## 1.1 APPENDIX III - DEVELOPMENT AND ANALYSIS OF GEORGES BANK ACCESS AREA SEASONAL RESTRICTION ALTERNATIVES IN FRAMEWORK 24

### 1.1.1 Modify GB access area seasonal restrictions

Based on two primary sources of analyses the options in this section were developed. The first source of information is an analysis the Scallop PDT completed using observer data in and around access areas on GB. A generalized linear model (GLM) was developed to estimate bycatch rates by month using observer data from months the access areas have been open and modeling the bycatch rates for months the areas have been closed using data observer data from surrounding open areas.

The second source of information is based on results from a 2011 RSA project titled, "*Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch.*" Fourteen research trips were conducted in both Closed Area I and II from October 2010 through April 2012. Seasonal variations in scallop meat weights and YT flounder bycatch rates were evaluated. The Research Steering Committee reviewed the methods and results for this final report submitted in June 2012 and deemed it sufficient for the PDTs to use in developing management measures, even though additional data will be collected over the next year.

### 1.1.2 Scallop PDT Analysis

The Scallop PDT considered a wide range of information when developing the range of alternatives for the GB access area seasonal closures. First, YT bycatch rates were assessed from NMFS observer data. Second, bycatch rates and YT abundance by month were also evaluated using data from a 2011 RSA project that studied seasonal bycatch patterns in Closed Area I and II. Third, the PDT evaluated seasonal variations in scallop meat weights to identify seasons with the highest meat weights. The sections below summarize the various analyses and general conclusions.

#### 1.1.2.1 Spatial and temporal bycatch rates from observer data

The PDT evaluated monthly bycatch rates in CA1, CA2 and NL from all available observer data (1999-2011). These areas have always been closed to the scallop fishery between February 1 and June 14, so there are no observed trips for those months. The PDT decided to address this issue two ways: 1) develop a model to estimate bycatch rates for the months with no data points; and 2) calculate bycatch rates for missing data points with observer data from surrounding areas during the months the areas were closed. In addition, the PDT also explored using monthly bycatch rate data from a 2011 RSA funded project that estimated bycatch rates for several important bycatch species in Closed Area I and II. Ultimately, the model results were blended with bycatch rates from surrounding areas to "fill in" the months with no observer data points.

A generalized linear model (GLM) was developed to address the month and year effects observed from the data. The model estimated a mean d:k ratio by month and year for each area. Figure 1 has the model outputs by month and year including the variance for Closed Area II, I and Nantucket Lightship for the months with data. The PDT also explored estimating a d:k ratio for the months these areas have been closed using observer data from surrounding areas. For Georges Bank all observed trips within the YT stock area were combined (statistical areas 522, 525, 561 and 562 – including CA1 and CA2 observed trips). Input data varies based on the access area schedule, but the raw data suggests that d:k ratios were highest in 1999 and 2000, years with high effort levels in Closed Area II, and the months of June and July compared to other months during the year (Figure 2).

**Figure 1 – Discard to Kept ratio for yellowtail flounder:scallop catch by month and year for Closed Area II, Closed Area I and Nantucket Lightship using all observer data (1999-2011)**

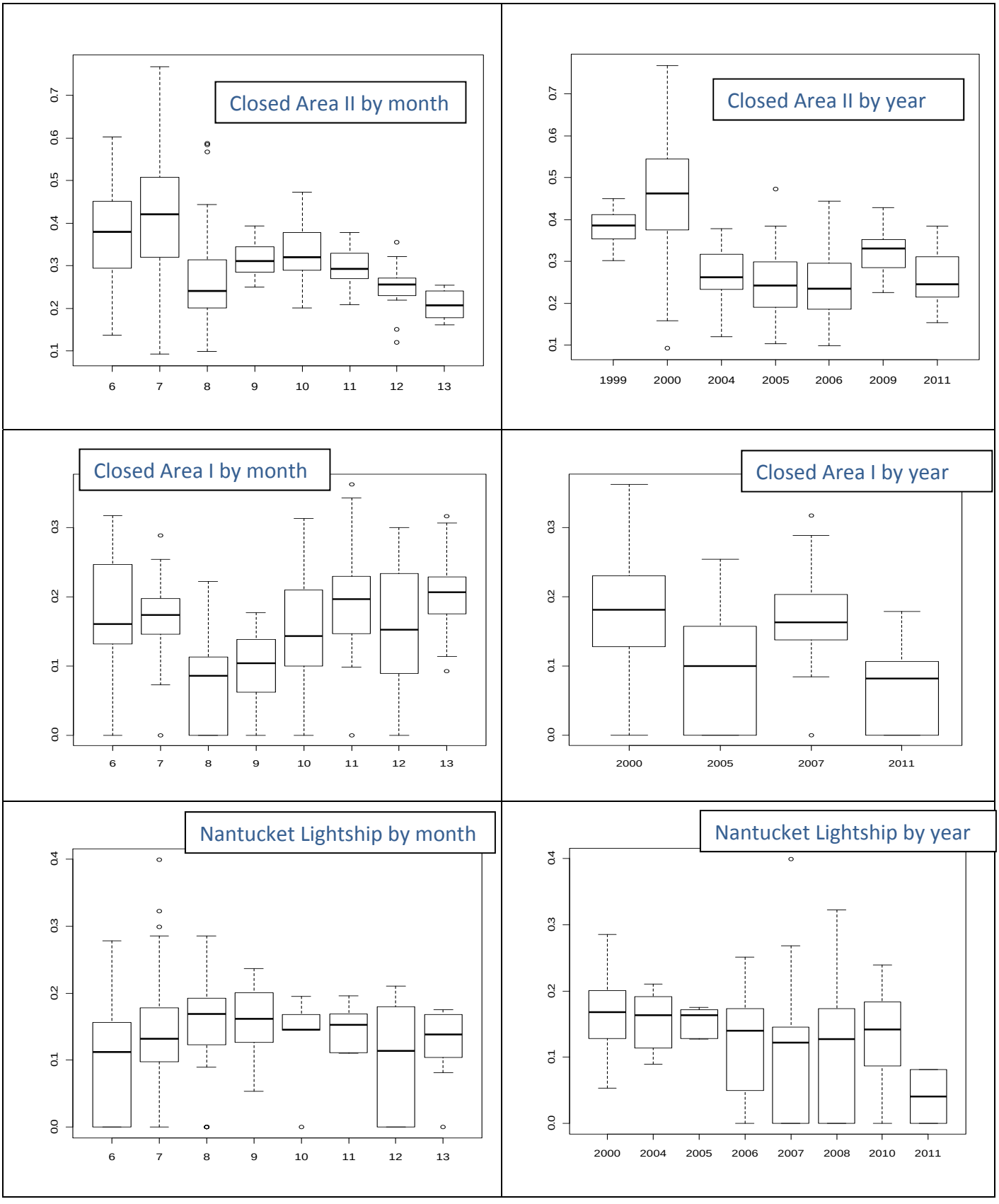
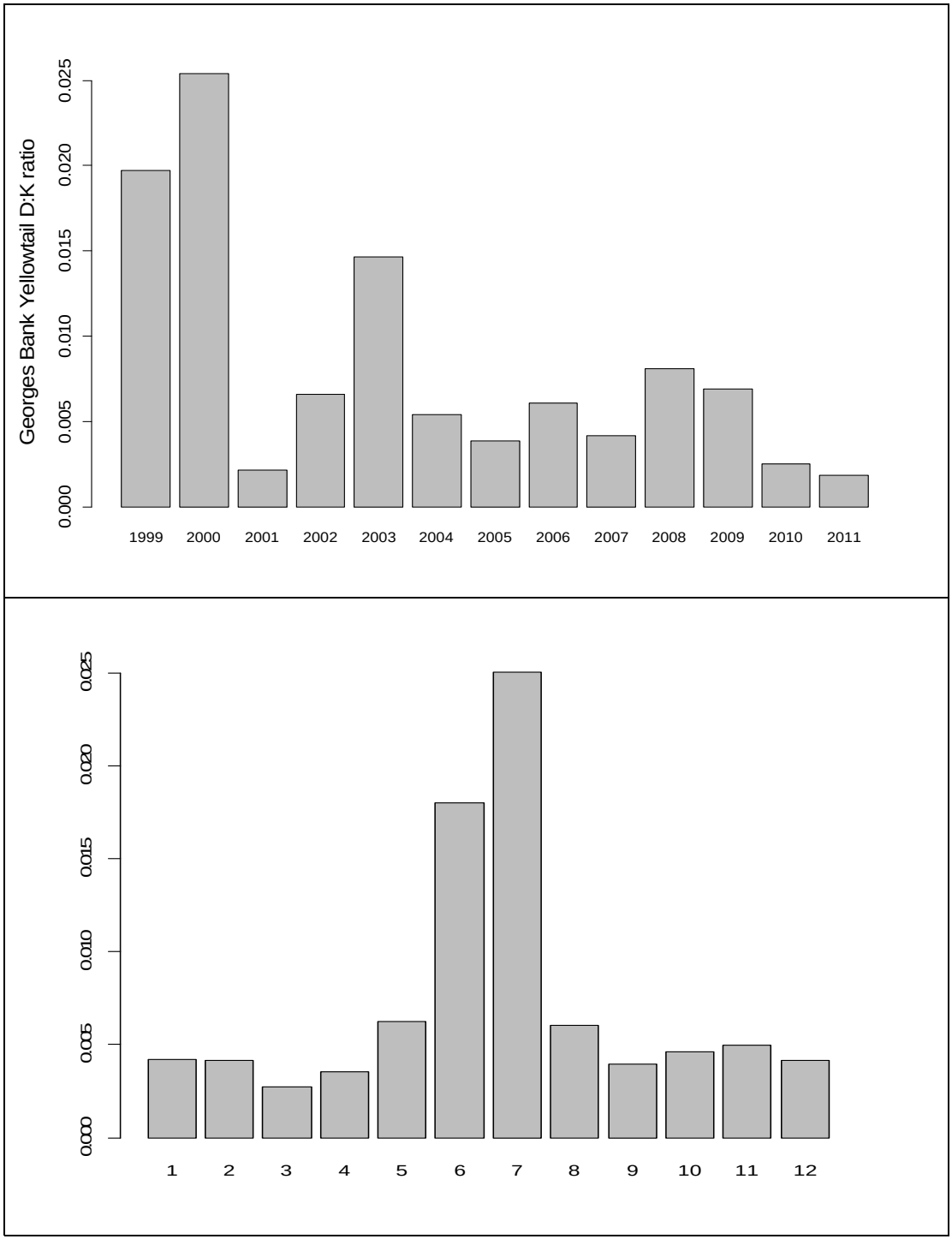


**Figure 2 – D:K ratios for yellowtail flounder in the scallop fishery from all observed trips within the GB YT stock area (1999-2011)**



#### 1.1.2.1.1 Results

- *Closed Area II*

The analyses from observer data within the closed areas only suggests that for Closed Area 2 bycatch rates are highest in October and lowest in May-July. For Closed Area II the model suggests a strong year effect with tight error bars: highest bycatch rates in 2001 and 2009 and lowest rates in 2005 and 2006 (Figure 3). The model suggests an increase in bycatch rate as the season progresses (depletion effect) but the error bars are relatively large later in the season when the number of observed trips declines and data points are fewer, so these findings are not very compelling (Figure 4).

For the months the area is open, June 15 – Jan 31, there seems to be a month effect - highest bycatch in October (Figure 5). The model also assessed if there is a location effect within the access area and the results suggest that bycatch is highest in the northwest corner of the access area. The analyses were expanded to include trips in open areas for the months CA2 is closed and this did not add much to the overall conclusion. Similar year effects for the observer data in open areas on southern GB (stat areas 525 and 562 open) (Figure 6). Discard rates slightly higher in the fall and lowest in July, but many months are uncertain because there is limited data by month in these areas (Figure 7). Based on results from observer data in and around Closed Area II, an earlier opening date and closure in the fall could help reduce YT and improve scallop yield.

**Figure 3 – GAM model for observer data in CA2 from 1999-2011 (Year Effect)**

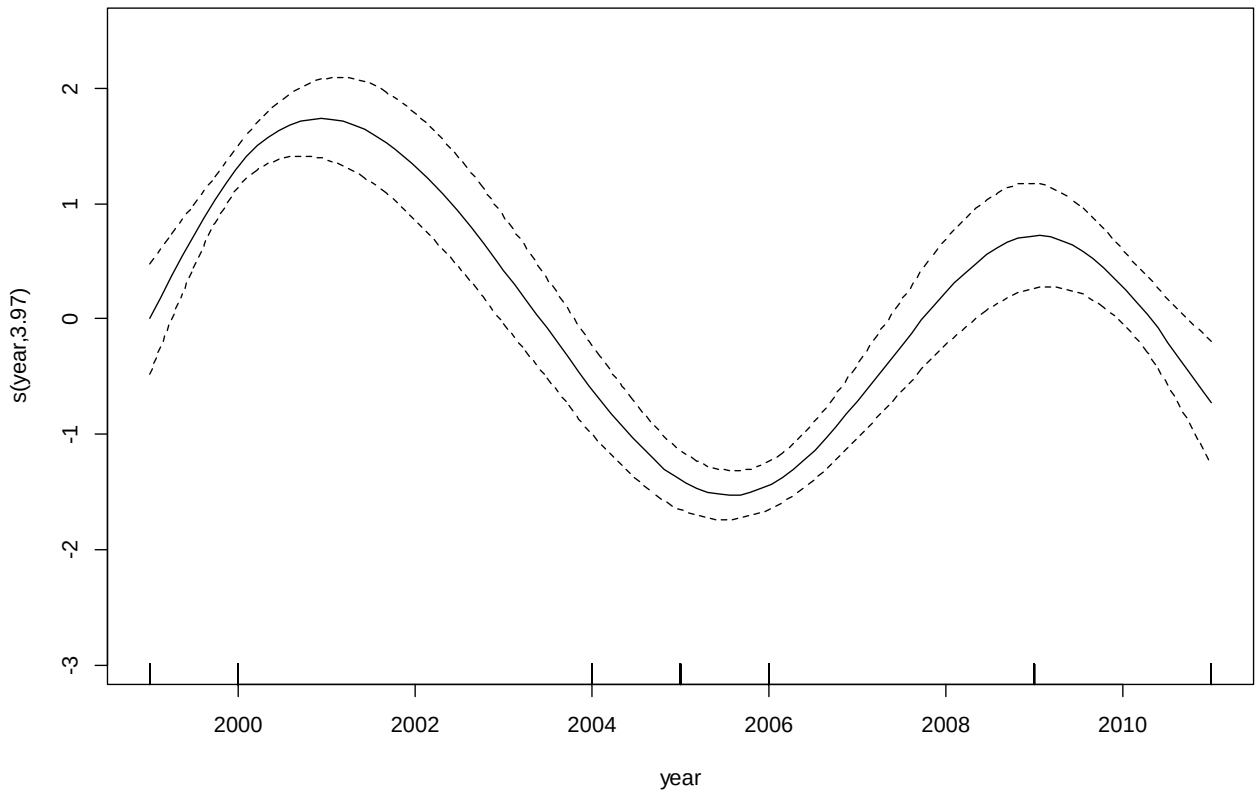


**Figure 4 – GAM model results for CA2 observer data – depletion effect (D:K ratio increases with time after opening)**

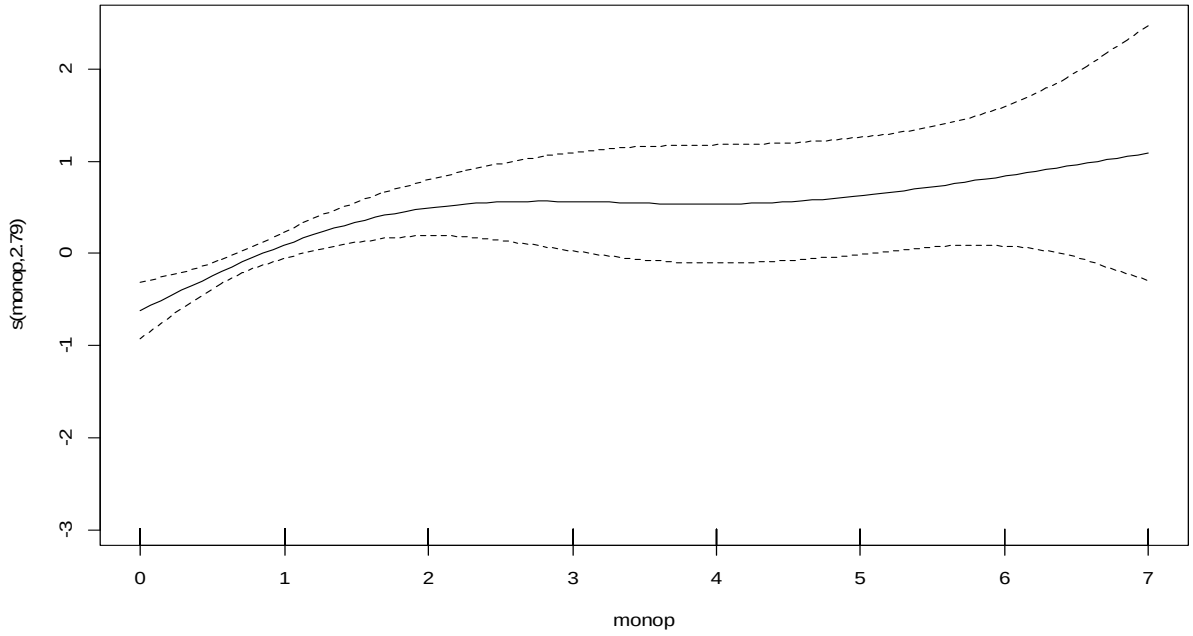



**Figure 5 – GAM model for observer data in CA2 June-January only – month effect**

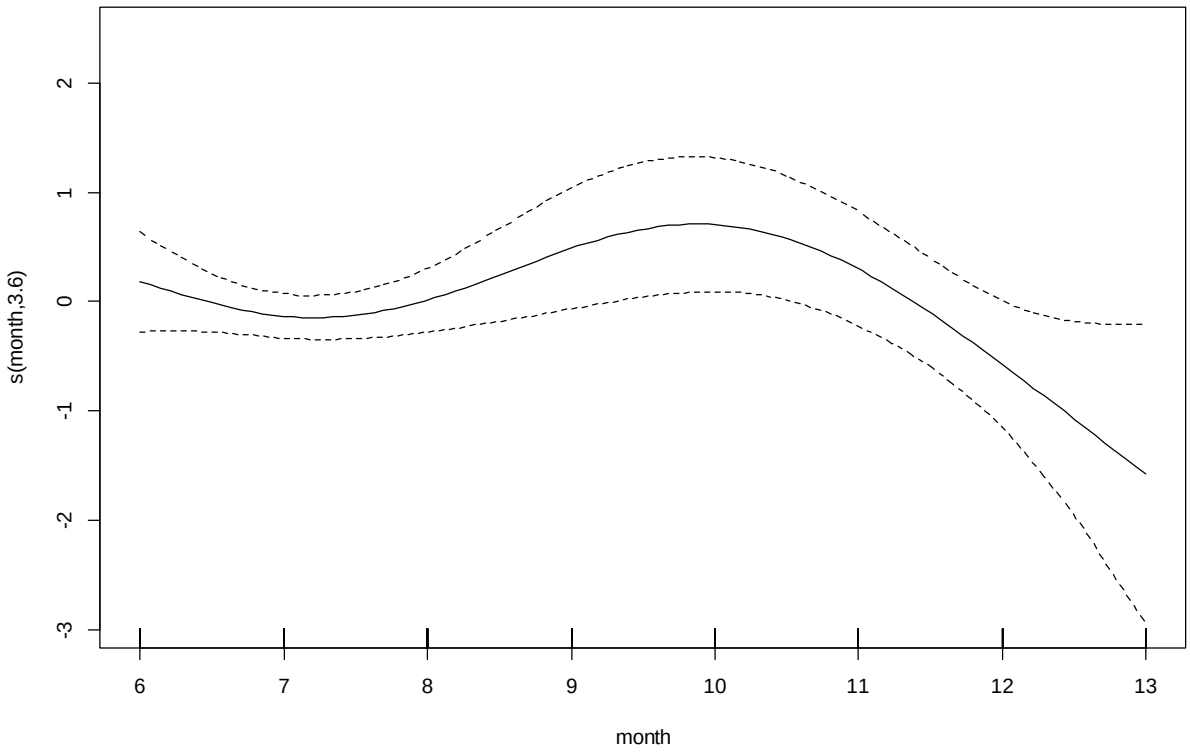


Figure 6 – GAM model for observer data in areas outside of CA2 (southern GB areas 525 and 562) – Year effect

