

Theme Session M

Avoidance of bycatch and discards: technical measures, projects and state of data

ICES CM 2009/M:01

The development of international guidelines on bycatch management and reduction of discards

Frank Chopin

The FAO Code of Conduct for Responsible Fisheries (CCRF) calls for sustainable use of aquatic ecosystems and requires that fishing be conducted with due regard for the environment. However, there is growing concern that the combined effect of failing to minimize the catch of undersized fish of target species, non-target fish species, and non-fish species is threatening the long-term sustainability of fisheries, the maintenance of biodiversity and contributing to food insecurity, thus affecting the livelihoods on those dependent on fish resources. The United Nations General Assembly has urged States, RFMO/As and other relevant international organizations to reduce or eliminate bycatch, catch by lost or abandoned gear, fish discards, and to consider the development of standards for reducing or eliminating discards, such as through the development of an international plan of action, at the 28th session of the Committee on Fisheries of the Food and Agriculture Organization of the United Nations (COFI). At COFI 28 in 2009, FAO reported on bycatch and discards within the context of illegal, unreported, and unregulated (IUU) fishing, and reiterated the concern that in poorly managed fisheries, unreported and unregulated (i) landings of bycatch, (ii) discards, and (iii) precatch losses are issues of major concern. In response, Norway proposed and COFI supported the development of international guidelines on bycatch management and reduction of discards through the process of an expert consultation followed by a technical consultation. This paper describes the process of developing international guidelines and highlights the importance for coherency on definitions and terms associated with bycatch and discards.

Keywords: FAO, bycatch, discards, international guidelines, Code of Conduct for Responsible Fisheries, COFI.

Contact author: Frank Chopin, FAO, Rome, Italy [e-mail: fancis.chopin@fao.org].

ICES CM 2009/M:02

The evolution of a discard policy in Europe

Lisa Borges

The European Commission, as the executive body of the European Union, has the mandate for proposing future policies in fishery management. In European waters the practice of discarding part of the catch at sea is currently legal, and in some circumstances compulsory. However, discards have become more important in the public eye, increasing pressure for the EC to propose measures to, if not ban altogether, at least reduce discards significantly. Since 2006, specific EC initiatives have been taken to consult stakeholders in order to shape a future discard policy. The proposal that followed was based on a progressive reduction of discards by fishery, where specific discard reduction targets were set over a period of time. However, an international incident increased public awareness on discards and, together with the slow pace of implementation of the above approach, significantly increased the political pressure for the EC to deal quickly with this issue. At the same time, some Member States argued for increases in total allowable catches in order to decrease discards of commercially sized species. These events resulted in a rethink of the future discard policy, but more importantly it highlighted the difficulty of protecting a unique strong year class of stocks under severe fishing pressure and in poor state. The issues associated

with the new discard policy in data quality, control, and enforcement and its effectiveness in protecting a strong year class are presented and discussed in this paper.

Keywords: discards, management policy, European fisheries.

Contact author: Lisa Borges, European Commission, Directorate General for Maritime Affairs and Fisheries, Rue Joseph II, 79, B-1049 Brussels, Belgium [tel: +32 2 29 96265, fax:+32 2 299 4802, e-mail: lisa.borges@ec.europa.eu].

ICES CM 2009/M:03

Discard mitigation—what we can learn from waste minimization practices in other natural resources?

B. Stockhausen, R. Officer, and R. Scott

Solutions to the problem of discarding have been debated for decades. In general, measures to eliminate discarding have had limited success. Governments and research institutes continue to struggle with fishery management issues, and control and enforcement schemes to halt the wastage of valuable resources. This paper looks at other resource sectors and their ability to extract a high yield in a sustainable way and how these methods can be applied to fisheries. We will describe mitigation measures in other resource sectors such as livestock farming, agriculture, and waste management. With a specific focus on forestry, we illustrate the handling, utilization, and mitigation of discards and waste. In terms of biological impact, economic objectives, and management approaches the harvesting of trees has noteworthy similarities to industrialized fishing. We demonstrate that fishery scientists could learn from analogous developments in these sectors to successfully implement sustainable harvest schemes in fisheries.

Keywords: discard mitigation, fishery management, bioeconomic objectives, forestry.

Contact author: Björn Stockhausen, European Commission, Joint Research Center, Maritime Affairs Unit, TP 051, Via E. Fermi, 21027 Ispra, Italy [tel: +39 0332 789683, e-mail: bjorn.stockhausen@jrc.it].

ICES CM 2009/M:04

Dealing with discards

Michael Park

Regional Advisory Councils (RACs) were set up to provide greater stakeholder involvement in fishery management at a regional level. RACs are structured to provide a balance between those that represent industry, the commercial face of fishing, and those whose role it is to ensure a suitable and responsible use the environment and the seas that we fish. The North Sea RAC (NSRAC) is one of the most progressed of these groups, communicating with the European Commission on many issues, not least that of discards. The NSRAC recognizes the wish of the Commission to eliminate discarding by 2012. Bycatch and discards are among the most serious challenges in seeking sustainable fisheries and reducing them is part of “the ecosystem approach” to fishery management. Whereas the historical, traditional description of a discard was of an undersized fish, or a fish of non-commercial benefit, the modern discard takes on a very different mantle. In many cases it is the result of a breakdown in relationship between opportunity, catchability, and capacity. The initial Cod Recovery Plan set out to lay the foundation for cod recovery yet failed to take account of, or acknowledge, the problems of discarding the industry faced when the management regime failed to respond accordingly to an increasing biomass. The group has supported many national initiatives including those currently in operation in Scotland, England, and Denmark. This presentation sets out to give an insight to the role that the NSRAC provides as the “hub” of international stakeholder debate on the issue of discards.

Keywords: none.

Contact: Michael Park, NSRAC [e-mail: m.park@btconnect.com].

ICES CM2009/M:05

Monitoring and controlling bycatch: a fishing industry-generated solution

R. D. Stanley, H. McElderry, J. Koolman, and T. Mawani.

The groundfish industry in British Columbia and the Department of Fisheries and Oceans, Canada implemented the B.C. Groundfish Integrated Pilot Project in March 2006. The project was initiated, in general, because of the difficulty of managing many species of groundfish across many different licence/gear sectors and, in particular, because of the difficulty in quota-managing stocks without discard information. In spite of a difficult birth, this initiative in its first three years has progressed beyond the expectations of industry and government participants. Motivated in part by a combination of the “carrot” (ITQs) and “big stick” (fix it or lose it) approaches, the fishing industry took the lead role in designing, funding, and implementing a cost-effective 100% monitoring programme in a small-boat fleet of over 250 vessels. This monitoring now provides accurate and statistically defensible estimates of total catch by species, removing the need for more complex, and possibly biased, discard estimation procedures. Furthermore, the accurate monitoring of total catch by species (discarded and retained) by each vessel in near-real time provides managers with relatively simple options for minimizing discards through individual species caps. With this individual accountability framework, fishers are motivated to develop their individualized strategies to reduce non-desirable catches, as opposed to the more problematic approach of top-down design and enforcement of temporal or spatial closures, or gear restrictions. The presentation focuses on the importance of a bottom-up industry-driven solution to the problem and the key elements within the industry and its interaction with the governments that led to the current level of success.

