4.1 Assessment of the northern and southern rock sole (*Lepidopsetta polyxystra and bilineata*) stocks in the Gulf of Alaska for 2014

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Executive Summary

Due to the government shut-down in October 2013, stock assessments for an abbreviated suite of model runs are required only for Steller sea lion prey species (walleye pollock, Pacific cod, Bering Sea/Aleutian Islands Atka mackerel), and species where a conservation concern has been noted. For all other Tier 1-3 stocks, updated projections from last year using 2013 catch data are required at a minimum. Results will be presented in executive summaries using the "off-year" format for stocks on biennial assessment cycles.

Summary of results

The 2012 stock assessment document contains the most recent information for the full stock assessment (http://www.afsc.noaa.gov/REFM/Docs/2012/GOAnsrocksole.pdf).

New information and projections

The biomass estimate from the 2013 GOA NMFS bottom trawl survey for northern rock sole was a slight increase (2.3%) from the estimate from the 2011 survey. The biomass estimate from the 2013 survey for southern rock sole was an increase of 9% from the estimate from the 2011 survey.

The catch totals for 2012 and 2013 for the shallow-water flatfish complex and rock sole were updated and used in the projections to obtain updated harvest specifications. The total rock sole catch for 2012 and 2013 was assumed to be split equally between northern and southern rock sole. No stock assessment models were run.

Northern rock sole

Quantity	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
	2013	2014	2014	2015
M (natural mortality rate)	0.2,0.275*	0.2, 0.275*	0.2,0.275*	0.2, 0.275*
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	89,300	80,000	87,300	79,300
Female spawning biomass (t)	42,700	36,500	40,600	34,400
Projected				
$B_{100\%}$	50,300	50,300	50,300	50,300
$B_{40\%}$	20,100	20,100	20,100	20,100
$B_{35\%}$	17,600	17,600	17,600	17,600
F_{OFL}	0.180	0.180	0.180	0.180
$maxF_{ABC}$	0.152	0.152	0.152	0.152
F_{ABC}	0.152	0.152	0.152	0.152
OFL (t)	11,400	9,900	11,000	9,700
maxABC (t)	9,700	8,500	9,400	8,300
ABC (t)	9,700	8,500	9,400	8,300

Status	As determined *last* year for: 2011	2012	As determined *this* year for: 2012	2013
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

* for males; estimated

Southern rock sole

Quantity	As estimated or *specified last* year for: 2013	2014	As estimated or *recommended this* year for: 2014	2015
M (natural mortality rate)	0.2, 0.267*	0.2, 0.267*	0.2, 0.267*	0.2, 0.267*
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	208,800	192,700	208,800	195,200
Female spawning biomass (t)	82,800	72,500	81,500	69,300
Projected				
$B_{100\%}$	112,900	112,900	112,900	112,900
$B_{40\%}$	45,100	45,100	45,100	45,100
$B_{35\%}$	39,500	39,500	39,500	39,500
F_{OFL}	0.230	0.230	0.230	0.230
$maxF_{ABC}$	0.193	0.193	0.193	0.193
F_{ABC}	0.193	0.193	0.193	0.193
OFL (t)	21,900	19,300	21,400	18,900
maxABC (t)	18,600	16,400	18,200	16,000
ABC (t)	18,600	16,400	18,200	16,000
Status	As determined *last* year for: 2011	2012	As determined *this* year for: 2012	2013
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

* for males; estimated

Table 4.1 – Estimated catch (in metric tonnes) for shallow water flatfish (SWFF) and total rock sole catch from the Alaska Fisheries Information Network (AKFIN) (as of 2013-10-30).

Year	SWFF catch (AKFIN)	U/N/S rock sole catch (AKFIN)	% U/N/S rock sole
1991	5,224.6	0.1	-
1992	8,333.8	42.0	-
1993	9,113.7	8,112.1	89.0
1994	3,843.0	3,008.1	78.3
1995	5,436.9	3,923.9	72.2
1996	9,372.4	6,595.3	70.4
1997	7,779.6	5,466.8	70.3
1998	3,567.3	2,532.3	71.0
1999	2,578.4	1,765.4	68.5
2000	6,928.7	5,386.7	77.7
2001	6,163.3	4,771.7	77.4
2002	7,177.3	5,564.3	77.5
2003	4,648.5	3,554.6	76.5
2004	3,094.2	2,216.7	71.6
2005	4,805.1	4,130.5	86.0
2006	7,651.7	5,763.3	75.3
2007	8,692.0	6,727.4	77.2
2008	9,725.9	7,269.1	74.7
2009	8,485.0	6,538.7	77.1
2010	5,533.7	3,285.3	59.4
2011	3,990.8	3,094.4	77.5
2012	4,022.7	2,828.6	70.3
2013	4,974.3	3,667.2	73.7

Table 4.2 – Fishery observer extrapolated catch (based on sampled catch) in metric tonnes (as of 2013-10-30) for undifferentiated (U), northern (N), and southern (S) rock sole, and shallow water flatfish (SWFF)

Year	U rock sole	N rock sole	S rock sole	SWFF	%SWFF catch observed
1990	1,260.9			1,500.0	18.8
1991	1,285.8			1,458.6	27.9
1992	2,005.5			2,321.4	27.9
1993	1,117.1			1,373.7	15.1
1994	409.0			662.2	17.2
1995	810.0			1,067.6	19.6
1996	877.6			1,332.4	14.2
1997	977.9	36.2	44.8	1,331.9	17.1
1998	344.9	78.3	144.5	769.5	21.6
1999	204.0	102.2	100.7	575.1	22.6
2000	772.7	124.0	153.6	1,398.8	20.2
2001	863.1	162.8	152.4	1,401.4	22.7
2002	1,040.0	158.5	110.1	1,565.2	21.8
2003	488.6	89.8	130.8	944.4	20.3
2004	232.5	48.1	155.5	706.3	22.8
2005	411.6	47.7	73.9	669.2	13.9
2006	618.6	144.3	55.7	1,042.1	13.6
2007	1,114.0	133.4	176.1	1,671.1	19.2
2008	1,097.8	169.2	281.2	2,044.8	21.0
2009	167.3	499.9	442.8	1,468.5	17.3
2010	125.6	373.3	366.1	1,302.4	23.5
2011	102.6	144.9	292.7	645.5	16.2
2012	137.0	365.8	699.1	1,486.2	36.9
2013	35.2	476.5	436.1	1,123.3	21.9

Table 4.3 – GOA NMFS bottom trawl survey biomass (in mt) and population estimates

Year	Species	Total biomass	std dev	Total numbers	std dev
1984	U	137,623	12,208	404,285,245	43,401,215
1987	U	123,393	20,329	281,015,223	37,864,353
1990	U	156,032	19,472	329,427,129	40,836,229
1993	U	173,044	14,570	346,198,094	29,291,722
1996	N	78,845	9,930	208,492,467	30,477,247
1999	N	61,543	15,134	151,313,021	34,652,753
2001	N	64,809	9,887	140,508,433	17,513,605
2003	N	79,648	9,514	203,049,571	26,460,258
2005	N	91,459	10,123	216,801,482	23,769,367
2007	N	102,303	12,046	227,003,343	26,624,065
2009	N	95,846	16,068	257,075,774	51,973,203
2011	N	72,875	12,427	148,039,674	24,568,593
2013	N	74,586	13,587	152,326,011	31,004,369
1996	S	127,390	12,580	186,116,865	16,990,673
1999	S	106,235	10,580	154,084,268	15,292,879
2001	S	122,492	14,643	174,732,258	20,118,997
2003	S	126,819	12,480	199,376,622	15,983,336
2005	S	147,665	15,084	240,030,524	25,605,394
2007	S	161,617	11,764	256,910,791	19,144,732
2009	S	191,765	22,591	300,479,225	33,990,620
2011	S	120,573	10,318	174,623,722	15,912,209
2013	S	131,441	13,993	182,199,716	16,748,495

