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Condition of cod in Divisions 2J+3KL during the autumns of 1978-1995

by

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Abstract

The condition of cod in Divisions 2J+3KL was monitored by sampling catches during autumn research assessment surveys in the offshore in 1978-1995 and the sentinel survey in the inshore during summer-autumn 1995. In the offshore, the somatic condition of cod in Divisions 2J and 3K recovered from low levels in 1991-1992 to moderate levels in 1993-1995. Liver index, which had declined in Division 2J, remained at a relatively low level. Preliminary analysis revealed that sampling has varied spatially within Divisions over time, and that there is spatial heterogeneity in condition within Divisions. Thus, some of the variability observed in the time-series of cod condition may be related to the sampling itself. When liver index data are aggregated into groups defined by aggregations of cod rather than Division boundaries, the contrast between patterns in the north and patterns in the south become more apparent; of considerable interest is an increase in liver index on the plateau of Grand Bank at the time that liver index declined rapidly in Division 2J. Condition of cod inshore in 1995 increased considerably over time at one site which was monitored during July-August. Condition at 14 other sites, each of which was monitored only 1-3 times in September-October, was highly variable, but generally good.

Introduction

The condition of cod in Divisions 2J, 3K and 3L (the "northern cod") has been monitored routinely in the offshore environment since 1978 to help assess the physical well-being or fitness of the animals. When the cod stock declined to a low level in the early 1990's, it was postulated that part of the decline may be due to increased mortality attending a lowering of energetic reserves (Atkinson and Bennett 1994). Such a lowering of reserves may have been caused by a decline in the quantity or availability of prey resources. Bishop and Baird (1994) found that age-specific somatic condition and liver index of cod sampled during the autumn assessment surveys in 1978-1992 declined in the early 1990's in both Division 2J and Division 3K, with the effect being more pronounced in Division 2J. In Division 3L there was generally no change in somatic condition but an increase in liver index. Additional monitoring of somatic condition since 1992 has revealed that the declining trend in Division 2J was reversed in 1993-1994 (Bishop et al. 1995).

Bishop and Baird (1994) also conducted regression analyses between somatic condition index and the biomass of capelin estimated acoustically during Canadian autumn capelin surveys in Divisions 2J and 3K. They found positive relationships for many ages in Divisions 2J and 3K, but for only one age in Division 3L. A concern with this analysis is that biomass estimates from the capelin surveys contrast with trends in other indices. There is a concensus that capelin biomass did not decline dramatically in the early 1990's (Anon. 1995). However, there was a southeastward change in capelin distribution during the autumn (Lilly 1994; Lilly 1995), and in many years the capelin were late arriving in the inshore for spawning (Nakashima 1996). Both factors may have influenced the availability of capelin to cod, particularly in Division 2J. The infuence of capelin on changes in cod condition should be re-examined.

The condition of cod in the inshore environment has not been monitored on a routine basis, but sampling was conducted during the 1980's on an opportunistic basis (unpublished data). Samples were collected at various sites in Divisions 2J, 3K and 3L during the 1995 sentinel survey.

This paper provides an update of the condition of cod caught during the autumn assessment surveys offshore, and presents a preliminary look at the data collected inshore in summer and autumn 1995.

Materials and Methods

Research vessel surveys

A programme of monitoring the weight of cod caught during research vessel studies was started in 1977-1978. Both the protocol for selection of animals and the methodology for measuring the weights (or volumes) have changed several times since the late 1970's (Shelton and Lilly (1995)). These changes have not yet been thoroughly documented.

Cod were measured (fork length, cm) and weighed (to the nearest 10 g) before being cut (round weight) and after removal of the organs from the abdominal cavity (gutted weight). The liver was also weighed (g) or measured volumetrically (ml). The condition of the fish was expressed using Fulton's condition factor ((weight/length^3)*100), and the relative size of the liver (liver index) was expressed the same way.

Condition values presented in previous reports were probably means for the sampled fish, without taking into account the length stratification in the sampling. Condition values have been recalculated, weighting each individual fish condition by the ratio of the population number per 3 cm length class to the number of fish sampled in the same length class, where the population number is calculated by areal expansion of the stratified mean catch at length per tow (Smith and Somerton 1981).

Sentinel survey

A sentinel survey for cod was conducted at 58 sites in Divisions 2J3KL during the summer and autumn of 1995 (Davis et al. 1996). A total of 635 cod from 18 communities were sampled for condition (Table 3). The majority of these cod were caught by fishers operating from 4 communities on Fogo Island in Division 3K. The sampling on Fogo Island differed from that at other sites in several ways. The sampling occurred during July-August, and was completed before sampling started at other sites. In addition, sampling on Fogo Island consisted of numerous small samples, whereas at other sites there was usually a single, relatively large sample. Fish caught on Fogo Island were sampled while still fresh, whereas cod from other areas were frozen and sampled after thawing in fresh water in the laboratory at NAFC in St. John's.

Results and Discussion

Offshore surveys

Average Fulton's condition for cod of ages 2-12 are provided in Tables 1 and 2 for round weights and gutted weights respectively. The gutted values for ages 3-6 are illustrated by Division in Fig.1. Illustrations for older ages are available in previous reports (eg. Bishop and Baird 1994; Taggart et al. 1994; Bishop et al. 1995), but are not provided in the present paper because sample sizes were very small or nil in recent years. In all three Divisions, there was no systematic change in condition from 1994 to 1995.

Average liver indices for cod of ages 3-6 are illustrated by Division in Fig. 2. In general, there was little change between 1994 and 1995. A large decline occurred in cod of age 6 in Division 2J, but the 1995 value is based on just 2 fish. Compared with levels in the 1980s, liver indices in the period 1991-1995 have been low in Division 2J, steady in Division 3K, and elevated in Division 3L.

What caused the changes in condition?

Several hypotheses have been proposed to explain the observed changes in condition. As noted above, it has been postulated that the changes are related to changes in the abundance or distribution of prey, specifically capelin (Bishop and Baird 1994; Lilly 1995). Annual variability in the timing of surveys relative to a fixed biological cycle could also be important. In addition, it has been postulated that annual variabilty in phasing of the biological cycle relative to a fixed survey time might create the appearance of annual variablity in condition (C. Taggart, E. Colbourne, J. Morgan, pers. comm.).

Before these hypotheses are tested, it is perhaps useful to review changes in the sampling protocol and to test the possibility that annual variability in estimates of condition are caused by the sampling itself. Changes to be investigated include changes in the geographic pattern of sampling and changes in the way the weight of fish and their organs have been determined. Only the former will be introduced in this paper.

