European Commission

JRC SCIENTIFIC AND POLICY REPORTS

Scientific, Technical and Economic Committee for Fisheries (STECF)

-

Bio-economic Methodology (STECF-17-05)

Edited by Ralf Döring & Finlay Scott

This report was reviewed by the STECF during its 54th plenary meeting held from 27 to 31 March 2017 at JRC, Ispra, Italy

Report EUR XXXXX EN

Joint Research Centre

Contact information
Name: STECF secretariat
Address: Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra VA, Italy
E-mail: stecf-secretariat@jrc.ec.europa.eu
Tel.: +39 0332 789343

JRC Science Hub
https://ec.europa.eu/jrc

JRCXXXXX

EUR XXXXX EN

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

Luxembourg: Publications Office of the European Union, 2017

How to cite: Scientific, Technical and Economic Committee for Fisheries (STECF) – Bio-Economic Methodology (EWG-17-05); Publications Office of the European Union, Luxembourg; EUR XXXX EN; doi:XXXXXXXX

Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. This report is concerned with the use of bio-economic models for providing advice, particularly on proposed changes to TACs.

Authors:

STECF advice:

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

EWG-16-20 report:

Döring, R., Accadia, P., Bastardie, F., Brigaudeau, C., Carpenter, Carvalho, N., G., Garcia, D., Guillen, J., Hamon, K., Hoff, A., Knittweis, L., Macher, C., Maynou, F., Jardim, E., Prellezo, R., Rodgers, P., Scott, F., Taylor, M.

TABLE OF CONTENTS

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) – BIO-ECONOMIC METHODOLOGIES (STECF-16-20)

The EWG-16-20 report was reviewed during the plenary meeting held at the JRC, Ispra, Italy, 27-31 March 2017.

REQUEST TO THE STECF

STECF is requested to review the report of the STECF Expert Working Group meeting, evaluate the findings and make any appropriate comments and recommendations.

BACKGROUND

DG Mare discussed with the STECF about the need for short- and long-term socio-economic assessments. The analysis of the TAC and quota proposal was of special interest and it was decided to organize an Expert Working Group to discuss and propose possible ways to assess the socio-economic impacts, with the following ToRs:

1) Assessment of social and economic impacts of TAC and quota proposals:

a) Review methods (e.g. the dependency analysis) and models for the short-term assessment of social and economic impacts on the fleets of the TAC and quota proposal. Part of these assessments shall be the testing of assumptions provided by DG Mare. The models should allow a straightforward, easily applicable assessment.

b) As the TAC and quota proposal is part of a longer-term approach to reach MSY assess under the same group of assumptions how a longer-term analysis can be performed.

2) Assessment of social and economic impacts of fisheries management options: Identify bio-economic models, which are available for social and economic impact assessments and list the fisheries for which they are applicable. Additionally, the EWG shall highlight important gaps.

3) For the AER: Following STECF advice of the July plenary of 2016, please analyse the way the economic projections (economic data is two years old and the projection shall give some information on the current year) are done in the AER against other approaches in order to propose a standard methodology to be used by STECF in the future.

Additionally, DG Mare provided the following explanation to the EWG:

There is an increasing need to integrate economic analysis in the scientific advice process of EU fisheries and conservation measures. Economic objectives were explicitly introduced in the Art. 2.1 of the reformed CFP ("*The CFP shall ensure that fishing and aquaculture activities are environmentally sustainable in the long-term* and are managed in a way that is consistent with the objectives of achieving economic, social and employment benefits, and of contributing to the availability of food supplies"). This need for further integration of economic analysis in the EU scientific advice process, in particular, includes:

1. The assessment of social and economic impacts of TAC and quota proposals. The economic advice for supporting DG MARE in the negotiation process for TACs requires robust estimates of the potential economic impacts to the EU fleets (in terms of profit margin, income, employment, etc…) of several TAC scenarios. The economic advice should satisfy, ideally, the following conditions: 1) to be produced in a short timeframe, limited for the delivery the scientific advice for all the EU stocks and the TAC negotiations in December, 2) complete coverage in terms of EU fleets and be based on the latest data available for the EU fleets

under the DCF and DCMAP, 3) provide a user-friendly interface that allows instantaneous simulations of TACs (for the short term analysis), 4) robustness of the results and be able to provide a sensitive analysis or uncertainty estimates to test key factors outside of TACs (e.g. fuel prices, phasing in of the landing obligation,...) that are significant to fleet performance. This economic advice should be conformed by two inputs:

1. Short term analysis: Short term projections (one year ahead) of different policy scenarios (e.g. TACs) as defined by DG MARE. The results in the study should be reliable estimates for the EU fleets economic performance in the following year. Such an analysis should use the latest available data on fuel prices and fish prices (e.g. EUMOFA, etc).
2. Long term analysis: The TAC and quota proposal should be considered as part of a longer-term approach to reach MSY. This calls for assessing under the same group of assumptions as applied for the short term projections how a longer-term analysis can be performed.

2 Assessment of economic impacts of fisheries management options. There is a need to provide scientific advice on the social and economic impacts of policy options or scenarios as defined by DG MARE (especially of long-term management plans).

3 Bring the economic performance results presented in the AER more up-to-date and complete (e.g. Mediterranean Sea region). The AER report is the main source of economic data and analysis at EU level that serves important policy uses. End-users and stakeholders of the AER report often need projections that give some information on the current year (as opposed to only reporting economic data two years old).

STECF COMMENTS

The Expert Working Group 16-20 (EWG) convened in January 2017 in Ispra (Italy), to discuss the methodological approaches to address the needs of DG MARE for socio-economic assessments (short and long term), to give an overview on the available bio-economic models for impact assessments of long-term management plans or other management measures and to discuss the methods for projections in the Annual Economic Report (AER). The report reflects the work by 3 STECF members, 11 external experts, and 4 experts of JRC that attended the meeting.

STECF notes that all the ToRs were covered by the EWG.

STECF notes that to cover the assessment of social and economic impacts of TAC and quota proposals, 15 models were presented to the EWG. The EWG identified BEMEF as the only available model which covers almost all TACs within the EU in the Northeast Atlantic region. However, the EWG also identified some limitations on the economic and social advice provided using this model (i.e., the missing feedback between the biology and economy and missing uncertainty estimates). STECF notes that given these limitations identified, the economic assessment of the TACs proposal can be misleading, since such assessment would lack the long-term effects of the TAC proposals (driving the fisheries to F_{MSY}). Moreover, by not including fleet interactions, the limitations created by the landing obligation (i.e. choke effects, changes in swaps) will not be taken into account. Finally, STECF considers that all projections must be reported together with the margins of error, to avoid creating a perception of over-precision.

