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Catchability Comparison Between Lofoten and Campelen Gears

by

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Abstract

During the EU bottom trawl survey on Flemish Cap in July 1999-2001, a comparative trial between the Lofoten survey gear and a Campelen 1800 shrimp trawl was carried out. Results are interpreted based on the main differences between both gears: the gear geometry, being the vertical opening of the Campelen gear the highest, the footrope, being the Lofoten the lightest, and the cod-end mesh size, being the Campelen one the smallest.

KEYWORDS: Lofoten, Campelen, catchability, Flemish Cap, Cod, American plaice, Redfish, Greenland halibut.

Introduction

The adoption in 1995 of the Campelen 1800 shrimp trawl as the standard gear for bottom trawl surveys of fisheries by the Northwest Atlantic Fisheries Centre, St. John's, Newfoundland, Canada, creates expectation on the usefulness of that gear as a common tool for others surveys in the area. One candidate to shear the same gear was the EU bottom trawl survey on Flemish Cap, carried out annually since 1988. A Lofoten gear with a 35 mm cod-end mesh size is currently used in this survey, and it has been chosen taking into account: a) the known roughness of the Flemish Cap bottom, b) the coincidence with the design and main characteristics of most of the Spanish and Portuguese commercial gears in the zone, and c) the appropriateness of such gear to catch the commercially most important species on the bank at the time the survey started: cod, American plaice and redfish. However, the use of a Campelen gear would make ease the comparison with the results from other areas were the same gear and fishing protocols are used.

Material and Methods

Comparative trials between the Lofoten gear used in the survey and a Campelen 1800 gear were carried out during the 1999, 2000 and 2001 surveys (Vázquez 2000; Saborido-Rey and Vázquez 2001; Vázquez 2002).

The Campelen 1800 shrimp trawl gear has been manufactured according to the specifications (McCallum and Walsh 1994), however the fishing doors were the same used with the Lofoten gears: this means 850 Kg instead of the specified 2,000 Kg doors, which implies less lateral opening, and less maximum possible speed for trawling.

The method followed for the comparison was to make alternative tows with both gears in the same geographical position. Tows made with a gear were repeated the next day with the other one. Following the target of making 20 comparative hauls each year, 58 paired valid tows were finally available for comparison. Positions of the tows were selected with the following criterion: to maximise the number of visited strata and to maximise the depth range. For the following analyses, no year, stratum or depth factors were considered, so the pool of 58 hauls is considered a

uniform sampling set. However, annual indices were calculated to have an alternative estimation of the variability of the results.

Results

Fifty-eight paired tows were used for the comparison, and such number is considered low to produce fine results (Pelletier 1998). In addition, the abundance of several species, i.e.: cod and American plaice, was very low, resulting in very scarce data for an exact comparison. In these circumstances, only approximate conclusions were attempted. Table 1 summarizes the results obtained in the three years for most abundant species, and Table 2 do it for other abundant species on the bank.

Figure 1 shows comparative catch and length distributions for main species. Two graphics are presented for each of them: catches at left and length distributions at right. Catches are shown in a natural scale, instead of a logarithmic one, because that transformation produced a quite similar graphic for all species, its interpretation being uncertain. The occurrence of extraordinary catches was judged from these plots. For juvenile redfish there is a 26 (Lofoten) to 225 Kg (Campelen) point, but that ratio is inside the range observed for this species. For *Sebastes marinus* there was an additional 5,571 to 64 Kg point, not presented in the plot, judged as extraordinary and discarded for further considerations. The point corresponding to 1 to 188 Kg, even judged extraordinary, was only excluded for calculating length distributions. For *Sebastes mentella* exists a 5,418 to 752 Kg point that strongly influences the results, but there is no reasons to exclude it for catch ratios calculation.