Geographic variability in sampling

The geographic distribution of sampling for round (and gutted) weight varied among years (Fig. 2). For example, in 1982 most of the fish collected in Div. 2J were caught in the southern half of the Division, whereas in 1984 and 1985 most of the sampling came from the north. In 1987 most of the sampling in Division 3L occurred in the south, whereas in 1989 most occurred in the north. Spatial variability in sampling would probably not matter much if there were no geographic heterogeneity within Divisions. An initial examination of geographic variability in mean condition index (gutted weight) by set is illustrated in Fig. 3. In 1989 fish taken in many sets in the coastal regions of Div. 3K had low condition, whereas fish caught in many sets in the east had high condition. In 1991, cod caught in the Hawke Saddle - Belle Isle Bank area had low condition, whereas cod on northern Hamilton Bank and southeast of Funk Island Bank had relatively high condition. This among-year variability in spatial pattern will be investigated further.

Another consideration is how representative the sampling is relative to the size of the catch. Because the sampling protocol was to obtain a specific number of fish per length group per Division, without consideration to set or stratum, it would not be possible in most years and Divisions to adjust the sampling to the catch. There remains the possibility that large catches will be under-represented and small catches over-represented.

Sampling specific groups of fish

Under ideal circumstances, one would monitor a given group of fish as it moves through its annual migration. The analyses conducted thus far have been by Division. Even though many of the cod caught during the autumn surveys are thought to be migrating from inshore feeding areas to offshore overwintering areas, there are nevertheless areas in which the fish appear to be concentrated. Areas recognized by Lilly (1994,1995) are: (1) from the northern limit of the survey to the coastal shelf off northern Newfoundland, especially the northern tip of Hamilton Bank and near the isthmus leading to Belle Isle Bank; (2) the outer trough between Belle Isle Bank and Funk Island Bank; (3) the outer trough between Funk Island Bank and Grand Bank, and from there southeastward along the northeastern slope of Grand Bank; and (4) the plateau of Grand Bank. Note that the 3K/3L boundary passes through area (3), so that fish in the 3K portion of area (3) may be distinct from fish in area (2) in northern Division 3K and fish in the 3L portion of area (3) may be distinct from the concentration on the plateau of Grand Bank (area 4).

To help explore broad-scale variability in condition, the following 5 regions were defined. Area (1) above was divided into northern 2J and southern 2J, with the dividing line running along the axis of Hawke Saddle. The other 3 regions were areas 2-4 as defined above. Liver index was chosen for this preliminary analysis because it has varied more widely than somatic condition. A mean liver index was calculated for all cod 45-62 cm sampled in each of these areas each year (Fig. 4). The liver index of cod in northern Division 2J increased from moderate levels in the early 1980s to high levels in the late 1980s before declining dramatically in 1991. For the very few cod remaining in northern Division 2J since 1991, liver indices have been low. The pattern in southern Division 2J was similar, but the liver index has recovered to a moderate level. Cod in northern 3K experienced a similar pattern, but

with a less severe decline in the early 1990s. Cod near the 3K/3L line and in northeastern Division 3L rose from relatively low levels in 1978-1984 to moderate levels in 1985-1994. Cod on the plateau of Grand Bank experienced a sudden rise in liver index between 1990 and 1991, the period during which cod in Division 2J and northern 3K were experiencing a decline. Clearly, changes in condition cannot be discussed without consideration of spatial variability. Further study will include the possibility that some of the changes in condition reflect changes in the dominant "group" of fish within these areas. Such changes could be caused by changes in migration patterns or changes in relative abundance of "groups".

Sentinel survey

The condition and liver index of cod sampled during the sentinel survey varied among locations (Table 3). The median Fulton's condition index (round weight) for all cod combined was 0.944 (Table 4), which compares favourably with a median of 0.958 (5th and 95th percentiles: 0.799 and 1.172) for all cod 30 cm or longer sampled during autumn bottom-trawl surveys offshore in Div. 2J3KL in 1980-1989. The median of 0.797 for gutted weight compares favourably with a median of 0.775 (5th and 95th percentiles: 0.671 and 0.901) for the same offshore cod. The median liver index was 0.046, which was less than the median liver index of 0.055 (5th and 95th percentiles: 0.021 and 0.107) for offshore cod.

Condition will vary over space and time, and among fish of different sizes. A simple illustration of the influence of time is seen when mean condition from individual samples is plotted against the date of sampling. (For this analysis, all fish from the four communities on Fogo Island were combined, and all samples of one fish were deleted.) The condition of fish caught around Fogo Island improved during the duration of the study from July 12 to August 30 (Fig. 5). The liver index increased from below 0.04 to approximately 0.07. The interpretation of observations from other sites during September and October is not clear. There is considerable variation among samples. However, without sequential sampling within a site, it is difficult to determine where the cod are on their seasonal cycle. During an unpublished study at Bonavista in 1983 and 1984, it was found that the liver index of cod caught in shallow water increased from approximately 0.04 in mid-late June to a peak of about 0.07 in July before declining to about 0.04-0.05 by October.

Were any cod in critical condition?

The various studies of condition in cod in Divisions 2J3KL have revealed annual variablity in fish caught offshore during the autumn, particularly in Division 2J, and temporal and spatial variability in fish caught in the inshore. It is not yet known if the levels found are indicative of fish in critical condition. Dutil et al. (1995) have provided metrics for what they consider to be fish in a jeopardized state, based on their laboratory studies of Gulf of St. Lawrence cod, but the condition formulations which they have used cannot be applied directly to the data available for cod in Divisions 2J3KL. Following additional analyses, it should be possible to make certain simplifying assumptions and caste the data for 2J3KL cod in a way which permits direct comparison with their values.

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Table 1. Average Fulton's condition (round weight) at age for cod caught during autumn surveys in Div. 2J3KL.

