

## FU19 *Nephrops* Grounds

### 2011 UWTV Survey Report

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## Abstract

This report provides the main results and findings of the second underwater television survey of the various *Nephrops* grounds in Functional Unit 19. The survey was multi-disciplinary in nature collecting UWTV, CTD and other ecosystem data. In total 35 UWTV stations were successfully completed on the following *Nephrops* grounds : Bantry Bay, Galley, Cork Channels and Helvick. Raised abundance estimates for these grounds are provided for the first time based on improved knowledge of the boundaries of those areas.

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 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 824 t (ICES, 2011). 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, 2009 & 2011). This is only the second time that an UWTV survey has been carried out in FU19 by the Marine Institute, Ireland. This survey was multi-disciplinary in nature; the specific objectives are listed below:

1. To obtain 2011 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.

This report details the final UWTV results of the FU19 2011 survey and also documents other data collected during the survey.

## Material and methods

The spatial extent of the *Nephrops* grounds in FU19 were defined using integrated VMS-logbook data using the methods described in Gerritsen and Lordan 2011. The cumulative effort between 2006-2011 for vessel days where *Nephrops* comprised >30% of the daily landings was plotted. The boundaries of the contiguous patches were then manually drawn using Map Viewer. The UWTV stations in FU19 were randomly picked from within these polygons. Some co-ordinates of clean *Nephrops* fishing tows were obtained from the fishing industry during the survey; many of these fell within the polygons defined. The discrete grounds have been named as: Bantry Bay, Galley Ground 1-4, Cork Channels and Helvick 1-3 and are shown in Figure 2. Station depths ranged from 18 metres in Bantry Bay to 104 metres in the Galley Grounds.

The 2011 FU19 survey took place on RV. Celtic Voyager between 18<sup>th</sup> to 20<sup>th</sup> August. The protocols used were those reviewed by WKNEPHTV 2007 (ICES, 2007) and used in all other grounds surveyed by Ireland. 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 addition CTD profile was logged for the duration of each tow using a Seabird SBE 9. This data will be

processed later. There was no time available for sediment sampling or beam trawling in FU19.

In line with SGNEPS recommendations all scientists were trained/re-familiarised using training material and validated using FU15 reference footage prior to recounting at sea (ICES, 2009). As the FU19 UWTV survey is in its infancy there is no FU19 specific reference footage available. The signature features of *Nephrops* burrows system are comparable across the different areas and it is recognised that FU15 is a particularly difficult area to count. Using that training material was deemed appropriate for this survey. Figure 3 shows individual's counting performance in 2011 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 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. Numbers of sea-pen species were also recorded due to OSPAR Special Request (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 4). Consistency and bias between individual counters was examined using Figure 5. There were no obvious problems.

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 2011 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). Figure 6 and Figure 7 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.

To estimate the abundance the area of each ground based on a VMS (2005-2008) delimited polygon was calculated in Arcgis10 and an average value used (Table 1). The abundance estimation is the product of the mean density and ground area. The

sample variances, standard errors, t-values and 95% CI were calculated for each ground.

## Results

The summary statistics for the FU19 stations are given in Table 2. The 2011 abundance estimate for FU19 not including Galley ground 4 is 850 million burrows. When the 2006 estimate for Galley Ground 4 is included for the entire FU19 grounds the abundance estimate is 724 million burrows. The mean density estimates (no./ m<sup>2</sup>) for each of the *Nephrops* grounds are shown in Figure 8. Estimates for the various grounds vary considerably. In 2011 the mean density for Galley Grounds 1-3 are similar ~ 0.73 (no./ m<sup>2</sup>) whereas the mean density varies for the Helvick patches from 0.06 to 0.78 (no./m<sup>2</sup>). 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 3). Different densities are apparent on the various different grounds within this FU. For the 2011 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. All sea-pens were identified from the video footage as *Virgularia mirabilis*. Trawl marks were noted at 6% of the stations surveyed and were only noted for some minutes of the total duration of the station footage.

## Discussion

Data for assessment of *Nephrops* in this area has been rather sparse in the past. This survey was initiated by Ireland in 2006 to address these data deficiencies and improve the scientific basis for managing the stock. It was not possible to complete the planned indicator stations due to time constraints linked to weather and technical down time from 2007 to 2010. This has resulted in a patchy UWTV data set for FU19 which to date only covers 2006 and 2011 and only some of the grounds have been surveyed (Figure 1, Table 2).

In recent years FU 19 has accounted for around 14 % or 824 t of the total landings (~ 5,500 t) from the wider Celtic Sea (FU19, 20, 21 & 22) (ICES, 2011b). The Galley Ground 4 represents around 39% of the total area where *Nephrops* are currently fished in FU19 based on areas shown in Figure 1, Table 3. The mean density estimates for the discrete grounds vary suggesting variable population densities and growth. For the 2011 survey the number of observations on each individual patch is relatively low making the RSE estimates not that relevant. Aggregating all areas together gives a mean burrow density of 0.5 with a RSE of around 13% which is below the 20% threshold recommended by SGNEPS 2012.

