Update on the UWTV Survey on the Celtic Sea *Nephrops* Grounds

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Introduction

This is the fourth in a time series of UWTV surveys on the 'Smalls grounds'. The 2006 survey covered the distinct mud patches of the Smalls Grounds and also indicator stations on the Labadie Bank, Nymphe Bank and Seven Heads, whereas the 2007 to 2009 survey covered the Smalls grounds only due to poor weather and time contraints. This report details the results of the 2009 survey for the Smalls ground *Nephrops* stock.

Material and methods

Indicator stations in the Labadie Bank, Nymphe Bank and Seven Heads were randomly picked based on VMS information. For the Smalls Ground prior information was available on the distribution of sediments was available and the boundaries of the fishing grounds were obtained from VMS. The survey design for the main area the Smalls Grounds is a randomised fixed grid where a point is picked at random and stations are carried out at a fixed distance north-south and east-west. The distance between stations is currently 3 nautical miles. An adaptive approach is taken where by stations are continued past the known perimeter of the ground until the burrow densities are close to zero.

Survey timing was generally standardised to July each year. In 2006, 18 indicator stations and the Smalls Grounds stations were covered. In 2007 to 2009, poor weather and technical problems did not allow the indicator stations to be surveyed. The protocols used were those reviewed by WKNEPHTV 2007 (ICES, 2007).

In line with SGNEPS 2009 recommendations all scientist were trained/re-familiarised using training material prior to recounting at sea (ICES, 2009). 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 the classification. In addition the numbers of *Nephrops* burrows complexes (multiple burrows in close proximity which appear to be part of a single complex are only counted once), *Nephrops* in and *Nephrops* out of burrows counted by each scientist for each one-minute interval was recorded. Notes were also recorded on the occurrence of trawl marks, fish species and other species during the one-minute interval. Finally, if any there was any time during the one-minute where counting was not possible 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 1). Consistency and bias between individual counters was examined using Figure 2. Figure 3 and Figure 4 shows the variability in density between minutes and operators (counters) for each station.

The main change in protocol this year relates to the amount of time recounted. Following the recommendation of SGNEPS the time for verified recounts was reduced from 10 to 7 minutes (ICES, 2009b).
The recount data were screened for one minute intervals with an 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 2009 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).

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 for stations within the main fishing area 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 1416.666667 and maximum lag distance of between 24-25 km. A model variogram $\gamma(h)$, was produced with a linear component (Equation 8). 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 8: 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 kriged 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 for 2006 to 2009 on the Smalls Grounds is presented in Figure 5. This shows inter-annual variation in modal burrow densities.

The geo-statistical structural analysis is shown in the form of variograms in Figure 6. 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 7. There is good concordance between the observation and model estimates though there may be some underestimation

The blanked kriged contour plot and posted point density data are shown in Figure 8. The kriged contours correspond well to the observed data. The results indicate that in 2006 high densities were apparent throughout the central part of the Smalls ground. Densities subsequently decreased in 2007 with a slight decrease in 2009. In general the densities are higher towards the south and central area of the ground.

The summary statistics from this geo-statistical analysis are given in Table 1 and Figure 10. The 2009 estimate of 1421 million burrows is a 26% decrease on the highest to date in 2006. The estimates have been stable at around 1400 million burrows except for the 2006 estimate of approximately 1900 million burrows. The estimation variance of the survey as calculated by EVA is relatively low (CVs in the order <6%).

Figure 9 shows the standardised length frequency distributions of *Nephrops* caught using a beam trawls on the Smalls ground during the 2006 to 2009 surveys. The results indicate large numbers of recruits in both sexes with modal length around 17mm CL in 2006 which did not occur in 2007 to 2009.

Discussion

Data for assessment of *Nephrops* in this area has been rather sparse in the past. The main source of significant new information on this stock comes from the fishery independent UWTV survey initiated by Ireland in 2006. This survey indicates that burrow density in 2009 decreased slightly ~ 2% from that observed in 2008 but has remained stable.

The methods employed during the Celtic Sea UWTV surveys have recently been discussed and documented by WKNEPHTV (ICES, 2007), and SGNEPS (ICES, 2009a). In 2009 the Benchmark Workshop on *Nephrops* assessment, held in Aberdeen, Scotland, addressed the problems encountered while generating TAC advice for *Nephrops* in 2008 (ICES, 2009b). These problems arose from different approaches in handling uncertainty and potential bias when using underwater TV surveys to estimate the abundance of *Nephrops* populations in Functional Units The workshop also considered the major uncertainties and assumptions in translating UWTV survey data to abundance or biomass.FU20-22 was not one of the focus stocks at this workshop.

The conclusion was that there is a continuum in terms of how surveys are used. Using the survey as a relative index to tune some assessment model is the least demanding since assumptions and bias (provided they are stay reasonably constant over time) are handled as catchability term. Using the survey as absolute estimator of biomass is the most rigorous since the assumptions and biases need to be accounted for or minimised to obtain an accurate result.

