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An Evaluation of Stock Status of Witch Flounder
in NAFO Divisions 3NO

by

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Catch history

Reported catches during the period 1971-84 ranged from a low
of about 2,400 tons in 1980 and 1981 to as high as 15,000 tons in
1971 (Table 1), however, from 1975-84 annual catches rarely
exceeded 6,000 tons. With a substantial increase in effort in
1985 and 1986, especially by EC-Spain and EC-Portugal, catches
rose rapidly to levels of 8,800 and 9,100 tons respectively. This
increased effort was primarily concentrated on the "tail" of the
Grand Bank in the NAFO Regulatory area of Division 3N. Non-
Contracting parties such as South Korea, USA, Cayman Islands and
Panama also contributed to increased catch levels. Catches
remained relatively high in 1987 and 1988 at 7,500 tons annually,
declined to 3,700 tons in 1989 and remained stable at nearly
5,000 tons in 1991-92. Overall catch statistics for this stock,
however, are inadequate and must be treated cautiously given that
there are catches by non-contracting parties which are not
reported to NAFO and are only estimated from surveillance
reports. There are also species specific catches which must be
determined from formulated breakdowns of landings reported as
unspecified flounders.

The main prosecutors of this fishery historically were
Canada and the former Soviet Union. Canadian catches fluctuated
from between 1,200 and 3,000 tons from 1985-91 but increased to
about 4,300 tons in 1992. This increase in 1992 was essentially
the result of a quota transfer between Canada and the Russian
Federation. Catches by the USSR/Russian vessels declined from
between 1,000 and 2,000 tons in the period 1982-88 to less than
100 tons in 1989-90 and to 0 tons annually since then.

The first total allowable catch (TAC) for this resource was
introduced by ICNAF in 1974 at a level of 10,000 tons largely
based on average historical catches. This level remained in
effect until 1979 when it was reduced to 7,000 tons in
consideration of declining commercial catch rates. It was further
reduced to 5,000 tons in 1981 and has remained at that level to
the present. Although the TAC has not changed since 1981 this
should not be misconstrued as representing stability in the
population size. It is rather a result of the inability of the
Scientific Council to provide a more precise estimate due to
inadequate data. A comparison of annual catches and TAC's are
presented in Figure 1.

Commercial Fishery Data

i)   Catch and Effort

Catch and effort data from the directed fishery for the
period 1974 to 1989 were obtained from ICNAF/NAFO Statistical
Bulletins and were combined with provisional 1990-1991 NAFO data
and preliminary Canadian data for 1991-1992.

The catch/effort data were analyzed with a
multiplicative model (Gavaris 1980) to derive a standardized
catch rate series for hours fished. Effects included in the model

were a combination country-gear-tonnage class category type
(CGT), month, NAFO division and year. Individual observations of
catch or effort data less than 10 units were eliminated prior to
analysis as were categories where there was less than five
samples in the database except within the year category type.

The regression was significant (p <.05), explaining 66%
of the variation in catch rates (Table 2). The inclusion of CGT
and division categories had no significant effect in explaining
the catch rate variability. The data available for the analysis
is basically from the Canadian fishing in Division 3O. The
standardized catch rate series (Table 2, Fig. 2) shows little in
the way of trends although the 1991 value is the lowest in the
series followed by a slight increase in 1992 but is still at a
low level. The 1982 and 1990 values are clearly anomously high
for reasons unclear. However, if those values were ignored there
would appear to be somewhat of an increasing trend from about
1978-85 followed by a declining trend since that time. It must be
recognized, however, that most data pertain to fishing on
aggregations (prespawning) and significant changes in stock size
may not be easily detected until substantial reductions have
occurred that manifest themselves in areas of low density.

ii) Catch at Age

Catch at age data were available from the Canadian
commercial fishery from 1979-92. The data and catch at age
syntheses from 1979-91 were taken from previous documents in
which they were described. The 1992 Canadian catch is shown by
month, division and gear in Table 3 with the sampling scheme and
respective catch breakdown presented in Table 4. The results and
accompanying statistics for 1992 are available in Table 5. The
catch numbers at age, mean weights at age and catch weight at age
for the entire time series are presented in Tables 6, 7 and 8
respectively.

The age structure from the Canadian fishery (almost
entirely in Div. 3O) has been remarkably stable over the time
series (Table 6) ranging from age 5 to age 16 with the bulk of
the catch coming from within the age 9-12 category. There appears
to be some slight increase in the younger ages in the more recent
years, however, the reason for this is not readily apparent. A
possible reason is that historically the fishery occurred
primarily in winter-spring on pre-spawning concentrations where
one may expect larger fish whereas more recently the fishery is
spread throughout the year probably over a wider range of sizes.
According to Table 7 there does not appear to be any observable
change in growth patterns to suggest changes in partial
recruitment at age.

Research Vessel Surveys

Stratified-random research vessel surveys have been carried
out by Canada on the Grand Bank (including Div. 3NO) during
spring since 1971 although during the early period coverage was
limited and, in fact, for most years did not cover what may be
considered an adequate depth range (survey maximum equal to 200
fathoms or 366 meters) to fully represent the distribution of
witch flounder. Since 1990, on the other hand, depth coverage was
extended to 400 fathoms or 720 meters which should be more
representative but still not cover the entire range of depth
distribution as observed in other areas in recent years. In
addition to spring surveys, a time series of fall surveys was
instituted in 1990 for seasonal comparisons. Mean weights (kg)
per set including total biomass estimates and confidence limits
as well as biomass estimates by stratum for the spring surveys
are presented in Tables 9 and 10 for Div. 3N and Tables 11 and 12
for Div. 3O respectively. A plot of the divisional biomass
estimates is presented in Figure 3 for illustration.

i) Biomass Estimates

Estimated biomass in Div. 3N has been at very low
levels throughout the time period and in most years was less than
1,000 tons (Tables 9 and 10; Fig. 3). For Div. 3O estimates of
biomass showed considerable annual fluctuations, on average
between 6,000 and 12,000 tons particularly in the late 1980's and
are considered to be related to distributional differences

(Tables 11 and 12; Fig. 3). Nevertheless, the estimates
illustrate a sharp decline in the last few years with the
preliminary estimate for 1993 near the lowest observed. The most
significant observation is that despite the fact that survey
coverage during 1991-93 has been the most complete in the time
series it indicates a sharp systematic declining trend to levels
as low as anything previously experienced.

A comparison of biomass and abundance of spring versus fall
surveys is shown in Table 13. The series is too short to draw any
firm conclusions as to significant seasonal comparisons. In 1990
the fall estimate was higher than in spring whereas for 1991 and
1992 the reverse was true. The differences, however, especially
for the 1991-92 surveys were not large and put the biomass and
abundance in both instances among the lowest levels observed.

ii) Catch at Age

The age structure for the years 1984-92 from both the
spring and fall surveys in Div. 3O is shown in Table 14 and
Figure 4 (data from Div. 3N insufficient). The age structure is
quite similar to that previously described from the Canadian
commercial fishery. It is evident that the survey gear is not
very proficient at capturing young fish and in fact appears to
have much the same selection properties as the commercial gear.
Based on previous observations in other areas it is likely that
the younger age classes may not be in areas that are very
accessible to fishing operations. The fall surveys show a decline
in abundance since 1990 to the lowest level estimated although
this is not clear from the spring surveys. Considering that there
was a significant commercial fishery between the spring of 1992
and the fall of the same year as well as a very low estimate of
biomass in the spring of 1993 there is clearly room for concern.

iii) Geographic Distribution

In order to demonstrate the general distribution and
associated variability of witch flounder within the stock area a
series of annual plots of weight (kg) caught per set for the
period 1981-92 (spring surveys) are presented geographically in
Figure 5. In order to examine for seasonal differences in
distribution similar plots were constructed for for fall surveys
in Div. 3NO carried out during 1990-92. A cursory look at
distribution plots from the spring surveys indicates that witch
flounder is most abundant along the southwest side of the Grand
Bank primarily in Div. 3O. For most years the only significant
abundance outside the Canadian fishery zone is located in Div. 3O
although there are some caught along the eastern edge of Div.
3N. In some years the higher catches are more plentiful in over
the bank area especially in 1985 and 1988, which may explain the
unusually high biomass in those years as these high catches would
be associated with large strata. More recently, however, in 1991
and 1992 catches have been concentrated along the deeper slope
area of Div. 3O with little caught on the shallower parts of the
bank or in Div. 3N. Fall surveys (Fig. 6) show that witch
flounder are more widely distributed over the southern half of
the Grand Bank but again almost entirely in Div. 3O. Reasonable
catches in 1990 are relatively plentiful, however, catches
declined over the next two years to low levels by 1992.

