

WD presented at Working Group for the Celtic Seas Ecoregion (WGCSE)  
ICES, Copenhagen, Denmark, 12–21 May 2015

## ***Nephrops* discards, size composition, recruitment and directed effort of the Spanish fleets in Porcupine Bank (FU 16)**

Isabel González Herraiz<sup>1</sup>, Nélida Pérez<sup>2</sup>, Francisco Javier Gómez Suárez<sup>1</sup>, Hortensia Araujo<sup>2</sup>  
Instituto Español de Oceanografía (IEO), [isabel.herraiz@co.ieo.es](mailto:isabel.herraiz@co.ieo.es)



### **ABSTRACT**

*Spanish fleets have been fishing Norway lobster (*Nephrops norvegicus*) in Porcupine Bank for more than 45 years. Despite a huge Spanish effort descent in the area during this period, nowadays Spain is after Ireland the second country in *Nephrops* landings from this functional unit (12%). *Nephrops* discards in the Spanish fleets were traditionally considered negligible, but a revision about the issue is necessary. On the other hand, there are problems since 2005 to carry out length sampling from the fishery on the ports, since retained catch is now frozen on board. This lack of information can be addressed by length information collected by the observers on board. Concerning effort, Spain has been providing in the last decades effort data of the hake directed fleet (that collects almost all *Nephrops* catch) for the successive ICES working groups related to FU 16 *Nephrops*. New effort information more accurate and directed to *Nephrops* is needed. Taking into account this demands, discards rates and estimations, catch length information and *Nephrops* directed effort are presented on this document.*

### **INTRODUCTION**

Spanish fleets have been present in Porcupine Bank since their first exploratory trips in 1927 (Paz Andrade, 1958). There are two Spanish trawlers fleets in ICES Subareas VI and VII, one directed to hake (OTB\_DEF\_100-119) with main base in A Coruña port and other directed to flat fishes (OTB\_DEF\_70-99) with main base port in Vigo. Hake fleet is the most important in Porcupine Bank and captures the majority of the *Nephrops* catch. Hake fleet effort is currently maximum in the second quarter of the year. The highest *Nephrops* catches were 3931 t in 1982 (González Herraiz, 2011). Due to several reasons (political, economic, accession of Spain to the EEC, management measures...) hake fleet effort in the area has descent an 80% between 1980 and 2009 (ICES, 2013) and specifically a 79% since 2011 to 2014 (Castro, 2015). *Nephrops* has always been a very important resource for the Spanish fleets since its high economic value (from Porcupine Bank 18 €/kg with maxima of 60 €/kg) and the stability of its market in the country. Porcupine *Nephrops* landings have decrease a 97% from 1982 to 2014 and still being the first FU for Spain in landings (2012-2014), followed by FU 30 (Gulf of Cádiz). *Nephrops*

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<sup>1</sup> A Coruña Oceanography Centre, Spain

<sup>2</sup> Vigo Oceanography Centre, Spain

landings from Porcupine are the 54% of the *Nephrops* Spanish landings from ICES area (2012-2014)

Discard sampling in the area through observers on board was carried out sporadically under different projects (1988-1989: national project; 1994: EC project Pem/93/005; 1999-2000: EC project 98/095; 2001: EC project 99/063, only for megrim fleet) until the beginning of the EU DCF (Data Collection Framework) in 2003, when a systematic discard sampling currently in force was established. *Nephrops* discards in the Spanish fleets were traditionally considered negligible, but a revision of the available information about the issue is necessary. On the other hand, there are problems since 2005 to carry out length sampling from the Porcupine *Nephrops* fishery on the ports, since retained catch is now frozen on board (ICES, 2013b). This lack of information can be addressed by catch length information collected by the observers on board.

Concerning effort, Spain has been providing in the last decades effort data of the fleet directed to hake (that collects almost all *Nephrops* catch) for the successive ICES working groups related to FU 16 *Nephrops*. Before the logbooks and VMS (vessel monitoring system) were available effort information was collected through sales notes (auction) provided by ports authorities and the information collected by the samplers on ports. Since some years ago, ICES statistical rectangle information and geographical coordinates of the fishing activity are available, allowing to obtain more accurate and *Nephrops* directed effort indices.

The objective of this document is present for the first time the Porcupine *Nephrops* discard rates and estimations, catch length information and *Nephrops* directed effort.

