The "Smalls" *Nephrops* Grounds (FU22) 2012 UWTV Survey Report and catch options for 2013

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Abstract

This report provides the main results and findings of the seventh annual underwater television on the ‘Smalls grounds’ ICES assessment area; Functional Unit 22. The survey was multi-disciplinary in nature collecting UWTV, fishing, CTD and other ecosystem data. An analysis of the precision, accuracy and sampling intensity trade-offs showed that sampling intensity could be reduced without compromising the utility of the survey. Consequently, sampling intensity was reduced this year from around 100 stations in the past to 47 stations this year. The krigged burrow abundance estimate for Smalls ground has increased by 17% relative to 2011and was the second highest in the 7 year history of the survey. Abundance estimates have been fairly stable over the time series. The 2012 randomised isometric grid design result in a CV (or relative standard error) of 8%. Well below the upper limit of 20% recommended by SGNEPS 2012. *Nephrops* accounted for 22% of the catch weight from 6 beam trawl tows. Length-weight, maturity and by-catch data are all reported.

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 were the sediment is suitable for them to construct their burrows (Figure 1). 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 (ICES, 2012). The 2011 reported landings form the Smalls were the lowest in the last decade at only 1,237 t nevertheless these were estimated to be worth in the region of €6.1 m at first sale. The Smalls ground is particularly important to the Irish demersal fleet accounting for around 13% of the fishing effort by all demersal vessels >15m between 2006 - 2009 (Gerritsen, et al. 2012). Good scientific information on stock status and exploitation rates are required to inform sustainable management of this resource.

Nephrops spend a great deal of time in their burrows and their emergence behaviour is influenced many factors; time of year, light intensity and tidal strength. Underwater television surveys to monitor the abundance of *Nephrops* populations was pioneered in Scotland in early 1990s. Since then regular surveys have been conducted for many of the main *Nephrops* fisheries around Britain and Ireland (ICES, 2010). The technique has also been used in Danish, Greek, Italian and Spanish waters (ICES, 2012c). A direct approach of using the UWTV surveys as the basis for catch advice by applying harvest ratios (HRs) was proposed by Dobby & Bailey in 2006. Initially concerns about the accuracy of the UWTV surveys meant this approach was not widely accepted. WKNEPH 2007 discussed and documented the various uncertainties with UWTV surveys and further developed the HR approach (Dobby *et. al* 2007, ICES, 2007). Various studies were then carried out to investigate and mitigate uncertainties in the UWTV survey methodologies (e.g. Campbell et al 2009, ICES 2008 & 2010). Since 2009, ICES has provided annual advice for *Nephrops* stocks advice based on UWTV surveys and the methodologies proposed in WKNEPH (ICES 2009b).

This is the seventh in a time series of UWTV surveys in the Celtic Sea FU22 “Smalls” ground carried out by the Marine Institute, Ireland. The 2012 survey was multi disciplinary in nature; the specific objectives are listed below:

1. To complete randomised fixed isometric survey grid of ~47 UWTV with 4.5 nautical mile (Nmi) spacing stations on the “Smalls” *Nephrops* ground (FU22).
2. To carry out ~50 UWTV indicator stations in the wider Celtic Sea (FU19, FU20-21) if time allows.
3. To obtain 2012 quality assured estimates of *Nephrops* burrow distribution and abundance on the "Smalls” *Nephrops* ground (FU22). These will be compared with those collected previously.
4. 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.
5. To collect oceanographic data using a sledge mounted CTD.
6. To sample *Nephrops* and macro benthos using a 4 m beam trawl deployed at ~10 stations.

This report details: the change in survey design, the final UWTV results of the 2012 survey and also documents other data collected during the survey.

Material and methods

From 2006 to 2011 a randomised fixed square grid design has been used for the Smalls *Nephrops* ground. The grid spacing was 3 nautical miles (5.6km) and an adaptive approach is taken whereby stations are continued past the known perimeter of the ground until the burrow densities are 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), BGS sediment maps and previously collected UWTV data. SGNEPS (ICES, 2012c) recommended that a CV (or relative standard error) of < 20% is an acceptable precision level for UWTV surveys. SGNEPS also recommended that investigations into the precision of surveys be carried out and where possible survey effort should be extended to grounds not already covered with UWTV surveys (e.g. FU20-21).

Prior to this survey a study to investigate the accuracy and precision impact on increasing station spacing to 5.9 and 8.85 nmi was carried out. Figure 1 shows the various grid options of 5.9 and 8.85nmi and also density data obtained in 2011. The same methods to account for the spatial covariance and other spatial structuring and geo-statistical analysis of the mean and variance was carried out using SURFER version 8.02 for the various grid options and has been documented previously in other reports. The variograms, blanked krigged contour plot and posted point density data are shown in Figures 2.1 and 2.2. The 5.9nmi krigged contours correspond well to the observed data and depending on the density data the contours pick up the hot spots (Figure 2.2). However, the increased station spacing of 8.85 nmi does not pick up the varying density levels and the contour plot is more smooth (Figure 2.2). In general the densities are higher towards the central part of the ground.

The summary statistics from this geo-statistical analysis for the various grid options are given in Table 1. The estimates of abundance from the 5.9 nmi station spacing grid option1 and 2 are not significantly different from the estimate from the 2.95 nmi grid. Whereas the estimates from the 5.95 nmi grids 3 and 4 vary slightly for the year investigated. The estimation of variance from the 5.9 nmi grids as calculated by EVA is relatively low (CVs ranging from 5 - 14%) The estimation of variance for the 8.85 nmi grid option increases (CV in the order 24%). To maintain a CV < 20%, to achieve good spatial coverage over the ground and to generate burrow surface that reflects the underlying abundance an intermediate spacing of 4.5nmi would be an appropriate survey design. This resulted in a randomised isometric grid of 47 stations for FU22 Smalls in 2012. This reduced the required number of stations by around 50% and time by approximately 40%. The time saved could be used to extend survey coverage to other areas within Irish waters such as FU19 and FU20-21 within the survey schedule. The results of these other surveys are presented in separate reports.

The 2012 Celtic Sea survey took place on RV Celtic Voyager between 24th June to 03rd July. Survey timing was generally standardised to early July each year. The protocols used were those reviewed by WKNEPHTV 2007 (ICES, 2007). 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 2012 the USBL navigational data was used to calculate distance over ground for 100% of stations. In addition CTD profile was logged for the duration of each tow using a Seabird SBE 37. This data will be processed later.

Six valid beam trawl tows were conducted randomly across the Smalls ground once TV operations were successfully achieved. All *Nephrops* caught were sorted by sex and maturity category, weighed and measured using the NEMESYS electronic measuring system. A length stratified sub-sample of *Nephrops* were taken for each haul. Individual length, whole weight, tail weight, maturity and in the case of males appendix masculina lengths were recorded for each individual. The fish catch was identified to species level and weighted. The benthic catch was identified weighted (g) and counted. The UWTV station positions and tracks for the six valid beam trawl tows are shown in Figure 3.

In line with SGNEPS recommendations all scientists were trained/re-familiarised using training material and validated using reference footage prior to recounting at sea (ICES, 2009a). Figure 4 shows individual’s counting performance in 2012 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 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 were counted by each scientist for each one-minute interval was recorded. Following the recommendation of SGNEPS the time for verified recounts was 7 minutes (ICES, 2009a).

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). 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 5). Consistency and bias between individual counters was examined using Figure 6. 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. The USBL data 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 2012 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 7 and Figure 8 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 account for the spatial co-variance and other spatial structuring a geo-statistical analysis of the mean and variance was carried out using SURFER Version 8.02 the Smalls Grounds. The spatial structure of the density data was studied through variograms. Initially the mid-points of each UWTV transect were converted to UTMs. In addition to the survey stations various boundary positions were included in the analysis. The assumption at these boundary positions was that the *Nephrops* abundance was zero. These stations were outside the known distribution of *Nephrops* or suitable sediment and were approximately equidistant to the spacing within the main grid each year. An unweighted and unsmoothed omnidirectional variogram was constructed with a lag width of approximately 1417 and maximum lag distance of between 24-25 km. A model variogram $\gamma(h)$, was produced with a linear component (Equation 1). Model fitting was via the SURFER algorithm using the variogram estimation option. Various other experimental variograms and model setting were examined before the final model choice was made.

Equation 1: Linear Variogram Model

$$\gamma(h) = Co + S \cdot h$$

Where *Co* is the unknown nugget effect and *S* is the unknown slope.
The resulting annual variograms were used to create krigged grid files and the resulting cross-validation data were plotted. If the results looked reasonable then surface plots of the grids were made using a standardised scale. The final part of the process was to limit the calculation to the known extent of the ground using a boundary blanking file. The resulting blanked grid was used to estimate the mean, variance, standard deviation, coefficient of variation, domain area and total burrow abundance estimate.

Although SURFER was used to estimate the burrow abundance this does not provide the krigged estimation variance or CV. This was carried out using the EVA: Estimation VAriance software (Petitgas and Lafont, 1997). The EVA burrow abundance estimates were all extremely close to the Surfer estimate (+- 100 million burrows) with the exception of 2009 when the spatial coverage was poor.

Results

A histogram of the observed burrow densities from 2006 to 2012 on the Smalls *Nephrops* Grounds is presented in Figure 9. Boundary stations have been excluded where they occur outside a polygon based on the VMS activity of the *Nephrops* targeting fleet. This shows some inter-annual variation in modal burrow densities. In most years two modes are apparent at relatively high density (~0.9-1.0/m^2) and at moderate density (0.3-0.5/m^2). The 2012 survey results shows there are several quite high observations of burrow density ~1.5/m^2.

The geo-statistical structural analysis is shown in the form of variograms in Figure 10. There is a weak evidence of a sill at around 25km in 2007 and 2008. A comparison of the observed and expected density estimates – cross validation plots for each year is given in Figure 11. There is good concordance between the observation and model estimates though there may be some underestimation

The blanked krigged contour plot and posted point density data are shown in Figure 12. The krigged contours correspond well to the observed data. Highest densities are in the centre of the ground in all years. In general the densities are higher towards the south and central area of the ground. The highest densities observed in 2012 occur in a line running SE-NW towards the south of the area where high abundance has also been seen in the past (2006 and 2011).