Prognosis

From the information examined it would appear to be rather
clear that the level of biomass in Div. 3N has been and continues
to be quite low at least out to a depth of 720 meters. What
remains of any consequence of this witch flounder resource is
located in Div. 3O and although it cannot be concluded without
more detailed evidence, it is conceivable that the stock
component in Div. 3O is self sustaining.

In the past, the Scientific Council has been concerned that
the surveys have not extended deep enough to adequately assess
the population size of witch flounder and as a result was
reluctant to fully accept the status of the stock as suggested by
the data available. While this may very well have been a correct
approach in the past, with the more recent observations it cannot
reconcile the differences in the distribution patterns either

between the divisions or between the spring and fall in the
present analysis. The stock biomass during most of the 1980's in
Div. 30 would suggest stability in the range of 6,000 tons
assuming that the anomalously high 1985 and 1988 values are an
artifact of fish moving in over the bank occupying large strata
resulting in inflated estimates. Since 1990, however, there is
evidence of a sharp decline in biomass in Div. 30 to near the
lowest observed by the spring of 1993. This is particularly
disconcerting since the last three surveys have covered a much
more extensive depth range than any previously conducted.

Based upon the data presented here is would appear that the
foregoing assessment essentially reflects stock status in Div.
30. If the biomass trajectory of the recent period is correct it
would suggest that recent catch levels in this division may have
been somewhat higher than that which would maintain stable
biomass. It would seem prudent, therefore, that catch levels in
Division 30 probably should not exceed 2,000-2,500 tons. With
respect to Division 3N, little is known about the level of
biomass beyond depths of 720 meters although it is rather
inconceivable that it could be substantial. Some catch is taken
by Portugal as a by-catch in the redfish fishery although the
relatively small catch is more likely the result of intensive
fishing effort. Given the state of knowledge for witch flounder
in this division a by-catch fishery only may be more advisable.

References

Gavaris, S. 1980. Use of a multiplicative model to estimate
catch rate and effort from commercial data. Can. J. Fish.
Aquat. Sci. 37: 2272-2275.

Table 1 . Catches and TACs (t) of witch flounder in Div. 3NO from 1971-93.

Year	Country Canada	USSR	Other	Total	TAC
1971	178	14774	13	14965	
1972	3419	5738	20	9177	
1973	4943	1714	34	6691	
1974	2807	5235	3	8045	10000
1975	1137	5019	12	6168	10000
1976	3044	2991	-	6035	10000
1977	3013	2742	4	5759	10000
1978	1165	2275	33	3473	10000
1979	1193	1868	16	3077	7000
1980	425	1994	1	2420	7000
1981	381	2044	-	2425	5000
1982	1760	1969	3	3732	5000
1983	1674	1942	-	3616	5000
1984	834	1955	13	2802	5000
1985	2746	1908	4117	8771	5000
1986	2937	1724	4470	9131	5000
1987	2829	1425	3342	7596	5000
1988	1927	1037	4361	7325	5000
1989	1241	81	2366	3688	5000
1990*	2670	9	1411	4090	5000
1991*	2624	-	2223	4847	5000
1992*	4316	-	b600	4916	5000
1993	-	-	-	-	5000

*Provisional data.
bEstimated

TABLE [2]. ANOVA RESULTS AND REGRESSION COEFFICIENTS FROM A MULTIPLICATIVE MODEL TO DERIVE A STANDARDIZED CATCH RATE SERIES FOR WITCH IN NAFO DIV. 3NO. (1990-1992 BASED ON PRELIMINARY DATA)

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R............. 0.812
MULTIPLE R SQUARED..... 0.659

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	1.392E2	1.392E2	
REGRESSION	25	1.190E1	4.760E-1	6.174
Country|Gear|TC (1)	1	1.166E-1	1.166E-1	1.513 (NS)
Month (2)	7	1.605E0	2.293E-1	2.974
Division (3)	1	1.695E-1	1.695E-1	2.199 (NS)
Year (4)	16	1.027E1	6.417E-1	8.323
RESIDUALS	80	6.168E0	7.710E-2	
TOTAL	106	1.572E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
CGT	3125	INTERCEPT	-1.183	0.114	106
MONTH	4				
DIVISION	35				
YEAR	74				
1	3124	1	-0.096	0.078	20
2	1	2	-0.034	0.147	5
	2	3	0.030	0.089	19
	3	4	0.091	0.079	26
	5	5	-0.059	0.102	12
	10	6	-0.379	0.152	5
	11	7	-0.447	0.146	5
	12	8	-0.192	0.136	6
3	34	9	0.128	0.087	20
4	75	10	-0.122	0.159	6
	76	11	-0.256	0.132	10
	77	12	0.097	0.135	9
	78	13	-0.344	0.151	6
	81	14	0.038	0.225	2
	82	15	0.829	0.176	4
	83	16	0.136	0.141	8
	84	17	-0.140	0.191	3
	85	18	0.495	0.147	7
	86	19	0.314	0.138	8
	87	20	0.215	0.161	5
	88	21	-0.170	0.151	6
	89	22	0.082	0.160	5
	90	23	0.696	0.159	6
	91	24	-0.493	0.152	6
	92	25	-0.112	0.153	6

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1974	-1.1835	0.0131	0.316	0.036	2807	8874
1975	-1.3057	0.0180	0.279	0.038	1137	4072
1976	-1.4392	0.0130	0.245	0.028	3044	12427
1977	-1.0864	0.0130	0.349	0.040	3013	8644
1978	-1.5270	0.0157	0.224	0.028	1165	5200
1981	-1.1455	0.0420	0.324	0.066	381	1177
1982	-0.3543	0.0222	0.721	0.108	1760	2440
1983	-1.0470	0.0133	0.362	0.042	1674	4618
1984	-1.3234	0.0317	0.272	0.048	834	3061
1985	-0.6887	0.0151	0.518	0.064	2746	5299
1986	-0.8695	0.0140	0.433	0.051	2937	6787
1987	-0.9687	0.0184	0.391	0.053	2829	7235
1988	-1.3537	0.0159	0.266	0.034	1927	7233
1989	-1.1011	0.0193	0.342	0.048	1241	3624
1990	-0.4875	0.0184	0.633	0.086	2670	4220
1991	-1.6765	0.0165	0.193	0.025	2624	13606
1992	-1.2953	0.0169	0.282	0.037	4316	15289

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.135

LEGEND FOR ANOVA TABLE:

CGT CODE
3124 = Newfoundland TC 4 Bottom Trawl
3125 = Newfoundland TC 5 Bottom Trawl
DIVISION CODE
   34 = Division 3N
   35 = Division 3O

Table 3 . Breakdown of Canadian catches (t) by division, month, and gear of witch in Div. 3NØ, 1992.

Month	3N		3Ø		Total
	O.T.	SS+DS	O.T.	SS+DS	
Jan.	-	-	1	-	1
Feb.	-	-	158	-	158
Mar.	8	-	1340	32	1380
Apr.	-	-	645	219	864
May	-	-	35	25	60
June	1	-	287	41	329
July	1	-	265	25	291
Aug.	3	-	118	2	123
Sept.	4	-	79	3	86
Oct.	1	-	74	32	107
Nov.	1	-	113	36	150
Dec.	-	-	700	67	767
Total	19	-	3815	482	4316

Tables 4 . Samples used to calculate catch & weights at age for witch in the Canadian fishery in Div. 3NØ, 1992.

Age	Length	Key	Length Frequencey	Catch(tons)	Description
Q1	3Ø	(593)	OT, Feb., 3Ø (728)	159	OT, 3Ø, Jan.-Feb.
			OT, Mar., 3Ø (2342)	1348	OT, 3NØ, March
			SC, Mar., 3Ø (330)	32	Seine,3Ø, March
Q2	3Ø	(545)	OT, Apr., 3Ø (1327)	645	OT, 3Ø, April
			DS, Apr., 3Ø (324)	219	Seine 3Ø, April
			SS, Apr., 3Ø (309)		
			OT, May, 3Ø (320)	60	OT, Seine, 3NØ, May
			OT, June, 3Ø, (1254)	329	OT, Seine, 3NØ, June
Q3	3Ø	(296)	OT, July, 3Ø, (1066)	291	OT,Seine, 3NØ, July
			OT, Aug., 3Ø (331)	123	OT,Seine, 3NØ, Aug.
			OT, Sept., 3Ø (307)	86	OT, Seine, 3NØ, Sept.
Q4	3Ø	(464)	OT, Oct., 3Ø (391)	75	OT, 3NØ,Oct.
			DS, Oct., 3Ø (324)	32	Seine, 3NØ, Oct.
			SS, Oct., 3Ø (370)		
			OT, Nov., 3Ø, (656)	150	OT, Seine, 3NØ, Nov.
			OT, Dec., 3Ø, (1445)	767	OT, Seine, 3Ø, Dec.

