Centre for Environment Fisheries & Aquaculture Science

Cefas

CEND 12/14 Nephrops TV Survey Final Report - 2014

Title: Farn Deeps Nephrops Grounds (FU6) 2014 UWTV Survey Report.

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Abstract: This report provides the main results and findings of the 18th annual underwater television survey on the 'Farn Deeps grounds' ICES assessment area, Functional Unit 6. The survey was multi-disciplinary in nature collecting UWTV, backscatter data and other ecosystem data. The survey design consists of a randomised fixed grid of 110 stations where at each station a sledge mounted TV camera is deployed and a clear 10 minute tow is recorded onto DVD and DVT. In June 2014, 110 stations (TVID) were successfully surveyed in the Farn Deeps area with the TV sledge and multibeam, from 8 Jun to 15 Jun. No time was lost due to weather conditions and additionally the water clarity was very good to excellent throughout the footage recorded. Burrows were counted by each minute block for 7 clear minutes. The counting performance of the 2014 counters was generally very high, with a Linn's CCC scored average of 0.73. The resulting krigged burrow abundance estimate was 757 million burrows. This was a similar result of that obtained in 2012, and slightly higher than the abundance in 2013. As previous years the high abundance area is distributed in the east side of the ground. Overall densities remain low and abundance remains bellow MSY Btrigger. The CV (or relative standard error) for this survey was of around 3% which is in line with previous estimates and well below the upper limit of 20% recommended by SGNEPS 2012.

1. Introduction

The Norway lobster (*Nephrops norvegicus* L. 1758) has a wide area of distribution across European waters (from Iceland to the southern coast of Portugal, Morocco and the Mediterranean) and are managed within the scope of the International Council for the Exploration of the Sea (ICES). The *Nephrops* stock assessments are run annually, where catch options are defined for each functional unit (FU) and accordingly on advice from ICES the European Commission sets annual total allowable catches (TAC's) for this species at an ICES sub-area level.

The lack of age-structured data in addition to uncertain historic landings for a number of stocks makes the use of standard stock assessments and forecasting methods, based on commercial catch data, very difficult to apply and unreliable. Additionally, *Nephrops* spend a great deal of time in their burrows and their emergence behaviour is influenced by several factors: time of year, light intensity, tidal strength, etc. So, over the last 20 years, assessments for *Nephrops* have become progressively more reliant upon Underwater TV (UWTV) surveys which have enabled the development of fishery independent indicators of stock size, exploitation status and catch advice. This method was firstly implemented in 1992 by Marine Scotland on the Fladen ground, and has subsequently been put into practice by other countries such as Ireland, England, Denmark and Sweden. The UWTV surveys are now listed regularly in 15 ICES Functional Units, being widely used in the North Sea.

The standard methodology involves the use of a sledge mounted camera to film the seabed at a grid of stations conducting TV tows for 10 minutes. Each country has adopted different sampling designs, from random stratifications of the stations up to fix grids, which better fits the grounds. The aim is to identify and count the number of *Nephrops* burrow systems falling within a fixed field of view, along transects of known length. Counts of burrow systems are converted into densities at each station using the width of view and the length of the tow. Each system is assumed to represent one adult *Nephrops* with occupancy assumed to be 100%. Overall abundance is then estimated by raising the mean density to the appropriate strata area or by using geostatistical methods, and total survey abundance, variance and confidence limits are then calculated.

In deep waters the UWTV surveys are still not being used as a standard assessment procedure, due to the complexity of running a sledge at those depths. Alternatives to sledges have been experimented for example by IPMA in Portugal by fitting a camera to the trawl cable; disadvantages of this method are the speed of recording and the angle of the camera, making the visual identification of burrow systems very challenging.

Although this assessment method has been improved over the years there are still some constrains associated with this method. Misidentification of *Nephrops* burrows, high density of burrows, edge effects, clarity, variability of the counters are some of the sources of bias that have been identified in the past and addressed in specialized ICES study groups for *Nephrops* TV surveys. Progress was made in 2009 ICES Benchmark were the main sources of bias were estimated for each functional unit and an overall bias correction factor introduced adjusting the estimates of abundance.

The present survey focuses in the North Sea at the Farn Deeps (FU6) area, in the NE coast of England (Figure 1). Total landings in 2013 for this area reported 2982 tonnes.

CEFAS has performed annual UWTV surveys in the Farn Deeps area since 1996 (Table 1).

