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Update of Fishery and Research Survey Information on the Southern Gulf of St. Lawrence Cod Stock, April 1997

A.F. Sinclair, G.A. Chouinard, L.G. Currie

Department of Fisheries and Oceans, Gulf Fisheries Centre,
P.O. Box 5030, Moncton, N.B., E1C 9B6

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Abstract

Directed cod fisheries in the southern Gulf of St. Lawrence remained closed in 1996 as has been the case since September 1993. Total reported landings were 1142 t coming from by-catch in other fisheries, a sentinel survey, a mesh selection experiment, and a recreational fishery. The results of the 1996 research vessel survey, sentinel surveys, and input from the fishing industry indicates that stock size remains low. Adult biomass has increased since the closure but this is due mainly to growth. Recruitment of young fish remains well below average. Continued low levels of fishing and improved recruitment are required for stock recovery.

Résumé

La pêche dirigée de la morue du sud du golfe Saint-Laurent, interdite depuis septembre 1993, est demeurée fermée en 1996. Les débarquements totaux signalés ont atteint 1 142 t et provenaient de prises accessoires d'autres pêches, d'un relevé par pêche sentinelle, d'un essai de sélection par maillage et de la pêche récréative. Les résultats du relevé par navire de recherche de 1996 et des relevés par pêche sentinelle, et les données fournies par l'industrie de la pêche montrent que le stock demeure faible. La biomasse des adultes s'est accrue depuis la fermeture mais cela s'explique surtout par la croissance. Le recrutement de jeunes poissons demeure bien en deçà de la moyenne. Le rétablissement du stock exige le maintien de faibles niveaux de pêche et l'amélioration du recrutement.

Introduction

This report presents new information on stock status obtained from research vessel surveys and sentinel surveys.

Closure of the commercial cod fishery and the existence of a reliable research vessel survey have allowed direct estimation of the natural mortality rate (M) of this cod stock. M is an important parameter in stock assessments but it is very difficult to estimate when fishing is ongoing. Previous estimates were based on information collected prior to the mid-1970s and were based on indirect methods. A value of 0.2 has been used. However, the mortality rate measured by research vessel surveys since the fishery closure, and regressions of total mortality and fishing intensity for the period 1971 - 1996, indicate that M is closer to 0.4 for adult cod. It is also possible that M may have increased in the late 1970s although the precise time of a change still needs to be resolved (RAP Proceedings). Investigations of the recent dynamics of M are ongoing. The traditional sequential population analysis of the stock was not attempted pending completion of this research.

Description of the 1996 Fishery

Directed commercial cod fishing continued to be prohibited in 1996. Other fisheries which normally produce some cod by-catch were also closed in 1996, including Unit 1 redfish and 4T white hake. Fisheries for American plaice, witch flounder, winter flounder and dogfish were permitted. However, these fisheries were subject to a number of management measures designed to limit cod by-catch. A recreational fishery using hook and line gear was allowed. A sentinel survey conducted under a scientific protocol and designed to obtain additional indices of abundance of the stock was conducted. Experiments designed to collect information on mesh selection for otter trawls and Danish seines yielded significant catches of cod. In this section, a summary of landings, management measures and input from industry about the status of the southern Gulf of St. Lawrence cod stock in 1996 is provided.

Landings by gear, area, season, fishery type

The total reported landings of southern Gulf cod was 1142 t in 1996 (Table 1). This is slightly higher than landings for 1995 (1036 t) and represents the second lowest catch on record for this stock (Figure 1). The catches were entirely from NAFO Division 4T except for 2 t reported from 4Vn in the period of November-December.

Landings increased for all gear types except miscellaneous gears for which there were no reported landings in 1996 (Table 2). The sentinel surveys accounted for approximately 370 t. Landings by vessels involved in sentinel surveys were reported in the DFO catch and effort statistics from the Gulf/Maritimes Region but not from the Quebec Region. In order to fully account for these landings, estimates made at sea by fisheries observers were used instead of those reported in the DFO statistics. It would be useful if all sentinel survey landings were reported in the DFO landings statistics. A mesh selection experiment conducted by an otter trawler and a Danish seiner yielded 225 t of landings. The handline landings include 150 t estimated for recreational fisheries but not yet included in the DFO landings statistics (DFO, Resource Allocation Branch, pers. com.). These figures are preliminary and will change when the final results for the recreational fishery are tabulated.

Monthly landings peaked in September mainly due to the sentinel surveys. This trend is contrary to the traditional pattern with peaks in January (in 4Vn), April and November (in 4T) (Figure 3 in {Sinclair, 1994 #731}). Landings by fixed gears occurred predominantly in the period of August to October while the recreational fishery peaked in August.

Management measures

Management measures in 1996 were similar to those of 1995. With the continued closure of the fishery in 1996, DFO maintained the by-catch limits of 10% (by weight) of cod in fisheries directed toward other species. If a fleet sector exceeded this limit in an area, the fishery would be closed for at least 10 consecutive days. The duration of subsequent closures in the same area increased, and in one instance the fishery was closed for the rest of the year. There was no redfish fishery in 4Vn between January-April, 1996 or in 4T for the entire year because of the Unit 1 redfish closure. Flatfish fisheries were not permitted in 4Vn during the winter months (January-April).

In addition to the by-catch protocol, DFO implemented a small fish protocol whereby fisheries were closed if the percentage of small fish caught exceeded specific thresholds. The minimum fish sizes agreed to by the industry were the following:

- 30 cm for American plaice;
- 45 cm for white hake;
- 25 cm for winter flounder and yellowtail;
- 41 cm for cod.

There was an increase in regulated mesh size for American plaice and witch from 145 to 155 square resulting in very few small fish closures. Of the 82 closures in 4T during 1996, 3 were because of small flatfish and the rest cod by-catch (R. Hébert, DFO Resource Allocation, Moncton, pers. com.). DFO monitored landings of small fish through the dockside monitoring system. Samples collected by dockside monitors were compared to those collected by observers at sea. On two occasions, the plaice fishery was closed when dockside samples suggested that discarding at sea was taking place on vessels not covered by observers. Increased monitoring was also put in place in the fixed gear fishery.

Input from industry

The pre-assessment consultation was comprised of a series of Science Workshops, designed specifically to obtain the views of industry on the status of the stocks. These were held throughout the southern Gulf of St. Lawrence in late November and early December 1996. The meetings were held in Grande Rivière, Québec on November 28, in Cap-aux-Meules, Magdalen Islands, on November 29, in Caraquet, N.B. on December 3, in Charlottetown, P.E.I. on December 10, and in Port Hawkesbury, N.S., on December 11. Scientists presented a preliminary description of the 1996 fishery, results of the September 1996 fall groundfish survey, and results from sentinel surveys. Fishers were then invited to provide comments on these data and indicate whether or not this was consistent with their view of the stocks.

There was general agreement among fishers from the different areas about the status of the cod stock in the southern Gulf. Most participants agreed that cod abundance was low and that there has been little sign of improvement since the fishery has been closed. An exception was in Port Hawksbury where some participants felt that cod abundance was higher than indicated in recent assessments and that it had increased since the fishery was closed.

Commercial Fisheries Data

Data Updates

Commercial landings statistics were updated according to the final NAFO statistics for 1993 and 1994, and the revised Canadian data for 1995. An additional 98t were reported in 1993 compared to data available last year, with minor adjustments in all gears, and the bulk of the increase for the otter trawls. Reported landings for 1994 declined by 4t, with minor adjustments to all gears. The revised 1995 landings indicated an overall decline of 39t with the greatest decrease in miscellaneous gears, but increases in otter trawls, gillnets and handlines. The 1993, 1994 and 1995 estimated catch at age were modified accordingly and are given in Annex I, II, and III.

Age Calibration

Consistency of age determinations was verified by regular blind readings of a reference otolith collection. Tests were performed after each 1000 fish had been aged. The level of agreement with the reference collection was high with no bias detected (see below).

<u>Date</u>	<u>% agreement</u>	<u>direction of bias</u>
Reader # 1		
961218	91	0
970110	92	0
970120	85	0
970203	89	0
970217	94	0
Reader #2		
970303	87	0

Catch at Age

The calculation of the 1996 commercial catch at age was complicated by the limited fishery, as was the case in 1994 and 1995. It was necessary to use aging material collected during the sentinel surveys to augment the commercial samples. Catch at age was estimated separately for sentinel survey, mesh experiments, and commercial landings because of differences in fishing gear, seasons, and areas. We included all observer commercial length frequencies collected by the Gulf and Quebec region observer programs to estimate the size composition of commercial landings. Observer samples are collected on a set-by-set basis while commercial port samples are collected on a trip-by-trip basis. The set-by-set observer samples were weighted to the catch in the set, then combined within trips and weighted to the observer estimate of trip catch. Observer and port sample trips were combined and weighted to the total landings in the period/gear. A summary of the sampling data used in constructing the 1995 catch at age is given in Table 3.

The following length (L in cm)-weight (W in grams) relationship was obtained from the September 1996 research vessel survey and was used to calculate mean weights at age

$$W = 0.00510 * L^{3.1541}$$

Landings numbers, mean weights at age, and mean lengths at age for each age-length key are presented in Tables 4 to 6.

The total number of fish landed in 1996 was the lowest on record (Table 7). The modal age in the 1996 landings was 8 (1988 year-class) but relatively large numbers of age 4 - 9 were landed. Commercial weights at most ages increased in 1996, however they are still at the low end of the range observed (Table 8 and Figure 2). The commercial weights at age have been somewhat higher than those in the RV survey since the closure in 1993. This is likely the result of a higher proportion of the landings coming from fixed gears which tend to catch larger fish at age.

Research Data

September 1996 Survey

The annual groundfish survey in the southern Gulf of St. Lawrence was conducted September 7-30 on board the research vessel *Alfred Needler* (Mission N249, Chouinard et al. 1996). A total of 221 standard sets (30 minutes at 3.5 knots) were attempted in 4T, of which 208 were successful.

The 1995 survey results were strongly affected by one large tow that yielded nearly 6600 juvenile fish (age 1-3, the 1994, 1993, and 1992 year-classes respectively) (set 127, Sinclair et al. 1996). The estimated mean numbers per tow including this set was 98.9 fish; while the estimate was 65.9 fish if the set was excluded (Table 9). Last year it was concluded that set 127 should be excluded from the time series pending the results of the 1996 survey. The estimated mean numbers per tow in 1996 is 67.7 fish, and the size frequency of the catch indicates that the 1992-1994 year-classes are smaller than indicated in the 1995 survey if set 127 was included. Consequently, it appears that the set should be excluded from the population abundance index. The coefficients of variation of the mean numbers per tow at age of the research vessel surveys are given in Table 10.

Examination of the cod length frequencies from selected September surveys indicates that recruitment to the stock remains low and is probably inadequate to rebuild the stock (Figure 3). The stock was at very low abundance in 1977, however, there were two modes less than 40 cm in the length frequency distribution, indicating good recruitment. This was followed by another good year-class in 1979, and these led to an increase in adult fish abundance. Another large mode appeared in the length frequencies in 1982-83 and this led to an increase in adult abundance by 1985. In contrast, data from 1993-96, since the fishery closure, show no strong modes at lengths less than 40 cm, and adult abundance remains low.

The abundance of cod age 5 to 10 cod in the September 1996 survey was close to that predicted in last year's assessment (Sinclair et al. (1996) predicted 36.2 fish/tow, and the observed value was 45.6 fish/tow). The overall survey results since 1992 continue to be very low compared to those of previous years (Figure 4) and indicate that the southern Gulf cod stock has not yet recovered.

Weights at age estimated during the 1996 September survey are at the low end of the range observed since 1960, however there appears to be an increasing trend over the recent past, especially at older ages (Table 11, Figure 2).

Cod Condition

Two measures of both seasonal and annual condition factors were examined and compared. The first was Fulton's condition factor (K):

$$K = \alpha \frac{W}{L^3}$$

where W = fish weight (g). The seasonal index used carcass weight (total weight less stomach and gonad), and the annual index used total weight:
 L = fork length (cm)
 α = 100, a scaling factor to control the number of decimals

The second measure was the predicted weight of a 45 cm cod derived from least squares length-weight relationships:

$$W_{45} = aL^b$$

where W_{45} = predicted weight for a 45 cm fish
 a and b = parameters of the length-weight relationship
 L = length of fish (here 45 cm)

Seasonal cod condition has been monitored since September 1991 in the southern Gulf of St. Lawrence. Originally, a monthly sampling regime was followed as closely as possible. Since the fishery was closed in September 1993, samples were not always available. During the 1996 season, samples were collected in the sentinel surveys and the groundfish surveys from June to November 1996, as well as from the January and February 1997 groundfish surveys. Because of the cod migration, samples originate from 4Vn in winter (January-February), western Cape Breton in early spring and late fall and the western southern Gulf in summer.

A distinct seasonal cycle is evident in the Fulton's condition index, being low in the spring, before and during spawning, and reaching a maximum in the late fall (Figure 5). The fall condition is about 40% higher than that in the spring. Condition (for the period examined) was lowest in 1992. The condition in 1996 exhibited a slightly different pattern than in previous years. Condition was already near it's highest point in early summer and remained at levels comparable to the last three years until the late fall. However in January and February 1997, the condition had already declined to the low levels normally observed in early spring in previous years.

Annual condition indices for cod 40 to 50 cm and the predicted weight of a 45 cm cod using the annual length-weight relationship were calculated from the data collected during the September groundfish surveys. Trends in condition using the two measures are highly correlated. Both indices suggest an increase in condition in September, since 1993 (Figure 6).

Caution should be exercised when interpreting the annual condition indices as they do not appear to correspond well with the indications from the seasonal samples. For example, seasonal samples suggest that condition in 1992 was the lowest in the period 1991-1996, however, the annual samples do not suggest the same trend. The condition indices from the annual survey probably suffer from several deficiencies and biases. First, the condition indices from the annual survey are calculated using total weight which can be affected by the degree of feeding of the animals and gonadal development. Secondly, the samples are collected during the entire survey and could be affected both by temporal and areal differences. Finally, there may be 'aliasing' due to minor shifts in the physiological cycle. Seasonal monitoring of condition (somatic weight) is likely to provide a more meaningful index of changes in condition than the annual values.

Sentinel Surveys

A sentinel survey (also referred to as sentinel fishery) program to monitor changes in abundance and obtain biological information on groundfish was conducted in the southern Gulf of St. Lawrence in the fall of 1994 and in 1995. The program in the southern Gulf of St. Lawrence was expanded in 1996 to cover more areas, gear types and seasons following the recommendations of the FRCC (FRCC 1995). A total of 10 projects comprising 32 fishing vessels were conducted in 1996, up from 7 projects with 16 vessels in 1995 and 1 project of 2 vessels in 1994 (Table 12). For mobile gears, the coverage was expanded around the Magdalen Islands and Prince Edward Island. The number of fixed gear vessels increased from 6 in 1995 to 23 in 1996. For fixed gear, the coverage was expanded to the areas around P.E.I., N.B., the Gaspé Peninsula and the Magdalen Islands. In addition, the duration of the sentinel surveys was expanded. Most projects only started at the end of August in 1995, whereas in 1996, some projects started in the second week of July with all projects underway by the end of July. Projects in 1996 were completed by early October in Gaspé to late November in Nova Scotia.

The fishing locations for fixed gears were spread along the coastline (Fig. 7). Each vessel fished at two traditional fishing sites selected by the participating fishers (or their Association). The fishing locations were 2.5 miles in radius and at least 5 miles apart. Once the locations were determined they remained constant over the fishing season. Each vessel fished its gear 24 times with a maximum frequency of twice per week over the period of the fishing season. The fishing days could be consecutive within each 7-day period.

Two types of gear were used for fixed gear projects: longlines and gillnets. Once a type of gear was selected for a vessel, it remained constant during the entire season. For longlines, a maximum of 2500 hooks (size 12 circle-1 fathom apart) were used (1250 hooks at each of the two sites). The longlines could be bottom longlines or "floated" longlines (1-3 feet off bottom). The soak time for longlines was a minimum of 4-6 hours and a maximum of 24 hours. For gillnets, a total of 500 fathoms of net (10 nets of 50 fathoms) were used, five at each location. The gillnets were of regulation mesh (140 mm) and had a depth of 25 meshes. The soak time for gillnets was a minimum of 18 hours and a maximum of 24 hours.