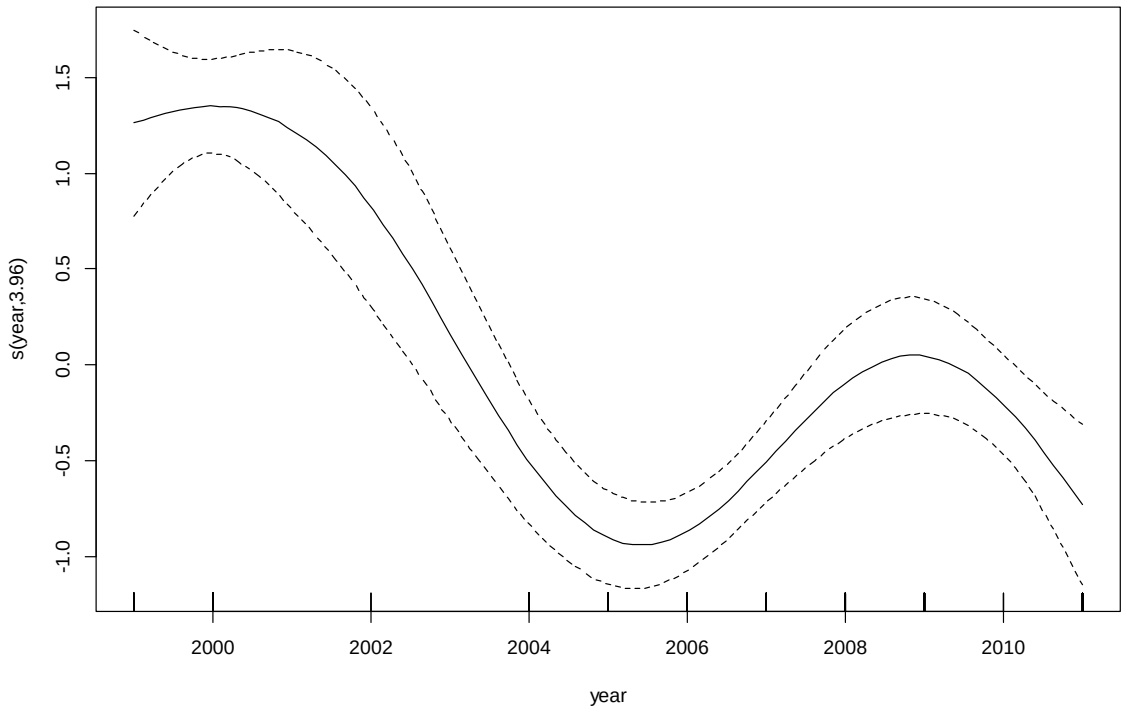
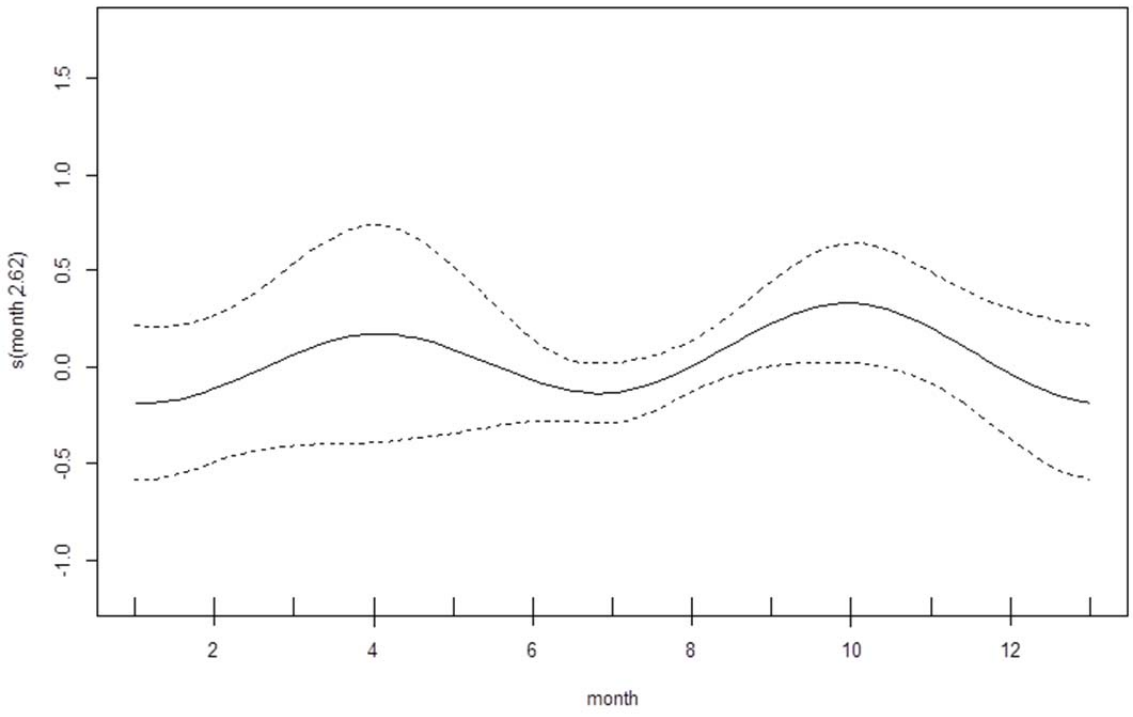


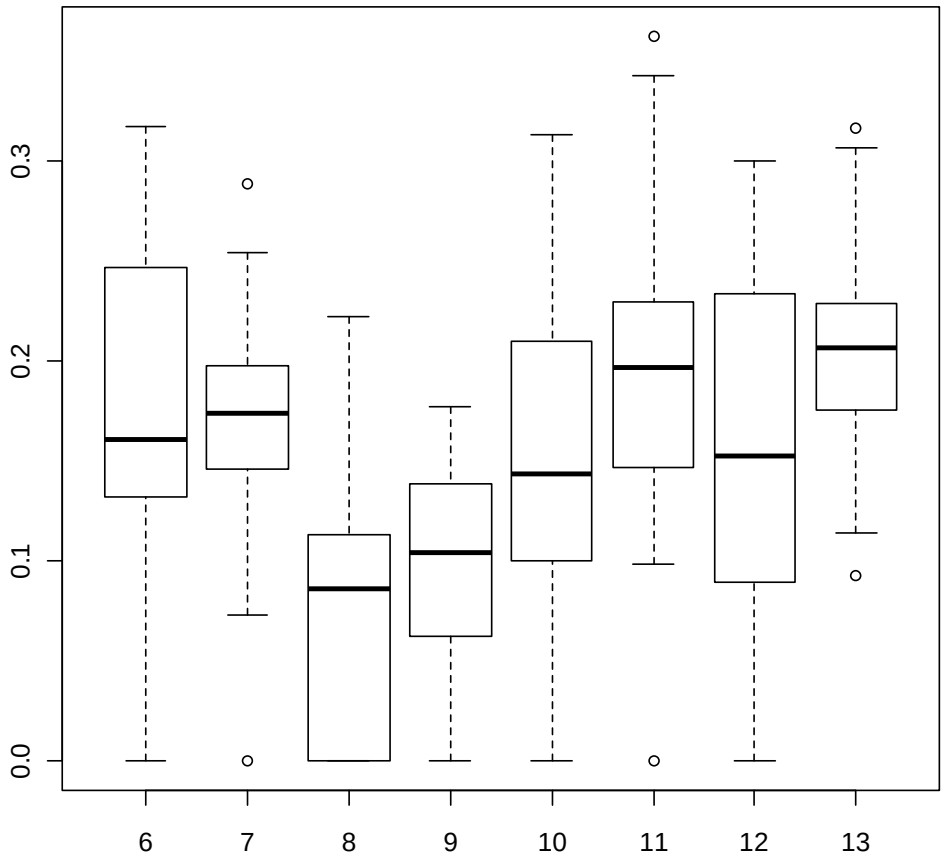

Figure 7 - GAM model for observer data in areas outside of CA2 (southern GB areas 525 and 562) – Month effect



- *Closed Area I*

Moving to Closed Area I, the preliminary results are not as clear. Bycatch rates are much lower overall in CA1 compared to CA2, and there does not seem to be a strong seasonal trend in this area. The months of November and January are the highest, but since overall bycatch is relatively low these results are likely driven more by meat weight variations (Figure 8). The results did not change much when the analyses are expanded to include observer data from surrounding areas (GB open) to populate the months when Closed Area I is closed.

Figure 8 – Box plots of D:K ratios for CA1 observer data by month (June-January only)




- *Nantucket Lightship*

For Nantucket Lightship the observer data from within the area suggests that discard rates highest in late summer (September) but fairly uncertain since there is limited observer coverage during that time of year(Figure 10). NL has had a series of openings and closures during this time series: the area was open in 2000, closed 2001-2003, open in 2004, closed in 2005, open in 2006-2008, closed in 2009, open in 2010, and closed in 2011(Figure 9). Overall the model estimates declines in discard rates as biomass accumulates until 2006 when the area was open for three years in a row with higher bycatch rates from depletion.

When these analyses were expanded with observer data from open areas in SNE for months NL was closed (stat areas 526, 539 and 537) bycatch rates declined over time and only a slight increase in bycatch rates in the fall compared to other months(Figure 11 and Figure 12). The error bars around the SNE observer data are relatively tight starting in 2003 since there is more observer data in all months for this area. Overall, bycatch rates fairly constant by month, especially in open areas, with potential higher rates in August/September from within NL and SNE open areas.

**Figure 9 – GAM model for observer data in NL (2000-2011 when area open) – Year effect**

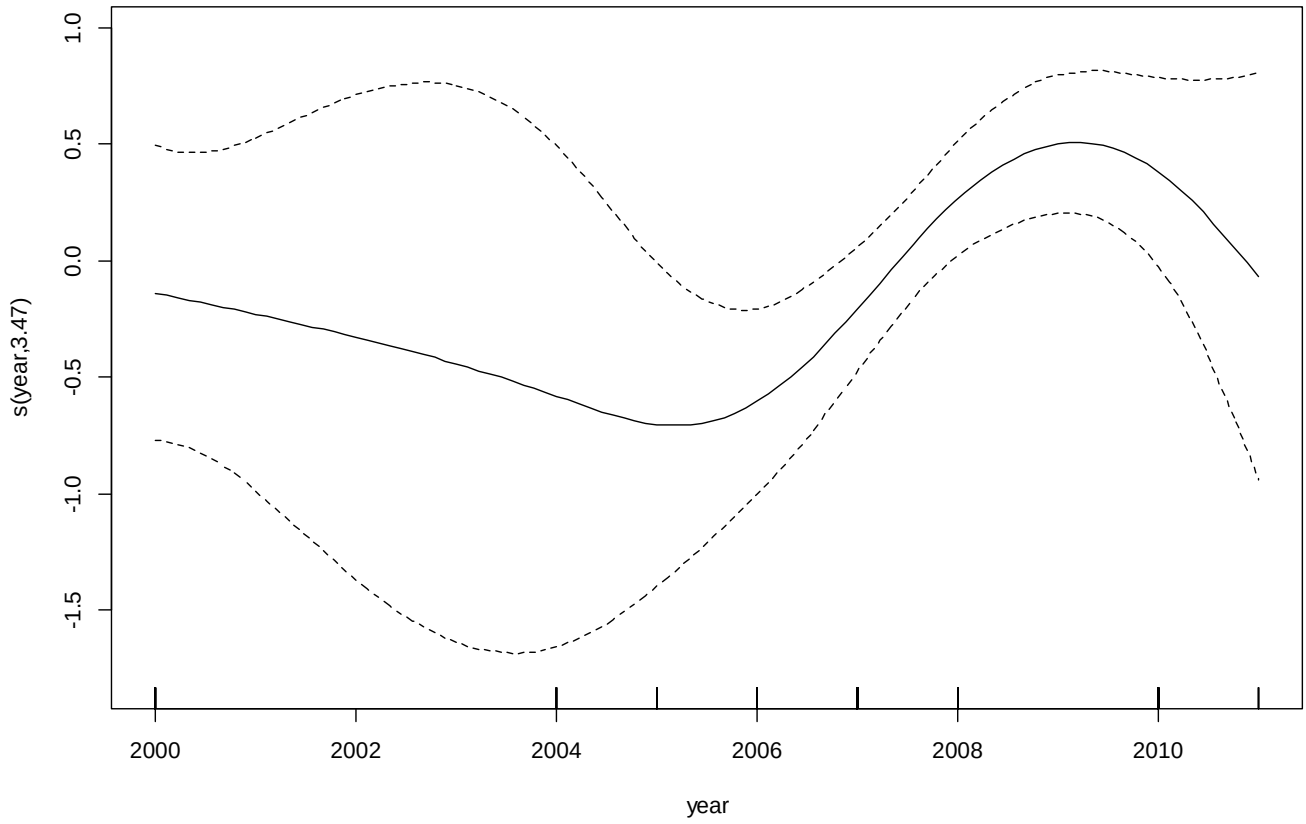


Figure 10 – GAM model for observer data in NL – Month effect

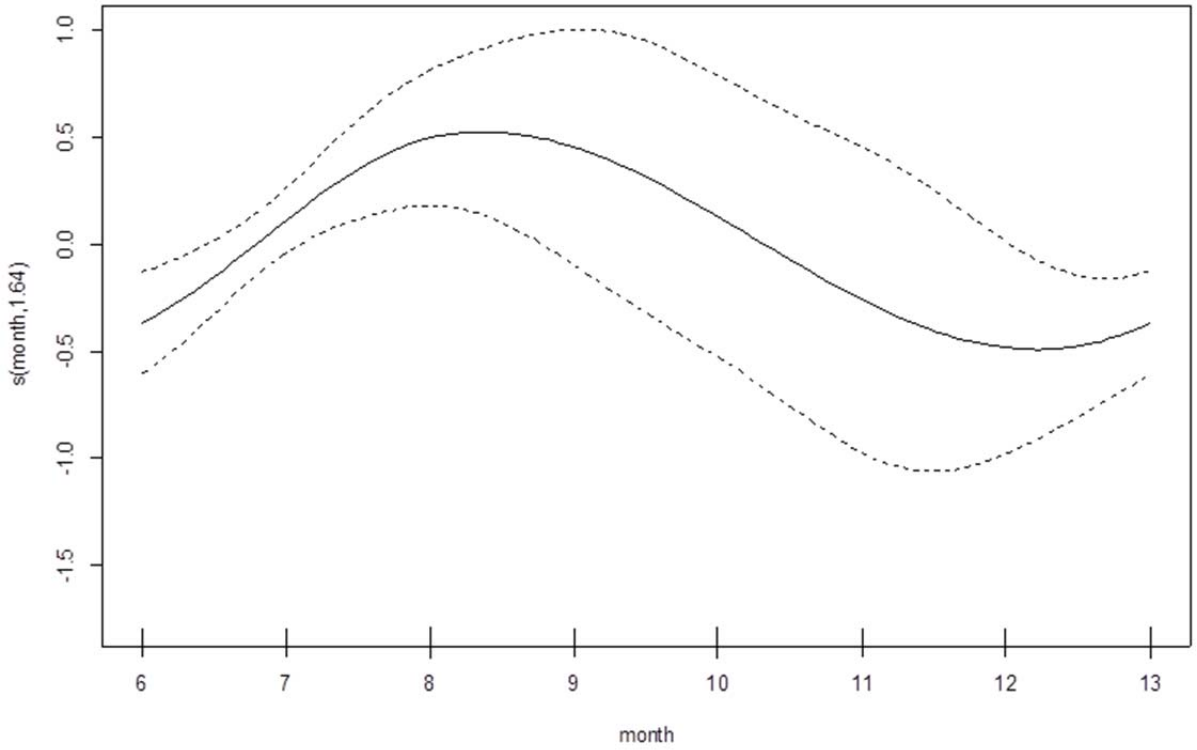



Figure 11 – GAM model for observer data, open areas in SNE (1999-2011) – Year effect

