Update on the 2010 UWTV Survey on the Celtic Sea *Nephrops* Grounds

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Introduction

This is the fifth 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 2010 survey covered the Smalls grounds only due to poor weather and time contraints. This report details the results of the 2010 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 *Nephrops* ground prior information 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 2010, 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).

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 second. The navigational data was quality controlled using an "r" script developed by the Marine Institute (ICES, 2009a). In addition depth was logged for the duration of the tow.

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, 2009). Figure 1 shows individual's counting performance 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 undergone, 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 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, 2009a). As usual 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. Distance over ground (DOG) for the majority of stations is estimated using an acoustic underwater positioning system known as a USBL. 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 2010 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 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 standard 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

There was also a minor data revision to survey estimated in the years 2006 and 2007 due to the amalgamation of survey data to a SQL server. This revision did not change the overall perception of the survey series Table 1 and Figure 6. 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 (an example is shown in Figure 2). Consistency and bias between individual counters was examined using Figure 3. Figure 4 and Figure 5 shows the variability in density between minutes and operators (counters) for each station.

A histogram of the observed burrow densities for 2006 to 2010 on the Smalls Grounds is presented in Figure 7. This shows inter-annual variation in modal burrow densities.

The geo-statistical structural analysis is shown in the form of variograms in Figure 8. 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 9. 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 10. The krigged 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 increase in 2010. 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 2 and Figure 11. The 2010 estimate of 1483 million burrows. 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 12 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. Fishing operations were not completed in 2010 during the survey due to poor weather. Fishing carried out later in

August 2010 yielded very low catches due to strong tides and lack of *Nephrops* emergence.

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 were highest in the first year of the series when the length distribution of beam trawl catches also indicated a recruitment event. Since then burrow densities have been very stable with a slight increase in 2010 relative to 2009. Around 45% of recent total landings from FU20-22 have been taken from the area covered by the UWTV survey in FU22 (Table 3).

The UWTV methods employed during the Smalls (FU22) surveys have recently been discussed and documented by WKNEPHTV (ICES, 2007), and SGNEPS (ICES, 2009a). A benchmark workshop on *Nephrops* assessments developed a methodology to used 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, 2010). 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 ~40cm for most of the area. A field of view (FOV) of ~75 cm has been confirmed for most stations using sledge mounted lasers. There maybe some random noise but this due to sinking and jumping in poor weather but this is normally not a major problem in FU22. The FOV is smaller than that used for Scottish stocks (FOV ~1m) resulting an edge effect bias correction factor of around 1.35 based on the findings of Campbell et al. (2009). Detection rates are thought to be relatively high (0.9). Visibility is generally good, most burrow systems have multiple entrances and are fairly evenly spaced making detection easier. There are some other burrowing macrobenthic species present in FU22 and misidentification is assumed to be in the order of 1.05. Fishing effort in FU22 is high 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 bias estimates appropriate to the survey are shown below;

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
20-22	Smalls	1.35	0.9	1.05	1	1.3

Bias corrected survey estimates for the Smalls (FU22) could be used to provide catch options and recent harvest ratio estimates for that component of FU 20-22.

References

Campbell, N., Dobby, H., and Bailey, N. 2009. Investigating and mitigating uncertainties in the assessment of Scottish *Nephrops norvegicus* populations using simulated underwater television data. ICES Journal of Marine Science, 66: 646–655.

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

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). ICES CM 2009/ACOM:33. 156 pp.

ICES. 2010. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE). ICES CM 2009/ACOM:09.

Table 1 (a): Unrevised summary geostatistics for the Nephrops UWTV surveys of the Smalls Ground from 2006-2010.

Ground	Year	Number of stations	Mean Density (no./m_2)	Domain Area (km_2)	Geostatistical Abundance (millions of 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%
	2009	67	0.47	2824	1421	5%
Smalls	2010	90	0.49	2861	1483	4%

Table 2: Revised summary geostatistics for the Nephrops UWTV surveys of the Smalls Ground from 2006-2010.

Ground	Year	Number of stations	Mean Density (no./m_2)	Domain Area (km_2)	Geostatistical Abundance (millions of burrows)	CV on Burrow estimate
	*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%
Smalls	2010	90	0.49	2861	1483	4%

*Minor data revision due to transfer of survey data to SQL server.

Table 3:

Year	FU 20-22	FU22	% taken in FU22
2003	4,984	1,921	39%

2004	4,234	1,726	41%
2005	4,889	2,355	48%
2006	4,216	1,647	39%
2007	5,247	2,807	54%
2008	5,759	2,704	47%
2009	5,000	1,857	37%
2010	4,222	2,345	56%
Ave 2003-10	4,819	2,170	45%

