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Preliminary Results of the ISUNEPCA UWTV Survey on the Gulf of Cadiz *Nephrops* Ground (FU 30)

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INTRODUCTION

The *Nephrops* stock from FU30 comprises the Spanish waters of the Gulf of Cadiz, defined as the Spanish Suratlantic Region. The western limit of the stock is at the Portuguese border, on the Guadiana River estuary, whereas the eastern border is at the Gibraltar Strait. The Gibraltar Strait separates the Gulf of Cadiz from the Mediterranean Sea and is considered a natural border. On the other hand, the Guadiana River does not seem to be a real boundary for splitting possibly different populations (FUs 29 and 30). This stock limit was decided mainly on management considerations, without clear biological basis.

Within FU 30, *Nephrops* grounds correspond to muddy and sandy areas ranging between 200 to 700 m depths. High fishing effort is particularly carried out around 500 m (Ramos et al., 1996). *Nephrops* in FU 30 is exploited mostly by Spanish trawlers. The bottom trawl fleet of the Gulf of Cadiz is characterized by the multispecifity of its landings (Sobrino, 1994; Jiménez, 2002; 2004). At present, *Nephrops* and the other target species of the Gulf of Cadiz bottom trawl fleet are landed by a unique and highly multispecific *metier,* due to changes in the abundance of target species and fleet regulations (Silva et al., 2007; ICES, 2007). Landings are clearly seasonal with high values from April to September (Vila, 2005). *Nephrops* represents 1.5% of the total trawl landings from the area. Despite annual catches of *Nephrops* are small compared with other Atlantic *Nephrops* stock (≈100 t annually in 2009-2013 period), this species gives valuable revenues for the trawl fleet.

Currently, the ICES advice for FU 30 is on the basis of a data-limited approach, meaning that no analytical stock assessment is conducted in this FU. According to this approach, FU 30 is considered as category 3.1.4 (ICES, 2012a) and it is assessed mainly by the analysis of the LPUE series trend. Thus, the catch recommendation is set at a long-term average, with and "uncertainty cap" or "change limit" of ± 20% comparing with recent catches.

ICES assesses and provides catch options based on the UWTV surveys in many *Nephrops* stocks in Atlantic NE waters and suggests that this methodology remains the most appropriate for the moment (ICES, 2012b). In this sense, the Spanish Oceanographic Institute (IEO) carried out an exploratory *Nephrops* UWTV survey on the Gulf of Cadiz fishing grounds in 2014 within the framework of a project supported by Fundación Biodiversidad and IEO. The survey was designed from a multidisciplinary approach. The specific objectives are listed below:

1. To set up the equipment and the UWTV survey methodology in the Gulf of Cadiz
2. To obtain estimates of *Nephrops* burrows densities from a randomized isometric grid of UWTV stations spacing 5 nautical miles

3. To obtain density estimates of macro benthos species and the occurrence of trawl marks on the sea bed
4. To collect sediment samples using a meso Box-Corer
5. To collect oceanographic data using a sledge mounted CTD

MATERIAL AND METHODS

The exploratory ISUNEPCA UWTV survey was carried out from 22nd August to 1st September 2014 in the Spanish Gulf of Cadiz waters (FU 30) onboard RV Angeles Alvariño. The UWTV designs followed a randomized isometric grid of stations at 5 nm spacing. The grid spacing was determinate based on a time constraints of getting the survey completed within a time window of around 11 days with a work schedule about 14 hours per day. This resulted in 35 planned stations. The stations ranged from 130-640 m depth with an average depth around 410 m (Table 1). Additionally, 7 stations located on the shallower edge of the study area were considered as reserve.

The boundary used to delineate the limits of the *Nephrops* ground was based on VMS data of fishing activity in the 2012-2013 period. The VMS positional data were selected from fishing vessels targeting *Nephrops* using the logbooks. Geographical positions are available at least every two hours and the speed when the vessels are fishing ranges between 3 and 4 knots but speeds up to 5 knots can be achieved according to the knowledge from onboard fisheries observers. Therefore, speed values lower 5 knots were selected for the analysis. Records at entries and exits from main ports and from distances to the coast lower 6 mn, where is forbidden trawling, were removed. Additionally, records allocated lower 200 m isobata were removed too since *Nephrops* catches were near zero. The surveyed area was calculated on the base on the VMS analysis defining squares of 5x5 mn. The grid was established from the vertices of these squares covering the most of the *Nephrops* fishing ground.

