FSS Survey Series: 2012/03

Boarfish Acoustic Survey
Cruise Report

09 July – 26 July, 2012

Photo: Ciaran O'Donnell

MFV Father McKee

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1   Introduction

From the early 1970s the abundance of boarfish (*Capros aper*) was seen to increase exponentially and distribution ever increasingly spread northwards along the western seaboard and Bay of Biscay (Blanchard and Vandermeirsch, 2005). At the same time, boarfish were caught in increasing quantities in both pelagic and demersal fisheries. This in turn resulted in damage to more commercially valuable target species. Exploratory fishing for boarfish by Irish vessels began in the later 1980s when commercial quantities were encountered during the spring horse mackerel (*Trachurus* trachurus) and mackerel (*Scrombrus scomber*) fishery in northern Biscay. Several landings were made into Ireland for fishmeal during this time but due to logistical problems related to handling (prominent dorsal spines) this species was not favoured by processors. Interest increased again around the mid 1990s when Dutch pelagic vessels landed frozen samples to determine if a market could be developed for human consumption.

During the early 2000s the Irish landings were relatively small (<700t per yr) and it was not until 2006 that a directed fishery developed. Fishing was undertaken primarily by vessels from the Castletownbere and Killybegs based RSW fleets (refrigerated seawater vessels) which targeted boarfish from northern Biscay to the southern Celtic Sea. In 2007-08 vessels from Scotland and Denmark also began targeting boarfish in quantity. Irish landings are primarily landed into fishmeal plants in Denmark and the Faroe Islands with increasing amounts being landed in Killybegs in recent years. The boarfish fishery bridged an important gap between the short season fisheries for horse mackerel, mackerel and blue whiting (*Micromesistius poutassou*) affectively extending the fishing season for the RSW fleet from late August through to May.

A precautionary interim management plan was adopted in November 2010 covering ICES Divisions VI, VII and VIII and an EU TAC of 33,000t was set. Of this the Irish allocation for 2011 was 22,000t. This precautionary TAC was based on 50-75% of total landings from the period 2007-2009 which peaked at over 83,400t (2009). Landings in 2010 reached over 137,000t prior to the introduction of TAC control. In addition to the TAC, seasonal closures were implemented; from September 1-October 31 ICES (area VIIg) to protect herring feeding and pre spawning aggregations and from March 15–August 31 where mackerel are frequently encountered as a large bycatch. A catch rule ceiling of 5% bycatch was also implemented within the fishery where boarfish are taken with other TAC controlled species. In 2012 the EU TAC was set at 82,000t with an Irish allocation of 56,666t.

This survey represents the second exploratory research survey for boarfish undertaken along the western seaboard of Ireland. The commercial fishing vessel the MFV *Father McKee,* an active participant in the fishery, was equipped with a calibrated scientific echosounder (Simrad EK 60) and transducer within a towed body.

Data from this survey, in addition to the extensive biological research carried out on this species forms part of a larger program aimed at increasing the knowledge of this species and its abundance outside of the commercial fishery. Data from this survey will be presented for inclusion into the ICES Planning Group meeting for North Atlantic Pelagic Ecosystem Surveys in December 2012 (WGIPS) and for the ICES assessment Working Group for Widely Distributed Stocks (WGWIDE) meeting in August 2012.

2 Materials and Methods

2.1 Scientific Personnel

Organisation	Name	Capacity
FEAS	Ciaran O'Donnell	Acoustics (SIC)
KFO	Edward Farrell	Biologist
FEAS	Turloch Smith	Biologist
Contractor	Nigel Griffen	Fisheries Obs

2.2 Survey Plan

2.2.1 Survey objectives

The primary survey objectives of the survey are listed below:

- Collect integrated and calibrated acoustic data on boarfish (*Capros aper*) aggregations within the pre-determined survey area

- Determine the biomass and abundance of boarfish within the survey area

- Collect biological samples from directed trawling on insonified echotraces to determine age structure and maturity state of survey stock as well as to identify echotrace to species.

- Determine the extent and behaviour of boarfish aggregations within the survey area to aid the design of future surveys

- Dovetail with the RV Celtic Explorer in the northern area to ensure close spatio-temporal alignment and increase effective area coverage

2.2.2 Area of operation and survey design

The survey started in the Porcupine Bank area before moving to survey the shelf area between 53°30N and 47°30N from north to south following a pre-determined cruise plan (Figure 1). Area coverage was based on the distribution of catches from the IBTS survey time series, catch data and from the previous survey (O'Donnell *et al* 2011).Timing was planned to coincide with the arrival of the RV *Celtic Explorer* in the northern survey area to ensure a continuous, quasi-synoptic, coverage of the combined area.

In total 3,921nmi (nautical miles) of cruise track was undertaken by both vessels over 61 transects relating to a total area coverage of 51,555nmi². Transect spacing was set at 15nmi for the *Father McKee* and 7.5nmi for the *Explorer* component. For the area covered by the *Explorer* only strata bordering the shelf edge were considered during the analysis.

Coverage extended in coastal areas from the c.50m contour to the shelf slope (250m). An elementary distance sampling unit (EDSU) of 1nmi was used during the analysis of combined survey data.

The survey was carried out from 04:00–00:00 each day in line with the *Explorer* to coincide with the hours of daylight when boarfish are most often observed in homogenous schools. During the hours of darkness boarfish schools tend to disperse into mixed species scattering layers.

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2.3   Sampling protocols and equipment specifications

2.3.1 Acoustic equipment

Equipment settings were determined before the start of the survey and are based on established settings employed on previous surveys (O'Donnell *et al.,* 2004 & 2011).

Acoustic data were collected using a Simrad EK 60 scientific echosounder topside unit. A Simrad ES-38B (38 KHz) split-beam transducer was mounted within a towbody frame and deployed on the port side via a towing boom to a working depth of 3-3.5m (Appendix 1).

Cruising speed was largely determined by the weather and the affects on the quality of acoustic data. Where possible cruising speed was maintained at 10kts.

2.3.2 Calibration of acoustic equipment

The EK 60 was calibrated in Killybegs Harbour on 08 July prior to the start of the survey. The calibration was carried out using standard methodology as described by Foote *et al.* (1987) Results of the calibration are presented in Table 1. The calibration was successful and results were in line with those of previous calibrations.

2.3.4 Acoustic data acquisition

Acoustic data were recorded onto the hard-drive of the processing unit. The "RAW files" were logged via a continuous Ethernet connection as "EK5" files to laptop and a HDD hard drive as a backup. Sonar Data's Myriax Echoview® Live viewer (Version 5.0) was used to display the echogram during data collection to allow the scientists to scroll through echograms noting the locations and depths of target schools to a log file. A member of the scientific crew monitored the equipment continually. Time and location were recorded for each transect start/end position within each stratum. This log was also used to monitor "off track events" such as fishing operations.

2.3.5 Echogram scrutinisation

Acoustic data was backed up every 24 hrs and scrutinised using Sonar data's Echoview® (V 5.0) post processing software. The scrutiny process involved the allocation of echotraces (schools) to particular species or species mix categories, based on the information from the directed trawl hauls.

The NASC (Nautical Area Scattering Coefficient) values from each boarfish echotrace were allocated to one of 4 categories after scrutiny of the echograms. Categories identified on the basis of echotrace scrutiny were as follows:

1. "Definitely boarfish" echotraces were identified on the basis of captures of boarfish from the fishing trawls which were sampled directly. Based on the directly sampled schools we also characterised echotrace as definitely boarfish which appeared very similar on the echogram i.e. , large marks which showed as very high intensity (red), located high in the water column (day) and as strong circular schools.

2. "Probably boarfish" were attributed to smaller echotraces that had not been fished but which had similar characteristics to "definite" boarfish traces.

3. "Boarfish in a mixture" were attributed to NASC values arising from all fish traces in which boarfish were contained, based on the presence of a proportion of boarfish in the catch or within the nearest trawl haul. Boarfish were often taken during trawling in mixed species layers during the hours of darkness.

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

This set of categories allowed us to present the biomass estimates in terms of the best estimate (Cats 1-3), the minimum estimate Cat 1 + 3), and the maximum estimate (Cats 1-4).

Echograms were divided into transects and off track events, including trawl hauls and hydrographic stations were excluded. Echo integration was performed on regions which were defined by enclosing selected parts of the echogram that corresponded to one of the four categories above. The echograms were generally analysed and echo-integrals calculated, at a threshold of -70 dB, where necessary heavy backscatter from plankton was filtered out by thresholding at –65 dB.

2.3.6 Biological sampling

A single pelagic midwater trawl with the dimensions of 398m in total length with a 72m brailer was used during the survey. The horizontal net spread was averaged 120m from wing to wing. Mesh size in the wings was 12.8m through to 2cm in the cod-end liner. The net was fished with a vertical mouth opening averaging 50m, which was observed using a cable linked Simrad FS 70 net sonar (200 kHz). The net was fitted with Marport catch and tunnel sensors to monitor the amount catch entering the trawl.

All components of the catch were sorted to species and weight by species. For species other than boarfish, length and weight measurements were taken for 100 individuals per trawl in addition to a 300 fish length frequency sample. Length, weight, sex and maturity data were recorded for individual boarfish in a random 50 fish sample from each trawl haul. In addition a further 100 length/weight and 300 fish length frequency measurements were taken from each haul. Due to the complexity of aging boarfish, no aging was carried out onboard and samples were analysed back in the lab. The appropriate raising factors were calculated and applied to provide length frequency compositions for the bulk of each haul.

The decision to fish on particular echotraces was based on both the distance from other fishing operations on similar schools, and on the difference between recently observed echotraces and others previously sampled.

2.4   Analysis methods

2.4.1 Abundance estimates

The recordings of area back scattering strength (NASC) per nautical mile were averaged over a one nautical mile EDSU (Elementary sampling distance unit), and the allocation of NASC values to boarfish and other acoustic targets was based on the composition of the trawl catches and the appearance of the echotraces.

To estimate the abundance, the allocated NASC values were averaged for ICES statistical rectangles (1° latitude by 2° longitude). For each statistical area, the unit area density of fish (S_A) in number per square nautical mile ($N*nmi^{-2}$) was calculated using standard equations (Foote et al. 1987, Toresen *et al*. 1998).

NASC values assigned according to scrutinisation methods (section 2.3.5) were used to estimate the boarfish 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 (ICES, 1994):

Herring   TS = $20log_{10}L – 71.2$ dB per individual (L = length in cm)

Sprat   TS = $20log_{10}L – 71.2$ dB per individual (L = length in cm)

Mackerel   TS = $20log_{10}L – 84.9$ dB per individual (L = length in cm)

Horse mackerel   TS = $20log_{10}L – 67.5$ dB per individual (L = length in cm)

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

Gadoids   TS = $20log_{10}L – 67.4$ dB per individual (L = length in cm)

For boarfish (*Capros aper*) a species specific TS length relationship was applied based on theoretical swimbladder modelling from as yet unpublished data (Fassler *et al.* in review).

    Boarfish   TS = $20\log_{10}L - 65.98$ dB per individual (L = length in cm)

To estimate the total abundance of fish, the unit area abundance for each statistical rectangle was multiplied by the number of square nautical miles in each statistical square and then summed for all statistical rectangles for the total area. Biomass estimation was calculated by multiplying abundance in numbers by the average weight of the fish in each statistical rectangle and then sum of all squares by rectangle and summed for the total area.

3   Results

3.1   Boarfish abundance and distribution

The results presented here are a composite of data collected during this survey and on the northwest herring survey (RV *Celtic Explorer*). Surveys were timed to ensure a continuous, quasi-synoptic, coverage of the combined area over 33 days from north (59°N) to south (47°30'N). Both surveys used calibrated echosounders but no inter-vessel acoustic or fishing intercalibration exercises were carried out due to time restraints.

