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Possible by-catch provisions for undulate ray in ICES areas VIIde, VIIIab and IX (STECF-15-03)

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This report was reviewed by the STECF by written procedure in February 2015

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Abstract

The STECF provided advice in relation to possible by-catch provisions for undulate ray in ICES areas VIIde, VIIIab AND IX by written procedure in February 2015.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Possible by-catch provisions for undulate ray in ICES areas VIIde, VIIIaband IX (STECF-15-XX)

THIS REPORT WAS ISSUED BY WRITTEN PROCEDURE IN FEBRUARY 2015

Background

The landing of the undulate ray has been prohibited in 2009 as per the annual fishing opportunities regulation. Following claims that the species was locally abundant, in particular in the Normano-Breton Gulf (area VIIde) and in the Pertuischarentais (area VIIIab), the French fishermen set up fisheries-science partnerships (Raimouest, RaieBeca and RECOAM) to study the abundance of the undulate ray in these areas and the final results were delivered in 2014. A similar Portuguese initiative in area IXa is still ongoing in 2015. These results were communicated to ICES in the context of the WGEF of October 2014. In recognition of the efforts undertaken by the fishermen, the undulate ray was taken out of the prohibition list in 2014 for areas VII and VIII and in 2015 for area IX. However, a zero TAC is still in force which means that the species still cannot be landed at present. In light of the additional data gathered during the fisheries-science partnership, the Commission asked in January 2015 experts to examine on the basis of an *ad hoc* contract the possibility to set by-catch quotas for the undulate ray in areas VII, VIII and IX. The experts were also requested *i.a.* to provide guidance on the management measures that may ensure a sustainable exploitation of those stocks.

Rationale for the written procedure: The Commission committed in December to seeking STECF's advice as a matter of priority in 2015, with regard to the expectations of the Member States, the sector and the efforts they deployed since 2009. If STECF concluded that the setting of a by-catch provision would be in line with the precautionary principle, the written procedure would also allow the fishing opportunities for 2015 to be amended in a timely manner. Therefore, the STECF is kindly requested to undertake this assessment as a matter of urgency and resort to the written procedure. The Commission kindly requests that STECF's advice be provided if possible by 20 February 2015 and no later than 28 February 2015.

Background documentation

Terms of reference of the *ad hoc* contract.

1. Report drafted by the experts commissioned for the *ad hoc* contract under references Ares(2014)4255067, Ares(2014)4247231 and Ares(2014)4265278 - *Ad hoc request to the STECF on a possible bycatch provision for undulate ray* Rajaundulata *in VIIde, VIIIab and IX.*(see Annex I of the present report)
2. Data collected in the framework of the fisheries-science partnership studies Raimouest, RaieBeca and RECOAM.
3. Council regulation (EU) 2015/104 of 19 January 2015 fixing for 2015 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014[1].

[1]http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0104&from=EN

4. ICES' advice (June 2014) on the undulate ray in areas VIIde, VIIIab and IXa[2].

Request to the STECF

1. The STECF is requested to answer the questions posed to the experts group (1st background document). To this end, the STECF is requested to review the report produced by the experts commissioned by the European Commission and form their advice on the basis of the background documents supplied and others if suitable.
2. The STECF is also requested to answer, if possible, the questions for which the experts group could not conclude. In particular, the experts could not recommend an explicit level of by-catch in line with the precautionary approach.
3. Finally, the STECF is requested to:
   a. List in a table the data currently available to assess the stocks of undulate ray in areas VIIde, VIIIab and IXa. The STECF is requested to indicate clearly what data are available at the level of each Member State.
   b. Explain in a table (i) what further data are necessary to provide a full analytical assessment using the same categories as in 3.a. (stock level and Member State level). In this same table, the STECF is also requested to comment on (ii) the quality of the data and the length of the time series available (iii) and the timeframe within which an analytical assessment could reasonably be expected if currently data collection schemes were pursued. The STECF may make all additional comments it deems suitable.

Observations of the STECF

ToR 1. The STECF is requested to answer the questions posed to the experts group (1st background document). To this end, the STECF is requested to review the report produced by the experts commissioned by the European Commission and form their advice on the basis of the background documents supplied and others if suitable.

1a. <u>Review of available studies and literature</u>: The STECF is requested to review the available studies, data and literature pertinent to this request. Among others, this review should document the survivability of released undulate rays under commercial fishing conditions.

The ad hoc report provides a detailed and comprehensive summary of the current state of the art with respect to current knowledge on species distribution and stock units; life history characteristics; recent scientific advice; discard survival and industry perceptions of the stock.

It is clear from the ad hoc report that stock status and trends in all areas are not well understood. Owing to its coastal distribution, undulate ray isnot caught in any large quantities in the Celtic Seas and Biscay-Iberianecoregions and therefore little information is available to inform on stock abundance trends in these areas.

The French Channel survey (CGFS), which covers ICES divisionVIId (1988-present) hasslightly higher catch rates and, aggregating data over clusters of several (6) years, does indicate an increase in abundance and

[2]VIIde http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/rju-ech.pdf
VIIIab http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/rju-8ab.pdf
IXa http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/rju-9a.pdf

frequency of occurrence of undulate ray in recent years.There are also indications from the Channel Beam trawl survey that abundance has increased (WGBEAM, 2013).Based on mark-recapture tagging analysis, ICES also notes that there is an increasing trend in biomass in division VIIIab (Bay of Biscay). In other areas (ICES division IXa; VIIbj and VIIIc), there wasinsufficient data to draw any conclusions about trends in abundance and/or biomass.

Commercial catch data are not informative as the landings of undulate ray were not differentiated from other species of skates and rays before 2009 therefore preventing any time series analysis of historic catch or LPUE trends.

Some data from observer trips undertaken in VIIe between 2011 and 2013 on board commercial otter trawl and trammel netters is presented in the ad hoc report. STECF notes that this provides useful information on the proportion of undulate ray >78cm total length (TL) (proposed minimum size) and the total weight of observed catch. Undulate ray larger than 78 cm made up 15 to 23% of the total number caught and 44% to 61% of the weight per year in the otter trawl catches. Bottom trammel nets caught a much higher proportion of larger skates, with about 90% of the catch of undulate ray in this métier comprised of individuals larger than 78 cm TL.

While the observed catchesshow an upward trend in both metiers, it is unclear whether the data is standardised by the level of observer effort and therefore cannot be used to draw any reliable conclusions on the stock trend.

STECF notes that the utility of any minimum retention size is dependent on the assumption that discarded fish (< minimum size) survive the process of discarding. Several studies have shown that rays havethe highest levels of post-release survival among fish species. Observed survival rates are in general over 50% for all gears and reaching 80% in many cases (STECF 14-19). The ad hoc contract summarises the available knowledge on discard survival of undulate ray and other skates and rays. Undulate ray is considered by the authors to have "low at-vessel mortality" for otter trawlers and coastal netters, but that mortality at-vessel increased in the beam trawl fleet. In addition, the authors provide suggestions for a possible code of conduct for fishing operations and on-board handling.

2a. *<u>Compatibility of the measures proposed with the precautionary approach</u>: (a) The STECF is requested to indicate whether those management measures are compatible with the precautionary approach; and (b) If possible, the STECF is also requested to identify for the point 2a. above (i) the change in terms of fishing mortality that will be applied to each stock, and (ii) the implications for the development of each of the stocks.*

Among the management measures that will likely prevent directed fisheries on undulate ray and minimisemortality on egg-laying females, the following measures were contained in the draft management plan proposed by the French Authorities:

- Measure 1: Fixing a minimum size of conservation of 78 cm. Undersized specimens must be carefully and immediately released.
- Measure 2: Landing a maximum of 1 to 10% of the total catches per trip. Each step of the scenario between 1 to 10% should be evaluated.
- Measure 3: Setting a threshold of 20 to 100 kg of *raja undulata* after which a total allowed of catches can be authorized to be landed. The different thresholds should be evaluated in relation to the fleet segment and the fishing areas.
- Measure 4: Setting a three months closure fishing period per year.
- Measure 5: Providing for fishermen a code of practice recalling the proper manners to manipulate and release raja undulataAll supernumerary raja undulatamust be carefully and immediately released. This obligation is based on their high survivability.

Following consultationbetween STECF and the EC, clarifications were received on how measures 2 and 4 should be interpreted.

- *Measure 2: Landing a maximum of 1 to 10% of the total catches per trip. Each step of the scenario between 1 to 10% should be evaluated.*

Commission's comment on measure 2

"The Commission considers that the maximum landing percentage should be regarded as a percentage of the total catch of all species (i.e. undulate ray plus all other species caught). We wish to know what the maximum percentage of by-catch is considered consistent with the precautionary approach is (e.g. is 10% consistent or less and if less what is the percentage?). Please also refer to point 3 as regards alternative ways of setting the ceiling."

- *Measure 3: Setting a threshold of 20 to 100 kg of raja undulata after which a total allowed of catches can be authorized to be landed. The different thresholds should be evaluated in relation to the fleet segment and the fishing areas.*

Commission's comment on measure 3

"The Commissionwish to determine a maximum quantity from 20 kg to 100 kg (with intervals of 10 kg) above which a fisherman would fall under the percentage condition under 'measure 2'. The possible maximum landings should be evaluated in relation to the fleet segment and the fishing areas."

Observations of the STECF

Observations on Minimum retention sizes

STECF considered that the protection of immature undulate ray is an important element of any management plan. Themanagement measures proposes setting a minimum size of 78cm. STECF notes that Minimum landing size (MLS) can be used to protect juveniles, although it would only be beneficial if it reducesfishing effort on nursery grounds and/or if discard survival is high. As noted above, survival is considered to be relatively high, at least for static nets and otter trawlers, which would suggest that this measure, in conjunction with improved handling and fishing practices, would reduce fishing mortality on juveniles. STECF notes that in order to assess the potential impact of setting a minimum size of 78cm, the ad hoc report presents a number of stock simulations which demonstrate that such a measures could assist in the recovery of the stock.

However, STECF considers that these should be treated as a preliminary or exploratory analysis.The outcomes illustrate that improvements in selection pattern will lead to an increase in stock size but should not be used in any quantitative way given the underlying assumptions regarding: historic selection pattern; unknown stock recruit relationship; the unknown status of the stock at the time of catch moratorium and the underlying assumption that fishing mortality has been zero since its introduction, which is not supported by the available discard data. Notwithstanding, if managers chose to permit a limited by-catch fishery, the introduction of such a minimum size is likely to lead to improvements in the stocks status but it is not possible to quantify the effect of this management measure per se on the stock status.

STECF notes that skates and rays are subject to existing minimum size limits included in national and regional by-laws (see http://www.southern-ifca.gov.uk/byelaws). The ad hoc report considers thatit may be pertinent to harmonise any future provisions with existing regulations. STECF notes that the minimum size applied in UK coastal waters is smaller (i.e. 63 cm) than that presented in the management proposals (i.e. 78 cm) and therefore any harmonisation with the existing UK measures would offer *reduced* protection of juveniles in comparison. The simulations noted above were undertaken based on a minimum size of 78cm and thereforea comparative analysis should be undertaken to assess the relative impact of setting a minimum size of 63cm as opposed to 78cm proposed in the draft management plan. STECF considers that, based on PA considerations, clearly the higher value is more appropriatein the case of undulate ray because will reduce the landing of individuals smaller than first maturity (L_{50} is around 78 cm-TL).

STECF observations on trip limits

The authors of the ad hoc report consider that trip limits would be an appropriate precautionary management measure to deter target fisheries for undulate ray, whilst allowing a proportion of the catches of undulate rayto be landed. STECF considers that trip limits set as a *percentage*of the total retained catch should not be used as means to limit landings of undulate ray as it is not possible to know *a priori* what the total retained catch (all species) will be on a given trip and therefore what the resultant landings of undulate ray would be. STECF considers that if trip limits are to be used as a management tool to restrict landings of undulate ray, then theses should take the form of a quantitative limit (kg) per trip. Furthermore, STECF considers that if the management authorities wish to introduce such a limit as a means of regulating fishing mortality, then such a measure if used in isolation,could lead to unpredictable and unsustainable catches as it is not possible *a priori* to identify the number of trips that will occur in future. STECF notes that the French fleet operating in VIIde comprises 289 vessels, which undertake trips of short duration (24-48 hrs). Managers should be cognisant, that if trip limits are used as the only means to regulate landings, even a small per vessel/per trip allocation could translate into significant landings e.g. if the 289 vessels undertake 100 trips per year and are allocated a small by-catch of for example 30 kg per trip, this would equate to potential landings of 867 t, which is almost three times higher than the "best" estimate of landings prior to the introduction of the zero TAC (see below). Incidentally, this value is close to the recent discard estimates associated with this fleet (ca. 800 t [ICES, 2014]).STECF therefore considers that if trip limits are introduced, they would need to be allocated to only a small number of vessels i.e. a sentinel fleet and be constrained by an overall cap on landings (TAC) (see below).

STECF observations on overall catch limits (TAC)

Given the limitations of managing outtake via trip limits identified above, STECF advises that if individual vessel catch limits are to be used as a management measure, then the overall catch should be capped through the introduction of a species specific TAC for each of the management areas where appropriate.

However, given the lack of precise historic species-specific catch data for undulate ray and the absenceof an analytical assessment, it is not possible to quantify the level of catches that led to the stock decline in the first instance and therefore it is not possible to determine the level of landings (TAC)or associated trip limitsthat would be consistent with an appropriate exploitation rate on undulate ray. The authors of the ad hoc report estimated, based on interviews and historic observer data, that the annual landings of undulate ray from Division VIIdebefore the ban, was around 300 t and those from VIIIab were in the order of 82 – 120 t. STECF notes that there are no estimates of historic landings of undulate ray from ICES division IXa.

STECF notes that lack of basic catch and effort data and the limited survey coverage remains a barrier to the development of an analytical assessment based on fishery dependent and independent data. The authors of the ad hoc report consider that a limited or sentinel fishery could be established to promote the collection of the necessary biological and transversal data to undertake an analytical assessment once a sufficient time series is established. STECF considers that this may be desirable, at least in ICES areas VIIdeand VIIIabwhere there are indications of recent increases in abundanceof undulate ray (ICES, 2014), but STECF is unable to compute an appropriatelevel of permissible landingstherefore the choice of any trip or overall catch limit is a decision for managers. If managers chose to permit a limited amount of landings through such a programme, to be precautionary thisshould initially be set at a low level which could be adjusted accordingto the results of subsequent assessments of the stocks e.g. based on CPUE trends.

STECF considers that a pragmatic upper limit for a TAC for undulate ray in Division VIIde would be the estimated annual landings of 300 t identified in the ad hoc report, as the stock appears to have been able to sustain landings of that orderand at the same time there are indications that the stock has increased. Nevertheless, there is no objective scientific basis to assess whether such landings are likely todeliver exploitation rates that are in line with the objectives of the CFP or to estimate the level of risk to the stock.Consequently STECF advises that a more precautionary approach should be taken given the uncertainty associated with the historic landings estimate and the limitations of the available survey information. STECF considers that this should beset an annual limit on landings of less than 300 t, noting that lower values imply lower risk of a decline in the stock. While there is no basis to specify what this should be, STECF suggests a pragmatic and precautionary starting point could be to set a landings limit of 100t and to adjust this as more data and information becomes available e.g. CPUE, survey data.

Regarding undulate ray in ICES Divisions VIIIab, the supporting documentation made available to STECF shows that catches of undulate ray ranged from 82 to 120 t per annum prior to the introduction of the moratorium. STECF notes that there is no objective scientific basis to assess whether such landings are likely to deliver exploitation rates that are in line with the objectives of the CFP or to estimate the level of risk to the stock.Given this, STECF considers that a precautionary approach should be taken if managers decide to permit landings given the uncertainty associated with the historic landings estimate and thelimitations of the mark-recapture approach used by ICES to assess the trends in abundance. STECF considers that the available information for this stock is more limited in comparison to VIIde. Furthermore, STECF notes that ICES

(2014), based on the mark-recapture study, suggests a biomass of between 194 and 269 t. STECF therefore considers that any species specific TAC for this area this should be set an annual limit on landings substantially less than 82-120 t, noting that lower values imply lower risk of a decline in the stock. While there is no basis to specify what this should be, STECF suggests a pragmatic and precautionary starting point could be to set a landings limit of <<20 t and to adjust this as more data and information becomes available e.g. CPUE. Furthermore, given the available biomass estimate from ICES, STECF suggests that further exploratory analysis using the methods developed by Zhou et al. (2012) and Le Quesne and Jennings (2012) should be undertaken to assess whether such a catch level is consistent with MSY objectives.