The sledge and the main equipment were developed and made by a small company, which performed the sledge operations during the survey (Figure 1). The UWTV equipment is composed of:

- *Image system:* 2 FullHD (1080x1920 pixels) videocameras which are placed in 2 reduced size CPUs with a processor of 700 MHz, 512 Mb RAM and 16 Gb for the storage memory
- *Lighting system:* 1 high power LED made according to the model of this company
- *Lasers system*: 2 lasers of 200 mW
- *Navigation system*: accelerometer and magnetometer both tri-axial with internal data processor, offering offset data of heading, pitch and roll with precision of 1^0
- *Communication system:* 1 multiplexor and an IBERCISA MCS-E/30/1500-11 (1500 m and 11 mm diameter coaxial cable)
- *Auxiliary system*: 1 high capacity lithium battery
- *Deck system*: a control unit

The sledge was deployed and towed at the side of the vessel using an 11 mm diameter coaxial cable. The malfunction of the stern portico and the allocation of the winch on the deck, which is to starboard, and not center on the deck were the reasons to decide using the side. This option results in a continuous and without jumpy displacement of the sledge.

The sledge was deployed with vessel stopped and when the sledge went down up to half of depth, the vessel was about 1-1.5 knots. Once stable on the seabed the sledge was towed at between 0.5-0.6 knots in order to obtain the best possible conditions for counting burrows and 13 good minutes were recorded. This time corresponds to 200 m swept, approximately. The footages were recorded onto internal memory of the image system and were downloaded after each station onto to computer. Footages files were converted from H264 to MPEG4 format and recorded on DVD disc. Vessel position (DGPS) was logged to text file via Hyperterminal and a HiPAP transponder on the sledge was used to obtain the sledge position. The distance over ground estimate (DOG) was calculated using the sledge position for all stations and the field of view of the video footages was 75 cm (FOV), which was confirmed using lasers.

According to the SGNEPS recommendations all scientists were trained and familiarized with the identification of *Nephrops* burrows (ICES, 2008) using training material and validated using reference footages from Porcupine Bank since the burrow density could be the most similar to the Gulf of Cadiz. Linn's concordance correlation coefficient (CCC) was used to analyze the individual's counting against the reference counts. SGNEPS (ICES, 2009) suggests that individual's counts should be higher 0.8 but a lower threshold might be considered acceptable establishing a CCC value limit of 0.5. In this survey a threshold ≥ 0.5 was accepted for considering a reader as valid. Two trained "burrow identified" scientists independent of each other in the lab conducted all recounts after the survey. The number of *Nephrops* burrows systems and *Nephrops* in and out of burrows were counted for each one-minute interval according to WKNEPHBID (ICES, 2008). Visibility was subjectively classified using the follow classification key: excellent, good, ok, ok-poor, poor and nil.

Estimates of density at each station were calculated from standardized *Nephrops* burrows recounts divided by the area observed. This area was calculated multiplying the DOG by the FOV. Then, *Nephrops* burrows density was raised to the total area surveyed. In this WD the correction factors were not applied to account the edge effect and for occupancy and identification.

In addition, the footages will be used to estimate the density of macro benthos species and trawl marks on the seabed. This task is in process at this time.

At each station, CTD profile was logged for the duration of the tow using a SBE 37. This data will be processed later.

Finally, samples of seabed sediment were collected at each of 35 planned UWTV stations using a meso Box-Corer for granulometric and organic material analysis during the survey. All the samples were frozen for further analysis in the lab. This task is in process at this time.

