International Council for the
Exploration of the Sea

CM 1994/K:44
Shellfish Committee

Results of a discard study on the Belgian *Nephrops* fishery in the central North Sea

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ABSTRACT

In June and September 1993 two sampling campaigns were carried out on board of a commercial *Nephrops* trawler currently operating in the Botney Gut - Silver Pit area (central North Sea), to investigate fishermen's selection and discarding of *Nephrops*.

The numbers of *Nephrops* caught, landed and discarded varied widely from one haul to another, depending on the season, the time of day and the location of the hauls. Fishermen's selection curves are presented for male and female *Nephrops* separately. The differences in selection pattern between males and females were related to the occurrence of soft, recently moulted females, and to the developmental stage of the female gonads.

Survival experiments on *Nephrops* discards revealed a clear relationship between the type of damage sustained during the catching and sorting process, and the immediate mortality rates. A tentative estimate of the long-term survival rate of the discards is given.

This study was subsidized by the Commission of the European Communities, Directorate General for Fisheries (contract no. BIO 1992/3), and by the Institute for Scientific Research in Industry and Agriculture (ISRIA), Brussels, Belgium.

INTRODUCTION

The models currently used to assess the state of exploitation of *Nephrops* stocks require an input data file with the removals-at-length, i.e. the numbers landed (currently derived from market sampling programmes) plus the "dead discards" (see e.g. ICES, 1994).

Estimates of the discards-at-length can be obtained in different ways : either directly, from discard sampling programmes, or indirectly, by applying a fishermen's selection curve to the size distribution of the landings. Discard data derived from sampling programmes are clearly to be preferred over estimates obtained by raising the numbers-at-length in the landings to numbers-at-length in the catches, using averaged fishermen's retention rates. Particularly the estimates for the smallest sizes in the discards will be much more reliable when derived from samplings.

The logistics of a discard sampling programme, however, can become fairly complex, especially when the vessels stay on the grounds for up to two weeks, as is the case for the Belgian *Nephrops* trawlers operating in the central North Sea. Under these circumstances the use of an averaged fishermen's selection curve may be the only alternative left to estimate the numbers discarded.

Estimates of the "dead discards" are obtained by multiplying the numbers-at-length in the discards by an "annualized" discard mortality rate. Until now, the mortality rate used by the ICES *Nephrops* Working Group was 75 % (see e.g. ICES, 1994). This value was based on various studies (amongst others by GUEGUEN and CHARUAU, 1975, and CHARUAU *et al.*, 1982), and, for reasons of consistency, has been applied indifferently to most *Nephrops* stocks in the NW European waters.

The main aim of the present study was to collect information on discarding practices and fishermen's selection in the Belgian *Nephrops* directed fishery in the Botney Gut - Silver Pit area (central North Sea).

In the margin of this study, experiments were carried out on the survival of the *Nephrops* discards.

CATCH SORTING PROCESS on BELGIAN *Nephrops* TRAWLERS

The Belgian *Nephrops* directed trawlers, fishing in the Botney Gut - Silver Pit area, usually stay 9-12 days on the grounds, during which 50-70 hauls of 3½ hours each (time required for shooting and hauling excluded) are made.

Immediately after shooting the gear, the catch of the previous haul is being sorted. The catch is shovelled on a sorting table (usually placed on the fore-deck, right in front of the winches) and hand-sorted by the crew (Figure 1). While sorting, the *Nephrops* are graded into *Nephrops* to be landed whole (mostly > 35 mm CL), and *Nephrops* to be tailed (mostly 30-40 mm CL; together with soft or damaged animals of larger sizes) (Figure 2). Fish are sorted into three "categories" : roundfish, flatfish, and so-called "precious" fish, such as turbot, brill, halibut and anglerfish. The discards are collected in baskets on both sides of the sorting table and then returned to the sea, or washed overboard by a constant flow of water from a hose laying on deck.

After sorting, the *Nephrops* are thoroughly rinsed by hose, and then stored on ice. Fish are gutted (except for dogfish, tope, spurdog and gurnards), washed, and also stored on ice (Figure 2).

MATERIALS and METHODS

Size compositions of landings and discards

Size composition data on the *Nephrops* landings and discards were collected during two voyages, viz. in June and September 1993, with a Belgian *Nephrops* trawler currently fishing in the Botney Gut - Silver Pit area. All data were collected under "normal" operational conditions, actually meaning that the scientific crew did not interfere with e.g. the choice of the fishing grounds, the duration of the hauls, or the catch sorting process.

Shortly after the catch had been sorted by the ship's crew, the volumes of each fraction in the landings (viz. *Nephrops* to be landed whole and *Nephrops* to be tailed), and the total volume of the "trash" (including the *Nephrops* discards) were measured in fish baskets (ca. 40 litres) or 20 litre buckets. The *Nephrops* discards were sorted by the scientific crew from 2 or 4 baskets of "trash" (viz. 1 or 2 baskets from each side of the sorting table, depending on the quantities of *Nephrops* discards contained in the "trash").

Whenever possible, ½-1 basket of whole *Nephrops* (usually 100-350 animals), and ¼-½ basket of *Nephrops* to be tailed (usually 100-250 animals) were measured, together with varying numbers of discards (again depending on the quantities of *Nephrops* discards contained in the "trash) (Tables 1 and 2). The length measurements (carapace length, CL, to the nearest mm) were recorded for males and females separately, and, for the females, by reproductive stage (non-ovigerous, ovigerous and hatching).

Data processing

The numbers-at-length in the samples were first raised to total numbers landed and discarded per standard haul of 3½ hours, using raising factors based on the ratios between the total volume of each fraction in the catch and the volume of the corresponding samples. These data were then grouped into so-called "data sets" of six standard hauls each (taken within a time span of approximately 48 hours), which were chosen so as to cover a full period of 24 hours. The numbers thus obtained give an idea of the total numbers of *Nephrops* landed and discarded per fishing day. The groupings of standard hauls into "data sets" are also shown in Tables 1 and 2.

All subsequent calculations (e.g. the proportions retained by the crew, the proportions landed whole or tailed, etc.) were then based on the numbers-at-length, obtained by summing the numbers landed and discarded at length across each "data set" of six standard hauls.

Fishermen's selection curves

Fishermen's selection curves were calculated using ConStat's "CC" package. For each "data set" four selection ogives were calculated, viz. a Logit, a Probit, a Log Log, and a Complementary Log Log curve (in tables and figures referred to as C Log Log). Details on the "CC" package, and on the criteria used to evaluate the goodness of fit of the selection curves can be found in POLET and REDANT (1994).

Discard survival experiments

During the September voyage, 10 experiments were carried out to collect data on the short-term survival of discarded *Nephrops*. For each of these experiments, 50 *Nephrops* were taken *ad random* from the discards, and transferred to a 150 litres plastic container, where they were kept under a constant, gentle flow of seawater.

After approximately 1 hour the animals were sexed and measured, and their condition was recorded (alive, poor, and moribund or dead), along with any signs of external damage (1 or 2 claws missing, carapace and/or abdomen damaged). The evaluation of their condition was based on several criteria; such as locomotory activity (both in and out of the water) and the way they held their claws. In case of doubt the animals were gently turned on their back : those which promptly rolled over again were then considered as being alive, those which only very slowly rolled over as being in poor condition, and those which failed to roll over as being moribund or dead.

RESULTS

Numbers landed and discarded per day

The numbers of *Nephrops* landed and discarded per day (i.e. per set of six standard hauls) during the two voyages are shown in Figure 3. The total numbers of *Nephrops* taken per haul varied considerably within each voyage and within each "data-set" of six standard hauls, depending on the time of day and the location of the hauls (Tables 1 and 2).

The difference between the two voyages in the numbers of *Nephrops* caught, landed and discarded was most striking : from June to September, the average numbers of *Nephrops* caught per day increased by a factor of $\approx$ 10. Over the same period of time, the numbers landed increased by $\approx$ 6 and the numbers discarded by $\approx$ 23 (Figure 3). Peak values in the numbers landed and discarded per day were recorded towards the end of the September voyage, with figures of $\approx 40\ 10^3$ and $\approx 60\ 10^3$ respectively.

