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Scallop fishing area 29: Stock status and update for 2008

Zone de pêche 29 du pétoncle : État du stock et mise à jour pour 2008

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ABSTRACT

A total of 246 t of scallop meats were landed in SFA 29 against a TAC of 250 t in 2007. The quotas for Subareas C and D were exceeded while landings did not reach the TAC in Subareas A and B. Commercial catch rates and survey indices for commercial size scallops (shell heights ≥ 100 mm) indicate little change in stock status in 2007 compared to 2006. Catches of scallops in the 2007 survey with shell heights less than 50 mm were above average throughout the SFA 29 area with the higher densities in the till/silt bottom type in Subareas A and B. Abundance estimates of this size class are qualitative at best given the selectivity of the survey gear and the actual strength of these year classes (2005 and 2006) will need to be confirmed by the 2008 survey. Analysis of daily catch rate data using a depletion model indicated that the 2007 catch levels of 12 t for Subarea A resulted in a median exploitation rate of 0.54. This high rate may be more indicative of local conditions than the whole subarea as fishing was limited to just a few locations in A. The median exploitation rates for the other subareas were 0.21 for C, 0.16 for D and 0.13 for B. The balance between biomass gains through recruitment and growth, and losses due to mortality are not known for the SFA 29 area. Keeping exploitation in 2008 at levels in the range of the expected growth in biomass in Subareas B, C and D should result in small or negligible declines in population biomass. That is, catches for 2008 would be in the order of 65, 22, and 61 t in Subareas B, C and D, respectively. Applying the same rationale to Subarea A would result in a recommended catch of less than 1 t in Subarea A. Given the highest densities of the 2005 and 2006 year-class were observed in Subarea A, the fishery should be limited there to improve the survival of these young scallops. Observer coverage of the scallop fishery in SFA 29 was low in 2007 due to priorities being given to the coverage of other fisheries at the same time and no coverage of the East of Baccaro fleet due to contractual issues. Bycatch of lobster by the SFA 29 scallop fishery in 2007 was estimated at less than 0.1% of the number of lobsters landed by the Lobster Fishing Area (LFA) 34 lobster fishery in the SFA 29 area. Estimated landings of other fish and invertebrate species based upon the observer data indicated that as seen in previous analyses crabs, skates, flounders and sculpins made up the largest proportion of the bycatch species.

RÉSUMÉ

Les débarquements totaux de chair de pétoncles pour la zone de pêche au pétoncle (ZPP) 29 s'est chiffré à 246 t en 2007; le TAC était de 250 t. Les quotas des sous-zones C et D ont été dépassés, tandis que les débarquements n'ont pas atteint le TAC dans les sous-zones A et B. Les taux de prise de la pêche commerciale et les indices du relevé pour les pétoncles de taille commerciale (hauteur de coquille ≥ 100 mm) indiquent peu de changement dans l'état du stock de 2007 comparativement à celui de 2006. Dans le relevé de 2007, les prises de pétoncles d'une hauteur de coquille inférieure à 50 mm étaient supérieures à la moyenne dans l'ensemble de la ZPP 29, les densités les plus élevées ayant été observées sur les fonds de till et de limon des sous-zones A et B. Les estimations de l'abondance de cette classe d'âge sont au mieux qualitatives compte tenu de la sélectivité de l'engin employé pour le relevé, et il faudra confirmer l'effectif réel de ces classes d'âge (2005 et 2006) dans le relevé de 2008. L'analyse des données du taux de prise quotidien effectuée à l'aide d'un modèle d'appauvrissement indique que les taux de prise de 12 t pour la sous-zone A en 2007 ont donné un taux d'exploitation médian de 0,54. Ce taux élevé reflète plutôt des conditions locales que la situation d'ensemble dans la sous-zone, car la pêche a été limitée à quelques secteurs de la sous-zone A. Les taux d'exploitation médians des autres sous-zones étaient de 0,21 pour la sous-zone C, de 0,16 pour la sous-zone D et de 0,13 pour la sous-zone B. On ne connaît pas la différence entre les gains qu'a connus la biomasse par le recrutement et la croissance et les pertes attribuables à la mortalité pour la ZPP 29. Le fait de maintenir en 2008 des taux d'exploitation de l'ordre de la croissance attendue dans la biomasse des sous-zones B, C et D devrait se traduire par des baisses faibles ou négligeables de la biomasse de la population. Ainsi, les prises en 2008 devraient être de l'ordre de 65, de 22 et de 61 t dans les sous-zones B, C et D respectivement. Si on applique le même raisonnement à la sous-zone A, on obtient un taux de prise recommandé pour cette zone inférieur à 1 t. Compte tenu des densités élevées des classes d'âge de 2005 et de 2006 observées dans la sous-zone A, la pêche devrait être limitée dans ces eaux pour permettre une meilleure survie des jeunes pétoncles. La couverture de la pêche au pétoncle par des observateurs dans la ZPP 29 a été faible en 2007 puisque la priorité a été accordée à la couverture d'autres pêches durant la même période; l'absence d'observateurs sur la flottille de l'est de Baccaro est attribuable à des problèmes contractuels. Les prises accessoires de homard dans la pêche au pétoncle pratiquée dans la ZPP 29 en 2007 ont été estimées à moins de 0,1 % du nombre de homards débarqués dans cette zone par les pêcheurs de la zone de pêche du homard (ZPH) 34. Les estimations des débarquements d'autres poissons et invertébrés fondées sur les données d'observateurs indiquent, conformément aux analyses précédentes, que les crabes, les raies, les poissons plats et les chabots constituaient la plus grande partie des prises accessoires.

INTRODUCTION

Scallop Fishing Area (SFA) 29 encompasses a very large inshore area inside the 12-mile territorial sea, from the south of Yarmouth (latitude 43°40′ N) to Cape North in Cape Breton (Fig. 1). This report refers to only that portion of SFA 29 west of longitude 65°30′ W continuing north to Scallop Production Area 3 at latitude 43°40′ N.

Prior to 1986, the Full Bay Scallop fleet had fished in this area. Following the 1986 inshore/offshore scallop fishing agreement, fishing by the Full Bay fleet was restricted to north of latitude 43°40′ N. A limited fishery by the Full Bay fleet was granted from 1996–98 in the northern portion of SFA 29 as defined above. Access was again granted to this fleet in 2001 with a full at-sea monitoring program, and with a condition of a post-season industry-funded survey. Scallop fishers had consulted with lobster fishers in the area to deal with potential conflicts. Lobster by-catch was minimal in 2001 despite high scallop catch rates (for more details on the history of this fishery see Smith and Lundy (2002)). Lobster bycatch continues to be monitored in this fishery.

In 2002, the Minister approved access to SFA 29 by the Full Bay fleet and inshore east of Baccaro licence holders who are authorized to fish in SFA 29 west of longitude 65°30′ W. SFA 29 inshore scallop licenses were historically restricted to the east of Baccaro Point (east of longitude 65°30′ W). Five subareas within SFA 29 (A to E) were defined for the 2002 fishery based upon areas of similar densities of commercial size scallops in the 2001 survey (Fig. 1). These subareas were designed to provide flexibility in the allocation of catch and fishing effort for the 2002 fishery and have been retained as part of the fishing plan since then (Smith and Lundy 2002).

A three-year joint project agreement was signed in 2002 with the two fishing fleets, Natural Resources Canada, and Department of Fisheries and Oceans with all parties providing funds to conduct multi-beam acoustic mapping of the seafloor and other scientific work. Beginning in 2005 the annual research survey has incorporated the bottom type into its stratified design. Details on the multibeam project including geological interpretation and analyses of the data in a fisheries science context are given in Smith (2006).

This report summarizes commercial fishery, research survey and observer data for the 2007 fishery and provides advice for the 2008 fishery. The scallop fishery in this area was last assessed in 2007 (Smith et al. 2007).

Commercial Fishery

The fishery management plan sets a 100 mm minimum shell height for retained scallops and in this report, scallops with shell height 100 mm and greater will be referred to as commercial size and 90–99 mm scallops will be referred to as recruits for the following year.

All subareas but D opened for the 2007 fishing season on June 11 while Subarea D opened two days later. Subareas D and C closed on June 22 and July 10, respectively with the total landings over-running the quotas in both cases (Table 1). The remaining two subareas closed on July 21 with quota remaining in each subarea.

A total of 25 meat weight samples were collected from the fishery with more than half of the samples representing catches of the East of Baccaro fleet (Table 2). This has been the best sample coverage of the East of Baccaro fleet to date. However, no samples from either fleet were taken from any landings from Subarea A. This subarea had the lowest landings of all of the subareas and this may have lead to a very low probability of the landings from this area being included in the random sample for meat weights. Overall, average meat weights are higher this year with the larger meat weights coming from Subareas B and D.

Commercial catch rate

Until recently, commercial catch and effort information has been available in the scallop commercial catch and effort database on a trip basis only. While daily catch rates were given in the database, these were estimated assuming a constant catch rate over the whole trip. Starting in 2007, the scallop commercial catch and effort database is being restructured so that daily catch rates are estimated by apportioning out the actual landed weight for a trip by the fishermen's estimate of their daily catch as a portion of their estimate of the total catch in a trip. To-date only the results for the 2007 fishing year are available. The data for the 2001 to 2006 fishing years in SFA 29 will be reprocessed in 2008.

Catch rates by month, fleet and subarea are presented in Table 3. As was the case last year Area D continues to have higher catch rates than the other subareas. Overall catch rates in 2007 are similar to those in 2006 and are at the lowest level in their respective subarea (Fig. 2). However, these catch rates still exceed recent levels reported for the Bay of Fundy scallop fishery (10 to 20 kg/h, DFO 2008).

Last year's analysis of the spatial patterns in catch rate indicated that effort was matching abundance spatially resulting in similar catch rates everywhere (Smith et al. 2007). These results raised the concern that trends in annual catch rate estimates may not completely correspond to trends in population biomass. The catch rate data were analyzed on a trip basis and the recent availability of daily catch rate will help to refine this analysis.

Some of the scallop fishing industry have suggested that in-season adjustments to TACs may be useful for this fishery (referred to as`'rolling TACs' in the offshore scallop fishery). Assuming that mean catch rates are proportional to abundance, the level at which they had declined by 20 percent from their highest level at the beginning of the season was calculated. This level would correspond to a 0.20 exploitation rate, a reference level that has been used for the Bay of Fundy scallop fishery (see Smith et al. 2008). The date at which this 20 percent level was reached is indicated on Figures 3 and 4. In all cases except for Subarea B (Full Bay catch rate), this level was reached before each subarea was actually closed down. While this kind of in-season approach may be useful with more refinement, we need to conduct a more formal analysis of the catch rate data as a measure of exploitation.

The daily catch rate data do tend to show that most vessels are encountering similar catch rates, however in Subareas B, C and D high densities are still being observed on an occasional basis (Figs 3 and 4). Overall, the daily catch rates also exhibit declines over their short season making them amenable to analysis using depletion type models to quantify the impact of the fishery on the population (Leslie and Davis 1939). Assuming a closed population, that is, no recruitment, natural mortality and minimal growth during the period of the fishery then the population biomass at the beginning of the fishery (B_0) should decrease simply as a function of the catches (C_i) up to and including time t. That is,

$$B_t = B_0 - \sum_{i=1}^{t} C_i. \tag{1}$$

Assuming that commercial catch rate observed at time t, K_t is proportional to the biomass at that time then,

$$
\begin{aligned}
K_t &= qB_t \\
&= q(B_0 - \sum_{i=1}^{t} C_i) \\
&= qB_0 - q\sum_{i=1}^{t} C_i .
\end{aligned} \tag{2}
$$

This model is often treated as a least-squares linear regression problem with intercept $B_0^{'} = qB_0$ and slope q (e.g., Hilborn and Walters 1992). Maximum likelihood estimates for this model when estimating abundance in numbers were given by Gould and Pollock (1997). A Bayesian approach for abundance in numbers was given in Pezzack et al. (2006).

There are three main quantities that can be obtained from the model in equation 2. The slope is the catchability coefficient for the fishery, while dividing the intercept by the slope gives the population biomass B_0 at the beginning of the fishery. The exploitation rate of the fishery on the population at the end of the fishery (time i) can be estimated as,

$$
\hat{E} = \frac{\sum_{i=1}^{I} C_i}{B_0} \tag{3}
$$

Treating this depletion model as a least-squares problem can result in estimates of $q < 0$ which violates the model assumptions. In addition, this approach makes it difficult to evaluate the uncertainty associated with the estimates of B_0 and E. In this assessment we have recast the depletion model into a Bayesian form with the likelihood for K_t in equation 2 set as a normal distribution with mean at time t equal to $B_0^{'} - q\sum_{i=1}^{t} C_i$ and variance σ^2. A normal non-informative prior is assigned to $B_0^{'}$ (mean=0, variance=10^6) while a positive half normal distribution was used as the prior on q. A uniform (0,100) distribution was used as the prior on σ. By including the estimates for E and B_0 in this framework, standard errors and Bayesian confidence intervals are straightforward to calculate.

Catch rates by fleet and by day within each of Subareas A to D were calculated as the ratio of catch to effort for each. We only used commercial log data where catch, effort, date and location were provided. The number of records available by day and fleet were highly variable in addition to there being differing levels of variability of catch and effort for any one day and fleet. This variability was incorporated into the analysis by weighting the variance σ^2 in the model by the standard error associated with each daily catch rate estimate. That is, the variance associated with the model in equation 2 is now expressed as $\mathbf{V}\sigma^2$, where $\mathbf{V}$ is a diagonal matrix with element v_{ii} equal to the standard error for the catch rate for day i. The standard error was estimated using the jackknife estimate recommended by Smith (1980) for catch rate estimates.

Monte-Carlo markov chain simulations using the Gibbs sampler in WinBugs (Lunn et al. 2000) were used to find the estimates for this model. Two chains with separate starting values were used for each run with the first 10,000 replicates discarded as a burn-in and the second 10,000 replicates per chain kept to describe the posterior distributions of the parameters. The degree of convergence to the posterior distribution was evaluated using the Brooks-Gelman-Rubin method (Brooks and Gelman 1998).

There was only one complete logbook for the East of Baccaro fleet in Subarea A and therefore analysis was limited to Full Bay logs only in this subarea. The daily catch rate in Subarea A declined by more than half over the period of the fishery for a total catch of 11.5 t (Fig. 5A). This high rate may be more indicative of local conditions than the whole subarea, as fishing was limited to just a few locations in A. Total biomass at the beginning of the fishery in 2007 was estimated to be between 15 and 33 t (Table 4). Median exploitation for Subarea A for 2007 was estimated at 0.54 (95% credible bounds of 0.31 and 0.69).

There were enough complete logs from both fleets in Subareas B, C and D to include data from both fleets and to fit models with random effects to account for differences due to fleet. These models were evaluated using the Deviance information criteria statistic DIC, Speigelhalter et al. (2002), but the addition of fleet did not improve the fit to the data (Table 5)

The decline in catch rate in Subarea B was very gradual (Fig. 5B) and median exploitation was estimated to be 0.13 (95% credible bounds of 0.01 and 0.26) for a catch of 80 t (Table 4). Biomass was estimated to be between 299.4 and 5263 t at the start of the 2007 season.

Catch rates declined more in Subareas C and D (Fig. 5C,D) than in B with median exploitation at 0.21 and 0.16, respectively. Catchabilities (q) in C and D were estimated to be three and two times higher than in B which seems to be supported by the higher amounts of rugged bottom observed in B relative to C and D (Table 4). Biomass in C was estimated to be between 135 and 1873 t. While Subarea D had similar biomass estimates to B, exploitation was estimated higher because of the higher catchability estimated for D.

