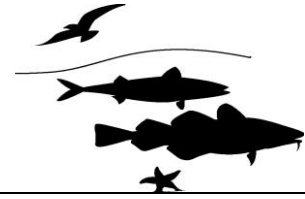




*Marine Institute*  
*Foras na Mara*



## **FU19 *Nephrops* grounds 2015 UWTV survey report and catch options for 2016.**

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## Abstract

This report provides the main results of the sixth underwater television survey of the various *Nephrops* patches in Functional Unit 19. The survey was multi-disciplinary in nature collecting UWTV, CTD, multi-beam and other ecosystem data. In 2015 a total 39 UWTV stations were successfully completed. The mean density estimates varied considerably across the different patches. The 2015 raised abundance estimate of 482 million burrows was a 24% decrease from the 2014 estimate. Taking into account the uncertainty (CV of 13%) there is no significant difference in abundance estimates since 2011. Using the 2015 abundance estimate and recent mean weights and discard parameters would imply total catches of 793 t fishing at  $F_{msy}$  in 2016. This stock will be subject to the landing obligation in 2016 and the calculation of catch options assume that all catches will be landed in 2016. The catch can be partitioned into landings of 543 t and discards of 250 t. The estimated discards rates in FU19 are relatively high and impact of this on the catch options is discussed. One species of sea pen was observed; *Virgularia mirabilis* which has been observed on previous surveys of FU19.

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

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## Introduction

*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 2014 worth around € 95 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, 2015a). The 2014 landings of 468 t are estimated to be worth € 3.1 m at first sale. The *Nephrops* fishery in FU19 occurs on several spatially discrete mud patches which are spread out over a large area (Figure 1).

*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). The survey was multi-disciplinary in nature and also covered some stations in FU17, FU22 and FU2021 the results of which are presented elsewhere (Lordan et al., 2015, Doyle et al., 2015). The specific objectives of 2015 survey are listed below:

1. To obtain 2015 quality assured estimates of *Nephrops* burrow densities from several of the discrete mud patches of *Nephrops* ground in FU19.
2. To carry out ~75 UWTV stations in FU2021, ~ 40 stations in FU22 and ~ 25 stations in FU17.
3. 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.
4. To collect oceanographic data using a sledge mounted CTD.

This report details the final UWTV results of the 2015 FU19 survey and also documents other data collected during the survey. Operational survey details are available in form of a survey narrative from the scientists in charge (CL and JD). The 2015 abundance are used to generate catch options for 2016 in line with the recommendations and procedures outlined in the stock annex for FU19 (ICES, 2014, 2015).

## Material and methods

The spatial extent of the *Nephrops* grounds in FU19 has been defined using 2006-2014 integrated VMS-logbook data using the methods described in Gerritsen and Lordan (2011) ) along with using multi-beam backscatter data from seabed mapping programmes (ICES, 2014b). The discrete patches have been named as: Bantry Bay, Galley Ground 1-4, Cork Channels and Helvick 1 & 2 these are shown as polygons in Figure 1. The area of each ground polygon is shown in Table 1. *Nephrops* also occur outside these defined polygons in areas like Kenmare Bay which was surveyed for the first time this year (1 station).

In 2015 UWTV stations 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 as in previous years.

The 2015 FU19 survey took place on RV. Prince Madog 30<sup>th</sup> June-11<sup>th</sup> July and on RV. Celtic Voyager 02<sup>nd</sup>-03<sup>rd</sup> September due to vessel breakdown in the early summer. Surveys in other years were generally between June-September. The operational protocols used were those reviewed by WKNEPHTV 2007 (ICES, 2007) and used in all other grounds surveyed by Ireland. They can be summarised as follows: 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 2 seconds. The navigational data was quality controlled using an “r” script developed by the Marine Institute (ICES, 2009b). In 2015 the USBL navigational data was used to calculate distance over ground for 76% of the stations. For those stations where the USBL sensor was not operational, the amount of cable paid in/out on a minute by minute basis was recorded. This data was used to correct the SHIP position used to calculate distance travelled by the sled. Station depths ranged from 34 metres in Helvick to 117 metres in the Galley Grounds.

In line with SGNEPS recommendations all scientists were trained/re-familiarised using training material and validated using FU22 reference footage prior to recounting at sea (ICES, 2009b). There is no FU19 specific reference footage available yet.

Individual’s counting performance in 2015 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 and correcting for the various biases. The USBL or corrected SHIP positional was 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 all tows using lasers during the 2015 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). A global mean density and summary statistics (Number of Stations, Standard Deviation, Standard Error, 95% Confidence Intervals and CV) were estimated for all stations and multiplied by the total area given in Table 1 to estimate the raised abundance estimate with confidence intervals. The same approach was used in 2014. Prior to 2013 some other adjustments were made to account for incomplete survey coverage. Details of these are given in previous survey reports (Lordan, *et al.*, 2013).

A CTD profile was logged for the duration of each tow using a calibrated Seabird SBE 37. The sensor takes readings every 5 seconds and will be processed at a later stage to calculate an average bottom temperature and salinity for each cast.