Thirty six hauls (*Father McKee:* 29; *Explorer*: 7) were carried out during the survey 26 of which contained boarfish (Figure 1, Table 2). In total, 5,952 lengths and 1,997 length/weight measurements were taken in addition to 897 individual boarfish otiliths collected for aging.

3.1.2 Boarfish biomass and abundance

A full breakdown of the surveyed stock structure is presented by strata, age, length, biomass, abundance and area in Tables 4, 5 & 6 and Figures 3 & 4.

Boarfish	Millions	Biomass (t)	% contribution
Total estimate			
Definitely	11,106	673,047	82.0
Probably	1,969	117,612	14.3
Mixture	479	30,276	3.7
Total estimate	**13,554**	**820,935**	**100**
Possibly	15	967	
SSB Estimate			
Definelty	11,041	671,680	82.0
Probably	1,949	117,197	14.3
Mixture	478	30,249	3.7
SSB estimate	**13,468**	**819,126**	**100**
Possibly	15	967	

Biomass derived using a modelled boarfish TS-Length relationship (-65.98dB).

3.1.3 Boarfish distribution

A total of 1,168 boarfish schools were identified during the survey. Of this 82 % were categorised as 'definitely' boarfish, 14% as 'probably', 4% 'boarfish in a mixture' and 0.6% as 'possibly'. A full breakdown of school categorisation, abundance and biomass by ICES statistical rectangle is provided in Table 9.

In the northernmost area and Porcupine Bank boarfish were observed in small low density clusters (Figure 2 & Figure 5a,b). Three percent of the total number of schools observed were found within the 16 strata covered. In total, the northern area contained 1.2% to the TSB and 1.1% of TSN. Although important in terms of western and northern stock containment these areas would not be considered core spawning areas for boarfish.

Two areas of high core abundance were noted during the survey. The Western area; along the west coast of Ireland (52°-54°N) contained over 47% of the total number of schools detected within 20 strata. This area was characterised by large number of high density monospecific schools and numerous smaller high density schools (Figure 5c). This area contained the 2 highest biomass strata of the survey (Figure 2 & Table 9). Boarfish in this area were predominantly distributed in water depths between 70-140m and schools were often located higher in the water column (c.40m from surface) than in areas further south (Figure 5e). In total the Western area contributed 42.3% to the TSB and 41.8% to the TSN.

Moving south into the Celtic Sea, the second highest density core area was located between 49°30N and 47° 30'N (Southern area). This area covered the largest area (26 strata) and also contained numerous high density monospecific schools representing 50% of the total observed. The main area was centred on the shelf edge and contained the third and fifth largest contributing strata respectively. As well as a high concentration of fish along the shelf edge spawning schools were also located on shelf to the east in a bathymetrically complex area characterised by Banks and canyons. The Banks complex which characterises this region would be regarded as an important over-wintering and nursery habitat for boarfish. In total the Southern area contributed 56.5% to the TSB and 57.2% to the TSN.

Within the Southern area a sub area of high distribution was defined between 50°-51°N around an area associated with the commercial fishery and known locally as the redfish Bank (Figure 5d). The distribution of schools in this area was more centred on a Bank complex which is the main bathymetric feature in the area and not so much on the shelf edge as in the western or southern core areas. Schools in this area were made up of a mixture of numerous high and medium density schools. The fourth largest contributing stratum was located around the redfish Bank contrasting to the much lower abundance observed in this area in 2011 (Figure 5d, Table 9).

July is the peak of the spawning period as determined from histological analysis of catch samples. It can be inferred from distribution observed during the survey that movements to the shelf edge are part of an annual spawning pattern. Immature fish do not appear to undertake the movement to the shelf edge in great number and stay on shelf year round until maturity. During the survey all mature individuals were observed to be spawning i.e. in either a ripe or running state.

3.1.4 Boarfish stock structure
An age length key compiled primarily from commercial samples collected during 2011/2012 fishery was applied during the analysis of survey data. This ALK was used in place of a survey derived ALK due to the unavailability of aged samples during the analysis. The ALK is considered comprehensive covering a wide range of lengths (2.5-18cm) including those encountered during this survey (7.5-18cm).

Age distribution as determined from survey samples indicate that the stock is dominated by the following age classes in terms of abundance: 20+, 12, 10 and 9 &13 year old fish and 20+, 12, 16 and 10 years in terms of biomass respectively (Figure 3, Table 5 & 6).

Very few immature (< 9.7 cm TL) boarfish were observed during the survey (0.2% of TSB and 0.6% of TSN). Immature fish were primarily located on shelf on the Banks complex south of 51°N (Table 7 & 8, Figures 2 & 4). Survey data did not indicate the presence of aggregations of juveniles or potential hotspots of juvenile distribution.

3.2   Other pelagics

3.2.1   Herring
Few herring (*Clupea* harengus) echotraces were observed during the survey and only one trawl sample yielded herring (Table 2, Figure 5f). No biomass or abundance calculation was made for this species.

A total of 276 herring were measured and 100 length and weights were recorded. The modal length of herring was 26.5cm (range 21-30.5cm) and mean weight was 177g.

3.2.2   Horse mackerel
Horse mackerel (*Trachurus trachurus*) were encountered in 41% of survey hauls and were most frequently encountered in deeper waters (>80m) and often occurred in catches with boarfish (Table 2). No biomass or abundance calculation was made for this species.

A total of 817 horse mackerel were measured and 494 length and weights were recorded. The modal length of horse mackerel was 28cm (range 20-38cm) and mean weight was 222g.

Horse mackerel were widely distributed throughout the survey area from the Porcupine Bank to the southern Celtic Sea occurring mainly as medium density schools spaced over a wide area. In 2011, in the southern area horse mackerel were found mixed with boarfish in high density bottom layers over a wide area. It was not possible to accurately determine horse mackerel from boarfish in these layers by acoustic means alone as both species have a very similar TS range. Furthermore it was not always possible to trawl due to poor ground in this bathymetrically complex area. This year horse mackerel and boarfish layers were more easily discerned as separate layers as the latter tended to be further off the bottom and separate from the more demersally orientated horse mackerel.

Cursory analysis of stomach contents would suggest that horse mackerel were feeding on recently spawned boarfish eggs. This would in part explain the presence of horse mackerel in and around boarfish spawning aggregations.

3.2.3   Blue whiting

Blue whiting (*Mircomesistius poutassou*) were encountered in 35% of trawls (Table 2). No calculation of biomass was determined from survey data at this time.

A total of 992 blue whiting were measured and 877 length and weights were recorded. The modal lengths of mackerel occurred at 13cm and 19cm (range 11-26cm) and mean weight was 27g.

Blue whiting were found widely distributed along the shelf edge. Large high density schools of mature fish were observed along the offshore inter-transects south of 51°N but were not actively targeted by trawling during the survey (Figure 5h). In addition numerous high density on shelf schools of 1-group immature fish were observed from 53°N southwards with the high concentration south of 51°N and were trawl sampled for verification purposes (Figure 5g). The presence of numerous high density schools of immature blue whiting is a positive signal for the stock, which appears to be emerging from a prolonged period of poor recruitment (O'Donnell *et al.* 2012).

4   Discussion and conclusions

4.1 Discussion

Overall, the survey can be considered as having been a success with all components of the work program completed as planned with no downtime. The cruise track was adapted to account for real time observations. Easterly extension in the mid and southern Celtic Sea was reduced where required and effort was reallocated further south along the shelf edge, where the likelihood of encountering boarfish was greatest.

The geographical distribution of boarfish across surveys shows a similar pattern for the same level of survey effort with the 2 highest abundance areas dominating between years (southern and western areas). The total number of schools detected in 2012 was 17% higher than in 2011, whereas school allocation to the def category remained comparable with 80% (+/-1%) in both years. Allocation of schools to the def category was aided by comprehensive trawl coverage throughout the survey

The main difference between years related to school size (NASC value) with 3 individual schools observed this year of higher NASC value than the largest school recorded in 2011. The largest of which was over 52% greater than the maximum recorded in 2011.   The increased number and size of schools observed in 2012 is reflected by the 47% increase in biomass between years.

The increase in detection of schools maybe accounted for primarily by the change in survey methodology to survey only during daylight hours which has no doubt played a large part in increasing positive detection of monospecific boarfish schools. The daytime behaviour of boarfish in relation to proximity to the seabed showed differences between years and this will have also species allocation and therefore abundance. In 2011 boarfish schools along the shelf break in the southern region (48°-49°30N) were located close to/on the bottom and often mixed with horse mackerel in high density homogeneous layers. This area is a known hot spot for horse mackerel in the commercial fishery. In these high abundance areas trawling close to the bottom was not always possible due to the complex bathymetry and possibility of gear damage. In such instances this would have left a portion of the stock unaccounted for. In 2012 boarfish schools in this area were observed to occupy a position slightly off the bottom, allowing for effective trawl sampling and accurate categorisation.

Boarfish behaviour in terms of school positioning in the water column showed geographical differences from north to south. In the western area boarfish schools were exclusively located on shelf and were observed higher in the water column. In the southern area schools located on the shelf edge were closer to the seabed when in comparable water depths. As boarfish are spawning during the survey this behaviour maybe a spawning strategy related to ambient hydrographic conditions encountered for exposed sites on the shelf edge.

Size structure of boarfish within trawl catches showed a trend towards larger fish further north and a broader length range further south possibly due to coverage of nursery habitat. This size trend is consistent with previous observations from 2011 and with commercial catch data.

The stock was considered to be sufficiently well contained within the survey area. Reports from the PELGAS acoustic survey in the Bay of Biscay (mid May to mid June) reported only blue whiting and mackerel echotraces north of 47°N (Pierre Pettitgas *pers comm.*). However, this survey does not routinely report boarfish abundance. Geographical overlap was therefore achieved but with a temporal gap of over one month. Hydrographic conditions as reported by the PELGAS survey indicate that the water column was poorly stratified and that phytoplankton and zooplankton biomass was low. No CEFAS acoustic survey in the Celtic Sea this year.

4.2 Conclusions

Acoustically derived estimates of abundance are used as a relative index of abundance of the stock present within the survey area at the time of surveying. The survey therefore acts as a

'snapshot' of the stock and should not be considered as a measure of absolute stock abundance. The use of an abundance index allows for the percentage change between successive estimates to be tracked over time to reveal trends in stock abundance as the time series develops.

The 2011 pilot survey was used to determine a baseline from which to base future surveys. Geographical coverage can now be considered as established in all but the southern boundary. Southern containment of the stock is a potential weak spot and continued coverage is a requirement. As the French survey (PELGAS mid May-mid June) does not routinely report boarfish distribution it is not possible to determine the southern extent of the survey boundary prior to actual surveying and as a result it is difficult to plan the survey temporally without this information.

In 2012 the survey methodology was further refined by switching to daylight surveying. The switch to daylight surveying has no doubt led to an increase in school detection more so than could be attributed to year effects alone. The daylight sampling protocol has increased the precision of the survey estimate and should be maintained in the future.

Comprehensive trawl coverage, as in the previous survey, allowed for positive identification of boarfish schools which increased the precision of the stock estimate. The increase in the number of schools observed in 2012 resulted in a lower abundance CV of 10.6% as compared to 17.6% in 2011.

The daytime behaviour of boarfish in relation to proximity to the seabed should also be considered here as it is a trait that may affect the precision of future estimates due to limitations on effective sampling (species composition). This behaviour is most pronounced in the southern region which also contains the largest proportion of the stock. As boarfish and horse mackerel are very similar acoustically this compounds problems associated with determining species composition of mixed species scattering layers without the means of trawl sampling.