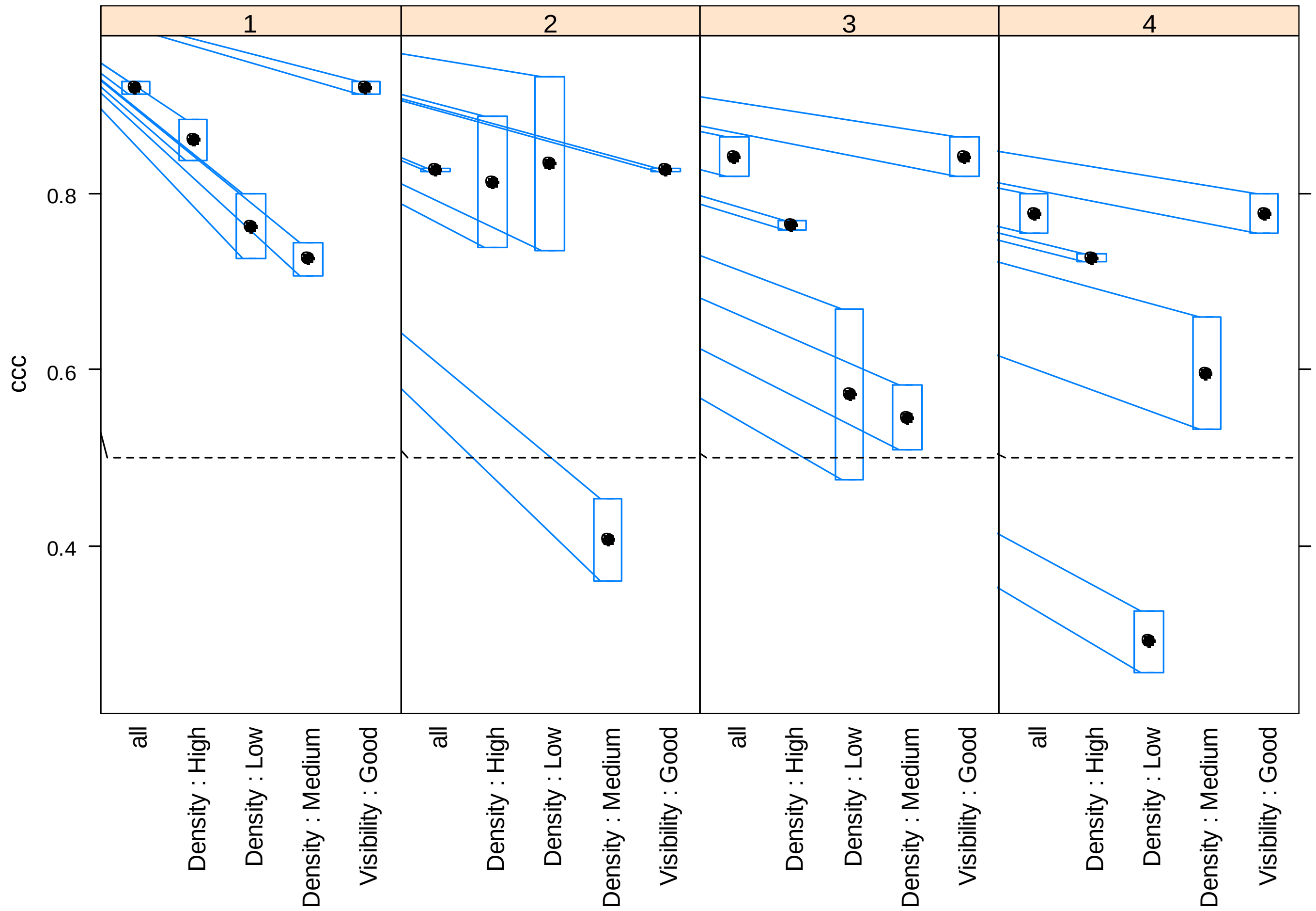

Figure 1: Counting performance against the reference counts as measured by CCC for Smalls ground. Each panel represents an individual. The x-axis (from left to right), all stations pooled, high density, low density, medium density and visibility good.

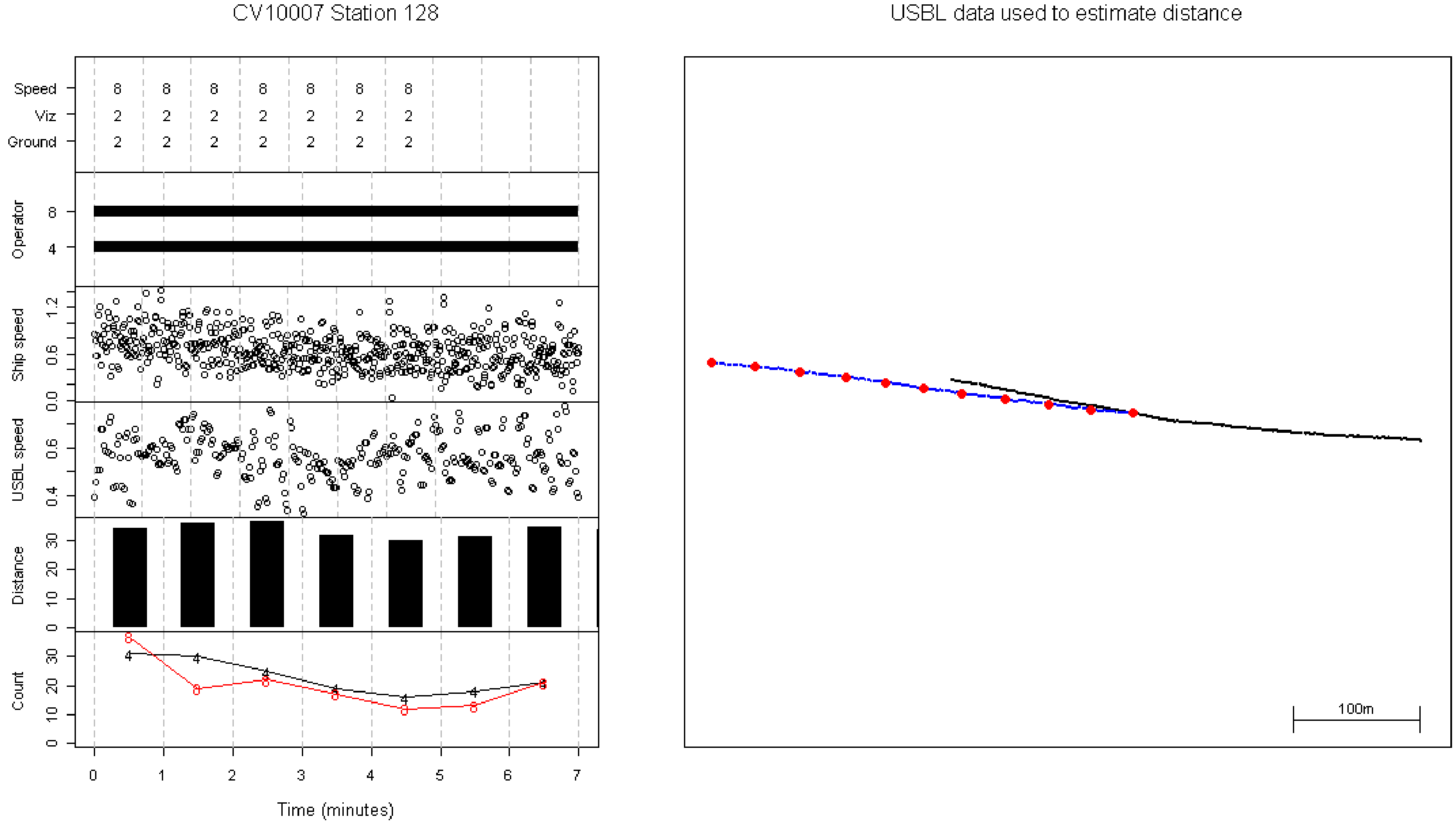

Figure 2 : R tool quality control plot of station 128 of the Smalls Grounds FU20-22 Survey 2010.