STECF notes that currently there are no survey or fishery data available that can be used to determine whether there are any positive trends in abundance in the undulate ray stock in ICES Division IXa. Furthermore, STECF notes an absence of landings estimates prior to the introduction of the moratorium. STECF is therefore unable to provide any basis that can be used to set a species specific TAC for this stock. STECF considers that in the first instance, at-sea observer data should be collected to quantify CPUE and these could be used in future to determine trends in CPUE. An extension of existing survey coverage or the development of a dedicated survey should also be considered a priority in order to develop of fishery independent time series of abundance.

Considering the desire to set individual vessel trip limits identified in the proposed management measures, STECF advises that it is appropriate to firstly decide on an upper limit on landings for undulate ray (TAC) and then to decide how this should be allocated to individual vessels. Noting the number of vessels engaged in the fishery, managers may want to consider the need to regulate through a licencing scheme, the overall number of vessels which are permitted to land undulate ray. Furthermore, catch allocations should be made on the basis to permit a limited by-catch of undulate ray and not to develop a targeted fishery (ICES, 2014).

STECF considers that in an attempt to control and estimate exploitation rates; landings, catches and effort would need to be closely monitored so that future limits on landings could be adjusted in line with changes in CPUE.Effort should be monitored at a sufficient resolution to quantify the amount and frequency of gear deployed including in the case of static nets, the length of nets, mesh size and soak time. Furthermore, to permit the development of spatial and temporal management measures, location and timing of fishing effort should also be documented.

STECF observations on spatial and temporal measures

STECF notes that while spatio-temporal management may be an appropriate precautionary management measure, the lack of historic data on the spatial and temporal distribution of catches prevents any analysis of the appropriate scale or timing of such measure or its potential efficacy. The adoption of temporary seasonal closures to protect egg-laying females and small juveniles may be more effective than spatial management, as the latter may simply lead to a re-distribution of the fishing effort. To propose spatial closure measures more detailed information on the distribution of the stock, as well as impacts on the fleets are required. The rationale for any seasonal closure requires less information (i.e. the proportion of mature females carrying egg-cases per month).

STECF considers that any seasonal closure of the fishery or a seasonal ban on landing undulate ray should include the spawning season, when mature females migrate into coastal waters to deposit eggs. STECF notes that studies have indicated that spawning of undulate off western Portugal occurs from February to May, which is broadly similar to that noted for other skates in European Atlantic waters. However, identifying the most appropriate window for a seasonal closure would benefit from further data for the different undulate ray stocks. STECF notes that seasonal limits are in place in ICES area IXa under Portuguese national law, which restricts landings of all skate species to a maximum of 5% of the total catch during the month of May. Furthermore, STECF notes that studies are currently underway in Portugal (project UNDULATA initiated in 2014) to study the efficacy of this and other management measures and to also provide data to help develop an analytical assessment for undulate ray in Portuguese waters.

STECF considers that, although the coastal nature of undulate ray is theoretically conducive fordeveloping spatial management, other management measures e.g. overall catch limits would be more pragmatic and effective, at least in the short term

2b *Management options compatible with the precautionary approach: If the answer to point 2a is negative, the STECF is requested to propose alternative settings for the management measures proposed by the French authorities that are compatible with the precautionary approach. In particular, taking account of the catches of the vessels that would possibly catch and land the undulate ray, the STECF is requested to indicate whether the allocation of a percentage bycatch is compatible with the precautionary approach.*

STECF considers that there is no basis to propose alternative strategies to those presented by the French authorities for the management of undulate ray. As noted above, STECF considers the application of by-catch limits as a percentage of overall catch as inappropriate given that it is not possible to *a priori* determine the level of total catches, and as a consequence, the associated catches of undulate ray (see above).

STECF considers that a maximum landing size may be an appropriate precautionary management measure to reduce fishing mortality on larger females, provided that their survival rate is high, but that the exact details of the measure would need to be further developed.

If managers decide to permit either a sentinel or limited commercial fishery, then this would require close monitoring of catch and effort data, including the monitoring and documentation on gear parameters and actual effort e.g. length of nets deployed and associated soaking time. To facilitate the development of spatial management measures, data on the spatial distribution of catch and effort data should be collated.

2c *Optimal combination of measures: In light of the results of point 3 (sic) above, as appropriate, the STECF is requested to comment on the combination(s) it deems optimal. To this end, the STECF should take account of the combination(s) of measures that maximise the economic return obtained from undulate ray stocks while keeping the fishing pressure at the lowest possible level.*

STECF notes the given the lack of analytical assessment for any of the stocks of undulate ray and the paucity of species disaggregated catch and economic data, it is not possible to determine the combinations of measures that would lead to the minimal level of fishing mortality while maximising the economic benefit. STECF notes that the current zero TAC would be consistent with keeping fishing pressure at its lowest possible level assuming that this has led to a cessation of targeted fishery and that there is a moderate to high level of discard survival. If managers agree to permit limited catches, then STECF considers that an overall, species specific catch limit (TAC) should be introduced. This should also be combined with trip limits based on a maximum landings weight (rather than percentage cap) and that the minimum size proposed should also be introduced. Managers may also want to consider the application of additional measures such as a maximum landing size and seasonal closures to protect spawning females.

2d *Comments on the code of practice: The code of practice is not ready for assessment and the STECF is requested to provide indications as to what this document should contain to maximise survival of discarded rays in general. The undulate ray should be treated separately, if appropriate.*

To maximise longer term survival of undulate ray after capture and release, guidelines on the best practices when catching and handling skates and rays should be developed. Minimising physical damage, internal and external, of captured specimens can be achieved by adopting measures such as the following:

i) Reduce tow duration / soak time on grounds where undulate ray may be expected to occur;

ii) When hauling nets and lines, try to return lively undulate ray to the sea as soon as possible, and preferentially retain those that may not survive (whilst still working within any trip limits and size restrictions)

iii) When processing trawl catches, process undulate ray as quickly as possible;

iv) Release unwanted skates and rays as soon as safe and practical

v) Avoid leaving unwanted skates and rays on deck, and not in direct sunlight

vi) If fish cannot be released immediately, keep specimens in clean seawater and release them as quickly as possible. Having a net bin on board can help revive fish (make sure the seawater pipe is running with fresh seawater before filling netbins)

vii) Avoid using a gaff to skates and ray on board

viii) When holding skates and rays, try to support their belly and avoid lifting or dragging fish by the tail or eye sockets

ix) Do not stand on the fish

x) Remove all gear remains (e.g. lines) from the caught specimen or cut the trace as short/close to the body as possible.

xi) When releasing fish into the sea, try to place them in the sea (small boats) or gently slide them head first from as low a height as safely possible. Do not throw them.

Additional requests to STECF

3. *The STECF is also requested to answer, if possible, the questions for which the experts group could not conclude. In particular, the experts could not recommend an explicit level of by-catch in line with the precautionary approach.*

As noted previously, there is no analytical basis for selecting a specific level of by-catch or overall TAC for any of the stocks of undulate ray.

4. STECF is requested to:

    c. *List in a table the data currently available to assess the stocks of undulate ray in areas VIIde, VIIIab and IXa. The STECF is requested to indicate clearly what data are available at the level of each Member State.*

Table 3.1 Fishery dependent and independent data currently available pertinent to the stocks of undulate ray.

Country/Stock	Parameter	VIIde	VIIIab	IXa
France	Landings data	No [1]	No [1][2]	NA
	Discard data	Yes	Yes	NA
	Survey data	Yes (partial)	Yes (insufficient)	NA
	Length distribution	Yes	Yes	NA
UK	Landings data	No [1]	NA	NA
	Discard data	Yes	NA	NA
	Survey data	Yes (partial)	NA	NA
	Length distribution	Yes	NA	NA
Portugal	Landings data	NA	NA	No [1]
	Discard data	NA	NA	Yes [3]
	Survey data	NA	NA	Yes (insufficient)
	Length distribution	NA	NA	Yes [4]

NA – Not applicable

[1] Limited landings data available, but limited data in recent years. No separated landings statistics for the species before 2009, no landings after 2009 (all catch discarded).

[2] Estimates of landings before 2009 were made based upon the decline in landings of skates and rays (species combined) after the ban of landings of Raja undulate.

[3] Few data from onboard observations

[4] Data from onboard observations, particularly those derived from Portuguese project on mark and recapture

As noted previously, prior to 2009 landings data were not disaggregated by species and due to the landings prohibition introduced in 2009, there is no times series of landings or effort data available for any MS. STECF notes that ICES will host a workshop in 2015 (WKSHARKS) which will work to collate the landings data for sharks, rays, skates and dogfishes, at the highest spatial resolution and at least per ICES Division, as well as year and Member State. WKSHARKS will also compile an agreed landings dataset for each stock considered by ICES WGEF and agree on a standard exchange format for submission and upload of landing data to WGEF. WKSHARKS aims to establish a database for holding landings data in future, guaranteeing quality control and consistency over time and develop a standard operating procedure for stock coordinators.

Table 3.2. Biological parameters currently available.

Parameter/Stock	VIIde	VIIIab	IXa (Portuguese studies)
Age and growth	No age and growth studies undertaken, some data available from tagging studies	No age and growth studies undertaken, some data available from tagging studies	Published age and growth studies available
Length-weight	Available (UK & FR)	Available	Available
Length-width	Available (UK & FR)	Available	Available
Fecundity (ovarian)	No data	No data	Some data available
Fecundity (Egg-laying rates)	No data	No data	No data
Egg-laying season	No data	No data	Some data available
Size at maturity	Some data (UK) Maturity at length by sex (available from project report) (FR)	Maturity at length by sex (available from project report) (FR)	Maturity at length/age by sex (Coehlo and Erzini, 2006)
Tagging studies	Tagging undertaken, but recording of some recaptures may be affected by earlier prohibition	Tagging undertaken 2001-14. Proportion recaptured used for exploratory stock assessment, movement and growth estimation (unpublished)	Some studies
Location of nursery grounds	Some data (UK & FR)	Some data (including distribution of egg capsules strandings)	Some data

d. *Explain in a table (i) what further data are necessary to provide a full analytical assessment using the same categories as in 3.a. (stock level and Member State level). In this same table, the STECF is also requested to comment on (ii) the quality of the data and the length of the time series available (iii) and the timeframe within which an analytical assessment could reasonably be expected if currently data collection schemes were pursued. The STECF may make all additional comments it deems suitable.*

The overall paucity of fishery dependent and independent data inhibits the development of a full analytical assessment for all stocks of undulate ray. STECF further notes that the current spatial coverage of the available fishery dependent survey only covers the fringes of the VIIde stock and is absent in other areas. In order to obtain data that could be useful in the development of an analytical assessment, survey coverage needs to be improved substantially and monitoring of catch and effort through observer programmes should be continued and possibly expanded.

STECF notes that there are a number of national initiatives currently underway to redress some of these aspects, including the collection of catch and effort data. However, until a time series is established, the prospectof a full analytical assessment is limited. Consequently, STECF is not is a position to determine what the possible timeframe will be as this will be dependent on the assessment method used and its data requirements. STECF notes that the available information varies considerably between stocks but that it is improving due to dedicated research projects.

Conclusions of the STECF

STECF considers that, based on the limited information available, stocks of undulate ray in the Channel, the Bay of Biscay and Atlantic Iberian waters differ considerably and should be treated independently. STECF notes that there are indications of an increasing trend in abundance in the Channel stock (VIIde) and Bay of Biscay stock (VIIIab), but there is insufficient information available to provide any judgment on trends in abundance or biomass for the other stocks. Given that there is evidence that discard survival rates are in excess of 50%, it is likely that the current moratorium has led to positive increases in stock status, but it is not possible to determine the current status relative to MSY considerations.

STECF notes the ICES advice for all three stocks is that there should be no targeted fishery. STECF agrees with this advice.Furthermore, ICES notes that "*Any possible provision for bycatch to be landed should be part of a management plan, including close monitoring of the stock and fishery*". STECF acknowledges the efforts to develop a management plan but given the lack of analytical assessment, is unable to determine whether the elements contained are sufficient to maintain the continued growth of the stock, nor is it able to determine whether these elements are in accordance with MSY or PA considerations. Notwithstanding, STECF considers that in addition to the ongoing research, a restricted and closely monitored by-catch may assist with the development of an analytical assessment and could be used as a future indicator of stock development and the basis of an adaptive management strategy. STECF notes that the decision to permit a limited by-catch and at which level is a management decision as there is no objective means to provide quantitative catch advice.

STECF considers that an overall, stock specific TAC is required to limit any permitted outtake and this value should be determined in the first instance. If managers then wish to provide individual vessel allocations, then these should be based on a fixed catch allocation and not set as a percentage of the total catch as this will lead to unpredictable outtakes. The cumulative vessel allocations should not exceed the overall stock specific TAC. STECF notes that for ICES division VIIde, there are imprecise landings estimates of approximately 300 t per year prior to the introduction of the moratorium. STECF considers that if managers wish to establish a limited by-catch TAC for this area, then this should be set at a value substantially lower than this e.g. <100 t but STECF is unable to asses if such a level is consistent with MSY objectives. For undulate ray in ICES Division VIIIab, the information available is more limited and a more precautionary approach is required. Based on the limited catch data available, if managers wish to provide a limited by catch TAC, then this should be set at levels substantially below the pre moratorium landings estimate of 82 – 120 t. STECF suggests a pragmatic and precautionary starting point could be to set a landings limit of <<20 t and to adjust this as more data and information becomes available e.g. CPUE. Furthermore, given the available biomass estimate from ICES, STECF suggests that further exploratory analysis using the methods developed by Zhou et al. (2012) and Le Quesne and Jennings (2012) should be undertaken to assess whether such a catch level is consistent with MSY objectives.

STECF notes that it is not in a position to determine whether such landings levels are in accordance with the provisions of the CFP. If managers decide upon a limited TAC then STECF advises that catches and effort be closely monitored and used as the basis of an adaptive management approach.

STECF notes that there are no historic catch estimates available for the undulate ray stock in IXa and there are no fishery independent data available to determine trends in abundance. STECF is therefore not in a position to provide any landings advice for the management for this stock given the lack of informationavailable.

STECF notes that if managers decide to permit a limited by-catch or sentinel fishery, then spatial and temporal catch and effort data must be collected. This should include details of total catches of undulate ray (landings plus discards), gear parameters (including soak time/tow duration) and any other parameters that the relevant scientific institutes consider necessary.

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1 - Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. 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 invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. 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

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Annex I - Report drafted by the experts commissioned for the ad hoc contract under references Ares(2014)4255067, Ares(2014)4247231 and Ares(2014)4265278 - Ad hoc request to the STECF on a possible bycatch provision for undulate ray Raja undulata in VIIde, VIIIab and IX

Ad hoc request to the STECF on a possible bycatch provision for undulate ray *Raja undulata* in VIIde, VIIIab and IX

1. Introduction

1.1 Distribution and stock units

Undulate ray *Raja undulata* is a coastal skate that occurs along the inner continental shelf of the Northeast Atlantic from northwest Africa to the British Isles, including parts of the Mediterranean Sea (Ellis *et al.*, 2012a; Fig. 1). Within the ICES area, it is currently assumed to comprise five management units which may be biologically discrete stock units. These five units are southwest Ireland (ICES Divisions VIIb,j), English Channel (VIId,e), Bay of Biscay (VIIIa,b), Cantabrian Sea (VIIIc) and western Iberian waters (IXa). The distribution of undulate ray may not be continuous in some of these areas, and there may be some more localised 'sub-stocks', depending on the degree of mixing.