STECF also notes that the EWG considered that the multi-model approach (the integrated models currently available and used for the economic impact assessment of the multi-annual plans and new additions such as the SEAFISH-model and MACRO-Fish) is still the best approach to pair the short term and long terms perspectives of TACs proposals within the MSY objective. STECF also notes the limitations of this approach already identified by the EWG. Firstly, integrated models require a high amount of personal and financial resources to be updated, given the level of detail of their conditioning. Secondly, a single model conditioned for all the fisheries which is representative of all the TACs within the EU does not currently exist.

STECF notes that the EWG built a list of models which can be used for the quantitative assessment of the impact of fisheries management options. These are the models that were already used for the economic impact assessment of the multi-annual plans and new additions such as MACRO-Fish.

STECF notes that the EWG16-20 identified some gaps in regional/species coverage from the models used in the multiannual impact assessment EWGs. In the West of Scotland, Irish Sea, Ionian and Aegean Seas and the Black Sea, no models were available/parameterized during the meeting for demersal fisheries. Regarding small pelagics, except in the Adriatic, the gaps are unclear since dedicated EWG didn't take place yet. Finally, deep sea stocks were not covered.

STECF notes that the BEMEF model (the one used for projections in the AER of the years 2015 and 2016) was presented to the EWG. It also notes that the EWG identified some limitations from the information provided. STECF also notes that for the projections of the Mediterranean fleet segments two different approaches have been taken. In the years 2013 and 2015 projections were based on the HDA0.2 model, but in 2014, the equations derived from the conclusions of the STECF 11-19 (2014) were used. STECF also notes that these projections were not made for all of the Mediterranean Member States' fleet segments (due to lack of data availability). STECF agrees with the EWG that in order to achieve consistency across years, these projections should be done using a single model approach.

STECF CONCLUSIONS

STECF concludes that a mixed approach based on a quick overview using short term forecasts complemented by detailed assessment of critical TAC changes could be achieved using integrated models. The EWG discussed this option, including a protocol proposal. STECF endorses the protocol proposed by the EWG and notes how this protocol should be further developed in detail, including all institutions involved in advisory process (ICES, DGMARE, STECF). STECF agrees with EWG proposal to have another bio-economic workshop to support the development of a coherent multi-model approach. Such an approach would allow for the challenges of providing operational decision support to be addressed (in terms of the required data, common assumptions to be made, common outputs and interface to be developed etc.), and would underline the need to create a framework for annual integrated assessment of TAC options, considering resources and time needed.

STECF concludes that a common database with stock assessment results and DCF data will be a relevant development on bio-economic modelling, given the time require to collate all the data coming from different sources. Development of calibration methods based on an integrated database gathering main data needed for bio-economic parametrisation would improve the ability to perform impact assessments in a short interval. STECF is aware that DG Mare is working on the so called 'Fish-Hub' which would connect the different databases, and data will be available from the different sources in one place. This will most likely fulfil the role of a common database but should be further elaborated when the 'Fish-Hub' will be set up. STECF concludes that Fish-Hub should be tested by modellers, in order to check if it fits the bio-economic parametrisation requirements.

STECF concludes that the list of models provided by the EWG helps on understanding which models could be used to assess different management measures. STECF also concludes that this list could be further detailed in a follow up bio-economic modelling EWG.

STECF agrees with the EWG that all alternatives have limitations and that there will never be one model to cover all fisheries and be applicable for all management measures.

In terms of the projections of the AER, STECF concludes that updating economic variables 1 year (the year before the publication of the AER) to match the transversal variables can be carried out using the current methodology. STECF also concludes that 2 year projections (the publication year of the AER) can be performed if a clear statement of model limitations is provided alongside a description of the model assumptions. During the first meeting on the AER 2017, a group of experts will work on improvements of the BEMEF, which will address the relevant limitations identified in section 5 of the EWG report.

For the Mediterranean STECF agrees with the EWG on that, for consistency across years, these projections should be done using a single model approach. STECF concludes that the available possibilities should be reviewed by a follow up bio-economic modelling.

CONTACT DETAILS OF STECF MEMBERS

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

Name	**Address**[1]	**Tel.**	Email
STECF members			
Abella, J. Alvaro	Independent consultant	Tel. 0039-3384989821	aabellafisheries@gmail.com
Andersen, Jesper Levring	Department of Food and Resource Economics (IFRO) Section for Environment and Natural Resources University of Copenhagen Rolighedsvej 25 1958 Frederiksberg Denmark	Tel.dir.: +45 35 33 68 92	jla@ifro.ku.dk
Arrizabalaga, Haritz	AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel.: +34667174477	harri@azti.es
Bailey, Nicholas	Marine Scotland Science, Marine Laboratory, P.O Box 101 375 Victoria Road, Torry Aberdeen AB11 9DB UK	Tel: +44 (0)1224 876544 Direct: +44 (0)1224 295398 Fax: +44 (0)1224 295511	baileyn@marlab.ac.uk n.bailey@marlab.ac.uk
Bertignac, Michel	Laboratoire de Biologie Halieutique IFREMER Centre de Brest BP 70 - 29280 Plouzane, France	tel : +33 (0)2 98 22 45 25 - fax : +33 (0)2 98 22 46 53	michel.bertignac@ifremer.fr
Borges, Lisa	FishFix, Brussels, Belgium		info@fishfix.eu
Cardinale, Massimiliano (vice-chair)	Föreningsgatan 45, 330 Lysekil, Sweden	Tel: +46 523 18750	massimiliano.cardinale@slu.se

Name	Address[1]	Tel.	Email
STECF members			
Catchpole, Thomas	CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft Suffolk, UK NR33 0HT		thomas.catchpole@cefas.co.uk
Curtis, Hazel	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K.	Tel: +44 (0)131 524 8664 Fax: +44 (0)131 558 1442	Hazel.curtis@seafish.co.uk
Daskalov, Georgi	Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Tel.: +359 52 646892	Georgi.daskalov@gmail.com
Döring, Ralf (vice-chair)	Johann Heinrich von Thünen Bundesforschungsinstitut, für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei - AG Fischereiökonomie, Palmaille 9, D-22767 Hamburg, Germany	Tel.: 040 38905-185 Fax.: 040 38905-263	ralf.doering@thuenen.de
Gascuel, Didier	AGROCAMPUS OUEST 65 Route de Saint Brieuc, CS 84215, F-35042 RENNES Cedex France	Tel:+33(0)2.23.48.55.34 Fax: +33(0)2.23.48.55.35	Didier.Gascuel@agrocampus-ouest.fr
Lloret, Josep	Associate Professor (Professor Agregat), University of Girona (UdG), Spain		josep.lloret@udg.edu
Knittweis, Leyla	Department of Biology University of Malta Msida, MSD 2080 Malta		Leyla.knittweis@um.edu.mt
Malvarosa, Loretta	NISEA S.c.a.r.l.		malvarosa@nisea.eu
Martin, Paloma	CSIC Instituto de Ciencias del Mar Passeig Marítim, 37-49 08003 Barcelona Spain	Tel: 4.93.2309500 Fax: 34.93.2309555	paloma@icm.csic.es
Motova, Arina	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K	Tel.: +44 131 524 8662	arina.motova@seafish.co.uk

