

A Survey Of Nursery Grounds For Celtic Sea and VIIj Herring

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Abstract

The need for a recruit index for the herring stock in the Celtic Sea and Division VIIj has long been recognised. In order to develop a survey for recruits and pre-recruits, good information on the distribution of these fish is required. This study is based on a pair trawl survey, conducted in February 2008. The area covered was from central-east Irish coast (Dundalk Bay) to central west Irish coast (Galway Bay), with special attention paid to the bays and inlets of the south and southwest coast. The overall aim was to map out the distribution of 0- and 1-ring herring so that decisions could be made on the design of a future survey for young fish. The catch was quantified and sorted according to species. Herring were sampled for length, weight, sex, maturity and age. Young herring appeared as a light dust on the 38 kHz frequency. The east coast of Ireland, from Dundalk Bay to Howth was identified as an important nursery area, though it was not possible to ascertain what proportion of these juveniles were of Celtic Sea origin. Within the Celtic Sea the main nursery grounds identified were Dungarvan Bay, Cork and Kinsale Harbours. All the bays surveyed in VIIj contained juvenile herring. Overall this survey was a success. It provided updated information on the occurrence of young herring along the coast. Along with information from fishermen, and literature sources it allows for the development of recruit surveys for herring of this stock. Further work remains to be done on discriminating the juveniles by season of spawning.

Keywords: herring, nursery area, Celtic Sea

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1 Introduction

Herring in the Celtic Sea and southwest Ireland has supported a commercial fishery for many years. It is assessed using catch at age and acoustic survey data. It has long been recognised that an index of recruitment is required, though none yet exists. Since 50% of 1-ringers are considered to be mature (ICES, 2009) these recruits contribute to the SSB. In recent years, the age distribution has been truncated, so that the recruits make an increasing proportion of the spawning stock biomass (SSB). Recruitment has always been poorly estimated in the assessment. A survey of recruitment would be beneficial to the assessment and advisory process for this stock.

Trawl surveys were conducted in the 1970s, to develop a recruit index (Molloy, 1979, 1980, 2006; Molloy and Corten, 1975). However, only a weak correspondence could be found between these data and the catch at age data used in the assessment (Molloy, 2006). As a consequence, these trawl surveys were discontinued in the late 1980s. Recently, ICES investigated the use of the International Bottom Trawl Surveys (IBTS) carried out by Ireland, France and the U.K. but found the between-year-variation was too great to yield any meaningful estimates (ICES, 2005, 2006). ICES also investigated the use of the Northern Ireland groundfish survey, but also was unable to establish a good correlation with the catch at age data (ICES, 2004 and references therein). Another approach was to use beach seines and catches of small herrings from sprat weirs (Bracken and Kennedy, 1967), though this program was not continued.

The purpose of this study was to identify the main nursery grounds for juvenile herring in this area. This information could be used to develop a new series of trawl surveys. The method employed was the pair trawl. The Irish Sea was included because it is known that it is a nursery for herring of Celtic Sea origin (Brophy and Danilowicz, 2002; Molloy et al. 1993). Though this has rarely been used in quantitative fisheries surveys, it is a very efficient means of catching pelagic fish and many experienced Irish skippers and crews were available to conduct such work. The survey also provided an opportunity to obtain samples from the VIIaS closed area, at a time when no fishing was permitted in 2008.

2 Materials and Methods

Based on initial consultations with several fishermen, the decision was taken to survey the area using pair trawling. This was because this gear is better suited to catching herring, is the main gear used to target herring and sprat, and there are many vessels capable of deploying it. The survey was conducted on the pair team of polyvalent trawlers FVs *Eternal Dawn* and *Atlantic Quest* of Killybegs, Co. Donegal. Details of the vessels are presented in Table 1. The vessels form a pair team that has been in operation for 8 years.

2.1 Survey design

The area covered ranged from Dundalk Bay to Galway Bay. Within this general area, strata were chosen, based on previous surveys and information from fishermen that suggested where juvenile herring would be located. These strata were as follows (see Figure 1):

Dundalk Bay to Howth	Crook Haven
Kish Bank / Codling Bank	Dunmanus Bay
Saltees to Tramore	Bantry Bay
Waterford Harbour	Kenmare River
Helvick Hd./ Dungarvan	Dingle Bay
Cork Harbour	Tralee Bay
Kinsale Harbour	Mouth of the Shannon
Long Island Bay	Galway Bay

The bays and estuaries were scouted using zigzag tracks with each vessel taking opposite sides alternately. In more confined locations such as Kinsale Harbour, the vessels kept to the channel. Other areas were scouted using parallel track design. Usually, tracks were parallel to the coast, with the vessels about 1 mile apart. In many cases, the vessels stopped steaming for the night to await first light to survey bays and inlets. Owing to a lack of time, some areas that might have potentially contained juvenile herring were not covered in detail. These included Oyster Haven, Youghal Harbour, Ardmore Bay, Long Island Bay and Crook Haven.

2.2 Data recording

During searching operations, data from the Simrad EA60 echosounders were recorded. A record was kept of observations from the echosounders and on the sonars. During this process the following parameters were measured: time; position; course; wind speed; direction; wave height; tide direction and speed; tide direction and speed (Sodena) and surface temperature (EA60). Significant marks, in the opinion of the skipper, were recorded on Sodena software also.

