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Age composition, growth and maturity of cod in inshore waters of Divisions 2J, 3K and 3L as determined from sentinel surveys (1995-1997)

by

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Abstract

Samples of cod (Gadus morhua) caught during sentinel surveys in Divisions 2J, 3K and 3L during 1995-1997 provided information on age compositions, lengths-at-age and age at 50% maturity. Age compositions from linetrawl catches in 3K provide evidence of an increase in the number of age-classes making important contribution to the catch during 1995-1997. Age compositions in gillnet catch during 1997 were dominated by the 1990 year-class throughout southern 3K and 3L. The importance of both the 1989 and 1992 year-classes increased toward the south. Age at maturity of fish in the inshore is difficult to estimate because of the paucity of small fish in the sentinel samples, but it does not appear to differ from that of fish in the offshore. The life history of cod in the inshore is discussed.

Résumé

Des échantillons de morue (Gadus morhua) prélevés pendant les relevés par pêche sentinelle des divisions 2J, 3K et 3L, de 1995 à 1997, ont permis d'obtenir des renseignements sur la composition par âges, la longueur selon l'âge et l'âge à 50 % de maturité. La composition par âges des captures de la pêche à la palangre en 3K montre un accroissement du nombre de classes d'âge formant une partie importante des captures pendant cette période. La composition par âges des captures au filet maillant réalisées en 1997 montre que ces dernières étaient dominées par la classe d'âge de 1990 dans le sud de 3K et en 3L. L'importance des classes d'âge de 1989 et de 1992 augmentait en direction du sud. L'âge à maturité des poissons de la zone côtière est difficile à estimer à cause du nombre très restreint de petits poissons au sein des échantillons de la pêche sentinelle, mais cet âge ne semble pas différer de celui noté en zone nauturière. Le cycle vital de la morue de la zone côtière fait l'objet d'une discussion.

Introduction

Sentinel surveys were conducted in the inshore of Divisions 2J, 3K and 3L at various times from summer 1995 to autumn 1997 (Davis MS 1996). Cod sampled from these surveys provide biological information on fish that are landward of the sampling conducted during the standard research vessel bottom-trawl surveys.

Catches from the sentinel surveys have been included with all other landings in the analysis of catch at age and mean weight-at-age for those fish caught in 2J+3KL in 1995-1997 (Shelton et al. MS 1996; Murphy et al. MS 1997; Lilly et al. MS 1998b). This paper uses sentinel survey data alone to explore variability in age compositions and length-at-age associated with gear, area and time. In addition, the age at maturity of cod caught in the inshore is compared with that of cod caught during the offshore survey.

This paper provides part of the documentation of the 1998 zonal assessment of the 2J+3KL cod stock (January-February 1998, St. John's, NF). During the meeting there was a request for sentinel survey catch rates disaggregated by gear, Division, year and age. These analyses were examined only very briefly at the end of the meeting. They are provided without comment in Appendix 1 of this paper. In addition, there was a request for length and age compositions for cod caught by gillnets and linetrawls from 3K to 3Ps in 1997. These analyses were tabled but not discussed by the meeting and are not reproduced in this paper.

Materials and Methods

Surveys and sampling

Sentinel surveys for cod were conducted by fishing enterprises operating from many communities (Fig. 1) in Divisions 2J, 3K and 3L at various times during summer and autumn 1995-1997. The primary goal of these surveys was to determine catch rates on traditional fishing grounds, primarily with linetrawls and gillnets, but also to a much lesser extent with traps.

Participants

The primary collectors of data in the Sentinel Survey are inshore fish harvesters. The process of participant selection was as follows.

Through consultation with fish harvesters and fisheries organizations, traditional inshore fishing grounds were identified and mapped.

In the winter of 1995, the communities within the boundaries of the identified coastal areas were advised via the media and word-of-mouth of sentinel information meetings. The objective of the meetings was to present both the scientific and administrative rationale and structure for the project. A representative from one or both of the project sponsoring organization and the Department of Fisheries and Oceans (DFO) Science Branch attended the meetings.

Fishers who met eligibility criteria were invited to apply to participate in the survey. The criteria included five years as head of a fishing enterprise and a willingness to participate in a six week science training program.

Where more than one application was received from an area, the project sponsor conducted a draw or lottery to select the participant. While there was considerable interest in the project in most areas, there were many sites from which only one application was received and others where additional canvassing was required in order to enlist participants.

In order to minimize inter-annual enterprise effects on data collection, participants are expected to remain with the survey over a number of years. It is also expected that most of the sampling activities will continue once commercial fishing activities resume and the sentinel participants will form a core of index fish harvesters.

Training

In order to establish a standardized data collection routine, provide a rationale for the data collection methods and establish an initial and thorough point of contact, a science training program was developed jointly by DFO and the Marine Institute of Memorial University of Newfoundland in the eighteen months prior to the start of the sentinel survey.

One person from each sentinel survey crew participated in a six week training course prior to commencing survey activities. The training course provided an introduction to data collection, sampling methods and tools and the use of computers and electronic oceanographic monitoring instruments. Participants also received overviews of the ocean environment, resource management and presentation/communication skills.

Sampling

In 1995, sampling was conducted at 56 sites and ran for a maximum of 15 weeks over the period from July to December. In 1996 and 1997, sampling was conducted over 12 weeks at 60 sites. The timing of sampling was determined after discussions with fish harvesters but was targeted for seasonally appropriate times based on historical fishing patterns. While constrained by the number of sampling weeks, an effort was made to sample during the same period each year.

Cod Traps

Several of the sites were designated for use with cod traps. The specific location of each trap site was chosen after consultation between DFO scientists, fish harvesters and the Fishermen, Food and Allied Workers Union (FFAW). Site selection was based on the need to survey throughout inshore areas and targeted historical fishing areas using the historical patterns of gear use.

Designated trap crews fished cod traps for a maximum period of five weeks and then switched to either baited trawl lines or gill nets for an additional period of seven weeks. Non-trap sites fished either baited hooks or gill nets for the full twelve weeks.

Trap crews fished five days per week for five weeks. Fishing days in the week were selected at the discretion of the crew and depended primarily on weather conditions. All berths selected for traps were considered prime trap locations.

When a trap was hauled, the crew noted the soak time since the previous haul and estimated how much fish had been caught. On three days each week they removed a sample of approximately 100 fish for biological sampling and released the remaining catch. Meshed fish and dead or floating fish were retained and brought ashore. While it is acknowledged that Japanese style cod traps could have higher mortalities of fish than modified Newfoundland traps, fish harvesters were asked to release as much live fish as possible.

Gillnets and linetrawls

Both gillnet and linetrawl crews fished up to three days per week. All fish caught in gillnets and on hooks were landed.

Gillnet crews fished 2-6 fifty fathom 140 mm (5½ inch) monofilament gillnets. The nets were rigged 2-3 to a fleet. In most cases, they were fished in two nets per fleet, with one fleet fished at a control site (see below) and one fleet at each of two experimental sites. If catches exceeded 500-700 kg per week, the number of nets in a fleet was reduced. However, some consideration was given to bottom topography and net performance when reducing the number of nets in a fleet.

Linetrawl crews fished a maximum of 1000 hooks per day. These were deployed at the control site and one or two experimental sites. The number of hooks per tub was reduced if landings exceeded 500-750 kg per week.

Sampling strategy

Prior to the start of sampling with gillnets and linetrawls, a fixed (control) location on the fishing grounds was established for each site for the duration of the project. The control site was a location that was chosen to reflect average fishing activity over a fishing season. It is expected that the same control site will be occupied over years. Since fishing grounds and gear usage may change depending on season, a sentinel participant may use different gears at different times of the year, and there may be a control site for each gear type.

Each fishing day, up to half of the gear was set at the control site. The remainder (experimental) was set anywhere on the fishing grounds at the discretion of the crew. The location of each fishing set was plotted on a nautical chart. The time of the set and the soak time for the gear was recorded to the quarter hour. If high catch rates were experienced at one experimental location on a particular day, set locations were moved for the following fishing day. Environmental observations were recorded and included wind direction and speed, percent cloud cover, tide conditions, presence of invertebrates (bait) and other fish species in the area, marine mammals, sea birds and any other variable which may have influenced fishing behavior.

When the gear was retrieved, any catches from the control and experimental gear were kept separate and sampled on shore. All fish were counted, measured (fork length in cm), sexed, and examined for parasites. Observations were made on stomach contents and fullness. Otoliths were sampled based on length frequency requirements.

At selected sites, a sample of up to 100 fish was collected every other week, frozen and transported to St. John's for detailed observations (see below). All information was recorded on forms similar to those used by the Port Sampling Section and on the research vessels. Otoliths were stored in manila envelopes with relevant information recorded on the outside. Fin clips were stored on blotter paper in the envelopes.

Other biological samples were collected on an "as-needed" basis. These included fin clips and/or blood samples for genetic studies and liver samples for toxicological studies.

DFO staff from the Fisheries Evaluation Section and the Commercial Sampling Section provided field support through weekly visits to sites and regular phone contact. Project sponsors maintained regular contact with participants for administrative support and scientific liaison.

