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The Assessment of the Cod Stock in NAFO Div. 3NO

by

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Nominal catch and catch at age

Cod catches, along with corresponding TACs, from NAFO Div. 3NØ for a recent period are as follows (000s t):

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
TAC	26	26	17	17	26	33	33	33	40	25
Catch	19	24	32	29	27	37	51	39	43	

Catches for 1986, 1987, and 1988 are provisional.
TACs for 1982 and 1983 exclude expected catches by Spain.

Catches from this stock declined from a peak of about 227,000 t in 1967 to a low of about 15,000 t in 1978 and have subsequently increased (Fig. 1). With the exception of 1986, catches since 1984 have been stable and averaged about 38,000 t. The higher catch in 1986 (51,000 t) was due mainly to larger than average catches by both Spain and Portugal. Historical catches by country are presented in Table 1. Catches in 1988 (Table 2) were mainly by Canada (50%) and the EC (42%). Canadian landings were taken from Divisions 3N and 3Ø in similar proportions (54% and 46% respectively) with the majority being taken by Newfoundland-based otter trawlers.

Sampling data available (Table 3), obtained by Canadian Port Samplers, were used to adjust monthly catches (Table 2) to produce catch, average weight, and length at age for the Canadian commercial catch at age in 1988 (Table 4). Average weight at age were determined by applying a length-weight relationship (log weight = 3.0879 log length - 5.2106) to length frequencies and age length keys. For the Canadian fishery, the calculated catch was about 99% of the reported catch. The 1981 and 1982 year-classes were dominant in the 1988 Canadian catch. The low abundance of the 1983 year-class in the catch is consistent with the most recent assessment of this stock (Baird and Bishop, 1988) which estimated it as the smallest on record.

Research vessel survey data

Stratified-random research vessel surveys have been conducted by Canada in Div. 3N since 1971, with the exception of 1983, and in Div. 3Ø since 1973, with the exception of 1974 and 1983. Surveys from 1971 to 1982 were conducted by the research vessel A. T. CAMERON, and those since 1984 were conducted by the sister ships A. NEEDLER and W. TEMPLEMAN. The stratification scheme used for the stratified-random research vessel surveys in Div. 3NØ is shown in Figure 2. Biomass estimates by strata for these surveys are presented in Tables 5 and 6, with mean number and weight per tow values in Table 7. Biomass in both divisions increased sharply from 1982 to 1984, was somewhat stable from 1984 to 1986, and increased sharply again in 1987, especially in Div. 3Ø. Estimates decreased substantially in 1988 for both Divisions with those for Div. 3Ø showing a further large biomass decrease in 1989. Declines in recent years in cod abundance are much larger than those obseived in biomass (Table 7). The average weight of fish in the survey catch increased from the 1980-87 average of 2.0 kg to the 1988-89 estimate of about 6.0 kg.

As survey coverage is incomplete, mostly in the earlier period, estimates of abundance for non-sampled strata were obtained using an analysis of variance of the ln catch per tow for sampled strata. As in recent assessments, the current analysis weights each stratum mean by its stratum area in square nautical miles. Tables 8 and 9 show survey abundance estimates for Div. 3N and 3Ø respectively with estimated values for strata which were not surveyed. Estimated abundances for Div. 3N and 3Ø in 1989 were the second and third lowest in their respective time series.

Estimates of mean number of cod per standard tow at age are given in Table 10, with these same estimates adjusted for non-sampled strata shown in Table 11. The 1981 and 1982 year-classes, which dominated the commercial catch, are also relatively strong in the survey catch. There appears to be more older fish in the survey population than previously observed, with the age group 14 and older about double the next highest value in the time series.

Commercial catch-effort data

Catch and effort data for 1977 to 1985 was obtained from NAFO statistical bulletins, while that for the Canadian otter trawl fleet from 1986 to 1988 was provided by the Department of Fisheries and Oceans, Canada. Spanish pair trawl data for 1987 was taken from the Spanish Research Report for that year (Vasquez, 1988). Seasonal patterns for otter trawls and pair trawls are different (Tables 12 and 13) and were, therefore, analyzed separately. Data with greater catch and effort were less variable, so estimated weights calculated according to Judge et. al. (1980 p. 132) were applied in a weighted regression of a multiplicative model (Gavaris, 1980). Four categories used in this model are country/gear/tonnage class, month, NAFO Division, and year. The possible effects of truncation and rounding errors were reduced by eliminating data with less than 10 t catch or 10 hours effort from the analysis. The model explained about 36% of the variation in the otter trawl data (Table 12); but, with the exception of division, all categories were significant. The model explained about 60% of the variation in the Spanish pair trawl data (Table 13) and all categories were significant. Canadian otter trawl catch rates (Table 14, Fig. 3) increased from 1977 to 1982 and subsequently declined with the exception of a small increase in 1988. Spanish pair trawl catch rates showed a general decline from 1977 to 1984, declines in 1985 and 1986, and a small increase in 1988.

Review of 1988 assessment

For the 1988 assessment of this stock, the terminal fishing mortality chosen was that which was most consistent with general trends in age 6+ abundance from research vessel surveys conducted by both Canada and the USSR. STACFIS concluded that for 1987, F = 0.20 (Table 16) would be most appropriate (Scientific Coun. Rep., 1988, p. 34).

It was concluded that Canadian survey results for 1984 and 1987 and Soviet results for 1985 and 1987 appeared anomalous (SC. Rep. 1988, p. 34) and would best be omitted from calibration attempts. For determining age 3 recruitment, the age 3 value for 1986 from the Soviet survey was also considered anomalous and this value was also eliminated from further analysis.

The adaptive framework (Gavaris, 1988) with RV data as described above was used to estimate the population size for 1987. The formulation was as follows:

PARAMETERS:

- year-class estimates

  $N_{i,1987}$ $\quad i = 4\text{-}9$

- calibration coefficients for Canadian RV numbers

  $K1_i$ $\quad i = 3\text{-}9$

- calibration coefficients for Soviet RV numbers

  $K2_i$ $\quad i = 3\text{-}9$

STRUCTURE:

- Natural mortality assumed to be 0.20
- Error in catch at age assumed negligible
- F for oldest age group (12) was calculated as the total for ages 7-10
- F for age groups 10-13 in 1987 set equal to the total for ages 7-9 in 1987
- Intercepts not fitted

INPUT:

- $C_{i,t}$ $i = 3\text{-}12$ $t = 1977\text{-}87$
- Canadian $RV1_{i,t}$ $i = 3\text{-}9$ $t = 1977\text{-}82, 1985\text{-}86$
- Soviet $RV2_{i,t}$ $i = 3\text{-}9$ $t = 1977\text{-}84, 1986$
- Data for age 3, 1986, from Soviet RV not included
- RV surveys related to the population at the same age fished to the time of the survey

OBJECTIVE FUNCTION:

- Minimize

$$\sum_{it}\{obs(lnRV1_{it})-pred(lnRV1_{it})\}^2 + \sum_{it}\{obs(lnRV2_{it})-pred(lnRV2_{it})\}^2$$

SUMMARY:

- Number of observations = 118
- Number of parameters = 21

When intercept terms were included in the model, estimates of terminal fishing mortality were unreasonably low with the size of the 1981-82 year-classes estimated to be about an order of magnitude larger than any previously observed year-class for this stock. Therefore, intercepts were not included in the ADAPT relationships. The abundance for ages 4-9 estimated by the model had coefficients of variation ranging between 50% and 90%, but the catchabilities for both surveys were significant for all ages (Table 17) with all CVs being about 30%. No large correlations between estimated parameters were observed (Table 18).

Table 19 shows January 1 population abundance and fishing mortality derived from ADAPT. The fully-recruited fishing mortality (ages 7+) estimated from this analysis is about twice that estimated during the 1988 assessment of this stock (Table 16), but the numbers of fish at ages 5 and 6 are currently estimated to be higher by 45% and 33% respectively. The total age 3+ population abundance derived from the ADAPT analysis is about 7% higher than that estimated at the 1988 assessment.

The current assessment information is presented in Appendix I.

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Table 1. Catch (metric tons) of cod in NAFO Divisions 3NO.

Year	Canada	Spain	Portugal	USSR	Others	Total
1953	39,884	12,633	7,919	-	5,761	66,197
1954	17,392	88,674	24,045	-	4,650	134,761
1955	6,053	64,987	27,711	-	15,605	114,356
1956	5,363	42,624	15,505	-	1,390	64,882
1957	9,641	51,990	21,740	-	6,819	90,190
1958	4,812	29,436	11,608	-	2,195	48,051
1959	3,687	39,994	17,730	48	2,911	64,370
1960	3,408	33,972	14,347	24,204	3,746	79,677
1961	5,428	32,284	9,059	22,854	3,099	72,724
1962	3,235	17,413	3,653	7,971	2,712	34,984
1963	5,079	37,632	10,004	10,184	6,843	69,742
1964	2,882	37,185	8,095	9,510	6,789	64,461
1965	4,229	64,652	1,692	17,166	11,448	99,187
1966	6,501	52,533	5,070	39,023	5,792	108,919
1967	3,446	77,948	9,703	118,845	16,842	226,784
1968	3,287	69,752	6,752	78,820	6,900	165,511
1969	3,664	71,160	4,940	29,173	8,768	117,705
1970	4,771	67.034	3,185	28,338	8,233	111,561
1971	2,311	89,915	6,589	19,307	8,174	126,296
1972	1,736	76,324	11,537	12,198	1,579	103,374
1973	1,832	42,403	7,759	27,849	586	80,429
1974	1,360	38,338	6,602	26,911	178	73,389
1975	1,189	16,616	5,560	20,785	24	44,174
1976	2,065	9,880	2,620	8,992	726	24,283
1977	2,532	8,827	1,742	4,041	462	17,604
1978	6,246	5,813	641	1,819	199	14,718
1979	9,938	13,782	1,140	2,446	545	27,941
1980	5,084	8,999	1,145	3,261	871	19,360
1981	6,096	13,299	1,091	3,187	671	24,344
1982	10,185	14,361	2,466	3,985	608	31,605
1983	11,374	12,320	1,109	3,238	778	28,818
1984	8,705	13,590	1,071	3,306	431	27,103
1985	18,179	13,682	608	3,968	462	36,899
1986[a]	17,204	23,395	6,890	1,181	2,802	51,472
1987[a]	18,426	15,788	4,108	375	233	38,930
1988[a]	19,625		16,502	2,590	401	39,118

[a]Provisional.

Table 2. Cod landings (t) from NAFO Divisions 3NO by country, month, and division in 1988.

	3N						30							3NO					
	Can(N)			Can(M)			Can(N)				Can(M)								
Month	OT	GN	LL	OT	SSc	LL	OT	LL	GN	SSc	OT	LL	GN	EC	USA	USSR	Japan	Faroes	Cuba
J						3	25				270	59		22	10				
F							237				44	88		83		185			
M	64		5				562	206	31	18	135	247		315	2	648			
A	56		2			75	331	50	161	39	52	249		209	33	136	1		
M	603	8	100	45	5	124	635	309	239		344	168	15	581	33	44			
J	423	79	86	56		319	1021		69	46	19	145		3397	19				
J	1387	203	139	102	28	317	300	275			1	106	27	1700	20	22			
A	1254		34	103		177	93	7		5	4	38		1602	37	15			7
S	345		10	4		123	50	77			6	69	84	2949	23	51			2
O	860			50		81	192				68	141	21	1735	27				
N	1956			36		53	204	55		65	22	40		2373	39	136			
D	1155					141	706			1	541	78		1506	23	1353			
Total	8103	290	376	396	33	1413	4356	979	500	174	1506	1428	147	16502	266	2590	1	125	9

Total 3NO = 39194

Table 3. Commercial sampling by Can(N) for cod in NAFO Divisions 3NO during 1988.

Quarter	Gear	Div.	Number aged	Month	Number measured	Landings (t) Country/month	Landings (t) Can(N+M)
1	OT	30	49	Feb.	116	237	1922
2	"	"	472	Apr.	404	370	882
				May	562	635	1710
				June	489	1067	1300
					1455		3892
1+2	OT	3N	66	May	413	603	2053
			587[a]		1984		7867
3	OT	30	69	Aug.	126	93	1137
	"	3N	308	July	639	1387	2176
				Aug.	1370	1254	1568
				Sept.	378	345	482
					2387		4226
			377[a]		2513		
4	OT	30	166	Nov.	709	204	2068
	SSc	"	154	"	834	65	71
			320[a]		1543	269	2139
	OT	3N	699	Oct.	297	860	991
				Nov.	3731	1956	2045
				Dec.	352	1155	1296
			699		4380		4332
1-4		3NO	1983		10420		19701

[a]Combined A/L keys were used to obtain age frequencies for the gear and quarter indicated.

TABLE 4. CATCH, AVERAGE WEIGHT AND LENGTH AT AGE FOR THE COMMERCIAL FISHERY FOR COD BY CANADA IN DIVISIONS 3NO DURING 1988.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
3	0.742	43.789	32	7.95	0.25
4	1.018	48.751	148	22.89	0.15
5	1.418	54.159	700	68.87	0.10
6	1.865	59.115	2765	109.73	0.04
7	2.321	63.263	1556	95.67	0.06
8	4.093	75.532	421	36.66	0.09
9	5.685	83.807	219	23.94	0.11
10	7.533	92.073	188	14.68	0.08
11	9.709	100.961	139	10.80	0.08
12	11.200	105.775	81	7.67	0.09
13	12.745	110.440	98	8.18	0.08
14	14.235	114.569	67	6.44	0.10
15	14.723	115.385	31	4.05	0.13
16	17.520	122.813	7	1.45	0.21
17	18.567	125.184	5	2.55	0.49
18	20.751	130.000	1	0.53	0.65
19	30.971	148.000		0.00	0.01

Table 5. Biomass estimates (MT) by stratum from survey cruises in Div. 3N.

Strata	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989
357			1383				29		52	332	135	92	0	2102	259		18	22
358		1061	1772				383		483	1054	229	236	182	122	547	1803	229	486
359		312	258			660	147		190	478	208	13	71	0	134	43	44	21
360		1966			306	1950	4040	2182	1416	1738	3743	1238	7877	9161	1945	1282	494	1202
361	2909	4525	2525	350	3246	2618	5894	8203	2666	4173		8125	12838	29220	50957	27584	15887	12722
362	2127	9695	4222	2233	306	1666	6836	6621	1632	5847	8701	3708	40764	16509	19686	69852	12714	16464
373	8159	3423	1855	2362		1031	1750	4300	1838	857	4578	6647	17916	2446	2897	6788	5959	6090
374	501	702	273	0	135		1248	1324	479	0	146	2369	8335	877	769	1058	4032	489
375	3270	9977	1042	955	1060		5429	3598	369	3229	29835	5943	2404	18475	14586	8034	16512	20104
376		1892	806		383	77	9672	102	868	855	2208	2	1049	391	1883	2876	4454	745
377		550	14	83	283		1380	130	22	287	428	22	29	13	54	328	0	9
378	530	4146	404	632			687	90	281	939	104	303	133	470	256	73	96	81
379			1828	515			50	0	601	178	53	179	129	324	365	4	15	22
380	9	322	1317	206			52		232	57	25		224	847	135	454	181	176
381	480	1429	2386	359	122		2677	393	196	427	533	2186	478	1544	747	82	270	39
382	142	2458	9	69		42	948	2215	220	285	182	36	0	16	61	12	7	419
383	231	1479	1	16		44	324	1564	146	0	430	5	294	0	0	818	71	335
Total	18357	43935	20096	7781	15381	8088	41546	30722	11692	20736	51538	31104	92725	82515	95280	121091	60982	59425
Upper limit	35959	58509	29260	13257	35224	13399	61360	37915	16334	28150	120675	46068	123845	108355	162513	159883	80483	81925
Lower limit	755	29362	10931	2304	-4462	2776	21732	23529	7051	13322	-17600	16141	61605	56674	28046	82300	41481	36925

Table 6. Biomass estimates (MT) by stratum from survey cruises in Division 3O.

Strata	1973	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989
329	211		6422	180	2008	357	18	487	373	560	840	304	45335	9436	682
330	9251	475	287	593	2218	3753	470	3371	123	3626	4642	2130	5654	2767	1713
331	288	729	454		342	150	609		38	2630	3423	685	804	1224	183
332		830	351	940	4525	2266	9		3474	2358	13471	2499	9808	8681	1369
333		525	82	0	2	0	28		153	0	147	232	1057	0	1040
334			6	0	6	0	43		8	0	570	3481	59	248	136
335	22		3		0	0	10		11	0	0	126	18	39	7
336	29	0	0	136	3	1	286		104	0	34	45	17	18	23
337	78	1906	32	630	614	23	133		610	434	1203	8497	2674	382	2787
338	4298	5563	1876	6953	1334	5729	1795		5659	29905	7485	14405	9838	9124	14874
339	1547	40			249	1475		505	610	1087	359	29	354	233	146
340		2029	2690	298	966	3718	386	4294	2849	6827	5431	5796	77479	12421	2977
351	3092	1562	2684	8141	4334	47954	5629	6821	4498	43455	23490	38217	66032	15852	11619
352	3075	426	1429	6120	3961	10008		5625	6236	34168	29692	15071	49765	57457	34373
353	3265	77	2	262	84	1573	2		472	0	6083	951	9610	626	2371
354	439		38	8		34	273	44	125	489	219	180	2179	530	25
355	76	0	4			24	367	32	135	0	135	12	114	19	195
356	11					12	49	9		0	0	32	7	102	74
Total	25681	14161	16360	24261	20646	76966	15733	15363	25478	125339	97223	92699	280807	119157	74595
Upper Limit	35514	58392	65071	38015	34853	133278	24517	25164	33764	169942	126100	136099	382599	179304	134314
Lower Limit	15848	30070	-32350	10508	6442	20645	6950	5561	17191	80736	68346	49299	179014	59009	14876

Table 7. Mean number and weight of cod per standard tow from research vessel surveys in NAFO Division 3N, 3O, and 3NO.

Div.	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989
Mean Number per tow																		
3N	44.60	33.33	12.17	8.91	17.10	10.30	32.37	25.00	5.59	11.28	18.38	15.54	40.01	24.96	10.34	55.37	8.30	7.01
3O			10.48		10.31	12.63	18.93	16.93	46.36	8.52	8.62	21.86	36.36	15.84	33.72	116.31	16.20	9.82
3NO			12.46		13.23	11.61	25.70	20.78	26.28	9.85	14.60	18.77	38.03	20.24	22.44	87.07	12.39	8.46
Mean Weight per tow																		
3N	24.51	34.05	18.03	8.91	17.57	8.24	33.32	25.98	9.34	16.56	46.30	25.01	74.05	65.90	76.09	97.66	48.70	47.43
3O			25.19		12.17	12.63	19.42	15.93	57.28	12.17	22.32	19.13	93.8	72.35	68.98	208.96	88.67	55.48
3NO			21.40		14.48	10.71	26.36	20.72	32.74	14.29	37.00	21.92	84.01	69.24	72.41	155.55	69.39	51.60

Table 8. Cod abundance (000s) from stratified-random cruises in Division 3N. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989
0-30	375	1593	5076	3826	398	1435	6616	(1328)	7474	4329	263	508	10583	1578	1746	3184	912	2167	1116	1674
	376	1499	(1740)	788	37	(243)	1294	113	3601	225	225	113	225	33	7933	48	177	2813	375	113
31-50	360	2992	(7146)	1516	(863)	(1095)	2302	3425	4211	1011	1273	2695	523	2118	5680	3005	552	1198	1422	165
	361	1853	5747	5796	835	904	3623	723	5610	4764	1166	1808	(4622)	4961	3283	10293	3310	10484	2841	1904
	362	2520	2484	11823	984	1466	431	1021	5830	7440	757	1203	3859	1608	18971	4385	2391	43871	1702	2605
	373	2520	18897	3831	142	426	(1942)	76	946	5959	327	331	1892	1589	8160	770	675	4307	1097	822
	374	931	1563	175	175	1	140	(186)	1607	1817	297	1	163	1677	2893	175	47	266	363	28
	383	674	74	1644	51	25	(124)	17	320	1493	34	1	118	25	34	1	1	422	51	84
51-100	359	421	(1903)	822	622	(303)	(688)	4709	1359	(1392)	549	2133	611	126	95	0	1264	332	269	95
	377	100	(621)	1066	143	613	413	(104)	2800	105	73	490	1146	276	56	105	23	758	0	19
	382	647	425	3447	16	130	(243)	24	2639	1943	243	255	146	194	0	134	12	16	24	81
101-150	358	225	(2425)	861	4189	(397)	(885)	(414)	262	(1776)	431	1993	135	1343	380	448	760	1478	549	729
	378	139	619	3673	459	1683	(620)	(290)	657	120	400	1445	193	1236	318	2181	433	151	157	198
	381	182	1195	779	861	79	156	(280)	3267	364	155	379	779	1851	301	2391	1312	68	191	102
151-200	357	164	(373)	(320)	1157	(57)	(133)	(60)	12	(272)	49	336	37	382	0	2361	137	(319)	6	18
	379	106	(406)	(349)	1802	785	(146)	(67)	24	0	671	408	40	322	175	525	801	4	8	44
	380	116	17	118	641	70	(104)	(47)	22	(212)	96	26	15	(104)	83	788	136	313	226	118
Total		16682	50712	41732	13373	9709	19861	12844	40640	33220	7008	14124	25085	19426	50108	31262	12943	68968	10397	8778
Estimated mean no. per tow			40.50	33.33	10.68	7.75	15.86	10.28	32.45	26.53	5.60	11.28	20.03	15.01	40.02	24.97	10.34	55.08	8.30	7.01

Table 9. Cod abundance (000s) from stratified-random cruises in Division 3O. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	1973	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989
31-50	330	2089	2144	419	679	889	1071	3674	1411	941	359	1921	1461	823	3763	993	342
	331	456	34	49	624	(325)	240	205	1284	(219)	377	993	548	214	650	240	137
	338	1898	2451	4987	3230	9047	1311	2666	1681	(2621)	4103	10116	2391	2976	5305	1781	3818
	340	1716	(1739)	215	4164	258	708	1730	386	859	2340	2898	2733	2576	55431	1178	615
	351	2520	2837	936	615	4843	2535	39981	1513	3689	8701	18538	4413	32509	28753	2913	1470
	352	2580	3409	1290	1791	5965	4648	3486	2113	(3288)	3486	11814	4859	2988	12097	8821	3769
	353	1282	224	705	48	320	1732	4388	48	(310)	257	1	674	165	1700	1674	385
51-100	329	1721	129	(551)	3682	172	1731	1012	65	129	753	775	501	501	42933	22133	388
	332	1047	(1255)	1729	367	1729	7309	2613	118	(930)	5678	236	1839	458	2546	1297	393
	337	948	735	688	356	249	320	516	48	(276)	285	142	939	882	451	249	1281
	339	585	220	22	(212)	(250)	329	1361	(127)	198	2448	1054	88	29	278	102	15
	354	474	261	(186)	712	36	(401)	729	2075	107	107	142	261	178	1975	160	36
101-150	333	151	(17)	958	85	0	4	0	6	(11)	60	0	17	53	340	0	283
	336	121	9	0	0	141	5	2	95	(4)	41	0	9	45	9	5	5
	355	103	19	0	4	(18)	(24)	19	128	19	151	0	398	12	54	12	178
151-200	334	92	(8)	(4)	7	0	2	0	21	(5)	3	0	152	856	14	70	52
	335	58	7	(0)	1	(1)	0	0	3	(0)	4	0	0	40	4	7	4
	356	61	2	(0)	(1)	(1)	(2)	5	18	2	(2)	0	0	9	2	30	37
Total		17902	15498	12738	16580	24242	22372	62388	11140	13609	29155	48628	21283	45316	156302	21767	13206
Estimated mean no. per tow.			11.53	9.48	12.34	18.04	16.65	46.43	8.29	10.13	21.70	36.19	15.84	33.72	116.31	16.20	9.82

Table 10. Mean number of cod at age and per standard tow from research vessel surveys in NAFO Divisions 3NO.

# Sets	1971[a] 45	1972[a] 45	1973 94	1974[a] 37	1975 58	1976 78	1977 88	1978 88	1979 172	1980 140	1981 77	1982 130	1984 116	1985 178	1986 203	1987 191	1988 161
Age																	
1	0.0	0.01	0.07	0.05	0.46	0.58	0.01	0.55	3.09	0.01	0.35	1.56	0.01	0.01	.02	.21	.01
2	4.18	1.17	2.64	1.39	3.16	3.89	2.35	0.71	0.93	5.39	0.38	9.37	3.28	0.41	.70	2.77	1.67
3	42.14	9.01	2.69	4.97	4.70	2.89	9.71	7.07	2.33	1.38	5.39	1.18	6.20	4.47	.71	2.85	2.22
4	5.80	19.28	1.88	0.89	2.64	1.83	6.29	8.17	9.25	0.67	1.58	3.54	9.90	6.05	7.71	9.33	.46
5	4.43	1.72	2.48	0.44	0.59	1.66	4.63	2.48	7.84	1.07	1.83	.60	5.29	2.41	6.46	34.86	.41
6	1.06	.71	0.50	0.38	0.31	0.26	1.54	0.96	1.76	0.44	2.32	.47	5.60	.88	1.62	21.25	1.06
7	1.08	.58	0.28	0.14	0.60	0.07	0.49	0.61	0.52	0.21	1.13	.78	1.87	.97	.68	8.33	1.17
8	0.48	.41	0.20	0.04	0.25	0.13	0.22	0.04	0.26	0.18	0.50	.58	1.00	.73	.65	1.78	.78
9	0.24	.30	0.22	0.01	0.25	0.06	0.10	0.01	0.10	0.18	0.53	.26	1.81	.88	.50	1.94	.82
10	0.03	.17	0.13	0.07	0.08	0.07	0.10	0.03	0.02	0.09	0.24	.16	1.57	1.34	.74	.69	.87
11	0.08	.08	0.06	0.03	0.01	0.02	0.01	0.04	0.06	0.05	0.04	.07	.86	.98	1.20	.77	.44
12	0.14	.05	0.09		0.02		0.04	0	0	0.07	0.14	.05	.32	.49	.65	.71	.55
13			0.14		0.01		0.09	0.04	0.04	0.03	0.06	.01	.11	.24	.36	.81	.79
14+	0.47	.36	0.50	0.15	0.15	0.05	0.12	0.01	0.10	0.12	0.17	.14	.22	.39	.52	.77	1.24
Mean no. per tow	60.13	33.85	11.89	8.56	13.23	11.51	25.70	20.72	26.30	9.89	14.66	18.76	38.03	20.24	22.42	87.07	12.39
Upper Limit	117.35	51.51	15.47	12.50	25.93	17.94	33.96	31.81	47.18	12.85	23.61	25.28	47.82	24.06	44.11	119.64	15.18
Lower Limit	2.93	16.10	8.33	4.62	0.52	5.09	17.45	9.90	5.49	6.91	5.70	12.24	28.25	16.42	0.74	54.49	9.60

[a]Survey 3N only.

Table 11. Mean number per tow at age of cod from RV surveys conducted by Canada in Div. 3NO (1971, 1972 & 1974 surveys in 3N only).
Estimates adjusted for non-sampled strata.

1/ 6/89

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988
1	0.00	0.01	0.07	0.05	0.44	0.57	0.01	0.57	3.14	0.01	0.36	1.54	0.01	0.01	0.02	0.21	0.01
2	2.82	1.15	2.47	1.26	3.00	3.84	2.29	0.73	0.95	5.30	0.39	9.23	3.28	0.41	0.70	2.76	1.67
3	28.38	8.87	2.52	4.50	4.46	2.85	9.44	7.31	2.37	1.36	5.48	1.16	6.20	4.47	0.71	2.84	2.22
4	3.91	18.98	1.76	0.81	2.51	1.80	6.12	8.45	9.40	0.66	1.61	3.49	9.90	6.05	7.72	9.30	0.46
5	2.98	1.69	2.32	0.40	0.56	1.64	4.50	2.56	7.97	1.05	1.86	0.59	5.29	2.41	6.47	34.75	0.41
6	0.71	0.70	0.47	0.34	0.29	0.26	1.50	0.99	1.79	0.43	2.36	0.46	5.60	0.88	1.62	21.18	1.06
7	0.73	0.57	0.26	0.13	0.57	0.07	0.48	0.63	0.53	0.21	1.15	0.77	1.87	0.97	0.68	8.30	1.17
8	0.32	0.40	0.19	0.04	0.24	0.13	0.21	0.04	0.26	0.18	0.51	0.57	1.00	0.73	0.65	1.77	0.78
9	0.16	0.30	0.21	0.01	0.24	0.06	0.10	0.01	0.10	0.18	0.54	0.26	1.81	0.88	0.50	1.93	0.82
10	0.02	0.17	0.12	0.06	0.08	0.07	0.10	0.03	0.02	0.09	0.24	0.16	1.57	1.34	0.74	0.69	0.87
11	0.05	0.08	0.06	0.03	0.01	0.02	0.01	0.04	0.06	0.05	0.04	0.07	0.86	0.98	1.20	0.77	0.44
12	0.09	0.05	0.08	0.00	0.02	0.00	0.04	0.00	0.00	0.07	0.14	0.05	0.32	0.49	0.65	0.71	0.55
13	0.00	0.00	0.13	0.00	0.01	0.00	0.09	0.04	0.04	0.03	0.06	0.01	0.11	0.24	0.36	0.81	0.79
14+	0.32	0.35	0.47	0.14	0.14	0.05	0.12	0.01	0.10	0.12	0.17	0.14	0.22	0.39	0.52	0.77	1.24
1+	40.50	33.33	11.11	7.75	12.56	11.35	24.99	21.42	26.74	9.73	14.91	18.48	38.05	20.25	22.54	86.80	12.49
2+	40.50	33.32	11.05	7.70	12.12	10.78	24.98	20.85	23.60	9.72	14.55	16.94	36.04	20.24	22.52	86.59	12.48
3+	37.68	32.17	8.58	6.45	9.12	6.94	22.70	20.12	22.65	4.42	14.17	7.72	34.76	19.83	21.82	83.83	10.81
4+	9.30	23.30	6.06	1.95	4.66	4.09	13.25	12.81	20.28	3.06	8.69	6.56	28.56	15.36	21.11	80.99	8.59
5+	5.40	4.31	4.30	1.14	2.16	2.29	7.14	4.36	10.88	2.40	7.08	3.07	18.65	9.31	13.39	71.69	8.13
6+	2.41	2.62	1.98	0.74	1.59	0.65	2.64	1.80	2.91	1.35	5.22	2.48	13.36	6.90	6.93	36.94	7.72

TABLE 12. RESULTS FROM THE REGRESSION OF LN CATCH RATE FOR COD IN DIV. 3NO FOR THE 1977-88 PERIOD USING CANADIAN OTTER TRAWL DATA.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.598
MULTIPLE R SQUARED..... 0.358

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	5.201E1	5.201E1	
REGRESSION	26	4.784E1	1.840E0	8.327
TYPE 1	3	1.075E1	3.582E0	16.207
TYPE 2	1	3.399E-2	3.399E-2	0.154
TYPE 3	11	2.358E1	2.144E0	9.699
TYPE 4	11	9.231E0	8.391E-1	3.797
RESIDUALS	389	8.597E1	2.210E-1	
TOTAL	416	1.858E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3124	INTERCEPT	-0.072	0.215	416
2	34				
3	1				
4	77				
1	3125	1	0.105	0.067	188
	27124	2	0.404	0.095	55
	27125	3	0.454	0.079	82
2	35	4	-0.023	0.058	277
3	2	5	-0.424	0.152	28
	3	6	-0.596	0.145	33
	4	7	-0.677	0.144	38
	5	8	-0.929	0.138	48
	6	9	-0.879	0.138	46
	7	10	-0.762	0.150	32
	8	11	-0.707	0.154	30
	9	12	-0.709	0.162	21
	10	13	-0.780	0.146	36
	11	14	-0.415	0.136	48
	12	15	-0.215	0.140	40
4	78	16	-0.114	0.180	35
	79	17	0.202	0.176	43
	80	18	-0.060	0.198	18
	81	19	0.162	0.195	19
	82	20	0.458	0.177	33
	83	21	0.396	0.174	39
	84	22	0.234	0.175	38
	85	23	0.237	0.174	39
	86	24	0.125	0.171	44
	87	25	0.073	0.169	51
	88	26	0.137	0.171	47

TABLE 13. RESULTS FROM THE REGRESSION OF LN CATCH RATE FOR COD IN DIV. 3NO FOR THE 1977-87 PERIOD USING SPANISH PAIR TRAWL DATA.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.775
MULTIPLE R SQUARED..... 0.601

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	1.036E2	1.036E2	
REGRESSION	24	9.798E1	4.082E0	13.830
TYPE 1	2	2.541E0	1.270E0	4.303
TYPE 2	1	1.080E0	1.080E0	3.660
TYPE 3	11	9.302E0	8.457E-1	2.865
TYPE 4	10	7.747E1	7.747E0	26.246
RESIDUALS	220	6.494E1	2.952E-1	
TOTAL	245	2.665E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	19164	INTERCEPT	-1.273	0.273	245
2	34				
3	1				
4	77				
1	19165	1	0.165	0.073	114
	19166	2	0.492	0.233	10
2	35	3	0.227	0.118	45
3	2	4	0.290	0.338	8
	3	5	-0.066	0.287	15
	4	6	0.060	0.283	15
	5	7	0.221	0.261	25
	6	8	0.462	0.260	26
	7	9	0.573	0.269	24
	8	10	0.205	0.273	22
	9	11	0.023	0.269	23
	10	12	0.131	0.263	27
	11	13	0.133	0.262	28
	12	14	0.515	0.271	22
4	78	15	-1.103	0.153	30
	79	16	0.981	0.196	16
	80	17	-0.171	0.166	30
	81	18	0.619	0.182	20
	82	19	0.360	0.171	23
	83	20	0.621	0.180	20
	84	21	1.189	0.175	22
	85	22	0.694	0.173	21
	86	23	0.237	0.170	21
	87	24	0.365	0.183	16

TABLE 14. CATCH RATE INDEX FOR COD IN DIV. 3NO USING CANADIAN OTTER TRAWL DATA FOR THE PERIOD 1977-88.

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1977	-0.8678	0.0279	0.463	0.077	17604	38061
1978	-0.9820	0.0128	0.416	0.047	14718	35400
1979	-0.6657	0.0100	0.571	0.057	27941	48913
1980	-0.9283	0.0194	0.437	0.061	19360	44277
1981	-0.7054	0.0186	0.547	0.074	24344	44532
1982	-0.4100	0.0110	0.737	0.077	31605	42863
1983	-0.4720	0.0103	0.693	0.070	28818	41571
1984	-0.6342	0.0117	0.589	0.063	27103	46011
1985	-0.6306	0.0112	0.591	0.062	36899	62400
1986	-0.7426	0.0097	0.529	0.052	51472	97291
1987	-0.7944	0.0096	0.502	0.049	38930	77497
1988	-0.7306	0.0102	0.535	0.054	39118	73074

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.114

TABLE 15. CATCH RATE INDEX FOR COD IN DIV. 3NO USING SPANISH BAIR TRAWL DATA FOR THE PERIOD 1977-87.

	PREDICTED CATCH RATE					
	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1977	-0.6457	0.0232	0.601	0.091	17604	29290
1978	-1.7491	0.0208	0.200	0.029	14718	73721
1979	0.3355	0.0349	1.594	0.296	27941	17528
1980	-0.8166	0.0246	0.506	0.079	19360	38241
1981	-0.0271	0.0262	1.114	0.179	24344	21851
1982	-0.2854	0.0216	0.862	0.126	31605	36647
1983	-0.0249	0.0251	1.117	0.176	28818	25796
1984	0.5431	0.0229	1.974	0.297	27103	13733
1985	0.0485	0.0222	1.204	0.179	36899	30648
1986	-0.4088	0.0209	0.763	0.110	51472	67499
1987	-0.2812	0.0270	0.864	0.141	38930	45073

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.155

Table 16. January 1 population numbers and fishing mortality for cod in Div. 3NO from the 1988 assessment of this stock (F = 0.20).