For the mobile gear projects, the same fishing areas that were identified in collaboration with fishers in 1995 were fished. In addition, other areas (particularly on the north side and west end of P.E.I. and around the Magdalen Islands) were added. Each of these traditional fishing areas (Fig. 8) were subdivided into squares of 3 nautical miles. Each vessel in the project completed 12 fishing trips consisting of 12 fishing sets in pre-determined squares within the fishing areas (generally 4 sets in each of three areas). The fishing locations for each trip were selected randomly by DFO at the beginning of the projects. Normally, fishing the 12 sets in one trip and recording all the information required between 2 to 3 days at sea. Trips were spread over the fishing season with a maximum of one trip per 7 day period.

Two types of gear were used for the mobile gear project: otter trawl and Danish (Scottish) seines. Both gears used a codend with 145 mm square mesh except for New Brunswick seiners who used 145 diamond mesh to be consistent with previous years. On three trips (trips #4, 8 and 12), a 60 mm liner was placed in the lengthening piece and codend to retain smaller fish in order to provide an indication of the abundance of juvenile fish. The sets for trawlers were of 60 minutes duration (calculated from the time the winches are stopped to the time the gear is brought back) at each location. Seiners conducted a regular fishing set at each location.

Total catches in the sentinel surveys amounted to 371 t. A breakdown of catches is given in Table 13. Mean monthly catch rates were calculated as the ratio of the total catch by gear to the total effort, for each month.

Cod catch rates by seines were generally higher than trawls; seines completed a regular fishing set as opposed to trawls where set duration in 1996 was one hour, and one-half hour in 1995. (Fig. 9 and 10). Gaspé trawlers and the N.B. seiners were fishing in overlapping areas (Fig. 8).

Catch rates by seines decreased from west to east, both with and without a liner (Fig. 9). Seine catch rates were highest in northeastern N.B., lower around the Magdalen Islands and lowest off Cape Breton. It must be remembered that N.B. seiners were using 145 diamond mesh (to be consistent with last year) as opposed to 145 square mesh in all other areas. The catch rates for N.B. seines in 1996 were similar to those in both 1994 and 1995. Similarly, 1996 catch rates for N.S. seines with liner were not significantly different from those seen in the previous year.

Otter trawl catch rates for cod were higher off the coast of Cape Breton than in either western and eastern P.E.I. or along the Gaspé peninsula (Fig. 10). Generally, catch rates for otter trawl were higher than those observed in 1995.

Catch rates by longlines were highest around N.S. where catches of 200 to 500 kg per 1000 hooks were frequent and even reached 1000 kg per 1000 hooks on several occasions (Fig. 11). P.E.I. showed the second highest catch rates with frequent catches of 100 to 400 kg per 1000 hooks. Along the Gaspé coast, longline catches were very poor with no fish being caught on most instances. Catches along the coast of northeastern N.B. and off the Magdalen Islands were intermediate with less than 100 kg per 1000 hooks being caught during most trips. Catch rate for longlines in N.S. were higher than those observed in 1995 (Fig. 11).

Gillnet catch rates, although lower than those for longlines, showed a similar pattern to longline catches. Catches were highest in both N.S. and P.E.I., lower in N.B. and virtually nil in Gaspé (Fig. 11).

Cod length frequencies in 1995 and 1996 were compared for the two projects which yielded the bulk of the catches (Fig. 12). The length frequencies for the N.B. seiners (with liners) show the progression of two modes; one at 24-27 cm in 1995 corresponding to the 1993 year-class and one at 40 cm. A mode consistent with that observation is apparent in 1996 at about 34-36 cm for the N.S. and western P.E.I. otter trawlers and at 33 in the N.B., N.S. and Magdalen Islands seine catches. The length frequencies for longlines in N.S. in 1995 and 1996 indicate that the increase in the catch rates was largely due to an increase in larger fish in the catch.

Summary

Catch Rates: Comparisons with previous years were possible for N.B. seiners, Gaspé trawlers, and N.S. longliners. Catch rates of cod increased in 1996 over those observed in 1995 for Gaspé trawlers and N.S. longlines. Catch rates for N.B. seiners in 1996 were similar to those observed in both 1994 and 1995. Where an increase in catch rates is observed, it appears in gears which are designed to catch mostly mature fish. Catch rates suggest a modest increase in the fishable biomass.

Recruitment: Length-frequencies indicate a mode at around 33-36 cm in both the eastern and western portions of the southern Gulf. These fish are likely from the 1993 year-class, suggesting that it is somewhat better than the 1992 year-class which is considered to be very poor. This mode is consistent with one seen at about 34 cm in the 1996 September groundfish research survey.

January 1997 Survey

A groundfish survey was conducted in Cabot Strait from January 5-27, 1997 on board the research vessel *CSS Wilfred Templeman*. The survey was part of a research project on the identification of the mixture of cod stocks in the Gulf of St. Lawrence and its approaches. The main objective of this survey was to determine the distribution of Atlantic cod and other groundfish species in the Cabot Strait area during the winter. The second objective of the survey was to collect samples necessary for the stock identification project as well as several other biological studies (cod condition, etc.). Surveys in the area have been conducted in January 1994 and 1995 on the *Alfred Needler* using a Western IIA trawl. In 1996 and 1997, the surveys were conducted on the *Wilfred Templeman* with the Campelen trawl.

At each location, a standard 15-minute tow, using a Campelen 1800 survey trawl (with 12.7 mm liner in lengthening piece and codend), was conducted. Strong winds hampered the second half of the survey. Only 109 sets could be attempted, of which 104 were successful and, as a result, coverage was not as complete as in previous years.

A contoured map of the cod catches in kg per tow (Figure 13) shows that the largest catches were made on the slopes of the Laurentian Channel. There appears to be a lower concentration of cod in the middle of the Channel than on both sides. This is consistent with the current stock definition of cod in this area where the northern Gulf stock (3Pn4RS) is thought to overwinter on the northern slope of the Laurentian Channel in 3Pn and the southern Gulf stock overwinters on the southern slope in 4Vn. The distribution is similar to that observed in surveys conducted from 1994 to 1996 in January (Chouinard 1994, Sinclair et al. 1995, Sinclair et al. 1996).

The length frequency distributions in the surveys conducted in the southern Gulf (4T) in September and along the southern edge of the Laurentian Channel in Cabot Strait (4T and 4Vn) in January (Figure 14) indicate that the increase in the January 1997 estimate may be caused by the increased recruitment of the 1993 year-class to the survey gear. This year-class would correspond to the modes observed at 22-28 cm in January 1996, 31-34 cm in September 1996 and 34-40 cm in January 1997. In the previous assessment this year-class was considered to be somewhat larger than adjacent year-classes.

Analysis Methods

Analysis of RV Data

Multiplicative Analyses

The RV mean numbers per tow at age were analyzed with a multiplicative model to obtain information on trends in recruitment and total mortality in the pre-recruit ages. The model was

$$\ln A_{ij} = \beta_0 + \beta_1 I + \beta_2 J + \epsilon$$

where

- A_{ij} = the RV index at age i and year-class j
- I = a matrix of 0 and 1 indicating age
- J = a matrix of 0 and 1 indicating year-class

Sinclair et al. (1995) reported that the southern Gulf RV survey gave consistent estimates of relative year-class strength for cod beginning at age 2 and continuing to age 12. Results for two groups of ages, 2-3 (pre-recruit ages) and 4-6 (recruiting ages) were analyzed separately. In addition, two analyses were performed for the ages 2-3 data, one including set 127 in 1995 and the second excluding this observation. The main effect vector for year-class (β_2) was interpreted as an index of relative year-class strength. The difference between the year-class effects estimated for the two age groups was interpreted as an index of total mortality of the respective year-classes. Inter-year-class differences in the mortality index were interpreted as differences in total mortality (see Sinclair et al. 1995 for details).

The fit of the three multiplicative models was good. The total variance explained was between 85 - 90% (Table 14). The assumption of normal distribution of residuals was not violated.

The large set of small fish in 1995 (set 127) still had an important influence on the results of the age 2-3 analysis, but less so than last year. Having only one RV estimate in last year's assessment, the 1993 year-class was estimated to be above average in abundance, similar to the high values of the late 1970s and early 1980s. However, from the 1996 survey, this year-class appeared to be well below average in abundance. Using two years of RV estimates, if set 127 in 1995 was included, the 1993 year-class was estimated to be about average in abundance (Fig. 15). If set 127 was removed, the 1993 year-class was estimated to be of similar abundance to the below average year-classes of the late 1980s and early 1990s. This interpretation now appears to be more likely.

The age 4-6 RV mean numbers per tow in 1995 were virtually unaffected by the large catch in set 127, thus the inclusion or deletion of this set would have little effect on the results of this multiplicative analysis. The year-class effects from the analysis of the age 4-6 data indicate that the 1992 year-class is below average in abundance at these ages (Fig. 16). The pattern for other year-classes is similar to that reported last year.

The trend in total mortality between ages 2-3 and 4-6 is similar to that reported last year. The estimate of relative Z for the 1992 year-class, the new observation this year, is the lowest in the time series (Figure 17). The difference in the relative Z indicates that the 1985-87 year-classes experienced, on average, a total mortality 0.75 greater than the three previous and four following year-classes. In the normal scale, this suggests that only half as many of them survived the recruitment phase as did the year-classes before and after. The 1992 year-class appears to be experiencing below average mortality, perhaps reflecting lower fishing mortality.

Direct Estimates of Relative F

Sinclair et al. (1994, Section 7.2) described a new method for examining trends in fishing mortality using a relative estimate of fishing mortality obtained from the ratio of catch at age divided by the RV population estimates at age. The analysis was repeated here with the current data. The estimated relative F at ages 4, 7, and 10 were plotted.

The relative fishing mortalities were high in the early 1970s followed by a decline at the time of extended fisheries jurisdiction in 1977 (Figure 18). The relative F was stable in most of the 1980s but increased sharply beginning in 1988 until a peak in 1992. With the closure of the cod fishery in September 1993 the relative F dropped to the lowest level previously seen and with the continuance of the closure, the relative F declined further in 1994 and 1995, and remained low in 1996.

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Tables

Table 1: Landings (t) of southern Gulf of St. Lawrence cod, 1965-96, by area and time period relevant to the management unit. The column "stock" indicates the landings used in the analytical assessment, and is the total for 4T, 4Vn (J-A), 4Vn (N-D), and 4Vs. The TAC applies to the traditional management unit, 4TVn (J-A).

Year	4T	4Vn(J-A)	4Vn(N-D)	4Vs	Stock	4TVn(J-A)	TAC
65	46471	16556	2077		65104	63027	
66	38282	16603	2196		57081	54885	
67	34245	7071	2096		43412	41316	
68	37910	8641	2440		48991	46551	
69	40905	6914	2442		50261	47819	
70	43410	21055	1523		65988	64465	
71	40669	15706	1556		57931	56375	
72	42096	25704	1517		69317	67800	
73	25756	24879	1308		51943	50635	
74	28580	20167	1832		50579	48747	63000
75	28853	13618	795		43266	42471	50000
76	17600	15815	3928		37343	33415	30000
77	19536	2683	4665		26884	22219	15000
78	25453	12439	1128		39020	37892	38000
79	46695	9301	1700		57696	55996	46000
80	36157	18477	2592		57226	54634	54000
81	48132	17045	1970		67147	65177	53000
82	43418	14775	3476		61669	58193	60000
83	48222	13073	2695		63990	61295	62000
84	40652	14712	2200		57564	55364	67000
85	47819	14319	1835		63973	62138	67000
86	48066	15709	1444	3463	68682	63775	60000
87	43571	7555	1437	2029	54592	51126	45200
88	44616	7442	1165	2496	55719	52058	54000
89	43617	9191	1887	2574	57269	52808	54000
90	41552	9688	2031	4606	57877	51240	53000
91	31938	6781	1830	8911	49460	38719	48000
92	27899	6782	2282	4164	41127	34681	43000
93	4121	1161	55		5337	5282	13000
94	1190	139	1		1330	1329	
95	1032		4		1036		
96	1140		2		1142		

Table 2: Landings (t) by gear of the southern Gulf of St. Lawrence cod stock, 1965-96.

Year	Otter trawl	Seines	Gillnets	Longlines	Handlines	Misc.	Total
1965	48854	2735	3571	4713	0	5231	65104
1966	37023	2444	9414	3062	0	5138	57081
1967	24823	2293	9948	2536	2469	1343	43412
1968	29553	1064	12933	1344	2942	1155	48991
1969	28131	1234	9581	5014	5066	1235	50261
1970	43652	1798	9786	6258	3205	1289	65988
1971	36338	2267	9676	3600	4011	2039	57931
1972	50615	2121	7896	1792	2103	4790	69317
1973	36467	2137	8223	925	2135	2056	51943
1974	35815	1768	6141	1352	1292	4211	50579
1975	29080	1983	6330	245	3530	2098	43266
1976	28928	1384	4459	163	1191	1218	37343
1977	14695	3269	5931	692	1299	998	26884
1978	22669	4504	8929	1015	1449	454	39020
1979	31727	8845	12022	1622	1957	1523	57696
1980	32698	10095	4260	2827	1562	5784	57226
1981	34509	12563	4053	7017	1061	7944	67147
1982	32242	11360	4205	5481	916	7465	61669
1983	32880	13857	3010	4754	1286	8203	63990
1984	32316	10732	6891	5058	1903	664	57564
1985	40177	11935	5287	4261	2078	235	63973
1986	41653	15380	4328	5314	1975	32	68682
1987	31961	9759	4792	5926	2106	48	54592
1988	34055	12017	3936	4074	1602	35	55719
1989	34260	15492	2796	3396	1190	135	57269
1990	37354	14094	1962	3289	1048	130	57877
1991	35216	9282	1679	2502	778	3	49460
1992	28408	8660	1263	1890	875	31	41127
1993	2143	328	1313	842	705	6	5337
1994	213	404	302	103	153	155	1330
1995	110	379	101	78	101	267	1036
1996	269	398	134	127	214		1142

Table 3: Age-length keys used in the calculation of the 1996 catch-at-age for southern Gulf of St. Lawrence cod.

KEY	FISHERY	SAMPLES	SAMPLE SIZE			TOTAL	Catch(t)
			Port	Observer	Sentinel		
1	OTB APR-JUNE	APR-JUN OTB LENGTHS			74	74	0.472
		APR-JUN ALL GEARS AGES	263	103		366	
2	OTB JUL-SEPT	JUL-SEP OTB LENGTHS	33	2860		2893	86.913
		JUL-SEP ALL GEARS SENTINEL AGES			1008	1008	
3	OTB OCT-DEC	OCT-DEC OTB LENGTHS		894		894	3.970
		OCT-DEC ALL GEARS SENTINEL AGES			880	880	
4	SENTINEL OTB JUL-SEPT	JUL-SEP OTB SENTINEL LENGTHS			17386	17386	28.654
		JUL-SEP OTB SENTINEL AGES			184	184	
5	SENTINEL OTB OCT-DEC	OCT-DEC OTB SENTINEL LENGTHS			6459	6459	27.324
		OCT-DEC OTB SENTINEL AGES			210	210	
6	MESH SEL. OTB JUL-SEPT	JUL-SEP OTB MESH SEL. LENGTHS		19218		19218	50.326
		JUL-SEP ALL GEARS SENTINEL AGES			1008	1008	
7	MESH SEL. OTB OCT-DEC	OCT-DEC OTB MESH SEL. LENGTHS		17836		17836	71.186
		OCT-DEC ALL GEARS SENTINEL AGES			880	880	
8	SNU APR-JUNE	APR-JUN SNU LENGTHS	692	800		1492	31.788
		APR-JUN ALL GEARS AGES	263	103		366	
9	SNU JUL-SEPT	JUL-SEP SNU LENGTHS	641	150		791	48.908
		JUL-SEP ALL GEARS SENTINEL AGES			1008	1008	
10	SNU OCT-DEC	OCT-DEC SNU LENGTHS	586	310		896	33.669
		OCT-DEC ALL GEARS SENTINEL AGES			880	880	
11	MESH SEL. SNU JUL-SEPT	JUL-SEP SNU MESH SEL. LENGTHS		5332		5332	48.167
		JUL-SEP ALL GEARS SENTINEL AGES			1008	1008	
12	MESH SEL. SNU OCT-DEC	OCT-DEC SNU MESH SEL. LENGTHS		9722		9722	55.506
		OCT-DEC ALL GEARS SENTINEL AGES			880	880	
13	SENTINEL SNU JUL-SEPT	JUL-SEP SNU SENTINEL LENGTHS			52152	52152	138.129
		JUL-SEP SNU SENTINEL AGES			321	321	
14	SENTINEL SNU OCT-DEC	OCT-DEC SNU SENTINEL LENGTHS			14356	14356	42.047
		OCT-DEC SNU SENTINEL AGES			249	249	
15	GNS APR-JUNE	APR-JUN GNS LENGTHS		211		211	1.597
		APR-JUN ALL GEARS AGES	263	103		366	
16	GNS JUL-SEPT	JUL-SEP GNS LENGTHS	145	2053		2198	88.368
		JUL-SEP ALL GEARS SENTINEL AGES			1008	1008	
17	GNS OCT-DEC	OCT-DEC GNS LENGTHS		282		282	4.716
		OCT-DEC ALL GEARS SENTINEL AGES			880	880	
18	SENTINEL GNS JUL-SEPT	JUL-SEP GNS SENTINEL LENGTHS			13232	13232	33.565
		JUL-SEP GNS SENTINEL AGES			145	145	
19	SENTINEL GNS OCT-DEC	OCT-DEC GNS SENTINEL LENGTHS			2127	2127	5.791
		OCT-DEC GNS SENTINEL AGES			95	95	
20	LLS APR-JUNE	APR-JUN LLS LENGTHS		1		1	0.006
		APR-JUN ALL GEARS AGES	263	103		366	
21	LLS JUL-SEPT	JUL-SEP LLS LENGTHS	271			271	32.727
		JUL-SEP ALL GEARS SENTINEL AGES			1008	1008	
22	SENTINEL LLS JUL-SEPT	JUL-SEP LLS SENTINEL LENGTHS			31019	31019	60.694
		JUL-SEP LLS SENTINEL AGES			358	358	
23	SENTINEL LLS OCT-DEC	OCT-DEC LLS SENTINEL LENGTHS			11435	11435	34.206
		OCT-DEC LLS SENTINEL AGES			326	326	
	UNSAMPLED						213.654
	TOTAL CATCH						1142.383

Table 4: Landings (numbers) at age by gear and time period, 1996. The age-key numbers correspond with Table 3.