Size compositions of landings and discards

The averaged length frequency distributions of the landings and the discards (all "data sets" combined, males and females separately), are shown in Figures 4 and 5 for the June voyage, and in Figures 6 and 7 for the September voyage.

Fishermen's selection

The fishermen's selection curves (giving the proportions of *Nephrops* retained by the crew, to be landed either whole or as tails) for males and females separately, are plotted in Figures 8-15 for the June voyage, and in Figures 16-23 for the September voyage. The curves which best fitted the observed retention rates are shown as bold, solid lines ; alternatives, which gave a more or less equally good fit, as thin, solid lines ; the others as dashed lines. The parameters α and ß, and the L_{50}'s are summarized in Tables 3 (June voyage) and 4 (September voyage).

In general, fishermen's selection on male *Nephrops* was much sharper than on females. The selection curves for the males are much steeper than those for the females, especially between the lengths at 50 % and 100 % retention. In most cases, selection on the males could be best described by means of a symmetrical Logit or Probit curve, whereas an asymmetrical Log Log curve usually gave the best fit for the females.

There are several reasons for these differences in selection pattern. During the June voyage, large numbers of females were in a soft condition, and discarding was often considerable, especially on the largest animals (Figures 12-15). During the September voyage, however, discarding was closely related to the reproductive stage of the females. Large females with fully developed, dark green ovaries are claimed to have a very short shelflife, even when kept on ice, and therefore many of them were discarded.

The fishermen's selection curves for all "data sets" are compared in Figures 24 (males) and 25 (females).

These figures reveal a marked consistency in discarding practice throughout each of the two voyages (particularly for the males), and a clear difference in discarding practice between the two voyages (for both males and females). In June, when the quantities of *Nephrops* taken were small, the L_{50}'s for both males and females were around 28 mm CL (i.e. only 3 mm above the legal minimum landing size of 25 mm CL). In September, however, when the catches were much larger, the selection curves clearly shifted to the right, and the L_{50}'s increased by about 5 mm, to values between 32 and 34 mm CL (Figures 24 and 25 ; Tables 3 and 4).

Discard survival

The size distribution of the *Nephrops* used in the survival experiments (all experiments combined - see text table below) was very close to the size distribution of the discards as a whole (Figures 6 and 7).

Size class	No. of animals
≤ 20 mm	17
21-25 mm	55
26-30 mm	286
31-35 mm	132
36-40 mm	10
Total no.	500

In terms of size distribution, the animals in the experiments can therefore be considered as a fairly representative sample of the discards.

At the end of the experiments (i.e. after 1 hour re-immersion in seawater), 257 or 51.4 % of the animals were still alive, 77 or 15.4 % were considered as being in poor condition, and 166 or 33.2 % as being moribund or dead (Figure 26 and Table 5). The percentages of live animals at the end of individual

experiments ranged from 30 to 64 % (mostly 50-60 %) ; the percentages of moribund and dead animals from 16 to 48 % (mostly 30-45 %) (Table 5).

There is a clear relationship between discard mortality and the type of damage sustained during the catching and sorting process. The highest proportions of "survivors" (conditions alive and "poor" combined) were found amongst the undamaged animals (≈ 82 %), and the lowest proportions (≈ 16 %) amongst the animals whose carapace and/or abdomen was damaged (Figure 27).

A tentative estimation of the long-term survival rate of the discards (based on the assumption that none of the damaged animals, and none of the animals which were in a poor condition would eventually survive), gave a value of about 40 % (Figure 26).

DISCUSSION

Size compositions of landings and discards ; fishermen's selection

In the absence of data on the discarding practices on other *Nephrops* trawlers, it is difficult to speculate on how the results of the present study compare to the situation in the Belgian *Nephrops* fishery as a whole.

Discarding practices and fishermen's selection are clearly influenced by a multitude of factors, such as catch rates, market demand and the acceptability of "small" *Nephrops* (say < 35 mm CL) to the market (as reflected by the auction prices paid for "small" and "medium" sized *Nephrops*). Circumstantial evidence (obtained from length composition data on the landings of other Belgian *Nephrops* trawlers, and from informative talks with their skippers) suggests, however, that the differences in discarding practise between vessels operating in the Botney Gut - Silver Pit area are rather small.

The "liberal" discarding practices on the Belgian *Nephrops* trawlers (with sometimes considerable proportions of *Nephrops* above the MLS being returned to the sea), make that the quantities of *Nephrops* discarded can be very large, especially during the peak season of the fishery. Since the survival of the discards is generally rather low (see next section), the absolute numbers of *Nephrops* being removed from the population as a consequence of discard mortality, can be expected to be large too.

Even when the catch rates were low, such as during the June voyage, compliance with the legal minimum landing size (25 mm CL) was acceptable. The numbers of *Nephrops* < 25 mm CL retained were small, and there were no indications that retention was intentional. The work-load on *Nephrops* trawlers

can be substantial, particularly when the catches are excessive. Under these circumstances it is not surprising that size selection is not always perfect.

The findings on compliance with the minimum landing size are largely confirmed by the results of the ongoing *Nephrops* port sampling programme. There also, very small numbers only of *Nephrops* < 25 mm CL were found, viz. < 0.05 % of the landings in numbers (REDANT, unpublished data for the years 1992-93).

Discard survival

The short-term mortality rates of the *Nephrops* discards in this study are fairly similar to the ones obtained by other investigators. SIMPSON and SYMONDS (1968), who studied the survival of *Nephrops* discards on commercial trawlers in the Irish Sea, reported 33.4 % dead and 7.8 % moribund animals, after 1 hour re-immersion in seawater. EDWARDS and BENNETT (1980), who did similar survival experiments on a research vessel, albeit with much shorter hauls but under simulated commercial sorting conditions, reported 28.8 % deaths, also after 1 hour re-immersion. In the present study, the proportion of dead and moribund *Nephrops* after 1 hour re-immersion was 33.2 %, and the proportion of animals in poor condition 15.4 % (which gives 48.6 % for "poor", moribund and dead combined).

The findings on the critical effect of body damage on discard survival are in line with those from earlier studies (GUEGUEN and CHARUAU, 1975 ; EDWARDS and BENNETT, 1980). Experiments in the Irish Sea, for example, revealed that the survival of *Nephrops* discards (after 24 hours re-immersion in seawater) was highest (93 %) if the animals were undamaged. It became progressively worse as one, then two claws were lost, and was lowest (53 %) when the animals had sustained severe body damage (EDWARDS and BENNETT, 1980). A similar trend occurs in the results of the present study (Figure 27). For several reasons, however, the actual percentages of "survivors" in the two studies are not directly comparable. Haul duration in the Irish Sea experiments (1 hour) was much shorter than in the North Sea (3½ hours), which may have resulted in (much) lower immediate mortality rates. The experimental set-up too differed markedly and, on top of this, different criteria were used to assess the condition of the animals at the end of the experiments.

The tentative estimation of the long-term survival rate (viz. ≈ 40 %) is considerably higher than the value of ≈ 30 % reported for the long-term survival of *Nephrops* discards in the Bay of Biscay (GUEGUEN and CHARUAU, 1975 ; CHARUAU *et al.*, 1982), and than the figure of only 19 % reported for the Celtic Sea (CHARUAU *et al.*, 1982). The experiments in the Celtic Sea, however, were done at the peak of the moulting season, and this was taught to have caused the very low survival rates.

CHARUAU *et al.* (1982) also proposed "annualized" survival rates, taking the seasonal variations in (a) the quantities of *Nephrops* discarded, and (b) their survival rates into account. These were 30-40 % for the Bay of Biscay, and 20-50 % for the Celtic Sea.

