Update on the 2010 UWTV Survey of the Western Irish Sea *Nephrops* Grounds (FU 15)

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Introduction

Since 2003 a joint UWTV survey has been carried out by the Marine Institute (Ireland) and AFBI (Northern Ireland). For the first time in 2009 this survey was used to develop catch options for the stock using a bias corrected survey estimate as an absolute measure of stock size and recent discard rates and mean weight to forecast catch (ICES, 2009a). This report details the results of the 2010 survey for the western Irish Sea *Nephrops* stock. We also update the catch option table using the most recent survey estimate.

Material and methods

For the western Irish Sea prior information was available on the distribution of sediments was available and the boundaries of the fishing grounds were obtained from VMS data from the Republic of Ireland. The survey design 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 3.5 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 August each year. In 2010, 149 stations were surveyed. Of these 51 were carried out on RV Corystes and 98 were carried out on RV Celtic Voyager. 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, 2009b). In addition depth was logged for the duration of the tow.

In line with SGNEPS recommendations all scientist were trained/re-familiarised using training material, validated and reference footage prior to recounting at sea (ICES, 2009b). 2009b). 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 “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. Figure 4 and Figure 5 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 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 was carried out using SURFER Version 8.02. The spatial structure of the density data was studied through variograms. Initial 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 1417m and maximum lag distance of between 53-55 km. A model variogram $\gamma(h)$, was produced with an exponential 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: Exponential Variogram Model

$$\gamma(h) = C\left[1 - e^{-h}\right]$$

Where C is the scale for the structural component of the variogram and h is the aniostrophically.
The resulting annual variograms were used to create kriged 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 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 (+- 0.1 billion burrows).

Results.

A histogram of the observed burrow densities for 2003 to 2010 on the western Irish Sea is presented in Figure 6. Over the time series available the density estimates observed are very similar with modal density of around 1/m2.

The geo-statistical structural analysis is shown in the form of variograms in Figure 7. There are a few outliers apparent but they appear have little leverage on the variogram models observed. A comparison of the observer and expected density estimates for each year is given in Figure 8. There is good concordance between the observation and model estimates.

The blanked kriged contour plot and posted point density data are shown in Figure 9. The kriged contours correspond very well to the observed data. The results indicate densities decreased from 2006 to the lowest levels observed in 2008. The 2010 result shows an increase in densities mainly in the southern and western side. These densities plots show a relatively dynamic situation although some parts of the ground have consistently higher or lower densities there is also a fair bit of inter-annual variability.

The summary statistics from this geo-statistical analysis are given in Table 1. The 2010 burrow abundance estimate is a 7% increase from 2009. The CV for 2010 was 3% indicating a very precise survey estimate as observed in previous years. The time series of survey estimates together with CVs are shown in Figure 10. The mean densities and overall abundance is estimated to have decreased from 2006 to the lowest 4.9 billion observed in 2008. The estimates have been similar for most years in the order of 5- 6 billion.

Discussion

This is a relatively well studied *Nephrops* stock with size information on catches extending back to the 1970s, a trawl survey series since 1994 and larval production surveys in a few years. Despite the above concerns about the accuracy of recent catch data and unknown and variable growth rates have hampered the development of analytical assessments.

The UWTV survey was developed in 2003 and has become the main source of fishery independent information on this stock. The methods employed during the Irish Sea UWTV surveys have recently been discussed and well documented by WKNEPHTV, WKNEPHBID and SGNEPS (ICES, 2007, 2008 and 2009b). The uncertainty estimates in the survey were examined initially using EVA during WKNEPH 2009 and updated for all years here. This analysis indicates that the survey method (randomised grid and geostatistical estimation of abundance) does estimate the abundance very precisely compared with other approaches.

The development of the UWTV survey abundance estimates correlates very well with the summer trawl survey. Both series indicate high abundance in 2003 and 2004 and a decline in abundance thereafter (Figure 10 and 11). The trawl survey shows that catch rates in 2010 declined below the mean of the series whereas UWTV burrow abundances increased slightly.

The WKNEPH reported developed a methodology for developing catch options based directly on the surveys (ICES, 2009a). In addition, WKNEPH developed a methodology for estimating long term fishing mortality reference points. The methodology was used by WGCSE to develop a catch option table according to the stock annex (ICES, 2009c). Table 2 is an updated catch option table for FU15 using the 2010 survey estimate none of the other inputs have been changed.

In conclusion, the survey estimates themselves are precisely estimated given the relatively homogeneous distribution of burrow density and the modelling of spatial structuring. The 2010 survey is a statistically significant 7% increase compared with 2009. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates. In the provision of catch options based on the bias corrected absolute survey estimates, additional uncertainties also arise related to the bias correction factor, mean weight in the landings and the discard rates.

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

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

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, pp 52.

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

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

Table 1: Summary geostatistics for the Nephrops UWTV surveys of the western Irish Sea from 2003-2010.

Ground	Year	Number of stations	Mean Density (No./m_2)	Domain Area (km_2)	Revised Geostatistical abundance estimate Estimate	CV on Burrow estimate
Western Irish Sea	2003	160	1.12	5295	6.3	3%
	2004	147	1.13	5310	6.3	3%
	2005	141	1.16	5281	6.5	4%
	2006	138	1.10	5194	6.2	4%
	2007	148	1.06	5285	5.9	3%
	2008	141	0.88	5287	4.9	3%
	2009	142	0.95	5267	5.3	3%
	2010	149	1.02	5307	5.7	3%

Table2: Updated management option table for FU15 with 2010 survey estimate included.

