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Discard Pattern of Hake Southern stock from the Spanish Trawl Fleet

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ABSTRACT

Two exploitation units (North and South) of Hake (*Merluccius merluccius*) are assessed in the ICES Working Group of Hake, Monk and Megrim. In ICES Divisions VIIIc and IXa, Portuguese and Spanish ships captured this species mainly in mixed bottom trawl fisheries, but also in long-liners, gill net or in artesanal fleets. As far now, discard data are not used in the assessment of this species, though they are considered significantly high for younger ages. Discards data are available for Spanish trawlers for 1993, 1994, 1997, and the period from 1999 to 2001. This current paper shows available data of discards for Spanish Southern hake stock (Divisions VIIIc and IXa) as well as to present the sample level for the different periods. Some estimations on discard rate in number and in weight are also showed. Most of the results were obtained by different EU funded research projects. Several problems related to the raising method are discussed. Finally, the possibilities and difficulties to use discard data in stock assessment are numbered.

Keywords: discard, hake, *Merluccius merluccius*, Spanish Northcoast

INTRODUCTION

In many fisheries, discards constitute a major contribution to fishing mortality in younger ages of commercial species. However, relatively few assessments in ICES stock working groups take discards into consideration. This happens mostly due to the long time series needed (not available for all the fleets involved in the exploitation of most stocks) but also to the large amount of research effort needed to obtain this kind of information (Alverson et al, 1994; Kulka, 1999).

Apart from the advantage of using discards in assessments, fisheries monitoring with observers on board increases the detail and accuracy of the basic information and also supports management decisions to improve the conservation of exploited stocks. The knowledge of discards and their use in stock assessment may also contribute, in co-operation with the industry, to refine fishing and management strategies (Kulka, 1999).

The discard information has been obtained with observers on board and financial assistance of the Commission of the European Communities and the Instituto Español de Oceanografía (IEO). It covers the activities of some of the most important Spanish fleets (trawlers and pair trawlers in ICES Divisions VIIIc and IXa). The scheme is based on voluntary participation of fishing vessels. Commercial ship owners have no obligation to carry observers on board; thus the success of this study depended on their voluntary cooperation. It must be noted that cooperation of skippers and crews has been frequently enthusiastic and they always showed interest in the development of the work.

A discard sampling programme of Spanish trawlers has been carried out since 1993, although with some gaps in the time series. Discards data are available for Spanish trawlers for 1993, 1994, 1997,

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and the period from 1999 to 2001. The main reason for this discontinuity in data collection is that all this research on discards was driven by EU research projects, with a fixed period of observation.

The aim of this paper is to show available data of discards for Spanish Southern hake stock (Divisions VIIIc and IXa) as well as to present the sample level for the different periods. Some estimations on discard rate in number and in weight are also showed. Several problems related to the raising method are discussed. Finally, the possibilities and difficulties to use discard data in stock assessment are numbered.

MATERIAL AND METHODS

Definitions:

Concerning the terminology used, we have decided to use the definitions as proposed at a bycatch standardized nomenclature Workshop, in Newport (USA), February 1992 (Alverson *et. al.*, 1994) as operational definitions in this report.

- **Target Catch:** The catch of a species or species assemblage which is primarily caught in a fishery.
- **Discarded Catch:** Part of the total catch returned to the sea (usually discards).
- **Bycatch:** Discarded catch plus incidental catch (retained catch of non-targeted species).
- **Total Catch:** Overall catches of the haul or fishery, considering discards and retained catch.
- **Discard Ratio:** The ratio of total catch which is discarded given as a percentage ($100 * \text{Discard} / \text{Catch}$).