## Results

The summary statistics for the various discrete *Nephrops* patches within FU19 are given in Table 3. 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 2015 mean adjusted<sup>1</sup> density estimates for these vary considerably from the lowest observed in Cork Channels ground of 0.08 (burrow/m<sup>2</sup>) to the highest observed estimate of 0.53 (burrow/m<sup>2</sup>) at Galley Ground 2. The mean density for most patches showed a decrease compared with 2014 and the relative densities were similar.

The time series of summary statistics for FU19 are given in Table 4 and presented graphically in Figure 6. The 2015 raised abundance estimate of 482 million burrows is a 24% decrease from the 2014 estimate (Figure 7). The CV or RSE for the 2015 survey was 13% which is below the upper limit of <20% recommended by SGNEPS (ICES, 2012).

Sea-pen distribution across the FU19 *Nephrops* grounds is mapped in Figure 8. Only one species - *Virgularia mirabilis* was identified from the video. 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.

The input parameters for the catch option tables, mean weight and proportions of removals retained, are given in Table 5 and 6. The catch and landings options at

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

various different fishing mortalities are calculated in line with the stock annex using the 2015 survey abundance. These are presented in table 7.

## Discussion

The time series of UWTV survey information is developing for this Functional Unit. Several discrete mud patches with fished *Nephrops* populations have been identified and the survey coverage and precision since 2011 has been reasonable. It is clear that there are consistent differences in density in the different patches but most patches seem vary annually in a similar way. Scientific knowledge of the spatial distribution of the *Nephrops* habitat in this area is developing thanks to new multi-beam data, more extensive VMS data and information from the fishing industry particularly for inshore areas.

Discard rates for this FU are estimated to be relatively high ~ 50% by number in the last three years. Because harvest rates are calculated on the basis of numbers and 25% of the *Nephrops* in this area are assumed to have survived up to now this presents a problem in calculating catch options for 2016. *Nephrops* in this area will be covered under the landings obligation in 2016 but it is not yet clear how this will be implemented in practice. Under the Landings Obligation scenario in Table 7 it is assumed that all catches will be landed in 2016 so the discards that would have survived up to now are also removed from the fishery. In this scenario fishing at  $F_{msy}$  in 2016 would imply total catches of 793 t which implies; landings or in ICES terminology “wanted catch” of 543 t and discards or “unwanted catch” of 250 t. Under the discarding is allowed scenario, two options are presented. The first assumes that discarding continues at its current rate, here total catches would be higher (904 t). This is because 25% of the discards are assumed to survive increasing the mean weight of the dead removals (L +DD). The second scenario assumes that discards are around 7% by weight in 2016. The predicted catch and landings in this scenario is significantly higher.

In reality we should not expect that the fishery in FU19 will be able to adapt to reduce discards to 7% so quickly. However, the imposition of the landings obligation on *Nephrops* fisheries in 2016 should result in changes in selectivity in the fisheries with high discard rates like FU19. This is not taken into account in any of the catch advice because it is not possible to predict exactly what might happen. The main message is that any improvements in selectivity in the fishery and reductions in discards will result in increased mean weight in the catches. This will in turn reduce overall mortality on the stocks and allow for catch increases in the future.

An important objective of this UWTV survey is to collect 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 frequency of trawl marks observed on these grounds was relatively low although they are extensively fished.

The CTD data collected, over time will augment the knowledge base on habitat and oceanographic regime.

Monitoring the occurrence and frequency of sea-pens observed on these *Nephrops* patches is important in the context of OSPAR's designations of sea-pen and burrowing megafauna communities as threatened. The sea-pen *Virgularia mirabilis* were observed on previous surveys of FU19. Monitoring *Nephrops* stock and the benthic habitat is also important in the context of the MFSD indicators (e.g. sea floor integrity).

The main objectives of the survey were successfully met. The UWTV footage quality was excellent and in 2015 and all of the *Nephrops* patches within FU19 were successfully surveyed. The multi-disciplinary nature of the survey means that the information collected is highly relevant for a number of research and advisory applications.

