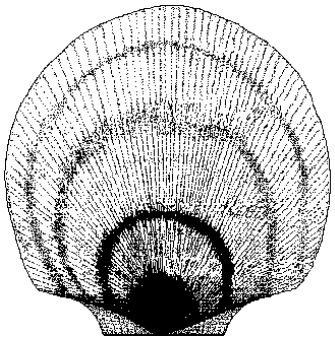
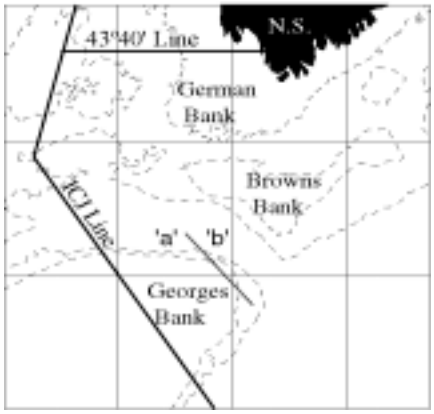


Georges Bank Scallop



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.

The most recent assessment of this stock was conducted in the spring of 2000 (SSR C3-17 (2000)). This assessment is the first update of the stock status.

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. Zone 'b' is managed with a higher meat count than zone 'a' and a rolling TAC. As long as catch rates do not decrease significantly and the meat count is met, a further quota is allowed over the next period.

- From a TAC of 6,800 t in 2000 (6,200 zone 'a'; 600 zone 'b'), 6,212 t were caught in zone 'a' and 601 t in zone 'b'. Scallops corresponding to age 5 made up 57% of the catch in zone 'a'. Catch-rates were also exceptionally high.

- The fishery targeted biomass estimate (ages 4-7) has been rising since 1995 and reached the highest level recorded over the last 20 years in 2000.

- Incoming year-classes (1996 and 1998) to the fishery estimated from survey data appear above average. Recruited age groups also appear abundant.

- In zone 'a', an exploitation rate of 19% on the age groups 4-7 at the 2000 effort level

would give a TAC for 2001 of 4,450 t. It would allow the biomass of ages 4-7 to increase by 12%. At an exploitation rate of 30%, a TAC of 7,000 t would allow the biomass of ages 4-7 to increase by only 1%.

The Fishery

Landings (thousands of tonnes)

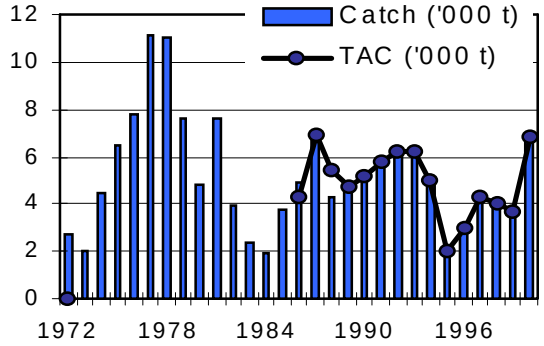
Year	1970-79 Avg.	1980-89 Avg.	1990-96 Avg.	1997	1998	1999	2000
TAC	-	-	4.8	4.3	4.0	3.7	6.8
Catch	5.9	5.1	4.8	4.3	4.0	3.7	6.8

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.

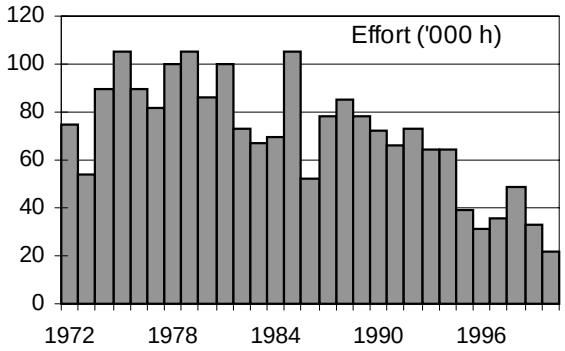
The management of zone 'b' included 'rolling' TAC's and a meat count of 50 meats per 500 g. Since 1998, zone 'b' has a quota of 200t per 6-week time period. At the end of the first 6 weeks, catch rates and meat counts were such that a further 200 t was allowed over the next 6-week period. This approach is called a rolling TAC. After review, the TAC rolled 3 times in 2000 for a total of 600 t. The TAC had rolled 6 times the previous year.