Table 4.4 – Results for the projection scenarios for northern rock sole for Model 3

Scenarios 1 and 2, Maximum tier 3 ABC harvest permissible						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	10,061	11,740	1,414	43,810	0.020	90,832
2013	9,743	11,369	2,000	43,389	0.030	88,913
2014	9,432	11,007	9,432	40,638	0.152	87,317
2015	8,382	9,784	8,382	34,460	0.152	79,324
2016	7,653	8,934	7,653	29,590	0.152	73,842
2017	7,163	8,363	7,163	26,404	0.152	70,186
2018	6,843	7,990	6,843	24,363	0.152	67,738
2019	6,631	7,742	6,631	23,013	0.152	66,097
2020	6,456	7,536	6,456	22,139	0.151	65,001
2021	6,317	7,371	6,317	21,608	0.150	64,268
2022	6,214	7,250	6,214	21,262	0.148	63,818
2023	6,155	7,180	6,155	21,018	0.148	63,567
2024	6,120	7,140	6,120	20,884	0.147	63,488
2025	6,105	7,121	6,105	20,806	0.147	63,464
2026	6,101	7,117	6,101	20,746	0.147	63,389
Scenario 3, F_{ABC} at average F over the past 5 years						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	2,549	11,740	1,414	43,810	0.020	90,832
2013	2,469	11,369	2,000	43,389	0.030	88,913
2014	2,389	11,007	2,389	41,384	0.037	87,317
2015	2,331	10,746	2,331	39,040	0.037	86,262
2016	2,306	10,637	2,306	37,104	0.037	86,051
2017	2,305	10,634	2,305	36,256	0.037	86,401
2018	2,319	10,699	2,319	36,119	0.037	87,010
2019	2,339	10,793	2,339	36,296	0.037	87,716
2020	2,360	10,890	2,360	36,625	0.037	88,426
2021	2,380	10,982	2,380	37,038	0.037	89,051
2022	2,397	11,062	2,397	37,411	0.037	89,595
2023	2,412	11,128	2,412	37,695	0.037	90,057
2024	2,424	11,184	2,424	37,958	0.037	90,493
2025	2,435	11,234	2,435	38,177	0.037	90,843
2026	2,444	11,278	2,444	38,334	0.037	91,048
Scenario 4, 1/2 Maximum ABC harvest permissible						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	5,270	11,740	1,414	43,810	0.020	90,832
2013	5,104	11,369	2,000	43,389	0.030	88,913
2014	4,940	11,007	4,940	41,120	0.077	87,317
2015	4,664	10,397	4,664	37,367	0.077	83,748
2016	4,484	10,000	4,484	34,269	0.077	81,494

2017	4,375	9,762	4,375	32,426	0.077	80,184
2018	4,316	9,632	4,316	31,427	0.077	79,440
2019	4,287	9,567	4,287	30,871	0.077	79,045
2020	4,271	9,533	4,271	30,587	0.077	78,856
2021	4,264	9,518	4,264	30,487	0.077	78,752
2022	4,261	9,512	4,261	30,435	0.077	78,707
2023	4,260	9,508	4,260	30,377	0.077	78,696
2024	4,260	9,508	4,260	30,360	0.077	78,753
2025	4,262	9,514	4,262	30,352	0.077	78,802
2026	4,266	9,522	4,266	30,328	0.077	78,766
Scenario 5, No fishing (F_{ABC} = 0)						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	0	11,740	1,414	43,810	0.020	90,832
2013	0	11,369	2,000	43,389	0.030	88,913
2014	0	11,007	0	41,624	0.000	87,317
2015	0	11,073	0	40,621	0.000	88,618
2016	0	11,253	0	39,879	0.000	90,460
2017	0	11,506	0	40,128	0.000	92,599
2018	0	11,795	0	41,008	0.000	94,765
2019	0	12,086	0	42,106	0.000	96,827
2020	0	12,354	0	43,255	0.000	98,713
2021	0	12,594	0	44,393	0.000	100,350
2022	0	12,802	0	45,399	0.000	101,760
2023	0	12,976	0	46,229	0.000	102,959
2024	0	13,124	0	46,961	0.000	104,018
2025	0	13,252	0	47,582	0.000	104,892
2026	0	13,361	0	48,078	0.000	105,538
Scenario 6, Whether N rock sole are overfished – $SB_{35\%}$ = 17,400						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	11,740	11,740	1,414	43,810	0.020	90,832
2013	11,369	11,369	11,369	42,381	0.180	88,913
2014	9,725	9,725	9,725	35,252	0.180	78,123
2015	8,584	8,584	8,584	29,306	0.180	70,827
2016	7,838	7,838	7,838	24,806	0.180	66,134
2017	7,372	7,372	7,372	22,022	0.180	63,226
2018	6,987	6,987	6,987	20,379	0.177	61,419
2019	6,598	6,598	6,598	19,441	0.170	60,401
2020	6,414	6,414	6,414	19,003	0.166	60,026
2021	6,355	6,355	6,355	18,858	0.165	59,944
2022	6,340	6,340	6,340	18,819	0.164	59,986
2023	6,347	6,347	6,347	18,804	0.164	60,073
2024	6,365	6,365	6,365	18,835	0.164	60,216

2025	6,377	6,377	6,377	18,863	0.164	60,324
2026	6,394	6,394	6,394	18,873	0.164	60,328
Scenario 7, Whether N rock sole is approaching overfished condition						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	11,740	11,740	1,414	43,810	0.020	90,832
2013	11,369	11,369	9,743	42,564	0.152	88,913
2014	9,947	9,947	8,523	36,309	0.152	79,717
2015	8,949	8,949	8,949	30,792	0.180	73,439
2016	8,118	8,118	8,118	25,985	0.180	68,101
2017	7,581	7,581	7,581	22,945	0.180	64,677
2018	7,216	7,216	7,216	21,077	0.179	62,470
2019	6,790	6,790	6,790	19,921	0.172	61,072
2020	6,536	6,536	6,536	19,303	0.168	60,397
2021	6,420	6,420	6,420	19,031	0.166	60,120
2022	6,371	6,371	6,371	18,909	0.165	60,053
2023	6,358	6,358	6,358	18,845	0.164	60,085
2024	6,367	6,367	6,367	18,848	0.164	60,205
2025	6,375	6,375	6,375	18,864	0.164	60,305
2026	6,391	6,391	6,391	18,869	0.164	60,310

Table 4.5 – Results of the projection scenarios for southern rock sole for Model 3