Division 2J

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	0.846	0.845	0.848	0.916	0.835	0.853	0.849	0.859	0.881	0.863	0.891	0.879	0.828	0.820	0.745	0.834	0.882	0.834
3	0.872	0.900	0.920	0.958	0.904	0.949	0.938	0.927	0.920	0.980	0.932	0.942	0.886	0.845	0.800	0.851	0.850	0.847
4	0.898	0.923	0.814	0.973	0.886	1.005	0.961	0.955	1.036	0.979	0.999	0.954	0.924	0.870	0.809	0.872	0.851	0.868
5	0.937	0.907	0.948	0.957	0.956	0.944	0.983	0.979	1.033	0.985	0.979	0.992	0.935	0.854	0.829	0.869	0.888	0.864
6	0.909	0.995	0.927	1.022	0.945	0.897	0.955	0.978	1.079	1.036	1.030	0.996	0.947	0.839	0.794	0.842	0.908	0.895
7	0.879	0.922	0.930	1.004	0.930	0.861	0.945	0.962	1.041	0.969	1.010	1.020	0.967	0.821	0.805	0.828	0.953	
8	0.905	0.818	0.935	1.058	0.896	1.015	0.931	0.973	0.974	1.102	1.013	1.052	0.994	0.846				
9	0.959	1.041	1.037	0.921	0.900	1.001	0.961	0.831	1.127	0.960	1.158	1.040	0.992	0.895				
10	0.979	0.995	1.077	1.066	1.005	0.951	0.947	0.931	1.004	0.974	1.071	1.141	0.966	0.948				
11	1.038	1.061	0.991	1.018	1.061	0.969	0.986	0.987	1.136	1.061	1.065	1.067	1.048	1.033				
12	1.149	1.031	1.116	1.059	1.105	0.955	1.007	0.988	1.054	1.039	1.098	1.003	1.079	0.983				

Division 3K

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	0.801	0.790	0.795	0.917	0.813	0.829	0.775	0.861	0.845	0.863	0.859	0.851	0.817	0.835	0.840	0.847	0.837	0.851
3	0.807	0.859	0.917	0.922	0.949	0.860	0.835	0.896	0.900	0.904	0.921	0.912	0.841	0.846	0.810	0.868	0.869	0.862
4	0.848	0.910	0.946	0.886	0.882	0.934	0.850	0.873	0.970	0.932	0.958	0.932	0.875	0.885	0.853	0.871	0.882	0.846
5	0.856	0.928	0.892	0.934	0.886	0.898	0.892	0.936	0.983	0.952	0.984	0.949	0.884	0.892	0.883	0.872	0.865	0.868
6	0.863	0.926	0.869	0.959	0.860	0.862	0.889	0.951	1.071	0.962	1.012	1.013	0.911	0.906	0.912	0.935	0.936	0.892
7	0.853	0.887	0.846	0.892	0.877	0.934	0.930	0.909	1.052	1.073	1.029	1.004	0.943	0.890	0.926	0.959	0.979	
8	0.903	0.898	0.822	0.915	0.894	0.962		0.933	1.015	0.997	1.089	1.004	0.948	0.900	0.917	0.874	0.973	
9	0.947	0.918	0.907	1.046	0.858	0.958	0.941	1.067	1.044	1.034	1.020	1.006	0.922	0.915	0.835			1.043
10	0.908	0.962	0.955	0.925	0.960	0.952	0.860	0.924	1.102	1.118	1.057	0.997	0.966	0.936				
11	0.778	0.952	1.032	1.098	0.901	1.048	1.031	0.969	1.086	1.126	0.998	1.023	0.951	0.907				
12	1.066	1.117	0.982	1.025	1.017	0.906	0.969	1.037	1.028	1.029	1.088	0.967	1.025	0.978				

Division 3L

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2				0.841	0.798	0.824		0.771	0.862	0.842	0.878	0.846	0.801	0.890	0.859	0.840	0.870	1.087
3				0.906	0.904	0.830		0.876	0.878	0.856	0.917	0.874	0.861	0.889	0.977	0.877	0.920	0.894
4				0.914	0.875	0.847		0.875	0.887	0.864	0.884	0.878	0.861	0.931	0.979	0.902	0.893	0.889
5				0.924		0.846		0.882	0.931	0.877	0.925	0.926	0.892	0.931	1.000	0.923	0.937	0.912
6				0.884		0.810		0.838	0.913	0.837	0.955	0.919	0.906	0.946	1.001	0.999	0.959	0.990
7				0.903		0.917		0.844	0.966	0.855	0.890	0.917	0.929	0.909	0.974	0.979	0.996	1.071
8				1.004	0.886	0.897		0.871	0.851	0.883	0.912	0.997	0.952	0.965	0.945	1.057	1.051	1.036
9				0.955	0.968	0.895		0.957	0.965	0.895	0.970	0.924	0.965	0.970	1.013			
10				1.119	0.973	0.899		0.978	1.003	1.094	0.922	1.046	0.964	0.958	0.946	0.978		
11				1.004	0.982	0.963		0.942	0.928	0.961	0.995	1.035	1.001	1.036	1.058			
12				1.104	0.938	0.903		1.019	1.029	0.943	1.051	1.107	0.969	0.980	1.019			

Table 2. Average Fulton's condition (gutted weight) at age for cod caught during autumn surveys in Div. 2J3KL.

Division 2J

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	0.733	0.718	0.738	0.781	0.735	0.731	0.713	0.722	0.718	0.730	0.753	0.745	0.714	0.710	0.666	0.741	0.803	0.740
3	0.729	0.755	0.788	0.811	0.775	0.772	0.758	0.741	0.779	0.813	0.786	0.764	0.741	0.736	0.710	0.758	0.755	0.743
4	0.762	0.763	0.718	0.810	0.757	0.803	0.774	0.755	0.814	0.792	0.816	0.772	0.745	0.735	0.693	0.759	0.745	0.758
5	0.771	0.750	0.764	0.816	0.816	0.774	0.784	0.769	0.816	0.770	0.786	0.786	0.744	0.724	0.709	0.752	0.773	0.736
6	0.747	0.785	0.750	0.821	0.801	0.729	0.767	0.757	0.815	0.783	0.812	0.789	0.753	0.702	0.678	0.717	0.771	0.735
7	0.731	0.762	0.738	0.795	0.757	0.661	0.776	0.751	0.814	0.783	0.798	0.782	0.743	0.707	0.687	0.722	0.779	
8	0.722	0.695	0.743	0.809	0.737	0.789	0.732	0.761	0.778	0.836	0.815	0.806	0.762	0.705				
9	0.764	0.823	0.806	0.749	0.729	0.789	0.751	0.669	0.849	0.768	0.811	0.793	0.771	0.738				
10	0.779	0.794	0.814	0.859	0.814	0.758	0.755	0.724	0.794	0.772	0.813	0.874	0.748	0.783				
11	0.834	0.831	0.760	0.855	0.855	0.801	0.786	0.730	0.870	0.792	0.798	0.806	0.817	0.835				
12	0.904	0.766	0.838	0.845	0.858	0.786	0.799	0.725	0.828	0.795	0.827	0.766	0.828	0.830				

