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Joint Report of the Study Group on Unaccounted Fishing Mortality (SGUFM) and the Workshop on Unaccounted Fishing Mortality (WKUFM)

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Executive Summary

Unaccounted fishing mortality can be a source of bias in the estimation of total fishing mortality for a considerable number of stocks on which ICES currently gives advice, including many "critical" species. Illegal, unreported and unregulated fishing (IUU) and discarding are of the greatest concern to the stock assessment working groups at present. Other potential sources of unaccounted fishing mortality (e.g. escape mortality and ghost fishing) may also be affecting some fisheries, but as of yet their impact has not been properly assessed.

Following a preliminary review of the status and utilisation of UFM data by ICES stock assessment working groups, the Study Group on Unaccounted Fishing Mortality (SGUFM) concludes the greatest obstacle preventing ICES working groups from including information about unaccounted fishing mortality in their stock assessments is the acquisition of accurate and usable data. This same problem was highlighted by the ICES – FAO Working Group on Fishing Technology & Fish Behaviour (WGFTFB) Topic Group on Unaccounted Mortality in Fisheries (2000), yet little progress has been made since. From both reviews, it appears that the scale of this problem is substantial, but this must be resolved if progress is to be made by ICES in implementing the "Ecosystem Approach to Fisheries Management". A work-plan for SGUFM is proposed to gather relevant information on UFM and assess the impact of this information upon the management of selected stocks. However, it was also recognised by SGUFM that, with particular reference to illegal and misreported fishing activities, where information is sensitive to a nation state or an individual skipper, it cannot be utilised by the WGs in stock assessments. This presents a major a problem to some WGs, meaning some catch estimates may be knowingly and significantly under-estimated.

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1 Introduction

Fishing mortality is an important variable in fisheries science and is the key to the effective management of a fishery. However its estimation remains imprecise because, in addition to the reported catch, there are other unaccounted sources of fishing mortality. In an ecosystem–based approach to the management of fisheries, the lack of such information may lead to erroneous conclusions and recommendations, which if uncorrected could threaten the sustainability of the affected stocks and undermine global food security. In addition to the direct impact upon the stocks, unaccounted fishing mortality also leads to lost economic opportunities for the fishers (Schmidt, 2004) and may detrimentally impact the ecosystem as a whole. Having a clear view of the effect of unaccounted fish mortality on a fishery therefore remains a priority for fisheries managers.

This report summarises the work of the ICES Study Group and Workshop on Unaccounted Fishing Mortality [SGUFM and WKUFM]. It provides an overview of the major sources of unaccounted fishing mortality and reviews the level of understanding that the ICES Stock Assessment Working Groups currently have about these potential sources of bias to fishing mortality in the fisheries upon which they advise. Recommendations from WKUFM are presented and a work-plan for SGUFM is proposed – to gather relevant information on UFM and assess the impact of this information upon the management of selected stocks.

1.1 Terms of Reference

ICES Study Group for Unaccounted Fishing Mortality [SGUFM]

The terms of reference for SGUFM in 2005 are:

a) consider issues relating to the sources of fishing mortality other than those that can be accounted for by the reported catch;

b) report on the current knowledge of unaccounted mortality; and

c) review and make recommendations on methods used to estimate escape mortality from towed fishing gears.

Workshop on Unaccounted Fishing Mortality [WKUFM]

A workshop (WKUFM) was held at the Fisheries Research Services Marine Laboratory, in Aberdeen, UK, on 25–27 September 2005 to:

a) identify measurable components of unaccounted fishing mortality; and

b) define indices for assessing their relative impacts in key fisheries, for different capture methods.

1.2 Participants

Details of the Participants in SGUFM and WKUFM are listed in Annexes 4 and 5, respectively.

2 An Overview of the Major Sources of Unaccounted Fishing Mortality

2.1 Background

The problem of unaccounted fishing mortality has been recognised since Holt's early work in the 20th Century (Harley *et al.*, 2000). Ricker (1976) first categorised the various potential sources of unaccounted mortality with his review of mortality in the Pacific salmon fishery. These subcategories of fishing mortality were then formalised into a simple unifying model by the ICES Sub-group on Methodology of Fish Survival Experiments (ICES, 1994) which has been further developed by subsequent ICES Study Groups on Unaccounted Mortality (ICES, 1995 and 1997) and other authors (Chopin *et al*., 1996). There have been a number of reviews in the past decade that have discussed the concept of unaccounted mortality, but these have generally concentrated on one particular aspect, namely bycatch and discards (Alverson and Hughes, 1996; Alverson, 1998; Chopin and Arimoto, 1995; and Hall, 1996).

The Study Group on Unaccounted Mortality in Fisheries (ICES, 1995) defined Fishing Mortality (F) as "The sum of all fishing induced mortalities occurring directly as a result of catch or indirectly as a result of contact with or avoidance of the fishing gear". They further recognised the following definable sub-components of F:

$$F = Fc + Fb + Fd + Fe + Fo + Fg + Fa + Fh$$

Landed Catch (Fc): Catch mortality should include all reported or estimated commercial fishing landings, plus landings from recreational fisheries and subsistence fisheries. This subcomponent was not considered in any detail by the previous study groups on unaccounted mortality and it will not be discussed in this report.

Illegal, misreported and unreported landings (F_b): is the mortality of fish that should be accounted for in the landed catch but is not because the records of landings are not reported, underestimated or misreported with respect to area and/or species.

Discard mortality (Fd): is the mortality of fish actively released by fishermen after capture.

Escape mortality (Fe): is defined as the mortality of fish that actively escape from a fishing gear, prior to the catch being landed on deck.

Drop out mortality (Fo): is the mortality due to captured fish dying and dropping out of the gear, prior to the catch being landed on deck. Examples include fish washed out of a codend during trawling or haulback, or fish lost from hooks and gillnets.

Avoidance Mortality (Fa): is the mortality directly or indirectly associated with the stress, fatigue and injuries of fish actively avoiding fishing gear.

Ghost fishing mortality (F_g): is the death of fish being caught in ghost fishing gear; where ghost fishing gear is lost or discarded gear that continues to fish for an indefinite period.

Habitat degradation mortality (Fh): is any mortality associated with the degradation of an aquatic environment as a direct result of fishing activity.

In addition to these sub-components of unaccounted fishing mortality, a number of other sources may by considered as subsets of at least some of these sub-components (namely, discard and escape mortality), for example mortality as the result of enhanced risk of Predation (F_p) and Infection (F_i).

2.2 Sources of Unaccounted Fishing Mortality most relevant to ICES

Unaccounted fishing mortality is recognised as a potential source of error in fishing mortality estimates by most stock assessments working groups (see Annex 2). The members of these working groups were generally satisfied that, with respect to their stocks, all the potential sources of unaccounted fishing mortality had been correctly identified by ICES (1995). Discussions at the WKUFM concluded that of the nine potential sources of UFM identified by ICES (1995), there were four which were of particular relevance to the management of the stocks for which ICES provides advice:

- Illegal, Unreported and Unregulated Fishing
- Discards
- Escape mortality
- Ghost Fishing

Concerns were expressed by a number of the stock assessment WG members that the levels of UFM, particularly IUU, in some fisheries now undermine the validity of the catch data to such an extent that the stock assessment WGs (SA-WGs) can no longer produce analytical assessments based on commercial data for some stocks. Instead survey data are used to estimate relative biomass and trends in total mortality. Therefore it may be argued that all forms of fishing mortality, including all those listed as being of interest to SGUFM, are accounted for by such assessments. Although of course it is not possible to partition each of the components and assess their individual effects.

The following paragraphs provide an overview of each of the four major sources of unaccounted fishing mortality, and supplement and update the more comprehensive reviews provided by the WFTFB Topic Group on Unaccounted Fishing Mortality (ICES, 2000). Particular focus is given to illegal, unreported and unregulated fishing because: i) it is seen as the single most important source of UFM by many of the SA-WGs and ii) substantial developments in methods addressing IUU fishing have been made since ICES (2000) was written.

2.2.1 Illegal, Unreported and Unregulated Fishing (IUU).

Illegal, unreported and unregulated (IUU) fishing is a global problem affecting all capture fisheries, to varying degrees, in both domestic waters and the high seas; irrespective of their target species, fishing gear or scale of the operations (Doulman, 2000; Schmidt, 2004). There are increasing concerns that IUU is a major source of uncertainty in stock assessments, and a serious threat to the conservation and management of global fisheries (Bray 2000; Evans, 2000; ICES, 1994, 2000; and 2004). However it is not a new phenomenon, indeed in some indigenous societies, where traditional conservation measures remain in use, infringement of these conservation rules carries strong social and economic sanctions (Doulman, 2000).

The true global scale of IUU fishing is unknown because most available information is anecdotal. Where more reliable estimates do exist, they have generally been made for fisheries were IUU is perceived to be a particular problem, therefore extrapolation of the estimates to a global or regional scale would introduce an unfair bias. IUU fishing is of great concern among the regional fisheries management organisations responsible for high seas stocks. FAO estimate that the combined legal and IUU catch on the high seas is ~8 million tonnes per annum, which consists mostly of tuna and deep sea species and constitutes a doubling of catch in last 20 years (Schmidt, 2004). CCAMLR estimate the amount of toothfish taken by IUU fishing, between 1997 and 2000, to be ~90,000 tonnes, which was more than twice the level of the registered catches. NEAFC reported that up to 20% of redfish trade in 2001 originated from IUU activities (NEAFC, 2002). While ICCAT estimate that in 2001/2, 25,000 tonnes of

the tuna catch in their region was from IUU fishing, constituting 18% of all tuna fishing activity.

For most ICES stock assessment working groups (SA-WGs) illegal, unreported and unregulated fishing (IUU) represents the single largest potential source of UFM for their stocks (see Annex 2). AFWG report that for NE Arctic cod between 90,000 – 115,000t of catch per annum has gone unreported because of transhipment since 2002. For Baltic cod, WGBFAS estimate that the true catch is between 35–45% greater than is currently reported. Based on observations from vessel detection systems (using satellite imagery), NWWG report that Redfish catches maybe underestimated by 25%. Other SA-WGs are aware of potential biases in catch data due to IUU fishing that are seriously compromising their stock assessments, but presently have no way of quantifying this error (e.g. WGMHSA, WKNSSK and WGDEEP).

2.2.1.1 International Legal Framework

The international community formally recognised IUU fishing as a problem in 1992 at the FAO International Conference on Responsible Fishing, at which the Cancun Declaration was made calling upon FAO to develop an International Code of Responsible Fishing (FAO, 1992). Since then, a progression of international declarations, agreements, action plans and codes of practice have been drawn up (see Schmidt, 2004 for a brief review). Key among these is the International Plan of Action for IUU Fishing (IPOA-IUU)(FAO, 2001) which was originally developed as a voluntary instrument and at the World Summit of Sustainable development (September 2002, Johannesburg, South Africa) targets and timetables were set for implementing the IPOA-IUU by 2004. The IPOA-IUU defines the various IUU activities with respect to their legal status, which are summarised here:

- Illegal fishing is conducted by national or foreign vessels in waters under the jurisdiction of a State (or of a Regional Fisheries Management Organisation [RFMO] to which that state is party), without the permission of that State (or RFMO), or in contravention of its laws and regulations.
- Unreported fishing are fishing activities which have not been reported, or have been misreported, to the relevant national authority (or RFMO), in contravention of relevant laws and regulations.
- Unregulated fishing is conducted on stocks for which no state (or RFMO) has taken responsibility for their management and conservation; or by vessels without nationality (or flying the flag of a State not party to any relevant RFMO) and who therefore do not consider themselves bound by the relevant national laws (or RFMO regulations).

The IPOA-IUU aims to prevent, deter and eliminate IUU fishing by providing countries with a "toolbox" of comprehensive, effective and transparent measures with which they can address IUU fishing, either directly or through the relevant RFMOs. In recent years, efforts by national and regional governments to combat IUU fishing have focused on the IPOA-IUU approach (e.g. EU Commission, 2002).

2.2.1.2 Is IUU fishing a scientific problem?

It has been argued that the mitigation of IUU activities is not a scientific problem, but instead is a matter of management, governance and politics (ICES, 1994, 1995 and 1997). However, discussions at WKUFM concluded that fisheries science could contribute to the resolution of the IUU fishing problem, or at least mitigate its effects, in three important ways:

1) Identify Affected Stocks and Fisheries – many fisheries scientists work directly with fishers and, as a result, have nurtured a mutual trust and respect. This relationship can, and does, produce important information and data on IUU

activities. However, this information can only be used with caution, as it is highly sensitive and often gathered under the strictest confidentiality – betrayal of this confidence would seriously damage the relationship between scientist and fisher.

2) Formulate Practical Solutions – in conjunction with the industry, management and regulatory bodies, scientists at all levels could provide an important contribution to developing mitigating measures and technologies.

3) Develop Approaches to Manage the Uncertainty Generated by IUU – the management of a stock can be seriously undermined by the uncertainty associated with any IUU activities. So, as with other sources of UFM, methods must be developed to estimate the magnitude of the IUU mortality and utilising these data and the uncertainty associated with them in the management of the affected fishery. The utilisation of UFM data is discussed in more detail in section 4.0.

2.2.1.3 Sources of IUU Fishing Mortality

The main driver for IUU fishing is thought to be simple economics (Bray, 2000; Schmidt, 2004); where increased profitability from IUU activities, through increased revenue or reduced running costs, will inevitably entice fishers to flout or ignore conservation and management regulations. Various scenarios may catalyse IUU activity (for a more detailed review see Bray, 2000 and Schmidt, 2004), these include:-

- Ineffective management (including unregulated fisheries);
- Fleet overcapacity and restrictive management measures (e.g. TACs, effort limitation, etc);
- Insufficient and ineffective enforcement;
- Tax benefits, subsidies and investment incentives from "Flags of convenience" states;
- Extra-ordinary economic pressures – e.g. Increasing fuel costs; and
- De-stigmatised perception of IUU activities by society, due to underestimation of environmental and social impacts.

In addition to these key drivers, it should be recognised that once established in a fishery, IUU activities can generate a self propagating cycle (Schmidt, 2004). That is, the illegal activities of one fisher can encourage other fishers to do the same, through economic necessity in some cases or by undermining confidence in the management and enforcement of regulations. Moreover, the uncertainty generated from the IUU fishing undermines the stock assessment of an affected stock, necessitating more stringent management regulations for the fishery. This in turn generates further economic restrictions for the fishers making the option of IUU activity more attractive. Once established, this cycle can be very difficult to break. Furthermore, over time the practice of IUU fishing can become engrained within the culture of a fishing community – effectively de-stigmatising these illegal and arguably anti-social activities (Paton, 2005).

Before considering how to estimate the magnitude of IUU mortality it is necessary to expand the FAO definitions of IUU to give a more informative description of how the IUU activities can manifest themselves.

Illegal fishing – non-compliance with national or RFMO laws and conservation rules can take various forms:

i. Unlicensed fishing – with respect to estimates of IUU this is also likely to lead to non-reporting of catch;
ii. Breaking technical regulations (i.e. Mesh-size/gear specific regulations, minimum landing sizes, non-discarding regulations) – these may not necessarily be associated with non-reporting or misreporting of the catch, but are likely to lead to excessive and/or illegal discarding and therefore additional mortality in non-target sizes and species of fish; and

iii. Fishing in Closed Areas – at best these will generate area misreporting (see below), but may also be associated with non-reporting.

Unreported catch – with respect to estimating the magnitude of IUU associated fishing mortality these infringements of national laws and RFMO conservation rules are of particular interest. They occur as clandestine landings, disguised landings at registered ports or as transhipments to factory vessels at sea, with an associated falsification of official logbooks and landing records.

i. Non-reporting – failure to disclose catch;
ii. Under-reporting – under-estimation of the catch – this may be done deliberately or may result from inaccurate methods for estimating bulks catches (e.g. Røttingen *et al*., 2002);
iii. Misreporting by species – catch of a restricted species may be deliberately disguised as another, unrestricted species; or alternatively, species may be incorrectly identified;
iv. Misreporting by area – deliberating reporting of catches of a species from a restricted or closed area, as originating from another unrestricted area; and
v. Over-reporting – an inevitable result of misreporting by species and area, but may also result from unscrupulous fishers wishing to develop a "track record" in a particular species or area.

Unregulated fishing – failure to manage the conservation of a stock or control a component of the prosecuting fishing will inevitably lead to non-reporting of catch and other sources of UFM (see later sections).

i. Unregulated fishery – of particular concern because no monitoring or management measures will be in place to conserve the exploited stock;
ii. Unlicensed Vessels – are likely to generate non-reporting errors, but may also be guilty of breaking technical regulations and fishing in closed areas.

It is clear, after considering the various sources of IUU fishing, that estimation of the unaccounted catch of target species alone would fail to give a true description of the impact of IUU activities on an ecosystem. Efforts should be made to account for bycatch estimation and other potential sources of UFM when considering IUU. Although this can be difficult because the fishing practices, catch composition and discarding behaviour of illegally operated vessels may differ considerably from vessels operating legally, from which estimates of catch composition and discarding practises are made.

