Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL SURVEY REPORT

RV CEFAS ENDEAVOUR
Survey: C END 09 - 2019

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DURATION: **24/06/2019 (01:30 BST) - 01/07/2019 (08:00 BST)**

LOCATION: **Farn Deeps, North Sea (Functional Unit 6)**

AIMS:

Primary Objective

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

Secondary Objectives

2. To conduct a standard underwater TV survey of 20 additional stations on the Farn Deeps grounds (as per objective 1). These stations are surveyed by NEIFCA as part of their annual autumn TV survey of inshore grounds. By surveying the same stations during the early Summer, we will be able to estimate seasonal variations in burrow densities.

3. Collect chlorophyll samples to test for nutrients from the surface water for ASMIAC project. (N. Greenwood- Cefas, Lowestoft)

SUMMARY:
This report summarises the main results and findings of the 23rd annual underwater television survey on the 'Farn Deeps grounds' ICES assessment area, Functional Unit 6. The survey was multi-disciplinary in nature collecting UWTV video transects and 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 visually clear 10-minute tow is recorded digitally. In June 2019, 90 stations (TVID) were successfully surveyed in the Farn Deeps area with the TV sledge, from 24th June to 30th June. This year, the survey was half a day shorter than previously and with unanticipated downtime, 19 stations had to be dropped. Downtime was due to weather conditions, technical issues with the camera sledge and

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to enable H&S improvements to sledge deployment and recovery operations. This resulted in a prioritised grid aimed to maximise station coverage. Of the stations surveyed, 1 was dropped due to technical issues with the camera system and 3 had to be repeated due to stability issues caused by loss of the drogue. Water clarity was good to excellent throughout the footage recorded, 2 stations required repeats due poor visibility. A new reference set of calibration videos was used from the 2018 survey footage. All burrow counters completed calibration training to a required concordance to ensure competence and calibration for burrow recounts prior to the survey. Standard protocol for burrows recounts was followed. Counts were recorded in 1-minute blocks for a total of 8 minutes comprising of 1 calibration minute, followed by 7 clear minutes of recorded counting. The counting concordance of the 2019 counters was generally high (average Linn's concordance correlation coefficient, CCC = 0.66). Preliminary results indicate an increased abundance when compared to last year, and at its highest level since 2006 with abundance above the Btrigger threshold as determined by ICES. As with previous years the highest abundance of burrows were recorded on the west side of the ground especially in the central west region of the grid.

NARRATIVE:

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 23 years in the Farn Deeps, 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 24 ICES Functional Units and 3 other *Nephrops* grounds (ICES 2019), being widely used in the North Sea, Celtic Sea, Irish Sea, East Atlantic as well in the Mediterranean.

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 and 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 (ICES 2019). Progress was made in 2009 ICES Benchmark where 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 for the 2018/2019 season for this area were 1807 tonnes*.

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

Table 1 – Summary of the UWTV results, 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
2014	110	Summer	0.24	755	18	Geostatistics
2015	110	Summer	0.18	568	13	Geostatistics
2016	110	Summer	0.24	697	19	Geostatistics
2017	110	Summer	0.29	909	21	Geostatistics
2018	109	Summer	0.31	954	23	Geostatistics
2019	91	Summer	0.37	1163	26	Geostatistics

