An analysis of Georges Bank yellowtail flounder monthly catch rates in Closed Area 1 and Closed Area 2 from the bycatch survey

Prepared for the Groundfish PDT

By

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The research set aside project: Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch conducted standardized survey of bycatch in scallop trawls in Closed Areas I and II in 2010-2012 provides estimates of yellowtail catches. I used a dataset provided by Devora Hart (NEFSC) to estimate differences in monthly catches of yellowtail flounder in the study area. The dataset consists of only "standardized selected" stations (Figures 5and 6) as described in (Smolowitz et al, 2012). Focusing on yellowtail catches rather than the yellowtail: scallop discard ratio, eliminates the confounding effects of changes in scallop yields on the seasonal availability of yellowtail in the closed areas.

	Closed Area I			Closed Area II		
	Year			year		
month	2010	2011	2012	2010	2011	2012
Jan	0	0	11	0	0	29
Feb	0	0	11	0	0	29
Mar	0	11	11	0	29	29
Apr	0	11	11	0	29	29
May	0	11	0	0	29	0
June	0	11	0	0	29	0
July	0	11	0	0	29	0
Aug	0	11	0	0	29	0
Sept	0	11	0	0	29	0
Oct	11	11	0	29	29	0
Nov	0	0	0	0	0	0
Dec	0	11	0	0	29	0

Table 1. Count of sampling "standardized selected" stations by area, month and year.

Methods

The number of stations sampled varied by month and year, with incomplete sampling in all years. Sampling occurred in all months but January, February and November in 2011 (Table 1). I used an analysis of variance to compare $\log_e$ yellowtail catch per tow by month for 2011 for "standardized selected" stations only. I evaluated A- posteriori paired monthly mean $\log_e$ YT catches using Tukey-Range method to account for simultaneous testing procedures. I set the familywise error rate set at 0.05 for the 36 paired monthly comparisons. I separately analyzed each closed area because sample sizes differed by area, and the Tukey Range method (also known as Tukey's honestly significant difference test) assumes equal sample sizes.

Results

Boxplots of the yellowtail catch per tow by month for closed Area II in 2011 are shown in Figure 1. The distributions of catch rates are shifted higher in August, September and October relative to the overall median and the distribution s of catches per tow for April, May and June are below the overall median. The inter-quartile range of the distributions appears relatively homogeneous for all months. Boxplots of the yellowtail catch per tow by month for Closed Area I in 2011 are shown in Figure 2. These boxplots are more difficult to interpret. The small sample size (11) causes the notch to exceed the inter-quartile range in all months but December. Both March and December have only 1 tow with yellowtail. Median catch rates are higher in spring and December than in the late summer/ early fall months (August-October). As with Closed Area II, no sampling occurred in January, February or November in 2011.

An ANOVA of yellowtail catch rates for Closed Area II indicated significant month effect (Table 2). Diagnostics indicated that distribution of residuals was significantly different from normal and that station s225 in September 2011 was an outlier and had influence. Other diagnostics were not remarkable. Summaries of paired month comparison of mean catch rates are shown in Tables 4 and 5 and Figure 2. Sixteen out of the thirty six paired comparisons had statistically significant differences at the adjusted 0.05 p-value. Catch rates in October were significantly higher than March, April, May, June, July, and December. Similarly, yellowtail catch rates for September were significantly higher than March, April, May, June, and July. The paired monthly comparisons for August were also similar, with August having significantly higher mean catch rate than March, April, May, June, and July. For Closed Area II, monthly mean catch rates are higher for late summer-early fall than winter-spring. Information is not available for November, January and February. This seasonal pattern is consistent with Devora Hart's analysis of yellowtail: scallop catch ratio.

An ANOVA of yellowtail catch rates for Closed Area I indicated a significant month effect (Table 3). Diagnostics indicated heterogeneous variance and the distribution of residuals was not normal (leptokurtosis was present). None of the paired month comparisons were significantly different according to the Tukey range test (Table 6; Figure 4). Smaller sample sizes within the month (11 stations) may have contributed to the finding of no significant differences in comparison of monthly means, even though month effects are statistically significant.