2.2.1.4 Methods for estimating IUU fishing mortality

In a review document for the FAO-IPOA, Evans (2000) explains that considerable progress could be made in accounting for IUU fishing by simply improving monitoring and data collection programmes. Fisheries data can be collected through data reporting from the fishery directly (e.g. mandatory logbooks, catch documentation schemes [CDS], voluntary diary schemes, vessel registration and licensing, and registration of fish processor) and fishery independent data collection (e.g. on-board observers, inspections in harbour and at sea, GPS based vessel monitoring schemes [VMS], satellite imagery vessel detection systems [VDS]).

When the catch and effort statistics from a fishery are thought to be biased by IUU fishing activities, various analytical techniques have been developed and employed recently to generate estimates of the magnitude of the IUU catch. These approaches are reviewed in a recent consultative report to the UK's Department of International Development (MRAG, 2005) and broadly group the methods in two categories: 1) statistical accounting methods and 2) model-based estimation methods. However, these are still dependent to some degree upon the collection of fundamental catch and effort data (Evans, 2000).

Statistical Accounting Methods

1) Comparison of trade based estimates and reported catch – this can in theory be applied to any species using data from catch documentation schemes (CDS) (e.g. bluefin tuna, bigeye tuna and sword in the ICCAT region (Restrepo, 2004) and using import/export data (e.g. toothfish (Lack and Sant, 2001), orange roughy (Lack *et al*., 2003) and Baltic cod (Esmark and Jensen, 2004)). Although, these methods are highly dependent upon the quality and resolution of the import/export data. They can also be confounded by open-market and trade agreements that undermine the reliability of such data (e.g. see Annex 2: WGMHSA).

2) Estimating IUU fishing effort – by estimating the number of unregulated fishing vessels and extrapolating estimates of catch rates, using data from licensed fisheries (e.g. Baltic cod - Anon, 2005; and Tuna in the IOTC region – Herrera, 2002). This method is clearly reliant on the collection of a complex array effort and catch data (MRAG, 2005); moreover it is based on the tentative assumption that the catch rate and composition of the legitimate fishery is representative of the IUU vessels.

3) Incorporation of estimates of bycatch and bird/mammal interactions – the above method (2) can be expanded to estimate the associated bycatch of IUU fishing (e.g. CCAMLR, 2004). But it is again likely to experience considerable biases because the use of selective fishing gears and associated discarding practises by IUU vessels may be very different from legitimate fishing operations.

Model-based Estimation Methods

1) using population models - to estimate the overall unaccounted mortality in a stock from CPUE and fishery-independent survey data (e.g. Gavaris and Van Eeckhaute, 1998; Plagányi, 2004; B-ADAPT – see Annex 2 - WGNSSK). However, it is a mistake to label this misreporting – it could equally be due to a difference between the assumed and the actual levels of natural mortality, for example. This difference is more correctly referred to as “unaccounted removals” (Needle, pers. comm.).

2) quasi-quantitative Monte-Carlo integration – in which all available data on under-reporting (and other sources of UFM) in different regulatory regimes is combined in a single analysis (e.g. Ainsworth and Pitcher, 2005; Pitcher et al, 2002; Pitcher and Watson, 2000). Each regime is scored with respect to its influence on under-reporting; the values being based on available data. Confidence intervals around the estimates of misreporting are derived using a Monte Carlo simulation based on likely error ranges.

3) models of IUU behaviour and surveillance encounter probabilities – where surveillance encounters with both legitimate and IUU vessels are treated as random samples, allowing a relationship between the recorded encounters with IUU vessels and the total (accounted and unaccounted) IUU effort to be modelled (e.g. Agnew and Kirkwood, 2004). Such models should also consider the active avoidance of surveillance by IUU vessels (Ball, 2004).

An advantage of the population model based estimates is that confidence intervals may also be calculated. However, statistical accounting based estimates do not come with estimates of variance. So in stock assessments they are usually included as absolute catch (i.e. treated with same certainty as declared catch) meaning lower levels of uncertainty are implied by the assessment than are actually the case.

2.2.1.5 IUU Fishing and the ICES Stock Assessment Process

Reports of IUU fishing available to the SA-WGs are limited and generally anecdotal. Clearly any sources of IUU information need to be given assurances of confidentiality; otherwise the information may not be forthcoming. However, following discussions with the European Commission (EC), the Annual Meeting of Assessment Working Group Chairs (AMAWGC)

(ICES 2005a) advised that it is no longer acceptable to make estimates of mis- and non-reporting and make corrections to catch data without revealing the sources of both the data and the problems. Thus where information is sensitive to a nation state or an individual skipper, it cannot be utilised by the WGs to adjust catch estimates. This has generated a problem for some WGs, meaning some catch estimates are significantly under-estimated. This issue must be addressed urgently by AMAWGC and ACFM as inclusion of IUU data and information without prejudice is seen as fundamental to the provision of better management advice.

2.2.2 Discard mortality

The group discussed the issues surrounding the global problem of discarding and possible mitigations mechanisms. It is not the intention to report the causes of discards, this has been dealt with in a previous 'Unaccounted Mortality" discussion group (ICES, 2000) and by many other authors (e.g. Alverson *et al.*, 1994 and 1998; Hall, 1996), but rather to consider possible solutions to the problems within the ICES region.

In recent years the estimates of global discards have been significantly downgraded. In 1994 the FAO (Alverson *et al*, 1994) estimated that between 19.9 and 39.5 (mean 27) million metric tonnes of the worlds global catches were discarded, representing almost 30% of the total (see ICES (2000) for a summary of the principal drivers). The mean value of 27 million tonnes is extensively cited in peer and non-reviewed literature, by NGO's, governmental agencies and scientific commissions, including ICES (see Environmental Status of European Seas report, p41). Subsequent to the 1994 estimates, FAO undertook two further revisions, in 1998 and 2005. The 1998 revision downgraded the estimate to ~20 million tonnes. However, the 2005 revision demonstrates a dramatic reduction in the estimate – 7.3 million tonnes, representing ~8% of the global catch. The author notes that the recent estimates are not comparable due to the use of differing methodologies. The reasons cited for this decline have included:

"(i) Greater utilization of bycatch species in Asia and elsewhere for both aquaculture and human consumption; (ii) adoption of more selective fishing technologies and methods; (iii) a decline in the intensity of fishing for some species having high bycatch rates; (iv) a variety of management actions that prohibit discarding in some countries, set bycatch quotas, impose time/area closures, and establish marine protected areas and no trawl zones; and (v) more progressive attitudes by fishery managers, user groups and society towards the need to solve discarding problems."

2.2.2.1 Reducing Discard Mortality at Source

The workshop participants identified a number of possible avenues to reduce the level of discards within the ICES arena.

In a few ICES member and associate countries, Norway, Iceland and Faeroe Islands, managers have implemented a 'no discard' policy, where legislation relates specifically to catch composition, for example, in Norway, if the catch composition exceeds 15% of fish below the permissible catch size, the vessel must move area and the area will be closed until research demonstrates that the composition falls below the 15% level. This has greatly encouraged the uptake of technical conservation measures to reduce bycatch e.g. Nordmøre grids in the *Pandalus* fishery or to increase the 50% retention length e.g. grids in the demersal trawl fishery. To minimise the risk of temporal area closures and gain access to area that would otherwise be closed due to high concentrations of juveniles, the fishing industry in general readily accepts the use of BRD technology, for example the widespread use of Nordmøre shrimp grids the *Pandalus* shrimp fisheries and mesh and size selective grids that ensure that the selection span is well above the minimum catch sizes.

As expected the reported discard levels in these fisheries are small in comparison to other countries, regions e.g. EU. The recent FAO report acknowledges that the banning of discards

in a particular management zone does influence the type of management tools, which tend to be in sharp contrast to those implemented in regions where some degree of discarding is acceptable.

In contrast many of the EU fisheries are governed based on prohibition of catch onboard or landings, this can cause high levels of discards due to a mismatch between mesh selection and minimum landing sizes (MLS) or due to bycatch composition regulations. This is particularly problematic in mixed-species fisheries e.g. *Nephrops.* The workshop participants felt that the abolition of MLS may help reduce discard levels but appreciate that this may encourage the use of less selective gears in the presence of markets willing to purchase small fish. Similarly, when discarding occurs due to quota imbalances (e.g. lack of quota for a particular species); the participants felt that the removal of the quota system and replacement with an effort based management plan would help reduce discarding.

Many of the fisheries in the North East Atlantic suffer from growth over-fishing, where the fishable stock comprises mainly of fish at or below minimum landing sizes. Fishermen thus tend to focus effort on this component of the stock which can result in high level of discarding due to the fact that selection is not knife edged. This also makes it problematic to introduce technical mitigation measures, as the associated short-term losses are unacceptable to the industry.

2.2.2.2 Accounting for Discarding in Stock Assessments

Implementation of the EU Data Collection Regulation (Commission Regulation (EC) No 1639/2001) has resulted in more discard data becoming available. A number of SA-WG members are of the opinion that this data may reduce bias by giving a fuller picture of the numbers of young fish in the stock, but on the other hand, discard sampling rates are often low and the information can therefore be noisy.

The inclusion of new series of discard data in stock assessments is not straightforward. Available discard data are highly variable. The discarding behaviour can change according to fleet, areas, time and importance of a year class. Raising protocols to estimate the total volume of discards in a given stock differ between countries. Sampling and raising procedures therefore need to minimise bias and maximise precision. Unfortunately, it is still difficult to determine the accuracy (or bias) in most discard estimations as raising procedures still rely upon commercial logbook information which suffers from misreporting.

Several methods have been developed to estimate discards of young commercial fish species. These can be considered in two groups; direct and indirect methods of estimation (Sokolov, 2003). Direct methods are based on the measurement of fish directly onboard the fishing vessels (Hylen, 1967; Hylen and Smedstad, 1974; Jermyn and Robb, 1981; Tamsett, 1999). Indirect methods use other data sources and assumptions to calculate discards:

- quantitative estimation of small fish discards can be done on the basis of comparison of length measurements by onboard observers and shore-based sampling of landings (Palsson *et al.*, 2002; Palsson, 2003, Sokolov, 2003);
- results from studies of fishing gear selectivity followed by recalculation of the reported catch (Dingsør, 2001, Matsushita and Ali, 1997);
- analysis of catch length frequencies on the assumption that all fish shorter than a certain length are discarded (Sokolov, 2001);
- interviewing of skippers on their return to harbour and analysis of their reports;
- data provide by skippers directly at sea (Jermyn and Hall, 1978).

The choice of one or another method to estimate discards depends on the availability and completeness of initial data.

Discard information may not be used in stock assessments for a variety of reasons, mainly due to issues relating to data quality and representativity. An example is that sampling effort was not great enough to give a precise enough samples or that it is clear that some ages are missing from the discard information. A further example is that the fleets sampled do not exert a large enough proportion of effort on the stock concerned and other fleet components are likely not to have similar discarding patterns, so again are not representative, and extrapolation is not valid. Another reason cited is that if discarding is not seen to be a large problem, discard estimates have been excluded from analyses as their inclusion was considered to add noise into the assessments.

2.2.3 Escape mortality (F_e)

The use of selective fishing gears has a large potential to reduce fishing pressure on non-target species and juveniles and to reduce discards. Selective fishing gears, however, can be justified only if significant numbers of escaping fish survive. If most of the fish escaping from trawl codends and other selective devices (e.g. small mesh panels) die, conservation measures specifying minimum mesh sizes or other selective devices are of little value. In the worst case, the effect of this type of unaccounted mortality on fish stocks may be negative because the overall mortality caused by exploitation is underestimated. Hence, quantification of the survival rates of escaping fish is of fundamental importance when selectivity is improved.

The results of experiments conducted on post-trawl mortality, here called escape mortality, suggest that mortality is highly species-specific. In general, relatively high survival has been observed for some commercially exploited gadoids such as cod and haddock (e.g. Breen, 2004, Main and Sangster 1990, 1991; Soldal et al. 1993; Sangster et al. 1996; Suuronen et al. 1996a, 2005; Soldal and Engås 1997; Wileman *et al*., 1999; Ingolffson *et al*., 2002). Substantially lower survival rates have been recorded for small pelagic species such as vendace and herring (e.g. Suuronen et al. 1995; 1996b; 1996c). Few studies, however, have adequately and quantitatively explained the full range of mortalities that can occur when fish escape from fishing gears under commercial fishing conditions (Chopin and Arimoto 1995; ICES, 2000; Suuronen 2005).

A number of mechanisms may cause physical injury, stress and mortality in fish; the passage through a mesh or a selective device is not the only potentially damaging factor. In many cases, escape occurs after the fish have been subjected to a wide variety of capture stressors and possible damage through contact with other fish, debris or the gear itself. Fish escaping from fishing gears may suffer immediate as well as delayed mortalities (e.g. Ryer *et al*., 2004). Moreover, changes in water temperature, pressure and light conditions may strongly affect the fate of escaping fish. The robustness and ability of various species to withstand the physical disruptions and fatigue associated with the process of capture and escape vary substantially. The smallest escapees often appear the most vulnerable. Apparently, smaller fish with poorer swimming ability are less able to avoid injury when swimming within the gear and during escape. They may also have less physical strength to make active escape attempts, and may therefore stay longer inside the gear before escaping. The smallest fish are generally also more delicate than larger individuals, and are therefore more susceptible to all types of capture-induced injury. Nevertheless, the specific reasons why some fish ultimately die are still poorly understood. Until the effects on mortality of various critical factors and their interactions are better understood, there will be a lack of confidence in generalising escape mortality results to a wider range of fishing conditions, gear designs and operations and fish species. Further work is required to identify the damaging mechanisms that cause injuries.

Research on the mortality of fish escaping from fishing gears has tended to focus on the mortality of fish kept in a sheltered environment such as a sea bed cage, for a relatively short time. Factors such as predation on injured fish and the ability of a fish to recover fully from its injuries or stress are more difficult to monitor, and are therefore poorly understood. The fate of fish after multiple encounters with fishing gears is largely unknown. Moreover, the cumulative effects of all stressors are likely to have a strong influence on the probability of long-term survival. These areas clearly require more investigation. Methods for assessing escape mortality rates across a wide range of fisheries and environmental conditions are not yet adequate. It is necessary to develop appropriate methodologies, collect more realistic data and obtain a better understanding of the main sources of injury; stress and mortality under various conditions (see Lehtonen et al. 1998; Breen et al. 2002; Breen 2004; Suuronen 2005).

Developing gear modifications that guarantee high chances of survival for escapees requires a good understanding of how fish react to gear under various conditions, including in situations when vision is limited or not operative (Suuronen 2005). Clearly, fish that should escape from a fishing gear should stay inside the gear for as short a time as possible, and should not enter into the aft part of the codend where the risk of serious injury is highest. Installing escape panels or other sorting devices in front of the codend would probably enhance the escape and survival chances of undersized fish. It is evident that voluntary escape will cause less injury to fish than mechanical sorting. Hence, facilitating the voluntary escape of fish through appropriate constructions and operational improvements would increase the likelihood of survival. Use of non-abrasive netting materials, exclusion of debris and large objects from the codend, and use of better gear designs and riggings would further enhance the survival likelihood. It is clear that there is still substantial scope for improving the survival of trawl escapees by using better gear modifications and operational solutions.

It is worth noting that the fate of escaping fish is becoming increasingly important because of a recent strong tendency among fisheries management authorities to increase minimum mesh sizes and/or to use various other controls that improve selection (e.g. Suuronen 2005). If mortality is high, the benefits of changing selectivity may be largely overestimated (Breen and Cook, 2002). For many important fish species there are insufficient estimates of escape survival to conduct an assessment of its impacts on stocks and fisheries. Failure to quantify the biological impacts of this largely unknown mortality could result in biases in fisheries management decision-making processes.

2.2.4 Ghost Fishing

Ghost fishing occurs when passive gears such as gillnets, trammel nets, tangle nets or even pots are lost or discarded and continue to fish, catching commercial and non-commercial fish and crustaceans, as well as marine mammals, sea birds and turtles (see Brown et al, 2005, for a comprehensive review). Concern over ghost fishing has been heightened recently due to the fact that modern gears are made of non-biodegradable materials that can continue to catch fish for long periods. The main causes of gear loss as identified in the EU funded Fantared study (EC contract FAIR-PL98-4338) includes:

- Conflict between the towed and static gear sectors;
- Water depth;
- Working rough ground/hauling in poor weather conditions;
- Poorly made and inappropriately specified gear;
- Working very long fleets of nets; and
- Working more gear than can be hauled regularly.

Over time, increasing catch weight causes nets to collapse and attract scavenging organisms, but once the nets have been cleaned they may clear and resume “ghost-fishing”. The ultimate

length of this fishing cycle will depend on a number of environmental parameters such as tide and weather as well as biological effects such as marine fouling, which increases the visibility of nets reducing catch efficiency over time. In inshore waters it would appear that lost nets have minimal impact as the gear tends to fouled up quickly, however in deeper waters, bio-fouling stops occurring and water movement slows substantially. This is thought to be a particular problem at depths greater than 200m. In these circumstances prolonged ghost fishing is possible and this is born out by the experiences of Norway (*Humborstad et al, 2003)* and Canada (*Way, 1976*), where retrieved nets several years old have been found actively fishing.