Leng distribution were calculated using paired tows for which catch ratio Campelen / Lofoten or their inverse, was geater that 10 (cod, A. plaice and *S. fasciatus*), 20 (G. halibut and grenadier), 30 (*S. mentella*), 50 (juvenile redfish and *S. marinus*) or 60 times (shrimp). This procedure was thought to exclude data from paired tows where one of the gears caught nothing or almost nothing, to make more homogeneous the sample. The ratios of Campelen / Lofoten frequency by length class were calculated by fit to a bilinear function:

$$r = (a\,l + b) / (l + c)$$

r – frequency ratio
l – length
a, b, c – parameters

The minimum square fit was weighted by the total joint frequency at each length group. To solve the cases where the Lofoten frequency was cero, frequencies were grouped, including five original length classes in each group. The ratios calculated in this way and the fitted curve are presented in Figure 1, right, where fit parameters and determination coefficient (r^2) for the fit are shown as footnotes. For cod and American plaice, even the fit to a straight line was not significant. The fit was fairly good for all other species ($r2 \geq 0.69$) and, in general, the relationship showed a increasing trend of the ratio with decreasing length, indicating a generalized higher efficiency of the Campelen gear for small size fish.

Discussion

The comparison of the catchability of these gears needs to take into account three factors: first, the difference in gear geometry and rigging, the main factor of catchability, second, the difference in footrope: 35 cm steel bobbins in the Lofoten and a heavier rockhopper in the Campelen, and third, the difference in cod-end mesh size: 35 mm in the Lofoten gear and 20 mm for the Campelen, which implies different retention of species with fish length in the selection range. Catchability differences by fish length not attributed to different mesh sizes were also observed, so not only crude comparison of catches was carried out but also differences by length groups were considered. Our results are coincident with the conclusion after comparing the Campelen shrimp trawl with the Engels 145 otter trawl: the catch rate is strongly dependent of the fish length (Warren 1997). It is important to note that the Campelen gear in our trial was used with smaller fishing doors than specified, which may result in shorter lateral opening.

The current cod stock in Flemish Cap is made up of small length fish; results indicate that these small size cod are best caught by the Campelen gear: 1.21 times more than for Lofoten gear, probably due to its wider swept path. The variability in catch ratio (Table 1) is attributed to the random variability of the results, also observed in Figure 1. This ratio does not show significant relation with length of fish in the observed size range, but the sample size was

quite reduced. The change in the footrope would produce a decreasing rate as the fish length increase (Godo and Sunnana 1992), and we attribute the no significance of the test to the small size of the sample available.

Large size American plaice, most of fish in the current population, were better caught by the Campelen gear: ratio 1.85. No relationship was found between this ratio and length of fish in the 35 to 55 cm length interval. However it would be expected, taking into account the difference in footropes of both gears (Godo and Walsh 1992). Results of the Campelen and Engels 145 comparative trial (Warren 1997) showed a strong declining ratio with length. Nevertheless, the conclusion is strongly dependent of the highest ratio for small size fish, and the ratio is uniform in the 35 to 55 cm length interval, even the variability is higher. In a recent comparative experiment between a Campelen gear and a *Pedreira* carried out in the Newfoundland Grand Bank (Paz *et al*. 2002), the Lofoten / Pedreira catch ratio observed for fish in the 30 to 50 cm length range was less than 0.5. Even the *Pedreira* is a gear almost equivalent to the Lofoten, it was used with 15 cm rubber discs in the foot rope instead of 35 cm steel bobbins used in our survey. In addition, the length of the wraps is 200 m for the *Pedreira* and 100 m for the Lofoten. In conclusion, even the Campelen gear has been the same in both experiments, the particular rigging of the *Pedreira* makes it more efficient.

The catch ratio for redfish as a whole appears quite dependent of the fish length: the Campelen gear being more efficient for small fish which have a wider pelagic distribution, and the Lofoten gear being more efficient for fish larger than 25 cm, approximately. The declining of catch ratio with increasing fish length is best observed in juvenile redfish, where the sizes are the smallest, and the lowest ratio for large fish is observed in *S. mentella*. For *S. marinus*, catch ratio decline seems to reach a value of 1.0 at around 35 cm, but results are no significant beyond that length. The results are quite similar for *S. mentella*, where a catch ratio equal 1.0 is reached at around 25 cm length, being the Lofoten catches the highest for large fish. It is necessary to note that results of each redfish species are strongly dependent of a single paired haul, and it produces uncertainty on conclusions.

For Greenland halibut, the Lofoten gear seems to be more efficient than the Campelen one. The overall catch rate is 0.40, although the rate comes close to 1 for fish less than 20 cm length. These results are not consequence of a single paired tow, as in the case of *S. mentella*, and seem to be quite consistent. This species is the only one where a strong less than one ratio was observed when considering main species (Table 1) and secondary species (Table 2). This low catch rate of the Campelen gear compared to the smaller Lofoten could be a due to some herding effect of the wraps in the Lofoten gear or to some dispersing properties of the Campelen. What is surprising is that those possible effects be only observed in Greenland halibut.