4.3 Recommendations

The following recommendations are based on observations made during the survey and are provided as a means of improving the precision of future surveys.

- Daylight sampling protocol (04:00-23:00) should be continued to allow for the most effective detection of boarfish. Crepuscular changes in behaviour are rapid and during the hours of darkness detection cannot be accurately determined. Optimum conditions would allow for surveying to stop at first onset of dawn/dusk. However, the practicalities of this would not allow for effective geographical coverage in the time available.
- Focus on core spawning areas. With 2 surveys now in place core abundance areas are now more easily recognised. Increased transect resolution is recommended to more accurately determine abundance in these core areas. To accommodate this in terms of survey effort coverage in peripheral areas such as the Porcupine Bank could be dropped/reduced.
- The timing of the survey should continue to be aligned with the northwest herring survey to extend the area coverage in the northern area and ensure northern containment of the stock.
- Southern containment of the stock needs to be further investigated to increase the precision of future estimates in terms of stock containment.

Acknowledgements

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Table 1. Survey settings and calibration report (38kHz) for the tow body system (Simrad ER60 echosounder).

Echo Sounder System Calibration

Vessel :	F/V Father McKee	Date :	8/7/2012
Echo sounder : EK60 Tow Body		Locality :	Killybegs
Type of Sphere : CU 64	TS_{Sphere}: -33.50 dB (Corrected for sound velocity or t,S)	Depth(Sea floor) :	16 m

Calibration Version 2.1.0.12

Comments:
Killybegs 08.07.12. Good conditions

Reference Target:

TS	-33.50 dB	Min. Distance	8.0m
TS Deviation	5 dB	Max. Distance	11.5m

Transducer: ES38B Serial No.

Frequency	38000 Hz	Beamtype	Split
Gain	26.50 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.10 deg	Along. Beam Angle	6.99 deg
Athw. Offset Angle	-0.07 deg	Along. Offset Angl	-0.15 deg
SaCorrection	-0.62 dB	Depth	3.00 m

Transceiver: GPT 38 kHz 009072033933 1 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.190 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:
ER60 Version 2.2.1

TS Detection:

Min. Value	-50.0 dB	Min. Spacing	100 %
Max. Beam Comp.	6.0 dB	Min. Echolength	80 %
Max. Phase Dev.	8.0	Max. Echolength	180 %

Environment:

Absorption Coeff.	9.3 dB/km	Sound Velocity	1503.6 m/s

Beam Model results:

Transducer Gain =	24.97 dB	SaCorrection =	-0.61 dB
Athw. Beam Angle =	7.42 deg	Along. Beam Angle =	7.27 deg
Athw. Offset Angle =	0.28 deg	Along. Offset Angle=	0.03 deg

Data deviation from beam model:
RMS = 0.21 dB
Max = 0.63 dB No. = 345 Athw. = -1.0 deg Along = 0.3 deg
Min = -0.99 dB No. = 61 Athw. = -2.2 deg Along = 2.2 deg

Data deviation from polynomial model:
RMS = 0.18 dB
Max = 0.76 dB No. = 345 Athw. = -1.5 deg Along = 0.3 deg
Min = -0.98 dB No. = 61 Athw. = 2.2 deg Along = -2.2 deg

Comments :
Flat calm conditions
Wind Force : 5 kn. **Wind Direction :** NE (45 degrees)
Raw Data File: C:\Program files\Simrad\Scientific\EK60\Data\Calibration 08.07.12
Calibration File: C:\Program files\Simrad\Scientific\EK60\Data\Calibration 08.07.12

Calibration : Ciaran O'Donnell

Table 2. Catch composition and position of hauls undertaken by the MFV *Father McKee* and for the Celtic Explorer.

Father McKee

No.	Date	Lat. N	Lon. W	Time	Bottom (m)	Target btm (m)	Bulk Catch (Kg)	Boarfish %	Mackerel %	Herring %	H Mack %	Others^ %
1	09.07.11	53 32.83	014 03.93	20:10	340	120	150	78.7	10.0		7.7	3.5
2	10.07.12	53 04.52	013 30.36	17:05	255	240	3		12.4		20.9	66.7
3	11.07.12	52 50.79	013 35.02	10:30	229	225	5,000		3.4		96.6	
4	12.07.12	53 35.40	011 36.53	14:17	221	180	2,500		0.9		2.1	97.0
5	12.07.12	53 20.91	010 44.50	23:00	114	0-65	100			73.6		26.4
6	13.07.12	53 14.72	012 26.42	10:57	355	250	2,000	62.4	5.5		32.0	
7	13.07.12	53 05.13	011 47.32	18:03	180	80	300	95.6	1.9		0.9	1.6
8	14.07.12	52 51.61	011 59.62	10:00	216	120-200	10,000	100.0				
9	14.07.12	52 36.06	011 28.97	19:41	145	90	1,000	88.6	11.0		0.3	
10	15.07.11	52 21.05	010 54.91	06:45	119	90	1,000					100.0
11	15.07.11	52 21.04	011 25.45	10:09	150	120	10,000	99.9	0.1			
12	16.07.12	51 37.32	011 16.73	09:00	204	144	2,000	99.9			0.1	
13	16.07.12	51 06.17	011 31.43	23:04	582	520	2,500					100.0
14	17.07.12	51 06.61	010 57.00	06:30	176	30-50	500		6.7		93.3	
15	17.07.12	51 06.10	010 16.57	10:35	136	70	2,000	98.2	1.8			
16	18.07.12	50 36.38	009 59.75	08:48	136	0-20	1,000	14.1	60.2		0.1	25.7
17	18.07.12	50 36.54	009 11.06	13:20	90	0-25	2,000	100.0				
18	19.07.12	50 06.04	009 10.56	11:27	105	0-25	4,000	71.1	2.5		26.4	
19	20.07.12	49 50.15	010 44.23	07:36	153	0-20	2,000		0.8			99.2
20	20.07.11	49 34.72	011 00.94	13:11	202	0-40	4,000		0.7			99.3
21	20.07.12	49 35.10	010 07.44	18:10	122	0-11	2,500		0.3			97.7
22	21.07.12	49 20.29	008 47.83	07:32	147	0-12	1,500	5.2	2.1		92.7	
23	21.07.12	49 20.50	010 47.50	15:47	162	10-150	4,500	100.0				
24	21.07.12	49 02.40	010 46.60	22:21	160	20-80	4,500	67.3				32.7
25	22.07.12	49 02.69	010 04.71	08:06	126	20-80	750	100.0				
26	22.07.12	49 03.17	008 16.36	16:19	149	95	5,500	100.0				
27	23.07.12	48 33.43	009 44.69	14:47	180	0-100	8,000	100.0				
28	24.07.12	47 48.57	007 28.68	10:07	243	0-40	1,000	100.0				
29	25.07.12	48 18.82	009 25.43	00:15	141	0-50	2,000	100.0				

^ Includes non target pelagic/demersal species and other taxa

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Table 2. Continued

Celtic Explorer

No.	Date	Lat. N	Lon. W	Time	Bottom (m)	Target btm (m)	Bulk Catch (Kg)	Boarfish %	Mackerel %	Herring %	H Mack %	Others^ %
8	27.06.12	56.793	8.953	15:47	123	107	400	66.9	4.7	26.3	1.9	0.2
10	28.06.12	56.414	9.042	21:44	144	114	300	61.7	22.4	0.8	2.2	12.9
14	01.07.12	55.923	9.142	07:39	170	60	1,500	88.5	3.1	0.0	8.3	0.0
15	01.07.12	55.783	9.092	10:54	133	128	3,500	1.1	7.7	0.4	90.9	0.0
20	03.07.12	55.417	9.589	17:51	188	50	2,000	8.6	86.4	0.0	5.0	0.0
27	07.07.12	53.803	10.675	21:34	124	104	33	2.3	0.4	39.0	0.0	58.4
29	08.07.12	53.545	11.397	15:28	177	97	25	0.9	79.4	0.0	7.2	12.6

^ Includes non target pelagic/demersal species and other taxa

Table 3. Age length key compiled from commercial catch and survey samples collected during 2011-2012. This ALK was applied to boarfish samples collected during the survey.

Length (cm)	Age (years) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.5	0.0	0.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.6	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10.5	0.0	0.0	0.6	0.2	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.2	0.1	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11.5	0.0	0.0	0.0	0.0	0.1	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.5	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.3
14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.4
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.5
15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.8
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0

Table 4. Boarfish length at age (years) as abundance (millions) and biomass (000's tonnes).

Length (cm)	Age (years) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+	Abundance (millions)	Biomass (000s t)	Mn wt (g)
4.5																							
5																							
5.5																							
6																							
6.5																							
7																							
7.5	6.9																				6.9	0.1	10.6
8	13.5																				13.5	0.2	17.7
8.5		10.2	51.2																		61.5	1.3	20.6
9			70.9	26.6	17.7																115.2	2.8	23.9
9.5			39.6	11.3		11.3	5.7														67.8	1.9	27.4
10			3.8	19.1	11.4	22.9	11.4	11.4													80.0	2.5	31.3
10.5				4.7	28.2	112.8	47.0	28.2	9.4												230.3	8.2	35.5
11					11.1	188.8	155.5	133.3	100.0	55.5		11.1									655.3	26.3	40.1
11.5						21.8	218.3	327.5	174.6	196.5	152.8	152.8	43.7								1288.0	58.0	45.0
12							145.7	255.0	291.4	291.4	291.4	182.2	291.4	72.9	72.9	72.9	36.4	109.3	36.4	36.4	2185.8	110.1	50.4
12.5							123.8	82.5	165.0	247.5	165.0	330.0	247.5	206.3	82.5	82.5	206.3	165.0	41.3	288.8	2433.9	136.6	56.1
13								44.5	89.1		89.1	267.2	356.3	133.6	222.7	178.1	44.5	89.1	89.1	578.9	2182.0	135.9	62.3
13.5									72.4			72.4	108.6	181.0	36.2	181.0	72.4	144.8		543.0	1411.7	97.2	68.8
14											29.8	29.8	29.8	29.8		178.6	119.1	119.1	29.8	595.2	1160.7	88.0	75.8
14.5																68.3	34.2	68.3	34.2	649.0	853.9	71.1	83.3
15																				424.7	424.7	38.8	91.2
15.5																				246.5	246.5	24.6	99.7
16																				26.2	26.2	2.9	108.6
16.5																				23.2	23.2	2.7	118.0
17																				7.2	7.2	0.9	127.9
17.5																				80.1	80.1	11.1	138.4
18																							
18.5																							
19																							
19.5																							
20																							
TSN	20.43	10.24	165.5	61.63	90.29	699.8	925.8	721.5	806.8	908.8	618.8	1046	815	623.5	414.2	724.9	476.4	695.5	230.7	3499	13,554.5		
TSB	0.3	0.2	4	1.7	3.2	29.8	43	33.9	39.9	48.2	33.1	59.5	49.5	38.3	24.7	49.2	31.2	45	14.8	271.6		820.9	
SSN	0	4.1	116.6	55.19	86.74	698.7	925.2	721.5	806.8	908.8	618.8	1046	815	623.5	414.2	724.9	476.4	695.5	230.7	3499	13,467.4		
SSB	0	0.085	2.871	1.549	3.126	29.74	42.94	33.88	39.9	48.21	33.12	59.48	49.47	38.28	24.65	49.25	31.2	45	14.8	271.6		819.1	
Mn wt (g)	15.3	20.6	23.9	27.7	35.6	42.5	46.4	47	49.5	53	53.5	56.9	60.7	61.4	59.5	67.9	65.5	64.7	64.2	77.6			
Mn L (cm)	8.7	9.8	10.2	10.8	11.7	12.5	12.9	12.9	13.1	13.5	13.5	13.8	14.1	14.2	14	14.7	14.5	14.4	14.4	15.3			

Table 5. Boarfish total biomass (000's tonnes) at age (years) by ICES statistical rectangle.