2.2.5 Considering other potential sources of UFM

It was discussed during WKUFM that while "Drop-out", "Avoidance", "Predation" and "Infection" mortality were all theoretically possible, their further consideration by SGUFM at this stage would be of little benefit because so little is known about their likely respective magnitudes in any fishery. "Dropout" mortality would be very difficult to differentiate from current estimates of escape mortality using the methods presently used to estimate the latter; since the pre-escape status of individual fish would need to be known by the experimenter prior to their escape. "Avoidance", "Predation" and "Infection" mortality can all be considered together as "Delayed" mortality, where the stresses of interacting with a fishing gear can lead to physiological, behavioural and immunological impairment. Although these theoretical sources of unaccounted fishing mortality are now supported by a growing body of experimental evidence (Davis, 2005; Ryer, 2003; Ryer *et al*., 2004 and Sneddon *et al*., 2003), it is unlikely that any reliable estimates of their magnitude will be defined in the foreseeable future.

Concerning "habitat degradation", it has been suggested that the alteration of seafloor habitat, caused in particular by towed demersal gears, may result in additional unaccounted fishing mortality as a result of the reduction in available resources (i.e. removal of food or space). This may be particularly important where areas of 'Essential Fish Habitat' (e.g. nursery grounds) are affected. However, although there have been a number of key publications describing how habitats are altered by different fishing gears (For reviews see Auster and Langton, 1999; Johnson, 2002; Thrush and Dayton, 2002), and there is evidence of changes in fish community level indicators related to homogenisation of habitat (Auster *et al.*, 1996; Auster, 1998; Veale *et al.*, 2000; Thrush and Dayton, 2002), there is little, or no way of quantifying the actual mortality to different species that may occur as a result of this. In addition, this mortality is not a direct effect of fishing; it is an indirect effect or consequence of the direct effect – habitat alteration. Thus it was felt that it is important to distinguish between the direct effects of fishing (mortality and alteration of habitat) and the consequences of these effects (indirect effects), which ultimately depend on the interaction of the direct effects with other factors important in driving variability in population and community structure and size (e.g. other biotic or abiotic drivers). The significance of making this distinction is that although there is potential to incorporate the direct effects of fishing in increasingly realistic indices of unaccounted mortality, it is not sensible to try to include the indirect effects.

3 Unaccounted Fishing Mortality and the Precautionary Approach

The precautionary approach and the precautionary principle introduce alternative ways of handling uncertainty in science for policy. In this section some aspects of the precautionary approach will be presented considered relevant for the handling of uncertainty in unaccounted fishing mortality in fisheries advice. The way the precautionary approach is made operational in fisheries management is more or less limited to the implementation of precautionary reference points. Standard ICES advice and communication makes it difficult to include unaccounted fishing mortality in stock evaluations if it is not quantified within a certain standard. An example will be presented to illustrate the possibilities and the limitations within the ICES framework. The section will conclude with some alternative approaches on how to handle the uncertainty in unaccounted fishing mortality in ICES advice.

3.1 The Precautionary Approach

The origin of the concept of the precautionary principle is as *Vorsorgeprinzip* in Germany. The rhetoric of precaution then moved via *a precautionary measure* and *a precautionary approach* to *the precautionary principle* (Adams, 2002). The difference between the concepts is vague, but Adams (2002) suggests that the precautionary principle is more general and allows to be applied to different situations. While *a precautionary approach* and *the precautionary principle* are concepts regularly used in white papers and international agreements, their actual implementation in decision-making is often unclear. This has generated some criticism of the principle with claims that it is unable to make operational. Sandin *et al.* (2002), on the other hand, claim that the precautionary principle is no vaguer than other decision principles and that it can be made precise through elaboration and practice. Adams (2002) recognizes that agreements may not be specific on how to implement the principle, but argues that the principle enables a debate of how to take into account the different interests at stake. Thus, what it means in practice is a matter for negotiation between the stakeholders involved in the particular case and that the principle is an alternative to purely technology-based management.

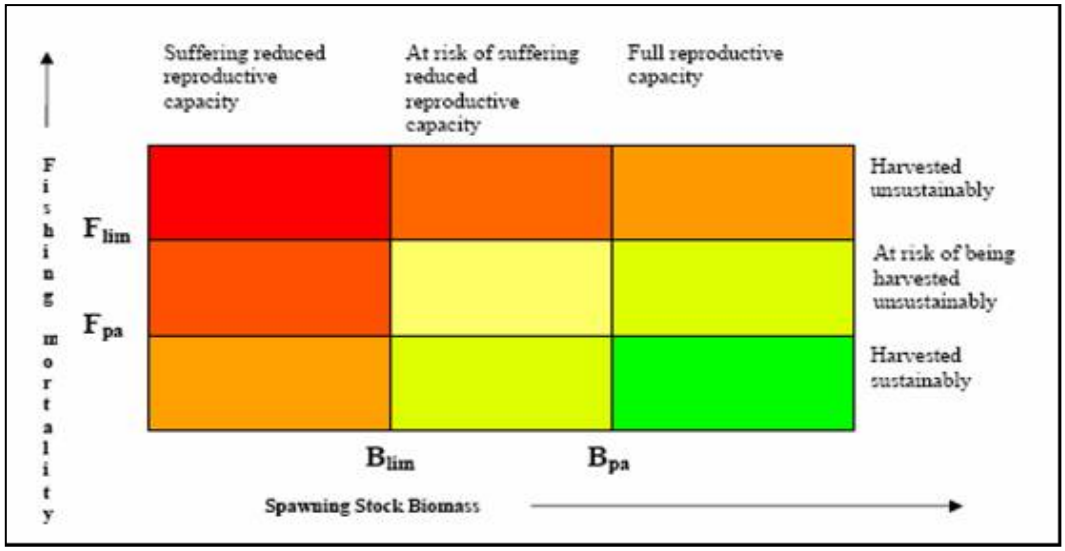
Management in accordance with the precautionary principle is based on science, but there is an acceptance of uncertainty in scientific knowledge. This has been articulated as a *shift in burden of proof*, meaning that action can be taken before an environmental danger is proved. Another element of the precautionary principle is *the polluter pays*: the burden of proof in demonstrating that a particular technology, practice or product is safe should lie with the developer, not the general public. Also the polluter should pay for any environmental damage created.

Agreements based on the precautionary principle normally assume that the uncertainty is reducible with time and effort. The academic literature reflects a more radical view on the role and the capability of science for policy (Wynne, 1992, Funtowicz and Ravetz, 1990 and 1991, Gibbons *et al*., 1994, Nowotny *et al*., 2001) arguing that the most important aspect of the preventive paradigm is that it implies an acceptance of *limitations* of science. Uncertainty may not be reducible due to the complexity of, say, the ecosystem and human behaviour. Because of this complexity, scientific knowledge is built on assumptions like simplifications and generalizations, which may affect scientific advice to a high degree. In worst cases, advice may become irrelevant or wrong. The literature listed above argues that assumptions should be open to the public for scrutiny to discuss the uncertainties in assumptions, what implications they may have and how this should affect decisions on environmental issues.

3.2 ICES and the Precautionary Approach

The UN Fisheries and Agriculture Organisation (FAO) have had a major influence on how the precautionary approach (PA) was made operational in fisheries management of ICES stocks. First of all FAO defines the precautionary "approach" to have less legal significance than a "principle" and less sensitive to radical application. For example, there is little implication of *the polluter pays* within the EU fisheries. The fisheries have no obligation to prove that there is enough fish to fish, and have no economic responsibilities to the public when a fish stock is depleted.

The most distinct change in fisheries management in relation to the precautionary approach is the implementation of precautionary reference points. ICES has to some extent adopted the framework presented in the Annex II of the UN agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks (UN, 1995).



The precautionary reference points (PA reference points) are illustrated in the "precautionary flag" (ICES, 2004a (p. 1–7)). Below the spawning stock biomass level of $\mathbf{B_{lim}}$ the stocks is thought to suffer reduced reproductive capacity. Because of the uncertainty in stock assessment, a buffer, $\mathbf{B_{pa}}$, is defined to ensure a low risk of actually crossing $\mathbf{B_{lim}}$. Likewise, $\mathbf{F_{lim}}$ is defined as the upper limit of sustainable fishing, and $\mathbf{F_{pa}}$ ensures a low risk of crossing $\mathbf{F_{lim}}$. $\mathbf{B_{pa}}$ and $\mathbf{F_{pa}}$ are thus operational or management trigger reference points.

The precautionary approach has had little influence on the science supporting fisheries management. The actual change was defining the precautionary reference points at a more cautious level than management advice was based on earlier. There has been a move towards involving stakeholders in fisheries management and more transparency in scientific advice, but yet it is far from what was discussed in the previous section.

For the discussion in the next section, it is worth noting the following: a) the PA reference points are based on experienced stock fluctuations and uncertainties, implying that future uncertainties like a considerable increase of black landings is not reflected in the risk considerations, b) in most cases the PA points are the only quantified uncertainties of spawning stock biomass and fishing mortality rate and c) together with caveats in the text, the PA points are the only communication of uncertainty in ICES advice.

3.3 Unaccounted Fishing Mortality in Management Advice

In management advice, it may be necessary to address unaccounted fishing mortality in two situations: a) to improve the precision of stock assessments (by including quantified information on discards, black landings or other mortality that is not reported) and b) where unaccounted fishing mortality is thought to be undermining the effectiveness of conservation management measures, resulting in detrimental effects on the exploited stock and ecosystem.

ICES advice has since 2004 had some standard headings where uncertainties and concerns can be addressed: *Management considerations, Factors affecting the fisheries and the stock (*where relevant sub-headings are *Regulations and their effects* and *Changes in fishing technology and fishing patterns)* and *scientific basis* (where the relevant sub-heading is *Uncertainties in assessments and forecast)*. The problems under these headings are normally expressed as text. In the advice on Northeast Arctic cod (ICES, 2005b) the problem of illegal trans-shipping was addressed under *Single stock exploitation boundaries* in addition to the three main headings listed above.

In the next section we will look closer at an example on how ICES has handled non-reported catches and discuss how this was communicated in ICES advice.

3.3.1 An Example: Northeast Arctic Cod and Trans-shipping

The ACFM advice in 2003 included the following warning in the text (ICES, 2003): "*Concerns about underreporting of catches in recent years continue. Both discards and unreported landings will reduce the effect of management measures and it is important that management agencies ensure that all catches are counted against the TAC regulations*." There is no indication on the level of this problem and, as will be argued, the presentation of the advice actually undermines the problem.

Table 1: Forecast for 2004 (ICES, 2003).

Basis: F(2003)=$\mathbf{F}_{sq}$=0.70; Catch=578; SSB(2004)=652.

***F**(2004)*	*Basis*	*Landings (2004)*	*SSB (2005)*
0.00	*0*	*0*	*1189*
0.25	*0.36*$\mathbf{F}_{sq}$*	*266*	*965*
0.40	*$\mathbf{F}_{pa}$ (=0.57*$\mathbf{F}_{sq}$)*	*398*	*858*
0.44	*Catch rule 2 (=0.63*$\mathbf{F}_{sq}$):1.1*2003TAC*	*435*	*830*
0.50	*Catch rule 1 (=0.73*$\mathbf{F}_{sq}$)*	*486*	*788*
0.70	*1.0*$\mathbf{F}_{sq}$*	*623*	*682*

Weights in '000t.

Shaded scenarios considered inconsistent with the precautionary approach.

One of the main components of ICES advice is the catch forecast table (Table 1). The first row of the table explains the choices for parameters in the intermediate year. Remember, the advice was given in 2003 so that the fishing activity is not yet ended for that year. The fishing mortality rate for that year is chosen to be the same as estimated for 2002, the catch in 2003 the same as the agreed TAC and SSB is the predicted spawning stock biomass after fishing in 2003. The left column contains different options of fishing mortality rates (F), followed by a column with the reason for choosing the specific Fs (not important in this connection), the total catches associated with the F options and the level of spawning stock biomass after the following year's landings. The shaded areas of the table are options not considered consistent with the precautionary approach. The advice for 2004 was (which can be read from the table) to keep the catches below 398 000 t.

A quick glance at the number of non-zero digits of the numbers in the table indicates an uncertainty of a couple percent. This gives the impression that although there is a problem expressed in the text, it is not considerable as the advice is presented with a high precision. The uncertainty is still handled only through defining the precautionary reference points, and there is no indication in the advice that the uncertainty is not taken care of. Indirectly, this means that the risk calculations include this uncertainty.

The ICES advice has indirectly taken care of the underreporting in the predictions. The problem is handled by setting the fishing mortality rate in the intermediate year (2003) to the F the previous year as the basis for predictions. This gave a higher F in the intermediate year to compensate for the quite common problem of underestimating F. (From 2004 this was changed to the average F from the last 3 years.)

The message of unreported landings is quite vague. ICES operates with a false precision in advice and tables which gives an expression that exact advice can be provided although there are problems. In other words, the problems are under control. The problem of non-reported catches has been handled in an ad hoc way by altering F in the intermediate year. However, this "works" only if F previous year (or *years*) has been higher than the F corresponding to that year's TAC. It is also a very indirect way of dealing with unreported catches and lacks transparency.

The year after, in 2004, Norwegian authorities had provided estimates for trans-shipped cod in 2002 and 2003: 90 000t each year (ICES, 2004b). In 2005 the estimate for 2003 was revised to 115 000t and trans-shipped cod was estimated at 90 000t for 2004 (ICES, 2005b). To get an idea of the dimension of these illegal catches, the TAC in 2002 and 2003 was 395 000t and in 2004: 486 000t (ICES, 2005b). From 2004, estimates of trans-shipping have been added to the reported landings in the assessment of the stock.

3.4 Various solutions

The above example illustrates that ICES can handle illegal catches when it is quantified, but without estimates the ICES way of producing and presenting advice can contribute to conceal a problem rather than communicate it. Now follow some ways to address unaccounted fishing mortality that is uncertain.

3.4.1 Precision

Make sure that the precision in ACFM advice is real. When problems of uncertainty, like unaccounted fishing mortality, are addressed in the text but its consequences are not demonstrated, a false precision gives the impression that the problem is not so serious after all. The ICES Working Group on Fishery Systems has addressed this problem and states that the precision is in conflict with transparent and credible advice (ICES, 2004c). ICES still needs a push to recognize that the idea of significant digits is a good rule of thumb, a matter of scientific dignity and that it is the standard way of presenting numbers.

3.4.2 UFM presented as text

When the numbers in advice are presented with a real precision, warnings or concerns in the text make more sense. As mentioned in a previous section, there are some standard headings in ICES advice that are relevant for UFMs: *Management considerations, Factors affecting the fisheries and the stock* (where relevant sub-headings are *Regulations and their effects* and *Changes in fishing technology and fishing patterns*) and *scientific basis* (where the relevant sub-heading is *Uncertainties in assessments and forecast*).

3.4.3 Scenarios of UFM

Addressing uncertainties in the text without demonstrating or explaining their consequences on advice is not very informative. There is a common hesitation to include non-quantified information like UFM because a chosen quantity (a guesstimate) is perceived as arbitrary and non-scientific. The common solution is to ignore the problem when assessing the stock and to try to compensate with ad hoc solutions (see example above). But does this mean that the quantity zero is less arbitrary or the status quo F? A more neutral way of dealing with the problem is to present scenarios with different reasonable levels of UFM. The options should be prepared so that they can be directly used in assessments. Then the working groups can carry out assessment runs with alternative input to demonstrate their implications.

3.4.4 Secondary risk

If the unaccounted fishing mortalities add considerably to the assessment uncertainties the uncertainty is not reflected in the precautionary reference points. Uncertainties not included in risk assessments are called *secondary risks* (Wynne, 1992). Secondary risks can be fatal when a stock is estimated to be outside the "border" of precaution. One solution to this problem is to alter the precautionary reference points to include additional uncertainty and risk. Alternatively, if a specific uncertainty cannot be included in the evaluation of a harvest control rule, the Study Group on Management Strategies (ICES, 2005c) recommends that it should be stated that: 'the HCR might not be in accordance with the precautionary approach because the assumptions that the advice system rests on is violated and that the consequences are unknown.'

3.4.5 Non-scientific problems

When unaccounted fishing mortalities are thought to be considerable but uncertain, the problem is a management problem more than a scientific problem. Quantified advice can be misused to legitimise management decisions, as considerations only addressed in the text look weak. Scientists should consider the role of scientific advice carefully when uncertain advice is given, especially when stocks are in a critical state. Uncertainty can make it impossible to produce quantitative advice that makes sense. In such cases, quantified advice should not be given. Management in accordance with the precautionary approach should focus more on regulation, enforcement, incentives, social security etc than quantified stock assessments.

