ICES WGQAF REPORT 2008

ICES FISHERIES TECHNOLOGY COMMITTEE

ICES CM 2008/FTC:03

REF. RMC

Report of the Working Group on Quantifying all Fishing Mortality (WGQAF)

21–23 April 2008

Tórshavn, Faroe Islands

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2008. Report of the Working Group on Quantifying all Fishing Mortality (WGQAF), 21–23 April 2008, Tórshavn, Faroe Islands. ICES CM 2008/FTC:03. 24 pp.

Contents

Executive summary

The ICES Working Group on Quantifying all Fishing Mortality (WGQAF) met for the first time in Tórshavn, Faroe Islands, from 21–23 April 2008. The meeting was chaired by Philip MacMullen (UK). WGQAF was established in response to a recommendation of an earlier ICES EG, the Study Group on Unaccounted Fishing Mortality (SGUFM). The goals of WGQAF, paraphrased from the WG's ToRs for 2008 include provision of guidance and advice to ensure that:

- previously unaccounted mortality is factored into stock assessment,
- management measures reflect a greater understanding of the impacts of fishing operations,
- resource wastage is be reduced and accounted for, and
- data from researchers, gear technologists, vessel operators and the supply chain is incorporated to generate a more global perspective on total fishing mortality.

Topics discussed at the 2008 meeting included:

- the importance of considering all sources of mortality in stock assessment,
- examples of sources of mortality that may not have been taken into account,
- innovative approaches for quantifying and mitigating mortality including industry (self) sampling and working with the private sector to obtain information on fishing mortality associated with IUU,
- working group priorities including strategies for working with other ICES EGs and non ICES entities, and
- the definition of bycatch and related terms.

The following presentations were also provided by WGQAF members during the 2008 meeting:

- The inclusion of escape mortality estimates in stock assessments using ADAPT – Alain Fréchet (Canada) and Mike Breen (UK),
- Mortality of mackerel (*Scomber scombrus* L) crowded in purse seines – I. Huse, J. Saltskår, and A. V. Soldal (Norway),
- Industry/Science solutions in a data poor elasmobranch fishery – Philip MacMullen (UK),
- Fish Pots – "the dark side" – Mike Breen (UK).

WGQAF members agreed that the following activities would take place before or during the next meeting of the working group

- continue work on the application of unaccounted mortality data to stock assessments and report back in 2009,
- Update reports on the incorporation of components of F in stock assessment through direct contact with WG chairs and AMAWGC ,
- review information on IUU fishing available from fishing companies and discuss appropriate use,
- review best practices for reducing 'collateral' mortality in fisheries,
- develop lines of communication with WGECO and seek guidance on WGQAF priorities,

- review the potential for self-sampling to address mortality questions and report back on a self-sampling Workshop in June 2008 (see below),
- review the status and content of the US National Bycatch Report,
- plan a joint topic group on bycatch & associated definitions with WGFTFB for the 2009 meeting, and
- meet for 1–2 days in association with WGFTFB in 2009, the sessions to run consecutively.

WGQAF will meet in Ancona, Italy from 16–17 May 2009 to address the following ToRs:

a) Review and consider recent research and development concerning unaccounted mortality in commercial fisheries including;

  i) the application of unaccounted mortality data to stock assessments,

  ii) various sources of data regarding IUU, and

  iii) the potential for use of self (industry) sampling to account for discard mortality.

b) Review ongoing work for mitigating unaccounted mortality associated with ghost fishing including consideration of best practices for reducing collateral mortality in fisheries.

c) Report on communication with, and guidance received from AMAWGC, WGFTFB, WGECO, assessment working groups, other ICES EGs, and organizations outside ICES.

1 Opening of the meeting

The ICES Working Group on Quantifying All Fishing Mortality (WGQAF) held its first meeting in Tórshavn, Faroe Islands, from 21–23 April, 2008. The WGQAF Chair, Philip MacMullen (UK) chaired the meeting and Bill Karp (USA) acted as rapporteur. Additional meeting participants included Mike Breen (UK), Alain Fréchet (Canada), Sofie Vandemaele (Belgium), Philip Walsh (Canada), Irene Huse (Norway), and Frank Chopin (FAO). Further details can be found in annex 1.

2 Adoption of the agenda

The meeting agenda can be found in Annex 2. There was considerable discussion of the goals and objectives of the working group, and of strategies for successfully undertaking the work.

3 Terms of reference for 2008 meeting

Terms of reference for the first meeting of WGQAF were to:

a) maintain an overview of developments in the field and report to relevant ICES WGs (especially AMAWGC, WGFTFB, WGECO);

b) prioritise and coordinate responses to issues arising from a), for example:

  i) Slippage in NEA Mackerel fishery;

  ii) Ghost fishing; and

  iii) Inclusion of escape mortality estimates in stock assessment;

c) advise on the need for workshops and meetings to address specific issues arising from a) and b); and

d) liaise as necessary outside ICES in order to access data and influence events.

The principal goal of the 2008 meeting was to initiate work in support of the establishment of WGQAF:

"The innovative work of SGUFM has resulted in a widespread acceptance of the need to identify and quantify all sources of fishing-related mortality. Previously unaccounted-for mortality sources may be greater than that arising from discarding in some fisheries. The new WG will provide the means by which assessment WGs and others can express their priorities and see these communicated to researchers working on fish survival and on related gear technology topics. The expectation is that fishing gear design, and particularly the design of technical conservation devices, can take account of our increasing understanding of previously unaccounted-for sources of mortality. It is anticipated that other sources of data will also become available, particularly commercial operators.