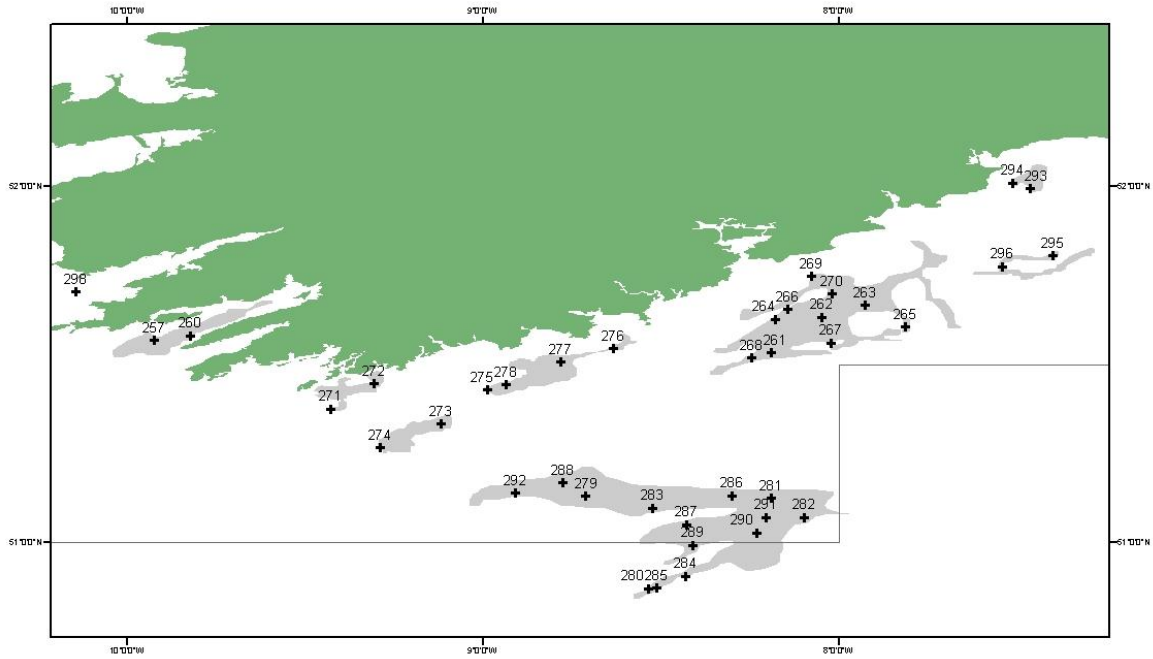
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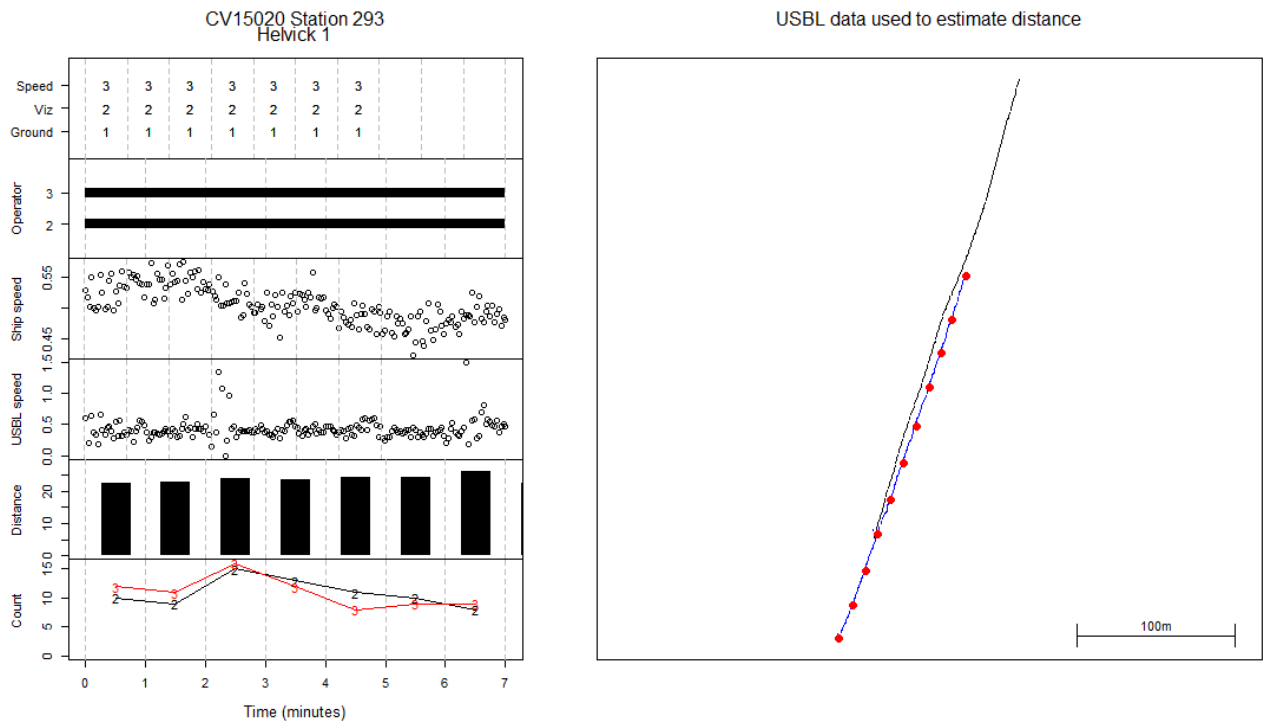
## References