Table 5.

	AGE	AVERAGE		CATCH		
		WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
	★ 4	0.043	21.685	2	1.12	0.48
	★ 5	0.071	24.853	7	1.82	0.27
	★ 6	0.163	31.238	36	7.10	0.20
	★ 7	0.234	34.516	334	29.52	0.09
	8	0.300	37.026	973	55.33	0.06
	9	0.380	39.488	1314	66.40	0.05
	10	0.489	42.324	1464	72.32	0.05
	11	0.605	44.924	1985	82.03	0.04
	★12	0.751	47.669	1318	66.96	0.05
	★13	0.928	50.561	491	37.67	0.08
	★14	1.213	54.453	55	9.52	0.17
	★15	1.511	57.996	5	1.80	0.38

★ TYPE NOTE FOR AN EXPLANATION

Table 6. CATCH AT AGE OF WITCH FLOUNDER IN THE CANADIAN FISHERY IN DIV. 3NO.

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
5	0	0	0	0	0	0	2	1	0	0	0	4	1	7
6	0	0	0	8	0	1	12	9	9	1	0	19	17	36
7	8	5	0	43	7	9	67	66	72	35	15	109	54	334
8	46	22	10	393	93	88	337	464	421	222	124	398	394	973
9	199	97	31	558	487	246	938	1184	1174	679	334	858	721	1314
10	516	228	95	922	791	387	1254	1513	1270	1056	514	1115	717	1464
11	664	177	149	630	740	431	1255	1231	1389	1079	650	1199	1324	1985
12	280	35	143	431	452	183	960	649	755	457	468	969	1143	1318
13	81	10	109	293	74	38	222	122	129	105	138	285	374	491
14	24	0	29	55	17	5	36	10	7	15	10	31	32	55
15	0	0	0	11	4	0	0	0	0	0	0	4	0	5
16	0	0	0	2	2	0	0	0	0	0	0	0	0	0
5+	1818	574	566	3346	2667	1388	5083	5249	5226	3649	2253	4991	4777	7982

Table 7. WEIGHT AT AGE OF WITCH FLOUNDER IN THE CANADIAN FISHERY IN DIV. 3NO.

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
5	0.000	0.000	0.000	0.000	0.000	0.000	0.090	0.115	0.000	0.000	0.000	0.135	0.049	0.071
6	0.000	0.000	0.000	0.216	0.000	0.166	0.133	0.160	0.147	0.185	0.000	0.164	0.143	0.163
7	0.187	0.249	0.000	0.240	0.228	0.248	0.209	0.230	0.212	0.231	0.208	0.213	0.170	0.234
8	0.272	0.332	0.267	0.359	0.345	0.343	0.293	0.330	0.299	0.323	0.280	0.296	0.250	0.300
9	0.345	0.445	0.315	0.422	0.431	0.444	0.390	0.425	0.409	0.402	0.378	0.385	0.344	0.380
10	0.498	0.662	0.423	0.517	0.526	0.547	0.479	0.533	0.501	0.494	0.466	0.477	0.424	0.489
11	0.717	0.905	0.531	0.613	0.706	0.670	0.610	0.664	0.628	0.594	0.570	0.580	0.563	0.605
12	0.903	1.264	0.716	0.717	0.920	0.830	0.763	0.839	0.805	0.741	0.703	0.704	0.729	0.751
13	1.141	1.485	0.883	0.804	1.170	1.051	1.006	0.992	1.011	0.958	0.904	0.873	0.937	0.928
14	1.239	1.752	1.136	1.067	1.328	1.229	1.189	1.289	1.214	1.153	1.318	1.180	1.182	1.213
15	1.434	0.000	0.000	1.342	1.499	1.552	0.000	0.000	0.000	0.000	0.000	1.427	1.971	1.511
16	0.000	0.000	0.000	1.752	1.916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 8. CATCH WEIGHT (T) AT AGE OF WITCH FLOUNDER IN THE CANADIAN FISHERY IN DIV. 3NO.

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
5	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6	0	0	0	2	0	0	2	1	1	0	0	3	2	6
7	1	1	0	10	2	2	14	15	15	8	3	23	9	78
8	13	7	3	141	32	30	99	153	126	72	35	118	98	292
9	69	43	10	235	210	109	366	503	480	273	126	330	248	499
10	257	151	40	477	416	212	601	806	636	522	240	532	304	716
11	476	160	79	386	522	289	766	817	872	641	370	695	745	1201
12	253	44	102	309	416	152	732	545	608	339	329	682	833	990
13	92	15	96	236	87	40	223	121	130	101	125	249	350	456
14	30	0	33	59	23	6	43	13	8	17	13	37	38	67
15	0	0	0	15	6	0	0	0	0	0	0	6	0	8
16	0	0	0	4	4	0	0	0	0	0	0	0	0	0
5+	1191	422	363	1873	1717	840	2845	2975	2878	1972	1241	2676	2629	4312

Table 9. Average weight per set of witch flounder in NAFO Division 3N from research vessel surveys from 1971-92.

Stratum	ATC 187 1971	ATC 199 1972	ATC 208-9 1973	ATC 222 1974	ATC 233 1975	ATC 245 1976	ATC 263 1977	ATC 277 1978	ATC 289 1979	ATC 304 1980	ATC 327-329 1982	AN 27 1984	AN 43 WT 29 1985	WT 47 1986	WT 58 WT 59 1987	WT 70 1988	WT 82 1989
357	-	-	1.20(2)	-	-	-	7.26(2)	-	6.50(3)	2.05(3)	8.50(2)	0.30(2)	4.25(2)	5.40(2)	7.00(1)	0.25(2)	1.00(2)
358	-	2.95(4)	2.42(3)	-	-	-	6.02(2)	-	1.13(2)	0.27(3)	2.50(2)	1.25(2)	11.0(2)	1.20(2)	4.50(2)	0.75(2)	0.50(2)
359	-	8.47(3)	20.88(3)	-	-	43.28(3)	1.82(2)	-	2.72(4)	1.38(4)	6.00(2)	4.25(2)	1.1(2)	1.90(2)	0.88(2)	4.00(2)	4.20(2)
360	-	0.11(4)	-	-	0.0(4)	1.36(4)	0.45(3)	2.61(4)	3.23(9)	1.18(11)	5.86(7)	5.07(7)	0.27(16)	1.80(13)	1.63(15)	4.00(12)	0.66(6)
361	0.0(2)	0.0(3)	0.0(4)	0.0(4)	1.46(4)	0.0(5)	0.0(5)	0.0(4)	0.14(8)	0.50(7)	0.17(6)	0.60(5)	0.0(7)	0.00(10)	0.25(8)	0.26(7)	0.00(10)
362	1.82(2)	0.0(4)	0.0(5)	0.0(4)	0.0(3)	0.0(5)	0.0(4)	0.0(3)	0.08(12)	0.14(11)	0.00(8)	0.00(7)	0.23(11)	0.20(14)	0.00(13)	0.51(10)	0.01(8)
373	0.0(4)	0.0(4)	0.0(4)	0.0(4)			0.0(3)	0.31(4)	0.08(11)	0.0(8)	0.00(5)	0.00(3)	0.0(9)	0.00(14)	0.00(13)	0.00(10)	0.00(10)
374	0.0(2)	0.0(2)	0.0(4)	0.0(2)	0.0(2)		0.0(4)	0.0(4)	0.0(4)	0.0(3)	0.00(4)	0.00(5)	0.0(4)	0.00(6)	0.00(5)	0.00(5)	0.0(5)
375	0.30(3)	0.0(3)	0.0(3)	0.0(3)	0.0(3)		0.0(3)	0.09(5)	0.0(5)	0.0(4)	0.00(5)	0.00(4)	0.0(8)	0.00(8)	0.00(8)	0.00(6)	0.0(8)
376	1.13(2)	0.0(2)	0.0(3)	0.0(3)	0.0(2)	0.0(3)	13.17(2)	0.0(2)	0.0(4)	0.0(3)	0.00(7)	0.75(2)	0.0(7)	0.00(9)	0.06(8)	0.00(6)	0.0(8)
377	0.45(2)	0.0(2)	0.0(2)	1.13(3)	0.0(2)		4.81(2)	11.81(2)	1.29(3)	2.51(4)	0.00(2)	1.25(2)	0.0(2)	0.00(2)	5.00(2)	0.20(2)	2.50(2)
378	0.0(3)	0.45(2)	1.36(2)	2.88(3)			14.30(2)	4.77(2)	7.57(3)	2.50(2)	2.00(2)	2.40(2)	1.13(2)	1.70(2)	8.75(2)	1.35(2)	1.00(2)
379	0.68(2)	-	0.68(2)	1.82(2)			6.81(2)		5.60(3)	2.80(3)	1.50(2)	0.25(2)	0.9(2)	1.80(2)	11.00(2)	2.70(2)	1.40(2)
380	-	5.56(2)	2.12(3)	1.99(4)			5.45(2)	11.35(3)	4.20(2)	1.33(3)		1.25(2)	3.25(2)	0.00(3)	9.50(2)	2.00(2)	0.50(2)
381	-	0.91(4)	0.0(3)	0.0(3)	1.08(2)		0.61(3)	0.0(3)	2.57(3)	1.25(4)	1.00(2)	1.25(2)	0.3(2)	1.50(3)	4.00(2)	2.75(2)	0.00(2)
382	-	0.0(4)	0.0(3)	0.0(2)		0.0(2)	0.0(3)	0.0(3)	0.0(3)	0.81(4)	0.00(2)	0.00(3)	0.0(4)	0.00(4)	0.13(3)	0.00(2)	0.00(3)
383	-	0.0(2)	0.0(2)			0.0(3)			0.0(3)	0.00(4)	0.00(2)	0.00(3)	0.67(3)	0.00(4)	0.42(3)	0.00(3)	0.00(3)
723	-																
724	-																
725	-																
726	-																
727	-																
728	-																
Biomass (t)	432	409	754	78	218	1674	768	973	1165	569	1166	1439	462	639	888	1265	316
Lower limit	-3982	-499	-984	29	-123	-1305	421	-264	409	286	-974	453	-120	96	463	-567	-1040
Upper limit	4847	1316	2491	126	560	4652	1115	2211	1921	852	3306	2424	1044	1182	1313	3097	1671

