

Theme Session K

Discarding: quantities, causes, and consequences

ICES CM 2006/K:01

A Bayesian estimator for discard weight in commercial marine fisheries

Mark S. Kaiser

Estimators of discard weight are commonly based on survey sampling methodology, such as traditional ratio estimators. Little attention has been given to the development of alternative statistical approaches for estimating discard weights from observer data or careful assessment of the likely performance of estimators outside of the theoretical context of finite population estimation. An alternative estimator is proposed, based on connecting observed and unobserved trips through information on whether a trip results in kept catch of a species of concern. Bayesian modeling of conditional probabilities of discard given kept catch or the absence of kept catch, and the conditional distribution of discard weights given discard allows the model to produce estimates of discard weights in an efficient manner. The proposed estimator is shown to be superior to traditional sampling based estimators using data from the northeast groundfish fishery in the United States. Issues involved in the application of the proposed estimator that need further development and investigation are identified.

Keywords: discard estimation; Bayesian methods; mixture models.

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ICES CM 2006/K:02 – Withdrawn

ICES CM 2006/K:03

Modeling the distribution of haddock discards conditional on landings and other factors

Colin Millar and Rob Fryer

Discards have historically been estimated using design-based inference. Here we pursue a modeling approach using the data collected by the Fisheries Research Services observer programme over the period 1978–2003. We assume that, on any trip, discarding either occurs or it doesn't, and when it does, the number of discards has a gamma distribution. This leads to a binomial mixture of a degenerate distribution at zero and a gamma distribution, also known as a zero-inflated gamma. We use Bayesian methods to fit the zero-inflated gamma distribution with landings, gear, area fished, season, and year

as explanatory variables. We fit this model separately to the numbers of haddock discarded at each age. This allows us to estimate the total number of haddock discarded at age each year, with appropriate credible intervals.

Keywords: discards, Bayesian inference, random walk metropolis Hastings, zero-inflated gamma distribution.

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ICES CM 2006/K:04

Propagation of uncertainty in bycatch estimates through VPA stock assessment models

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Recent studies have shown that age-structured stock assessment models can be sensitive to the assumed levels of discards-at-age. And as such, it is quite likely that uncertainty in the amount of discards-at-age will impact the degree of uncertainty in the final stock assessment output. Using estimators of discard weight as input into the model, we examine how uncertainty in those estimates may propagate through traditional VPA models, which treat catch as known without error. We will examine the effects on fishing mortality and population size over time. As a case study, we use a modified ADAPT model applied to yellowtail flounder on Georges Bank.

Keywords: discard estimates, stock assessment, uncertainty.

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ICES CM 2006/K:05

Fishery discards management and environmental impact in Falkland Islands fisheries

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The continental shelf and slope around the Falkland Islands are rich in fishery resources. These waters support major squid, finfish, and ray fisheries, which yield 100–400 thousand MT per annum using jigging, longlining, and trawling techniques. Analysis of observers reports revealed that the annual fishery discards rate is negligible

and represents a mean of 4.7% of the commercial catch (which was about 9,000 MT in 2000–2005), including 1.1% of undersized and damaged commercial species and 3.6% of non-commercial objects. Discarded commercial items are mostly hoki and bluewhiting, others are less important. The rock cod, *Patagonotothen ramsayi* was the most abundant discard species representing 54% of discards by trawlers. In recent years fleets have begun to process large rockcod, and in 2004–2005 about 10% of the catch of this species was commercially used. Probably most of fisheries' discards return to sea providing an abundant source for sea-bottom scavenging, because they were found in stomachs of almost all fish, whose diet was investigated. Discarded elasmobranchs show remarkable survival rates. A proportion of discards is consumed by seabirds, but seabird mortality is negligible because oftori lines used as bird scaring devices by both trawlers and longliners.

Keywords: discards, Falkland Islands, fisheries, management.

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ICES CM 2006/K:06

The Barents Sea and Russia: demersal fishery and discards

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The Barents Sea is an area of all year round, large-scale fishery for demersal fish, among which the main species are cod, haddock, saithe, catfishes, Greenland halibut, redfishes, etc. Russian demersal fishery targets cod and haddock, the total catch of which accounts for about 85% of the Russian annual yield.

