European Commission

JRC SCIENCE FOR POLICY REPORT

Scientific, Technical and Economic Committee for Fisheries (STECF)
-
Long-term management of skates and rays
(STECF-17-16)

Edited by Michel Bertignac & Finlay Scott

Joint Research Centre

EUR XXXXX EN

Contact information

Name: STECF secretariat

Address: Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra VA, Italy

E-mail: stecf-secretariat@jrc.ec.europa.eu

Tel.: +39 0332 789343

JRC Science Hub

https://ec.europa.eu/jrc

JRCXXXXX

EUR XXXXX EN

PDF	ISBN XXXXXXX	ISSN 1831-9424	doi:XXXXXXXX
STECF		ISSN 2467-0715	

Luxembourg: Publications Office of the European Union, 2017

How to cite: Scientific, Technical and Economic Committee for Fisheries (STECF) – Long-term management of skates and rays (STECF-17-16. Publications Office of the European Union, Luxembourg, 2017, ISBN XXXXXX, doi:XXXXXXXX, PUBSY No.

Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. This report focusses on the long-term management of skates and rays.

Authors:

STECF advice:

Ulrich, C.., Abella, J. A., Andersen, J., Arrizabalaga, H., Bailey, N., Bertignac, M., Borges, L., Cardinale, M., Catchpole, T., Curtis, H., Daskalov, G., Döring, R., Gascuel, D., Knittweis, L., Lloret, J., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nord, J., Prellezo, R., Raid, T., Sabatella, E., Sala, A., Scarcella, G., Soldo, A., Somarakis, S., Stransky, C., van Hoof, L., Vanhee, W., van Oostenbrugge, Hans , Vrgoc, Nedo

EWG-17-10 report:

Bertignac, M., Borges, L., Clarke, M., Ellis, J., Figueiredo, I., Gadenne, H., Jung, A., Rihan, D., Scott, F., Walker, P.

TABLE OF CONTENTS

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) - Long-term management of skates and rays (STECF-17-16)

Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting and the additional information received from the Regional Groups after the EWG, evaluate the findings and make any appropriate comments and recommendations.

STECF response

Background for the STECF 17-10

Skates and rays are currently managed under five regional TACs. Each is a general skate and ray TAC including several species. ICES (International Council for the Exploration of the Sea) used to publish generic skates and rays stock assessment scientific advice but increasing scientific knowledge and data reporting at species level has allowed for the provision of advice at a more detailed level. As a result, TACs in each region include individual stocks which may have very different stock development and status and different advice and as STECF has previously noted, "the approach of setting combine TACs (…) does not offer adequate protection for ray species that require reductions in F" (STECF, 2014).

In recent years, a number of requests for scientific advice have been issued by the EU regarding the management of European skate and ray stocks. This includes a request to ICES in 2013 to explore alternative management measures, to list the associated data needs and explore the state of knowledge on the fishing activity (ICES, 2013); a request to STECF in 2015 on a proposal for an alternative TAC calculation method proposed by France (STECF, 2015); and a request to ICES in 2016 to review proposal of an in-year TAC adjustment in division 7d (ICES, 2016). In 2016, the Commission proposed a change to skate and ray TAC management for 2017, with several new sub-TACs for different species. The proposal used the existing "SRX" quota allocation key, applying the relative stability shares to each sub-TAC. Feedback from stakeholders and Member States raised concerns that such an allocation did not reflect current fishing activity and the distribution of species within the management area, causing significant socio-economic impact on fishermen. Thus at the December Fisheries Council, the proposal reverted back to the 2016 system of combined skate and ray quota management, but with a joint statement from Member States and the Commission to further explore alternative management options.

In March 2017, the Commission received advice from the North-Western Waters Advisory Council (NWWAC) suggesting several alternative management measures and requested they be reviewed by STECF. The Commission organised a seminar with fishermen, scientists, national administrations and other stakeholders in May 2017. This meeting helped in the drafting of these terms of reference for EWG 17-10.

STECF observations

The working group was held in Brussels, Belgium, 16-20 October 2017. The meeting was attended by 10 experts in total, including 2 STECF members and 1 JRC expert.

Terms of Reference for EWG-17-10

To review possible management options and recommend a new approach for the sustainable management of skates and rays fisheries.

The review and assessment of management options should consider; sustainability such as MSY proxies, the regional approach to fisheries management, mixed fisheries approach to catches of skates and rays and possible "choke" species, socioeconomic impacts and the practical applicability of management measures. Practical applicability would include the consideration of relative stability, including the evaluation of historic landing data, ease of enforcement / control and the risk to increased misreporting.

The Commission understands that many of the skate stocks concerned are data-limited and does not expect definitive quantitative simulations. A risk-based approach may be more suitable; however suggestions and analysis by STECF should include information on how skates and rays can be fished and managed sustainably in accordance with the CFP objectives in each scenario, with suggestions on appropriate safeguards and monitoring techniques.

Furthermore, the expert working group is requested to:

a) Collect and analyse information available for those fleets/métiers involved in the catch of skates and rays, by identifying (i) those métiers (or higher aggregation levels) catching skates, (ii) the catch composition (species and length composition) of the métiers, and (iii) the social and economic dependence of the métier on the main skate and rays species. Provide an overview of the current scientific knowledge and data availability regarding mixed-fisheries involved in the catch of skates and rays

b) Evaluate the usefulness of closed areas/seasons as measures for controlling fishing mortality and/or protecting spawning fish and reducing mortality on juveniles (survey data, scientific knowledge available in the literature).

c) Collate and review the results of research on selectivity and relevant bycatch mitigation measures for relevant fishing gears (haul time etc.) that would either help avoid the catch of skates and rays, or that could increase their discard survival. Evaluate the effect of the most relevant technical measures affecting the selectivity of fishing gears.

d) Collate and review information on the survival rates of skates and rays (updating STECF 2014). The output would be a table of stocks / species versus métier /fleet segment for each sea basin or TAC unit. This exercise should consider to what extent information from one métier / fleet could be extrapolated to other fleets, detailing the criteria to do so. If this is not possible, then the working group is requested to conduct a gap analysis, detailing what information would be required to consider extrapolation and high survivability exemptions across all species of skates and rays, métiers and fleer segments per sea basin or TAC unit, whichever is more suitable.

e) Compare the relative merits (Pros and cons) of potential alternative management measures proposed in the attached documentation by the NWWAC and the Dutch Elasmobranch Society, as well as the output of the 12 May Focus Group. These potential management measures can be considered in a qualitative, risk-based framework for each sea basin or TAC unit, based on expert opinion. DG MARE understands that no one measure will be perfect, so where possible, combinations of management measures that mitigate risks, should be suggested by the working group.

STECF observes that the ToRs were very ambitious and broad ranging. The EWG made substantial progress towards delivering all ToRs but was not able to recommend a new approach for the sustainable management of skates and rays fisheries. The approach followed by the EWG 17-10 was to group the ToRs as follows:

The first category, including ToR a, c and d, is presented as a compilation and review of available information related to i) the fleets and métiers involved in the capture of skates and rays, ii) the results of research on selectivity and bycatch mitigation measures and iii) the survival rates following discarding.

ToR a *Skate catch data*

The EWG presented tables indicating the occurrence by ICES Division of 32 species of skates (Rajiformes) in the North-east Atlantic and those that are, or have been, exploited commercially in northern European fisheries (16 species). Information on the interactions of different gears with skate species are summarised and the differences in these interactions between inshore, coastal and off-shore fleets described, as well as specific skate fisheries by ICES area (ToR a.i). Data on the composition of skates caught in different fisheries and length frequencies in the full catch are presented but only for a few examples (ToR a.ii). STECF observes that the social and economic dependence of the métier on the main skate species could not be addressed (ToR a.iii).

STECF observes there is no single dataset that can provide all relevant skate fisheries data; there are various subsets of relevant data available, however the data sources used by EWG 17-10 are not clearly described. The EWG also noted that the ICES Working Group on Elasmobranch Fishes (WGEF) considers that some 'species-specific' records held in official data are inaccurate, which can be due to a range of issues (e.g. coding errors, misidentifications, misreporting). STECF observes that there is consensus that data limitations exist for skate stocks, but the nature of these limitations and the stocks to which they apply have not yet been defined. For example, there are discard data available in the STECF FDI database that is not referred to in the ICES advice.

ToR d) *Skate discard survival*

EWG-17-10 collated and reviewed available information on the discard survival rates of skates. As requested, the EWG updated a table from STECF (2015) and presented seven studies in European waters, of which only two estimated discard survival. The other studies reported either vitality values or the percentage of individuals that survived after the observation period.

STECF observes that, while it was useful to update the survival study table, modifying the table to include an assessment of the quality of the estimates would improve its utility. The table includes a column 'short-term'. STECF observes that the phrases of 'short-term' and 'long-term' discard survival estimates can be misleading, consequently the outputs of the ICES Workshop on Methods to Estimate Discard Survival (WKMEDS) no longer use these terms. There are two methods to estimate discard survival, i) deploying tags on discarded fish and retrieving those tags to determine the fate of the fish; and ii) taking fish at the point they would be discarded, holding them in captivity and recording their fate. When using this captive observation method, it is necessary that all mortalities associated with the commercial catch and sorting process are observed. This means that the monitoring period has to be sufficiently long to demonstrate that mortalities have stopped. If the monitoring period is too short, then the discard survival rates overestimate the true levels. But when applied correctly, both methods generate robust discard survival estimates, and the main difference between the two methods is that when using tags, the discard estimate includes the effect of predation, which is missing when using captive observation.

Therefore, some of the 'short-term' estimates presented may be robust discard survival rates that do not include predation, while other estimates may be generated from insufficient monitoring periods, but this cannot be determined from the table. Similarly, the EWG reports that none of the studies provide long-term discard survival estimates, however, STECF observes that one study using DST tags deployed on thornback rays (*Raja clavata*) was based on data collected for up to 317 days (Catchpole, 2017). Instead of short and long term estimates, the table could be modified in the future to include the experimental method used and the quality of the study. A critical review process developed by WKMEDS and used by STECF in assessing discard survival evidence has previously been applied to the reported studies (Catchpole, 2017), and this includes assessing whether all mortalities were observed when using the captive observation method.

Discard survival estimates are needed to support requests for exemption from the landing obligation. STECF observes that current estimates cover a limited number of métiers, areas and species, and because the factors that influence survival are poorly understood extrapolation across species, fisheries and areas is challenging. The EWG also recognised that it is important to further encourage good practice on fish handling when discarded alive.

ToR c) *Selectivity*

The EWG reports that gear-based technical measures for towed gears such as increased codend mesh sizes and square mesh panels are ineffective in increasing size selectivity for skates and rays because their large, flattened body shape prevents escape once inside fishing gears (Ellis et al., 2016). However, this type of modification can improve the condition of skates and therefore their survival chances, by reducing the volume of catch in the codend (e.g. Enever et al., 2010).

STECF observes that improvements in the selectivity of trawls for skates can be achieved through modifications which utilise the difference in shape and size of skates and behaviour compared with other species in the catch. The EWG divided these into sorting grids and By-catch Reduction Devices (BRDs), escape panels and separator trawls, and other trawl gear modifications. The short review provided by the EWG demonstrated good potential for these modifications to reduce catches of skates and rays.

The EWG reports that for static gears and long line fisheries, the options for reducing skate bycatch are limited, but there have been few studies to date. A number of possible modifications were given, including restricted lengths of net, limiting soak times, adjusting mesh size, hanging ratio and height of the net and modifying the thickness and colour of netting material for static nets and hook design for long lines.

STECF observes that reducing skate catches is often not a specific objective of gear trials, and observations of incidental catches of skates are not always recorded, and therefore information on the effect on skate of modified gears maybe more difficult to find. Under a Landing Obligation choke species scenario, where the quota for skates and rays is limited, there is likely to be an increase in interest in gear modifications that reduce skate catches.

ToRs b and e) *Management Measures*

The second group of ToRs, including ToR (b) and (e), is presented as a comparison of the relative merits of potential alternative management measures. The EWG notes that because no analytical stock assessments are available, there is no means for a quantitative evaluation of management measures. It was decided to draw up a list of the pros and cons of a set of potential management measures and compare them using selected criteria.

TAC options

STECF observes that four methods of TAC setting were considered: general skate and rays TACs by region (status quo), general TACs with sub-TACs for particular stocks, TACs by genus and stock based TACs. The EWG note that ICES produces advice that allows the setting of landing TACs at stock level, but to set TACs on a catch basis, it will be necessary to get better estimates of dead discards. Related to this, the misidentification at species level and uses of generic categories in the reporting of landings and discard data also needs to be addressed. STECF observes that it would be useful to determine the level of confidence in the landing and discard data for the different stocks.

The EWG noted that the control of fishing mortality by stock will be higher in the case of TACs set at stock level and lower in the case of TACs combining all species. The current general skate and ray TACs may not offer adequate protection for stocks that require reductions in F and conversely, may limit catch opportunities for stocks in good condition. The EWG also report that incentives to misreport are likely to be lower for general TACs since the possibility of a TAC to become limited increases with the number of TACs – this has particular relevance in the context of the LO. However, while this true, STECF observes that the argument against splitting a TAC for a group of skate species to reduce the likelihood of reaching a choke point is essentially the same as that for grouping similar species to reduce the risk of choke, so this argument must be carefully considered.

Landing trip limits

This management measure would limit the quantities landed of selected species on a trip by trip basis. STECF observe that this measure was considered outside a quota limit system, but recognise that total removals would need to be managed to control fishing mortality. The main observation was that the utility of the approach was dependent on the species demonstrating good survival on release when the landing threshold is exceeded, and this evidence is currently limited.

Spatio-temporal measures

The EWG reports that spatio-temporal measures are useful only where they demonstrably control fishing mortality. These can be used to reduce mortality on stocks on a case-by-case basis and may be complemented by other generalised management measures. STECF observes that the tables presented listing species by ICES area could be used to build an evidence map which could then be used to demonstrate where data are sufficient to assess different management options. The EWG reports that the areas likely to be affected by spatio-temporal measures are potentially quite large with associated effects on wider fisheries. STECF observes that, in terms of species identification, the spatial distribution of commercial catches of different species could be validated using survey data.

Effort management

The EWG conclude that effort management may have fewer control and enforcement issues compared with other options. However, measuring (and limiting) increase in fishing efficiency is extremely difficult, which would undermine this approach. Moreover, it would difficult to reconcile effort management for skates caught in combination with other species managed with quotas.

Size restrictions

Size restrictions of landings (minimum and/or maximum) would need to be specific to each species. The EWG noted that this measure would be in contradiction with the landing obligation if implemented in association with catch limits, unless exemptions on the basis of high survival are in place.

Prohibited species

The EWG states that the prohibited species list should be used for species which are biologically sensitive to any exploitation. STECF observe also that "Prohibited species" by their nature are sensitive species, mostly CITES listed, where even limited fishing activity could result in a serious risk to their conservation. There is currently no procedure on which to base decisions to include or exclude species from the prohibited list in the TACs and quota regulations. Moreover, the benefits of classifying species as prohibited are unknown without more information of the discard survival of incidental catches, and do not necessarily lead to a decrease in mortality.

STECF conclusions

STECF acknowledges that the general skate and ray TACs may not offer adequate protection for stocks that require reductions in F and conversely, may limit catch opportunities for stocks in good condition. There are also potential impacts on skates and rays management when the landing obligation is applied from 1 January 2019.

STECF acknowledges that data limitations exist for skate and ray stocks, and concludes that the nature of these limitations and the stocks to which they apply need to be better identified. STECF highlights that the main impediment to setting more specific TACs is the lack of evidence in terms of total catch (landings + dead discards). Similarly, more detailed catch information is needed to assess the utility of spatio-temporal, effort and other management measures.

STECF acknowledges the progresses achieved by ICES, which produced advice for 33 stocks of skates and rays in 2017. However, in most of these cases the absence of discard data prohibits catch advice. STECF concludes that emphasis should be given on utilising what discard information and survival information is available, applying the same protocols as with other stocks. This will identify those stocks for which data are sufficient to assess management options. STECF considers that this work is of sufficient scale to warrant a follow-up EWG that would focus on collating stock specific discard information and use survey data as a validation for species identification. Socioeconomic considerations could also be included..

STECF observes additionally that, assuming the approach used in recent years for implementing the Landing Obligation continues, any available discard data will be utilised as part of the TAC adjustment process when skates and ray stocks come under the Landing Obligation in 2019.

STECF concludes that when reporting on survival studies it is preferable to include the method applied and an assessment of the quality of the estimates using the critical review process developed by ICES WKMEDS. STECF concludes that evidence on discard survival of skates and rays is limited to a few métier-area-species combinations. Because the factors that influence survival are poorly understood, extrapolation across species, fisheries and areas is difficult, and more practical studies to estimate discard survival of skates and rays for key fisheries are needed.

STECF concludes that there is potential to improve selectivity towards skates and rays. To date, there are only few trials in European fisheries which have focussed on improving gear selectivity towards skates and rays, however, the incentive to avoid catches of skates and rays may increase with the implementation of the Landing Obligation.

STECF concludes that the development of transparent criteria is needed to classify species as prohibited in the TACs and quota regulations.

References

Tom Catchpole, Serena Wright, Victoria Bendall, Stuart Hetherington, Peter Randall, Elizabeth Ross, Ana Ribiero Santos, Jim Ellis, Jochen Depestele (ILVO), Suzanna Neville (2017). Ray Discard Survival. Enhancing evidence of the discard survival of ray species. Lowestoft: CEFAS.

ICES (2013). Report of the ICES Advisory Committee 2013. ICES Advice, 2013. Book 11. 31 pp.

ICES (2016) Request from EU for ICES to review a proposal of an in-year TAC adjustment for 2016 for skates and rays (SRX) in Division 7.d. ICES Technical Services 2016, Book 11. 13p.

STECF (2015). Scientific, Technical and Economic Committee for Fisheries (STECF) – 48th Plenary Meeting Report (PLEN-15-01). 2015. Publications Office of the European Union, Luxembourg, EUR XXXX EN, JRC XXXX, 75 pp.

Contact details of STECF members

[1] - Information on STECF members' affiliations is displayed for information only. In any case, Members of the STECF shall act independently. In the context of the STECF work, the committee members do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

Name	**Address**[1]	**Tel.**	Email
STECF members			
Abella, J. Alvaro	Independent consultant	Tel. 0039-3384989821	aabellafisheries@gmail.com

Name	**Address**[1]	**Tel.**	Email
STECF members			
Andersen, Jesper Levring	Department of Food and Resource Economics (IFRO) Section for Environment and Natural Resources University of Copenhagen Rolighedsvej 25 1958 Frederiksberg Denmark	Tel.dir.: +45 35 33 68 92	jla@ifro.ku.dk
Arrizabalaga, Haritz	AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel.: +34667174477	harri@azti.es
Bailey, Nicholas	Marine Scotland Science, Marine Laboratory, P.O Box 101 375 Victoria Road, Torry Aberdeen AB11 9DB UK	Tel: +44 (0)1224 876544 Direct: +44 (0)1224 295398 Fax: +44 (0)1224 295511	baileyn@marlab.ac.uk n.bailey@marlab.ac.uk
Bertignac, Michel	Laboratoire de Biologie Halieutique IFREMER Centre de Brest BP 70 - 29280 Plouzane, France	tel : +33 (0)2 98 22 45 25 - fax : +33 (0)2 98 22 46 53	michel.bertignac@ifremer.fr
Borges, Lisa	FishFix, Brussels, Belgium		info@fishfix.eu
Cardinale, Massimiliano (vice-chair)	Föreningsgatan 45, 330 Lysekil, Sweden	Tel: +46 523 18750	massimiliano.cardinale@slu.se
Catchpole, Thomas	CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft Suffolk, UK NR33 0HT		thomas.catchpole@cefas.co.uk
Curtis, Hazel	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K.	Tel: +44 (0)131 524 8664 Fax: +44 (0)131 558 1442	Hazel.curtis@seafish.co.uk
Daskalov, Georgi	Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Tel.: +359 52 646892	Georgi.daskalov@gmail.com

Name	**Address**[1]	**Tel.**	Email
STECF members			
Döring, Ralf (vice-chair)	Thünen Bundesforschungsinstitut, für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei - AG Fischereiökonomie, Palmaille 9, D-22767 Hamburg, Germany	Tel.: 040 38905-185 Fax.: 040 38905-263	ralf.doering@thuenen.de
Gascuel, Didier	AGROCAMPUS OUEST 65 Route de Saint Brieuc, CS 84215, F-35042 RENNES Cedex France	Tel:+33(0)2.23.48.55.34 Fax: +33(0)2.23.48.55.35	Didier.Gascuel@agrocampus-ouest.fr
Knittweis, Leyla	Department of Biology University of Malta Msida, MSD 2080 Malta		Leyla.knittweis@um.edu.mt
Lloret, Josep	Associate Professor (Professor Agregat), University of Girona (UdG), Spain		josep.lloret@udg.edu
Malvarosa, Loretta	NISEA, Fishery and Aquaculture Research, Via Irno, 11, 84135 Salerno, Italy	Tel: +39 089795775	malvarosa@nisea.eu
Martin, Paloma	CSIC Instituto de Ciencias del Mar Passeig Marítim, 37-49 08003 Barcelona Spain	Tel: 4.93.2309500 Fax: 34.93.2309555	paloma@icm.csic.es
Motova, Arina	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K	Tel.: +44 131 524 8662	arina.motova@seafish.co.uk
Murua, Hilario	AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel: 0034 667174433 Fax: 94 6572555	hmurua@azti.es
Nord, Jenny	The Swedish Agency of Marine and Water Management (SwAM)	Tel. 0046 76 140 140 3	Jenny.nord@havochvatten.se
Prellezo, Raúl	AZTI -Unidad de Investigación Marina Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	Tel: +34 667174368	rprellezo@azti.es

Name	Address[1]	Tel.	Email
STECF members			
Raid, Tiit	Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallin, EE-126, Estonia	Tel.: +372 58339340 Fax: +372 6718900	Tiit.raid@gmail.com
Sabatella, Evelina Carmen	NISEA, Fishery and Aquaculture Research, Via Irno, 11, 84135 Salerno, Italy	TEL.: +39 089795775	e.sabatella@nisea.eu
Sala, Antonello	Italian National Research Council (CNR) Institute of Marine Sciences (ISMAR), Largo Fiera della Pesca, 1 60125 Ancona - Italy	Tel: +39 071 2078841 Fax: +39 071 55313 Mob.: +39 3283070446	a.sala@ismar.cnr.it
Scarcella, Giuseppe	1) Italian National Research Council (CNR), Institute of Marine Sciences (ISMAR) - Fisheries Section, Largo Fiera della Pesca, 1, 60125 Ancona – Italy 2) AP Marine Environmental Consultancy Ltd, 2, ACROPOLEOS ST. AGLANJIA, P.O.BOX 26728 1647 Nicosia, Cyprus	Tel: +39 071 2078846 Fax: +39 071 55313 Tel.: +357 99664694	g.scarcella@ismar.cnr.it gscarcella@apmarine.com.cy
Soldo, Alen	Department of Marine Studies, University of Split, Livanjska 5, 21000 Split, Croatia	Tel.: +385914433906	soldo@unist.hr
Somarakis, Stylianos	Institute of Marine Biological Resources and Inland Waters (IMBRIW), Hellenic Centre of Marine Research (HCMR), Thalassocosmos Gournes, P.O. Box 2214, Heraklion 71003, Crete, Greece	Tel.: +30 2810 337832 Fax +30 6936566764	somarak@hcmr. gr
Stransky, Christoph	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany	Tel. +49 40 38905-228 Fax: +49 40 38905-263	christoph.stransky@thuenen.de
Ulrich, Clara (chair)	Technical University of Denmark, National Institute of Aquatic Resources, (DTU Aqua), Charlottenlund Slot, JægersborgAllé 1, 2920 Charlottenlund, Denmark		clu@aqua.dtu.dk
van Hoof, Luc	IMARES, Haringkade 1, Ijmuiden, The Netherlands	Tel.: +31 61061991	Luc.vanhoof@wur.nl

Name	Address[1]	Tel.	Email
STECF members			
Vanhee, Willy	Independent consultant		wvanhee@telenet.be
van Oostenbrugge, Hans	Fisheries Economics, Wageningen Economic Research, formerly LEI Wageningen UR, The Hague, The Netherlands		Hans.vanOostenbrugge@wur.nl
Vrgoc, Nedo	Institute of Oceanography and Fisheries, Split, Setaliste Ivana Mestrovica 63, 21000 Split, Croatia	Tel.: +385 21408002	vrgoc@izor.hr

REPORT TO THE STECF

EXPERT WORKING GROUP ON
Long-term management of skates and rays
(EWG-17-10)

Brussels, Belgium, 16-20 October 2017

1 EXECUTIVE SUMMARY

Skates and rays are currently managed under five regional TACs. Each of those TACs is a generalized skates and rays TAC including several species that are fished and caught within this TAC. Historically, ICES used to publish generic advice for skates and rays. Increased scientific knowledge of the distribution and range of various species and improved species identification and catch reporting has allowed for the provision of advice at a stock level. In recent years, several requests were made to the STECF to evaluate possible management approaches and changes to TAC calculation (e.g. STECF 15-01). In March 2017, the Commission received advice from the North-Western Waters Advisory Council (NWWAC) suggesting several alternative management measures and requested they be reviewed by STECF.