Table 1 – Summary of the UWTV results for the autumn season, since 1997, showing number of valid stations, mean density per meter square, abundance, confidence interval and the method used to estimate the abundance.

Year	Stations	Season	Mean density (burrows/m²)	Absolute Abundance (millions)	95%CI (millions)	Method
1997	87	Autumn	0.46	1500	125	Box
1998	91	Autumn	0.33	1090	89	Box
1999	-	Autumn	No survey	Box		
2000	-	Autumn	No survey	Box		
2001	180	Autumn	0.56	1685	67	Box
2002	37	Autumn	0.33	1048	112	Box
2003	73	Autumn	0.33	1085	90	Box
2004	76	Autumn	0.43	1377	101	Box
2005	105	Autumn	0.49	1657	148	Box
2006	105	Autumn*	0.37	1244	114	Box
2007	105	Autumn*	0.28	858	23	Geostatistics
2008	95	Autumn*	0.31	987	39	Geostatistics
2009	76	Autumn*	0.22	682	38	Geostatistics
2010	95	Autumn*	0.25	785	21	Geostatistics
2011	97	Autumn*	0.28	878	17	Geostatistics
2012	97	Autumn*	0.24	758	13	Geostatistics
2013	110	Summer	0.23	706	18	Geostatistics

The specifics objectives of 2014 survey are listed below:

1. To conduct a standard underwater TV survey of *Nephrops* burrow densities on the Farn Deeps grounds, 55o 35′ - 54o 45′ N and 1o 30′ - 0 o 40′ W, and to evaluate *Nephrops* abundance in this area (110 stations).

2. To conduct seabed Multibeam survey at each TV survey stations.

3. To collect surface water samples. This data will be used for the Shelf Sea Biogeochemistry Research Programme, WP1 Candyfloss (NERC/Defra funded)[1] and will contribute to estimating the size of the

[1] Shelf Sea Biogeochemistry Research Programme –The goals of this project are (1) to quantify the role of the NW European shelf seas in the global nutrient and carbon cycles, and (2) to understand the critical processes by which this role is sustained. The project will rely on a year-long whole NW European shelf sampling programme using vessels of opportunity (Objective 1) along with process studies on 4 cruises in the Celtic Sea (Objective 2) The whole shelf sampling programme will allow a synoptic assessment of the distribution and cycling of inorganic and organic carbon and nutrients, CO2 and N2O. Daily sampling from Endeavour is part of Objective (1) and will contribute to estimating the size of the shelf carbon pump over the whole NW European shelf, and its relationship to the global carbon cycle.
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shelf carbon pump over the whole NW European shelf, and its relationship to the global carbon cycle.