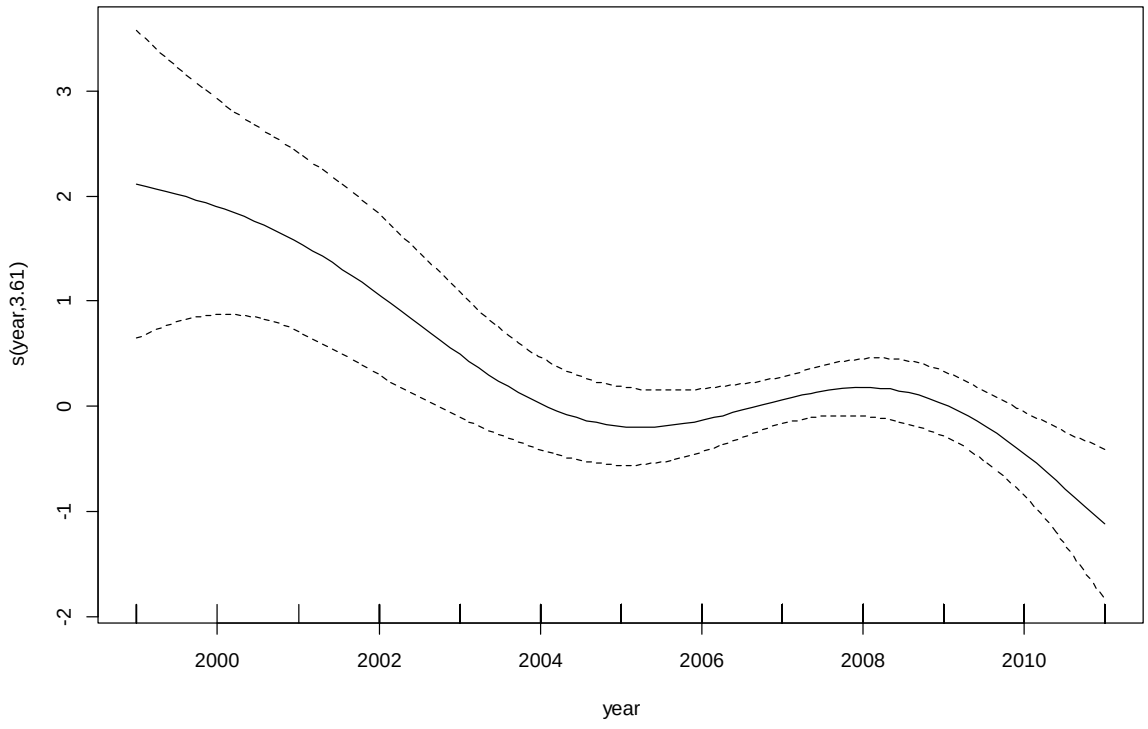
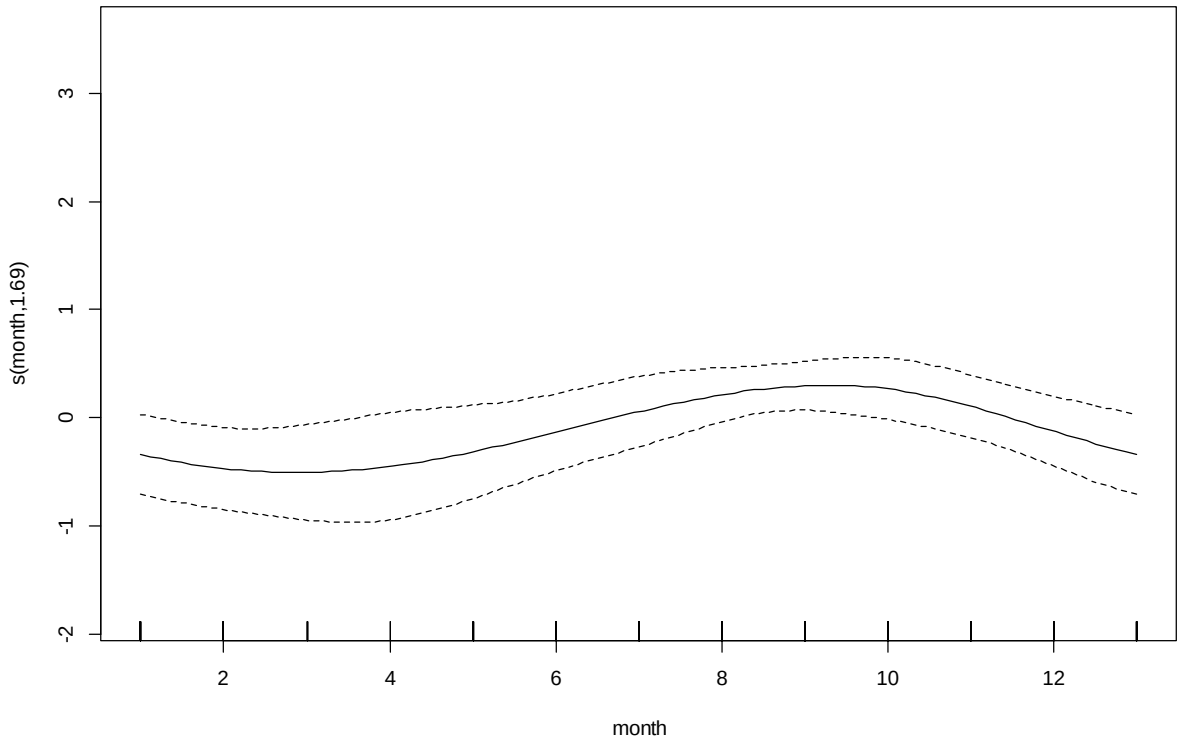


**Figure 12 - GAM model for observer data, open areas in SNE (1999-2011) – Month effect**



#### 1.1.2.2 Results from seasonal bycatch study in CA1 and CA2 (2011 RSA Award)

A 2011 RSA award examined seasonal changes in yellowtail bycatch rates in Closed Area I and II, among other research objectives. The results from that study were reviewed by the NEFMC Research Steering Committee on June 25, 2012. The Committee deemed several relative data sets to be sufficient for PDT use in developing management measures, even though additional data will be collected over the next year.

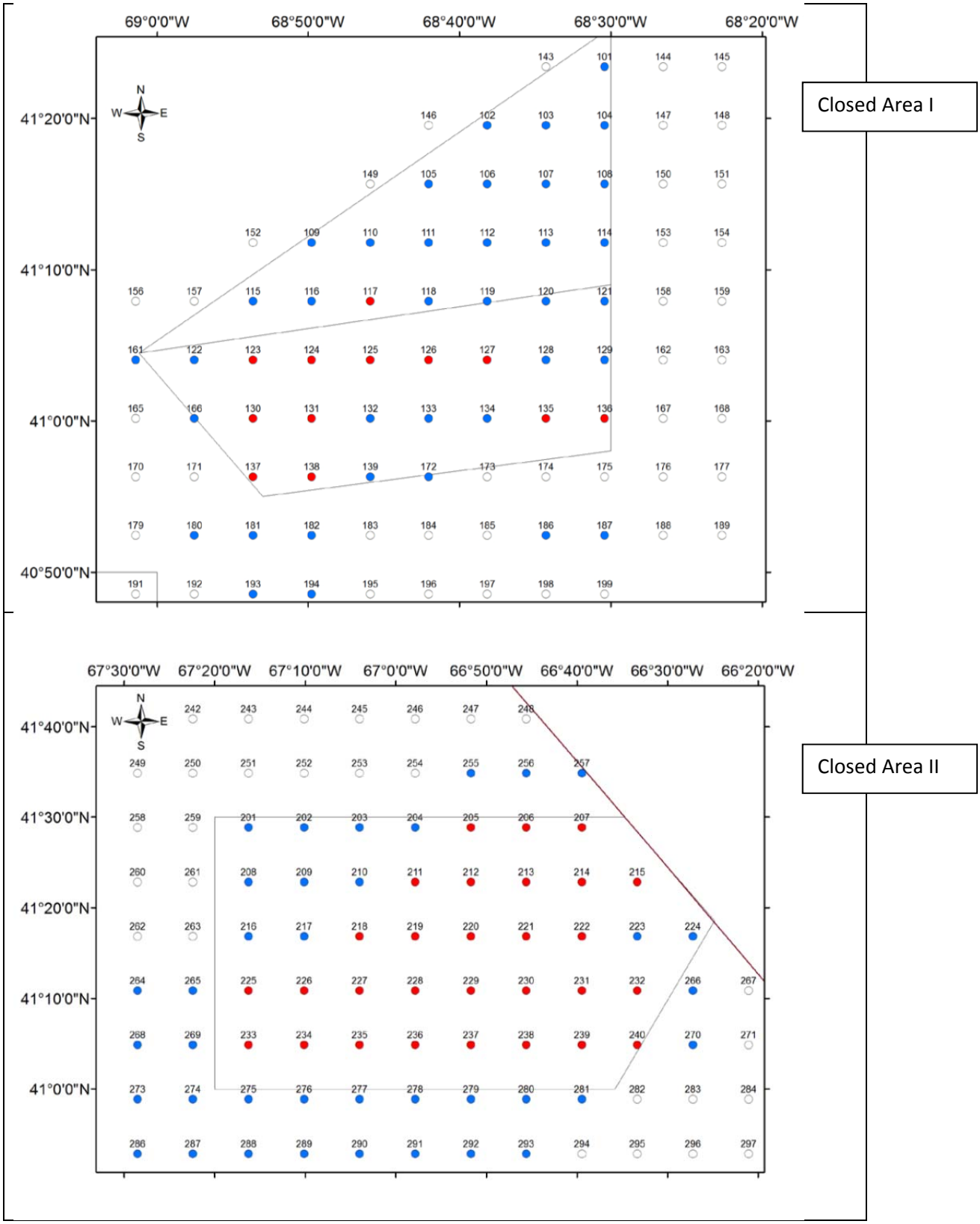
In summary, fourteen research trips have been completed to date on eleven distinct commercial vessels (October 2010, and each month starting in March 2011-April 2012). The researchers also plan to forward results from May and June 2012, which are part of the 2012 RSA project, but are important months to evaluate bycatch rates since those months are before the access areas open on June 15. The project has four overall objectives: 1) quantify seasonal bycatch rates of important bycatch species; 2) characterize fishing gear performance by comparing a turtle deflector dredge to a commercial dredge; 3) biology of important bycatch species including RAMP discard mortality analysis, maturity analysis, and fungal infection analysis; and 4) biology of scallops including seasonal effects on sea scallop reproduction and energetics and growth (scallop shell height: meat weight relationship analysis). For the purposes of this action only several components are directly relative: maturity of bycatch analysis, seasonal scallop growth (shell height:meat weight relationships), and bycatch rate and distribution analysis.

The study is a paired tow grid design with one standard 15-foot wide turtle deflector dredge towed from one side of the vessel that was constant throughout the project, and a second commercial dredge provided by each vessel. The specifications of the various commercial dredges used for each trip is summarized in Table 1. Each trip was about 80 stations, 40 in each closed area, taking approximately seven days per trip. Over the course of the study some stations were dropped that had no YT or scallops, high concentrations of sand dollars, or rocky bottom; and several stations were added outside the access areas. Therefore, the results were presented two ways: a “standardized group” with only stations successfully occupied on all 14 trips inside the access areas, and a second group with all successful stations (Figure 13). Only the results from the standardized group using the turtle deflector dredge were used for the bycatch rate analysis between trips, not the results from the commercial dredge with stations that varied between trips.

**Table 1 – Gear specifications for the vessels that participated in the 2011 Seasonal bycatch study**

| | | Celtic | Westport | Arcturus | Turtle | Liberty | Endeavour | Regulus | Resolution | Ranger | Horizon | Wisdom | Venture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dredge Width (ft) | | 15 | 15 | 15 | 15 | 13 | 15 | 15 | 15 | 15 | 15 | 15 | 13 |
| Pressure Plate Width (inches) | | 8 | 8 | 8 | 8 | 8 | 8 | 9.5 | 8 | 9 | 1.5 | 1 | 8.5 |
| Wheel Diameter (inches) | | 16 | none | 18 | 16 | 17 | 20 | 17 | 23 | 22 | 18 | 8 | 16 |
| Dredge Builder | | Quinn | unknown | Dockside | Dockside | Blue Fleet | Blue Fleet | Blue Fleet | Dockside | Dockside | Dockside | Dockside | Blue Fleet |
| Turtle Chains | # up/downs | | | | | 11 | 13 | 13 | 13 | 14 | 19 | 11 | 18 (trawlex |
| | # ticklers | | | | | 6 | 8 | 10 | 9 | 10 | 9 | 7 | 9 |
| | Chain Link size | | | | | 3/8 | 3/8 | 3/8" | 1/2 | 2.25 in | 3/8 | | 5/8 |
| Bag (Belly) | | 10 x 40 | 9 x 40 | 9 x 40 | 10 x 40 | 9 x 38 | 7 x 40 | 7 x 38 | 10 x 42 | 8 x 38 | 9 x 44 | 10 x 38 | 9 x 36 |
| Apron | | 8 x 40 | 13 x 40 | 10 x 40 | 8 x 40 | 7 x 38 | 8 x 40 | 8 x 38 | 8 x 42 | 7 x 38 | 8 x 44 | 10 x 38 | 7 x 36 |
| Side Piece | | 6 x 17 | 5 x 16 | 5 x 17 | 6 x 17 | 6 x 18 | 5 x 19 | 5 x 25 | 4 x 20 | 5 x 20 | 4 x 44 | 5 x 18 | 5 x 19 |
| Diamond # rings/side | | 14 | 14 | 13 | 14 | 13 | 14 | 13 | 14 | 14 | 15 | 13 | 13 |
| Skirt | | 3 x 38 | 2 x 36 | dog chains | 3 x 38 | | 3 | | | 3 links | 4 x 18 | | 2 links |
| Sweep | # of links | 125 | 121 long | 141 | 125 | 127 | 113 | 105 | 147 | 139 | 149 | 154 | 117 |
| | Link size | | | | | 5/8 | 5/8 | 5/8 | 5/8 | 3 inches | 5/8 | long | 5/8 |
| | Dog chains | | | | | | | 1/4 | | None; shackles | 22 link, 5/8 inch | 1 inch | None; shackles |
| Standard Twine Top | | 7.5 x 60 | 8.5 x 80 | 8.5 x 90 | 8.5 x 60 | 8.5 x 90 | 8.5 x 80 | 7.5 x 43 | 10.5 x 36 | 9 x 33 | 8 x 96 | 11 x 90 | 7.5 x 80 |
| Twine top mesh size (inches) | | 11.5 | 11.5 | 11.5 | 11.5 | 11 | 10.5 | 11 | 11 | 10.5 | 12 | | 10 |

**Figure 13 – Stations in and around the access areas surveyed. Stations occupied successfully on every trip within the access areas in red (standardized group)**



#### 1.1.2.2.1 Summary of maturity results

Maturity data was collected on all valid tows. Fish were sampled using the NEFSC 6-stage maturity technique (Burnett et al. 1989). The level of training varied for scientific crew on each trip, so some results were dropped. For YT over 4,700 fish were measured and staged for maturity. Results indicated a spawning event in the spring peaking in May/June 2011, followed by YT resting until January when they began to develop for next year spawn. See Table 4 and Figures 3-15 of report. The maturity results by month for the YT sampled in this study have been included below in

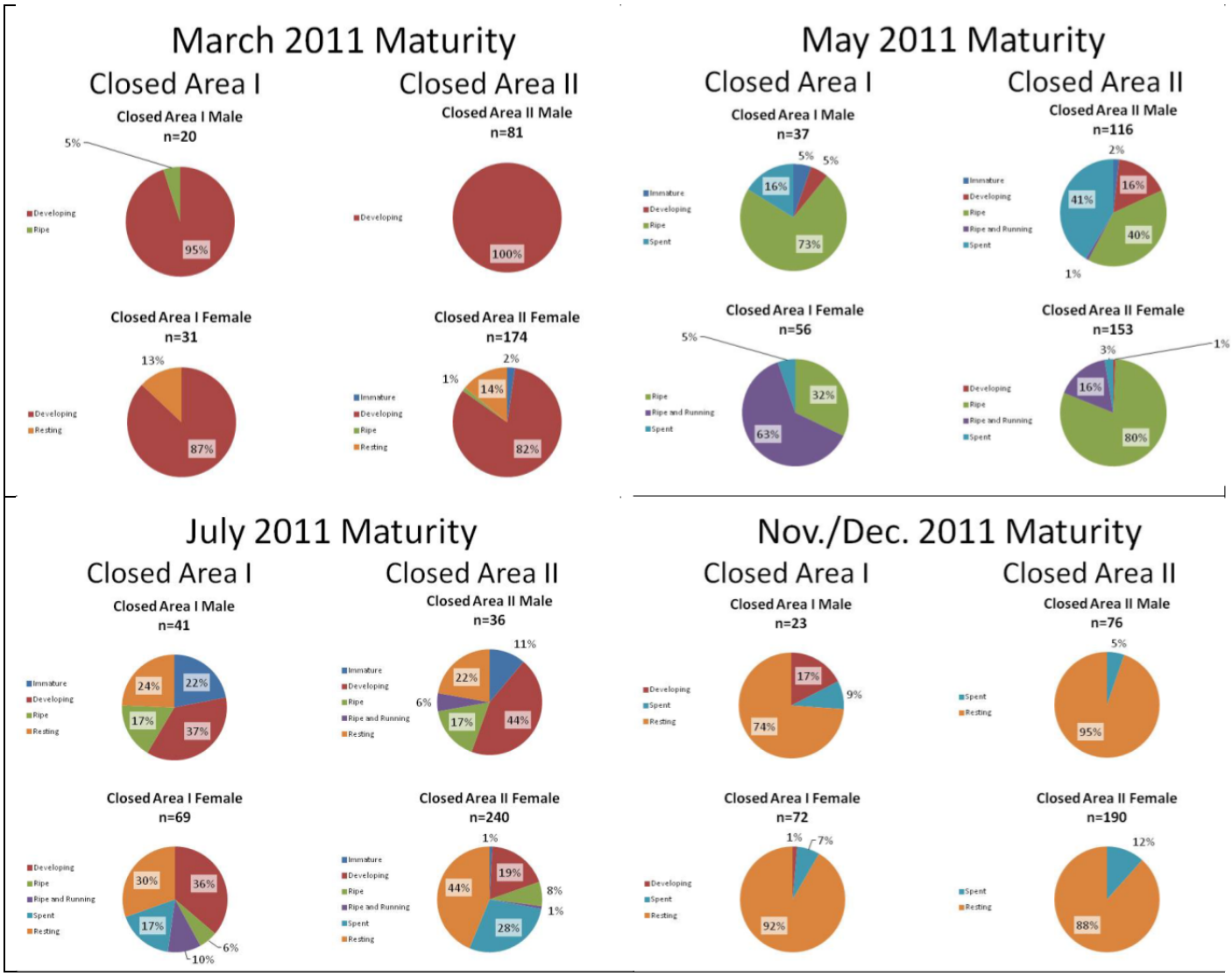
Table 2. A sample of the monthly YT maturity pie charts in the RSA study have been included as well: March showing the majority of fish developing; May showing a large percent of YT ripe and running; July the fish maturity is mixed; and in Nov/Dec most fish are spent or resting (Figure 14).