Keywords: discards, electronic monitoring, ITQ, groundfish.

Contact author: R. D. Stanley, Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C. Canada [e-mail: Rick.stanley@dfo-mpo.gc.ca].

ICES CM 2009/M:06

The Fehmarn Landing Obligation Study—a fundamentally new management approach to solve the discard problem

Christopher Zimmermann and Daniel Stepputtis

Discards are one of the major obstacles for a sustainable management of commercial fisheries. Representatives of the fishery and science have developed an unconventional approach to solve the problem. We planned to test the feasibility and medium-term advantages and disadvantages of a complete discard ban (or landing obligation) for the fishery, science, and management for one particular fleet in the Western Baltic. Central elements of this study were: (i) landing obligation—all catch of marine animals including undersized fish or non-target species will be retained on board, landed, and counted against the quota (if applicable); (ii) management instruments—the fishery will be (in the final stage of the project) managed exclusively by total allowable catches (TACs) and quotas and by permanent or temporally restricted area closures for spawning aggregations, which are comparatively easy to control; (iii) reduction of technical measures—as direct benefit for the fishery, technical measures and days-at-sea regulations which are increasingly complex, difficult to control and to implement, will be mostly abandoned, and rules will be kept constant for a number of years; and (iv) scientific monitoring—the study will be monitored scientifically, in terms of biology (sea and market sampling) and economy. Although we received a lot of support for the study and managed to overcome a number of foreseeable and unforeseen obstacles, we found out that EU legislation does currently not allow such a study to be conducted. This contribution will report about the lessons we learned before we could even start to collect data.

Keywords: discards, fishers' responsibility, deregulation.

Contact author: Christopher Zimmermann, Johann Heinrich von Thünen-Institut, Institute of Baltic Sea Fisheries, Alter Hafen Süd 2, 18069 Rostock, Germany [e-mail: christopher.zimmermann@vti.bund.de].

ICES CM 2009/M:07

Is selective fishing more harmful to marine communities than even exploitation? Theoretical investigations

M.-J. Rochet, E. Benoît, and J. S. Collie

Bycatch and discards are recognized as major issues in fisheries throughout the world. More selective fishing methods that harvest only usable fish are considered to be the solution for greatly reducing bycatch. But more selective fisheries might conflict with another goal of modern fishery management: to harvest in ways that do not impede ecosystem structure and function. The idea has been put forward that exploitation should be balanced across trophic levels to maintain ecosystem trophic structure. Are selective fisheries targeting restricted but potentially key components of a community more harmful to community functioning than non-selective exploitation that evenly harvests from most parts of the community? We will present theoretical predictions of the contrasting effects of selective vs. even fishing on exploited communities, using two modelling approaches. First, we used a biomass size spectrum model describing the distribution of biomass across body size classes. Simulations with a time-dependent continuous model in which the energy flow is governed by size-dependent predation suggest that selective fishing targeting a restricted size range in the community generates oscillatory dynamics with a wider amplitude than less-selective fishing, especially when large fish are targeted; in addition, size diversity is lower with size-selective fishing. Second, we parameterized LeMANS, an existing, length-based multispecies model designed to evaluate community responses to fishing, for Georges Bank and the North Sea. Simulations demonstrate that community metrics such as species evenness and size diversity generally decrease as the number of species fished increases. However, for a similar catch, the metrics are always higher when fishing unselectively all species than any subset of species.

Keywords: indicators, ecosystem approach to fishery management, biodiversity, fishing selectivity, community.

Contact author: M.-J. Rochet, Ifremer, rue de l'île d'Yeu, BP 21105, 44311 Nantes Cedex 3, France [e-mail: mjrochet@ifremer.fr].

ICES CM 2009/M:08

Reconciling single-species management objectives in an integrating framework for avoiding overquota catches: main outcomes of the AFRAME project

Clara Ulrich, Dorleta Garcia, Bo S. Andersen, José Castro, Dimitrios Damalas, Hans Frost, Leyre Goti, Katell Hamon, Reiner HilleRisLambers, Ayoe Hoff, Irene Huse, Cecilie Kvamme, Stephanie Mahévas, Christos Maravelias, Stuart Reeves, and Marina Santurtun

It is acknowledged that single-species management is a source of discarding in mixed fisheries, because individual management objectives may not be consistent with each other, although the species are caught simultaneously in non selective fishing operations. As such, the total allowable catch (TAC) of a species may be exhausted before the TAC of another species, leading to catches of valuable fish which cannot be legally landed. This important issue has never been quantitatively accounted for in the traditional ICES advice. The FP6 AFRAME research project, in cooperation with FP6 EFIMAS and other research projects, has developed a quantitative framework for addressing this issue: the Fcube (Fleets and Fisheries Forecast) approach. This method builds on the understanding of the catching potential of the individual fleets (groups of vessels) and métiers (type of activity) for the various species, based on an assumed relationship between effort and fishing mortality. The method is integrated in the Fisheries Libraries in R (FLR) framework and as such can be used in a very flexible way. The framework was successfully applied to address a broad range of issues and scenarios to three demersal case studies suffering major mixed-fisheries interactions: the North Sea, the Western waters, and the eastern Mediterranean waters. This paper presents an overview of the main outcomes of the project. We investigate the consistency of the

single-species management objectives, and propose an operational tool for providing robust and sustainable mixed-fisheries advice minimizing the risks of overquota catches.

Keywords: fishery management, fleets, métiers, mixed fisheries, overquota, TAC.

Contact author: Clara Ulrich, Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua), Charlottenlund Castle, 2920 Charlottenlund, Denmark [tel: +45 33 96 33 95, e-mail: clu@aqu.dtu.dk].

ICES CM 2009/M:09

Technological changes in the framework of the northern hake long-term management plan

Dorleta Garcia, Raul Prellezo, Marina Santurtun, and Luis Arregi

In 2007 an evaluation of the proposed long-term management plans (LTMPs) for the northern stock of hake was carried out. The evaluation was conducted under a management strategy evaluation approach (using Fisheries Libraries in R (FLR)), with a parameterization based on the ICES assessment of this stock. In the LTMP definition phase some additional questions about the combinations of harvest control rules (HCR) and technical changes (mesh changes) were raised by the European Commission and the North Western Water Regional Advisory Council. In this paper we give answers to these questions raised. Mesh size changes and discards have been simulated by extending the model used to evaluate the LTMP in the most important traditional fishing units (FUs). Furthermore, special attention has been paid to the effect of these changes on the accompanying species. In order to answer the questions raised, a base case, mesh sizes currently in use, has been compared with five alternative scenarios: a decrease in the mesh size of FU03 (gillnets in Subarea VII), an increase in the mesh size of FU13 (gillnets in Subarea VIII) and FU14 (trawlers in Subarea VIII), and a final scenario simulating a simultaneous increase in the mesh size of FU13 and FU14. The alternative scenarios have been evaluated against the base case in terms of variation of discards (hake and accompanying species), population structure and total biomass of hake and economic performance of the fleets.