## **MATERIALS AND METHODS**

### *Quarterly landings and effort data*

Hake fleet data were obtained from the auction (sales notes) provided by the ports control institutions and also from logbooks since 2003. “Hake fleet” includes also trawlers from based in the port of Celeiro. “Megrim fleet” data were extracted from logbooks ( $\geq 2003$ ) and includes also trawlers based in the port of Marín. Sales notes did not allow identifying the trip fishing area; therefore data in the past were referred to ICES Subareas VI and VII in general. Since 2007 the metier of each Spanish trip in ICES area from logbooks is identified by multivariate analysis. This allocation absolutely verified the traditional identification of hake fleet with A Coruña and Celeiro base ports and megrim fleet with Vigo and Marín base ports. Hake fleet lands in its base ports and also in different Irish or French ports. These landings abroad are carried by lorry to A Coruña fish market.

### *Discard weight estimations and catch length distribution*

Different discard sampling programmes with observers on board were carried out in the Spanish bottom otter trawl fleets (=métiers) in the ICES Subareas VI and VII by metier and year in 1988-1989, 1994, 1999-2000 and by metier and quarter since 2003 by the Spanish Institute of Oceanography (IEO) (Table 1). Megrim fleet data before 2003 were not used for this paper because most of its activity was in the southern part of de ICES division VIIj, outside FU 16, and it is not possible identify the few trips of the metier carried out in Porcupine bank in that period.

*Nephrops* sampled discard weight and catch (retained + discarded) length distributions numbers were raised to metier level by effort (number of trips). Gaps in the average discard weight by trip quarterly series were covered with the average of the previous and following quarter value and raised to the respective quarterly effort for the annual estimations.

**Table 1.** Spanish discards sampling level for ICES Subareas VI and VII carried out by IEO observers on board (1988-2014). Megrim fleet data before 2003 were not used in this paper because the majority its activity is outside FU 16 and is not possible to identify the few trips in FU 16 in this period.

Year	A CORUÑA FLEET Directed to hake OTB_DEF_100-119_0_0				VIGO FLEET Directed to flat fishes OTB_DEF_70-99_0_0				Total		
	No Trips	No Hauls	No Vessels	Catch NEP No/trip	No Trips	No Hauls	No Vessels	Catch NEP No/trip	No Trips	No Hauls	No Vessels
	1988	8	181	8	15 385	6	190	5	57	14	371
1989	3	96	3	46 282	5	136	5	1 473	8	232	8
1990											
1991											
1992											
1993											
1994	10	334	10	30 883	10	369	9	8 727	20	703	19
1995											
1996											
1997											
1998											
1999	2	49	2	9 395	4	181	4	980	6	230	6
2000	3	86	3	30 150	7	302	7	4 771	10	388	10
2001					2	100	2				
2002											
2003	2	54	2	36 545	7	315	7	11 562	9	369	9
2004	3	61	3	15 845	8	338	8	7 884	11	399	11
2005	3	60	3	5 259	7	276	7	4 613	10	336	10
2006	4	75	4	10 329	9	301	9	1 291	13	376	13
2007	3	69	3	32 580	9	299	9	13 280	12	368	12
2008	4	107	4	5 564	7	246	7	7 568	11	353	11
2009	6	143	6	5 430	9	285	9	445	15	428	15
2010	4	85	4	4 804	9	297	9	1 791	13	382	13
2011	2	40	2	14 508	9	253	9	433	11	293	11
2012	2	26	2	57 941	9	314	9	15 202	11	340	11
2013					10	316	10	6 926	10	316	10
2014	1	13	1	1 265	12	299	10	2 190	13	312	11

### Effort directed to *Nephrops*

Days with speed suitable for the fishing activity in the polygon of the *Nephrops* fishing area established for the close season were identified in 2001-2013 for each Spanish trawler using the VMS in order to calculate the effort directed to *Nephrops*. Fishing days were selected with independently they have *Nephrops* landings or not. Those fishing days for each vessel were selected in logbooks to have each day fishing hours, number of hauls, DCF metier, landings, etc. A *Nephrops* directed effort was calculated with the days of all the trips in the *Nephrops* fishing area and other index was calculated only with the days from the trips where *Nephrops* constituted 30% or more of the trip landings in weight (ICES, 2013).

## RESULTS & DISCUSSION

### Landings

Hake fleet *Nephrops* landings values are similar in sales notes and logbooks ( $\geq 2003$ ) except for 2004-2005 and 2007, when landings were smaller in logbooks (Fig. 1). Logbooks coverage in the first years of the series was not complete; therefore auction values were in their day considered better and sent to the ICES Working Group. Moreover in 2005 there was a *Nephrops* landings, effort and DPUE peak in both Spanish and international data that is better reflected in 2004-2005 and 2007 sales notes than in logbooks.