Scenarios 1 and 2, Maximum tier 3 ABC harvest permissible						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	18,770	22,100	1,414	85,758	0.014	209,978
2013	18,589	21,882	2,000	87,561	0.020	208,511
2014	18,259	21,490	18,259	81,571	0.193	208,843
2015	16,095	18,946	16,095	69,397	0.193	195,257
2016	14,458	17,025	14,458	58,548	0.193	187,356
2017	13,328	15,700	13,328	50,267	0.193	183,472
2018	12,498	14,607	12,498	44,930	0.191	182,173
2019	11,519	13,464	11,519	42,444	0.180	182,674
2020	11,283	13,209	11,283	41,971	0.177	184,572
2021	11,388	13,347	11,388	42,445	0.177	186,685
2022	11,629	13,641	11,629	43,314	0.179	188,622
2023	11,865	13,928	11,865	44,216	0.180	190,121
2024	12,066	14,170	12,066	45,000	0.182	191,428
2025	12,230	14,366	12,230	45,609	0.183	192,201
2026	12,343	14,502	12,343	46,042	0.184	192,497
Scenario 3, F_{ABC} at average F over the past 5 years						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	3,697	22,100	1,414	85,758	0.014	209,978
2013	3,665	21,882	2,000	87,561	0.020	208,511
2014	3,603	21,490	3,603	86,026	0.036	208,843
2015	3,507	20,916	3,507	81,869	0.036	209,774
2016	3,436	20,507	3,436	76,928	0.036	212,775
2017	3,401	20,317	3,401	72,823	0.036	217,052
2018	3,402	20,348	3,402	70,431	0.036	221,945
2019	3,435	20,569	3,435	70,086	0.036	227,152
2020	3,492	20,928	3,492	71,335	0.036	232,230
2021	3,564	21,370	3,564	73,383	0.036	236,869
2022	3,642	21,846	3,642	75,792	0.036	241,064
2023	3,721	22,318	3,721	78,182	0.036	244,710
2024	3,796	22,765	3,796	80,397	0.036	248,050
2025	3,864	23,168	3,864	82,349	0.036	250,719
2026	3,924	23,521	3,924	84,014	0.036	252,752
Scenario 4, 1/2 Maximum ABC harvest permissible						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	9,543	22,100	1,414	85,758	0.014	209,978
2013	9,458	21,882	2,000	87,561	0.020	208,511
2014	9,294	21,490	9,294	84,321	0.095	208,843
2015	8,712	20,148	8,712	76,922	0.095	204,135
2016	8,255	19,104	8,255	69,384	0.095	202,601

2017	7,942	18,399	7,942	63,261	0.095	203,241
2018	7,767	18,014	7,767	59,286	0.095	205,190
2019	7,707	17,894	7,707	57,609	0.095	207,970
2020	7,732	17,966	7,732	57,650	0.095	210,995
2021	7,810	18,157	7,810	58,586	0.095	213,856
2022	7,916	18,404	7,916	59,950	0.095	216,484
2023	8,031	18,666	8,031	61,376	0.095	218,735
2024	8,142	18,923	8,142	62,700	0.095	220,830
2025	8,243	19,157	8,243	63,840	0.095	222,390
2026	8,328	19,354	8,328	64,775	0.095	223,441
Scenario 5, No fishing (F_{ABC} = 0)						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	0	22,100	1,414	85,758	0.014	209,978
2013	0	21,882	2,000	87,561	0.020	208,511
2014	0	21,490	0	87,089	0.000	208,843
2015	0	21,403	0	85,067	0.000	213,345
2016	0	21,428	0	81,981	0.000	219,418
2017	0	21,618	0	79,452	0.000	226,335
2018	0	21,981	0	78,411	0.000	233,510
2019	0	22,495	0	79,285	0.000	240,719
2020	0	23,115	0	81,683	0.000	247,576
2021	0	23,794	0	84,821	0.000	253,819
2022	0	24,490	0	88,269	0.000	259,475
2023	0	25,168	0	91,636	0.000	264,457
2024	0	25,806	0	94,767	0.000	269,022
2025	0	26,389	0	97,572	0.000	272,808
2026	0	26,909	0	100,021	0.000	275,856
Scenario 6, Whether S rock sole are overfished – $SB_{35\%}$ = 39,000						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	22,100	22,100	1,414	85,758	0.014	209,978
2013	21,882	21,882	21,882	81,656	0.230	208,511
2014	18,835	18,835	18,835	69,720	0.230	189,152
2015	16,445	16,445	16,445	58,263	0.230	177,166
2016	14,724	14,724	14,724	48,426	0.230	170,977
2017	12,518	12,518	12,518	41,499	0.210	168,717
2018	11,016	11,016	11,016	37,829	0.191	169,944
2019	10,719	10,719	10,719	36,803	0.185	173,396
2020	11,061	11,061	11,061	37,332	0.188	177,249
2021	11,612	11,612	11,612	38,464	0.193	180,502
2022	12,162	12,162	12,162	39,717	0.199	182,963
2023	12,612	12,612	12,612	40,793	0.203	184,573
2024	12,920	12,920	12,920	41,597	0.206	185,721

2025	13,115	13,115	13,115	42,135	0.208	186,213
2026	13,229	13,229	13,229	42,454	0.209	186,207
Scenario 7, Whether S rock sole is approaching overfished condition						
Year	ABC	OFL	Catch	SSB	F	Total Bio
2012	22,100	22,100	1,414	85,758	0.014	209,978
2013	21,882	21,882	18,589	82,661	0.193	208,511
2014	19,273	19,273	16,372	72,394	0.193	192,411
2015	17,170	17,170	17,170	61,222	0.230	182,517
2016	15,286	15,286	15,286	50,712	0.230	175,020
2017	13,418	13,418	13,418	43,129	0.219	171,734
2018	11,559	11,559	11,559	38,887	0.196	171,686
2019	11,058	11,058	11,058	37,487	0.189	174,345
2020	11,263	11,263	11,263	37,752	0.190	177,696
2021	11,720	11,720	11,720	38,699	0.194	180,646
2022	12,209	12,209	12,209	39,825	0.199	182,945
2023	12,624	12,624	12,624	40,823	0.203	184,482
2024	12,914	12,914	12,914	41,584	0.206	185,611
2025	13,102	13,102	13,102	42,104	0.208	186,112
2026	13,214	13,214	13,214	42,419	0.209	186,125

Figure 4.1 – Total catch for GOA shallow-water flatfish by area (as of 2013-10-30)

