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Executive summary

The second meeting of the Working Group on *Nephrops* Surveys (WGNeps; formerly known as SGNEPS until 2012) took place on 10–13 November 2015 in Cadiz, Spain. The meeting was chaired by Ana Leocádio (Cefas, UK), and attended by the following countries: Ireland, Portugal, Denmark, Northern Ireland, Scotland, Iceland, Spain, France, and Italy. WGNeps is the coordination Expert Group for *Nephrops* UWTV and Trawls surveys within the ICES areas and in a preliminary and exploratory way in some Geographical sub-areas (GSA) in the Mediterranean. Various updates on survey design were presented, discussed and concluded by the Expert Group (EG) at the meeting. Coordination between surveys across countries and laboratories was also carried out at the meeting. WGNeps adopted multi-annual ToRs in 2013 and this meeting focused mainly on finalizing the SISP (Series of ICES Survey Protocols) and the CRR (Cooperative Research Report) documents, continuing the work initiated during the 2013 meeting. Both SISP and CRR should be completed early 2016. Additionally a new set of ToRs was discussed for 2016–2018.

1 Introduction

The second WGNeps meeting was kindly hosted by Dr Yolanda Vila, at the Instituto Español de Oceanografía (<http://www.ieo.es/>) in Cadiz, Spain. WGNeps is the coordination group for *Nephrops* UWTv and trawl surveys within ICES and Geographical sub-areas (GSA) in the Mediterranean and has a quality assurance and development role.

The specific tasks at the 2015 meeting in Cadiz were as follows:

- 1) Review of the UWTv and Trawl *Nephrops* surveys results.
Make conclusions/recommendations as appropriate. More focus on the new surveys.
 - a) To ensure quality and coverage are maintained;
 - b) To endorse any proposed changes to the design;
 - c) To coordinate survey activity. Improve collaborations.
- 2) Review progress on the UWTv SISP and Trawl SISP documents.
- 3) Review progress on the UWTv CRR document.
- 4) To review the WGISUR reports and discuss the utility of *Nephrops* UWTv surveys as platforms for the collection of data for OSPAR and MFSD indicators.
- 5) To review video enhancement, video mosaicking, automatic burrow detection and other new technological developments.
- 6) Review any progress on funding possibilities for new UWTv project as recommended by WGNeps - [DevNepS](#).
- 7) Formulate the requirements to the ICES data centre for an UWTv database.
- 8) Discuss the multiannual ToRs for 2016–2018.
- 9) Summary of the outputs for *Nephrops* benchmarks – FU14 and FU17.

2 Changes to UWTV survey design, coverage and intensity

This section provides an update for the various UWTV currently undertaken in the North Sea and Mediterranean areas. This section includes any modifications done on survey design, coverage and procedures.

Ireland

Since 2012, Ireland has modified sampling intensity and increased survey coverage based on the recommendations of SGNEPS 2012. The total numbers of stations for 2015 remains broadly similar ~330 to previous years (Figure 2.1).

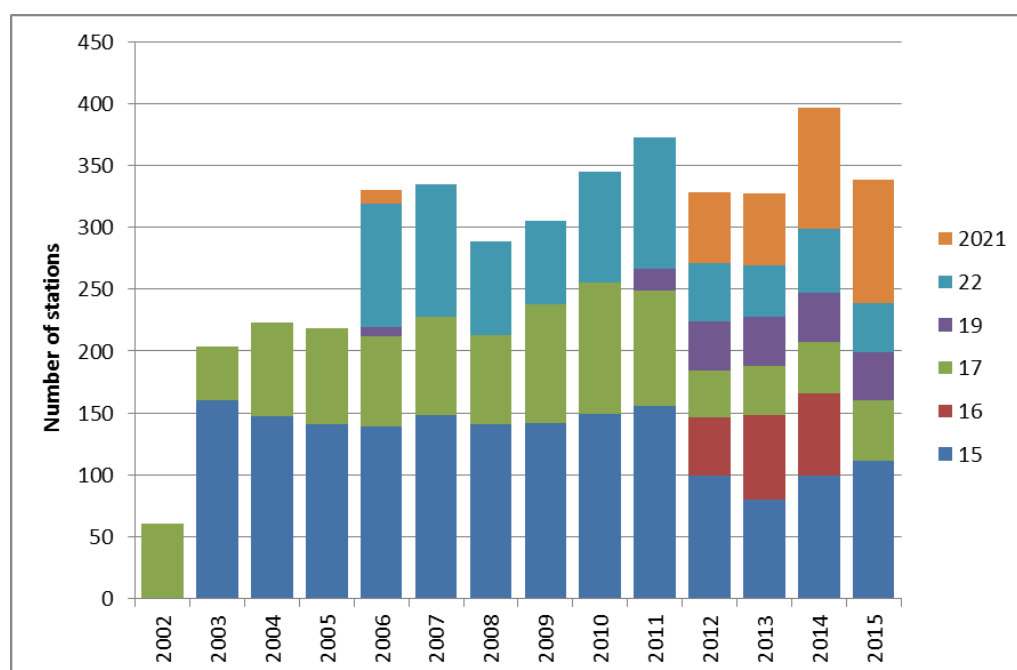


Figure 2.1 Time-series of the total number of UWTV stations carried out by Ireland by Functional Unit (Stations in FU15 are carried out in collaboration with AFBI in UK-NI).

The numbers of stations in FU15, FU17, and FU22 were reduced in 2015. In addition the survey design was change from a randomized square grid to a randomized iso-metric grid where all stations were equidistant. The CVs for surveys where sampling intensity was reduced either had no or minor decreases in relative precision (Table 2.1). 100% coverage of all the *Nephrops* grounds was achieved in 2015 with the exception of FU16 Porcupine Banks, which could not be surveyed despite several attempts. Figure 1.2 shows the mean density by station for grounds surveyed in ICES area VII in 2015 where the highest density estimates are observed in FU15 and lowest in FU20-21. Figure 2.3 shows the individual counts by minute and run with the un-weighted average count.

In recent years, there has been a good flow of staff exchange on UWTV surveys in ICES area VII mainly on the collaborative UWTV survey in the Irish Sea (FU14 and FU15). In 2015, scientists from JNCC (Joint Nature Conservation Committee) joined some surveys as this organization uses data products from the UWTV survey.

The individual survey reports and further details of the survey design and numbers of stations are available from the Marine Institute Open Access Repository at <http://oar.marine.ie/handle/10793/59>.

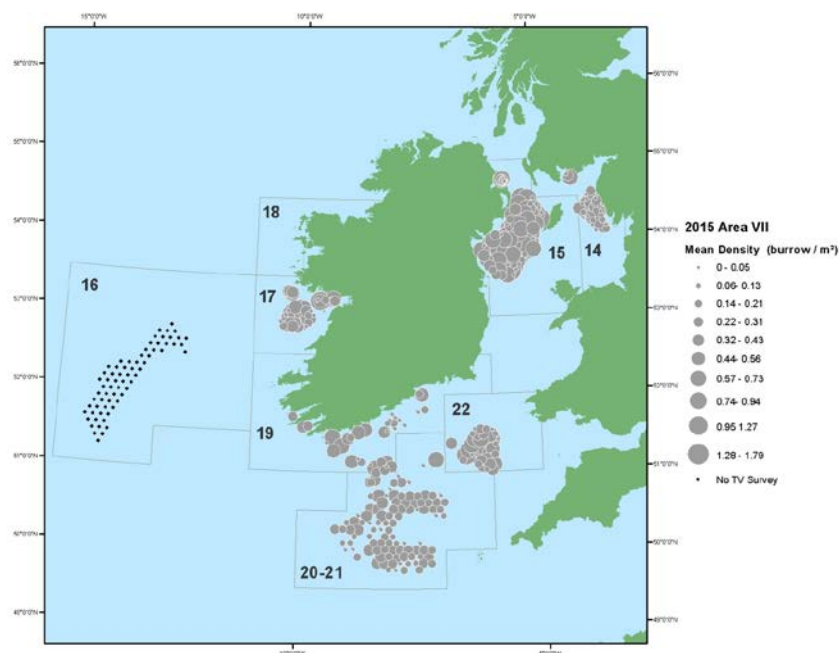


Figure 2.2 2015 Mean density (burrow/ m²) by station for *Nephrops* grounds in ICES area VII.

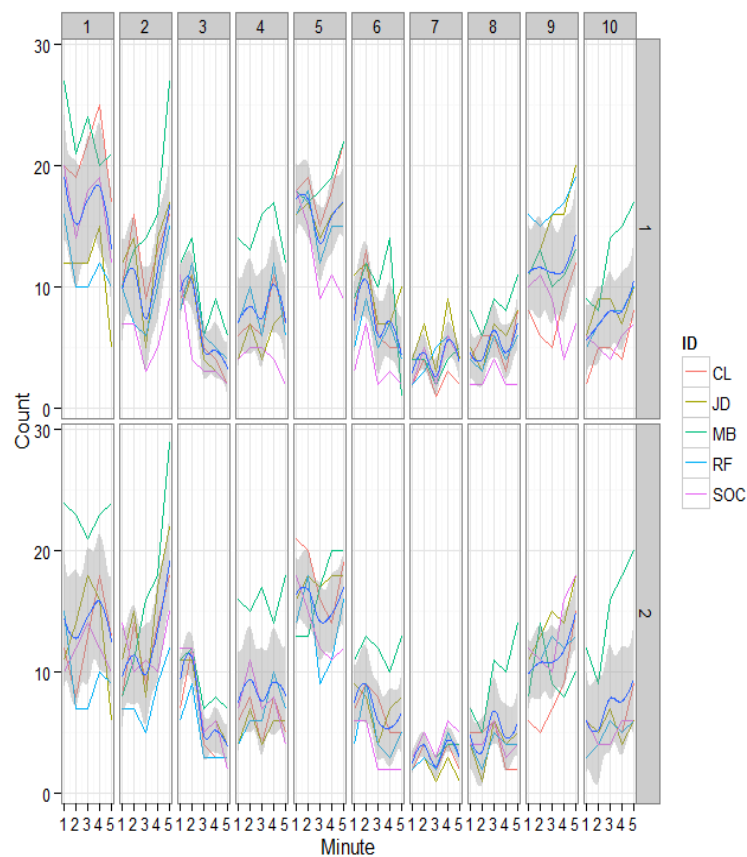


Figure 2.3 FU20-21 Individual counts by minute and run with the un-weighted average count.

UWTV Survey FU16

In 2015, FU16 Porcupine Banks which could not be surveyed despite several attempts. This was partly due to engine breakdown of the national research vessel RV Celtic Voyager in the early summer. A replacement research vessel (RV Prince Madog) was chartered to complete the UWTV survey season, however, unfavourable weather conditions during the late summer severely hampered attempts to get to the Porcupine ground, which lies approx. 230 nautical miles from Galway. The ICES advice for 2016 for this stock is based on the results of the 2014 UWTV survey. The density estimates in 2012 to 2014 are relatively similar and would be considered low (mainly $\sim 0.1 \text{ m}^2$).

UWTV Survey FU17

This stock was benchmarked in 2015 and the area of each *Nephrops* patch was revised using data sources such as integrated VMS, multibeam backscatter imagery, UWTV density estimates, IGFS and observer cpue, sediment data and fishers' knowledge (ICES, 2015). The redefinition of the 3 discrete grounds in FU17 resulted in $\sim 30\%$ increase in overall area from 1007 km^2 to 1320 km^2 . The 2015 survey achieved full coverage of the stock area defined at IBPNeph. The new area estimates are now used to generate total abundance for *Nephrops* on each patch in FU17 and the historic time-series was revised accordingly. Further details on this survey available at: <http://oar.marine.ie/handle/10793/1095>.

UWTV Survey FU19

In 2015, UWTV stations for FU19 were randomly picked within each using the "Create Random Points" tool in ArcToolbox of ArcGIS10. The sampling effort, i.e. numbers of stations, on each ground was determined by relative area. The 2015 survey achieved full coverage of the stock area defined at Benchmark Workshop on Celtic Sea stocks, WKCELT (ICES, 2014). Area of this ground is estimated at 1973 km^2 . For the first time in 2015 one TV station was completed on the Kenmare Bay mud patch. Area of this patch is currently unknown but data will be assessed to define this *Nephrops* patch similar to the process that was carried out at WKCELT 2014. Further details on this survey available at: <http://hdl.handle.net/10793/1096>.

UWTV Survey FU22

A total of 33 UWTV stations were surveyed successfully (good quality video footage) carried out over an isometric grid at 4.5 nmi or 8.3 km intervals. 17% of the planned stations (7) could not be completed due to very poor visibility conditions encountered at seabed as a result of strong spring tides. In line with standard operating procedures these 7 stations were abandoned completely after at least 2 attempts were made at each station. For robust geostatistical analysis, all stations on the grid need to be surveyed. The following fill-in procedure was carried out and deemed appropriate given the stock stability over the time-series: buffer zone of 2 nautical miles distance was generated around the missing stations and the average of the selected historic TV density estimates calculated and used as mean density estimate for these missing stations. There is added uncertainty in the 2015 estimate of abundance because 17% of the planned UWTV stations could not be successfully surveyed due to poor visibility on the seabed. This added uncertainty is not reflected in the ICES advice graphs. Further details on this survey available at: <http://oar.marine.ie/handle/10793/59>.

UWTV Survey FU2021

In February 2014, WKCELT concluded that full survey coverage was needed before *Nephrops* in FU20-21 could be moved into a full UWTV survey category for assessment and advice (ICES, 2014). The 2015 survey achieved full coverage of the stock area defined at WKCELT using VMS linked logbook information for Ireland and France (ICES, 2014). Area of this ground is calculated at 10 014 km² which is the largest *Nephrops* ground in ICES area 7. Within this area, a randomized isometric grid of 96 stations with a 6.0 nautical mile spacing was planned for the 2015 survey. The density estimates in 2013 to 2015 are relatively similar and would be considered low (mainly ~0.2 m²). During this survey reference counts for FU20-21 were generated. Figure 2.3 shows the count data by station and run for each of the 5 experienced counters. There is some variability between the counters illustrating the difficult nature of the footage in this area as this *Nephrops* ground is not a homogenous mud patch, the sediment and topography changes a lot between stations. There are benthic megafauna species, that dig burrows in the seabed, some of which are known such as *Goneplax rhomboids* and *Munida* species but others which are unknown and these may cause confusion. It was deemed appropriate to use the arithmetic mean of the 5 experienced counters with equal weighting to generate the reference counts for this FU. This is line with reference counts generated for other FUs (ICES, 2008). Further details on this survey available at: <http://oar.marine.ie/handle/10793/59>.

Table 2.1 2015 UWTV stock abundance and CV (relative standard error) by FU.

VARIABLE	FU16	FU17 ARAN GROUNDS ONLY	FU19	FU22	FU2021
UWTV Stock abundance (millions individuals)	Not available	480	482	1 363	2 003
CV (Relative standard error)	NA	6%	13%	7%	3%

Conclusion/Recommendation

WGNeps recommends defining the area of the Kenmare Bay *Nephrops* patch using similar methods presented at WKCELT (2014) and IBPNeph (2015).