The UWTV methods employed during the FU19 survey have recently been discussed and documented by WKNEPHTV (ICES, 2007), and SGNEPS (ICES, 2009a). A benchmark workshop on *Nephrops* assessments developed a methodology to use UWTV survey data and harvest ratios from SCA (Separable Length Cohort Analysis) as the basis of management advice (ICES, 2009b). This approach was further developed in 2010 has been applied to all other *Nephrops* stocks with UWTV surveys

in ICES Sub-areas VI and VII (ICES, 2011). Catch options are calculated by applying a bias correction factor to the UWTV survey estimate, using mean weight in the landings, mean proportions of the catch retained and harvest ratios at different reference points from an SCA analysis to calculate landings options.

The burrow systems are estimated to be of moderate size ~40 cm for most of the area. A field of view (FOV) of ~75 cm on the UWTV survey has been confirmed for most stations using sledge mounted lasers. There may be some random noise in the FOV due to sinking and jumping in poor weather, but this is normally not a major problem in FU19. The FOV is smaller than that used for Scottish stocks (FOV ~1 m) resulting an edge effect bias correction factor of around 1.25 based on the findings of Campbell *et al.* (2009). Burrow system detection rates are thought to be relatively high (0.9).

Visibility is generally good; most systems have multiple entrances and are fairly evenly spaced making detection easier. There are some other burrowing macrobenthic species present in FU19 and misidentification is assumed to be in the order of 1.15. Fishing activity in FU19 is intensive and unoccupied burrows are likely to be filled in quickly due to a combination of fishing and hydrodynamic sediment disturbance. As for most other areas the assumption is that all the burrows counted are occupied by a single *Nephrops*.

The cumulative biases associated with the estimates of *Nephrops* abundance for FU19 are:

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
19	S and SW coast Ireland	1.25	0.9	1.15	1	1.3

Bias corrected survey estimates for the South and South-west coast (FU19) could be used to provide catch options and recent harvest ratio estimates.

It is likely that the *Nephrops* populations in the wider Celtic Sea are linked in a meta-population sense, further information is needed to estimate stock size and exploitation rates for the discrete *Nephrops* grounds. The diverse nature of the habitat and wide spatial distribution means designing and routinely executing an UWTV survey for the remaining areas particularly challenging. Integrating UWTV survey work with the Irish Groundfish Survey or on another existing UWTV survey could be a way to address this challenge in the future.

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 main objectives of the survey were successfully met. The UWTV footage quality was excellent given the prevailing conditions although it was not possible to survey Galley ground 4. The multi-disciplinary nature of the survey means that the information collected is highly relevant for a number of research and advisory applications.

### **Acknowledgments**

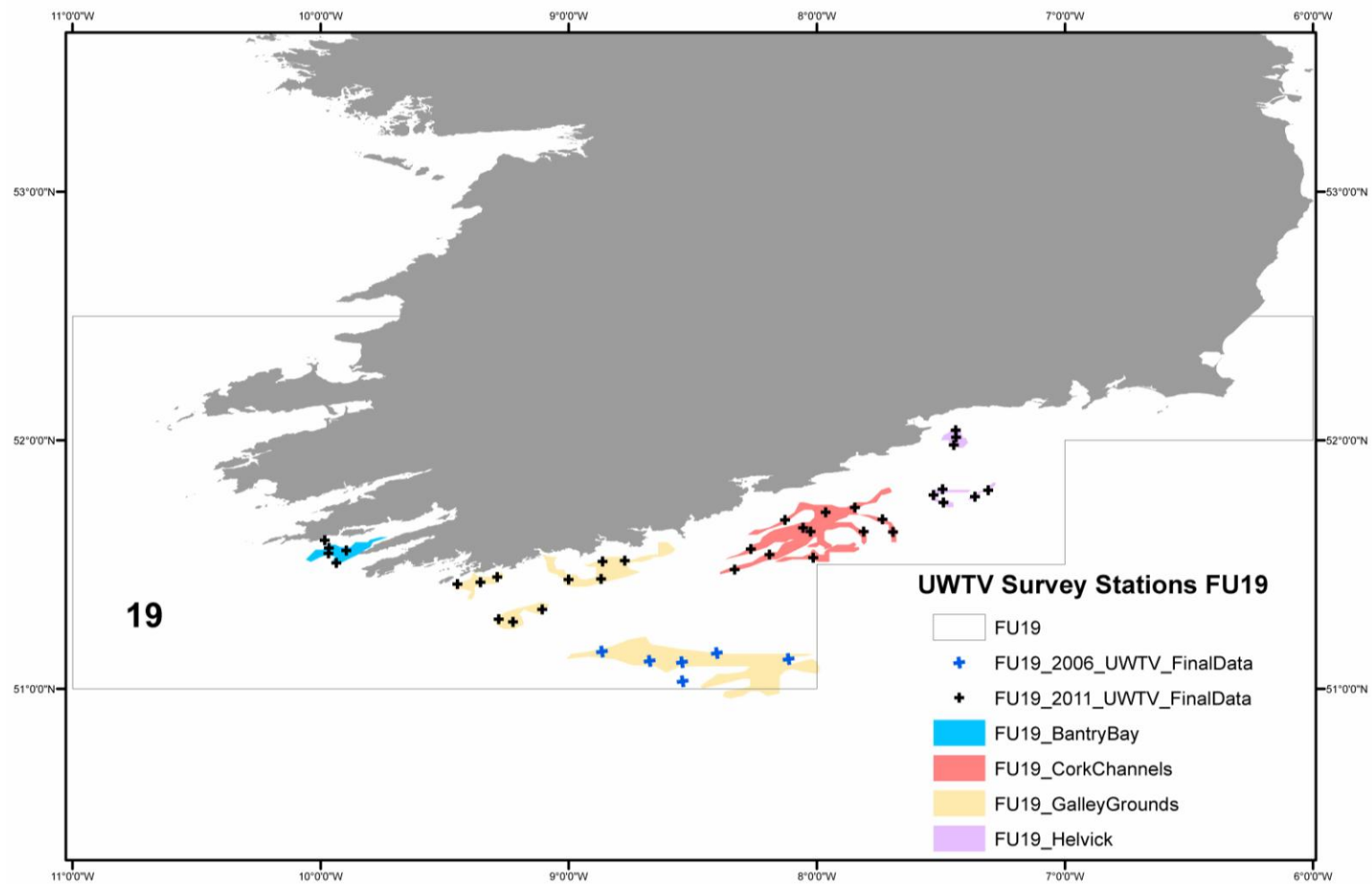
We would like to express our thanks and gratitude to Colin McBrearty (Captain) and crew of the RV. Celtic Voyager for their good will and professionalism during the survey and also to Declan Murray P&O Maritime IT & Instrumentation Technician, for handling all onboard technical difficulties. To Aodhan Fitzgerald of RV Operations at the Marine Institute for organising survey logistics. And thanks to the Marine Institute staff onboard for their hard work and enthusiasm.