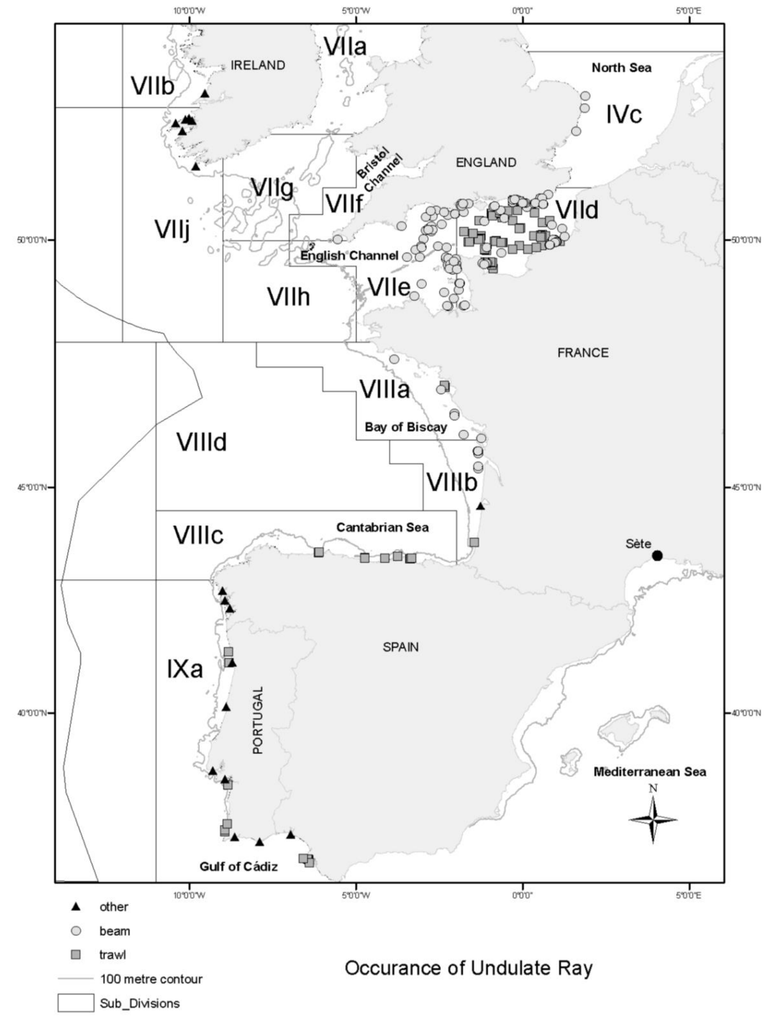

Fig. 1: Distribution of undulate ray in European Atlantic waters (From Ellis *et al.*, 2012a)

1.2 Life history

Undulate ray is a relatively large-bodied skate species that attains a maximum total length (L_T) of at least 114 cm (Ellis *et al.*, 2012a). Females are estimated to mature at 86.2 cm L_T (about 8 years old) while males mature at 76.8 cm L_T (about 7 years). The maximum potential fecundity of the species is estimated at about 70 follicles per female per reproductive season and the size-at-hatching is approximately 14 cm L_T. Recent studies have indicated a longer reproductive season (from December to June) than previously reported, with potentially two peaks of activity in one year. Population biological events such as mating, egg-bearing and egg-laying tend to occur at the same time of the year, resulting in a synchronisation of the reproductive cycle of the entire population (Pereira *et al.*, in press). Summary details of the life history, from Portuguese studies, is summarised in Table 1.

Table 1. Summary of published life history data for undulate ray in Portuguese waters (ICES Division IXa) giving L_{50} (A_{50}): Length (age) at 50% maturity; M_{50}: size-at-maternity; growth parameters L_∞: asymptotic length, k: growth rate and t_0: size at age-0; L_{max}: maximum observed length (age): L_{max} (A_{max}); A_∞: maximum theoretical age; $TW \sim aL_T^b$: length-weight relationship; *r'*: potential rate of population increase; and M: natural mortality. Sources are [1] Coelho & Erzini, 2002; [2] Coelho & Erzini, 2006; [3] Moura *et al.* 2007; [4] Serra-Pereira *et al.* 2010; [5] Serra-Pereira *et al.*, in press.

Period Region		1999–2001 Algarve	1999–2001 Algarve	2003–2006 Centre	2001–2008 North/Centre	2003–2013 North/Centre
Depth range (m)		–	–	–	–	4 to 128 (mostly 30–40)
Egg-laying depth range (m)		–	–	–	–	10 to 55 (mostly < 30)
Length range (cm)		19.4–88.2	32.0–83.2	23.7–90.5	48.0–95.9	23.5–95.9
L_{50} (cm)	F	76.2	–	83.8	–	86.2±2.6
	M	73.6	–	78.1	–	76.8±2.4
A_{50} (years)	F	8.98	–	9	–	8.7±0.3
	M	7.66	–	8	–	7.6±0.4
M_{50} (cm)		–	–	–	–	95.7±15.3
Reproductive period		Dec–Feb	–	Feb–May	–	Dec–Jun
Fecundity (eggs per female)		–	–	–	–	69.8±3.4
Size-at-birth (cm)		–	–	–	–	13.5
L_{max} (cm)		88.2	83.2	90.5	–	95.9
L_∞ (cm)		110.2	119.3	113.7	–	–
k ($year^{-1}$)		0.11	0.12	0.15	–	–
t_0 (years)		–1.58	–0.41	–0.01	–	–
A_{max} (years)		13	9	12	–	12.6
A_∞ (years)		–	28.9	23.6	–	–
$W = aL_T^b$	a	–	–	–	$1.92*10^{-5}$	–
	b	–	–	–	2.86	–
r' (using Jennings *et al.* (1999)		–	–	–	–	0.49
M: Jensen 1996 method (Pauly 1980 method)		–	–	–	–	0.24 (0.27)
References		[1], [2]	[3]	[3]	[4]	[5]

1.3 History of advice and conservation

ICES first provided advice on this species in 2008, but just for the North Sea and Celtic Seas ecoregions. ICES advised that "*Target fisheries for this species should not be permitted and measures should be taken to minimize bycatch*" (ICES, 2008b, c). The rationales for this was a decline in reported species-specific French landings (see Table 18.2a in ICES, 2008a), that undulate ray had not been recorded in the English beam trawl survey of the eastern English Channel in 2006 and 2007, despite being present in preceding years (1993–2005), and reported catches by recreational anglers in Tralee Bay (Ireland) that had decreased from the start of the time series (see Fig. 18.5 in ICES, 2008a). ICES took the view that "*Given that this large-bodied species has a patchy distribution in the inshore waters of the Celtic Seas ecoregion, it is susceptible to localized over-exploitation*".

Subsequently the European Commission stated that "*Undulate ray … (in) … EC waters of VI, VII, VIII, IX and X … may not be retained on board. Catches of this species shall be promptly released unharmed to the extent practicable*" (CEC, 2009). During 2009, the issue of non-retention of undulate ray became an issue for some coastal fishing communities from the English Channel to Iberian waters. The fishing industry queried the basis for the regulations, especially as they appeared to go beyond the ICES advice, and were also applied to the Bay of Biscay and Iberian waters, for which ICES had not provided any advice. In 2010 undulate ray was listed as a prohibited species on quota regulations (Section 6 of CEC, 2010), that stated "*It shall be prohibited for EU vessels to fish for, to retain on board, to tranship and to land … undulate ray (Raja undulata) … in EU waters of ICES zones VI, VII, VIII, IX and X*".

In 2010, ICES were specifically asked to advise whether there was a basis for listing undulate ray as a 'prohibited species' and ICES (2010) advised that "*There is no basis in the current or previous ICES advice for the listing of undulate ray as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia eco-region fisheries legislation. Alternative measures proposed by ICES are given separately for the English Channel, SW Ireland, and Biscay/Iberia. In view of the poor knowledge and patchy distribution of these populations, ICES recommends a precautionary approach to the exploitation of these populations of undulate ray. Therefore should be no target fishing unless information is available to show that such fisheries are sustainable*".

In 2014, undulate ray was only listed as a 'prohibited species' in EU waters of ICES subareas VI, IX and X. However, for other areas where a total allowable catch for skates and rays was managed, it was stipulated that quotas "*shall not apply to undulate ray (Raja undulata) … When accidentally caught, these species shall not be harmed. Specimens shall be promptly released. Fishermen shall be encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species*" (CEC, 2014).

In 2006, the International Union for the Conservation of Nature (IUCN) held a Red Listing workshop to assess all European chondrichthyans, and the information available at that time were used to justify a threatened listing of 'Endangered'. This assessment noted that "*Its patchy distribution means that populations are widely separated, possibly with little exchange. In the areas where it is known to be locally common, available data suggest declines have occurred*" (Gibson *et al.*, 2008). Once again, the data available were the recreational angling data from Tralee Bay, the English beam trawl survey in VIId, French reported species-specific landings and a decline in overall skate landings from southern Portugal, where undulate ray is a common species in the artisanal fishery.

It should also be noted here that more recent studies have indicated that undulate ray have long had a fragmented distribution (see Ellis *et al.*, 2012a), and whilst such a distribution pattern is certainly something to consider for managers, it should not be used to infer a population decline. Furthermore, the re-appearance (and continued presence) of undulate ray in the English Channel beam trawl survey since 2008, catch rates in the French Channel Groundfish Survey, and its occurrence in the western English Channel give no evidence of current declines.

1.4 Fisher perspective

Various coastal fishers operating over much of the distribution range of undulate ray maintain that this species is locally abundant in some areas, and this has been made highlighted at meetings of the North Western Waters Regional Advisory Council (NWWRAC), and the subsequent North Western Waters Advisory Council.

The issue has been highlighted by French fishers for the Normano-Breton Gulf (VIIe) and the Pertuis Charentais region (area VIIIa, approximately between 45°30N, north of the Gironde estuary and 46°30N, north of Ile de Ré), which was the main rationale for this request. Furthermore, it can be noted that fishers from the Channel Islands (also in the Normano-Breton Gulf), parts of southern England (Lyme Bay to Beachy Head), Galicia and other parts of Spain, and Portugal have also highlighted that undulate ray can be the dominant skate species on coastal fishing grounds.

Since 2011, French fishers have conducted a series of Fisheries Science Partnerships studies to improve our understanding of undulate ray stocks in the English Channel and Bay of Biscay. The results were available to inform the work of the ICES Working Group on Elasmobranch Fishes in June 2014.

More recently a study by the Portuguese scientific institute IPMA, in cooperation with fishermen associations, on the dynamics of undulate ray off the Portuguese mainland coast is ongoing. In addition, the Portuguese authorities communicated to ICES the management measures they were implementing for skates in their Atlantic Iberian waters.

1.5 Recent ICES advice

In 2014, ICES provided more detailed advice for each of the five management units.

The undulate ray stock in VIIb,j is considered more isolated than other stocks, and data from recreational anglers indicate that there may have been some depletion of the stock. ICES advised on the basis of precautionary considerations that "*there be no targeted fishery on this stock. This isolated stock has a very local distribution, mainly in Tralee Bay on the Southwest Irish coast; bycatch in this vicinity should be monitored and reduced to the lowest possible level. Measures to mitigate bycatch should be developed and implemented in consultation with the stakeholders. In Divisions VIIb and VIIj, ICES considers that it is appropriate that the species continues to be promptly released if caught*" (ICES, 2014b).

However, for three other stocks (VIId,e; VIIIa,b; IXa), more recent investigations and data collation (often undertaken by scientists in collaboration with the fishing industry, or through chartering of commercial vessels for surveys) have confirmed that undulate ray is locally abundant on some coastal grounds. These grounds are often in areas not surveyed effectively during the existing scientific trawl surveys used by ICES expert groups.

Whilst the fragmented and coastal distribution is still viewed as important justification for precautionary management and no target fisheries, there is no strong evidence of population declines in these areas and, since restrictive management was introduced, there is an indication of increasing abundance. For these three areas ICES advised, on the basis of precautionary considerations, that "*there should be no targeted fisheries on this stock. Any possible provision for bycatch to be landed should be part of a management plan, including close monitoring of the stock and fishery"* (ICES, 2014a, c, e).

The information on stock status of the fifth management unit (VIIIc) was more deficient, and so ICES advised that "*on the basis of the precautionary approach, considering also the patchy distribution of this stock and its susceptibility to local depletion, that there be no targeted fishery for this stock in 2015 or 2016, unless information is provided to show that such fisheries are sustainable. Measures to mitigate bycatch in coastal fisheries should be implemented in 2015 and in 2016*" (ICES, 2014d). It is possible that dedicated field sampling (e.g. joint fishery-science projects) in this area may also indicate that there are some areas where undulate ray can be locally abundant.

1.6 Purpose of this report

Following updated ICES advice and the improved scientific knowledge of this species, the French and Portuguese authorities requested that a bycatch quota be allowed for *Raja undulata* in the English Channel, Bay of Biscay and Atlantic Iberian waters. This request was accompanied by a series of management measures the French would envisage applying at national level by means of national legislation. Hence, STECF was requested to assess the management measures proposed by the French and Portuguese authorities (some are already in place for skates and rays in Portuguese waters), noting that if the status of the three stocks (VIId,e; VIIIa,b; IXa) differed considerably they should be treated separately for these three areas. The STECF was requested to answer the questions below and was invited to make any comment it deemed suitable in the framework of this request.

Whilst it has been indicated that available data (in particular the limited duration of species-specific landings and appropriate indices of abundance) are not currently sufficient to inform on the exact status of the stocks or for full analytical stock assessments, low-levels of exploitation, if accompanied by continuing data collection, would allow improved assessment and management in the future. It is also noted here that, given the data available and time available for this review, some of the evaluations in this report are qualitative or semi-quantitative.

1. Review of available studies and literature: The STECF is requested to review the available studies, data and literature pertinent to this request. Among others, this review should document the survivability of released undulate rays under commercial fishing conditions.

   This is addressed in Sections 1 and 2

2. Compatibility of the measures proposed with the precautionary approach: (a) The STECF is requested to indicate whether those management measures are compatible with the precautionary approach; and (b) If possible, the STECF is also requested to identify for the point 2a. above (i) the change in terms of fishing mortality that will be applied to each stock, and (ii) the implications for the development of each of the stocks.

3. Management options compatible with the precautionary approach: If the answer to point 2a is negative, the STECF is requested to propose alternative settings for the management measures proposed by the French authorities that are compatible with the precautionary approach. In particular, taking account of the catches of the vessels that would possibly catch and land the undulate ray, the STECF is requested to indicate whether the allocation of a percentage bycatch is compatible with the precautionary approach.

4. Optimal combination of measures: In light of the results of point 3 above, as appropriate, the STECF is requested to comment on the combination(s) it deems optimal. To this end, the STECF should take account of the combination(s) of measures that maximise the economic return obtained from undulate ray stocks while keeping the fishing pressure at the lowest possible level.

   Objectives 2–4 are addressed in Section 3

5. Comments on the code of practice: The code of practice is not ready for assessment and the STECF is requested to provide indications as to what this document should contain to maximise survival of discarded rays in general. The undulate ray should be treated separately, if appropriate.

   This is addressed in Section 4

2. Summary of recent scientific studies and literature

This section addresses the first terms of reference.

The biology of undulate ray was reviewed by Ellis *et al.* (2012a) and recently updated by Pereira *et al.* (in press). The controversial prohibited listing and cessation of fishing opportunities has catalysed a variety of applied studies on this species over much of its Atlantic range. This is evidenced by the various working documents submitted to the ICES WGEF that have provided information on the species in recent years (Delamare *et al.*, 2013; Leblanc *et al.*, 2013, 2014; Serra-Pereira *et al.*, 2013; Stéphan *et al.*, 2013, 2014; Biais *et al.*, 2014; Figueiredo *et al.*, 2014; Silva *et al.*, 2014).

2.1 English scientific investigations (VIId,e)

Recent investigations on undulate ray undertaken by CEFAS have included work to better understand the potential discard survival of skates and rays, during which time field work focused on grounds where undulate ray were locally common, so as to also allow improved data collection for undulate ray (Ellis *et al.*, 2012a,b). These studies have confirmed undulate ray to be one of the main species in the skate assemblage around parts of the Isle of Wight and Channel Islands. The vitality of undulate ray was generally high in the fisheries examined (coastal netters and otter trawlers), indicating low at-vessel mortality, but survival decreased in the beam trawl fleet.

For tangle nets, Ellis *et al.* (2012b) reported that "*soak times of approximately 24 hrs resulted in low levels of mortality (at least in the short-term), with only 0.8–1.7% of skates*[1] *considered to be dead (or near dead) when the gillnets were retrieved. When soak time increased to >40 hours, then the proportion of skates considered dead increased to just over 12%. It should be noted that these values do not include any post-capture mortality*".

In terms of otter trawlers, Ellis *et al.* (2012b) found that "*No skates were dead on capture, although one specimen of blonde ray was badly damaged and recorded as near dead (this specimen was not tagged). Of the 332 rays released, 33% were considered lively and 67% considered sluggish. Overall, for tows of less than 2 h duration, the majority of skates were rated as 'lively, and for tows 2–4 h duration, the majority were rated as 'sluggish'. Although anecdotal, it was noted that in the few catches where a lot of kelp was taken, that fish appeared to be in a better condition, possibly because they were protected from abrasion in the cod-end and/or kept moist whilst on deck*". Undulate ray was the second most abundant species in this study.