Table 9.   (continued)

Stratum	WT 94-96 1990	WT 105-6 1991	WT 119-120 1992	WT 136-137* 1993
357	0.77(2)	0.00(2)	1.10(2)	2.55(2)
358	1.60(2)	0.00(2)	1.34(2)	3.83(2)
359	0.00(2)	0.00(2)	0.00(2)	0.33(2)
360	0.00(15)	0.00(12)	0.08(14)	0.41(11)
361	0.09(9)	0.00(8)	0.00(8)	0.00(7)
362	0.00(10)	0.00(10)	0.00(12)	0.00(9)
373	0.00(10)	0.00(11)	0.00(10)	0.00(9)
374	0.00(5)	0.00(5)	0.00(5)	0.15(3)
375	0.00(8)	0.00(6)	0.00(6)	0.00(6)
376	0.00(7)	0.00(7)	0.00(7)	0.00(6)
377	0.00(2)	0.00(2)	0.00(2)	0.00(2)
378	0.00(2)	0.41(3)	1.11(2)	0.00(2)
379	3.35(2)	0.21(2)	1.15(2)	0.00(2)
380	0.60(2)	0.00(2)	0.00(2)	0.00(2)
381	2.75(2)	0.00(2)	0.00(3)	0.00(2)
382	0.00(3)	0.00(2)	0.00(2)	0.00(2)
383	0.00(2)	0.00(3)	0.00(2)	0.00(3)
723	-	2.75(2)	3.71(2)	2.58(2)
724	-	12.00(2)	7.63(2)	9.95(2)
725	-	3.42(2)	1.20(1)	2.25(2)
726	-	7.08(2)	1.28(2)	2.92(2)
727	-	0.00(2)	0.28(2)	1.90(2)
728	-	4.08(2)	0.95(2)	4.89(2)
Biomass (t)	83	263	216	445.57
lower Limit	-8	-734	84	N/A
Upper Limit	174	1259	348	N/A

*Preliminary analysis.

Table 10. Estimated biomass (tons) per stratum of witch flounder from research vessel surveys in Div. 3N from 1971-92.

Stratum	Depth (fath)	Area (sq.n.m.)	Units (000s)	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1982	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993a
375	<=30	1593	120	36	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0
376		1499	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
360	31-50	2992	225	0	25	0	0	0	305	38	586	725	265	1316	1139	61	404	366	898	101	0	0	18	92
361		1853	139	0	0	0	0	203	0	63	0	19	70	24	83	0	0	21	36	0	13	0	0	0
362		2520	189	344	0	0	0	0	0	0	0	15	26	0	0	44	38	0	96	0	0	0	0	0
373		2520	189	0	0	0	0	0	0	0	59	15	0	0	0	0	0	0	0	0	0	0	0	0
374		931	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
383		674	51	34	0	0	0	0	0	0	0	0	0	0	0	34	0	21	0	0	0	0	0	0
359	51-100	421	32	0	268	660	0	0	1368	58	0	86	44	190	134	35	60	28	126	133	0	0	0	10
377		100	8	0	0	0	8	0	0	99	0	10	19	0	6	0	0	38	2	17	0	0	0	0
382		647	49	0	0	0	0	0	0	30	0	0	39	0	0	0	0	6	0	0	0	0	0	0
358	101-150	225	17	0	50	41	0	0	0	102	0	19	5	42	21	186	20	76	13	14	27	0	23	65
378		139	10	12	5	14	30	0	0	50	123	79	26	21	13	12	18	91	14	17	0	4	12	0
381		182	14	6	12	0	0	15	0	74	155	35	17	14	17	4	20	55	38	0	38	0	0	0
357	151-200	164	12	0	0	15	0	0	0	89	0	80	25	105	4	52	66	86	3	20	9	0	14	31
379		106	8	0	0	5	14	0	0	114	38	45	22	12	19	7	14	88	21	11	27	2	9	0
380		116	9	0	48	18	17	0	0	59	0	37	12	0	2	28	0	83	17	4	5	0	0	0
723	201-300	155	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	43	30
725		105	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	9	18
727		160	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	23
724	301-400	124	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112	71	93
726		72	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	13	16
728		156	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	11	57
Total Biomass (tons)				432	408	754	70	218	1673	776	972	1165	570	1166	1438	462	641	965	1265	316	118	263	226	445
Lower limit				-3282	-449	-984	29	-123	-1305	421	-264	409	286	-974	453	-120	96	463	-567	-1040	-8	-734	84	UNK
Upper limit				4847	1316	2491	126	560	4652	1115	2211	1921	852	3306	2424	1044	1182	1313	3097	1671	174	1259	348	UNK

Table 11. Average weight per set of witch flounder in NAFO Division 30 from research vessels surveys from 1973-92.