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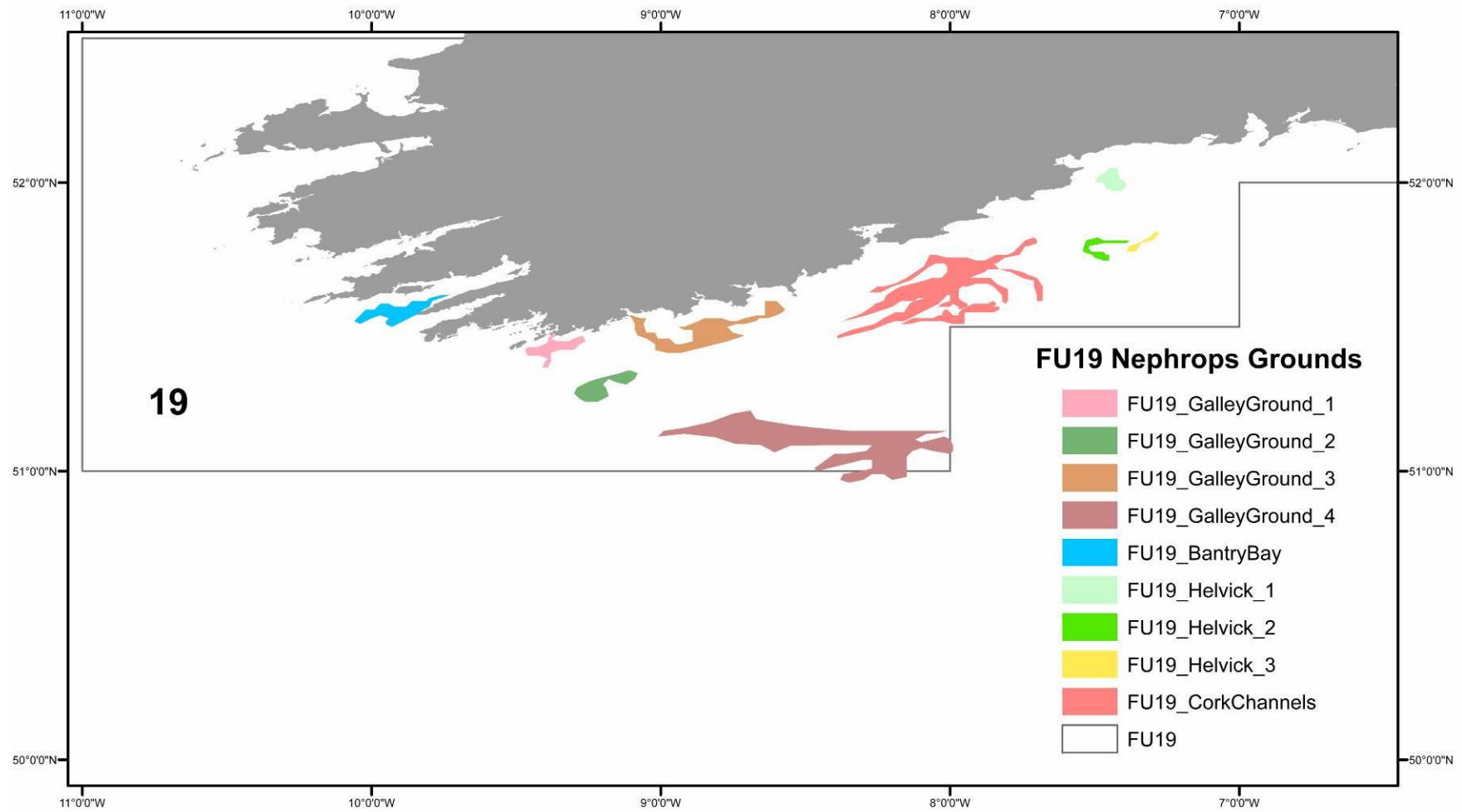
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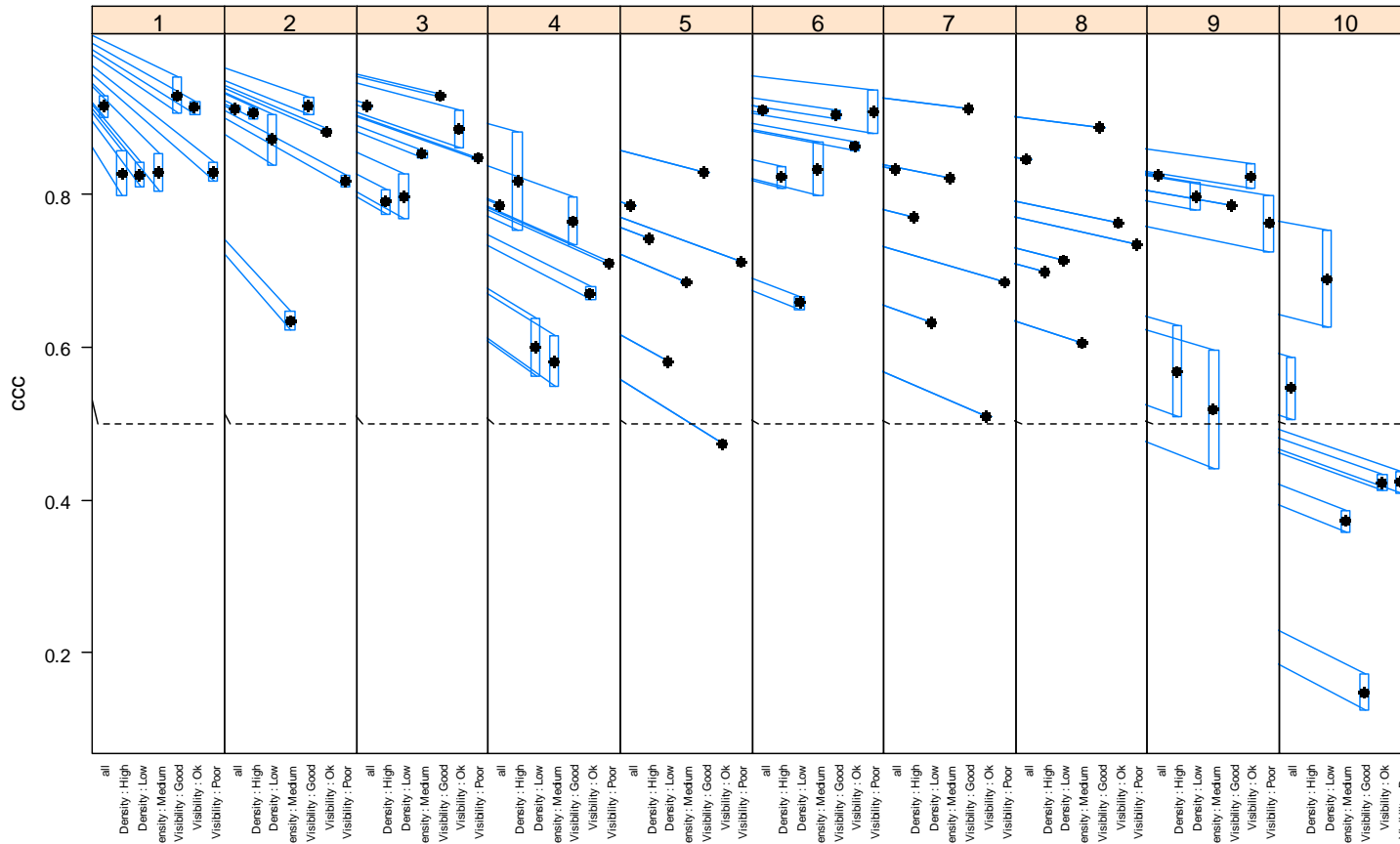