** Provisional result*

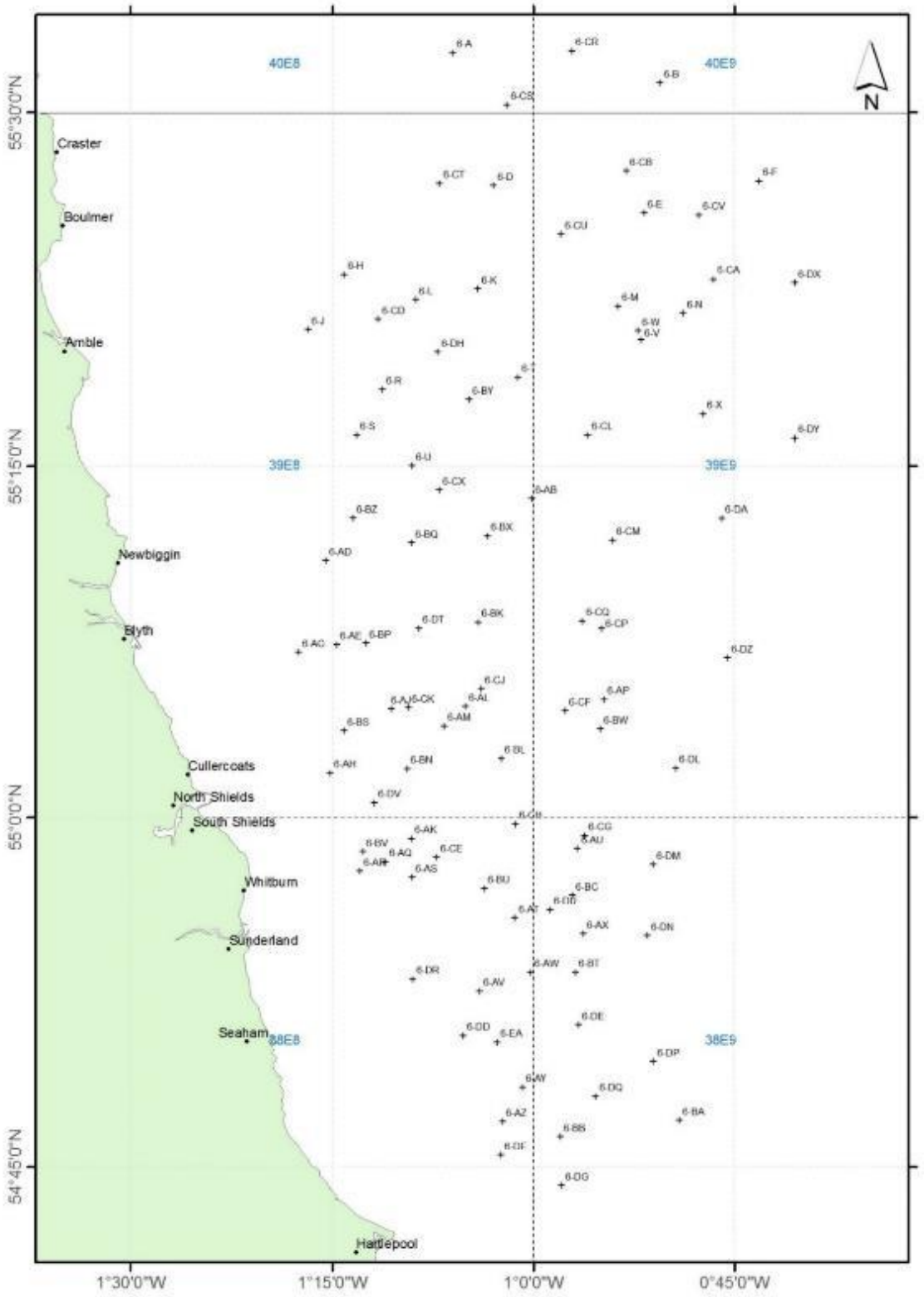


Figure 1 – Map showing the location of the surveyed area in the Function Unit 6 area (91 stations).

METHODS:

The 2019 North Sea *Nephrops* UWTV survey took place on RV Cefas Endeavour between 24th June to 1st July. The embarkation and debarkation ports were both Lowestoft.

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 visually clear 10-minute tow was recorded in MP4 video file format, recorded directly to two separate drives to provide a backup. Vessel position using a differential global positioning system (DGPS) and sledge position using an ultra-short baseline (USBL) transponder were recorded every 10 seconds.

The camera system, lights, lasers, altimeter and compass used on the sledge were all manufactured by STR. The camera, lights and lasers were controlled by an onboard MUX box, which communicated with a MUX box on board. Camera cable B (coax) was used to receive the live footage from the video camera.
The sledge was equipped with (Figure 2):

- An IP camera (720p) at an oblique angle to the seabed, sighted towards the front of the sled.
- The sledge was mounted with 6 LED lights: 2 LED lights on either side plus 2 LED lights at the front to fully illuminate the field of view.
- Two green fan lasers to delimit the field of view (field of view 82.5 cm);
- A transponder to provide position and for sledge retrieval if lost;
- The ESM2 logger, to record turbidity readings, depth; salinity and oxygen levels;
- An independent altimeter and compass.

Figure 2 – Sledge used during C End 09/19, showing the equipment setup. *Photos by Chris Firmin (Cefas)*.

Dynamic Positioning (DP) was used throughout the survey to provide precision positioning and a continuous towing speed of approximately 0.7 knots.

Recounts

In line with ICES SGNEPS recommendations, all scientists were trained using training material and validated using reference footage (measured by Linn's CCC) prior to recounting June 2019 footage. A limit of 0.5 was used to identify counters who need further training. On completion of this process, all recounts from C End 09/19 were conducted as blind counts by two different counters during the survey. The number of Nephrops burrow systems and the activity in and out of the burrows were

counted by each 1-minute block. This included a warm-up minute for the counter to familiarise themselves with footage from the station followed by 7 clear minutes of recorded counting. If the field of view became obscured by cloud the seconds obscured were recorded and any 1-minute blocks with more than 20 minutes obscured were rejected. A Linn's CCC threshold of 0.5 was again applied to check if stations needed to be reviewed by a third counter.