Key Gear Quarter	1 OTB 2	2 OTB 3	3 OTB 4	4 OTB 3	5 OTB 4	6 OTB 3	7 OTB 4	8 SNU 2	9 SNU 3	10 SNU 4	11 SNU 3	12 SNU 4	13 SNU 3	14 SNU 4
3	2	3705	101	774	643	1099	1452	48	18	277	10975	5083	2513	4162
4	3	8538	295	1021	2808	3562	4197	149	94	835	18824	6521	6166	9456
5	28	14109	688	3603	4291	9565	10366	1218	536	3015	22145	4689	11732	11132
6	22	13314	664	3659	2384	10321	10034	1544	908	3413	30818	7973	10403	8531
7	47	9777	505	4930	2437	6869	8439	3679	1671	3135	22072	7161	6044	6587
8	53	13835	683	5025	4313	9370	11673	3852	4461	5118	21980	8382	7549	7881
9	33	6536	318	1402	2679	3511	6080	2499	3799	2963	11622	3185	2515	3682
10	22	2142	89	1135	1117	980	2177	1431	2207	1403	2248	821	712	1261
11	8	462	23	254	271	128	597	506	1215	356	513	51	69	352
12	4	431	8	117	128	128	263	100	478	201	598	12	83	142
13	2	171	2	33		27	134	9	352	106	133	16	10	71
14		18	2			5	25		118	32			4	12
15		0	0			1	9		4	8			1	4
		2				2			60				1	
Total	224	73041	3379	21953	21073	45568	55444	15034	15923	20863	141927	43895	47801	53271

Key Gear Quarter	15 GNS 2	16 GNS 3	17 GNS 4	18 GNS 3	19 GNS 4	20 LLS 2	21 LLS 3	22 LLS 3	23 LLS 4	Unsamp	TOTAL
3	29	261	326		3			179	174	7321	39145
4	17	532	853	3			0	935	630	15054	80492
5	209	771	863	3	32		44	3264	2949	24214	129469
6	227	2175	815	1030	165	0	320	5085	4037	27110	144953
7	168	6998	666	2438	582	1	1477	4712	2892	23761	127047
8	213	12691	882	6305	885	1	3565	9078	4047	32631	174473
9	116	8429	403	2185	488	1	2667	7270	2121	17140	91646
10	60	3615	97	672	200		1475	1834	1893	6347	33939
11	26	1361	26	316			787	1071	711	2094	11195
12	8	1124	9	201	8		476	427	353	1220	6521
13	3	369	2	25			260	286	272	525	2806
14		31					37	92	38	95	509
15		0						3	7	8	44
		16					34	41		36	191
Total	1074	38373	4942	13179	2363	3	11141	34277	20125	157555	842429

Table 5: Mean weight (kg) at age by gear and time period, 1996.

Key Gear Quarter	1 OTB 2	2 OTB 3	3 OTB 4	4 OTB 3	5 OTB 4	6 OTB 3	7 OTB 4	8 SNU 2	9 SNU 3	10 SNU 4	11 SNU 3	12 SNU 4	13 SNU 3	14 SNU 4
3	0.314	0.404	0.433	0.534	0.385	0.444	0.460	0.375	0.518	0.495	0.285	0.327	0.418	0.392
4	0.402	0.521	0.532	0.384	0.456	0.625	0.559	0.473	0.737	0.575	0.383	0.381	0.544	0.485
5	0.748	0.768	0.932	0.752	0.911	0.825	0.911	0.752	0.960	0.965	0.728	0.686	0.758	0.831
6	1.016	0.940	1.126	0.851	1.061	0.944	1.126	1.032	1.403	1.194	0.819	0.887	0.873	1.032
7	1.730	1.316	1.204	1.277	1.237	1.152	1.312	1.780	2.197	1.462	1.047	1.023	1.087	1.192
8	2.313	1.492	1.368	1.377	1.812	1.259	1.613	2.181	2.795	1.866	1.328	1.269	1.195	1.499
9	3.016	1.912	1.592	2.115	1.860	1.539	1.835	2.960	3.385	2.212	1.513	1.484	1.483	1.770
10	3.401	2.358	1.942	2.405	2.230	1.851	2.339	3.225	4.009	2.738	2.222	1.717	1.746	2.300
11	3.866	2.966	2.195	3.192	2.823	3.433	2.838	3.143	4.086	3.652	2.984	3.258	3.448	2.892
12	5.645	2.409	2.584	2.267	2.854	2.667	2.869	4.244	3.460	3.416	2.907	4.623	2.590	2.803
13	7.438	4.273	2.723	2.932		3.849	2.941	7.438	4.421	3.161	3.414	2.665	3.849	2.982
14		3.918	4.660			6.180	4.734		4.934	4.808			7.786	4.736
15			5.335			7.972	5.335		7.972	5.335			7.972	5.335
16+		4.931				5.056			5.517				5.320	
All	2.191	1.144	1.154	1.217	1.300	1.058	1.315	2.104	3.068	1.661	0.918	0.884	0.909	1.034

Key Gear Quarter	15 GNS 2	16 GNS 3	17 GNS 4	18 GNS 3	19 GNS 4	20 LLS 2	21 LLS 3	22 LLS 3	23 LLS 4	Average weight (kg)
3	0.344	0.386	0.420		0.210			0.491	0.494	0.359
4	0.476	0.466	0.446	0.532				0.787	0.611	0.472
5	0.711	1.067	0.935	0.576	1.532		1.477	0.994	1.032	0.812
6	0.840	1.638	1.119	1.691	1.813	1.666	2.143	1.295	1.317	0.988
7	1.379	2.095	1.232	2.144	2.146	1.666	2.393	1.662	1.591	1.352
8	2.110	2.257	1.336	2.567	2.383	1.666	2.761	1.701	1.877	1.689
9	3.883	2.315	1.420	2.906	2.329	1.666	2.995	2.094	2.254	2.054
10	3.769	2.596	1.754	2.944	2.880		3.396	2.865	2.603	2.639
11	3.775	2.974	1.859	3.346			3.665	3.151	2.687	3.229
12	5.616	2.597	2.157	2.702	3.367		3.131	3.179	2.522	2.882
13	7.438	3.174	2.368	5.942			3.640	3.770	2.812	3.584
14		4.985					5.004	4.633	4.592	4.818
15								7.972	5.335	5.949
16+		5.365					5.346	5.173		5.360
All	1.743	2.223	1.022	2.522	2.304	1.666	2.945	1.776	1.715	1.321

Table 6: Mean length (cm) at age by gear and time period, 1996.

Key Gear Quarter	1 OTB 2	2 OTB 3	3 OTB 4	4 OTB 3	5 OTB 4	6 OTB 3	7 OTB 4	8 SNU 2	9 SNU 3	10 SNU 4	11 SNU 3	12 SNU 4	13 SNU 3	14 SNU 4
3	33.00	35.29	36.22	38.24	34.84	36.42	36.96	34.91	38.37	38.01	31.86	32.98	35.73	34.97
4	35.33	38.19	38.62	34.76	36.56	40.51	39.26	37.49	42.90	39.71	34.81	34.95	38.68	37.46
5	43.21	43.43	46.19	43.26	45.88	44.50	45.88	43.24	46.58	46.75	42.60	41.93	43.32	44.55
6	47.45	46.13	49.04	44.87	47.99	46.39	48.95	47.57	51.83	49.87	44.41	45.37	45.25	47.62
7	55.51	51.05	50.06	50.86	50.33	49.28	51.15	56.16	60.08	52.84	47.67	47.37	48.36	49.62
8	60.25	53.11	52.09	52.05	56.38	50.68	54.44	59.40	64.86	56.76	51.19	50.62	49.88	53.15
9	65.76	57.37	54.30	58.98	56.66	53.95	56.57	65.37	68.94	59.63	53.49	53.01	53.44	55.81
10	67.98	60.65	57.74	60.94	60.38	56.39	61.22	67.08	73.02	64.18	59.58	55.56	55.53	60.84
11	72.21	66.72	59.41	67.12	63.71	69.18	64.28	66.84	73.78	69.72	66.72	67.98	69.29	64.51
12	80.88	62.58	63.36	60.98	65.33	63.94	65.46	73.59	69.72	69.17	65.70	77.37	63.09	64.94
13	90.00	74.31	65.18	67.00		72.35	66.37	90.00	75.64	67.56	69.93	65.00	72.44	66.47
14		73.40	77.52			83.85	77.92		78.67	78.32			90.52	77.92
15			81.00			92.00	81.00		92.00	81.00			92.00	81.00
16+		79.00				79.60			81.82				80.88	
All	57.92	47.84	48.80	49.00	49.69	47.54	50.44	57.87	66.19	54.01	44.62	44.14	45.21	46.32

Key Gear Quarter	15 GNS 2	16 GNS 3	17 GNS 4	18 GNS 3	19 GNS 4	20 LLS 2	21 LLS 3	22 LLS 3	23 LLS 4	Average length (cm)
3	33.94	35.06	36.01		29.00			37.91	37.84	33.97
4	37.38	36.92	36.63	39.00				43.87	40.57	37.01
5	42.55	47.71	46.15	40.00	54.44		53.57	47.20	47.80	44.15
6	44.71	54.96	49.01	56.15	57.22	56.00	60.08	51.21	51.61	46.84
7	51.44	59.81	50.47	60.38	60.34	56.00	62.41	55.34	54.51	51.39
8	57.60	61.14	51.82	63.79	62.41	56.00	65.19	55.66	57.14	55.01
9	71.74	61.54	52.84	66.27	61.84	56.00	66.63	59.49	60.65	58.48
10	70.99	63.67	56.59	65.47	66.38		69.36	64.96	63.84	63.21
11	71.24	66.60	57.61	69.04			71.23	67.73	64.14	67.87
12	81.32	63.88	60.69	64.95	70.00		67.62	68.12	63.19	65.70
13	90.00	68.34	62.50	83.78			71.16	71.97	65.41	70.53
14		78.81					79.09	76.88	77.17	78.04
15								92.00	81.00	83.56
16+		81.09					81.00	80.16		81.07
All	52.87	60.45	46.75	63.23	61.63	56.00	66.29	55.80	55.11	49.72

Table 7: Landings at age ('000) of southern Gulf of St. Lawrence cod, 1971-96. The table includes landings in 4T, 4Vn(Nov.-Apr.), and 4Vs(Jan.-Apr.).

Year	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1971	6	2099	7272	9262	5916	2331	1251	520	130	354	75	120	154	68	29558
1972	3179	22247	12018	6666	7561	3551	952	547	372	120	51	14	47	38	57361
1973	1374	6999	14498	5325	3720	2800	1861	557	338	100	69	47	12	24	37723
1974	2993	5400	5033	9690	3102	1854	1772	1054	260	198	81	29	6	19	31490
1975	1567	8910	6933	2540	3297	1319	1119	801	680	151	53	76	7	67	27519
1976	508	4093	9996	6975	1708	1257	478	285	148	145	47	17	12	10	25679
1977	659	4960	5899	3320	1773	400	284	182	114	50	53	10	4	5	17712
1978	548	10037	10897	4596	2681	1108	244	248	110	72	44	5	13	6	30610
1979	148	5138	15913	11251	3509	1724	865	295	253	66	33	17	16	8	39235
1980	295	1920	14674	14142	9789	1522	808	404	143	30	18	8	14	26	43793
1981	98	3829	7380	19144	13116	6200	913	463	203	71	89	2	14	4	51526
1982	518	1621	10671	8700	12539	7663	2533	444	142	76	5	2	2	1	44917
1983	42	1147	6311	12124	11936	7646	5379	2668	139	51	18	10	5	5	47481
1984	30	1319	4210	7410	9085	6949	5173	2937	942	151	52	7	5	9	38278
1985	175	1561	10307	17163	8342	6094	3975	2277	971	353	26	6	8	6	51265
1986	136	3546	8295	23645	9739	4069	3041	2372	1197	803	159	19	3	2	57027
1987	80	1029	7400	10851	18933	7011	2250	1684	700	417	132	112	14	13	50627
1988	111	1725	5241	11259	9072	12151	6813	1818	970	466	202	51	44	8	49931
1989	71	1658	6065	12398	10714	7316	7628	5171	990	465	153	49	37	15	52730
1990	540	2973	7508	10613	10207	6983	4468	4644	2066	385	122	37	30	29	50605
1991	286	5178	10371	9586	8416	4735	3173	1754	955	587	91	25	16	9	45184
1992	487	3437	12511	9912	5290	3453	2059	910	510	375	112	12	5	9	39081
1993	53	262	904	1174	946	499	223	135	74	36	31	7	9	2	4353
1994	28	53	96	208	279	154	70	27	19	8	14	2	0	0	949
1995	68	132	143	129	222	133	59	24	13	5	2	1	0	0	931
1996	39	80	129	145	127	174	92	34	11	7	3	1	0	0	842

Table 8: Average weights at age (kg) from the commercial fishery for the southern Gulf of St. Lawrence cod stock, 1971-1996.

