

## **FU19 *Nephrops* Grounds**

### **2013 UWTV Survey Report and catch options for 2014.**

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## Abstract

This report provides the main results and findings of the fourth underwater television survey of the various *Nephrops* grounds in Functional Unit 19. The survey was multi-disciplinary in nature collecting UWTV, CTD, multi-beam and other ecosystem data. In 2013 a total 40 UWTV stations were successfully completed. Adjusted burrow density estimates varied considerably across the different grounds. The 2013 raised abundance estimate of 397 million burrows is a 20% decrease from the 2012 estimate. Taking into account the uncertainty (CV of 17%) this is not significantly different from abundance estimates in 2011 or 2012. Using the 2013 abundance and recent mean weight and discard implies 2014 total catch advice fishing at  $F_{msy}$  ( $=F_{35\%spr}$ ) of 618 tonnes which results in landings of no more than 521 tonnes.

Key words: *Nephrops norvegicus*, stock assessment, geostatistics, underwater television (UWTV), benthos.

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## Introduction

The prawn (*Nephrops norvegicus*) are common in the Celtic Sea occurring in geographically distinct sandy/muddy areas where the sediment is suitable for them to construct their burrows. The *Nephrops* fishery in VII is extremely valuable with landings in 2012 worth around € 80 m at first sale. The Celtic Sea area (Functional Units 19-22) supports a large multi-national targeted *Nephrops* fishery mainly using otter trawls and yielding landings in the region of ~6,000 t annually. Over the last decade reported landings from FU19 have been at around 800 t (ICES, 2013). The 2012 landings of 770 t are estimated to be worth € 4.8 m at first sale. The *Nephrops* fishery in FU19 occurs on several spatially discrete mud patches which are spread out over a vast area (Figure 1).

It is well documented that *Nephrops* spend a great deal of time in their burrows and their emergence behaviour is influenced by many factors; time of year, light intensity and tidal strength. Underwater television surveys and assessment methodologies have been developed to provide a fishery independent estimate of stock size, exploitation status and catch advice for several *Nephrops* stocks around Ireland (ICES, 2009a & 2011). This is the third consecutive time (2011 – 2013) that an UWTV survey has been carried out in FU19 by the Marine Institute, Ireland where in 2006 only one ground within this FU was surveyed. This survey was multi disciplinary in nature; the specific objectives are listed below:

1. To obtain 2013 quality assured estimates of *Nephrops* burrow densities from several of the discrete mud patches of *Nephrops* ground in FU19.
2. To collect ancillary information from the UWTV footage collected at each station such as the occurrence of sea-pens, other macro benthos and fish species and trawl marks on the sea bed.
3. To collect oceanographic data using a sledge mounted CTD.
4. To collect multibeam data to determine the extent of the *Nephrops* mud patches within FU19.

This report details the final UWTV results of the 2013 FU19 survey and also documents other data collected during the survey. The 2013 abundance are used to generate catch options for 2014 in line with the recommendations and procedures outlined in the stock annex for FU19.

## Material and methods

The spatial extent of the *Nephrops* grounds in FU19 has previously been defined using 2006-2008 integrated VMS-logbook data using the methods described in Gerritsen and Lordan (2011) (Figure 1). The discrete grounds have been named as: Bantry Bay, Galley Ground 1-4, Cork Channels and Helvick 1-3 and are shown as polygons in Figure 1. The area of each ground polygon was calculated in Arcgis10 using different projections and an average value used (Table 1). The ground boundaries are under review as part of the ICES benchmark planned for 2014. In 2013 UWTV stations were randomly picked from slightly different ground polygons (defined using more extensive 2006-2011 VMS data) using the “Create Random Points” tool in ArcToolbox of ArcGIS10. The sampling effort on each ground was determined by relative area. To be consistent with previous surveys the abundance

estimates were calculated by multiplying the mean density in each ground by the area of each ground in Table 1. In most years an adjustment was needed for unsampled grounds (normally based on assumed densities for unsampled grounds).

The 2013 FU19 survey took place on RV. Celtic Voyager in two legs due to weather and time constraints (Leg1:16<sup>th</sup> -18<sup>th</sup> June 2013 and Leg 2: 5<sup>th</sup> -6<sup>th</sup> September 2013) where the survey time also included UWTV operations in other FUs 16, 17 and FU2021. Results of these surveys are available in separate reports. The protocols used were those reviewed by WKNEPHTV 2007 (ICES, 2007) and used in all other grounds surveyed by Ireland. Station depths ranged from 36 metres in Bantry Bay to 114 metres in the Galley Grounds.

At each station the UWTV sledge was deployed and once stable on the seabed a 10 minute tow was recorded onto DVD. Vessel position (DGPS) and position of sledge (using a USBL transponder) were recorded every 1 to 2 seconds. The navigational data was quality controlled using an “r” script developed by the Marine Institute (ICES, 2009b). In 2013 the USBL navigational data was used to calculate distance over ground for 98% of stations whereas ship data was used for the remaining 2% of stations.

