Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL SURVEY REPORT

RV CEFAS ENDEAVOUR
Survey: C END 07a – 2022 – Nephrops UWTV

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DURATION: **26/05/2022 (07:42 BST) - 01/06/2022 (21:50 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°35' - 54°45' N and 1°30' - 0°40' W, (shown in black on figure 1) and to evaluate Nephrops abundance (110 stations)

Secondary Objectives

2. To carry out trials of the continuous flow plankton imager device
3. Take daily water samples from the underway supply for filtering and freezing

SUMMARY:

This report summarises the main results and findings of the 26th annual underwater television (UWTV) 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 May 2022, 109 of 110 stations (TVID) were successfully surveyed in the Farn Deeps area with the TV sledge, from 27th May to 31st May. Downtime was due to weather conditions with some minor technical and operational issues relating mostly to the topside systems. Of the 110 planned stations, 1 station was abandoned after 2 attempts due to risk of damage to the camera sledge from hard ground. 1 further station repeated due to issues with the topside system. After repeats, all footage was

considered of acceptable quality (water clarity was 99.2% moderate to excellent, 0.8% poor, 0% unreadable). The reference set of calibration videos used was from the 2020 survey using high definition (HD) footage. All burrow counters completed calibration training to a required concordance to ensure competence and calibration for burrow recounts prior to the survey. The standard ICES protocol for burrow recounts (ICES 2022a) 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 2022 counters was generally high (average Linn's concordance correlation coefficient, CCC = 0.71). Preliminary results indicate that abundance this year was 878 million. This represented a decrease of approximately 12% compared to the 2021 survey abundance of 982 million. As with previous years the highest abundance of burrows were recorded on the west side of the ground.

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 25 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 25 ICES Functional Units and 1 other *Nephrops* ground (ICES 2022), being widely used in the North Sea, Celtic Sea, Irish Sea, East Atlantic as well in the Mediterranean.

Cefas has performed annual UWTV surveys in the Farn Deeps area since 1996. 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 fixed grids, whichever 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 specialised ICES study groups for *Nephrops* TV surveys (ICES 2022). Progress was made in 2009 ICES Benchmark (ICES 2009) 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 UK landings for the 2021/2022 season (Oct – Mar) for this area were 1726 tonnes, up from the 2020/2021 season total of 1020 tonnes.

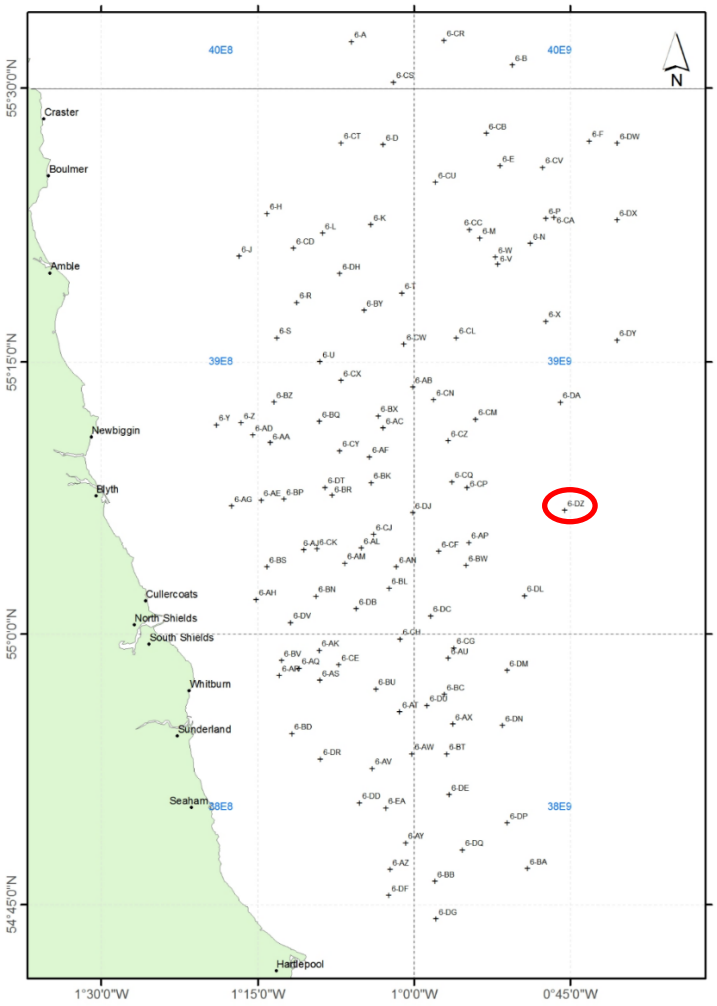


Figure 1 – Map showing the location of the surveyed area in the Function Unit 6 area (110 stations). Station 6-DZ (circled in red) was abandoned due to hard ground and risk of damage to sledge.