Mark-recapture data confirm that released skates can be recaptured in subsequent months and years, so indicating a degree of survival, but estimates of post-release mortality are not available. It should also be noted that the prohibited listing probably deterred fishers from returning information on tagged undulate ray, and so the return rates for undulate ray would be expected to be low.

Whilst estimates of post-release mortality are not available yet, it confirms that at-vessel mortality is low. This indicates that skates and rays can be released alive from these coastal fisheries. Other studies examining the discard survival of skates and rays have also reported high (>50%) survival (see Ellis *et al.*, 2014 and references therein).

CEFAS scientists continue to collect data on undulate ray on trawl surveys, whereby lively individuals are tagged and released, and moribund fish subject to biological investigations. Whilst this has allowed the collection of some maturity information (McCully *et al.*, 2012), more detailed studies on the length at maturity, fecundity and reproductive cycle are needed.

[1] All rajids combined

There have been some preliminary analyses of some tagging data (Ellis *et al.*, 2011), but the prohibited listing of undulate ray has meant that fishers could not retain and land tagged individuals, thus compromising some scientific investigations.

Most recently, data collation and field studies were used to collect information on the occurrence of juvenile undulate ray along the south coast of England, in order to better understand nursery grounds.

2.2 French scientific investigations (VIId,e; VIIIa,b)

A number of recent French studies on undulate ray were carried in three national projects funded by FFP (France Filière Pêche France, http://www.francefilierepeche.fr/).

Estimation of landings before the ban and socio-economic impact: A socio-economic study of the impact of the ban of undulate ray landings was carried out for the French Atlantic coast (Delamare 2014). This study analysed landings of skates and rays from 2003 to 2011 from La Turballe to St Jean de Luz. Before 2009, undulate ray was not recorded separately in fish auction markets. Times series of landings by port and gear for categories such as "miscellaneous rays" and "other rays", which included undulate ray before 2009, were treated taking into account the increasing proportion of landings that were recorded by species from 2009. The total sales were about 566 tonnes and 547 tonnes in 2007 and 2008 respectively and fell to 206–343 tonnes in 2009–2011. The bulk of the drop in landings occurred in La Cotinière, a port located in the Central Bay of Biscay. The study ascribed this drop of ray landings to the ban of undulate ray landings (Delamare, 2014).

In the Normano-Breton Gulf (NBG, Western Channel, ICES Division VIIe) the proportion of the various species in the total landings of rays, mostly reported aggregated was estimated by interviews carried out in 2012. The species composition of the landings before 2009 from these interviews was compared to on-board observations data from 2005 to 2014 and to landings in Cherbourg, where landings by species at the auction market were available for 2008 (Leblanc *et al.*, 2014). Interviews led to an estimate of 74% of undulate ray in total ray landings before 2009. From on-board observations the proportion of undulate ray in the total skate and ray catch was estimated to 50% based upon 1387 fishing operations, and sales of rays at the auction market of Cherbourg in 2008 were made up of 58% undulate ray. Spatial analysis of interview and on-board observations both suggest that the NBG is the main area of abundance of undulate ray in the English Channel. Based on the decline in total landings of skates and rays (all species) from 2007–08 to 2009–10, annual landings of undulate ray before the ban was estimated to be 300 t for the whole of Division VIIe, and 160 t for the NBG. The economic impact of the landings ban was estimated from the contribution of all rays to the total value of sales. Rays were estimated to make up 16%, 11% and 8% of sales of trawlers, netters and longliners respectively, from 2009, these contributions fell to 2.4%, 1.8% and 5% respectively.

In addition to loss of sales, changes in fishing practices were reported as socio-economic impacts. Bottom trawlers and longliners were reported to have stopped fishing in areas were undulate ray is abundant, and netters were reported to have stopped fishing for rays, because undulate ray was the main catch from these vessels when they targeted rays. The interviews suggested that some netters first targeted other ray species before halting completely fishing for rays.

Biology: Length at first maturity has been estimated in the Bay of Biscay and Normano-Breton Gulf. The length at 50% maturity was estimated to 81.2 and 84 cm L_T for males and females respectively, in the Bay of Biscay and to 78.2 and 82.8 cm L_T in the in the Normano-Breton Gulf. These estimations were based on 1695 males and 642 females. Estimates for females were preliminary estimates

(Stéphan *et al.*, 2014). No individual seem to reach maturity before 75 cm L_T, corresponding to 5.1 kg, based on the length-weight relationship or from Dorel (1986)

A length-weight relationship was estimated for the Normano-Breton Gulf as:

$W = 0.00346.\ L_T^{3.118}$

This relationship estimates weights at length very close to those from Dorel (1986) for the English Channel and from Coelho and Erzini (2002) for southern Portugal, but higher weights-at-age were estimated by Serra-Pereira *et al.* (2010) for Portuguese waters.

Tagging was carried out both in the Bay of Biscay and Channel, with about 2500 undulate rays tagged in the Bay of Biscay, and about 1500 in the NBG, of which 7.8 % and 6.8% were recaptured in the Bay of Biscay and Normano-Breton Gulf respectively (Stéphan *et al.*, 2014). All recaptured individuals where caught in the same region where they were tagged. Distance travelled between tagging and recapture travelled did not exceed 80 km and were mostly less than 20 km. Distance travelled did not appear correlated to time at liberty.

On-going analyses of tag-recapture data in the RECOAM project suggest that observed growth of recapture rays in French waters is consistent with von Bertalanffy growth parameters estimated in Portuguese waters (Eric Stéphan, APECS, pers. comm.). Mean length increment per year of individuals larger than 80 cm seem to be around 3 cm only.

Estimation of abundance: Abundance was estimated in the Bay of Biscay only. Based on tag-recapture data, the biomass of undulate ray larger than 65 cm L_T was estimated between 51 and 70 tonnes in the outer Gironde estuary and 87 to 120 tons in the Central Bay of Biscay between latitudes of about 45°12 and 46°24.

Survey indicators: Owing to its coastal distribution undulate ray is not caught is large quantities in trawl surveys carried in the Celtic Seas and Biscay-Iberian ecoregions by England, Ireland, France, Spain and Portugal. In these surveys, the catch are only occasional and do not inform much on abundance trends.

Nevertheless, one of the surveys that reports undulate ray frequently is the French Channel groundfish survey (CGFS), which is carried out in the eastern Channel (ICES Division VIId; 1988–present). The sampling plan of this survey has been the same over time. Because the number of specimens caught each year is low, it may not be reliable to inform on short term trends. However, aggregating several years allows abundance trends to be inferred. Occurrence of undulate ray in this survey by groups of 6 years were plotted (Fig. 2). The last period, 2009–2014 corresponds to years since the landings ban of this species. In this period, undulate ray was caught in a higher proportion of hauls than previously (Table 2), and hauls with catch were more widespread throughout the eastern Channel, suggesting a larger occupied habitat than previously. It should be noted than the first group of years includes only 3 years instead of 6. The proportion of hauls where the species was caught was significantly higher during the six last years than previously (Table 2). Using groups of 3 years instead of 6, suggests a larger increase in the proportion of hauls where the species was caught, close to 10% (Annex 1).

The central Bay of Biscay, where a mark-recapture estimate of the biomass was done, may correspond to the area where undulate ray is most abundant and include la Cotinière where the highest landings were estimated, but the distribution of the species in the Bay of Biscay is larger.

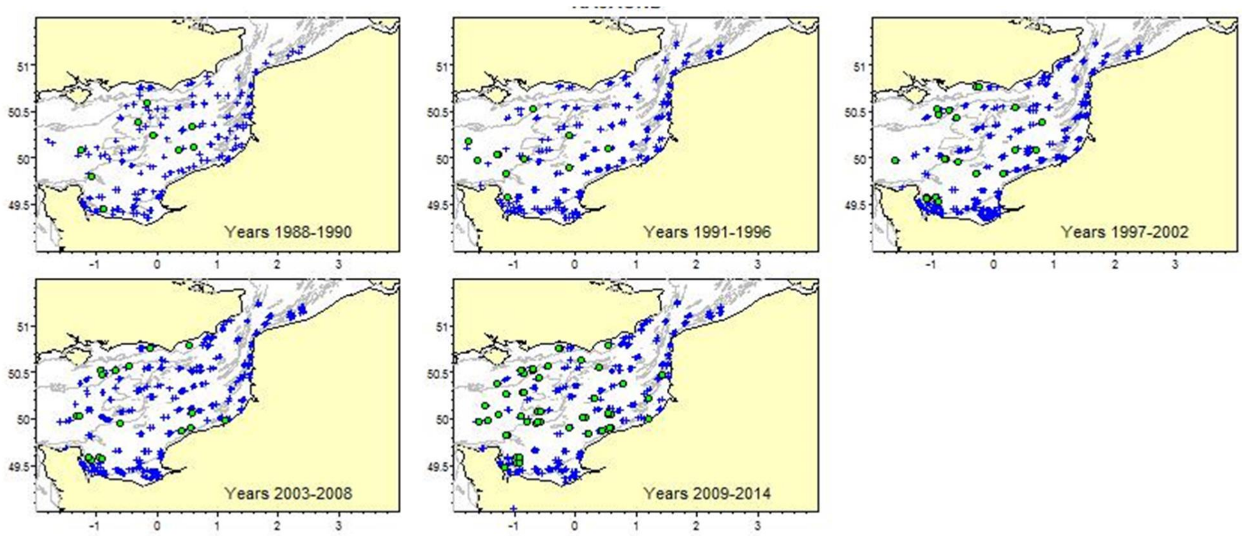

Fig. 2. Occurrence of undulate ray in the eastern Channel (CGFS survey) for the years 1988–1990, 1991–1996, 1997–2002, 2003–2008 and 2009–2014. Blue crosses represent hauls without catch of undulate ray and green circle hauls with catch.

Table 2. Indicator of occurrence of undulate ray in the eastern Channel from the CGFS survey 1988–2014.

Years	Number of hauls	Number of haul with catch	Mean number in hauls with catch	Variance of the mean number	Proportion of haul with catch	Variance of the proportion
1988–1990	204	9	1.11	0.11	0.044	0.0002
1991–1996	445	12	1.33	0.79	0.027	0.0001
1997–2002	587	25	1.32	0.31	0.043	0.0001
2003–2008	618	22	1.41	0.35	0.036	0.0001
2009–2014	611	59	1.55	1.31	0.097	0.0001

<u>Estimation of the effect of the envisaged measures based on on-board observation in the Western Channel VIIe</u>: Estimations were made using the cost R-package. COST is an international data format for Sampling, Landings, and Effort Data from Commercial Fisheries (Jansen et al., 2009) and an R-package for data analysis (http://www.ifremer.fr/cost/Software-Packages.).

The catch of undulate in observed fishing operations in VIIe was analysed for two métiers: bottom trawl targeting demersal fish (OITB-DEF) and trammel nets targeting demersal fish (GTR-DEF). The observed length distributions in those metiers from 2011 to 2013 are shown in Annex 1.

Bottom trawlers targeting demersal fish caught similar sized undulate ray in 2011–2013. Undulate ray larger than 78 cm made up 15 to 23% of the total number caught and 44% to 61% of the weight per year (Table 3). Bottom trammel nets caught a much higher proportion of larger skates, with about 90% of the catch of undulate ray in this métier comprised of individuals larger than 78 cm L_T (Table 4).

The length distribution from these on-board observations are consistent with the other data and knowledge of the studied métiers. Bottom trawling targeting demersal fish catch undulate rays from all the size range of the species, large individual make up a same proportion in number by significant in weight. Trammel net catches include mostly large rays.

Table 3. Observed catch in number and weight of *Raja undulata* in ICES Division VIIe from bottom trawlers targeting demersal fish (OTB_DEF). Observed total catch in number and weight, estimated number and weight of undulate ray larger than 78 cm L_T.

Year	Total number	Total weight(t)	Number ≥78 cm	%	Weight(t) ≥78 cm	%
2011	373 213	849.0	86 427	23.2%	373.2	44.0%
2012	445 843	664.6	74 349	16.7%	347.7	52.3%
2013	733 726	756.6	108 305	14.8%	462.3	61.1%

Table 4. Observed catch in number and weight of *Raja undulata* in ICES Division VIIe from trammel netters targeting demersal fish (GTR_DEF). Observed total catch in number and weight, estimated number and weight of undulate ray larger than 78 cm L_T.

Year	Total number	Total weight(t)	Number ≥78 cm	%	Weight(t) ≥78 cm	%
2011	440	2	380	86.4%	1.9	95.0%
2012	441	1.9	358	81.2%	1.7	89.5%
2013	2112	9.4	1656	78.4%	8.3	88.3%

Mean catch per day of métiers sampled in the western Channel were calculated. Daily catches in excess of 100 kg of undulate ray large than 78 cm L_T were observed in a few métiers only, mostly trammel nets targeting skates and rays and trammel nets targeting demersal fish. Catches in excess of 100 kg/day were only observed in a small proportion of bottom trawling fishing trips.

This analysis of on-board observations suggest that with the fishing practice used in 2011–2013 in the western Channel, daily catches in excess of 100 kg of undulate larger than 78 cm L_T are scarce, and represent bycatch. This does not represent the effect of changing fishing strategies that could arise from a change in the regulation for the species. Observed catches in excess of 100 kg/day were from small coastal fishing vessels that, under any possible provision for landing bycatch, could also be subject to additional rules such as a seasonal closure.

Spatial distribution of undulate rays along French coasts: The spatial distribution of undulate ray can be appraised from fisheries and the participatory science project of APECS CapoeRa (http://www.asso-apecs.org/Les-premiers-resultats-nationaux.html), where elasmobranch egg capsules are collected by voluntary people (these samples are usually from the strand line on beached). The geographical distribution of samples (one sampling is one egg capsule harvest from one person in one day and one location) and the spatial distribution of the number of undulate rays capsules collected show a quite similar number of samples collected along the coast of the western Channel and Northern Bay of Biscay (corresponding to ICES Divisions VIId and VIIIa) with slightly more samples in the central Bay of Biscay. There are fewer samples along the coasts of the eastern Channel and southern Bay of Biscay (VIId and VIIIb). The distribution of the number of undulate ray capsules clearly show that the Normano-Breton Gulf and the central Bay of Biscay are two main areas of abundance (Fig. 3). Egg capsules are found along of the northern and southern coasts of Brittany but clearly in smaller numbers for a similar sampling intensity. These data confirm that stock units used by ICES with two distinct stocks in the Channel and Bay of Biscay are appropriate.

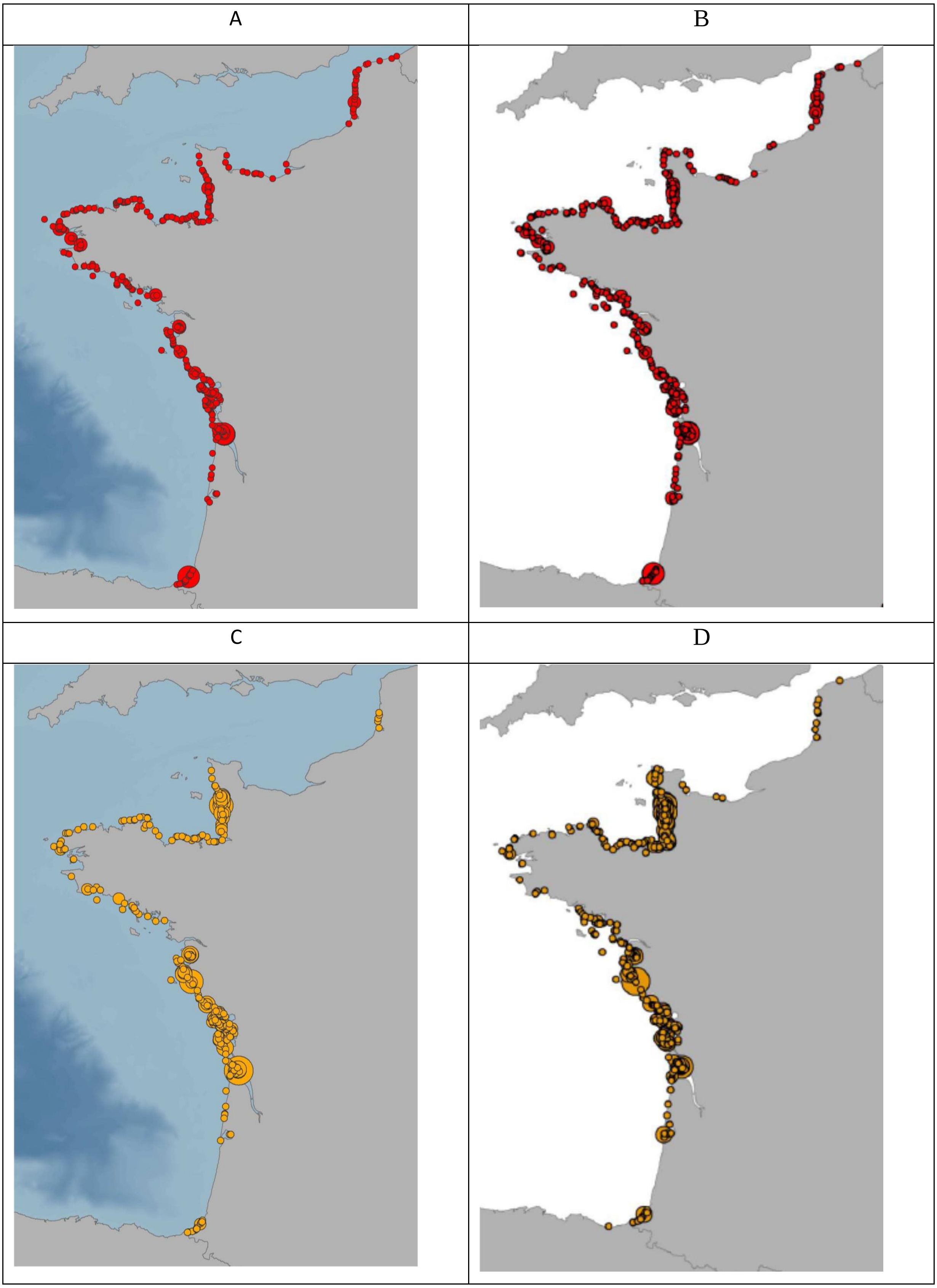

Fig. 3. Spatial distribution of egg capsule collections in 2011 (A) and 2012 (B), and numbers of egg capsules of undulate ray recorded in 2011 (C) and 2012 (D). Maps from APECS (2011, 2012).