Both vessels used the same settings for their EA60 echosounders, as follows:

38 kHz TVG 60, School Gain 60, Fish Gain 51, Bottom Gain 65

200 kHz TVG 60, School Gain 69, Fish Gain 64, bottom gain 70

2.3 Fishing

Where possible fishing was conducted in each stratum. In many areas it was impossible to shoot owing to the presence of pot gear. Young herring were identified as light blue scatter on the echosounder and fishing took place on such traces. Hauls on echo traces continued until the sensors indicated that sufficient fish had entered the net. Where no traces were visible in a strata, fishing took place, and such hauls were of one hour duration. It was intended to conduct two hauls per stratum. Time of fishing was recorded from when warps were fully shot until the headline began to lift off the bottom on hauling. The following gear parameters were recorded for each haul: headline distance from surface, warp shot, net opening and bottom depth. A note was also made of targeting success, or the presence of echo traces on the 50 kHz and on the EA60 frequencies.

Both vessels shot the net, usually on alternate hauls. Measured only sampling was conducted on both vessels, whilst biological sampling was conducted on the *Eternal Dawn*. Fish for biological sampling, caught on *Atlantic Quest*, were transferred to *Eternal Dawn*. This was because more scientific staff were on board that vessel. For large hauls (> 1 tonne), the bulk catch was estimated by the skipper. For smaller hauls all fish were taken on board and quantified by number of baskets, or the amount in an 800 kg bin. A representative sample (2-3 baskets) was then taken from different levels in the bin. Fixed weights were assumed for baskets of different fullness. Sub-sampling was undertaken when necessary, using standard protocols. For large fish, such as cod or pollack, all specimens were removed from the bin and sampled, with the appropriate raising factors applied.

A major factor in the success of fishing hauls, was the presence of static (mainly shrimp and crab pots) around the coast. This precluded fishing in some areas. Upon entering an area, contact was made with local pot fishermen and a network of contacts was developed. This allowed for accurate positions of static gear to be obtained and prevented any conflicts or towing away of gear. A dedicated watch was maintained when fishing for static gear dahns. Only in one instance (Codling Bank) did a haul have to be aborted. In many cases an area was scouted before fishing, if static gear was known to be present.

Particular attention was given to fishing in Division VIIaS. This was because the area had been closed in 2008, as part of the rebuilding plan in place for this stock. It was necessary to obtain information on the size and age frequency of herring in this closed area. Therefore extra fishing on marks was performed 5 times in this area.

2.4 Ageing of herring

Sampling for age, sex, maturity, length and weight was conducted randomly, with 50 fish being taken per haul. For consistency, all samples were aged according to the convention used for the Celtic Sea herring stock, that the last winter ring is only counted after the 1st April. Separate age length keys were constructed for each ICES Division, VIIaN, VIIaS, VIIg and VIIj. These were applied to raised length frequencies by stratum and area to produce age distributions.

2.5 Biological studies

Condition was investigated using Fulton's condition factor (Ricker, 1975). Maturity was assessed using the 8-point scale.

One otolith from each pair collected was kept for later otolith microstructure analyses, for further studies to identify whether fish were of autumn or winter spawning origin.

3 Results

Catch quantities of herring are presented in Figure 2 and Table 2. Catches varied considerably with the largest being taken from Kinsale Harbour. Fishing duration was not uniform, and catch rates do not reflect abundance. Table 3 shows the catch composition by haul. It can be seen that herring and sprat dominated in most areas, with pilchard occurring in several hauls in widely separated areas.

Table 4 shows the percentage length frequency distributions by haul. Length frequencies show that smallest herring were located in the western Irish Sea stratum, from Dundalk Bay to Howth (VIIaN), and also in lower Dunmanus Bay and mid and lower Bantry Bay (VIIj). The broadest size frequency ranges were found in the Irish Sea (VIIaN) and the south western bays (VIIj) see Figure 3 a. Much narrower size ranges were observed along the south coast. Clear size modes were evident in some hauls, especially in the Irish Sea.

Age frequency distributions by ICES Division are shown in Figure 3b and Table 5 and by stratum in Table 6. The broadest range of ages was in eastern Celtic Sea (VIIaS). Greatest proportions of 0-ring herring were located in the Irish Sea VIIaN and SW Ireland (VIIj), with negligible proportions to the south of Ireland (VIIg) and eastern Celtic Sea (VIIaS). In particular the western Irish Sea (VIIaN), and Dingle Bay (VIIj) had larger proportions of 0-ringers. Very few 0-group fish were located in Waterford or Kinsale Harbours (VIIaS).

The areas with greatest concentrations of 0-ring herring were between Dundalk Bay and Howth, in the Helvick Head/Dungarvan area and in Kenmare, Bantry and Dingle Bays. It can be seen from Table 5 that the age distribution in the Irish Sea is strongly skewed towards 0- and 1-ring fish. Herring of 1-winter ring were found in good quantities in most areas, with the notable exception of Dingle Bay. Condition factor and length weight relationship data show little variation over the survey area (Table 7).

A comparison was made between the age frequencies from this and other surveys of Celtic and Irish Sea herring in the same season (Figure 4). Table 8 shows that the current survey selected more 1-ring herring than either the Celtic Sea acoustic survey or the commercial catches from the Celtic Sea. A comparison of Tables 5 and 8 shows that the VIIaN Irish Sea and Division VIIj had strong representation of 0-ring fish, but that these were not picked up by other surveys or by the commercial fisheries.

4 Discussion

The survey conducted in 2008 was considered a success. It was the first attempt to map the distribution of juvenile herring of the Celtic Sea stock. It showed the proportions of juvenile (0- and 1-ring) herring in the Irish and Celtic Seas, and in Division VIIj. In the Irish Sea, it was not possible to determine the proportion of these fish that were of Celtic Sea origin. However otolith samples have been collected that can be used to determine the spawning season of these fish, following the approach of Brophy and Danilowicz (2002). The uncertain contribution from Irish Sea nursery areas to the Celtic Sea fishery has been a problem for assessment of the stock for many years (ICES, 2008; Molloy, 2006).

