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Witch Flounder Population Trends in NAFO Divisions 2J, 3K and 3L

by

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Abstract

Canadian fall surveys since the late 1970's indicated that witch flounder were widely distributed throughout the shelf area in deeper channels around the fishing banks primarily in Div. 3K. By the mid 1980's they were rapidly disappearing and by the early 1990's had virtually disappeared from the area entirely except for some very small catches along the slope in Division 3L. The fall 1998-2006 surveys indicate no change in this distribution pattern. For the three divisions combined, the biomass index declined from about 65,000 tons in 1984 to 1100 tons in 1995, by far the lowest in the time series. Mean weight per tow decreased from a maximum of near 6 kg/tow in 1984 to a low of 0.23 kg/tow in 1995. The small increase in biomass index and mean weight per tow observed between 1995 and 1996 was almost exclusively a result of inclusion of the deeper strata surveyed in Division 3L. The estimates have remained the same since then. The stock size remains extremely low.

Fisheries and management

The fishery for witch in this area began in the early 1960's and increased steadily from about 1,000 t in 1963 to a peak of over 24,000 t in 1973 (Table 1; Fig. 1). Catches declined rapidly to 2,800 t by 1980 and subsequently fluctuated between 3,000 and 4,500 t to 1991. The catch in 1992 declined to about 2,700 t, the lowest since 1964, and further declined to around 400 t by 1993 (Table 1). Until the late 1980's, the fishery was conducted by Poland, USSR and Canada (Table 1) mainly in Div. 3K (Fig. 1). More recently, the regulated fishery has been mainly Canadian although EU (Portugal and Spain) has taken increased catches in the NAFO Regulatory area of Div. 3L since the mid-1980's. Although only 12 t were reported for 1994, a catch of 491 t was indicated for Spain in the Spanish Research Report (SCS Doc. 95/15) for the Regulatory Area of Div. 3L. In 1995 and 1996 total catches were estimated to be about 780 and 1370 tons, respectively. However, it is believed that these catches could be overestimated by 15-20% because of misreported Greenland halibut. The catches in 1997 and 1998 were estimated to be about 850 and 1100 tons, respectively most of which was reported from the NAFO Regulatory Area of Div. 3L. From 1999 to 2005 catches ranged from 155 to 830 t and in 2006 was the lowest in the time series at 84 t.

During 1988-92, the Canadian fishery was particularly successful by fishing on pre-spawning concentrations in the deep slopes of Div. 3K, especially in depths beyond 700 m. Between 1988 and 1993, however, the area fished had become increasingly smaller and substantially deeper as the resource became depleted. The fishery during the winter of 1993 was very poor with the best catch rates occurring in depths greater than 1400 m. No directed fishing by Canada has been permitted since 1994 due to the poor state of the stock.

The stock has been regulated by TAC since 1974 (first introduced by ICNAF) and managed by Canada within its zone since the introduction of the 200 mile national limit and has been under moratorium from 1995 to the present (Fig. 1). Because of the poor state of the stock, the NAFO Fisheries Commission agreed to extend the moratorium to the NAFO Regulatory Area in 1998 and has continued to 2007.

Canadian Research Vessel Surveys

Distribution

Changes in spatial distribution patterns of witch flounder over the 20 year history of the surveys from 1978-97 were presented in a previous assessment as graphical distribution maps (SCR Doc. 98/64). Survey distribution data from the late 1970's and early 1980's indicated that witch flounder were widely distributed throughout the shelf area in deeper channels around the fishing banks primarily in Div. 3K. By the mid 1980's, however, they were rapidly disappearing and by the early 1990's had virtually disappeared from the area entirely except for some very small catches along the slope and more to the southern area. Since 1998, surveys catch witch flounder mostly along the deep continental slope area, especially in Division 3L both inside and outside the Canadian 200-mile fishery zone (see Bowering 1998; 1999; 2000; 2001; 2002) and in 2005 and 2006 (Fig. 2) distributions are similarly restricted.

Biomass and Abundance Indices

Stratified-random research vessel surveys have been conducted in the fall in Div. 2J, 3K and 3L since 1977, 1978 and 1981 respectively. As indicated above, up until 1994, the surveys were conducted using an *Engel* 145' high-rise groundfish trawl whereas the 1995-2006 surveys were carried out with a much more efficient *Campelen 1800* shrimp trawl. All data presented here are now in *Campelen 1800* trawl catch equivalents for 1977-94 with the actual data for 1995-2006.

For Div. 2J, biomass estimates ranged from as high as 5,900 t in 1986 to a low of less than 200 t in 2003 and increased to almost 970 t in 2006, although the majority of the estimate results from one stratum (Tables 2 and 14; Fig. 3a). Mean weight per tow peaked at 1.82 kg/tow in 1986 and declined to 0.05 kg/tow in 2003 (Tables 11 and 15; Fig. 3b). Since then values have increased and in 2006 mean weight per tow was 0.28 kg/tow.

In Div. 3K, during 1979-85, there was a period of relative stability where most annual biomass estimates were near 50,000 t (Tables 3 and 14; Fig. 3a). Since that time estimates have declined considerably to around 400 t in 1995, the lowest in the time series. Estimates increased slightly after 1995 ranging from 500-1400 tons from 1996-2003. In 2004, the biomass estimate increased to over 2600 t, and remained at around 2900 t in 2005 and 2006, however in each of the last three surveys the majority of the estimate has been the result of high catches in one or a few strata (Table 3; Fig. 3a). Corresponding to the period of higher biomass estimates (1979-85), the mean weights per tow in Division 3K ranged from 8 to 13 kg/tow (Tables 12 and 15; Fig. 3b) and declined to a low of 0.09 kg/tow in 1995. Mean weights per tow have remained low since then and in 2002 were again at an all time low of 0.09 kg/tow. Since then estimates have increased to 0.59 kg/tow in 2006, but are still much lower than the maximum observed.

For Div. 3L, biomass estimates varied generally between 7,000 and 13,000 t from 1984 to 1990 but declined rapidly since then to a low of around 400 t in 1995 (Tables 4 and 14; Fig. 3a). In 1996 the Canadian autumn survey expanded to include deeper water strata (depths of 732-1097). In that year, half of the biomass estimate of 1,800 t was attributed to depths greater than 731 m (Table 4). Seventy percent of the 1997 estimate (1,100 t) was attributed to the deeper strata and 50% of the 1998 estimate (1,000 t) came from the deeper strata. The 1999 estimate decreased to around 800 tons with about 30% of the estimate accounted for by the new deep strata (Table 4; Fig. 3a). Little change occurred in the 2000 and 2001 surveys, however, the biomass and abundance in the deeper strata appear to have been declining since 1996 and contributed little to the survey estimates in these years (Table 4). In 2002, the increase in the estimate from 2001 (from 1000 t to 2400 t) was due almost entirely to the biomass estimate in one stratum and for 2003 was estimated to be again around 1000 tons (Table 4). In 2004, difficulties with the Canadian autumn survey resulted in incomplete coverage, particularly in the deeper strata of Div. 3L (SCR Doc. 05/34) and the biomass estimate was the lowest in the time series at 451 t. Coverage in strata greater than 731m was very limited in the 2005 survey as well, but the biomass estimate increased to 1,000 t. The biomass estimate in 2006 increased to around 2,000 t, although there were almost no witch caught in strata surveyed greater than 731m.