RESEARCH SURVEY

Abundance indices

Annual surveys in SFA 29 have been conducted since 2001 when the current fishery started. The survey design for 2001 was a simple random design over the whole area. From 2002 to 2004, a stratified random design was used with strata defined by the management Subareas A to E. Starting in 2005, strata have been defined by the bottom types as identified by geologists as part of the joint industry/government multibeam mapping project conducted in this area (Smith 2006). In last year's document (Smith et al. 2007), annual estimates from the 2001 to 2004 surveys were recalculated as post-stratified estimates based on the bottom-type strata within the management subareas. The surficial bottom type maps are currently being revised to account for sidescan sonar and seismic data. The survey data will be re-analyzed when these new maps are available.

Surveys over the whole area since 2001 have been conducted using a vessel from the Full Bay fleet for the survey (F/V Julie Ann Joan, 2001–2003, 2005–2007; F/V Branntelle 2004). Starting in 2005, approximately 30 additional survey stations in Subareas C and D have been conducted by a vessel from the East of Baccaro fleet. Previous documents have commented on difficulties in the interpretation of comparative survey data from the East of Baccaro and Full Bay fleet vessels used to conduct the survey (e.g., Smith et al. 2007). In addition, there were difficulties in comparing shell height frequencies between catches from the two vessels in 2006. These differences appeared to be due to lack of training of the observers in the use of the measuring boards used for shell height. As a result, the abundance and biomass estimates from the East of Baccaro vessel portion of the survey has been treated as a separate time series.

The annual survey in this area has been funded through a Joint Project Agreement between DFO and the scallop fishing industry since 2001. In 2007, the LaRocque court decision changed the funding basis for surveys like this one. Funds allocated by DFO in 2007 were used to fund a basic survey of 90 stations over Subareas A to D using the F/V Julie Ann Joan. The East of Baccaro fleet completely funded 30 survey stations using one of their own vessels in Subareas C and D in 2007. Measurements of numbers, weight and shell height on this part of the survey were made by an industry technician who had been trained on the proper use of the scallop shell height measuring board. However, there was no opportunity to conduct comparative tows with the Full Bay vessel.

The spatial distribution of commercial size scallops (≥ 100 mm shell height) in the 2007 survey was similar to recent years with the larger catches in C and D (Fig. 6). Scallops with shell heights between 90 and 99 mm are expected to grow to commercial size in 2008 and were mainly limited to Subarea C in 2007, compared to 2003–2006 when this size class was abundant and widespread throughout C and D (Fig. 7).

The most noteworthy observation from the 2007 survey was the abundant and widespread distribution of scallops of 1 and 2 years old (Fig. 8). These scallops were found throughout the area and are of similar size (< 50 mm) to those found in SPA 3 in the June survey (Smith et al. 2008). Abundance estimates of this size class are qualitative at best given the selectivity of the gear and the actual strength of this year-classes (2005 and 2006) will need to be confirmed by the 2008 survey.

The relative abundance of these 1 and 2 year old (< 50 mm shell height) scallops were evident in the shell height frequencies for the different subareas from the survey (Fig. 9 through 16). The higher densities were found in the till/silt bottom type in Subarea A and the sand-wedge bottom type in Subarea B (Fig. 17). The only other major year-class that we have experience with here occurred in Subareas C and D and was mainly associated with the thin sand and glacial till bottom types.

Stratified estimates of the size categories corresponding to ages 3, 4, 5 and 6+ are provided in Table 6 by subarea and type of survey vessel in the most recent years. Time trends for commercial size (age 6+) and recruits (age 5) are plotted in Figure 18. As was noted in last year's assessment there is little evidence of population dynamics in these trends, especially in Subareas B and D where large numbers in commercial size abundance (2002 in B and 2005 in D) were not preceded by large numbers of recruits. Overall it is very difficult to follow cohorts in the shell height frequency data for these surveys (Fig. 9 through 16) which may explains why it has been difficult to fit population models to the survey data.

Closer examination of the survey data suggests that for the current sampling intensities, the patchiness of the scallops can result in the occasional very large catches that can dominate the strata estimates. As noted earlier, the commercial catch rate data also exhibit these occasional large catches, especially in Subareas B, C and D (Figs 3 and 4). In the 2002 survey, 14 survey stations were randomly allocated to depths less than 42.5 m in Subarea B resulting in catches from 0 to 2495 scallops (average 749.1). These tows made up a large part of the apparent increase in abundance in 2002 (Fig. 18B). This depth range only received 3 stations in the 2001 survey and 4 stations in 2003 with mean numbers per tow of 257.8 and 432.5, respectively. In 2004, this depth range received 14 survey stations again but the mean number per tow fell to 190.6. So the lower means in 2001 and 2003 relative to 2004 may have resulted from reduced coverage while the lower mean in 2004 may have also reflected declines due to harvesting. Depth ranges being sampled inconsistently over time also appear to underly the apparent large increase in Subarea D in 2005.

Large year-to-year changes do not occur in the Bay of Fundy surveys without evidence of incoming recruitment to substantiate the change. Scallops have a less patchy distribution in the Bay than in SFA 29 and the sampling intensities in areas that have been surveyed for over 28 years (e.g., SPA 4) are between 2 and 3 times what they are in SFA 29. Larger numbers of observation per subarea can usually offset the sensitivity of mean estimates from the occasional large catch. However, this is not an option for data already collected and further work on accounting for distribution differences by depth may make the survey abundance trends more informative.

Growth trends

Differences in growth rates by subarea were shown in last year's document (Smith et al. 2007). This year we present details on modelling growth differences by bottom type. As in earlier investigations of spatial variation of growth (e.g., Smith et al. 2001), a mixed effects model was used with a standard von Bertalanffy growth curve representing fixed effects with random effects associated with the measurements taken in each survey tow.

$$W_{ij} = (W_\infty - w_{\infty i})[1 - \exp(-(K - k_i) \times (a_{ij} - (T_0 - t_{0i})))] + \varepsilon_{ij} \qquad (4)$$

where, W_{ij} is the meat weight (g) of scallop j in survey tow i and a_{ij} is the age (y) of scallop j in location i. The fixed effects or population parameters are population asymptotic meat weight (g), W_∞; population Brody growth parameter (y^{-1}), K; and the population age at which $W_{ij} = 0$, t_0. The associated random effects for location i are $w_{\infty i}$, k_i and t_{0i}.

The random effects associated with location are all assumed to follow a Normal distribution with zero mean and variance-covariance matrix $\sigma^2 \mathbf{D}_i$. For the von Bertalanffy model the variance-covariance matrix is of dimension 3×3 with diagonal elements $\sigma^2_{w_\infty}$, σ^2_k, and $\sigma^2_{t_0}$. The general procedure of fitting the nonlinear mixed effects model assumes that the variance-covariance matrix is a general positive definite matrix allowing the fitting algorithm to estimate covariances between the random effects.

The mixed-effects model was fit separately to data from the 2006 and 2007 survey. For both years, the random effects structure was established first and then the effects of bottom type on the fixed effect parameters were evaluated. There was enough structure in the variation of parameter estimates between tows to indicate that a random effects model was called for (Table 7). The results of the log-likelihood tests showed that for the 2006 data assuming a random effects model for W_∞ was adequate to explain the between tow variation. Further there was evidence for increasing variance with increasing meat weight and the addition of a power model for the variance term was enough to correct for this heteroscedasticity. The fit of the model for the 2007 data provided similar results with the addition of random effects term for k and the model also needed a power model for the variance (Table 8).

Bottom type was only found to have a significant effect on W_∞ for both 2006 (Table 9) and 2007 (Table 10). In the case of 2006, this effect was mainly due to W_∞ for till silt being significantly lower than that for bedrock, while the same term for glacial till and thin sand were not significantly different than that for bedrock. However, in 2007, W_∞ for till silt was not significantly less than that for bedrock while W_∞ for glacial till and thin sand bottoms were significantly greater than that for bedrock. The bedrock bottom type as identified by the geologists corresponds to a heterogenous collection of bottom types that may include sand, gravel and till but is dominated by bedrock.

Growth curves corresponding to predictions based on the fixed effects and random effects are presented in Figure 19 for 2006 and in Figure 20 for 2007 on a tow by tow basis. Each panel represents data for an individual tow (tow number in panel strip) and the bottom type for the tow has been identified in each panel. The red curve represents the random effects solution for that tow which may be above or below the blue fixed effects curve which is constant for each bottom type. Note that the random effects for till silt were much more variable in 2007 than in 2006 which may explain why it's respective W_∞ was not significantly different from bedrock in 2007.

FISHERY BYCATCH

Lobster

Data sources for lobster bycatch come from both the scallop survey and observer data from the SFA 29 scallop fishery. The regular monitoring of the SFA 29 fishery by onboard observers is unique relative to other scallop fisheries and has been required since this fishery began in 2001. In 2007, observer coverage was low compared to coverage in 2001–2005. Observers were in short supply due to the department's priority of having 100% coverage of the groundfishery on Georges Bank at the same time as the SFA 29 scallop fishery. There were also contractual/financial issues with arranging observers for the East of Baccaro boats. Individual scallop fishermen were not responsible for this decline in coverage.

There were a total of 41 days with observer data representing the required coverage for the Full Bay fleet. With respect to fishing days observed, this represents 3.5% of the fishing days in SFA 29 in 2007, down from the 3.8% coverage in 2006. In years previous to 2006, observer coverage ranged from 8 to 21% of the fishing days.

From the scallop survey, the mean numbers of lobsters per tow was highest in Subarea B at approximately 3 lobsters per tow (Fig. 21). Subarea B has had the highest catch rate of lobsters for most of the series. In Subareas A, D and C the catch rate was generally less than 1 lobster per tow.

Most lobsters caught during observed fishing trips were in Subarea B (Fig. 22) similar to previous years. In Subareas A, C and D most tows had no lobsters. Observer data on the number and condition of lobsters by subarea, are shown in Table 11. Of the 194 lobsters caught as a bycatch, 126 were uninjured, 34 were injured, 4 were dead and the condition was not recorded for 30. As in previous years assessments, it is possible to estimate the total number of lobsters landed during scallop fishing by assuming the numbers of lobsters caught on the observed trips are representative. The number of lobster caught in each observed trip was converted to a rate of bycatch catch per tonne of scallop catch and then multiplied by the total scallop catch in the subarea of SFA 29 where the trips occurred. The estimated total number of lobsters caught by the Full Bay Fleet was 3842; the estimated number injured or dead was 898 (Table 12). These estimates are near the middle of the range of estimates for 2002–2006. If we assume that the lobster bycatch proportions observed on the Full Bay vessels are representative of the East of Baccaro Fleet (estimates for 2002 to 2006 presented in Table 13), the estimated total number of lobsters caught as a bycatch during scallop fishing in SFA 29 is 5396, and the estimated number injured or dead is 1269. As indicated last year, these numbers are a small fraction ($< 0.1\%$) of the lobsters landed by the LFA 34 lobster fleet in the area corresponding to SFA 29.

As far as the direct effects of the scallop fishery on the lobster stock, the only information available is the catch during the scallop fishery and the scallop survey. There are no available data on what the bottom impacts are. To evaluate all potential impacts would be challenging and expensive.

Indirect information on the effect of the scallop fishery comes from trends in the lobster landings by the directed lobster fishery in LFA 34 (Table 14). Trends in lobster catches by the lobster fishery in the SFA 29 area as a whole are not indicative of an area that has been adversely affected by the scallop fishery since 2001. Lobster landings by the lobster fishery in the SFA 29 area peaked in 2001–02 similar to landings in LFA 34 as a whole. In 2006–07 lobster landing in SFA 29 were down 5% from the peak in 2001–02 and down 4% from the previous year. In LFA 34 lobster landings in 2006–07 were down by a large percentage (5% from the previous year and 16% from the peak in 2001–02). Subareas in SFA 29 show different trends, but given the error associated with aggregating the lobster landings (10 minute grids) by the SFA 29 areas, it is best to consider the larger scale (SFA 29 as a whole). The lobster landings trends are consistent with the idea that the scallop fishery has not had a negative effect on the lobster fishery, but it is recognized that landings trends by themselves cannot confirm there has been no effect.

Direct injury and mortality of lobsters due to the scallop fishery is likely greater in localized areas of high lobster density. Effort should be taken to avoid areas and times when lobsters are in high concentrations or are soft-shelled. A better understanding of the timing of lobster movements and molting is important to avoid locations and times when lobsters are concentrated or less mobile due to molting. The molting period for lobsters is mainly July–October, so fishing in areas of known lobster concentrations should be avoided during this period.

Other species

Observers onboard the scallop fishing vessels also record the other invertebrates and fish species that are caught with the scallops. A total of 113 taxonomic groups of animals, many only identified to the genus or family level, have been recorded in the bycatch of this fishery since 2001. The observers do not record the condition of these animals and there are no data on the survival rate of these animals once they have been returned to the water. Animals such as sea anemones that have been detached from their substrate will die but it is not clear in the records if these animals were caught in a detached state or were still attached to the large number of rocks, etc., that occur in the catch.

Estimates of total catch of each of these species were developed in a similar manner to estimates of total lobster bycatch (see above). Estimated catch weights of bycatch species are approximate as the observers generally record the lowest weights as one kilogram. It is likely that the catch weights of smaller animals (e.g., sculpins, crabs) were overestimated because of this practice. Also, observer coverage in 2007 was low relative to 2001–2005 and estimates of bycatch are likely to be less reliable than estimates from those years.

The species with the highest bycatch by mean catch over the 2001–2007 period were Jonah and rock crabs (Table 15). The estimate for the bycatch of hermit crabs in 2007 does not seem to be reasonable given catches in the previous years. Sculpins, skates, monkfish and flounder are the other major groups of species in the bycatch of the scallop fishery. With the exception of sculpins these were the same species identified in the presence/absence results presented last year (Smith et al. 2007). As was noted in the last assessment, the identification of the different species of skate should be treated with caution.

The bycatch of commercial gadoid species were among the rarer species encountered either in terms of annual catch (cod 0.01 to 0.09 t) or terms of only occasionally appearing in the catch in any one year (haddock, pollock, white hake).

STOCK STATUS AND ADVICE FOR 2008

As noted above, the survey trends of commercial size scallops in each of the four main Subareas (A, B, C, D) appear to be overly sensitive to occasional large catches characteristic of the patchy distribution of scallops in SFA 29. This patchiness is also evident in the occasional large catch rates that are seen in the commercial fishery (Figs 3 and 4). There are two main signals that we can attribute to stock status from these surveys. First, there do not appear to be large numbers of scallops in the 90–99 mm shell height range that will recruit to the fishery in 2008 and therefore the abundance of commercial size scallops in 2008 is not expected to be greater than it was in 2007. Second, the next above-average year-class expected to recruit to fishery will not be in the ≥ 100 mm shell height range until 2010 or 2011 and therefore the population of commercial size scallops is expected to stay the same or decline until then, depending upon the rates of exploitation and natural mortality over the next two years.

The population biomass of commercial size scallops is not expected to increase dramatically in the next few years. Using the information from the growth curves in Table 10 and the mean meat weights in Table 2, growth in biomass is expected to be in the range of 7 to 13% for Subarea A (till silt), 12 to 13% in Subarea B (bedrock), 9 to 14% in Subarea C (glacial till) and 13 to 16 % in Subarea D (thin sand) for 2008. At present we do not know enough about the balance between growth, recruitment and natural mortality for scallops in these subareas to determine catch levels based upon surplus production. In the Bay of Fundy, a level of less than 0.2 for exploitation appears to result in population growth on average (Smith et al 2008), however, the meat sizes in the fisheries there tend to have a wider range in size and on the average tend to be smaller than in SFA 29. As a result, the growth potential for these smaller, younger scallops tend to be higher than for the generally older scallops in SFA 29.

