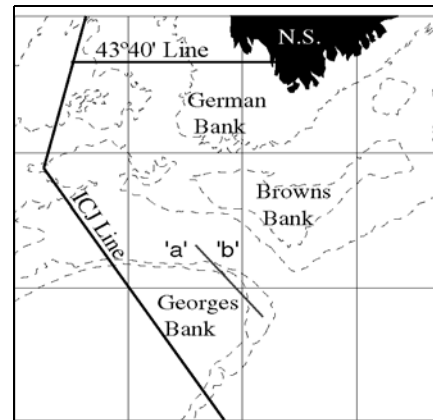


Georges Bank Scallop



Background

The sea scallop, *Placopecten magellanicus*, is found only in the Northwest Atlantic, from Cape Hatteras to Labrador. Scallops are aggregated in patches and harvestable concentrations are called beds. Major areas of offshore fishing activity are Georges Bank, the Scotian Shelf (Middle Grounds, Sable Island Bank, Western Bank, Browns Bank, and German Bank), and St. Pierre Bank. Scallops prefer a sandy, gravel bottom and occur in depths of 35 to 120 m.

Scallops have separate sexes. They mature at age 2. The female gonad is red in colour and the male gonad colour is creamy white. The major spawning period is August to October. The fertilized eggs develop in the water column until settlement on the bottom within 30 to 60 days.

Growth is estimated from the position of annual rings on the shell. The growth rate varies from one area to another and is influenced by season, depth, and temperature.

Offshore scallop vessels range from 27 to 46 m length overall. The offshore fleet uses a New Bedford offshore scallop rake or drag, 4 to 4.9 m in width. Two drags are fished simultaneously, one on each side of the vessel.

Summary

- Georges Bank has been managed as two zones, 'a' and 'b', since 1998. The main focus of this report is zone 'a'. Zone 'b' includes the deeper, less productive waters.
- In 2002, catches in zones a and b were greater than 6,500 t for the third year in a row with 33% less effort than in 2001 in zone 'a'. Effort distribution was highly concentrated and the southern portion of Georges Bank was lightly exploited. Half of the catch in zone 'a' were age 5 scallops.
- The 2002 commercial catch rates were similar to those in 2000 and are the second highest since 1981.
- Recruited age groups (ages 4+) were abundant while pre-recruits were below average in abundance.
- In 2002, recruited biomass was very high for the third year in a row. It was the highest since 1981 at over 3 times the historical value. However, pre-

recruit biomass has declined from the most recent high in 2000.

- The fishery targeted biomass (ages 4-7) was close to 25,000 t in 2002. Age 5 scallops make up 42% of the targeted biomass. New recruits at age 4 contribute only 10%.
- Over the last 20 years, the exploitation rate on the targeted biomass has been on a declining trend, from 50% in the early 1980's to less than 20% after 1995. It has been stable at 18-19% for the last 3 years.
- Given the distribution and abundance of target age group at the start of 2003, any catch scenario greater than 3,500 t could deplete stock biomass. In zone 'a', an exploitation rate of 11% on the age group 4-7 would give a TAC for 2003 of 5,000 t. It would reduce the biomass of ages 4-7 by 25%. An exploitation rate of 15% would keep the TAC at the 2002 catch level (6,450 t). As a result, the biomass of ages 4-7 would decrease by 27% during 2003. An exploitation rate of 17% would keep the fishing effort at the 2002 level and generate a TAC of 7,150 t. The biomass of ages 4-7 would decrease by 29% under that scenario.

The Fishery

Landings (thousands of tonnes)

Year	1970- 79 Avg.	1980-89 Avg.	1990- 98 Avg.	1999	2000	2001	2002
TAC	-	-	4.6	3.7	6.8	6.9	6.7
Catch	5.9	5.1	4.6	3.7	6.8	6.9	6.7

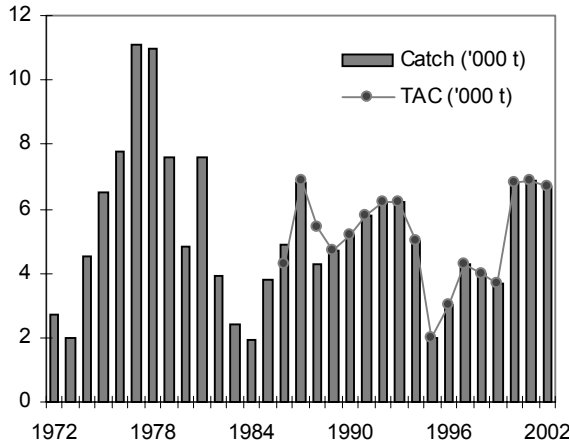
The scallop grounds of Georges Bank are divided into the traditional area (zone 'a') and a marginal growth area (zone 'b'). Zone 'a' continues to be managed by a meat count set at 33 meats per 500 g.

Harvest advice on zone 'a' only is provided in this status report.