The survey shows areas where concentrations of 0- and 1-ring herring were found. It should be noted that the south coast was surveyed during a period of strong tides and very calm conditions with slight wind from the east. Fish behaviour and catchability may be different during these conditions. It can be concluded that the main juvenile areas are Dundalk Bay, Dungarvan Bay, Cork Harbour, Kinsale Harbour and the southwestern bays.

The 2005/2006 year class (1-ringers) appeared strong in this survey, also appearing strong in the 2007/2008 Celtic Sea acoustic survey (Figure 4). The peak in abundance of 1-ringers in the present survey is higher because these fish were targeted. The acoustic survey selects older fish. Apart from 1-ring fish, the current survey does not match the commercial fishery age frequency well. This is not surprising because the commercial fishery targets adults. This survey was clearly successful at targeting juveniles. The relative weakness of the 2004/2005 year class (2-ring) in the Celtic Sea catches and acoustic survey is reflected by the results of the current survey.

The 2005/2006 year class (1-ringer) was also strong in VIIaN catches in 2007. In addition many 0-ringers (2006/2007) were also registered in this survey in VIIaN. There is no evidence of a strong year class from commercial catches in subsequent seasons (ICES, 2009) or the most recent acoustic survey (Saunders et al. 2009). The strongly skewed VIIaN age frequency suggests that the fish in that region emigrate elsewhere. It is not clear what proportion of these fish would recruit to the Celtic Sea fishery in 2008/2009 as 2-ringers and what would remain in the Irish Sea. Further work on segregating these fish according to spawning origin is required.

The catch composition in Sub-Division VIIaS gives a fishery independent estimate of stock composition during a period of closure. It can be seen, from Table 5, that 1- and 3-ringers predominated, with slightly less 2-ringers. There was little evidence of 0-group abundance in the area. Though fish older than 4-ringer are present, they were in small numbers. Fish of 1- and 2-ring were better represented in survey catches from this area than in the 2007/2008 commercial fishery that was dominated by 3-ringers. Overall, the survey showed the same pattern of strong and weak year classes as the recent stock assessment (ICES, 2009).

Closure of Sub-Division VIIaS has been a feature of industry-led management initiatives throughout the 2000s. The effect of these closures cannot be fully evaluated until the measure has been in place for several years. However the results of this survey suggest that the area is an important location for young mature fish. During the period of stock collapse the spawning grounds in this area were one of the few areas where fishable concentrations of herring were available. Closing these grounds can be expected to have controlled fishing mortality on these spawning components. However the closure can be expected to have little efficacy as a protection measure for juvenile herring.

The age distribution in Division VIIj is somewhat different to that of the Celtic Sea divisions. This region is normally considered to contain autumn spawning herring (Farran, 1944; Grainger, 1976; Molloy, 2006). Like the northwest Irish Sea it was found to contain large proportions of 0-groups. Molloy (1968) noted the importance of Bantry Bay as a nursery and considered that these fish recruited to the Celtic Sea winter-spawner population. It seems likely that Bantry and the other bays in VIIj are nurseries for native juveniles and immigrant fish from further east.

This study provides details of nursery grounds for Celtic Sea and VIIj herring. The results can be used to develop a recruit index to aid the stock assessment of this population. The need for a recruit index is high, if the stock continues to be dependent on recruiting year classes. The disappearance of older age groups from the population over the past years means that the contribution of the incoming year class is greater. Thus SSB has been heavily reliant on recruitment (ICES, 2009). If the stock is managed subject to a lower fishing mortality rate, and the age distribution widens, then the influence of recruitment would not be so great.

Tables and Figures

Table 1. Technical specifications of the survey vessels employed.

	<i>Eternal Dawn</i>	<i>Atlantic Quest</i>
Skipper	Kevin Boyle	Denis Carbery
Home port	Killybegs	Killybegs
Length OA	19.8	19.76
Beam	8	7.6
Draught	5	4.6
Main Engine	485 KW, Caterpillar 3508	Mitsubishi
Engine power (HP)	485	671
Headline transducer	50 kHz	50 kHz
Sonars	Furuno SFV 24 Low Frequency 24 kHz Furuno CSH 72 High Frequency 200 kHz	Furuno CSH 55 22 kHz Furuno CSH 73 180 kHz
Echosounders	Simrad ES 60 200 kHz Simrad ES 60 38 kHz	Simrad ES 60 200 kHz Simrad ES 60 38 kHz
Nets	71.32 * 60.35 m bridles 15 fa clump weight 1.5 t 16 mm sprat brailer	71.32 * 60.35 m bridles 15 fa clump weight 1.5 t 16 mm sprat brailer
Net monitoring	Scanmar 50 kHz headline transducer Scanmar catch sensors	Scanmar sensors Simrad sensors

