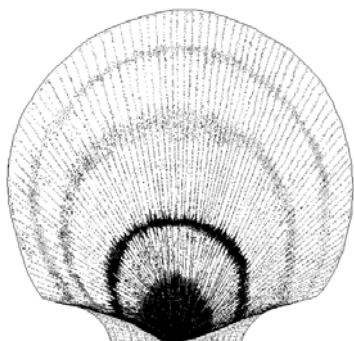




Maritimes Region

Stock Status Report C3-17(2002)



Georges Bank Scallop

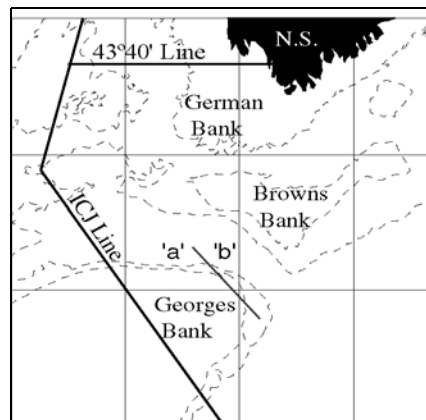
Background

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.
- From a TAC of 6,900 t in 2001 (6,500 zone 'a'; 400 zone 'b'), 6,480 t were caught in zone 'a' and 395 t in zone 'b'. Ages 4 and 5 scallops contributed almost equally to the catch in zone 'a'.
- Catch rates dropped 37% from last year; they are still well above average. While effort has decreased markedly since 1994, there has been a 70% rise from 2000 to 2001. However, effort is still low compared to pre-1994.
- The fishery targeted biomass (ages 4-7) peaked in 1999 and has declined thereafter. The 2001 biomass estimate is near average.
- The pre-recruits index of the 1998 year-class does not appear as strong as first observed in the 2000 survey at age 2. The abundance of recruited age groups is fairly high.

- The fully recruited index for 2000 had tripled over 1999 and is the highest of the 21-year time series. There has been a small (5%) reduction in the fully recruited index for 2001.
- In zone 'a', an exploitation rate of 20% on the age groups 4-7 would give a TAC for 2002 of 5,000 t. It would allow the biomass of ages 4-7 to increase by 4%. An exploitation rate of 23% at the $F_{0.1}$ level would give a TAC of 5,700 t. The biomass of ages 4-7 would decrease by only 1%. An exploitation rate of 27% would keep the TAC at the 2001 level (6,500 t). A 7% decrease in the biomass of ages 4-7 would take place.

The Fishery

Landings (thousands of tonnes)

Year	1970-79 Avg.	1980-89 Avg.	1990-97 Avg.	1998	1999	2000	2001
TAC	-	-	4.7	4.0	3.7	6.8	6.9
Catch	5.9	5.1	4.7	4.0	3.7	6.8	6.9

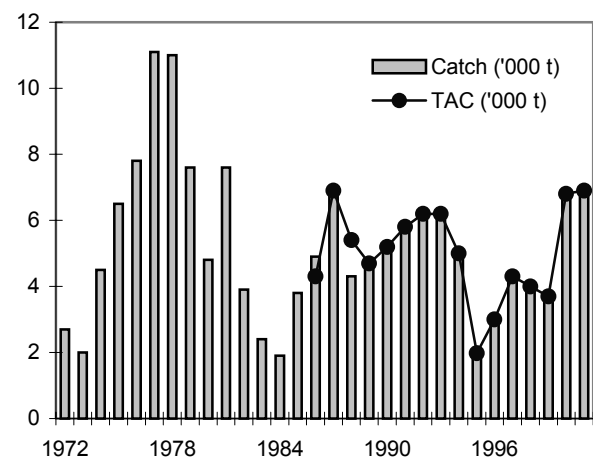
The voluntary introduction of satellite tracking on offshore scallop vessels in early 1998 has allowed micro management of fishing areas to become a reality. Under experimental management in 1998, the scallop grounds of Georges Bank were divided into the traditional area (zone 'a') and a marginal growth 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. Since 1998, zone 'b' has been allocated a quota of 200 t per 6-week time period. At the end of the first 6 weeks, if catch rates 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 rolled twice in 2001 for a total of 400 t. The number

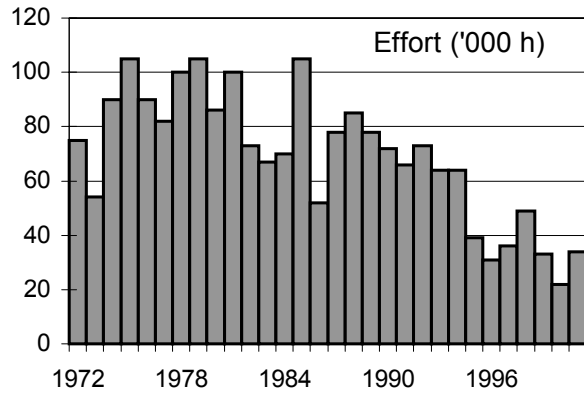
of rolls has declined over the last 3 years due to weaker incoming recruitment.

