

# Appendix IID Survey report for RV Scotia 27 June -20 July 2003

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## 1. INTRODUCTION

### Background

This survey was developed from 1979 to 1983 and has been carried out annually since 1984 to provide estimates of adult herring in the Orkney Shetland area. The survey is designed to provide indices of abundance at age for herring.

### Objectives

- To conduct an acoustic survey to estimate the abundance and distribution of herring in the north western North Sea and north of Scotland between 58-61·45°N and 4°W to 2°E, Faroese waters.
- To Obtain echosounder trace identification using pelagic trawl and demersal trawl.
- To obtain samples of herring for biological analysis, including age, length, weight, sex, maturity and ichthyophonus infection
- To obtain samples of herring for genetic analysis for HERGEN.
- To obtain photographic records for fish maturity analysis.
- To obtain hydrographic data for comparison with the horizontal and vertical distribution of herring.
- To obtain plankton samples for acoustic identification work.

## 2. Survey Description and Methods

### 2.1 Staff

John Simmonds	Cruise Leader
Iain Penney	Fish Lab Technician 2nd half
Robert Watret	Fish Lab Technician 1st half
Phil Copland	Acoustic Technician
Marco Kienzle	Fisheries Biologist
Michael Stewart	Acoustic Technician 1st half
Owen Goudie	Fish Lab Technician
Angus Mair	Phd Student
Jose Xavier	BAS student
Norma Garcia-Nunez	MSc Student pt 1st half
Juan Zwalinowski	Phd Student pt 2nd half

### 2.2 Narrative

Scotia sailed at 1200 UTC on 27 June 2001 and made passage and anchored in Scapa Flow to calibrate the acoustic instruments on all scientific sounders. At 0730 Scotia left Scapa Flow and commenced survey at 1015 UTC at 59° 03' N 2° 37' W. The survey was carried out on east west transects on a 15n.mi. spacing progressing northwards between 2E, the Scottish mainland, and the Orkney and Shetland Islands from 0200 to 2200 UTC. The cruise track is given in Figure IID1. This section was chosen to be carried out first to coincide with FRV Tridens which also surveyed part of this area during these days After five transects were carried out Scotia steamed south overnight and surveyed the area between 58° N and 59° N, returning north to carry on the survey to the east of Shetland. Additional short transects were added into the survey in areas of expected higher herring abundance to the east of Shetland. Scotia broke off the survey at 2200 on 9 July FRV Scotia at 60°

41°N 1°30'E) and docked in Lerwick at 0700 UTC on 10 July for a mid cruise break. Scotia sailed again at 0700 UTC on 11 July and recommenced the survey at 60° 48'N 0° 44'W at 1245 BST. FRV Scotia continued the survey north to 61° 33'N and then progressed southwards to the west of Shetland carrying out 7.5 n.mi spaced transects west of Shetland. Scotia carried out an inter-ship comparison with FV Enterprise on 19 July in an area between 59° 30'N 4° 00'W and 60° 00'N 3° 20'W. FV Enterprise was carrying out an acoustic survey for herring to the west of Scotland. Scotia finished the survey at 0400 UTC on 20 July.(58° 43'N 3° 25'W). FRV Scotia then proceeded to Scappa Flow to carry out a second calibration of the acoustic instruments. FRV Scotia departed Scappa Flow following successful calibration of acoustic instruments at 1600 UTC and sailed to Aberdeen and docked at 0530 UTC on 21 July 2003.

### 2.3 Survey design

The survey track (Fig 1) was selected to cover the area in two levels of sampling intensity based on agreed boundaries to the east, west and south, and the limits of herring densities found in previous years to the north and north west. A transect spacing of 15 nautical miles was used in most parts of the area with the exception areas both east and west of Shetland where short additional transects were carried out at 7.5 n.mi. spacing. On the administrative boundaries of 2°E and 4°W the ends of the tracks were positioned at twice the track spacing from the area boundary, giving equal track length in any rectangle within the area. The between-track data was then included in the data analysis. Transects at shelf break were continued to the limits of the stock and the transect ends omitted from the analysis. Transects at the coast were continued as close inshore as practical, those on average less than half a transect spacing from the coast were excluded from the analysis, those at greater distance were included in the analysis. The origin of the survey grid was selected randomly within a 15 n.mi. interval the track was then laid out with systematic spacing from the random origin. Where the 7.5 n.mi. transect spacing was used the same random origin was used.

### 2.4 Calibration

Two calibrations were carried out in Scappa Flow on the transducer systems used during the survey one at the beginning of the survey on the night of 27/28 June and one at the end of the survey on 20 July. Standard sphere calibrations were carried using 38.1mm diameter tungsten carbide sphere for 18, 38 and 120kHz. A 36.4mm sphere was used for 200kHz. For the 38kHz agreement between this years calibration and the previous year was better than 0.2 dB. Agreement between the calibrations was better than 0.1dB. The calibration settings and results for 38kHz are given in Table IID1.

### 2.5 Acoustic data collection

The acoustic survey on FRV *Scotia* was carried out using a Simrad EK500 38 kHz sounder echo-integrator with transducer mounted on the drop keel. For most of the survey the keel was kept at 1m extension placing the transducer at 7m depth. Only during bad weather was the keel lowered to 3m extension with the transducer at 9m depth. Additional data was collected at 18 120 and 200kHz. Data was archived for further data analysis carried out using Echoview software and Marine Lab Analysis systems. Only data from 38,120 and 200kHz systems were used in the analysis. Data was collected from 0200 to 2200 UTC. Paper records were kept for acoustic data at 38. A total of 2,784 n.mi. were surveyed and included in the analysis.

### 2.6 Biological data - fishing trawls

Pelagic trawl hauls (positions shown in Fig 1) were carried out during the survey on the denser echo traces. The pelagic fishing gear used throughout the survey was PT160. The haul was monitored

using Simrad FS903 scanning netsonde and computer recordings of the hauls were archived to PC using screen capture software. Each haul was sampled for length, age, maturity and weight of individual herring. In addition weights of gonads and livers were also collected. Between 250 and 500 fish were measured at 0.5 cm intervals from each haul. Otoliths were collected with one per 0.5 cm class below 20.5 cm, three per 0.5cm class from 21-25.5cm and ten per 0.5 cm class for 26.0 cm and above. The same fish were sampled for whole weight, gonad weight, liver weight, sex, maturity, stomach contents and macroscopic evidence of Ichthyophonus infection. The maturity scale used in data collection was the Scottish 8 point scale.

Demersal trawls were carried out at 20 of the pelagic trawl locations immediately following the pelagic trawls on a reverse track. The trawl used throughout was the BT101 Monk trawl. In all but 2 demersal hauls all species were counted and measured, subsamples were taken on two hauls.

## 2.7 Hydrographic data

Surface temperature and salinity was collected throughout the survey. CTD stations were taken at each night location (2200hrs) and mini-logger recordings of temperature were taken at each haul location.

## 2.8 Data analysis

Data from the echo integrator were averaged over quarter hour periods (2.5 n.mi. at 10 knots). Echo integrator data was collected from 11 m below the surface (transducer at 7 m depth) to 0.5 m above the seabed, for most of the survey. The data were divided into seven categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output;

- 1)"herring traces",
- 2)"probably herring traces" and
- 3)"probably not herring traces" all below 50 m
- 4) shallow herring schools above 50 m,
- 5) shallow schools not herring above 50m,
- 6) mixture including herring blue whiting, and mackerel
- 7) mixture including herring and mackerel

To calculate integrator conversion factors the target strength of herring and for gadoid species in the mixture were estimated using the TS/length relationship recommended by the acoustic survey planning group (Anon, 1992):

$$\begin{aligned} TS &= 20\log_{10}L - 71.2 \text{ dB per individual for herring} \\ TS &= 20\log_{10}L - 67.5 \text{ dB per individual for all gadoid} \\ TS &= 20\log_{10}L - 84.9 \text{ dB per individual for mackerel} \end{aligned}$$

The weight of herring at length was determined by weighing individual fish from each pelagic trawl haul. Lengths were recorded by 0.5 cm intervals to the nearest 0.5 cm below.

