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Results of Data Conversions for American Plaice in Div. 3LNO from Comparative Fishing Trials Between the Engel Otter Trawl and the Campelen 1800 Shrimp Trawl

by

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Abstract

During 1995 the Canadian Department of Fisheries and Oceans, Science Branch, Newfoundland Region replaced its *Engel* bottom otter trawl used in groundfish surveys with a *Campelen 1800* shrimp trawl. This paper presents the results of an exercise to convert data on American plaice (*Hippoglossoides platessoides*) collected using the Engel trawl to Campelen equivalents. The data from a comparative fishing exercise suggested that for American plaice <= 23 cm. the conversion factor should be 10.02, for fish >= 40 cm. the conversion factor should be 1.0, and for fish between 24 and 39 cm. inclusive the conversion should be defined by the equation : $\ln(y) = 39.958 + 0.358[X - 41 \ln(X)]$. The conversion results in a large increase in the number of small, young fish.

Introduction

During 1995 the Canadian Department of Fisheries and Oceans, Science Branch, Newfoundland Region replaced its *Engel* bottom otter trawl with bobbin footgear used in groundfish surveys with a *Campelen 1800* shrimp trawl using rockhopper footgear. In order to establish a link between the two sets of survey data, comparative fishing trials were conducted in 1996 to develop conversion factors between the two fishing gears. The trials were conducted between the regular survey vessel *RV Wilfred Templeman* (WT) using the new survey gear and its sister ship *RV Alfred Needler* (AN) using the old survey gear. It was assumed that there was no difference between vessels and that the only observed differences in catch were a result of the use of the different fishing gears. Six species were investigated, including American plaice.

A thorough description of the experimental design and analytical methodology can be found in Warren et al. (1997) and thus will not be described in detail here. The conversion factors derived are dependent on fish length, given the different selectivities of the 2 trawls involved. The purpose of this paper is to illustrate the results of the conversion factors and the impact on length and age distribution, as well as trends in stock size of A.plaice in Div. 3LNO, using the newly converted data time series. A similar analysis was conducted for several other species from the same experiment, including cod (Stansbury 1997) and witch flounder (Bowering and Orr 1998).

Materials and Methods

Length frequencies, standardized for towing distance, for American plaice in NAFO Divisions 3LNO were converted from Engel trawl catches to Campelen 1800 trawl catch equivalents for the years beginning in 1985. The data converted were spring surveys in Div. 3LNO during 1985-95 and fall surveys in Div. 3LNO during 1990-94. All subsequent surveys were actually carried out using the Campelen 1800 trawl. The experiment most relevant to these areas is the WT-AN trials. However the earlier trial between the *Teleost* (using an identical

Campelen trawl) and the *Gadus Atlantica* (using an Engel trawl similar to the one used in the AN-WT work) was also examined (Warren, 1996).

Results and Discussion

Development of conversion factors

The data gathered during the WT-AN experiment are so scattered above 40 cm., with a wide range of ratios sometimes at adjacent length groups, that the equation in this range can not be considered reliable (Fig. 1). There appears to be a similar problem above this length in the Teleost-Gadus experiment as well (Fig. 1). The results for American plaice in the WT-AN experiment are the only ones for any species in either experiment that show a leveling off of the ratio above 1:1 (Warren et al. 1997). The model fit gives a ratio of 1.127. However, there are twice as many data points below the predicted line in this range as above it. The mean ratio in the 41-67 cm range is 1.06 and the ratio of the sums of number of fish caught over this range is 1.04.

The results from both experiments would indicate that the upper cut off should be around 40 cm. Given that the WT-AN curve is the more reliable one above 40 cm, but that most of the residuals are below the line, and that the observed data would suggest a ratio closer to 1:1, we decided that the curves from both conversions should be leveled off at 40 cm at 1:1.

At the lower end of the curve the equation from the WT-AN rises extremely steeply (Warren et al 1997). This is based on very low sample size (6 fish $\leq$ 17 cm caught by the Engel). Sample size does not become at all reasonable until the 20-21 cm range (26 fish caught by the Engel). This suggests a lower cut off immediately above this length, and so to convert these smaller lengths we multiplied by the conversion for 22.5 cm, the mid point of the 22-23 cm length grouping. Fish below that size should not be ignored, as they were routinely caught as small as 6.5 cm in the Engel surveys, and leaving out fish less than 20 cm would eliminate a large portion of the population. Also, because of the wide range of lengths at a given age for A. plaice, fish as old as 6 or 7 will be affected by whatever is done with fish less than 20 cm. We feel that it is better to make a conversion (albeit an underestimate) than to not convert this length group. This will result in three classes of estimates of abundance at age: very unreliable (approximately ages 1-3), intermediate reliability (approximately ages 4-5) and good reliability (approximately ages 6 and above). These differences in reliability will result from the variable proportions of the population made up of fish less than 20 cm in these age groups. However, these levels of reliability are probably not much different from what they were with the Engel given the selectivity of that trawl.