Keeping exploitation in 2008 at levels in the range of the expected growth in biomass in Subareas B, C and D should result in small or negligible declines in population biomass assuming that recruitment just balances off losses due to natural mortality. That is, catches in 2008 should be in the order of 65, 22, and 61 t in Subareas B, C and D, respectively (Table 16). Applying the same rationale to Subarea A would result in a recommended catch of less than 1 t in Subarea A. As noted earlier, the exploitation estimate for Subarea A probably does not reflect the area as a whole and the recommended catch could be higher. However, given the high densities of the 2005 and 2006 year-classes were observed in Subarea A, the fishery should be limited there to improve the survival of the young scallops in this area.

There was not enough survey information to recommend catch levels for Subarea E. Scallop landings from this subarea have ranged from 0 to 11 t since this fishery opened in 2001, and it is likely that the habitat in this subarea is marginal for scallop.

This document records information available to the science peer review RAP meeting held on April 30, 2008. Additional information presented to the SFA 29 Advisory meeting is presented in the Appendix.

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Table 1: Scallop landings (meats, t) for Scallop Fishing Area 29. Landings by subarea in 2001 determined from log records. TAC for Subareas A, B and E were combined in 2004. TAC for Subarea A and E combined in 2006.

		Full Bay		East of Baccaro		Total	
Year	Subarea	TAC (t)	Landings (t)	TAC (t)	Landings (t)	TAC (t)	Landings (t)
2001	29A		(2)				
	29B		(71)				
	29C		(309)				
	29U		(18)				
	Total	400	400			400	400
2002	29A	75	1	25	4	100	5
	29B	150	193	50	75	200	268
	29C	375	334	125	106	500	440
	Total	600	528	200	185	800	713
2003	29A						
	29B	150	114	51	38	201	152
	29C	188	33	63	32	251	65
	29E		2		2		4
	Total	338	149	114	72	452	221
2004	29A	150.0	70.2	50.0	9.9	200	80.1
	29B		33.1		46.8		79.9
	29E		0.2		3.4		3.6
	29C	187.5	123.8	62.5	35.2	250	159.0
	29D	112.5	148.6	37.5	40.0	150	188.6
	Total	450.0	375.9	150.0	135.3	600	511.2
2005	29A	45.0	2.5	15.0	2.2	60	4.7
	29B	30.0	22.7	10.0	26.3	40	48.9
	29C	75.0	91.9	25.0	23.4	100	115.3
	29D	41.25	63.2	13.75	10.7	55	73.9
	29E		8.8		1.7		10.5
	Total	191.25	189.1	63.1	64.3	255	253.3
2006	29A	18.75	20.4	6.25	1.1	25	21.5
	29E		0.8		1.0		1.8
	29B	93.75	87.8	31.25	27.8	125	115.6
	29C	75.00	85.7	25.00	25.6	100	111.3
	29D	112.50	113.0	37.50	42.9	150	155.9
	Total	300	307.7	100	98.4	400	406.1
2007	29A	18.75	10.49	6.25	0.99	25.00	11.48
	29E		0.24				0.24
	29B	75.00	55.56	25.0	24.32	100.00	79.88
	29C	37.50	47.86	12.5	11.03	50.00	58.89
	29D	56.25	69.00	18.75	26.35	75.00	95.35
	Total	187.50	183.15	62.50	62.69	250.00	245.94

Table 2: Statistics from meat weight samples of scallop vessels in Scallop Fishing Area 29 for the 2007 fishing season. All samples collected by an industry supported dockside monitoring program. Statistics on the percentage by number of meats in the sample that were less than 8 g are also given.

		Meat Weight (g)			Count	Number of	Percent < 8 g		
Month	N	Mean	Min.	Max.	per 500 g.	Samples	Mean	Min.	Max.
29A									
				No samples					
29B									
				Full Bay					
June	89	23.1	10.8	41.6	21.9	2	0.0	0.0	0.0
July	240	21.9	7.6	41.0	23.4	5	0.3	0.0	1.6
				East of Baccaro					
June	75	29.0	20.7	35.6	17.3	2	0.0	0.0	0.0
29C									
				Full Bay					
July	73	29.7	14.4	47.8	17.1	2	0.0	0.0	0.0
				East of Baccaro					
June	46	22.9	10.0	34.0	21.8	1	0.0	0.0	0.0
July	96	22.6	9.7	33.2	22.2	2	0.0	0.0	0.0
29D									
				Full Bay					
June	131	23.4	8.9	54.2	21.4	3	0.0	0.0	0.0
				East of Baccaro					
June	330	26.9	14.4	52.1	18.8	8	0.0	0.0	0.0

Table 3: Commercial catch rate of scallop meats (kg/h) by month, subarea and fleet for SFA 29 in 2007.

Fleet	June	July	Aug	Sept	All
All Subareas					
Full Bay	34.2	26.3			31.3
E. Baccaro	34.1	22.3			29.3
Subarea A					
Full Bay	30.2	14.6			26.5
E. Baccaro					
Subarea B					
Full Bay	30.5	24.2			27.4
E. Baccaro	34.0	22.9			27.9
Subarea C					
Full Bay	32.0	30.8			31.3
E. Baccaro	24.9	20.9			22.9
Subarea D					
Full Bay	40.3				40.3
E. Baccaro	39.6				39.6
Subarea E					
Full Bay					
E. Baccaro			18.4		18.4

Table 4: Parameter estimates for the Bayesian form of the Leslie depletion model presented in Equation 2. $\hat{B}_0'$ is the intercept in equation 2 and $\hat{\sigma}$ is the standard deviation of K_t. B_0 is the estimate of beginning of fishing season biomass (t), while q represents the average catchability of the gear. Exploitation (%) is estimated as cumulative catch at the end of the season divided by B_0. All estimates based only on Class 1 commercial log data (no missing information in logs).

Subarea	Credible Regions	Parameter estimates				
		$\hat{B}_0'$	$\hat{q}$	$\hat{\sigma}$	B_0 (t)	exploitation (E)
A	0.025	27.05	0.835	1.39	14.7	0.31
	Median	34.34	1.816	2.08	18.9	0.54
	0.975	41.47	2.794	3.65	33.0	0.69
B	0.025	23.88	0.005	1.90	299.4	0.01
	Median	26.10	0.044	2.28	598.8	0.13
	0.975	28.82	0.095	2.79	5262.0	0.26
C	0.025	26.05	0.014	2.73	134.9	0.03
	Median	30.20	0.120	3.43	252.3	0.21
	0.975	34.92	0.253	4.54	1873.0	0.39
D	0.025	38.54	0.005	3.14	209.9	0.01
	Median	44.87	0.087	4.28	513.6	0.16
	0.975	53.44	0.246	6.27	7677.0	0.40

Table 5: Results of fitting depletion models to daily scallop commercial fishing log data from 2007 without and with random effects for fleet in SFA 29. Deviance information criteria (DIC) used to screen models with a reduction of less than 5 units used to indicate no added information from random effects model. No results were presented for Subarea A as complete logs were only available from one fleet.

Subarea	Model	DIC
B	no fleet	325.2
	fleet	325.6
C	no fleet	229.3
	fleet	227.9
D	no fleet	155.2
	fleet	155.7

Table 6: Survey total numbers index (thousands) in scallop fishing area 29 by management subareas. Survey vessels: 2001–2003, 2005a, 2006a, 2007a F/V Julie Ann Joan, 2004 F/V Branntelle, 2005b F/V Overton Bay, and 2006b, 2007b F/V Faith Alone.

		Shell Height (mm)				
Subarea	Year	65–80	80–90	90–100	≥ 100	No. of tows
A	2001	85.6	343.0	2298.8	14086.2	18
	2002	0.0	131.4	339.3	7888.1	20
	2003	42.4	0.0	299.1	10236.0	12
	2004	0.0	0.0	0.0	8152.2	15
	2005a	0.0	0.0	0.0	8298.2	13
	2006a	0.0	0.0	0.0	4216.6	12
	2007a	0.0	0.0	0.0	5169.7	12
B	2001	1024.3	1671.0	3528.0	25220.6	46
	2002	2248.4	629.8	2069.1	50397.8	54
	2003	2592.6	966.3	2111.0	37539.0	34
	2004	953.8	474.3	601.1	18607.8	41
	2005a	509.4	255.43	1660.5	25114.0	44
	2006a	492.5	212.3	351.5	9863.8	40
	2007a	1745.9	531.9	311.9	13332.7	40
C	2001	1555.8	312.2	744.1	26021.9	20
	2002	2113.4	1149.9	2275.0	9150.8	24
	2003	2354.6	5073.9	5053.6	13609.0	23
	2004	629.6	867.0	4934.9	10559.6	18
	2005a	194.5	0	1243.6	13552.0	7
	2005b	358.38	364.4	2410.8	11622.0	10
	2006a	221.7	300.0	387.1	4584.3	17
	2006b	205.4	412.2	382.5	2644.5	9
	2007a	2299.9	827.7	436.7	3775.2	15
	2007b	2299.8	258.6	282.2	8028.4	11
D	2001	587.2	87.9	64.5	2544.3	19
	2002	3460.5	826.9	923.6	8395.9	27
	2003	22688.4	9742.5	7474.8	10940.0	24
	2004	1760.5	2144.5	5845.6	9731.3	21
	2005a	898.9	1249.7	4738.1	32918.0	30
	2005b	889.08	2858.5	9429.8	27856.0	19
	2006a	75.5	416.1	474.1	6447.7	20
	2006b	499.6	564.3	1933.5	12271.8	17
	2007a	957.6	827.7	225.1	4796.7	23
	2007b	2061.7	194.8	330.2	12496.5	19

Table 7: Model selection results for mixed-effects growth models for meat weight and age data from the 2006 survey. Likelihood ratio tests used for random effects in A and Wald statistics used in B for fixed effects.

A: Random effects

Model	df	Log likelihood	Ratio	p -value
Fixed effects only (W_∞, k, t_0)	4	-2542		
Fixed+Random effects (W_∞, k, t_0)	10	-2279	527.31	<0.0001
Fixed+Random effects (W_∞, k)	7	-2279	0.64	0.8872
Fixed+Random effects (W_∞)	5	-2280	2.36	0.3076
Fixed+Random effects (k)	5	-2295	31.95	<0.0001
Variance = power function	6	-2173	214.20	<0.0001

B: Fixed effects (Random effects (W_∞))

Model	DF $_n$	DF $_d$	F -value	p -value
W_∞ ~ Bottomtype	3	864	6.19	0.0004
k ~ Bottomtype	3	864	0.68	0.5635
t_0 ~ Bottomtype	3	864	0.37	0.7739

Table 8: Model selection results for mixed-effects growth models for meat weight and age data from the 2007 survey. Likelihood ratio tests used for random effects in A and Wald statistics used in B for fixed effects.

A: Random effects

Model	df	Log likelihood	Ratio	p -value
Fixed effects only (W_∞, k, t_0)	4	-2792		
Fixed+Random effects (W_∞, k, t_0)	10	-2449	685.42	<0.0001
Fixed+Random effects (W_∞, k)	7	-2451	2.97	0.3968
Fixed+Random effects (W_∞)	5	-2456	11.48	0.0032
Fixed+Random effects (k)	5	-2464	26.39	<0.0001
Variance = power function	6	-2341	219.2	<0.0001

B: Fixed effects (Random effects (W_∞, k))

Model	DF $_n$	DF $_d$	F -value	p -value
W_∞ ~ Bottomtype	3	852	5.28	0.0013
k ~ Bottomtype	3	852	1.81	0.1431

Table 9: Estimates of fixed effects parameters for growth model applied to 2006 data. Random effects variance modelled with power term (0.6363).

Model term	Estimate	Std. Error	t-value	p -value
W_∞ (bedrock)	42.38	1.985	21.35	<0.0001
W_∞ (glacial till-bedrock)	1.99	2.973	0.67	0.5042
W_∞ (thin sand-bedrock)	-1.17	2.444	-0.48	0.6315
W_∞ (till silt-bedrock)	-10.59	3.003	-3.52	0.0004
k	-2.05	0.058	-35.33	<0.0001
t_0	1.57	0.023	68.06	<0.0001

Table 10: Estimates of fixed effects parameters for growth model applied to 2007 data. Random effects variance modelled with power term (0.5217).

Model term	Estimate	Std. Error	t-value	p -value
W_∞ (bedrock)	65.67	8.85	7.42	<0.0001
W_∞ (glacial till-bedrock)	5.22	2.19	2.38	0.0176
W_∞ (thin sand-bedrock)	14.92	3.75	3.98	0.0001
W_∞ (till silt-bedrock)	-2.85	10.09	-0.28	0.7780
k	-2.68	0.13	-21.18	<0.0001
t_0	1.46	0.03	42.36	<0.0001

Table 11: Numbers of lobsters and condition notes recorded by observers during 41s aboard vessels of the Full Bay Scallop Fleet during the 2007 scallop fishery in SFA 29. Note that condition was not recorded for all lobsters caught. N/A refers to condition being recorded as unknown.

		Alive			
Subarea	N/A	No injury	Injured	Dead	Grand Total
A	0	7			7
B	21	102	28	4	155
C	9	12	3		24
D	0	5	3		8
Total	30	126	34	4	194

Table 12: Estimated total numbers of lobsters caught in the scallop fishery by Full Bay Scallop fleet for 2001–2007 based upon observer data. NA = observer did not record scallop catch. DI (%) refers to the percentage of dead or injured lobsters.

		Observer data			Fishery	Estimated	
Year	Area	No. lobsters	DI (%)	Meats (t)	Meats (t)	No. lobsters	DI
2001	A	35		0.4	2	183	
	B	706		23.2	71	2158	
	C	102		72.2	309	436	
	Unknown				18		
	Total	843		95.8	400	2777	
2002	A	0	0	0.0	1	0	
	B	815	38	33.0	193	4773	1814
	C	90	39	43.6	334	690	269
	E	0	0	0.0		0	
	Total	905		76.6	528	5463	2083
2003	A	0	0	0.0	0	0	
	B	1297	37	31.4	114	4713	1743
	C	38	39	9.1	33	138	54
	E	78	33	NA	2	NA	
	Total	1413		80.5	149	4851	1797
2004	A	12	30	11.4	70.2	74	22
	B	200	15	12.6	33.1	527	79
	C	87	14	22.3	123.8	483	68
	D	3	33	9.6	148.6	46	15
	E	20	20	0.2	0.2	26	5
	Total	322		56.1	375.9	1156	189
2005	A	0	0	0	2.5	0	
	B	151	24	3.3	22.7	1047	251
	C	50	17	12.3	91.9	375	64
	D	0	0	5.4	63.2	0	
	E	107	19	3.1	8.8	308	59
	Total	308		24.1	189.1	1730	374
2006	A	17	18	1.1	20.4	309	56
	B	640	37	14.7	88.5	3861	1429
	C	30	43	6.6	86	393	169
	D	9	11	13.1	113.1	78	9
	E	0	0	0	0.01	0	
	Total	696		35.4	308.0	4641	1662
2007	A	7	0	1.28	10.49	57	0
	B	155	24	2.68	55.56	3213	771
	C	24	20	2.3	47.86	499	100
	D	8	38	7.71	69.00	72	27
	E				0.24		
	Total	194		14.0	183.15	3842	898

Table 13: Estimated total numbers of lobsters caught in the scallop fishery by East of Baccaro fleet for 2001–2006 based upon observer data. NA = observer did not record scallop catch. DI (%) refers to the percentage of dead or injured lobsters. Entries for meat weights from observer data for 2003 and 2005 corrected for errors contained in Table 11 in Smith et al. (2007).