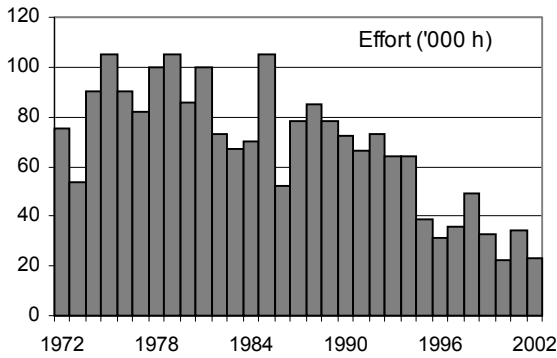
The management of zone 'b' includes 'rolling' TAC's and a meat count of 50 meats per 500 g. At the end of the first 6 weeks of fishing, if commercial catch rates (CPUE) and meat counts are good, a further 200 t is allowed over the next 6-week period. This approach is called a rolling TAC. After review, the TAC did not roll in 2002. CPUE remained low, at rates 20% lower than in 2001, from the beginning of the fishery. Meat counts, on a trip basis, also increased to an average of 36 meats per 500 g in 2002 from 31 meats per 500 g in 2001. Since 1998, this is the first year that stock conditions do not allow more than one 200t quota.

The fishery for roe-on product landed 11% of the total catch, expressed as tonnes of meats. Usually the meat component of the roe-on product fishery ranges from <1% to 5% since that fishery started in 1988. Despite the high landings of roe-on product, the amount of roe component (roe to roe-on product) landed was below normal for each month (May to August) that the fishery for roe-on product took place.

The overall TAC for Georges Bank zones 'a' and 'b' reached 6,700 tonnes in 2002. The traditional area (zone 'a') TAC was 6,500 t, the same as in the previous year. Catches in 2002 were 6,469 t in zone 'a' and 192 t in zone 'b'. Catches in zone 'a' have been slightly over 6,000 tonnes for 3 years in a row.



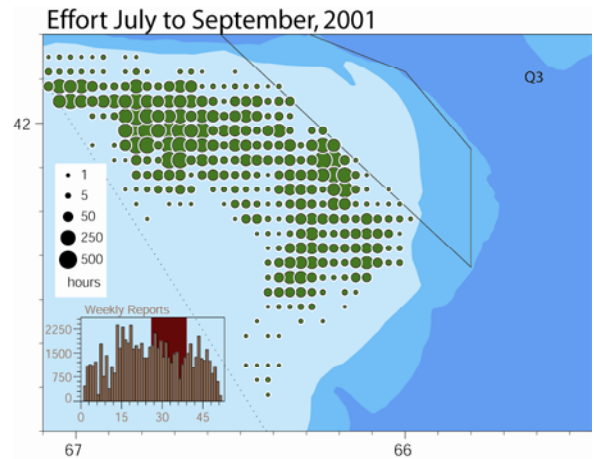
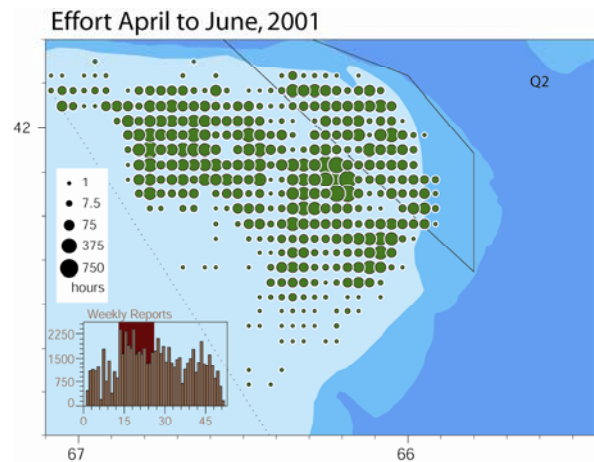
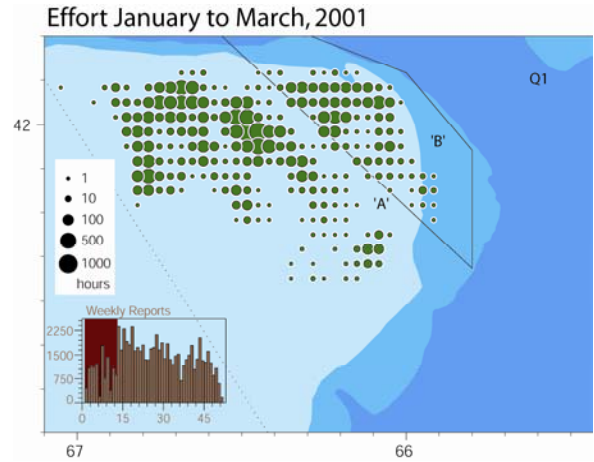
While **effort** in zone 'a' has generally decreased markedly since 1994, it had risen 70% from 2000 to 2001. The 2002 effort fell back to 2000 levels. Labour problems during January to March disrupted the normal patterns of seasonal effort. Atypically, over 25% of the annual effort was expended during the last quarter (Oct.-Dec.).