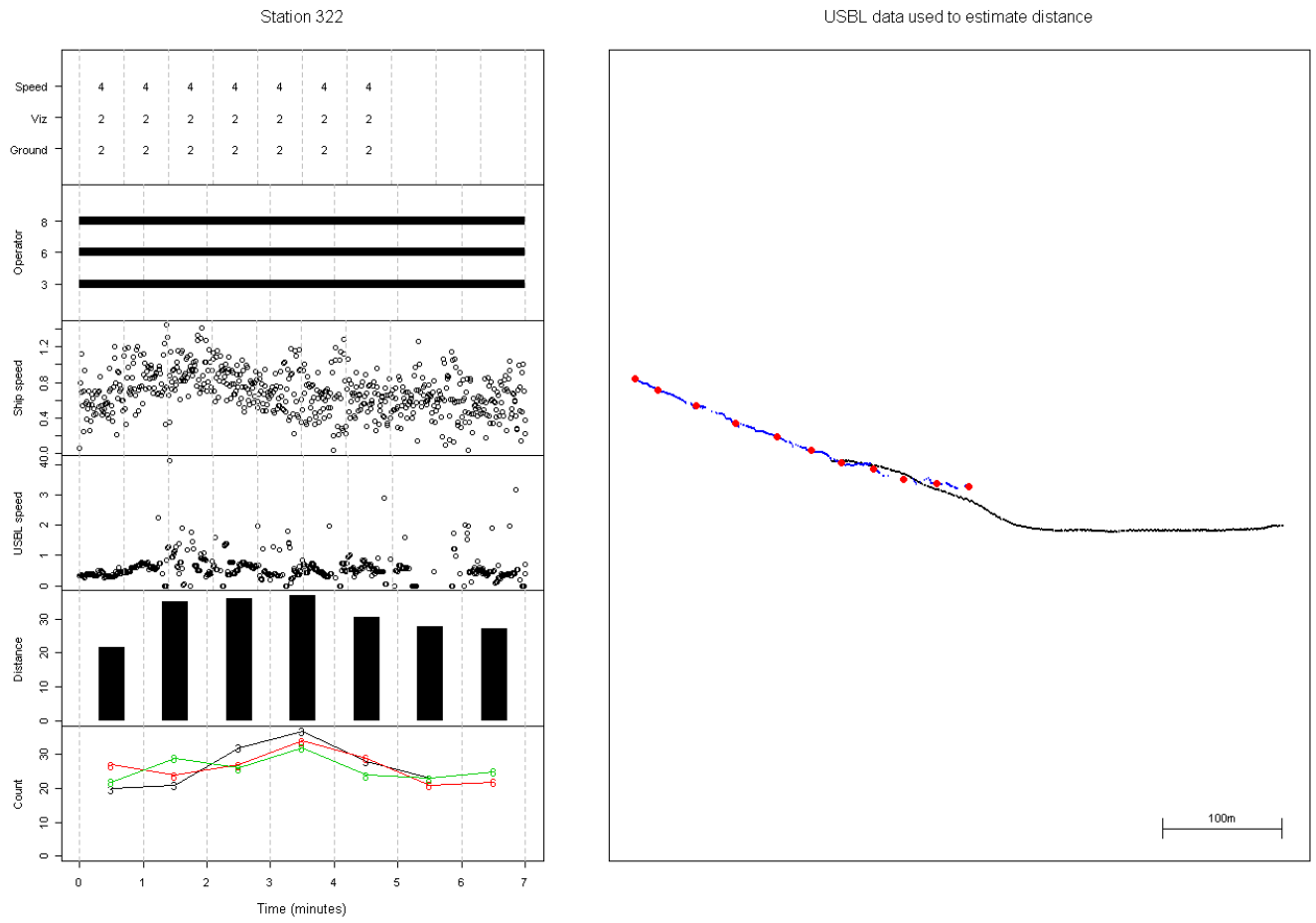
**Figure 1:** Stations completed on the 2006 and 2011 FU19 *Nephrops* UWTW surveys.