AGE	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1971	0.76	0.82	1.11	1.40	2.15	3.67	3.83	5.25	6.00	4.78	6.85	7.42	7.96	17.72	1.96
1972	0.36	0.56	0.91	1.33	1.52	2.55	4.82	5.97	7.13	8.08	8.85	10.25	5.65	11.23	1.16
1973	0.46	0.67	0.92	1.28	1.69	2.31	3.59	5.51	6.03	7.95	6.16	6.72	8.86	6.12	1.37
1974	0.60	0.78	1.09	1.49	1.96	2.68	2.89	4.11	5.97	7.07	8.30	6.87	9.84	12.65	1.61
1975	0.48	0.74	1.15	1.76	2.36	2.75	3.22	3.70	4.46	6.95	9.20	6.30	8.39	6.19	1.57
1976	0.46	0.78	1.11	1.54	2.19	2.84	3.23	3.79	4.62	5.09	6.19	9.87	10.45	15.05	1.45
1977	0.52	0.81	1.27	1.79	2.42	3.51	4.27	4.31	5.10	5.57	6.45	8.61	12.56	9.88	1.52
1978	0.40	0.68	1.03	1.66	2.27	2.81	4.33	4.63	6.37	6.46	6.23	5.09	11.56	10.17	1.27
1979	0.51	0.71	1.01	1.42	2.22	3.31	4.07	7.14	6.96	6.69	4.70	8.79	15.52	17.34	1.47
1980	0.58	0.69	0.92	1.22	1.50	2.78	3.08	4.00	7.83	6.01	9.98	5.81	9.13	9.35	1.30
1981	0.50	0.68	0.85	1.13	1.39	1.84	3.19	4.17	4.47	5.60	6.11	7.08	3.49	8.35	1.30
1982	0.75	0.76	0.97	1.16	1.45	1.72	2.27	3.27	4.01	4.14	6.46	6.92	4.18	11.10	1.37
1983	0.33	0.61	0.89	1.14	1.31	1.58	1.73	2.01	4.84	7.63	8.55	10.51	12.09	14.76	1.35
1984	0.45	0.65	0.79	1.09	1.38	1.61	2.07	2.27	3.05	4.93	5.66	8.61	11.74	13.23	1.50
1985	0.44	0.57	0.76	0.99	1.42	1.67	1.83	2.14	2.41	2.89	8.33	5.71	11.41	12.97	1.24
1986	0.43	0.60	0.81	1.01	1.29	1.75	1.98	1.89	2.64	2.23	3.07	4.83	15.36	13.55	1.20
1987	0.27	0.49	0.70	0.86	0.99	1.25	1.85	2.16	2.24	3.15	3.57	4.03	12.41	14.21	1.08
1988	0.40	0.60	0.77	0.92	1.04	1.13	1.29	1.90	2.23	2.72	3.52	5.67	5.92	14.32	1.12
1989	0.53	0.63	0.77	0.90	1.07	1.19	1.22	1.40	1.94	2.15	2.55	3.49	3.41	2.76	1.09
1990	0.56	0.72	0.85	1.03	1.17	1.28	1.36	1.41	1.50	1.84	2.59	3.36	2.81	7.98	1.14
1991	0.53	0.65	0.85	1.01	1.22	1.41	1.51	1.60	1.63	1.73	2.20	2.50	3.08	3.80	1.09
1992	0.55	0.65	0.81	1.00	1.22	1.45	1.61	1.85	1.88	1.91	2.27	5.52	6.58	9.88	1.05
1993	0.41	0.56	0.70	1.00	1.40	1.81	1.93	2.21	2.29	2.09	2.04	3.00	5.84	13.18	1.23
1994	0.36	0.57	0.79	1.04	1.46	1.87	2.26	2.18	2.50	2.41	2.04	2.31	2.38	13.52	1.40
1995	0.25	0.49	0.67	0.90	1.18	1.49	2.12	2.52	2.98	3.39	4.87	4.94	4.19	10.16	1.09
1996	0.36	0.47	0.81	0.99	1.35	1.69	2.05	2.64	3.23	2.88	3.58	4.82	5.95	5.36	1.32

Table 9: Mean numbers per tow at age of southern Gulf of St. Lawrence cod from the annual research vessel surveys, 1971-96. There are two entries for 1995, the first excludes set 127, and the second (1995a) includes set 127.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	0+	3+	5+
1971		0.10	0.73	8.72	8.84	7.90	6.09	3.99	1.24	0.32	0.35	0.25	0.11	0.02	0.11	0.13	0.28	39.16	38.34	20.78
1972		0.53	3.60	7.85	18.02	6.84	5.77	3.97	2.40	0.49	0.40	0.44	0.14	0.06	0.05	0.05	0.08	50.70	46.56	20.70
1973	0.03	0.12	6.20	12.24	5.79	9.25	4.32	3.07	2.25	1.43	0.38	0.11	0.27	0.04	0.07	0.02	0.19	45.77	39.42	21.40
1974		0.14	3.55	14.51	11.03	4.73	5.67	2.12	1.44	1.46	0.49	0.19	0.10	0.24		0.04	0.13	45.83	42.13	16.59
1975		0.54	8.19	6.27	9.24	7.24	2.46	1.73	1.14	0.51	0.35	0.43	0.11	0.05	0.01	0.01	0.00	38.27	29.54	14.03
1976		4.30	9.85	38.38	9.91	7.45	3.36	0.92	0.64	0.34	0.31	0.27	0.09	0.05	0.02	0.03	0.03	75.95	61.80	13.51
1977	0.01	1.05	30.26	26.55	19.01	7.08	3.69	1.91	0.91	0.64	0.41	0.34	0.33	0.32		0.06	0.10	92.66	61.33	15.77
1978		1.23	9.29	54.73	40.86	19.72	5.55	3.21	1.01	0.43	0.54	0.64	0.11		0.15	0.05	0.00	137.50	126.99	31.40
1979	0.19	0.18	32.52	31.85	65.04	39.17	15.98	4.14	1.71	0.82	0.26	0.26	0.21	0.07	0.06	0.04	0.02	192.51	159.63	62.74
1980	0.32	1.41	6.73	41.14	30.51	53.54	26.39	9.50	1.65	0.80	0.34	0.11	0.04	0.03	0.05	0.02	0.02	172.60	164.14	92.48
1981	0.28	5.34	21.91	21.92	67.15	56.53	55.54	23.42	12.72	1.77	0.74	0.36	0.14	0.06	0.06	0.10	0.14	268.18	240.66	151.59
1982	0.34	4.74	38.42	23.22	27.50	31.90	50.82	26.51	12.83	4.05	0.47	0.20	0.13	0.07	0.02		0.03	221.25	177.75	127.03
1983	0.01	7.57	24.58	52.76	47.60	25.97	18.45	15.91	10.59	5.01	3.26	0.85	0.17	0.45	0.05	0.07	0.00	213.30	181.15	80.79
1984		1.91	11.27	16.62	36.99	49.10	17.53	9.87	10.31	4.70	2.10	0.79	0.09	0.04	0.09	0.02	0.02	161.44	148.26	94.65
1985	4.31	9.71	15.28	38.64	41.88	67.91	70.29	15.69	6.65	4.60	2.19	1.61	0.52	0.17			0.07	279.51	250.21	169.69
1986	2.06	7.11	24.68	35.22	36.62	36.86	43.97	31.77	9.47	2.01	2.75	1.11	0.78	0.22	0.14		0.06	234.82	200.98	129.14
1987	0.44	0.91	12.71	24.91	23.04	31.69	23.94	31.03	11.11	2.49	1.77	0.66	0.53	0.23	0.11	0.03	0.02	165.60	151.54	103.59
1988	1.70	3.89	19.05	70.02	64.56	51.26	35.86	19.36	20.94	12.18	2.38	0.55	0.32	0.27	0.10	0.11	0.00	302.55	277.91	143.33
1989	0.28	12.78	27.01	34.63	32.49	29.46	30.93	16.98	10.84	10.62	6.99	1.33	0.43	0.23	0.18	0.05	0.12	215.35	175.27	108.16
1990	0.20	2.07	6.62	35.40	26.35	19.31	13.64	9.41	5.31	3.13	3.61	1.69	0.34	0.06	0.09	0.02	0.01	127.26	118.38	56.63
1991	1.47	2.74	7.70	15.89	33.24	26.37	10.18	5.85	3.97	1.66	1.05	1.08	0.63	0.08	0.02	0.01	0.01	111.95	100.05	50.91
1992	0.61	1.92	4.69	9.81	13.78	12.24	6.58	2.55	1.20	0.75	0.32	0.20	0.10	0.06	0.01		0.01	54.83	47.61	24.02
1993	0.66	0.60	6.51	9.17	14.01	16.45	10.80	4.94	1.61	0.65	0.37	0.11	0.05	0.12	0.02	0.02	0.01	66.09	58.31	35.14
1994	1.25	0.66	1.79	7.61	9.07	9.73	12.03	7.76	2.79	1.12	0.41	0.30	0.08	0.04	0.02		0.01	54.67	50.97	34.29
1995	8.25	1.12	4.17	5.86	10.23	10.11	8.01	10.39	4.82	1.82	0.57	0.30	0.12	0.03	0.03	0.02	0.00	65.84	52.29	36.21
1995a	8.10	13.58	16.91	13.43	11.09	10.16	7.94	10.24	4.63	1.75	.56	.29	.12	.03	.03	.02		98.88	60.29	35.77
1996	0.78	2.73	2.21	7.25	12.61	11.16	9.81	7.50	8.14	3.84	1.12	0.38	0.11	0.10	0.01	0.01	0.03	67.78	62.07	42.20

Table 10: Coefficients of variation of mean numbers per tow at age from research vessel surveys, 1971-1996.

Age	1	2	3	4	5	6	7	8	9	10	11	12
1971	47.0	22.9	12.3	15.1	17.6	16.5	14.1	16.0	20.7	25.3	22.9	17.0
1972	49.0	26.0	19.0	13.4	13.2	12.8	12.1	13.1	13.9	17.5	22.5	30.0
1973	46.7	21.8	18.8	19.3	19.1	17.7	17.3	15.5	16.2	19.8	27.2	39.7
1974	43.4	22.6	12.4	13.3	19.7	21.4	17.4	19.7	18.9	17.2	23.5	27.8
1975	64.3	37.8	31.3	26.3	22.3	23.1	23.2	23.3	22.7	24.5	28.5	30.6
1976	27.7	15.5	15.0	14.8	21.6	24.4	27.4	25.2	30.8	27.6	32.6	36.8
1977	25.8	31.8	19.7	15.6	13.6	15.1	17.2	25.9	21.3	26.8	27.8	31.1
1978	48.2	20.7	29.0	32.3	35.7	29.7	26.5	22.4	42.8	37.7	71.0	51.4
1979	47.4	22.1	14.5	11.8	10.7	9.0	8.3	9.8	12.3	32.1	22.7	22.9
1980	32.9	18.6	26.2	16.4	14.0	13.0	11.2	13.1	16.5	21.2	21.1	28.8
1981	25.5	33.0	16.3	16.4	16.8	16.4	15.3	14.2	13.2	14.9	15.3	24.1
1982	24.5	28.2	24.2	18.8	21.6	22.2	18.6	16.0	13.9	24.8	32.1	51.1
1983	21.1	13.0	11.9	14.1	12.9	9.9	10.2	10.6	13.3	11.8	18.3	36.8
1984	16.6	16.1	13.6	14.7	15.8	10.5	7.9	7.7	8.3	8.0	10.1	22.7
1985	57.6	21.1	13.8	21.0	26.5	28.7	25.8	20.2	19.6	19.2	15.4	41.6
1986	43.7	28.6	23.4	15.7	13.9	12.6	12.2	12.0	9.6	11.5	11.8	12.3
1987	37.3	20.4	14.8	12.1	11.5	10.9	12.3	14.8	15.5	18.7	19.1	17.5
1988	59.2	42.4	38.9	26.0	18.7	14.5	13.4	12.6	12.8	14.5	19.8	18.0
1989	60.0	28.7	20.2	14.6	11.7	11.4	11.3	11.3	11.5	12.4	12.2	13.5
1990	20.2	19.8	14.4	12.4	11.1	10.3	10.1	9.8	10.1	10.0	10.0	12.0
1991	32.4	18.7	22.0	24.5	21.3	15.0	12.3	11.1	10.4	11.0	10.1	11.0
1992	31.3	24.7	16.6	13.7	13.6	12.9	13.0	12.9	12.7	13.3	16.3	11.9
1993	22.7	20.3	18.3	12.7	9.3	9.3	9.6	10.2	10.2	12.3	11.7	16.7
1994	25.1	18.3	17.2	13.7	11.0	10.0	10.1	11.2	13.0	13.4	15.3	24.8
1995	30.8	24.3	16.5	14.3	12.5	11.8	11.0	10.4	10.8	15.2	17.1	18.4
1996	16.0	24.5	26.2	23.8	19.1	16.3	15.6	15.0	15.4	16.5	18.0	22.5

Table 11: Mean weights (kg) at age of southern Gulf cod from research vessel surveys, 1960-1996.

Age	3	4	5	6	7	8	9	10	11	12	13	14	15
1960	0.35	0.67	1.12	1.72	2.00	2.77	3.57	3.25	3.71	3.31	4.29	12.85	5.98
1961	0.31	0.55	0.90	1.36	2.08	2.75	3.41	4.83	6.51	6.87	7.56	9.01	14.86
1962	0.36	0.65	0.93	1.33	1.96	2.86	5.64	7.22	7.90	11.03		14.86	
1963	0.38	0.61	0.92	1.09	1.46	2.00	2.79	4.91	2.99	8.15	9.04	5.98	
1964	0.40	0.58	0.91	1.20	1.35	1.95	2.55	4.28	6.71	8.99		4.53	
1965	0.40	0.69	1.18	1.24	1.66	2.01	2.52	2.88	4.93		8.31		9.38
1966	0.39	0.79	1.29	1.58	1.91	2.26	2.43	3.36	4.75	6.53	7.82	9.95	
1967	0.45	0.70	1.45	1.88	2.38	2.46	2.86	4.14	4.62	6.17	8.00	10.19	11.18
1968	0.41	0.79	1.34	1.88	2.64	3.85	2.58	3.08	3.90	5.61	6.41	10.22	10.60
1969	0.44	0.85	1.40	1.96	2.63	3.51	4.23	2.84	7.19	6.73	6.82	7.04	10.77
1970	0.42	0.75	1.22	1.73	2.49	3.30	4.44	4.77	3.70	4.25	5.29	4.96	8.62
1971	0.41	0.75	1.15	1.42	2.00	3.03	4.59	5.49	6.31	4.43	3.56	4.26	6.61
1972	0.39	0.73	1.22	1.55	1.95	2.72	3.92	4.61	6.00	6.30	5.08	10.77	6.13
1973	0.34	0.75	1.18	1.56	1.94	2.39	2.84	4.97	5.29	8.78	3.58	2.98	4.89
1974	0.46	0.74	1.20	1.67	2.13	2.31	2.42	3.51	4.39	5.66	11.03		4.31
1975	0.30	0.74	1.20	1.80	2.39	2.87	3.22	4.29	4.81	5.99	10.04	11.35	13.88
1976	0.26	0.73	1.32	1.87	2.50	3.04	3.06	4.07	5.31	4.41	6.97	4.90	3.37
1977	0.34	0.66	1.35	1.95	2.70	4.33	3.88	5.38	4.92	5.87	8.75		14.96
1978	0.33	0.74	1.22	2.06	2.49	3.63	5.40	6.57	9.46	9.03		7.37	10.47
1979	0.26	0.59	0.97	1.48	2.18	2.81	3.65	6.94	7.37	6.41	11.97	4.84	13.29
1980	0.35	0.61	0.94	1.24	1.64	3.05	3.79	4.61	5.16	6.45	9.35	10.22	7.77
1981	0.30	0.65	0.87	1.18	1.42	1.78	3.09	3.89	4.58	7.67	11.49	9.52	11.67
1982	0.28	0.60	0.94	1.13	1.43	1.67	2.18	4.03	5.77	9.91	7.61	13.10	
1983	0.26	0.43	0.74	1.17	1.29	1.54	1.97	1.98	4.92	6.15	12.66	3.95	9.42
1984	0.27	0.42	0.60	1.00	1.37	1.45	1.92	2.23	3.46	11.62	7.45	11.62	7.45
1985	0.32	0.50	0.69	0.84	1.16	1.76	1.78	2.05	2.73	6.05	12.67		
1986	0.27	0.51	0.65	0.81	1.04	1.33	2.32	1.82	2.91	3.64	7.05	11.51	
1987	0.25	0.42	0.65	0.79	0.93	1.13	1.49	1.80	2.37	2.20	4.45	6.77	15.67
1988	0.30	0.47	0.66	0.85	0.94	1.06	1.27	2.40	2.48	3.61	3.99	13.91	15.32
1989	0.28	0.49	0.70	0.89	1.06	1.11	1.17	1.29	2.03	3.59	5.16	6.94	7.66
1990	0.33	0.54	0.76	0.96	1.14	1.24	1.27	1.35	1.44	2.34	6.47	8.74	5.66
1991	0.27	0.48	0.69	0.93	1.09	1.25	1.40	1.36	1.37	1.68	3.88	7.92	18.63
1992	0.30	0.43	0.72	0.93	1.10	1.25	1.49	1.89	1.98	1.41	1.43	1.62	
1993	0.30	0.45	0.64	0.91	1.06	1.26	1.41	2.21	1.49	2.47	1.53	5.23	8.81
1994	0.31	0.46	0.66	0.83	1.12	1.34	1.49	1.58	2.42	2.83	1.96	1.83	
1995	0.25	0.50	0.67	0.84	1.03	1.25	1.60	2.33	2.54	3.36	3.60	6.62	8.59
1996	0.34	0.45	0.77	0.93	1.10	1.29	1.58	2.36	2.59	4.32	3.54	1.76	4.19

Table 12: Summary of sentinel survey programs in the southern Gulf of St. Lawrence 1994-1996.

1994	Gaspé Peninsula	Magdalen Islands	New Brunswick	Nova Scotia	Prince Edward Island
Number of mobile gear vessels			2		
Number of fixed gear vessels					
Time period			Sept. to Nov.		

1995	Gaspé Peninsula	Magdalen Islands	New Brunswick	Nova Scotia	Prince Edward Island
Number of mobile gear vessels	2		4	2	2
Number of fixed gear vessels				6	
Time period	Aug. to late Oct.		July to late Oct.	Aug. to late Nov.	Sept. to Nov.

1996	Gaspé Peninsula	Magdalen Islands	New Brunswick	Nova Scotia	Prince Edward Island
Number of mobile gear vessels	2	1	2	2	2
Number of fixed gear vessels	4	2	6	6	5
Time period	July to early Oct.	July to late Oct.	July to late Oct.	July to late Nov.	July to mid Nov.