Name	Address[1]	Tel.	Email
STECF members			
Murua, Hilario	AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel: 0034 667174433 Fax: 94 6572555	hmurua@azti.es
Nord, Jenny	The Swedish Agency of Marine and Water Management (SwAM)	Tel. 0046 76 140 140 3	Jenny.nord@havochvatten.se
Prellezo, Raúl	AZTI -Unidad de Investigación Marina Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	Tel: +34 667174368	rprellezo@azti.es
Raid, Tiit	Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallin, EE-126, Estonia	Tel.: +372 58339340 Fax: +372 6718900	Tiit.raid@gmail.com
Sabatella, Evelina Carmen	NISEA, Via Irno, 11, 84135 Salerno, Italy	TEL.: +39 089795775	e.sabatella@nisea.eu
Sala, Antonello	Italian National Research Council (CNR) Institute of Marine Sciences (ISMAR), Largo Fiera della Pesca, 1 60125 Ancona - Italy	Tel: +39 071 2078841 Fax: +39 071 55313 Mob.: +39 3283070446	a.sala@ismar.cnr.it
Scarcella, Giuseppe	1) Italian National Research Council (CNR), Institute of Marine Sciences (ISMAR) - Fisheries Section, Largo Fiera della Pesca, 1, 60125 Ancona – Italy 2) AP Marine Environmental Consultancy Ltd, 2, ACROPOLEOS ST. AGLANJIA, P.O.BOX 26728 1647 Nicosia, Cyprus	Tel: +39 071 2078846 Fax: +39 071 55313 Tel.: +357 99664694	g.scarcella@ismar.cnr.it gscarcella@apmarine.com.cy
Soldo, Alen	Department of Marine Studies, University of Split, Livanjska 5, 21000 Split, Croatia	Tel.: +385914433906	soldo@unist.hr
Somarakis, Stylianos	Institute of Marine Biological Resources and Inland Waters (IMBRIW), Hellenic Centre of Marine Research (HCMR), Thalassocosmos Gournes, P.O. Box 2214, Heraklion 71003, Crete, Greece	Tel.: +30 2810 337832 Fax +30 6936566764	somarak@hcmr. gr
Stransky, Christoph	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany	Tel. +49 40 38905-228 Fax: +49 40 38905-263	christoph.stransky@thuenen.de

Name	Address[1]	Tel.	Email
STECF members			
Ulrich, Clara (chair)	Technical University of Denmark, National Institute of Aquatic Resources, (DTU Aqua), Charlottenlund Slot, JægersborgAllé 1, 2920 Charlottenlund, Denmark		clu@aqua.dtu.dk
van Hoof, Luc	IMARES, Haringkade 1, Ijmuiden, The Netherlands	Tel.: +31 61061991	Luc.vanhoof@wur.nl
Vanhee, Willy	Independent consultant		wvanhee@telenet.be
van Oostenbrugge, Hans	Fisheries Economics, Wageningen Economic Research, formerly LEI Wageningen UR, The Hague, The Netherlands		Hans.vanOostenbrugge@wur.nl
Vrgoc, Nedo	Institute of Oceanography and Fisheries, Split, Setaliste Ivana Mestrovica 63, 21000 Split, Croatia	Tel.: +385 21408002	vrgoc@izor.hr

REPORT TO THE STECF

EXPERT WORKING GROUP ON Bio-economic methodology (EWG-16-20)

Ispra, Italy, 23-27 January 2017

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1. INTRODUCTION

DG Mare discussed with the STECF about the need for short- and long-term socio-economic assessments (see Chapter 2 for an explanation). The analysis of the TAC and quota proposal was of special interest and it was decided to organize an Expert Working Group to discuss and propose possible ways to assess the socio-economic impacts.

This report includes firstly a description of the possibilities for short-term assessments and other instruments to identify possible critical TAC changes for the upcoming year (Chapter 3).

In the next chapter the report gives an overview of the available models for short- and long-term socio-economic assessments. The available models don't cover all areas and fisheries. Additionally, the models are developed to answer different questions and to assess a variety of management options (including TAC changes).

Thirdly, the report discusses the possibilities for projections for the new AER in 2017.

1.1. Terms of Reference for EWG-16-20

The Expert Working Group of STECF was requested to perform the following tasks:

1) Assessment of social and economic impacts of TAC and quota proposals:

> a) Review methods (e.g. the dependency analysis) and models for the short-term assessment of social and economic impacts on the fleets of the TAC and quota proposal. Part of these assessments shall be the testing of assumptions provided by DG Mare. The models should allow a straightforward, easily applicable assessment.
>
> b) As the TAC and quota proposal is part of a longer-term approach to reach MSY assess under the same group of assumptions how a longer-term analysis can be performed.

2) Assessment of social and economic impacts of fisheries management options: Identify bio-economic models, which are available for social and economic impact assessments and list the fisheries for which they are applicable. Additionally, the EWG shall highlight important gaps.

3) For the AER: Following STECF advice of the July plenary of 2016, please analyse the way the economic projections (economic data is two years old and the projection shall give some information on the current year) are done in the AER against other approaches in order to propose a standard methodology to be used by STECF in the future.

1.2. Explanation: Use of the term of fleet segment in the Report

Over time the definition of a fleet segment has changed in various EU data collection regulations. Currently the following definition is applied for the economic data calls:

2008/949/EC - Fleet segment: a group of vessels with the same length class (LOA) and predominant fishing gear during the year, according to the Appendix III. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment.

The "fleet segments" were designed to aggregate vessels (by year and FAO area) and compute economic variables, as stated in chapter III.A.2 in regulations, 2008/949/EC and 2010/93/EU.

The "metiers", also defined in the above mentioned regulations, represent a different fleet segmentation (by ICES sub-division and quarter) and represent the effect those fleets have on fish stocks, e.g. through fishing mortality.

Bioeconomic models need to link the economic information with the biological information and model the feedback between the two, so that effects of different management strategies can be assessed both in terms of impact on fleets and stocks. Due to the nature of economic variables (vessel based) and fisheries data (stock and gear based), the mapping of "fleet segments" into "metiers" require a modelling process using transversal variables. Transversal variables are collected at a level of granularity that cross the above mentioned "fleet segments" and "metiers".

Alternatively, the raw data on economic information may be aggregated using a different definition of "fleet segment", although this option is only available to the Member States, due to confidentiality issues.

In this report "fleet segments" refers to the aggregation of vessels as defined by regulations 2008/949/EC and 2010/93/EU, for the objectives set therein.