- Gerritsen HD and Lordan C, (2011). Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. *ICES J Mar Sci* 68 (1): 245-252.
- Lordan, C., Doyle, J., Hehir, I., O'Sullivan, D., Allsop, C., O'Connor, S., Blaszkowski, M., Butler, R., Burke, C., and Stewart, P. 2013. FU19 *Nephrops* Grounds 2013 UWTV Survey and catch options for 2014. Marine Institute UWTV Survey report.
- Lordan, C., Doyle, J., Fitzgerald, R., O'Connor, S., Blaszkowski, M., and Butler, R. 2015. The "Smalls" *Nephrops* Grounds (FU22) 2015 UWTV Survey Report and catch options for 2016. Marine Institute UWTV Survey report.
- Lordan, C., Doyle, J., Fitzgerald, R., O'Connor, S., Blaszkowski, M., Stokes, D., Ni Chonchuir, G., Gallagher, J., Butler, R., Sheridan, M., Simpson, S., Blandon A. and Meakins, B. 2015. The Labadie, Jones and Cockburn Banks *Nephrops* Grounds (FU20-21) 2015 UWTV Survey Report and catch options for 2016. Marine Institute UWTV Survey report.
- ICES 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14 Ref: LRC, PGCCDBS.
- ICES 2009a. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM: 2009/ACOM:33
- ICES 2009b. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15. Ref: TGISUR.
- ICES 2011. Report of the ICES Advisory Committee 2011. ICES Advice.2011. Book 1: Introduction, Overviews and Special Requests. Protocols for assessing the status of sea-pen and burrowing megafauna communities, section 1.5.5.3.
- ICES 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2012/SSGESST: 19. Ref: SCICOM, ACOM
- ICES 2014. Report of the Benchmark Workshop on Celtic Sea stocks (WKCELT), 3–7 February 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014\ACOM:42. 194 pp.
- ICES 2015. Report of the Working Group for Celtic Seas Ecoregion (WGCSE). ICES CM: 2015/ ACOM:12.