Mean weight per tow in Division 3L (Tables 13 and 15; Fig 3b) ranged from 2 to 2.5 kg/tow in the early part of the survey series (1984-1990). A rapid decline in mean weight per tow then resulted in the lowest observed at 0.08 kg/tow in 1995. The inclusion of deep water strata (previously not surveyed) in 1996 explains the over three-fold increase in mean weight per tow to 0.28 kg/tow. Mean weight per tow ranged from 0.10 to 0.38 kg/ tow from 1997-2005 and in 2006 was 0.33 kg/tow.

The abundance indices followed similar trends as the biomass indices and are shown in Tables 5-7 and Table 16 for Divisions 2J, 3K and 3L, respectively and illustrated in Fig. 3a by Division and in Fig. 4 and Table 16 for the divisions combined. The mean numbers per tow by Division are given in Tables 8-10 and Table 17, and are shown in Fig. 3b. The exception is in the estimate of abundance and mean number per tow for Division 3L, which both show an increase from 1999-2002 (Fig. 3b). The trend in these indices is questionable when the confidence limits are considered, however, and declined once more in 2003 and 2004. The 2005 and 2006 abundance estimates are similar to the 2004 estimates in all Divisions.

For the three divisions combined, there was a very steady and rather systematic decline in the biomass index from about 65,000 tons (nearly 6 kg/tow) in 1984 to 1100 tons (0.23 kg/tow) in 1995, the lowest in the time series (Fig. 4; Table 14). Although there has been a very slight increasing trend in recent years, this increase is less obvious in the abundance index, suggesting any increase might be due to growth of the stock rather than recruitment. The current level of stock size is extremely low.

Assessment Results

Precautionary limit reference points

In the absence of an analytical assessment for this stock, it has not been possible to calculate precautionary limit reference points directly. As a proxy for B_{lim} , 15% of the highest observed biomass estimate has been used and is calculated to be approximately 9800 t (Fig. 5). However, the highest observed biomass estimates are in the early part of the time series when the survey did not cover the entire stock area. As a result, B_{lim} may be underestimated using this method. The stock has been below this B_{lim} since 1992.

Current Status

The stock remains at an extremely low level with current indices of stock size based on survey trends at about 5% of the average of the early 1980's when the stock was considered at a reasonably healthy level.

References

- Bowering, W.R. 1998. Changes in Distribution and Trends in Stock Size of the Witch Flounder Resource in Divisions 2J, 3K and 3L. NAFO SCR Doc. 98/64, Ser. No. N3056: 16p.
- Bowering, W.R. 1999. Distribution and Abundance of Witch Flounder in Divisions 2J, 3K and 3L. NAFO SCR Doc. 99/35, Ser. No. N4093: 14p.
- Bowering, W.R. 2000. Stock status update of witch flounder in Divisions 2J, 3K and 3L. NAFO SCR Doc. 00/13.
- Bowering, W.R. 2001. An update of the Distribution and Population Trends of witch flounder in Divisions 2J, 3K and 3L. NAFO SCR Doc. 01/64, Ser. No. N4442: 14p.
- Bowering, W.R. 2002. Witch Flounder in Divisions 2J, 3K and 3L: a Stock Status Update. NAFO SCR Doc. 02/52, Ser. No. N4664: 15p.
- Healey, B.P. and K.S. Dwyer. 2005. A Simple Examination of Canadian Autumn Survey Trends in NAFO Divisions 3LNO for Greenland Halibut and American plaice: The Impact of Incomplete Survey Coverage of this Survey in 2004. NAFO SCR Doc. 05/34, Ser. No. N5117: 23p.

Table 1. Catch statistics by country of witch flounder in Divisions 2J, 3K and 3L during 1963-2006. In 1998-2001, and 2005 small portions of the "Others" catch are from Division 3M.

Year	Canada	Fed. Rep. Germany	German Dem. Rep.	Poland	USSR/ Russia	UK	Others	Total
1963	17	3	0	259	89	7	570	945
1964	103	0	0	752	164	24	1	1044
1965	128	29	0	1876	2056	58	0	4147
1966	187	9	1045	559	1868	29	0	3697
1967	901	0	332	926	1933	9	0	4101
1968	446	0	358	1990	7834	33	5	10666
1969	1355	0	546	957	9726	1	0	12585
1970	4020	0	508	3566	9934	0	2	18030
1971	8030	75	508	5404	2018	9	9	16053
1972	5520	6	648	4013	7016	225	0	17428
1973	3761	1348	2327	11802	2834	258	2031	24361
1974	1868	1082	272	5302	6917	29	493	15963
1975	1352	446	374	4583	4763	0	687	12205
1976	2081	606	110	3828	3022	3	975	10625
1977	4371	300	203	3052	392	0	0	8318
1978	1979	23	58	3490	1345	1	8	6904
1979	1392	0	22	1855	150	22	656	4097
1980	1459	0	16	1235	45	0	68	2823
1981	2661	0	32	1385	85	0	31	4194
1982	1206	0	4	1151	552	0	68	2981
1983	1483	0	50	1005	516	0	34	3088
1984	2077	0	27	1617	1000	2	85	4808
1985	1305	26	33	565	1006	-	68	3003
1986	1199	2	7	3	21	-	2684 ^a	3916
1987	854	-	56	765	1057	-	1743	4475
1988	3270	-	10	760	4	-	110	4154
1989	4059	-	4	691	5	-	147	4906
1990	3271	-	-	-	-	-	696	3967
1991	2805	-	-	-	-	1	1208	4014
1992	1736	5	-	-	-	2	954	2697
1993	343	-	-	-	-	-	59	402
1994	12	-	-	-	-	-	491 ^b	503
1995	7	-	-	-	-	-	777	784
1996	11	-	-	-	-	-	1371	1382
1997	8	-	-	-	-	-	847	855
1998	-	-	-	-	2	-	1113	1115
1999	2	-	-	-	20	-	278	300
2000	85	-	-	-	6	-	578	669
2001	161	-	-	-	31	-	605	797
2002	166	-	-	-	15	-	258	439
2003	110	-	-	-	7	-	630	747
2004	26	-	-	-	16	-	787	829
2005	42	-	-	-	2	-	111	155
2006	53	-	-	-	3	-	28	84

^aSince 1985 the "Others" category is mainly comprised of EU catches

^bSpain (SCS Doc. 95/15)

Table 4. Estimated Biomass (tons) of Witch Flounder (M+F) in each stratum from surveys in Div. 3L during fall of 1983-2006.
(Engel 145 data converted to Campelen Units for 1983-94).