For some time, the ICES *Nephrops* Working Group has been using a discard survival rate of 25 % (see e.g. ICES, 1994), which is clearly below the figures proposed by CHARUAU, *et al.* (1982), or the tentative estimate based on the results of the present study. The lower value was justified by several arguments, including the effect of predation on the discards just returned to the sea-bed, and the fact that discarding may take place away from the *Nephrops* grounds (in which case the chances for the discards to survive can be expected to be nil). The latter has been reported for a number of "near-shore" *Nephrops* fisheries, such as in the Scottish coastal waters and in some parts of the Irish Sea, where the vessels stay out for one or, at the most, two days, and where the catch of the last haul is being sorted while the vessels are returning to port. Fishing practices in the Botney Gut - Silver Pit area are, however, completely different : the vessels stay on the grounds for at least one week, and all discarding takes place on the *Nephrops* grounds. Therefore, the use of a higher discard survival rate may be more appropriate for this particular stock.

ACKNOWLEDGEMENTS

The authors thank the crew of the vessel which was engaged in this project for their most valuable cooperation, and Mr. E. Buyvoets, Mr. B. Demaerel and Mr. R. Focke for their technical assistance.

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Table 1 - Groupings of hauls into "data sets" of six hauls each, and numbers of Nephrops measured during the June voyage (17-29.06.1993)

Data set	Haul no.	Date	Hour at start	Landings whole		Landings tails		Discards	
				FS (*)	No.	FS (*)	No.	FS (*)	No.
Jun S1	3	18.06.93	16.30	1:1	361	1:1	105	2:4½	16
	5	19.06.93	0.30	1:2	247	1:2	178	1:4	68
	6	19.06.93	4.30	1:2	342	1:2	344	2:5½	158
	8	19.06.93	12.30	1:1	135	1:1	38	2:11½	9
	10	19.06.93	20.30	1:2	212	1:2	226	4:11½	101
	13	20.06.93	8.30	1:1	360	1:1	209	1:1	117
Jun S2	14	20.06.93	12.30	1:1	279	1:2	146	1:1	194
	16	20.06.93	20.30	1:1	191	1:1	167	4:5½	123
	18	21.06.93	4.30	1:3	333	1:5	210	1:7	210
	19	21.06.93	8.30	1:2	312	1:3	199	1:2½	251
	21	21.06.93	16.30	1:2	364	1:5	185	1:4	163
	23	22.06.93	0.30	1:1	232	1:1	97	4:5½	68
Jun S3 (**)	45	26.06.93	1.30	1:1	239	1:1	105	1:2	41
	47	26.06.93	11.00	1:1	39	1:1	27	1:2	23
	48	26.06.93	15.00	1:1	88	1:1	12	1:1½	17
	52	27.06.93	8.30	1:1	145	1:1	55	4:4½	38
	54	27.06.93	16.30	1:1	242	1:1	93	1:1½	35
	55	27.06.93	20.30	1:2	278	1:2	173	2:2½	84
	57	28.06.93	4.30	1:2	218	1:1	243	1:2	61

(*) FS : Fraction sampled.
(**) Hauls 47 and 48 were averaged, and then considered as being one haul.

Table 2 - Groupings of hauls into "data sets" of six hauls each, and numbers of Nephrops measured during the September voyage (28.08-09.09.1993)

Data set	Haul no.	Date	Hour at start	Landings whole		Landings tails		Discards	
				FS (*)	No.	FS (*)	No.	FS (*)	No.
Sep S1	21	01.09.93	14.15	1:2	227	1:6	251	1:9½	207
	23	02.09.93	22.30	1:4	383	1:6	283	1:24	301
	25	02.09.93	6.30	1:4	531	1:9	243	1:8	559
	26	02.09.93	10.30	1:3	300	1:3	382	1:6½	477
	28	02.09.93	18.30	1:8	288	1:6	301	1:6½	510
	30	03.09.93	2.30	1:3	362	1:3	245	2:3½	237
Sep S2	31	03.09.93	7.00	1:6	307	1:6	233	1:15½	433
	33	03.09.93	15.00	1:2	242	1:2	259	1:4½	203
	35	04.09.93	23.00	1:7½	300	1:6	293	1:10	485
	36	04.09.93	3.00	1:6	314	1:6	242	1:9½	421
	38	04.09.93	11.00	1:6	274	1:5¼	317	1:18	590
	40	04.09.93	19.00	1:6	291	1:6	218	1:11¼	425
Sep S3	44	05.09.93	11.00	1:7	440	1:8	254	1:21	610
	46	05.09.93	19.00	1:9	459	1:6	282	1:22	394
	48	06.09.93	3.00	1:5	462	1:7	231	1:12	400
	49	06.09.93	7.00	2:39	499	1:13	229	1:12½	1298
	51	06.09.93	15.00	2:31	442	1:10	264	1:27	450
	53	07.09.93	23.15	1:7½	261	1:4	234	1:16	339

(*) FS : Fraction sampled.

Table 3 - Fishermen's selection curves for Nephrops during the June voyage

Data set	Sex	Curve (*)	α	ß	L50
Jun S1	Males	*Logit*	*0.336*	*- 9.700*	*28.9*
		Probit	*0.219*	*- 6.304*	*28.9*
		C Log Log	*0.223*	*- 6.903*	*29.3*
		Log Log	**0.278**	**- 7.610**	**28.6**
Jun S2	Males	*Logit*	*0.442*	*-12.631*	*28.6*
		Probit	**0.300**	**- 8.631**	**28.8**
		C Log Log	*0.315*	*- 9.505*	*29.0*
		Log Log	*0.368*	*-10.040*	*28.3*
Jun S3	Males	*Logit*	*0.410*	*-11.763*	*28.7*
		Probit	0.316	- 9.112	28.8
		C Log Log	*0.319*	*- 9.729*	*29.3*
		Log Log	**0.335**	**- 9.137**	**28.3**
All sets combined	Males	Logit	0.393	-11.286	28.7
		Probit	*0.274*	*- 7.882*	*28.8*
		C Log Log	*0.287*	*- 8.748*	*29.2*
		Log Log	**0.321**	**- 8.750**	**28.4**
Jun S1	Females	*Logit*	*0.261*	*- 7.820*	*30.0*
		Probit	0.234	- 6.976	29.7
		C Log Log	*0.264*	*- 8.325*	*30.1*
		Log Log	**0.185**	**- 5.085**	**29.5**
Jun S2	Females	*Logit*	*0.328*	*- 9.369*	*28.6*
		Probit	**0.197**	**- 5.605**	**28.5**
		C Log Log	*0.238*	*- 7.244*	*28.9*
		Log Log	0.244	- 6.512	28.2
Jun S3	Females	Logit	0.311	- 9.064	29.1
		Probit	*0.216*	*- 6.266*	*29.1*
		C Log Log	*0.260*	*- 8.033*	*29.5*
		Log Log	**0.228**	**- 6.172**	**28.6**
All sets combined	Females	*Logit*	*0.307*	*- 8.840*	*28.8*
		Probit	*0.199*	*- 5.715*	*28.8*
		C Log Log	*0.237*	*- 7.273*	*29.1*
		Log Log	**0.224**	**- 6.016**	**28.4**

(*) Curves giving the best fit to the observed retention rates are shown in bold ; alternatives, giving a more or less equally good fit, in normal script ; and the others in italics.

Table 4 - Fishermen's selection curves for Nephrops during the September voyage

Data set	Sex	Curve	α	ß	L50
Sep S1	Males	**Logit**	**0.482**	**-15.627**	**32.4**
		Probit	*0.302*	*- 9.830*	*32.6*
		C Log Log	*0.351*	*-11.910*	*32.9*
		Log Log	*0.380*	*-11.824*	*32.1*
Sep S2	Males	*Logit*	*0.547*	*-18.255*	*33.4*
		Probit	**0.336**	**-11.203**	**33.3**
		C Log Log	*0.441*	*-15.219*	*33.7*
		Log Log	*0.404*	*-12.943*	*33.0*
Sep S3	Males	**Logit**	**0.558**	**-18.932**	**33.9**
		Probit	*0.364*	*-12.350*	*34.0*
		C Log Log	*0.436*	*-15.289*	*34.2*
		Log Log	*0.437*	*-14.289*	*33.6*
All sets combined	Males	**Logit**	**0.530**	**-17.692**	**33.4**
		Probit	*0.343*	*-11.475*	*33.5*
		C Log Log	*0.409*	*-14.166*	*33.8*
		Log Log	*0.413*	*-13.296*	*33.1*
Sep S1	Females	Logit	0.417	-13.591	32.6
		Probit	*0.271*	*- 8.785*	*32.4*
		C Log Log	*0.348*	*-11.781*	*32.8*
		Log Log	**0.293**	**- 9.046**	**32.1**
Sep S2	Females	Logit	0.522	-17.575	33.7
		Probit	*0.346*	*-11.578*	*33.5*
		C Log Log	*0.458*	*-15.830*	*33.8*
		Log Log	**0.362**	**-11.667**	**33.2**
Sep S3	Females	Logit	0.484	-16.435	34.0
		Probit	*0.318*	*-10.692*	*33.7*
		C Log Log	*0.449*	*-15.634*	*34.0*
		Log Log	**0.335**	**-10.822**	**33.4**
All sets combined	Females	Logit	0.469	-15.972	33.7
		Probit	*0.307*	*-10.263*	*33.4*
		C Log Log	*0.416*	*-14.398*	*33.7*
		Log Log	**0.327**	**-10.463**	**33.1**

(*) Curves giving the best fit to the observed retention rates are shown in bold ; alternatives, giving a more or less equally good fit, in normal script ; and the others in italics.