For this particular survey field of view, occupancy, edge effects and biomass outside the survey area become critical when using the survey as an absolute abundance estimate. Whilst it is not possible to quantify these it is possible to estimate the relative scale of the problem. Variation in the field of view probably adds some random noise but this has been shown to relatively minor using lazers to confirm the field of view at ~75 cm for most stations. If anything the field of view will be underestimated in very soft mud which are not that common in the Celtic Sea. The edge effect has not been estimated or corrected for may lead to an over-estimation bias in abundance by between 25-34%. Occupancy also and important unknown and in this survey the assumption is that all those burrows counted are occupied by a single *Nephrops*. Because the Celtic Sea survey covers only part of the *Nephrops* meta-population in the Celtic Sea there is significant biomass outside the surveyed area. An approach to estimate catch options including biomass outside the survey area needs to be developed. Improved spatially explicit data will help in this regard.

The relative UWTV survey index of burrow abundance has remained stable. This may due to the large numbers of "recruits" (CL~17mm) which occurred in 2006 but not in 2009. It is premature to have catch advice based on the short time series available. Currently there is no serious concern about the stock status since burrow densities are high.

References

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 2008. Report of the Workshop and training course on Nephrops burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES 2009a Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES 2009b Report of the Benchmark Workshop on *Nephrops* (WKNEPH), 2–6 March 2009, Aberdeen, UK. ICES CM 2009/ACOM:33. 156 pp.

Petitgas and Lafont, 1997. EVA (Estimation VAriance). A geostatistical software on IBM-PC for structure characterization and variance computation. Version 2.

Ground	Year	Number of stations	Mean Density (No./M2)	Domain Area (m2)	Geostatistical abundance estimate (million burrows)	CV on Burrow estimate
	2006	100	0.62	2847	1914	3%
	2007	107	0.46	2915	1402	6%
	2008	76	0.47	2698	1448	6%
Smalls	2009	67	0.47	2824	1421	5%

Table1: Summary geostatistics for the Nephrops UWTV surveys of the Smalls Ground from 2006-2009.