WGNeps recommends to scope out use of high definition camera and monitors with existing fibre optic cable to stay current with technical developments in UWTV technology and to replace existing older equipment where possible.

WGNeps recommends that reference footage from FU20-21 be reviewed by at least one international experienced counter at *Nephrops* burrow identification training course in 2016.

WGNeps recommends that fill in procedures for areas which could not be surveyed be reviewed by relevant Working Groups.

WGNeps recommends promoting and facilitating when possible on UWTV surveys, staff exchange from national laboratories.

WGNeps recommends promoting and facilitating when possible on UWTV surveys, staff exchange from other institutes who may use survey data.

UK Northern Ireland – FU15

This was the 13th survey in a time-series of UWTV surveys in the Irish Sea (ICES Division 7a) carried out jointly by the Agri-Food and Biosciences Institute (AFBI), Northern Ireland (UK), the Marine Institute, Ireland, and Cefas, UK. The survey took place on RV Corystes between 4 and 13 August 2015. The survey covered the western Irish Sea (FU15) (reported in this section) and the eastern Irish Sea (FU14) (reported under UK-England).

The specific objectives of the survey are listed below:

- 1) To complete a randomized fixed isometric survey grid of 100 UWTV with 4.5 nautical miles spaced stations on the western Irish Sea *Nephrops* ground (FU15);
- 2) To obtain 2015 quality assured estimates of *Nephrops* burrow distribution and abundance for FU15. These will be compared with those collected previously;
- 3) To collect ancillary information from the UWTV footage at each station such as the occurrence of sea-pens, other macro benthos and fish species and trawl marks on the seabed;
- 4) Technology, staff and protocol transfer between AFBI, the Marine Institute, and Cefas.

From 2003 to 2015, a randomized fixed square grid for the western Irish Sea (FU15) *Nephrops* ground has been used. An adaptive approach is taken whereby stations are continued past the known perimeter of the ground until the burrow densities are zero or very close to zero. The initial ground perimeter has been established using a combination of integrated logbook-VMS data (using the methods described in Gerritsen and Lordan, 2011), British Geological Survey (BGS) and other sediment maps, and previously collected UWTV data. The same ground boundaries have been used throughout the time-series. The grid spacing from 2003 to 2011 was 3.5 nautical miles. Following a review (Doyle *et al.*, 2013) the grid design was changed from a 3.5 nmi to 4.5 nmi in 2012. In 2013, the grid spacing was increased further to a 5.0 nmi isometric grid, whereas a 4.5 nmi isometric grid was used again in 2014 and 2015 to ensure all edge of ground areas were represented adequately.

The main motivation to increase the grid spacing was to achieve full spatial coverage of FU15 while giving the option to reallocate ship time to increase coverage in other Functional Units (FU16, FU20-21 and FU19); also in line with SGNEPS recommendations (SGNEPS, 2012). Reducing the number of stations is not expected to have significantly affected the accuracy of the survey estimate given the apparent spatial autocorrelation in density across the area. Doyle *et al.* (2013) assessed the impact of increasing station spacing on the accuracy of the resulting abundance estimates using a removal analysis, and found that increasing up to 7nmi station spacing did not affect the accuracy of the result. The precision (measured by the coefficient of variation) does not appear to have been significantly reduced in 2012–2015 by comparison to earlier years, with a CV of 3% which was in line with previous estimates (varying between 2% and 4%), which are all well below the SGNEPS 2012 recommendation of 20%.

The 2015 design consisted of a randomized isometric grid of 100 stations at 4.5 nautical mile intervals out over the full known extent the stock. At each station, the UWTV sledge equipped with standard definition camera with a known field of view was deployed and once stable on the seabed a 10-minute tow was recorded onto DVD.

Vessel position (dGPS) and position of sledge (using an USBL) were recorded every 1 to 2 seconds. All stations were successfully surveyed with 5 re-do stations due to visibility issues on first attempts. Weather conditions were poor at the beginning of the survey and the RV *Corystes* was restricted to working in Belfast Lough, so additional footage was opportunistically collected over *Nephrops* ground in this Lough.

The navigational data were quality controlled using an “R” script developed by the Marine Institute (ICES, 2009b). In 2015, the USBL navigational data were used to calculate distance over ground for 100% of stations.

Within the western Irish Sea, the average burrow density (adjusted to account for bias factors) was 0.73 burrows/m². This is very similar to the 2014 figure of 0.75 burrows/m². The summary statistics from the geo-statistical analysis show in 2015 a final abundance estimate (adjusted to account for bias factors) of 4.3 billion burrows, which is close to that estimated in 2008 and 2013. The overall burrow abundance trend is stable although the abundance did decline between 2007 and 2008, and between 2012 and 2013. The survey precision as measured by the coefficient of variation for 2015 was 3% indicating a very precise survey in line with CVs observed previously.

Notes were also recorded on the occurrence of trawl marks, fish species and other species. Semi-quantitative assessment of sea-pen species were also recorded according to OSPAR Special Request (ICES, 2011). All sea-pens were identified from the video footage as *Virgularia mirabilis*; 12% of the 2015 survey stations had *V. mirabilis* present. Trawl marks were noted at 19% of the stations surveyed.

Within Belfast Lough, average burrow density was 0.23 burrows/m² (adjusted to account for bias factors) and sea-pens (*V. mirabilis*) were present in 18% of stations.

A trawl survey was also completed 20–25 August, with 24 trawl stations across FU15 sampled by *Nephrops* trawl and also a 2 m beam trawl: 12 711 *Nephrops* were measured to generate length frequencies for males and females and establish the sex ratio.

Conclusion/Recommendation

There were some issues with sledge sinkage near the centre of ground where the mud is particularly soft, and this was noted as the outer two lasers used to measure field of view were disappearing at times. Revision to the sledge to minimize sinkage and/or reconfiguration of the lasers to precisely estimate changes in field of view so that densities can be adjusted in this situation are required and recommended for forthcoming surveys. In addition, when the sledge sank into softer mud the lights produced a “spotlighted” effect, which made identification of burrow systems nearer the edge of the field of view more challenging.

There were also some challenging areas within FU15 where dense *Calocaris macandreae* and/or *Goneplax rhomboides* burrows were causing some difficulties in distinguishing *Nephrops* burrow systems, and further training on burrow identification in very dense grounds such as these is recommended. In addition, the possibility of newer camera technologies improving colour balance to help distinguish *Nephrops* “runways”/tracks are also to be considered. AFBI is investigating improvements in lighting and moving to high definition cameras.

Scotland

At the 2015 WGNPS meeting at IEO in Cádiz, Spain, Marine Scotland Science (MSS) provided a short presentation on several aspects of the Scottish 2015 annual UWTV surveys, which were in addition to the standard cruise work package.

The January cruise on board the MRV Alba na Mara was a continuation of work carried out on the five previous surveys at the same time of year. The aim of the survey was to map the extent of the muddy habitat in Loch Linnhe (Figure 2.4), located in the South Minch (FU12) to provide a quantifiable; evidence based surface area suitable for *Nephrops* within the loch. This was achieved using the UWTV drop frame and applying the same approach as previous surveys as presented at SGNEPS 2010. The expected outcome is to be able to calculate the surface area of mud from all the sea lochs and significant areas of open water on the west coast of Scotland that are at present not included in the main assessment surveys, adding these values to the existing data of mud in each relevant FU. This could increase the surface area in which to raise abundance values to. However as seen from the first three surveys in this series, the area in the North Minch sea lochs area represented an insignificant overall increase in surface area, and to include these additional areas in the assessment models would generate considerable associated problems. Further work in the South Minch to the south of Mull is planned to continue during 2016. Local fishers report that it is very large area where *Nephrops* are targeted but BGS show this region as sand/rock and therefore not yet included in the annual assessment survey. If the 2016 cruise successfully achieves its aims, this will complete all the South Minch surveys in this series, providing new data to be analysed and presented at a future Working Group for discussion.

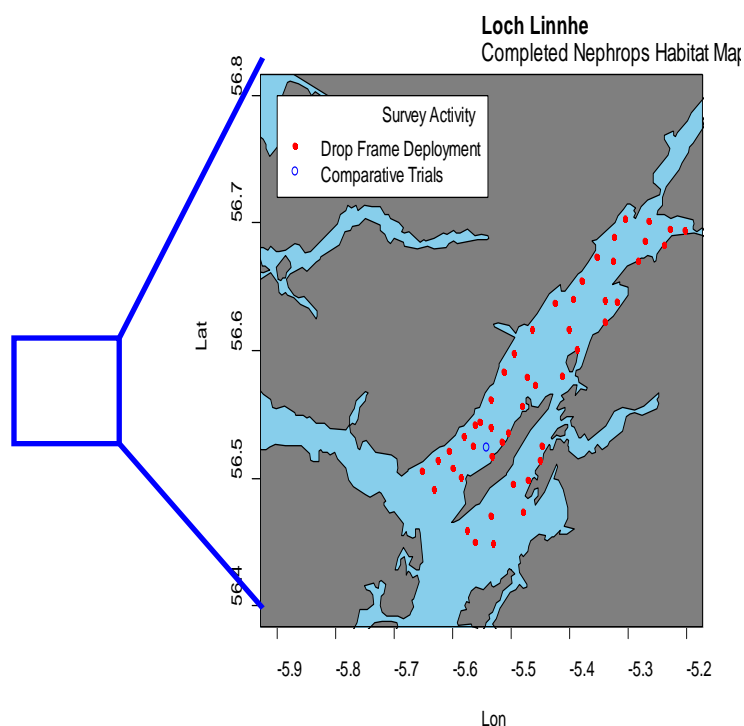


Figure 2.4 Sampling locations on January 2015, MRV Alba na Mara, Loch Linnhe survey.

During summer the MRV Alba na Mara cruise, very good weather conditions resulted in spare time which was used to gather comparative TV footage between the sledge and drop frame. This work was originally presented at SGNEPS 2012 and each year since MSS has managed to add to the dataset by repeating this work. The drop frame is used by MSS in areas where there could be a risk of potential entanglement or damage to the sledge, (e.g. creels, rocks, fish farms, etc.) – i.e. areas currently not surveyed. As the drop frame does not come into contact with the seabed, this reduces the risk of damage to both scientific equipment and fishing gear. However the camera on the drop frame is closer to the seabed compared to when mounted on the sledge and due to the nature of how the frame is suspended over the stern of the vessel and the considerable influence the sea state has on the quality of the images recorded, this makes it difficult to calculate the field of view resulting in an inconclusive value for the area surveyed. By installing two, parallel lasers, a fixed field of view is created and when this value is multiplied by the distance travelled the area surveyed can be calculated, and the abundance of *Nephrops* complexes can then be calculated by counting only those complexes that pass between the two laser dots on the seabed. The work is carried out by deploying the sledge in 5 parallel tracks 100 m apart, followed by the drop frame. The three deployments of the drop frame lie within the area surveyed by the sledge – so the footage gathered is over exactly the same ground and in the same conditions as that covered by the sledge, allowing the video to be unbiased and comparable. The video library for this comparative work is growing with initial analysis on a small sample of data showing promise but a re-run of the analysis is required to include the more recent survey data. It is hoped this work will continue into future years until statistically robust dataset can be established with clear outcomes.

Also during summer the MRV Alba na Mara cruise a Go Pro 3+ housed in an aluminium canister engineered by MSS was attached to the sledge during normal UWTV operations to investigate if this approach could provide any advantages to the survey. The camera was set to record either stills or video, although both were recorded simultaneously on one deployment. The results were varied; the relatively slow shutter speed proving a problem if the sledge was moving forward resulting in blurred images. However if a still was taken when the sledge was stationary, a 12 MP image with very fine detail was captured which would be ideal for training or presentation purposes. The camera was set up for time-lapse photography, but MSS engineers are working on developing a remote control to activate the shutter as required. The video quality was not as good a quality as the standard Kongsberg camera; this was due to lighting and is being addressed in other surveys conducted by MSS. Other issues such as short battery life and a low specification graphics card and processor on the PC caused problems when using the Go Pro, however these are being resolved and the intention is to use this camera on future surveys.

During summer the MRV Alba-na-Mara survey a HD camera and Panasonic flat screen monitor were trialled as possible replacements for existing hardware. The results were not as positive as hoped, with limited HD support for the camera and inferior image quality on the flat screen, alternative approaches continue to be investigated. These issues were presented to the Working Group (WG) for discussion.

MSS observers take GPS units to sea and record where the fishing activity they are involved with takes place in each of the FUs. This work is carried out on smaller vessels that do not have VMS monitors and therefore fishing patterns are difficult to map accurately. This GPS data provides additional information on fleet activity and changes throughout the years. The data have been collated for the WG and then over-

laid onto the 2015 UWTv survey positions. This provides a clear indication and validation that the surveys are being carried in the same areas where the fleet fish for prawns (Figure 2.5).

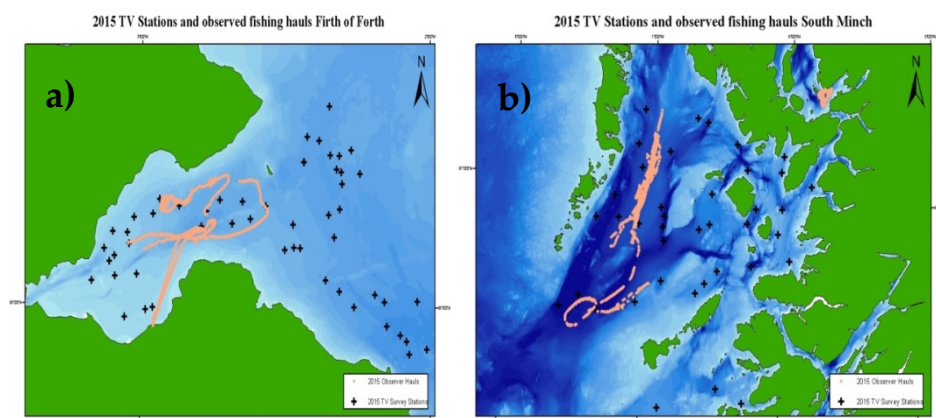


Figure 2.5 a) 2015 UWTv stations and observed fishing hauls in the Firth of Forth b) 2015 UWTv stations and observed fishing hauls in the South Minch.

At previous WG's there has been discussion about creating a centralized UWTv database. MSS stores all the Scottish UWTv survey data on a bespoke relational ACCESS database, which could be easily adapted to accept new fields and various data formats. During MSS surveys, once all the data have been reviewed and entered into various spreadsheets, the uploaded data are open to anyone with permission to access the database to interrogate. This has provided a great source of interest from both within and out with MSS (including SNH, JNCC, and BGS), resulting in several papers using the data available to comment on a variety of topics (habitat mapping, occurrence of sea pens, sediment distribution, etc.).

Conclusion/Recommendation

MSS will continue with two summer *Nephrops* TV surveys in 2016, to provide data for assessment Working Groups (WGCSE and WGNSSK) as well as ancillary data (litter, morphometrics and LFDs from trawls, sea pen occurrence, etc.). MSS will schedule to conclude the sea loch habitat mapping series in 2016 and present the results at future Working Groups. MSS will continue to trial different camera and TV monitor arrangements to ensure the future success of surveys and acceptable succession of existing, aging equipment.