Stratum	ATC 207, 208, 209 1973	ATC 233 1975	ATC 245 1976	ATC 263 1977	ATC 277 1978	ATC 291 1979	ATC 303 1980	ATC 318-319 1981	ATC 327-329 1982	AN 27 1984	AN 43 1985	WT 47 1986	WT 58-59 1987	WT 70 1988	WT 82 1989	WT 94-96 1990
329	0.0(2)	-	29.96(2)	1.36(3)	0.96(5)	0.04(6)	0.0(2)	0.0(2)	0.0(6)	0.0(5)	0.0(8)	0.00(8)	0.00(9)	3.29(7)	0.24(9)	0.12(7)
330	0.15(6)	0.15(3)	0.0(3)	0.0(3)	0.42(6)	1.62(7)	0.0(2)	1.13(4)	0.0(7)	0.0(4)	0.0(10)	0.00(9)	0.00(11)	0.08(9)	0.00(11)	0.00(10)
331	0.0(2)	0.0(2)	0.0(2)	-	6.14(2)	0.76(3)	6.25(2)	-	0.07(4)	28.83(3)	5.5(3)	0.50(4)	0.03(2)	6.50(2)	0.00(2)	-
332	-	3.40(2)	12.41(3)	9.69(3)	10.76(3)	0.40(4)	15.50(2)	-	72.75(4)	19.0(2)	61.5(5)	15.50(6)	22.96(5)	40.48(4)	10.35(5)	29.52(5)
333	-	0.68(2)	1.59(2)	0.23(2)	1.51(3)	0.34(2)	3.25(2)	-	19.38(4)	0.40(2)	2.38(2)	0.30(3)	0.00(2)	2.95(2)	0.40(2)	5.88(2)
334	-	-	1.36(2)	0.11(2)	1.36(3)	0.38(3)	1.75(2)	-	9.07(4)	0.0(2)	3.25(2)	2.50(2)	0.07(2)	0.81(2)	1.55(2)	1.85(2)
335	0.0(2)	-	4.62(3)	-	0.79(2)	0.0(2)	7.17(3)	-	2.25(2)	0.0(2)	12.15(2)	1.90(2)	0.10(2)	6.25(2)	2.50(2)	10.18(2)
336	0.61(3)	1.25(2)	15.89(2)	6.81(2)	1.59(2)	0.28(4)	12.50(2)	-	15.00(2)	0.50(2)	0.5(2)	2.00(2)	1.30(2)	2.50(2)	0.00(2)	2.42(2)
337	2.80(3)	0.68(3)	6.54(2)	3.63(2)	1.25(2)	0.0(4)	2.17(3)	-	1.67(3)	0.45(2)	29.7(5)	11.60(5)	12.57(6)	7.58(4)	12.33(5)	13.65(5)
338	13.26(5)	5.90(2)	10.74(3)	3.63(4)	0.14(5)	0.32(7)	4.40(5)	-	0.28(5)	0.70(5)	32.22(9)	5.30(9)	5.21(9)	12.13(8)	8.50(10)	1.66(8)
339	2.95(2)	0.0(2)	-	-	2.95(2)	2.42(3)	-	6.75(2)	0.45(4)	4.00(2)	0.0(3)	0.10(3)	3.40(3)	1.83(3)	0.00(3)	0.00(3)
340	-	0.0(3)	2.19(6)	0.0(3)	0.57(2)	3.15(7)	0.0(2)	0.40(3)	0.07(6)	0.13(4)	0.64(9)	0.00(8)	0.11(9)	0.00(7)	0.00(9)	0.04(9)
351	0.14(5)	0.67(4)	0.0(4)	0.32(5)	0.0(5)	0.91(11)	0.65(10)	19.50(4)	0.39(9)	2.23(6)	0.87(9)	1.60(14)	0.86(13)	3.24(10)	0.74(13)	0.33(12)
352	0.09(5)	2.83(4)	0.17(4)	0.23(5)	0.34(4)	0.87(6)	3.14(11)	-	0.61(7)	0.29(7)	3.32(11)	0.70(14)	4.34(13)	4.20(11)	2.02(13)	5.27(13)
353	18.77(3)	7.42(3)	11.80(2)	8.78(3)	11.36(3)	1.59(5)	7.50(4)	-	23.83(3)	25.00(2)	8.33(6)	7.70(7)	12.08(6)	43.70(5)	17.32(7)	10.76(6)
354	22.40(3)	-	14.07(3)	2.27(2)	-	1.19(4)	8.50(3)	0.25(2)	7.50(2)	8.00(2)	2.0(3)	17.00(3)	4.25(2)	6.50(2)	0.47(2)	3.95(2)
355	0.23(2)	2.72(2)	4.99(2)	-	-	0.45(4)	2.75(2)	1.90(2)	12.75(2)	4.00(2)	13.0(2)	2.60(2)	4.75(2)	0.15(2)	6.10(2)	6.07(2)
356	0.91(2)	-	-	-	-	0.68(2)	27.50(2)	0.85(2)	-	0.50(2)	8.75(2)	2.10(2)	2.15(2)	0.75(2)	2.90(2)	7.24(2)
717	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
718	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
719	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
720	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
721	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
722	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biomass (t)	4,899	2,609	9,025	2,808	2,760	1,425	4,309	4,240	9,187	6,014	13,735	4,675	5,996	12,175	5,237	6,031
Lower limit	1960	1125	-24552	557	572	900	-434	-5549	-5569	3800	7922	2502	3632	4795	2955	280
Upper limit	7837	4093	42602	5059	4947	1951	9051	14030	23942	8228	19549	6848	8360	19555	7519	11781

Table 11. (Continued)

Stratum	1991 WT 105-6	1992 WT 119-120	1993[a]
329	2.24(9)	0.00(8)	0.00(6)
330	0.00(11)	0.00(10)	0.00(7)
331	0.00(2)	0.00(2)	0.00(2)
332	17.68(6)	13.85(5)	2.56(4)
333	19.55(2)	2.88(2)	2.48(2)
334	1.80(2)	7.73(2)	1.14(2)
335	4.77(3)	130.03(3)	5.41(2)
336	24.93(2)	74.90(2)	4.43(2)
337	12.54(5)	4.91(4)	3.90(2)
338	0.00(10)	0.46(4)	1.08(6)
339	0.00(3)	0.00(2)	0.00(2)
340	0.00(9)	0.58(5)	0.00(6)
351	0.00(12)	0.00(10)	0.00(9)
352	0.12(14)	0.30(8)	0.18(7)
353	0.00(7)	1.50(4)	1.27(4)
354	2.08(3)	2.05(2)	13.00(2)
355	7.00(2)	1.23(2)	1.75(2)
356	3.85(2)	12.49(2)	5.10(2)
717	0.60(2)	3.73(2)	1.53(2)
718	0.68(2)	0.98(2)	3.13(2)
719	15.20(2)	88.26(2)	2.72(2)
720	15.92(2)	7.50(2)	5.43(2)
721	5.23(2)	3.13(2)	2.10(2)
722	1.13(2)	2.93(2)	7.57(2)
Biomass (t)	3,482	3,885	1,548
Lower limit	1299	1936	N\A
Upper limit	5664	5833	N\A

[a]Preliminary.

Table 12. Estimated biomass (tons) per stratum of witch flounder from research vessel surveys in Division 3O from 1973-92.

Stratum	Depth (fath)	Area (sq. n. M.)	Units (000s)	1973	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993a
330	31-50	2089	157	24	24	0	0	66	254	0	177	0	0	0	0	0	13	0	0	0	0	0
331		456	34	0	0	0	0	210	26	214	0	2	987	188	17	1	222	0	0	0	0	0
338		1898	142	1889	841	1530	517	20	46	627	0	40	100	4590	755	742	1728	1211	237	0	66	154
340		1716	129	0	0	282	0	73	406	0	52	9	17	82	0	14	0	0	5	0	75	0
351		2520	189	26	127	0	61	0	172	123	3689	74	422	165	303	163	613	140	62	0	0	0
352		2580	194	17	548	33	45	66	168	608	0	118	56	643	136	841	813	391	1021	23	58	35
353		1282	96	1806	714	1136	845	1093	153	722	0	2293	2406	802	741	1162	4205	1667	1035	0	144	122
329	51-100	1721	129	0	0	3870	176	124	5	0	0	0	0	0	0	0	425	31	16	289	0	0
332		1047	79	0	267	975	762	846	31	1218	0	5718	1493	4833	1218	1804	3181	813	2320	1390	1088	201
337		948	71	199	48	465	258	89	0	154	0	119	32	2113	825	894	539	877	971	892	349	278
339		585	44	130	0	0	0	130	106	0	296	20	176	0	4	149	80	0	0	0	0	0
354		474	36	797	0	501	81	0	42	302	9	267	285	71	605	151	231	17	141	74	73	463
333	101-150	151	11	0	8	18	3	17	4	37	0	220	5	27	3	0	33	5	67	222	33	28
336		121	9	6	11	144	62	14	3	114	0	136	5	5	18	12	23	0	22	226	680	40
355		103	8	2	21	39	0	0	3	21	15	99	31	101	20	37	1	47	47	54	10	14
334	151-200	92	7	0	0	9	1	9	3	12	0	63	0	22	17	0	6	11	13	12	53	8
335		58	4	0	0	20	0	3	0	31	0	10	0	53	8	0	27	11	44	21	566	24
356		61	5	4	0	0	0	0	3	126	4	0	2	40	10	10	3	13	33	18	57	23
717	201-300	93	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	26	11
719		76	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87	504	16
721		76	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	18	12
718	301-400	111	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	8	26
720		105	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	59	43
722		93	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	20	53
Biomass (tons)				4900	2609	9023	2809	2761	1426	4310	4241	9186	6015	13736	4681	5982	12146	5234	6033	3481	3888	1549
Lower limit				1960	1125	-24552	557	572	900	-434	-5549	-5569	3800	7922	2502	3632	4795	2965	280	1299	1936	UNK
Upper limit				7837	4093	42602	5059	4947	1951	9051	14030	23942	8228	19549	6848	8360	19556	7519	11781	5664	5833	UNK

Table 13. Comparison of results from spring and fall research vessel surveys in 1990-92 for witch flounder in Div. 3NO.