Hake fleet *Nephrops* landings have a decrease of 97% between 1982 and 2014 (ICES, 2014) (Fig. 1). Hake fleet obtained the 93% of the *Nephrops* landings (2012-2014) and Megrim fleet the 7% (Fig. 1).

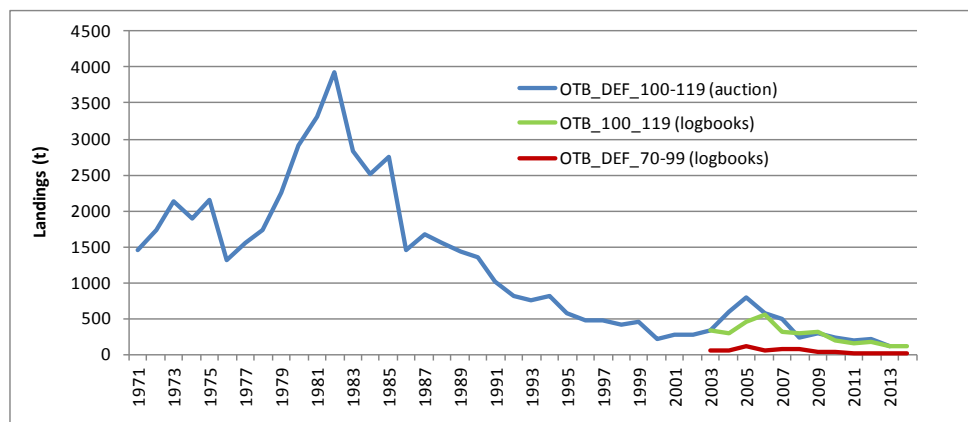
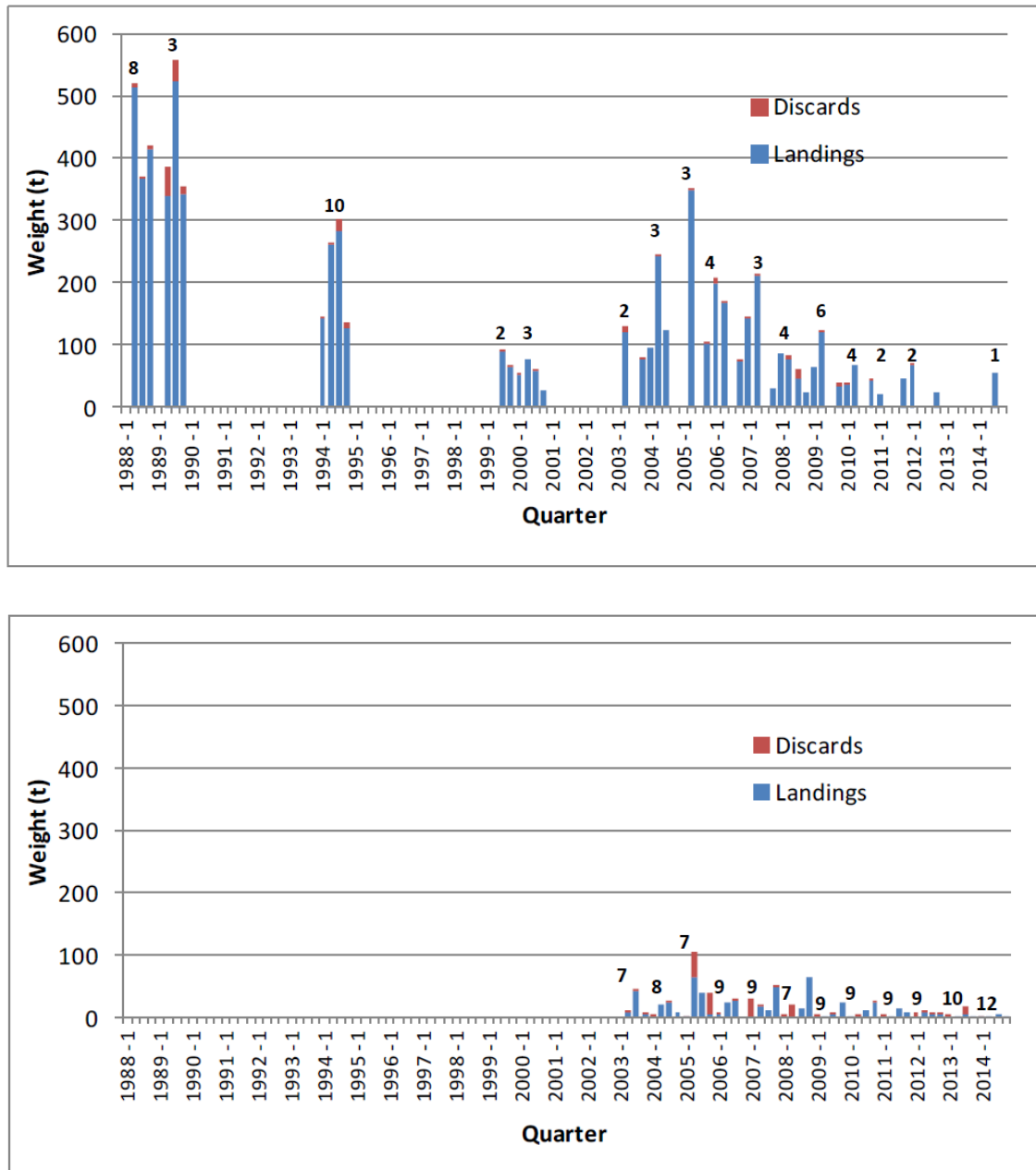


