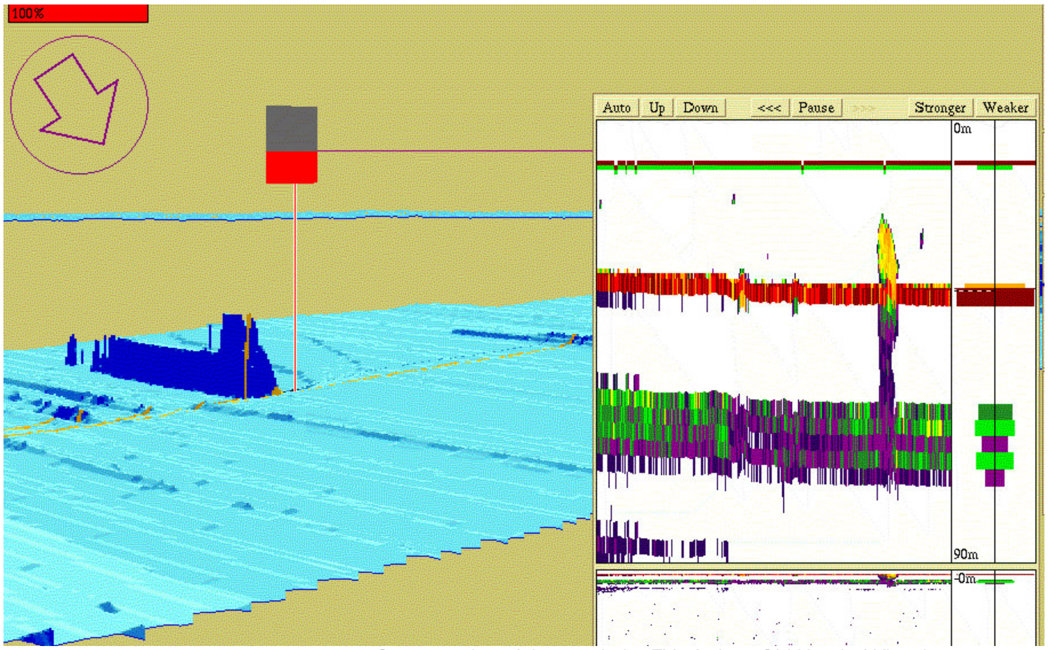
Acoustic Survey Cruise Reports

ICES Divisions VIIb, j & g and VIIaS



Cross-section of the wreck the FV "*Ardent*" Old Head of Kinsale.

CELTIC SEA HERRING ACOUSTIC SURVEY 2005

RV Celtic Explorer
2nd – 21st October
and

FV Regina Ponti
17th – 23rd October

Report by

Ciaran O'Donnell, Ian Doonan, Graham Johnston, Deirdre Lynch,
Leonie Dransfeld and David Wall[1]

[1] Irish Whale and Dolphin Group (IWDG)

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Introduction

In the Celtic Sea and ICES Division VIIj, to the south and southwest of Ireland, herring are an important commercial species to the pelagic fleet. The local fleet is composed of dry hold polyvalent vessels and a number of purpose built RSW (Refrigerated seawater) vessels. This stock is composed of both autumn and winter spawning components. The commercial fishery has historically taken place within 6nmi (nautical miles) of the coast and focused on aggregated schools within the spawning cycle. In recent years the RSW fleet has actively targeted offshore summer feeding grounds in the south Celtic Sea. In division VIIj, the fishery traditionally begins in early October and is concentrated within several miles of the shore bays and inlets. The division VIIaS fishery peaks towards the year end in December, but may be active from mid October depending on location. In division VIIg, along the south coast herring are targeted from October to January at a number of known spawning sites and surrounding areas. Overall, the protracted spawning period of the two components extends from October through to January, with annual variation of up to 3 weeks. Spawning occurs in successive waves in a number of well known locations including large scale grounds and small discreet spawning beds.

The stock structure and discrimination of herring in this area is not fully understood. It is known that fish in the eastern Celtic Sea recruit from nursery areas in the Irish Sea and tagging studies have shown linkages between these areas also. For the purpose of stock assessment and management these areas have been combined since 1982. For a period in the 1980's, egg and larval surveys were conducted for herring in this area. However, since 1989, acoustic surveys have been carried out, and currently are the only tuning indices available. In the Celtic Sea and VIIj, herring acoustic surveys have been carried out since 1989, and the current survey is the 16th in the series.

The autumn 2005 survey is the most comprehensive survey carried out in the current time series. The geographical confines of the annual 21 day survey were expanded to include areas to the south of the main winter spawning grounds in an effort to identify the whereabouts of winter spawning fish before the annual inshore spawning migration. Spatial resolution of acoustic transects were increased over the entire south coast survey areas. The acoustic component of the survey was complimented by a continuation of the detailed hydrographic work carried out in the Celtic Sea in 2004. In addition a second inshore survey was carried out along the southern coast using a chartered commercial fishing vessel (FV *Regina Ponti*). This second survey focused on area between 0.5nmi and 10nmi offshore and covered the main autumn and winter spawning areas along the south coast.

Materials and Methods

Area coverage

Area coverage by the *Celtic Explorer* during the autumn 2005 survey started in the southwest at Loop Head (Figure 1) at the mouth of the Shannon Estuary (Division VIIb) and extended along the south western seaboard covering the main bays and inlets (VIIj). The south coast was covered in continuity from Mizen Head to Carnsore Point (VIIg and VIIaS). A parallel transect design was adopted for the main body of the survey. Transects were set running perpendicular to the coastline and lines of bathymetry. Offshore extension increased to 67nmi (nautical miles) to take in offshore areas such as the "Trench" trawl grounds. Along the south coast, transect spacing was set at 2nmi over the entire region providing a high degree of spatial resolution throughout. Historically, transect spacing of between 1 to 4nmi has been used. For bays and inlets in the southwest region (VIIj) a combined zigzag and parallel transect approach was used to best optimise coverage.

In total the *Celtic Explorer* survey transect length was in the order of 2,789nmi.

Area coverage by the FV *Regina Ponti* during the 5 day commercial survey started at the Old Head of Kinsale, in the west, and worked in an easterly direction to the Saltee Islands in the East (Figure 2). Parallel transects of equal spacing and running perpendicular to the lines of bathymetry were used to cover the entire survey area. Transect spacing was set at 2nmi (nautical miles) over the main autumn spawning areas in the west and east, increasing to 4nmi outside spawning areas to retain spatial continuity. Offshore transect extension reached a maximum of 12nmi, with further extension where necessary to contain fish echotraces within the survey area.

The *Regina Ponti* total survey transect length was in the order of 786nmi.

Acoustic data Acquisition

Equipment settings for the acoustic equipment were determined before the start of the survey program and were based on established settings employed by FSS on previous surveys. The settings used on the *Celtic Explorer* acoustic array are detailed in Table 1. Table 2 details the settings employed for the towed body as used on the *Regina Ponti.*

The acoustic data were collected using the Simrad ER60 scientific echosounder onboard the *Celtic Explorer*. Simrad split-beam transducers of 18, 38, 120 and 200 KHz are mounted within the vessels drop keel and lowered to the working depth of 3m below the vessels hull or 8.8m below the sea surface.

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A single Simrad ES-38B (38 KHz) split-beam transducer mounted within a towed body and was deployed from the *Regina Ponti* at approximately 3m off the port side amidships at a working depth of approximately 3m.

Acoustic data were observed and recorded onto the hard-drive of the respective processing units. The "RAW files" were logged via a continuous Ethernet connection as "EK5" files to the vessels server (*Celtic Explorer*) and the ER60 hard drive as a backup in the event of data loss. In addition, as a further back up a hard copy was stored on DVD. Sonar Data's Echoview® Echolog (Version 3.2) live viewer was used to display the echogram during data collection to allow the scientists to scroll through echograms noting the locations and depths of fish shoals. The equipment was monitored continually by a member of the scientific crew. A 15 minute log was taken recording time, position from the vessels GPS and any comments. This log was used to monitor the time spent off track during fishing operations and hydrographic stations plus any general observations.

Calibration of Acoustic equipment

Calibration of the acoustic system onboard the *Celtic Explorer* was carried out following the principles as described by Foote *et al.* (1997). Calibration of the ER60 was carried out in Dunmanus Bay Co. Cork on the 5th October. While the towed body system was calibrated in Ringaskiddy on the 17th of October. The appropriate correction factors were then applied to these data before the final biomass estimates were calculated. Calibration results were well within the boundaries expected and no irregularities were identified between previous calibrations. The ER60 acoustic array was last calibrated in March 2005 and the towed body system in January 2002.

Onboard the *Celtic Explorer* the 38 KHz transducer was calibrated along with the following frequencies, 18, 120, 200 KHz. The 18 and 38 KHz frequencies were calibrated using standard target copper spheres (63mm and 60mm respectively). The 120 and 200 KHz frequencies were both calibrated using a 38.1mm tungsten carbide standard target sphere. The generated biomass data presented here were generated solely from data acquired through the 38 KHz transducer. The higher (120 and 200 KHz) and lower (18 KHz) frequency data was used primarily for non-quantitative species recognition.

The towed body single frequency system (38KHz) was calibrated using a standard 60mm copper sphere.

Biological Sampling

A single pelagic midwater trawl with the dimensions of 19m in length (LOA) and 6m at the wings ends and a fishing circle of 330m was employed on both vessels during the survey (Figure 20). Mesh size in the wings was 3.3m through to 10mm in the cod-end lining. Onboard the *Celtic Explorer* the twine thickness of the net is increased to allow for the differences in vessel power. The net was fished with a vertical mouth opening of approximately 11m, which was observed using both a cable linked "BEL Reeson" netsonde (50 kHz).

Onboard the *Celtic Explorer* the net was fitted with a Scanmar depth sensor, distance sensors all of which were configured and viewed through a Scanmar Scanbas system.

On both vessels all components of the catch from the trawl hauls were sorted and weighed; fish and other taxa were identified to species level. Fish samples were divided into species composition by weight. Species other than herring were weighed as a component of the catch. Length frequency and length weight data were collected for each component of the catch. Length measurements of herring, sprat and pilchard were taken to the nearest 0.5cm below. Age, length, weight, sex and maturity data were recorded for individual herring within a random 100 fish sample from each trawl haul, where possible. All herring were aged onboard. The appropriate raising factors were calculated and applied to provide length frequency compositions for the bulk of each haul.

Decisions to fish on particular echo-traces were largely subjective and an attempt was made to target marks in all areas of concentration not just high density shoals. No bottom trawl gear was used during this survey. However, the small size of the midwater gear used onboard and its manoeuvrability in relation to the vessel power allowed samples at or below 0.5m (+/- 0.5m) from the bottom to be taken in areas of clean ground.

Acoustic data analysis

Acoustic data was backed up every 24 hrs onboard the *Celtic Explorer* and scrutinised using Sonar data's Echoview® (V 3.2) post processing software for the previous days work. Partitioning of data into the categories below was largely subjective and was viewed by a scientist experienced in viewing echograms. Biological information was then applied directly to individual schools where possible. When no directed fishing had taken place o then a nearest neighbour approach is adopted.

Onboard the *Regina Ponti* all data was collected for analysis back at the laboratory.

The S_a values from each log interval were partitioned into the 4 categories after inspection of the echograms. Categories identified on the basis of trace recognition were as follows:

1. "Definitely herring" echo-traces or traces were identified on the basis of captures of herring from the fishing trawls which had sampled the echo-traces directly, and on large marks which had the characteristics of "definite" herring traces (i.e. very high intensity (red), narrow inverted tear-shaped marks either directly on the bottom or in mid-water and in the case of spawning shoals very dense aggregations in close proximity to the seabed).

2. "Probably herring" were attributed to smaller echo-traces that had not been fished but which had the characteristic of "definite" herring traces.

3. "Herring in a mixture" were attributed to S_A values arising from all fish traces in which herring were thought to be contained, owing to the presence of a proportion of herring within the nearest trawl haul or within a haul which had been carried out on similar echo-traces in similar water depths.

4. "Possibly herring" were attributed to small echo-traces outside areas where fishing was carried out, but which had the characteristics of definite herring traces.

The "EK5" files were imported into Echoview (Version 3.20) for echo post-processing. The echograms were divided into cells using a time/distance grid of 15 minutes. Cells define sets of sample values of an echogram, from which integration variables can be calculated through echo integration. Echo integration was performed by selecting marks or scatter, which belonged to one of the four categories above. Regions were drawn around the various marks and the software calculates S_a values for the selected regions. S_a values were obtained by drawing regions around schools and then defining the regions as one of the four categories. The echograms were analysed at a threshold of -70 dB and where necessary plankton was filtered out by thresholding at –65 dB.

The allocated echo integrator counts (S_a values) from these categories were used to estimate the herring numbers according to the method of Dalen and Nakken (1983).

The following TS length relationships used were those recommended by the acoustic survey planning group (Anon, 1994):

Herring	TS = 20logL – 71.2 dB per individual (L = length in cm)
Sprat	TS = 20logL – 71.2 dB per individual (L = length in cm)
Mackerel	TS = 20logL – 84.9 dB per individual (L = length in cm)
Horse mackerel	TS = 20logL – 67.5 dB per individual (L = length in cm)

The TS length relationship used for gadoids was a general physoclist relationship (Foote, 1987):

Gadoids	TS = 20logL – 67.5 dB per individual (L = length in cm)

The TS length relationship used for pilchards was as follows (Svellingen and Ona, 1999):

Pilchard	TS = 20logL – 66.4 dB per individual (L = length in cm)

The analysis produced density values of numbers and biomass per nautical mile squared for each 15 min log interval. The survey area was stratified into sub-divisions using analysis areas of 0.25° of latitude by 0.5° of longitude Inshore intertransects were not included in the analysis for the main survey area. Area calculations of herring distribution within ICES sub-divisions were calculated using a Universal Transverse Mercator projection in "ArcMap" GIS (Geographical Information System) mapping package.

Abundance estimate was generated using length-weight relationships determined from trawl samples taken onboard the *Celtic Explorer* during the course of the survey and applied to both data sets.

Herring weight (grams)	$= 0.00256 * L^{3.3375}$	(L = length in cm)
Sprat weight (grams)	$= 0.00233 * L^{3.4189}$	(L = length in cm)
Pilchard weight (grams)	$= 0.00013 * L^{4.3132}$	(L = length in cm)
Horse mackerel weight (grams)	$= 0.00975 * L^{2.9496}$	(L = length in cm)
Mackerel weight (grams)	$= 0.00751 * L^{3.0206}$	(L = length in cm)

Hydrographic data collection

Hydrographic stations were carried out during the survey at predetermined locations along the acoustic track (Figure 1). Data on temperature, depth, sound velocity and density data were collected using a Seabird 911 rosette sampler from 1m subsurface to 5m above the seabed. Coverage was broken down into 3 transects of up to 67nmi in length. In the southwest, the Shannon estuary was covered. Along the south coast CTD cast were carried out along transects extending offshore from Cork harbour and Ballycotton. Hydrographic stations were carried out 6nmi apart in all the areas covered.

In addition to CTD casts, vessel underway data was also collected over the entire survey area providing salinity, temperature and ambient Chlorophyll A levels in the surface waters (to 5m).

Marine Mammal and Seabird Observers

During the survey an observer kept a daylight watch on marine mammal sightings from the crow's nest (18m above sea level).

During cetacean observations, watch effort was focused on an area dead ahead of the vessel and 45^{o} to either side using a transect approach. Sightings in an area up to 90^{o} either side of the vessel were recorded. The area was constantly scanned during these hours by eye and with binoculars. Ships position, course and speed were recorded, environmental conditions were recorded every 15 minutes and included, sea state; visibility; cloud cover; swell height; precipitation; wind speed & wind direction. For each sighting the following data were recorded: time; location; species; distance; bearing; number of animals (adults, juveniles and calves) and behaviour. Relative abundance (RA) of cetaceans was calculated in terms of number of animals sighted per hour surveyed (aph). RA calculations for porpoise, dolphin species and minke whales were made using data collected in ≤ Beaufort sea state 3. RA calculations for large whale species were made using data collected in ≤ Beaufort sea state 5.

Results

Herring stock size

***Celtic Explorer* broad scale survey estimate**

Herring	Millions	Biomass (t)	% Weight
TSB Estimate			
Definitely	231.8	26958.6	72.1
Probably	11.6	1360.5	4.1
Mixture	81.6	4598.6	23.8
Total estimate	324.9	32917.7	100
Possibly	24	2903.7	
Possible estimate	349.0	35821.4	
SSB Estimate			
Definitely	203.4	24737.5	87.7
Probably	9.8	1219.5	4.3
Mixture	16.8	2240.1	7.9
SSB estimate	230	29718	100

The TSB (total stock biomass) estimate is composed of over 72% of echotraces classified as "definitely" herring that were in the most part observed from between 4 and 60 nmi (nautical miles) offshore (Figures 1 & 3, Table 3). Both the TSB and SSB (spawning stock biomass) estimates were generated primarily from 3 large single high density herring echotraces (Figure 3).

A breakdown of the estimate is provided by age (Figure 9, Tables 5, 6, 7 & 8), and maturity (Figure 9, Tables 9 & 10).

A large proportion of both the TSB and SSB estimates were generated from echotraces positively identified as herring (72% and 87% by weight respectively). The proportion of the overall estimate attributed to the mixed species category (by weight) is higher in the TSB estimate than in the SSB estimate. This may be attributed to the occurrence of juvenile herring in mixed species layers in known inshore nursery areas in the southwest, where mature herring were absent.

***Regina Ponti* small scale survey estimate**

Herring	Millions	Biomass (t)	% Weight
TSB Estimate			
Definitely	22.9	2417.7	33.3
Probably	40.1	593.2	8.2
Mixture	5.6	4246.2	58.5
Total estimate	68.64	7257.1	100
Possibly	64.2	6858	
Possible estimate	132.8	14115.1	
SSB Estimate			
Definitely	15	1874.5	33.3
Probably	26.4	3299.3	58.5
Mixture	3.7	460	8.2
SSB estimate	45.1	5634	100

The estimated TSB (total stock biomass) from the survey was 7,257 t, representing some 69 million individuals. Of this, the largest proportion by weight (over 50%) was attributed to herring contained within mixed schools. A full breakdown of the estimate is provided by age (Figure 9, Tables 11 & 12), maturity (Tables 13 & 14) and spatial distribution (Figure 2, 6 and Table 4).