Table 2. Shooting positions for fishing hauls conducted

Haul	Time		Shoot		Div	Area	Headline	Opening	Depth	(kg)	
	Shoot	Haul	Lat	Lon						Catch	herring
1	1055	1155	53 53 14	6 06 78	VIIaN	Clogherhead	7	11.5	15.3	782	735
2	1639	1739	53 28 50	5 58 24		Lambay Island	4	13.5	16.7	211	7
3	940	1040	53 35 81	05 35 81		Gas Pipeline	25	15.4	40	274	0
4	1457	1607	53 22 43	06 00 41		Howth	13.8	10	12	40	5
5	825	925	53 41 41	06 03 50		Drogheda Bar	3.5	10.6	14	43	19
6	1722	1727	53 12 56	05 59 70		Codling Bank	-	-	15.5	3	0
7	1110	1125	52 02 03	06 56 56	VIIaS	Saltees	11.5	14.5	24	6,000	5,529
8	1530	1635	52 10 61	06 56 46		Waterford Harbour	0	3	3	43	30
9	1710	1730	52 01 97	07 06 69		Tramore	14	13.8	25	4,000	3850
10	1951	2009	52 04 51	07 25 50		Helvick Head	14.2	11.4	18.5	115.24	0.5
11	905	935	52 04 67	07 25 87		Helvick Head	7	11.4	17	2400	139
12	1530	1550	51 49 88	08 16 04	VIIg	Cork Harbour	9.7	8	8	42	3
13	910	920	51 41 35	08 29 87		Kinsale Harbour	0	3	3	20,000	15,458
14	1610	1630	51 32 77	09 00 27	VIIj	Union Hall	3	11.8	12	489	7
15	1400	1430	51 31 96	09 47 01		Dunmanus B.lower	18	11.9	30	564	134
16	1539	1600	51 34 36	09 40 12		Dunmanus B. upper	3	13	17.2	240.24	0.24
17	1130	1150	51 43 85	09 32 39		Bantry B. Glengarriff	0, 3	8	8	197.79	76.42
18	1410	1418	51 39 39	09 40 38		Bantry B. middle	11	12.6	22.2	428.847	36.16
19	1604	1619	51 34 25	09 52 18		Bantry B. lower	18	13.5	31	423.52	15.11
20	950	1010	51 47 96	09 50 12		Kenmare River	7.6	13.3	17	1235.33	99.21
21	825	855	52 07 06	10 03 24		Dingle B. Inch	1	6.2	7	37.53	8.75
22	1046	1130	52 03 31	10 19 38		Dingle B. outer			25	328.08	3.46
23	1647	1657	52 16 15	10 07 23		Brandon Bay	1	9.3	10	38.94	1.15
24	1140	1243	53 14 48	09 04 29	VIIb	Galway B. Mutton Is.	0-1	10	10	+	+
25	1405	1430	53 12 42	09 16 74		Galway Bay mid.	4	13.6	19	+	+

A survey of potential nursery grounds for Celtic Sea and Vllj herring

Table 3. Catch composition by haul, species weights expressed in kg. Zero values represented by a minus sign: -, values < 1 kg, by a plus sign: +

Haul	Area	Total	Herring	Sprat	Pilchard	Mackerel	Cod	Haddock	Whiting	Cephalopods	Others	Grey gurnard	Sea trout
1	NE Clogherhead	782	735	41	-	-	-	-	5	0	-	-	-
2	E Lambay	211	7	4	-	-	-	200	-	-	-	-	-
3	Gas Pipeline	274	0	122	-	-	7	9	32	8	62	1	-
4	E. Howth	40	5	30	-	-	5	-	-	-	-	-	-
5	Boyne Bar	43	19	14	-	-	5	-	-	-	6	-	-
6	Codling Bank	3	0	1	-	-	-	-	2	-	-	0	-
7	Saltees	6000	5529	-	252	219	-	-	-	-	-	-	-
8	Waterford Harbour	43	30	2	-	-	2	-	7	-	-	-	1
9	Tramore	4000	3850	42	-	109	-	-	-	-	-	-	-
10	Helvick Head	115	1	100	-	-	-	-	-	-	-	-	-
11	Helvick Head	2400	139	2164	-	6	-	-	10	-	12	-	-
12	Cork Harbour	42	3	38	-	-	-	-	-	-	-	-	-
13	Kinsale Harbour	20000	15458	-	4344	198	-	-	-	-	-	-	-
14	S. Union Hall	489	7	427	-	-	-	-	0	-	-	-	-
15	Dunmanus B.lower	564	134	257	-	-	5	11	150	-	-	-	-
16	Dunmanus B. upper	240	+	240	-	-	-	-	-	-	-	-	-
17	Bantry B. Glengarriff	198	76	120	1	1	-	-	-	-	-	-	-
18	Bantry B. mid	429	36	388	2	2	-	-	1	-	-	-	-
19	Bantry B. outer	424	15	363	30	-	10	-	5	0	-	-	-
20	Kenmare R.	1235	99	23	-	1113	-	-	-	-	-	-	-
21	Dingle B. Inch	38	9	27	-	0	-	-	-	-	-	-	-
22	Dingle B. outer	328	3	320	-	-	-	-	5	-	-	-	-
23	Brandon B.	39	1	-	38	-	-	-	-	-	-	-	-
24	Mutton Island	+	+	-	-	-	-	-	-	-	-	-	-
25	Galway Bay	+	+	-	-	-	-	-	-	-	-	-	-

Haul	<i>continued</i>	Total	Dab	Grey mulley	Flounder	Plaice	B. whiting	Hake	Gar	Anchovy	Scad	Norway pout	Poor cod
1	NE Clogherhead	782	-	-	-	-	-	-	-	-	-	-	-
2	E Lambay	211	-	-	-	-	-	-	-	-	-	-	-
3	Gas Pipeline	274	-	23	-	1	-	-	-	7	0	0	3
4	E. Howth	40	-	-	-	-	-	-	-	-	-	-	-
5	Boyne Bar	43	-	-	-	-	-	-	-	-	-	-	-
6	Codling Bank	3	-	-	-	-	-	-	-	-	-	-	-
7	Saltees	6000	-	-	-	-	-	-	-	-	-	-	-
8	Waterford Harbour	43	-	-	-	-	-	-	-	-	-	-	-
9	Tramore	4000	-	-	-	-	-	-	-	-	-	-	-
10	Helvick Head	115	3	12	-	-	-	-	-	-	-	-	-
11	Helvick Head	2400	-	1	69	-	-	-	-	-	-	-	-
12	Cork Harbour	42	-	1	-	-	-	-	-	-	-	-	-
13	Kinsale Harbour	20000	-	-	-	-	-	-	-	-	-	-	-
14	S. Union Hall	489	-	-	-	-	-	-	-	-	-	-	-
15	Dunmanus B.lower	564	1	-	-	8	-	-	-	-	-	-	-
16	Dunmanus B. upper	240	-	-	-	-	-	-	-	-	-	-	-
17	Bantry B. Glengarriff	198	-	-	-	-	-	-	-	-	-	-	-
18	Bantry B. mid	429	-	-	-	-	-	-	-	-	-	-	-
19	Bantry B. outer	424	-	-	-	-	-	0	-	-	-	-	-
20	Kenmare R.	1235	-	-	-	-	-	-	-	-	-	-	-
21	Dingle B. Inch	38	-	-	-	-	1	-	-	0	-	-	-
22	Dingle B. outer	328	-	-	-	-	-	-	-	-	-	-	-
23	Brandon B.	39	-	-	-	-	-	-	-	-	0	-	-
24	Mutton Island	+	-	-	-	-	-	-	-	-	-	-	-
25	Galway Bay	+	-	-	-	-	-	-	-	-	-	-	-