			Implied fishery	
	Harvest rate	Survey Index (Millions)	Retained number (Millions)	Landings (tonnes)
	0%	4,623	0	0
	2%	"	68	1,020
	4%	"	135	2,041
	6%	"	203	3,061
	8%	"	271	4,081
	10%	"	339	5,102
	12%	"	406	6,122
F0.1	12.2%	"	413	6,224
	14%	"	474	7,142
	16%	"	542	8,163
	18%	"	610	9,183
F2009	18.03%		611	9,198
	20%	"	677	10,203
Fmax	20.4%	"	691	10,407
	22.0%		745	11,224
	24%	"	813	12,244

		Basis
Landings Mean Weight (KG)	0.0151	Sampling 2008 & 2009
Survey Overestimate Bias	1.14	WKNEPH 2009
Survey Numbers (Millions)	5271	UWTV Survey 2010
Prop of removals retained by the Fishery	0.73	Sampling 2008 & 2009

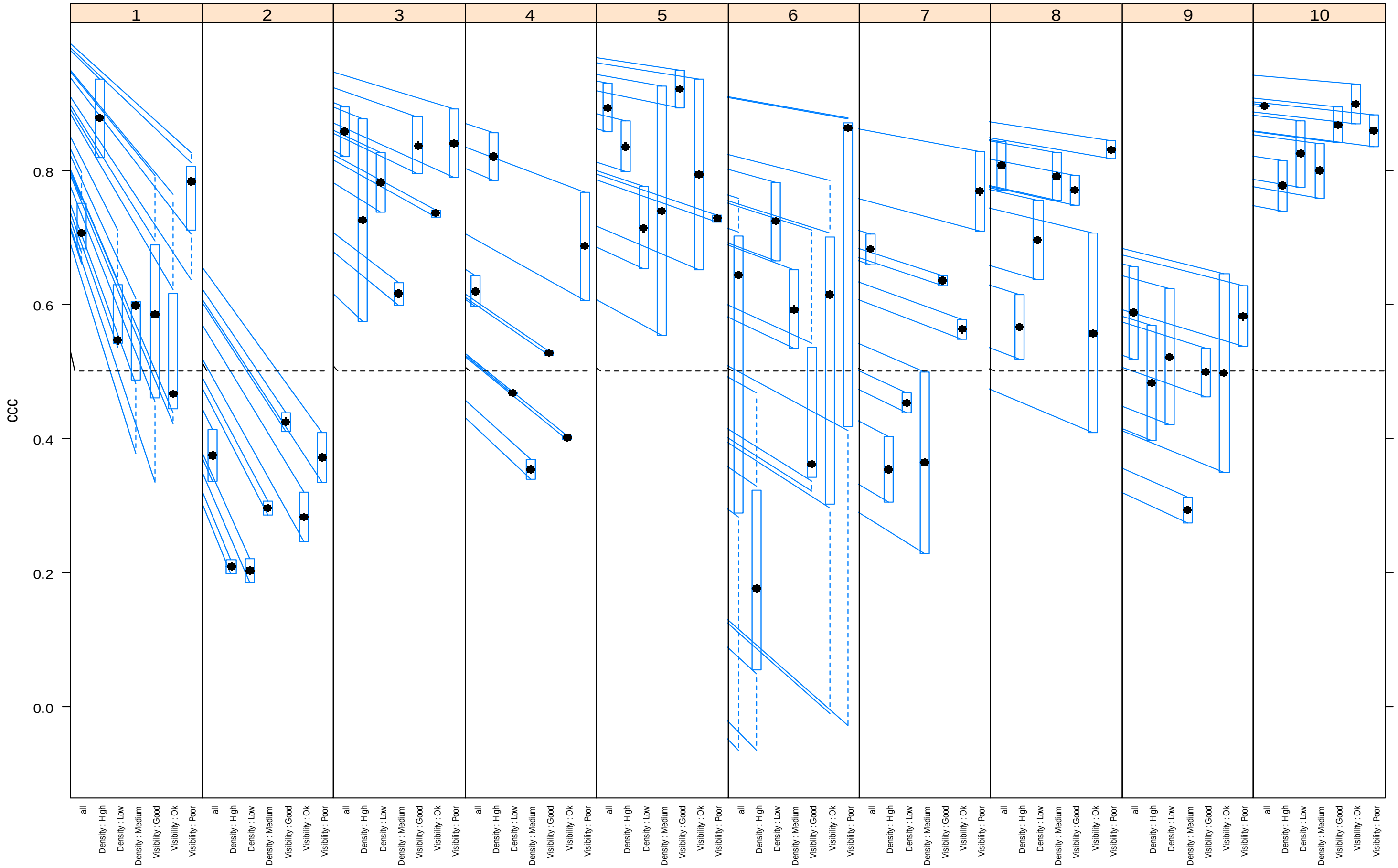

Figure 1 : Counting performance against the reference counts as measured by CCC for FU15. Each panel represents an individual. The x-axis (from left to right),all stations pooled, high density, low density, medium density, visibility good, visibility ok and visibility poor.