England

FU5

Due to funding constraints, Cefas is no longer covering this ground, although the possibility of having a collaborative survey in future is being discussed with the Netherlands. More information regarding future options to reinstate this survey will be discussed in future and this information will be passed on to the WGNPS.

FU6

No gear or design changes were made to the current survey in the Farn Deep ground.

The 2015 survey was conducted in-between the 5th - 12th of June and covered all 110 stations. The work was all undertaken according to the standard protocols, which include pre-survey training and standardization of counter's performance. All counters must count the reference footage to a predetermined standard before being given access to the current survey footage.

The visibility was, as with the previous two years, very good, 80% of footage was classed as "Excellent", 19% as "Good", and 1% as "Moderate".

As an extra in the 2015 survey, additional stations were added to better define the limits of the ground. In total 9 extra TV stations were added and 15 multibeam lines were done. Most of this work was focused in the west side of the ground. Preliminary results revealed extension of the mud ground in the area close to North Shields and trawl marks were occasionally observed outside the main ground.

FU14

An inter-benchmark process was conducted for FU14 between June and September 2015.

The 2015 Irish Sea *Nephrops* UWTV survey took place on the RV *Corystes* on 5–13 August. The departure and arrival port was Belfast. This survey covered both western (FU15) and eastern (FU14) side of the Irish Sea. The survey in the East Irish Sea area is of a fixed grid design and is carried out using the same protocols used in UWTV surveys in the western Irish Sea, although this year, for the first time, Lynn's concordance coefficient code was used to identify stations which required a 3rd counter.

A burrow counting training day was set up on Tuesday 4 August to brief scientific staff with procedures and revised reference counts results.

In 2015, new exploratory stations (14-AS, 14-AT, 14-AU, 14-AV, and 14-AW) were added to support the benchmark process on the review of the ground boundaries for this stock (Figure 2.6).

All 42 stations were surveyed, of which 60% were survey in good clarity conditions and 40% in moderate to poor conditions. Deterioration of the water clarity was mainly related with strong tides, as no fishing vessels were present at the time of this survey.

- 21% of stations fell under the CCC (Lin's concordance correlation coefficient) threshold of 0.5.
- Agreement was not achieved for 5 stations: 14-L, 14-V, 14-AJ, 14-AL, and 14-AF. Average count was used for these stations.
- Training section was done for these stations to identify issues on burrow identification.
- Main factors identified in no agreement were due to: existence of multi-species burrows in the ground - high burrow density but not necessary for *Nephrops*, small burrows, visibility, and overall not clear *Nephrops* signatures.
- To avoid discarding stations an average count was used per station to get final densities per station.
- All 42 stations were used in the assessment.

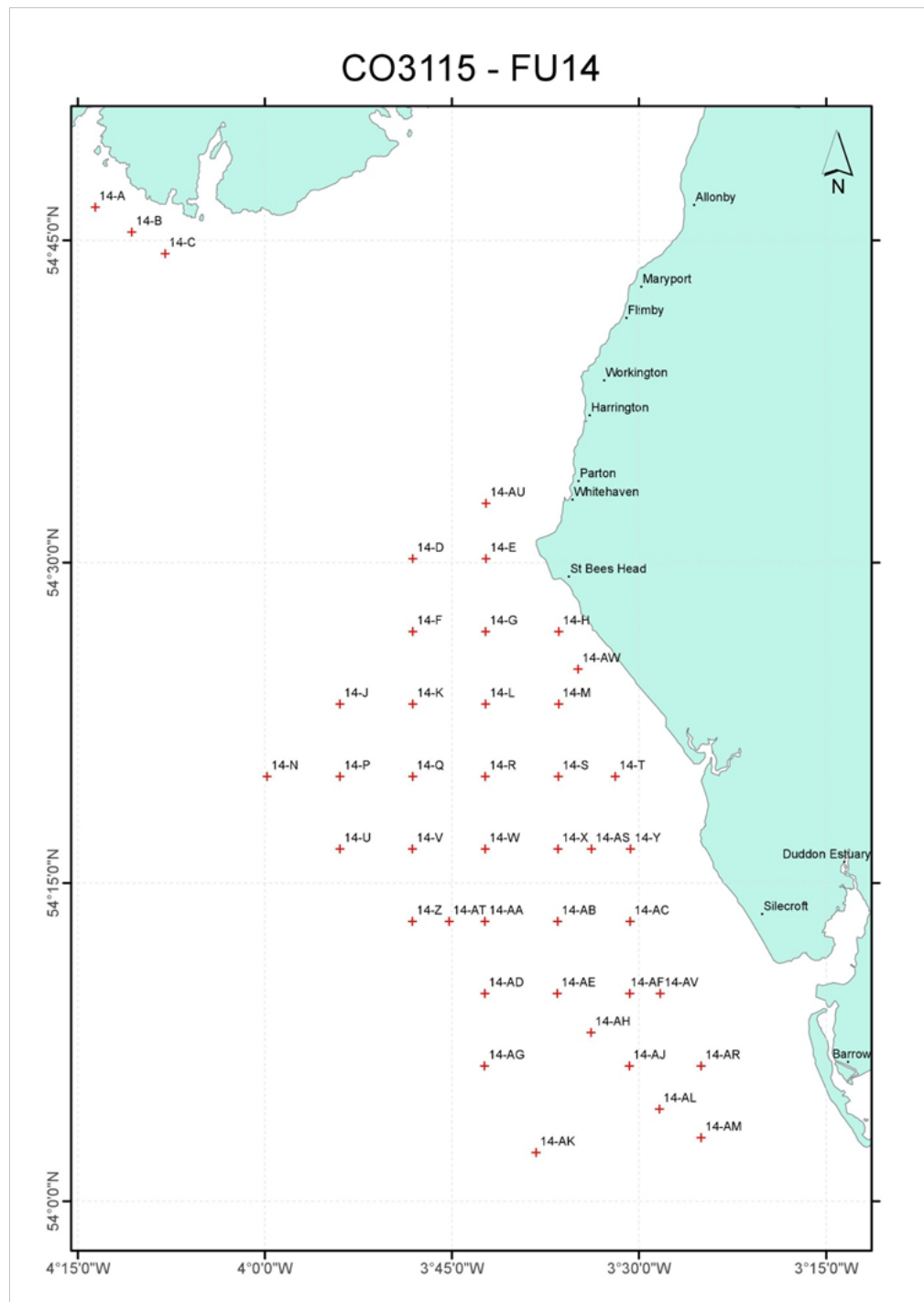


Figure 2.6 Sampling locations on August 2015 for the FU14 survey.

Conclusion/Recommendation:

As in other *Nephrops* stock there are a number of generic research questions related to occupancy and edge effect bias that needs still to be investigated.

- For FU 14 and FU6 more accurate mapping of the spatial extent of the grounds and fisheries, this includes having positional data for < 12 metre vessels and more survey data in the boundary areas to better define these grounds.

- For FU 14 there is a need to improve the spatial coverage and sampling of landings and discards, this includes increasing the sampling levels to covers Northern Irish vessels, as the current sampling is mainly focused on local vessels from Whitehaven port.
- For FU14 there is a need to get area specific length-weight and maturity data to validate the parameters used for this FU.
- For FU 14 better knowledge is required of the difference in growth and population structure across the area.

Denmark/Sweden – FU 3–4

The 2014 survey was carried by Denmark during several short periods from the end of August to the end of September in Subareas 1, 2, 5, and 7 and by Sweden during June in Subareas 3, 4, and 6 (Figure 2.7). The late timing of the Danish survey period was due to technical problems with the new technical set up of the sledge system. Denmark completed 94 stations but several of them were not suitable for analysis due to either poor visibility or problems with the GPS position recording system. Similarly, Sweden encountered difficulties with water clarity, and the overall achieved coverage for both countries together was 80% of the planned stations. Area coverage was in particular poor in Subarea 2, which resulted in a CV of 25 % whereas the CVs for the other subareas were well below 20%. With the inclusion of Subarea 7, which was sampled the first time in 2014, the total survey area increased to 9535 km² and the average bias corrected *Nephrops* burrow density was 0.39 burrows/m² with an overall relative standard error of 5.8%.

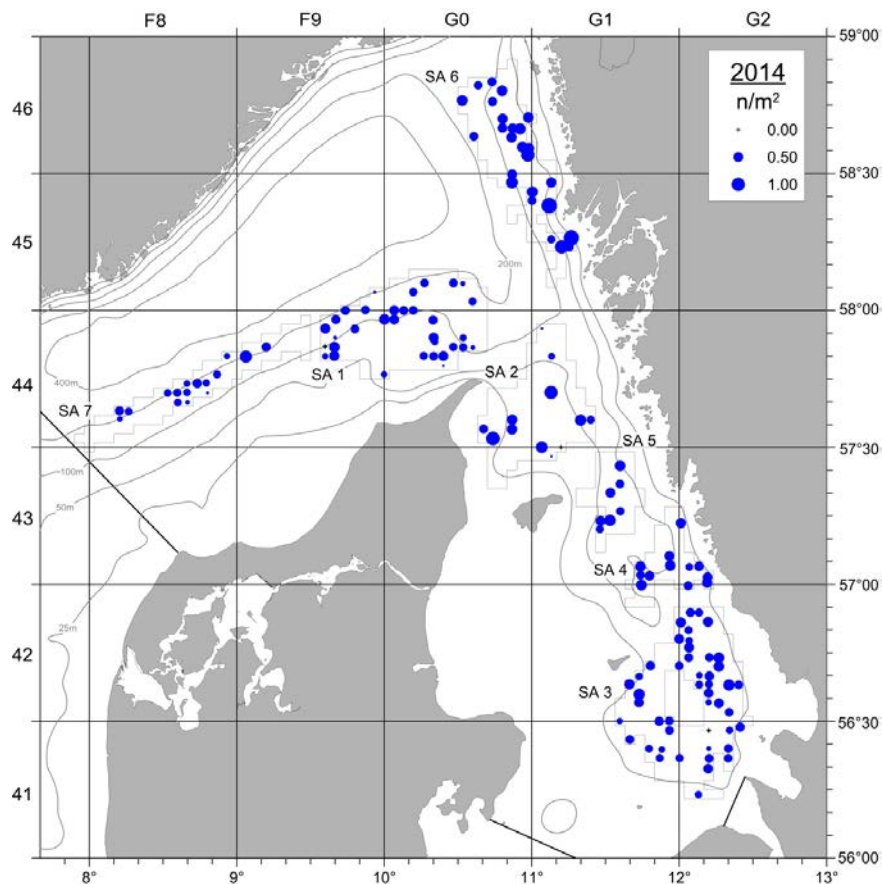


Figure 2.7 Sampling locations and *Nephrops* burrow density in UWTV survey in the Skagerrak and Kattegat in 2014 (SA: subarea).

Conclusion/Recommendation

The new Subarea 7 in the western Skagerrak has been integrated in the survey and will for now on routinely be sampled. Another Subarea or an extension of Subarea 2 towards the Swedish coast should be considered for future surveys at the benchmark meeting in 2016.

Refinement of subarea boundaries and stratification based on updated VMS, logbook data and sediment maps should be carried out together with the distribution of creeled grounds in Swedish coastal areas. Rocky bottoms in eastern subareas should be redefined and corrected for estimation of the total *Nephrops* grounds areas in 3a.

A set of reference footage should be established for the Danish/Swedish UWTV survey in the Skagerrak and Kattegat. The collaboration between the readers of the two countries should be increased whereby the stations read by the two countries should be randomized. This could be organized by workshops held alternating between two institutes.

Spain – FU 30 Gulf of Cadiz

The Spanish Oceanographic Institute (IEO) carried out the second *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds in 2015. This survey took place on board the RV Ramón Margalef on 4–13 June. This year the HD camera was changed for one with a field of view wider in order to ensure the complete vision of the lasers on the bottom of the screen, which are separated 75 cm. The rest of the equipment was the same than 2014 (WD Vila *et al.*, ICES 2014).

The design of the survey followed a randomized isometric grid. In 2015, the distance between stations decreased to 4 nm (5 nm in 2014) and the number of stations was increased (42 in 2014). A total of 63 stations were planned and 3 stations were considered as reserve. Only 5 stations allocated in the shallower border were considered null because of the poor visibility. The survey achieved 92% coverage. These stations ranged from 98–650 m depth with an average depth around 351 m (Figure 2.8).

The initial ground perimeter was established in 2014 using VMS data of fishing activity in combination with the logbooks from the 2012–2013 period. In 2015, stations were allocated further away of this perimeter since *Nephrops* burrow systems were observed in the shallower limit. Therefore, the surveyed area was increased in relation last year (~15% more) and it corresponds to 3322 km².

The sledge was towed at 0.5–0.7 knots in order to obtain the best possible conditions for counting burrows and 10 minutes were recorded. This time corresponds to 180 m swept, approximately. Vessel position (DGPS) and HiPAP transponder on the sledge was used to obtain the ship and sledge position, respectively. The distance over ground estimate (DOG) was calculated using the sledge position and the field of view of the video footages was 75 cm (FOV), which was confirmed using lasers. However, when the HiPAP transponder failed, vessel position was used. This occurred in the 7% of the stations.

Lin's concordance correlation coefficient (CCC) was used to analyse the individual's counting against the reference counts (Porcupine Bank Reference footages). The CCC value obtained for the six counters was higher 0.5. However, the Porcupine Bank reference footages could not be appropriated for the Gulf of Cadiz area. In this Spanish *Nephrops* ground the burrow density is higher, the mean size of the systems burrows are lower and is common to find other burrowing fauna that influence in the identification of *Nephrops* burrows. The self-confidence of the counters has increased

but additional expert assessment in identification of *Nephrops* burrows is recommended.

The mean burrow density was 0.116 burrows/m². Assuming 100% occupancy the total number of *Nephrops* in the Gulf of Cadiz was estimated to be around 384 million of individuals (unadjusted data) (Figure 2.9). The total *Nephrops* abundance was estimated by the swept-area method but the spatial covariance and other spatial structuring Geo-statistical analysis are being performed.

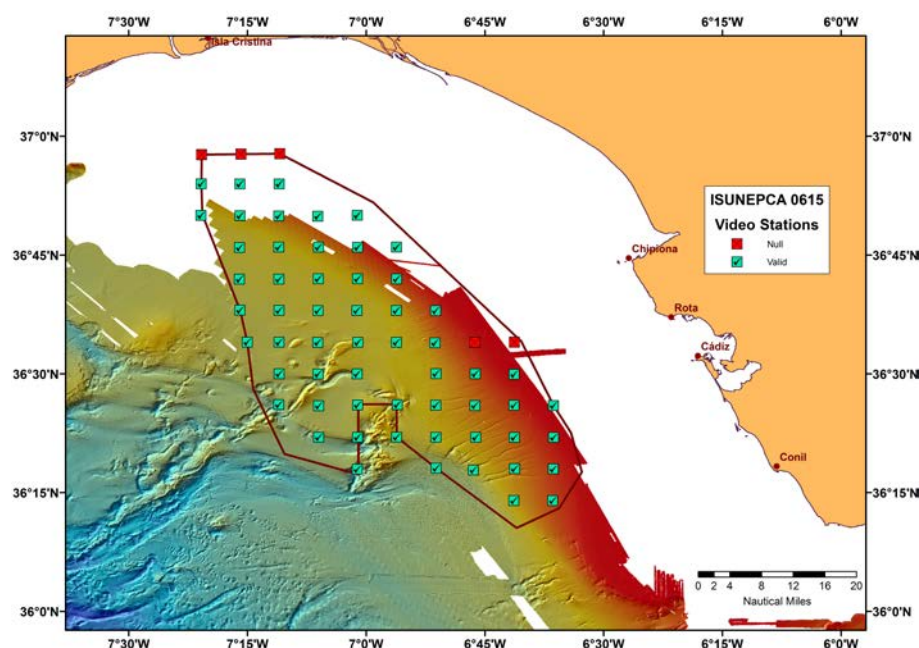


Figure 2.8 UWTB stations and area surveyed in the Gulf of Cadiz UWTB survey in 2015.

