Update of Landings and Discards of Spiny Dogfish in 2014

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Executive Summary

The purpose of this report is to summarize the most recent information on the status of spiny dogfish (*Squalus acanthias*) in 2014. Due to mechanical problems the NEFSC spring bottom trawl survey in 2014 was unable to sample critical strata in the Mid-Atlantic region. For this reason, it was not possible to update population abundance estimates in 2014 nor was it possible to provide updated estimates of fishing mortality rates, or conduct projections of stock size under varying fishing mortality rates. This report summarizes total estimated catch of spiny dogfish in 2013 and compares it to catch projections from previous years.

US landings decreased about 31% from 10,660 mt in 2012 to 7,312 mt in 2013 (Table 1). US landings in 2013 were approximately equal to the 2008-12 average of 7,013 mt. Recreational landings and distant water fleet landings were negligible, totaling only 98 mt. Canadian landings were not yet available for 2013 but have averaged about 77 mt since 2009.

Recreational landings and discards were obtained from the Marine Recreational Information Program (MRIP) http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index. In 2013 MRIP program transitioned to a new probability sampling design for estimating catch per unit effort. The sampling survey is known as the Access-Point Angler Intercept Program; potential effects of this new program on the estimates of spiny dogfish are not fully known. An analysis of the transition from Marine Recreational Fisheries Statistics Survey (MRFSS) to MRIP estimators for the period 2004 to 2011 revealed negligible differences (-7%) in landings and discard estimates (Rago and Sosebee, 2013). Over the past 5 years (2009-2013) recreational catch represents only about 4% of the total catch of spiny dogfish. As a source of total mortality, recreational catch can be considered negligible.

Total discards increased slightly from 11,626 mt in 2012 to 12,820 mt in 2013. The 2013 estimate is approximately equal to the average of the previous 5 years (12,901 mt). Similar patterns were observed for dead discards. Total dead discards have been relatively stable since 2000. There were no major changes in the discarding patterns among fleets. The ratio of dead discards to landings in 2013 increased slightly to 0.68. The slight decline in utilization of the spiny dogfish (i.e. landings/ catch) may be due to reduced markets in 2013.

Total catch estimates in 2013 were about 50% of the 2013 ABC of 24,709 mt

No survey abundance estimates could be computed in 2014 for spiny dogfish. The raw 3-yr average of female spawning stock biomass (SSB) swept area biomass in 2013 of 235,900 mt was about the same as the 241,000 mt in 2012. Pup production was the highest observed in the time series since 1968. Male biomass for 2013 in the 36 to 79 cm size range was the highest observed in the time series.

Female spawning stock biomass estimates from 2009 to 2013 exceeded the biomass reference point. Therefore, the stock was not overfished and was rebuilt in 2013. Stochastic model estimates of median female spawning stock biomass in 2013 was 211,372 mt (compared to 215,444 mt in 2012). The probability of stock size in 2013 being below the SSB target was less than 25%. The sampling distribution of SSB in 2013 suggested that the probability of SSB being below the SSB threshold is less than 3% (Rago and Sosebee, 2013). Since total catch in 2014 was only 12,420 mt, and natural mortality is thought to be low (M=0.092 in the assessment model), the likelihood of a large decline in true abundance is thought to be low.

A. Catch Trends

1. This document summarizes the most recent information on spiny dogfish stock status catch data from 2013. Catch data include landings from US and distant water commercial fisheries, and US recreational landings. Canadian landings and discards were not yet available for 2013 when this report was prepared. 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 landings estimates are summarized in Table 1 and Fig. 1. US landings decreased about 31% from 10,660 mt in 2012 to 7,312 mt in 2013 (Table 1). US landings in 2013 were approximately equal to the 2008-12 average of 7,013 mt. Recreational landings and distant water fleet landings were negligible, totaling only 98 mt. Canadian landings were not yet available for 2013 but have averaged about 77 mt since 2009.

3. The estimates of recreational landings were updated for the period 2004 to 2011 (Table 2). The changes represent the application of an alternative estimator to the historical data collected under the Marine Recreational Fisheries Statistics Survey (MRFSS). The new program, known as the Marine Recreational Information Program (MRIP) is in the process of revising the historical data as well as advancing an improved sampling design for future surveys. Changes in the historical data bases were restricted to 2004 to 2011. To be clear, the re-estimation of recreational catch estimates for 2004 onward represents the application of a revised estimator to the historical

MRFSS data. The revised estimates are now consistent with the actual sampling collection program employed under MRFSS.

4. Differences between the recreational landings and discard estimates for 2004 to 2010 were relatively minor (Table 2). MRIP estimates of landings are about 18% lower than MRFSS. MRIP estimates of discards are about 7% lower (Fig. 2). In view of the small overall magnitude of the change and the minor contribution of recreational catch to the total removals, no historical adjustment of recreational catches was made. In 2011 the ratio of recreational catch to total catch was 3.3%. Hence changes of 18% and 7%, respectively, to recreational landings and discards would represent negligible changes to the historical catch series.

5. Recreational landings and discards were obtained from the Marine Recreational Information Program (MRIP) http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index. In 2013 MRIP program transitioned to a new probability sampling design for estimating catch per unit effort. The sampling survey is known as the Access-Point Angler Intercept Program; potential effects of this new program on the estimates of spiny dogfish are not fully known. An analysis of the transition from Marine Recreational Fisheries Statistics Survey (MRFSS) to MRIP estimators for the period 2004 to 2011 revealed negligible differences (-7%) in landings and discard estimates (Rago and Sosebee, 2013). Over the past 5 years (2009-2013) recreational catch represents only about 4% of the total catch of spiny dogfish. As a source of total mortality, recreational catch can be considered negligible.

6. The precision of the recreational landings (A + B1) in 2013 was relatively poor with Proportional Standard Errors of 48.1 and 56.9% respectively (Table 2). The precision of the discarded dogfish estimates (B2) was much better at 11.9%

7. The primary sources of commercial discards are otter trawls (6,897 mt CV=7.2%) and sink gill nets (3,107 mt, CV=9.8%). Discards of spiny dogfish by scallop dredges (127 mt CV=9.5%) and long lines (37 mt, CV=48.3%) are negligible. (Table 3). Additional estimates of precision of discard estimates by gear and sex may be found in Appendix 1.

8. Total discards increased slightly from 11,626 mt in 2012 to 12,820 mt in 2013. The 2013 estimate is approximately equal to the average of the previous 5 years (12,901 mt) (Table 3). Similar patterns were observed for dead discards (Table 3). Application of mortality rates for trawl (50%), gillnet (30%), scallop dredge (75%), line gear (10%) and recreational (20%) resulted in a total dead discard estimate of 5,010 in 2013. Total dead discards have been relatively stable since 2000 (Fig. 2).