POPULATION NUMBERS (000S) 31/ 5/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	46589	45802	24151	25669	36031	23395	36816	58518	46439	9585	23574
4	19258	37594	36667	19708	20762	29067	18878	29075	47858	37969	7707
5	8369	13533	26855	26558	15106	16065	22008	14871	22900	36511	28520
6	4525	4562	8802	13656	18315	11287	11713	16306	10898	13136	24124
7	1444	2348	2995	4687	9319	13029	8326	8501	11248	6176	6813
8	460	664	1602	1653	3236	5997	9285	6196	5856	6929	3694
9	509	216	452	1072	1186	2158	3560	6559	4421	4073	4805
10	126	228	125	317	809	806	1228	2214	4540	3204	2821
11	84	44	140	87	235	582	469	790	1314	3235	2269
12	62	31	29	104	65	157	330	311	551	840	2305
3+	81426	105024	101818	93510	105065	102544	112613	143342	156025	121658	106633

FISHING MORTALITY 31/ 5/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	0.015	0.022	0.003	0.012	0.015	0.015	0.036	0.001	0.001	0.018	0.023
4	0.153	0.136	0.123	0.066	0.056	0.078	0.039	0.039	0.071	0.086	0.058
5	0.407	0.230	0.476	0.172	0.091	0.116	0.100	0.111	0.356	0.214	0.134
6	0.456	0.221	0.430	0.182	0.141	0.104	0.121	0.171	0.368	0.457	0.158
7	0.576	0.182	0.394	0.171	0.241	0.139	0.095	0.173	0.284	0.314	0.200
8	0.554	0.186	0.202	0.132	0.205	0.322	0.147	0.137	0.163	0.166	0.200
9	0.605	0.351	0.153	0.081	0.186	0.363	0.275	0.168	0.122	0.167	0.200
10	0.843	0.284	0.163	0.099	0.130	0.341	0.241	0.322	0.139	0.145	0.200
11	0.781	0.222	0.099	0.093	0.202	0.367	0.212	0.160	0.248	0.139	0.200
12	0.578	0.193	0.306	0.148	0.228	0.209	0.147	0.161	0.215	0.217	0.200

Table 17. Results from ADAPT using RV data showing parameter estimates for ages 3-9 numbers with corresponding slopes and residuals between ln observed and predicted RV. This formulation is similar to the 1988 assessment of this stock.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.073575
MEAN SQUARE RESIDUALS 0.662778

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
3	ABUNDANCE	2.28054E4	1.15133E-1	1.98079E5	0.00
4	ABUNDANCE	4.98491E3	4.45279E3	1.11950E0	0.89
5	ABUNDANCE	4.24728E4	2.26067E4	1.87877E0	0.53
6	ABUNDANCE	3.16335E4	1.62876E4	1.94218E0	0.51
7	ABUNDANCE	3.90622E3	2.50168E3	1.56144E0	0.64
8	ABUNDANCE	2.29281E3	1.48300E3	1.54606E0	0.65
9	ABUNDANCE	2.20279E3	1.34332E3	1.63980E0	0.61
3	RV1 SLOPE	1.23662E-4	4.07591E-5	3.03398E0	0.33
4	RV1 SLOPE	1.63950E-4	5.09941E-5	3.21508E0	0.31
5	RV1 SLOPE	1.75214E-4	5.38758E-5	3.25218E0	0.31
6	RV1 SLOPE	1.60241E-4	4.96402E-5	3.22806E0	0.31
7	RV1 SLOPE	1.77308E-4	5.51469E-5	3.21519E0	0.31
8	RV1 SLOPE	1.93167E-4	6.04217E-5	3.19699E0	0.31
9	RV1 SLOPE	2.35727E-4	7.35341E-5	3.20568E0	0.31
3	RV2 SLOPE	3.86442E-4	1.18792E-4	3.25310E0	0.31
4	RV2 SLOPE	4.82541E-4	1.40968E-4	3.42306E0	0.29
5	RV2 SLOPE	5.23974E-4	1.52713E-4	3.43110E0	0.29
6	RV2 SLOPE	5.48637E-4	1.63716E-4	3.35116E0	0.30
7	RV2 SLOPE	5.72531E-4	1.71826E-4	3.33203E0	0.30
8	RV2 SLOPE	4.91738E-4	1.47613E-4	3.33127E0	0.30
9	RV2 SLOPE	6.51557E-4	1.92458E-4	3.38545E0	0.30

LOG RESIDUALS FOR CANADIAN RV SURVEY INDEX 5/ 6/89

	1977	1978	1979	1980	1981	1982	1985	1986
3	0.605	0.480	0.076	-0.549	0.557	-0.660	-0.551	-0.007
4	0.828	0.470	0.716	-1.254	-0.429	0.070	-0.382	-0.067
5	1.386	0.281	0.809	-1.174	0.014	-1.198	-0.077	-0.088
6	1.027	0.533	0.530	-1.412	0.120	-0.961	-0.242	0.359
7	0.963	0.662	0.312	-1.153	-0.116	-0.725	-0.067	0.077
8	1.164	-0.876	0.122	-0.317	0.069	-0.399	0.112	0.078
9	0.114	-1.359	0.226	-0.089	0.976	-0.311	0.394	0.002

SUM OF RV 1 RESIDUALS : -0.3313968485 MEAN RESIDUAL : -0.0059178009

LOG RESIDUALS FOR SOVIET RV SURVEY INDEX 5/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1986
3	0.392	0.302	-0.557	-0.678	-0.360	0.390	0.180	0.283	1.751
4	0.570	0.135	-1.212	-0.994	-0.502	0.125	0.336	0.909	0.584
5	0.906	0.697	-1.021	-1.298	-1.008	0.614	0.074	0.831	0.156
6	0.817	0.770	-0.835	-0.951	-1.724	-0.030	0.631	0.157	1.117
7	1.259	0.488	-0.338	-0.501	-1.572	-0.654	0.125	0.218	0.927
8	1.677	0.934	-0.326	0.182	-1.033	-2.288	-0.332	0.041	1.098
9	0.364	0.682	-0.051	-0.529	-0.961	0.325	0.234	-0.787	0.675

SUM OF RV 2 RESIDUALS : 1.4198939837 MEAN RESIDUAL : 0.0225379997

Table 18. Correlations between parameters estimated from ADAPT using RV data with a formulation similar to the 1988 assessment of this stock.

PARAMETER CORRELATION MATRIX 31/ 5/89

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.000	-0.000	0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000
2	1.000	1.000	0.098	0.024	0.049	0.074	0.071	-0.375	-0.045	-0.028	-0.035	-0.040	-0.039	-0.040	-0.033	-0.049	-0.035	-0.039	-0.045	-0.043	-0.041
3	1.000	0.098	1.000	0.073	0.097	0.104	0.117	-0.261	-0.253	-0.055	-0.059	-0.062	-0.064	-0.066	-0.060	-0.246	-0.062	-0.067	-0.070	-0.071	-0.069
4	1.000	0.024	0.073	1.000	0.130	0.109	0.123	-0.064	-0.223	-0.238	-0.070	-0.068	-0.071	-0.077	-0.223	-0.071	-0.237	-0.080	-0.080	-0.080	-0.079
5	1.000	0.049	0.097	0.130	1.000	-0.000	0.020	-0.131	-0.152	-0.253	-0.289	-0.096	-0.151	-0.267	-0.201	-0.200	-0.152	-0.339	-0.201	-0.186	-0.256
6	1.000	0.074	0.104	0.109	-0.000	1.000	0.139	-0.198	-0.126	-0.115	-0.212	-0.296	-0.154	-0.191	-0.184	-0.186	-0.212	-0.129	-0.346	-0.176	-0.210
7	1.000	0.071	0.117	0.123	0.020	0.139	1.000	-0.190	-0.202	-0.131	-0.124	-0.257	-0.348	-0.232	-0.177	-0.187	-0.214	-0.226	-0.199	-0.367	-0.247
8	1.000	-0.375	-0.261	-0.064	-0.131	-0.198	-0.190	1.000	0.119	0.075	0.094	0.106	0.103	0.105	0.088	0.130	0.093	0.103	0.119	0.114	0.110
9	1.000	-0.045	-0.253	-0.223	-0.152	-0.126	-0.202	0.119	1.000	0.105	0.087	0.092	0.102	0.102	0.109	0.123	0.114	0.105	0.101	0.113	0.105
10	1.000	-0.028	-0.055	-0.238	-0.253	-0.115	-0.131	0.075	0.105	1.000	0.108	0.082	0.092	0.112	0.119	0.091	0.116	0.123	0.107	0.105	0.113
11	1.000	-0.035	-0.059	-0.070	-0.289	-0.212	-0.124	0.094	0.087	0.108	1.000	0.110	0.106	0.136	0.110	0.111	0.105	0.144	0.145	0.122	0.138
12	1.000	-0.040	-0.062	-0.068	-0.096	-0.296	-0.257	0.106	0.092	0.082	0.110	1.000	0.131	0.126	0.106	0.108	0.117	0.115	0.154	0.144	0.133
13	1.000	-0.039	-0.064	-0.071	-0.151	-0.154	-0.348	0.103	0.102	0.092	0.106	0.131	1.000	0.136	0.107	0.111	0.115	0.138	0.132	0.167	0.141
14	1.000	-0.040	-0.066	-0.077	-0.267	-0.191	-0.232	0.105	0.102	0.112	0.136	0.126	0.136	1.000	0.119	0.121	0.118	0.156	0.150	0.152	0.152
15	1.000	-0.033	-0.060	-0.223	-0.201	-0.184	-0.177	0.088	0.109	0.119	0.110	0.106	0.107	0.119	1.000	0.099	0.126	0.122	0.126	0.121	0.122
16	1.000	-0.049	-0.246	-0.071	-0.200	-0.186	-0.187	0.130	0.123	0.091	0.111	0.108	0.111	0.121	0.099	1.000	0.100	0.124	0.128	0.124	0.124
17	1.000	-0.035	-0.062	-0.237	-0.152	-0.212	-0.214	0.093	0.114	0.116	0.105	0.117	0.115	0.118	0.126	0.100	1.000	0.116	0.131	0.128	0.123
18	1.000	-0.039	-0.067	-0.080	-0.339	-0.129	-0.226	0.103	0.105	0.123	0.144	0.115	0.138	0.156	0.122	0.124	0.116	1.000	0.143	0.155	0.158
19	1.000	-0.045	-0.070	-0.080	-0.201	-0.346	-0.199	0.119	0.101	0.107	0.145	0.154	0.132	0.150	0.126	0.128	0.131	0.143	1.000	0.149	0.156
20	1.000	-0.043	-0.071	-0.080	-0.186	-0.176	-0.367	0.114	0.113	0.105	0.122	0.144	0.167	0.152	0.121	0.124	0.128	0.155	0.149	1.000	0.158
21	1.000	-0.041	-0.069	-0.079	-0.256	-0.210	-0.247	0.110	0.105	0.113	0.138	0.133	0.141	0.152	0.122	0.124	0.123	0.158	0.156	0.158	1.000

Table 19. January 1 population numbers and fishing mortality for cod in Div. 3NO derived from ADAPT using RV data with a formulation similar to the 1988 assessment of this stock.

POPULATION NUMBERS (000S) 31/ 5/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	44773	39416	19005	20430	27319	19539	30278	71991	67055	6241	22758
4	18384	36107	31439	15495	16474	21935	15721	23723	58889	54848	4969
5	7940	12817	25638	22277	11657	12554	16169	12286	18518	45542	42340
6	4224	4211	8216	12659	14811	8463	8839	11525	8782	9548	31518
7	1352	2101	2707	4207	8503	10160	6013	6147	7333	4443	3875
8	448	590	1400	1418	2843	5328	6935	4303	3929	3725	2276
9	487	206	390	906	993	1836	3013	4636	2871	2495	2181
10	121	210	117	267	674	649	965	1766	2965	1935	1529
11	79	40	126	80	194	472	340	575	947	1945	1230
12	58	27	26	92	59	124	239	205	375	539	1250
3+	77866	95727	89064	77832	83527	81059	88512	137156	171663	131262	113926

FISHING MORTALITY 31/ 5/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	0.015	0.026	0.004	0.015	0.020	0.017	0.044	0.001	0.001	0.028	0.024
4	0.161	0.142	0.144	0.085	0.072	0.105	0.047	0.048	0.057	0.059	0.091
5	0.434	0.245	0.506	0.208	0.120	0.151	0.139	0.136	0.462	0.168	0.088
6	0.498	0.242	0.469	0.198	0.177	0.142	0.163	0.252	0.481	0.702	0.119
7	0.630	0.206	0.447	0.192	0.267	0.182	0.135	0.248	0.477	0.469	0.382
8	0.574	0.212	0.235	0.156	0.237	0.370	0.203	0.204	0.254	0.335	0.347
9	0.642	0.372	0.179	0.096	0.226	0.443	0.334	0.247	0.194	0.290	0.506
10	0.899	0.313	0.176	0.118	0.158	0.446	0.318	0.423	0.221	0.253	0.405
11	0.860	0.247	0.111	0.102	0.251	0.478	0.305	0.228	0.363	0.242	0.405
12	0.636	0.225	0.353	0.169	0.252	0.274	0.209	0.255	0.334	0.361	0.405

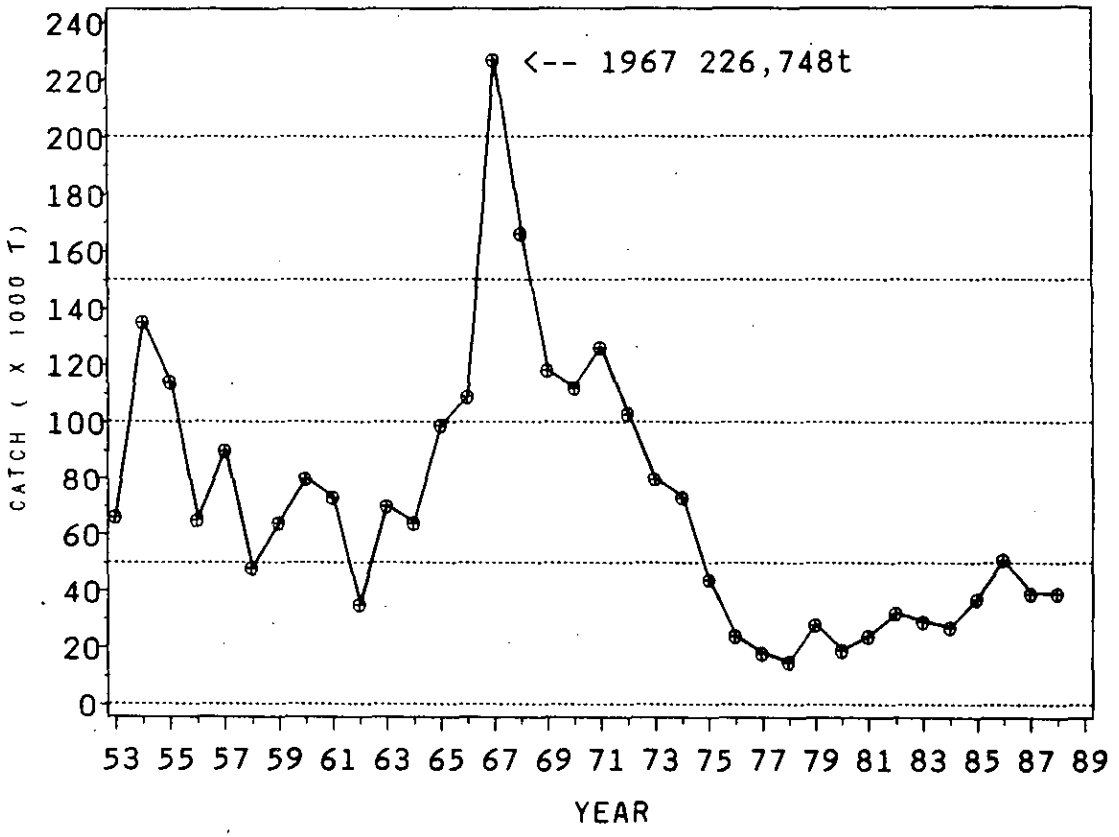


FIG. 1. Catches of cod in Divisions 3NO for the 1953-88 period.

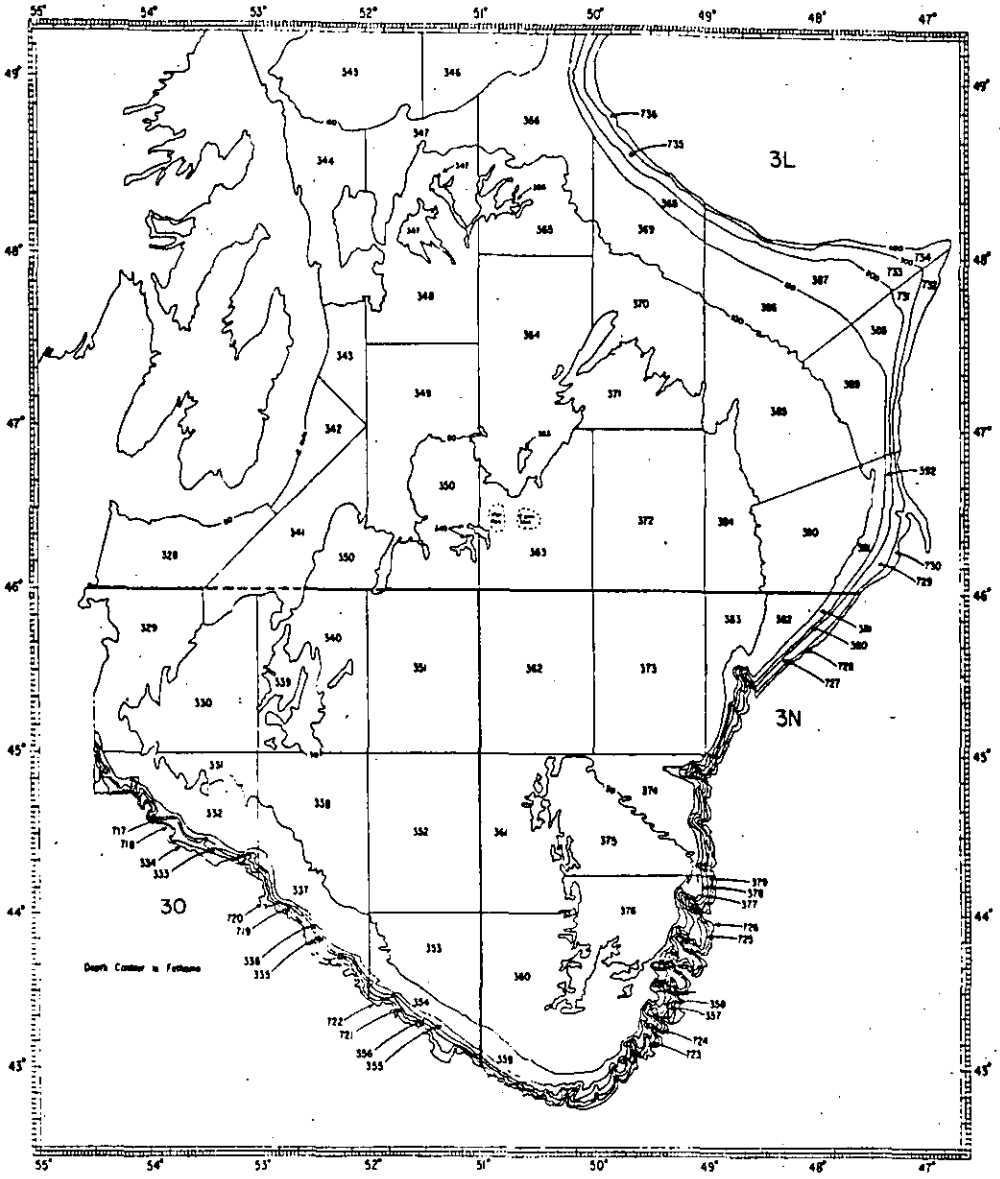


Fig. 2. Stratification scheme used for stratified-random research vessel groundfish surveys in NAFO Div. 3LNO

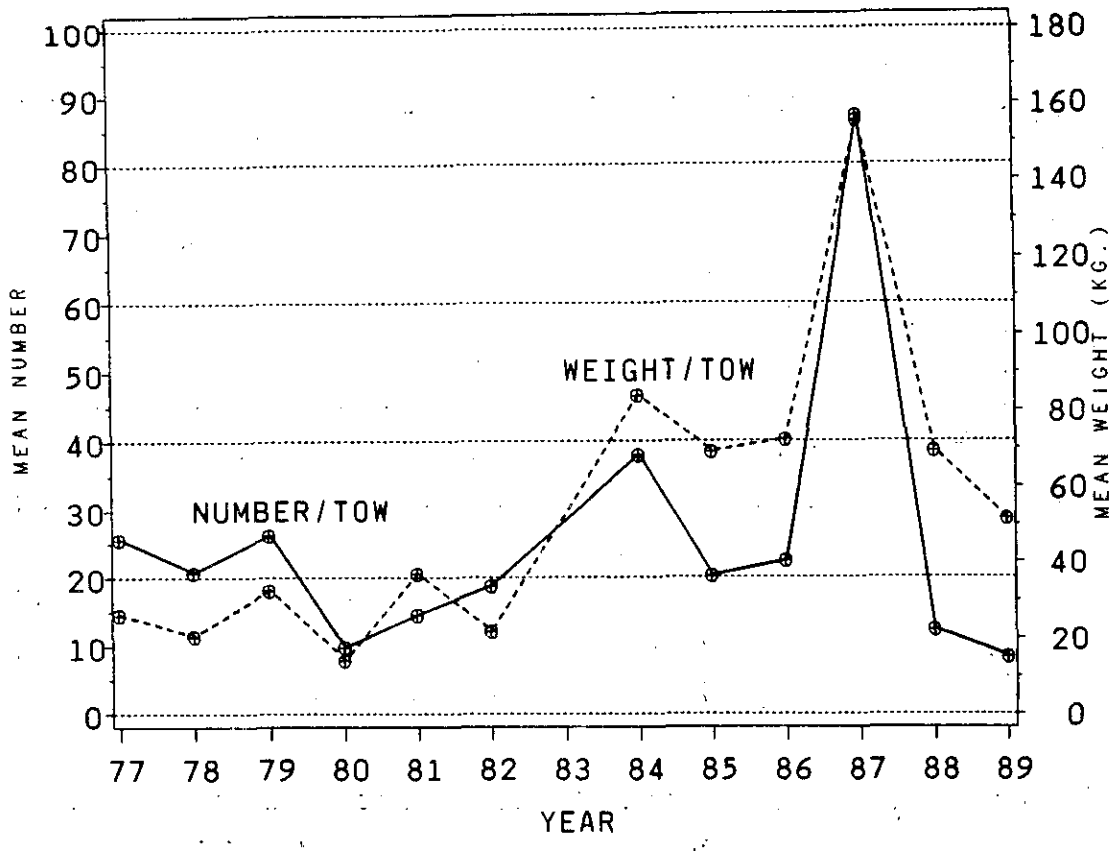


FIG. 3. Mean numbers and weights per tow of cod from Canadian RV surveys in Divisions 3no.

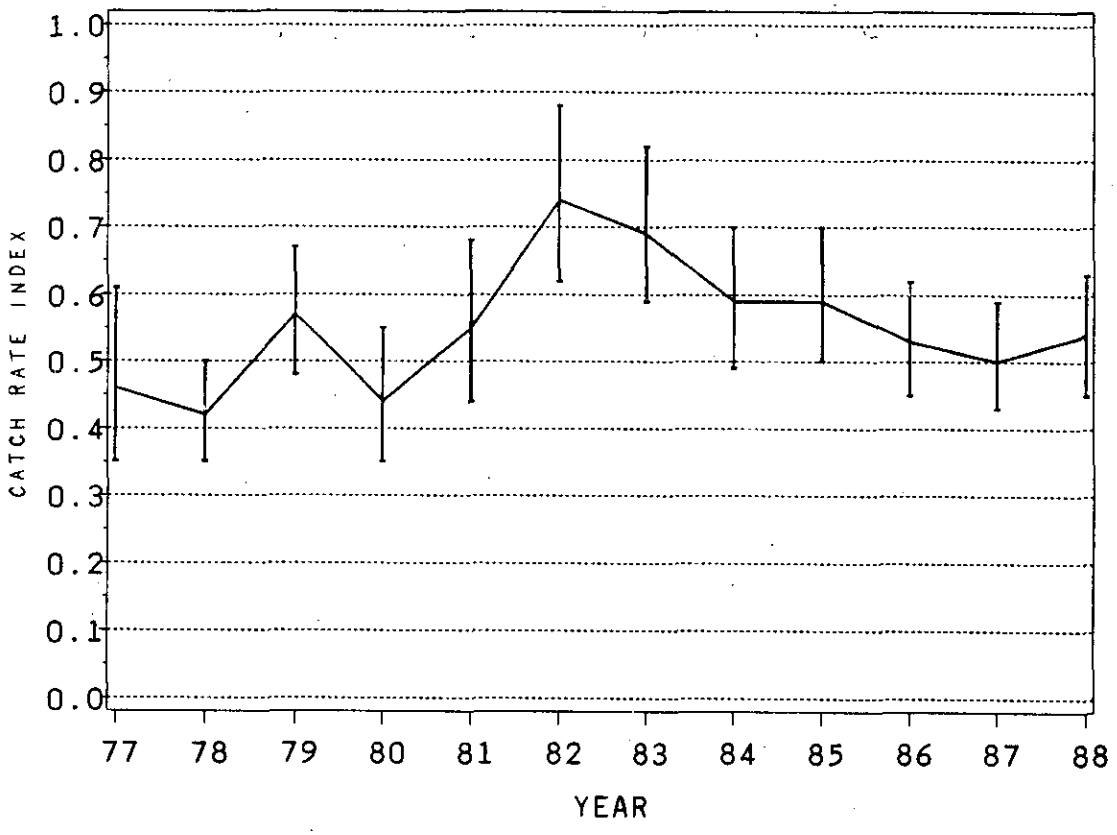


FIG 4. Catch rate index with approximate 90% C. I. for Div. 3NO cod using Canadian otter trawl data.

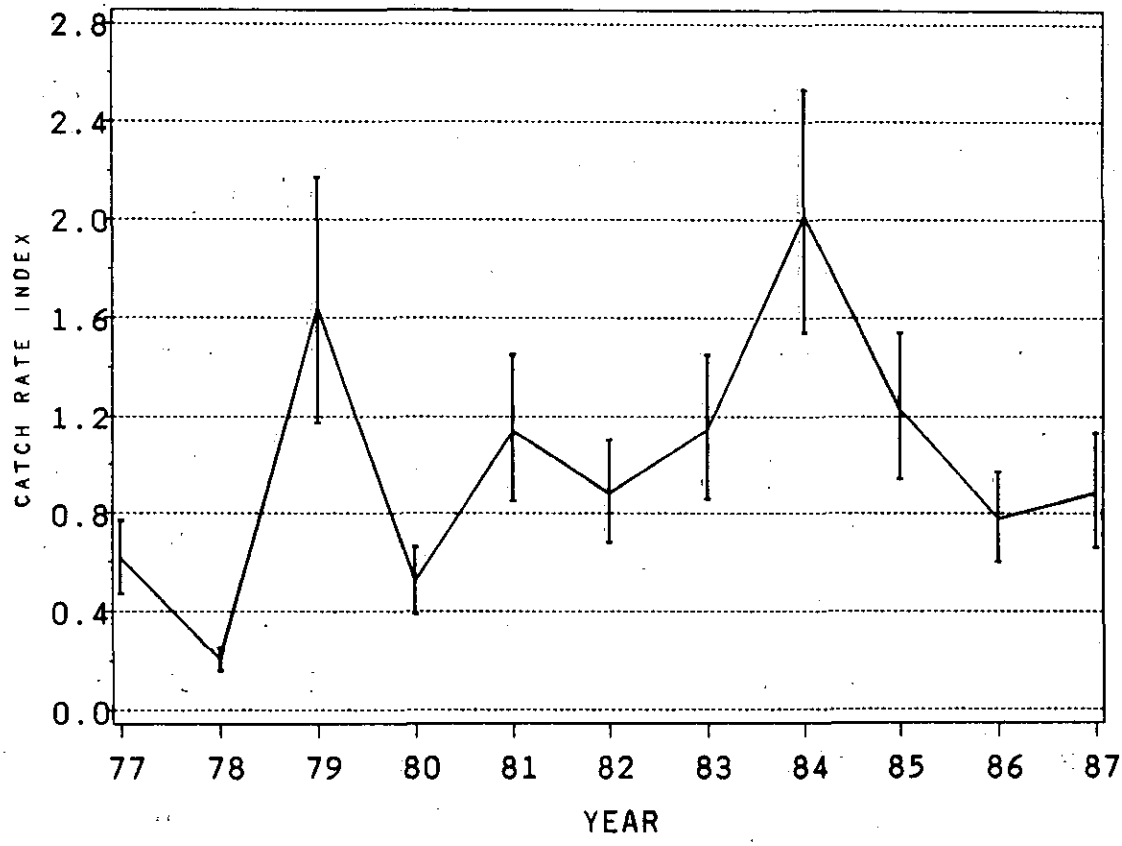


FIG 5. Catch rate index with approximate 90% C. I. for Div. 3NO cod using Spanish pairtrawl data.

APPENDIX I

Further on the Assessment of the Cod Stock in NAFO Div. 3NO

Catch and Weight at Age

Sampling data for 1988 were available for the entire Canadian fishery (given originally in this document), the Spanish pair trawl fishery for the fourth quarter (Vasquez & Gandaras, 1989) and the Portuguese gillnet fishery (Godinho, 1989). The Spanish pair trawl sampling data indicated that a relatively larger proportion of age 2 and 3 year-old cod were taken in the fourth quarter by this gear than was implied by any other sampling. It was decided, therefore, to adjust pair trawl catches for the first three quarters with Div. 3N Canadian sampling. Portuguese otter trawl catches, as well as catches for other countries were also adjusted using Canadian sampling. Table 1 shows the ase compositions for the various country/gear components involved in the cod fishery in Div. 3NO during 1988. The dominant yearclasses in the fishery were those of 1981 and 1982, the same yearclasses that dominated the 1987 commercial catch.

The average weights at age of cod taken commercially in Div. 3NO during 1988 are given in Table 2. Average weights associated with catches adjusted by Canadian sampling were combined with weights estimated from the Portuguese gillnet fishery. The calculated catch is about 94% of the 42,508 t of cod reported taken in 1988.

Catch and average weight at age for the 1959-88 period are given in Tables 3 and 4 respectively. The number of cod of age 4 years caught during 1988 is the lowest number taken at this age in the 30-year time series, indicating the weakness of the 1984 yearclass. The number of cod of age 6 years taken in 1988 is the largest since 1974, indicating that this yearclass maybe relatively strong. The average weights at age for 1988 are generally lower than those of recent years with the weights for ages 6 and 7 the lowest observed in the 30-year time series.

Commercial Catch/Effort

Standardized catch rates for Spanish pair trawls were derived by Canadian scientists for the 1977-87 period (originally in this document) and by Spanish scientists for the 1982-88 period (Vasquez & Gandaras, 1989). These indices agreed quite well for overlapping years (Table 5). The 1988 index derived by Spanish scientists was adjusted by the relationship between both indices for overlapping years and appended to the 1977-87 pair trawl catch-rate series derived from the Canadian analysis.

As was the case last year catch-rate indices from the Canadian otter trawl and Spanish pair trawl fisheries were combined after weighting the Canadian index to the area inside (80%) and the Spanish index to the area outside (20%) of the Canadian 200-mile fishery zone (Table 6). The combined catch-rate index, although variable in the earlier period, showed a general increase from 1977 to 1982, stability from 1982 to 1984 with a subsequent decline (Figure 1).

Estimation of Stock Size

Commmercial catch rate and research vessel survey indices of abundance were analysed in separate formulations of the adaptive framework. The commercial catch rate data used in ADAPT were the average of otter trawl and pair trawl indices given in Table 6. The partial recruitment used for this analysis was the average of the 1981-85 period and is as follows:

Age (years)	3	4	5	6	7-12
Partial recruitment	.08	.29	.67	.79	1.00

Parameters estimated in this formulation are given in Table 7 with January 1 population numbers and fishing mortalities shown in Table 8. The fully recruited F in this case is about 0.75 which is about 3-4 times the average of the 1977-84 period. The January 1 population numbers are the lowest observed in the 12-year analysis. It was stated in last years report that this catch-rate index may not reflect stock abundance because the definition of directed effort for the Canadian otter-trawl fleet may be inappropriate. This situation is unchanged and results of this calibration analysis should be regarded with caution.

A formulation of ADAPT using research vessel survey data included Canadian and Soviet information for the 1977-88 period. The Soviet data was taken from Bulatova et. al. (1989) and as well there was no Canadian survey in 1983. Parameter estimates and residuals from this formulation are given in Tables 9 and 10 respectively with population numbers and fishing mortality presented in Table 11. The fully recruited F for 1988 is about 0.65 while the age 3+ population abundance for that year is estimated to be about 42 million fish.

During the last assessment of this stock (NAFO SC Reports, 1989, p. 32) some years in both the Canadian and Soviet survey series were identified as anomalous because survey estimates at age for these years are not consistent with adjacent years. The years identified are 1984 and 1987 for Canadian surveys and 1985 for Soviet surveys. Discrepancies in the age structure were also identified for the 1987 Soviet survey data. While the average age for cod estimated from the survey is about 1 year less than the 1986 survey, the average weight of cod in the catches is about 3-4 times larger than that of 1986. A similar discrepancy occurs for 1988 although not to the same extent as 1987. It was decided to omit all the years described above in a final formulation of the adaptive framework.

That formulation is as follows:

PARAMETERS:

- Yearclass estimates
  $N_{i,1988}$ i = 3-9
- Calibration coefficients for RV numbers
  $K(Can)_i$ i = 3-9

  $K(USSR)_i$ i = 3-9

STRUCTURE:

- Natural mortality was assumed = 0.20.
- Error in catch at age assumed negligble.
- F on oldest age (12) calculated as total F for ages 7-10.
- F for ages 10-12 in 1988 set equal to the total F for ages 7-9 in 1988.
- Intercepts not fitted.

INPUT:

- $C_{i,t}$ i = 3-12, t = 1977-88
- $RV(Can)_{i,t}$ i = 3-9, t = 1977-82, 85-86, 88
- $RV(USSR)_{i,t}$ i = 3-9, t = 1977-84, 86

OBJECTIVE FUNCTION:

- Minimize

$$\sum_i \sum_t [obs(lnRV(Can)_{i,t}) - pred(lnRV(Can)_{i,t})]^2 +$$

$$\sum_i \sum_t [obs(lnRV(USSR)_{i,t}) - pred(lnRV(USSR)_{i,t})]^2$$

SUMMARY:

- Number of observations = 126
- Number of parameters = 21

Intercept terms, when included in the model, for the most case were not significant and gave unrealistic values for fishing mortality in 1988 so were therefore, not included in this final formulation. Abundance estimates for ages 3 and 4 were not significant and CV's for ages 5-9 were about 50% (Table 12). All slopes were significant with all CV's about 30%. Residuals shown in Table 13 and in Figs. 2-15 indicate that survey abundance estimated by Canada and the USSR may be too low. The information given in Table 14 indicates that there are no high correlations between estimated parameters. The age 3+ population abundance estimated from this analysis is about 73 million fish and is the lowest in the 12 year period analysed (Table 15). The fully recruited fishing mortality for 1988 is about 0.36.

The results of a cohort analysis for the 1959-88 period using fishing mortalities obtained from ADAPT are shown in Tables 16-18. The 1984 and 1985 year-classes at age 3 were estimated at 10 and 33 million individuals respectively.

References

Bulatova, A.Yu., S.A.Kuzmin, V.N.Petrov, and S.V.Ratusny. 1989. Assessment of cod stock in the NAFO Subarea 3 based on the 1988 trawl-acoustic survey data. NAFO SCR Doc. 89/5 Ser. No. N1569. 23 p.

Godinho, M.L. 1989. Portuguese research report. NAFO SCS Doc. 89/15. Ser. No. N1629. 12 p.