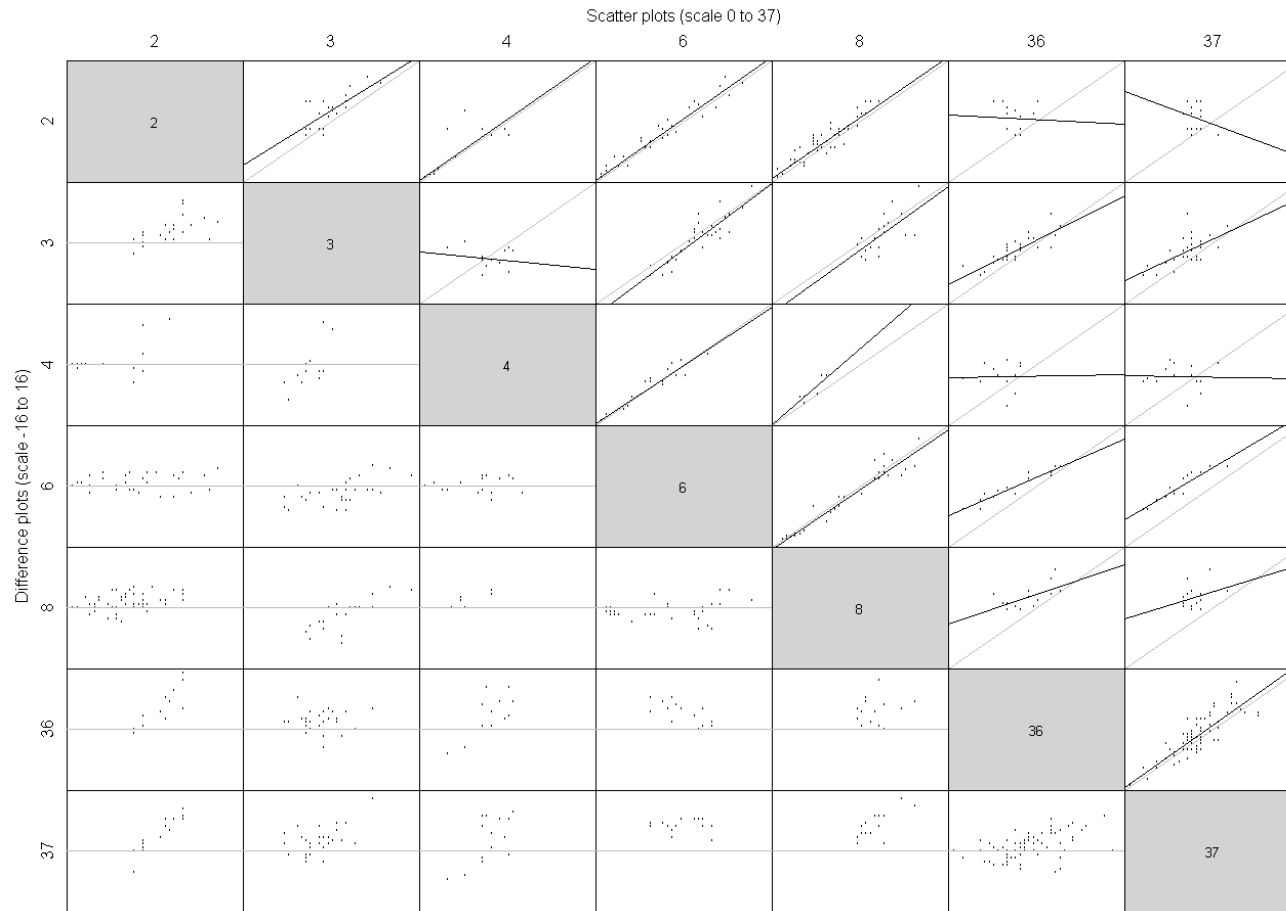
**Figure 2:** *Nephrops* grounds in FU19 *Nephrops* based on integrated VMS06-11 data.