The effect of the two main catchability factors: gear geometry and cod-end mesh size, are well observed in shrimp. The Campelen gear, with higher mouth opening and smaller mesh size, made larger catches containing smaller length shrimp. Overall catch ratio was quite stable in the three years.

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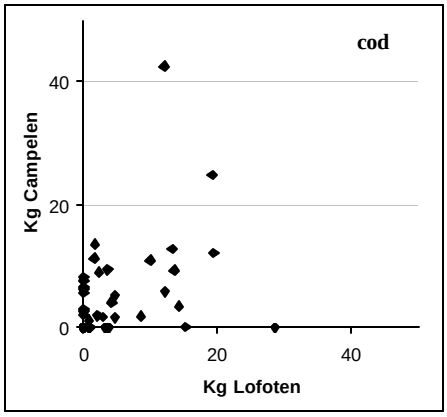
Table 1 – Results of selected species. Gear A: Lofoten B: Campelen
Catch in Kg corresponds to the whole catch obtained with all comparative hauls.
Catch if Kg/mile or Number/mile are total catch divided by the whole distance towed.
Occurrence is the number of hauls in which one fish appeared, at the least.

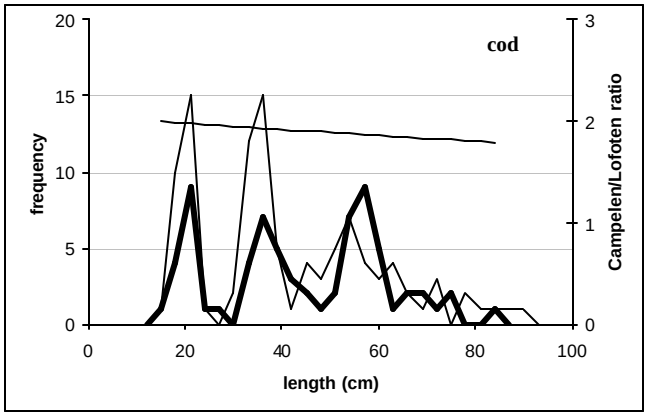
Species	survey	Catch ratio B/A	Catch (Kg/mile) A	Catch (Kg/mile) B	Catch (Kg) A	Catch (Kg) B	Catch (N/mile) A	Catch (N/mile) B	Occurrence (hauls) A	Occurrence (hauls) B	Occurrence (hauls) A+B
	1999	1.81	33	60	59	89	18	46	6	9	6
	2000	1.06	48	51	84	85	18	25	10	10	6
	2001	0.90	39	35	68	52	45	48	12	9	9
cod	total	1.21	120	146	210	226	81	120	28	28	21
	1999	1.84	54	100	94	148	47	93	7	9	7
	2000	2.76	31	85	54	145	41	94	9	10	7
American	2001	1.56	94	147	166	224	128	182	8	10	8
plaice	total	1.85	180	333	313	517	216	369	24	29	22
	1999	37.78	0	7	0	11	17	634	4	10	4
	2000	2.59	62	162	110	267	1965	5665	16	18	16
juvenile	2001	8.94	34	304	60	456	2377	23763	11	12	11
Sebastes	total	4.89	97	473	170	734	4360	30061	31	40	31
	1999	6.71	12	80	20	119	32	207	13	14	13
	2000	0.90	244	219	425	361	546	516	17	18	17
Sebastes	2001	1.84	19	35	33	52	53	137	14	13	12
marinus	total	1.22	275	334	478	532	632	861	44	45	42
	1999	0.42	343	145	560	209	1617	863	8	11	8
	2000	0.26	5274	1390	9351	2289	19840	6507	14	14	14
Sebastes	2001	0.95	156	148	273	223	667	862	13	13	11
mentella	total	0.29	5773	1683	10184	2721	22124	8232	35	38	33
	1999	1.26	71	90	118	133	407	606	14	15	14
	2000	0.69	515	354	904	588	2647	2157	20	20	20
Sebastes	2001	1.86	41	76	72	115	276	730	15	17	12
fasciatus	total	0.83	628	520	1094	835	3330	3492	49	52	46
	1999	0.40	283	112	461	168	462	190	13	14	13
	2000	0.58	131	76	231	124	247	174	16	16	16
Greenland	2001	0.28	185	52	324	78	250	84	16	13	13
halibut	total	0.40	599	240	1015	370	960	447	45	43	42
	1999	2.12	14	29	22	41	27	120	7	7	7
	2000	3.42	12	42	22	69	35	150	9	10	9
Roughhead	2001	1.81	25	44	43	67	60	148	9	11	9
grenadier	total	2.29	51	116	87	177	122	418	25	28	25
	1999	5.00	139	694	228	1027	22.5	204.5	9	13	9
	2000	7.14	120	858	212	1403	22.9	210.3	17	20	17
	2001	7.95	95	759	168	1133	14.8	161.3	16	18	16
Shrimp*	total	6.52	355	2312	608	3563	60.3	576.1	42	51	42