The activities of this Group will lead ICES into a more holistic approach towards the management process, where:

- previously unaccounted mortality is factored into stock assessment,
- management measures reflect a greater understanding of the impacts of fishing operations,
- resource wastage can both be reduced and accounted for, and

- data from researchers, gear technologists, vessel operators and the supply chain can be incorporated to generate a more global perspective on total fishing mortality. "

4 Importance of considering all sources of mortality in stock assessment

Initial discussions focussed on the importance of considering all sources of mortality in stock assessment. While conventional stock assessment methods recognise fishing mortality (F) as a single term in the assessment equation, there are, in reality, many components of F which may be associated with retained catch, discard, unobserved mortality following escape from fishing gear, mortality due to encounters with ghost fishing gear, etc. In their presentation entitled "The inclusion of escape mortality estimates in stock assessments using ADAPT", Alain Fréchet (Canada) and Mike Breen (UK) presented a framework for inclusion of multiple sources of F in the stock assessment process and illustrated their approach by including escape mortality estimates in an assessment of North sea haddock.

Following this presentation, WGQAF members further discussed concerns about inconsistency in handling of all components of F in stock assessments, the need to quantify uncertainty associated with all sources of fishing mortality and the need to carry measures of uncertainty through the assessment.

5 Examples of sources of mortality that may not be taken into account

WGQAF discussed several examples of research on sources of mortality that may not currently be accounted for.

5.1 Slippage in purse seine fisheries

Irene Huse (Norway) presented results from a research study entitled "Mortality of mackerel (*Scomber scombrus* L) crowded in purse seines". This work documented major unaccounted mortality concerns in purse seine fisheries for mackerel (and potentially other species) as a result of the stress experienced by fish as they escape over the lip of the net. This post-release mortality could be delayed for a substantial period of time. Estimates of overall mortality levels associated with this factor had not been made.

Suggestions for addressing the problem included increased monitoring (e.g. video, VMS), pre-capture catch sampling and possibilities for regulation to prohibit slippage. Participants also discussed factors that influence or contribute to stress. One observation from the research was that oxygen saturation in the water where the fish were being held after 'drying up' could fall to ~28%.

The author plans to publish her research findings and to continue this type of research.

5.2 Ghost fishing

Mike Breen (UK) presented his paper "Fish Pots – the dark side". Members of WGQAF were particularly interested in his perspective regarding fishing mortality caused by lost or derelict pots. This was followed by a broader discussion of the impacts of all types of abandoned gear, the importance of research to characterize and quantify ghost fishing mortality, and the need for mitigation.

5.3 Illegal, Unregulated and Unreported (IUU) fishing

Phil MacMullen raised general concerns regarding IUU and the need for WGQAF to address the "unreported" and, therefore, generally unaccounted aspect. He suggested that it might be possible to obtain useful information from the UK fishing and processing sectors. Members agreed that this possibility should be investigated. Phil agreed to follow up and report back at the next meeting of the working group.

6 Innovative approaches for quantifying and mitigating mortality

Several topics were considered under this heading.

6.1 UK skate and ray project

Phil MacMullen presented a talk entitled "Industry/Science solutions in a data poor elasmobranch fishery". He described approaches taken to bring environmental, harvesting, processing, and government stakeholders together to address a range of conservation and management issues associated with fisheries for skates and rays off the UK. Several lessons can be learned from this exercise. Of particular interest to WGQAF was the system that was put in place to capture and manage industry-provided catch data, by species, for fisheries that had previously lacked this capability. Under the right circumstances, stakeholders can work together to address fishery management problems and facilitate the collection of essential catch data.

6.2 Industry sampling

Industry sampling of catch and bycatch takes place in several countries including Norway, Canada and the US. The most well-established of these programs is the Norwegian Research Fleet which involves a number of vessels which fish with different gear types throughout Norway and includes extensive training and data verification components.

While some working group members expressed scepticism regarding the integrity of data provided by industry members, it was generally understood that industry sampling might be the only mechanism available for collecting bycatch mortality data and biological samples in many instances and that it would be constructive to evaluate the successes and limitations of these types of programs. It was, therefore, agreed that WGQAF should review existing reports of industry sampling activities and work with other ICES EGs to establish guidelines for implementation of industry sampling programs and appropriate use of data collected by these programs.

Some WGQAF members (Irene Huse and Phil MacMullen) plan to participate in the ICES Workshop on Fishers Sampling of Catches (WKSC) which will take place in Copenhagen in June, 2008. They will report back at the next meeting of WGQAF.

6.3 Multispecies/ecosystem modelling

Alain Fréchet led a discussion on the use of multispecies and ecosystem modelling as a means of identifying potentially unaccounted fishing mortality associated with specific stocks. This topic will be addressed at a future meeting of WGQAF.

6.4 Mitigating the impacts of lost fishing gears

The topic of mitigation was addressed by SGUFM to a limited extent. However, WGQAF members spent some time discussing issues associated with the recovery of static gear and appropriate strategies. For example, many types of abandoned gear

become ineffective in shallow water relatively quickly but this is not generally the case in deep water. Other topics discussed under this heading included the difficulty of assessing the effectiveness of gear recovery projects, circumstances when lost gear may become favourable habitats and collateral damage that may be caused by some types of gear recovery programs. There was, however, general agreement on the importance of well-designed gear recovery programmes and the need to work with industry to facilitate recovery of abandoned gear. It was also agreed that this topic would be discussed in greater detail at a future meeting of WGQAF.

7 Priorities

Since the ToRs for WGQAF are broad and the WG's objectives have not yet been prioritized, there was considerable discussion of the relative importance of each of the issues discussed, and of the need to develop a prioritized workplan. Members agreed, however, that input from several other EGs would be necessary to complete this process, and that interactions with these EGs should take place during the next year so that WGQAF can develop a prioritized workplan at its 2009 meeting. In particular, discussions will be held with WGECO, individual stock assessment working groups and at the next AMAWGC meeting. While WGQAF favoured an approach which would take into account mortality of all species (quota and non quota) it was agreed that specific guidance should be sought from WGECO on this matter.