Depth Range (m)	Old Stratum Area	New Stratum Area	Stratum	Year																						
				84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
30 - 56	. .	268	784																							
57 - 92	2071	2071	350	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18		
	1780	1780	363	85	0	50	0	0	0	264	33	41	0	0	0	0	0	0	0	0	0	0	0	0		
	1121	1121	371	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2460	2460	372	144	0	0	0	16	0	38	8	0	0	27	0	0	0	0	0	0	0	0	0	0		
	1120	1120	384	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	.	465	785																							
93 - 183	1519	1519	328	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	1574	1574	341	230	0	0	34	34	0	0	0	0	0	0	0	1	0	0	0	0	0	0	25	393		
	585	585	342	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		
	525	525	343	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2120	2120	348	334	0	0	0	44	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
	2114	2114	349	306	0	155	0	36	0	145	0	0	0	0	0	0	0	2	0	0	17	0	117	0		
	2817	2817	364	202	0	143	0	39	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	1041	1041	365	100	0	68	29	18	0	0	36	0	0	0	0	0	0	0	0	0	0	0	21	0		
	1320	1320	370	190	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	2356	2356	385	340	0	79	58	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	1481	1481	390	159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	.	84	786																							
	.	613	787																							
	.	261	788																							
	.	89	790																							
	.	72	793																							
	.	216	794																							
	.	98	797																							
	.	72	799																							
184 - 274	1494	1582	344	159	37	29	127	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	2	0		
	983	983	347	467	0	42	0	154	66	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0		
	1394	1394	366	186	355	307	171	110	187	27	0	7	0	0	0	0	0	0	0	0	0	6	0	0		
	961	961	369	374	570	706	320	1061	429	473	162	0	0	0	0	0	0	0	0	0	0	0	0	1		
	983	983	386	168	519	1082	1518	1750	442	218	307	875	0	0	0	0	0	0	0	0	0	0	1	0		
	821	821	389	196	133	760	250	138	21	79	0	27	0	0	38	0	0	0	11	0	0	0	0	5		
	282	282	391	0	32	0	9	0	0	0	70	22	0	0	36	0	25	0	0	0	0	0	0	0		
	.	164	795																							
184 - 366	.	72	789																					0		
	.	227	791																					5		
	.	100	798																					2		
275 - 366	1432	1432	345	4484	1227	617	3693	2099	2358	750	0	61	73	0	10	3	5	35	3	5	0	8	5	1	36	43
	865	865	346	1423	2240	3321	1201	1823	1287	1863	203	40	14	0	0	12	3	1	20	16	8	4	1	0	72	97
	334	334	368	47	29	386	23	64	144	106	39	14	0	0	22	0	0	0	0	6	0	0	0	0	3	12
	718	718	387	169	404	276	572	1775	1546	3668	159	52	32	12	63	8	2	0	5	38	4	6	0	1	17	
	361	361	388	1229	48		589	92	126	0	125	173	0	14	0	0	0	12	0	5	17	6	4	0	3	32
	145	145	392	55	13	20	50	13	0	0	0	0	0	4	0	0	0	0	0	14	0	0	0	0	0	0
	.	175	796																							
	.	81	800																							
367 - 549	186	186	729	146	127	280				48	274	246	42	131	2	151	24	0	0	1	13	33	12	0	3	32
	216	216	731	498	248					465	178	356	38	79	19		0	7	19	16	4	3	13	22	25	47
	468	468	733	328	1164					1618	2110	610	183	60	23	12	0	41	54	62	50	106	8	248	230	166
	272	272	735	367	34	1714					222	216	40	12	3	20	23	18	12	3	3	12	0	61	45	
	.	50	792																							
550 - 731	170	170	730	104	16					130	6	140	88	83	0	21	11	10	59	274	113	0	14	0	48	
	231	231	732	282	235					29	207	283	41	194	16	147	121	440	252	230	207	115	107	106	36	183
	228	228	734	30	184					168	100	11	106	49	37	127	15	149	95	47	17	79	4	0	84	
	175	175	736		268	709				355	913	90	70	20	10	261	41	135	93	415	185	1196	104	195	758	
732 - 914	.	227	737																							
	.	223	741																							
	.	348	745																							
	.	159	748																							
915 - 1097	.	221	738																							
	.	206	742																							
	.	392	746																							
	.	126	749																							
1098 - 1280	.	254	739																							
	.	211	743																							
	.	724	747																							
	.	556	750																							
1281 - 1463	.	264	740																							
	.	280	744																							
	.	229	751																							
Grand Total				13210	7881	10743	8679	9294	6606	10341	5274	3131	778	663	418	1806	1095	1906	826	968	1042	2428	1010	451	1003	1987
Biomass >731m				0	0	0	0	0	0	0	0	0	0	0	29	1002	765	1014	262	12	134	667	674	0	48	21
Percent >731m				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	55.4	69.8	53.2	31.8	1.2	12.9	27.5	66.8	0.0	4.8	1.1

Table 7. Abundance (000s) per stratum of Witch Flounder (M+F) from surveys in Div. 3L during fall of 1983-2006.
(Engel 145 data converted to Campelen Units for 1983-94).

Depth Range (m)	Old Stratum Area	New Stratum Area	Stratum	Year																									
				84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06			
30 - 56	.	268	784																74	0	0	0	0	0					
57 - 92	2071 1780 1121 2460 1120	2071 1780 363 371 372 1120 465	350 363 371 372 384 785	166 92 44 182 128	0 0 0 0 0	0 35 0 0 0	0 0 0 26 0	0 0 0 0 0	0 0 0 0 0	0 306 0 34 0	0 43 0 13 0	0 39 0 0 0	0 0 0 0 0	0 0 0 34 0	0 0 0 0 0	0 0 44 0 0	0 0 0 0 0	0 0 0 0 0	74 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 41 0 0 0					
93 - 183	1519 1574 585 525 2120 2114 2817 1041 1320 2356 1481	1519 1574 585 525 2120 2114 2817 1041 1320 2356 1481	328 341 342 343 348 349 364 365 370 385 390	52 217 0 90 292 291 271 143 233 324 136	0 0 0 0 0 162 0 55 0 122 0	0 24 0 0 58 0 32 29 30 36 0	0 27 0 0 0 0 55 0 0 25 0	0 0 0 0 0 166 32 0 0 0 0	0 0 0 0 0 0 0 48 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 42 0 43 0 0 0 0	0 0 0 0 0 0 43 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 42 0 43 0 0 0 0	0 0 0 0 0 0 43 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 125 0 0 0 0 0	0 0 0 0 0 42 0 0 0 0 0	0 0 0 0 0 148 0 48 0 0 0	0 606 0 0 0 42 0 0 0 0 0					
184 - 274	1494 983 1394 961 983 821 282	1582 983 1394 961 983 821 282	344 347 366 369 386 389 391	206 586 157 359 186 169 0	46 0 362 507 568 158 39	117 34 431 661 1082 875 0	154 0 219 330 1792 226 19	0 135 110 1348 1974 169 0	0 108 164 529 352 28 0	0 0 32 162 237 75 91	0 0 8 0 270 38 26	0 0 0 0 1262 0 0	0 0 0 39 0 0 33	0 0 0 0 0 38 0	0 0 0 0 0 0 0	0 0 38 0 0 0 19	0 0 0 0 0 0 0	0 0 0 0 0 0 0	64 0 38 0 0 301 0	0 45 0 0 0 0 0	87 0 0 0 0 80 0	131 0 77 0 0 0 0	50 0 34 0 0 38 0	0 0 32 0 0 151 0	44 0 0 39 0 0 10				
184 - 366	.	72	789																5	5	22	5	24						
275 - 366	1432 865 334 718 361 145	1432 865 334 718 361 145	345 346 368 387 388 392	6895 2380 46 165 1440 80	1488 3498 46 444 50 20	739 3927 459 247 819 20	4531 1487 23 691 149 70	2589 2427 69 2025 149 20	3180 1606 207 1679 149 0	2088 389 115 198 116 0	345 170 69 66 199 0	394 76 14 33 0 0	0 0 23 99 14 0	113 0 0 23 0 0	70 35 0 49 0 0	223 317 0 44 149 0	439 178 282 0 44 124	149 282 119 20 23 309	117 79 278 326 59 44	79 468 184 105 569 214	468 184 105 569 214	184 105 569 214	105 569 214	569 214					
367 - 549	186 216 468 272	186 216 468 272	729 731 733 735	217 877 338 661	192 371 1609 37	409 371 2320																							
550 - 731	170 231 228 175	170 231 228 175	730 732 734 736	105 365 21	23 302 267																								
732 - 914	.	227	737																										
915 - 1097	.	221	738																										
1098 - 1280	.	254	739																										
1281 - 1463	.	264	740																										
Grand Total				17914	10401	12839	10500	11269	8002	14453	7428	4748	1572	1428	1004	5297	4383	6755	2655	5361	7316	10776	6090	3990	7023	5091			
Biomass >731m				0	0	0	0	0	0	0	0	0	0	0	139	2108	1821	2337	669	67	349	1350	1890	0	125	31			
Percent >731m				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	39.8	41.6	34.6	25.2	1.2	4.8	12.5	31.0	0.0	1.8	0.6			

Table 8. Mean Numbers per Tow of Witch Flounder (M+F) in each stratum from surveys in Div. 2J during fall of 1977-2006. Engel 145 data converted to Campelen Units for 1977-94.