Figure 1. *Nephrops* landings of all fleets (above) and the Spanish fleets (below) in FU16 (1971-2014).

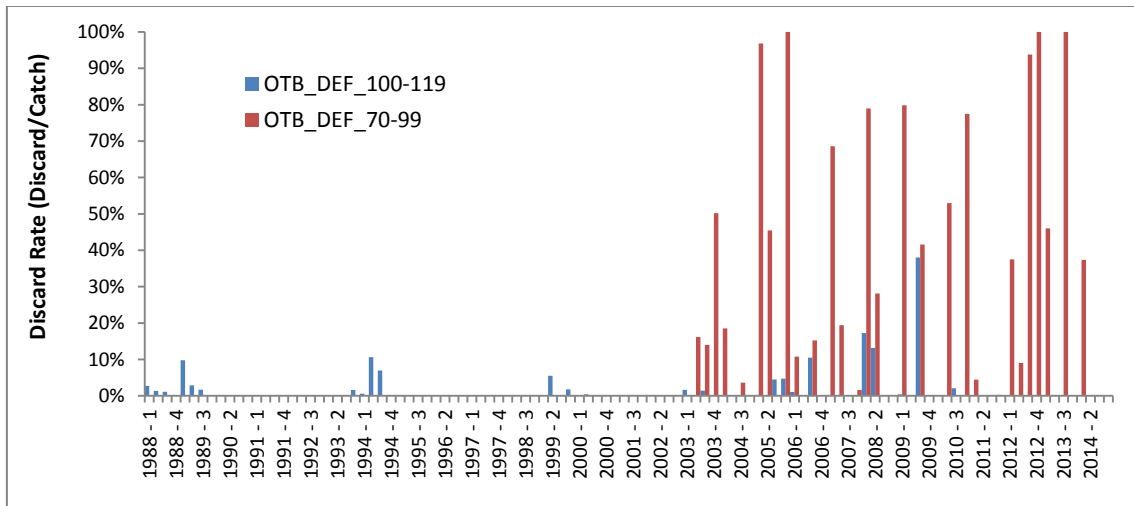
### Discards weight estimations

Figure 2 shows quarterly discard weight estimations by métier (fleet) and also annual discard sampling coverage. Hake fleet *Nephrops* landings are much higher than those from the megrim fleet. There is a high variability between quarters for both landings and discards weights in the two fleets. Megrim fleet presents a higher *Nephrops* discard rate.



