APPENDIX B9: Scallop Dredge Rock Chain Analysis and Calibration

It is believed that the capture of large rocks during standard scallop survey dredge hauls reduces scallop dredge performance. In addition, the interception of large rocks can cause delays to the standard survey, reduce effective strata sampling in marginal habitat (rocky), can be a safety issue and more often than not, result in gear damage. To resolve this issue in the past, an attempt was made to repeat dredge hauls at all random sites that captured large rocks. Because of the uncertainty, the following study was conducted.

Starting in 2001, NEFSC collected annual comparative paired dredge hauls during the standard summer survey. The comparison dredge hauls were between the standard 8 foot wide New Bedford style scallop dredge and another of the same design but rigged with rock excluding chains. The rock chains are laid across and vertically over the dredge mouth opening to create smaller windows in order to exclude rocks but still catch scallops in strata where there is a prevalence of rocks. Paired tows were conducted at random sites within the Great South Channel (GSC) strata set (49, 50, 51, and 52) aboard the R/V Albatross IV (Figure 1). These 4 channel strata were the only strata considered for comparison due to the rugged habitat (Figure 2). The purpose of the study was to identify a statistical difference in terms of catch between the standard dredge and the rock chain dredge configuration and then produce a calibration coefficient to apply to historical catches from the study strata set.

NEFSC conducted 79 paired dredge hauls in the hard habitat site (GSC) for the survey years of 2001, 2002, 2004, 2005, and 2006 (Figure 1). No comparative tows were conducted in 2003. See Table 1 for a year by year breakdown of pairs per sampling year. Presented below are the results of 6 comparisons. The first three tests were conducted using raw scallop catches, while the last three tests had an adjustment to the catch based on longer tow distances. Tow distances were determined by a dredge angle recording device to calculate total bottom time. All catch values were log transformed for each comparison and pairs with zero catch in either both or one were excluded from the analysis. See Table 2 for a listing of catch by dredge type, year, and pair.

The first set of three comparisons (A, B, and 1) were conducted to look at just the raw catch numbers without any tow distance effect. See Figure 3 for a catch distribution by pair. A parametric t-test and a non-parametric Wilcoxon Rank Sum test were conducted for all tests (Table 3).

Test A was comprised of the 39 pairs from 2001 and 2002; test B was the 40 pairs from 2004, 2005, and 2006, while test 1 was all 79 pairs (all years).

The results of test A produced a significant difference for the parametric test (p=0.006) between the two dredge types. The non parametric test was the same result (p=0.005). The mean difference (0.504) back transformed was 1.655, a bias correction yielded 1.794 and approximate correction was 2.969. The bias correction was performed to compensate for the transformation of normal random variable to a log transformed one. [Calculation $\exp(S.D.^2/2)$]. The approximate correction was calculated by multiplying the bias correction by the mean difference

Test B (40 pairs from 2004 – 2006) was not significant for both parametric (p=0.126) and non-parametric (p=0.102). If a calibration was needed, the approximate correction for Test B was 1.099 (mean difference = -0.185) and would be a negative adjustment to the rock chain catches, which is opposite of Test A.

Test 1 (79 pairs all years) was not significant for both parametric (p=0.166) and non-parametric (p=.188). If a calibration was needed, the approximate correction for Test 1 was 1.896 (mean difference = 0.155) and would be a positive adjustment to the non rock chain catches, which is opposite of Test A as well

The second set of comparisons was C, D, and test 6. These comparisons are set up the same way as the three described above, except that the catch data has been standardized by

tow distance. Also, the tow distances were a combination of calculated distances from the inclinometer exercise and 7 regression predicted tow distances referred to as the "combo". The catches were then standardized to (.95nm/new trackline) ratio before being analyzed. The attempt was to reduce the affect of the tow distances on the mean difference