Depth Range (m)	Year		Year																																		
	Old Stratum Area	New Stratum Area	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06					
101 - 200	1427 1823 1594 2582 2246	633 205 1870 2264 733 778 238	201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
201 - 300	440 1608 774 1725 1171 1270 1428 508 480 448 330 384 441 567 354 288 268 180 686 420 133	621 680 1035 1583 1341 1302 2196 2196 530 487 588 251 360 450 222 229 204 288 241 158 598 414 133	202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
301 - 400	480 448 330 384 441 567 354 288 268 180 686 420 133	621 680 1035 1583 1341 1302 2196 2196 530 487 588 251 360 450 222 229 204 288 241 158 598 414 133	203	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
401 - 500	354 288 268 180 686 420 133	621 680 1035 1583 1341 1302 2196 2196 530 487 588 251 360 450 222 229 204 288 241 158 598 414 133	204	1.50	0.00	1.50	0.00	2.00	2.67	0.33	2.50	0.00	2.00	0.50	1.50	2.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
501 - 750	664 420 270 228 237 185 230 239	557 362 218 228 185 230 239	212	23.50	2.00	9.50	2.50	8.00	16.00	18.67	12.33	17.75	51.00	14.25	7.50	9.75	13.33	4.50	4.00	1.00	3.67	4.00	2.83	3.50	9.00	7.00	6.00	0.89	1.50	1.50	7.50	13.00	18.22	18.22			
751 - 1000	213 182 177 195 225 232 303	283 186 231 228 185 230 239	219	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
1001 - 1250	324 236 228 232 303	283 186 231 228 185 230 239	220	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
1251 - 1500	286 201 226 180	330 201 226 180	221	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
All strata	180	237	233	2.16	0.59	0.97	1.42	0.99	2.01	1.52	1.23	1.26	2.90	1.03	0.86	1.67	2.49	2.13	0.76	0.82	0.72	0.65	0.50	0.54	0.72	0.74	0.57	0.32	0.43	0.21	0.54	0.65	0.78				

Table 13. Mean Weight (kg) per Tow of Witch Flounder (M+F) in each stratum from surveys in Div. 3L during fall of 1983-2006. (Engel 145 data converted to Campelen Units for 1983-94).

Depth Range (m)	Old Stratum Area	New Stratum Area	Stratum	Year																						
				84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
30 - 56	.	268	784												0.00	0.00	0.00		0.02	0.00	0.00	0.00	0.00	0.00		
57 - 92	2071	2071	350	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06		
	1780	1780	363	0.35	0.00	0.20	0.00	0.00	0.00	1.08	0.13	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	1121	1121	371	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	2460	2460	372	0.43	0.00	0.00	0.00	0.05	0.00	0.11	0.02	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	1120	1120	384	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	.	465	785											0.00	0.00	0.00		0.00	0.01	0.00	0.00	0.00	0.00	0.01		
93 - 183	1519	1519	328	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	1574	1574	341	1.06	0.00	0.00	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.11	1.81		
	585	585	342	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00		
	525	525	343	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	2120	2120	348	1.14	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	2114	2114	349	1.05	0.00	0.53	0.00	0.12	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.40	0.00		
	2817	2817	364	0.52	0.00	0.37	0.00	0.10	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	1041	1041	365	0.70	0.00	0.47	0.21	0.13	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00		
	1320	1320	370	1.05	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	2356	2356	385	1.05	0.00	0.24	0.18	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	1481	1481	390	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	.	84	786												0.05	0.02	0.03		0.03	0.11	0.01	0.05	0.02	0.10		
	.	613	787												0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00		
	.	261	788												0.00	0.00	0.01		0.01	0.00	0.00	0.00	0.00	0.00		
	.	89	790												0.02	0.01	0.11		0.00	0.10	0.01	0.00	0.00	0.00		
.	72	793												0.00	0.00	0.00		0.00	0.00	0.20	0.00	0.01	0.29			
.	216	794												0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00			
.	98	797												0.01	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00			
.	72	799												0.00	0.00	0.00		0.00	0.00	0.01	0.00	0.00	0.00			
184 - 274	1494	1582	344	0.77	0.18	0.14	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00		
	983	983	347	3.45	0.00	0.31	0.00	1.14	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00		
	1394	1394	366	0.97	1.85	1.60	0.89	0.57	0.97	0.14	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00		
	961	961	369	2.83	4.31	5.34	2.42	8.02	3.25	3.58	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01		
	983	983	386	1.24	3.84	8.00	11.23	12.94	3.27	1.61	2.27	6.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	821	821	389	1.74	1.17	6.73	2.22	1.22	0.19	0.70	0.00	0.00	0.24	0.00	0.00	0.34	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.04		
	282	282	391	0.00	0.83	0.00	0.23	0.00	0.00	0.00	1.80	0.56	0.00	0.00	0.93	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
.	164	795												0.00	0.00	0.00		0.02	0.00	0.00	0.00	0.00	0.00			
184 - 366	.	72	789											0.00	0.01	0.01		0.02	0.01	0.04	0.10	0.01	0.01			
	.	227	791											0.14	0.02	0.00		0.00	0.01	0.02	0.10	0.00	0.15			
	.	100	798											0.01	0.14	1.56		0.24	1.65	0.02	0.00	0.25	0.13			
275 - 366	1432	1432	345	22.76	6.23	3.13	18.75	10.66	11.97	3.81	0.00	0.31	0.37	0.00	0.05	0.02	0.02	0.18	0.01	0.02	0.00	0.04	0.03	0.00		
	865	865	346	11.96	18.82	27.91	10.09	15.32	10.81	15.66	1.70	0.34	0.12	0.00	0.00	0.10	0.03	0.01	0.17	0.14	0.06	0.03	0.01	0.00		
	334	334	368	1.03	0.64	8.40	0.49	1.40	3.13	2.31	0.84	0.31	0.00	0.00	0.48	0.00	0.01	0.00	0.00	0.13	0.00	0.00	0.01	0.08		
	718	718	387	1.71	4.09	2.79	5.79	17.97	15.65	37.14	1.61	0.53	0.32	0.12	0.63	0.08	0.02	0.05	0.38	0.04	0.06	0.00	0.00	0.01		
	361	361	388	24.75	0.97		11.87	1.85	2.54	0.00	2.51	3.48	0.00	0.28	0.00	0.00	0.00	0.25	0.00	0.11	0.34	0.13	0.07	0.00		
	145	145	392	2.74	0.64	0.99	2.50	0.63	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.01		
	.	175	796												0.00	0.04	0.08		0.01	0.18	0.05	0.00	0.00	0.38		
.	81	800												0.71	0.24			0.56	2.18	2.00	0.06	0.34	0.66			
367 - 549	186	186	729	5.71	4.95	10.94				1.88	10.69	9.63	1.62	5.11	0.09	5.92	0.93	0.00	0.04	0.53	1.29	0.45	0.00	0.11		
	216	216	731	16.75	8.34					15.66	5.98	11.98	1.28	2.67	0.63		0.00	0.25	0.62	0.55	0.13	0.09	0.45	0.74		
	468	468	733	5.10	18.07					25.13	32.78	9.48	2.85	0.93	0.37	0.19	0.00	0.64	0.84	0.96	0.78	1.65	0.13	3.85		
	272	272	735	9.82	0.92	45.82				5.93	5.76	1.06	0.32	0.09	0.54	0.63	0.48	0.31	0.08	0.08	0.33	0.00	0.00	1.64		
	.	50	792												8.05	5.35	1.65		4.19	7.80	7.07	6.59	7.15	11.49		
550 - 731	170	170	730	4.43	0.67					5.54	0.27	5.99	3.77	3.54	0.00	0.90	0.46	0.44	2.53	11.71	4.85	0.01	0.58	0.00		
	231	231	732	8.88	7.40					0.92	6.50	8.90	1.30	6.12	0.51	4.64	3.80	13.85	7.93	7.23	6.50	3.63	3.33	1.14		
	228	228	734	0.96	5.86					5.36	3.20	0.37	3.37	1.57	1.17	4.04	0.47	4.76	3.03	1.48	0.53	2.51	0.14	0.00		
	175	175	736		11.15	29.44				14.73	37.94	3.74	2.92	0.82	0.43	10.86	1.72	5.60	3.88	17.22	7.70	49.70	4.34	8.12		
732 - 914	.	227	737											0.62	4.15	3.33	14.03	4.83	0.36	3.98	16.08	2.18	1.55	0.35		
	.	223	741											3.75	5.35	10.20	0.22	0.00	0.10	5.18	0.49			0.33		
	.	348	745											3.23	4.43	2.58	1.36	0.01	0.01	0.00	0.15			0.00		
	.	159	748											4.00	0.00	0.00	1.83	0.00	0.00	0.00	1.70			0.00		
915 - 1097	.	221	738											0.32	10.88	4.19	0.78	0.00	0.00	0.22	0.19	13.90		0.00		
	.	206	742											1.												