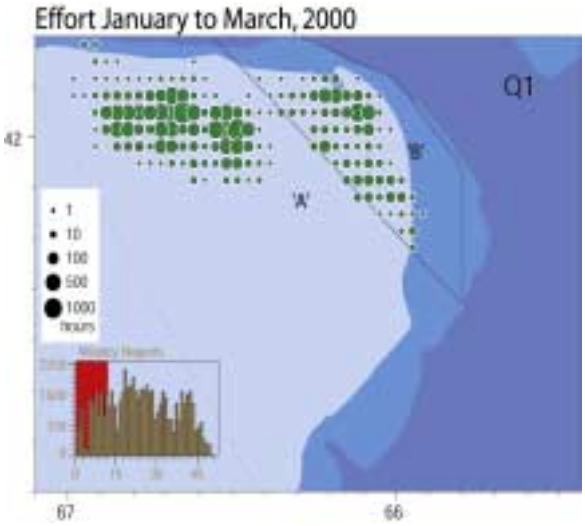
In 1995, a voluntary industry monitoring program to discourage the presence of small meats in the catch (50+ meats per 500 g) was implemented. A low tolerance level (10% by number of meats 10 g or less) added more restriction to the regulatory 33 meats per 500g.

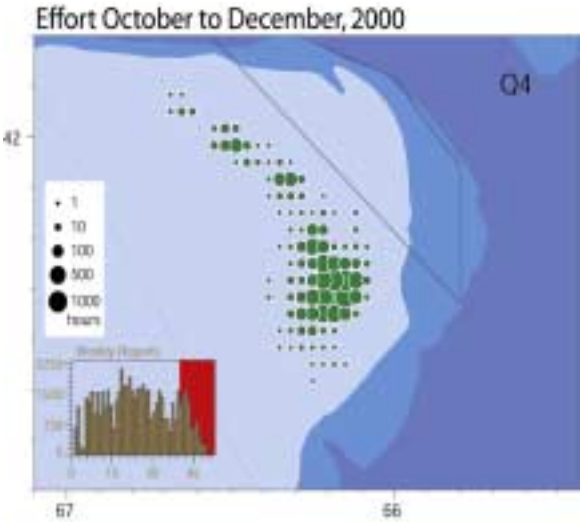
The overall TAC for Georges Bank zones 'a' and 'b' reached 6,800 tonnes for 2000. The traditional area (zone 'a') TAC was 6,200 t, a 250% increase over 1999. A strong year-class entering early to the fishery contributed significantly to the increase.