The summary statistics from this geo-statistical analysis are given in Table 3 and Figure 13. The 2012 estimate of 1947 million burrows is well above average and close to the maximum of the series observed in 2006. The estimation variance of the 2012 survey as calculated by EVA is relatively low (CV of 8%) and within the SGNEPS2012 recommendation (ICES, 2012c).

Figure 14 shows the standardised length frequency distributions of *Nephrops* caught using a beam trawl on FU22 Smalls ground during the 2006 to 2012 surveys. The results indicate large numbers of recruits in both sexes with modal length around 17mm CL in 2006 which did not occur since then. For plotting purposes the individuals <10mm caught in 2012 were split evenly between males and females as it is not possible to accurately assign sex to individuals that small. Figure 16 is a summary of the length frequency by tow. There is both variability in the sample size and structure between tows. Carapace lengths ranged from 11 mm to 53 mm for one large male.

In 2012 various morphmetric measurements were made during the survey. The estimated length-weight parameters are given in Table 5 together with those currently used in data raising and by ICES for this stock. Bias correction factors for the length-weight conversions are also provided since linear models were fitted to the log CL and log weight data. Male growth was allometric and the b parameter estimate was not significantly different from that used for this stock. Female growth was also estimated to be allometric and was significantly different (p>0.001) that that used by ICES but not significantly different to the male length-weight relationship (ICES, 2012a).

The relationship between total weight and tail weight was also investigated using data collected on the survey. The mean conversion factor from tail weight to whole weight was 2.929 with a standard error of 0.0218.

Figure 15 depicts a modelled maturity ogive (binomial GM) for female *Nephrops* where 50% of the females are mature at 26 CL mm. The segmented regression for males is not presented due to a poor fit.

Table 3 summarises the fish catches where *Pleuronectes platessa* (European plaice) was recorded in all beam tows with the highest catch of 5.602 kgs recorded in tow 6. A summary of the benthic components by tow in presented in Table 4, where *Nucula* *nucleus* (nut clam) was the most abundant and recorded in five tows. The octopus species *Eledone cirrhosa (curled octopus)* was also recorded in all six tows – this species is a noted predator of crustaceans and has been filmed lying close to or at the *Nephrops* burrow entrances. It is important to note that the mud burrowing shrimp *Calocaris macandrae* was also recorded in four tows. The burrow of this species can cause confusion in identification in areas of very soft mud and high densities of *Nephrops* burrows such as the western Irish Sea *Nephrops* ground, but this species is not deemed to be problematic in the Smalls ground. *Goneplax rhomboids,* a burrowing crab species, was also recorded in four tows.

Sea-pen distribution across the Smalls *Nephrops* grounds is mapped in Figure 16. All sea-pens were identified from the video footage as *Virgularia mirabilis*. *V.mirabilis* was also present at stations where trawl marks were recorded. This seapen species was recorded as frequently present at 13% and occasionally present at 38% of total stations. Trawl marks were noted at 28% of the stations surveyed with trawl marks present for the entire transect for 9% of stations.

Discussion

This survey series was commenced by Ireland in 2006 to address the data deficiencies and improve the scientific basis for managing the stock. In 2012 the survey information up to 2011 was used as the main basis for the ICES assessment and advice for "the Smalls" (FU 22) (ICES, 2012a&b). ICES concluded that the *Nephrops* stock was fished at a sustainable rate (ICES, 2012b). The 2012 burrow abundance estimates have increased by over 19%. Table 6 is an updated management option table giving catch options at various levels of fishing mortality for 2013. Using the 2012 estimate of abundance would increase the catch option at F_{msy} ($=F_{35\%spr}$) from 2,600 tonnes as proposed by ICES in July to ~3,100 tonnes.

In recent years "the Smalls" (FU 22) has accounted for around 38% or 2,300 t of the total landings (~ 5,500 t) from the wider Celtic Sea (FU19, 20, 21 & 22) (ICES, 2012b). The Smalls represents around 32% of the total area where *Nephrops* are currently fished in the Celtic Sea (based on areas shown in Figure 1). While it is likely that the *Nephrops* populations in the Celtic Sea are linked in a meta-population sense, further information is needed to estimate stock size and exploitation rates for the other *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. The time saved by decreasing sampling intensity on the Smalls has been used in 2012 to extend survey coverage into FU19 and FU20-21. The cost was reduction in survey precision from around 3 to 8% which is well within the limits established by SGNEPS (ICES, 2012c).

No signal of *Nephrops* recruitment was observed in 2012 compared to that noted in 2006. However, only six tows were conducted over the central part of the grid due to time constraints. Variability between *Nephrops* catch and size structure between the tows is linked to *Nephrops* emergence patterns as well as the underlying density. The collection of length-weight and maturity data are required under the Data Collection Framework (DCF). The length-weight parameters estimated during the survey for females were significantly different from those used currently. This may be a seasonal bias but could have implication for the raising of sampling data. The conversion factor from tail weight to whole weight is also somewhat different to that normally used. The observed female L_{50} estimate ~26 mm is close to previous observations for this stock from Irish sampling but significantly below that reported in the stock annex for FU20-22 = 31 mm. . The onset of maturity is not particularly relevant to the current assessment and advisory framework although it is something that should be monitored.

Macrobenthos data from the trawl catches were collected for the second time this year. Over time these will be used to develop an understanding of the macrobentic community structure and dynamics. The dominant species by weight and number was the nut clam *Nucula nucleus* followed by *Crangon* species (brown shrimp) and then *Nephrops norvegicus*. *Eledone cirrhosa* (curled octopus) was present in all tows. Overall there is a similar benthic species composition between the tows reflecting the habitat type encountered which is generally sandy mud. *Virgularia mirabilis* was caught in one tow by the beam trawl despite the common occurrence of *Virgularia mirabilis* observed on the video footage. This illustrates that the catchability of epibenthic species in the beam trawl is often very different to what is visible on video footage. These different sampling methods may not always reflect underlying occurrence or abundance.

Two other burrowing species: *Goneplax rhomboids* (box crab) and *Calocaris macandrae* (mud burrowing shrimp) were recorded. Of those *Calocaris macandrae* was the most abundant. The burrows of these species can lead to confusion with *Nephrops* burrows in areas of very soft mud and high burrow densities. However, such allocation errors are minimised due to the training procedures employed during the survey. These include refresher training on classical *Nephrops* burrow signatures and consistency verification with reference count analyses (ICES 2008 & 2009).

A broad diversity of fish species were caught (24 species). Of these *Pleuronectes platessa* (European plaice) was the most abundant followed by *Glyptocephalus cynoglossus* (witch) and *Lophius piscatorius* (monkfish). These species are typically encountered in the catches of surveys and commercial vessels on “the Smalls”.

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 for the seventh successive year. The UWTV coverage and footage quality was excellent on “the Smalls”. Weather and technical downtime meant that indicator stations in FU20-21 were not achieved, although 20 TV stations were completed in FU19 and this data will be presented in a separate report. Also the number of beam trawls was limited to 6 out of a planned 10. 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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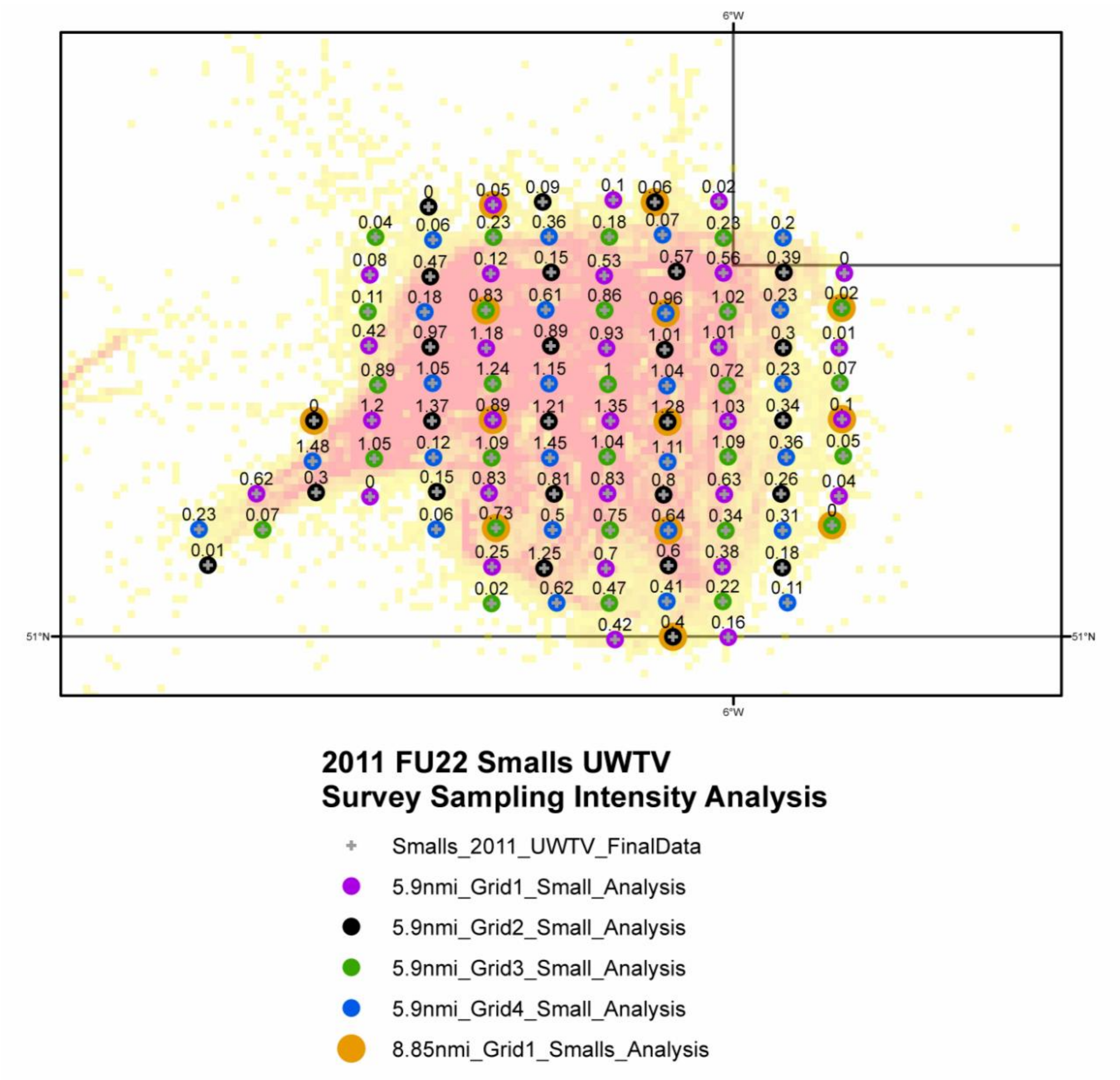

Figure 1: FU22 Smalls grounds: Grid options for station spacing of 2.9, 5.9 and 8.85 nmi and density data obtained in 2011 overlaid on a heat map *Nephrops* directed fishing activity.

