CENTRE FOR ENVIRONMENT, FISHERIES & AQUACULTURE SCIENCELOWESTOFT LABORATORY, LOWESTOFT, SUFFOLK, ENGLAND

Report

Survey CEND 10/13
North Sea (FU6 – Farn Deeps)

ANA.M. LEOCADIO (SIC)

KAREN VANSTAEN (2SIC)

ANDY.R. LAWLER

DEREK EATON

DAVE PALMER

ROB MASEFIELD

EWEN BELL

MARC WHYBROW

JON ELSON

CLAIRE POWEL

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INTRODUCTION

The Norway lobster (*Nephrops norvegicus*) is common throughout the North Sea being a very important fishery for the UK. 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 2012 for this area reported 2460 tonnes.
Currently the assessment on *Nephrops* stocks, in the North Sea, is based on underwater television surveys (UWTV) which provides a fishery independent estimate of stock size, exploitation status and catch advice (ICES, 2008). The *Nephrops* stock assessments are run annually and accordingly on advice from ICES the EC sets annual TACs for this species.
CEFAS has performed annual UWTV surveys in the Farn Deeps area since 1996.

The specifics objectives of 2013 survey are listed below:

Primary objective (all stations):

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

Secondary objectives (only in selected stations ~ 90 stations):

2. To conduct seabed multibeam survey at and between TV survey stations.
3. To conduct seabed sediment sampling, using a day-grab.
4. To use the sediment profile imagery (SPI) camera to take cross section photographs of soft sediment.

Figure 1 – Map showing the location of the surveyed area in the Function Unit 6 area.

MATERIAL AND METHODS

The 2013 North Sea *Nephrops* UWTV survey took place on RV Endeavour between 8th to 17th June. The departure and arrival port was Lowestoft.

Primary objective- 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 (see 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 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.

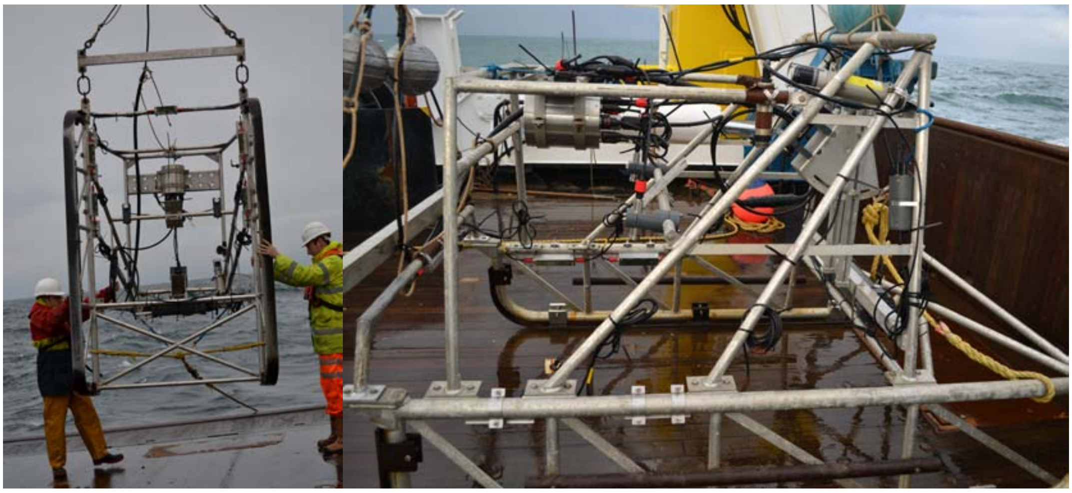


Figure 2 – Sledge used during CEnd10/13, showing the equipment setup. *Photos by Robin Masefield (Cefas)*.

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 2013 footage. A limit of 0.5 was used to identify counters who need further training. On completion of this process, all CEND 10/13 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 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.

Secondary objectives

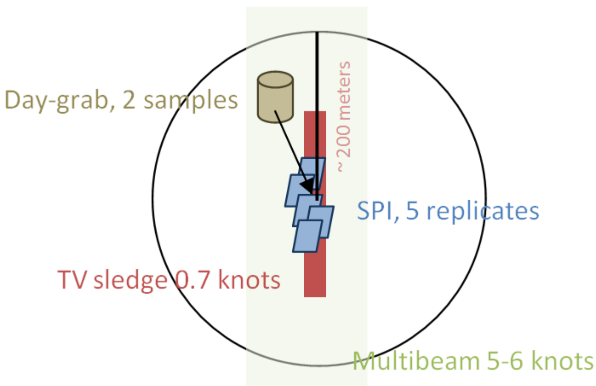
Additionally, complementary information was collected for DP342 project "Better value for money: integration of approaches in support of Nephrops assessments".

Survey design

This survey design aims at fitting the geo spatial model, so the dependent variable will be *Nephrops* density and the covariates the redox, backscatter and sediment. This is an exploratory study to check if these variables can be used to increase confidence in the *Nephrops* abundance estimates and if they can be used as predictors in the model.