1.3. Need of DG Mare for bio-economic assessment

DG Mare provided the following explanation to the EWG:

There is an increasing need to integrate economic analysis in the scientific advice process of EU fisheries and conservation measures. Economic objectives were explicitly introduced in the Art. 2.1 of the reformed CFP ("*The CFP shall ensure that fishing and aquaculture activities are environmentally sustainable in the long-term and are managed in a way that is consistent with the objectives of achieving economic, social and employment benefits, and of contributing to the availability of food supplies*"). This need for further integration of economic analysis in the EU scientific advice process, in particular, includes:

1. The assessment of social and economic impacts of TAC and quota proposals. The economic advice for supporting DG MARE in the negotiation process for TACs requires robust estimates of the potential economic impacts to the EU fleets (in terms of profit margin, income, employment, etc…) of several TAC scenarios.

   The economic advice should satisfy, ideally, the following conditions: 1) to be produced in a short timeframe, limited for the delivery the scientific advice for all the EU stocks and the TAC negotiations in December, 2) complete coverage in terms of EU fleets and be based on the latest data available for the EU fleets under the DCF and DCMAP, 3) provide a user-friendly interface that allows instantaneous simulations of TACs (for the short term analysis), 4) robustness of the results and be able to provide a sensitive analysis or uncertainty estimates to test key factors outside of TACs (e.g. fuel prices, phasing in of the landing obligation,...) that are significant to fleet performance.

   This economic advice should be conformed by two inputs:

   - Short term analysis: Short term projections (one year ahead) of different policy scenarios (e.g. TACs) as defined by DG MARE. The results in the study should be reliable estimates for the EU fleets economic performance in the following year. Such an analysis should use the latest available data on fuel prices and fish prices (e.g. EUMOFA, etc).

   - Long term analysis: The TAC and quota proposal should be considered as part of a longer-term approach to reach MSY. This calls for assessing under the same group of assumptions as applied for the short term projections how a longer-term analysis can be performed.

2. Assessment of economic impacts of fisheries management options. There is a need to provide scientific advice on the social and economic impacts of policy options or scenarios as defined by DG MARE (especially of long-term management plans).

3. Bring the economic performance results presented in the AER more up-to-date and complete (e.g. Mediterranean Sea region). The AER report is the main source of economic data and analysis at EU level that serves important policy uses. End-users and stakeholders of the AER report often need projections that give some information on the current year (as opposed to only reporting economic data two years old).

2. Short and long term assessment of the TAC and Quota proposals (TOR 1)

2.1. History of TAC assessment

In 1998, the EIAA model (Economic Interpretation of ACFM Advice, Frost et al. 2009) was developed as part of the Concerted Action: Economic Assessment of European Fisheries (EAEF). The model was constructed to make joint use of the costs and earnings data and the information forwarded by ACFM and the Commission about TACs for the coming year. The model was applied by a STECF working group for the 1999 TACs in a 'specimen report' covering 14 fleets (SEC (2003) 288). This modelling of TAC proposals continued and was expanded from 1998-2007. Notable developments include an increase in coverage as economic data for more fleets was reported (and standardised), the inclusion of multiple TAC scenarios, and additional modelling features such as 'species drivers' to indicate TACs that drive effort and TACs that are caught as by-catch. Some modelling features were included in some years but not others, such as a static projection of economic performance at a state of MSY using TAC and biomass estimates, as well as the use of fuel prices and fish prices for sensitivity analysis (see for example, SEC (2004) 1710).

From the beginning of the TAC assessments, it was recognised that only providing short-term assessment generates a bias towards the highest TACs. The STECF report on the first TAC assessment in 1998 (SEC(1998) 2048), stated that: "*Various members of the STECF expressed the view that some longer-term perspective should be elaborated along with the very short-term interpretation presented now. The current presentation puts too much stress on the possible short-term losses and disregards expected longer term benefits.*" This aspect of TAC assessment did not change significantly in the following years.

In 2004, a STECF sub-group produced a report "Further improvements of the EIAA model including long term perspective and effect of recovery plans" (SEC(2005) 259). In it, recommendations were made to enhance the EIAA with the inclusion of calculations on overcapacity and resource rent, validation of the results with confidence intervals, and the use of in-year data. Few changes were made to the EIAA model for subsequent TAC assessments, although models that have expanded on the EIAA (Fishrent and BEMEF, see Section 4) have incorporated these suggestions.

Since the assessment of 2008 TACs using the EIAA model, there has been no public assessment of TAC proposals through STECF. However, over this period bioeconomic modelling has been completed on fisheries management plans, some using the EIAA model, but mostly using a number of integrated bioeconomic models that emerged during this time.

A 2014 STECF report, "Reporting needs under the Common Fisheries Policy" (STECF-14-23) suggested the need to bring back TAC assessment under the reformed CFP, alongside the assessment of management measures and assessment of the best way to achieve management objectives. It was estimated that economic simulation models (e.g. BEMEF, EIAA, Fishrent) could cover all or most of the biologically assessed stocks in 1 or 2 weeks.

2.2. Short-term assessment approaches

For performing short-term assessments of social and economic impacts on fleets of TAC and quota proposals, three approaches have been identified:

1. Short-term projection models, i.e. following a similar approach used in 2015 and 2016 in the evaluations for the Annual Economic Report (AER)
2. Integrated bioeconomic models (which can be used for both for short and long term projections)
3. Economic general dynamic equilibrium models for the short term.

2.2.1 Short-term projection models

Short-term projection models are relatively simple models that are based on constant assumptions (e.g. based on historical catch, effort and TAC share observations). They do not include any consideration of the biology and have only a limited consideration of economic theory. The models are able to provide coverage over a wide range of TACs and fisheries (for example, the BEMEF model used for the AER in 2015 and 2016 (STECF 2016) covered 150 TACs). They are relatively easy to condition as most are based on fleet segments that are normally defined through currently available DCF data, and have a short run time. Most short-term projection models can be used for projecting a single year into the future, for example, as is currently done in the AER reports.

However, short-term projection models also have some limitations, which seriously restrict their potential for use in providing advice on TACs and quotas. As the economic data that will be used for providing advice on the TACs and quotas will be two years old, the model will effectively be required to perform a three-year forecast. This is outside the scope of their application given their simple constant assumptions. Additionally, the lack of consideration of the feedback between economy and biology, means that they cannot fully assess the economic consequences of the longer-term approach to reach MSY that the TAC proposals are part of. The danger of not considering the longer term consequences is that setting a very high TAC looks like an attractive option. The structure of the fleets in the model may not be flexible enough to allow the evaluation of a full range of scenarios, e.g. they may not be able to include technical interactions in the fishery. Moreover, many of these models do not provide uncertainty estimates, which are essential for understanding possible outcomes and communicating model results. Given the limitations of short-term projection models, they cannot be considered to be a suitable tool for providing the required advice on TACs and quotas.