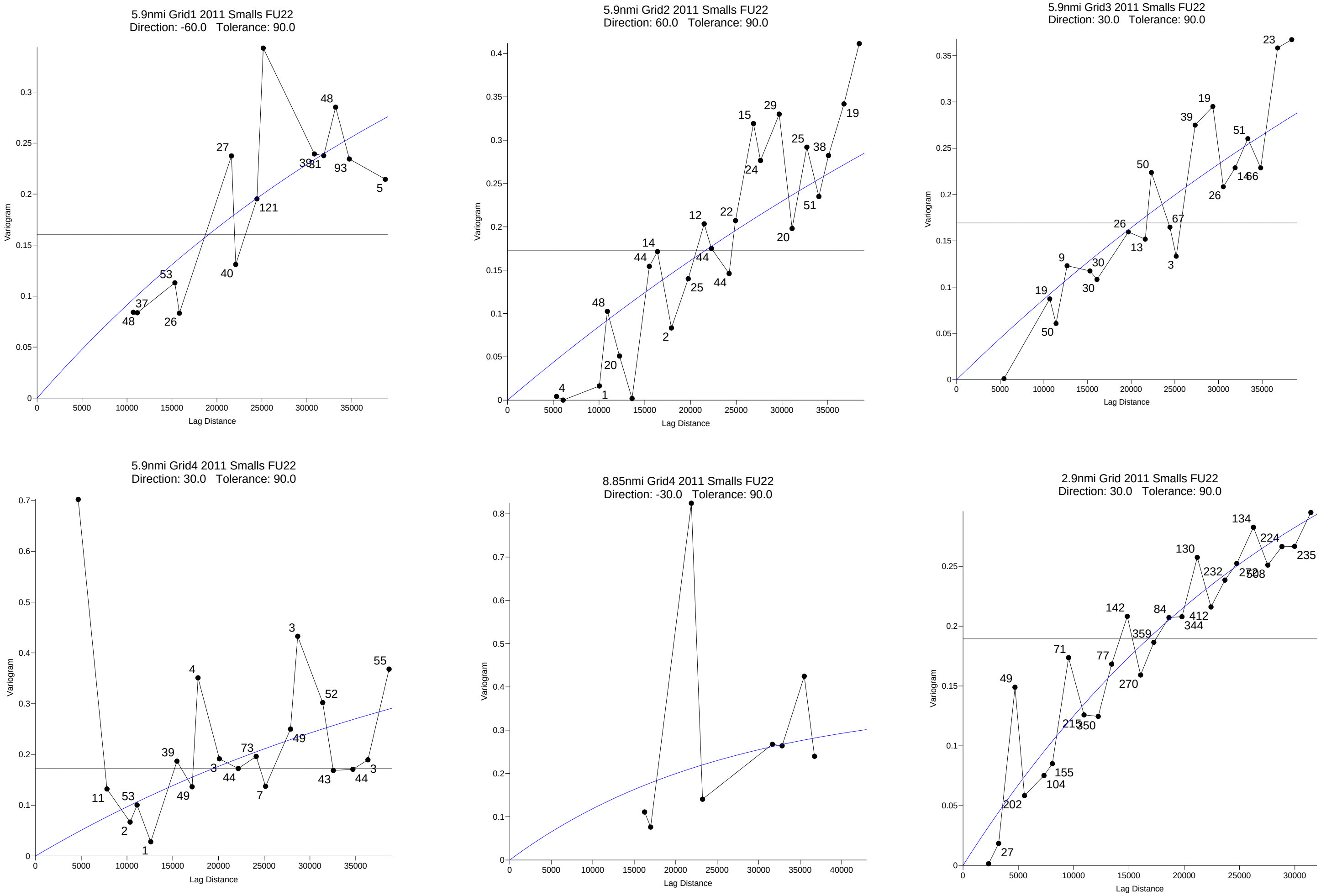

Figure 2.1: FU22 Smalls grounds: Omnidirectional mean variograms of station spacing of 2.9, 5.9 and 8.85 nmi grids from the 2011 UWTV survey.

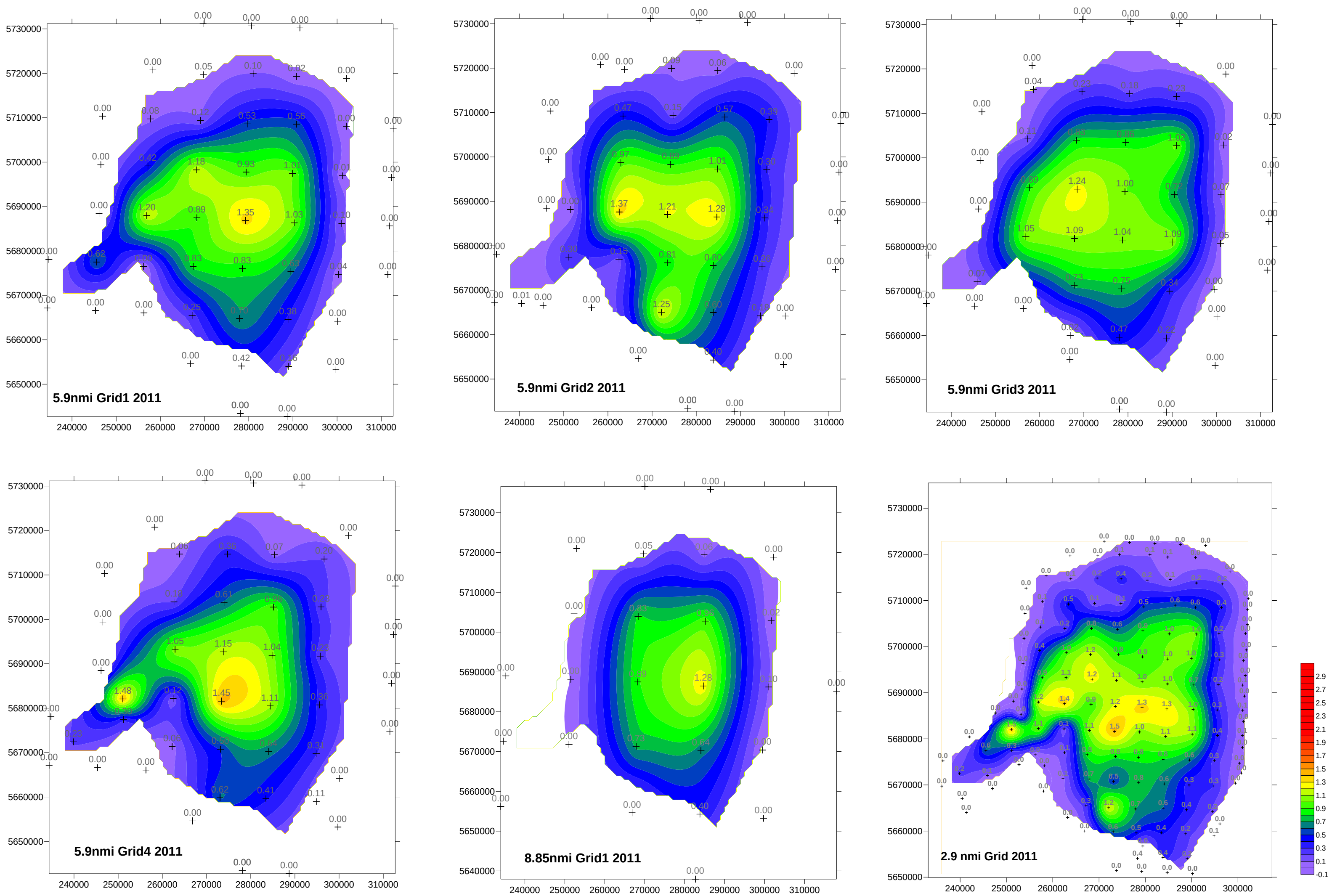

Figure 2.2: FU22 Smalls grounds: Contour plots of the krigged density estimates 5.9, 8.85 and 2.95 nmi grid options.