* abundances in ‘000

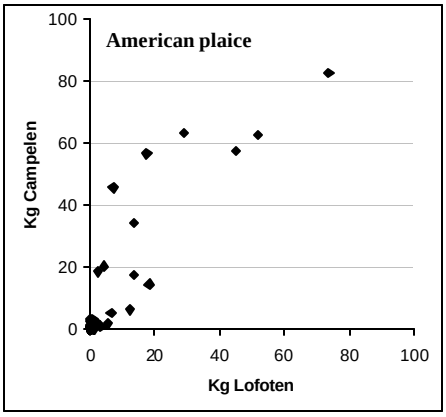
Table 2 – Results from two comparative trials between Lofoten and Campelen fishing gears by repeating tows.
Catch ratio: quotient between mean catch per mile Campelen/Lofoten
Occurrence: number of hauls where each species occurred in the gears: Lofoten–Campelen–both.
Catch – Catch in number: absolute values: Lofoten–Campelen

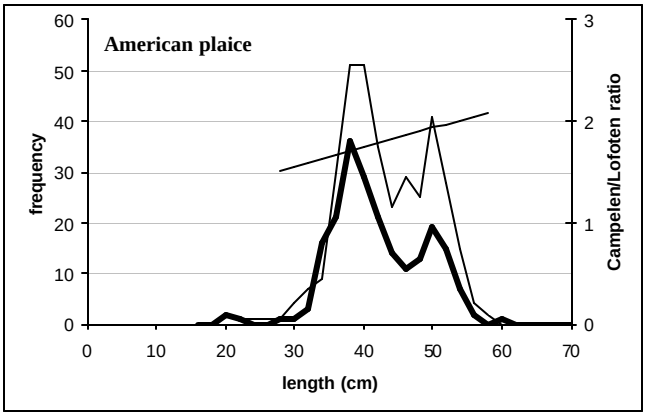
Species	Catch ratio	Occurrence	Catch (Kg)	Catch in Number	Observations
Raja radiata	5.93	6-14-5	15-82	9-50	no size differences observed
	4.39	11-19-10	26-109	16-82	
	2.71	14-18-12	56-130	20-58	
Chauliodus sloani	1.64	6-8-6	2-2	54-84	no size differences observed
		0-0-0	0-0	0-0	
	3.86	5-6-4	1-2	10-38	
Stomias boa	1.36	2-2-1	0.1-0.1	21-44	no size differences observed
		0-1-0	0-1	0-1	
	2.20	8-7-7	1-1	24-72	
Urophycis chesteri	6.20	7-10-7	6-35	113-935	effect of the small cod-end mesh
	2.59	12-13-12	11-27	187-768	size of the Campelen gear
	2.64	6-7-6	5-12	30-169	
Antimora rostrata	2.77	2-2-2	9-22	75-301	effect of the small cod-end mesh
		0-0-0	0-0	0-0	size of the Campelen gear
	2.33	5-5-5	37-74	243-625	
Nezumia bairdi	3.41	9-10-9	10-31	172-1054	no size differences observed
	3.98	10-14-10	4-16	137-626	
	2.49	12-12-12	15-33	188-522	
Wolffish (*A. lupus*)	3.54	12-12-11	38-116	92-359	the smallest sizes was better
	2.06	17-19-17	41-80	134-496	caught by the Campelen gear
	2.52	13-13-12	41-90	100-573	
Wolffish (*A. minor*)	1.60	11-14-11	64-92	35-65	no size differences observed
	1.88	12-16-11	62-109	29-63	
	1.67	7-9-5	35-50	9-15	
Lycodes smarki	16.40	6-11-6	2-31	11-230	the smallest sizes was better
	3.76	9-12-9	5-19	26-121	caught by the Campelen gear
	1.73	8-9-6	6-9	21-41	
Lycodes reticulatus	5.58	11-13-11	5-26	43-362	sizes <25 cm were better caught by
	1.55	11-16-11	24-35	363-813	the Campelen gear
	1.02	8-9-8	17-15	110-171	
Triglops murrayi	11.01	9-10-9	1-9	42-646	no size differences observed
	25.57	10-16-10	1-16	40-1566	
	7.47	9-11-8	2-13	50-596	
Witch flounder	4.03	6-11-6	11-38	20-62	no size differences observed
	2.31	12-13-10	25-56	93-106	
	2.66	7-11-7	17-39	19-48	
Squid	2.04	11-10-6	0.2-1	15-85	effect of the small cod-end mesh
		0-6-0	0-0	0-0	size of the Campelen gear
	5.49	9-16-8	0.2-1	10-74	