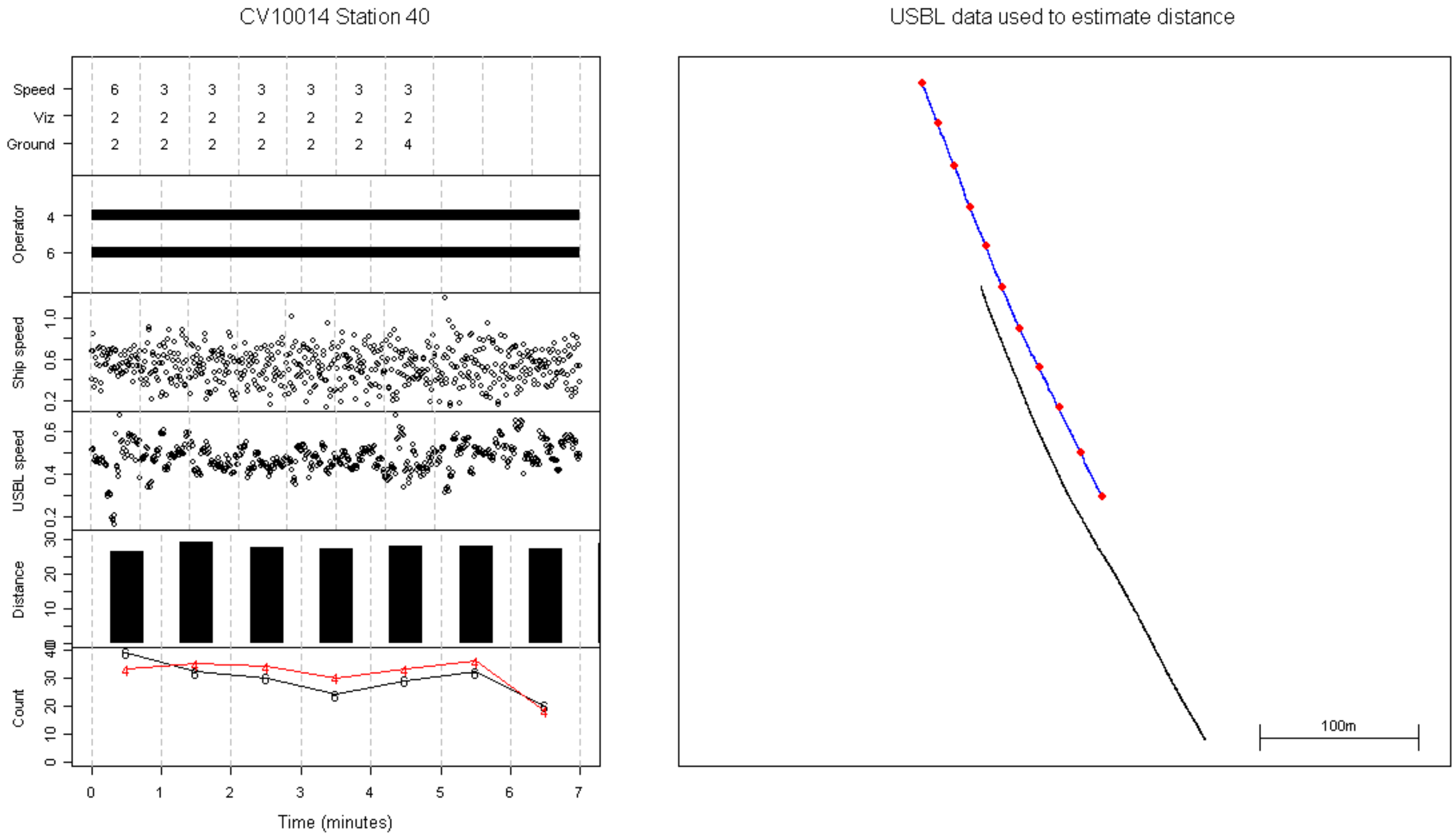

Figure 2 : R tool quality control plot of station 40 UWTV Survey of the Irish Sea Grounds FU15 2010.