Table 13: Summary of 1996 cod and hake catch results in southern Gulf of St. Lawrence sentinel surveys. GNS = gillnets, LLS = Longlines, OTB = Otter trawl, SNU = Seine, OTB-E = Otter trawl in eastern P.E.I., and OTB-W = Otter trawl in western P.E.I., GAS=Gaspé, MAG=Magdalen Islands.

Area	Gear	Liner	# trips	Amount of gear (sets, nets or 1000 hooks)	Catch (kg)	Catch rate (kg per set, kg per net or kg per 1000 hooks)	Numbers	Numbers per tow, net or 1000 hooks
GAS	GNS		48	463	1693	3.7	910	2.0
GAS	LLS		48	120	67	0.6	40	0.3
GAS	OTB	no	18	216	14796	68.5	8924	41.3
GAS	OTB	yes	6	73	9049	124.0	9375	128.4
N.B.	GNS		49	479	4048	8.5	1512	3.2
N.B.	LLS		38	51	5320	104.9	2622	51.7
N.B.	SNU	no	20	233	94520	405.7	84172	361.3
N.B.	SNU	yes	6	60	47351	789.2	58842	980.7
P.E.I.	GNS		51	500	18280	36.6	7670	15.3
P.E.I.	LLS		64	130	27869	213.8	13344	102.4
P.E.I.	OTB-E	no	9	107	732	6.8	266	2.5
P.E.I.	OTB-E	yes	3	36	3301	91.7	2995	83.2
P.E.I.	OTB-W	no	9	105	1125	10.7	588	5.6
P.E.I.	OTB-W	yes	3	36	4402	122.3	5569	154.7
MAG	LLS		48	121	6123	50.5	4342	35.8
MAG	SNU	no	11	103	13075	126.9	5725	55.6
MAG	SNU	yes	3	33	15073	456.8	28423	861.3
N.S.	GNS		48	475	15335	32.3	5850	12.3
N.S.	LLS		96	240	56369	234.9	30574	127.4
N.S.	OTB	no	9	108	8325	77.1	3946	36.5
N.S.	OTB	yes	3	36	14266	396.3	11855	329.3
N.S.	SNU	no	9	107	3853	36.0	1831	17.1
N.S.	SNU	yes	3	36	6304	175.1	13755	382.1
Total			602		371276		303130	

Table 14: Summary statistics from three multiplicative analysis of research survey catches at age of southern Gulf of St. Lawrence cod, 1971-96.

Analysis	N	R ²	Effect	DF	F-ratio	P
Age 2-3, all sets in 1995	52	0.85	age	1	25.6	0.0000
			year-class	26	4.3	0.0003
Age 2-3, set 127 in 1995 excluded	52	0.90	age	1	39.1	0.0000
			year-class	26	6.8	0.0000
Age 4-6, all sets in 1995	75	0.90	age	2	17.1	0.0000
			year-class	27	15.4	0.0000

Figures

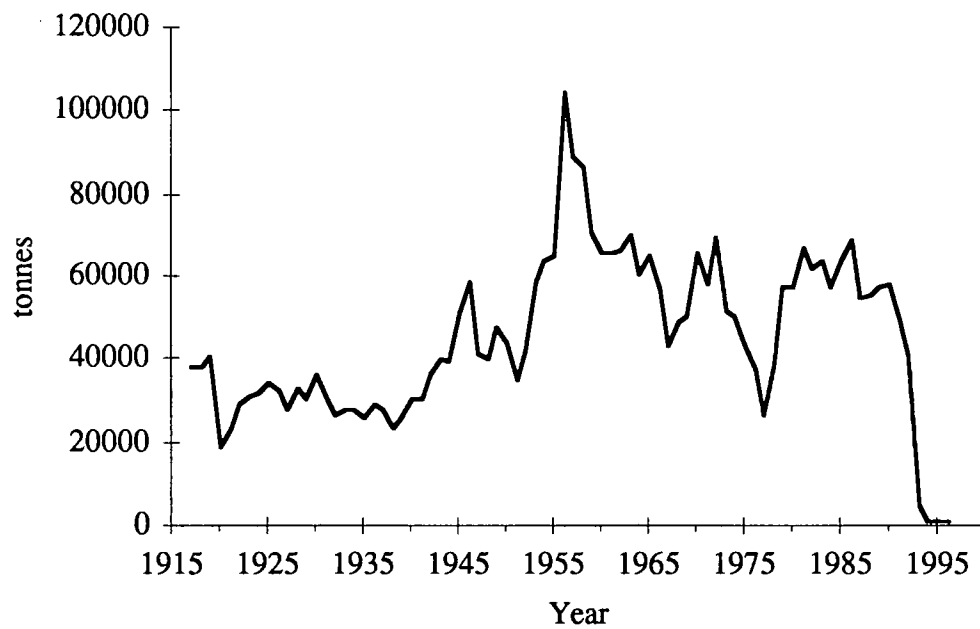


Figure 1: Landings of southern Gulf cod, 1917 - 1996.

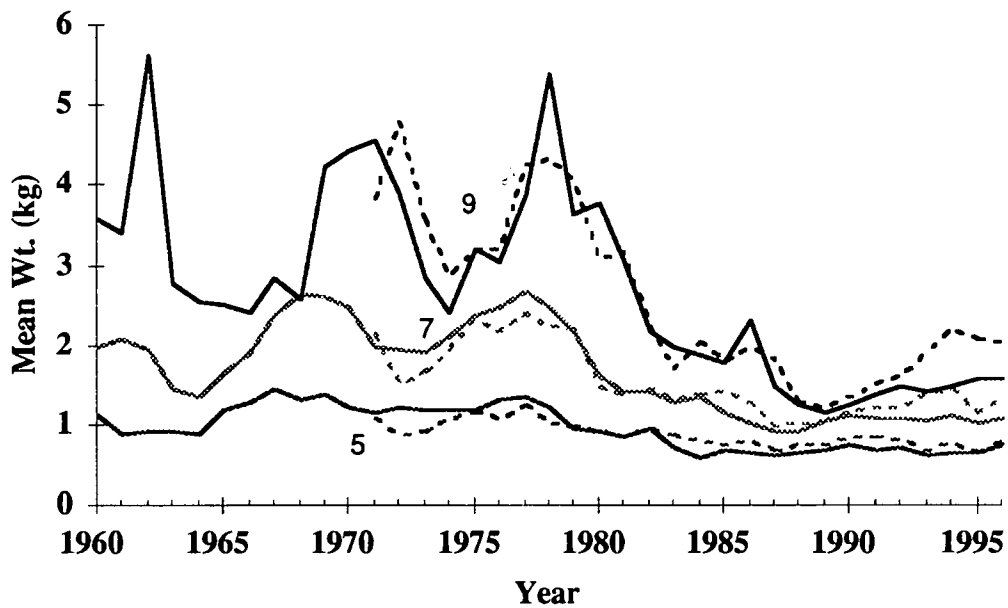


Figure 2: Trends in mean weights at age 5, 7, and 9 (kg) of southern Gulf cod from the commercial fishery (dashed lines) and the research vessel surveys (solid lines), 1960 to 1996.

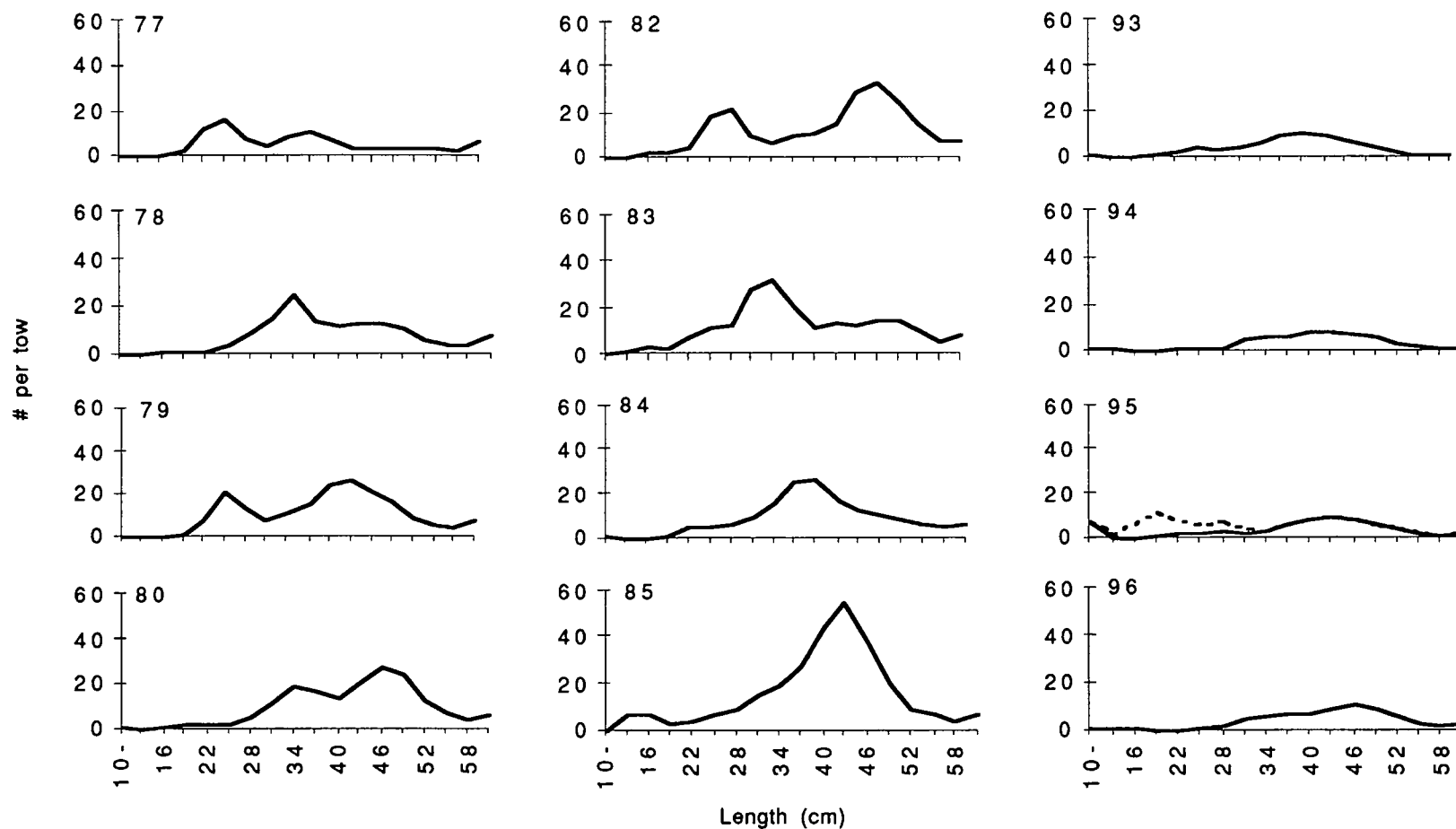


Figure 3: Annual length frequencies (mean numbers per tow at length) of southern Gulf cod from selected years of the September groundfish surveys, 1977-80, 1982-85, 1993-96. These years were chosen to compare the size compositions from previous periods when the stock increased in size (1977-80, 1982-85) with the current period. The dashed line in the 1995 graph includes set 127, while the solid line does not. Where the recruitment (fish less than 40 cm) of relatively large year-classes can be followed in the first two time periods, recruitment has been poor in 1993-96.

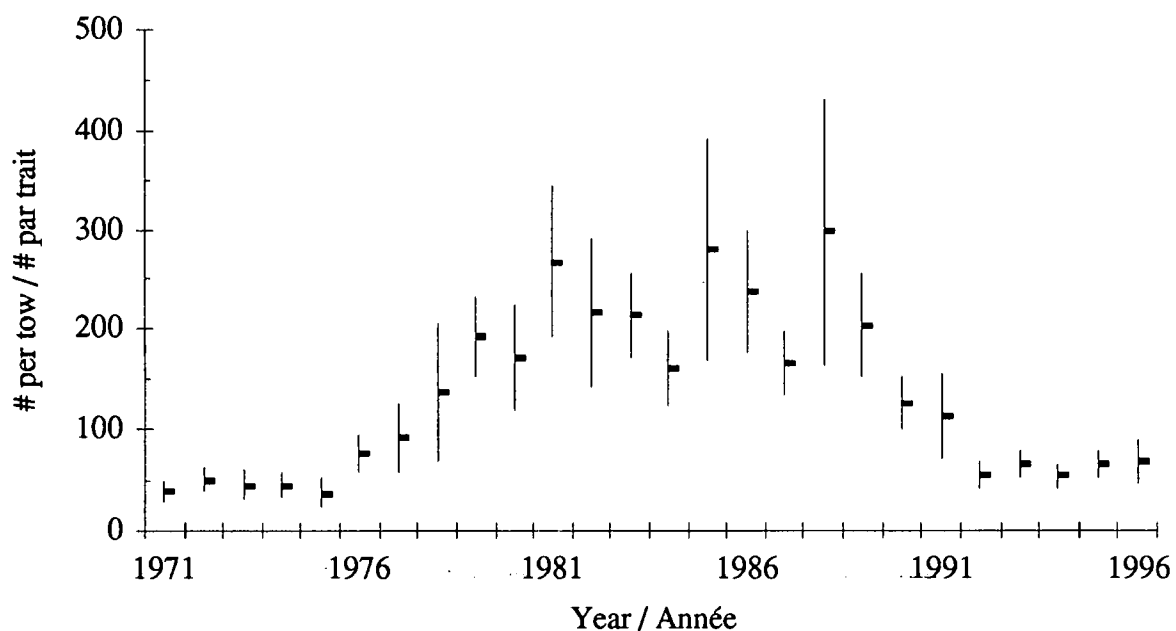


Figure 4: Mean numbers per tow (ages 0+) of southern Gulf cod from the September groundfish survey, 1971 to 1996. Vertical bars give 2 standard errors.

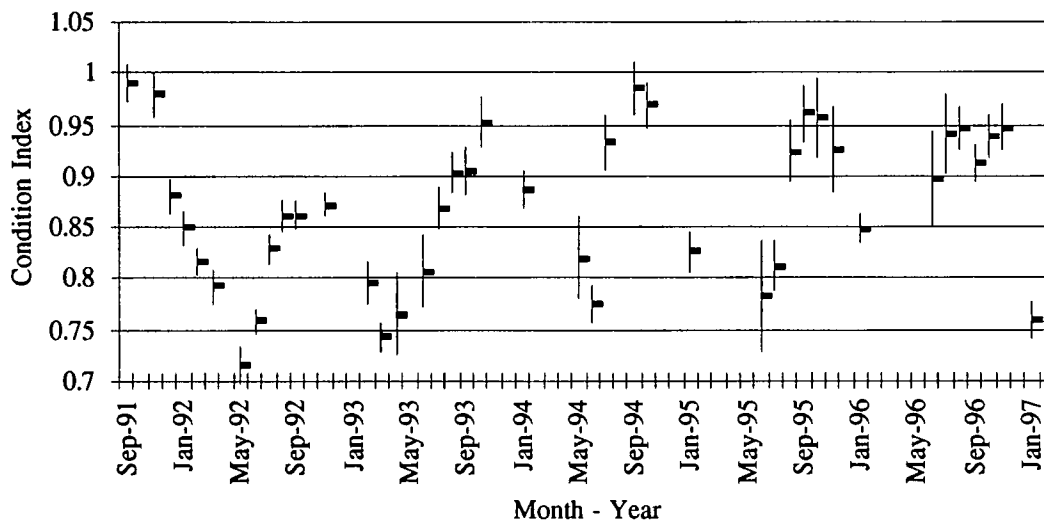


Figure 5: Seasonal change in condition index (carcass weight/length³) for southern Gulf of St. Lawrence cod of 45-50 cm between September 1991 and January 1997. Error bars give 2 standard errors.