For winter flounder over 1,300 fish were measures and staged. Results indicated a spawning event in Feb/March, with most fish resting in August, and staring to develop for the next spawn in Nov/Dec.

**Table 2 – Maturity results for YT including sample size and mean size for each month of the survey and totals for sample size and grand mean for each sex (March 2011 through April 2012)**

| | Yellowtail Flounder | | | |
|---|---|---|---|---|
| Month | Female n | Female Mean | Male n | Male Mean |
| 3 | 205 | 38.6 | 101 | 33.7 |
| 4 | 253 | 38.7 | 94 | 33.9 |
| 5 | 209 | 37.6 | 153 | 35.5 |
| 6 | 203 | 37.3 | 139 | 36.1 |
| 7 | 309 | 37.6 | 77 | 33.6 |
| 8 | 282 | 38.3 | 118 | 33.7 |
| 9 | 294 | 38.5 | 122 | 34.1 |
| 10 | 346 | 38.8 | 85 | 33.9 |
| 11 | 30 | 38.9 | 5 | 33.4 |
| 12 | 232 | 39.0 | 95 | 34.7 |
| 1 | 263 | 38.6 | 114 | 34.5 |
| 2 | 164 | 39.0 | 77 | 34.9 |
| 3 | 175 | 38.6 | 120 | 34.4 |
| 4 | 361 | 38.4 | 112 | 33.8 |
| Total | 3326 | 38.4 | 1412 | 34.4 |

Figure 14 – Sample of monthly maturity for YT from 2011 RSA project




### 1.1.2.2.2 Summary of shell height: meat weight results

Over 4,300 scallops were measured in this study. Scallop shell heights ranged from 82mm to 176 mm and meat weights varied from 5-121 g. For results see Tables 10-13 and Figures 19-23 of the report. Meat weights were always higher in Closed Area I relative to Closed Area II and overall meat weights peaked from May-July and decreased to their through from August – February. Several key figures from the report have been included below to highlight the meat weight variation by month.

Figure 15 – Temporal trends for the predicted meat weight of a 125mm shell height scallop from two areas

Depth was calculated as the mean depth of each area (CAI=65.06m, CAII=73.02m).

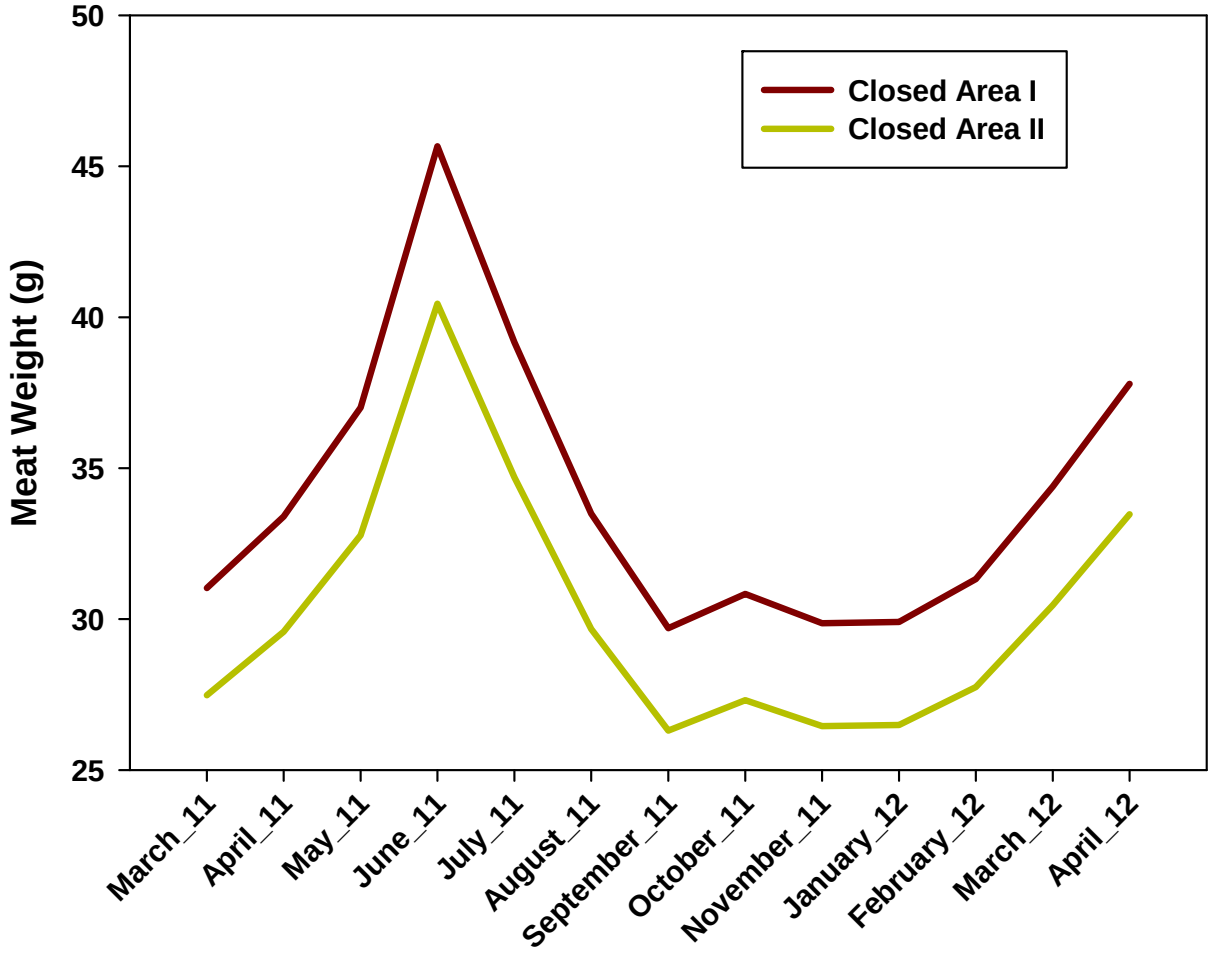


Figure 16 – Comparison of estimated curves for each month in Closed Area I (two l:w relationships for GB from NEFSC SARC included for comparison)

Depth was calculated as the mean depth of each area (CAI=65.06m).

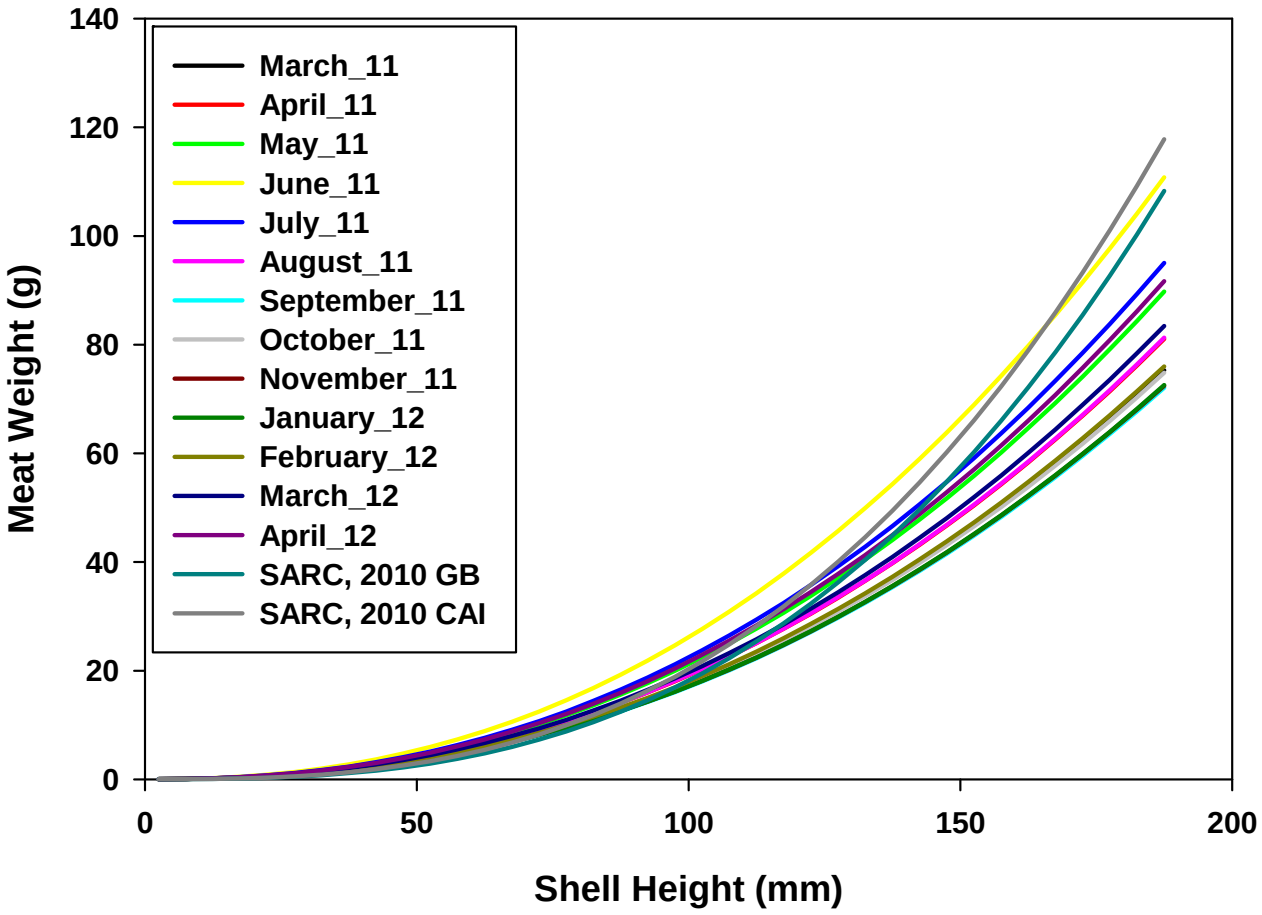
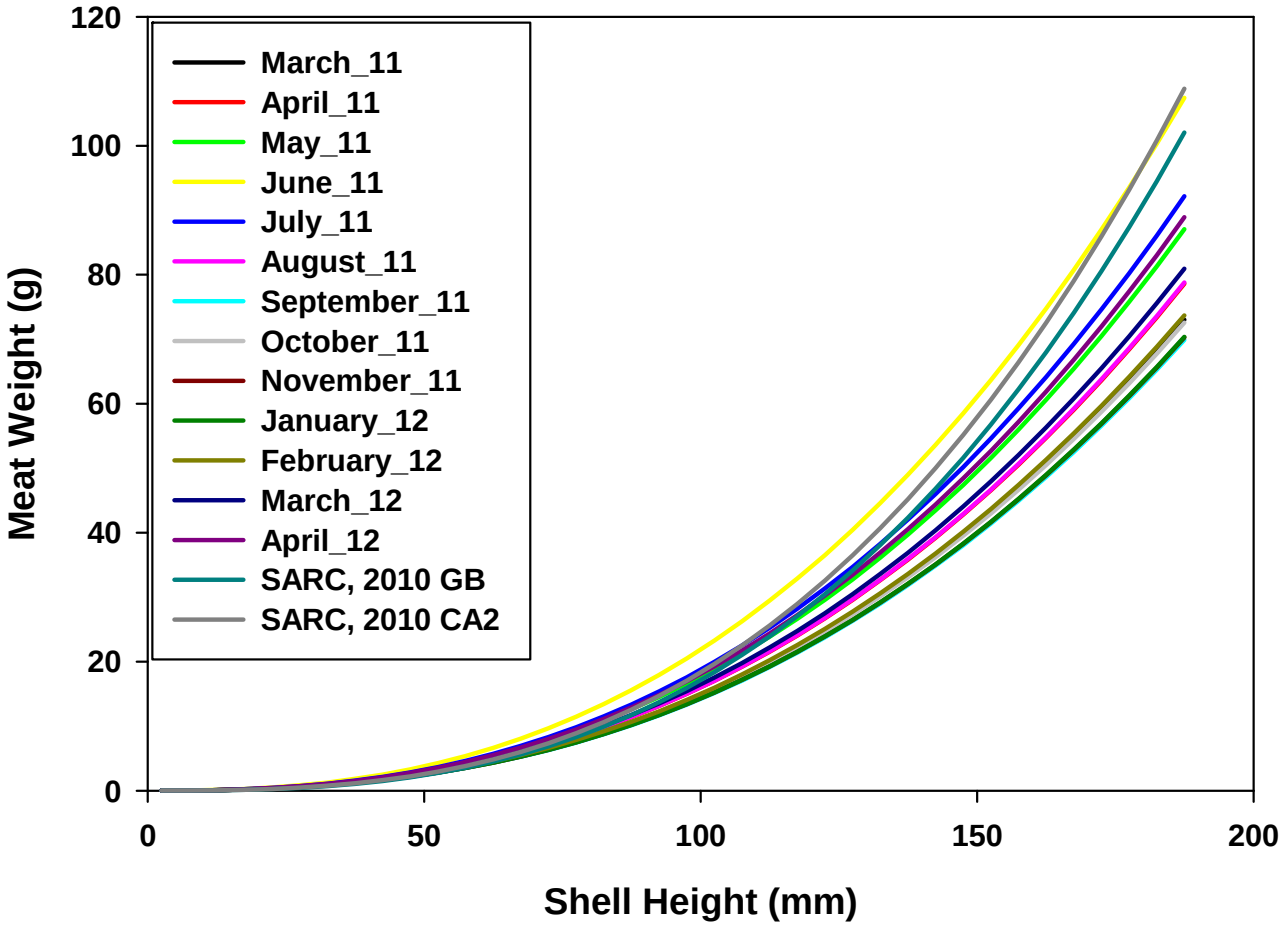


Figure 17 - Comparison of estimated curves for each month in Closed Area II (two l:w relationships for GB from NEFSC SARC included for comparison)

Depth was calculated as the mean depth of each area (CAII=73.02m).




### 1.1.2.2.3 Summary of bycatch rate analysis results

Bycatch rate was determined for each trip by dividing the weight of the bycatch species (based on length measurements and converted to weights from derived tables (NOAA, 20113)) by the meat weights of scallop catch from the turtle deflector dredge tows. The results are for 41 selected stations that were sampled on all 14 trips inside of CA1 and CA2. See Tables 14-21 and Figures 24-42 of the report for the average rates per trip and Figures 43-46 have the distribution of bycatch rates within each area by station for YT flounder only.

The total scallop meat weights in pounds from the standardized stations is summarized in Table 3. Table 4 shows that these is higher abundance of YT in CA2 compared to CA1 and in CA2 the largest numbers were in the months of Aug-Oct, and the highest bycatch rate was in October 2011. The length frequencies

of important bycatch species are included in Appendix A. The distribution of bycatch ratios by month and by station for each access area have been included in this summary as well ().

Table 3 – Totals of scallop meat weights in pounds from selected standardized stations inside CA1 and CA2 (TDD only)

| | CAI | CAII | Total |
|---|---|---|---|
| **Oct 10** | 2290.76 | 2220.05 | 4510.81 |
| **Mar 11** | 2530.92 | 2058.03 | 4588.95 |
| **Apr 11** | 2353.29 | 1638.51 | 3991.81 |
| **May 11** | 3800.49 | 3214.34 | 7014.84 |
| **Jun 11** | 4527.96 | 4150.00 | 8677.96 |
| **Jul 11** | 2877.04 | 2652.85 | 5529.89 |
| **Aug 11** | 2033.12 | 1704.40 | 3737.51 |
| **Sep 11** | 1554.05 | 1526.99 | 3081.04 |
| **Oct 11** | 1808.48 | 1670.68 | 3479.16 |
| **Dec 11** | 1328.73 | 1482.48 | 2811.21 |
| **Jan 12** | 1514.82 | 1391.33 | 2906.15 |
| **Feb 12** | 928.88 | 1385.16 | 2314.05 |
| **Mar 12** | 1185.19 | 1340.22 | 2525.41 |
| **Apr 12** | 1340.33 | 1565.82 | 2906.15 |

Table 4 – YT flounder catch from TDD from standardized stations only (12 in CA1 and 29 in CA2) Oct2010-April2012

| | CAI | | CAII | | Bycatch Rate | |
|---|---|---|---|---|---|---|
| **Date** | # | lbs | # | lbs | CAI | CAII |
| **Oct 10** | 0 | 0 | 537 | 574.4 | 0.00000 | 0.25873 |
| **Mar 11** | 3 | 3.15 | 186 | 201.2 | 0.00124 | 0.09776 |
| **Apr 11** | 8 | 6.2 | 172 | 172.7 | 0.00263 | 0.10540 |
| **May 11** | 17 | 15.6 | 116 | 109.1 | 0.00410 | 0.03394 |
| **Jun 11** | 23 | 18.1 | 123 | 123.3 | 0.00400 | 0.02971 |
| **Jul 11** | 17 | 13.5 | 108 | 104.4 | 0.00469 | 0.03935 |
| **Aug 11** | 8 | 7.55 | 450 | 431.7 | 0.00371 | 0.25329 |
| **Sep 11** | 1 | 1.35 | 445 | 457.2 | 0.00087 | 0.29941 |
| **Oct 11** | 16 | 16.75 | 527 | 560 | 0.00926 | 0.33519 |
| **Dec 11** | 24 | 27.1 | 201 | 222.65 | 0.02040 | 0.15019 |
| **Jan 12** | 9 | 9.3 | 188 | 209.1 | 0.00614 | 0.15029 |
| **Feb 12** | 2 | 1.8 | 169 | 192.1 | 0.00194 | 0.13868 |
| **Mar 12** | 2 | 1.3 | 197 | 213 | 0.00110 | 0.15893 |
| **Apr 12** | 5 | 5.8 | 253 | 258.45 | 0.00433 | 0.16506 |

Figure 18 – Box and whisker plot of the distribution of the bycatch ratio by station of YT in CA1 for each month of the survey. The mean, 25 and 75 percentiles (interquartile range), and outliers shown. Data from multiple years combined.