4 A preliminary review of the status of "unaccounted fishing mortality" (UFM) in ICES stock assessment working groups

In order to assess the current status of "unaccounted fishing mortality" (UFM) in the ICES stock assessment working groups, a preliminary review was conducted to determine for each stock the perceived level of concern about the potential sources of UFM and the degree to which these sources were being taken account of in the stock assessment and resulting advice. The information presented in this preliminary review should not be considered definitive and it will be updated and expanded in 2006 by SGUFM and members of the SA-WGs, as described in section 4.0. The review utilised information and data from the ICES Joint ACFM and ACE Advice Report 2004, the stock assessment working group reports and personal correspondence with, and contributions from, the stock assessment working group chairmen and members. A summary of the results of the review are presented in this section and Annex 1, while the details of the correspondence with the stock assessment working group chairmen and members is summarised in Annex 2. Annex 2 also presents some examples of the data used when UFM information is accounted for in stock assessments and fisheries advice.

The availability of estimates and their utilisation is summarised (in Annex 1) for each potential source of unaccounted fishing mortality: no significant level of mortality (A); estimates available and included in stock assessments (B); estimates available but excluded for stock assessments (C); no estimates available (D); and no available information (blank). Where estimates are available, an approximate grading of the quality of the data is given: Reliable (1); suspect or incomplete (2); and unreliable (3). Of the ~150 stocks on which ICES currently gives advice, 37 have been defined by the Advisory Committee for Fisheries Management (ACFM) as "critical species" within their respective ecosystems (see Annex 3 for an explanation of "Critical Species"). The "critical" status of each stock is also listed in Annex 1.

Figure 1a) IUU's - All stocks

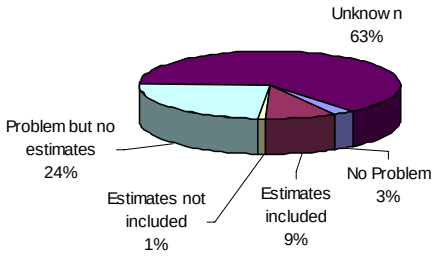


Figure 1b) Discards - All stocks

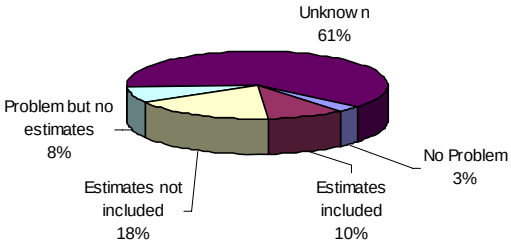


Figure 2a) IUU's - Critical stocks

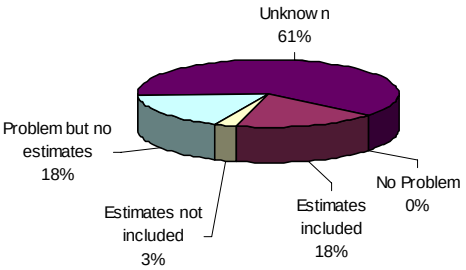
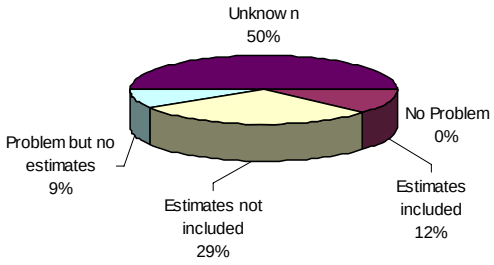


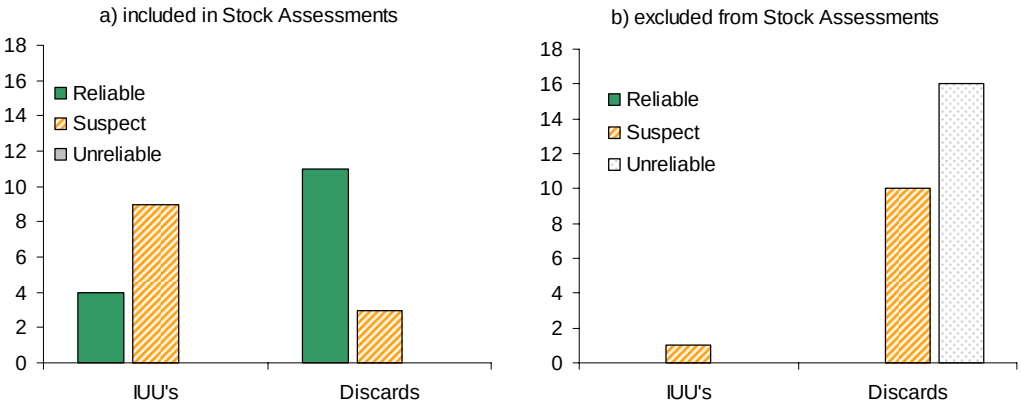
Figure 2b) Discards - Critical stocks



It is clear from Annex 1, that four of the sources of unaccounted fishing mortality are recognised as potential sources of error in estimates of fishing mortality by any of the stock assessment working groups: Illegal, unreported and unregulated fishing (IUU); discard mortality, escape mortality and ghost fishing. Although, concerns about escape mortality and ghost fishing have only been expressed by NWWG and WGDEEP, respectively, and no estimates have been included in any assessment. Moreover, for the great majority of stocks there is no information available about the perceived risk of errors due to unaccounted fishing mortality. This may simply reflect the fact that unaccounted mortality indeed presents no risk in these stocks, but is more likely to result from a failure to recognise the problem or at least report it. Where the occurrence of UFM in a fishery is recognised, there appears to be a paucity of data on which to base estimates of IUUs for inclusion in any stock assessments (Figures 1a and b). There are more estimates of discard mortality for affected stocks, which is likely to be due to an increased availability of data resulting from the implementation of the EU Data Collection Regulation (Commission Regulation (EC) No 1639/2001). However, the majority of these estimates are excluded from the stock assessment analysis.

It is interesting to note that for the critical species, there is a greater perceived risk of the occurrence of both IUU and discard mortality (Figures 2a and 2b). Moreover for these species, were there is a perceived risk of UFM, estimates are available for both IUU and discards for a greater proportion of the affected stocks. This may reflect the fact that these stocks, due to their critical status, are subject to more restrictive management controls that by their nature: increase the likelihood of IUUs; or the negation of technical measures, thus increasing discarding. Alternatively, it may be the result of a focused effort by the respective stock assessment working groups to maximise the data available for estimating fishing mortality in the stocks which are greatest risk of over-exploitation.

Figure 3: Data Quality of UFM estimates.



Finally, where UFM estimates are available they appear to be of varying quality (Figures 3a and b). Some estimates are clearly so unreliable, that despite the need for UFM data they are excluded from the stock assessment analysis. This is particularly true for discard mortality, explaining why the majority of estimates are excluded from the stock assessments. More detailed explanations for some of these exclusions are presented in Annex 2, but this problem requires further investigation to establish why such data is excluded and, more importantly, what requirements the stock assessment working groups have for valid data. Interestingly, estimates of IUU appear to be more readily acceptable for inclusion in advice, with a greater perceived confidence in the data, despite the clandestine nature of this source of mortality. This may demonstrate certain pragmatism among the SA-WGs in utilising “non-scientific” IUU data, whereas they are more openly critical of discard data which has been collected through dedicated scientific sampling programmes.

5 A Proposed Workplan for SGUFM – An Assessment of the Impact of Unaccounted Fishing Mortality on Fisheries Management in ICES

The WKUFM concluded that, from the SGUFM review of the UFM information currently considered in the advice on stocks provided by the stock assessment working groups (SA-WGs) (Section 3.0 and Annexes 1 and 2), it was clear that the SA-WGs did not have access to all the available information and data on UFM. More importantly, it was apparent from the correspondence with the chairmen and members of the SA-WGs that their considerable workload meant they could dedicate only limited resources to this additional task.

It was decided that SGUFM could assist the SA-WGs in their work by:

- sourcing relevant and usable UFM data and information;
- highlighting methods and approaches for including these data in the stock assessment process;
- identifying stocks for which the uncertainty due to UFM may seriously undermine the management of that fishery; and
- assessing the impact of including UFM data and information on the management of selected fisheries.

These actions will be coordinated into a dedicated impact assessment, to be undertaken by SGUFM over the remainder of its tenure. The impact assessment will take a two level approach: 1) A qualitative assessment of all critical stocks; and 2) a semi-quantitative assessment of selected stocks.

5.1 Qualitative Assessment

Building on the results of the preliminary assessment described in section 3.0, a review will be undertaken to identify further sources of data and information on the four major sources of UFM for all critical stocks, by fleet (nation) and gear. This review will initially focus on the critical stocks, but will also consider stocks for which significant levels of UFM exist that may seriously undermine the management of that fishery. It is necessary to stratify the assessment to the level of gear-type because the selective properties of different fishing gears and the operation of those gears mean the resulting discard; escape and ghost-fishing mortalities will have gear specific properties. Moreover, it will also be necessary to assign an estimate of relative effort/fishing power for each gear-type to determine the relative importance of any associated fishing mortality.

For each critical stock and for each major source of UFM (by fleet and gear), a qualitative score will be given for the perceived bias to F and on the quality of data on which that judgment is based. These qualitative scores will be based on the following criteria:

Qualitative score on perceived bias to F:

A. No perceived Risk of additional mortality
B. Significant source of additional mortality but accounted for in SAs
C. Significant source of UFM not addressed by SAs, but estimates available
D. Significant source of UFM not addressed by SAs and no estimates
E. No information

Qualitative score on information/estimate sources:

1. Refereed publications
2. non refereed, but reliable publication/report/data
3. suspect / incomplete data
4. anecdotal information
5. Unreliable

The review described earlier in this report took a similar approached to this qualitative assessment, but only described the status of the SA-WGs' knowledge and actions with respect to UFM at a stock level. This proposed qualitative assessment will be more in-depth, describing the UFM status of each critical stock to the level of fleet and gear-type. Moreover, information will be sought from: non ICES scientists and academics, the fishers' representative organisations, national fishery protection agencies and non-governmental organisations, in addition to the members of the ICES SA-WGs and other expert groups.

5.2 Semi-quantitative assessment

It was proposed that based on the results of the qualitative assessment, a number of stocks would be selected to be assessed at a semi-quantitative level, at a dedicated workshop in 2006. The criteria used to select the stocks for assessment would be:

- Perceived potential for UFM to undermine the management of the stock;
- Range and reliability of UFM data for the stock; and
- Co-operation from the respective SA-WG.

The workshop would be used to develop methods to allow the stock assessment working groups and fisheries managers to give due consideration to unaccounted fishing mortality for sensitive stocks, even were the available data is poor. It will consider not only the inclusion of UFM data into the relevant stock assessments, but also the management of the uncertainty generated by this data and/or other more anecdotal evidence. For this to be a worthwhile process, it is clear the direct involvement of members of the respective SA-WG for the selected stocks will be paramount. It is also essential that the transparency issues surrounding use of IUU information be addressed.

5.2.1 Inclusion of UFM information and data in Fisheries Management Process

Methods for including UFM data in stock assessments have been identified, moreover in some cases are being utilised by some SA-WGs in the assessment of a limited number of stocks (see section 2.2.2.2 and Annex 2). The selection of method used to apply UFM data to a stock assessment is dependent not only on the format of the data, but also the source of the UFM.

Four basic formats of UFM data were identified by SGUFM:

Type 1 – a matrix of absolute values or estimates of UFM in terms of year and length or age, to be added to the catch data for a stock.;

Type 2 – an algorithm or raising factor applied to the catch data, in terms of length or age, and year;

Type 3 – a simple estimate or multiplier to raise the catch data, without reference to length or age; and

Type 4 – reliable anecdotal information, without reference to magnitude.

Source dependent data characteristics include:

IUU – At best, estimates of IUU are most likely to be type 3, but will more commonly consist of anecdotal evidence (type 4) (Evans, 2000).

Discards – Examples of type 1 data already exist for discards in terms of the number/weight of discarded fish (e.g. WGNSSK, Annex 2). However, it is also possible the selection characteristics of the fishery may have been described in terms of an algorithm or discard selectivity ogive (type 2), based on data from monitoring programmes. Moreover, estimates of the survival of discarded animals may also be

available, which are likely to be type 2 data. Although, a 100% discard mortality rate is often assumed.

Escape – This data is usually generated by experimental studies and is predominantly type 2. A description of the retention characteristics of the species, with respect to gear type, is essential; along with an estimate of escape survival. Moreover, a description of the exploited population in terms of length or age will be necessary, if the escaping population is to be estimated from the catch data alone.

Ghost Fishing – Estimates of mortality due to ghost fishing should be derived from a measure of increased effort from the "ghost fleet", and as such are likely to take the form of a type 3 estimate. The effort raising factor will take account of: the estimated amount of gear lost or abandoned; the longevity of the gear; and the efficiency of the gear over its expected lifetime.

Where type 1 estimates of UFM exist, methods are well established among the SA-WGs for the inclusion of these data in stock assessments (e.g. 2004 WGNSSK report (ICES CM 2005/ACFM:07)). A number of methods have been identified for using type 2 data to estimate UFM from catch data and including those estimates in stock assessments (e.g. Björnsson and Jónsson, 2004; Breen and Cook, 2002; Harvey *et al.*, 2000; Serafino, 2005). Although, these estimates are inherently less accurate than type 1 data, they do provide a useful means of accounting for UFM in the management of a fishery, particularly were the UFM is related to size/age (e.g. Escape mortality – Sangster *et al*, 1996, Suuronen *et al*, 1996b). Type 3 data, while seemingly crude in many cases, should under the "precautionary approach" still be utilised by the fishery managers to provide a simplistic raising factor for existing estimates of landed catch.

In the event that only anecdotal evidence for a source of unaccounted fishing mortality is available, various analytical methods can be employed to give an estimate of the difference between reported and actual removals (e.g. ADAPT – Gavaris and Van Eeckhaute, 1998; and B-ADAPT – see Annex 2 – WGNSSK).

5.2.2 Managing the Uncertainty Associated with UFM Information

At WKUFM a convincing presentation was made (Hauge, 2005 – presented in Section 3) which summarised a number of considerations for how to manage a fishery where considerable uncertainty existed in the catch estimates due to UFM. These included:

- Make sure the precision in ICES advice is real. Otherwise it is in conflict with transparent and credible advice (FSWG, 2004).
- Where UFM is strongly suspected but is not implemented in the stock assessment, PA points or the HCR: ICES should state that the HCR might not be in accordance with the PA (SGMAS, 2005).
- Present assessment scenarios with different "estimated" levels of UFM, to establish the relative impact of the uncertainty upon management decisions.
- If a stock has crossed the borders of precaution and UFM is thought to be a problem, *the problem is not a scientific one*. Science can be misused to legitimise management decisions. In such cases the precautionary approach should rather focus on enforcement, incentives, social security etc.
- When uncertainty makes it impossible to produce advice, REFUSE and explain why.

Concerns have been expressed by some members of the SA-WGs about including arbitrary estimates of UFM in stock assessments. Haugh (2005) argues that failure to include any estimate is an equally arbitrary action. Moreover, such an action is clearly counter to the

precautionary approach and contravenes the UN Fish Stocks Agreement (to which all ICES member states are signatories) which states in article 6.2:

> *"States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures."*

Finally, where this approach of providing elevated estimates of total fishing mortality proves to be impractical or unacceptable, serious re-examination of the use of catch based controls on a fishery, as opposed to effort based controls, should be considered (Cotter et al, 2004).

6 Conclusions and Recommendations

Unaccounted fishing mortality can be a source of bias in the estimation of total fishing mortality for a considerable number of stocks on which ICES currently gives advice, including many "critical" species. Illegal, unreported and unregulated fishing (IUU) and discarding are of the greatest concern to the stock assessment working groups at present. Other potential sources of unaccounted fishing mortality (e.g. escape mortality and ghost fishing) may also be affecting some fisheries, but as of yet their impact has not been properly assessed.

The greatest obstacle preventing ICES working groups from including information about unaccounted fishing mortality in their stock assessments is the acquisition of accurate and usable data. This same problem was highlighted by the WGFTFB Topic Group on Unaccounted Mortality in Fisheries (2000), yet little progress has been made since. From both reviews, it appears that the scale of this problem is substantial, but this must be resolved if progress is to be made by ICES in implementing the "Ecosystem Approach to Fisheries Management". However, it was also recognised by SGUFM that, with particular reference to illegal and misreported fishing activities, where information is sensitive to a nation state or an individual skipper, it cannot be utilised by the SA-WGs in stock assessments due to transparency issues. This presents a major a problem to some SA-WGs, meaning some catch estimates may be knowingly and significantly under-estimated.

The following recommendations were made by WKUFM to the ICES Study Group on Unaccounted Fishing Mortality [SGUFM]:

- Establish specialist sub-groups / coordinators in the following areas: IUU, Discard, Escape mortality, Ghost fishing, and stock assessment / management application;
- Maintain ongoing dialogue with the stock assessment working groups, and provide feedback on UFM info between SGUFM and SA-WGs;
- Establish dialogue with other ICES expert groups – AMAWGC, WGSTAL, SGFI, PGCCDBS, SGMAS, SGMSNS, SGBYSAL, WGRED, WGECO and WGMG;
- Explore why UFM data is excluded from some stock assessments and investigate whether this may be resolved;
- Undertake a more comprehensive review process to establish the current level of knowledge on unaccounted fishing mortality by –
  - i) Describing UFM with respect to individual gears types in each fishery; and
  - ii) Including sources of data not considered by stock assessment WGs;
- Hold a workshop (April 2006) to explore and develop methods to allow the stock assessment working groups and fisheries managers to give due consideration to unaccounted fishing mortality for all stocks. Apply indices/estimates of UFM to selected stocks, in collaboration with relevant WG members and assess the sensitivity of stock assessments to assumptions of UFM.