Test C (39 pairs from 2001 to 2002 with combo tow distance adjustment) yielded a significant result (p=0.006) for the parametric test and for the nonparametric test (p=0.006). Even with the tow distance adjustment to catch, the statistical results were the same as test A. The approximate correction for the calibration from test C. was 2.958 to positive adjust the non rock chain tows. Test D (40 pairs from 2004 to 2006 with combo tow distance adjustment) yielded non-significant parametric results (p=0.109) and non-parametric results (p=0.097). The approximate correction for the calibration for test D. was 1.096 but in a negative adjustment to the rock chain catches. Test 6 (79 pairs from 2001 to 2006 with combo tow distance adjustment) yielded non-significant parametric results (0.189) and non-parametric results (p=0.198). The approximate correction for the 79 pairs was 1.892 to positive adjust the non rock chain catches

The same result occurs whether the tow distance adjustment is included or not. The approximate correction (1.896) for Test 1 (unadjusted catches) is almost the same as approximate correction (1.892) for Test 6 (adjusted catches by tow distance combo). This seems to indicate that a correction factor could be made for historical catches by just using the un-adjusted catches and the approximate calibration from them

A third comparison was conducted that separated the catches by strata groupings rather than years. One test compared strata (49, 50, and 51). The results were significant (p=0.042) for the parametric, but not significant for the non-parametric (p=0.061). The other test was not significant for both parametric and non-parametric.

Because the catch differences seemed to shift by period (2001/2002 vs. 2004-2006) and the direction of the differences between periods, an additional analysis was performed to look at the affect of strata set and year. A generalized linear model approach was chosen to test for year and strata differences using a unified approach. A gamma likelihood was used for the data to avoid the log transformation and incorporate the linear relationship between the mean and variance (Figure 4)[10]. In addition, an identity link was used as the catches from the rock chain tows appeared to be linearly related to the catches from the tows made without rock chains (Figure 4). A full factorial model with factors Year.Period (2001, 2002 vs. 2004, 2005, and 2006) and Strata.group (49, 50, 51 vs. 52) was fit to the data (Annex 1). The resulting analysis of deviance indicates that only the coefficient for the non-rock chain catch covariate and terms containing Year.Period were significant (Table 4). Model selection using Akaike's information criteria resulted agreed with this and the final model was of the form (Table 5):

$$Catch_{RC} = Year.Period + Catch_{NRC} + Year.Period:Catch_{NRC}$$

The implications of this result are that for the period 2001/2002, non-rock chain catches would be converted to rock chain catches as:

$$Catch_{RC} = 6.755303 + 1.43794 \times Catch_{NRC}$$

while for the experiments run in 2004 to 2006:

$$Catch_{RC} = (6.755303 - 4.661788) + (1.43794 - 0.4364523) \times Catch_{NRC}$$

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[10] SPLUS was used to conduct analysis of these data.

These results are not useful for converting non-rock chain catches to rock chain equivalent catches for the time series given the differences found between years. Dredge loading differences between time periods will be investigated from the existing dataset for the next SARC.

Annex 1.

SPLUS commands used in this analysis:

Fit full factorial model:

>vics.data.corrected.full.glm<-glm(formula = RC.Test.1 ~ NRC.Test.1 * Year.Period * Strata.group, family = Gamma(link = identity), data = vicsdata.corrected)

Analysis of deviance:

>anova(vics.data.corrected.full.glm,test="F")

Model selection using Akaike Information criteria (AIC):

>vics.data.corrected.red.glm<-step.AIC(vics.data.corrected.full.glm)[11]

[2]Step.AIC is available in the MASS library.

APPENDIX B9 Table 1: Distribution of Pairs Among Years and Strata.

Year	Pairs	Strata 49	Strata 50	Strata 51	Strata 52
2001	21	0	10	3	8
2002	18	1	8	5	4
2004	23	6	5	7	5
2005	3	1	2	0	0
2006	14	0	3	4	7
Total:	79	8	28	19	24

