Areal Patterns in the 2J3KL Offshore Witch Fishery, 1979-89

by

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Abstract

Catches of 2J3KL witch following a decline in the 1970's have remained at a relatively stable level for the past 5 years. Research vessel surveys have indicated a downward trend in the biomass in the early 1980's, reaching a new equilibrium in 1986. This study using commercial fisheries data (Newfoundland Observer Program) showed that biomass for the area of fishing activity (the prespawning concentrations) showed a very similar downward trend. This apparent reduction has occurred in spite of stable and relatively low fishing effort since 1986.

Data obtained directly from the commercial fishery provided some insight for the observed patterns. In spite of the apparent reduced biomass, catch rates have tended to increase during the 1980's. This may in part be due to a shift in activity to deeper grounds. In depths less than 750 m, catch rates were stable during the 1980's. In greater than 750 m there was an upward trend. Fishing activity shifted from an average of 600 m in 1979-81 to 750 m in 1987-89. Correspondingly, a significant change occurred between 1982 and 1986 with respect to extent of fishing grounds. Area fished was reduced from about 6000 km^2 in the early 1980's to 2-3000 km^2 during the past 3 years. Changes in depth range and area fished may have affected observed catch rates.

Résumé

Après avoir connu une baisse dans les années 1970, les prises de plie grise dans les divisions 2J3KL sont restées relativement stables au cours des cinq dernières années. Les études des navires scientifiques dénotaient une tendance à la baisse dans la biomasse au début des années 1980, puis un nouvel équilibre en 1986. La présente étude, fondée sur les données de la pêche commerciale (Programme des observateurs de Terre-Neuve) révèle une tendance à la baisse comparable dans la biomasse des lieux de pêche (concentrations préalables au frai). Cette diminution apparente s'est manifestée en dépit d'un effort de pêche relativement faible depuis 1986.

Les données émanant directement de la pêche commerciale fournissent quelques indications à cet égard. Malgré la réduction apparente de la biomasse, les taux de prises ont été la hausse au cours des années 1980, situation qui pourrait être partiellement imputable à un déplacement de la pêche vers des lieux plus profonds. Dans les profondeurs inférieures à 750 m, les taux de prises sont demeurés stables dans la décennie 1980. Dans les eaux de plus de 750 m, elles étaient à la hausse. L'activité de pêche, pratiquée entre 1979 et 1981 dans des eaux ayant en moyenne 600 m de hauteur, s'est déplacée vers des profondeurs de 750 m de 1987 à 1989. De plus, entre 1982 et 1986, le territoire de pêche s'est rétréci, passant d'environ 6 000 km au début des années 1980 à 2 000 à 3 000 km au cours des trois dernières années. Ces changements dans la profondeur et la superficie des lieux exploités ont pu avoir une incidence sur les taux de prises.

Introduction

Following an increase in the 1960's, catches of 2J3KL witch peaked at 24,361 t in 1973 then rapidly declined over the next 5 years. Since 1979, catches have remained at a relatively low and stable level ranging from 2,807 t to 4,886 t, averaging 3,800 t. In spite of these low levels, results of research vessel surveys have indicated a downward trend in the biomass particularly since 1984. Bowering and Brodie (1989) documented a change in biomass from 46,068 t in 1984 to 26,473 t in 1986. Biomass then appeared to be stabilized at the lower level. The authors noted that particularly in 3K the population appears to have reached a new equilibrium after 1986. This apparent reduction in biomass has occurred in spite of a stable and relatively low fishing effort since 1979.

A part of the witch fishery in each year has been observed (Newfoundland Observer Program) since 1979. Details of catch and effort data including catch position and depth were collected set by set. Information contained in these data were used to explain the patterns that have occurred during the 1980's. In particular, location, depth and extent of area fished were examined to see if fishing strategy had changed significantly. Affects related to the changes are discussed.

Methods

Details of the offshore directed fishery for witch were collected on a set by set basis according to standard methods (Kulka and Firth 1987). Data for countries other than Canada were grouped and classified as foreign. Much of the foreign effort was attributable to three or fewer Polish vessels in any given year and mainly during a 3 month period over a restricted area. This provided for a level of standardization in the data. Species listed on the license for foreign countries determined the directed species. For Canada, observers determined directed species from the captain prior to the fishing set. In this way, directed species was defined as main species sought for both the foreign and Canadian effort.