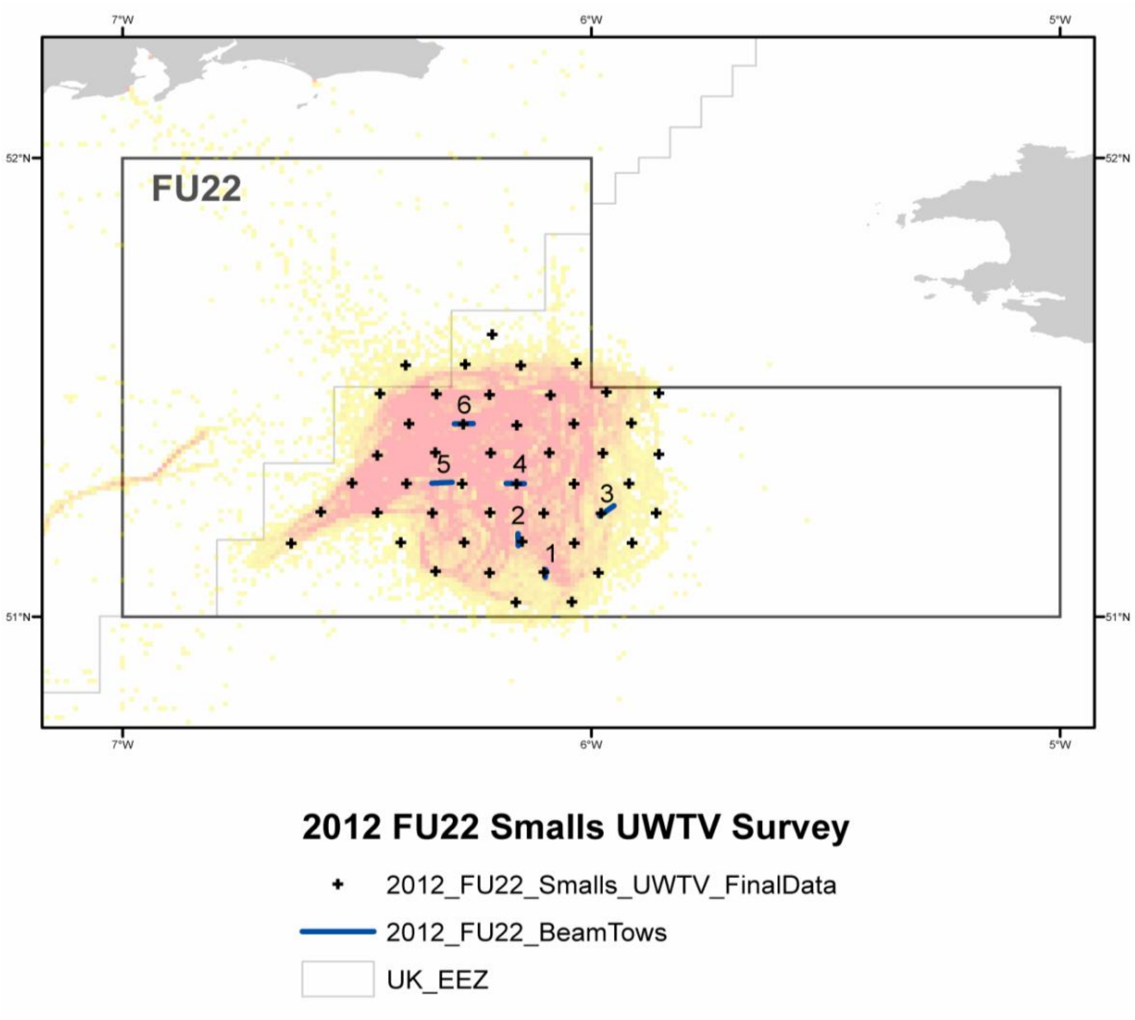

Figure 3: FU22 Smalls grounds: TV and Beam trawl stations completed on the 2012 survey overlaid on a heat map *Nephrops* directed fishing activity.

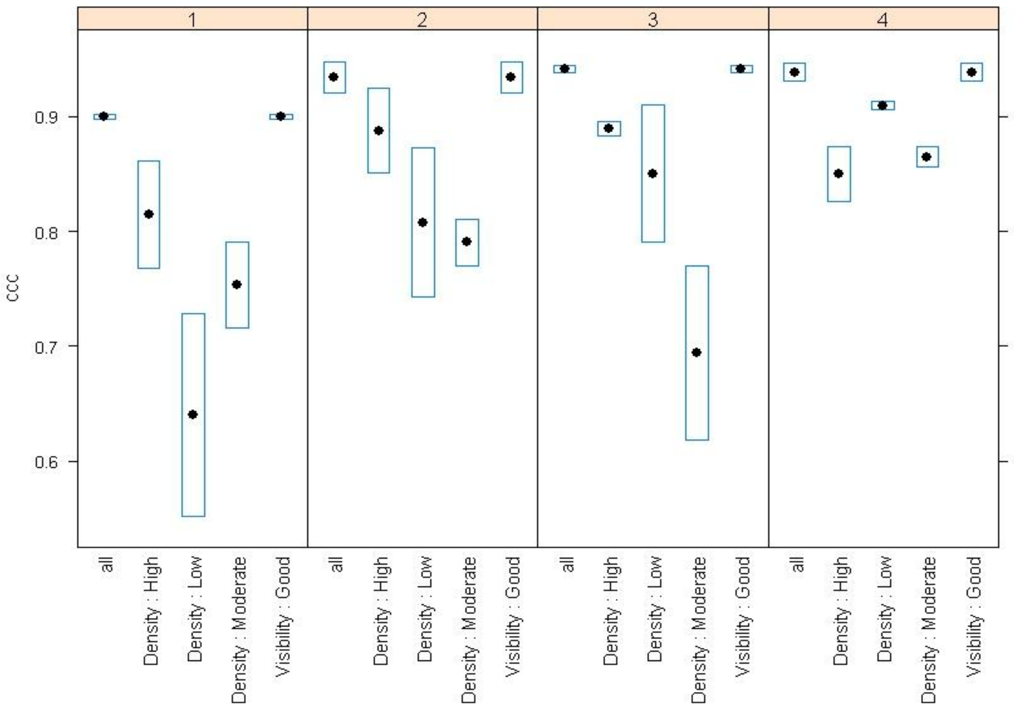

Figure 4: FU22 Smalls grounds: 2012 Counting performance against the reference counts as measured by Linn's CCC for FU22 Smalls reference set. Each panel represents an individual. The x-axis (from left to right), all stations pooled, high density, low density, medium density and visibility good.

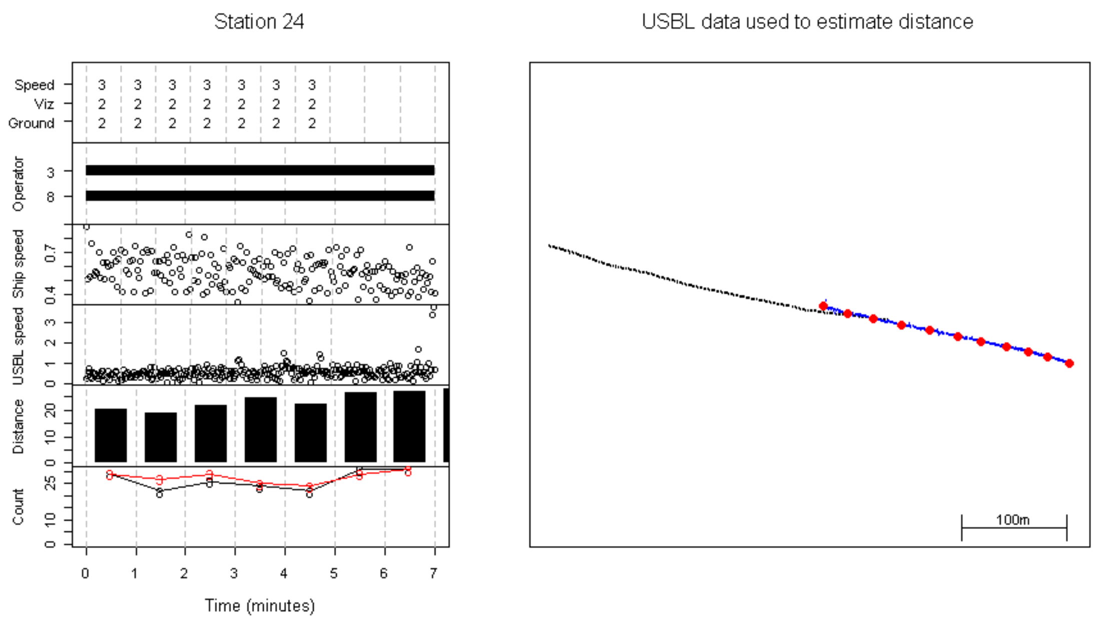

Figure 5 : FU22 Smalls grounds: r - tool quality control plot for station 24 of the 2012 survey

2012.

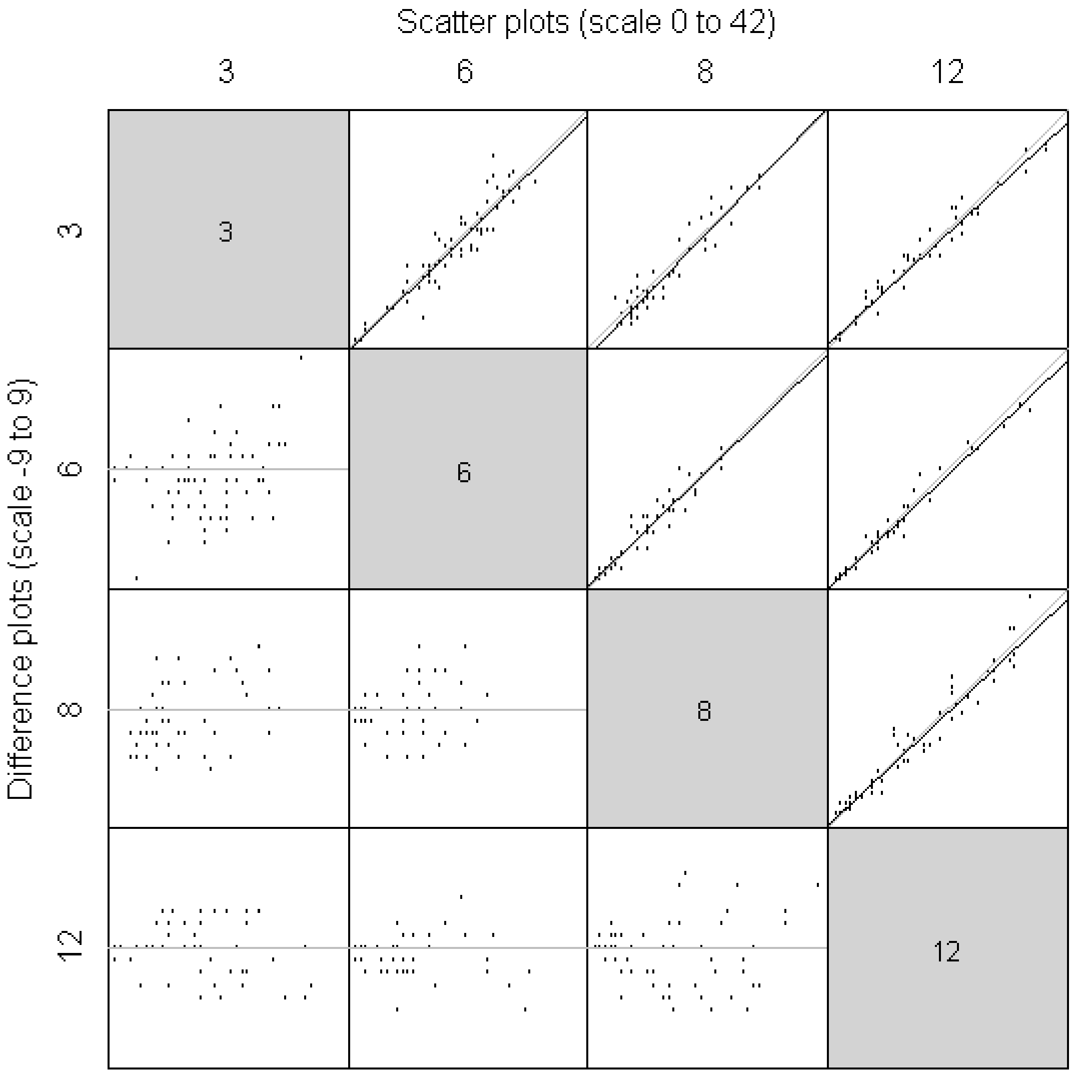

Figure 6 : FU22 Smalls grounds: Scatter plot analysis of counter correlations for the 2012 survey.