To process the data for extraction of schools the variable computation method available in Echo View was used. The method used in 2001 was used again this year. Previously when processing by hand (2000 and before) a small 'background' value for scattered fish was removed from integrator layers with many fish schools. It was noted that fish schools appear consistently on 38,120 and 200kHz echograms while other features such as plankton may be strong on some frequencies and weak on others. The processing was

$$Sv_{used} = Sv_{38} * [Sv_{38} + Sv_{120} + Sv_{200} ** Blur > -170\text{dB}]$$

Where Blur is a convolution matrix

[ 1 2 1  
 2 1 2  
 1 2 1]

The Blur convolution filter is chosen as a suitable smoothing function as previous experiences suggests it is well suited to the types of amplitude distributions expected from echoes from fish aggregations. It provides a smoother spatial filter for filling in values in a school than either a centered weighted or uniform averaging filters.

Data are allocated to quarter statistical rectangles by their mid point location, the estimate of density is obtained as the arithmetic mean of all values weighted by duration of the run to accommodate the small number of short ESDUs.

Biological information in post stratified method based on kolmogorof Smirnov test (see MacLennan and Simmonds 1992). The length frequency data is given in Table IID4.

The mixed species categories were apportioned using the catches in the local area. For the gadoid mixtures hauls 245 and 257 were used individually to give numbers by species. For mackerel herring mixture to the west of Shetland catches from hauls 287, 288 and 289 were combined. These mixtures contribute less than 2% to the total estimate of herring.

### 3. RESULTS

#### 3.1 Acoustic data

The distribution of NASC values along the cruise track is shown in Figure IID2. The herring are distributed more evenly in 2002 than in 2001 the largest single 2.5n.mi. ESDU contributes only 4% of the population estimate from FRV Scotia.

#### 3.2 Biological data

A total of 40 pelagic trawl hauls were carried out (Fig 1), the locations, dates and time of these are shown in Table IID2. All 40 hauls had significant numbers of herring were used to define eight herring survey sub areas (Fig 3). Table IID3 shows the total catch by species. The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table IID4. The spatial distribution of mean length is shown in Figure IID3. A total of 3,294 otoliths were taken to establish 8 age length keys, one per area, the total number of otoliths taken by length and age is given in Table IID6. There is again evidence of only very small amounts of ichthyophonous in the population. This was similar to last year. Only 6 herring from 3,294 herring sampled were found to show macroscopic evidence of infection. From these numbers its not possible to infer age or size of the infected fish. The stratified weight at length data was used to define the weight-length relationship for herring, which was:

$$W = 2.024 \cdot 10^{-3} L^{3.465} \text{ g (L measured in cm)}$$

The proportions of mature 2 ring and 3 ring herring were initially estimated at 47% and 83% respectively. This is a very different proportion for both 2 ring and 3 ring mature to those found in 2001 and 2002 (2wr 88% 3wr 96%). The differences were investigated. The herring found in the North West (analysis areas I, II, III, VII and VIII in Figure IID3) are similar to those found throughout the area in 2001 and 2002. Those found in the South East (analysis areas IV, V and VI) are different. The proportions mature can be seen in Figure IID4 for the three years and for the two sections of the area in 2003. The mean length of 2 and 3wr herring in the different stages of maturity was also investigated (Figure IID5). Immature herring at 2 and 3wr are a similar size in the

three years and the two parts of the area in 2003. Mature herring at 2wr are larger than immature herring and similar among years but may be smaller in the South East. Mature 3wr herring are a similar size in all years though larger 3wr herring are found in the North West. The abundance of immature 2wr herring is relatively greater in 2003 than previous years leading to a smaller less mature population in the area. On average 2wr herring are 1.3cm smaller in 2003 than in 2001 or 2003. In addition the maturity ogive is to be slightly higher in 2003 by about 0.4cm (Figure IID6). Further investigation of the maturity ogive suggested that there may be some difference in interpretation of maturity stage. The maturity staging was investigated further. The weight of gonads by maturity stage were compared for the last 3 years. Cumulative distributions of gonad weight are shown in Figure IID6 for 2001,2&3 at stage 2 and 3. 2003 is shown as having both the heaviest immature gonads and the lightest mature ones. This suggests delayed development but also the possibility that some maturing gonad might have been classed as immature. The results from 2001&2 suggest a number of weight and fish length criteria.

- no mature gonads weighed more than 3g

- the 50% mature point occurred at gonad weight of 1.0g

- the 50% mature point occurred at fish length of 23.0cm

These criteria developed from earlier years were compared in the NW and SE parts of the area through the maturity ogive. The outcome is shown in Figure IID7. The NW part of the area is relatively unaffected by the change in method. However, the SE area is rather sensitive to the choice. The high gonad weights seen in data from 2003 were thought to be potentially incorrect and it was decided to use the value of 1g derived from 2001/2 data. This results in fractions mature of 0.65 and 0.93% respectively.

Thus there is a suggestion that the 2000 yearclass has grown more slowly and is maturing later than earlier yearclasses. In contrast, the 1999 yearclass has grown at the same rate and mean weights are higher those from the 1997 and 98 yearclasses. The change in fraction mature is due primarily to a shift in overall growth.

### 3.3 Biomass and Abundance estimates

The numbers and biomass of fish by quarter ICES statistical rectangle are shown in Figure IID7. A total estimate of 16,210 million herring or 2,504 thousand tonnes was calculated for the survey area. 2,275 thousand tonnes of these were mature. Herring were found mostly in water with the seabed deeper than 100 m, with traces being found in waters with depths of up to 200 m. The survey was continued to 250 m depth for most of the western edge between 0E and 4EW. Herring were generally found in similar water depths and location to 2001 however, the distributions were slightly more northerly with more herring found east of Shetland. The proportion of 4 ring herring was much higher than last year, rising from 16% of the total 2+ biomass in 2001 to 35% in 2002, this yearclass now dominates the adult population. The incoming 2000 yearclass contributes 24% but as only 60% by weight is mature this will be an important yearclass. The fish traces were continuous in character similar to previous years mixed in size but in most case quite separate from other species. Table IID6 shows the estimated herring numbers mean lengths weights and biomass and proportion mature at age 2 & 3 ring by age class.

In addition to the 2,504 thousand tonnes of herring, approximately 400 thousand tonnes of other fish species were observed in mid water in similar depths and conditions. Examination of the catch by species (Table IID1) shows that the numbers of fish species other than herring caught in pelagic hauls were very small and very variable indicating the difficulty of allocating this component among these species so this has not been attempted. The dominant species other than herring must be considered to be blue whiting, mackerel with some Norway pout. For the second time no cod

were caught as bycatch in any of the pelagic hauls. Though some were caught in demersal hauls The survey indicates that the overall biomass is similar to last year with 4 and 2 ring herring dominating.

### 3.4 Ichthyophonous Infection

Only 6 out of 3,294 fish examined for macroscopic evidence of ichthyophonous infection were found to contain this.

**Table IID1.** Simrad EK500 38 kHz system and analysis settings used on the Scotia herring acoustic survey 27/6-20/7/2003.

<b>Transceiver Menu</b>	
Frequency	38 kHz
Sound speed	1490 m.s <sup>-1</sup>
Max. Power	2000 W
Equivalent two-way beam angle	-21.0 dB
Default Transducer Sv gain	26.67dB
3 dB Beamwidth	7.1°
<b>Calibration details</b>	
TS of sphere	-42.36 dB
Range to sphere in calibration	9.94
Measured NASC value for calibration	3150
Calibration factor for NASCs	0.934
Calibration constant for MILAP (optional)	0.93 at -35 dB
<b>Log Menu</b>	
Simulated	2.5 n.mi. at 10 knots
<b>Operation Menu</b>	
Ping interval	1.5 s at 250 m range 2.5 at 500 m range
<b>Analysis settings</b>	
Bottom margin (backstep)	0.5 m
Integration start (absolute) depth	11 m
Range of thresholds used	-70 dB on 38 -170 on combined blurred 38,120,200

**Table IID2.** Details of the fishing trawls taken during the Scotia herring acoustic survey, 27/6-20/7/2003: No. = trawl number; Trawl depth = depth (m) of headrope \*if net is on bottom; Gear type P=pelagic, D=demersal, O=other; Duration of trawl (minutes); Total catch in kg Use: h=used to qualify herring acoustic data, s= used to qualify sprat acoustic data (blank if neither).

