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A factor to convert meat weight to round weight in the Iceland scallop, Chlamys islandica in Newfoundland

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Abstract

This document reviews the derivation and use of the conversion factor (9.2) to transform meat weights to round weights in the Newfoundland Iceland scallop fishery. Factors that influence its derivation are discussed. As presently constituted, the conversion factor is based on dissections of fresh scallops and seeks to determine biological yield, regardless of how much of the "meat" is recovered/lost from the commercial shucking process. In addition to innate variables, manual shucking is subject to numerous imponderables, including gross weight changes resulting from water loss and seepage of pallial fluids from scallops between the time of capture and processing. As in other species, the conversion factor should not be considered as an incontrovertible universal constant; rather it is a best-case effort to estimate composite, year-round removals from an entire fishing area rather than from a specific aggregation at any given time.

Résumé

Le présent document traite de l'obtention et de l'utilisation du facteur de conversion (9,2) appliqué à la transformation du poids des chairs en poids brut pour la pêche du pétoncle d'Islande de Terre-Neuve. On y discute des facteurs influant sur le calcul du facteur. Dans sa forme actuelle, le facteur de conversion est fondé sur une dissection des pétoncles à l'état frais et a pour objet de déterminer le rendement biologique, indépendamment de la quantité de « chair » obtenue ou perdue au cours du processus d'écaillage commercial. Outre les variables innées, l'écaillage manuel est source de nombreux impondérables, y compris la modification du poids brut suite à la perte d'eau ou de fluides palléaux entre le moment de la capture et celui de la transformation. Comme pour les autres espèces, le facteur de conversion ne doit pas être considéré comme une constante universelle indéniable, il s'agit plutôt de la meilleure estimation composite possible obtenue à partir des captures faites au cours de l'année dans l'ensemble d'une zone de pêche et non à partir d'une concentration particulière et à un moment donné.

Introduction

Catch limits (Total Allowable Catches or TACs) for aggregations of the Iceland scallop in Newfoundland are provided in weights round (also called whole weight, shell weight or green weight). It is thought that this provides for more accurate estimates of removals as per wet biomass estimates from research surveys than would if TACs were based on weight of meat landed. The latter would not adequately address the very significant losses incurred from the manual shucking of scallops.

The fishery directed at this species began in the Strait of Belle Isle in the Gulf of St. Lawrence (NAFO Subdiv. 4R). During the early years (1969-80's) much of the scallops caught here was discharged in the shell at ports along the coast for land-based processing. Consequently it was relatively easy to monitor removals (Table 1). Over time fishers realized that the incremental gains from the sale of meats was sufficiently attractive to desert the practice of selling whole scallops in the shell. Moreover, shucking scallops at sea and returning resultant shells (disarticulated valves) back to the sea bottom ("beds") is thought to confer greater ecological benefits to resource sustainability than would *carte blanche* removal of scallops for land -based processing (K. S. Naidu, unpublished). Shell debris is widely considered to be a preferred settlement substrate (PSS) for a number of scallop species (Orensanz et.al. 1991). Beginning in the early 1990's the majority of 4R fishers began to shuck their catch at sea and sold meats only. By this time annual catch limits had been imposed on the Iceland scallop harvested from St. Pierre Bank and Strait of Belle Isle, making it all the more critical to use a species-specific conversion factor for the total (Newfoundland) fishery. As with the then burgeoning fishery over St. Pierre Bank, it became necessary for Statistics Branch to estimate scallop round weight from the weight of meats landed (as is the practice in Canada for the sea scallop, Placopecten magellanicus). For convenience, a conversion factor of 8.3 specific for the sea scallop had been also used throughout the Atlantic to estimate round weight from a given weight of meats. In spite of repeated attempts to change the statistical protocols to reflect species-specific differences in yield in the two species, no changes were made until 1993. Up to this point there was no attempt to distinguish as separate and distinct the meats drawn from the two species. Statistics Branch (St. John's, Newfoundland) then had requested that we develop a factor to convert landed meat weight to round weight for all aggregations within it's jurisdiction.

Using such data as were then available, mostly from St. Pierre Bank and to a lesser extent data that had been assembled from the Strait of Belle Isle, prior to transfer in 1982 of research mandate to the then Gulf Region, a factor of 9.2 had been proposed as a suitable factor to estimate whole (in-the-shell) weight from a given weight of meats in the commercial fishery. Statistics commenced using this conversion factor in 1994. Since then, however, the Iceland scallop fishery has expanded significantly. Area-wise the fishery has expanded to now include the eastern Grand Banks of Newfoundland, sometimes beyond the 200 mi Canadian Economic Zone. Closer to shore, aggregations off the Perch Rocks and Cape Ballard Bank along the eastern shore and along the Labrador coast have also become commercialized (Fig. 1).

The need to revisit the factor to convert meat weight to round is occasioned principally by a small number of participants in the Strait of Belle Isle fishery who now have returned to the practice of landing their catches round. In 1998 and 1999 the landing of whole scallops accounted for only 13.6% and 5.4% of the nominal removals respectively at 1307 t and 1054 t round. This sector of the fleet considers the conversion factor of 9.2 as disproportionately high and punitive to that sector and suggest that the factor should be around 7.6. Recognizing that for a given catch level a lower conversion factor permitted higher removals, the fleet sector that shucked at sea and landed only meats saw immediate benefits from a lower factor and supported the initiative. To address fisher concerns and with their cooperation, fishery officers from the area attempted to reconcile the alleged difference. Their findings are also reported herein.

This document summarizes the approximately 20-year accumulated information on area-specific meat yields in the Iceland scallop and corresponding conversion factors for the Newfoundland fishery.

Methods

Data from several sources were utilized: (a) sampling onboard research vessel missions, (b) sampling at ports of discharge or processing plants and (c) independent observations by fishers and fishery officers.

(a) Sampling onboard research vessels

The collection of biological data on meat yield is a normal and essential component of all scallop missions. For this purpose, the catch is sorted on deck and "bushelled" into baskets. Catch weights (kg) are first determined followed immediately by shell-height measurements (mm). Whole (round) weights are based on fresh, wet weights. In some areas, including 4R, catch rates have dropped to levels that allow sorting and weighing of catches to be completed in less than 15 minutes. Random samples of scallop of known weight (round) consisting of only commercial-sized scallops (>60mm) are carefully dissected to completely extract the adductor muscle. Both the striated and non-striated fractions are recovered from each scallop for a given sample and average yields and counts are computed from several samples for the entire area. [The meat count is a standard market terminology that seeks to estimate the number of meats in a pound]. Sometimes data are assembled on size-specific (shell-height) meat weights to develop meat-weight/shell-height regressions. For the latter, individual meats from known sizes of scallop are dissected from each scallop and individually frozen in separate whirl-pack bags for later weight determinations in the laboratory. Where a heavy epibiont load is encountered (e.g. barnacles, tunicates) yield determinations are computed for both round weight as caught and net weight after all encrustations have been removed from the shell. Such treatments are noted.