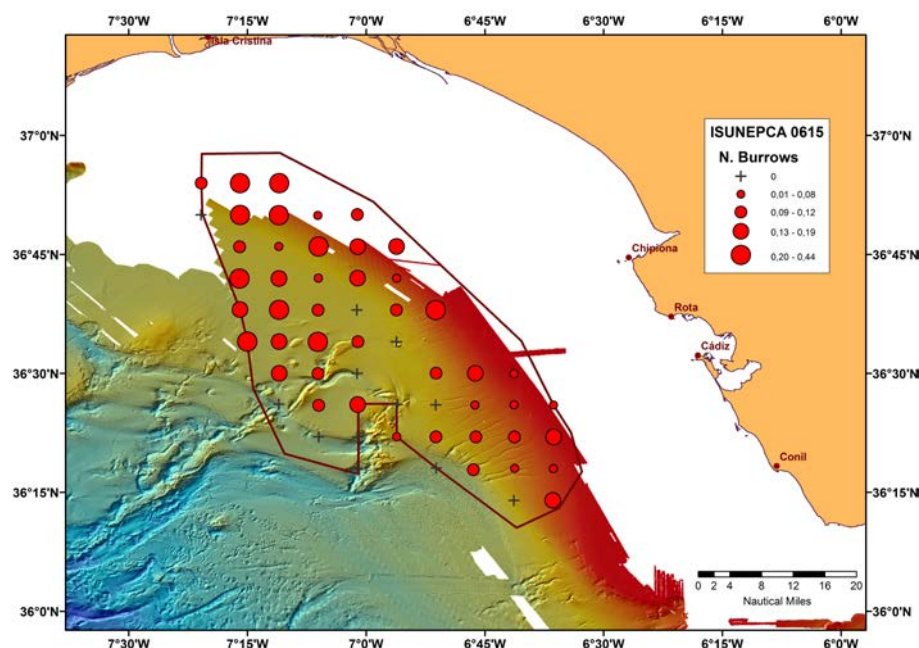


Figure 2.9 *Nephrops* burrow density (unadjusted data) in the Gulf of Cadiz UWTB survey in 2015.

Conclusion/Recommendation

The survey is still developing. The boundaries of the *Nephrops* ground were improved in 2015 but need to continue the exploration. Sediment and bathymetric data will be used to better define the area boundaries. A workshop on the identification of the *Nephrops* burrows is recommended since there is a need to increase the capacity on burrowing counting skills.

Italy

GSA-17 Adriatic Sea – Pomo Pits

The Adriatic Sea (GFCM Geographical Sub-areas (GSA) 17 and 18) is one of the most important and most productive area for the fishery of *Nephrops norvegicus* in Italian waters and in the whole Mediterranean basin (Morello *et al.*, 2009; FAO FISHSTAT data). An important fishing ground occurs in the Central Adriatic depressions (the Pomo - or Jabuka in Croatian - Pits, part of GSA 17), which represents also a nursery for European hake (*Merluccius merluccius*) (Angelini *et al.*, in press). The Norway lobster stock located in this area is distinct from other Adriatic populations and is characterized by small-sized and slow-growing individuals (Frogliia and Gramitto, 1982; Vrgoć *et al.*, 2004). Furthermore, this area represents a fishing ground shared by two fleets from different countries (Italy and Croatia), which fish there regularly (Martinielli *et al.*, 2013). The Pomo/Jabuka pits have been the subject of many discussions aiming to establish an area closed to fishery (e.g. ADRIAMED, 2008; De Juan and Lleonart, 2010). Finally, for 1 year from August 2015, the Pomo area has been partially closed to trawling activities carried out by both fleets (D.M. 03/07/2015).

After some trials carried out in 1994 and 2004 by CNR-ISMAR (Frogliia *et al.*, 1997; Morello *et al.*, 2007), in 2009, under the auspices of the FAO-ADRIAMED project, ISMAR-CNR of Ancona (Italy) and IOF of Split (Croatia) started a series of UWTV surveys in the Pomo Pits area. The footages collected during the surveys are analysed at a later stage in the institute laboratories by a team composed of Italian and Croatian scientists, applying consistently the criteria developed by ICES WGNeps (Martinielli *et al.*, 2013). During the Adriatic surveys, trawl hauls are usually carried out by means of an experimental net (sunrise and sunset) in order to obtain additional demographic and biological data relating to the stock. However, the UWTV surveys are not part of the DCF (Data Collection Framework) for Italy and Croatia.

Thanks to the Italian National Flagship Program RITMARE, in 2012 CNR-ISMAR received funding for the enhancement of scientific surveys for the acquisition of independent information on fisheries resources, thus a new UWTV system (partially funded by RITMARE) was designed and acquired (ICES, 2014). After the first trials in 2013, new modifications were carried out leading to satisfying results about image quality, collection of environmental parameters and operability. In 2013, the new system was trialled and only half of the usual monitoring program was completed during the survey, while in 2014 the scheduled program was covered in the entire study area. In April 2015, the survey was again carried out with a reduced program due to delays in the arrival of permits by the authorities and due to bad weather conditions.

The collected footage has already been analysed and the obtained results have been calculated following the original stratified random sampling design (Martinielli *et al.*, 2013). Furthermore post-stratification experiments based on the bathymetry of the area, demographic information, commercial catches, VMS data and on the new defi-

inition of the fishing ground given by D.M. 03/07/2015 are currently in progress (Figure 2.10).

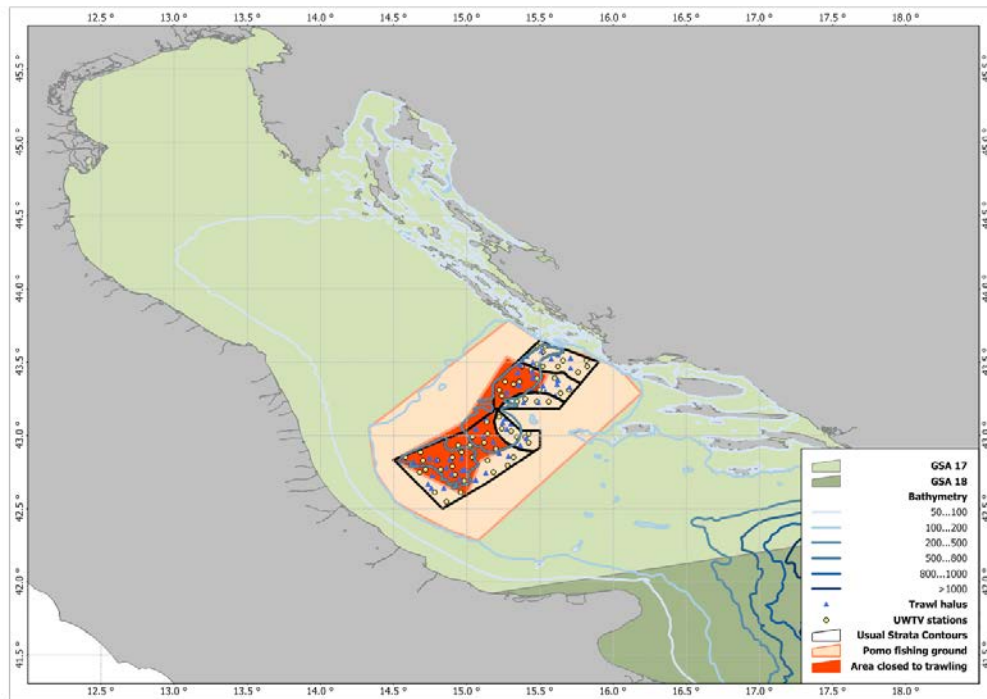


Figure 2.10 Location of the trawl hauls and of the UWTV stations performed during the surveys in the central Adriatic Sea (Pomo/Jabuka Pits) with indication of the areas usually applied for the stratification and the new contours of the fishing ground defined in D.M. 03/07/2015.

Conclusion/Recommendation:

A new UWTV survey in spring 2016 is strongly recommended in order to evaluate the short/medium term effect of the closure to trawling activities in the Pomo Pits area. Moreover, this would be a great opportunity to assess effects such as modification in density or population structure both for Norway lobster and other important benthic and demersal species associated and to evaluate the recovery time in an area previously subject for decades to very intense fishing pressure.

Due to their promising results, post-stratification experiments will be further enhanced to take advantage of the obtained datasets in the most suitable way in order to assess eventual effects of the fishery closure and to feed with the new UWTV time-series available for the study area both ecosystem models and stock assessment methodologies applied in the Adriatic.

In addition, the use of uncertainty parameters specific for this study area needs further refinements.

France – FU23 and FU24 – Bay of Biscay

The second UWTV survey (Langolf TV) of the *Nephrops* ground in FU23 and FU24 was carried out on 20–29 July 2015 on board RV. Prince Madog (the Celtic Voyager was not available due to an engine breakdown). This survey was funded by the French fishing industry (CNPMM) and an industry observer was on board during the first half of the survey.

The main objectives of this survey were:

- to investigate the use of this survey method and train staff in the methodology
- to map the full extent of this *Nephrops* ground in FU23 and FU24
- to calculate a mean burrow density.

A randomized fixed square grid with station spacing of 4.7 nautical miles resulted in 165 planned TV stations for this ground. The initial ground perimeter has been established based on sediment data (Dubrulle *et al.*, 2007). The area is estimated at 11 680 km² using the sediment data only. Figure 2.11 shows the planned 2015 UWTV stations and sediment data available. This survey used the Marine Institute Ireland UWTV system equipment and processing methods. The UWTV system is a load bearing fibre optic armoured cable with a multiplexer. The sledge based on Scottish design had two cameras mounted at fixed angles, four light units, 6-point laser system, sled transponder, and a CTD.

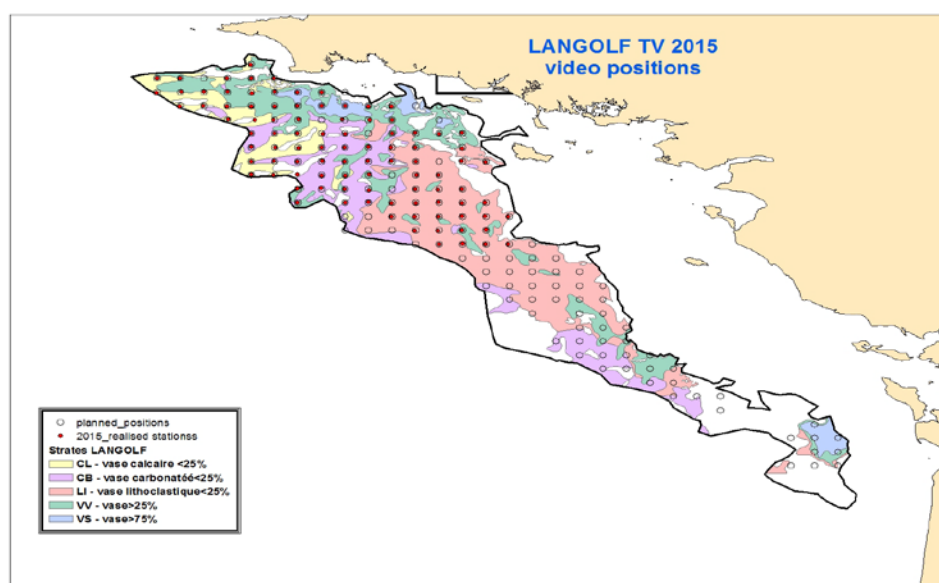


Figure 2.11 2015-UWTV station plan overlaid on sediment data. Open circles planned stations, red dots completed TV stations. Black outlines denotes the limit of *Nephrops* fisheries (fishers surveys)

Similar to UWTV method in other labs the sledge was towed at approx. 0.8 knot for 10 minutes maintaining good ground contact and speed using the winch. The field of view of 0.75 metre was confirmed by lasers for the majority of stations where sometimes in very soft muds the sledge tended to sink. The high quality footage was recorded on DVD. Vessel position (DGPS) and position of sledge using a transponder were recorded. Sled sensor was not operational for 20% of the stations.

As the previous survey, it was decided to use FU22 reference footage to train staff in *Nephrops* burrow identification as footage from FU22 is relatively straightforward to count with moderate density and classic features. Figure 2.12 shows individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC). A threshold of 0.5 was used to identify counters who needed further training. Once this training and testing process had been undertaken, all recounts were conducted by two scientists independent of each other on board the research vessel during the survey.

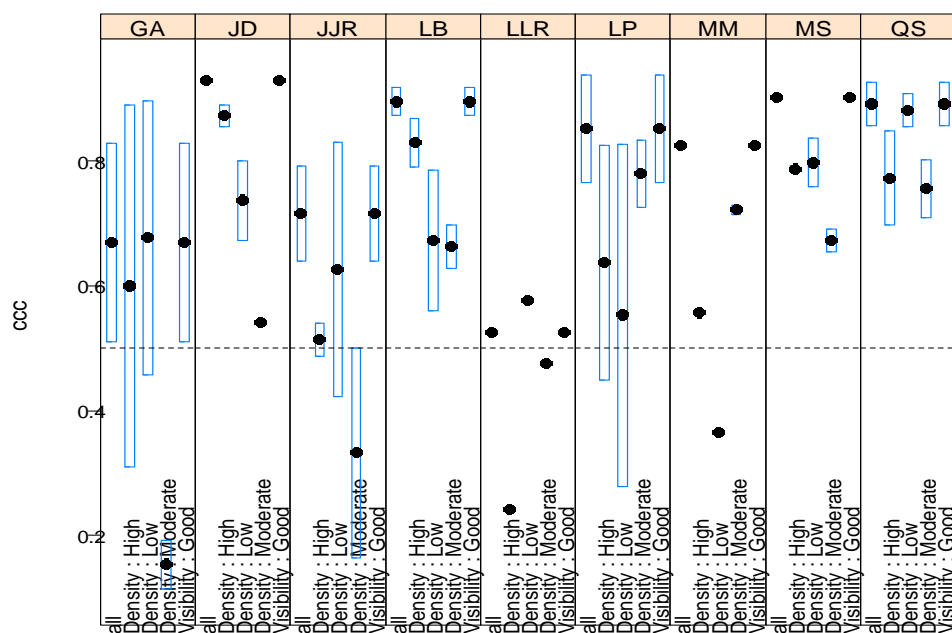


Figure 2.12. 2015 Counting performance against the reference counts as measured by Linn's CCC for FU22 "Smalls". Each panel represents an individual. The x-axis (from left to right), all stations pooled, high density, low density, medium density and visibility good.