The main fishing gear used in the Russian demersal fishery is a bottom trawl, but during the recent decade an increase in longline catches has been noted also. Selectivity of these gears does not confine catches merely to fish of desirable species and size, and the distribution areas of most demersal fish in the Barents Sea coincide. This means that in practice fishery for any target demersal species proves to be a mixed fishery, with catches comprising fish of different size.

Fishermen are not interested in making products of undersized or by-caught fish because of their low commercial value compared to large cod and therefore undesirable fish are often thrown away.

The paper gives a thorough analysis of reasons behind discarding of demersal fish in the Russian fishery in the Barents Sea. Methods developed at PINRO were used to estimate discards in the Russian demersal fishery as follows:

- discards of demersal fish in the cod fishery from 1996 to 2004 (bottom trawl);
- discards of undersized cod in the cod fishery from 1983 to 2004 (bottom trawl);
- discards of demersal fish in the longline fishery.

Keywords: Barents Sea, bottom trawl, demersal fish, discards, long-line.

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ICES CM 2006/K:07

Bottom trawl discards in the Gulf of Suez, Egypt

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This study is the first assessment of discard composition of the bottom trawl fishery in the Gulf of Suez. The data were collected from about 77 hauls on a commercial trawler. The trawl fishery in the Gulf of Suez is directed at shrimp but many finfish species and invertebrates are caught as bycatch, with the ratio of shrimp catch to bycatch estimated as 1:15. About 56.1% of the total bycatch was discarded at sea. The rate of discards per hour was found to be 28.2% higher than the rate of landed catch per hour. The main components of the discards were fish and crustaceans. The discarded quantities were studied in relation to depth, duration of the hauls, landed catch of each haul, and the area (eastern and western sides of the Gulf of Suez). The discarded catch of fish showed a more precise relationship with the landed catch in each haul than did crustaceans and echinoderms. Discard percentage decreases with the increase in depth. The size-frequency distributions of discarded fish and invertebrates proved to be a good measurement to study discarding, to compare differences between the two areas, and to investigate the discarding procedure in relation to depth.

Keywords: trawling discards, Red Sea, Gulf of Suez.

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ICES CM 2006/K:08 – Withdrawn

ICES CM 2006/K:09

Trends in abundance of demersal fish species captured as bycatch in the offshore shrimp survey off North Iceland

Elena Guijarro Garcia, L. Taylor, and U. Skúladóttir

The offshore shrimp fishery commenced in Iceland in 1974, and since 1984 has represented between 68% and 94% of the annual catch of shrimp in Icelandic waters. Most of the shrimp fishing effort is concentrated off North Iceland at depths between 100 and 650 m. The use of sorting grids has been mandatory since June 1995. Landings of fish by the shrimp fleet decreased drastically during 1995 and ceased afterwards. Data collection on all bycatch species in the offshore shrimp stock assessment survey started in 1988. The goal of this paper is to combine survey and logbook data to describe the demersal fish assemblage in the offshore shrimp fishing grounds, taking into consideration the depth distribution, the intensity of fishing effort and the size structure of the main commercial species. Multivariate analysis techniques such as canonical analysis along with generalised linear models are used to investigate the temporal and spatial variability of bycatch composition and abundance. During the period 1988–2005, 79 fish bycatch species have been recorded. The trend of fish bycatch abundance recorded during offshore shrimp stock assessment surveys, all species combined, followed closely the trend of fishing effort (measured as trawling hours), but have been asynchronous since 1999, when fish abundance started to increase. The distribution area of juvenile cod and haddock, which are the principal commercial species along with redfish, overlaps with the offshore shrimp fishing grounds. These three species feature prominently in the bycatch.

Keywords: bycatch, demersal fish, shrimp trawling, impact of fishing, N Atlantic, Iceland.