As only 33% of the TSB estimate was generated from the "definitely" herring category, the abundance estimate should be treated with a degree of caution. The occurrence of single high density herring marks encountered was low overall, with only one large herring mark encountered and positively identified through trawling. This was partly due to the timing of the survey and the mismatch with peak spawning events. The occurrence of large offshore high density herring schools identified on the RV *Celtic Explorer* survey further indicated that inshore migration into spawning sites had yet to take place. Of the marks encountered on track, directed trawling proved difficult with a poor capture rate. To compensate for the lack of herring sampled during this survey, herring samples from the *Celtic Explorer* taken within the same area were used to validate the acoustic data where necessary (Tables 5 & 6, Figure 9).

Herring distribution

***Celtic Explorer* broad scale survey**

A total of 45 trawl hauls were carried out onboard the *Celtic Explorer* (Figure 1 & Table 3). Of this, 18 contained herring and 8 contained over 50% of herring by weight of catch and numbers.

In the Shannon region (VIIb-j) very few single mark herring echotraces were observed. Anecdotal evidence from pelagic fishermen actively working the area reported seeing sizeable marks of herring in the days after the survey vessel had left the area. Juvenile herring were found mixed with sprat in the Dingle Bay area (Haul 10), in Dunmanus Bay and the area to the south of Baltimore (Hauls 11 and 12 respectively) and is consistent with the results of previous surveys. The absence of autumn spawning herring from known spawning areas may therefore be a consequence of timing. Adult herring taken from a mixed trawl (n=5) catch in the Kerry Head region indicated the dominant maturity stage to be stage 4.

In the Celtic Sea, the first large distinct herring echotraces encountered were at the Old Head of Kinsale (Figures 3, Table 3). Further offshore (10-20nmi) single and mixed herring echotraces were noted. From the Old Head to Ballycotton few single herring echotraces were observed, herring were taken in this area but as part of mixed species catches. In total 10 hauls were carried out in this area and extending out to 64 nmi offshore, 7 of which occurred within 4 nmi of the coast.

From Ballycotton to Mine Head single herring echotraces were more abundant, this was especially true for offshore areas. Two distinct bands or regions of herring were evident at 20nmi and 40-60nmi offshore which were found to contain single high density echotraces. A significant number of mixed species catches containing herring were taken linking these two regions. The largest mark encountered during the survey was located some 58nmi offshore from Mine Head (Figure 3 & 10a). Of the 8 hauls containing herring within this area, 50 % of hauls contained over 92% herring by weight and numbers.

In the southeast (Tramore to Baginbun) single herring echotraces were found to be most abundant in inshore areas, namely at Baginbun. Herring were also taken as part of mixed catches from areas further to the south from 8-32nmi. No herring were observed in Waterford harbour in this years survey. The December 2004 survey (Table 15) found little herring in this area as compared to the 2003 (October-November) herring estimate. However, this may be a consequence of survey timing rather than and indication of distribution patterns.

Overall, the occurrence of large single herring echotraces further offshore and the lack of single marks encountered in inshore spawning areas may be a consequence of timing. This is reflected in the dominant pre-spawning maturity stages observed from catches (Figure 9). Actively spawning individuals were only found in significant numbers in the Baginbun area. Marks encountered closer to shore appear to be the autumn spawning component of the stock as it moves towards the spawning grounds. The occurrence of herring in mixed layers further offshore may be part of winter and autumn spawning components that have yet to form pre-spawning migrations to inshore spawning grounds. As the Celtic sea fishery was closed at the time of the survey up to date positional information provided by the fleet was lacking.

***Regina Ponti* small scale survey**
A total of 15 trawl hauls were carried out onboard the *Regina Ponti* (Figure 2 & Table 4). Of this, 2 contained herring and 2 contained over 50% of herring by weight.

In the Kinsale to Cork Harbour area no single homogenous herring echotraces were observed. This area had been surveyed by the RV *Celtic Explorer* some 8 days previously and produced several hundred tonnes of "definitely" herring.

The Ballycotton spawning area also yielded little or no large single herring schools. The eastern most side of this spawning area, towards Mine Head, produced one cluster of "definitely" herring marks encountered during the survey (Figure 2 & 6).

The eastern most area around Waterford Harbour and Baginbun, produced little herring during the survey. Indeed, the latter area produced no herring attributed marks.

Overall, the key spawning areas of the autumn component of the stock (approaches to Cork Harbour, Ballytcotton to Mine Head, approaches to Waterford Harbour and Baginbun) where normal autumn spawning takes place were found to contain low levels of herring. The larger broad scale survey undertaken by the RV *Celtic Explorer* found a significant amount of herring some 60nmi (nautical miles) offshore from Mine Head.

Herring stock composition

Analysis of herring taken during the survey indicate the stock to be composed of ages between 1-6 winter rings (Figure 9, Table 6). From the broad scale survey the southwestern region produced the highest number of juvenile herring, which were found to be mixed with sprat in Bays and Estuaries. The dominant year class overall was found to be 2-year olds of the 2003 year class, by weight (39%) and by numbers (36%). 1 and 4-winter ring fish were found to be the second and third most frequently encountered at 14% and 20% by weight and 17% and 15% by numbers respectively (Tables 7 & 8).

A lack of 3-winter ring fish was observed from both survey and commercial catch samples in the Celtic Sea. From the survey estimate 3 winter-ring fish contributed only 11% by weight and 8% by numbers of the TSB and TSN (Tables 7 & 8 and Figure 9).

The stock was found to be dominated by mature fish, by both weight and by numbers (Table 6). The occurrence of spent fish encountered was relatively low. This combined with the offshore distribution of echotraces would indicate the bulk of spawning had yet to take place. (Herring maturity for survey data is based on assumptions that all herring with winter rings 1-2 are classed immature, those of 3, 4, 5 & 6 are considered mature and those of 7, 8 & 9 winter rings are spent).

Percentage length frequencies derived from trawl samples that were used to generate the stock profile are shown in Table 5.

Secondary and tertiary pelagic species

Currently no management control measures exist in the Celtic Sea or ICES division VIIj for pilchard or sprat. As a result commercial landings are likely to increase in the coming years due to restrictions on the annual TAC (total allowable catch) of herring. At present no routine sampling of commercial landings of sprat or pilchard is carried out by FSS.

Celtic Explorer **broad scale survey estimate**

Pilchard	Millions	Biomass (t)	% weight
Total estimate			
Definitely	55.4	5388	70.7
Mixture	20.8	2233	29.3
Probably	0	0	0
Total estimate	76.1	7621	100

Regina Ponti **small scale survey estimate**

Pilchard	Millions	Biomass (t)	% weight
Total estimate			
Definitely	4.2	302.1	21.38
Mixture	22.7	1110.9	78.62
Probably	0	0	0
Total estimate	27.0	1413	100

Pilchard biomass estimates for both the *Celtic Explorer* and *Regina Ponti* surveys are presented by category by biomass (Table 16 & 20) and numbers (Table 17 & 21) respectively.

Pilchard distribution was highest in the Celtic Sea from Cork to Waterford Harbour (Figure 4 & 7). Smaller amounts were observed in the Dingle Bay area. In total pilchard were taken in 9 out of 60 combined survey hauls (Table 3 & 4). Single pilchard high density marks were observed around the Daunt and Cork Buoy area as well as further offshore from the Cork area (Figure 10c & 11b). Pilchard were also taken as part of mixed species catches as far out as 50nmi.

***Celtic Explorer* broad scale survey estimate**

Sprat	Millions	Biomass (t)	% weight
Total estimate			
Definitely	900.0	8882	30.61
Mixture	1671.0	20137	69.39
Probably	0	0	0
Total estimate	2571.0	29019	100

***Regina Ponti* small scale survey estimate**

Sprat	Millions	Biomass (t)	% weight
Total estimate			
Definitely	247.2	1677.9	81.53
Mixture	71.5	380.1	18.47
Probably	0	0	0
Total estimate	318.8	2058	100

Sprat biomass estimates for both the *Celtic Explorer* and *Regina Ponti* surveys are presented by category by biomass (Table 18 & 22) and numbers (Table 19 & 23) respectively.

Sprat were found throughout the survey area, with the exception of the area to the north of Slea Head (Figure 5 & 8). Sprat catches were composed of individuals between 5-15.5cm, the mean size encountered was 13cm. Sprat were taken in 28 out of 60 combined hauls for both surveys (Tables 3 & 4). Catches from the 2005 survey reflect the progression of the then small sprat length class (mean 9.5cm) that dominated 2004 survey and occurred throughout the survey area in large numbers. Sprat most frequently encountered as single high density echotraces mainly within 10 nmi of the coast (Figure 10b & 11a), but also to a high degree as the dominant component of mixed species catches.

As over 69% of the total sprat biomass by weight was determined from mixed species catches the estimate should be treated with a degree of caution. This can be accounted for due to the nature of mixed layer echotraces, which can be highly variable in species composition over short geographical distances. Mixed layers are often composed of feeding aggregations concentrated on layers of planktonic assemblages including invertebrates. The reliability of biomass estimates from such layers may be highly variable due to the weighting of unaccounted components of non-fish catches to the overall NASC (nautical area scattering coefficient) for the layer in question.

Horse mackerel were the most abundant species encountered in the Shannon region. The size range from trawl samples in the area yielded fish of between 22-29cm (mean 24cm). The bulk of scad echotraces occurred along the 70-90m contours in the area to the west of the Shannon Estuary and north of the Kerry Head region. Large marks were encountered in an area southwest of the Blasket Islands (Figure 10e).

Hydrography

Physical Oceanography

The distribution of surface temperature and salinity collected by the underway *Celtic Explorer* thermosalinograph is shown in Figures 12a-b. Surface temperatures averaged around 14.5ºC in the Celtic Sea with some warm water pockets >15ºC degrees occurring in the central Celtic Sea close to the southern limits of the survey track. A band of cooler water was seen inshore along the coast from Baginbun to the Shannon Estuary. Larger pockets of cool water <13.5ºC were observed to the southwest of Ireland close to the bays of Bantry, Kenmare and Dingle. Surface salinity values ranged between 33.5 and 35.2. The central Celtic Sea was associated with surface salinities of 34.5. Higher levels of above 35 were measured on the western approaches suggesting the presence of oceanic water. Along the south coast low salinities were observed between Waterford Harbour and Mine Head, at Ballycotton, Cork Harbour and Kinsale, demonstrating the input of freshwaters from the river tributaries. In the southwest and west low salinities were also seen in the bays and inlets due to freshwater input.

During this survey, three CTD transects were carried out to examine the vertical distribution of temperature, salinity and density. The first transect ran from the mouth of the Shannon estuary towards the shelf edge with five stations 6 nautical miles apart (Figure 13a-c). Surface temperatures across the transect averaged around 14ºC degrees with no notable change between the mouth of the estuary and the deeper waters. Strong stratification was observed across the entire transect with a thermocline occurring around 60 metres. Vertical distribution of salinity showed the fresh water influence of the Shannon River up to a depth of 30 metres. Reduced surface salinities were still apparent at the most oceanic station. The second transect ran from Cork Harbour southwards to 51ºN (Figure 14a-c). It consisted of 9 CTD stations 6 nautical miles apart. Surface temperature and salinity values increased southwards from the shore indicating fresh water input from the Lee river. The water column was stratified across the entire transect with a strong thermocline formed around 40 metres depth. A weakening of the thermocline was observed towards the inshore stations suggesting that some mixing was occurring. The transect was also stratified in terms of salinity with a layer of low salinity water (<35) lying above water of >35 salinity with strongest changes occurring at ca. 40 meters depth. The vertical density distribution observed during the third CTD transect from Ballycotton to 51ºN was similar to that of the Cork transect (Figure 15a-c). Strong stratification occurred across the transect with a thermocline forming at ca. 40 meters. Lower temperatures and salinities towards the coast indicated fresh water input from the Blackwater river.

Biological distribution in relation to horizontal temperature & salinity patterns

Horizontal and vertical NASC values were superimposed onto the temperature plots to examine whether there were any spatial links between the distribution of the different fish species and their environment. Most established herring spawning grounds are situated in the inshore bays, which are characterised by lower temperatures and salinities due to freshwater dilution. However the horizontal distribution of fish did not seem to be strongly linked with any spatial trends in temperature or salinity. Herrings were mainly found in the Celtic Sea with high NASC values in the central region (Fig. 16a). Some herring aggregations were also found close to the shore and in the different bays. On the Ballycotton transect some herring were found close to the inshore stations. These fish were distributed close to the bottom below the thermocline at a maximum depth of 68 meters (Figure 17a). Pilchards occurred in the Celtic Sea in some inshore areas and across the warm water pockets south of Cork Harbour (Figure 16b). Along the Cork Harbour transect, pilchards were located close to the inshore stations along the sloping bottom. They occurred above and below the thermocline at maximum depth of 78 metres. Sprat was concentrated along the south and southwest coast with some aggregations occurring in the central Celtic Sea (Figure 16c). They were located on both the Cork Harbour and the Ballycotton transects. Pure sprat was found in the shallow inshore stations above the thermocline, while sprat in a mix was agregated close to the bottom in water depths between 70-80metres (Figure 17c and 18c).

Marine Mammal and seabird observations

A total 76.9 hours of survey time were logged with 48.4% (37.2hrs) of this at ≤ Beaufort sea state three. Twenty three sightings of two cetacean species, totalling 483 individuals were recorded (Figure 19).

During calibration procedures in Dunmanus Bay (6 October), no survey was conducted (apart from an initial survey to check the bay for cetacean activity). Occasional checks during the day found no cetacean activity in the bay.

The two species of cetacean identified were; common dolphin (*Delphinus delphis*), and bottlenose dolphin (*Tursiops truncatus*). Three sightings of unidentified dolphin species were made; these were thought to be common dolphins. The single sighting of a group of five bottlenose dolphins occurred at Roche's Point, at the entrance to Cork Harbour. Later observation by an IWDG volunteer on shore, confirmed the group to consist of four adults and one calf/juvenile. The animals were observed feeding and tossing fish close to the shore at Roche's Point.

Common dolphins were the most commonly encountered cetacean species and were found throughout most of the survey area. Relative abundance of common dolphins varied from 0 – 23.7aph with the highest relative abundances recorded off the Waterford coast, (Figure 19). Group size ranged from 1 – 160 animals, with a mean group size of 23.3 animals (SD=36.68).

There was a marked absence of baleen whale activity during this survey. During the 2004 herring acoustic survey (conducted during late November and December) fin whales and humpback whales occurred frequently along the south coast from Clear Island to Hook Head. Less common dolphin activity was encountered during the current survey in comparison to 2004, although this may be due to poor weather conditions limiting survey effort in the areas of highest noted activity in 2004
Although a number of individual sightings of fin and humpback whales were made by IWDG volunteers from shore during the survey period, no large whale activity was sighted from the ship, suggesting that the small number of whales present during the period were active close inshore.

It is possible that the lack of large whale activity was purely due to the earlier dates set for the 2005 survey, however it is planned to assess fisheries and hydrographic data to see whether there is a more specific ecosystem based explanation for the differences in large whale activity between 2004 and 2005.

Discussion

Overall, the 2005 survey program was deemed a success. Little time was lost due to adverse weather, which allowed for extensive trawl sampling to be carried out. The hydrographic component of the survey onboard the *Celtic Explorer* had to be cut due to mechanical failure and a small amount of downtime occurred as a result.

The acoustic time series of abundance and biomass estimates for this stock is highly variable with much noise in the data. The overall trend appears to be downward since the mid-1990's. The 2004 acoustic stock estimate for herring was the lowest in the time series (Table 15). The standard operating procedure for ICES assessments of stocks is to use the abundance of 2 to 5-winter rings only. Furthermore, acoustic estimates of SSB are not used, because of poor model diagnostics. Therefore, the most important information from the current survey is the abundance at age data.

The biomass estimate of herring generated from the broad scale survey (*Celtic Explorer)* reflects the stock age structure as revealed from sampling of commercial landings data. In both instances the lack of 3 winter ring fish is strongly evident. The progression of this age class has been monitored through the stock with routine sampling of commercial landings and the 2004 acoustic survey. It appears from the 2005 survey results that a moderately strong 2-winter ring year class exists in the Celtic Sea, the temporal progression of which will continue to be monitored. Confidence in the 2005 herring estimate is relatively high due to the number of marks assigned to the definitely herring category and the degree of coverage obtained from a two vessel survey. However, the low number of single large high density herring marks which contribute a high proportion of the overall estimate should be considered.

Further work is required into the linking of hydrographic data with herring distribution and the abiotic factors that determine spawning migration patterns. It is intended to increase the degree of coverage in the 2006 survey to help increase the understanding of the environmental queues used by herring in the Celtic Sea.

The timing of the survey was considered to be good and the stock was deemed to be adequately covered within the survey confines. The small scale survey (*Regina Ponti*) confirmed herring to be distributed mainly outside 10 nmi from the coastline, by their lack of presence within the survey area. The use of an additional vessel to survey the Celtic Sea stock concurrently with the *Celtic Explorer* does not therefore provide any additional benefit to the overall survey. The use of a commercial vessel for future surveys would be better suited to either assessing summer offshore feeding grounds or detailed surveying of winter spawning sites.

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We would like to express our thanks to the skipper and crew of the FV *Regina Ponti* We would like to thank all the skippers who provided position information on the whereabouts of herring schools prior to the survey start.

Participants List (C. Explorer)

Leg 1	Capacity
Ciaran O'Donnell	Cruise Leader (SIC)
Graham Johnston	
Ian Doonan	
Deirdre lynch	(Deck Scientist)
Grainne Ni Chonchuir	
Theresa Mahon	(Student)
Naomia Soffer	(Student)
Dermot Fee	(Student)
Frankie Griffin	(Gear Consultant)

Leg 2	Capacity
Graham Johnston	(SIC)
Ian Doonan	
Deirdre lynch	(Deck Scientist)
Turloch Smith	
Afra Egan	
Brendan O'Hea	
Susan Beattie	
Roisin Ni Bhrian	(Student)

Participants List (R. Ponti)

Name	Capacity
Ciaran O'Donnell	Cruise Leader (SIC)
Robert Bunn	
Macdara O'Cuaig	
Ross Fitzgerald	

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Table 1. Settings for the Simrad ER 60 echosounder on the *C Explorer*, employed during the Celtic Sea and VIIb-aS herring acoustic survey, October 2005.