In line with SGNEPS recommendations all scientists were trained/re-familiarised using training material and validated using FU17 reference footage prior to recounting at sea (ICES, 2009b). There is no FU19 specific reference footage available yet. Individual’s counting performance in 2013 against the reference counts was measured by Linn’s concordance correlation coefficient (CCC). A threshold of 0.5 was used to identify counters who needed further training. Once this process had been undertaken, all recounts were conducted by two trained “burrow identifying” scientists independent of each other on board the research vessel during the survey. During this review process the visibility, ground type and speed of the sledge during one-minute intervals were subjectively classified using a classification key. In addition to the numbers of *Nephrops* burrows complexes (multiple burrows in close proximity which appear to be part of a single complex which are only counted once), *Nephrops* activity in and out of burrows was also counted by each scientist for each one-minute interval. Following the recommendation of SGNEPS the time for verified recounts was 7 minutes (ICES, 2009b).

Notes were also recorded each minute on the occurrence of trawl marks, fish species and other species. Abundance categories of sea-pen species were also recorded due to OSPAR Special Request (ICES 2011). A key was devised to categorise the densities of seapens based SACFOR abundance scale (Table 2) after ICES (2011). Finally, if there was any time during the one-minute where counting was not possible, due to sediment clouds or other reasons, this was also estimated so that the time window could be removed from the distance over ground calculations. The “r” quality control tool allowed for individual station data to be analysed in terms of data quality for navigation, overall tow factors such as speed and visual clarity and consistency in counts (Figure 2). Consistency and bias between individual counters was examined using Figure 3. There is some variability between counters but no obvious bias or excessive deviations.

The recount data were screened for one minute intervals with any unusually large deviation between recounts. Means of the burrow and *Nephrops* recounts were standardised by dividing by the survey area observed. Either the USBL or estimated sledge lay-back were used to calculate distance over ground of the sledge. The field of view of the camera at the bottom of the screen was estimated at 75cm assuming that the sledge was flat on the seabed (i.e. no sinking). This field of view was confirmed for the majority of tows using lasers during the 2013 survey. Occasionally the lasers were not visible at the bottom of the screen due to sinking in very soft mud (the impact of this is a minor under estimate of densities at stations where this occurred). The abundance estimation is the product of the mean density and ground area. The 95% CI and relative standard error were calculated for each ground.

A CTD profile was logged for the duration of each tow using a Seabird SBE 37. This data will be processed later. Seabed mapping was carried during Leg 2 using the EM3002\_478 Multibeam Echosounder and this was used to collect bathymetric and sediment hardness data. This system operates efficiently in max. 150 m depth and can provide total swathe coverage of ~280m. These data will be processed at a later stage and results will aid in area definition of the discrete mud patches.

## Results

The summary statistics for the various discrete *Nephrops* patches within FU19 are given in Table 4. Figure 4 and Figure 5 shows the variability in density between minutes and operators (counters) for each station. These show that the burrow estimates are fairly consistent between minutes and counters. The 2013 mean adjusted<sup>1</sup> density estimates for these vary considerably from the lowest observed in Helvick 0.06 (burrow/m<sup>2</sup>) to the highest observed estimate of 0.59 (burrow/m<sup>2</sup>) at Galley Ground 3. The mean density for Helvick patches are similar ~ 0.06 (burrow/m<sup>2</sup>) whereas the mean density varies for each of the Galley Grounds patches from 0.019 to 0.59 (burrow/m<sup>2</sup>).

The time series of summary statistics for FU19 are given in Table 5 and Figure 6. The 2013 raised abundance estimate of 397 million burrows is a 20% decrease from the 2012 estimate. The CV or RSE for the 2013 survey was 17% which is below the upper limit <20% recommended by SGNEPS (ICES, 2012).

In terms of area the Galley Grounds (1-4) account for 60% of the total grounds in FU19 and Galley Ground 4 is the largest of these representing 39% (Table 6). Different densities are apparent on the various different grounds within this FU. For the 2013 survey the number of observations on each individual patch is relatively low making the RSE estimates not that relevant.

Sea-pen distribution across the FU19 *Nephrops* grounds is mapped in Figure 9 and were identified from the video footage as *Virgularia mirabilis* and *Pennatula*

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<sup>1</sup> Note the “adjusted” density estimates in this report are adjusted by dividing by 1.3 (Table 3) to take account of edge effect over estimation of area viewed during UWTV transects (see Campbell et al 2009).

*phosphorea*.. Trawl marks were noted at 10% of the stations surveyed and were only noted for some minutes of the total duration of the station footage.

## Discussion

In response to the WKNEPH 2012 recommendations Ireland reviewed survey effort in FU15, 17 and 22 and reallocated survey effort to FU16, 19 and 20-21 (ICES, 2012). The main aim was to achieve some UWTV survey coverage for the main *Nephrops* grounds fished in ICES sub-area VII whilst maintaining the accuracy and acceptable precision for existing survey series. Several discrete mud patches with fished *Nephrops* populations have been identified in FU19. Scientific knowledge of the spatial distribution of the *Nephrops* habitat and population in this area is developing thanks to new multibeam data (Figure 8), more extensive VMS data and information from the fishing industry particularly for inshore areas. A review of ground polygons is one of the key tasks to be addressed when the stock is benchmarked at WKCELT in 2014. In the interim the workup procedure for the 2013 survey is consistent with that previously used for FU19.