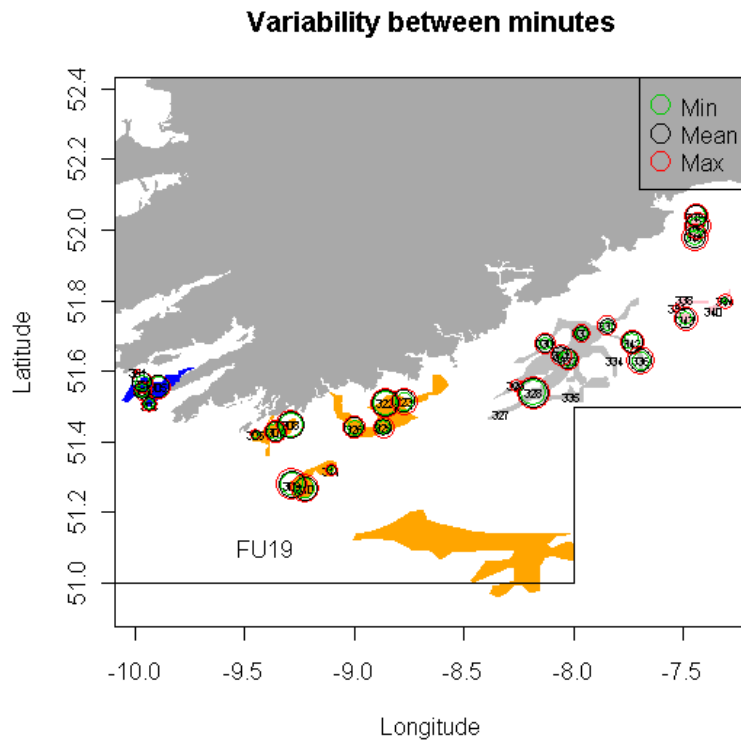
**Figure 3:** 2011 Counting performance against the reference counts as measured by Linn’s COCC using FU15 reference material. Each panel represents an individual. The x-axis (from left to right), all stations pooled, high density, low density, medium density and visibility good.



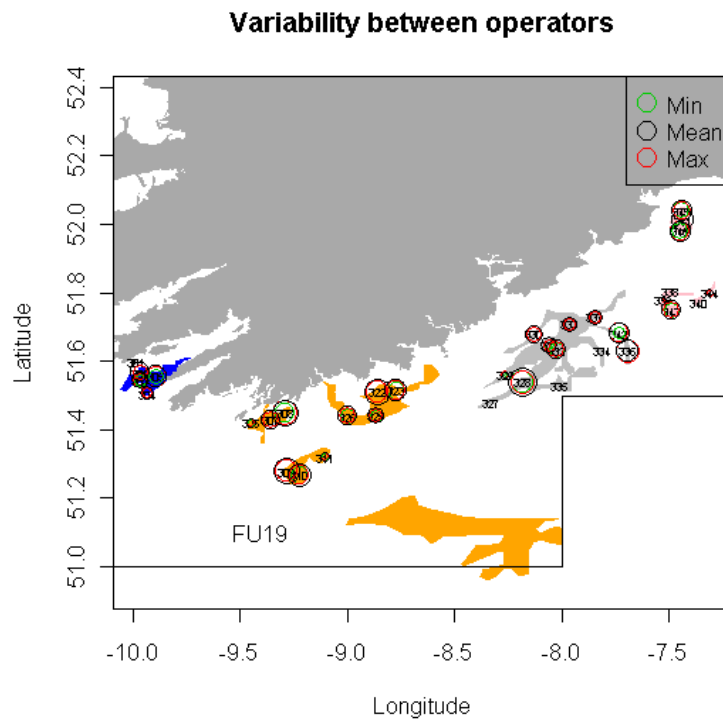
**Figure 4** : r - tool quality control plot for station 322 (Galley Grounds 3) FU19 2011 UWTV survey.