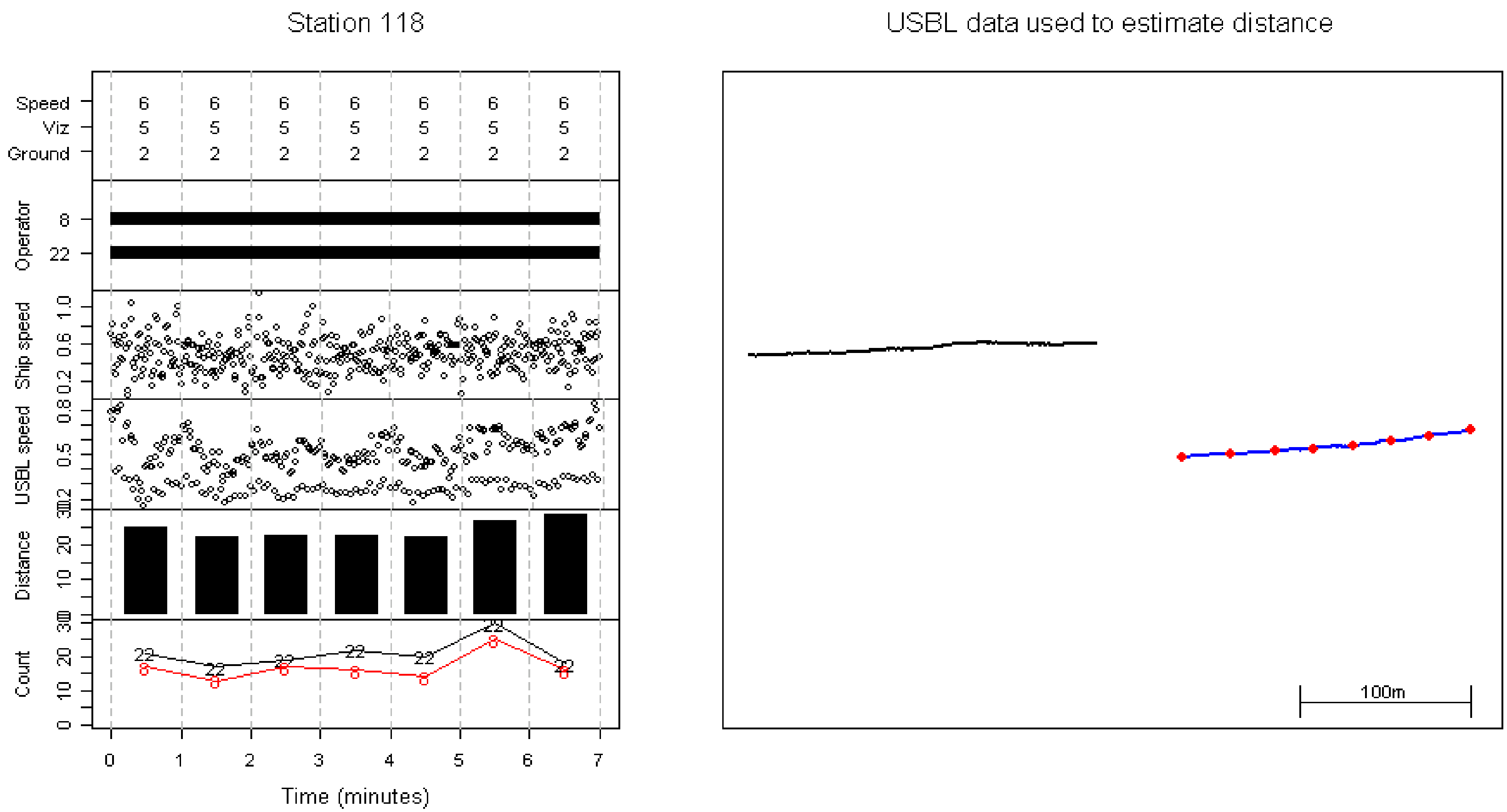

Figure 1.R tool quality control plot of station 118 of the Smalls Grounds FU20-22 Survey 2009.

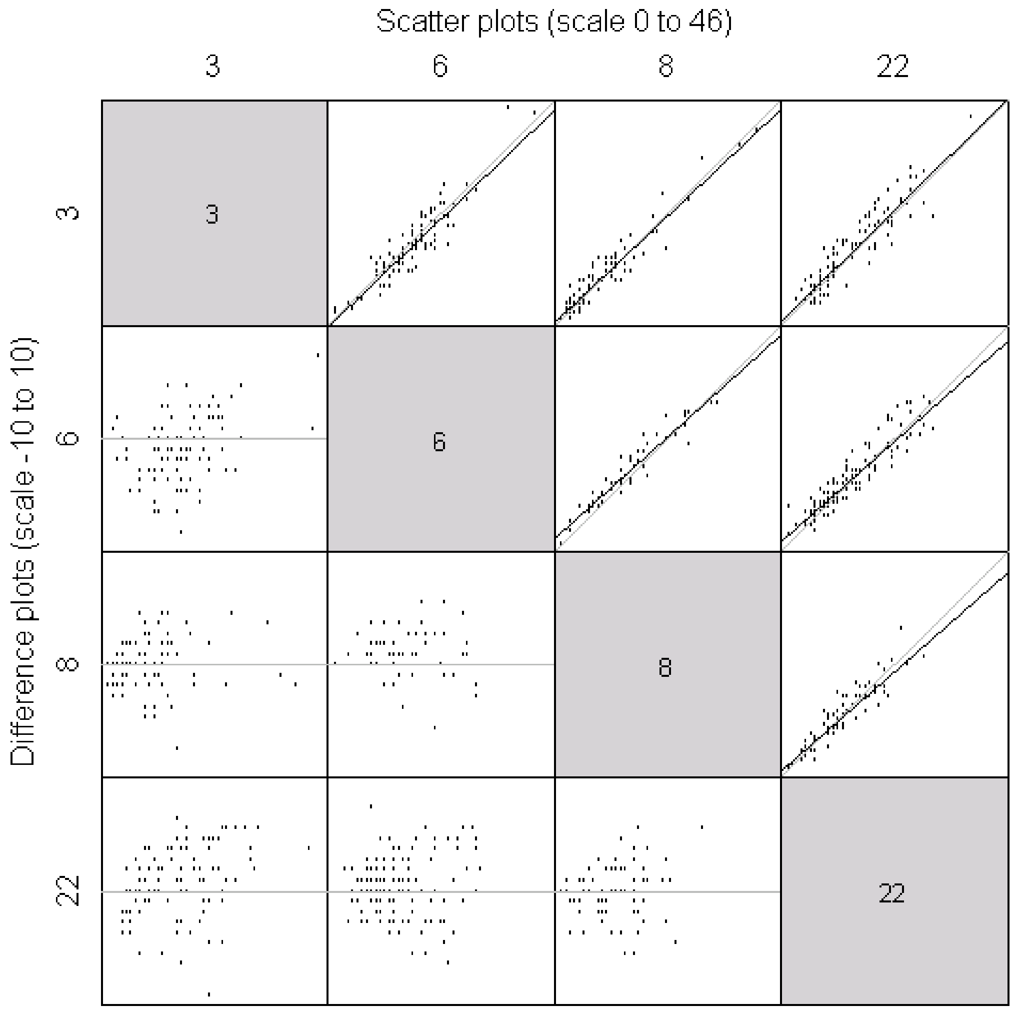

Figure 2.Scatterplot analysis of counter trends during 2009 UWTV Survey of the Smalls Grounds FU20-22.