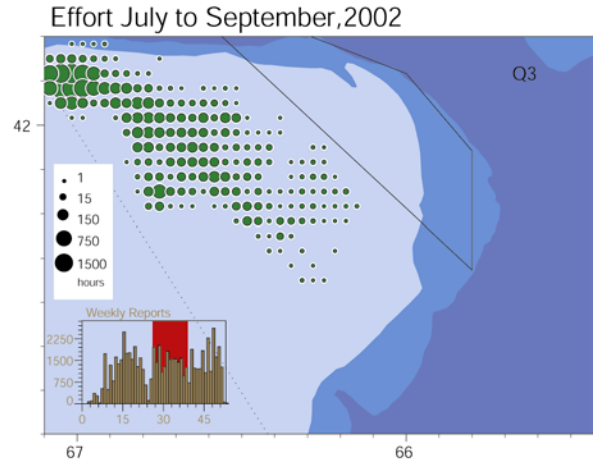
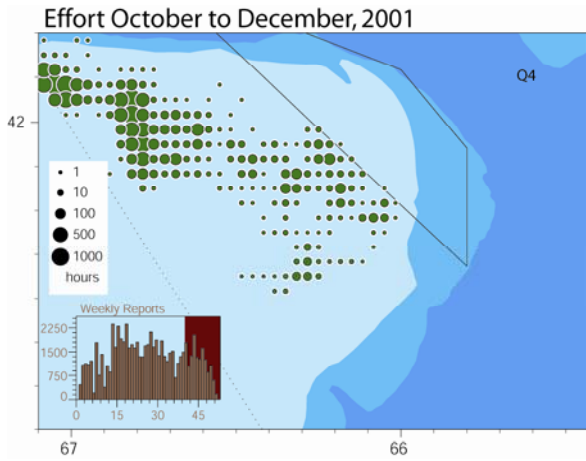


Satellite-based monitoring data show concentrations of fishing activities during the year on a quarterly basis. Over the last few years, fishing activities have usually been concentrated in specific areas. A pattern of repeated activities developed along the northern edge of Georges Bank, close to the ICJ line, during the last quarter of 2001 that continued throughout 2002. While the fleet concentrated effort in that location, the southern portion of Georges

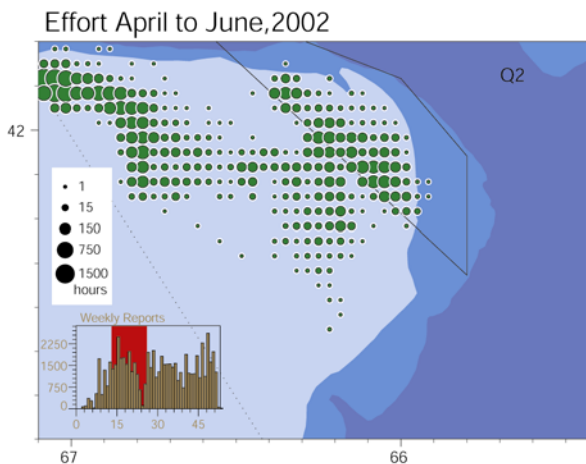
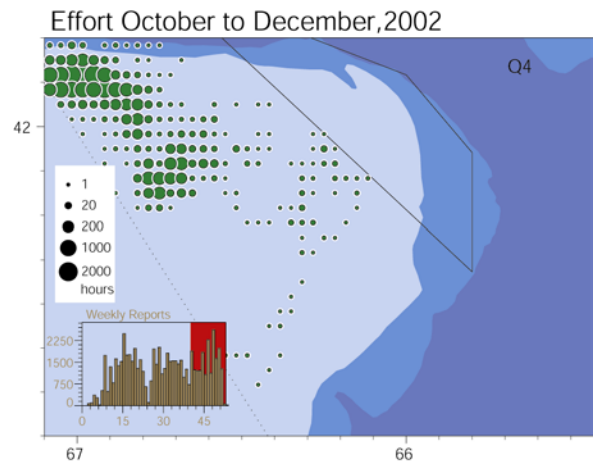
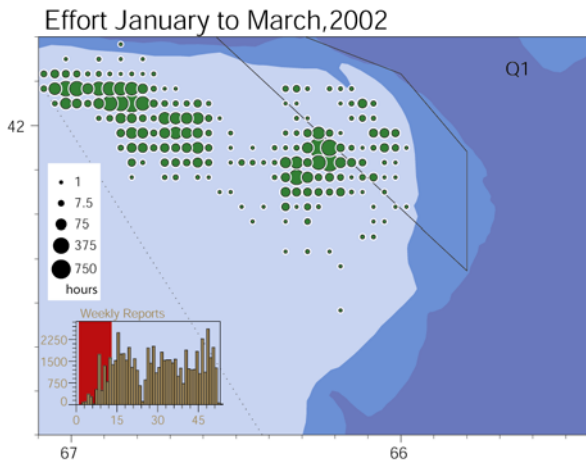
Bank was lightly exploited. Distribution patterns of fishing effort shift with availability of scallop beds in terms of density and meat size.