9. Total discards in US otter trawl fleet and sink gill nets in 2013 were about the same as in 2011 and 2013. (Table 3). The ratio of dead discards to landings in 2013 of 0.68 represents an increase from the previous two years (Table 4, Fig. 3). Discard rates as a fraction of total catch increased slightly in

2013 (Table 4, Fig. 3). The slight decline in utilization of the spiny dogfish (i.e. landings/ catch) may be due to reduced markets in 2013.

10. Biological samples collected by port agents are used to estimate size composition and sex ratios for spiny dogfish in landings (Table 5). Overall Landings are dominated by females, a trend that has persisted since the US EEZ fishery began (Fig. 4). Most fishing takes place near shore where females are more abundant. Despite the large increase in landings in 2011 the fraction of females in the landings (92%) was nearly equal to the landings fractions in the previous two years. In 2012 and 2013 the percent females in the landings exceeded 95% (Table 5). The average weights of female dogfish landed in 2012 and 2013 was about 5% higher than the average of the previous 5 years.

11. About 2.3 million female dogfish were landed in 2013; about 196 thousand male dogfish were landed. Since average weights have been relatively constant, the decline in catch numbers mirrors the trends in total landings biomass (Table 5).

12. The sex ratios of discarded fish are similarly dominated by females, but represent only 76% of total discards by weight (Table 6). This difference, compared to landings, is likely due to the much higher rate of discarding of male fish. On a numerical basis, about 52% of the dogfish caught in 2013 were landed (Tables 5 and 6). In contrast, only about 12% of male dogfish caught are subsequently landed.

B. Survey Indices

1. Due to mechanical problems the NEFSC spring bottom trawl survey in 2014 was unable to sample critical survey strata in the Mid-Atlantic region. (Survey strata missing in 2014 were 01610-01680, 03320,03350,03380,03410,03440) For this reason it is not possible to compute a valid estimate of relative abundance for spiny dogfish in 2014. If the Bigelow is unable to conduct the spring bottom trawl survey in 2015 an analysis of the entire time series of truncated survey strata may be warranted.

C. Stochastic Estimates of Biomass and Fishing Mortality

1. As noted in Section B.1, it was not possible to compute a consistent abundance index for 2014 due to the absence of sampling in critical Mid-Atlantic strata. The stochastic estimator of abundance could not be implemented for 2014.

D. Harvest Scenarios

1. The absence of abundance estimates precluded any evaluation of updated harvest scenarios.

E. Logical Assessment of Potential Impacts of Catches in 2013 on Stock Status

1. The absence of an abundance estimate for 2014 precludes a rigorous assessment of the effects of 2013 removals on stock status. However, the estimated total catch is only about 50% of the ABC for 2013. Female spawning stock biomass estimates from 2009 to 2013 exceeded the biomass reference point. Therefore, the stock was not overfished and was rebuilt in 2013. The stochastic model estimate of median female spawning stock biomass in 2013 was 211,372 mt (compared to 215,444 mt in 2012). The probability of stock size in 2013 being below the SSB target was less than 25%. The sampling distribution of SSB in 2013 suggested that the probability of SSB being below the SSB threshold is less than 3%. (Rago and Sosebee, 2013). Since total catch in 2014 was only 12,420 mt, (or 50% of the ABC) and natural mortality is thought to be low (M=0.092 in the assessment model), the likelihood of a large decline in true abundance is also thought to be low.

F. Potential Indicators of Stock Status during Multi-year fishery management Quotas

Many of the potential stock status indicators rely on the survey indices and could not be estimated in 2014. These are denoted as NA in the following table.

Potential Indicator	***Metric***	***Evaluation***	***Reference***
Discards	Changes in ratio of discard to landings	Ratio has been steadily declining since 2004 suggesting more efficient utilization of the resource. This slight uptick in 2013 may be due to market conditions	Figure 3, Table 4
	Changes by gear type	Sink gill net discard rates have declined over time. Otter trawl discards have remained steady at about 3000 mt in last 5 years-	Table 3.
Survey Abundance Trends	Average Size of Mature females	Mean length of mature females has been increasing since 1999. Average size of mature females is still well below rates observed in mid 1980s.	NA in 2014
	Ratio of mature males to females	Ratio has decreased to between 3 to 4 from earlier ratios near 7. Expected ratio, based on growth and maturity rates should be about 2.	NA in 2014
	Recruitment	Recruitment indices have been steadily increasing in recent years	NA in 2014
	Pup Size	Average length of male and female pups have increased steadily from a low of 26 cm in 1997 to about 29 in last 3 years. Average size is approaching level observed in the 1980s.	NA in 2014
	Size composition	Sizes of mature females are increasing slightly; males are relatively unchanged. Size composition of sub adults is broadening and approaching distribution seen prior to major fisheries in 1990s.	NA in 2014

Commercial Landings	Average Size	Average weight of landed females of about 2.9 kg represents a slight increase in 2013.	Table 5
	Sex ratio	Landings remain dominated by females with no apparent trend.	Table 5 Fig. 4
	Changes in Canadian Landings	Landings remain low. Between 2009-12 landings have averaged about 77 mt compared to 2,166 mt in previous 4 year period.	NA in 2014
Forecast accuracy	Comparison of OFL and ABC predictions between assessments	Median ABC projections from the 2012 assessment with projections in this assessment are within 10 to 13% of each other. This assessment suggests slightly higher values.	NA in 2014

G. References

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Table 1. Total spiny dogfish landings (mt, live) in NAFO Areas 2 to 6, 1962-2013

	United States				
Year	Commer-cial	Recre-ational	Canada	Distant Water Fleets	Total Landings
1962	235		0	0	235
1963	610		0	1	611
1964	730		0	16	746
1965	488		9	198	695
1966	578		39	9,389	10,006
1967	278		0	2,436	2,714
1968	158		0	4,404	4,562
1969	113		0	9,190	9,303
1970	106		19	5,640	5,765
1971	73		4	11,566	11,643
1972	69		3	23,991	24,063
1973	89		20	18,793	18,902
1974	127		36	24,513	24,676
1975	147		1	22,523	22,671
1976	550		3	16,788	17,341
1977	931		1	7,199	8,131
1978	828		84	622	1,534
1979	4,753		1,331	187	6,271
1980	4,085		660	599	5,344
1981	6,865	1,493	564	974	9,896
1982	5,411	70	389	364	6,234
1983	4,897	67		464	5,428
1984	4,450	91	2	391	4,935
1985	4,028	89	13	1,012	5,142
1986	2,748	182	20	368	3,318
1987	2,703	306	281	139	3,429
1988	3,105	359	1	647	4,112
1989	4,492	418	167	256	5,333
1990	14,731	179	1,309	393	16,611
1991	13,177	131	307	234	13,848
1992	16,858	215	868	67	18,008
1993	20,643	120	1,435	27	22,225
1994	18,798	155	1,820	2	20,774
1995	22,578	68	956	14	23,615
1996	27,136	25	431	236	27,827
1997	18,351	66	446	214	19,078
1998	20,628	39	1,055	607	22,329
1999	14,855	53	2,091	554	17,552
2000	9,257	5	2,741	402	12,405
2001	2,294	28	3,820	677	6,819
2002	2,199	205	3,584	474	6,462
2003	1,170	40	1,302	643	3,155
2004	982	105	2,362	330	3,778
2005	1,147	45	2,270	330	3,792
2006	2,249	94	2,439	10	4,792
2007	3,503	84	2,384	31	6,002
2008	4,108	214	1,572	131	6,025
2009	5,377	34	113	82	5,606
2010	5,440	21	6	127	5,594
2011	9,480	32	124	143	9,779
2012	10,660	19	65	137	10,881
2013	7,312	37	NA	61	7,410