No	Date	Postion	time (UTC)	Water Depth	Trawl Depth	Gear Type	Duration (min)	Total Kg
267	28/6	59 03.31N 001 57.14W	1332	76	66*	P	46	120
268	/	foul haul						
269	29/6	59 03.15N 000 11.13W	0319	132	122*	P	132	900
270	29/6	59 03.11N 000 04.82W	0500	144	134*	P	144	600
271	29/6	59 04.79N 000 08.02W	0630	142	140*	B	142	300
272	29/6	59 18.19N 000 29.57E	1851	132	122*	P	132	750
273	29/6	59 17.96N 000 30.74E	2040	130	128*	B	130	120
274	30/6	59 18.05N 000 34.70W	0522	126	116*	P	126	60
275	30/6	59 17.85N 001 30.65W	0903	99	89*	P	99	1500
276	30/6	59 17.74N 001 30.54W	1113	120	118*	B	120	300
277	1/7	59 33.07N 001 11.12W	0439	105	95*	P	105	180
278	1/7	59 33.18N 001 15.60W	0604	115	113*	B	115	240
279	1/7	59 33.03N 000 03.91W	1023	138	128*	P	138	1800
280	1/7	59 32.87N 000 08.12W	1213	140	138*	B	140	160
281	2/7	59 48.47N 000 06.21W	0528	130	120*	P	130	750
282	2/7	59 48.47N 000 49.78W	0922	127	117*	P	127	750
283	2/7	59 47.87N 000 46.84W	1057	127	125*	B	127	136
284	2/7	59 54.90N 000 41.08W	1459	125	115*	P	125	2400
285	3/7	58 47.85N 000 00.61E	0937	140	130*	P	140	750
286	3/7	58 48.00N 000 09.56E	1202	135	133*	B	135	170
287	3/7	58 47.81N 000 52.20W	1557	125	115*	P	125	300
288	4/7	58 03.36N 000 15.92W	1211	125	115*	P	125	2400
289	5/7	58 19.03N 000 18.13E	0606	145	135*	P	145	900
290	5/7	58 18.52N 000 18.51E	0754	145	143*	B	145	165
291	6/7	58 32.95N 000 22.01W	1000	115	105*	P	115	150
292	6/7	58 33.37N 000 16.23W	1156	120	118*	B	120	124
293	6/7	58 33.14N 000 41.42E	1551	150	148*	B	150	139
294	7/7	60 03.11N 000 19.49W	1044	115	105*	P	115	3600
295	7/7	60 10.97N 000 33.58E	1944	145	135*	P	145	450
296	7/7	60 10.90N 000 34.98E	2048	130	128*	B	130	60
297	8/7	60 23.81N 000 44.87E	0426	146	136*	P	146	1200
298	8/7	60 18.02N 000 05.53E	1350	155	145*	P	155	930
299	9/7	60 32.83N 000 07.38E	0615	125	115*	P	125	360
300	9/7	60 32.84N 000 10.51E	0800	127	125*	B	127	75
301	9/7	60 41.03N 000 41.61W	1240	98	88*	P	98	600
302	9/7	60 40.99N 000 32.14W	1416	125	115*	P	125	2400
303	9/7	60 40.94N 000 35.43W	1555	125	123*	B	125	60
304	11/7	60 47.96N 000 32.52W	1247	111	101*	P	111	1050
305	12/7	61 17.98N 000 09.85W	1207	167	157*	P	167	300
306	12/7	61 18.27N 000 12.97W	1344	167	165*	B	167	105
307	12/7	61 18.05N 000 49.65E	1838	162	152*	P	162	3000
308	12/7	61 18.02N 000 42.18E	1914	162	160*	B	162	420
309	13/7	61 32.95N 001 11.46E	0535	184	174*	P	184	1020
310	13/7	61 32.89N 000 32.88E	0919	195	185*	P	195	2100
311	13/7	61 32.88N 000 46.88W	1509	202	200*	B	202	510
312	13/7	61 32.82N 000 47.44W	1701	202	192*	P	202	450
313	14/7	60 48.82N 002 03.63W	0821	122	112*	P	122	195
314	15/7	60 26.04N 002 02.26W	0552	109	99*	P	109	1200
315	15/7	60 26.15N 001 54.77W	0730	120	118*	B	120	70
316	15/7	60 17.94N 003 34.32W	1528	130	128*	B	130	60
317	15/7	60 17.95N 003 39.15W	1728	130	120*	P	130	450
318	16/7	60 11.33N 002 20.71W	0657	120	110*	P	120	1800
319	16/7	60 10.99N 002 14.20W	0838	120	118*	B	120	105
320	16/7	60 02.87N 003 30.51W	1503	135	125*	P	135	2700
321	16/7	60 03.11N 003 35.15W	1659	135	133*	B	135	480
322	17/7	60 03.01N 004 32.57W	0400	130	120*	P	130	600
323	17/7	59 48.11N 001 41.49W	0833	115	105*	P	115	1200
324	17/7	59 55.00N 003 38.95W	1920	146	136*	P	146	900
325	17/7	59 55.03N 003 43.50W	2035	145	143*	B	145	60
326	18/7	59 40.85N 003 25.78W	0600	145	135*	P	145	300
327	18/7	59 33.04N 003 51.84W	0953	164	154*	P	164	300
328	18/7	59 32.82N 003 55.20W	1152	150	148*	B	150	60





**Table 3(cont.)** Total catch in number by species for trawl hauls from the Scotia acoustic survey 27/6 – 20/7/2003. Estimated total catch is given in kg

Haul No	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290
Est catch (Kgs)	120	FOUL	900	600	300	750	120	60	1500	300	180	240	1800	160	750	750	136	2400	750	170	300	2400	900	165
Herring	1336		6615	4740	240	4913	51	497	14300	31	1578	16	12120	357	4250	5975	1	19361	5767	257	3120	30480	6900	96
Mackerel			75				1	1	300	5		6		9			2							2
Sprat																								
Cod							1			6		3		5			4			1				2
Saithe					172		26			4		8		22	12		6			16				53
Blue Whiting										3							1							1
Norway Pout					308	12	404			288		690		985			78			1348				504
Poor Cod										20		5					4							
Gadiculus														3						3				1
Greater Argentine										5		5												
Lesser Argentine										18		63		1			5			1				
Haddock	4				270		69	11		375		467		35			252			147				86
Whiting					53	12	64	1		637		301		61			63			60	20			43
Hake										7		1		1			1							
Ling														1			2							
Scad										3							7							
Lythe																								
Cuckoo ray														1										
Starry ray														1										
4 Beard Rockling																								
C.Lyra										3														
Imperial Scaldfish										2														
Angler	4									5														
Norway haddock																	22							
Bluemouth																								
Greater Forkbeard																								
L.Spotted Dogfish												1					1							
Grey Gurnard								35		184		33					9							
Red Gurnard																								
Megrim																								
Plaice										47		23												
Lemon Sole										47		46		2										
Witch					2																			
Common Dab					2					198		30		1			5			1				
Long Rough Dab					17		16			9		8					2			7				12
Nephrops							57																	1
Ommastrephids																	2							1
Pandalus																								9
unidentified																								
Sample (kg)	30		60	30	290	60		60	30	180	30	240	60	160	60	30	136	45	60	30	30	30	50	165

**Table IID3(cont)** Total catch in number by species for trawl hauls from the Scotia acoustic survey 27/6 – 20/7/2003. Estimated total catch is given in kg