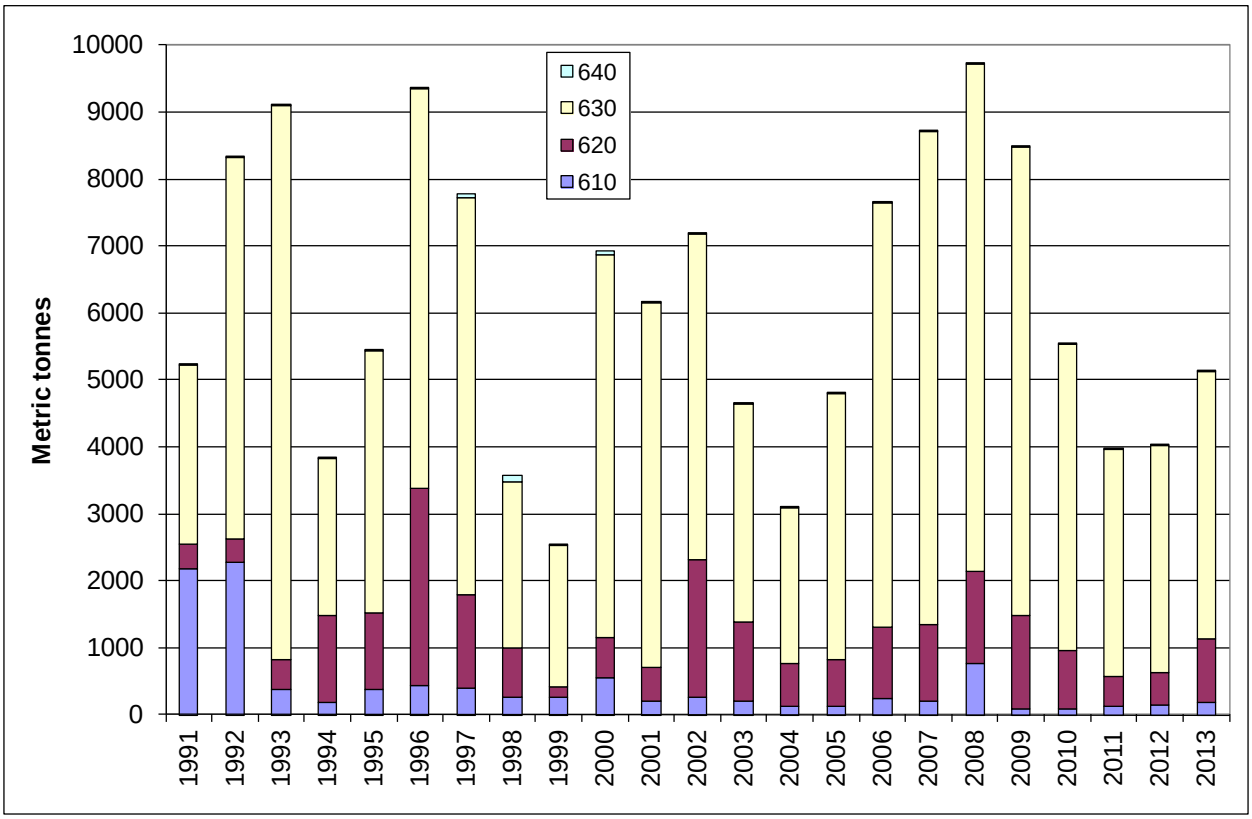


Figure 4.2 – Observed fishery catch of GOA U/N/S rock sole by area (based on extrapolated fishery observer data; as of 2013-10-30)

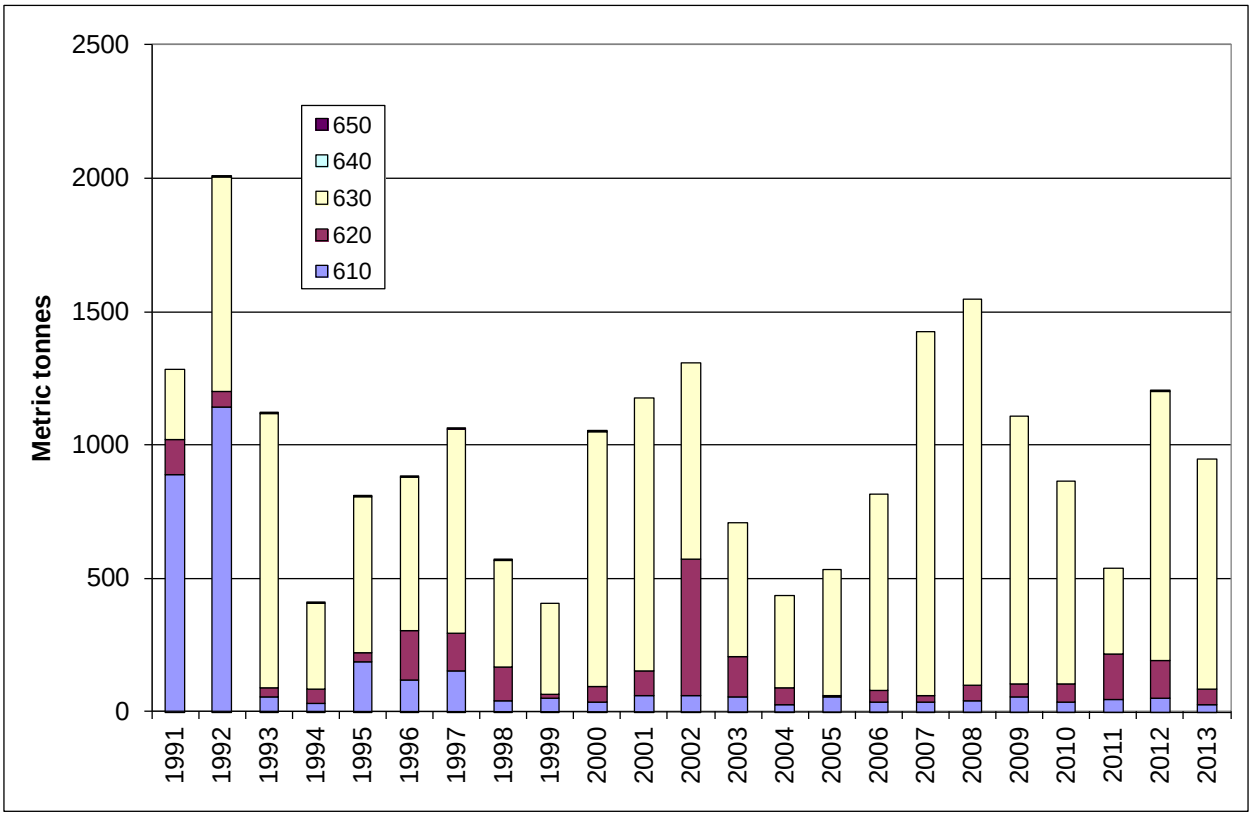


Figure 4.3 – Percent of the total shallow-water flatfish catch that is observed (based on extrapolated fishery observer data; as of 2013-10-30)