CAMANOC survey: In the western Channel, undulate ray is not abundant in offshore waters and in was not caught in high number during the CAMANOC survey, a bottom trawl survey undertaken for the first time in 2014 (Fig. 4). This survey did not sample the shallow waters in the Normano-Breton Gulf and along the Northern Brittany coast. During the same survey the species was caught in the eastern channel. It is likely that owing to the shallow habitats and freshwater influx in the eastern Channel, suitable habitats for undulate ray extend further offshore in the eastern Channel than elsewhere, at least for large adult caught in the CGFS survey. Ellis et al. (2012) reported that the larger individuals are caught deeper/more offshore.

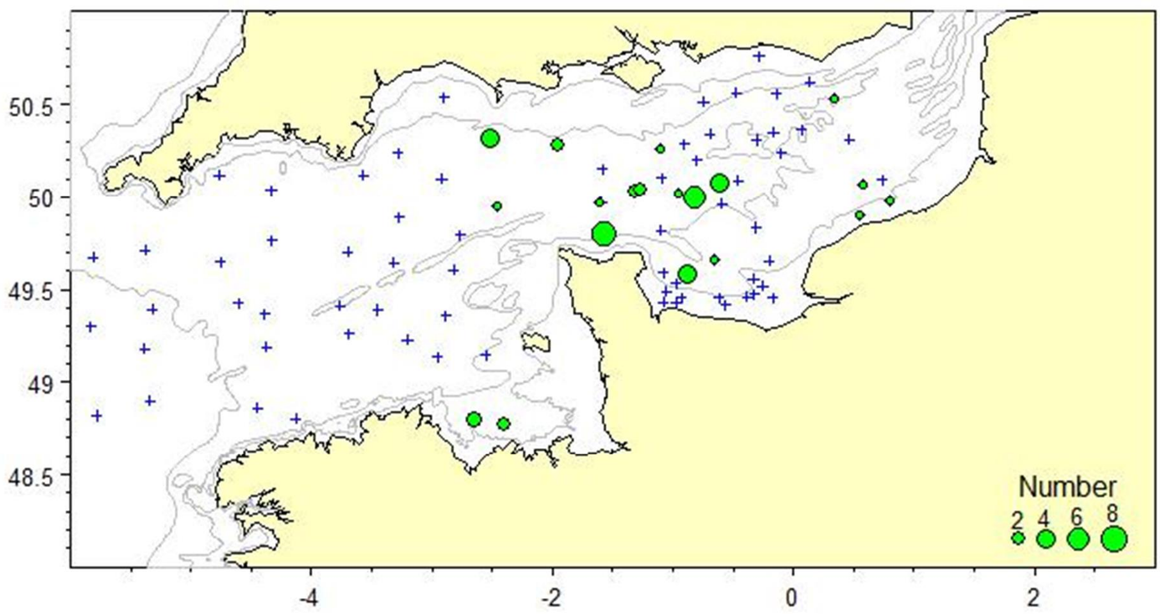

Fig. 4. Number of undulate rays per haul during the 2014 CAMANOC survey.

2.3 Portuguese scientific investigations (IXa)

Recent scientific studies carried out by IPMA have focused on the distribution and biology of *Raja undulata* in the coastal waters of the Portuguese mainland. In this region the species occurs along the continental shelf, being more frequently caught on specific grounds associated with sandy or coarse sandy bottoms (Serra-Pereira *et al.*, 2014), not geographically detailed yet, north off Matosinhos and Aveiro, in the centre of Peniche, in the southwest coast off Setúbal and in the south Algarve (Fig. 5).

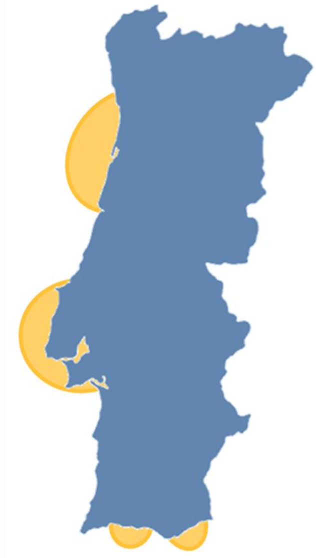

Fig. 5: Portuguese continental coast (ICES IXa) – Known areas of undulate ray concentration

The bathymetric distribution varies from 4 to 128 m deep, but undulate ray is more abundant at depths ranging from 30 to 40 m. Egg-laying sites are located between 10 and 55 m, but preferentially on grounds shallower than 30 m. Estuaries and coastal lagoons are likely to be important habitats for the species, particularly to newborn/juveniles and egg-laying females where both groups tend to concentrate during some periods of the year. Juveniles were recorded in the outer estuary of the Tagus (centre of Portugal) and within the Ria Formosa coastal lagoon (south of Portugal). Table 1 summarizes the main biological information available for *Raja undulata* in Portuguese waters.

A qualitative assessment of the health status of the captured specimens of *R. undulata* in Portuguese continental waters was performed using the scale from Enever *et al.* (2009). The assessment of the health status after capture is considered a good indication of the survivorship index of skates. The results obtained indicate that the survivorship of *R. undulata* after capture is high. The size of the specimens seems to be the variable with more influence in the survivorship of *R. undulata*. Although for both length groups, <50 cm and >50 cm $\mathbf{L_T}$, the percentage of individuals with "good" health status is high (83% and 92%, respectively), smaller individuals (<50 cm $\mathbf{L_T}$) showed a higher percentage of "poor" health condition. In general, for different soaking times and mesh sizes the survivorship of *R. undulata* is always very high (>82%).

The lack of accurate Portuguese fishery dependent data on skates and rays, particularly in relation to species identification, hinders the availability of historical fishery data, which is crucial to assess the status of the stock. The very coastal nature of this species further contributes to the scarcity of survey data available from Portuguese research vessel surveys that are not designed to inform on the status of more coastal species. To circumvent these deficiencies, in 2014 IPMA initiated a research project (UNDULATA), which focuses on the study of *R. undulata*. This project was constructed considering the actual EU regulation and it aims to contribute with relevant information on the species knowledge, particularly on the current exploitation status of the stock. The project also aims to provide data for the evaluation of alternative management measures, particularly the assessment of different local management measures.

3. Options for managing undulate ray as a bycatch fishery

This section addresses Terms of reference 2–4.

In the north-east Atlantic the status of each different undulate ray stocks is unknown, however our knowledge of the species´ biology and its distribution patterns suggests that, whilst it can be an important species in localised areas, it may potentially be vulnerable to over-exploitation. Hence, management measures that help prevent directed fisheries on undulate ray, including minimising mortality on egg-laying females, could usefully be considered.

In general terms, any management measure has advantages and disadvantages to the sustainability of the stock, to fishers and to enforcement officials. It is important to try and implement management measures that preferentially benefit the stocks of concern (taking into consideration fisher responses to management measures and how they may impact on other elements of the ecosystem) whilst being as pragmatic as possible to fishers and enforcement officials, to try and minimise the difficulties and disadvantages for the fishing industry.

Following on from the proposal submitted, the following management measures were considered:

- Minimum conservation reference sizes
- Trip limits (% of total catch)
- Trip limits (fixed upper limit)
- Seasonal closure

The STECF were also encouraged to consider other options, and so the following additional options for managers were also considered:

- Special fishing permit
- Maximum landing length
- Spatial management

3.1 Minimum conservation reference size

The request to be evaluated suggested "*Measure 1: Fixing a minimum size of conservation of 78 cm. Undersized specimens must be carefully and immediately released*".

Under the reformed Common Fisheries Policy, 'minimum conservation reference sizes' have replaced minimum landing sizes. The benefit to the stock from this management measure, however, does to some degree depend on discard survival and as to whether or not a species is included in the landing obligation. According to the later undersize fish would generally need to be landed, albeit with the proviso that "*the use of catches of species below the minimum conservation reference size shall be restricted to purposes other than direct human consumption*". Whilst it is likely that some Member States will apply for skates (Rajidae) to be exempt from the landing obligation, at least for some of the fisheries, it is not currently possible to state whether they will be included or not.

The adoption of a minimum conservation reference size, with a threshold at about the length at maturity, is likely to contribute to the protection of juveniles and immature fish throughout the whole year, particularly if post-released specimens have a high survival. The potential benefits of this measure include that fishing mortality should be decreased on juveniles and immature fish, so enabling them to reach maturity.

A minimum conservation reference size can, depending on the grounds utilised by juveniles and what other marketable species occur on those habitats, lead to a redistribution of fishing effort. Whilst the distribution of early stage juveniles of undulate ray is insufficiently known, several studies have indicated that 0-groups occur in the shallowest zones as is the case of Portuguese coastal lagoons (e.g. Ria Formosa (south off Portugal) Coelho, 2002) and estuaries (Moura *et al.*, 2007). In some areas, there is little fishing effort on these shallower grounds due to the preponderance of smaller fish and the safety implications of operating so close to shore. Hence, for some species, there can be 'de facto' refuges for juveniles in these shallow waters.

Potential issues for a minimum conservation reference size are whether it simply directs fishing mortality to larger fish, which may include larger females. For elasmobranchs, where recruitment is widely assumed to be closely dependent on the female spawning stock biomass, then any measures that may re-direct fishing mortality to that demographic stage may not have the desired consequences to the stock.

It should also be noted that for many fisheries, even if there is no legal minimum size, there is often a minimum marketable size. Smaller individuals are often of lower market value than adults, and as juvenile skates do not generally have thick pectoral fins (the primary location of marketable flesh), then the loss of revenue to fishers is generally acceptable.

Another issue to be considered is having equitable and consistent management measures. Several Sea Fishery Committee's around the coast of England (now replaced by Inshore Fisheries and Conservation Authorities, IFCAs) have had bylaws stipulating a minimum landing size for all skates and rays (typically 40–45 cm disc width), and in order to enable there to be a 'level playing field', it would be pragmatic for any new 'regional' size restrictions to be allied to existing measures.

Silva *et al.* (2012) showed that, for English fleets, skates are generally discarded when <40 cm L_T , with 50% retention occurring at about 50 cm L_T and full retention by about 60 cm L_T (Fig. 6).

Furthermore, there would need to be consideration as to what would be the most effective species-specific size restriction for skates (total length or disc width). Total length is the main unit of measurement used by scientists, whilst fishers often consider disc width, especially as the tips of the tail and caudal fin can sometimes be damaged.

Preliminary studies (Cefas data) on the relationship between total length (L_T) and disc width (D) for undulate ray in the English Channel indicate the following relationships:

$D = 0.5648.L_T + 4.713$ (n = 331, $r^2 = 0.9685$)

$L_T = 1.7147.D – 5.8709$ (n = 331, $r^2 = 0.9685$)

A minimum conservation reference size of 78 cm L_T (the value suggested in the original proposal) equates to a disc width of 48.8 cm disc width, whilst a disc width of 40 cm equates to a total length of 62.7 cm L_T.

Finally, it should also be noted that skates and rays may be landed as whole/gutted fish, 'butterfly wings' (the wings detached but joined together at the tip of the snout) or as 'wings' (where each pectoral fin is cut off). In the latter cases, it can be more difficult for enforcement officials to determine whether or not there has been infringement of size restrictions.

The *ad hoc* STECF review group considered that the protection of immature undulate ray is an important element of any management plan. Although there are currently insufficient data to fully quantify potential benefits of this measure, minimum conservation reference sizes are often advocated by the fishing industry and so it could be an acceptable management measure. If certain grounds were found to be important spawning/nursery grounds, then spatial management may be an alternative measure to protect immature fish.

In order to ensure comparability with local measures already in force in some of the stock area (see http://www.southern-ifca.gov.uk/byelaws), a minimum conservation reference size of 40 cm disc width could be considered (at least for the undulate ray stock in VIId,e), and this equates with a total length of 62–63 cm.

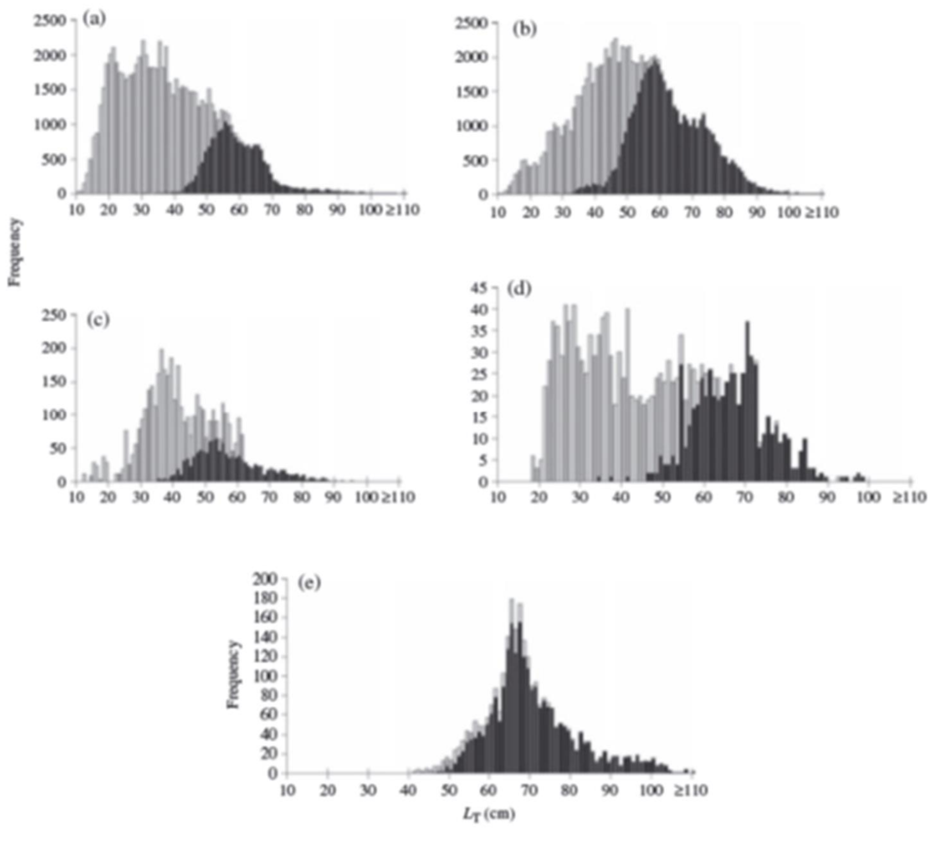

Fig. 6. Total length (L_T) frequency of commercial skates discarded (grey columns) or retained (black columns) taken in English fisheries (a) beam trawl, (b) otter trawl, (c) *Nephops* trawl, (d) gillnets (≤150 mm mesh size) and (e) gillnets and tangle nets (>150 mm mesh size). Source: Silva *et al.*, 2012.