Whilst reviewing the videos, the visibility, ground type, trawl marks, occurrence of bio-fauna, sledge ground contact, visibility obstruction and any other interference was recorded during each 1-minute intervals, using a predetermined classification key.

For analysis, counts of burrow systems are converted into densities at each station using the width of view (82.5 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 geo-statistical analysis is carried out in the whole area. Total survey abundance, variance and confidence limits are then calculated from this analysis.

Health and Safety

As required all staff had a valid ENG1 health certificate, Personal Sea Survival Certificate and a valid 'working near water' safety course.
Also, the following risk assessments were acknowledged:

- ✓ RA3022 Nephrops TV Cruise (updated during the survey)
- ✓ RA4038 (HS26 MPM-MAS-MIS-RA-16) Cameras with Laser Scaling Systems
- ✓ RA003 Access to and Work on RV Cefas Endeavour
- ✓ RA006 Deploying and Recovering Scientific Equipment (grabs, cameras, buoys) on vessels (reviewed during the survey)
- ✓ RA4052 (HS26 MPM-MAS-MOS-RA-05) Unloading and loading vehicles at ports docksides
- ✓ CP001-7 Fieldwork 'Including working in, on or near to water'
- ✓ CP001-17 Driving for Cefas
- ✓ FD-C&F-SHELL-SOP-01 MB001 NEPTVBurrowCount SOP V1.6.DOC (updated during the survey).
- ✓ 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 ship's sea-rider.
- ✓ FD-CF-SHELL-RA-09-MB001 – Nephrops TV cruise activities

Aspects of the camera sledge deployment and retrieval were modified in-survey, in consultation with shore-based teams and an onboard trained gear deployment specialist. Due to worsening weather conditions during the survey, additional safety actions were implemented to ensure safe deployment and retrieval of sledge which required stoppage time.

Technical Issues

- An STR High Definition 1080p camera systems using fibre-optic umbilical cable was proposed for use during this year's the survey, however the cable had to be repaired and re-terminated after damage sustained during CEND 07/19. Due to this the survey was conducted with the previously used IP 720p camera connected by coax cable

- The STR video feed dropped out between deployments from quite early on during the survey. Initially this was considered an issue with software incompatibility, however engineers could not isolate a root cause without significant downtime. Video capture was reduced to primary recording with backup after each station, which reduced dropout rates. However, video capture started to drop out during deployments towards the end of the survey resulting in the loss of data from one station
- The camera sledge was not supplied with a drogue and one was prepared using materials from the ship's net store after a temporary replacement was lost.

RESULTS:

In June 2019, 91 of the 110 stations of the standard survey grid were successfully surveyed in the Farn Deeps (FU6) with the UWTV camera sledge. Loss of the drogue on 26th June led to 3 stations having to be repeated due to instability of the camera sledge on the seabed. 2 stations were repeated due to lack of water clarity. With the fore mentioned exceptions, the visibility overall for the survey was mostly good, 96% of footage was classed as "Good", 3% as "Moderate", and less than 1% as "Poor" (see Table 2). This time of the year proved to be ideal to conduct the survey as weather conditions and sea state are generally favourable for camera sledge UWTV deployments, resulting in a more efficient survey when compared with other times of the year.

Table 2 - Classification of UWTV Survey footage 2011–2019.