The conversion used is as follows (for fish at length X):

for 24 cm $\leq X \leq$ 39 cm use the equation from Warren et al. 1997 to calculate the conversion factor:

$$\ln(y) = 39.958 + 0.358[X - 41 \ln(X)]$$

for 23 cm $\leq$ X the conversion factor is 10.02
for 40 cm $\geq$ X the conversion factor is 1.00.

Application of conversion factors

After the length frequencies were converted to Campelen trawl catch equivalents they were used in the standard stratified analysis program, along with annual age-length keys collected for each sex and each NAFO Division. This provided total numbers of American plaice caught, by length and age group, per standard Campelen set (0.8 nautical mile tow distance in 15 minutes with a wing spread of 16.84 m). In a separate analysis, the length-weight relationship used historically for the 3LNO American plaice stock ($\log_{10}$ wt = 3.3247 $\log_{10}$ len - 5.553) was applied to the converted abundance at length values to obtain biomass at length, and then summed over all lengths to get total estimated biomass in Campelen equivalents. Results of the biomass calculations are contained in Brodie et al. (1998).

For surveys conducted in Divisions 3LNO in spring 1985-97 the length data are shown in Tables 1a and 1b. The impact of the conversions on the smallest lengths can be easily seen in Fig. 2. At lengths less than 24 cm, the difference in abundance is a factor of 18.3 (10.02 conversion factor multiplied by 1.83 swept area difference).

When age length keys are applied to the converted data, the age compositions are shifted toward younger fish (Fig. 3, Tables 2a and b).

For surveys conducted in Divisions 3LNO in autumn 1990-94, the same procedure was used. However, at this time, the converted length frequencies have not been translated into numbers at age. This will be done in a subsequent analysis. The trends in total abundance, for both the converted and unconverted data in the spring and fall series, are shown in Figure 4. All datasets show the decline in stock size in the early 1990's, with the relative values estimated for the Campelen trawl being higher.

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Table 1a. Abundance index (millions) of American plaice, by length group, from Canadian spring surveys in Div. 3LNO. Data converted to Campelen trawl catch equivalents.

	Year										
Length(cm)	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
4.5			0.5				0.4				
6.5	0.6		1.1	0.4	0.4	0.9	1.3				
8.5	3.4	2.0	6.1	6.6	7.9	3.4	0.8	1.2	0.7		
10.5	4.4	6.4	21.0	15.3	11.9	9.2	6.6	7.2	2.8		0.8
12.5	12.4	12.4	19.6	11.8	16.2	23.4	19.4	4.8	1.4	1.6	1.8
14.5	25.2	22.2	29.6	25.8	22.5	48.5	22.5	20.9	5.1	5.4	3.4
16.5	58.9	41.2	74.3	50.5	65.6	84.0	60.1	37.5	11.2	3.9	3.6
18.5	109.7	100.4	182.0	96.2	141.1	185.3	96.4	46.7	33.3	15.2	6.9
20.5	164.5	167.8	299.3	186.3	299.9	263.8	155.9	76.1	90.8	39.5	15.9
22.5	297.6	273.4	421.4	349.8	408.5	419.3	255.8	122.1	164.4	64.9	29.4
24.5	292.3	281.9	334.5	309.7	294.0	331.2	196.3	85.7	110.6	60.6	38.9
26.5	236.5	239.2	291.8	258.1	239.2	213.3	131.8	73.8	92.9	49.7	37.3
28.5	197.9	194.0	244.5	226.6	195.1	142.3	91.8	54.7	73.0	37.9	34.8
30.5	170.0	173.8	221.1	195.8	158.7	104.2	65.7	40.2	46.6	29.5	22.0
32.5	156.5	157.1	184.7	171.6	144.9	90.4	48.5	30.6	39.9	22.4	19.5
34.5	132.2	133.8	158.1	142.9	122.3	74.9	36.8	20.3	26.6	17.3	13.3
36.5	115.7	107.4	125.5	114.9	100.8	60.6	29.0	14.5	18.9	11.9	9.1
38.5	100.7	86.9	96.0	91.0	78.7	47.9	22.1	10.5	14.1	9.2	7.4
40.5	82.5	66.9	69.5	72.5	54.5	35.9	17.2	9.8	9.0	6.1	5.5
42.5	69.7	55.2	60.6	56.9	48.0	30.9	15.3	7.9	7.0	4.6	4.3
44.5	56.3	43.2	48.2	47.1	38.9	24.6	14.2	6.0	4.8	4.0	2.5
46.5	43.3	31.7	35.1	36.0	27.5	21.4	11.3	5.3	3.5	2.1	1.5
48.5	32.3	23.9	27.7	25.9	22.1	15.3	9.2	3.6	3.1	1.2	0.8
50.5	23.8	18.6	18.9	18.8	15.1	11.1	5.7	2.0	2.0	1.1	0.9
52.5	17.3	12.2	13.6	13.6	11.1	8.0	4.9	1.6	1.5	0.4	0.4
54.5	11.5	8.9	10.0	10.0	8.1	5.4	3.4	1.8	1.0	0.9	0.4
56.5	9.1	6.8	7.5	6.6	6.2	4.9	3.0	1.1	0.8	0.8	0.4
58.5	6.5	4.9	5.5	4.9	4.5	4.4	2.2	1.1	0.5	0.3	0.2
60.5	5.0	3.4	4.3	3.2	3.2	2.6	1.5	0.7	0.5	0.3	0.0
62.5	3.5	2.1	3.3	2.2	2.3	2.3	1.0	0.5	0.4	0.4	0.1
64.5	2.5	1.9	2.0	1.6	1.8	1.6	0.9	0.6	0.3	0.2	
66.5	1.3	1.1	1.5	1.0	1.3	1.0	0.5	0.4	0.2	0.0	0.0
68.5	0.8	0.3	0.9	0.5	0.8	0.7	0.5	0.2	0.0		0.0
70.5	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.0	0.1		
72.5	0.2	0.1	0.2	0.0	0.1	0.1	0.1	0.2		0.0	
74.5	0.2	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0		
76.5		0.1	0.0	0.0					0.1		
78.5					0.0			0.0			
Total	2444.6	2263.6	3020.6	2554.2	2551.6	2273.3	1332.6	689.9	767.2	391.5	261.2