Table 2. Summary of spiny dogfish landings and discard estimates based on Marine Recreational Information Program estimates. As in previous assessments, the average weight of landed discarded spiny dogfish is assumed to be 2.5 kg. Discard mortality is assumed to be 20%. The revised MRIP estimator was used for 2004 to 2013. Differences between MRFSS and MRIP were considered minor relative to total catch (ie Commercial landings and discards); no adjustments were made to historical recreational data.

	Catch in Numbers								Numbers		*Weight (mt)*			Estimates used in Previous assessments				
Year	Observed Harvest (A)	PSE	Reported Harvest (B1)	PSE	Released Alive (B2)	PSE	Total Catch A+B1+B2	PSE	Total Landings A+B1 (number)	Discards B2 (number)	Landings (A+B1) (mt)	Discards (B2) (mt)	Dead Discards (mt)	Landings (mt)	Discards (mt)	% dif Landings	% dif Discard	Estimator
1981	5,943	49.1	591,300	52.1	118,440	31.3	715,683	43.4	597,243	118,440	1493	296	59	1,493	59	0.0	0.4	MRFSS
1982	12,460	38.6	15,712	45.5	139,730	21.4	167,902	18.5	28,172	139,730	70	349	70	70	70	0.6	-0.2	MRFSS
1983	13,154	36.3	13,675	34.1	215,973	23.7	242,803	21.2	26,829	215,973	67	540	108	67	108	0.1	0.0	MRFSS
1984	9,606	48.1	26,918	45.1	169,574	35.1	206,099	29.6	36,524	169,574	91	424	85	91	85	0.3	-0.3	MRFSS
1985	5,495	47.7	30,172	38.3	385,745	41.8	421,412	38.4	35,667	385,745	89	964	193	89	193	0.2	-0.1	MRFSS
1986	11,598	26.5	61,688	22.8	474,930	17.7	548,216	15.6	73,286	474,930	183	1187	237	182	237	0.7	0.2	MRFSS
1987	14,286	44	108,171	28.9	422,387	21.6	544,844	17.8	122,457	422,387	306	1056	211	306	211	0.0	0.1	MRFSS
1988	46,068	30.6	98,002	19.8	350,410	24.4	494,480	18	144,070	350,410	360	876	175	359	175	0.3	0.1	MRFSS
1989	63,031	40.6	104,511	34.4	539,731	17.2	707,273	14.5	167,542	539,731	419	1349	270	418	269	0.2	0.3	MRFSS
1990	22,364	26.1	49,045	28.6	468,085	14.6	539,494	13	71,409	468,085	179	1170	234	179	234	-0.3	0.0	MRFSS
1991	30,459	21.9	21,884	22.7	539,883	13.5	592,227	12.4	52,343	539,883	131	1350	270	131	270	-0.1	0.0	MRFSS
1992	46,753	22.8	50,483	23.1	407,485	10.6	504,721	9.1	97,236	407,485	243	1019	204	215	204	11.6	-0.1	MRFSS
1993	23,350	21.6	24,535	30.8	444,077	15.5	491,963	14.1	47,885	444,077	120	1110	222	120	222	-0.2	0.0	MRFSS
1994	17,714	34	44,230	35.6	387,274	15.2	449,218	13.6	61,944	387,274	155	968	194	155	194	-0.1	-0.2	MRFSS
1995	15,447	31.2	11,583	37.2	261,465	11.5	288,496	10.7	27,030	261,465	68	654	131	68	131	-0.6	-0.2	MRFSS
1996	8,500	29.8	1,843	48.4	131,672	12.7	142,015	11.9	10,343	131,672	26	329	66	25	66	3.3	-0.2	MRFSS
1997	21,017	24.4	5,582	54.9	337,431	12.1	364,030	11.3	26,599	337,431	66	844	169	66	167	0.7	1.0	MRFSS
1998	14,831	28.7	9,445	78.2	243,988	13.2	268,264	12.4	24,276	243,988	61	610	122	39	122	35.7	0.0	MRFSS
1999	11,995	52.5	9,710	68.2	214,974	11.5	236,679	11.1	21,705	214,974	54	537	107	53	106	2.3	1.4	MRFSS
2000	1,773	46.6	271	89.5	276,258	16.3	278,302	16.2	2,044	276,258	5	691	138	5	137	2.2	0.8	MRFSS
2001	7,771	39.7	3,459	44.6	842,583	9.1	853,812	9	11,230	842,583	28	2106	421	28	420	0.3	0.3	MRFSS
2002	2,281	32.3	79,691	43.8	669,469	10.6	751,440	10.5	81,972	669,469	205	1674	335	205	335	0.0	-0.1	MRFSS
2003	8,314	36.2	7,560	33.9	1,199,490	8	1,215,364	7.9	15,874	1,199,490	40	2999	600	40	597	-0.8	0.5	MRFSS
2004	19,328	44.7	28,761	38.9	1,315,796	14.1	1,363,885	13.6	48,089	1,315,796	120	3289	658	105	698	12.7	-6.1	MRIP
2005	6,894	33.5	7,230	37.9	1,339,412	19.9	1,353,536	19.7	14,124	1,339,412	35	3349	670	45	702	-27.4	-4.8	MRIP
2006	7,592	40.1	24,221	65.7	1,420,564	11.6	1,452,377	11.4	31,813	1,420,564	80	3551	710	94	768	-18.2	-8.1	MRIP
2007	2,134	44.2	32,352	67.3	1,557,079	12.7	1,591,565	12.5	34,486	1,557,079	86	3893	779	84	860	2.6	-10.5	MRIP
2008	10,930	35.3	34,701	38	1,078,307	12.6	1,123,938	12.2	45,631	1,078,307	114	2696	539	214	623	-87.6	-15.6	MRIP
2009	6,155	40.3	10,929	31.9	1,031,866	13	1,048,951	12.8	17,084	1,031,866	43	2580	516	34	574	20.4	-11.3	MRIP
2010	2,270	34.4	4,158	60.3	790,412	20.7	796,840	20.6	6,428	790,412	16	1976	395	21	386	-30.7	2.3	MRIP
2011	5,742	42.6	7,063	48.6	924,891	14.8	937,696	14.6	12,805	924,891	32	2312	462	NA	NA	NA	NA	MRIP
2012	3,413	65.7	4,103	63.6	549,820	18	557,336	17.7	7,516	549,820	19	1375	275	NA	NA	NA	NA	MRIP
2013	7,381	48.1	7,294	56.9	1,061,125	11.9	1,075,800	11.8	14,675	1,061,125	37	2653	531	NA	NA	NA	NA	MRIP