In 1995, a voluntary industry monitoring program, to discourage the presence of small meats in the catch (50+ meats per 500 g), was implemented. A low tolerance level (10% by number of meats 10 g or less) added more restriction to the regulatory 33 meats per 500g.

The overall TAC for Georges Bank zones 'a' and 'b' reached 6,900 tonnes for 2001. The traditional area (zone 'a') TAC was 6,500 t, a modest increase (5%) over the previous year. Catches in 2001 were 6,480 t in zone 'a' and 395 t in zone 'b'. The zone 'a' catch was the second highest since the implementation of TAC's in 1986.

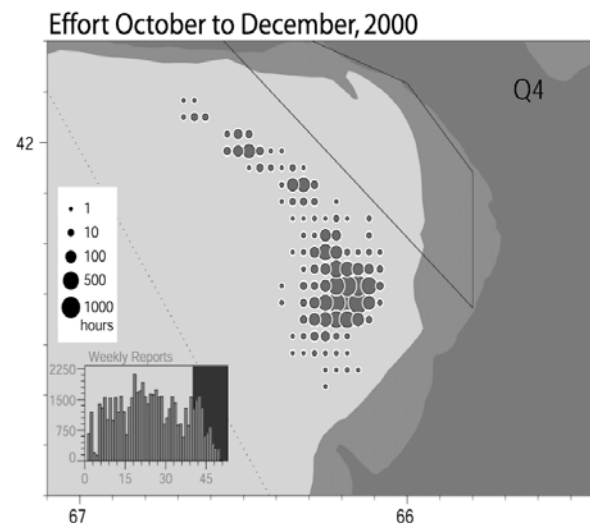
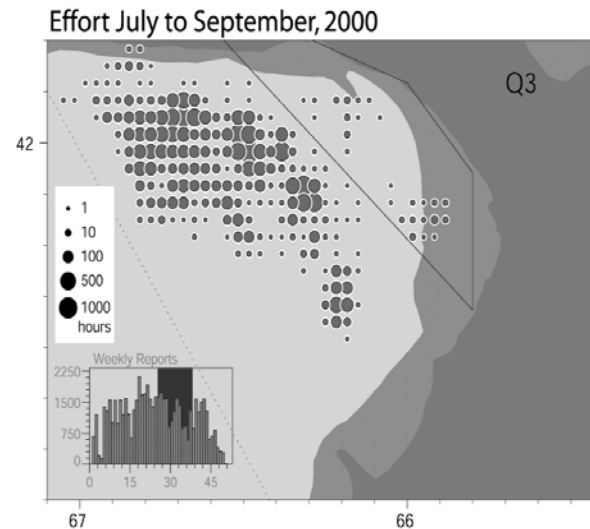
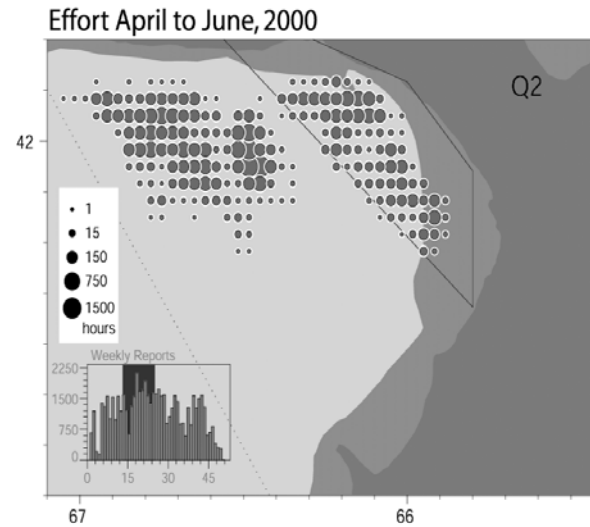
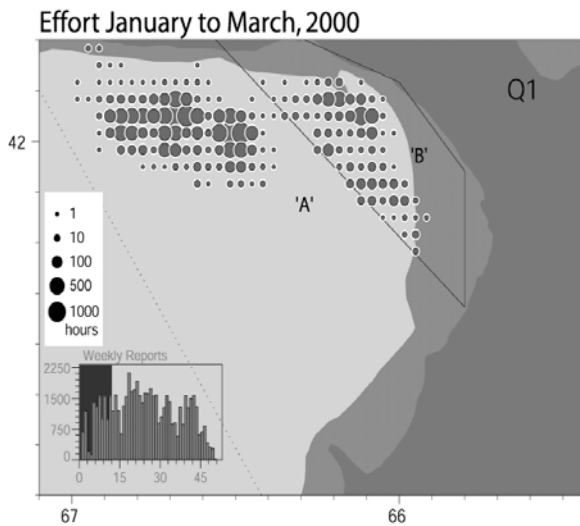


While **effort** in zone 'a' has generally decreased markedly since 1994, there has been a 70% rise from 2000 to 2001. However, effort is still low compared to pre-1994.