		Observer data			Fishery	Estimated	
Year	Area	No. lobsters	DI (%)	Meats (t)	Meats (t)	No. lobsters	DI
2002	A	8	25	0.1	4	460	115
	B	110	15	6.5	75	1268	190
	C	39	26	27.9	106	148	38
	E	0	0	0		0	
	Total	157		34.5	185	1876	343
2003	A	0	0	0	0	0	
	B	72	29	4.7	38	579	168
	C	184	13	6.2	32	953	124
	E	61	0	NA	2	NA	
	Total	317		10.9	72	1532	292
2004	A	3	0	1	9.9	29	0
	B	421	16	13.8	46.8	1426	228
	C	3	0	3	35.2	35	35
	D	0	0	1.4	40	0	
	E	0	0	0	3.4	0	
	Total	427		19.2	135.3	1490	263
2005	A	0	0	0	0	0	
	B	480	23	5.2	26.3	2426	558
	C	4	50	0.6	23.4	163	82
	D	0	0	0	0	0	
	E	25	12	0.5	1.7	81	10
	Total	509		6.3	51.4	2670	650
2006	A	0	0	0	8.8	0	
	B	794	17	11.1	27.9	2002	340
	C	46	37	2.5	25.3	464	172
	D	0	0	0.8	43.9	0	
	E	0	0	0	3.5	0	
	Total	840		14.3	109.4	2466	512

Table 14: Recent lobster landings (t) by the LFA 34 lobster fishing fleet. Shown are the landings by SFA subarea, for SFA 29 as a whole, for the area adjacent to SFA 29, and LFA 34 as a whole. 1 year change is 2006–07 relative to 2005-06; 5 year change is 2006–07 relative to 2001–02. 2006–07 landings are not finalized.

Area	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	% Change	
								1 year	5 year
Subarea A	352	448	323	367	314	335	362	8	-19
Subarea B	1343	1566	1239	1131	971	1120	1020	-9	-35
Subarea C	432	565	632	649	714	937	796	-15	41
Subarea D	348	294	432	387	493	596	609	2	107
Subarea E	538	631	499	484	363	479	547	14	-13
SFA 29	3013	3504	3125	3018	2855	3468	3335	-4	-5
Adjacent	3255	3920	3577	3779	2875	3209	3172	-1	-19
LFA 34	16503	19284	19000	18955	17007	16951	16158	-5	-16

Table 15: Estimated catches (t) of bycatch species in the SFA 29 scallop fishery based upon the observer database. Species arranged in descending order according to mean catch over 2001–2007.

	Catch (t)						
Species	2001	2002	2003	2004	2005	2006	2007
jonah crab	3.51	8.60	18.10	10.23	9.25	16.79	24.47
Atlantic rock crab	4.90	21.37	5.58	6.87	3.21	38.27	1.58
hermit crabs	1.13	7.19	1.24	3.12	1.67	3.30	18.13
longhorn sculpin	1.12	6.42	2.24	4.84	3.51	6.15	2.92
thorny skate	1.55	0.31	1.11	2.02	0.69	1.03	8.34
monkfish	1.01	8.88	0.72	1.75	0.69	1.11	0.64
toad crab,unident.		7.62		0.06	0.01	0.21	
skates (ns)	0.88	2.21	0.76	1.58	0.49	0.02	
northern stone crab							5.90
winter skate	0.48	1.49	0.62		1.50	0.62	0.04
sculpin (ns)	1.36	11.32	1.38	1.64	2.00	0.85	3.09
cancer crab (ns)							3.93
winter flounder	0.19	0.67	0.14	1.07	0.28	0.42	0.25
smooth skate	0.10	1.80	0.01	0.39	0.59	0.05	
little skate		0.51			0.11	1.64	0.04
round skate			0.08		0.02	0.61	
yellowtail flounder	0.01	0.14	0.01	0.16	0.03	0.12	0.22
witch flounder	0.02	0.01	0.04	0.22	0.02	0.14	0.02
cod	0.03	0.04		0.01	0.02	0.07	0.09
american plaice	0.05	0.03	0.01			0.04	0.06
striped Atlantic wolffish	0.01			0.08	0.05	0.03	
lumpfish	0.10				0.01	0.02	
barndoor skate		0.07					
ocean pout (common)		0.01	0.01	0.02		0.03	
redfish				0.01		0.03	
haddock		0.04					
spider crab (ns)	0.02						
halibut			0.01	0.01			
flounder unidentified				0.02			
grubby or little sculpin						0.02	
summer flounder	0.01						
shorthorn sculpin						0.01	
mailed sculpin						0.01	
white hake		0.01					
pollock		0.01					

Table 16: Expected gain in biomass from 2007 to 2008 from growth for each subarea of SFA 29. Median B_0 given in Table 3.

Subarea	median B_0	Landings 2007 (t)	Biomass (t) after fishery	Expected gain from growth (t)
A	18.9	11.5	7.4	0.7
B	598.8	79.9	518.9	64.9
C	252.3	58.9	193.4	22.2
D	513.6	95.4	418.2	60.7

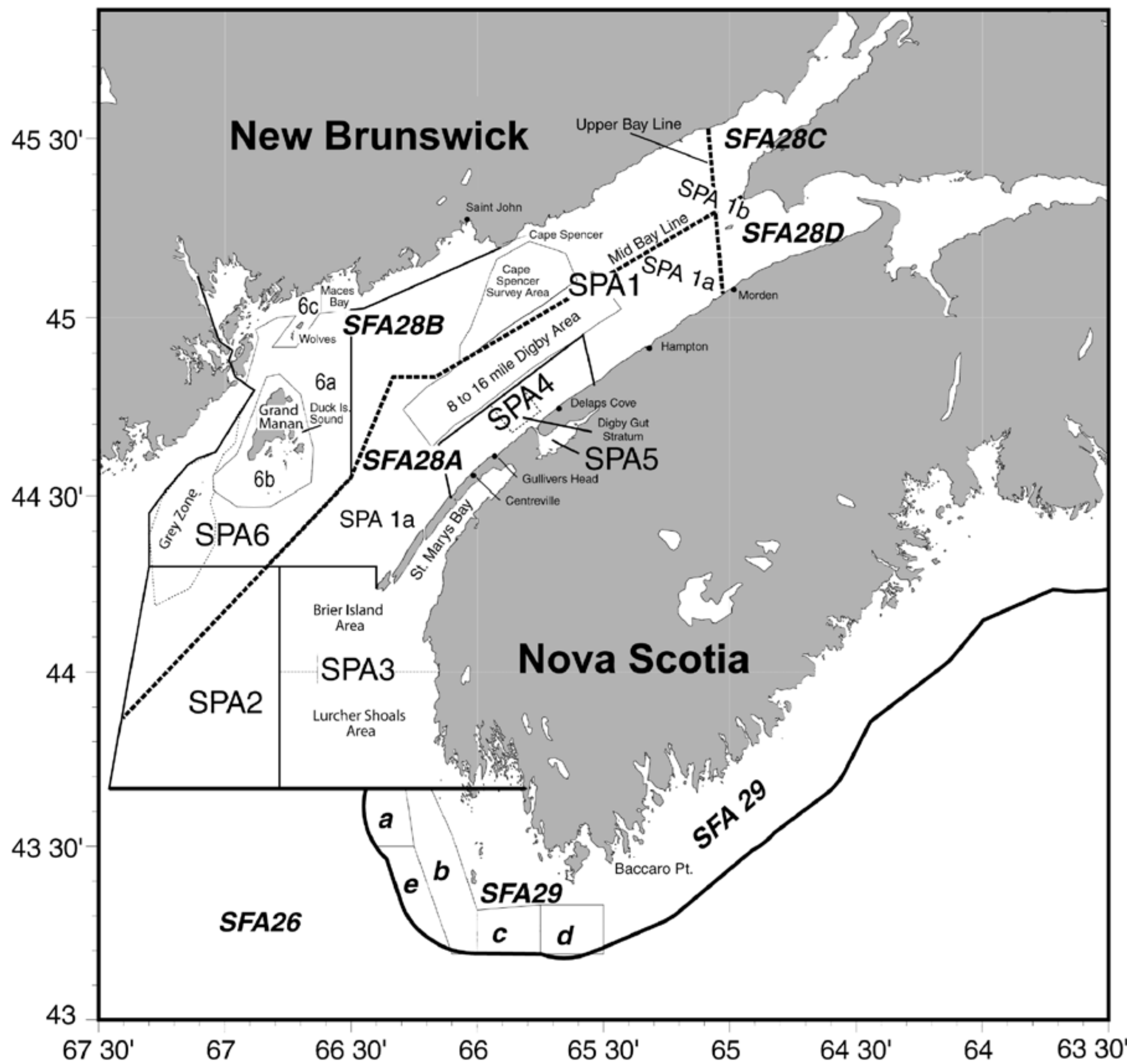

Figure 1: Map of Scallop Fishing Areas (SFA) and Scallop Production Areas (SPA).

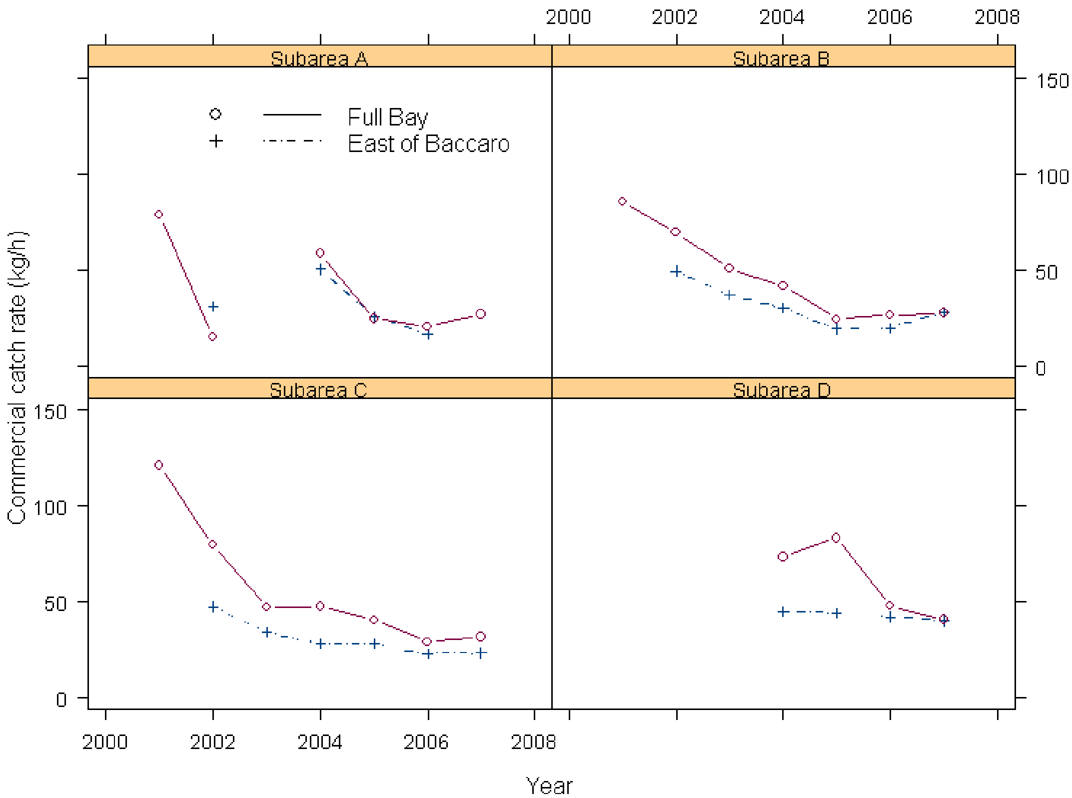

Figure 2: Mean commercial catch rate (kg/h) trends for SFA 29 scallop fishery for each subarea by fleet.

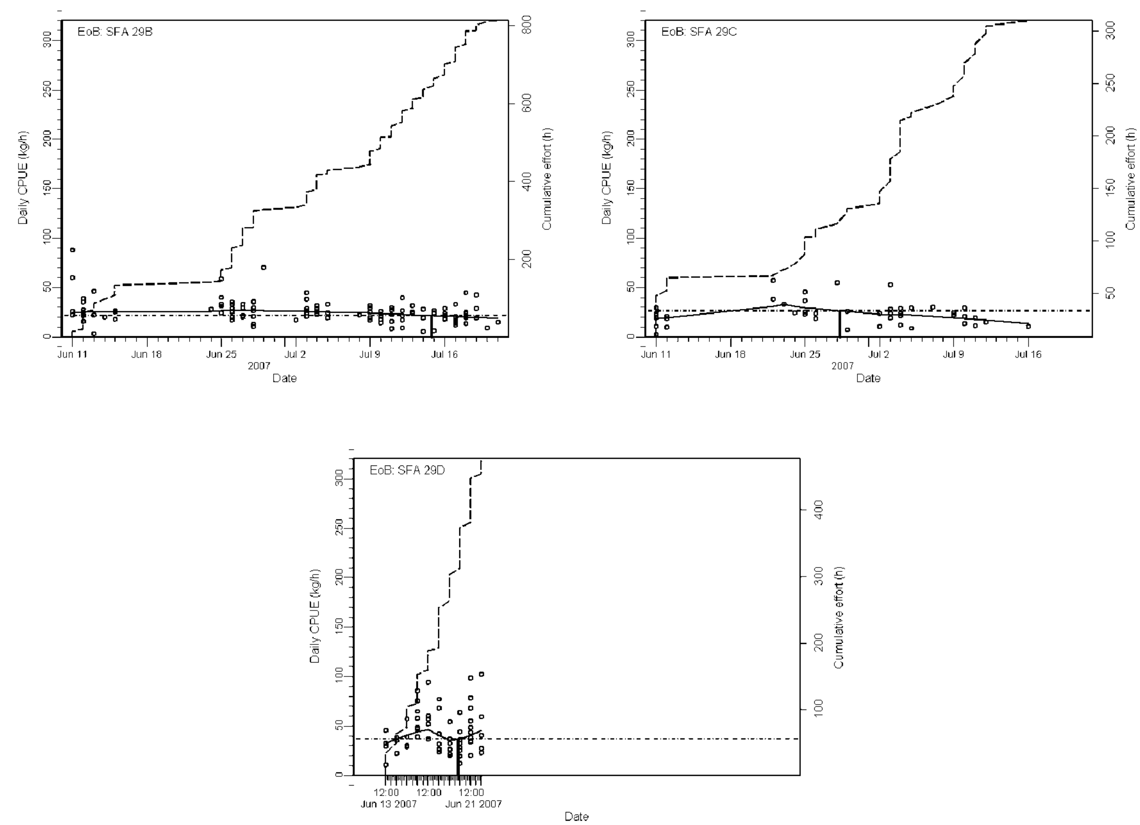

Figure 3: Daily catch rate (kg/h) from East of Baccaro Fleet vessel for Subareas B, C and D of Scallop fishing area 29 for 2007. Cumulative effort also presented (right-side axis). The dash-dot horizontal line indicates the level corresponding to a 20% decline from the highest catch rate in the season and the vertical line from this level to the x-axis indicates the date in the season this level was reached.