Table 5 - Results of the discard survival experiments : numbers alive, in poor condition, and moribund or dead, at the end of the experiments

Haul no.	Duration of exposure (*)	Alive		Condition "poor"		Moribund or dead	
		No.	%	No.	%	No.	%
35	1.00	26	*52*	11	*22*	13	*26*
36	1.00	15	*30*	11	*22*	24	*48*
44	1.00	21	*42*	6	*12*	23	*46*
46	1.45	32	*64*	10	*20*	8	*16*
48	2.00	27	*54*	7	*14*	16	*32*
49	1.15	26	*52*	8	*16*	16	*32*
49	2.30	28	*56*	6	*12*	16	*32*
51	0.30	25	*50*	6	*12*	19	*38*
51	1.45	29	*58*	11	*22*	10	*20*
53	1.30	28	*56*	1	*2*	21	*42*
All experiments		257	*51.4*	77	*15.4*	166	*33.2*

(*) Time lapse between end of haul and start of the survival experiments (in hours).

Figure 1

Catch sorting process on Belgian *Nephrops* trawlers

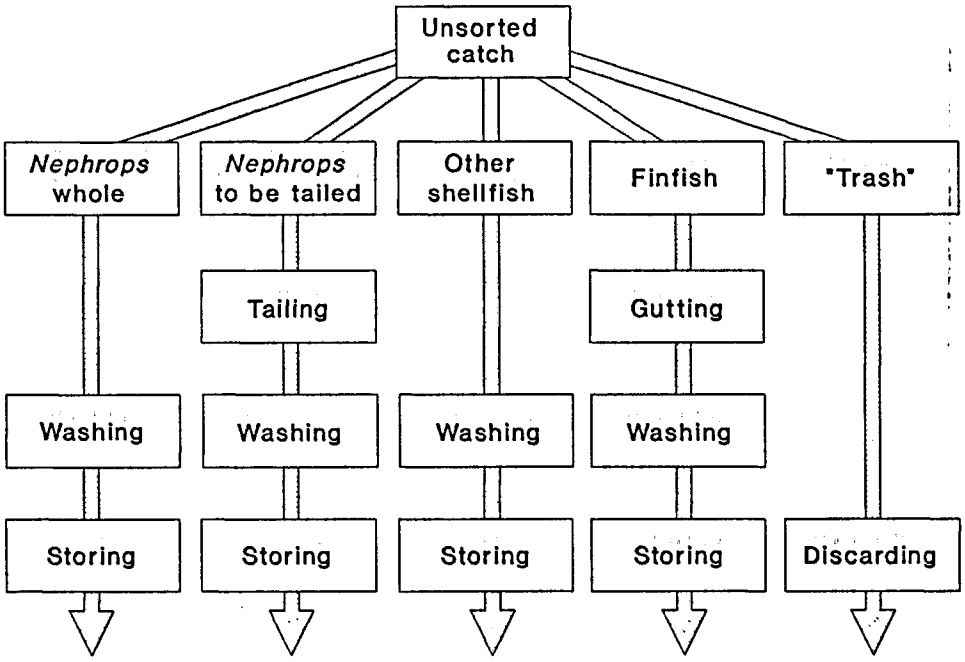


Figure 2

Nephrops : Numbers landed and
discarded per day
All "data sets" : Males + Females

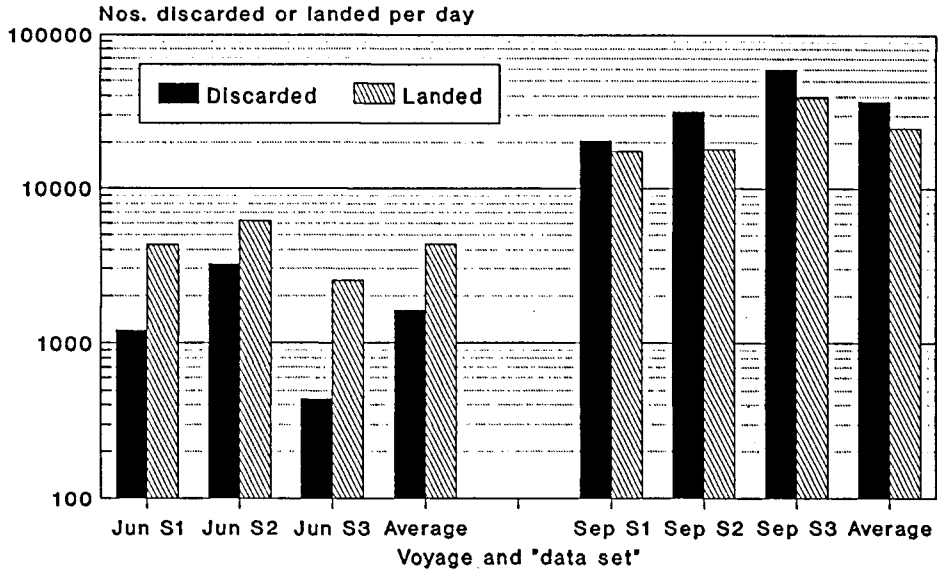
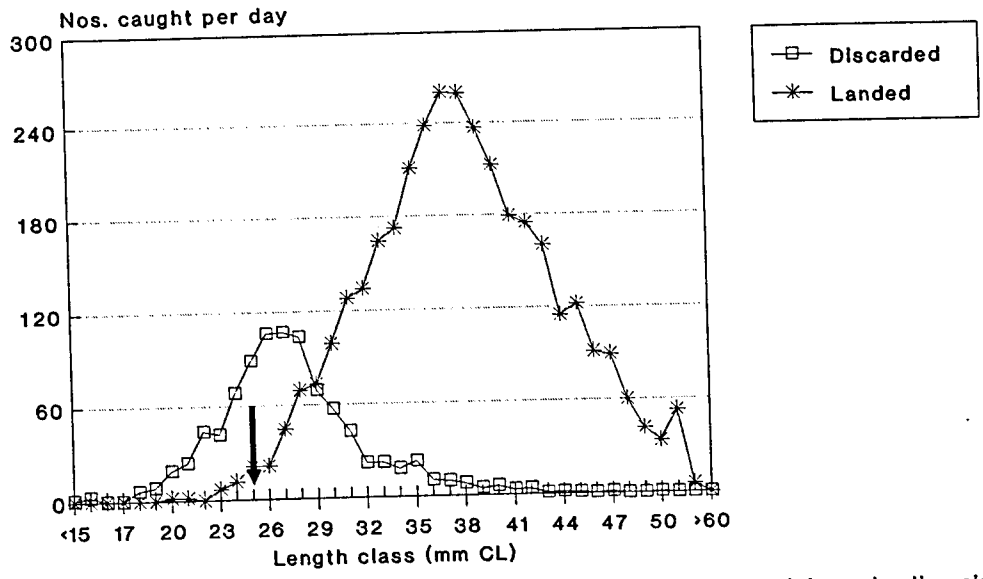