To assess changes in the fishing activity over the period of study, the catch data collected by observers were analyzed using SPANS (TYDAK Corp.) spacial analysis system. Fishing density charts showing contours of number of sets per km^2 were plotted to show where fishing activity was most concentrated. Catch per hour was then calculated for each set and the data were converted to contour-like thematic maps using a potential mapping technique. An estimate of biomass or weight of fish within the observed fishing ground was then estimated by areal expansion. The foreign data were used in the time series because only 3 of 11 years for Canadian effort were observed while data were available for all 10 years of the foreign fishery. No attempt was made to standardize the catch rate data because most of the fishery occurred over a restricted area mainly during the same 3 months each year. Also, the fishery was by a prosecuted few vessels of similar fishing power.

Potential mapping was chosen as a way to create a smooth or averaged surface from georeferenced point data. The method is particularly useful for analyzing variable data such as commercial catch effort as it tends to smooth random variance. The software calculates an average value for a subset of points which fall within a specified radius of a reference point. The reference point is then moved slightly and the process repeated. The sampling radius or zone of influence was chosen as 6.27 km, equivalent to 123 km^2 (6 minute square). This level was chosen because it approximates the distance over which a typical fishing set occurs. The potential mapping technique

assumes that the attribute value, in this case catch rate is related to values of the points around it. This effect is lessened with increasing distance from the reference point. The result is smoothing of the data to an interpretable contour plot.

Catch rate was categorized into four contour levels or catch rate strata: 0-0.75 t/hr (average 0.38), 0.75-0.95 t (0.85), 0.95-1.35 t (1.15) and greater than 1.35 t (1.45). A biomass was then estimated for each level by areal expansion as:

$$B = \sum_{1}^{n} \frac{a \times c}{(t \times w)/h}$$

where B = estimated biomass of fish over the area fished
n = catch rate category
a = area within contour level (km^2)
c = catch per hour
t = average tow length (km)
w = net width (set at 0.02 km)
h = average number hours per tow

The summed values from the four catch rate categories provided an index of biomass for the area fished. These estimates are not related to the research vessel survey index for two reasons. They were not based on random stratified sampling and they covered only the area fished by the foreign fleet for each year. Size of area fished, catch rate and index of biomass for the fishing grounds were plotted for 1979-89 to illustrate temporal trends.

A preliminary examination of the data suggested depth related changes in the fishing pattern. Therefore, average depth fished was plotted by year and catch rate was plotted against depth.

Results and Discussion

Observations of Canadian effort for 2J3KL witch was limited to 11% of the total fishery in 1980, almost none between 1981 and 1987, then 43 and 39% respectively (Table 1) in 1988 and 1989. In contrast, a significant percent of the foreign effort was observed for each year over the entire study period. Therefore, the following description of observed patterns pertains primarily to the foreign fishery. It should be noted that Canada did fish in virtually the same areas as the other countries in 1988 and 1989. In contrast, the 1980 Canadian effort occurred in shallower waters slightly to the west where by-catch of cod was much higher and catch rates were lower.

Fishing activity in the 1980's was more concentrated in 3K than in earlier years (Bowering and Brodie, 1989). Observer data indicated that in large part, the recent fishery was prosecuted over a relatively small area along the shelf edge. The majority of effort was restricted to a narrow band 50 km across at the widest point (49°53′ to 50°21′W). The area extended 235 km north to south from 49° to 50°55′N. Area fished ranged between 1,255 and 10,424 km^2 and average depth fished generally exceeded 600 m (Table 1). Fishing occurred in all months of the year but mainly February through mid-May. According to Bowering and Brodie (1989) this corresponded with the period and location of the prespawning and spawning concentration for this stock. Fishing pattern maps for each year also indicated lesser amounts of effort in shallower depths (275-500 m) to the southwest centered at 48°20′ to 49°N and on Funk Island Bank at

50°N 53°'W. Catch rate maps showed that catch rates of cod to the west and south of the main fishing area dropped significantly and by-catch of cod was much greater. Minor fishing effort in 3L at 47°15" to 47°35'N, and in 2J at 53°N, 52°W and 52°N, 56°W yielded low catch rates. Level of by-catch in these areas, fished mainly by Portugal and to a lesser extent USSR suggested that effort was not directed toward witch. Therefore, the greater part of recorded catches outside of 3K in the 1980's was likely by-catch with cod.

For both extent of the foreign fishing grounds and their estimated biomass, a significant change took place between 1982 and 1986 (Table 1, Fig. 1). Total area fished declined from a high of 10,424 km^2 to 2,235 km in 1987. It should be noted that the 1986 value of 784 km was based only on 19 sets and probably underestimated extent of the area fished in that year. The area fished dropped from about 6000 km^2 in the early 1980's to about 2000-3000 km^2 during the last 3 years. Those areas where fish were most concentrated (where catch rates exceeded 1.35 t/hr) did not reflect this downward pattern. In fact, the largest value, 1274 km^2 occurred in 1988. Canada in 1988 and 1989 fished an area similar in size and location to that of the foreign countries.