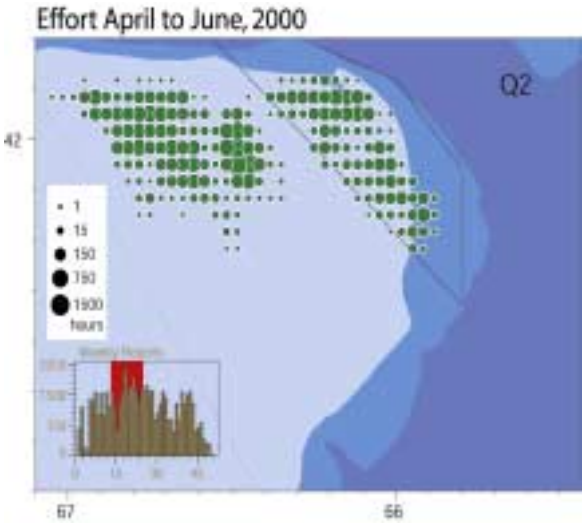


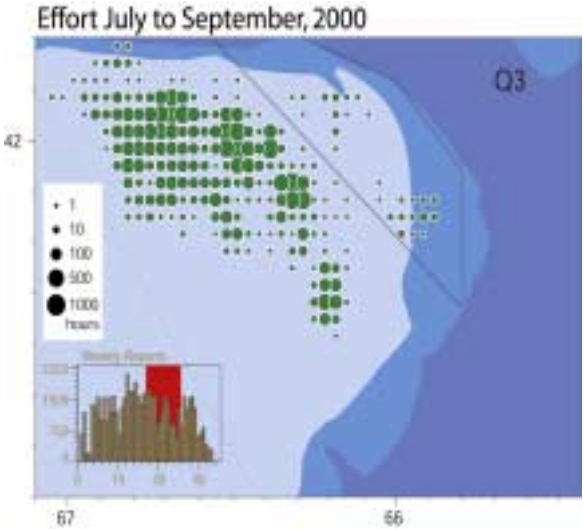
Effort in zone 'a' has decreased markedly since 1994. The 2000 effort levels are the lowest observed in the last 30 years. Satellite based monitoring data (see quarterly maps below) shows high concentrations of fishing activities during well defined periods. The southern half of zone 'a' only encountered effort from September until the end of the year.