Pros	**Cons**
Good coverage of TACs and fisheries	Short term only
Short conditioning and run time	No biology
Fleet segments, thus data accessible for conditioning	No technical interactions
Has been used in STECF advisory processes.	Fleet segments, thus not fully descriptive
	No uncertainty estimates included
	Projections are based on constant relationships, based on historical data/observations, relationships that may change in the longer run
	Comprehensive sensitivity analysis to assumptions not tested yet, e.g. robustness of results given model structure

Table 2-1 Pros and cons of applying a short-term projection model

2.2.2 Integrated bioeconomic models

Integrated bioeconomic models are more sophisticated than short-term projection models. They include the biological dynamics of the stocks of interest and a greater consideration of the economics, meaning that there is full integration and feedback between biological and economic components. Consequently, these models can perform short- as well as long-term simulations making them appropriate for providing the required TAC and quota advice along with longer-term assessments of the economic consequences of moving towards MSY. The greater sophistication of these models allows for the inclusion of a wide range of fisheries structures, i.e. they can support metier level fleet data at a regional level, which allows for assessments for the inclusion of technical interactions. Additionally, the models have often been developed with a range of stakeholders which allows a wide range of scenarios to be run. Many integrated bioeconomic models have been tested and peer-reviewed, e.g. through use in STECF advisory processes and applications in EU projects thereby increasing confidence in their future use. Also, uncertainty is fully considered in many of these models.

However, the increase in model complexity means that these models can only be operated by experts. Additionally, these types of models can often be computationally intensive, increasing the run time. The inclusion of a more complex fleet structure and biological components means that the models may be time-consuming to condition. For these models to be used to provide advice on TACs and quotas will therefore require increased preparation time and it will be necessary to identify potential stocks and fisheries of interest sufficiently in advance.

Pros	**Cons**
Full feedback and integration	Complexity of models and data structure
Suitable for short and long term projections	Require expert knowledge
Many have been used in STECF advisory process	Computationally intensive
Fleet / metier based approach, including technical interactions	Increased time for conditioning
Biological structure included	
Stakeholder involvement in model design	
Tested and peer-reviewed	
Many include uncertainty	

Table 2-2. Pros and cons of applying integrated bio-economic models

2.2.3 Economic general dynamic equilibrium models

Another approach would be the application of an economic general dynamic equilibrium model (e.g. Macro-Fish). This would allow the evaluation of economic and social parameters that are compatible with a given mixed-fisheries situation. The main advantage is that results can be evaluated using the macro-economic theory. It endogenously calculates the relationship between capacity and activity of the fishing firms and the prices compatible with this relationship. Current expectations in the economy are equivalent to what people think the future state of the economy will become. They act in line with these expectations in the short term and, therefore, the model includes a long-term perspective into a short-term projection.

This approach is important when dealing with the capital dynamics of the fishing firms. Following a MSY policy, such as the one in place by the EU CFP, implies a likely recovery of the fish stocks. However, it also could potentially imply short-term sacrifices. The fishing firms should balance the long-term (expected) benefits with the short-term losses to take the decision of staying or exiting the fishery. It affects results in terms of number of vessels, employment and wages.

The integrated bio-economic models so far are taking micro-economic theory in some kind of partial equilibrium into account. They model changes in behaviour of the fishers and influence of those changes on the fish stocks and habitats. Integrated bio-economic models could be usefully informed by a macro-economic approach assuming a simplification of the reality in a general equilibrium model. However, this type of model is not currently peer reviewed.

To consider the short term economic implications of a change in the TACs/quotas without solving the future expectations will not integrate the complete decision background and will potentially provide biased results. If the analysis is based on past-observed relationships, without considering any dynamics due to changes in future expectations, there could be a misinterpretation of the economic effects.

Pros	Cons
Suitable for short and long term projections	No feedback between economics and biology
Integration of economic theory (dynamic general equilibrium)	No integration of biological dynamics
It may be possible to include a simplified version into the integrated models	Needs a scientific peer review process

Table 2-3 Pros and cons of applying a dynamic general equilibrium model

2.3. Protocol for Impact assessments

From the European guideline on impact assessment (http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf), STECF 2010 defined a protocol for impact assessment based on a 4 steps process involving scientists, stakeholders and DGMARE:

1. **A Preparatory phase** to state the problem (stocks, fisheries and areas to be assessed), the timetable and the actors involved
2. **A Scoping meeting** to :
    - Select a number of tactical options to be evaluated
    - Select a number of plausible biological and economic scenarios against which the tactical options are tested
    - Decide on the models to be used
    - Define the criteria (indicators and performance measures) to be retained and presented for all scenarios and options to allow comparison between them
    - Identify specific data required and timescale for acquisition
    - Identify who will do what on what timescale and under what conditions
3. **A working phase** prior to the Impact Assessment meeting where models are parameterized and simulations of decided options are run
4. **An Impact Assessment report preparation meeting** where options simulated are assessed and reported

Missing in this protocol is the definition of (common) model assumptions.

The protocol was updated and developed in the SOCIOEC project towards the concept of a Sustainability Impact Assessment in particular regarding 2 aspects:

- the stakeholders engagement along the process
- the definition of a framework to compare options based on their efficiency, effectiveness, coherence and acceptability.

The following steps were identified and applied in a number of case studies (see SOCIOEC Deliverables of the WP5 and Malvarosa in prep):

Phase I- Problem analysis (main responsibility lies with the EC)

- Step 1: Scoping phase. Identification of the main problems to be solved and the main causes (e.g. overcapacity, overexploitation, etc…): what we need to change and why? Identification of the governance structure interested by the change and the related incentives scheme. Definition of the baseline scenario

Phase II Finding options (main responsibility lies with the EC)

- Step 2: Definition of general and specific objectives (target levels) in collaboration with stakeholders (e.g. MSY, economic viability, social stability).
- Step 3: Depending on step 1 and step 2, identification of policy instruments that are more likely to ensure the achievements of objectives (e.g. fleet reduction, quota reduction,

effort quota, etc…). Definition of possible scenarios (e.g. different effort or catch level and considerations of external factors, e.g. fuel prices).

Phase III Analysis (main responsibility lies with the scientific community)

- Step 4: In-depth IA analysis by mean of simulations of the scenarios identified, including the baseline scenario (status-quo).
- Step 5: Rating options (and select the best one, up to policy makers)

Phase IV Follow-up (main responsibility lies with the EC)

- Step 6: Compare what has been achieved in reality vs. objectives set.

Ideally, scientists would be involved in every step of the protocol, including the beginning to discuss the possible management and implementation options. Nevertheless, the main responsibility of carrying out the impact assessment resides with the EC's DG responsible for the regulation. The IA process is a tool for developing policies with inputs from science and taking into account the opinion of stakeholders. As such the responsibility and ownership of the IA is with the EC.

It should be noted that socio-economic impacts of conservation measures, such as TACs, are highly dependent on the policy instruments that are implemented. Socio-economic impact of TAC can be mitigated by management options, in particular by access regulation options that are operated at Member States level. Adjusting fishing time to catch a TAC either by keeping the same capacity in the fishery or adjusting the number of vessels in the fishery (e.g. by decommissioning schemes or by reallocation to other fisheries) will have different effects on expected impacts on profits and employment. Options to be tested (including alternative options to catch the TAC proposed) should thus be clearly defined.