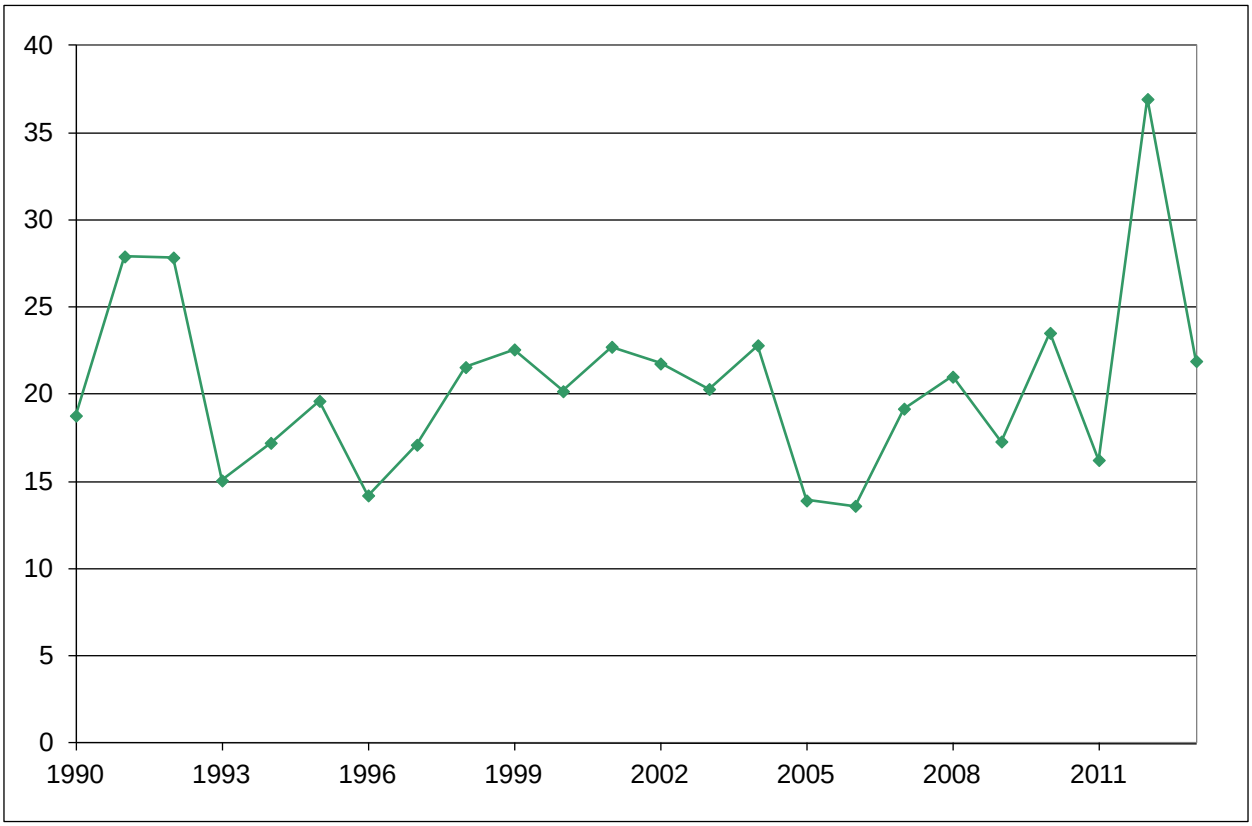


Figure 4.4 – Percent of the observed shallow-water flatfish catch that is U/N/S rock sole (based on extrapolated fishery observer data; as of 2013-10-30)