3.1.1. Case study: Simulation of the effect of a minimum conservation reference size of 78 cm on an undulate ray stock

In order to further investigate the effect of a minimum conservation reference size (MCR) of 78 cm for undulate rays stocks, a stock dynamic was simulated based upon the life history traits of the species using the generic stock simulator developed by Cefas in FLR (Mosqueira et al. , 2010). This simulation should be considered as exploratory, and further studies of this type should be conducted and benchmarked prior to using for management advice.

The Generic Life History Generator for FLR provides a function (genBRP) for generating a biologically plausible age-structured stock based on only a small number of parameters: length-weight relationship, growth curve, ages at 50% and 95% maturity, stock-recruit relationship and fishery selectivity.

The stock recruitment relationship was assumed to follow a Beverton-Holt model, in which case it is determined by the unexploited spawning stock biomass (SSB0) and the steepness, i.e. the ratio of expected recruitment at 20% of SSB0 to expected recruitment at SSB0. The natural mortality was estimated based on size-mortality relationship from Gislason et al., (2008).

Parameters used are given in Table 5. The length-weight relationship was taken from Dorel (1986) for the English Channel, and weights at length from this relationship are very similar to those observed in recent French projects. The growth curve was taken from Coelho and Erzini (2002). Slightly different growth parameters from Moura et al. (2008) gave a similar growth. Observed growth during liberty time of tagged undulate rays in recent French project are compatible with these growth parameters. Although the growth in the English Channel or Bay of Biscay is expected to be different, in statistical terms, from Portuguese waters owing to different environmental factors, the compatibility of the growth estimates from Portuguese waters and observed growth in French waters suggests that the likely geographical variations in growth do not make the stocks dynamics much different. The ages at 50% and 95% maturity were calculated from the growth curve and observed length at maturity. The stock-recruitment relationship and fishery selectivity are unknown for undulate ray.

There are few data on stock recruitment relationships in elasmobranch. Simulations were made with two contrasting assumptions: steepness (conventionally defined as the proportion of unfished recruitment produced by 20% of unfished spawning biomass) of 0.75 and 0.40 as well as an intermediate s=0.6. The first value (0.75) would be a relatively moderate value for a bony fish, but is considered unlikely for skates, because of the limited number of egg capsules spawned per female. Such steepness would imply that at low stock size the survival of eggs capsules and juveniles is much improved. This could arise from density-dependent mortality. In this case, at lower stock abundance, juvenile ray survival could be improved by at least two factors: (1) habitat availability and (2) reduced predation mortality. The habitat availability factor is likely to operate for undulate ray because adult rays, egg capsules and juveniles all occur in the same areas. When the stock is at high level, i.e. close to carrying capacity, juveniles may have to search, possibly to migrate away, for available habitats. The predation mortality factor does not imply cannibalism, but rather that when all fish stocks are exploited, the biomass of large predators susceptible to predate upon small rays in the size range 13–40 cm is reduced. The biomass of such predators may be around 40% of unexploited levels if all stocks are around B_{MSY}. As the current biomass of large demersal fish populations might be mostly below B_{MSY}, a reduced predation mortality of juvenile undulate ray, with respect its level in an unexploited fish community, may currently prevail. The second value of steepness (0.40) was estimated for *Raja rhina* from the Northeast Pacific (Punt and Dorn, 2014). This is the only steepness estimate found for a skate. *R. rhina* is a larger species than *R. undulata*, it may therefore have a lower steepness. Values of steepness below 0.4 hardly allow a fish stock to sustain any exploitation. The 0.6 steepness would be low value for a bony fish, possibly applying to low resilience species (see Punt and Dorn, 2014) and could be a sensible value for an elasmobranch.

Table 5. Input parameters used to simulate an undulate ray stock.

Growth parameters:

Parameter		Source
Length-weight relationship		
a	0.00415	Dorel (1986)
b	3.124	Dorel (1986)
Growth		
L_∞	109	Coelho and Erzini (2002)
K	0.11	Coelho and Erzini (2002)
Natural mortality	Eq. 1	Gislason et al. (2010)

[illegible] = [illegible] 1 + [illegible] [illegible]a[illegible] (Eq. 1)

Where: *M1* = 0.1 accounts for size-independent mortality, L_∞ and L_a are the asymptotic size and lthe length at age *a*, h = 1.71, I = 0.8 and n= –.166 are the parameters for the power function that scale predation with body size.

Selectivity at age: Simulations were run with fishing mortality-at-age which is the product of a single value multiplied by a fishing pattern, i.e. a selectivity-at-age. To set the selectivity at age before 2009, it was considered that rays larger than 50 cm L_T used to be landed. In the growth model, age 5 corresponds to 46 cm L_T. It was then assumed that rays of age 1–3 were not selected, rays of age 4 were 10% selected, age 5 50% and older ages 100%. This fishing pattern is further referred to as fishing pattern 1. It is roughly consistent with observation from Silva et al. (2012) described in section 3.1 of this report. Undulate ray reaches a size of 78 cm L_T at ages between 11 and 12 (Annex 1). As a consequence, the option to set a minimum landings size of 78 cm in 2015, was modeled by a selectivity-at-age of 0, 0.1, 0.5 and 1 for ages 1–9, 10, 11 and 12 and older respectively. This fishing pattern is further referred to as fishing pattern 2.

Simulations were run over 100 years. The first 50 years were used to generate assumed conditions in 2009. The state of the stock in 2009 was defined by the ratio of the SSB in 2009 to the virgin SSB (SSB_v). Two levels of SSB2009/SSB_v where simulated: SSB_{2009}=10% SSB_v and SSB_{2009}=20% SSB_v. These levels were chosen based on the assumption that the stock status justified the landings ban in 2009. These levels correspond to levels well below B_{MSY} and clearly to levels where management actions are needed. The fishing mortality in the 50 first simulated years was set to drive the stock at these levels under fishing pattern1. The fishing mortality in years 51 to 56 was set to 0 to simulate the landings ban. After year 57 the fishing mortality was set either to $F=F_{MSY}$ for fishing pattern 2 or to the mortality at age that had driven the stock to its (simulated) 2009 level multiplied by the selectivity-at-age of fishing pattern 2. The input parameters and assumptions on the stock status were combined to define a few scenarios (Table 6).

Simulations were made fully deterministic. Owing to the absence of data on variance of the growth, recruitment, and fishing mortality, it was considered that adding uncertainties would be fully assumption based. It is however noted that the biology of skates, spawning a small number of large eggs suggests that recruitment variability is not large.

Table 6. Simulated scenarios of a stock of undulate ray, *s* (steepness parameter of the Beverton-Holt stock recruitment relationship), SBB_{2009}/SSB_v and associated results (estimate of the ratio of SSB_{MSY}/SSB_v), F_{MSY} under the fishing patterns 1 and 2 (FP1, FP2), biomass increase after 6 years without fishing, level of biomass reached at the end of these 6 years representing years 2009–2014.

Scenario	B-H steepness (S)	SBB_{2009}/ SSB_v	SSB_{MSY} /SSB_v	F_{MSY} (FP1)	F_{MSY} (FP2)	Biomass increase 2009–2015	SSB_{2015}/ SSB_v
A	0.4	10%	40%	0.03	0.06	38%	14%
B	0.4	20%	40%	0.03	0.06	28%	28%
C	0.6	10%	33%	0.06	0.13	95%	21%
D	0.6	20%	33%	0.06	0.13	66%	35%
E	0.75	10%	28%	0.08	0.3	132%	26%
F	0.75	20%	28%	0.08	0.3	85%	40%

The two selectivity-at-age simulated before and after 2009 implies different F_{MSY}. It is obvious that when there is no fishing mortality before the age of first maturity, the stock can sustain a higher F for adult fish (Table 6). Incidentally, under all scenarios, the stock biomass increased during the landings ban (set here to years 51–57). When fishing resumes (year 58 represents 2015), the SSB continues to increase in most scenarios. Fishing at MSY would allow the stock to increase as long as it is below B_{MSY}. (Fig. 7, panels Fig. A,C,E). However, for S = 0.6 and 0.75, the stock reaches an SSB higher that SSB_{MSY} after 6 years without fishing mortality, and so decreases again when fishing is resumed. In these scenarios (S = 0.6 and 0.75) F_{MSY} is close to $F_{30\%SPR}$, the level of F which drive the SSB per recruits to 30% of the unexploited level.

Fishing adult fish with the fishing mortalities which drove the stock to 10–20% of SSB_v but with no fishing mortality on juveniles (up to age 9 which and increasing catchability for ages 10–12) always allowed the stock to further increase. For s = 0.6 and 0.75, these fishing mortalities are smaller than F_{MSY} and the stock increases above B_{MSY} (Fig. 7, panels D, F). For, s = 0.4, the fishing mortality is slightly higher than F_{MSY} but still allows the stock to further rebuilt from the level reached after the 6 years without fishing (Fig. 7, panel B).

The main result of these simulations is that, if the fishing mortality that prevailed before 2009 is resumed from 2015 at the same level for individuals larger than 78 cm (here considered to be between ages 11 and 12), without fishing mortality on smaller individuals, an undulate ray stock should increase. This applies to the three simulated scenarios for steepness. Although the fishing mortality for these stocks in unknown, a management measure that allows the same mortality for adults and protects juveniles should be operational, even if the species has a steepness as low as 0.4.

These simulations, however, have a number of shortcomings. They were designed to appraise what could be the trajectory of undulate ray stocks by considering that the stock had been overexploited, which is not known, and under the possibility of a resumption of exploitation. The simulations were based upon available life history data for the species. It is particularly noteworthy here to remind that the growth increments of the few tagged rays for which size was reliably measured at recapture is compatible with the growth curve used. The simulations assume that fishing mortality completely stopped for 6 years. This of course did not happen in the real world, where some accidental fishing mortality has occurred. However, there is little doubt that the biomass has increased over the past 6 years. The only area with a reliable survey indicator, the Eastern Channel, confirms this. Similarly, the simulated fishing mortality when fishing resumes is assumed to be 0 for juveniles up to age 9. Of course, some bycatch of juveniles occurs and, whilst survival is assumed to be high, it cannot be 100%. Lastly, the simulated stock was driven to low levels before the landings ban because this is the question of interest.

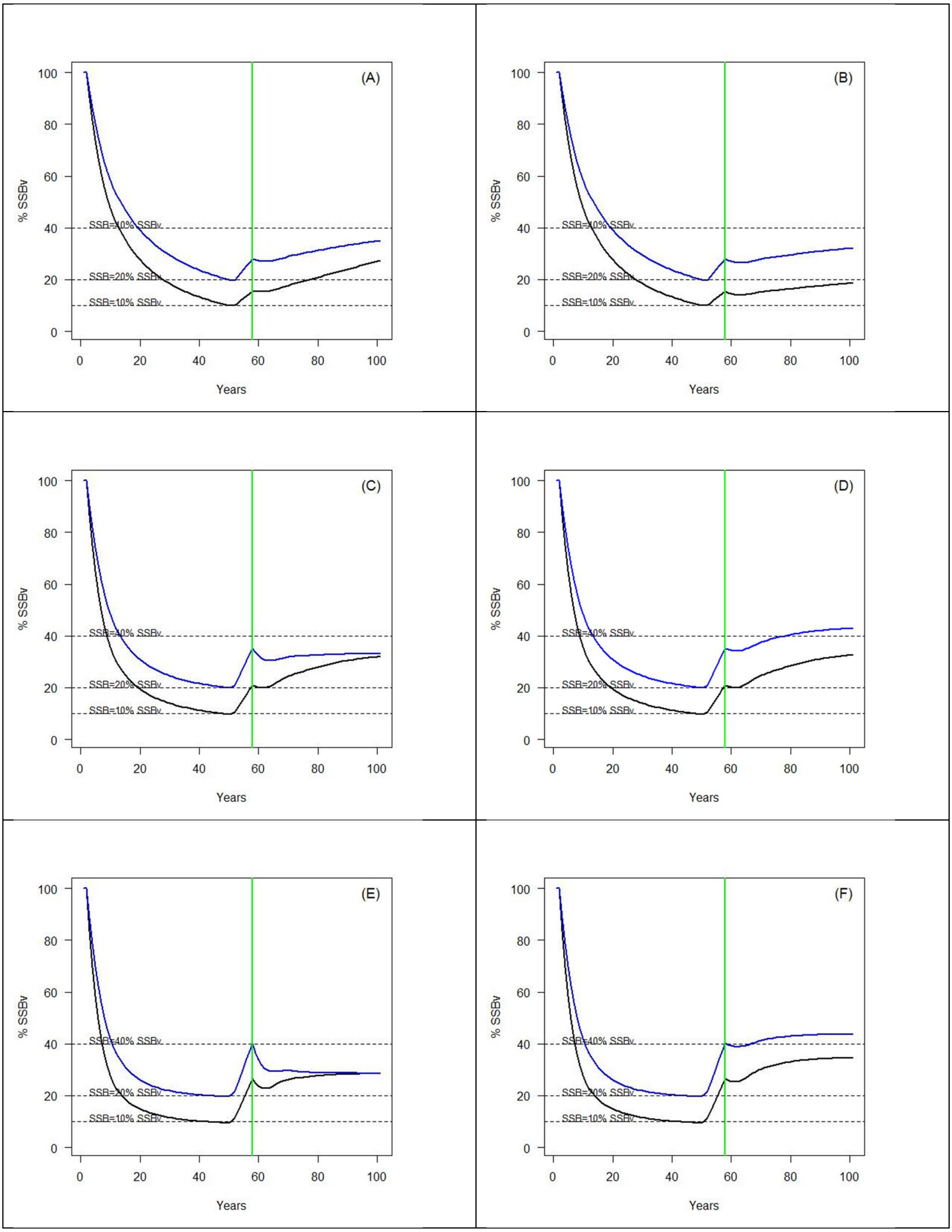

Fig. 7. Simulation of the trajectory of the estimated spawning biomass of an undulate ray stock, assuming steepness of 0.4 (panels A–B), 0.6 (panels C–D) and 0.75 (panels E–F). The fishing mortality from 2015, is assumed to be either F_{MSY} (panels A, C and E) or the fishing mortality at age prevailing before 2009 (which drove the stock to 10% or 20% of SSB_v) (panels B, D and F).

3.2 Trip limits

The request to be evaluated suggested:

- *Measure 2: Landing a maximum of 1 to 10% of the total catches per trip. Each step of the scenario between 1 to 10% should be evaluated.*
- *Measure 3: Setting a threshold of 20 to 100 kg of raja undulata after which a total allowed of catches can be authorized to be landed. The different thresholds should be evaluated in relation to the fleet segment and the fishing areas.*

Trip limits are a potentially valuable and pragmatic tool for preventing targeted fisheries, whilst allowing some bycatch to be landed. There are generally two approaches to implementing such trip limits, setting a provision of an absolute quantity (weight or numbers, depending on the fishery) per unit time (typically per trip or per day), or setting the limit as a proportion of the total catch.

Examples of these approaches include the United Kingdom's Tope order, whereby vessels are subject to national legislations that ensures catches of tope do not exceed 45 kg (total live weight) per day. Another example, is the European management of fisheries taking skates and rays in the North Sea, which are subject to a bycatch quota whereby skates and rays "*shall not comprise more than 25 % by live weight of the catch retained on board per fishing trip. This condition applies only to vessels over 15 metres' length overall*" (CEC, 2014).

There are, however, several problems with trip limits defined as a proportion of the catch on board. Firstly, it can encourage increased retention of non-target fish (including accumulating bycatch between successive trips) to maximise the retention allowance of the species subject to limits.

Secondly, it can be problematic for commercial vessels using certain gears (e.g. nets and longlines), as it is difficult to apply the measure as, for example, if a fisher catches a certain quantity of a bycatch quota species when retrieving a first fleet of gillnets, it is not possible to know what else will be caught in the remaining set gears. If fish are retained initially, but then the bycatch allowance quota is exceeded, then fish would be discarded dead. Furthermore, if a vessel sets some gear on grounds where a bycatch quota species occurs, and other gear where that species is uncommon, hoping to have the correct percentage at the end of the trip, but is boarded by enforcement officials after retrieving only some of the gear, the proportion on board may have (temporarily) been exceeded.

Before adopting a trip limit of *x* kg per day there are still major issues to be resolved:

(i) Can an appropriate value of x be identified that will ensure exploitation is sustainable for the stock?

(ii) Is enforcement easier if a trip limit is set per day or per trip?