APPENDIX B9 Table 2: Raw Catches by Year

Year	Pair #	RC	NRC	Year	Pair #	RC	NRC
2001	1	1809	1917	2004	40	1391	1408
2001	2	27	8	2004	41	80	30
2001	3	104	19	2004	42	10	30
2001	4	618	159	2004	43	47	54
2001	5	100	13	2004	44	17	81
2001	6	2701	2012	2004	45	503	454
2001	7	117	37	2004	46	32	38
2001	8	1756	1860	2004	47	302	662
2001	9	99	45	2004	48	303	723
2001	10	310	395	2004	49	2	1
2001	11	279	244	2004	50	550	815
2001	12	19	5	2004	51	83	180
2001	13	21	18	2004	52	275	172
2001	14	872	411	2004	53	56	57
2001	15	300	567	2004	54	18	29
2001	16	75	273	2004	55	2	3
2001	17	27	15	2004	56	48	23
2001	18	124	286	2004	57	14	9
2001	19	41	81	2004	58	141	246
2001	20	12	2	2004	59	3191	2923
2001	21	3	5	2004	60	468	78
2002	22	573	346	2004	61	31	10
2002	23	12	96	2004	62	56	110
2002	24	367	41	2005	63	39	275
2002	25	170	45	2005	64	454	670
2002	26	38	7	2005	65	368	180
2002	27	384	437	2006	66	1296	2127
2002	28	219	402	2006	67	361	1065
2002	29	173	96	2006	68	179	218
2002	30	223	53	2006	69	7	6
2002	31	24	250	2006	70	283	267
2002	32	5	2	2006	71	112	380
2002	33	419	108	2006	72	65	49
2002	34	35	19	2006	73	17	15
2002	35	59	20	2006	74	20	40
2002	36	1142	927	2006	75	18	17
2002	37	29	16	2006	76	722	1572
2002	38	1384	306	2006	77	244	154
2002	39	12	2	2006	78	267	486
				2006	79	1389	1968

APPENDIX B9 Table 3. Statistical Results and Calibration Coefficients

								Calibration	Bias	Approx.
Test	Mean Dif.	S.D.	S.E.	t stat	df	Sign.	Wilcox.	EXP(Mean Diff)	Correc.	Correc.
A	0.504	1.081	0.173	2.91	38	0.006	0.005	1.655	1.794	2.969
B	-0.185	0.748	0.118	-1.57	39	0.126	0.102	0.831	1.323	1.099
1	0.155	0.985	0.111	1.399	78	0.166	0.188	1.168	1.624	1.896
C	0.501	1.080	0.173	2.895	38	0.006	0.006	1.650	1.792	2.958
D	-0.197	0.759	0.120	-1.64	39	0.109	0.097	0.821	1.334	1.096
6	0.148	0.990	0.111	1.325	78	0.189	0.198	1.159	1.632	1.892

Paired Sample Comparisons

39 pairs = 2001 and 2002
40 pairs = 2004 to 2006
79 pairs = all years

APPENDIX B9 Table 4. Analysis of deviance for full factorial model

| Terms added sequentially	Df	Deviance	Residual Df	Residual Deviance	F- Value	Pr(F)
NULL			78	189.781		
+NRC.Test.1	1	125.792	77	63.988	128.271	0.000
+Year.Period	1	7.081	76	56.908	7.220	0.009
+Strata.group	1	0.033	75	56.875	0.033	0.855
+NRC.Test.1:Year.Period	1	3.382	74	53.493	3.449	0.067
+NRC.Test.1:Strata.group	1	0.428	73	53.065	0.436	0.511
+Year.Period:Strata.group	1	0.014	72	53.051	0.014	0.905
+NRC.Test.1:Year.Period:Strata.group	1	1.928	71	51.123	1.966	0.165