EWG 17-10 has carried out a general overview of the fisheries catching skates and rays, presenting their main characteristics in terms of catches, métiers and fleet interactions. This overview highlights some of the key features of the biology and exploitation of skates and rays that may be important to take into consideration when developing management measures (e.g. life history traits and distribution, mixed-fishery interactions).

A review of available studies on selective gears has been carried out both for towed and static gears, and a list of available references has been provided. This review shows that it is difficult to increase size selectivity for skates and rays due to their morphology. There are a number of gear modifications however, that have been shown to be potentially effective at reducing bycatch, (i.e. reducing the catch of skates and rays across the whole size range).

EWG-17-10 updated a list of survival rate estimates compiled by STECF (STECF, 2014), with recent published studies and information: survival rates are now provided at species level, and information on some of the important factors affecting survival is also given. EWG-17-10 notes that the estimates available cover only a limited number of métiers, areas and species. Furthermore, several of the available estimates are limited to short term survival rates and longer-term survival is still uncertain (large confidence intervals or very different estimates for the same species between different experiments). EWG-17-10 considers it would be premature to envisage any extrapolation of survival rates estimates across métiers. To both increase the coverage of gear, area and species and improve current estimates, EWG-17-10 considers that the model developed by Catchpole et al. (2017) for UK waters could be extended to other areas. Such a review should also highlight the main information gaps by species/métier where particular data collection and/or further analysis are needed.

EWG 17-10 has reviewed a series of measures potentially applicable for the management of skates and rays proposed by the NWWAC. The advantages and disadvantages of each measure in the context of fisheries catching skates and rays have been highlighted and the main data needed to implement, assess and monitor the measures have been listed. The different management measures have been reviewed independently, even though for some measures, some stocks, fisheries and/or areas, a combination of measures could potentially be more appropriate. EWG-17-10 considered that where a combination of measures is appropriate, they should be tailored to the specific needs and issues associated to the particular stocks or fisheries.

EWG-17-10 considered that, among the TAC based approaches reviewed by the group, the TAC by stock is the only one that permits the setting of limits on catches by stocks in line with individual stock development and the catch levels recommended by ICES. All other options would retain, to varying degrees, the problem of the current global TACs (e.g. limiting fishing opportunity for stocks for which the abundance is increasing, and insufficient protection for decreasing stocks or stocks of unknown status).

EWG-17-10 notes however that TACs set by stock may be compromised by species identification issues. TACs by stock could also create additional choke issues under the landing obligation over and above the other TAC options. In any case, it must be noted that adding more TACs (going from a generalized TAC system to a stock based TAC) may add extra monitoring requirements. Finally, the main impediment to any TAC based measure is lack of advice on outtake in terms of total catch (landings + dead discards). Currently, ICES only provides landings advice. Including discard information requires quantification of discards and survival of these discards. More work is required in these areas.

Regarding the spatio-temporal measures, EWG-17-10 considers that they could be used to reduce mortality on stocks on a case-by-case basis and may be complemented by other generalised management measures. Theoretical modelling work has been done and provides a firm analytical basis. In this context, size, location and timing of management measures can be developed in a participatory decision-making process. The areas to be closed are likely to be quite large which could potentially impact the general fishery. The difficulties in reaching agreement of managers and stakeholders for such large closures should not be underestimated.

Effort management may have fewer control and enforcement issues as compared to other options but measuring (and limiting) increase in fishing efficiency is extremely difficult, which possibly renders this measure ineffective in many fisheries. There may also be potential management conflicts in mixed fisheries where skates and rays are managed by effort while the other species are managed by TACs.

From the review carried out by EWG-17-10, it is clear that the underlying data for developing management options based on gear selectivity is currently limited. Current studies indicate that it is difficult to increase size selectivity for skates and rays but there are a number of gear modifications that have been shown to be effective at reducing bycatch (by reducing the catch over the whole size range). The adoption of such gears is dependent on whether the skate and ray species involved have a commercial value and the availability of fishing opportunities that allows them to be landed. Where such species are considered as part of the marketable catch, then there is little incentive to reduce bycatch as to do so would represent a loss of income. However, in a choke species scenario, where the quota for skates and rays is exhausted and the only option for a vessel to continue fishing in a specific fishery is to fish without catching skates and rays then such gears may be considered an option.

Size restrictions, either minimum, maximum or a combination should be tailored to species to be most effective. This management measure would however be in contradiction with the landing obligation if implemented in association with catch limits, except for species for which an exemption for high survival is granted. It may also be difficult to receive buy-in from fishers of limits set on maximum sizes as generally, larger rays have the highest commercial value.

The prohibited species list should ideally be used only for species which are biologically sensitive to any exploitation. Without additional measures to improve survival, listing will not necessarily lead to a decrease in mortality and may simply be a source of unaccounted mortality from the discarding of dead skates and rays and for which there is no requirement to report. The decision to include, or remove, any species onto or off the prohibited species list is currently not carried out according to transparent criteria. EWG-17-10 suggests to develop a procedure for listing and to develop transparent criteria in a participatory process.

Concerning data limitations and needs, EWG-17-10 notes that the current data requirement and sampling effort of the DCMap on skates and rays is insufficient to provide robust estimates of various parameters (e.g. maturity, commercial catch composition, sex-ratio and abundance indices) needed for stock assessment and management. Increasing needs on information on catches and fisheries may imply adjustments of the DCMap for the data collection for skates and rays.

The most crucial data gaps at the current time are discard survival (vitality and at-vessel mortality, and short- and longer term discard survival) and estimates of (dead) discards. These topics should have the highest priority. Further data and knowledge issues which require attention are: improved delineation of biological stock units, more robust estimates of stock status and development of MSY reference points or proxies. Those are key elements needed to be able to quantitatively evaluate the performances and impacts (biological, socio-economical) of various management measures.

In conclusion, EWG-17-10 has completed an initial review of potential management measures applicable to skates and rays. Due to the diversity of species in terms of biological characteristic, complexity of fisheries catching them and data limitations, it was not possible to fully and quantitatively evaluate any particular management measures or group of measures and further work is needed. EWG-17-10 considers that a way forward could be for managers and relevant stakeholders to first decide on the objectives of potential management measures (and the scope in terms of species and areas, and governance framework). It is only once these have been identified that a subsequent scientific evaluation by STECF may be possible. Although a combination of management measures might be the best option, in some cases EWG-17-10 considers important to avoid developing too complex frameworks which may be difficult to implement, control and monitor and may generate low levels of compliance and buy-in by fishers.

2 INTRODUCTION

2.1 Background

Skates and rays are currently managed under five regional TACs. Although each is a generalized skates and rays TAC, the reality is that there are multiple different species that are fished and caught within this TAC. Historically, ICES (International Council for the Exploration of the Sea) used to publish generic advice for skates and rays. Increased scientific knowledge of the distribution and range of various species, has allowed for the provision of advice at a more detailed level. Advice is biennial, with Celtic Sea and Biscay-Iberian stocks having updated advice in 2016, whilst the advice for North Sea and Azorean stocks was published in 2015. New advice for 2017 was released on October 6^{th}. Although ICES is publishing more detailed advice on individual skates and rays stocks, some are still considered data-limited stocks. There are also potential impacts on skates and rays management when the landing obligation is applied to mixed fisheries from 1 January 2019.

Skates and rays are caught in both targeted fisheries and as a by-catch in multiple fisheries and are important species for many Member States. As such, there have been previous requests to the STECF to evaluate possible management approaches and changes to TAC calculation (STECF 15-01), as well as on a specific bycatch provision for undulate ray (Raja undulata) (STECF 15-03).

In 2016 the Commission proposed a change to skates and rays TAC management for 2017, with several new sub-TACs proposed for different species. The proposal used the existing "SRX" quota allocation key, applying the same sharing mechanism to the individual sub TACs. Feedback from stakeholders and Member States raised concerns that such an allocation did not reflect current fishing activity and the overlap between regional fisheries and the distribution of species within the management area, and so would create significant socio-economic impacts on fishermen and not provide any extra protection for sensitive species. Therefore, at the December Fisheries Council, it was agreed by Member States to revert back to the 2016 TACs with a joint declaration from Member States and the Commission to further explore skates and rays quota management.

On the 24 March 2017, the Commission received advice from the North-Western Waters Advisory Council (NWWAC) suggesting several alternative management measures and requested they be reviewed by STECF.

Recognising this positive initiative by the NWWAC, the Commission sought to investigate the suitability and applicability of these measures to other sea basins, such as South-Western Waters and the North Sea. The Commission organised a focus group and seminar with fishermen, scientists, national administrations and other stakeholders on the 12 May 2017 in Brussels. This meeting helped in the drafting of these terms of reference for EWG 17-10.

2.2 Terms of Reference for EWG-17-10

To review possible management options and recommend a new approach for the sustainable management of skates and rays fisheries.

The review and assessment of management options should consider; sustainability such as MSY proxies, the regional approach to fisheries management, mixed fisheries approach to catches of skates and rays and possible "choke" species, socioeconomic impacts and the practical applicability of management measures. Practical applicability would include the consideration of relative stability, including the evaluation of historic landing data, ease of enforcement / control and the risk to increased misreporting.

The Commission understands that many of the skate stocks concerned are data-limited and does not expect definitive quantitative simulations. A risk-based approach may be more suitable; however suggestions and analysis by STECF should include information on how skates and rays can be fished and managed sustainably in accordance with the CFP objectives in each scenario, with suggestions on appropriate safeguards and monitoring techniques.

Furthermore, the expert working group is requested to:

a) Collect and analyse information available for those fleets/métiers involved in the catch of skates and rays, by identifying (i) those métiers (or higher aggregation levels) catching skates, (ii) the catch composition (species and length composition) of the métiers, and (iii) the social and economic dependence of the métier on the main skate and rays species. Provide an overview of the current scientific knowledge and data availability regarding mixed-fisheries involved in the catch of skates and rays

b) Evaluate the usefulness of closed areas/seasons as measures for controlling fishing mortality and/or protecting spawning fish and reducing mortality on juveniles (survey data, scientific knowledge available in the literature).

c) Collate and review the results of research on selectivity and relevant bycatch mitigation measures for relevant fishing gears (haul time etc.) that would either help avoid the catch of skates and rays, or that could increase their discard survival. Evaluate the effect of the most relevant technical measures affecting the selectivity of fishing gears.

d) Collate and review information on the survival rates of skates and rays (updating STECF 2014). The output would be a table of stocks / species versus métier /fleet segment for each sea basin or TAC unit. This exercise should consider to what extent information from one métier / fleet could be extrapolated to other fleets, detailing the criteria to do so. If this is not possible, then the working group is requested to conduct a gap analysis, detailing what information would be required to consider extrapolation and high survivability exemptions across all species of skates and rays, métiers and fleer segments per sea basin or TAC unit, whichever is more suitable.

e) Compare the relative merits (Pros and cons-see) of potential alternative management measures proposed in the attached documentation by the NWWAC and the Dutch Elasmobranch Society, as well as the output of the 12 May Focus Group. These potential management measures can be considered in a qualitative, risk-based framework for each sea basin or TAC unit, based on expert opinion. DG MARE understands that no one measure will be perfect, so where possible, combinations of management measures that mitigate risks, should be suggested by the working group.

An example template is attached to the background documentation as a guide. This template does not have to be strictly followed, but provides an example of comparing management measures against the criteria mentioned previously; e.g. sustainability, ease of control/enforcement, socio-economic impact (short (1-2 years) vs long-term (2+ years)) etc.

Background documentation:

1. PLEN 15-011

2. STECF 15-03, inclusive of background documentation from this contract2

3. Commission Services Non-Paper Skates and Ray 15 November 2016

4. Council Regulation (EU) 2017/127 of 20 January 2017 fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters 3

5. NWWAC 24 March 2017 Advice on Skates and Rays

6. PowerPoint presentation on possible Skates and rays Management by the Dutch Elasmobranch Society.

7. Flipcharts and feedback from the 8 May 2017 Brussels Focus Group on Skates and Rays management.

8. Example Excel template for comparing the pros, cons and risk analysis of management measures against criteria of concern.

2.3 Approach followed by EWG-17-10

The Terms of Reference can be grouped under two broad categories.

The first category, including ToR a, c and d, is a request for a compilation and review of available information related to i) the fleets and métiers involved in the capture of skates and rays, ii) the results of research on selectivity and bycatch mitigation measures and iii) the survival rates following discarding.

For ToR (a), EWG-17-10 has carried out a general overview of the fisheries catching skates and rays, presenting their main characteristics in terms of catches, métiers and fleet interactions. The objective is to highlight some of the key features of the biology and exploitation of skates and rays that may be important to take into consideration when developing management measures (e.g. life history traits and distribution, mixed-fishery interactions). This ToR is addressed in Section 3.

For ToR (c) (Section 4), a review of available studies on selective gears has been carried out both for towed and static gears and a list of available references has been provided.

For ToR (d) (Section 5), EWG-17-10 started from a list of survival rate estimates compiled by STECF (STECF, 2014). This list was updated with recent studies and information that is more detailed: survival rates are now provided at species level and information on some of the key factors impacting survival is also given.

The second category, including ToR (b) and (e), is a request for a comparison of the relative merits of potential alternative management measures. As was mentioned above, despite important improvement on the biological and fishery knowledge in recent years, skates and rays are still considered by ICES as data-limited stocks. This means that no analytical stock assessments are available and that the current advice is based on the precautionary approach. This also means that no quantitative evaluation of management measures is yet possible, in a way similar to the one conducted by STECF for the demersal fisheries of the Baltic sea, the North Sea and the North and South western waters (STECF, 2015). On this basis, as a first step in the development of management measures for skates and rays, it was decided, for comparison purpose, to draw up a list of the pros and cons of a set of potential management measures. Data needs associated with each of those measures are also provided.

EWG-17-10 started by selecting the potential management measure applicable to skates and rays from the documentation provided by the NWWAC (NWWAC 24 March 2017 Advice on Skates and Rays) and the Dutch Elasmobranch Society (Shark and ray management under the landing obligation, powerpoint presentation to the Choke symposium - 02 November - 2016 Copenhagen), as well as the output of the 12 May Focus Group. In addition to the current TAC based on a combination of several stocks, the management measures selected cover a large range of management tools. This includes:

- The baseline: Skates and Rays generalised TAC
- Skates and rays generalised TAC with sub-TACs for particular stocks
- TAC by stock (based on stock ICES advices)
- TACs by Genus
- Effort control
- Spatio-temporal management measures
- Landing trip limits (outside the quota system, and applied to a selection of species)
- Prohibited species list
- Minimum and or maximum size (by species, area or group)
- Gear modifications

EWG-17-10 has also identified several comparison criteria for the management measures listed above. Socio-economic criteria were not included by lack of expertise available during the working group. The selected criteria are in terms of:

- Capacity to control fishing mortality
- Ease of control and enforcement
- Potential issues related to compliance
- Potential for choke effects
- Data or information needs for implementation, monitoring and assessment and its availability
- Main sources of uncertainties

ToR (b) and (e) are addressed in section 6. For each management measure, a short description is provided together with the data needs in terms of implementation, monitoring and assessment. When possible, some practical examples are provided. The pros and cons are also listed. The information provided has been compiled in a summary table (Table 6.1) for ease of comparison.

EWG-17-10 decided to first look at the pros and cons of the different management measures taken independently, even though for some measures, some stocks, fisheries and/or areas, a combination of measures could potentially be more appropriate. However, it was not possible, from this separate review of measures, to suggest potential combinations for the management of skates and rays, as EWG-17-10 considers that this should be tailored to the specific needs and issues associated to the particular stocks or fisheries. Instead, EWG-17-10 provides some guidance on a possible way forward (section 7).

3 FISHERIES CATCHING SKATES (RAJIDAE) IN THE ICES AREA

This section of the report addresses the TOR "*Collect and analyse information available for those fleets/métiers involved in the catch of skates and rays, by identifying (i) those métiers (or higher aggregation levels) catching skates, (ii) the catch composition (species and length composition) of the métiers, and (iii) the social and economic dependence of the métier on the main skates and rays species. Provide an overview of the current scientific knowledge and data availability regarding mixed-fisheries involved in the catch of skates and rays*".

There is no single dataset providing all relevant data (landings, discards, species composition, size/sex composition) by gear, month, geographical location and nation. Various subsets of such data are available that provide such data for the main métiers.

It should also be noted that the ICES Working Group on Elasmobranch Fishes (WGEF) consider that some 'species-specific' records held in official data are inaccurate, which can be due to a range of issues (e.g. coding errors, misidentifications, misreporting). Hence, any efforts to collate data from various sources would require appropriate time and expertise to take account of such issues.

3.1 Skates and rays in the north-east Atlantic

For the purposes of this section, the members of the order Rajiformes are referred collectively as 'skates', even though some may have the term 'ray' in their common name.

Approximately 32 species of skate (Rajiformes) occur in the North-east Atlantic with the likelihood of more, as yet undescribed, species occurring in deep-water (Stehmann & Bürkel, 1984; Ebert & Stehmann, 2013; Table 3.1). These species are currently included across two families, the soft-nose skates (Family Arhynchobatidae) and hard-nose skates (Family Rajidae).

The soft-nose skates (Family Arhynchobatidae, *Bathyraja* spp.) are deep-water species, and as such not typically taken in European fisheries. The hard-nose skates (Family Rajidae) are more widespread on the continental shelf and slope across the ICES area (Table 3.2). The main commercial skate taxa (either historically or currently) in EU Atlantic waters are listed in Table 3.3, and largely refer to species in three genera: *Dipturus, Leucoraja* and *Raja.*

3.2 Commercial skate taxa

3.2.1 Genus Dipturus

There are at least four members of the genus *Dipturus* in European Atlantic seas. Blue skate *D. batis* and flapper skate *D. intermedius* were formerly widespread in the waters of northern Europe, but declined in geographical range during the 1960s and 1970s, which has been linked to overfishing (Brander, 1981). Flapper skate is locally common in Scottish waters, whilst blue skate is locally abundant in parts of the Celtic Sea. Both were formerly commercial species, but now they are listed as prohibited species[1] and cannot be landed.

The related Norwegian skate *D. nidarosiensis* and long-nosed skate *D. oxyrinchus* tend to occur on the outer continental shelf and upper slope, though the exact geographic ranges are uncertain. *D. nidarosiensis* is a prohibited species in ICES Divisions 6.a-b, 7.a-c, 7.e-h and 7.k. The taxonomy and identification of skates in this genus is problematic, and landings data have often been confounded (Iglesias et al., 2010; ICES, 2016, 2017b).

3.2.2 Genus Leucoraja

There are three members of the genus *Leucoraja* in European Atlantic seas, of which the smaller-bodied cuckoo ray *L. naevus* is the most widespread and best studied. *L. naevus* is widely distributed on the continental shelf, ranging from north of Scotland to southern Iberian waters, but is less frequent in Divisions 4.c and 7.d.

The two other members of the genus (sandy ray *L. circularis* and shagreen ray *L. fullonica*) are larger bodied and occur further offshore, with *L. fullonica* occurring on the outer continental shelf and upper slope, and *L. circularis* occurring on the edge of the continental shelf, upper slope and offshore banks. As such, both species are typically caught in fisheries operating in deeper waters, including around Rockall and Porcupine Bank. There are ongoing studies to better understand the biology of these species (e.g. Nicolaus et al., 2017).

3.2.3 Genus Raja

There are eight members of the genus *Raja* in European Atlantic seas, five of which are commercially important over the shelf seas of northern and western Europe.

Blonde ray *Raja brachyura,* thornback ray *R. clavata* and spotted ray *R. montagui* are, along with *L. naevus*, some of the most ubiquitous and common batoids in European Atlantic seas, occurring in shelf seas from north of Scotland to southern Iberian waters. Small-eyed ray *R. microocellata* and undulate ray *R. undulata* are more coastal species that are distributed from the southern and western British Isles to Iberian waters. Both species can be locally abundant in selected areas, possibly due to having more restricted habitats.

Of the remaining species, Mediterranean starry ray *R. asterias*, as its name implies, is a Mediterranean species that occurs very occasionally in the southern parts of Division 9.a; brown ray *R. miraletus* a small-bodied species of limited commercial interest; and Madeiran ray *R. maderensis* which occurs around Madeira and the Azores and is also of limited commercial interest.

3.2.4 Other genera

Most other skate taxa are of low or no commercial importance in Union waters of the Atlantic. Two exceptions to this are sailray *Rajella lintea*, which may be taken in Scandinavian seas and white skate *Rostroraja alba.* The latter was formerly an important

---

[1] The listing of a species on the prohibited species list means that the species must not be targeted, retained or transhipped. Accidental catch shall not be harmed and individuals should be released as soon as possible.

commercial species, but declined during the 20th century (Ellis et al., 2010). White skate is now listed as a prohibited species and is also a protected species in some areas (e.g. United Kingdom)

Table 3.1: Taxonomic list of skates (Rajiformes) occurring in the North-east Atlantic. Adapted from Stehmann and Bürkel (1984), Ebert & Stehmann (2013) and Last *et al*. (2017)

	Scientific name and authority	English name	FAO code
Family Arhynchobatidae			
1	*Bathyraja pallida* (Forster, 1967)	Pale ray	BYP
2	*Bathyraja richardsoni* (Garrick, 1961)	Richardson's ray	BYQ
3	*Bathyraja spinicauda* (Jensen, 1914)	Spinetail ray	RJQ
Family Rajidae			
4	*Amblyraja hyperborea* (Collett, 1879)	Arctic skate	RJG
5	*Amblyraja jenseni* (Bigelow & Schroeder, 1950)	Short-tail skate	RJJ
6	*Amblyraja radiata* (Donovan, 1808)	Starry ray	RJR
7	*Dipturus batis* (Linnaeus, 1758)	Blue skate (common skate)	RJB
8	*Dipturus intermedius* (Parnell, 1837)	Flapper skate (common skate)	
9	*Dipturus nidarosiensis* (Storm, 1881)	Norwegian skate	JAD
10	*Dipturus oxyrinchus* (Linnaeus, 1758)	Long-nosed skate	RJO
11	*Leucoraja circularis* (Couch, 1838)	Sandy ray	RJI
12	*Leucoraja fullonica* (Linnaeus, 1758)	Shagreen ray	RJF
13	*Leucoraja naevus* (Müller & Henle, 1841)	Cuckoo ray	RJN
14	*Malacoraja kreffti* (Stehmann, 1977)	Krefft's ray	JFT
15	*Malacoraja spinacidermis* (Barnard, 1923)	Soft skate	RJP
16	*Neoraja caerulea* (Stehmann, 1976)	Blue ray	BVC
17	*Neoraja iberica* Stehmann, Séret, Costa & Baro, 2008	Iberian pygmy skate	–
18	*Raja asterias* Delaroche, 1809	Mediterranean starry ray	JRS
19	*Raja brachyura* Lafont, 1873	Blonde ray	RJH
20	*Raja clavata* Linnaeus, 1758	Thornback ray	RJC
21	*Raja maderensis* Lowe, 1841	Madeiran ray	JFY
22	*Raja microocellata* Montagu, 1818	Small-eyed ray	RJE
23	*Raja miraletus* Linnaeus, 1758	Brown ray	JAI
24	*Raja montagui* Fowler, 1910	Spotted ray	RJM
25	*Raja undulata* Lacepède, 1802	Undulate ray	RJU
26	*Rajella bathyphila* (Holt & Byrne, 1908)	Deepwater ray	JRH
27	*Rajella bigelowi* (Stehmann, 1978)	Bigelow's ray	JRW
28	*Rajella dissimilis* (Hulley, 1970)	Ghost skate	JRQ
29	*Rajella fyllae* (Lütken, 1887)	Round skate	RJY
30	*Rajella kukujevi* (Dolganov, 1985)	Mid-Atlantic skate	–

31	*Rajella lintea* (Fries, 1838)	Sailray	RJK
32	*Rostroraja alba* (Lacepède, 1803)	White skate	RJA

Table 3.2: Nominal occurrence of skates (Rajiformes) in the North-east Atlantic by ICES Division (● = Present, ○ = absent; ⦿ = occasional vagrants likely to occur in the area, or distribution may extend to this division; ? = status uncertain). Adapted from Whitehead *et al.* (1984), Ellis *et al.* (2005a); ICES (2007; Table 1.4) and Ebert & Stehmann (2013). Information considered preliminary.