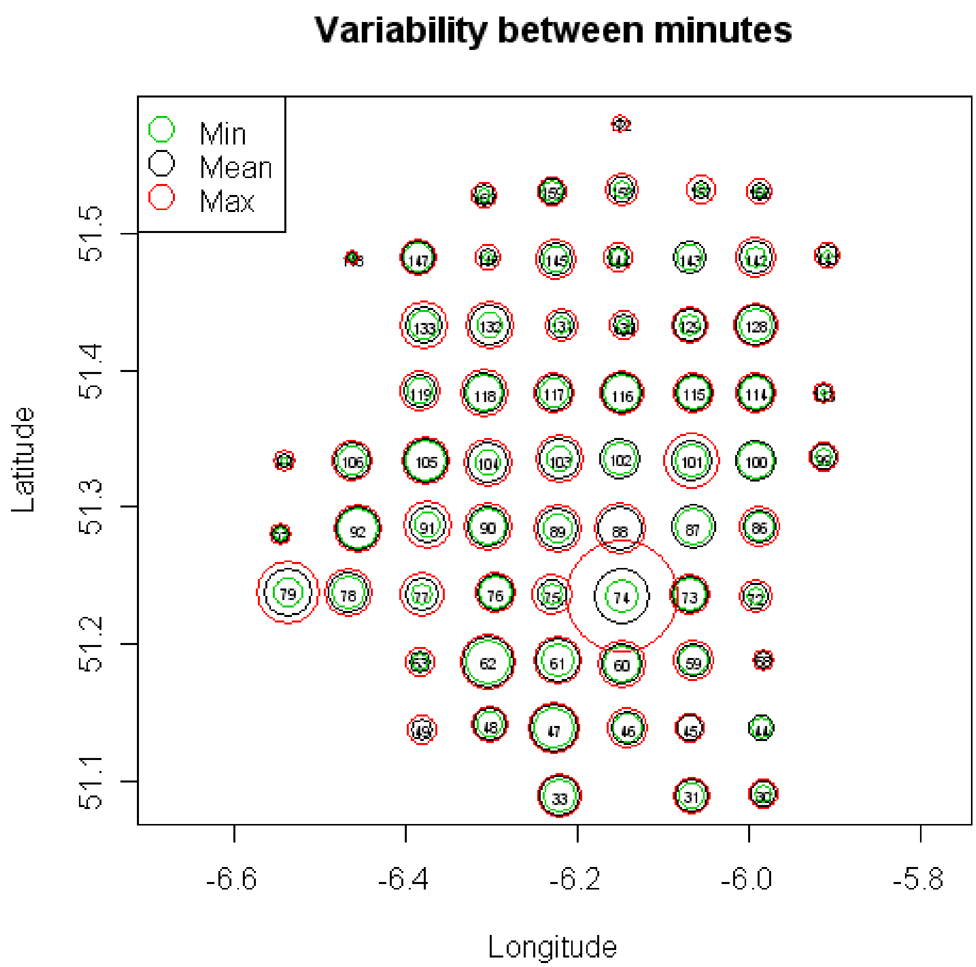

Figure 3. Plot of the variability in density between minutes for each station in 2009 survey.