Table 1b. Abundance index (millions) of American plaice, by length group, from Canadian spring surveys in Div. 3LNO. Data in Engel units.

	Year										
Length (cm)	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.5	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
8.5	0.2	0.1	0.3	0.4	0.4	0.2	0.0	0.1	0.0	0.0	0.0
10.5	0.2	0.4	1.1	0.8	0.6	0.5	0.4	0.4	0.2	0.0	0.0
12.5	0.7	0.7	1.1	0.6	0.9	1.3	1.1	0.3	0.1	0.1	0.1
14.5	1.4	1.2	1.6	1.4	1.2	2.6	1.3	1.1	0.3	0.3	0.2
16.5	3.2	2.2	4.1	2.8	3.6	4.6	3.5	2.0	0.6	0.2	0.2
18.5	6.0	5.5	9.9	5.2	7.7	10.1	5.6	2.5	1.8	0.8	0.4
20.5	9.0	9.2	16.3	10.2	16.3	14.4	8.8	4.1	5.0	2.2	0.9
22.5	16.2	14.9	23.0	19.1	22.2	22.8	14.3	6.7	9.0	3.5	1.6
24.5	27.0	24.2	30.9	28.6	27.0	30.6	18.4	7.8	10.2	5.5	3.6
26.5	33.8	34.2	41.8	37.0	34.1	30.5	18.9	10.4	13.2	7.0	5.2
28.5	40.4	39.6	50.0	46.2	39.6	29.0	18.8	11.0	14.8	7.6	6.9
30.5	46.3	47.3	60.1	53.2	42.9	28.3	18.2	11.0	12.7	8.0	6.0
32.5	51.8	52.1	61.6	57.2	47.8	29.7	16.0	9.8	13.1	7.1	6.3
34.5	52.2	53.0	62.6	58.4	48.2	29.8	15.1	8.5	10.8	7.1	5.5
36.5	51.8	48.2	56.0	51.3	44.7	27.4	13.8	6.9	9.0	5.7	4.3
38.5	48.4	42.6	46.1	43.6	37.5	23.4	11.4	5.5	7.2	4.7	3.8
40.5	45.0	38.5	37.9	39.5	29.6	18.6	9.4	5.4	4.9	3.3	3.0
42.5	38.0	30.1	33.1	31.0	26.1	16.8	8.5	4.3	3.8	2.5	2.4
44.5	30.7	23.6	26.3	25.7	20.1	13.4	8.1	3.3	2.8	2.2	1.4
46.5	23.6	17.3	19.2	19.7	15.0	11.7	6.3	2.9	1.9	1.2	0.8
48.5	17.6	13.0	15.1	14.2	12.0	8.4	5.1	2.0	1.7	0.6	0.5
50.5	13.0	10.2	10.3	10.3	8.2	6.1	3.2	1.1	1.1	0.6	0.5
52.5	9.4	6.6	7.4	7.4	6.0	4.4	2.7	0.9	0.8	0.2	0.2
54.5	6.3	4.9	5.5	5.4	4.4	2.9	2.0	1.0	0.6	0.5	0.2
56.5	5.0	3.7	4.1	3.6	3.4	2.7	1.7	0.6	0.5	0.4	0.2
58.5	3.6	2.7	3.0	2.7	2.4	2.4	1.2	0.6	0.3	0.2	0.1
60.5	2.7	1.9	2.4	1.7	1.7	1.4	0.9	0.4	0.3	0.2	0.0
62.5	1.9	1.2	1.8	1.2	1.2	1.3	0.5	0.2	0.2	0.2	0.0
64.5	1.4	1.0	1.1	0.9	1.0	0.8	0.5	0.3	0.2	0.1	0.0
66.5	0.7	0.6	0.8	0.6	0.7	0.6	0.3	0.2	0.1	0.0	0.0
68.5	0.4	0.2	0.5	0.3	0.4	0.4	0.3	0.1	0.0	0.0	0.0
70.5	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.0	0.1	0.0	
72.5	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0	
74.5	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0		
76.5		0.0	0.0	0.0	0.0			0.0	0.0		
78.5					0.0			0.0	0.0		
Total	588.4	529.1	635.3	578.2	507.4	378.2	216.2	111.8	126.7	72.2	54.3

Table 2a. Abundance index (millions) of American plaice, by age, from Canadian spring surveys in Div. 3LNO. Data converted to Campelen trawl catch equivalents.

