NOT TO BE CITED WITHOUT PRIOR REFERENCE TO THE AUTHORS

International Council for the Exploration of the Sea

C. M. 1995/K:36
Shellfish Committee

SQUID CATCH COMPOSITION IN THE ENGLISH CHANNEL BOTTOM TRAWL FISHERY: PROPORTION OF *LOLIGO FORBESI* AND *LOLIGO VULGARIS* IN THE LANDINGS AND LENGTH-FREQUENCIES OF BOTH SPECIES DURING THE 1993-1994 PERIOD.

by

J.P. Robin & E. Boucaud-Camou

Laboratoire de Biologie & Biotechnologies Marines,
I.B.B.A., Université de Caen 14032 CAEN cedex FRANCE

ABSTRACT

Fish market sampling of loliginid landings was carried out at Port-en-Bessin (Normandie, France) from November 1992 until February 1995. The numerical proportion of *Loligo forbesi* vs *L.vulgaris* was estimated per 2 month periods. The 2-stage sampling scheme was stratified to take into account the sorting out per commercial categories. Results indicate that the mixing of species changes during the fishing season in relation with differences in life-cycle timing: recruitment occured in summer in *L. forbesi* and in fall in *L. vulgaris* (with higher variability for this species). *L. forbesi* dominates 1993 and 1994 annual production. In both species, the bulk of landings depends on an annual cohort.

RESUME

L'échantillonnage des débarquements de calmars Loliginidés a été réalisé à la criée de Port-en-Bessin (Normandie, France) entre novembre 1992 et février 95. Le pourcentage en nombre des *Loligo forbesi* et *vulgaris* a été calculé par périodes de 2 mois grâce à un plan d'échantillonnage à 2 degrés incluant une stratification imposée par le tri des débarquements en catégories commerciales. On observe ainsi que la proportion des 2 espèces change au cours de la saison de pêche, ceci semblant lié à un décalage dans les cycles biologiques, avec un recrutement estival pour *L. forbesi* et automnal (plus variable) pour *L. vulgaris*. En 1993 comme en 94, la production annuelle est dominée par *Loligo forbesi*. Pour les 2 espèces, les animaux de moins d'un an constituent l'essentiel des débarquements.

Introduction

In the northeast Atlantic, *Loligo forbesi* Steenstrup, 1856 and *Loligo vulgaris* Lamarck, 1798 are two species of high commercial value which are not distinguished by the fishing industry or by fisheries statistics. Although both species have a wide distribution range, potentially from Norway to West Africa (Roper *et al*, 1984), geographical differences are observed and *L. forbesi* is considered to be the only species caught in Scottish waters (Pierce *et al*, 1994) and in the Azores (Porteiro and Martins, 1994) whereas *L. vulgaris* would dominate in the southern Galician fishery (Guerra *et al*, 1992) and in Potuguese coastal waters (Moreno *et al*, 1994), (Coelho *et al*, 1994).

In this context a 2-year study of French catches in the Atlantic was carried out from November 1992 to February 1995. It was focused on the production of the offshore bottom trawl fishery and on the landings of the Port-en-Bessin fish market (Calvados, France). This harbour is the second place for long-finned squid production in France. In the English Channel, the Port-en-Bessin fishery represents 25% of French catches (7D and 7E ICES divisions).

The aim of this study was to determine, on an annual basis, which species was the most abundant in the landings and what were the length structure of the fished populations. Seasonal fluctuations were also desirable to check whether changes in the mixing of species could be related to differences in the life cycle.

This was the first fish market sampling programme aimed at describing the total number of squid landed per species. With the hope that it may represent a "pilot study" in the sampling of multispecific landings a special attention was paid to methodological aspects.

Materials and methods

The sampling scheme has already been presented (Robin and Boucaud, 1993). The total harvest of a studied year was divided into 2-month periods to account for seasonal fluctuations. Within each period, a 2-stage sampling was performed with a sample of n studied days among N landing days (n = 4). On the *ith* studied day, a sample of mi squid boxes was analysed (with mi = 3 and Mi = total number of boxes landed on the *ith* day).

The sampling scheme included a stratification of the population of boxes to account for the sorting out of squid per "commercial categories". Fishermen split the landings into 5 categories (strata) roughly based on individual weight. The theoretical guideline used is:

stratum 5	=	squid < 100 g
stratum 4	=	[100 g , 200 g [
stratum 3	=	[200 g , 300 g [
stratum 2	=	[300 g , 500 g [
stratum 5	=	squid > 500 g

The basic information was collected by counting and measuring (DML dorsal mantle length, to the cm below) the animals of a box. If one consider the species *"s"* and length-group *"l"*, the number of animals falling into this group was: $y_{sl\,hij}$

(h denotes the stratum, i denotes the day, j denotes the box).

Squid were generally put into 40 kg boxes. However, in periods of low catch the quantities per category could be smaller. An auxiliary variate was used to take into account such incomplete boxes and also to reduce the number of small squid measured (by analysing one third and one fifth of the boxes in stratum 4 and 5, respectively)

In each period, final estimates were the total number of squid landed Y (and for the species "s", Y_s) and the numerical proportion of the species "s", $p_s = Y_s \,/\, Y$

Statistical variability of the estimates was given with confidence intervals: $Y \pm 2\sqrt{s^2(Y)}$ and we called "precision" the ratio: $\left[2\sqrt{s^2(Y)}\right] / Y$

Notations and formulae are listed in appendix 1, they are adapted from Cochran (1977) and Scherrer (1983). During the study period, a total of 50 days was analysed which represented 728 studied boxes. The average number of squid measured per studied day is 1500. An example of the counts per boxes is given in appendix 2 (period: Jan-Feb 1994).