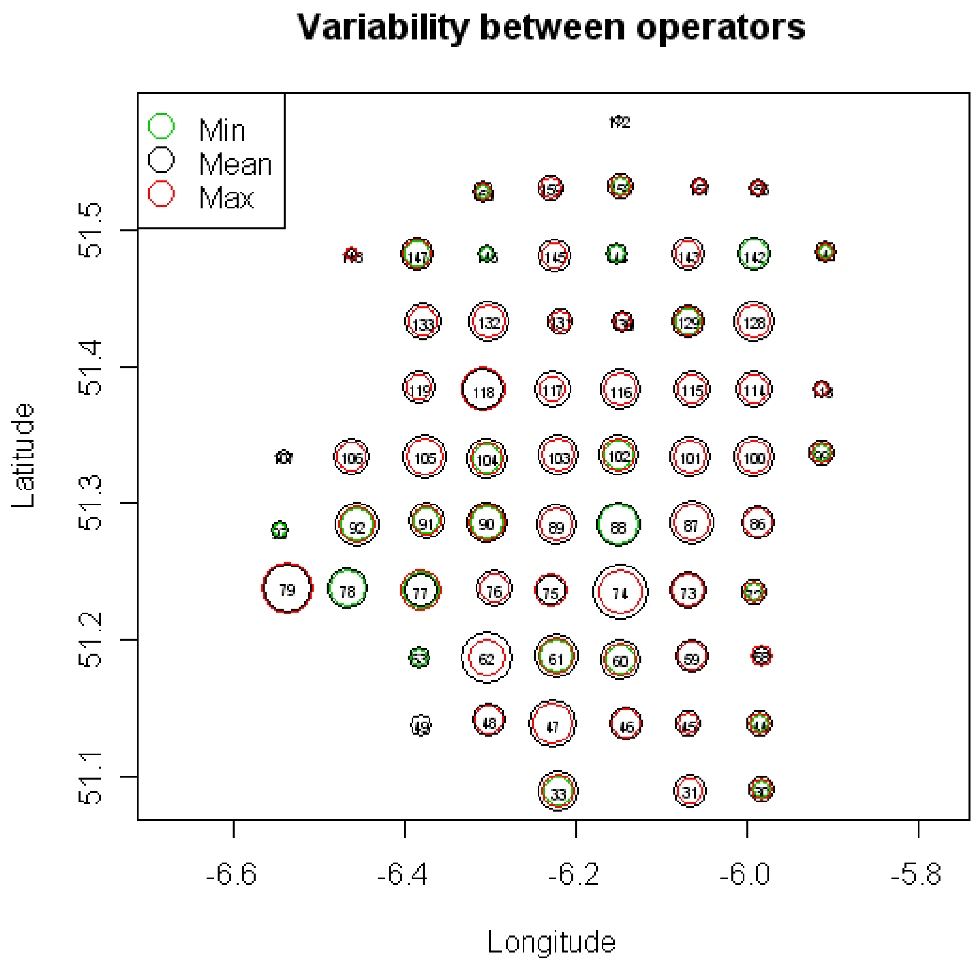

Figure 4. Plot of the variability in density between operators (counters) for each station in 2009 survey.

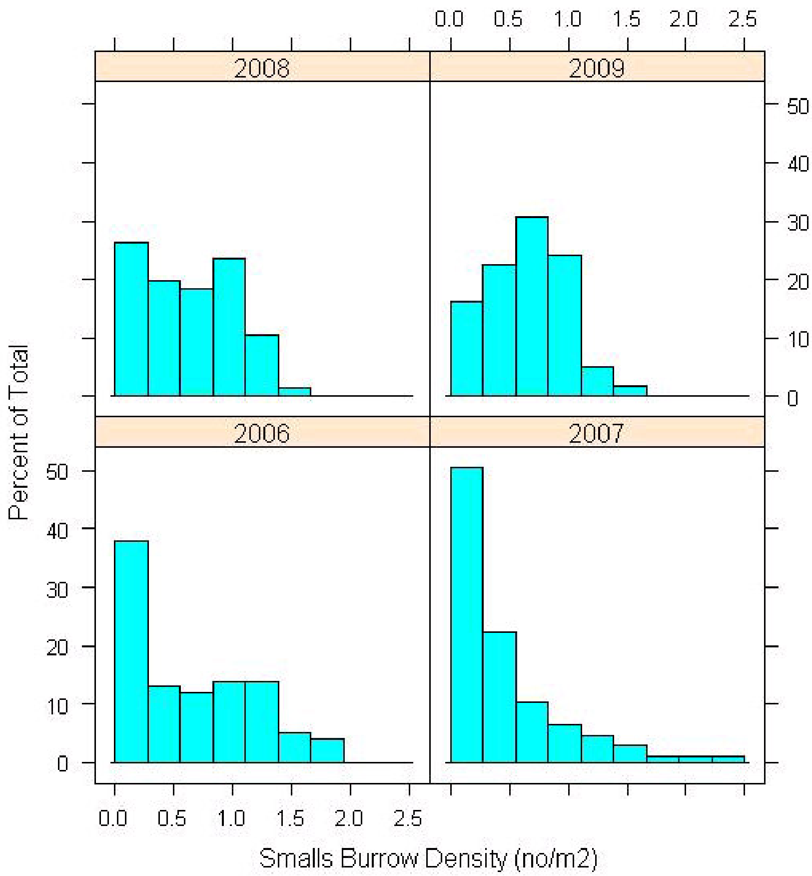

Figure 5: Burrow density distributions for the Smalls Grounds by year from 2006-2009.