Keywords: discards, management strategy evaluation, northern European hake, mesh size, simulation.

Contact author: Dorleta Garcia, AZTI-TECNALIA, Marine Research Division, Txatxarramendi Ugarte z/g, 48395 Sukarrieta, Basque Country, Spain [tel: +34 946029400, fax: +34 946870006, e-mail: dgarcia@azti.es].

ICES CM 2009/M:10

Stock assessment incorporating estimates of discards in some years and implications for prediction of future stock trajectories

C. Fernández, S. Cerviño, N. Pérez, and E. Jardim

Incorporating estimates of discards into stock assessment models is important in order to improve the reliability of assessment results and predictions of future stock trajectories under different management scenarios. Historical series of estimates of discards, however, often contain many missing years and this seriously hampers their incorporation into stock assessments. In this work, a Bayesian age-structured stock assessment model is developed that takes into account the discards information available and is able to handle gaps in the time-series of estimates. The model incorporates a term reflecting mortality resulting from discarding and appropriate assumptions about how this mortality may change over time are made. The result is a stock assessment that takes due account of the available information on discards whereas, at the same time, producing a complete time-series of discards estimates. The method is applied to the hake stocks in ICES Divisions VIIIc and IXa, which have experienced very high discards on the younger ages. Two runs of the model are performed, one assuming zero discards and another one incorporating the available discards estimates. Assessment results and projections of future stock trajectories under different scenarios of F-reduction are compared and implications for management commented on. Results demonstrate that not taking discards into account in the assessment process may drive predictions far away from reality.

Keywords: Bayesian, discards, hake, population dynamics, stock management.

Contact author: Carmen Fernández, Instituto Español de Oceanografía, Cabo Estai—Canido, Apdo. 1552, 36200 Vigo, Spain [e-mail: carmen.fernandez@vi.ieo.es].

ICES CM 2009/M:11

Evaluating the quality of bycatch data and bycatch estimates across disparate fisheries

S. Brooke, L. Desfosse, and W. Karp

In all, 274 commercial fisheries, managed by international, national, and regional fishery agencies, are catalogued in the first US National Bycatch Report (NBR). Sources and quality of data available for bycatch estimation, and methods employed to compute estimates, varied greatly among fisheries. Standardized criteria to evaluate data quality and bycatch estimation methods for each fishery included: adequacy of observer-collected and industry-reported data, adequacy of other types of data required for bycatch estimation, database considerations, and bycatch estimation approaches. Using these criteria, fisheries were classified into one of five tiers (0–4), with higher tier levels indicating increased confidence in bycatch estimates and data quality. Overall, this tier classification system revealed distinct differences in data quality and/or estimation methods among fisheries. However, some criteria influenced the outcome more markedly than others. The overall approach will be reviewed and, possibly, modified before the next edition of the NBR is produced. Nevertheless, the tier system developed for the first edition of the NBR performed well and provides a useful mechanism for comparing bycatch data quality and estimation methods among dissimilar fisheries, and for identifying data gaps and other deficiencies. The tier system will serve as a means for monitoring improvements over time and will assist in making decisions regarding allocation of funds to improve data collection and bycatch estimation.

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

Contact author: Samantha Brooke: National Marine Fisheries Service, Office of Science and Technology/National Observer Program, 1315 East-West Highway, Silver Spring, MD 20902, USA [tel: +1 301 713 2363, fax: +1 301 713 1875, e-mail: Samantha.Brooke@noaa.gov].

ICES CM 2009/M:12

A system for sampling and observing catches

Glenn Chamberlain

The purpose of this work is to count, measure, and identify fish caught during fishing operations through analysis of images taken of catches once they are on board a vessel. The current management approach used in the northeast region of the United States relies on allocation of days at sea (DAS). This approach has recently come under review and has resulted in movement towards a new strategy: sector management. Creation of sectors will require individual sectors to provide estimates of discarded and kept catch on a regular basis. The cost of methods used to collect this information would be prohibitive to fishers who would join sectors. To avoid this, cost-effective methods of collecting catch data are required. The monitoring system used in this research consists of a stereo-pair of digital still cameras used to capture images of catches on board fishing vessels in New England. The cameras are synchronized when capturing images and the images are analysed by trained viewers. Viewers count and identify individuals of caught species. Measurements of individual fish are made and used to estimate the total weight of each species on a tow-by-tow and total trip basis. Estimates of weight, length, and catch composition are compared with totals calculated using accepted techniques. Commercially available imaging software is used to calibrate the system to each individual vessel and measure fish present in images. There are multiple benefits of this work, including the collection of reliable, accurate, and precise data for fishery managers to use at relatively low cost.

Keywords: sector, stereo-pair, monitoring system.

Contact author: Glenn T. Chamberlain, UMass-Dartmouth, School for Marine Science and Technology, 200 Mill Road, Fairhaven, MA 02719-5252. USA [tel: +1 508 910 6368 e-mail: gchamberlain@umassd.edu].

ICES CM 2009/M:13

Using VMS and fishery data in a real-time closure scheme to reduce cod mortality and cut discards

N. Campbell, S. Holmes, C. Main, P. Fernandez, N. Bailey, and K. Barratt

In 2008, Scotland introduced a voluntary programme known as “Conservation Credits”, which involved real-time closures (RTCs) combined with gear requirements. This was designed to reduce mortality and discarding of cod. The scheme was incentivized by rewarding participating skippers with additional days at sea. The real-time closures system discouraged vessels from operating in areas of high cod abundance, and areas were closed for 21 days when catch rates, detected by Scottish Fishery Protection Agency vessels (SFPA), exceeded a trigger level. In 2009, the scheme has been further developed, taking advantage of provisions in the European Union effort management regulations agreed at the 2008 December Council. In response to STECF advice, the annual target for the number of closures has been increased substantially and they are more spatially widespread and mandatory, with up to 12 being implemented at any one time. The expected increase in closure frequency would have required inspectorate observations beyond available resources so a new means of designating closures was introduced, determined by landings per unit effort, based on fine scale VMS data and daily logbook records. In this study we present the method of closure determination and preliminary results on the success of the closure system in reducing catch and discards of cod, examine displacement of effort from closed areas and discuss the potential to apply the scheme to reduce discards of other species.

Keywords: VMS data, real-time closures, cod, discards.

Contact author: S. Holmes, Marine Scotland Science, Marine Laboratory, 375 Victoria Road, Aberdeen AB11 9DB, Scotland, UK [tel: +44 1224 295 507, fax: +44 1224 295 511, e-mail: S.Holmes@marlab.ac.uk].