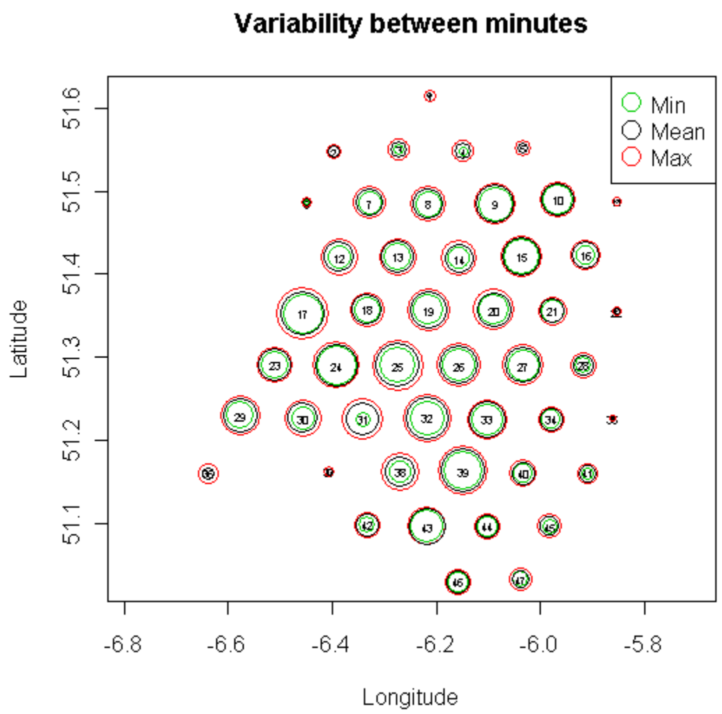

Figure 7 : FU22 Smalls grounds: Plot of the variability in density between minutes for each station in 2012.

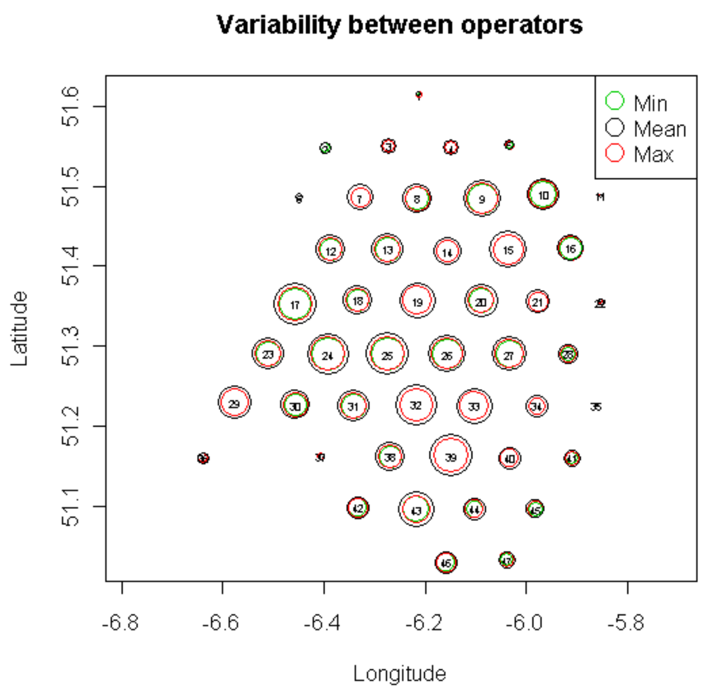

Figure 8 : FU22 Smalls grounds: Plot of the variability in density between operators (counters) for each station in 2012.

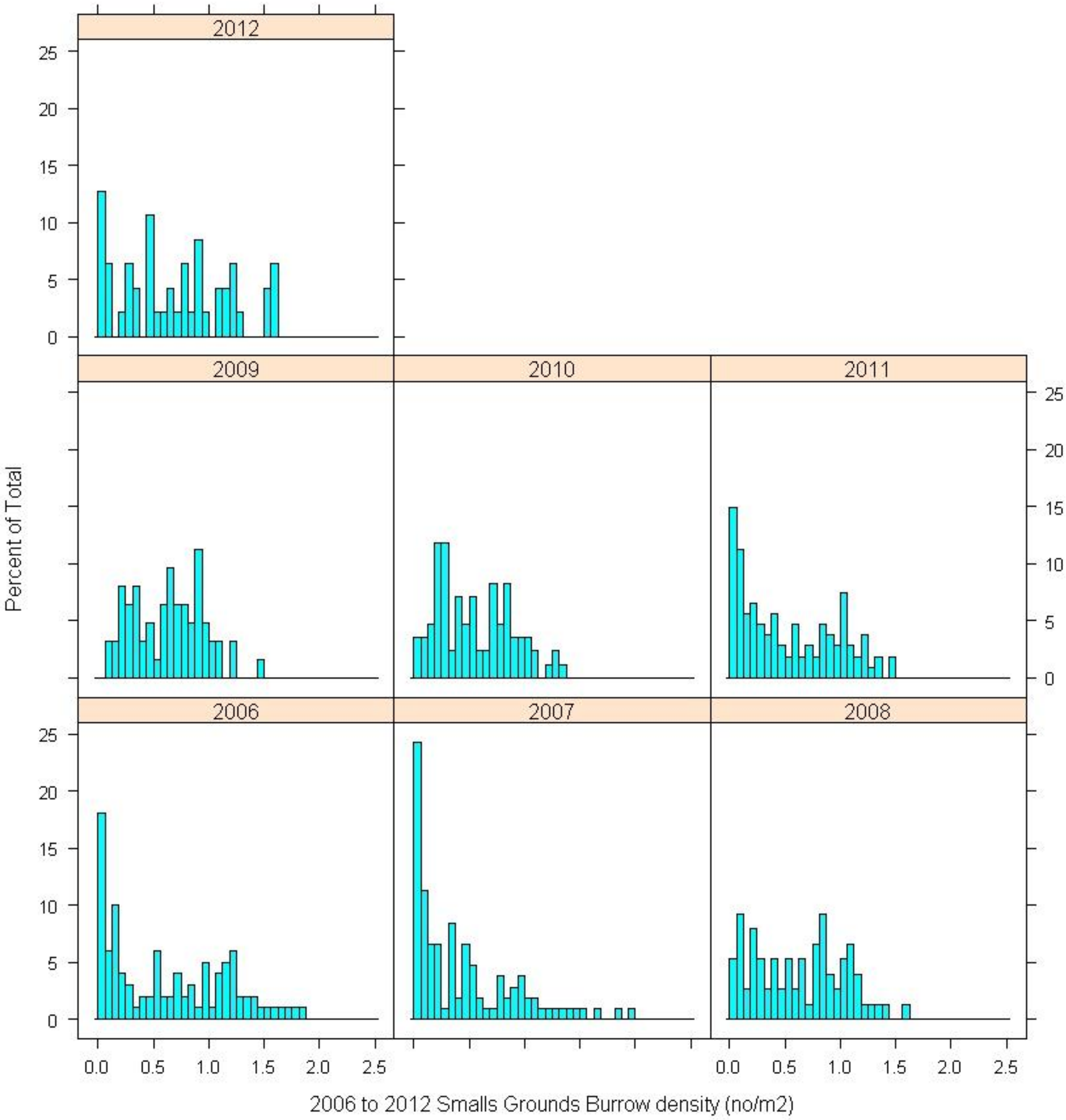

Figure 9: FU22 Smalls grounds: Histogram of burrow density distributions by year from 2006-2012.