The time series of UWTV data for FU19 is patchy. Since 2011 survey effort in this area has increased in response to ICES recommendations (ICES, 2012). In 2013 all of the the grounds have been surveyed (Table 5). Survey data up to 2012 was used by ICES assessment to assess the state of the stock (ICES, 2013). This analysis showed that the stock was fished at a sustainable rate and that abundance was stable (ICES, 2013). Although the point estimate of the 2013 burrow abundance is 20% lower than 2012 there is significant overlap in uncertainty bounds for all years.

Table 6 is an updated management option table giving total catches and landings options at various levels of fishing mortality for 2014. Using the 2013 estimate of abundance would implies total catch option at  $F_{msy}$  ( $=F_{35\%spr}$ ) of 618 tonnes which results in landings of no more than 521 tonnes, where total catches are the landings, plus dead and surviving discards.

An important objective of this UWTV survey is to collect various ancillary information. The occurrence of trawl marks on the footage is notable for two reasons. Firstly, it makes identification of *Nephrops* burrows more difficult as the trawl marks remove some signature features making accurate burrow identification more difficult. Secondly, only occupied *Nephrops* burrows will persist in heavily trawled grounds and it is assumed that each burrow is occupied by one individual *Nephrops* (ICES 2008). The CTD data will be processed at a later stage. This information is relatively easy to collect and over time will augment the knowledge base on habitat and oceanographic regime. The multibeam data will be available at a later stage and these results will aid in defining the discrete *Nephrops* grounds and refining the area calculations area for each of the grounds.

The main objectives of the survey were successfully met. The UWTV footage quality was excellent and in 2013 for the first time all of the *Nephrops* grounds within FU19 were surveyed. The multi-disciplinary nature of the survey means that the information collected is highly relevant for a number of research and advisory applications.