Satellite Tracking Data for 2001

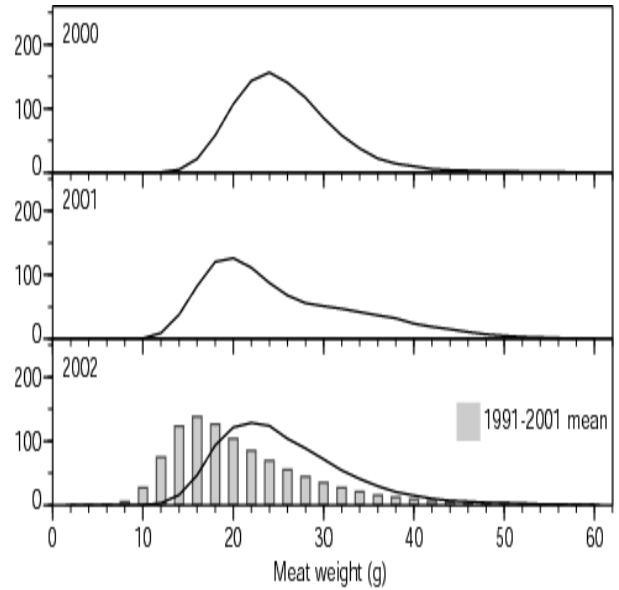
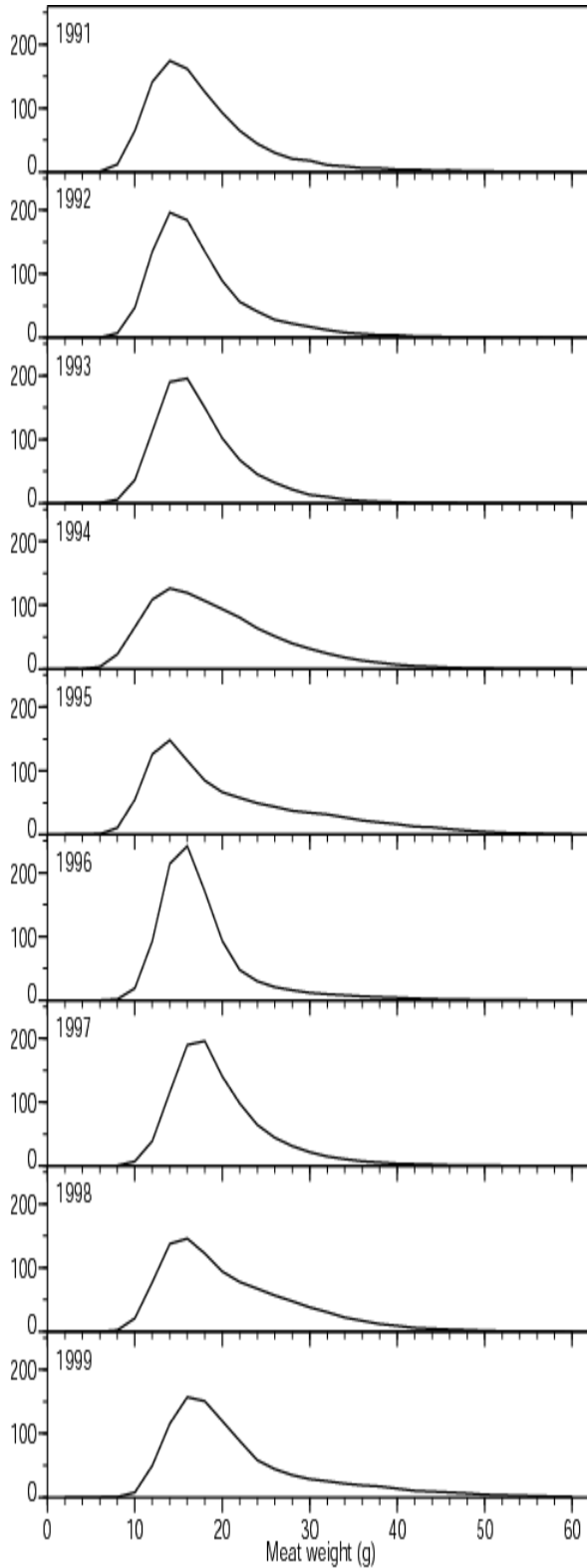




Satellite Tracking Data for 2002



The **meat weight** profile in the 2002 catch from zone 'a' is very similar to the 2000 profile, with a shift toward a larger scallop meat compared to the long term average (see last graph in the column of normalised weight distribution graphs starting in 1991). Half of the scallops caught in 2002 were age 5 with a minimal contribution of age 4 (13%) and no age 3 scallops.