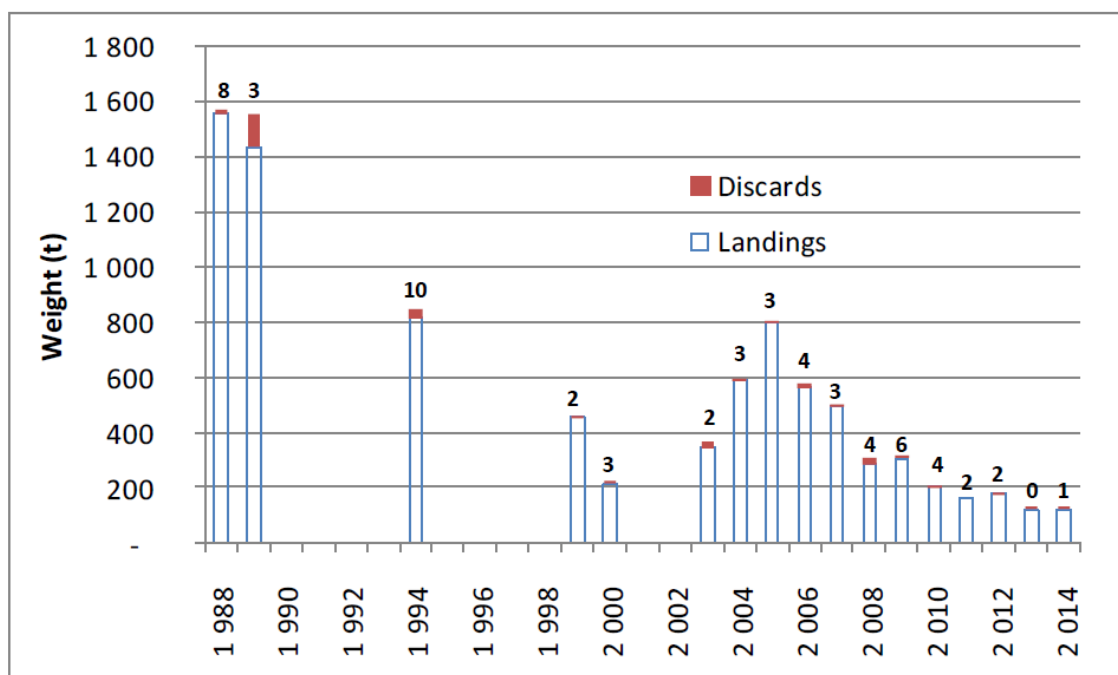
**Figure 2.** *Nephrops* landings and raised discards of the Spanish fleets in Porcupine Bank (FU 16) by metier and quarter (1988–2014). **Only for quarters with discard sampling.** Above: Hake fleet, below: Megrim fleet. Numbers over bars: number of trips sampled **each year**.

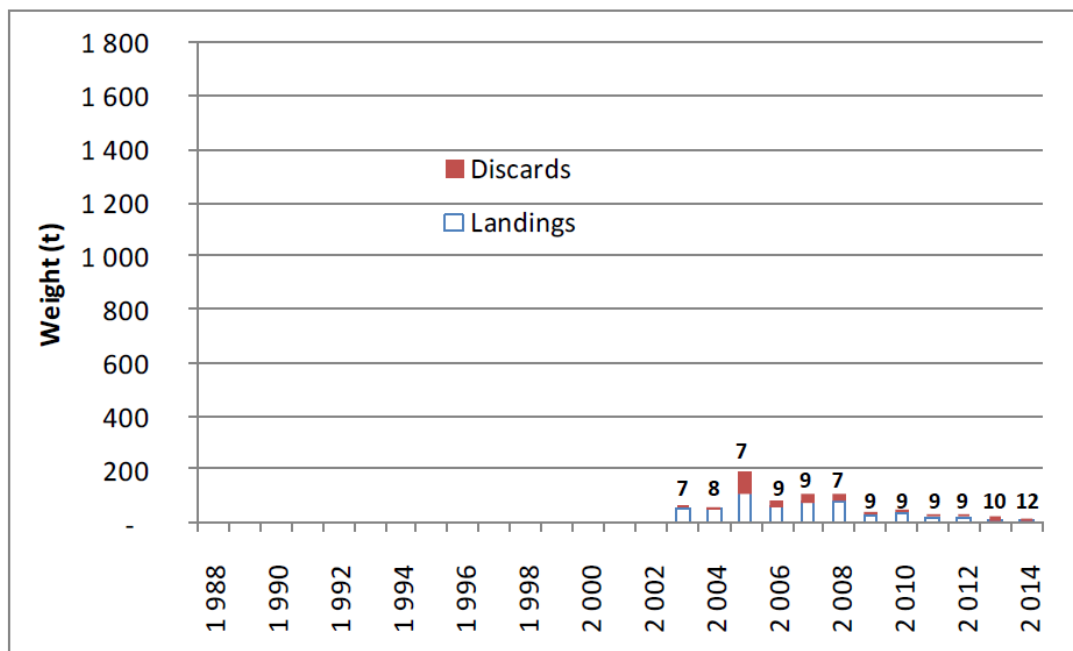
Figure 3 shows the high *Nephrops* discard rates (discard/catch) in the Megrim fleet and a period of increasing discard rate in some quarters in Hake fleet since 2005 to 2009. This pattern does not seem to be related with high quantity of individuals under the minimum landing size (25 mm CL) between 2005 and 2008 because this fraction was almost zero in catch in the period (Fig. 5; González Herraiz, 2011; ICES, 2013). High discard rates in some 2009 quarters in hake fleet could be related with a high recruitment in 2009 observed in the Spanish landings and survey in the area (González Herraiz, 2011) and in international length distribution (ICES, 2013).