Preliminary Results: 96 stations were completed in total. Due to weather constraints most of southern stations not completed with some gaps in northern end of ground. Two stations were "abandoned" due to hard ground or rocks present indicated by the camera on the sledge (no multibeam on board). These stations were used in analysis as zero density stations (Table 2.2).

Table 2.2. Stations abandoned in 2015 due to hard ground/rocks and sediment data available.

SURVEYID	STATION NUMBER	MID_LON	MID_LAT	DENSITY (N/M ²)	COUNT (N)	GROUND	SEDIMENT
CV15018	187	47.75756	-4.80301	0	0	Bay of Biscay	vase >75%
CV15018	200	47.59927	-3.74606	0	0	Bay of Biscay	vase >25%

The navigational data were quality controlled using an "r" script developed by the Marine Institute (ICES, 2009b) and examples are shown in Figure 2.13a-b. The USBL/sledge navigational data were used to calculate distance over ground for 78% of the stations. The visibility at the seabed was excellent during the survey.

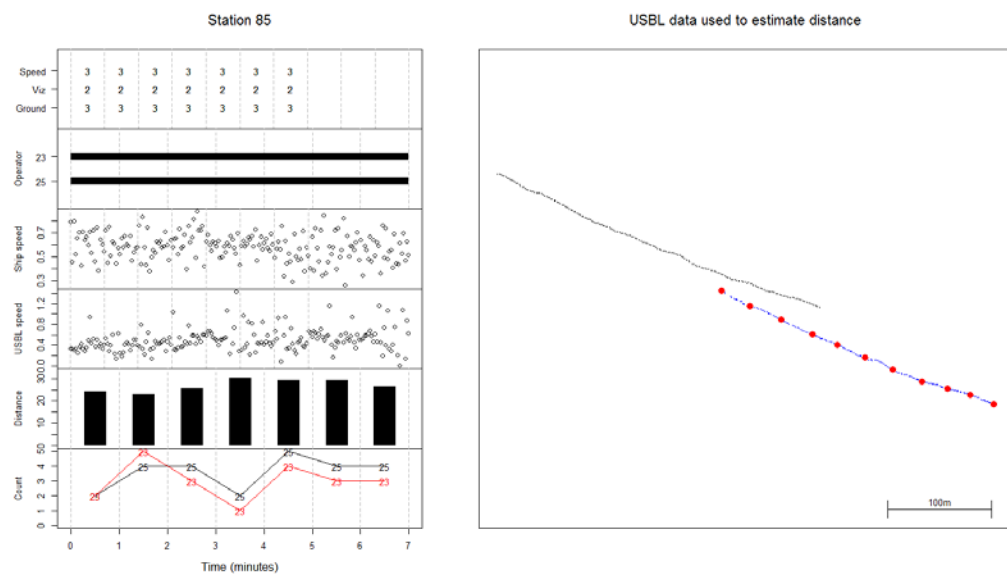


Figure 2.13a Quality control plot of station 85 of the 2015 survey.

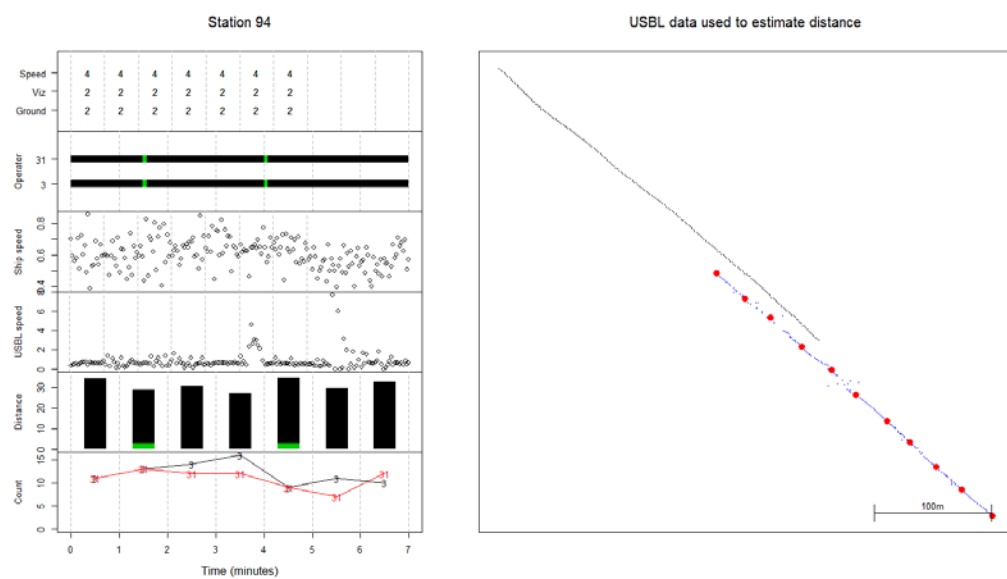


Figure 2.13b Quality control plot of station 94 of the 2015 survey. Footage indicated *Munida* and *Nephrops* interactions.

Overall consistency and bias between individual counters was examined using Figure 2.14. There is some variability between counters but there are no obvious bias or excessive deviations.

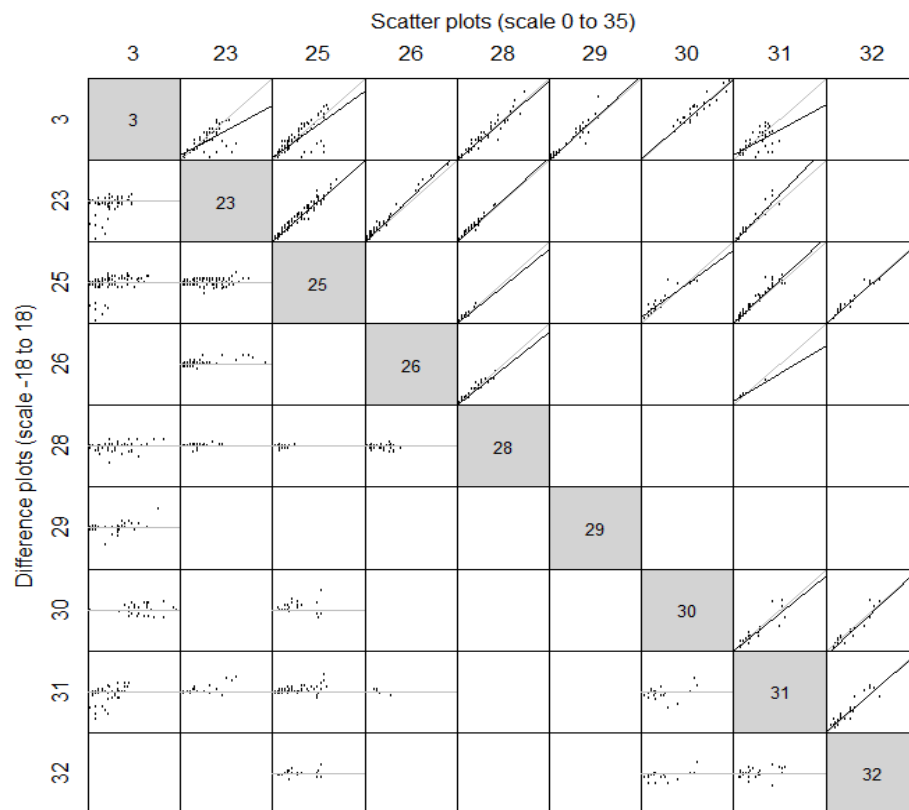


Figure 2.14 Scatterplot analysis of counter correlations for the 2015 survey.

Figures 2.15 and 2.16 show the variability of density between minutes and operators (counters) at each station. These show that the burrow estimates are consistent between minutes and counters. Some variability is evident between minutes at stations 115 and 150. High densities were observed in the northern sector of the grid with low densities observed over all (Figure 2.17).

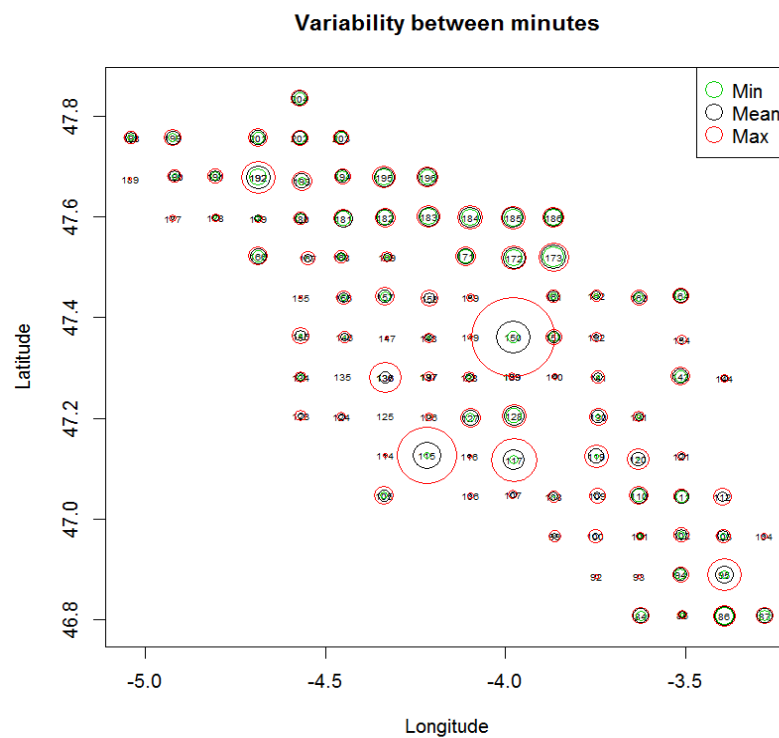


Figure 2.15 Plot of the variability of density between minutes for each station in 2015.

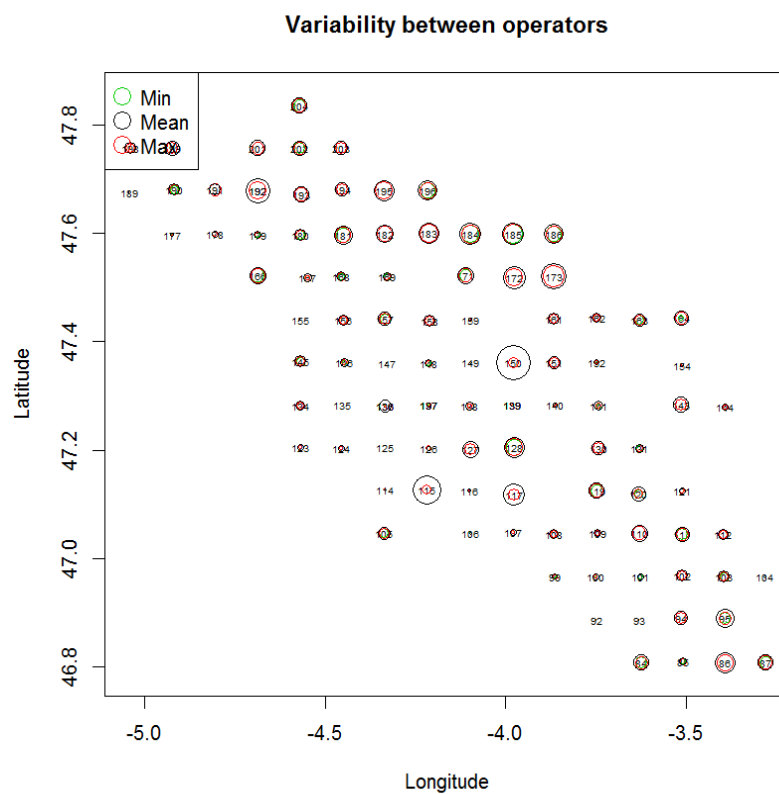


Figure 2.16 Plot of the variability of density between counters at each station in 2015.

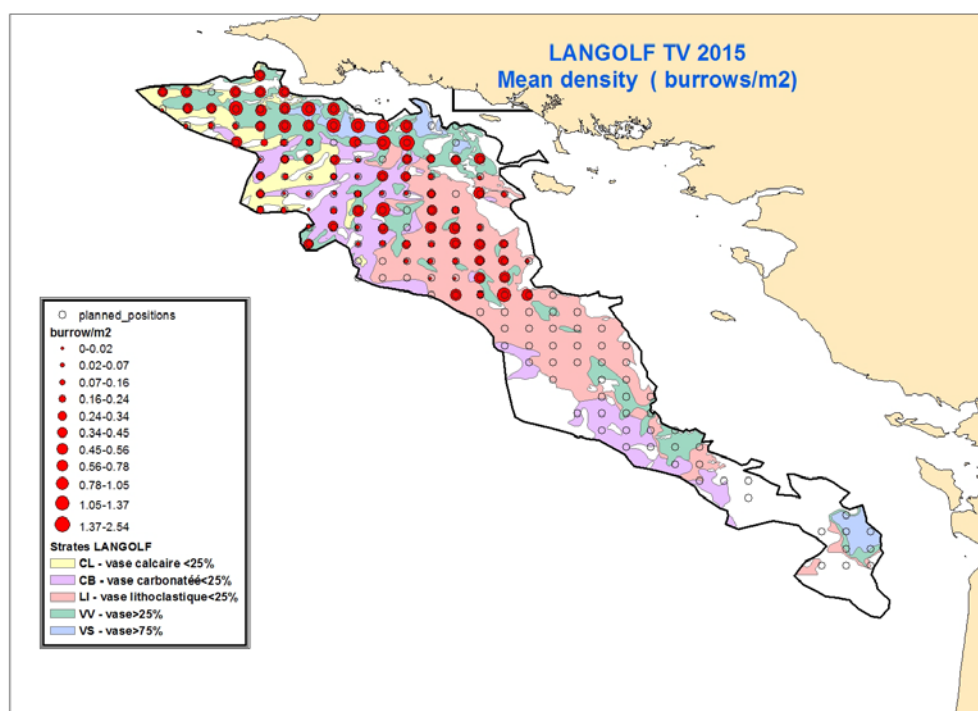


Figure 2.17 2015 *Nephrops* burrow density (burrows/m²) observed on the grounds.

The mean density for this survey that is based on the 98 stations, is 0.40 burrow/m² (Table 2.3). This is considered a moderate density *Nephrops* ground.

Table 2.3 Preliminary results of 2015 UWTV survey.

YEAR	FU	PLANNED STATIONS	NUMBER OF STATIONS COMPLETED	NUMBER OF ZERO DENSITY STATIONS	AVERAGE DISTANCE OVER GROUND (M)	FIELD OF VIEW (M)	NEPHROPS BURROW COUNT	MEAN DENSITY (BURROWS/M²)
2015	23 and 24	165	96	4	172	0.75	4 899	0.4

Conclusion/Recommendation

The survey was not so successful in relation to: number of stations completed within the time frame as there was weather downtime. Visual clarity at the seabed was excellent, identification of *Nephrops* burrows was relatively straightforward given the presence of other confusion species, and staff was trained to a high level in survey procedures. However, the survey can be viewed as exploratory as stations at the southern edge were not surveyed and sediment data here indicate the presence of substrata suitable for *Nephrops*. The use of sediment data only to define the ground boundary may not be complete. Some of stations that were abandoned due to “hard ground” type indicated soft sediments on the sediment map (Table 2). This demonstrates that the grid of stations should cover the entire ground boundary to fully map the extent of the grounds and to know the limits.