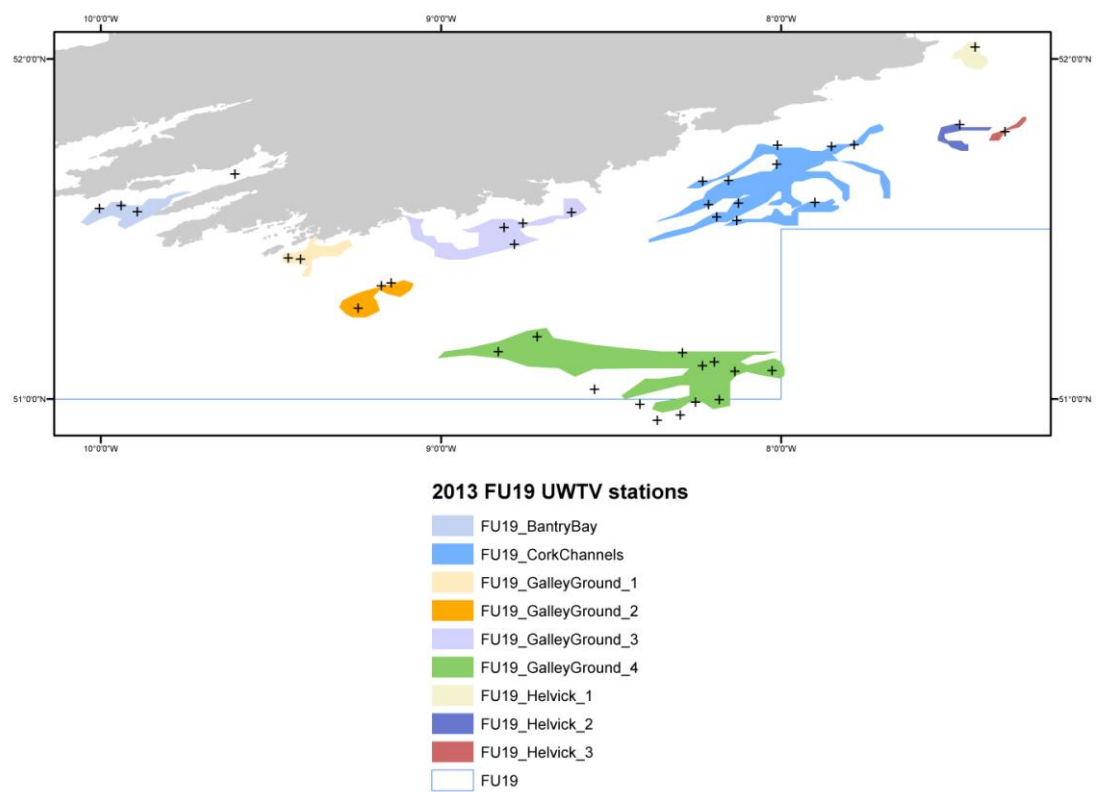
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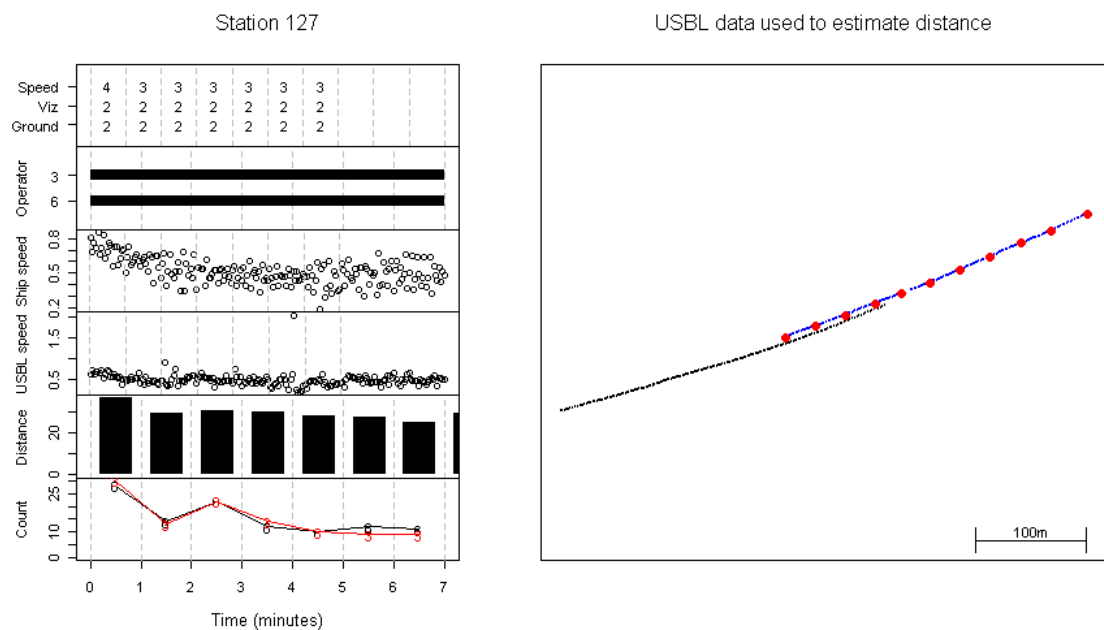
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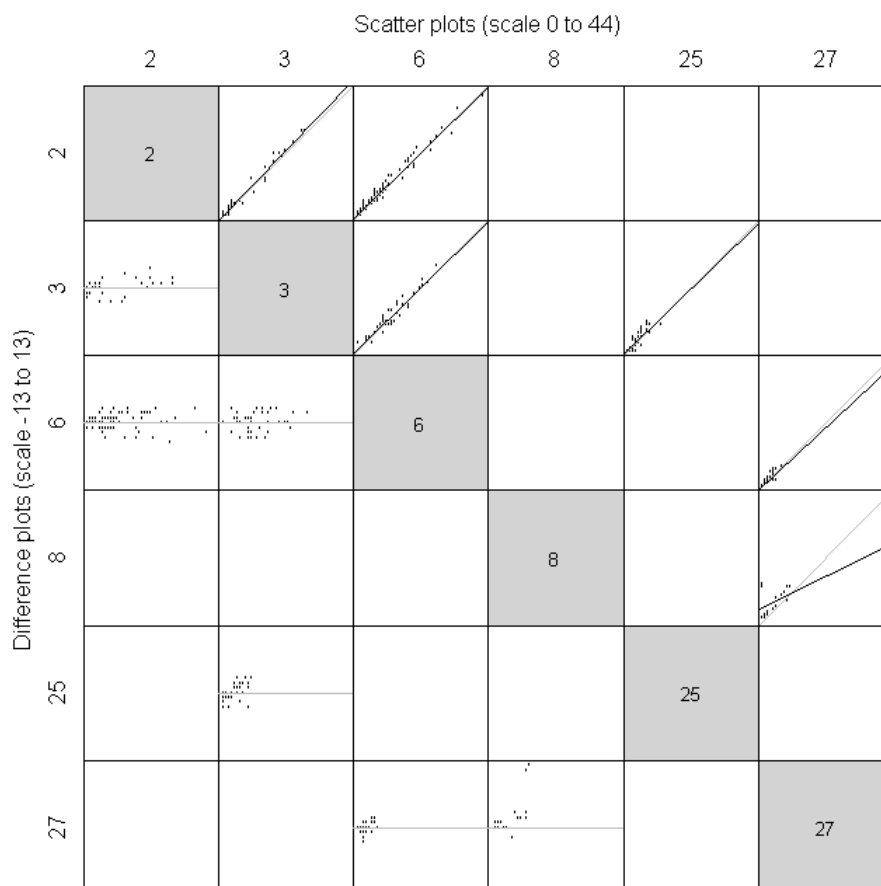