Handling of frozen fish

To obtain detailed information on maturity, condition and feeding of the cod, the frozen samples were transported to the Northwest Atlantic Fisheries Centre in St. John's, where they were thawed in fresh water and weighed (to the nearest 10 g) before being cut (round weight) and again after removal of the organs from the abdominal cavity (gutted weight). The stage of maturity was assessed based on visual examination of the gonads and fish were assigned to the category 'mature' or 'immature' based on criteria described by Templeman et al. (1978). The first stage in this scheme is classified as immature and all other stages show some evidence of maturing to spawn or of having spawned in the current year and are classed as mature. The 'other' or unknown' category was excluded from the analyses of maturity data. The gonad and liver were weighed (g). The stomach was weighed and put aside for detailed analysis of contents. The otoliths were saved and added to those collected in the field (Table 1). The number of fish that were sampled for length, age and body weights is provided in Table 2.

A few points are noted for those who might wish to repeat our analyses. (i) Those fish that were frozen for detailed analysis in the laboratory were not included in the length-frequencies. We have added them to the frequencies for all analyses of catch composition and length-at-age. (ii) Fishing enterprises fished at both control (fixed) sites, which did not vary over time, and experimental sites, which might change on a daily basis. Information on depth and position (latitude and longitude) of fishing was recorded only on the length-frequency forms. Because the electronic record for fish taken for the detailed analysis does not indicate whether the cod was taken from the control (fixed) site or an experimental site, it is not possible at present to match each fish with a specific length-frequency. (There are also some instances where length-frequencies do not exist for the date on which the detailed sample was taken.) Hence, the depth and position at which the fish were caught is not currently available. (iii) The otolith samples came from collections made directly by fishing enterprises and from those fish that were frozen for detailed sampling in the laboratory. The electronic record for those fish sampled directly by the fishing enterprises lacks information for either the fishing enterprise or the community from which the enterprise operated. Thus, the smallest spatial area for which there is an adequate sample size for ageing of fish is the commercial unit area (Fig. 2). That is, it is not possible to aggregate on the basis of community or fishing ground.

Data analyses

Age composition and length-at-age

To examine temporal and spatial variability in age composition and mean length-at-age, basic length-frequency and aging samples were combined into gear-area-time cells, where the gears were linetrawls, gillnets and traps, the areas were commercial unit areas (Fig. 2) and the time periods were one month or 2-3 adjacent months. The normal practice of weighting each length-frequency by the ratio of the landing weight to the sample weight (see, for example, Gavaris and Gavaris 1983) was not necessary for linetrawls and gillnets because the total catch was measured. In the case of traps, where usually only a sample was obtained, each frequency could have been weighted by the estimated catch, but that was not done for the present analyses. Analyses were conducted only for gear-area-time cells with an arbitrary minimum sample size of 100 aged fish. The length-frequencies and aging samples were combined into 3-cm groups before analyses. In almost all instances there were a few individuals toward either end of the length frequency that were of a length not represented in the aged sample. Therefore, the age compositions may underrepresent and possibly even miss ages toward either end of the range. In addition, the estimated length-at-age of ages toward either end of the distribution may not accurately reflect the length-at-age of individuals in the catch.

In the analyses of gillnet data, only length frequencies from the standard gillnet mesh size (140 mm) were selected. The mesh size is not recorded in the ageing data base, so any age samples from gillnets of other mesh size could not be excluded at this time.

Age at maturity

Maturity data from the sentinel surveys were obtained from the frozen samples (Table 3) and grouped by Division. Maturity data from autumn research bottom-trawl surveys in the offshore of Divisions 2J3KL from 1995 to 1997 were examined for comparison. Fish in the research vessel samples were examined fresh. For trawl survey samples and sentinel samples collected during August-December, one year was added to the age and the year because the fish collected at this time were maturing to spawn in the following calender year. Trawl and sentinel samples collected during the autumn were therefore compared with sentinel samples from the following spring.

The methodology used here to analyze maturity data was essentially as described by Morgan and Hoenig (1997), Morgan and Shelton (MS 1995) and Morgan and Brattey (1997). Because of the length-stratified collection of otoliths during research vessel surveys, the calculation of proportion mature at age included a weighting by the female population number at length (Morgan and Hoenig 1997). The sentinel data were also collected in a length-stratified manner so the proportions were weighted by the length frequency of the catch. Estimates of the observed proportion mature at age were tabulated. Age at 50% maturity (A50) and 95% confidence limits were produced using Probit analyses with a logit link function (SAS Institute Inc. 1989). Parameter estimates and their standard errors are also given using the numbers of aged fish as the sample size.

Results

Age composition of the catch

The age composition of the catch may vary depending on the type of gear and the time and location of deployment, as demonstrated for cod sampled from the sentinel surveys in Subdivision 3Ps (Lilly et al. MS 1998a). Variability associated with gear type and time of year has not yet been explored in the sentinel survey data from 2J, 3K and 3L.

To explore annual variability, age compositions were calculated for the linetrawl catch in commercial unit areas 3Kh and 3Ki in August - October of 1995, 1996 and 1997 (Table 4). The catch in 1995 was dominated by fish of ages 4 and 5 (1991 and 1990 year-classes), but there was also strong contribution from fish of age 6 (1989 year-class) and even some age 7 (especially in 3Ki). The 1986 and 1987 year-classes, which initially appeared strong in the surveys and then rapidly disappeared in the early 1990s (Lilly et al. MS 1998b), were very weakly represented in the 1995 linetrawl catch. Additional year-classes entered the catch in 1996 and 1997, so that by 1997 each of four year-classes (1990-1993) contributed more than 10% of the catch.

To explore spatial variability, age compositions were calculated for the 1997 gillnet catch in commercial units areas from 2Jm in the north to 3Lf in the south (Table 5). Age compositions from the two most northern areas were dominated by age 6 cod whereas those from the rest were dominated by age 7 (the 1990 year-class). It must be noted that it was not possible in the selection of fish for the age-length keys to select only those fish caught in the 5.5 in gillnets. Fish caught in the small mesh (3.25 in) gillnets and subsequently aged are included in both the age-length key and the catch to which the age-length key was applied. These fish from small mesh gillnets make their largest contribution in the most northern unit areas, where the total catch from 5.5 in gillnets was small. They are presumably responsible for the relatively large contribution of age 4 fish in 2Jm and 3Ka. Thus, the age-compositions from 2Jm and 3Ka, and perhaps from 3Kd as well, are not representative of the catch from 5.5 in gillnets alone, and are not directly comparable to the age-compositions from unit areas to the south and east.

In unit areas 3Kh to 3Lf, the 1990 year-class at age 7 dominanted the 1997 gillnet catch, particularly in the north. The contribution by the 1989 year-class (age 8) increased toward the south and was greatest in unit area 3Lf, adjacent to Subdivision 3Ps where the 1989 year-class was relatively strong (Stansbury et al. MS 1998). The 1992 year-class (age 5) was also a strong contributer in 3L, especially in 3Lj.

Length-at-age

For those year-classes well represented in the age compositions, length-at-age appeared consistent from year to year and length increments appeared to be strong (Table 4). The lengths-at-age were perhaps a little greater than those calculated for cod in the offshore of Division 3K (Lilly MS 1998).

There was almost no spatial variability in the length-at-age of cod of ages 6 and 7 in the gillnet catch from unit areas 3Ka to 3Lf (Table 5).

Maturity

Estimates of the proportion mature at age from sentinel sampling of the inshore in Divisions 2J+3KL were compared with estimates from the trawl survey from corresponding NAFO Divisions for spawning years 1995 to 1998. Estimates of A_{50} for female cod were in general slightly higher for female cod compared to males (females matured at older ages). The estimates ranged from 4.16 to 5.99 among females and from 3.00 to 4.65 among males. Many estimates from the sentinel samples are hampered by small sample sizes and lack of fish in the younger ages. Consequently, the model in some instances could not be fitted or parameter estimates have high standard errors. In most years the A_{50} confidence intervals from trawl survey and sentinel samples overlap, suggesting no difference in maturity schedules between them. The trawl survey samples show a south to north decline in age at maturity, with fish in the north maturing at younger ages. The trend is less discernable in the sentinel samples, possibly because of smaller sample sizes. The recent values of A_{50} for both sexes remain close to their lowest values in the time series (see Lilly et al. MS 1998b).

Discussion

The exploratory analyses of age compositions in the sentinel survey catches in 1995-1997 indicate an increase in the number of year-classes contributing to the linetrawl fishery in southern 3K, the dominance of the 1990 year-class in the gillnet fishery throughout southern 3K and 3L in 1997, and the stronger contribution by both the 1989 and 1992 year-classes to gillnet catches in 3L compared to 3K.

Size-at-age of cod caught in the inshore was explored only briefly. Additional analysis and a comparison with the offshore are warranted.

Maturity at age of cod in the inshore was found not to be significantly different from that in the offshore. Determination of age at maturity is difficult because the sentinel survey catches few young fish.

The present analyses of age composition, length-at-age and age at maturity and previous analyses of condition and feeding (Lilly MS 1997b) illustrate the value of the sentinel surveys in providing biological information on cod in the inshore of Divisions 2J, 3K and 3L at a time when commercial fisheries are closed, although the strong reliance on gillnets (which are highly size-selective) makes it difficult to obtain useful information on age compositions, lengths-at-age and proportions mature at age in the cod population. Scientific knowledge of cod in the inshore is rapidly increasing, but there is still much to be learned. We here provide a general description of the life history of cod in the inshore, and indicate some areas in which our knowledge remains weak.