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ICES CM 2006/K:10

Changes in the macrobenthic community in Breiðafjörður, West Iceland, following the cessation of scallop dredging

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Scallop dredging ceased in Breiðafjörður, Iceland following the collapse in scallop stocks in 2003, although the fishing effort in the period 2001–2003 was very small. During the period 1993–2001, 23 invertebrate bycatch taxa were recorded, amounting to 32.8% of the scallop catch. Between 2003 and 2005 the number of invertebrate bycatch taxa increased to 41 and their biomass amounted to 83.4% of the scallop catch. Although

the number of bycatch species has increased between the two periods, evenness and diversity have remained very similar. Following the closure of the fishery, the benthic community is still dominated by very resilient species, although productivity of some of the most abundant taxa recorded between 1993–2001 has dropped significantly. *Modiolus modiolus* and *Cucumaria frondosa* represented 32.3% and 25.3% respectively, of the total biomass between 1993–2001, but although they are still among the dominant species their biomass has declined to 20.9% and 17.9% between 2003 and 2005. On the other hand, the biomass of *Echinus esculentus* has increased twofold in the latter period, and it comprised 27.1% of the total bycatch biomass. Productivity of Anthozoans that have been categorised as being sensitive to fishing activities has also increased greatly since 2003. Multivariate analysis detected a large shift in the macrobenthic community from 2003 onwards.

Keywords: bycatch, scallop dredging, benthic community, impact of dredging, N Atlantic, Iceland.

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ICES CM 2006/K:11

Using discard observer data to address mixed-fishery issues

Mike Armstrong, Stuart Reeves, and Andy South

Sampling on board commercial fishing boats for estimation of discards also provides haul-level information on spatial and temporal variability in catch rates and species compositions. As well as the implications for sampling design and methods for raising to the fleet level, this can provide useful information on the nature of species linkages in mixed fisheries. Here we use data from the English discard sampling scheme to look at scales of variability in species composition of landed and discarded fish taken by different gears, with particular reference to co-occurring species requiring different management actions. The data are analysed to provide insight into possible approaches to managing these mixed fisheries.

Keywords: discards, mixed-fishery.

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ICES CM 2006/K:12

Impact of small-scale interactions between Norway lobster, dominant mega-fauna, and juvenile hake in the Bay of Biscay on bycatch composition

Verena M. Trenkel, François Le Loc'h, and Marie-Joëlle Rochet

Trawl fisheries for Norway lobster (*Nephrops norvegicus*) generate important bycatch of juvenile hake (*Merluccius merluccius*) as well as other benthic mega-fauna due to shared habitats. The composition of this bycatch which often becomes discards, varies in space and time on a seasonal and daily level. To study the small-scale spatio-temporal patterns of habitat sharing of this assemblage, we carried out a video survey in the northern part of the central mud bank (Grande Vasière) of the Bay of Biscay. Using a towed body we recorded high resolution videos in six sampling areas. The camera was equipped with parallel laser pointers for body size determination. Statistical modelling using generalised additive models (GAM) revealed strong diurnal activity patterns *in situ* similar to those in the catch: *Nephrops norvegicus* were observed more frequently outside their burrows at dawn and somewhat at dusk (no observations during night), while the decapod crustacean *Goneplax rhomboides* was observed less during the same periods. Juvenile *M. merluccius* were seen less often near the bottom in the early morning.

A spatial overlap index showed that on a small scale *G. rhomboides* and Norway lobster avoided each other, while no such effect was found in relation to the other dominant decapod crustacean (*Munida rugosa*) and juvenile hake. Average body size of *N. norvegicus* and to some degree hake was significantly smaller in trawlable sampling areas, pointing at a possible local impact of fishing.

Keywords: Norway lobster, spatial distribution, activity patterns, habitat sharing, technical interaction.

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ICES CM 2006/K:13

Sorting factors in the *Nephrops norvegicus* French trawl fishery of the Bay of Biscay (VIIIab)

Spyros Fifas, Claire Macher, Marie-Joëlle Rochet, and Céline D'Hardiville

The fishery for *Nephrops norvegicus* in the Bay of Biscay is exploited by about 230 French trawlers. It is managed by a TAC as well as a minimum landing size. This fishery discards both *Nephrops* and small hake (*Merluccius merluccius*). Up to 61% of the *Nephrops* catch in number is discarded (37% in weight). Within the European DCR (Data Collection Regulation) since 2002, 373

hauls from 141 trips have been sampled for discards and landings. This paper presents an analysis of the main factors determining sorting of the catch, as depicted by L50, the length at which the probability of being discarded is 50%. L50 are estimated by a GLM analysis of the sorting curves. The between- and within-trip variability of L50 is analysed in relationship with several independent variables such as harbour and district of vessels origin, latitude, longitude, depth, fishing gear (single or twin trawls), year, season, amount of total catch, and the percentile lengths L0.05 and L0.95 in total catch. Analysis at the trip level shows significant effects of district, season, year, as well as L0.05 and L0.95. At the haul level, the same factors are significant, as well as haul duration. These findings are interpreted in relationship with the costs and benefits for the fishermen of sorting *Nephrops*.