Table 14. Estimates of biomass (tons) of witch flounder from Canadian fall surveys in Div. 2J, 3K and 3L during 1977-2006.

	2J	3K	3L	2J3KL
1977	5123			
1978	1302	30353		
1979	2218	49789		
1980	3494	44962		
1981	2581	43406		
1982	4909	32429		
1983	3693	49251		
1984	2903	49038	13210	65151
1985	3030	35694	7881	46605
1986	5920	21359	10743	38022
1987	2063	21746	8679	32488
1988	1571	18110	9294	28975
1989	2653	8976	6606	18234
1990	3672	17088	10341	31101
1991	2669	4272	5274	12215
1992	1102	1863	3131	6095
1993	627	1327	778	2733
1994	462	846	663	1971
1995	263	435	418	1117
1996	370	855	1806	3031
1997	465	1116	1095	2676
1998	649	1255	1906	3810
1999	752	881	826	2460
2000	498	1200	968	2667
2001	209	1427	1042	2678
2002	404	471	2428	3303
2003	178	651	1010	1839
2004	476	2641	451	3568
2005	684	2842	1003	4529
2006	962	2889	1987	5838

Table 15. Mean weights (kg) of witch flounder per tow from Canadian fall surveys in Div. 2J, 3K and 3L during 1977-2006.

	2J	3K	3L	2J3KL
1977	1.56			
1978	0.39	7.08		
1979	0.72	12.33		
1980	1.11	11.48		
1981	0.80	11.09		
1982	1.52	8.44		
1983	1.13	13.30		
1984	0.93	11.63	2.49	5.15
1985	0.93	8.24	1.48	3.61
1986	1.82	5.35	2.11	3.08
1987	0.63	5.08	1.72	2.58
1988	0.49	4.50	1.84	2.36
1989	0.83	2.23	1.31	1.48
1990	1.13	3.94	1.96	2.42
1991	0.82	0.99	0.99	0.95
1992	0.34	0.43	0.59	0.47
1993	0.20	0.30	0.15	0.22
1994	0.14	0.20	0.12	0.15
1995	0.09	0.09	0.08	0.09
1996	0.11	0.17	0.28	0.20
1997	0.13	0.22	0.17	0.18
1998	0.19	0.25	0.30	0.25
1999	0.22	0.19	0.14	0.18
2000	0.14	0.25	0.16	0.18
2001	0.06	0.28	0.16	0.18
2002	0.12	0.09	0.38	0.22
2003	0.05	0.13	0.16	0.12
2004	0.14	0.52	0.10	0.27
2005	0.20	0.56	0.17	0.31
2006	0.28	0.59	0.33	0.40

Table 16. Estimates of abundance (000s) of witch flounder from Canadian fall surveys in Div. 2J, 3K and 3L during 1977-2006.

	2J	3K	3L	2J3KL
1977	7106			
1978	1962	59729		
1979	3016	84955		
1980	4503	72872		
1981	3190	70058		
1982	6486	52146		
1983	4963	75267		
1984	3840	79553	17914	101307
1985	4089	70384	10401	84874
1986	9432	40917	12839	63188
1987	3337	37279	10500	51117
1988	2746	35486	11269	49501
1989	5377	22734	8002	36114
1990	8110	29338	14453	51901
1991	6941	10045	7428	24414
1992	2463	6377	4748	13588
1993	2588	8918	1572	13078
1994	2369	4815	1428	8612
1995	1808	3546	1004	6358
1996	1724	5081	5297	12102
1997	1890	5716	4383	11989
1998	2505	7955	6755	17214
1999	2548	5441	2655	10644
2000	1964	7952	5361	15276
2001	1096	7220	7316	15631
2002	1497	3752	10776	16025
2003	715	3659	6090	10464
2004	1870	10424	3990	16284
2005	2254	10129	7023	19406
2006	2719	10065	5091	17875

Table 17. Mean numbers of witch flounder per tow from Canadian fall surveys in Div. 2J, 3K and 3L during 1977-2006.

	2J	3K	3L	2J3KL
1977	2.16			
1978	0.59	13.93		
1979	0.97	21.04		
1980	1.42	18.61		
1981	0.99	17.89		
1982	2.01	13.58		
1983	1.52	20.32		
1984	1.23	18.87	3.38	8.01
1985	1.26	16.24	1.95	6.57
1986	2.90	10.24	2.52	5.12
1987	1.03	8.71	2.08	4.06
1988	0.86	8.82	2.23	4.03
1989	1.67	5.65	1.58	2.94
1990	2.49	6.77	2.74	4.04
1991	2.13	2.32	1.39	1.89
1992	0.76	1.47	0.89	1.05
1993	0.82	2.03	0.31	1.04
1994	0.72	1.12	0.27	0.67
1995	0.65	0.77	0.19	0.50
1996	0.50	1.00	0.83	0.81
1997	0.54	1.12	0.69	0.80
1998	0.72	1.56	1.06	1.15
1999	0.74	1.17	0.45	0.76
2000	0.57	1.64	0.86	1.05
2001	0.32	1.42	1.15	1.05
2002	0.43	0.74	1.69	1.07
2003	0.21	0.72	0.96	0.70
2004	0.54	2.05	0.84	1.22
2005	0.65	2.00	1.20	1.35
2006	0.78	2.05	0.84	1.24