Vazquez,A. and G.P.Gandaras. 1989. Spanish research report for 1988. NAFO SCS Doc. 89/16. Ser. No. N1632. 10 p.

Table 1. Catch at age of cod (x 1000) in Divisions 3NO during 1988.

		Spain			Portugal			
Age	Canada	PT Qtr 1-3	PT Qtr 4	OT	GN	OT	USSR and Others	Total
2			256					256
3	32	1	235	1		4	3	276
4	148	35	91	6		16	18	314
5	700	375	159	47		87	131	1499
6	2765	2118	118	229		340	641	6211
7	1556	1431	152	140	7	192	394	3872
8	421	257	165	26	12	38	74	993
9	219	96	170	10	22	16	28	561
10	188	66	70	7	59	11	20	421
11	139	25	24	3	41	6	9	247
12	81	7	10	2	31	5	5	141
13	98	13		2	23	6	6	148
14	67	7		1	6	4	4	89
15	31	3		1	3	2	2	42
16	7	1				1	1	10
17	5	1						6
18	1							1
Tot.	6458	4436	1450	475	227	728	1336	15103
Catch (t)	19701	9052	5771	1066	2095	1832	2991	42508

Note - Spanish pair trawl catch at age for quarter 4 and Portuguese gillnet catch at age were obtained from respective Research Reports, all others were derived using Canadian sampling.

Table 2. Weight at age of cod (kg.) in Divisions 3NO during 1988.

	Canadian sampling		Portuguese gillnet		Average	
Age	No.	Wt.	No.	Wt.	No.	Wt.
3	41	0.74			41	0.74
4	224	1.00			224	1.00
5	1341	1.38			1341	1.38
6	6093	1.79			6093	1.79
7	3713	2.22	7	4.86	3720	2.23
8	816	3.74	12	5.93	828	3.77
9	368	5.00	22	7.11	390	5.12
10	291	6.63	59	8.13	350	6.88
11	182	9.35	41	9.46	223	9.37
12	100	11.20	31	10.66	131	11.07
13	125	12.61	23	12.35	148	12.57
14	83	14.31	6	12.43	89	14.18
15	38	14.84	3	12.84	41	14.69
16	9	17.73			9	17.73
17	6	18.51			6	18.51
18	1	20.75			1	20.75

Note - Average weight-at-age data not available for quarter 4 Spanish pair trawl sampling.

TABLE 3. CATCH AT AGE FOR DIV. 3NO COD, 1959-88 10/ 6/89

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
3	1711	1846	812	1026	313	6202	1013	753	20086	16359
4	13036	6503	4400	3882	5757	15555	7611	18413	62442	56775
5	5068	22050	11696	2206	11210	19496	7619	19681	50317	48608
6	6025	3095	15258	1581	4849	7919	13258	11795	18517	18485
7	3935	2377	2014	3594	1935	2273	9861	8486	4774	6337
8	1392	2504	1672	773	3840	1109	4827	4467	4651	1592
9	757	583	847	668	1165	788	1081	1829	236	505
10	926	387	196	433	608	328	1248	1694	180	178
11	1220	898	25	226	322	37	163	122	71	90
12	103	242	245	216	208	112	141	57	45	45
3+	34173	40485	37165	14605	30207	53819	46822	67297	161319	148974
4+	32462	38639	36353	13579	29894	47617	45809	66544	141233	132615
5+	19426	32136	31953	9697	24137	32062	38198	48131	78791	75840
6+	14358	10086	20257	7491	12927	12566	30579	28450	28474	27232

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	8154	2105	950	69	10058	6425	671	4054	607	920	72
4	12924	19703	26900	19797	27600	9501	8781	7534	2469	4337	3827
5	26949	10799	30300	12289	15098	10907	3528	5945	2531	2518	9208
6	11191	9481	11700	13432	5989	10872	2505	1084	1500	818	2784
7	2089	3646	3500	5883	1971	2247	3057	211	572	354	883
8	1393	1635	2500	1686	972	2147	1059	238	177	102	265
9	518	541	500	285	707	1015	921	44	209	58	58
10	292	149	200	216	243	676	461	37	65	51	17
11	134	227	100	78	137	428	252	13	41	8	12
12	202	90	50	74	116	257	152	9	25	5	7
3+	63846	48376	76700	53809	62891	44475	21387	19169	8196	9171	17133
4+	55692	46271	75750	53740	52833	38050	20716	15115	7589	8251	17061
5+	42768	26568	48850	33943	25233	28549	11935	7581	5120	3914	13234
6+	15819	15769	18550	21654	10135	17642	8407	1636	2589	1396	4026

	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	280	478	305	1179	58	57	155	486	276
4	1138	1032	1978	647	1000	2953	2836	394	314
5	3789	1194	1591	1893	1411	6203	6375	3249	1499
6	2057	2173	1012	1204	2324	3036	4357	3204	6211
7	665	1805	1528	686	1220	2519	1505	1123	3872
8	185	543	1492	1152	720	797	960	609	993
9	75	182	595	774	918	459	568	792	561
10	27	89	211	238	551	533	392	465	421
11	7	39	162	81	106	261	379	374	247
12	13	12	27	41	42	97	149	380	141
3+	8236	7547	8901	7895	8350	16915	17676	11076	14535
4+	7956	7069	8596	6716	8292	16858	17521	10590	14259
5+	6818	6037	6618	6069	7292	13905	14685	10196	13945
6+	3029	4843	5027	4176	5881	7702	8310	6947	12446

TABLE 4. WEIGHT AT AGE FOR DIV. 3NO COD, 1959-88 10/ 6/89

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.48	0.48	0.48	0.48
4	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.90	0.90	0.90	0.90
5	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.35	1.35	1.35	1.35
6	1.95	1.95	1.95	1.95	1.95	1.95	1.95	2.14	2.14	2.14	2.14
7	2.82	2.82	2.82	2.82	2.82	2.82	2.82	3.16	3.16	3.16	3.16
8	3.39	3.39	3.39	3.39	3.39	3.39	3.39	4.21	4.21	4.21	4.21
9	3.98	3.98	3.98	3.98	3.98	3.98	3.98	6.34	6.34	6.34	6.34
10	4.68	4.68	4.68	4.68	4.68	4.68	4.68	7.69	7.69	7.69	7.69
11	5.25	5.25	5.25	5.25	5.25	5.25	5.25	8.46	8.46	8.46	8.46
12	6.17	6.17	6.17	6.17	6.17	6.17	6.17	10.24	10.24	10.24	10.24

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	0.48	0.48	0.54	0.57	0.42	0.38	0.50	0.57	0.72	0.65	0.71
4	0.90	0.90	0.97	1.00	0.73	0.89	0.91	1.00	1.05	0.98	1.04
5	1.35	1.35	1.44	1.43	1.20	1.28	1.41	1.48	1.55	1.39	1.69
6	2.14	2.14	2.08	2.19	1.96	2.13	2.33	2.48	2.25	2.09	2.50
7	3.16	3.16	2.89	3.63	2.86	3.14	3.25	3.51	3.74	2.87	3.69
8	4.21	4.21	3.56	4.63	4.67	4.16	4.03	4.74	4.61	3.70	5.49
9	6.34	6.34	5.95	6.25	7.32	5.53	6.67	7.17	6.19	4.75	7.98
10	7.69	7.69	7.95	9.56	5.46	6.74	8.74	8.81	7.23	7.15	9.22
11	8.46	8.46	8.32	11.17	8.40	5.27	9.14	11.70	9.48	7.98	10.60
12	10.24	10.24	10.14	13.99	7.51	7.09	12.49	11.47	12.87	10.11	12.61

	1981	1982	1983	1984	1985	1986	1987	1988
3	0.90	0.94	0.85	0.79	0.48	0.39	0.49	0.74
4	1.27	1.17	1.17	1.15	0.86	1.00	0.82	1.00
5	1.84	1.50	1.67	1.51	1.37	1.65	1.30	1.38
6	2.69	2.20	2.63	2.28	2.05	2.15	1.83	1.79
7	3.55	3.83	3.80	3.04	3.25	3.50	2.88	2.23
8	5.33	5.26	5.20	4.05	4.65	5.43	4.76	3.77
9	7.13	7.49	6.27	5.76	6.62	7.95	7.27	5.12
10	9.10	8.80	8.08	7.22	8.32	9.76	8.95	6.88
11	9.01	9.82	8.99	8.92	9.15	9.91	9.86	9.37
12	10.15	12.28	11.01	12.61	11.13	9.90	12.59	11.07

Table 5. Estimation of "standardized" catch rate for Spanish pair trawls for 1988.

	Pair trawl CPUE		
Year	Canadian Analysis(a)	Spanish Analysis(b)	
1982	0.862	0.520	
1983	1.117	0.698	
1984	1.974	1.053	a = 1.9787b - 0.1304
1985	1.204	0.576	R-squared = 0.94
1986	0.763	0.467	
1987	0.864	0.510	
1988	(1.108)	0.626	

Table 6. Catch rate index derived from averaging Canadian otter trawl and Spanish pair trawl catch rates.

	Standardized catch rates		Normalized catch rates		Weighted average
Year	OT	PT	OT	PT	OT&PT
1977	0.463	0.601	0.840	0.606	0.793
1978	0.416	0.200	0.755	0.202	0.644
1979	0.571	1.594	1.036	1.607	1.150
1980	0.437	0.506	0.793	0.510	0.736
1981	0.547	1.114	0.993	1.123	1.019
1982	0.737	0.862	1.338	0.869	1.244
1983	0.693	1.117	1.258	1.126	1.231
1984	0.589	1.974	1.069	1.990	1.253
1985	0.591	1.204	1.073	1.214	1.101
1986	0.529	0.763	0.960	0.769	0.922
1987	0.502	0.864	0.911	0.871	0.903
1988	0.535	1.108	0.971	1.117	1.000

TABLE 7. RESULTS FROM ADAPT USING CPUE DATA SHOWING PARAMETER ESTIMATE OF AGE 7 ABUNDANCE WITH CORRESPONDING SLOPE, RESIDUALS BETWEEN LN OBS. AND PRED. CPUE AND CORRELATIONS BETWEEN ESTIMATED PARAMETERS.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.000605
MEAN SQUARE RESIDUALS 0.134446

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
7	ABUNDANCE	8.14702E3	2.95581E3	2.7562SE0	0.36
7	C/E SLOPE	1.03949E 5	1.48940E 6	6.97927E0	0.14

LOG RESIDUALS FOR COMMERCIAL CPUE (OT+PT) INDEX 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	0.802	-0.112	0.320	-0.446	-0.060	0.003	-0.075	0.088	-0.264	-0.456	-0.092

	1988
	0.290

SUM OF CPUE RESIDUALS : -0.0020000000 MEAN RESIDUAL : -0.0001666667

PARAMETER CORRELATION MATRIX 13/ 6/89

	1	2
1	1.000	-0.674
2	-0.674	1.000

TABLE 8. JANUARY 1 POPULATION NUMBERS AND FISHING MORTALITY FOR COD IN DIV. 3NO DERIVED FROM ADAPT USING COMMERCIAL CPUE.

POPULATION NUMBERS (000S) 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	44381	38612	16731	18852	26528	19047	30017	38894	37045	6931
4	18192	35787	30780	13633	15181	21286	15318	23509	31791	30279
5	7848	12661	25376	21738	10132	11496	15638	11956	18343	23356
6	4155	4135	8087	12444	14369	7215	7972	11091	8512	9405
7	1340	2045	2645	4102	8327	9798	4991	5438	6977	4222
8	444	580	1354	1367	2757	5184	6639	3466	3348	3433
9	483	204	382	869	952	1766	2895	4394	2186	2020
10	120	206	114	261	643	615	907	1670	2766	1375
11	78	40	122	78	189	446	312	528	868	1783
12	57	27	25	89	58	119	219	182	336	475
3+	77099	94295	85617	73433	79136	76972	84909	101126	112174	83278

	1987	1988
3	2707	5258
4	5534	1777
5	22224	4174
6	13354	15256
7	3758	8034
8	2095	2060
9	1942	1164
10	1140	874
11	771	513
12	1117	293
3+	54642	39403

FISHING MORTALITY 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	0.015	0.027	0.005	0.017	0.020	0.018	0.044	0.002	0.002	0.025	0.221	0.060
4	0.163	0.144	0.148	0.097	0.078	0.108	0.048	0.048	0.108	0.109	0.082	0.216
5	0.441	0.248	0.513	0.214	0.140	0.166	0.144	0.140	0.468	0.359	0.176	0.499
6	0.509	0.247	0.479	0.202	0.183	0.168	0.183	0.263	0.501	0.717	0.308	0.589
7	0.638	0.212	0.460	0.197	0.274	0.189	0.165	0.285	0.509	0.501	0.401	0.745
8	0.580	0.216	0.244	0.162	0.245	0.383	0.213	0.261	0.305	0.370	0.388	0.745
9	0.651	0.378	0.183	0.100	0.237	0.466	0.350	0.263	0.264	0.372	0.599	0.745
10	0.911	0.320	0.180	0.122	0.166	0.477	0.342	0.454	0.239	0.379	0.599	0.745
11	0.874	0.253	0.115	0.104	0.259	0.513	0.338	0.251	0.404	0.268	0.769	0.745
12	0.646	0.232	0.365	0.174	0.259	0.285	0.231	0.292	0.381	0.421	0.466	0.745

TABLE 9. PARAMETER ESTIMATES FOR AGE 3-9 ABUNDANCE WITH CORRESPONDING SLOPES FROM ADAPT USING CANADIAN AND SOVIET RV DATA.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.042273
MEAN SQUARE RESIDUALS 0.921993

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
3	ABUNDANCE	1.34533E4	9.51962E3	1.41321E0	0.71
4	ABUNDANCE	2.82946E3	1.44306E3	1.96073E0	0.51
5	ABUNDANCE	2.93263E3	1.03389E3	2.83651E0	0.35
6	ABUNDANCE	8.36428E3	1.83743E3	4.55216E0	0.22
7	ABUNDANCE	7.44155E3	2.64831E3	2.80993E0	0.36
8	ABUNDANCE	3.54536E3	1.57497E3	2.25107E0	0.44
9	ABUNDANCE	2.08144E3	9.01101E2	2.30989E0	0.43
3	RV1 SLOPE	1.75866E-4	5.39153E-5	3.26189E0	0.31
4	RV1 SLOPE	2.74563E-4	8.23065E-5	3.33586E0	0.30
5	RV1 SLOPE	2.67917E-4	8.01475E-5	3.34279E0	0.30
6	RV1 SLOPE	2.29363E-4	6.95732E-5	3.29671E0	0.30
7	RV1 SLOPE	2.33967E-4	7.20670E-5	3.24653E0	0.31
8	RV1 SLOPE	2.37498E-4	7.24405E-5	3.27853E0	0.31
9	RV1 SLOPE	3.21071E-4	9.79469E-5	3.27801E0	0.31
3	RV2 SLOPE	6.11276E-4	1.79348E-4	3.40833E0	0.29
4	RV2 SLOPE	5.27233E-4	1.51618E-4	3.47737E0	0.29
5	RV2 SLOPE	4.92587E-4	1.41946E-4	3.47025E0	0.29
6	RV2 SLOPE	4.71945E-4	1.39072E-4	3.39353E0	0.29
7	RV2 SLOPE	4.77865E-4	1.42459E-4	3.35440E0	0.30
8	RV2 SLOPE	4.64849E-4	1.37292E-4	3.38584E0	0.30
9	RV2 SLOPE	6.15695E-4	1.81099E-4	3.39976E0	0.29

TABLE 10. RESIDUALS BETWEEN LN OBS. AND PRED. RV FROM ADAPT USING CANADIAN AND SOVIET SURVEYS.

LOG RESIDUALS FOR CANADIAN RV SURVEY INDEX 13/ 6/89

	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987
3	0.252	0.093	-0.160	-0.835	0.220	-1.133	0.011	0.123	-0.137	1.516
4	0.318	-0.047	0.163	-1.650	-0.876	-0.429	0.379	-0.221	0.483	2.251
5	0.968	-0.137	0.383	-1.643	-0.277	-1.546	0.453	-0.649	0.272	2.431
6	0.674	0.184	0.181	-1.773	-0.292	-1.167	0.923	-0.773	-0.248	2.179
7	0.677	0.392	0.048	-1.416	-0.396	-1.066	0.522	-0.314	-0.464	2.009
8	0.958	-1.097	-0.075	-0.505	-0.120	-0.609	0.326	0.050	-0.082	0.995
9	-0.189	-1.665	-0.101	-0.386	0.689	-0.596	0.251	0.352	-0.114	1.326

	1988
3	0.013
4	-0.410
5	-0.291
6	0.075
7	-0.030
8	0.121
9	0.397

SUM OF RV 1 RESIDUALS : -0.2609854046 MEAN RESIDUAL : -0.0033894208

LOG RESIDUALS FOR SOVIET RV SURVEY INDEX 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	-0.067	-0.192	-0.899	-1.070	-0.803	-0.190	-0.396	0.482	1.577	1.516
4	0.488	0.045	-1.339	-0.960	-0.521	0.053	0.124	0.697	1.299	1.580
5	0.975	0.767	-0.961	-1.282	-0.809	0.754	0.154	0.757	1.658	1.038
6	0.974	0.930	-0.673	-0.802	-1.629	0.278	0.874	0.330	1.275	0.993
7	1.429	0.677	-0.143	-0.305	-1.394	-0.538	0.488	0.514	1.020	0.825
8	1.735	0.974	-0.259	0.257	-0.958	-2.235	-0.355	0.318	0.805	1.204
9	0.427	0.742	-0.013	-0.461	-0.881	0.407	0.286	-0.828	0.087	0.935

	1987	1988
3	0.025	-0.019
4	-0.579	-0.924
5	-1.642	-1.446
6	-1.507	-1.078
7	-0.969	-1.641
8	-0.401	-1.123
9	-0.083	-0.657

SUM OF RV 2 RESIDUALS : -0.2604035955 MEAN RESIDUAL : -0.0031000428

TABLE 11. JANUARY 1 POPULATION NUMBERS AND FISHING MORTALITY FOR COD IN DIV 3NO DERIVED FROM ADAPT USING CANADIAN AND SOVIET RV DATA.

POPULATION NUMBERS (000S) 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	44817	40810	16922	19126	26910	22041	33978	37317	24057	5012
4	18283	36144	32580	13789	15406	21599	17769	26752	30500	19644
5	7895	12735	25668	23211	10260	11679	15894	13963	20998	22299
6	4205	4174	8148	12683	15575	7320	8123	11300	10155	11579
7	1362	2086	2677	4152	8523	10786	5077	5561	7149	5567
8	447	598	1387	1393	2798	5345	7448	3536	3449	3574
9	485	206	397	896	973	1799	3026	5056	2244	2103
10	121	208	116	273	666	632	935	1777	3309	1422
11	78	40	124	80	199	465	327	550	956	2227
12	58	27	26	91	59	127	234	194	354	547
3+	77752	97027	88045	75694	81368	81793	92811	106005	103170	73973

	1987	1988
3	3980	13426
4	3963	2819
5	13517	2888
6	12489	8127
7	5538	7326
8	3196	3518
9	2057	2066
10	1207	968
11	809	568
12	1480	324
3+	48237	42029

FISHING MORTALITY 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	0.015	0.025	0.005	0.016	0.020	0.015	0.039	0.002	0.003	0.035	0.145	0.023
4	0.162	0.142	0.139	0.096	0.077	0.107	0.041	0.042	0.113	0.174	0.116	0.131
5	0.437	0.247	0.505	0.199	0.138	0.163	0.141	0.118	0.395	0.380	0.309	0.832
6	0.501	0.244	0.474	0.198	0.167	0.166	0.179	0.258	0.401	0.538	0.333	1.718
7	0.624	0.208	0.453	0.195	0.267	0.170	0.162	0.278	0.493	0.355	0.254	0.856
8	0.575	0.209	0.237	0.159	0.241	0.369	0.187	0.255	0.295	0.352	0.236	0.370
9	0.646	0.373	0.176	0.097	0.232	0.455	0.332	0.224	0.256	0.355	0.554	0.354
10	0.903	0.316	0.176	0.116	0.160	0.460	0.330	0.420	0.196	0.363	0.554	0.644
11	0.863	0.249	0.113	0.102	0.244	0.487	0.320	0.240	0.359	0.208	0.715	0.644
12	0.636	0.227	0.357	0.171	0.253	0.265	0.214	0.271	0.357	0.355	0.331	0.644

TABLE 12. PARAMETER ESTIMATES FOR AGE 3-9 ABUNDANCE WITH CORRESPONDING SLOPES FROM ADAPT USING CANADIAN AND SOVIET RV DATA WITH YEARS DETERMINED TO BE ANOMALOUS OMITTED.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.072554
MEAN SQUARE RESIDUALS 0.647802

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
3	ABUNDANCE	2.03403E4	1.73947E4	1.16933E0	0.86
4	ABUNDANCE	2.94083E3	2.41267E3	1.21891E0	0.82
5	ABUNDANCE	5.95420E3	2.95609E3	2.01422E0	0.50
6	ABUNDANCE	2.09762E4	9.82663E3	2.13462E0	0.47
7	ABUNDANCE	1.34869E4	6.23969E3	2.16147E0	0.46
8	ABUNDANCE	4.10173E3	2.30672E3	1.77816E0	0.56
9	ABUNDANCE	2.39001E3	1.26997E3	1.88193E0	0.53
3	RV1 SLOPE	1.18072E-4	3.56881E-5	3.30844E0	0.30
4	RV1 SLOPE	1.76059E-4	5.27483E-5	3.33772E0	0.30
5	RV1 SLOPE	1.63055E-4	4.71209E-5	3.46035E0	0.29
6	RV1 SLOPE	1.33666E-4	3.85349E-5	3.46870E0	0.29
7	RV1 SLOPE	1.54223E-4	4.53890E-5	3.39780E0	0.29
8	RV1 SLOPE	1.88098E-4	5.52655E-5	3.40354E0	0.29
9	RV1 SLOPE	2.47517E-4	7.22188E-5	3.42732E0	0.29
3	RV2 SLOPE	4.42464E-4	1.27021E-4	3.48339E0	0.29
4	RV2 SLOPE	4.76059E-4	1.33610E-4	3.56304E0	0.28
5	RV2 SLOPE	5.26741E-4	1.48994E-4	3.53531E0	0.28
6	RV2 SLOPE	5.12536E-4	1.44427E-4	3.54877E0	0.28
7	RV2 SLOPE	5.35691E-4	1.51156E-4	3.54397E0	0.28
8	RV2 SLOPE	4.67117E-4	1.30764E-4	3.57220E0	0.28
9	RV2 SLOPE	6.15712E-4	1.72565E-4	3.56801E0	0.28

TABLE 13. RESIDUALS BETWEEN LN OBS. AND PRED. RV FROM ADAPT USING CANADIAN AND SOVIET SURVEYS WITH ANOMALOUS YEARS OMITTED.

LOG RESIDUALS FOR CANADIAN RV SURVEY INDEX 13/ 6/89

	1977	1978	1979	1980	1981	1982	1985	1986	1988
3	0.639	0.449	0.173	-0.520	0.536	-0.780	-0.152	-0.386	-0.005
4	0.747	0.384	0.562	-1.273	-0.517	-0.072	-0.095	0.223	-0.006
5	1.451	0.341	0.862	-1.200	0.143	-1.145	-0.207	0.387	-0.680
6	1.194	0.705	0.695	-1.258	0.184	-0.714	-0.295	0.208	-0.766
7	1.074	0.781	0.438	-1.037	-0.010	-0.725	-0.058	-0.137	-0.373
8	1.179	-0.895	0.124	-0.309	0.066	-0.418	0.104	-0.088	0.188
9	0.054	-1.425	0.122	-0.167	0.905	-0.399	0.456	-0.093	0.500

SUM OF RV 1 RESIDUALS : 0.3348331494 MEAN RESIDUAL : 0.0053148119

LOG RESIDUALS FOR SOVIET RV SURVEY INDEX 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1986
3	0.244	0.089	-0.642	-0.830	-0.563	0.087	-0.117	0.497	1.188
4	0.574	0.134	-1.284	-0.928	-0.506	0.067	0.179	0.753	0.963
5	0.894	0.680	-1.047	-1.404	-0.954	0.589	-0.013	0.639	0.568
6	0.870	0.828	-0.784	-0.911	-1.777	0.106	0.676	0.127	0.818
7	1.293	0.534	-0.286	-0.459	-1.541	-0.730	0.269	0.256	0.615
8	1.717	0.938	-0.300	0.214	-1.011	-2.285	-0.452	0.185	0.947
9	0.409	0.720	-0.051	-0.503	-0.928	0.339	0.223	-0.940	0.684

SUM OF RV 2 RESIDUALS : -0.3349307946 MEAN RESIDUAL : -0.0053163619

TABLE 14. CORRELATIONS BETWEEN ESTIMATED PARAMETERS FROM ADAPT USING CANADIAN AND SOVIET SURVEYS WITH ANOMALOUS YEARS OMITTED.

PARAMETER CORRELATION MATRIX 13/ 6/89

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	0.01	0.08	0.07	0.06	0.04	0.06	-0.35	-0.03	-0.04	-0.03	-0.03
2	0.01	1.00	0.02	0.07	0.09	0.04	0.04	-0.03	-0.35	-0.03	-0.03	-0.04
3	0.08	0.02	1.00	0.06	0.13	0.09	0.09	-0.23	-0.05	-0.26	-0.05	-0.06
4	0.07	0.07	0.06	1.00	0.12	0.11	0.11	-0.20	-0.20	-0.06	-0.25	-0.06
5	0.06	0.09	0.13	0.12	1.00	0.12	0.20	-0.16	-0.25	-0.26	-0.14	-0.35
6	0.04	0.04	0.09	0.11	0.12	1.00	0.13	-0.11	-0.11	-0.19	-0.24	-0.15
7	0.06	0.04	0.09	0.11	0.20	0.13	1.00	-0.17	-0.10	-0.11	-0.20	-0.26
8	-0.35	-0.03	-0.23	-0.20	-0.16	-0.11	-0.17	1.00	0.08	0.10	0.10	0.09
9	-0.03	-0.35	-0.05	-0.20	-0.25	-0.11	-0.10	0.08	1.00	0.08	0.09	0.11
10	-0.04	-0.03	-0.26	-0.06	-0.26	-0.19	-0.11	0.10	0.08	1.00	0.08	0.11
11	-0.03	-0.03	-0.05	-0.25	-0.14	-0.24	-0.20	0.10	0.09	0.08	1.00	0.10
12	-0.03	-0.04	-0.06	-0.06	-0.35	-0.15	-0.26	0.09	0.11	0.11	0.10	1.00
13	-0.03	-0.03	-0.06	-0.06	-0.23	-0.36	-0.14	0.08	0.09	0.11	0.11	0.13
14	-0.03	-0.03	-0.06	-0.06	-0.25	-0.15	-0.34	0.09	0.09	0.10	0.10	0.15
15	-0.04	-0.03	-0.23	-0.06	-0.25	-0.17	-0.17	0.10	0.08	0.13	0.08	0.12
16	-0.03	-0.03	-0.04	-0.19	-0.15	-0.17	-0.16	0.08	0.08	0.07	0.11	0.09
17	-0.02	-0.03	-0.05	-0.05	-0.28	-0.11	-0.18	0.07	0.08	0.09	0.08	0.13
18	-0.02	-0.02	-0.05	-0.05	-0.19	-0.26	-0.12	0.06	0.07	0.09	0.09	0.10
19	-0.02	-0.02	-0.05	-0.05	-0.19	-0.14	-0.26	0.07	0.07	0.08	0.09	0.12
20	-0.02	-0.03	-0.05	-0.05	-0.23	-0.17	-0.15	0.06	0.07	0.09	0.08	0.11
21	-0.02	-0.03	-0.05	-0.05	-0.22	-0.18	-0.17	0.06	0.07	0.09	0.08	0.11

	13	14	15	16	17	18	19	20	21
1	-0.03	-0.03	-0.04	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02
2	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.03	-0.03
3	-0.06	-0.06	-0.23	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05
4	-0.06	-0.06	-0.06	-0.19	-0.05	-0.05	-0.05	-0.05	-0.05
5	-0.23	-0.25	-0.25	-0.15	-0.28	-0.19	-0.19	-0.23	-0.22
6	-0.36	-0.15	-0.17	-0.17	-0.11	-0.26	-0.14	-0.17	-0.18
7	-0.14	-0.34	-0.17	-0.16	-0.18	-0.12	-0.26	-0.15	-0.17
8	0.08	0.09	0.10	0.08	0.07	0.06	0.07	0.06	0.06
9	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07
10	0.11	0.10	0.13	0.07	0.09	0.09	0.08	0.09	0.09
11	0.11	0.10	0.08	0.11	0.08	0.09	0.09	0.08	0.08
12	0.13	0.15	0.12	0.09	0.13	0.10	0.12	0.11	0.11
13	1.00	0.12	0.11	0.09	0.10	0.12	0.10	0.11	0.11
14	0.12	1.00	0.11	0.09	0.11	0.09	0.12	0.10	0.10
15	0.11	0.11	1.00	0.07	0.10	0.09	0.09	0.09	0.09
16	0.09	0.09	0.07	1.00	0.07	0.07	0.07	0.07	0.07
17	0.10	0.11	0.10	0.07	1.00	0.08	0.09	0.09	0.09
18	0.12	0.09	0.09	0.07	0.08	1.00	0.08	0.08	0.08
19	0.10	0.12	0.09	0.07	0.09	0.08	1.00	0.08	0.08
20	0.11	0.10	0.09	0.07	0.09	0.08	0.08	1.00	0.08
21	0.11	0.10	0.09	0.07	0.09	0.08	0.08	0.08	1.00

TABLE 15. JANUARY 1 POPULATION NUMBERS AND FISHING MORTALITY FOR COD IN DIV. 3NO DERIVED FROM ADAPT USING CANADIAN AND SOVIET RV DATA WITH ANOMALOUS YEARS OMITTED.

POPULATION NUMBERS (000S) 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	45364	42576	18073	20777	29215	23064	35490	50789	47155	9523
4	18554	36591	34026	14732	16758	23486	18607	27990	41530	38556
5	7987	12957	26034	24396	11032	12786	17439	14649	22011	31330
6	4272	4249	8330	12983	16545	7952	9029	12565	10717	12408
7	1383	2140	2738	4301	8769	11580	5595	6303	8185	6027
8	452	615	1432	1443	2920	5546	8098	3960	4056	4422
9	491	210	411	933	1014	1899	3191	5588	2591	2600
10	122	213	119	284	696	666	1016	1912	3744	1706
11	79	41	128	82	208	489	354	617	1067	2583
12	59	28	26	94	61	135	254	217	409	637
3+	78763	99621	91319	80026	87216	87603	99073	124589	141465	109793

	1987	1988
3	4116	20301
4	7657	2930
5	29001	5912
6	19883	20804
7	6217	13379
8	3573	4074
9	2752	2374
10	1615	1536
11	1042	901
12	1772	514
3+	77626	72727

FISHING MORTALITY 13/ 6/89

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	0.015	0.024	0.004	0.015	0.018	0.015	0.037	0.001	0.001	0.018	0.140	0.015
4	0.159	0.140	0.133	0.089	0.070	0.098	0.039	0.040	0.082	0.085	0.059	0.126
5	0.431	0.242	0.496	0.188	0.127	0.148	0.128	0.113	0.373	0.255	0.132	0.326
6	0.491	0.239	0.461	0.192	0.157	0.152	0.159	0.229	0.376	0.491	0.196	0.396
7	0.611	0.202	0.441	0.187	0.258	0.158	0.146	0.241	0.416	0.323	0.223	0.382
8	0.567	0.202	0.229	0.153	0.230	0.353	0.171	0.224	0.245	0.274	0.209	0.311
9	0.635	0.365	0.169	0.093	0.221	0.425	0.312	0.200	0.218	0.276	0.393	0.300
10	0.891	0.307	0.172	0.111	0.152	0.431	0.299	0.383	0.171	0.293	0.383	0.358
11	0.847	0.243	0.109	0.099	0.232	0.456	0.292	0.211	0.315	0.177	0.505	0.358
12	0.623	0.220	0.346	0.164	0.244	0.248	0.196	0.240	0.302	0.297	0.269	0.358

TABLE 16. Jan 1 Population numbers for cod in Div. 3NO with F_t = 0.358 for 1988.

POPULATION NUMBERS (x 10^4)

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
3	5368	5309	8214	10776	7825	11238	16252	20999	18324	10050
4	9390	4240	4180	6652	8729	6378	8640	13215	17124	13185
5	1949	6508	2883	3024	5095	6626	3815	6385	9153	8370
6	1646	1137	3383	1302	2276	3157	3661	2434	3447	2941
7	1234	802	651	1348	923	1425	1868	1798	925	1147
8	428	654	442	351	779	581	961	637	704	326
9	286	225	309	210	217	290	375	350	117	156
10	336	166	131	176	112	72	166	209	121	75
11	220	191	101	90	105	37	30	23	18	83
12	30	70	75	80	53	57	27	10	8	8
3+	20888	19303	20320	24009	26115	29862	35795	46060	49942	36340
4+	15520	13994	12106	13234	18290	18623	19542	25061	31619	26290

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	12785	8032	8442	6211	3502	3654	2283	2714	4536	4258	1807
4	6748	9730	6386	6826	5079	1957	2410	1808	1855	3659	3403
5	5658	4355	6183	2794	3797	1661	743	1179	799	1296	2603
6	2455	2194	2589	2321	1176	1743	373	289	427	425	833
7	735	997	938	1061	685	421	443	78	138	214	274
8	365	413	487	451	336	382	141	86	45	61	143
9	123	173	190	172	217	187	119	20	49	21	41
10	82	54	93	111	115	114	62	14	12	21	12
11	45	40	30	58	71	72	32	9	8	4	13
12	60	25	13	16	40	46	20	3	6	3	3
3+	29055	26013	25351	20020	15018	10236	6625	6200	7876	9962	9132
4+	16270	17981	16908	13810	11516	6583	4342	3486	3340	5704	7324

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	2078	2921	2306	3549	5079	4716	952	1000	3300
4	1473	1676	2349	1861	2799	4153	3856	766	775
5	2440	1103	1279	1744	1465	2201	3133	2900	591
6	1298	1654	795	903	1257	1072	1241	1938	2080
7	430	877	1158	559	630	818	603	622	1338
8	144	292	555	810	396	406	442	357	407
9	93	101	190	319	559	259	260	275	237
10	28	70	67	102	191	374	171	161	154
11	8	21	49	35	62	107	258	104	90
12	9	6	14	25	22	41	64	177	51
3+	8002	8722	8760	9907	12459	14147	10979	8351	9024
4+	5925	5800	6454	6358	7380	9431	10027	7351	5724

TABLE 17. Average population biomass for cod in Div. 3NO with F_t = 0.358 for 1988.