Division 3K

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	0.683	0.707	0.708	0.793	0.722	0.725	0.685	0.730	0.749	0.768	0.753	0.716	0.711	0.733	0.735	0.727	0.741	0.733
3	0.719	0.741	0.786	0.793	0.815	0.742	0.719	0.744	0.714	0.757	0.785	0.750	0.714	0.719	0.700	0.741	0.767	0.744
4	0.747	0.757	0.805	0.769	0.758	0.781	0.733	0.731	0.774	0.772	0.796	0.755	0.724	0.736	0.711	0.720	0.768	0.730
5	0.747	0.780	0.747	0.826	0.754	0.768	0.753	0.765	0.783	0.785	0.799	0.763	0.734	0.733	0.718	0.717	0.730	0.737
6	0.739	0.747	0.726	0.789	0.738	0.728	0.744	0.784	0.798	0.778	0.808	0.781	0.744	0.742	0.739	0.746	0.765	0.766
7	0.730	0.739	0.729	0.749	0.731	0.799	0.784	0.746	0.820	0.819	0.808	0.768	0.749	0.730	0.754	0.721	0.780	
8	0.773	0.746	0.687	0.751	0.732	0.809		0.764	0.795	0.788	0.833	0.779	0.749	0.738	0.736	0.732	0.799	
9	0.784	0.738	0.758	0.847	0.721	0.760	0.781	0.841	0.821	0.796	0.819	0.791	0.732	0.755	0.679			0.795
10	0.744	0.761	0.795	0.756	0.766	0.762	0.717	0.744	0.849	0.811	0.831	0.793	0.749	0.778				
11	0.642	0.752	0.861	0.836	0.749	0.838	0.822	0.778	0.840	0.832	0.788	0.808	0.771	0.741				
12	0.845	0.812	0.762	0.815	0.813	0.755	0.789	0.835	0.785	0.810	0.852	0.792	0.778	0.803				

Division 3L

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	0.718	0.707	0.718		0.680	0.769	0.721	0.748	0.734	0.716	0.746	0.744	0.721	0.750	0.935
3	0.778	0.803	0.724		0.749	0.765	0.733	0.781	0.759	0.734	0.748	0.801	0.741	0.784	0.752
4	0.794	0.765	0.746		0.740	0.757	0.745	0.730	0.764	0.729	0.769	0.788	0.737	0.741	0.758
5	0.767		0.735		0.756	0.790	0.748	0.781	0.782	0.752	0.769	0.795	0.715	0.758	0.761
6	0.729		0.700		0.717	0.781	0.714	0.796	0.776	0.742	0.773	0.796	0.777	0.776	0.804
7	0.751		0.775		0.715	0.816	0.724	0.741	0.768	0.763	0.741	0.793	0.737	0.775	0.861
8	0.824	0.767	0.764		0.708	0.730	0.735	0.758	0.804	0.777	0.763	0.723	0.741	0.725	0.780
9	0.798	0.800	0.744		0.790	0.775	0.743	0.781	0.729	0.773	0.779	0.803			
10	0.888	0.827	0.749		0.783	0.808	0.852	0.746	0.798	0.785	0.758	0.743	0.787		
11	0.800	0.807	0.793		0.774	0.775	0.803	0.736	0.802	0.795	0.817	0.814			
12	0.885	0.771	0.752		0.817	0.811	0.783	0.828	0.822	0.792	0.771	0.808			

Table 3. Sample sizes and mean condition of cod sampled during the sentinel survey in Division 2J3KL in 1995. The four communities on Fogo Island are in bold lettering.

Community	No. of Samples	No. of Fish	Condition round	Condition gutted	Liver Index
Triangle	1	13	0.979	0.788	0.038
Williams Harbour	2	4	1.023	0.854	0.064
Great Brehat	3	17	1.032	0.858	0.066
Conche	7	12	0.998	0.811	0.059
LaScie	1	34	0.971	0.838	0.045
Shoe Cove	1	24	0.956	0.820	0.053
Deep Bay	**21**	**101**	**0.948**	**0.803**	**0.044**
Joe Batts Arm	**21**	**99**	**0.935**	**0.790**	**0.045**
Tilting	**21**	**94**	**0.943**	**0.799**	**0.048**
Seldom	**17**	**89**	**0.909**	**0.777**	**0.046**
Lumsden	1	22	0.911	0.781	0.047
Eastport	1	6	0.951	0.816	0.051
Bonavista	1	24	0.997	0.844	0.066
Little Catalina	1	15	1.003	0.811	0.070
Foxtrap	1	35	0.911	0.788	0.042
Petty Harbour	1	7	0.883	0.754	0.044
Calvert	1	16	0.998	0.824	0.055
Admirals Beach	1	23	1.001	0.820	0.062
Total	103	635			
Average (unweighted)			0.964	0.810	0.053

Table 4. Simple descriptive statistical summary of the condition of cod sampled during the sentinel survey in Division 2J3KL in 1995.

Index	Mean	Percentiles 5th	Percentiles median	Percentiles 95th	3 lowest
Condition (round)	0.948	0.805	0.944	1.122	0.717, 0.750, 0.757
Condition (gutted)	0.802	0.690	0.797	0.931	0.638, 0.643, 0.656
Liver index	0.049	0.024	0.046	0.084	0.012, 0.012, 0.016