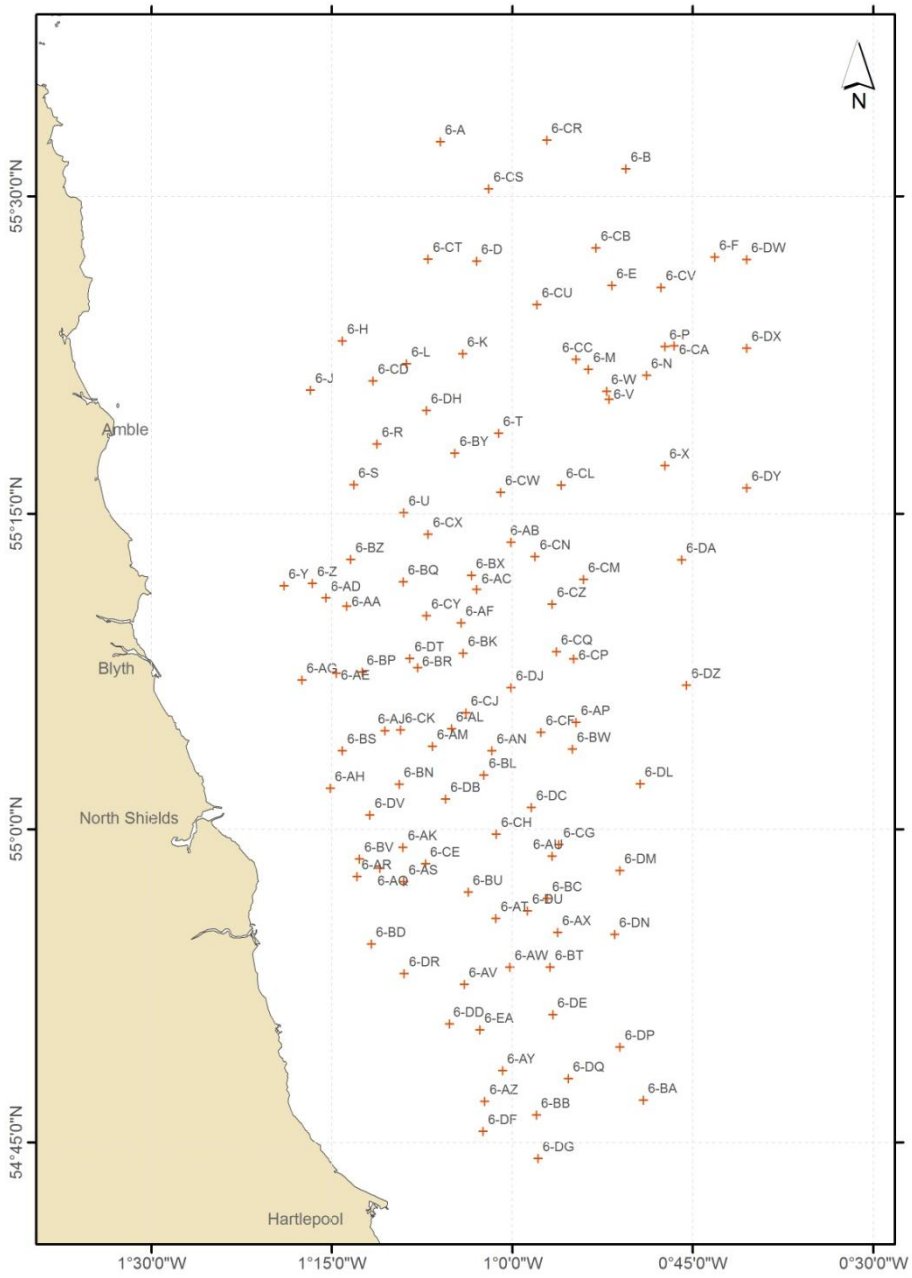


Figure 1 – Map showing the location of the surveyed area in the Function Unit 6 area (110 stations).

2. Material and Methods

The 2014 North Sea *Nephrops* UWTV survey took place on RV Endeavour between 8th to 15th June. The departure and arrival port was Lowestoft.

TV survey – Survey design

For the Farn Deeps the survey design is based on a randomised fixed grid and includes a total of 110 stations. The initial ground perimeter has been delimited by the combination of VMS data and BGS sediment maps.

At each station a sledge mounted TV camera was deployed and a clear 10 minute tow was recorded onto DVD and DVT. Vessel position (DGPS) and position of sledge (using a USBL transponder) were recorded every 1 to 2 seconds.

The sledge was equipped with (Figure 2):

- A camera at an oblique angle to the sea bed, sighted towards the front of the sled; the standard Smirad camera was used in this survey. After doing some trial runs with the HD camera in Apr 2012 survey and comparing standard footage with HD recordings no clear evidence was found that the HD footage was clearer. Thus, until further technological developments the Simard camera will be the standard camera used allowing also a wider filed of view (81.5 cm).
- The sledge was mounted with 5 LED lights: 2+2 LED lights on the side plus 1 LED light on the top to fully illuminate the field of view. The light intensity could be remote controlled in the lab through a software (build in-house).
- Two fan lasers (red colour) to delimit the field of view (field of view 81.5 cm);
- A transponder so that the sledge can be retrieved if lost;
- An ESM2 logger, to record turbidity readings, depth and salinity.