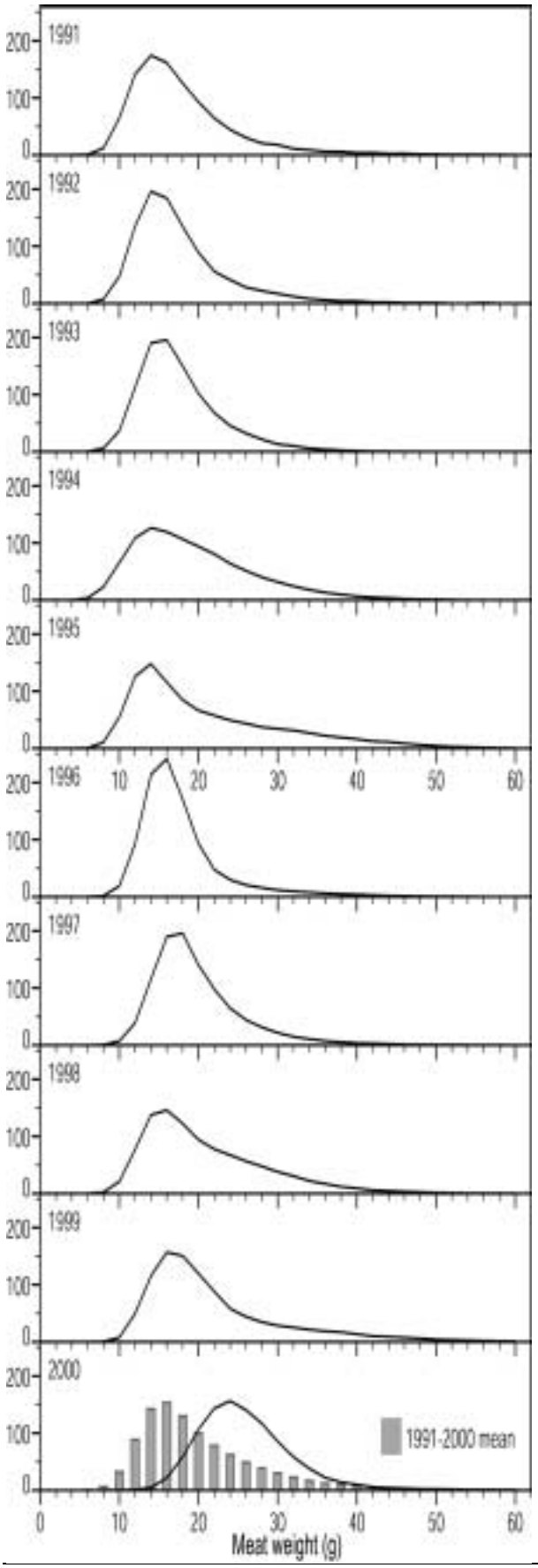








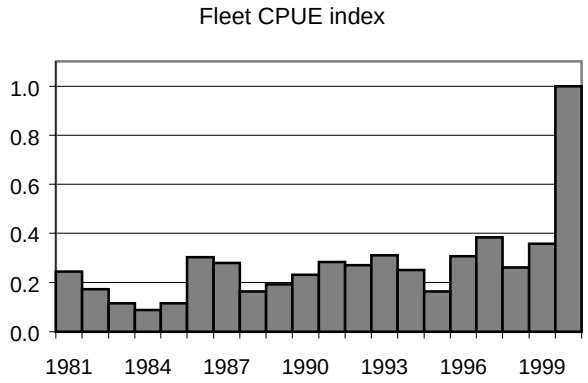
The **meat weight** profile in the catch from zone 'a' shifted markedly toward a larger scallop meat in 2000 compared to the long term average (last graph in the column of weight distribution graphs starting in 1991). The modal meat weight distribution was at 23-24 g or a 21-count scallop (number of meats per 500 g). Monthly mean trip counts ranged from 17 to 23 meats per 500 g; these are very low counts. Meats corresponding to the weight at age 5 made up for 57% of the catch. It is usually well below 40%.



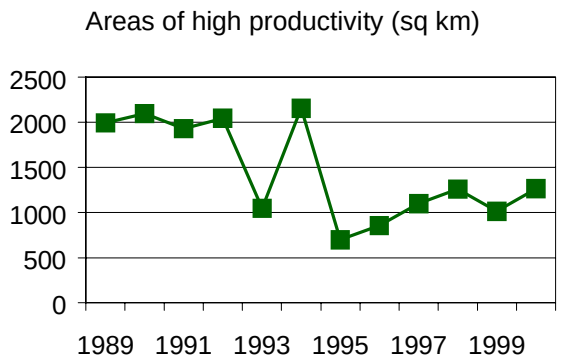
Resource Status

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.

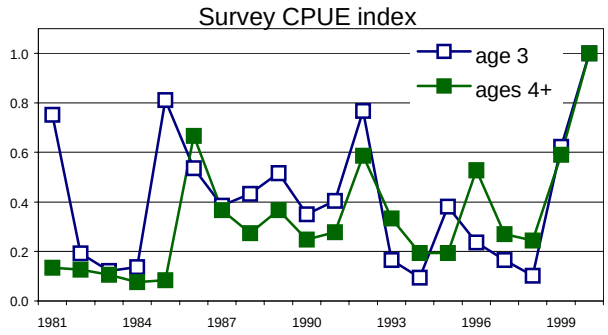
Commercial catch-rates experienced during the 2000 fishery were exceptionally high. The estimated mean for the year is 3 times the next highest level observed in 1997. Year 2000 started with unusually high catch-rates that declined gradually during the fishing season; Oct.-Dec. rates were still high.



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 km^2 since 1997. In the past, areas up to 2,000 km^2 have delivered high catch rates. In 2000, exceptionally high catch rates were concentrated in a relatively small area.

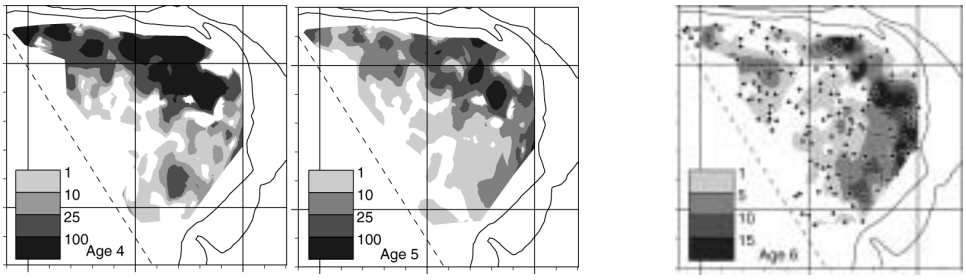


Survey catch rates for all age groups of scallops were high in 2000. Higher numbers of age 5+ were observed especially in the southern portion of the Bank. The abundance of age 5 is also inflated because of the rapid growth rate of the strong 1996 year-class (age 4) in 1999. As a result, the survey index for the 4+ age group is the highest of the 20-year series. The index for age 3 scallops, the 1997 year-class, is likely overestimated due to an influx of fast growing age 2 scallops. The 1998 year-class at age 2, is very strong and is also distributed widely on the Bank, including along the edge of the southern portion. It will be recruiting to the fishery in 2002-2003.