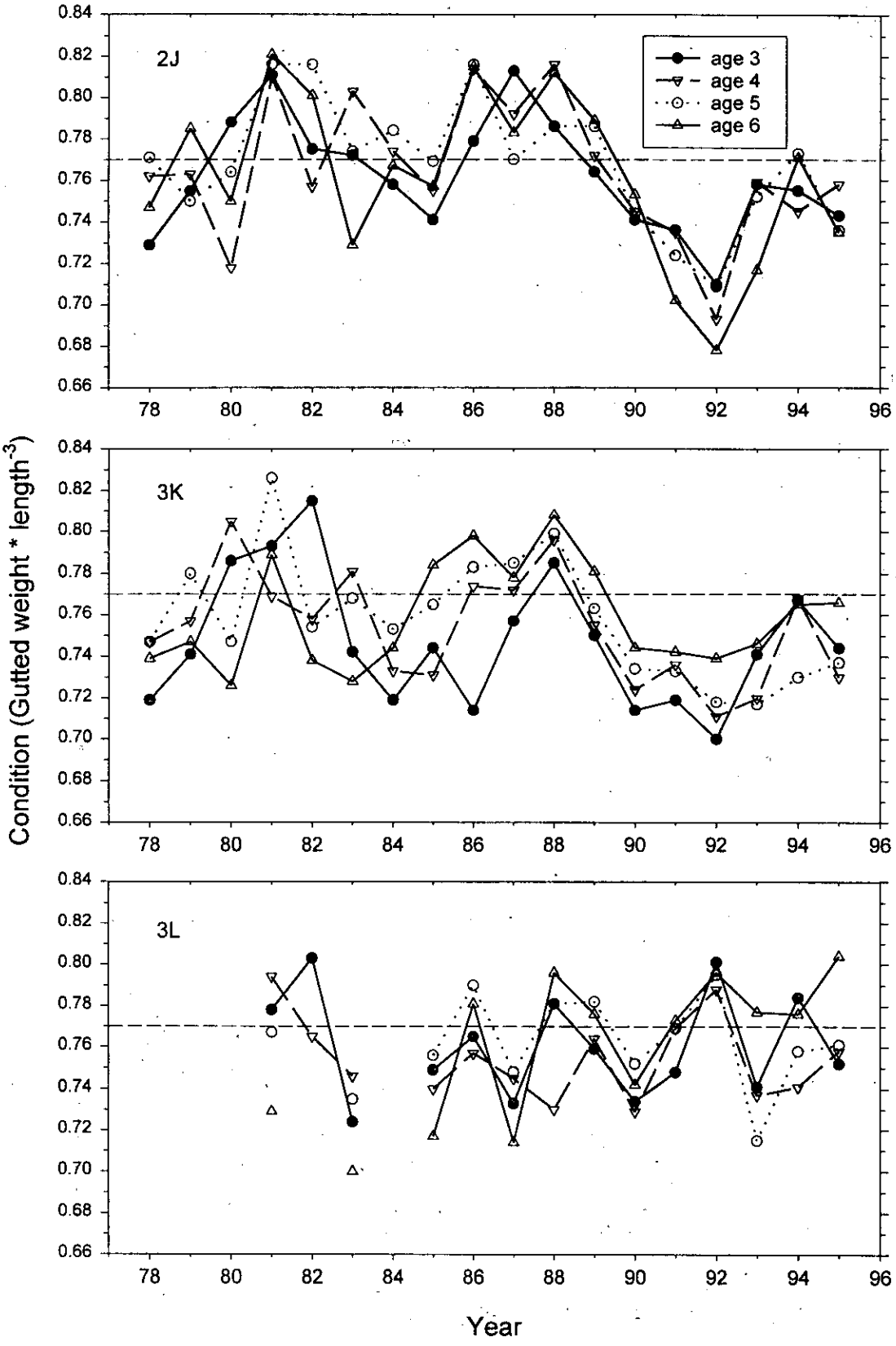

Fig. 1 Average Fulton's condition (gutted weight) at ages 3-6 for cod sampled during autumn surveys in Divisions 2J3KL. A condition factor of 0.77, which is the overall average reported by Taggart et al. (1994), is shown for reference.

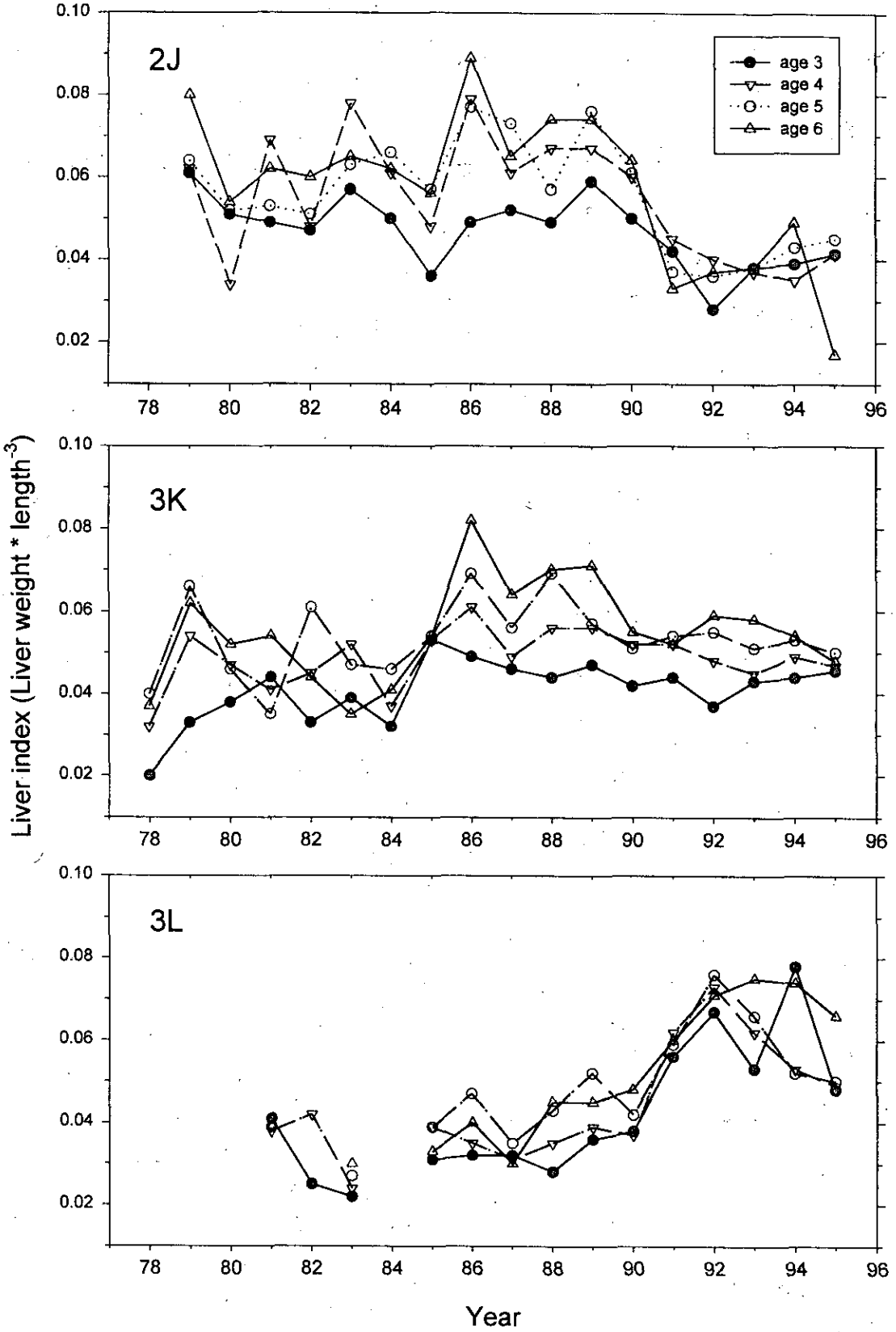

Fig. 2. Average liver index at ages 3-6 for cod sampled during autumn surveys in Divisions 2J3KL.