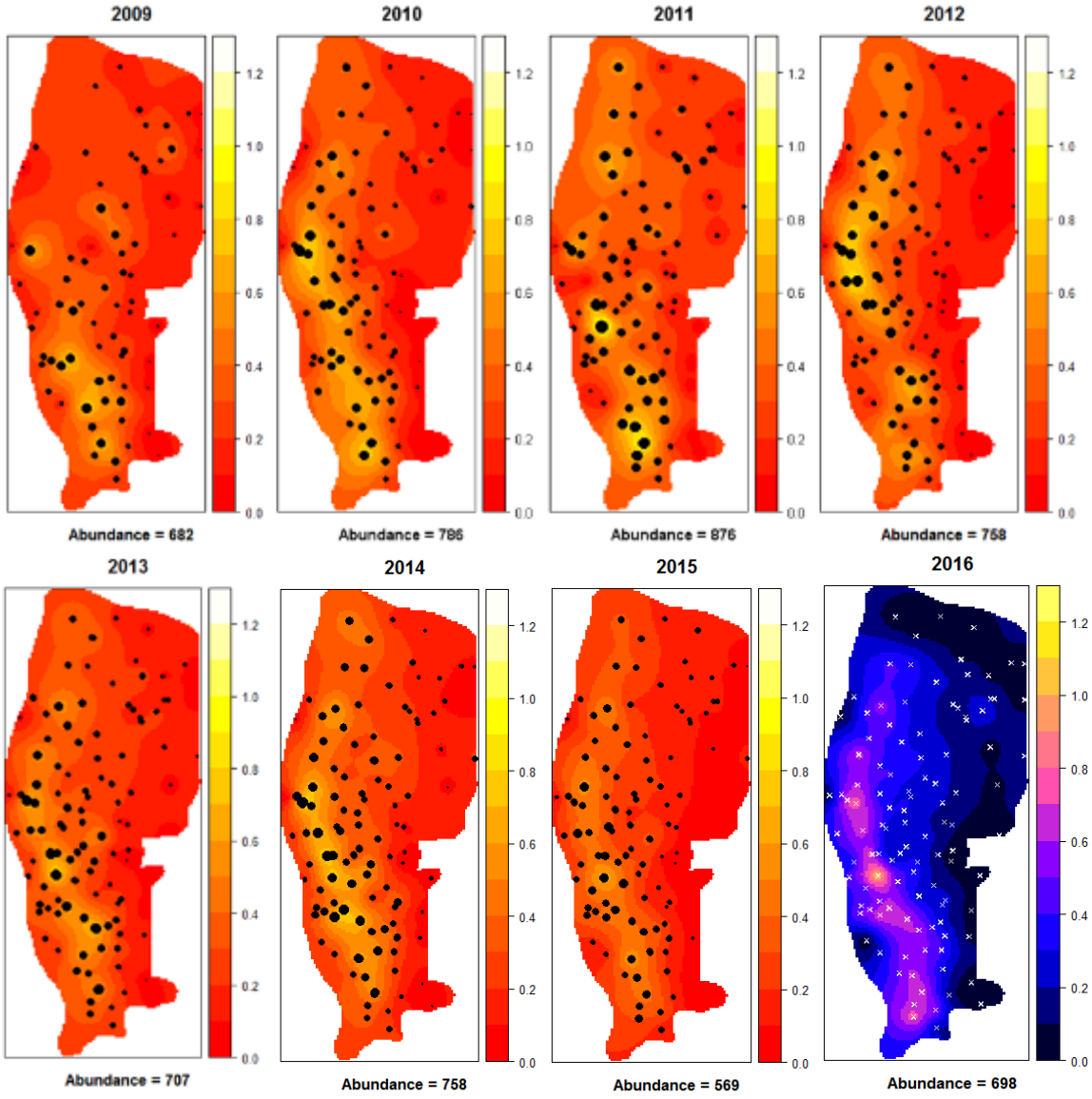
	Good	Moderate	Poor/ none
2011 – Autumn	49%	48%	2%
2012 – Autumn	74%	22%	4%
2013	95%	5%	0%
2014	91%	9%	0%
2015	99%	1%	0%
2016	92%	8%	0%
2017	93%	7%	0%
2018	97%	3%	0%
2019	96%	3%	1%

Primary Objective

Nephrops burrow live-counts were made over a 10-minute tow, which was recorded in mp4 file format and backed up on two external hard drives. All recordings were then recounted under controlled conditions and the Linn's CCC with a pass threshold of 0.5 was applied using an R script to validate stations and to identify which stations required a 3rd counter.

- Prior to counting, counters viewed a 1-minute warm-up of footage from the station. Counts were noted from the warm-up minute, however not used in the abundance estimation, nor in the counting performance.
- Burrows were counted by each minute block for 7 clear minutes. The counting performance of the 2019 counters was generally high, with a Linn's CCC scored average of 0.66.
- Similar to previous year's results the high abundance area is distributed in the west side of the ground. Abundance was particularly high in the central west ground (Figure 3).

- Abundance has now increased from its lowest observed point in the time series in 2016 of 697 million, to 909 million in 2017, 954 million last year to 1163 this year. The advice will be revised again in the autumn given that the change is more than 1 standard deviation (Table 3).
- Abundance is now above the 2007 trigger level (Figure 4).