RESULTS

ISUNEPCA_0814 is the first *Nephrops* UWTV survey in the Gulf of Cadiz and it must be considered as an exploratory survey. This survey offered the opportunity to set up the equipment and the methodology in this area. In addition, it was an important training both

for the scientists and the crew of the vessel. Thus, scientists were able to get to know the survey protocol, the use of the UWTV equipment and *Nephrops* burrow identification.

Figure 2 shows the results of the VMS analysis and the abundance of *Nephrops* obtained during the ARSA bottom trawl spring survey series (SpSGFS-cspr-WIBTS-Q1_1993-2014). The *Nephrops* ARSA distribution is in concordance with the spatial distribution of the fishing activity on the ground in the Gulf of Cadiz. Nevertheless, small quantities of *Nephrops* occur below 200 m isobata and on the deepest area (about 600-700 m) although none bottom trawl fleet activity targeting to *Nephrops* is observed in the VMS. The UWTV stations covered relatively well the entire distribution of the *Nephrops* ground corresponding to a 1986 Km^2 (Figure 3). However, some difficulties were found when the UWTV stations were allocated on the ground. Firstly, *Nephrops* fishing ground (FU 30) borders on Portuguese waters, therefore none station could be added in an adaptive way to ensure that the boundaries of the ground were surveyed. On the other hand, the bathymetry on the Gulf of Cadiz shows a rugged bottom with deep channels and some mud volcanoes located on the southwestern area. To avoid these submarines structures 4 stations were slightly moved (20, 25, 33 and 37).

All planned UWTV stations were completed but the UWTV stations considered as reserve could not carry out within of the time window of the survey. 10 of the 35 planned stations were visited again because the visibility was very poor or nil. The mainly reason was the fishing activity which causes considerable amounts of suspended material in the water near the seabed making difficult the identification of *Nephrops* burrows. Most of these stations were revisited during the weekend when the fleet is docked in accordance with the regulation. However, the bad visibility conditions remained in 3 of them that were considered null stations. All stations were classified according to the visual clarity (Table 2). Most of them showed clear waters and were classified as excellent and good visibility (46% and 31%, respectively). The visual clarity was acceptable in a number of stations corresponding to 11% as Ok and 3% as OK-poor. Finally, a low percentage of the stations showed a visibility classified as poor (3%) and nil (6%). Only in 2 footages some one-minute intervals had more than 30 uncountable seconds. These minutes were eliminated in the further analysis.

The two counters obtained a CCC value higher than 0.5 but independent recounts showed a bias (Figure 4). Differences between counters were found in footages in poor-ok conditions of visibility, with small *Nephrops* burrows and with high density of other burrowing species. Moreover, all recounts were carried out in the lab after de survey and during a wide period, which could influence in the *Nephrops* quantification.

The distribution of preliminary burrows density (within correction factor applied) from these recounts on the footages indicates a modal distribution around 0-0.3 burrows/m^2 with a range of observations relatively low (Figure 5). Figure 6 shows the preliminary burrows density by UWTV station. The *Nephrops* density in the border of the area was relatively high but it was not possible to add UWTV stations in an adaptive way in order to ensure the boundaries of the ground in this first survey. Nevertheless, it will be difficult to extend UWTV stations in the west of the area since it limits with Portuguese waters. The mean burrow density was 0.102 burrows/m^2. The total numbers of burrows counted during the survey was raised to the area surveyed (1986 Km^2) to give a preliminary and

not corrected estimate of the number of burrows system in the Gulf of Cadiz. Assuming 100% occupancy the total number of *Nephrops* in the Gulf of Cadiz was estimated to be around 200 millions of individuals.

The spatial co-variance and other spatial structuring Geo-statistical analysis will be conducted using ARCGIS software. However, some difficulties are identified as the low number of observations and no observations with zero densities on the boundary ground. A number of assumptions will need to be considered and explored.