	Year										
Age (yrs)	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0											
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.3	4.4	27.9	8.5	6.2	9.7	1.7	4.5	2.4	0.0	0.0
3	50.2	31.3	100.7	80.4	86.8	45.5	30.6	33.5	9.5	2.5	2.0
4	159.0	109.8	221.6	191.3	445.1	348.3	84.1	59.8	120.5	21.1	11.1
5	263.8	256.0	460.2	368.6	336.1	618.7	398.2	110.3	138.1	99.2	41.9
6	454.6	561.4	747.5	616.6	551.8	377.9	364.2	190.1	180.1	106.0	57.5
7	595.7	577.2	656.2	543.9	470.2	371.0	180.2	150.9	160.1	85.4	59.9
8	389.8	307.1	398.3	315.0	273.7	200.3	112.9	63.4	89.4	43.3	49.9
9	208.0	193.7	184.6	217.8	187.6	130.5	67.5	34.1	32.2	20.0	27.5
10	140.2	98.1	101.1	85.3	74.7	77.5	35.2	17.5	16.5	5.4	8.3
11	84.3	46.0	41.8	48.6	39.8	32.4	22.3	9.4	7.6	4.0	2.7
12	45.2	34.4	33.8	32.6	27.1	21.5	13.4	5.4	4.3	1.4	0.5
13	22.7	21.7	19.9	18.7	16.8	14.4	7.2	3.3	1.8	1.2	0.1
14	14.0	8.9	11.1	12.0	9.7	8.8	5.5	1.8	1.3	1.0	0.0
15	9.5	7.3	8.9	8.7	8.6	7.0	5.5	3.0	1.5	0.5	0.0
16	4.2	3.8	4.2	4.8	4.0	4.2	2.2	1.6	0.8	0.3	0.0
17	0.9	2.1	1.9	1.6	2.5	2.6	1.3	0.3	0.6	0.0	0.0
18	0.1	0.6	0.9	0.8	0.9	0.9	0.7	0.5	0.1	0.0	0.0
19	0.0	0.1	0.2	0.1	0.2	0.3	0.3	0.1	0.1	0.0	0.0
Ages 1+	2444.5	2263.8	3020.9	2555.3	2541.8	2271.5	1333.0	689.7	767.0	391.3	261.5
Ages 6+	1969.1	1862.2	2210.5	1906.5	1667.5	1249.2	818.3	481.6	496.5	268.4	206.5
Ages 9+	529.1	416.6	408.6	431.0	371.8	300.1	161.1	77.1	66.9	33.7	39.2
Ages 12+	96.6	78.9	81.0	79.3	69.7	59.7	36.1	16.0	10.5	4.4	0.7

Table 2b. Abundance index (millions) of American plaice, by age, from spring surveys in Div. 3LNO. Data in Engel units.

	Year										
Age(yrs)	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0											
1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.3	1.5	0.5	0.4	0.3	0.1	0.3	0.1	0.0	0.0
3	2.7	1.6	5.4	4.2	4.8	2.3	1.7	1.8	0.5	0.1	0.1
4	11.2	6.8	13.0	11.7	26.1	19.6	4.8	3.4	7.8	1.2	0.8
5	22.1	17.5	28.5	27.5	26.4	48.3	27.1	7.0	10.8	7.6	4.8
6	45.5	55.5	74.2	69.4	68.5	35.6	39.7	19.3	19.4	13.1	9.2
7	103.9	120.1	147.1	121.7	98.7	60.1	30.5	23.9	28.1	17.4	11.6
8	125.7	113.2	152.2	121.6	105.8	63.2	30.9	18.1	27.4	15.8	13.2
9	94.1	93.0	92.2	106.5	84.5	59.3	29.4	14.8	14.4	9.5	9.3
10	71.9	52.8	55.2	46.5	37.6	40.7	18.5	9.2	8.7	3.0	3.6
11	44.6	25.1	22.8	26.6	20.0	17.8	12.2	5.1	4.1	2.1	1.2
12	24.2	18.8	18.4	17.7	14.0	11.7	7.4	2.9	2.3	0.8	0.3
13	12.4	11.8	10.8	10.2	8.4	7.7	4.0	1.7	1.0	0.6	0.1
14	7.7	4.9	6.0	6.5	5.1	4.7	3.0	0.9	0.7	0.5	0.0
15	5.3	3.9	4.4	4.2	4.6	3.3	2.1	1.3	0.4	0.3	0.0
16	2.6	2.1	2.3	2.6	2.2	2.3	1.3	0.9	0.5	0.1	0.0
17	0.6	1.1	1.0	0.9	1.3	1.4	0.7	0.1	0.3	0.0	0.0
18	0.2	0.3	0.6	0.5	0.5	0.5	0.3	0.3	0.1	0.0	0.0
19	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.0	0.0
Ages 1+	575.0	529.0	636.0	579.0	509.0	379.0	214.0	111.1	126.7	72.2	54.2
Ages 6+	538.8	502.8	587.3	535.2	451.3	308.5	180.2	98.6	107.5	63.2	48.5
Ages 9+	263.7	214.0	213.9	222.5	178.3	149.5	79.1	37.3	32.6	16.9	14.5
Ages 12+	53.1	43.1	43.7	42.9	36.3	31.7	19.1	8.2	5.4	2.3	0.4