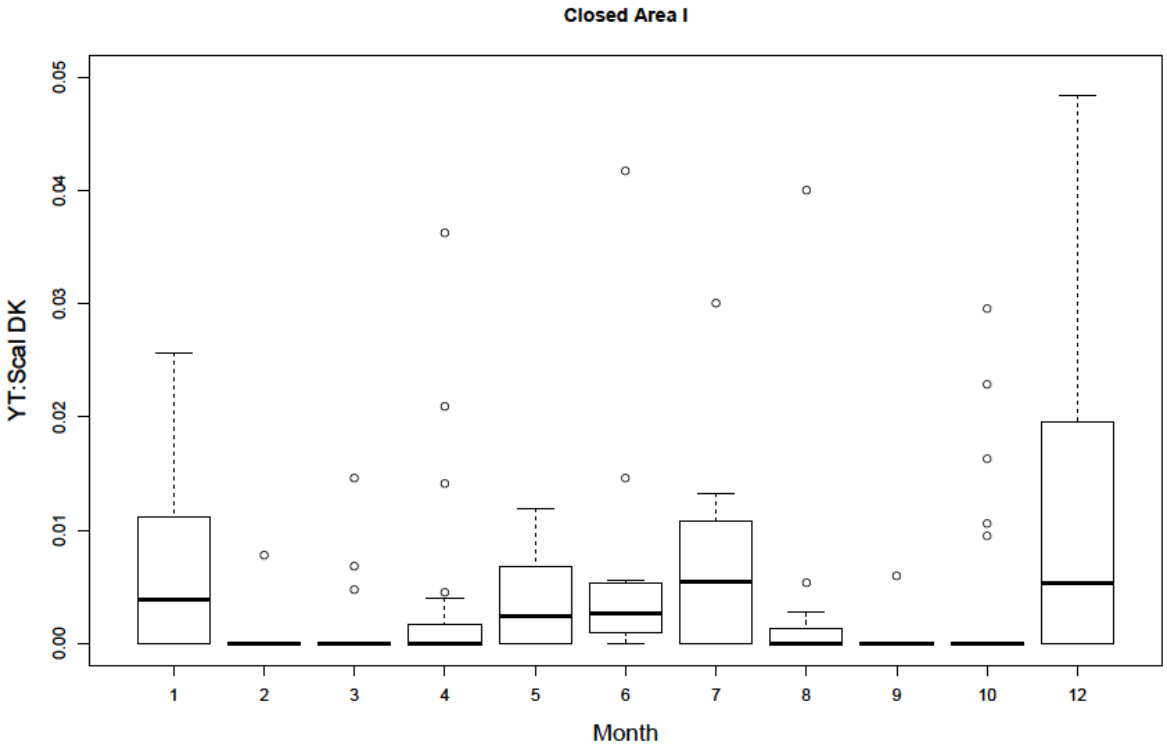



Figure 19 – Distribution of YT bycatch ratio by station in CA1 for each of the 14 survey trips

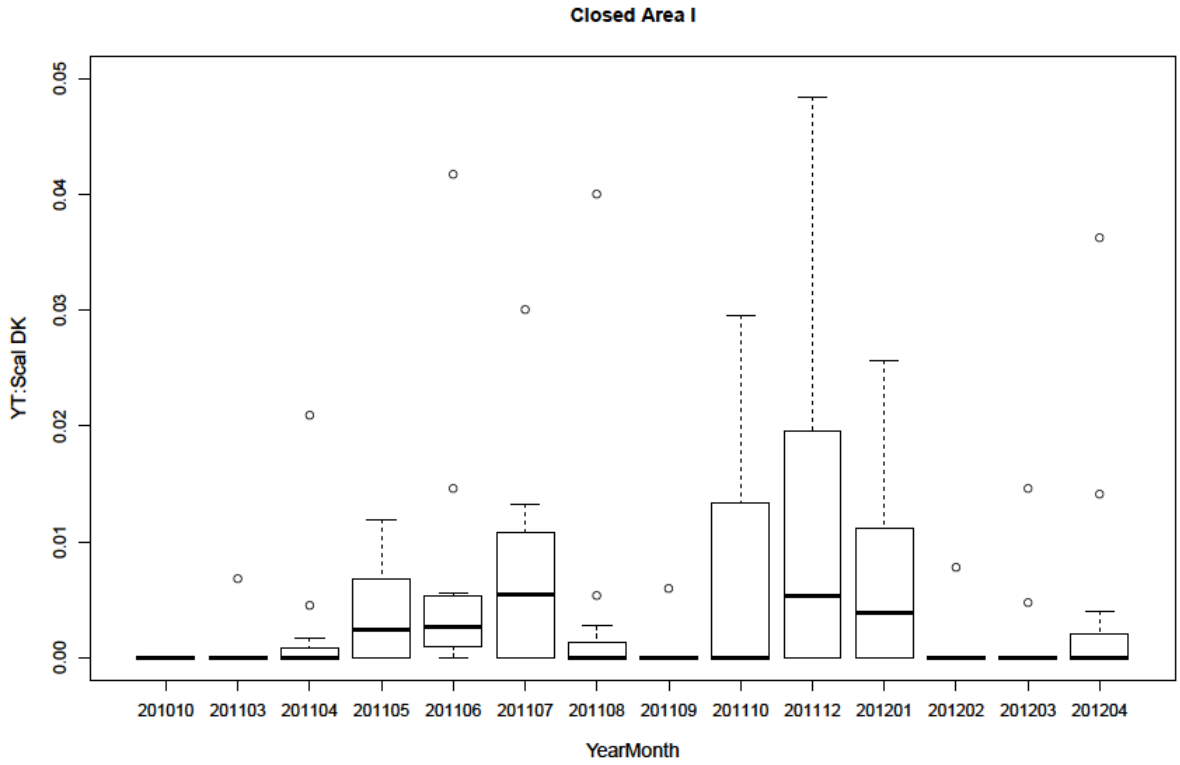


Figure 20 - Box and whisker plot of the distribution of the bycatch ratio by station of YT in CA2 for each month of the survey. The mean, 25 and 75 percentiles (interquartile range), and outliers shown. Data from multiple years combined.

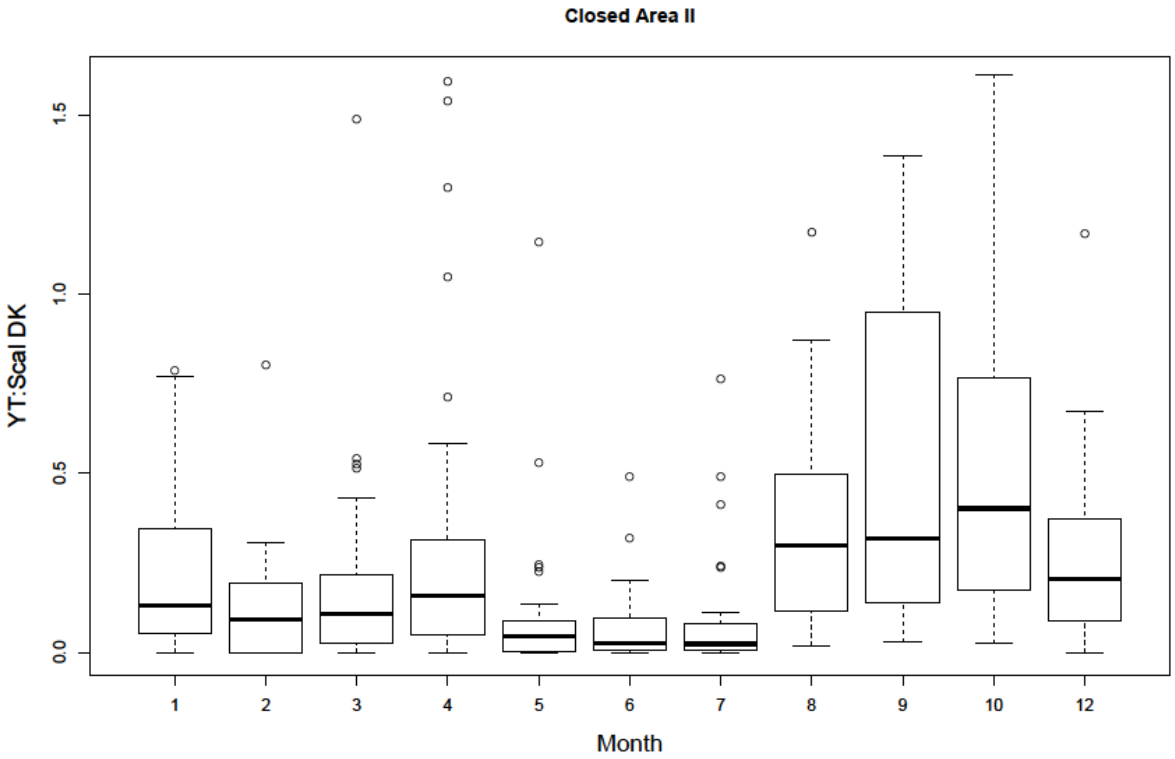
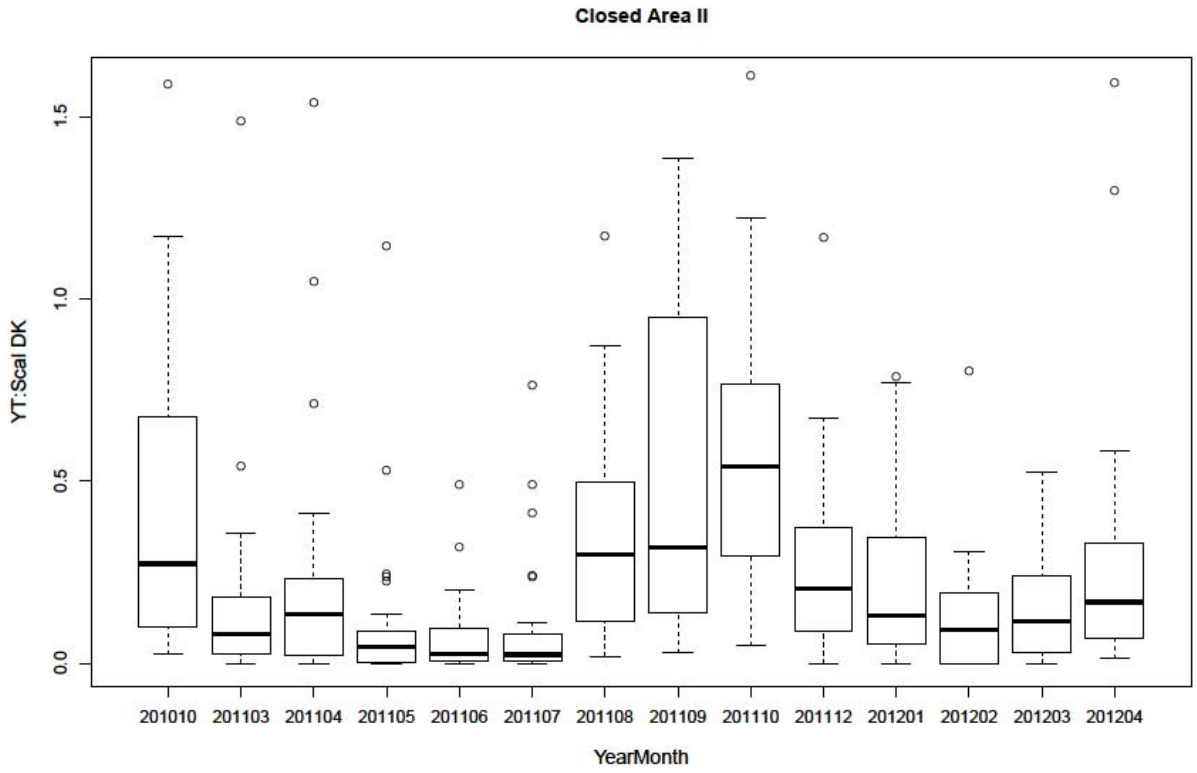



Figure 21 - Distribution of YT bycatch ratio by station in CA2 for each of the fourteen survey trips



#### 1.1.2.2.4 Overall summary of analysis from RSA seasonal bycatch study

**Input from RSC**

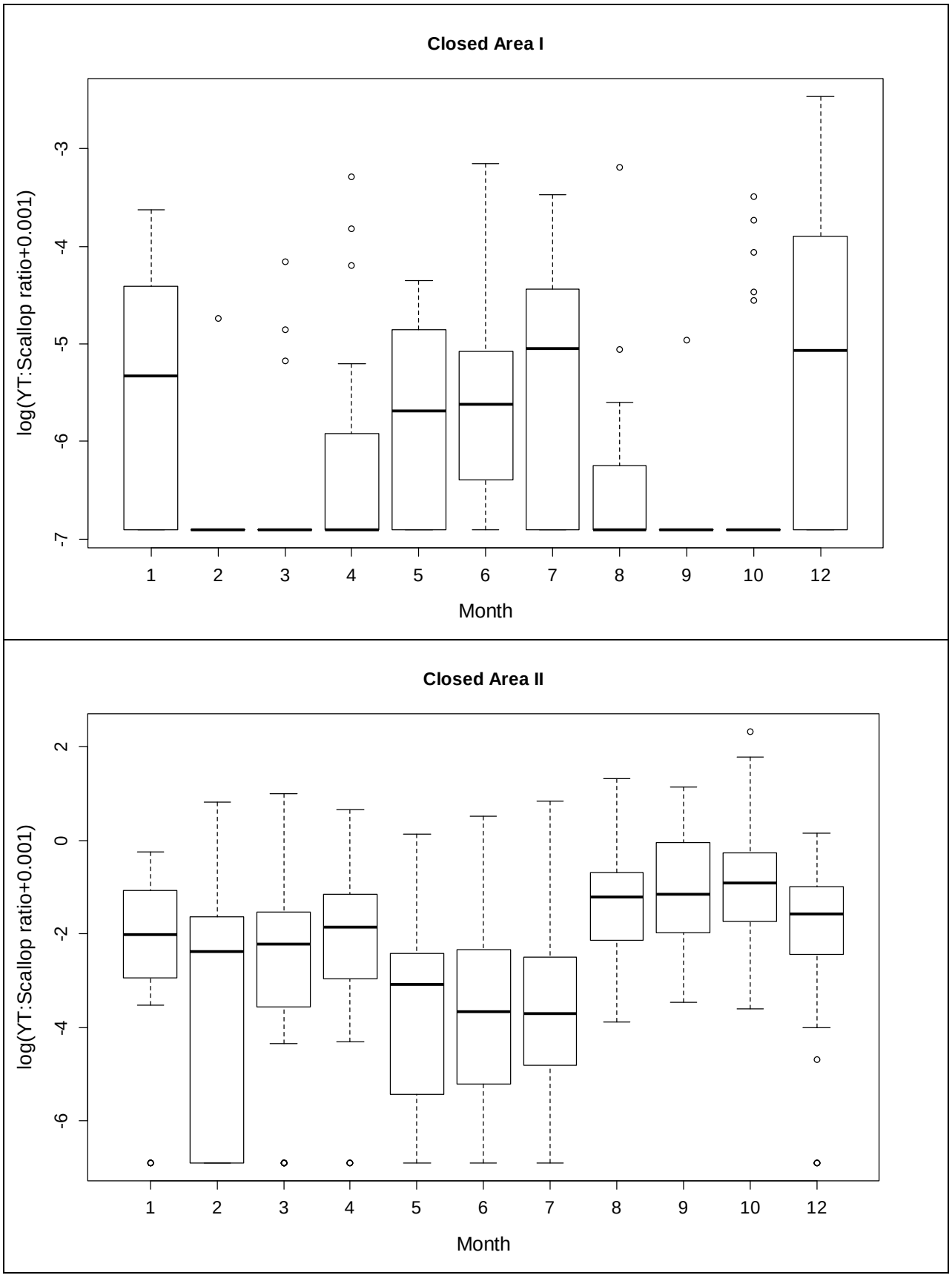
The RSC reviewed the 2011 RSA project, "Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch", on June 25, 2012. Some concerns were raised about the thoroughness of the NEFSC technical review and suggested that more work should be done to look at the data on a tow by tow basis, rather than simply taking mean YT bycatch rates per month for each area.

> ***RSC Consensus***
> ***The Committee agreed that the report is not yet a final report in the traditional sense, but some components have immediate application to some current management needs. The RAMP component results are not sufficient for application to setting mortality rates in the assessment. The PDTs have access to all of the data, and that data are sufficient for the PDTs to use in developing management measures, even though additional data will be collected over the next year. The report also raises a number of questions for future research or investigation.***

**Additional analyses of 2011 RSA data by the Scallop PDT**

The PDT took the monthly bycatch data and ran it in the same GAM model that was developed for the observer data. Due to the relatively large number of zero tows of YT and several large outliers with large tows of YT in CA2 (Figure 18 - Figure 21), the PDT completed log-transform boxplots using the same data to get rid of all the zero tows (Figure 22). The updated boxplots show that D:K rates in CA2 are higher in the fall compared to other months. Bycatch rates in Closed Area I are not as consistent by month and seasonal changes in scallop meat weights are likely a larger driver than seasonal changes in YT.

Figure 22 – Log-transformed boxplots of bycatch ratios by month for Closed Area I and 2 using 2011 RSA data



### 1.1.2.3 Alternatives developed by the Scallop PDT

The PDT discussed that moving the opening date earlier in May would improve scallop yield and reduce fishing mortality. Since there is a possession limit in access areas fishing for scallops when meat weights are largest also reduces bottom contact time and bycatch because fewer scallops are needed to harvest the possession limit.

In general, there are two ways to approach these seasonal restrictions: develop a fixed opening and closing date, or leave the areas open all year and identify a fixed time period to close the areas when bycatch rates are highest. The PDT discussed that having the areas open longer could have beneficial impacts of spreading effort out, but in access areas there is a fixed possession limit so there is less incentive to fish in high meat weight months compared to open areas. Therefore, there may be advantages to have shorter windows when meat weights are higher to reduce fishing mortality, bycatch, and associated impacts.