General discussion of life history of cod in the inshore

Many cod in Divisions 2J+3KL historically migrated on a seasonal basis between summer feeding areas in shallow coastal waters and overwintering areas offshore, primarily near the shelf break. It was known that some cod remained in coastal waters throughout the winter, but it was assumed that these represented a small portion of the total stocks (Lilly 1996b, 1997a). The situation changed in the early to mid-1990s as the abundance of cod declined dramatically in the offshore and aggregations of cod became more noticeable in shallow coastal waters. The stock affinities of the cod currently in coastal waters are not yet clear. They could belong to some component(s) which formerly migrated between the offshore and inshore and have remained inshore, or they could belong to inshore (coastal, bay) components. Additional study is required to more fully understand the life history of the cod presently inshore and to provide a broader context for the ongoing tagging and genetic studies.

<u>Spawning</u>: The presence of spawning cod in inshore waters has been known for many years (Hutchings, et al. 1993; Lilly 1996b, 1997a; Potter 1996; Neis 1997), and information on the timing and location of spawning is increasing rapidly from acoustic studies and biological sampling during sentinel surveys. There appears to be spatial variability in the timing and duration of spawning, even at the scale of a few kilometers. For example, Smedbol and Wroblewski (1997) found that the peak spawning of cod in fjords in western Trinity Bay was from mid-June to mid-July in 1991-1993. They postulated that this may have been later than usual because of low water temperatures. Brattey (1997) reported that most fish in a dense aggregation in outer Smith Sound in April 1996 were in spawning condition, whereas most in the inner reaches of Smith Sound and in both Northwest Arm and Southwest Arm were not yet ready to spawn. There is need for additional monitoring on the scale of about one week to determine the timing and duration of spawning in each area and to gather evidence on whether there are specific areas into which cod migrate to spawn. This information is required as part of broader studies on how well these inshore fish are reproducing, and may be required in support of management measures. (For example, there is interest in restricting fishing during the spawning season.)

<u>Distribution</u>: Seasonal changes in distribution are still not well understood. If we consider, for example, the deep fjord-like inlets of western Trinity Bay, which have been studied more intensively than any other inshore area, there appear to be dense aggregations at times in winter

and early spring, at least since 1995 (Rose MS 1996; Brattey and Porter MS 1997; S. Walsh, DFO, pers. comm.). Recaptures from tagging studies indicate that these fish move into shallow water in spring and spread out along the coast (Taggart et al. 1995). It is thought that these fish spawn within the inlets before migrating out (Brattey and Porter MS 1997), but the actual timing of spawning, outward migration, feeding, and return migration have not been documented. Details are even more sketchy for the remainder of the coast.

Growth and condition: Information on length-at-age and condition of cod in the inshore has accumulated rapidly with the increase in sampling during inshore acoustic surveys (Brattey 1997) and the advent of inshore sentinel surveys (Lilly MS 1996a, MS 1997b), but there is insufficient sampling at each location to characterize the annual pattern. Sampling during the sentinel surveys in 2J3KL has occurred mainly during the summer and early autumn. Frequent observations throughout the year at specific sites will enhance our ability to monitor the well-being of the fish, to calculate their productivity, and to understand the relationships among feeding, growth and reproduction. Good understanding of the seasonal pattern will also help in determination of the most appropriate time to conduct annual monitoring.

Feeding: The general impression from earlier studies of feeding (eg. Templeman 1965; Lilly 1987) is that cod in inshore waters feed intensively for a few weeks in early summer when capelin are inshore to spawn, but that feeding is much less intense both before and after the capelin run. If cod remain inshore throughout the year, what food is available to them, and what quantity of cod can be supported? Large quantities of food are brought to the inshore by the annual migration of capelin and, in some years, squid (Lilly and Osborne MS 1984). Local resources include herring, a variety of benthic invertebrates, and macrozooplankton, especially hyperiid amphipods (Lilly and Botta MS 1984; Lilly MS 1996a; Brattey 1997). Seasonal monitoring of stomach contents at several sites will provide insight into what is being consumed. This is an essential first step in determining at what level cod in the inshore may be limited by food resources, and whether the cod may be having an increasing impact on inshore fauna.

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Table 1. Number of cod samled for length and age from catches in the 2J3KL sentinel surveys, by gear, year, commercial unit area and month. There are additional samples to be added for 1997.

Year	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Trap														
1995	KH								91					91
	KI							178	126					304
1996	JM								25					25
	KA							11	9					20
	KD								6	37	25			68
	KH							65	46					111
	KI							114						114
	LA							124	13					137
	LB						46	107						153
	LF							21	34					55
	LJ						1	47	81					129
1997	JM							1	19	10				30
	KA							34		25				59
	KD									82				82
	KH							86	14					100
	KI						19	344	9					372
	LA						65	80						145
	LB							119	34					153
	LF							29	33					62
	LJ							128	118					246
Total							131	1488	658	154	25			2456
Handline														
1995	LJ									25	69			94
1996	JM							12	47	9				68
	KD											28		28
	LF									15				15
	LJ							50	46	46	24			166
1997	JM						2	44	16					62
	KA										30			30
	LF									20				20
	LJ							23	36	78				137
Total							2	129	145	193	123	28		620

(cont'd)

Table 1 (cont'd). Number of cod samled for length and age from catches in the 2J3KL sentinel surveys, by gear, year, commercial unit area and month. There are additional samples to be added for 1997.

Year	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Linetrawl														
1995	KH									83	55	21		159
	KI										151			151
	LA								30	34	68			132
	LB								26	21	42			89
	LF										99			99
	LJ									37				37
1996	JM									1				1
	KD									6	16			22
	KH								30	140	47	4		221
	KI								54	98	28			180
	LA									39	10			49
	LF									44	83			127
1997	KD										50			50
	KH								47	123				170
	KI								15	106				121
	LA									41				41
	LF									54	34			88
	LJ									18				18
	LQ										19			19
Total									202	845	702	25		1774
Gillnet														
1995	JM									12	8			20
	KA										16	1		17
	KD										36			36
	KH								6	31	21			58
	KI								92		41			133
	LA								16	18				34
	LB									33	66	2		101
	LF								52	10				62
	LJ								6	33				39
	LQ								27		50			77
1996	JM								12	50	21			83
	KA							13	27	47	4			91
	KD						2	80	78	41	78	12		291
	KH						19	202	33			36		290
	KI							86	215	35	7	46		389
	LA							101	146	75		11		333
	LB						18	67	131	104				320
	LF							76	105	42				223
	LJ						64	86	51	134	53		11	399
	LQ							99	89	83	47			318
1997	JM							16	80	165	30			291
	KA							15	32	32	24			103
	KD						4	83	57	7	32			183
	KH						67	85	42					194
	KI							44	165					209
	LA							50	106	52				208
	LB						46	79	128	77				330
	LF							161	121	53				335
	LJ						38	75	29	91	25			258
	LQ							65	71	130	8			274
Total							258	1483	1917	1355	567	108	11	5699

Table 2. Number of cod sampled for length, age and body weights from catches in the 2J3KL sentinel surveys, by gear, year, commercial unit area and month. There are additional samples to be added for 1997.

Year	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Trap														
1995	KI							178	127					305
1996	KD										6			6
	KH							16	29					45
	LB						37							37
	LJ								59					59
1997	JM									10				10
	KD									16				16
	KH								14					14
	KI						19	259	9					287
	LJ							35	57					92
Total							56	488	295	26	6			871
Handline														
1995	LJ										7			7
1996	LJ							8	5	6				19
1997	KA										30			30
	LJ								16	25				41
Total								8	21	31	37			97
Linetrawl														
1995	KH									58				58
	KI										22			22
	LA										24			24
	LF										35			35
	LJ									16				16
1996	KH									63				63
	KI								50	12				62
1997	KD										50			50
	KH									80				80
	KI									106				106
	LF									47	16			63
Total									50	382	147			579
Gillnet														
1995	JM									12	8			20
	KA										16	1		17
	KD										12			12
	KI								77					77
	LA									7				7
	LB										16			16
	LQ										23			23
1996	JM									1	19			20
	KD							23	19					42
	KH							19						19
	KI								167					167
	LA							60	18					78
	LB						18	40	44	21				123
	LJ								25	31				56
	LQ							56	22	54	20			152
1997	JM									20	29			49
	KA										3			3
	KD								7	7				14
	KI								113					113
	LA								22					22
	LB						15	40	52	43				150
	LF							44						44
	LJ									27				27
	LQ								11	40	8			59
Total							33	282	577	263	154	1		1310

Table 3. Numbers of cod sampled for age and maturity during the Sentinel survey in NAFO Divs. 2J-3KL.

				Month						
Year	Gear	Area	Community	Jun	Jul	Aug	Sep	Oct	Nov	Dec
95	Cod trap	3Ki	Deep Bay	0	43	38	0	0	0	0
			Joe Batt's Arm	0	45	36	0	0	0	0
			Seldom	0	47	21	0	0	0	0
			Tilting	0	43	32	0	0	0	0
	Gill net	2Jm	Charlottetown	0	0	0	12	10	0	0
			Williams Harbour	0	0	0	0	8	0	0
		3Ka	Grand Brehat	0	0	0	0	16	1	0
		3Kd	Conche	0	0	0	0	12	0	0
		3Ki	Deep Bay	0	0	20	0	0	0	0
			Joe Batt's Arm	0	0	18	0	0	0	0
			Seldom	0	0	21	0	0	0	0
			Tilting	0	0	18	0	0	0	0
		3La	Eastport	0	0	0	7	0	0	0
		3Lb	Catalina	0	0	0	0	16	0	0

cont'd:

Table 3. Cont'd.