METHODS:

The 2022 North Sea *Nephrops* UWTV survey took place on RV Cefas Endeavour between 26th May and 1st June. The embarkation and debarkation port was Lowestoft. 24-hour operations were in place throughout the survey, including 24-hour Marine Operations survey engineer cover.

Survey Design

For the Farn Deeps the survey design is based on a randomised fixed grid and includes a total of 110 stations (figure 1). 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 avi 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 logged every 3 seconds.

The camera system, lights, lasers, altimeter and compass used on the sledge were all manufactured by STR. The camera, lights and lasers were operated via an onboard STR PC and control box. A fibre-optic umbilical cable was used to receive the live footage from the video camera.

The sledge was equipped with:

- An STR camera (1080p) 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 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.

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 WGNEPS recommendations (Dobby 2021), all scientists were trained using training material and validated using reference footage (measured by Linn's CCC) prior to recounting May 2022 footage. A limit of 0.5 was used to identify counters who need further training. On completion of this process, all recounts from CEnd 07a/22 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 block with more than 20 seconds obscured were rejected. Validation between counters was again carried out by Linn's CCC with a threshold of 0.5. Those below the threshold were reviewed by a third counter.

In reviewing the videos, the first designated counter also noted the visibility, ground type, trawl marks, occurrence of bio-fauna, sledge ground contact, visibility obstruction and any other interference for each 1-minute intervals, using a predetermined classification key. Subsequent counters noted visibility, visibility obstruction and other interference only.

For analysis, counts of burrow systems are converted into densities at each station using the width of view (82 cm) and the length of the tow (extracted from tower position vessel logging) adjusted by a bias correction factor (taking into account burrow detection and identification rates as well as an edge effect). 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 read and acknowledged where appropriate:

- ✓ RA3022 Nephrops TV Cruise
- ✓ IIT031 Activity plan for RV Cefas Endeavour
- ✓ RA002 Access to and Work in laboratories and Workshops
- ✓ RA003 Access to and Work on RV Cefas Endeavour
- ✓ RA006 Deploying and Recovering Scientific Equipment (grabs, cameras, buoys) on vessels (reviewed during the survey)
- ✓ CP001-7 Fieldwork 'Including working in, on or near to water'
- ✓ CP001-17 Driving for Cefas
- ✓ FD-C&F-SHELL-SOP-01 MB001 NEPTV Burrow Count SOP V1.6.DOC (updated during the survey).

All staff were required to complete an H&S induction upon joining the Endeavour. A general briefing and toolbox sessions was carried out prior to departure. Task-specific toolbox sessions were carried out before each activity commenced or changed. H&S observations were made as part three dedicated hazard spotting sessions and via the ship's safety observation cards. For this survey, sledge deployment operations were carried out by at least two AWSM crew member and an experienced Marine Operations engineers.

Covid-19 mitigation measures were in place for the survey including pre-travel LFT testing for remote staff, then for all staff further LFT testing on embarkation and 72 hours after departure. Guidance was issued regarding occupancy of workspaces, enhanced cleaning, increased ventilation and social distancing.

Technical Issues

- Main lab Tower Adderlink box (infRX16) had intermittent issues with the screen going black as the box went offline. Unable to determine if this is a power supply issue or an issue with the Adderlink box itself as there were no power supply spares onboard.
- 3 of the 5 sledge skid retaining brackets on each side were badly corroded and bolts had no washers. Vessel crew and survey engineers needle gunned excessive corrosion off, put washers on and applied Tef-gel to bolts. One bracket forward left bent out of shape. Recommend that these brackets (6 in total) be

cut off and replaced with stainless steel, similar to the other 2 brackets on each skid. Recommendation to improve quality of gear inspections ashore prior to mob.

- HIPAP beacon had connectivity issues. Only one functional beacon, M11, seemed to work. HIPAP was reporting as not logging on Tower display and no visual display of sledge position. Log files were okay (including HIPAP data) however recommend display issues looked into before future survey.
- Tower crashing due to data overflows. Partially fixed by survey engineers carrying out regular downloads and clearing of data however Tower still occasionally crashing for unidentified causes. Recommend increasing the data capacity of the software.
- Minor damage to aft sledge protective cage from lowering the sledge before it was fully clear of the vessel. Threaded bar bent 45 degrees. No damage to oil filled junction box or pressure compensator. Bar bent back into shape by survey engineers.