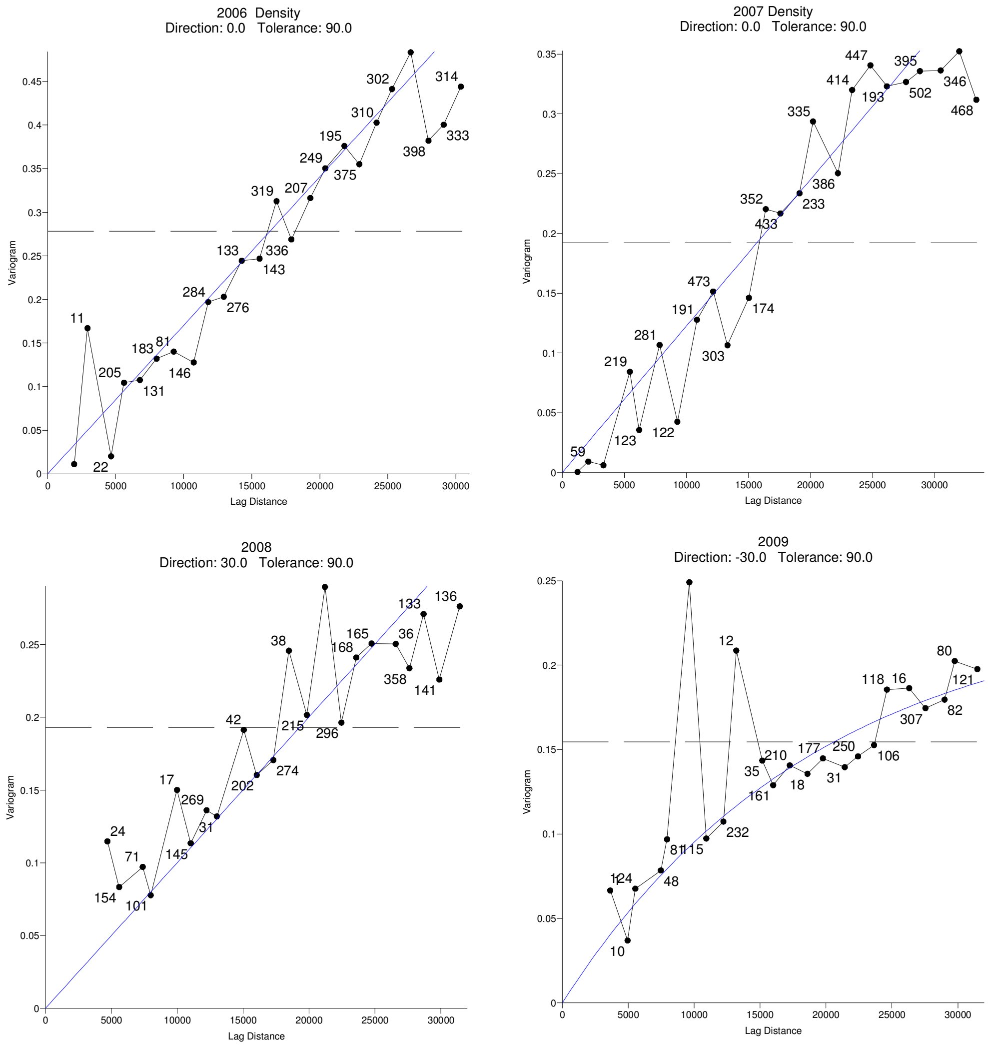

Figure 6: Omnidriectional mean variograms for the Smalls Grounds by year from 2006-2009.

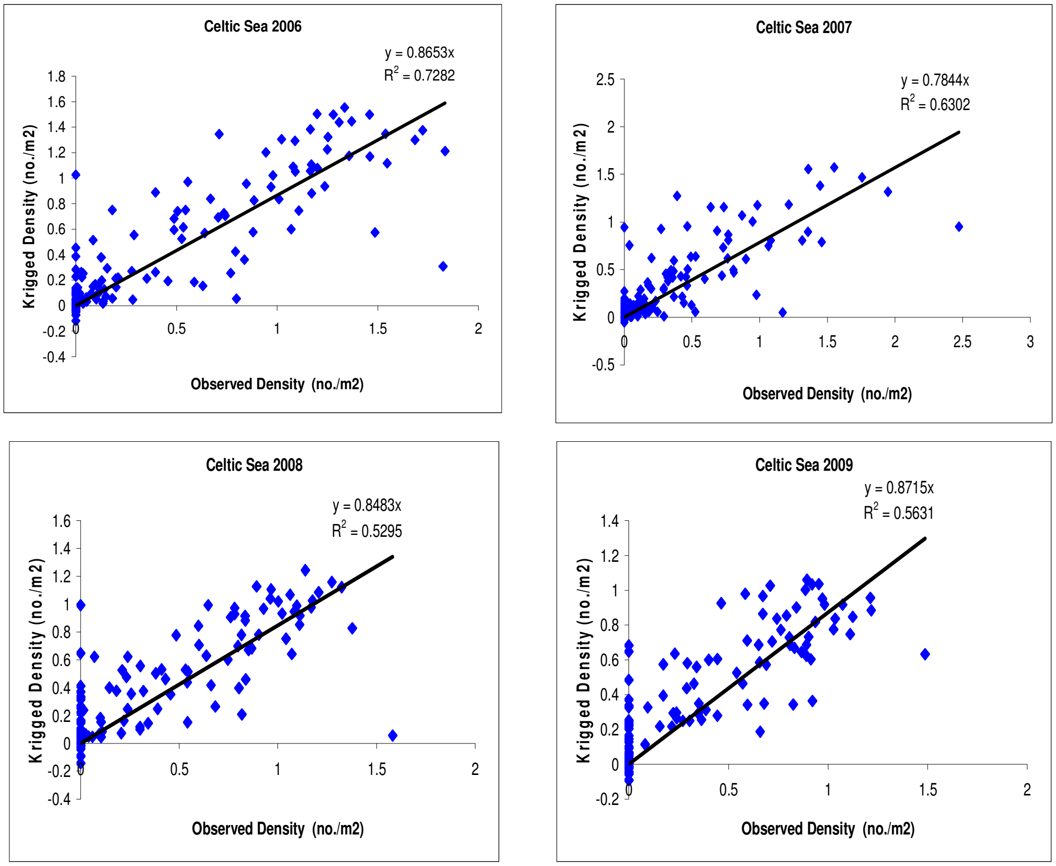

Figure 7: Cross validation plots for the Smalls Grounds by year from 2006-2009.