POPULATION BIOMASS (AVERAGE)

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
3	2008	1983	3110	4081	2972	4151	6166	9118	7495	3979
4	6446	2885	2928	4788	6256	4090	6114	9954	11007	8007
5	1884	5931	2486	3291	5061	6247	3841	6434	7387	6510
6	2289	1700	4276	2148	3544	4790	5109	3338	4473	3405
7	2577	1704	1369	2926	2083	3321	3227	3687	1815	2159
8	1071	1561	1057	945	1677	1595	2051	1294	1529	875
9	879	692	942	621	525	885	1131	1367	599	727
10	1202	612	511	645	315	224	340	600	775	452
11	686	653	474	367	413	164	93	120	106	597
12	137	312	343	382	229	285	101	56	48	52
3+	19178	18033	17498	20192	23077	25751	28172	35968	35233	26764
4+	17170	16050	14388	16111	20104	21601	22006	26850	27738	22785

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	5370	3445	3651	3038	1513	1255	774	1129	2327	2746	1062
4	4918	7041	3911	5010	3058	915	1532	1124	1559	3256	2837
5	4936	4584	5321	2692	3773	1034	615	1044	876	1623	2607
6	3463	3163	3665	2788	1609	1861	402	476	765	774	1274
7	1766	2249	2103	1822	1883	732	685	196	333	659	580
8	1084	1210	1274	1139	1178	1052	257	266	149	233	431
9	528	817	931	843	999	827	269	104	239	99	163
10	451	314	569	710	880	352	182	93	65	121	71
11	288	202	188	404	641	345	67	66	58	31	88
12	447	183	90	105	428	204	67	32	46	29	20
3+	23250	23207	21702	18551	15963	8577	4850	4530	6417	9573	9134
4+	17880	19762	18051	15514	14449	7322	4076	3401	4090	6827	8072

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	1327	2362	1951	2685	3634	2050	334	432	2203
4	1330	1865	2377	1936	2861	3112	3355	553	687
5	3417	1731	1620	2781	1900	2295	4154	3208	634
6	2685	3743	1475	1995	2330	1670	1926	3004	2805
7	1316	2497	3729	1798	1550	1986	1643	1460	2262
8	667	1265	2241	3518	1307	1523	1912	1396	1202
9	645	590	1057	1565	2652	1402	1644	1516	956
10	225	533	434	646	1046	2602	1314	1095	810
11	75	152	352	251	451	763	2133	737	647
12	100	50	134	231	221	358	497	1781	437
3+	11787	14789	15870	17406	17952	17762	18912	15183	12645
4+	10460	12426	13919	14721	14317	15712	18578	14751	10441

TABLE 18. Fishing mortality for cod in Div. 3NO with F_t = 0.358 in 1988.

FISHING MORTALITY

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	0.036	0.039	0.011	0.011	0.004	0.063	0.007	0.004	0.129	0.198	0.073
4	0.167	0.186	0.124	0.067	0.076	0.314	0.102	0.167	0.516	0.646	0.238
5	0.339	0.469	0.595	0.084	0.279	0.393	0.249	0.416	0.935	1.027	0.747
6	0.519	0.358	0.705	0.144	0.268	0.325	0.511	0.767	0.901	1.186	0.701
7	0.434	0.397	0.418	0.349	0.264	0.194	0.876	0.737	0.844	0.944	0.377
8	0.445	0.550	0.542	0.279	0.787	0.237	0.810	1.491	1.310	0.777	0.547
9	0.345	0.338	0.361	0.432	0.898	0.357	0.384	0.862	0.251	0.444	0.629
10	0.363	0.298	0.180	0.316	0.919	0.693	1.771	2.250	0.180	0.305	0.503
11	0.950	0.732	0.028	0.326	0.412	0.119	0.934	0.873	0.570	0.128	0.398
12	0.465	0.478	0.440	0.349	0.559	0.243	0.863	1.044	0.961	0.882	0.463

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	0.029	0.013	0.001	0.382	0.216	0.033	0.180	0.015	0.024	0.004	0.015	0.018
4	0.253	0.627	0.386	0.918	0.769	0.515	0.617	0.159	0.140	0.133	0.089	0.070
5	0.320	0.780	0.666	0.579	1.294	0.745	0.815	0.431	0.242	0.496	0.188	0.127
6	0.649	0.692	1.021	0.828	1.169	1.358	0.536	0.491	0.239	0.461	0.192	0.157
7	0.518	0.532	0.949	0.383	0.892	1.436	0.353	0.611	0.202	0.441	0.187	0.258
8	0.575	0.839	0.532	0.385	0.970	1.767	0.363	0.568	0.203	0.229	0.153	0.230
9	0.424	0.343	0.202	0.446	0.914	1.953	0.283	0.635	0.365	0.169	0.093	0.221
10	0.368	0.272	0.243	0.266	1.070	1.763	0.352	0.891	0.307	0.172	0.111	0.152
11	0.969	0.453	0.161	0.240	1.062	2.057	0.182	0.847	0.243	0.109	0.099	0.232
12	0.505	0.571	0.715	0.379	0.945	1.603	0.350	0.621	0.220	0.346	0.165	0.244

AGE	1982	1983	1984	1985	1986	1987	1988
3	0.015	0.037	0.001	0.001	0.018	0.055	0.009
4	0.098	0.039	0.040	0.082	0.085	0.059	0.046
5	0.148	0.128	0.113	0.373	0.255	0.132	0.326
6	0.152	0.159	0.229	0.376	0.491	0.196	0.396
7	0.158	0.146	0.241	0.416	0.323	0.223	0.382
8	0.353	0.171	0.224	0.245	0.274	0.209	0.311
9	0.425	0.312	0.200	0.218	0.276	0.383	0.300
10	0.431	0.300	0.383	0.171	0.293	0.383	0.358
11	0.456	0.292	0.211	0.315	0.177	0.505	0.358
12	0.248	0.196	0.240	0.302	0.297	0.269	0.358

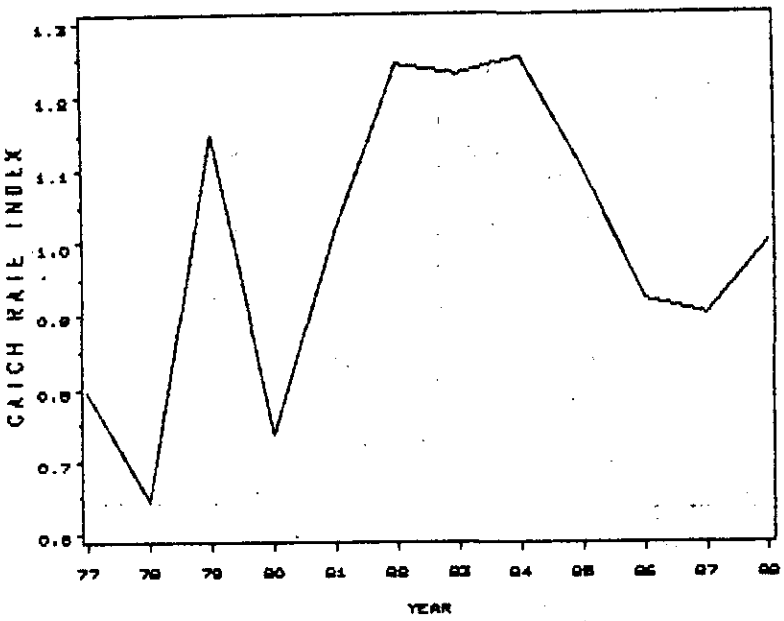
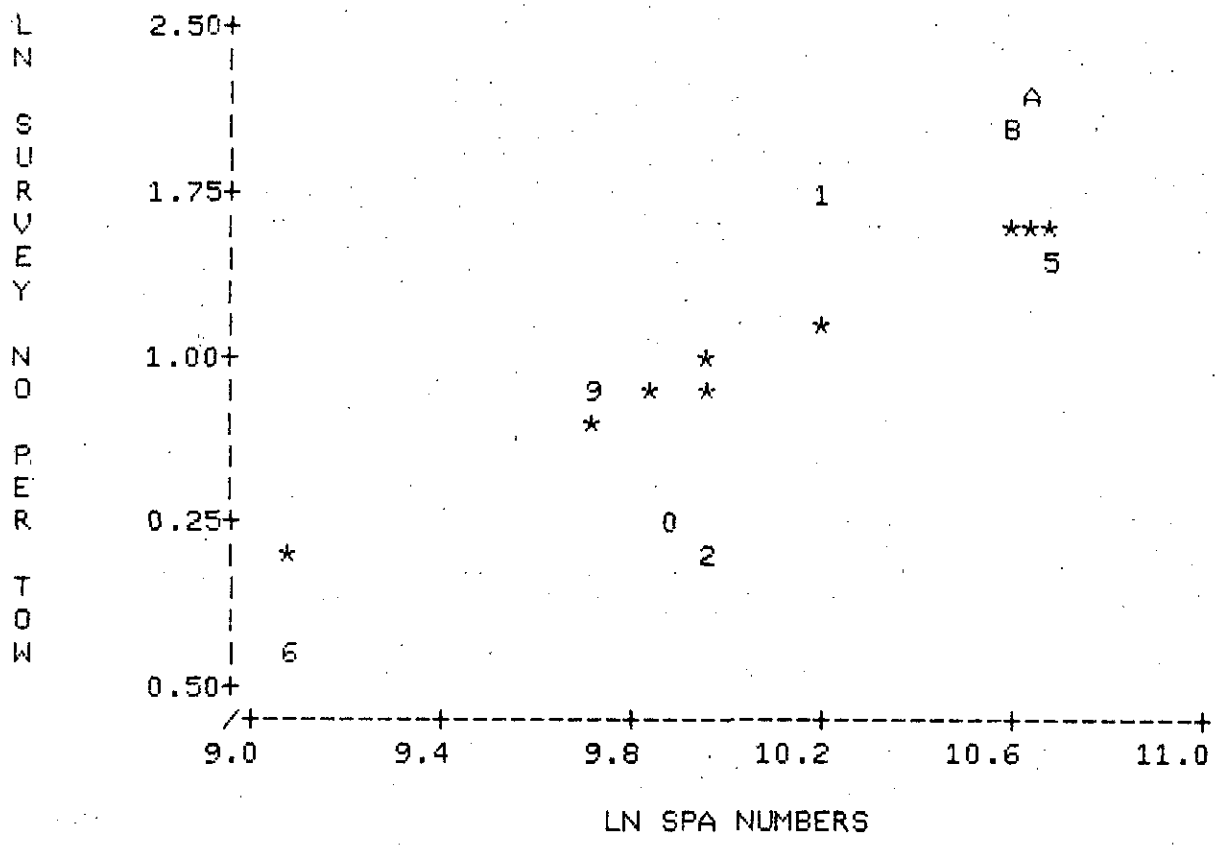


FIG. 1. Catch rate index derived from averaging Canadian OT & Spanish PT catch rates.

AGE 3 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

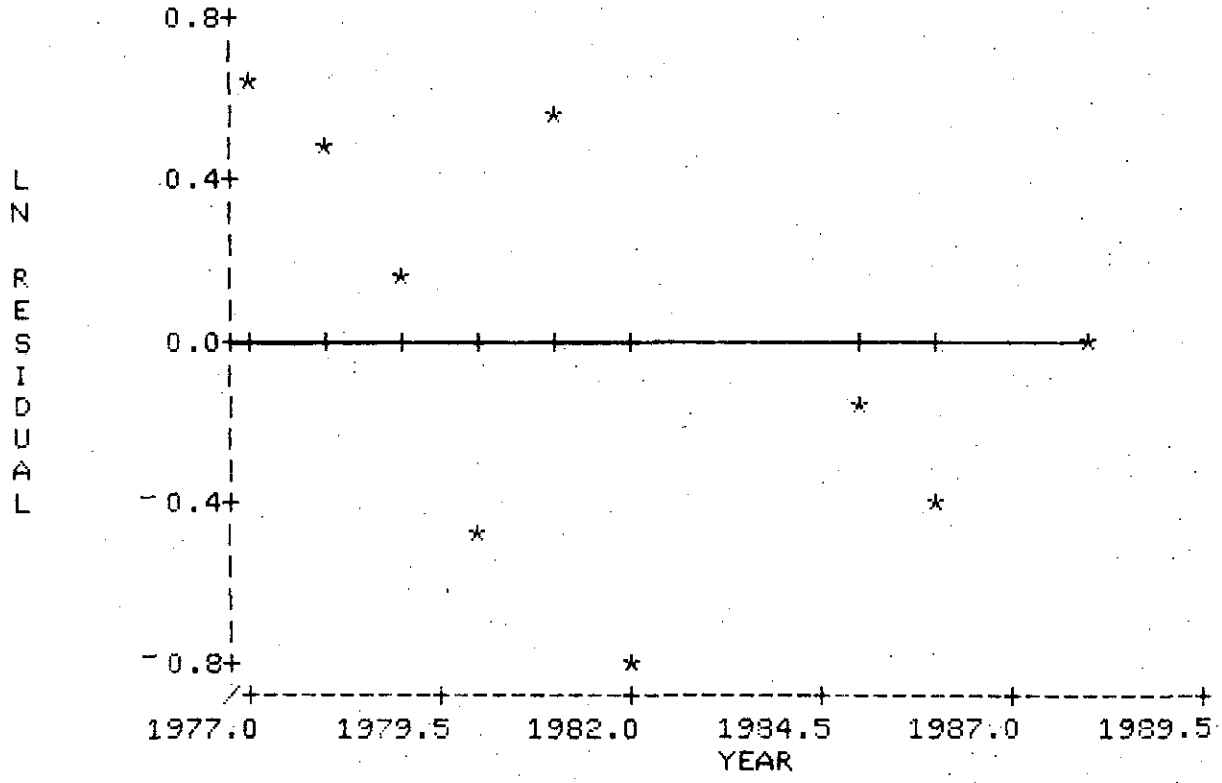
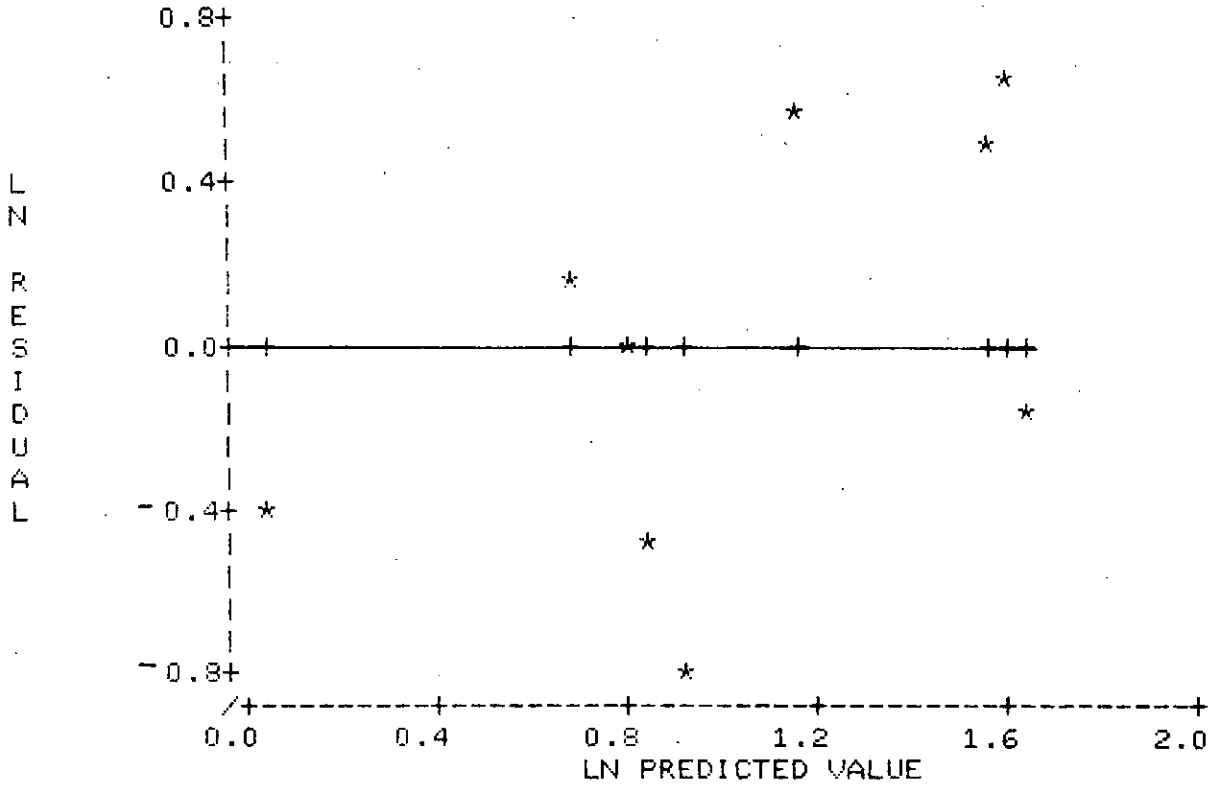


Figure 2. Age 3 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

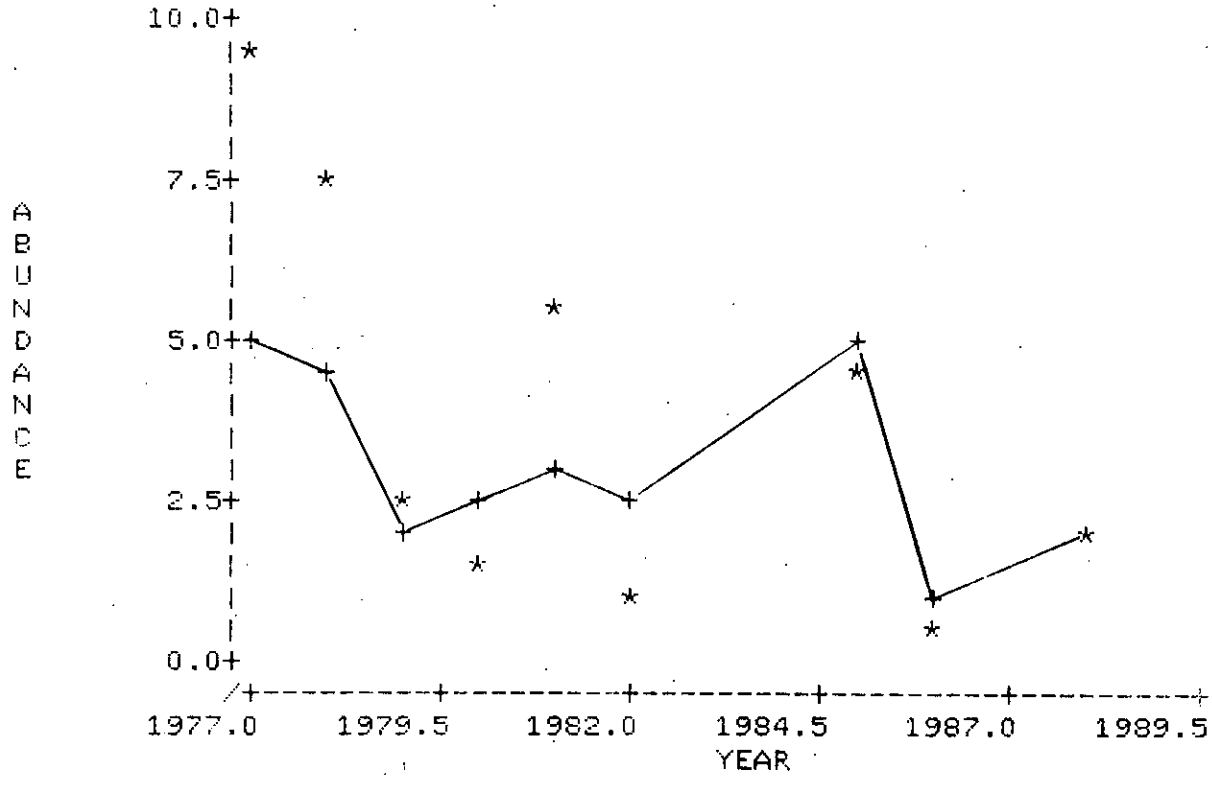
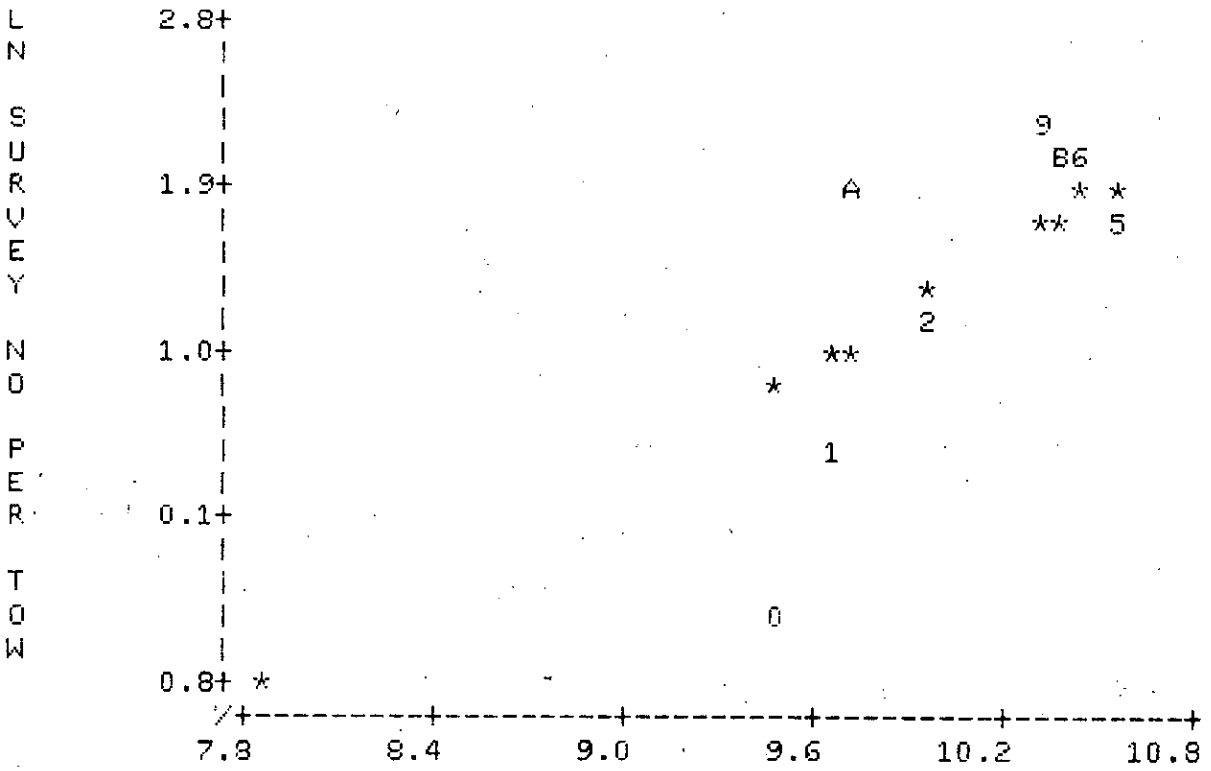


Figure 2. Continued (observed *, predicted +).

AGE 4 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

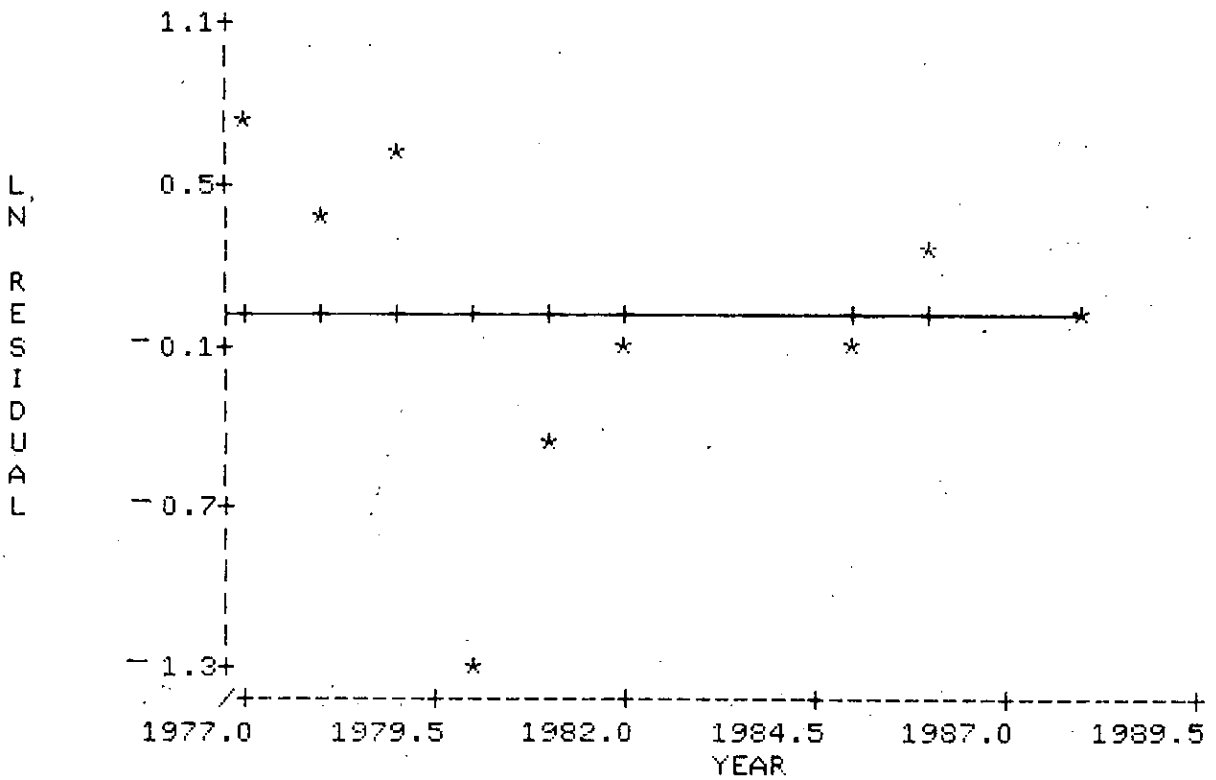
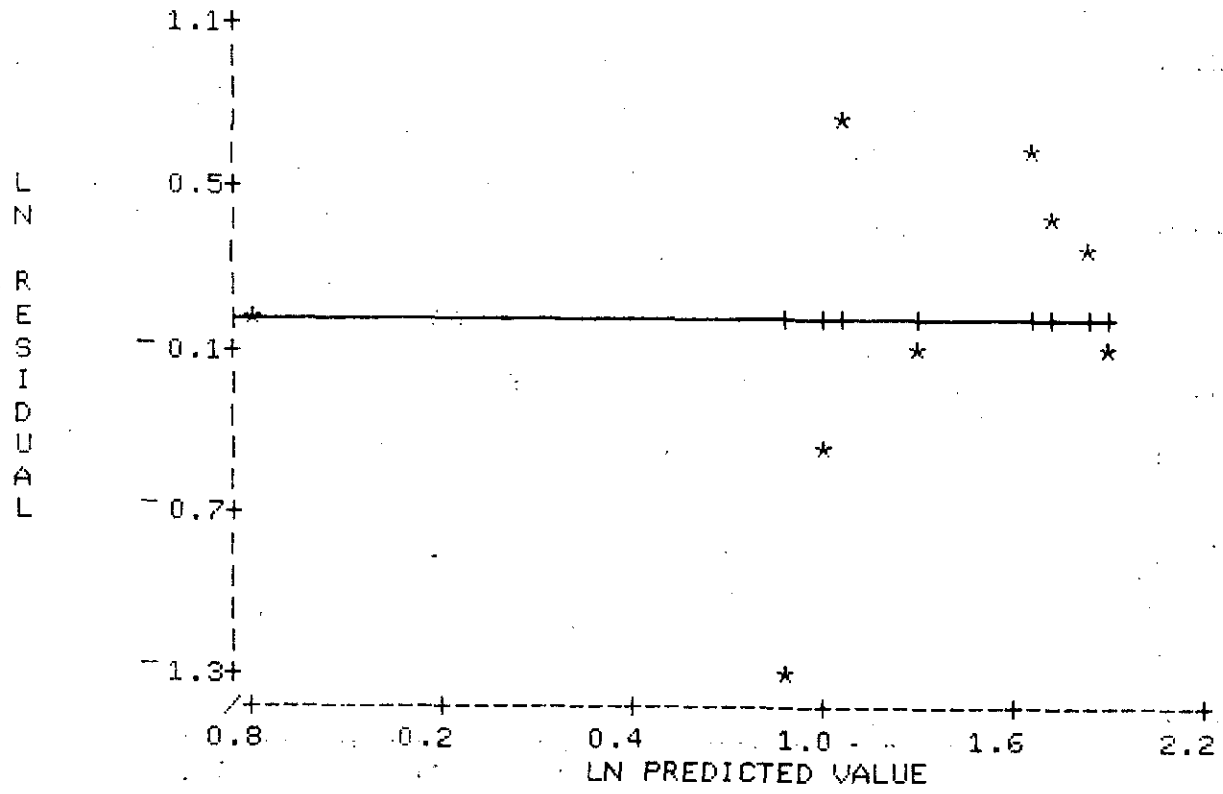


Figure 3. Age 4 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

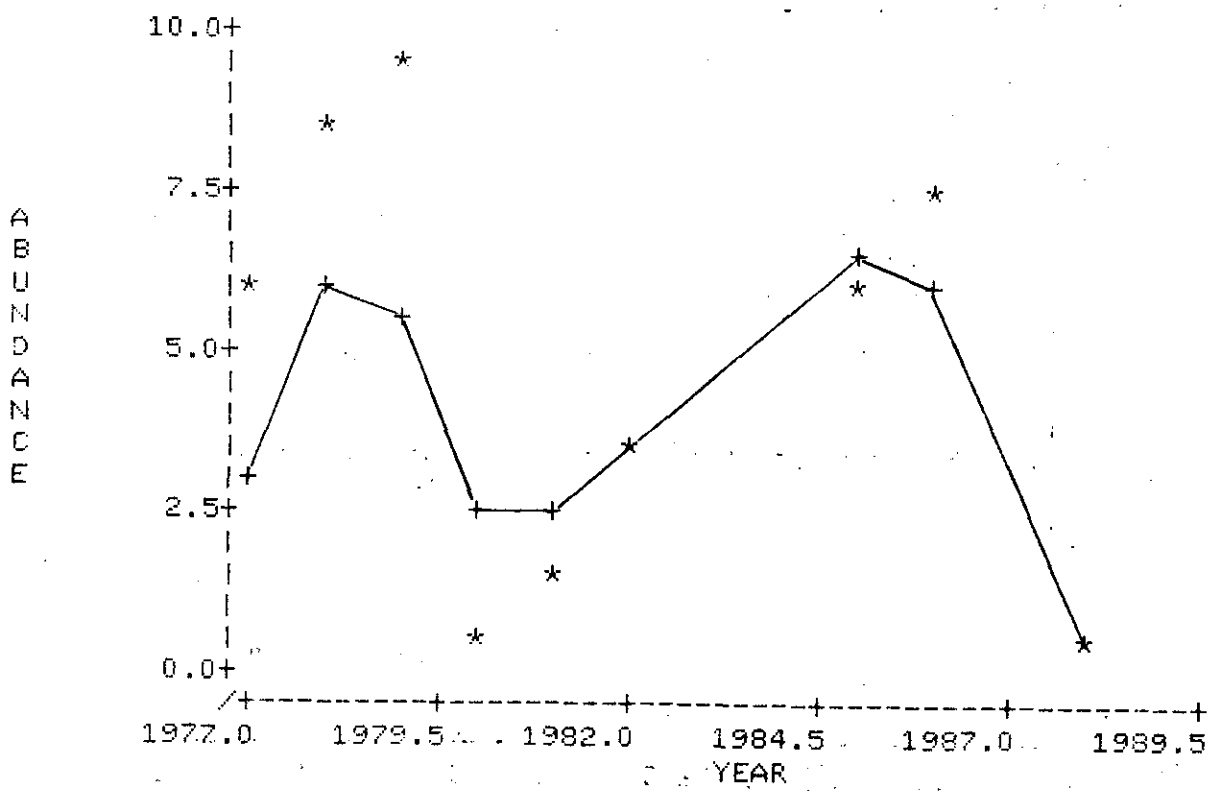
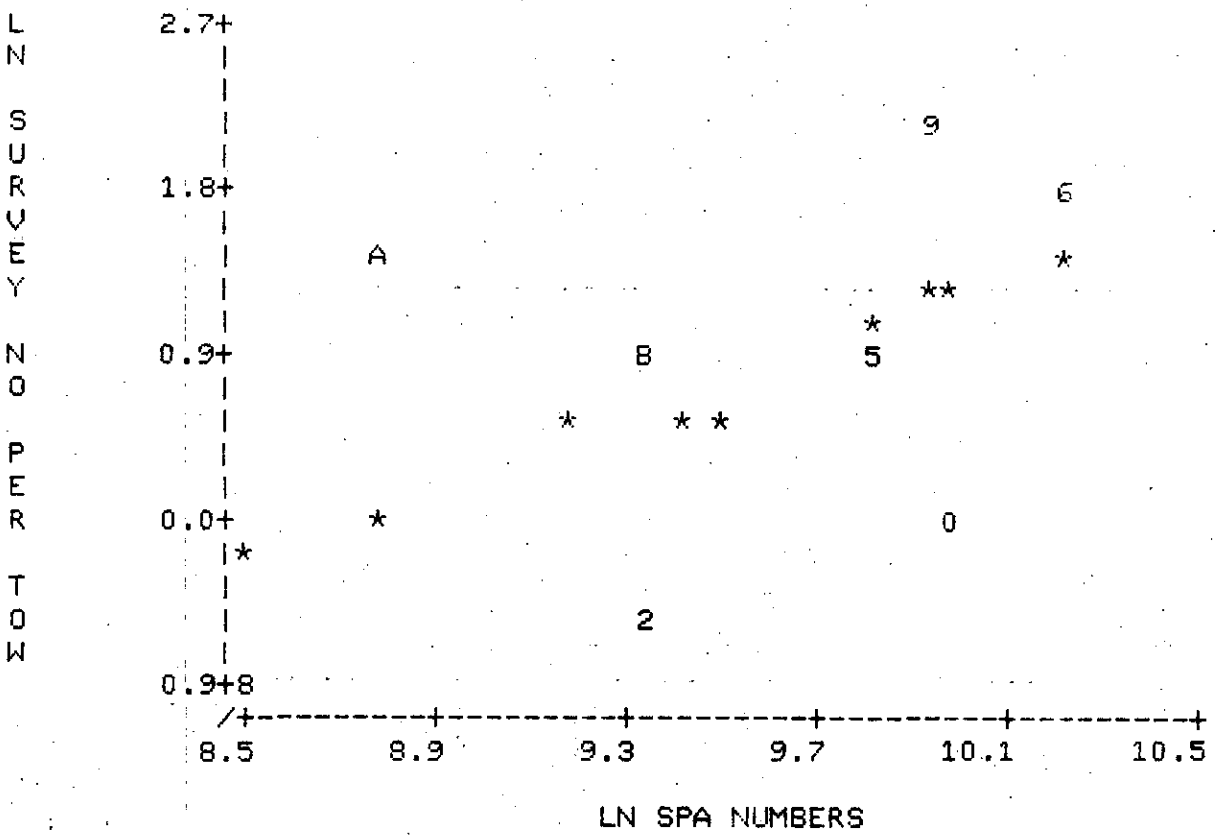


Figure 3. Continued (observed *, predicted +).