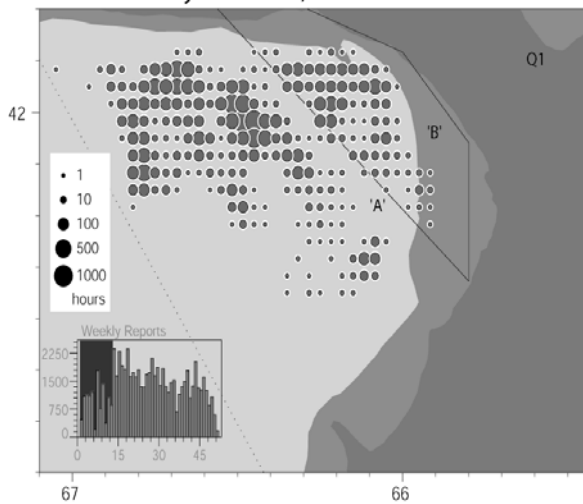
Satellite based monitoring data show concentrations of fishing activities during the year on a quarterly basis. Fishing activities were concentrated into more specific areas in 2000, compared to 2001. The southern half of zone 'a' attracted effort only in the last quarter of 2000 and little effort during the middle of 2001. Distribution patterns of fishing effort shift with availability of scallop beds in terms of density and meat size.