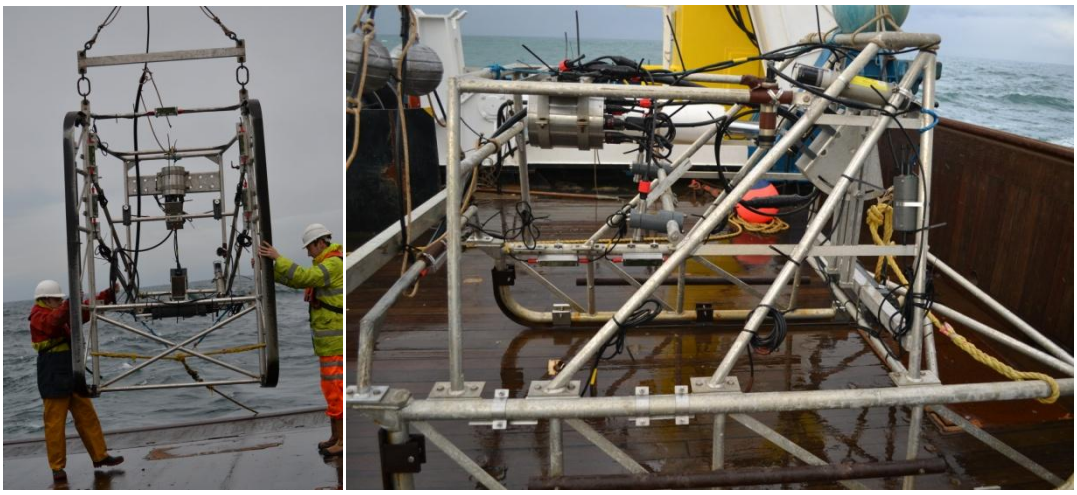


Figure 2 – Sledge used during CEnd12/14, showing the equipment setup. *Photos by Robin Masefield (Cefas).*

The Dynamic Positioning system (DP) was used throughout the survey to provide a controlled towing speed of around 0.7 knot.

Recounts

In line with SGNEPS recommendations all scientists were trained/re-familiarised using training material and validated using reference footage (measured by Linn's concordance correlation coefficient (CCC)) prior to recounting June 2014 footage. A limit of 0.5 was used to identify counters who need further training. On completion of this process, all CEND 12/14 recounts were conducted, as blind counts, by two persons during the survey. Here, the number of *Nephrops* burrow systems and the activity in and out of the burrows were counted by each minute block (for 7 clear minutes). In case the field of view became obscured by cloud the seconds obscured were recorded and all minute blocks with more than 20 minutes obscured were rejected. After all counts completed again the Linn's CCC (with a threshold of 0.5) was applied to check which stations needed to be revisited and were a 3rd or 4th counter needed to be added.

Whilst reviewing the videos, the visibility, ground type, trawl marks, occurrence of bio-fauna, ground contact of the sledge, cloud and any other interference was recorded during each one-minute intervals, using a classification key.

For posterior analysis, counts of burrow systems are converted into densities at each station using the width of view (81.5 cm) and the length of the tow (extracted from tower position vessel logging). Each system is assumed to represent one adult *Nephrops* and occupancy is assumed to be 100%. To estimate the spatial structure of *Nephrops* densities a geo-statistical analysis is carried out in the whole area and the total survey abundance, variance and confidence limits are then calculated.

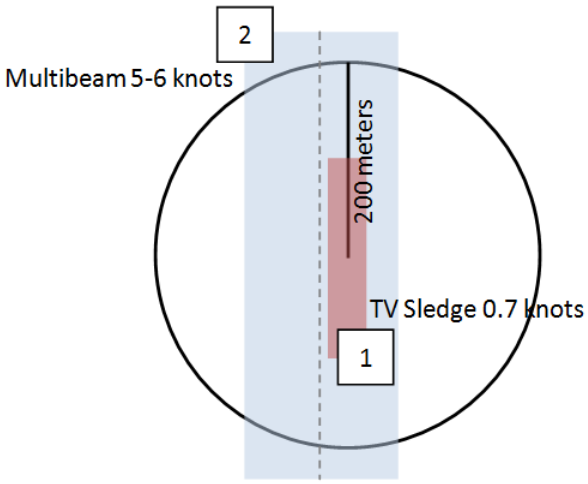
Multibeam survey

Swathe data were collected over each TV station. The equipment used was an EM2040 (300 KHZ), with a Multibeam angle of 60 degrees for each head.

Before deploying the sledge a run through was done slightly offset of the centre of the station (approx. 40m) covering the direction of the eventual sledge run. The offset was to ensure the sledge track avoided the nadir, the point directly below the ship where the data from the two Multibeam sensors overlap. The processing package used to analyse these data re-interprets the backscatter data from either side of the nadir much more easily.

1. Multibeam through station slightly offset the centre of the station (~ 40m). Tower data recorded using CRP.

2. TV sledge through the centre of the stn – Stern gantry. Tower data recorded using stern gantry.



The Swathe bathymetry data was processed at sea as it was collected. The swathe data processing suite FSMGT was used to produce, for each station, a matrix of 0.1 metre cells or tiles covering the area swept and a point estimate of mean backscatter (-dB) calculated for each tile.