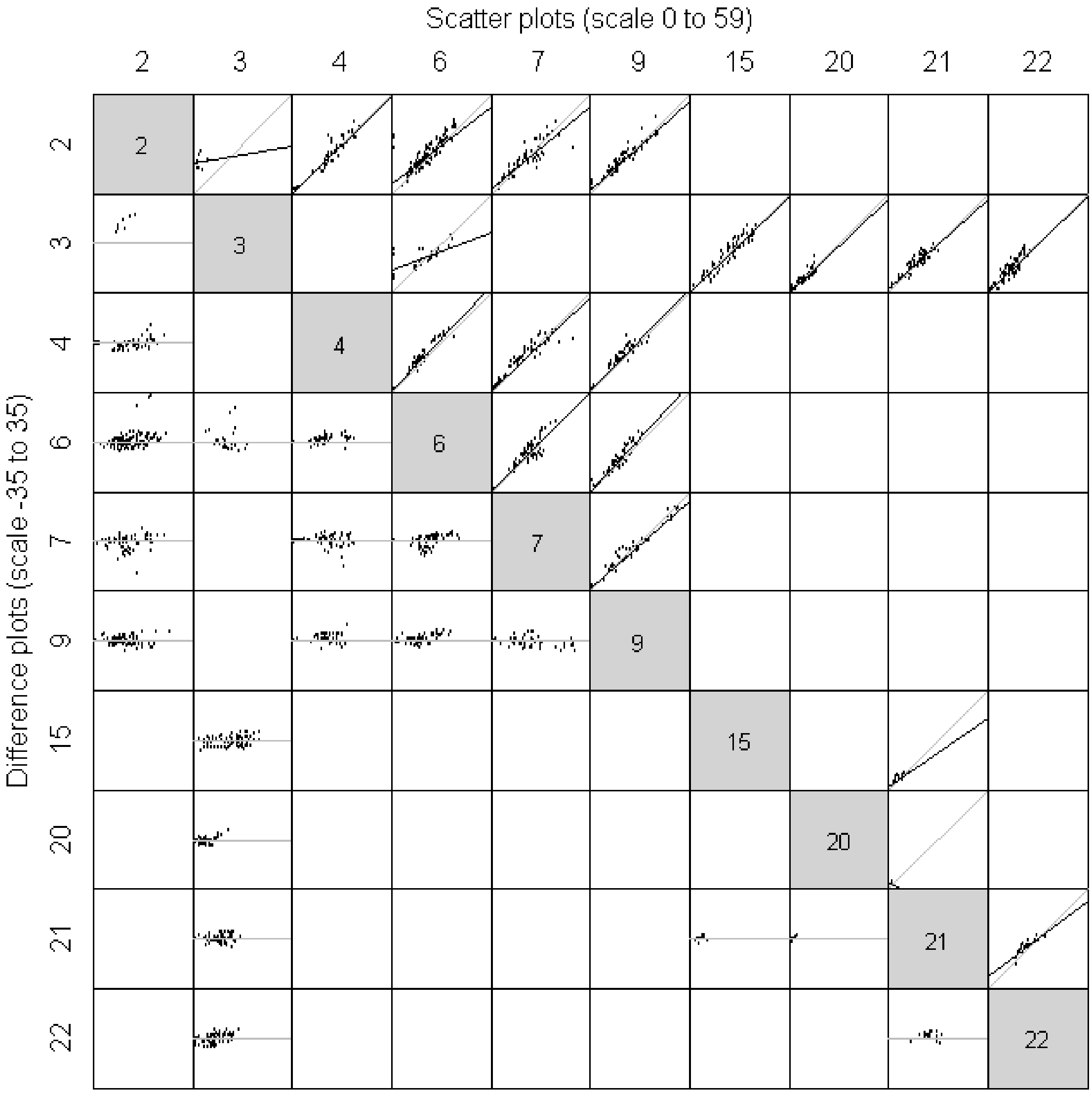

Figure 3 : Scatterplot analysis of counter trends during UWTV Survey of the Irish Sea Grounds FU15 2010.

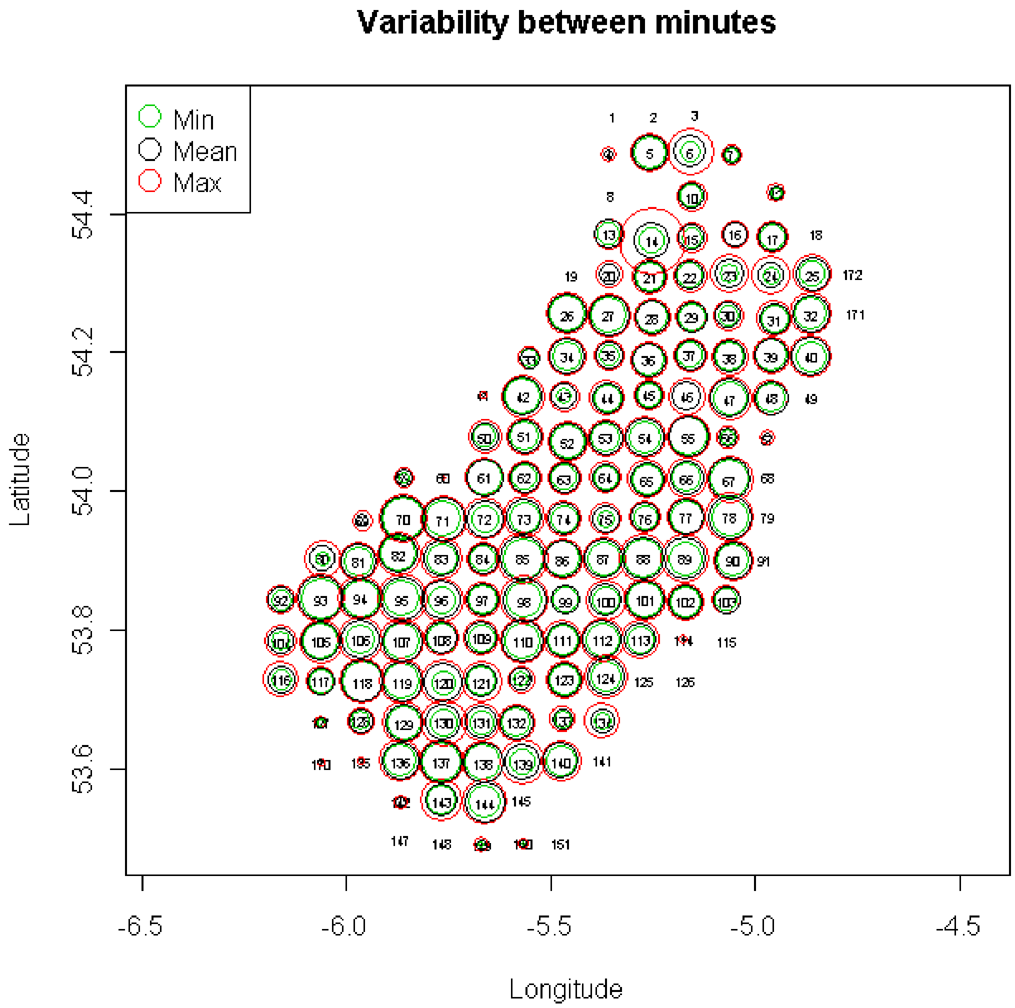

Figure 4 : Plot of the variability in density between minutes for each station in the 2010 survey.