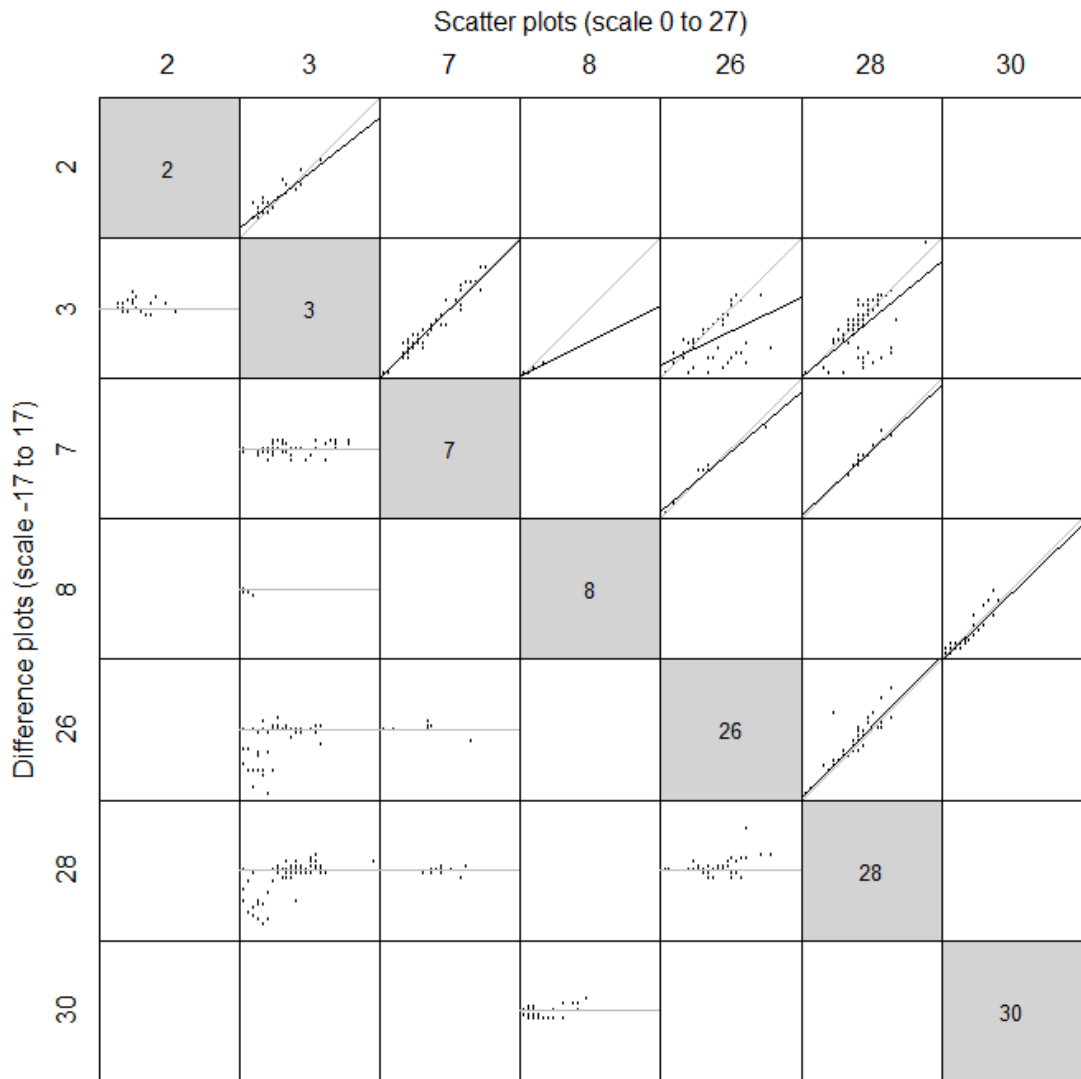




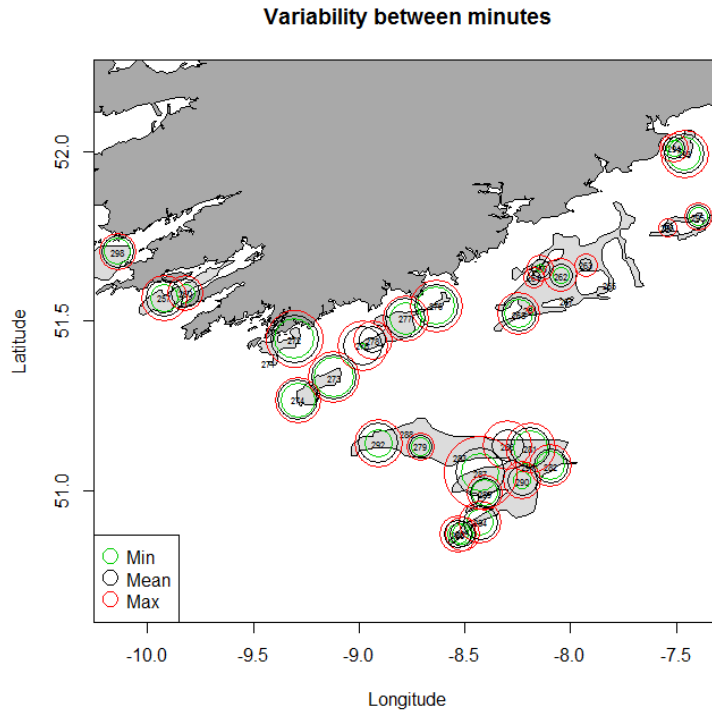
**Figure 1:** Stations completed on the 2015 FU19 *Nephrops* UWTW survey and area polygons of the discrete *Nephrops* grounds.



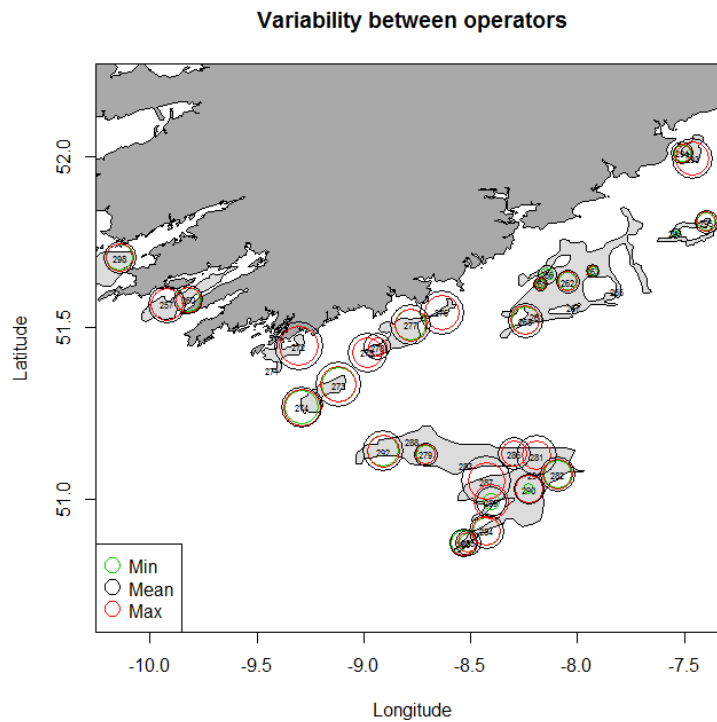