These mosaics were then processed further using ArcGIS. R was used to produce a smoothed sledge and ship track from the continuous logging of the ships and sledge positions in Tower. These tracks were truncated to the period of the count.

Both the Swathe Mosaics and the sledge and ship tracks were plotted together within ArcGIS (Figure 3).

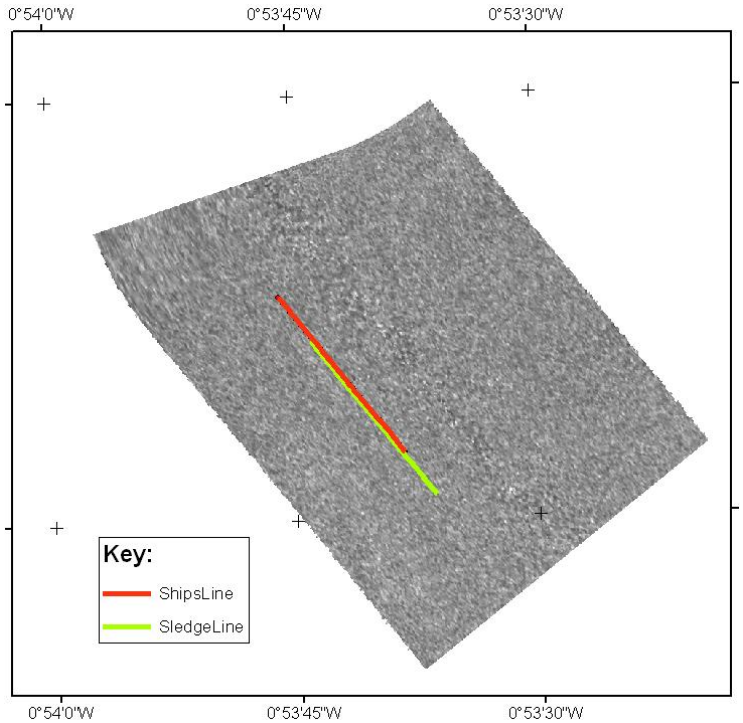


Figure 3 – Example of the outcome of a swathe mosaic with the sledge and ship tracks on top (example TVID 6-M).

A 1m wide polygon was created using the analysis tools for each station covering the length of the track. This represents the transect covered by the sledge and the stretch of video analysed (Figure 4). The range of decibel values of this example station are presented in table 1 and the frequency of the decibel distribution on figure 5.

The point estimates from the back scatter mosaics that were masked by these polygons were extracted to a file for analysis. The ordinal position of each point estimate was preserved in this data so that backscatter measurements can be compared directly with the counts collected from the video for each minute block along the length of the sledge track.

The figure below shows the data extracted from the backscatter for a section of the 1 metre wide using the sledge transect in the example above.

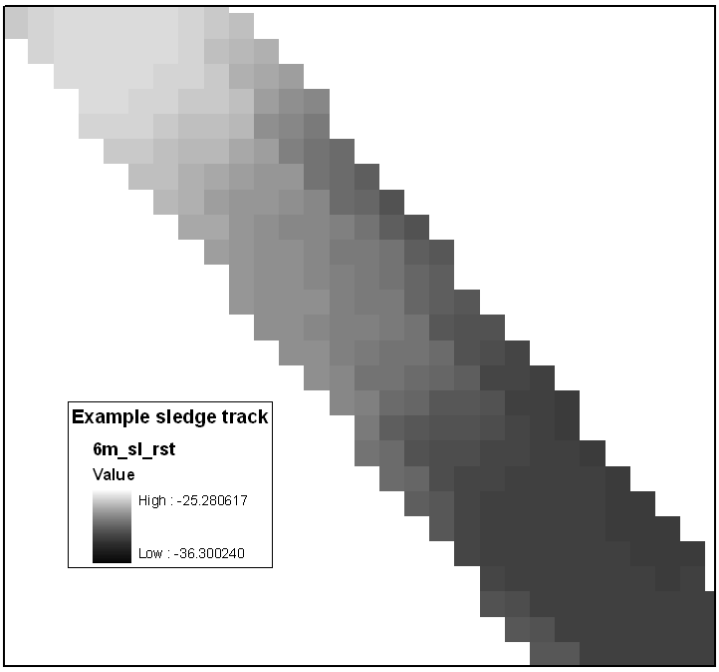


Figure 4 – Example of data extracted from the backscatter for a section of the 1 metre swathe mosaic, in this case by using a sledge track (example TVID 6-M).