ICES CM 2009/M:14 Poster

Discards in the fisheries under the German flag: results from seven years of national data collection in the North Sea and North Atlantic

Jens Ulleweit, Kay Panten, and Christoph Stransky

Since 2002, Germany has been obliged to collect fishery data to support the European Common Fishery Policy. Sampling of the commercial fishery under the German flag is one duty within the EU Fisheries Data Collection Programme. During the past seven years, 183 fishing trips were sampled by scientific observers on board commercial fishing vessels to collect data on catch compositions and biological parameters with special emphasis on the proportions of landed and discarded fish. The results demonstrate that the proportion of discards depends on the fishery. The highest discard rates were observed on beam trawl fishing trips. At the level of individual fishing trips, discard rates varied extremely within a fishery segment. The highest variations were found in the beam and bottom otter trawl fishery, whereas the discard rates in high-seas fisheries were low.

Keywords: data collection, discards, discard ban, discard reduction.

Contact author: Jens Ulleweit, Johann Heinrich von Thünen-Institut, Institut für Seefischerei, Palmallee 9, 22767 Hamburg, Germany [tel: +49 40 38905 217, fax: +49 40 38905 263, e-mail: jens.ulleweit@vti.bund.de].

ICES CM 2009/M:15

From mobile closures to individual incentives: Chinook salmon bycatch reduction efforts in the Bering Sea pollock fishery

Alan C. Haynie

Bycatch is repeatedly noted as a primary problem of fishery management and as the foremost negative impact of commercial fishing. In the Bering Sea pollock fishery, salmon bycatch reduction measures have included gear modifications but have principally consisted of area closures. Bycatch levels of chum and Chinook salmon have risen substantially since the beginning of the decade and

significant areas of the pollock fishery have been closed at some points between 2002 and 2007. These closures have consisted of both large long-term salmon savings area closures and short-term voluntary rolling hot spot (VRHS) closures. More recently, the North Pacific Fishery Management Council has acted to impose a hard cap on the pollock fishery which would close the fishery if it were reached. In this paper, we consider the effectiveness of different management actions taken and under consideration to manage salmon bycatch. We examine the effectiveness of spatial closures designed to reduce salmon bycatch in the Bering Sea pollock fishery. We compare the relative effectiveness of spatial management measures that have been implemented with tradable salmon bycatch programmes that will be implemented in 2011. We demonstrate the importance of having individual bycatch quota under a hard cap which could otherwise erode benefits in the rationalized fishery.

Keywords: bycatch, incentive programmes, spatial closures, bycatch quota.

Contact author: Alan C. Haynie, NOAA Fisheries/NMFS, Alaska Fisheries Science Center—F/AKC2, 7600 Sand Point Way NE, Bldg 4, Seattle, WA 98115, USA [tel: +1 206 526 4253, e-mail: Alan.Haynie@noaa.gov].

ICES CM 2009/M:16

Mortality of North Sea herring that is crowded and subsequently slipped from a purse-seine

Maria Tenningen, Aud Vold, and Jostein Saltskår

Catch regulation by slipping whole or parts of the catch has traditionally been used in purse-seine fisheries for pelagic species if the catches are considered too big or the quality or size of the fish is considered unsatisfactory. This is particularly the case when the prize differs between sizes or quality groups of fish (high grading) as is often found with herring. No information is available, however, on the survival rate of herring that are slipped from the purse-seine or how significant this mortality is in relation to total fishing mortality. The aim of this study is to quantify mortality of herring crowded to different degrees in the purse-seine and subsequently slipped. Large-scale open sea survival experiments were carried out in the North Sea in 2008. Herring encircled by a purse-seine were transferred from the seine to large circular net pens where crowding was carried out by lifting the bottom of the net pen. The mortality rate five days after crowding ranged from 1.8% in the least-crowded group to 27.9% in the most-crowded group (control group mortality was 0.9 and 1.0%). The experiment was repeated in May 2009 and in this paper we present the combined results from the 2008 and 2009 experiments. The results provide important information on the crowding densities that can be tolerated in purse-seine fisheries for herring and whether there is a need to revise the legislation on slipping in purse-seine fisheries.

Keywords: unaccounted mortality, slipping, purse-seine, herring, crowding.

Contact author: Maria Tenningen, Institute of Marine Research Bergen, Norway [tel: +47 55238463, e-mail: maria.tenningen@imr.no].

ICES CM 2009/M:17

Mitigating bycatch with spatial and temporal hot-spot avoidance using patterns in discard mortality rate

Adam Barkley and Steve Cadrin

Most assessment models assume a discard mortality rate of 100% as an upper bound because the actual rate is often unknown or is highly variable. Bycatch reduction devices are useful in reducing the amount of unwanted bycatch, but in fisheries that discard large portions of a target species because of regulated trip limits, conservation engineering solutions are limited. For example, the southern New England flatfish complex has a high rate of target species discards. We investigated reflex impairment as a proxy for discard mortality, and evaluated the sensitivity of stock assessments to different levels of discard mortality. A positive relationship was detected between reflex impairment and discard mortality, as well as positive relationships between tow time, air exposure, and mortality. *In situ* observations were used to identify "hot spots" of discard mortality

to allow for spatial and temporal avoidance in the fisheries. Sensitivity analyses revealed that biological reference points can differ markedly when using different values of discard mortality.

Keywords: bycatch, discard mortality rate.

Contact author: Adam Barkley, NOAA/University of Massachusetts Cooperative Marine Education and Research Program [tel: 1 508 910 6394, e-mail: u_abarkley@umassd.edu].

ICES CM 2009/M:18

The effect of hook and bait sizes on size selection of cod, haddock, and wolffish in longline fisheries

Ólafur Arnar Ingólfsson and Haraldur Arnar Einarsson

This study demonstrates the effects of hook and bait sizes on size selection of three commercial species, and thus the bycatch of juvenile fish. The effects of hook and bait sizes on fishing efficiency and size composition of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and wolffish (*Anarhichas lupus*) were investigated in a designed experiment in the Icelandic longline fishery. Five hook sizes (EZ 10–14) and two bait sizes (~10 and 30 g) were compared. The bait was saury (*Cololabis saira*). Bait sizes affect catch rates and size selection in longline fishery for haddock, cod, and wolffish. Higher catch rates of haddock were obtained with small bait, but large bait caught cod and wolffish more effectively. The proportion of fish caught with large vs. small bait increases significantly with fish size for all three species, and the relationship can be described with a logistic curve. Smaller hooks result generally in higher catches, but there are interactions between bait and hook sizes for cod and haddock; hook sizes affect size selection of cod when small baits are used, and haddock selection when large baits are used. The proportion of catches of juvenile fish appears to be inversely related to fish abundance.

Keywords: longline, hook size, bait size, cod, haddock, wolffish.

Contact author: Ólafur Arnar Ingólfsson, Marine Research Institute. Árnagata 2-4, 400 Ísafjörður, Iceland [tel: +354 5752303, e-mail: olafur@hafro.is].