CONCLUSIONS

1. The boundaries of the *Nephrops* ground have to be better defined
2. How to extend the boundaries *Nephrops* ground in the border with Portuguese waters?
3. Increase the intensity of UWTV stations and decrease the distance between them
4. Bathymetry must be taken to account when the UWTV stations are allocated on the grid
5. Higher training of readers and good knowledge of the burrows of other species is needed
6. The *Nephrops* identification and quantification must be carried out during the survey

Acknowledgements

This survey is in the framework on the project "Estimación de la abundancia de cigala *Nephrops norvegicus* en el Golfo de Cádiz a través de imágenes submarinas (ISUNEPCA)" which has been supported by Fundación Biodiversidad (Agricultura, Alimentación y Medio Ambiente Ministry) and the Spanish Oceanographic Institute (IEO). Thanks to the crew of RV Ángeles Alvariño. Thanks to the Thalasatech's personal for their hard work throughout the survey, all the scientists and the grant holders Cristina Barragán and Ramón Romero.

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Table 1. Characteristics of the UWTV stations.

Station	Date	Start				Finish				Validity
		Time (UTM)	Latitude	Longitude	Deep	Time (UTM)	Latitude	Longitude	Deep	
1	29/08/2014	8:54	36° 53.9'	7° 20.5'	255	9:08	36° 53.9'	7° 20.7'	252	SI
2	29/08/2014	10:26	36° 54.1'	7° 14.8'	136	10:39	36° 54'	7° 14.7'	137	SI
4	28/08/2014	8:19	36° 48.9'	7° 20.7'	490	8:31	36° 49'	7° 20.8'	490	SI
5	28/08/2014	19:14	36° 49.1'	7° 14.9'	433	19:28	36° 49'	7° 14.8'	433	SI
6	28/08/2014	17:49	36° 49.1'	7° 8.5'	287	18:02	36° 49'	7° 8.4'	288	NO
7	28/08/2014	16:29	36° 49.1'	7° 2.3'	132	16:42	36° 49'	7° 2.2'	131	SI
9	28/08/2014	6:34	36° 43.9'	7° 14.5'	509	6:47	36° 44'	7° 14.6'	508	SI
10	31/08/2014	7:55	36° 43.9'	7° 8.2'	480	8:08	36° 44'	7° 8.3'	480	SI
11	31/08/2014	9:35	36° 43.9'	7° 2.1'	350	9:49	36° 44'	7° 2.2'	350	SI
12	27/08/2014	11:52	36° 43.9'	6° 55.9'	131	12:05	36° 44'	6° 56'	131	NO
13	30/08/2014	16:16	36° 39.1'	7° 14.8'	552	16:30	36° 39'	7° 14.7'	552	SI
14	31/08/2014	6:24	36° 38.9'	7° 8.3'	512	6:37	36° 39'	7° 8.4'	512	SI
15	31/08/2014	11:14	36° 38.9'	7° 2'	501	11:27	36° 38.9'	7° 2.1'	501	SI
16	31/08/2014	12:44	36° 38.8'	6° 55.8'	366	12:57	36° 38.9'	6° 55.9'	369	SI
18	26/08/2014	11:50	36° 33.9'	7° 14.4'	568	12:03	36° 34'	7° 14.6'	568	SI
19	26/08/2014	10:17	36° 33.9'	7° 8.2'	504	10:30	36° 34'	7° 8.3'	490	SI
20	29/08/2014	15:22	36° 34.2'	7° 01'	494	15:35	36° 34.1'	7° 0.9'	494	SI
21	26/08/2014	6:28	36° 34'	6° 55.9'	451	6:30	36° 34'	6° 55.9'	445	NO
22	25/08/2014	17:07	36° 34'	6° 49.7'	254	17:20	36° 34'	6° 49.8'	259	SI
24	24/08/2014	18:59	36° 29'	7° 14.7'	617	19:12	36° 29'	7° 14.6'	617	SI
25	25/08/2014	7:29	36° 29.7'	7° 8.4'	566	7:41	36° 29.7'	7° 8.5'	573	SI
26	25/08/2014	9:05	36° 28.8'	7° 2'	568	9:18	36° 28.9'	7° 2.1'	570	SI
27	25/08/2014	11:51	36° 29.1'	6° 56.1'	468	12:05	36° 29'	6° 56'	468	SI
28	25/08/2014	13:37	36° 29.1'	6° 49.9'	399	13:50	36° 29'	6° 49.8'	399	SI
29	25/08/2014	15:50	36° 29'	6° 43.6'	173		36° 29'	6° 43.6'		NO
30	30/08/2014	12:25	36° 19.4'	7° 2.1'	640	12:39	36° 19.5'	7° 2.2'	649	SI
31	24/08/2014	17:18	36° 24.1'	7° 8.5'	617	17:32	36° 24'	7° 8.4'	612	SI
32	24/08/2014	14:25	36° 24'	7° 2.3'	563	14:37	36° 24'	7° 2.2'		SI
33	24/08/2014	11:13	36° 24.1'	6° 55.3'	497	11:26	36° 23.9'	6° 55.3'	499	SI
34	24/08/2014	8:09	36° 24.1'	6° 49.8'	421	8:25	36° 23.9'	6° 49.8'	423	SI
35	30/08/2014	6:31	36° 23.9'	6° 43.4'	295	6:44	36° 23.9'	6° 43.5'	291	SI
37	24/08/2014	12:39	36° 19.7'	6° 56'	544	12:51	36° 19.6'	6° 56'	544	SI
38	23/08/2014	14:05	36° 19.1'	6° 49.7'	621	14:18	36° 19'	6° 49.9'	478	SI
39	30/08/2014	9:44	36° 18.9'	6° 43.3'	378	9:57	36° 18.9'	6° 43.4'	380	SI
40	30/08/2014	8:11	36° 18.9'	6° 37.3'	197	8:24	36° 19'	6° 37.4'	199	SI