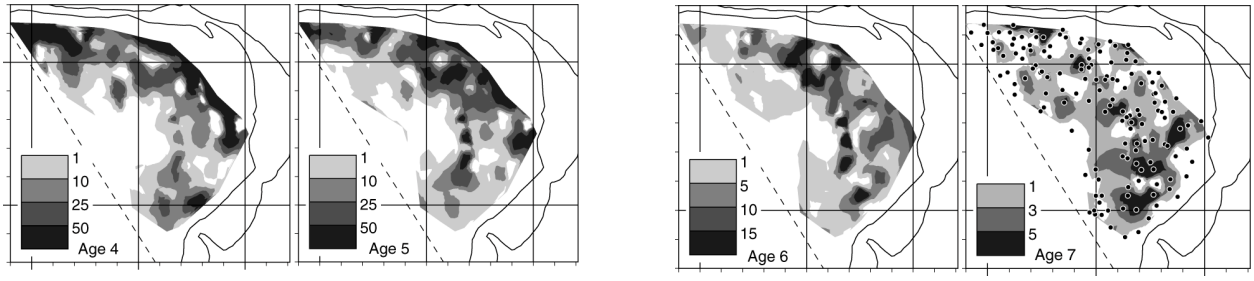


The spatial distribution of numbers at age for ages 4 to 7 from research survey data is presented in the following shaded contour plots. Survey locations are shown by dots on a map for each survey. The contour plots for ages 4 and 5 in 2000 shows a wide distribution over the Canadian side of Georges Bank.