**Based on these analyses the Scallop PDT developed several options (1, 2, 3A) (Table 5). The AP developed Option 3B, and Option 4 was included to eliminate the seasonal closures to complete the range of alternatives under consideration. See Section 2.2.1 of FW24 alternatives for more details.**

**Table 5 – Summary of GB Access Area seasonal restriction alternatives under consideration in FW24**

| | No Action | Modify Season | | | | | Eliminate Season |
|---|---|---|---|---|---|---|---|
| | | Option 1 | Option 2 | Option 3A** | Option 3B | | |
| Access Area | All areas | All areas | All areas | All areas | CA2 | CA1/NL | All Areas |
| Mar | C | C | O | C | O | O | O |
| Apr | C | C | O | C | O | O | O |
| May | C | O | O | O | O | O | O |
| Jun | O (6/15) | O | O | O | O | O | O |
| Jul | O | O | O | O | O | O | O |
| Aug | O | O | O | O | C (Aug 15) | O | O |
| Sep | O | C | C | C | C | O | O |
| Oct | O | C | C | C | C | O | O |
| Nov | O | C | C | C | C (Nov 15) | O | O |
| Dec | O | C | O | O | O | O | O |
| Jan | O | C | O | C | O | O | O |
| Feb | C | C | O | C | O | O | O |
| Total Months Closed | 4.5 | 8 | 3 | 7 | 3 | 0 | 0 |

** Scallop Cmte replaced Option 3A with 3B, and Council did not include 3a for consideration, thus it was not fully analyzed in Framework 24.

### 1.1.3 Input from GF PDT about potential impacts on groundfish mortality and spawning

The Groundfish PDT has also prepared separate analyses using the 2011 RSA seasonal bycatch report. The GF PDT has evaluated differences in YT and WP monthly bycatch rates on a tow by tow basis from that study. Detailed analyses will be appended to FW24. The bullets below summarize input from the GF PDT from their meeting summary (GF PDT meeting October 12, 2012). The separate working papers prepared by the GF PDT are attached at the end of this Appendix.

**Timing of Scallop Fishery Access to GB Closed Areas**

8. Scallop FW 24 will be a joint action that considers changing the dates that scallop vessels are allowed access to the GB access areas (CAI, CAII, NLCA). The PDT reviewed the following sources of information to evaluate the impact of the alternatives on groundfish resources (primarily yellowtail flounder and windowpane flounder).

a. "An analysis of Georges Bank yellowtail flounder monthly catch rates in closed area 1 and closed area 2 from the bycatch survey"; PDT analysis prepare by Steve Correia. This report uses data from "Optimizing the Georges Bank Scallop Fishery by Maximizing Meat Yield and Minimizing Bycatch; Final Report prepared for the 2011 Sea Scallop Research Set Aside"; Smolowitz, Ronald, Kathryn Goetting, Farrell Davis, and Dan Ward; 2011.

b. "An analysis of Georges Bank windowpane monthly catch per tow in Closed Area 2 from the scallop dredge bycatch survey"; PDT analysis prepared by Steve Correia. This report uses data from Smolowitz et al. 2011.

c. Scallop fishery time/area closure to reduce yellowtail flounder bycatch on Georges Bank in 2007; Canadian Science Advisory Secretariat Science Response 2007/001.

d. Evaluation of Closed Areas Using Yellowtail Flounder Tagging Studies; summary of a presentation given by Dr. Steve Cadrin at the Northeast Regional Tagging Symposium, 2008

e. NMFS/NOAA EFH Source Documents for yellowtail flounder and windowpane flounder

9. The PDT's discussion focused on two issues. The first was the likely effects of changing the access dates on catches of yellowtail and windowpane flounder. The second was on the likely effects of changing the access dates on the effects of scallop fishing on yellowtail flounder spawning activity. The two yellowtail stocks that may be most affected by the changes are SNE/MA yellowtail flounder (NLCA) and GB yellowtail flounder (CAI and CAII). GB YTF is overfished and in a rebuilding program; overfishing is occurring. Recent recruitment is the lowest on record (TRAC 2012). SNEMA YTF is not overfished and overfishing is not occurring (SAW 54, 2012). Compared to historic levels, the stock is at a low stock size, partly as the result of poor recruitment for the last 20 years. Northern windowpane flounder is overfished and overfishing was occurring in 2010.

*Discards*

10. The main source for information on seasonal differences in scallop dredge catches of yellowtail and windowpane flounder are the two papers prepared by Steve Correia (attached). These papers analyze data from an ongoing experiment that uses commercial scallop dredges to sample stations in CAI and CAII. The conclusions are comparable to a different analytic approach used by the Scallop PDT. Because of inconsistent sampling of stations in CAI, the PDT does not believe that conclusions can be drawn about seasonal changes in catch rates. Only some of the stations in this area were sampled each month and they cover only part of the area fished by the scallop industry. In CAII, most of the stations were sampled each month and generally the stations not sampled were in areas that are not typically fished by scallop vessels. The stations used for the analyses are shown in Figure 1 from the PDT report. The results cited below are only applicable for the consistently sampled stations.

11. In CAII, the experimental results indicate that yellowtail flounder catch rates per tow are lowest in the May – July period, and are highest in the August – October period. Pairwise comparisons of catch by month indicate that catch rates in August – October are significantly different (higher) than catch rates from March through July. Catch rates in May/June/July are not significantly lower than catch rates in March and April. Figure 2 gives a quick overview of these results.

12. In CAI, the months with the highest discard rates are May, June, July, and December; months with lower rate are April, August, and September. Because of small sample sizes and inconsistent sampling, the PDT does not believe that statistical inferences are sound for this area.

13. In CAII, windowpane flounder catch rates peaked in March. Other months where catches wee high included April and December. Windowpane flounder catches were lowest from June through September. Figure 3 gives a quick overview of these results. There were insufficient data to draw conclusions for CAI.

14. There is no new information for the seasonal trends of yellowtail flounder catches in the NLCA. Analyses in FW 11 (1999) concluded that catch rates were highest in the spring and early summer.

*Spawning of Yellowtail Flounder*

15. Numerous sources document that yellowtail flounder spawning on GB peaks in May and June on Georges Bank. There is little detailed information on the location of spawning aggregations. There is no information on whether fishing activity – including scallop dredges - interferes with spawning behavior of yellowtail flounder. This is different than the case for cod, where some studies suggest that fishing activity disrupts spawning activity.

16. Since the mid-1990's, the NMFS surveys have indicated that yellowtail flounder is primarily located in survey stratum 16, which overlaps CAII. In the last four or five years there has been some expansion into stratum 13. If yellowtail flounder aggregated in CAII during spawning season, though, the expectation would be that the catch rates in the ongoing experiment would peak in May and June. This was not the case; as shown in Figure 2 of the PDT report, catches in May and June were lower than in other months. While a high percentage of fish in these months were developing or ripe and running, the experiment suggests that spawning aggregations may be located elsewhere.

*Recommendations*

17. The PDT was advised that FW 24 will consider the following options for the timing of access to the GB access areas. Some of the options are considering slight variations of the dates shown.

a. No Action (access allowed June 15 – January 31)
b. Modify dates: Option 1: areas closed October 1 – April 30
Option 2: areas close September 1 – November 30
Option 3A: NLCA closed September 1 – November 30 and March 1 – April 15; CAI and CAII closed September 1 – April 15
Option 3B: CAII closed August 15 – November 15; no closure for CAI and the NLCA
c. No access date restrictions

18. For CAII, From the standpoint of groundfish bycatch, the months of May, June, and July appear to be those most likely to minimize catches of YTF and windowpane flounder. For YTF, the months of August – November should be avoided to reduce catches of YTF. For WINP, the months of March and April should be avoided.

19. At present, scallop fishery catches of GOM/GB windowpane flounder are small but not inconsequential. In FY 2011, catches were estimated as 33 mt out of the total catch of 161 mt, or 20 pct. The scallop experiment catch per tow in CAII increased by a factor of ten in March and April when compared to June and July. This is a concern as the ACL was exceeded in FY 2011 and the stock is overfished. It is possible that allowing dredge activity in CAII in March and April could accelerate the need to allocate a sub-ACL for this stock to the scallop fishery.

20. From the standpoint of avoiding any possible interference with YTF spawning, the months to avoid fishing in GB access areas are May/June. However, to date the PDT has not found research on the impacts of fishing activity on YTF spawning and no research is available that identifies specific spawning locations within the CAI or CAII scallop access areas. The PDT also notes that FW 48 will consider allowing groundfish sectors to request access to parts of CAI, CAII, and the NLCA between May 1 and February 15; the PDT is doubtful that scallop dredges will have greater impacts on spawning activity than groundfish trawls.

21. Scallop management options 1 and 3A address concerns over GOM/GB windowpane flounder to some extent. Options 2, 3A, and 3B would reduce activity in CAII during the period when yellowtail flounder catch rates would be expected to be highest.

22. In the context of a system that allocates a sub-ACL to the scallop fishery, it can be argued that the seasonal differences in catch rates are unimportant as long as the scallop fishery is held to the sub-ACL through effective AMs. The PDT notes, however, that the Council may base the allocation on the amount the scallop fishery is expected to catch. In this case, then, moving the fishery to periods of lower catches may benefit the groundfish fishery by reducing the expected catch. More problematic is the difference in accountability between the two fisheries. If the scallop fishery exceeds its sub-ACL, and this leads to an overage of the overall ACL, the provisions of the US/CA Understanding require a 1 for 1 reduction in the quota the following year. This immediately results in a reduction in the quota available to the groundfish fleet, even if that fleet stayed within its sub-ACL. The scallop fishery AM, on the other hand, does not get implemented until the following year and while it may limit access to certain areas it does not necessarily reduce overall scallop fishing effort.

### 1.1.4 Preliminary economic impacts of the alternatives under consideration on the scallop fishery

Framework 24 includes several options to modify GB seasonal restrictions to provide access during months with highest scallop meat weights and to minimize yellowtail bycatch. Under no action, access to GB areas starts on June 15$^{th}$ and they stay open until the end of January of the following year. Overall, those areas would be closed to fishing for 4.5 months with no action (**Table 5**).

#### 1.1.4.1.1 Option 1 - Closure period would be modified to provide access during months with highest scallop meat weights to reduce fishing time and scallop fishing mortality

This option would provide access earlier starting in May because that would improve scallop yield and reduce fishing mortality. Since there is a possession limit in access areas, fishing for scallops when meat weights are largest also reduces bottom contact time and bycatch because fewer scallops are needed to harvest the possession limit. However, this alternative would reduce the months GB access areas open to fishing to four months keeping the area closed after August. The net economic impacts of this alternative compared to no action will depend whether the positive impacts on the scallop yield will outweigh the costs associated with reduced flexibility with narrowing the fishing season to 4 months under this option.

It is evident from **Table 7** and **Table 8** that as a result of late opening of the GB access areas in 2011 (in August) a major proportion (78% of all landings in CA1 and 48% of all landings in CA2) of the scallop lb. were landed in the month of August. Comparison with **Table 9** indicates that when those areas were opened on June 15$^{th}$ in 2012, the landings were more evenly spread among months from June to September 12. Considering that 62% of CA2 TAC, 67% of the CA1 TAC and 30% of the NLS TAC were landed so far by September 12, closing these areas will result in a shift of effort from September –January to May-August under Option1. This is expected to have both positive and negative economic impacts on the scallop fishery. Narrowing fishing season to four months will reduce the flexibility for vessel owners to choose when to fish and to adjust their fishing patterns to the changes in prices and fuel costs from one months to another with a possible increase in fishing costs and some negative impacts on the revenues. On the other hand, shifting effort to months with high meat weights could reduce the fishing time to land the possession limit and have a favorable impact on fishing costs outweighing some of the negative impacts.

Containing effort to 4 months from May to August (instead of spreading the effort through June 15 to January under no action) could also have some negative impacts on the average prices and revenues

scallop fishermen receive from these areas. Table 6 shows that average ex-vessel prices from May to August window were higher compared to prices in months from January to April, but lower than the prices in the period from September to December in 2010 and 2011. Even though, during those months scallop landings include more of larger scallops with a price premium, increase in the supply of those scallops in a shorter period of time (due to the closures) could have some dampening impact on their prices holding other factors (including the changes in demand for exports, import prices, income and preferences of consumers) that affect price constant. However, it is uncertain, to what extent the price premium associated with larger scallops over the May to August period could offset some of the negative effects of the effort shifts.

Over the long-term, opening the access areas early and shifting effort from low meat weights months (October is the lowest) to high meat weight months (June is highest) will have positive impacts on the scallop resource and future yield from the scallop fishery with positive economic impacts. It will also reduce bottom contact time and bycatch because fewer scallops would be needed to harvest the possession limit reducing the risk for triggering AMs in case yellowtail ACL is exceeded. Thus, the net economic impacts of Option 1 compared to no action is uncertain in the short-term, ranging from a small negative impact to a slight positive impact. However, the positive impacts on the scallop yield and reduction of the risk of triggering yellowtail AMs could result in positive economic impacts over the long-term.

**Table 6. Average Ex-vessel scallop prices by month**

| Month | 2010 | 2011 | 2010-2011 Average |
|---|---|---|---|
| 1 | 6.25 | 9.79 | 7.79 |
| 2 | 6.99 | 9.46 | 8.35 |
| 3 | 7.20 | 9.29 | 8.30 |
| 4 | 6.77 | 9.75 | 8.11 |
| **Average of 1 to 4** | **6.86** | **9.55** | **8.17** |
| 5 | 6.54 | 9.85 | 8.31 |
| 6 | 7.14 | 9.51 | 8.38 |
| 7 | 9.83 | 9.93 | 9.86 |
| 8 | 8.45 | 9.80 | 9.31 |
| **Average of 5 to 8** | **7.99** | **9.77** | **8.91** |
| 9 | 8.56 | 10.45 | 9.52 |
| 10 | 8.67 | 10.25 | 9.49 |
| 11 | 9.43 | 10.60 | 9.99 |
| 12 | 9.77 | 10.95 | 10.35 |
| **Average of 9 to 12** | **8.96** | **10.50** | **9.73** |

**Table 7. Monthly distribution of landings in CA1 and CA2 in 2011 (Open from August 2011 to January 2011)**

| Area | Month | Scallop lb. | Percentage distribution of landings by month |
|---|---|---|---|
| CA1 | 8 | 6,500,546 | 78% |
| | 9 | 1,059,078 | 13% |
| | 10 | 508,716 | 6% |
| | 11 | 146,577 | 2% |
| | 12 | 161,585 | 2% |
| Total | | 8,376,502 | 100% |
| CA2 | 8 | 1,284,116 | 48% |
| | 9 | 654,057 | 24% |
| | 10 | 405,058 | 15% |
| | 11 | 257,353 | 10% |
| | 12 | 70,979 | 3% |
| Total | | 2,671,563 | 100% |

**Table 8. Monthly distribution of landings in Nantucket Lightship area in 2010 (Open from June 28 to January 2011)**

| Area | Month | Scallop lb. | Percentage distribution of landings by month |
|---|---|---|---|
| NSA | 6 | 13,465 | 0% |
| | 7 | 5,553,301 | 97% |
| | 8 | 79,042 | 1% |
| | 9 | 24,462 | 0% |
| | 10 | 4,280 | 0% |
| | 12 | 72,401 | 1% |
| | Total | 5,746,951 | 100% |

**Table 9. Monthly distribution of landings in Nantucket Lightship, CA1 and CA2 area in 2012 (Open from June 15 to January 2011)**

| Date | Closed Area I | Closed Area II | Nantucket Lightship | All Areas |
|---|---|---|---|---|
| June-12 | 666,124 | 988,169 | 268,991 | 1,923,284 |
| July-12 | 1,499,011 | 1,331,517 | 724,315 | 3,554,843 |
| August-12 | 660,261 | 902,787 | 538,940 | 2,101,988 |
| September-12 | 803,308 | 694,523 | 209,123 | 1,706,954 |
| Total | 3,628,704 | 3,916,996 | 1,741,369 | 9,287,069 |
| Area TAC | 5,886,000 | 5,886,000 | 2,943,000 | 14,715,000 |
| % of Total TAC | | | | |
| June-12 | 11% | 17% | 5% | 13% |
| July-12 | 25% | 23% | 12% | 24% |
| August-12 | 11% | 15% | 9% | 14% |
| September-12 | 14% | 12% | 4% | 12% |
| Total | 62% | 67% | 30% | 63% |
| Area TAC | 100% | 100% | 50% | 100% |

**Option 2 - Closure period would be modified to only the months with highest yellowtail flounder bycatch**

This option would allow access to the GB areas for nine months and keep it closed only in the months of September to November. Thus, it would provide more flexibility to vessels about when to fish compared to both Option 1 and no action with positive impacts on profits. Furthermore, it will shift effort from some of the low meat weight months (November) to high meat weight months benefiting the scallop resource. This could reduce the fishing time and the trip costs since fewer scallops will be needed to harvest the possession limit.

**Option 3a - Closure period would take into account scallop meat weights, YT bycatch, and traditional fishing trends**

The Scallop PDT also discussed that it could be beneficial to consider an alternative that is based on the months when meat weights are poor, YT bycatch is high, and also takes into account traditional fishing trends. Specifically, this alternative would close the areas consistent with Option 2 when YT bycatch rates are highest, but it would be more restrictive to also limit fishing when scallop meats are poor to reduce scallop fishing mortality. Finally, this alternative would also provide for a very limited amount of fishing in the winter when some vessels traditionally take a "Christmas trip". Thus this option would have higher economic benefits compared to Option 1, but will provide less flexibility for vessels compared to Option 2 with uncertain economic impacts in the short-term and possibly positive economic impacts over the long-term.

**Option 3b – Advisory Panel recommendation**

Based on an AP recommendation, the Committee revised one of the GB seasonal closure alternatives so that only CA2 would be closed from Aug15-Nov15 (a combination of the lowest meat weights and highest YT) and no closures for CA1 and NL. The main rationale provided from the AP meeting was that overall bycatch is low in CA1 and there does not seem to be a strong seasonal difference. Therefore, imposing a seasonal restriction may not do much and could actually shift effort into higher bycatch areas if vessels fish in open areas when NL is closed.

This option would provide higher flexibility to vessels compared to no action and other options since CA2 would close for only 3 months and CA1 and NL would be open all year, resulting in positive economic benefits for the scallop fishery. It is more likely, however, the long-term benefits of this option would be somewhat lower compared to Options 1 to 3a since the effort could occur in CA1 and NL during the low-meat weight seasons as well.