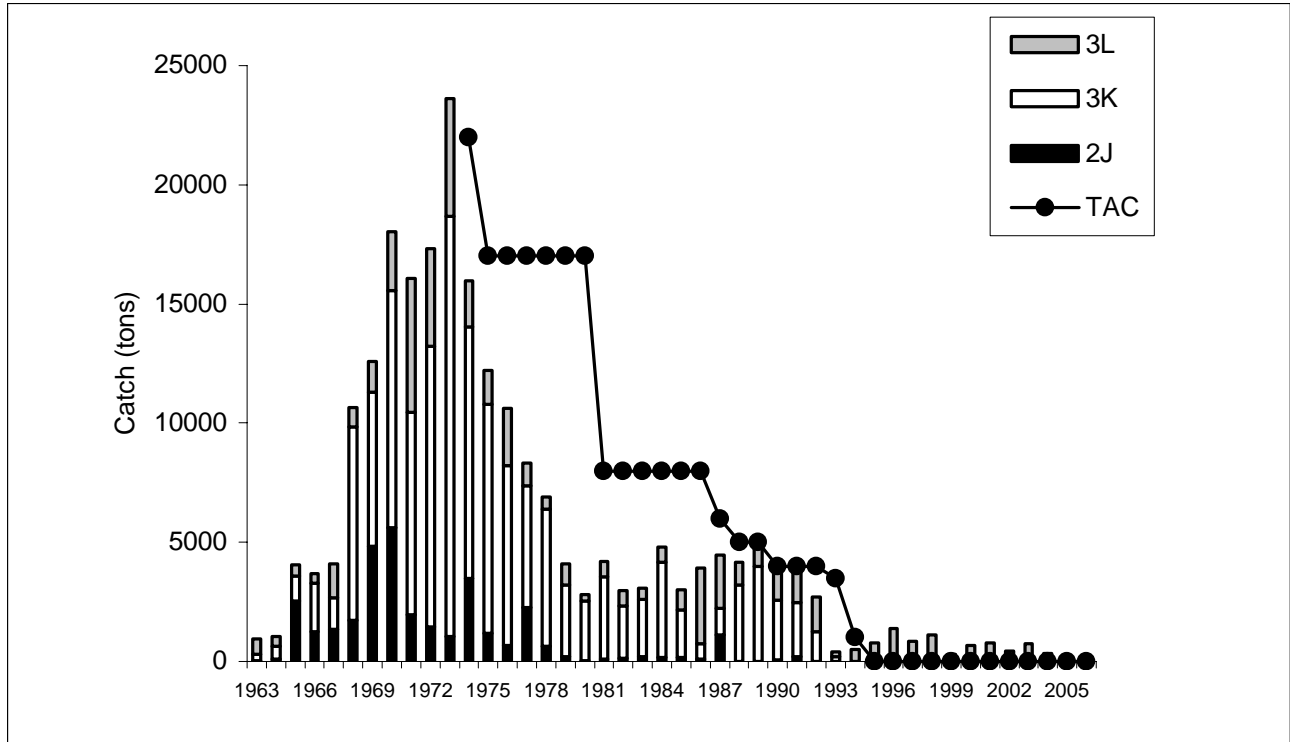


Fig. 1. Commercial catches and TACs of witch flounder in Divisions 2J, 3K and 3L during 1963-2006. Catches in Div. 3M are included for 1998-2000. Although not included, the estimated catches in Div 3M from 2001-2004 averaged 360 tons.

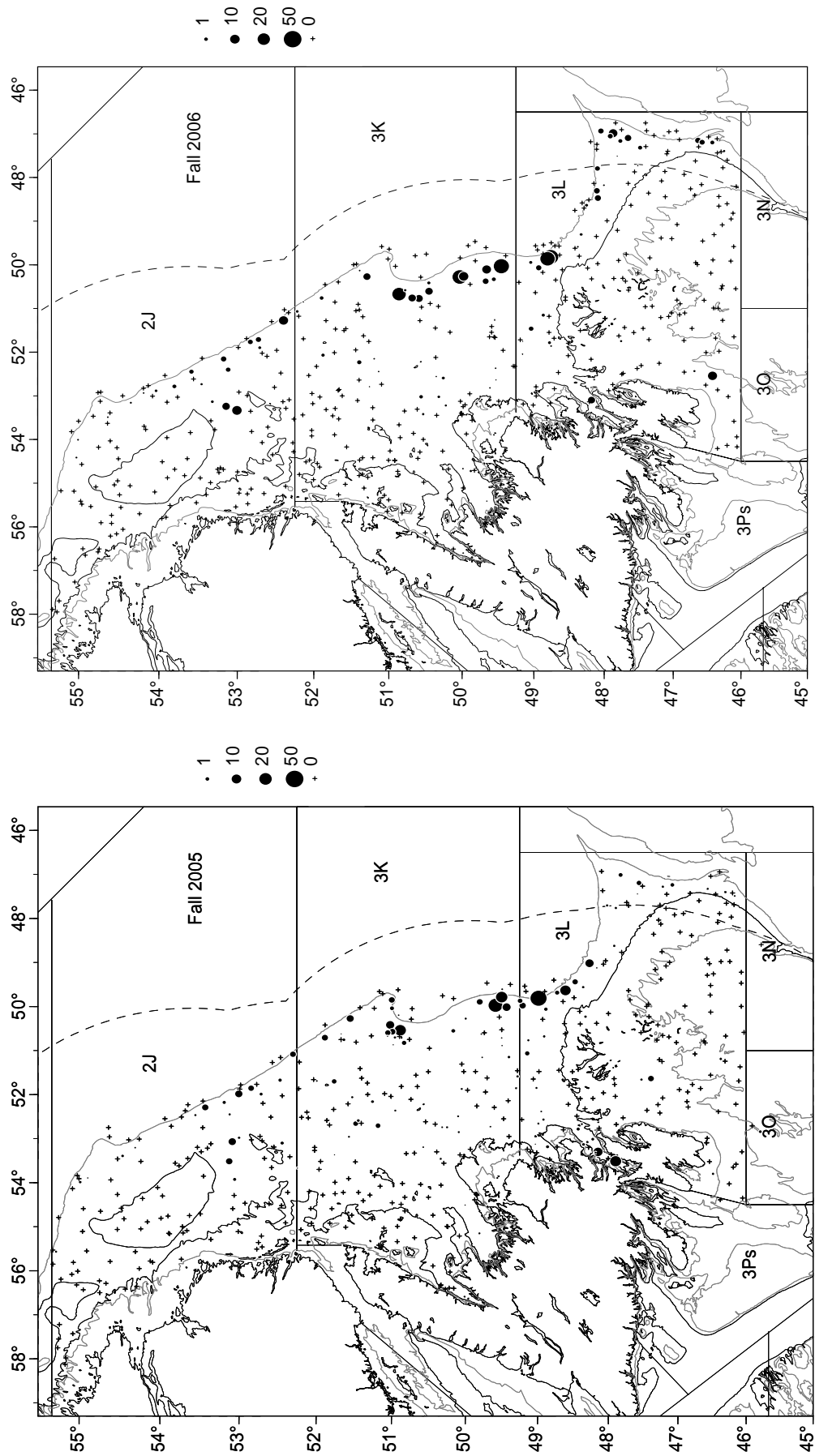
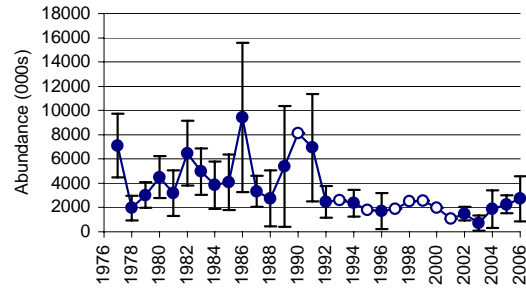
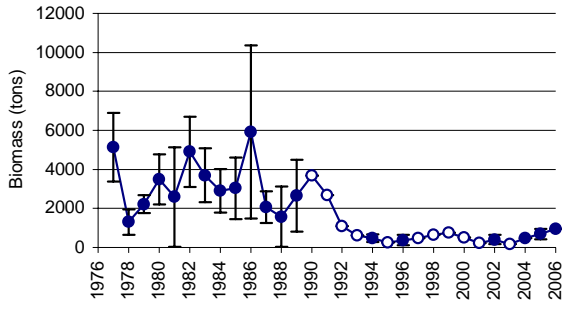
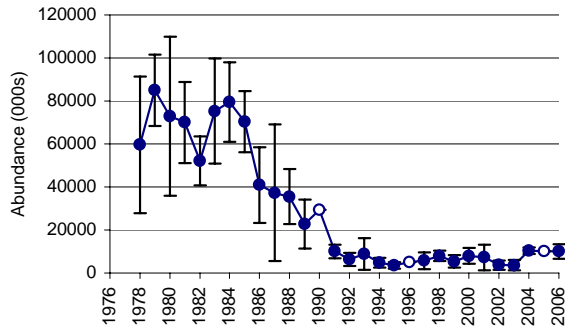
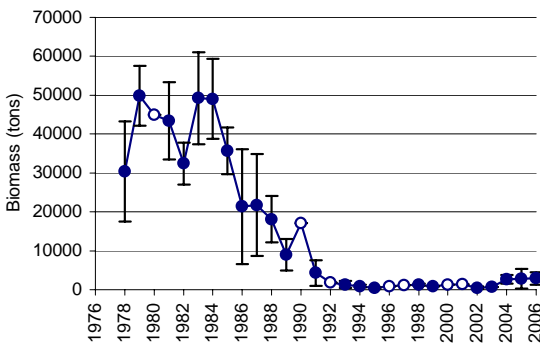