Table 3. Estimated total discards of spiny dogfish (mt) from commercial and recreational US fisheries, 1981-2013. The values for otter trawl and gill net from 1981-1989 are hindcast estimates (see SARC 43)

								Assumed Discard Mortality Rate					
								0.50	0.30	0.75	0.10	0.20	
	Total Discards							Dead Discards					
Year	Otter Trawl	Sink Gill Net	Scallop Dredge	Line gear	Recreational	Total		Otter Trawl	Sink Gill Net	Scallop Dredge	Line gear	Recreational	Total Dead
1981	36,360	5,360	na	na	296	42,016		18,180	1,608	na	na	59	19,847
1982	42,910	4,454	na	na	349	47,713		21,455	1,336	na	na	70	22,861
1983	42,188	4,042	na	na	540	46,770		21,094	1,213	na	na	108	22,415
1984	39,625	4,918	na	na	424	44,967		19,813	1,475	na	na	85	21,373
1985	33,354	4,539	na	na	964	38,857		16,677	1,362	na	na	193	18,232
1986	31,745	4,883	na	na	1,187	37,815		15,873	1,465	na	na	237	17,575
1987	29,050	4,864	na	na	1,056	34,970		14,525	1,459	na	na	211	16,195
1988	28,951	5,132	na	na	876	34,959		14,476	1,540	na	na	175	16,190
1989	28,286	5,360	na	na	1,344	34,990		14,143	1,608	na	na	269	16,020
1990	34,242	6,062	na	na	1,170	41,474		17,121	1,819	na	na	234	19,174
1991	19,322	11,030	32	97	1,350	31,831		9,661	3,309	24	10	270	13,274
1992	32,617	5,953	827	650	1,019	41,066		16,309	1,786	620	65	204	18,983
1993	17,284	9,814	209	44	1,110	28,461		8,642	2,944	157	4	222	11,969
1994	13,908	2,887	723	na	968	18,486		6,954	866	542	na	194	8,556
1995	16,997	6,731	378	na	654	24,760		8,499	2,019	284	na	131	10,932
1996	9,402	3,890	121	na	329	13,742		4,701	1,167	91	na	66	6,025
1997	6,704	2,326	198	na	837	10,065		3,352	698	149	na	167	4,366
1998	5,268	1,965	120	na	610	7,963		2,634	590	90	na	122	3,435
1999	7,685	2,005	41	na	532	10,263		3,843	602	31	na	106	4,581
2000	2,728	4,684	14	na	685	8,111		1,364	1,405	11	na	137	2,917
2001	4,919	7,204	30	na	2,099	14,252		2,460	2,161	23	na	420	5,063
2002	5,540	4,997	58	4,015	1,673	16,283		2,770	1,499	44	402	335	5,049
2003	3,853	5,413	103	2	2,987	12,358		1,927	1,624	77	0	597	4,225
2004	8,299	4,031	53	497	3,490	16,370		4,150	1,209	40	50	698	6,146
2005	7,515	3,338	15	1,175	3,509	15,552		3,758	1,001	11	118	702	5,589
2006	7,773	3,369	14	131	3,840	15,126		3,886	1,011	10	13	768	5,688
2007	8,115	5,133	61	73	4,300	17,681		4,058	1,540	45	7	860	6,510
2008	5,604	4,864	237	260	3,115	14,080		2,802	1,459	178	26	623	5,088
2009	7,010	4,874	364	835	2,869	15,952		3,505	1,462	273	84	574	5,897
2010	5,564	2,385	196	509	1,930	10,584		2,782	716	147	51	386	4,081
2011	6,540	2,831	226	356	2,312	12,264		3,270	849	170	36	462	4,787
2012	6,687	2,959	432	172	1,375	11,626		3,344	888	324	17	275	4,848
2013	6,897	3,107	127	37	2,653	12,820		3,448	932	95	4	531	5,010

Table 4. Total landings, discards and total catch for spiny dogfish, 1989-2013.

Year	Total Discard	Total Dead Discards (mt)	Total Landings (mt)	Dead Disc/Landings	Total Discard / Landings	Total Catch (mt)
1989	34,990	16,020	5,333	3.00	6.56	21,353
1990	41,474	19,174	16,611	1.15	2.50	35,785
1991	31,831	13,274	13,848	0.96	2.30	27,122
1992	41,066	18,983	18,008	1.05	2.28	36,991
1993	28,461	11,969	22,225	0.54	1.28	34,194
1994	18,486	8,556	20,774	0.41	0.89	29,330
1995	24,760	10,932	23,615	0.46	1.05	34,547
1996	13,742	6,025	27,827	0.22	0.49	33,852
1997	10,065	4,366	19,078	0.23	0.53	23,443
1998	7,963	3,435	22,329	0.15	0.36	25,764
1999	10,263	4,581	17,552	0.26	0.58	22,134
2000	8,111	2,917	12,405	0.24	0.65	15,321
2001	14,252	5,063	6,819	0.74	2.09	11,882
2002	16,283	5,049	6,462	0.78	2.52	11,510
2003	12,358	4,225	3,155	1.34	3.92	7,380
2004	16,370	6,146	3,778	1.63	4.33	9,925
2005	15,552	5,589	3,792	1.47	4.10	9,382
2006	15,126	5,688	4,792	1.19	3.16	10,480
2007	17,681	6,510	6,002	1.08	2.95	12,512
2008	14,080	5,088	6,025	0.84	2.34	11,113
2009	15,952	5,897	5,606	1.05	2.85	11,503
2010	10,584	4,081	5,594	0.73	1.89	9,675
2011	12,264	4,787	9,779	0.49	1.25	14,566
2012	11,626	4,848	10,881	0.45	1.07	15,729
2013	12,820	5,010	7,410	0.68	1.73	12,420

Table 5. Summary of estimated landings of US, Canadian and foreign fisheries by sex, 1982-2013. US recreational landings included. Estimated total weights based on sum of estimated weights from sampled length frequency distributions from port samples. Estimated weights computed for female as W = exp(-15.025)^L^3.606935 and males as W = exp(-13.002)*L^3.097787 with weight in kg and length in cm. "Samples" = number of measured dogfish.