Data collection on board

The available discard information was obtained from consecutive international and national studies carried out with observers on board demersal heavy trawling vessels (õBakaõ type) and demersal pair trawlers operating in ICES West and Central area of Division VIIIc and Northern area of Division IXa (see Annex I for a detailed list of projects). Since 1999 sampling took into account the three different trawl gears which use the trawl fleet: Pair trawl, and the alternative use of the classical Baka trawl gear and the demersal Very High Vertical Open (VHVO) trawl gear, targeted to horse mackerel (Lart, 2002). All fishery units were sampled, particularly in recent years where use of VHVO gear has increased.

The onboard information covers discarded and retained catch in weight and numbers and length distributions for Southern hake, among other species, for the years 1993, 1994, 1997, 1999 (second semester), 2000 and 2001. The sampling level in years 1993 and 2001 is considered to be low. Allen *et al.* (2002) reported that a need for sampling Baka trawlers of an average of seven hauls per trip requires either one trip of 39 vessels or two trips of 25 vessels to obtain a CV of 20%. Those values are far away from the 1993 and 2001 sampling levels, but achieving such a high level means a strong investment that has been only fulfilled in scarce occasions. The same authors also reported that achieving a CV of 20% for pair trawlers requires either one trip for 96 vessels or two trips for 50 vessels.

The discards sampling programme was based on stratified random sampling per Fishery Unit (fleet by ICES Division). Location, duration of hauls and vessel characteristics (such as horse power, ship speed, etc.) and environmental parameters were recorded in each sampling trip. The observers recorded the quantity discarded and the quantity retained by species. Samples of the catches and discards were recorded by species and the length composition of the most abundant species.

Incidental catches of marine mammals and sea birds were taken when happened. When landings were sorted in size categories, sampling of landings was stratified.

Total discard weight was estimated depending on the discarded way used, i.e., boxes, shovels, etc. From the discarded part of the catch one or more boxes (13 kg), depending on the size and diversity of discards, were collected. All discards in this sample were sorted by species and raised to the total volume of discard. Estimates of the discard weight of commercial species were calculated from length distributions using length/weight relationship (if available) given by Pereda and Perez (1995). As processing procedures on board differ between vessels, it was not always possible to follow the standard procedure described.

Age at length keys (ALKs) on discarded hake are also available since 1999. ALKs from research surveys are available since 1993. However it must highlight they produced mean weight-at-age probably different from those of discards.

Raising method

An important source of variation in the discard estimations would be the choice of the raising method. Several raising options are generally considered in discard studies (ICES CM, 2000a): raising by effort (in number of trips or hours of trawling) and raising by landings (in weight or numbers), etc.

The present paper shows the result of discard rates for hake obtained in different projects based on different raising methods, depending on the different approaches suggested by literature. Differences in the results between the discards values obtained by every raising method (by effort, weight or numbers) were probably smaller than the error associated to the methods. This is because of the high CVs, the importance of the option chosen is probably minor (Lart, 2002). Nevertheless raising method options need further investigation in order to include hake discard data into assessment.

RESULTS

The discards sampling level for the years with observers on board vessels are presented in Table 1. Observation effort was lower in 1993 and 2001. In 1999 and 2000 Coefficients of Variation (CV) are shown. They are expressed as a percentage of the mean catch by haul of the discarded and retained catches by weight and number. In most years the discards showed high CVs. This was due to the seasonal variability in the catch composition over a year, and the variations between trips, ports and boats such as those described in Allen *et al.*, 2002.

Discards of hake are estimated to be around 950 tn considering all trawls gears, both divisions and raised to effort (Tables 2 and 3). The discard rate in weight was between 3% to 29%, i.e. estimated amount of discards with respect to landings (Table 4). Due to the fact that most individuals are young fish, this percentage reaching values between 21% and 75% when the discard rate is expressed in number. Length frequencies of hake by fishery and considering retained and discard are shown in figure 1.

A short description of the different métiers is presented (see Lart, 2002 for a detailed description):

Spanish Baka Otter Trawl Mixed Fishery: ICES East-Divisions VIIIc

Effort in this métier is only concentrated in ICES Division VIIIc, along the Cantabrian Sea. This métier targets a range of species including Atlantic mackerel, anglerfish, horse mackerel, megrim (two species of megrim are included with same name in the landings), hake or blue whiting. Abundance of mackerel is highly seasonal, with most of the catches of this species occurred during the first half of the year.