Figure 1b suggests an upward trend in the catch rates over the period of study and was particularly high in 1987, 1988 and 1989. Figure 2a suggests that in part this may be due to a shift in fishing effort to deeper waters. The average depth fished in the early 1980's was about 600 m and 750 m after 1986. Figure 1b shows a distinct relationship between depth and catch rate. The elevated catch rate at 100-150 m (.51 t/hr) can be attributed to a small number of sets in 3L. The remaining data mainly reflects fishing in 3K. Here, three distinct levels of catch rate were observed: average of 0.25 t/hr between 50 and 450 m, 0.8 t/hr between 450-750 m and 1.1 t/hr in depths greater than 750 m. The range bars show that in depths exceeding 850 m, variance decreased and there were no zero catches. Hence, the higher commercial catch rates in 1987, 1988, and 1989 may in part be related to the greater average depths fished. Figure 1b also indicates that after 1982, catch rates in depths greater than 750 m were consistently higher than those of the shallower areas and the two lines (catch rate less than 750 m and greater than 750 m) diverged over time. This pattern was not observed before 1982 suggesting a change in the distribution of prespawning concentrations at about this time.

The estimate of biomass for the area fished by foreign fleets was very similar to the estimate of biomass for 3K from research vessel surveys. While it would seem unlikely that the two independent estimates of biomass are comparable because of very different methods of estimation and the former pertaining only to the prespawning concentration, the similarities both in terms of trend and magnitude are striking.

Conclusions

The commercial fishery for witch in 2J3KL in recent years has tended to focus more on the prespawning concentrations located in a narrow band along the shelf break in 3K. Since 1979, foreign fishing grounds have tended to become smaller in extent and deeper. In the late 1980's Canadian vessels also shifted to deeper water such that their fishing ground now overlaps with that of the foreign fleets.

Commercial fishing data suggests a reduction in the biomass of 2J3KL witch in the mid 1980's, similar to the pattern identified from research vessel surveys. However, both Canadian and foreign effort in 1988 and 1989 were higher than in the previous two

years. Part of the perceived changes in biomass may be due to a shifting of the stock to greater depths in recent years, particularly since 1982. Commercial catch rates in depths less than 750 m were stable or slightly declining during the 1980's while rates in depths greater than 750 m have been higher particularly in 1987, 1988 and 1989. The foreign commercial fishery in 1987-89 was prosecuted at somewhat greater depths than in previous years and this may account in part for the higher catch rates in those years.

Reference

Bowering, W. R., and W. B. Brodie. 1989. Witch flounder in Divisions 2J, 3K, and 3L. CAFSAC Adv. Doc. 89/46. 20 p.

Table 1. 1979–1989 observed witch fishery in 2J3KL.

Year	Country[a]	# sets	Area fished (km^2)[b] by c/r category .38	.85	1.15	1.45	Total	Km^2/ hr	Observed catch (t)	Reported catch (t)	% of fishery observed	Fishing ground biomass (t)	Average depth fished (m)
1979	C	–	–	–	–	–	–	–	–	1392	–	–	–
	F	316	5133	1017	1078	328	7556	.45	714	2704	27	29,740	448
1980	C	98	2158	306	113	144	2721	.14	158	1459	11	10,134	220
	F	418	4898	1051	577	190	6716	.12	1100	1348	88	31,604	594
1981	C	9	711	–	–	–	711	.14	16	2661	–	1,929	–
	F	450	5025	591	851	479	6946	.12	1044	1533	69	34,046	632
1982	C	7	318	94	27	–	439	.13	5	1206	–	1,785	–
	F	198	9427	496	442	59	10424	.14	255	1775	14	32,843	473
1983	C	1	–	–	–	–	–	.17	3	1483	–	–	–
	F	288	6402	1171	760	285	8618	.14	507	1605	38	33,680	542
1984	C	–	–	–	–	–	–	–	–	2090	–	–	–
	F	251	2746	726	858	129	4459	.13	1053	2731	39	21,611	692
1985	C	–	–	–	–	–	–	–	–	1305	–	–	–
	F	48	3142	327	36	–	3505	.12	82	1698	5	12,611	574
1986	C	–	–	–	–	–	–	–	–	1199	–	–	–
	F	9	784	–	–	–	784	.13	1	2717	–	2,861	155
1987	C	–	–	–	–	–	–	–	–	866	–	–	–
	F	117	822	521	453	439	2235	.13	641	3283	20	14,704	750
1988	C	382	773	370	1434	703	3280	.11	1410	3275	43	29,784	830
	F	105	1475	102	220	1274	3068	.13	521	886	60	21,141	736
1989[c]	C	316	1128	206	1214	1339	3887	.12	1560	4052	39	32,846	910
	F	52	206	331	665	53	1255	.13	206	834	25	17,953	770

[a] C = Canada; F = Foreign fisheries.