Figure 3

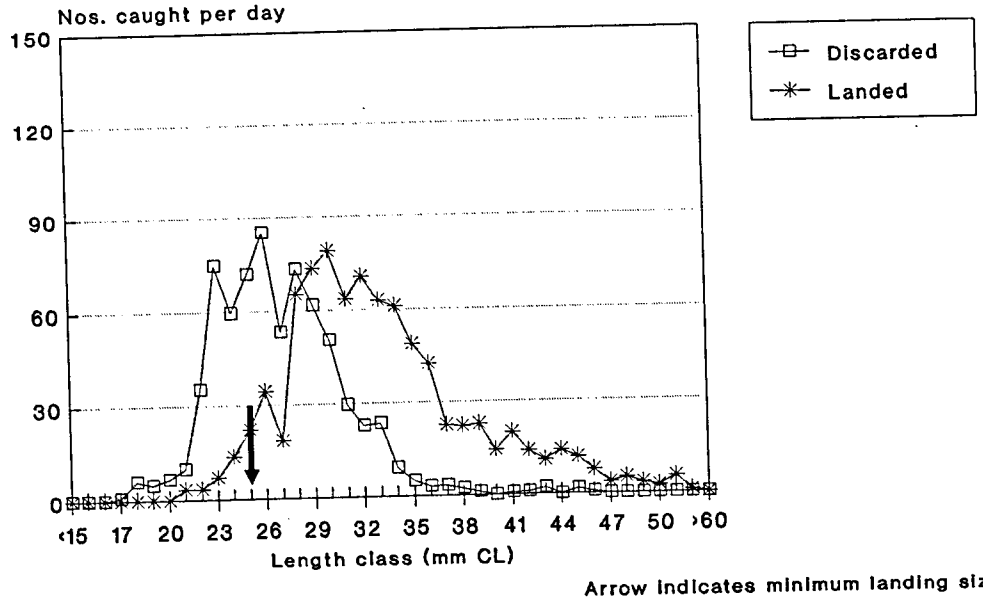
Nephrops : Size composition of landings and discards
June : All "data sets" : Males



Arrow indicates minimum landing size

Figure 4

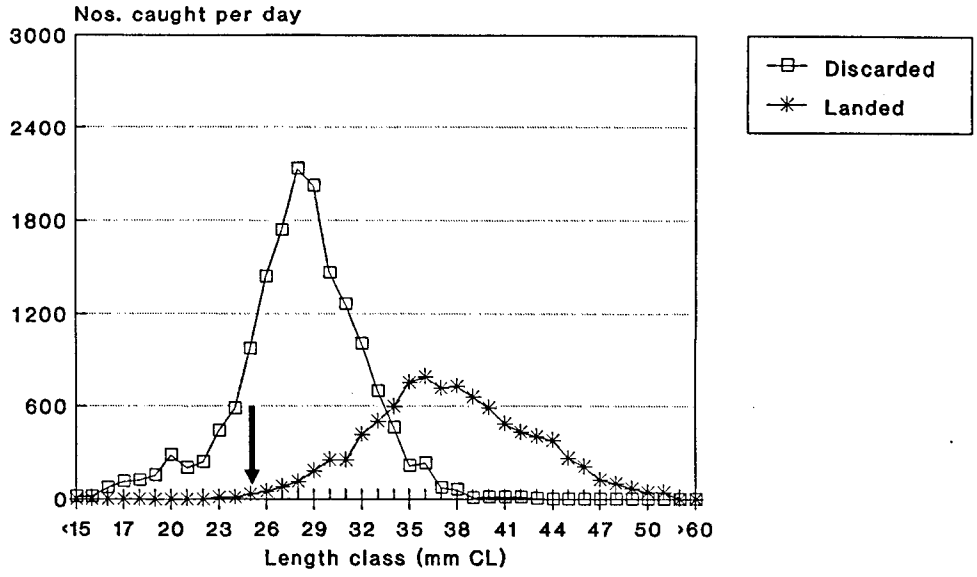
Nephrops : Size composition of landings and discards
June : All "data sets" : Females



Arrow indicates minimum landing size

Figure 5

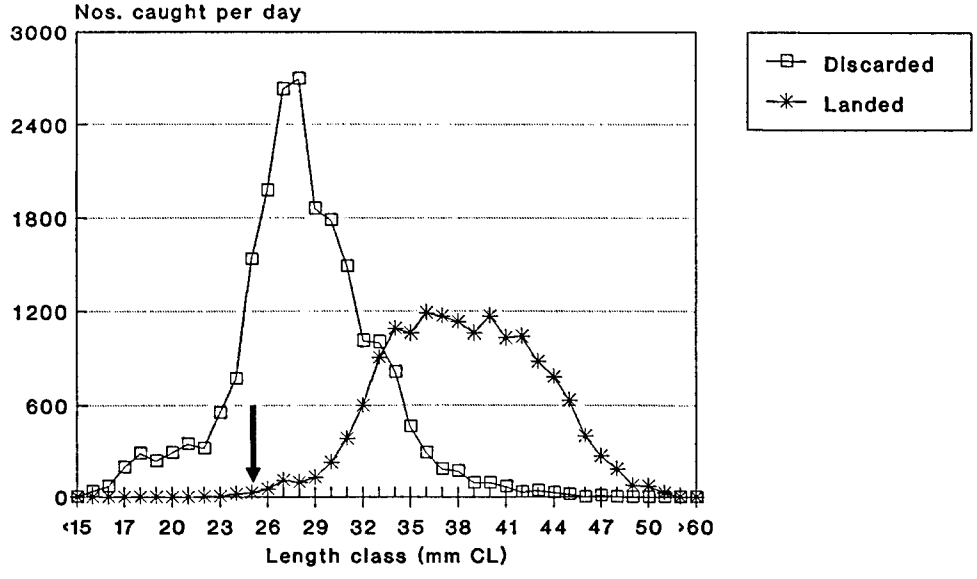
Nephrops : Size composition of
landings and discards
September : All "data sets" : Males



Arrow indicates minimum landing size

Figure 6

Nephrops : Size composition of
landings and discards
September : All "data sets" : Females