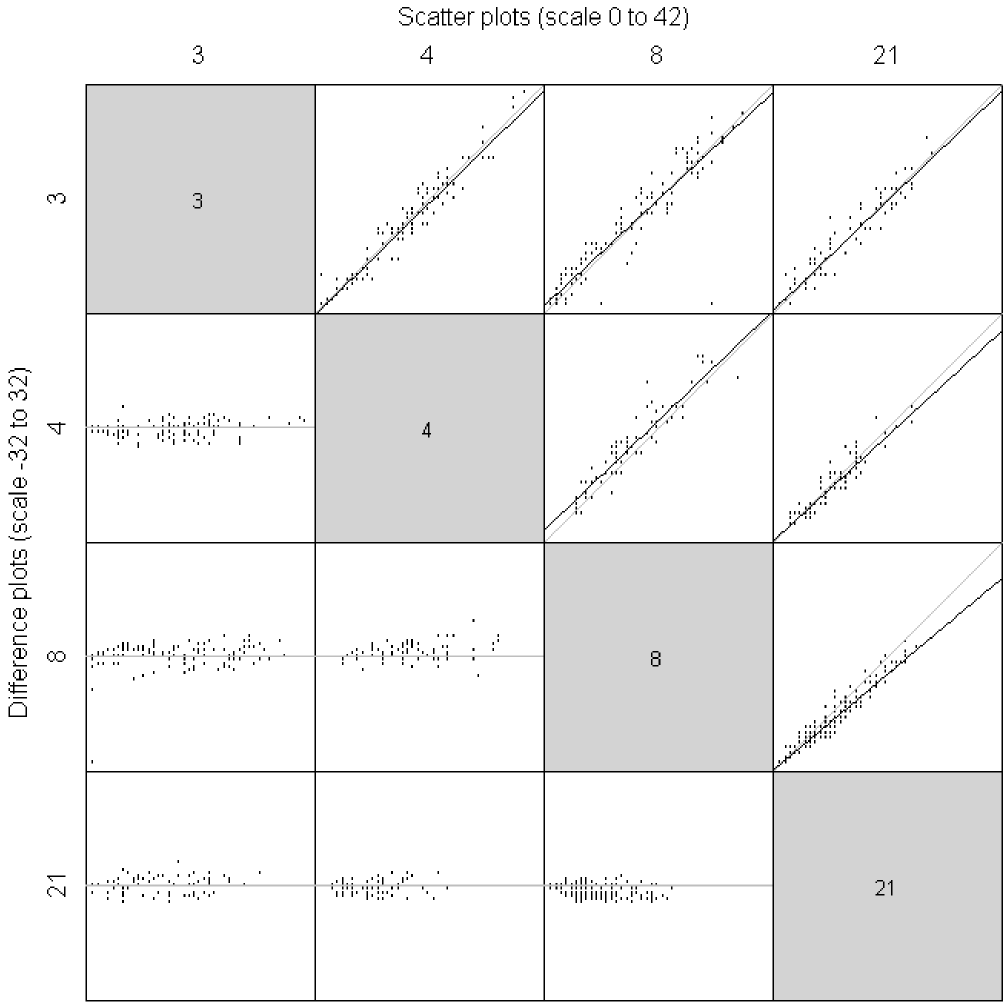

Figure 3 : Scatterplot analysis of counter trends during 2010 UWTV Survey of the Smalls Grounds FU20-22.