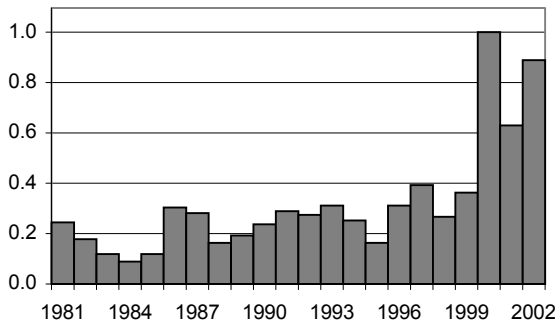


Resource Status

Logbooks provided catch and effort data from which CPUE were estimated. Landings are monitored at dockside. Catch in numbers at age were derived from port samples. Relative biomass indices were derived from research vessel surveys (RV). A Sequential Population Analysis model estimated population abundance based on RV biomass indices, CPUE, and age composition in the stock.

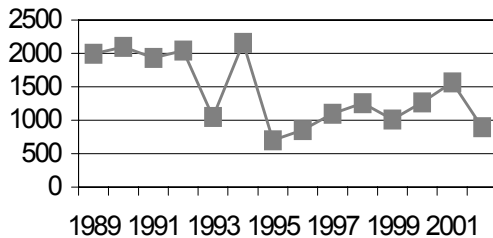
CPUE experienced during the 2000 fishery had been exceptionally high. It declined 37% in 2001 to increase in 2002 close to where it was in 2000. The 2002 CPUE is the second highest since 1981. Monthly CPUE's peaked in June and remained relatively high for the rest of the year.

Fleet CPUE index



High productivity is inferred from areas of high CPUE. The **area of high productivity** is the proportion of Georges Bank maintaining high CPUE (greater than 1 kg/crew-hour-meter). In the past, areas up to 2,000 km² have delivered high CPUE. The high CPUE of 2002 came from an area 45% smaller than in 2001. It is the first time since 1997 that the area of high CPUE was less than 1,000 km². 2002 may represent a low point of the series however, there were other beds available elsewhere on Georges Bank that the fleet did not exploit.

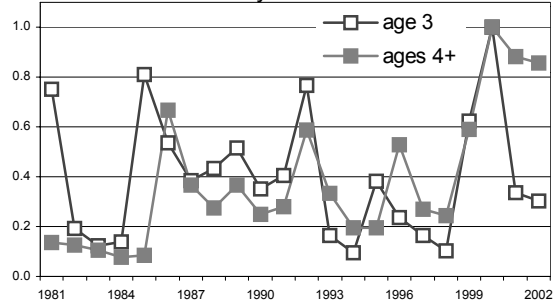
Areas of high productivity (sq km)



RV catch rates for all age groups of scallops peaked in 2000. In 2001 and 2002, they were still high for recruits (ages 4+) but pre-recruits (age 3) remain at low levels. The 1997 year class at age 5 had one of the highest abundance ranking for age 5 of the RV series. The 1998 year class at age 4 was above average and seventh highest overall since 1981. RV observations tend to indicate that the pre-

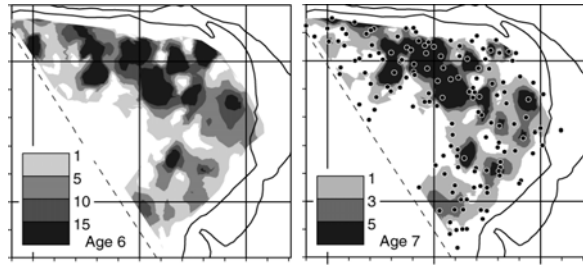
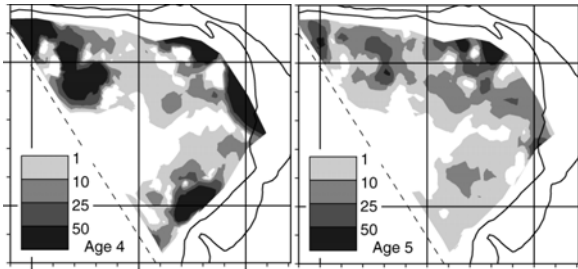
recruit index represented by the 1999 year class is weak.

Survey CPUE index

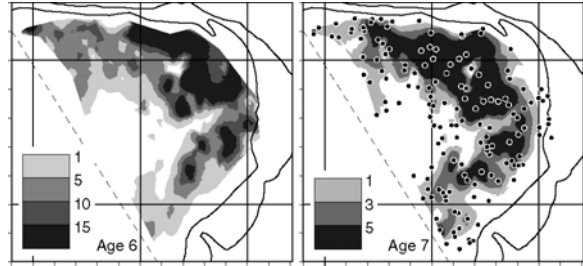
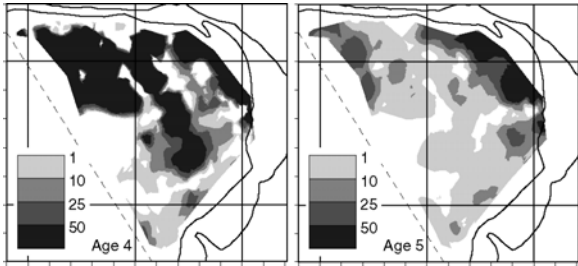


The spatial distribution of numbers at age for ages 4 to 7 from RV data is presented in the following shaded contour plots. RV locations are shown by dots on a map for each survey. The contour plots for ages 4 and 5 show important concentrations in the southern portions of Georges Bank.