Keywords: *Nephrops*, trawl, discards, sorting.

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ICES CM 2006/K:14

A microeconomic model of discarding behaviour

Claire Macher, Olivier Guyader, and Jean Boncoeur

The paper proposes a formal analysis of the discarding problem, with an application to the French *Nephrops* trawlers in the Bay of Biscay (VIIIab). Most of the microeconomic models developed in this field do not include all the relevant variables or constraints to explain discarding in these fisheries. A model of discarding behaviour is described in this paper. It takes into account a more realistic analysis of the factors and constraints explaining discarding in these fisheries.

The costly labour of sorting the catch is included in the approach and the importance of the trip and tow durations constraints is analyzed.

The impact of management measures on the economic incentives to discard is then discussed.

Keywords: *Nephrops* fishery, trawl, sorting, discarding behaviour, microeconomic model.

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ICES CM 2006/K:15

Estimating bycatch and discard in United States commercial fisheries

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The Magnuson-Stevens Fishery Conservation and Management Act, the Endangered Species Act, Marine Mammal Protection Act, and international agreements identify the stewardship role of the National Marine Fisheries Service (NOAA Fisheries) in leading the collaborative effort to monitor and reduce the bycatch and discard of living marine resources within the United States EEZ. NOAA Fisheries has initiated development of a national report to provide a comprehensive summary of regional and national bycatch and discard estimates in U.S. commercial fisheries. The initial report will quantify the impacts and amounts of bycatch and discard for fish, marine mammals, sea turtles, and seabirds in priority fisheries. Estimates will be based on information collected by fisheries observers and reports submitted by fishers and fish processing companies. Observer data is utilized for a variety of assessment and monitoring purposes and, when available, is considered the most accurate source of information for monitoring fisheries bycatch. For fisheries with little or no observer coverage, industry reports are either the primary or only source of data for bycatch and discard estimation. The NOAA Fisheries Bycatch and Discard Report will address regional bycatch issues, provide background information on regional fisheries, consider the impacts of bycatch on fisheries and ecosystems, and describe methods which have potential for reducing bycatch. Bycatch mortality for specific fisheries will be assessed and the report will be updated periodically. This report will serve as a strategic document to guide future monitoring and data collection, and provide input for setting management goals.

Keywords: fisheries observers, bycatch, discards, estimation procedures.

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ICES CM 2006/K:16

Raising procedures for discards: Adapting sampling theory

Joël Vigneau

What is the best raising procedure for discard sampling in fishery science? Literature is extensive about the issue but is always case-specific, i.e. hardly adaptable to any sampling plan or based on some assumptions difficult to guarantee. The specific workshop on discards (Anon., 2003) proposes formulas that are too simplistic as they do not take into account all the components of variance. Here, three raising procedures strictly based on Coch-

ran's sampling theory (Cochran, 1977) are proposed. The objective is to build step by step the reasoning for estimating the total volume of discards, in weight or in number, from the hypothesis up to the associated variance. The basic raising procedures presented are meant to be easily implemented for any stock by any institute and be the referential to which innovative raising procedures should be compared. The purpose is to define common procedures for raising discard sampling independently of research being done on the optimum raising procedures for any particular stock. In other words, all the innovative raising procedures aiming to improve the precision of the estimates or modelling of discarding behaviour in a purpose of improving knowledge are very much welcome, but always in association, or compared to, raising procedures following sampling theory. With the objective of clarity, the exact reference to the chapters of the two books always cited (Cochran, 1977 and Thomson, 1992) will be provided and, when possible also the reference to the exact formulas specified in Cochran's sampling theory.

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ICES CM 2006/K:17 – Withdrawn

ICES CM 2006/K:18 – Withdrawn

ICES CM 2006/K:19

Portuguese bottom trawl, longline and purse seine fleets fishing and discarding practices

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The Portuguese discard sampling programme carried out in the Portuguese continental waters is based on a quasi-random sampling of co-operative commercial vessels. It includes the discards of the bottom trawl (fish and crustacean fleets), the longliners, and purse seiners fleets. The aim of this work is to characterize the fishing procedures of those fleets and their discarding practices. Along the Portuguese coast around one hundred bottom trawlers, 15 longliners, and 135 purse seiners operate, each with distinct characteristics and fishing efforts and operating in different behavior. This paper tries to characterize the distinct operating pattern of each fleet.