8 Definition of bycatch and associated terms

Frank Chopin (FAO) expressed concerns regarding serious disparities among regional and national definitions of bycatch and associated terms (e.g. target catch, retained catch, kept catch, discard). These disparities may have serious consequences when attempts are made to compare fishing performance and efficiency on an international or worldwide basis. This could also be of considerable importance in the design of monitoring and data collection systems. Frank provided some examples of marked differences in the definitions of bycatch.

WGQAF discussed the potential role of ICES, FTC, and WGQAF in resolving these inconsistencies and developing recommendations for standardized definitions. It was agreed that this topic should be discussed at a joint WGQAF/WGFTFB session in 2009. Frank indicated that FAO might formally seek advice from ICES on this matter.

9 Future activities

WGQAF members agreed that the following activities would take place before or during the next meeting of the working group:

- continue work on the application of unaccounted mortality data to stock assessments and report back in 2009,
- update reports on incorporation of components of F in stock assessment through direct contact with WG chairs and AMAWGC,
- review information on IUU available from fishing companies and discuss appropriate use,
- review best practices for reducing 'collateral' mortality in fisheries ,
- develop lines of communication with WGECO and seek guidance on WGQAF priorities,

- review the potential for self-sampling to address mortality questions and report back on June 2008 Workshop,
- review the status and content of the US National Bycatch Report,
- plan a joint topic group on bycatch & associated definitions with WGFTFB for the 2009 meeting, and
- meet for 1–2 days in association with WGFTFB in 2009. Sessions to run consecutively.

10 Summaries of Presentations

10.1 The inclusion of escape mortality estimates in stock assessments using ADAPT – Alain Fréchet (Canada) and Mike Breen (UK)

The issue of unaccounted fishing mortality (e.g. ICES, 2005) is gaining more recognition worldwide and has led to some directed research to assess its impact on resources via stock assessments. The North Sea haddock is one of the few stocks for which many sources of fishing mortalities have been identified and is thus an ideal candidate to illustrate the role of such mortalities in stock assessments. Aside from the directed human consumption fishery, these additional sources of fishing mortalities include bycatch, industrial bycatch, escape mortality on the bottom, during haul-up and at the surface as well as inferences concerning seabird predation at surface.

Historically, fish as young as age 0 have been included in the catch in this fishery and, with a regulated minimum landing size (MLS) of 30 cm, a significant proportion of the catch was being discarded. In recent years (2000–2002) there has been a substantial increase in mesh size (100mm to 120mm) to address this discard mortality. Results from Project SURVIVAL (Breen *et al.*, 2007) suggest that the post-selection ("escape") mortality mostly affects fish from age 0 to 2.

The analysis used an adaptation of the methods defined by Breen and Cook (2002) to estimate a correction factor ("*U*"), for each age cohort in each year of the assessment simulation, which is based on known selectivity probabilities and survival estimates from Project SURVIVAL (Breen *et al.*, 2007). The various sources of mortalities were estimated for the period of 1963 to 2006 for each age group (0 to 10 years old). It started with the basic status-quo formulation accepted in the last assessment of this stock (ICES, 2007). To this each of the additional sources of mortality were considered sequentially to evaluate the overall estimation of fishing mortality (see Table 1). The inclusion of these additional sources of mortality yields greater estimates of recruitment and total fishing mortality (F) in comparison to the status-quo scenario.

The basic approach used in the analysis was to modify the catch at age to reflect larger removals due to the inclusions of additional sources of mortality. This was done using the "*U*" statistic.

Revised catch $_{(i,t)}$ = Original catch $_{(i,t)}$ * $U_{(i,t)}$

Where $_i$ = age i and $_t$ = year t

The estimate of recruitment and total fishing mortality for 0-group haddock from the "*U*" corrected stock assessment simulations should be viewed with caution because in recent years this age group has been poorly represented in the catch data, due the increase in size selectivity of the gear. As a result, its calculation is based on a highly inflated correction factor (U >10,000). Therefore, the adjusted estimates of fishing mortality will be highly sensitive to small variations in the catch data. It is also impor-

tant to remember, that this age group will not be exposed to the same level of contact with fishing gear over the year as the older age groups.

This exercise shows that the inclusion of additional sources of fishing mortalities can change the perception of stock status in relation to precautionary biological limits. In this case, the current view of total fishing mortality is below the precautionary limit (F_{pa}), but this changes with the inclusion of escape mortality estimates to reach F_{lim} and even exceed F_{lim} in the case of an extreme scenario (Figure 1). Of course, these results cannot be generalized as they are in proportion to the magnitude of unaccounted fishing mortalities in a specific fishery. Such inclusions in the stock assessment process are thus strongly encouraged for other fisheries, where relevant data are available, as it may lead to significant changes in the perceptions of stock status. It may eventually lead to revisions to the precautionary approach, limit reference points and harvest control rules for affected stocks.

References

Breen, M., and Cook, R. 2002. Inclusion of Discard and Escape Mortality Estimates in Stock Assessment Models and its likely impact on Fisheries Management. ICES CM 2002/V: 27, 15pp.

Breen, M., Huse, I., Ingolfsson, O.A., Madsen, N. and Soldal, A.V. 2007. SURVIVAL: An assessment of mortality in fish escaping from trawl codends and its use in fisheries management. EU Contract Q5RS-2002-01603 Final Report.

ICES. 2005. Joint report of the Study Group on Unaccounted Fishing Mortality (SGUFM) and the Workshop on Unaccounted Fishing Mortality (WKUFM). ICES CM 2004/B:08.

Table 1. Four scenarios included in simulations of the North Sea Haddock stock assessment using ADAPT.