**Figure 2:** r - tool quality control plot for station 293 (Helvick 1) FU19 2015 UWTW survey.



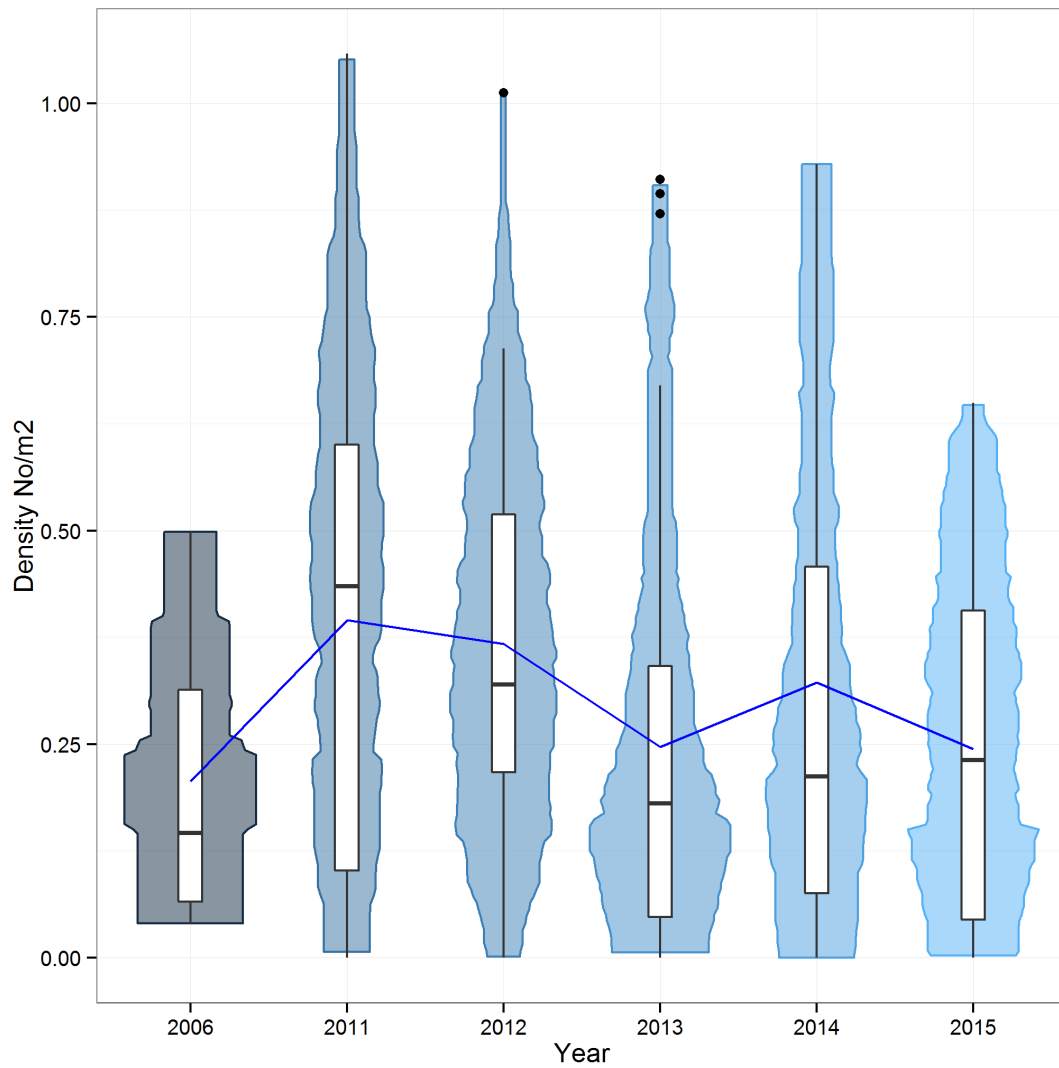
**Figure 3:** Scatter plot analysis of counter trends during FU19 2015 UWTV survey.