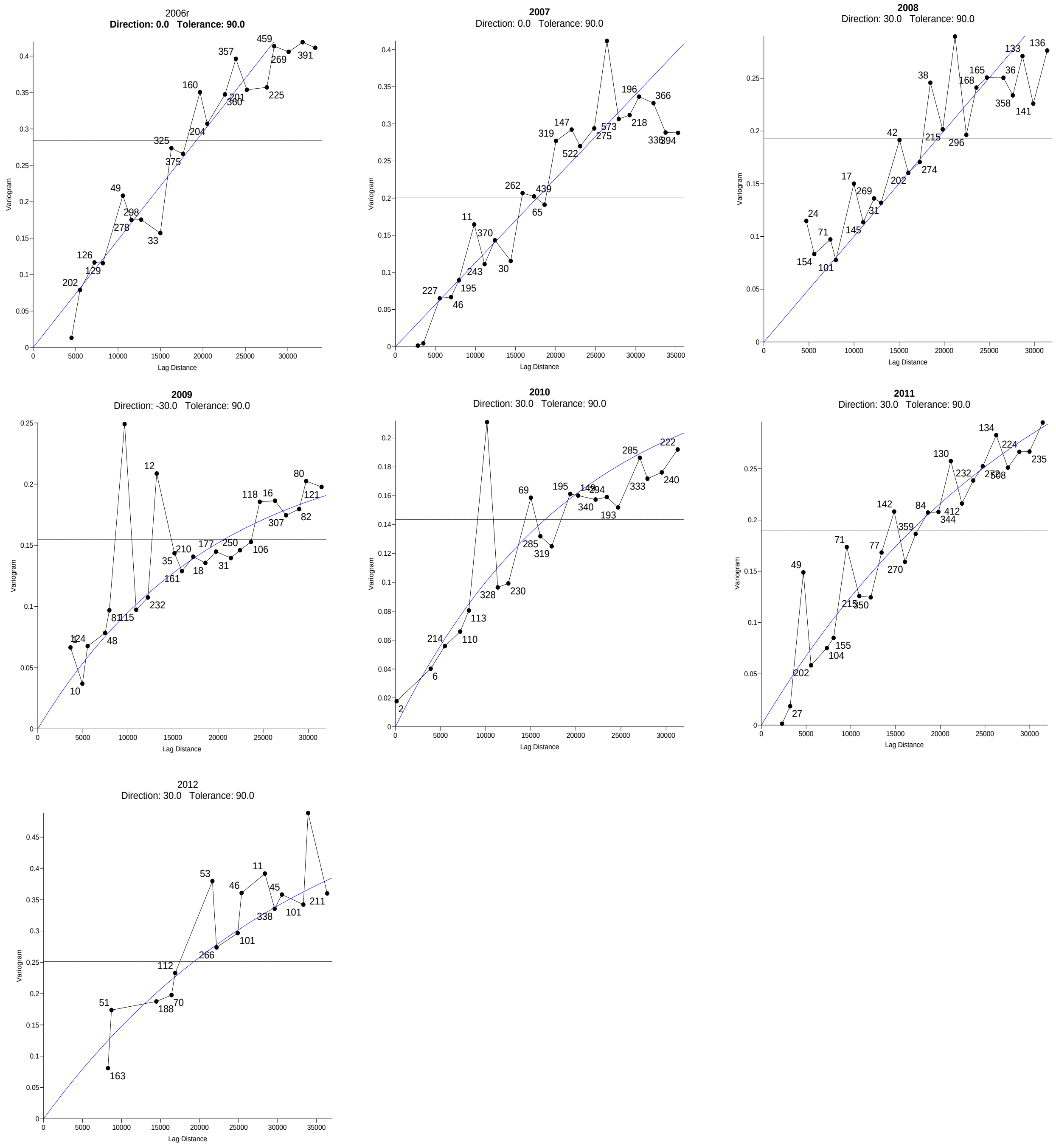

Figure 10: FU22 Smalls grounds: Omnidirectional mean variograms by year from 2006-2012.

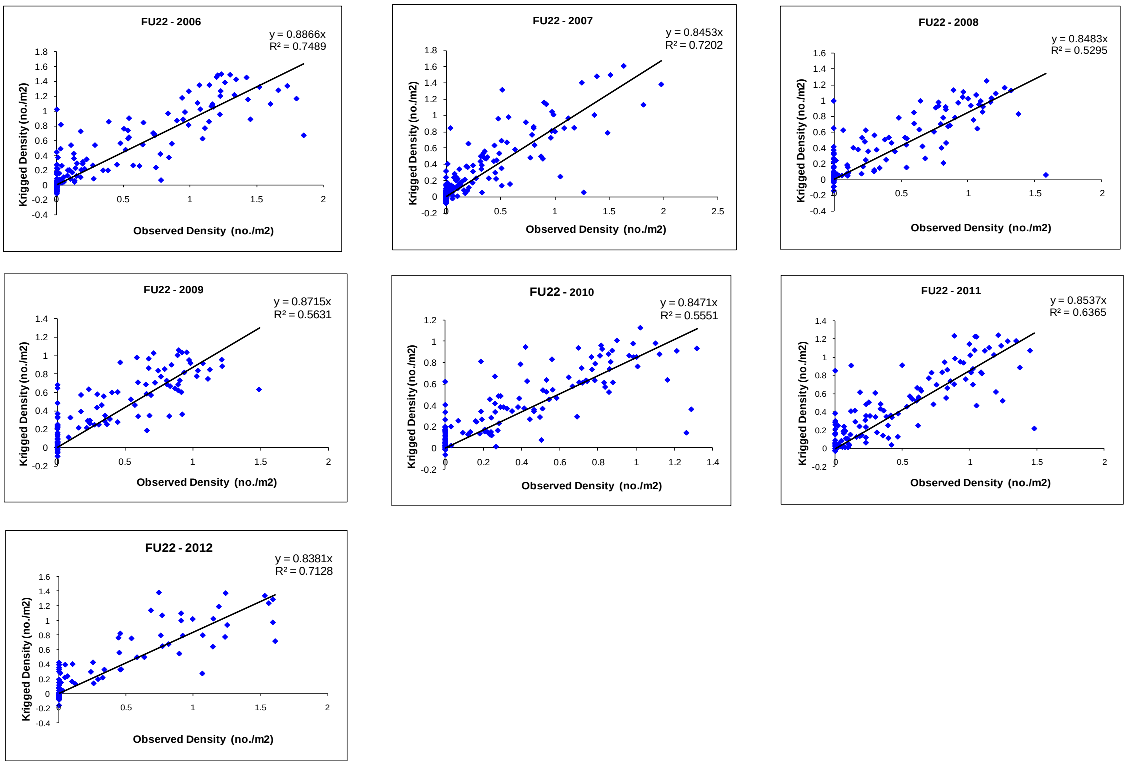

Figure 11: FU22 Smalls grounds: Cross validation plots by year from 2006-2012.

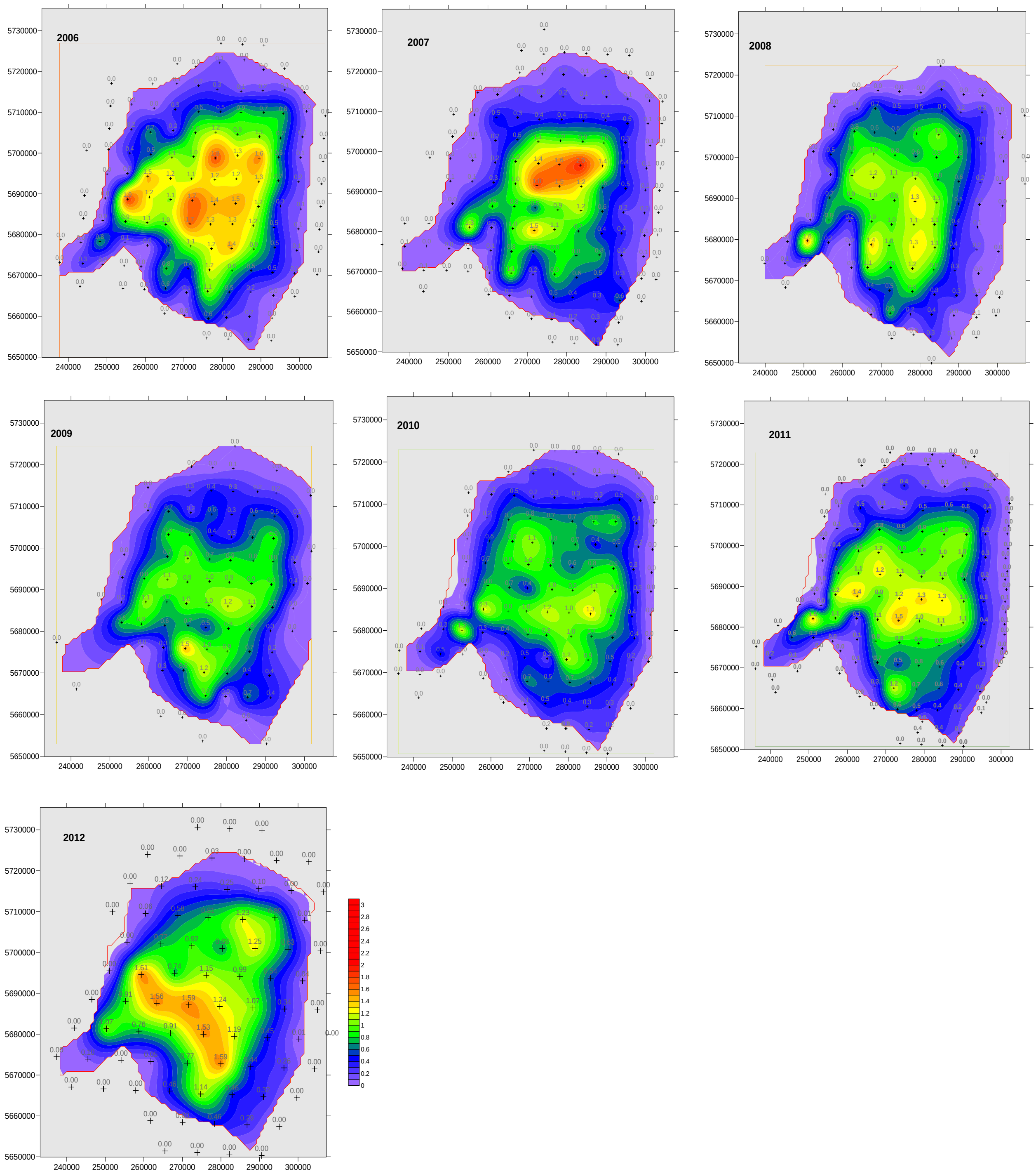

Figure 12: FU22 Smalls grounds: Contour plots of the krigged density estimates by year from 2006-2012.

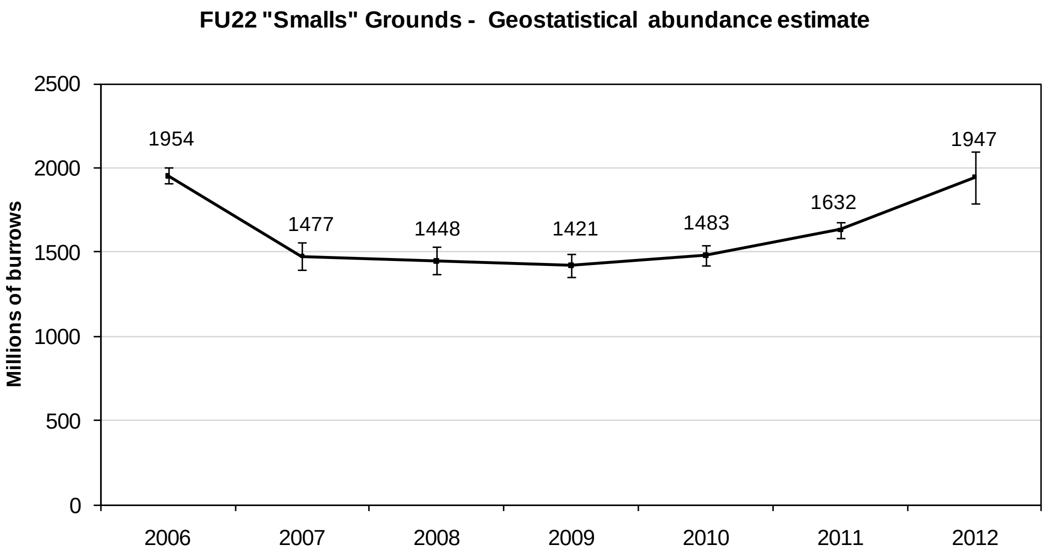

Figure 13: FU22 Smalls grounds: Time series of geo-statistical abundance estimates (in millions of burrows) from 2006-2012.