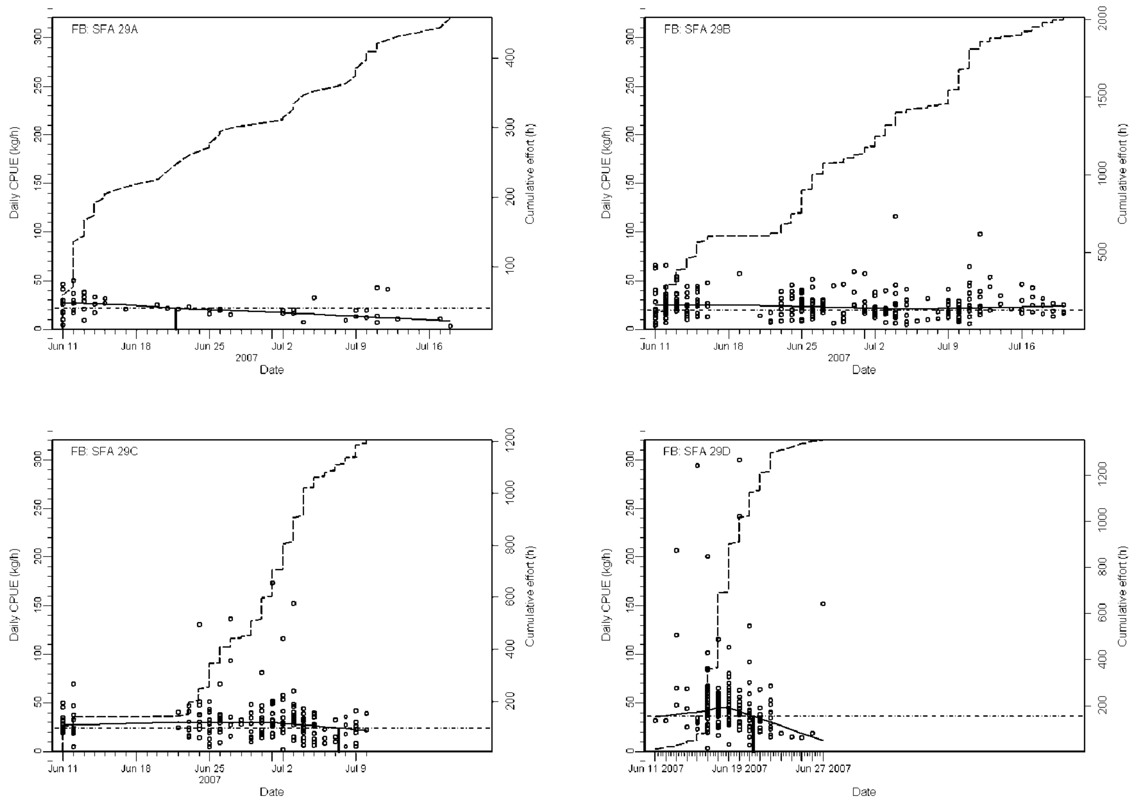

Figure 4: Daily catch rate (kg/h) from Full Bay Fleet vessel for Subareas A, B, C and D of Scallop fishing area 29 for 2007. Cumulative effort also presented (right-side axis). The dash-dot horizontal line indicates the level corresponding to a 20% decline from the highest catch rate in the season and the vertical line from this level to the x-axis indicates the date in the season this level was reached.

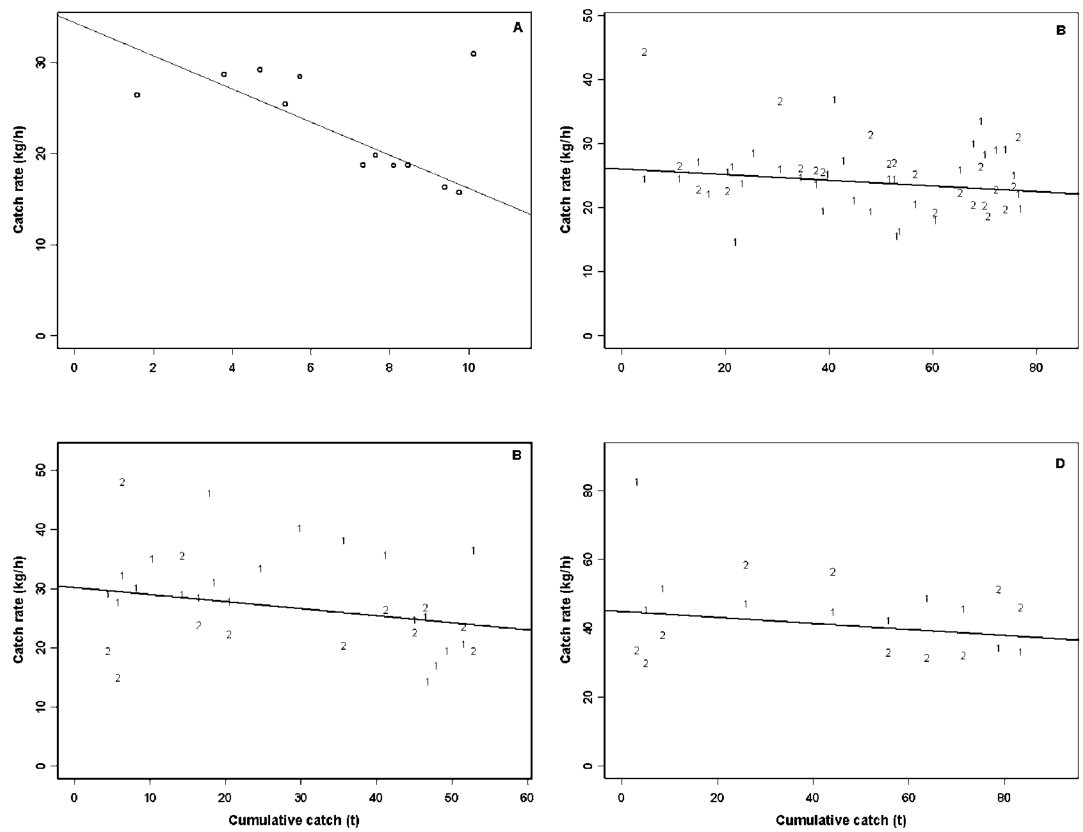

Figure 5: Fit of Leslie depletion model to catch rate (kg/h) and cumulative catch for Subareas A, B, C and D of Scallop fishing area 29 for 2007. Symbols: 1 = Full Bay fleet, 2 = East of Baccaro fleet.

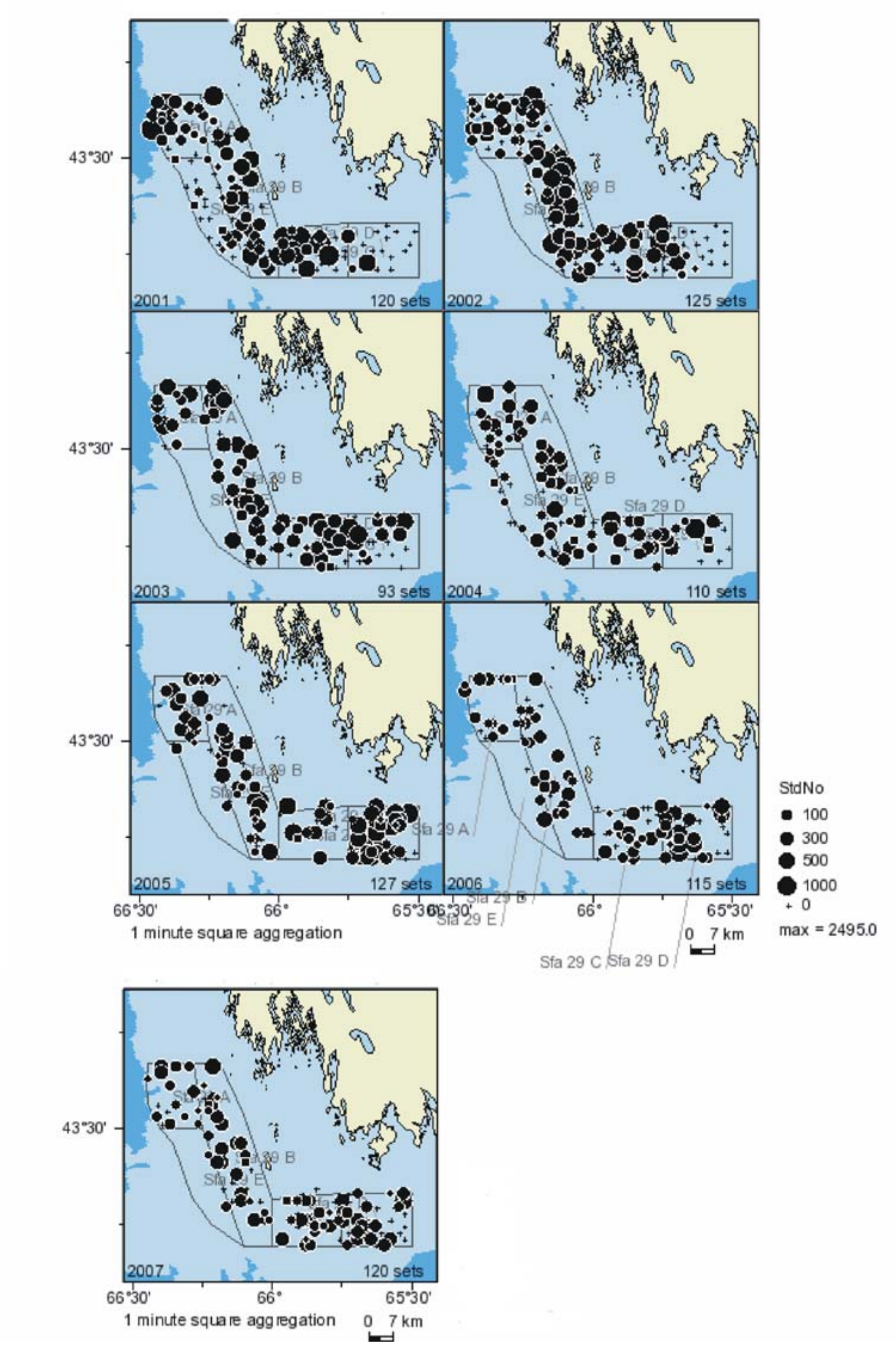

Figure 6: Spatial distribution of scallops for shell heights 100 mm and larger (corresponding to approximately age 6+) caught during the 2001–2007 scallop research surveys in SFA 29.

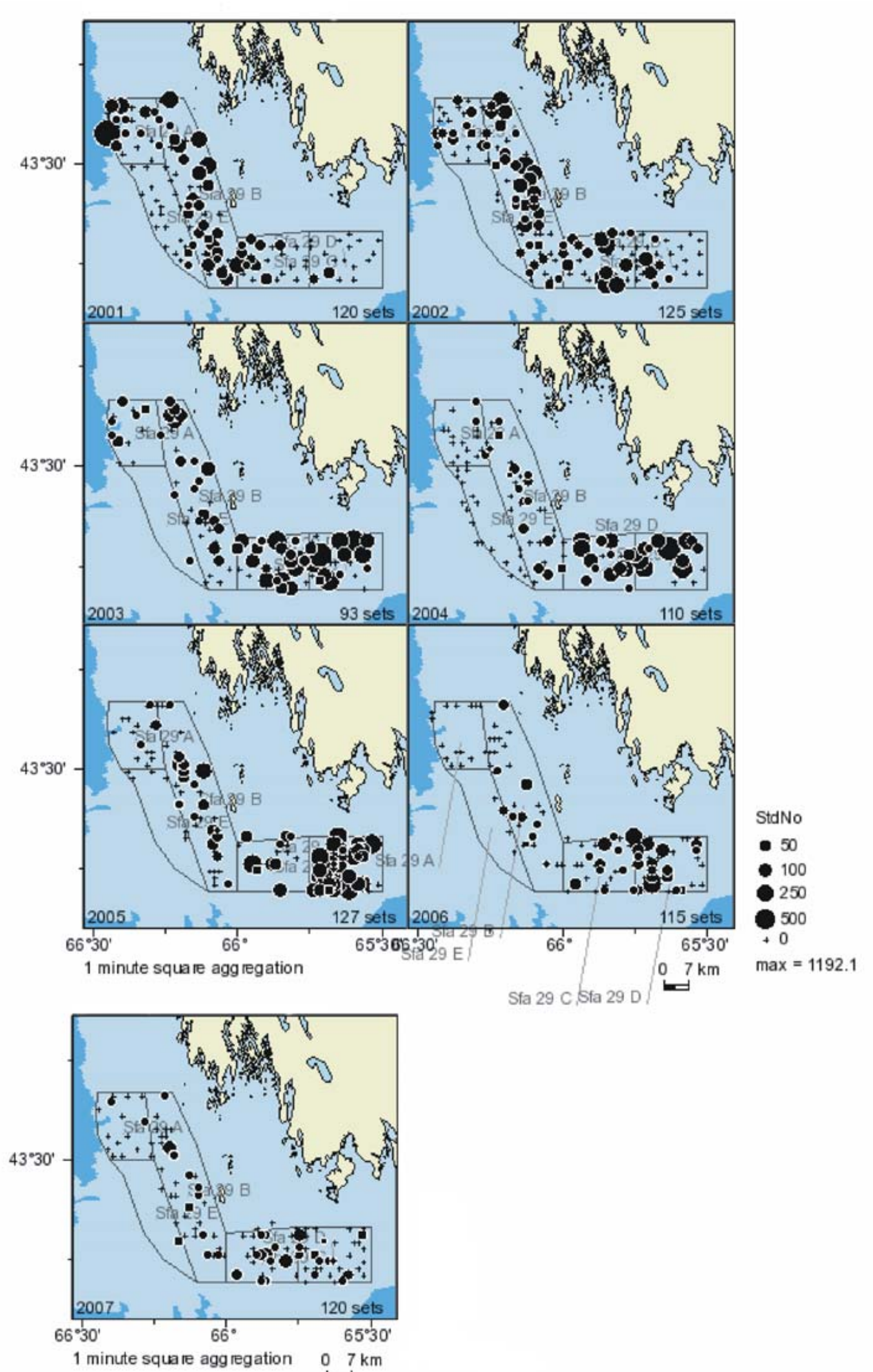

Figure 7: Spatial distribution of scallops for shell heights from 90 to 99 mm (corresponding to approximately age 5) caught during the 2001–2007 scallop research surveys in SFA 29.