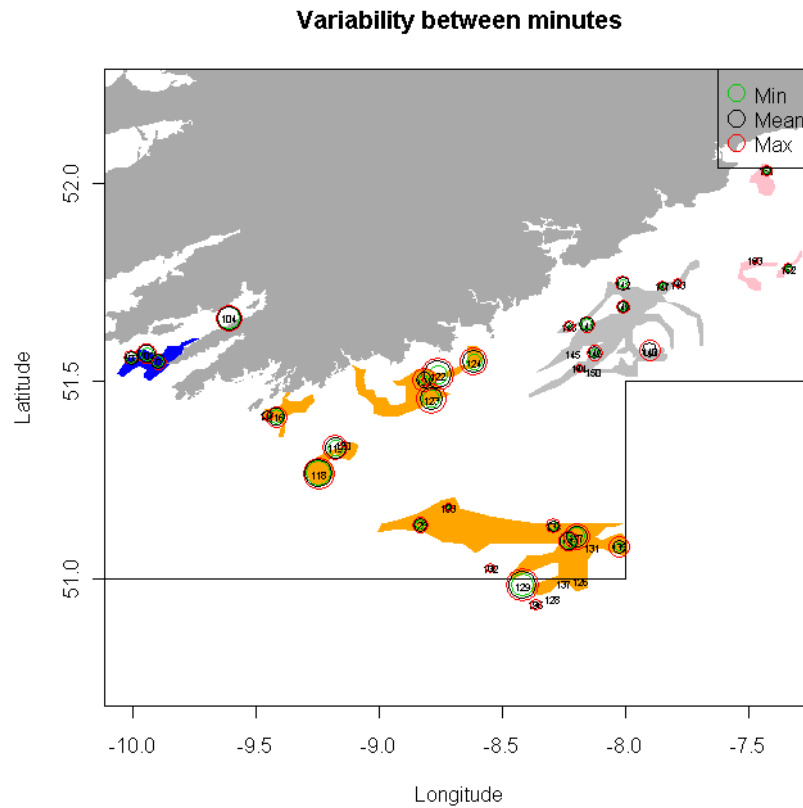
**Figure 1:** Stations completed on the 2013 FU19 *Nephrops* UWTW survey and area polygons of the discrete *Nephrops* grounds.



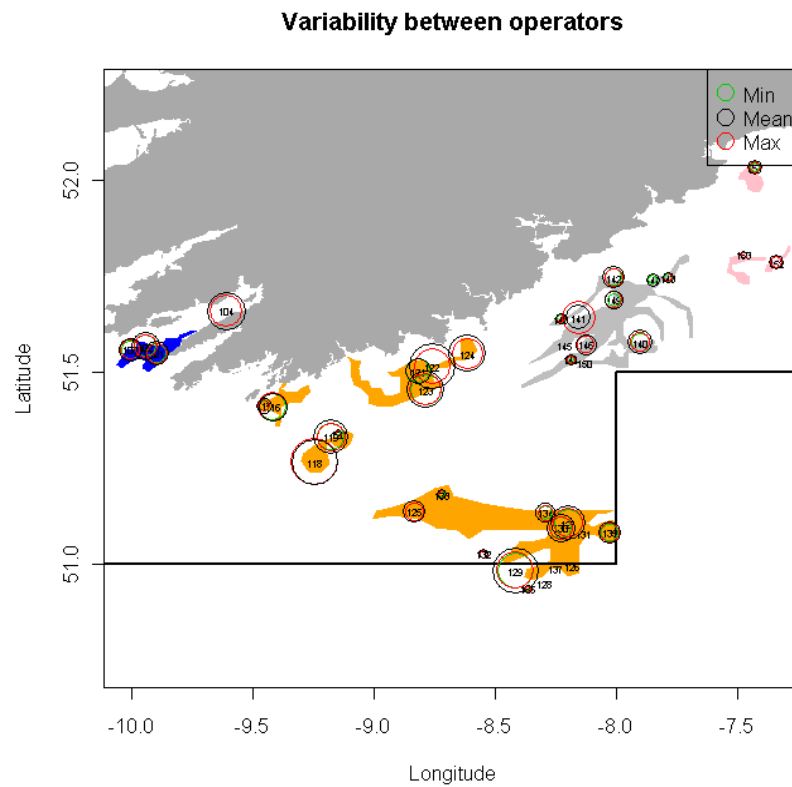
**Figure 2:** r - tool quality control plot for station 127 (Galley Grounds 4) FU19 2013 UWTv survey.