**Figure 4:** Plot of the variability in density between minutes for each station FU19 2015 UWTV survey.

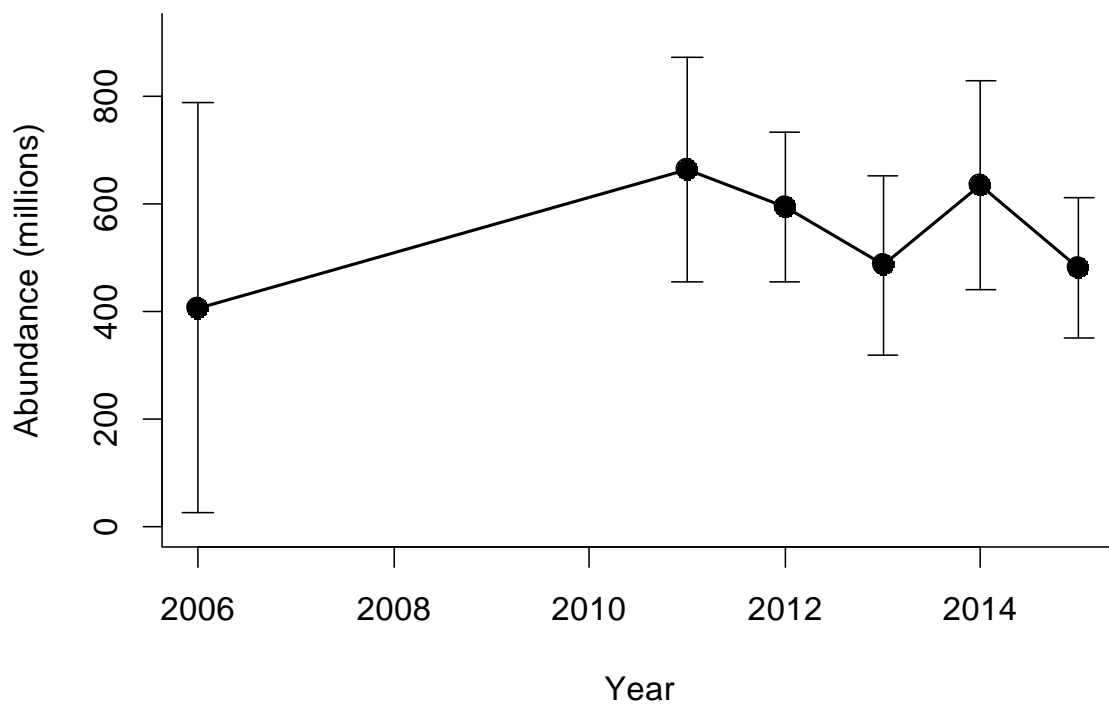


**Figure 5:** Plot of the variability in density between operators (counters) for each station FU19 2015 UWTV survey.

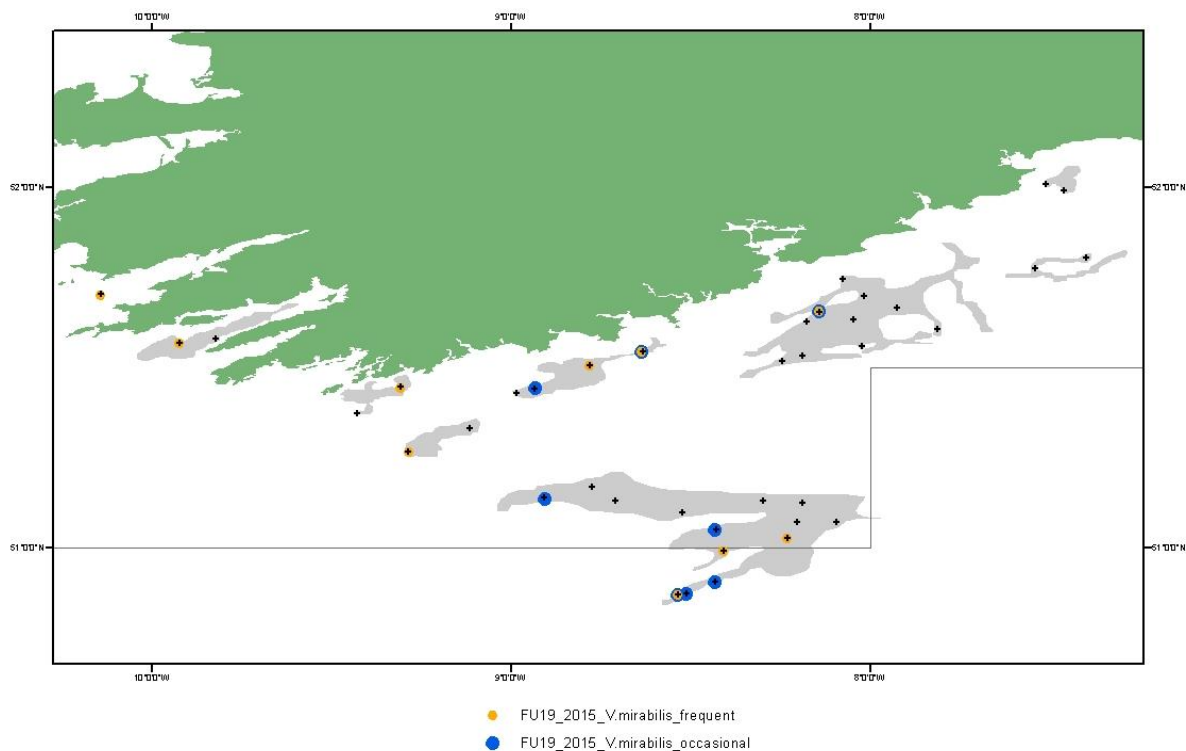


**Figure 6:** Violin and box plot a of adjusted burrow density distributions by year from 2006-2015. The blue line indicates the mean density over time. The horizontal black line represents the median, white box is the inter quartile range, the black vertical line is the range and the black dots are outliers. No TV survey from 2007 – 2010.

### FU 19 : TV abundance



**Figure 7:** Time series of raised abundance estimates (in millions of burrows) for FU19. No survey data from 2007 to 2010.



**Figure 8:** Stations where the seapen *Virgularia mirabilis* were observed during the FU19 2015 UWTV survey. Black dots indicate TV station.



**Table 3 :** Detailed summary statistics for the various *Nephrops* patches in FU19 over the time series. (N = number of stations, Mean Density (no/m<sup>2</sup>) is adjusted for the bias correction factor, sd, se and ci are the standard deviation, standard error and 95% confidence intervals on the mean density).

Year	Ground	N	Mean Density (no/m <sup>2</sup> )	sd	se	ci
2006	Galley Grounds 4	6	0.21	0.18	0.08	0.19
2011	Bantry	5	0.33	0.23	0.1	0.28
2011	Cork Channels	12	0.35	0.32	0.09	0.2
2011	Galley Grounds 1	3	0.52	0.41	0.24	1.02
2011	Galley Grounds 2	3	0.59	0.43	0.25	1.07
2011	Galley Grounds 3	4	0.58	0.22	0.11	0.35
2011	Helvick 1	3	0.6	0.01	0.01	0.04
2011	Helvick 2	5	0.12	0.21	0.09	0.26
2012	Bantry	1	0.2	NA	NA	NA
2012	Cork Channels	9	0.27	0.17	0.06	0.13
2012	Galley Grounds 2	4	0.59	0.12	0.06	0.19
2012	Galley Grounds 3	1	0.51	NA	NA	NA
2012	Galley Grounds 4	16	0.39	0.16	0.04	0.09
2012	Helvick 1	3	0.33	0.13	0.08	0.33
2012	Helvick 2	6	0.33	0.41	0.17	0.43
2013	Bantry	4	0.38	0.2	0.1	0.31
2013	Cork Channels	11	0.12	0.1	0.03	0.07
2013	Galley Grounds 1	2	0.23	0.18	0.13	1.59
2013	Galley Grounds 2	3	0.48	0.44	0.25	1.09
2013	Galley Grounds 3	4	0.59	0.24	0.12	0.38
2013	Galley Grounds 4	13	0.19	0.27	0.07	0.16
2013	Helvick 1	1	0.09	NA	NA	NA
2013	Helvick 2	2	0.06	0.05	0.04	0.48
2014	Bantry	4	0.25	0.05	0.03	0.09
2014	Cork Channels	10	0.1	0.06	0.02	0.04
2014	Galley Grounds 1	2	0.61	0.41	0.29	3.69
2014	Galley Grounds 2	2	0.82	0.14	0.1	1.23
2014	Galley Grounds 3	4	0.66	0.23	0.12	0.37
2014	Galley Grounds 4	14	0.29	0.29	0.08	0.17
2014	Helvick 1	2	0.67	0.28	0.2	2.53
2014	Helvick 2	2	0.03	0.04	0.03	0.39
2015	Cork Channels	10	0.08	0.11	0.03	0.08
2015	Galley Grounds 1	2	0.32	0.46	0.32	4.12
2015	Galley Grounds 2	2	0.53	0.08	0.06	0.74
2015	Galley Grounds 3	4	0.40	0.14	0.07	0.23
2015	Galley Grounds 4	14	0.27	0.19	0.05	0.11
2015	Helvick 1	2	0.30	0.23	0.16	2.08
2015	Helvick 2	2	0.09	0.09	0.06	0.79
2015	Kenmare Bay	1	0.30	NA	NA	NA