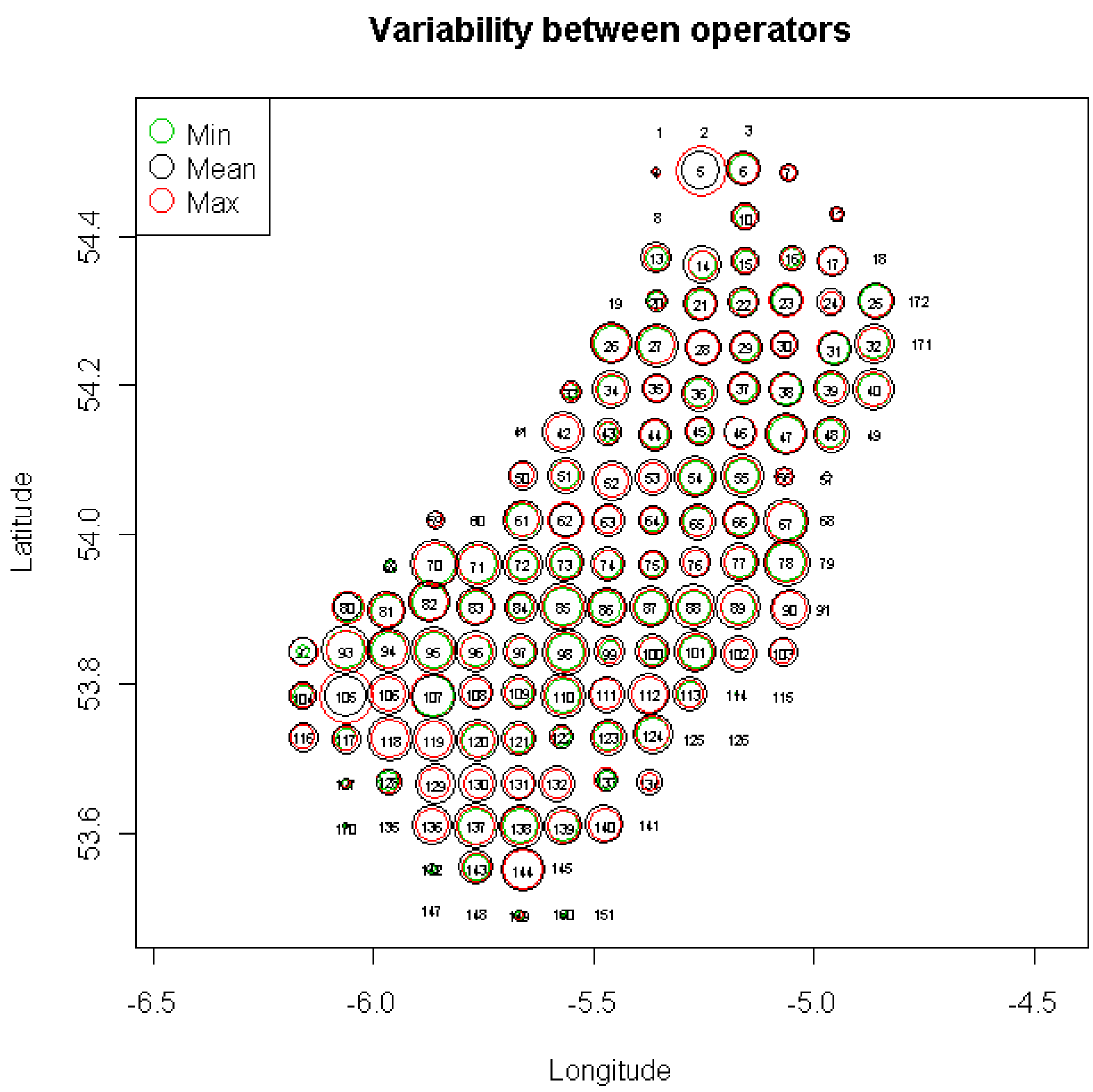

Figure 5 : Plot of the variability in density between operators (counters) for each station in the 2010 survey.