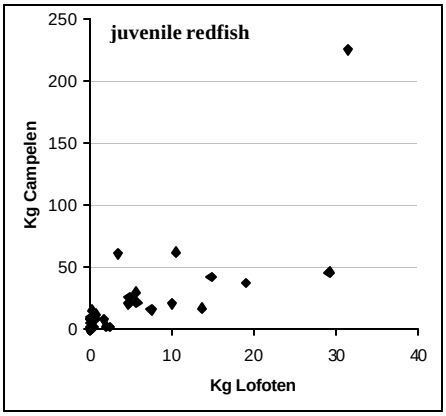


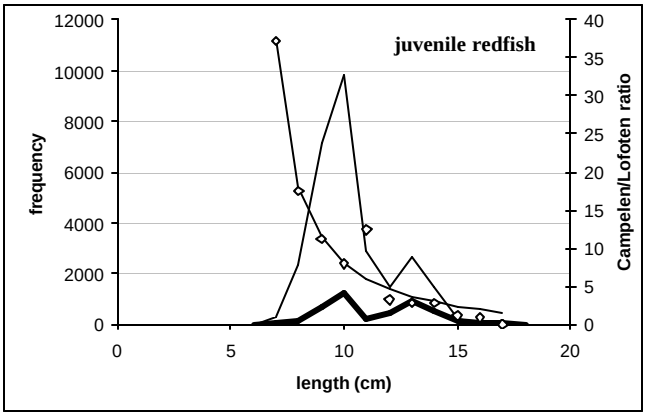
$r^2 = 0.00$





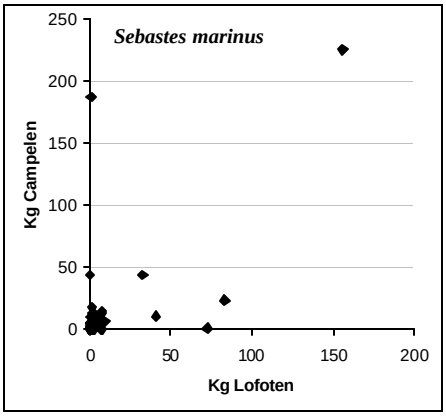
$r^2 = 0.04$

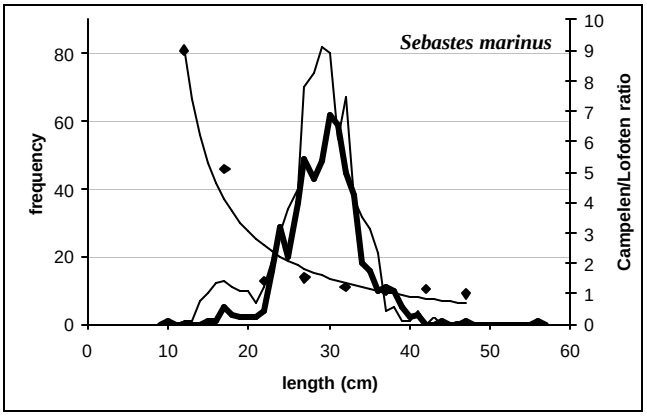




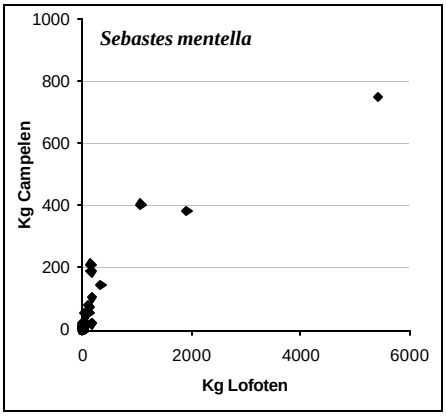
$r = (-2.23\,l + 54.92) / (l - 5.95)$ $r^2 = 0.83$

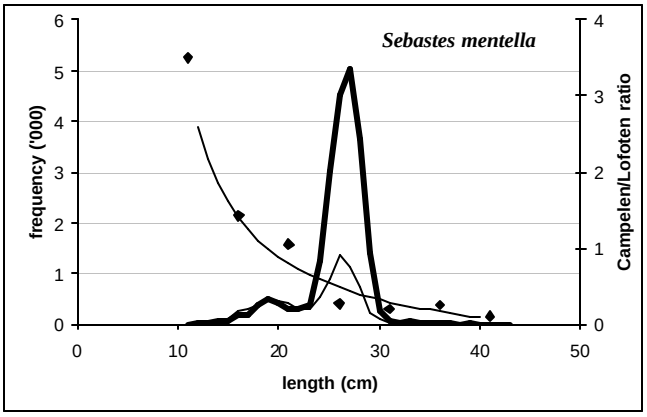
Figure 1 – For each species: Left – catch in kg taken in paired tows. Right – Length frequencies taken