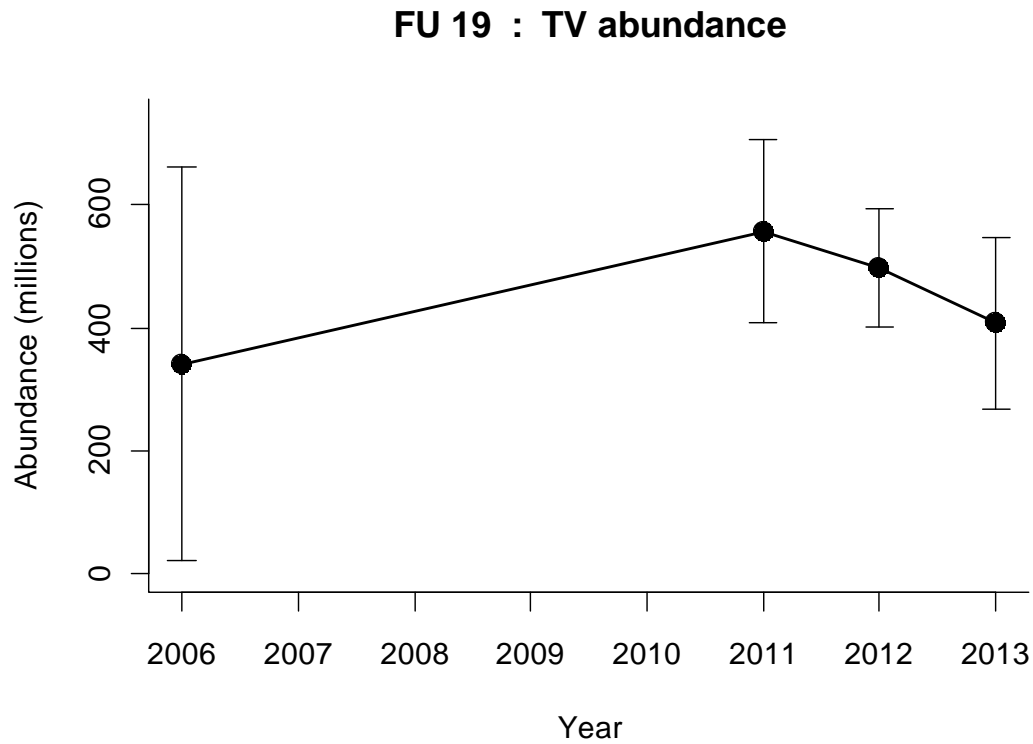
**Figure 3:** Scatter plot analysis of counter trends during FU19 2013 UWTv survey.



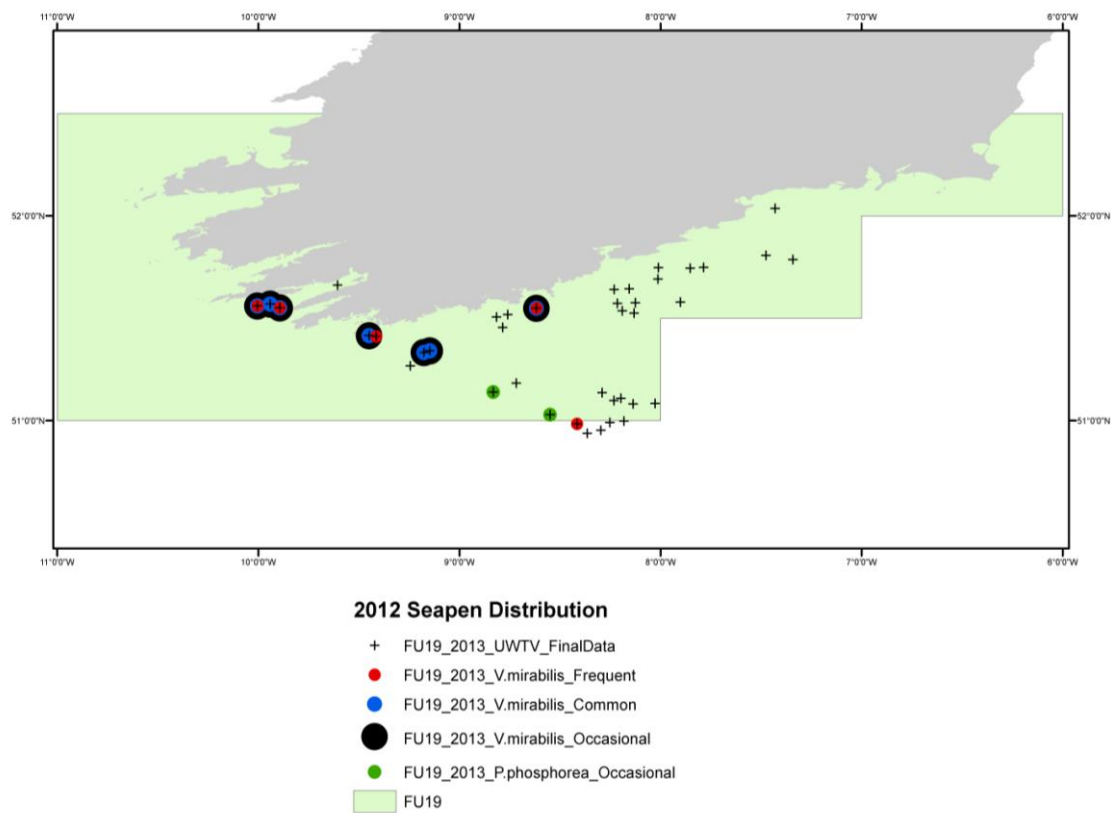
**Figure 4:** Plot of the variability in density between minutes for each station FU19 2013 UWTV survey.