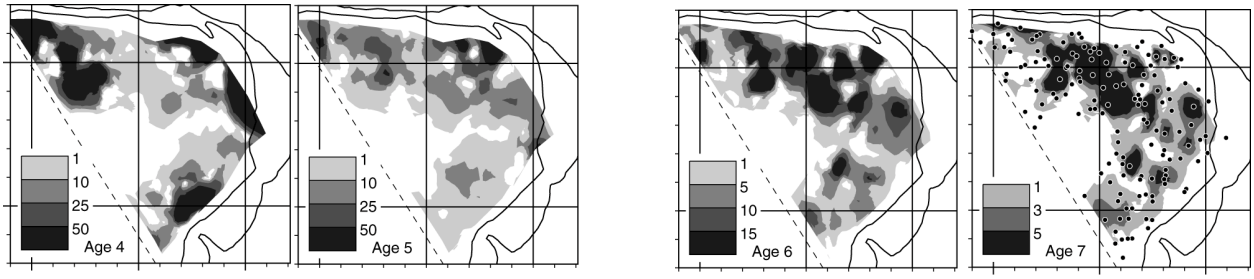
1996



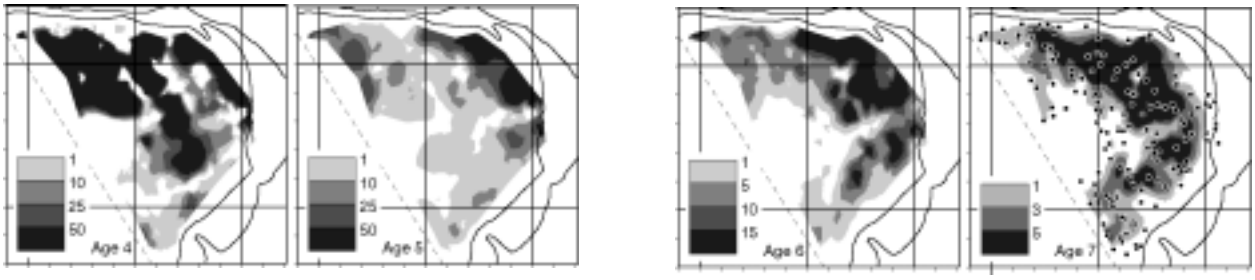
1997



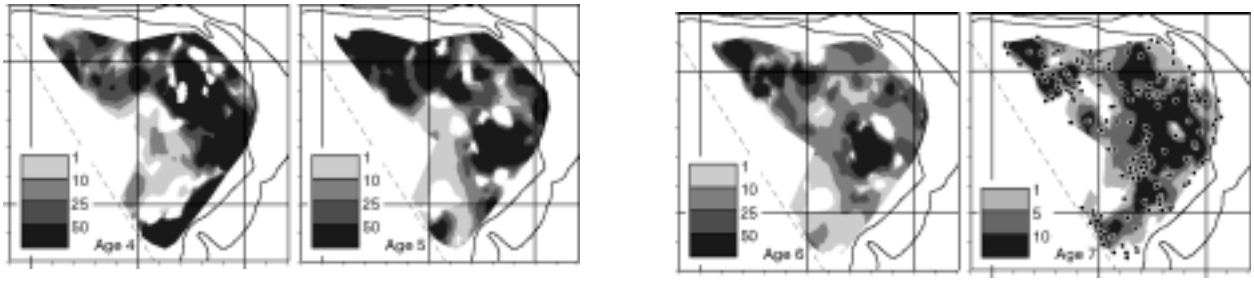
1998



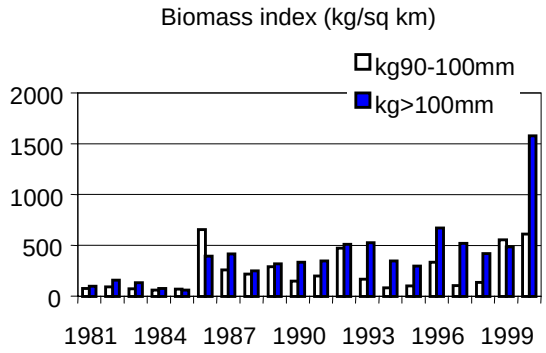
1999



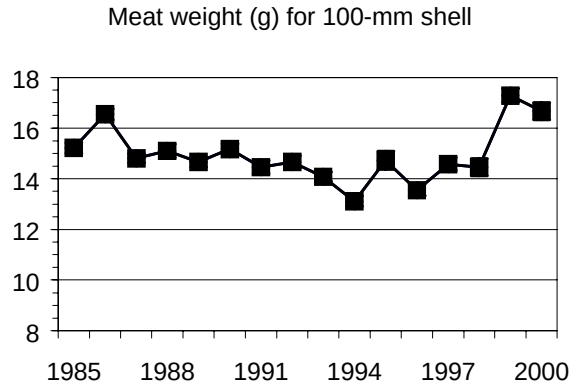
2000



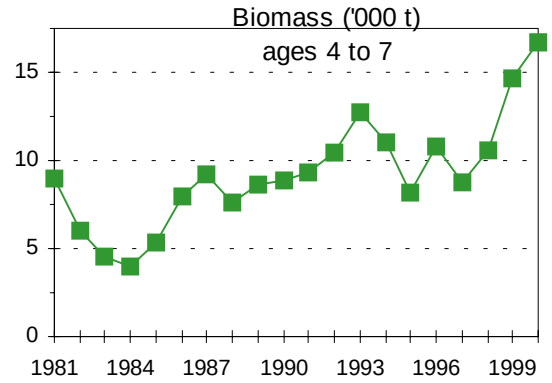
A **biomass index for shell height groupings** has been developed from research survey data for the period 1981-2000. Fully recruited indices (shell height over 100 mm) have generally been much higher after the implementation of catch limits and lower meat count in 1986. The fully recruited index for 2000 has tripled since 1999 and is the highest of the 20-year time series. There is more variability in the index for young recruits (shell height 90-100 mm). The index is high for both 1999 and 2000 suggesting a large influx of young recruits to the fishery for a few years to come.