Regarding to hake, this métier have a discard rate around 21-27%. The size of fish below the Minimum Legal Size (MLS =27 cm) was the most probable reason for discarding small fish of these species. Hake was discarded in low proportion and all of the individuals discarded were smaller than MLS. According to Lart (2002), hake is the only species whose change in retained catch has a noticeable economic impact, however hake represented only between the 15% and 4% (for 1999 and 2000 respectively) of the total value of landed volume.

Spanish Baka Otter Trawl Mixed Fishery: ICES West-Divisions VIIIc and IXa

Effort in this métier is concentrated in ICES Division VIIIc and IXa, particularly Galicia North and South. This métier targets a large range of species including horse mackerel, blue whiting, Atlantic mackerel, hake, anglerfish, megrims, Norway lobster, pout or cephalopods (Illex, Eledone, etc). The relative economic importance of most of the species changed along the sampled period.

Some economically important species, such as blue whiting, hake and four spot megrim, had very high discard rates of between 87 and 51%. Coefficients of variation in terms of numbers of fish are high for most of the species. Mean results of this métier should be used with precaution. Undersized hake were discarded in quite large numbers. Fish being smaller than the MLS was the most important reason for discarding small fish of this species. Damaged fish was also a reason for discarding.

Spanish Very High Vertical Opening (VHVO) Bottom Trawl targeting horse mackerel: ICES West-Divisions VIIIc and IXa.

Very High Vertical Opening (VHVO) bottom trawls are designed for using a cod end mesh size of 65mm and present a vertical opening of 5.0-5.5m and wingspread of 18-20m (Fonseca et al, 2000). An increasing percentage (dependent on port) of vessels carry both trawl gears, Baka Otter Trawl for mixed fishery and the VHVO targeting horse mackerel. Changes of the gear are in relation to the specific abundance of the species or with markets forces.

This métier targets specifically on horse mackerel and contributed around 80% of landed value in this fishery. Only mackerel and hake contribute significantly to the total landed value, around 14%. The target species horse mackerel has an insignificant discard ratio, 3%. The other economically important species mackerel and hake have discard rates of between 42% and 70% respectively. Discards of a large proportion of hake, below the 27cm minimum landing size (MLS) were observed. Coefficients of variation in terms of numbers of fish are high, particularly for discards. Mean results of this métier should also be used with precaution.

Spanish Pair Trawl targeting blue whiting: ICES Divisions VIIIc and IXa

Pair trawlers present a vertical opening of around 25m and the wingspread of 65m (Meixide and Padín in Fonseca et al, 2000). This métier targets specifically on blue whiting (more than 90% of total catch and 85% of the total retained species by weight was blue whiting) which contributed around 60% of landed value in this fishery. Of the other species, hake contribute significantly to

the total landed value, around 30%, however only 3% of the total catch by weight was of this species.

Discarding of blue whiting appear to mostly relate to market forces imposing a minimum marketable size and to damaged fish due to the high bulk of catch per haul and long haul duration (up to 15 hours in some cases). Very few small hake were caught in second semester of 1999 and almost all of the catch was retained. Discards of small hake occurred in the year 2000. Very few small hake were retained, the retention ogive plots indicate a retention L_{50} of 29 cm; the cause of the discarding was that the small fish were below the MLS. Of the minor species small quantities of mackerel and horse mackerel were caught and in most of the cases, high proportions are retained.

DISCUSSION

Knowledge of discard rates of commercial species may prompt an important input in the assessment of fish stocks. Discard data will be of great importance for the evaluation of general management, calculating strategies and also for the effects of specific proposals for technical measures. Excluding discards from assessments is the same as pretending that they do not exist (Alverson *et. al.*, 1994; Kulka, 1999).