**Figure 3.** *Nephrops* discards rates (discard/catch) of the Spanish fleets in Porcupine Bank (FU 16) by metier and quarter (1998-2014). **Only for quarters with discard sampling** (observers on board). OTB\_DEF\_100-119: Fleet directed to hake, OTB\_DEF\_70-99: fleet directed to flat fishes.

Figure 4 shows annual discard weight estimations by metier and again the higher level of discards weight and rate of the Megrim fleet.





**Figure 4.** *Nephrops* landings and raised discards of the Spanish fleets in Porcupine Bank (FU 16) by metier and year (1988-2014). Above: Hake fleet, below: Megrim fleet. **Only for years with discard sampling** except Hake fleet value in 2013 (estimated). Numbers over bars: number of trips sampled each year.

**Table 2.** *Nephrops* discards weight estimation in the Spanish fleets in Porcupine Bank by year (1988-2014) (t).

\* Quarterly estimated with other years sampling data.

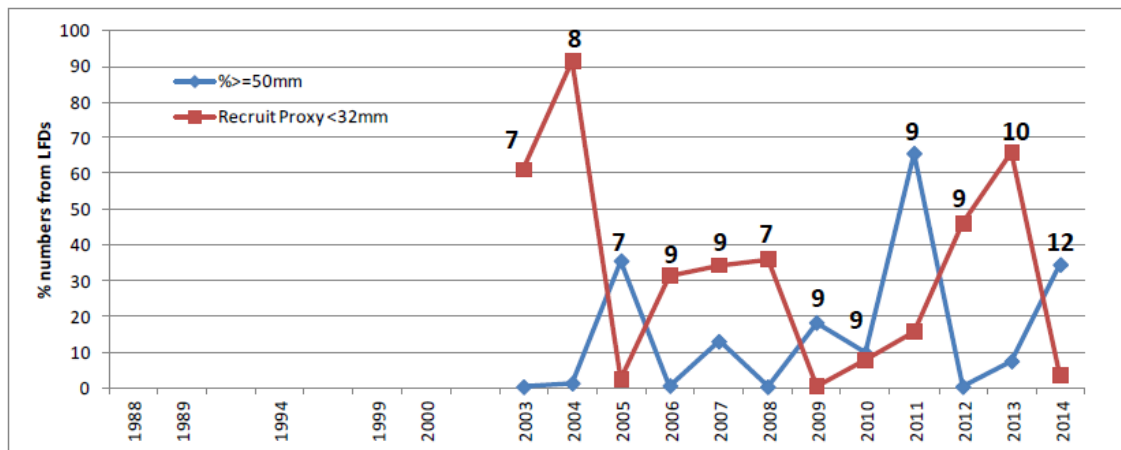
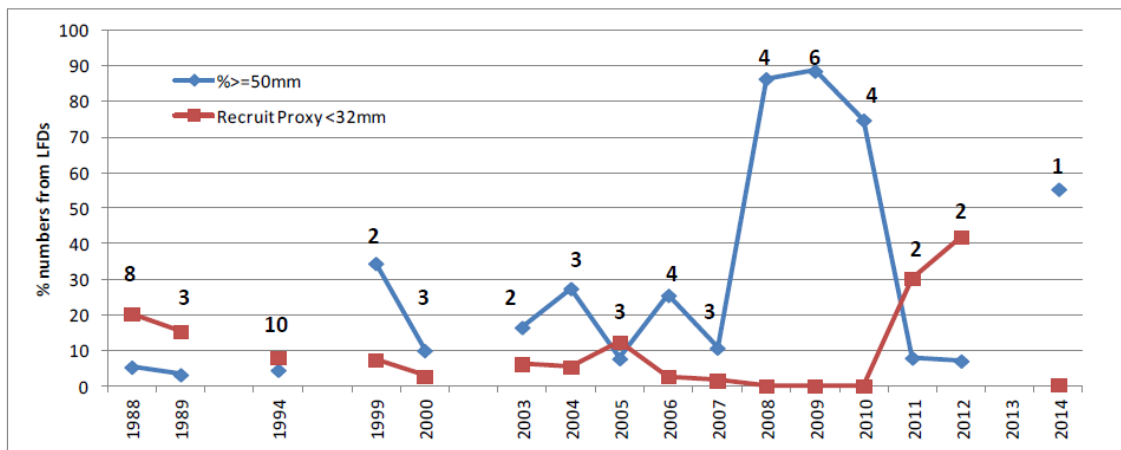
	Hake fleet	Megrim fleet
1988	20	
1989	118	
1990		
1991		
1992		
1993		
1994	31	
1995		
1996		
1997		
1998		
1999	5	
2000	1	
2001		
2002		
2003	21	6
2004	0	1
2005	1	79
2006	12	20
2007	1	33
2008	23	23
2009	10	5
2010	4	10
2011	0	0
2012	1	11
2013	2*	17
2014	0	9