Conclusions

Mean yellowtail catches are significantly higher for late summer-early fall months than spring months in Closed Area II in 2011. Although month effects were significant for mean yellowtail catch in Closed Area I, diagnostics suggest that some assumptions of ANOVA may not be met and the model may be unreliable for testing month effects or monthly comparisons.

Literature cited

Smolowitz, R.; Goetting, K.; Davis, F.; and Ward D. (May 2012). Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch. Final Report.

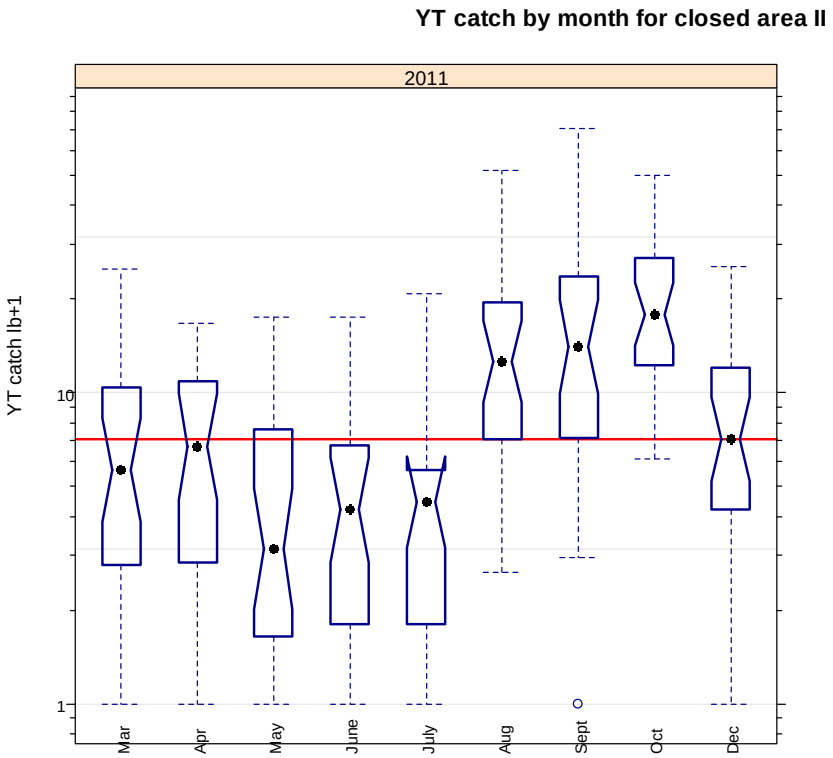

Figure 1. Boxplots of yellowtail catch (lb+1) per two in Closed Area II by month for 2011. Y-axis scale is logarithmic. Black dots are medians and non-overlapping notches indicate approximately 95% confidence interval for differences in median. Folded notch for July indicates that notch for that month may not be reliable as indicator of differences in median. Red line is median yellowtail catch rate for all months pooled. No sampling occurred in January, February or November in 2011.