Fig. 2. Weight (kg) per set of witch flounder from Canadian surveys in NAFO divisions 2J, 3K, and 3L during autumn 2005 and 2006.

2J



3K



3L

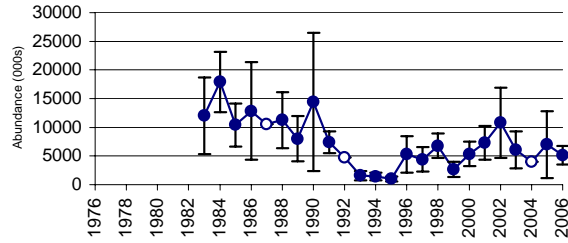
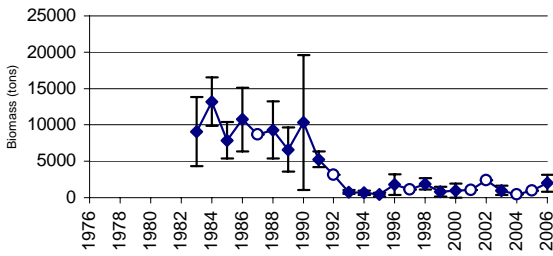
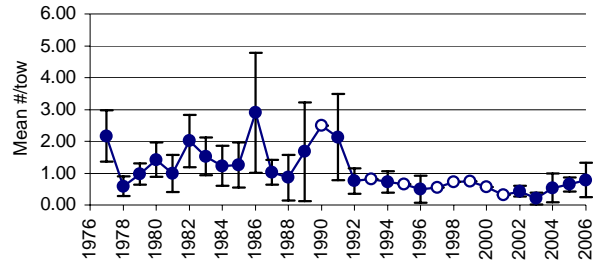
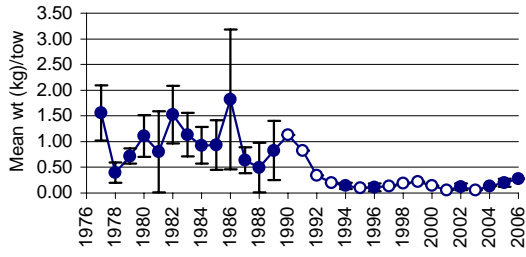
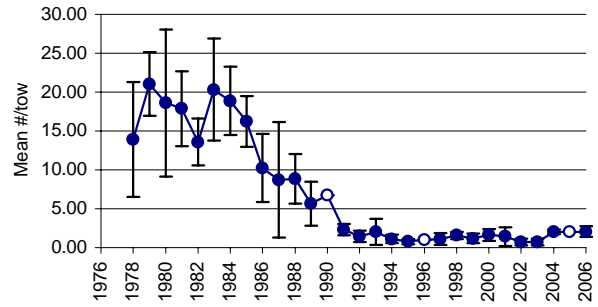
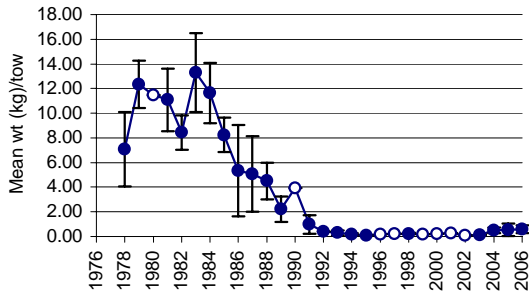


Figure 3a. Biomass (tons) and Abundance (000's) for 2J, 3K and 3L fall surveys. Where lower confidence limit was negative, error bars were omitted (hollow symbol).

2J



3K



3L

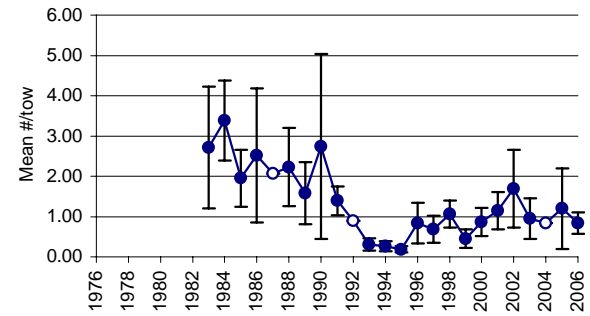
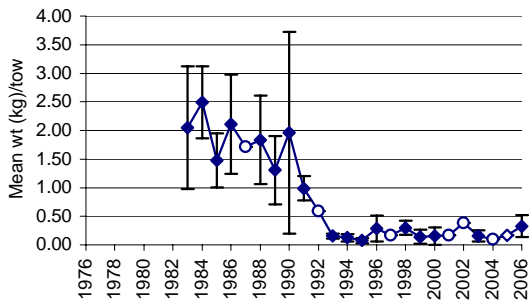


Figure 3b. Mean numbers and weights(kg) per tow for 2J, 3K and 3L fall surveys. Where lower confidence limit was negative, error bars were omitted (hollow symbol).