with the Lofoten (thick line) and Campelen (narrow line) gears. Ratio plots and fitted curve. Parameters of the fitted curve in the footnote: r = ratio, l = fish length, r^2 = determination coefficient.



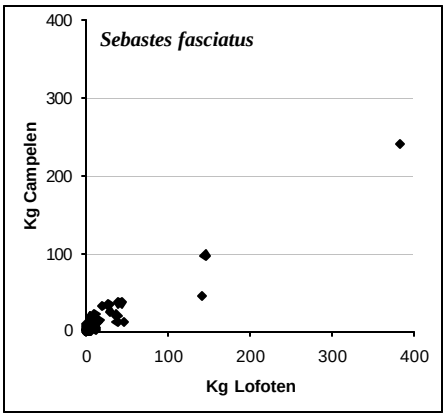


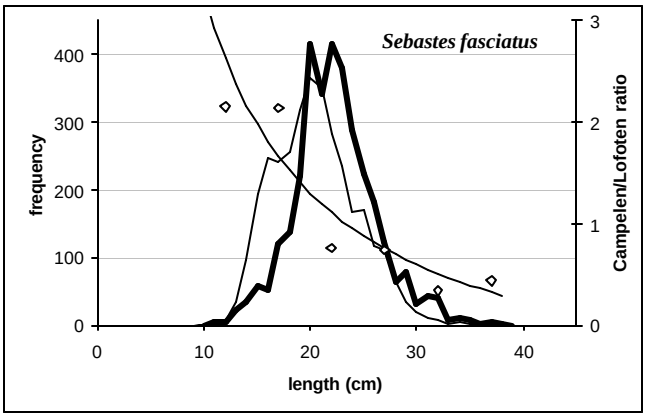
r = (-0.41 *l* + 46.44) / (*l* – 7.44) r^2 = 0.81





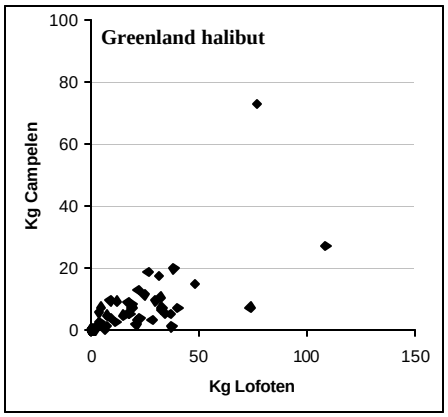
= (-0.48 *l* + 22.34) / (*l* – 5.61) r^2 = 0.74