Region	Strata	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+	Total
Western	36D6	0	0	0	0	0	0	0.1	0.1	0.2	0.3	0.2	0.4	0.4	0.3	0.2	0.4	0.2	0.3	0.1	1.6	4.9
	35D5	0	0	0	0	0	0.1	0.4	0.3	0.5	0.8	0.6	1.2	1.2	0.9	0.6	1.1	0.7	0.9	0.3	4.6	14.3
	35D6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.3
	34D9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34D5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
	34D6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	33D5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
	33D6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	36D8	0	0	0	0	0	1	1.9	1.6	2.1	2.8	2	3.8	3.4	2.5	1.8	2.9	1.7	2.6	0.9	12	43
	36D9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
	35D9	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0.1	0	0	0.1	0	0	0	0.2	0.8
	35D8	0	0	0	0	0	0.3	0.6	0.5	0.7	0.9	0.6	1.3	1.1	0.8	0.6	0.9	0.5	0.8	0.3	3.8	13.7
	35D7	0	0	0	0	0	0.3	0.5	0.4	0.6	0.8	0.5	1	0.9	0.7	0.5	0.9	0.6	0.8	0.3	4	12.8
	34D8	0	0	0.1	0.1	0.3	3.7	5.5	4.3	5.1	6.1	4.2	7.4	6.2	4.6	3.2	5.4	3.3	5	1.7	24.3	90.7
	34D7	0	0	0	0	0.1	1	1.5	1.2	1.5	2	1.4	2.6	2.5	1.8	1.3	2.2	1.3	1.9	0.7	10.5	33.3
	33D9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	33D8	0	0	0	0	0.1	2	3.9	3.4	4.5	5.9	4.1	8.2	7.1	5.1	3.6	5.8	3.8	5.4	1.9	33.2	98
	33D7	0	0	0	0	0	0.2	0.4	0.3	0.4	0.6	0.4	0.8	0.7	0.5	0.4	0.6	0.4	0.5	0.2	3.2	9.6
	32D9	0	0	0	0	0	0.2	0.3	0.3	0.3	0.5	0.3	0.6	0.5	0.5	0.3	0.6	0.4	0.5	0.2	3.6	9
	32D8	0	0	0	0	0	0.3	0.6	0.5	0.6	0.9	0.6	1.1	1	0.9	0.5	1.1	0.7	1	0.3	6.6	16.5
Southern	31D9	0	0	0	0	0	0.2	0.3	0.3	0.4	0.5	0.3	0.6	0.5	0.4	0.3	0.6	0.4	0.5	0.2	4.2	9.8
	31D8	0	0	0	0	0	0.1	0.2	0.2	0.2	0.3	0.2	0.4	0.3	0.3	0.2	0.4	0.2	0.3	0.1	2.3	5.7
	31E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30E0	0.1	0.1	1.1	0.4	0.4	2.3	3	2.1	2.4	2.7	1.9	3.1	2.6	1.9	1.3	2.2	1.5	2	0.7	12	43.6
	30D9	0	0	0.1	0	0.1	0.7	1.2	1	1.2	1.6	1	2	1.8	1.5	0.9	2.1	1.2	1.8	0.5	13.4	32.1
	30D8	0	0	0	0	0	0	0.1	0	0.1	0.1	0.1	0.1	0.1	0.1	0	0.1	0.1	0.1	0	0.7	1.6
	29E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
	29E0	0	0	0.4	0.1	0.1	0.7	0.8	0.6	0.6	0.6	0.4	0.5	0.3	0.2	0.2	0.2	0.2	0.3	0.1	0.9	7.2
	29D9	0.1	0	0.8	0.3	0.3	2.1	2.8	2.1	2.3	2.6	1.7	2.8	2.1	1.7	1.1	1.9	1.3	1.9	0.6	10.9	39.4
	29D8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28E1	0.1	0	0.7	0.2	0.2	1.2	1.3	1	1	0.9	0.6	0.8	0.5	0.4	0.3	0.4	0.3	0.4	0.1	1.6	12.2
	28E0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0	0.1	0	0	0	0	0	0	0	0.1	0.8
	28D9	0	0	0	0	0	0	0.1	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0.1	0.6
	28D8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27E1	0	0	0.1	0.1	0.2	2	2.2	1.7	1.7	1.6	1	1.4	0.7	0.6	0.4	0.5	0.3	0.7	0.2	2.5	17.9
	27E0	0	0	0.1	0.1	0.1	0.9	1	0.8	0.8	0.7	0.6	0.7	0.4	0.3	0.2	1.8	1.1	1.7	0.7	24.8	36.8
	27D9	0	0	0.2	0.1	0.2	1.7	2.4	1.8	2.1	2.4	1.6	2.7	2.1	1.8	1	2.4	1.6	2.3	0.7	16.1	43.2
	27D8	0	0	0.1	0.1	0.1	0.8	1	0.8	0.9	1	0.7	1.1	0.8	0.6	0.4	0.5	0.4	0.6	0.2	2.2	12
	26E1	0	0	0.1	0.1	0.4	3.4	3.9	3.1	3	2.8	1.8	2.6	1.4	1.1	0.8	1	0.7	1.3	0.4	4.4	32.3
	26E0	0	0	0	0	0.2	2.5	3.7	2.9	3.4	4	2.7	4.6	3.6	2.8	1.8	2.7	1.9	2.8	0.9	11.3	51.8
	26D9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.1	0.1	0.1	2.3	2.9
	25E1	0	0	0	0	0.1	0.7	0.9	0.7	0.8	1	0.6	1.2	1	0.8	0.4	0.8	0.6	0.8	0.2	3	13.8
	25E0	0	0	0	0	0.1	0.5	0.6	0.5	0.6	0.8	0.5	0.9	0.8	0.7	0.3	0.5	0.4	0.5	0.1	1.6	9.3
	25E2	0	0	0	0	0	0.2	0.5	0.4	0.7	1.2	1	2.1	2.1	1.8	0.9	3.6	2.3	3	0.9	20.6	41.3
	24E2	0	0	0	0	0	0.1	0.2	0.2	0.3	0.5	0.4	0.9	0.9	0.8	0.4	1.5	1	1.2	0.4	8.7	17.4
	24E3	0	0	0	0	0	0.2	0.4	0.3	0.5	1	0.8	1.6	1.7	1.4	0.7	2.9	1.8	2.3	0.7	16.2	32.5
N & Porc	37D9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37D8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	38E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	38E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	38D9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	39E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
	39E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
	39D9	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0	0.1	0	0.2	1.5
	40E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
	40E0	0	0	0	0	0	0.1	0.2	0.1	0.2	0.3	0.2	0.4	0.3	0.3	0.2	0.4	0.2	0.3	0.1	1.4	4.6
	41E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.3
	41E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	1.2
	42E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	42E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	1.2
	Total	0.3	0.2	4	1.7	3.2	29.8	43	33.9	39.9	48.2	33.1	59.5	49.5	38.3	24.7	49.2	31.2	45	14.8	271.6	820.9
	%	0	0	0.5	0.2	0.4	3.6	5.2	4.1	4.9	5.9	4	7.2	6	4.7	3	6	3.8	5.5	1.8	33.1	100

Table 6. Boarfish total abundance (millions) at age (years) by ICES statistical rectangle.