Results

Loliginid landings in weight:

Loliginid landings at the Port-en-Bessin fish market were 927 and 747 tonnes in 1993 and 1994, respectively. Seasonal trends (fig. 1) showed that the highest landings were observed in summer and fall. In both years, the period of highest catch of small animals (commercial category N° 5) was July-August. In May 1993 and May 1994, landings were very low (< 1.3% of the annual landings) and this very small part of the crop was not considered in the estimation of numerical proportions. Then, instead of May-June, we studied only June, with 2 studied days.

Number of squid landed per species:

The results of the sampling programme are given in table 1 and figure 2. During the overall study period the number of *Loligo forbesi* and *L. vulgaris* landed showed great fluctuations corresponding to a marked annual cycle.

L. forbesi landings peaked in July-August and sagged in March-April.

L. vulgaris was not observed in the landings during the June-September period. *L. vulgaris* landings peaked in winter (in January-February 1993 and in November-December 1993 and 1994). It is worth noting that peak landings showed greater variability in *L. vulgaris* than in *L. forbesi* (varying by a factor 5 and 1.3, respectively). A striking consequence of the shift in the *L. vulgaris* maximum (from Nov-Dec 1992 to Jan-Feb 1993) is that the proportion of the 2 species in the overall annual landings remained constant in 1993 and 1994 (with 80% of *L. forbesi*). Looking at a "squid fishing season" (June N - April N+1) one might better say that *L. forbesi* represented 94% in 1993-1994 and about 75% in June 1994 - February 1995.

The statistical variability of the totals remained rather low except in the June periods (and March-April 1994) when the studied days were only 2.

Length-distributions of the landings:

The same sampling scheme was used to estimate the number of squid landed per DML length-class. Estimated length-frequencies per 2-month periods (figs. 3 and 4) underlined that each species entered the fishery with the juvenile of an annual cohort. A mode around 15 cm DML was observed in *Loligo forbesi* in July-Aug.1993 and 1994 and a similar pattern was observed in *L. vulgaris* in Nov-Dec.1992, 1993 and 1994.

Adding up the estimated numbers per length-class, the histograms of the annual catch were plotted (fig. 5). In *L.forbesi*, they underlined that, despite lower landings in 1994 than in 1993, the structure of the fished population remained constant. On the contrary, in *L. vulgaris* landed animals were larger in 1993 than in 1994.

In the analysis of seasonal fluctuations of length data, it seemed more relevant to consider only the second stage of the sampling scheme and to analyse changes from one studied day to the next. In a first step, the 50 histograms were summarized with mean DML vs time (fig. 6). Again, this suggested in both species the growth of an annual cohort with *L .forbesi* recruitment in June and *L. vulgaris* recruitment in October (with very similar sizes for both recruits).

Discussion

Although *Loligo forbesi* and *L. vulgaris* were both known to occur in English Channel trawl catches (Holme, 1974), this study provided the first quantitative estimates of the proportion of both species. *L. forbesi* dominated in 1993 and 1994 landings. However, seasonal fluctuations of the mixing were observed and *L. vulgaris* was more abundant in landings by the end of the "squid fishing season" (i.e. January-April). Seasonal patterns can explain the different picture obtained with research surveys carried out in a particular time (such as Channel Ground Fish Surveys which take place in October). This study contributed to the identification of English Channel stocks (Anonymous, 1993). Changes in abundance and in length structures are consistent with the annual life cycle descibed in Scottish or Spanish populations (Pierce *et al*, 1994), (Guerra *et al*, 1994)

Nevertheless, the sampling of commercial landings also has sources of bias which are worth noting. Port-en-Bessin trawlers use a 40 mm mesh net (square) which determines recruitment size (DML range 10-15 cm). The activity of the fishing fleet was not taken into account in this analysis. Though all boats operate in the English Channel, it seems that the fishing grounds change during the season, with a part of the fishing fleet moving from West in summer to East in winter. The influence of this "migration", on catch composition could be analyzed. by sampling other harbours along the English Channel coast or by taking into account geographical origin for the landings.

The present study may represent a guideline for future fish-market sampling. The problem of mixed species is often encountered in fish stocks (Dupouy *et al*, 1988). Stratification (sorting out per commercial categories) is known as an element of the sampling scheme that produce gains in precision. In the study case, it has a double effect: the number of squid per studied kg is more homogeneous within a stratum but also changes in species composition do not involve all strata at once (the recruits of one species appear in stratum 5 and the large squids of stratum 1 are almost always *Loligo forbesi*).

Acknoledgements

This work was funded by the Commission of the European Communities within the frame of the E.E.C. research programme in the fisheries sector (Contract AIR 1CT92 0573).

We would also like to thank Mrs Odile Pons (INRA, Jouy-en-Jossas, France) for her suggestions in the estimation of the variance of the proportions and the students of the University of Caen who participated in the fish-market observations.

References

Anonymous, 1993. Biogeographical identification of English Channel Fish and Shellfish Stocks. IFREMER-MAAF, RI DRV 93-028: 256p.

Cochran W.G., 1977. Sampling Techniques, Third Edition, John Wiley and Sons Ltd., New York, 428p.

Coelho M.L., J. Quintela, V. Bettencourt, J. Mattos Silva, H. Villa, 1994. Population structure, maturation patterns and fecundity of the squid *Loligo vulgaris* from southern Portugal. Fish. Res. 21: 87-102.

Dupouy H., J.J. Rivoalen, B. Kergoat, 1988. Le taux de mélange des baudroies (*Lophius piscatorius* et *L. budegassa*) dans les débarquements du Plateau Celtique. ICES C.M. 1988/G:64 : 19p.