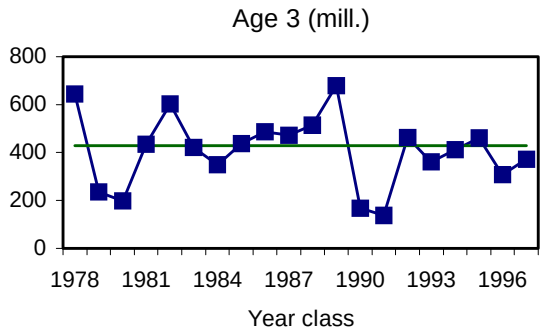
The status of the stock may also be monitored with a **meat weight index**. Large meats for a fixed shell height have not been seen on Georges Bank since 1986. A 14-g meat in a 100-mm scallop shell is typical of the period 1993-1998. The meat of a 100-mm scallop was 17% heavier in 1999 than in 1998. This was mainly due to the rapid growth experienced on the northern edge of Georges Bank. There has been a slight drop in weight for 2000 but it is still above average.



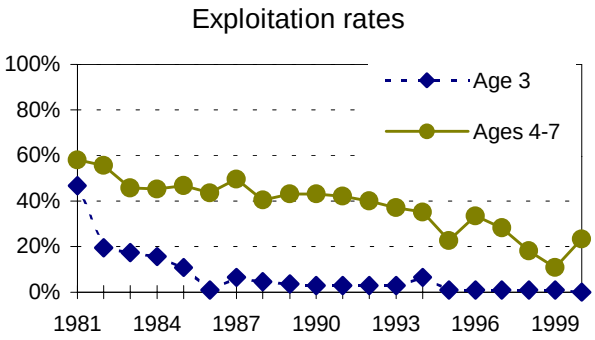
The **fishery targeted biomass** from the population model (sum of ages 4-7) has been increasing since 1995 and is the highest of the time series due to good recruitment and exceptional growth.



Recruitment has been near average (horizontal line in graph below) after the very weak 1990 and 1991 year-classes. Research survey results show stronger 1996 and 1997 year-classes than the population model. The 1996 year-class was underestimated as a result of the increased growth rate, causing scallops of the 1996 year-class at age 3 to look like scallops at age 4 in 1999. The first observations of the 1997 year-class at age 2 indicated a weak year-class, but the 1998 year-class at age 2, is abundant. This year-class also grew quite rapidly in 1999 so that in 2000, a portion appears to be at a size normally associated with age 3 scallop.



The **exploitation rate** on the targeted age group declined from 33% in 1996 to 11% in 1999 before rising to 23% in 2000. It had reached the lowest point in 1999 at 11%. 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+ 1981-2000	Increasing since 1995	Highest of the series
Exploitation estimate ages 4 to 7 1981-2000	Decreasing	Modest rise
Commercial catch rates 1981-2000	Stable	Extremely high
Biomass survey, ages 3 to 7 1981-2000	Varying	Very high; almost double figure for 1999
Recruitment survey, age 3 1981-2000	Increasing	Above average
Survey biomass index 90-100 mm shell height 1981-2000	Low	Above average
Meat weight index 1985-2000	Stable	Small decline from record high
Areas of high productivity	Stable	Low-concentrated

Sources of Uncertainty

The projection results carry a certain degree of **uncertainty** that is a function of how well year-class strengths are estimated. There is no doubt that the 1996 and 1998 year-classes will have a significant impact on the Georges Bank scallop stock. The extent of the impact will become better defined as the year-classes age. To date, the abundance estimates rely mainly on survey observations.

The main source of uncertainty in this year's assessment appears to be the fast growth of recent year-classes.