The WGNeps recommends that the next UWTV survey should be conducted in the appropriate spatial scale at the aim of limiting the actual stock contour vs. the heterogeneity of the sediment.

Moreover, the UWTV survey in the Bay of Biscay should last longer than during the first two years 2014 and 2015 (e.g. 14 days instead of 10).

Quantitative information combining UWTV and trawling involving in the proportion of *Nephrops* and other burrowing crustaceans mainly squat lobster (*Munida* sp.) should allow to propose correction factor for the burrows counting. Many progresses on that should be taken into consideration for the future benchmark workshop (autumn 2016) which could define reference points for the stock.

Furthermore a reference set should be produced for this *Nephrops* ground.

3 Changes to trawl survey design, coverage and intensity

Portugal

FU 28 and 29 (Southwest and South Portugal)

A grid was designed for the trawl survey to cover the main crustacean fishing grounds within the range of 200–750 m. The substratum in these grounds is characterized by muddy sediments composed by different percentages of silt and clay.

The sampling grid is composed by a total number of 80 rectangles, with 22 in FU28 and 58 in FU29. Each rectangle has 6.6 minutes of latitude x 5.5 minutes of longitude for the SW coast and vice-versa for the south coast, corresponding approx. to 33 nm². Figure 3.1 shows the grid overlaying the fishing grounds, defined by VMS data. The areas deeper than 750 m, where the giant scarlet prawn occurs, are not covered.

One station is carried out within each rectangle. The hauls are carried out during daytime with a speed of 3 knots and have duration of 30 minutes. Although directed at the crustacean species (Norway lobster, rose shrimp, and red and blue shrimp), data from all other taxa and species are also collected, as well as marine litter.

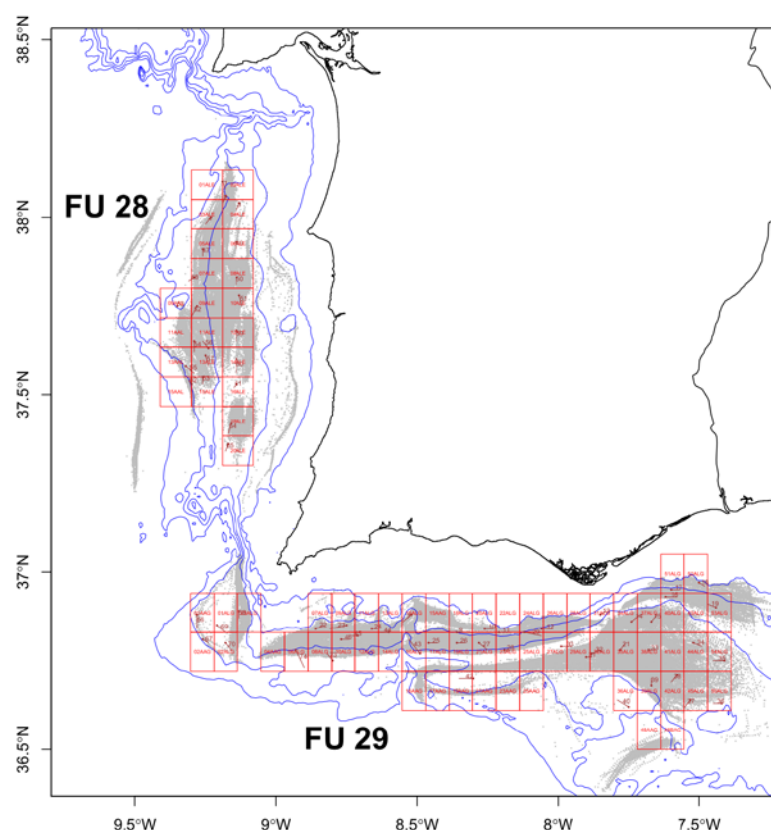


Figure 3.1 Survey grid in FUs 28 and 29 and trawl stations overlaying the crustacean fishing grounds represented by VMS records (in grey).

In general, the survey is carried out in June, in the peak of the fishing season, where *Nephrops* males and females are equally available to the gear and most of females are in pre-spawning state, with ripe ovaries. The trawl survey provides an index of relative abundance and biomass of *Nephrops* stocks, which has been used in stock assessment.

Figure 3.2 shows the spatial distribution of the biomass index in the most recent years.

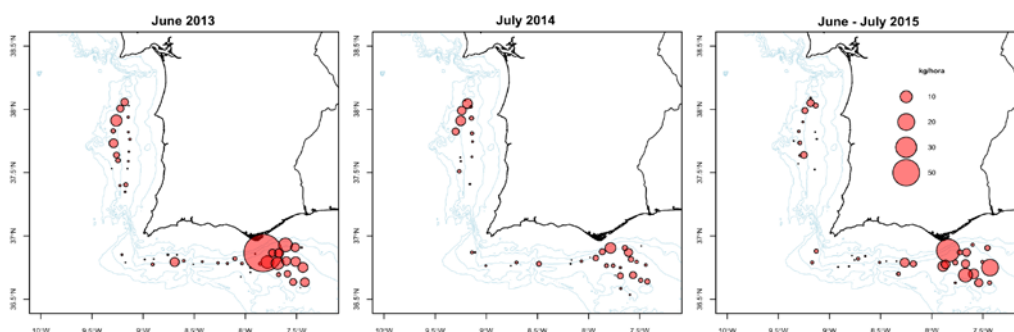


Figure 3.2 Spatial distribution of Norway lobster biomass index.

The abundance currently index is estimated, based on a post-stratification of the area by zones and depth strata, to compare with previous surveys indices. Geo-statistical methods are being explored to characterize the spatial distribution of *Nephrops*.

The biomass survey index is very noisy and the CV is high. In Figure 3.3, the standardized commercial cpue and the biomass survey index trends are shown. The biomass index plotted was obtained from FU29, where 70% of the crustacean fishing effort is deployed, in areas deeper than 400 m, in order to compare with the target standardized *Nephrops* cpue.

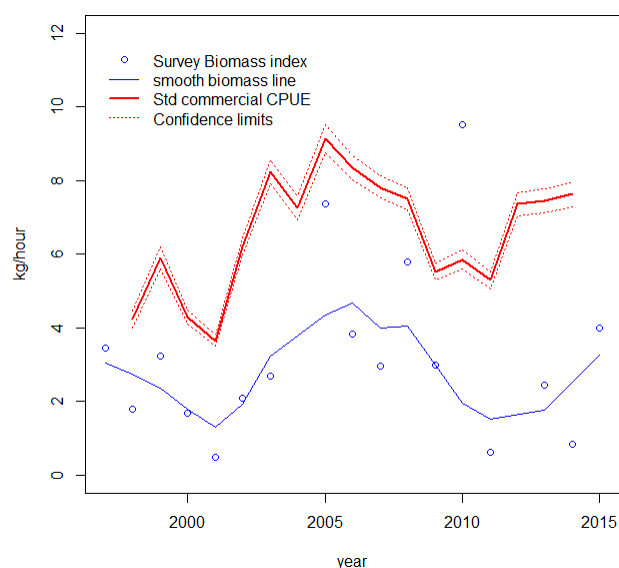


Figure 3.3 Survey biomass index (blue dots and smooth trend line) and standardized commercial cpue (red line).

Spain

FU31 (Cantabria Sea), FU25 (West of Galicia) and FU26 (South of Galicia)

The SpGFS-WIBTS-Q4 covers the northern Spanish shelf comprised in ICES Division 8c and the northern part of 9a, including the Cantabrian Sea and off Galicia waters. However, this survey is not targeting to estimate *Nephrops* abundance. *Nephrops* survey abundance index is not used in the assessment of FUs 25, 31, and 26.

Conclusion/Recommendation

This survey is not specifically directed to *Nephrops* and it is not used in the assessment.

FU 30 (Gulf of Cadiz)

No survey specially designed to evaluate abundance indices of *Nephrops* is carry out in FU30. The bottom-trawl surveys SpSGFS-cspr-WIBTS-Q1 and SpGFS-caut-WIBTS-Q4 occur in the Southern part of ICES Division 9a, the Gulf of Cádiz, which corresponds to the FU30. The *Nephrops* abundance index from spring survey series is used in the assessment of FU30. However, this survey is not specifically directed to *Nephrops* and it is not carried out during the main *Nephrops* fishing season.

Conclusion/Recommendation:

This survey is not specifically directed to *Nephrops* and it is not carried out during the main *Nephrops* fishing season. However, the analysis of the abundance index survey trend is used in the assessment.

Iceland – FU1

Trawl surveys have been carried out on all Icelandic *Nephrops* grounds (FU1) with more or less the same methods since 1968. In total there are around 55 tows completed annually during spring (May). The stations are spread out in an even manner on 11 discrete areas (Figure 3.4), but their location was initially based on older research tows and information from the fleet. The number of tows on each subarea is proportional to their estimated size. The hauls are carried out during daytime (06:00–18:00) with a speed of 2.5 knots and have duration of 120 minutes (5.0 nm). The tow-depth ranges from 116 to 280 m (mean depth of 167 m). The *Nephrops* are the target species but data from all other taxa and species are also collected. At each station a minimum of 200 *Nephrops* (~20 kg basket) are length measured and maturity stages of females are recorded. A special emphasis is on flatfish species and otoliths samples are gathered from around 1700 individuals. Otoliths are also extracted and stomach content recorded from cod, haddock, ling, and anglerfish (5 individuals in each station).



Figure 3.4 *Nephrops* trawl-survey stations in FU1.

The stock index from the trawl survey in FU1 has decreased substantially from it is highest value of 2008 and is now at its lowest recorded level (Figure 3.4). Historically the cpue has fluctuated in similar manner as the survey index but in recent years it has been higher and is still above its long-term average.

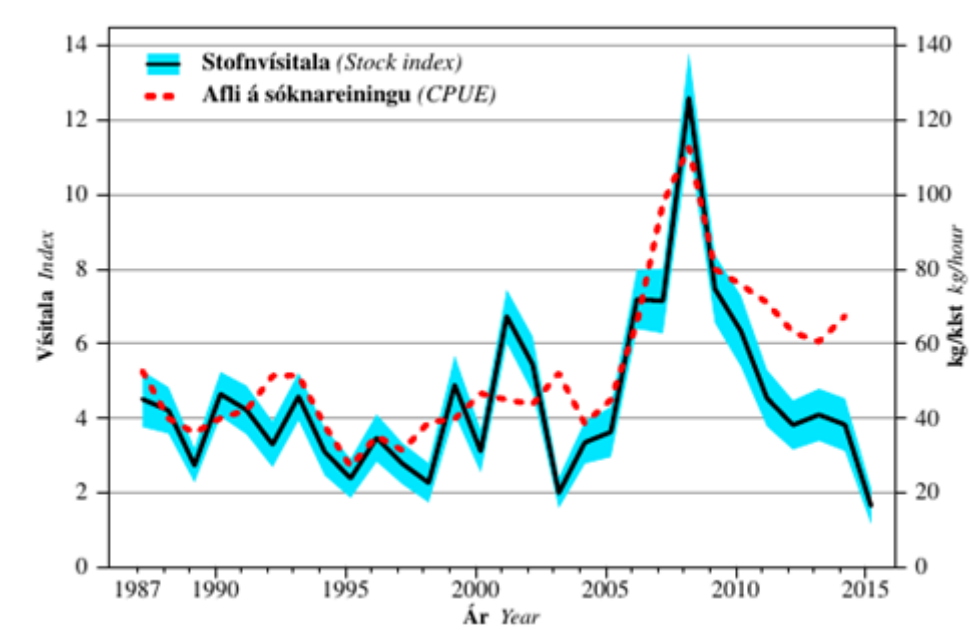


Figure 3.4 Stock index from the *Nephrops* trawl-survey (FU1) and standardized cpue, 1987–2015.

Conclusion/Recommendation:

The current trawl survey is important for acquiring length frequency and other biological data. The abundance index from this survey has not been used in the assessment. It will be proposed to conduct a full UWTV survey on Icelandic *Nephrops* grounds in 2016. Meanwhile the boundaries of the grounds will be defined with log-book and VMS data.

France – Bay of Biscay (FU23–24)

In the Bay of Biscay (FU23–24), the annual survey called LANGOLF was exclusively a trawl one for the time-series 2006–2013; however, it was stopped in 2014 because of financial constraints and replaced by an UWTV one for which trawling operations continue to be carried out with commercial vessels (for estimating sex ratio, LFDs for *Nephrops*, moreover proportion *Nephrops*/*Munida* sp. in the catches).

In the Bay of Biscay, *Nephrops* grounds correspond to muddy areas: the first one, which is the largest one, is in Division 8a and is called “la grande vasière”, the second one in Division 8b is called “vasière de la Gironde”. The overall area extends for around 11 700 km².

Males are sexually mature when they are about 6.5 cm long (20 mm CL) and two years old, females when they are about 8 cm long (24 mm CL) and two and a half years old. Incubation takes 7 months in the Bay of Biscay. Egg number increase according to size (a 7–8 cm long female has a mean egg number around 650, a 9 cm long 800 eggs, a 15 cm long 4000 eggs).

The Bay of Biscay *Nephrops* fishery (Figure 3.5) has a major impact on the Northern Stock of Hake, because the *Nephrops* fishing grounds are on a hake nursery. Hake discards are very important. Bycatch of other species is not as large although it can seasonally reach a high level (e.g. blue whiting, horse mackerel).

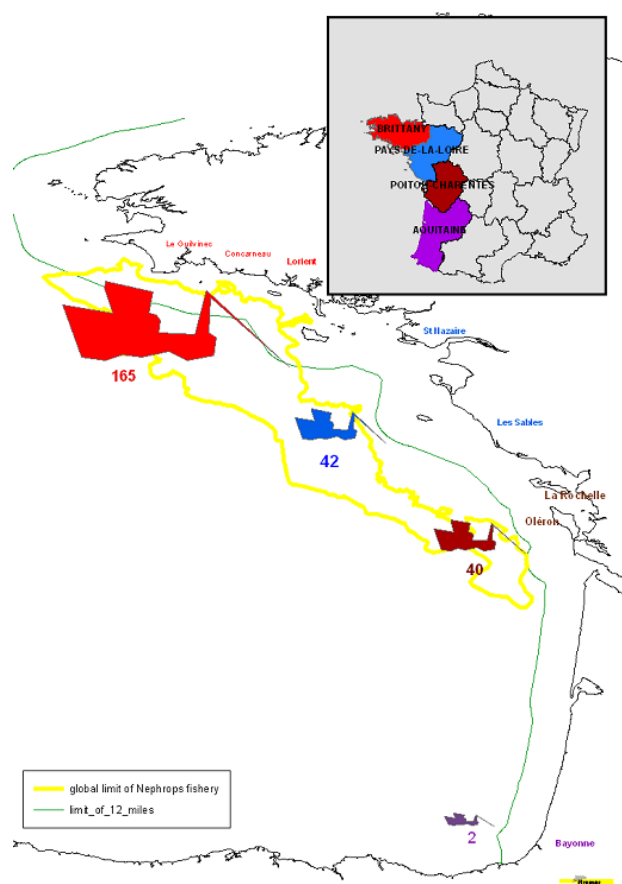


Figure 3.5 *Nephrops* fishery in the Bay of Biscay. Fleet by administrative region (numbers of vessels in 2004; current fleet is composed from 175 units possessing the specific license; the proportion between regions remains unchanged).