Satellite Tracking Data for 2000

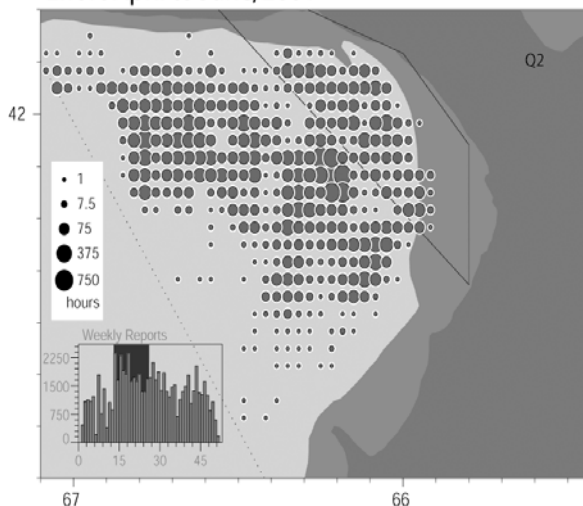


Satellite Tracking Data for 2001

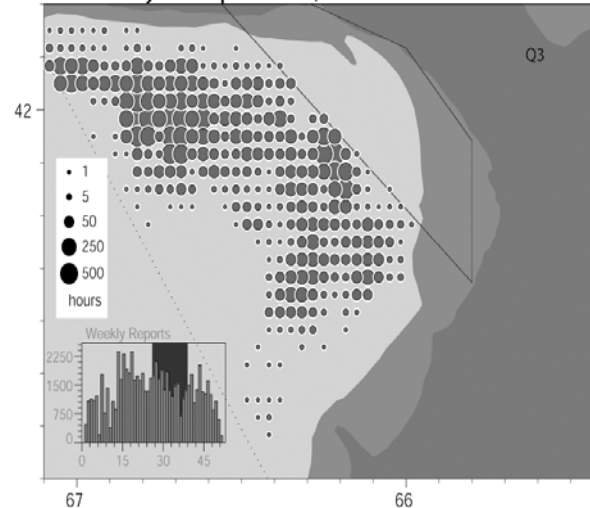
Effort January to March, 2001



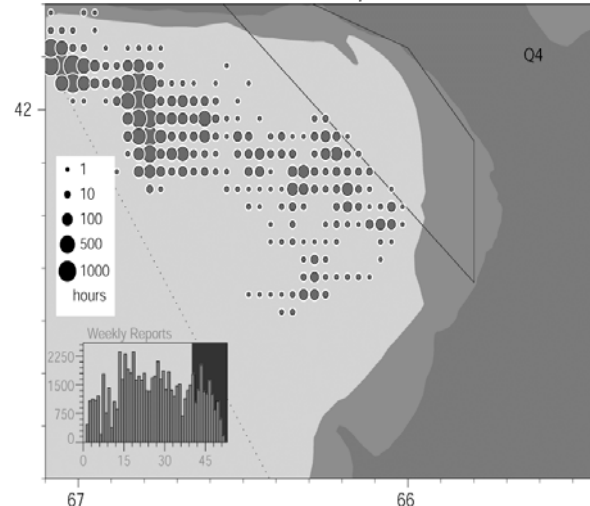
Effort April to June, 2001



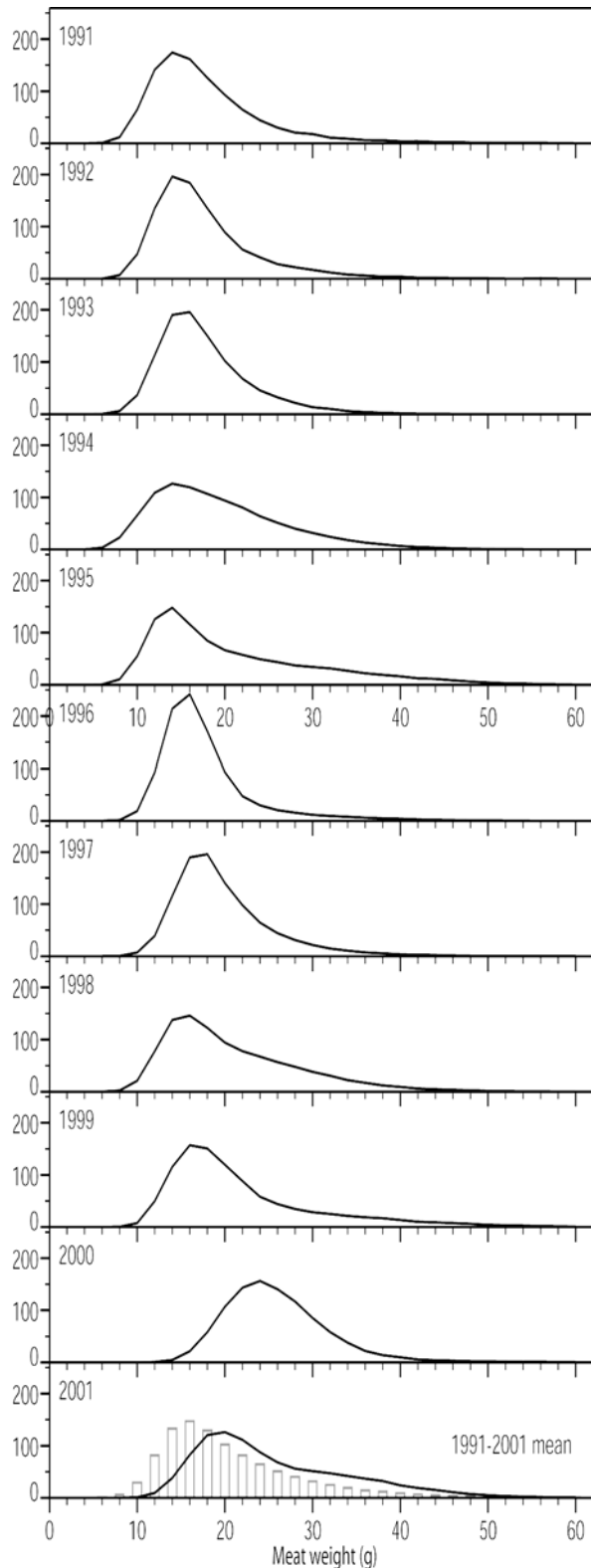
Effort July to September, 2001



Effort October to December, 2001



The **meat weight** profile in the catch from zone 'a' had shifted toward a larger scallop meat in 2000, compared to the long term average (last graph in the column of normalised weight distribution graphs starting in 1991). The 2001 profile is reverting closer to the mean although the proportion of meats over 20 g is still above average. As the year progressed, the modal meat weight went from 23 g in the first quarter to 19 g in the second, 17 g in the third, and 15 g in the last quarter. While meats corresponding to the weight at ages 4 and 5 contributed equally to the catch overall, age 4 scallops made up 75% of catch in the last quarter.

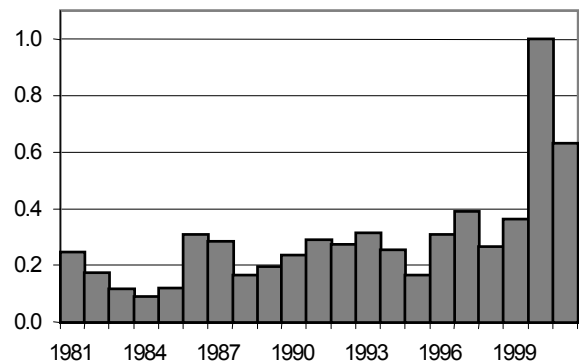


Resource Status

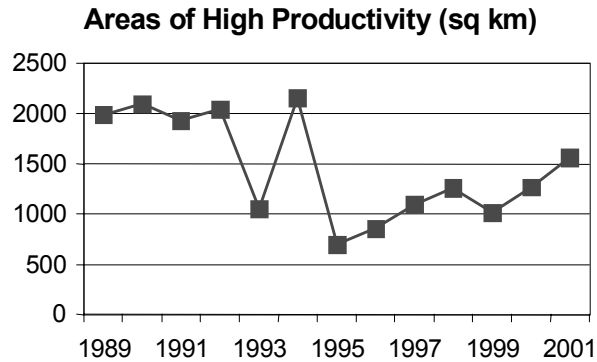
Logbooks provided catch and effort data from which catch rates (CPUE) were estimated. Landings are monitored at dockside. Catch in numbers at age were derived from port samples. Relative biomass indices were derived from research surveys. A Sequential Population Analysis model estimated population abundance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

Commercial catch rates experienced during the 2000 fishery had been exceptionally high. They declined 37% in 2001 but are still the second highest rates since 1981. Monthly figures remained high throughout the year and started to rise during the last quarter.