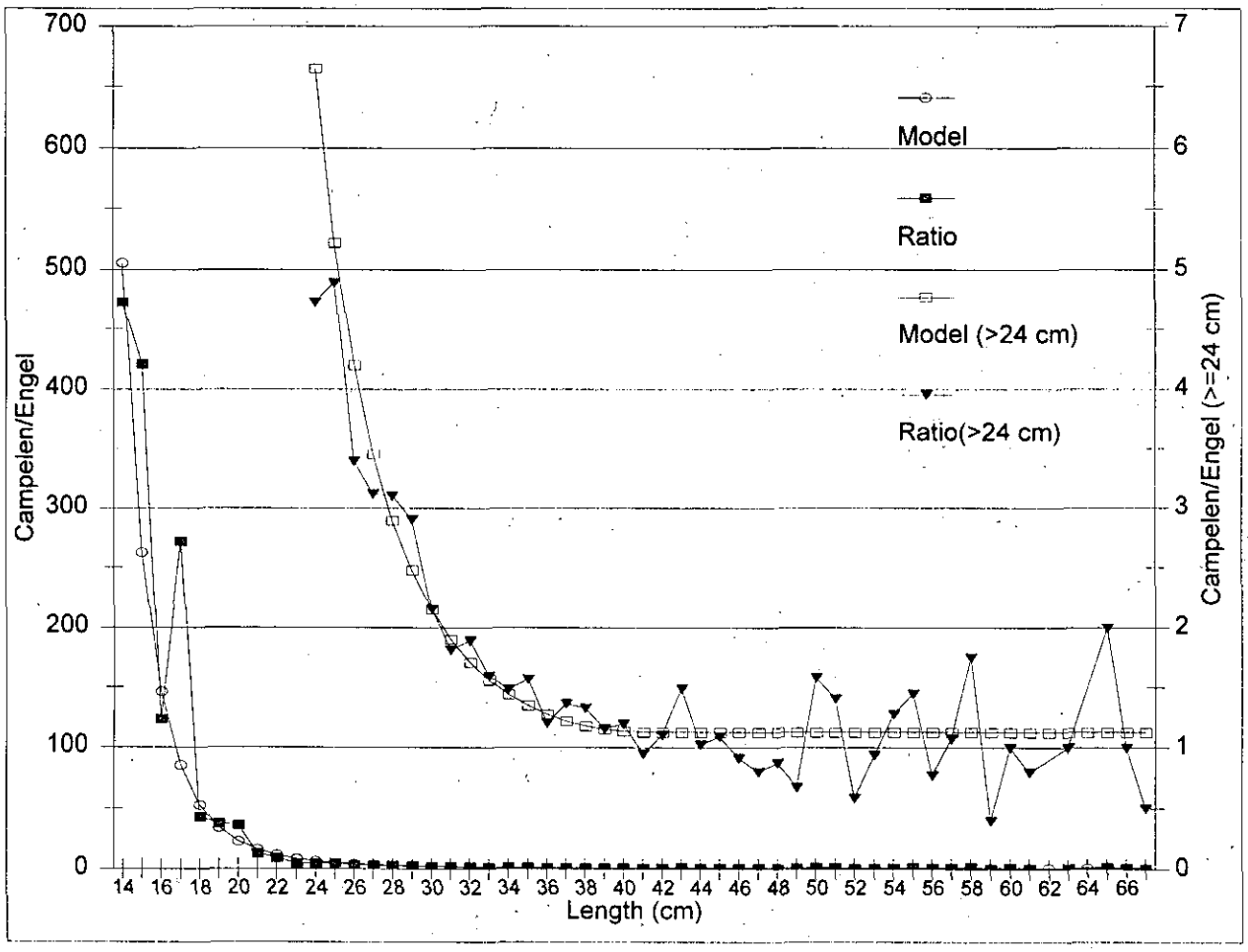

Fig. 1 Ratios of Campelen catch to Engel catch, by length group, from comparative fishing trials between the 2 gears on the *Wilfred Templeman* and *Alfred Needler*. Data from A.plaice > 24 cm are replotted using the second y-axis.