Scientific name	1	2.a	2.b	5.a	5.b	3.a	4.a	4.b	4.c	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.d	8.e	9.a	9.b	10	12	14
Bathyraja pallida	○	○	○	○	○	○	○	○	○	○	○	○	?	●	○	○	○	○	?	●	●	?	?	?	●	●	○	?	●	●	○
B. richardsoni	○	○	○	○	○	○	○	○	○	○	●	○	?	●	○	○	○	○	?	●	●	⦿	⦿	?	●	●	○	?	●	●	○
B. spinicauda	●	●	●	●	●	⦿	⦿	○	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●
Amblyraja hyperborea	●	●	●	●	●	○	⦿	○	○	⦿	⦿	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	?	●
A. jenseni	○	?	?	●	●	○	○	○	○	⦿	⦿	○	○	⦿	○	○	○	○	○	⦿	⦿	○	○	○	○	○	○	○	●	●	●
A. radiate	●	●	●	●	●	●	●	●	⦿	●	●	○	⦿	⦿	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●
Dipturus batis	○	?	?	●	●	?	?	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	?	?	?	?	?	?
D. intermedius	○	●	?	●	●	?	●	●	?	●	●	●	●	●	?	?	?	●	●	●	●	?	?	?	?	?	?	?	?	?	?
D. nidarosiensis	?	●	?	●	●	⦿	●	○	○	●	●	○	●	●	○	○	○	○	○	●	●	?	?	?	●	●	○	○	○	?	?
D. oxyrinchus	?	●	?	?	●	●	●	○	○	●	●	○	●	●	○	○	○	⦿	●	●	●	●	●	●	●	?	●	●	?	?	?
Leucoraja circularis	○	●	○	●	●	●	●	⦿	○	●	●	○	●	●	○	○	○	⦿	●	●	●	●	●	●	●	?	●	●	?	?	?
L. fullonica	●	●	?	●	●	●	●	⦿	○	●	●	⦿	●	●	○	●	⦿	●	●	●	●	●	●	●	●	?	●	●	?	?	?
L. naevus	○	●	○	○	?	●	●	●	⦿	●	●	●	●	●	⦿	●	●	●	●	●	●	●	●	●	●	?	●	⦿	?	?	?
Malacoraja kreffti	○	○	○	●	●	○	○	○	○	⦿	⦿	○	⦿	⦿	○	○	○	○	○	⦿	⦿	○	○	○	○	○	○	○	○	●	○
M. spinacidermis	○	○	○	●	●	○	○	○	○	⦿	●	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●
Neoraja caerulea	○	○	○	○	?	○	○	○	○	●	●	○	●	●	○	○	○	○	○	●	●	○	○	○	●	?	○	○	○	?	○
N. iberica	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	?	●	●	○	○	○
Raja asterias	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	⦿	○	○	○	○
R. brachyuran	○	⦿	○	○	○	○	●	●	●	●	⦿	●	●	⦿	●	●	●	●	●	●	○	●	●	●	⦿	○	●	⦿	○	○	○
R. clavata	○	●	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	⦿	●	●	●	●	⦿	●	⦿	●	○	○
R. maderensis	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○
R. microocellata	○	○	○	○	○	○	○	○	⦿	⦿	○	●	●	○	●	●	●	●	●	●	○	●	●	●	○	○	●	○	○	○	○
R. miraletus	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	⦿	○	○	●	?	○	○	○
R. montagui	○	⦿	○	○	?	⦿	●	●	●	●	●	●	●	⦿	●	●	●	●	●	●	⦿	●	●	●	●	○	●	⦿	○	○	○
R. undulata	○	○	○	○	○	○	○	○	⦿	○	○	⦿	●	○	●	●	⦿	⦿	●	●	○	●	●	●	○	○	●	○	○	○	○
Rajella bathyphila	○	○	○	●	●	○	○	○	○	●	●	○	●	●	○	○	○	○	○	?	?	○	○	○	○	○	○	○	?	●	●
R. bigelowi	○	○	○	●	●	○	○	○	○	●	●	○	●	●	○	○	○	○	○	●	●	○	○	○	●	●	●	●	○	●	●
R. dissimilis	○	○	○	○	?	○	○	○	○	●	●	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○
R. fyllae	●	●	●	●	●	●	●	?	○	●	●	○	●	●	○	○	○	○	●	●	●	●	?	○	●	●	○	○	○	●	●
R. kukujevi	○	○	○	?	●	○	?	○	○	?	●	○	?	●	○	○	○	○	○	●	●	○	○	●	●	●	○	?	●	●	?
R. lintea	●	●	?	●	●	●	⦿	○	○	⦿	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●

Rostroraja alba	○	○	○	○	○	○	○	○	⦿	○	○	⦿	●	○	⦿	●	⦿	⦿	⦿	●	○	●	●	●	○	○	●	○	○	○	○

Table 3.3: List of skates that are, or have been, exploited commercially in northern European fisheries. Those species currently listed as 'prohibited species' on EU TAC and quota regulations, but which are known to have been important commercial species in former times, are included. Those species prohibited in all (or all expected) EU waters of the ICES area are marked ††, and those species listed as 'prohibited species' in certain ICES Divisions are marked †.

FAO code	L_{max}	Scientific name	English name	Spanish name	French name	Portuguese name	Dutch name	Norwegian name
RJB	≈ 150 cm	*D. batis* ††	Blue skate	Noriega	Pocheteau gris	Raia oirega	Vleet	Glattskate
	≈ 230 cm	*D. intermedius* ††	Flapper skate	–	–	–	–	–
JAD	≈ 200 cm	*D. nidarosiensis* †	Norwegian skate	Raya noruega	Pocheteau de Norvège	–	Noorse rog	Svartskate
RJO	≈ 150 cm	*D. oxyrinchus*	Long-nosed skate	Raya picuda	Pocheteau noir	Raia bicuda	Scherpsnuitrog	Spisskate
RJI	≈ 120 cm	*L. circularis*	Sandy ray	Raya falsa vela	Raie circulaire	Raia-de-São-Pedro	Zandrog	Sandskate
RJF	≈ 120 cm	*L. fullonica*	Shagreen ray	Raya cardadora	Raie chardon	Raia pregada	Kaardrog	Nebbskate
RJN	72–81 cm	*L. naevus*	Cuckoo ray	Raya santiguesa	Raie fleurie	Raia-de-dois-olhos	Koekoeksrog	–
RJH	≈ 120 cm	*R. brachyura*	Blonde ray	Raya boca de rosa	Raie lisse	Raia pontuada	Blonde rog	Prikkskate
RJC	110–130 cm	*R. clavata* †	Thornback ray	Raya de clavos	Raie bouclée	Raia-brocheada	Stekelrog	Piggskate
JFY	≈ 80 cm	*R. maderensis*	Madeira skate	Raya de Madeira	Raie de Madère	Raia da Madeira	–	–
RJE	91 cm	*R. microocellata*	Small-eyed ray	Raya colorada	Raie mêlée	Raia-zimbreira	Kleinoogrog	–
JAI	≈ 60 cm	*R. miraletus*	Brown ray	Raya de espejos	Raie miroir	Raia-de-espelhos	–	–
RJM	75–80 cm	*R. montagui*	Spotted ray	Raya pintada	Raie douce	Raia manchata	Gevlekte rog	Flekkskate
RJU	114–120 cm	*R. undulata* †	Undulate ray	Raya mosaica	Raie brunette	Raia-mosaica	Golfrog	–

RJK	≈ 125 cm	*R. lintea*	Sailray	Raya vela	Raie voile	Raia-nevoeira	Zeilrog	Hvitskate
RJA	≈ 240 cm	*R. alba* ††	White skate	Raya bramante	Raie blanche	Raia-branca	Witte rog	–

3.3 General overview of those métiers catching skates

The generalities of commercial fleets and métiers that catch skates are described below. For the purposes of this report, we have differentiated between 'inshore, coastal and deepwater fleets'. Coastal fleets refer to those vessels that generally operate closer to their home port, often in shallower water (at least in those areas where there is a broad continental shelf) and mainly involve smaller vessels. It is important to differentiate between these fleets as the coastal fleets can often have a proportionally greater economic interest in some coastal skate species (e.g. *Raja brachyura, R. microocellata, R. undulata*). The main fleets, usually involving larger vessels that operate over broader areas of the continental shelf are referred to here as 'offshore fleets', with 'deep-water' fleets referring to those vessels fishing along the edge of the continental shelf and continental slope.

3.3.1 Inshore and coastal fleets

Skates, especially those within the genus *Raja,* are often found in coastal and inner continental shelf seas. In these areas, skates are either a bycatch or, in areas of high local and/or seasonal abundance are targeted. Target fisheries for skates can be of high importance for coastal fleets over much of the ICES area.

Species such as *R. clavata, R. montagui* and *Leucoraja naevus* are widespread on the inner continental shelf for much of the Union waters of the ICES areas., Other species (e.g. *R. brachyura, R. microocellata* and *R. undulata*) may be proportionally more abundant in inshore waters and in areas of high local abundance*.* Skates in the genus *Leucoraja* are not generally taken in large quantities by inshore fleets, unless there is a narrow continental shelf and access to waters >50 m close to shore (e.g. around the south-west UK, Ireland, Iberian waters). In some inshore areas of the northern ICES areas, including Scotland and Northern Ireland, members of the common skate complex *Dipturus* are also found in areas close to shore.

<u>Nets</u>*:* Skates are caught as a bycatch in the various gillnet fisheries, including set gillnets and demersal driftnets. They may also be targeted in larger mesh nets (e.g. trammel and tangle nets), where the minimum mesh sizes is ≥220 mm. Such fisheries generally exploit the larger species such as *R. clavata, R. brachyura, R. microocellata* and *R. undulata.* For the inshore fleet, soak times typically range from 2-3 h (e.g. some demersal driftnets) up to 24-48 h.

<u>Trawls</u>*:* Skates are a bycatch in various inshore trawl fisheries, including multi-rig trawls for Nephrops and shrimp. In areas of high local abundance, skates can be a very important catch component and may even be the target species in some areas or seasons. Such fisheries often exploit the broader skate complex, including *R. clavata, R. brachyura, R. montagui, Leucoraja naevus* and, in some areas, *R. undulata* and *R. microocellata.* For the inshore fleet, haul times would be expected to range from 0.5-4 h.

<u>Longline</u>*:* Skates are an important catch component in inshore demersal longline fisheries and are also the target species in some areas and/or seasons. Such fisheries generally exploit the larger species such as *R. clavata, R. brachyura* and *R. undulata.* For the inshore fleet, soak times for longlines can be about 2-4 h (e.g. in the southern North Sea), but may be left overnight in other areas.

3.3.2 Offshore fleets

A broader range of skate genera occur on the outer continental species, including *Raja* (*R. clavata, R. montagui*), *Leucoraja* (*L. naevus* and, on the outer shelf and upper slope, *L. circularis* and *L. fullonica*), larger skates (*Dipturus* spp.) are often found on the continental shelf and upper slope.

Nets: Various types of set nets (including gillnets, tangle nets and trammel nets) are used by larger vessels operating offshore, typically for fleets targeting anglerfish, hake and large gadoids. Skates are typically a bycatch (of varying commercial importance) in most areas, although there are some areas where they may have been targeted (e.g. parts of the Celtic Sea). Soak times in these fisheries can range up to several days.

Otter trawl: Skates are a bycatch in various offshore trawl fisheries. In areas of high local abundance, skates can be a very important catch component and may even be the target species or species complex in some areas or seasons. Such fisheries often exploit the broader skate complex, including *R. clavata, R. brachyura, R. montagui* and *Leucoraja naevus.*

Beam trawl: Skates are typically a bycatch in various beam trawl fisheries (including beam trawl fisheries for flatfish, as well as shrimp fisheries). Beam trawls generally catch smaller individuals of skates compared to other gears.

Longline: There are occasional longline fisheries in the deeper parts of the ICES areas (e.g. for hake, ling and tusk), where skates can be an incidental bycatch.

3.3.3 Deepwater fleets

There are a range of deep-water fisheries operating in the ICES area, including longline fisheries and some trawl fisheries. A wide range of skate taxa might be encountered as bycatch, including representatives from two distinct families in the order Rajiformes (Rajidae and Arhynchobatidae). Nevertheless, there is no indication of any notable quantities being either landed or caught.

3.3.4 Miscellaneous fisheries and gears

In addition to the main commercial gears taking skates, there can also be an incidental bycatch of skates in other fisheries (Table 3.4). For example, there are several dredge fisheries for invertebrates (e.g. scallops and other bivalves) that can capture skates, primarily smaller individuals and, potentially, egg cases. Whilst there have been several localised accounts of such fisheries interacting with skates (e.g. Palma *et al*., 2003; Craven *et al*., 2013), there is generally a paucity of information on the catches, discards and discard survival.

Table 3.4: Higher level métiers and interactions with skates (Rajidae)

Level 2: Gear class	Level 3: Gear group	Level 4: Gear type	Involvement in skate fisheries
Dredges	Dredges	Boat dredge [DRB]	Skates can be a bycatch in various dredge fisheries (e.g. for scallops)
		Mechanised/Suction dredge (HMD)	Minimal interactions with skates, but potential interactions with early life history stages, including egg cases
Trawls	Bottom trawls	Bottom otter Trawl (OTB)	Skates can be an important bycatch and, in some areas, there can be targeted fisheries for the skate complex
		Multi-rig otter trawl [OTT]	Skates can be an important bycatch and, in some areas, there can be targeted fisheries for the skate complex
		Bottom pair trawl [PTB]	Skates can be an important bycatch
		Beam trawl [TBB]	Skates are a bycatch, and this gear may catch proportionally more juveniles in comparison to other bottom trawls
	Pelagic trawls	Midwater otter trawl [OTM]	Skates may be an incidental bycatch, depending on fishing location and fishing depths
		Pelagic pair trawl [PTM]	Skates may be an incidental bycatch with very rare occurrence, depending on fishing location and fishing depths
Hooks and Lines	Rods and Lines	Hand and Pole lines [LHP] [LHM]	Minimal interactions
			Minimal interactions
		Trolling lines [LTL]	Minimal to no interactions
	Longlines	Drifting longlines [LLD]	Minimal interactions for surface longlines
		Set longlines [LLS]	Skates can be an important bycatch in bottom-set longlines and, in some areas, there can be targeted fisheries for skates
Traps	Traps	Pots and Traps [FPO]	Minimal interactions
		Fyke nets [FYK]	Skates may be an incidental bycatch, depending on fishing location (e.g. fyke nets set in marine waters)
		Stationary uncovered pound nets [FPN]	Minimal interactions
Nets	Nets	Trammel net [GTR]	Skates can be an important bycatch in bottom-set trammel and, in some areas, there can be target fisheries for skates (i.e. where the mesh size is ≥220 mm)
		Set gillnet [GNS]	Skates can be an important bycatch and, in some areas, there can be target fisheries for skates (i.e. where the mesh size is ≥220 mm)
		Driftnet [GND]	Skates can be an important bycatch in demersal driftnets
Seines	Surrounding nets	Purse seine [PS]	Minimal interactions
		Lampara nets [LA]	Minimal to no interactions
	Seines	Fly shooting seine [SSC]	Skates can be an important bycatch
		Anchored seine [SDN]	Skates can be an important bycatch
		Pair seine [SPR]	Skates can be an important bycatch
		Beach and boat seine [SB] [SV]	Coastal skates may be taken
Other gear	Other gear	Glass eel fishing	Minimal interactions
Misc. (Specify)	Misc. (Specify)	-	

3.4 Skates and their fisheries by area

In general terms, skates are a bycatch in mixed demersal fisheries using bottom trawls and gill- and trammel nets, with some target fisheries (large-mesh tangle and trammel nets, demersal lines and otter trawl) occurring in some areas of high local abundance.

3.4.1 Skagerrak (Division 3.a)

Otter trawls are the most common gear types used with the fisheries typically catching gadoids, other groundfish, *Pandalus*, plaice, and *Nephrops.* The species composition of the catch depends on the area and depth fished and the gear design, including cod-end mesh size. Bottom seine fisheries also operate in this area and have similar mesh sizes and target species as otter trawl fisheries. In the shallower areas the Skagerrak there are also gillnet fisheries operated by small and medium-sized vessels targeting flatfish and demersal fish. The skate fauna of the Skagerrak is poorly known, especially in deeper waters, but they are likely to be taken in both trawl and gillnet fisheries.

According to Council Regulation (EU) 2017/127 catches of *Leucoraja naevus, Raja brachyura* and *Raja montagui* should be reported separately for this TAC area (although none of these species seem to have been recorded in trawl surveys, Heessen et al., 2015). *Amblyraja radiata, Dipturus batis*-complex and *Raja clavata* are prohibited species in the area and there is no requirement for landings of *L. circularis, L. fullonica, Dipturus nidarosiensis* and *Rajella lintea*, which may occur in the deeper waters of Division 3.a, to be reported by species.

3.4.2 North Sea (Divisions 4.a-c)

In the North Sea, skates are caught mainly as a bycatch in mixed trawl fisheries for roundfish and flatfish. Otter trawls (with mesh sizes greater than 100 mm) target haddock, cod, whiting, anglerfish, megrim, and plaice, with important bycatch of *Nephrops* and some flatfish species. Some vessels target saithe in deeper waters in the north of the region. Other parts of the otter trawl fleet operate with mesh sizes less than 100 mm. This fleet primarily targets *Nephrops* in muddy areas and, in other fishing grounds, a mix of fish and shellfish (including cephalopods). Bottom seine fisheries operate mainly in the central and southern North Sea with limited effort in the northern North Sea. This fleet targets the same species as the otter trawl fleet and the fishing gear used has similar mesh size. Trawl fisheries in the northern North Sea would be expected to have a bycatch of *L. naevus, R. montagui* and *Dipturus intermedius*.

In the shallow parts of the southern and central North Sea in the southern Bight, beam and pulse trawl fisheries have particularly intense fishing activity. The most important species caught are sole and plaice in terms of value and volume, respectively, with other flatfish (e.g. turbot and brill) valued species. Because of the relatively small codend mesh size (80 mm) used in beam trawls targeting flatfish, significant quantities of fish below minimum sizes may be caught, resulting in high discard rates. Small beam trawlers (<24 m LOA) target brown shrimp in the southern North Sea and coastal areas using a 20–25 mm codend mesh size. These fisheries also catch various species of skates.

In the North Sea are there are also mixed fisheries using static fishing gears. In the southern North Sea, gillnet fisheries target flatfish (sole) and demersal fishes. Some of these fisheries seasonally and/or locally target *Raja clavata.* When conducted in deeper areas of the northern North Sea, gillnet fisheries target anglerfish. Gillnet fisheries using small mesh sizes (90 mm) usually target sole, and may have considerable discard rates of dab. In the northern North Sea, longline fisheries target saithe, cod, haddock, ling and tusk. There are also inshore longline fisheries in the south-western North Sea, where the main species of commercial interest are cod, bass, *Raja clavata* and *R. brachyura.* The latter is usually taken in low numbers but is of higher value.

According to Council Regulation (EU) 2017/127, catches of *Leucoraja naevus, Raja brachyura, Raja clavata* and *Raja montagui* should be reported separately for this TAC area, and these are among the main skate species in the area (Heessen et al., 2015). *Amblyraja radiata* and *Dipturus batis*-complex are both prohibited species in this area. There is no necessity for landings of *L. circularis, L. fullonica, Dipturus nidarosiensis, Dipturus oxyrinchus* and *Rajella lintea* (which may occur in the northern North Sea), or for *Raja microocellata* and *Raja undulata* (which may extend into the southernmost part of the North Sea) to be reported to species.

3.4.3 Eastern English Channel (Division 7.d)

Skates in the eastern English Channel are caught mainly in mixed demersal fisheries. Otter trawls are the most common métier operating over the wider area. This fleet operates with mesh sizes less than 100 mm and catches a variety of fish and shellfish species (including cuttlefish). There are also beam trawl fleets targeting sole and plaice, that are known to capture juvenile skates.

In the English Channel there are also gillnet fisheries that take Rajidae species as either a target species or bycatch. The bycatch is taken in gillnet fisheries for flatfish (e.g. sole) and roundfish.

There are also dredge fisheries for scallops. These fisheries occur primarily on sand-gravel substrates and there are some exclusion zones to protect sensitive habitats in some areas. The potential interaction of this fishery with skates is unknown.

According to Council Regulation (EU) 2017/127, catches of *Leucoraja naevus, Raja brachyura, Raja clavata, Raja montagui* and *Raja undulata* should be reported separately for this TAC area (the latter in a sub-TAC). *Amblyraja radiata* and *Dipturus batis*-complex are both prohibited species in this area, although the former is not expected to occur in the area. There is currently no necessity for landings of *Raja microocellata* to be reported at the species level.

Celtic Seas Ecoregion

This ecoregion displays subtle differences in the skate assemblages, and are so described in finer detail below.

According to Council Regulation (EU) 2017/127, landings of *Leucoraja circularis, Leucoraja fullonica, Leucoraja naevus, Raja brachyura, Raja clavata* and *Raja montagui* should be reported to species in this TAC area. There are sub-TACs for two stocks, allowing for *Raja undulata* to be landed from Division 7.e and *Raja microocellata* to be landed from 7.f-g. These should also be recorded to species level. Prohibited skate species in this TAC area are *Raja undulata* (Subarea 6), *Dipturus batis*-complex (Subareas 6-7 and elsewhere), *Rostroraja alba* (Subareas 6-7 and elsewhere) and *Dipturus nidarosiensis* (Divisions 6.a-b, 7.a-c, 7.e-h and 7.k). There is currently no requirement for *Dipturus oxyrinchus* to be reported to species level.

3.4.4 Northwest Scotland (Divisions 6.a-b)

Skates are caught mainly in mixed demersal fisheries operating with otter trawls. As a consequence of fishing effort restrictions resulting from the EU's cod management plan (Regulation 1342/2008), the main otter trawl fisheries are predominantly for *Nephrops* fisheries and mixed demersal species mainly hake, anglerfish and megrim. There are also mixed gadoid fisheries using larger mesh size, typically 120 mm. Such fisheries will catch *Dipturus intermedius, Raja clavata, Raja montagui* and *Leucoraja naevus.* Vessels operating in the deeper waters, including Rockall, will catch deep-water species, including *L. fullonica.*

In inshore areas, scallop fisheries (using dredge) operate on sand-gravel substrates, and these fisheries may have some bycatch of skates.

3.4.5 West of Ireland (Divisions 7.b-c and 7.j-k)

Rajidae species are mainly caught in mixed demersal fisheries operating with otter trawls. The rays are caught along with cod, haddock, whiting, plaice, sole, hake, anglerfish and megrim. They are also caught in targeted artisanal fisheries in a few places along the coast using gill and tangle nets, and sometimes longlines. Beam trawlers are confined mainly to 7.g, and majority of vessels employ meshes of 80 mm.