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Annex 1: Summary of a Preliminary Assessment of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments

Appendix 1a – Preliminary Summary of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Regions 1–2).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Capelin	1	Barents Sea	Subareas I & II, ex DIV IIa W of 5degW	AFWG	Update							
Cod	1	NE Arctic	Subareas I & II	AFWG	Observation list		B1	C2				
Cod	1	Norwegian Coastal	?Subarea II?	AFWG	Observation list	Critical						
Greenland Halibut	1	NE Arctic	Subareas I & II	AFWG	Update							
Haddock	1	NE Arctic	Subareas I & II	AFWG	Update		D	D				
Saithe	1	NE Arctic	Subareas I & II	AFWG	Benchmark							
Sebastes marinus	1	NE Arctic	Subareas I & II	AFWG	Experimental	Critical		C2				
Sebastes mentella	1	NE Arctic	Subareas I & II	AFWG	Experimental	Critical		C2				
Shrimp	1	Barents Sea	Subarea I	WGPAND	Benchmark							
Shrimp	1	Norwegian Sea	Subarea II	WGPAND	Benchmark							
Capelin	2	Icelandic	Subareas V and XIV and Div IIa W of 5degW	NWWG	Update	Critical		D				
Cod	2	Greenland	Subarea XIV	NWWG	?	Critical	B2	D				
Cod	2	Icelandic	Div Va	NWWG	Update							
Haddock	2	Icelandic		NWWG	Update				C2			
Halibut	2	Greenland	Subareas V and XIV	NWWG	?	Critical						
Herring	2	Icelandic	Div Va	NWWG	Benchmark							
Saithe	2	Icelandic		NWWG	Benchmark							
Sebastes marinus	2		Subareas V, VI, XII and XIV	NWWG	?			D				
Sebastes mentalla	2	Continental shelf	Subareas V, VI and XIV	NWWG	?		D	D				
Sebastes mentalla	2	Irminger Sea		NWWG	?	Critical	C2	C2				

Status Codes

A	No known problem
B	Estimates included in stock assessment
C	Estimates available but not included
D	Problem but no estimates
Blank	No available information

Data Quality

1	Reliable
2	Unproven or not directly related
3	Unreliable
X	UNOBTAINABLE

Appendix 1b – Preliminary Summary of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Region 4).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Anglerfish	4	Div IIIa & Subareas	IIIa, IV & VI	WGNSSK	?							
Cod	4	North Sea, Eastern Channel & Skaggerak	IV, VIId & IIIa	WGNSSK	Observation list	Critical	B2	B1				
Haddock	4	North Sea & Div IIIa	IV & IIIa	WGNSSK	Benchmark			B1				
Herring - Autumn	4	North Sea, Eastern Channel & Skaggerak	IV, VIId & IIIa	HAWG	Observation list							
Herring - Spring	4		IIIa, 22-24	HAWG	?							
Horse Mackerel	4	North Sea	IV	WGMHSA	?							
Mackerel	4	North Sea	IV	WGMHSA	?	Critical	B1					
Nephrops	4	North Sea (various areas)	All	WGNSSK	Benchmark							
Norway Pout	4	North Sea	IV	WGNSSK	Update	Critical						
Norway Pout	4		Other	WGNSSK	Update							
Pandalus	4	North Sea (Fladden ground)	IVa	WGPAND	?							
Pandalus	4	Skaggerak & Norwegian Deeps	IIIa & IVa East	WGPAND	?							
Plaice	4	Eastern Channel	VIId	WGNSSK	Update			B1				
Plaice	4	North Sea	IV	WGNSSK	Observation list			B1				
Plaice	4	Skaggerak	IIIa	WGNSSK	Update			B1				
Saithe	4	North Sea, Div IIIa & Subarea VI	IV, IIIa & VI	WGNSSK	Benchmark			B1				
Sandeel	4	North Sea	IV	WGNSSK	Update	Critical						
Sandeel	4		Other	WGNSSK	Update							
Sole	4	Eastern Channel	VIId	WGNSSK	Update							
Sole	4	North Sea	IV	WGNSSK	Update			B1				
Sole	4	Skaggerak	IIIa	WGNSSK	?							
Sprat	4	North Sea	IV	HAWG	?							
Whiting	4	North Sea & Eastern Channel	IV & VIId	WGNSSK	Update			B1				

Status Codes

A	No known problem
B	Estimates included in stock assessment
C	Estimates available but not included
D	Problem but no estimates
Blank	No available information

Data Quality

1	Reliable
2	Unproven or not directly related
3	Unreliable
X	UNOBTAINABLE

Appendix 1c – Preliminary Summary of the Status of Information on Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Region 3 and 5).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Cod	3	Faroe Bank	Vb2	NWWG	?							
Cod	3	Faroe Plateau	Vb1	NWWG	Observation list	Critical						
Haddock	3	Faroe	Div Vb	NWWG	Update							
Saithe	3	Faroe	Div Vb	NWWG	Benchmark							
Anglerfish	5	Div IIIa & Subareas IV & VI	IIIa, IV & VI	WGNSDS	Update		D					
Cod	5	Rockall	VIb	WGNSDS	No assessment		D					
Cod	5	West of Scotland	VIa	WGNSDS	Benchmark	Critical	D	B2				
Haddock	5	West of Scotland	VIa	WGNSDS	Benchmark		D	C3				
Hake	5	Northern Stock	IIIa, IV, VI, VII and VIIIabd	WGHMM	Observation list	Critical	B2	C3				
Herring	5	West of Scotland	VIa	HAWG	Update							
Megrim	5	West of Scotland & Rockall	VI	WGNSDS	Update		D					
Nephrops	5	West of Scotland (Management area C)	VIa	WGNSDS	Benchmark		D					
Norway Pout	5	West of Scotland	VIa	WGNSDS	No assessment		D					
Sandeel	5	West of Scotland	VIa	WGNSDS	No assessment		D					
Whiting	5	Rockall	VIb	WGNSDS	No assessment		D	D				
Whiting	5	West of Scotland	VIa	WGNSDS	Update		D	C3				

Status Codes

A	No known problem
B	Estimates included in stock assessment
C	Estimates available but not included
D	Problem but no estimates
Blank	No available information

Data Quality

1	Reliable
2	Unproven or not directly related
3	Unreliable
X	UNOBTAINABLE

Appendix 1d – Preliminary Summary of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Region 6).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Anglerfish (L. budegassa)	6	-	VIIb-k, VIIIa,b	WGNSDS	Update		B2	C3				
Anglerfish (L. piscatorius)	6	-	VIIb-k, VIIIa,b	WGNSDS	Update		B2	C3				
Cod	6	Celtic Sea	VIIe-k	WGSSDS	Benchmark	Critical	D	C3				
Cod	6	Irish Sea	VIIa	WGNSDS	Benchmark	Critical	B2	C3				
Haddock	6	Rockall	VIb	WGNSDS	No Assessment	Critical	D					
Haddock	6	-	VIIb-k	WGSSDS	Update			C3				
Haddock	6	Irish Sea	VIIa	WGNSDS	Benchmark		D	C3				
Hake	6	Northern Stock	IIIa, IV, VI, VII and VIIIabd	WGHMM	Observation list		B2	C3				
Herring	6	Celtic Sea	VIIf, g	HAWG	Update							
Herring	6	Irish Sea	VII	HAWG	?							
Herring	6		VIa & VIIb,c	HAWG	Update							
Megrim	6	Celtic Sea	VIIb,c,e-k & VIIIa,b,d	WGHMM	Benchmark		B2	B2				
Nephrops	6	Management Area J	FU 14 &15	WGSSDS	?			C3				
Nephrops	6	Management Area L	VIIb,c,j,k	WGHMM	Benchmark			C3				
Nephrops	6	Management Area M	VIIf,g,h & VIIa	WGSSDS	?			C3				
Nephrops	6	Management Area N	VIIIa,b	WGHMM	Benchmark			B1				
Plaice	6	Celtic Sea	VIIf, g	WGSSDS	Benchmark	Critical						
Plaice	6	Irish Sea	VIIa	WGNSDS	Update		D					
Plaice	6	SW Ireland	VIIh-k	WGSSDS	?							
Plaice	6	W of Ireland	VIIb,c	WGSSDS	?							
Plaice	6	Western Channel	VIIe	WGSSDS	Update	Critical						
Sole	6	Bay of Biscay	VIIIa, b	WGSSDS	Observation list	Critical						
Sole	6	Celtic Sea	VIIf, g	WGSSDS	Update	Critical						
Sole	6	Irish Sea	VII	WGNSDS	Update		D					
Sole	6	SW Ireland	VIIh-k	WGSSDS	?							
Sole	6	W of Ireland	VIIb,c	WGSSDS	?							
Sole	6	Western Channel	VIIe	WGSSDS	Observation list	Critical						
Whiting	6	Irish Sea	VIIa	WGNSDS	Benchmark	Critical	D	C3				
Whiting	6		VIIe-k	WGSSDS	Benchmark			C3				

Appendix 1e – Preliminary Summary of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Region 7).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Anchovy	7		VIII	WGNPBW	?							
Anchovy	7		IXa	WGNPBW	?							
Anglerfish - L. budegassa	7		VIIIc & IXa	WGHMM	Update	Critical						
Anglerfish - L. piscatorius	7		VIIIc & IXa	WGHMM	Update	Critical						
Black scabbardfish	7		IXa	WGDEEP	Observation list		D			D		
Blue Whiting	7	Combined stocks	I-IX, XII & XIV	WGNPBW	Observation list	Critical						
Hake	7	Northern stock		WGHMM	Observation list							
Hake	7	Southern stock	VIIIc & IXa	WGHMM	Observation list	Critical		D				
Horse Mackerel	7	Southern stock	IXa	WGMHSA	Benchmark							
L. bude	7		VIIb, k & VIIIa, b, d	WGHMM	Update							
L. pisc.	7		VIIb, k & VIIIa, b, d	WGHMM	Update							
Mackerel - NEA	7	Southern	-	WGMHSA	Update		D					
Megrim	7		VII & VIIIa, b, d	WGHMM	Benchmark							
Megrim - L.	7		VIIIc & IXa	WGHMM	Benchmark							
Megrim - L. whiff	7		VIIIc & IXa	WGHMM	Benchmark							
Nephrops	7	Cadiz (FU 30) (Management Area Q)	IXa	WGHMM	Benchmark			C2				
Nephrops	7	Cantabrian Sea (FU25-31) (Management Area O)	VIIIc	WGHMM	Benchmark	Critical		C2				
Nephrops	7	Galacian West & N of Portugal (FU26-27)	IXa	WGHMM	Benchmark	Critical		C2				
Nephrops	7	SW & S of Portugal (FU 28-29) (Management Area Q)	IXa	WGHMM	Benchmark	Critical		C2				
Red Sea bream	7		IX & X	WGDEEP	Observation list		D			D		
Sardine	7		VIIIc & IXa	WGMHSA	Update							

Appendix 1f – Preliminary Summary of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Region 8 and 9).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Brill	8		22, 26, 28, 29, 30 & 32	WGBFAS	No Assessment							
Cod	8	Kattegat	IIIb	WGBFAS	Observation list		D	D				
Cod	8		25-32	WGBFAS	Observation list	Critical	B2	B1				
Cod	8		22-24	WGBFAS	Update		A	B1				
Dab	8		22, 26, 28, 29, 30 & 32	WGBFAS	No Assessment							
Flounder	8		22, 26, 28, 29, 30 & 32	WGBFAS	No Assessment							
Flounder	8		24-25	WGBFAS	Exploratory		A	D				
Herring	8	GoR		WGBFAS	Update		B1	A				
Herring	8		22-24 & IIIa	HAWG	Update		B1					
Herring	8		25-29 & 32 excl GoR	WGBFAS	Update		D	A				
Herring	8		30	WGBFAS	Update		A	A				
Herring	8		31	WGBFAS	Update		A	A				
Plaice	8		22, 26, 28, 29, 30 & 32	WGBFAS	No Assessment							
Salmon	8	Main Basin & Gulf of Bothnia		WGBAST	Observation list							
Salmon	8			WGBAST	Update							
Sea Trout	8			WGBAST	?							
Sole	8		IIIa	WGBFAS	Benchmark		D	D				
Sprat	8		22-32	WGBFAS	Benchmark		D	D				
Turbot	8		22, 26, 28, 29, 30 & 32	WGBFAS	No Assessment							
Anchovy	9	Biscay		WGMHSA	Benchmark							
Blue Whiting	9			WGNPBW	Observation list							
Hake	9	Northern Stock		WGHMM	?			C3				
Herring	9	Norwegian Spring Spawning		WGNPBW	Update							
Horse Mackerel	9	Western		WGMHSA	Benchmark							
Mackerel	9	NE Atlantic		WGMHSA	Update		D					
Sardine	9			WGMHSA	Update							

Status Codes

A	No known problem
B	Estimates included in stock assessment
C	Estimates available but not included
D	Problem but no estimates
Blank	No available information

Data Quality

1	Reliable
2	Unproven or not directly related
3	Unreliable
X	UNOBTAINABLE

Appendix 1g – Preliminary Summary of the Status of Unaccounted Fishing Mortality in ICES Stock Assessments (ICES Region 10).

Species	Region	Area	ICES Area	WG	Assessment	Status	Sources of UFM (WG record) - coded					
							IUU	Discards	Escape	Ghost	Habitat	Other
Black Scabbardfish	10		V VI VII VIII and IX	WGDEEP	Observation list		D			D		
Blue ling	10		I-XII & XIV	WGDEEP	Observation list	Critical	D			D		
Golden Eye Perch	10		X	WGDEEP	Observation list		D			D		
Greater Forkbeard	10		VI VII VIII and IX	WGDEEP	Observation list		D	C2		D		
Greater Silver Smelt	10		IIa III V VI VII	WGDEEP	Observation list		D			D		
Ling	10		IIa IVa V VI & VII	WGDEEP	Observation list	Critical	D	A3		D		
Orange roughy	10		VI VII X & XII	WGDEEP	Observation list		D			D		
Red Sea Bream	10		X and IX (VI VII VIII)	WGDEEP	Observation list		D			D		
Roundnose Grenadier	10		IIIa V VI VII XII	WGDEEP	Observation list		D	C2		D		
Tusk	10		IIa IVa V VI	WGDEEP	Observation list	Critical	D			D		

Status Codes

A	No known problem
B	Estimates included in stock assessment
C	Estimates available but not included
D	Problem but no estimates
Blank	No available information

Data Quality

1	Reliable
2	Unproven or not directly related
3	Unreliable
X	UNOBTAINABLE

Annex 2: Summary of correspondence with Stock Assessment Working Groups

Arctic Fisheries Working Group [AFWG]

Chair: Yuri A. Kovalev **Contact:** kovalev@pinro.ru

Critical Species

Norwegian coastal cod, *Sebastes marinus* and *Sebastes mentella* from the Arctic Region are identified by ICES ACFM as being critical species at risk in that ecosystem, based on the advice from the Arctic Fisheries working group (AFWG). The AFWG recognised that the stocks of Norwegian coastal cod, *Sebastes marinus* and *Sebastes mentalla* are currently at a very low level, and all these stocks have problems with hidden catches/mortality from different sources.

Moreover, at recent AFWG meetings it has been recognised that there is growing evidence of both substantial discarding and mis-/unreporting of catches throughout the Barents Sea for most groundfish stocks in recent years (ICES CM 2002/ACFM:18, ICES CM 2001/ACFM:02, ICES CM 2001/ACFM:19, Dingsor WD 13 2002 WG, Hareide and Garnes WD 14 2002 WG, Nakken WD 10 2001 WG, Nakken WD8 2000 WG, Schone WD4 1999 WG, Sokolov, WD 9 2003 WG, Ajiad *et al*. WD24 2004 WG).

Illegal, unreported and unregulated fishing (IUU)

Illegal, unreported and unregulated catches (IUUs) is an important problem that AFWG has been trying to address since 1995. In order to an attempt to improve the accuracy of the input catch statistics, and hence the quality of stock assessment analysis, AFWG now includes available estimates of the unreported landings of NE Arctic Cod. The estimates used are listed in Table 2.1.

Unreported catches of NE Arctic Cod in 2003 and 2004 were distributed using total international trawl catch age distribution in Division IIb on half the unreported catch and total international trawl catch age distribution in Subarea I on the other half. Also, the 2002 catches were distributed using the total international trawl catch age distribution in Subarea I. This caused a slight revision, as previously the total international (i.e. all gears combined) catch age distribution in Subarea I was used. The latest AFWG report (AFWG 2004) contains comparisons of different XSA runs (with and without taking into account information on unreported catches).