Table 2 – Processed station summary, showing range of decibel values of this example station (6-M) and the number of backscatter points collected in the transect.

Station TVID	N points	Mean dB	SD	Min	Max
6-M	16557	-29.8769	3.1665	-36.3002	-25.2806

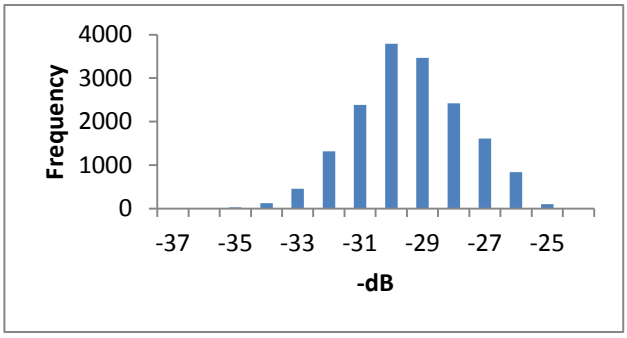


Figure 5 – Frequency distribution of the decibel values for example station 6-M.

These data will be further on incorporated in the geospatial model used to estimate the abundance. This variable will work as a co-variable and will be used to test if it can be used to increase confidence in the *Nephrops* abundance estimates and used a predictor variable in the model.

Collect surface water samples

Water samples were collected daily (3 different types of samples per day) form the Ferrybox sample outlet. One of the samples was preserved with mercuric chloride for analysis of total alkalinity/dissolved inorganic carbon. Additionally two more samples were collected for analysis of inorganic nutrients and dissolved organic matter.

This data will be used for the Shelf Sea Biogeochemistry Research Programme, WP1 Candyfloss (NERC/Defra funded) and will contribute to estimating the size of the shelf carbon pump over the whole NW European shelf, and its relationship to the global carbon cycle.

Health and Safety

As required all staff had a valid ENG1 health certificate and a Personal Sea Survival Certificate.

Also the following risk assessments were acknowledged:

✓ FD-C&F-SHELL-SOP-01 MB001 NEPTVBurrowCount SOP V1.3.DOC

✓ G02 – Travelling while on official duty in Official or private vehicles, including loading and unloading equipment, baggage, etc, but excluding the carriage of dangerous chemicals, the use of HGV or specialised vehicles;

✓ G03 – Participation in research cruises on CEFAS owned and managed ships. The collection of samples and data all subsequent processing whilst on-board, including the use of the ships sea-rider.

✓ FD-CF-SHELL-RA-09-MB001 – *Nephrops* TV cruise activities

✓ HS 16 – MPM-RACS-MAN- Preparation and use of mercuric chloride (for use in nutrients samples).

Technical aspects/failures

- LED lights failed

- Multibeam settings.

- The bridge was using a single waypoint displayed in tower as a reference to navigate by when doing the Multibeam. It was difficult to keep the ship on the course that the sledge was to be towed and within 50m of that waypoint. Reference rings (50m radius) were added into tower to help the steering but for future surveys other solutions need to be explored. As the direction of the tides don't change greatly among stations, one solution could be to add a wayline in tower 50m from the centre of the station.

3. Results and Final Considerations

In June 2014, 110 stations (TVID) were successfully surveyed in the Farn Deeps (FU6) with the TV sledge and Multibeam, from 8 Jun (19:20 GMT) to 15 Jun (02:00 GMT) (Table 2). No time was lost due to weather conditions; weather was in fact very good throughout the survey and additionally the water clarity was very good to excellent. This time of the year proved to be ideal to do the survey as all conditions are more favourable to run a more efficient survey and it proved also to save time as much less stations needed to be revisited due to bad weather conditions and/or poor water clarity.

Due mainly with all interference recorded in the first part of the grid, 58 stations were revisited and a second run through with Multibeam was made to ensure good data quality and also to ensure the sledge track was covered, as at some stations the Multibeam didn't cover the sledge track and/or crossed the nadir.

Regarding the TV sledge, only 1 station was repeated due to cloud in the first run. The footage of the second run was of much better quality and so the first footage was discarded and not included in the analysis.