Survey	Index	Div. 3N	Div. 3O	Total
Spring 1990a	Abundance ('000)	145	9293	9438
	Biomass (t)	83	6031	6114
Fall 1990	Abundance	489	11351	11840
	Biomass	434	8955	9389
Spring 1991	Abundance	672	5880	6552
	Biomass	263	3482	3745
Fall 1991	Abundance	957	3212	4169
	Biomass	777	2106	2883
Spring 1992	Abundance	501	6982	7483
	Biomass	216	3885	4101
Fall 1992	Abundance	1700	6026	7726
	Biomass	1267	3536	4803
aNo strata deeper than 200 fm surveyed.				

Table 14. Mean number per set of witch flounder, by age, from Canadian research vessel surveys in Div. 3O during 1984-92 (S=spring, F=fall).

| Age	1984	1985	1986	1987	1988	1989	1990 (S)	1990 (F)	1991 (S)	1991 (F)	1992 (S)	1992 (F)
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	0.04	-	-	-	-	-
3	-	-	-	-	0.01	-	-	0.01	-	-	-	-
4	-	0.01	0.02	-	-	-	-	-	-	-	-	-
5	-	0.10	0.01	0.01	0.01	-	-	0.01	0.02	0.01	0.04	-
6	0.06	0.08	0.06	0.07	0.02	-	0.01	0.01	0.06	0.01	0.04	0.03
7	0.12	1.22	0.26	0.22	0.12	0.02	0.19	0.11	0.16	0.07	0.19	0.27
8	0.94	5.88	0.66	0.60	0.97	0.07	0.56	0.44	0.36	0.26	0.56	0.74
9	1.59	5.44	1.09	1.59	1.85	0.25	0.67	0.89	0.45	0.29	0.88	1.04
10	1.70	2.58	0.90	1.60	2.93	0.59	1.13	1.66	0.69	0.41	1.05	0.80
11	2.51	0.47	1.00	1.23	4.48	1.39	1.94	2.34	1.24	0.75	1.13	1.00
12	1.14	0.04	0.52	0.96	3.52	1.89	1.64	1.81	0.88	0.51	0.76	0.49
13	0.26	-	0.13	0.25	1.19	1.00	0.81	1.06	0.32	0.05	0.33	0.07
14	0.16	-	0.01	-	0.11	0.18	0.11	0.10	0.08	-	0.01	0.06
15	-	-	-	-	-	0.02	-	-	-	-	-	-
Total	8.48	15.82	4.66	6.43	15.21	5.41	7.10	8.44	4.26	2.35	5.04	1.70
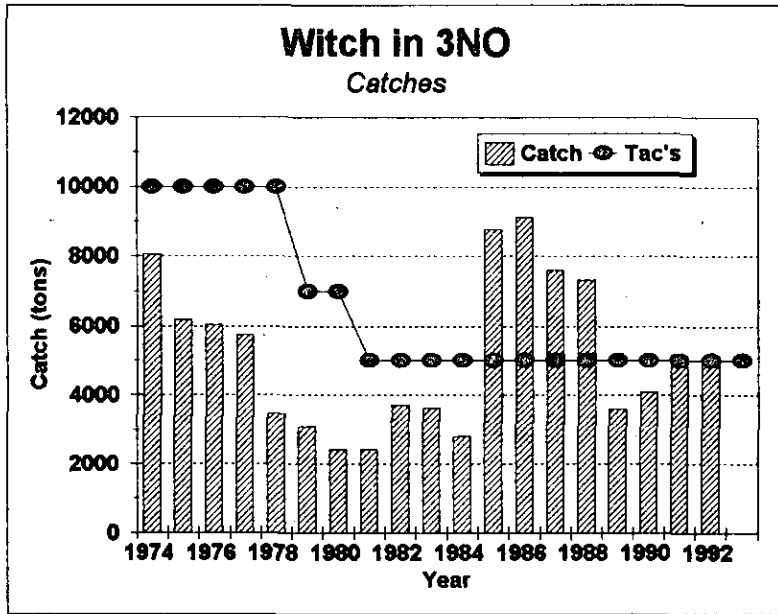
Fig. 1. Commercial catches of witch flounder in Div. 3NO from 1974-92 and TAC's 1974-93. The catch in recent years includes estimates of those non-reported.
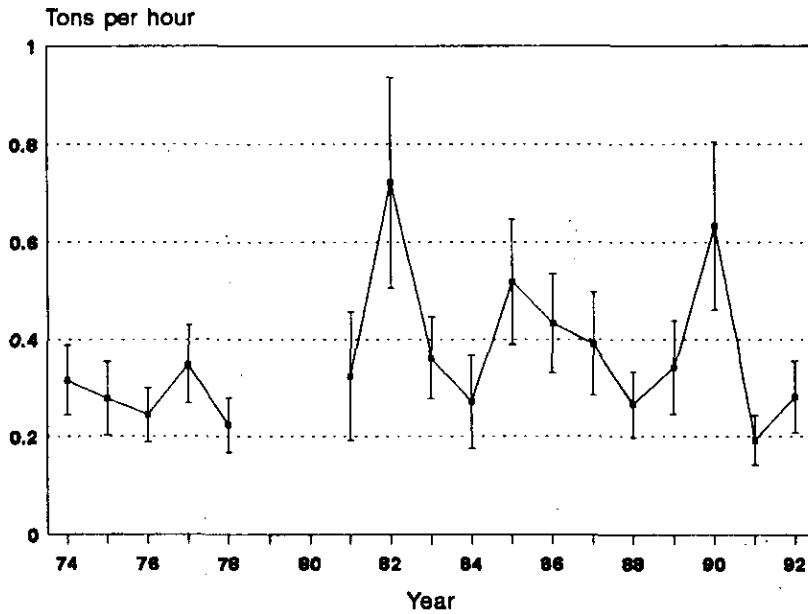