3.4.6 Irish Sea, Bristol Channel and northern Celtic Sea (Divisions 7.a and 7.f-g)

The Irish Sea mixed gadoid fisheries, using larger mesh size, has declined in line with the EU's cod management plan (Regulation 1342/2008), and the main otter trawl fishery in the Irish Sea (Division 7.a) is currently the *Nephrops* fishery. Comparatively few skate species occur on the main *Nephrops* grounds. There are also mixed demersal trawl fisheries in the northern Celtic Sea and Bristol Channel, and a range of skate species occur on these grounds. There are also some localised and/or seasonal trawl fisheries targeting the wider skate complex (*R. brachyura, R. clavata, R. microocellata* (mostly in 7.f-g) and, to a lesser extent, *L. naevus* and *R. montagui*) in the south-western Irish Sea (Divisions 7.a) and Bristol Channel (7.f-g).

Beam trawlers also operate in the area (mesh sizes of 80–89 mm) and, whilst often targeting plaice and sole, will operate on grounds where skates occur.

Various gillnet fisheries operate in Divisions 7.a and 7.f-g, often targeting large gadoids and, further west, catching anglerfish. Turbot and brill are important bycatch species, with a range of skates also taken. The mesh sizes used vary, but recently the use of larger mesh sizes (varying from 150 -219 mm) has increased. There are some localised and/or seasonal fisheries targeting the wider skate complex (*R. brachyura, R. clavata, R. microocellata* and *R. montagui*) with nets of ≥220 mm mesh size. *Dipturus batis* appear to be locally abundant in parts of the Celtic Sea, and are a bycatch in some net fisheries.

The scallop fisheries operating in this area, including in the Irish Sea, are known to have a bycatch of *L. naevus* which is frequently discarded in the scallop fishery around the Isle of Man (Craven et al., 2013).

There is also a large recreational fishery for skates, particularly for those species close to shore, with some ports having locally important charter boat fisheries. There is likely to be some retention of skates, although the levels of these catches are unknown.

3.4.7 Western English Channel and approaches (Division 7.e and 7.h)

There are a range of bottom trawl fisheries (otter and beam trawl) in the area, as well as net fisheries (gillnet, wreck net, trammel net) operating in this area. There are also important fisheries for a range of shellfish, some of which will presumably have minimal interactions with skates (e.g. pot fisheries for crab and lobster), and other fisheries in which skates may be a bycatch (e.g. trawling for cuttlefish and dredging for scallops).

There is a high diversity of skates in this area (*Dipturus batis, Leucoraja fullonica, L. naevus, Raja brachyura, R. clavata, R. microocellata, R. montagui* and *R. undulata*) all locally abundant in various parts of the area.

Biscay-Iberian Ecoregion

This ecoregion displays subtle differences in the skate assemblages, and are so described in finer detail below.

According to Council Regulation (EU) 2017/127, landings of *Leucoraja naevus, Raja brachyura* and *Raja clavata* should be reported to species in this TAC area. There are sub-TACs for *Raja undulata* in both Subarea 8 and Subarea 9, and landings of this species should also be recorded to species level. Prohibited skate species in this TAC area are *Dipturus batis*-complex (Subareas 8-9 and elsewhere) and *Rostroraja alba* (Subareas 8-9 and elsewhere). There is currently no requirement for landings of *Dipturus oxyrinchus, Leucoraja circularis, Leucoraja fullonica, Raja microocellata* and *Raja montagui* to be reported to species level.

3.4.8 Bay of Biscay (Divisions 8.a-b, 8.d-e)

In the Bay of Biscay, Spanish and French trawl fleets are the main métiers landing skates. In 2016, skate landings originated mainly from Divisions 8.a–b (77%), and these were mostly from France (1560 t). In the 1960s, skates were taken primarily by bottom trawl fisheries operating in the northern parts of the Bay of Biscay. At that time, *Raja clavata* was the main landed species and was targeted seasonally. After the 1980s, *Leucoraja naevus* became the main skate species landed by the French fisheries. After 1986, landings of both these species declined. Other skates are also landed, including *L. circularis, L. fullonica, R. microocellata, D. batis* complex and *D. oxyrinchus*. There have been no major annual landings of *Rostroraja alba* by French fleets in the past three decades.

The historical French catches of skates in coastal fisheries are poorly known. Species landings of coastal, such as *Raja brachyura, R. microocellata* and *Raja undulata* began to be reported after the EU legislation on species recording of landings (Council Regulation (EC) 43/2009).

Spanish demersal fisheries operating in the Bay of Biscay (Divisions 8.a–b and 8.d) catch various skate species using different fishing gears. Most landings are a bycatch from trawl fisheries targeting demersal teleosts, (e.g. hake, anglerfish and megrim). *L. naevus* and *R. clavata* are the most important landed species.

3.4.9 Cantabrian Sea (Division 8.c)

Skate landings in Division 8.c account for *ca.* 20% of the total landed from Subarea 8, and are mainly from Spain (407 t in 2016). The Spanish demersal fisheries operating in the Cantabrian Sea catch skates as a bycatch in trawl fisheries targeting demersal teleosts. The most important species caught by these fisheries are *L. naevus* and *R. clavata*.

There are also some artisanal fisheries that operate closer to the coast that catch various skates, as a bycatch. The Spanish artisanal fleets catching skates are not well described but most of the skate landings have been attributed to gillnet fisheries operating in bays along the northern coast of Spain. Historically, and due to their comparatively low commercial value, most skate species caught by these artisanal fisheries were landed under a unique generic name.

3.4.10 Atlantic Iberian waters (Division 9.a)

In the western parts of the Iberian Peninsula, skates are caught mainly as bycatch in fisheries targeting other species (fin-fish and crustaceans). In the past, in the north of Spain there was a targeted skate fishery that used a special fishing gear, a gillnet type known locally as 'raeiras' (DOG nº 31 15/02/2011). This fishery took place at more coastal areas and inside rias and estuaries. At present, there are no Spanish directed fisheries and most of the landings come from the trawl fisheries targeting other species (Rodriguez-Cabello et al., 2005). In the inshore areas, i.e. inside Galician estuaries, the artisanal fleet operates with a special type of gillnet known locally as 'miño' (DOG nº 31 15/02/2011), and this commonly catches skates. The two most important species in this fishery are *Raja montagui* and *R. brachyura* (Bañón et al., 2008). The landings from these inshore fisheries represent nearly 9% of the Spanish total landings of skate in this/the ICES area (Bañón et al., 2008). *Raja undulata* is caught mainly in the coastal waters of Galicia (northern part of Division 9.a and western part of Division 8.c). Other skate species caught in Galician waters include *R. brachyura, R. microocellata, R. montagui, R. clavata* and *L. naevus.*

Along the Portuguese continental coast (Division 9.a), skate species are caught mainly by the polyvalent segment, which represents around 75% of the total landed weight, followed by the trawl segment (24%). The trawl fleet segment included vessels that operate with mesh sizes of 55, 65 or 70 mm.

The Portuguese polyvalent segment includes vessels with ranging from 5 to 27 m in overall length which generally operate in waters between 10 and 150 m deep. These vessels may use a range of fishing gears and catch a high diversity of skate species. Vessels in this fleet may have more than one fishing gear (e.g. trammel nets, gillnets, longline, trawl, traps and/or pots) and consequently different fishing gears may be used during a fishing trip. Within the polyvalent segment, skates are caught mainly by nets (trammel and gillnets). For the period 2008-2016 the landed weight derived from nets represented 65-78% of the total landed weight, while longline and artisanal trawl represented 19- 24%, and up to 5% respectively.

In the Gulf of Cádiz, skates are taken mainly as a bycatch in Spanish fisheries targeting demersal species, mostly involving the trawl fleet. The artisanal fishing fleet operating in shallow waters close to the Guadalquivir river mouth with trammel nets catch other batoids, mainly *Dasyatis pastinaca* and *Myliobatis aquila*. These two species are economically important being locally consumed. Hydraulic dredges targeting clams *Chamaela gallina* may also catch batoid species.

3.4.11 Azores (Division 10.a)

Two broad types of fisheries occur in ICES Subarea 10: the 'oceanic fisheries', which involves large midwater and bottom trawlers and longliners that operate in the central region and northern parts of the Mid-Atlantic Ridge (MAR), and the 'Azorean fishery'. Through time, skate landings from the former have been relatively small, or even absent, and at present their catches are considered minimal, as limited demersal fishing occurs in the MAR. Fisheries operating within the Azorean EEZ catch several skate species, typically in the multispecies demersal fishery, that uses handlines or bottom longlines, and by the black scabbardfish fishery that uses bottom longlines. *Raja clavata* is the most commercially important skate caught and landed (ICES, 2005, 2017b).

3.5 Length distribution of skates in example fisheries

There are no internationally collated data to show the length compositions of skates taken in the various European fisheries. However, some examples from particular case studies are presented below, which can be used to infer the types of length compositions that can be seen in different fisheries.

In terms of the length distributions of skates that are discarded or retained, it should be noted that there are various factors that influence discarding patterns, ranging from commercial drivers (e.g. market price, condition of fish caught) to the influence of management measures (e.g. quota available, regional bylaws relating to minimum sizes etc.). Hence, any information presented below on the size distribution of discarded/retained skates should be viewed as examples only, and not necessarily indicative for specific fisheries.

Ellis et al. (2010) and Silva et al. (2012) provided information on the length distributions of skates taken in various UK fisheries by broad métier. In general terms, beam trawlers mostly capture skates from ≈10 cm (size at hatching) to ≈70 cm, peaking at about 20-40 cm, and with only occasional captures of skates >90 cm. In contrast, whilst otter trawlers also capture newly hatched skates, the peak length range was ≈40-60 cm, and proportionally more fish within the 70-90 cm size range would be taken. The size range of skates taken in gillnets (≤150 mm mesh size) was also quite broad, but recently hatched fish (20-30 cm length range) were not usually observed. Gillnets (including tangle and trammel nets) with larger mesh sizes (>150 mm) appeared the most size selective, with most fish from 50-90 cm. These gears were one of the more effective for catching larger (>90 cm) skates (Figure 3.1).

Whilst larger skates are also taken in longline fisheries, these gears also capture fish of more moderate size. For example, studies on *R. clavata* in the southern North Sea indicate that trawls catch proportionally more small fish, followed by gillnets, longlines and large mesh gillnets the most size selective (Figures 3.2-3.3). Comparable patterns in the size compositions of skates are seen in other species and fleets (Figure 3.4). ICES (2017a) provide further examples of the size compositions of skates taken by various national métiers.

Length–frequency distributions of *L. naevus* and *R. clavata* (Figure 3.5), and *R. brachyura* and *R. microocellata* (Figure 3.6) from the Portuguese commercial polyvalent and trawl fleets (2008–2016) were extrapolated to the total estimated landed weight of each species. Length distributions and their ranges were similar between years for the fleets, but there were differences in the length distributions between the two fleets. For both *R. brachyura* and *R. microocellata*, landings from trawlers could comprise of proportionally smaller length classes, with larger fish taken by the polyvalent fleet.

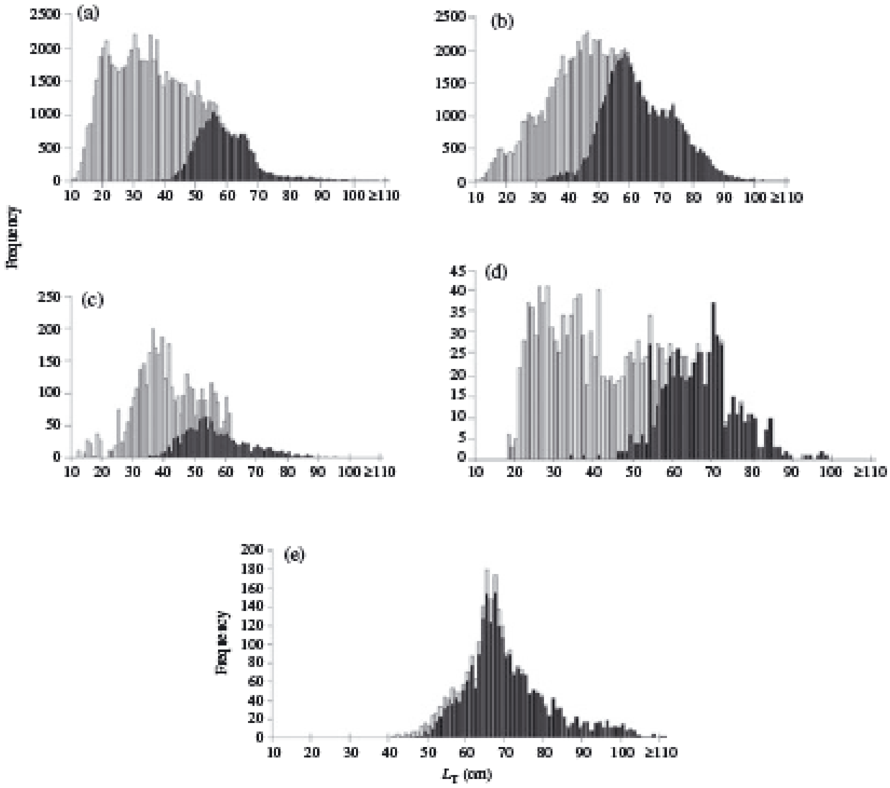


Figure 3.1: Length frequency distribution (numbers at total length) of commercial skates (excluding *Dipturus batis*-complex and *Raja undulata*) for (a) beam trawl, (b) otter trawl, (c) *Nephrops* trawl, (d) gillnets (≤150 mm mesh size) and (e) gillnets (>150 mm mesh size), showing those that were discarded (grey) and retained (black). From Silva et al. (2012).

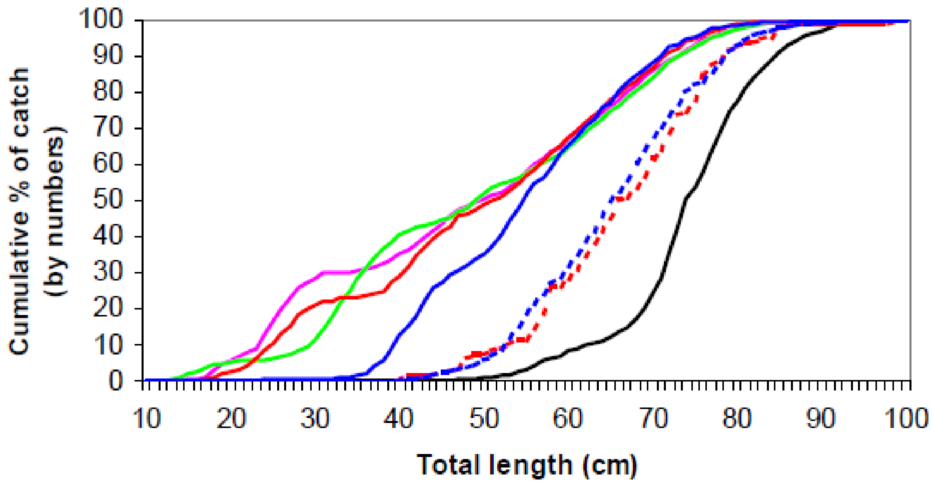


Figure 3.2: Length frequency distribution (cumulative percentage by total length) of thornback ray *Raja clavata* caught in the southern North Sea by three inshore trawlers

(solid pink, red and green lines), gillnets (solid blue line), longline (dashed lines) and gillnets (>260 mm mesh size). From Ellis *et al*. (2008).

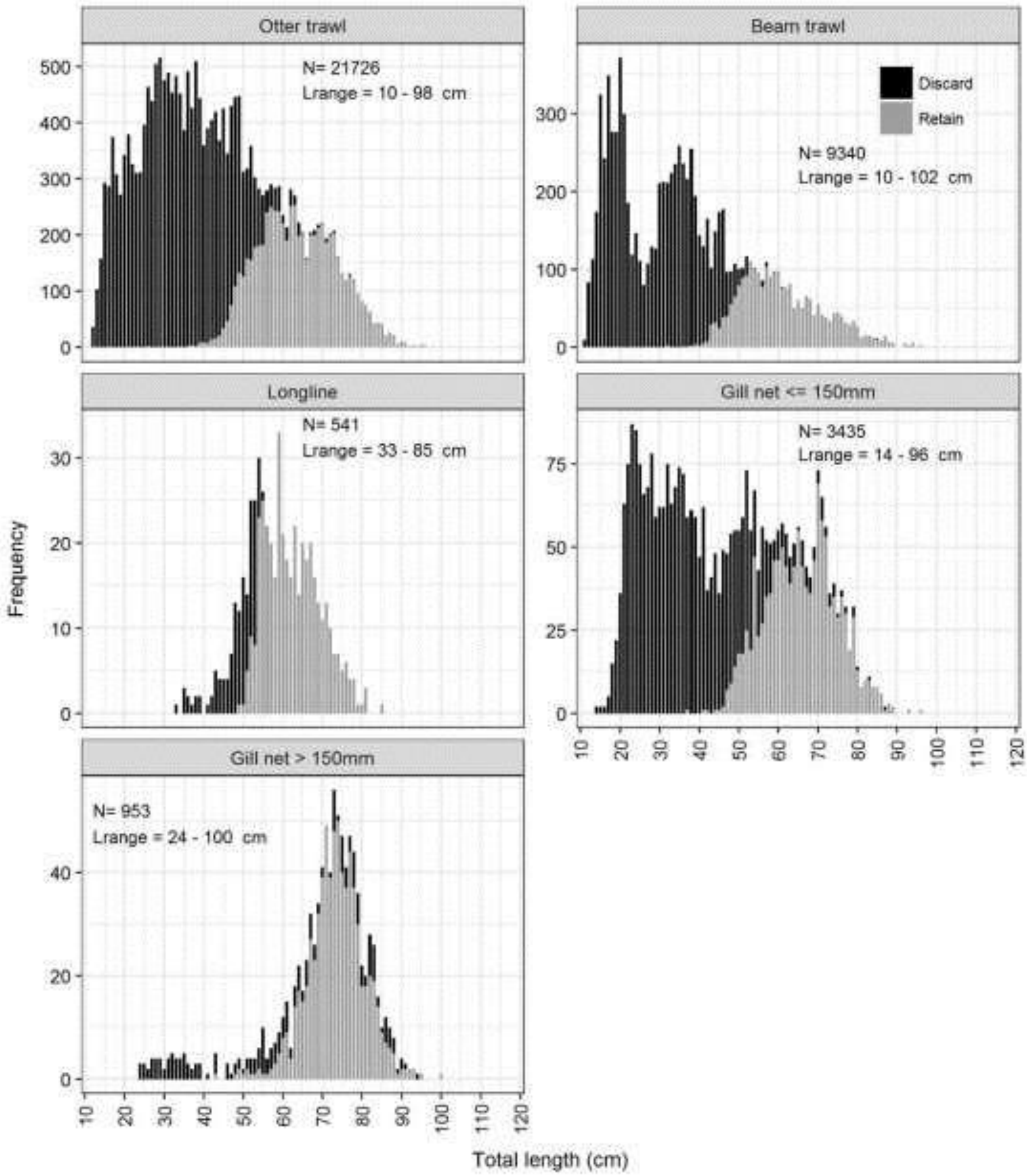


Figure 3.3 Length-based discard-retention patterns of thornback ray *Raja clavata* caught in ICES Divisions 4.b.c and 7.d) by otter trawl, beam trawl, longline, gill net (≤150 mm mesh size) and gillnet (>150 mm mesh size) as recorded during the UK (English) observer programme (2002-2016). From ICES (2017a).

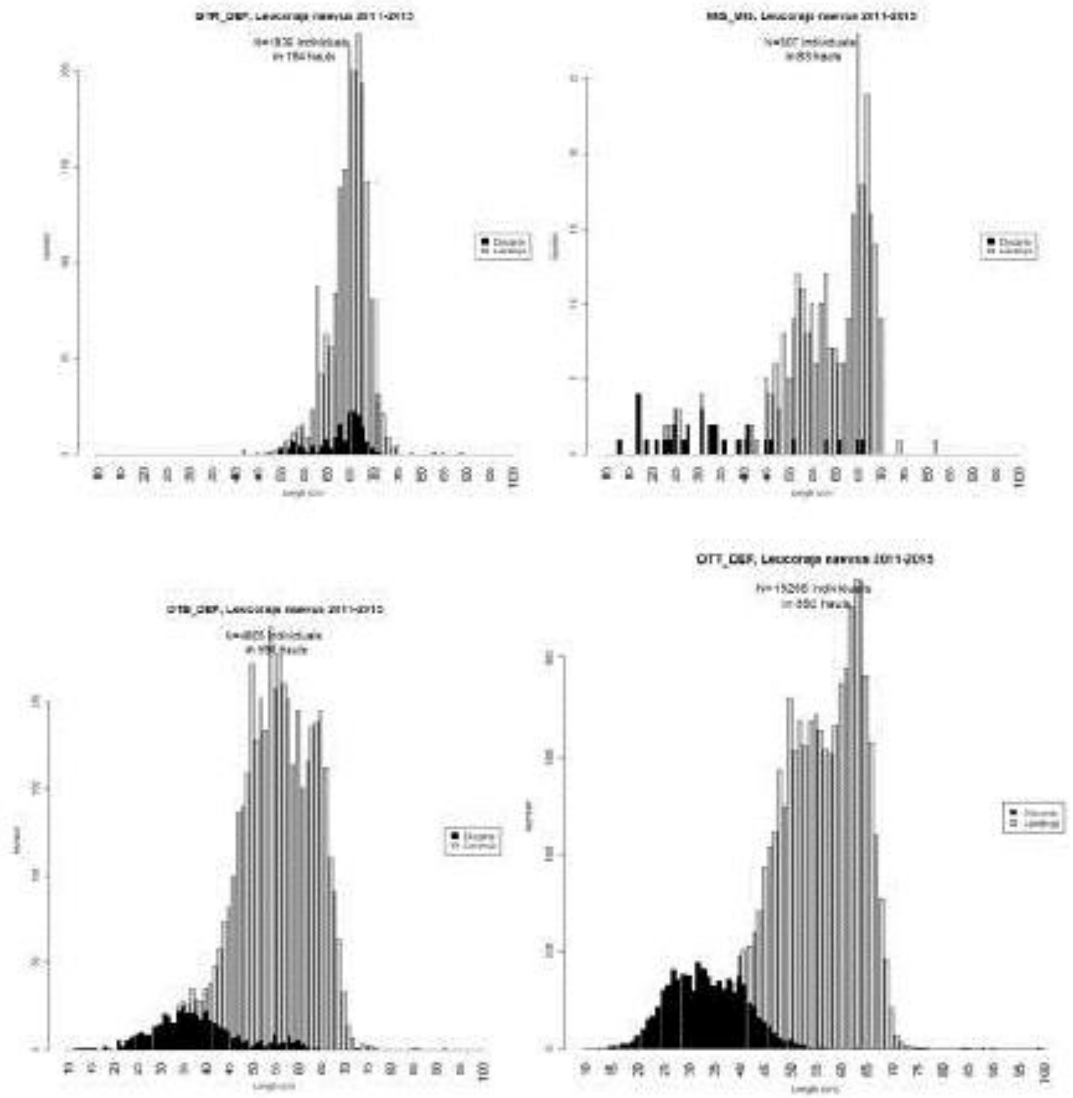
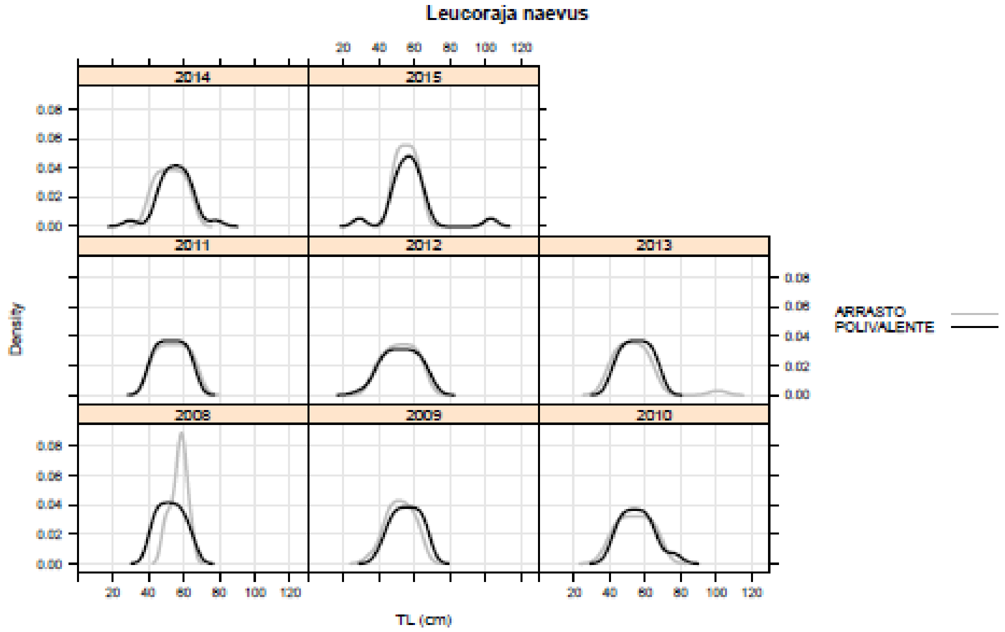


Figure 3.4. Length-based discard-retention patterns of cuckoo ray *Leucoraja naevus* caught in ICES Subareas 6 and 7 by métier (2011-2016 combined), as recorded during the French observer programme. Métiers are GTR-demersal fish (top left), miscellaneous gears (top right), OTB-demersal fish (bottom left) and OTT-demersal fish (bottom right). From ICES (2017a).