AGE 5 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

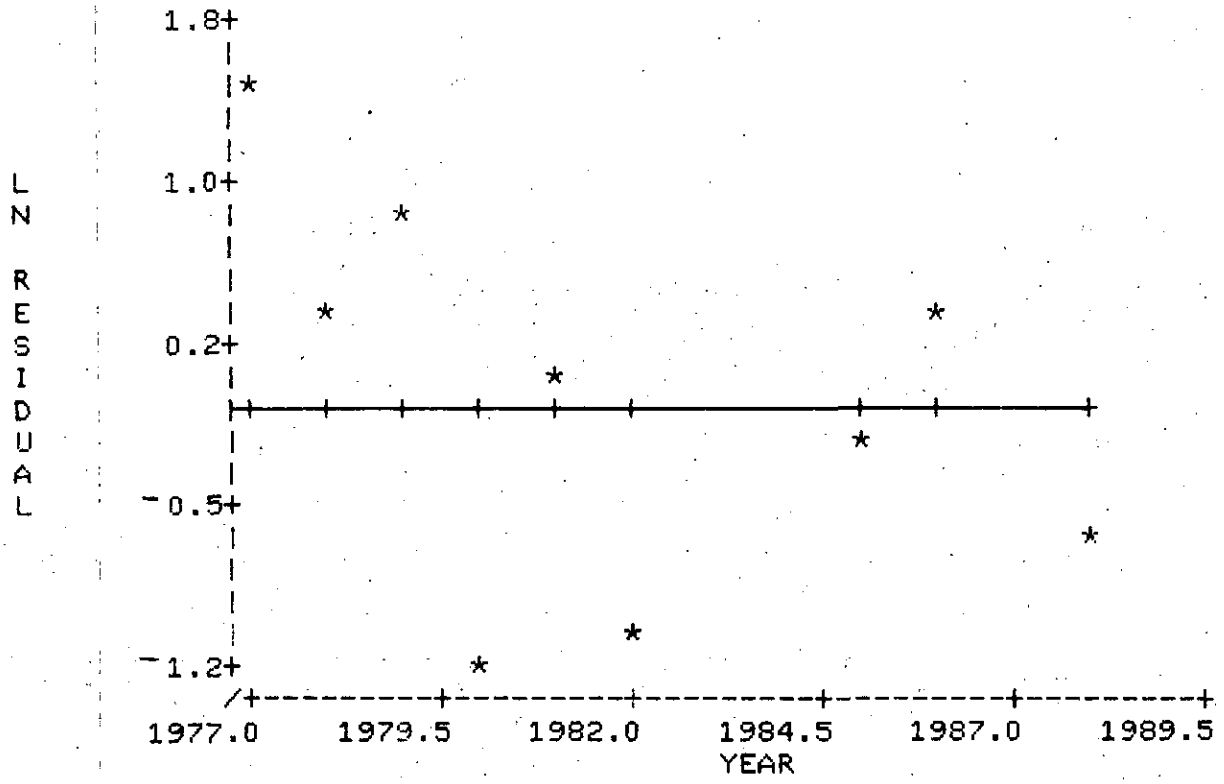
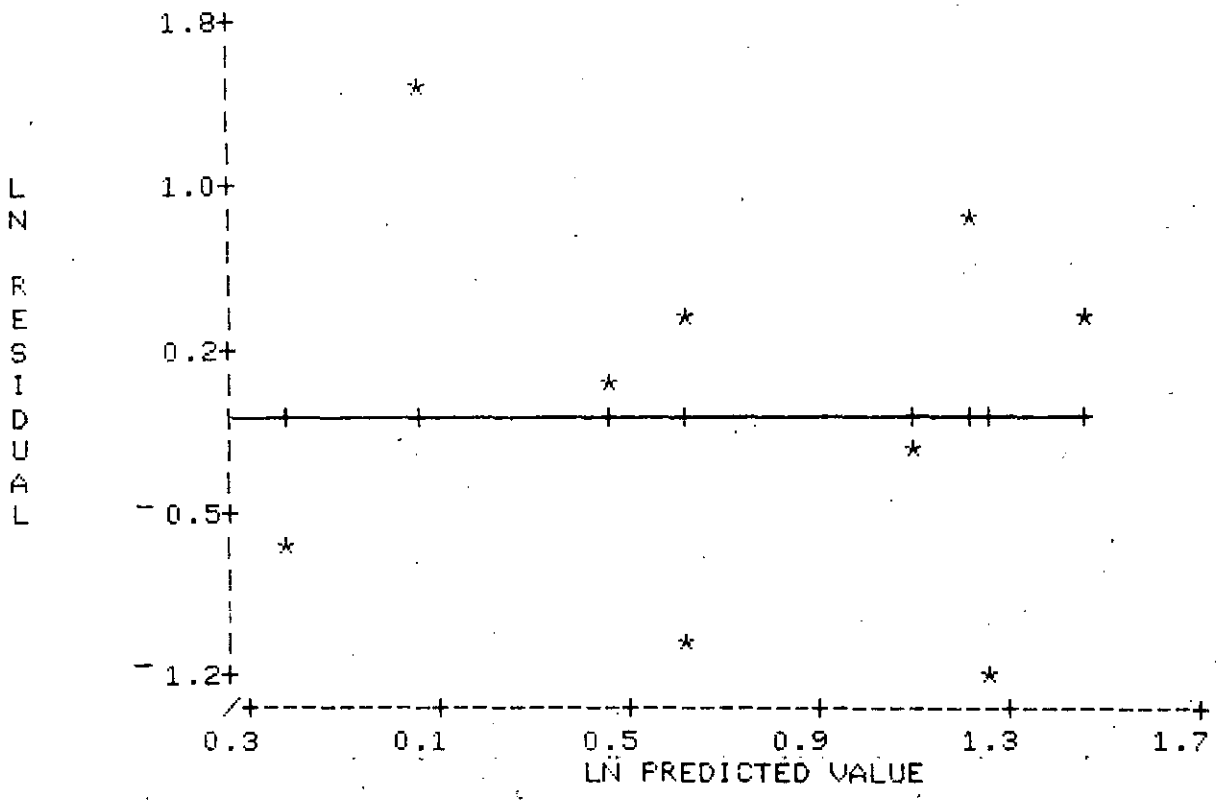


Figure 4. Age 5 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

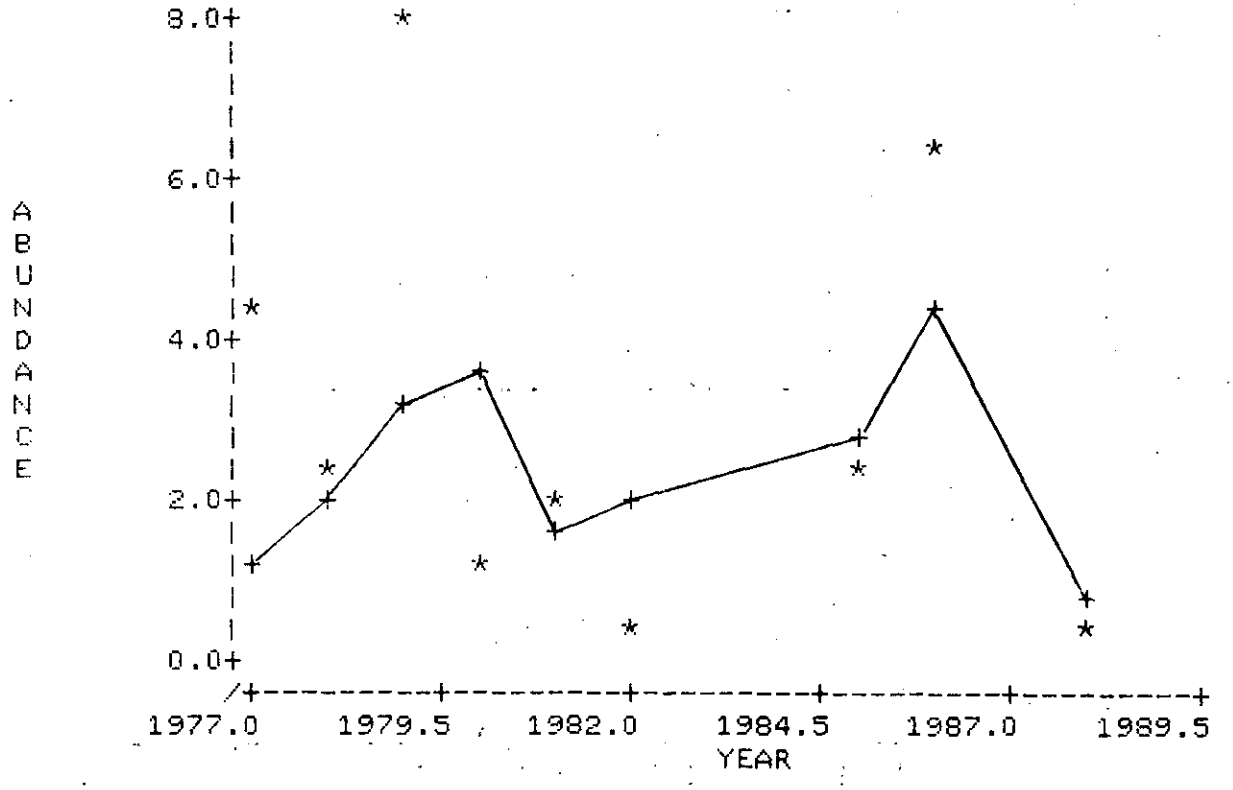
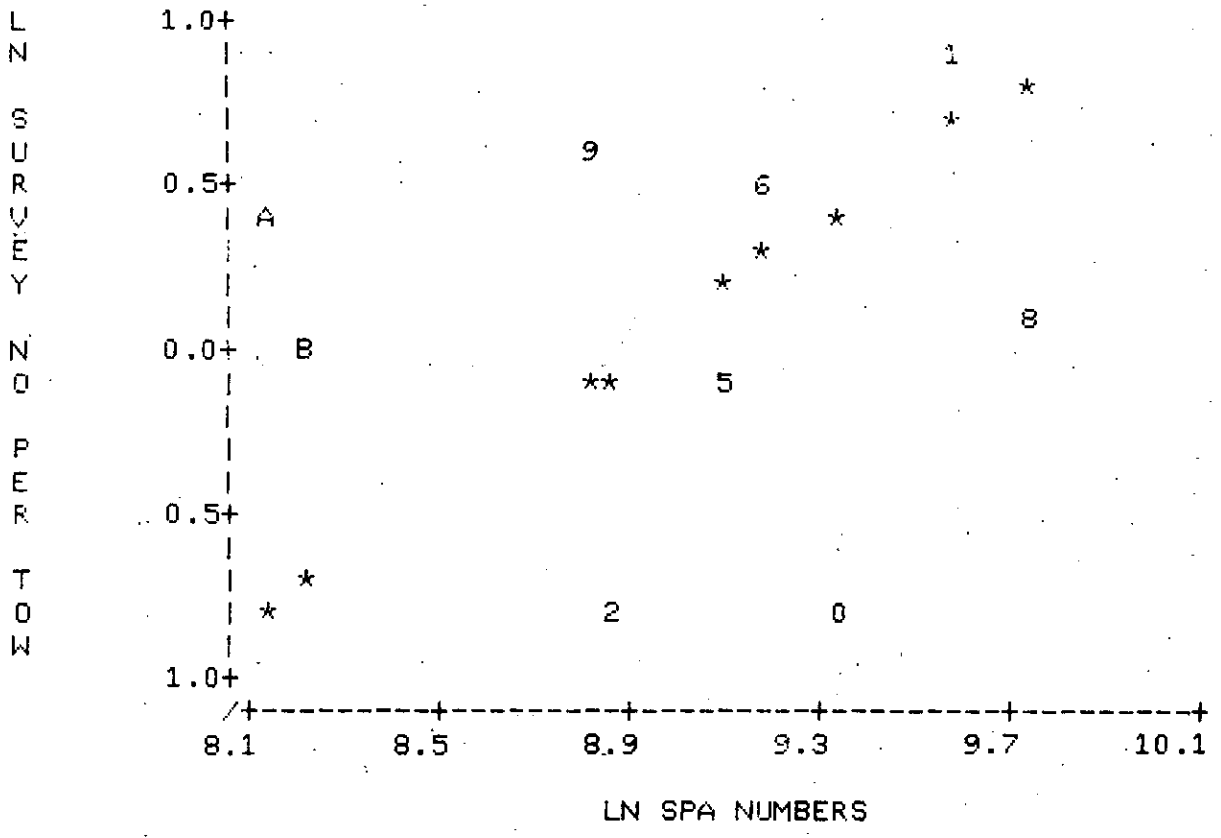


Figure 4. Continued (observed *, predicted +).

AGE 6 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

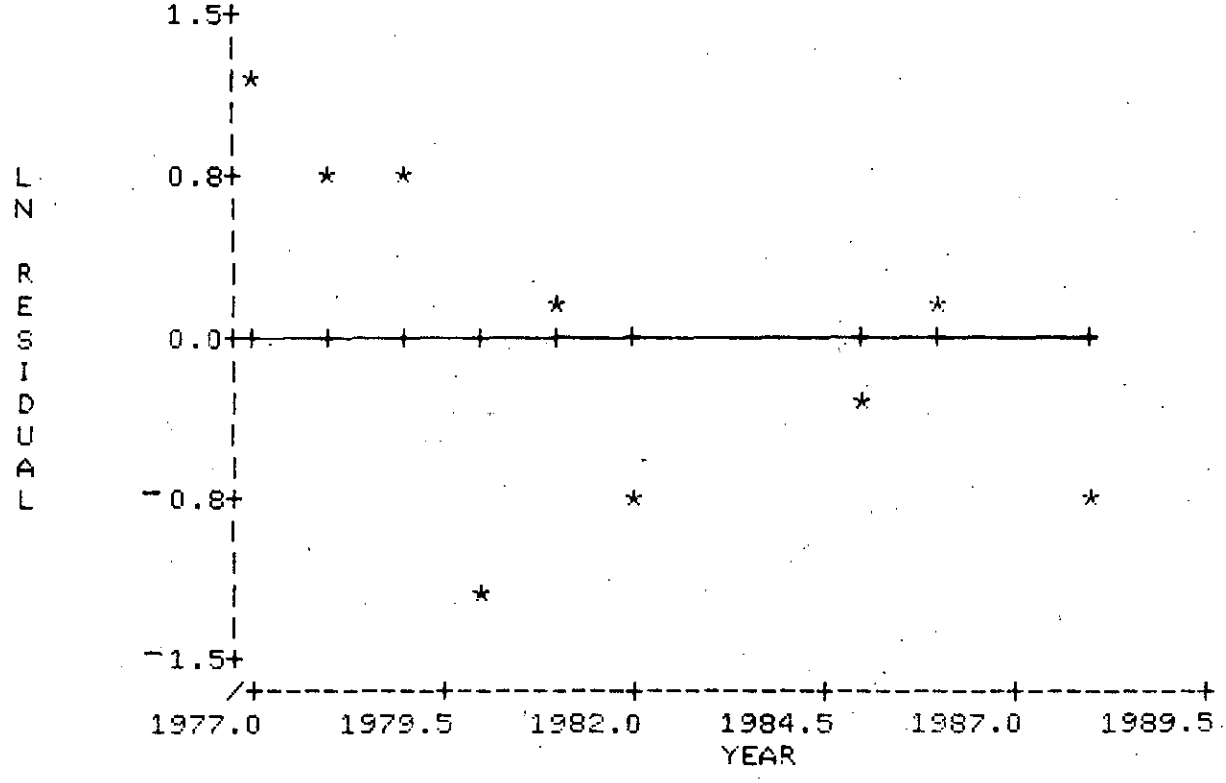
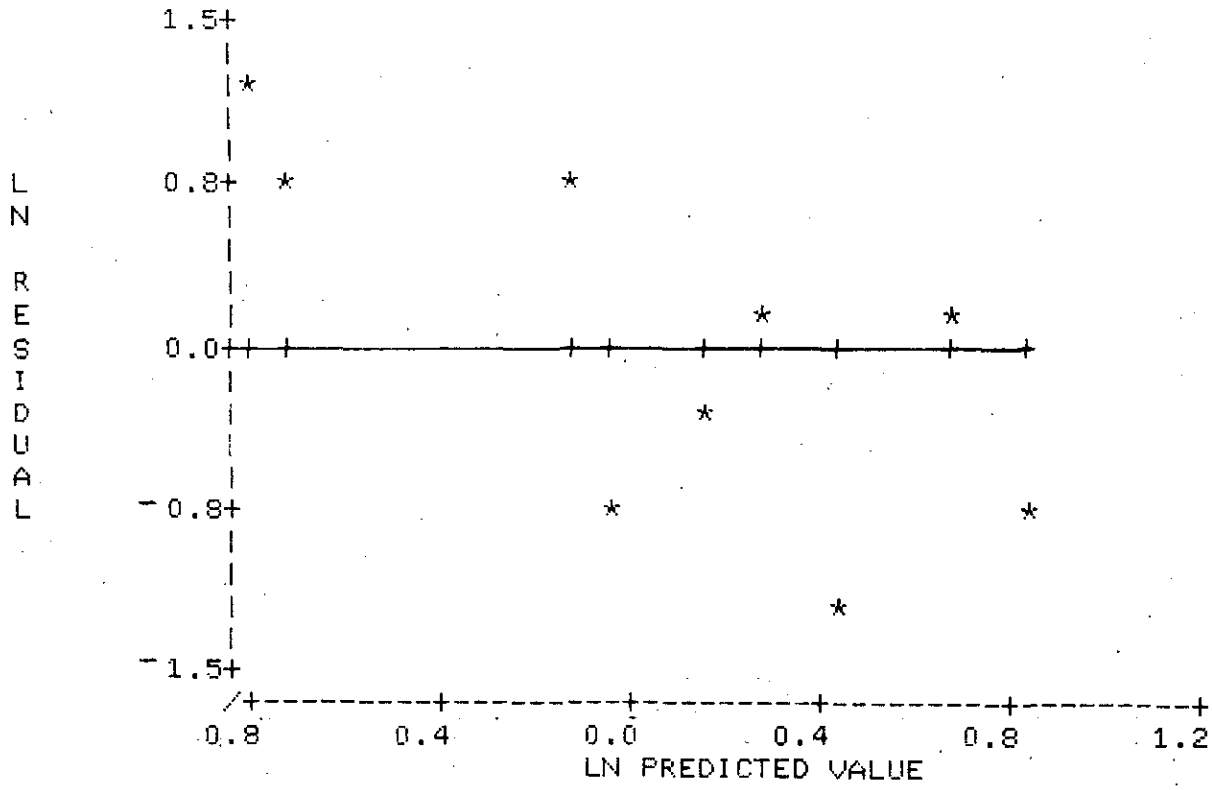


Figure 5. Age 6 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

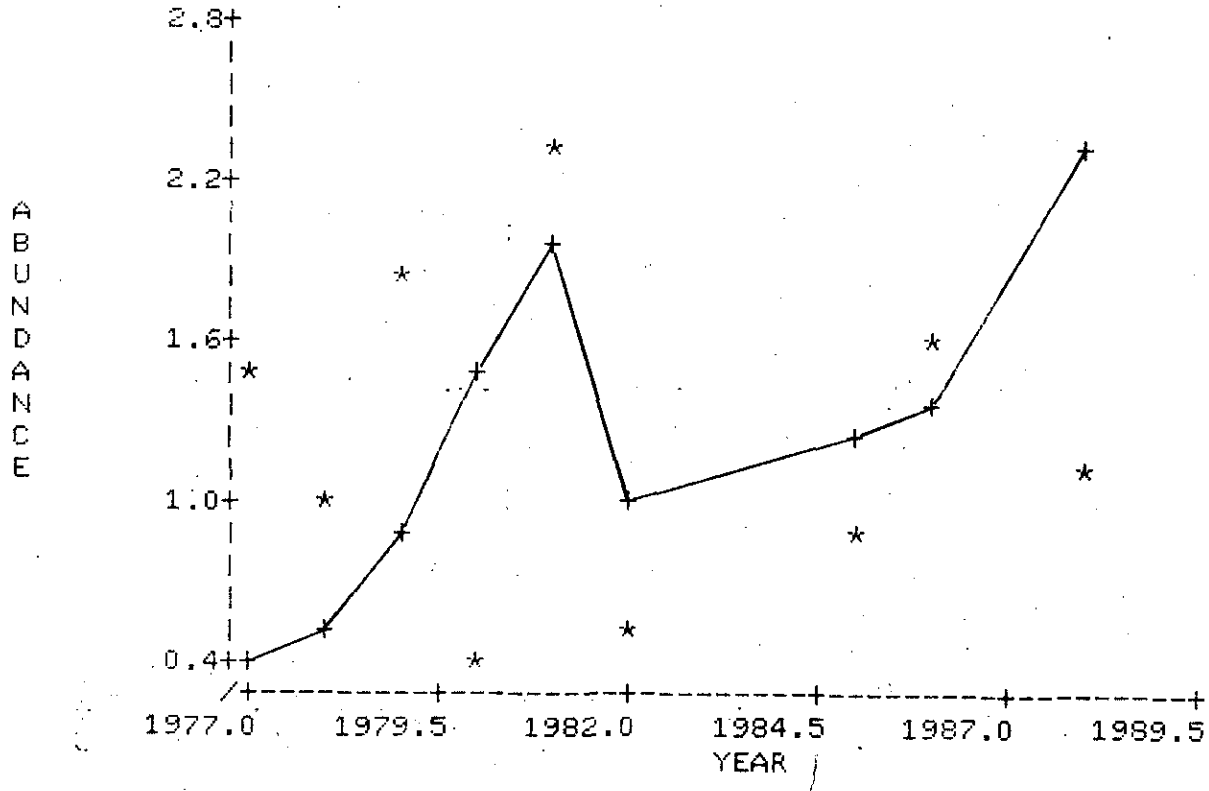
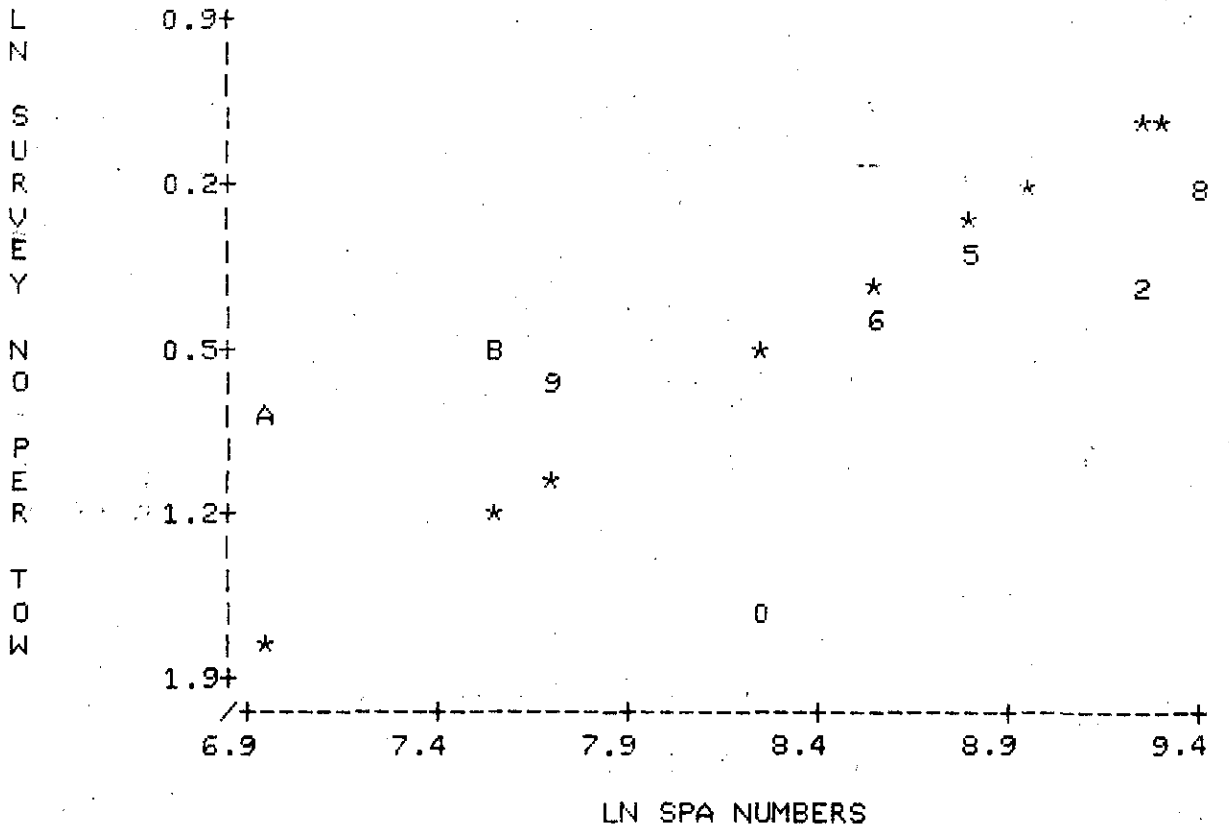


Figure 5. Continued (observed *, predicted +).

AGE 7 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

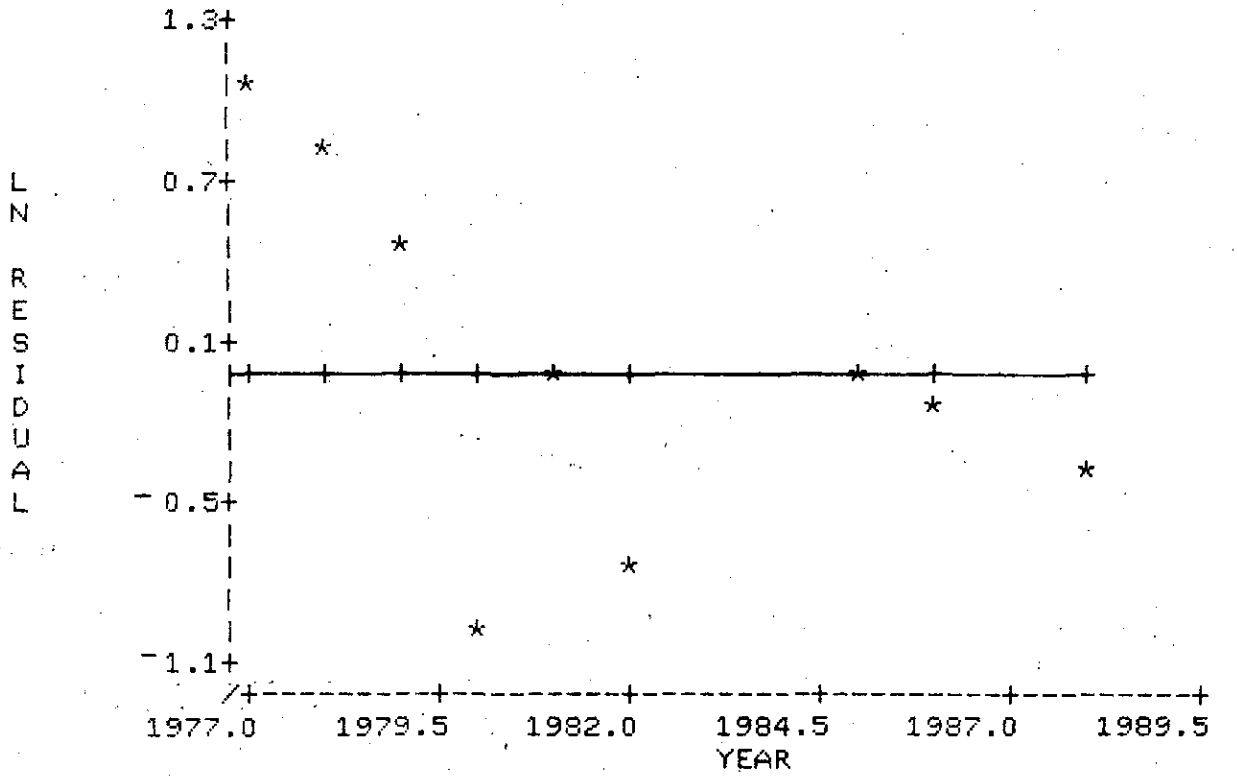
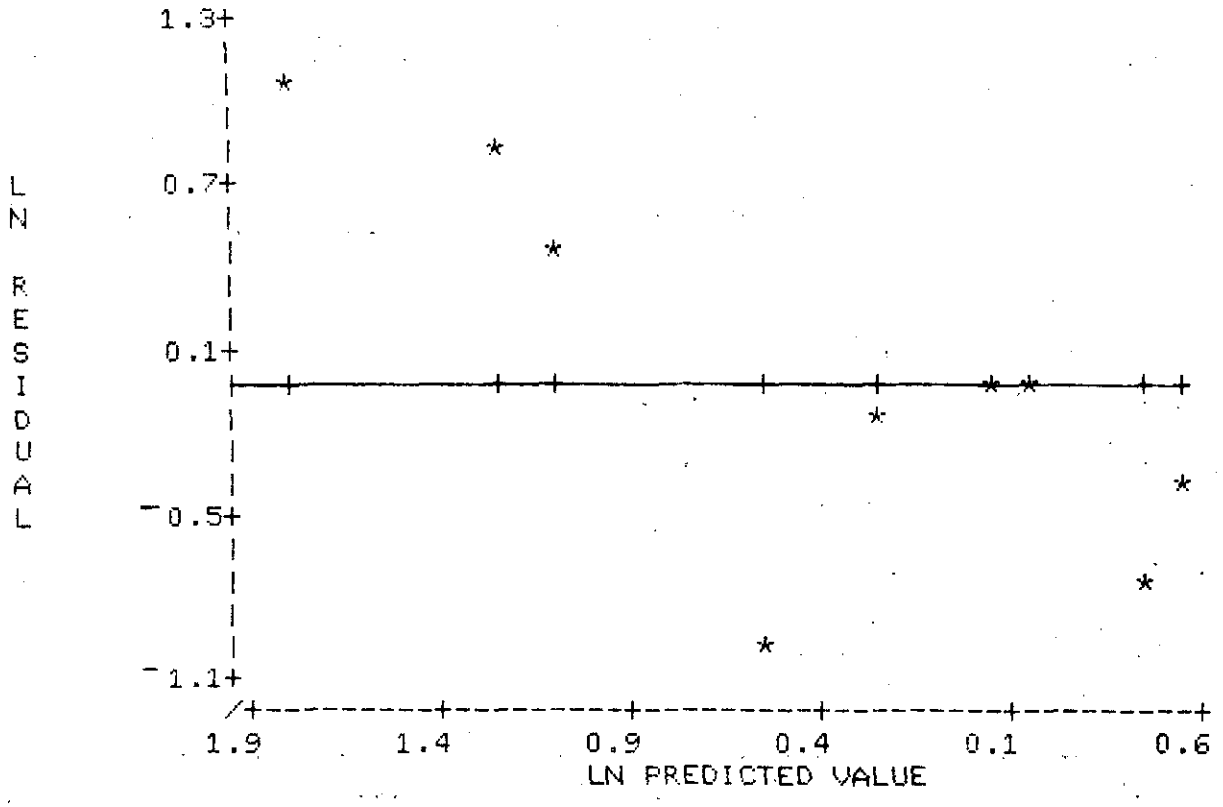


Figure 6. Age 7 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

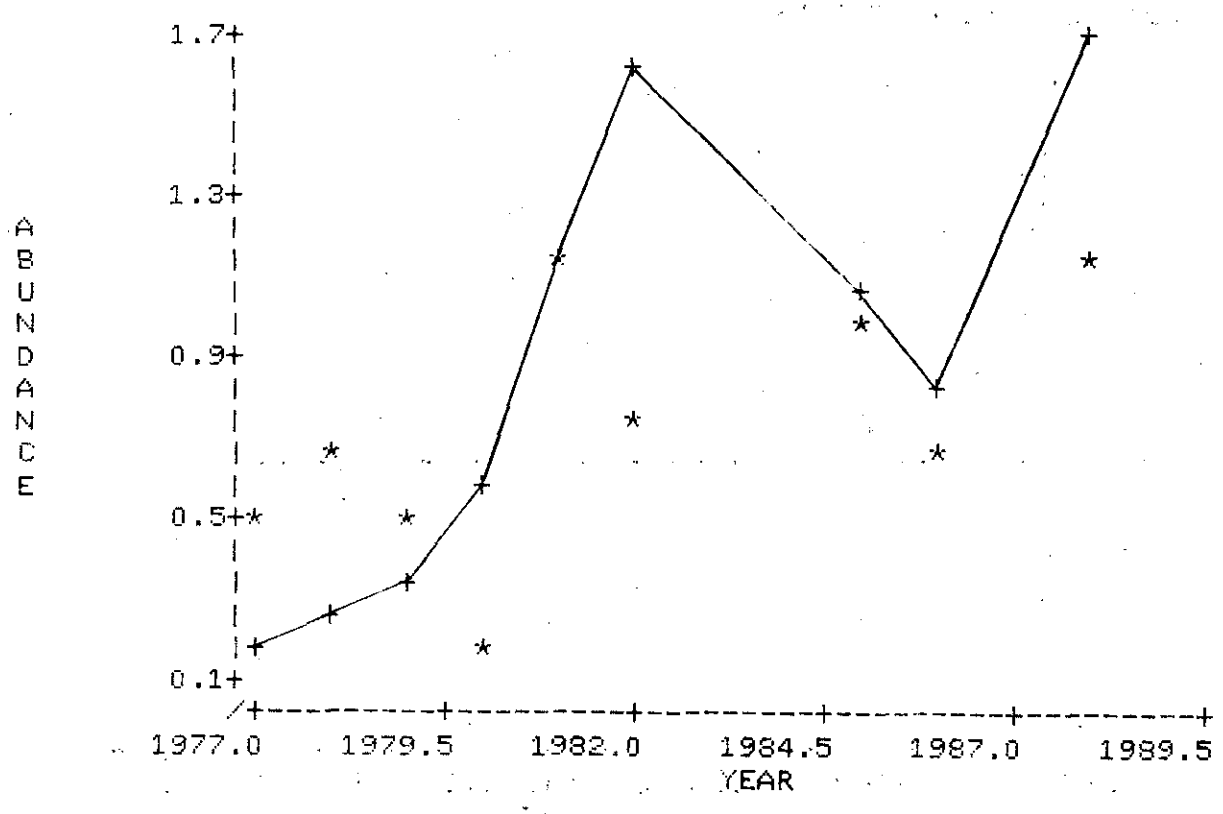


Figure 6. Continued (observed *, predicted +).