RESULTS:

Primary Objective

Aim 1:

The primarily objective was achieved, with 109 of 110 TVID stations of the standard survey grid successfully surveyed in the Farn Deeps (FU6) with the UWTV camera sledge. 1 station was abandoned after 2 attempts due to risk of damage to the camera sledge from hard ground. 1 further station repeated due to issues with the topside (Tower) system.

Weather was generally reasonable, though deteriorated sufficiently that work had to be halted on 1 occasion for a total of 6.5 hours.

All data were input and quality checked while at sea; analysis was also completed while aboard to calculate the preliminary abundance estimation for the ground. Further QC will be undertaken before the results of the survey are considered robust and submitted to ICES.

- The preliminary estimate of abundance is 878 million (Figure 1). This suggests abundance has decreased by around 12% from 2021 and that the abundance remains just above the MSY $B_{trigger}$ level of 858 million.
- Similar to the 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 (Figures 1 and 2).
- The visibility overall for the survey was mostly good, 99% of footage was classed as "Good" or "Moderate", and 1% as "Poor".
- The Linn's CCC score averaged 0.71.

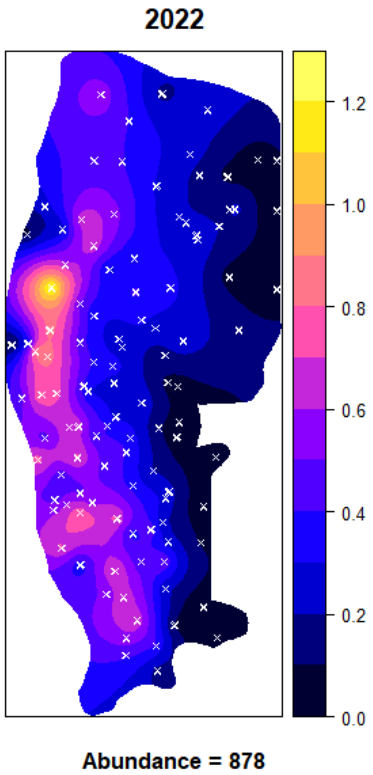


Figure 2 – Preliminary geostatistical output for 2022 showing map of *Nephrops* density distribution (Abundance in millions and density colour scale in numbers m^2)

Secondary Objectives

Aim 2:

The plankton imager device was successfully trialled and viable plankton images identified and stored from the continuous feed. Software development carried out during the survey and revised operational guidance produced. The system was left running fully autonomously without major issue for much of the latter part of the survey. It was clear from the field trials that the system is best suited for fishing surveys that do not require significant using of the ship's DP system. This is due to the imager being sensitive to presence of air bubbles, with significant aeration of the continuous water supply being caused by disturbance from the DP and its proximity to the water intake.