The onboard discarding procedures of the various fleets, i.e. the way sorting is conducted and what motivates the discharge of caught animals, are also discussed.

Keywords: Portugal, trawl, longline, purse seine, fishing and discarding practices.

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ICES CM 2006/K:20

Does discarding sustain the Irish Sea *Nephrops* fishery?

Sara-Jane Moore, Colm Lordan, Richard Briggs, and Pieter-Jan Schon

The *Nephrops* stock in the Irish Sea has sustained heavy fishing effort and catches since the 1960s. Discarding is a major feature in the fishery with 20–50% of the *Nephrops* caught by number (~10–30% by weight) being discarded. In addition to this various other commercial and non-commercial species are routinely discarded in the fishery despite various TCMs to reduce bycatches. It is logical to assume that discard mortality impacts on *Nephrops* population structure and inputs from discarding alters the trophodynamics of the ecosystem in the Irish Sea. Recently the fishing industry in Northern Ireland has suggested a radical solution to the discarding problem by proposing a discard ban in the fishery. In this paper data from discard programmes in the Republic and Northern Ireland are used to describe discarding practices in the fishery and to estimate the discard volume and composition as accurately and precisely as possible. Data from UWTV, trawl and beam surveys is used to profile the benthic communities in the Irish Sea. The impacts of discarding on the energy flow through the food web will be considered. The overall objective is to ascertain the role of discarding in sustaining the stock and whether a discard ban might have an impact on stock dynamics.

Keywords: discarding, *Nephrops* fishery, Irish Sea, ecosystem.

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ICES CM 2006/K:21 – Withdrawn

ICES CM 2006/K:22

Protection of postmolt male snow crab (*Chionoecetes opilio*) in the southwestern Gulf of St. Lawrence: Strategy to avoid discarding mortality of future recruitment to the fishery

Mikio Moriyasu, Marcel Hebert, Elmer Wade, and Gilles Miron

A management closure protocol by grids or sectors when the incidence of soft-shelled males (SSM) exceeds a threshold of 20% was implemented in the southwestern Gulf of St. Lawrence snow crab fishery (Area 12) in 2000 to protect the reproductive potential of the stock and achieve maximum yield-per-recruit by minimizing the catch of SSM. It also allows fishermen to fish by shifting their effort from areas of high SSM incidence to non- or less-problem areas. Data from fishermen's log-books, at-sea observer biological information, and annual

trawl surveys were analyzed over a 13-year period (1990–2002) to determine the variations in the SSM incidence in the commercial catches. Geographic distribution of hard-shelled (HSM) and soft-shelled males varied significantly from year to year. There was a negative exponential relationship between the percentage of SSM ≥ 83 mm CW (SSM $_{\geq 83}$) in the catch and the catch per unit of effort (CPUE) of commercial-sized (larger than 95 mm in carapace width) hard-shelled males ≥ 95 mm CW (HSM $_{\geq 95}$). A prediction of the percentage of SSM in catches was done by an exponential model using ratio of total abundance of SSM $_{\geq 83}$ prior to the fishing season versus the remaining abundance of adult HSM $_{\geq 95}$ after the fishing season. There was a linear relationship between the observed and predicted values in the percentage of SSM from 1990 to 2000, while the predicted values in the percentage of SSM were much higher than the observed values in 2001 and 2002. These outliers occurred after the implementation of the SSM protocol, thus suggesting that the implementation of the new SSM closure protocol introduced in 2000 substantially reduced the incidence of SSM in commercial catches.

Keywords: discarding, soft-shelled crab, fisheries management strategy, snow crab, Northwest Atlantic, Southwestern Gulf of St. Lawrence.

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ICES CM 2006/K:23 – Poster

Difficulties on applying the requirements of Commission Regulation (EC) No 1639/2001 in the estimation of discards from Basque Country trawl fleets

Isabel González Herraiz, J. Ruiz, and M. Santurtun

The trawl fleet of the Basque Country (Spain) is composed of “Baca” bottom trawlers, prosecuting a mixed fishery, and pair trawlers, operating with Very High Vertical Opening nets (VHVO) directed at hake as the target species. Ondarroa is the base and landing port for the majority of the trawlers, operating in ICES Subareas VI, VII, and VIII.