Inclusion of reliable estimates of discards will improve assessments. As this might not affect assessments and short term catch predictions of stocks management under "status quo" conditions, but it does underestimate potential long-term yields and biomasses. Excluding discards would also underestimate the effects of future technical measures to be implemented in the fisheries such as mesh size increase, because the fish which "did not exist" and have not be taken into account in the calculation will suddenly appear in the catches (Alverson *et. al.*, 1994).

The main reason for the poor information on discards is the large amount of research effort needed to sample these data. Obtaining adequate discard information requires an intensive discard sampling programme. These factors make it very difficult and expensive to estimate the number of fish of a certain species discarded on a yearly basis. An estimate of the total number of fish discarded by a fleet in a year would require a sampling scheme which at least takes into account the spatial and temporal distribution of this fleet. The spatial component relates to the distribution and abundance of undersize and adult fish, which varies between areas. The temporal component relates to the changes in distribution in different periods of the year: concentrations on the spawning grounds in the spawning season; recruitment of new year classes to the gear when they appear on the fishing grounds or reach catchable size. Distribution patterns might also differ between years when recruitment originates from different areas with variable contribution to the total recruitment each year.

Several factors influence the quality of the estimate, such as bad weather, bad working conditions on board, the small size of the ship and the tasks to be performed on deck, the alternation of observers and differences in the on-board processing of discards by the crew. Apart from the above sources of error, a probable systematic error may be caused by the varying know-how of taxonomy of the different observers.

There are different reasons to discuss whether incorporating discards hake for the estimation of the overall mortality associated with an exploited fish population:

1. This species has a high level of discards, particularly at younger ages.
2. The discard sampling level is good for most of the period analysed.

3. Although the series with a discard estimation available is shorter than the landing series, it covers a period long enough to try the assessment and corresponds to a period without changes in the regulations.
4. A research survey is used as tuning fleet by the ICES WGHMM (ICES CM, 2002). The Spanish survey provides estimates for young ages and covers all the Spanish stock distribution area. These ALKs from surveys could be also to estimate discards in young ages.

However, some other difficulties were observed during this study and should be taken into account whether introducing discards into assessment:

- a) The sampling level in the years 1993 and 2001 is considered to be low.
- b) As aforementioned, a source of variation in the estimation of discards would be the choice of raising method. Since differences in results obtained with each of the raising methods (by weight or numbers) are probably smaller than the error associated to both methods due to high CVs, the importance of the option chosen is minor.
- c) A procedure of discards estimation is needed in years when discard sampling was not available.
- d) Another source of variation in the assessment could be the use of the same ALKs for discards and landings from 1990 to 1997.

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Lart, W. (co-ordinator). 2002. Monitoring of discarding and retention by trawl fisheries in Western Waters and the Irish Sea in relation to stock assessment and technical measures. Final Report. Contract Ref. 98/095.

ANNEX I: List of projects

1987-1988. Discard of the Spanish trawl fleet in Sub-area VII. IEO Project.

1993. Discard of the Spanish trawl fleet in Sub-area VII. IEO Project

1994-1996. Discards of the Spanish fleet in ICES Divisions. EC Project: Pem/93/005.

1996-1999. On-board sampling of fish landed and discarded by commercial vessels. EC Project: 95/094.

1999-2001 Monitoring of discarding and retention by trawl fisheries in Western Waters and the Irish sea in relation to stock assessment and technical measures. EC Project: 98/095.

1999-2000 Optimización del palangre de fondo mediante la demostración de un sistema de maniobra automática y el desarrollo de un cebo artificialö. Ref. 1FD97-0064-CO3-02.

1997-2000 Cephalopod Resource Dynamics: Patterns in Environmental and Genetic Variation. EC FAIR CT 1520.

Table 1. Annual discards sampling level and observation effort on board.