The group wants to emphasize that models are part of a decision support process that should follow basic steps identified and should engage stakeholders and managers, particularly in the definition of instruments, scenarios, assumptions and outputs needed for decision support.

2.3.1 Technical issues for IA

Several integrated bio-economic models were developed at EU level in the last decade to assess potential biological, economic and social impacts of management scenarios in a decision support context. A multi-model approach has been adopted to address impact assessment issues with the development of fishery/area specific models developed to be able to assess key management fishery/area specific scenarios. Those models were used by stakeholders and managers for decision support in regional, national and European contexts (IA of MAP, IA of TAC advice etc).

The recommended approach for short-medium-long term IA of scenarios was:

- an Integrated bio-economic approach
- a Fleet/métier approach
- a Multi-model approach
- a Fishery/regional approach

A review of these models is proposed in section 4. The models include the main biological and economic dynamics needed to assess short, medium and longer-term impacts to highlight trade-offs between options in the transition phases and show alternative pathways to objectives.

The models were developed to address the key challenges of operational IA however running scenarios still requires substantial resources and time regarding the different steps of the protocol adopted to run scenarios. Below we present the tentative steps and timing appropriate for a TAC impact assessment. It should be noted that this process aims to provide advice before the negotiations at the Council of Ministers in December. For the Baltic Sea, the timeline would have to be adapted to provide the assessment of the economic impact of TAC for the earlier negotiations.

Key steps	Key issues	Key actors involved	Pre-requisites (Resources data, experts, model constraints)	Time
1/ Identification of critical/contentious stocks (wrt to decreasing TAC)	Timing problem (when do we identify contentious stocks?) - official ICES advice comes in June-July (for most areas) some advice may arrive late (November) but models need to be updated to be used	DGMARE should identify probable contentious stocks for which bio-economic analysis will be required	Modelers should be requested as early as possible (before summer) to run their model to provide bio-economic advice because models require to be updated and this needs to be planned	Possibly June (before ACOM, after ICES WG)
2/ Identification of fishery(ies)/area at stake (stocks, fleets, market concerned according to management issue)	Fleets / metiers fishing on contentious stocks should be identified. Because of DCF fleet segments definition, flexibility of some fleets (and not others) to report their effort on other species, and choke species effect, this analysis should not be limited to dependency criteria	**Scoping meeting** JRC/STECF should centralize the analysis and make experts aware of upcoming request	Identification of fleets could partly rely on the work of the experts of the Balance WG. Modelers should be requested as early as possible (before summer) to run their model to provide bio-economic advice because models require to be updated and this needs to be planned	Beginning of June
3/ Extraction of most appropriate, recent data series (by stock, fleet, market)	Inconsistency between the data sources (when available) DCF Economic data n-2 available online in July DCF Transversal data n-1 available in July ICES and GFCM Stock assessment data n-1: available in July (on request to the WG stock coordinator(s))	**Scoping meeting** (with 2/) Model experts (for selected models to be used)	Data: Individually in National institutes, based on the DCF data (available online) and on request to ICES/GFCM WG coordinators Resources: time (and therefore money) need to be devoted to steps 2/ to X/ by national institutes. **Where will funding come from?**	Beginning of June
4/ Define shared	Define shared assumptions:	**Methodological meeting**		Every year

approach - Parameterization of models - assumptions - indicators	- for parameterization and calibration : eg Economic data n-1 --> updated for year n - behaviour (quota uptake, entry-exit) - External factors (fuel prices) -	Model experts, DGMARE, stakeholders		Does not need to happen between June and September
5/ Definition of scenarios	- scenarios to be tested	TAC scenarios should be taken from ICES advice sheets in discussion with DGMARE		July after ICES advice
6/ simulation of scenarios and indicator production	Time and planning	**Assessment report preparation meeting** And preparation work model experts	Preparatory work and writing report in WG	Beginning of October
7/ Production and visualization of results	Define shared output indicators, and way of representing results (shiny like user friendly interface to the results)	Part of the **methodological WG** JRC could host the data and develop and maintain the Shinny application	Common data platform to share simulation results	After the STECF plenary before council of ministers

Table 2-4 Timeline for an impact assessment of TAC and quota proposals

2.3.2 Data availability

One of the most time consuming parts of the model update is to extract, format and estimate the data required, including conditioning the uncertainty of the different parameters. The bio-economic models require a lot of data including biological, economic and the so-called transversal variables (catch and effort). Biological data include (age structured) assessment outputs and biological parameters (such as natural mortality, maturity and weight at age). Economic data include costs and earnings at the fleet segment level. Transversal variables should match both the biological and economic levels of disaggregation. Currently there is a mismatch across the different data sources. Catch (landings and discards at age) are not available at the fleet segment level while effort and landings data (provided by gear type and FAO division or sub-division levels) from the fleet economic data-call are not available at the metier level (often the appropriate level to model the bio-economic interactions). The new FDI should help reconcile the different data sets.

Even if data is available at the right level of aggregation data, accessing the data can be challenging. Ideally the DCF fleet economic data, FDI data and stock assessment data would be available from databases directly accessible to allow for easy routine data extraction for the bio-economic models. To our knowledge, such databases are not available.

2.3.3 Requirements to be fulfilled by DG MARE

In the EWG, it was made clear that the appropriate tools for TAC impact assessment do not cover all TACs and fisheries and that model applications are regions/fishery specific. To know which models need to be run for the TAC assessment, the identification of contentious stocks and TACs need to happen early in the year by DG MARE in order to make sure that the models are up-to-date in time for results are provided.

Most contentious stocks could easily be identified at the beginning of the year based on the biological status of the stock the previous year (if a stock is at MSY it is less likely to become contentious) and based on the economic importance of the species.

DG MARE's role in the TAC impact assessment will be crucial at several steps of the process. They will need to be involved in the scoping meeting, to discuss the model's assumptions, scenarios, indicators and visualization in order to define outputs that are useful to them. The resources needed to run an assessment should be made explicit in the scoping meeting.

2.3.4 First discussion on indicators

Economic indicators that would be important to compare different TAC scenarios include employment, profit and income at national level. Those indicators should be provided in absolute terms and relative to the previous year.