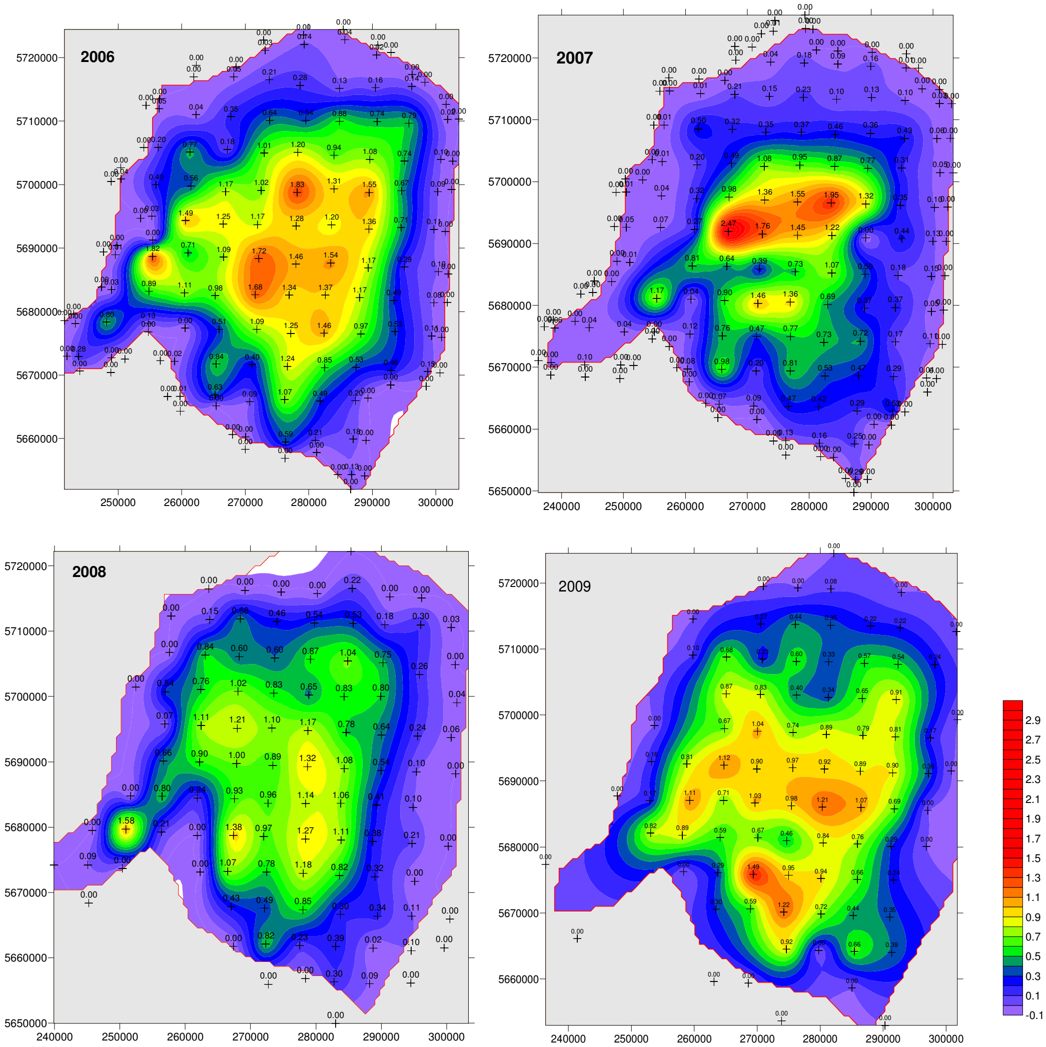

Figure 8: Contour plots of the krigged density estimates for the Smalls Grounds from 2006-2009.