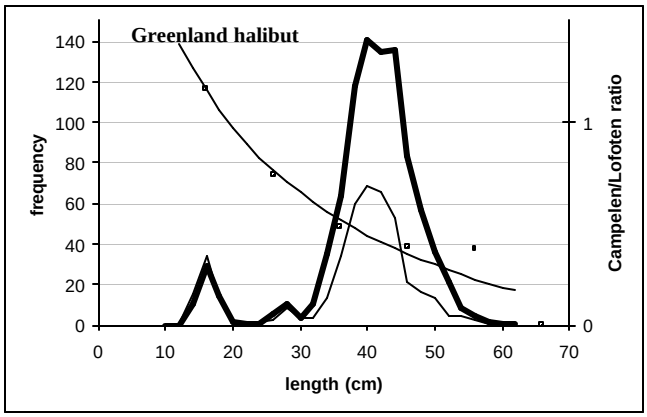




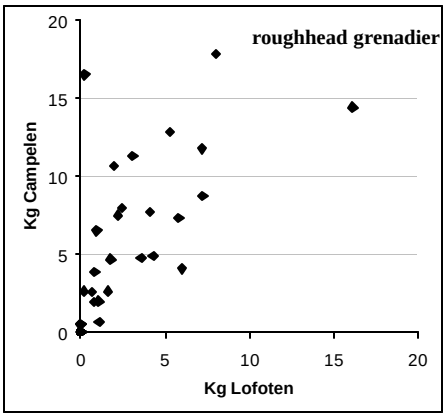
= (-0.86 *l* + 47.27) / (*l* + 0.87) r^2 = 0.69

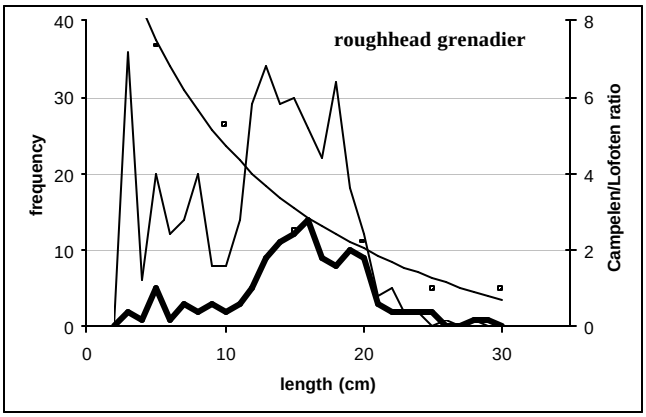
Figure 1 (continuation)



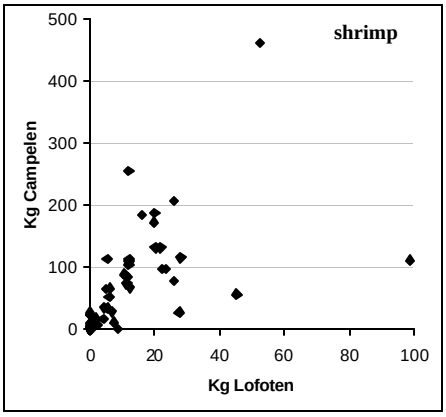


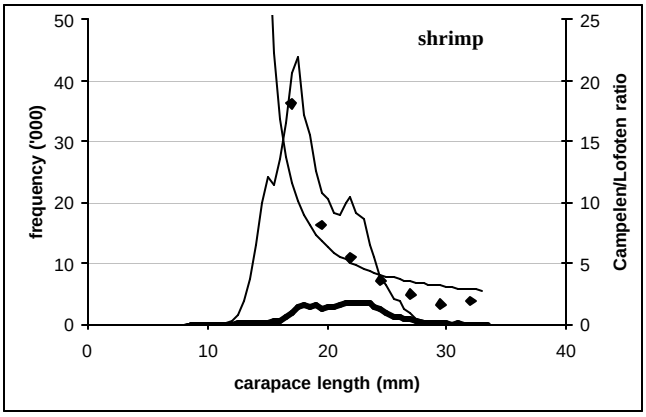
= (-0.54 l + 47.14) / (l + 17.23) r^2 = 0.96





= (3.17 l + 123.38) / (l + 9.42) r^2 = 0.95





= (1.14 l + 15.00) / (l – 14.04) r^2 = 0.74

Figure 1 (continuation)