Fig. 2. Standardized CPUE with approximate 95% confidence intervals for Witch flounder in Div. 3NO from 1974-1992.
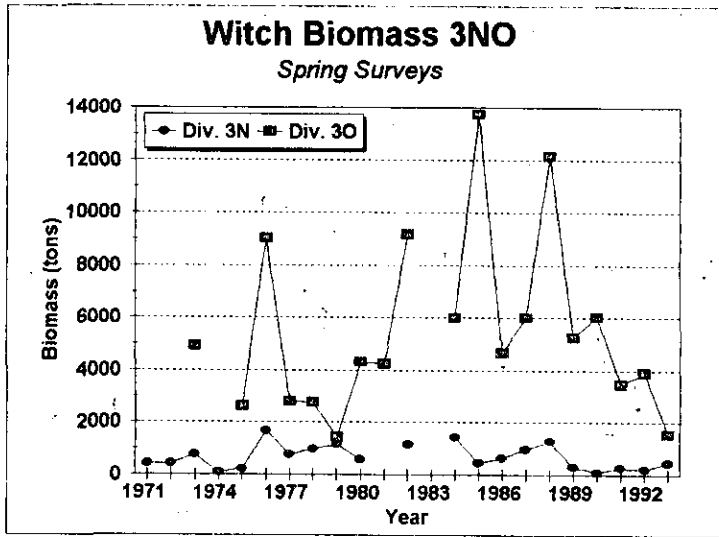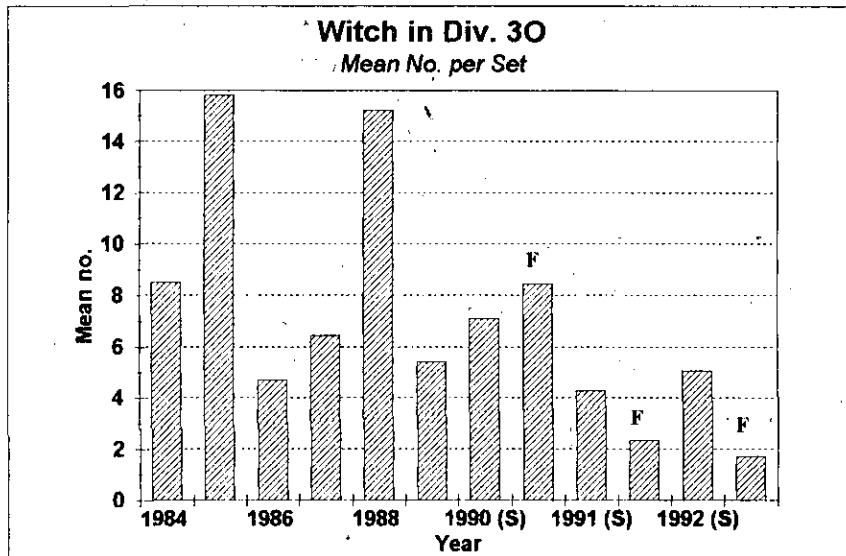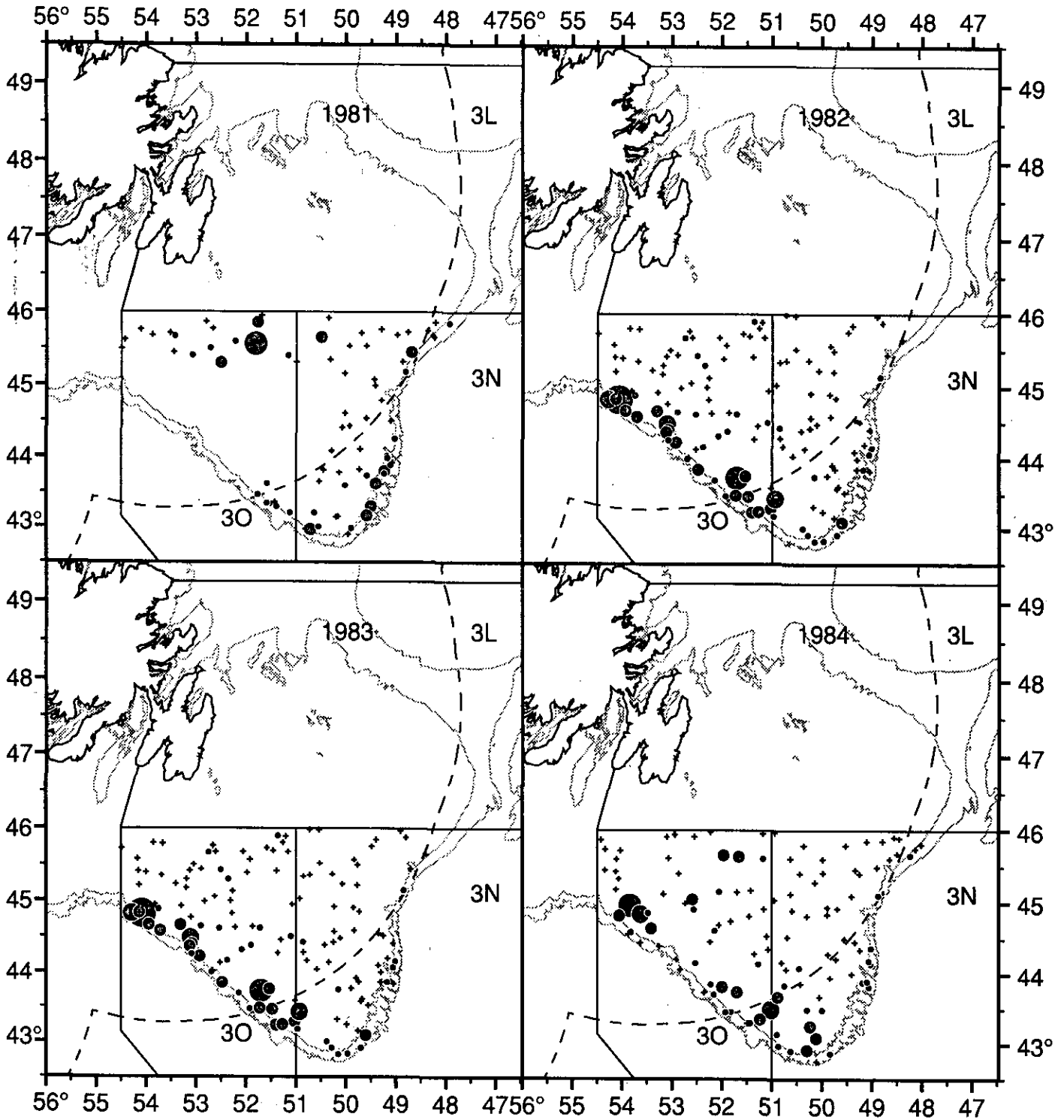
Witch Biomass 3NO
Spring Surveys

Fig. 3 Biomass estimates of witch flounder in Div. 3NO
from Canadian spring surveys during 1971-93.

Witch in Div. 3O
Mean No. per Set

Fig. 4 Mean number of fish caught per set of witch flounder from Canadian
research vessel surveys in Div. 3O during 1984-92 (S=spring, F=fall).

Figure 5   Distribution of witch flounder catches (kg/tow) from Canadian
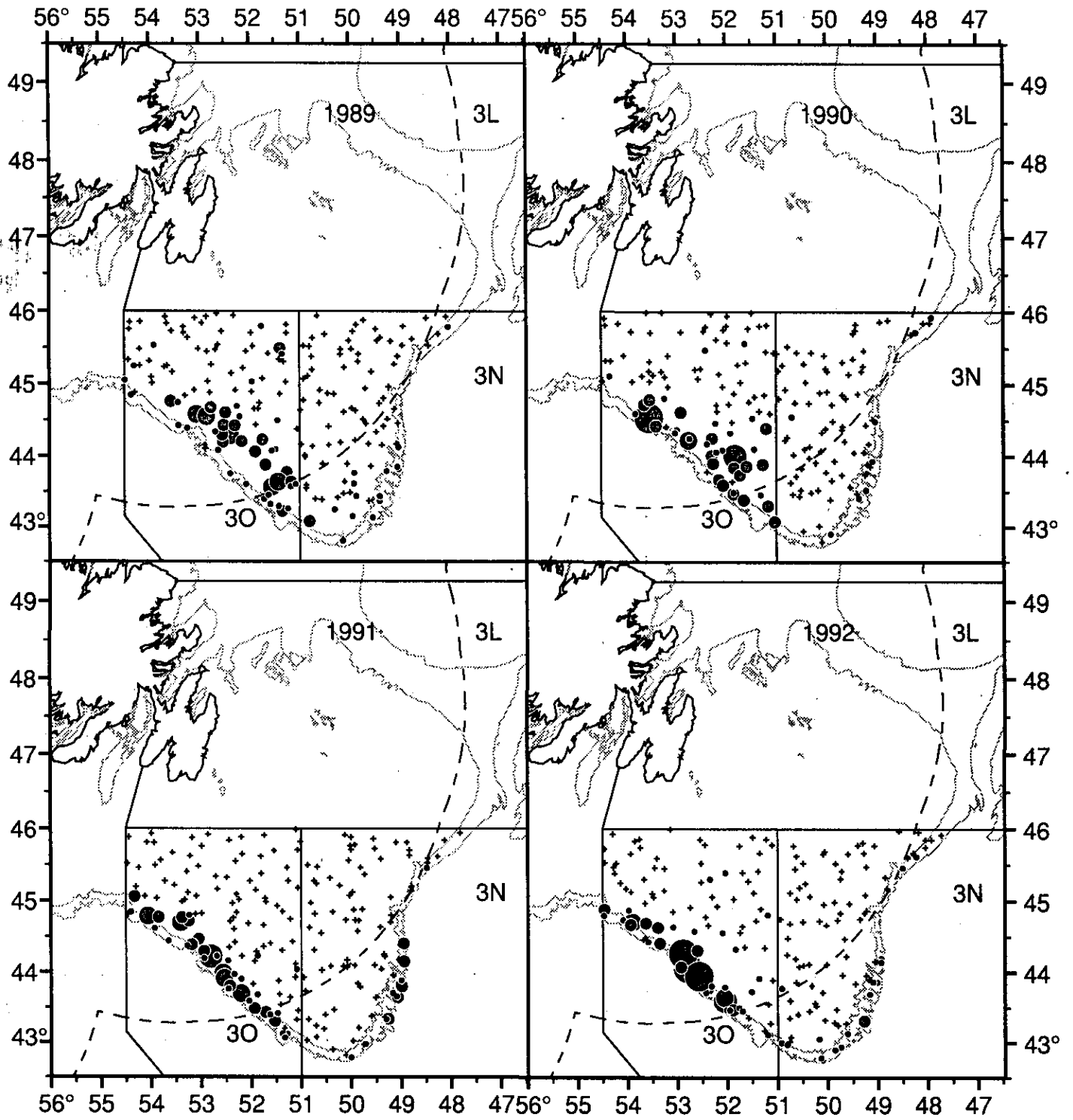stratified random bottom trawl surveys conducted during spring.