	NMFS Biological Samples from Ports								Prorated Landings by Sex				
Year	Total Samples Males	Est Total Wt (kg) Males	Average Wt (kg) Males	Total Samples Females	Est Total Wt (kg) Females	Average Wt (kg) Females	Fraction Females by Weight	Total Landings (mt)	Est Landings (mt) of Males	Est Landings (mt) of Females	Number of Males Landed (000)	Number of Females Landed (000)	Total Numbers Landed (000)
1982	24	52.0	2.167	680	3015.7	4.435	0.9830	6234	106	6128	49	1382	1431
1983				610	2513.9	4.121	1.0000	5428	0	5428		1317	1317
1984	9	15.8	1.760	1499	6626.0	4.420	0.9976	4935	12	4923	7	1114	1120
1985	21	35.2	1.678	1657	6799.2	4.103	0.9948	5142	27	5116	16	1247	1263
1986	64	104.1	1.626	1165	4669.0	4.008	0.9782	3318	72	3246	44	810	854
1987	31	52.7	1.700	2000	7550.1	3.775	0.9931	3429	24	3406	14	902	916
1988	7	14.8	2.114	1764	7560.7	4.286	0.9980	4112	8	4104	4	957	961
1989	35	67.5	1.927	1375	5528.0	4.020	0.9879	5333	64	5269	33	1311	1344
1990	19	33.7	1.772	2230	8916.6	3.998	0.9962	16611	63	16549	35	4139	4174
1991	161	379.2	2.356	1518	5923.9	3.902	0.9398	13848	833	13015	354	3335	3689
1992	12	22.3	1.861	3187	12180.6	3.822	0.9982	18008	33	17975	18	4703	4721
1993	42	78.4	1.866	2773	9927.5	3.580	0.9922	22225	174	22051	93	6159	6253
1994	47	86.6	1.843	2092	6639.9	3.174	0.9871	20774	267	20507	145	6461	6606
1995	25	38.9	1.555	2266	6676.6	2.946	0.9942	23615	137	23479	88	7969	8056
1996	569	886.7	1.558	1662	4397.6	2.646	0.8322	27827	4669	23158	2996	8752	11749
1997	303	449.1	1.482	382	780.9	2.044	0.6349	19078	6966	12112	4700	5925	10625
1998	68	85.4	1.257	683	1434.5	2.100	0.9438	22329	1255	21073	999	10034	11033
1999	93	130.3	1.401	311	625.5	2.011	0.8276	17552	3026	14527	2160	7223	9382
2000	345	473.1	1.371	1921	3921.2	2.041	0.8923	12405	1335	11069	974	5423	6397
2001	12	17.1	1.422	215	456.5	2.123	0.9640	6819	246	6573	173	3096	3269
2002	1	1.3	1.279	278	752.5	2.707	0.9983	6462	11	6451	9	2383	2392
2003	34	48.3	1.421	966	2338.4	2.421	0.9798	3155	64	3091	45	1277	1322
2004	15	23.9	1.593	1180	3296.9	2.794	0.9928	3778	27	3751	17	1343	1360
2005	745	1018.7	1.367	2065	5196.0	2.516	0.8361	3792	622	3171	455	1260	1715
2006	646	924.4	1.431	4211	10382.9	2.466	0.9182	4792	392	4400	274	1785	2058
2007	507	720.7	1.421	2865	7514.8	2.623	0.9125	6002	525	5477	370	2088	2458
2008	236	342.0	1.449	2925	7973.8	2.726	0.9589	6025	248	5777	171	2119	2290
2009	472	696.6	1.476	3378	9161.6	2.712	0.9293	5606	396	5210	268	1921	2189
2010	821	1213.4	1.478	4963	14217.4	2.865	0.9214	5594	440	5154	298	1799	2097
2011	868	1109.9	1.279	4800	12786.8	2.664	0.9201	9779	781	8998	611	3378	3989
2012	213	371.8	1.746	3763	10727.9	2.851	0.9665	10881	365	10516	209	3689	3898
2013	450	736.7	1.637	5441	16258.3	2.988	0.9567	7410	321	7089	196	2372	2569
formula	*A*	*B*	*C=B/A*	*D*	*E*	*F=E/D*	*G=E/(E+B)*	*H*	*I=(1-G)*H*	*J=G*H*	*K=I/C*	*L=J/F*	*M=K+L*

Table 6. Summary of estimated discards of combined US fleets by sex, 1991-2013. Estimated total weights based on summation of estimated weights from sampled length frequency distributions. Estimated weights computed from length-weight regressions. Female W = exp(-15.025)^L^3.606935. Male W = exp(-13.002)*L^3.097787 with weight in kg and length in cm. "Samples" = number of measured dogfish that were discarded. 2010 estimates based on fishing year rather than calendar year.

	NMFS Biological Samples of Discards from Observers								Prorated Discards by Sex				
Year	Total Samples Males	Est Total Wt (kg) Males	Average Wt (kg) Males	Total Samples Females	Est Total Wt (kg) Females	Average Wt (kg) Females	Fraction Females by Weight	Total Dead Discards (mt)	Est Discards (mt) of Males	Est Discards (mt) of Females	Number of Males Discarded (000)	Number of Females Discarded (000)	Total Numbers Discarded (000)
1991	376	463	1.231	894	2350	2.628	0.8355	13274	2184	11090	1775	4219	5994
1992	449	504	1.123	632	1090	1.724	0.6836	18983	6007	12976	5347	7526	12873
1993	57	62	1.087	130	414	3.184	0.8697	11969	1559	10410	1434	3270	4704
1994	207	207	1.001	747	1397	1.870	0.8708	8556	1105	7451	1104	3985	5090
1995	2191	2342	1.069	2384	3064	1.285	0.5668	10932	4735	6197	4431	4821	9251
1996	1643	1833	1.115	1370	2013	1.469	0.5234	6025	2871	3153	2574	2147	4721
1997	1359	1391	1.024	1427	2070	1.451	0.5980	4366	1755	2611	1714	1800	3514
1998	1289	1320	1.024	1463	1939	1.326	0.5951	3435	1391	2044	1359	1542	2901
1999	447	440	0.984	870	1808	2.078	0.8044	4581	896	3685	911	1773	2684
2000	423	568	1.343	1498	3207	2.141	0.8495	2917	439	2478	327	1157	1484
2001	650	842	1.295	2987	7377	2.470	0.8976	5063	518	4545	400	1840	2241
2002	1293	1819	1.407	5880	13899	2.364	0.8843	5049	584	4464	415	1889	2304
2003	4711	5367	1.139	12826	27210	2.121	0.8353	4225	696	3529	611	1664	2275
2004	10878	14480	1.331	28583	64771	2.266	0.8173	6146	1123	5023	844	2217	3060
2005	7470	9450	1.265	13024	28593	2.195	0.7516	5589	1388	4201	1098	1914	3011
2006	4512	5449	1.208	7041	14559	2.068	0.7277	5688	1549	4139	1283	2002	3284
2007	3955	5183	1.310	9830	24621	2.505	0.8261	6510	1132	5378	864	2147	3011
2008	3096	3969	1.282	6140	14857	2.420	0.7892	5088	1073	4015	837	1659	2496
2009	1719	2088	1.215	3083	6849	2.221	0.7664	5897	1378	4519	1134	2034	3169
2010	1634	2190	1.340	2086	4994	2.394	0.6952	4081	1244	2837	928	1185	2113
2011	2286	2920	1.278	2428	5864	2.415	0.6675	4787	1591	3196	1246	1323	2569
2012	734	1010	1.376	1384	3302	2.386	0.766	4848	1136	3712	825	1556	2381
2013	448	381	0.850	701	1210	1.725	0.761	5010	1200	3810	1411	2208	3620
formula	*A*	*B*	*C=B/A*	*D*	*E*	*F=E/D*	*G=E/(E+B)*	*H*	*I=(1-G)*H*	*J=G*H*	*K=I/C*	*L=J/F*	*M=K+L*