Echo sounder:		Simrad ER 60
Frequency:		38 kHz
Transducer:		ES 38B- Serial
Absorption Coefficient:		0.067 dB/Km (manual)
Pulse length:		1.024 m/s
Bandwidth:		2.425 KHz
Transmitting Power:		2000 W (Max)
Angle Sensitivity:		21.9 dB
2- way beam angle:		-20.6
Gain:		25.98
S_A Correction:		-0.70
3 dB Beam Width:		
	Alongship:	6.96°
	Athwartship:	.04°
Max Range:		500m

Table 2. Settings for the Simrad EK 60 echosounder towed body onboard the *R Ponti*, employed during the Celtic Sea (VIIg) commercial herring acoustic survey, October 2005.

Echo sounder:		Simrad EK 60
Frequency:		38 kHz
Transducer:		ES 38B- Serial
Absorption Coefficient:		0.067 dB/Km (manual)
Pulse length:		1.024 m/s
Bandwidth:		2.43 KHz
Transmitting Power:		2000 W (Max)
Angle Sensitivity:		21.9 dB
2- way beam angle:		-20.6
Gain:		26.09
S_A Correction:		-0.70
3 dB Beam Width:		
	Alongship:	6.97°
	Athwartship:	7.00°
Max Range:		250m

Table 3. Celtic Sea and VIIj herring acoustic survey 2005. Position, water depth, depth of trawling and percentage species composition of fishing hauls carried out on the *C Explorer*. (* denotes: non pelagic species and invertebrate catch).

No.	Date	Lat.	Lon.	Time	Bottom	Target	Bulk Catch	Herring	Mackerel	Scad	Sprat	Pilchard	Others*
		N	W		(m)	(m)	(t)	%	%	%	%	%	%
1	02-Oct	52 43.08	9 53.10	11:58	75	10	163	-	90	9.6	0.19		0.1
2	02-Oct	52 34.30	10 00.23	18:25	75	15	39	-	83	1.45	14.08	-	1.86
3	03-Oct	52 29.39	9 58.15	01:11	40	10	170	0.63	84.43	-	2.39	2.72	9.43
4	03-Oct	52 27.18	10 11.53	07:37	80	5	200	-	3.53	94.6	-	-	1.83
5	04-Oct	52 14.13	10 57.62	09:00	130	70	110	-	99.85	-	-	-	0.15
6	04-Oct	52 03.41	10 46.31	12:42	92	15	0	-	-	-	-	-	-
7	04-Oct	52 03.37	11 03.56	19:45	140	6	50	-	-	-	-	-	100
8	05-Oct	51 52.57	11 04.04	04:00	160	110	60	-	-	-	-	-	101
9	05-Oct	52 02.88	10 13.05	11:40	35	6	100	-	98.06	-	1.68	0.46	-
10	05-Oct	52 04.15	10 24.61	14:14	41	5	56	4.2	94.6	-	-	0.89	0.3
11	07-Oct	51 31.88	09 49.57	08:15	64	10	110	0.007	-	-	93.9	-	6
12	07-Oct	51 28.34	09 22.88	16:13	55	10	165	1.6	0.09	-	98.3	-	-
13	08-Oct	51 34.48	08 40.57	04:15	35	10	0	-	-	-	-	-	-
14	08-Oct	51 34.41	08 31.41	13:08	60	12	118	-	1.21	-	98.78	-	0.006
15	08-Oct	51 38.08	08 30.88	15:12	25	0	500	98.47	0.37	-	-	1.16	-
16	09-Oct	51 41.93	08 15.84	11:38	40	0	87	-	14.75	-	-	84.93	0.32
17	09-Oct	51 24.17	08 15.85	16:35	90	0	68	-	0.14	-	67.72	-	32.14
18	09-Oct	51 04.95	08 12.57	23:05	103	0	0	-	-	-	-	-	-
19	10-Oct	51 44.33	08 09.21	04:47	45	10	150	-	46.75	-	29.9	7.47	15.88
20	10-Oct	51 45.81	08 02.66	18:35	38	10	150	-	29.14	-	0.05	70.15	0.67
21	11-Oct	51 47.76	07 59.22	06:14	30	16	93		98.06		1.76		0.19
22	11-Oct	51 49.43	07 57.66	12:20	22	5	11	27.93	72.07				
23	11-Oct	51 39.53	07 56.27	14:42	80	10	74		0.84	0.36	97.06		1.63
24	13-Oct	51 51.46	07 46.29	06:02	25	6	300		99.04				0.96
25	13-Oct	51 46.67	07 43.01	09:05	70	5	400		1.13		97.98		0.89
26	13-Oct	51 14.44	07 39.86	16:10	95	5	28	22.28	7.77	0.49	21.51		47.94

Table 3 cont.

No.	Date	Lat.	Lon.	Time	Bottom	Target	Bulk Catch	Herring	Mackerel	Scad	Sprat	Pilchard	Others*
		N	W		(m)	(m)	(t)	%	%	%	%	%	%
28	15-Oct	51 02.02	07 36.52	07:22	100	20	1000	97.78	1.99		0.04		0.21
29	15-Oct	51 20.66	07 33.42	12:15	85	10	63	0.35	99.55	0.001			0.1
30	15-Oct	51 31.11	07 33.21	14:30	80	10	1200	91.58	6.06		2.36		
31	15-Oct	51 58.91	07 33.33	18:21	35	10	300	93.96		0.001	4.18	0.32	1.54
32	16-Oct	52 03.74	07 26.89	09:10	36	5	130	0.47	6.56		92.28		0.61
33	16-Oct	51 58.13	07 23.57	11:44	53	2	200		22.82	76.86			0.33
34	16-Oct	51 27.91	07 23.41	16:10	86	5	140	96.34			3.65		
35	17-Oct	51 07.35	07 14.05	11:36	90	22	67	27.76			70.57		1.67
36	17-Oct	51 59.27	07 13.61	17:44	59	5	120	0.14			96.9		2.93
37	18-Oct	52 03.44	07 07.33	05:56	40	10	400		22.9		0.04	76.7	0.4
38	18-Oct	51 56.23	07 03.68	08:42	65	13	24		3.9		85.9	9.6	0.7
39	18-Oct	52 01.09	07 00.43	18:00	52	5							
40	18-Oct	52 00.09	06 56.99	20:46	55	6	130		1.23	96.09		0.5	2.18
41	19-Oct	52 02.00	06 50.47	11:29	47		250	0.28	31.36	18.67		46.96	2.73
42	19-Oct	52 09.78	06 47.25	19:57	22	4	2000	99.71	0.29				
43	20-Oct	51 43.09	06 37.55	08:17	68	12	76		5.28		94.74		0.08
44	20-Oct	51 26.14	07 20.17	14:25	82	8	800	100					
45	20-Oct	51 26.41	07 16.19	20:24	80	32	400	95.91			4.07	0.02	

Table 4. Celtic Sea (VIIg) herring acoustic survey 2005. Position, water depth, depth of trawling and percentage species composition of fishing hauls carried out onboard the *R Ponti*. (* denotes: non pelagic species and invertebrate catch).

No.	Date	Lat.	Lon.	Time	Bottom	Target	Bulk Catch	Herring	Mackerel	Scad	Sprat	Pilchard	Others*
		N	W		(m)	(m)	(t)	%	%	%	%	%	%
1	02-Oct	52 43.08	9 53.10	11:58	75	10	163	-	90	9.6	0.19		0.1
2	02-Oct	52 34.30	10 00.23	18:25	75	15	39	-	83	1.45	14.08	-	1.86
3	03-Oct	52 29.39	9 58.15	01:11	40	10	170	0.63	84.43	-	2.39	2.72	9.43
4	03-Oct	52 27.18	10 11.53	07:37	80	5	200	-	3.53	94.6	-	-	1.83
5	04-Oct	52 14.13	10 57.62	09:00	130	70	110	-	99.85	-	-	-	0.15
6	04-Oct	52 03.41	10 46.31	12:42	92	15	0	-	-	-	-	-	-
7	04-Oct	52 03.37	11 03.56	19:45	140	6	50	-	-	-	-	-	100
8	05-Oct	51 52.57	11 04.04	04:00	160	110	60	-	-	-	-	-	101
9	05-Oct	52 02.88	10 13.05	11:40	35	6	100	-	98.06	-	1.68	0.46	-
10	05-Oct	52 04.15	10 24.61	14:14	41	5	56	4.2	94.6	-	-	0.89	0.3
11	07-Oct	51 31.88	09 49.57	08:15	64	10	110	0.007	-	-	93.9	-	6
12	07-Oct	51 28.34	09 22.88	16:13	55	10	165	1.6	0.09	-	98.3	-	-
13	08-Oct	51 34.48	08 40.57	04:15	35	10	0	-	-	-	-	-	-
14	08-Oct	51 34.41	08 31.41	13:08	60	12	118	-	1.21	-	98.78	-	0.006
15	08-Oct	51 38.08	08 30.88	15:12	25	0	500	98.47	0.37	-	-	1.16	-

Table 5. Percentage length frequency of herring from trawl catches, as used in calculating abundance. Celtic Sea and VIIj herring acoustic survey 2005.

Haul	10	11+12	15	26+28	31	30+34	42	44	
Length (cm)									**Total**
13		3							**3**
13.5		1							**1**
14		7							**7**
14.5		3							**3**
15		20							**20**
15.5		10							**10**
16	6	34							**40**
16.5	17	11							**28**
17	33	7							**40**
17.5	33	2							**35**
18	11								**11**
18.5									
19		1							**1**
19.5					1				**1**
20				1	8	1		1	**10**
20.5			1	2	6	1		1	**10**
21			4	4	10	2	1	1	**21**
21.5			6	3	7	1	0	3	**21**
22		2	6	4	7	5	3	5	**32**
22.5			6	5	5	5	7	8	**36**
23			7	11	6	9	7	9	**49**
23.5			8	8	4	12	8	14	**54**
24			4	9	5	10	7	11	**47**
24.5			7	7	2	9	8	9	**42**
25			7	6	4	9	12	6	**44**
25.5			6	3	5	5	13	5	**38**
26			9	11	9	6	12	6	**54**
26.5			14	10	8	10	9	6	**57**
27			7	7	8	8	5	6	**42**
27.5			5	7	3	4	4	5	**28**
28			2	1	1	2	2	1	**10**
28.5							1	1	**2**
29							1		**1**
29.5									
30									
Total	**100**	**98**	**99**	**99**	**99**	**99**	**100**	**98**	**792**
%	**12.62**	**12.37**	**12.50**	**12.50**	**12.50**	**12.50**	**12.62**	**12.37**	**100**

Table 6. Age length key composed from herring samples taken from survey trawls. Celtic Sea and VIIj herring acoustic survey 2005.

Age (winter rings)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Length (cm)									**Total**
13	1								**1**
13.5	1								**1**
14	3								**3**
14.5									**0**
15	9								**9**
15.5	4								**4**
16	20								**20**
16.5	5								**5**
17	16								**16**
17.5	10								**10**
18	1								**1**
18.5	1								**1**
19		1							**1**
19.5		5							**5**
20		13							**13**
20.5		6	1						**7**
21		17		1					**18**
21.5		12	1		1				**14**
22		18	7		3				**28**
22.5		13	17		1				**31**
23		3	27		2				**32**
23.5		11	30		1				**42**
24		5	45	3	2	1			**56**
24.5		1	26	2	5				**34**
25		1	20	6	7	1			**35**
25.5		1	17	5	16				**39**
26		5	11	12	34	2			**64**
26.5		1	6	13	14	7	1	1	**43**
27			6	6	12	14	2		**40**
27.5			1	3	6	12	2		**24**
28				2	4		2		**8**
28.5					1	1	2		**4**
29									**0**
30									
Total	**71**	**113**	**215**	**53**	**109**	**38**	**9**	**1**	**609**
%	**12**	**19**	**35**	**9**	**18**	**6**	**1**	**0**	**100**

Table 7. Total biomass (tonnes) of herring at age (winter rings) by ICES subdivision from the *C Explorer* survey. Celtic Sea and VIIj herring survey 2005.

Rings	0	1	2	3	4	5	6	7	Total
EO 34-4	0	0	0	0	0	0	0	0	**0**
D9 33-5	147	0	0	0	0	0	0	0	**147**
D9 33-9	998	0	0	0	0	0	0	0	**998**
EO 32-7	10	0	0	0	0	0	0	0	**10**
EO 31-1	1	0	0	0	0	0	0	0	**1**
EO 31-2	16	0	0	0	0	0	0	0	**16**
EO 31-4	41	1	0	0	0	0	0	0	**42**
EO 31-5	98	2	0	0	0	0	0	0	**101**
E1 32-8	0	303	715	271	499	219	47	8	**2063**
E1 31-2	0	293	691	262	482	212	46	8	**1995**
E1 31-5	0	58	137	52	95	42	9	2	**394**
E2 32-4	0	9	0	0	0	0	0	0	**10**
E2 32-2	0	4	1	0	0	0	0	0	**5**
E2 32-5	0	348	1208	330	607	274	73	8	**2849**
E2 32-7	0	11	0	0	0	0	0	0	**11**
E2 32-8	0	1513	5208	1421	2619	1182	316	35	**12294**
E2 31-2	0	256	372	61	120	49	11	1	**871**
E2 31-4	0	12	66	38	69	40	8	1	**233**
E2 31-5	0	919	1678	277	540	219	51	5	**3690**
E2 31-7	0	110	356	112	208	108	22	3	**918**
E2 31-8	0	131	569	272	498	280	54	7	**1810**
E3 33-1	0	0	0	0	0	0	0	0	**0**
E3 32-1	0	1	1	0	0	0	0	0	**2**
E3 32-4	0	559	1775	384	771	352	93	8	**3941**
E3 32-7	0	0	0	0	0	0	0	0	**0**
E3 31-1	0	1	1	0	0	0	0	0	**2**
E3 33-4	0	0	0	0	0	0	0	0	**0**
E3 33-7	0	1	1	0	0	0	0	0	**2**
E2 32-9	0	0	0	0	0	0	0	0	**0**
D9 33-8	512	0	0	0	0	0	0	0	**512**
Total	**1823**	**4534**	**12778**	**3480**	**6511**	**2976**	**730**	**86**	**32918**
%	**6**	**14**	**39**	**11**	**20**	**9**	**2**	**0**	**100**

Table 8. Total numbers (millions) of herring at age by ICES subdivision from the *C Explorer* survey. Celtic Sea and VIIj herring survey 2005.

Rings	0	1	2	3	4	5	6	7	Total
EO 34-4	0	0	0	0	0	0	0	0	**0**
D9 33-5	4	0	0	0	0	0	0	0	**4**
D9 33-9	30	0	0	0	0	0	0	0	**30**
EO 32-7	0	0	0	0	0	0	0	0	**0**
EO 31-1	0	0	0	0	0	0	0	0	**0**
EO 31-2	1	0	0	0	0	0	0	0	**1**
EO 31-4	1	0	0	0	0	0	0	0	**1**
EO 31-5	4	0	0	0	0	0	0	0	**4**
E1 32-8	0	4	6	2	4	1	0	0	**17**
E1 31-2	0	3	6	2	3	1	0	0	**17**
E1 31-5	0	1	1	0	1	0	0	0	**3**
E2 32-4	0	0	0	0	0	0	0	0	**0**
E2 32-2	0	0	0	0	0	0	0	0	**0**
E2 32-5	0	4	11	2	4	2	0	0	**24**
E2 32-7	0	0	0	0	0	0	0	0	**0**
E2 32-8	0	18	48	10	19	8	2	0	**104**
E2 31-2	0	4	4	0	1	0	0	0	**9**
E2 31-4	0	0	1	0	0	0	0	0	**2**
E2 31-5	0	13	16	2	4	1	0	0	**37**
E2 31-7	0	1	3	1	2	1	0	0	**8**
E2 31-8	0	1	5	2	3	2	0	0	**14**
E3 33-1	0	0	0	0	0	0	0	0	**0**
E3 32-1	0	0	0	0	0	0	0	0	**0**
E3 32-4	0	6	17	3	6	2	1	0	**34**
E3 32-7	0	0	0	0	0	0	0	0	**0**
E3 31-1	0	0	0	0	0	0	0	0	**0**
E3 33-4	0	0	0	0	0	0	0	0	**0**
E3 33-7	0	0	0	0	0	0	0	0	**0**
E2 32-9	0	0	0	0	0	0	0	0	**0**
D9 33-8	15	0	0	0	0	0	0	0	**15**
Total	**56**	**56**	**118**	**25**	**47**	**19**	**4**	**1**	**324.97**
%	**17**	**17**	**36**	**8**	**15**	**6**	**1**	**0**	**100**

Table 9. Breakdown of herring biomass (tonnes) at maturity by ICES subdivision from the *C Explorer* survey. Totals do not account for the "possibly" herring classification Celtic Sea and VIIj herring survey 2005.

	Immature	Mature	Spent	SSB
EO 34-4	0	0	0	**0**
D9 33-5	146	0	0	**0**
D9 33-9	140	0	0	**0**
EO 32-7	9	0	0	**0**
EO 31-1	7	0	0	**0**
EO 31-2	15	0	0	**0**
EO 31-4	9	0	0	**0**
EO 31-5	91	0	0	**0**
E1 32-8	210	1847	6	**1853**
E1 31-2	110	967	3	**970**
E1 31-5	42	371	1	**372**
E2 32-4	0	0	0	**0**
E2 32-2	4	1	0	**1**
E2 32-5	311	5665	21	**5686**
E2 32-7	0	0	0	**0**
E2 32-8	891	11361	44	**11405**
E2 31-2	147	669	1	**669**
E2 31-4	4	228	1	**229**
E2 31-5	522	2209	2	**2211**
E2 31-7	65	852	2	**854**
E2 31-8	136	1843	4	**1847**
E3 33-1	0	0	0	**0**
E3 32-1	0	0	0	**0**
E3 32-4	325	3608	10	**3618**
E3 32-7	0	0	0	**0**
E3 31-1	1	1	0	**1**
E3 33-4	0	0	0	**0**
E3 33-7	0	0	0	**0**
E2 32-9	0	0	0	**0**
Total	**3186**	**29624**	**94**	**29718**
%	**10**	**90**	**0**	**100**

Table 10. Total breakdown of herring numbers (millions) at maturity by ICES subdivision from the *C Explorer* survey. Totals do not account for the possibly herring classification. Celtic Sea and VIIj herring survey 2005.