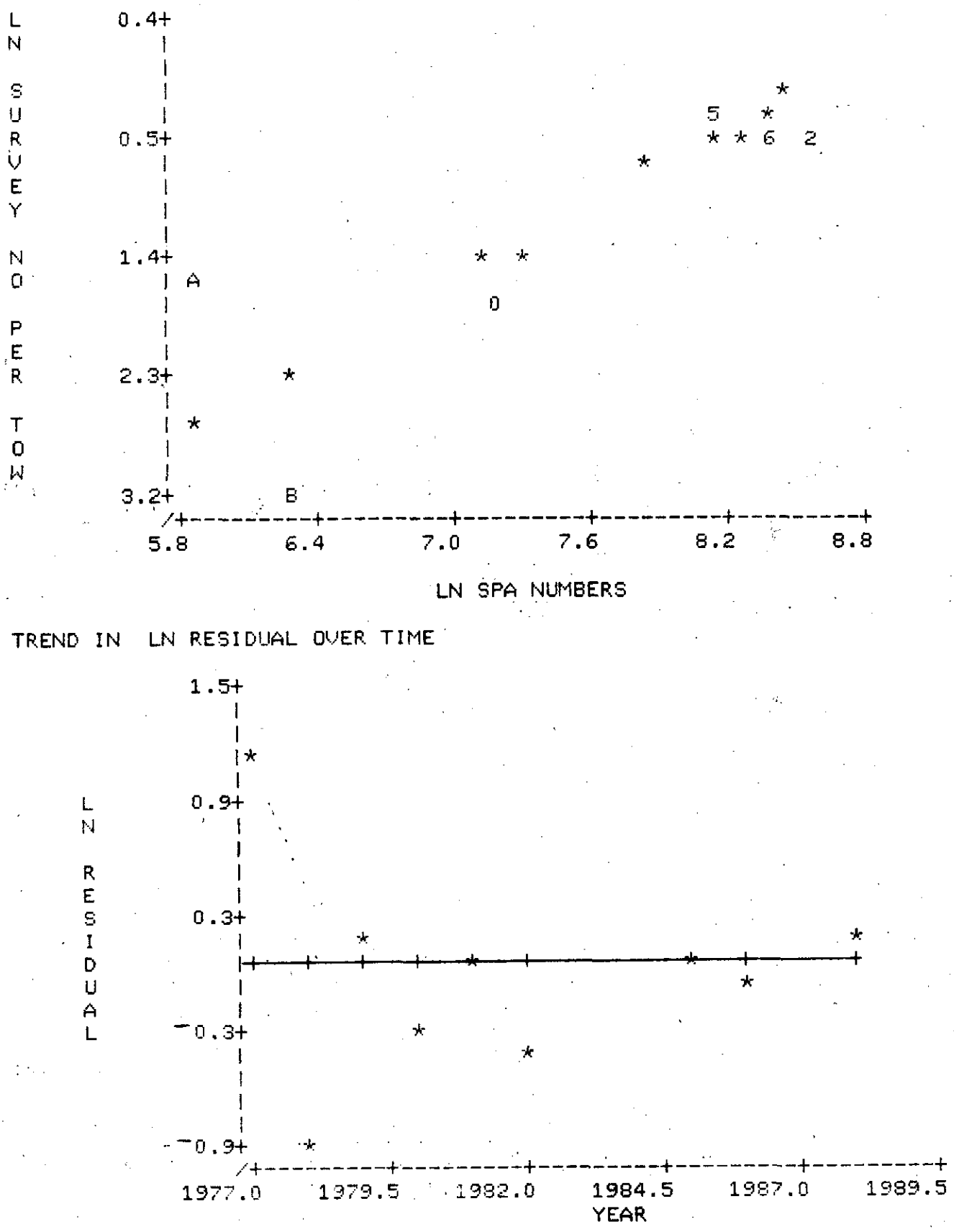
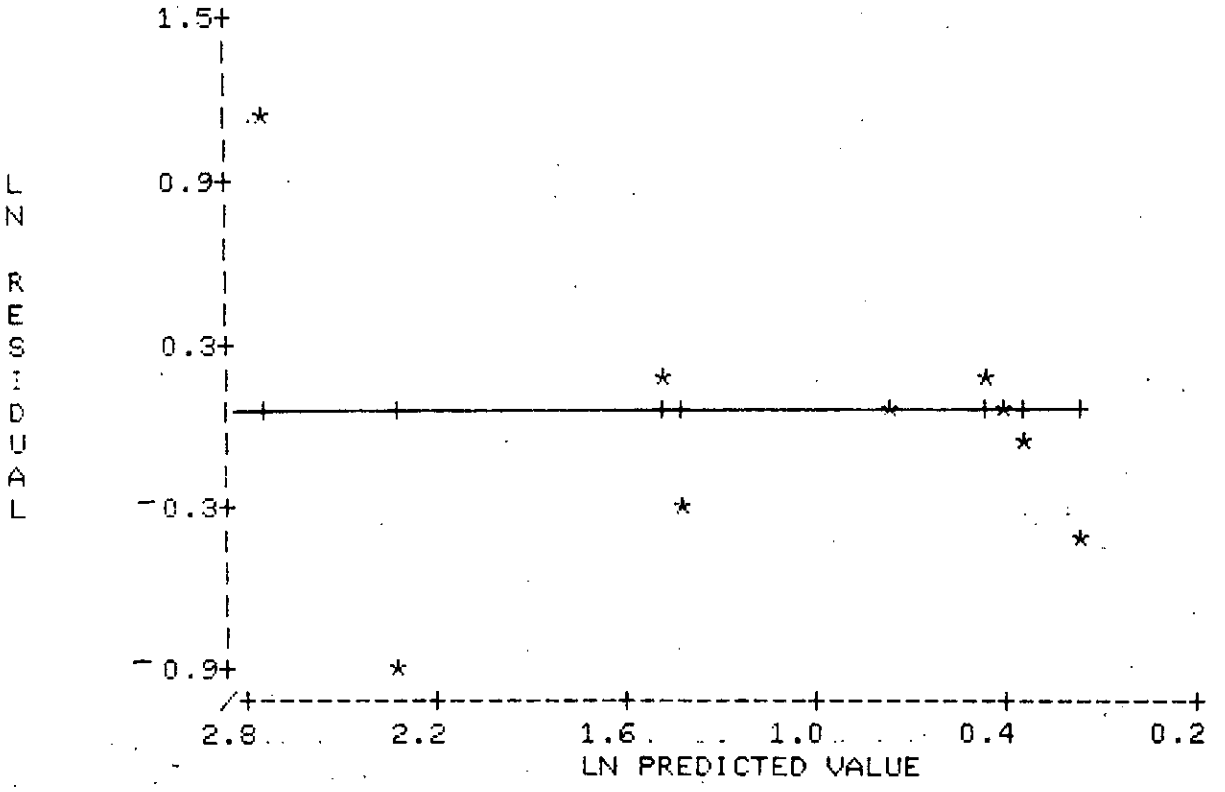


Figure 7. Age 8 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

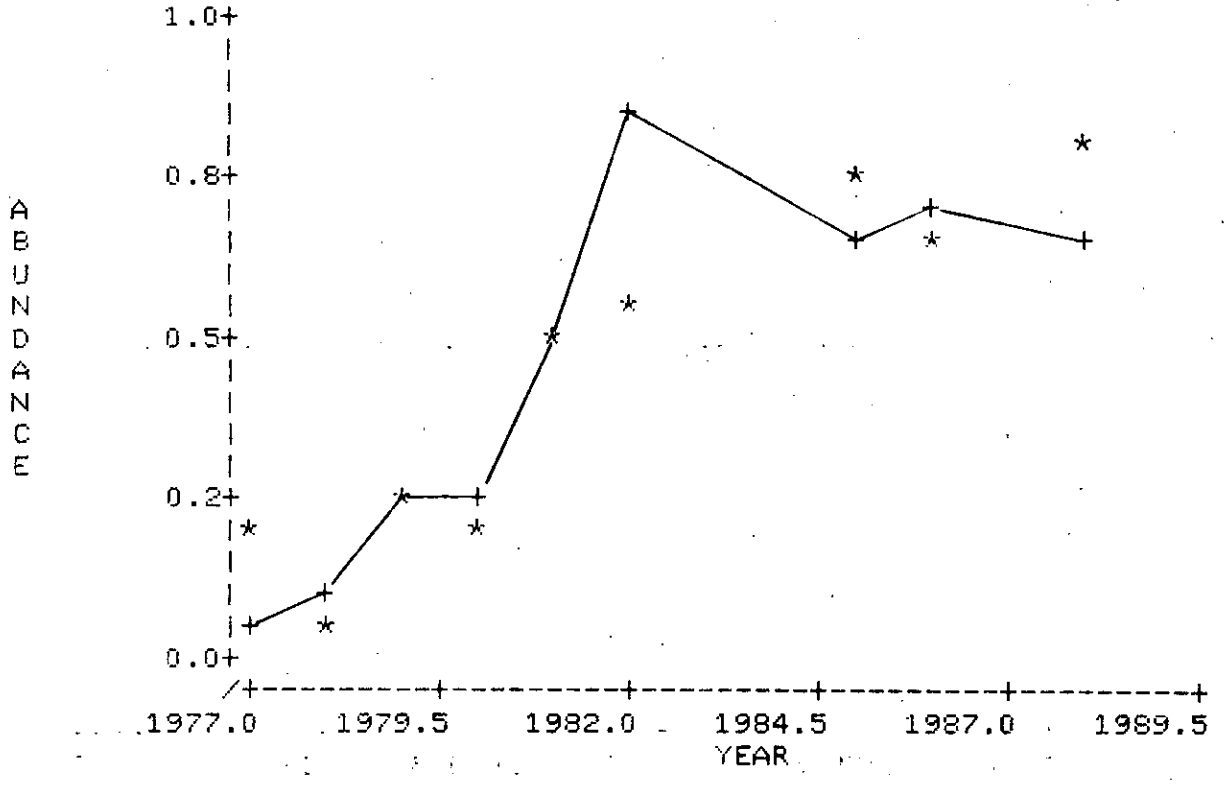
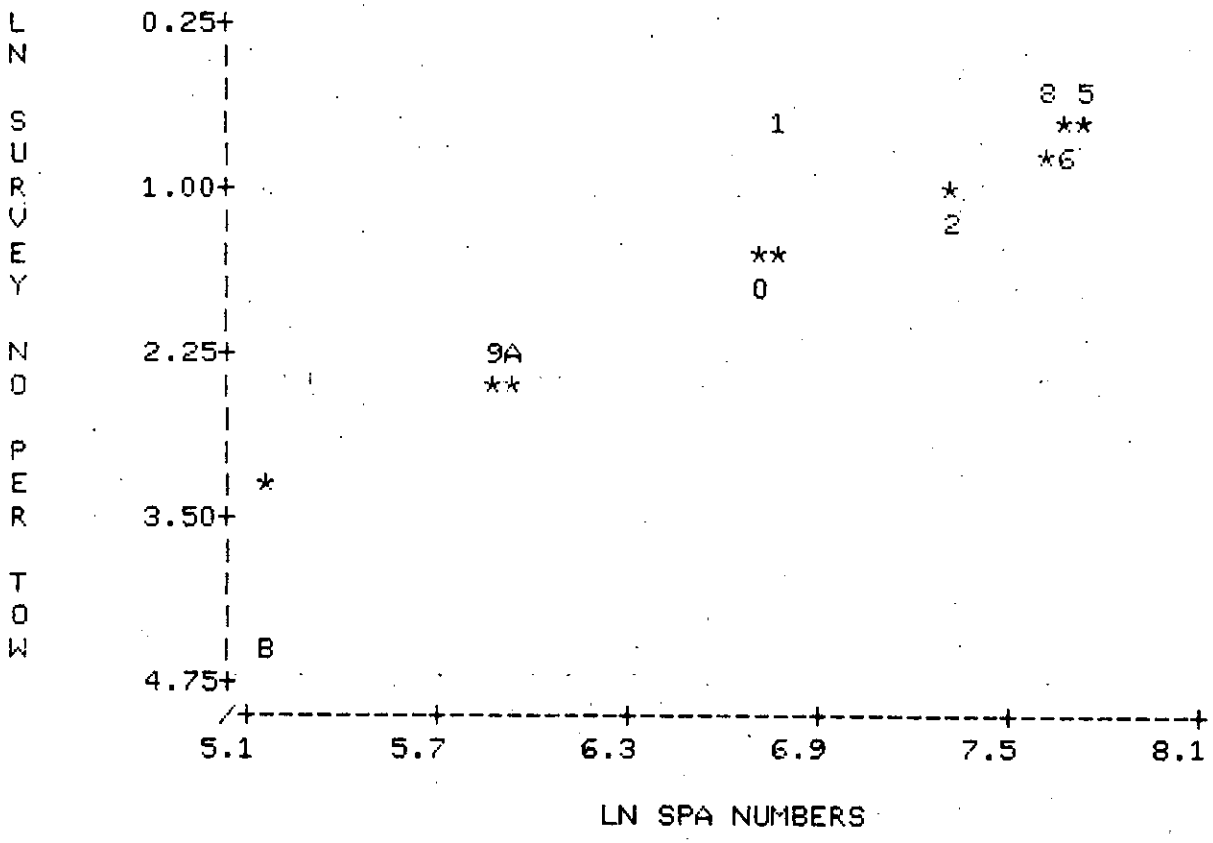


Figure 7. Continued (observed *, predicted +).

AGE 9 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

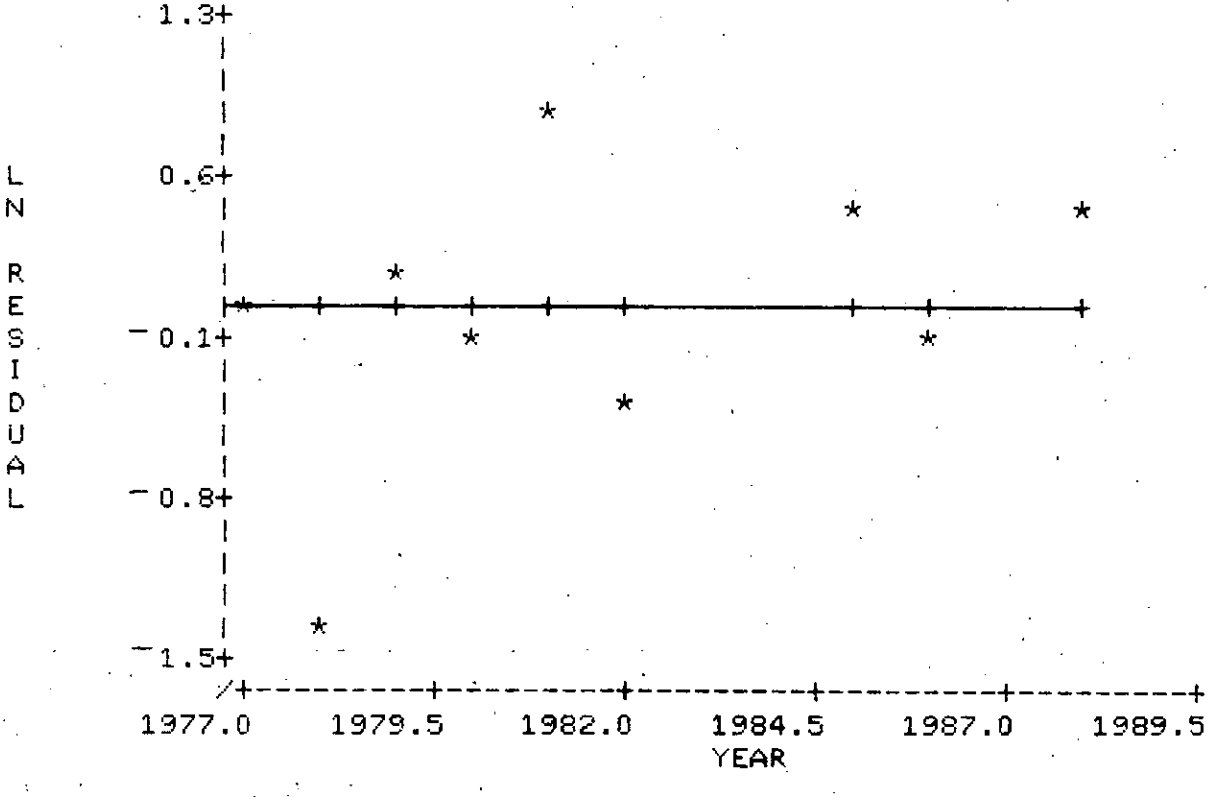
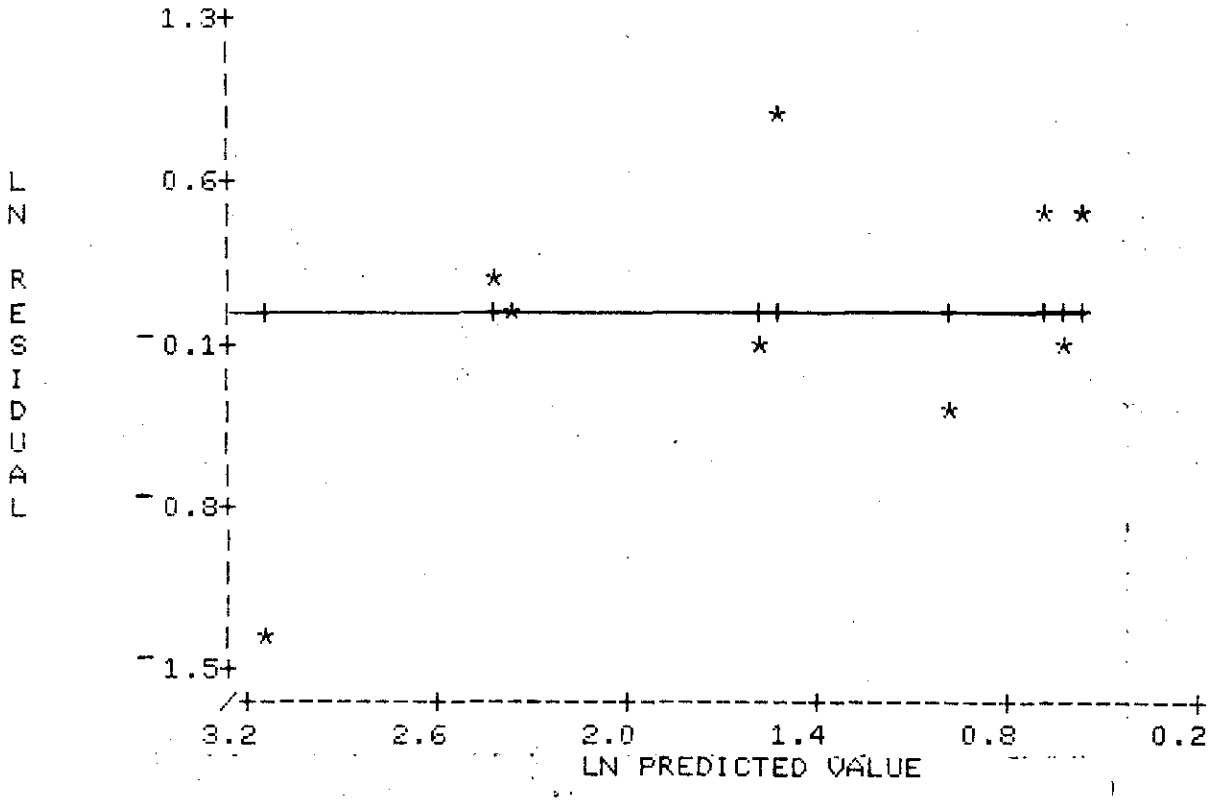


Figure 8. Age 9 plots from ADAPT using Canadian surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

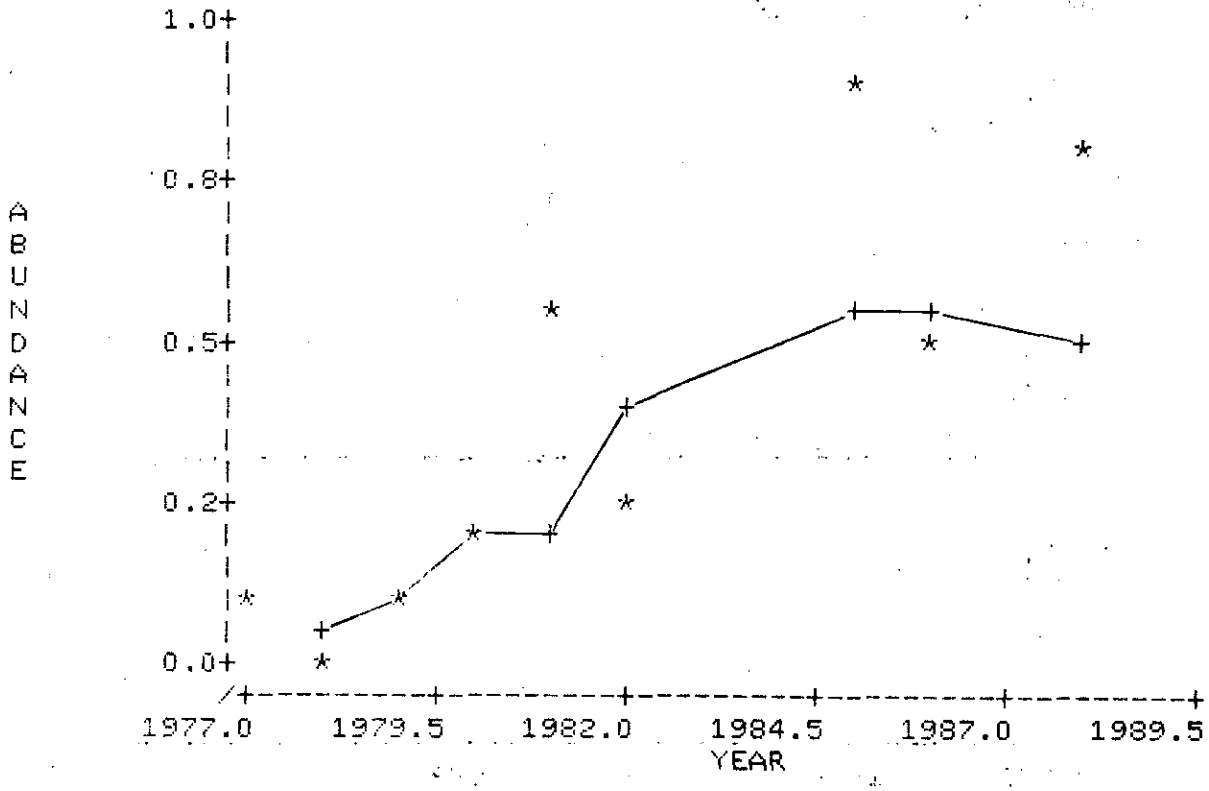
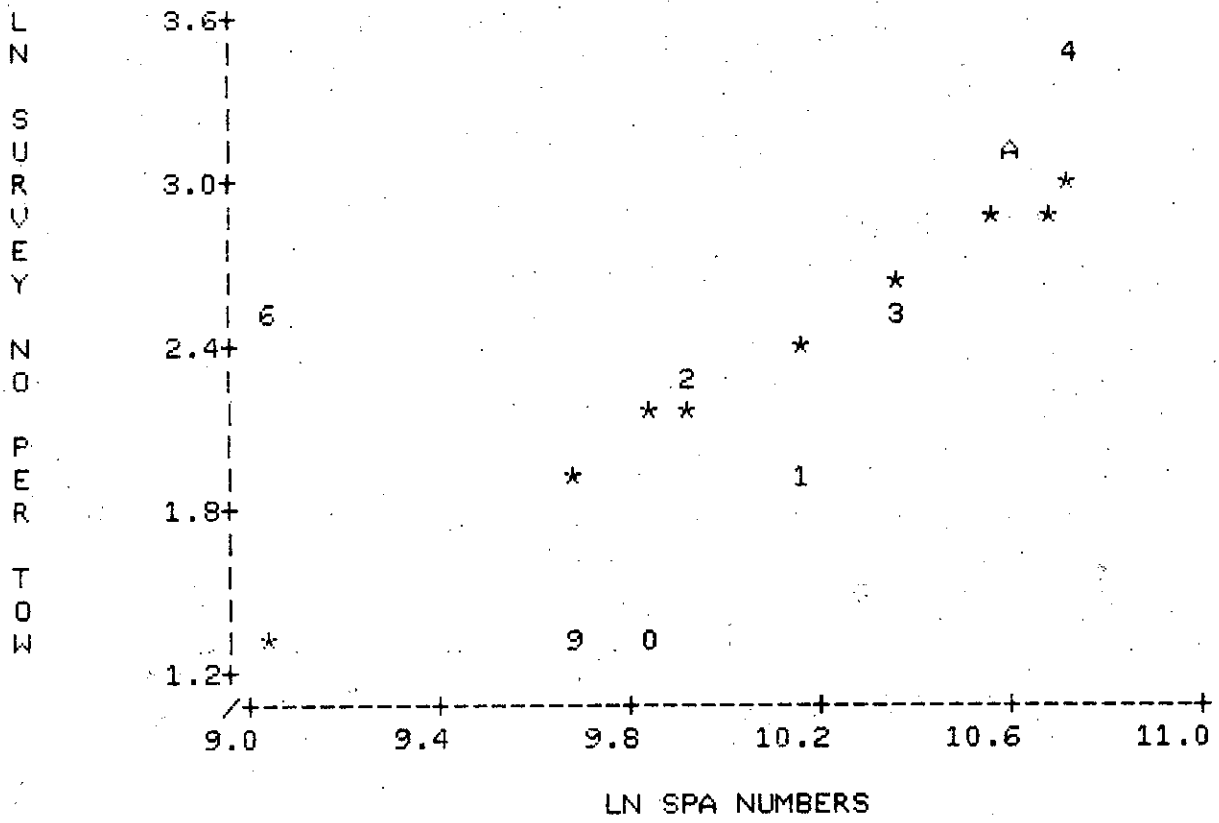


Figure 8. Continued (observed *, predicted +).

AGE 3 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

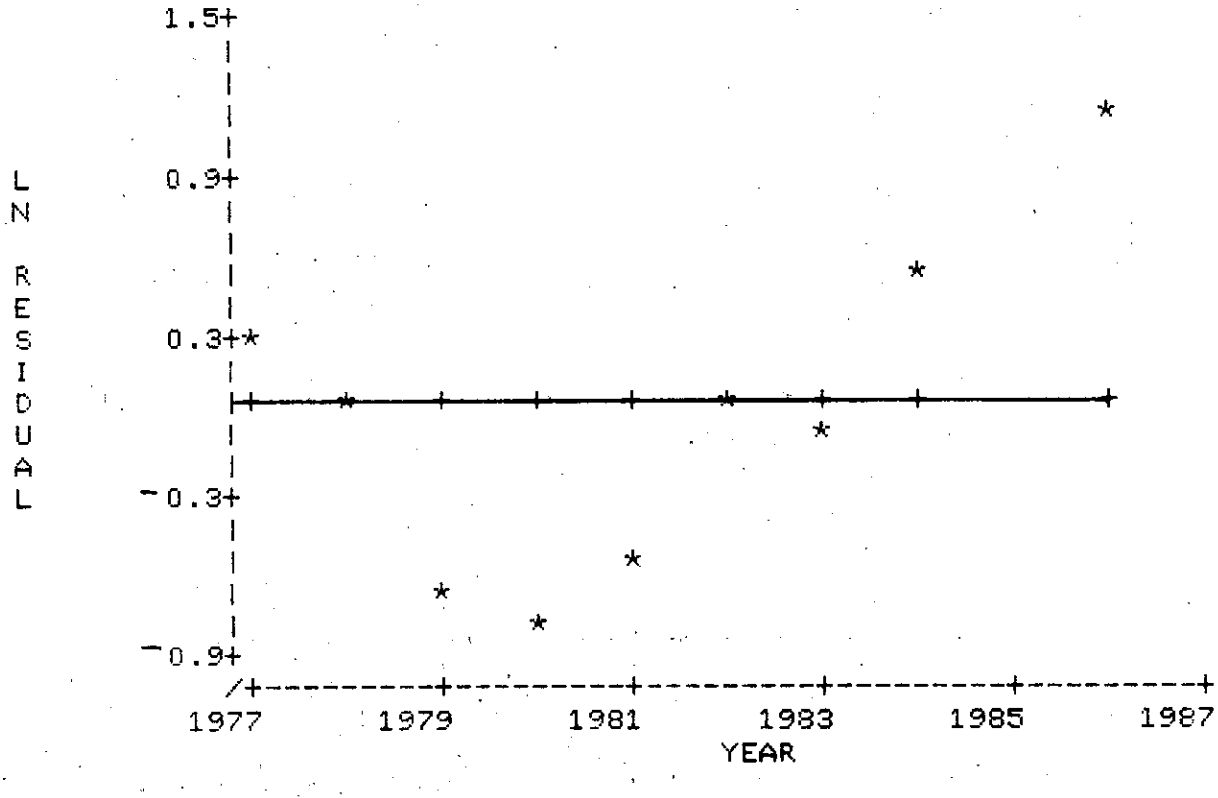
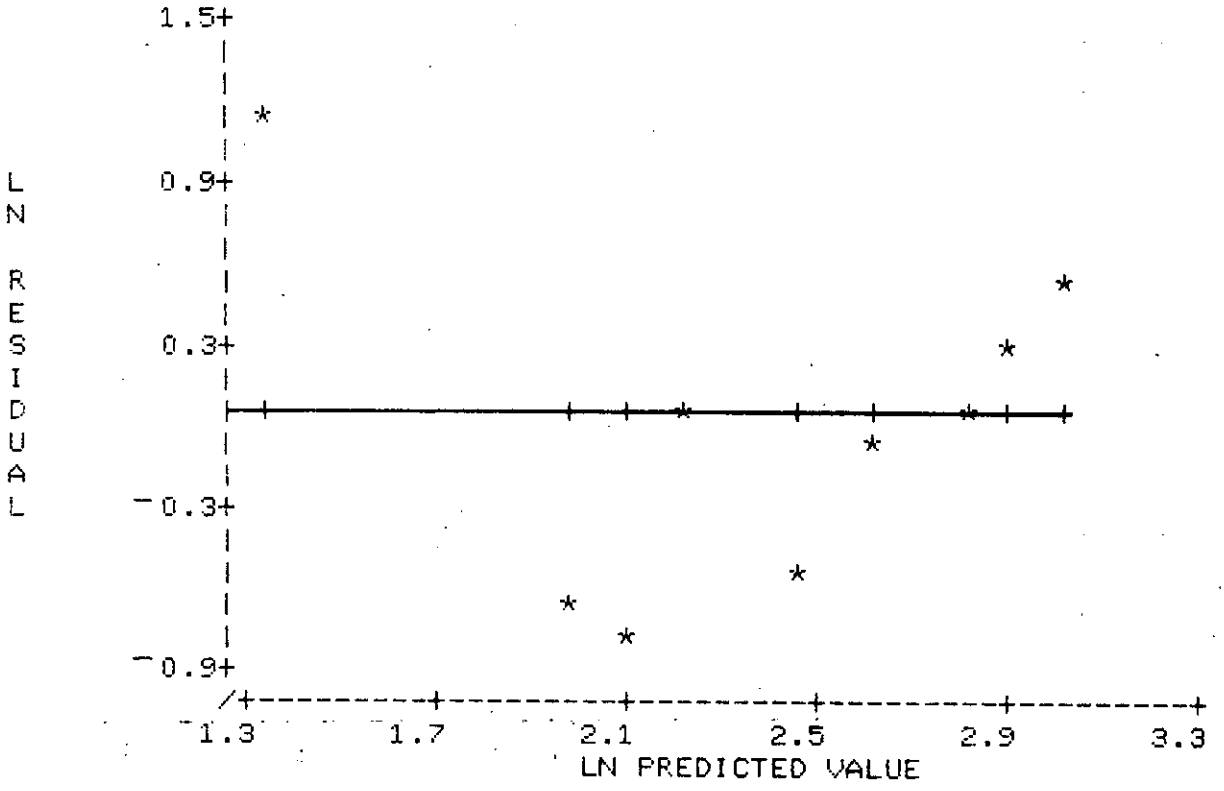


Figure 9. Age 3 plots from ADAPT using Soviet surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

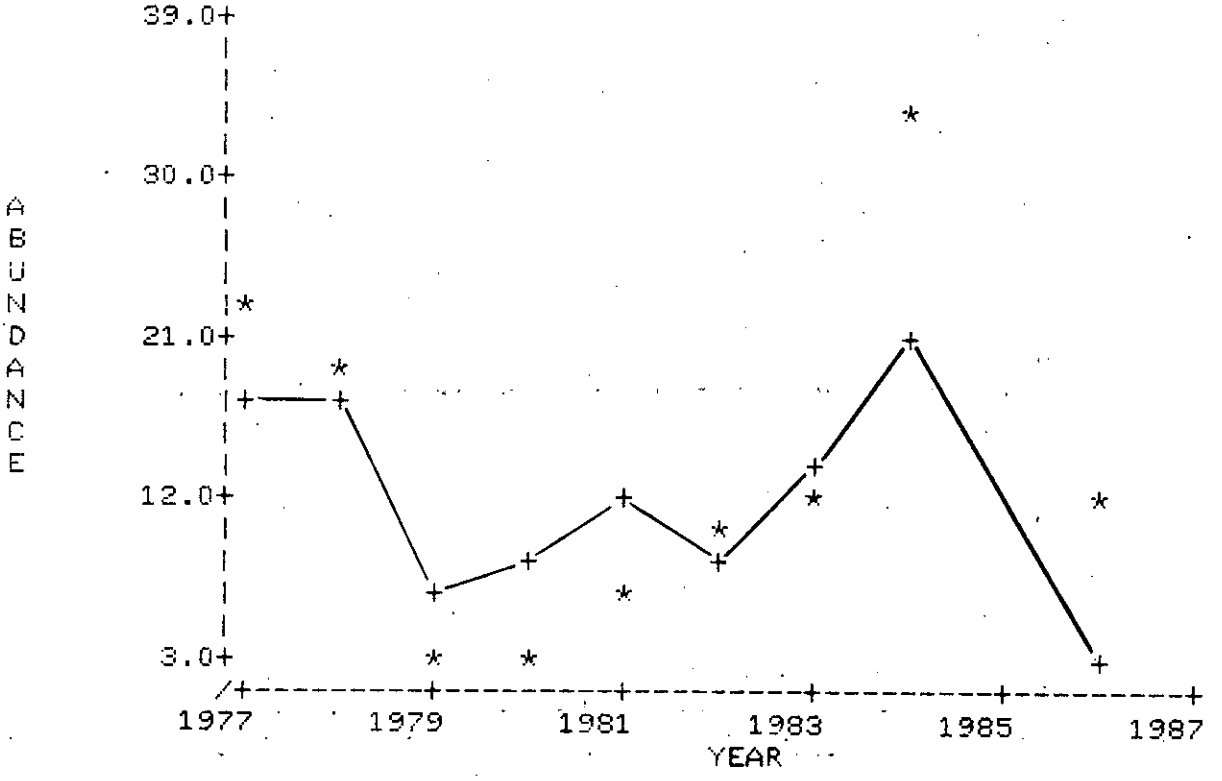
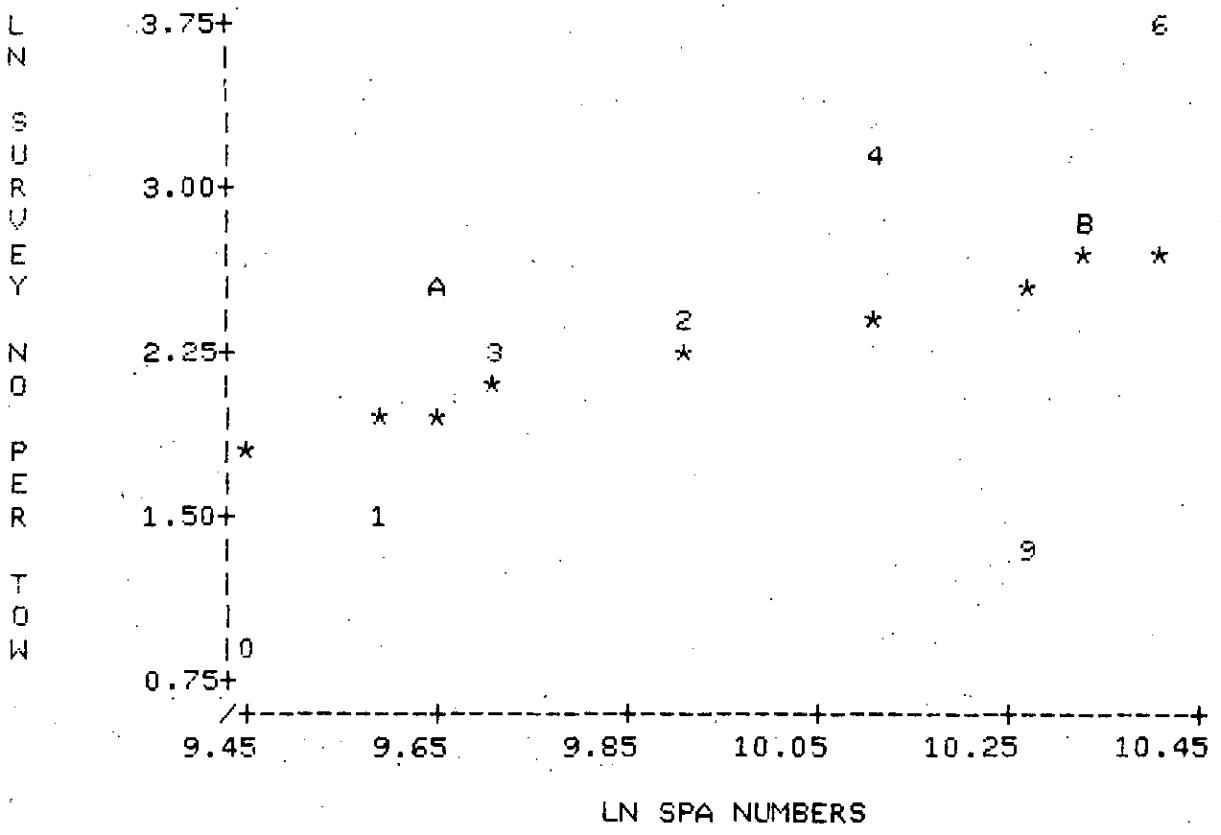


Figure 9. Continued (observed *, predicted +).