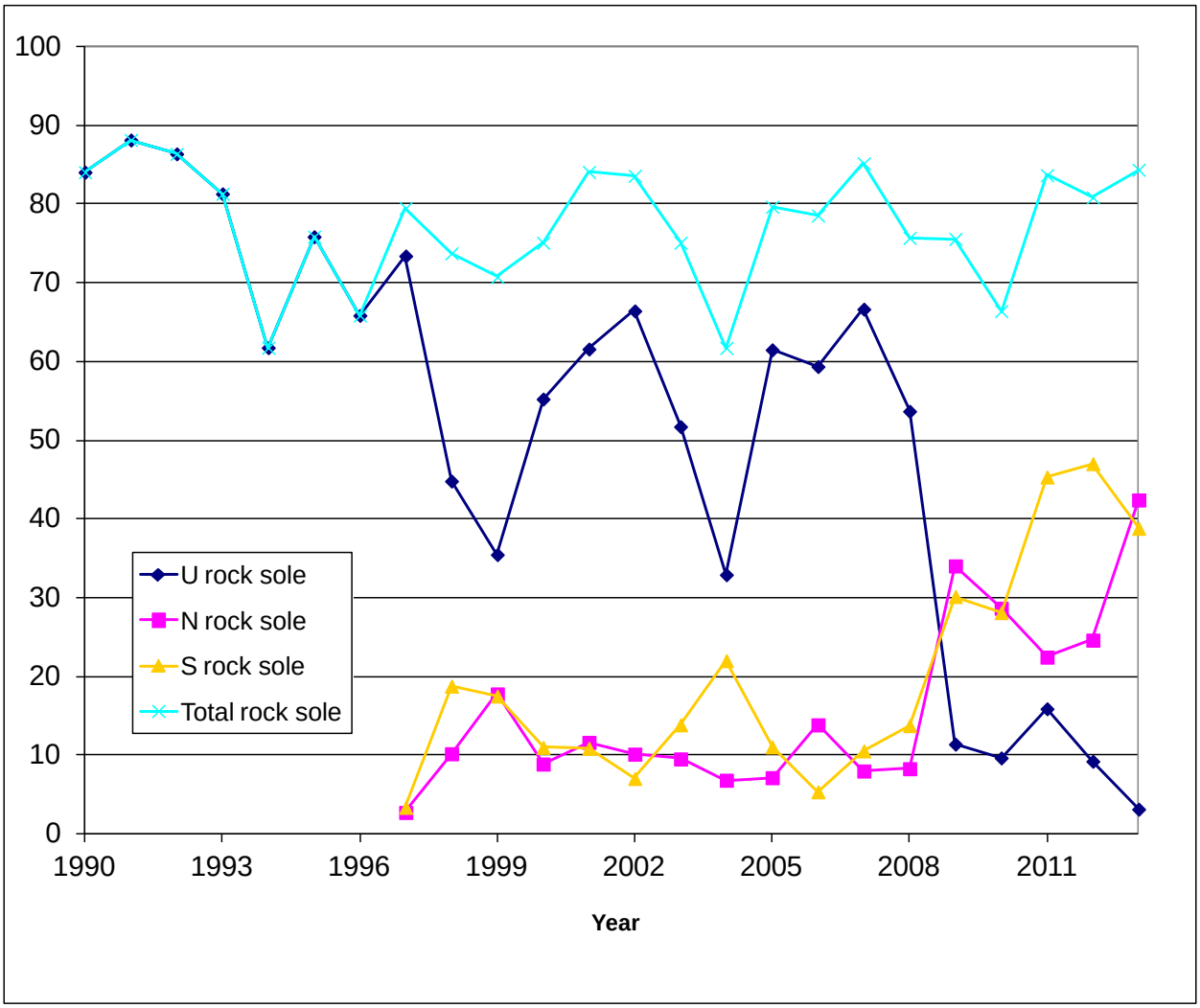


Figure 4.5 – GOA NMFS bottom trawl survey estimates for U rock sole by area

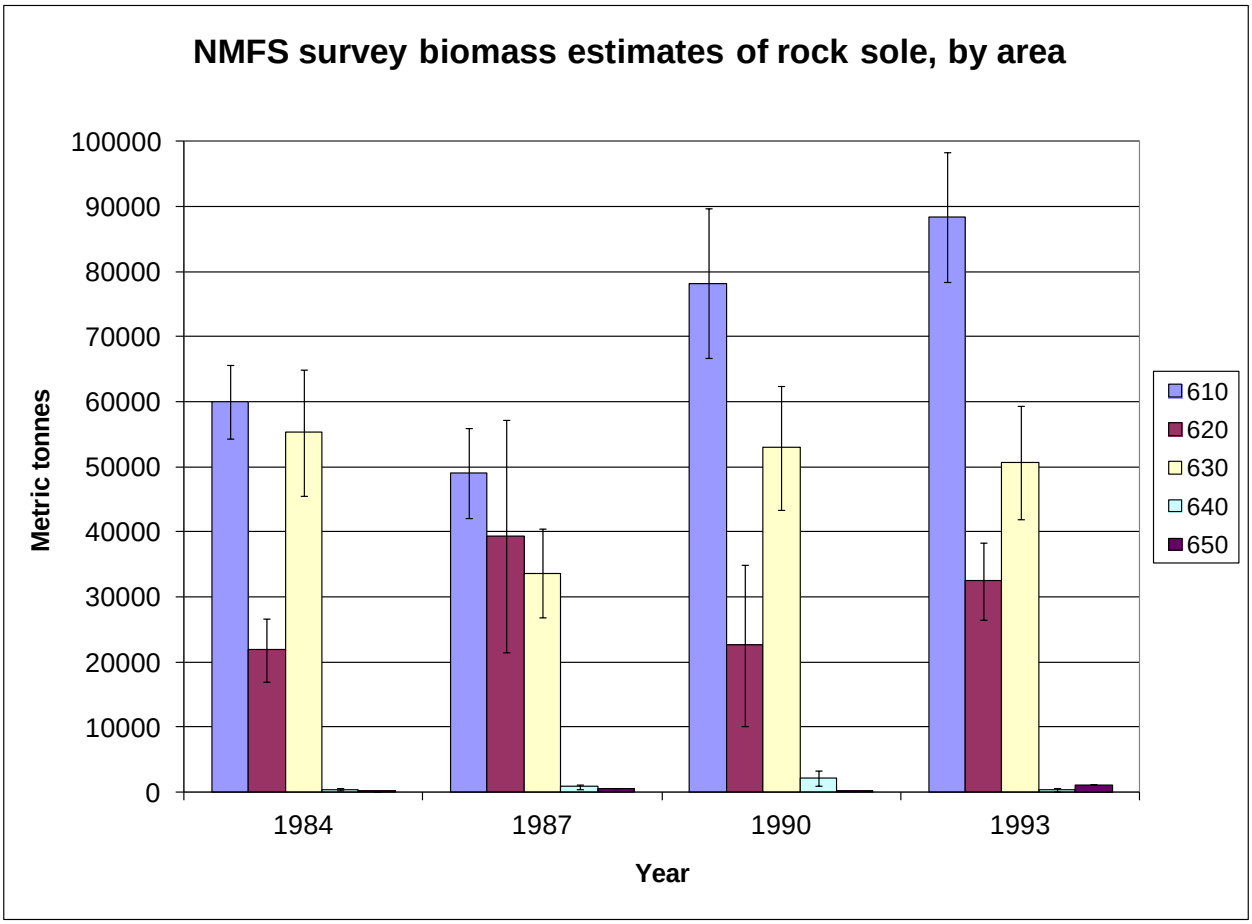


Figure 4.6 – GOA NMFS bottom trawl survey estimates for N rock sole by area

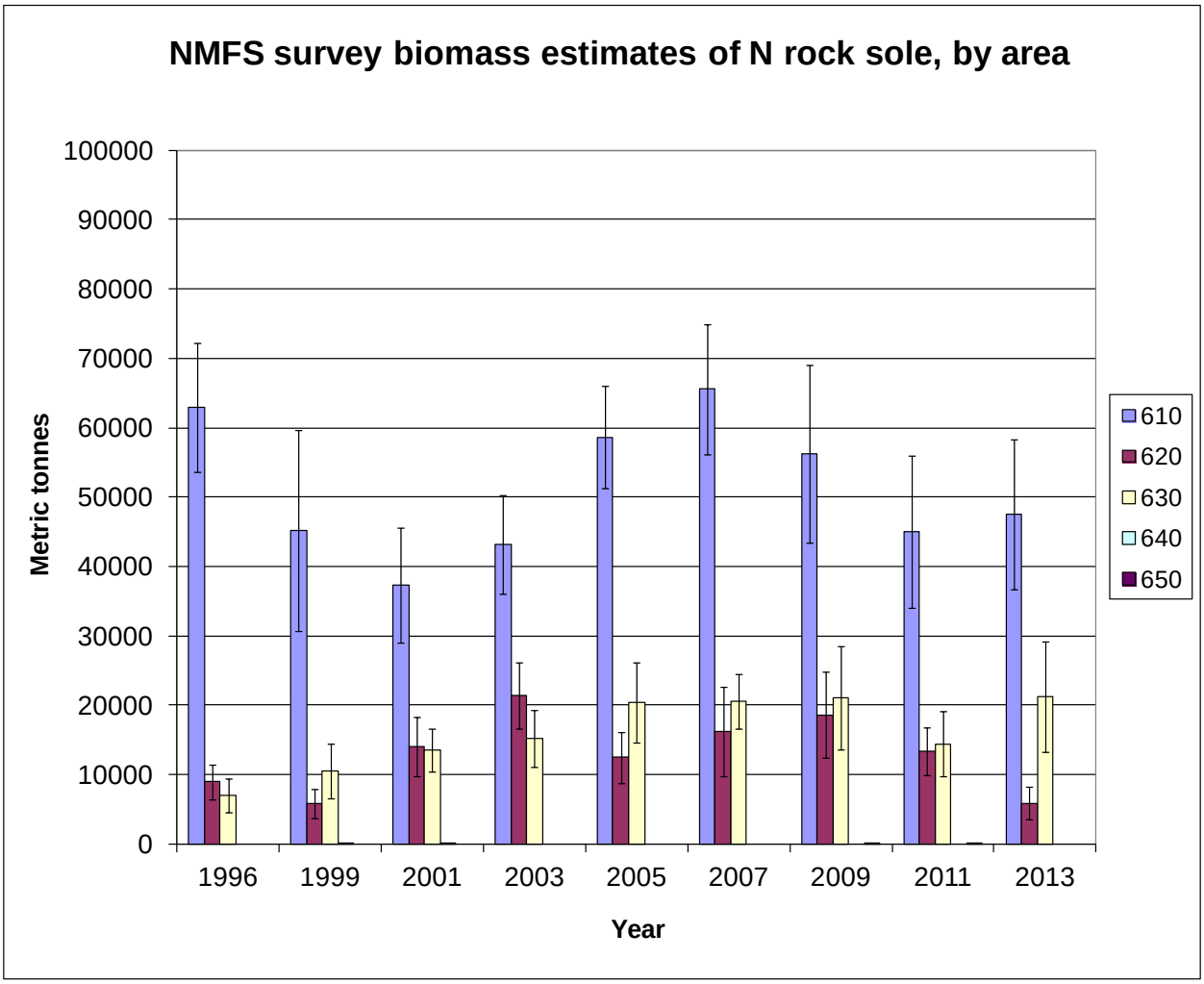


Figure 4.7 – GOA NMFS bottom trawl survey estimates for S rock sole by area