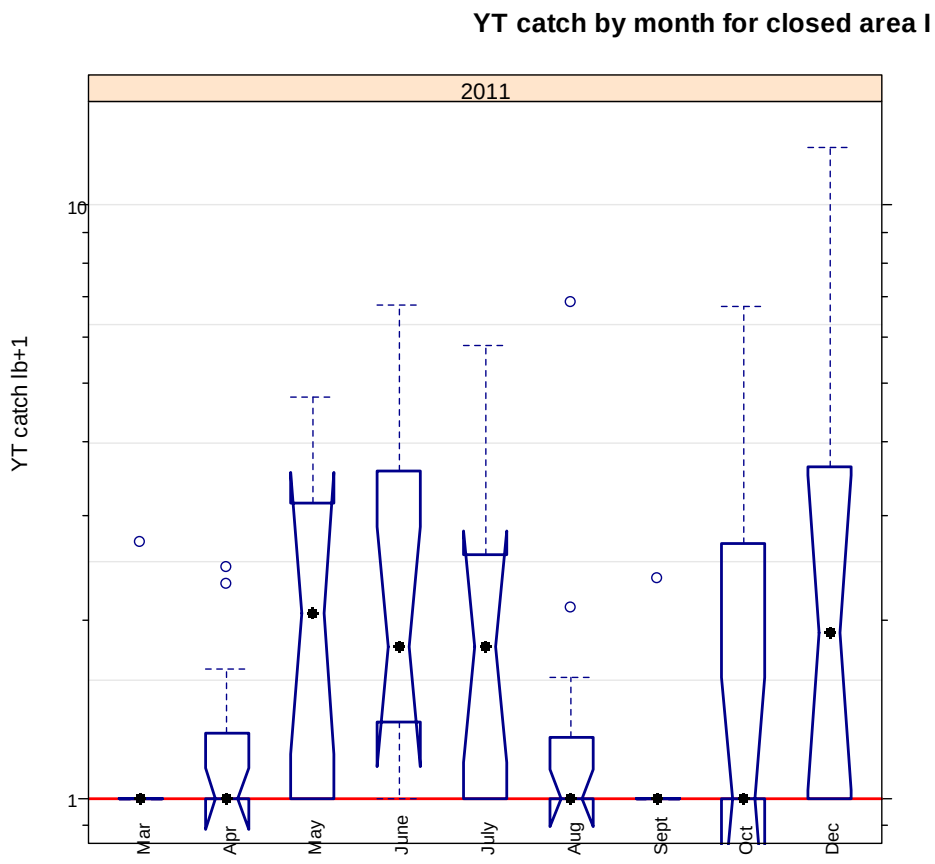

Figure 2. Boxplots of yellowtail catch (lb) +1 per two in Closed Area I by month. Y-axis scale is logarithmic. Black dots are medians and non-overlapping notches indicate approximately 95% confidence interval for differences in median. Folded notch for April-October indicates that notches for that month may not be reliable as confidence limits for comparing differences in medians. Red line is median yellowtail catch rate for all months pooled. No sampling occurred in January, February or November. Only 1 trip caught yellowtail in March and September.

	DF	Sum sq	Mean square	F-value	P(>F)
month	8	86.54	10.817	14.36	<0.001
residuals	252	189.8	0.753		

Table 2. Summary results of ANOVA of $\log_e$(catch+1) by month for Closed Area II for 2011.

	Df	Sum sq	mean square	F-value	P(>F)
month	8	7.16	0.8947	2.512	0.0164
residuals	90	32.06	0.3562		

Table 3. Summary results of ANOVA of $\log_e$(catch+1) by month for Closed Area I for 2011.

	monthly mean	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
		no data	no data	1.69	1.62	1.21	1.28	1.22	2.45	2.46	2.86	no data	1.82
Jan	no data	1.00	na	na	na	na	na	na	na	na	na	na	na
Feb	no data	na	1.00	na	na	na	na	na	na	na	na	na	na
Mar	1.69	na	na	1.00	0.62	0.62	0.66	0.62	2.14	2.16	3.23	na	1.13
Apr	1.62	na	na	1.08	1.00	0.66	0.72	0.67	2.30	2.33	3.48	na	1.22
May	1.21	na	na	1.62	1.50	1.00	1.08	1.00	3.46	3.51	5.23	na	1.83
Jun	1.28	na	na	1.51	1.40	0.93	1.00	0.93	3.22	3.26	4.86	na	1.70
July	1.22	na	na	1.61	1.50	1.00	1.07	1.00	3.45	3.49	5.21	na	1.82
Aug	2.45	na	na	0.47	0.43	0.29	0.31	0.29	1.00	1.01	1.51	na	0.53
Sep	2.46	na	na	0.46	0.43	0.26	0.28	0.29	0.99	1.00	1.49	na	0.52
Oct	2.86	na	na	0.31	0.29	0.19	0.21	0.19	0.66	0.67	1.00	na	0.35
Nov	no data	na	na	na	na	na	na	na	na	na	na	1.00	na
Dec	1.82	na	na	0.88	0.82	0.55	0.59	0.55	1.89	1.92	2.86	na	1.00

Table 4. Backtransformed differences between monthly column mean and monthly row means for in Closed Area II in 2011. Monthly means are in log (lbs+1). Yellow highlighted cells are significantly different at family wise error rate of 0.05. na indicates that sampling did not occur in January, February or November in 2011.