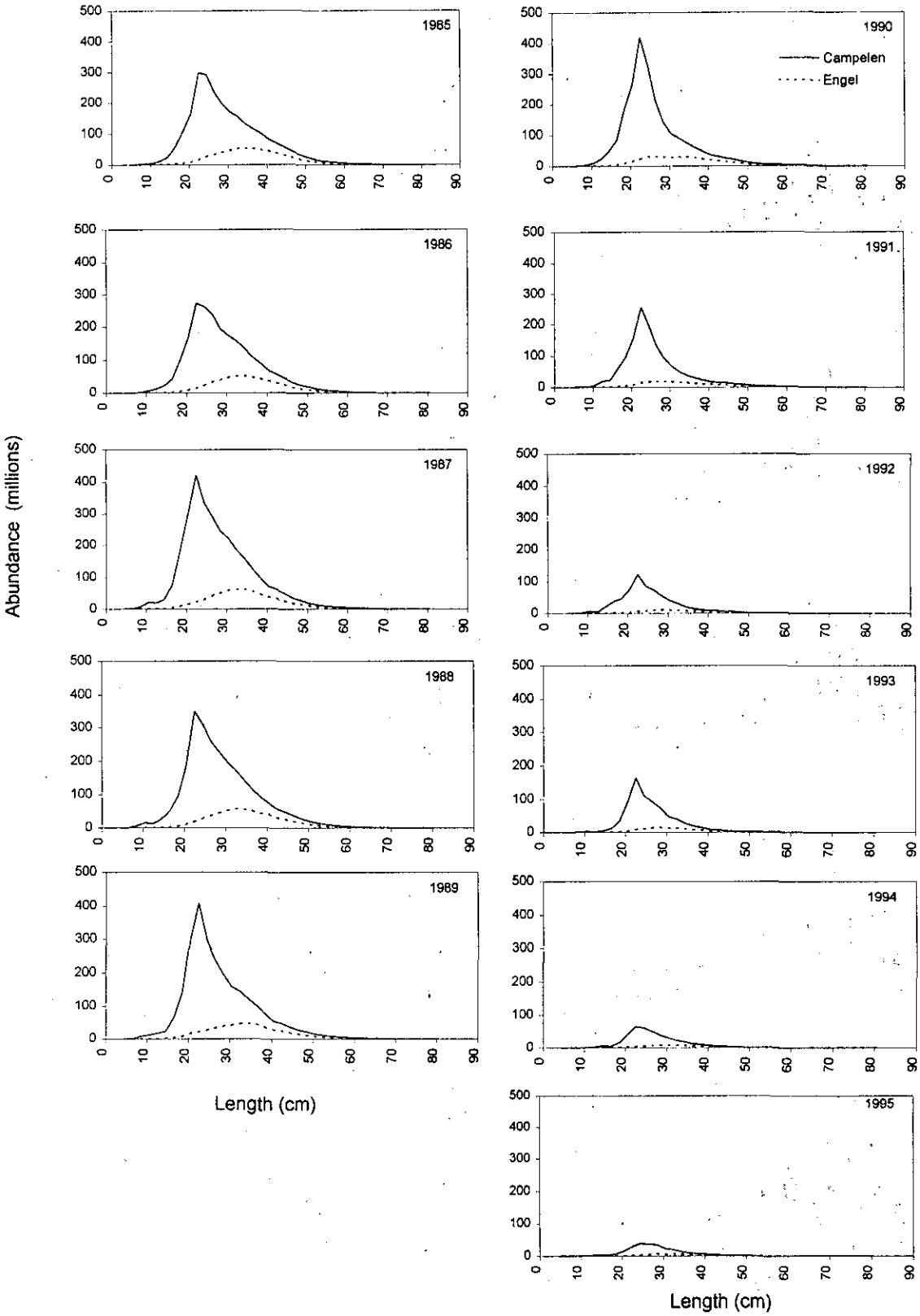

Figure 2. Abundance at length (cm) from 1985 to 1995 for converted (Campelen equivalent) and original (Engel) data.