Out of 110 stations 90 were selected to do the full coverage with all gears (TV sledge, day grab, SPI and multibeam coverage). The selection of the stations was made in order to use the geostatistical model that has been used to calculate the *Nephrops* abundance.

1. Multibeam through station slightly offset the centre of the station (~ 50m)
2. TV sledge through the centre of the stn – Stern gantry
3. Day grab (collect 2 samples) – Side gantry
4. SPI with 5 replicates (5m apart) – Side gantry



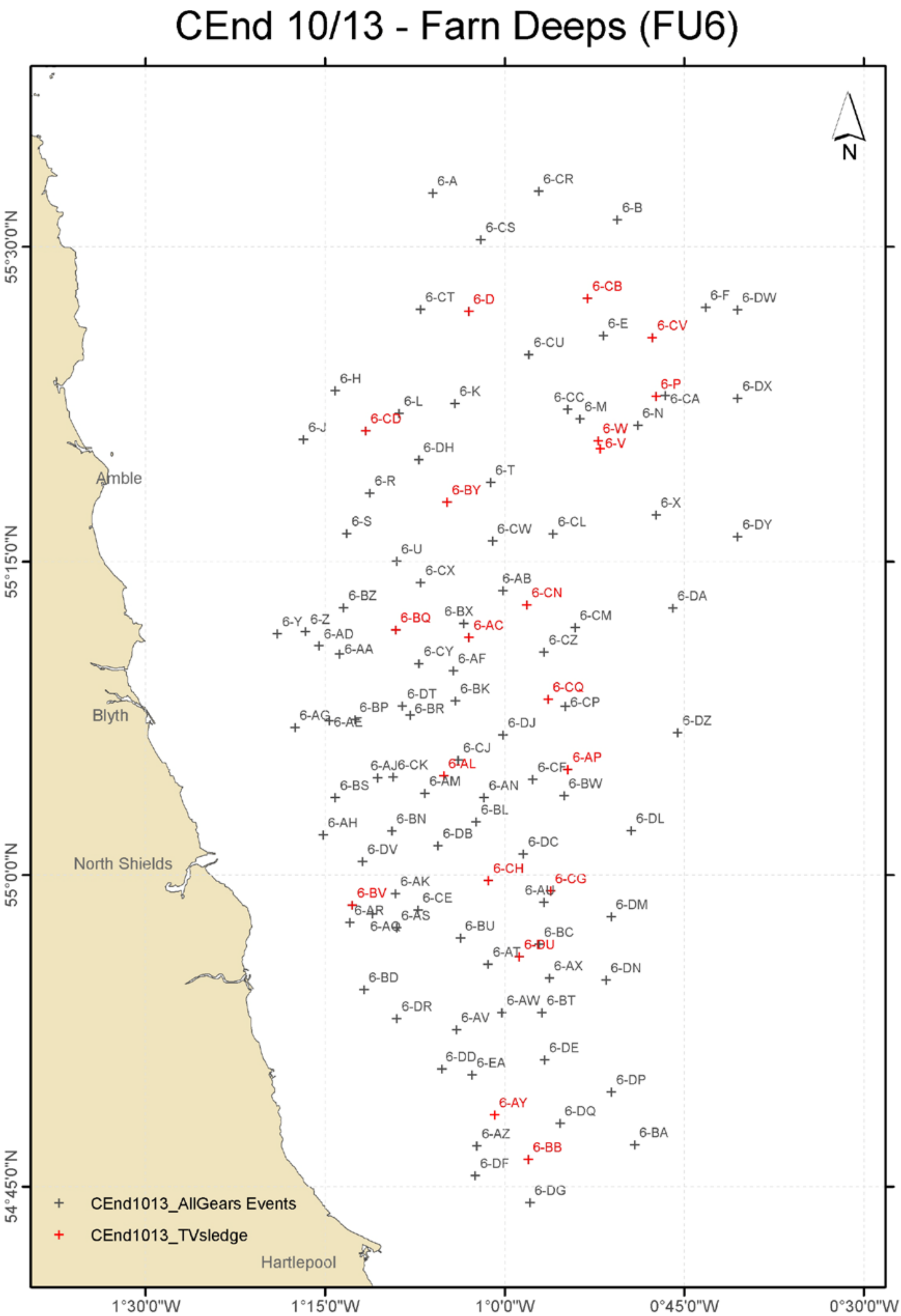


Figure 3 - CEnd10/13 final stations for Farn Deeps area (FU6). Red stations: TV sledge only; Grey Stations: Full coverage with all gears (TV sledge + day grab + SPI + multibeam).

Sediment samples

In order to map the sediment of the Farn Deeps ground a 0.1 m^2 day-grab was used in each station (Figure 4). This device samples an area of 0.1 m^2, to a maximum depth of 14 cm. The garb was deployed from the side gantry.