Concerns have also been raised that haddock may constituent as much as 10% of the trans-shipped fish in the Barents Sea (K.H. Hauge, pers. com.). The Norwegian Directorate of Fisheries will be investigating this potential source of UFM.

Discards

There are currently no estimates of discard mortality included in any AFWG stock assessment.

Although estimates of discard mortality for cod in this region (Dingsor, 2001 and Sokolov, 2003), there are concerns over the accuracy of this data due to the considerable variation in the estimates from overlapping years in these studies. Therefore the AFWG decided these discrepancies should be clarified before these data are used in the stock assessment. In addition, an ICES paper (Sokolov, 2004) estimating cod discard in the Russian bottom trawl fishery in the Barents Sea in 1983–2002 was available to the group. The discard was found to be highly variable over this time period and affected mainly age groups 3 and 4, and on

average, 6 million individuals, mostly age groups 3 and 4 (30–45 cm), were annually discarded. On average, this composes about 6% of the total number of cod caught.

Ajiad *et al*. (2005) presents preliminary results on the total redfish bycatch in the Norwegian shrimp fishery during 1983-2003 based on data from the Norwegian commercial shrimp landing statistics, data from the Norwegian fishery surveillance agency and the scientific shrimp surveys.

Table 2.1 North-East Arctic COD. Total catch (t) by fishing (Data provided by Working Group members.)

Year	Sub-area I	Division IIa	Division IIb	Unreported catches	Total catch
1961	409 694	153 019	220 508		783 221
1962	548 621	139 848	220 797		909 266
1963	547 469	117 100	111 768		776 337
1964	206 883	104 698	126 114		437 695
1965	241 489	100 011	103 430		444 983
1966	292 253	134 805	56 653		483 711
1967	322 798	128 747	121 060		572 605
1968	642 452	162 472	269 254		1 074 084
1969	679 373	255 599	262 254		1 197 226
1970	603 855	243 835	85 556		933 246
1971	312 505	319 623	56 920		689 048
1972	197 015	335 257	32 982		565 254
1973	492 716	211 762	88 207		792 685
1974	723 489	124 214	254 730		1 102 433
1975	561 701	120 276	147 400		829 377
1976	526 685	237 245	103 533		867 463
1977	538 231	257 073	109 997		905 301
1978	418 265	263 157	17 293		698 715
1979	195 166	235 449	9 923		440 538
1980	168 671	199 313	12 450		380 434
1981	137 033	245 167	16 837		399 037
1982	96 576	236 125	31 029		363 730
1983	64 803	200 279	24 910		289 992
1984	54 317	197 573	25 761		277 651
1985	112 605	173 559	21 756		307 920
1986	157 631	202 688	69 794		430 113
1987	146 106	245 387	131 578		523 071
1988	166 649	209 930	58 360		434 939
1989	164 512	149 360	18 609		332 481
1990	62 272	99 465	25 263	25 000	212 000
1991	70 970	156 966	41 222	50 000	319 158
1992	124 219	172 532	86 483	130 000	513 234
1993	195 771	269 383	66 457	50 000	581 611
1994	353 425	306 417	86 244	25 000	771 086
1995	251 448	317 585	170 966		739 999
1996	278 364	297 237	156 627		732 228
1997	273 376	326 689	162 338		762 403
1998	250 815	257 398	84 411		592 624
1999	159 021	216 898	108 991		484 910
2000	137 197	204 167	73 506		414 870
2001	142 628	185 890	97 953		426 471
2002	184 789	189 013	71 242	90 000	535 045
2003	163 109	222 052	51 829	115 000	551 990
2004 [1]	177 888	219 261	92 296	90 000	579 445

[1] Provisional figures.

Baltic Fisheries Assessment Working Group [WGBFAS]

Chair: T. Gröhsler **Contact:** tomas.groehsler@ior.bfa-fisch.de

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 identifies cod in SD 25–32 as being the only critical species at risk in Baltic ecosystem, based on the advice from The Baltic Fisheries Working Group [WGBFAS].

Illegal, Unreported and Unregulated Fishing (IUU)

It is suspected that there is considerable under-reporting of cod landings throughout the Baltic region, but particularly for catches from SD 25–32. Estimates of under-reporting are based upon unofficial information from individual members of WGBFAS, by country. There is information on substantial misreporting [of cod] in 1993–1996, and this has also been the case since 2000 (see Table 2.1.1) It is not possible to provide reliable stock estimates based on fishery-independent information alone. The alternatives available are therefore i) stock assessments based on catch information, including information on mis- and non reporting or ii) very poor or very heavily biased assessments. In this situation ICES has chosen to include mis- and non-reportings in the assessment.

Catch misreporting, mostly in the form of unreported landings, tends to result from a combination of restrictive quotas, the absence of other fishing opportunities and inadequate inspection. However, the precise circumstances can differ between countries, so information was obtained from representatives of each of the countries contributing data to the WG. The information supplied by each country is summarised below in order to illustrate the nature of the information available, and to allow the reliability of the estimates to be evaluated. However, there was a clear consensus amongst WG members that individual countries should not be identified. There were two main reasons for this :

- Information obtained on misreporting is regarded as for assessment purposes only, and the resultant catch estimates should not be made public in case of political problems if these estimates are seen to be different to the official figures.
- The estimates are often based on information which has been provided by fishers as a result of trust being established between fishers and scientists. If the information is then made public, there is a risk that this will lead to loss of trust, which would then make it difficult to obtain information in the future or even to obtain access to fishing vessels for sampling purposes.

As a result of these potentially major problems, the individual countries concerned are not identified below, but are instead clustered into groups of one or more countries according to the information available.

The information supplied is summarised below, together with the raising factors (RFs) applied to the landings data that of that group of countries in order to account for suspected misreporting.

Group A: A rough estimate based on informal contacts with the industry. Assumed RF = 1.5

Group B: Information is available from at sea sampling, formal and informal contacts with the fishing industry and, and from inspection of import/export records. Taken together these sources of information indicate total catches about 100% greater than the reported figure. Assumed RF = 2.0.

Group C: Either no information available, or information indicates no or negligible misreporting. Assumed RF = 1.0

Table 2.1.1 Total landings (tons) of COD in the ICES Sub-divisions 22-32 by country.

Year	Denmark	Estonia	Finland	German Dem.Rep.[2]	Germany, Fed. Rep.	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands[4]	Norway	Unallo-cated[3]	Total
1965	35,313		23	10,680	15,713			41,498		21,705	22,420				147,352
1966	37,070		26	10,589	12,831			56,007		22,525	38,270				177,318
1967	39,105		27	21,027	12,941			56,003		23,363	42,980				195,446
1968	44,109		70	24,478	16,833			63,245		24,008	43,610				216,353
1969	44,061		58	25,979	17,432			60,749		22,301	41,580				212,160
1970	42,392		70	18,099	19,444			68,440		17,756	32,250				198,451
1971	46,831		53	10,977	16,248			54,151		15,670	20,910				164,840
1972	59,717		76	13,720	15,516			57,093		16,471	30,140				192,733
1973	66,050		95	14,408	28,706			49,790		18,389	20,083				197,521
1974	57,810		160	10,976	22,224			48,650		16,435	38,131				194,386
1975	62,524		298	14,742	24,880			69,318		17,965	49,289				239,016
1976	77,570		287	8,552	26,626			70,466		20,168	49,047				252,736
1977	73,505		310	10,967	30,806			47,702		18,127	29,680				211,097
1978	50,611		1,437	9,345	15,122			64,113		16,793	37,200				194,621
1979	59,704		2,938	8,997	19,375			79,754		23,093	75,034	3,850			272,745
1980	75,529		5,962	7,406	18,407			123,486		33,201	124,350	1,250			389,591
1981	92,648		5,681	12,936	18,281			120,901		44,330	87,746	2,765			385,288
1982	91,927		8,126	11,368	21,860			92,541		46,548	86,906	4,300			363,576
1983	107,624		8,927	10,521	25,154			76,474		53,740	92,248	6,065			380,753
1984	113,701		9,358	9,886	42,031			93,429		65,927	100,761	6,354			441,447
1985	107,627		7,224	6,593	31,798			63,260		54,723	78,127	5,890			355,242
1986	98,464		5,633	3,179	22,422			43,236		49,572	52,148	4,596			279,250
1987	83,844		3,007	5,114	18,816			32,667		47,429	39,203	5,567			235,647
1988	74,742		2,904	4,634	18,295			33,351		54,968	28,137	6,915			223,946
1989	65,935		2,254	2,147	15,342			36,855		55,919	14,722	4,520			197,694
1990	56,700		1,731	1,629	7,745			32,028		54,474	13,461	3,558			171,326
1991	50,606	1,810	1,711		9,443	2,627	1,865	25,748	3,299	39,490		2,611			139,210
1992	30,420	1,368	485		6,449	1,250	1,266	13,314	1,793	15,940		593			72,878
1993	17,667	70	225		5,126	1,333	605	8,909	892	12,048		558		18,978	66,411
1994	24,805	952	594		7,079	2,831	1,887	14,335	1,257	25,530		779		44,000	124,049
1995	38,204	1,049	1,861		14,692	6,653	4,513	25,000	1,612	27,966		777	293	18,993	141,613
1996	48,494	1,388	3,139		19,358	8,741	5,524	34,855	3,306	36,119		706	289	10,815	172,734
1997	40,549	1,420	1,547		14,484	6,187	4,601	31,659	2,803	28,374		600			132,224
1998	29,477	1,196	1,039		10,992	7,778	4,176	25,778	4,599	16,609					101,644
1999	38,083	1,062	1,572		15,439	6,914	4,371	26,580	5,202	15,927					115,150
2000	32,042	609	1,819		13,080	6,280	5,165	22,120	4,231	19,172				23,118	127,636
2001	29,150	805	1,717		12,738	6,298	3,137	21,992	5,032	21,026				23,677	125,572
2002	21,543	37	1,717		8,767	4,867	3,137	15,688	3,793	14,568				17,562	91,898
2003	22,303	591	1,151		8,129	3,617	2,767	15,943	3,707	13,746				22,147	94,100
2004[1]	20,707	1,192	859		7,310	5,056	2,041	15,120	3,410	14,163				19,563	89,421

[1]Provisional data. [2]Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.
[3]Working group estimates. No information available for years prior to 1993.
[4] For 1997 landings not officially reported, estimated by the WG.

More information on IUU fishing is available for individual stocks in the Baltic region and is detailed in the WGBFAS 2005 Report to ACFM:

- Cod in Kattegat (Subdivision 21)(Page 63)
- Cod in Subdivisions 22–24 (Page 105)
- Sole in Div IIIa (Page 221)
- Flounder in Subdivisions. 24–25 (Page 284)
- Herring in Sudden 25–29 and 32 (excl. GOR) (Page 321)
- Herring in Gulf of Riga (Page 364)
- Sprat in Subdivisions. 22–32 (Page 468)

Angling

Angling and sports fishing can generate a significant source of unregulated and unreported catch. Angling for cod is relatively well established in Germany, Denmark, and on the Øresund coast of Sweden. There is increasing interest in Poland, and also in Russia, although a restrictive recreational quota has been implemented during 2004. There has been no development of sea angling off Latvia. No quantitative information is available on the extent

of angling catches, although there are some preliminary indications that they may be relatively large in some cases, e.g. in SD23 (Øresund). Denmark, Sweden, Germany and Poland are all implementing surveys to obtain more information on these recreational fisheries.

Discards

Discard data [for cod] are available since 1996 (particularly for Cod in Subdivisions 22–24) (see Table 2.3.5–7) and are applied in the assessment as yearly proportions per age-group discarded. Before 1996, an average proportion discarded per age-group estimated for 1996–2003 is applied. The season and area coverage of discard sampling requires improvement. A relationship between year-class strength and discard rates cannot be estimated from the available data. Due to changes in technical regulation, e.g. increase of minimum landing size, introduction of BACOMA 110 and varying closures, discard rates may have additionally varied

More information on discarding is available for other stocks in the Baltic region and is detailed in the WGBFAS 2005 Report to ACFM:

- Cod in Kattegat (Subdivision 21)(Page 63)
- Cod in Subdivisions 22–24 (Page 105)
- Sole in Div IIIa (Page 221)
- Flounder in Subdivisions. 24–25 (Page 284)
- Herring in Sudden 25–29 and 32 (excl. GOR) (Page 321)
- Herring in Gulf of Riga (Page 364)
- Sprat in Subdivisions. 22–32 (Page 468)

Table 2.3.5 Cod in SD 22-24. Discard in numbers (thousands) by gear type and year.

Stock	22-24

Gear type	Year								
	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gillnet	592	691	189	220	349	2114	474	2865	119
Trawl	25919	15723	20476	14252	14750	9256	5712	8791	6122
Grand Total	26511	16414	20665	14472	15098	11370	6186	11656	6241

Table 2.3.6 Cod in SD 22-24. Landing and discard in numbers (thousands) by age group.

Stock	22-24

Age group	Year									
	1996		1997		1998		1999		2000	
	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard
Age0	0	15	0	39	0	85	0	250	0	325
Age1	395	21025	3658	15264	3968	16309	1387	4317	3096	7798
Age2	28610	5162	3762	97	23553	4154	27903	9606	12439	5201
Age3	20584	308	28004	15	3238	116	14002	299	19897	1774
Age4	3647	1	5174	0	4534	0	1832	0	3942	0
Age5	2217	0	1030	0	701	0	1146	0	306	0

Age group	Year							
	2001		2002		2003		2004	
	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard
Age0	0	44	0	0	0	16	0	149
Age1	2399	4033	1624	2000	2178	1565	368	2666
Age2	13709	6612	8612	3437	12795	8737	3500	1171
Age3	10969	640	8801	1615	6527	489	10009	2252
Age4	5168	41	2155	19	1898	11	3489	3
Age5	856	0	912	40	333	0	633	0

Table 2.3.7 Cod in SD 22-24. Discard percentage (of landing+discard) in SD22-24 by age group.

Age group	Year								
	1996	1997	1998	1999	2000	2001	2002	2003	2004
Age0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Age1	98.2	81.6	80.4	75.7	71.6	62.7	55.2	41.8	87.9
Age2	15.3	2.5	15.0	25.6	29.5	32.5	28.5	40.6	25.1
Age3	1.5	0.1	3.5	2.1	8.2	5.5	15.5	7.0	18.4
Age4	0.0	0.0	0.0	0.0	0.0	0.8	0.9	0.6	0.1
Age5	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0

Baltic Salmon and Trout Working Group [WGBAST]

Chair: I. Perä **Contact:** ingemar.pera@fiskeriverket.se

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 based on the advice from WGBAST identify salmon in the Gulf of Finland as being in a “precarious state” although not as a critical species in the Baltic ecosystem.

Information on Unaccounted Fishing Mortality

At the time of writing, there was no evidence that unaccounted fishing mortality was considered in the stock assessments conducted by this working group.

Herring Assessment Working Group for the Area South of 62°N [HAWG]

Chair: Mark Dickey-Collas **Contact:** mark.dickeycollas@wur.nl

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 does not identify herring as being a critical species at risk in any of the designated ecosystems. However herring in the Baltic is identified as being at risk with respect to precautionary levels of fishing mortality and that estimates of catch are imprecise.

Information on Unaccounted Fishing Mortality

At the time of writing, there was no evidence that unaccounted fishing mortality was considered in the stock assessments conducted by this working group.

Northern Pelagic and Blue Whiting Fisheries Working Group [WGNPBW]

Chair: A. Gudmundsdottir **Contact:** asta@hafro.is

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 identifies blue whiting as being a critical species at risk in Iberian Region ecosystem, based on the advice from WGNPBW.

Information on Unaccounted Fishing Mortality

At the time of writing, there was no evidence that unaccounted fishing mortality was considered in the stock assessments conducted by this working group.

North-Western Working Group [NWWG]

Chair: E. Hjörleifsson **Contact:** einarhj@hafro.is

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004, based on the advice from NWWG, identifies Greenland Cod, Greenland Halibut (in the Irminger Sea), *Sebastes mentalla* (in the Irminger Sea) and Icelandic Capelin from the North-Western Areas as being critical species at risk in that ecosystem. In addition, cod on the Faroe Plateau is identified as a critical species in the Faroe Islands ecosystem, as well as *Sebastes marinus* and *Sebastes mentalla* in the Arctic ecosystem.

Illegal, Unreported and Unregulated Fishing (IUU)

NWWG is aware, but has no data available on, illegal fishing activities in the North-Western Areas.

It is estimated that landings of Greenland Cod, by the effort regulated fleet, are under-estimated in the TAC for Greenland Cod by the order of ~10000 tonnes (ICES Joint ACFM and ACE Advice Report 2004).

The NWWG has during the last years identified problems with of unreported catches of pelagic redfish. There have been observations of individual vessels from nations not reporting catches to international organisations like ICES/NEAFC/FAO/NAFO. These unreported catches have, however, not been quantified as the number of nations not reporting has been unknown and hence the effort of their vessels is unknown. During the NWWG meeting in 2004, a presentation of ongoing EU project (IMPAST) dealing with this issue was given (WD29 of NWWG2004). Two studies were conducted by the EC Joint Research Centre using a satellite imagery vessel detection system (VDS) to detect fishing vessels in the NEAFC regulated red-fish fishery, south west Iceland, and indicated that the unreported effort might be of significant amount and that during the observations in June 2002 and 2003, the effort could be more than 25% higher than reported to NEAFC.