Guerra A., F. Rocha, F. Casas, M.T. Fernandez, 1992. *Loligo vulgaris* and *Loligo forbesi* (Cephalopoda, Loliginidae) ; their present status in Galician Fisheries. ICES C.M. 1992/K:40 : 20p.

Guerra A., F. Rocha, 1994. The life history of *Loligo vulgaris* and *Loligo forbesi* (Cephalopoda, Loliginidae) ; in Galician waters (NW Spain). Fish. Res. 21: 43-69.

Holme N.A., 1974. The biology of *Loligo forbesi* Steenstrup (Mollusca: Cephalopoda) in the Plymouth area. J. mar. biol. Ass. U.K., 54: 481-503.

Moreno A., M. Morais da Cunha, J. M.F. Pereira, 1994. Population biology of veined squid (*Loligo forbesi*) and European squid (*Loligo vulgaris*) from the Portuguese coast. Fish. Res. 21: 71-86.

Pierce G.J., P.R. Boyle, L.C. Hastie, L. Key, 1994. The life history of *Loligo forbesi* (Cephalopoda: Loliginidae) in Scottish waters. Fish. Res., 21: 17-41.

Porteiro F., H.R. Martins, 1994. Population biology of *Loligo forbesi* Steenstrup, 1856 (Mollusca: Cephalopoda) in the Azores: sample composition and maturation of squid caught by jigging. Fish. Res., 21: 103-104.

Robin J.P., E. Boucaud, 1993. Proportion of the squid Loligo forbesi and Loligo vulgaris in French landings of the English Channel bottom trawl fishery: sampling scheme of the Port-en-Bessin landings and preliminary results. ICES C.M. 1993/K:20 : 9p.

Roper C.F.E., M.J. Sweeney, C.E. Nauen, 1984. FAO species catalogue Vol. 3 Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish. Synop. , 125 vol.3 : 277 p.

Scherrer B., 1983. Techniques de sondage en écologie. (in Startégies d'échantillonnage en écologie. Frontier S. (ed.) Masson, Paris) : 65-162.

Table 1: Loliginid landings at the Port-en-Bessin fish-market: estimated numbers and statistical variability

Time-Periods	All species	Confidence Lower	limits Upper	precision
N+D-92	783 000	771 000	794 000	1.5%
J+F-93	668 000	658 000	679 000	1.5%
M+A-93	251 000	244 000	258 000	2.7%
J-93	274 000	254 000	293 000	7.3%
J+A-93	1 772 000	1 740 000	1 804 000	1.8%
S+O-93	884 000	852 000	916 000	3.6%
N+D-93	534 000	513 000	555 000	3.9%
J+F-94	157 000	155 000	160 000	1.6%
M+A-94	47 000	43 000	51 000	8.8%
J-94	142 000	136 000	148 000	4.2%
J+A-94	1 320 000	1 292 000	1 348 000	2.1%
S+O-94	1 029 000	993 000	1 065 000	3.5%
N+D-94	965 000	948 000	982 000	1.7%
J+F-95	381 000	365 000	397 000	4.3%

Time-Periods	*L.vulgaris*	Confidence Lower	limits Upper	precision	Proportion (vulg/total)	precision
N+D-92	457 000	435 000	479 000	4.8%	58.4%	5.5%
J+F-93	558 000	542 000	573 000	2.9%	83.4%	4.6%
M+A-93	188 000	180 000	197 000	4.5%	74.9%	6.8%
J-93	9 000	0	21 000	131.3%	3.3%	40.9%
J+A-93	0	0	0	n.c.	0.0%	n.c.
S+O-93	7 000	4 000	10 000	40.7%	0.8%	40.9%
N+D-93	100 000	82 000	117 000	17.6%	18.7%	14.1%
J+F-94	72 000	68 000	76 000	5.6%	45.9%	3.5%
M+A-94	29 000	27 000	32 000	7.7%	62.2%	34.5%
J-94	0	0	0	n.c.	0.0%	n.c.
J+A-94	0	0	0	n.c.	0.0%	n.c.
S+O-94	96 000	75 000	117 000	21.9%	9.3%	14.1%
N+D-94	537 000	508 000	565 000	5.3%	55.6%	4.3%
J+F-95	293 000	277 000	309 000	5.4%	77.0%	13.5%

Time-Periods	*L. forbesi*	Confidence Lower	limits Upper	precision	Proportion (forb/total)	precision
N+D-92	325 000	301 000	350 000	7.5%	41.6%	13.1%
J+F-93	111 000	97 000	124 000	12.1%	16.6%	5.1%
M+A-93	63 000	55 000	71 000	12.3%	25.1%	12.7%
J-93	264 000	232 000	296 000	12.1%	96.7%	31.9%
J+A-93	1 772 000	1 740 000	1 804 000	1.8%	100.0%	2.3%
S+O-93	877 000	845 000	909 000	3.6%	99.2%	9.9%
N+D-93	434 000	407 000	461 000	6.2%	81.3%	15.9%
J+F-94	85 000	81 000	89 000	5.1%	54.1%	8.3%
M+A-94	18 000	15 000	20 000	15.4%	37.8%	46.5%
J-94	142 000	136 000	148 000	4.2%	100.0%	24.4%
J+A-94	1 320 000	1 292 000	1 348 000	2.1%	100.0%	3.9%
S+O-94	933 000	895 000	970 000	4.0%	90.7%	7.3%
N+D-94	428 000	396 000	461 000	7.6%	44.4%	4.7%
J+F-95	88 000	80 000	95 000	8.6%	23.0%	20.3%