For important stocks the long term trade-offs on biological recovery, futures gains (npv – net present value, profit) and future catch should be highlighted:

The protocol identified intends to build from the different experts' experience of using models for decision support to:

- Identify the key methodological steps when running impact TAC scenarios
- Identify potential improvements in the process

2.3.5 Increasing responsiveness

Several aspects were identified that would improve the ability of models to provide IA in a shorter time:

- **Data considerations**: calibration of models is a time consuming step that could be improved by the designing of a relevant database and the development of calibration methods and tools based on those databases, in particular existence of ICES and GFCM data bases gathering input and output for IA. This would also enable methodologies to be shared between models.
- **Options and assumptions considerations**: translation of scenarios into options to test under assumptions is a key step. Interpretations and translation of same scenarios can give a high diversity of options. A clear and shared definition and agreement about options to test and most valid assumptions between scientists, stakeholders and managers when testing TAC impact would be an important step forward; This should be based on a review of the possible scenarios and assumptions among the different approaches developed.
- **Considerations regarding outputs**: setting common output indicators and output format and visualization would improve the process of IA

Those considerations highlight the need to for methodological bio-economic groups to work on the following issues:

- Methodological issue 1: Define shared assumptions for parameterization and calibration
- Methodological issue 2: Define shared assumptions and scenarios to be tested (setting external factors, behaviours, etc)
- Methodological issue 3: Define shared output indicators, and way of representing results

2.4. Tools to inform description of critical fisheries/fleets/stocks regarding TAC changes

2.4.1 New FDI

JRC gave a presentation on the proposed new Fisheries Dependent Information (FDI) data base and associated data call. With the phasing out of existing fishing effort management regimes, (to be replaced by the multi annual plans formed under the new CFP) there is an opportunity to change the structure of what was the 'effort' data call. In addition two data collection framework (DCF) workshops on transversal variables (Castro Ribeiro, et al. 2016) demonstrated several inconsistencies between the current effort data set and the transversal variables submitted under the DCF fleet economic data-call that makes it difficult/impossible to link economic data collected according to the fleet segments within large geographic domains (FAO major fishing areas, although the transversal variables linked to these fleet segments are provided by division or sub-division) and biological data held at métier level. JRC has prepared a draft outline of a data base and data call with the following main objectives:

- A single data base containing transversal data for the entire EU fleet.
- Data collected at an aggregated level (to prevent data confidentiality issues) but in as disaggregated and general way as possible, so as to best accommodate future (and as yet unidentified) end user needs.
- Data collected in a way consistent with the DCF fleet economic data call (in terms of dimensions included, definitions and aggregations) to facilitate bio-economic modelling.
- The rationalization of data calls; eliminating calls for essentially the same data from more than one DG MARE data call.
- A data base that much more clearly reflects the sampling schemes used by member states to collect sampled data.

The process has naturally included consultations between JRC and DGMARE and within DGMARE as to their end user needs going forwards. In the short to medium term the most clearly defined need of DGMARE is information on the discard behavior and catch profiles of fleets coming under the Landings Obligation and the impact of the LO over time. The data base reflects this but in a way that should allow adaptation to other uses in future.

2.4.2 TAC Depencency Indicator (TDI)

Background

The assessment of the socio-economic impacts of TACs on EU national fleets at present relies on economic data collected through the EU Data Collection Framework (DCF) Multiannual programme (Commission Decision 2010/93/EU). These data are analysed and presented in the Annual Economic Reports (AER) on the performance of the EU fishing fleets produced by STECF. The AER presents a number of socio-economic performance indicators calculated for fleet segments as defined under the DCF Multiannual programmes for data collection.[1] In addition STECF produces an annual report on the Balance between fleet capacity and fishing opportunities.

In order to provide an estimate of the economic relevance that each stock subjected to a TAC has on EU fishing fleets from a regulatory perspective, the TAC Dependency Indicator (TDI)[2] was developed by Natale et al. (2016). The TDI simply consists of a proportion between the value of landings associated to a given TAC unit[3], and the total value of landings of a fleet segment ('*fleet segment*' refers to '*economic fleet segment*' throughout this section unless indicated otherwise), and is thus a first step in combining the economic and the biological perspectives. As such the

[1] 'Fleet segment' is defined in the DCF (2010/93/EU, chapter 1, definition(d)) as "a group of vessels with the same length class (LOA) and predominant fishing gear during the year, according to the Appendix III. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment" and operationalized in Chapter III.A of the same regulation.

[2] Formely known as the Fish Stock Dependency (FSD) indicator.

[3] A TAC unit is a combination of a species or species group in a particular regulation area, i.e. Fisheries Management Zones (FMZ).

TDI cannot assess the impact of TACs and quotas changes, but can be used by policy makers as a first step to gather information on:

- which fleet segments are more dependent on a given TAC unit?
- which TAC units are mostly targeted by a given fleet segment?

Indicator calculation

The TDI indicator is calculated for the TAC units listed in Council Regulation (EU) 2016/72. To build the TDI indicator, a preliminary step is to define TAC units by Fishery Management Zones. These FMZs are geographical areas delineated by DG-MARE with a regulatory perspective in mind (zone-area-species). These areas do not necessarily correspond to FAO fishing areas (division or sub-division) or ICES rectangles.

Since policy makers (DG MARE) require information on which could be impacted by TACs and quotas changes, the TDI is calculated for fleet segments by linking economic information to the TAC unit as GVA per TAC unit (which involves the deduction of variable and fixed costs from income). It is assumed that costs are the same for all TAC units since the analysis is carried out at the fleet segment level. The calculation is based on the following formula:

$$TDI_{TACunit,fleet} = \frac{Value\ of\ landings_{TACunit,fleet}}{Value\ of\ landings_{fleet}}$$

The costs are proportionally attributed to the TAC units on the basis of proportionality criteria using the following formula:

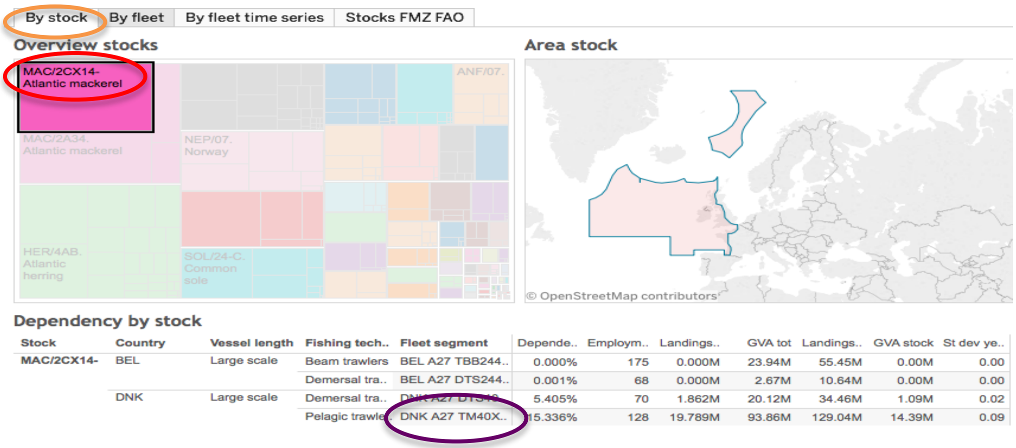
$$GVA_{TACunit,fleet} = Turnover_{TACunit,fleet} - Variable\ costs_{fleet} * \frac{Turnover_{TACunit,fleet}}{Turnover_{fleet}} - Fixed\ costs_{fleet} * \frac{Turnover_{TACunit,fleet}}{Turnover_{fleet}}$$