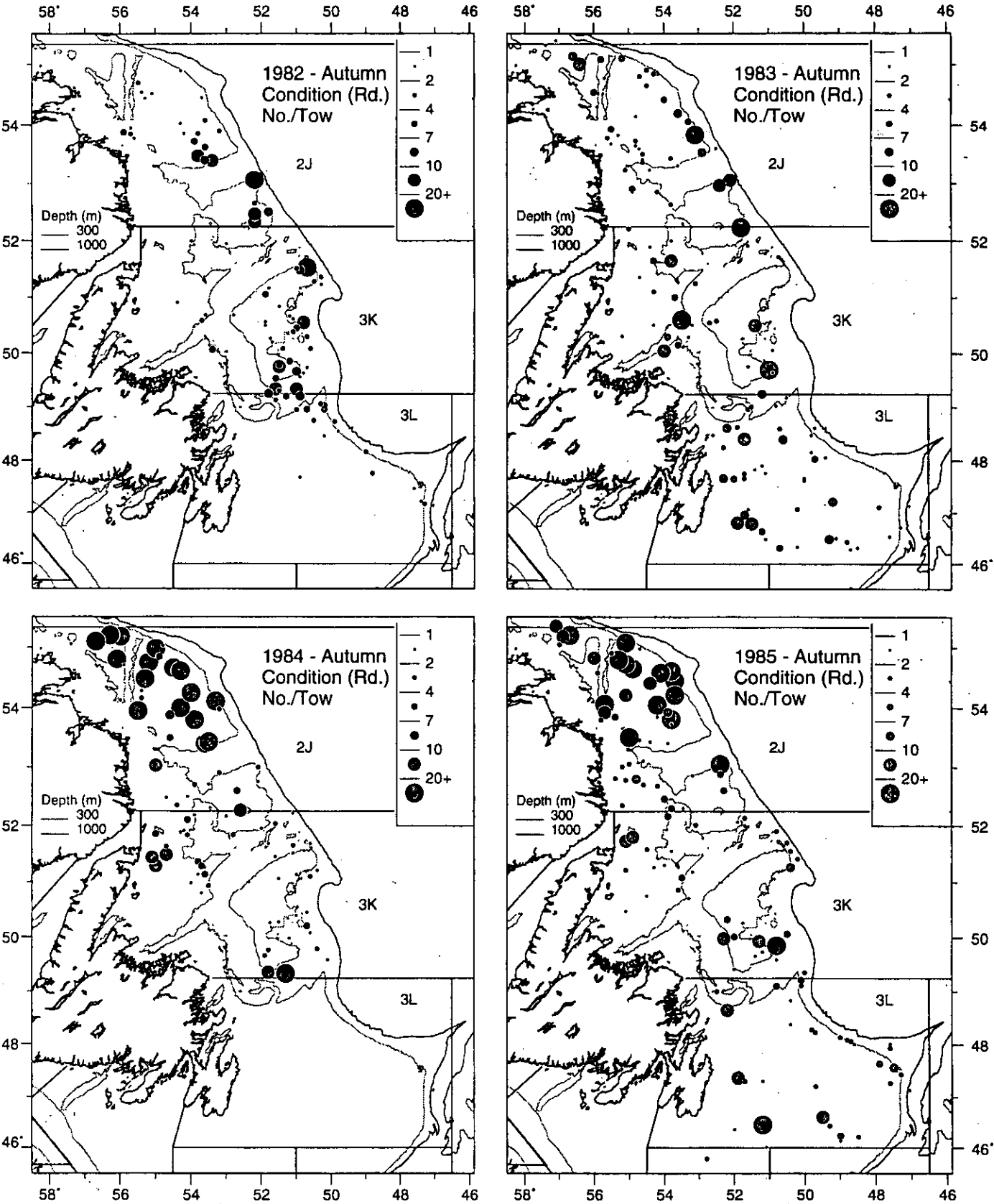

Fig. 3. The number of cod of all ages sampled for round weight at each fishing station during the autumn assessment surveys in 1982-1986.

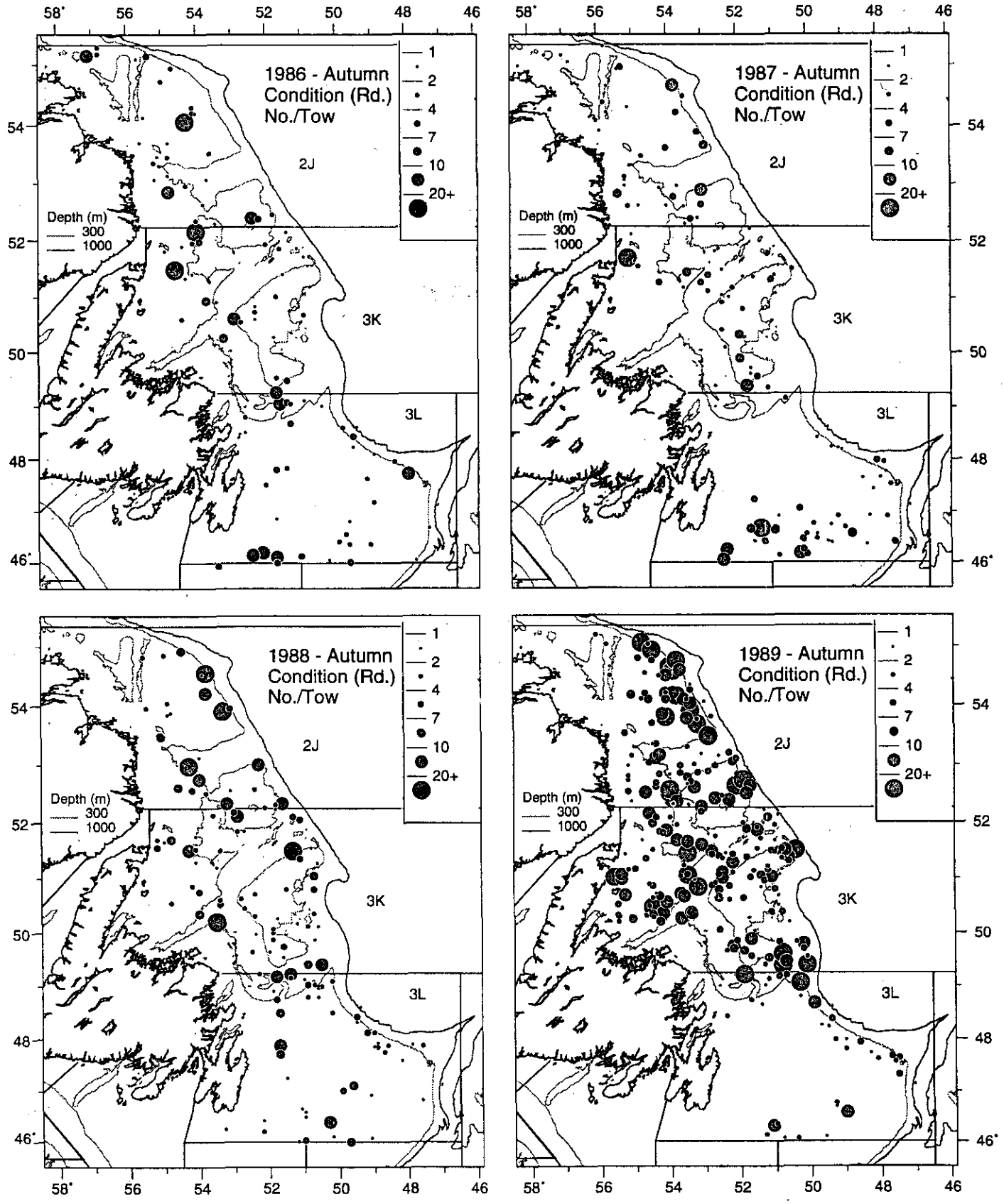
1986 - Autumn
Condition (Rd.)
No./Tow
1987 - Autumn
Condition (Rd.)
No./Tow
1988 - Autumn
Condition (Rd.)
No./Tow
1989 - Autumn
Condition (Rd.)
No./Tow
1
2
4
7
10
20+
Depth (m)
300
1000
2J
3K
3L
58°
56
54
52
50
48
46
54
52
50
48
46°