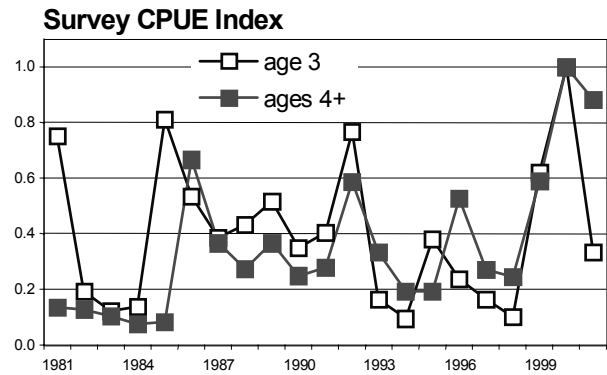
Fleet CPUE Index



High productivity is inferred from areas of high catch-rates. The **area of high productivity** is the proportion of Georges Bank maintaining high catch rates (greater than 1 kg/crew-hour-meter). This area has been over 1,000 km² since 1997. In the past, areas up to 2,000 km² have delivered high catch rates. The high catch-rates of 2001 came from an area 25% larger than in 2000.

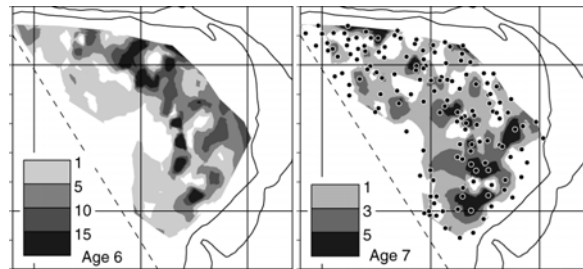
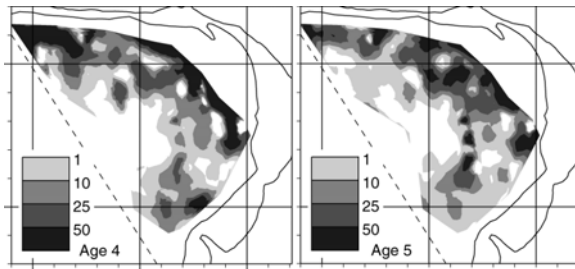


Survey catch rates for all age groups of scallops peaked in 2000. Except for pre-recruits (age 3), the 2001 survey catch rates are still high despite a small drop. High densities of age 5+ scallops were observed, especially in the southern portion of the Bank where fishing effort has been light if present at all. The estimate for ages 4+ may include younger, larger scallops because of the pulse of fast growth experienced after the unusually high primary production of 1999. The pre-recruits index (1998 year-class) does not appear to be as strong as first observed in the 2000 survey at age 2. This may be due to an overestimate of year-class strength in 2000 or that larger scallops, which are actually age 3 in 2001, were classified as age 4. Current abundance estimates of the 1998 year-class suggest that it is below average.

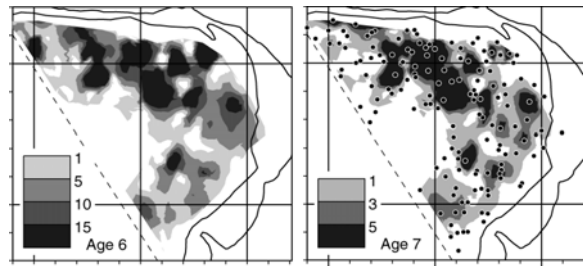
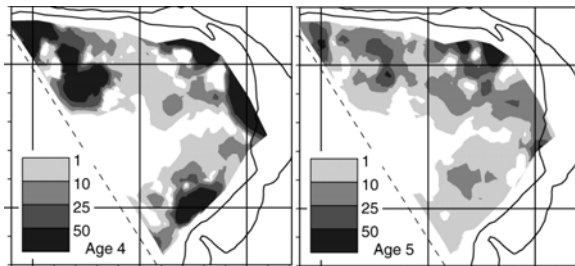


The spatial distribution of numbers at age for ages 4 to 7 from research survey data is presented in the following shaded contour plots. Survey locations are shown by dots on a map for each survey. The contour plot for age 4 in 2001 shows a wide distribution of densities higher than 50 scallops per tow on the Canadian side of Georges Bank.