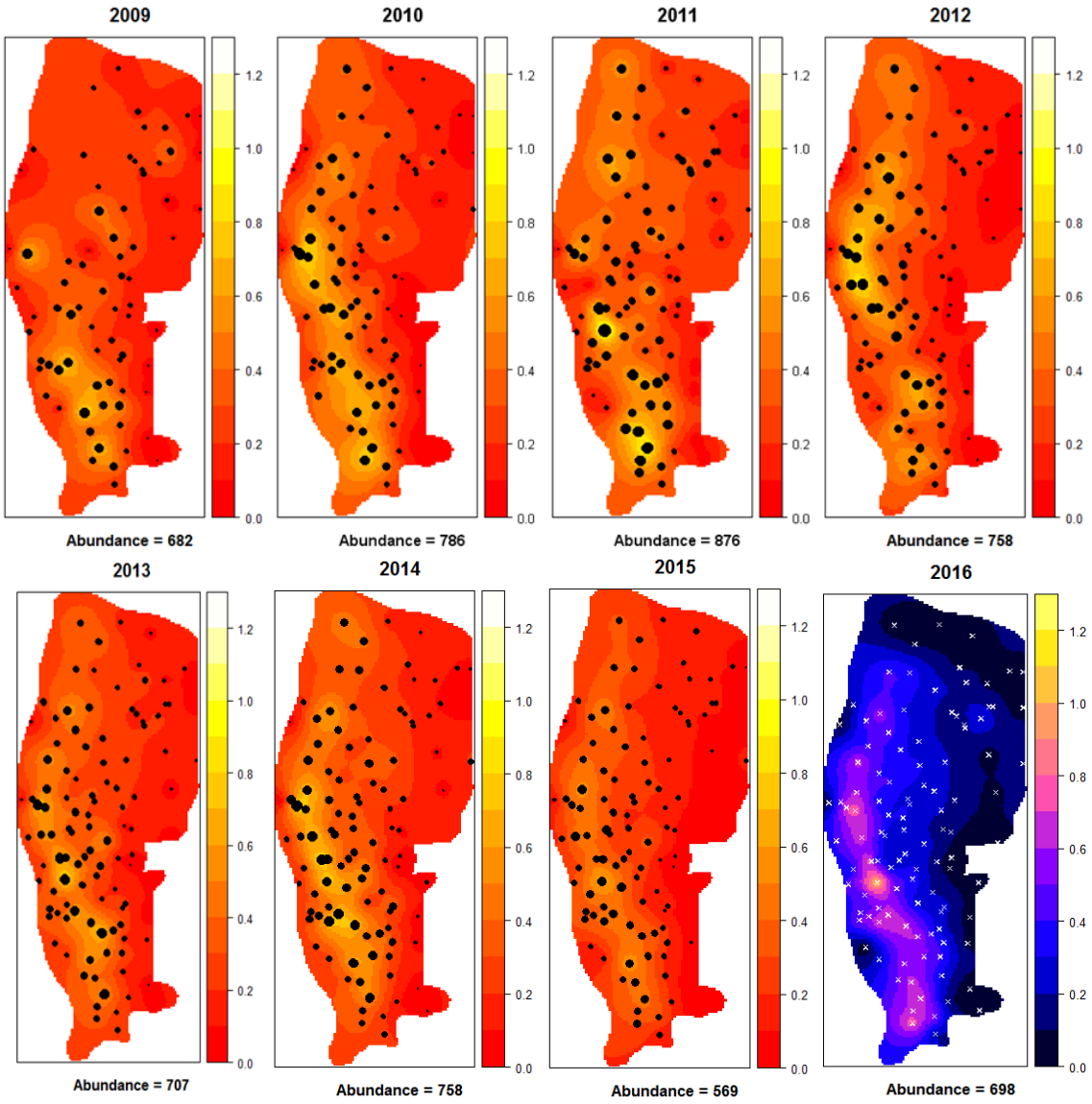
Aim 3:

Chlorophyll samples were collected twice daily at dawn and dusk using the surface water flow pipe. Water samples were filtered then stored in the -80°C freezer onboard.

Discussion

The timing of the survey was slightly earlier than in recent years (May instead of June) which may have affected observation of burrow systems. Factors such as growth of *Nephrops* affecting size and detectability of burrow systems as well as natural mortality effects on the underlying abundance. Fishing mortality during summer months is typically low. Overall likely impact of the change in timing is also considered to be low.

From its lowest observed point in the time series in 2016 of 697 million, abundance increased to 1163 in 2019, reducing broadly linearly since to 878 million in 2022 (Table 2). The 2022 abundance is just above the MSY $B_{trigger}$ level of 858 million, set as the lowest observed abundance of the time series (Figure 3 and Table 1).