Recognizing that water drip from fresh-caught scallops impacts on the estimation of yields, a study had been conducted at sea in 1991 to determine water loss from scallops held out of water. Four baskets of fresh-caught scallops were separately weighed at sea. The baskets were stored on the fishing deck and re-weighed at approximately 6-hr intervals until no further weight changes were observed.

(b) Port samplings

Over the years numerous port samples have been collected and examined. These are normally made at the ports of discharge where scallops are processed and/or transshipped. Much of the early (1980-82) sampling of the Iceland scallop came from the Strait of Belle Isle. These data are based on biological dissections as per at-sea observations, but scallops would have been held out of water for varying periods. The information also allowed us to examine the relationship between meat yield/conversion factor with individual whole weight and size (shell height) of scallop. Limited data from biological sampling at fish plants allowed some insight into seasonal variations in meat yield.

(c) Data compiled by area fishers

In July 1998 a field study had been conducted by area fishers and fishery officers from the West Coast Regional Office (Corner Brook). Scallops were harvested, brought ashore, weighed out and shucked the following day by fishers as per commercial practice. There was no direct participation in this exercise by Science Branch; neither was there established methods and procedures for acquiring such data. The results of this joint investigation are separately presented. These data were provided to us by the Regional Office in Corner Brook.

Results

Meat yields assembled from biological dissections using fresh-caught scallops from St. Pierre Bank (Tables 2 and 3), Strait of Belle Isle (Table 4), and the eastern Grand Banks of Newfoundland (Table 5) are separately summarized. Data used in deriving the conversion factor currently used (9.2) are mostly from St. Pierre Bank (NAFO Subdiv. 3Ps, Table 2) and to a lesser extent from limited data from the Strait of Belle Isle. Information, sometimes limited, from the more recently exploited aggregations is also summarized (Table 6). Source of samples is identified in Figure 1. Size-specific shell height-meat weight regressions from biological dissections for most of these aggregations are summarized (Table 7). It is clear that there are very real differences in meat yield from the various aggregations sampled. Shucking practices (Fig. 2), especially at sea, invariably result in the loss, or non-realization of potential yield (Naidu 1987). The differences in meat recovery from biological dissections and those realized from the commercial fishery are significant and are size-dependent. The loss has been determined to be negatively correlated to shell size and increases from about 11% at 90 mm shell height to 30% at 60 mm. The estimated average difference (20%) between biologically-dissected and crew, sea-shucked Iceland scallops had been factored into the estimation of round weight from meats.

Water loss from freshly-caught scallops was estimated at 20% (Table 8). Weak, but nevertheless significant, relationships exist between meat weight (based on biological dissections) and individual size (shell height) and individual whole round weight (Figs.3 and 4). Seasonally, over a two-year period, the conversion factor varied narrowly from a high of 10.6 in April to a low of 8.9 in November (Table 9). There were no observations during the December-March period when the quota would have been exhausted and the Strait typically covered with ice.

Data assembled by a joint study involving fishery officers and area fishers are separately presented (Table 10). These observations are based on scallops that had been held out of water for an extended period. Besides they represent calculations based on samples collected over a fairly small area in a single day.

Discussion

As in other species/applications, the conversion factor to uniformly estimate whole weight from a given fish/shellfish using only a fraction of the fish/shellfish that is sought, retained and landed is fraught with difficulty. It is evident that yields and resultant conversion factors to transform meat weights to weights round vary from one area to another. In addition to this spatial variation, there are seasonal as well as temporal variations within any given area. Some of the high yields encountered no doubt reflect higher productivity within that area (e.g. Lilly Canyon and Carson Canyon, NAFO Div. 3N). Similarly, low yields sometimes may simply reflect a high epibiont load (Table 11). Also, meat recovery rates are influenced by numerous imponderables. As such, the derivation and application of a composite conversion factor applicable throughout to every aggregation within a given jurisdiction is problematical and is subject to challenge.

In a commercial setting shucking normally occurs at sea usually between fishing tows. In the small boat fishery, typically with catch rates of 2-3 bushels per tow, shucking seldom becomes limiting to production. Rapid manual shucking, however, invariably results in the loss of meat that would not otherwise occur in the biological dissections used to extract meats for estimating yields (Naidu 1987). Several factors, including speed, experience, sea state, shucking habits and individual utensil preferences together affect the efficiency of meat extraction. Some fishermen, for example, leave the catch fraction on the right valve. Full and complete recovery of meat is seldom a preoccupation among fishers. Meats are pooled into individual plastic tubs of varying capacities and subsequently transferred into cotton bags each weighing between 35-40 lbs (16-18 kg). Bags are stored on ice. Discharge times vary considerably between areas. Because of the proximity of fishing aggregations to home ports, meats from the Strait of Belle Isle fishery, for example, are discharged on a daily basis. Fishing excursions in this day fishery seldom exceed 15 hrs, dock-to-dock. More frequently, however, distance from shore, sometimes exceeding 200 mi, make frequent port calls impossible and cost prohibitive. In these situations, scallop meats are stored on ice for up to ten days. Water absorption may occur during periods of prolonged storage. Dock-side monitors weigh out meats at discharge ports. A conversion factor of 9.2 is used throughout by Statistics Branch to transform landed meat weights to weights round to (a) monitor removals against a catch limit for any given area, and (b) to compile fishery catch statistics.