Arrow indicates minimum landing size

Figure 7

Nephrops : Fishermen's selection
June : Data set 1 : Males

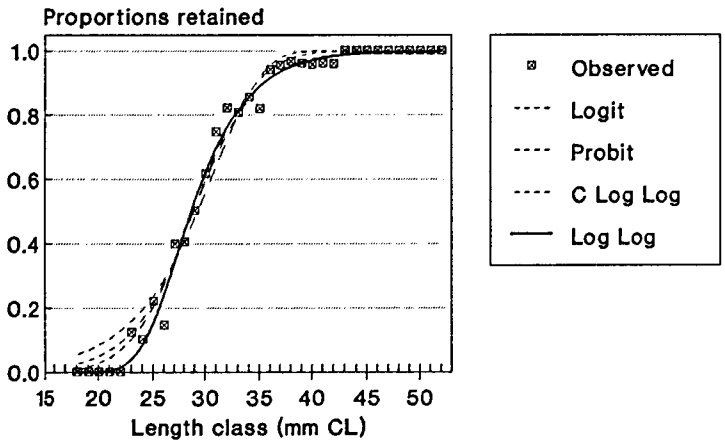


Figure 8

Nephrops : Fishermen's selection
June : Data set 2 : Males

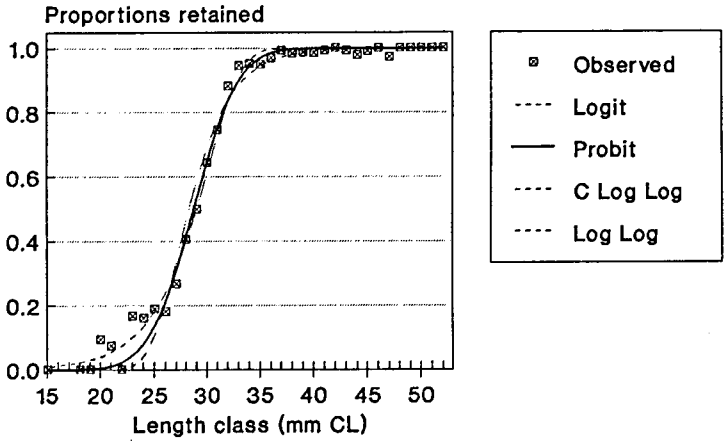


Figure 9

Nephrops : Fishermen's selection
June : Data set 3 : Males

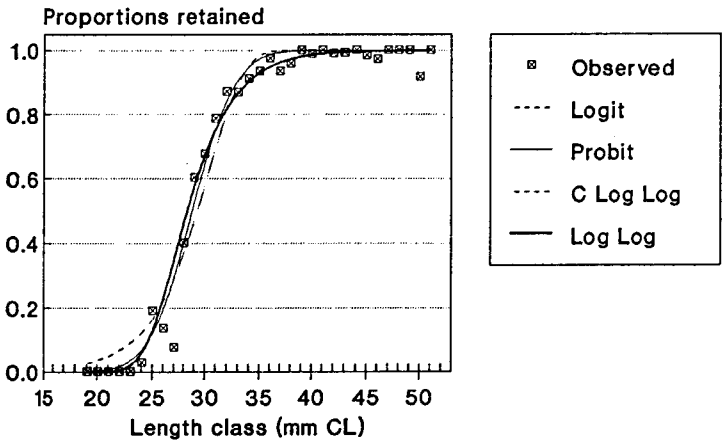


Figure 10

Nephrops : Fishermen's selection
June : All "data sets" : Males

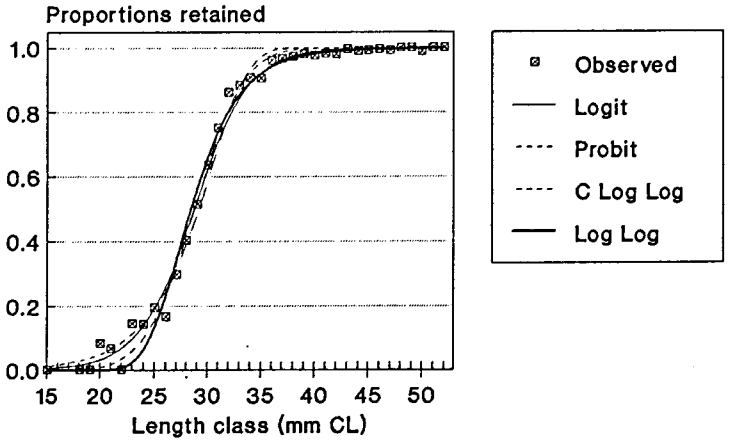


Figure 11

Nephrops : Fishermen's selection
June : Data set 1 : Females

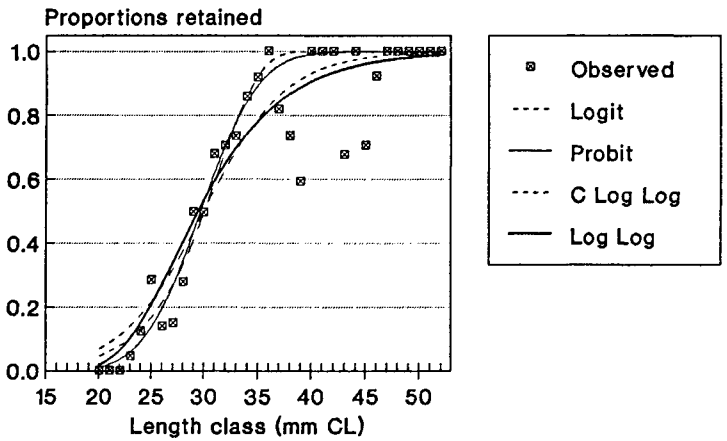


Figure 12

Nephrops : Fishermen's selection
June : Data set 2 : Females

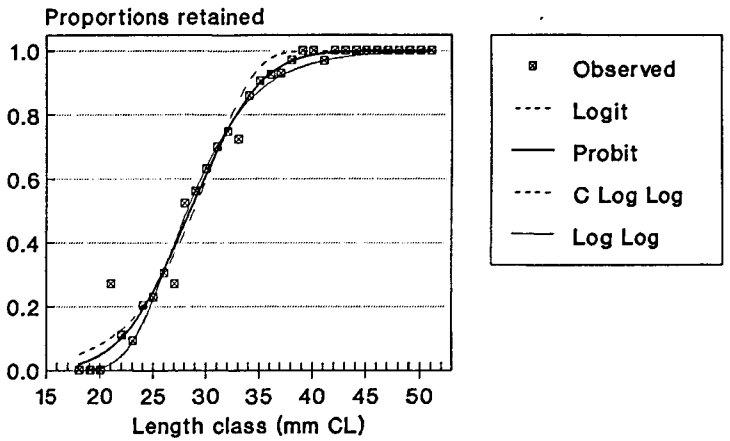


Figure 13

Nephrops : Fishermen's selection
June : Data set 3 : Females

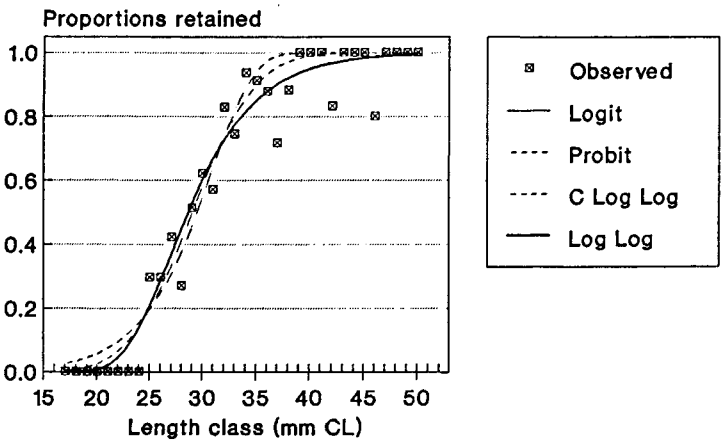


Figure 14