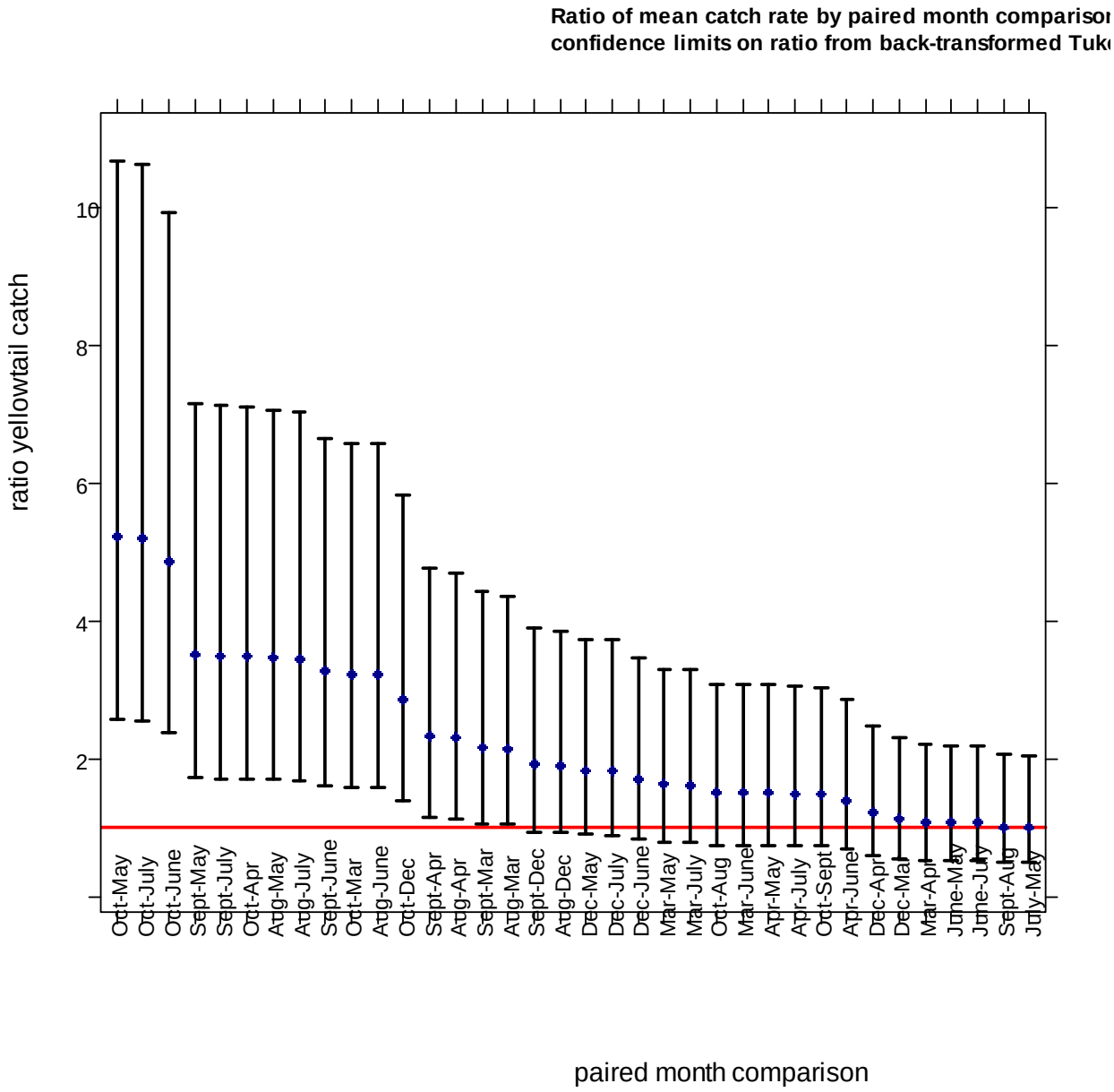

Figure 3. Ratio of mean yellowtail catch rates between paired month comparisons with 95% confidence limits for Closed area II. Red line=1. Ratio's are significantly different from 1 at familywise error rate =0.05 if confidence limits do not overlap red line.