Year	Gear	Area	Community	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Gill net	3Lq	Admiral's Beach	0	0	0	0	23	0	0
	Handline	3Lj	Petty Harbour	0	0	0	0	7	0	0
	Line trawl	3Kh	La Scie	0	0	0	34	0	0	0
			Shoe Cove	0	0	0	24	0	0	0
		3Ki	Lumsden	0	0	0	0	22	0	0
		3La	Bonavista	0	0	0	0	24	0	0
		3Lf	Foxtrap	0	0	0	0	35	0	0
		3Lj	Calvert	0	0	0	16	0	0	0
1996	Cod trap	3Kd	Conche	0	0	0	0	6	0	0
		3Kh	La Scie	0	16	29	0	0	0	0
		3Lb	Hopeall	37	0	0	0	0	0	0
		3Lj	Aquaforte	0	7	34	0	0	0	0
			Petty Harbour	0	13	25	0	0	0	0
	Gill net	2Jm	Charlottetown	0	0	0	1	19	0	0
		3Kd	Conche	0	23	19	0	0	0	0

cont'd:-

Table 3. Cont'd'

Year	Gear	Area	Community	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				Month						
		3Kh	La Scie	0	19	0	0	0	0	0
		3Ki	Deep Bay	0	0	54	0	0	0	0
			Joe Batt's Arm	0	0	31	0	0	0	0
			Seldom	0	0	44	0	0	0	0
			Tilting	0	0	38	0	0	0	0
		3La	Eastport	0	60	18	0	0	0	0
		3Lb	Catalina	18	40	44	21	0	0	0
		3Lj	Aquaforte	0	0	25	31	0	0	0
		3Lq	Admiral's Beach	0	56	22	54	20	0	0
	Handline	3Lj	Petty Harbour	0	8	5	6	0	0	0
	Line trawl	3Kh	La Scie	0	0	0	63	0	0	0
		3Ki	Deep Bay	0	0	18	0	0	0	0
			Joe Batt's Arm	0	0	18	0	0	0	0
			Tilting	0	0	14	12	0	0	0
1997	Cod trap	2Jm	Charlottetown	0	0	0	10	0	0	0

cont'd:-

Table 3. Cont'd.

Year	Gear	Area	Community	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				Month						
	Cod trap	3Kd	Conche	0	0	0	16	0	0	0
		3Kh	La Scie	0	0	14	0	0	0	0
		3Ki	Deep Bay	5	76	0	0	0	0	0
			Joe Batt's Arm	0	51	9	0	0	0	0
			Seldom	14	56	0	0	0	0	0
			Tilting	0	76	0	0	0	0	0
		3Lj	Aquaforte	0	35	33	0	0	0	0
			Petty Harbour	0	0	24	0	0	0	0
	Gill net	2Jm	Charlottetown	0	0	0	20	29	0	0
		3Ka	Grand Brehat	0	0	0	0	3	0	0
		3Kd	Conche	0	0	7	7	0	0	0
		3Ki	Deep Bay	0	0	34	0	0	0	0
			Joe Batt's Arm	0	0	39	0	0	0	0
			Seldom	0	0	5	0	0	0	0
			Tilting	0	0	35	0	0	0	0

cont'd:-

Table 3. Cont'd

Year	Gear	Area	Community	Month						
				Jun	Jul	Aug	Sep	Oct	Nov	Dec
		3La	Eastport	0	0	22	0	0	0	0
		3Lb	Catalina	15	40	23	43	0	0	0
			Heart's Content	0	0	29	0	0	0	0
		3Lf	Foxtrap	0	44	0	0	0	0	0
		3Lj	Aquaforte	0	0	0	27	0	0	0
		3Lq	Admiral's Beach	0	0	11	40	8	0	0
	Hand line	3Ka	Grand Brehat	0	0	0	0	30	0	0
		3Lj	Petty Harbour	0	0	16	25	0	0	0
	Line trawl	3Kd	Goose Cove	0	0	0	0	50	0	0
		3Kh	La Scie	0	0	0	80	0	0	0
		3Ki	Deep Bay	0	0	0	67	0	0	0
			Tilting	0	0	0	39	0	0	0
		3Lf	Foxtrap	0	0	0	47	16	0	0

Table 4. Age composition and mean length-at-age of cod sampled from the linetrawl catch in 3Kh and 3Ki during August-October 1995-1997. Also provided for each year-area cell are the mean and the 10th and 90th percentiles of the lengths of the fish, the number of fish aged, the number of fish caught, and the number of fish that were not assigned an age when the age-length key was applied to the length composition because they were of a length not represented in the aged sample. The highlighted cells in the age compositions indicate the 1990 year-class and highlighted cells in the lengths-at-age indicate values based on fewer than 5 aged fish.

	1995		1996		1997	
Age	3Kh	3Ki	3Kh	3Ki	3Kh	3Ki
Age composition of catch						
2			0.7	0.3		
3	2.3	12.8	13.1	11.0	8.8	4.6
4	44.3	37.6	25.6	26.4	30.2	19.4
5	**44.8**	**34.0**	39.7	33.5	28.9	34.3
6	6.5	11.8	**17.9**	**23.6**	18.4	18.2
7	1.0	3.8	2.5	4.4	**12.0**	**21.3**
8	0.5	0.0	0.4	0.8	1.7	1.7
9	0.5		0.2	0.0	0.1	0.5
10	0.1			0.1		
11						
12						
13						
14						
Mean length-at-age						
2			**33.8**	**29.6**		
3	37.4	37.7	40.1	38.5	38.7	38.4
4	45.7	45.3	45.4	44.0	45.8	42.3
5	53.9	51.9	52.9	50.6	54.1	52.5
6	59.3	56.5	60.0	59.1	61.9	58.9
7	71.3	62.7	69.2	63.9	67.9	65.4
8	**65.8**	**76.0**	**69.0**	**70.5**	71.4	**71.7**
9	**61.0**		**77.3**	**88.0**	**82.0**	**70.0**
10	**79.0**			**82.0**		
11						
12						
13						
14						
Mean length	50.6	48.4	50.9	50.3	53.7	54.2
10th - 90th	42-60	38-59	40-62	39-62	41-67	40-68
No. of fish aged	138	151	217	180	170	121
No. of fish in catch	7990	10449	7086	6504	12125	10355
No. not represented	5	120	1	1	17	116

Table 5. Age composition and mean length-at-age of cod sampled from the gillnet catch in each unit area during July-September 1997 (July-October in 3Ka). Also provided for each area cell are the mean and the 10th and 90th percentiles of the lengths of the fish, the number of fish aged, the number of fish caught, and the number of fish that were not assigned an age when the age-length key was applied to the length composition because they were of a length not represented in the aged sample. The highlighted cells in the age compositions indicate the 1990 year-class and highlighted cells in the lengths-at-age indicate values based on fewer than 5 aged fish.

Age	2Jm Jul-Sep	3Ka Jul-Oct	3Kd Jul-Sep	3Kh Jul-Sep	3Ki Jul-Sep	3La Jul-Sep	3Lb Jul-Sep	3Lf Jul-Sep	3Lj Jul-Sep	3Lq Jul-Sep
Age composition of catch										
2	0.2					0.0				
3	4.7	2.1	0.2	0.1		0.1	0.1	0.4	0.1	
4	17.1	8.0	0.2	0.4	0.3	1.2	0.9	2.3	2.0	1.8
5	9.4	12.2	13.3	6.2	2.6	15.6	15.0	22.4	29.0	18.2
6	39.9	40.4	31.4	21.2	22.8	33.1	26.4	26.2	18.4	21.0
7	**19.3**	**27.9**	**47.1**	**66.3**	**65.9**	**44.5**	**45.7**	**34.5**	**37.7**	**36.3**
8	6.7	9.5	5.4	5.2	7.5	5.6	9.6	10.8	10.3	18.5
9	1.3			0.2	0.9		2.0	1.8	1.9	2.9
10	0.6			0.4	0.0		0.1	1.4	0.7	1.0
11	0.9		2.3				0.1	0.2		0.1
12							0.0	0.0	0.1	0.2
13							0.0			
14										
Mean length-at-age										
2	**25.0**					**31.0**				
3	37.5	34.6	**40.0**	**39.0**		39.2	39.2	38.1	**40.7**	
4	43.2	42.3	**40.0**	42.9	**43.2**	51.5	50.5	55.6	53.8	53.9
5	50.3	53.3	57.5	55.6	56.2	57.9	59.2	58.1	58.1	56.2
6	60.7	60.6	61.2	61.1	60.8	61.0	61.8	61.1	61.6	60.4
7	63.3	65.3	64.9	64.3	65.7	64.2	64.3	64.3	64.9	64.2
8	68.5	61.7	66.0	70.2	66.6	71.6	67.7	68.8	69.2	66.5
9	**70.8**			**83.9**	**77.9**		74.0	75.5	74.9	68.9
10	**67.0**			**77.5**	**91.0**		**91.8**	69.5	82.7	80.3
11	**62.3**		**62.4**				**90.0**	86.6		**87.5**
12							**94.0**	**94.0**	**88.0**	**87.6**
13							**88.0**			
14										
Mean length	56.7	59.1	62.7	63.4	64.5	62.4	63.3	62.6	62.8	62.5
10th - 90th	39-67	46-67	57-69	57-70	58-72	56-69	58-69	56-70	56-70	55-70
No. of fish aged	261	103	147	127	209	208	284	335	195	266
No. of fish in catch	559	389	2779	8612	5777	11747	11279	6931	10010	12304
No. not represented	1	1	8	2	45	26	0	0	29	20

Table 6. Observed proportion mature at age of female and male Atlantic cod (<u>Gadus morhua</u>) in NAFO Divs. 2J3KL during 1996 spawning year. A50=median age at maturity (years); L95% and U95%=lower and upper 95% confidence intervals. Parameter estimates of the logit model are shown: Int=intercept, SE=standard error, n=number of fish examined, dot=no fish sampled, n/f indicates model could not be fitted.