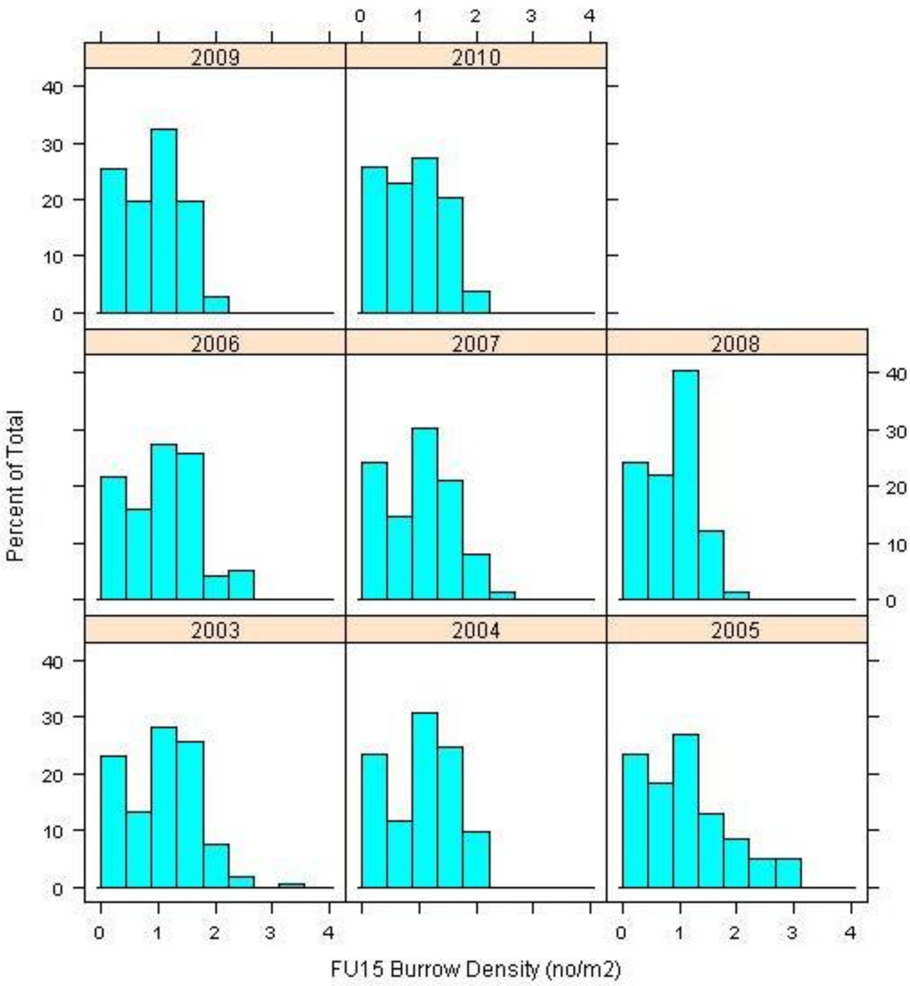

Figure 6 : Burrow density distributions for the western Irish Sea by year from 2003-2010.

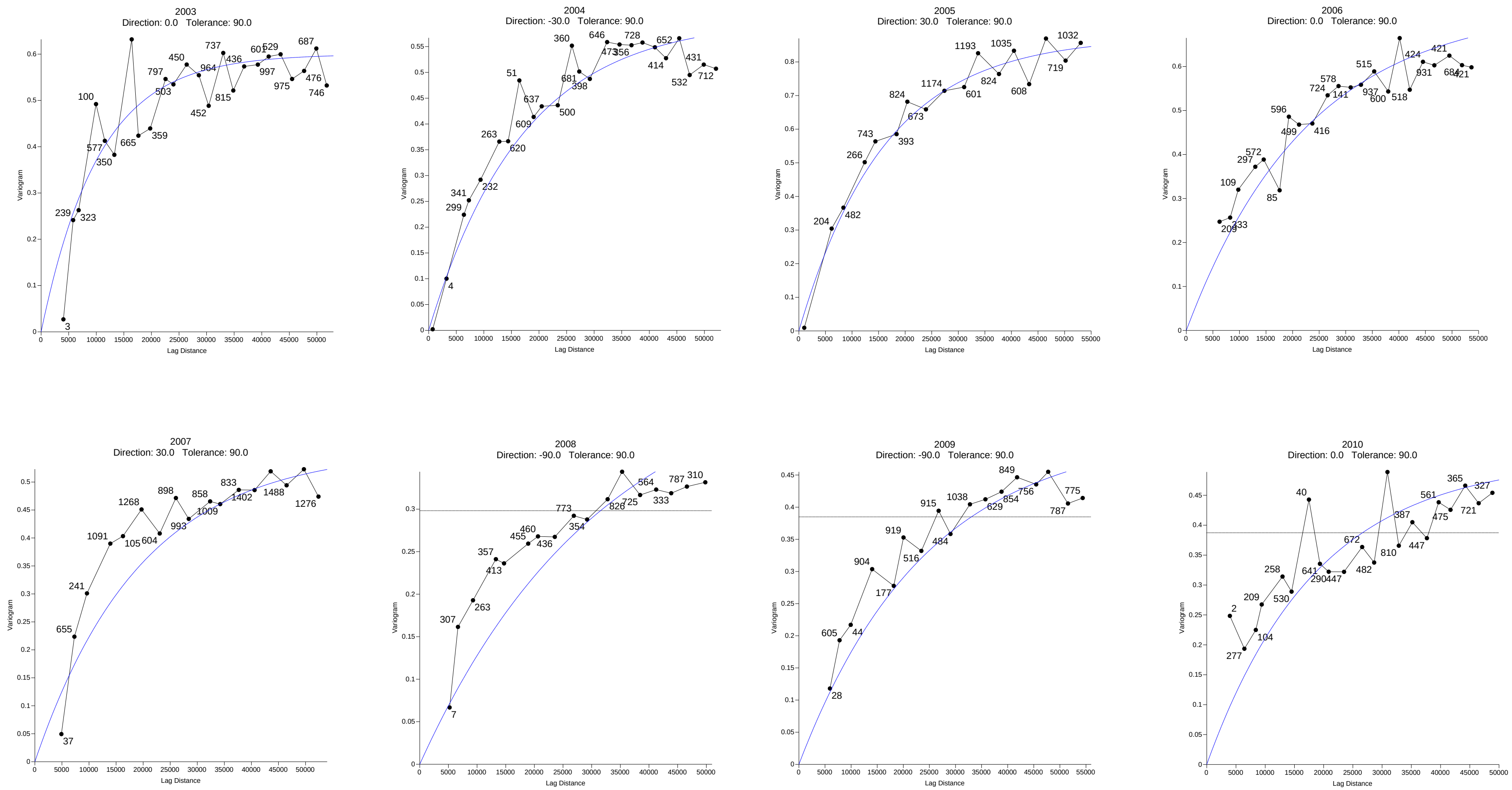

Figure 7 : Omnidirectional mean variograms for the western Irish Sea by year from 2003-2010.