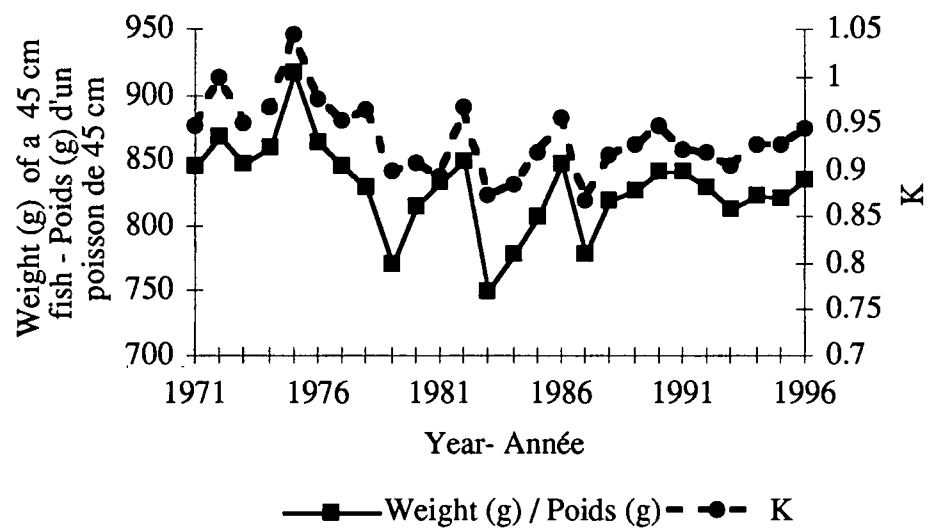


Figure 6: Trends in annual condition factors for southern Gulf of St. Lawrence cod, 1971-96.

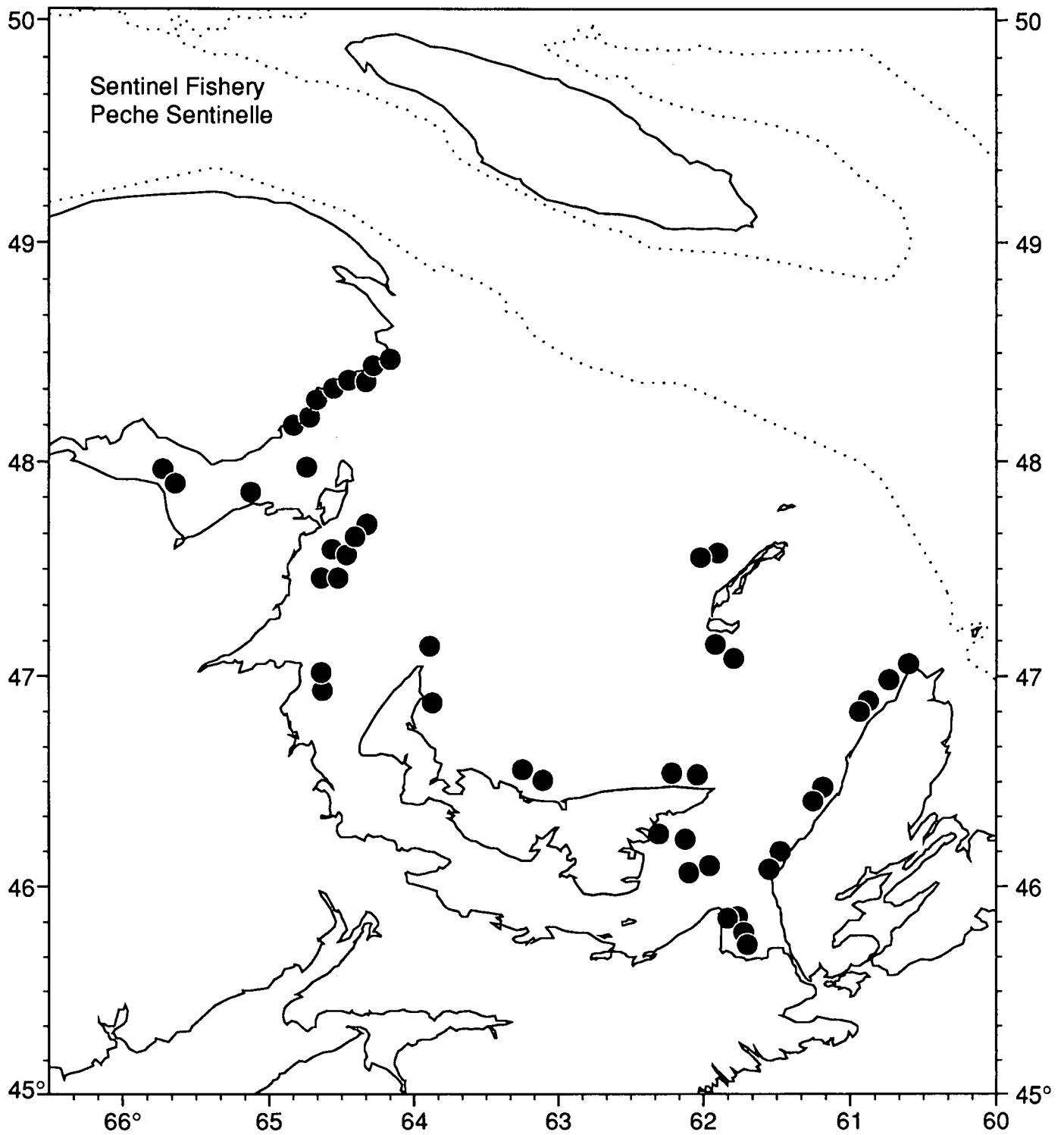


Figure 7: Locations of the fishing sites for the fixed gear sentinel fishery program in 1996.

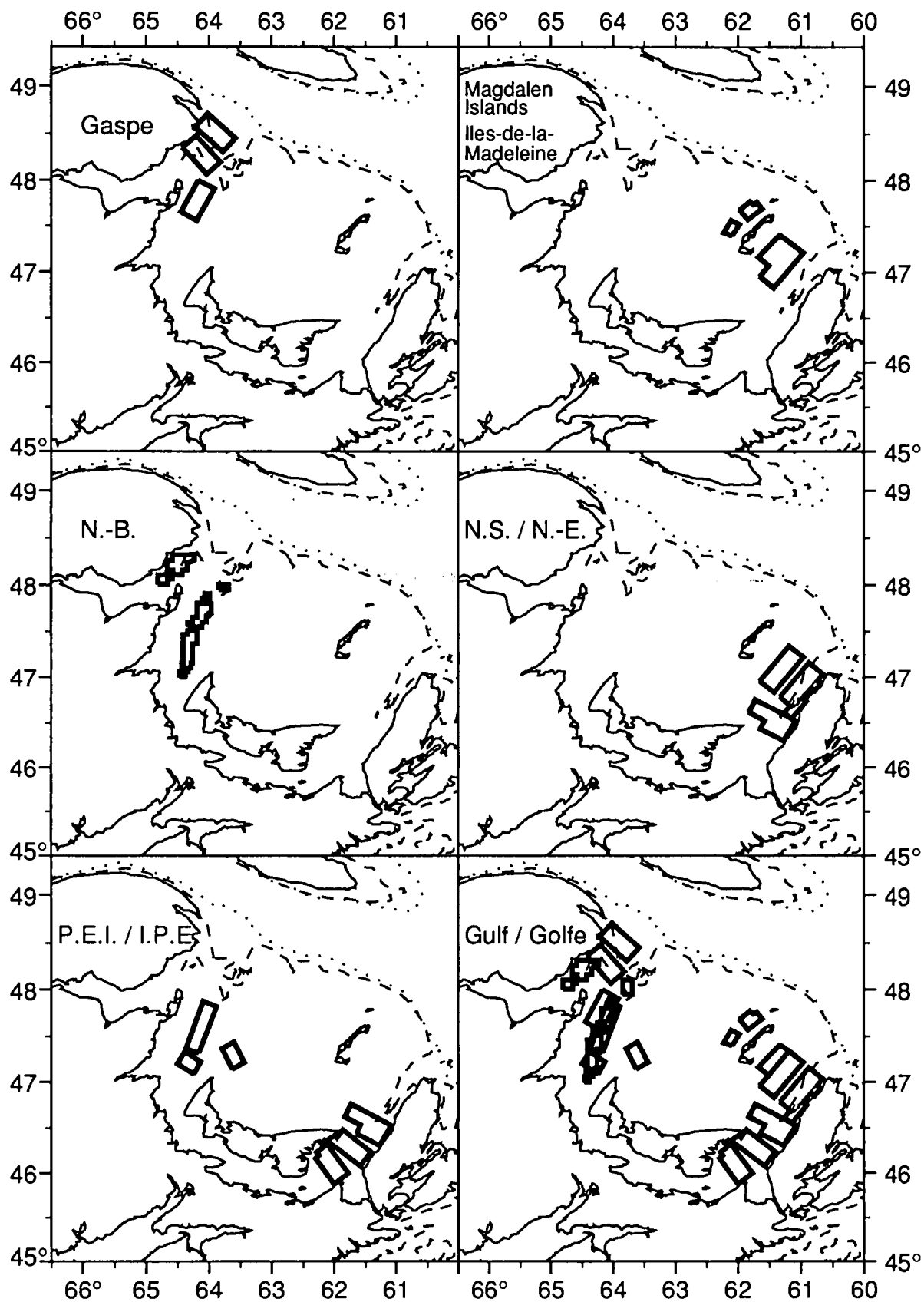


Figure 8: Locations of the fishing sites for the mobile gear sentinel fishery program in 1996.

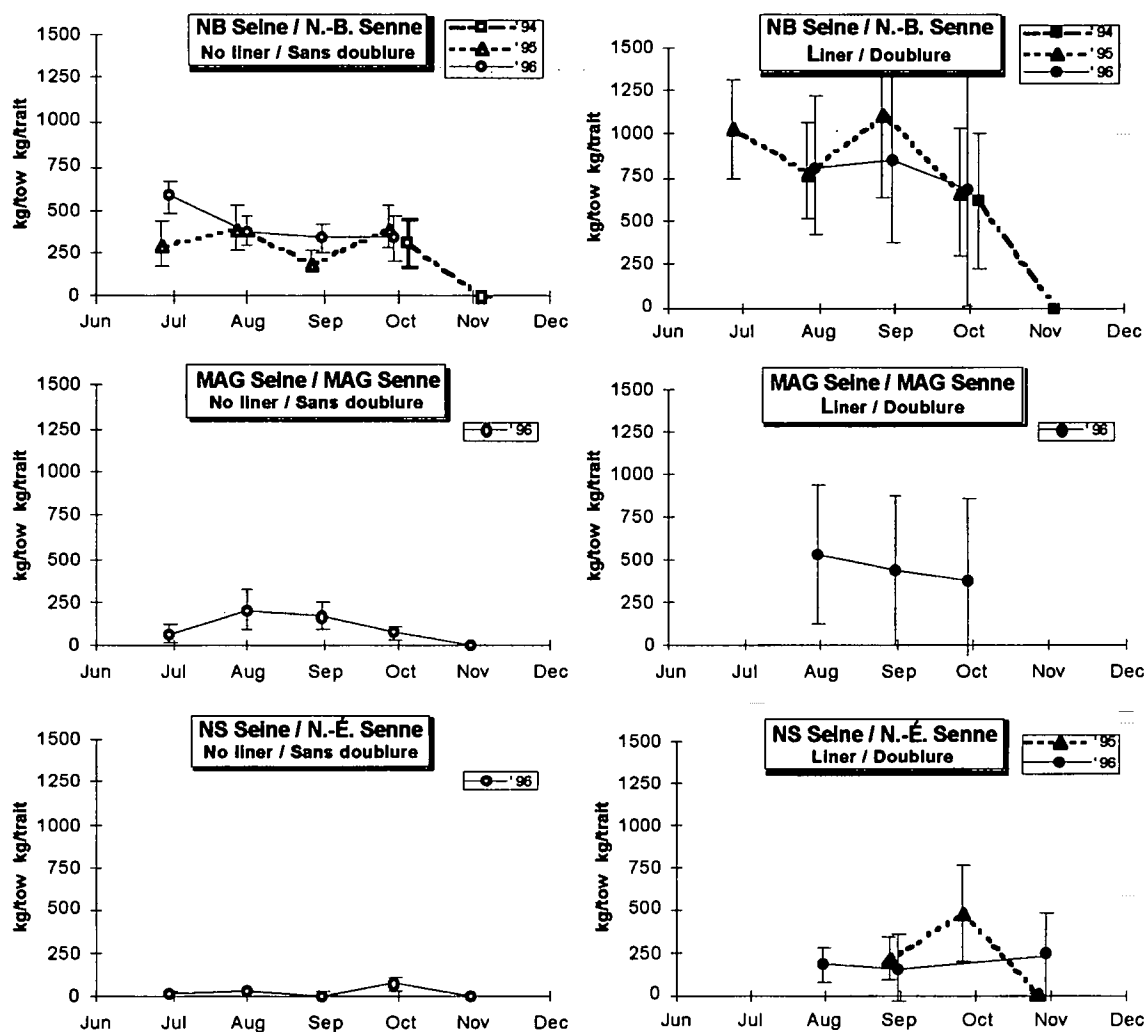


Figure 9: Mean monthly cod catch rates for the 1994-96 sentinel survey using Danish seines in the southern Gulf of St. Lawrence.

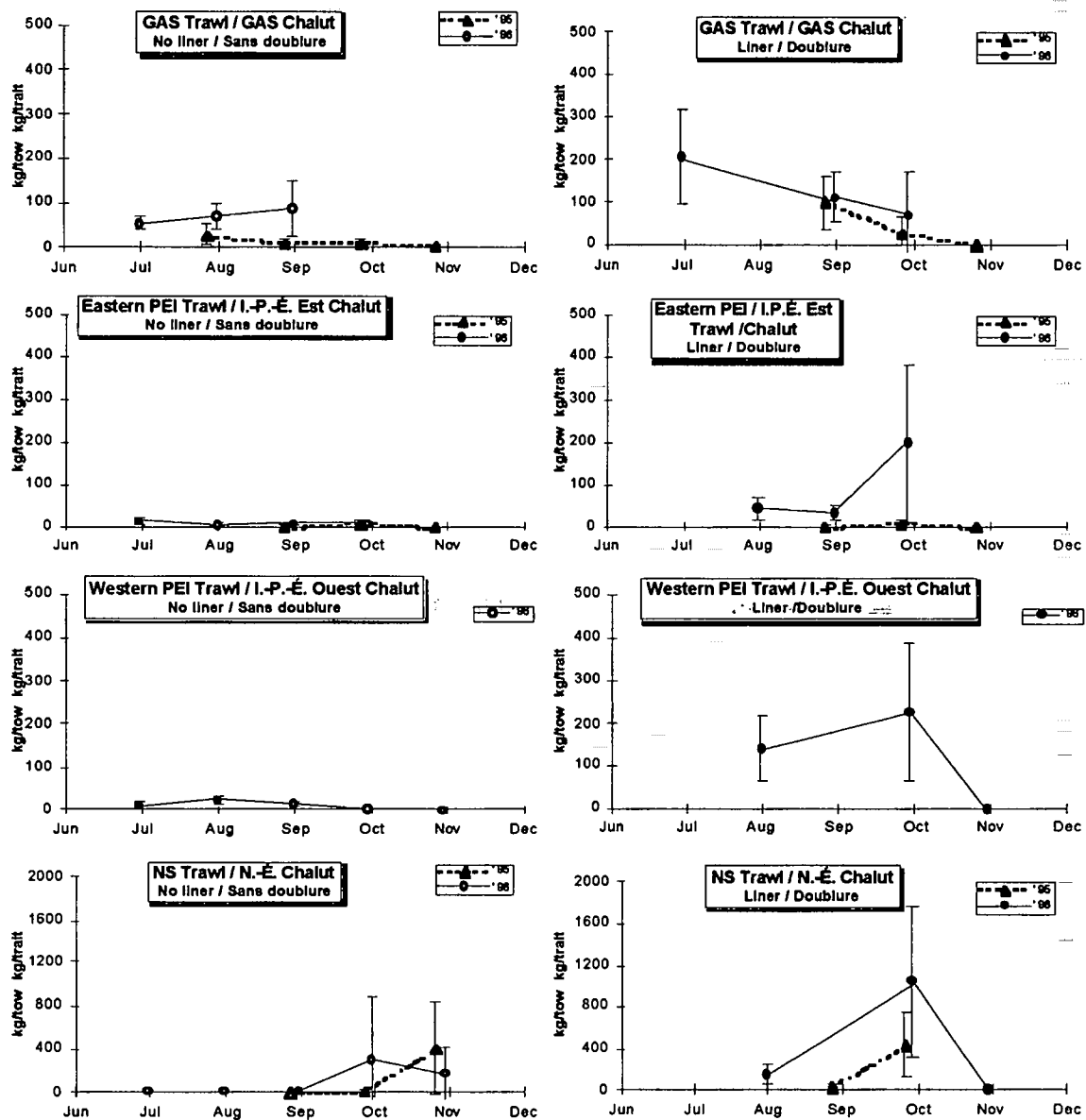


Figure 10: Mean monthly cod catch rates for the 1995-96 sentinel survey otter trawl projects in the southern Gulf of St. Lawrence. Note the difference in scaling between graphs. Otter trawl data in 1995 was multiplied by 2 to compensate for differences in tow duration used in 1996.