ICES CM2009/M:19

Celtic Sea cod—gear-based technical measures to help reduce discarding

D. J. Rihan, D. McDonald, and D. Browne

In recent years there have been moves by the European Commission to have Celtic Sea cod (ICES Area VIIb–k) included in the cod recovery plan with other cod stocks, citing the poor state of this stock. Irish, French, and UK fishers, however, all consistently reported that there are in fact more cod in the Celtic Sea and the scientific advice is incorrect. Over this period the total allowable catch (TAC) has become increasingly restrictive and led to reported elevated discarding of cod caught in the mixed fisheries in the Celtic Sea. In 2007 and 2008 Irish fishers were forced to discard large quantities in quarters 3 and 4 owing to the Irish cod quota being exhausted. This is neither a good situation for the fishers in having to dump good fish, nor for the scientists as much of these discards go unreported, nor for the cod. In order to try to address this issue, a series of trials were undertaken in 2009 to test gear options that would allow *Nephrops* fishers to continue to fish with reduced cod catches and therefore potentially reduce discarding of over-quota fish later in the year. The trials were carried out over a 20-day period in March/April 2009 with several different gear modifications. The three gear options tested were a rigid grid, a 160-mm square mesh panel, and an inclined separator panel. The results demonstrated that reductions in cod catches of 80% could be achieved with the rigid grid and smaller reductions of 20–50% with the other two gear options. However, the grid excluded all other marketable fish as well as cod and therefore, while effective, may not necessarily be acceptable to *Nephrops* fishers in terms of loss of revenue. This paper discusses the implications of the trials and the relative merits of the gear options tested in terms of reducing discarding but also allowing fishers to remain viable.

Keywords: discarding, cod, Celtic Sea, rigid grid, inclined separator panel, 160-mm square mesh panel.

Contact author: D. J. Rihan, An Bord Iascaigh Mhara, PO Box 12, Crofton Road, Dun Laoghaire, Co. Dublin, Republic of Ireland [tel: +353 1 2144104, fax: +353 1 2300564, e-mail: rihan@bim.ie].

ICES CM 2009/M:20

Avoidance of unwanted bycatch in the blue whiting fishery in the Faroese fishing zone by use of a sorting grid system

Oleg M. Lapshin, Kristian Zachariassen, Viacheslav A. Tatarnikov, and Jan Arge Jacobsen

Because of the bycatch of unwanted species such as saithe (*Pollachius virens*), mackerel (*Scomber scombrus*), and redfish (*Sebastes marinus*) in the blue whiting (*Micromesistius poutassou*) fishery in the Faroese fishing zone, the Faroese and Russian fishery authorities decided in 2006 to introduce a special sorting grid system when fishing for blue whiting. This system is mandatory to use in large parts in the Faroese fishing zone. The system consists of a special sorting grid with a 55-mm bar space inserted into the trawl in front of the codend, forming an additional netting section. In front of the grid a small leading panel was inserted to lead the blue whiting from the escape opening. Video recordings were used to observe the behaviour of blue whiting in front of the escape opening. The bycatch was collected in special collector codends. Experiments in 2008 and 2009 were used to analyse the amount of blue whiting escaping with unwanted species, and comparison of the quantity of unwanted species in the presence/absence of the sorting system in the trawl. By using the sorting grid a decrease in the bycatch of saithe was obtained ranging from 1.46–3 times, and of all unwanted species (saithe, mackerel, redfish, and haddock) the reduction was 0.25–3.25 times. The efficiency of the sorting grid system as a management tool depends on the season of the year, as the abundance of unwanted species in the blue whiting shoals varies during the year.

Keywords: blue whiting, sorting system, unwanted species bycatch.

Contact author: Kristian Zachariassen, Faroe Marine Research Institute (FMRI), PO Box 3051 Nóatún 1 FO-110 Torshavn, Faroe Islands [tel: +298 35 39 00, fax: +298 35 39 01, e-mail: krisac@hav.fo]

ICES CM 2009/M:21

Bycatch amelioration using cutaway trawls in the Celtic Sea *Nephrops* fishery

Emmet H. Jackson, Coilin Minto, Daniel McDonald, and Dominic Rihan

Bycatch and discarding of groundfish remains problematic in *Nephrops* fishery despite legislative requirements for technical conservation measures. These measures (e.g. inclined panels) work on the principle of removing unwanted fish from the net; the cutaway trawl, in contrast, avoids the capture of unwanted bycatch prior to it entering the net. Pairwise tests of standard and cutaway *Nephrops* trawls were conducted in the Celtic Sea (ICES Area VIIg) in June 2005. This study reports on the effect of the gear modifications on the dominant bycatch species of whiting, hake, and cod. The data from 18 hauls were analysed, both in terms of numbers caught and length-class retention, using a generalized estimation framework. The cutaway trawl design demonstrates that, in commercial conditions, a significant reduction in bycatch, of 50% of whiting and 42% of hake, is possible without compromising the catch of the target species, *Nephrops*. Cod catches, however, did not demonstrate any significant reduction, possibly owing to behavioural differences in the interaction with the gear. Comparative length-class retention analysis with a standard prawn trawl demonstrates that effectiveness of the reduction of bycatch increases with body length, across the three species. The overall findings provide evidence that the cutaway trawl can substantially reduce bycatch in the *Nephrops* fleet. The implication for its use in management is discussed in relation to current legislation.

Keywords: Celtic Sea, *Nephrops*, bycatch, cutaway trawl.

Contact author: Emmet Jackson, Bord Iascaigh Mhara, BIM, Crofton Road, Dun Laoghaire, Co. Dublin, Ireland [e-mail: Jackson@bim.ie].

ICES CM 2009/M:22

Bycatch reduction in a small-meshed North Sea trawl fishery through gear developments

Ole R. Eigaard and J. Rasmus Nielsen

A lightweight sorting grid was developed in order to improve sustainability in the small-meshed Norway pout trawl fishery in the North Sea with extensive bycatch problems. The aim was to identify potential technical management measures that can reduce unintended bycatch through improved gear selectivity. The grid was tested in various configurations, with the objective to optimize grid handling and selectivity. An experimental fishery conducted at Fladen Ground demonstrated the possibility of conducting a very clean fishery for Norway pout with a minimum of unintended bycatch. A fishery with two different grid orientations, backwards leaned and forwards leaned, resulted in Norway pout catches of 96.4% and 96.3% of total catch weight in the codend, respectively, with only limited loss of target species (7.3% and 11.5% of potential catch). Both grid orientations were also highly efficient at sorting out other gadoids (haddock, whiting, cod, hake, and saithe), releasing approximately 90% in weight of those entering the trawl. Observed catch differences between orientations are probably associated with different species/size availability of the three trials. After several modifications, a final design of an enforced down-scaled and forward-leaned grid solved all handling problems encountered. However, the grid durability was still not entirely satisfactory and further development has to secure long-term grid performance under commercial fishing conditions.