Region	Strata	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+	Total
Western	36D6	0.0	0.0	0.0	0.0	0.1	1.1	2.6	2.1	3.2	4.7	3.3	7.0	6.7	4.8	3.3	5.6	3.8	4.9	1.7	22.0	76.9
	35D5	0.0	0.0	0.0	0.0	0.2	3.1	7.7	6.1	9.4	13.8	9.7	20.6	19.5	14.0	9.6	16.3	11.1	14.5	5.0	64.5	224.9
	35D6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.2	0.4	0.4	0.3	0.2	0.3	0.2	0.3	0.1	1.3	4.4
	34D9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	34D5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.7	2.4
	34D6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	33D5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.3	1.1
	33D6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	36D8	0.0	0.0	0.0	0.0	1.1	21.1	39.2	32.5	41.2	51.7	36.0	66.8	55.6	40.4	29.3	43.8	27.1	40.7	14.1	167.2	707.6
	36D9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.2	1.0
	35D9	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.6	0.8	0.9	0.7	1.2	1.0	0.7	0.5	0.8	0.5	0.7	0.3	2.9	12.8
	35D8	0.0	0.0	0.0	0.0	0.3	6.8	12.7	10.6	13.4	16.8	11.7	21.8	18.1	12.9	9.6	13.8	8.5	12.9	4.6	52.4	227.1
	35D7	0.0	0.0	0.0	0.0	0.3	5.9	10.8	8.6	10.9	14.0	9.6	17.9	15.2	11.9	7.5	13.8	8.8	12.6	3.9	54.9	206.8
	34D8	0.0	0.4	3.8	2.7	8.7	86.2	119.0	90.7	103.2	115.2	80.3	130.6	102.5	75.6	53.8	81.6	51.6	78.3	27.0	334.6	1546.0
	34D7	0.0	0.0	0.0	0.1	2.0	22.3	32.3	24.7	30.0	36.2	25.1	45.6	40.0	28.6	20.9	33.0	19.9	29.4	10.5	142.7	543.4
	33D9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	33D8	0.0	0.0	0.0	0.1	2.6	44.3	80.3	67.8	86.3	108.6	74.4	142.8	117.4	84.0	61.1	88.1	59.3	85.8	30.8	431.6	1565.4
	33D7	0.0	0.0	0.0	0.0	0.3	4.3	7.8	6.6	8.4	10.6	7.3	13.9	11.4	8.2	6.0	8.6	5.8	8.4	3.0	42.1	152.6
	32D9	0.0	0.0	0.0	0.1	0.3	3.8	6.6	5.2	6.5	8.5	5.7	10.5	8.8	7.5	4.3	8.9	5.6	8.2	2.3	45.8	138.6
	32D8	0.0	0.0	0.0	0.2	0.6	6.9	12.0	9.6	11.9	15.6	10.4	19.3	16.2	13.7	7.8	16.3	10.3	15.0	4.3	83.8	253.8
Southern	31D9	0.0	0.1	0.9	0.2	0.4	4.8	7.4	6.2	7.1	8.7	5.7	10.6	8.7	7.1	4.4	9.2	5.4	8.2	2.5	52.0	149.5
	31D8	0.0	0.0	0.0	0.1	0.2	2.4	4.2	3.3	4.1	5.4	3.6	6.7	5.6	4.7	2.7	5.6	3.5	5.2	1.5	28.9	87.6
	31E0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30E0	4.8	3.0	47.1	13.8	12.4	56.9	66.1	47.4	50.1	51.8	35.8	54.0	42.5	31.2	21.5	33.6	22.8	31.6	10.6	157.9	794.9
	30D9	0.0	0.4	3.1	0.8	1.4	16.3	24.6	20.2	23.5	28.7	19.1	35.3	29.8	23.7	15.0	30.2	18.0	26.7	8.3	168.4	493.4
	30D8	0.0	0.0	0.2	0.0	0.1	0.8	1.2	1.0	1.2	1.4	0.9	1.7	1.4	1.2	0.7	1.5	0.9	1.3	0.4	8.6	24.6
	29E1	0.1	0.0	0.6	0.2	0.1	0.5	0.6	0.4	0.4	0.4	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.4	4.9
	29E0	1.9	1.2	17.8	5.0	4.1	17.0	17.9	12.9	12.4	11.2	7.5	9.3	5.3	4.1	2.8	3.5	2.8	4.3	1.4	13.4	155.7
	29D9	3.0	2.1	33.0	10.3	9.7	51.2	61.1	46.4	48.2	49.6	33.5	50.4	35.3	27.5	18.3	29.0	19.7	29.6	9.5	142.3	709.7
	29D8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28E1	3.3	2.0	30.1	8.4	7.0	28.8	30.3	21.8	20.9	18.9	12.8	15.7	8.9	7.0	4.8	5.9	4.7	7.2	2.3	22.8	263.7
	28E0	0.2	0.1	2.1	0.6	0.5	2.0	2.1	1.5	1.4	1.3	0.9	1.1	0.6	0.5	0.3	0.4	0.3	0.5	0.2	1.6	18.2
	28D9	0.0	0.0	0.2	0.1	0.2	0.9	1.2	0.9	0.9	1.0	0.7	1.0	0.7	0.5	0.4	0.4	0.3	0.5	0.2	1.6	11.6
	28D8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27E1	0.0	0.0	2.4	2.4	5.8	47.6	49.4	38.9	36.2	31.8	20.2	26.3	12.4	9.9	7.6	8.3	5.5	11.5	3.9	34.0	354.2
	27E0	0.2	0.1	3.2	1.7	3.1	22.6	23.1	17.9	16.6	14.4	10.5	12.9	6.7	5.7	3.3	23.6	13.7	22.5	9.1	258.3	469.2
	27D9	0.1	0.0	7.3	4.6	6.1	41.0	52.4	39.3	42.2	45.6	31.4	47.4	34.2	28.6	16.6	35.1	24.1	34.9	10.8	193.9	695.5
	27D8	0.0	0.0	3.8	2.4	2.9	18.2	22.7	17.3	18.3	18.8	13.1	19.3	12.9	9.4	6.8	8.0	6.5	9.3	3.3	31.0	224.1
	26E1	0.0	0.0	4.1	4.2	10.2	83.5	87.2	68.5	64.3	57.4	36.4	48.5	24.2	19.5	14.2	15.8	11.0	21.6	7.1	61.0	638.9
	26E0	0.0	0.0	1.0	1.5	5.0	56.7	79.5	62.2	69.7	75.8	50.4	82.2	60.1	45.8	30.8	42.1	31.0	45.0	14.7	157.0	910.4
	26D9	0.0	0.0	0.2	0.1	0.1	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.0	2.0	1.1	1.7	0.7		24.0	32.0
	25E1	0.2	0.0	1.1	1.1	2.2	17.2	20.7	15.4	16.9	19.2	11.9	20.9	16.4	13.9	7.5	11.8	9.8	12.7	3.4	43.6	245.9
	25E0	0.0	0.0	0.7	0.8	1.4	11.1	14.0	10.1	11.6	13.9	8.5	15.5	12.7	10.8	5.6	8.0	7.2	8.9	2.2	25.3	168.3
	25E2	3.1	0.3	1.3	0.1	0.5	4.5	9.6	8.0	12.3	21.0	15.6	34.0	33.5	28.0	14.4	50.4	32.1	41.6	12.7	263.2	586.0
	24E2	1.3	0.1	0.5	0.0	0.2	1.9	4.0	3.4	5.2	8.9	6.6	14.3	14.1	11.8	6.1	21.2	13.5	17.6	5.4	110.9	247.0
	24E3	2.4	0.2	1.0	0.0	0.4	3.5	7.6	6.3	9.7	16.5	12.3	26.8	26.4	22.1	11.4	39.6	25.3	32.8	10.0	207.2	461.4
N & Porc	37D9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	37D8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	37E0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	37E1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	38E1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	38E0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	38D9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	39E1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	39E0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.6	0.6	0.7	0.4	0.8	0.4	0.3	0.3	0.3	0.1	0.4	0.1	0.9	6.9
	39D9	0.0	0.0	0.0	0.0	0.0	1.2	2.1	2.4	2.5	2.7	1.7	3.1	1.5	1.3	1.0	1.3	0.5	1.6	0.5	3.4	26.7
	40E1	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.3	0.4	0.4	0.3	0.5	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.6	4.1
	40E0	0.0	0.0	0.0	0.0	0.1	1.7	3.1	3.0	3.6	4.9	3.3	6.7	5.6	4.3	3.0	5.4	2.9	4.7	1.5	19.5	73.1
	41E1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	2.5	3.9
	41E0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.4	0.3	0.6	0.5	0.4	0.3	0.6	0.4	0.5	0.2	9.2	14.2
	42E1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	42E0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.4	0.3	0.6	0.5	0.4	0.3	0.6	0.4	0.5	0.2	9.0	13.9
	Total	20.4	10.2	165.5	61.6	90.3	699.8	925.8	721.5	806.8	908.8	618.8	1045.6	815.0	623.5	414.2	724.9	476.4	695.5	230.7	3499.3	######
	%	0.2	0.1	1.2	0.5	0.7	5.2	6.8	5.3	6.0	6.7	4.6	7.7	6.0	4.6	3.1	5.3	3.5	5.1	1.7	25.8	100.0
	Cv (%)	26.2	33.5	30.0	23.7	16.5	13.7	12.1	12.2	12.1	11.4	11.4	11.5	12.4	11.5	12.4	11.4	10.6	10.6	11.4	12.3	NA

Table 7. Boarfish biomass (000's tonnes) by maturity by ICES statistical rectangle.

Region	Strata	Imm	Mature	Spent	Total
Western	36D6	0	4.9	0	4.9
	35D5	0	14.3	0	14.3
	35D6	0	0.3	0	0.3
	34D9	0	0	0	0
	34D5	0	0.2	0	0.2
	34D6	0	0	0	0
	33D5	0	0.1	0	0.1
	33D6	0	0	0	0
	36D8	0	43	0	43
	36D9	0	0.1	0	0.1
	35D9	0	0.8	0	0.8
	35D8	0	13.7	0	13.7
	35D7	0	12.8	0	12.8
	34D8	0	90.7	0	90.7
	34D7	0	33.3	0	33.3
	33D9	0	0	0	0
	33D8	0	98	0	98
	33D7	0	9.6	0	9.6
	32D9	0	9	0	9
	32D8	0	16.5	0	16.5
Southern	31D9	0	9.7	0	9.8
	31D8	0	5.7	0	5.7
	31E0	0	0	0	0
	30E0	0.5	43.1	0	43.6
	30D9	0	32	0	32.1
	30D8	0	1.6	0	1.6
	29E1	0	0.2	0	0.2
	29E0	0.2	7	0	7.2
	29D9	0.4	39	0	39.4
	29D8	0	0	0	0
	28E1	0	12	0	12
	28E0	0	1	0	1
	28D9	0	1	0	1
	28D8	0	0	0	0
	27E1	0	18	0	18
	27E0	0	36.8	0	36.8
	27D9	0.1	43.1	0	43.2
	27D8	0	12	0	12
	26E1	0	32.3	0	32.3
	26E0	0	51.8	0	51.8
	26D9	0	2.9	0	2.9
	25E1	0	13.8	0	13.8
	25E0	0	9.3	0	9.3
	25E2	0.1	41.2	0	41.3
	24E2	0	17.4	0	17.4
	24E3	0	32.5	0	32.5
N & Porc	37D9	0	0	0	0
	37D8	0	0	0	0
	37E0	0	0	0	0
	37E1	0	0	0	0
	38E1	0	0	0	0
	38E0	0	0	0	0
	38D9	0	0	0	0
	39E0	0	0	0	0
	39E0	0	0.4	0	0.4
	39D9	0	1.5	0	1.5
	40E1	0	0.2	0	0.2
	40E0	0	4.6	0	4.6
	41E1	0	0.3	0	0.3
	41E0	0	1.2	0	1.2
	42E1	0	0	0	0
	42E0	0	1.2	0	1.2
	Total	1.8	819.1	0	820.9
	%	0.2	99.8	0	100

Table 8. Boarfish abundance (millions) by maturity by ICES statistical rectangle.

| Region	Strata	Imm	Mature	Spent	Total
Western	36D6	0	76.9	0	76.9
	35D5	0	224.9	0	224.9
	35D6	0	4.4	0	4.4
	34D9	0	0	0	0
	34D5	0	2.4	0	2.4
	34D6	0	0	0	0
	33D5	0	1.1	0	1.1
	33D6	0	0	0	0
	36D8	0	707.6	0	707.6
	36D9	0	1.0	0	1.0
	35D9	0	12.8	0	12.8
	35D8	0	227.1	0	227.1
	35D7	0	206.8	0	206.8
	34D8	1.7	1544.3	0	1546.0
	34D7	0	543.4	0	543.4
	33D9	0	0.0	0	0.0
	33D8	0	1565.4	0	1565.4
	33D7	0	152.6	0	152.6
	32D9	0	138.6	0	138.6
	32D8	0	253.8	0	253.8
Southern	31D9	0.6	148.9	0	149.5
	31D8	0	87.6	0	87.6
	31E0	0	0	0	0
	30E0	24.4	770.5	0	794.9
	30D9	1.7	491.7	0	493.4
	30D8	91.0	24.5	0	24.6
	29E1	0.3	4.6	0	4.9
	29E0	9.5	146.2	0	155.7
	29D9	16.8	692.9	0	709.7
	29D8	0	0	0	0
	28E1	16.0	247.6	0	263.7
	28E0	1.1	17.1	0	18.2
	28D9	53.0	11.5	0	11.6
	28D8	0	0	0	0
	27E1	0.4	353.8	0	354.2
	27E0	1.2	468.0	0	469.2
	27D9	2.1	693.4	0	695.5
	27D8	1.0	223.1	0	224.1
	26E1	0.6	638.3	0	638.9
	26E0	0.2	910.2	0	910.4
	26D9	0.1	31.9	0	32.0
	25E1	0.4	245.6	0	245.9
	25E0	0.1	168.2	0	168.3
	25E2	4.0	582.1	0	586.0
	24E2	1.7	245.4	0	247.0
	24E3	3.1	458.3	0	461.4
N & Porc	37D9	0	0	0	0
	37D8	0	0	0	0
	37E0	0	0	0	0
	37E1	0	0	0	0
	38E1	0	0	0	0
	38E0	0	0	0	0
	38D9	0	0	0	0
	39E0	0	0	0	0
	39E0	0	6.9	0	6.9
	39D9	0	26.7	0	26.7
	40E1	0	4.1	0	4.1
	40E0	0	73.1	0	73.1
	41E1	0	3.9	0	3.9
	41E0	0	14.2	0	14.2
	42E1	0	0	0	0
	42E0	0	13.9	0	13.9
	Total	87.1	13,467	0	13,555
	%	0.6	99.4	0	100

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Table 9. Boarfish biomass and abundance by ICES statistical rectangle.