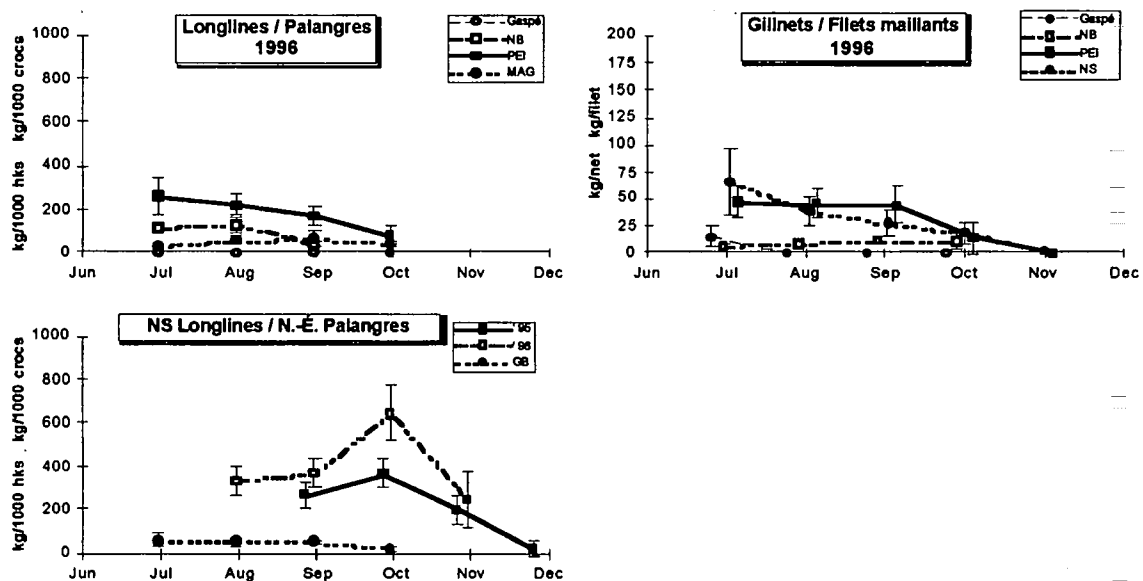


Figure 11: Mean monthly cod catch rates for the fixed gear sentinel survey projects in 1995-96 in the southern Gulf of St. Lawrence. The Nova Scotia longline project in 1995 and 1996 covered the west coast of Cape Breton. The line labelled "GB" is for a project in St. Georges Bay in 1996.

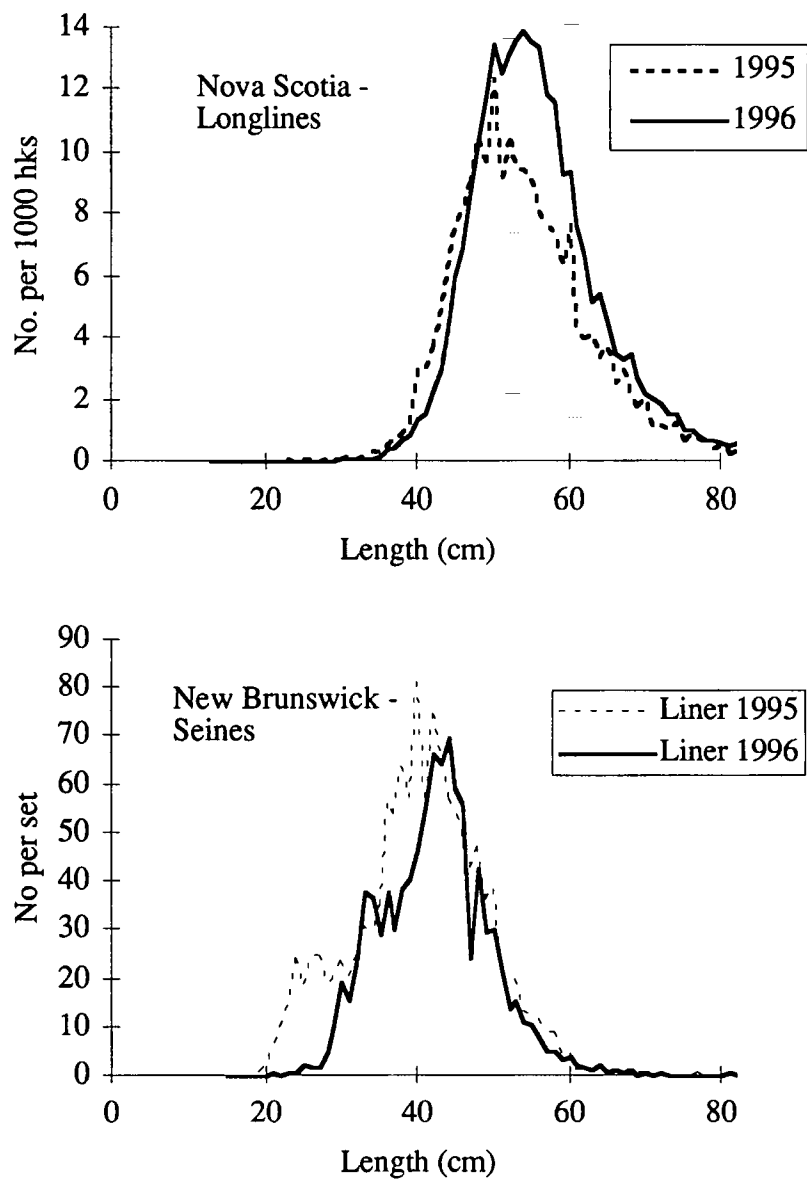


Figure 12: Length frequencies for seines in New Brunswick and longlines in Nova Scotia in the 1995-96 sentinel surveys.

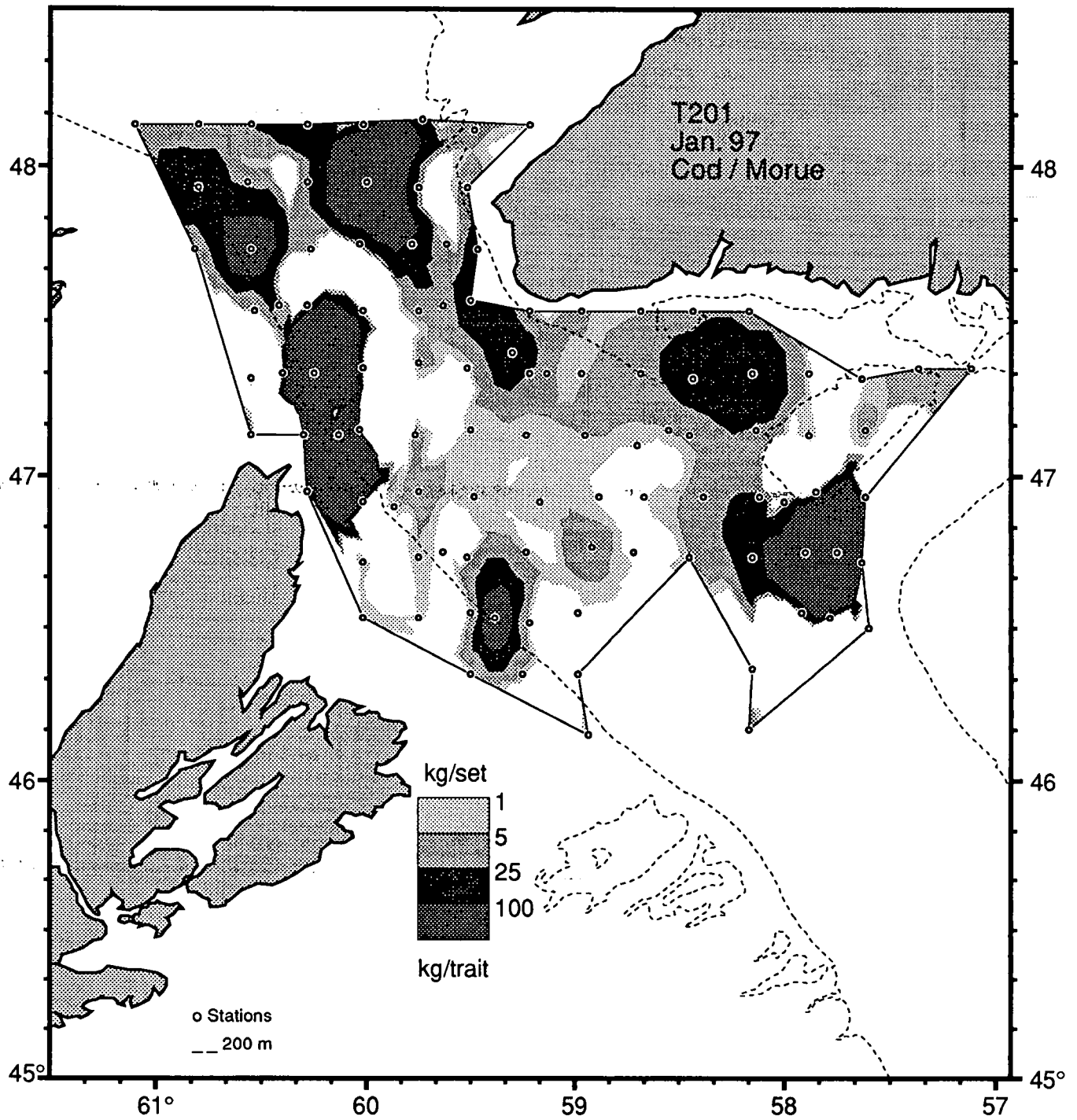


Figure 13: Catches of cod during the January 5-27, 1997 groundfish survey (T201) in Cabot Strait (kg/standard tow).

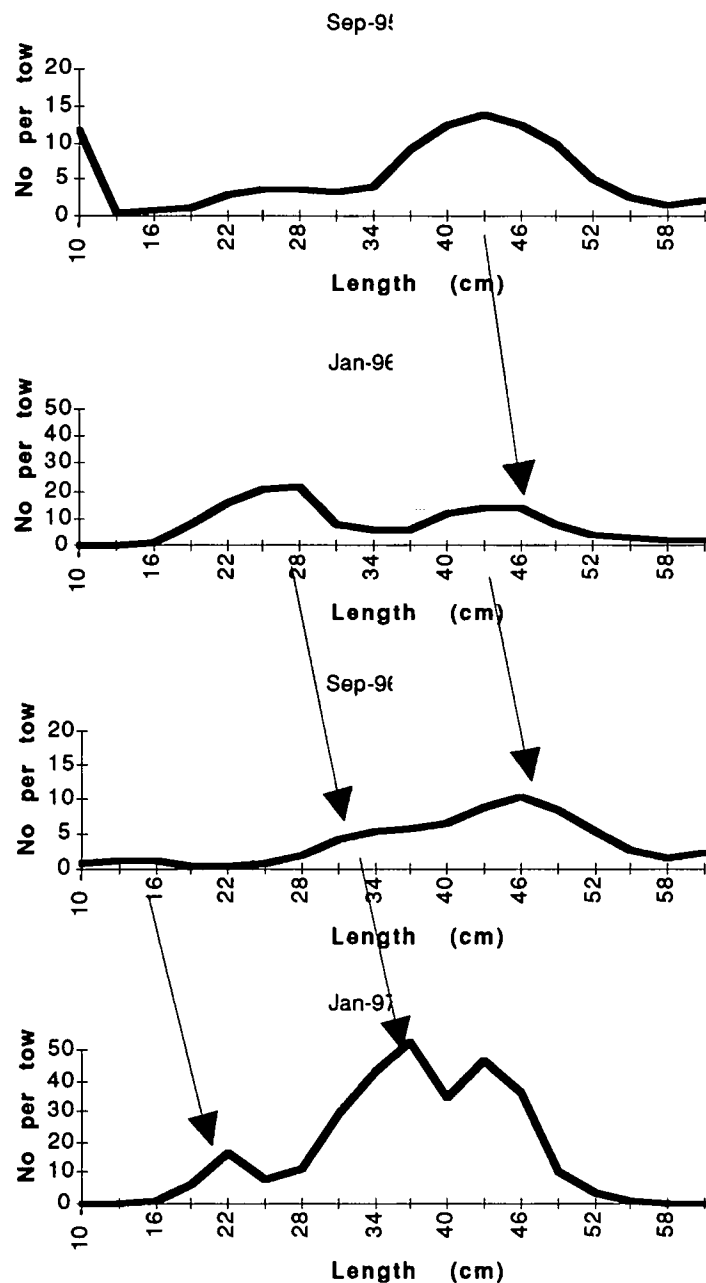


Figure 14: Mean numbers per tow at length from recent September southern Gulf of St. Lawrence and Cabot Strait groundfish surveys. The September surveys were conducted by the *Alfred Needler* using a western IIA trawl and the January surveys were conducted by the *Wilfred Templeman* using a Campelen 1800 trawl. Note the differences in scale.

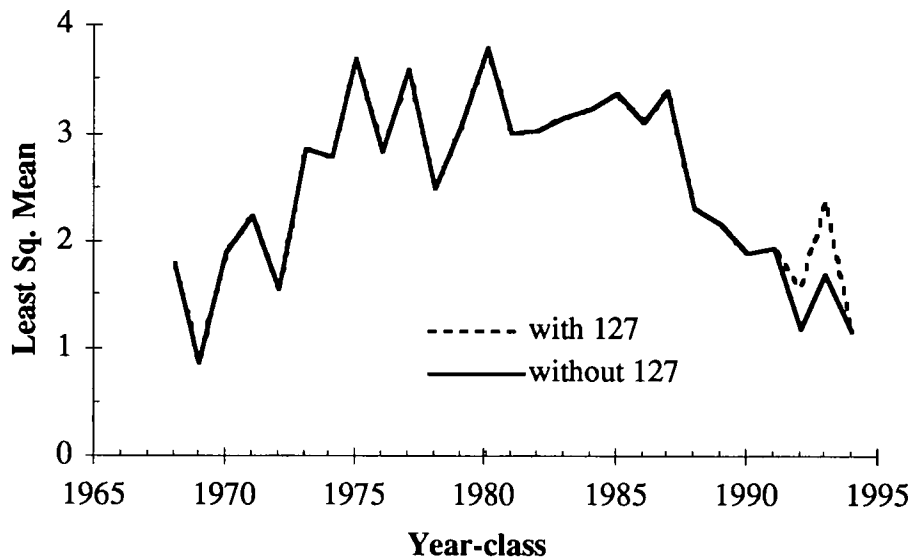


Figure 15: Relative year-class strengths of southern Gulf cod shown as least square means from multiplicative analyses of September RV survey mean numbers per tow for ages 2 and 3. The solid line is from an analysis that excludes set 127 in 1995, the dashed line includes this set.

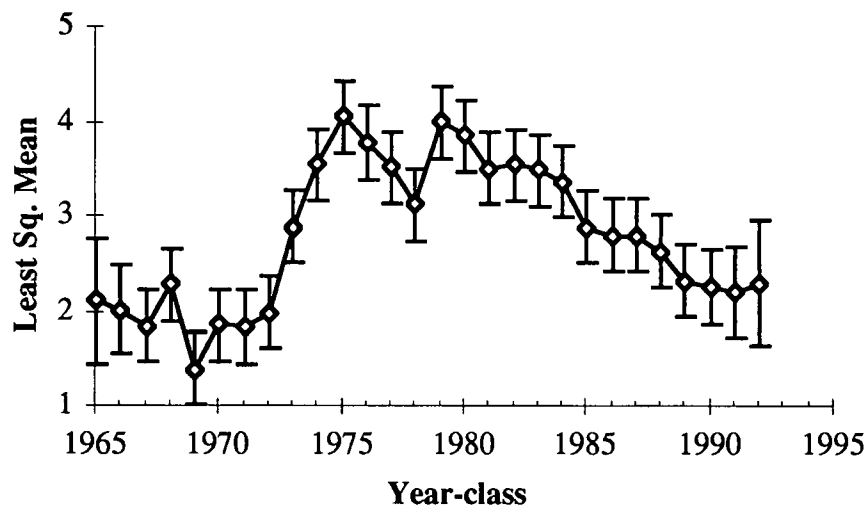


Figure 16: Relative year-class strengths of southern Gulf cod shown as least square means from multiplicative analyses of September RV survey mean numbers per tow for ages 4, 5, and 6. Vertical bars show 2 standard errors.