Table 4. Percentage length frequencies of herring per haul. Zero values represented by a minus sign: -, values < 1, by a plus sign: +. (give info on where these places are)

	1	2	4	5	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
	NE Clogherhead	E Lambay	E Howth	E. Boyne Bar	E Baginbun	Waterford H	S. Tramore	E Helvick Head	E Helvick Head	Cork H.	Kinsale H	S. Union Hall	Dunmanus B.lower	Dunmanus B. upper	Bantry B. Glengarriff	Bantry B. mid	Bantry B. outer	Kenmare R.	Dingle Inch	Dingle Outer	
11	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.5	+	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	3	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
12.5	8	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	9	2	2	5	-	+	-	-	-	-	-	-	2	-	-	5	-	-	-	-	-
13.5	8	3	4	9	-	-	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-
14	13	6	2	12	-	-	-	-	-	-	-	-	4	-	-	5	-	-	+	-	-
14.5	10	2	1	14	-	-	-	-	-	-	-	-	3	-	+	2	5	-	+	-	-
15	15	2	2	18	-	-	-	-	-	-	-	-	4	-	+	1	10	2	+	-	-
15.5	9	1	-	14	-	-	-	-	4	-	-	-	3	-	-	3	12	-	2	-	-
16	5	2	-	6	-	+	-	11	8	-	-	-	5	-	+	3	19	-	7	1	1
16.5	3	-	-	3	-	1	-	22	13	5	-	13	1	-	1	11	10	4	11	1	1
17	-	-	-	+	-	+	-	22	7	2	1	13	10	17	-	9	10	2	21	5	5
17.5	-	-	-	+	-	1	-	11	8	5	-	-	6	-	+	14	7	2	21	14	14
18	+	-	-	-	-	+	-	-	8	5	1	-	4	50	1	14	2	-	20	16	16
18.5	1	-	-	-	-	+	-	-	1	7	1	-	2	17	-	7	7	2	10	20	20
19	3	2	-	1	-	-	-	-	1	2	+	13	2	-	+	1	-	1	4	15	15
19.5	2	7	-	1	1	1	1	-	3	5	1	-	2	-	1	-	-	5	1	3	3
20	3	12	4	1	1	2	1	-	3	5	2	-	1	-	1	-	-	5	-	1	1
20.5	2	10	5	1	6	2	1	-	5	5	7	-	1	17	1	-	-	7	1	-	-
21	1	11	11	2	11	1	7	-	1	5	14	-	2	-	3	-	2	7	-	1	1
21.5	-	8	7	1	9	3	5	-	-	-	-	16	-	4	-	3	-	5	13	-	1
22	-	8	15	1	10	3	8	-	-	10	8	-	7	-	2	2	5	13	-	-	-
22.5	-	5	8	1	7	3	6	11	3	7	9	-	4	-	3	1	-	5	-	-	-
23	-	4	12	1	9	3	12	-	1	2	4	-	6	-	3	2	2	5	-	3	3
23.5	-	7	5	1	8	5	9	-	1	2	7	25	4	-	4	2	2	14	+	1	1
24	-	1	5	1	11	7	16	-	5	5	7	-	4	-	4	1	-	4	-	4	4
24.5	-	2	4	+	10	14	14	11	7	10	9	-	7	-	10	3	-	1	-	5	5
25	-	1	4	+	11	13	12	-	8	10	5	38	4	-	12	2	-	4	-	-	-
25.5	-	-	1	-	3	9	2	-	4	2	4	-	5	-	17	-	2	-	+	1	1
26	-	4	2	-	1	9	2	-	4	-	2	-	1	-	7	3	-	2	+	-	-
26.5	-	1	2	-	1	6	2	-	1	-	1	-	2	-	7	1	-	-	-	1	1
27	-	1	1	-	1	6	2	11	1	2	1	-	-	-	6	-	-	-	-	-	-
27.5	-	-	-	-	+	5	1	-	1	2	1	-	-	-	6	-	-	-	-	-	-
28	-	1	-	-	+	5	-	-	-	-	+	-	-	-	3	-	-	-	-	-	-
28.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
29.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A survey of potential nursery grounds for Celtic Sea and VIIj herring

Table 5. Percentage age distribution by ICES Division. Age in winter rings.

ICES Division	0	1	2	3	4	5	6	7	8	9+
VIIaN	80	17	2	1	-	-	-	-	-	-
VIIaS	3	31	27	31	2	2	1	2	0	-
VIIg	3	62	8	23	2	2	-	-	-	-
VIIj	47	38	10	4	0	0	-	-	-	-

Table 6. Percentage age distribution by stratum. Age in winter rings.