For the FU23-24 *Nephrops* trawl survey (conducted on board RV “Gwen Drez” for 2006–2013), the sampling plan was a stratified random one. Strata correspond to sedimentary units according to the mud composition and its origin (Figure 3.6). The allocation of the sampling effort by stratum combined surface with indicator linked to the fishing pressure (provided either by DCF sampling on board information or by VMS data (Tables 3.1 and 3.2)). The standardised trawl series French *Nephrops* trawl survey in Bay of Biscay Langolf was stopped in 2014. Then in 2014 and 2015 to obtain data on the *Nephrops* population random trawls were carried out by commercial vessels at the same time as the UWTV operations. The sampling protocol was the same as that employed in previous years. (Table 3.3).

Start time of the haul is defined as the moment when the vertical net-opening and door spread are stable. Stop time is defined as the start of pull back. The haul duration is fixed at 30 minutes and the average speed is 3–3.5 knots. The daily trawling arrangement is planned taking into account daily variations of *Nephrops* activity outside burrows usually maximized at dawn and dusk. The SCANMAR system sensors were used on board RV GwenDrez to monitor in real time the trawl geometry: door to door distance, wings horizontal opening and vertical opening.

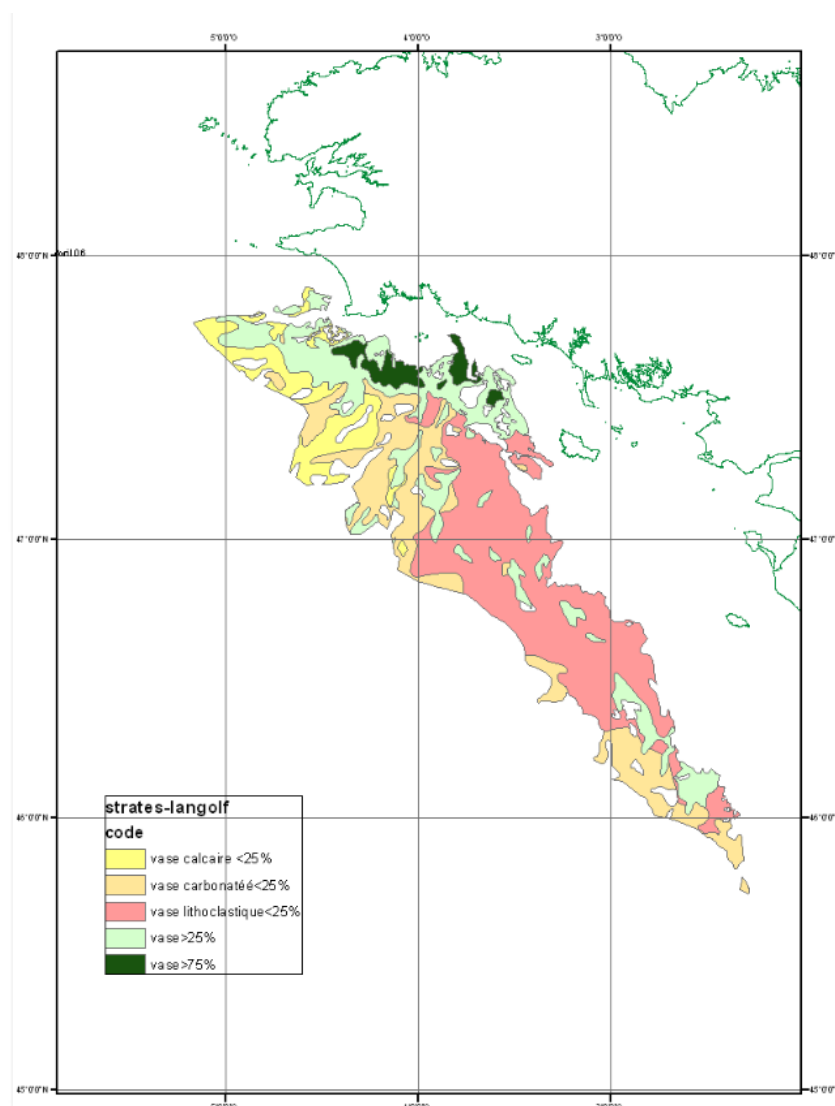


Figure 3.6 Representation of the five sedimentary strata in the Bay of Biscay (FU23-24).

Table 3.1 Bay of Biscay (FU23-24). Distribution (%) of the *Nephrops* fishing effort by sedimentary stratum and by district or harbour (GV=Le Guilvinec; CC+LO=Concarneau and Lorient; South=Le Croisic, Les Sables d'Olonne, La Cotinière).

STRATUM	LABEL	GV	CC+LO	SOUTH	TOTAL
1	Mud > 75%	4.43	4.89	2.80	12.12
2	Mud > 25%	18.90	26.09	9.09	54.08
3	Calcareous mud < 25%	9.10	0.00	0.00	9.10
4	Lithoclastic mud < 25%	0.00	11.42	8.39	19.80
5	Carbonated mud < 25%	3.50	0.00	1.40	4.90
		35.93	42.40	21.67	100.00

Table 3.2 Surfaces (km²) of the sedimentary strata in the Bay of Biscay. Allocation vs. surface (W_surf) and distribution of the fishing effort (W_eff) from the commercial fleet. Number of trawling stations (N) by stratum.

STRATUM	LABEL	SURFACE	W_SURF	W_EFF	W_COMB	N (on 50)
1	Mud > 75%	633.1003	0.0542	0.1212	0.0877	4
2	Mud > 25%	2 691.5138	0.2305	0.5408	0.3856	19
3	Calcareous mud < 25%	1 152.8603	0.0987	0.0910	0.0949	5
4	Lithoclastic mud < 25%	4 663.6355	0.3994	0.1980	0.2987	15
5	Carbonated mud < 25%	2 535.6100	0.2172	0.0490	0.1331	7

ACTUAL NUMBER OF STATIONS:							
2006	2007	2008	2009	2010	2011	2012	2013
71	68	82	70	76	69	74	68

Table 3.3 *Nephrops* FU23-24. Schedule time for LANGOLF "Gwen Drez" 2006–2013, LANGOLF-TV 2014–2015.

YEAR	VESSELS + ACTUAL DURATION	DATES
2006	Gwen Drez (14 days)	7–23/04
2007		8–24/05
2008		16/05–5/06
2009		13–29/05
2010		14–31/05
2011		17–30/05
2012		3–19/05
2013		4–20/05
2014	Atlantique (7 days) + Sanaga (3 days) associated to "RV Celtic Voyager" for UWTV survey	20–29/09
2015	Atlantique (6 days) + Pastenague (2 days) associated to "RV Prince Madog" for UWTV survey	20–29/07

Conclusion/Recommendation:

The previous time-series provided exploitable quantitative information on the specificity of the Bay of Biscay central mud bank ecosystem although it was stopped. Nevertheless, more recent information obtained by commercial trawlers associated to the UWTV survey should allow to calculate correction factor of proportion between *Nephrops* and squat lobsters (*Munida* sp.) in order to correct bias on burrows counting.

4 The Series of ICES Survey Protocols (SIPS)

Work and discussions on the UWTV and Trawl SIPS progressed well at the meeting and the documents will be submitted at the beginning of 2016.

5 The Cooperative Research Report (CRR)

Work and discussions on the Cooperative Research Report (CRR) progressed well at the meeting and the document will be submitted at the beginning of 2016.

6 Inter-benchmark FU14 and FU17

A detailed overview was presented to this meeting on the inter-benchmark process for FU14 and FU17 which was conducted by correspondence from June to September 2015.

FU14

This was the first benchmark exercise for the East Irish Sea *Nephrops* stock - FU14.

There were three main areas requiring investigation as part of the inter-benchmark process for FU14 *Nephrops*:

- Revisions to the area of the *Nephrops* grounds based on new available data: VMS, UWTv data, and sediment information;
- A review of fishery data and raising procedures;
- Review of Reference points: F_{MSY} proxies and $MSY_{B_{trigger}}$

Three different approaches were tested to redefine the current fishing area in the main ground: Fit to VMS data (based on VMS data); Weighted overlay (parameters weights: based 60% VMS, 30% *Nephrops* densities and 10% sediment distribution); Co-kriging (VMS is the main variable; and *Nephrops* densities and sediment distribution are secondary variables). The redefinition of the main polygon resulted in a 6% decrease for the main area, from 1032.75 km² to 1019.79 km², although in total due to the increase of Wigtown Bay the total FU14 fishing area is still very similar, from 1052.37 km² to 1087.01 km².

Three sampling programme that collected biological information for *Nephrops* in the East Irish Sea were identified: *Nephrops* catch sampling (catch component, 1999 to current); Observer programme (retain and discard component, 2003 to current); Market sampling (landings component, 1983 to current). Results were discussed at the Working Group for the Celtic Seas Ecoregion 2015 (WGCSE). It was agreed that the market sampling data would not be suitable to raise the total landing data as it is biased towards the bigger size classes, thus on this basis the observer programme was combined with the catch sampling programme to derive the annual landing length distribution. Mean weight, sizes for landings, and discards were updated retrospectively up to 2000. Sex ratio was also updated showing currently a very even exploitation pattern between sexes (proportion of males = 0.48 (average 2013–2014)). A single discard ogive was fitted, by pooling all years (2003–2014) and mesh sizes, showing a final discard selection for the East Irish Sea at $L_{50} = 23.54$ and a $L_{25} = 24.77$ mm CL and the discard selection survival rate was updated to 10%.

New MSY explorations were carried out at the current IBP for FU14. A SCA (separable cohort analysis, model Bell) was used to estimate sustainable stock specific Harvest Ratio reference points. $F_{0.1}$ is still suitable as F_{MSY} proxy for this stock, which now corresponds to a harvest rate of 11%. $B_{trigger}$ was identified for the first time for this stock, which is now set at 350 million (abundance observed in 2009).

Recommendations/Conclusions

As in other *Nephrops* stock there are a number of generic research questions related to occupancy and edge effect bias that needs still to be investigated. There are also specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

- More accurate mapping of the spatial extent of the grounds and fisheries, this includes having positional data for < 12 metre vessels and more survey data in Wigtown Bay area to better define this ground.
- Improvement of spatial coverage and sampling of landings and discards, this includes increasing the sampling levels to covers Northern Irish vessels, as the current sampling is mainly focused on local vessels from Whitehaven port.
- Area specific length-weight and maturity data to validate the parameters used for this FU.
- Better knowledge of the difference in growth and population structure across the area.

FU17

The main areas requiring investigation for FU17 *Nephrops* were:

- Review of catch and effort data.
- Review of biological parameters: sex ratio, female maturity, growth parameters, natural mortality.
- Revise area for Aran, Galway Bay and Slyne Head *Nephrops* grounds based on new available data and rework the abundance estimates. The shapefiles of the FU17 ground are available at:
<http://data.marine.ie/downloads/fisheries/NephropsGrounds.zip>
- Review of sampling and raising procedures.
- Reference points: F_{MSY} proxies and propose $MSY B_{trigger}$.

As part of the 2015 IBP process the full kriging procedure for the Aran ground from 2002 to 2015 was reviewed and fully documented through an r markdown document (Lordan, WD1). The geostatistical analysis was carried out using RGeostats package (Renard D. *et al.*, 2015).

Recommendations/Conclusions

IBPNeph recommended that the area boundaries should only be refined when substantial additional data becomes available (e.g. new backscatter data, sediment sampling data and improved VMS data to include vessels of size 12 metres). Any future area revisions should be considered by WGNeps.

7 Update on the ICES UWTv database

The working group identified the minimum data requirements that should be included in future ICES UWTv database. This work will be further developed in the coming years and is part of the ToRs for 2016–2018.

Table 7.1 Information required to be included in future ICES UWTv database

PARAMETER	UNIT
Vessel	NA
FU	NA
Ground	NA
Station	Alfa Numerical
Longitude	Decimalised
Latitude	Decimalised
Density	Adjusted (n/m ²)
Distance over ground	Metres
Area	m ²
Count	Number of burrows
Field of view - fov	Metres
Source	Source of distance
Shape file for all FUs	NA

8 Review the WGISUR reports and discuss the utility of *Nephrops* UWTV surveys as platforms for the collection of data for OSPAR and MFSD indicators

Task included in the next set of ToRs for 2016–2018.

9 Technological developments

A presentation was given by Jordan Feeings describing the work currently being undertaken by DTU Aqua to create video mosaics from UWTV survey footage. At present, the program is capable of creating 1 minute strips which are built up while viewing the footage. As the mosaics are being built it is possible to annotate them, making it possible to identify a range of features, e.g. *Nephrops* burrows, trawl tracks and sea pens (Figure 9.1). The possibility of being able to view the footage at the same time as the mosaics are being built allows for viewing the burrows from different angles as the sled passes over the top. This allows the reader to gain a better impression of the different features (e.g. burrow complexes) while annotating the mosaics. A plan was made for several counters to analyse a series of survey footage to be able to determine whether counts differ from those obtained through the standard method.

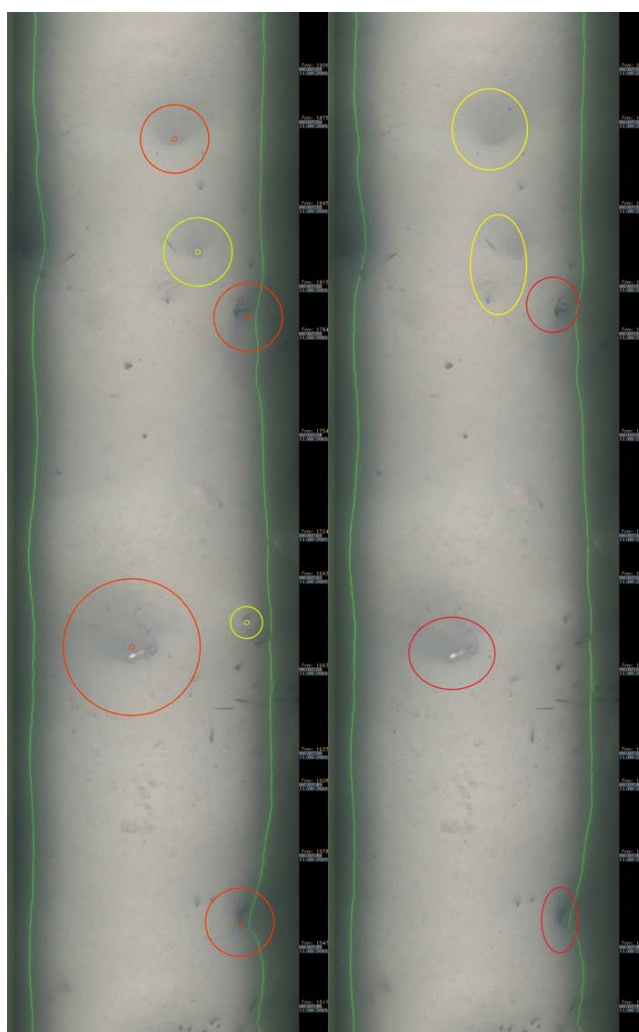


Figure 9.1 shows 2 examples of the same footage (FU 3-4) as counted by 2 different people. Red circles denote burrow entrances and yellow circles denote auxiliary entrances to the same burrow complex.