Region	Category Stratum	No. transects	No. schools	Def schools	Prob schools	Mix schools	% zeros	Def Biomass	Prob Biomass	Mix Biomass	Biomass (000't)	SSB (000't)	Abundance millions
Western	36D6	1	5	5	0	0	0	4.9	0	0	4.9	4.9	76.9
	35D5	2	12	2	10	0	0	6.4	7.9	0	14.3	14.3	224.9
	35D6	2	3	0	3	0	50	0	0.3	0	0.3	0.3	4.4
	34D9	2	0	0	0	0	100	0	0	0	0	0	0.0
	34D5	2	1	0	1	0	50	0	0.2	0	0.2	0.2	2.4
	34D6	2	0	0	0	0	100	0	0	0	0	0	0.0
	33D5	1	3	0	3	0	0	0	0.1	0	0.1	0.1	1.1
	33D6	1	0	0	0	0	100	0	0	0	0	0	0.0
	36D8	1	42	42	0	0	0	43	0	0	43	43	707.6
	36D9	1	3	0	3	0	0	0	0.1	0	0.1	0.1	1.0
	35D9	1	6	6	0	0	0	0.8	0	0	0.8	0.8	12.8
	35D8	2	60	59	1	0	0	13.7	0	0	13.7	13.7	227.1
	35D7	2	70	70	0	0	0	12.8	0	0	12.8	12.8	206.8
	34D8	2	110	92	18	0	0	77.7	13	0	90.7	90.7	1546.0
	34D7	2	55	55	0	0	0	33.3	0	0	33.3	33.3	543.4
	33D9	2	0	0	0	0	100	0	0	0	0	0	0.0
	33D8	2	105	105	0	0	0	98	0	0	98	98	1565.4
	33D7	2	22	22	0	0	0	9.6	0	0	9.6	9.6	152.6
	32D9	2	9	9	0	0	0	9	0	0	9	9	138.6
	32D8	2	27	25	2	0	0	16.3	0.2	0	16.5	16.5	253.8
Southern	31D9	2	16	16	0	0	0	9.8	0	0	9.8	9.7	149.5
	31D8	2	9	9	0	0	0	5.7	0	0	5.7	5.7	87.6
	31E0	1	0	0	0	0	100	0	0	0	0	0	0.0
	30E0	2	34	9	0	25	0	18.3	0	25.3	43.6	43.1	794.9
	30D9	2	32	9	20	3	0	2.5	24.9	4.7	32.1	32	493.4
	30D8	2	1	0	1	0	50	0	1.6	0	1.6	1.6	24.6
	29E1	2	1	1	0	0	50	0.2	0	0	0.2	0.2	4.9
	29E0	2	21	21	0	0	0	7.2	0	0	7.2	7	155.7
	29D9	2	49	19	30	0	0	20.3	19.1	0	39.4	39	709.7
	29D8	2	0	0	0	0	100	0	0	0	0	0	0.0
	28E1	2	21	16	5	0	50	10	2.2	0	12.2	11.8	263.7
	28E0	2	2	2	0	0	50	0.8	0	0	0.8	0.8	18.2
	28D9	2	3	3	0	0	50	0.6	0	0	0.6	0.6	11.6
	28D8	2	0	0	0	0	100	0	0	0	0	0	0.0
	27E1	2	46	19	10	17	0	10.5	7.2	0.2	17.9	17.9	354.2
	27E0	2	40	37	3	0	0	36.5	0.3	0	36.8	36.8	469.2
	27D9	2	82	82	0	0	0	43.2	0	0	43.2	43.1	695.5
	27D8	2	11	11	0	0	50	12	0	0	12	12	224.1
	26E1	2	36	36	0	0	0	32.3	0	0	32.3	32.3	638.9
	26E0	2	69	65	4	0	0	44.6	7.2	0	51.8	51.8	910.4
	26D9	1	1	1	0	0	0	2.9	0	0	2.9	2.9	32.0
	25E1	2	21	21	0	0	50	13.8	0	0	13.8	13.8	245.9
	25E0	1	7	7	0	0	0	9.3	0	0	9.3	9.3	168.3
	25E2	1	39	14	25	0	0	11.5	29.8	0	41.3	41.2	586.0
	24E2	1	6	6	0	0	0	17.4	0	0	17.4	17.4	247.0
	24E3	1	17	17	0	0	0	32.5	0	0	32.5	32.5	461.4
N & Porc	37D9	4	0	0	0	0	100	0	0	0	0	0	0.0
	37D8	1	0	0	0	0	100	0	0	0	0	0	0.0
	37E0	1	0	0	0	0	100	0	0	0	0	0	0.0
	37E1	0	0	0	0	0	100	0	0	0	0	0	0.0
	38E1	0	0	0	0	0	100	0	0	0	0	0	0.0
	38E0	4	0	0	0	0	100	0	0	0	0	0	0.0
	38D9	4	0	0	0	0	100	0	0	0	0	0	0.0
	39E0	0	0	0	0	0	100	0	0	0	0	0	0.0
	39E0	4	3	0	3	0	50	0	0.4	0	0.4	0.4	6.9
	39D9	1	5	0	5	0	0	0	1.5	0	1.5	1.5	26.7
	40E1	4	3	1	2	0	50	0	0.2	0	0.2	0.2	4.1
	40E0	4	13	11	2	0	25	4.2	0.4	0	4.6	4.6	73.1
	41E1	4	4	4	0	0	75	0.3	0	0	0.3	0.3	3.9
	41E0	4	2	2	0	0	75	1.2	0	0	1.2	1.2	14.2
	42E1	4	0	0	0	0	100	0	0	0	0	0	0.0
	42E0	3	3	0	3	0	67	0	1.2	0	1.2	1.2	13.9
	Total	122	1130	931	154	45	43	673	117.6	30.3	821	819.1	13,554.5
	Cv (%)	-	-	-	-	-	-	-	-	-	10.7	NA	10.6

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Table 9. Boarfish survey time series.

Years	2011	2012
0	-	-
1	4.7	20.4
2	10.7	10.2
3	51.5	165.5
4	167.3	61.6
5	384.7	90.3
6	1015.2	699.8
7	1000.1	925.8
8	601.3	721.5
9	899.4	806.8
10	790.7	908.8
11	246.8	618.8
12	434.6	1045.6
13	267.7	815
14	244.5	623.5
15	119.9	414.2
16	193.3	724.9
17	49.7	476.4
18	147.0	695.5
19	294.0	230.7
20+	855.8	3499.3
TSN (mil)	7,779	13,554
TSB ('000t)	433,584	820,935
SSB ('000t)	432,882	819,126
CV	17.6	10.6
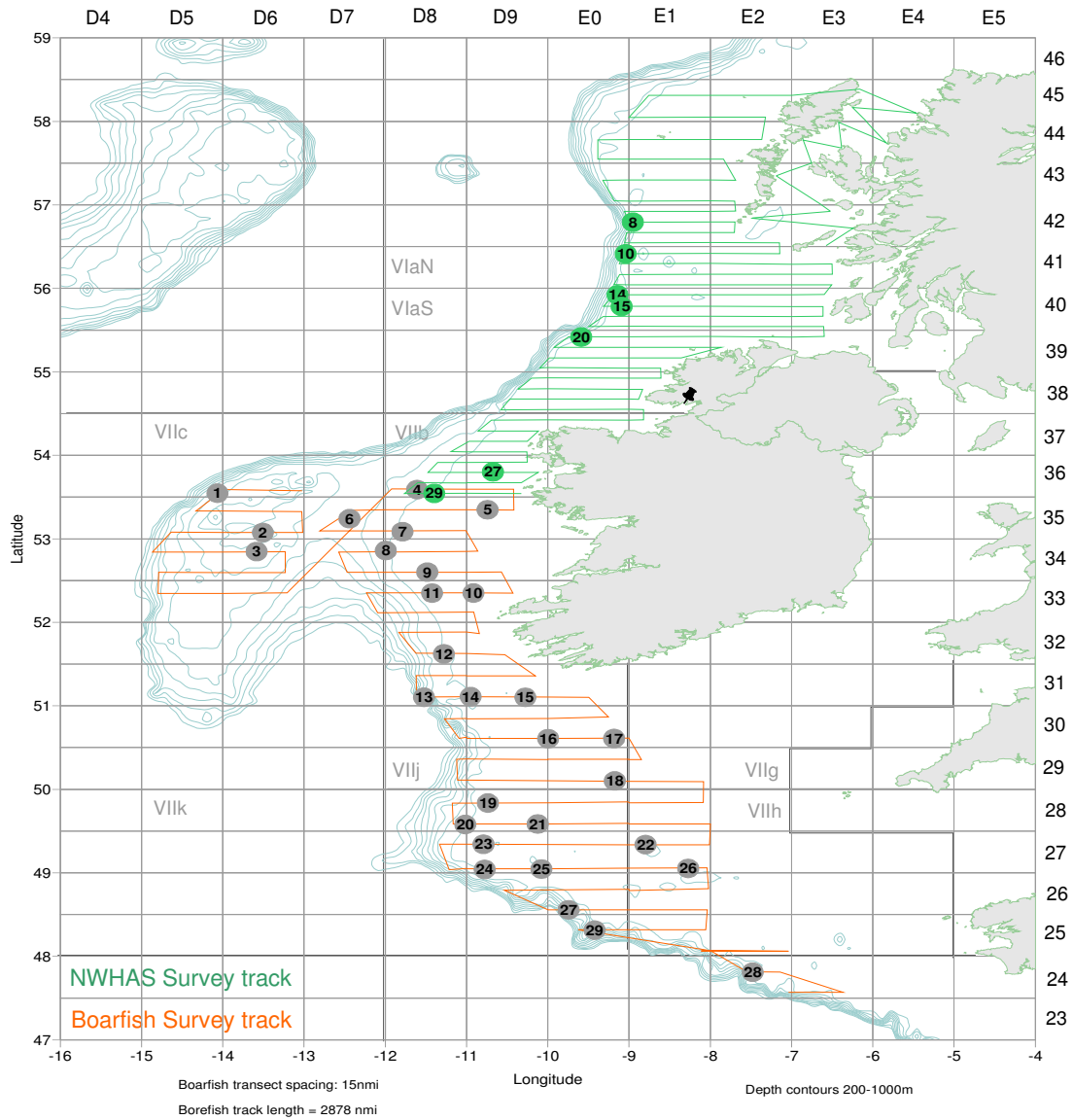
Figure 1. Cruise tracks and haul positions for the FV *Father McKee* (orange) and RV *Celtic Explorer* (green). Note: Only hauls containing boarfish are shown for Celtic Explorer. Black pin represent calibration site.
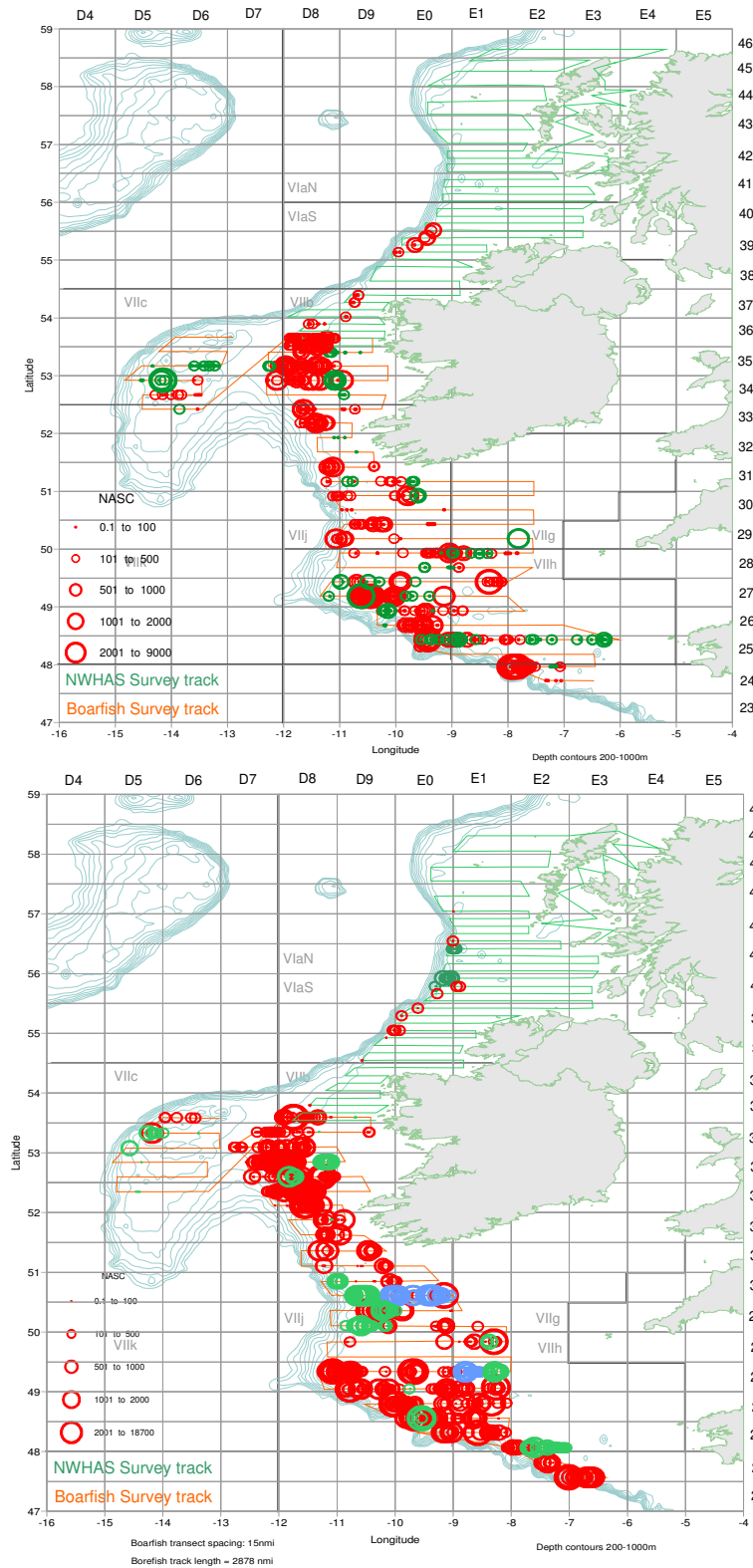
Figure 2. NASC plot of boarfish distribution Top panel 2011 and bottom panel 2012 results. Note: Circle size proportional to NASC value. Red circles represent 'definitely' boarfish category, green 'probably boarfish' and blue 'boarfish in a mix.
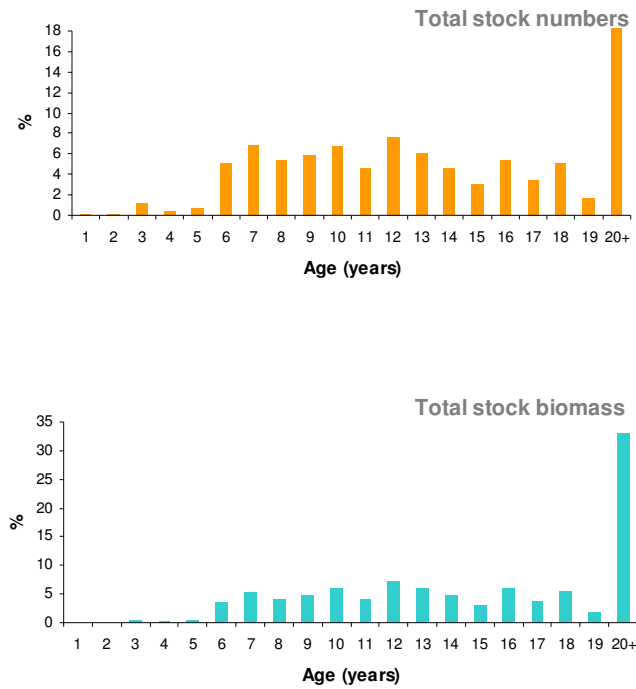
Figure 3. Percentage breakdown of TSN (top) and TSB (bottom) of survey stock.