Haul No	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314
Est catch (Kgs)	150	124	139	3600	450	60	1200	930	360	75	600	2400	60	1050	300	105	3000	420	1020	2100	510	450	195	1200
Herring	1520	156	408	20480	2550	71	5984	4665	2034		11175	15200	78	4725	1203	21	11167	24	3477	7644	18	1548	456	4660
Mackerel		1	7						6						9	4		2					356	60
Sprat																								
Cod						2										1		2						
Saithe		2	9			4		15		16			2			28		459	36		38	6		
Blue Whiting						20										119		8			8952			
Norway Pout		201	271			147				684			258			476		300			20			
Poor Cod		3	1							11			6			5					4			
Gadiculus																					86			
Greater Argentine						2										4					99			
Lesser Argentine		1				2				3			10			3					6			
Haddock		218	88			24				65			79			46		30			15		1	
Whiting	10	66	18			51				22			83			10		15						
Hake						3							2			3		1			4			
Ling										1						3		1			2			
Scad						1				53			18		6	107		74			76			
Lythe																								
Cuckoo ray																								
Starry ray																								
4 Beard Rockling						1																		
C.Lyra																								
Imperial Scadfish																								
Angler						1																		
Norway haddock										1														
Bluemouth																								
Greater Forkbeard																								
L.Spotted Dogfish													1											
Grey Gurnard						1				4			1			10		2			1			
Red Gurnard																								
Megrim						7				1			3			2		10			6			
Plaice													1											
Lemon Sole						1				1			21			1		6			1			
Witch						4										1								
Common Dab		7	2										3											
Long Rough Dab		16	1			11				8			4			2		2						
Nephrops						17				1														
Ommastrephids			1																					
Pandalus			59																					
unidentified																								
Sample (kg)	30	124	139	90	75	60	90	60	60	75	60	60	60	90	90	105	90	420	90	75	510	75	195	120

**Table IID3 (cont.)** Total catch in number by species for trawl hauls from the Scotia acoustic survey 27/6 – 20/7/2003. Estimated total catch is given in kg

Haul No	315	316	317	318	319	320	321	322	323	324	325	326
Est catch (Kgs)	70	60	450	1800	105	2700	480	600	1200	900	60	300
Herring	29		2125	9720	65	14040	18	3940	8400	4860	96	1500
Mackerel	10			1170	1	135	1		680	90	5	285
Sprat												
Cod		4			4		3					
Saithe		27			1		38					
Blue Whiting		205					1657			195	269	
Norway Pout		237			4		44				82	
Poor Cod	1	11			9		7				9	
Gadiculus												
Greater Argentine		7										
Lesser Argentine	21	8			3		10				7	
Haddock	137	15			226		42				22	
Whiting	62				20		10				11	
Hake	6						2					
Ling		1					5					
Scad	21	18			25		13				5	
Lythe							87					
Cuckoo ray												
Starry ray												
4 Beard Rockling												
C.Lyra												
Imperial Scaldfish												
Angler												
Norway haddock		61										
Bluemouth		7									1	
Greater Forkbeard												
L.Spotted Dogfish	4	1			4		1				1	
Grey Gurnard	21	5			1		2				2	
Red Gurnard							1					
Megrim	19						3					
Plaice	17	4			1							
Lemon Sole	43	1			12		1				42	
Witch												
Common Dab	73	1										
Long Rough Dab	7											
Nephrops												
Ommastrephids												
Pandalus												
unidentified												
Sample (kg)	70	60	60	60	105	60	480	30	30	60	60	60

**Table IID4.** Herring length frequency proportion for individual trawl hauls by sub-area (Figure IID3) for the *Scotia* acoustic survey (27/6 – 20/7/2003) length in cm, weight in g, calculated target strength in dB per individual using  $TS=-71.2+20\log(L)$ .

Haul/ length	305	307	309	310	312	313	314	317	327	Mean I	281	295	297	304	Mean II
21.0															
21.5															
22.0												0.2			0.1
22.5							0.2		0.4	0.1		0.2		0.2	0.1
23.0						0.3	0.2		0.4	0.1			0.2	0.2	0.1
23.5						0.3	0.4		1.5	0.2	0.3	1.2	1.6	0.2	0.8
24.0						2.0	0.6		0.8	0.4	1.8	5.9	3.3	2.0	3.2
24.5	0.8					1.7	1.5		1.5	0.6	5.9	7.8	5.6	2.0	5.3
25.0	0.3	0.3				0.9	1.7		1.9	0.6	6.2	8.2	6.2	5.4	6.5
25.5	1.9	0.6	0.7			0.9	1.5		2.3	0.9	5.3	8.7	8.9	8.6	7.9
26.0	5.8	0.3	0.3			0.9	2.1	0.7	3.8	1.5	8.2	10.6	11.4	8.9	9.8
26.5	8.0	2.4	0.7	1.5	0.4	0.9	4.3	2.5	5.7	2.9	9.1	8.5	10.0	11.1	9.7
27.0	11.6	8.7	2.0	4.4	1.2	2.6	6.4	11.0	13.6	6.8	11.2	10.8	12.0	9.6	10.9
27.5	19.7	12.5	0.3	2.6	2.7	4.6	10.9	19.4	15.5	9.8	16.5	11.8	12.2	9.9	12.6
28.0	12.5	12.8	6.7	10.3	13.6	4.8	9.0	20.5	16.2	11.8	15.6	10.8	10.0	12.6	12.3
28.5	14.7	14.9	10.1	14.3	16.3	12.5	8.8	19.1	18.9	14.4	9.7	6.8	6.7	6.4	7.4
29.0	12.2	13.4	16.8	14.3	17.1	11.7	10.7	12.0	7.5	12.9	5.6	5.6	5.1	6.9	5.8
29.5	6.6	10.7	13.4	16.8	16.7	16.2	8.2	6.0	6.4	11.2	1.8	0.9	2.2	4.2	2.3
30.0	1.7	2.7	14.8	10.6	12.0	16.0	11.6	2.8	1.5	8.2	0.9	1.4	1.8	5.7	2.4
30.5	1.9	6.3	10.1	11.4	8.5	13.1	5.4	3.5	1.1	6.8	0.9	0.5	1.6	3.2	1.5
31.0	1.1	5.7	7.7	2.9	5.8	6.0	7.5	1.8	0.4	4.3	1.2		0.4	1.0	0.7
31.5	0.6	1.8	5.0	6.2	1.9	1.7	5.8	0.7	0.4	2.7			0.2	1.0	0.3
32.0	0.3	4.2	7.0	3.3	1.6	2.3	1.3			2.2			0.2	0.5	0.2
32.5		0.6	1.3		1.2	0.9	0.4		0.4	0.5			0.2		0.1
33.0		0.6	1.3	0.4	0.4		0.9			0.4				0.2	0.1
33.5			0.3	0.7	0.4		0.2			0.2					
34.0	0.3	0.9	1.3	0.4	0.4					0.4					
34.5		0.3					0.2			0.1					
35.0		0.3								0.0					
Number	361	335	298	273	258	351	466	283	265		340	425	449	405	
mean length	28.4	29.4	30.3	29.9	29.8	29.6	29.3	28.8	28.2	29.3	27.6	27.1	27.4	27.9	27.5
mean weight	222	251	279	265	263	258	248	231	216	248	202	189	196	210	199
TS/individual	-42.1	-41.8	-41.6	-41.7	-41.7	-41.7	-41.9	-42.0	-42.2	-41.8	-42.4	-42.5	-42.4	-42.3	-42.4
TS/kilogramme	-35.6	-35.8	-36.0	-35.9	-35.9	-35.9	-35.8	-35.7	-35.5	-35.8	-35.4	-35.3	-35.4	-35.5	-35.4

**Table IID4 (cont.).** Herring length frequency proportion for individual trawl hauls by sub-area (Figure IID3) for the *Scotia* acoustic survey (27/6 – 20/7/2003) length in cm, weight in g, calculated target strength in dB per individual using  $TS = -71.2 + 20\log(L)$ .