Scenario	F Discards	F E(Depth)	F E(Surface)
Status Quo	Yes	No	No
Scenario 4	Yes	Yes	No
Scenario 5	Yes	Yes	Predation (p=0.4)
Scenario 6	Yes	Yes	Predation (p=1.0)

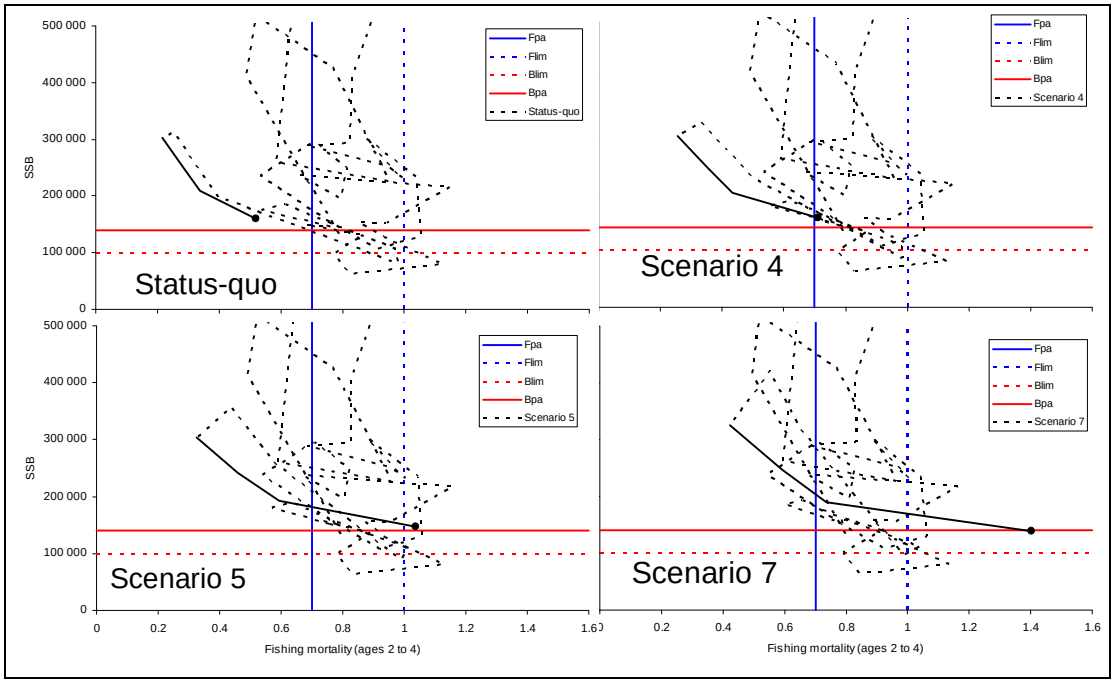

Figure 1. The effect on Total Fishing Mortality and Spawning Stock Biomass for four different escape mortality scenarios (see Table 1) included in simulations of the North Sea Haddock stock assessment using ADAPT.

10.2 Mortality of mackerel (*Scomber scombrus* L) crowded in purse seines – I. Huse, J. Saltskår, and A. V. Soldal (Norway)

A new offshore method was used to study the effect of crowding with subsequent slipping from a purse seine on the mortality of Atlantic mackerel (*Scomber scombrus* L). Mackerel were carefully transferred from a purse seine into two identical large floating net-pens through a transfer channel. One pen was used as control and left floating in the sea without further treatment. The other was used for simulating crowding and slipping from purse seines. The water volume in the pen was gradually decreased by hoisting the bottom of the pen by a crane until the fish started to show flash expansion behaviour (or started to 'boil' as denoted by fishermen), and this density was kept for 15 (2006) or 10 min (2007). The volume was then returned to normal and the net-pens left drifting freely in the open sea for 3 to 6 days. Fish was filled in experimental or control pens ten times. Although four of these were somewhat deranged by experimental problems, it was evident that crowding had a major effect on survival of mackerel. In all five experiments, the mortality was higher among the crowded fish (80–100% mortality) than among the controls (0.1–46% mortality), and the difference was significant. The experiments showed that slipping of mackerel from purse seines should be avoided, if possible, to avoid massive killing of fish.

10.3 Industry/Science solutions in a data poor elasmobranch fishery – Philip MacMullen (UK)

Introduction

Philip MacMullen gave a presentation on elasmobranch fisheries in the UK based on around 12 species of *Rajidae*. Of these at least one, *Raja batis*, is classified by IUCN as

'endangered'. This species is slow growing, late maturing, and vulnerable to fishing gear almost from the point of hatching. The other species exhibit a wide variation in growth rate and average age at maturity. Within the Common Fisheries Policy there is no provision for recording landings at species level. Given the limited data available, and the vulnerability of *R batis*, ICES advice for area IV is zero catch.

In 2006 a campaign by radical environmentalists in the UK urged UK retail outlets to de-list all *Rajidae* – and most announced plans to do so within days or weeks.

Problem

The UK industry includes an identifiable sector – of fishermen, merchants and processors – that is highly dependent upon these species. It claimed that there were several targeted fisheries for the faster-growing species that had seen no decline in catch rates over recent years and that the stocks were showing no signs of stress. Given this belief would it be possible to keep markets open for *Rajidae* spp. in the face of determined campaigning?

Approach

Industry body Seafish set up a supply chain group comprising fishermen, merchants, processors, retailers and food service as well as representatives of the fisheries science community, fisheries management, statutory conservation advisors and cooperative environmental non-governmental organisations (eNGOs). This group identified a range of issues that were amenable to resolution and that could start to bring the species-based fisheries into the mainstream of science-based management.

The group recognised that UK and European authorities were aware of the management needs of the species concerned but had consistently given these a low priority, certainly relative to quota-managed species' needs. There was a limited knowledge of the distribution, abundance, seasonality, catch rates and fishing and release mortality of the species, hence no basis for developing a management strategy.