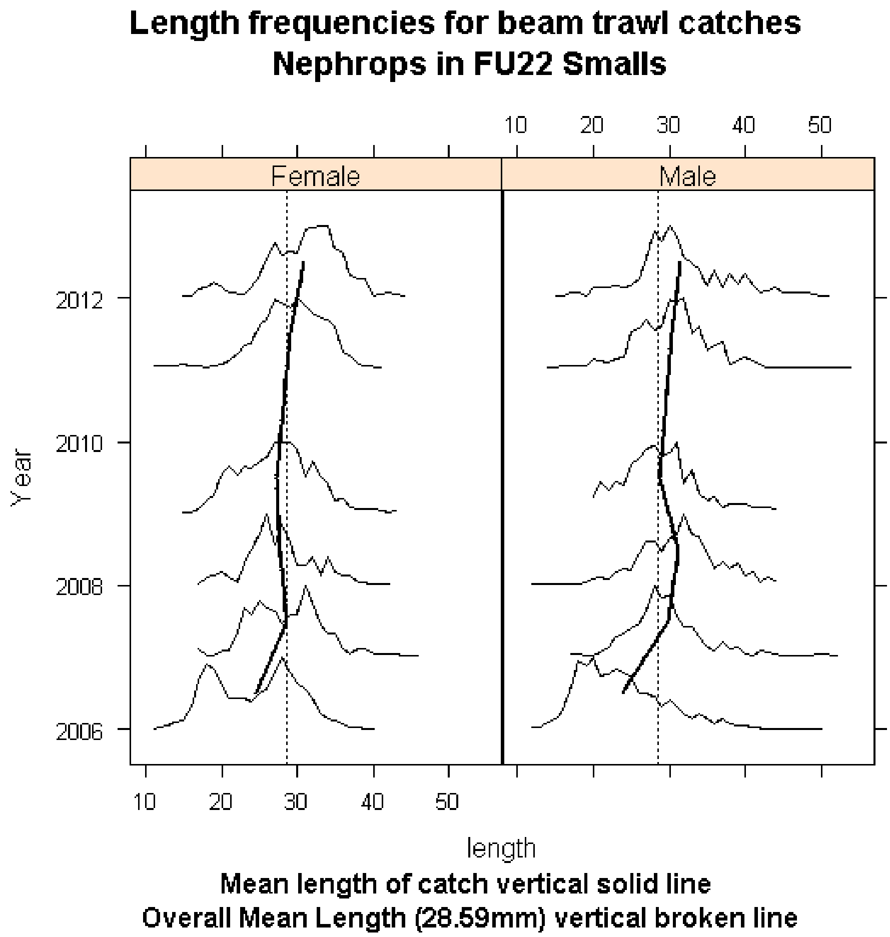

Figure 14: FU22 Smalls grounds: Standardised length frequency distributions for *Nephrops* caught using beam trawls in July 2006 to 2012 (except 2010).

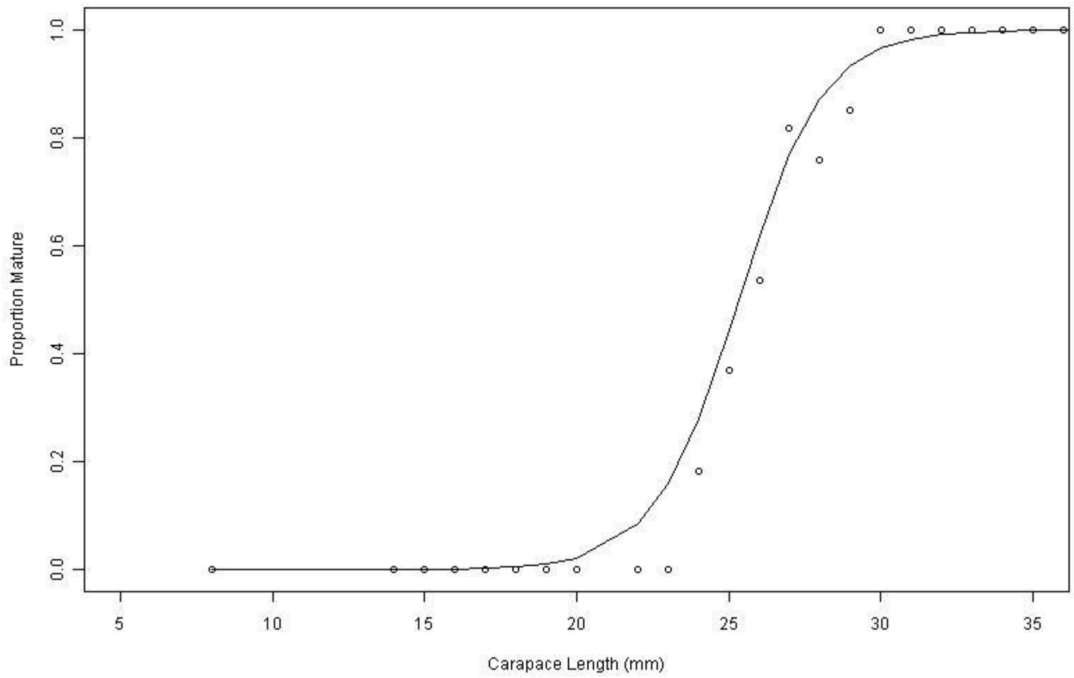

Figure 15: FU22 Smalls grounds: Female *Nephrops* maturity ogive (L_{50}~26 mm).

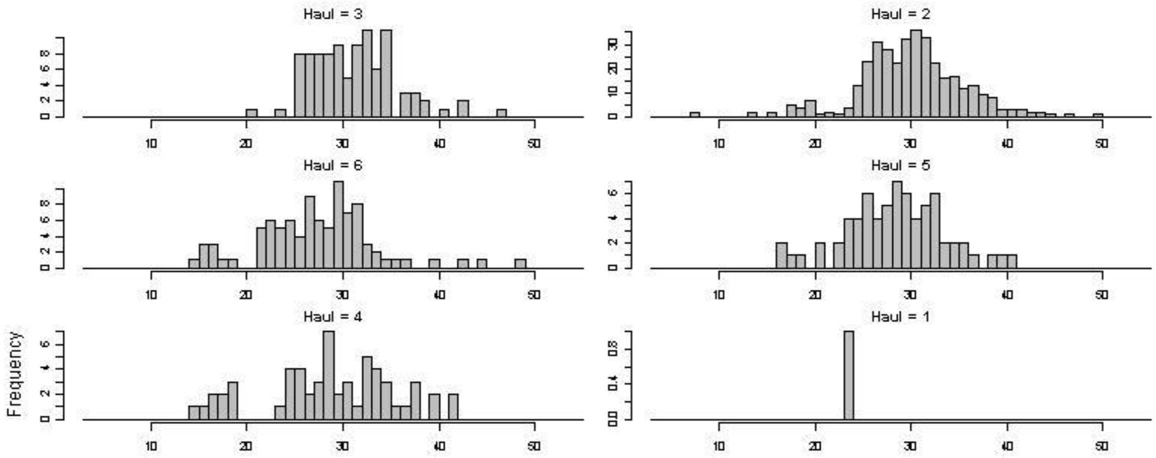

Figure 16: FU22 Smalls grounds: *Nephrops* length frequencies by haul in 2012.

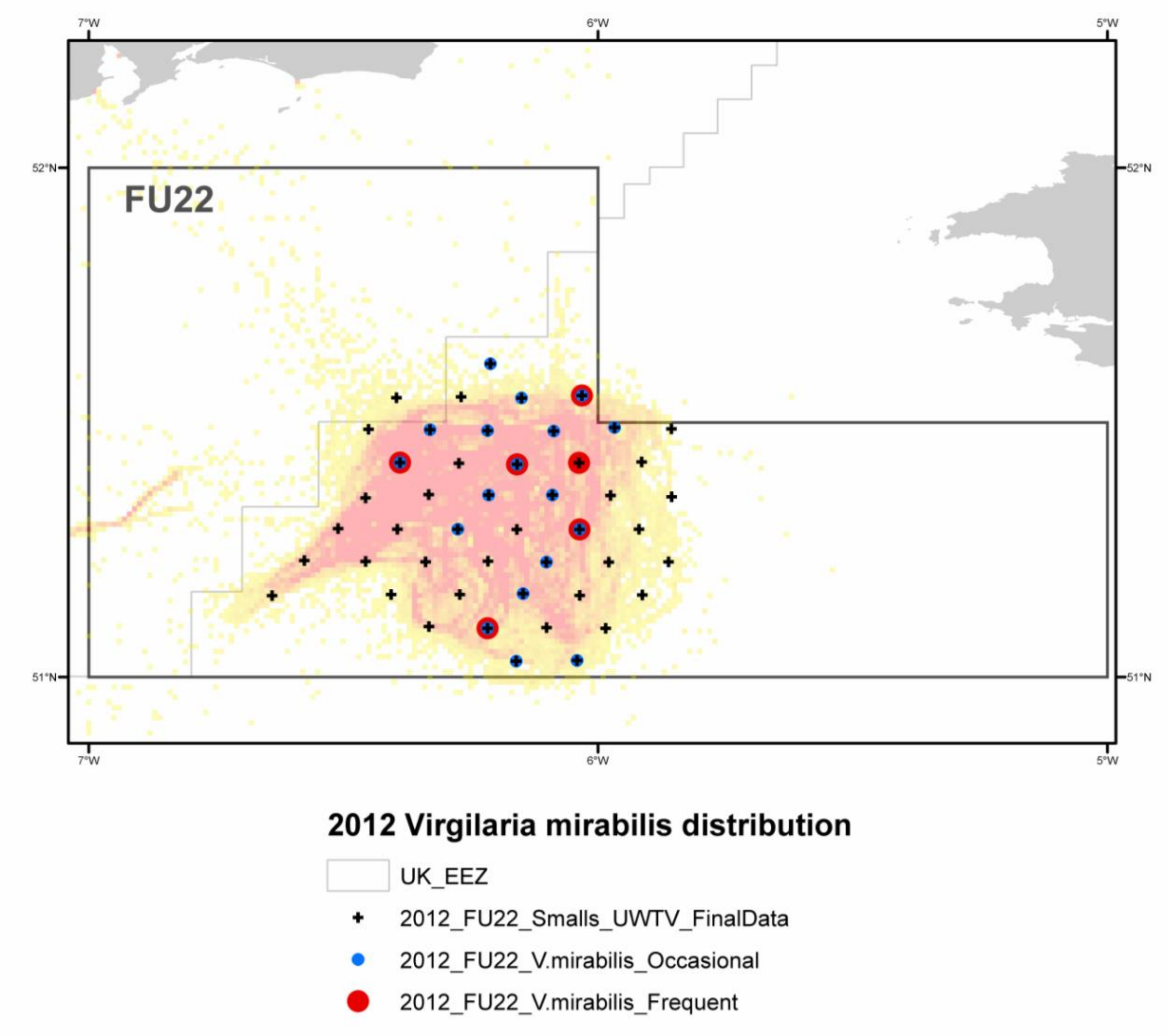

Figure 16: FU22 Smalls grounds: Stations where *Virgilaria mirabilis* was identified during the 2012 survey overlaid on a heat map *Nephrops* directed fishing activity.