Sometimes when aggregations are close to home ports, fishers prefer to land whole scallops for land-based processing. Although not ecologically sound (Naidu et al. 1995), these enterprises are thought to maximize such benefits as they are reasonably entitled to by maximizing the duration of employment/income. Here, scallops are sorted on deck and put into rectangular fish boxes. When full, these boxes are left on deck often without ice. Shell gape occurs as soon as scallops are held out of water. Depending on the time between capture and discharge, up to 20% of the original weight of scallops may be lost through passive escape of water and mantle fluids. The loss is sometimes exacerbated by rapid adductions of the adductor muscle. Dockside determination of weights round are therefore biased. For a given volume of scallops, dockside weights are invariably lower than if the same volume of scallops had been weighed immediately after it had been caught. Scallops are then either sold to a formal enterprise or, alternatively, shucked by the crew. Processing of whole scallops may commence immediately upon arrival or more frequently delayed until the following day. Yields from these long-held-out-of-water scallops are higher (as per determinations by the July 1998 study by area fishers) because of the attendant water (weight) loss. In fact, when the water loss is factored into their derivation, there is little difference in the two estimates. As well, it is likely that a land-based work environment is more conducive to the fuller extraction of meats than shucking at sea where a constantly moving platform may compromise shucking efficiency. With a weekly enterprise quota in place, the sector that chooses to land scallops round does not exhaust its weekly quota as rapidly as those who shuck their scallops fresh at sea. The estimation of round weight is based on the yield from freshly-caught scallops. As yields from scallops long held out of water are higher (lower conversion factor), some participants inevitably were left with the impression that they had been short-changed. The weekly catch limit (7,360 lb. shell stock in 4R) is reached sooner when meat weight is transformed into round weight equivalents using the conversion factor (9.2) derived from fresh scallops (as per estimated biomass). Understandably, enterprises processing scallops at sea would like to see the lower conversion factor (derived from higher yields from drained scallops) adopted throughout for the determination of round weight equivalents. In effect, this would compromise the catch limit by allowing additional removals estimated at 20%. During the 1998 fishing season, for example, the TAC for 4R (930 t round) had been exhausted by August 01. The standard conversion factor of 9.2 had been used throughout to monitor removals against imposed catch limits. Intense lobbying by the 4R area fishers (July 1998) resulted in an ad-hoc revision of the conversion factor. Using the higher yield realized from partially drained/dehydrated scallops a factor of 7.6 had been empirically derived and applied against cumulative removals to secure additional volumes (~330 t round). The fisher-derived conversion factor is problematical in that its usefulness is limited to restricted areas within the Strait of Belle Isle and time (July). The factor currently used by Statistics, on the other hand, seeks to address spatial and temporal considerations.

Freshness of product used in estimating yield is of critical importance. Biomass estimates and yields are invariably based on fresh-caught weights. By extension, the monitoring of fishery removals regardless of product type landed must also be based on a conversion factor derived from fresh scallops.

Epibiont loads on scallops vary widely within and among aggregations and change overtime. Encrustation by barnacles, sponges, and tunicates feature significantly in the estimation of yields (Table 11). Incremental weight contributions from these can amount to a full third (34%) of the gross weight of scallops.

In addition to differences in productivity and other innate variables among different areas and temporal changes thereof, a composite conversion factor derived some years ago from a few aggregations may not fully address spatial and seasonal/temporal variability in meat yield for all Newfoundland aggregations. Where little recruitment has been detected, as in 4R, higher yields may result from medium-to-long-term reductions in scallop density (Naidu et.al. 1998). The modal shell size from research vessel surveys in the Strait of Belle Isle in 1995 and 1997 was estimated at 90 mm (Naidu et al. 1998). Using the relationship between individual scallop size (SH) and biological yield (Fig. 4) and allowing for incomplete recovery of meat (~20%), a population consisting primarily of large animals (~90mm) would point to a conversion factor of 9.27.

As presently constituted, the conversion factor seeks to address biological yield (what is available from each scallop) regardless of source or time (month) of capture or how much of the "meat" is recovered/lost in the shucking process. It is an average value for the jurisdiction derived from a number of aggregations over space and time. It should not be considered as an incontrovertible, universal constant. While the efficiency of meat recovery is higher (i.e. lower conversion factor) in most well-maintained mechanical shucking devices (Naidu 1989) and approaches that estimated from biological dissections, manual shucking especially at sea, is subject to various factors including time scallops are held out of water before shucking, experience, shucking habits and utensil used. The conversion factor used in transforming meat weights to weights round must be seen as a best-case scenario to estimate cumulative scallop removals from the entire region, rather than from a single localized aggregation. Since the majority of scallops (~95%) harvested from Newfoundland waters continues to be shucked fresh at sea, it is likely that it provides the best estimate of scallop removals from the entire area (approx. 450,000 n mi^2) in question. To the extent that it was intended to monitor Iceland scallop removals from disparate aggregations year-round, the conversion factor of 9.2 remains a defensible tool to achieve a legitimate goal for the Department of Fisheries and Oceans. Ad hoc changes to this factor to accommodate client demands will severely compromise prescribed exploitation rates for the species for any given area and render questionable fishery statistics for the species.

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Table 1. Nominal landings of the Iceland scallop from the Strait of Belle Isle, Gulf of St. Lawrence, 1969-98. A species-specific conversion factor of 9.2 was used when and where applicable to estimate round weight from meat weight.

Year	Landings (t, round)	No. of active licences	Effort (boat days)	Catch per unit effort (unadjusted)	
				kg (round) /boat/day	t (round) /boat/year
1969	248	-	-	-	-
1970	192	-	-	-	-
1971	167	-	-	-	-
1972	2596	-	-	-	-
1973	2189	-	-	-	-
1974	244	24	269	907	10.7
1975	-	-	-	-	-
1976	-	-	-	-	-
1977	-	-	-	-	-
1978	-	-	-	-	-
1979	450	16	459	981	28.1
1980	1133	14	774	1463	80.9
1981	1530	24	1262	1212	63.3
1982	349	24	413	845	14.5
1983	371	23	485	765	16.1
1984	1523	46	1272	1197	33.1
1985	2546	107	2887	882	23.8
1986	1942	88	2270	856	22.1
1987	1141	57	n/a	-	20.0
1988	447	30	n/a	-	14.9
1989	155	14	n/a	-	11.1
1990	88	11	n/a	-	8.0
1991	457	24	n/a	-	19.0
1992	1296	72	n/a	-	18.0
1993	2122	71	n/a	-	29.9
1994	2294	80	2769	828	28.7
1995	1497	43	2113	708	34.8
1996	1204	46	1385	869	26.2
1997	1205	45	1313	918	26.8
1998	1307	41	1364	959	31.9

n/a = not available

[1] Sources of landing and effort statistics:
1969-81: CAFSAC Res. Doc. 82/02
1982-83: CAFSAC Res. Doc. 86/77
1984-90: Can. MS Rept. 2154
1990-92: Science Branch, Gulf Region
1993: Statistics Branch, Newfoundland Region
1994-98: Science Branch, Newfoundland Region

Table 2. Meat yields and attendant conversion factors for the Iceland scallop from St. Pierre Bank (NAFO Subdiv. 3Ps), 1990. Commercial fishery yield is based on 80% recovery of meat (see Naidu 1987).