Haul	.Length	294	298	299	301	302	318	326	Mean III	269	270	272	279	282	284	285	289	323	Mean IV
	20.0																		
	20.5									0.2				0.4					0.1
	21.0						0.3	0.0									1.2		0.1
	21.5						0.7	0.1	0.2	0.4				1.7	0.3	0.7	1.2		0.5
	22.0	0.2	0.3				0.3	0.1	0.5	2.1				2.1	1.7	1.5	2.0	0.5	1.1
	22.5	0.4			0.4		1.9	2.0	0.7	2.5	8.9	1.5	0.5	4.6	2.5	2.2	3.8	1.0	3.0
	23.0	2.9	1.0	0.6	2.0	0.5	8.3	5.0	2.9	7.9	8.4	4.3	0.7	7.1	10.7	5.6	5.8	3.3	6.0
	23.5	3.5	4.2	3.8	4.7	6.3	9.9	4.0	5.2	10.9	10.5	7.6	2.7	13.8	8.8	9.8	5.8	11.0	9.0
	24.0	7.8	5.1	8.3	6.3	10.8	6.5	9.0	7.7	16.1	19.0	15.8	6.9	18.8	15.7	13.4	11.0	21.4	15.4
	24.5	8.4	6.8	13.6	9.4	15.3	8.0	8.3	10.0	21.3	19.4	15.3	9.2	18.4	17.1	18.2	13.0	17.6	16.6
	25.0	11.3	9.6	13.9	8.7	13.4	10.2	8.0	10.7	16.6	13.1	13.0	9.2	15.5	11.6	15.0	17.4	12.4	13.7
	25.5	10.7	8.7	13.3	8.3	12.1	9.0	10.7	10.4	10.0	8.0	9.2	10.4	8.4	6.6	12.8	13.3	11.9	10.1
	26.0	8.8	11.3	10.6	6.9	11.1	5.6	5.7	8.6	6.6	5.1	7.6	9.7	2.5	7.7	9.3	9.9	9.0	7.5
	26.5	12.1	10.6	10.6	11.2	8.2	4.9	7.7	9.3	3.9	3.4	9.7	9.7	2.5	9.4	6.3	5.8	1.9	5.8
	27.0	11.3	9.6	8.3	9.6	8.7	11.4	8.3	9.6	1.6	0.8	6.6	12.9	2.5	3.3	2.0	6.1	5.2	4.6
	27.5	10.4	12.9	5.0	8.9	5.8	4.6	4.3	7.4	1.1	0.8	4.8	10.1	0.8	2.2	1.3	2.3	1.9	2.8
	28.0	4.7	8.4	5.0	7.4	1.6	0.9	6.3	4.9	0.2		2.0	8.2	0.4	1.4	0.9	0.6	1.0	1.6
	28.5	2.9	5.1	2.9	6.3	2.9	2.8	4.3	3.9	0.5		1.5	5.2	0.4	0.6	0.9	0.9	1.4	1.3
	29.0	2.9	1.9	1.8	3.8	1.1	2.8	2.7	2.4			0.3	2.0			0.2			0.3
	29.5	0.8	1.9	0.3	4.0	0.5	2.2	2.0	1.7			0.5	1.5		0.6				0.3
	30.0	0.2	0.3	1.2	0.9	1.1	2.2	3.0	1.3				0.2					0.5	0.1
	30.5	0.4	1.0	0.3	0.7	0.8	2.5	1.7	1.0				0.7						0.1
	31.0	0.2	0.3	0.3			3.4	2.0	0.9			0.3	0.2						0.1
	31.5			0.3			0.9	2.3	0.5										
	32.0		0.6		0.4		0.9	1.0	0.4										
	32.5		0.3				0.9		0.2										
	33.0						0.3	0.3	0.1										
	33.5																		
Number		512	311	339	447	380	324	300		441	237	393	404	239	363	461	345	210	
mean length		26.5	26.9	26.4	26.9	26.1	26.6	26.8	26.6	25.1	24.8	25.7	26.8	24.8	25.2	25.3	25.4	25.4	25.4
mean weight		175	185	172	184	167	181	185	179	144	138	158	182	139	148	148	150	150	151
TS/ind		-42.7	-42.6	-42.8	-42.6	-42.8	-42.7	-42.6	-42.7	-43.2	-43.3	-43.0	-42.6	-43.3	-43.1	-43.1	-43.1	-43.1	-43.1
TS/kilog		-35.2	-35.3	-35.1	-35.3	-35.1	-35.2	-35.3	-35.2	-34.8	-34.7	-35.0	-35.2	-34.7	-34.8	-34.8	-34.9	-34.9	-34.9

**Table IID4(cont.)** Herring length frequency proportion for individual trawl hauls by sub-area (Figure IID3) for the *Scotia* acoustic survey (27/6 – 20/7/2003) length in cm, weight in g, calculated target strength in dB per individual using  $TS=-71.2+20\log(L)$ .

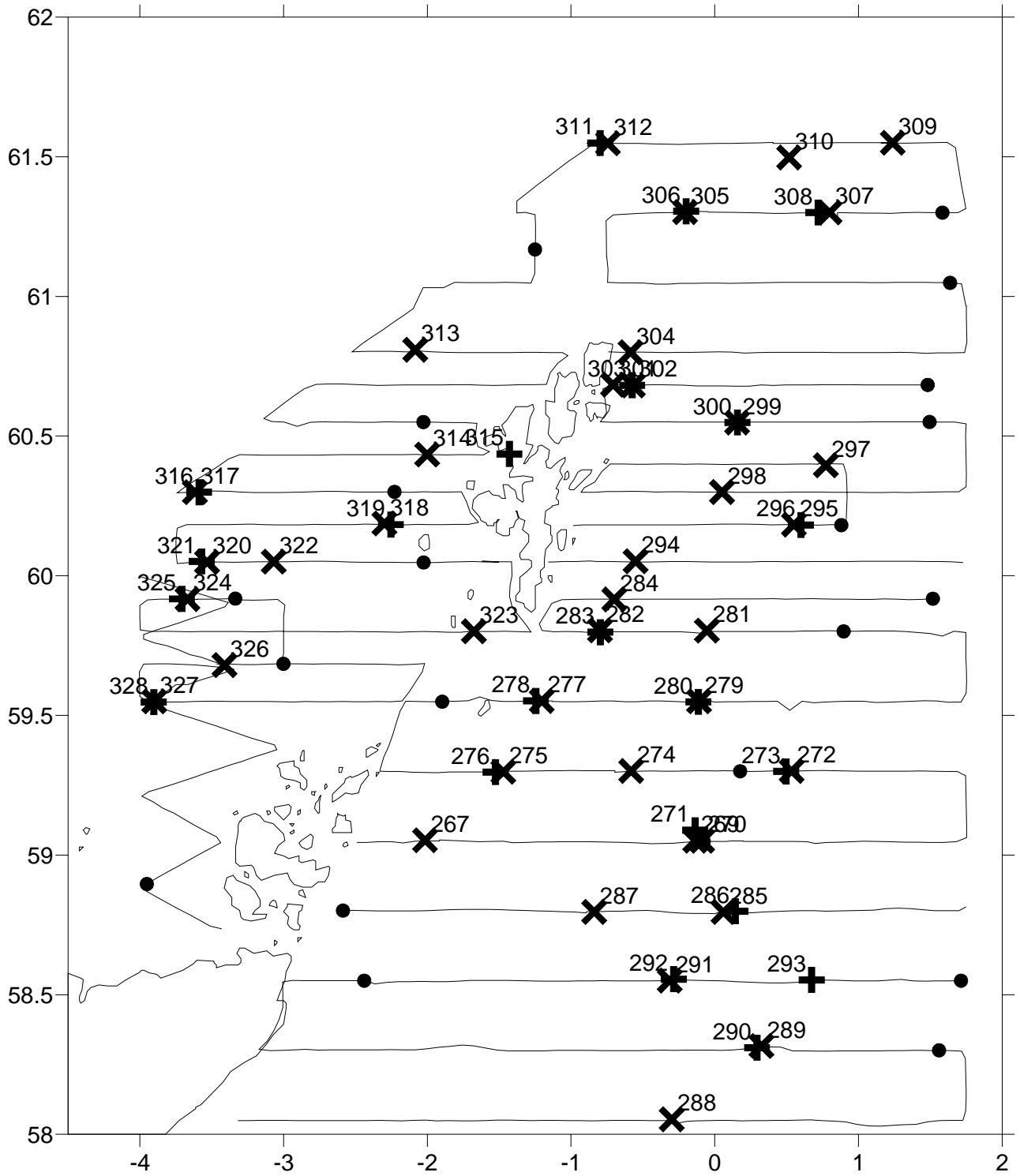
Haul /length	274	275	277	287	288	291	Mean V	267	Mean VI	322	Mean VII	320	324	Mean VII
17.5								0.6	0.6					
18.0								0.3	0.3					
18.5								0.9	0.9					
19.0								0.6	0.6					
19.5								0.6	0.6					
20.0					0.5		0.1	1.5	1.5					
20.5	1.4	1.0	0.4	1.0	1.6		0.9	1.8	1.8					
21.0	4.0	2.4	0.8	2.9	6.0	1.6	3.0	13.2	13.2	2.0	2.0			
21.5	8.9	13.3		10.9	11.3	4.9	8.2	17.4	17.4					
22.0	10.7	20.3	4.9	19.9	17.3	10.5	13.9	25.7	25.7	9.6	9.6			
22.5	11.7	17.5	7.2	17.0	19.4	15.8	14.8	16.2	16.2	17.8	17.8		0.3	0.2
23.0	10.7	21.0	16.7	16.0	13.9	20.7	16.5	10.8	10.8	21.8	21.8	1.0	0.6	0.8
23.5	7.8	14.0	23.6	7.4	10.8	14.1	12.9	6.6	6.6	19.3	19.3	1.0	0.3	0.6
24.0	12.3	6.3	19.8	12.2	8.1	14.1	12.1	2.1	2.1	12.7	12.7	2.6	4.0	3.3
24.5	10.9	2.4	14.1	5.8	7.1	7.6	8.0	0.6	0.6	8.6	8.6	4.2	7.1	5.6
25.0	6.8	1.0	4.6	2.6	2.9	4.9	3.8	0.9	0.9	5.6	5.6	7.4	8.0	7.7
25.5	4.2	0.3	3.4	2.6	0.8	3.6	2.5	0.3	0.3	1.0	1.0	6.4	5.9	6.1
26.0	4.2	0.3	2.7	0.6		0.7	1.4					6.4	8.3	7.4
26.5	2.6		0.4	1.0		1.3	0.9			0.5	0.5	11.2	9.9	10.5
27.0	2.4		1.1	0.3	0.3		0.7			1.0	1.0	16.0	16.4	16.2
27.5	1.0						0.2					14.4	12.0	13.2
28.0	0.4						0.1					5.1	9.3	7.2
28.5			0.4				0.1					7.1	7.4	7.2
29.0												4.2	1.5	2.9
29.5												4.5	2.2	3.3
30.0												2.2	1.9	2.0
30.5												2.6	1.9	2.2
31.0												1.9	0.9	1.4
31.5												0.6	1.5	1.1
32.0												0.3	0.3	0.3
32.5												1.0	0.3	0.6
Number	497	286	263	312	381	304		334		197		312	324	
mean length	24.0	23.1	24.3	23.4	23.2	23.8	23.6	22.5	22.5	23.8	23.8	27.6	27.4	27.5
mean weight	126	109	128	114	110	120	118	99	99	120	120	204	197	200
TS/individual	-43.6	-43.9	-43.5	-43.8	-43.9	-43.7	-43.7	-44.1	-44.1	-43.7	-43.7	-42.4	-42.4	-42.4
TS/kilogramme	-34.6	-34.3	-34.6	-34.4	-34.3	-34.5	-34.4	-34.1	-34.1	-34.5	-34.5	-35.4	-35.4	-35.4