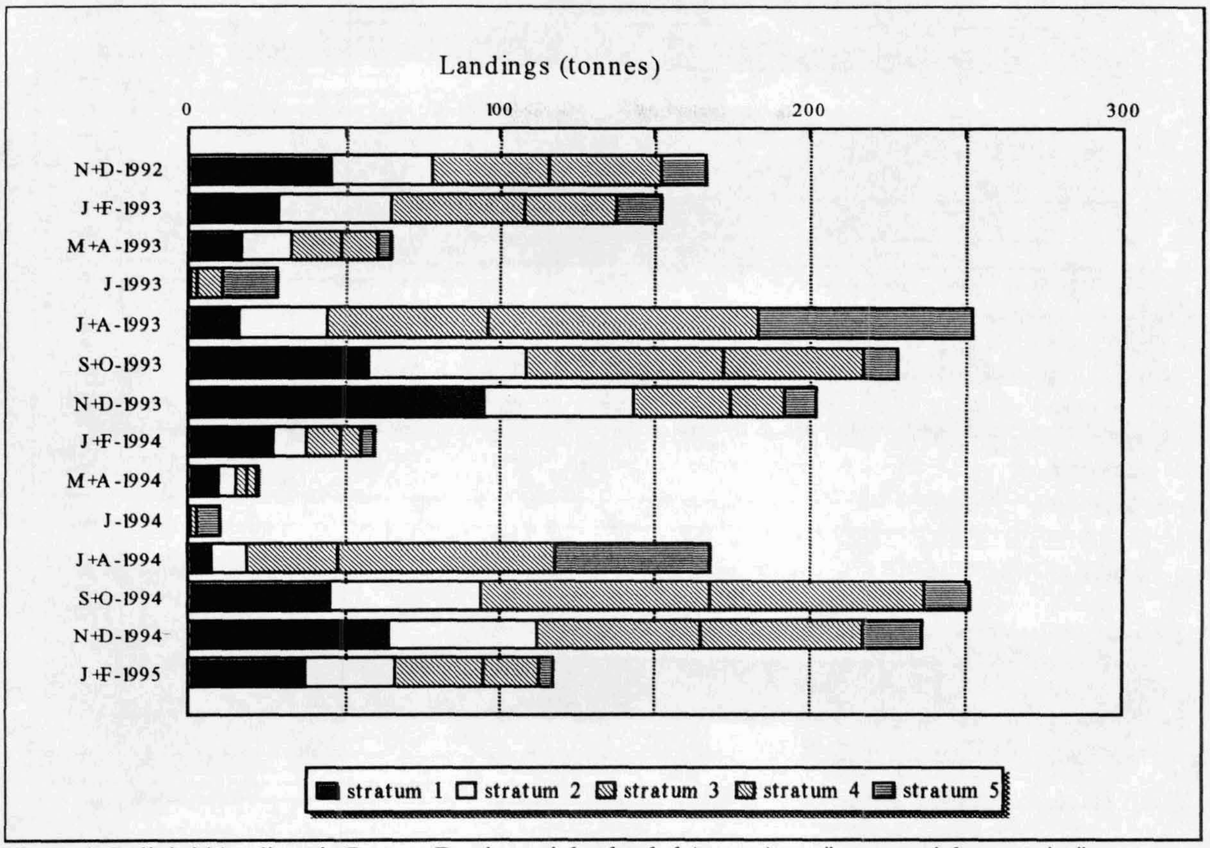

Figure 1: Loliginid landings in Port-en-Bessin weights landed (tonnes) per "commercial categories"