**Eliminate GB access area seasonal restrictions**

This alternative would remove any seasonal restriction for scallop fishing in portions of the existing GF closed areas. This alternative may be selected if it is found that limited scallop fishing in portions of the GF closed areas year round would not have substantial negative impacts on groundfish mortality and spawning. This option would provide higher flexibility to vessels compared to no action and all the other options including 3b above with some positive economic benefits for the scallop fishery in the short-term. It is more likely, however, for the long-term benefits of this option to be lower compared to the economic benefits from other options since fishing effort could occur in the access areas during the low-meat weight seasons resulting in higher fishing costs and lower benefits for the scallop resource. In addition, this option is not pro-active and does not avoid fishing during the high YT bycatch months.

# An analysis of Georges Bank windowpane monthly catch per tow in Closed Area 2 from the scallop dredge bycatch survey

Prepared for the Groundfish PDT

By

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September 27, 2012

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 windowpane catches. I used a dataset provided by Deirdre Boelke (NEFMC) to estimate differences in monthly catches of windowpane in the study area. The dataset consists of only "standardized selected" stations (Figure 2, Table 1) as described in (Smolowitz et al, 2012). Focusing on windowpane catch per tow rather than the windowpane: scallop discard ratio, eliminates the confounding effects of changes in scallop yields on the seasonal availability of windowpane in the closed areas.

| | Closed Area II | | |
|---|---|---|---|
| | | | year |
| month | 2010 | 2011 | 2012 |
| Jan | 0 | 0 | 28 |
| Feb | 0 | 0 | 28 |
| Mar | 0 | 28 | 28 |
| Apr | 0 | 28 | 28 |
| May | 0 | 28 | 0 |
| June | 0 | 28 | 0 |
| July | 0 | 28 | 0 |
| Aug | 0 | 28 | 0 |
| Sept | 0 | 28 | 0 |
| Oct | 28 | 28 | 0 |
| Nov | 0 | 0 | 0 |
| Dec | 0 | 28 | 0 |

**Table 1. Count of sampling "standardized selected" stations by area, month and year. These totals do not include station 218, which was sampled in all months in 2011 but not 2012.**

## 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 windowpane catch per tow by month for 2011 for "standardized selected" stations only. This eliminates the confounding year effects with month effects for incomplete sampling years of 2010 and 2012.

The windowpane data are significantly different from normal and monthly variances are heterogeneous and do not meet assumptions of either the ANOVA or the Tukey range test. Therefore, I used the Kruskal-Wallace non-parametric test to test for homogeneity of location of windowpane catch rates by month. I used pairwise Wilcoxon tests to test for shifts in location of catch rates by month and controlled the family-wise error rate at 5% using Bonferroni adjustment procedure to account for the 36 A-posteriori monthly comparisons.

**Results**

Boxplots of the windowpane 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 March, April and May relative to summer months of June, July and August. Catches distribution are shifted higher for October and December compared with the summer months. The inter-quartile range of the distributions appears relatively heterogeneous for all months. No sampling occurred in January, February or November in 2011.

An ANOVA of windowpane catch per tow rates for closed area II indicated significant month effect (Table 2). Diagnostics indicated that distribution of residuals was significantly different from normal and variances were heteroscedastic. Differences between monthly mean catch rates are shown in Table 3. Confidence limits and p-values are not provided as inference from the Tukey-Range test is not likely valid giving inability for these data to meet assumptions of the test.

Results from the Kruskal-Wallace test ($p<0.001$) indicated that location was heterogeneous among months. Pairwise Wilcoxon tests (Table 4 and Table 5) resulted in significantly median differences in location for 22 out of 36 monthly comparisons. Note that many ties occur in the ranking of monthly catch per tow, mostly because of many zero catch values. Probability values from the Wilcoxon test are not exact because of ties. However, the confidence intervals are constructed using a different algorithm than p-values derived from the distribution of Wilcoxon test statistics. Months with significant differences in location can be determined by having confidence intervals that do not overlap zero. The paired month comparisons with significant median differences in location are the same whether P-values are used or confidence intervals that do not overlap zero criteria are used to make inferences in shifts in location.

Windowpane catch rates in March were higher than all other months. April was also significantly higher than all months but December. Median difference in location was significantly higher in May than June, August and September. However, the shifts in location were small (1 lb). Median differences in location were higher in December compared to June, July, August, September and October. For closed area II, monthly catch per tow for windowpane is higher during spring months (March-May) compared with catch per tow during summer months (June-October).

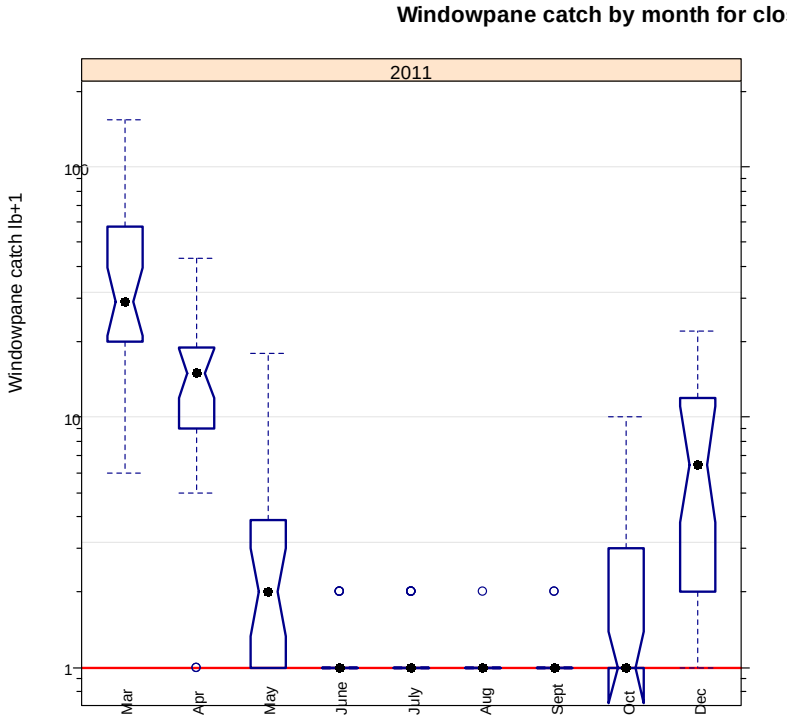


**Figure 1. Boxplots of windowpane catch (lb+1) for standardized selected stations in closed area II by month for 2011. Y-axis scale is logarithmic. Black dots are medians and non-overlapping notches indicate approximately 95% confidence interval for differences in median. Folded notch for October indicates 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.**

| | DF | Sum sq | Mean square | F-value | P(>F) |
|---|---|---|---|---|---|
| Month | 8 | 39694 | 4962 | 31.96 | <0.001 |
| Residuals | 243 | 37722 | 155 | | |

**Table 2. Summary results of ANOVA of windowpane catch per tow by month for closed area II for 2011.**

| | monthly mean | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | no data | no data | 40.5 | 14.4 | 2.9 | 0.1 | 0.2 | 0.0 | 0.1 | 1.3 | no data | 7.3 |
| Jan | **no data** | 0 | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** |
| Feb | **no data** | **na** | 0 | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** |
| Mar | **40.5** | **na** | **na** | 0.0 | -26.1 | -37.7 | -40.4 | -40.3 | -40.5 | -40.5 | -39.3 | **na** | **na** |
| Apr | **14.4** | **na** | **na** | 26.1 | 0.0 | -11.6 | -14.3 | -14.2 | -14.4 | -14.4 | -13.1 | **na** | **na** |
| May | **2.9** | **na** | **na** | 37.7 | 11.6 | 0.0 | -2.7 | -2.6 | -2.8 | -2.8 | -1.6 | **na** | **na** |
| Jun | **0.1** | **na** | **na** | 40.4 | 14.3 | 2.7 | 0.0 | 0.1 | -0.1 | -0.1 | 1.1 | **na** | **na** |
| July | **0.2** | **na** | **na** | 40.3 | 14.2 | 2.6 | -0.1 | 0.0 | -0.2 | -0.1 | 1.1 | **na** | **na** |
| Aug | **0.0** | **na** | **na** | 40.5 | 14.4 | 2.8 | 0.1 | 0.2 | 0.0 | 0.0 | 1.3 | **na** | **na** |
| Sep | **0.1** | **na** | **na** | 40.5 | 14.4 | 2.8 | 0.1 | 0.1 | 0.0 | 0.0 | 1.2 | **na** | **na** |
| Oct | **1.3** | **na** | **na** | 39.3 | 13.1 | 1.6 | -1.1 | -1.1 | -1.3 | -1.2 | 0.0 | **na** | **na** |
| Nov | **no data** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | 0 | **na** |
| Dec | **7.3** | **na** | **na** | 33.3 | 7.1 | -4.4 | -7.1 | -7.1 | -7.3 | -7.2 | -6.0 | **na** | **0** |

**Table 3. Difference between monthly column mean and monthly row means for in closed area II in 2011. Monthly mean catch per tow are in lb. na indicates that sampling did not occur during that month in 2011.**

| Month pair | Median difference | Lower limit | Upper limit | P-value |
|---|---|---|---|---|
| March-Aug | 28.00 | 20.00 | 54.00 | <0.001 |
| March-Sept | 28.00 | 20.00 | 54.00 | <0.001 |
| March-June | 28.00 | 20.00 | 54.00 | <0.001 |
| March-July | 28.00 | 19.00 | 54.00 | <0.001 |
| April-Aug | 13.51 | 8.00 | 18.00 | <0.001 |
| March-Oct | 27.00 | 18.00 | 54.00 | <0.001 |
| April-Sept | 13.49 | 8.00 | 18.00 | <0.001 |
| April-June | 13.45 | 8.00 | 18.00 | <0.001 |
| April-July | 13.40 | 8.00 | 18.00 | <0.001 |
| March-May | 27.00 | 15.00 | 53.00 | <0.001 |
| Aug-Dec | -5.00 | -11.00 | -1.00 | <0.001 |
| Sept-Dec | -5.00 | -11.00 | -1.00 | <0.001 |
| April-Oct | 13.00 | 6.00 | 17.00 | <0.001 |
| June-Dec | -5.00 | -11.00 | -1.00 | <0.001 |
| March-Dec | 22.00 | 9.00 | 48.00 | <0.001 |
| July-Dec | -5.00 | -11.00 | -1.00 | <0.001 |
| April-May | 11.00 | 4.00 | 16.00 | <0.001 |
| May-Aug | 1.00 | 0.00 | 2.00 | <0.001 |
| Oct-Dec | -5.00 | -11.00 | 0.00 | <0.001 |
| May-Sept | 1.00 | 0.00 | 2.00 | <0.001 |
| March-April | 16.00 | 3.00 | 42.00 | <0.001 |
| May-June | 1.00 | 0.00 | 2.00 | <0.001 |
| Aug-Oct | 0.00 | -2.00 | 0.00 | 0.001 |
| Sept-Oct | 0.00 | -2.00 | 0.00 | 0.003 |
| May-Dec | -4.00 | -10.00 | 0.00 | 0.004 |
| May-July | 0.00 | 0.00 | 2.00 | 0.004 |
| April-Dec | 7.00 | -1.00 | 14.00 | 0.004 |
| June-Oct | 0.00 | -1.00 | 0.00 | 0.017 |
| July-Aug | 0.00 | 0.00 | 0.00 | 0.047 |
| July-Oct | 0.00 | -1.00 | 0.00 | 0.059 |
| July-Sept | 0.00 | 0.00 | 0.00 | 0.134 |
| June-Aug | 0.00 | 0.00 | 0.00 | 0.169 |
| May-Oct | 0.00 | -1.00 | 2.00 | 0.253 |
| June-Sept | 0.00 | 0.00 | 0.00 | 0.400 |
| June-July | 0.00 | 0.00 | 0.00 | 0.497 |
| Aug-Sept | 0.00 | 0.00 | 0.00 | 0.571 |

**Table 4. Summary of results from pairwise Wilcoxon test for paired monthly windowpane catch per tow in closed area II in 2011. Cells with yellow highlighting have median difference (first month – second month) in location that is significantly different from 0 using a Bonferroni adjusted critical value (1.004) to obtain a family-wise error rate of 5%. Cells with pink highlighting have significantly different location, but the magnitude of difference is small. Confidence limits are also adjusted for family-wise error rate using Bonferroni adjustment to the 95% confidence limits (adjusted to a 0.9986 CI).**

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | **0** | | | | | | | | | | | |
| Feb | **na** | **0** | | | | | | | | | | |
| Mar | **na** | **na** | **0** | | | | | | | | | |
| Apr | **na** | **na** | 16 | **0** | | | | | | | | |
| May | **na** | **na** | 27 | 11 | **0** | | | | | | | |
| Jun | **na** | **na** | 28 | 13 | 1 | **0** | | | | | | |
| July | **na** | **na** | 28 | 13 | 0 | 0 | **0** | | | | | |
| Aug | **na** | **na** | 28 | 14 | 1 | 0 | 0 | **0** | | | | |
| Sep | **na** | **na** | 28 | 13 | 1 | 0 | 0 | 0 | **0** | | | |
| Oct | **na** | **na** | 27 | 13 | 1 | 0 | 0 | 0 | 0 | **0** | | |
| Nov | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **na** | **0** | |
| Dec | **na** | **na** | 22 | 7.0 | -4 | -5 | -5 | -5 | -5 | -5 | **na** | **0** |

**Table 5. Median difference of catch per tow distribution (lb) from Wilcoxon test (column month-row month). Cells with yellow highlights have a statistically significant shift in location using Bonferroni adjusted critical value. Cells with pink highlights are also statistically significant shift in location, but median differences in locations are small. No sampling in January, February and November in 2011 in Closed Area II.**

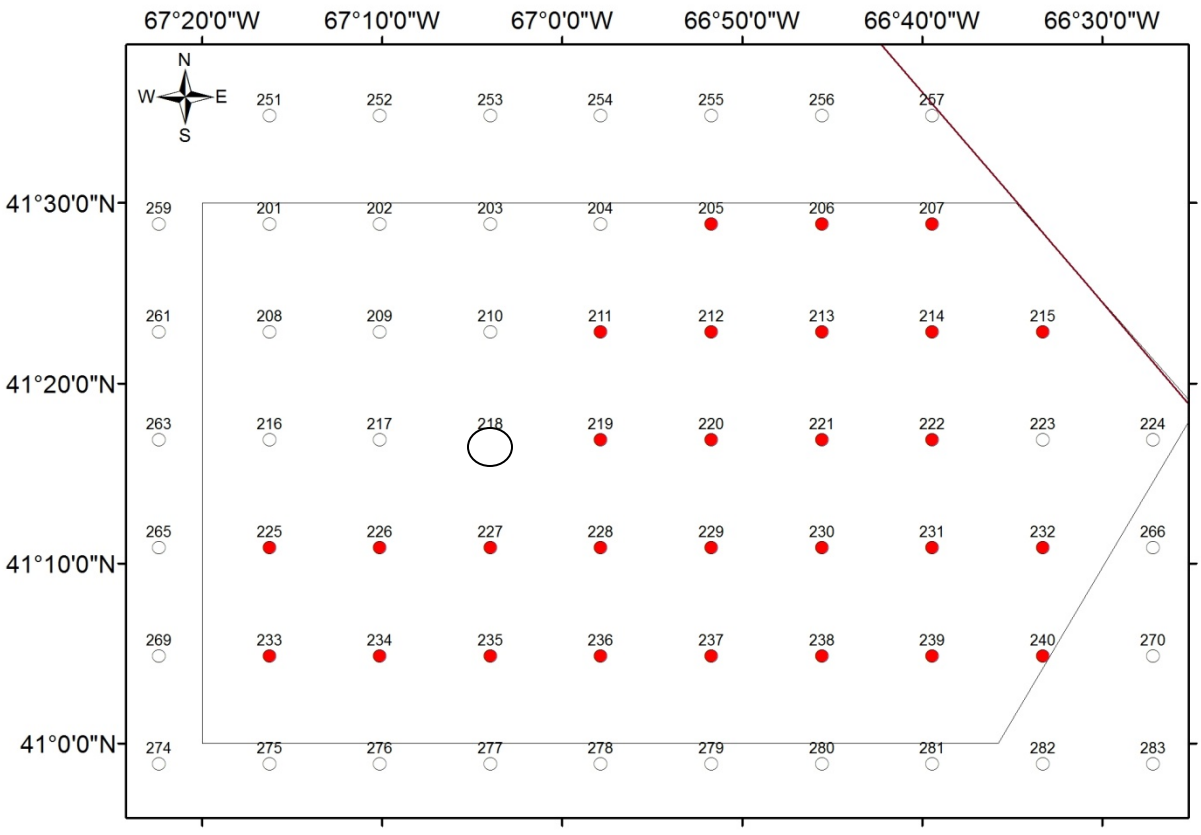


**Figure 2. Station locations within Closed Area II. Red dots indicate consistently sampled stations that were used in the analysis. Open dots represents stations that were dropped during the study. Note that station 218 was not included in the analysis of windowpane because it was not included in the standard**

## 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.

# 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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August 17, 2012

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.