AGE 4 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

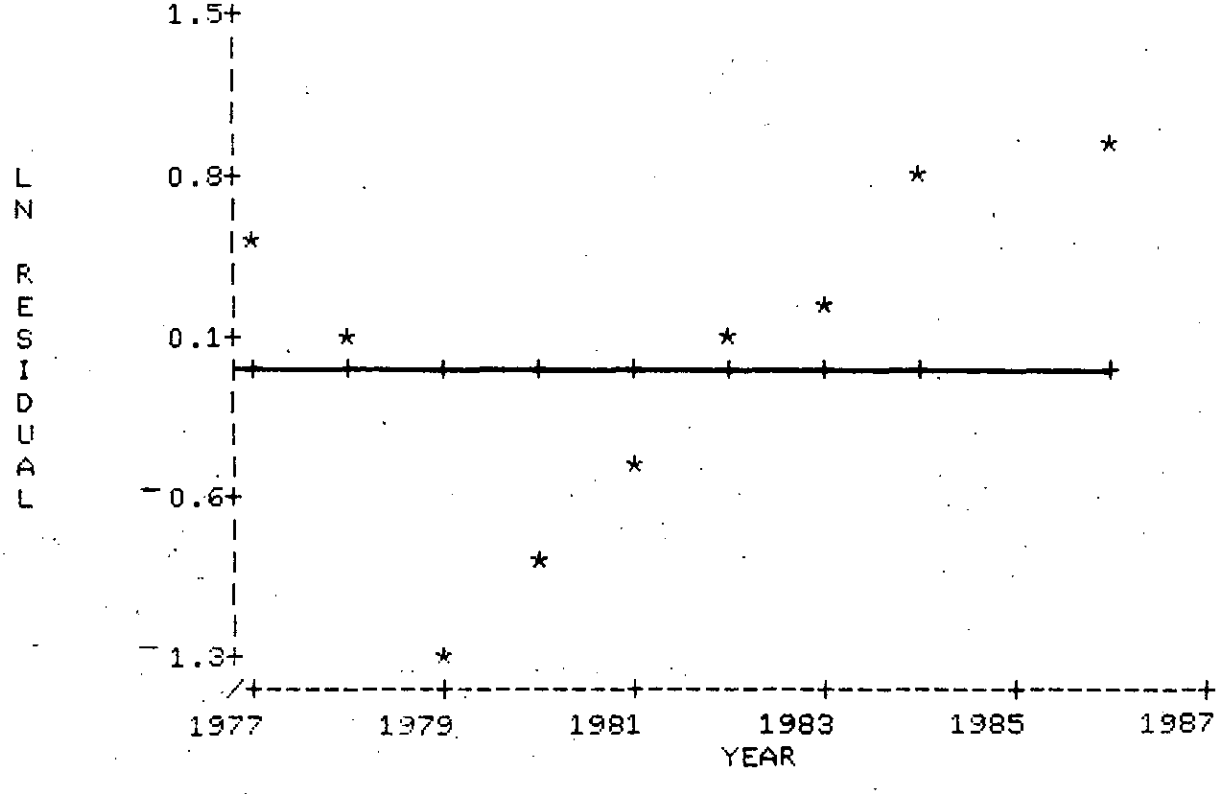
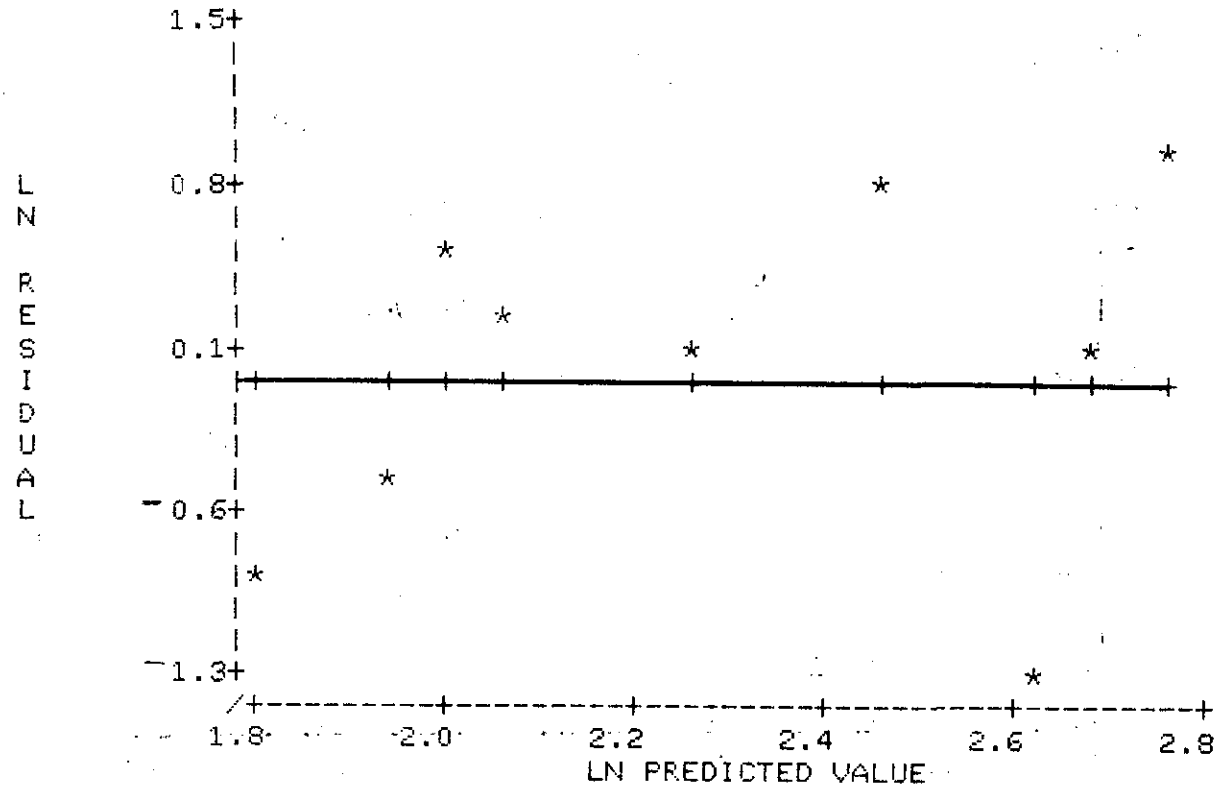


Figure 10. Age 4 plots from ADAPT using Soviet surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

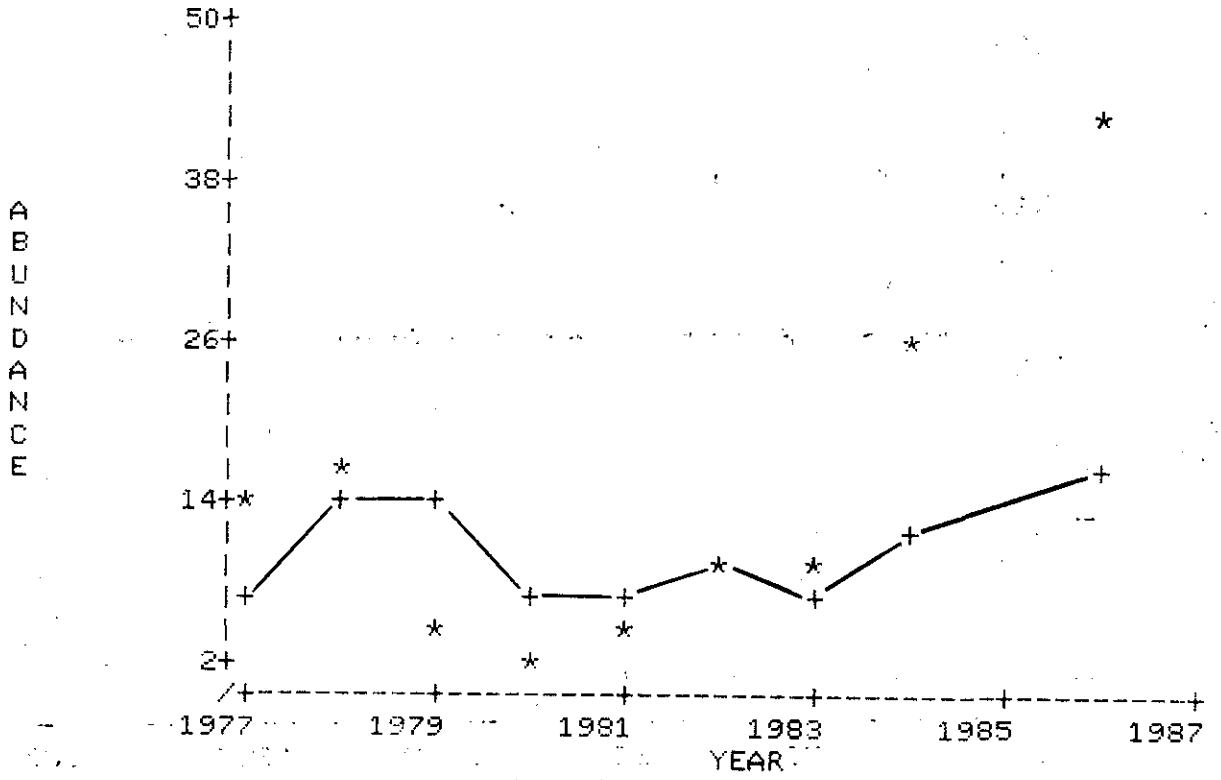
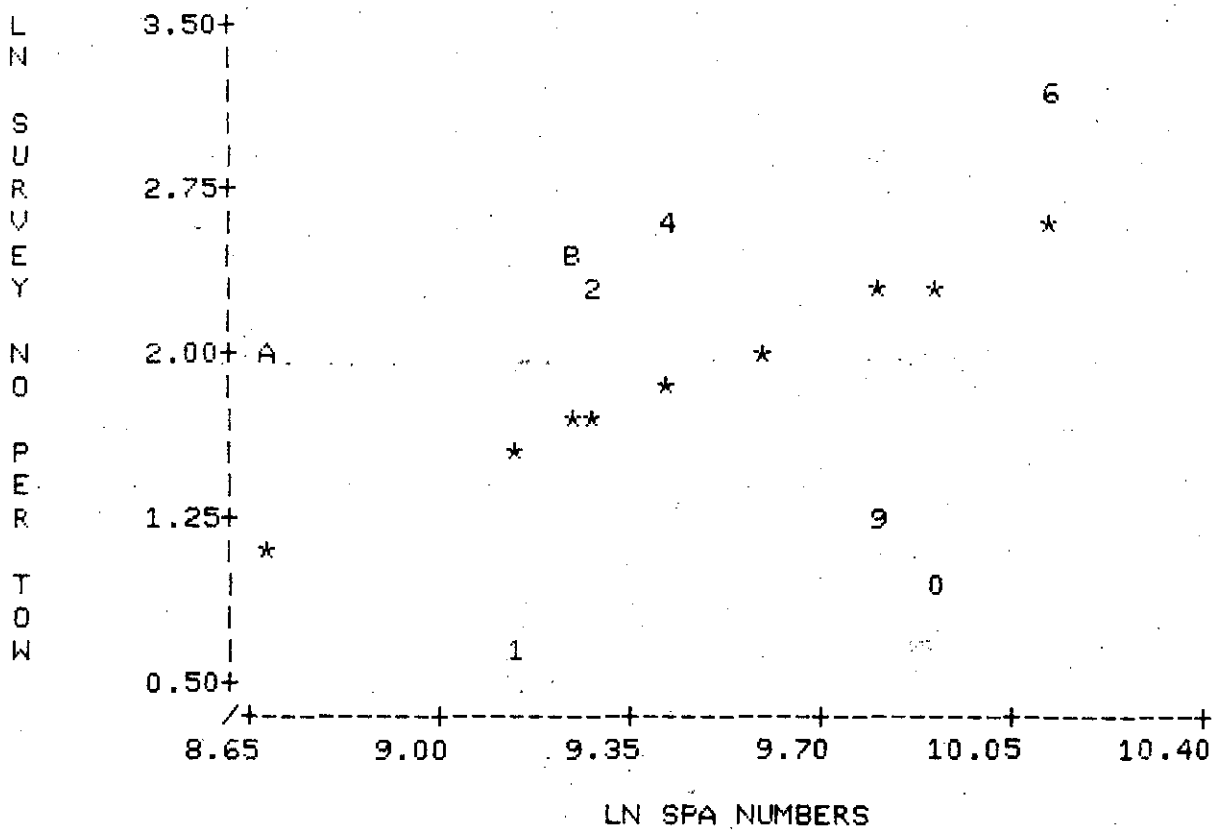


Figure 10. Continued (observed *, predicted +).

AGE 5 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

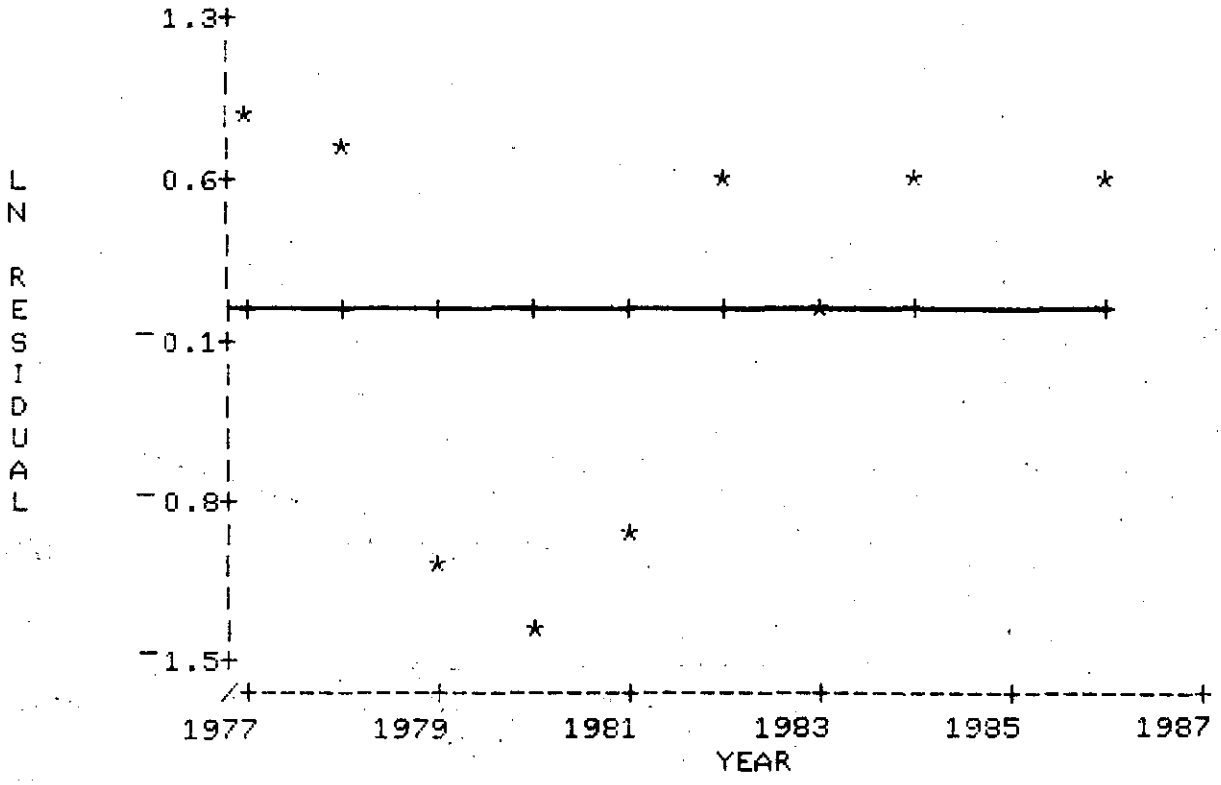
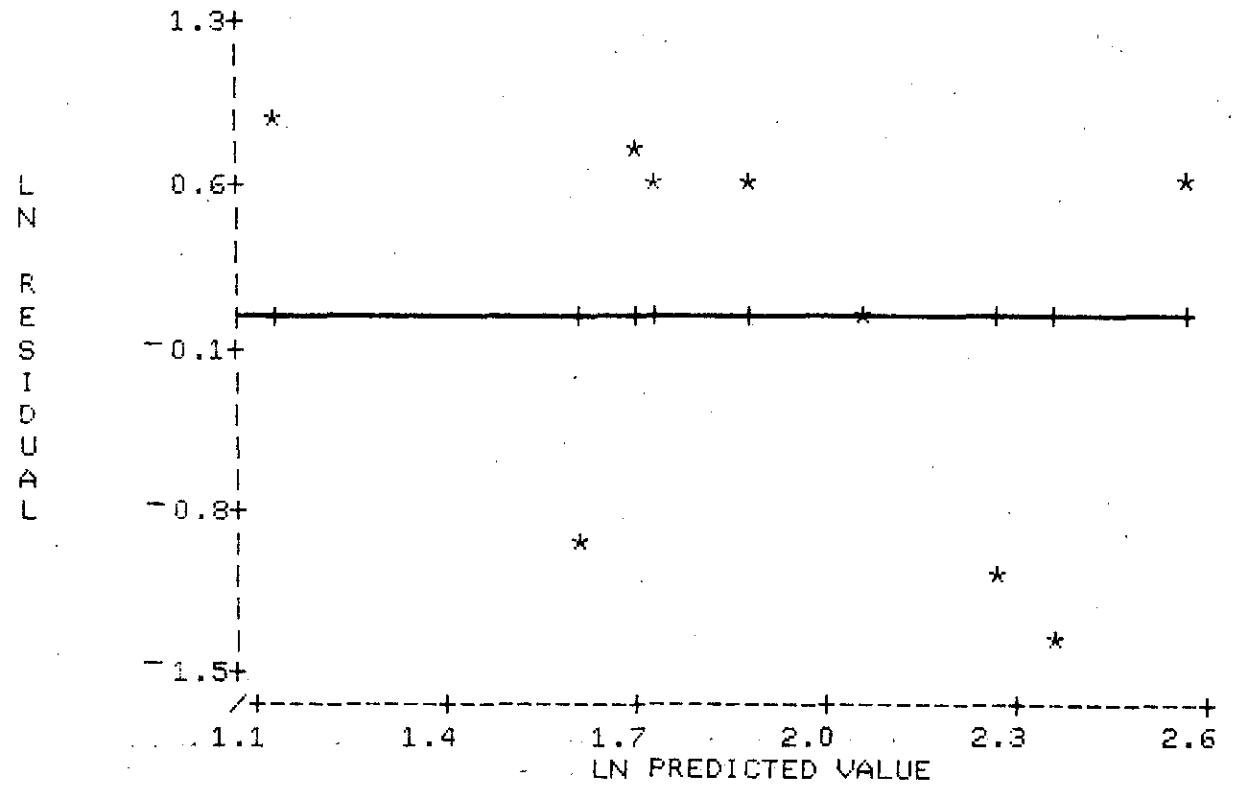


Figure 11. Age 5 plots from ADAPT using Soviet surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

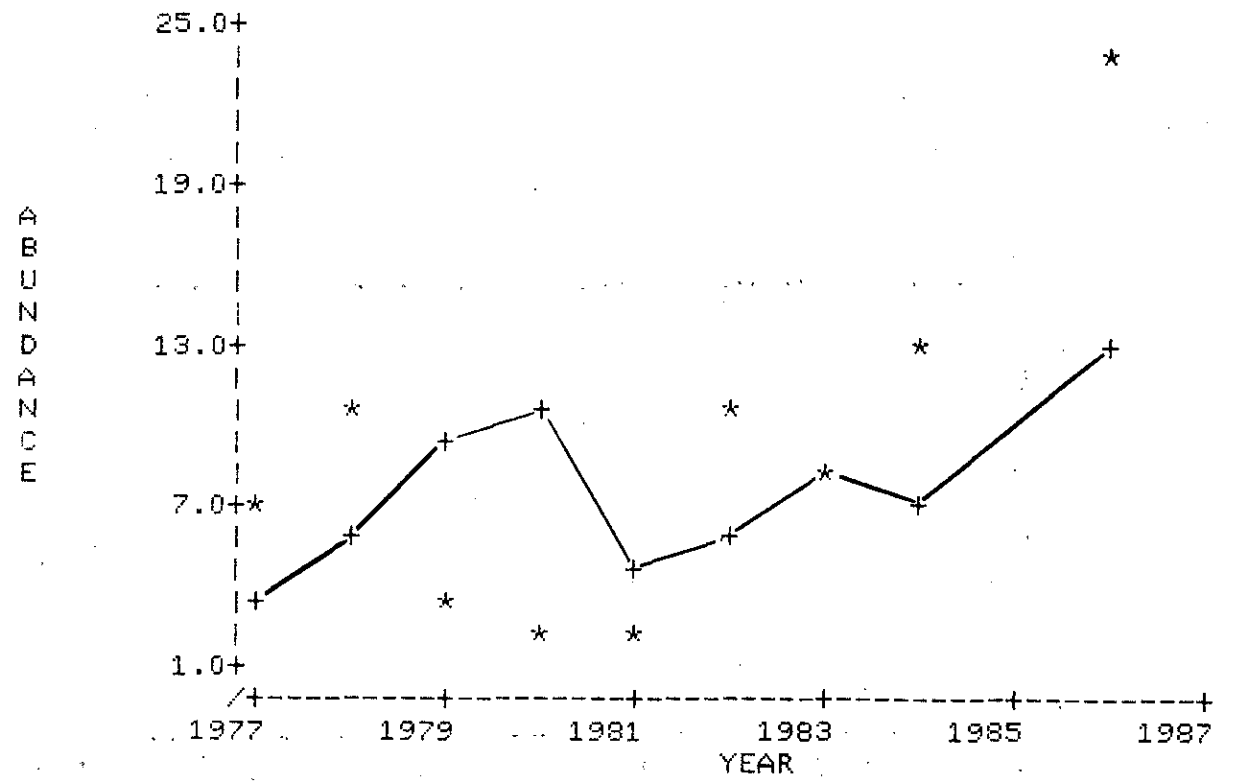
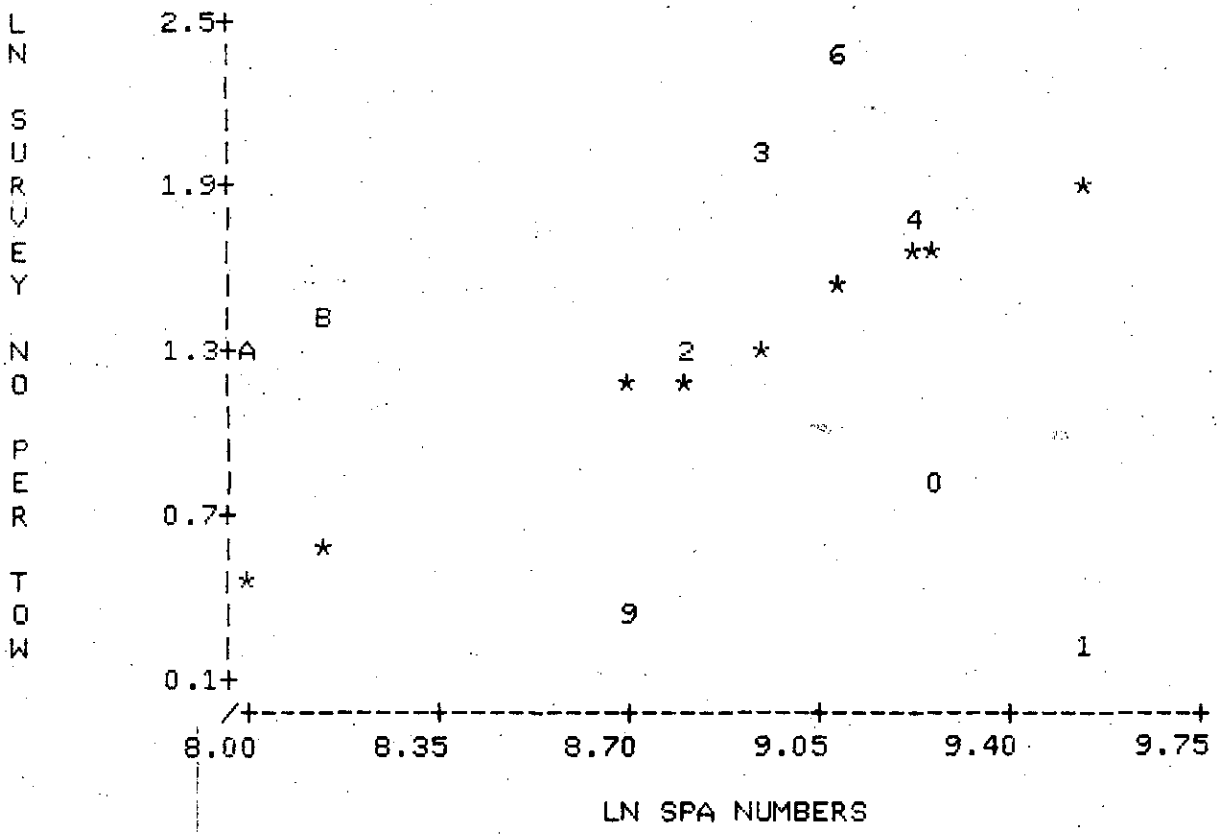


Figure 11. Continued (observed *, predicted +).

AGE 6 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

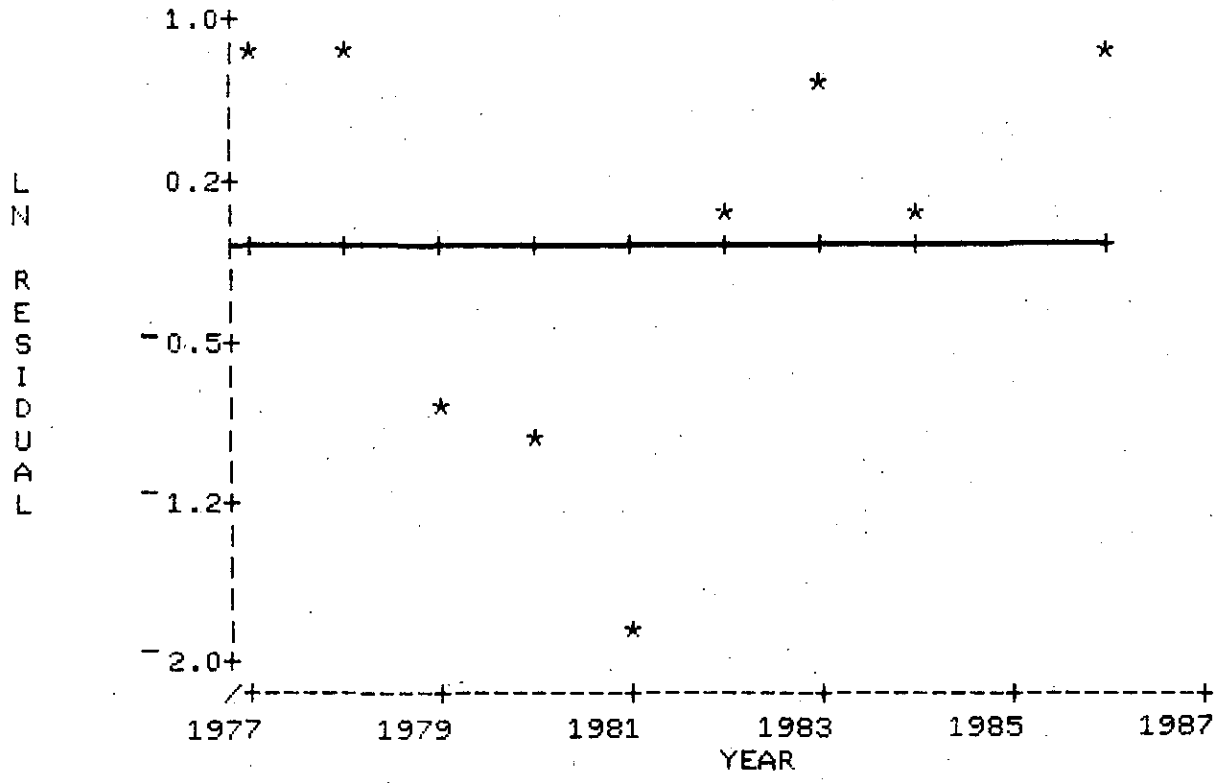
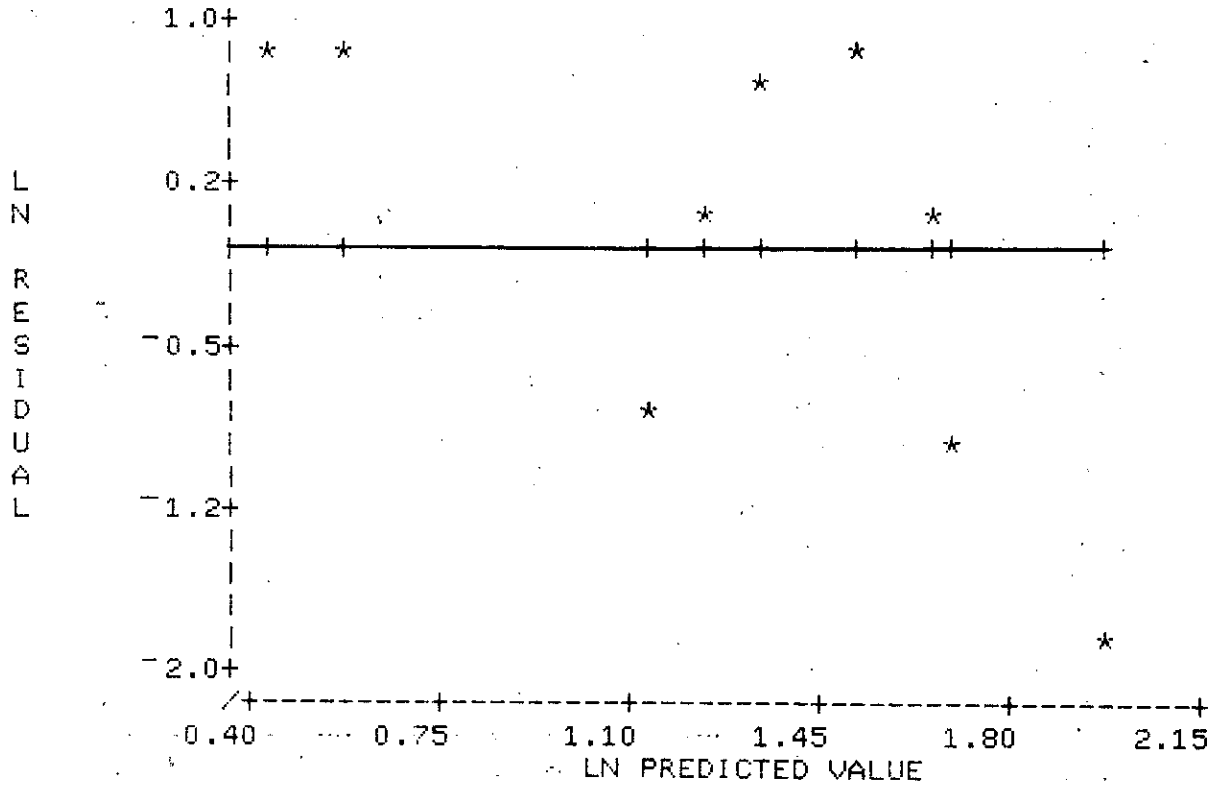


Figure 12. Age 6 plots from ADAPT using Soviet surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

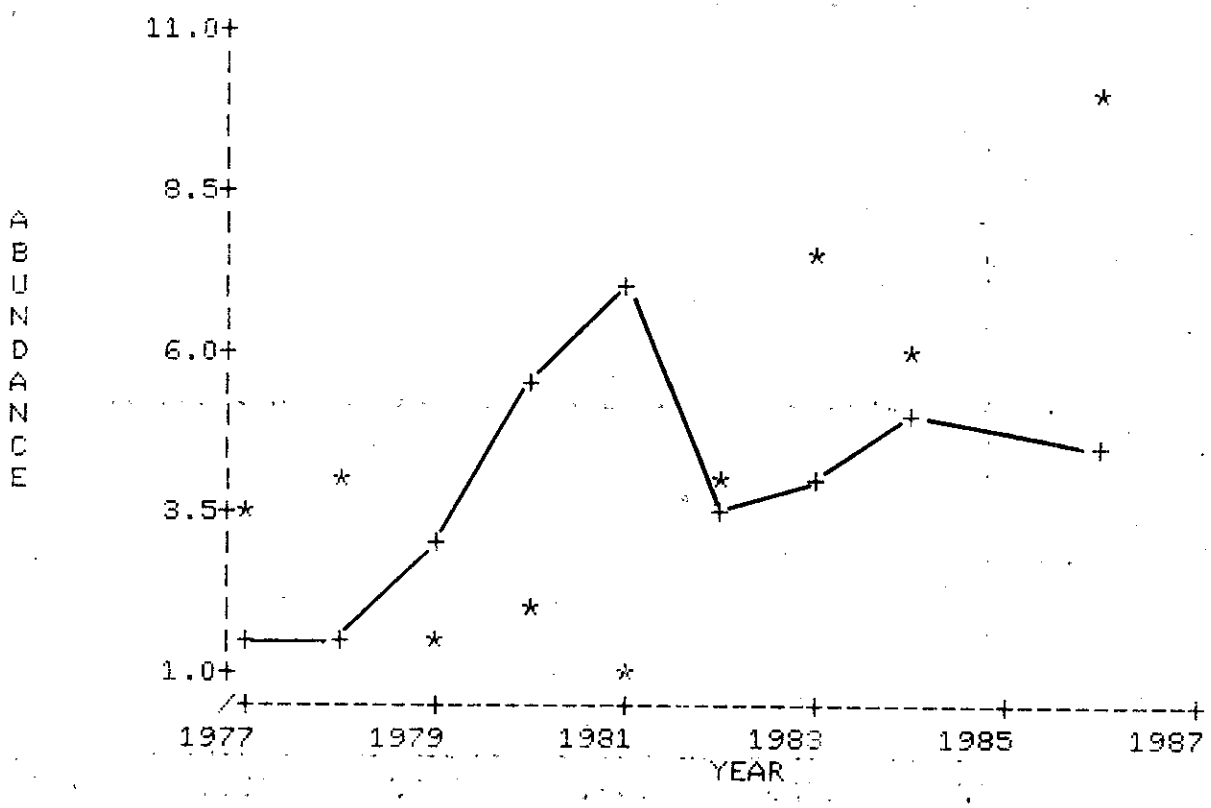
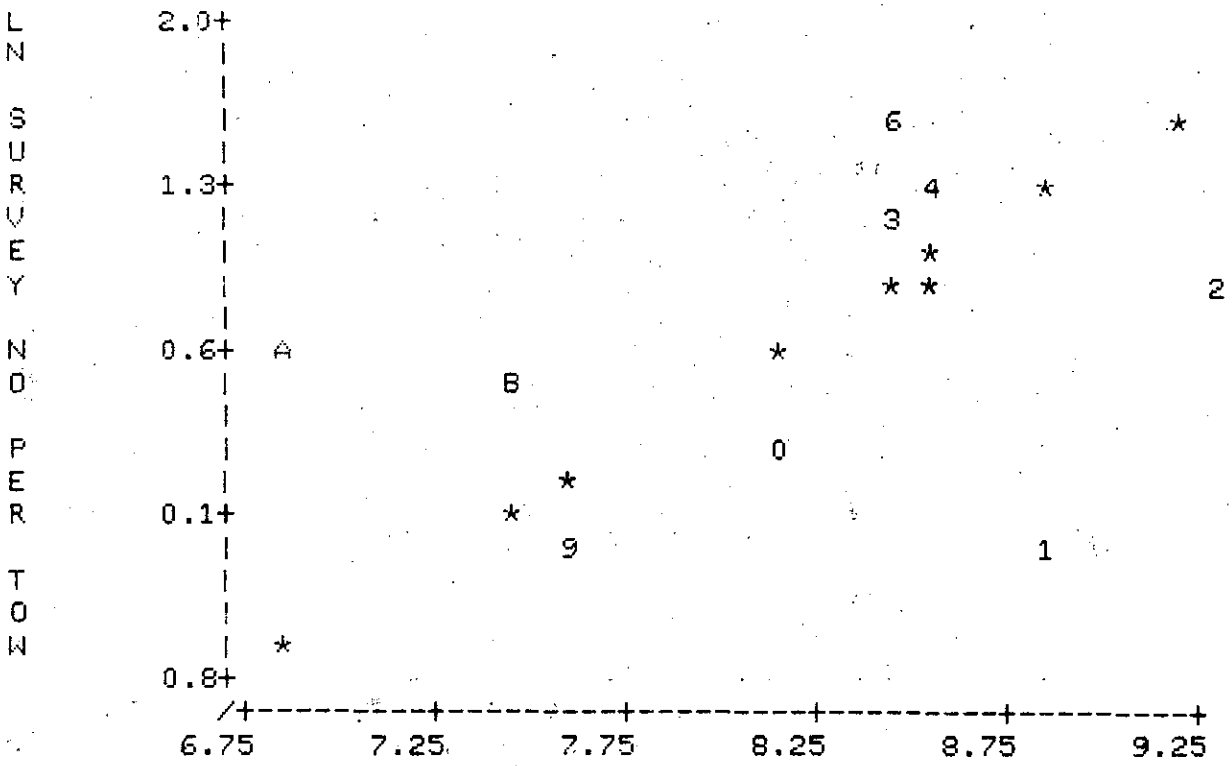


Figure 12. Continued (observed *, predicted +).