[b] Area fished (in km^2) was divided into 4 strata according to catch rate. The mid-point of the catch rates in each strata are listed.

[c] 1989 data are incomplete.

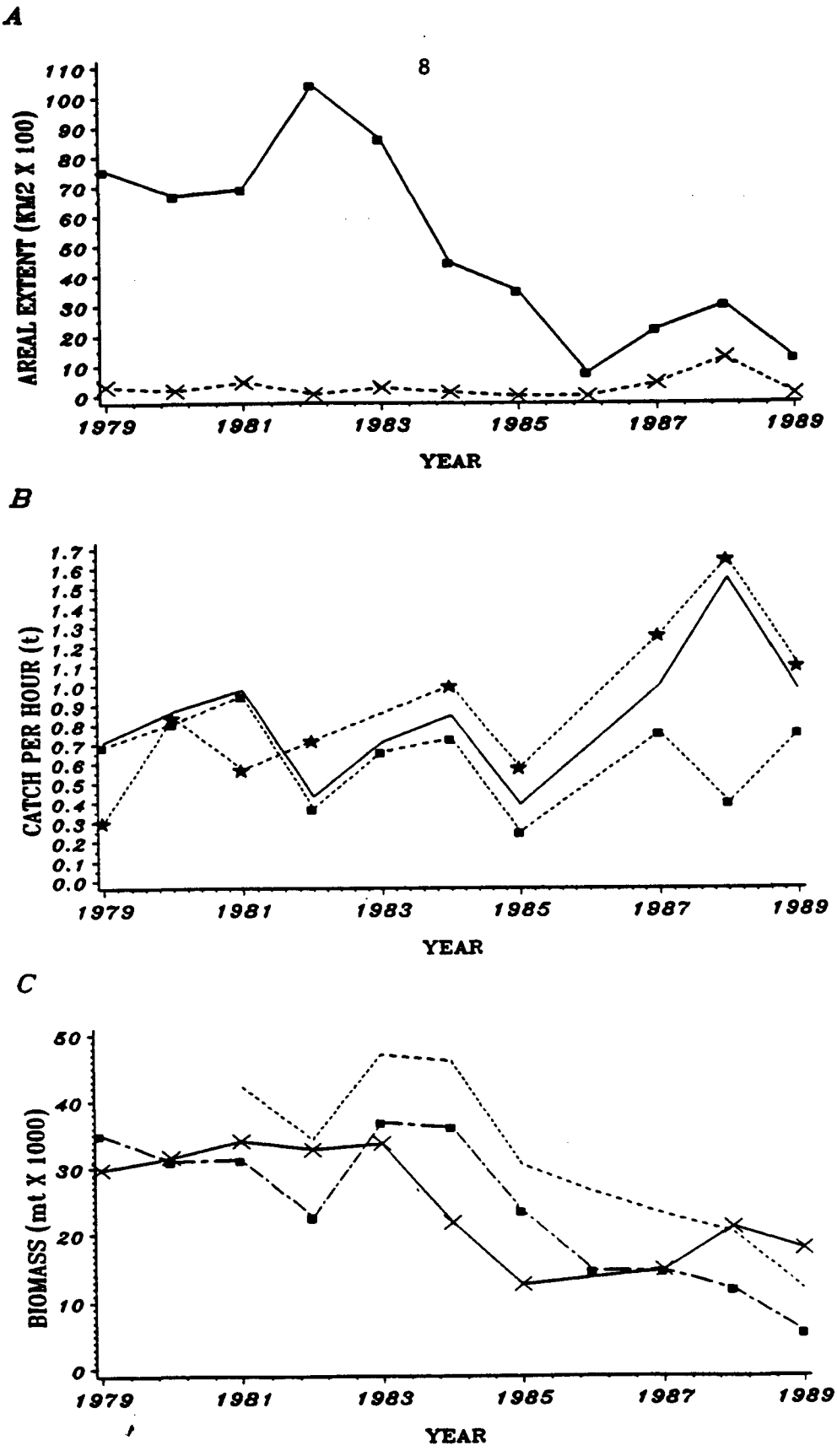

Fig. 1. Yearly trends in a) extent of the area fished by foreign vessels ■——■ total area, x--x locations where catch rate exceeded 1.35 t/hr. b) catch rate where ✱—— ✱ is value for sets where depth exceeded 750 m, _____ average yearly rate, ■---■ where depth was less than 750 m. c) index of biomass where --- is the research vessel survey estimate for 2J3KL, ■---■ research vessel survey estimate for 3K, X——X commercial data estimate for fishing grounds.