Stratum		0	1	2	3	4	5	6	7	8	9+
I	Dundalk - Howth	80	17	2	1	-	-	-	-	-	-
III	Saltees - Tramore	5	13	24	39	3	5	2	7	2	-
IV	Waterford Harbour	1	33	28	31	2	2	1	2	0	-
V	Helvick Head / Dungarvan	53	12	11	19	2	2	1	1	-	-
VI	Cork Harbour	32	35	4	24	0	5	-	-	-	-
VII	Kinsale Harbour	3	62	8	23	2	2	-	-	-	-
VIII	Dunmanus Bay	47	30	16	7	0	-	-	-	-	-
IX	Bantry Bay	41	19	24	16	1	0	-	-	-	-
X	Kenmare River	22	66	8	3	0	1	-	-	-	-
XI	Dingle Bay	94	2	3	1	0	-	-	-	-	-

Table 7. Length weight relationships and condition factors by ICES Division.

	7aN	7aS	7g	7j
Sample size (n)	200	210	69	39
Intercept (a)	-5.86	-5.13	-4.75	-4.07
Slope (b)	3.28	3.02	2.90	2.68
Coefficient of determination (r^2)	0.98	0.96	0.97	0.80
Fulton's condition factor	0.65	0.64	0.64	0.62

Table 8. Comparison of % age frequency for the current survey and other surveys of the Irish and Celtic Seas during the 2007/2008 season.

Cohort	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998
Rings	0	1	2	3	4	5	6	7	8	9
Current Survey All Divisions	14	48	19	15	1	1	0	0	0	0
Celtic Sea Acoustic	0	23	15	48	7	2	3	1	0	0
Irish Sea Acoustic	0	12	17	56	9	2	3	1	0	0
Celtic Sea Catch at age		12	17	56	9	2	3	1	0	0
Irish Sea Catch at age	0	43	39	11	4	2	1	0	0	0

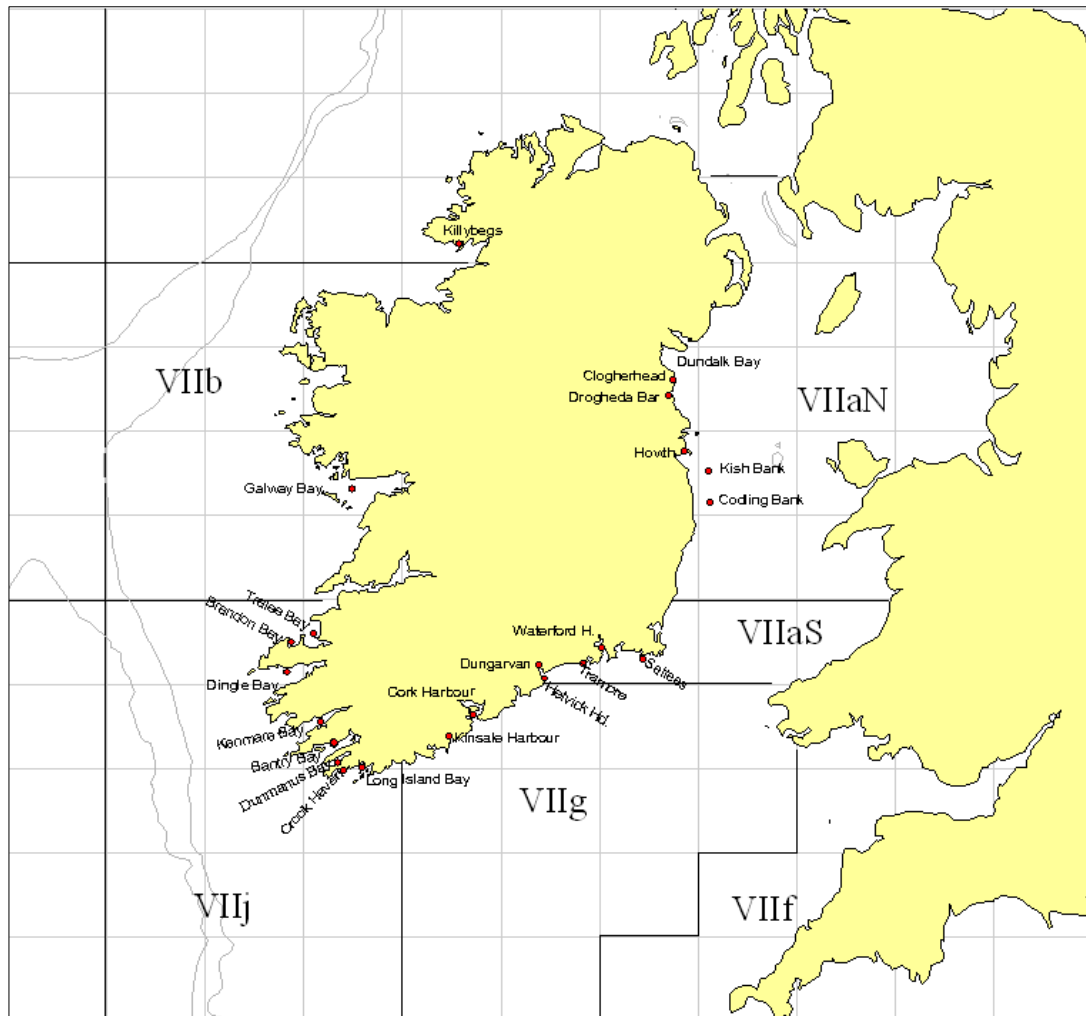


Figure 1. Placenames mentioned in the text.