Keywords: bycatch, industrial fishery, North Sea, Norway pout, selectivity, sorting grid, sustainability.

Contact author: Ole Ritzau Eigaard, National Institute of Aquatic Resources (DTU-Aqua), Charlottenlund Castle, Jægersborg Alle 1, DK-2920 Charlottenlund, Denmark [tel: +45 33 96 33 00, e-mail: ore@aqu.dtu.dk].

ICES CM 2009/M:23 Poster

Maximizing the survival of bycatch discarded by commercial estuarine fishers in New South Wales, Australia

Matt K. Broadhurst, Sebastian S. Uhlmann, Russell B. Millar, and Craig P. Brand

Technical strategies for mitigating collateral fishing mortality have traditionally involved improving gear selectivity (to reduce bycatches). However, few of these modifications are completely effective, and so other ancillary strategies are often required. One concomitant approach is to modify operational and/or handling procedures to reduce some of the negative impacts to discards. The utility of this latter strategy was recently examined for estuarine gillnetters, trawlers, and seiners working in New South Wales. More than 150 deployments were completed, during which 81 000 discarded organisms comprising 30 species were assessed for their immediate mortalities, whereas almost 4000 live individuals of 13 species were subsequently caged and monitored, along with controls, for their short-term (<10 days) fate. There was considerable variability among fatalities, attributed to species-specific tolerances to withstand seven dominant factors: (i) the deployment duration of the gear, (ii) catch weight, (iii) salinity, (iv) temperature of the fished river/estuary, (v) presence of jellyfish, (vi) duration of air exposure, and (vii) extent of sunlight/cloud cover during sorting. For many species, fatalities could be mitigated by choosing when and where to fish (to avoid high temperatures and jellyfish abundances and low salinities), using bycatch reduction devices to reduce jellyfish and catch weights and deploying all gears for the minimum duration. Once catches are brought on board, air exposure and direct sunlight can be minimized by sorting in water-filled containers. Combinations of these strategies were shown to significantly reduce discard mortalities (by a third for some species) and, if implemented, should ultimately contribute towards resource sustainability.

Keywords: discard mortality, collateral mortality, penaeids, beach-seines, prawn trawls, prawns seines, gillnets, selectivity.

Contact author: M. K. Broadhurst, NSW Department of Primary Industries, Fisheries Conservation Technology Unit, PO Box J321, Coffs Harbour, NSW 2450, Australia [tel: +61 2 6648 3905, fax: +61 2 6651 6580, e-mail: mbroadhurst@nmsc.edu.au].

ICES CM 2009/M:24 Poster

The Russian experience of using at-sea observer data for estimation of discards in the Barents Sea

E. V. Gusev, K. M. Sokolov, and K. V. Drevetnyak

The Barents Sea is an area of large-scale demersal fishery. The Russian demersal fishery in the Barents Sea is based on two species: cod and haddock (85% of the total demersal fish catch). The fishery is conducted all the year round in the whole area of the Barents Sea. This is a large-scale fishery, and a bycatch of non-target fish, the number of which, from recent Russian data, exceeds 200 species, cannot be avoided. Such bycatches, especially those of non-commercial species, can be discarded. In addition, trawl catches, depending on the season and fishing area, contain a certain number of undersized cod and haddock which can also be discarded. PINRO has developed a scheme for collecting biological and catch data by scientific observers on board fishing vessels. At-sea observer data are used to estimate discards by Russian fleet fishing for demersal species in the Barents Sea. The paper presents estimates of discards in the Russian demersal fishery and describes measures to reduce discards in the Barents Sea currently used in Russia. Other measures that have potential for reducing bycatch are proposed.

Keywords: Barents Sea, bottom trawl, bycatch, demersal fish, discards.

Contact author: Konstantin V. Drevetnyak, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, Murmansk, 183038, Russia [tel. +7 8152 47 22 31, fax: +7 8152 47 33 31, e-mail: drevko@pinro.ru].

ICES CM 2009/M:25 Poster

Circle hooks as a mitigation measure for loggerhead sea turtles bycatch in the Mediterranean Sea

Susanna Piovano, Yonat Swimmer, and Cristina Giacoma

We tested a hook with a circular shape to verify its effectiveness in reducing the bycatch of loggerhead sea turtle (*Caretta caretta*) in the Mediterranean Basin. Seven experimental fishing trips with 30 sets total were conducted on a single commercial fishing vessel in the Strait of Sicily in 2005–2007. We chose a circle hook with gape width similar to the J hook traditionally used in Italian swordfish longlines. Circle and J hooks were alternated along the length of the mainline, with 1000 baited hooks per set. In all, 26 sea turtles were hooked; all were immature-size loggerheads. Turtles were caught at a statistically greater frequency on J hooks than on circle hooks. With regards to the target species, we found that the catch rate, the weight, and the upper jaw fork length of swordfish were not significantly affected by the type of hook employed. Our findings suggest that circle hooks can effectively reduce the incidental capture of immature loggerhead sea turtles in a Mediterranean swordfish longline fishery without affecting the target species.

Keywords: *Caretta caretta*, incidental capture, pelagic, longline fishery, Mediterranean Sea.

Contact author: Susanna Piovano, Dipartimento di Biologia Animale e dell'Uomo, Torino University, Via Accademia Albertina 13, 10123 Torino, Italy [e-mail: susanna.piovano@unito.it].

ICES CM 2009/M:26 Poster

Active fluttering net panel or rope array inside codend to increase selectivity

Yonghae Kim and Daesung Whang

The selectivity of fishing gear can be controlled by physical elements, such as mesh size, mesh shape, grid, etc., as well as biological factors, such as in relation to fish behaviour. Fish escapes have been shown to be higher at more approach to mesh net as an erratic reactions rather than keeping positions as an optomotor response. However existing codend construction for improving selectivity such as square mesh window or grid was constant positions at constant towing speed

(i.e. constant stimulus with time and space). In our study variable stimuli such as visual, water flow, or physical contact for fish were generated by free end net panel or ropes array to change their positions as fluttering with time. The rectangular net panel or rope array fixed as two points at the lacing rope of codend like flagging was stretched horizontally or vertically and then fluttered up and down or left and right irregularly by the turbulent flow inside the codend. Flume tank experiments were carried out using juvenile sea bream in a model codend (0.4 × 1.5 m) with fluttering net panel or rope array by video observations. These flapping movements of net panel or rope array could chase fish to approach to net wall of codend and resulted to increase escape ratio compared with existing codend only. These fluttering net panel or rope array were revealed a little drag and flexible so that no difficulty in hauling operation is expected in real application while higher selectivity of codend.

Keywords: fluttering net panel, ropes array, codend, selectivity.

Contact author: Yonghae Kim, Gyeongsang University, College of Marine Science, 445 Inpyeongdong, Tongyoung, 650-160, Republic of Korea [tel: +82 55 640 3097, +82 10 4156 3097, fax: +82 55 648 0170, e-mail: yonghae@gnu.kr, and timo7s@hanmail.net].