	Females								
	Inshore sentinel (fall 95)			Offshore trawl survey (fall 95)			Inshore sentinel (spring 96)		
Age	2J	3K	3L	2J	3K	3L	2J	3K	3L
2	.	.	.	0	0	0	.	.	.
3	.	.	0	0	0	0	.	.	0
4	.	0	0	0.03	0.03	0	.	.	0.42
5	1	0.58	0.56	0.54	0.33	0.37	.	0.77	0.91
6	1	0.71	1	1	0.63	0.68	.	1	1
7	.	0.97	1	1	.	0.86	.	1	1
8	1	1	1	.	.	1	.	1	1
9	1	1	1	.	.	.	.	.	1
10	.	1	.	.	.	.	.	.	1
11	1	.	.	.	.	.	.	.	1
12	.	.	.	.	.	.	.	.	.
A50	n/f	5.13	n/f	4.95	5.45	5.63	n/f	n/f	4.16
L 95%	n/f	4.86	n/f	4.61	5.09	5.27	n/f	n/f	3.67
U 95%	n/f	5.38	n/f	5.43	6.19	6.12	n/f	n/f	4.48
Slope	n/f	1.63	n/f	4.00	2.45	1.93	n/f	n/f	3.17
SE	n/f	0.28	n/f	1.51	0.55	0.37	n/f	n/f	0.82
Int	n/f	-8.37	n/f	-19.79	-12.24	-10.85	n/f	n/f	-13.19
SE	n/f	1.48	n/f	7.43	2.66	1.98	n/f	n/f	3.64
n	12	151	82	102	174	113	0	24	150

	Males								
	Inshore sentinel (fall 95)			Offshore trawl survey (fall 95)			Inshore sentinel (spring 96)		
Age	2J	3K	3L	2J	3K	3L	2J	3K	3L
2	.	.	.	0	0	0	.	.	.
3	.	.	.	0.10	0.04	0.04	.	.	0
4	.	0.46	0.51	0.61	0.22	0.31	.	0.80	0.41
5	1	0.68	1	0.93	0.80	0.54	.	1	1
6	.	0.88	1	1	1	1	.	1	1
7	.	0.93	0.88	.	1	1	.	1	1
8	1	1	1	.	.	1	.	1	1
9	1	1	1	.	.		.	.	1
10	.	1	1	.	1		.	.	1
11	.	.	1	.	.		.	.	1
12	.	.	.	.	.		.	.	.
A50	n/f	4.20	n/f	3.86	4.49	4.61	n/f	n/f	n/f
L 95%	n/f	3.42	n/f	3.59	4.26	4.30	n/f	n/f	n/f
U 95%	n/f	4.59	n/f	4.18	4.83	4.97	n/f	n/f	n/f
Slope	n/f	1.02	n/f	2.66	2.37	1.81	n/f	n/f	n/f
SE	n/f	0.26	n/f	0.57	1.70	0.35	n/f	n/f	n/f
Int	n/f	-4.27	n/f	-10.28	-10.65	-8.31	n/f	n/f	n/f
SE	n/f	1.25	n/f	2.16	1.70	1.55	n/f	n/f	n/f
n	3	139	44	93	211	106	0	34	89

Table 7. Observed proportion mature at age of female and male Atlantic cod (Gadus morhua) in NAFO Divs. 2J3KL during 1997 spawning year. A50=median age at maturity (years); L95% and U95%=lower and upper 95% confidence intervals. Parameter estimates of the logit model are shown: Int=intercept, SE=standard error, n=number of fish examined, dot=no fish sampled, n/f indicates model could not be fitted.

	Females								
	Inshore sentinel (fall 96)			Offshore trawl survey (fall 96)			Inshore sentinel (spring 97)		
Age	2J	3K	3L	2J	3K	3L	2J	3K	3L
2	.	.	.	0	0	0	.	.	.
3	.	0	.	0	0	0	.	.	0
4	0.27	0	0	0.02	0	0	.	0	0.96
5	0.75	0.47	0.87	0.44	0.35	0.22	.	0.96	1
6	1	0.98	0.93	1	0.59	0.34	.	1	1
7	1	1	0.99	1	1	1	.	1	1
8	.	1	1	1	.	1	.	1	1
9	1	1	1	.	.	1	.	1	1
10	.	.	1	.	.	1	.	.	1
11	.	.	1	.	.	.	.	.	.
12	.	.	.	.	.	.	.	.	.
A50	n/f	5.04	4.75	5.04	5.51	5.99	n/f	n/f	n/f
L 95%	n/f	4.90	4.33	4.85	5.19	5.61	n/f	n/f	n/f
U 95%	n/f	5.16	5.04	5.35	6.05	6.57	n/f	n/f	n/f
Slope	n/f	4.04	2.32	3.92	2.59	1.94	n/f	n/f	n/f
SE	n/f	0.77	0.42	0.99	0.56	0.47	n/f	n/f	n/f
Int	n/f	-20.36	-11.00	-19.79	-14.28	-11.60	n/f	n/f	n/f
SE	n/f	3.70	2.22	4.84	2.83	2.67	n/f	n/f	n/f
n	4	191	165	193	221	87	0	51	64

	Males								
	Inshore sentinel (fall 96)			Offshore trawl survey (fall 96)			Inshore sentinel (spring 97)		
Age	2J	3K	3L	2J	3K	3L	2J	3K	3L
2	.	.	.	0	0	0	.	.	.
3	.	0	.	0.03	0.17	0.07	.	0	0.61
4	1	0.38	0.12	0.62	0.49	0.30	.	1	0.94
5	1	0.85	0.70	0.95	0.62	0.69	.	0.79	1
6	1	1	1	1	1	1	.	1	1
7	.	1	1	1	.	1	.	1	1
8	.	1	1	1	1	1	.	.	1
9	.	1	1	.	.	.	.	.	1
10	1	.	1	.	.	.	.	.	.
11	.	1	1	.	.	.	.	.	1
12	.	.	.	.	.	.	.	.	.
A50	n/f	4.27	4.65	3.89	4.17	4.45	n/f	n/f	n/f
L 95%	n/f	3.73	4.13	3.76	3.92	4.11	n/f	n/f	n/f
U 95%	n/f	4.52	5.01	4.05	4.50	4.88	n/f	n/f	n/f
Slope	n/f	2.87	3.70	3.58	1.46	1.92	n/f	n/f	n/f
SE	n/f	0.54	1.01	0.55	0.22	0.46	n/f	n/f	n/f
Int	n/f	-12.24	-17.19	-13.96	-6.10	-8.55	n/f	n/f	n/f
SE	n/f	2.48	4.96	2.1	0.80	2.02	n/f	n/f	n/f
n	6	152	119	200	239	73	0	25	70

Table 8. Observed proportion mature at age of female and male Atlantic cod (Gadus morhua) in NAFO Divs. 2J3KL during 1998 spawning year. A50=median age at maturity (years); L95% and U95%=lower and upper 95% confidence intervals. Parameter estimates of the logit model are shown: Int=intercept, SE=standard error, n=number of fish examined, dot=no fish sampled, n/f indicates model could not be fitted.