Fig. 3 (cont.)

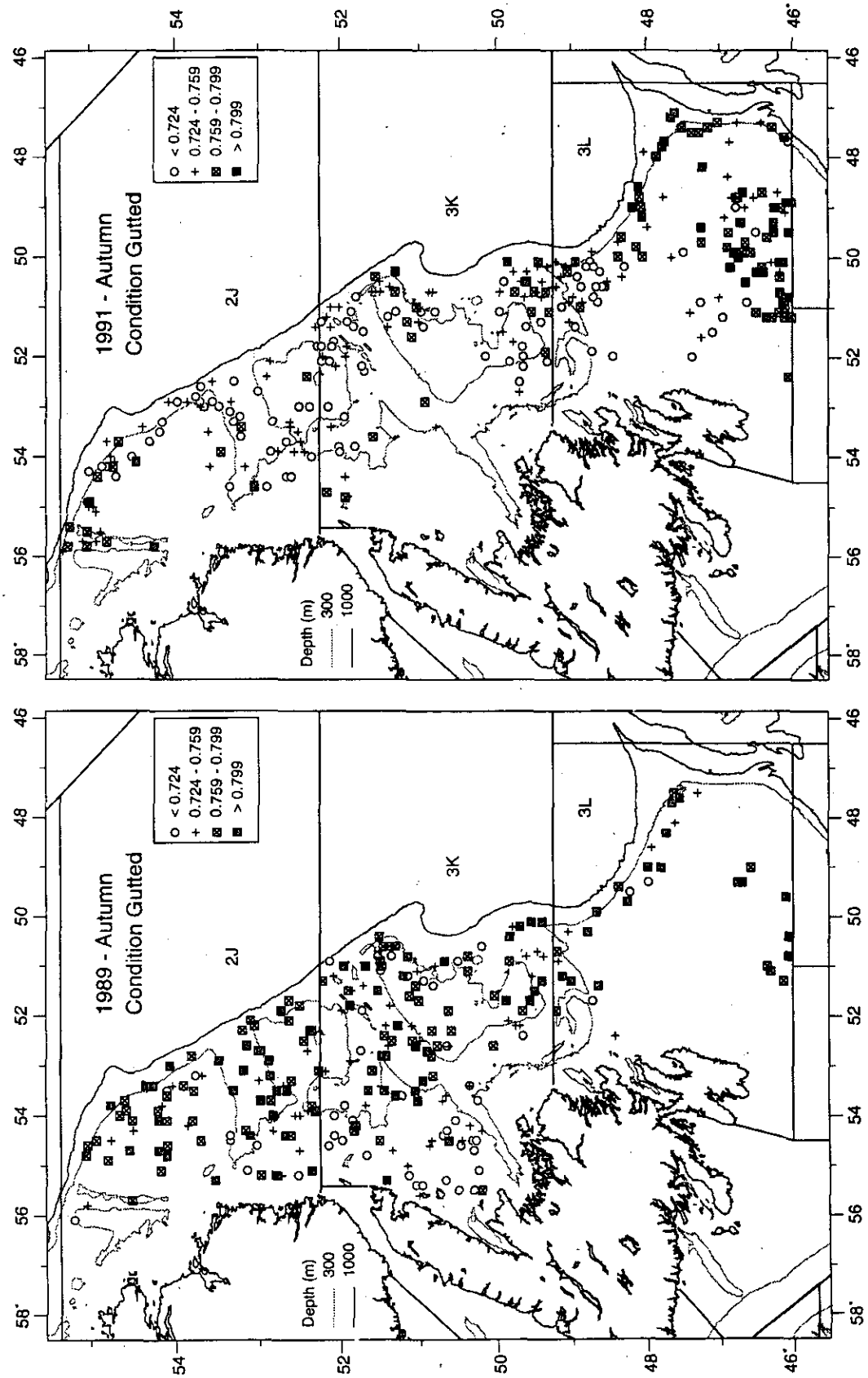

Fig. 4. The average Fulton's condition (gutted weight) of all cod sampled at each fishing station during the autumn assessment surveys in 1989 and 1991.