	Immature	Mature	Spent	SSN
EO 34-4	0	0	0	**0**
D9 33-5	4	0	0	**4**
D9 33-9	30	0	0	**30**
EO 32-7	0	0	0	**0**
EO 31-1	0	0	0	**0**
EO 31-2	1	0	0	**1**
EO 31-4	1	0	0	**1**
EO 31-5	4	0	0	**4**
E1 32-8	3	15	0	**17**
E1 31-2	3	14	0	**17**
E1 31-5	1	3	0	**3**
E2 32-4	0	0	0	**0**
E2 32-2	0	0	0	**0**
E2 32-5	3	21	0	**24**
E2 32-7	0	0	0	**0**
E2 32-8	12	92	0	**104**
E2 31-2	3	6	0	**9**
E2 31-4	0	2	0	**2**
E2 31-5	10	27	0	**37**
E2 31-7	1	7	0	**8**
E2 31-8	1	13	0	**14**
E3 33-1	0	0	0	**0**
E3 32-1	0	0	0	**0**
E3 32-4	4	30	0	**34**
E3 32-7	0	0	0	**0**
E3 31-1	0	0	0	**0**
E3 33-4	0	0	0	**0**
E3 33-7	0	0	0	**0**
E2 32-9	0	0	0	**0**
D9 33-8	15	0	0	**15**
Total	**95**	**229**	**0**	**230**
%	**29**	**71**	**0**	**100**

Table 11. Biomass (tonnes) of herring at age (winter rings) from the *R Ponti* survey. Celtic Sea (VIIg) commercial herring acoustic survey 2005.

Rings	0	1	2	3	4	5	6	7	Total
E2 32-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
E2 32-2	0.00	1711.69	1856.96	708.84	1372.36	601.02	148.05	17.69	**6416.63**
E2 33- 9	0.00	214.06	232.22	88.64	171.62	75.16	18.51	2.21	**802.43**
E3 33-7	0.00	3.28	15.17	4.82	9.95	3.40	1.35	0.09	**38.06**
E3 33- 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
E2 32-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Total	**0.00**	**1929.03**	**2104.36**	**802.31**	**1553.93**	**679.58**	**167.92**	**19.99**	**7257.12**
%	**0.00**	**26.58**	**29.00**	**11.06**	**21.41**	**9.36**	**2.31**	**0.28**	**100.00**

Table 12. Numbers (millions) of herring at age (winter rings) from the *R Ponti* survey. Celtic Sea (VIIg) commercial herring acoustic survey 2005.

Rings	0	1	2	3	4	5	6	7	Total
E2 32-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
E2 32-2	0.00	23.64	17.25	5.08	10.01	3.79	0.84	0.12	**60.74**
E2 33- 9	0.00	2.96	2.16	0.64	1.25	0.47	0.11	0.01	**7.60**
E3 33-7	0.00	0.03	0.14	0.03	0.07	0.02	0.01	0.00	**0.31**
E3 33- 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
E2 32-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Total	**0.00**	**26.63**	**19.55**	**5.76**	**11.33**	**4.29**	**0.95**	**0.13**	**68.64**
%	**0.00**	**38.79**	**28.48**	**8.38**	**16.51**	**6.25**	**1.39**	**0.20**	**100.00**

Table 13. Biomass (tonnes) of herring at maturity from the *R Ponti* survey. Celtic Sea (VIIg) herring acoustic survey 2005.

	Immature	Mature	Spent	SSB
E2 32-1	0.00	0.00	0.00	**0.00**
E2 32-2	1441.69	4959.75	15.19	**4974.94**
E2 33- 9	180.29	620.24	1.90	**622.14**
E3 33-7	1.44	36.49	0.13	**36.62**
E3 33- 4	0.00	0.00	0.00	**0.00**
E2 32-4	0.00	0.00	0.00	**0.00**
Total	**1623.41**	**5616.48**	**17.22**	**5633.70**
%	**22.37**	**77.39**	**0.24**	**100**

Table 14. Numbers (millions) of herring at maturity from the *R Ponti* survey. Celtic Sea (VIIg) herring acoustic survey 2005.

	Immature	Mature	Spent	SSN
E2 32-1	0.00	0.00	0.00	**0.00**
E2 32-2	20.92	39.73	0.09	**39.82**
E2 33- 9	2.62	4.97	0.01	**4.98**
E3 33-7	0.02	0.29	0.00	**0.29**
E3 33- 4	0.00	0.00	0.00	**0.00**
E2 32-4	0.00	0.00	0.00	**0.00**
Total	**23.55**	**44.99**	**0.10**	**45.09**
%	**34.31**	**65.55**	**0.14**	**100.00**

Table 15. Celtic Sea and VIIj Herring acoustic survey time series. Abundance (millions), biomass and SSB (thousand tonnes). Age in winter rings. * The 1999/2000 July survey was not used in tuning.

Season	1990 1991	1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000*	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006
0	205	214	142	259	41	5	3	-	-	13	-	23	19	-	25	26	13
1	132	63	427	217	38	280	134	-	21	398	23	18	30	41	73	13	54
2	249	195	117	438	127	551	757	-	157	208	97	143	160	176	323	29	125
3	109	95	88	59	160	138	250	-	150	48	85	36	176	142	253	32	26
4	153	54	50	63	11	94	51	-	201	8	16	19	40	27	61	16	50
5	32	85	22	26	11	8	42	-	109	1	21	7	44	6	16	3	20
6	15	22	24	16	7	9	1	-	32	1	8	3	23	8	5	1	5
7	6	5	10	25	2	8	14	-	30	-	2	2	17	3	2	-	1
8	3	6	2	2	3	9	1	-	4	-	1	-	11	-	-	-	-
9+	2	-	1	2	1	5	2	-	1	-	-	1	23	-	-	-	-
Total	904	739	882	1107	399	1107	1253		705	677	252	250	542	404	758	119	292
Biomass	103	84	89	104	52	135	151		111	58	30	33	80	49	89	13	33
SSB	91	77	71	90	51	114	146		111	23	26	32	74	39	86	10	30

Table 16. Breakdown of pilchard biomass (tonnes) by ICES subdivision from the *C Explorer* survey. Celtic Sea and VIIj herring survey 2005.

	Def	Prob	Poss	Mix	TSB
D9 32-3	324	-	-	-	**324**
D9 33-8	19	-	-	-	**19**
E1 32-5	7	-	-	-	**7**
E1 32-6	8	-	-	-	**8**
E1 31-3	2374	-	-	201	**2575**
E1 31-6	-	-	-	561	**561**
E1 31-9	-	-	-	510	**510**
E2 32-2	207	-	-	257	**464**
E2 32-5	577	-	-	280	**857**
E2 32-8	428	-	-	152	**580**
E2 32-6	1154	-	-	9	**1163**
E2 32-3	290	-	-	1	**291**
E2 31-3	-	-	-	7	**7**
E3 33-7	-	-	-	26	**26**
E2 31-6	-	-	-	205	**205**
E2 33-9	-	-	-	24	**24**
Total	**5388**	**0**	**0**	**2233**	**7621**
%	**70.70**	**0.00**	**0.00**	**29.30**	**100**

Table 17. Breakdown of pilchard numbers (millions) by ICES subdivision from the *C Explorer* survey. Celtic Sea and VIIj herring survey 2005.

	Def	Prob	Poss	Mix	TSN
D9 32-3	4.2	-	-	-	**4.2**
D9 33-8	0.2	-	-	-	**0.2**
E1 32-5	0.1	-	-	-	**0.1**
E1 32-6	0.1	-	-	-	**0.1**
E1 31-3	26.1	-	-	2.2	**28.3**
E1 31-6	-	-	-	6.2	**6.2**
E1 31-9	-	-	-	3.8	**3.8**
E2 32-2	1.6	-	-	1.9	**3.5**
E2 32-5	5.2	-	-	2.5	**7.7**
E2 32-8	3.9	-	-	1.4	**5.3**
E2 32-6	11.2	-	-	0.1	**11.3**
E2 32-3	2.8	-	-	-	**2.8**
E2 31-3	-	-	-	0.1	**0.1**
E3 33-7	-	-	-	0.3	**0.3**
E2 31-6	-	-	-	2	**2**
E2 33-9	-	-	-	0.2	**0.2**
Total	**55.4**	**0**	**0**	**20.7**	**76.1**
%	**72.80**	**0.00**	**0.00**	**27.20**	**100**

Table 18. Breakdown of sprat biomass (tonnes) by ICES subdivision from the *C Explorer* survey. Celtic Sea and VIIj herring survey 2005.

	Def	Prob	Poss	Mix	Total
E0 34-4	381	-	-	-	**381**
D9 34-6	21	-	-	-	**21**
D9 34-8	2	-	-	-	**2**
E0 34-7	33	-	-	-	**33**
E0 33-1	32	-	-	-	**32**
D9 34-9	2	-	-	-	**2**
D9 33-9	1	-	-	-	**1**
D9 33-8	-	-	-	-	**0**
D9 32-9	131	-	-	-	**131**
D9 32-2	48	-	-	-	**48**
D9 32-4	92	-	-	-	**92**
D9 32-6	-	-	-	-	**0**
E0 32-7	548	-	-	-	**548**
E0 31-1	58	-	-	-	**58**
E0 31-5	689	-	-	-	**689**
E0 31-2	599	-	-	-	**599**
E0 31-3	188	-	-	-	**188**
E0 31-6	202	-	-	-	**202**
E1 31-1	231	-	-	-	**231**
E1 31-4	54	-	-	-	**54**
E1 32-5	-	-	-	53	**53**
E1 32-8	6	-	-	437	**443**
E1 31-2	55	-	-	-	**55**
E1 315	636	-	-	1002	**1638**
E1 32-6	-	-	-	947	**947**
E1 32-9	-	-	-	2079	**2079**
E1 31-3	-	-	-	566	**566**
E1 31-6	-	-	-	12	**12**
E2 32-1	-	-	-	1288	**1288**
E2 32-4	-	-	-	4265	**4265**
E2 32-7	215	-	-	868	**1083**
E2 31-4	-	-	-	1122	**1122**
E2 32-2	870	-	-	-	**870**
E2 32-5	180	-	-	-	**180**
E2 32-8	120	-	-	-	**120**
E2 31-2	365	-	-	-	**365**
E2 31-5	291	-	-	-	**291**
E2 31-8	46	-	-	-	**46**
E2 31-9	-	-	-	819	**819**
E2 31-6	-	-	-	602	**602**
E2 33-9	1094	-	-	527	**1621**
E2 32-3	233	-	-	538	**771**
E2 32-6	41	-	-	134	**175**
E2 32-9	194	-	-	941	**1135**
E2 31-3	-	-	-	1596	**1596**
E3 32-4	280	-	-	-	**280**
E3 32-7	-	-	-	608	**608**
E3 31-1	-	-	-	471	**471**
E3 33-7	47	-	-	-	**47**
E3 33-8	897	-	-	854	**1751**
E3 32-2	-	-	-	408	**408**
Total	**8882**	**0**	**0**	**20137**	**29019**
%	**30.61**	**0.00**	**0.00**	**69.39**	**100**

Table 19. Breakdown of sprat numbers (millions) by ICES subdivision from the *C Explorer* survey. Celtic Sea and VIIj herring survey 2005.

	Def	Prob	Poss	Mix	Total
E0 34-4	68	-	-	-	**68**
D9 34-6	4	-	-	-	**4**
D9 34-8	-	-	-	-	**0**
E0 34-7	3	-	-	-	**3**
E0 33-1	3	-	-	-	**3**
D9 34-9	-	-	-	-	**0**
D9 33-9	-	-	-	-	**0**
D9 33-8	-	-	-	-	**0**
D9 32-9	10	-	-	-	**10**
D9 32-2	4	-	-	-	**4**
D9 32-4	7	-	-	-	**7**
D9 32-6	-	-	-	-	**0**
E0 32-7	70	-	-	-	**70**
E0 31-1	7	-	-	-	**7**
E0 31-5	80	-	-	-	**80**
E0 31-2	69	-	-	-	**69**
E0 31-3	22	-	-	-	**22**
E0 31-6	23	-	-	-	**23**
E1 31-1	27	-	-	-	**27**
E1 31-4	6	-	-	-	**6**
E1 32-5	-	-	-	7	**7**
E1 32-8	1	-	-	54	**55**
E1 31-2	6	-	-	-	**6**
E1 315	43	-	-	70	**113**
E1 32-6	-	-	-	66	**66**
E1 32-9	-	-	-	145	**145**
E1 31-3	-	-	-	36	**36**
E1 31-6	-	-	-	1	**1**
E2 32-1	-	-	-	128	**128**
E2 32-4	-	-	-	281	**281**
E2 32-7	12	-	-	51	**63**
E2 31-4	-	-	-	66	**66**
E2 32-2	51	-	-	-	**51**
E2 32-5	10	-	-	-	**10**
E2 32-8	8	-	-	-	**8**
E2 31-2	63	-	-	-	**63**
E2 31-5	50	-	-	-	**50**
E2 31-8	8	-	-	-	**8**
E2 31-9	-	-	-	148	**148**
E2 31-6	-	-	-	109	**109**
E2 33-9	76	-	-	38	**114**
E2 32-3	16	-	-	38	**54**
E2 32-6	3	-	-	10	**13**
E2 32-9	13	-	-	67	**80**
E2 31-3	-	-	-	114	**114**
E3 32-4	19	-	-	-	**19**
E3 32-7	-	-	-	44	**44**
E3 31-1	-	-	-	34	**34**
E3 33-7	6	-	-	-	**6**
E3 33-8	112	-	-	111	**223**
E3 32-2	-	-	-	53	**53**
Total	**900**	**0**	**0**	**1671**	**2571**
%	**35.01**	**0.00**	**0.00**	**64.99**	**100**

Table 20. Biomass (tonnes) of pilchard by ICES subdivision from the *R. Ponti* survey. Celtic Sea (VIIg) herring acoustic survey 2005.

	Def	Prob	Poss	Mix	Total
E1 32- 5	0	0	0	62.2	**62.2**
E1 32-8	161.3	0	0	288.8	**450.1**
E1 31- 2	0	0	0	214.2	**214.2**
E1 32-6	0	0	0	317.3	**317.3**
E1 32-9	0	0	0	228.4	**228.4**
E2 33-9	43.8	0	0	0	**43.8**
E3 33- 4	56.8	0	0	0	**56.8**
E3 33-7	40.2	0	0	0	**40.2**
Total	**302.1**	**0**	**0**	**1110.9**	**1413**

Table 21. Numbers (millions) of pilchard by ICES subdivision from the *R. Ponti* survey. Celtic Sea (VIIg) herring acoustic survey 2005.

	Def	Prob	Poss	Mix	Total
E1 32- 5	0	0	0	1.2	**1.2**
E1 32-8	2.3	0	0	6	**8.3**
E1 31- 2	0	0	0	4.5	**4.5**
E1 32-6	0	0	0	6.2	**6.2**
E1 32-9	0	0	0	4.8	**4.8**
E2 33-9	0.6	0	0	0	**0.6**
E3 33- 4	0.8	0	0	0	**0.8**
E3 33-7	0.6	0	0	0	**0.6**
Total	**4.2**	**0**	**0**	**22.7**	**27**

Table 22. Biomass (tonnes) of sprat by ICES subdivision from the *R. Ponti* survey. Celtic Sea (VIIg) herring acoustic survey 2005.

	Def	Prob	Poss	Mix	Total
E1 32-8	18	0	0	0	**18**
E1 32-6	4.3	0	0	104.7	**109**
E2 32-1	0	0	170.6	26	**26**
E2 32-2	861.5	0	363.6	0	**861.5**
E2 32-4	71.9	0	0	249.4	**321.3**
E2 32-5	0	0	0	0	**0**
E2 33-8	3.5	0	100	0	**3.5**
E2 33-9	718.7	0	0	0	**718.7**
Total	**1677.9**	**0**	**634.2**	**380.1**	**2058**

Table 23. Numbers (millions) of sprat by ICES subdivision from the *R. Ponti* survey. Celtic Sea (VIIg) herring acoustic survey 2005.

	Def	Prob	Poss	Mix	Total
E1 32-8	4.5	0	0	0	**4.5**
E1 32-6	1.1	0	0	26.3	**27.4**
E2 32-1	0	0	28	4.3	**4.3**
E2 32-2	141.2	0	59.6	0	**141.2**
E2 32-4	11.8	0	0	40.9	**52.7**
E2 32-5	0	0	0	0	**0**
E2 33-8	0.6	0	16.4	0	**0.6**
E2 33-9	88.1	0	0	0	**88.1**
Total	**247.2**	**-**	**104**	**71.5**	**318.8**

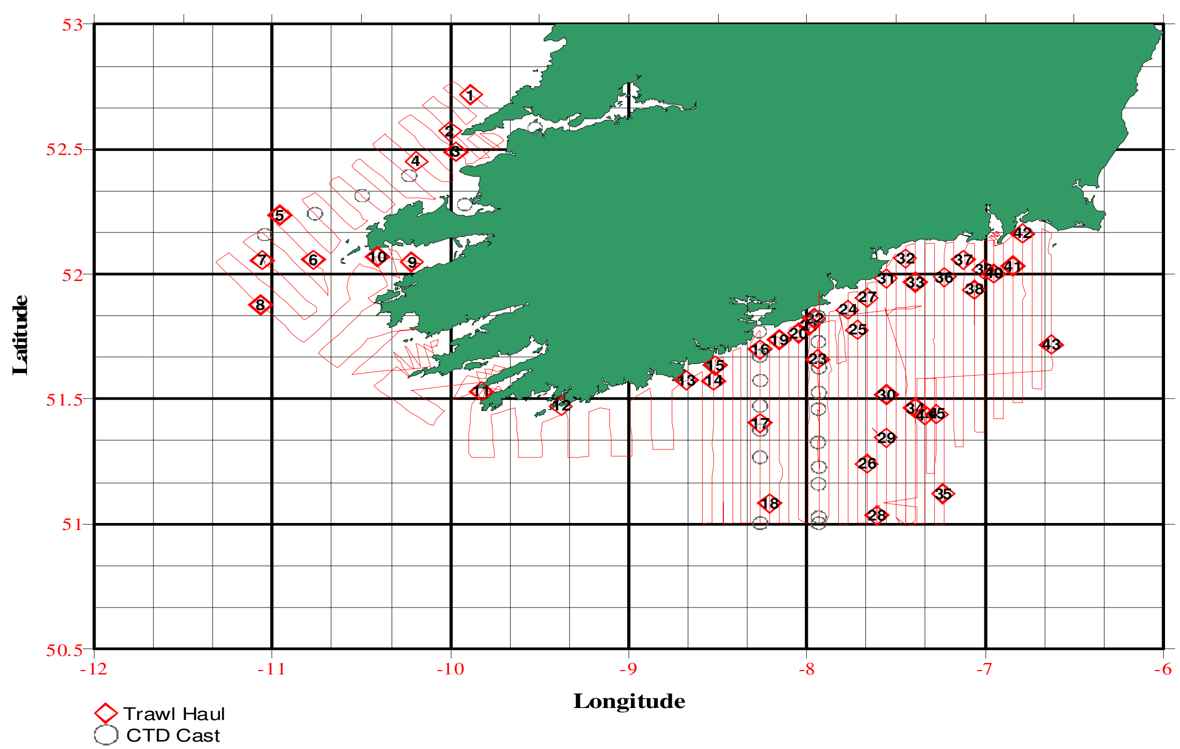


Figure 1. Cruise track haul positions and hydrographic stations for the *C. Explorer* survey. Celtic Sea and Division VIIj herring acoustic survey October, 2005.