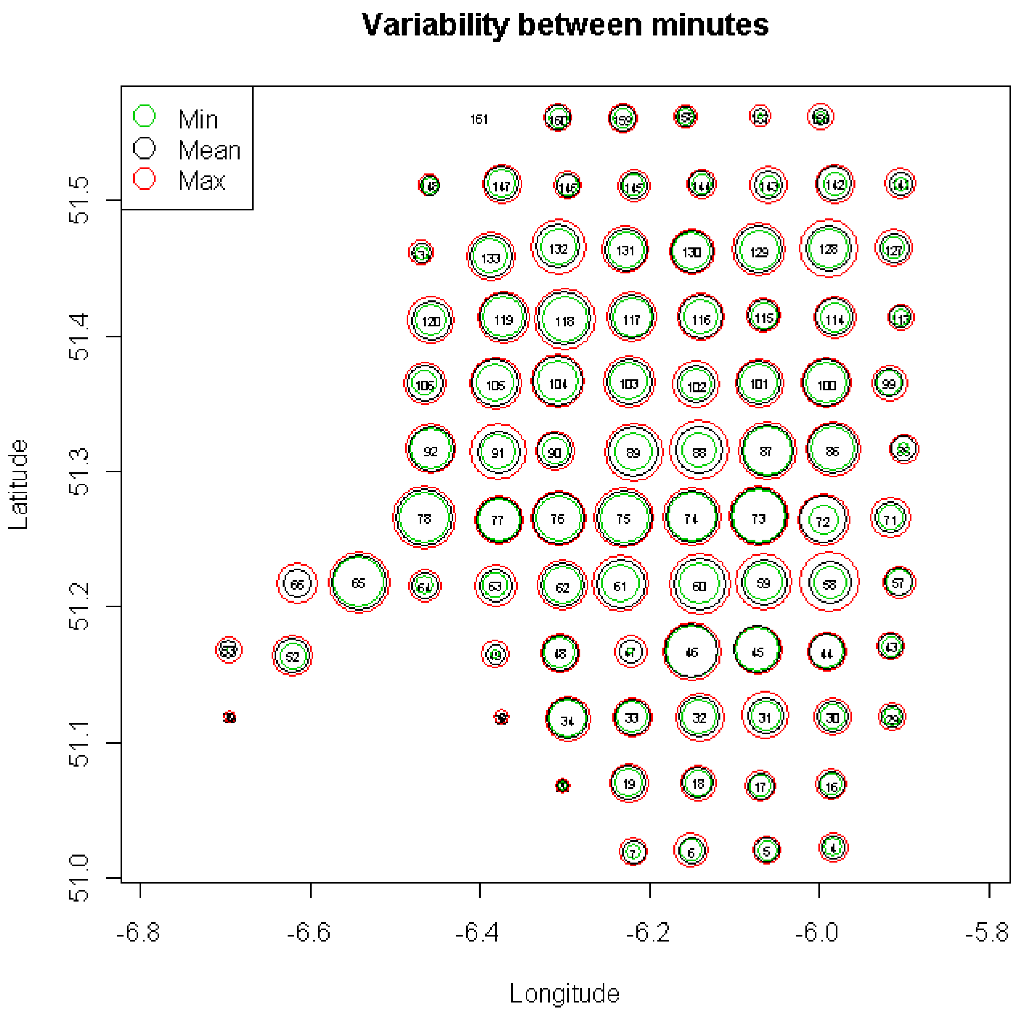

Figure 4 : Plot of the variability in density between minutes for each station in 2010 survey.

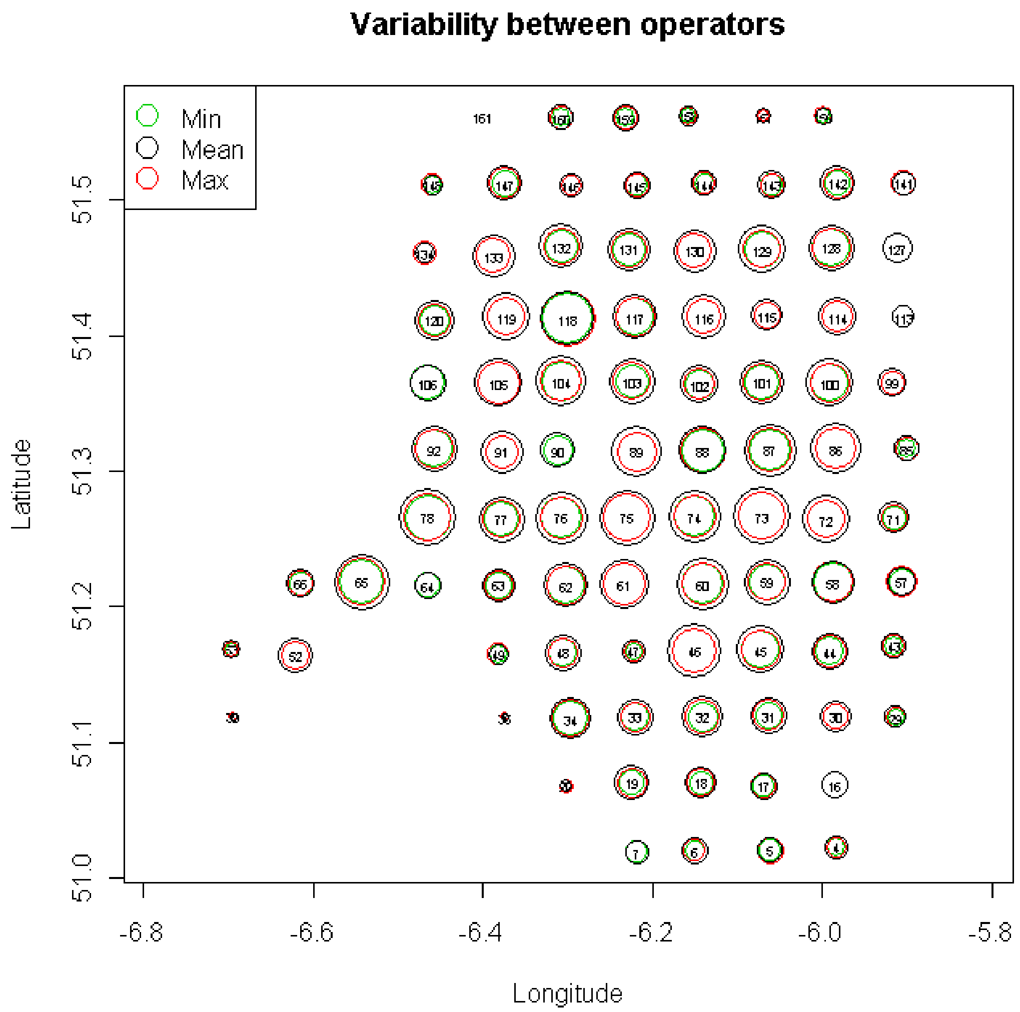

Figure 5 : Plot of the variability in density between operators (counters) for each station in 2010 survey.