— 0.1
— 5
— 25
— 50
— 100+

+ 0
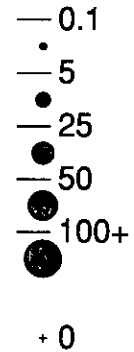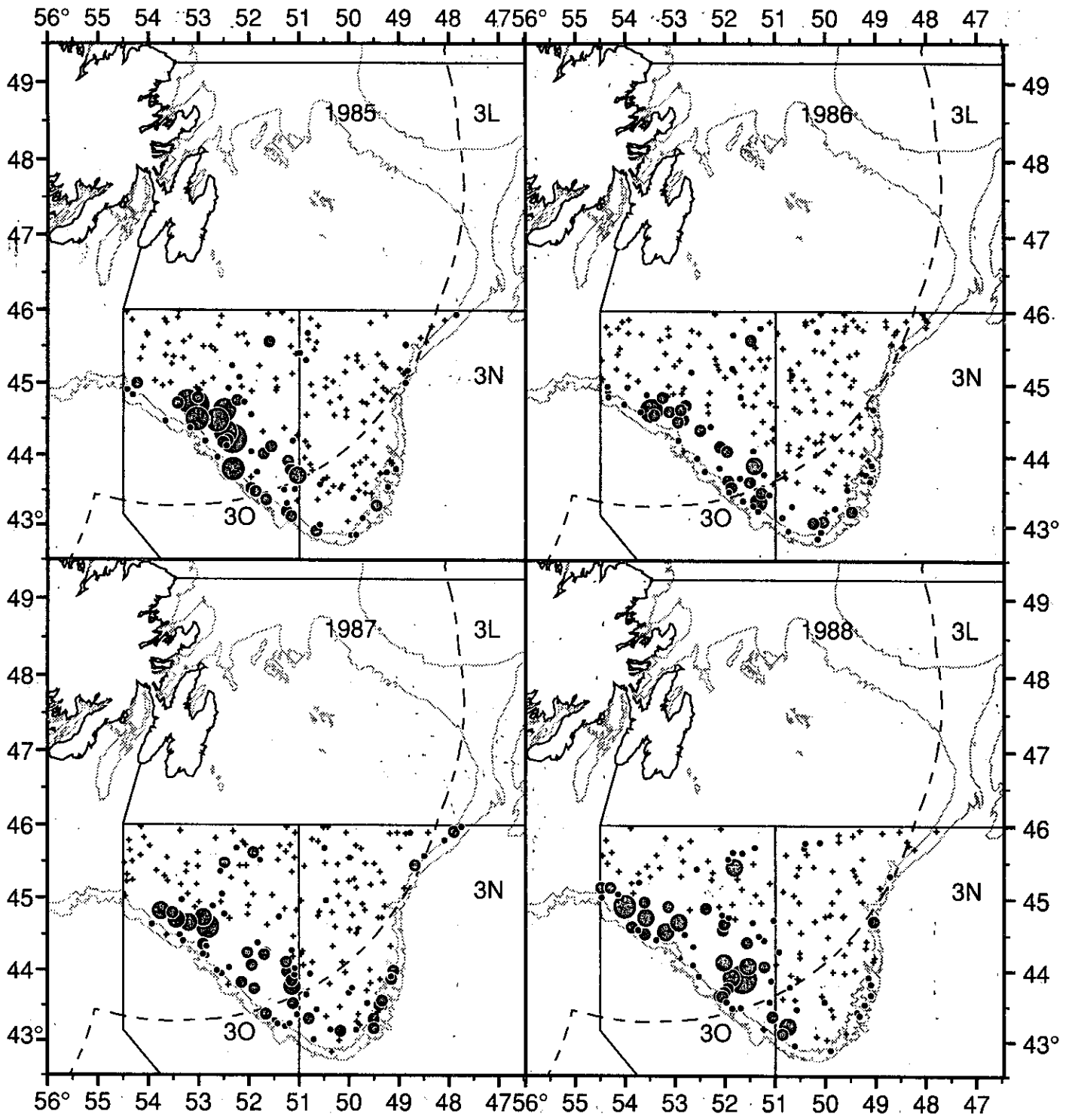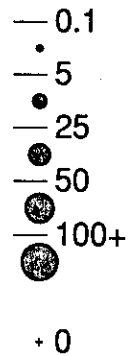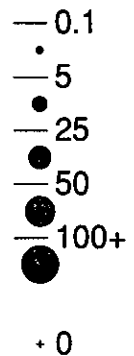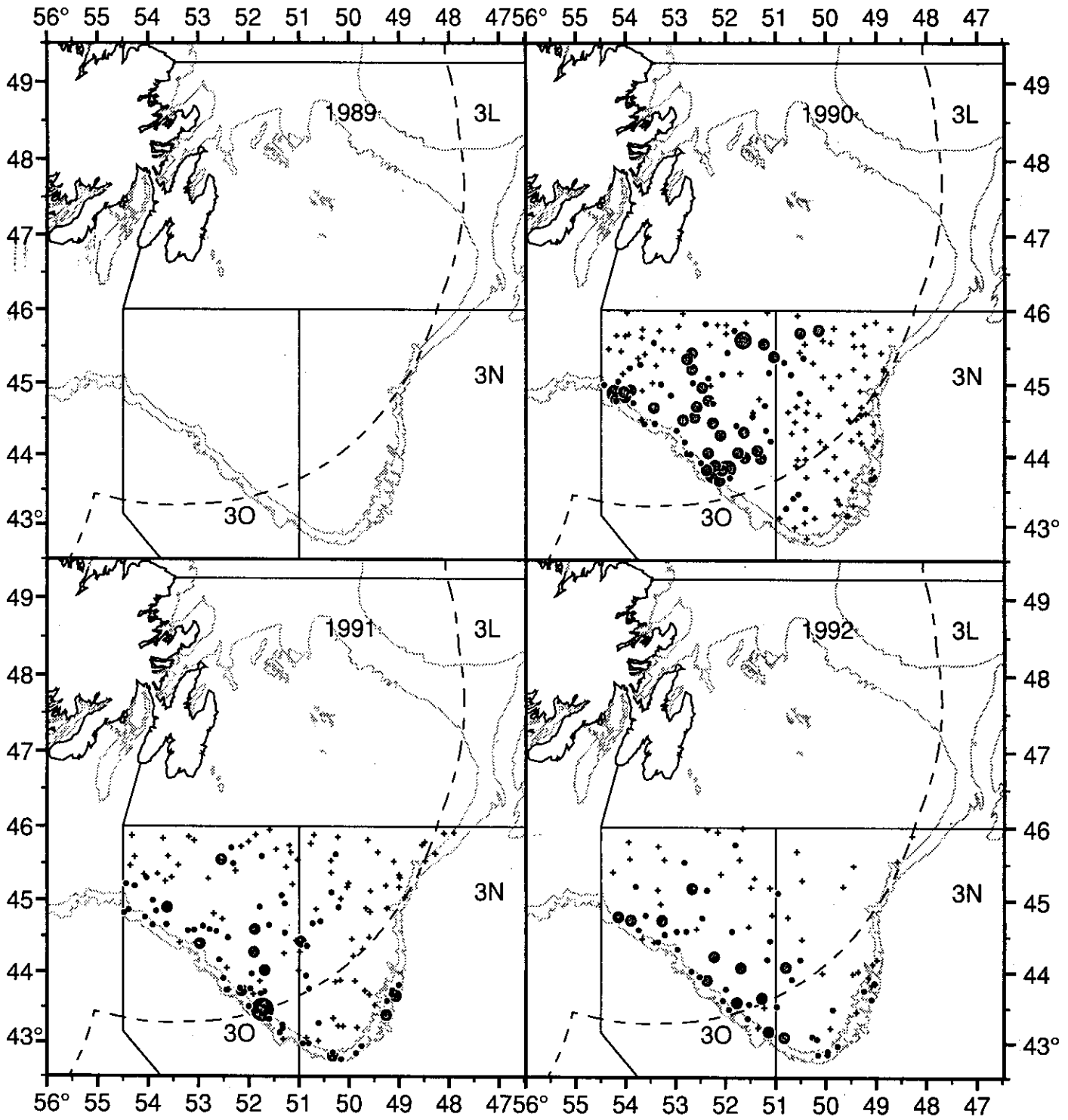
Figure 5   Continued.

Figure 5 : Continued.

Figure 6   Distribution of witch flounder catches (kg/tow) in NAFO Div. 3NO
from Canadian fall stratified random surveys.