(iii) Can the theoretical total by-catch landed be estimated for undulate ray, given that different vessels may be involved, catches of some fish can be highly seasonal and the number of fishing days can be limited by weather and tides, and will this value guarantee its sustainability?

Portuguese data collected under the DCF and the Pilot Study on Skates during 2008–2013, indicates that undulate ray is caught more frequently by the polyvalent fleet segment. The frequency of catch rates (captured weight (kg) per trip) based on on-board observations, undertaken during the Pilot Study on Skates, at Torreira and Espinho (located off Matosinhos and Aveiro), Baleal and off Santa Cruz (located off Peniche) and Cabo Raso (located off Cascais) is presented in Fig. 8. Most trips catch <50 $kg.trip^{-1}$.

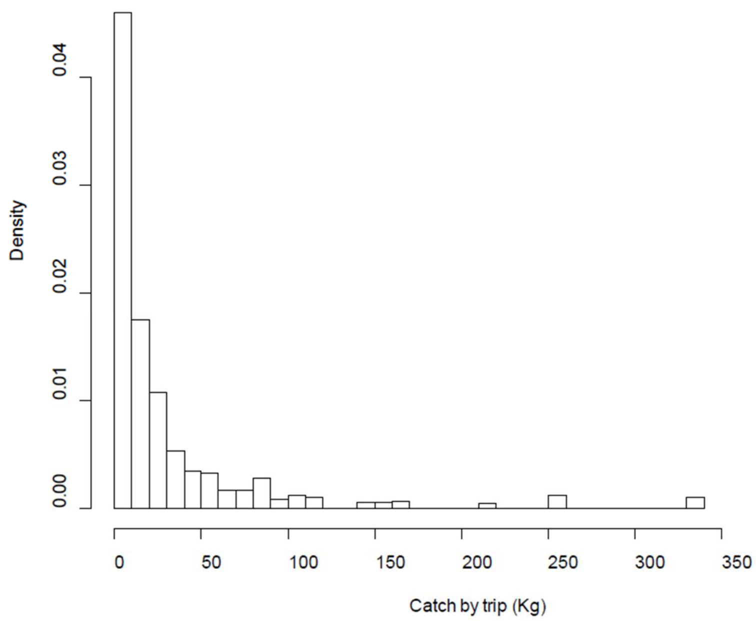

Fig. 8. Frequency distribution of undulate ray catches (kg per trip) as observed in the Portuguese polyvalent fleet operating with trammel nets (2008–2013) in ICES Division IXa.

The *ad hoc* STECF review group considered that trip limits would be an appropriate precautionary management measure to deter target fisheries for undulate ray, whilst allowing a proportion of the bycatch to be landed. Trip limits set as a percentage should not be considered for undulate ray and any trip limits introduced should take the form of a quantitative limit (kg) per trip. Whilst there are insufficient data to determine what this level should be, it could initially be set at a low level (using the precautionary approach) and, depending on subsequent assessments of the stock, be adjusted accordingly. In order to ensure that the levels of exploitation have a better managed upper limit, then trip limits could usefully be used in conjunction with a licensing scheme in order to regulate the number of participating vessels (see 3.4: Special fishing permits), or through establishing a stock-specific quota that cannot be exceeded.

3.3 Seasonal management

The request to be evaluated suggested "*Measure 4: Setting a three months closure fishing period per year*".

Whilst newly hatched and smaller juvenile undulate ray are likely to be most abundant on certain grounds, larger fish may have a larger home range. Nevertheless, adults will often aggregate seasonally for, for example, mating or egg-laying. This allows for some consideration of the options of seasonal (or spatial) management for undulate ray

Undulate ray are thought concentrate during some periods of the year for egg-laying, with females tending to aggregate on sandy banks shallower than 30 m. The adoption of temporary seasonal closures to protect egg-laying females and small juveniles may be more effective than spatial management, as the latter may simply lead to a re-distribution of fishing effort. To propose spatial closure measures more detailed information on the distribution of the stock, as well as impacts on the fleets are required. The rationale for any seasonal closure requires less information (i.e. the proportion of mature females carrying egg-cases per month).

Seasonal management could range from a seasonal closure of a fishery (if the fishery/gear in question was thought to result in high discard mortality) to a 'simpler' seasonal ban on the landing of undulate ray during the spawning season (if discard survival is deemed high). The latter would have less impact on the fleet, and such seasonal management could help minimise fishing mortality on the spawning population and help maximise reproductive output.

As the exact nature of any seasonal management could usefully be related to the local fisheries that may take undulate ray and the discard survival, the impacts of such measures on the local fishing communities could be variable. As such, there could usefully be discussions with local fishers in order to determine the best options for such approaches, which could be done under the remit of regional management, and not as a top-down measure established for all stocks.

Studies have indicated that spawning off western Portugal occurs from February to May, which is broadly similar to that noted for other skates in European Atlantic waters. However, identifying the most appropriate window for a seasonal closure would benefit from further data for the different undulate ray stocks.

The *ad hoc* STECF review group considered that seasonal management was an appropriate precautionary management measure, but that the exact details of the measure would need to be developed following consultation with local fishers. Any seasonal closure of the fishery or a seasonal ban on landing undulate ray would be best targeted to the spawning season, when mature females may come into coastal waters to deposit eggs.

In order to ensure comparability with local measures already in force in Portuguese waters, any seasonal management in IXa should consider the existing Portuguese national legislation Portaria no. 315/2011, which allows the landing of a maximum of 5% bycatch of any skate species (family Rajidae) during May. Any seasonal closure that encompasses May is considered appropriate, but an improved knowledge on peak spawning periods of the various stocks are required to better identify the optimal periods of any seasonal restrictions.

3.4 Special fishing permits

The limited information on undulate ray stocks impedes the quantitative evaluation of the impact of different fishing levels on the stocks that would support advice on bycatch quotas. Undulate ray is a coastal species, and vessels commonly operating close to the coast, which would encounter undulate ray most frequently, can be highly variable in terms of effort (which may be more influenced by weather conditions than the offshore fleet) and many of the vessels in the coastal fleet use different gears, depending on what is locally and seasonally abundant and their market prices. Furthermore, these fleets can be highly variable in the numbers of full-time and part-time vessels. Hence, the adoption of bycatch limits should not be used in isolation and would preferably be supplemented with other technical measures.

Regulation that ensures good control of the fishery and appropriate monitoring needs to be established in order to guarantee that fishing will not have a detrimental and irreversible impact on the stocks. As a result, the merits of issuing a 'special fishing permit' that would allow a selected number of vessels in the coastal fleet (for example, a restricted number of vessels with LOA < 10 or 12m) to land small quantities of undulate ray caught as incidental species. Vessels with such a permit could then be requested to provide appropriate information in order to allow the monitoring of the fishery, including:

- Fishing grounds (latitude, longitude and depth)
- Gear used, gear characteristics and fishing effort
    - For trawl gears, this would include the size of the mesh, type of trawl (e.g. single rig or twin rig), average wing spread and door spread, and trawling time
    - For net gears, this would include the mesh size, length and height of net, total length of nets deployed, soak time
    - For longlines, this would include the number and size of hooks used, bait and soak time.
- Catch of main target species and catch of undulate ray (biomass and numbers retained, and numbers and estimated biomass of discarded undulate ray)

Vessels in any such scheme would be obliged to allow scientific observers on board in order to collect further information on undulate ray (sex and sex composition, biological information). Logbook data and information from observers should allow the collection of adequate data for the monitoring, assessment and management of the stock.

There could also be consideration of establishing a tagging scheme, whereby those vessels with special permits could be trained to tag and release a certain number of fish. The use of tag and recapture information would allow other assessment methods to be trialled.

The *ad hoc* STECF review group considered that management of undulate ray through trip limits should be augmented by another measure to provide an upper limit on total landings. Given the coastal nature of undulate ray, and that the coastal fleets operating on such grounds (vessels <10 m or <12 m LOA) have largely been disproportionately more impacted by the restrictions on this species. Allowing a limited number of these vessels to apply for a 'special fishing permit' to allow small amounts of bycatch to be landed could be a pragmatic way of developing sustainable exploitation whilst developing monitoring and sampling programmes.

3.5 Maximum landing length

Several authors have indicated that there are also potential benefits to protecting the mature female part of elasmobranch stocks. Whilst sufficient data to validate this for undulate ray are lacking, there should be consideration of whether a maximum landing length (MLL) is a potentially useful management option. A maximum landing length can be a useful option when there is a clear sexual dimorphism in size (with females attaining a larger size) and/or there is increased reproductive output (in terms of fecundity and pup size) from the largest females in the population. Hence, such measures have been introduced for certain crustacean fisheries and, in European seas, there was formerly a MLL for spurdog *Squalus acanthias.*

The potential advantages of a MLL is that fishing mortality may be reduced on mature female fish throughout the year in all areas, as long as discard mortality is low. Whilst estimates of discard mortality are not known for all fisheries exploiting undulate ray, the limited data available in conjunction with the coastal nature of the species (with corresponding shorter tow durations and soak times in commercial fisheries) would suggest that discard survival may be high. Some coastal fishermen consider undulate ray to be one of the hardier skates. An additional advantage is that a MLL may help deter vessels operating on grounds where large females aggregate and are predominant.

The disadvantages of a maximum landing length is that it the larger fish to be discarded are often more valuable, and so fishers may not support such measures, although this could depend at the length it is set and the perceived economic loss. Another potential disadvantage of a MLL is that, depending on quantities that can be landed, it may simply redirect fishing mortality on other life-history stages.

As indicated for other management options above, a MLL may not be the most pragmatic and effective management option in all areas, and so discussions with local fishers would be needed to determine the appropriateness of such a measure and the size at which it should be set.

The MLL for spurdog was set at a somewhat arbitrary level (100 cm), which was a length larger than the maximum length of males, and so only benefited mature females. The available data on the length composition of undulate ray does not indicate that there is such a pronounced sexual dimorphism in size (although females generally attain a larger size than males in most elasmobranch species).

Exploratory studies, using data collected under the English discard observer programme (raised catch numbers by sex and length, all gears combined, all areas, but only for the years 2002–2007, so as to avoid periods where restrictive management was in place) are illustrated in Fig. 9. These data indicate that undulate ray >97 cm L_T are usually female (ca. 6% of measured females were ≥97 cm L_T, whereas <1% of the male samples were ≥97 cm L_T). A maximum landing length of 97 cm L_T (which equates with a disc with of 60 cm) should, therefore, provide protection to mature female undulate ray.

The *ad hoc* STECF review group considered that a maximum landing length may be an appropriate precautionary management measure to reduce fishing mortality on larger females, but that the exact details of the measure would need to be developed following regional consultations with local fishers.

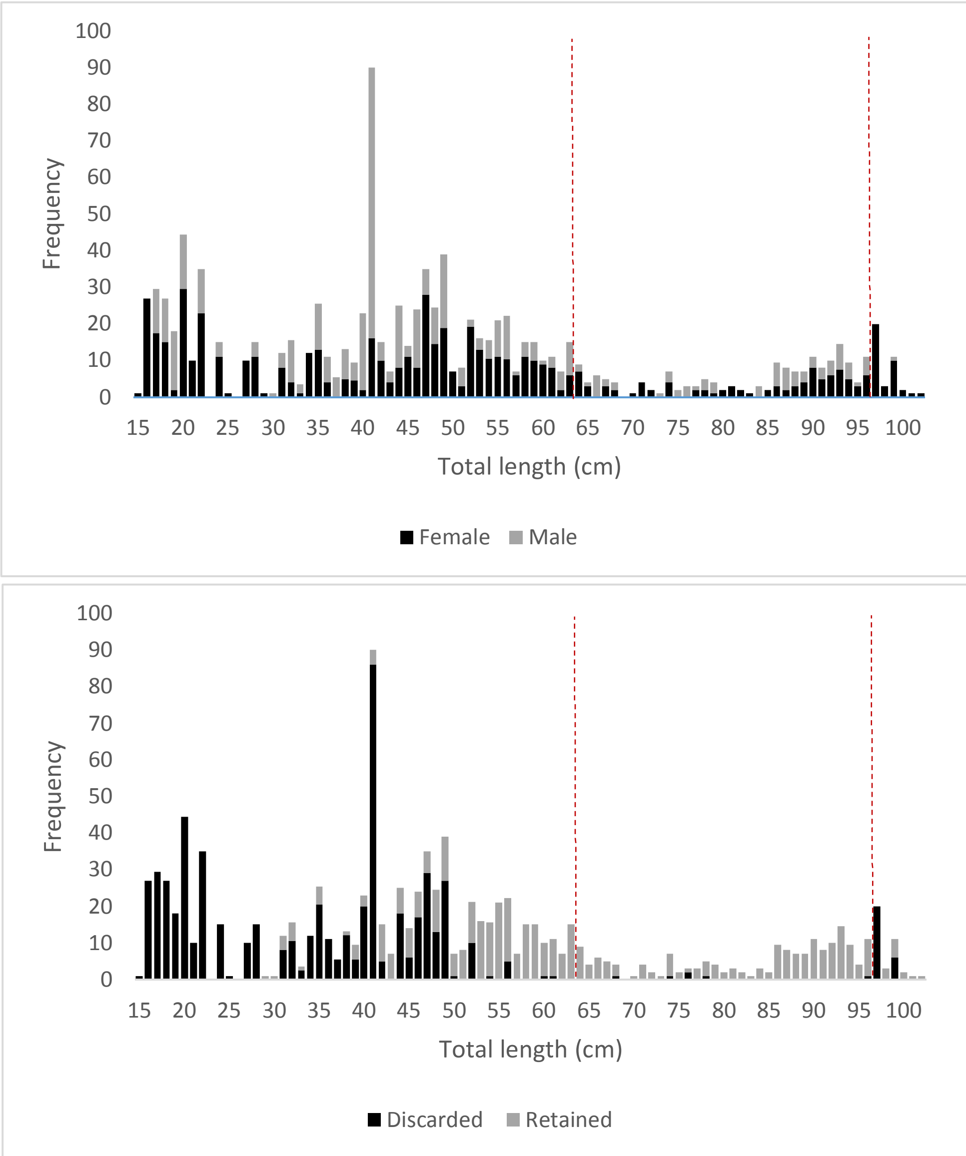

Fig. 9. Length-frequency of undulate ray reported in the English discard observer programme (raised numbers, all gears, 2002–2007) indicating sex composition (top) and discard/retention patters (bottom). Red lines indicate examples of possible minimum conservation reference size (40 cm disc width; 63 cm total length) and maximum landing length (60 cm disc width; 97 cm total length). The majority of fish >97 cm are female.

3.6 Spatial management

There have been several studies to better understand our knowledge of the distribution and habitat use of undulate ray, and the coastal nature of this species suggests spatial management might be quite an effective management tool. However, if spatial management takes the form of gear restrictions or closed areas over small sections of the coastal zone, there could be potentially high impact on some coastal fleets, as their vessels may not have the ability to operate on other fishing grounds (depending on speed of vessel, average trip length, distance to other grounds, hydrography of the area). Given this, and that more data on the seasonal distribution of undulate ray would be required, spatial management should only be considered if, for example, it was proposed by the fishing industry as a more pragmatic alternative to other measures, or if improved date became available to better identify and delineate areas of ecological importance.

Although the coastal nature of undulate ray is theoretically conducive to developing spatial management, the *ad hoc* STECF review group considered that other management measures would be more pragmatic, at least in the short term. There are currently insufficient data to identify appropriate sites and as to how this may impact on the coastal fleet. Furthermore, many European nations are already developing networks of Marine Protected Areas, and so some undulate ray habitat may be subject to management.

3.7 Suite of measures

ICES advice in 2014 for undulate ray in the English Channel (Divisions VIId,e), Bay of Biscay (Divisions VIIIa,b) and western Iberian waters (IXa) was that "*there should be no targeted fisheries on this stock. Any possible provision for bycatch to be landed should be part of a management plan, including close monitoring of the stock and fishery*" (ICES, 2014a, c, e).

This implies that low levels of exploitation could be allowed in these areas, as long as there are measures to prevent target fisheries (i.e. a small allowance for some incidental bycatch to be landed) and that there is a regional management plan and monitoring. Given the coastal nature of the stocks, and that catch rates in many internationally-coordinated trawl surveys have a poor signal for this species, the coastal fleet could assist in improved monitoring of the stock.

The information on undulate ray gathered under the monitoring program will enable, at an initial stage of the program, to apply simple stock assessment techniques that are being developed under the data-poor framework (e.g. Carruthers *et al.*, 2014; Cadrin and Dickey-Collas, 2015; Geromont, 2015). These new approaches are oriented to stocks not yet assessed and for which biological or fishery data are insufficient or only available for a very short time-series. It is also important to make note that funds for applying the more traditional assessment techniques to those stocks are not expected to become available.