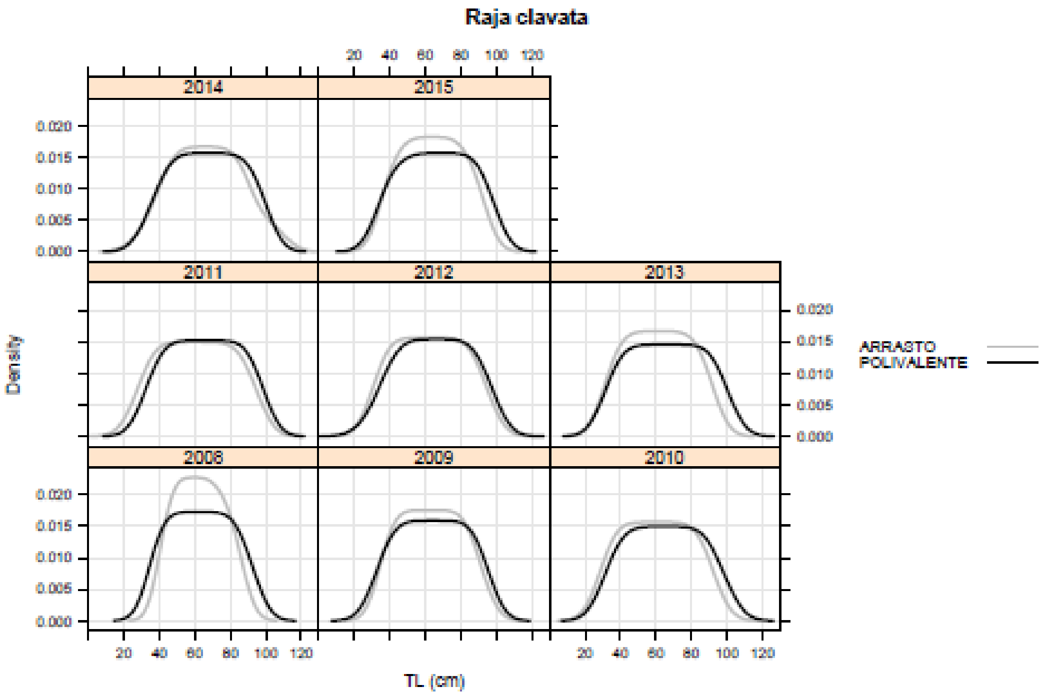


Figure 3.5: Length–frequency distribution of *Leucoraja naevus* (top) and *Raja clavata* (bottom), (2008–2015) caught off mainland Portugal (Division 9.a) by the polyvalent fleet (black line) and trawl fleet (grey line). Source: ICES (2017b).

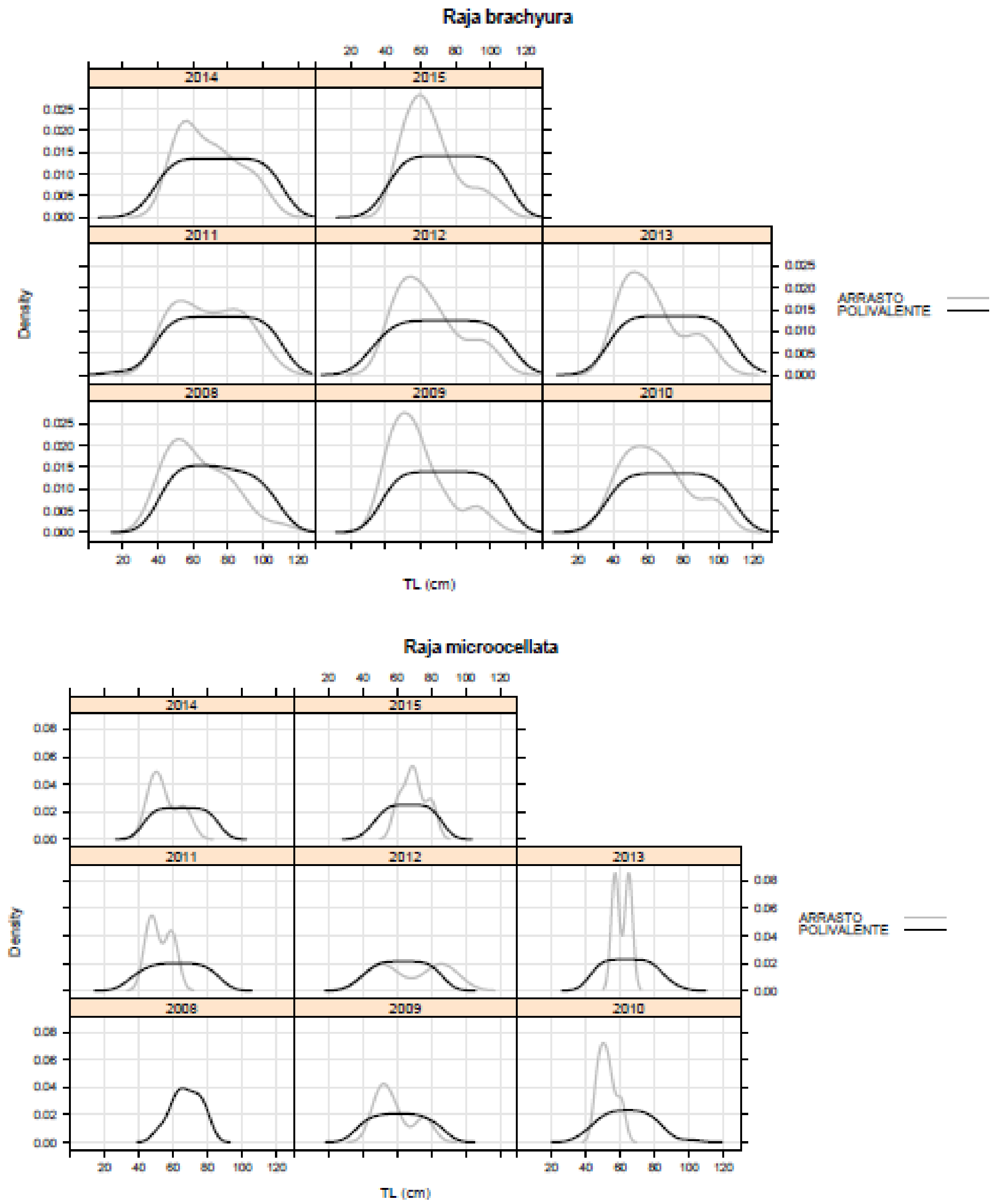


Figure 3.6 (continued): Length–frequency distribution of *Raja brachyura* (top) and *Raja microocellata* (bottom) (2008–2015) caught off mainland Portugal (Division 9.a) by the polyvalent fleet (black line) and trawl fleet (grey line). Source: ICES (2017b).

3.6 Species composition of skates in commercial landings

There have been various published studies providing information on species composition of skates, and these studies can provide both historical (Steven, 1932; Holden, 1963; Du Buit, 1973; Fahy 1989, 1991) and more recent perspectives (Machado *et al*., 2004; Figueiredo *et al.,* 2007; Silva *et al.,* 2012).

The species composition of skates, can vary both seasonally and spatially. Some areas, such as the southern North Sea, have a comparatively low species richness of skates, and *R. clavata* is by far the main species encountered (Ellis *et al.,* 2008; Silva *et a*l., 2012; Table 3.5). In contrast, other regions (e.g. Celtic Sea) have a greater range of skate taxa (Table 3.6).

ICES WGEF has recently collated data for elasmobranch landings by nation (ICES, 2016). These data also available by fleets, although the data supplied are to varying levels of gear type, category and métier. ICES WGEF has regularly noted that some of the species-specific information in official/national data are inaccurate, which can be due to misidentifications or coding errors (ICES, 2016, 2017b). These data collated by ICES could be used to provide a more up-to-date synthesis of the species composition by ICES Division and gear.

Table 3.5: Species composition of skates in UK fisheries operating in the southern North Sea and eastern English Channel, based on reported landings and CEFAS observer programme (retained species only). Species denoted * are considered questionable records, and may be due to either misidentifications or coding errors. Source: Silva et al. (2012)

Species name	Beam trawl						Gill and tangle net						Otter trawl					
	Reported landings			Observer data			Reported landings			Observer data			Reported landings			Observer data		
	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
*A. hyperborea**	-	1.0	3.0	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-
D. batis	-	<0.1	-	-	-	-	0.3	-	0.3	-	-	-	-	-	-	-	-	-
*D. oxyrinchus**	-	-	-	-	-	-	0.8	<0.1	1.0	-	-	-	<0.1	-	<0.1	-	-	-
*L. circularis**	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-
*L. fullonica**	-	-	-	-	-	-	<0.1	<0.1	0.1	-	-	-	-	-	<0.1	-	-	-
L. naevus	-	0.3	0.3	-	-	-	-	<0.1	<0.1	-	-	-	-	-	-	-	-	-
R. brachyura	30.8	29.6	26.2	66.8	24.5	30.1	6.4	12.5	8.6	1.2	0.4	-	4.6	3.4	1.8	-	5.1	18.9
R. clavata	46.2	53.0	55.9	33.2	73.4	60.1	90.5	84.2	86.8	97.1	99.4	100.0	94.5	95.4	97.6	100.0	39.9	72.0
R. microocellata	4.2	2.0	0.4	-	-	3.7	-	1.4	1.0	1.7	-	-	0.1	0.3	0.2	-	16.7	1.2
R. montagui	15.7	13.7	14.1	-	2.1	6.1	0.1	1.6	2.3	-	0.3	-	0.6	0.7	0.2	23.1	7.9	-
R. undulata	3.1	0.4	-	-	-	-	1.9	0.1	-	-	-	-	0.1	0.1	-	-	15.3	-
R. alba	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	<0.1	-	-	-
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 3.6: Species composition of skates (Rajidae) in UK fisheries operating in the Celtic Sea, based on reported landings and CEFAS observer programme (retained species only). Species denoted * are considered questionable records, and may be due to either misidentifications or coding errors. Source: Silva et al. (2012)

Species name	Beam Trawl						Gill and tangle nets						Otter trawl					
	Reported landings			Observer data			Reported landings			Observer data			Reported landings			Observer data		
	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
*A. radiata**	0.5	0.6	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D. batis	7.7	0.5	-	18.3	-	-	25.1	<0.1	-	-	-	-	4.0	-	-	-	-	-
*D. nidarosiensis**	-	-	-	-	-	-	-	-	-	-	-	-	20.6	2.8	<0.1	-	-	-
D. oxyrinchus	0.4	-	<0.1	-	-	-	-	1.2	0.5	-	-	-	11.0	5.3	-	-	-	-
L. circularis	2.9	1.0	0.1	-	-	-	3.0	-	-	-	-	-	0.1	1.8	0.1	-	-	-
L. fullonica	1.4	1.7	0.7	6.2	4.6	15.0	-	0.2	6.0	-	-	23.0	5.6	15.0	30.1	-	-	-
L. naevus	72.9	78.8	77.0	73.7	93.2	82.6	37.7	41.6	22.2	4.5	90.9	59.7	30.3	47.7	46.6	0.1	-	0.2
R. brachyura	4.7	5.6	5.3	<0.1	-	-	20.3	22.1	4.4	3.0	-	0.5	8.8	4.7	4.4	60.4	8.8	37.3
R. clavata	4.5	5.7	6.4	1.3	0.6	-	3.0	9.0	28.8	46.9	-	0.4	14.1	16.6	12.0	12.1	43.1	19.1
R. microocellata	5.1	5.8	8.6	0.3	-	-	10.9	21.9	29.2	44.6	-	-	4.8	5.5	5.7	25.5	41.8	40.3
R. montagui	<0.1	0.4	1.6	0.1	1.7	2.4	-	4.0	9.0	1.0	9.1	16.4	0.1	0.7	1.2	1.9	6.3	3.0
R. alba	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

4 SURVIVAL

4.1 Background

As stated in STECF 2014 "Article 15 paragraph 2(b) of the landing obligation allows for the possibility of exemptions from the landing obligation for species for which "scientific evidence demonstrates high survival rates"". Two previous STECF (STECF-14-19 and STECF-15-01) reports have reviewed existing information on survivability of discards, including skates and rays, and have commented on factors that influence survivability.

STECF (14-19) has provided guidance on best practice to undertake survival studies. EWG-13-16 has identified three methodologies for conducting survival experiments (i.e. captive observations, vitality/reflex assessments and tagging/biotelemetry experiments). STECF has identified the gears that catch skates and rays and has classified them by proportion of total landed catch of skates and rays. These are bottom trawls, gillnets and entangling nets, beam trawls, trammel nets and longlines. Minimum and maximum observed survivability rates were reported for rays and skates at the family/group level, by gear and country. STECF-15-01 confirmed in the findings of STECF-14-19, reporting that species of ray have discard survival rates between 64% and 79% across all gears. They also reported that discard rates vary with biological attributes and type of gears and handlings (ICES, WKMEDS 2014).

STECF reported by gear type and by area (limited to ICES Subareas 4–7) for which no information was available on survivability of skates and rays. STECF suggested that these gaps could potentially be filled by comparing studies with the same species for similar gears and similar handling procedures to determine if discard survivability rates were comparable enough and therefore possibly transferable between areas.

4.2 Available information on survival rates of skates and rays

EWG-17-10 was asked to "collate and review available information on the survival rates of skates and rays updating STECF 2014, producing a table of stocks/species versus métier/fleet segment for each sea basin or TAC unit".

The table of discard survival rates per métier from STECF-01-15 was updated bringing the level of detail from family to species. Next to the survival rate of discarded fish, mortality at vessel and tow/soak duration were added in the table (Table 4.1).

Only seven studies in European waters (highlighted in grey and blue in the table) were found and of these only two (Enever *et al*., 2009; Catchpole *et al*., 2017) had estimated survival rate for discards. The other studies reported either vitality values or the percentage of individuals that survived after the observation period. No information on long-term survival rates after discarding is available in those studies. Studies carried out outside of European waters were also reported to determine whether it would be possible to use such information to fill in gaps on certain métiers used also in European waters.

The above mentioned studies reported an effect of depth (Endicott and Agnew, 2004), sex (Endicott and Agnew, 2004; Laptikhovsky *et al*., 2004; Enever *et al*., 2009), catch mass (Enever *et al*., 2009), tow and soak duration (Ellis *et al*., 2008; Bendall *et al*., 2012; Mandelmann *et al*., 2012) with the level of survival/vitality recorded. It would thus be useful to obtain, in future studies, a quantification of the effects of some of those factors on the estimates of survival rates of discarded fish

EWG-17-10 notes that recent studies lead to the revision of some survival rate estimates previously reported (STECF-15-01). Catchpole *et al*. (2017) re-estimated discard survival in UK waters reviewing the available data from previous studies applying the latest analytical methods to obtain more robust estimates. They found that previous estimates (Enever *et al.* 2009) may have overestimated survival at discard for *Raja brachyura* (Table 4.1 in blue) therefore indicating that more robust data analysis and data collection are still needed to better estimate skate and ray discard survival rates.

EWG-17-10 notes that there might be some potential to increase survival of discarded fish by improving handling. This could be done through projects aiming at improving communication with fishers and/or through specific training.

Table 4.1 Estimates of survival at discard and mortality at vessel across gear types and species. Studies highlighted in grey and blue were from European waters outside the Mediterranean.

SPECIES	GEAR	LOCATION	REFERENCE	OBSERVATION PERIOD	SHORT TERM SURVIVAL (%)	AT VESSEL MORTALITY (%)	TOW DURATION OR SOAK TIME
Leucoraja naevus	Otter trawl	VII g,f (U.K. - Bristol Channel)	Enever et al. (2009)	3 days	**33**	NA	3.2h
Raja microocellata					**51**		3.1h
Raja brachyura					**55**		3.9h
Raja clavata					**59**		3.9h
Raja microocellata	Otter trawl	VII g,f (U.K. - Bristol Channel)	Enever et al. (2010)	2 days	67	NA	5.5h
Leucoraja naevus	Beam trawl	Dulas Bay, North Wales (UK)	Kaiser and Spencer (1995)	5 days	59	0	0.5h
Raja clavata	Demersal trawl	NorthEast Atlantic; southern North Sea	Ellis et al. (2008)	NA	NA	0.6	0.5-1.5h
	Longline			NA	NA	0	2-4h
	Gillnets (inshore vessels): fixed and drifters			NA	NA	2 (fixed); 0 (drifters)	overnight (fixed); 1-3h (drifters)
Raja sp.	Beam trawls	NorthEast Atlantic; North Sea	Depestele et al. (2014)	3-4 days	72	NA	0.17h; 1.5h
Dipturus batis - complex	Trammel nets and gillnets	NorthEast Atlantic; Celtic Sea	Bendall et al. (2012)	NA	NA	6.6; 8.6 (higher at longer soak time)	12-26h ; 36-48h
Raja clavata	Demersal trawl	Bristol Channel	Catchpole et al. (2017)	See Enever et al. (2009)	**57-69**	See Enever et al. (2009)	See Enever et al. (2009)
Raja brachyura	Beam trawl	English western channel			**45 (22-65)**		
Leucoraja naevus					**34 (15-54)**		
Raja clavata	Trammel nets	Southern North Sea	Catchpole et al. (2017)	Electronic tagging	**95**	NA	NA
Raja clavata	Otter trawl	Antalaya bay (Eastern Mediterranean)	Saygu and Deval (2014)	2 days	81	2	NA
Raja miratelus					21	26	
Bathyraja Psammobatis sp.	Squid trawl	Falkland Islands	Laptikhovsky (2004)	3 hours	71	NA	NA
Bathyraja brachiurops					55		
Bathyraja griseocauda					0		
Rhinoraja macloviana					0		
Rhinoraja magellanica					60		
Bathyraja sp.					75		
Psammobatis sp.					60		

Amblyraja radiata	Otter trawl	Gulf of Maine (USA)	Mandelman et al. (2012)	3 days	81; 77	<1	15-20mins; 2-4h
Malacoraja senta				4 days	41; 40		
Leucoraja ocellata				5 days	92; 91		
Leucoraja erinacea				6 days	86; 78		
Leucoraja ocellata	Scallop dredge fishery	Southern Gulf of St. Lawrence (Canada)	Benoit et al. (2010)b	2 days	62.5-100	NA	NA
Amblyraja radiata, Malacoraja senta, Leucoraja ocellata	Bottom trawl	Southern Gulf of St. Lawrence (Canada)	Benoit et al. (2010)a	2;>3 days	42-100	50	NA
Amblyraja radiata, Malacoraja senta, Leucoraja ocellata	Longline					30	
Amblyraja radiata, Malacoraja senta, Leucoraja ocellata	Bottom trawl	Southern Gulf of St. Lawrence (Canada)	Benoit et al. (2012)	2;>4 days (72h)	65 (43-80) (total survival estimate)	NA	1-2h
Raja sp.	Longline	South Georgia	Endicott and Agnew (2004)	12 hours	75 (1200m-1300m depth)-46 (1300m-1500m)-24(1500m-2000m); 68 (males) - 34 (females)	0	NA
Leucoraja erinacea	Scallop dredges	NorthWest Atlantic	Rudders et al. (2015)	3 days	50.9	NA	0.17h; 1.5h
Leucoraja ocellata					34.8		NA
Zearaja maugeana	Gillnets	Tasmania	Lyle et al. (2014)	NA	>87.2	0-9 (higher as soak time increases)	2-24h
Raja whitleyi							
Leucoraja eglanteria	Bottom longline	Gulf of Mexico	Scott-Denton et al. (2011)	NA	NA	4	0.9-32.2h

4.3 Data extrapolation to fleets segments/métiers/species not covered by the available studies

EWG-17-10 was asked to "consider to what extent information from one métier / fleet could be extrapolated to other fleets, detailing the criteria to do so. If this is not possible, then the working group is requested to conduct a gap analysis, detailing what information would be required to consider extrapolation and high survivability exemptions across all species of skates and rays, métiers and fleet segments per sea basin or TAC unit, whichever is more suitable".

In 2015, STECF-15-01 listed a series of fisheries (area and gear combination) for which it was unable to identify skates and rays survival data:

- TR1 and TR2 in North Sea (IVab);
- GT1 in North Sea (IVc);

- BT, GT1 and TR2 in the Eastern Chanel (VIId);
- TR1 and TR2 in Western Channel (VIIe & VIIh);
- BT1 and GN1 in the Bristol Chanel (VIIfg);
- GN1 and TR1 in the Irish Sea (VIIa) and;
- TR1 and TR2 in West of Scotland (Vb & VIab).

Since then, estimates of survival rates have only been provided for the métier GT1 in the southern North Sea (Catchpole et al., 2017) and, for all other gear and area combinations, there is still a lack of information on discards survival rates.

STECF-15-01 noted that "for many of the area/gear/species combinations where there is an absence of survival information, it may be worthwhile considering whether there are studies with similar gears and the same species from other areas, the results from which could be extrapolated from".

However, STECF noted "that such analogies should not be applied across gear types (e.g. assuming that the survival rates from longline fisheries would be comparable with gill nets for example"). In a more recent review, Catchpole *et al*. (2017) reached a similar conclusion and reported that due to the limited number of survival rate estimates available in the literature, it may be difficult for the moment to extrapolate values across métiers and that more studies are needed to cover a larger palette of gears, species and areas. To both increase the coverage of gear, area and species and improve current estimates, a data review and analysis, on the model developed by Catchpole et al. (2017) on UK waters should be extended to other areas. Such review should also highlight the main data gaps where particular efforts are needed.

The compilation of available studies presented in Table 4.1 confirms the limited number and large variability of estimates of discard survival rates. It also shows that those estimates are not always comparable, as they focus on different métiers, areas and species and often use different methods to collect and analyse data. For instance, three studies (Ellis *et al*., 2008; Enever *et al*., 2009; Saygu and Deval, 2014) relates to the same species (*Raja clavata*) and the same gear (demersal trawl), but in different areas, with different tow durations and observation periods. The estimates obtained are affected by different parameters and vary from 57 to 87 %. EWG-17-10 thus considers that it would be premature to envisage any extrapolation of survival rates estimates across métiers before more work is carried out as explained above. This consideration is also valid for the extrapolation of such estimates across species and/or fleets segments. The different species may have different biological characteristics, which may affect survival (body size (as an adult), skin hardness, body robustness); the type and operation of gears (e.g. soak time/tow duration); the deck handling procedures (e.g. time taken to sort the catch); and the broad environmental conditions that may vary across fleet segments. Another approach to estimating mortality of discards, could be to carry out a retrospective analysis of the data from tagging experiments which has been collected in the past decades.

4.4 Conclusions

Discard survival estimates are needed to support future requests regarding the exemption measure associated with the landing obligation. Currently, the estimates available only cover a limited number of métiers, areas and species, which are caught by commercial fisheries. Information in support of high survival exemption requests are limited and extrapolation of estimates of survival rates across métiers rather difficult. Furthermore, the available estimates are limited to short term survival rates and are still considered uncertain (due for instance to limited sample sizes and duration of experiments).

To highlight the data gaps on species and métiers by area which limit improvement in current survival estimates, EWG-17-10 suggests that a review and analysis, based on the model developed by Catchpole et al. (2017) on UK waters should be extended to other areas. It needs to be stressed that in order to allow easy comparisons between studies and simplify validation, a standardized data collection procedure and analysis should be followed. Further data collection using tagging technologies (e.g. conventional, electronic, satellite, acoustic) should be encouraged when considered appropriate to provide better estimates of both short and long-term survival.