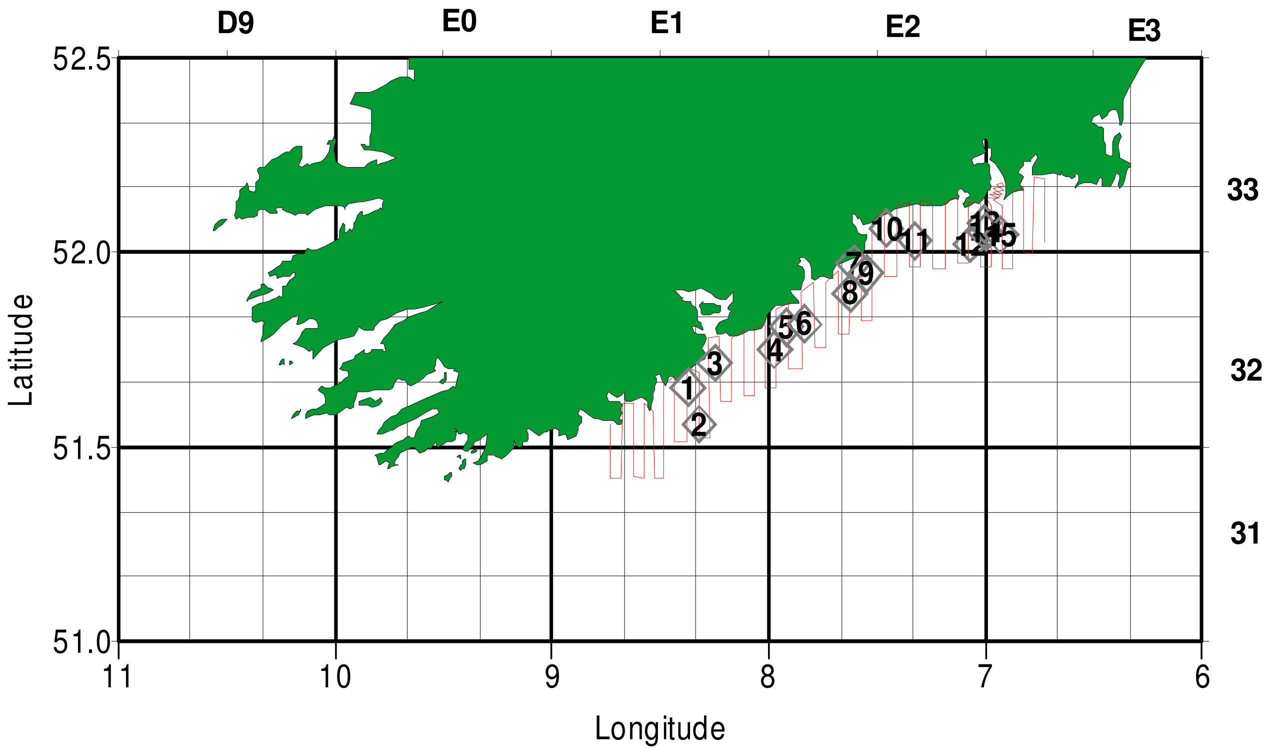


Figure 2. Cruise track and area coverage of the FV *Regina Ponti* during the commercial Celtic Sea acoustic survey, October, 2005. Haul positions are demoted in black and numbered sequentially.

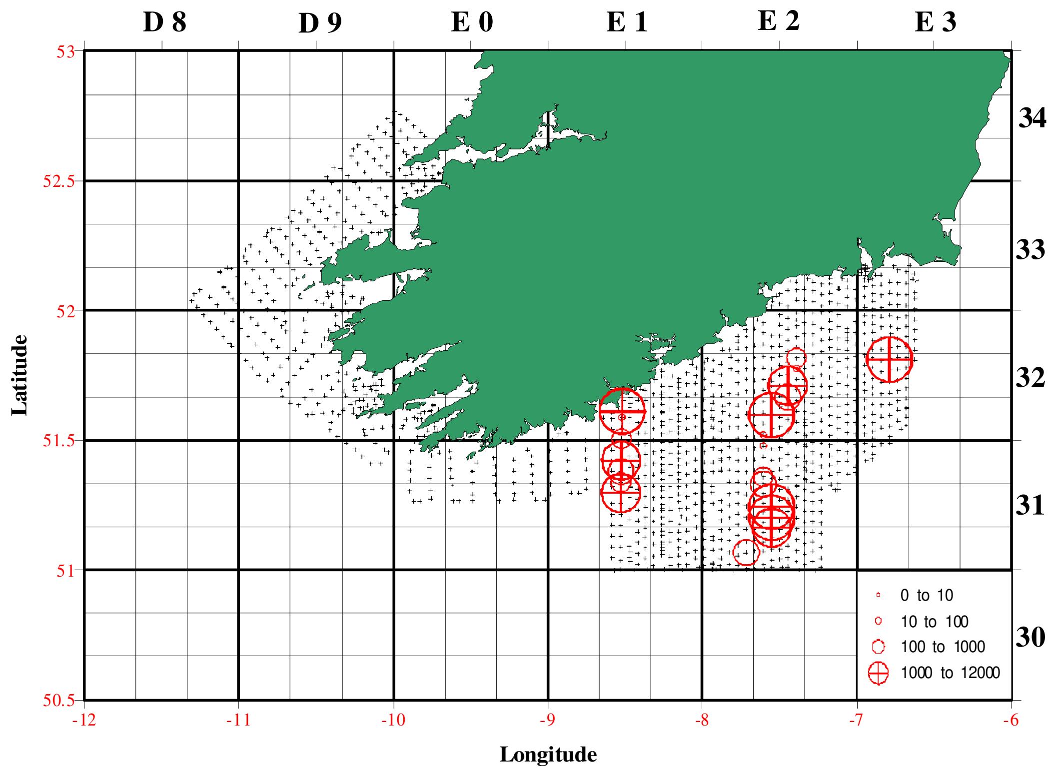


Figure 3. Post plot showing the distribution of "definitely" and "probably" categories of total herring NASC values from the *C. Explorer* survey. Celtic Sea and Division VIIj herring acoustic survey, October, 2005.

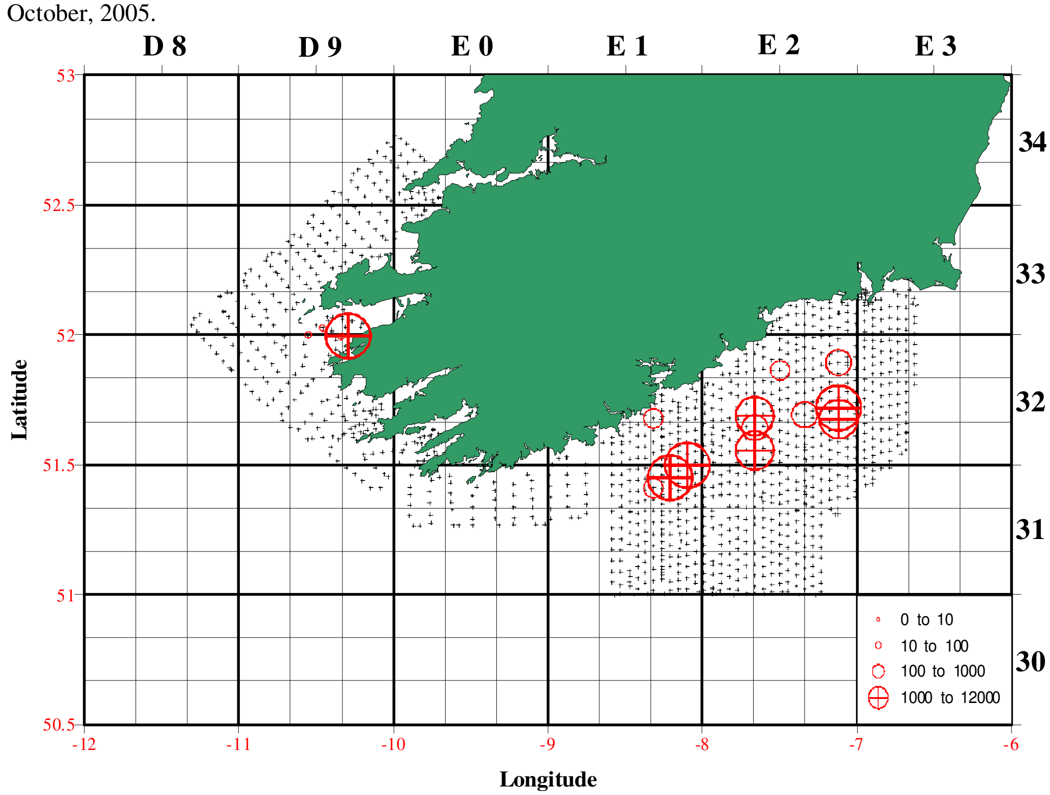


Figure 4. Post plot showing the distribution of "definitely" and "probably" categories of Pilchard NASC. Celtic Sea and Division VIIj herring acoustic survey, October, 2005.

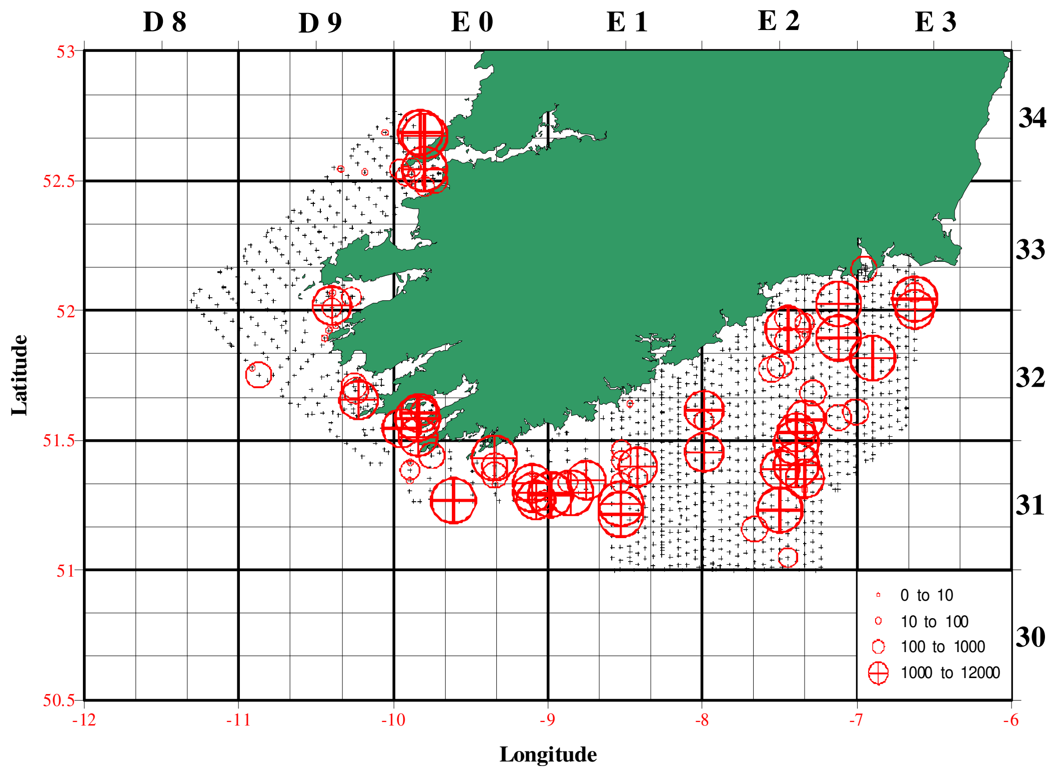


Figure 5. Post plot showing the distribution of "definitely" and "probably" categories of sprat NASC. Celtic Sea and Division VIIj herring acoustic survey, October, 2005.

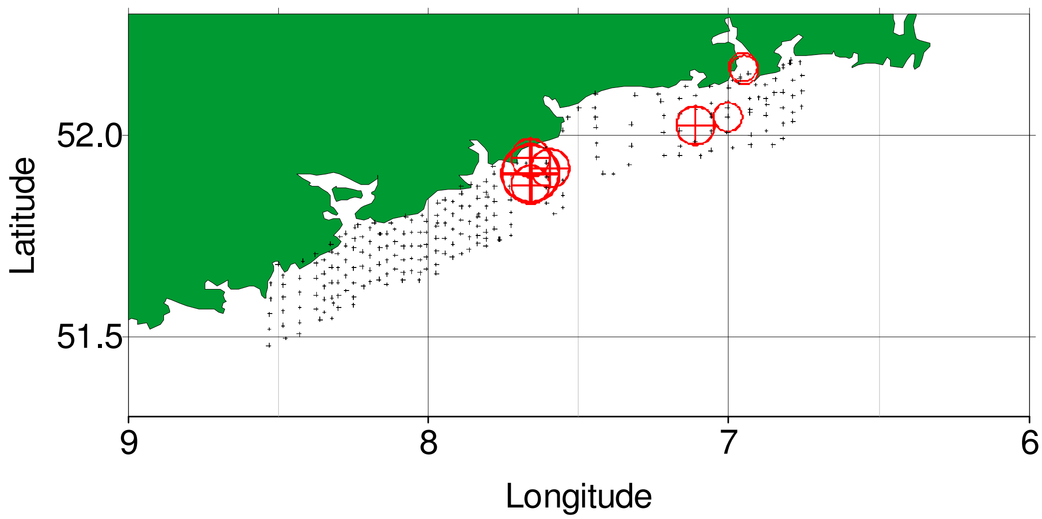


Figure 6. Post plot showing “definitely” and “probably” herring NASC distribution. Regina Ponti Celtic Sea acoustic survey, October, 2005.

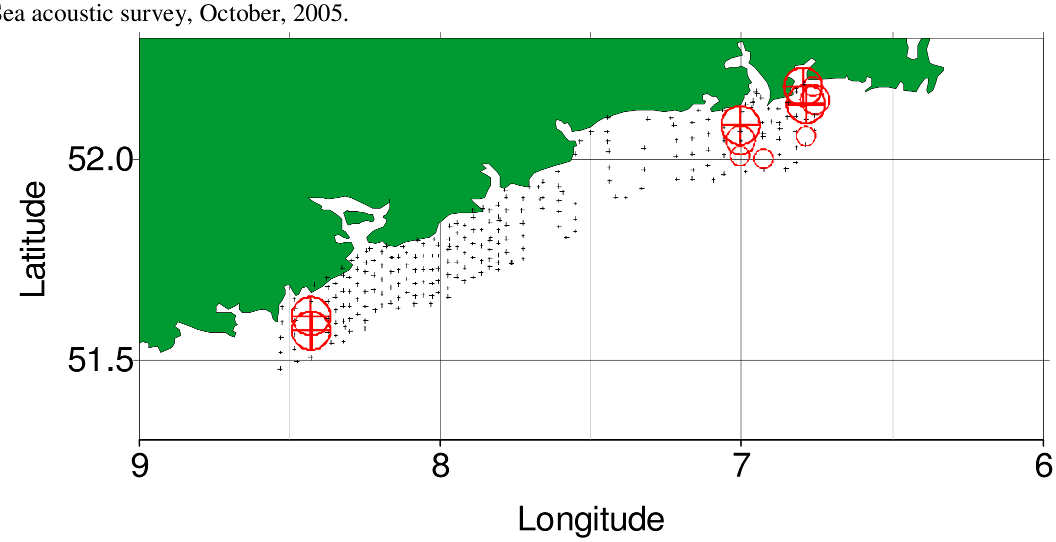


Figure 7. Post plot showing “definitely” and “probably” pilchard NASC distribution. Regina Ponti Celtic Sea acoustic survey, October, 2005.