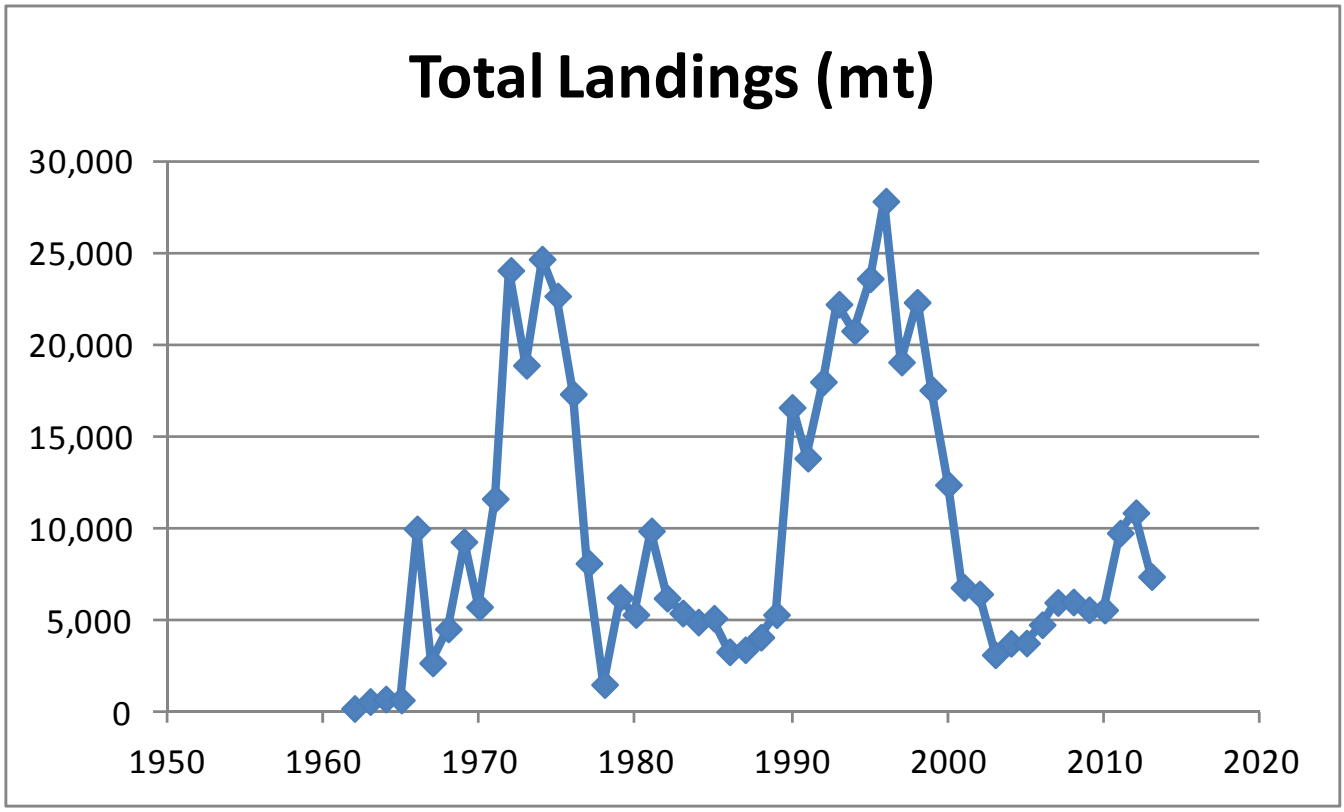

Figure 1. Estimated total landings (mt, live) of spiny dogfish in NAFO Areas 2 to 6, 1962-2013.