Commission Regulation (EC) No 1639/2001 determines the precision levels required for the estimates of commercial landings, discards, and recreational catches. For the discards of the main species, the smallest precision level is required (1, precision 25% for a 95% confidence level, CV $\leq 12.5\%$) (ICES, 2004) and derogation can be obtained if the requirement entails excessive costs. Discards of the others species must be covered by pilot surveys.

The difficulties in reaching the precision level 1 for discards based on the differences in catch composition be-

tween “Bacas” and VHVO pair trawls will be investigated for the period 2000 to 2004.

Keywords: Baca, pair trawls, hake, discards, precision levels, CV.

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ICES CM2006/K:24 – Poster

Estimating discards in the *Nephrops norvegicus* French trawl fishery of the Bay of Biscay (VIIIab)

Marie-Joëlle Rochet, Michel Bertignac, Spyros Fifas, Olivier Gaudou, and Catherine Talidec

Catches of *Nephrops* trawlers fishing in the Bay of Biscay have been sampled monthly since June 2002. The aim of this sampling is to estimate discards of this fleet, which operates on a hake nursery. Data were collected by onboard observers from about 500 hauls of 142 trips.

Nephrops trawlers discard about half of their *Nephrops* catches in numbers, and a third in weight. About one thousand tonnes of hake and two thousand tonnes of *Nephrops* are discarded yearly by this fleet, and this has been steadily increasing since 2003. The overall precision (coefficient of variation) of total discard estimates in numbers and weight varies from 12% to 27%, depending on sampling effort. The appropriateness of alternative raising procedures (e.g., ratio estimator involving landings) is investigated.

Keywords: *Nephrops*, hake, trawl, discards, raising.

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ICES CM 2006/K:25 – Poster

Long-term benefits of a simple technical measure (mesh size): Case study of pair trawls in the Bay of Biscay (VIIIabd), another reason for accomplishing regulation

Jon Ruiz, I. González Herraiz, M. Santurtun, and I. Quincoces

The VHVO pair trawl fleet of the Basque Country operates mainly in the ICES Divisions VIIIabd and is directed at hake. The Northern stock (ICES Division IIIa, Subareas IV, VI, and VII and Divisions VIIIabd) of this species has been under a recovery plan since 2004. Consequently, an increase in mesh size for certain fisheries and areas was established.

Catches of the pair trawl fishery before and after the change in mesh size are compared for the same period of

the year and fishing area. The impact of this change in the long-term biomass is studied.

As a preliminary consequence of this technical measure, it can be stated that when economical and biological benefits and stability in management in the long-term is proven, a higher commitment of the industry to these management plans would be expected.

Keywords: Bay of Biscay, VHVO pair trawls, hake, mesh size, long term management.

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ICES CM 2006/K:26 – Poster

The progressive improvement of the selectivity of French bottom trawls for *Nephrops (Nephrops norvegicus)* and Hake (*Merluccius merluccius*) in the Bay of Biscay (VIIIab)

Céline D'Hardivillé, F. Morandeau, M. Meillat, and P. Larnaud

The *Nephrops* fisheries of the Bay of Biscay discard both *Nephrops* and small hake. When the hake stock experienced a severe depletion in 2001 the European Commission implemented a drastic policy to save the species. Then Ifremer (with representatives of the professional and governmental agencies) began to modify *Nephrops* trawls to improve their inter-specific selectivity. Concurrently, studies have been started which aim at increasing the selectivity in order to protect *Nephrops* for which catches per effort unit have fallen. Separator panel, *Nephrops* grids, square mesh panel, or mesh side increase, the fisheries technology laboratory of Lorient multiplied tank tests and tests at sea, on professional and scientific trawlers so as to develop selectivity devices which offer an interesting compromise between *Nephrops* and hake escapement and commercial losses. The objective of this study is also to retrace the history of technical progress in limiting discards by enhancing the main results. For young hake, the square mesh panel in the baitings, which offers a regular average escape of 27% was adopted by the profession in 2005. Regarding young *Nephrops*, the last versions of tilted grids in the trawl belly gave good results: a L50 of 22 mm for the 13 mm bar spacing grid, 27 mm for the 15 mm one and 36 mm for the 20 mm one. Nevertheless, current tests achieved onboard professional trawlers will have to bear comparison with a new selectivity device: a square mesh panel placed under the extension piece which will be tested in 2006–2007.