Finally, it would be important to further encourage good practice on fish handling when discarded alive. This could be done through projects aiming at improving communication with fishers and/or through training.

5 SELECTIVITY

Typical gear-based technical measures for towed gears such as increased codend mesh sizes and square mesh panels are considered ineffective in increasing size selectivity for skates and rays because their large, flattened body shape prevents escape once inside fishing gears (Ellis et al., 2016).

Increasing codend mesh sizes to the extent required for reducing the catches of small skates and rays could be prohibitive given the resulting losses of marketable catches of other species. This partly explain why research into increasing size selectivity for such species has been limited. Enever *et al*. (2010) did investigate the effects of different configurations of codend construction and mesh size on the survival of skates, which showed changing from 80 mm diamond to 100 mm square mesh in the codend improved the condition of skates, and hence survival of discarded individuals. However, there is no indication from this study that size selectivity was anyway improved for skates and rays. Experiments carried out in the mixed fisheries in the Celtic Sea by France using 100mm T90 codends with 120mm square mesh panels compared to standard diamond mesh codend likewise did not show any increases in size selectivity for skates and rays (Fiche et al., 2017).

Meillat *et al*., 2011 reported on trials in the early 1990s with a prototype semi-rigid grid placed in the bottom panel of a standard demersal trawl tested in the Bay of Biscay. The objective of this trail was primarily to reduce the catches of small anglerfish and megrim. These trials showed a reduction in the catch of Cuckoo ray below 40cm of around 55%. The majority of rays released were below 32cm. No further trials are reported with this type of grid device.

There have been a number of studies of selective gears that have indirectly shown impossible to reduce the catches of skates and rays. None of these gears increase size selectivity but simply reduce the catch of skates and rays across the whole size range. These can be divided into:

1. Sorting grids and By-catch Reduction Devices (BRDs)
2. Escape panels and separator trawls
3. Other Trawl gear modifications

The following is a short review of the relevant work carried out with these gears which have shown reductions in catches of skates and rays.

5.1 Sorting grids and By-catch Reduction Devices (BRDs)

The use of rigid sorting grids is now common practice in a multitude of fisheries and in particular in shrimp fisheries. In many of these fisheries such grids have been demonstrated to reduce the catch of skates and rays in a number of bottom trawl fisheries (Brothers, 1991; Hartill et al., 2016; Lomeli & Wakefeld, 2013; Cosgrove et al., 2016; Willems et al., 2016). In some cases (i.e. Canadian *Pandalus* shrimp fisheries) skate bycatch has been reduced to almost zero (Brothers,

1991) although generally in such fisheries skate bycatch is unwanted and the species encountered have no or very low commercial value.

The results of trials reported by Willems et al., 2016 in a trawl fishery for seabob shrimp in Suriname showed that the size, morphology and behaviour of skates and rays are key factors in understanding the potential benefits of the various excluder devices. In these trials the grids used tended to facilitate the escape of larger species, but showed less of a reduction in the catches of juveniles and smaller-bodied species.

Brewer et al. (2006) examined the catches of prawn trawls fitted with turtle excluding devices (TED) and by-catch reduction devices (BRD) to reduce unwanted bycatch in prawn fisheries. This study reported that nets with TEDs or combined TED–BRDs successfully reduced ray bycatch, with upward-excluding TEDs more effective for reducing shark catches. The use of trawls with only BRDs was less successful.

While most of these trials show sorting grids and similar type devices effective at reducing skates and ray bycatch, there is evidence that elasmobranchs, especially large batoids, can clog grids (Isaksen et al., 1992; Lomeli & Wakefeld, 2013). This can compromise the retention of target species and act as a disincentive for fishermen from using such systems voluntarily).

5.2 Escape panels

There are have been several trials with gears fitted with escape panels placed in the bottom panels of trawls which have shown reductions in skate and ray bycatch. None of these experiments have specifically designed to reduce skate and ray bycatch but have noted this as an outcome from such trials. Anon (2011) reported on trials in the squid fishery off Massachusetts with a modified trawl that was constructed with two rows of 32” mesh (~800 mm) in the belly section of the trawl. While no quantitative results were reported, it was observed that the number of skate was drastically reduced when using the experimental net.

Similar types of release panels have been tested in Scotland as reported by Kynoch et al. (2009, 2010). In these experiments a range of diamond mesh panels of 300mm, 600mm and 800mm were placed in the bottom sheet of demersal trawls. The main objective was to reduce the catch of cod but there were indications that catches of rays were decreased significantly. In this case much of the ray catch was of marketable species.

5.3 Trawl gear modifications

There has been considerable research into developing trawl modifications that use the natural behaviour of fish in trawls to sort different components of the catch into separate parts of a trawl and allow them to be treated in different ways. Main and Sangster (1982) showed in experiments with a modified trawl fitted with a horizontal separator panel that it was possible to sort low swimming species such as *Nephrops*, flatfish and skates and rays from higher swimming species such as haddock and whiting. In these initial trials with this separator trawl, 100% of the catch of skates and rays was retained in a lower codend. Trials carried out by BIM in Ireland (Anon., 1997) with a similar designed separator trawl showed that 88% of catches of spotted, blonde, cuckoo and thornback ray were sorted into a lower codend. It was noted, though, that any rays that were retained in the top codend tended to be larger specimens. In these trials the objective was not necessarily to reduce the catch of bycatch species but simply to sort catches in to different components.

Using a similar approach relating by exploiting behaviour differences between species to reduce unwanted bycatch, fishermen in New England in collaboration with the net manufacturers Superior Trawl, and fishery specialists developed the Eliminator Trawl™ (Beutel et al., 2008). The goal of this trawl design was to reduce cod bycatch, while retaining catch of targeted haddock. The trawl is essentially a high opening demersal trawl with large mesh sections in the top and bottom panels of the trawl and cutaway bottom wings that allow low swimming fish to escape like skates and rays, cod and flatfish to escape. Christensen (2014) reported that that, based on the work in New England, the Eliminator Trawl was found to have a significant impact on reducing skate bycatch. The control net caught primarily skates, haddock, and winter flounder. The results from the trials carried out showed catches from the Eliminator Trawl were reduced by 98.6%, totalling 258kg compared to 18,956 kg in the standard trawl gear. While not the main species of interest in Beutel et al.'s (2008) study, the Eliminator Trawl had the most significant impact on skate bycatch of any bycatch species, while retaining similar catch levels for haddock.

Revill and Horan (2008) similarly report of reductions in bycatch of rays in trials using an Eliminator style trawl in the North Sea. In these trials a 43% reduction in catches of a range of non-commercial species including unspecified species of rays was observed. Reeves and Armstrong (2009) report on further trials with an Eliminator type trawl in the North Sea saithe fishery. Several species of rays including cuckoo ray, common skate and starry ray are a bycatch in this fishery (both wanted and unwanted). These trials again showed reductions in the catches of all these species although it also significantly reduced the catches of saithe.

McHugh et al. (2017) reported on more recent trials with a modified trawl with a raised fishing line. Raising the fishing line involved lengthening the droppers between the fishing line and the ground gear to approximately 1m and effectively creating an escape opening for bottom swimming fish to escape in the gap between the fishing line and the footrope. The main aim was to reduce the catch of cod while maintaining the catch of haddock and whiting. This gear was tested in the mixed demersal fishery in the Celtic Sea and in which mixed rays are a bycatch. These trials showed a reduction in total ray catch of 80%. These are similar results to those reported by Bayse et al. (2016) who tested a modified squid trawl with a drop-chain groundgear setup. The objective of this trial was to reduce the bycatch of finfish in the Nantucket Sound squid fishery. They reported that 90% of skates encountered avoided entering the trawl and escaped under the fishing line and based on video analysis results concluded that the drop-chain trawl was effective at allowing skates to escape

Kynoch et al. (2015) showed that not using a tickler chain can reduce the catch of sharks, skates and rays in mixed demersal trawl fisheries in the North Sea. In these trials the presence of the tickler chains increased the catch of skates and rays by a factor of 3.6. However, in this instance catches of anglerfish *Lophius* spp., one of the main target species in the fishery, were significantly reduced suggesting in this fishery that removing tickler chains would not be a measure supported by the fishing industry.

5.4 Gillnets and longlines

For static gears the options for reducing bycatch are limited and there have been few such studies to date that have investigated modifications to reduce bycatch of skates and rays. Based on the characteristics of the species and the operation of such gears, potential bycatch mitigation measures in gillnet fisheries could include spatial and temporal restrictions, restricted lengths of net, limiting soak times, changes to mesh size, hanging ratio and height of the net and modifying the thickness and colour of netting material (Thorpe & Frierson, 2009; Baeta et al., 2010). These, however, remain unproven and indeed in many European countries, large mesh entangling nets with relatively long soak times are used specifically to target rays. On the whole these are selective fisheries given the size of mesh used and that the fisheries are concentrated in areas of abundance.

In longline fisheries there are limited options for reducing unwanted catches. There have been numerous publications on the potential use of magnets and electropositive metals attached to longlines to reduce bycatch of elasmobranchs. According to the review by Favaro & Côté (2015), such devices remain unproven.

5.5 Conclusions

- Improving the size selectivity of towed gears for skates and rays is difficult due to their morphology. There is only limited evidence from trials carried out by France with a type of flexible sorting grid that showed size selectivity for cuckoo ray could be increased.
- There are numerous trials with sorting grids that have shown that catches of skates and rays can be reduced. In most cases these devices have been tested in fisheries where skates and rays are classified as unwanted catches due to the species involved being of low or no commercial value. In certain circumstances the effectiveness of such devices has been reduced due by larger skates or rays blocking or clogging up the grid compromising the retention of target species.
- Several trials have demonstrated that installing large mesh panels in the bottom panels of trawls can reduce skate and ray bycatch. As with sorting grids in some cases this has been a favourable outcome as the species are classed as unwanted bycatch. However, in other fisheries (e.g. mixed demersal fisheries in the North Sea) this is a negative outcome as the skates and rays catch is valued by the fishermen operating in the fishery.
- Trawl modifications such as the use of the Eliminator™ trawl as well as the use of trawls with raised fishing lines have also been shown effective at reducing the bycatch of skates and rays. Such trawl designs exploit behaviour differences between species to reduce unwanted bycatch. Removing tickler chains has also be shown to reduce skate and ray catches in mixed demersal fisheries in the North Sea but the removal of tickler chains significantly reduce the catch of other target species, particularly anglerfish, in this fishery.
- There are limited ways of increasing selectivity in gillnet and longline fisheries and few trials have been carried out from which to draw any conclusions as to whether this is possible or not.
- Potential bycatch mitigation measures in gillnet fisheries could include spatial and temporal restrictions, restricted lengths of net, limiting soak times, changes to mesh size, hanging ratio and height of the net and modifying the thickness and colour of netting material. None of these have been tested to any degree and in any cases gillnet fisheries for skates and rays tend to be targeted and conducted with large mesh gillnets making them selective in some regards.
-
- The overall conclusion is that it is difficult to increase size selectivity for skates and rays but there are a number of gear modifications that have been shown to be effective at reducing bycatch. The adoption of such gears is dependent on whether the skates and ray species involved have a commercial value and the availability of fishing opportunities that allows them to be landed. Where such species are considered as part of the marketable catch then there is little incentive to reduce bycatch as to do so would represent a loss of income. However, in a choke species scenario, where the quota for skates and rays is exhausted and the only option for a vessel to continue fishing in a specific fishery is to fish without catching skates and rays then such gears may be considered an option.

6 MANAGEMENT MEASURE EVALUATIONS

6.1 TAC based management measures

Several types of TAC based management measures have been reviewed (Table 6.1). They include:

- Generalized skate and rays TACs: This is the current method of TAC setting for skates and rays. The objective is to limit the combined total allowable catch of all stocks of skates and rays across several management areas.
- Generalized TAC with sub-TACs for particular stocks: the objective is to restrict the total allowable catch by management areas for all stocks of skates and rays combined with specific sub-TACs for some particular stocks. The choice of the particular stock could be based on several criteria (e.g. the more vulnerable stocks or the more important in terms of catches or revenues)
- TAC by genus: the objective is to restrict total allowable catch at the scale of genus of skates and rays (Raja and Leucoraja).
- TAC by stocks (from ICES advices): the objective is to limit total allowable catch at the individual stock level for skates and rays by management area as defined by the ICES stocks advice.

6.1.1 Information needed

For most stocks of skates and rays, ICES already produce advice that allows the setting of TACs. However, this advice is currently a landing advice. In order to set TACs on a catch basis, it will be necessary to get better estimates of dead discards. This implies improvement in both estimates of discards and survival rates of discarded fish.

Despite improvement in recent years, recurring misidentification at species level and uses of generic categories occurs in the reporting of landings and discard data. It is thus important to improve species identification and increasing information on catches and fisheries may imply adjustments of the DCMap in terms of the skates and rays data collection.

In the case of generalized TACs with sub-TAC for particular stocks, it is worth noting that the selection criteria for sub-TAC stocks may have direct consequences on the effectiveness of the management method and buy-in by stakeholders. This would be facilitated if the criteria were developed in a transparent, collegial and revisable way (e.g. stocks targeted, stocks with poor or unknown status, stocks with low level of landed, etc…). A sub-TAC would probably be more useful for species where there are targeted fisheries and reasonable catch data.

For all TAC management options, building performance indicators will require information on the level of F and SSB and the definition of reference points. Proxies could be used until suitable metrics can be estimated (e.g. stock size indicators as currently used by ICES for several stocks of skates and rays).

6.1.2 Pros and cons

It is evident that the level of control of fishing mortality by stock will vary between TAC allocation method and it is expected that the capacity of controlling F will be higher in the case of TACs set at stock level and lower in the case of TACs combining all species. In the case of aggregated TACs combining stocks with different status, the management measure may not offer adequate protection for stocks that require reductions in F and conversely, may limit catch opportunities for stocks in good condition. Additionally, in the case of a generalized TAC with sub-TACs, if a sub-TAC is restrictive, this may result in an increase in fishing pressure on the other generalized stocks of the same area, once the sub-TAC level has been reached for the specific stock(s).

Control and enforcement will also vary depending on the TAC management options. It can be expected to be easier to implement in the case of a generalized TACs considering it does not required species-specific or genus information, as species identification is an issue with some species of skate and ray. This may still be a problem for TACs set at stock level although this could be mitigated once improvement in species identification has been made (training/awareness raising with fishermen). In any case, it must be noted that adding more TACs (going from a generalized TAC system to a stock based TAC) may add extra monitoring requirements. The fact that skates and rays are mainly caught by mixed fisheries targeting other species needs also to be taken into considerations.

In all cases, some incentives for misreporting exist, although this could be expected to be much less important in the case of a generalized TAC. This can be due to misidentification but also to deliberate misreporting of TAC catches once quota allocation is reached. Additionally, misreporting can still occur for prohibited species although is rare as catches of such species tend to be limited.

All TACs management option can produce, to a various degree, the dangers of skates and rays of being choke species. This is possibly highest for TAC by stocks as more TACs need to be defined. This effect will be linked to the exemptions granted in the landing obligation as well as other tools and flexibility measures available under the CFP. The survival rate per species, métier and area will be of particular importance.

6.2 Landing trip limits

This management measure would limit the quantity of a (or several) selected stock(s) on a trip by trip basis. The measure is considered here outside a quota limit system.

6.2.1 Information needs

Landing trips limits requires information on catch (or landings) weights by trip for each métier together with discard survival. Data on landings by trip is available but length distributions of landings/discards are only available for some fisheries from at-sea observer programmes. Building performance indicators will require information on the landings or catch data by trip (to verify compliance) and on F and SSB to assess the stock status.

6.2.2 Pros and cons

This measures can potentially control fishing mortality by deterring the development of target fisheries for species that survive discarding. It may however encourage high grading by retaining larger (mature) individuals. If the survival rate of the species selected is low, this measure will not control F. Control and enforcement can be easy at point of landing but can be more problematic if the fishery operates from a large number of ports. Absolute limits in kg per trip would be easier to enforce than percentages of catch. There might be issues with species identification as for other management measures based on catch/landing limits. There is also a need for better definition of conversion factors for processed to live weight (including the option to land individual whole/gutted)

Poor knowledge on the spatial-temporal distribution and abundance of some lesser-known species in relation to fleet dynamics (e.g. is there an area of high local abundance in relation to some specific fleets) may be a source of uncertainty in the implementation of such measure together with discard survival rates. Furthermore, the selected level of the landing limit and its market value could potentially affect compliance.

6.3 Effort control

In a fishing effort management system, fishing is limited by the amount of effort exerted and not by the amount of fish caught. A prerequisite is however that the relation between fishing effort and fishing mortality of a species is known. In an effort regulated system the fishing mortality can be, for instance, limited by the number of fishing vessels (expressed as kilowatt or gross tonnage) multiplied by their fishing days deployed (Lovgreen *et al*., 2009).

6.3.1 Information needs

Effort management tools require an appropriate measure of effective unit of fishing effort to account for vessel size/power and gear effectiveness, effort information spatially discriminated by métier, fleet dynamic and catch composition data. This information is already partially available in fleet registers, in the STECF FDI database by métier, and from logbooks and observers programmes, although discard data for skates and rays is sparse and information on dead discards is missing.

6.3.2 Pros and cons

It must firstly worth noting that while this management method has been used by the European Commission over recent years, there is currently a tendency to move away from effort as a management method.

If there is correlation between fishing mortality (F) and effort, control of fishing effort could be used as a useful measure to manage fishing mortality. However, technological creep, capacity increases and fishers know how all can lead to higher fishing efficiency with the resulting effect that F will not necessarily be controlled by effort. In addition, effort limitations may change fleet dynamics with fisheries changing to other métiers, which could also lead to changes in F. The bycatch of skates and rays in mixed fisheries might increase, particularly if 'abundance hotspots' and fleet dynamics are not taken into account in the design of the system.

Controlling a fishing effort system is somewhat straightforward as the amount of effort exerted can be easily measured by days away from port associated to VMS data; this may however be less appropriate for static gears or small vessels with no VMS system on board. An additional advantage is that there is no incentive for misreporting catches as there are no constraints on catches. It also provides the flexibility for fishing operators to manage their activity according to live occurrence of catches and market demands. However, measuring (and limiting) increase in fishing efficiency is extremely difficult, and thus possibly rendering this measure ineffective in many fisheries. Furthermore, managing skates and rays by effort while other species caught in the same fisheries would be managed by TACs may be very complex.

6.4 Landing sizes

This management could be used to protect juveniles with a minimum conservation reference size (mcrs) and/or reproducers with a maximum landing size. It could be set by species or by group of species and/or by area although it would be preferable to avoid setting different size in different areas. The size measure could be set by length or width and should be harmonised across regions and species. However, it should be noted that this management measure would be in contradiction with the landing obligation if implemented in association with catch limits, except in the case of exemptions for high survival. In case of no exemption, the introduction of a maximum landing size might be problematic. The landing obligation uses a mcrs to differentiate between fish that can be used for human consumption (above mcrs) and fish that cannot (below mcrs); under the LO, all fish have to be landed. It is thus not clear how such rationale could be implemented with a maximum size (illegal to sell fish above the maximum size) and if this would work.

6.4.1 Information needed

Targeted sizes should be identified at species level using biological parameters. Length at maturity and first maternity, and growth are needed to implement the measure on juveniles. Length at first and full maternity, fecundity at length, spawning periodicity, growth and longevity are needed for reproducers, especially large females with higher reproductive rate. Data needed to define minimum size are readily available even if they are not always published and just available in grey literature. This is less the case for maximum landing size where data availability is limited. Life history parameters are also limited for most species.

This type of management and landing sizes definition would ideally take place in a participatory modelling process with stakeholders and should take into account the benefit for the stock and the socio-economic impact. Catch data (size composition by métier at a level 6, to include for instance gill net mesh size), fishing practice data (retention ogive) and survivorship by métier are needed to assess their potential benefit. Length/weight relation and market data (price per size grade) are also needed to assess their potential socio-economic impact by métier.

Defining performance indicators will require information on the actual level of F and SSB and defined reference points. Proxies can however be used until suitable metrics can be estimated (e.g. stock size indicators as currently used by ICES). Alternative indicators could be the length/age composition of the catch or average length of catches in order to measure the proportion of the undersized/oversized fraction in the total catch. This metric is however very sensitive to population structure and may give an overall positive or negative impression of whether it is working or not.

6.4.2 Pros and cons

Minimum conservation reference sizes can control fishing mortality on juveniles, furthermore it may incentivise better size selection by gear selectivity or avoiding areas with high densities of juveniles. Regarding gear selectivity improvements, options may be relatively limited as already mentioned in Section 5. High grading can lead to increased exploitation of mature females.

Maximum landing sizes can control fishing mortality on reproducers, furthermore it may incentivise better size selection by gear selectivity or avoiding times/areas with high density of large reproducers, but low grading can lead to increased exploitation of juveniles. Limited knowledge on annual egg production and its contribution to recruitment is a source of uncertainty to assess the benefit of this measure. Socio-economic impact is expected to be largely negative as bigger fish are more valuable. This suggests it would be difficult to achieve agreement on such measures.

Combination of minimum and maximum landing size can control the fishing mortality of both juveniles and reproducers. Socio-economic impact of maximum landing size is expected to be largely negative as bigger fish are more valuable, suggesting that it would be difficult to achieve agreement on such measures.

The efficiency of management based on landing sizes will depend on the level of discard survival rate and if an exemption from the landing obligation is implemented. Good handling practice can increase survivorship and consequently the benefits of this type of management.

If the landing sizes are defined by group of species ("one size for all"), which could make the implementation of the measure easier for fishermen, this can lead to changes in species targeting and not be beneficial to the smaller or larger bodied species. It may thus not control mortality adequately per species. If set by stock, it may be compromised by species identification issues.

Such measures would be relatively easy to implement from a control and enforcement perspective provided the level of inspection is adequate. It only requires size measurement inspections, which can be difficult if skates and rays are winged at sea. These measures could possibly increase dead discarding which is currently difficult to quantify as information on dead discards is missing for most species.

6.5 Gear selectivity

Gear selectivity improvement could be used to avoid or reduce the catch of a species (for instance unwanted or prohibited species) or increase size selectivity (change in exploitation pattern). It could mitigate bycatch and also improve discard survival. Several gear-based technical measures could potentially be considered depending on the area and/or the fishery.

6.5.1 Information needed

Selectivity studies per species and size are needed but are relatively limited (see section 5). Some data are only available in certain areas and fisheries so further work is needed.

6.5.2 Pros and cons

Skates and rays size (large and flattened body shape) make improving selectivity difficult. However, it is possible to use more selective gears to reduce the catch across the whole size range to control fishing mortality in mixed fisheries where skates and rays are a bycatch. The utility of such measures is dependent on the importance of the skate and ray bycatch and also the extent of any potential losses of other marketable species associated with the use of selective gears.

Limitations on control and enforcement are similar to any other technical measures. As with other measures, dialogue with stakeholders and step-by-step implementation may help compliance. Some difficulties for control may arise if, to account for fishery and area specificities, a large variety of technical measures are implemented.

This type of measure may reduce the choke risk if unwanted catches in mixed fisheries can be reduced. This may need finding trade-offs between reducing the bycatch of skates and rays to avoid choking mixed fisheries (with some potential loss in revenues) with the impact of a total closure of the fishery.

6.6 Spatio-temporal measures

These measures include closure of specified areas to some or all fisheries partially or permanently. Fisheries management cannot in general be achieved through closed areas alone and require permanent controls on fishing mortality. Closed areas are usually more efficient when they actively reduce fishing mortality (Horwood et al. 1998). Alternatively, temporal measures such as avoidance of catching skates and rays could be implemented by a 'move-on' principle in which the fishery relocates if a certain level of catch density is achieved.

The current ICES assessment (only based on trends in abundance for some stocks) may be insufficient to act as performance indicators for spatio-temporal closures. Stock composition in terms of sex, maturity, size, age etc. could act as secondary indicators. However, these secondary indicators must be considered carefully when defining the objectives of any closure. Moreover, these objectives must guarantee positive outcomes in terms of the primary indicators of stock health, viz. fishing mortality and SSB or suitable proxies thereof.