Month comparison	Mean ratio	Lower 95% CL	Upper 95% CL	Adjusted P value
Oct-May	5.23	2.59	10.56	0.000
Oct-June	4.86	2.41	9.81	0.000
Oct-July	5.21	2.58	10.51	0.000
Sept-May	3.83	1.89	7.78	0.000
Sept-July	3.81	1.88	7.75	0.000
Sept-June	3.56	1.75	7.23	0.000
Oct-Apr	3.48	1.72	7.03	0.000
Aug-May	3.46	1.71	6.99	0.000
Aug-July	3.45	1.71	6.96	0.000
Oct-Mar	3.23	1.60	6.52	0.000
Aug-June	3.22	1.59	6.50	0.000
Oct-Dec	2.86	1.41	5.77	0.000
Sept-Apr	2.55	1.25	5.18	0.002
Sept-Mar	2.36	1.16	4.80	0.006
Aug-Apr	2.30	1.14	4.65	0.008
Aug-Mar	2.14	1.06	4.31	0.023
Sept-Dec	2.09	1.03	4.25	0.034
Dec-Aug	0.53	0.26	1.07	0.111
Dec-May	1.83	0.91	3.70	0.155
Dec-July	1.82	0.90	3.68	0.162
Dec-June	1.70	0.84	3.44	0.306
May-Mar	0.62	0.31	1.25	0.442
July-Mar	0.62	0.31	1.25	0.455
Oct-Aug	1.51	0.75	3.05	0.657
June-Mar	0.66	0.33	1.34	0.667
May-Apr	0.67	0.33	1.34	0.673
July-Apr	0.67	0.33	1.35	0.686
June-Apr	0.72	0.35	1.45	0.860
Oct-Sept	1.37	0.67	2.77	0.907
Dec-Apr	1.22	0.60	2.46	0.994
Dec-Mar	1.13	0.56	2.28	1.000
Sept-Aug	1.11	0.54	2.25	1.000
Apr-Mar	0.93	0.46	1.87	1.000
June-May	1.08	0.53	2.17	1.000
July-June	0.93	0.46	1.88	1.000
July-May	1.00	0.50	2.03	1.000

Table 5. Summary of results from Tukey range test for paired monthly yellowtail catches in Closed Area II in 2011. Cells with yellow highlighting have ratio of monthly mean significantly different from 1 at familywise error rate of 0.05.

Month	Ratio	Lower CL	Upper CL	p adjusted
Sept-June	0.50	0.22	1.12	0.15
Dec-Sept	2.00	0.89	4.50	0.15
June-Mar	1.98	0.88	4.45	0.17
Dec-Mar	1.98	0.88	4.44	0.17
Sept-May	0.56	0.25	1.25	0.35
May-Mar	1.78	0.79	3.99	0.37
June-Apr	1.77	0.79	3.98	0.39
Dec-Apr	1.77	0.79	3.97	0.39
Sept-July	0.58	0.26	1.31	0.47
July-Mar	1.69	0.75	3.80	0.50
Aug-June	0.61	0.27	1.38	0.60
Dec-Aug	1.63	0.73	3.66	0.60
Oct-Sept	1.60	0.71	3.60	0.65
May-Apr	1.59	0.71	3.57	0.67
Oct-Mar	1.58	0.71	3.55	0.68
July-Apr	1.51	0.67	3.40	0.79
Aug-May	0.68	0.30	1.53	0.85
Oct-Apr	1.41	0.63	3.18	0.91
Aug-July	0.72	0.32	1.61	0.93
Oct-Aug	1.30	0.58	2.93	0.98
Oct-June	0.80	0.36	1.79	0.99
Dec-Oct	1.25	0.56	2.81	0.99
Sept-Aug	0.81	0.36	1.82	1.00
Aug-Mar	1.22	0.54	2.73	1.00
July-June	0.85	0.38	1.92	1.00
Dec-July	1.17	0.52	2.62	1.00
Sept-Apr	0.88	0.39	1.98	1.00
Oct-May	0.89	0.40	2.00	1.00
Apr-Mar	1.12	0.50	2.51	1.00
June-May	1.11	0.50	2.50	1.00
Dec-May	1.11	0.50	2.50	1.00
Aug-Apr	1.09	0.48	2.44	1.00
Oct-July	0.93	0.42	2.10	1.00
July-May	0.95	0.42	2.14	1.00
Sept-Mar	0.99	0.44	2.22	1.00
Dec-June	1.00	0.44	2.24	1.00