Set	Strat.	N	Round wt. (kg)	Biol. meat Wt. (kg)	Biol. yield (%)	Comm. meat wt. (kg)	Comm. yield (%)	Comm. conversion factor
34	320	43	4.00	0.593	14.8	0.4744	11.9	8.43
39	320	108	8.00	1.119	14.0	0.8952	11.2	8.94
48	321	150	8.90	1.201	13.5	0.9608	10.8	9.26
49	321	89	8.15	0.963	11.8	0.7704	9.5	10.58
51	321	84	6.75	0.808	12.0	0.6464	9.6	10.44
55	321	132	5.80	0.712	12.3	0.5696	9.8	10.18
58	321	55	6.20	0.733	11.8	0.5864	9.5	10.57
59	321	125	7.40	1.041	14.1	0.8328	11.3	8.89
72	312	124	6.00	0.712	11.9	0.5696	9.5	10.53
74	312	158	7.80	0.957	12.3	0.7656	9.8	10.19
75	312	110	4.70	0.640	13.6	0.5120	10.9	9.18
76	312	100	5.65	0.702	12.4	0.5616	9.9	10.06
77	312	149	8.00	1.088	13.6	0.8704	10.9	9.19
78	312	103	8.10	1.149	14.2	0.9192	11.3	8.81
80	312	125	6.75	0.945	14.0	0.7560	11.2	8.93
81	312	136	6.65	0.883	13.3	0.7064	10.6	9.41
83	312	122	7.00	0.942	13.5	0.7536	10.8	9.29
85	312	122	7.00	1.027	14.7	0.8216	11.7	8.52
86	312	127	7.00	1.066	15.2	0.8528	12.2	8.21
87	312	100	7.00	1.032	14.7	0.8256	11.8	8.48
88	312	93	7.00	0.992	14.2	0.7936	11.3	8.82
89	312	95	7.00	1.028	14.7	0.8224	11.7	8.51
90	312	101	7.00	1.071	15.3	0.8568	12.2	8.17
91	312	125	7.00	1.066	15.2	0.8528	12.2	8.21
92	312	108	7.00	1.054	15.1	0.8432	12.0	8.30
104	315	156	7.50	1.037	13.8	0.8296	11.1	9.04
107	315	103	6.90	0.969	14.0	0.7752	11.2	8.90
110	315	103	8.00	1.002	12.5	0.8016	10.0	9.98
112	315	100	7.00	0.924	13.2	0.7392	10.6	9.47
115	315	95	7.00	0.949	13.6	0.7592	10.8	9.22
138	314	110	6.50	0.944	14.5	0.7552	11.6	8.61
139	314	120	6.00	0.891	14.9	0.7128	11.9	8.42
140	314	129	6.50	0.943	14.5	0.7544	11.6	8.62
142	314	88	6.00	0.842	14.0	0.6736	11.2	8.91
143	314	104	7.00	0.987	14.1	0.7896	11.3	8.87
144	314	141	7.00	0.968	13.8	0.7744	11.1	9.04
145	314	115	7.00	1.043	14.9	0.8344	11.9	8.39
146	314	159	7.00	1.013	14.5	0.8104	11.6	8.64
147	314	141	7.00	1.037	14.8	0.8296	11.9	8.44
148	314	102	7.00	0.982	14.0	0.7856	11.2	8.91
150	314	106	7.00	0.941	13.4	0.7528	10.8	9.30
151	314	82	8.00	0.996	12.5	0.7968	10.0	10.04
153	314	91	7.00	0.994	14.2	0.7952	11.4	8.80
159	314	111	6.00	0.786	13.1	0.6288	10.5	9.54
160	314	105	6.50	0.899	13.8	0.7192	11.1	9.04
163	314	109	6.00	0.793	13.2	0.6344	10.6	9.46

Table 2. Continued...

Set	Strat.	N	Round wt. (kg)	Biol. meat Wt. (kg)	Biol. yield (%)	Comm. meat wt. (kg)	Comm. yield (%)	Comm. conversion factor
164	314	136	6.50	0.914	14.1	0.7312	11.2	8.89
166	314	85	7.50	1.135	15.1	0.9080	12.1	8.26
167	314	140	7.00	1.028	14.7	0.8224	11.7	8.51
173	314	82	7.00	0.990	14.1	0.7920	11.3	8.84
177	312	115	7.50	1.069	14.3	0.8552	11.4	8.77
178	312	109	7.00	1.084	15.5	0.8672	12.4	8.07
179	312	106	7.00	1.125	16.1	0.9000	12.9	7.78
180	312	112	7.00	1.172	16.7	0.9376	13.4	7.47
181	312	119	6.25	0.920	14.7	0.7360	11.8	8.49
182	312	145	6.00	0.807	13.5	0.6456	10.8	9.29
184	312	130	5.50	0.899	16.3	0.7192	13.1	7.65
185	312	88	4.00	0.626	15.7	0.5008	12.5	7.99
186	312	140	7.00	0.966	13.8	0.7728	11.0	9.06
187	312	116	5.00	0.751	15.0	0.6008	12.0	8.32
190	312	111	5.00	0.762	15.2	0.6096	12.2	8.20
221	402	98	7.00	1.210	17.3	0.9680	13.8	7.23
227	402	75	6.60	1.083	16.4	0.8664	13.1	7.62
228	402	67	7.25	1.159	16.0	0.9272	12.8	7.82
64	-	7,128	431.80	61.164	14.2	48.931	11.3	8.83

Table 3. Meat yields and conversion factors for the Iceland scallop from St. Pierre Bank (NAFO Subdiv. 3Ps), 1990-93. Commercial fishery yield is based on 80% recovery of individual meats (see Naidu 1987).

Date	No. of sets	N	Round wt. (kg)	Biol. Meat Wt. (kg)	Biol. yield (%)	Comm. meat wt. (kg)	Comm. yield (%)	Comm. conversion factor
Aug. 1990	64	7,128	431.80	61.164	14.2	48.931	11.3	8.83
Apr. 1991	5	808	47.00	5.951	12.7	4.761	10.1	9.87
Aug. 1991	14	1,986	136.86	20.332	14.9	16.266	11.9	8.41
Aug. 1992	13	1,297	97.33	12.77	13.1	10.216	10.5	9.53
July 1993	33	3,944	249.40	31.25	12.5	25.00	10.0	9.98
Σ	129	15,163	962.39	131.467	13.7	105.174	10.9	9.15

Table 4. Meat yields and attendant conversion factors for the Iceland scallop from the Strait of Belle Isle (NAFO Div. 4R), 1995 and 1997. Commercial fishery yield is based on 80% recovery of individual meats (see Naidu 1987).