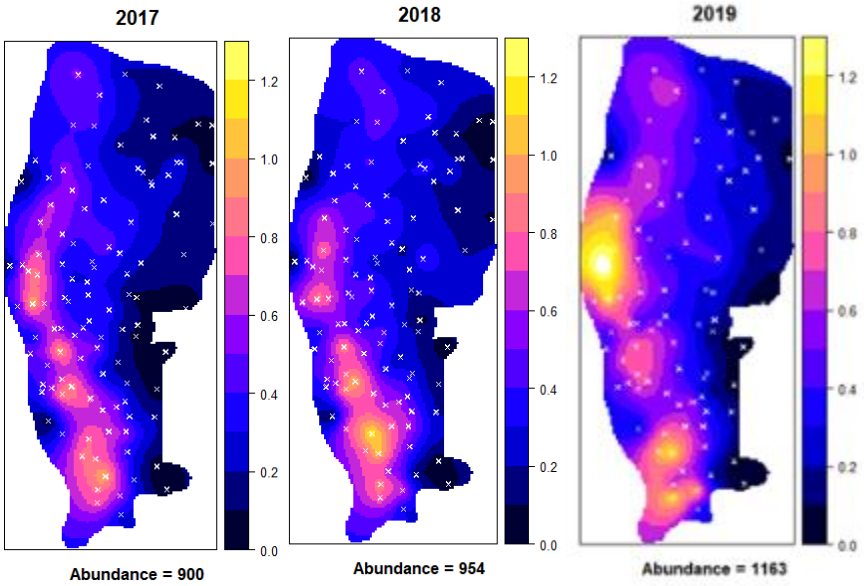


Figure 3 – Geostatistical outputs 2009 – 2019, maps of *Nephrops* density distribution (m^2).

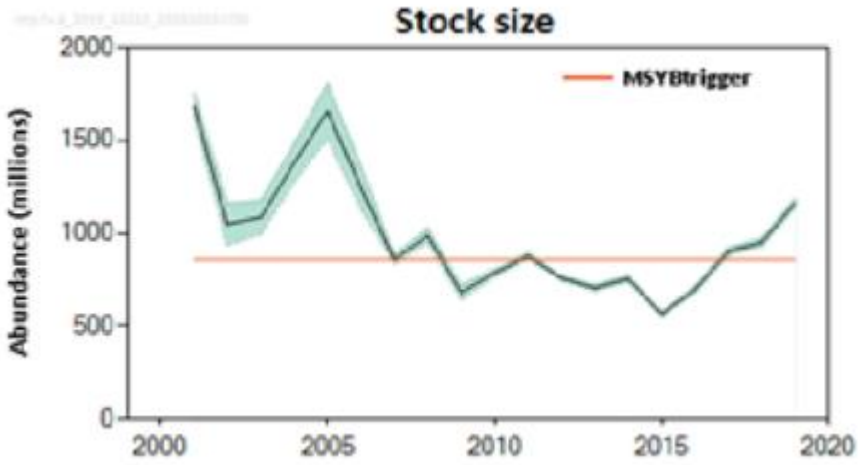


Figure 4 – *Nephrops* abundance estimates from the UWTV Survey 2001–2018.

Table 3 – Results using the geostatistical model from UWTV-FU 6 *Nephrops* survey in 2007–2018.

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	755	18

2015	110	0.18	568	13
2016	110	0.24	697	19
2017	110	0.29	909	21
2018	109	0.31	950	23
2019	91	0.37	1163	26

The primarily objective was achieved with 91 of the 110 TVID stations successfully surveyed with the UWTV camera sledge, all data was input, and quality checked while onboard and additional preliminary analysis was made to calculate the abundance estimation for the ground.

Secondary Objectives

Aim 2: There was no time available to survey any of the NEIFCA stations, all were dropped.

Aim 3: Samples were collected daily using the surface water flow pipe. Water samples were filtered then stored in the -80oC freezer onboard.

Final Considerations

Despite moderate amounts of operational and technical downtime, the main objective of the survey (*Nephrops* abundance estimation) was successfully met for this year in the Farn Deeps. The UWTV spatial coverage was reasonable (83% stations done with the TV sledge) and the overall footage quality was very good to excellent in the Farn Deeps grounds due to generally favourable weather conditions.

ACKNOWLEDGMENT:

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 for sorting technical difficulties. Finally, thanks to all Cefas staffs onboard for their hard work and enthusiasm in making this survey a success.

Chris Firmin
SIC (Scientist-in-charge)
13 November 2019

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REFERENCES:

ICES. 2019. Report of the Working Group on Nephrops Surveys (WGNEPS). 6-8 November. Lorient, France. ICES CM 2018/EOSG:18. 226 pp.