Discards

NWWG is aware, but has no data available on, discarding activities in the North-Western Areas.

The ICES Joint ACFM and ACE Advice Report 2004 also states that both *Sebastes marinus* and *Sebastes mentalla* form a considerable bycatch in the Arctic saithe and cod fisheries, and that there is a substantial juvenile bycatch of *S. mentalla* in the shrimp trawl fisheries of the arctic. Although, no data is currently available on this discard mortality and therefore no account is made of it in the assessment of these species. The NWWG identifies there is an urgent need for quantitative information on the bycatches in the shrimp fisheries and on the effectiveness of the sorting grids to reduce discard rates. The Greenlandic Institute of Natural Resources is setting up a project to investigate this matter (C. Stransky, pers. com.).

Extract from NWWG 2005 report

An offshore shrimp fishery with small meshed trawl (44 mm in the codend) began in the early 1970s off West Greenland. This fishery expanded to East Greenland in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery License Control showed that redfish is bycatch in the shrimp fishery off Greenland. No information was available in recent years to quantify the bycatch and about the length distribution of the fish caught. The amount of bycatches of juvenile redfish in the shrimp fishery, however, is expected to be considerably high. Since 1st October 2000, sorting grids with 22 mm bar spacing have been mandatory to reduce the bycatches. The documentation of the effect of sorting grids on the bycatches is needed in order to estimate the bycatch of young redfish in the shrimp fishery.

In late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the bycatch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a bycatch in the fishery, but also juveniles of other species. Since the large year classes of *S. marinus* disappeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery.

Other sources of UFM

A recent paper (Björnsson and Jónsson, 2004) presented evidence of unaccounted fishing mortality, assumed to be escape mortality, among Icelandic haddock.

ICES CM 2004/FF:24

Estimation of hidden mortality of Icelandic haddock caused by the fisheries.

Höskuldur Björnsson and Einar Jónsson

Marine Research Institute, Reykjavík, Iceland

Results from the Icelandic groundfish survey show that all age groups of haddock are much more available to the survey than corresponding age groups of most other species and at age 2 haddock is close to fully recruited to the survey. High catchability of small haddock in the groundfish survey combined with the common perception that small haddock is relatively sensitive to handling could indicate that hidden mortality caused by the fisheries may be a relatively large problem. Discard analysis comparing length measurements from landings and from inspectors aboard the fishing vessels indicate that discard of undersized haddock is considerable in the haddock fishery and proportionally larger than for example in the cod fishery. In recent years, most haddock year classes have been large and most of those year classes have become progressively larger in every new survey, indicating possible reduction in hidden mortality compared to earlier years. The spatial distribution of those year classes is compared with previous ones such that larger proportion inhabits the waters north of Iceland where fishing effort has been small in this period. In this paper the spatial distribution of the commercial fishing effort and the spatial distribution of haddock in the groundfish survey in March are matched and an index of the number of haddock "filtered"' by the fisheries is calculated, based on the fishing effort and overlap of the spatial distribution of the fisheries and the haddock. The index of filtering is then used in a catch at age model as a measure of hidden mortality. Results confirm that hidden mortality caused by the fisheries could be important for the dynamics of this stock and explain some of the discrepancies seen in survey indices in recent years.

Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK]

Chair: C. Needle **Contact:** needlec@marlab.ac.uk

Critical Species

The ICES Joint ACFM & ACE Advice Report 2004 identifies Cod, Norway Pout and Sandeel as being critical species at risk in North Sea/Skagerrak ecosystem, based on the advice of WGNSSK. Moreover, Plaice and Sole are highlighted as being at risk and it is recommended that fishing mortality is reduced, although the species are not highlighted as being critical.

Illegal, Unreported and Unregulated Fishing (IUU)

At present no direct estimates of IUUs are incorporated in the catch statistics of any of the species assessed by WGNSSK. One reason for this may be: "Reports of unrecorded discarding and misreporting are anecdotal at best, and sources cannot be named (otherwise they won't be sources for long)" (Needle, pers. comm.). Some estimates of illegal and unreported lands have been incorporated in WGNSSK stock assessments in the past, particularly for Cod and Haddock; however no details of those estimates were available at the time of writing.

Currently, for cod a model (B-ADAPT) is used in which the level of catch in recent years is estimated by using recent survey data –in effect giving an estimate of the difference between reported and actual removals. However, it is a mistake to label this misreporting – it could equally be due to a difference between the assumed and the actual levels of natural mortality, for example. This difference is usually referred to as "unaccounted removals". This model, or similar, is not currently used for any other stock.

Notes on B-ADAPT

The following text is adapted from section 1.3.3 of the 2005 WGNSSK (*draft*) report and further details on the background of the model and simulation testing can be found in Appendix 4 to the 2004 WGNSSK report (ICES CM 2005/ACFM:07).

In recent years indices of North Sea cod population abundance N and fishing mortality F calculated from survey catch per unit effort (CPUE) have indicated higher levels of abundance and mortality rates than those estimated by catch at age analysis. Within the model diagnostics generated from fits of catch at age models to the North Sea cod assessment data, the inconsistencies between the population abundance estimated from the two data sources have been apparent in the residuals about the mean of log survey catchability (q = CPUE/N). The residuals have been positive in recent years at the majority of ages, a pattern that is consistent across surveys. This indicates a mismatch between the levels of reported landings and actual removals. Actual removals are essentially, total mortality, and the difference between reported landings and actual removals is then either unaccounted mortality, or a change in catchability in surveys. Unaccounted mortality may be due to a number of causes (those associated with unaccounted fishing mortality and unaccounted natural mortality), and while these are currently not distinguished, an alternative model can be used to estimate a more realistic level of removals than indicated by the reported landings.

B-ADAPT is a modification of a model term ADAPT proposed by Gavaris and Van Eeckhaute (1998) to estimate removals bias in Georges Bank Haddock. The model assumes the existence of two periods in the data time series: a period in which no bias occurs in the reporting of landings data and a period in which bias in the reported landings is known or suspected to exist. The first period allows the estimation of the catchability-at-age of the survey (which is assumed to be constant through time) and thus in the second period the bias (which is assumed to be constant across ages) can be estimated.

Note that it is assumed that during both periods, landings numbers at age have relatively low random sampling variability (relative to survey variance) so that the population numbers at age can be determined using the virtual population analysis (VPA).

Although originally applied to investigate potential bias due to misreporting, B-ADAPT can be used to investigate any potential bias resulting from a discrepancy between total mortality, as estimated from survey data, and estimated fishing mortality, as estimated, ultimately, from reported landings. Thus, given an assumed known natural mortality, total unaccounted fishing mortality may be estimated using this method.

Discards

Estimates of discards of haddock and whiting, and more recently, cod and plaice are now included in the assessment analysis conducted by WGNSSK. For cod, haddock and whiting, discard estimates for the international fleets are raised from the Scottish sampling programme. For plaice, discard estimates are a combination of observed rates from the Dutch sampling programme, along with a model that reconstructs historical discard rates based on growth modelling. The discard data collected by other countries has not been used because it is either not provided at all to stock coordinators, or is given as a total discarded weight without age information (and thus cannot be used without making gross assumptions about selectivity), or the sampling rates are considered too low. Also, France have a derogation from discard sampling in the EU Data Collection Regulations, therefore no information on discard mortality is available for that member country.

The WGNSSK Chair, Coby Needle, is of the opinion that: “Discard data will reduce bias by giving a fuller picture of the numbers of young fish in the stock, but on the other hand, discard sampling rates are never high enough and the information is therefore noisy. If you’re only

interested in SSB or mean F of older fish, including discards might actually be a bad idea. But they must be included if you are looking at stock-recruit models, or mixed-fisheries analyses."

Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy [WGMHSA]

Chair: Ciaran Kelly **Contact:** ciaran.kelly@marine.ie

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 identify mackerel as being a critical species at risk in the North Sea ecosystem, based on the advice from WGMHSA. In addition, it was recommended there should be a reduction in exploitation of the southern component of the NEA mackerel stock.

The status of mackerel in the North Sea is described as "critical" as the stock is at a low level relative to its size in the seventies. However, whether this is due to overexploitation or a migration change (concomitantly the western component increased in size) remains unclear (C. Kelly, pers. comm.).

Illegal, Unreported and Unregulated Fishing (IUU)

There are no large misreporting issues with North Sea mackerel. Although 10,000 t are arbitrarily assigned to the catch of this stock to cover potential mixing in IVa with the western component in the 4th quarter. In addition, there are bycatches of NS mackerel which are estimated by the Netherlands whose German, home and French fleets fish for horse mackerel in the North Sea. No details of these estimates were available to the author at the time of writing.

There is long suspected to be a problem of misreporting in the NEA mackerel fishery, probably stemming back to the early nineties. The WGMHSA had until now ignored this problem on the basis that if it were consistent then it would only scale the assessment and the TAC was set proportionally. However with the change in assessment adopted by ACFM it is now recognised that this problem needs to be addressed. At present there is no monitoring programme to provide estimates and direct estimates from the industry are likely to prove unreliable. The WGMHSA did endeavour to do a study comparing export quantities with official removals, however this exercise was confounded by the fact that European producers could export mackerel of non-European origin meaning the original source was not clearly traceable.

Another issue raised by the WGMHSA Chair (C. Kelly), is "area misreporting", which affects mortality estimates when misreported across boundaries which correspond to stock limits.

Working Group on the Assessments of Northern Shelf Demersal Stocks [WGNSDS]

Chair: R. Officer **Contact:** rick.officer@marine.ie

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 identifies Cod (West of Scotland and Irish Sea), Haddock (Rockall) and Whiting (Irish Sea) as being critical species at risk in their respective ecosystems, based on the advice from WGNSDS.

Although there is no assessment for Rockall haddock, the ACFM still considers the status of this stock to be critical.

Illegal, Unreported and Unregulated Fishing (IUU)

Over the last decade, the quality of the commercial data for stocks assessed by the WGNSDS has deteriorated due to the unknown level of IUU. At the 2004 and 2005 WGNSDS meetings, the ability to use the commercial data as the basis for analytical assessments was seriously compromised (R. Officer, pers. comm.). The result is that the WG no longer produces analytical assessments based on commercial data for most stocks. Instead survey data are used to estimate relative biomass and trends in total mortality. Therefore it may be argued that all forms of fishing mortality, including all those listed as being of interest to SGUFM, are unaccounted for by such assessments. Although of course it is not possible to partition each of the components and assess their individual effects. There are a couple of exceptions to this: West of Scotland haddock and Irish Sea cod. WGNSDS 2005 did not present analytical catch at age assessments for these stocks. However, at its meeting in August 2005 the Review Group for the WGNSDS requested such assessments. These were presented as Working Documents to the RG. The Review Group assessment for Irish Sea cod does include estimates of mis-reporting. The method used is well documented in Annex 2 of the Review Group Report.

Extract from WGNSDS 2005 Draft Report

WGNSDS has included misreported landings within the "unallocated" landings figures reported for each stock. These unallocated landings represent adjustments to nominal landings figures to correct either for misreporting or for differences between official statistics and data obtained by national scientists. The general term misreporting is used throughout this report to include misreporting by area, misreporting of landings by species and under- or over-reporting of landings.

The main inadequacy in landings data available to WGNSDS is the unknown level of misreporting. Anecdotal information provided by fishermen from several countries indicates that under-reporting of landings of some species is widespread and significant, particularly for stocks with restrictive TACs. Furthermore there is evidence of over-reporting of landings of some species for which TACs are not set, or are not restrictive. Mis-allocation of landings into other TAC areas is also known, although the WG has attempted to correct for this where possible: for example Irish Sea cod and Celtic Sea cod.

Previous assessments of some WGNSDS stocks have included estimates of landings by one country based on a quayside survey of landings rather than official log-book data. This resulted in substantial unallocated catches implying significant misreporting, and this was identified by ACFM as a major concern. The Annual Meeting of Assessment Working Group Chairs (AMAWGC) (ICES 2005a) advised that it is no longer acceptable to make estimates of mis- and non-reporting and make corrections to catch data without revealing the sources of both the data and the problems. Term of Reference *g)* asks the WG to provide information on the distribution of misreporting and the methods used to obtain information on misreporting.

As the misreporting estimates used previously by WGNSDS are for one country only, and there is evidence that the practice is more widespread, the WG cannot provide the transparency requested by AMAWGC, and it is no longer possible to provide catch estimates partially corrected for misreporting. As a result, the absolute values of landings and landings at age, based on reported catches, are considered too biased to allow an analytical catch-based assessment. Survey data do not extend sufficiently far back in time to allow misreporting to be estimated from survey data.

The history of WG attempts to quantify misreporting is given in the 2000 WG report (ICES CM 2001/ACFM:01). A summary of past practices is given below.

Stocks in Subarea VI

Previous Working Groups had expressed a view that misreporting of area VI gadoids had not been significant because of low availability of fish relative to quotas. However, the 2004 and 2005 Working Groups have not been able to make an informed judgement on misreporting of area VI gadoids. Values for misreported landings of VIa haddock in 1992 – 1994, inferred from survey data, are given in ICES CM 1996/Assess:1 and ICES CM 1997/Assess:2 and are included in the assessment files.

For anglerfish and megrim in Division VIa the existence of a restrictive precautionary TAC in Division VIa but no catch restrictions in the adjacent areas of the North Sea up until 1998 is suspected to have led to extensive reporting of catches from VIa into IVa. Such an effect is apparent in the reported distribution of catches by one nation where catches of anglerfish and megrim reported from the statistical rectangles immediately east of the 4oW boundary (the E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of these species. This proportion has reached up to 57% in the case of anglerfish and 75% in the case of megrim. As it is strongly suspected that the large majority of catches reported from the E6 squares are actually taken in Division VIa the landings totals used in previous assessments of these stocks had been corrected for this effect. The correction was applied by first estimating a value for the true catch in each E6 square and then allocating the remainder of the catch into VIa squares in proportion to the reported catches in those squares. The 'true' catches in the E6 squares were estimated by replacing the reported values by the mean of the catches in the adjacent squares to the east and west. This mean was calculated iteratively to account for increases in catches in the VIa squares resulting from reallocation from the E6 squares.

Stocks in Division VIIa

Misreporting of cod, haddock and whiting in the Irish Sea has occurred during the 1990s due to restrictive quotas. This has mainly taken the form of misreporting between VIIa and surrounding regions (mainly from the Celtic Sea into the Irish Sea), and misreporting of species compositions (both over- and under-reporting). Reported (official) landings data from one country taking a significant part of the international catch have in the past been adjusted at source for area-misreporting based on local knowledge of fleet activities. Species-misreporting by another important national fleet has been estimated using a sampling method based on observations made by scientists taking length measurements in the ports. The mean observed weights of the three gadoid species per landing were calculated by port and gear type in 2002, and raised to the total number of landings for each port and gear in which at least one of the three species was recorded.

An analogous procedure was used for estimating haddock landings in 1993–2001 and landings of cod and whiting in 1998–2001. For cod and whiting in 1991–1997, observed and reported landings were compared and the mean proportion reported was calculated for different gear types. The mean proportions reported were used to correct the total reported landings for each species. Further details are given in ICES CM 1999/ACFM:1. The sample-based estimates of landings at official fish markets exclude any "black" landings made at non-designated ports or times and correct only for misreporting of species compositions. Possible increases in black landings may have occurred in the more recent years when some TACs have been set to achieve substantial reductions in fishing mortality without effective mechanisms for controlling fishing effort to the necessary extent. This is of concern not only for the accuracy of the assessments, but also for the appropriateness of assessment methods such as XSA in which survey and commercial CPUE data are evaluated against population numbers reconstructed from commercial catch data (see also Casey, J: Working Document 5; 2002 meeting of WGNSSK ICES CM 2003/ACFM:02).

Discards

Implementation of the EU Data Collection Regulation (Commission Regulation (EC) No 1639/2001) has resulted in some discard data being available for most stocks within the scope of WGNSDS. High grading is suspected in some stocks, although its significance has not been possible to estimate.

A number of working documents are presented by WGNSDS concerning discarding and its estimation:

WD3: Sampling units and auxiliary variables in discards estimation provides a sensitivity analysis on sample allocation and raising procedures for Irish fleets.

WD4: Discarding by the Irish demersal fishery.

WD8: Historic discard levels of VIIa plaice addresses concerns of the 2004 Review Group over the non-inclusion of discard data in the Irish Sea plaice assessment.

Furthermore each stock section in the WGNSDS 2005 report (draft) includes further comments on available discard data.

With respect to the inclusion of discard estimates in the stock assessments only discards of cod for the West of Scotland are considered. Discard data is available for UK and Irish fleets operating in the Irish Sea, but this data is not used in the WGNSDS assessments due to concerns about raising methods and the precision of the estimates. Concerns over the quality of the discard data principally relate to the unvalidated representativeness of the sampling, and the high variability in discard estimates resulting from the use of different auxiliary variables when raising sample estimates to fleet/fishery estimates. However, it is thought that the uncertainty in the total catch is a far more important issue inhibiting assessment that the issues over discard data.

