.998	1.000
2037	0.027	0.005	706,551	12,482	6,751	5,644	1,107	5,731	4,335	1,396	3.864	1.000	1.000
Average	0.062	0.007	356,243	12,483	6,751	5,644	1,107	5,732	4,335	1,397	1.948	0.864	0.997
Ave '08-17	0.086	0.007	223,910	12,485	6,752	5,644	1,108	5,733	4,335	1,398	1.224	0.747	0.994
Ave '18-27	0.064	0.008	308,474	12,483	6,751	5,644	1,107	5,732	4,335	1,396	0.000	0.000	0.000
Ave '28-37	0.035	0.006	536,346	12,482	6,751	5,644	1,107	5,731	4,335	1,396	0.000	0.000	0.000
Formula	*A*	*B*	*C*	*D=E+H*	*E=F+G*	*F*	*G*	*H=I+J*	*I*	*J*	*K*	*L*	*M*

Table 7. Summary of stochastic projections for spiny dogfish under a constant quota harvest strategy equal to current catch plus 5,000 mt for 2008 to 2037. Table entries are means of predicted values.

Scenario = Qsqplus5000

	Average												
Year	F on females	F on males	SSB (mt)	Total Catch (mt)	Total Landing (mt)	Female Landings (mt)	Male Landings (mt)	Total Discards (mt)	Female Discards (mt)	Male Discards (mt)	SSB(t)/ SSB_target	Probabilty (SSB>SSB_target)	Probabilty (SSB> SSB_thresh)
2008	0.176	0.009	194,577	17,390	9,414	7,904	1,510	7,976	6,072	1,904	1.064	0.618	1
2009	0.150	0.009	234,361	17,554	9,487	7,905	1,582	8,067	6,072	1,995	1.282	0.854	1.000
2010	0.133	0.009	247,415	17,393	9,415	7,905	1,510	7,977	6,072	1,905	1.353	0.882	1.000
2011	0.124	0.010	244,189	17,488	9,457	7,905	1,553	8,031	6,072	1,959	1.335	0.856	1.000
2012	0.120	0.010	231,293	17,452	9,442	7,905	1,536	8,011	6,072	1,938	1.265	0.794	1.000
2013	0.120	0.011	215,389	17,513	9,469	7,906	1,563	8,044	6,073	1,971	1.178	0.708	1.000
2014	0.124	0.011	196,541	17,484	9,456	7,905	1,551	8,028	6,072	1,956	1.075	0.592	0.982
2015	0.131	0.011	177,036	17,480	9,454	7,905	1,549	8,026	6,072	1,954	0.968	0.458	0.950
2016	0.142	0.011	156,952	17,482	9,455	7,905	1,550	8,027	6,072	1,955	0.858	0.316	0.896
2017	0.155	0.011	139,800	17,482	9,455	7,905	1,550	8,027	6,072	1,955	0.764	0.204	0.828
2018	0.164	0.011	149,843	17,482	9,455	7,905	1,549	8,027	6,072	1,955	0.819	0.280	0.858
2019	0.167	0.011	168,386	17,482	9,455	7,905	1,550	8,027	6,072	1,955	0.921	0.408	0.898
2020	0.162	0.011	192,270	17,484	9,456	7,905	1,551	8,028	6,072	1,956	1.051	0.554	0.932
2021	0.153	0.012	217,512	17,480	9,454	7,904	1,550	8,026	6,072	1,955	1.189	0.666	0.950
2022	0.142	0.012	241,267	17,482	9,455	7,906	1,549	8,027	6,073	1,955	1.319	0.742	0.960
2023	0.133	0.012	262,170	17,482	9,455	7,906	1,549	8,027	6,073	1,954	1.434	0.786	0.964
2024	0.126	0.012	279,239	17,480	9,454	7,904	1,549	8,026	6,072	1,954	1.527	0.812	0.964
2025	0.122	0.012	292,154	17,485	9,456	7,906	1,550	8,028	6,073	1,956	1.598	0.822	0.962
2026	0.123	0.012	300,377	17,482	9,455	7,905	1,550	8,027	6,072	1,955	1.643	0.826	0.958
2027	0.129	0.012	304,412	17,469	9,447	7,898	1,549	8,021	6,067	1,954	1.665	0.820	0.950
2028	0.138	0.012	307,566	17,437	9,429	7,880	1,550	8,008	6,053	1,955	1.682	0.816	0.944
2029	0.147	0.012	312,297	17,401	9,409	7,860	1,550	7,992	6,037	1,955	1.708	0.812	0.938
2030	0.155	0.012	320,519	17,374	9,394	7,844	1,549	7,980	6,025	1,955	1.753	0.814	0.936
2031	0.161	0.012	332,832	17,342	9,376	7,827	1,549	7,966	6,012	1,954	1.820	0.820	0.934
2032	0.167	0.012	349,712	17,317	9,361	7,811	1,550	7,955	6,000	1,955	1.912	0.830	0.934
2033	0.171	0.011	370,758	17,285	9,343	7,794	1,549	7,941	5,987	1,954	2.027	0.842	0.934
2034	0.173	0.011	395,577	17,255	9,326	7,777	1,550	7,928	5,974	1,955	2.163	0.854	0.936
2035	0.175	0.011	423,015	17,218	9,306	7,755	1,550	7,913	5,957	1,956	2.313	0.864	0.938
2036	0.177	0.011	451,947	17,175	9,282	7,733	1,549	7,894	5,940	1,954	2.471	0.872	0.938
2037	0.179	0.011	481,301	17,137	9,260	7,710	1,549	7,877	5,923	1,955	2.632	0.880	0.938
Average	0.148	0.011	273,024	17,416	9,418	7,870	1,548	7,998	6,045	1,953	1.493	0.713	0.947
Ave '08-17	0.138	0.010	203,755	17,472	9,450	7,905	1,545	8,022	6,072	1,949	1.114	0.628	0.966
Ave '18-27	0.142	0.012	240,763	17,481	9,454	7,904	1,550	8,027	6,072	1,955	0.000	0.000	0.000
Ave '28-37	0.164	0.012	374,552	17,294	9,349	7,799	1,549	7,945	5,991	1,955	0.000	0.000	0.000
Formula	*A*	*B*	*C*	*D=E+H*	*E=F+G*	*F*	*G*	*H=I+J*	*I*	*J*	*K*	*L*	*M*