	Females					
	Inshore sentinel (fall 97)			Offshore trawl survey (fall 97)		
Age	2J	3K	3L	2J	3K	3L
2	.	.	.	.	0	0
3	.	.	.	0	0	0
4	0	0.33	0.18	0.09	0.12	0.07
5	0.57	0.61	0.87	0.36	0.6	0.72
6	1	0.97	1	1	1	0.88
7	1	1	1	.	.	.
8	1	1	1	.	.	1
9	1	1	1	.	.	1
10	.	1	1	.	.	1
11	.	.	1	.	.	.
12	.	.	1	.	.	.
A50	n/f	4.50	4.45	5.11	4.78	4.89
L 95%	n/f	4.20	4.14	4.82	4.55	4.57
U 95%	n/f	4.75	4.67	5.65	5.13	5.47
Slope	n/f	1.80	3.40	2.30	2.74	2.75
SE	n/f	0.27	0.70	0.53	0.52	0.64
Int	n/f	-8.10	-15.15	-11.74	-13.08	-13.44
SE	n/f	1.33	3.31	2.47	2.34	2.88
n	35	199	204	97	135	107

	Males					
	Inshore sentinel (fall 97)			Offshore trawl survey (fall 97)		
Age	2J	3K	3L	2J	3K	3L
2	.	.	.	.	0	0
3	.	.	0	0	0.27	0.10
4	1	0.74	0.61	0.79	0.78	0.51
5	1	0.84	0.83	0.91	1.00	0.71
6	1	0.92	1	1	1	1
7	.	1	1	.	.	1
8	1	1	1	.	.	1
9	.	1	1	.	1	1
10	.	1	1	.	.	.
11	.	.	1	.	.	.
12	.	.	1	.	.	.
A50	n/f	3.00	3.95	3.71	3.44	4.17
L 95%	n/f	0.57	3.46	3.39	3.22	3.88
U 95%	n/f	3.78	4.27	3.86	3.63	4.52
Slope	n/f	0.97	1.94	3.69	2.47	1.70
SE	n/f	0.28	0.43	0.96	0.43	0.32
Int	n/f	-2.90	-7.66	-13.66	-8.45	-7.10
SE	n/f	1.36	1.88	3.79	1.52	1.29
n	13	171	151	91	131	129

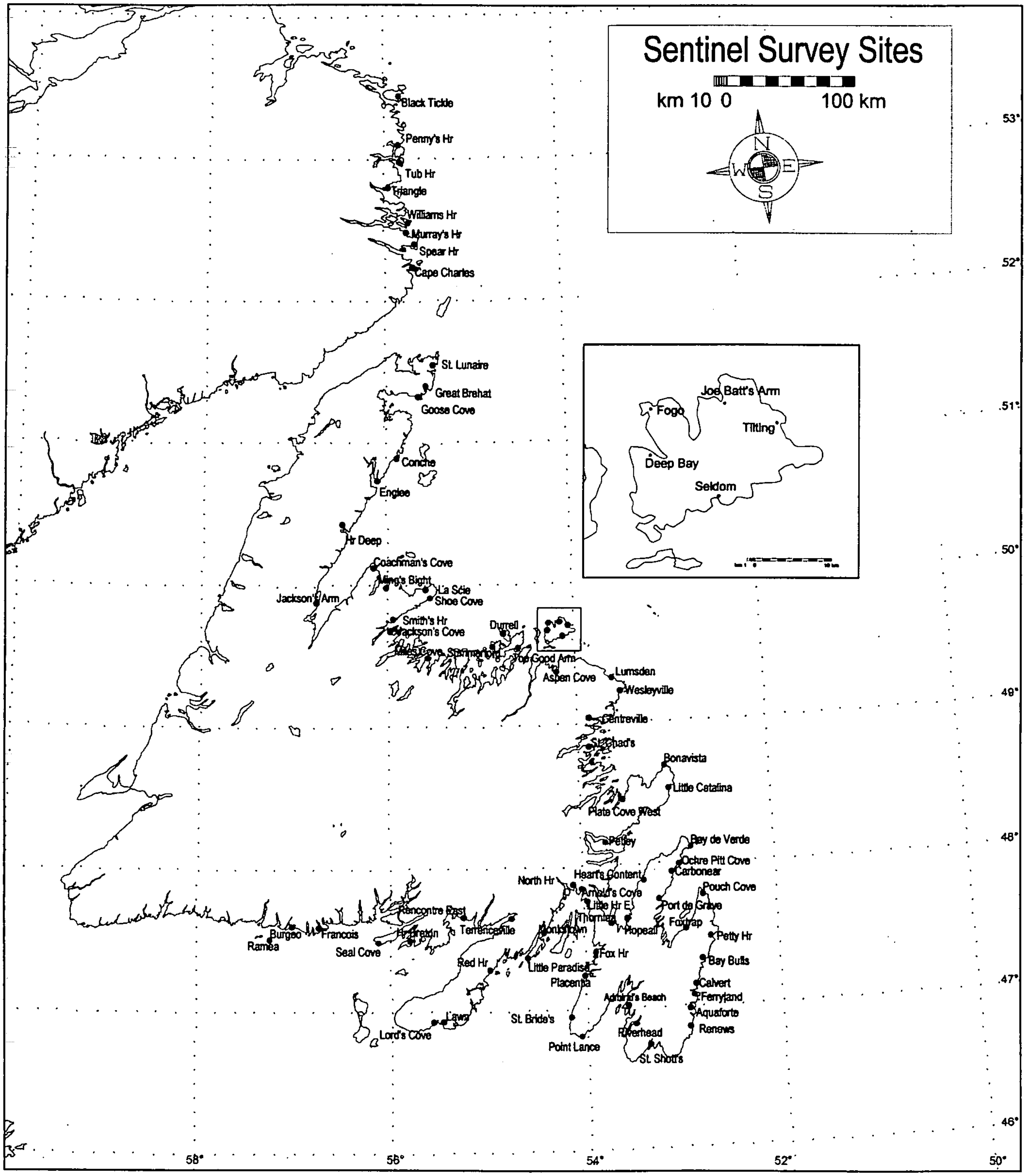

Fig. 1. Sentinel survey sites.

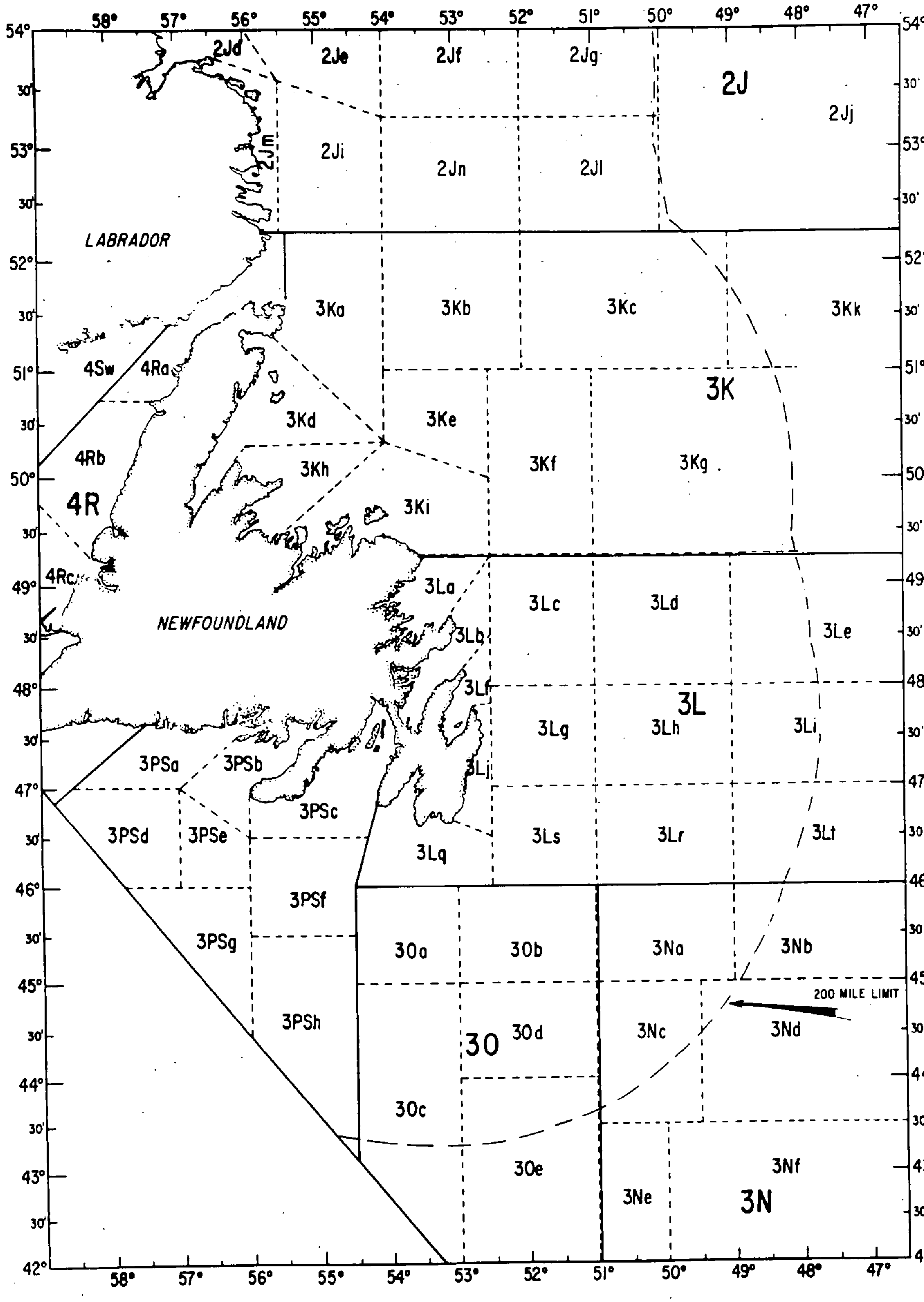

Fig. 2. Commercial fishery statistical unit areas.

Appendix 1. Age-disaggregated catch rates during the sentinel surveys in Divisions 2J, 3K and 3L. Analyses for a given gear were limited to periods when fishing was conducted with that gear in all three years (1995-1997).. The periods were:

Gillnet	July 16 - September 30
Linetrawl	August 16 - September 30
Trap	July 1 - July 31

For each unit (gear, Division and year), we provide a table showing the aggregated catch rate, the age composition, the average length-at-age, the average weight-at-age (calculated from the mean length-at-age with the commonly used weight-length relationship for this stock) and the age-disaggregated catch rate.