Working Group on the Assessment of Southern Shelf Demersal Stocks [WGSSDS]

Chair: Wim Demare **Contact:** wim.demare@dvz.be

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 identifies cod, plaice and sole in the Celtic Sea, plaice and sole in the Western Channel and sole in the northern part of the Bay of Biscay as being critical species at risk in their respective ecosystems, based on the advice from WGSSDS.

Discards

Discarding is thought to be a problem in some fisheries in these ecosystems, particularly those targeting round-fish, anglerfish and *Nephrops*. Although no details of estimates were available at the time of writing.

Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim [WGHMM]

Chair: V. Trujillo **Contact:** valentin.trujillo@vi.ieo.es

Critical Species

The ICES Joint ACFM and ACE Advice Report 2005 based on the advice from this working group identifies: Hake, both Anglerfish (*L. piscatorius* + *L. budegassa*) and *Nephrops* in MA O and some FUs in MA Q as being a critical species at risk in Iberian Region ecosystems, as well as in the Northern Stock and Megrim as being in risk in the Celtic Sea ecosystem.

Discards

Discarding of hake and megrim is thought to be a problem in a number of fisheries. There is a discard monitoring programme operating for some fisheries in the Iberian Region, Bay of Biscay and Celtic Sea, however sampling is considered poor. Discard estimates for megrim are integrated into assessment process. In the case of northern hake, estimates were integrated in the past but due some problems with the quality and availability of the estimates it was decided in recent years to remove these from the assessment.

Working Group on the Biology and Assessment of Deep Sea Fisheries Resources [WGDEEP]

Chair: Odd Bergstad **Contact:** oddaksel@imr.no

Critical Species

The ICES Joint ACFM and ACE Advice Report 2004 identifies ling, blue ling and tusk as being critical species at risk in the deepwater ecosystems, based on the advice from WGDEEP.

The Chair of WGDEEP (Odd Aksel Berstad) qualified this advice with the following statement: “The assessments for ling, blue, ling, and tusk are not satisfactory, and conclusions are based on very simple analyses, varying somewhat between areas. The population structure remains uncertain; hence a common advice is issued for the entire areas of distribution.” Moreover he expressed his concerns for other deep-sea species such as orange roughy, roundnose grenadier, black scabbardfish and red seabream, considering them to be at as great a risk of depletion as ling and tusk.

Illegal, Unreported and Unregulated Fishing (IUU)

There are concerns over the misreporting of Golden-eye perch and roundnose grenadier and there is a considerable bycatch of greater forkbeard in a number of fisheries. (ICES Joint ACFM and ACE Advice Report 2004).

Odd Aksel Berstad (WGDEEP Chair) considered that most target species are reported reasonably well, but that discard species or minor species of low value might be misreported, either intentionally or unintentionally. His greatest concern was that WGDEEP has no way of quantifying the level of misreporting in any stock, as it has no access to any direct information or statistics on illegal, unreported or misreported landings. Therefore, armed only with anecdotal evidence, the scale of the problem is impossible to assess for any deepwater species, particularly considering their large area of distribution. Furthermore, the incentive to misreport

may have increased recently after regulatory measures were introduced in some waters, e.g. the EC TAC regulations.

It is suspected that there are unreported catches in international waters, and Odd Aksel Berstad states that WGDEEP has never been satisfied with the compilation of data on effort and landings from these waters. The relevant area is the NEAFC Regulatory Area, and NEAFC ought to be a source of information, but this body also has problems compiling the information.

Discards

Discard data has been collected for some fisheries – for roundnose grenadier and Baird's smoothhead caught by Spanish trawlers fishing the Hatton Bank; and Baird's smoothhead and various deepwater sharks, particularly D*eania calceus*, caught by the Irish deepwater fleet targeting black scabbard and orange roughy in ICES areas VIIk and VIIc. However this data, which can be seen in recent WGDEEP reports, has been provided by WG members based mainly on national efforts. The problem is that most such efforts have been poorly co-ordinated, and there is no central database where the records are kept for the future. Many discard sampling schemes are short-term, only a few are good and continuous.

Greater forkbeard is a significant bycatch in some major fisheries, i.e. the long-line fisheries for ling and tusk in the northern North Sea and to the west of the British Isles. In the 1990s several rounds of discard sampling documented this, and this has been included in the WGDEEP reports. Some of the bycatch is landed, varying with market demand.

Before entering the data into assessment procedures, efforts are made to derive a total catch of a given species, including the reported landings plus discards. But it has proved difficult to do this in a formal way for these deepwater species, where WGDEEP usually has to resort to simple CPUE analyses or production models.

Other sources of UFM

Ghost fishing of lost and abandoned gillnets on the slope and deep shelf areas is currently a major concern. An international project (DEEPNET) has been investigating this problem and has conducted surveys on the slope and deep shelf areas to the west of Ireland and the UK. To date, more than 300km of lost or abandoned nets have been found, that appear to have been fishing for upwards of 8 months (D. Rihan – pers. comm.). Additional information will be presented on this project at WKUFM.

Annex 3: Notes on the New ICES advice format and ecosystem approach to management

ICES has recently changed how it presents advice on fisheries and the marine ecosystem to its customers. In line with its move to an "Ecosystem Approach to Marine Resource Management", it is now presenting integrated advice from each of the main advisory committees: the Advisory Committee on Fishery Management (ACFM); the Advisory Committee on Ecosystems (ACE); and the Advisory Committee the Marine Environment (ACME).

Integrated advice, including fisheries advice, is now presented on a regional ecosystem basis with respect to the following areas:

The Barents Sea (ICES Subarea I and parts of Subarea II);

- Waters around Iceland (Division Va and parts of Subareas XII and XIV);
- Waters around the Faroe Islands (Division Vb);
- The North Sea (Subarea IV), the Skagerrak (Division IIIa) and the Eastern Channel (Division VIId);
- West of Scotland (Subarea VI);
- The Irish Sea (Division VIIa), West of Ireland (Division VIIb and c), the Celtic Sea and SW of Ireland (Divisions VIIf,g,h,j,k), the Western Channel (Division VIIe) and northern parts of the Bay of Biscay (Divisions VIIIa,b,d,e);
- The Iberian Region (Division VIIc and Subareas IX and X);
- The Baltic Sea (Subdivisions 22–32); and
- Deep-water south of 62°N (water depths >200m).

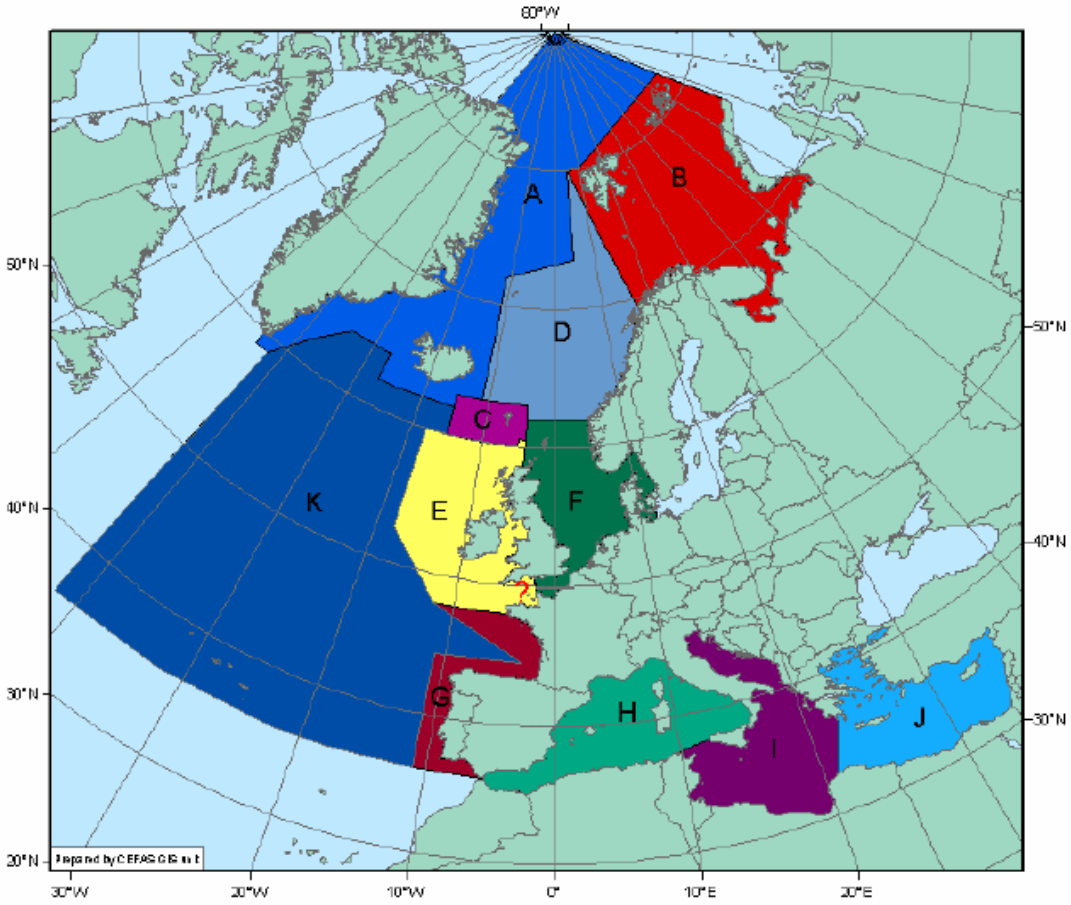
In addition to these regional ecosystems, widely migrating stocks including salmon are dealt with separately:

- Widely migrating stocks (blue whiting, Norwegian spring spawning herring, mackerel, horse mackerel and hake);
- Elasmobranchs; and
- North Atlantic salmon.

For fisheries advice, all stocks belonging to a given area are discussed in context with that area, together with an overview of the ecosystem, the state of the stocks and fisheries in that area. Consideration is given to mixed fisheries and where necessary "critical species", which appear to be overexploited or at risk of overexploitation, are highlighted and overall advice about the mixed fishery, is based on the needs of these critical stocks. For those fisheries for which the mixed fisheries issues are known to be minor the advice is given on a stock basis.

This change in advice policy by ICES now means that SGUFM must prioritise its efforts, by focusing on the species and fisheries defined in the report as "Critical". To this aim SGUFM and WKUFM will initially focus their efforts on the species/fisheries currently defined as "critical" by the ICES assessment working groups (See Table 1 and Annex 2 for further details).

Figure 1: Proposed eco-regions for the implementation of the ecosystem approach in European waters.



Proposed eco-regions for the implementation of the ecosystem approach in European waters as defined by WGRED. The eco-regions are Greenland and Iceland Seas (A), Barents Sea (B), Faroes (C), Norwegian Sea (D), Celtic Seas (E), North Sea (F), South European Atlantic Shelf (G), Western Mediterranean Sea (H), Adriatic-Ionian Seas (I), Aegean-Levantine Seas (J) and Oceanic northeast Atlantic (K). Equidistant azimuthal projection. The question mark denotes the western Channel (ICES Area VIIe), which could be placed in either the Celtic Sea or North Sea eco-region.

Annex 4: List of participants in SGUFM

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Annex 5: List of participants at the Workshop on Unaccounted Fishing Mortality [WKUFM] in Aberdeen, UK, 25–27 September 2005

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Annex 6: Draft 2005 Resolution for the Study Group on Unaccounted Fishing Mortality [SGUFM]

The **Study Group on Unaccounted Fishing Mortality** [SGUFM] (Chair: Mike Breen, UK) will continue to work in 2006 to:

a) conduct and report on a comprehensive literature review, building upon the work of the previous Study Groups on issues relating to the sources of fishing mortality other than those that can be accounted for by the reported catch;

b) review and evaluate the report of the September 2005 Aberdeen Workshop on Unaccounted Fishing Mortality [WKUFM] and incorporate it's recommendations where applicable;

c) collate available data on sources of unaccounted fishing mortality (2006) and produce a comparative summary of their relative impacts, for different capture methods in key fisheries (2007);

d) review and make recommendations on methods used to estimate escape mortality from towed fishing gears;

SGUFM will report by 30 September 2006 to the Fisheries Technology Committee and make its report available to WGFTFB and all stock assessment WGs.

A progress report, including a report from the second workshop [WKUFM 2], will be made to the WGFTFB meeting in Izmir, Turkey, 3–7 April 2006.

Supporting Information

Priority	The current activities of this Group will lead ICES into issues related to quantifying sources of fishing mortality in addition to those that can be accounted for with commercial landings data. Consequently these activities are considered to have a very high priority
Scientific Justification and relation to Action Plan	Action Item 2.1, 2.3-a) Action Item 2.1, 4.10-b) Action Item 2.3, 3.5, 3.16-c) Action Item 3.16-d) Terms of reference a-d. Fishing mortality is one of the less documented variables in fisheries science, and particularly because of unaccounted mortality. In an Ecosystem –based management of fisheries, such lack of information may lead to erroneous conclusions and recommendation. Having a clear view of the impact of unaccounted fish mortality becomes a priority. The objective of the Study group is to publish a comprehensive review of the main sources of fish mortality that are not accounted for by the reported catch and to produce a series of recommendations. This group will meet prior to the ICES ASC in September 2006. It will report annually to FTC on progress and produce a more detailed report at least every third year. This report will be also reviewed by WGFTFB before finalization for consideration by FTC. The SG plans to hold a further workshop in April 2006 [WKUFM 2].
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	Members of SGUFM currently include: A. Bilbao (Spain), T. Blasdale (UK), M. Breen (UK), L.R. Cruz (Faroe Islands), D. Erickson (USA), M. Farrington (USA), A. Frechet (Canada), D. Garcia (Spain), N. Graham (Norway), E, Grimaldo (Norway), K. H. Hauge (Norway), I. Huse (Norway), O. Ingolfsson (Iceland), P. MacMullen (UK), C. Millar (UK), H. Milliken (USA), M. Pol (USA), A. Revill (UK), D. Rihan (Eire), P. Serafino (UK), A.V. Soldal (Norway), A. Stewart (UK), and P. Suuronen (Finland). There are other scientists active in this area in Europe, Canada and USA, including members of WGFTFB, who may be recruited to SGUFM on an *ad hoc* basis.
Secretariat facilities	None
Financial	None
Linkages to other Groups or	WGFTFB and stock assessment WGs.

Committees	
Linkages to Advisory Committees	Work is of direct relevance to issues being dealt with in ACE and ACFM
Linkages to other organizations	FAO
Cost Share	ICES 100%

Annex 7: Draft 2005 Resolution for a Workshop on Unaccounted Fishing Mortality [WKUFM]

A second **Workshop on Unaccounted Fishing Mortality** [WKUFM] (Chair: M. Breen*, UK) will be held, in conjunction with WGFTFB, in Izmir, Turkey from 31 March – 2 April 2006 to:

a) identify measurable components of unaccounted fishing mortality; and

b) define indices for assessing their relative impacts in key fisheries, for different capture methods.

WKUFM will report by 30 April 2006 for the attention of the Fisheries Technology Committee, the Study Group on Unaccounted Fishing Mortality (SGUFM), and the Working Group on Fishing Technology and Fish Behaviour (WGFTFB) and all stock assessment WGs.

Supporting Information

Priority	High: This Workshop will contribute to the activities of the Study Group on Unaccounted Fishing Mortality (SGUFM) and, as such, will lead ICES into issues related to quantifying sources of fishing mortality, in addition to those that can be accounted for with commercial landings data.
Scientific Justification	Action Item 3.16, 4.3, 4.10-a) and b) The objective of this workshop will be to assess the impact of unaccounted fishing mortality on the management of selected key stocks, on which ICES currently advises. The sources of unaccounted fishing mortality that will be addressed are:- Illegal, unreported and unregulated fishing; Discard mortality; Escape mortality; and Ghost fishing. One of the main reasons that these potential sources of fishing mortality have not been accounted for in the management of fisheries, both globally and in ICES, has been the absence of good scientific information. Recent and ongoing work by SGUFM and WKUFM has identified sources of information on unaccounted fishing mortality for some stocks and methods for assessing their impact upon the management of the affected fisheries. This Workshop will assess the impact of unaccounted fishing mortality on the management of key selected stocks, based on information and data currently being gathered by SGUFM. This work will provide essential information and data for the work currently being conducted by SGUFM and the stock assessment WGs.
Resource Requirements	No ICES resources
Participants:	Members of SGUFM, WGFTFB and some stock assessment WGs, but contributions from other ICES members and individuals not affiliated with ICES may be sought.
Secretariat facilities	None required beyond report compilation
Financial	No specific funding from ICES, non-ICES participants to incur their own costs.
Linkages to other Committees or Groups	This work will contribute to the activities of the Study Group on Unaccounted Fishing Mortality (SGUFM); and will be of interest to the Working Group on Fishing Technology and Fish Behaviour (WGFTFB) and the stock assessment Working Groups. The work is of direct relevance to issues dealt with in ACE and ACFM
Linkages to other organisations	FAO
Cost:	ICES 100%