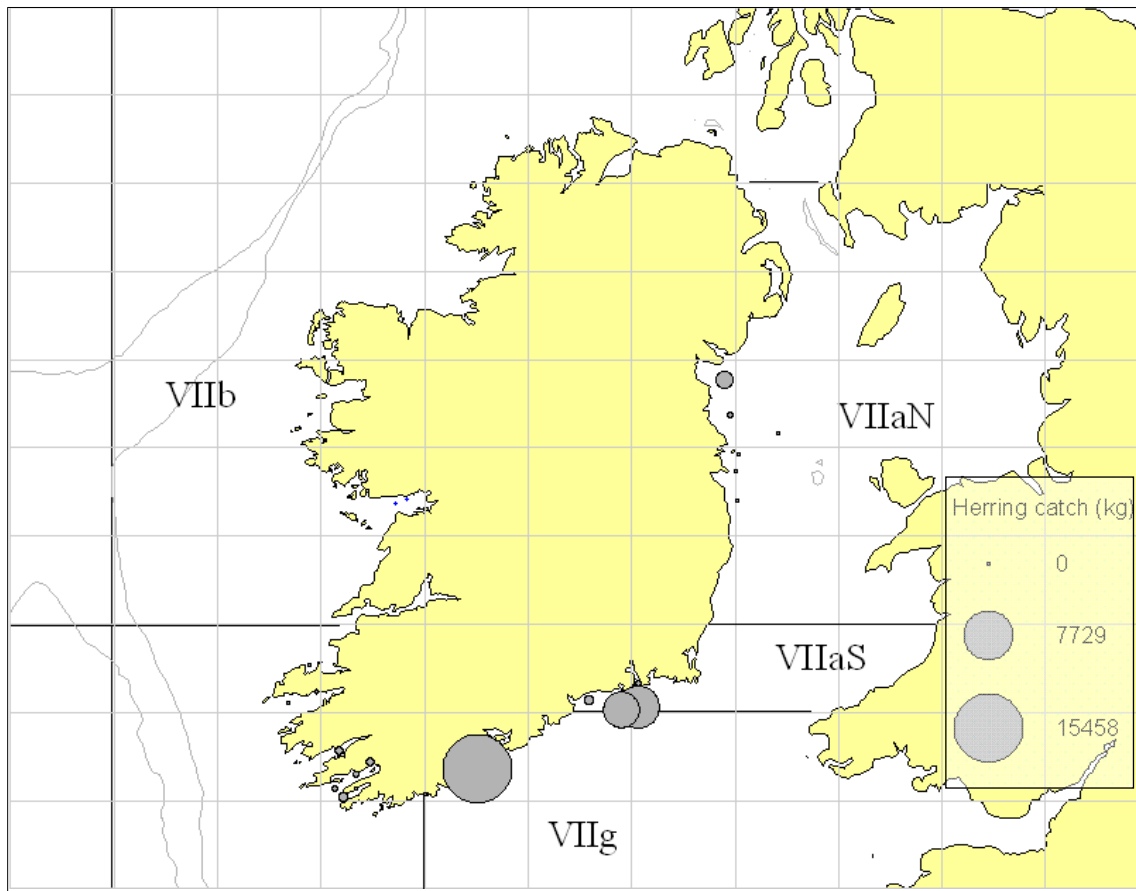


Figure 2. Haul positions, and bulk herring catch (kg).