The catch rates are in units of number of fish per net for gillnets and number of fish per 1000 hooks for linetrawls.

Tables 1-3 provide catch rates for gillnets.

Tables 4-5 provide catch rates for linetrawls.

Tables 6-7 provide age compositions for traps, but the catch rates have not yet been calculated.

Table 8 provides a summary of the age-disaggregated catch rates.

Notes:

Only cod that were sold were included in the calculation of catch and effort. Therefore, cod frozen for detailed analysis in the laboratory were not included in the calculation of catch composition.

There are some instances (eg. gillnet in 2J in 1996) where the number of otoliths exceeds the catch. We assume that this is because most of the fish caught were frozen for detailed analysis in the laboratory.

Some of the age compositions are based on small sample sizes.

Appendix Table 1. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Gillnet (140 mm mesh) in Division 2J in the period July 16 - September 30.

1995 Catch = 87 Effort = 23 C/E = 3.783

Av. length = 52.18 No. of otoliths = 12

Age	Total catch Numbers	Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3						0.000
4	1	2.94	49.00	1.02	1.0	0.111
5	11	33.33	53.59	1.34	14.8	1.261
6	0	0.00			0.0	0.000
7	12	35.78	58.16	1.73	20.8	1.353
8	8	22.06	60.40	1.95	15.6	0.834
9	2	5.88	61.00	2.01	4.0	0.222
10						0.000
11						0.000
12						0.000
13						0.000
Total	34				56.2	3.782

1996 Catch = 23 Effort = 234 C/E = 0.098

Av. length = 55.00 No. of otoliths = 62

Age	Total catch Numbers	Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	3	18.06	37.92	0.46	1.4	0.018
4	2	9.72	38.71	0.49	1.0	0.010
5	2	12.02	54.72	1.43	2.9	0.012
6	3	16.02	62.29	2.14	6.4	0.016
7	5	28.16	63.99	2.33	11.6	0.028
8	2	13.74	62.91	2.21	4.4	0.014
9	0	1.85	58.00	1.72	0.0	0.002
10	0	0.43	61.00	2.01	0.0	0.000
11						0.000
12						0.000
13						0.000
Total	17				27.7	0.098

1997 Catch = 313 Effort = 240 C/E = 1.304

Av. length = 56.87 No. of otoliths = 260

Age	Total catch Numbers	Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	15	5.45	37.18	0.43	6.5	0.071
4	43	15.50	42.39	0.65	28.0	0.202
5	24	8.49	50.11	1.09	26.2	0.111
6	113	40.37	60.66	1.97	222.8	0.526
7	57	20.29	63.11	2.23	127.0	0.265
8	20	7.26	68.96	2.93	58.6	0.095
9	4	1.33	71.31	3.25	13.0	0.017
10	2	0.61	67.00	2.68	5.4	0.008
11	2	0.70	58.00	1.72	3.4	0.009
12						0.000
13						0.000
Total	280				490.9	1.304

Appendix Table 2. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Gillnet (140 mm mesh) in Division 3K in the period July 16 - September 30.

1995 Catch = 2204 Effort = 549 C/E = 4.015

Av. length = 60.07 No. of otoliths = 129

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3						0.000
4						0.000
5	765	36.30	57.09	1.63	1250.4	1.457
6	772	36.66	61.42	2.05	1581.4	1.472
7	456	21.64	63.95	2.32	1058.2	0.869
8	98	4.66	65.83	2.54	248.7	0.187
9	16	0.74	67.00	2.68	42.9	0.030
10						0.000
11						0.000
12						0.000
13						0.000
Total	2107				4181.5	4.015

1996 Catch = 8184 Effort = 531 C/E = 15.412

Av. length = 60.78 No. of otoliths = 670

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	9	0.12	36.89	0.42	3.8	0.018
4	95	1.19	48.23	0.97	92.3	0.183
5	1270	16.03	57.15	1.64	2083.4	2.471
6	5180	65.38	60.81	1.99	10292.0	10.077
7	1075	13.57	64.29	2.36	2535.9	2.091
8	244	3.08	66.78	2.65	647.4	0.475
9	37	0.46	76.07	3.97	146.8	0.071
10	10	0.13	73.86	3.62	36.2	0.020
11	2	0.03	89.80	6.62	13.2	0.005
12	1	0.01	82.00	5.00	5.0	0.002
13						0.000
Total	7923				15856.1	15.412

1997 Catch = 5860 Effort = 466 C/E = 12.575

Av. length = 63.51 No. of otoliths = 427

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	7	0.13	40.56	0.57	4.0	0.016
4	32	0.60	44.23	0.74	23.8	0.075
5	380	7.00	57.15	1.64	623.3	0.880
6	1588	29.23	61.08	2.01	3199.0	3.676
7	2958	54.46	65.43	2.49	7367.1	6.848
8	432	7.95	66.16	2.58	1113.6	1.000
9	6	0.10	89.36	6.52	39.1	0.013
10	9	0.16	86.76	5.95	53.6	0.020
11	20	0.37	64.00	2.33	46.5	0.047
12						0.000
13						0.000
Total	5432				12470.0	12.575

Appendix Table 3. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Gillnet (140 mm mesh) in Division 3L in the period July 16 - September 30.

1995 Catch = 6180 Effort = 834 C/E = 7.410

Av. length = 61.52 No. of otoliths = 195

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2	1	0.02	28.00	0.18	0.2	0.001
3	8	0.12	40.00	0.55	4.4	0.009
4	47	0.71	44.10	0.74	34.6	0.053
5	1734	26.18	59.10	1.82	3155.3	1.940
6	2706	40.84	61.06	2.01	5443.8	3.026
7	1028	15.52	62.91	2.21	2268.0	1.150
8	921	13.91	65.56	2.51	2308.6	1.031
9	132	1.99	66.18	2.58	340.6	0.147
10	40	0.60	60.28	1.93	77.3	0.044
11	9	0.13	82.00	5.00	45.0	0.010
12						0.000
13						0.000
Total	6626				13677.7	7.412

1996 Catch = 19639 Effort = 824 C/E = 23.834

Av. length = 62.15 No. of otoliths = 1173

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2	3	0.02	30.00	0.22	0.7	0.005
3	41	0.23	40.12	0.55	22.6	0.055
4	369	2.09	51.74	1.21	445.1	0.498
5	1993	11.30	58.00	1.72	3420.7	2.693
6	10051	56.97	61.89	2.10	21087.3	13.578
7	3886	22.03	64.23	2.35	9139.7	5.251
8	908	5.15	66.86	2.66	2417.4	1.227
9	290	1.65	69.56	3.01	872.6	0.393
10	80	0.45	74.92	3.78	302.7	0.107
11	14	0.08	81.97	5.00	69.9	0.019
12	8	0.04	77.80	4.25	34.0	0.010
13						0.000
Total	17643				37812.6	23.836

1997 Catch = 18882 Effort = 789 C/E = 23.932

Av. length = 62.84 No. of otoliths = 1008

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2	1	0.01	31.00	0.25	0.3	0.002
3	27	0.14	39.19	0.51	13.8	0.034
4	353	1.82	54.28	1.40	493.7	0.436
5	3850	19.78	58.45	1.76	6768.6	4.734
6	5123	26.32	61.40	2.05	10487.1	6.299
7	7433	38.19	64.35	2.37	17585.2	9.139
8	2168	11.14	67.81	2.78	6030.4	2.666
9	323	1.66	73.05	3.50	1130.5	0.397
10	131	0.68	75.56	3.89	509.0	0.163
11	35	0.18	89.28	6.50	227.6	0.043
12	14	0.07	89.20	6.49	90.8	0.017
13	2	0.01	88.00	6.22	12.4	0.002
Total	19460				43349.3	23.932

Appendix Table 4. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Linetrawl in Division 3K in the period August 16 - September 30.

1995 Catch = 3724 Effort = 25650 C/E = 145.2

Av. length = 48.07 No. of otoliths = 83

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	264	7.10	36.16	0.40	105.3	10.308
4	1944	52.32	44.95	0.78	1519.4	75.961
5	1239	33.35	52.57	1.27	1570.4	48.419
6	215	5.79	57.83	1.70	365.9	8.406
7	6	0.17	67.00	2.68	16.1	0.247
8	29	0.79	64.82	2.42	70.2	1.147
9	18	0.48	61.00	2.01	36.1	0.697
10						0.000
11						0.000
12						0.000
13						0.000
Total	3715				3683.3	145.185

1996 Catch = 4709 Effort = 29000 C/E = 162.4

Av. length = 50.05 No. of otoliths = 328

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2	29	0.63	33.08	0.30	8.8	1.023
3	663	14.27	39.59	0.53	350.1	23.172
4	1153	24.83	44.12	0.74	850.4	40.319
5	1641	35.32	51.84	1.21	1992.3	57.352
6	976	21.01	58.84	1.79	1751.4	34.116
7	157	3.39	64.20	2.35	368.9	5.505
8	21	0.46	69.36	2.98	62.6	0.747
9	4	0.08	76.92	4.11	16.4	0.130
10	1	0.01	82.00	5.00	5.0	0.016
11						0.000
12						0.000
13						0.000
Total	4645				5405.8	162.379

1997 Catch = 8745 Effort = 29610 C/E = 295.3

Av. length = 54.26 No. of otoliths = 276

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	595	7.45	38.13	0.47	279.8	22.003
4	1903	23.84	45.11	0.79	1503.5	70.409
5	2492	31.21	53.49	1.34	3331.8	92.175
6	1498	18.77	60.72	1.98	2963.1	55.435
7	1313	16.45	66.38	2.60	3418.9	48.583
8	155	1.94	71.69	3.30	511.9	5.730
9	27	0.34	74.43	3.71	100.1	1.004
10						0.000
11						0.000
12						0.000
13						0.000
Total	7983				12109.2	295.339

Appendix Table 5. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Linetrawl in Division 3L in the period August 16 - September 30.