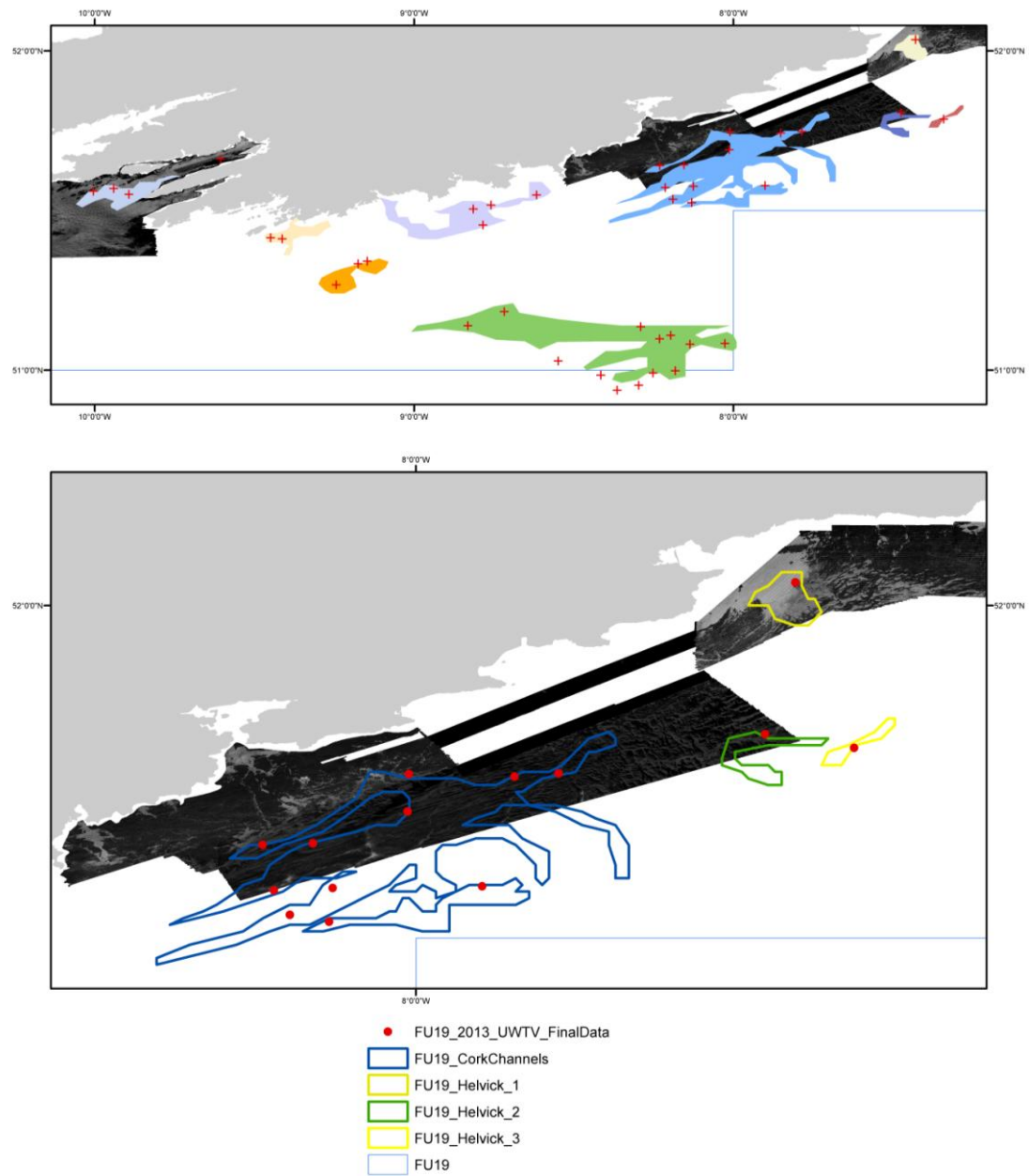
**Figure 5:** Plot of the variability in density between operators (counters) for each station FU19 2013 UWTV survey.



**Figure 6 :** Time series of raised adjusted abundance estimates (in millions of burrows) from 2006-2013 for FU19. No survey data from 2007 to 2010.



**Figure 7:** Stations where seapens were identified during the FU19 2013 UWTV survey.



**Figure 8:** Backscatter data from Irish seabed mapping programmes showing where the dark grey indicates hard ground and the light grey indicates more soft ground.

**Table 1:** Area calculations for the various *Nephrops* grounds in FU19 using ArcGIS10 based on integrated VMS based polygons.