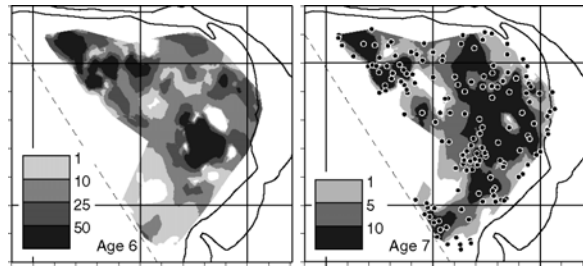
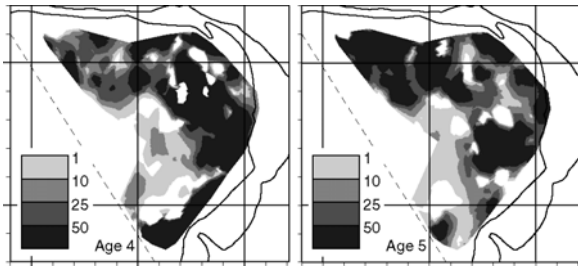
1998



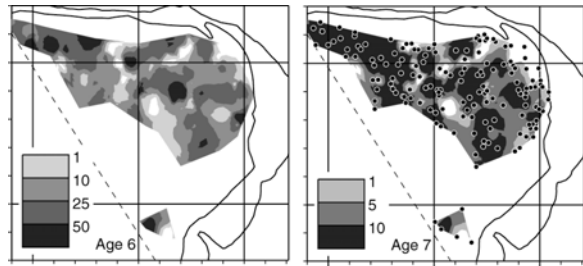
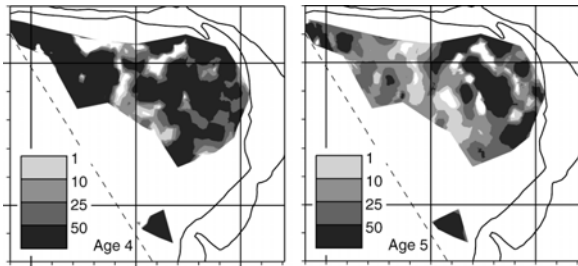
1999



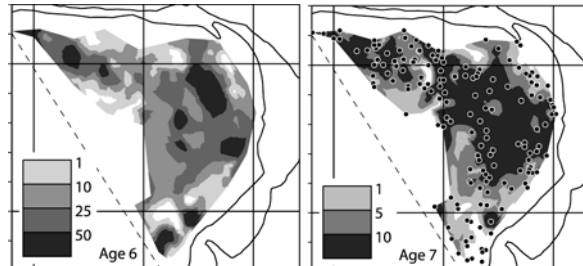
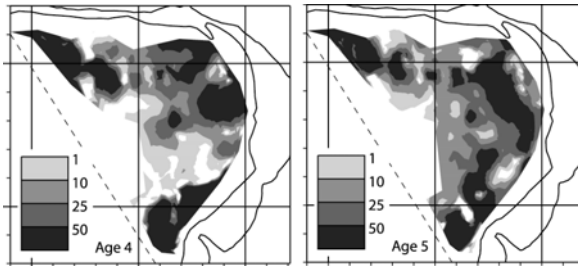
2000