A total of 7 CTD dips were carried out to calibrate the Multibeam.

Table 2 – Shows the invalid number of repetitions. *after several attempts no footage recorded. **edge station where were too many rocks to be considered safe to record any footage; zero counts.

Gear	Surveyed stations (TVID)	Number of repetitions
TV Sledge	110	1
CTD	7	0
Multibeam	110	58

Primary objective- TV survey

Nephrops burrow live-counts were made over a 10-minute tow, which was recorded on DVD and DV tape. All recordings were then recounted under controlled conditions and the CCC code was used to validate stations and to identify which stations required a 3rd counter, for this propose a threshold of 0.5 was used.

- Burrows were counted by each minute block for 7 clear minutes. The counting performance of the 2014 counters was generally very high, with a Linn's CCC scored average of 0.73.

- As previous years the high abundance area is distributed in the east side of the ground (Figure 7).

- The abundance index is back up to the level in 2012 (almost exactly = 757 million), so the advice will be revised again in the autumn given that the change is more than 1 standard deviation (Table 3).

- Abundance is still below the 2007 trigger level though (Figure 6).

- Following the MSY approach (Harvest rate = 7%) the advice for landings will go from 985t to 1132t.

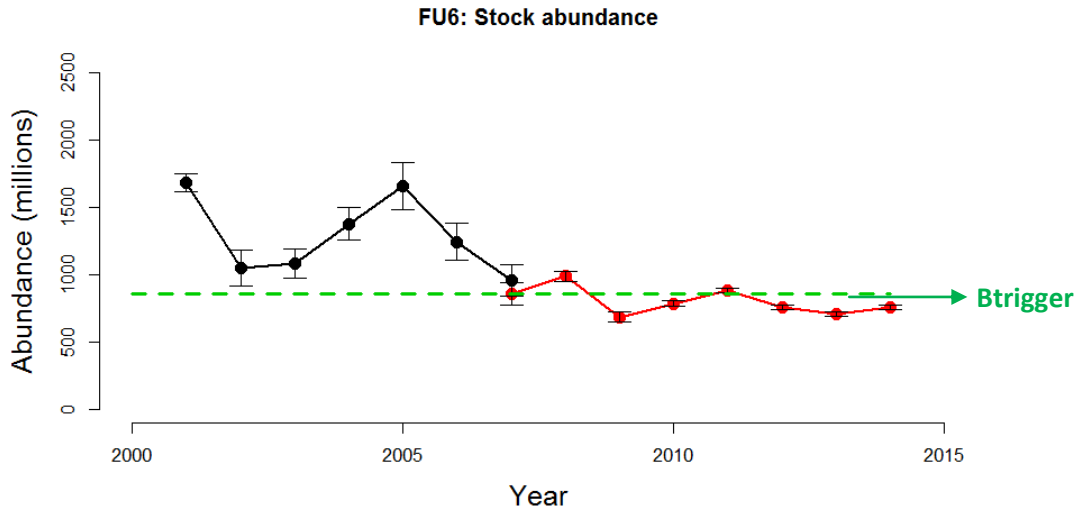
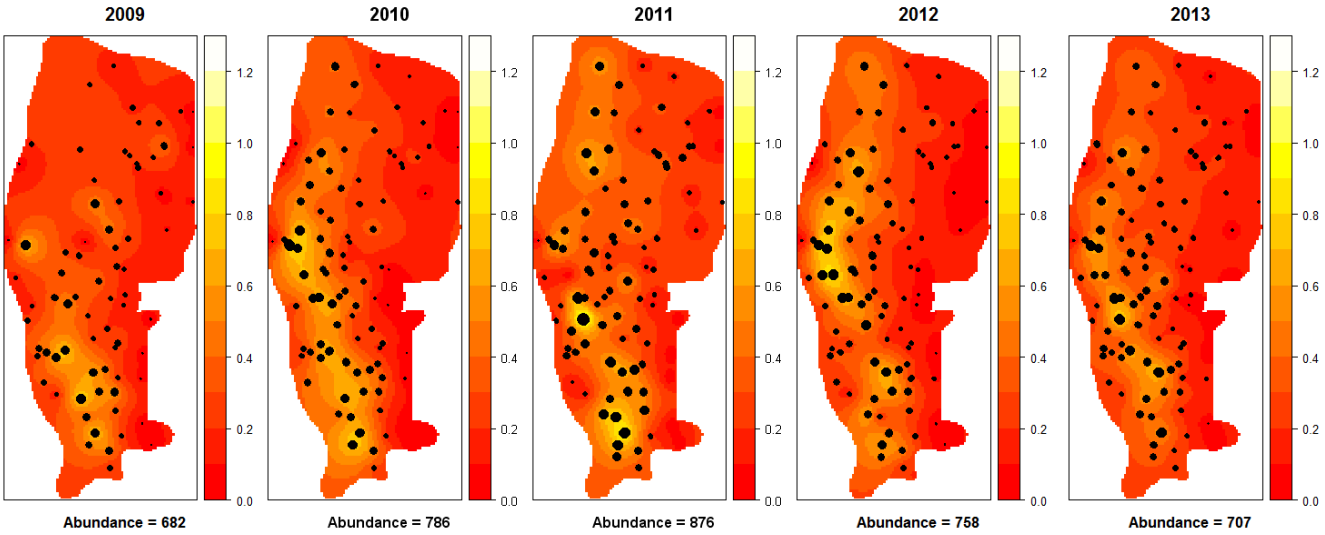