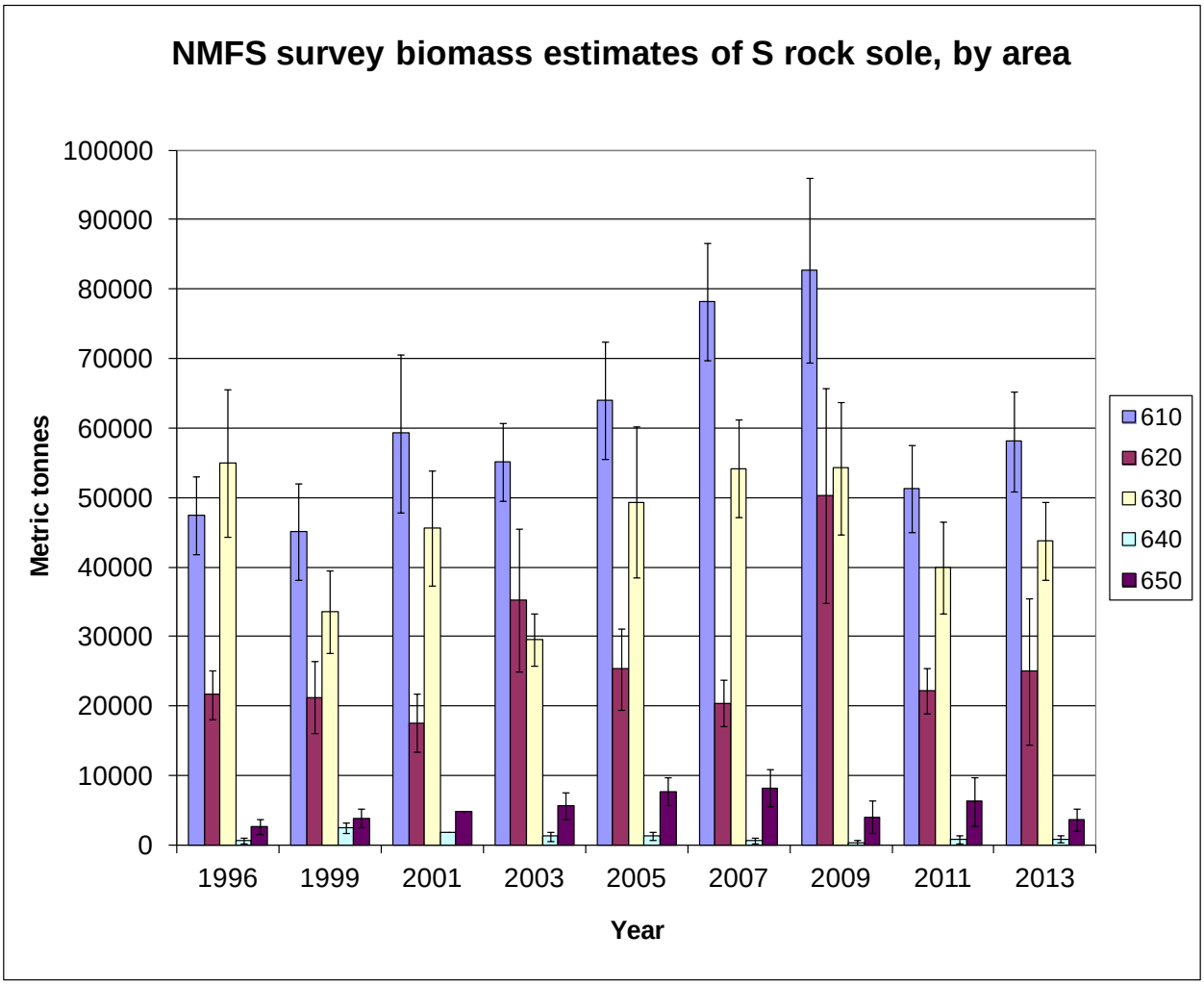


Figure 4.8 – GOA NMFS bottom trawl survey estimates for U/N/S rock sole

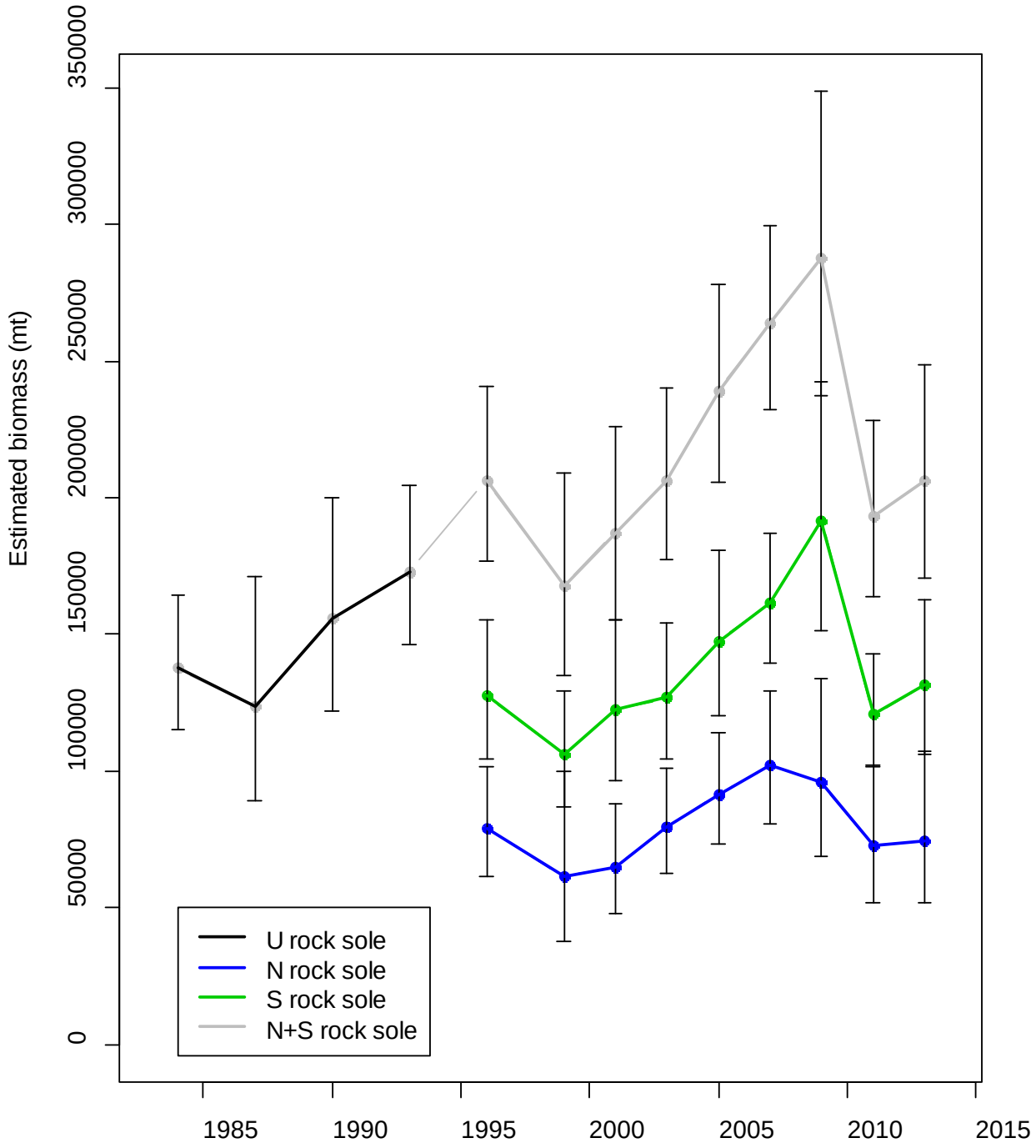


Figure 4.9 – Population lengths from the GOA NMFS bottom trawl survey for northern rock sole (female – top half of each plot, male – bottom half of each plot; the x-axis is 1 to 66 cm)