Year	Set	N	Round wt. (kg)	Biol. meat Wt. (kg)	Biol. yield (%)	Comm. meat wt. (kg)	Comm. yield (%)	Comm. Conversion factor
1995	D	82	10.50	0.975	9.3	0.780	7.4	13.46
	F	75	10.15	0.940	9.3	0.752	7.4	13.50
	16	109	10.00	1.170	11.7	0.936	9.4	10.68
	34	105	10.00	0.814	8.1	0.651	6.5	15.36
	39	36	5.06	0.532	10.5	0.426	8.4	11.88
	44	80	9.75	1.058	10.9	0.846	8.7	11.53
	49	78	9.75	1.103	11.3	0.882	9.1	11.05
	52	74	9.95	1.180	11.9	0.944	9.5	10.54
	61	83	9.92	1.098	11.1	0.878	8.9	11.30
	74	90	10.15	1.012	10.0	0.810	8.0	12.53
	81	109	10.05	0.907	9.0	0.726	7.2	13.84
Subtotal (95)	11	921	105.28	10.789	10.2	8.631	8.2	12.20
1997	58	66	10.30	1.434	13.9	1.147	11.1	8.98
	66	37	5.55	0.700	12.6	0.560	10.1	9.91
	70	57	6.72	1.030	15.3	0.824	123	8.16
	71	45	6.35	0.825	13.0	0.660	10.4	9.62
	72	75	10.05	1.130	11.2	0.904	9.0	11.12
	82	38	5.50	0.644	11.7	0.515	9.4	10.68
	90	33	5.20	0.726	14.0	0.581	11.2	8.95
	105	111	9.95	1.146	11.5	0.917	9.2	10.85
	115	49	5.25	0.592	11.3	0.474	9.0	11.08
	122	44	3.80	0.546	14.4	0.437	11.5	8.70
Subtotal (97)	10	555	68.67	8.773	12.8	7.018	10.2	9.79
Total	21	1,476	173.95	19.562	11.2	15.649	9.0	11.12

Table 5. Meat yields and attendant conversion factors for the Iceland scallop from the Lilly Canyon and Carson Canyon (Grand Banks of Newfoundland (NAFO Div. 3N)), 1994 and 1997. Commercial fishery yield is based on 80% recovery of individual meats (see Naidu 1987).

Year	Set	N	Round wt. (kg)	Biol. meat Wt. (kg)	Biol. yield (%)	Comm. Meat wt. (kg)	Comm. yield (%)	Comm. conversion factor
July 1994	82	123	13.00	1.540	11.8	1.232	9.5	10.55
	89	127	14.05	1.710	12.2	1.368	9.7	10.27
	101	97	11.75	1.310	11.1	1.048	8.9	11.21
	126	138	12.85	1.390	10.8	1.112	8.7	11.56
	127	149	13.70	1.580	11.5	1.264	9.2	10.84
	128	164	13.50	1.960	14.5	1.568	11.6	8.61
	129	155	14.98	2.190	14.6	1.752	11.7	8.55
	131	146	11.10	2.000	18.0	1.600	14.4	6.94
	135	134	9.00	1.530	17.0	1.224	13.6	7.35
	139	124	10.00	1.745	17.5	1.396	14.0	7.16
	141	106	10.00	1.705	17.1	1.364	13.6	7.33
	142	126	11.00	1.830	16.6	1.464	13.3	7.51
	144	129	10.95	1.610	14.7	1.288	11.8	8.50
	146	105	10.00	1.630	16.3	1.304	13.0	7.67
	149	144	14.52	2.135	14.7	1.708	11.8	8.50
	151	148	13.31	1.922	14.4	1.538	11.6	8.65
	153	123	14.54	1.800	12.4	1.440	9.9	10.10
	155	133	13.08	1.620	12.4	1.296	9.9	10.09
	159	140	14.84	1.858	12.5	1.486	10.0	10.00
	161	118	10.10	1.650	16.3	1.320	13.1	7.65
	173	110	10.00	1.570	15.7	1.256	12.6	7.96
	176	118	10.00	1.610	16.1	1.288	12.9	7.76
	197	127	10.70	1.780	16.6	1.424	13.3	7.51
	215	180	17.80	2.790	15.7	2.232	12.5	7.97
	220	150	14.62	2.260	15.5	1.808	12.4	8.09
	233	109	13.10	1.795	13.7	1.436	11.0	9.12
	235	130	10.00	1.490	14.9	1.192	11.9	8.39
	238	116	14.00	1.800	12.9	1.440	10.3	9.72
	242	153	14.55	2.350	16.2	1.880	12.9	7.74
Sub-total (94)	29	3822	361.04	52.16	14.4	41.73	11.6	8.65
July 1997	64	100	8.60	0.908	10.6	0.726	8.4	11.85
	79	128	10.45	1.292	12.4	1.034	9.9	10.11
	85	69	10.94	0.912	8.3	0.730	6.7	14.99
	94	104	10.40	1.588	15.3	1.270	12.2	8.19
	96	105	10.00	1.553	15.5	1.242	12.4	8.05
	102	76	8.71	1.014	11.6	0.811	9.3	10.74
	108	99	10.49	1.656	15.8	1.325	12.6	7.92
	117	118	10.45	1.628	15.6	1.302	12.5	8.03
	137	94	7.90	0.928	11.7	0.742	9.4	10.65
	139	102	10.00	1.196	12.0	0.957	9.6	10.45
	143	95	9.91	1.172	11.8	0.938	9.5	10.57
	145	96	9.45	1.436	15.2	1.149	12.2	8.23
Sub-total (97)	12	1,186	117.30	15.28	13.0	12.23	10.4	9.59
Overall LCC	41	5,008	478.34	67.443	14.1	53.956	11.3	8.87

Table 6. Meat yields and attendant conversion factors for the Iceland scallop from Green Bank (NAFO Subdiv. 3Ps), eastern Grand Banks (NAFO Div. 3L), Lilly Canyon and Carson Canyon (NAFO Div. 3N) and other aggregations as identified. Estimates of commercial fishery yield are based on 80% meat recovery (see Naidu 1987).

NAFO Div.	Area	Years	No. of Samples	No. of Scallops Sampled	Round Wt. (kg)[1]	Biol. Meat Wt. (kg)	Biol. yield (%)	Comm. meat wt. (kg)	Comm. yield (%)	Comm. conversion factor
3Ps	St. Pierre Bank	90-93[2]	129	15,163	962.39	131.47	13.7	105.17	10.9	9.15
3Ps	Green Bank	90-91	12	1,520	85.70	11.37	13.3	9.10	10.6	9.42
3L	Eastern 3L	94	9	1,437	122.95	11.36	9.2	9.09	7.4	13.53
3N	LCC	94; 97[3]	41	5,008	478.34	67.44	14.1	53.96	11.3	8.86
3N	3Nf	97	3	383	31.50	3.57	11.3	2.85	9.1	11.05
3N	3LN	95	10	1,237	99.80	12.20	12.2	9.76	9.8	10.22
4R	Straits	95; 97[4]	21	1,476	173.95	19.56	11.2	15.65	9.0	11.12
Overall			225	26,224	1954.63	256.97	13.1	205.58	10.5	9.51

1 All round weights are reported "as caught" with weight contributions from epibionts
2 See Tables 2, 3
3 See Table 5
4 See Table 4

Table 7. Size-specific shell-height meat-weight regressions for Iceland scallop aggregations in the Newfoundland area.