**Table IID 5** FRV Scotia 27/6-20/7/2003 Numbers of herring otolithed at length and at age, lengths in mm measured to the nearest 0.5cm below, ages in winter rings(wr). Of the 3294 otoliths taken 1 was unreadable.

Len	1	2l	2m	3i	3m	4	5	6	7	8	9+	Grand Total	
175	1											1	
180	1											1	
185	1											1	
190	1											1	
195	1											1	
200	1		1									2	
205			7									7	
210			9	1								10	
215			13									13	
220			18	1								19	
225			21	4								25	
230			49	24	3							76	
235			47	54	4	1						106	
240			38	83	12	4	6					143	
245			20	117	10	10	7					164	
250			16	119	10	17	15	2				179	
255			4	95	9	35	33	2	1			179	
260			1	61	4	58	45	2	1			172	
265			1	32	1	83	55	11				183	
270				12	1	79	83	7				182	
275				15	1	114	159	15	6	1		311	
280				4		82	153	19	8	12	1	279	
285				5		41	178	12	12	12	2	264	
290						37	115	14	26	11	5	208	
295						14	91	27	26	19	2	182	
300						6	58	15	25	32	7	145	
305						2	25	12	27	52	12	138	
310						1	9	11	14	50	9	107	
315						3	10	3	8	23	11	75	
320							1	5	4	27	12	62	
325							2		2	7	2	25	
330								2		4	1	15	
335							1		1		3	5	
340								1		1		10	
345											2	2	
350									1			1	
Grand Total		6	245	628	55	587	1045	160	161	252	67	88	3294

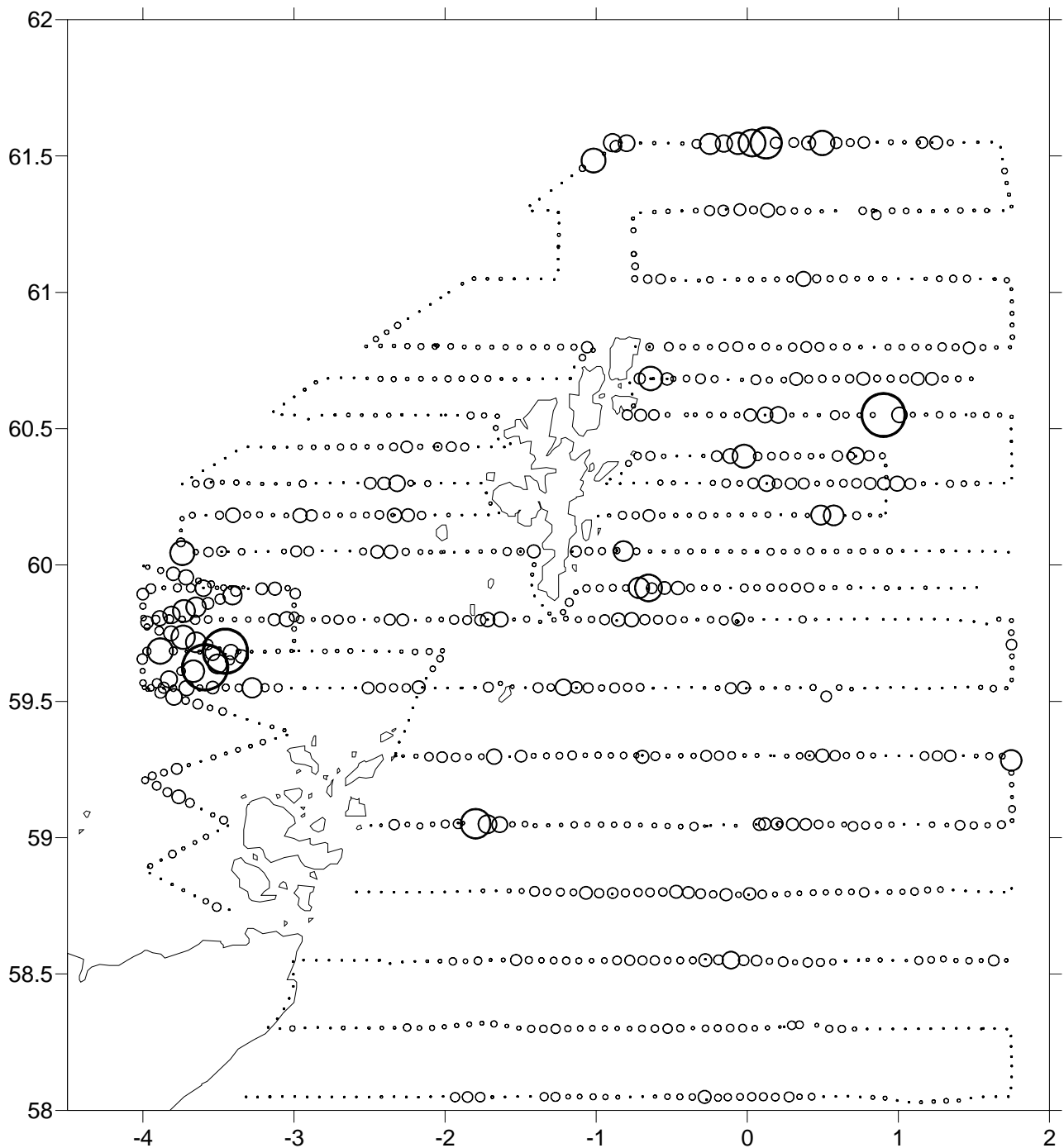
**Table IID6.** Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the Scotia 27 June to 20 July 2002 herring acoustic survey.