The procedure of collecting these samples included:

- Record positions of each day grab dip (manual fix on tower).
- Photograph sediment samples (sample proof).
- From each day grab sample (one per station) 2 sediment samples were collected:
    - One pot of sediment (just first 2 cm, fill at least ½ box) for subsequent particle size analysis (PSA) analysis at Cefas Lowestoft. This sample was frozen at -20°C after collection;
    - One syringe (5 cm^3) of sediment was also kept aside in a small jar for rapid fines analysis (RFA). These samples were kept in the fridge at approximately 5°C while waiting for processing. Results will be later on compared with the standard PSA analysis.

Figure 4 – Use of the 0.1 m^2 Day grab during retrieving. *Photo by Robin Masefield (Cefas)*.

Rapid Fines Analysis (RFA)

A full description of this technique can be found in Silburn *et al*. (in prep). The RFA samples were placed in a clear plastic tube (200mm length, 16mm diameter) and 20ml filtered seawater added. Samples were then gently agitated for 20 seconds until completely suspended in the seawater. The tubes were then allowed to settle in a vertical position for 24 hours. Once settling had taken place samples were placed in a light box and photographed using an Olympus Stylus Tough-8000 set at 12 mega pixels; macro on; exposure set to -2.0; and the flash off. Subsequent image analysis of the photos is to be carried out at Cefas Lowestoft in order to estimate %silt/clay particles in the sediment.

Particle Size Analysis (PSA) – to be completed post-cruise

The method used is described in NMBAQC's Best Practice Guidance: Particle Size Analysis (PSA) for Supporting Biological Analysis (Mason, 2011). After transport to the lab, PSA samples will be thawed and subsequently size segregated by wet sieving at 1 mm, with the finer fraction (< 1 mm) to be analysed on a Malvern Mastersizer 2000 laser sizer and the coarse fraction (> 1 mm) to be dry sieved at 0.5 phi intervals down to 4 phi. Results from dry sieving and laser sizing were combined to give a full particle size analysis.

Sediment profile images - SPI

The Sediment Profile Image (SPI) camera was deployed from the side gantry at 90 TVID stations (Figure 5). Each SPI deployment consisted of five casts spaced approximately 5-10m apart, each cast consisting of two images taken at 15 second intervals. The position was recorded for each cast. After deployment images were uploaded and checked for image quality. Images were found to be either underexposed, underpenetrated, or overpenetrated at a total of 25 stations, requiring these stations to be revisited.

Figure 5 – Use of the SPI camera during deployment. *Photo by Robin Masefield (Cefas)*.

Images were analysed using ImageJ to estimate sediment type, presence/absence burrows and measure apparent redox potential discontinuity (aRPD). The technique is described in Teal *et al*., 2009. A total of 25 stations were analysed during the survey, with the rest to be analysed back in the laboratory.

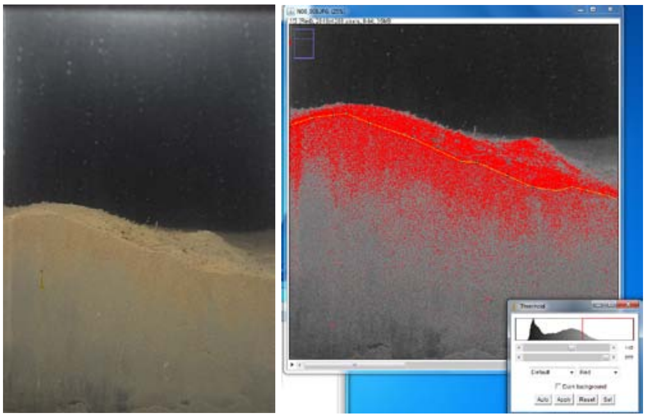


Figure 6 – SPI Image and screen capture during analysis using ImageJ, highlighting the aRPD.

Multibeam

Swathe data were collected on the survey over the TV stations. Before deploying the sledge a run through was done slightly offset of the centre of the station (~ 50m) 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.

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 backscatteer (-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 7).