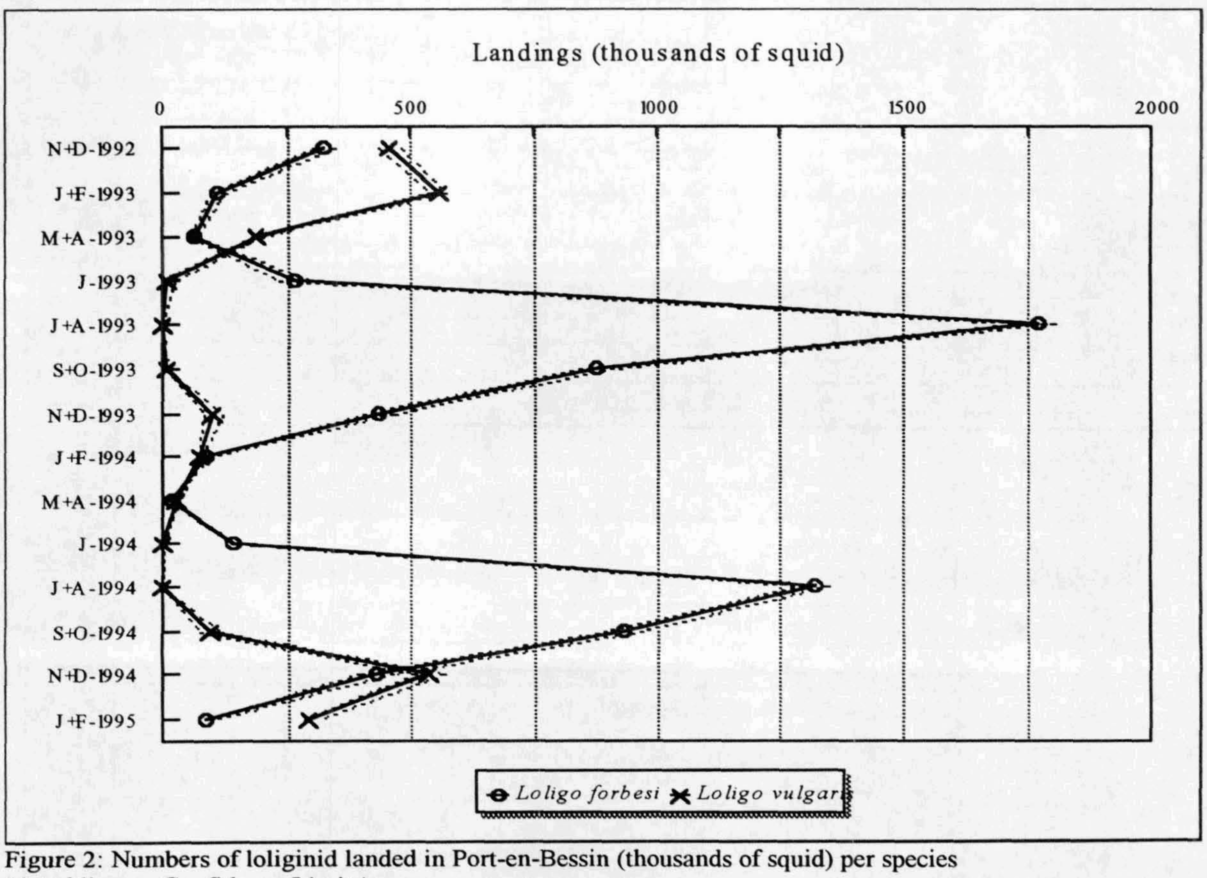

Figure 2: Numbers of loliginid landed in Port-en-Bessin (thousands of squid) per species
(doted lines = Confidence Limits).

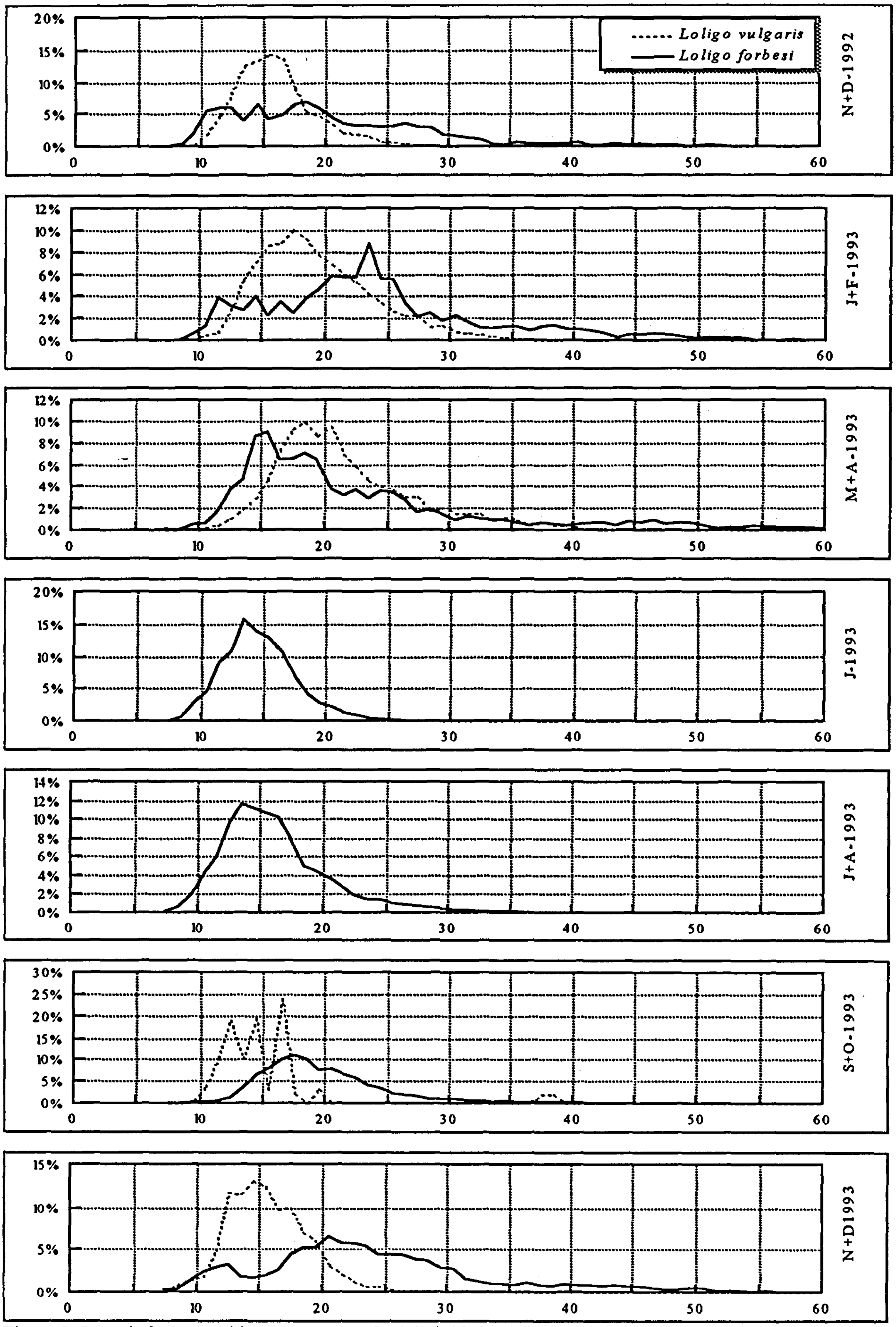

Figure 3: Length-frequency histograms (DML) for loliginids landed in Port-en-Bessin (period: Nov1992-Dec1993)