6.6.1 Information needed

Modelling exercises are required to identify the extent of any closure. Modelling requires geo referenced data on distribution and abundance, by life history stages and species, including information on movement habitat quality and human activity. Information is required on the level of F, or suitable proxies, to feed into a decision-making process to determine size, location and timing of closures. This would ideally take place in a participatory modelling process (Clarke et al. 2007; Hegland et al. 2009). Modelling should take into account existing closures such as MPAs, and their effects in reducing F. Much of the data requirements are met by VMS data, but these may not be readily available for all countries, and perhaps automatic identification system (AIS) data could be an alternative.

A modelling tool, developed by Dedman et al. (2017) can be used to develop closed areas. It generates options for location and size of closed areas based on the priorities of stakeholders, 9notably the minimisation of fishing effort displacement. Results of hypothetical modelling in Irish Sea rays show that closing high CPUE cells results in a smaller closed area that displaces the most fishing effort, whereas closing low fishing effort areas results in a larger closed area that displaces the least fishing effort (Dedman et al. 2017). Another approach was taken by Wiegand et al. (2011) using a four-season age-structured life-table matrix model to evaluate the relative effectiveness of seasonal closures versus size-based landing restrictions. This study showed that while long seasonal closures and full marine protected areas could be more effective at ensuring the recovery of thornback rays, length restrictions may be simpler to implement under the current institutional framework and may have less impact on the multispecies trawl fisheries operating in the area (Wiegand et al, 2011).

6.6.2 Pros and cons

It is self-evident that closure to all fishing of 100% of a stock's distribution will reduce F to zero. Such full closures are meaningful for endangered sedentary species in discrete areas (Hilborn et al. 2004). But in general, partial closures cannot guarantee a particular degree of fishing mortality reduction. A key concern in framing such closures is displacement of effort to other areas, which would reduce or eliminate the supposed benefits. For fisheries managed by quotas, a displacement of the fleet from one locality to another, where the same population is fished, will generally have little effect if the same quota is caught (Horwood et al. 1998).

In terms of control and enforcement, closed areas appear to have obvious benefits in terms of ease of enforcement using VMS, and inspections. However, given that ray and skate are targeted by multiple gears and fleets, not all active vessels may be covered by VMS. Furthermore, static gears cannot be monitored by VMS alone. The process to develop such measures may be self-defeating, see below. Closures leading to potentially decreasing fishing opportunities and increasing competition between users will be difficult to reach agreement on.

6.6.3 Practical examples

There is no example of an extant spatio-temporal closure as a fisheries management measure for rays, but a marine reserve to protect *Dipturus intermedius* has been implemented in Scotland (Scottish Government, 2014). This closure does not, however, cover the entire stock distribution though some of the skates are fairly sedentary and do not move beyond its confines (Neat et al. 2015). Therefore, the measure may be useful for the sedentary portion of the population. Further research may be required to investigate the extent of sedentary behaviour in this stock.

Experience of two previous failed attempts, in 2013, to establish such closures in the Irish and Celtic Seas may be instructive. The Irish Sea box closure was proposed by industry. The first step was a small closed area, to be progressively increased subject to advice from science on the extent required. The proposal was not adopted because managers were concerned that the initial proposed area was too small to regulate fishing effort to any great extent. Managers also were not convinced that an iterative process to increase the area could be operationalised.

The Celtic Sea box closure was recommended to managers and stakeholders by a group of scientists who had identified an area in the Celtic Sea with high abundance of rays, but apparently no fishing effort. The proposal failed to reach wider agreement within the European industry when it became apparent that there was significant effort by Belgian vessels in the area.

The main lessons from these failed exercises is that there needs to be full participation of all international stakeholders and managers throughout the process, with available information readily evaluated in a participatory modelling exercise. Another lesson is that for closures to be effective they need to be quite large in extent (Dedman *et al*. 2017; Stefansson and Rosenburg, 2005; Murawski *et al*. 2000; Wiegand *et al*. 2011). Very importantly, the governance and administrative framework does not exist to implement them, especially for multispecies trawl fisheries (Wiegand *et al* 2011). Such mismatches between theory and current practice may also have prevented consideration by managers of the real time incentive concept defined by Kraak *et al*. (2012). This study allows fishers to dynamically choose how to spend fishing opportunities by limited fishing in sensitive areas. If closed areas are implemented without case by case evaluation and appropriate monitoring programs, there is a risk of unfulfilled expectations, the creation of disincentives, and a loss of credibility (Hilborn *et al*. 2004).

6.7 Prohibited species list

The listing of a species on the prohibited species list means that the species must not be targeted, retained or transhipped. Accidental catch shall not be harmed and individuals should be released as soon as possible.

The ICES WGEF has looked at the usefulness of this measure (ICES, 2016) and writes: *The list of prohibited species on the TACs and quotas regulations (e.g. CEC, 2016a) is an appropriate measure for trying to protect the marine fish of highest conservation importance, particularly those species that are also listed on CITES and various other conservation conventions. Additionally, there should be sufficient concern over the population status and/or impacts of exploitation that warrants such a long-term conservation strategy over the whole management area.* See Appendix 1.

6.7.1 Information needed

In order to determine if a species has to be listed on the prohibited species list, evidence that this species is biologically sensitive to any exploitation needs to be provided. It is also necessary to know if any (inter)national legislation is applicable for the species. Furthermore, the outcome of a productivity-susceptibility analysis per fishery should be available together with estimates of discard survival rate, studies on interaction of the species with the gear, avoidance and selectivity and information on handling to reduce mortality. Once the measure is in place, at sea monitoring can be used to determine compliance, although the probability of observing catches (and release) of the species may be low due to its sporadic occurrence. Information for monitoring could also be obtained indirectly from abundance indices if available. Here again, due the sporadic occurrence of the species, such indices may be poorly estimated or unavailable.

6.7.2 Pros and cons

This measure has, potentially, the ability to control fishing mortality, but this is dependent on the rate of survival of the individuals after discarding and encounter rate with the fishing gear. The measure could also be an incentive to avoid catching. It cannot however be considered as a stock rebuilding measure. Once the species is on the prohibited species list, no data can be collected other than the fact that it has been caught, as the individuals must be released as soon as possible which may lead to difficulty to assess compliance. Several factors may lead to non-compliance: possible high value of the products, species identification issues, non-transparency in the criteria used to include the species in the list leading to poor acceptancy/buy-in of the measure, difficulty to predict the location of aggregations or individuals which makes difficult any avoidance.

If implemented alone, the measure has no potential for choke.

6.7.3 Practical application

There are currently no transparent criteria to include, or remove, a species onto or off the prohibited species list. The effectiveness of this measure can be measured by the level of compliance. It is therefore suggested to develop a procedure for listing and to develop transparent criteria in a participatory process. Alternative management options to reduce mortality and maintain data provision should be part of this procedure.

Table 6.1. A summary of the main pros and cons of different potential management measures for skates and rays

Management Measures	Information needed as a basis for implementation	Data availability and limits	Control Fishing Mortality Pro	Con	Control and Enforcement Pro	Con	Potential issues related to compliance	Choke	Sources of uncertainty	Potential performance indicator
Skates and rays generalised TAC	ICES catch advice	ICES is currently landings advice so estimates of dead discard needed. Improvement in species-specific catch estimates Better stock identification	Limited	Limited control at stock level	Easy as species is not required for monitoring quota uptake		Low incentive for misreporting except for prohibited species	Potential for choke effects, depending on potential exemptions	Quantification of survival per species and métier Species identification	Ideally F and SSB or proxies for all species Reference points defined
Generalised TAC with sub-TAC for particular stocks	ICES catch advice	ICES is currently landings advice so estimates of dead discard needed. Improvement in species-specific catch estimates Better stock identification	For the sub-TAC stocks and partially for the others	Restrictive sub-TAC may result in an increase in F on the other generalised stocks Limited control of F for the species not in the sub-TAC	Potentially easy to control subject to species identification	Increase in resources for monitoring species specific data for Sub-TAC	Species identification and misreporting Non-transparent criteria for selecting Sub-TAC stocks	High potential for choke effects, depending on potential exemptions	Quantification of survival per species and métier. Transparent selection of stocks under sub-TAC. Species identification	Ideally F and SSB or proxies for all species Reference points defined
TACs by Genus	ICES catch advice	ICES is currently landings advice so estimates of dead discard needed. Improvement in species-specific catch estimates Better stock identification	Partly	Control F at genus level, not at stock level	Potentially easy to control subject to genus identification	Increase in resources for monitoring species specific data for the genera	Species identification and (low potential) for misreporting	Potential for choke effects, depending on potential exemptions	Quantification of survival per species and métier Species identifications	Ideally F and SSB or proxies for all species. Reference points defined
TAC by stock (ICES advice)	ICES catch advice	ICES is currently landings advice so estimates of dead discard needed. Improvement in species-specific catch estimates Better stock identification	Potential to control F at the stock level		Potentially easy to control subject to species identification	Increase in resources for monitoring species specific data	Species identification and misreporting	High potential for choke effects, depending on potential exemptions	Quantification of survival per species and métier Species identifications	Ideally F and SSB or proxies for all species. Reference points defined
Landing trip limit (outside the quota system, and applied to selected species)	Catch (landings) weights by trip for each métier by season/area. Discard survival. Market value	Numbers at length retained/discarded available for some fisheries from at-sea observer programmes. Landings (catch) data by trip available. Discard survival rates estimates needed	For species that survive discarding. Deters the development of target fisheries.	No control for species that do not survive discarding. May encourage high grading (e.g. retaining of larger (mature) females)	Easy at point of landing (more problematic if large number of port). absolute limits (kg per trip) is easier to enforce than percentages of catch	Species identification; better definition of conversion factors for processed to live weight (including the option to land individual whole/gutted)	Appropriate conversion factors availability. Degree of variance/tolerance established. Stakeholder consultation to agree on the landing limit	No	Spatial-temporal distribution and abundance of some lesser-known species in relation to fleet dynamics (e.g. is there an area of high local abundance in relation to some specific fleets); discard survival. The selected level of the limit and market value would affect effectiveness.	Landings/catch data by trip (to verify compliance). F and SSB (to assess stock status).

Management Measures	Information needed as a basis for implementation	Data availability and limits	Control Fishing Mortality Pro	Con	Control and Enforcement Pro	Con	Potential issues related to compliance	Choke	Sources of uncertainty	Potential performance indicator
Effort	Standardised measure of effort per métier and spatial distribution. Catches composition. Stock status	Fisheries Dependent Information (FDI) available but discard information incomplete. Species composition available (observer programmes and log books). Data on effort available from fleet register	Yes if correlation between fishing mortality (F) and effort. Applicable to mixed fisheries	Technological creep, increase in capacity and fishers know how increase efficiency. Shift to other métier may increase F. Increase in bycatch of skates and rays in mixed fisheries. Fleet dynamics not taken into account	Potentially easy; no incentive for misreporting catches	Technological creep is difficult to control	Displacement of effort and transfer to other fisheries.	No potential for choke effects without a TAC	Changes to other métiers need to be quantified or regulated; technological creep; applicability in mixed fisheries	Ideally F and SSB or proxies.
Minimum size	Species-specific size at maturity/first maternity; size composition by métier (level 6); discard survival by size/métier; retention ogive; price/size; growth	Data mostly available. Missing life history for some species. Species identification and estimation of dead discards needs improvement	If discard survival rate is high and good discard practice; potential incentive for size selection or changes in fishing ground	Ineffective if discard survival rate is low or it increases exploitation of mature females. If "one size for all" then may not control F adequately per species. Improvement in gear selectivity may be difficult.	Easy to implement by measurement on inspection	Potential increase of dead discarding	Species identification. Standardisation of size measurement needed	No potential for choke if without a TAC. If associated with catch limits, work if high survival and exemption granted otherwise in contradiction with the landing obligation.	If defined for a group of species, can lead to changes in species targeting, possibly not benefiting the larger bodied species. Species identification if implemented at species level	Primary indicator is F and SSB or their proxies ; secondary indicator is size (% undersized) composition in catch
Maximum size	Species-specific female size at first or full maternity, fecundity at length, spawning periodicity; size composition by métier (level 6); retention ogive; price/size grade; growth and longevity	Data available in some cases. Missing life history in most species. Species identification and estimation of dead discards needs improvement	If discard survival rate is high and good discard practice; potential incentive for size selection or changing fishing ground	Ineffective if survival low or low grading	Easy to implement by measurement on inspection	Possible increased dead discarding, difficult to implement if fish are winged at sea	Species identification. Standardisation of size measurement needed	No potential for choke if without a TAC. If associated with catch limits, work if high survival and exemption granted otherwise in contradiction with the landing obligation.	Species identification if implemented at species level	Primary indicator is F and SSB or their proxies ; secondary indicator is size (%mature) composition in catch
Minimum and maximum size combined	See both of above	Data available in some cases. Missing life history in most species. Species identification and estimation of dead discards needs improvement	If discard survival rate is high and good discard practice; potential incentive for size selection or changing fishing ground	Ineffective if survival low	Easy to implement by measurement on inspection	Possible increased dead discarding	Species identification; Standardisation of size measurement needed	No potential for choke if without a TAC. If associated with catch limits, work if high survival and exemption granted otherwise in contradiction with the landing obligation.	Species identification if implemented at species level	Primary indicator is F and SSB or their proxies ; secondary indicator is size composition in catch

Management Measures	Information needed as a basis for implementation	Data availability and limits	Control Fishing Mortality Pro	Con	Control and Enforcement Pro	Con	Potential issues related to compliance	Choke	Sources of uncertainty	Potential performance indicator
Gear selectivity	Selectivity studies, species and size composition of catch, list of prohibited species	Limited. Only available in some areas and some gears. Further work needed but difficult to increase size selectivity due to the skates and rays morphology.	Possible for some fisheries. May work better for limiting bycatch	Maybe more difficult in mixed fisheries. Difficult to increase size selectivity.	Potentially easy to control	Difficult if large number of technical measures implemented	If too many measures implemented	May reduce the choke risk if unwanted catches in mixed fisheries can be reduced.	Difficult to measure if a large variety of measures are implemented . A results based approach could be preferable.	Primary indicator is F and SSB or their proxies ; secondary indicator is size composition in catch.
Spatio-temporal management	Geo referenced data on distribution and abundance; Distribution and level of current fishing pressure (F or F proxies) and spatio-temporal management measures already implemented (MPA); Catch composition in relevant fisheries. Data from at-sea monitoring programmes;	Most data already available (Surveys, VMS); Surveys not covering all species and areas. VMS data not always available to scientists. Limited data availability for vessels without VMS; Use of automatic identification system (AIS) data as an alternative; Limited availability of fish movement data (tagging)	Can reduce fishing mortality subject to conditions on a case by case basis : e.g. sufficient extent of the closure; Potential to control other sources of mortality besides fishing;	Displacement of effort and transfer to other fisheries inside the area; Potential for increased effort on border; In areas with multiple users (e.g. harbours, dredging) other sources of mortality may be difficult to control;	Potentially easy to control (VMS);	Difficulties for fisheries not covered by VMS; Difficult to assess fishing activities and effort for static gears;	Permitted fisheries may still be catching skates and rays.	This type of management without TAC has no potential for choke	Displacement of effort and transfer to other fisheries inside or outside the area; Difficulty to assess impacts (e.g. increase in stock, decrease in F); Difficulty to select the type of spatio-temporal management (from seasonal gear restrictions to full no-take zone); Variable availability and resolution of vessel data for scientific investigations	Depends on the type spatio-temporal management measure. Could include demographic composition of stock (e.g. size and gender) or local increase in abundance; Ideally F and SSB or proxies for relevant stocks
Prohibited species list	Evidence of very rare occurrence. (Inter)national legislation. Productivity-Susceptibility Analysis (PSA) per fishery. Discard survival rate. Interaction of the species with the gear, selectivity and handling to reduce mortality.	ICES advice and consideration of species listed on CITES and CMS partially available. PSA available for some fisheries in North and Celtic Seas. (Limited) avoidance and discard survival studies and gear selectivity. Handling protocols available (potentially difficult to implement at sea). Abundance indices available for some species.	Possible but dependent on the rate of discards survival; May be an incentive not to fish the stock;	Dependent on encounter rate and discard survival rate. Not a rebuilding measure.	No fishing for, or landings allowed, so at sea and market inspections possibly straightforward	Possibly, not to be detected during inspections at sea and in the market place as potentially a sporadic occurrence. Species identification both at sea and in the market place problematic. Catch might not be reported	Possible high value of products. Species identification issues. Non-transparency in listing criteria leading to poor acceptance of the measure. Difficulty to predict location of aggregations or individuals makes difficult any avoidance.	No	Catch level, occurrence and fishery interaction. Species identification. Rates of discard survival and handling methodologies. Information on population productivity. Loss of data from commercial and scientific sources.	Levels of compliance (no targeting, landing or transhipment)

7 CONCLUSION WITH SOME GUIDANCE FOR NEXT STEPS

The conclusions from EWG-17-10 are split into general conclusions related to the review of the potential management measures, elements associated with main data and knowledge gaps and needs and some guidance for the next steps.

7.1 Management measure review

- Among the TAC based approaches reviewed by the group, the TAC by stock is the only one that permits the setting of limits on catches by stock in line with individual stock development and the catch levels recommended by ICES. All other options would retain, to varying degrees, the problem of the current global TACs (e.g. limiting fishing opportunity for stocks for which the abundance is increasing, and insufficient protection for decreasing stocks or stocks of unknown status)
- TACs set by stock may be compromised by species identification issues. This might be offset in certain cases by incentives to provide better data at stock level by fishers. TACs by stock could also create additional choke issues over and above the other TAC options. In any case, it must be noted that adding more TACs (going from a generalized TAC system to a stock based TAC) may add extra monitoring requirements.
- The main impediment to any TAC based measure is lack of advice on outtake in terms of total catch (landings + dead discards). Currently, ICES only provide landings advice for skates and rays. Including discard information requires quantification of discards and survival of these discards. More work is required in these areas.
- Spatio-temporal measures can only be successful if they can demonstrably control fishing mortality. These can be used to reduce mortality on stocks on a case-by-case basis and may be complemented by other generalised management measures. Theoretical modelling work has been done and provides a firm analytical basis. In this context, size, location and timing of management measures can be developed in a participatory decision-making process. The areas to be closed are likely to be quite large which could potentially impact the general fishery. The difficulties in reaching agreement of managers and stakeholders for such large closures should not be underestimated.
- Effort management may have fewer control and enforcement issues as compared to other options. However, measuring (and limiting) increase in fishing efficiency is extremely difficult, which possibly renders this measure ineffective in many fisheries. There may also be potential management conflicts in mixed fisheries where skates and rays are managed by effort while the other species are managed by TACs.
- The underlying data for developing management options based on gear selectivity is currently limited. Current studies indicate that it is difficult to increase size selectivity for skates and rays but there are a number of gear modifications that have been shown to be effective at reducing their bycatch. The adoption of such gears is dependent on whether the skates and ray species involved have a commercial value and the availability of fishing opportunities that allows them to be landed. Where such species are considered as part of the marketable catch then there is little incentive to reduce bycatch as to do so would represent a loss of income. However, in a choke species scenario, where the quota for skates and rays is exhausted and the only option for a vessel to continue fishing in a specific fishery is to fish without catching skates and rays then such gears may be considered an option.
- Size restrictions, either minimum, maximum or a combination should be tailored to species to be most effective. This management measure would however be in contradiction with the landing obligation if implemented in association with catch limits, except for species for which an exemption for high survival is granted. It may also be difficult to receive buy-in from fishermen of limits set on maximum sizes as generally, larger rays have the highest commercial value.

- The prohibited species list should ideally only be used for species which are biologically sensitive to any exploitation. Without additional management measures to improve survival, listing will not necessarily lead to a decrease in mortality. The decision to include, or remove, any species onto or off the prohibited species list is currently not carried out according to transparent criteria. It is suggested to develop a procedure for listing and to develop transparent criteria in a participatory process.

7.2 Data limitation and needs

- EWG-17-10 notes that the current data requirement and sampling effort of the DCMap on skates and rays is insufficient to provide robust estimates of various parameters (e.g. maturity, commercial catch composition, sex-ratio) needed for stock assessment and management. Consequently, increasing needs on information on catches and fisheries may imply adjustments of the DCMap for the data collection for skates and rays.
- The most crucial data gaps at the current time are discard survival (vitality and at-vessel mortality, and short- and longer-term discard survival) and estimates of (dead) discards. These topics should have the highest priority.
- Regarding survival of discarded fish, the EWG notes that the estimates available only cover a limited number of métiers, areas and species. Several of the available estimates are limited to short term survival rate and are still uncertain. To both increase the coverage of gear, area and species and improve current estimates, a data review and analysis, on the model developed by Catchpole et al. (2017) on UK waters should be extended to other areas. Such a review should also highlight the main data gaps where particular efforts are needed.
- Further data issues which require attention are improved delineation of biological stock units, more robust estimates of stock status and development of MSY reference points or proxies. Those are key elements needed to be able to quantitatively evaluate the performances and impacts (biological, socio-economical) of various management measures. EWG-17-10 notes that some ICES working groups (WKMSYcat34, WKlife) or EU and/or national research projects (Damara, Drumfish), although not necessarily specifically on skates and rays, may contribute to progress on those topics.

7.3 Next steps

- EWG-17-10 was asked to "recommend a new approach for the sustainable management of skates and rays fisheries." Due to the diversity of species in terms of biological characteristics, complexity of fisheries catching them and data limitations, it is not currently possible to fully and quantitatively evaluate any particular management measures or group of measures. A way forward would be for managers and relevant stakeholders to first decide on the objectives of potential management measures (and the scope in terms of species and areas, and governance framework). It is only once these have been identified that a subsequent scientific evaluation may be possible.
- Any change to the current management practice should be based on an evaluation of current and potential measures, may include a combination of the measures presented in this report and may vary regionally. The participation of stakeholders to discuss the viability of potential measures and improve subsequent uptake and compliance is important. This could be carried out in the context of participating modelling and/or with the development of management strategy evaluation framework. Any development of participatory modelling for regional areas should be at a regional level that is consistent with biological stock units.
- It is worth noting that although a combination of management measures might be the best option in some cases, it is very important to avoid developing complex frameworks which may be difficult to implement, control and monitor and may generate low levels of compliance and buy-in by fishermen.
- Specificities in the biology of skates and rays should be considered when developing both alternative stock assessment methods and management frameworks. This should be considered together with regional differences in skate assemblages, metrics for abundance, demography, geographic range and fishing pressure.

8 REFERENCES

The references associated with section 3, 4 and 5 are listed separately.

General references

Clarke, M.W., Uriarte, A., Coers, A., Campbell, A., Dickey-Collas, M., Egan, A., Ghiglia, M., Harkes, I., Kelly, C.J., Müller, J., O' Donoghue, S., Olesen, C., Roel, B. Tait, A., and van Balsfoort, G. 2007. A new scientific initiative with the Pelagic RAC to develop a management plan for western horse mackerel. ICES CM 2007/O:20.

Dedman, S., Officer, R., Brophy, D., Clarke, M. and Reid, D. G. Towards a flexible Decision Support Tool for MSY-based Marine Protected Area Design for skates and rays. – ICES Journal of Marine Science, 74: 576–587.

Hegland, T. J., & Wilson, D. C. 2009. Participatory modelling in EU fisheries management: western horse mackerel and the pelagic RAC. Maritime Studies, 8(1), 75-96.

Hilborn, R., Stokes, K., Maguire, J.J., Smith, T., Botsford, L.W., Mangel, M., Orensanz, J., Parma, A., Rice, J., Bell, J. and Cochrane, K.L., 2004. When can marine reserves improve fisheries management?. Ocean & Coastal Management, 47(3), pp.197-205.

Horwood, J.W., Nichols, J.H. and Milligan, S. 1998. Evaluation of closed areas for fish stock conservation, Journal of Applied Ecology. 35 (6) 893–903.

ICES. 2016. Report of the Working Group on Elasmobranch Fishes (WGEF), 15–24 June 2016, Lisbon, Portugal. ICES CM/ACOM:20. 26 pp.

Kraak, S. B., Reid, D. G., Gerritsen, H. D., Kelly, C. J., Fitzpatrick, M., Codling, E. A., and Rogan, E. 2012. 21st century fisheries management: a spatio-temporally explicit tariff-based approach combining multiple drivers and incentivising responsible fishing. ICES Journal of Marine Science, 69(4), 590-601.