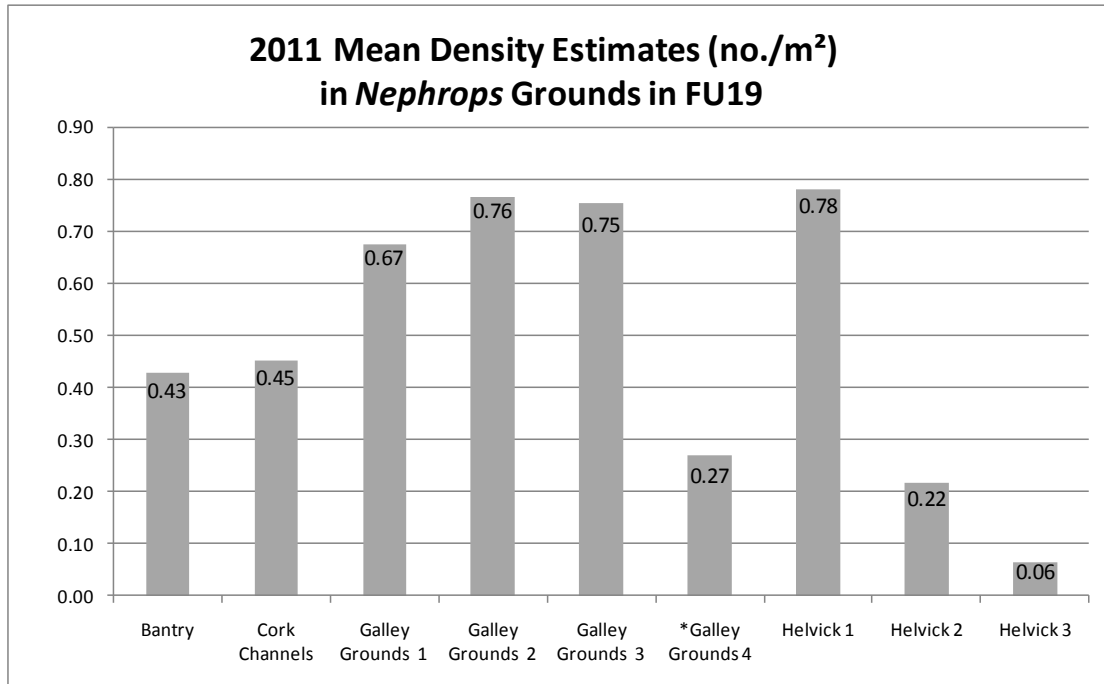
**Figure 5** : Scatter plot analysis of counter trends during FU19 2011 UWTV survey.