After several meetings the group agreed a strategy for the future of the fisheries. This involved:

- Seafish establishing a landings database on its website,
- agreeing the full range of common name variants against Latin names,
- the Shark Trust and Seafish designing and printing laminated identification guides to the species of *Rajidae* caught in UK waters (Figure 1),
- identifying the principal fishermen and merchants involved in targeted fisheries for *Rajidae*,
- gaining agreement from the merchants (point of first sale) that they would input data provided by fishermen to the Seafish web-based data base,
- agreeing a programme of research into the release survival of certain *Rajidae* related to the fishing method deployed and a number of other variables such as, for towed gears, length of tow, and negotiating a code of 'best operating practice' so that fishermen and others participating in the 'responsible' supply chain could gain some recognition of their efforts.

Results

Taking a 'supply chain' approach enabled all players in the fishery to come to a consensus position on a number of issues and remove the threat to the fishery. This has

been on the basis of being able to demonstrate that there are fisheries targeting the faster-growing species

At the time of reporting the database has been operating for about 15 months and is yielding data that appear robust to those in the science community with a specific interest in elasmobranchs. Several retrievals are shown as Figures 2–6.

Conclusions

Many elasmobranch fisheries are data-poor. The characteristics of many species make them vulnerable to fishing pressure both in directed fisheries and as bycatch.

In these circumstances a common, precautionary response is to advocate fishery closures.

This example shows that it is possible to take a supply chain approach, using market feedback to incentivize fishermen, and generating fishing mortality data that can help inform the management process.

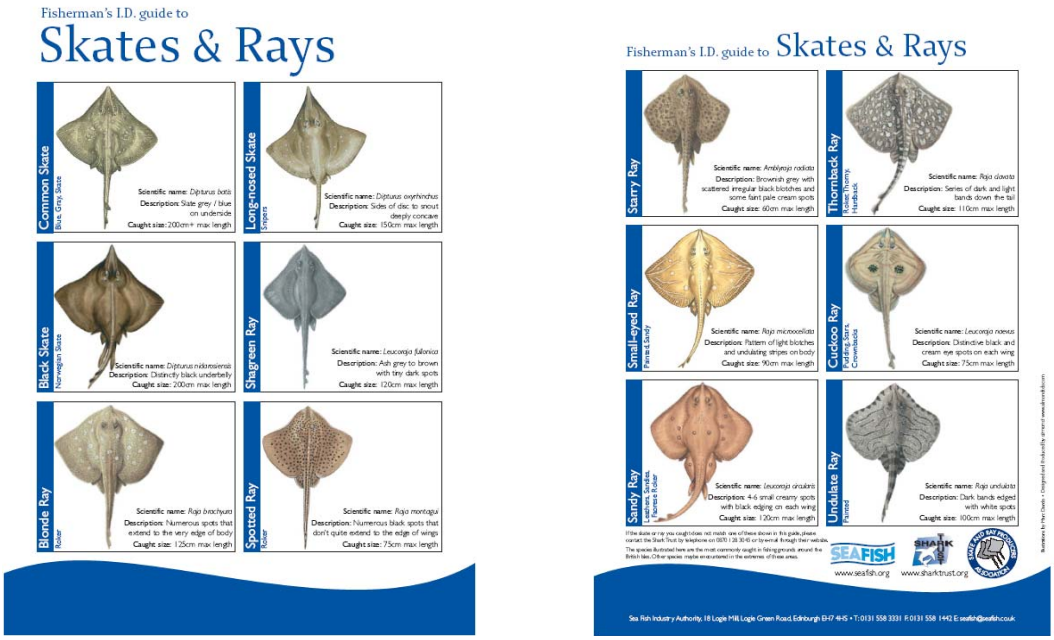

Figure 1. Fishermen's identification guide.

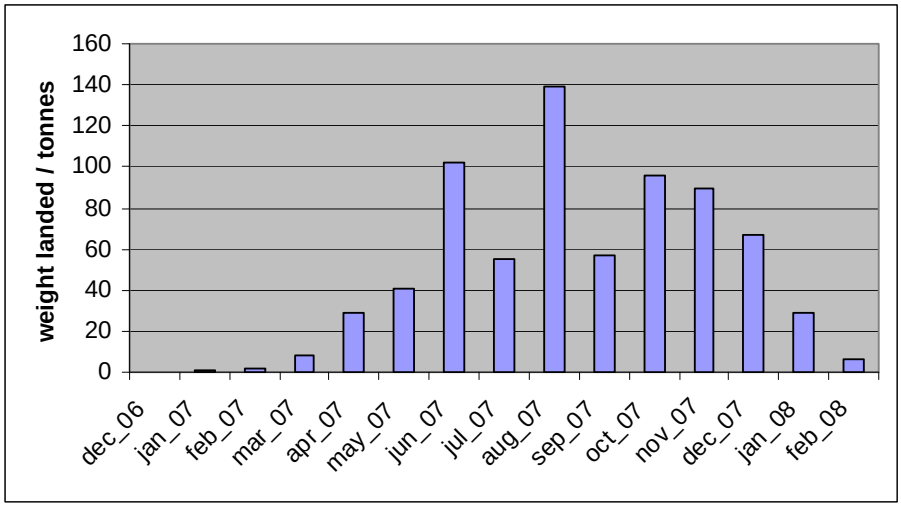

Figure 2. Volume of all skate and ray species landed into the UK – December 2006 to February 2008.