Shell Height (mm)	4R (Gulf of St. Lawrence Aug. A Sept.) 1995	1997	3N (Lilly / Carson Canyons B) 1996	1997	3L C 1994	3Nf D 1997	3Ps (Strat, 911) E 1991	3LN F 1995
40	1.9	1.6	1.8	1.7	1.4	1.5	1.3	1.3
45	2.5	2.2	2.5	2.3	2.0	2.0	1.9	1.9
50	3.2	2.9	3.4	3.1	2.6	2.6	2.6	2.6
55	3.9	3.8	4.5	4.1	3.4	3.3	3.4	3.4
60	4.8	4.9	5.8	5.3	4.3	4.1	4.4	4.4
65	5.8	6.1	7.3	6.7	5.3	5.0	5.6	5.6
70	6.7	7.5	9.0	8.2	6.5	6.0	6.9	7.0
75	8.0	9.1	11.0	10.0	7.9	7.1	8.5	8.6
80	9.3	10.3	13.3	12.1	9.4	8.4	10.3	10.4
85	10.7	12.9	15.8	14.4	11.1	9.7	12.3	12.4
90	12.2	15.2	18.7	17.0	12.9	11.2	14.5	14.7
95	13.8	17.6	21.8	19.8	15.0	12.8	17.0	17.2
100	15.5	20.4	25.3	23.0	17.2	14.6	19.8	20.1

A. 4R:
1995: log W = 2.2938 log SH - 3.3962 (r^2 = 0.65), DFO Atl. Fish. Res. Doc. 96/49
1997: log W = 2.7957 log SH - 4.2826 (r^2 = 0.85), CSAS Res. Doc. 98/148.

B. Lilly/Carson Canyons:
1995: log W = 2.8960 log SH - 4.3889 (r^2 = 0.91), DFO Atl. Fish. Res. Doc. 95/136.
1997: log W = 2.8726 log SH - 4.3843 (r^2 = 0.93), CSAS Res. Doc. 98/149.

C. 3L:
1994: log W = 2.7239 log Sh - 4.2112 (r^2 = 0.87), DFO Atl. Fish. Res. Doc. 95/136.

D. 3Nf:
1997: log W = 2.4773 log SH - 3.7914 (r^2 = 0.88), CSAS Res. Doc. 98/149.

E. 3Ps:
1991: log W = 2.9383 log SH - 4.58 (r^2 = 0.96), CAFSAC Res. Doc. 92/31.

F. 3LN:
1995: log W = 2.9548 log SH - 4.6070 (r^2 = 0.91), DFO Atl. Fish. Res. Doc. 96/76.

Table 8. Weight change as a function of time in scallops held out of water. Data assembled from St. Pierre Bank onboard the chartered vessel, Gadus Atlantica, August 1991. Air temperature = 22.8± 1.7°C.

Basket	Time lapsed (hrs) 0	6	12	19	Percent Weight Loss
A	24.0	20.0	19.0	19.0	21
B	23.0	19.0	18.0	18.0	22
C	25.5	21.5	20.0	20.0	22
D	25.0	21.5	20.0	20.0	20
Totals	97.5	82.0	77.0	79.0	21

Table 9. Seasonal variations in meat yield and attendant conversion factors in the Iceland scallop from the Strait of Belle Isle. These observations are from detailed biological sampling at fish plants and based on scallops long held out of water.

Year	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	
1980	10.35	10.49	9.60	9.45	9.78	9.35	9.27	9.27	9.69
1981	9.88	9.40	9.20	8.91	8.97	8.57	8.50	8.50	8.99
Mean	10.6	9.4	9.4	9.2	9.4	9.0	8.9	8.9	9.34

Table 10. Yields and conversion factors derived independently by west-coast Fishery Officers and area fishers, July 1998.

Vessel	Captain	Shellstock	Meats	Yield (%)	C.F.
Starlight	Sam McLean	2,105 lbs	275 lbs.	13.064	7.65
Northern Tri	Merv Applin	2,391 lbs	339 lbs.	14.178	7.05
Sea Pearl	Stewart Mitchelmore	3,566 lbs	315 lbs	13.291	7.52
Lady Ruth	Scott Mitchelmore	3,566 lbs	462 lbs	12.956	7.72
Starlight	Sam McLean	3,067 lbs	402 lbs	13.107	7.63
Violet Karen		2,432 lbs	297 lbs	12.212	8.19
Totals		15,931 lbs	2,090 lbs	13.1	7.6

Table 11. Epibiont loads in the Iceland scallop from several aggregations in the Newfoundland Region.

NAFO Div.	Area	Year	No. of Samples	No. of Scallops Sampled	Round weight (kg) Gross	Net	Epibiont Load (%)	Comm. Conversion Factor
3L	Eastern 3L	1994	9	1,437	122.95	80.60	34.4	13.53
3L/3N	3LN	1995	10	1,237	99.80	87.87	12.0	10.22
3N	3Nf	1997	3	383	31.50	30.95	1.7	11.05
3N	LCC	1994	29	3,822	361.04	336.45	6.8	8.86
	LCC	1997	12	1,186	117.30	97.04	17.3	
	Combined		41	5,008	478.34	433.49	9.4	
3Ps	St. Pierre Bank	1996	7	893	61.92	59.61	3.7	9.15
	St. Pierre Bank	1998	2	64	11.30	8.00	29.2	
	Combined		9	957	73.22	67.61	7.7	
4R	Straits	1995	10	885	100.22	90.90	9.3	11.12
	Straits	1997	10	555	68.67	63.05	8.2	
	Combined		20	1,440	168.89	153.95	8.9	