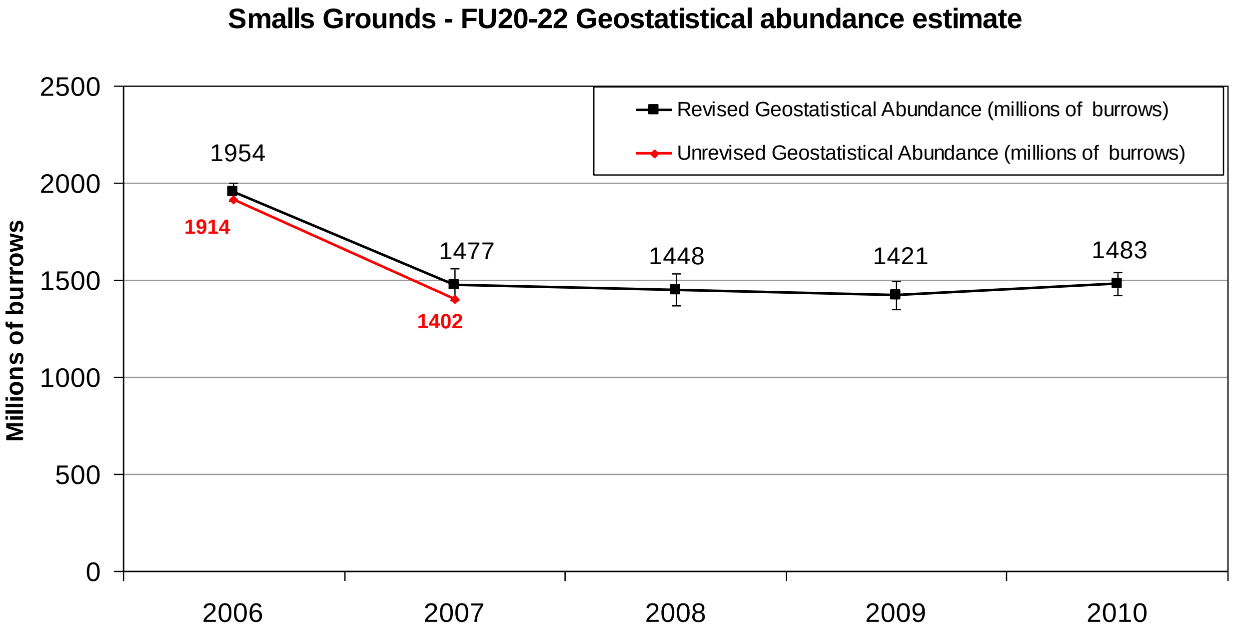

Figure 6: Time series of geostatistical abundance estimates (in millions of burrows) for the Smalls grounds where 2006 and 2007 revised due to amalgamation of survey data to SQL server.

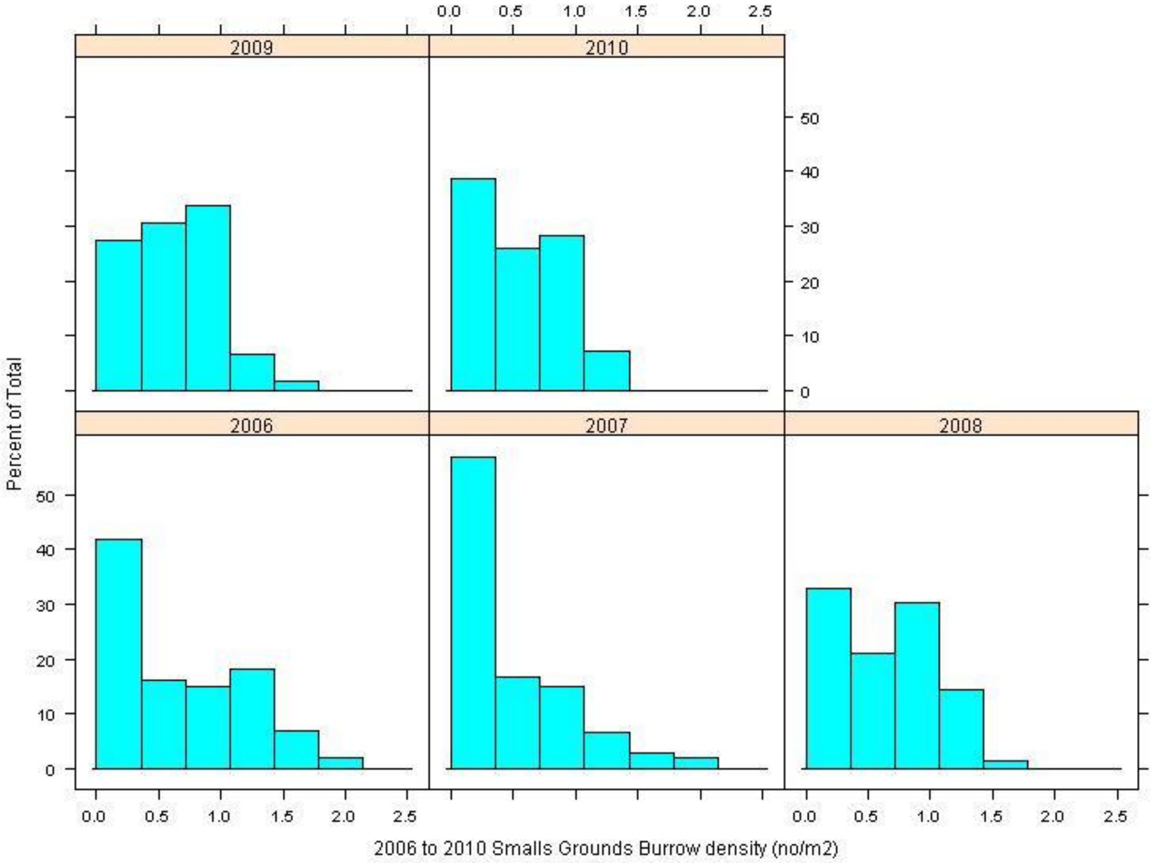

Figure 7: Burrow density distributions for the Smalls Grounds by year from 2006-2010.