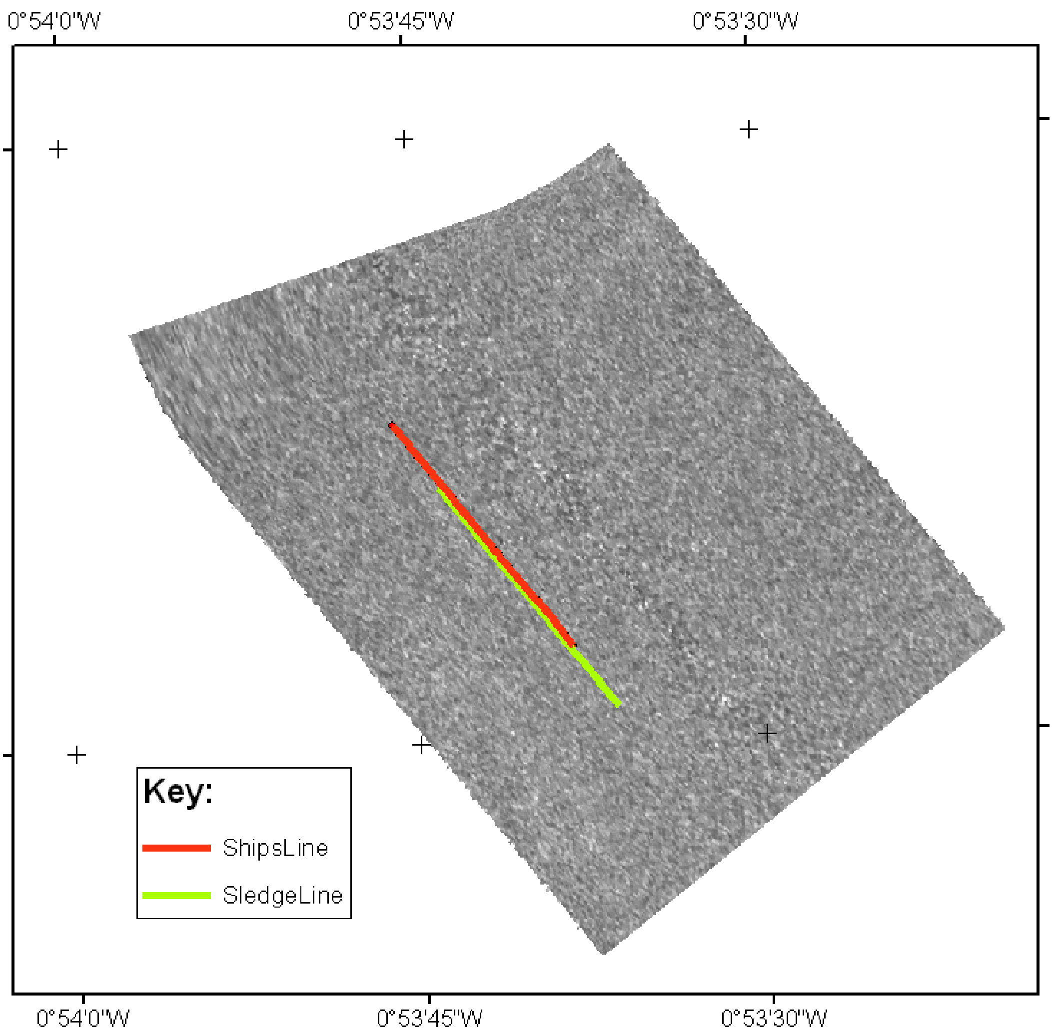


Figure 7 – Example of the outcome of a swathe mosaic with the sledge and ship tracks on top (example TVID 6-M).

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 8). The range of decibel values of this example station are presented in table 1 and the frequency of the decibel distribution on figure 9.

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.

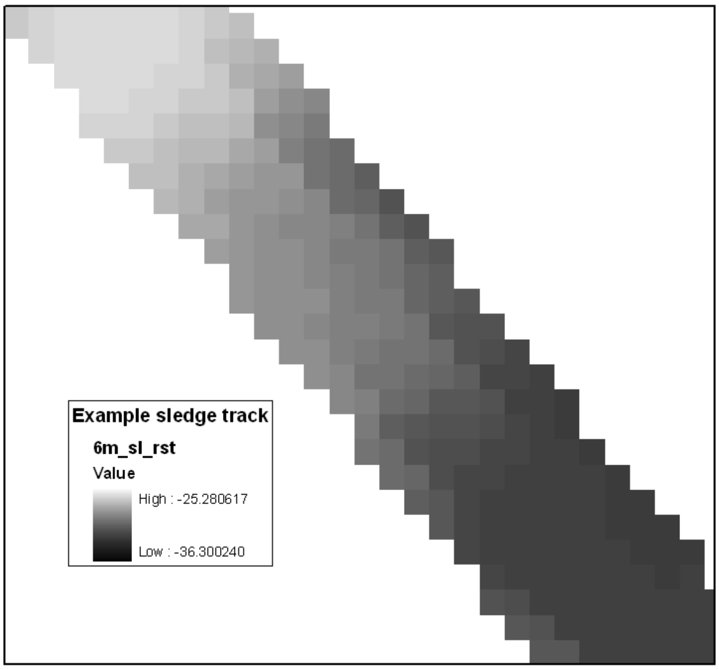


Figure 8 – Example of data extracted from the backscatter for a section of the 1 metre swathe mosaic, in this case by using a sledge track (example TVID 6-M).