Keywords: *Nephrops* trawlers, selectivity, *Nephrops*, hake, square mesh panel, tilted grid.

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ICES CM 2006/K:27 – Poster

The French experience in sampling discards at sea

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While experiences in sampling discards are significantly increasing in Europe, this contribution presents a general view of the approach to this problem in France. We will give an overview of the historical sampling programmes, the methodologies used with respect to the different contexts, the problems encountered, and some preliminary results obtained.

Firstly, experiences from the 80's will be recalled, based on 2 case studies: (1) the French trawler fleet targeting demersal fish and *Nephrops* in the Celtic Sea and Bay of Biscay, and (2) the multi métiers artisanal fleet in the Western English Channel. Methodologies and results will be analysed.

Since 2002 a more general approach has been carried out with respect to the new European regulation (EU Reg. 1639/2001) and the experience from the past has been used to design the sampling. The methodology used and problems encountered at each step of the process will be discussed. We came to the conclusion that to raise discards estimates at the fleet or segment level, a métier/fleet matrix is necessary. This element is currently being developed and is expected to provide the missing link.

The discussion will be illustrated by results at an intermediate scale with data raised to the sampled trips. This experience will be used to propose ways of improvement for the future.

Keywords: discards, sampling, métier, fleet, France.

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ICES CM 2006/K:28 – Poster

Investigating the factors which influence the *Nephrops* fleet discards of the Bay of Biscay and control measures to improve fishing practices and encourage a decrease of bycatch

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The objective of this work is to contribute to the study of bycatches of the french *Nephrops norvegicus* trawlers of the Bay of Biscay. The aim is to identify discards behaviour according to biological, spatiotemporal, technical, and tactical factors. Since 2002, 373 hauls achieved over

151 trips have been sampled for discards and landings. All bycatches have been listed and quantified for each haul (and for one fishery hour), but only European hake (*Merluccius merluccius*) and *Nephrops* (*Nephrops norvegicus*) have been studied because both stocks are experiencing depletion and are the essential important discarded species in this fishery: up to 61% of the *Nephrops* catch in number (37% in weight) and up to 95% of the hake catch in number (78% in weight).

Firstly, for each species, the between-haul and -trip variabilities of the percentage of discards (in weight and in number) are analysed in relationship with several variables: *Nephrops* or/and hake landings, district of vessels' origin, latitude, longitude, depth, characteristics of fishing gear (headline length, groundrope type, selectivity curves, etc.), year, season, haul duration. Thanks to these results and to a cartography of discards/landings of all hauls, we can infer management rules as partial closing of fishery zones and modification of fishing gear. Finally, the biological consequences of these new rules were tested with the assistance of Isisfish, a software developed by Ifremer to model biological and economical consequences of management rules on certain stocks.

Keywords: *Nephrops* trawlers, bycatch, discards, *Nephrops*, European hake, fishery management.

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ICES CM 2006/K:29 – Poster

Elasmobranch bycatch in trammel net fisheries off the Portuguese coast

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Elasmobranchs are an important component of bycatches of the Portuguese artisanal fisheries, but no assessment or management programme has yet been established. In the past few years, elasmobranch catches have been decreasing in Portugal, which might indicate that these species are being overexploited. This study analysed elasmobranch catches in trammel net fisheries off the west coast of Portugal. Thirty-seven sampling surveys were conducted onboard commercial fishing vessels which target mainly sole, on a seasonal basis between October 2004 and August 2005. A total of 11 elasmobranch species were caught, 9 Rajiformes and 2 Carchariniformes, representing 4% of the total fish catches and 15% of the total weight. Capture per unit effort (CPUE) was calculated for the different species. *Raja undulata* was the most important species in weight (8512,4 g/10000 m of net) and *Raja clavata* the most important in number (7,4 ind/10000 m of net). A marked seasonality was noticed, the lowest value of species richness being registered in Spring (4 species) and the highest in Autumn (11 species). These seasonal variations could be related to the migratory habits of these species. For the most abundant

species it was also possible to outline depth range preferences. In the trammel net fisheries, the majority of the elasmobranchs caught were either landed for sale (89%) or consumed by fishermen (3%). Discards values were low (8% of the total elasmobranch catches). Species with low or no commercial value, such as *Myliobatis aquila* and *Torpedo torpedo*, were always discarded.