**Figure 6 :** Plot of the variability in density between minutes for each station FU19 2011 UWTV survey.

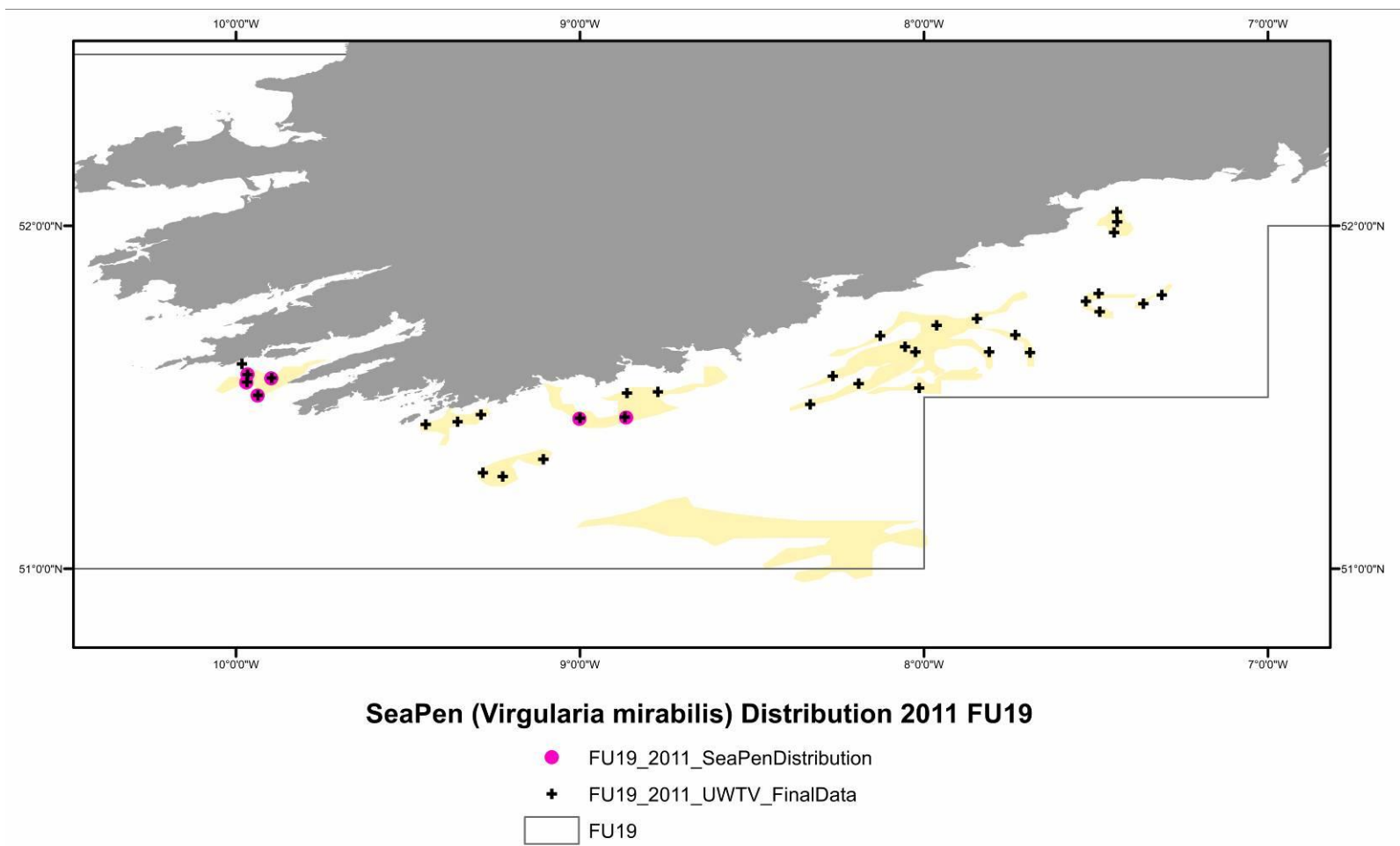


**Figure 7 :** Plot of the variability in density between operators (counters) for each station FU19 2011 UWTV survey.



**Figure 8 :** Mean density estimates (no./ m<sup>2</sup>) for the various grounds in FU19.  
 \*Galley ground 4 estimate is from 2006 UWTV survey.





**Figure 9:** Stations where *Virgularia mirabilis* was identified during the FU19 2011 UWTV survey.

FU	VMS0608 grounds Polygons	ArcGIS10 Projections			
		Eckert VI (world) (km2)	Irish National Grid (km2)	Cylindrical Equal Area (km2)	Average (km2)
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
19	All grounds	2,728.50	2,732.16	2,731.92	2,730.86

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

Year	Ground	Number of stations	Non zero stations	Area Surveyed (m <sup>2</sup> )	Area Estimates (km <sup>2</sup> )	Burrow count	Mean Density (no./ m <sup>2</sup> )	Var	Standard Deviation	Standard Error	t-value	95%CI	CViid (Relative SE)	Domain Area (Km <sup>2</sup> )	Raised abundance estimate (million burrows)
2006	Bantry	-	-	-	90.91	-	-	-	-	-	-	-	-	-	-
	Cork Channels	-	-	-	484.75	-	-	-	-	-	-	-	-	-	-
	Galley Grounds 1	-	-	-	61.88	-	-	-	-	-	-	-	-	-	-
	Galley Grounds 2	-	-	-	77.95	-	-	-	-	-	-	-	-	-	-
	Galley Grounds 3	-	-	-	202.75	-	-	-	-	-	-	-	-	-	-
	Galley Grounds 4	6	6	927.53	652.33	293	0.27	0.06	0.24	0.10	2.57	0.25	0.36	652.33	175.23
	Helvick 1	-	-	-	38.56	-	-	-	-	-	-	-	-	-	-
	Helvick 2	-	-	-	31.47	-	-	-	-	-	-	-	-	-	-
2011	Bantry	5	5	740.51	90.91	334	0.43	0.09	0.30	0.13	2.78	0.37	0.31	90.91	38.83
Cork Channels	12	9	1,645.84	484.75	768	0.45	0.17	0.41	0.12	2.20	0.26	0.26	484.75	218.64	
Galley Grounds 1	3	3	386.74	61.88	248	0.67	0.29	0.54	0.31	4.30	1.33	0.46	61.88	41.74	
Galley Grounds 2	3	3	447.43	77.95	352	0.76	0.32	0.56	0.32	4.30	1.40	0.42	77.95	59.62	
Galley Grounds 3	4	4	615.26	202.75	472	0.75	0.08	0.29	0.14	3.18	0.46	0.19	202.75	152.63	
Galley Grounds 4	-	-	-	652.33	-	-	-	-	-	-	-	-	-	652.33	na
Helvick 1	3	3	436.96	38.56	341	0.78	0.00	0.02	0.01	4.30	0.05	0.01	38.56	30.13	
Helvick 2	3	2	314.97	31.47	84	0.22	0.13	0.36	0.21	4.30	0.89	0.96	31.47	6.78	
Helvick 3	2	1	242.76	12.66	18	0.06	0.01	0.09	0.06	12.71	0.82	1.00	12.66	0.82	
*2011	FU19	35	30	4830.46	1,653.26	2616	0.51	0.16	0.40	0.07	2.03	0.14	0.13	1653.26	850.13
**2011	FU19														724.42

\*2011 Abundance estimate does not include 2006 Galley ground 4

\*\*2011 Abundance estimate includes 2006 Galley Ground 4 estimate

**Table 2** : Summary statistics for the *Nephrops* UWTV stations in FU19 from 2006-2011.

Ground	Area km2	%
Bantry	90.91	5%
Cork Channels	484.75	29%
Galley Grounds 1	61.88	4%
Galley Grounds 2	77.95	5%
Galley Grounds 3	202.75	12%
Galley Grounds 4	652.33	39%
Helvick 1	38.56	2%
Helvick 2	31.47	2%
Helvick 3	12.66	1%
Total	1653.26	

**Table 3 :** Area proportions of various *Nephrops* grounds in FU19.