Table 1 – 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

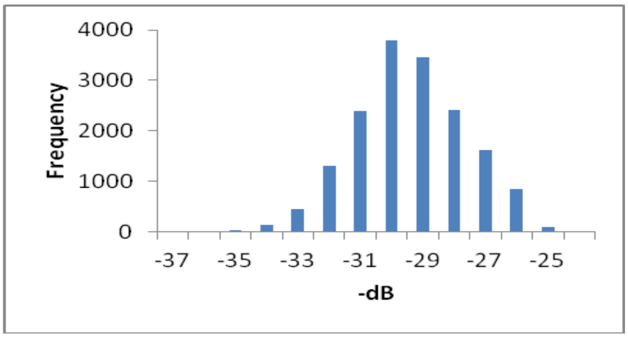


Figure 9 – Frequency distribution of the decibel values for example station 6-M.

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
- ✓ SOP_ 1386_SPI.doc
- ✓ HS26 EE-MENA-MET-RA-07 SOP 1386-Sediment Profile imaging.XLSX
- ✓ HS26 EE-MENA-MET-RA-03 SOP 1381-Day grabbing(2).XLSX
- ✓ Updated Day Grab SOP 1381.pdf

No COSHH required for the present survey.

Technical aspects/failures

- Re-termination of the side cable (SPI camera) and cable B (stern).

- 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.

- The SPI camera settings were not set up correctly by the start of the survey and it took a day until all settings were set up correctly. Weight used in each SPI dip should be recorded in the first details form in future surveys.

RESULTS and FINAL CONSIDEARATIONS

In June 2013, 110 stations (TVID) were successfully surveyed in the Farn Deeps (FU6) with the TV sledge, from 9 Jun (00:06 GMT) to 16 Jun (22:00 GMT). Additionally 90 out of 110 were surveyed using all gears (TV sledge, multibeam, day-grab and SPI) (Figure 10). 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.

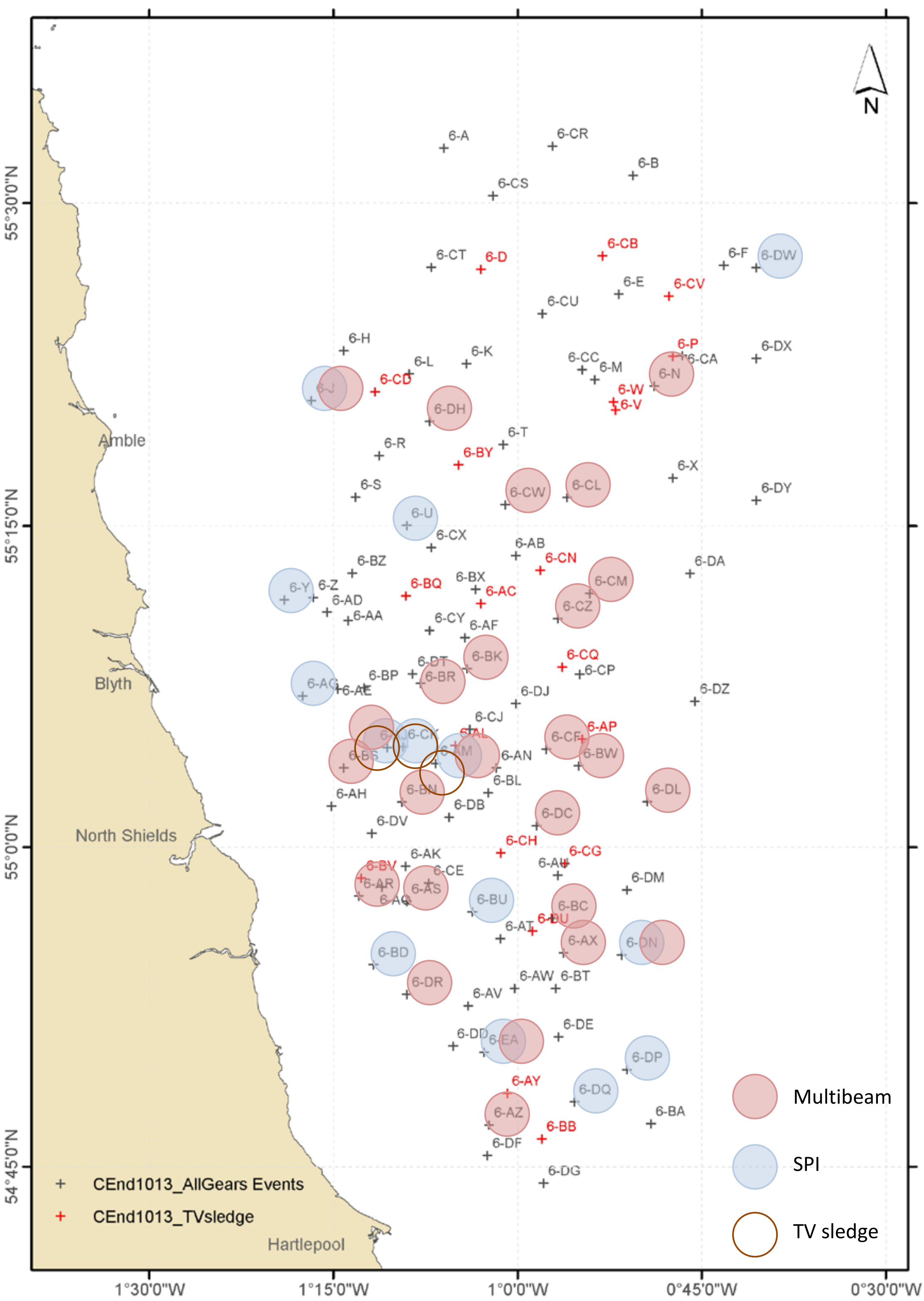


Figure 10 – CEnd 10/13 stations' surveyed showing repeated stations using multibeam (red), SPI (blue) and TV sledge (brown).