AGE 7 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

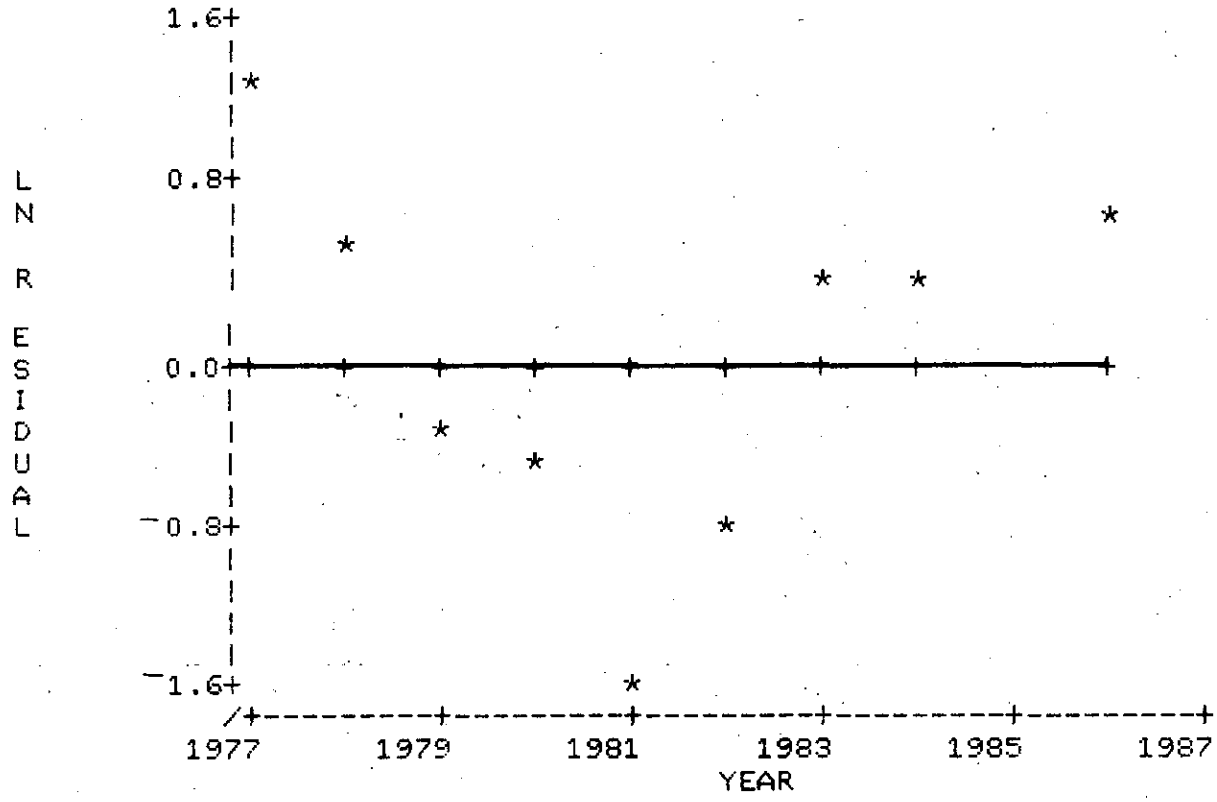
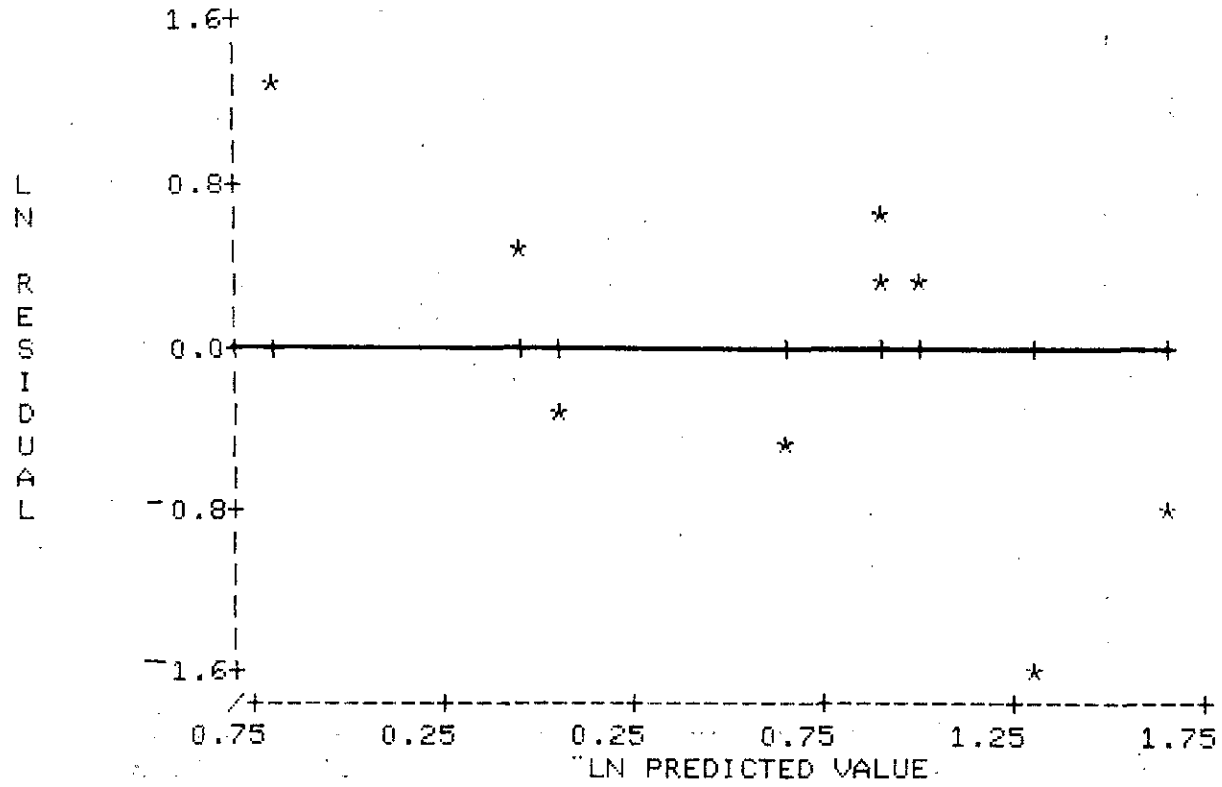


Figure 13. Age 7 plots from ADAPT using Soviet surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

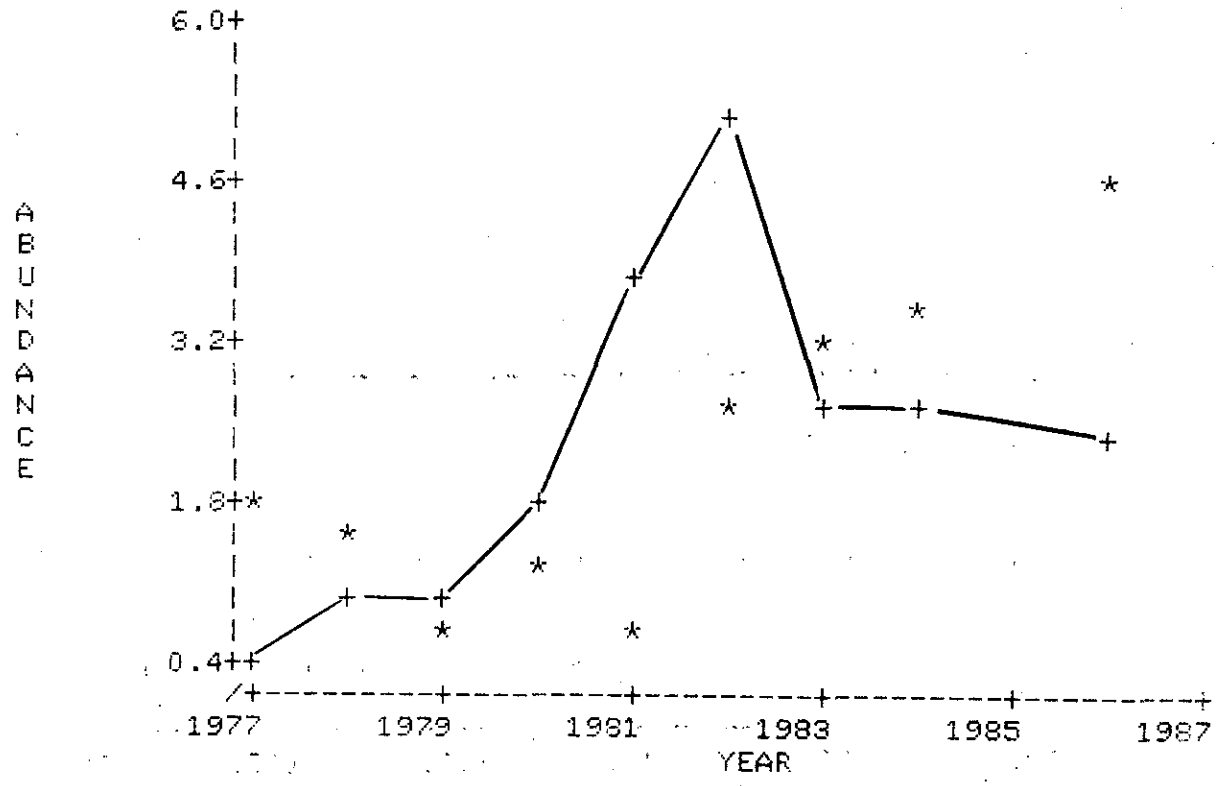
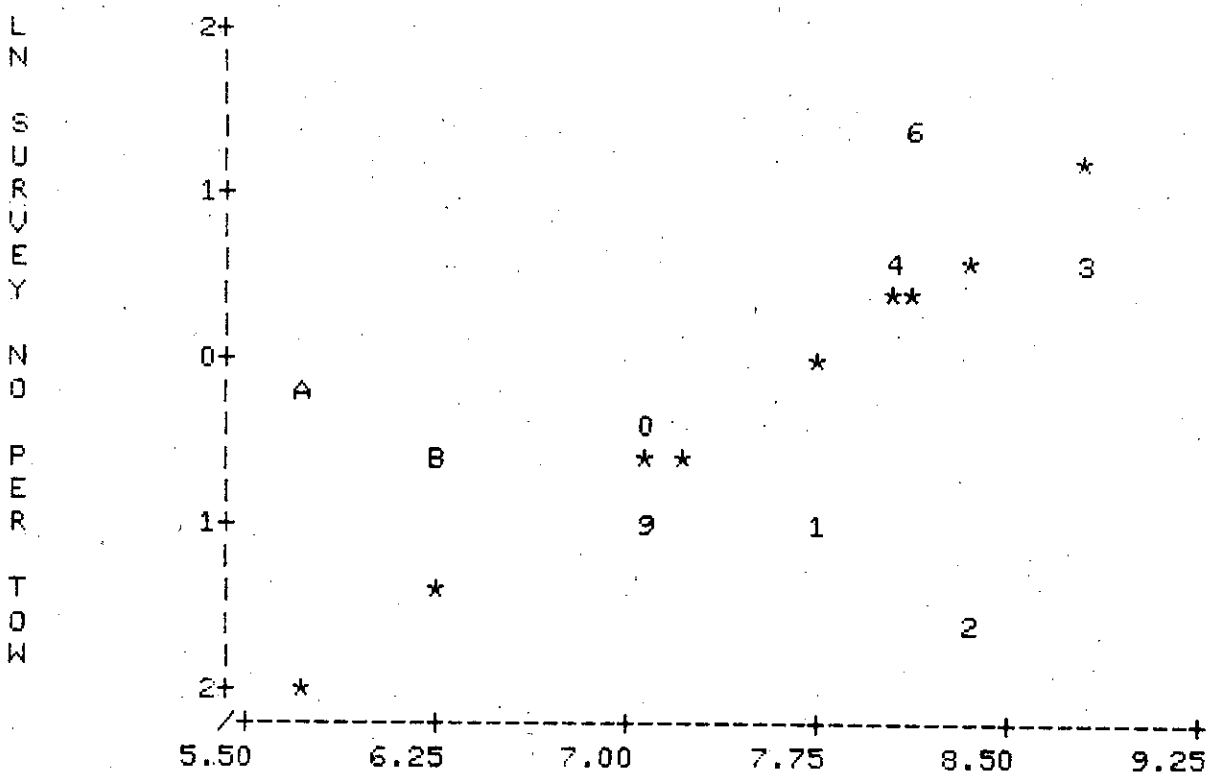


Figure 13. Continued (observed *, predicted +).

AGE 8 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

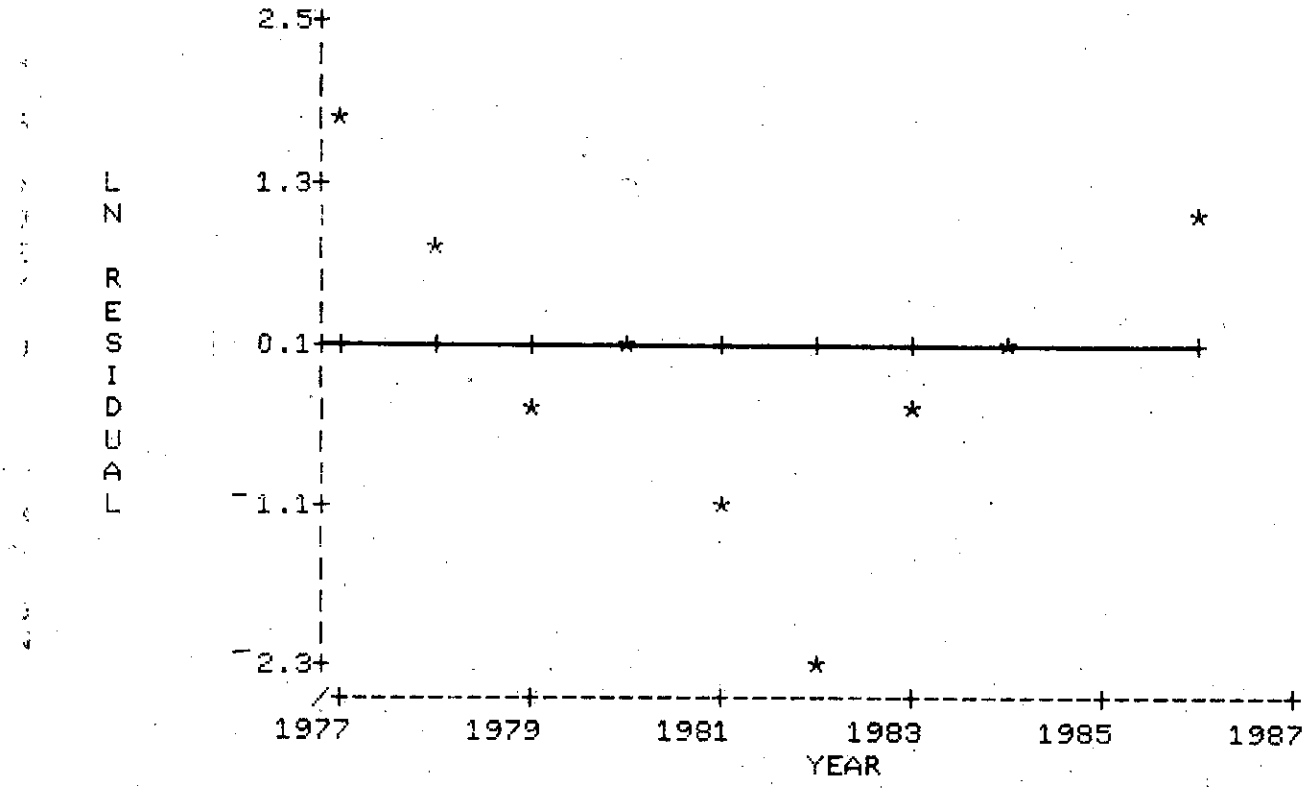
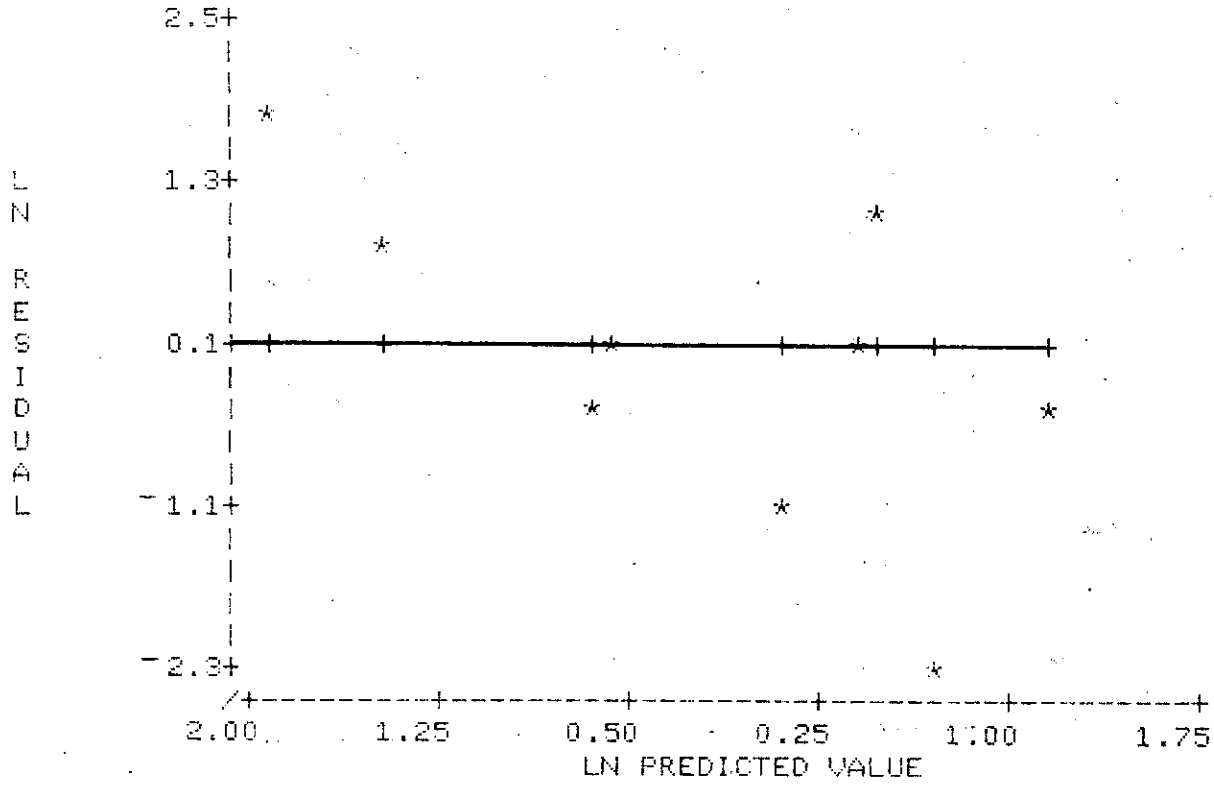


Figure 14. Age 8 plots from ADAPT using Soviet surveys.

LN RESIDUAL VS LN PREDICTED VALUE



TREND IN POPULATION ABUNDANCE OVER TIME

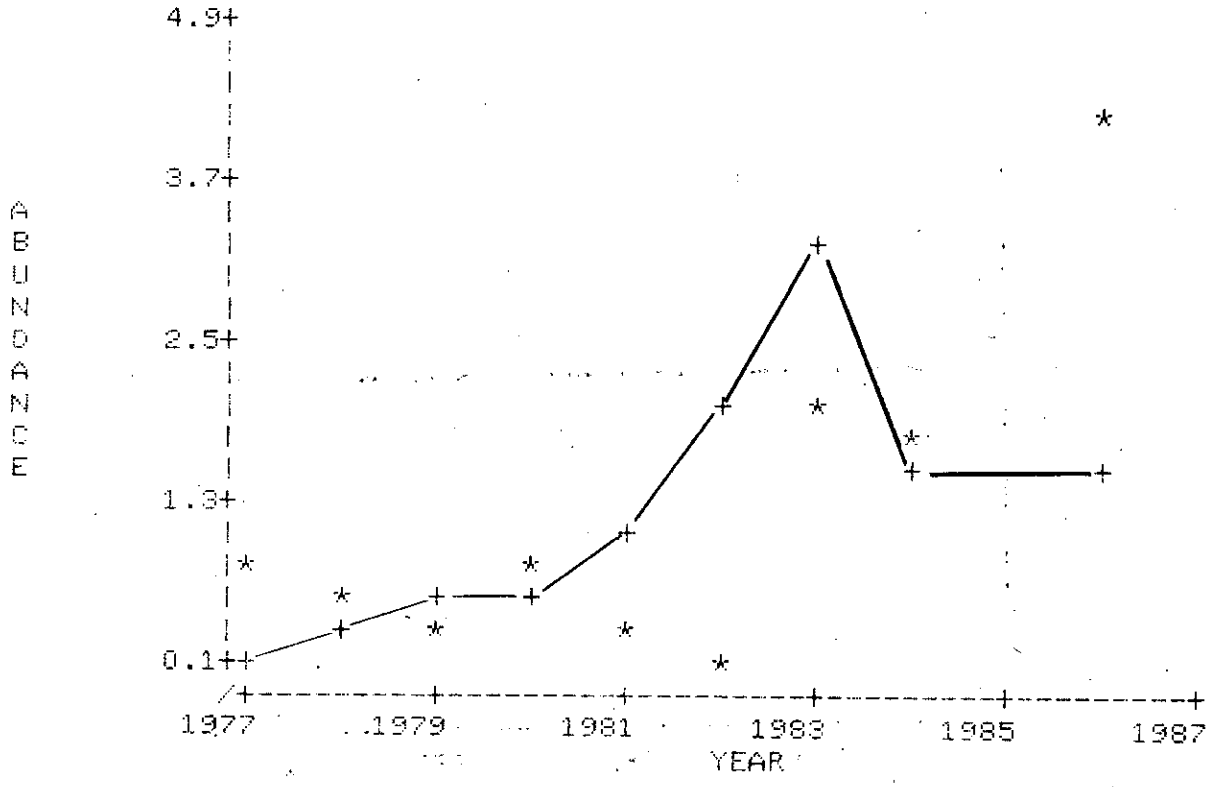
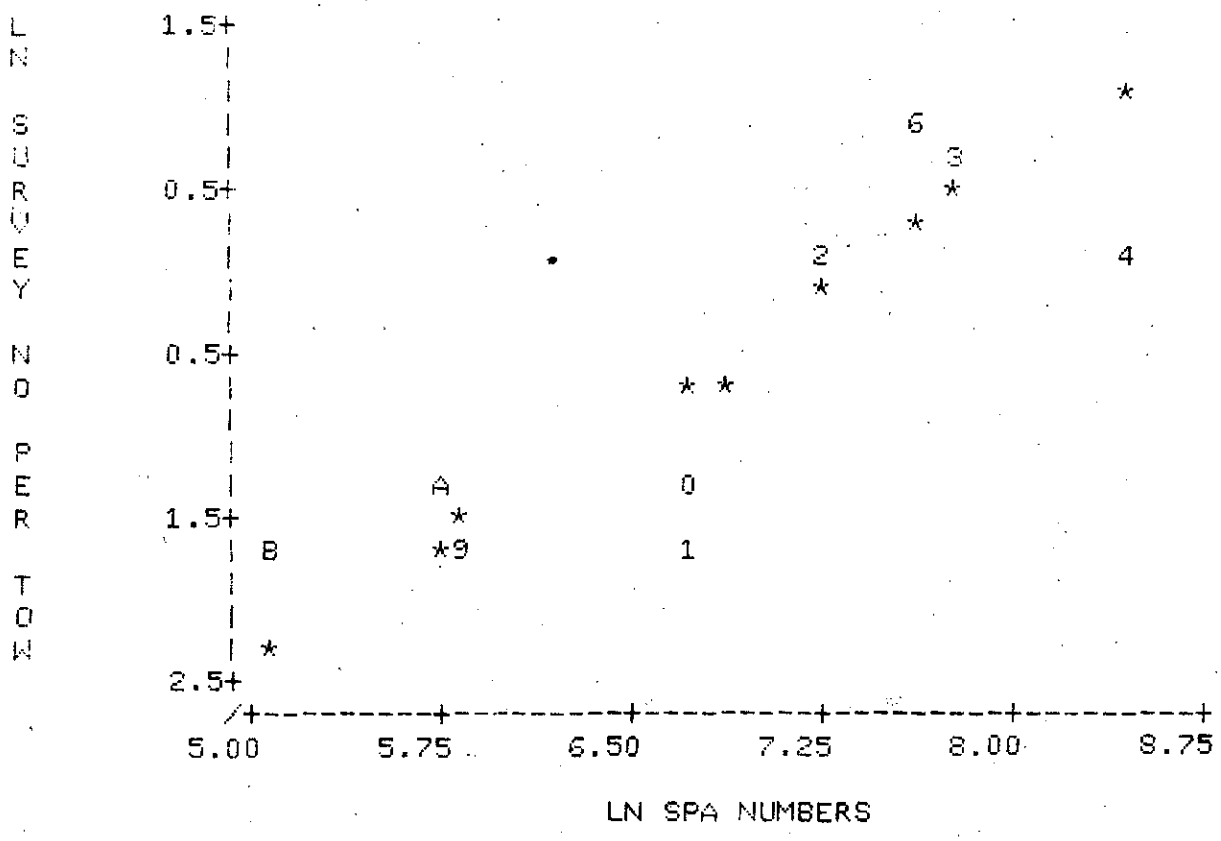


Figure 14. Continued (observed *, predicted +).

AGE 9 PLOTS
LN SURVEY NO. PER TOW VS LN SPA NUMBERS



TREND IN LN RESIDUAL OVER TIME

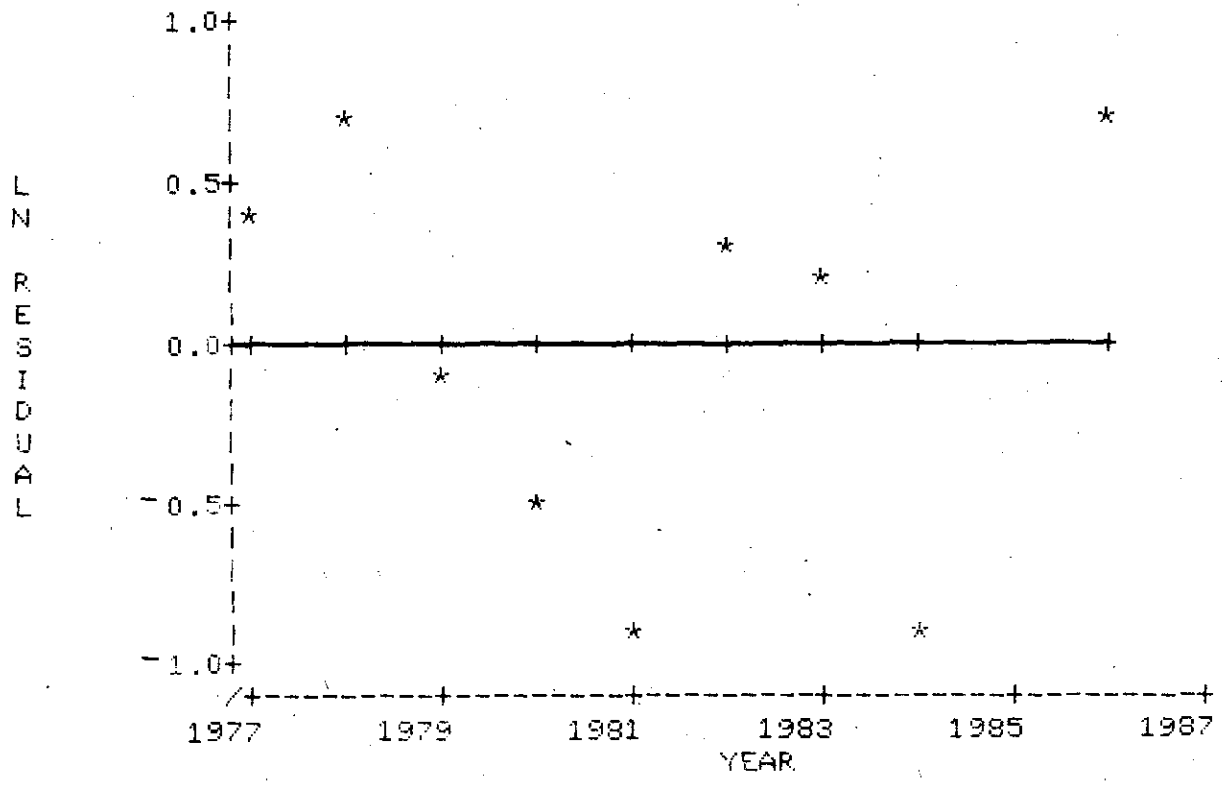
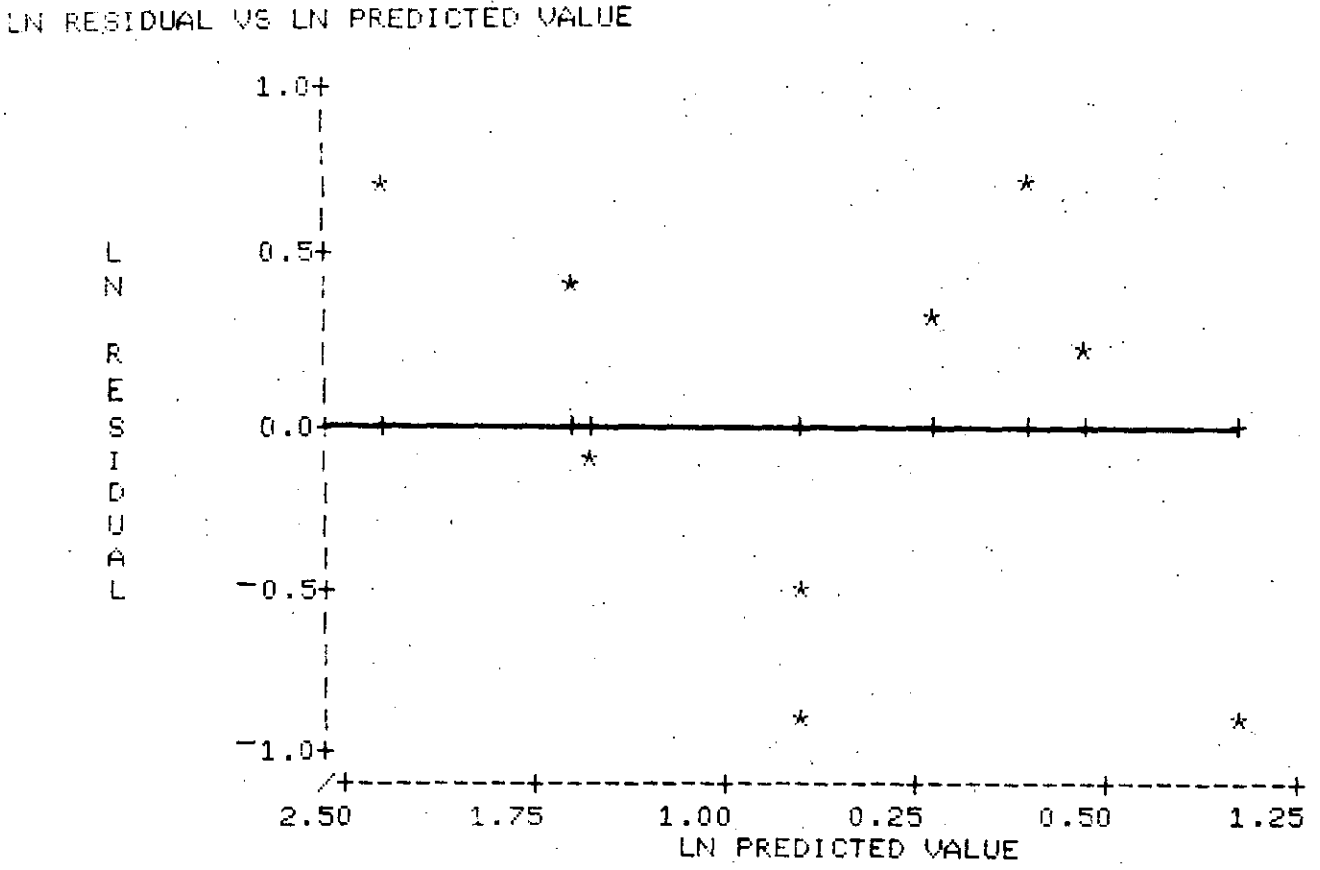


Figure 15. Age 9 plots from ADAPT using Soviet surveys.



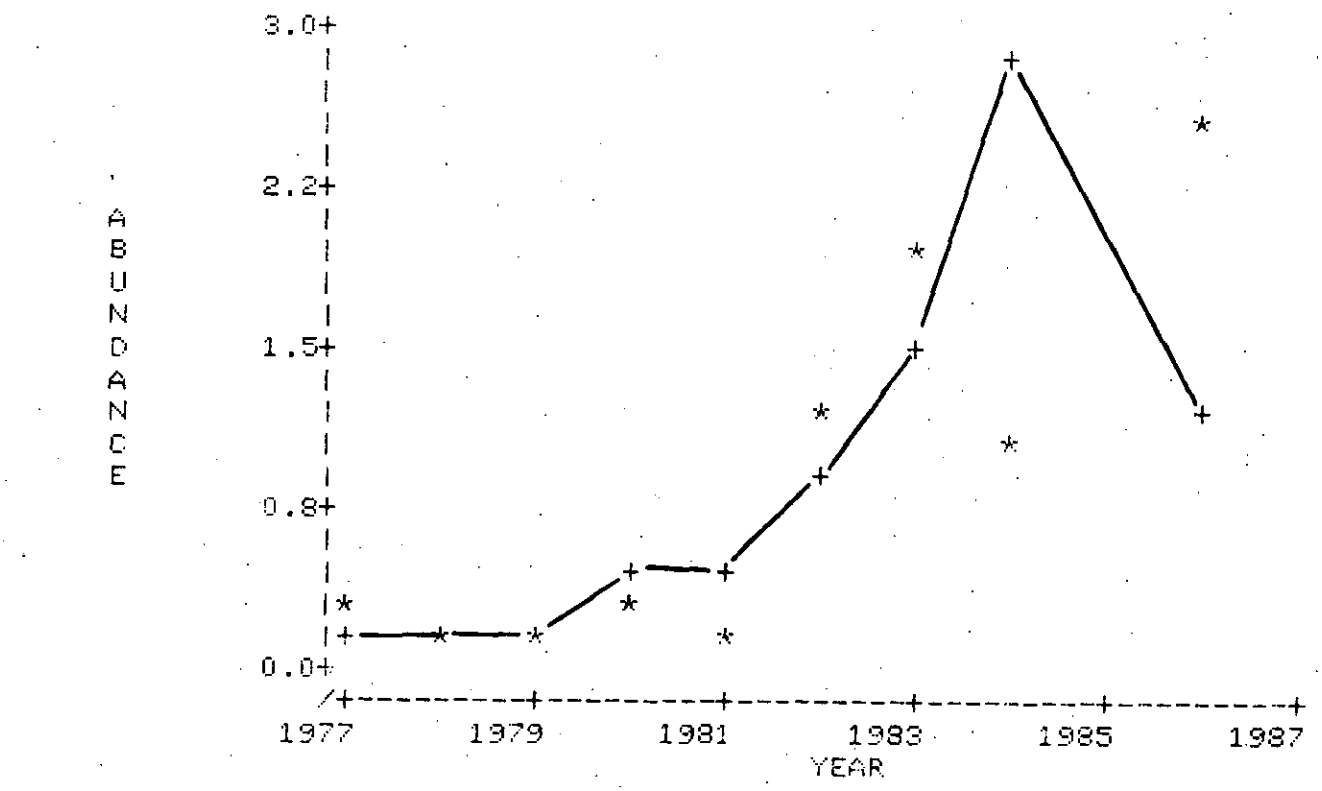


Figure 15. Continued (observed *, predicted +).