FU	Polygons (VMS 2006-2008 basis)	ArcGIS10 Projections			
		Eckert VI (world) (km <sup>2</sup> )	Irish National Grid (km <sup>2</sup> )	Cylindrical Equal Area (km <sup>2</sup> )	Average (km <sup>2</sup> )
19	Helvick 1	38.52	38.58	38.58	38.56
19	Helvick 2	31.44	31.48	31.49	31.47
19	Helvick 3	12.65	12.67	12.67	12.66
19	Helvick 1-3	82.61	82.72	82.74	82.69
19	Bantry Bay	90.92	91.08	90.72	90.91
19	Galley Grounds 1	61.81	61.91	61.91	61.88
19	Galley Grounds 2	77.88	77.99	77.99	77.95
19	Galley Grounds 3	202.56	202.85	202.85	202.75
19	Galley Grounds 4	651.79	652.61	652.61	652.33
19	Galley Grounds 1-4	994.04	995.35	995.35	994.91
19	Cork Channels	484.28	484.93	485.02	484.75

**Table 2:** Key for classification of Seapen abundance as used on Irish UWTV surveys.

Number/Min  
Common 20-200  
Frequent 2-19  
Ocasional <2

**Species**

*Virgularia mirabilis*

*Pennatula phosphorea*

*Funiculina quadrangularis*

Sea Pens								
<i>V. mirabilis</i>			<i>P. phosphorea</i>			<i>F. quadrangularis</i>		
C	F	O	C	F	O	C	F	O

**Table 3:** Cumulative bias factors for each *Nephrops* stock surveyed by UWTV method.

	<b>FU</b>	<b>Edge effect</b>	<b>Burrow detection</b>	<b>Burrow identification</b>	<b>Burrow occupancy</b>	<b><i>Cumulative Bias</i></b>
3&4 Skagerrak and Kattegat (IIIa)	FU3	1.3	0.75	1.05	1	1.1
6:Farn Deep	FU6	1.3	0.85	1.05	1	1.2
7:Fladen	FU7	1.45	0.9	1	1	1.35
8:Firth of Forth	FU8	1.23	0.9	1.05	1	1.18
9:Moray Firth	FU9	1.31	0.9	1	1	1.21
10: Noup	FU10	1.31	0.9	1	1	1.21
11:North Minch	FU11	1.38	0.85	1.1	1	1.33
12:South Minch	FU12	1.37	0.85	1.1	1	1.32
13:Clyde	FU13	1.19	0.75	1.25	1	1.19
14: Irish Sea East	FU14	1.3	0.85	1.05	1	1.2
15:Irish Sea West	FU15	1.24	0.75	1.15	1	1.14
16: Porcupine	FU16	1.26	0.95	1.05	1	1.26
17:Aran	FU17	1.35	0.9	1.05	1	1.3
19:South Coast	FU19	1.25	0.9	1.15	1	1.3
20&21 Labadie	FU20	1.25	0.9	1.15	1	1.3
22:Smalls	FU22	1.35	0.9	1.05	1	1.3
34: Devil's Hole	FU34	1.3	0.85	1.05	1	1.2

**Table 4 :** 2013 Detailed summary statistics for the various *Nephrops* ground in FU19.

Year	Ground	Number of stations	Area Surveyed (km <sup>2</sup> )	Area Estimates (km <sup>2</sup> )	Burrow count	Mean Density adjusted (burrow/m <sup>2</sup> )	95%CI	CViid (Relative SE)	Raised abundance estimate adjusted (million burrows)
2013	Bantry	4	0.54	91	282	0.38	0.31	0.20	35
	Cork Channels	11	1.60	485	254	0.12	0.07	0.19	59
	Galley Grounds 1	2	0.29	62	95	0.23	1.59	0.42	14
	Galley Grounds 2	3	0.44	78	300	0.48	1.09	0.40	38
	Galley Grounds 3	4	0.54	203	416	0.59	0.38	0.16	120
	Galley Grounds 4	13	1.93	652	488	0.19	0.16	0.30	126
	Helvick 1	1	0.15	39	17	0.09	-	-	3
	Helvick 2	1	0.38	31	33	0.06		0.65	2
	Helvick 3	1		13		0.06			

**Table 5 :** Overview of results from 2006-2013 for FU19.

FU	Year	Number of stations	Area Surveyed (km <sup>2</sup> )	Area Estimate (km <sup>2</sup> )	Burrow Count	Mean observed Density adjusted (burrow/m <sup>2</sup> )	Standard Deviation	Raised abundance estimate adjusted (million burrows)	95%CI on Abundance	CVs
FU19	2006	6	0.93	1,653	293	0.21	0.18	342	320	36%
	2007	No Survey Data								
	2008									
	2009									
	2010									
	2011	35	5	1,653	2616	0.34	0.26	557	148	13%
	2012	40	9	1,653	4124	0.30	0.18	498	96	9%
	2013	40	6	1,653	1884	0.25	0.26	397	139	17%



**Table 6 :** FU19: Short-term forecast management option table giving catch options for 2014 using the 2013 UWTV survey estimate.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F <sub>MSY</sub> proxy	618	521	87	10	7.5%
F <sub>2013</sub>	768	648	108	12	9.3%
F <sub>35%SpR</sub>	997	841	141	16	12.1%
F <sub>max</sub>	1047	883	148	16	12.7%

Weights in tonnes.

\* Total catches are the landings plus dead and surviving discards.

\*\* Total discard rate is assumed to be 28.7% of the catches (in number, average of the last three years, 2010–2012); discard survival is assumed to be 10%