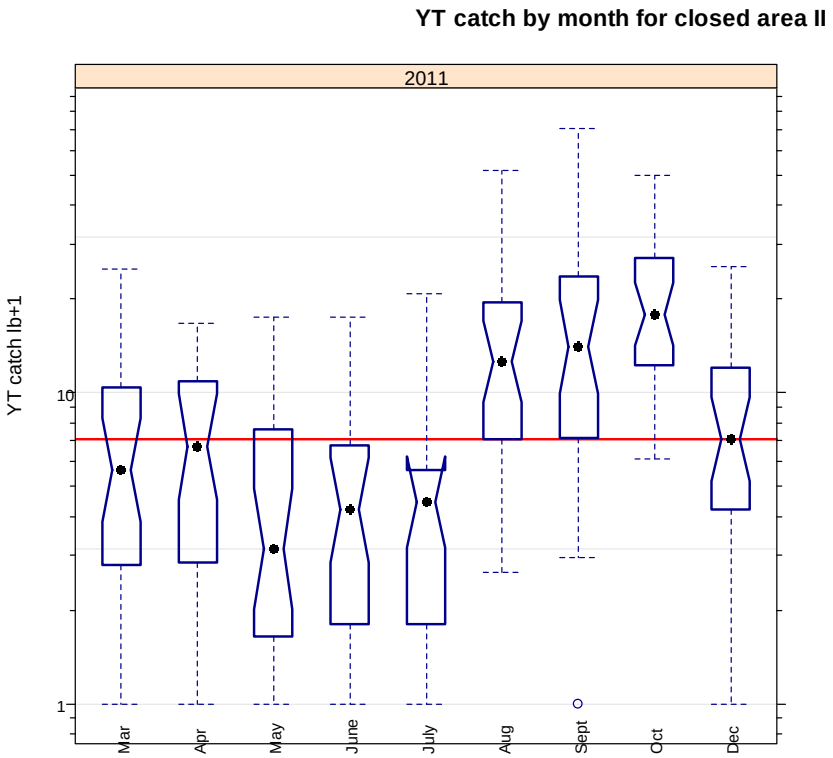


**Figure 1. Boxplots of yellowtail catch (lb+1) per two in Closed Area II by month for 2011. Y-axis scale is logarithmic. Black dots are medians and non-overlapping notches indicate approximately 95% confidence interval for differences in median. Folded notch for July indicates that notch for that month 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.**

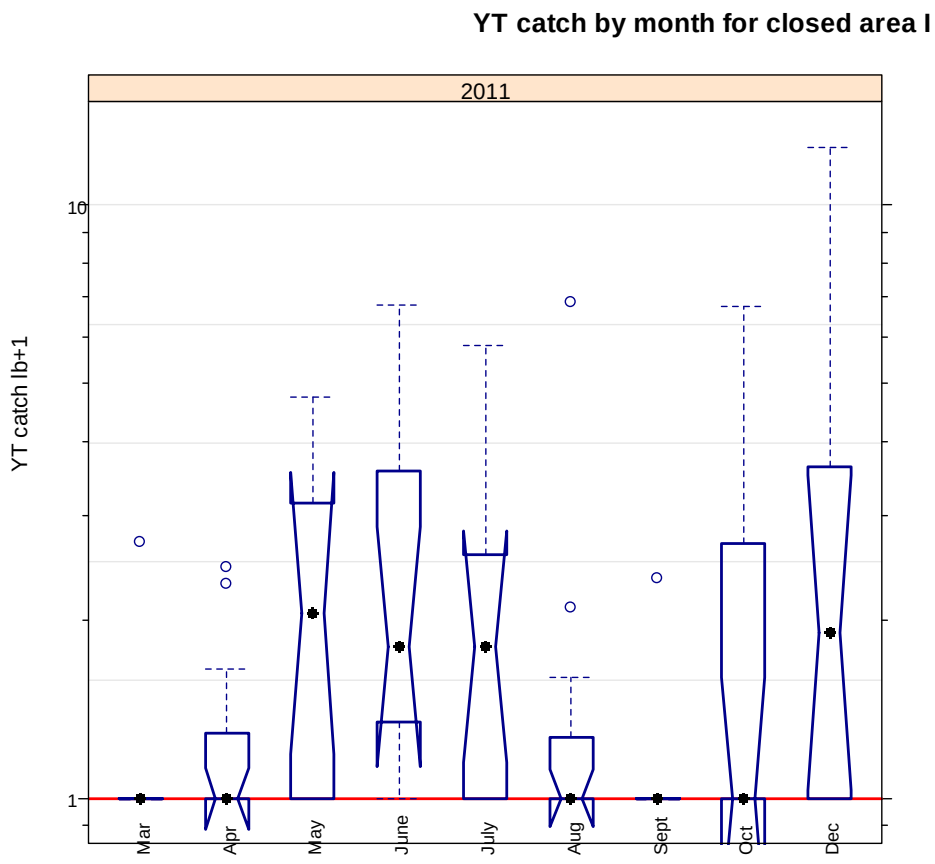


**Figure 2. Boxplots of yellowtail catch (lb) +1 per two in Closed Area I by month. Y-axis scale is logarithmic. Black dots are medians and non-overlapping notches indicate approximately 95% confidence interval for differences in median. Folded notch for April-October indicates that notches for that 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.**

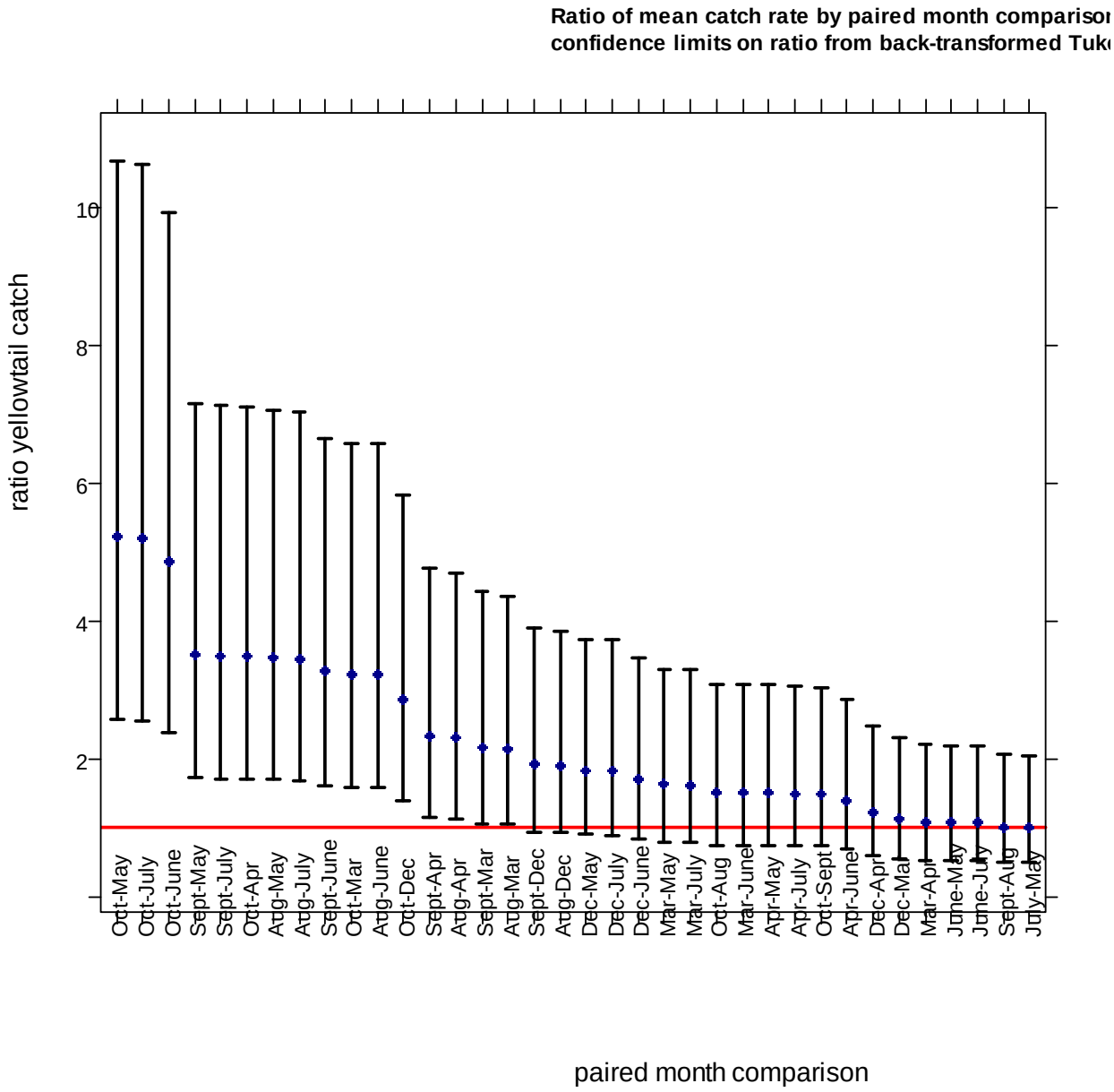


**Figure 3. Ratio of mean yellowtail catch rates between paired month comparisons with 95% confidence limits for Closed area II. Red line=1. Ratio's are significantly different from 1 at familywise error rate =0.05 if confidence limits do not overlap red line.**

| 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.**

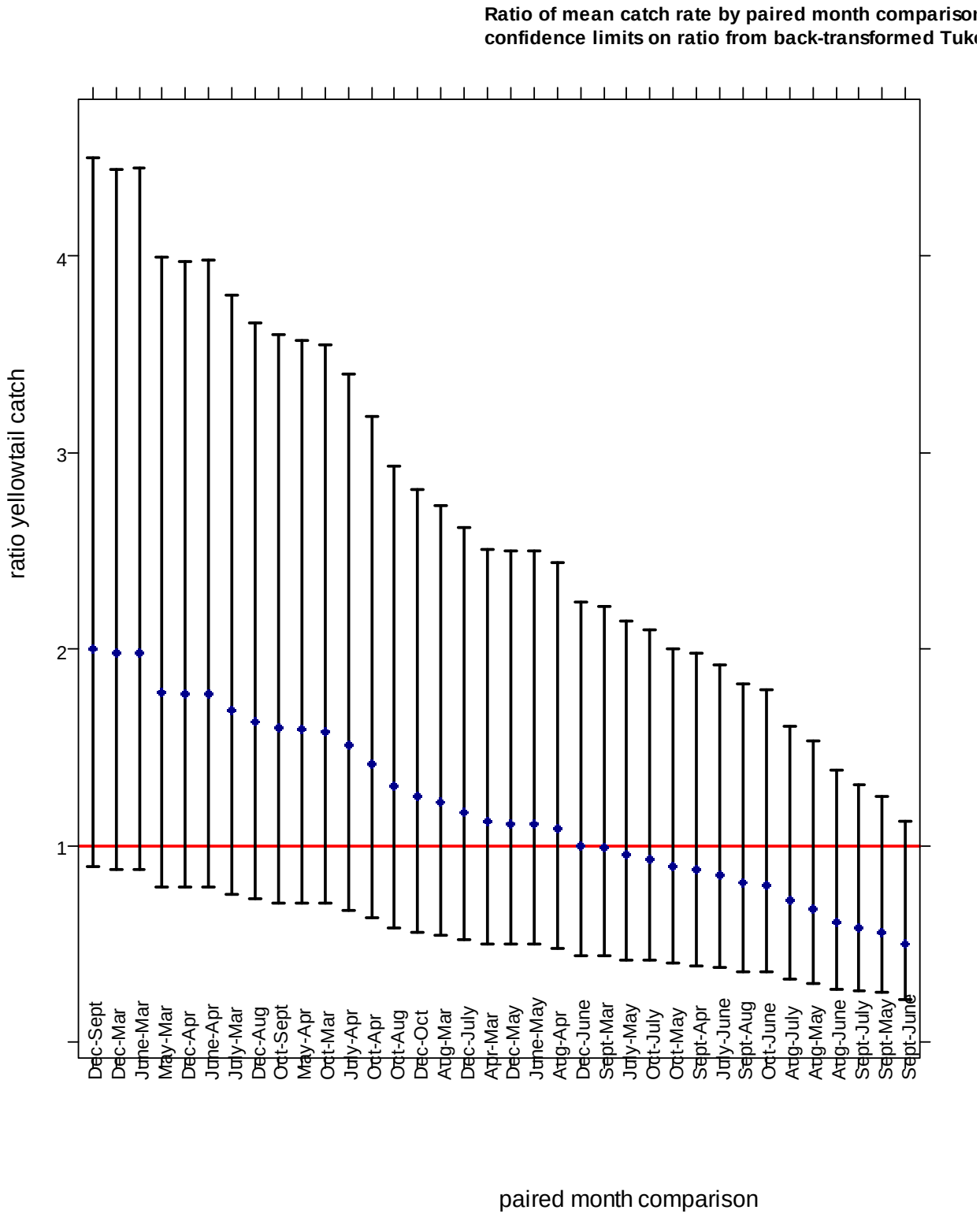


**Figure 4. Mean ratio of yellowtail catch rates between paired month comparisons with 95% confidence limits. Red line=1. Ratio's are significantly different from 1 at family wise error rate =0.05 if confidence limits do not overlap red line.**

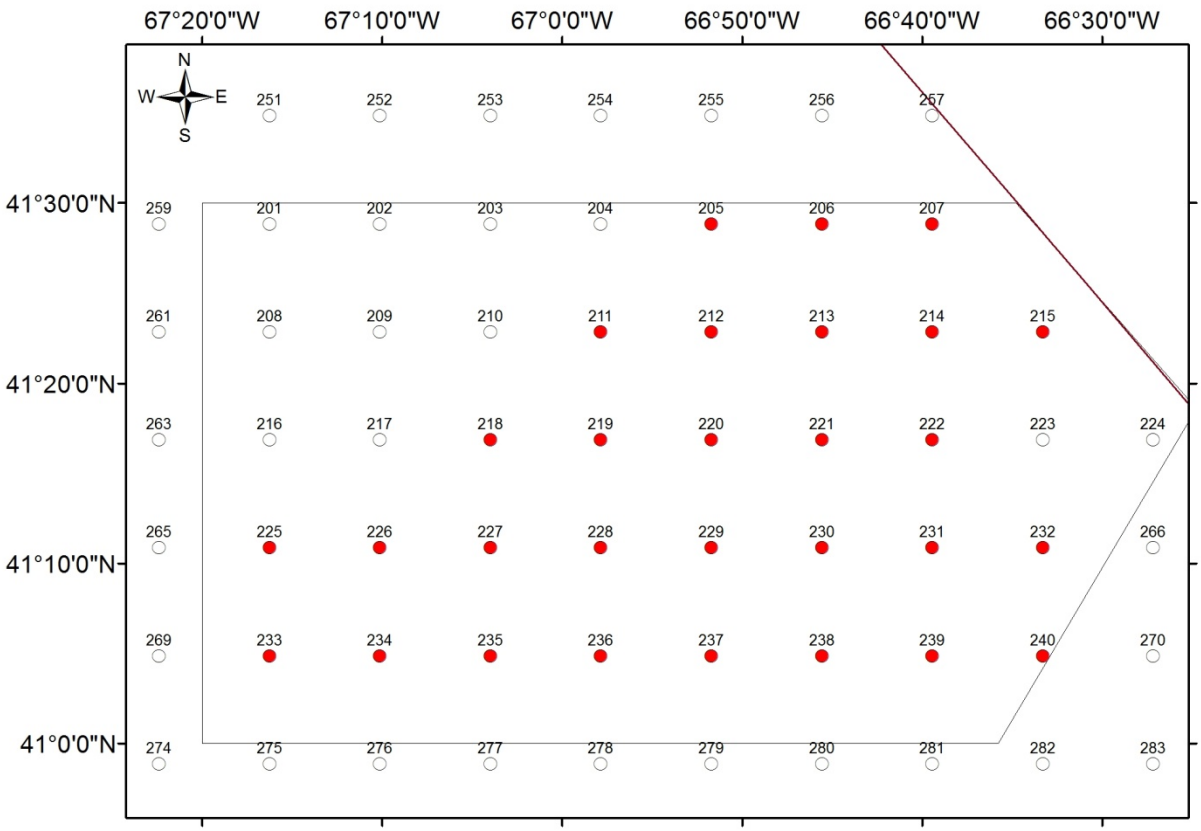


**Figure 5. Station locations within Closed Area II. Red dots indicate consistently sampled stations that were used in the analysis. Open dots represents stations that were dropped during the study.**

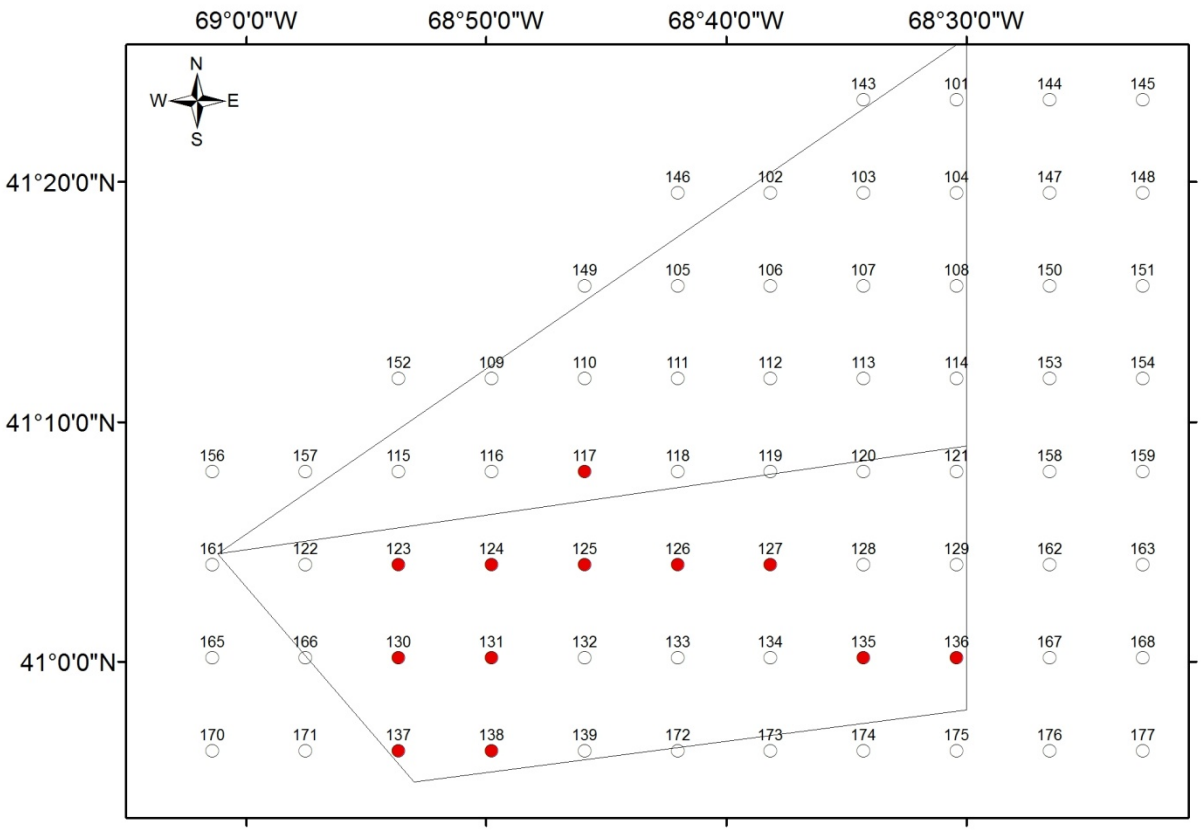


**Figure 6. Station locations within Closed Area I. Red dots indicate consistently sampled stations that were used in the analysis. Open dots represents stations that were dropped during the study.**