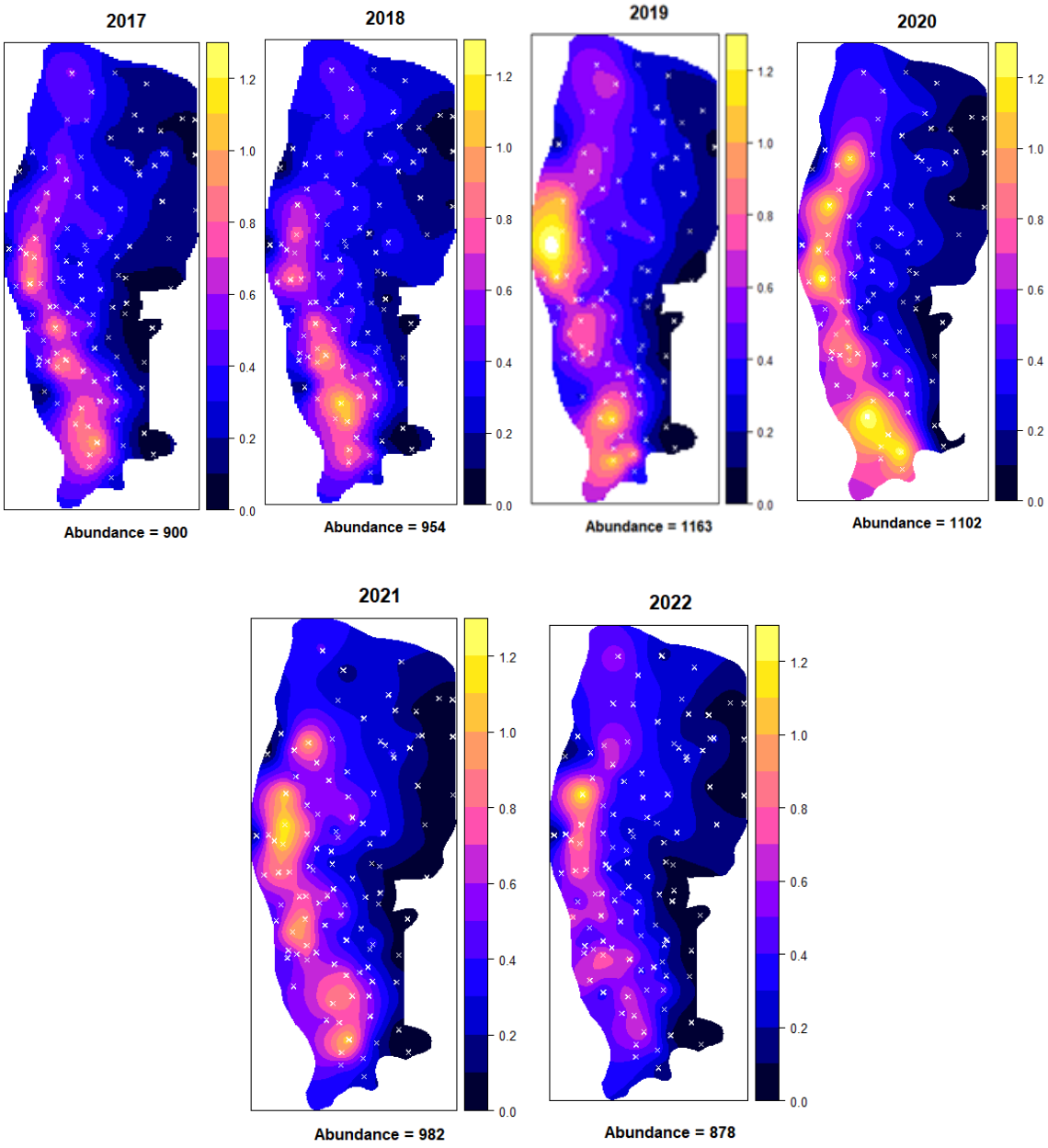


Figure 3 – Geostatistical outputs 2009 – 2022, maps of *Nephrops* density distribution (Abundance in millions and density colour scale in numbers m^2). 2022 result preliminary

Table 2 – Results using the geostatistical model from UWTV-FU 6 *Nephrops* survey from 2007–2022. (* 2022 result Preliminary).

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
2020	110	0.35	1102	24
2021	110	0.31	982	22
2022*	109	0.28	878	20

Counting performance of the 2022 counters was broadly consistent with previous years (Table 3). Proportions of stations requiring 3rd counts have been higher since 2013. Mean ccc scores have not changed markedly, though mean ccc score is based only on valid pairings of counts.

Table 3 – Counting performance and Lin's ccc scoring 2011–2022. (* 2022 scores preliminary)

	Proportion requiring 3rd counts	**Mean ccc score**
2011	0.23	0.74
2012	0.21	0.75
2013	0.15	0.73
2014	0.38	0.69
2015	0.27	0.75
2016	0.39	0.70
2017	0.48	0.66
2018	0.61	0.66
2019	0.41	0.72
2020	0.58	0.67
2021	0.42	0.71
2022*	0.42	0.71

The visibility overall for the survey was mostly good, 99% of footage was classed as "Good" or "Moderate", and 1% as "Poor" (Table 3). Whilst the small percentage of "poor" footage was considered was still considered countable, clarity may have affected observation of burrow systems.

Table 3 - Classification of UWTV Survey footage 2011–2022 (* 2022 result Preliminary)

	Good / Moderate	Poor/ none
2011 – Autumn	98%	2%
2012 – Autumn	96%	4%
2013	100%	0%
2014	100%	0%
2015	100%	0%
2016	100%	0%
2017	100%	0%
2018	100%	0%
2019	99%	1%
2020	83%	17%
2021	97%	3%
2022*	99%	1%

Final Considerations

Despite small amounts of weather 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 excellent (99% stations done with the TV sledge) and the overall footage quality was generally good in the Farn Deeps grounds.

A forward-facing sonic camera could be used on the sledge to identify rocks and other major hazards in front of the sledge. It hoped that this could be trialled next year.

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 AWSM for preparation and handling of the gear resulting in very few technical issues this year. Finally, thanks to all Cefas scientists both ashore and onboard for their hard work and enthusiasm in making this survey a success.

Chris Firmin (Scientist-in-charge)

REFERENCES:

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