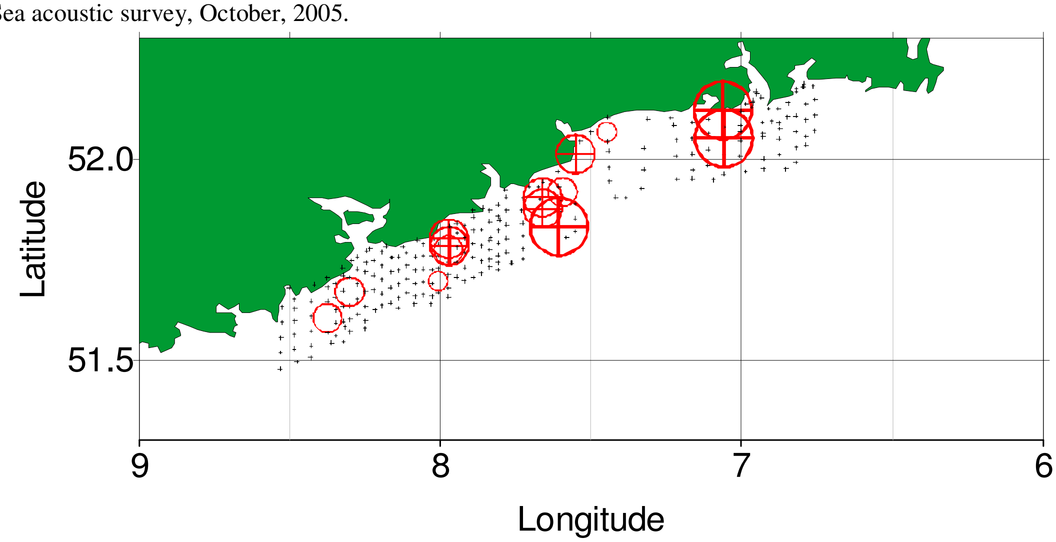
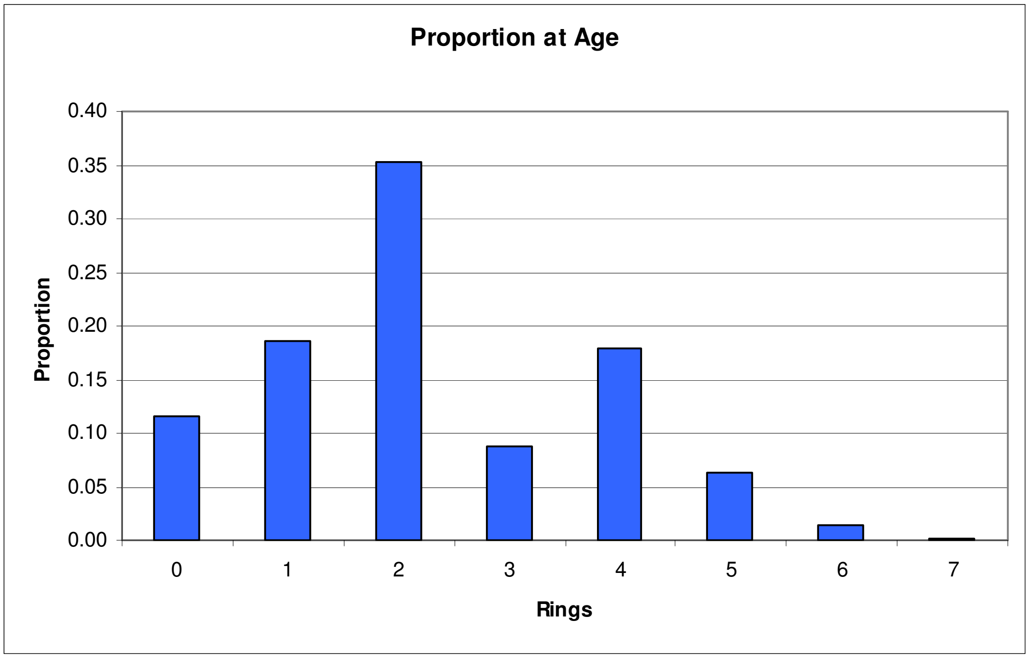


Figure 8. Post plot showing “definitely” and “probably” sprat NASC distribution. Regina Ponti Celtic Sea acoustic survey, October, 2005.



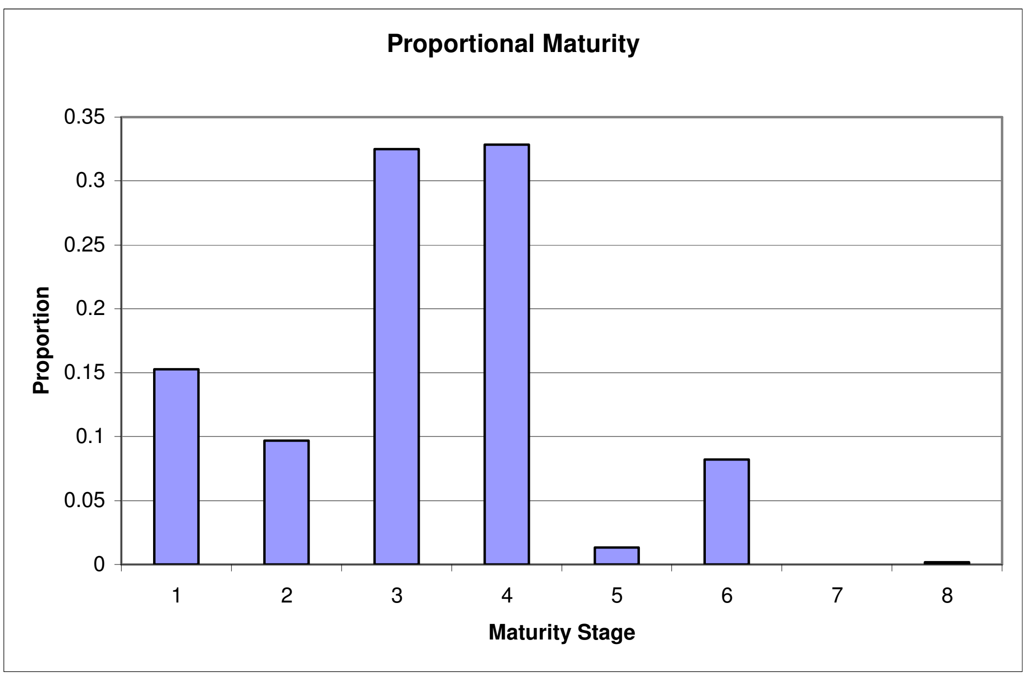
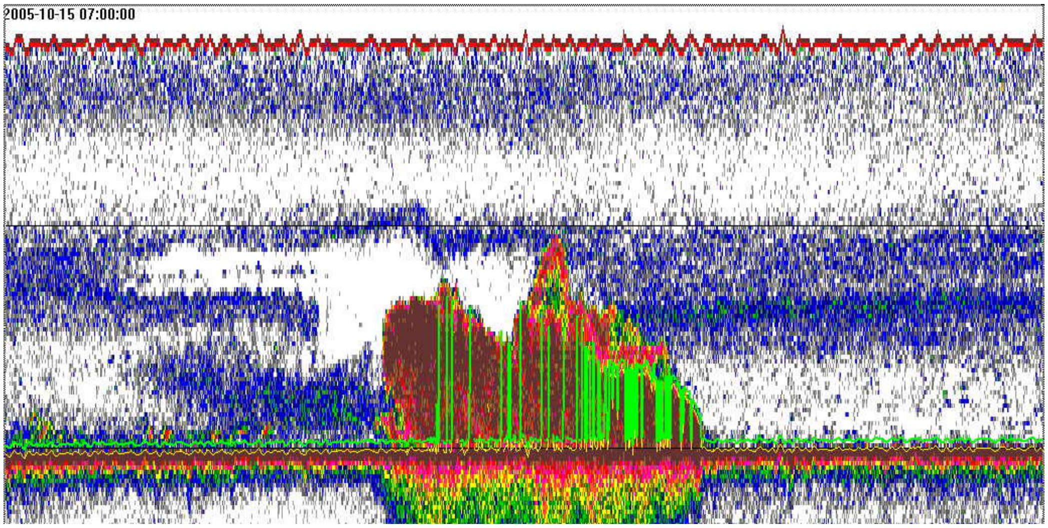
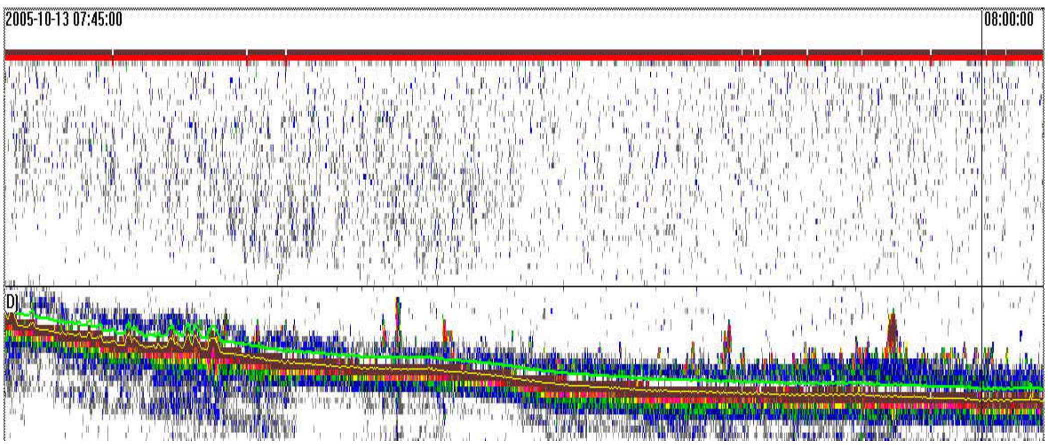


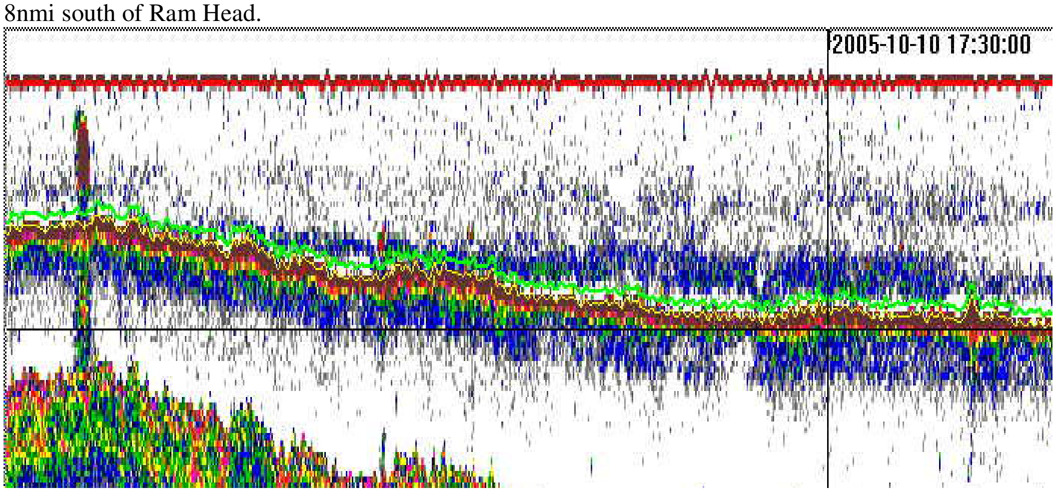
Figure 9. Breakdown of herring ages and maturity from combined survey trawl stations. Celtic Sea and Division VIIj herring acoustic survey, October, 2005.



a). ***Herring mark*** up to 42m tall in 100m of water (Haul 28-off track). Largest herring mark observed during the survey. Located 58nmi south of Mine Head.

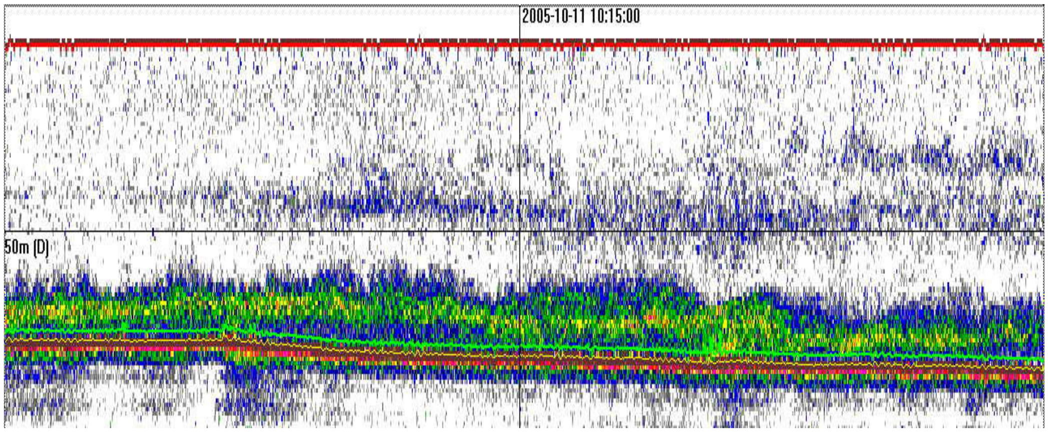


b). Bottom ***sprat marks*** (small red vertical columns) up to 5m tall in 70m of water (Haul 13). Located 8nmi south of Ram Head.

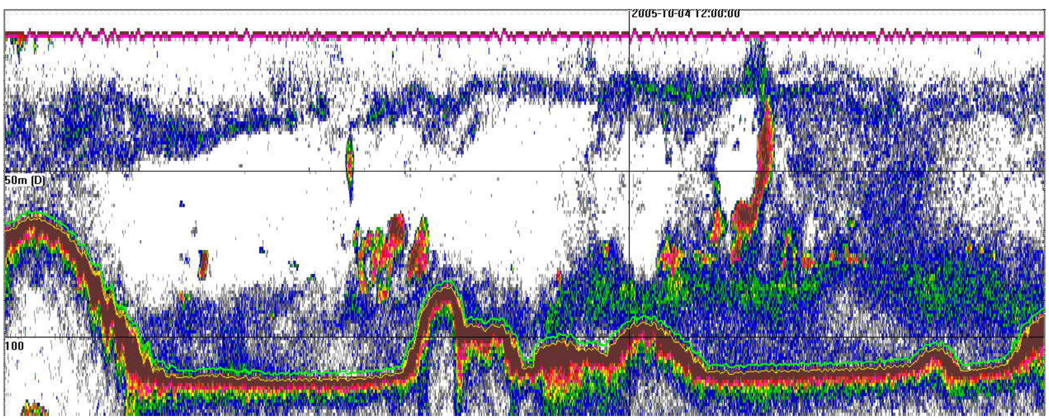


c). Bottom ***Pilchard mark*** (left of screen) up to 15m tall and just off the bottom in 38m of water (Haul 20). Located 4nmi southwest of Ballycotton Island.

Figure 10. Echograms (a-d) of main pelagic species encountered recorded on the Simrad ER 60, viewed using Echoview software (V3.2). *C. Explorer* survey. Celtic Sea and Division VIIj herring acoustic survey, October, 2005.

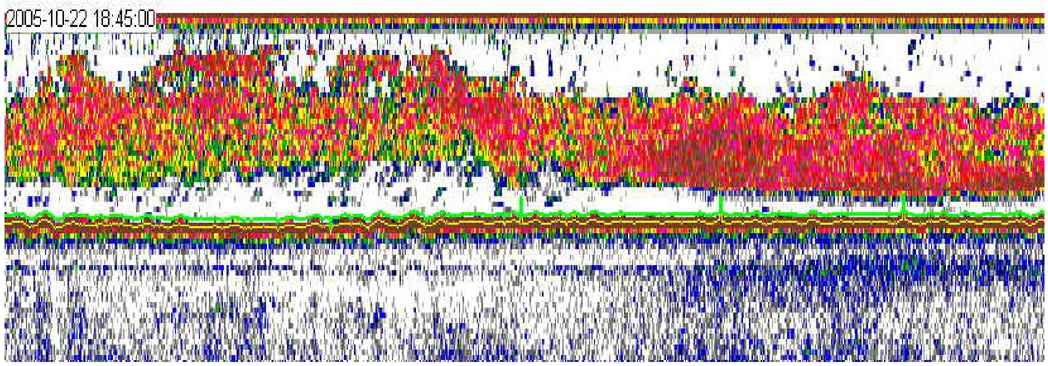


d). ***Mixed species mark*** (green, yellow, red mark) up to 8m tall 0-10m off the bottom in 22m. Catch was composed of 72% mackerel and 28% herring. This mixed layer is typical of the marks encountered and portioned as "herring in a mixture".

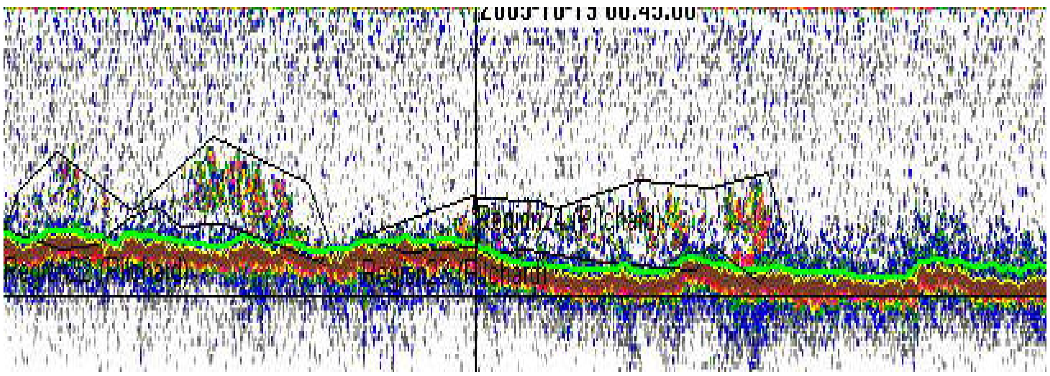


e). ***Scad mark*** (large red midwater marks) up to 45m tall located on top of hard bottom feature in 92m of water (Haul 6) 4nmi SW of the Blaskets Islands.

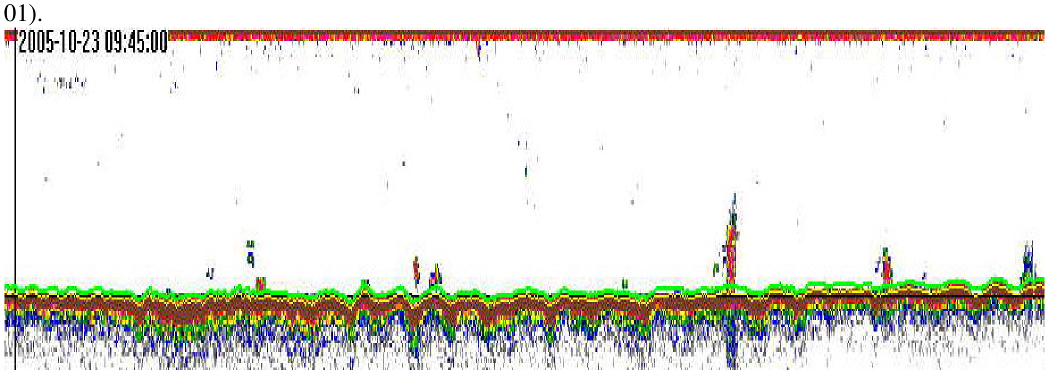
Figure 10. continued.



a). ***Sprat mark*** up to 38m tall in 46m of water, some 350m long. Largest single mark observed during the survey. Located east of Youghal Bay.