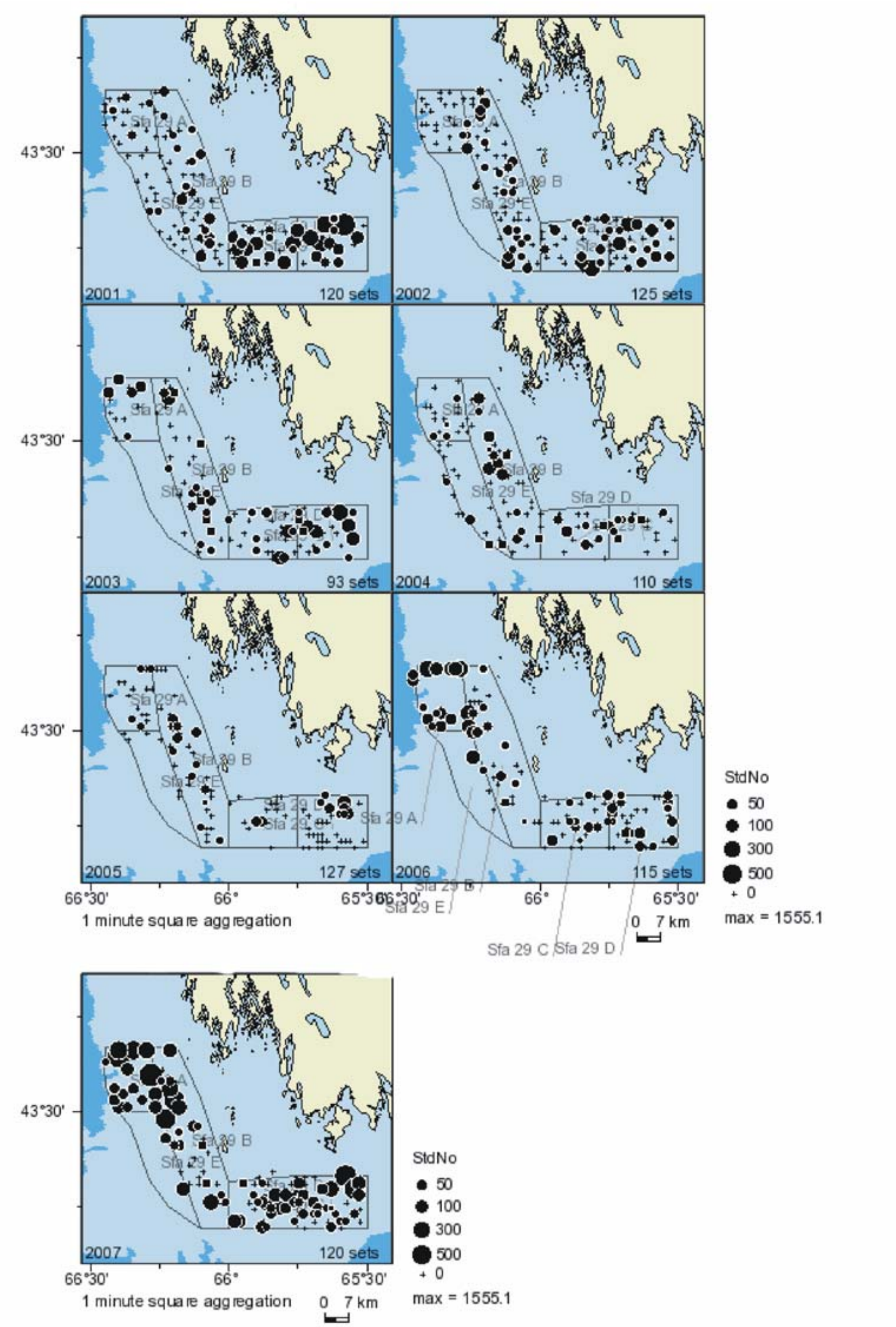

Figure 8: Spatial distribution of scallops for shell heights less than 50 mm (corresponding to approximately ages 1–2) caught during the 2001–2007 scallop research surveys in SFA 29.

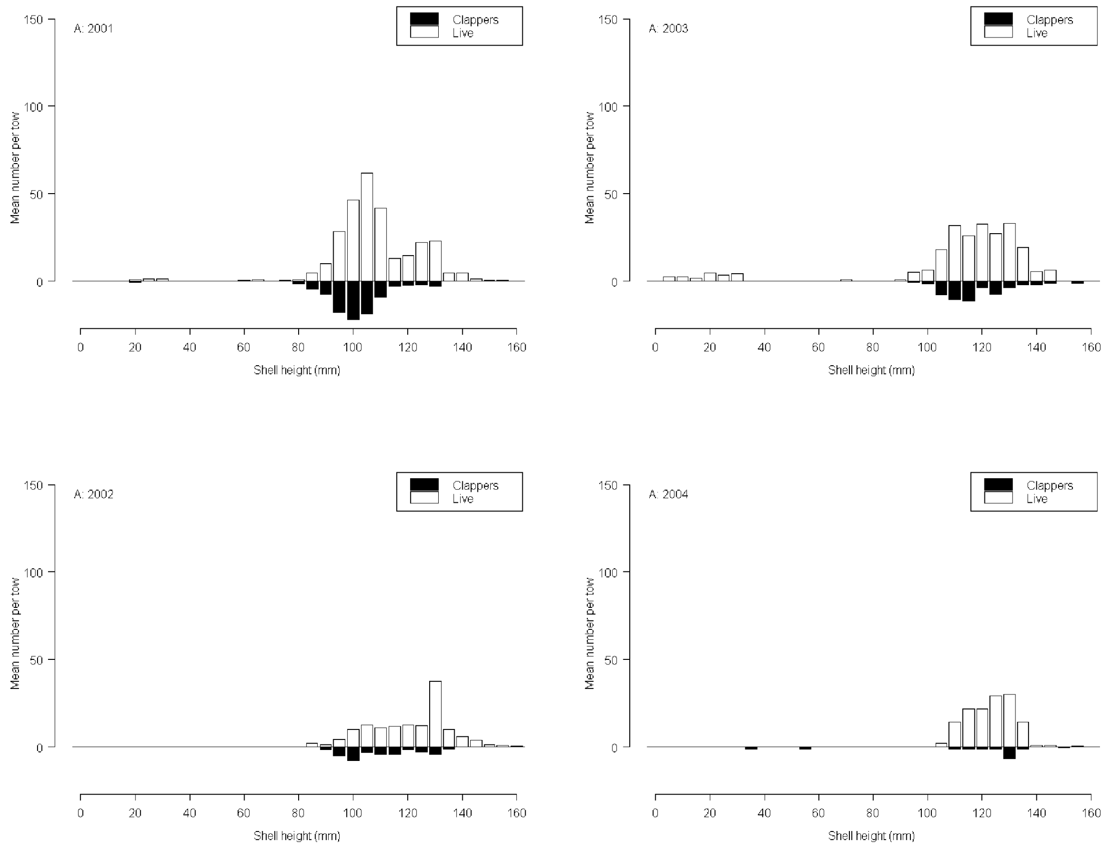

Figure 9: Shell height frequencies for SFA 29A from survey data for 2001 to 2004. Bin size for histogram is 5 mm.

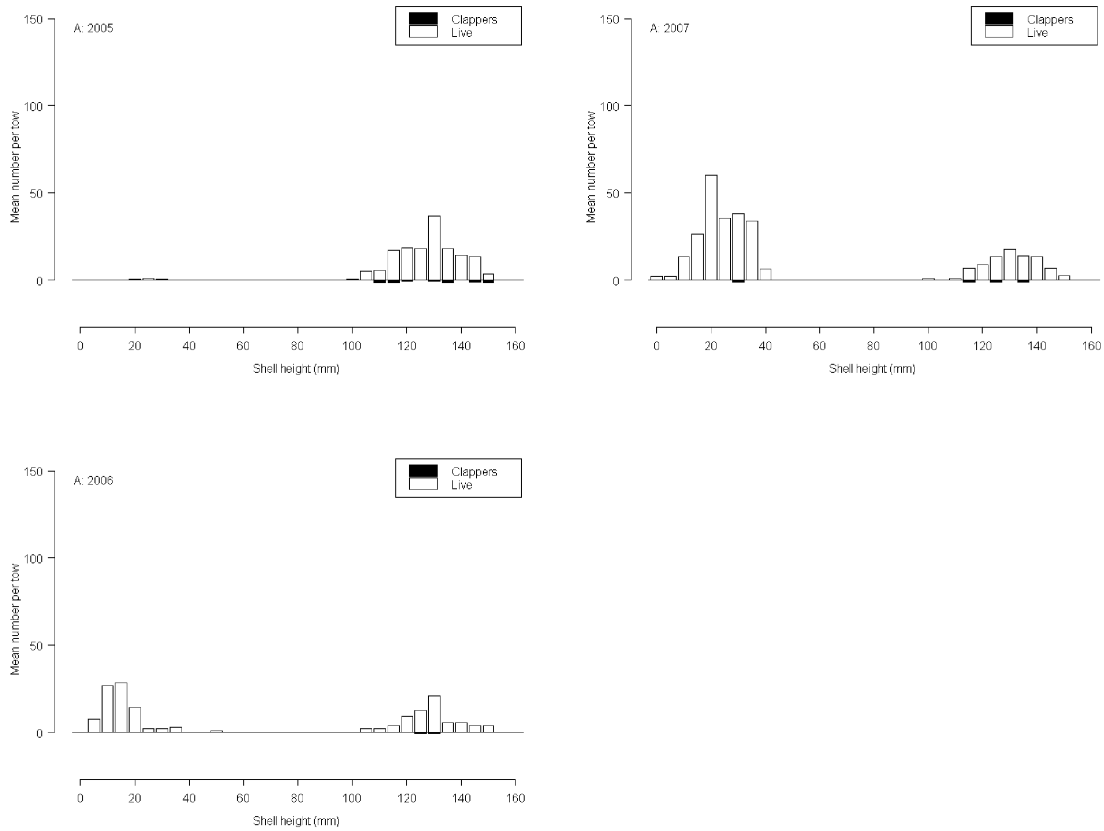

Figure 10: Shell height frequencies for SFA 29A from survey data for 2005 to 2007. Bin size for histogram is 5 mm.

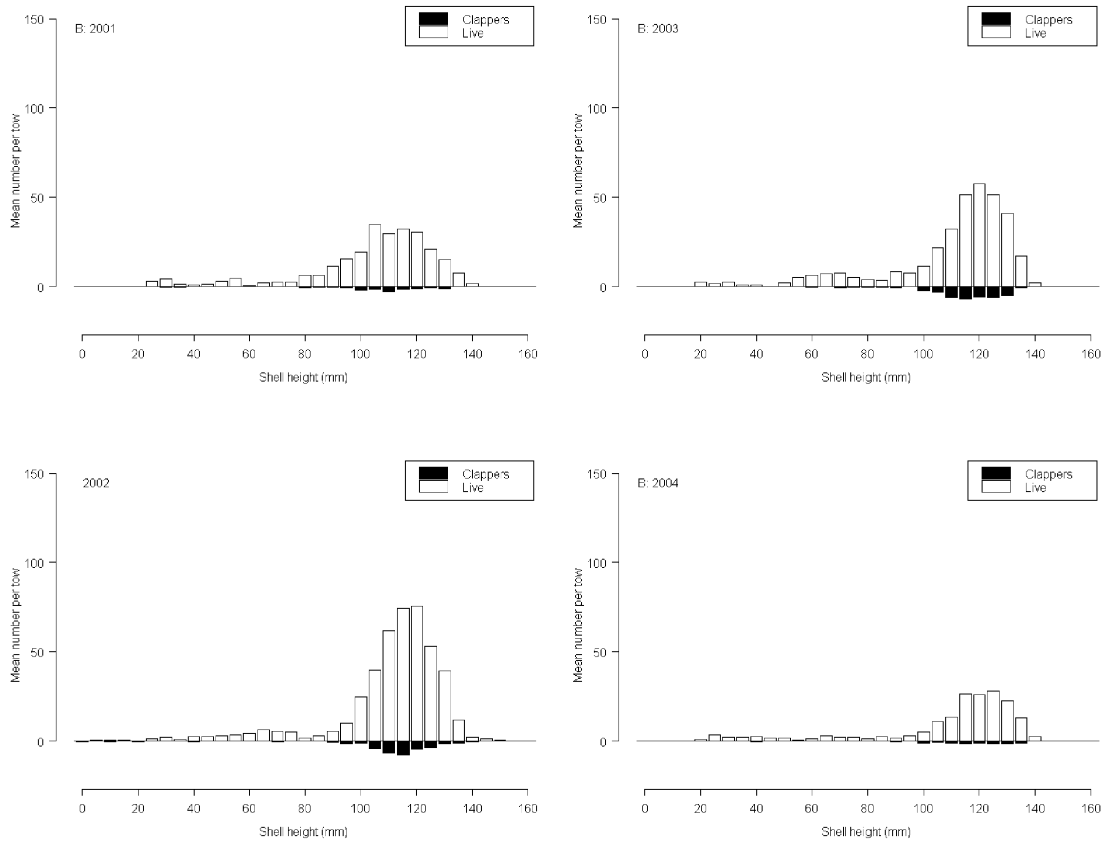

Figure 11: Shell height frequencies for SFA 29B from survey data for 2001 to 2004. Bin size for histogram is 5 mm.

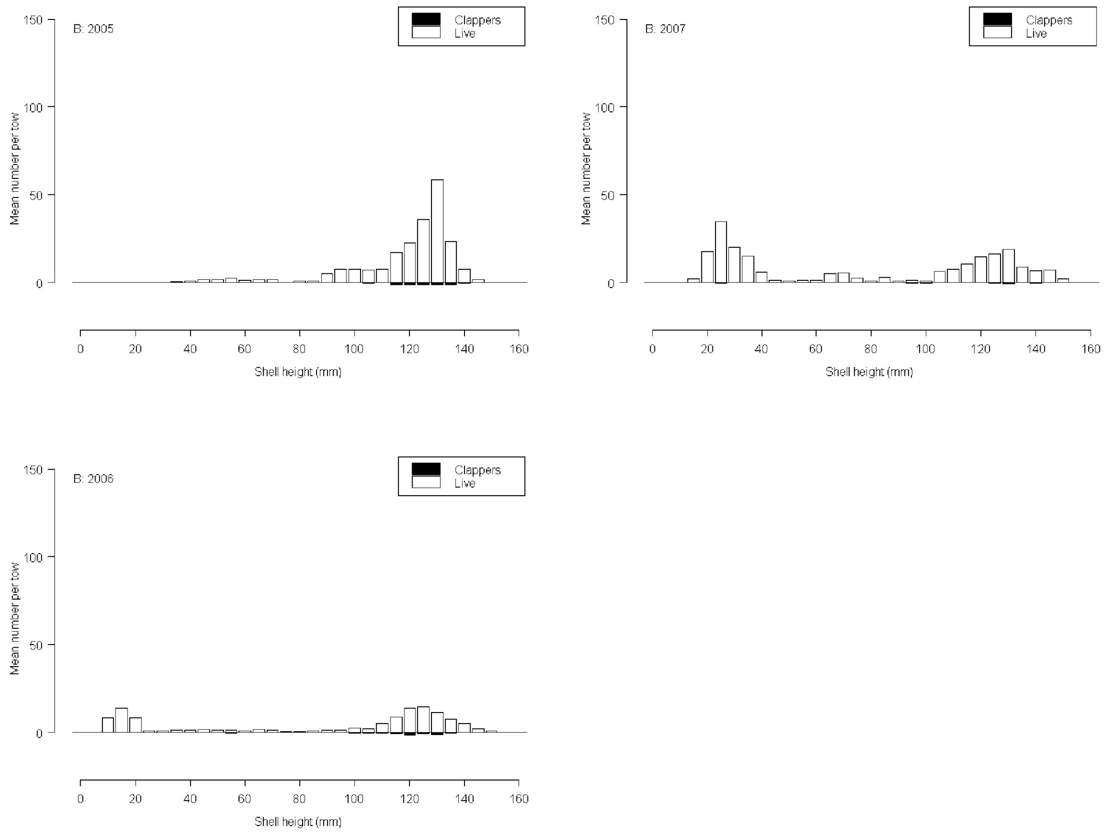

Figure 12: Shell height frequencies for SFA 29B from survey data for 2005 to 2007. Bin size for histogram is 5 mm.