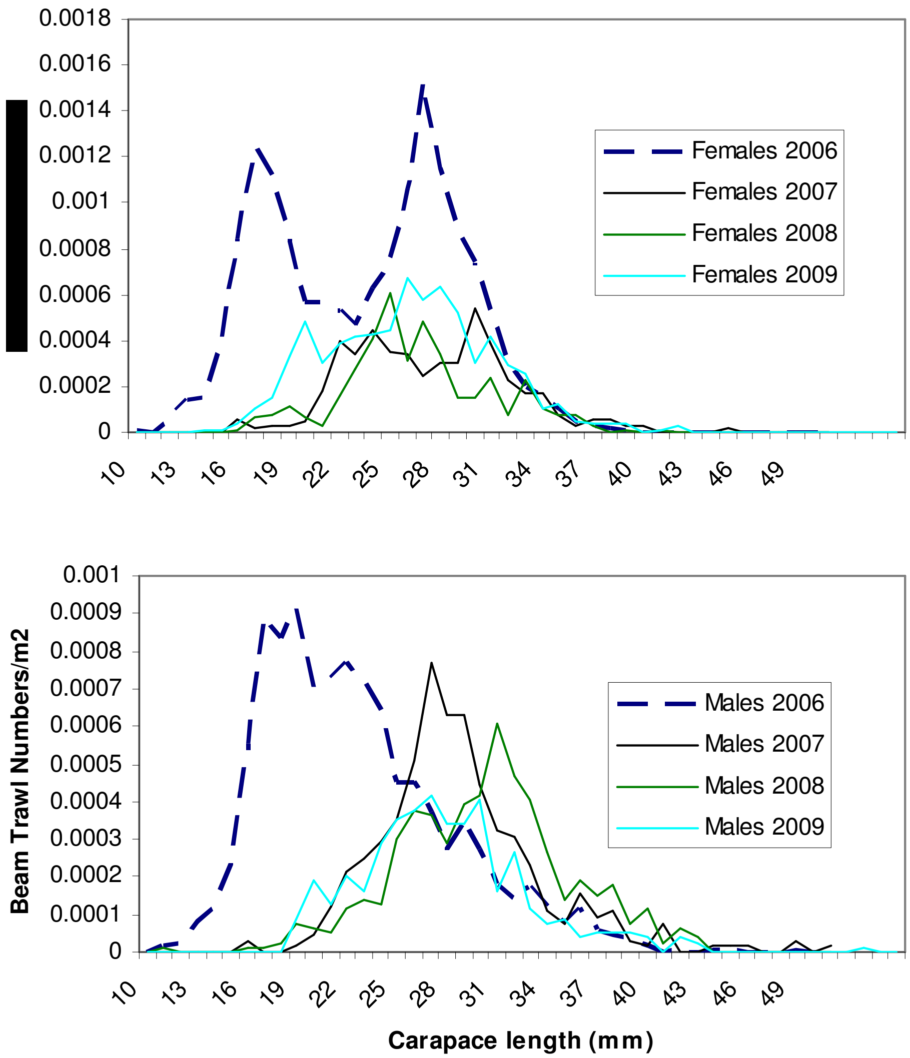

Figure 9: Standardised length frequency distributions for *Nephrops* caught using beam trawls (nos/m^2) in July 2006 to 2009 on the “Smalls” Celtic Sea *Nephrops* ground.

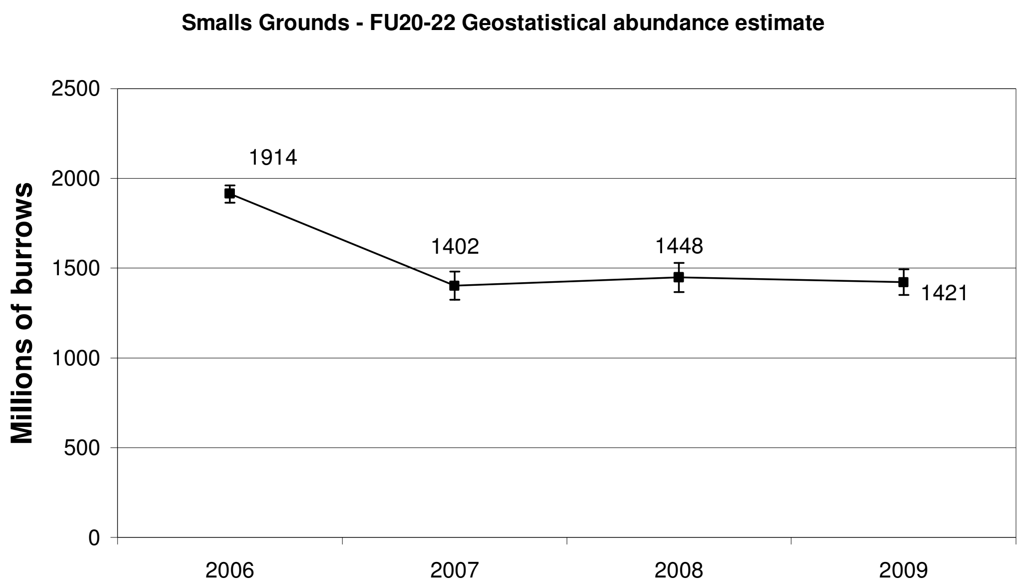

Figure 10: Time series of geo-statistical abundance estimates (in millions of burrows) for the Smalls Grounds from 2006-2009.