Table 2. Visual clarity by UWTV stations in number and percentage.

	UWTV Stations	
	Nº	%
Excellent	16	46
Good	11	31
Ok	4	11
Ok-poor	1	3
Poor	1	3
Nil	2	6

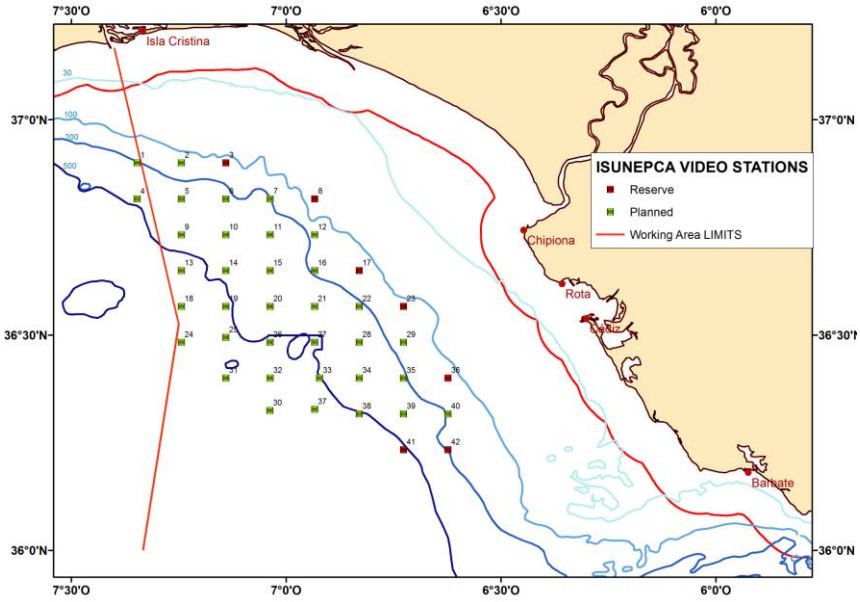

Figure 1. Distribution of the UWTV and Box-Corer stations in the ISUNEPCA_0814 Survey in the Gulf of Cadiz (*Nephrops* FU30).

Figure 2. Sledge used during ISUNEPCA_0814 UWTV Survey in the Gulf of Cadiz (*Nephrops* FU30).