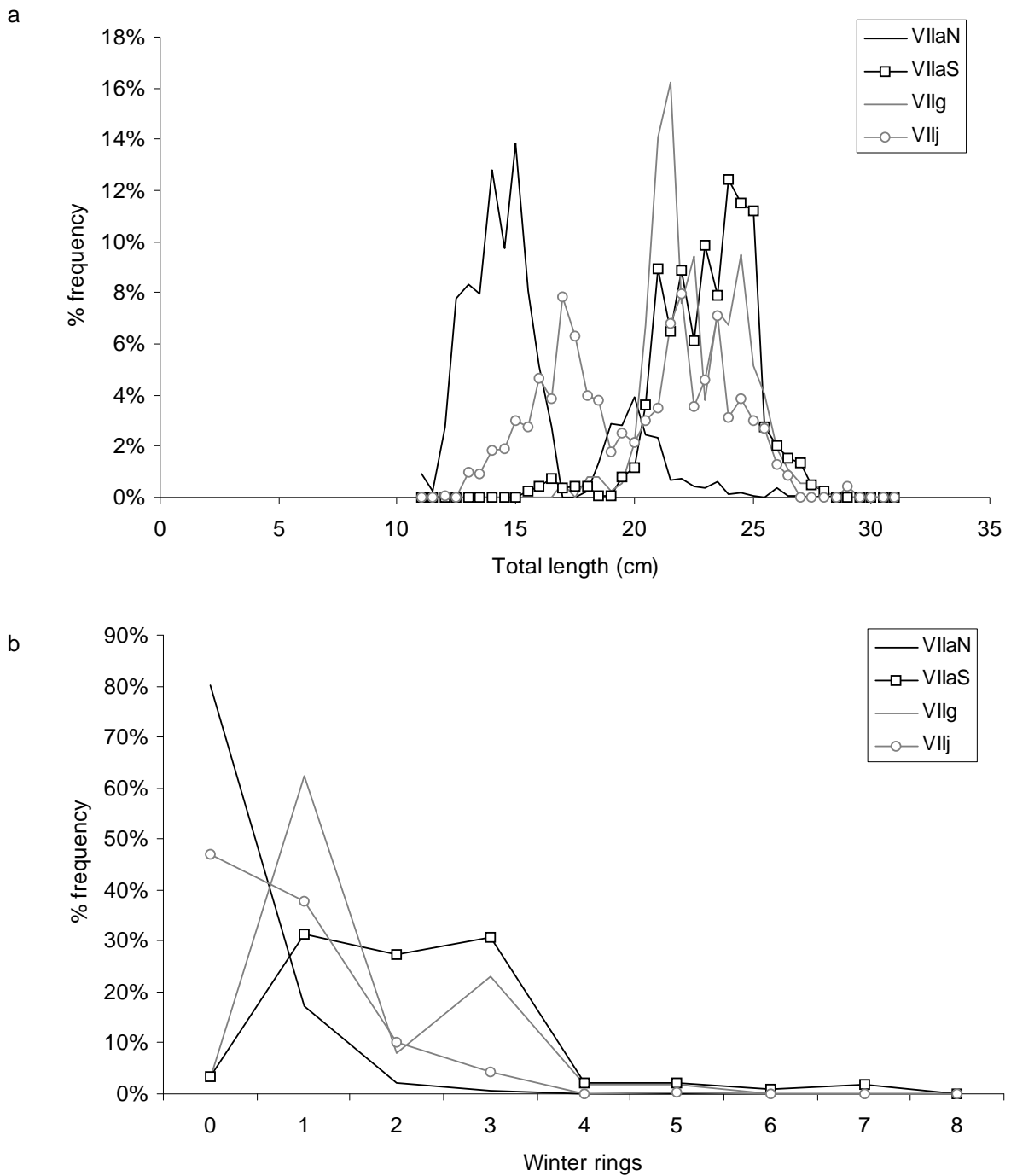


Figure 3. Percentage length (half cm) by ICES division (a) and age (winter rings) frequency for herring by ICES division (b).

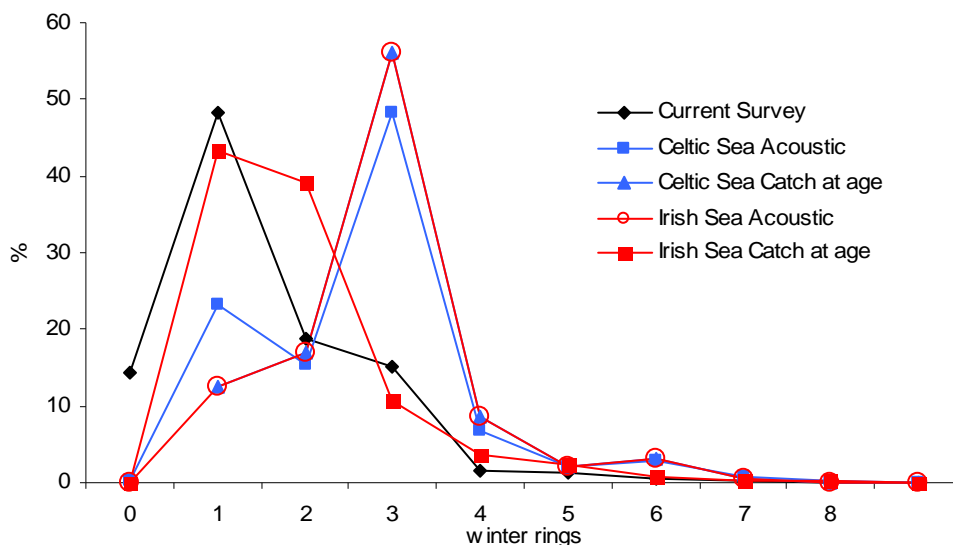


Figure 4. Comparison of % age frequency for the current survey and other surveys of the Irish and Celtic Seas during the 2007/2008 season.

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References

- Bracken, J. and M. Kennedy (1967). Notes on some Irish estuarine and inshore fishes. Irish Fisheries Investigations - Series B **3**: 30 pp.
- Brophy D, Danilowicz BS (2002). Tracing populations of Atlantic herring (*Clupea harengus* L.) in the Irish and Celtic Seas using otolith microstructure. ICES J MAR SCI 59 (6): 1305-1313
- Farran, G. P. (1944). "The herring fishery in Eire 1921 - 1941." Department of Agriculture Journal **51**(2): 34 pp.
- Grainger, R. J. (1976). "The inter-relationships of populations of autumn spawning herring off the west coast of Ireland." BIM Resource Record Paper (32): 21 pp.
- ICES, (1994). ICES report of the study group on herring assessment and biology in the Irish sea and adjacent waters, ICES CM 1994/H:5: 69 pp.
- ICES, 2004. Report of the Herring Assessment Working Group for the area south of 62°N. ICES 2004/ACOM:18. 551 pp.
- ICES, (2005). Report of the Herring Assessment Working Group for the area south of 62°N. ICES 2005/ACOM:16. 609 pp.
- ICES, (2006). Report of the Herring Assessment Working Group for the area south of 62°N. ICES 2006/ACOM:20. 618 pp.
- ICES, (2008). Report of the Herring Assessment Working Group for the area south of 62°N. ICES 2008/ACOM:02.
- ICES, (2009). Report of the Herring Assessment Working Group for the area south of 62°N. ICES 2009/ACOM:03. 658 pp.
- Molloy, J. (1968). "Herring investigations on the southwest coast of Ireland 1967." ICES CM 1968/H:14: 10 pp.
- Molloy, J. (1979). "Irish Sea young herring survey - July 1979." *Department of Fisheries and Forestry*
- Molloy, J. (1980). "The results of young herring surveys in the Irish Sea." ICES CM 1980/H:48: 11 pp.
- Molloy, J. (2006). The Herring Fisheries of Ireland (1900-2005), Biology, Research, Development and Assessment. Galway, Marine Institute. 235 pp.
- Molloy, J., Barnwall, E. and Morrison, J. (1993). "Herring tagging experiments around Ireland, 1991." Fisheries Leaflet 154: 7 pp.
- Molloy, J. and A. Corten (1975). Young herring surveys in the Irish Sea. ICES CM 1975/H:11: 19 pp.

Ricker, W.E. (1975) Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada*. 191. 382 pp.

Saunders, R., O'Donnell, C., Campbell, A., Lynch, D., Lyons, K. and Wall, D. (2009) Celtic Sea herring acoustic survey report 2009. FSS survey series 2009/03.

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