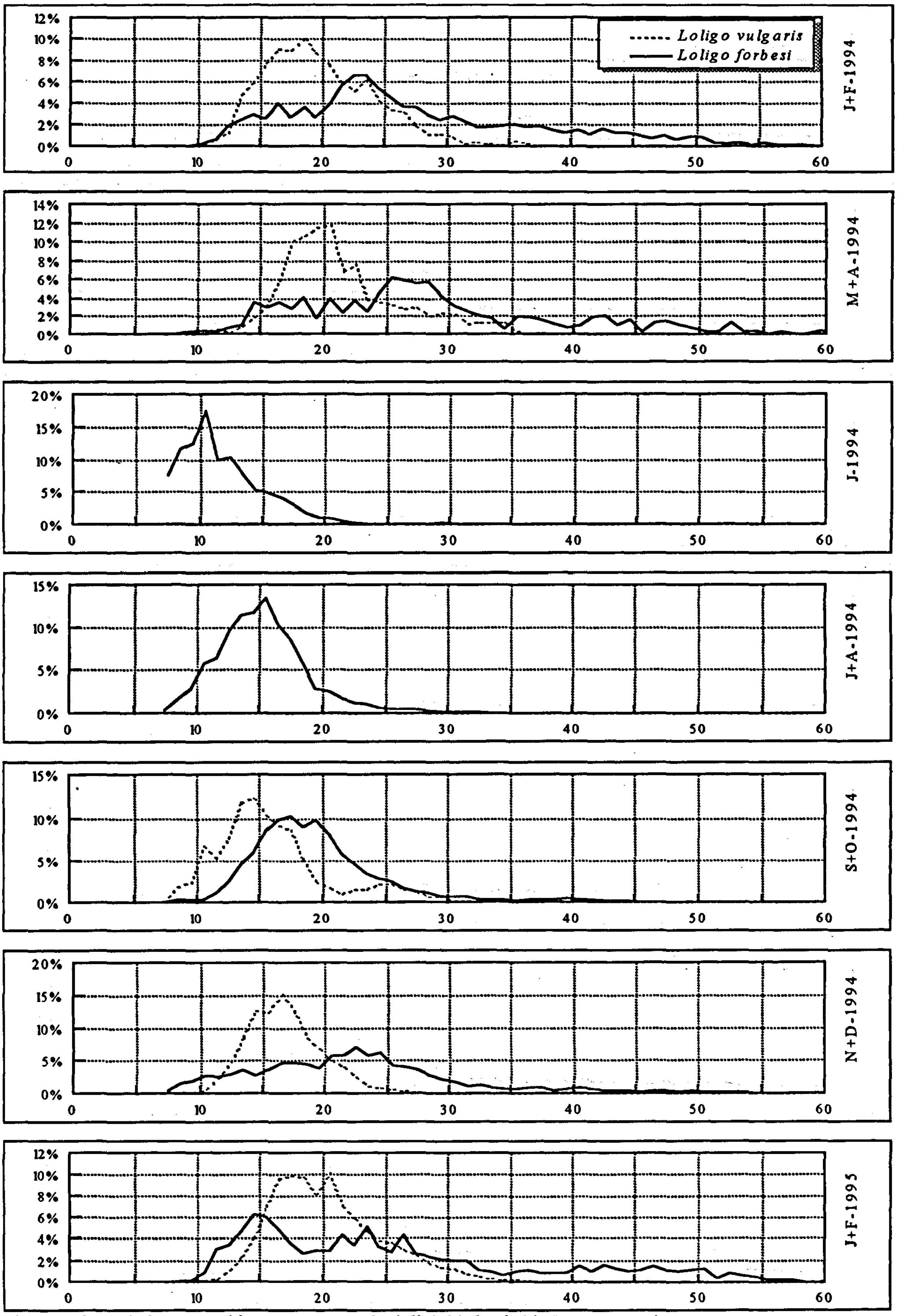

Figure 4: Length-frequency histograms (DML) for loliginids landed in Port-en-Bessin (period: Jan1994-Feb1995)