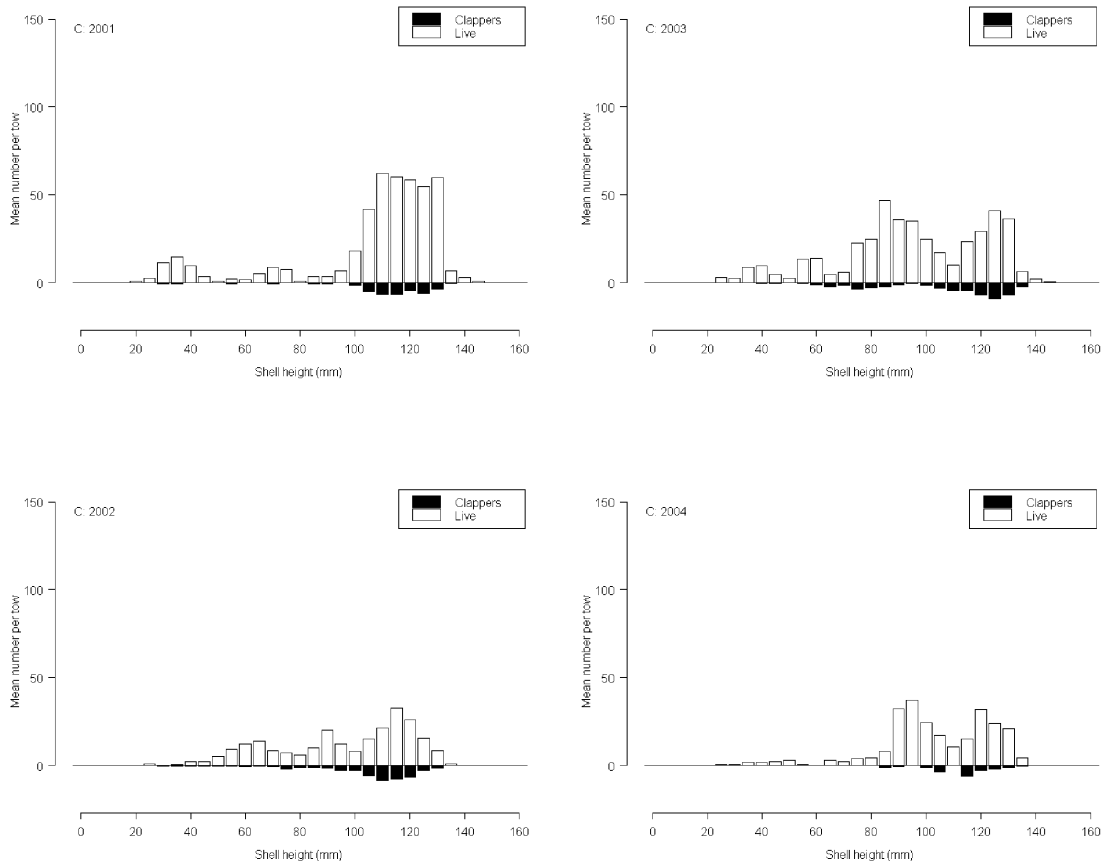

Figure 13: Shell height frequencies for SFA 29C from survey data for 2001 to 2004. Bin size for histogram is 5 mm.

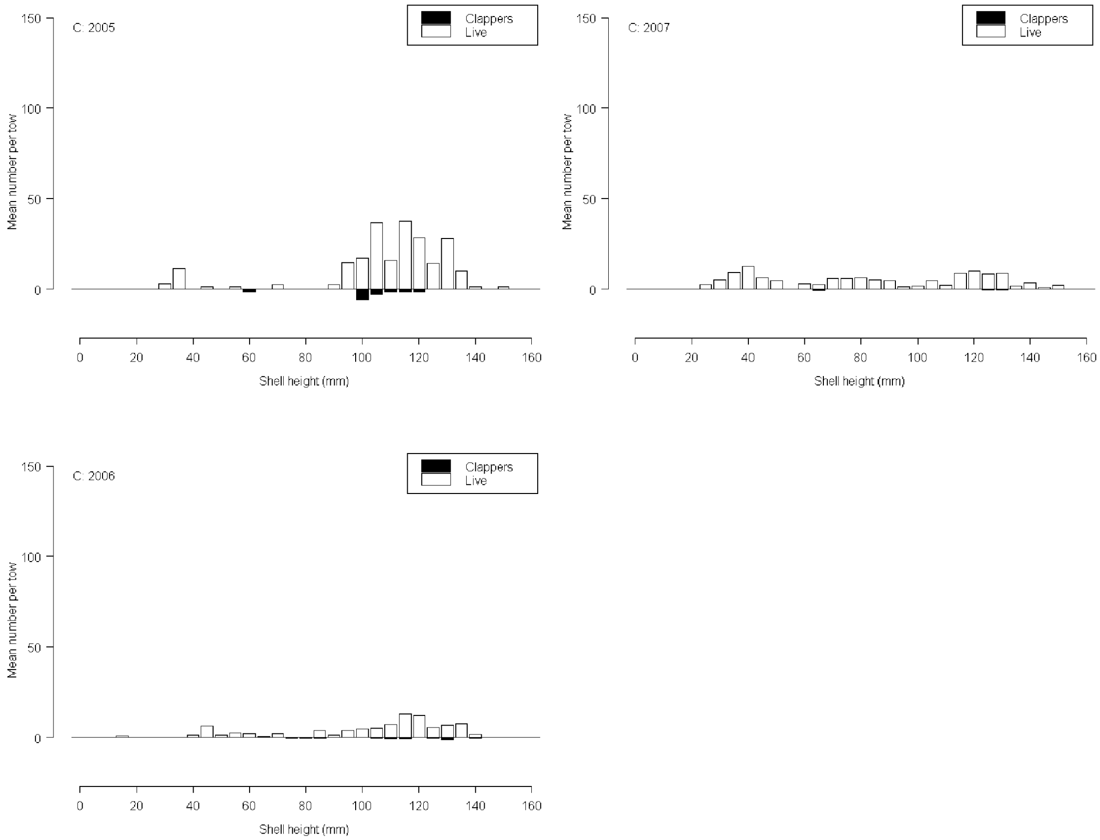

Figure 14: Shell height frequencies for SFA 29C from survey data for 2005 to 2007. Bin size for histogram is 5 mm.

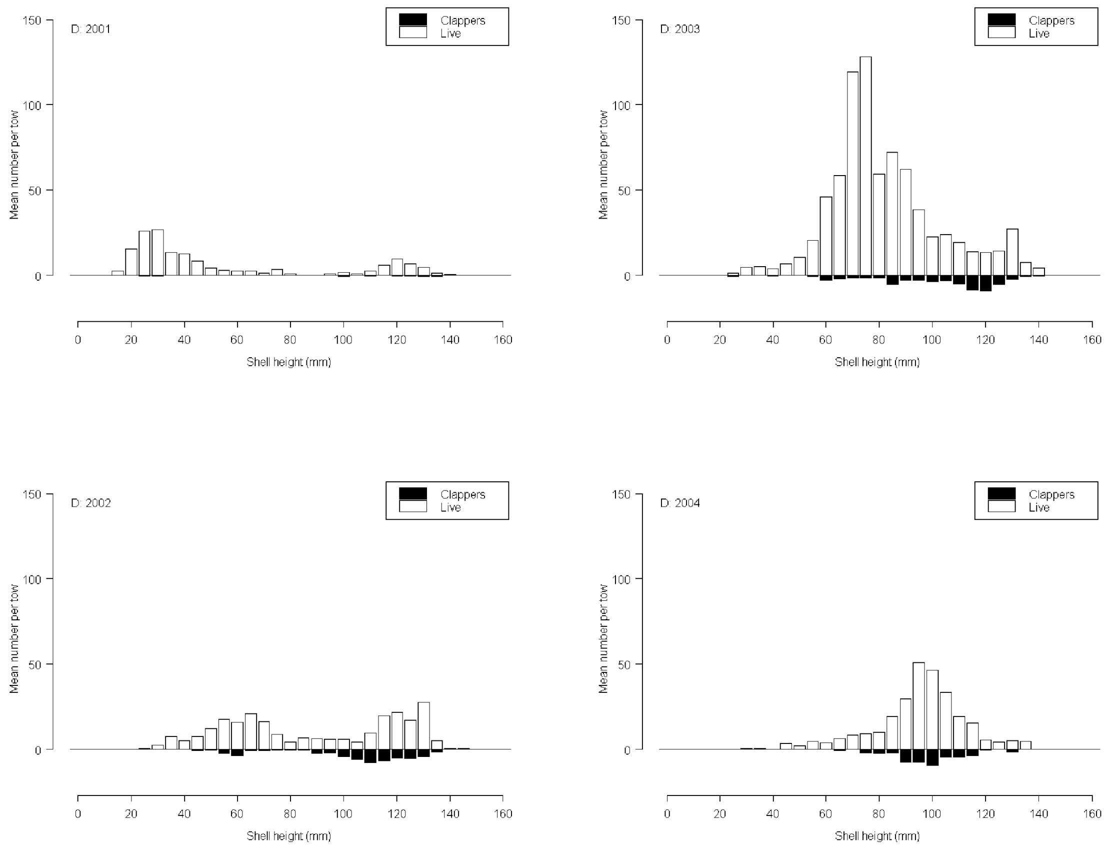

Figure 15: Shell height frequencies for SFA 29D from survey data for 2001 to 2004. Bin size for histogram is 5 mm.

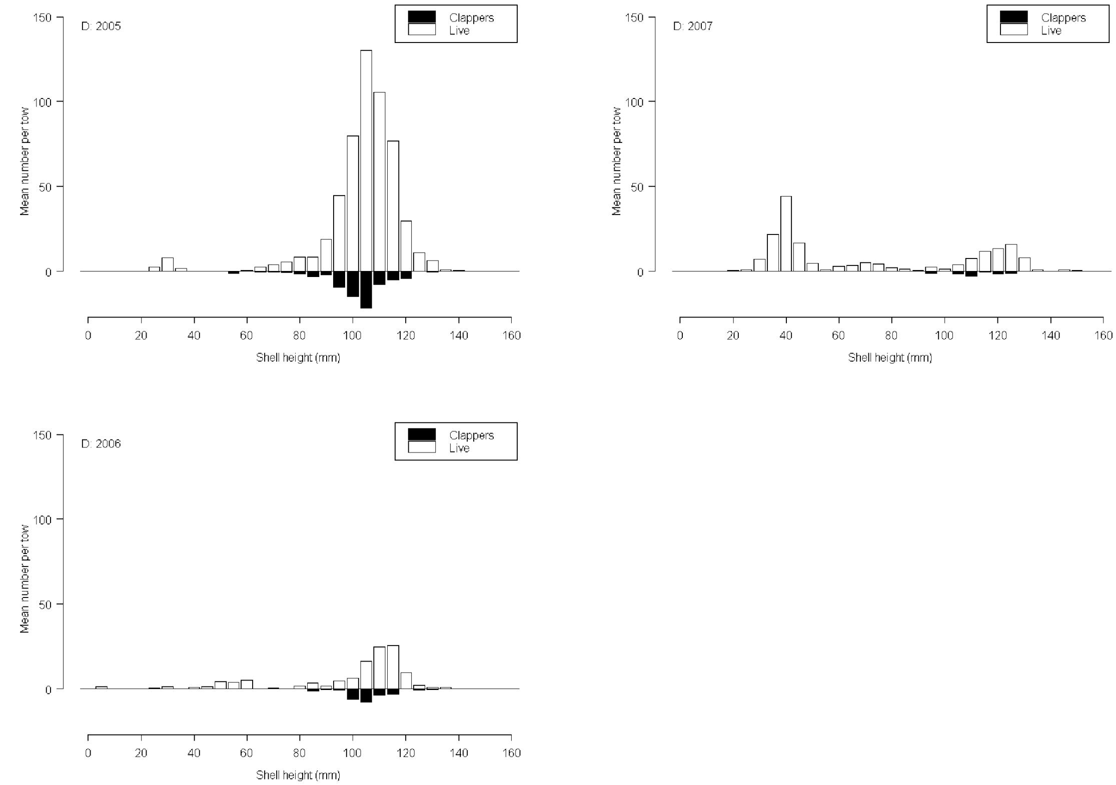

Figure 16: Shell height frequencies for SFA 29D from survey data for 2005 to 2007. Bin size for histogram is 5 mm.

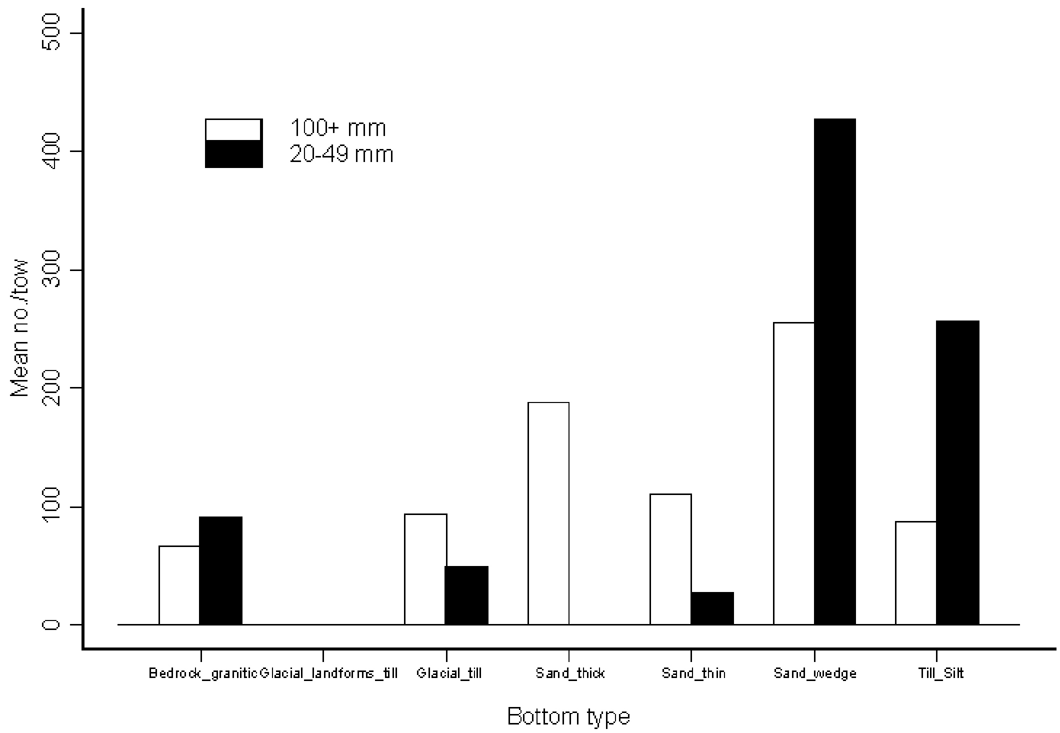

Figure 17: Number per tow of scallops by shell height group by bottom type from 2007 survey of SFA 29.

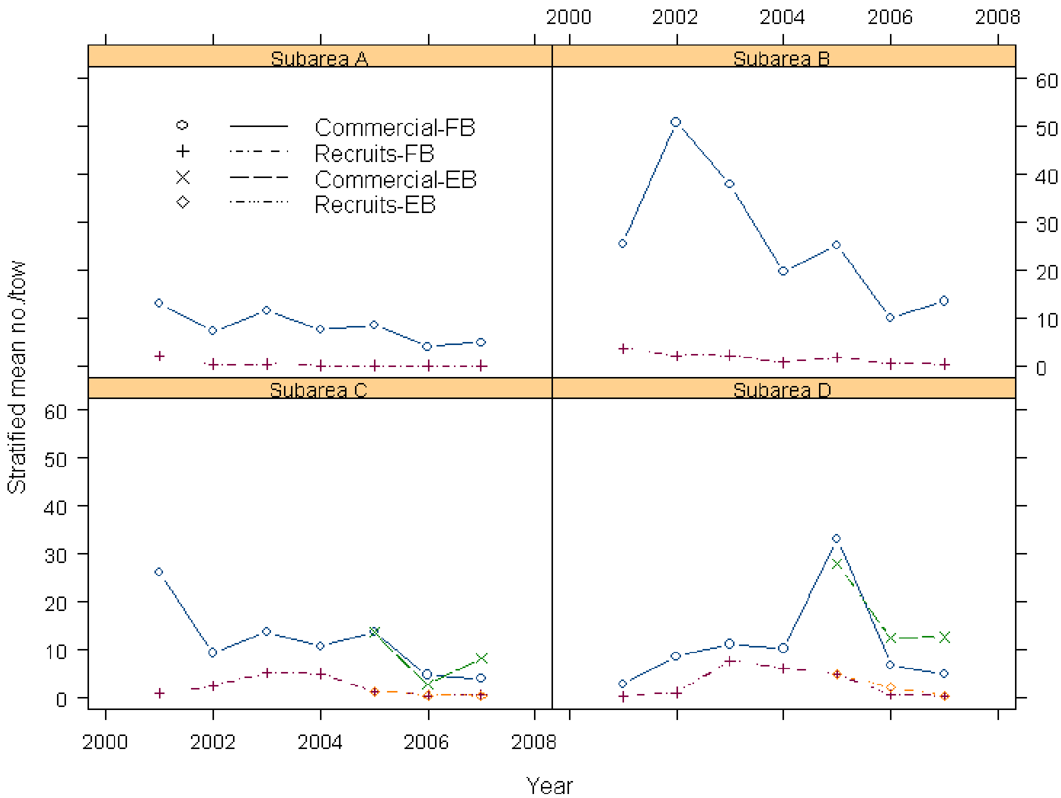

Figure 18: Annual trends of fully recruited (≥ 100 mm) and recruit (90–99 mm) size classes of estimates of survey abundance indices (numbers) from research surveys by subarea in SFA 29. Commercial and Recruits series estimated from F/V Julie Ann Joan (2001–2003, 2005–2006) and F/V Branntelle (2004) tows. Commercial-EB and Recruits-EB estimated from F/V Overton Bay (2005) and F/V Faith Alone (2006–2007).