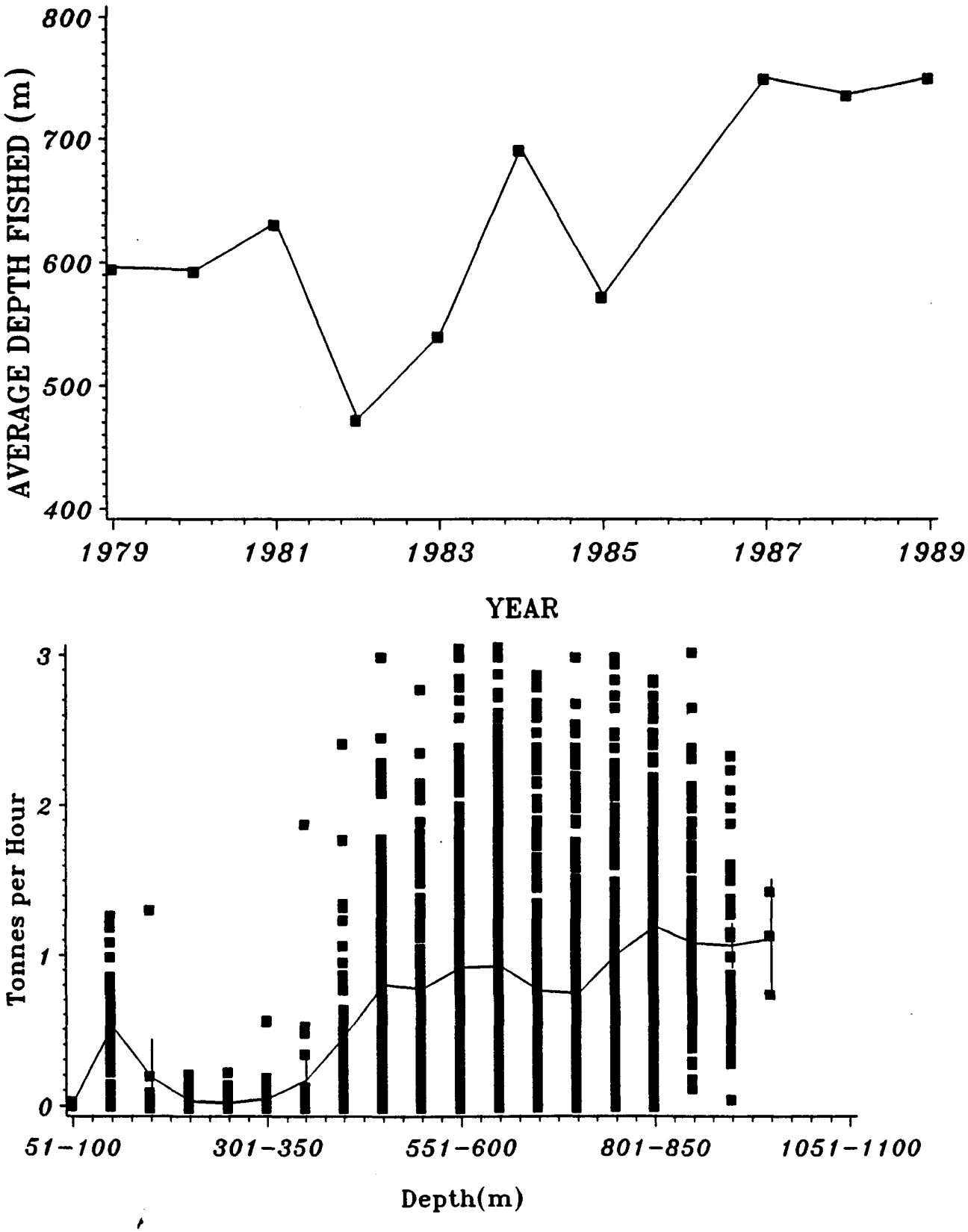

Fig. 2. a) average depth fished by the commercial fleet 1979-89.
b) catch per hour at depth. Vertical bands are range bars.