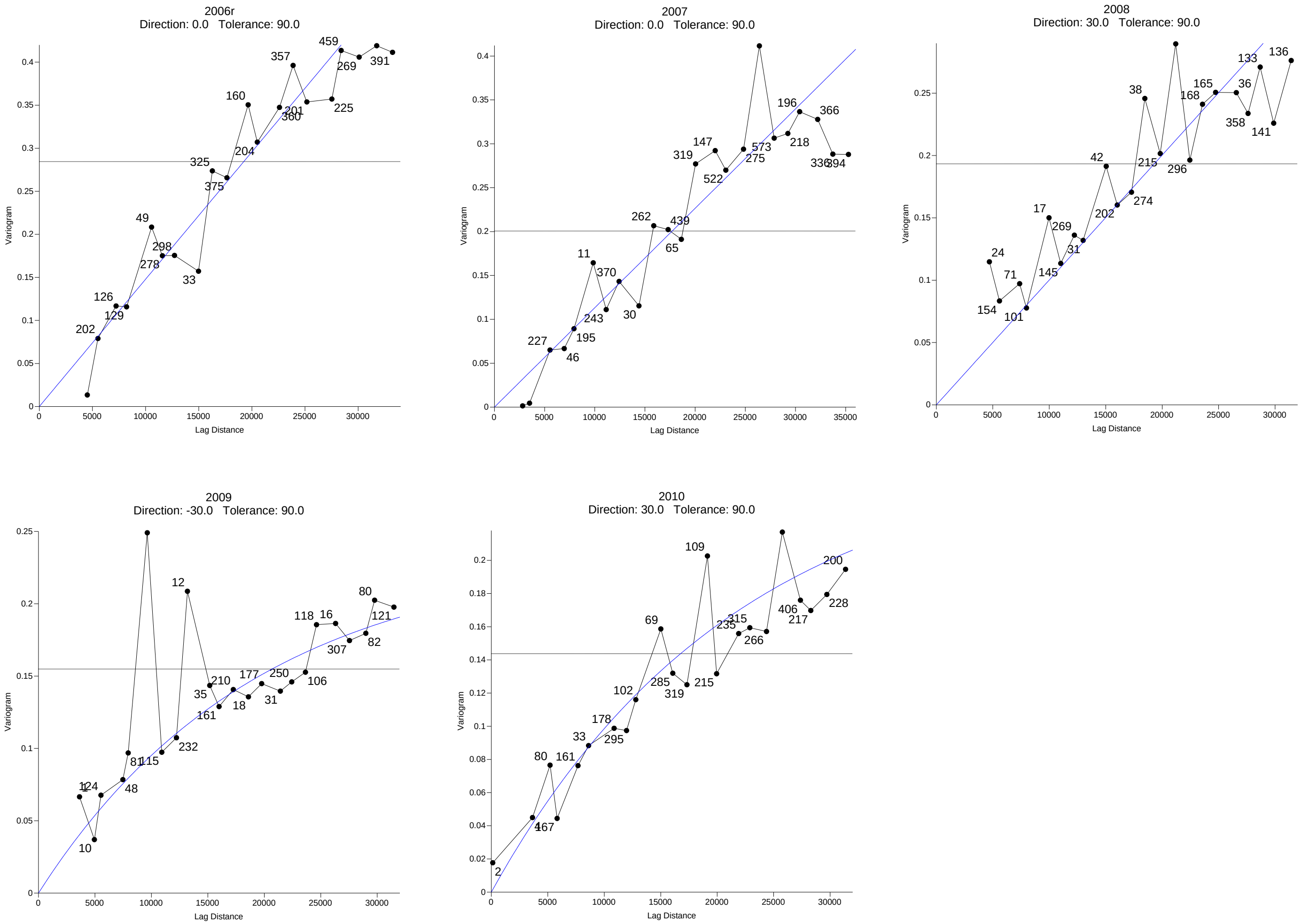

Figure 8: Omnidriectional mean variograms for the Smalls Grounds by year from 2006-2010.