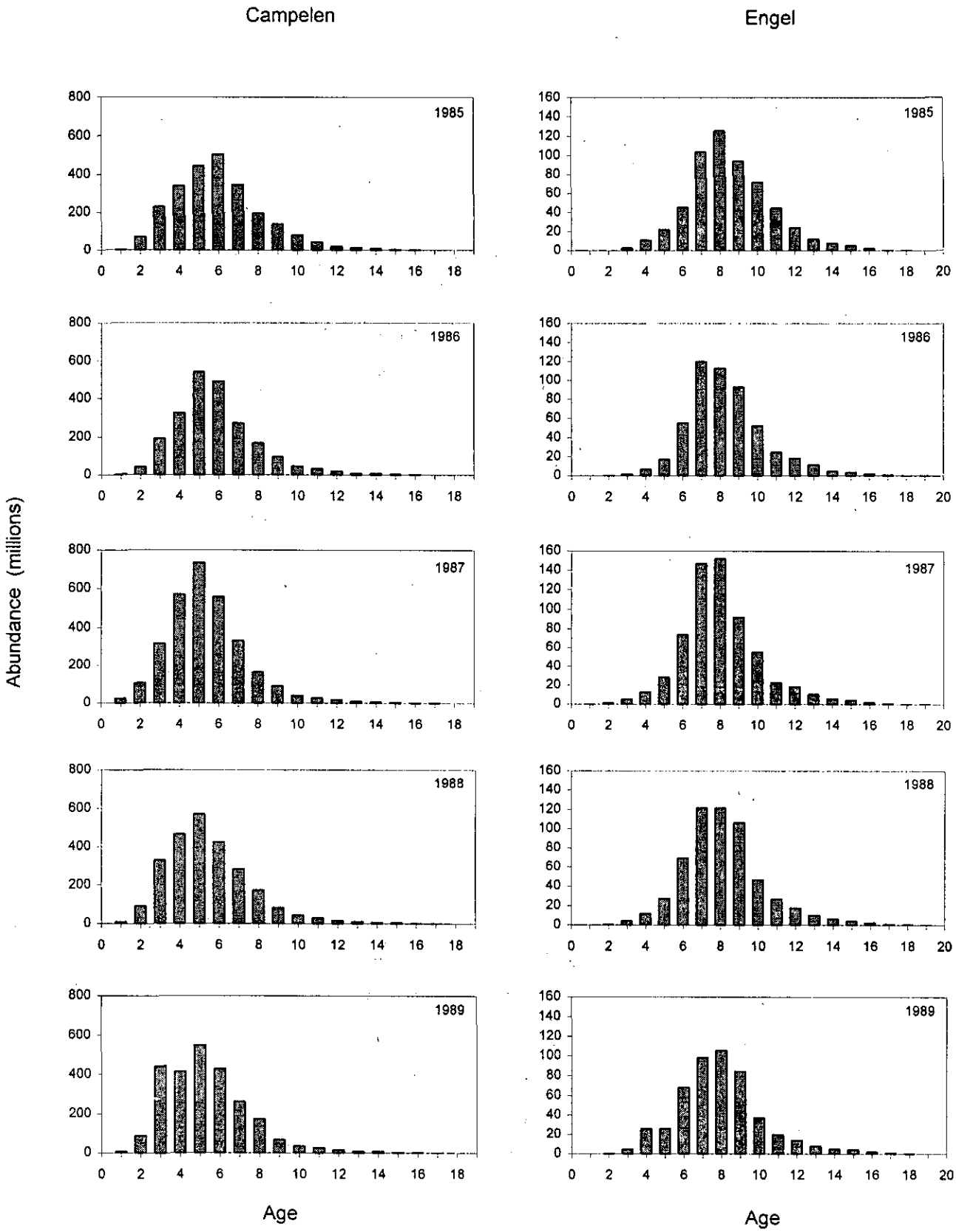

Figure 3. Abundance at age from 1985 to 1995 for converted (Campelen equivalent) and original (Engel) data.