Nephrops : Fishermen's selection
June : All "data sets" : Females

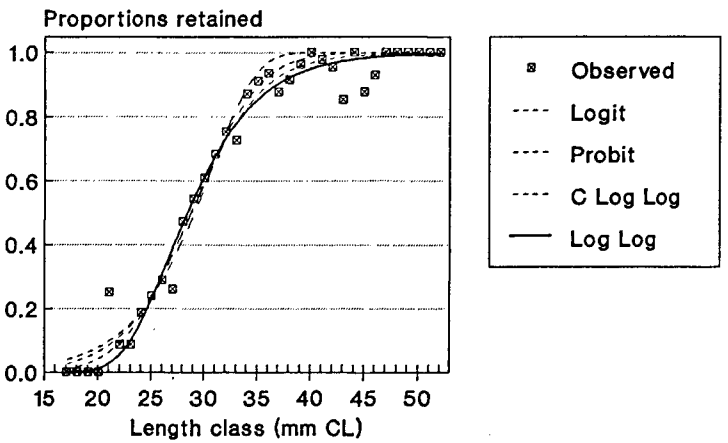


Figure 15

Nephrops : Fishermen's selection
September : Data set 1 : Males

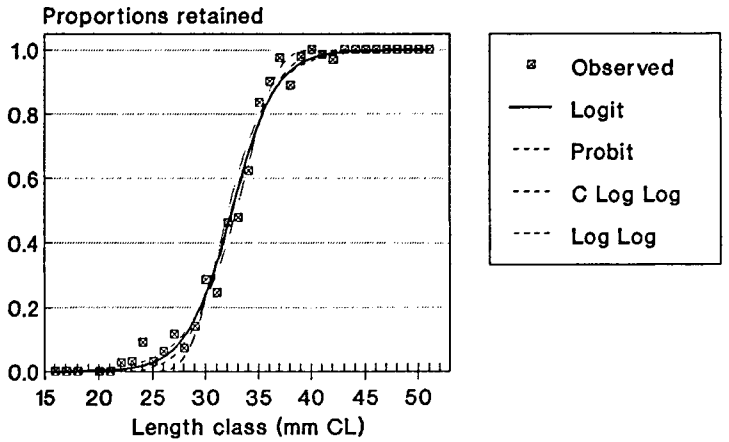


Figure 16

Nephrops : Fishermen's selection
September : Data set 2 : Males

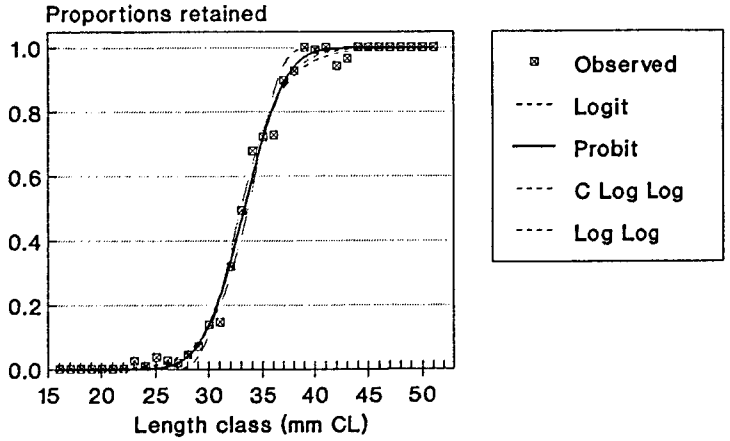


Figure 17

Nephrops : Fishermen's selection
September : Data set 3 : Males

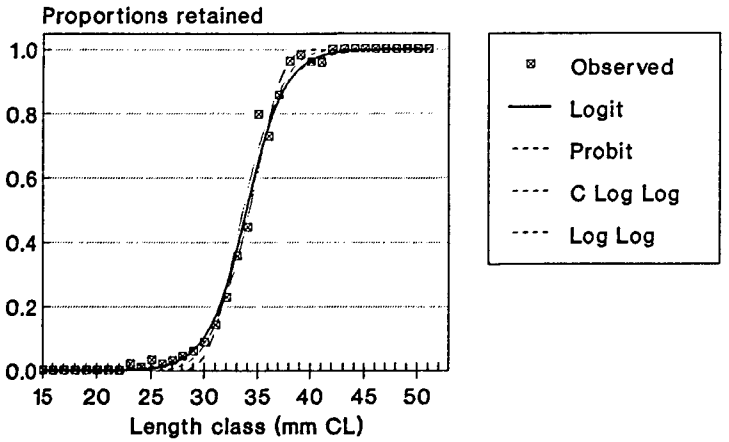


Figure 18

Nephrops : Fishermen's selection
September : All "data sets" : Males

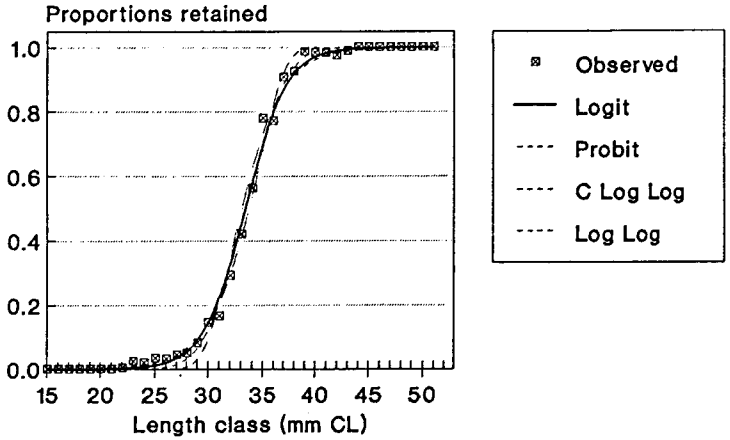


Figure 19

Nephrops : Fishermen's selection
September : Data set 1 : Females

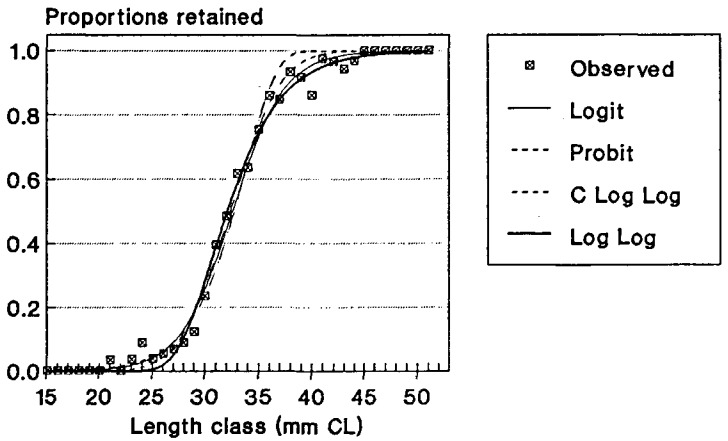


Figure 20

Nephrops : Fishermen's selection
September : Data set 2 : Females

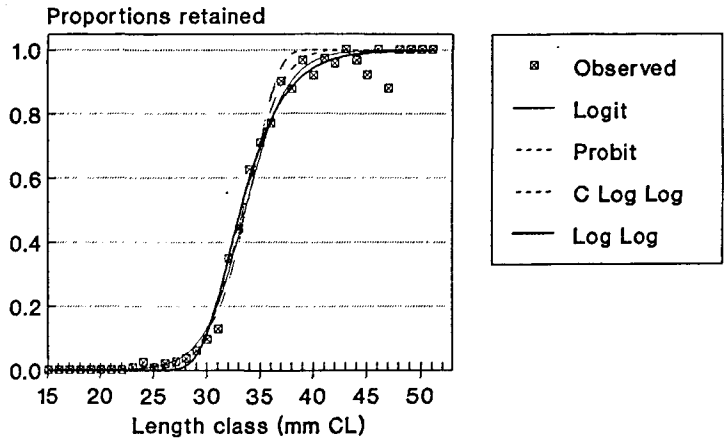


Figure 21

Nephrops : Fishermen's selection