Additionally another presentation was given on behalf of Dr David Corrigan and Catherine Fitzpatrick, Electronic Engineering Department, Trinity College Dublin, Ireland. The researchers have processed all of the Marine Institute 2014 UWTV footage into 365 mosaics (Figure 9.2).

The process can be summarized as follows:

- 1) Manual segmentation of stations from DVD video files.
- 2) Conversion of videos into a format compatible with Matlab.
- 3) Mosaicking using an updated version of the mosaicking algorithm first presented by Sooknanan (2014).

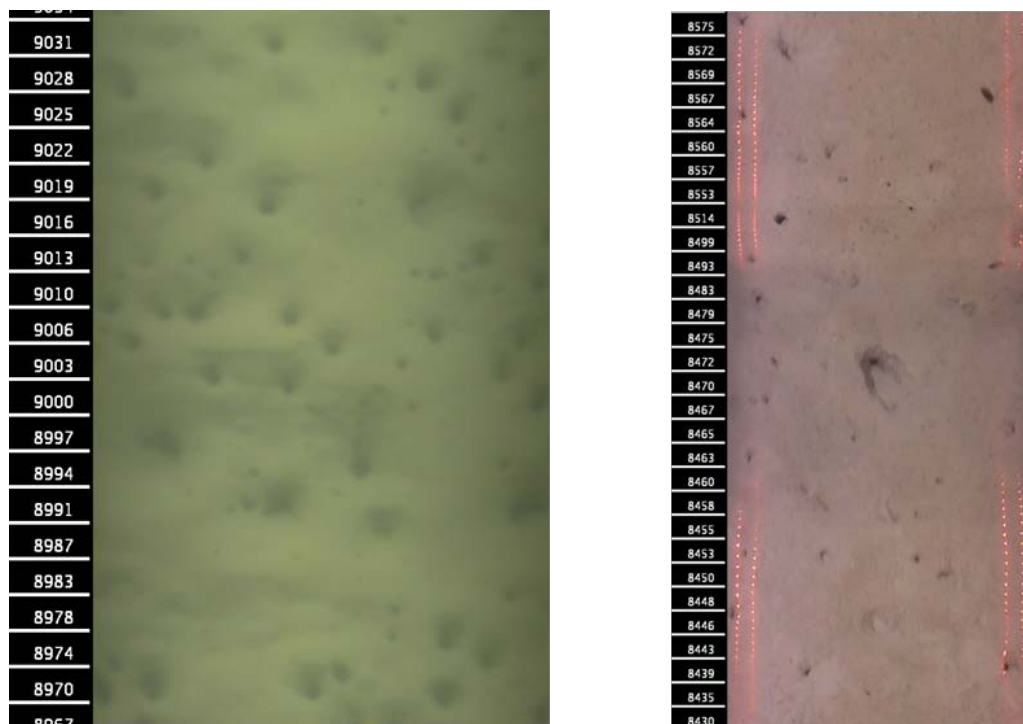


Figure 9.2 shows examples of a 2 second mosaic. FU15 mosaic on left and FU19 mosaic on right side. Computation time is lengthy in the order of a couple of hours to process 10 minutes of video.

Recommendations/Conclusions

WGNeps recommends that the mosaicking and automatic counting algorithm research needs to be continued and developed. Work should focus on automating the clip segmentation, reducing computation time and improving usability of the software. This will require implementation of existing technologies on a more efficient platform. Significant consultation with marine scientists will help specify requirements for the user-interface and presentation of mosaics. It is expected that this work will require external funding to finance it.

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Annex 1: List of participants

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Annex 2: Agenda and presentations

Day 1 Tuesday 10 November 2015

9:30–10:00 Welcome, Introductions adoption of agenda, report structure and allocate tasks

10:00–10:40 WGNeps 2015 review of survey activity for existing series

Updated on the Skagerrak and Kattegat UWTv survey Jordan P. Feekings, Kai Wieland, and Mats Ulmestrand (20 min)

Developments in Scottish UWTv surveys. Katie Boyle (20 min)

10:40–11:00 Coffee Break (view UWTv footage)

11:00–12:20 WGNeps 2015 review of survey activity for existing series

Developments on Marine Institute Surveys – Colm Lordan/Jennifer Doyle (20 min)

Developments on AFBI trawl and UWTv surveys - Annika Clements (20 min)

Developments on Cefas surveys - Ana Leocádio (20 min)

Developments on the UWTv survey in the Gulf of Cádiz Yolanda Vila (20 min)

12:20–13:00 *Nephrops* assessments in other areas

Nephrops in Icelandic waters Jónas P. Jónasson (20 min)

Nephrops in the Adriatic Sea Michela Martinelli (20 min)

13:00–14:00 Lunch

14:00–14:20 Review progress on the SISP and CRR documents – Set subgroups and allocate tasks.

14:20–15:45 Drafting Subgroups on SIPS and CRR

15:45–16:05 Coffee Break (view UWTv footage)

16:05–17:45 Drafting Subgroups on SIPS and CRR

17:45–18:00 Follow up - The DevNepS project proposal.

Day 2 Wednesday 11 November 2015

WGNeps 2015 review of survey activity for existing series continued...

9:00–09:30 Developments on the UWTv and trawl surveys in the Bay of Biscay. Spyros Fifas/Michèle Salaun

9:30–10:00 Developments on the trawl/UWTv surveys in Portugal. Cristina Silva (20 min)

Discussion on possible joined UWTv survey Portugal/Spain – southern stocks linked!

10:00–10:40 *Nephrops* Benchmarks outcomes and preparation

FU17 outcome – Jennifer Doyle (~15 min)

FU14 outcome – Ana Leocádio (~15 min)

Benchmark 2016, *Nephrops* stocks

10:40–11:00 Coffee Break (view UWTv footage)

11:00–13:00 Drafting Subgroups on SIPS and CRR
13:00–14:00 Lunch
14:00–15:45 Drafting Subgroups on SIPS and CRR
15:45–16:05 Coffee Break (view UWTv footage)
16:05–17:50 Plenary review of SISP – Finalize document
17:50–18:10 Update on the ICES UWTv database, ICES requirements.

Day 3 Thursday 12 November 2015

9:00–10:40 "Availability of *Nephrops norvegicus*: What laboratory research suggest us?"
- Valerio Sbragaglia/ Jacopo Aguzzi (presentation + videos on agonistic interactions of *Nephrops*)
10:40–11:00 Coffee Break (view UWTv footage)
11:00–13:00 Review the WGISUR reports and discuss the utility of *Nephrops* UWTv surveys as platforms for the collection of data for OSPAR and MFSD indicators.
13:00–14:00 Lunch
14:00–15:00 Review video enhancement, video mosaicking, automatic burrow detection and other new technological developments. Jordan P. Feekings.
15:00–15:45 Drafting Subgroups on CRR and Report
15:45–16:05 Coffee Break (view UWTv footage)
16:00–18:00 Plenary review of CRR – Finalize document

Day 4 Friday 13 November 2015

09:00–10:00 Multiannual ToRs for 2016/2018.
10:00–15:00 Review WGNeps report and draft recommendations.

Presentations given

Presentation 1: Updated on the Skagerrak and Kattegat (FU3-4) UWTW survey. Kai Wieland and Jordan Feekings, DTU Aqua, Hirtshals, Denmark

Presentation 2: Developments in Scottish UWTW surveys. Katie Boyle and Adrian Weetman, Marine Scotland Science, Aberdeen.

Presentation 3: Developments on Marine Institute Surveys. Jennifer Doyle, Marine Institute, Ireland

Presentation 4: Developments on AFBI trawl and UWTW surveys. Annika Clements, Agri-Food and Biosciences Institute (AFBI), UK-Northern-Ireland

Presentation 5: Developments on Cefas surveys.

Presentation 6: Developments of the UWTW survey in the Gulf of Cádiz. Yolanda Vila, Instituto Español de Oceanografía (IEO), Spain

Presentation 7: *Nephrops* in Icelandic waters. Jónas P. Jónasson, Marine Research Institute, Iceland

Presentation 8: *Nephrops* in the Adriatic Sea. Michela Martinelli, CNR, Italy

Presentation 9: Developments on the UWTW and trawl surveys in Ana Leocádio, Cefas, UK-England the Bay of Biscay. Spyros Fifas and Michèle Salaun, Ifremer, France

Presentation 10: The results of *Nephrops* Trawl surveys in Portugal FU28-29. Cristina Silva, IPMA, Lisbon

Presentation 11: IBP for FU17. Jennifer Doyle, Marine Institute, Ireland

Presentation 12: IBP for FU14. Ana Leocádio, Cefas, UK-England

Presentation 13: Availability of *Nephrops norvegicus*: What laboratory research suggests us?" - Valerio Sbragaglia and Jacopo Aguzzi

Annex 3: Draft WGNEPS ToRs (2016–2018)

A Working Group on *Nephrops* Surveys (WGNEPS), chaired by Ana Leocadio, UK, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2016	7-11 November	Reykjavík, Iceland	Interim report by 6 December 2016 to SSGESST (SSGIEOM)	
Year 2017				
Year 2018				

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
	Review SISP guidelines	SSGIEOM have developed guidelines for the SISP, and it is important to update those guidelines to reflect the use of the protocol by the EGs		Year 1	Reivew the current SISP guidelines.
a	To review any changes to design, coverage and equipment for the various <i>Nephrops</i> UWTV surveys.	To ensure surveys used by WKNEPH, WGCSE, and WGNSSK are fit for purpose.		Recurrent annual update	Survey summary including and description of alterations to the plan, to relevant assessment-WGs (WKNEPH, WGCSE, WGNSSK,) and SCICOM. Planning of the upcoming surveys for the survey coordinators and cruise leaders, and update the SISP accordingly.

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
b	To review the design, coverage, results and uses of <i>Nephrops</i> trawl surveys in consultation with WGISDAA.	There are trawl surveys for <i>Nephrops</i> in some area and trawling activity also takes place with UWTV surveys. These activities need review and co-ordination.		Recurrent annual update	Survey summary including and description of alterations to the plan, to relevant assessment-WGs (WKNEPH, WGCSE, WGNSSK, WGHMM,) and SCICOM. Planning of the upcoming surveys for the survey coordinators and cruise leaders, and update the SISP accordingly.
c	To review video enhancement, video mosaicking, automatic burrow detection and other new technological developments.	WGNEPS should periodically review emerging technologies that might improve survey methodologies.		Recurrent annual update	To update the SISP based on conclusions. Other publications when appropriate.
e	Discuss the utility of UWTV and trawl <i>Nephrops</i> surveys as platforms for the collection of data for OSPAR and MFSD indicators.	<i>Nephrops</i> UWTV surveys have a role in relation to benthic habitat monitoring and the collection of other environmental and ecosystem variables.		Year 2	To update the SISP based on conclusions
f	Develop an international database which will hold burrow counts, ground shape files & other data associated with UWTV surveys. Develop an international database on trawl surveys.	There is a need to centralize UWTV data in a single international database. Ensure data is available externally.		Year 2/3	ICES database

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
g	Review of existing datasets to evaluate possible factors affecting (i.e. currents, light, etc.) burrow emergence.	Recent behaviour aspects have been investigated in the laboratory. Important to investigate correlation with field data.		Year 2/3	Review paper
h	Developing R scripts for UWTV survey data processing including functions to QC, analyze and visualize data, and interface the tools with the data base (ToR f).	Improving standardisation of data QC and data processing. Support new developing surveys on data analysis.		Year 3	Document and R packages for UWTV survey data.

Summary of the Work Plan

Year 1	THE MAIN TASK WILL BE TO CARRY OUT A BURROW COUNTING TRAINING WORKSHOP AT A EUROPEAN LEVEL, THIS WILL TAKE PLACE IN REYKJAVÍK, ICELAND. THIS WG WILL BE EXTENDED FOR 1 DAY TO ACCOMMODATE THE TRAINING COURSE IN THE SAME WEEK. AROUND 2 DAYS WILL BE ALLOCATED TO REVIEW ANY CHANGES TO DESIGN, COVERAGE AND EQUIPMENT FOR THE VARIOUS <i>Nephrops</i> UWTV/TRAUL SURVEYS AND TO REVIEW VIDEO EN-HANCEMENT, VIDEO MOSAICKING, AUTOMATIC BURROW DETECTION AND OTHER NEW TECHNOLOG-ICAL DEVELOPMENTS AND THE REMAINING 3 DAYS WILL BE ALLOCATED TO THE BURROW COUNTING TRAINING WORKSHOP. THE FACILITIES AND EQUIPMENT WILL BE PROVIDED BY THE MARINE RESEARCH INSTITUTE IN ICELAND; ADDITIONAL EQUIPMENT MIGHT BE PROVIDED BY OTHER INSTITUTES IF REQUIRED.
Year 2	TOR a, b and c will be addressed annually. This year will focus on exploring the utility of UWTV and trawl <i>Nephrops</i> surveys as platforms for the collection of data for OSPAR and MFSD indicators (ToR e). Additionally ToRs f and g will also be addressed and plans for ToR h will be made. Decision will be made in relation to the need of further training on burrow counting. If necessary this will take place on year 3.
Year 3	TOR a, b and c will be addressed annually. Work will focus on ToRs f, g and h as well as reviewing any relevant changes to survey procedures. SISP will be updated accordingly.

Supporting information

Priority	<i>Nephrops</i> are a valuable species whose stocks are potentially susceptible to local depletion. UWTV/Trawl surveys are an integral part of the stock assessment and management advice provided by ICES. WGNPS is the international co-ordination group for <i>Nephrops</i> surveys focusing on planning, coloboration, quality control and survey development issues. This work is considered high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 15–20 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	This group will feed into the assessment working groups and subsequently on to ACOM
Linkages to other committees or groups	There is a very close working relationship with all the groups of WKNEPH. It is also very relevant to stock assessment experts groups that used the survey results i.e. WGCSE and WGNSSK Links with WGISDAA to address ToR b and WGISUR to address ToR e.
Linkages to other organizations	None

Annex 4: Recommendations

RECOMMENDATION	ADDRESSED TO
1. WGNeps proposes that an UWTV Database to should be developed to make the data available.	WGNeps and ICES Data Centre
2. A dedicated research project on <i>Nephrops</i> UWTV surveys has been proposed by WGNeps; “Further developing UWTV <i>Nephrops</i> survey methodologies (DevNepS)”. WGNeps recommends that this project be funded in the near future through funding mechnaisims such as EMFF.	DC-MAP co-ordinators in Member States.
3. WGNeps recommends that survey coverage be expanded to other improtant fisheries not currently assessed e.g. Horns Reef FU33, Bottney Gut FU5.	Regional Coordination Meeting of the DC-MAP