Table 6. Summary of results from Tukey range test for yellowtail catches in Closed Area I in 2011. None of the paired monthly comparisons have a ratio of monthly means significantly different from 1 at familywise error rate of 0.05.

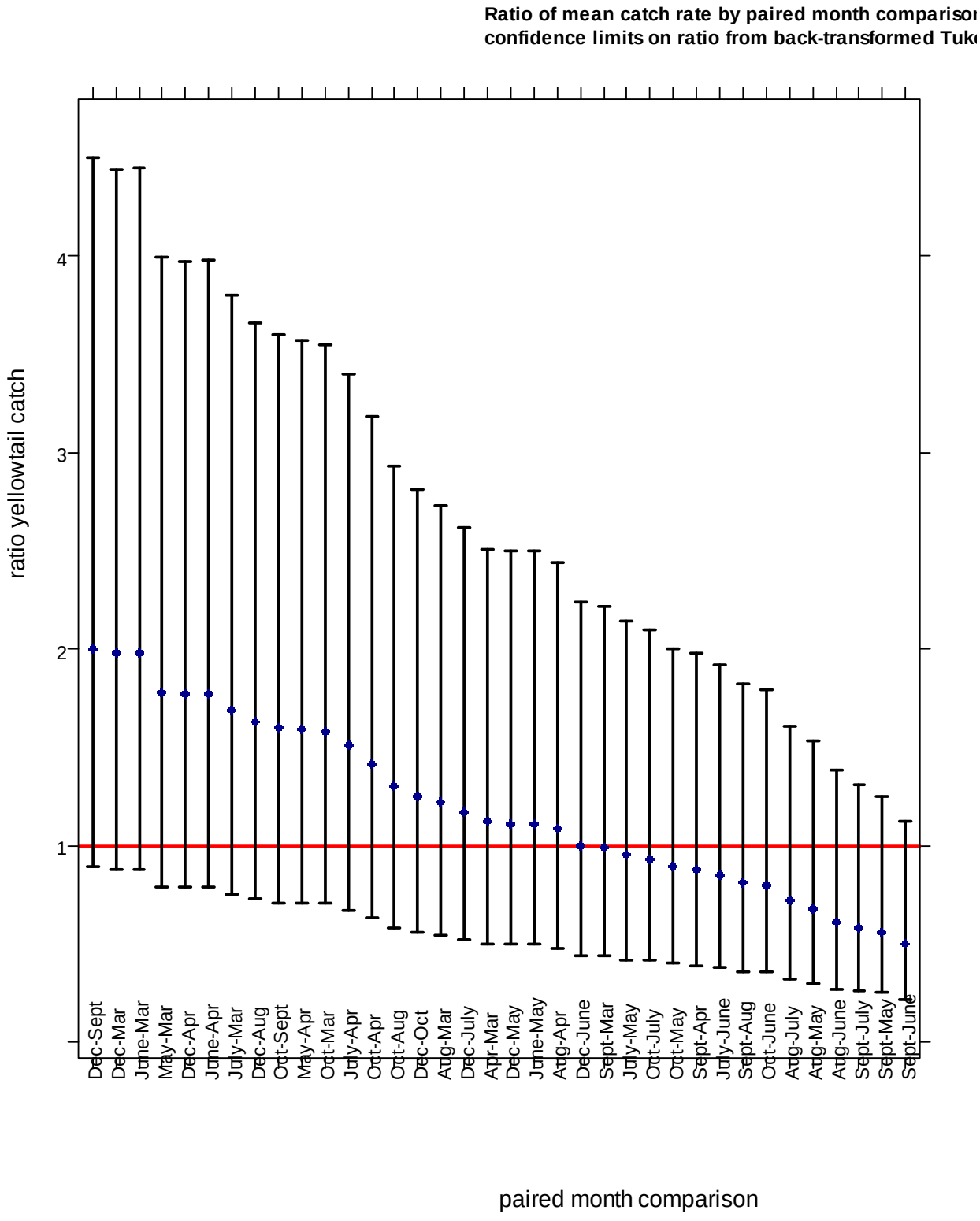

Figure 4. Mean ratio of yellowtail catch rates between paired month comparisons with 95% confidence limits. Red line=1. Ratio's are significantly different from 1 at family wise error rate =0.05 if confidence limits do not overlap red line.