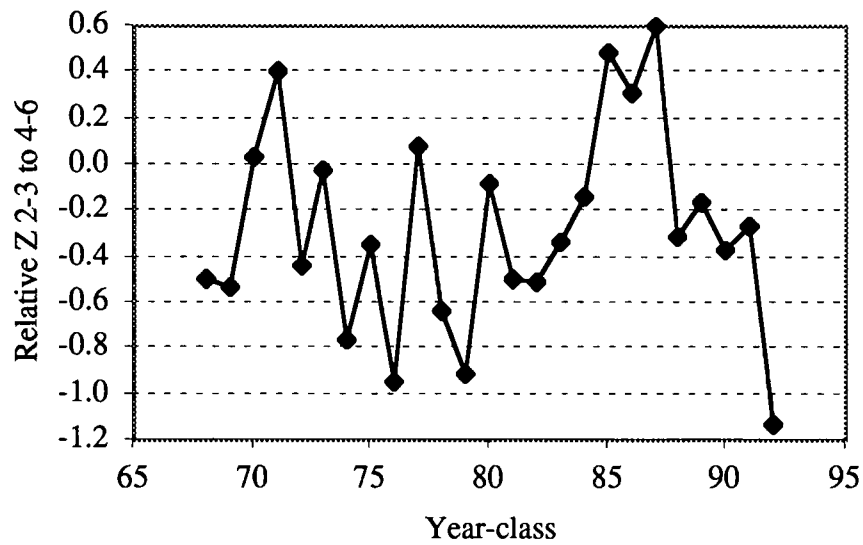


Figure 17: Trend in total mortality (relative) of the 1968-91 southern Gulf cod year-classes between the ages 2-3 and 4-6, estimated from September RV mean numbers per tow.

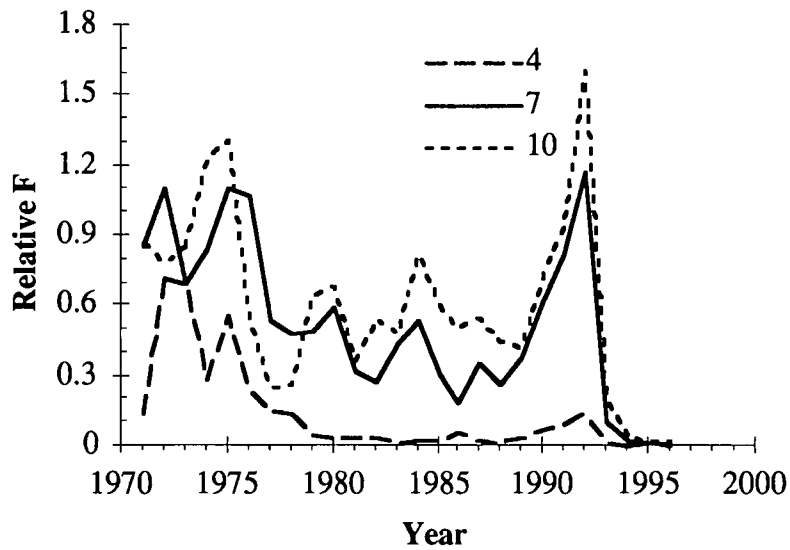


Figure 18: Estimates of relative fishing mortality for ages 4, 7, and 10 obtained directly from the ratio of catch at age divided by RV population estimates at age.

Appendix I: Update of the 1993 4T-Vn cod catch at age with final NAFO landings.

Age-Key	OTB 1	OTB 2	OTB 3	SNU 4	SNU 5	GNS 6	GNS 7	LLS 8	LLS 9	LLS 10	LHP 11	Unsamp	Total
Age													
3	1	0	4	0	1	0	0	4	8	1	34	0	53
4	5	0	39	0	7	2	0	15	48	8	137	0	262
5	32	35	182	4	35	3	12	43	159	34	364	1	904
6	277	137	238	33	51	9	59	31	136	31	171	1	1174
7	268	70	162	37	36	9	150	17	88	20	87	1	946
8	171	16	42	17	10	10	157	5	30	8	33	1	499
9	54	5	19	7	4	5	72	5	27	7	19	0	223
10	32	3	17	5	4	4	34	3	17	4	11	0	135
11	23	2	3	3	1	2	20	1	9	3	6	0	74
12	16	1	1	1	0	1	7	1	5	1	3	0	36
13	14	0	1	0	0	0	8	1	4	1	2	0	31
14	0	0	1	0	0	0	3	0	1	0	1	0	7
15	0	0	2	0	1	0	5	0	1	0	0	0	9
16+	0	0	0	0	0	0	2	0	0	0	0	0	2
Total	893	269	713	108	150	45	528	124	533	117	869	5	4353

Weights	Average												
Age													
3	0.343		0.498		0.543			0.439	0.429	0.512	0.382		0.406
4	0.416		0.630		0.659	0.492		0.573	0.605	0.668	0.510		0.556
5	0.700	0.743	0.776	0.896	0.796	0.745	0.941	0.706	0.747	0.772	0.604		0.698
6	1.026	0.903	0.967	1.116	0.991	1.131	1.354	1.024	1.051	1.050	0.886		1.001
7	1.331	1.114	1.118	1.530	1.141	1.857	1.944	1.303	1.439	1.468	1.394		1.400
8	1.588	1.415	1.467	1.845	1.462	2.286	2.255	1.367	1.701	1.945	1.594		1.812
9	1.660	1.487	1.522	2.502	1.491	2.938	2.350	1.385	1.698	1.787	1.736		1.928
10	1.530	1.676	1.654	2.593	1.530	4.921	3.303	1.432	1.808	1.824	1.732		2.209
11	1.627	1.776	1.546	2.498	1.737	4.371	3.307	1.481	1.907	2.504	2.131		2.289
12	1.705	2.461	1.954	2.942	1.969	3.744	2.930	1.427	2.018	1.871	1.866		2.093
13	1.495	7.742	1.587	8.874	1.589	3.212	3.035	1.368	1.871	2.217	1.784		2.039
14		3.717	1.763	3.271	1.763	5.385	3.433		3.583	2.964	1.874		3.004
15			1.355	8.563	1.344	12.187	8.885	2.058	2.177	2.248	2.058		5.843
16+				17.051		13.375	12.996						13.184
Average	1.301	1.004	0.999	1.601	1.034	2.338	2.287	0.923	1.103	1.197	0.811		1.226

Lengths	Average												
Age													
3	34.00		38.30		39.45			36.71	36.34	38.69	34.98		35.66
4	36.10		41.23		41.88	38.07		39.88	40.59	42.07	38.39		39.46
5	42.58	43.47	44.11	46.35	44.49	43.27	46.80	42.64	43.51	44.08	40.55		42.48
6	48.14	46.32	47.34	49.54	47.72	49.59	52.75	48.21	48.57	48.53	45.78		47.75
7	52.46	49.47	49.52	54.68	49.87	58.22	59.38	52.24	53.75	54.08	53.17		53.09
8	55.38	53.43	54.17	58.22	54.12	62.46	62.34	53.11	56.58	58.80	55.48		57.72
9	55.90	53.72	54.26	63.59	54.06	67.03	62.81	53.41	56.51	57.43	57.07		58.57
10	54.52	55.54	55.66	64.03	54.69	79.55	69.76	54.07	57.73	58.11	57.08		60.45
11	56.00	55.39	55.20	63.16	56.17	76.72	69.42	54.55	58.83	62.72	61.17		61.36
12	56.89	60.30	59.85	65.51	59.99	70.03	64.66	54.04	59.11	58.48	58.54		59.44
13	54.49	94.00	56.01	97.17	56.03	66.73	65.60	53.08	57.96	61.01	57.19		58.58
14		70.00	58.00	66.38	58.00	82.78	69.95		72.49	68.68	58.77		66.78
15			53.18	97.12	53.04	109.00	97.38	61.00	62.10	62.75	61.00		79.95
16+				121.45		112.02	110.77						111.29
Average	51.69	47.60	47.50	54.76	48.10	60.30	61.52	46.10	48.55	49.81	43.69		49.79

Appendix II: Update of the 1994 4T-Vn cod catch at age with final NAFO landings.

Age-Key	OTB 1	OTB 2	OTB 3	OTB 4	SNU 5	SNU 6	SNU 7	GNS 8	LLS 9	LHP 10	LRR 11	SENT 12	Unsamp	Total
Age														
3	62	32	1981	13	534	19	180	3482	730	400	3887	13169	3231	27721
4	3240	462	4282	401	1059	491	880	6657	3260	3991	11715	10741	6224	53404
5	5057	1374	6878	1634	2313	1783	3356	7681	8371	12672	24270	9215	11160	95764
6	29733	2396	10785	4034	5149	3985	9419	14949	17403	29045	45681	11348	24263	208190
7	59459	2882	9651	4771	9032	4225	13996	28246	21942	36256	47478	8756	32543	279238
8	18152	1350	4625	2387	6594	2242	7568	38111	11625	18772	22670	2201	17980	154276
9	1655	424	1702	1106	3557	939	3531	23655	5258	8008	11258	1160	8212	70467
10	130	183	657	525	1733	341	1613	8838	1991	2824	4977	393	3193	27399
11	328	175	434	294	1669	283	1191	4908	1508	2190	3233	778	2241	19232
12	1008	62	139	85	394	114	342	2209	610	692	1035	0	882	7571
13	1140	41	83	69	200	68	238	414	342	633	609	0	506	4343
14	0	2	49	31	105	23	73	527	175	188	249	50	194	1666
15	0	18	0	0	112	0	0	0	0	0	0	0	17	147
16+	0	4	0	0	42	0	0	0	0	0	0	0	6	52
Total	119964	9406	41266	15351	32492	14513	42388	139677	73215	115673	177063	57812	110653	949471

Weights	Average												
Age													
3	0.263	0.349	0.362	0.654	0.342	0.627	0.411	0.398	0.462	0.509	0.384	0.329	0.358
4	0.561	0.507	0.518	0.737	0.529	0.694	0.641	0.649	0.604	0.659	0.572	0.501	0.573
5	0.619	0.737	0.723	0.876	0.828	0.818	0.940	0.878	0.829	0.847	0.772	0.712	0.789
6	0.930	0.877	0.942	1.044	1.092	0.984	1.172	1.528	1.083	1.038	0.986	0.916	1.044
7	1.194	1.234	1.304	1.433	1.604	1.504	1.460	2.173	1.537	1.433	1.417	1.175	1.459
8	1.434	1.581	1.558	1.751	2.012	1.906	1.580	2.464	1.796	1.637	1.653	1.404	1.872
9	2.168	1.886	1.611	1.940	2.381	2.109	1.849	2.769	1.965	1.797	2.027	1.443	2.264
10	2.426	2.237	1.702	1.884	2.907	2.080	1.789	2.494	2.139	1.695	1.956	1.368	2.182
11	2.226	2.413	1.710	1.914	3.240	2.452	2.016	3.227	2.042	1.810	2.255	1.827	2.504
12	1.803	1.967	2.470	1.992	3.111	2.721	2.316	2.554	2.516	2.260	2.485		2.405
13	1.684	2.204	1.942	2.026	2.741	2.115	1.889	2.791	2.005	2.061	1.990		2.035
14		5.088	2.042	2.105	3.759	2.226	1.776	2.426	2.145	1.954	2.018	2.425	2.306
15		1.916			2.451								2.377
16+		17.064			13.172								13.525
Average	1.151	1.171	1.044	1.370	1.783	1.395	1.425	2.162	1.406	1.321	1.247	0.758	1.400

Lengths	Average												
Age													
3	31.00	34.00	34.10	41.67	33.38	41.10	35.58	35.36	37.01	38.31	34.75	33.04	33.96
4	39.53	38.17	38.32	43.26	38.49	42.39	41.08	41.18	40.35	41.60	39.57	37.89	39.57
5	40.80	42.98	42.61	45.61	44.45	44.62	46.51	45.22	44.60	45.00	43.62	42.58	43.89
6	46.38	45.41	46.43	48.05	48.68	47.12	49.95	53.59	48.54	47.98	47.10	46.22	47.88
7	50.36	50.75	51.57	53.01	55.02	53.52	53.62	60.99	54.30	53.09	52.72	50.08	53.29
8	53.39	54.84	54.62	56.35	59.20	58.09	55.09	63.79	57.19	55.55	55.53	53.09	57.83
9	60.38	58.18	55.22	58.21	62.49	59.94	57.50	66.27	58.86	57.13	58.94	53.56	61.44
10	64.00	60.73	56.08	58.10	66.02	59.74	57.04	63.83	60.29	56.33	58.51	52.58	60.68
11	62.19	62.38	56.63	58.54	68.41	63.14	58.99	69.53	59.63	57.65	61.03	57.84	63.28
12	57.63	57.95	63.49	59.87	67.39	65.88	62.15	64.79	64.08	61.99	63.65		63.07
13	54.68	57.76	59.34	60.14	64.25	60.90	58.90	67.00	59.90	60.41	59.82		59.34
14		80.53	60.16	60.80	71.49	62.00	57.51	64.00	61.20	59.29	59.93	64.00	62.38
15		58.88			63.71								63.04
16+		121.00			109.43								110.48
Average	49.42	49.04	47.20	51.91	55.67	51.88	52.88	59.97	52.21	51.42	49.93	42.30	51.70

Appendix III: Update of the 1995 4T-Vn cod catch at age with revised Canadian statistics landings.

	OTB	SNU	SNU	SNU	GNS	LLS	SENT J	SENT S	LHP +	
Age-Key	1	2	3	4	5	6	7	8	Unsamp	Total
Age										
3	0	0	0	660	50	2	4578	38342	24043	67676
4	601	0	86	8732	1955	157	15466	57792	46722	131510
5	3353	1505	1358	9231	1916	682	19909	54501	50947	143403
6	6435	5175	3090	8475	1414	1553	14119	42821	45782	128863
7	13406	12425	6337	9813	7724	5932	27721	59527	78737	221622
8	10214	11288	3373	4261	6905	5675	14724	29550	47385	133376
9	2929	4721	1226	1879	8311	3233	3736	12280	21113	59427
10	974	3043	357	353	3817	1329	1752	3795	8497	23916
11	0	1694	55	126	3004	810	470	2093	4547	12800
12	0	1464	115	58	842	222	0	731	1892	5325
13	0	216	34	49	745	104	0	169	726	2043
14	0	138	32	7	180	55	0	101	283	797
15	0	83	0	0	0	39	0	11	73	206
16+	0	0	0	2	88	0	0	0	50	140
Total	37912	41754	16061	43645	36951	19795	102475	301713	330797	931103

Weights	Average								
Age									
3				0.756	0.341	0.616	0.216	0.241	0.247
4	0.763		0.531	0.635	0.553	0.741	0.411	0.490	0.495
5	1.111	0.867	0.871	0.723	0.823	0.924	0.525	0.674	0.674
6	1.316	1.072	1.042	0.846	1.220	1.265	0.734	0.857	0.905
7	1.534	1.162	1.254	0.980	2.030	1.679	0.863	1.106	1.176
8	1.825	1.511	1.608	1.157	2.367	1.903	1.039	1.348	1.492
9	1.926	2.026	2.100	1.269	3.231	2.342	1.352	1.742	2.115
10	2.287	2.204	3.277	1.788	3.528	2.578	1.606	2.216	2.520
11		2.189	2.634	2.490	4.142	2.902	1.195	2.415	2.978
12		2.647	1.848	3.276	5.888	2.433		2.551	3.391
13		2.798	2.573	2.083	6.219	3.702		3.595	4.875
14		2.573	2.222	2.805	8.630	3.552		3.383	4.936
15		2.959				5.702		8.084	4.191
16+				12.799	10.103				10.161
Average	1.575	1.519	1.374	0.873	2.739	1.928	0.740	0.843	1.088

Lengths	Average								
Age									
3				43.77	30.00	41.00	29.55	29.71	29.90
4	43.70		39.07	41.24	39.39	43.40	36.43	37.77	37.97
5	49.39	45.42	45.61	43.03	44.83	46.42	39.43	41.88	41.95
6	52.11	48.66	48.09	45.11	50.10	51.10	43.94	45.21	46.03
7	54.37	49.71	51.09	47.43	59.37	56.01	46.22	48.86	49.81
8	57.81	53.69	55.03	49.85	62.88	58.32	49.08	52.14	53.76
9	58.73	58.99	59.67	51.05	68.81	62.14	53.27	56.05	59.50
10	62.11	60.13	69.34	56.50	70.73	64.08	56.72	60.18	62.98
11		59.93	65.25	63.30	74.52	66.70	51.76	61.85	66.02
12		63.10	58.42	69.30	83.39	62.93		62.72	67.93
13		66.76	65.00	60.07	83.73	71.51		70.63	76.94
14		65.00	62.00	65.02	96.00	70.35		67.98	76.81
15		68.00				84.00		94.00	74.86
16+				109.00	101.00				101.17
Average	54.84	53.37	52.03	45.32	63.67	58.09	43.24	43.42	46.90