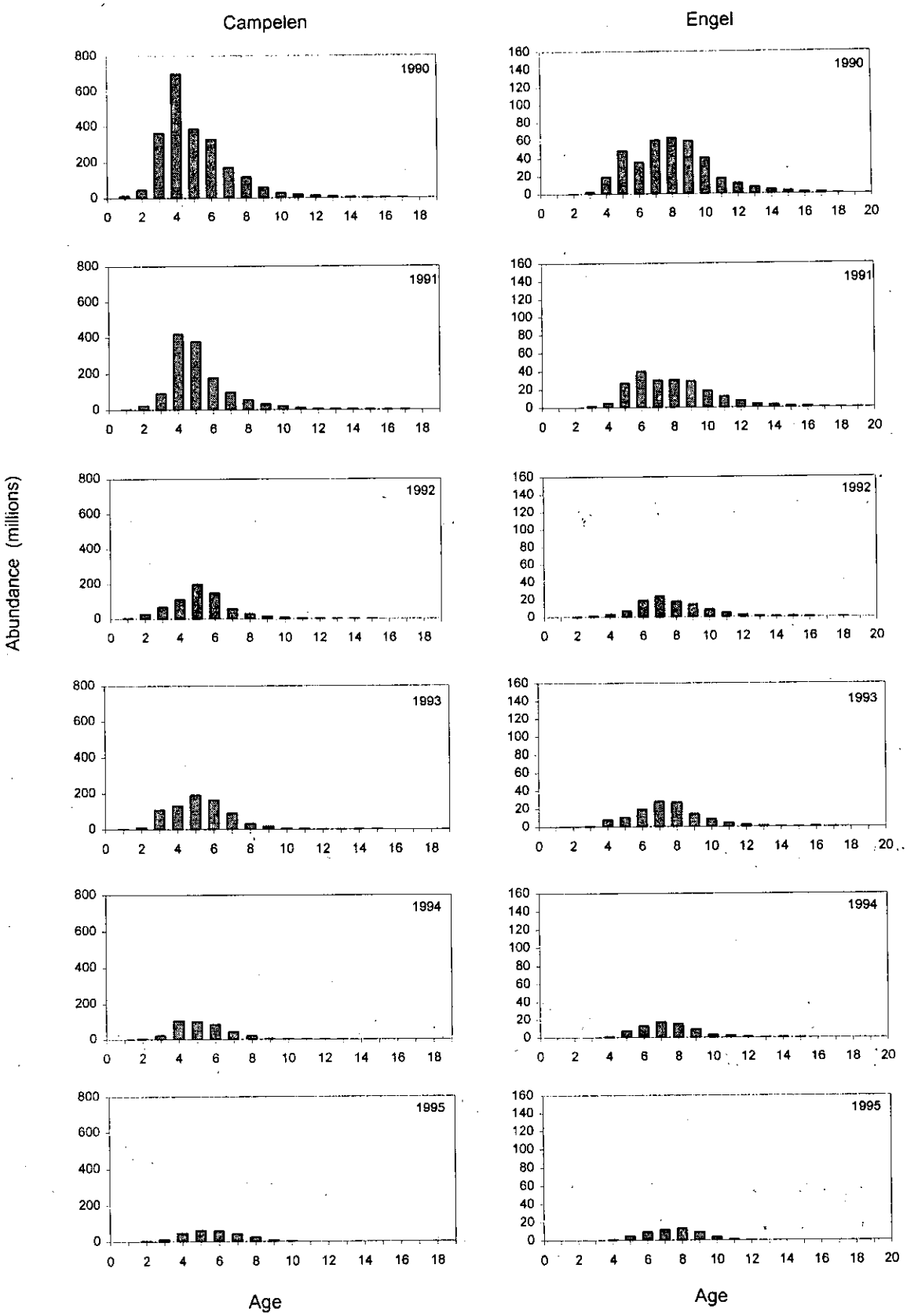

Figure 3 cont'd.

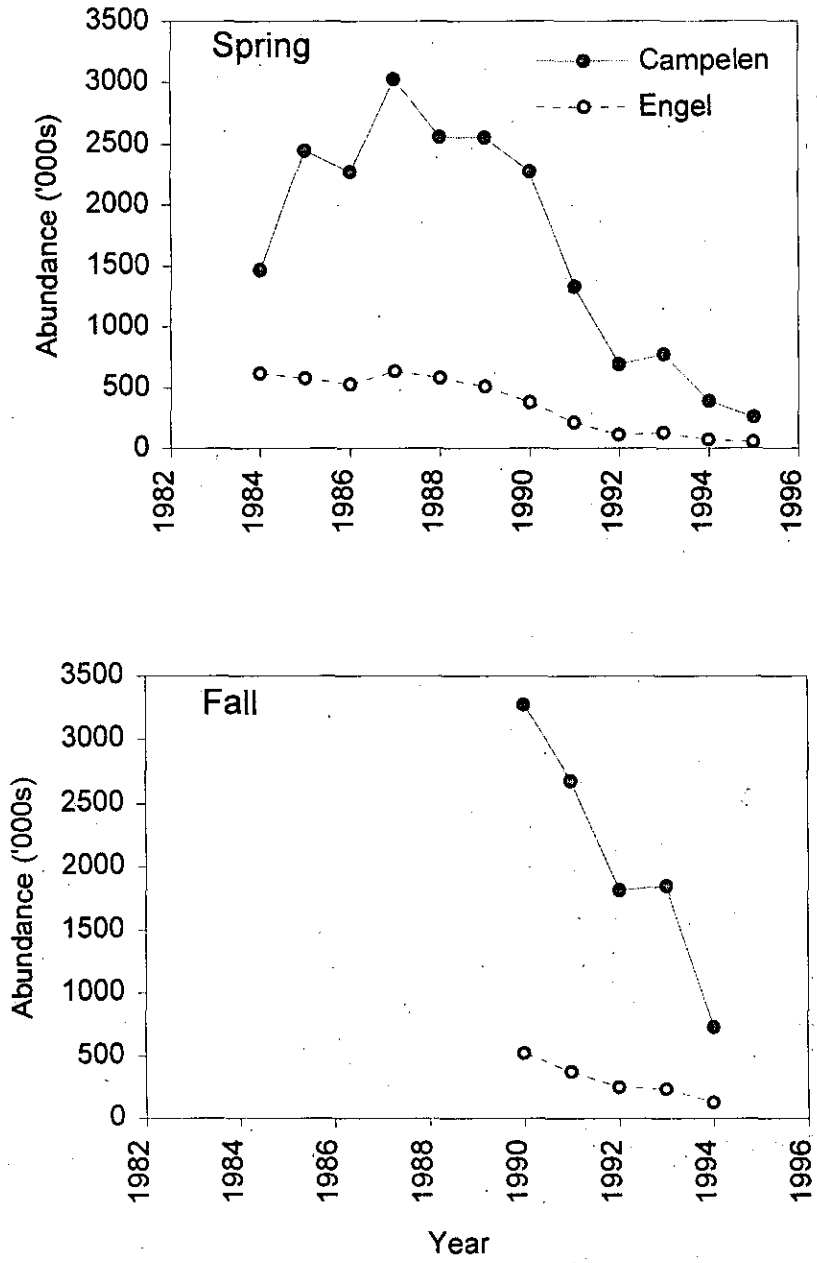

Figure 4. Abundance index for ages 1+ for Engel and Campelen equivalents. Data for 3LNO spring and fall surveys.