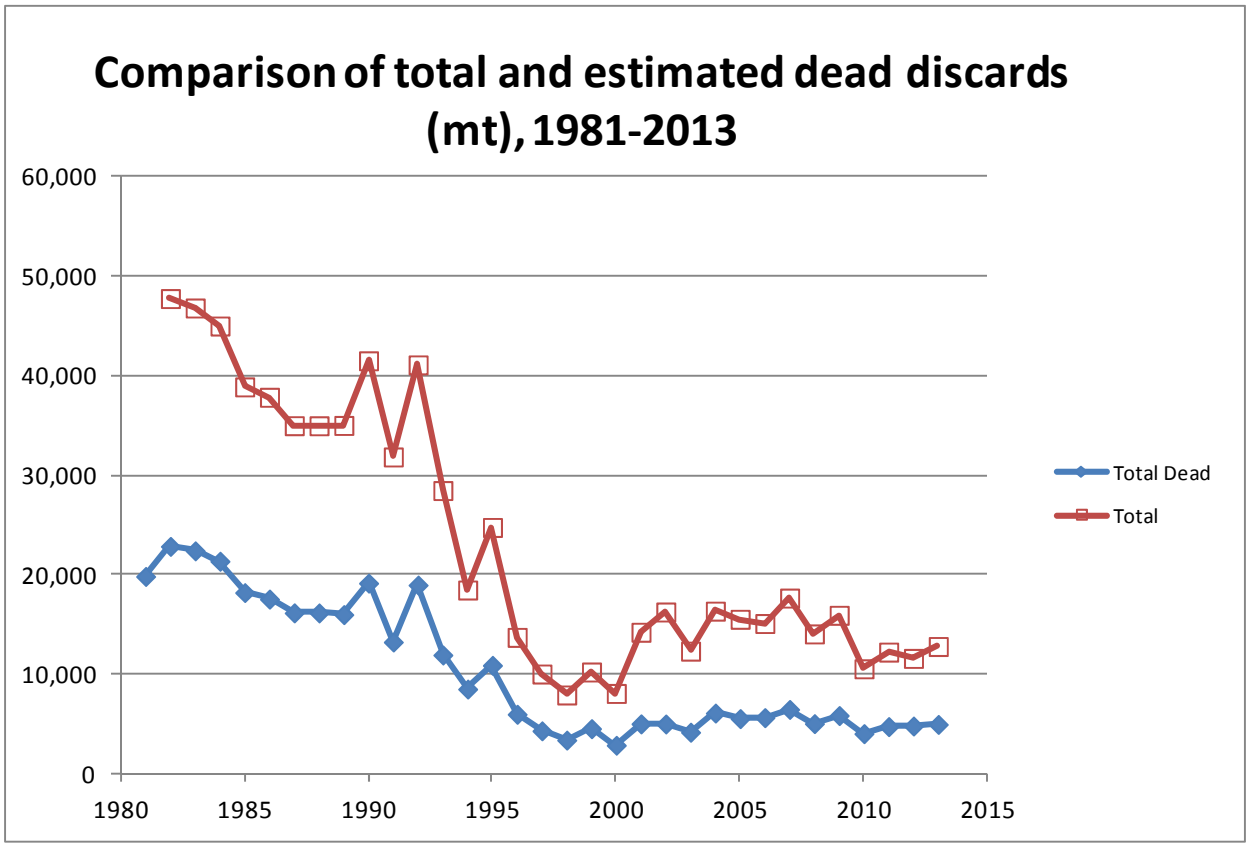

Figure 2. Estimated total and total dead discards in US, 1981-2013. Estimates for 1981 to 1989 are hindcast estimates rather than direct observations.

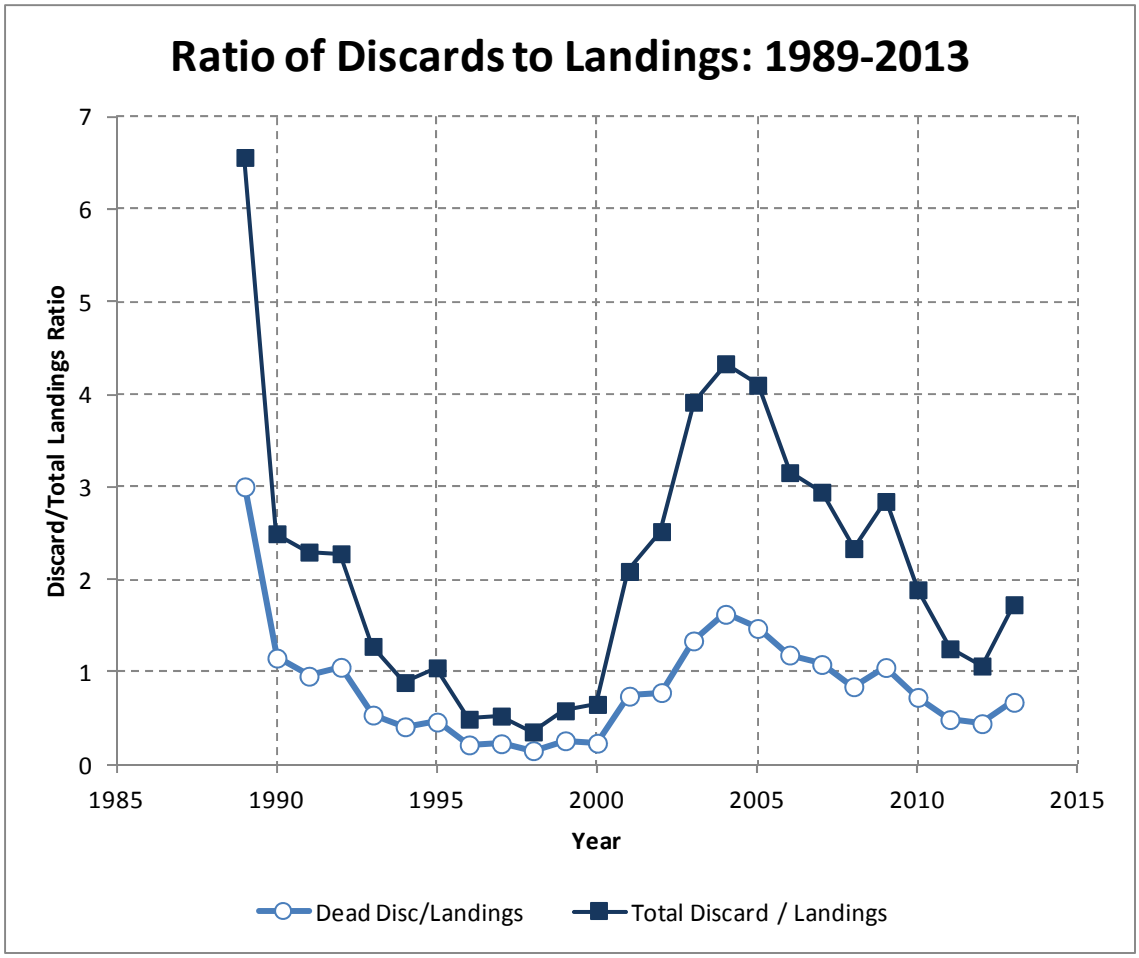

Figure 3. Trends in the ratio of total discards to landings and total dead discards to landings for spiny dogfish, 1989-2013.