**Table 4:** Final of results for UWTV surveys in FU19 from 2006-2015.

FU	Year	Number of stations	Mean Density adjusted (burrow /m <sup>2</sup> )	Standard Deviation	Raised abundance estimate adjusted (million burrows)	Upper 95%CI on Abundance	Lower 95%CI on Abundance	CVs
FU19	2006	6	0.21	0.18	408	789	26	36%
	2007	No Survey Data						
	2008							
	2009							
	2010							
	2011	35	0.34	0.26	665	842	488	13%
	2012	40	0.3	0.18	594	708	480	9%
	2013	40	0.25	0.26	487	653	166	17%
	2014	40	0.32	0.31	636	829	442	15%
	2015	39	0.24	0.20	482	612	352	13%



**Table 5 : Inputs to FU19 management option table.**

Year	Landings in Number (millions)	Discards in Number (millions)	Discard proportion D/(D+L)	Removals in Number (millions)	Dead discard rate (prop. by number)	Adjusted Survey (millions)	95% Conf. intervals (millions)	Harvest Ratio	Landings (t)	Discards (t)	Discard % of catch by weight	Mean Weight in landings (gr)	Mean Weight in discards (gr)	Mean Weight in catch (gr)
2006	26.2	2.6	0.09	28.1	0.068				741	37	5%	28.3	14.4	27.1
2007	30.8	1.5	0.05	31.9	0.036				957	26	3%	31.1	17.0	30.4
2008	25.7	5.5	0.18	29.8	0.139				866	107	11%	33.7	19.3	31.2
2009	27.3	17.8	0.39	40.6	0.328				833	258	24%	30.5	14.5	24.2
2010	24.4	20.0	0.45	39.3	0.381				722	269	27%	29.6	13.5	22.4
2011	24.3	30.7	0.56	47.3	0.487	665	171	7.1%	608	387	39%	25.0	12.6	18.1
2012	29.2	33.0	0.53	54.0	0.459	594	111	9.1%	770	420	35%	26.4	12.7	19.1
2013	28.5	33.4	0.54	53.6	0.468	487	161	11.0%	781	404	34%	27.4	12.1	19.1
2014	16.4	11.4	0.41	24.9	0.344	636	188	3.9%	468	161	26%	28.6	14.1	22.6
2015						<b>482</b>	<b>126</b>							
<b>Avg 2012-14</b>			<b>0.49</b>		<b>0.423</b>			<b>8.0%</b>				<b>27.45</b>	<b>12.97</b>	<b>20.30</b>

**Table 6:** The basis for the catch options.

Variable	Value	Notes
Stock Abundance	482	UWTV 2015
Mean weight in landings	27.4	Average 2012-2014
Mean weight in discards	13.0	Average 2012-2014
Discard proportion	49%	Average (proportion by number) 2012-2014
Discard survival rate	25%	Only applies in scenarios where discarding allowed
Dead discard rate	42.3%	Average (proportion by number) 2012-2014, only applies in scenarios where discarding allowed; calculated as dead discards divided by dead removals.

**Table 7 :** Short-term management option table giving catch options for 2016 using the 2015 UWTV survey estimate.

*Landing obligation*

Basis	Total catch	Wanted catch*	Unwanted catch*	Harvest rate**
MSY Approach	793	542	250	8.10%
$F_{MSY}$	793	542	250	8.10%
$F_{current}$ (2012-2014)	783	536	247	8.01%

\* "Wanted" and "unwanted" catch are used to described *Nephrops* that would be landed and discarded in the absence of the EU landing obligation based on discard rates estimates for average (2012-2014).

\*\* Calculated for dead removals and applied to total catch.

*Discarding allowed*

Basis	Total catch	Dead removals	Landings	Dead discards	Surviving discards	Harvest rate*
	L+DD+SD	L+DD	L	DD	SD	for L+DD
MSY Approach ( $F_{MSY}$ proxy) assuming recent discard rates	904	832	618	214	71	8.10%
MSY Approach ( $F_{MSY}$ proxy) assuming 7% discard rate in weight**	1028	1010	956	54	18	8.10%

\* Calculated for dead removals.

\*\* this scenario assumes that discards can be reduced to 7% by weight in 2016