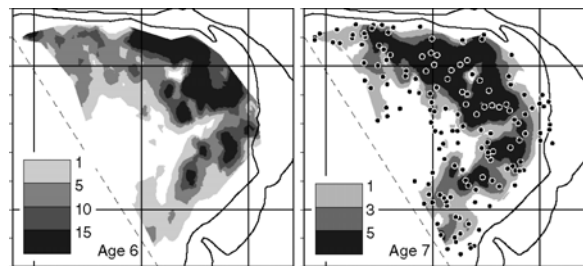
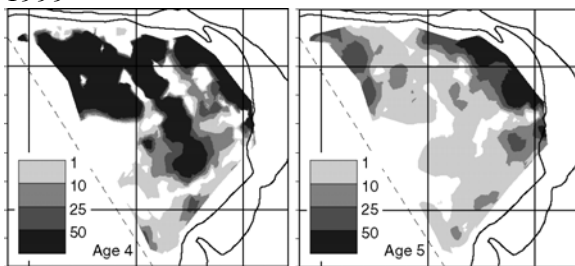
1997



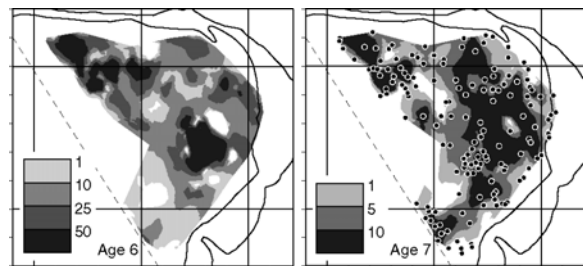
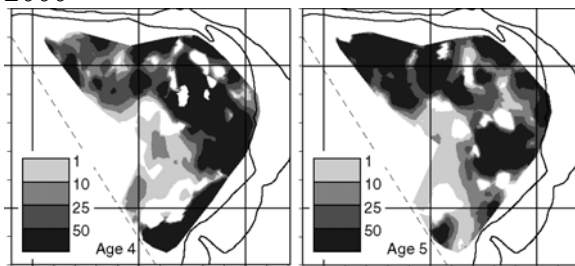
1998



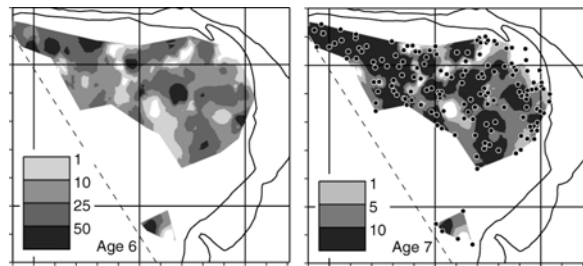
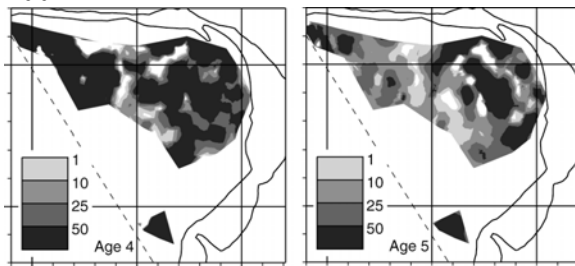
1999



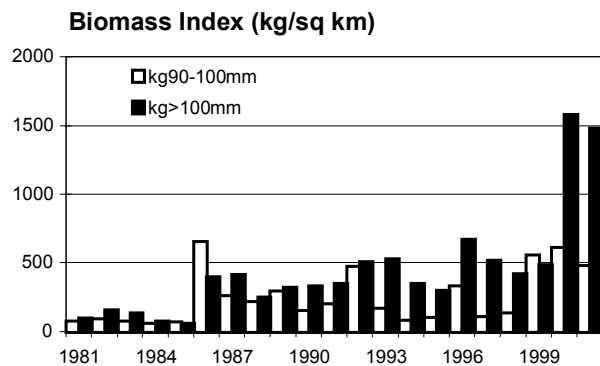
2000



2001

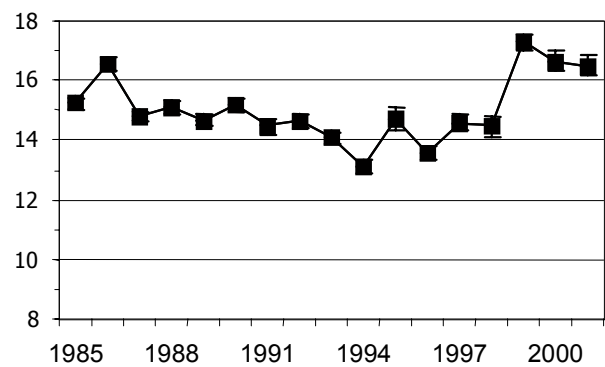


A **biomass index for shell height groupings** has been developed from research survey data for 1981–2001. Indices of fully recruited scallops (shell height over 100 mm) have generally been much higher after the implementation of catch limits and lower meat count in 1986. The fully recruited index for 2000 had tripled over 1999 and is the highest of the 21-year time series. There has been a small (5%) reduction in the fully recruited index for 2001. There is more variability in the index for young recruits (shell height 90–100 mm). The index has been high since 1999, suggesting a large influx of young recruits to the fishery for a few years to come.