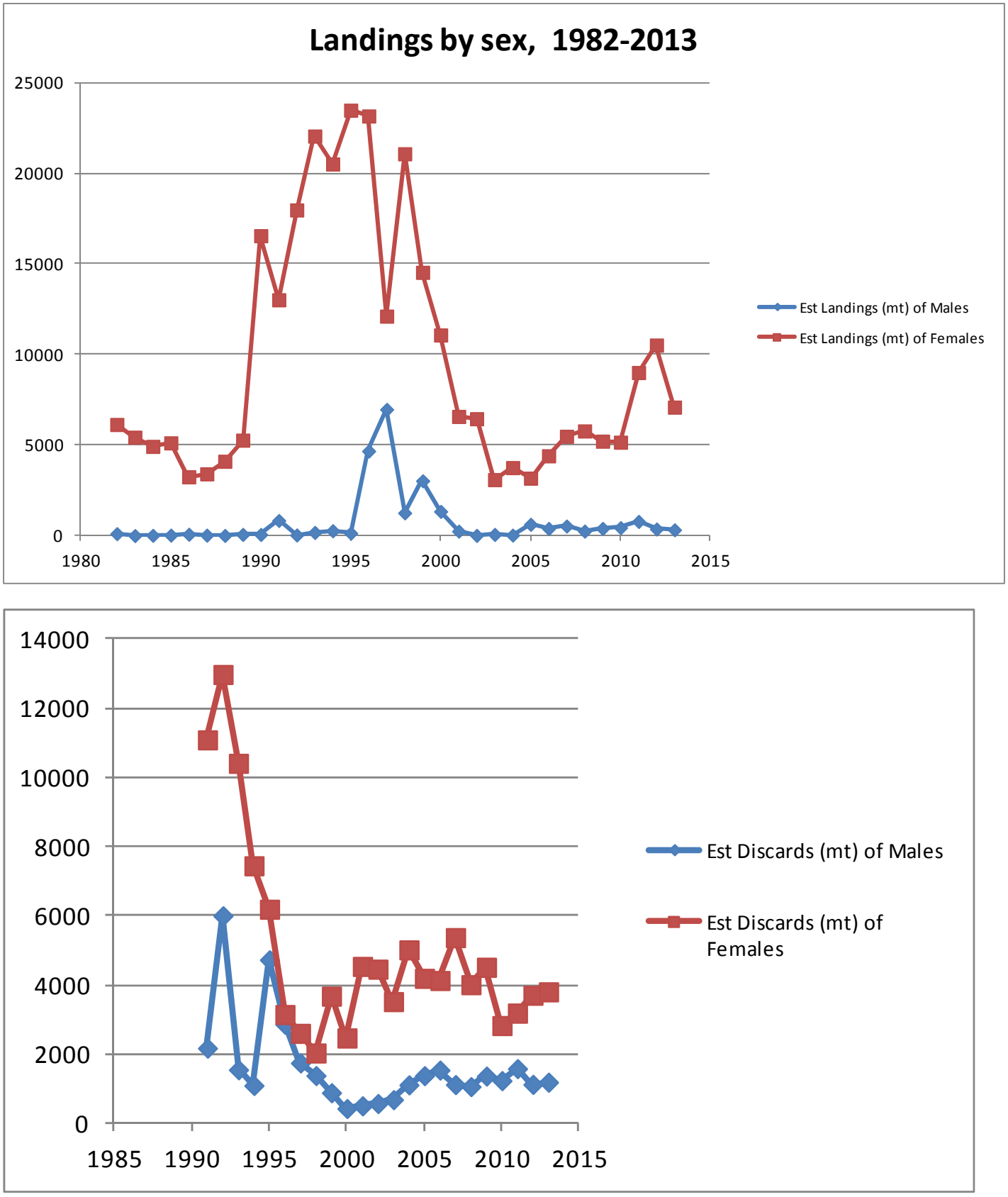

Figure 4. Estimated total landings(top) and total dead discards (bottom) in mt by sex, 1991-2013.

Appendix 1. Summary of total dead discards and standard errors for trawl, gill net and recreational discards for spiny dogfish by sex for 1990 to 2013.

	Trawl Discards (mt)				*Gill Net Discards (mt)*				*Recreational Discards (mt)*				*Landings (mt)*	
	Male		*Female*		*Male*		*Female*		*Male*		*Female*			
Year	*Total*	*SE*	*Total*	*SE*	*Total*	*SE*	*Total*	*SE*	*Total*	*SE*	*Total*	*SE*	*Males*	*Females.*
1990	7636.0	1918.55	9485.0	2382.9	256.0	65.12	1563.00	397.55	58.1	8.478	354.5	51.757	61.9	16378.1
1991	4309.0	843.49	5352.0	1047.6	466.0	54.53	2843.00	332.91	56.4	7.616	344.4	46.493	824.4	12878.6
1992	7274.0	1971.88	9034.0	2449.1	251.0	24.09	1535.00	147.10	58.9	6.242	359.5	38.108	32.5	17721.5
1993	3855.0	993.13	4788.0	1233.5	414.0	78.23	2530.00	477.57	48.1	7.456	293.7	45.516	173.0	21908.0
1994	3102.0	786.56	3852.0	976.9	122.0	36.74	744.00	224.31	49.0	7.444	299.0	45.445	266.3	20354.7
1995	2275.0	444.94	6224.0	1217.3	957.0	314.93	1062.00	349.68	90.0	10.356	100.0	11.498	137.0	23536.0
1996	1683.0	465.96	3018.0	835.9	599.0	181.61	568.00	172.39	53.4	6.839	50.7	6.492	4679.8	23213.2
1997	1716.0	566.41	1637.0	540.4	220.0	54.14	478.00	117.73	67.3	8.215	146.4	17.863	6941.6	12070.4
1998	1077.0	363.50	1558.0	525.9	239.0	69.66	351.00	102.48	65.1	8.593	95.8	12.642	1254.4	21059.6
1999	982.0	340.73	2860.0	992.3	117.0	31.19	485.00	129.44	30.9	3.586	128.3	14.884	3082.3	14798.7
2000	644.0	156.37	720.0	174.7	149.0	43.50	1256.00	367.38	13.3	2.191	112.1	18.503	543.8	11792.2
2001	428.0	68.78	2031.0	326.2	185.0	55.76	1977.00	596.91	38.1	3.464	407.5	37.079	242.3	6483.7
2002	533.0	168.91	2237.0	708.6	107.0	23.23	1392.00	301.06	40.5	4.291	524.5	55.601	114.7	5954.3
2003	524.0	101.64	1402.0	272.0	172.0	22.41	1452.00	189.62	67.3	5.455	569.8	46.150	63.1	3053.9
2004	1261.0	201.44	2888.0	461.3	127.0	11.85	1083.00	101.38	81.9	7.374	700.7	63.064	26.3	3623.7
2005	994.5	111.79	2762.9	310.6	192.6	24.29	808.89	102.03	125.4	15.053	526.9	63.229	488.4	2491.6
2006	790.8	88.89	2123.0	238.6	244.2	29.30	655.59	78.67	177.0	21.246	475.3	57.036	385.6	4330.3
2007	704.2	84.51	3353.0	376.9	290.5	34.86	1383.29	166.00	155.9	18.705	742.1	89.055	512.5	5339.9
2008	589.8	97.20	2212.2	364.6	307.1	55.13	1152.02	206.79	131.1	12.510	491.8	46.919	242.0	5652.1
2009	883.0	90.36	2895.0	296.4	361.0	52.52	1185.00	172.28	134.0	16.490	439.7	54.100	396.0	5201.0
2010	893.0	70.86	2036.0	161.6	234.0	23.19	533.00	52.89	118.0	13.130	268.7	29.950	440.0	5154.0
2011	1143.0	110.49	2296.0	222.0	294.0	15.27	591.00	30.67	154.0	22.440	309.0	45.070	781.0	8998.0
2012	859.0	77.80	2808.0	254.3	212.0	13.35	693.00	43.64	64.0	11.400	210.0	37.260	364.0	10516.5
2013	825.9	59.2	2622.1	188.0	223.2	21.9	708.8	69.5	127.2	15.1	403.8	48.1	321.0	7089.0