Age/Maturity	Number (millions)	Mean Weight (g)	Mean Length(cm)	Biomass (thousands of tonnes)
1A	49	61	19.0	3.0
2I	4258	111	22.8	474.4
2M	3825	145	24.6	555.1
3I	468	144	24.6	67.7
3M	2301	198	27.0	455.1
4A	3738	215	27.6	804.4
5A	454	238	28.5	108.3
6A	373	269	29.6	100.5
7A	539	292	30.3	157.3
8A	136	300	30.5	40.9
9+	162	330	31.4	53.3
Total	16304	173	25.7	2819.9

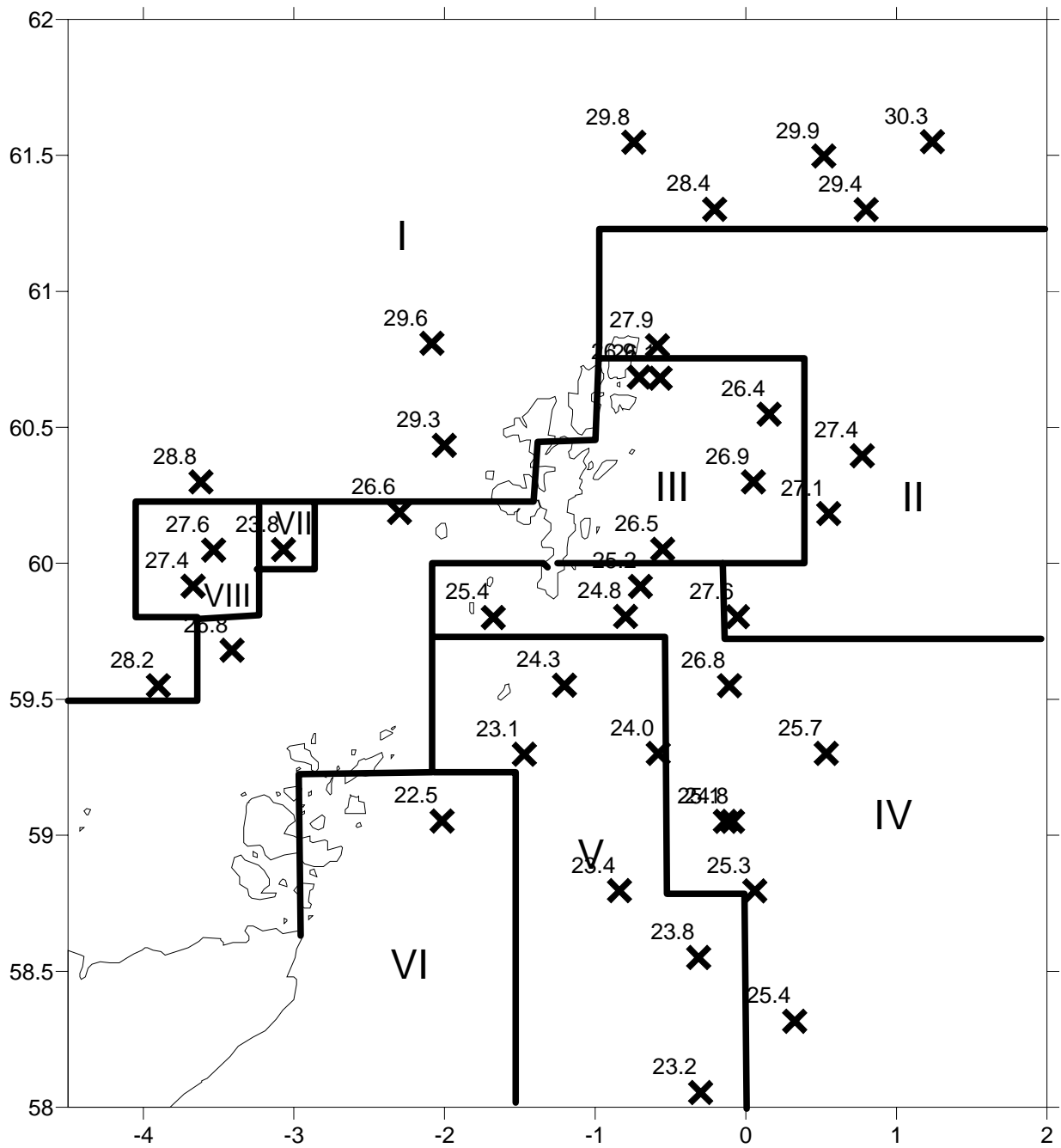


**Figure IID1.** Cruise track FRV SCOTIA for 27 June-20 July 2003 pelagic trawl stations ( X ), demersal trawl stations (+) CTD stations (●)





**Figure IID2.** Post plot of NASC values attributed to herring from FRV SCOTIA for 27 June-20 July 2003 Zig-zag track between 59 30 and 60N 4 and 3W was for inter-calibration and not used in the survey estimate



**Figure IID3.** Mean Length of herring from pelagic trawl catches, FRV SCOTIA for 27 June-20 July 2003 trawl station numbers are given in Figure IID1 and details in Tables 1 and 2. The eight analysis areas are shown in roman numerals and the length distributions, mean lengths, weights and target strengths are given by haul and area in Table IID4.

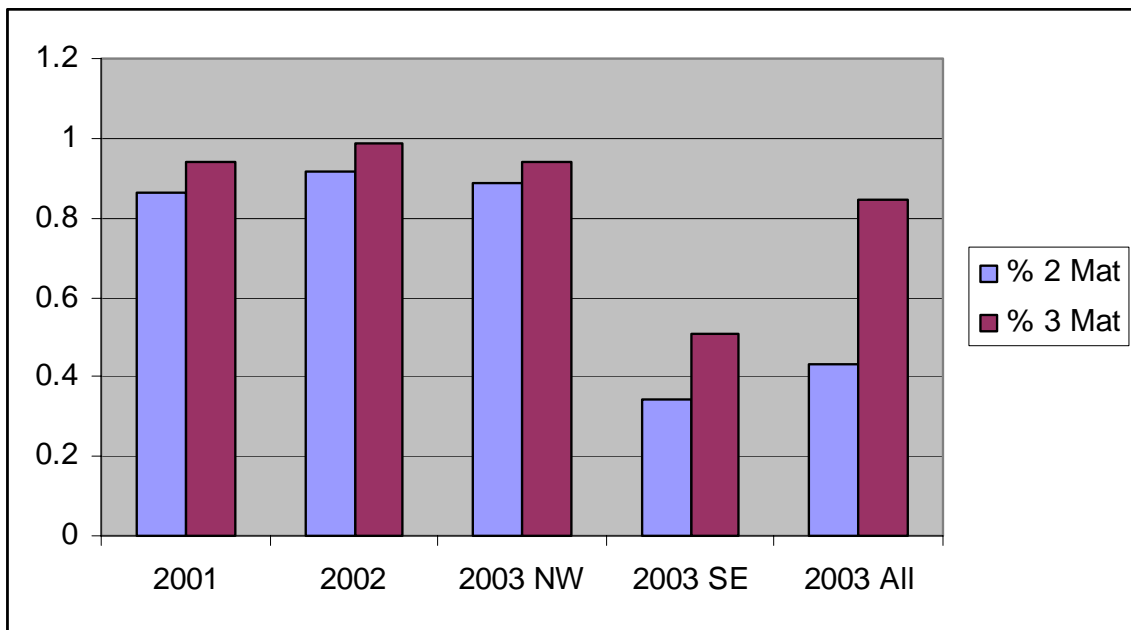


Figure IID4 Percentage of 2wr herring mature in the Scotia surveys in 2001 to 2003. Showing that the North western area contained herring of a similar proportion mature in 2003 as the whole area in 2001 and 2002. There are a large number of herring in the south western part of the area that are less mature.