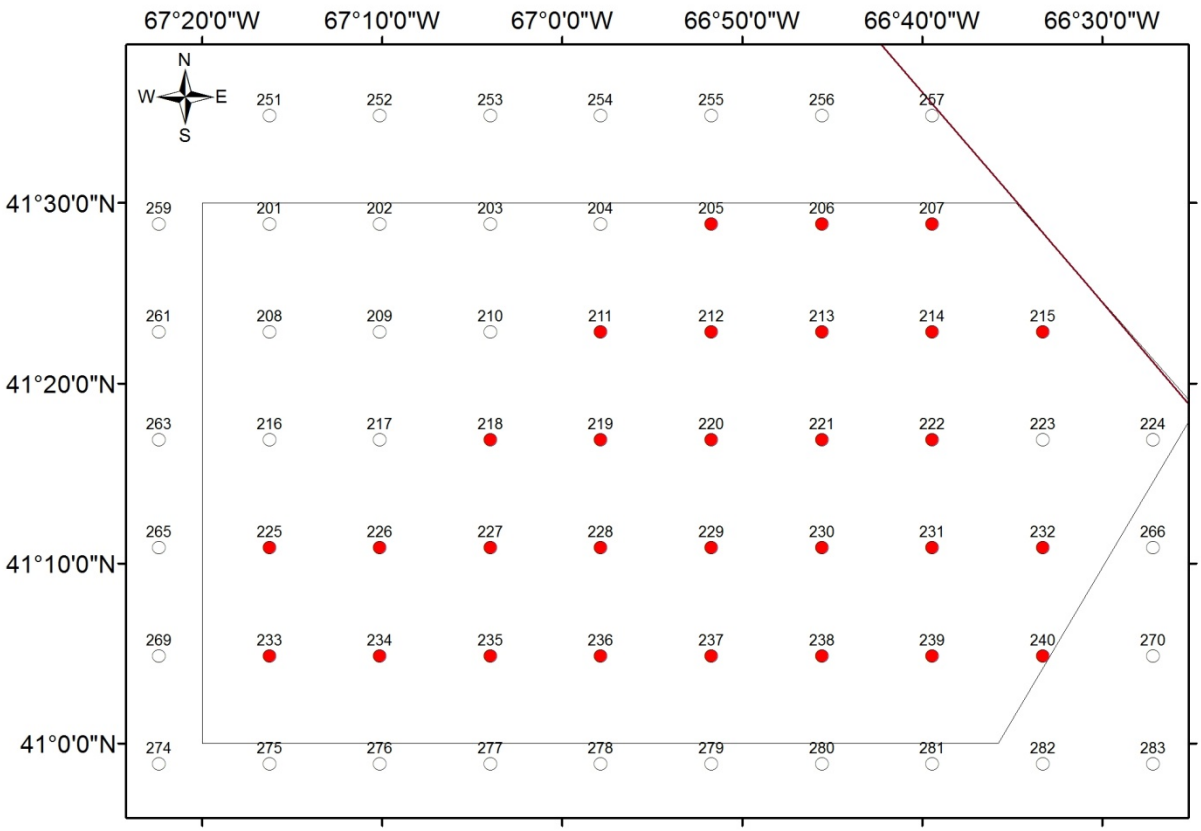

Figure 5. Station locations within Closed Area II. Red dots indicate consistently sampled stations that were used in the analysis. Open dots represents stations that were dropped during the study.