ICES CM 2009/M:27 Poster

Basis for a Bayesian approach to fishery discards

M. Viana, J. C. Wilson, and A. L. Jackson

“Reduce unwanted bycatch and eliminate discards” is the recommendation for European fisheries in order to fulfil the ecosystem approach to fishery management. Hence, information on the discard fish and fisheries is essential. Fisheries, and as a consequence discards data, have a natural hierarchical structure: discards are sampled at a haul level and hauls are nested within trips which are nested within fleets. A Bayesian approach to fisheries provides one of the most theoretically defensible framework within which hierarchical models can be built and probabilistic questions can be addressed. In addition, Bayesian methods make it possible to consider key parameter values with high levels of uncertainty within a single framework. The present study aspires not only to demonstrate the benefits of a Bayesian approach to discards modelling but also the importance of including variation and uncertainty in each step of compilation of discards estimates. All models were built under WinBUGS software version 3.0.3 with data from the Irish discards sampling programme. When available, informative priors for the Bayesian models were used. Although quantification of discards estimates remain broadly consistent under a Bayesian or frequentist approach, the more honest inclusion of error demonstrates that discards estimates may be over- or underestimated. We suggest that Bayesian statistics can be used to provide a structural framework to compare and contrast various management options for mitigating discards through a range of technical conservation measures.

Keywords: fishery discards, hierarchical structure, Bayesian methods, uncertainty.

Contact author: Mafalda Viana, School of Natural Sciences, Department of Zoology, Trinity College Dublin, Dublin 2, Ireland [tel: +353 0872829850, e-mail: vianam@tcd.ie].

ICES CM 2009/M:28 Poster

Strategic Spanish project relating responsible fishing on discard reduction (REDES)

Nérida Pérez and Rosa Fernández

A description of a recently designed strategic Spanish proposal with regard to responsible fishing for discard reduction (REDES) is presented. A gap in the research on fishing gear technology has been identified in Spain in recent years. REDES is a multidisciplinary proposal aiming to fill that gap. It is a proposal involving fishers' associations, ship owners, technology industries, research institutes, university departments, and environmental NGOs, collaborating towards selectivity improvement by introducing technological innovations in fishing gears. The aims of the project are to help to reduce discards in the Spanish trawler fleet under study, retaining the economic sustainability of fishing activities. REDES is structured in five independent coordinated work

packages: WP1–WP5. WP1 is for temporal series discard data analysis, including identification, distribution, and dynamics of target species for discard reduction and statistical modelling on discard spatiotemporal behaviour by the fishery. WP2 is a selectivity gear design centre, taking into account all stakeholders' knowledge and results from WP1. WP3 is a testing cluster. Computer simulations, flume tanks, and fishing trials will be carried out to test new gears and devices and compare their performance against traditional fishing methods. WP4 is for impact analysis and assessment, including selectivity inference, short-term economic impact, and long-term forecasting of the bioeconomical consequences of using the new gears. WP5 is a project management package, including dissemination of results and management of intellectual property issues, monitoring of regulatory and technological progress, and contribution to the definition of standards and standardization.

Keywords: project, discard, trawl, gear technology.

Contact author: N. Pérez. IEO, Spain [e-mail: nelida.perez@vi.ieo.es].

ICES CM 2009/M:29 Poster

A discard index for the English and Welsh fishing fleet

T. L. Catchpole, R. Enever, A. Revill, A. Reese, and D. Maxwell

Discards refer to the part of the catch that is not retained on board during commercial fishing operations and is returned to the sea. An index has been developed which provides a measure of the amount of discards that are generated by the English and Welsh fishing fleet. The index is based on sampled catches on board commercial vessels and the numbers of days fished by English and Welsh fishing vessels operating in ICES Subareas IV and VII. The data utilized are from all fish species (including non-commercial), commercial cephalopods (squids and cuttlefish), and *Nephrops norvegicus* (an alternative using 20 commercial species is also considered). The data are from vessels of 10 m and over (registered length); vessels using otter trawls, *Nephrops* trawls, beam trawls, and static nets (gillnets, trammelnets) and the index runs from 2002. The index can be presented in total quantities or as a rate (by effort, time, landings, or catches) and with confidence intervals. It can be disaggregated by gear or species.

Keywords: discards, English, Welsh, index.

Contact author: T. L. Catchpole, Cefas Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK [e-mail: thomas.catchpole@cefas.co.uk].

ICES CM 2009/M:30 Poster

Trawl modifications to avoid bycatch and discards on board Portuguese crustacean trawlers—a review

Paulo Fonseca, Aida Campos, Joaquim Parente, and Victor Henriques

Two distinct landing profiles have been defined for Portuguese crustacean trawl fleet, with rose shrimp and Norway lobster as the main targets. Bycatch comprises a diversified amount of invertebrates and fish, including a number of high-value demersal species, together with an important fraction of semi-pelagic fish with lower market value. Discards can attain large proportions relative to total landings, comprising either non-commercial bycatch or undersized individuals of commercially valuable species. A number of technical alterations to trawls such as square mesh codends or sorting grid devices have been developed by IPIMAR, often in cooperation with the fishing industry, with the purpose of protecting the immature fraction of commercial fish and mitigate bycatch and discards (EU BY-DISCARD, NECESSITY projects; MARE national project). However, their use was found to be associated with short-term economic losses that the industry is not prepared to accept, making these options difficult to implement. As such, a key factor for the commercial introduction of such options is that the economic benefits perceived by the final users overcome possible losses. Considering the current, increasing trend of anchoring recovery plans mainly on effort and area restrictions, the use of size- and species-selective gears

may represent a chance to overcome the loss of fishing opportunities. Future mandatory limitations on the percentages of discards will also provide increased motivation for the use of selective gears. Finally, the improvement in fish quality that can result from the adoption of selective devices and environmental friendly fishing practices can be a strong motivation for their introduction in commercial activity.

Keywords: crustacean trawl fleet, bycatch, discards, technical measures, selectivity, fish quality.

Contact author: Paulo Fonseca. INRB/L-IPIMAR. Av Brasília, 1449-006 Lisbon, Portugal [e-mail: pfonseca@ipimar.pt].

ICES CM 2009/M:31 Poster

Discard patterns of Henslowi crab (*Polybius henslowi*) by the Galician and Cantabrian (northern Spain) trawl fisheries

Xulio Valeiras, José María Bellido, Nélica Pérez, Hortensia Araujo, and Juan Santos

Henslow's swimming crab (*Polybius henslowi*) is an abundant crustacean species with pelagic habits. It is distributed along the northern and northwestern Spanish continental shelf and upper slope. The crab is a common species occurring at trawlable grounds and is discarded in large numbers by the Spanish trawl fisheries in the area. Estimates of discards are up to 20% of total discarded weight and around 40% of fish and crustaceans by number from commercial trawl catches in the area. More than 300 kg per fishing trip were discarded in 2007, and a great variability was observed in the haul catches of this species. This work aims to develop predictable models of discard abundance of Henslow's swimming crab in relation to spatial and temporal factors affecting fisheries using obtained information to reduce discards. Time-series data collected during on-board sampling by the IEO were analysed using generalized additive models (GAMs) to describe variations in the presence/absence and abundance of species. Models suggest an important effect of spatial and seasonal factors.