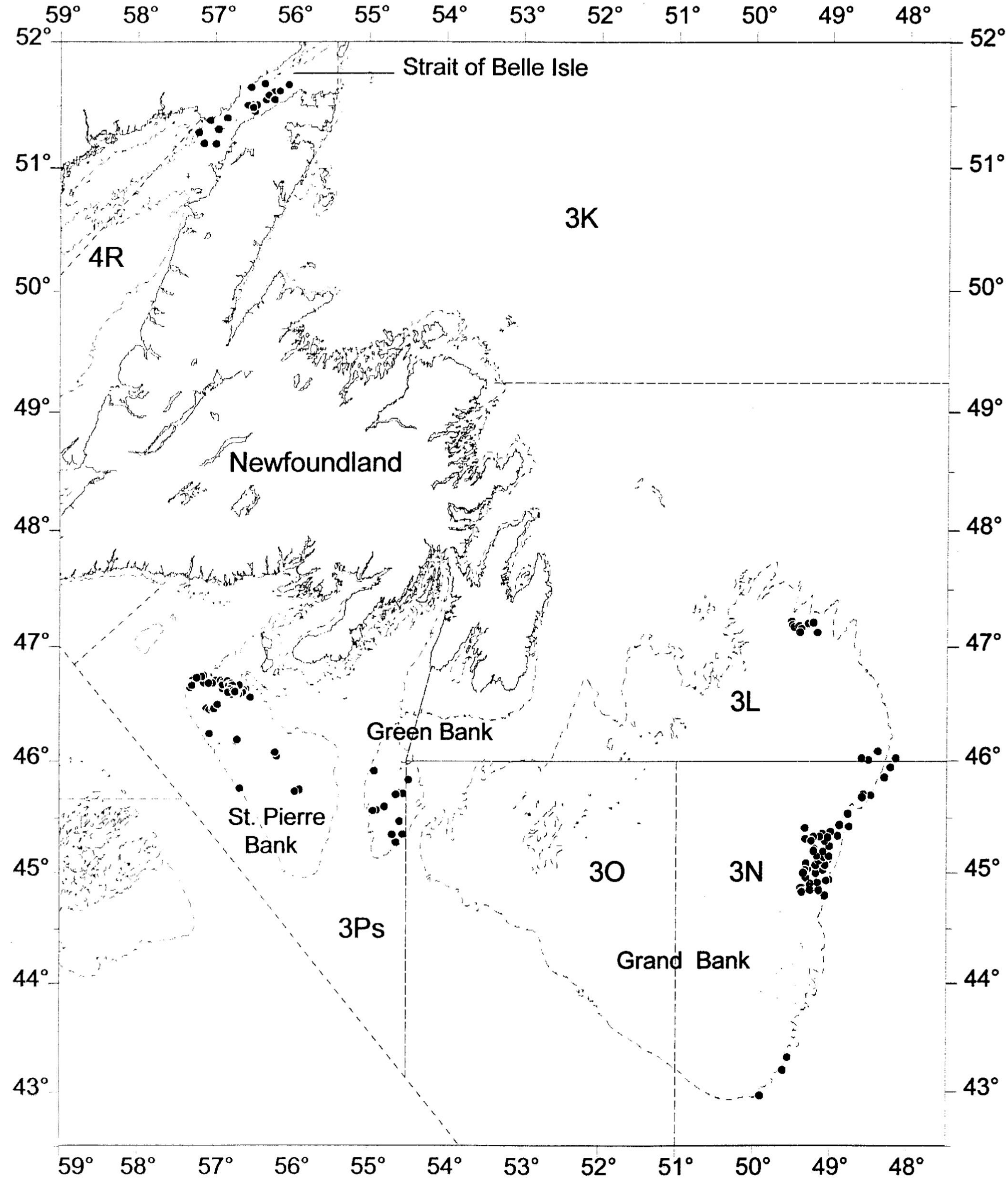

Fig.1. Distribution of sets used for the examination of conversion factors in the Iceland scallop fishery in the Newfoundland area.

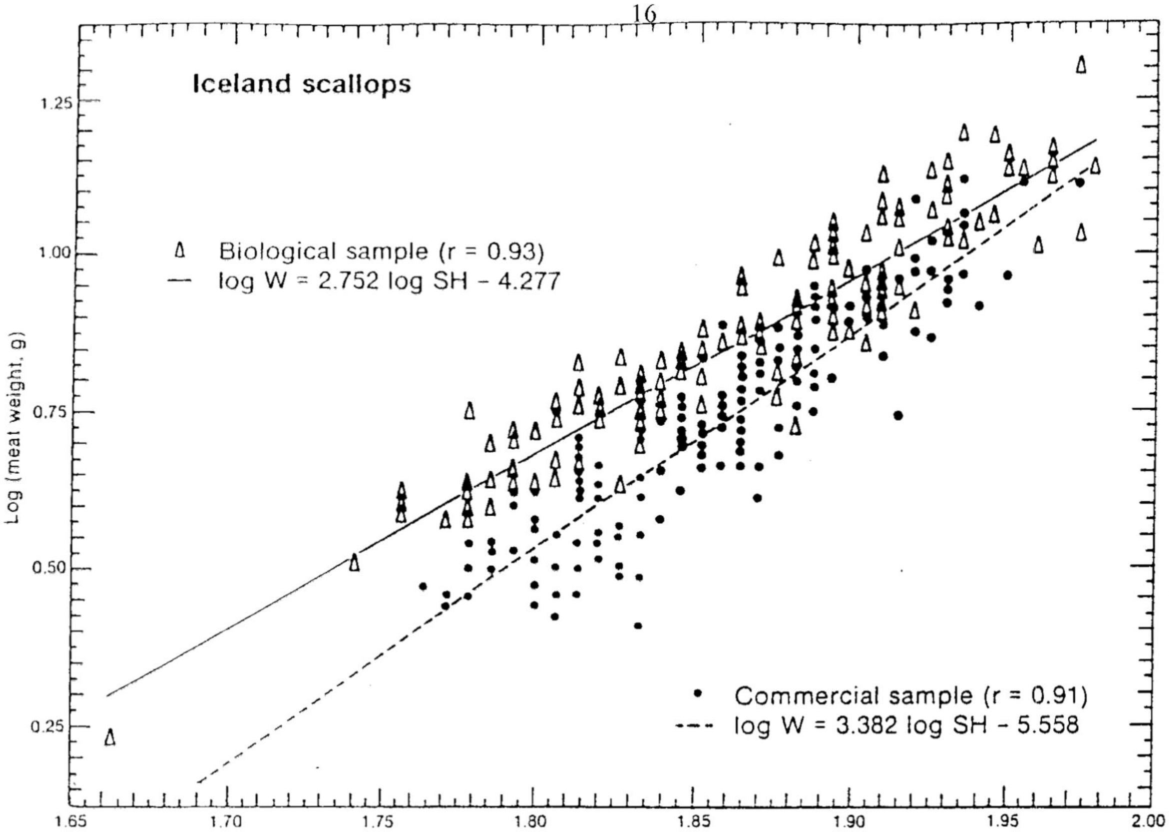

Fig.2. Shell height-meat weight relationships for the biological and commercial components of Iceland scallops from St. Pierre Bank (W=meat weight; SH=shell height; r=coefficient of correlation).