Preliminary suggestions for precautionary management measures are summarised below. While general issues for these options are highlighted, the exact details for each of the three management units would need to be developed between the fishing industry, scientists, enforcement officials and managers.

Minimum conservation reference size

A minimum size of 40 cm disc width is already established along parts of the south coast of England, and so this could be a pragmatic minimum conservation reference size, at least for the stock in VIId,e. This equates to a total length of 62–63 cm.

It should be noted that, on 22 August 2011, the Portuguese Administration adopted a national legislation (Portaria no. 170/2014) that establishes a minimum landing size of 52 cm total length for *Leucoraja* or *Raja*, valid for the whole continental Portuguese EEZ. For undulate ray, a 52 cm total length equates to ca. 34 cm disc width.

Maximum landing length

As a precautionary management measure to further deter fisheries from fishing on mature females, a maximum landing length could be introduced. A MLL of 60 cm disc width (which equates with a total length of 97 cm) should preferentially protect mature female undulate ray.

Trip limits

Trip limits, whereby vessels would only be able to land up to *x* kg per trip, would help prevent fishermen targeting undulate ray. Exact trip limits cannot be specified at the present time, as it would depend on the numbers and types of vessel operating in the stock area, agreement on how an upper limit would be set, and whether or not it was supported by other measures. Trip limits should be set initially at a low level, and following data collection and monitoring, could be adjusted accordingly.

Special fishing permit

In order to help limit the exploitation on undulate ray, and to ensure that this is accompanied by appropriate monitoring, then the ability to land undulate ray (within the trip limits and size restrictions above) should only be allowed for a limited number of coastal vessels (<10 or <12 m LOA). Vessels given an annual (renewable) fishing permit would also need to provide appropriate catch data.

Seasonal management

On 29 December 2011 the Portuguese Administration adopted a national legislation (Portaria no. 315/2011) that, in all of the continental Portuguese EEZ during the whole month of May, just allows the landing of skates belonging to the family Rajidae up to 5% of the vessel´s total landed weight per landing day.

Regional managers should examine the various options of having, for example, a three month temporal closure that encompasses May, in order to improve the protection of egg-laying females.

Other measures

Any provision for a bycatch fishery through the measures above would need to be supported by other measures, including:

- Undulate ray should only be landed whole/gutted, and not as wings (to ensure size restrictions can be enforced and that biological data can be collected)[2]
- There should be no transhipment of undulate ray (to ensure excess catches are discarded and not transhipped to other vessels)
- Vessels with special fishing permits would have to provide fishery data (georeferenced catch data and effort) to their national fisheries laboratory, to allow scientific observers on board so as to assist with any biological sampling and tag and release programmes deemed necessary
- A code of conduct would need to be developed in collaboration with the fishing industry (see Section 4)

Whilst the measures highlighted above have been identified as appropriate for undulate ray, some of these measures could also be beneficial to the management of other skates. The development of regional management plans for skate (Rajidae) assemblages should be a high priority and, in the first instance, could usefully be developed for a case-study area, as also indicated by ICES (2013).

[2] The merits of this measure could usefully be considered for skates and rays taken in other fisheries, but this would require discussions with the fishing industry

4 Discard survival and development of a Code of Practice

The proposal also indicated that Measure 5 (*Providing for fishermen a code of practice recalling the proper manners to manipulate and release Raja undulata*) would be developed.

Preliminary studies and anecdotal information from some commercial fishermen indicate that undulate ray should have quite a high survivorship rate after capture and release, at least in coastal fisheries (see section 2). Nevertheless, the provision of a Code of Practice with guidelines on actions and techniques that fishermen could use to maximise the survival of undulate ray (indeed, skates and rays in general) to be discarded is considered an important element of a management plan, particularly given the landing obligation.

To maximise longer term survival of undulate ray after capture and release, guidelines on the best practices when catching and handling skates and rays should be developed. Minimising physical damage, internal and external, of captured specimens can be achieved by adopting measures such as the following:

i) Reduce tow duration / soak time on grounds where undulate ray may be expected to occur;

ii) When hauling nets and lines, try to return lively undulate ray to the sea as soon as possible, and preferentially retain those that may not survive (whilst still working within any trip limits and size restrictions)

iii) When processing trawl catches, process undulate ray as quickly as possible;

iv) Release unwanted skates and rays as soon as safe and practical

v) Avoid leaving unwanted skates and rays on deck, and not in direct sunlight

vi) If fish cannot be released immediately, keep specimens in clean seawater and release them as quickly as possible. Having a net bin on board can help revive fish (make sure the seawater pipe is running with fresh seawater before filling netbins)

vii) Avoid using a gaff to skates and ray on board

viii) When holding skates and rays, try to support their belly and avoid lifting or dragging fish by the tail or eye sockets

ix) Do not stand on the fish

x) Remove all gear remains (e.g. lines) from the caught specimen or cut the trace as short/close to the body as possible.

xi) When releasing fish into the sea, try to place them in the sea (small boats) or gently slide them head first from as low a height as safely possible. Do not throw them.

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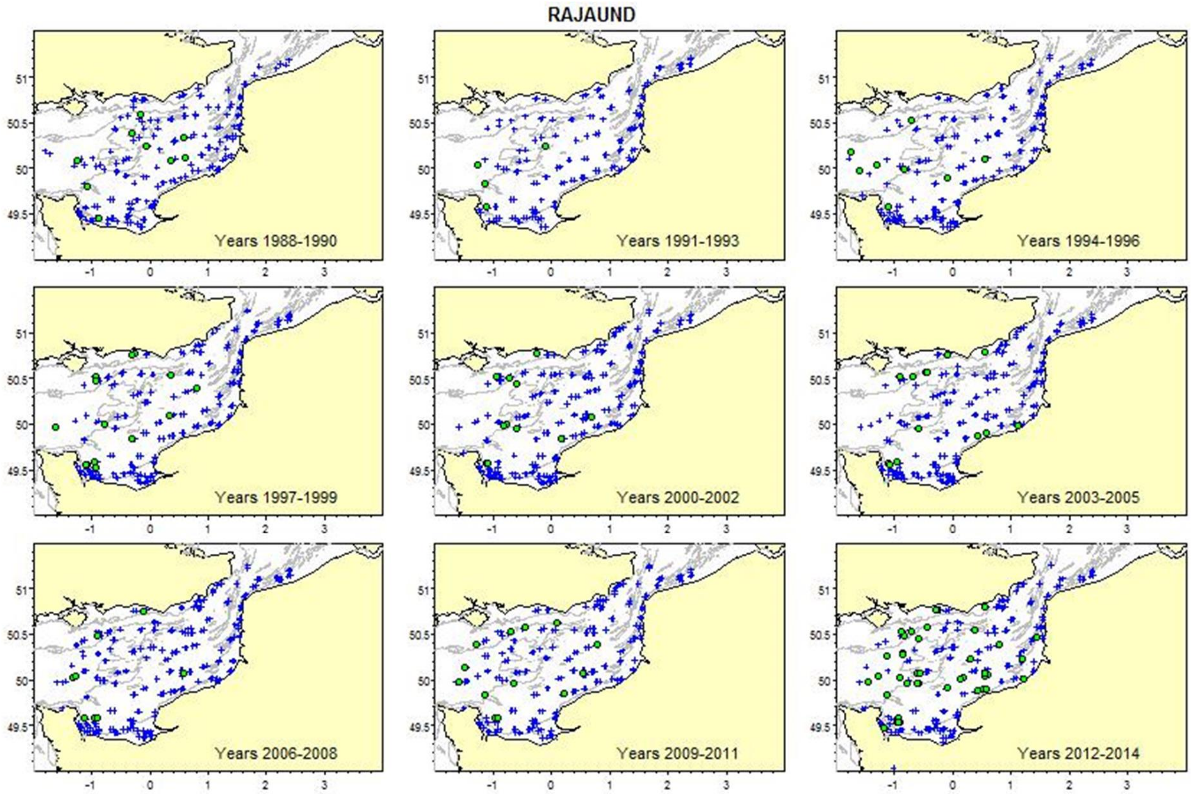
Annex 1: Occurrence of undulate ray in the CGFS survey by 3-year groups. Blue crosses represent hauls without catch of undulate ray and green circle hauls with catch.



Indicators of occurrence of undulate ray in the eastern Channel from the CGFS survey 1988-2014, by groups of 3 years.

Years	Number of hauls	Number of haul with catch	Mean number in hauls with catch	Variance of the mean number	Proportion of haul with catch	Variance of the proportion
1988-1990	204	9	1.11	0.11	0.044	0.00021
1991-1993	206	4	1.00	0.00	0.019	0.00009
1994-1996	239	8	1.50	1.14	0.033	0.00014
1997-1999	275	14	1.50	0.42	0.051	0.00018
2000-2002	312	11	1.09	0.09	0.035	0.00011
2003-2005	300	14	1.29	0.37	0.047	0.00015
2006-2008	318	8	1.63	0.27	0.025	0.00008
2009-2011	321	15	1.07	0.07	0.047	0.00014
2012-2014	290	44	1.73	1.65	0.152	0.00044

Annex 2. Length distribution of catch of undulate ray in French fisheries in the western Channel (ICES Division VIIe).

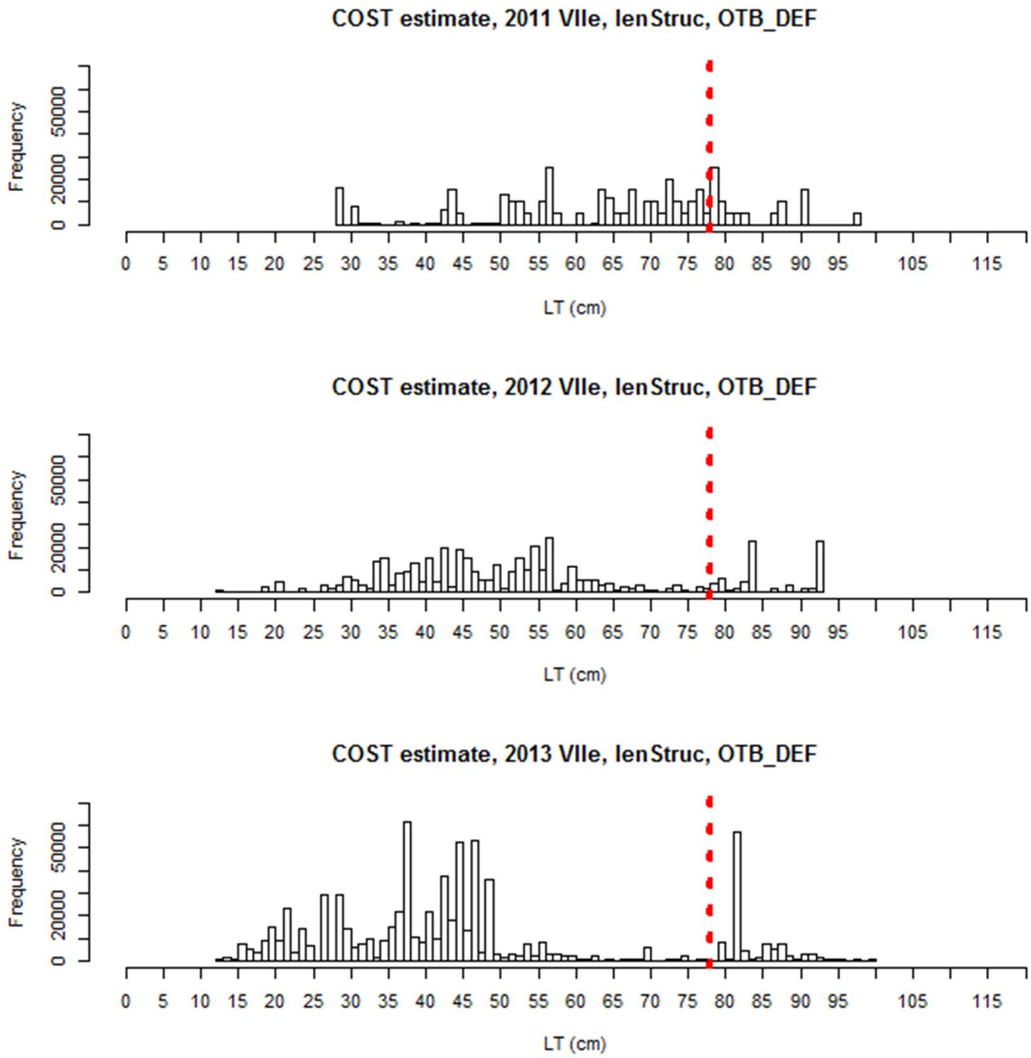


Figure 1. Length distribution of Raja undulata in on-board observations of the métier “bottom trawling targeting demersal fish (OTB-DEF)”. The red dashed line represents 78 cm L_T.

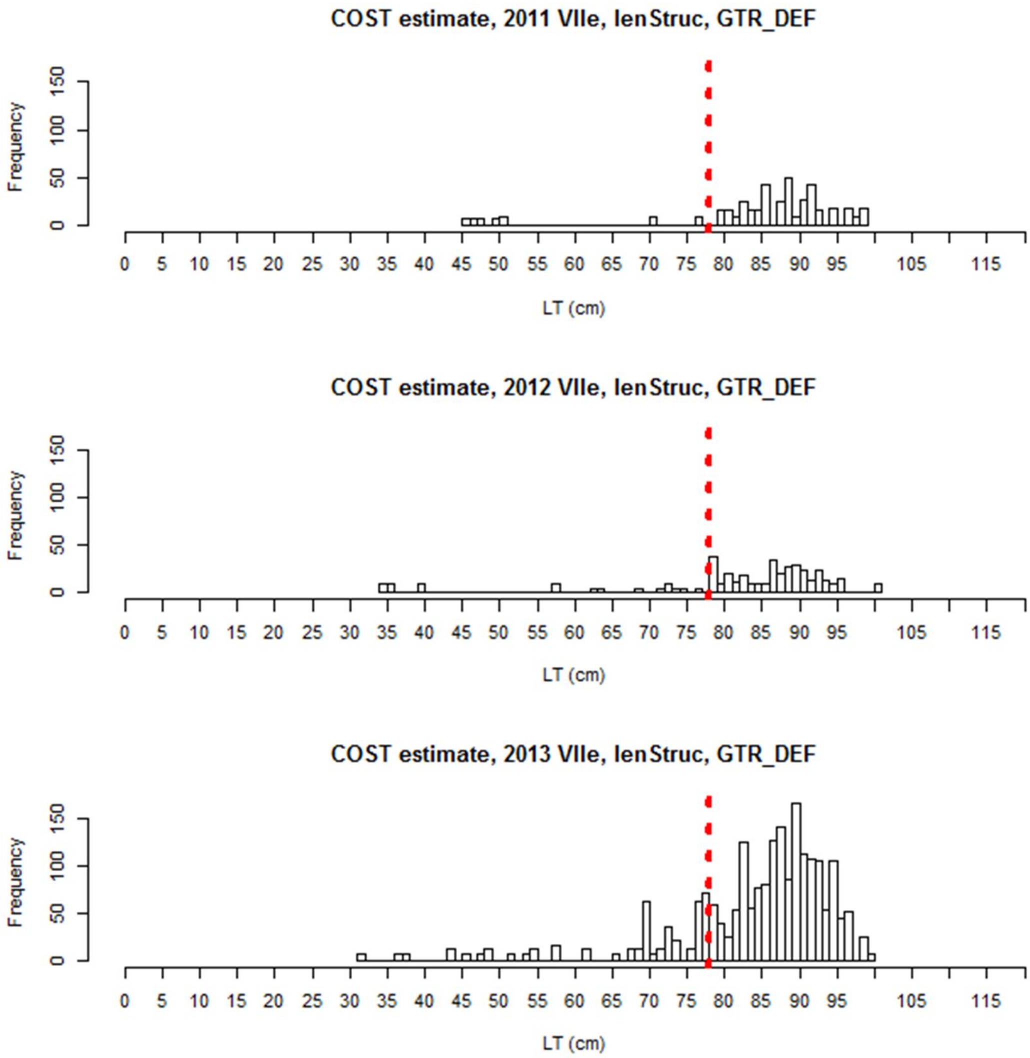


Figure 2. Length distribution of *Raja undulata* in on-board observations of the métier "Trammelnet targeting demersal fish (GTR-DEF)". The red dashed line represents 78 cm L_T.

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