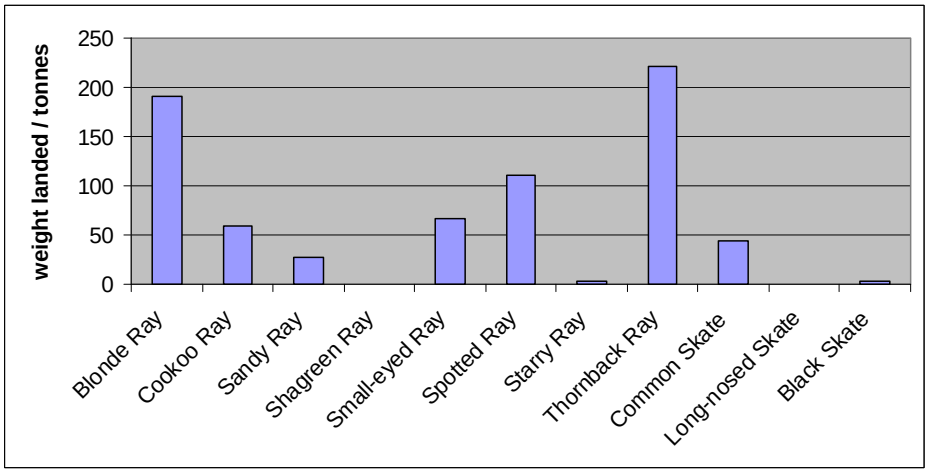

Figure 3. Breakdown of landings between December 20006 to February 2008 by species.

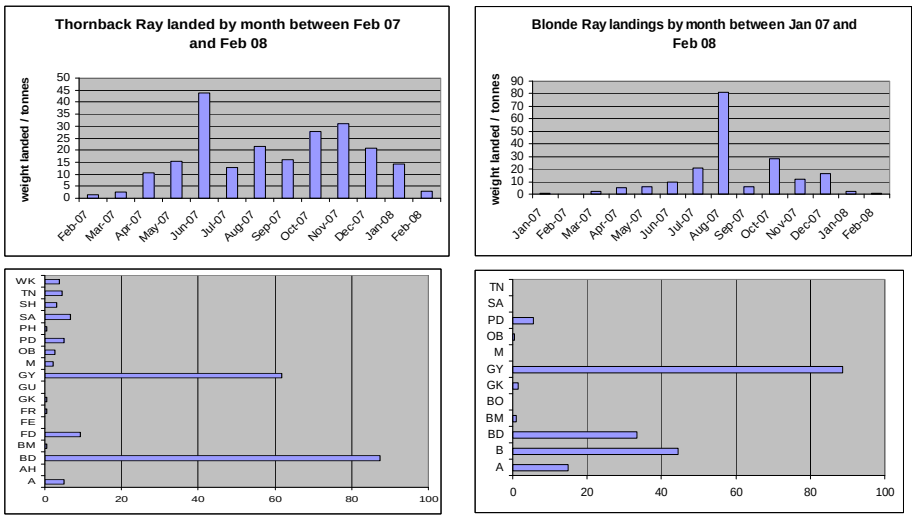

Figure 4. Breakdown of Thornback and Blonde Ray landings by month and port.

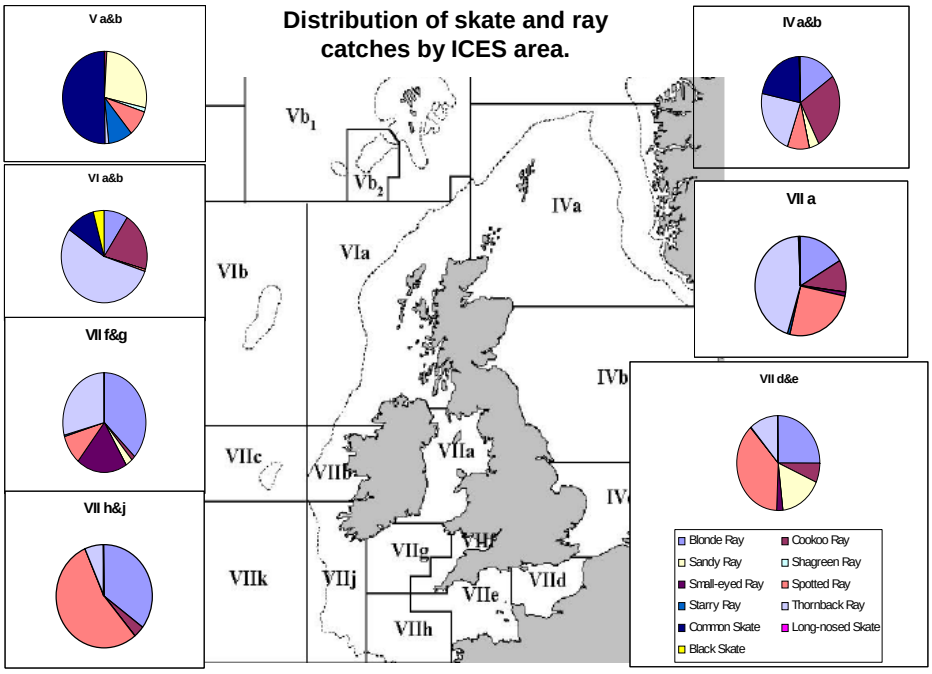

Figure 5. Distribution of UK skate and ray catches by ICES area.

10.4 Fish Pots – "the dark side" – Mike Breen (UK)

Fish pots have been identified as a potentially "responsible" fishing gear by the WGFTFB Topic Group on Alternative Fishing Gears (SGPOT) (ICES, 2006); in particular with respect to their environmental sustainability in terms of reduced environmental impact, low energy cost and the welfare of the catch/bycatch. However, this gear does have the potential to induce a number of detrimental effects upon the marine ecosystem and the users of that ecosystem.

These detrimental effects are now widely recognised for various static gears (for reviews see: Brown *et al.*, 2005; Brown and Macfadyen, 2007; Matsouka *et al.*, 2005) and can be summarised in the following broad categories:

- "Ghost-fishing": the continued catching of target species when lost;
- "Bycatch": the capture/entanglement of non-target species and charismatic mega-fauna;
- the physical impact of gears on the benthic environment;
- the contribution to marine debris and its associated effects; and
- conflicts with other users.