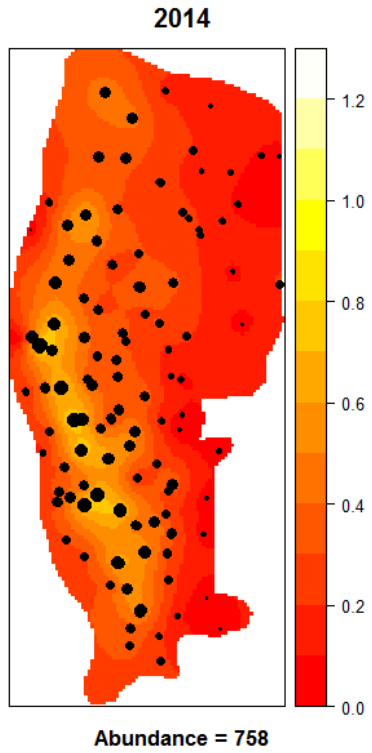
Figure 6 – *Nephrops* abundance estimates from the UWTV Survey 2001–2014. Geostatistical model used from 2007 (red line).

Table 3 – Results using the geostatistical model from UWTV-FU 6 *Nephrops* survey in 2007–2014.

Year	Stations	Mean density (burrows/m²)	Absolute Abundance (millions)	95% confidence interval (millions)
2007	105	0.28	858	23
2008	95	0.31	987	39
2009	76	0.22	682	38
2010	95	0.25	785	21
2011	97	0.28	878	17
2012	97	0.24	758	13
2013	110	0.23	706	18
2014	110	0.24	757	17

Figure 7 – Geostatistical outputs 2009 – 2014, maps of *Nephrops* density distribution (m²)





The primarily objective was fully achieved as all TVID stations were successfully surveyed with the TV sledge, all data was inputted and quality checked while onboard and additionally all analysis was made to calculate the final abundance estimation for the ground.

Secondary objectives

Data retrieved from the Multibeam (backscatter data) will be processed and analysed later on and integrated with the burrow counts densities. Preliminary results form 2013 survey show a relationship between the decibel values and the burrow densities, although these data needs to be further analysed and incorporated in the geospatial model along with the other variables, like the sediment type and the redox layer.

The main objective of the survey (*Nephrops* abundance estimation) was successfully met for this year in the Farn Deeps. The UWTV coverage was excellent (100% stations done with the TV sledge) and the overall footage quality was very good to excellent in the Farn Deeps grounds due to favourable weather conditions and minimal technical difficulties. Data retrieved from the multibeam (backscatter data) will be processed and analysed later on and integrated with the burrow counts densities. The collection of these data was successful in almost all stations and a good spatial coverage was achieved. The incorporation of these variables might be used to increase confidence in the *Nephrops* abundance estimates and be used as predictors in the model to estimate geospatial abundance.

ACKNOWLEDGMENTS

We would like to express our thanks and gratitude to the Captain and crew of RV Endeavour for their good will and professionalism during the survey. Also thanks to P&O Maritime for handling all gear and sort any technical difficulties. Finally, thanks to all CEFAS staffs onboard for their hard work and enthusiasm in making this survey a success.

Ana Leocadio (SIC)