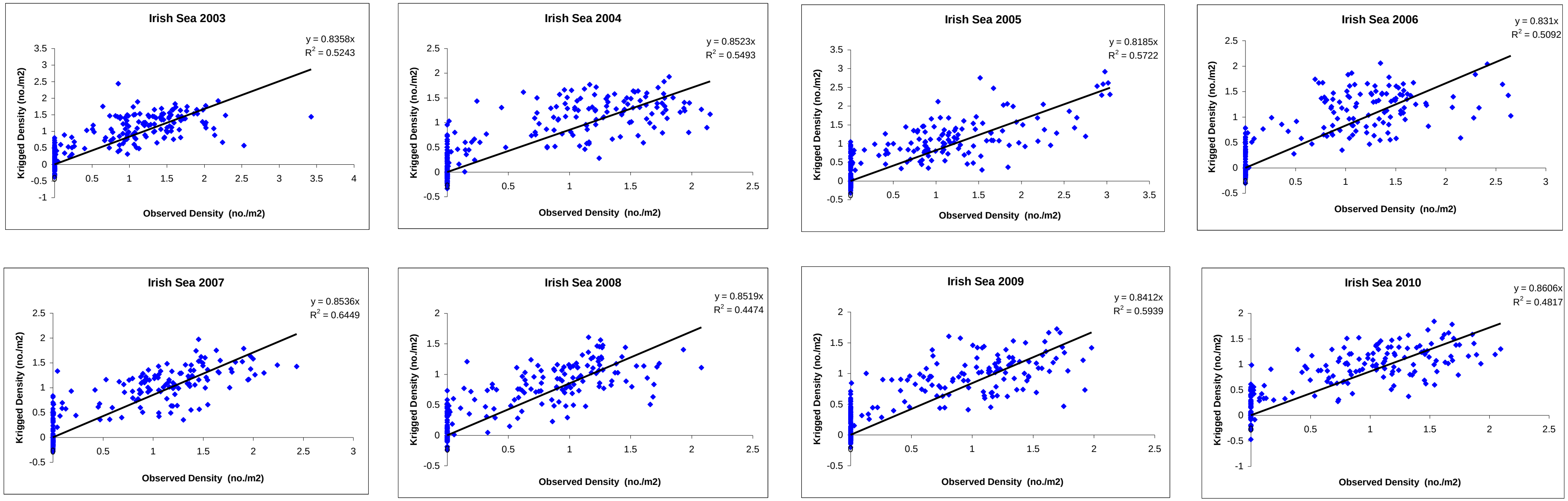

Figure 8 : Cross validation plots for the western Irish Sea by year from 2003-2010.