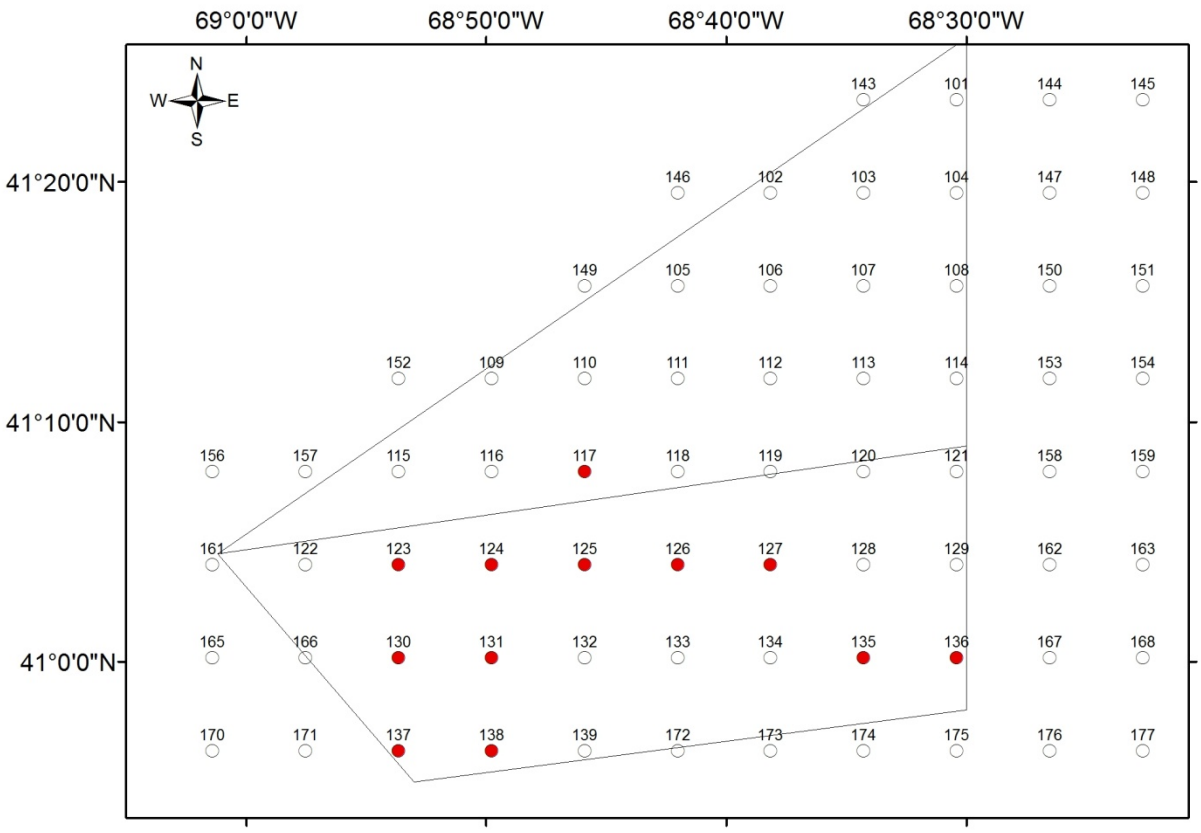

Figure 6. Station locations within Closed Area I. Red dots indicate consistently sampled stations that were used in the analysis. Open dots represents stations that were dropped during the study.