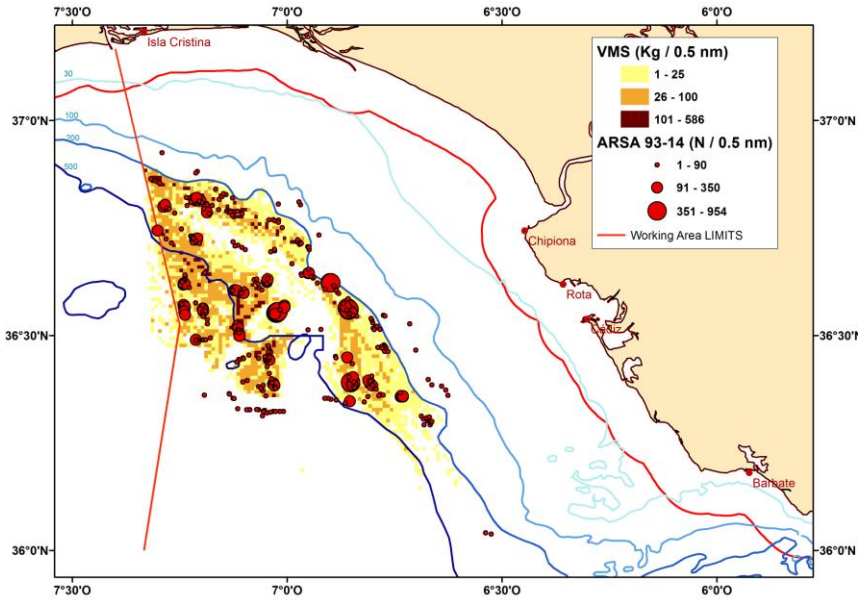

Figure 3. Fishing activity targeting *Nephrops* based on VMS (2012-2013) and *Nephrops* abundance obtained in the ARSA bottom trawl spring survey series (SpSGFS-cspr-WIBTS-Q1_1993-2014) in the Gulf of Cadiz.

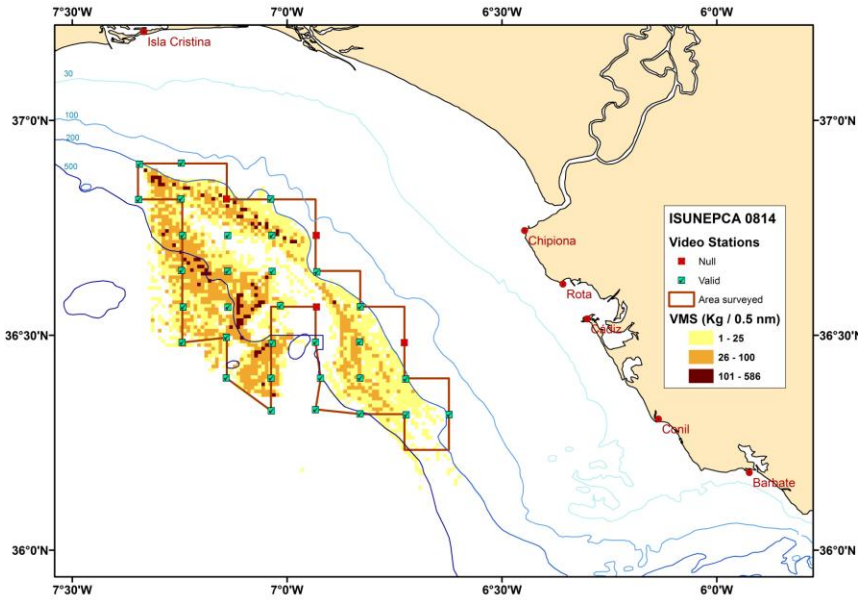

Figure 4. ISUNEPCA_0814 UWTV stations map and area surveyed overlaid on *Nephrops* fishing activity based on the VMS.