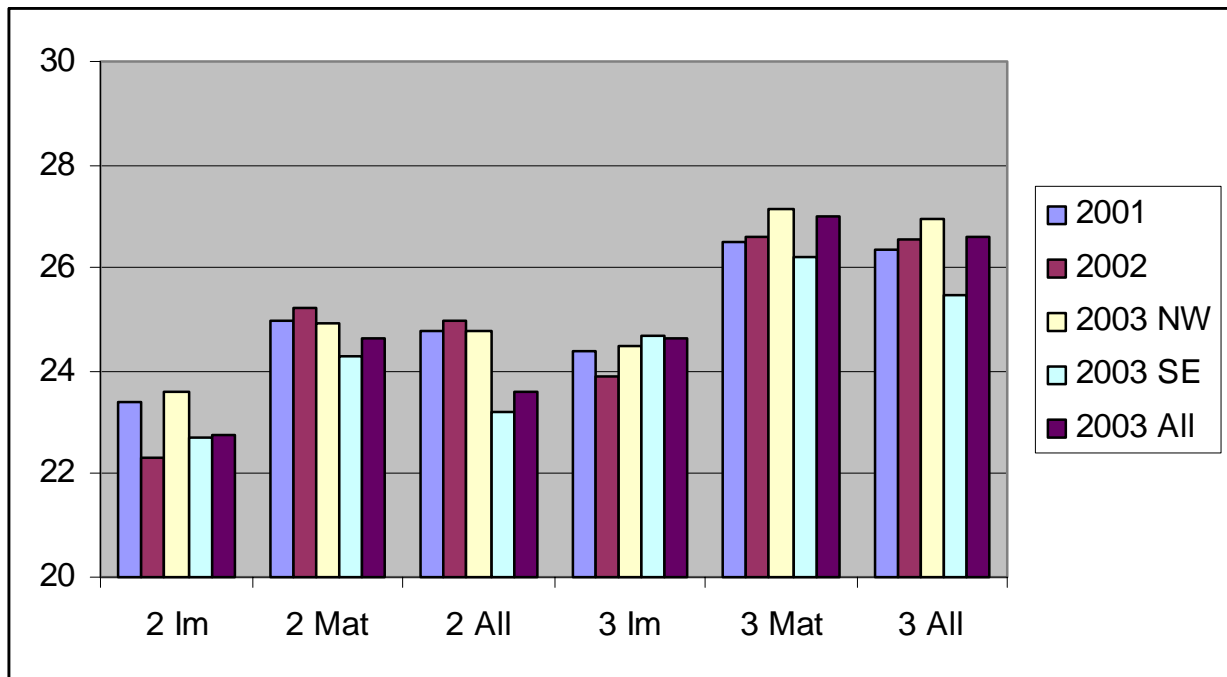


Figure IID5 Comparison of growth and maturity in 2001 to 2003. Mature and immature herring are similar sizes in all three years and all parts of the area. There is a higher proportion of 2 ring herring that are smaller and less mature than in previous years.

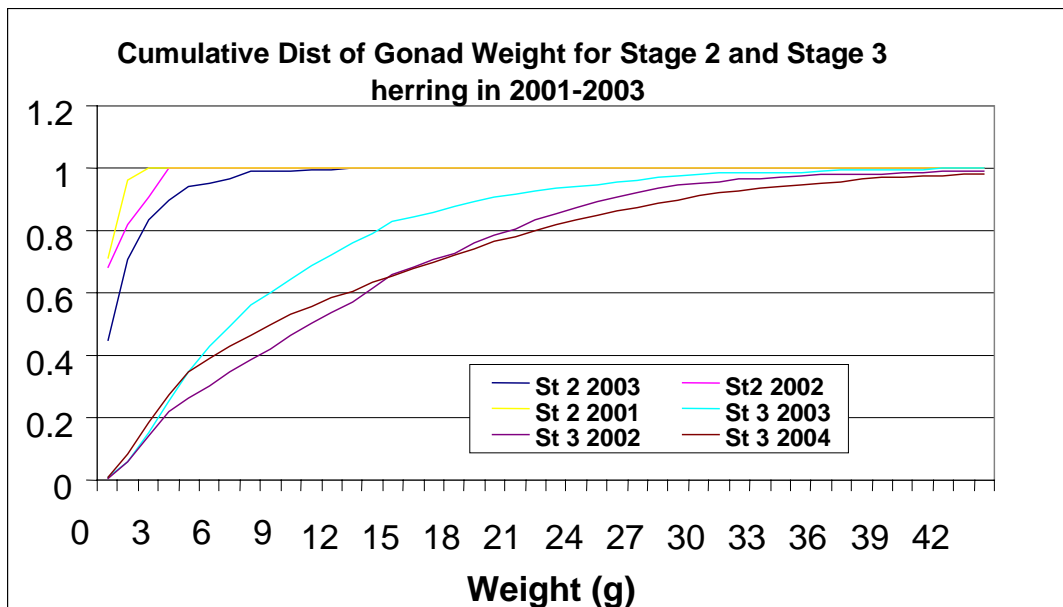


Figure IID6 Cumulative distribution of Gonad weight at stage 2 and stage 3 for the last three years 2001-2003

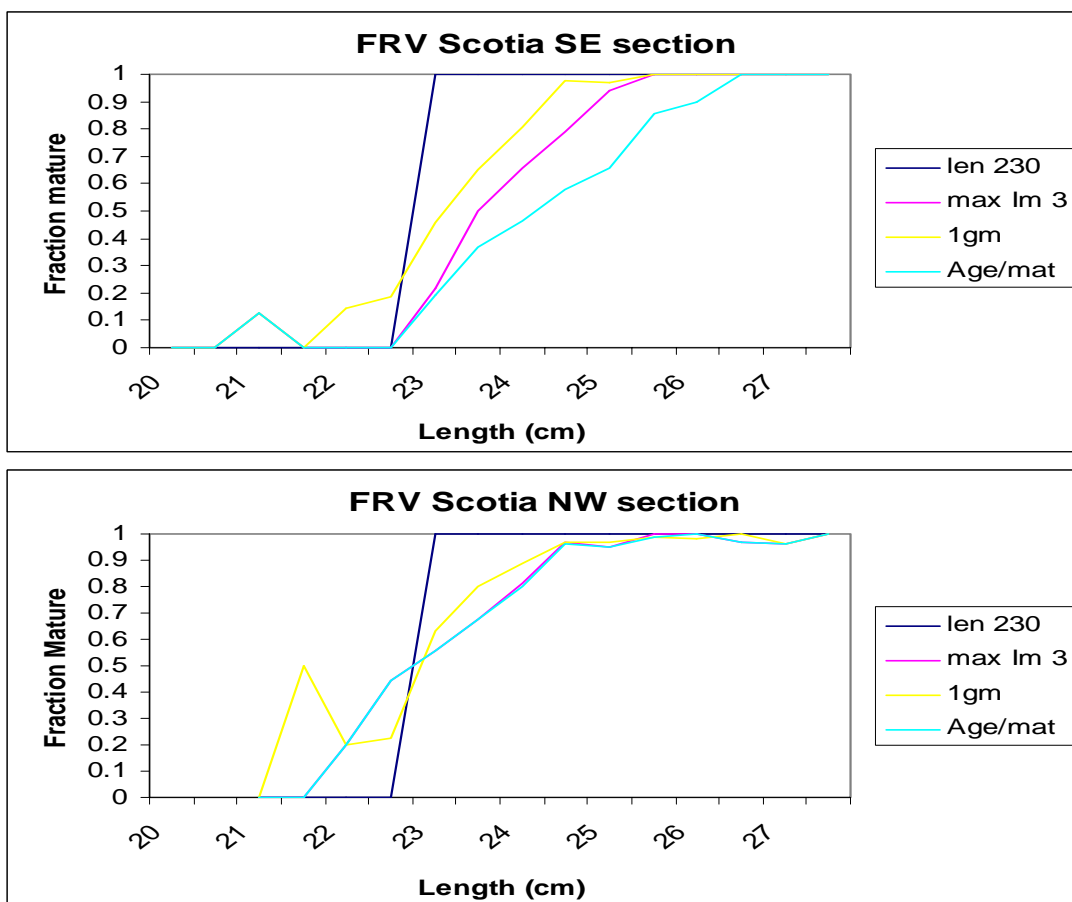


Figure IID7 Maturity at length Ogives for the FRV Scotia survey separated in to SE (areas I, II, III, VII and VIII) and NW (areas I, II, III, VII and VIII) showing maturity at length for the original data (Age/Mat), knife edge at gonad weight of 1gm (1gm), Maximum immature gonad of 3g (max im 3) and knife edge at 23 cm (len 230). The NW area is relatively insensitive to these choices. Maturity in the SE area. Of the length independent measures 1gm knife edge gives the best results.