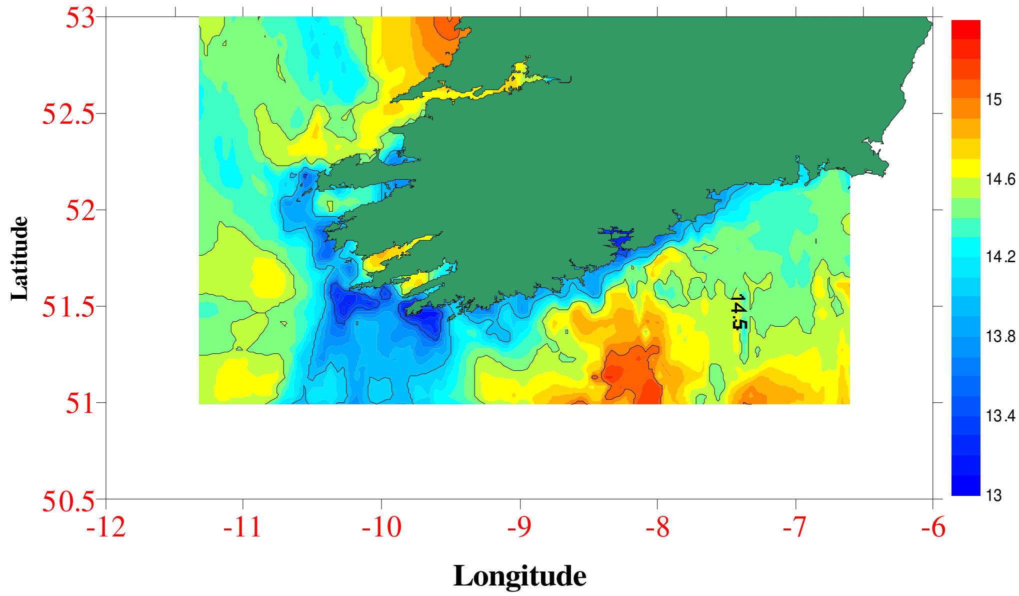


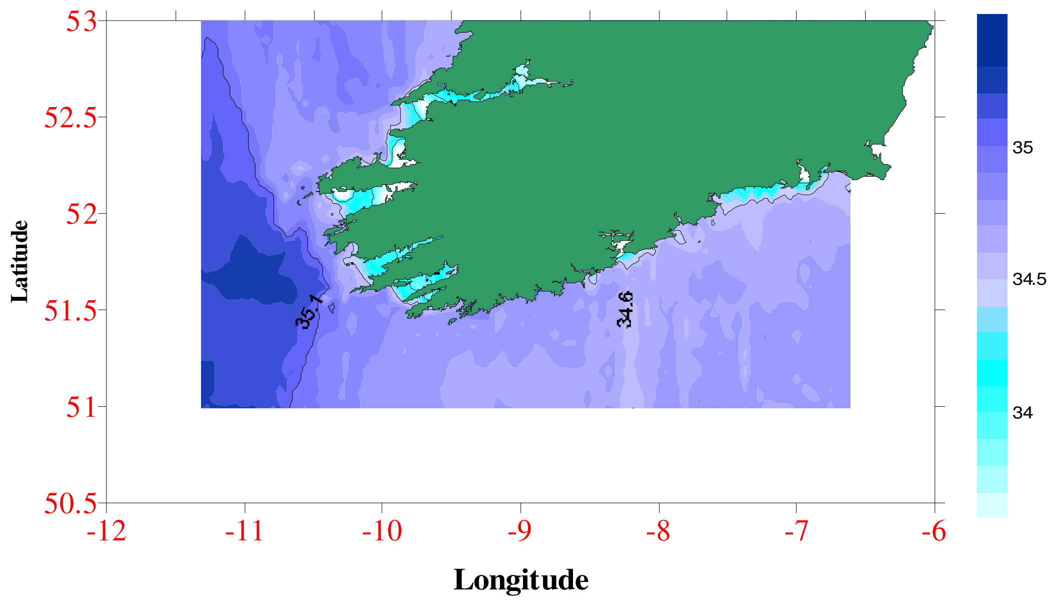
b). ***Pilchard mark*** up to 7m tall in 42m of water. Located 3nmi south of Old Head of Kinsale (Haul 01).



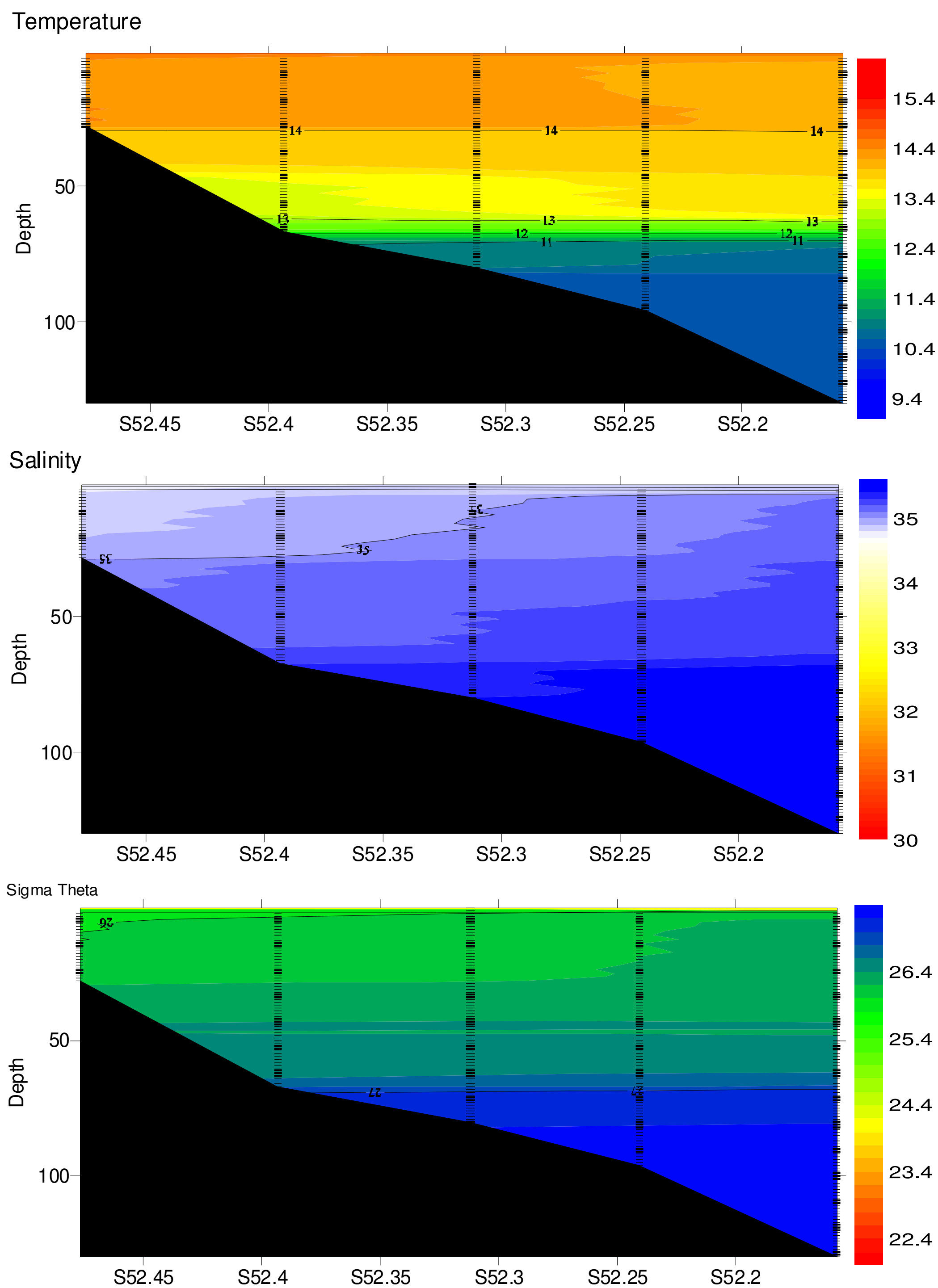
c). ***Mackerel mark*** up to 13m tall in 60m of water. Composed of 100% mackerel between 19-24cm in length. Located 5nmi S of Hook Head (Haul15).

Figure 11. Echograms (a-d) of main pelagic species encountered recorded on the Simrad ER 60, viewed using Echoview software (V3.2). *R. Ponti* Survey. Celtic Sea (VIIg) herring acoustic survey, October, 2005.



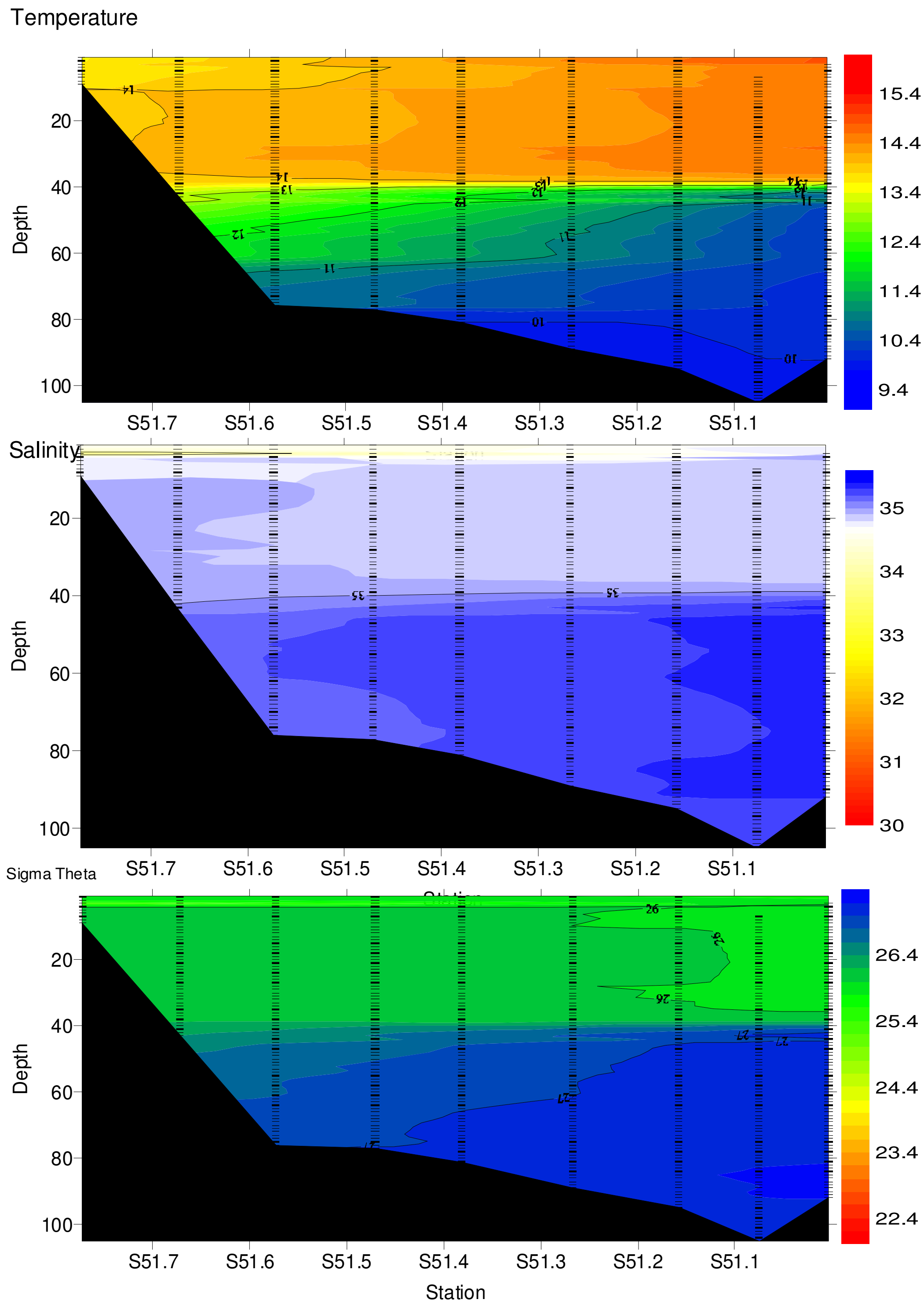


Figures 12.a & b) Horizontal temperature (above) and salinity (below) distribution from the Celtic Explorer underway thermosalinograph.

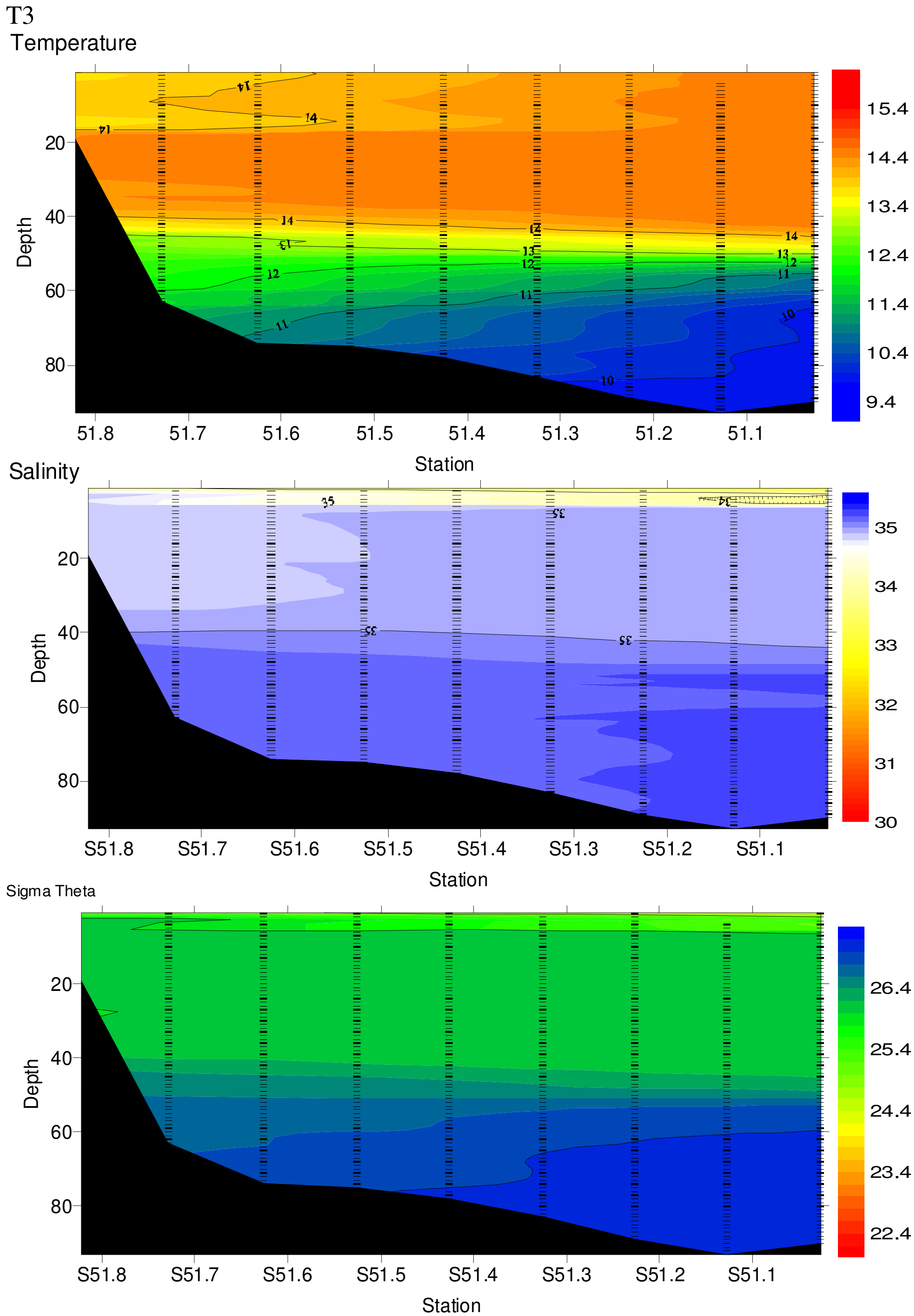


Figures 13.a-c.) Vertical distribution of temperature (above), salinity (middle) and density (below) of the Shannon estuary transect T1-S1-5.