September : Data set 3 : Females

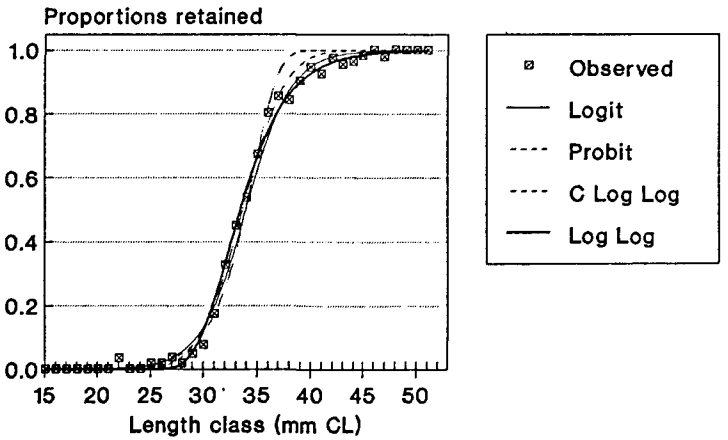


Figure 22

Nephrops : Fishermen's selection
September : All "data sets" : Females

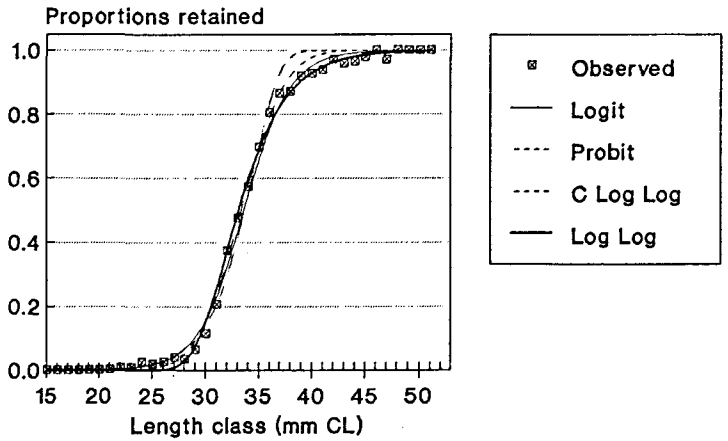
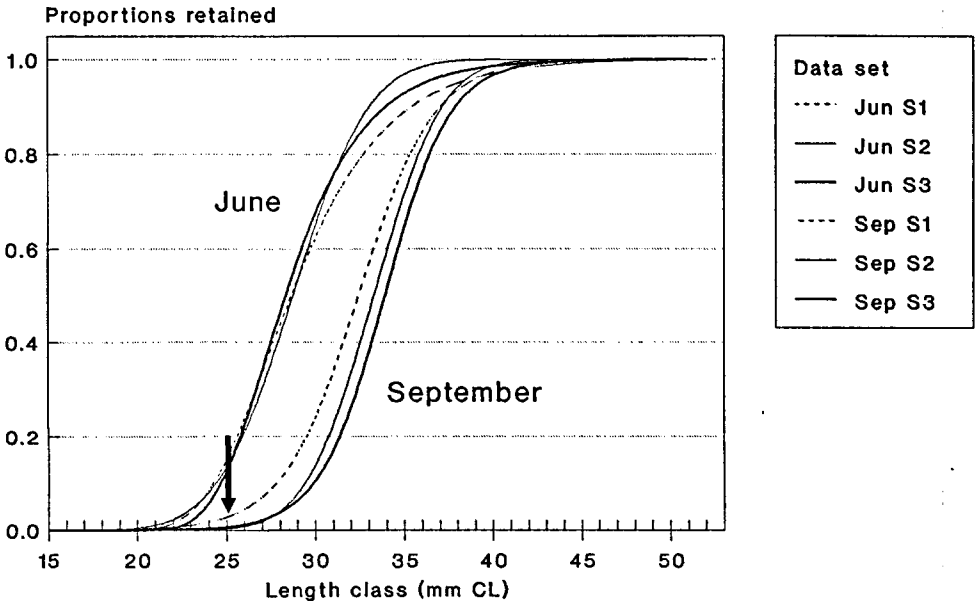


Figure 23

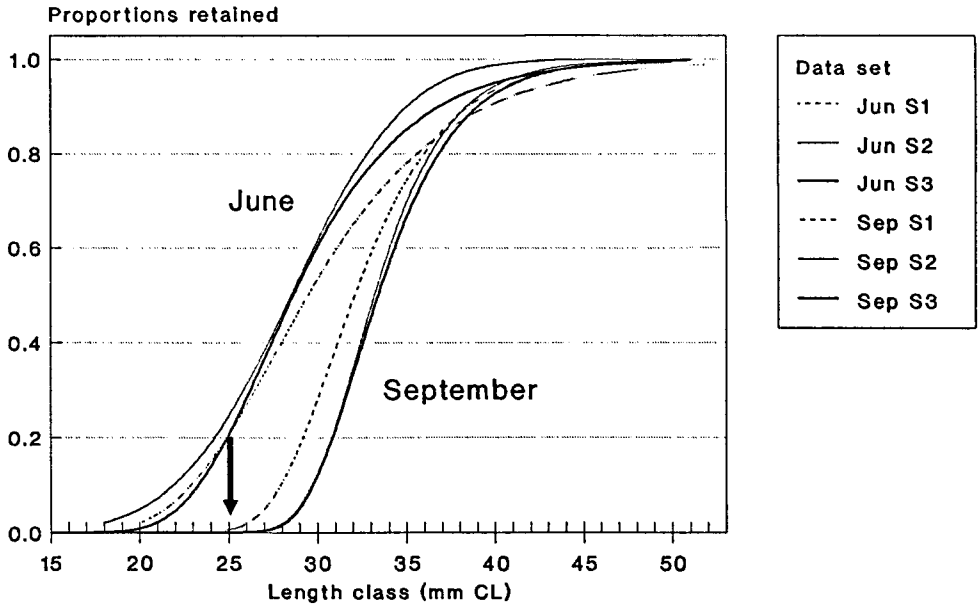
Nephrops : Fishermen's selection
Comparison June vs. September : Males



Arrow indicates minimum landing size

Figure 24

Nephrops : Fishermen's selection
Comparison June vs. September : Females



Arrow indicates minimum landing size

Figure 25

Nephrops : Discard survival experiments
Nos. of animals by "condition class" and
type of damage sustained

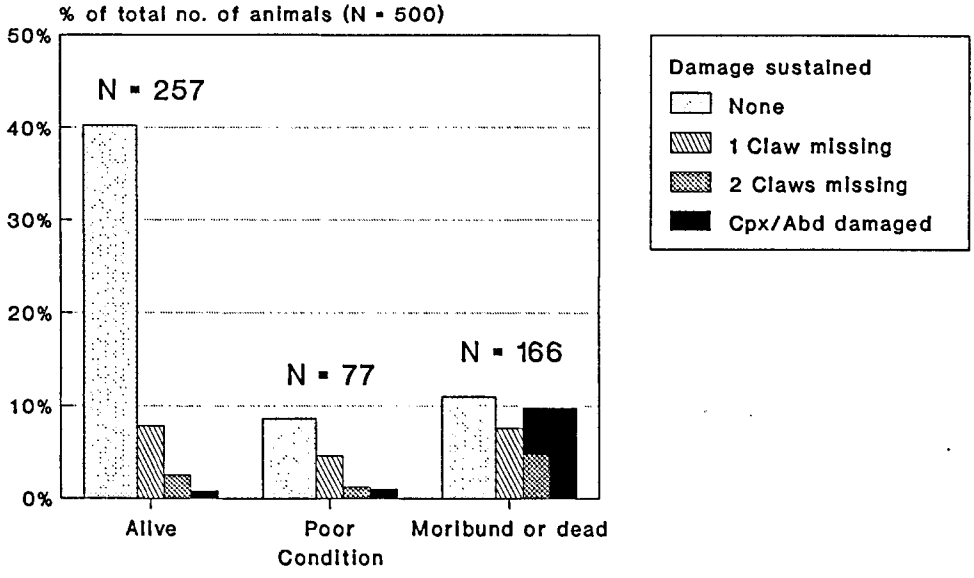


Figure 26

Nephrops : Discard survival experiments
Percentages alive, "poor", and moribund
or dead within each "damage class"

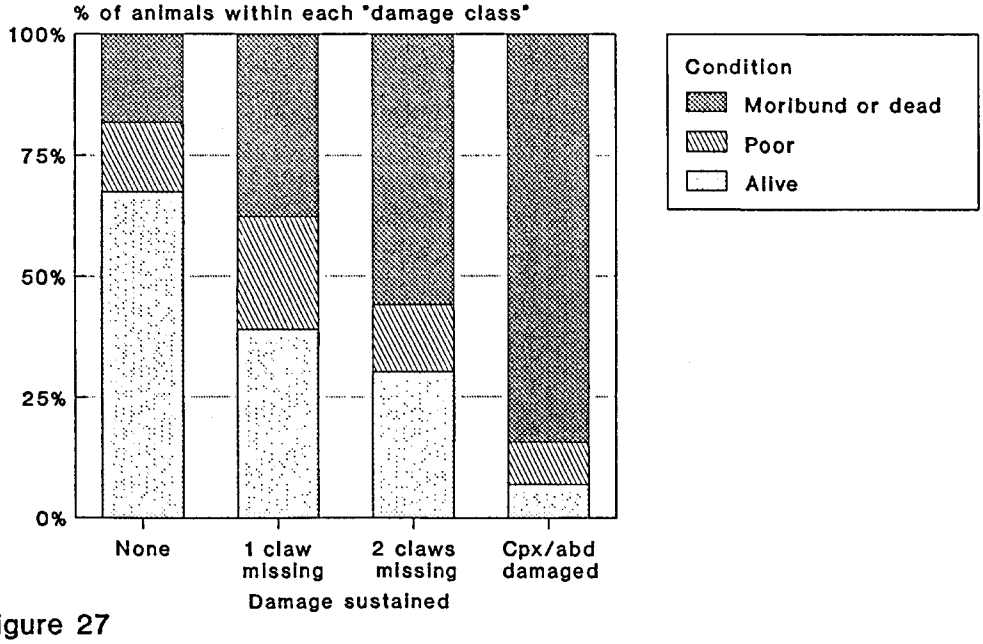


Figure 27