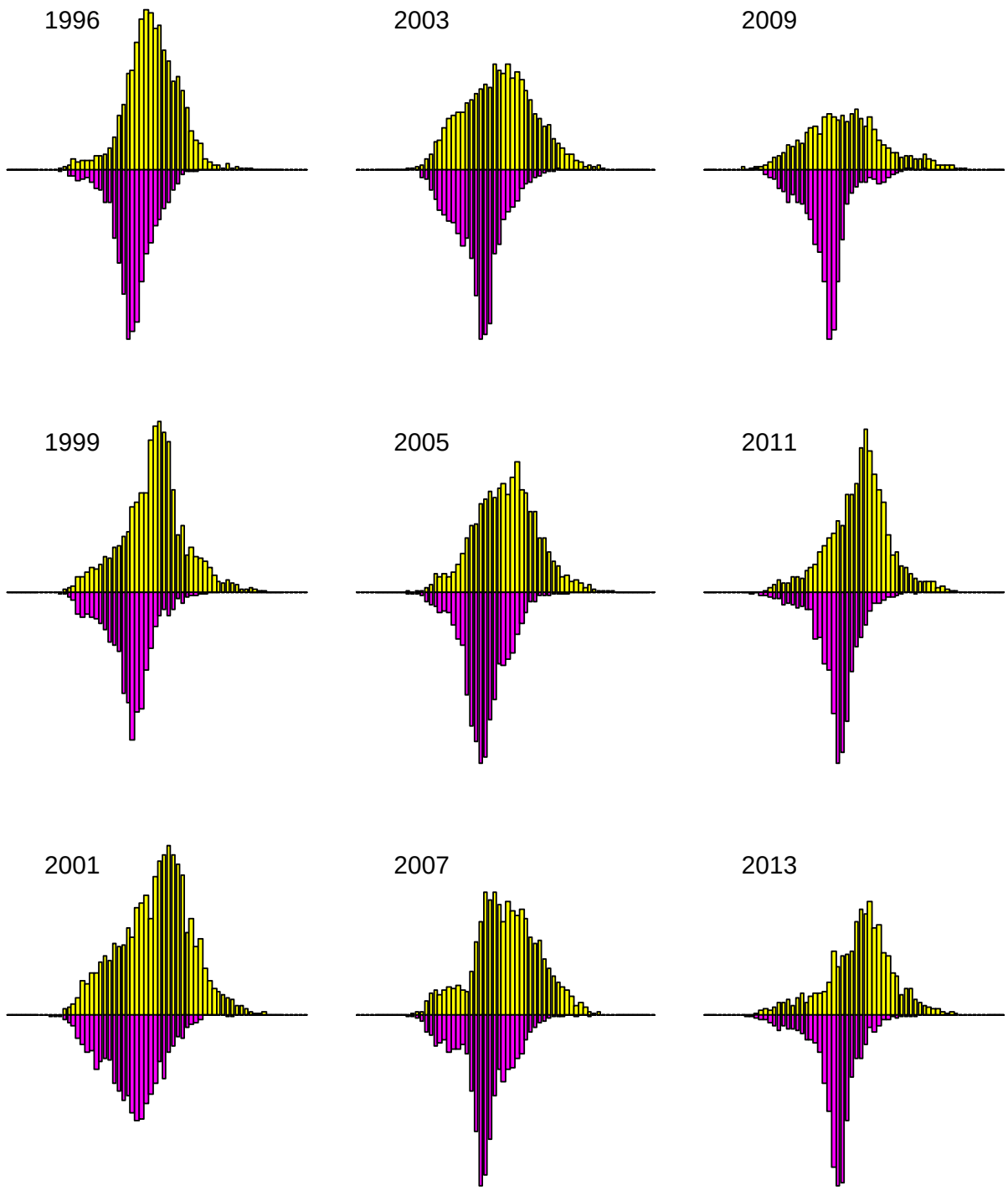
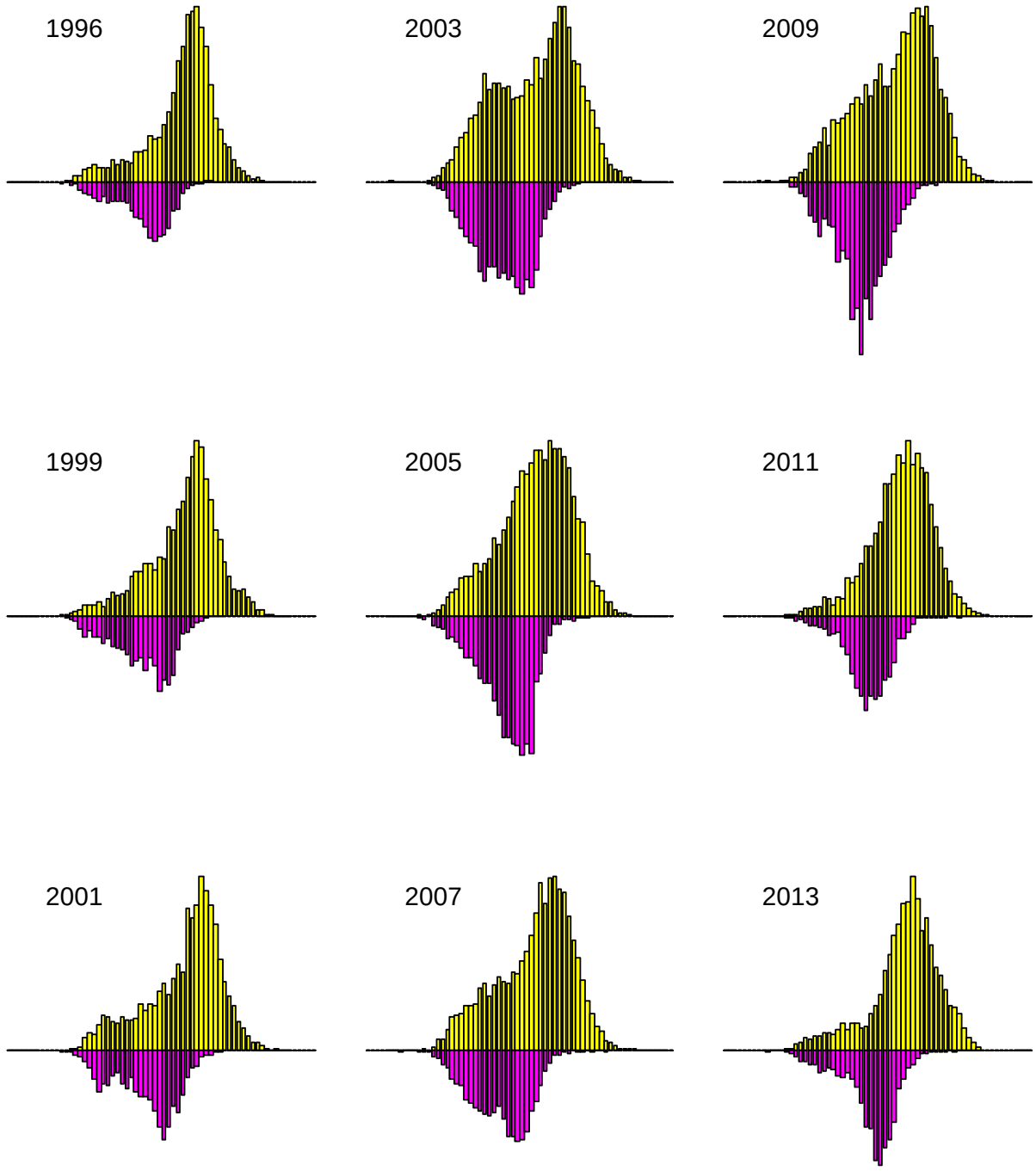


Figure 4.10 – Population lengths from the GOA NMFS bottom trawl survey for southern rock sole (female – top half of each plot, male – bottom half of each plot; the x-axis is 1 to 66 cm)



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