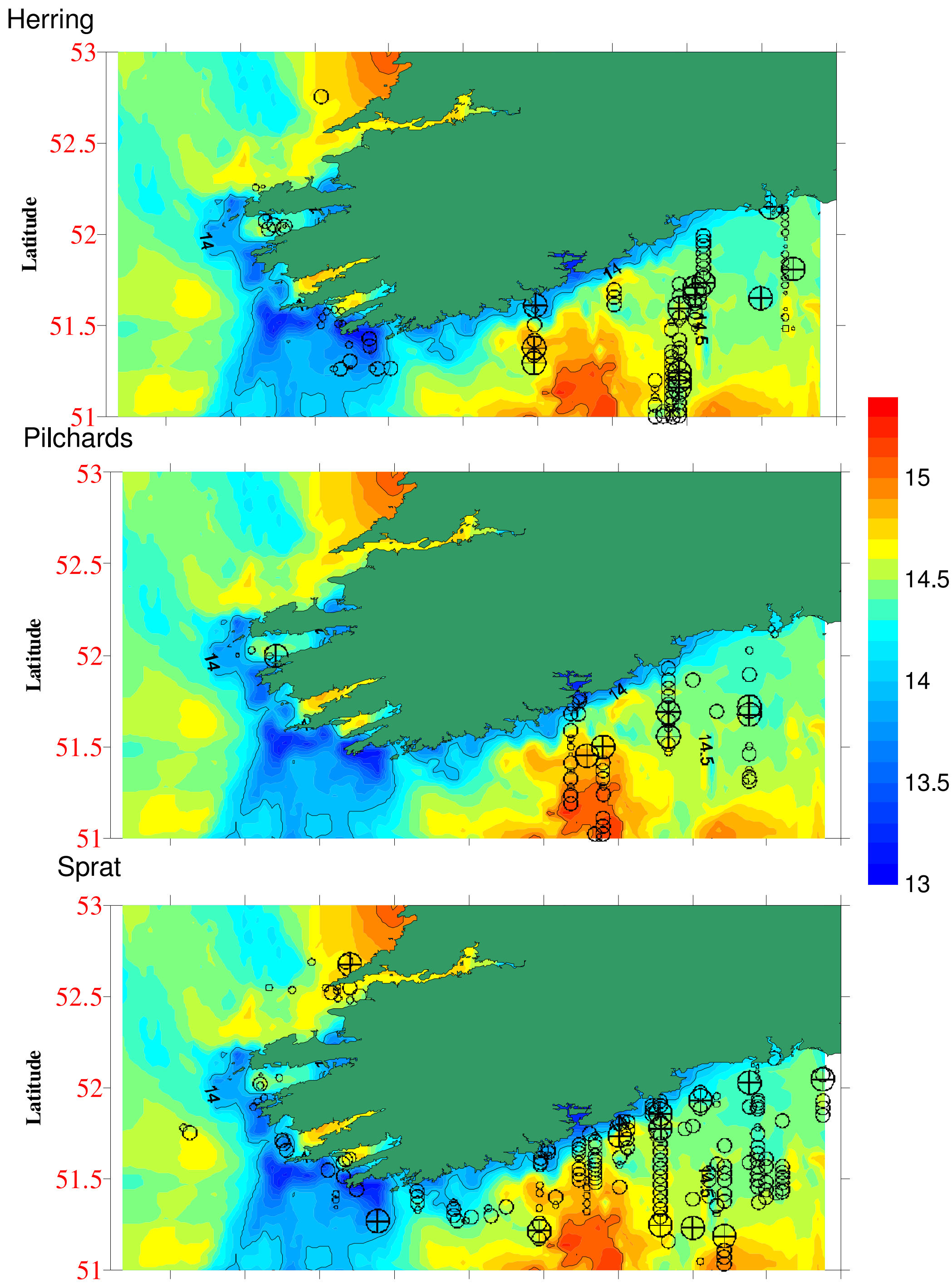
T2



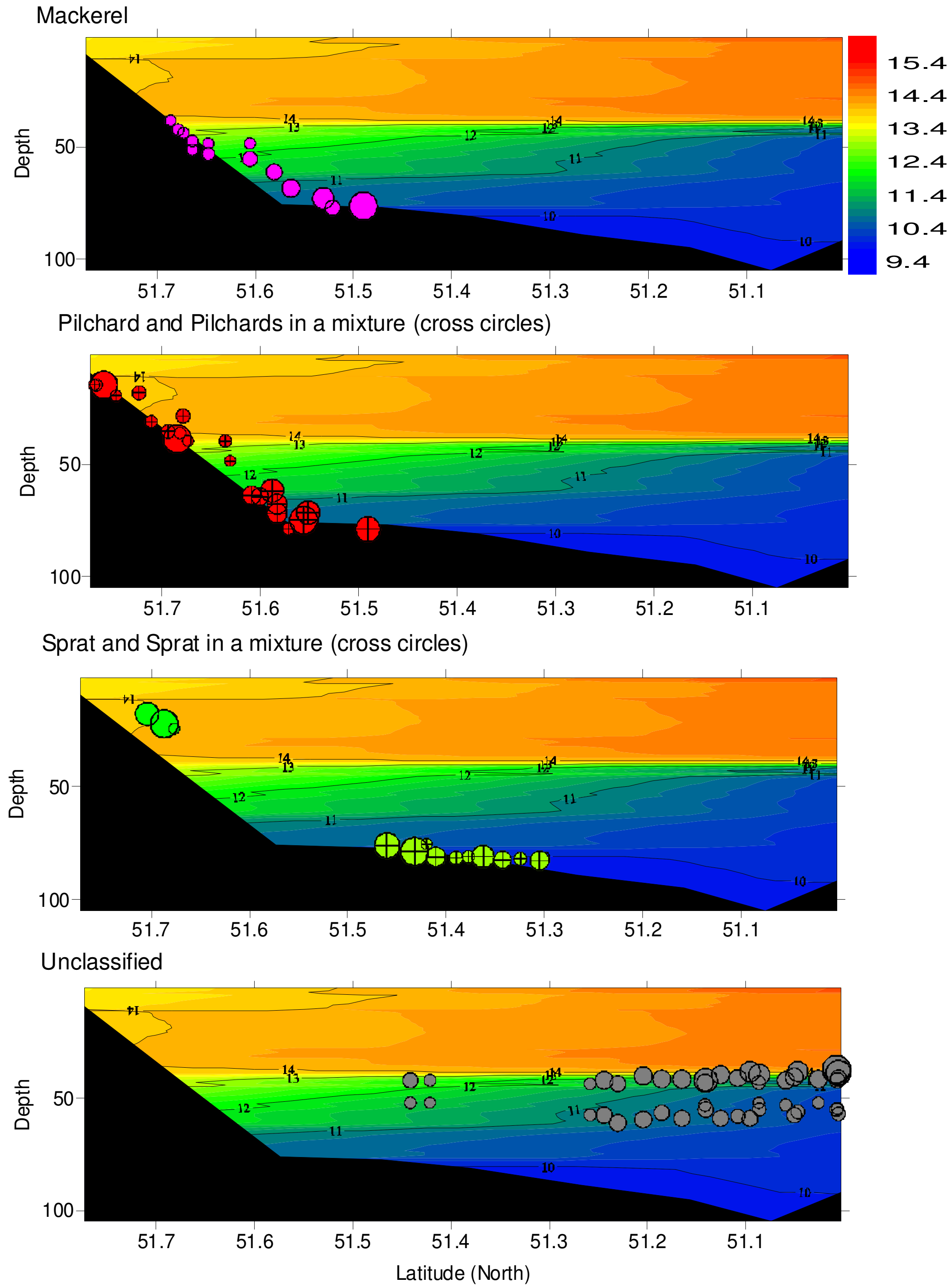
Figures 14.a-c.) Vertical distribution of temperature (above), salinity (middle) and density (below) of the Cork Harbour transect T2-S7-S15.



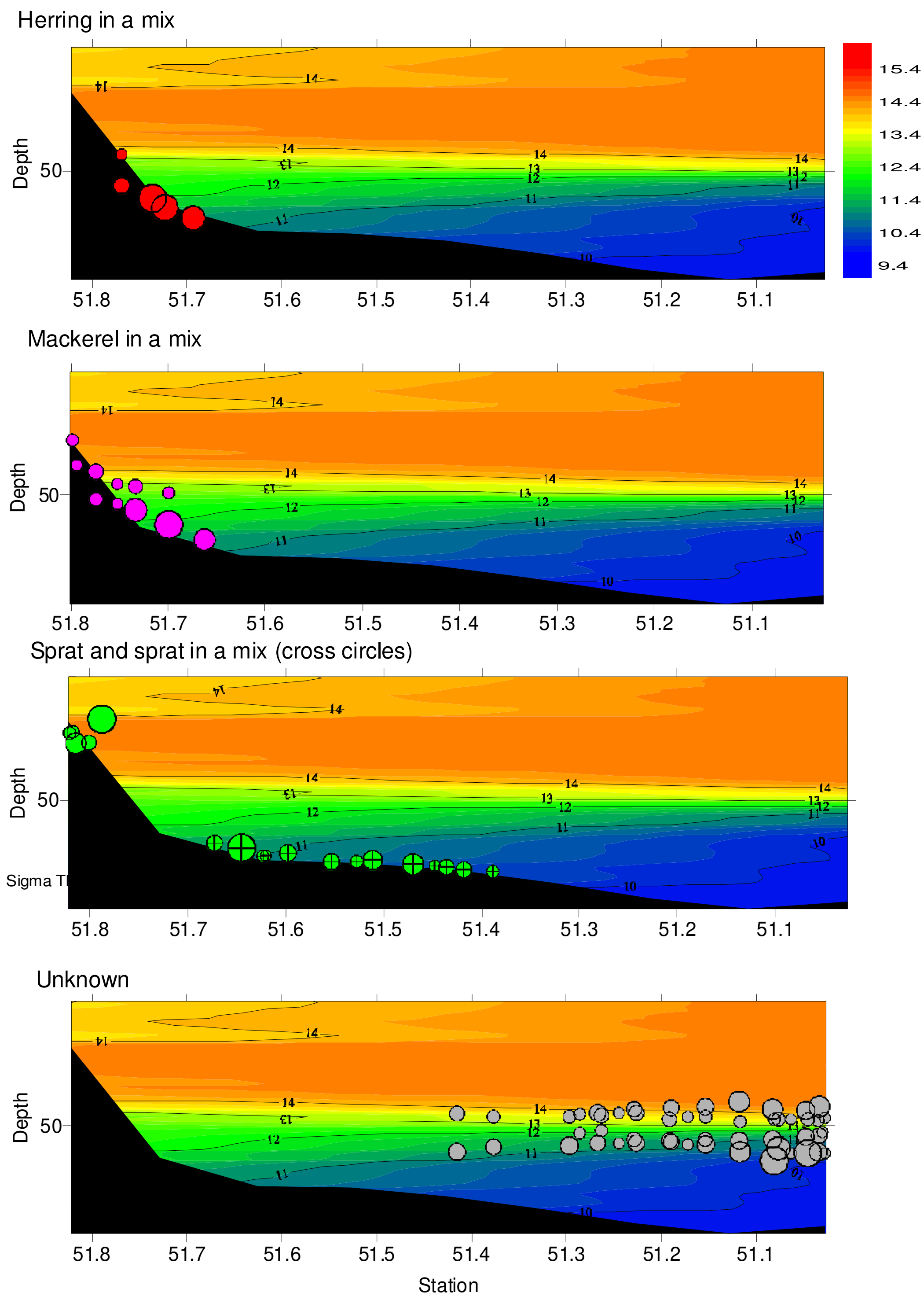
Figures 15.a-c.) Vertical distribution of temperature (above), salinity (middle) and density (below) of the Baginbun transect T3, S16-24.



Figures 16.a - c) Distribution of species NASC values in relation to sea surface temperature distribution.



Figures 17.a - d) Distribution of species NASC values in relation to vertical temperature distribution along the Cork Harbour transect T2, S7-S15.



Figures 18.a - d) Distribution of species NASC values in relation to vertical temperature distribution along the Cork Harbour transect T3, S16-S24.

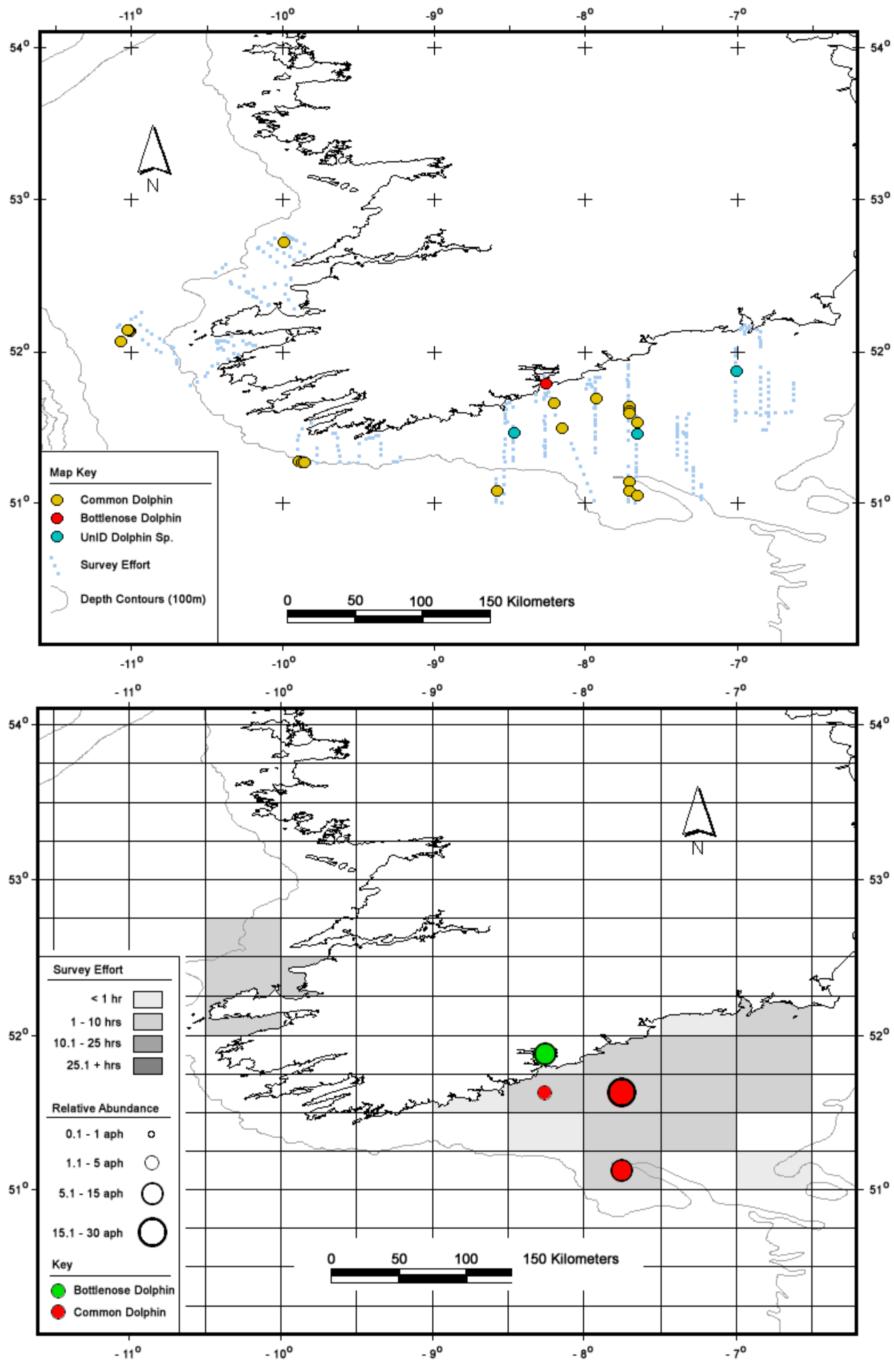


Figure 19. Distribution and size of group sightings of dolphin sightings related to survey effort (bottom). Celtic Sea and Division VIIj herring acoustic survey, October, 2005.

HERRING MIDWATER TRAWL

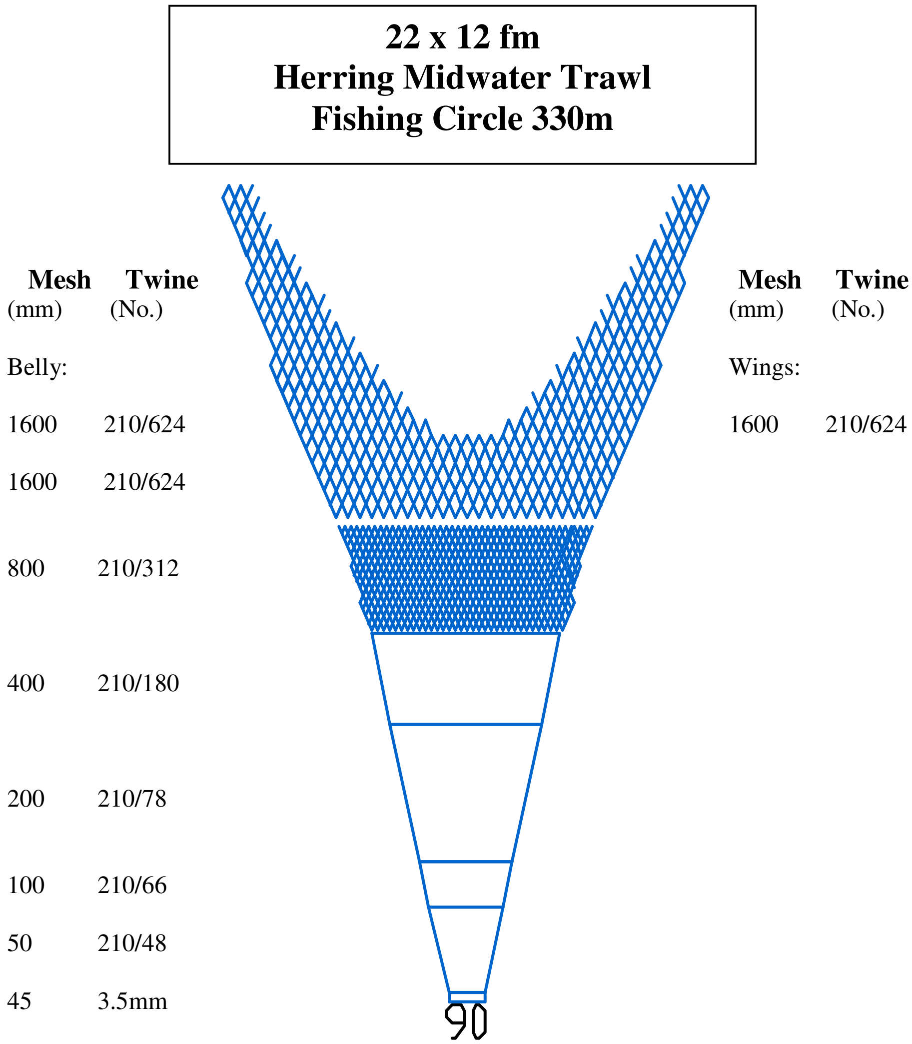


Figure 20. Single herring midwater trawl net plan and rigging layout as used for both acoustic surveys. Celtic Sea and Division VIIj herring acoustic survey, October, 2005. **Note:** All mesh sizes given in half meshes.

Herring Midwater trawl Codend Liner

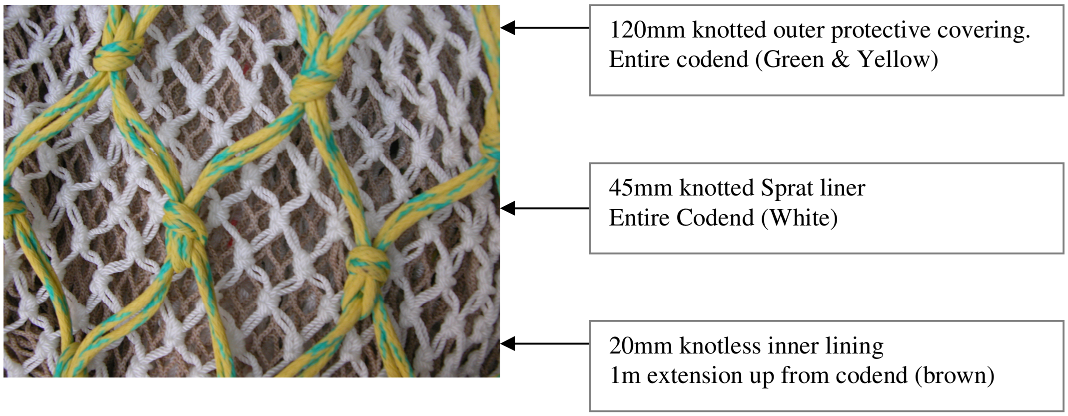


Figure 20. Cont.

Figure 21. FV *Regina Ponti* a 34.5 m stern trawler of the *Grand Sol* design employed for the small scale acoustic survey of VIIg, October, 2005.