Catch length distribution and recruitment

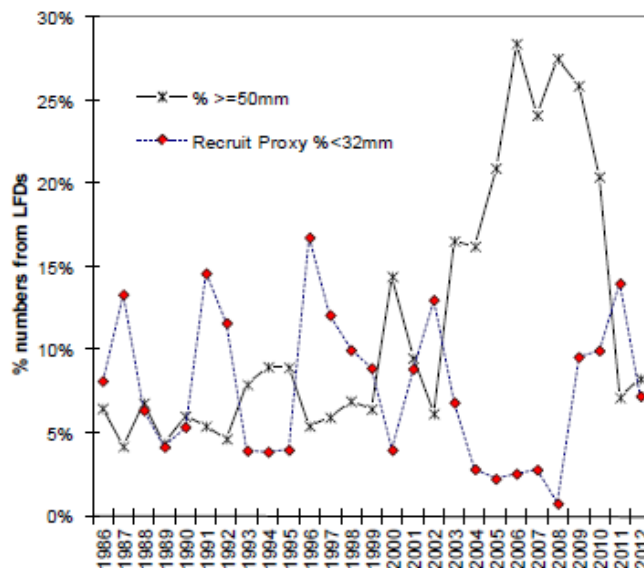
Trends in *Nephrops* catch length distribution in hake and megrim fleets are quite different (Fig. 5). Discard sampling is made by metier for the whole ICES Subareas VI and VII and hake fleet mostly fishes in Porcupine while the majority of the megrim fleet trips could have been carried out in the southern part of ICES Division VIIj. This could be the reason of the different length trends in both fleets together with the low sampling level.

In the fleet directed to hake (Fig. 5 above) there seems to be an increasing of the recruitment in 2011 and 2012, but data must be carefully taken due to the low sampling level in this fleet. As it has previously mentioned this increase in the recruitment after several years with very low values was already detected for 2009 and 2010 in the Spanish landings and survey (González Herraiz, 2011) and in the international landings length composition (ICES, 20013) (Fig. 5 below).

Catch recruitment trend in megrim fleet between 2004 and 2014 (Fig. 5 middle) is quite similar to the trend in landings between 2002 and 2012 (Fig. 5 below), a high decline followed by a plateau and an increase.



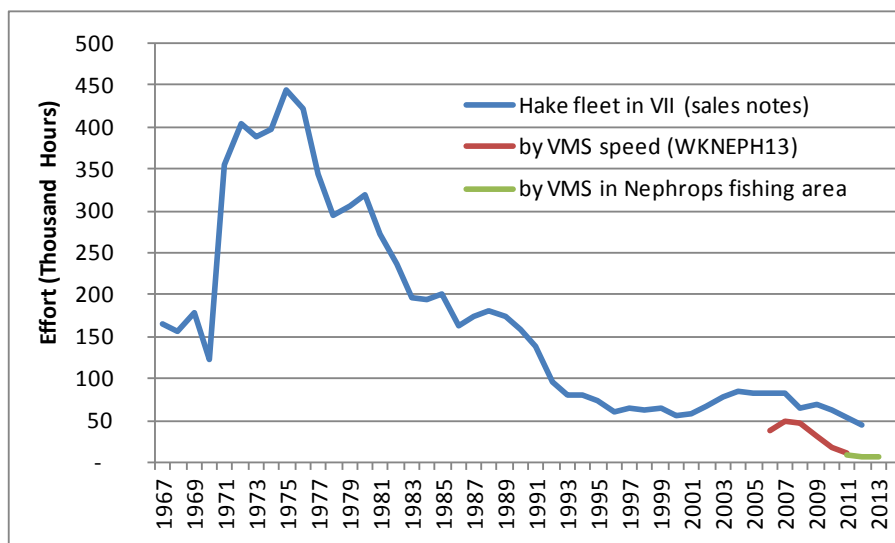




**Figure 5.** *Nephrops* from the Spanish fleets in Porcupine Bank (FU 16). Trends in the percentages of the sampled *Nephrops* <32 mm CL (a possible recruitment proxy) and >50 mm CL. Above and medium: Catch (landings + discards) (1988-2014), numbers over lines: number of trips sampled each year. Above: Hake fleet, middle: Megrin fleet (1988-2014), below: male landings (ICES, 2013). LFDs: Length frequency distributions.