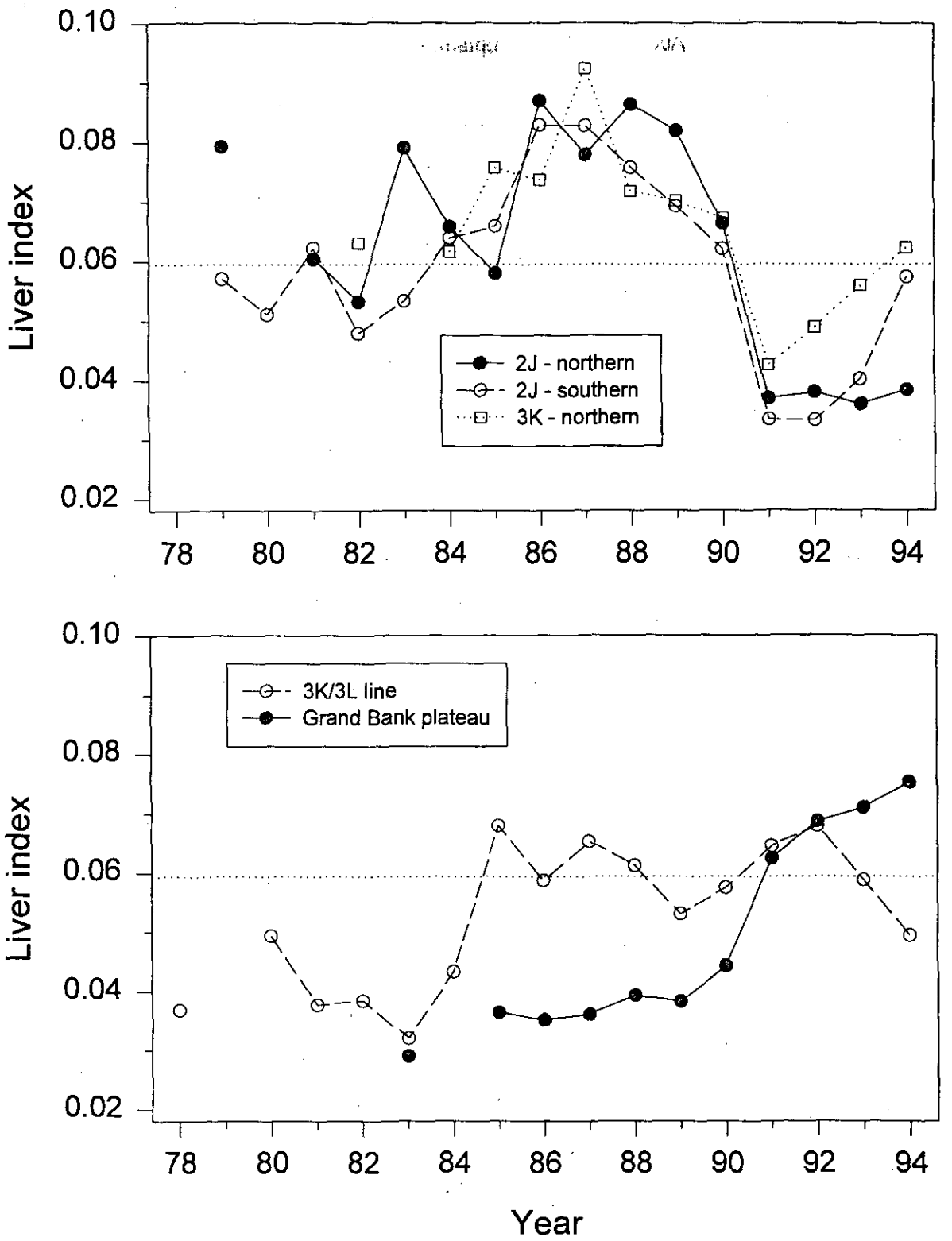

Fig. 5. Annual variability in mean liver index for cod 45-62 cm caught in five regions of Divisions 2J3KL during assessment surveys in the autumns of 1978-1994.

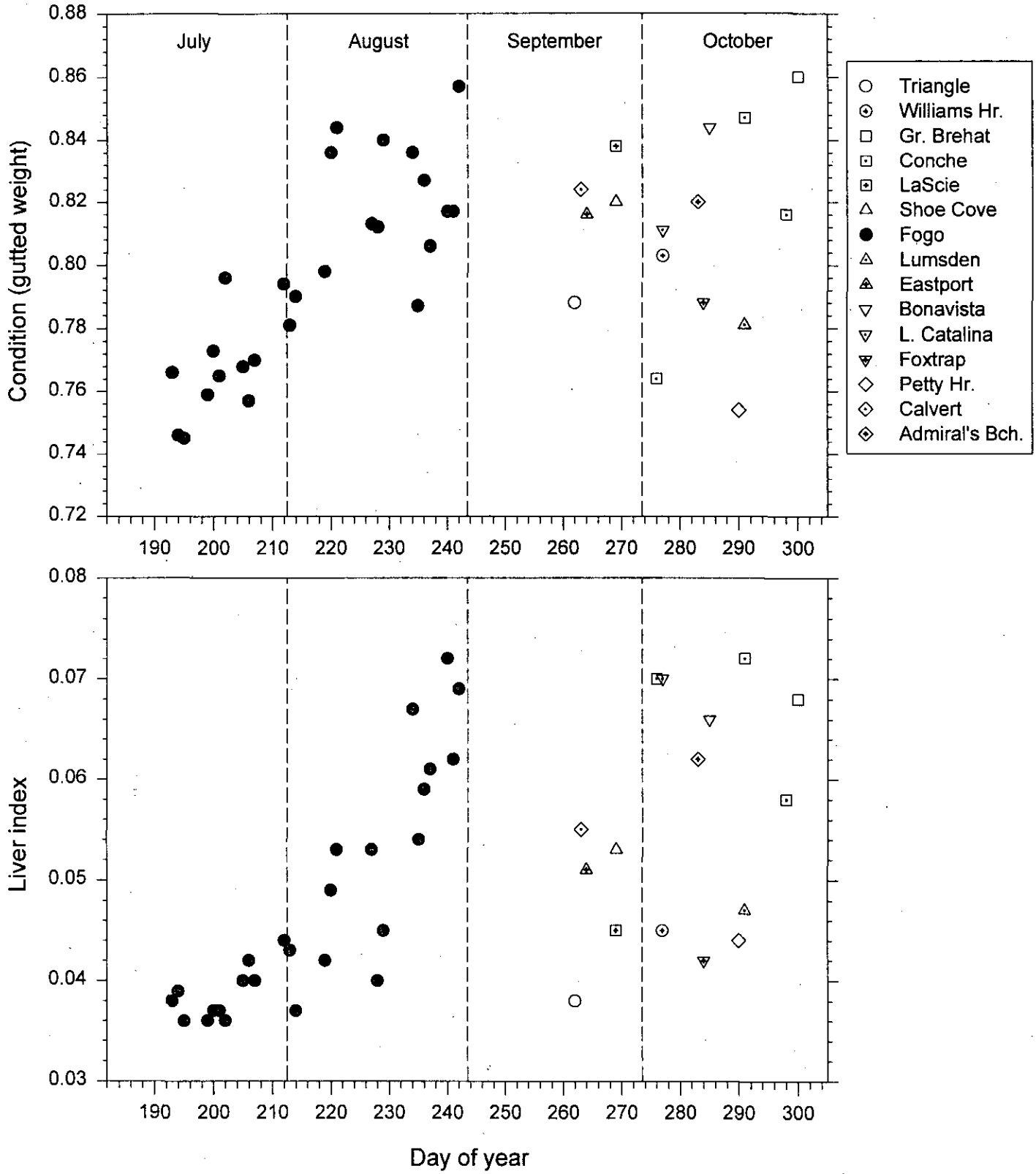

Fig. 6. Condition of cod sampled during the sentinel survey in Division 2J3KL in 1995. The data are aggregated by community and day of year. Any influence of fish size has been ignored. All samples collected from communities on Fogo Island on a specific day are aggregated. In the legend, communities are ordered from north (top) to south.