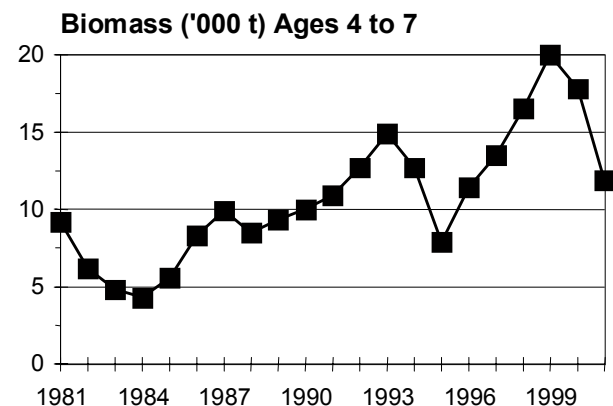


The status of the stock may also be monitored with a **meat weight index**. From 1987 to 1998, a meat weight of 15 g or slightly less in a 100-mm scallop shell was typical of the Georges Bank environmental conditions. The meat of a 100-mm scallop was 17% heavier in 1999 than in 1998. This was mainly due to the rapid growth experienced on the northern edge of Georges Bank. There has been a slight drop in the meat weight index for 2000 and 2001 but it is still above average.

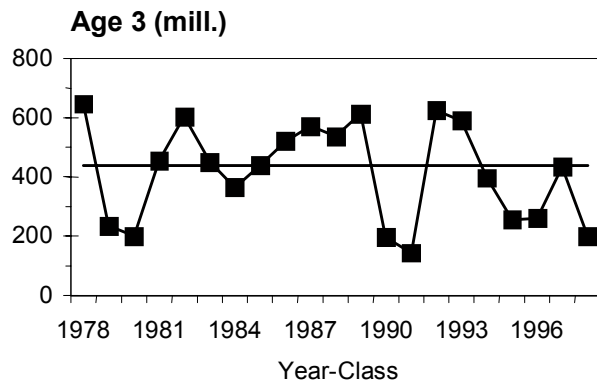
Meat Weight (g) for 100-mm Shell



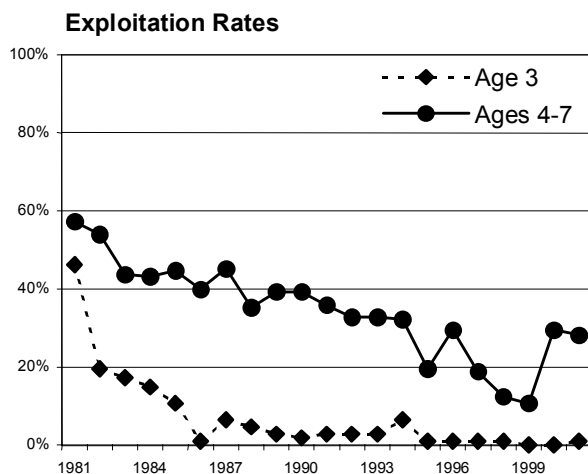
The **fishery targeted biomass** from the population model (sum of ages 4–7) increased from 1995 to 1999. Peak values in 1999 were due to good recruitment and exceptional growth. Biomass has been declining after that with 2001 reverting to the mean and 33% lower than 2000.



It became quite difficult to properly estimate year-class strength at the **recruitment** stage after 1999 when accelerated growth smeared year-class strength for the 1996, 1997, and 1998 year-classes. This phenomenon was more pronounced in scallop aggregations on the northern edge of Georges Bank. While the 2000 research survey results were showing a strong 1998 year-class at age 2, it would appear that this year-class is smaller according to the 2001 observations. Year-class strength at age 3 is a more stable indicator than at age 2.