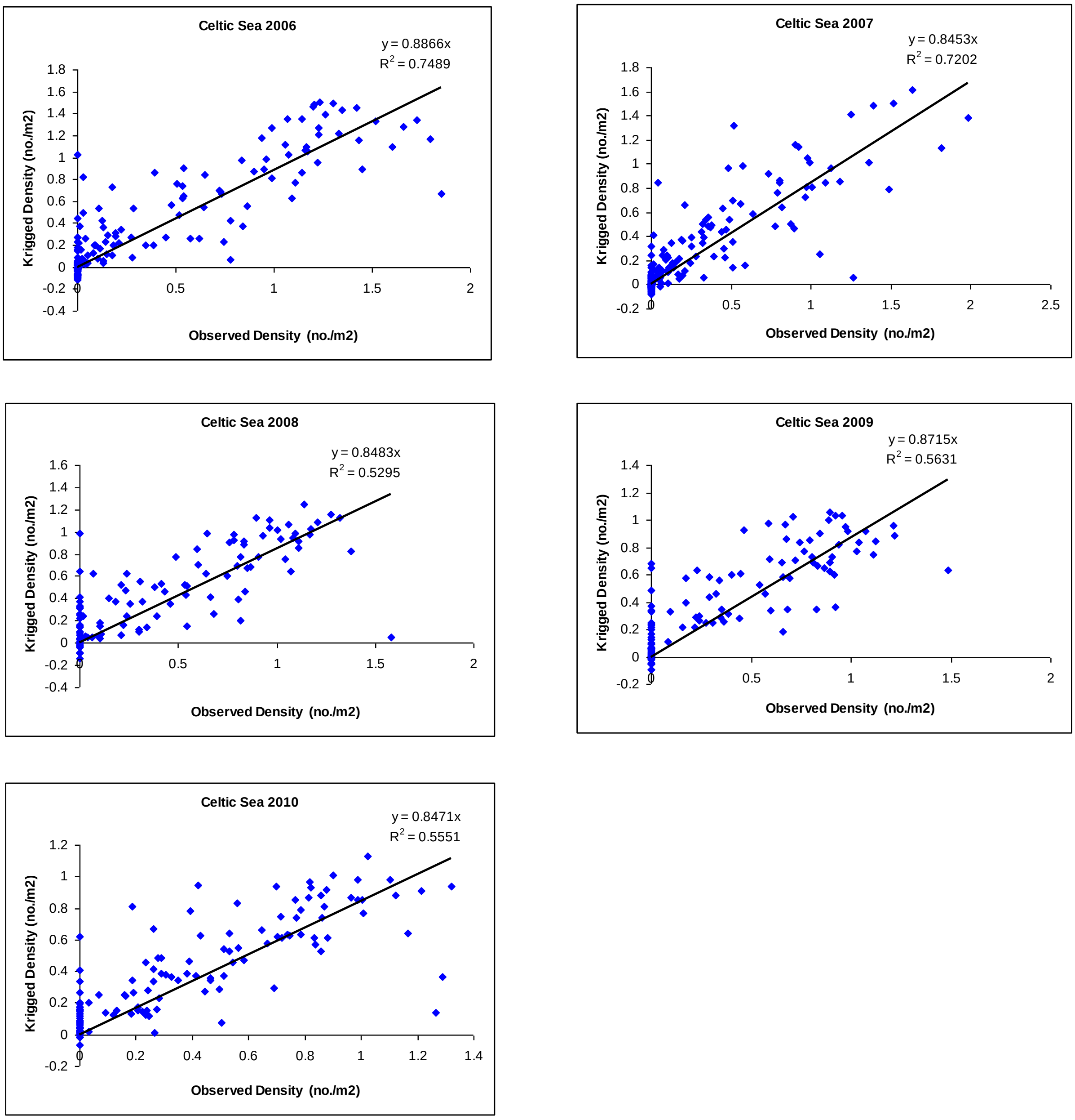

Figure 9: Cross validation plots for the Smalls Grounds by year from 2006-2010.

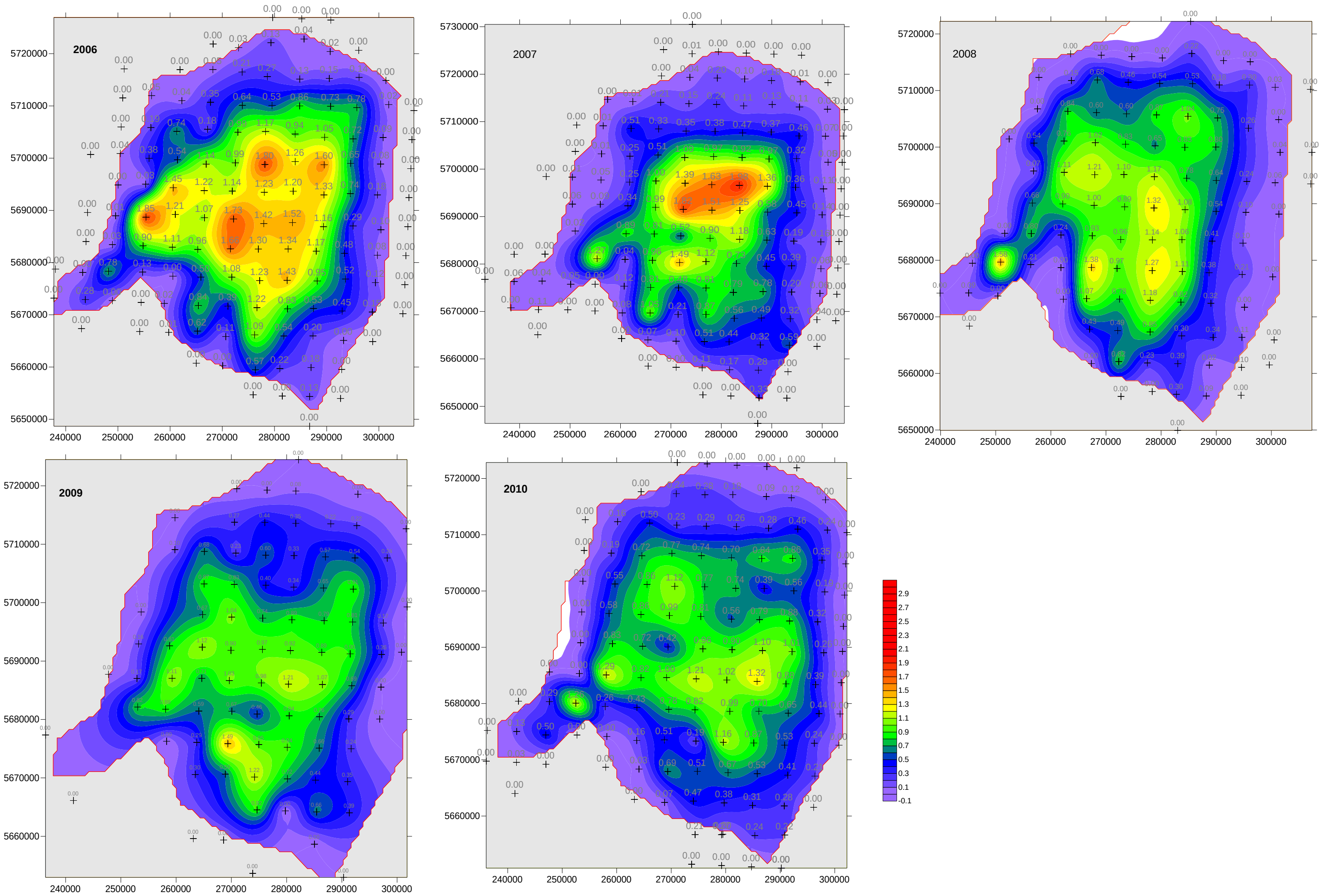

Figure 10: Contour plots of the krigged density estimates for the Smalls Grounds from 2006-2010