Due to difficulties in running and capturing the multibeam data slightly offset from the waypoint, 25 stations were revisited and a second run through with multibeam was made to ensure the sledge track was covered.

After a preliminary analysis of the SPI pictures, some images were considered to be unusable, thus 14 stations were repeated using SPI. Pictures were unusable because the camera settings were incorrect or/and because the incorrect penetration of the camera in the sediment, that in some cases was too deep and in others not enough.

Regarding the TV sledge, only 3 stations were 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.

All sediment collection, at the aimed stations, was successfully completed (Table 2).

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	Valid stations
TV Sledge	110	3	110
CTD	7	0	7
Multibeam	90	25	90
Day grab	91	0	91
SPI	90	14	~84

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; burrows were counted by each minute block for 7 clear minutes. The counting performance of the 2013 counters was generally very high with Linn's CCC scores >0.7 for most of the stations, although 16% of the stations were revisited by a 3rd counter to have concordance in the counts. A map of the average burrow counts for 2013 on the Farn Deeps is showed in Figure 11. As previous years the high abundance area is distributed in the east side of the ground.

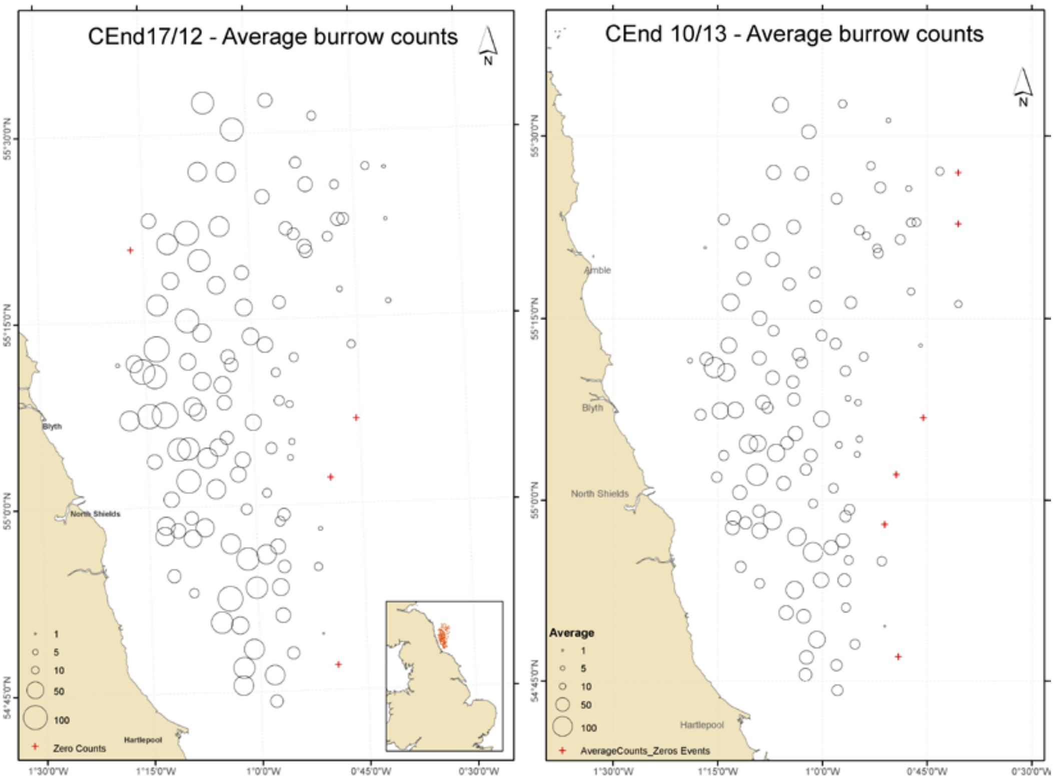


Figure 11 – CEND 10/13 bubble plot of the average burrow counts from standard TV tows on the Farn Deeps ground. Comparison of 2012 and 2013 average counts.

Trawl marks were noted at 56% of the stations surveyed (Figure 12 – orange stations) compared with 62% in last year. While last year the trawl marks were more localised in the eastern part of the ground, this year they were more spread around.

It is important to highlight the occurrence of trawl marks on the footage; it makes identification of *Nephrops* burrows more difficult as the trawl marks remove some signature features making accurate burrow identification more difficult; only occupied *Nephrops* burrows will persist in heavily trawled grounds and it is assumed that each burrow is occupied by one individual *Nephrops*.