Keywords: discards, trawling, discarding behaviour, swimming crab, northeastern Atlantic, Spain.

Contact author: Xulio Valeiras, Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Vigo. Box 1552. 36280 Vigo, Spain [e-mail: xulio.valeiras@vi.ieo.es].

ICES CM 2009/M:32 Poster

Discard reduction in the Northern Ireland *Nephrops* fishery

Richard Briggs

Irish Sea *Nephrops* are exploited mainly in the waters west of the Isle of Man primarily by Northern Ireland and Ireland with a combined first sale annual value of over €12 millions. As this is a nursery area for whitefish species such as whiting and haddock the fishery is characterized by high discard mortality, despite existing technical measures. Trials were performed using the twin-rig vessel MFV "Carreen" chartered from Kilkeel, Northern Ireland. Six experiments were performed with 69 comparative tows between a control gear and six experimental gear configurations over a 33-day period. Hauls were of similar duration to those performed commercially and nets were swapped between port and starboard sides of the vessel at regular intervals. The control gear was a standard 20-fathom *Nephrops* trawl with 80-mm mesh throughout and an 80-mm square mesh panel (SMP) positioned 2 m from the codend extension as used by the commercial fleet. Trials with a range of 120-mm SMP positions reduced catches of undersized whitefish and was especially effective when positioned 8 m from the codend extension. The most successful result was achieved by inserting a central strip of 12-mesh-wide 80-mm diamond-shaped mesh to support the SMP, which tended to sag otherwise. Results demonstrated a reduction in catch of both juvenile haddock catch (54%) and whiting (65%) with no loss in *Nephrops*.

Keywords: technical conservation, discards, *Nephrops* fishery.

Contact author: R. P. Briggs, Fisheries and Aquatic Ecosystems Branch, AFBI Headquarters, Newforge Lane, Belfast BT9 5PX, Northern Ireland, UK [tel: +44 2890 255503, fax +44 2890255004, e-mail richard.briggs@afbini.gov.uk].

ICES CM 2009/M:33 Poster

Bootstrap-based methods for estimating edge and dispersion parameters at minimum level of discard sampling strata

Juan Santos, Javier Roca, Xulio Valeiras, Hortensia Araujo, and Nélida Pérez

Estimates of discards from Spanish trawl fleets follow the general ICES raising procedures outlined in 2003, based on sampled trips (primary sampling unit) at multiple strata, each producing partial mean and variance estimations. Low and disaggregated sampling efforts yield biased and highly variable estimators across strata, especially for species with non-Gaussian catch behaviour. A non-parametric approach for estimates for discards at lowest sampling levels is proposed in this paper. Virtual resampling relying on a different bootstrap context has been used to infer catch density functions, mean and variance estimators, and standard errors. This methodology is applied to studying discard quantities and behaviour of the main caught species from the Spanish bottom-trawl fleet operating in ICES Subarea VII. Mean and variance of discards, both per haul and per trip, are calculated for the years sampled (2003–2008) being raised to the total fleet by a ratio estimator. Results obtained from the non-parametric methodology are compared with the classical approach, demonstrating differences in means and dispersion estimated terms. Bias from this comparison could reweight the importance of the total estimates of discards for some species.

Keywords: trawl, discards, bootstrap, non-parametric regression.

Contact author: Juan Santos, Instituto Español de Oceanografía, 36200, Cabo Estay-Canido. Vigo, Spain [tel: +34986492111, e-mail: Juan.santos@vi.ieo.es].

ICES CM 2009/M:34 Poster

Bycatch in the Greenland halibut fishery in East Greenland

Agnes C. Gundersen and James Kennedy

Greenland halibut (*Reinhardtius hippoglossoides*) is a deep-water flatfish species found in both the East and West Atlantic. In East Greenland it is most abundant at depths between 1000 and 1500 m. Fish living at this depth are generally slow-growing and long-lived and are unlikely to withstand a high fishing pressure. However, the composition and levels of bycatch from this fishery are poorly documented. Between 1993 and 2000 surveys were carried out in East Greenland using commercial fishing gear with the focus of the survey being on Greenland halibut. We present data on the species composition and size distribution of the bycatch species caught during these surveys and compare and contrast the differences in the composition and size distribution of the species in different areas and from different gears. Preliminary analysis of the data demonstrates that onion-eyed grenadier (*Macrourus berglax*) was the most abundant bycatch species in all three gears. It tended to occur in larger numbers in areas with low fishing intensity and in one survey accounted for up to 80% of the bycatch. Other common species included black dogfish (*Centroscyllium fabricii*), blue antimora (*Antimora rostrata*), redfish (*Sebastes marinus* and *Sebastes mentella*), and many species of deep-water sharks and rays. Fishing using gillnet gave the lowest level of bycatch per kilogram of Greenland halibut caught. Fishing in the fjords of East Greenland gave lower amounts of bycatch, but the Greenland halibut caught in fjords were smaller than in the offshore area and the catch was dominated by immature individuals.

Keywords: bycatch, discards, East Greenland, gillnet, Greenland halibut, longline, trawl.

Contact author: Agnes C. Gundersen, Møreforskning Marin, PO Box 5075, Larsgården, NO 6021 Ålesund, Norway [tel: +47 70 11 16 00 21, e-mail: agnes@mfaa.no].

ICES CM 2009/M:35 Poster

Species-selective *Nephrops* trawling: Icelandic grid experiments

Ólafur Arnar Ingólfsson

The value of fish bycatch in *Nephrops* trawls is often an important economic component of the Icelandic *Nephrops* fisheries. The mesh sizes in the *Nephrops* fisheries are significantly smaller than those generally used in the demersal fisheries and this results in bycatch of juvenile fish. A steel grid with 50- and 80-mm bar spacings and a horizontal separation panel were tested to separate fish from *Nephrops* in a demersal trawl. Two codends were connected to the grid and panel. Almost all the *Nephrops* catch entered the lower codend, and most of the fish the upper one. Fish separation varied among species and fish sizes. The results demonstrate that a significant separation can be achieved. There are also indications that by using a *Nephrops* grid in combination with bigger mesh sizes in the fish codend, and in the trawl belly, marketable fish could be retained, whereas most of undersized fish would escape.

Keywords: *Nephrops*, grid, selection, cod, haddock.

Contact author: Ólafur Arnar Ingólfsson, Marine Research Institute, Árnagata 2-4, 400 Ísafjörður, Iceland [tel: +354 5752303, e-mail: olafur@hafro.is].