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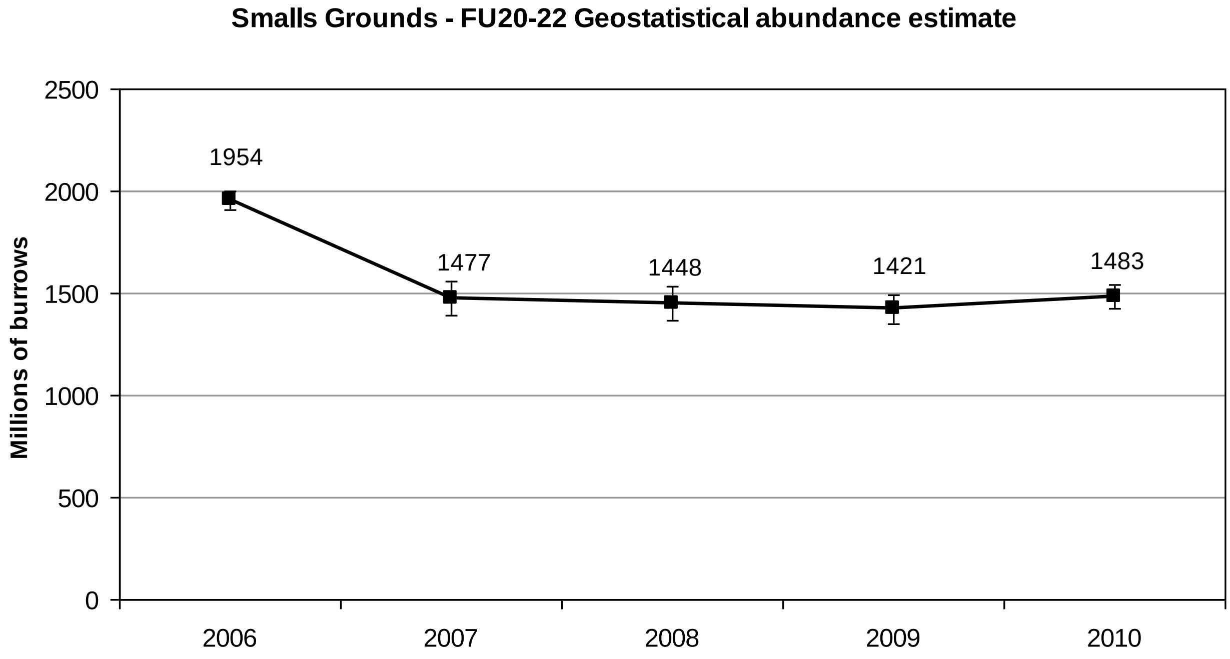

Figure 11: Time series of geo-statistical abundance estimates (in millions of burrows) for the Smalls Grounds from 2006-2010.

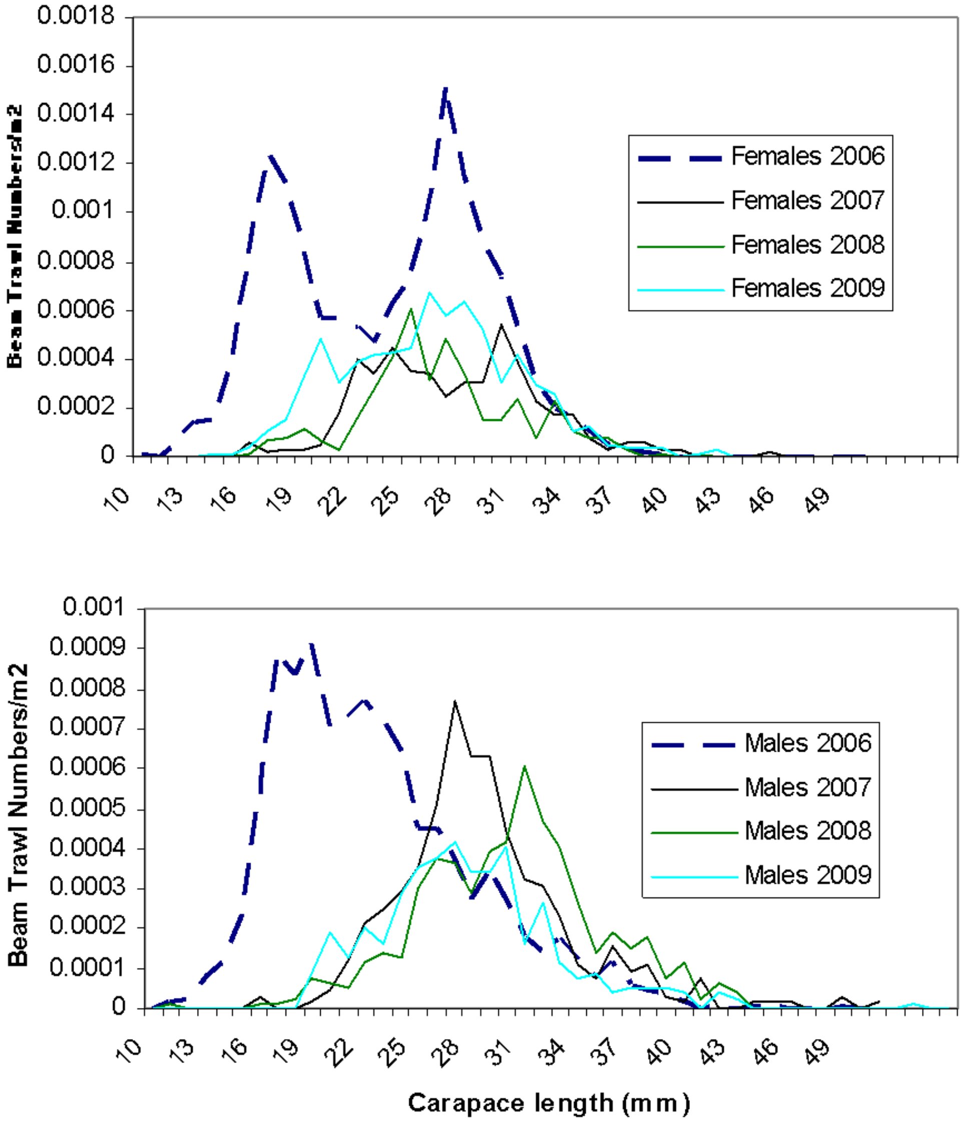

Figure 12: Standardised length frequency distributions for *Nephrops* caught using beam trawls (nos/m^2) in July 2006 to 2010 on the "Smalls" Celtic Sea *Nephrops* ground.