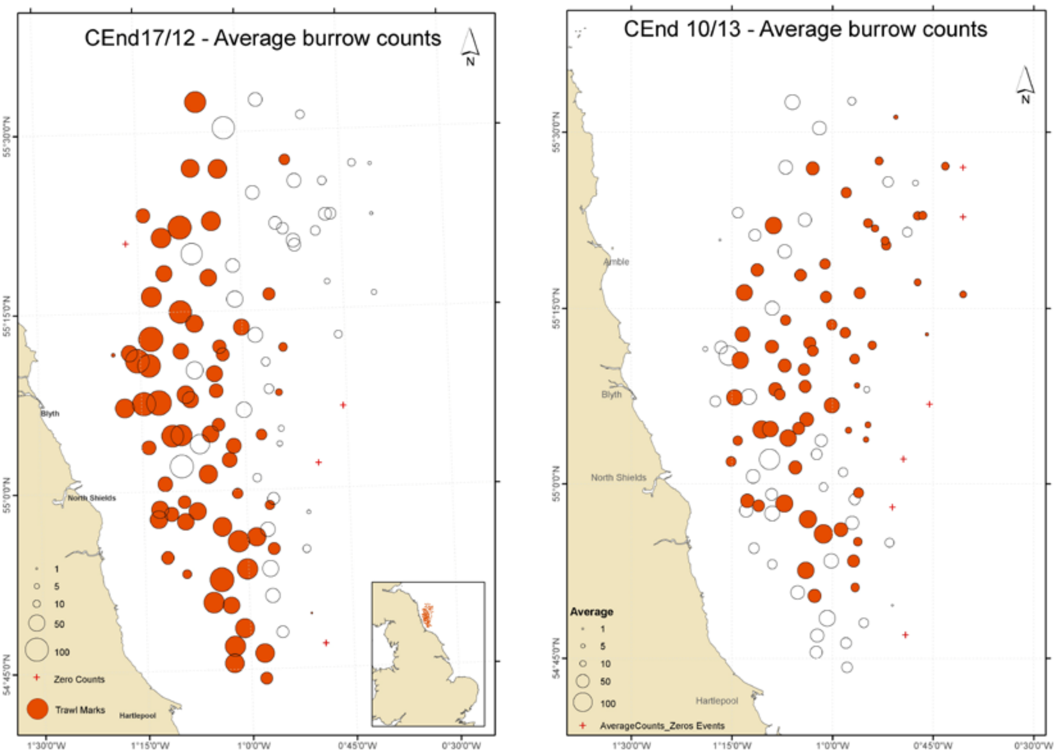


Figure 12 – CEnd 17/12 and CEnd 10/13 bubble plot of the relative burrow counts from standard TV tows on the Farn Deeps ground showing, in orange, the stations with observed trawl marks.

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), sediment samples and SPI will be processed and analysed later on and integrated with the burrow counts densities.

The multibeam processing provided around 15 000 point estimates of backscatter for each TV transect. Preliminary results show a relationship between the decibel values and the burrow densities (Figure 13), 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.
Figure 14 shows the spatial distribution of the decibel value for the sledge and vessel tracks and also compares this with the geospatial distribution of the *Nephrops* density. These results will be interpreted further on.

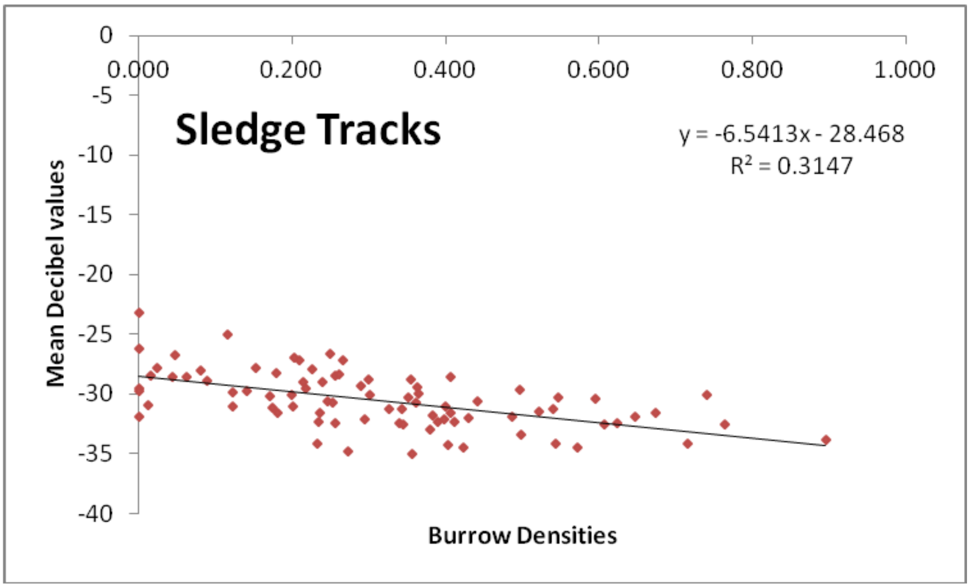


Figure 13 – Relationship between the average decibel value and the burrow densities, using the sledge tracks.