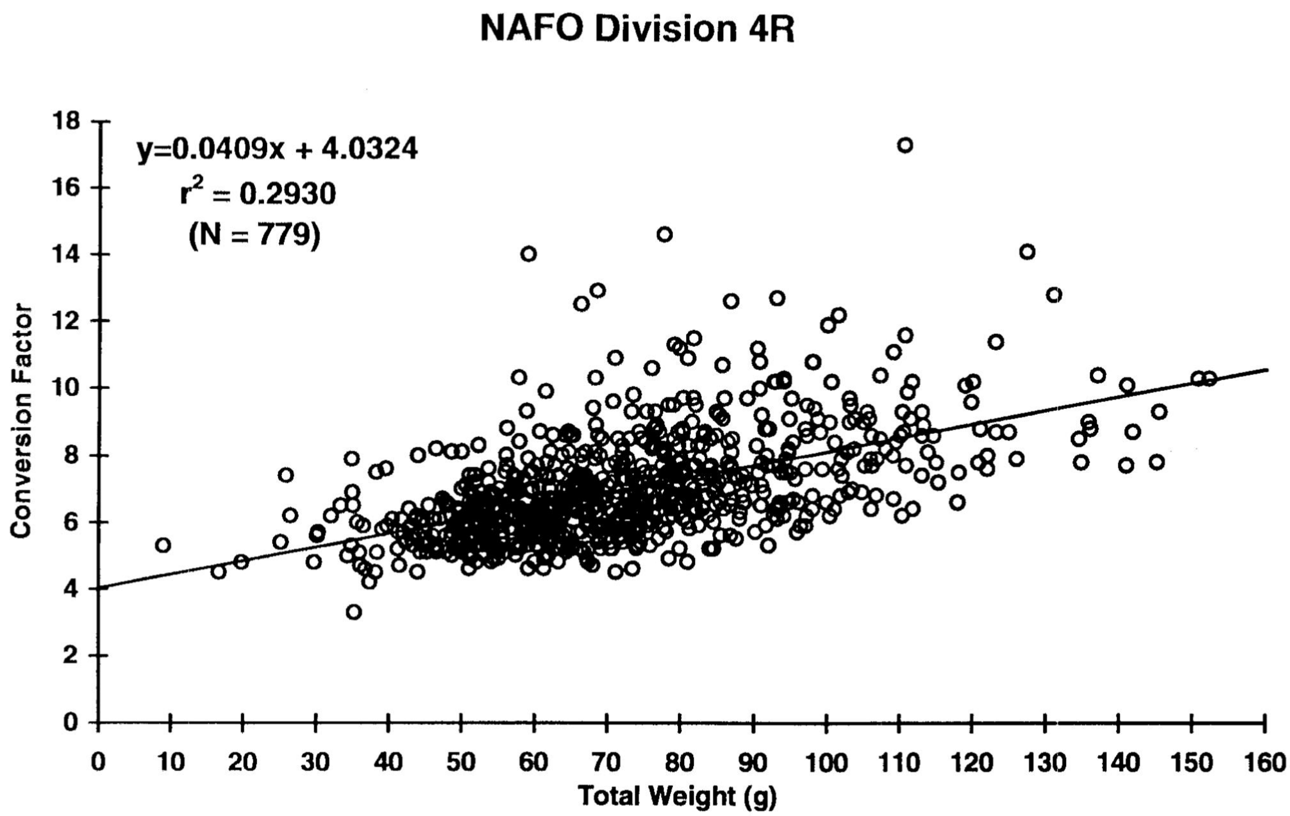

Fig.3. Correlation between the conversion factor and individual scallop weight (g) in 4R Iceland scallop.

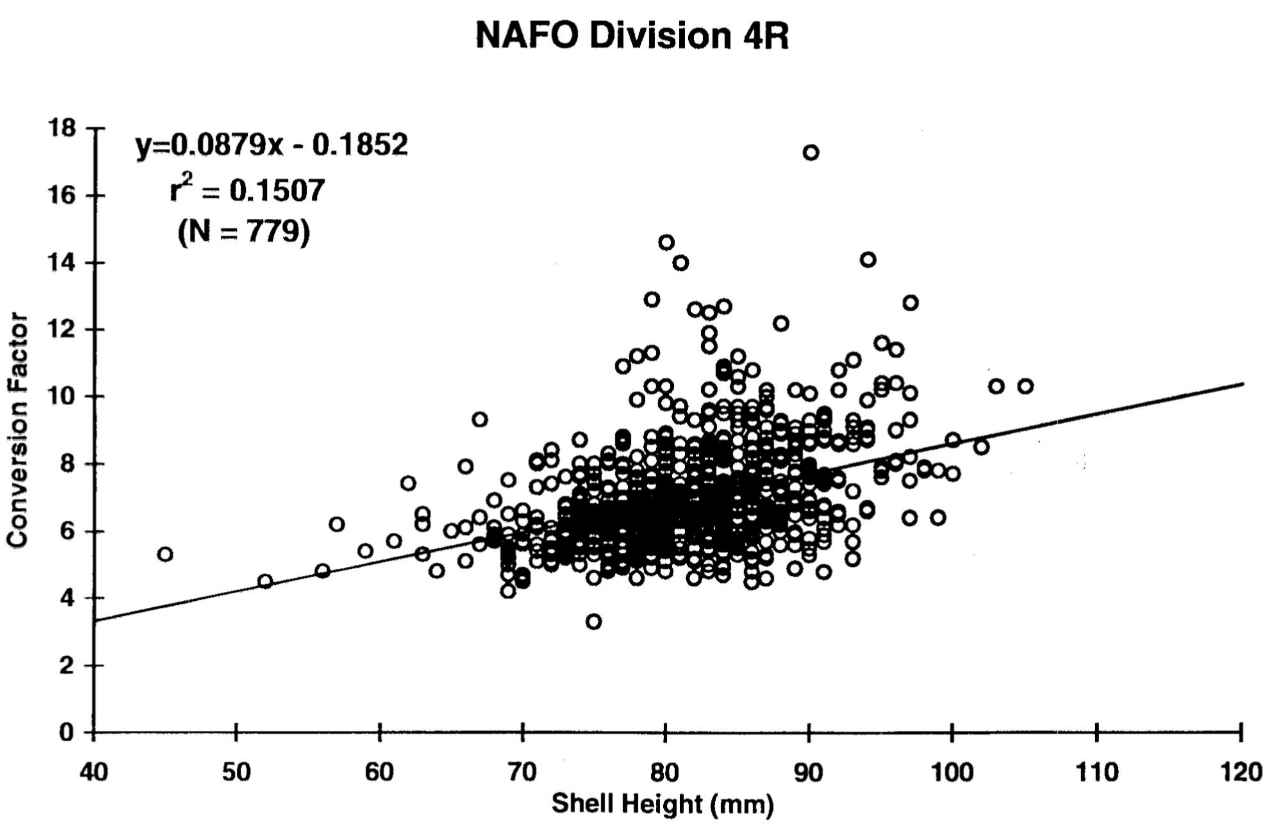

Fig.4. Correlation between the conversion factor and shell size (shell height,mm) in 4R Iceland scallop.