APPENDIX B9 Table 5. Analysis of deviance for reduced model

| Terms added sequentially	Df	Deviance	Residual Df	Residual Deviance	F Value	Pr(F)
NULL			78	189.781		
+NRC.Test.1	1	125.792	77	63.988	141.816	0.000
+Year.Period	1	7.081	76	56.908	7.983	0.006
+NRC.Test.1:Year.Period	1	3.411	75	53.497	3.846	0.054
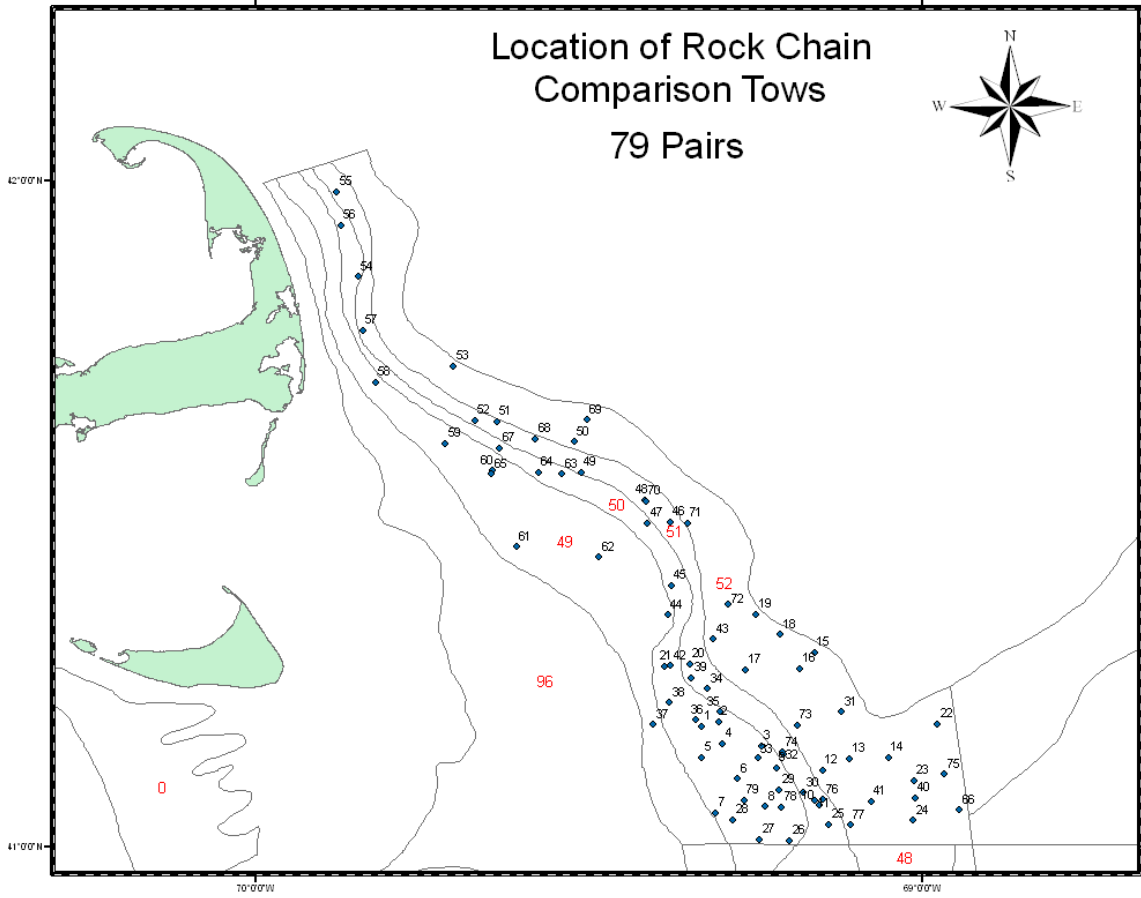
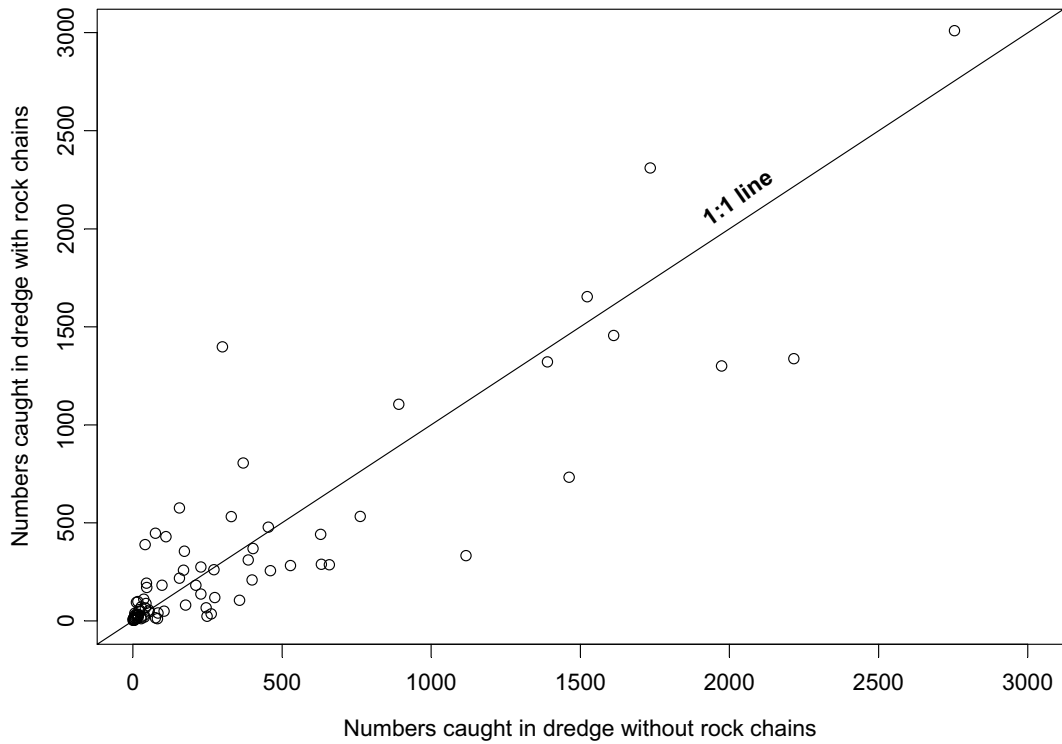APPENDIX B9 Figure 1. Location of 79 Paired Tows between the Rock Chain and the Standard Dredge
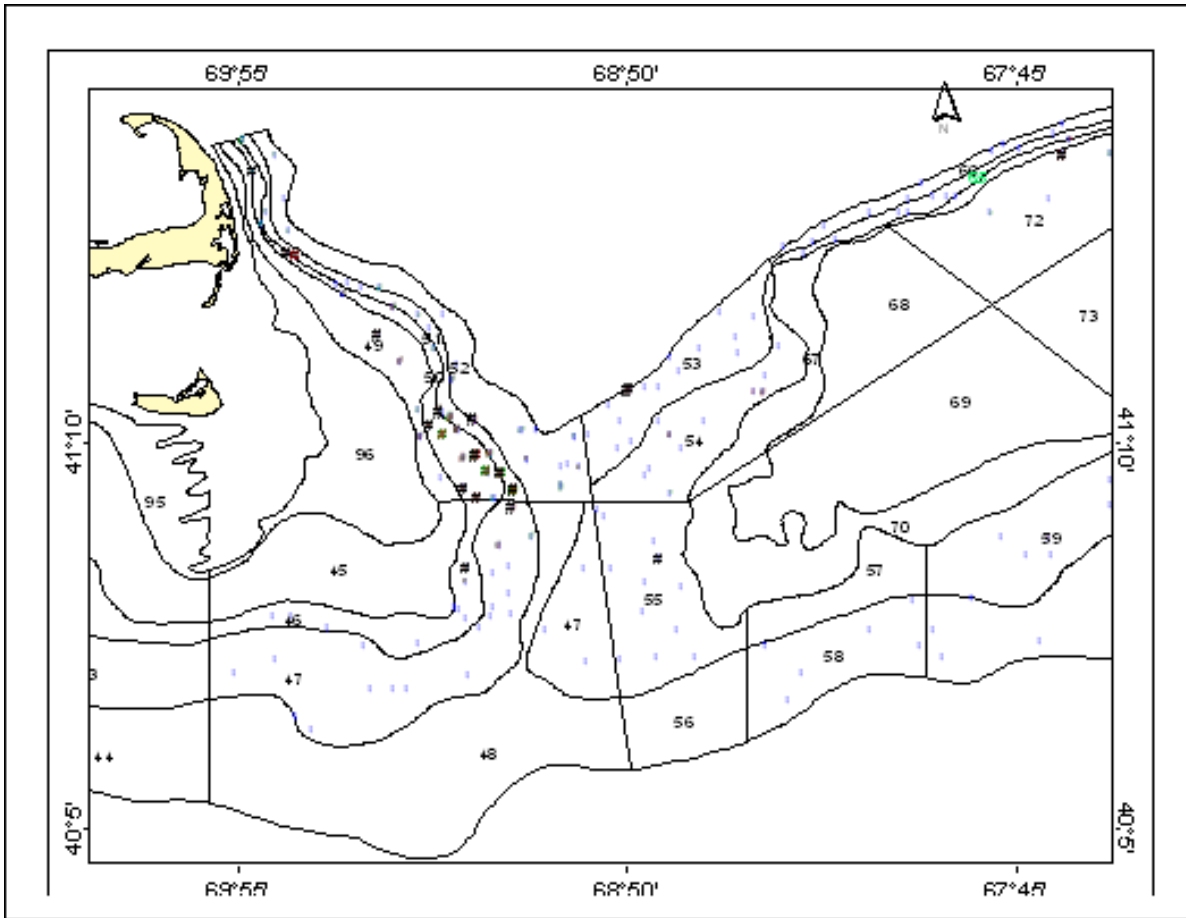
Blue Triangles = dredge hauls with no large rocks