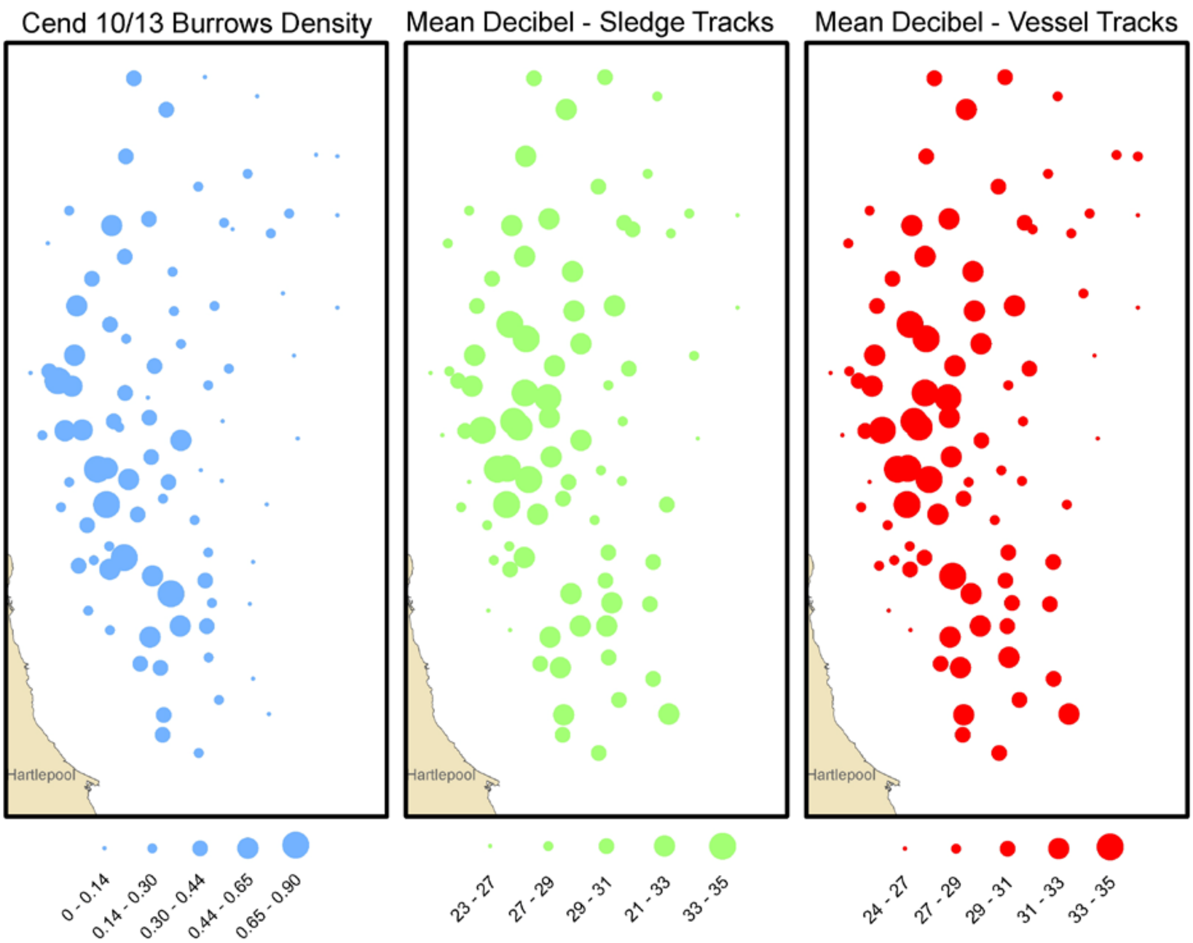


Figure 14 – Comparison of the spatial distribution of *Nephrops* densities (blue, 110 stn) with the mean decibel distribution in the surveyed area (green for the sledge tracks, 85 valid stn; red for the vessel tracks, 90 stn).

Sediment samples will be used to ground-truth the multibeam data and the SPI information. Additionally, the use of sediment profile images could contribute with valuable information on *Nephrops*-sediment assessments, mainly in relation to areas which could exhibit presence of *Nephrops* and relate this to the depth of the apparent redox discontinuity layer (aRPD). The images collected with the SPI camera can provide complementary profile information on burrow depth, structure and sizes.

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), sediment samples and SPI 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), 04/07/2013

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Teal LR, Parker R, Fones G, Solan M (2009) Simultaneous determination of in situ vertical transitions of color, pore-water metals, and visualization of infaunal activity in marine sediments. Limnology and Oceanography 54:1801–1810.