### Effort directed to *Nephrops*

Figure 6 shows the evolution of the effort of the Spanish fleets in Porcupine Bank. The longest series (traditional effort) was only for the hake fleet, the number of trips was multiplied by 12 days and 14 fishing hours per day in order to obtain effort hours and it was referred for the whole ICES Subareas VI and VII. The red series was obtained from VMS selecting speeds suitable for fishing (ICES, 2013b). The green series was obtained selecting fishing hours from logbooks of the days identified in VMS that vessels were in the *Nephrops* fishing area, even if those days there were *Nephrops* catch or not for all the trips. Effort has decreased a 90% between 1975 and 2012. Figure 6 shows the possible error that were done using traditional effort, nevertheless trends seems to be similar.



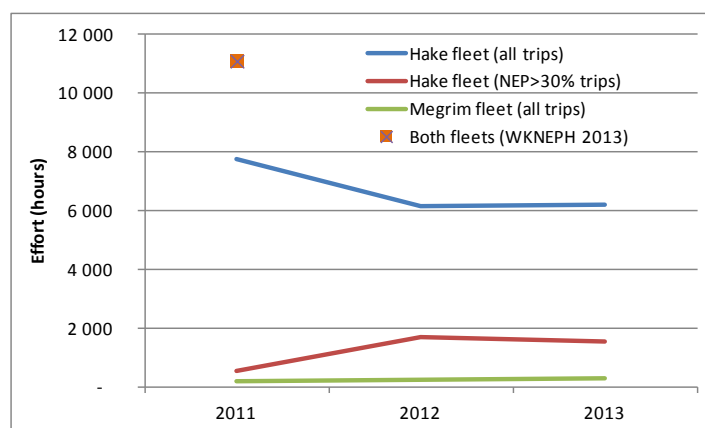
**Figure 6.** Spanish trawl effort in Porcupine Bank (hours) (1967-2013). Green line: all trips.

Table 3 shows *Nephrops* landings, effort and LPUE in the FU16 *Nephrops* fishing area by metier and year for all trips and for trips where *Nephrops* weight is 30% or more of the total weight for 2011-2013.

**Table 3.** *Nephrops* landings, effort and LPUE of the Spanish fleets in the FU16 *Nephrops* fishing area selected through VMS by metier and year for all trips and for trips where *Nephrops* weight is 30% or more of the total weight (2011-2013).

	2011	2012	2013	Average
<b>Hake fleet</b>				
All trips				
Landings (kg)	107 507	104 506	105 662	105 892
Effort (hours)	7 783	6 153	6 214	6 717
LPUE (kg/hours)	14	17	17	16
NEP>30% trips				
Landings (kg)	34 282	50 509	39 076	41 289
Effort (hours)	541	1 686	1 549	1 259
LPUE (kg/hours)	63	30	25	33
<b>Megrim fleet</b>				
All trips				
Landings (kg)	6 890	7 409	4 048	6 116
Effort (hours)	221	275	314	270
LPUE (kg/hours)	31	27	13	23
NEP>30% trips				
Landings (kg)	None			
Effort (hours)	None			
LPUE (kg/hours)	None			
<b>Total</b>				
All trips				
Landings (kg)	114 397	111 916	109 710	112 007
Effort (hours)	8 004	6 427	6 565	6 999
LPUE (kg/hours)	14	17	17	16
NEP>30% trips				
Landings (kg)	34 282	50 509	39 076	41 289
Effort (hours)	541	1 686	1 549	1 259
LPUE (kg/hours)	63	30	25	33

Figure 7 shows effort in the *Nephrops* fishing area of Porcupine from 2011 to 2013. While effort for the whole hake fleet trips has descended, the effort for the hake fleet trips directed to *Nephrops* has increased.



**Figure 7.** Spanish fleets effort in the *Nephrops* fishing area of Porcupine Bank (hours) (2011-2013).

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