Celtic Explorer Hauls
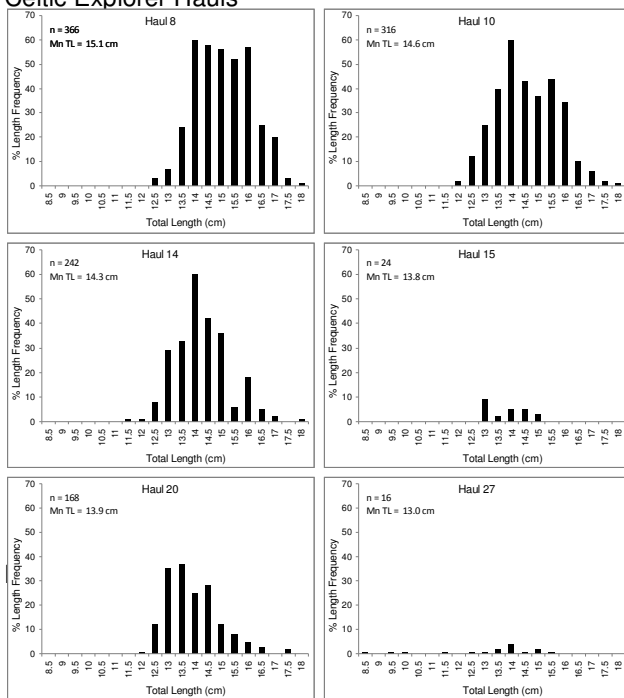
Figure 4. Percentage composition of boarfish by haul for survey area, Celtic Explorer 57°N-54°N and Father McKee 54°N-47°30'N.

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Father McKee Hauls
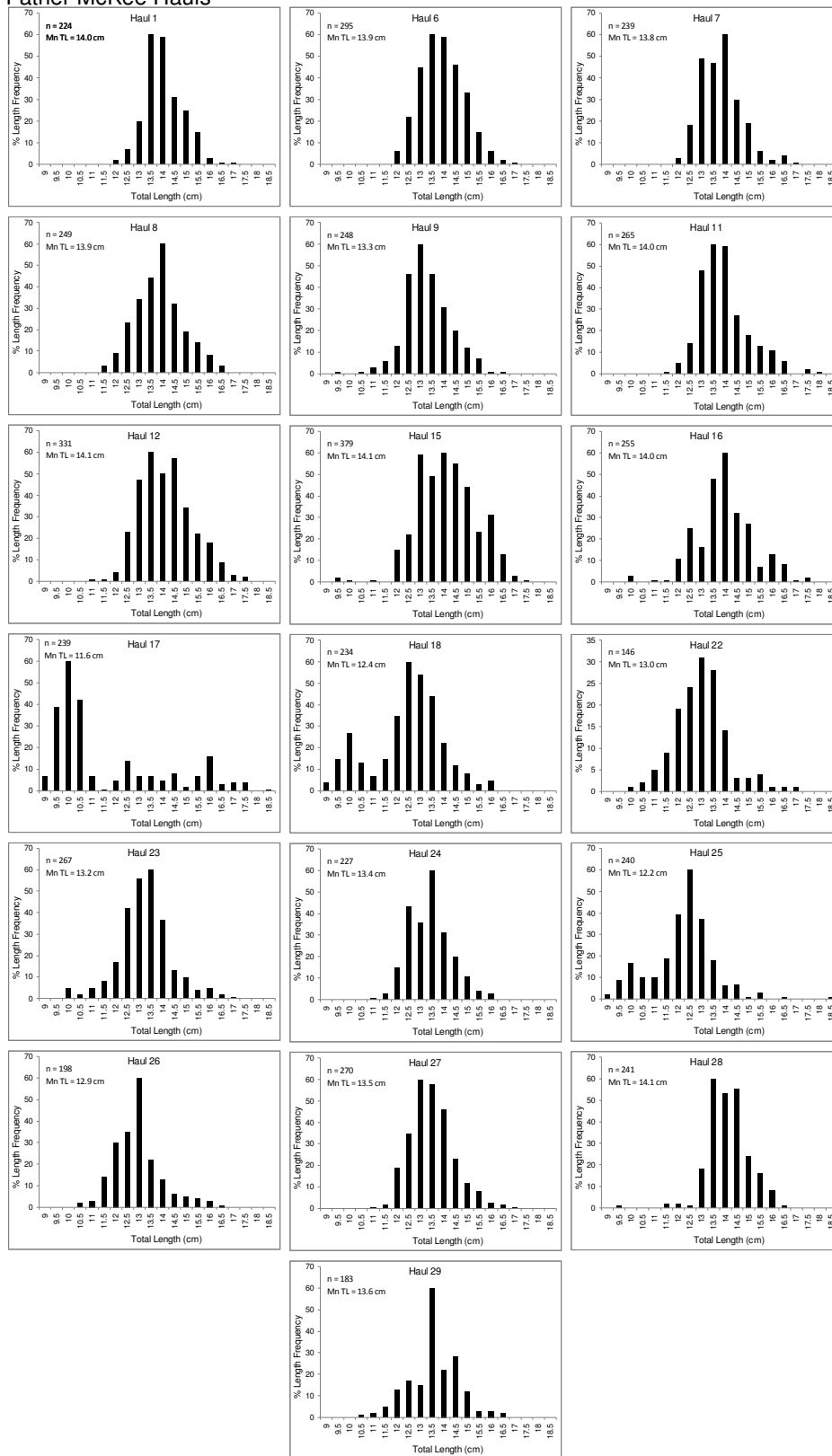
Figure 4. Continued
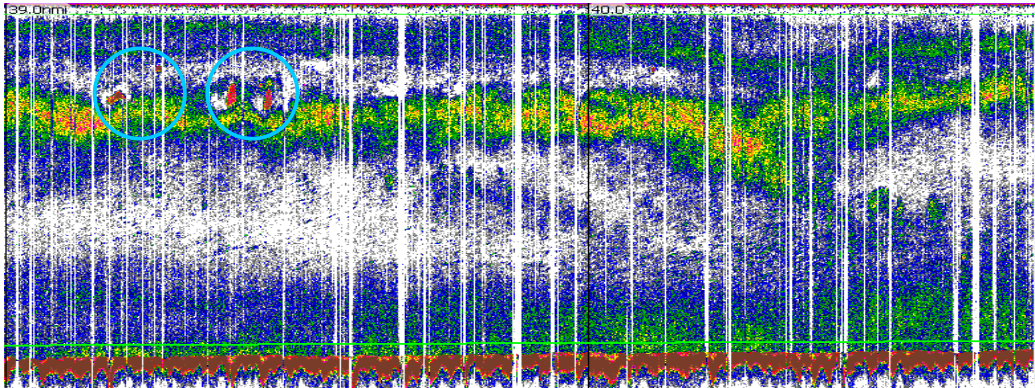
a). Northern Porcupine Bank scattering layer recorded prior to Haul 01. Heavy plankton layer dominates the picture with small/medium high density schools of boarfish occurring above this layer (circled) that were targeted during the trawl. Bottom depth is 320m with targets occurring at 80m.
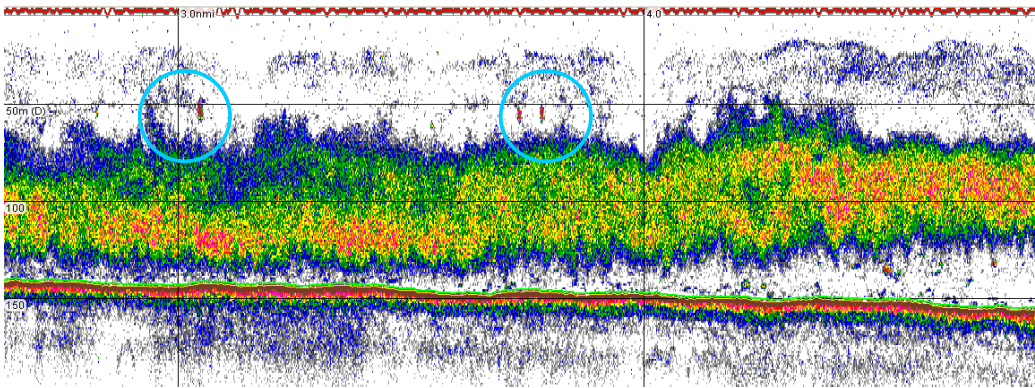
b). Boarfish schools from **northern area** (north of 54°-57°N) recorded prior to Haul 14 by the *Celtic Explorer.* Bottom depth is 170m with targets at 50m.
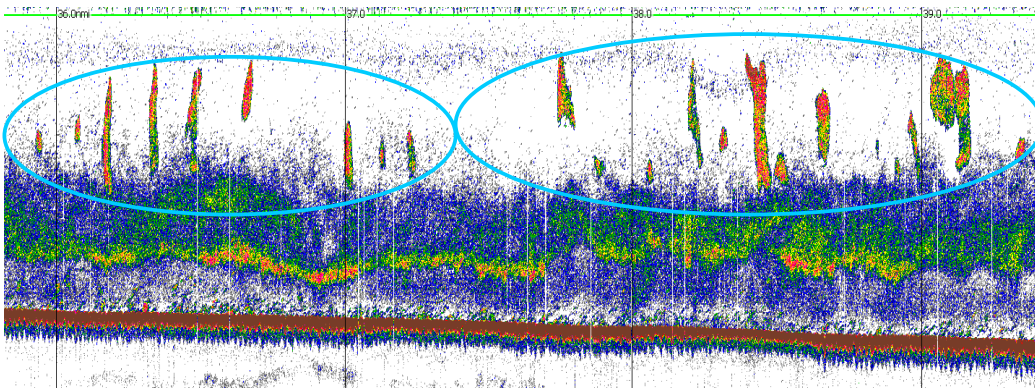
c). High-density midwater boarfish schools (circled) encountered in the high density **western area** (51°-54°N) prior to Haul 09. Bottom depth is 135m with targets occurring within 30m of the surface, some of the largest schools shown here have a vertical height of 50m. Note: echogram extends over 3.5nmi.