Another source of uncertainty arises from the fact that the same age/shell height model was assumed for all years. There is spatial heterogeneity in the distribution of age groups. The fleet is targeting scallop beds because of scallop size; this will affect catch rates used in the model.

Other uncertainties include variations in weight at age, partial recruitment, variations in natural mortality, systematic errors in data reporting or model misspecifications.

Outlook

Incoming year-classes (1996 and 1998) to the fishery estimated from survey data appear above average. Recruited age groups also appear abundant. Growth rate indicators are above average. Such stock conditions have rarely been observed previously.

Keeping the fishing effort at the 2000 level would generate a TAC for 2001 of 4,450 t with an exploitation rate of 19% on the targeted age group. The biomass of this targeted age group would increase 12% during 2001 under that scenario.

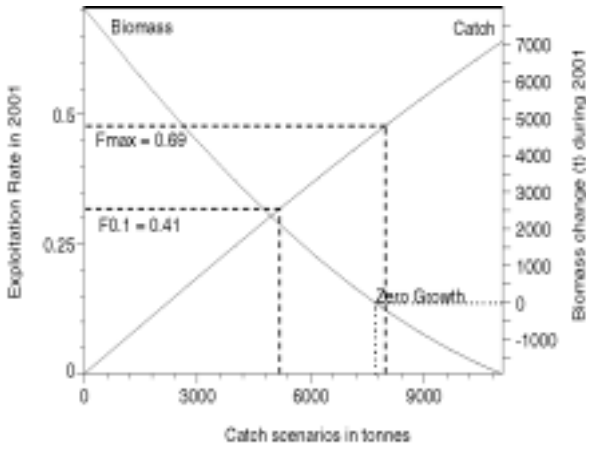
Catch projections at $F_{0.1,}$ corresponding to an exploitation rate of 22% on the targeted age group, would be around 5,250 t for 2001. The biomass of the targeted age group is projected to increase 9% by the end of 2001 under that scenario. The 1995 and 1996 year-classes would represent 40% of the total biomass.

A catch scenario of 7,000 t with an exploitation rate of 25% on age 3+, 30% on the targeted age group, would provide for a 3% increase of the total biomass and 1% for the targeted age group from the beginning of 2001 to the end of the year.

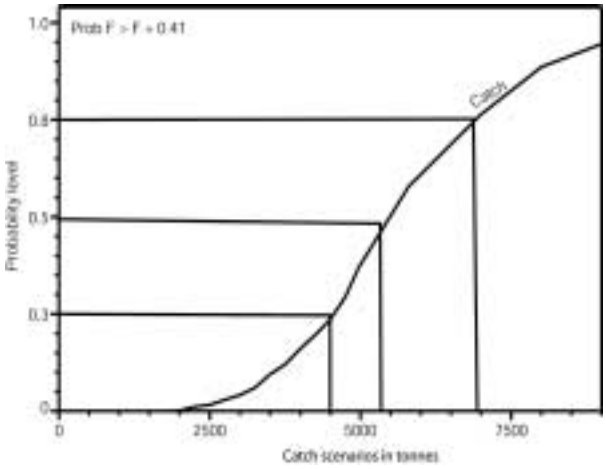
A catch scenario at F_{max}, 7,950 t, corresponds to an exploitation rate of 34% on the targeted age group. The total biomass would be 2% smaller at the end of 2001 but the biomass of the targeted age group would decline 5% during the year.

TAC(t)	Exploitation rate		Biomass (t) End of 2001		Change in B4-7 during 2001
	age 3+	ages 4-7	age 3+	ages 4-7	
4,450	16%	19%	27200	18250	+12%
5,250	19%	22%	26400	17700	+9%
7,000	25%	30%	24550	16450	+1%
7,950	30%	34%	23450	15500	-5%

Other catch scenarios may be considered in 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 30% risk that a catch scenario of 4,500 t exceeds $F_{0.1}$. A catch scenario of 5,250 t has a 50% risk of exceeding the target level while 6,900 t increase the risk to 80%.



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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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