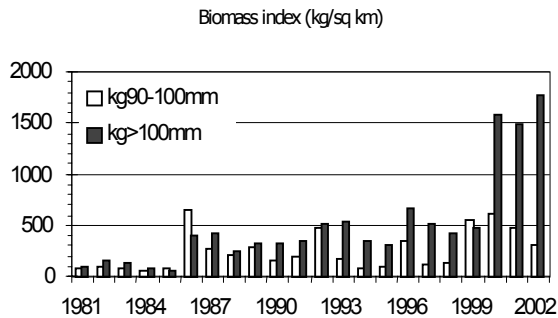
2001



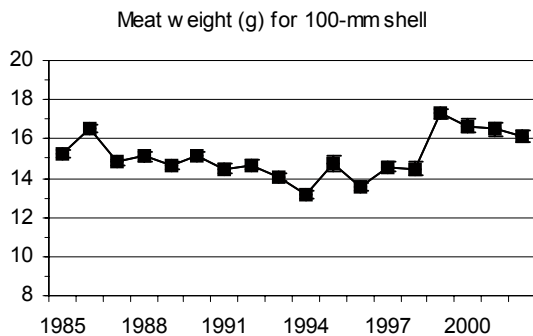
2002



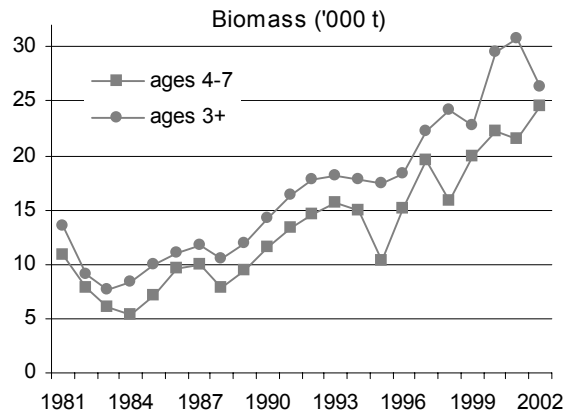
A **biomass index for shell height groupings** has been developed from RV data for 1981–2002. The index of fully recruited scallops (shell height over 100 mm) is very high in 2002, for the third year in a row. At 3 times the historical mean value, it is the highest since 1981. There is more variability in the index for recruits (shell height 90-100 mm). The index is gradually declining after peaking in 2000.



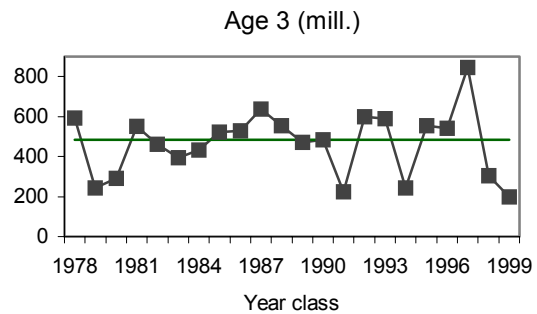
The status of the stock with respect to growth may also be monitored with a **meat weight index**. Prior to 1999, a meat weight equal to or less than 15 g in a 100-mm scallop shell was typical of the Georges Bank environmental conditions. In 1999, the meat of a 100-mm scallop became 17% heavier. This was mainly due to the rapid growth experienced on the northern edge of Georges Bank that year. Since then, the meat weight index continues to drop but remains higher than pre-1999 values. The 2002 meat weight index, at 16 g, corresponds to a 31-count scallop meat.



The **fishery targeted biomass** from the population model (sum of ages 4-7) is on a rising trend. After the most recent drop in 1998 the targeted biomass has been steadily rising to be close to 25,000 tonnes in 2002. This is the highest biomass observed in the time series. Age 5 scallops are contributing 42% of the targeted biomass. In comparison, new recruits at age 4 contributed only 10%.

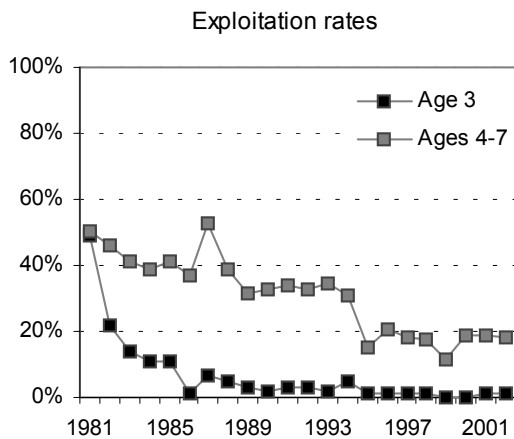


Pre-recruitment at age 3 is presently at low levels, reflecting the weakness of the 1999 year class, as observed in the most recent RV. There were few aggregations of age 3 scallops and densities within aggregations were not high. The value for the median (smooth line) in the graph below excludes the very high 1997 data point.



Over the last 20 years, the **exploitation rate** on the targeted age group has decreased substantially from 50 to less

than 20%. Since 1995, the target exploitation rate has varied from 15 to 20%. It has been stable around 18-19% for the last 3 years. The exploitation rate on age 3 has stayed low since 1986. The introduction of a 33 meat count in the fishery management plan at that time forced the fleet to direct for older scallops. Exploitation of age 3 scallops has been reduced to almost nil with the monitoring of small meats in the catch starting in 1995.



This stock assessment includes a compilation of attributes of stock status. Summarising these attributes in tabular form facilitates comparison and should be an aid for decision-makers.

Attribute	Recent trend	Current Status
Pre-recruitment, RV age 3 1981-2002	Varying	Low
RV biomass index 90-100 mm shell height 1981-2002	High end of range	Decreasing
Biomass estimate age 3+ 1981-2002	Increasing since 1995	Decrease from record high
RV biomass, ages 4 to 7 1981-2002	Varying	Second highest of the series, similar to 2001
CPUE 1981-2002	Stable at a high level	Second highest of the series
Exploitation estimate ages 4 to 7 1981-2002	Decreasing	Stable over last 3 years
Meat weight index 1985-2002	Stable	Small decline from record high
Areas of high productivity	Increase 1995 to 2001	Decreasing (Survey shows high density areas that were not fished)

Sources of Uncertainty

The projection results carry a certain degree of uncertainty that is a function of how well year class strengths are estimated. Estimating year class strength at age 2 is difficult. Scallops of that size are not consistently observed in the survey. They also tend to be highly aggregated, resulting in estimates of distribution and abundance that are imprecise.