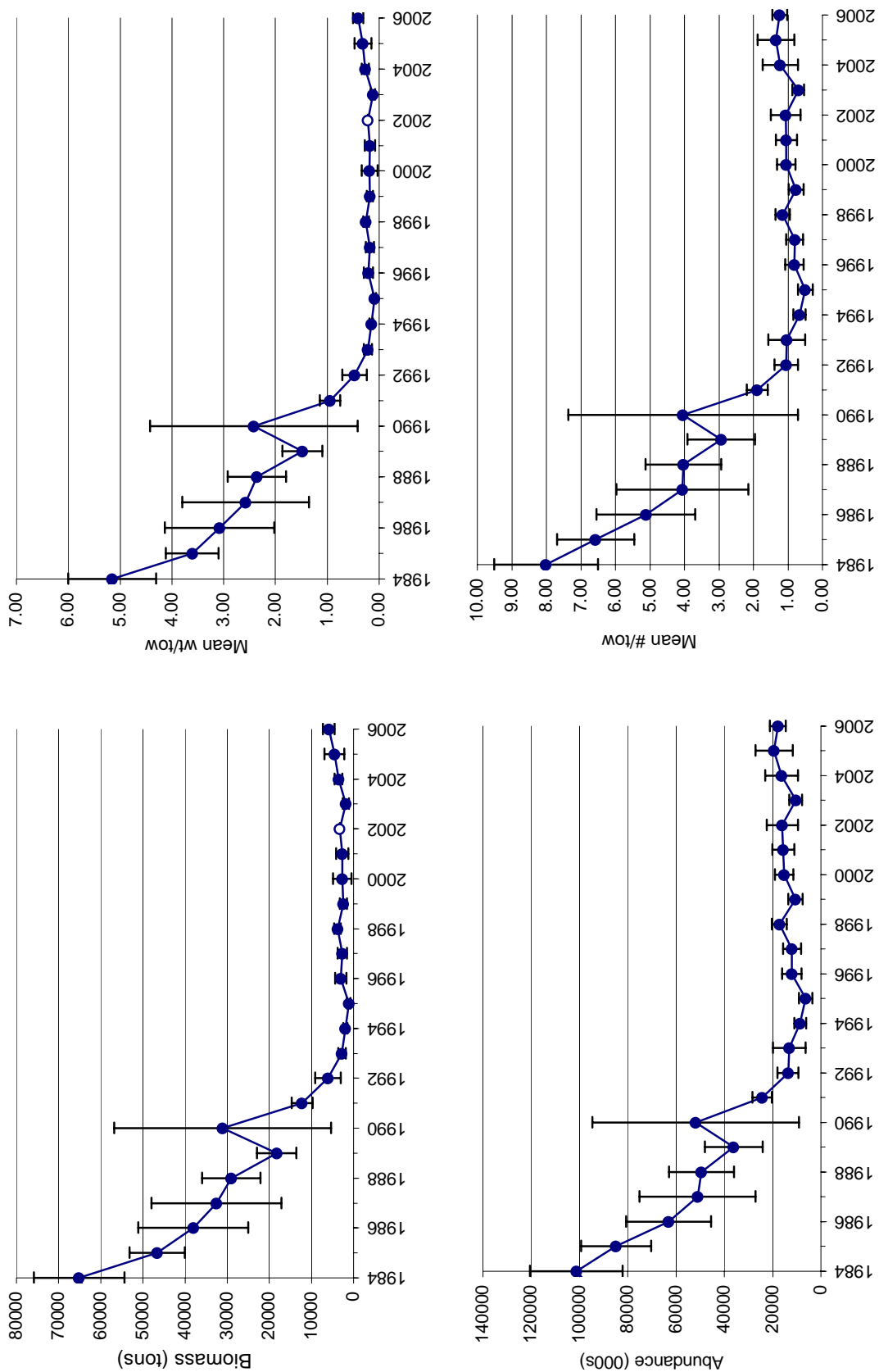


Fig. 4. Biomass (t) and abundance (000s) estimates, mean numbers and weights (kg) per tow, of witch flounder from Canadian fall surveys in 2J3KL based on Campelen trawl catch equivalents during 1984-2006. Where lower confidence limit was negative, error bars were omitted (hollow symbol).

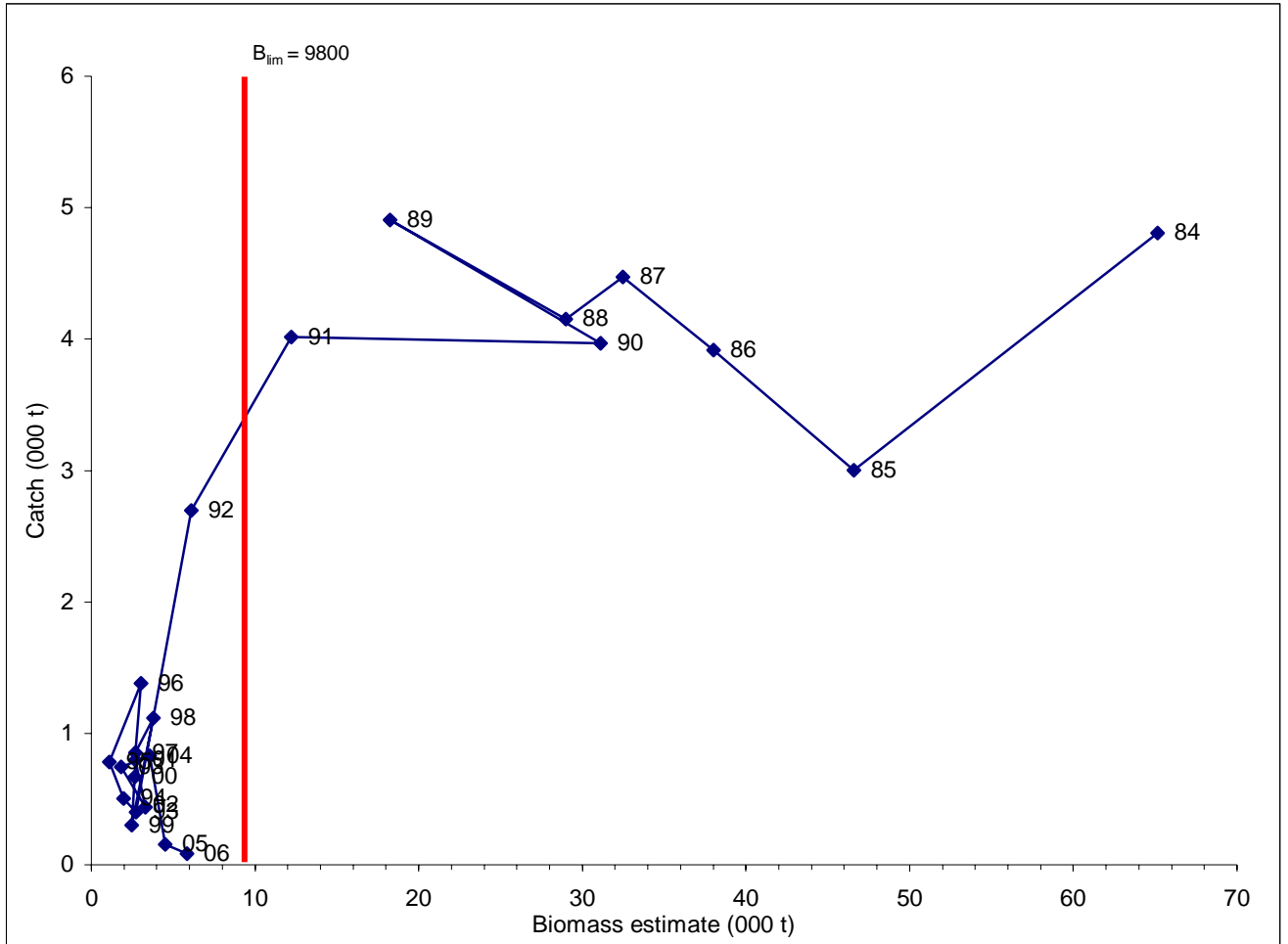


Figure 5. Catch (000 t) and biomass estimates (000 t) for 2J3KL witch flounder 1984-2006. B_{lim} is given at 15% of the highest observed biomass estimate.