Each of these issues was briefly reviewed and, where available, relevant examples given. It was recognised that because of the developing nature of fish pots as a commercial gear, limited data were available. It was noted that there has been a particular focus upon the ghost fishing properties of static gears, but there are few examples for fish pots. Discussions in both SGPOT and the Working Group for the Quantification of All Fishing Mortality (WGQAF) recognised the relatively benign nature of fish pots which means there is a minimal impact upon the welfare of captive fish (ICES 2007). Irrespective of whether lost pots kill fish or not, if captive in a pot the fish is removed from the fishable stock. From this perspective, Al-Masoori (2000) estimated that 3–15% of the total value of the fish pot fishery in the Sultanate of Oman was lost annu-

ally to ghost fishing. In Japan, an underwater survey identified 639 lost pots from a small inshore pot fishery which shared fishing grounds with aquaculture activities (Matsouka *et al.,* 1997). This was ten times the number of pots actively fish in the area each day by the fishery and of these ghost pots, 274 were still actively fishing (Matsouka *et al.,* 1997).

Some of the common causes of lost static gears, in decreasing order of relative importance, are (based on Brown *et al.,* 2005):

- conflict with other sectors, principally towed gear operators;
- working in deep water;
- working in poor weather conditions and/or on very hard ground;
- working very long fleets of pots; and
- working more gear than can be hauled regularly.
- [irresponsible disposal ("dumping") of gear].

But, because of the passive nature of the gear, it was suggested that ghost fishing and these other detrimental issues associated with pots are intrinsically linked and as such may have common solutions. These solutions can be both preventative and curative (Brown *et al*., 2005):

Preventive measures	Curative measures
• Reducing risks of conflict e.g. zoning of different users	• Reporting of gear loss for subsequent gear recovery campaigns
• Reducing risks of snagging e.g. gear modification	• Gear recovery campaigns
• Reducing efficiency of ghost nets e.g. biodegradable components	• Opportunistic gear recovery through demersal trawl surveys
• Reducing fishing effort e.g. net numbers, soak time	
• Improving gear recovery e.g. attachment of transponders	

However, the use of recovery schemes has been criticised by a number of authors because of: the inefficiency of current recovery techniques; the potential impact upon the seabed; the destruction of emerging habitats/communities on the establishing artificial reef associated with the gear; the issue of suitable disposal once the gear is recovered; as well as the relative cost of the recovery operations compared with the environmental benefits (Brown *et al.,* 2005; Brown and Macfadyen, 2007; Matsouka *et al.,* 2005; Wiig, 2004). In general, it is recognised that preventing gear loss or abandonment is better than any curative measures.

Discussions in SGPOT focused on two particular aspects of preventative mitigation: designing fish pot to promote conservation; and minimising loss of gear by avoiding conflict with other users. It was recognised by the group that conservation should be considered as a design priority, alongside catch efficiency, in the development of fish pots. Among the conservation design features considered were: floating pots, to minimise benthic impact; biodegradable construction materials, to reduce ghost fishing and marine debris; delayed surface marker buoys and location aids, to promote recovery of lost gear; and non-snagging pots and surface marker lines and floats, to

reduce loss of gear. To avoid conflicts with other users, the group noted that spatial and temporal separation of users appears to be the most commonly used and successful method, but careful design of the gear and mooring/marking methods could specifically reduce conflict with other fishing gears. It was proposed that the SGPOT Final Report and CRR should include a guideline code of practice for the responsible design and operation of fish pots.

References

Ager, O., and Oakley, J. 2006. Marine & Coastal Litter, Marine Life Topic Note. The Marine Biological Association of the United Kingdom.

Al-Masroori, H., Al-Oufi, H., McIlwain, J.L., and McLean E. 2004. Catches of lost fish traps (ghost fishing) from fishing grounds near Muscat, Sultanate of Oman. Fisheries Research, 69: 407–414.

Brown, J., G. Macfadyen, T. Huntington, J. Magnus, and J. Tumilty (2005). Ghost Fishing by Lost Fishing Gear. Final Report to DG Fisheries and Maritime Affairs of the European Commission. Fish/2004/20. Institute for European Environmental Policy / Poseidon Aquatic Resource Management Ltd joint report.

Brown, J., and Graeme Macfadyen, G. 2007. Ghost fishing in European waters: Impacts and management responses. Marine Policy, 31: 488–504.

ICES. 2006. Topic group on alternative fishing gears for traditional species that are environmentally friendly and responsible fishing methods. ICES Working Group on Fishing Technology & Fish Behaviour (WGFTFB), Izmir, Turkey, April 2006.

ICES. 2007. Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT), Dublin, April 2007.

Matsouka, T., Osako, T., and Miyagi, M. 1997. Underwater and Observation and assessment on ghost fishing by lost fish-traps. In: Zhou, Y., Zhou, H., Yao, C., Lu, Y., Hu, F., Chui, H. and Din, F. (eds). Fourth Asian Fish. Forum. Asian Fisheries Society, Beijing, China. 1997: 179–183.

Matsouka, T., Nakashima, T., and Nagasawa, N. 2005. A Review of Ghost Fishing: Scientific Approaches to Evaluation and Solutions. Fish. Sci., 71: 691–702.

Wiig, H.C. 2004. A Cost Comparison of Various Methods of Retrieving Derelict Fishing Gear. Department of Business, Economic Development and Tourism Strategic Industries Division, Honolulu, Hawaii, U.S.A.