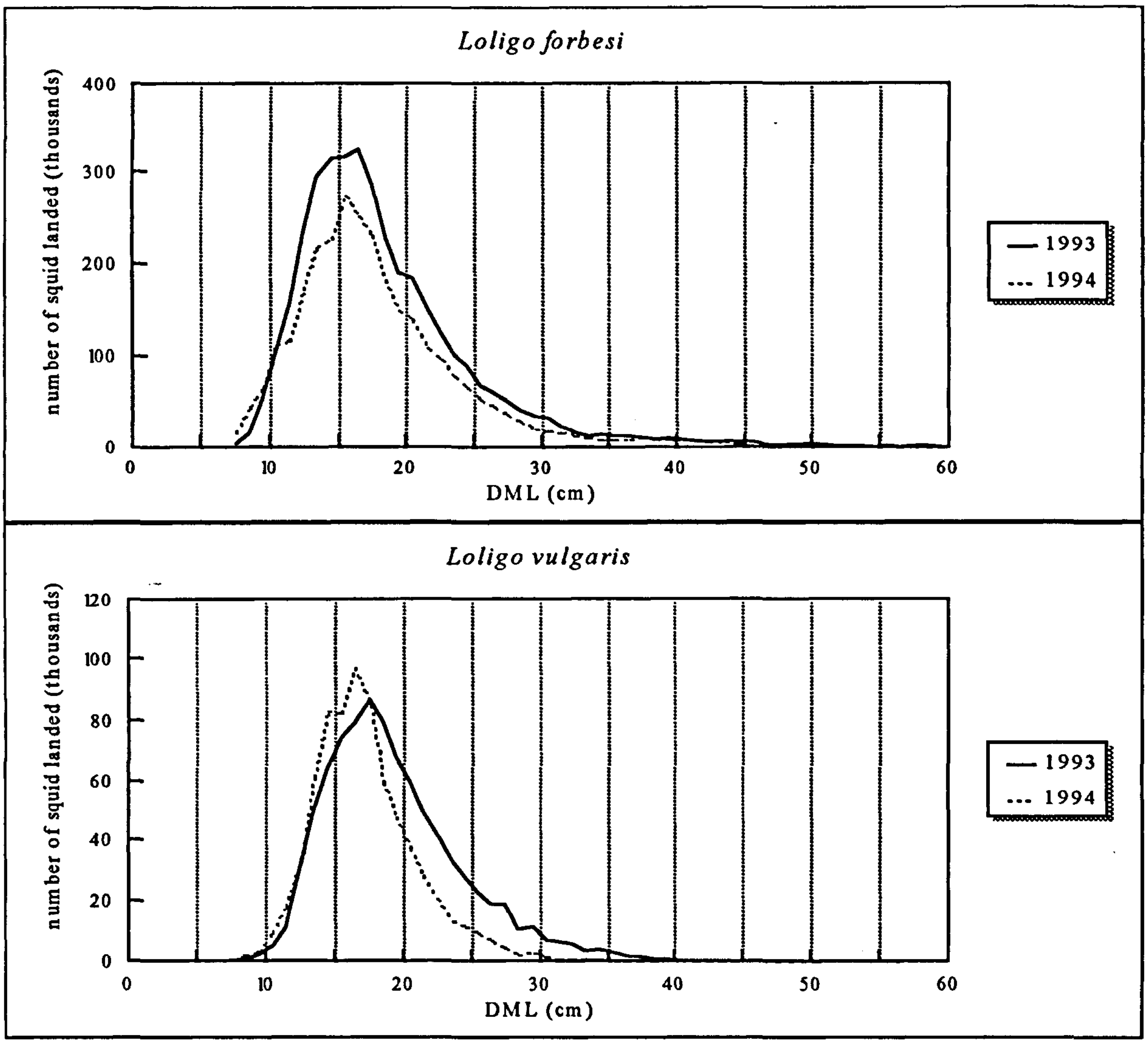

Figure 5: Length distributions (DML) of the overall annual landings in Port-en-Bessin

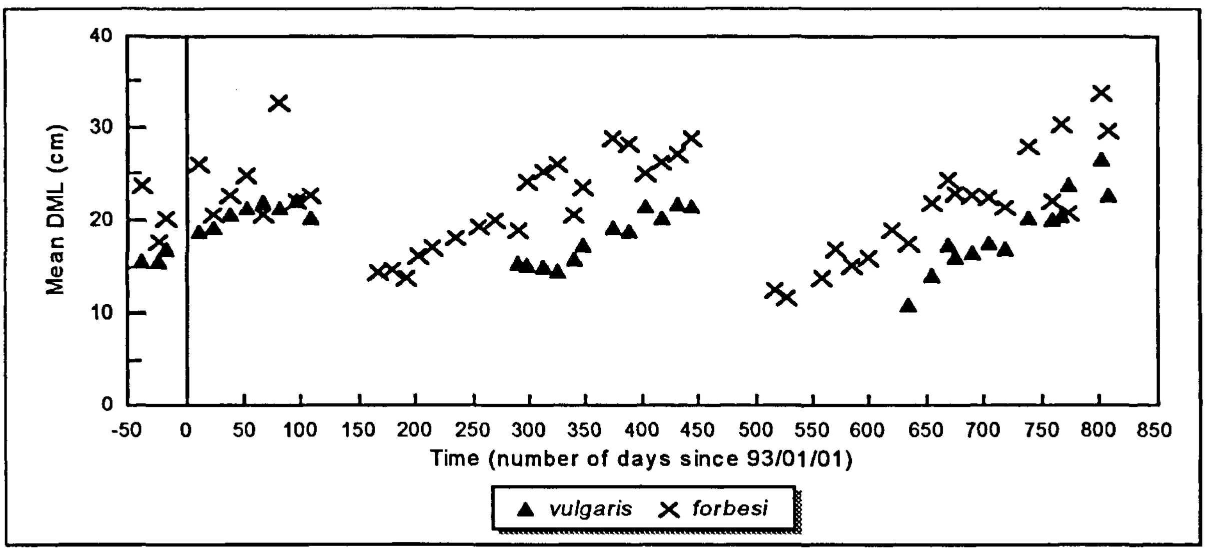

Figure 6: Time fluctuations in mean DML of the landings on the studied days.

Appendix 1: Notations and formulae used in the conputation of the numerical proportion of squid:

Notations:

The symbol ~ denotes that a parameter is estimated and $s^2(\tilde{u})$ is the estimated variance of the estimate $\tilde{u}$

h denotes the stratum (h=1...H)
i denotes the day (i= 1...N) with n studied days
j denotes the box (j=1..Mi) with mi studied boxes (on the ith day)

The total weight of squid landed during a 2-month period is : X

The total number of squid landed during a 2-month period is : $\tilde{Y}$

(in the species "s" $\tilde{Y}_s$ is calculated with similar formulae)

Numbers landed:

The basic information recorded is for one box of squid: y_{hij} and x_{hij} number and weight measured (hth stratum, ith day, jth box)

$\tilde{R}_{hi}$ = number of squid per studied kg (hth stratum, ith day) $\tilde{R}_{hi} = \dfrac{\sum_{j=1}^{m_{hi}} y_{hij}}{\sum_{j=1}^{m_{hi}} x_{hij}}$

$\tilde{R}_h$ = number of squid per kg (stratum h) $\tilde{R}_h = X_h \dfrac{\sum_{i=1}^{n} X_{hi}\tilde{R}_{hi}}{\sum_{i=1}^{n} X_{hi}}$ (with X_{hi} total weight landed, hth stratum, ith day)