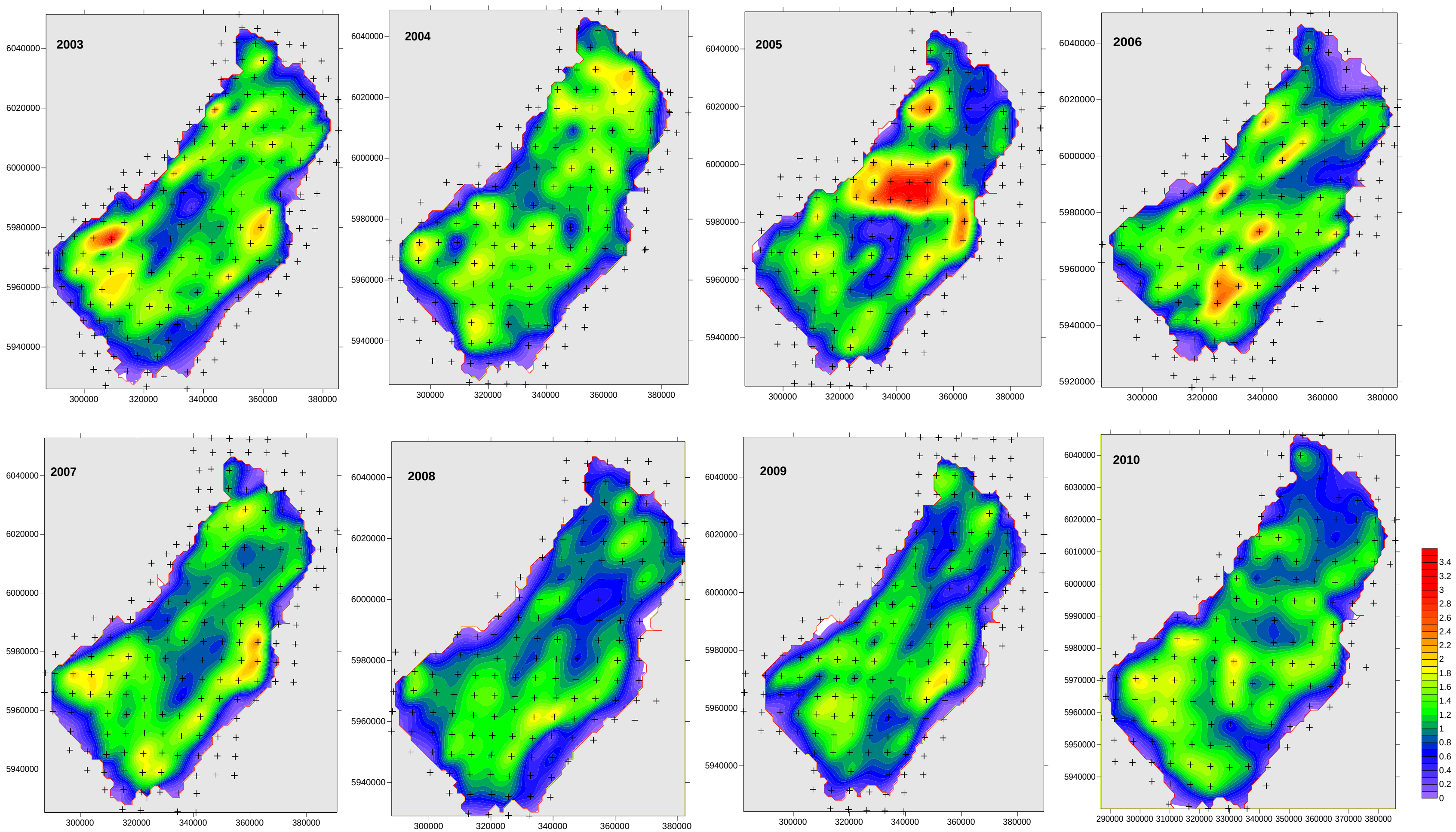

Figure 9 : Contour plots of the kriged density estimates for the western Irish Sea from 2003-2010.

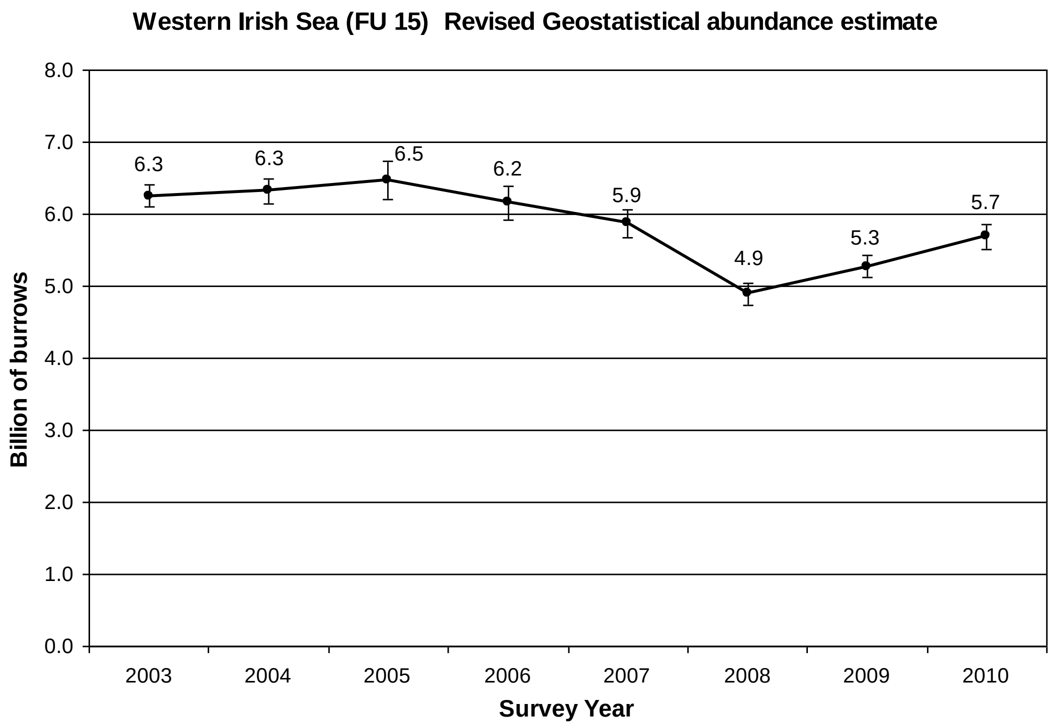

Figure 10 : Raised abundance estimates for the western Irish Sea from 2003-2009.

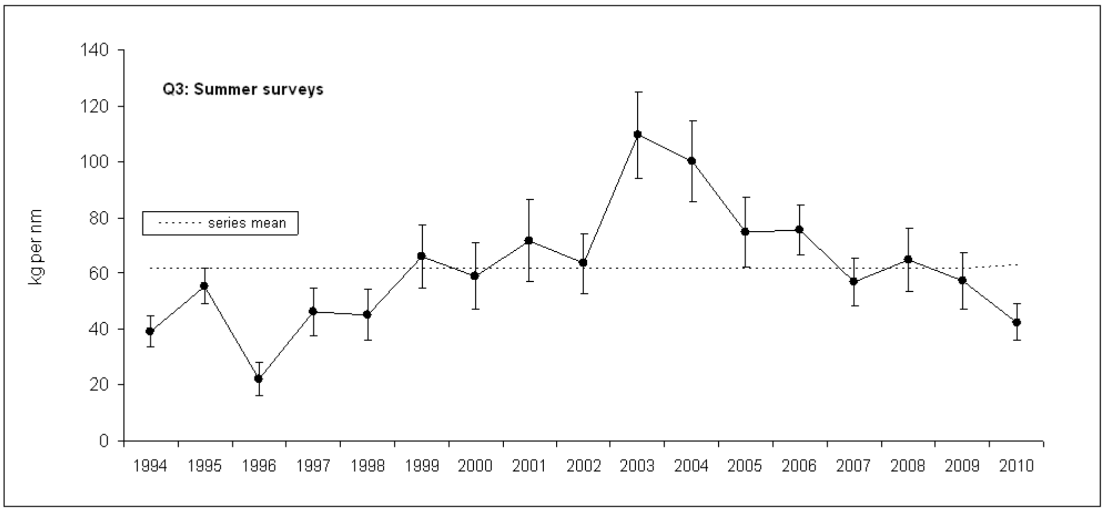

Figure 11 : Mean *Nephrops* catch (Kg nm-1) 1994-2010 (error bars = SE).