Figures 5a-h. Echotraces recorded prior to directed trawls. Boarfish survey, July 2012. Note: vertical bands on echograms represent 1nmi (nautical mile) intervals recorded at 38 kHz.
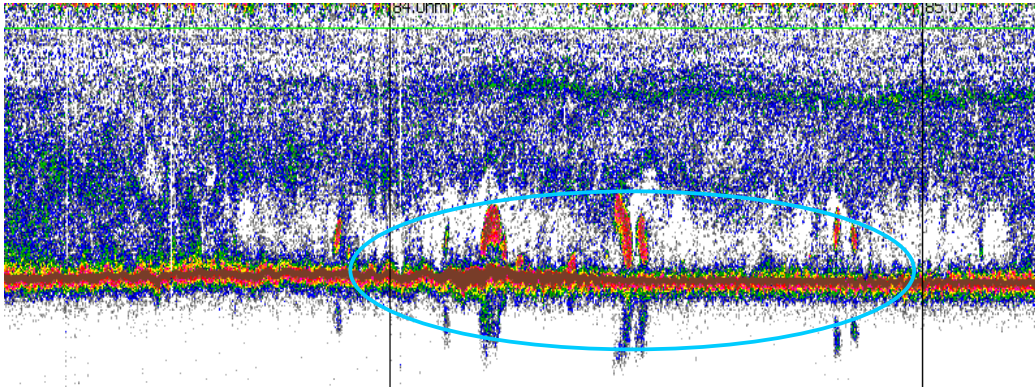
d). High density bottom schools of boarfish located in an area known commercially as the **redfish (boarfish) Bank** (30E0) which is targeted frequently during the fishery. Echogram recorded prior to Haul 17. Bottom depth is 65m with targets extending from 0-180m off the bottom.
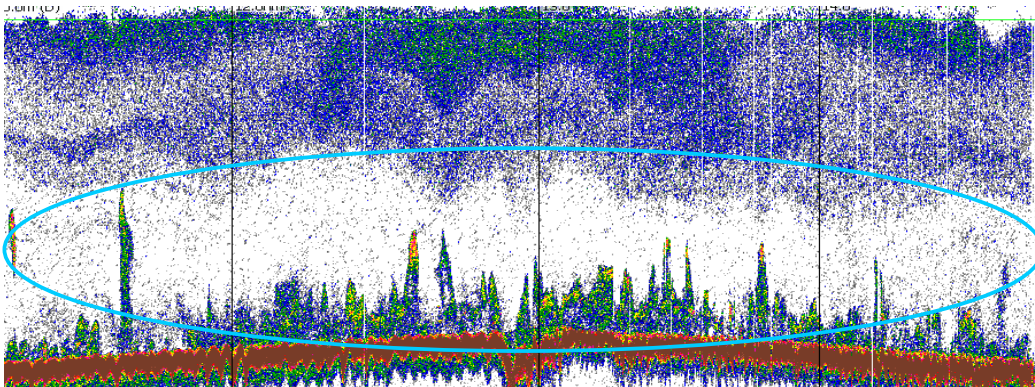

e). High density bottom layer of boarfish typical of those encountered in the **southern area** (south of 50°N). Echogram recorded prior to Haul 27. Bottom depth is 180m with targets extending from 0-100m off the bottom.
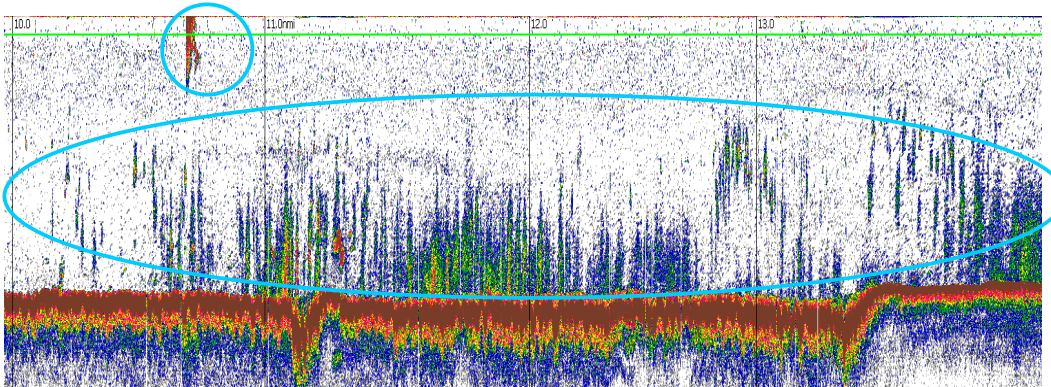
f). High density layer containing herring, sprat and 0-group sprat targeted during the trawl (**Haul 05**). Echotraces were recorded at dusk as the targets were beginning to rise from the bottom to feed in surface waters. Bottom depth is 76m with targets extending from 0-60m off the bottom and one surface school.

Figures 5a-h. continued.
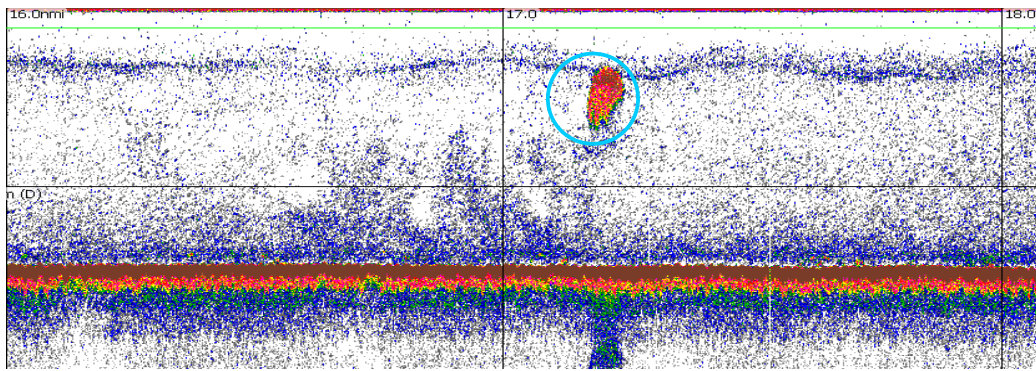
g). Large very high density school of 1-group blue whiting targeted during Haul 10. Bottom depth is 70m, school height 19m.
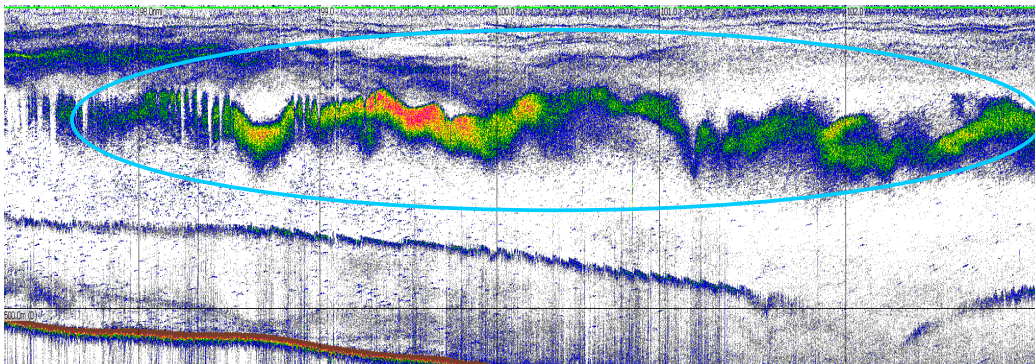
h). High-density off shelf schools of blue whiting recorded during an offshore inter-transect in strata 28D8. Mark intensity and size typical of those encountered south of 51°N. Note: echogram extends over 6nmi.

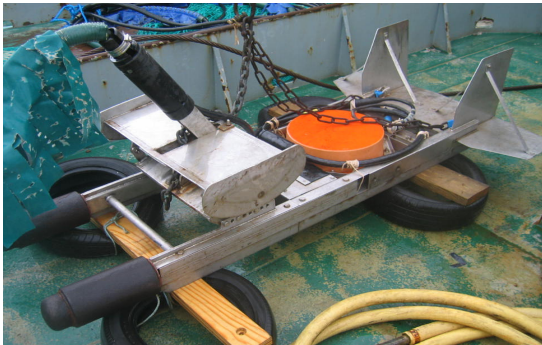**Figures 5a-h.** continued.
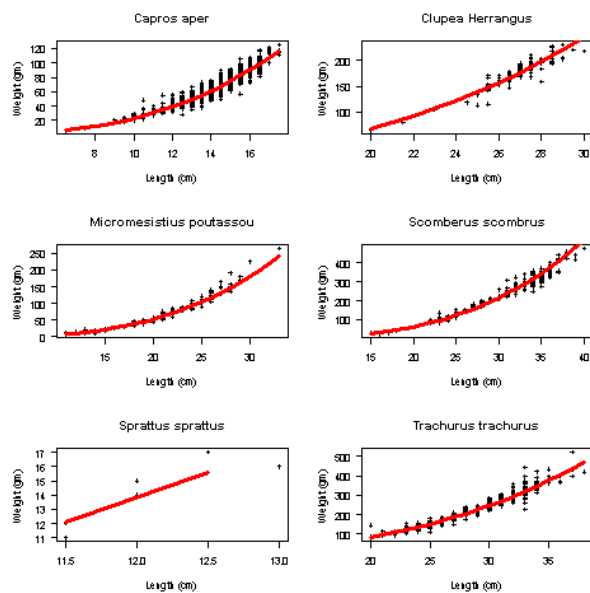
Figure 6. Length weight plots of major trawl component species used during the analysis.

Appendix 1

Details of the charter vessel and tow body set up used during the survey.

Figure 1. FV *Father McKee* (SO 708). 65m LOA

Figure 2. Tow sled with 38 kHz split beam transducer (orange centre screen).

Figure 3. Towing boom c.3m long with support stays.

Figure 4. Top side monitoring station located on the bridge. (L-R) Laptop running Sodena© navigation package, second laptop running Echoview© (Live viewing) and EK 60 topside PC unit.