There is spatial heterogeneity in the distribution of age groups. The fleet is targeting scallop beds because of scallop size and this targeting would suggest that CPUE are not strictly proportional to population size.

Other uncertainties include variations in weight at age, partial recruitment, variations in natural mortality, systematic

errors in data reporting or model misspecifications.

Outlook

The following evaluations of catch scenarios are based upon the population model used for this assessment. Other indicators presented in this document validate the status of the stock as represented by the population model. High levels of catches have been recorded for 3 years in a row while effort is at its lowest point since the early 1970's. CPUE indices are at record highs, with average meat weight in the catch reaching new highs. RV biomass indices of recruits has remained high over the last 3 years. Over 20 years of observations support most of these records. However, record highs may be coming to an end. Observations to date indicate that in general, below average recruitment follows years of above average recruitment. Given the distribution of target age group at the start of 2003 and that age 6 scallops make up 47% of the target population, any catch scenario greater than 3,500 tonnes would deplete the stock biomass. Given weak incoming recruitment, the target biomass (ages 4-7) could decrease rapidly since most of the biomass resides in older ages (6+).

A catch scenario of 5,000 t with an exploitation rate of 9% on age 3+ and 11% on the targeted age group (ages 4-7), would reduce the total biomass by 7% and 25% for the targeted age group from the beginning of 2003 to the end of the year.

Setting a TAC at the 2002 catch level (6,450 t), would produce an exploitation rate of 15% on the targeted age group. The biomass of the targeted age group

would decrease 27% during 2003 under that scenario.

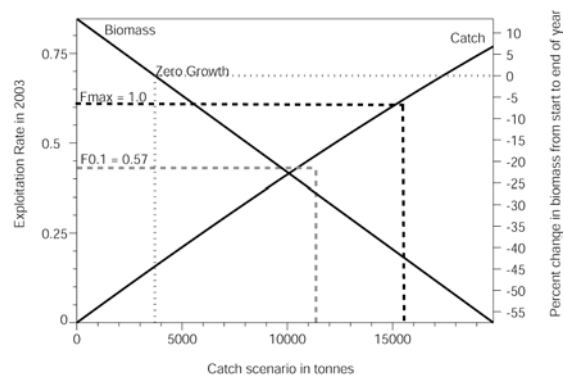
Keeping the fishing effort at the 2002 level would generate a TAC of 7,150 t for 2003. The exploitation rate on the targeted age group rises to 17% while the target biomass would drop by 29% during 2003.

Catch projections at $F_{0.1}$, corresponding to an exploitation rate of 30% on the targeted age group, would be around 11,200 t for 2003. Total biomass and the biomass of the targeted age group are projected to decrease 28 and 43% respectively by the end of 2003 under this scenario.

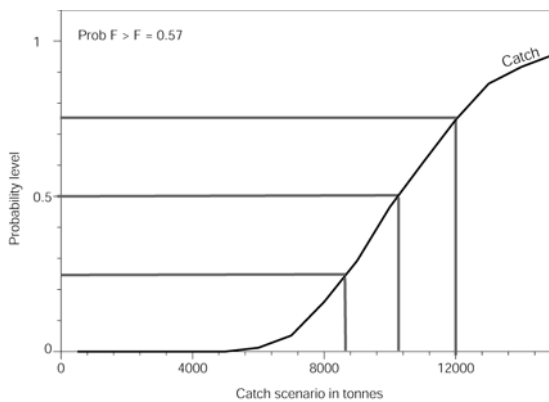
TAC(t)	Exploitation rate during 2003		Biomass (t) End of 2003	
	age 3+	ages 4-7	age 3+	ages 4-7
5,000	9%	11%	24,100	16,150
6,450	12%	15%	22,950	15,600
7,150	14%	17%	22,300	15,150
11,200	25%	30%	18,450	12,200

TAC(t)	Change in B3+ during 2003	Change in B4-7 during 2003
5,000	-7%	-25%
6,450	-11%	-27%
7,150	-14%	-29%
11,200	-28%	-43%

Other catch scenarios may be considered from the plot below.



It is possible to estimate the uncertainties from the model about stock size and use these in a risk analysis. The risk plot only incorporates the difference between the model and the data and not other sources of uncertainty. As an example, there is a 25% probability that a catch scenario of 8,700 t exceeds $F_{0.1}$ for age 5. A catch scenario of 10,300 t has a 50% risk of exceeding the $F_{0.1}$ level while a catch scenario of 12,000 t increases the risk to 75%.



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Robert, G., G.A.P. Black, M.A.E. Butler, and S.J. Smith. 2000. Georges Bank scallop stock assessment - 1999. DFO Can. Stock Assess. Sec. Res. Doc. 2000/016.

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