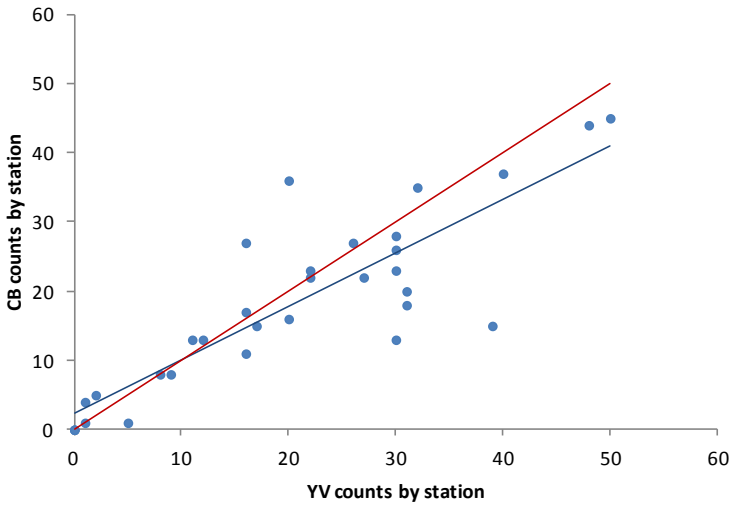

Figure 5. A scatterplot of the recounts made for each station by two counters independently. The blue line is the linear regression (r^2=0.74) and the red line indicates a 1-1 relationship.

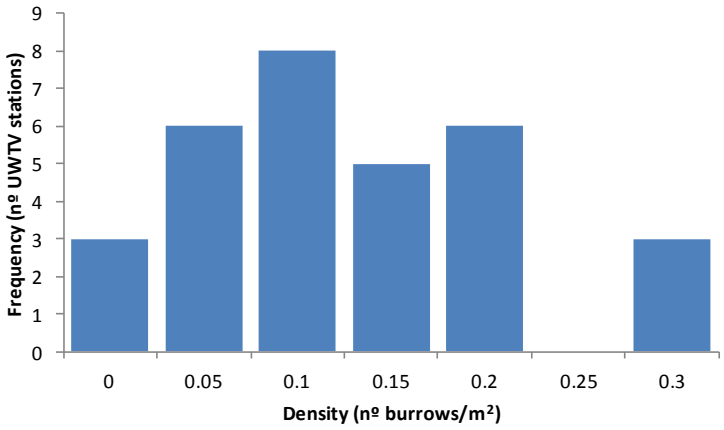

Figure 6. *Nephrops* density frequency distribution.

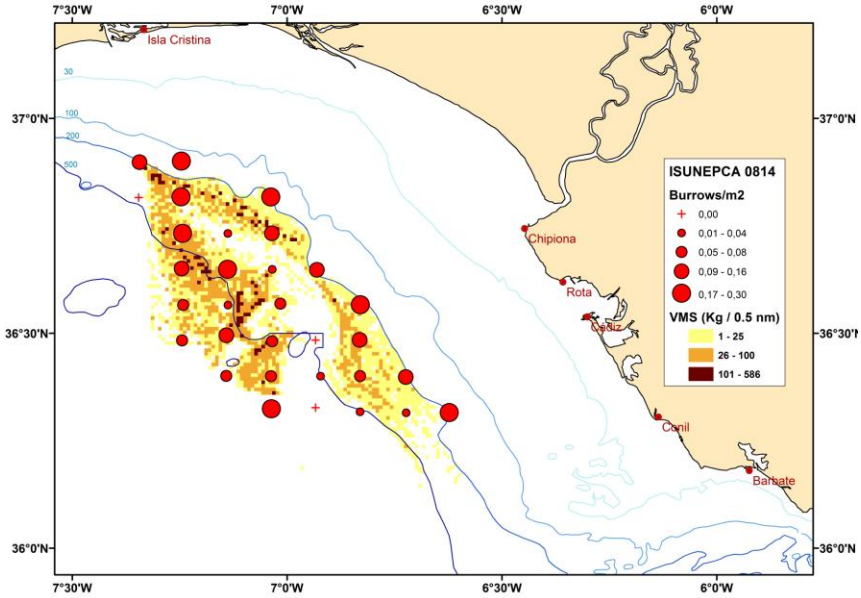

Figure 7. Preliminary *Nephrops* density distribution (within corrector factors applied) overlaid on *Nephrops* fishing activity based on the VMS in the Gulf of Cadiz (*Nephrops* FU 30).