Lovgreen, J, Hjelm, J., Ringdahl, K., Storr-Paulsen, M., Grohsler, T. 2009. Evaluation of the pilot effort regime in the Kattegat. Study and Pilot projects for carrying out the Common Fisheries Policy. Final Report of Lot 3. Fiskeriverket and DTU Aqua. 96 pp.
https://ec.europa.eu/fisheries/sites/fisheries/files/docs/publications/pilot_effort_regime_kattegat_en.pdf a

Murawski, S. A., Brown, R., Lai, H. L., Rago, P. J., and Hendrickson, L. 2000. Large-scale closed areas as a fishery-management tool in temperate marine systems: the Georges Bank experience. Bulletin of Marine Science, 66(3), 775-798.

Neat, F., Pinto, C., Burrett, I., Cowie, L., Travis, J., Thorburn, J., ... & Wright, P. J. (2015). Site fidelity, survival and conservation options for the threatened flapper skate (Dipturus cf. intermedia). Aquatic Conservation: Marine and Freshwater Ecosystems, 25(1), 6-20.

Scottish Government, 2014. Loch Sunart to the Sound of Jura NCMPA.
https://www.snh.scot/professional-advice/safeguarding-protected-areas-and-species/protected-areas/national-designations/marine-protected-area/nature-conservation-marine-4 accessed on the 24th October, 2017.

STECF, 2015. Scientific, Technical and Economic Committee for Fisheries (STECF) – Multiannual management plans SWW and NWW (STECF-15-08). 2015. Publications Office of the European Union, Luxembourg, EUR 27406 EN, JRC 96964, 82 pp.

Stefansson, G., and Rosenberg, A. A. (2005). Combining control measures for more effective management of fisheries under uncertainty: quotas, effort limitation and protected areas. Philosophical Transactions of the Royal Society of London B: Biological Sciences, 360(1453), 133-146.

Wiegand, J., Hunter, E., and Dulvy, N. K. 2011. Are spatial closures better than size limits for halting the decline of the North Sea thornback ray, Raja clavata?. Marine and Freshwater Research, 62 (6), 722-733.

References on fisheries description (Section 3)

Benoît, H. P., Swain, D. P., Niles, M., LeBlanc, S. & Davidson, L. A. (2010b). Incidental catch amounts and potential post-release survival of winter skate (Leucoraja ocellata) captured in the scallop dredge fishery in the southern Gulf of St. Lawrence (2006–2008). Canadian Science Advisory Secretariat Research Document 2010/043.

Cicia, A. M., Schlenker, L. S., Sulikowski, J. A.&Mandelman, J.W. (2012). Seasonal variations in the physiological stress response to discrete bouts of aerial exposure in the little skate, Leucoraja erinacea. Comparative Biochemistry and Physiology A 162, 130–138.

Craven, H. R., Brand, A. R. and Stewart, B. D. (2013). Patterns and impacts of fish by-catch in a scallop dredge fishery. Aquatic Conservation: Marine and Freshwater Ecosystems, 23: 152–170.

Depestele, J., Desender, M., Benoˆıt, H. P., Polet, H. & Vincx, M. (2014). Short-term survival of discarded target fish and non-target invertebrate species in the "eurocutter" beam trawl fishery of the southern North Sea. Fisheries Research 154, 82–92.

Du Buit, M.H. (1973). Variations saisonières et géographiqus des raies dans le capture des chalutiers concarnois: prise par unité d'effort, fréquence et importance des espèces. Cahiers de Biologie Marine, 14: 529–545.

Ellis, J. R., Burt, G. J., Cox, L. P. N., Kulka, D. W, and Payne, A. I. L. (2008). The status and management of thornback ray Raja clavata in the south-western North Sea. ICES CM 2008/K:13, 45 pp.

Ellis, J. R., McCully Phillips, S. R. and Poisson, F. (2017). A review of capture and post-release mortality of elasmobranchs. Journal of Fish Biology, 90: 653–722.

Ellis, J. R., Silva, J. F., McCully, S. R., Evans, M. and Catchpole, T. (2010). UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10, 38 pp.

Endicott, M. & Agnew, D. J. (2004). The survivorship of rays discarded from the South Georgia longline fishery. CCAMLR Science 11, 155–164.

Enever, R., Catchpole, T. L., Ellis, J. R. and Grant, A. (2009). The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. Fisheries Research, 97: 72–76.

Enever, R., Revill, A. S., Caslake, R. & Grant, A. (2010). Discard mitigation increases skate survival in the Bristol Channel. Fisheries Research 102, 9–15.

Fahy, E. (1989). Fisheries for ray (Batoidei) in western statistical area VIIa investigated through the commercial catches. Irish Fisheries Investigations Series B, 34: 14 pp.

Fahy, E. (1991). The southeastern ray Raja spp. fishery, with observations on the growth of rays in Irish waters and their commercial grading. Irish Fisheries Investigations Series B, 37: 18 pp.

Figueiredo, I., Moura, T., Bordalo-Machado, P., Neves, A., Rosa, C. and Gordo, L.S. (2007). Evidence for temporal changes in ray and skate populations in the Portuguese coast (1998–2003)–its implications in the ecosystem. Aquatic Living Resources, 20: 85-93.

Holden, M.J. (1963). The species composition of skates and rays landed at Fleetwood and Milford Haven. ICES CM1963 Near Northern Seas Committee, no. 57, 3 pp.

ICES (2016). Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK2), 19-22 January 2016, Lisbon, Portugal. ICES CM 2016/ACOM:40; 69 pp.

ICES (2017a). Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3), 20-24 February 2017, Nantes, France. ICES CM 2017/ACOM:38; 119 pp.

ICES (2017b). Report of the Working Group on Elasmobranchs (2017), 31 May-7 June 2017, Lisbon, Portugal. ICES CM 2017/ACOM:16; 1018 pp.

Kaiser, M. J. & Spencer, B. E. (1995). Survival of by-catch from a beam trawl. Marine Ecology Progress Series 126, 31–38.

Kynoch, R. J., Fryer, R. J. & Neat, F. C. (2015). A simple technical measure to reduce by-catch and discard of skates and sharks in mixed-species bottom-trawl fisheries. ICES Journal of Marine Science 72, 1861–1868.

Laptikhovsky, V. V. (2004). Survival rates for rays discarded by the bottom trawl squid fishery off the Falkland Islands. Fishery Bulletin 102, 757–759.

Lyle, J. M., Bell, J. D., Chuwen, B. M., Barrett, N., Tracey, S. R. & Buxton, C. D. (2014). Assessing the impacts of gillnetting in Tasmania: implications for by-catch and biodiversity. Institute for Marine and Antarctic Studies, University of Tasmania. Fisheries Research and Development Corporation (FRDC) Project No. 2010/016.

Machado, P. B., Gordo, L. S. and Figueiredo, I., 2004. Skates and rays species composition in mainland Portugal from the commercial landings. Aquatic Living Resources, 17(2), pp.231-234.

Mandelman, J. W., Cicia, A. M., Ingram, G. W. Jr., Driggers, W. B. III, Coutre, K. M. & Sulikowski, J. A. (2012). Short-term post-release mortality of skates (family Rajidae) discarded in a western North Atlantic commercial otter trawl fishery. Fisheries Research 139, 76–84.

Nicolaus, E. M., Barry, J., Bolam, T. P., Lorance, P., Marandel, F., McCully Phillips, S. R., Neville, S. and Ellis, J.R. (2017). Concentrations of mercury and other trace elements in two offshore skates: sandy ray Leucoraja circularis and shagreen ray L. fullonica. Marine Pollution Bulletin.

Palma, J., Reis, C. and Andrade, J. P. (2003). Flatfish discarding practices in bivalve dredge fishing off the south coast of Portugal (Algarve). Journal of Sea Research, 50: 129-137.

Rudders, D. B., Knotek, R. J., Sulikowski, J. A., Mandleman, J. A. & Benoît, H. P. (2015). Evaluating the condition and discard mortality of skates following capture and handling in the sea scallop dredge fishery. VIMS Marine Resource Report No. 2015–6. Gloucester Point, VA: Virginia Institute of Marine Science.

Saygu, I. & Deval, M. C. (2014). The post-release survival of two skate species discarded by bottom trawl fisheries in Antalya Bay, eastern Mediterranean. Turkish Journal of Fisheries and Aquatic Sciences 14, 1–7.

Silva, J. F., Ellis, J. R. and Catchpole, T.L. (2012). Species composition of skates (Rajidae) in commercial fisheries around the British Isles, and their discarding patterns. Journal of Fish Biology, 80: 1678–1703.

Steven, G. A. (1932). Rays and skates of Devon and Cornwall II: A study of the fishery; with notes on the occurrence, migrations and habits of the species. Journal of the Marine Biological Association of the United Kingdom, 18: 1-33.

References on survival (section 4)

Tom Catchpole, Serena Wright, Victoria Bendall, Stuart Hetherington, Peter Randall, Elizabeth Ross, Ana Ribiero Santos, Jim Ellis, Jochen Depestele (ILVO), Suzanna Neville (2017). Ray Discard Survival. Enhancing evidence of the discard survival of ray species. Lowestoft: CEFAS.

Bendall, V. A., Hetherington, S. J., Ellis, J. R., Smith, S. F., Ives, M. J., Gregson, J. & Riley, A.A. (2012). Spurdog, porbeagle and common skate by-catch and discard reduction. Fisheries Science Partnership 2011–2012, Final Report. Lowestoft: CEFAS. Available at http://webarchive.nationalarchives.gov.uk/20150203151336/http:/www.cefas.defra.gov.uk/publications-and-data/scientific-series/fisheries-science-partnership-reports.aspx/

Benoit, H. P., Swain, D. P., Niles, M., LeBlanc, S. & Davidson, L. A. (2010a). Incidental catch amounts and potential post-release survival of winter skate (Leucoraja ocellata) captured in the scallop dredge fishery in the southern Gulf of St. Lawrence (2006–2008). Canadian Science Advisory Secretariat Research Document 2010/043. Available at http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2010/2010_043_e.pdf/

Benoit, H. P., Hurlbut, T.&Chassé, J. (2010b). Assessing the factors influencing discard mortality of demersal fishes using a semi-quantitative indicator of survival potential. Fisheries Research 106, 436–447.

Benoit, H. P., Hurlbut, T., Chassé, J. & Jonsen, I. D. (2012). Estimating fishery-scale rates of discard mortality using conditional reasoning. Fisheries Research 125, 318–330.

Depestele, J., Desender, M., Benoˆıt, H. P., Polet, H. & Vincx, M. (2014). Short-term survival of discarded target fish and non-target invertebrate species in the "eurocutter" beam trawl fishery of the southern North Sea. Fisheries Research 154, 82–92.

Enever, R., Catchpole, T. L., Ellis, J. R. & Grant, A. (2009). The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. Fisheries Research 97, 72–76.

Enever, R., Revill, A. S., Caslake, R. & Grant, A. (2010). Discard mitigation increases skate survival in the Bristol Channel. Fisheries Research 102, 9–15.

Endicott, M. & Agnew, D. J. (2004). The survivorship of rays discarded from the South Georgia longline fishery. CCAMLR Science 11, 155–164.

Kaiser, M. J. & Spencer, B. E. (1995). Survival of by-catch from a beam trawl. Marine Ecology Progress Series 126, 31–38.

Laptikhovsky, V. V. (2004). Survival rates for rays discarded by the bottom trawl squid fishery off the Falkland Islands. Fishery Bulletin 102, 757–759.

Lyle, J. M., Bell, J. D., Chuwen, B. M., Barrett, N., Tracey, S. R. & Buxton, C. D. (2014). Assessing the impacts of gillnetting in Tasmania: implications for by-catch and biodiversity. Institute for Marine and Antarctic Studies, University of Tasmania. Fisheries Research and Development Corporation (FRDC) Project No. 2010/016. Available at http://dpipwe.tas.gov.au/Documents/Gillnetting_Impacts_Tas_Bycatch_Biodiversity_FRDC2010.pdf/

Mandelman, J. W., Cicia, A. M., Ingram, G. W. Jr., Driggers, W. B. III, Coutre, K. M. & Sulikowski, J. A. (2012). Short-term post-release mortality of skates (family Rajidae) discarded in a western North Atlantic commercial otter trawl fishery. Fisheries Research 139, 76–84.

Rudders, D. B., Knotek, R. J., Sulikowski, J. A., Mandleman, J. A. & Benoˆıt, H. P. (2015). Evaluating the condition and discard mortality of skates following capture and handling in the sea scallop dredge fishery. VIMS Marine Resource Report No. 2015–6. Gloucester Point, VA: Virginia Institute of Marine Science. Available at http://s3.amazonaws.com/nefmc.org/2.2-FR12-0030_VIMS-.pdf/

Saygu, I.& Deval,M. C. (2014). The post-release survival of two skate species discarded by bottom trawl fisheries in Antalya Bay, eastern Mediterranean. Turkish Journal of Fisheries and Aquatic Sciences 14, 1–7.

Scott-Denton, E., Cryer, P. F., Gocke, J. P., Harrelson, M. R., Kinsella, D. L., Pulver, J. R., Smith, R. C. &Williams, J. A. (2011). Descriptions of the U.S. Gulf of Mexico reef fish bottom longline and vertical line fisheries based on observer data. Marine Fisheries Review 73, 1–26.

References on selectivity (section 5)

Anon. 1997. Separator trawl trials off the North-west coast - mfv “Slieve Bloom” April 1997. BIM internal report. 12pp.

Anon. 2011. Reducing winter flounder retention through the use of avoidance gear adaptations – Squid trawl network – AGA Trip reports. Cornell Cooperative Extension’s Fisheries Program in partnership with University of Massachusetts School and Marine Science and Technology and University of Rhode Island Fisheries Center.

Baeta, F., Batista, M., Maia, A., Costa, M. J. & Cabral, H. (2010). Elasmobranch by-catch in a trammel net fishery in the Portuguese west coast. Fisheries Research 102, 123–129.

Bayse, S. M., Pol, M. V., and He, P. Fish and squid behaviour at the mouth of a drop-chain trawl: factors contributing to capture or escape. ICES Journal of Marine Science (2016), 73(6), 1545–1556. doi:10.1093/icesjms/fsw007 Original Article 73: 1545–1556.

Beutel, D., L. Skrobe, K. Castro, P. Ruhle Sr., P. Ruhle Jr., J. O'Grady, and J. Knight. 2008. Bycatch
reduction in the Northeast USA directed haddock bottom trawl fishery. Fisheries
Research 94(2): 190 – 198.

Brewer, D., Heales, D., Milton, D., Dell, Q., Fry, G., Venables, B.& Jones, P. 2006. The impact of turtle excluder devices and by-catch reduction devices on diverse tropical marine communities in Australia’s northern prawn trawl fishery. Fisheries Research 81, 176–188.

Brothers, G. 1991. Shrimping with sorting panels and modified trawls. DFO. 26pp.

Christensen, C.P. 2014. Opportunities for the reduction of skate bycatch in Atlantic Canada trawl fisheries: A case study of two innovative trawl gear designs [graduate project]. Halifax, NS: Dalhousie University.

Cosgrove, R., Browne, D., and McDonald, D. 2016. Assessment of rigid sorting grids in an Irish quad-rig trawl fishery for Nephrops. BIM Report. February 2016.

Enever, R., Revill, A. S., Caslake, R. & Grant, A. 2010. Discard mitigation increases skate survival in the Bristol Channel. Fisheries Research 102, 9–15.

Favaro, B. & Côté, I. M. (2015). Do by-catch reduction devices in longline fisheries reduce capture of sharks and rays? A global meta-analysis. Fish and Fisheries 16, 300–309.

Fiche, M, Morandeau, F, and Robert, M. , 2017. Using 100mm T90 netting in the extension and codend and a 120mm square mesh panel to reduce discards in whitefish fisheries. In O'Neill, F.G. and Mutch, K. (Eds): Selectivity in Trawl Fishing Gears. Scottish Marine and Freshwater Science Vol 8 No 1.Fiche et al., 2017)

Hartell, B.W., Cryer, M., MacDiarmid, A.B. 2006. Reducing bycatch in New Zealand's scampi trawl fisheries. New Zealand Aquatic Environment and Biodiversity Report No. 4. 53pp.

Isaksen, B., Valdemarsen, J., Larsen, R. & Karlsen, L. 1992. Reduction of fish by-catch in shrimp trawl using a rigid separator grid in the aft belly. Fisheries Research 13, 335–352.

Kynoch, R.J., Ferro, R.S.T. and Fryer, R.J. 2009. Trials to reduce cod by-catches in whitefish trawl fisheries by modifying the belly sheets of commercial trawl nets to incorporate large diamond mesh panels. Scottish Industry/Science Partnership (SISP) Report No 05/09.

Kynoch, R.J., O'Neill, F.G. and Fryer, R.J., 2010. Test for 300mm and 600mm netting in the forward section of a Scottish whitefish trawl. Fisheries Research, 108, 277-282.

Kynoch, R. J., Fryer, R. J. & Neat, F. C. (2015). A simple technical measure to reduce by-catch and discard of skates and sharks in mixed-species bottom-trawl fisheries. ICES Journal of Marine Science 72, 1861–1868. doi: 10.1093/icesjms/fsv037

Lomeli, M. J. & Wakefield,W.W. (2013). A flexible sorting grid to reduce Pacific halibut (Hippoglossus
stenolepis) by-catch in the US west coast groundfish bottom trawl fishery.
Fisheries Research 143, 102–108.

Main, J. and Sangster, G.I. 1982. A study of separating fish from Nephrops norvegicus in a bottom trawl. Scottish Fisheries Research Report Number 24. 8pp.

Meillat, M., Morandeau, F., Mehault S., Larnaud, P. 2011. Nephrops grid and Nephrops grid combined to square mesh cylinder and window. Presentation at information session on technical conservation measures, discards and escapement of juvenile fish. North western Waters Regional Advisory Group (NWWAC). Dublin 5 July 2011.

McHugh, M., Browne, D., Oliver, M., Tyndall, P., Minto, C., Cosgrove, R. 2017. Raising the fishing line to reduce cod catches in demersal trawls targeting fish species. BIM Fisheries Conservation Report. May 2017. 9pp.

Reeves, S. and Armstrong, F. 2009. Trials with an Eliminator-type trawl in the North Sea Saithe Fishery. Cefas Fisheries Science Partnership: 2009/10. December 2009. 14pp.

Revill, A. and Doran, S. 2008. Further North Sae fishing triasl with the "EliminatorTM " trawl (2008). CEFAS Project Reference: MF 1002 & C3307. December 2008. 6pp.

Willems, T., Depestele, J.,De Backer,A.&Hostens, K. 2016. Ray by-catch in a tropical shrimp fishery: do bycatch reduction devices and turtle excluder devices effectively exclude rays? Fisheries Research 175, 35–42.

Thorpe, T. & Frierson, D. (2009). Bycatch mitigation assessment for sharks caught in coastal anchored gillnets. Fisheries Research 98, 102–112.

9 APPENDIX

Information from ICES WGEF 2016 on the utility of the Prohibited species list on TAC and quotas regulations (ICES, 2016)

The list of prohibited species on the TACs and quotas regulations (e.g. CEC, 2016a) is an appropriate measure for trying to protect the marine fish of highest conservation importance, particularly those species that are also listed on CITES and various other conservation conventions. Additionally, there should be sufficient concern over the population status and/or impacts of exploitation that warrants such a long-term conservation strategy over the whole management area.

There are some species that would fall into this category. For example, white shark and basking shark are both listed on CITES and some European nations have given legal protection to these species. Angel shark has also been given legal protection in UK.

It should also be recognized that some species that are considered depleted in parts of their range may remain locally abundant in some areas, and such species might be able to support low levels of exploitation. From a fisheries management viewpoint, advice for a zero or near-zero TAC, or for no target fisheries, is very different from a requirement for 'prohibited species' status, especially as a period of conservative management may benefit the species and facilitate a return to commercial exploitation in the short term. Additionally, there is a rationale that a list of prohibited species should not be changing regularly, as this could lead to confusion for both the fishing and enforcement communities.

In 2009 and 2010 undulate ray (Raja undulata) was moved on to the prohibited species list. This had not been advised by ICES. Following a request from commercial fishers, the European Commission asked ICES to give advice on this listing. ICES reiterated that undulate ray would be better managed under local management measures and that there was no justification for placing undulate ray on the prohibited species list. There have been subsequent changes in the listing of this species. It was removed from the Prohibited Species List for Subarea 7 in 2014 (albeit as a species that cannot be retained or landed). In 2015, undulate ray was only maintained in the prohibited species list in Subareas 6 and 10. Small TACs were established for stocks in the English Channel and Bay of Biscay in 2015 and for the stock in the Iberian ecoregion in 2016.

Reference

ICES. 2016. Report of the Working Group on Elasmobranch Fishes (WGEF), 15–24 June 2016, Lisbon, Portugal. ICES CM/ACOM:20. 26 pp.

10 CONTACT DETAILS OF EWG-17-10 PARTICIPANTS

[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

STECF members			
Name	Address[1]	Telephone no.	Email
Bertignac, Michel (chair)	Laboratoire de Biologie Halieutique IFREMER Centre de Brest BP 70 - 29280 Plouzane, France	Tel: +33 (0)2 98 22 45 25	michel.bertignac@ifremer.fr
Borges, Lisa	FishFix, Brussels, Belgium		info@fishfix.eu

Invited experts			
Name	Address	Telephone no.	Email
Clarke, Maurice	Marine Institute, Rinville, Oranmore, Co, Galway, Ireland		Maurice.Clarke@Marine.ie
Ellis, Jim	Cefas Pakefield Road Lowestoft Suffolk NR33 0HT United Kingdom	Phone +44 1502 524300 Fax +44 1502 513865	jim.ellis@cefas.co.uk
Figueiredo, Ivone	IPMA Avenida de Brasilia 1449-006 Lisbon Portugal	Phone + 351 21 3027131 Fax + 351 21 3015948	ifigueiredo@ipma.pt
Gadenne, Hélène	MNHN – CRESCO 38 rue de Port-Blanc 35800 Dinard France	Phone +33 789068877	gadenne.helene@gmail.com
Jung, Armelle	Des Requins et des Hommes	Phone +33 6 14 38 60 01	armelle@desrequinsetdeshommes.org

	PO Box 70F BLP/Technopôle Brest Iroise 15 rue Dumont d'Urville 29280 Plouzané France		
Rihan, Dominic (by correspondance)	Bord Iascaigh Mhara, Crofton Road, Dun Laoghaire, Co Dublin, Ireland	Tel: +353 1 2144159	rihan@bim.ie
Walker, Paddy	Van Hall Larenstein University of Applied Sciences, Agora 1, PO Box 1528 8901 BV Leeuwarden Netherlands	Phone +31 6 222 78 193	paddy.walker@hvhl.nl

JRC experts			
Name	Address	Telephone no.	Email
Scott, Finlay	DG Joint Research Center		Finlay.SCOTT@ec.europa.eu

European Commission			
Name	Address	Telephone no.	Email
Shrives, Jonathan	European Commission Directorate-General for Maritime Affairs and Fisheries Unit C.1 – Fisheries Management, Atlantic North Sea and Baltic		jonathan.shrives@ec.europa.eu
Scott, Finlay	STECF secretariat		JRC-stecf-secretariat@ec.europa.eu

Observers			
Name	Address	Telephone no.	Email
Leblanc, Nicolas	Comité régionale des pêches de Normandie		nicolas.leblanc@comite-peches-normandie.fr
Lynch, John	NWWAC c/o Bord Iascaigh Mhara Crofton Road Dun Laoghaire Co. Dublin, Ireland		jleblana@hotmail.com

11 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on:
https://stecf.jrc.ec.europa.eu/ewg1710

List of background documents:

EWG-17-16 – Doc 1 - Declarations of invited and JRC experts (see also section 10 of this report – List of participants)

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: http://europea.eu/contact

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696, or
- by electronic mail via: http://europa.eu/contact

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: http://europa.eu

EU publications

You can download or order free and priced EU publications from EU Bookshop at: http://bookshop.europa.eu. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see http://europa.eu/contact).

XX-NA-xxxxx-EN-N

STECF

The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent, evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub
EU Science Hub - Joint Research Centre
Joint Research Centre
EU Science Hub

Publications Office

doi:xx.xxxx/xxxx

ISBN xxx-xx-xx-xxxxx-x