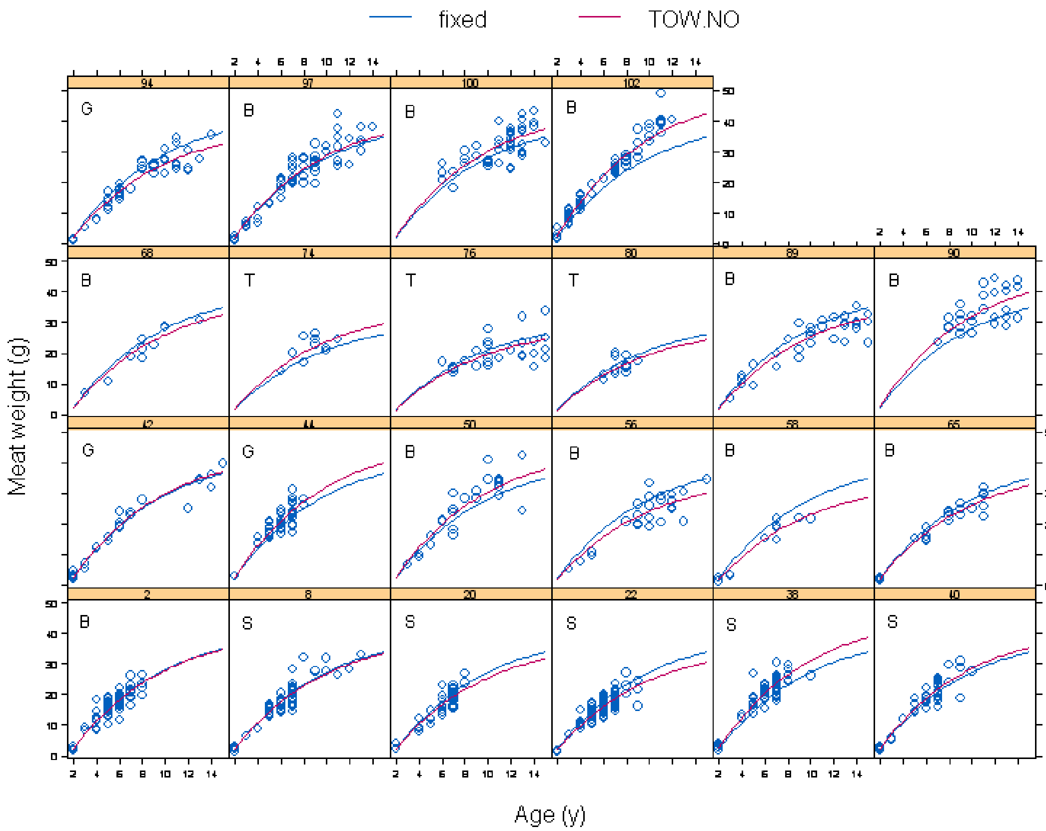

Figure 19: Predicted curves for Von Bertalanfy growth models for fixed effects (blue) as a function of bottom type and random effects (red) within each tow from the 2006 survey. Panels represent data by tow with tow number given in the strip name for each panel. Letters in the panels identify the bottom type as B = bedrock, G = glacial/till, S = thin sand and T = till/silt.

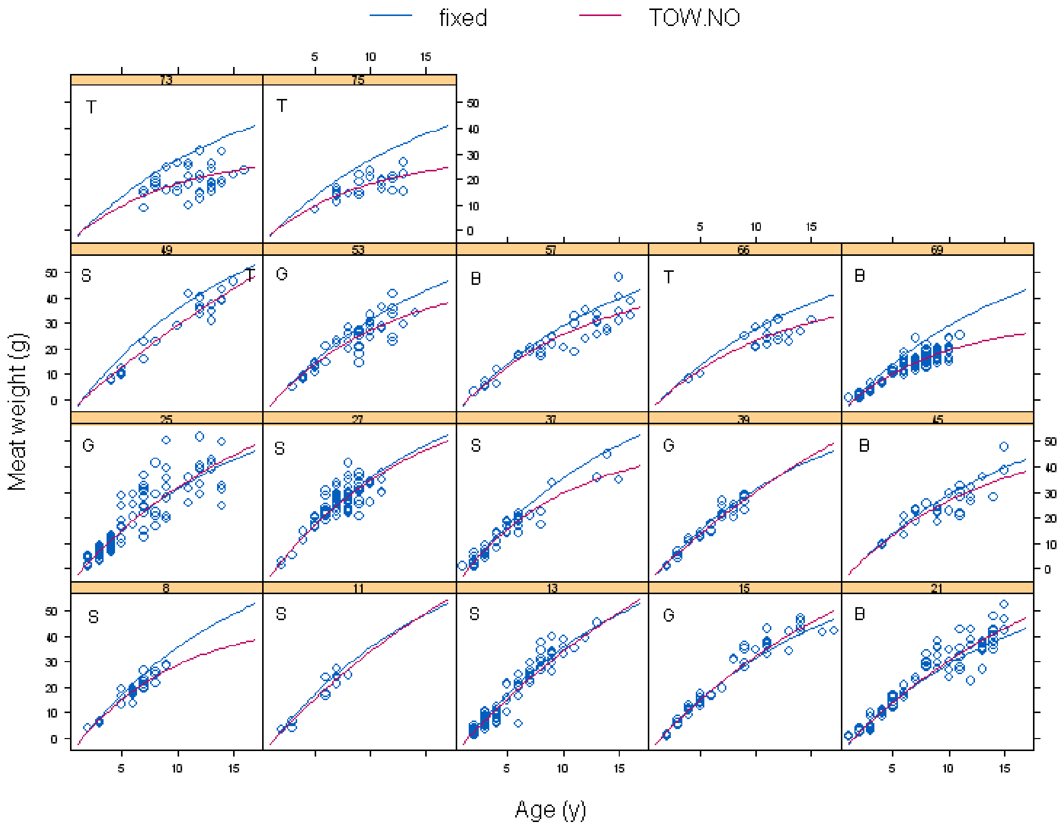

Figure 20: Predicted curves for Von Bertalanfy growth models for fixed effects (blue) as a function of bottom type and random effects (red) within each tow from the 2007 survey. Panels represent data by tow with tow number given in the strip name for each panel. Letters in the panels identify the bottom type as B = bedrock, G = glacial/till, S = thin sand and T = till/silt.

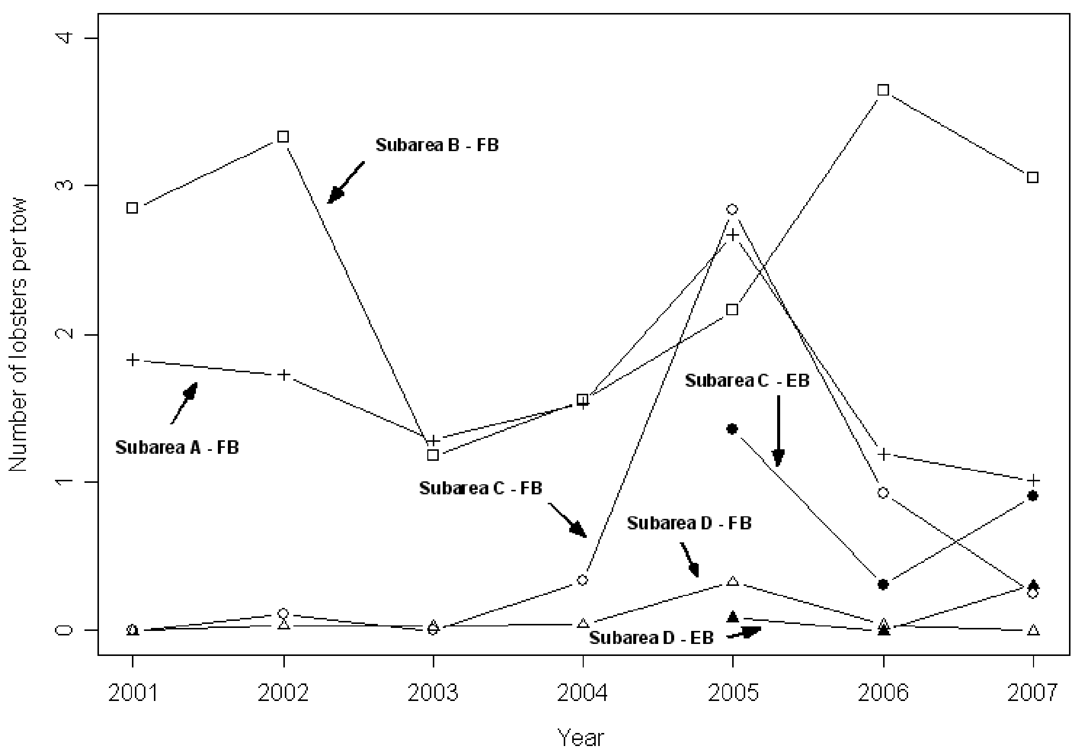

Figure 21: Lobster number per tow from scallop survey. The two series for Subareas C and D from 2005–2007 are for the different survey vessels (one from the Full Bay, one from the East of Baccaro fleet).

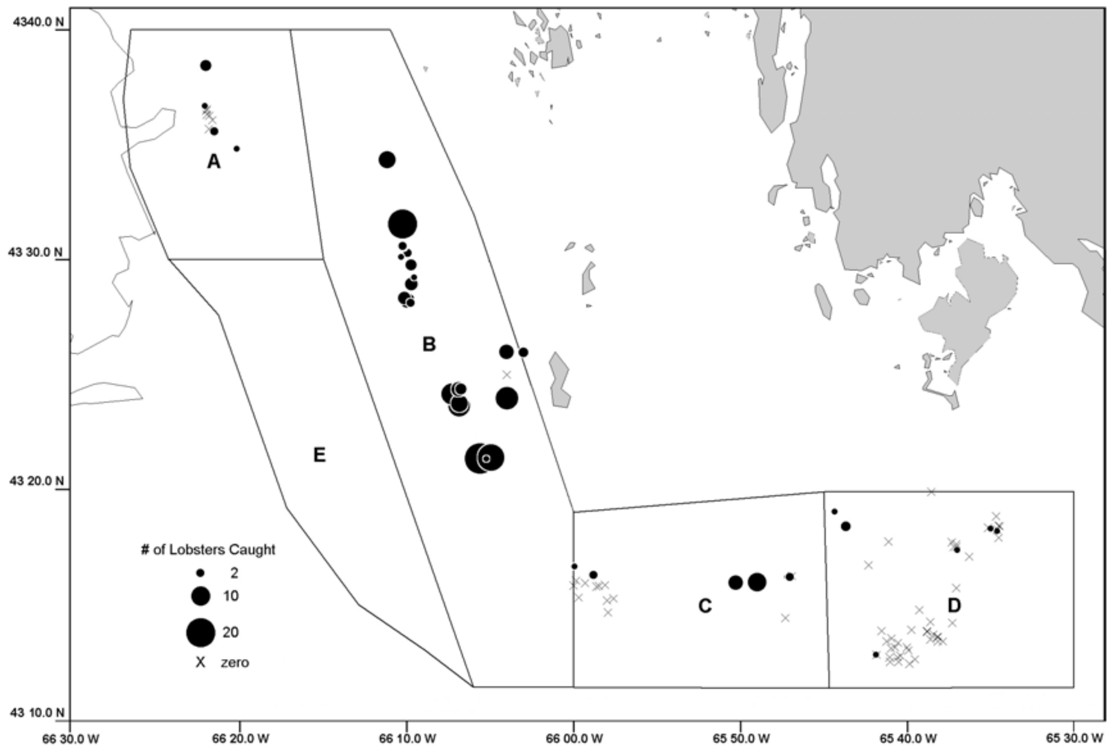

Figure 22: Location and number of lobsters caught in SFA 29 during 2007 from observed scallop fishing trips. Crosses indicate locations where no lobsters were captured.

APPENDIX

Decision table for SFA 29 Advisory meeting

The SFA 29 Advisory meeting to develop a fishing plan for 2008 was held in Yarmouth on May 9, 2008. At that time the following information was presented to the fishing industry and fisheries managers to aid their planning for the 2008 fishing season.

In the stock assessment meeting held at the Bedford Institute of Oceanography on April 30, 2008, catch levels corresponding to the growth rates were presented for each of the subareas of SFA 29. Setting exploitation rates equal to growth rates is admittedly a conservative approach and exploitation rates are set higher than this level for scallop fisheries in the Bay of Fundy and Approaches. There, decision tables based upon population models are used to set catch levels that do not have a high probability of exploitation rates exceeding 0.2. To date a specific probability has not been set but generally the probability used has been less than 0.50.

Population models similar to those in the Bay of Fundy scallop stock assessments have not been successful for scallops in SFA 29 because of problems following year-classes in the survey data. In this year's assessment of SFA 29, the 2007 commercial catch rate data were used to obtain estimated exploitation and biomass for each subarea from the rate of decline in the daily catch rate over the 2007 season.

Using only the variability inherent in these data and this method, the following decision table for SFA 29 was developed. The column labelled “Catch=Growth” corresponds to the catch levels given above. Expected exploitation rates and probability of exceeding 0.2 for each subarea are presented for a range of catches. For example, a catch of 100 t in Subarea B should correspond to a median exploitation rate of 0.17 but given the variability in the data and model, this catch has a 0.39 probability of the exploitation rate exceeding 0.2.

As noted above, the results of applying the model to Subarea A data probably reflected the very local nature of the fishery in 2007 (based on the VMS data) and not conditions over the subarea as a whole. A catch level in A for 2008 similar to last year of 11 to 12 t should be supportable.

		Scenarios					
Subarea		Catch < Growth	Catch = Growth	Catch > Growth			
A	Catch 2008 (t)		1				
	exploit (e)		0.14				
B	Catch 2008 (t)	40	65	80	**100**	120	140
	exploit (e)	0.07	0.12	0.14	**0.17**	0.20	0.24
	Pr(e>0.20)	0.00	0.11	0.24	**0.39**	0.51	0.61
C	Catch 2008 (t)	10	22	40	60	80	100
	exploit (e)	0.05	0.11	0.19	0.28	0.38	0.47
	Pr(e>0.20)	0.00	0.10	0.46	0.69	0.79	0.85
D	Catch 2008 (t)	40	61	80	100	120	140
	exploit (e)	0.08	0.13	0.16	0.20	0.25	0.29
	Pr(e>0.20)	0.10	0.27	0.40	0.51	0.59	0.65