1995 Catch = 3862 Effort = 47600 C/E = 81.1

Av. length = 51.93 No. of otoliths = 148

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2						0.000
3	209	5.36	37.67	0.45	94.6	4.349
4	1060	27.19	44.79	0.77	818.9	22.060
5	1317	33.80	51.34	1.18	1551.1	27.423
6	764	19.59	58.64	1.78	1356.6	15.894
7	483	12.39	60.97	2.00	967.3	10.053
8	32	0.81	66.41	2.61	83.5	0.657
9	33	0.85	57.40	1.66	54.9	0.690
10						0.000
11						0.000
12						0.000
13						0.000
Total	3898				4926.9	81.126

1996 Catch = 2195 Effort = 25150 C/E = 87.3

Av. length = 52.03 No. of otoliths = 83

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2	60	2.80	34.27	0.34	20.3	2.444
3	457	21.16	41.26	0.60	274.0	18.468
4	687	31.84	47.22	0.91	625.0	27.789
5	351	16.26	55.35	1.49	521.5	14.191
6	318	14.73	61.54	2.06	655.6	12.856
7	234	10.84	69.05	2.94	688.1	9.461
8	22	1.02	64.00	2.33	51.2	0.890
9	16	0.74	79.00	4.46	71.3	0.646
10	10	0.48	76.00	3.96	39.6	0.419
11	3	0.14	82.00	5.00	15.0	0.122
12						0.000
13						0.000
Total	2158				2961.6	87.285

1997 Catch = 2097 Effort = 12500 C/E = 167.8

Av. length = 56.31 No. of otoliths = 113

Age	Total catch Numbers	Total catch Percent	Av. Len.	Av. Wt.	Catch wt. (kg)	C/E at age
2	27	0.89	34.38	0.34	9.2	1.493
3	173	5.72	40.53	0.57	98.2	9.596
4	578	19.09	46.36	0.86	496.7	32.025
5	1022	33.78	54.15	1.39	1419.5	56.669
6	552	18.25	60.48	1.95	1078.4	30.616
7	539	17.81	66.53	2.62	1413.6	29.878
8	89	2.94	72.95	3.49	310.2	4.932
9	46	1.52	81.18	4.85	223.0	2.550
10						0.000
11						0.000
12						0.000
13						0.000
Total	3026				5048.7	167.760

Appendix Table 6. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Trap in Division 3K in the period July 1 - July 31.

1995 Catch = Effort = C/E =

Av. length = 38.38 No. of otoliths = 178

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2						
3	2	11.43	37.38	0.44	0.9	
4	7	49.87	41.91	0.63	4.4	
5	6	38.12	45.98	0.84	5.0	
6	0	0.58	52.00	1.23	0.0	
7						
8						
9						
10						
11						
12						
13						
Total	15				10.3	

1996 Catch = Effort = C/E =

Av. length = 42.57 No. of otoliths = 190

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2						
3	47	12.31	36.18	0.40	18.8	
4	199	51.66	39.67	0.53	105.7	
5	93	24.03	45.74	0.82	76.7	
6	40	10.40	53.80	1.36	54.5	
7	4	0.94	60.65	1.97	7.9	
8	2	0.62	58.34	1.75	3.5	
9	0	0.04	70.00	3.07	0.0	
10						
11						
12						
13						
Total	385				267.0	

1997 Catch = Effort = C/E =

Av. length = 53.21 No. of otoliths = 464

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2						
3	34	4.05	36.90	0.42	14.4	
4	118	13.91	42.30	0.65	76.5	
5	321	37.81	50.29	1.11	354.8	
6	187	22.04	57.53	1.67	313.0	
7	172	20.23	63.19	2.24	384.8	
8	14	1.59	65.47	2.50	34.9	
9	2	0.23	76.69	4.07	8.1	
10	0	0.05	79.00	4.46	0.0	
12	1	0.08	82.00	5.00	5.0	
12						
13						
Total	849				1191.5	

Appendix Table 7. Catch per unit effort (total catch / total effort) in sentinel surveys in Divisions 2J3KL, disaggregated by age in accordance with the age composition of the catch. Trap in Division 3L in the period July 1 - July 31.

1995 Catch = Effort = C/E =

Av. length = 48.65 No. of otoliths = 0

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
Total	104				0.0	

1996 Catch = Effort = C/E =

Av. length = 54.92 No. of otoliths = 299

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2						
3	7	1.50	42.04	0.64	4.4	
4	70	14.79	44.78	0.77	54.1	
5	110	23.26	50.92	1.15	126.3	
6	221	46.75	58.73	1.78	394.3	
7	52	11.04	60.50	1.96	101.7	
8	10	2.21	63.14	2.23	22.3	
9	2	0.42	69.80	3.04	6.1	
10	0	0.04	73.00	3.49	0.0	
11						
12						
13						
Total	472				709.2	

1997 Catch = Effort = C/E =

Av. length = 60.71 No. of otoliths = 219

	Total catch				Catch	C/E
Age	Numbers	Percent	Av. Len.	Av. Wt.	wt. (kg)	at age
2						
3	2	0.91	37.84	0.46	0.9	
4	17	7.53	45.74	0.82	14.0	
5	59	26.75	53.52	1.34	79.0	
6	34	15.61	59.65	1.87	63.6	
7	69	31.32	65.71	2.52	174.2	
8	30	13.49	70.77	3.17	95.2	
9	6	2.95	73.48	3.56	21.4	
10	1	0.53	74.60	3.73	3.7	
11	2	0.90	67.73	2.77	5.5	
12						
13						
Total	220				457.7	

Appendix Table 8. Summary of age-disaggregated catch rates from the sentinel surveys, by gear (gillnet and linetrawl), Division and year (1995-1997).

Gear	Division	Age	Catch rate 1995	1996	1997
Gillnet	2J	2	0.000	0.000	0.000
		3	0.000	0.018	0.071
		4	0.111	0.010	0.202
		5	1.261	0.012	0.111
		6	0.000	0.016	0.526
		7	1.353	0.028	0.265
		8	0.834	0.014	0.095
		9	0.222	0.002	0.017
		10	0.000	0.000	0.008
		11	0.000	0.000	0.009
		12	0.000	0.000	0.000
		13	0.000	0.000	0.000
			3.782	0.098	1.304
	3K	2	0.000	0.000	0.000
		3	0.000	0.018	0.016
		4	0.000	0.183	0.075
		5	1.457	2.471	0.880
		6	1.472	10.077	3.676
		7	0.869	2.091	6.848
		8	0.187	0.475	1.000
		9	0.030	0.071	0.013
		10	0.000	0.020	0.020
		11	0.000	0.005	0.047
		12	0.000	0.002	0.000
		13	0.000	0.000	0.000
			4.015	15.412	12.575
	3L	2	0.001	0.005	0.002
		3	0.009	0.055	0.034
		4	0.053	0.498	0.436
		5	1.940	2.693	4.734
		6	3.026	13.578	6.299
		7	1.150	5.251	9.139
		8	1.031	1.227	2.666
		9	0.147	0.393	0.397
		10	0.044	0.107	0.163
		11	0.010	0.019	0.043
		12	0.000	0.010	0.017
		13	0.000	0.000	0.002
			7.412	23.836	23.932

(cont'd)

Appendix Table 8 (cont'd). Summary of age-disaggregated catch rates from the sentinel surveys, by gear (gillnet and linetrawl), Division and year (1995-1997).

			Catch rate		
Gear	Division	Age	1995	1996	1997
Linetrawl	3K	2	0.000	1.023	0.000
		3	10.308	23.172	22.003
		4	75.961	40.319	70.409
		5	48.419	57.352	92.175
		6	8.406	34.116	55.435
		7	0.247	5.505	48.583
		8	1.147	0.747	5.730
		9	0.697	0.130	1.004
		10	0.000	0.016	0.000
		11	0.000	0.000	0.000
		12	0.000	0.000	0.000
		13	0.000	0.000	0.000
			145.185	162.379	295.339
	3L	2	0.000	2.444	1.493
		3	4.349	18.468	9.596
		4	22.060	27.789	32.025
		5	27.423	14.191	56.669
		6	15.894	12.856	30.616
		7	10.053	9.461	29.878
		8	0.657	0.890	4.932
		9	0.690	0.646	2.550
		10	0.000	0.419	0.000
		11	0.000	0.122	0.000
		12	0.000	0.000	0.000
		13	0.000	0.000	0.000
			81.126	87.285	167.760