TRAWL				PAIR TRAWL				VHVO			
	Trips	Sampling Hauls	Fishing hours		Trips	Sampling Hauls	Fishing hours		Trips	Sampling Hauls	Fishing hours
1993	3	8	53.9	1993	1	1	9	1993	NO DATA		
1994	53	447	2096	1994	8	7	47.03	1994	7	14	60.2
1995	NO DATA			1995	NO DATA			1995	NO DATA		
1996	NO DATA			1996	NO DATA			1996	NO DATA		
1997	67	439	1883.0	1997	31	39	315.6	1997	1	2	7.5
1998	NO DATA			1998	NO DATA			1998	NO DATA		
1999	44	250	944.0	1999	20	18	175.0	1999	NO DATA		
2000	70	367	1327.0	2000	42	42	320.0	2000	14	35	118.5
2001	11	43	145.1	2001	7	7	59.7	2001	3	6	25.2

Table 2. Estimated raised discards for Baka trawl by effort and landings and expressed in weight and number for the different sampled.

BAKA TRAWL		Weight			Number			
		Discards (Tn)			Discards (Thousands)			
		Raising Method			Raising Method			
		Raising Effort	Landing Weight	Landing Number	Raising Effort	CV	Landing Weight	Landing Number
1994	NO RAISING							
1995	NO DATA							
1996	NO DATA							
1997 ¹	VIIIc and IXa	918	1031	846	37732		40482	33815
1998	NO DATA							
1999 ²	VIIIc East Mixed	3			51	367		
	VIIIc-IXa West Mixed	211			6564	597		
2000	VIIIc East Mixed	2			48	298		
	VIIIc-IXa West Mixed	834			24012	196		
2001	NO RAISING							
¹ 1997 all trawl gears								
² 1999 data are only from second semester								

Table 3. Estimated raised discards for Pair trawl and VHVO trawl by effort and landings and expressed in weight and number for the different sampled.

PAIR TRAWL		Weight	Number		VHVO		Weight	Number	
		Discards (Tn)	Discards (Thousands)				Discards (Tn)	Discards (Thousands)	
		Raising Method	Raising Method				Raising Method	Raising Method	
		Raising Effort	Raising Effort	CV			Raising Effort	Raising Effort	CV
1994	NO RAISING				1994	NO RAISING			
1995	NO DATA				1995	NO DATA			
1996	NO DATA				1996	NO DATA			
1997 ¹	ALL TRAWL GEARS (figures in table 2)								
1998	NO DATA				1998	NO DATA			
1999 ²	VIIIc-IXa Mixed	2	13	399	1999* ¹	VIIIc-IXa West Mixed	NO DATA		
2000	VIIIc-IXa Mixed	72	974	249	2000	VIIIc-IXa West Mixed	56	782	162
2001	NO RAISING				2001	NO RAISING			

¹ 1997 all trawl gears
² 1999 data are only from second semester

Table 4. Percentage of discards in relation to landings for the different sampled years.

% DISCARDS								
Weight				Number				
1993	All Trawl Gears							
	IXa West Mixed				IXa West Mixed			
	11				20			
1994	VIIIc East Mixed		IXa West Mixed		VIIIc East Mixed		IXa West Mixed	
	3		12					
1995	NO DATA				NO DATA			
1996	NO DATA				NO DATA			
1997	K/f.h.	W. Landed	N° Landed		K/f.h.	W. Landed	N° Landed	
	21	25	26		70	75	75	
1998	NO DATA							
1999	Baka Trawl		Pair Trawl	VHVO	Baka Trawl		Pair Trawl	VHVO
	VIIIc East Mixed	VIIIc-IXa West Mixed	VIIIc-IXa Mixed	VIIIc-IXa West	VIIIc East Mixed	VIIIc-IXa West Mixed	VIIIc-IXa Mixed	VIIIc-IXa West
	3	22	0.4		21	69	1	
2000	2	29	7	40	27	73	28	70
2001		6				48	0.5	14

Figure 1. Length Frequency distributions of discards and retained catch for the several considered meters.