Annex 1: List of participants

Name	Address	Phone/Fax	Email
Mike Breen	Fisheries Research Services, 375 Victoria Road, Aberdeen, AB11 9DB, Scotland	Tel: +44 1224 295474 Fax: +44 1224 295511	breenm@marlab.ac.uk
Frank Chopin	FAO Rome	Tel: +3906 57055257	Francis.Chopin@fao.org
Alain Fréchet	Maurice Lamontagne Institute, 850 Route de la mer, Mont-Joli, G5H 3Z4, Canada	Tel: +1418 7750628 Fax: +1418 7750679	Alain.Frechet@dfo.mpo.gc.ca
Irene Huse	Institute of Marine Research, Nordnesgt 33, Bergen, N-5817, Norway	Tel: +47 55236808 Fax: +47 55236830	irene.huse@imr.no
Bill Karp	Alaska Fisheries Science Center (NOAA), 7600 Sand Point Way NE, Seattle, 98115, USA	+12065264000	Bill.Karp@noaa.gov
Philip MacMullen	Seafish, Saint Andrew's Dock, Hull, HU3 4QE, England	Tel: +44 1482 327837 Fax: +44 1482 223310	p_macmullen@seafish.co.uk
Philip Walsh	Marine Institute, 155 Ridge Rd., St. Johns, A1C5R3, Canada	Tel: +1 709 7780430 Fax: +1 709 7780661	Philip.Walsh@mi.mun.ca
Sofie Vandemaele	ILVO-FISHERY Ankerstraat 1 8400 Ostende, Belgium	Tel: +3259569883	Sofie.Vandemaele@ilvo.vlaanderen.be

Annex 2: Agenda

21 April

08:30 – 09:00 Registration

11:50 – 12:10 Introduction to the WG and its ToRs, invitation to attend later sessions

23 April

09:10 – 09:45 WGQAF, how to deliver? – investigating priorities, mechanisms and movers

09:45 – 10:15 The inclusion of escape mortality estimates in stock assessment, Alain Fréchet

10:15 – 10:45 Purse seine slippage in North Atlantic mackerel, Irene Huse

10:45 – 11:00 Break

11:00 – 11:30 Industry/science solutions in a data poor elasmobranch fishery, Phil MacMullen

11:30 – 12:30 All mortality – why only quota species? What about the ecosystem approach?

24 April

09:00 – 09:10 Housekeeping

09:10 – 09:40 Ghost fishing in static gears, Mike Breen and Phil MacMullen

09:40 – 10:40 data sources and functionality

10:40 – 11:00 Break

11:00 – 13:00 WGQAF, how to deliver? Revisiting priorities, mechanisms and movers

25 April

11:15 – 12:00 Report from WGQAF in WGFTFB plenary

Annex 3: WGQAF terms of reference for the next meeting

The **ICES Working Group on Quantifying all Fishing Mortality** [WGQAF] (Chair: Philip MacMullen, UK) will meet in Ancona, Italy from 16–17 May 2009 to address the following ToRs:

e) Review and consider recent research and development concerning unaccounted mortality in commercial fisheries including;

  i) Application of unaccounted mortality data to stock assessments.

  ii) Sources of data regarding IUU.

  iii) Potential for use of self (industry) sampling to account for discard mortality.

f) Review ongoing work for mitigating unaccounted mortality associated with ghost fishing including consideration of best practices for reducing collateral mortality in fisheries;

g) Report on communication with, and guidance received from AMAWGC, WGFTFB, WGECO, assessment working groups, other ICES EGs, and organizations outside ICES.

WGQAF will report by 16 June, 2009 to the attention of the Fisheries Technology Committee and the Resource Management Committee.

Supporting Information

Priority:	Stock assessment scientists, Chairs of assessment WGs and others have now accepted the significance of UFM. Flexible and effective liaison with them and other bodies will be substantially enhanced by the work of WGQAF. The importance of recognizing all sources of mortality in stock assessment, and of developing recommendations for mitigating UFM are of great importance in individual stock assessments and under the ecosystem approach. WGQAF will seek guidance from assessment WGs, WGECO, WGFTFB, AMAWGC and other EGs as well as outside bodies. WGQAF will then evaluate available information, formulate advice, and provide recommendations for future work. This is considered a high priority activity.

Scientific justification and relation to action plan:	Action Plan: 2.2, 3.2, 3.4, 3.6, 3.13, 3.16, 3.17, 3.18, 4.3, 4.13, 4.15, 5.11 The innovative work of SGUFM has resulted in a widespread acceptance of the need to identify and quantify all sources of fishing-related mortality. Previously unaccounted-for mortality sources may be greater than that arising from discarding in some fisheries. The new WG will develop and implement the means by which assessment WGs and others can express their priorities and see these communicated to researchers working on fish survival and on related gear technology topics. The expectation is that fishing gear design, and particularly the design of technical conservation devices, can take account of our increasing understanding of previously unaccounted-for sources of mortality. It is anticipated that other sources of data will also become available, particularly from commercial operators and that WGQAF will provide guidance regarding development of new programs and appropriate use of data collected. The activities of this Group will lead ICES into a more holistic approach towards the management process, where: • previously unaccounted mortality is factored into stock assessment, • management measures reflect a greater understanding of the impacts of fishing operations, UM is reduced and accounted for, and data from researchers, gear technologists, vessel operators and the supply chain is incorporated in the stock assessment process and in evaluations of the ecosystem impacts of fishing.
Resource requirements:	The additional resources required to undertake additional activities in the framework of this group are negligible.
Participants:	20–25 members and guests are expected
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups:	There is a very close working relationship with all the groups of the Fisheries Technology Committee. The work of WGQAF is also very relevant to the WGECO, AMAWGC, assessment WGs, and the Resource Management Committee
Linkages to other organizations:	The work of this group is closely aligned with similar work in FAO and elsewhere

Annex 4: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
1. Update reports on incorporation of components of F in stock assessment through direct contact with WG chairs and AMAWGC	P MacMullen (Chair)
2. Develop lines of communication with WGECO and seek guidance on WGQAF priorities	P MacMullen/ A. Fréchet
3. Plan a joint topic group on bycatch & associated definitions with WGFTFB for the 2009 meeting	P MacMullen/D. Rihan
4. Meet for 1–2 days in association with WGFTFB in 2009. Sessions to run consecutively	P MacMullen/D. Rihan