$\tilde{Y}_h$ = total number of squid landed in stratum h $\tilde{Y}_h = X_h\tilde{R}_h$

total number of squid landed $\tilde{Y} = \sum_{h=1}^{H}\tilde{Y}_h$ alternatively: $Y = X\tilde{R}$ (with $\tilde{R} = \sum_{h=1}^{H} W_h\tilde{R}_h$ and $W_h = X_h/X$)

Numerical proportion of the species "s"

$\tilde{p}_s = \tilde{Y}_s / \tilde{Y}$ which is also expressed: $\tilde{p}_s = \tilde{R}_s / \tilde{R}$

Estimated variances:

total numbers

$s^2(\tilde{Y}) = \sum_{h=1}^{H} s^2(\tilde{Y}_h)$ $s^2(\tilde{Y}_h) = X_h^2 s^2(\tilde{R}_h)$ $s^2(\tilde{R}) = \sum_{h=1}^{H}\left[W_h^2 s^2(\tilde{R}_h)\right]$

(2 stage sampling: S1 = between-days variations
S2 = averaged between-boxes variations $s^2(\tilde{R}_h) = S1 + S2$)

$$S1 = \frac{1}{n_h}\left(1-\frac{n_h}{N_h}\right)\frac{1}{(n_h-1)}\sum_{i=1}^{n_h}\left[\frac{X_{hi}^2}{\bar{X}_h^2}(\tilde{R}_h-\tilde{R}_{hi})^2\right]$$

$$S2 = \frac{1}{n_h N_h}\sum_{i=1}^{n_h}\left[\frac{X_{hi}^2}{\bar{X}_h^2}\frac{1}{m_{hi}}\left(1-\frac{m_{hi}}{M_{hi}}\right)\frac{\sum_{j=1}^{m_{hi}}(y_{hij}-\tilde{R}_{hi}x_{hij})^2}{\bar{x}_{hi}^2(m_{hi}-1)}\right]$$ with $\bar{x}_{hi} = \frac{1}{m_{hi}}\sum_{j=1}^{m_{hi}} x_{hij}$

proportions:

$s^2(\tilde{p}_s) = [s^2(\tilde{R}_s) + \tilde{p}_s^2 s^2(\tilde{R}) - 2s(\tilde{R}_s,\tilde{R})] / N^2\tilde{R}^2$ with $s(\tilde{R}_s,\tilde{R}) = \sum_{h=1}^{H} W_h \operatorname{cov}(\tilde{R}_{sh},\tilde{R}_h)$

$\operatorname{cov}(\tilde{R}_{sh},\tilde{R}_h) = C1 + C2$ with $C1 = \frac{1}{n_h}\left(1-\frac{n_h}{N_h}\right)\frac{1}{(n_h-1)}\sum_{i=1}^{n_h}(\tilde{R}_{sh}-\tilde{R}_{shi})(\tilde{R}_h-\tilde{R}_{hi})$

$$C2 = \frac{1}{n_h N_h}\sum_{i=1}^{n_h}\left[\frac{X_{hi}^2}{\bar{X}_h^2}\frac{1}{m_{hi}}\left(1-\frac{m_{hi}}{M_{hi}}\right)\frac{\sum_{j=1}^{m_{hi}}(y_{shij}-y_{shij})(y_{hij}-y_{hij})}{(m_{hi}-1)}\right]$$

Appendix 2: Counts per studied boxes and weights landed in the Jan-Feb 1994Period

	Overall landings (kg)	Landing days N		Studied days D 1 Box 1	******* Box 2	D 1 Box 3	D 2 Box 1	******* Box 2	D 2 Box 3	D 3 Box 1	******* Box 2	D 3 Box 3	D 4 Box 1	******* Box 2	D 4 Box 3
			studied weight	80.0	80.0	80.0	40.0	80.0	80.0	40.0	40.0	40.0	47.0	80.0	40.0
Stratum			vulgaris	3	5	6	4	1	0	0	0	2	11	10	3
1	27153	33	forbesi	80	80	81	30	73	77	27	25	25	47	79	33
			total	83	85	87	34	74	77	27	25	27	58	89	36
			landings of the day	2287.0			1173.0			816.0			818.0		
			studied weight	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	27.0	36.0	21.0
Stratum			vulgaris	14	92	12	18	12	14	4	10	23	21	16	6
2	11034	33	forbesi	75	0	72	53	77	74	33	58	67	48	66	38
			total	89	92	84	71	89	87	37	68	90	69	82	44
			landings of the day	757.0			338.0			498.0			250.0		
			studied weight	36.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	25.0	42.0	13.0
Stratum			vulgaris	57	39	58	58	54	32	44	37	97	41	108	25
3	11105	33	forbesi	71	112	75	75	90	75	78	96	23	38	37	20
			total	128	151	133	133	144	107	122	133	120	79	145	45
			landings of the day	576.0			335.0			1032.0			180.0		
			studied weight	14.0	13.5	13.5	14.0	15.0	13.5	13.5	13.5	13.5	13.0	13.5	13.5
Stratum			vulgaris	69	59	49	59	64	44	27	33	25	38	76	56
4	6452	33	forbesi	14	21	18	10	27	29	33	48	36	23	7	23
			total	83	80	67	69	91	73	60	81	61	61	83	79
			landings of the day	417.0			215.0			422.0			147.0		
			studied weight	8.0	8.0	8.0	8.0	17.0	8.0	8.0	8.0	8.0	6.0	8.0	8.0
Stratum			vulgaris	67	65	87	54	95	42	32	47	31	16	51	33
5	3824	33	forbesi	12	13	23	16	73	43	31	35	30	37	29	51
			total	79	78	110	70	168	85	63	82	61	53	80	84
			landings of the day	234.0			129.0			146.0			96.0		