Table 1: FU22 Smalls grounds: Overview of geostatistical results for the various 2011 grid options.

FU - Ground	Grid Option	Year	Number of stations	Mean Density (No./m2)	Domain Area (km2)	Geostatistical abundance estimate (millions of burrows)	CV on Burrow estimate
FU 22 Smalls	2.95 grid	2011	107	0.53	2881	1632	3%
	5.9 grid1	2011	29	0.54	2959	1668	5%
	5.9 grid2	2011	26	0.54	2965	1663	16%
	5.9 grid3	2011	27	0.57	2965	1742	13%
	5.9 grid4	2011	26	0.51	2965	1561	14%
	8.85 grid1	2011	13	0.48	2817	1487	26%

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	Sea Pens								
	V. mirabilis			*P. phosphorea*			*F. quadrangularis*		
	C	F	O	C	F	O	C	F	O
Virgularia mirabilis									
Pennatula phosphorea									
Funiculina quadrangularis									

Table 3: FU22 Smalls grounds: Overview of geostatistical results from 2006-2012.

FU	Ground	Year	Number of stations	Mean Density ($no./m_2$)	Domain Area (km_2)	Geostatistical Abundance (millions of burrows)	CV on Burrow estimate
22	Smalls	2006	100	0.63	2962	1954	2%
		2007	107	0.48	2955	1477	6%
		2008	76	0.47	2698	1448	6%
		2009	67	0.47	2824	1421	5%
		2010	90	0.49	2861	1483	4%
		2011	107	0.53	2881	1632	3%
		*2012	47	0.63	2934	1947	8%

* reduced isometric grid

Table 3 : FU22 Smalls grounds: Summary of 2012 fish catches (kg) by tow.

Species	Tow 1	Tow 2	Tow 3	Tow 4	Tow 5	Tow 6	Total Weight (kg)
ARGENTINA SPP	0.134	0.052	0	0	0	0	0.186
CALLIONYMUS LYRA	0.008	0	0.072	0	0	0	0.08
CALLIONYMUS MACULATUS	0	0	0.018	0	0	0	0.018
EUTRIGLA (CHELIDONICTHYS) GURNARDUS	0.272	0	0.466	0	0	0	0.738
GAIDROPSARUS VULGARIS	0	0.026	0	0.012	0.046	0.048	0.132
GLYPTOCEPHALUS CYNOGLOSSUS	1.86	0.62	1.978	0.082	0.702	0.188	5.43
GOBIES	0	0.012	0	0	0	0.008	0.02
HIPPOGLOSSOIDES PLATESSOIDES	0.206	0.496	1.492	0.188	0.106	0.074	2.562
LEPIDORHOMBUS WHIFFIAGONIS	1.112	0.944	1.561	0	0.648	0	4.265
LIMANDA LIMANDA	0	0	0.062	0	0	0	0.062
LOPHIUS PISCATORIUS	0.348	0	2.93	0	0	1.762	5.04
MELANOGRAMMUS AEGLEFINUS	0	0	0.004	0	0	0	0.004
MERLANGIUS MERLANGUS	0.002	0	0.246	0	0.154	0.626	1.028
MERLUCCIUS MERLUCCIUS	0.002	0.064	0.06	0.058	0	2.896	3.08
MICROCHIRUS VARIEGATUS	0.054	0	0.474	0	0	0	0.528
MICROSTOMUS KITT	0	0	0.122	0	0.054	0	0.176
PHYCIS BLENNOIDES	0	0	0	0	0	0.042	0.042
PLEURONECTES PLATESSA	3.864	2.162	0.318	0.34	1.656	5.602	13.942
SCYLIORHINUS CANICULA (Female)	0	0	0.808	0	0.346	0.054	1.208
SCYLIORHINUS CANICULA (Male)	0	0	0	0	0.212	0.012	0.224
SOLEA SOLEA	0	0	0.848	0.12	0.208	0	1.176
TRISOPTERUS ESMARKI	0	0.088	0.076	0.044	0.2	0.13	0.538
TRISOPTERUS MINUTUS	0.316	0.092	0.074	0.06	0.118	0.084	0.744
ZEUGOPTERUS PUNCTATUS	0	0	0.016	0	0	0	0.016
Total	8.178	4.556	11.625	0.904	4.45	11.526	41.239

Table 4 : FU22 Smalls grounds: Summary of 2012 benthic catch by tow in weight (kg) and number.

	Tow 1		Tow 2		Tow 3		Tow 4		Tow 5		Tow 6	
Species	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Aphrodite aculeata	0	0	0	0	0.022	1	0.026	1	0	0	0.112	10
Asterias rubens	0.050	3	0.044	2	0	0	0	0	0.124	3	0.066	1
Astropecten irregularis	0.102	8	0.036	3	0.268	22	0.118	16	0.052	6	0.012	2
Broken shell	0	0	0	0	0	0	0	0	4.800	0	2.770	0
Buccinum undatum	0	0	0	0	0	0	0.322	1	0.050	1	0	0
Calocaris macandrae	**0**	**0**	**0.012**	**6**	**0**	**0**	**0.004**	**2**	**0.002**	**2**	**0.012**	**7**
Cerianthus membranecous	0	0	0.034	1	0	0	0	0	0	0	0	0
Colus spp	0	0	0.002	1	0	0	0	0	0	0	0	0
Crangon spp	0.008	1	0.014	66	0.001	38	0.022	29	0.361	412	6.590	599
Dichelopandulus bonneri	0	0	0	0	0	0	0.156	57	0.730	235	0.470	131
Eledone cirrhosa	**0.454**	**4**	**0.686**	**6**	**1.148**	**8**	**1.142**	**5**	**0.490**	**3**	**0.148**	**1**
Goneplax rhomboides	**0**	**0**	**0.002**	**2**	**0.012**	**2**	**0.004**	**3**	**0**	**0**	**0.004**	**1**
Inachus dordettensis	0	0	0	0	0.004	1	0	0	0	0	0	0
Liocarcinus depurator	0	0	0	0	0	0	0	0	0.326	20	0.008	2
Liocarcinus holsatus	0	0	0.016	23	0.008	7	0.008	11	0.002	3	0.001	1
Luida sarsi	0	0	0	0	0.010	1	0	0	0	0	0	0
Lunatia spp	0.188	58	0.548	171	0.516	136	1.258	376	0.361	83	0	0
Macropodia spp	0	0	0	0	0.002	2	0	0	0	0	0.001	0
Nephrops norvegicus	**0.008**	**1**	**7.461**	**361**	**2.052**	**97**	**1.102**	**57**	**1.176**	**69**	**1.552**	**93**
Nucula nucleus	0	0	0.982	461	0.036	19	4.966	2660	2.477	1527	11.832	7159
Pagurus bernardus	0	0	0	0	0	0	0	0	0.094	5	0	0
Pagurus spp	0	0	0	0	0.024	5	0	0	0	0	0.104	0
Pontophilus spinosa	0	0	0.004	6	0.001	1	0.002	3	0	0	1.348	104
Processa spp	0.001	1	0	0	0	0	0	0	0	0	0.016	0
Scalpellum scalpellum	0	0	0	0	0.005	1	0.004	1	0	0	0	0
Sepiola spp	0	0	0.001	2	0.005	8	0	0	0.230	2	0	0
Stichastrella rosea	0.005	1	0	0	0.008	1	0	0	0	0	0	0
Virgilaria mirabilis	**0**	**0**	**0.001**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Weed	0	0	0	0	0	0	0.002	0	0	0	0	0
Total	0.808	77	2.382	1,112	2.070	350	8.030	3,222	5.299	2,371	23.494	8,111

Table 5. FU22 Smalls grounds: Length-weight parameters by sex estimated for *Nephrops* caught during the 2012 survey together with those currently used to raise the sampling data.

FU	Year	Parameters	Female	Male
22	2012	a currently used for FU22	0.000684	0.000322
		b currently used for FU22	2.963	3.207
		a estimated	-8.06498	-8.28508
		a 2.5% Confidence Intervals	-8.345277	-8.598186
		a 97.5% Confidence Interval	-7.784684	-7.971978
		b estimated	3.18605	3.26229
		b 2.5% Confidence Intervals	3.101365	3.171281
		b 97.5% Confidence Interval	3.27073	3.3533
		Bias Correction Factor	1.00637	1.007398
		Number of Observations	117	95

Table 6 :. FU22 Smalls grounds: Short-term forecast management option table giving catch options for 2013 revised using 2012 UWTV estimate.

			Implied fishery	
	Harvest rate	Adjusted Survey (millions)	Retained number (millions)	Landings (tonnes)
MSY framework	10.9%	1,498	140	3,102,152
F_{2011}	5.3%	1,498	68	1,515,187
$F_{0.1\ Combined}$	7.5%	1,498	96	2,130,049
$F_{max\ Combined}$	12.3%	1,498	158	3,508,148
	0%	1,498	0	0
	2%	1,498	26	571,825
	4%	1,498	52	1,143,650
	6%	1,498	77	1,715,476
	8%	1,498	103	2,287,301
	10%	1,498	129	2,859,126
	12%	1,498	155	3,430,951

		Basis
Landings Mean Weight (Kg)	22.1711	Sampling 2003-11
Survey Overestimate Bias	1.30	WGCSE 2011
Survey Numbers (Millions)	1947	UWTV Survey 2012
Prop. Retained by the Fishery	0.86	Sampling 2009-11