Keywords: elasmobranch, trammel nets, bycatch, discards, Portugal.

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ICES CM 2006/K:30 – Poster

Correlations between interannual variations in blue whiting, horse mackerel and European hake abundances as estimated from discards surveys and the role of these species in European hake diet in Northern Atlantic Spanish waters (ICES Subareas VIIIc and North-IXa)

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The Spanish demersal bottom trawl discards in Northern Atlantic Spanish waters (ICES Subareas VIIIc and IXa-N) are constituted by species mixtures, mainly blue whiting *Micromesistius poutassou* (Risso, 1826), and also to a lesser scale horse mackerel *Trachurus trachurus* (L., 1758). Observers onboard commercial vessels (not systematically, since 1994 to 2005) sampled both the discarded and retained catches in order to estimate the level and discard ratio. The interannual variability in the abundance index of main species is an additional result. Blue whiting and horse mackerel represent two of the most important prey for European hake *Merluccius merluccius* (L., 1758), one of the most important commercial species for the Spanish demersal trawl fleet, and a species in which cannibalism plays a varying role in its diet. Sampling of hake stomach contents and its diet composition is carried out every year during the autumn bottom trawl survey on the continental shelf of the North Spanish coast (SP-NCGFS).

The objective of the present work is to compare the interannual variation in abundance for blue whiting, horse mackerel, and hake as estimated from the discards sampling programme on commercial vessels, with the observed annual variation in the importance of these species in the diet of hake.

Keywords: Discard, European hake diet, abundance, *Merluccius merluccius*, *Micromesistius poutassou*, *Trachurus trachurus*.

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ICES CM 2006/K:31 – Withdrawn

ICES CM 2006/K:32 – Poster

Catches of target species and bycatches of the trammel net sole fishery off the west coast of Portugal

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Soles are important resources in Portuguese fisheries and are exploited in multi-species fisheries that use mainly trammel nets. The catches of target species, bycatches, and discards of this fishery were studied from October 2004 until August 2005 off the west coast of Portugal. A total of 37 sampling surveys aboard commercial fishing vessels were made. The number and weight of individuals of all species caught were registered, as well as the amount discarded and retained for fishermen. A total of 112 species were identified: *Solea senegalensis* and *Sepia officinalis* were the main target species caught and *Scomber japonicus*, *Aspitrigla obscura*, and *Callyonimus lyra* were the most discarded fishes, corresponding to 28% in weight and 36% in number of discards. Discards represented 22% of the total catches in weight, while the amount retained by fishermen for consumption or direct selling was 12% in weight. The overall estimate for the annual discards value in this fishery was 174 tonnes, comprising 200 fishing vessels. Inconsistencies between the catches recorded onboard and the official landings were detected for the main target species. Data from official landings at fishing docks are the ones used in sole fisheries statistics, which emphasize the relevance of a different approach using more realist estimates.

Keywords: sole, trammel nets, bycatch, discards, Portugal.

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ICES CM 2006/K:33 – Poster

Discarding practices in a coastal trammel net fishery

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Trammel net discards in Algarve (Portugal) were considerable, with a total of 105 species discarded. The overall discard rate in terms of catch in numbers was 49%, with small pelagic fish species accounting for most of the discards.

Scomber japonicus, *Sardina pilchardus*, and *Boops boops* were the dominant discard species, accounting for 55% of the total numbers discarded. Strong seasonal

variation in discarding was found, reflecting differences in métiers and the versatility of trammel nets as a gear. Discarding, both in terms of numbers of species and individuals decreased with increasing inner panel mesh size. The main reasons for discarding were as follows: 1) species of no or low commercial value (e.g. *Scomber japonicus*), 2) commercial species that were damaged or spoiled (e.g. *Pagellus erythrinus*), 3) undersized commercial species (e.g. *Pagellus acarne*), and 4) species of commercial value but not caught in sufficient quantities to warrant sale (e.g. *Sardina pilchardus*). A decrease in

soak time together with appropriate choice of mesh sizes could contribute to a reduction in discarding.

Keywords: discards, bycatch, fisheries, trammel nets, Portugal.

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