The **exploitation rate** on the targeted age group declined steadily since the early 1980's, to reach a minimum near 10% in 1999. It has climbed since then, with the 2001 rate slightly below 2000 at 28%. The exploitation rate on age 3 has stayed low since 1986, when the 33 meat count forced the fishery 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
Biomass estimate age 3+ 1981-2001	Increasing since 1995	Decrease from record high
Exploitation estimate ages 4 to 7 1981-2001	Decreasing	Modest rise last 2 years
Commercial catch rates 1981-2001	Stable	Second highest of the series
Biomass survey, ages 4 to 7 1981-2001	Varying	Second highest of the series
Recruitment survey, age 3 1981-2001	Varying	Below average
Survey biomass index 90-100 mm shell height 1981-2001	Low	Above average
Meat weight index 1985-2001	Stable	Small decline from record high
Areas of high productivity	Slowly rising	Medium-concentrated

Sources of Uncertainty

The main source of uncertainty in this year's assessment appears to be the unusually fast growth of recent year-classes. The same age/shell model is assumed for all years and as a result, the faster growing year-classes will look older than they really are. This effect will introduce uncertainty into how well the population model estimates the strength of these recent year-classes. The extent of the impact will become better-defined in future stock assessments as these year-classes grow older.

The 2001 research survey undertook limited coverage to the bank south of latitude 41.7°N, where aggregations of age 3 scallops had been observed in the area in the previous survey. As a result, there is the possibility that the abundance of age 4 scallops has been underestimated by the 2001 survey.

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 commercial catch rates 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 miss-specifications.

Outlook

The following evaluations of catch scenarios are based upon the population model used for this assessment. While the uncertainties noted above for the model suggest caution in interpreting the results, other indicators presented in this document should be taken into account when evaluating the status of the stock. In particular, record highs have been observed for catch rate indices, survey biomass levels and growth-rate since 1999. Over 20 years of observations support some of these records. At present, most indicators seem to be going back toward average conditions, although some are still high relative to their past values.

A catch scenario of 5,000 t with an exploitation rate of 16% on age 3+ and 20% on the targeted age group (ages 4-7), would provide for a 1% increase of the total biomass and 4% for the targeted age group from the beginning of 2002 to the end of the year. This is the only scenario with projected increase in biomass.

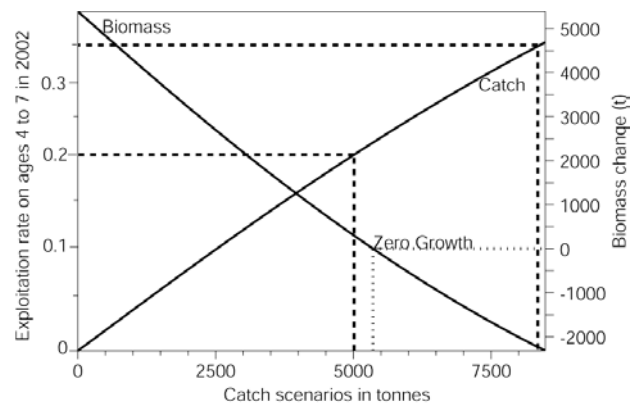
Catch projections at $F_{0.1}$, corresponding to an exploitation rate of 23% on the targeted age group, would be around 5,700 t for 2002. Total biomass and the biomass of the targeted age group are projected to decrease 2 and 1% respectively by the end of 2002 under that scenario.

Keeping the TAC at the 2001 level (6,500 t), would produce an exploitation rate of 27% on the targeted age group. The biomass of this targeted age group would decrease 7% during 2002 under that scenario.

A catch scenario at F_{max} (8,300 t), corresponds to an exploitation rate of 35% on the targeted age group. The total biomass would be 15% smaller at the end of 2002 but the biomass of the targeted age group would decline 19% during the year.

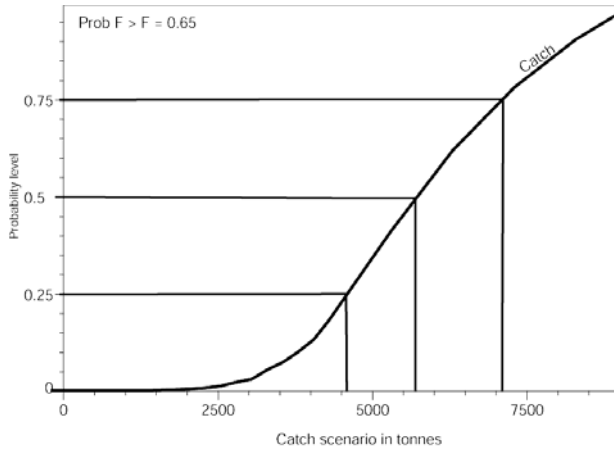
TAC(t)	Exploitation rate		Biomass (t)		Change in B4-7 during 2002
	age 3+	ages 4-7	End of 2002 age 3+	ages 4-7	
5,000	16%	20%	25800	11600	+4%
5,700	18%	23%	25050	11050	-1%
6,500	21%	27%	24250	10450	-7%
8,300	28%	35%	22250	9350	-19%

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. In the model used here, there is a 25% risk that a catch scenario of 4,550 t exceeds $F_{0.1}$ for age 5. This age group is the only one that is fully recruited to the fishery. A catch scenario of 5,700 t has a 50% risk of

exceeding the $F_{0.1}$ level while a catch scenario of 7,100 t increases the risk to 75%.



For more Information

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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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