APPENDIX B9 Figure 2. A Sample of the Distribution of Large Rocks on a Typical Scallop Survey
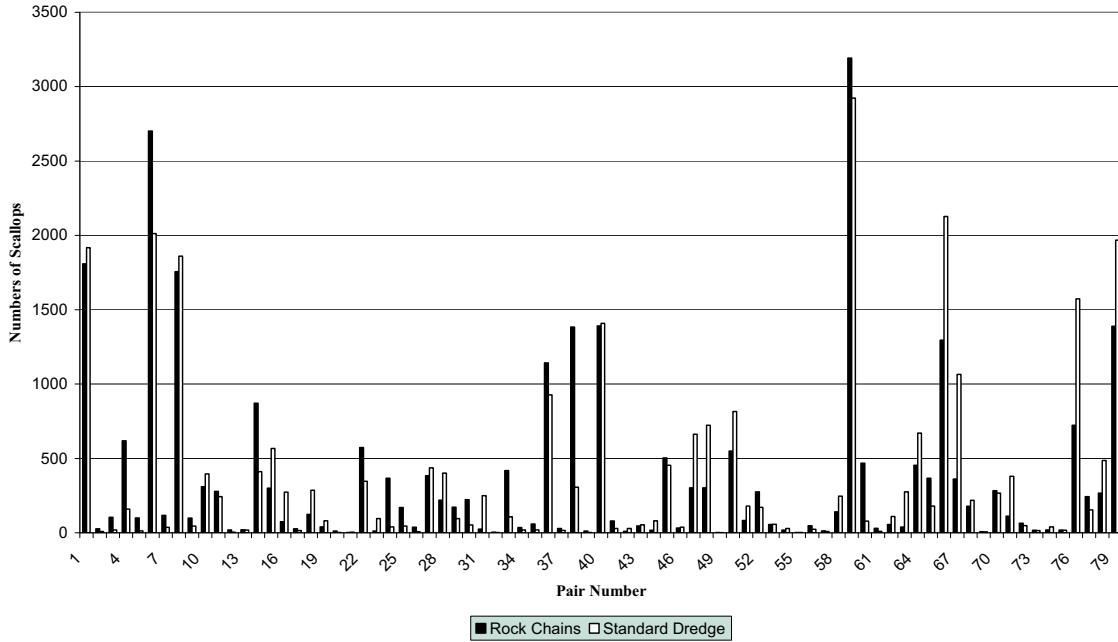
APPENDIX B9 Figure 3. Raw catches over all years for both dredge types.

APPENDIX B9 Figure 4. Catches from dredge with and without rock chains; 1:1 line added for reference.