The web tool

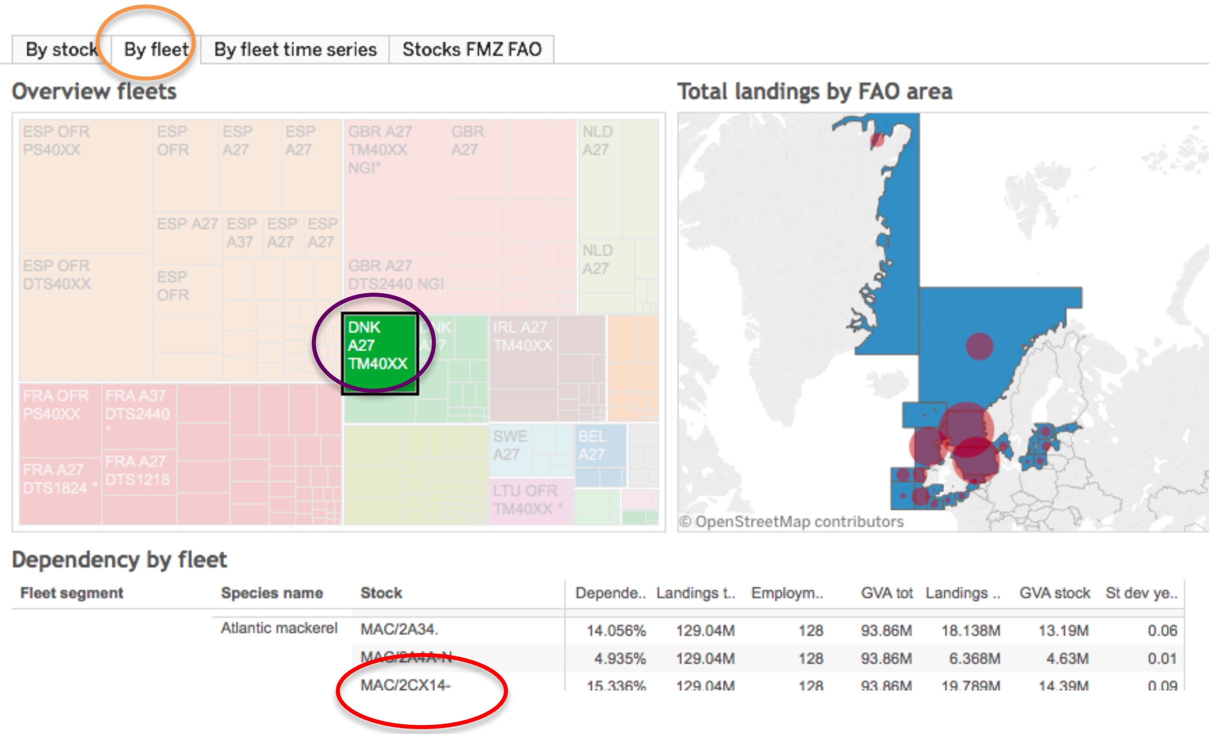
The results for the TDI can be visualised using a dedicated tool; a prototype can be accessed online[4]. Currently, four selections are possible: stock[5] (TAC unit), fleet, fleet time series and stocks (TAC unit) FMZ FAO.

[4]https://visualise.jrc.ec.europa.eu/t/dcf/views/StockdependencyEU3/Bystock?%3Aembed=y&%3Adisplay_count=no&%3AshowVizHome=no#1

[5] All references to 'stock' in the TDI tool and report have subsequently been changed to TAC unit in the revised versions.

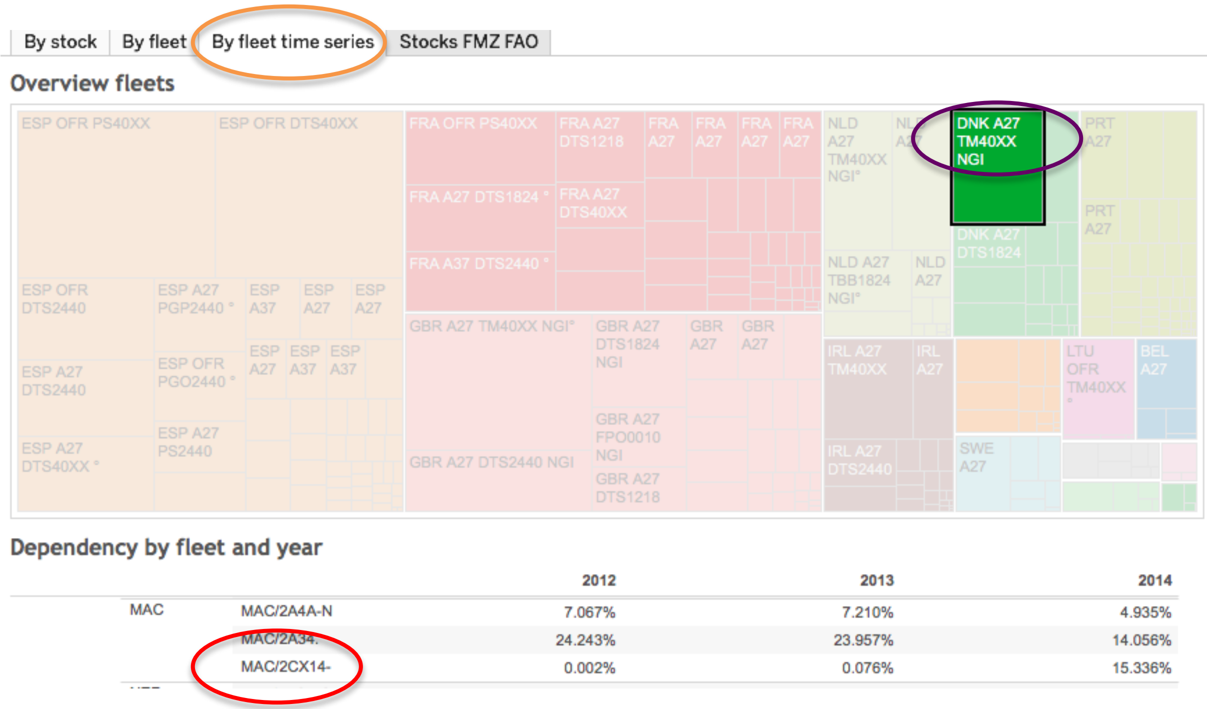


After selecting a TAC unit (using the '*By stock*' tab), for example MAC/2CX14-, the regulatory area (FMZ) appears on the map and the dependency indicator is shown by fleet segment, for example pelagic trawlers DNK A27 TM40XX. The dependency of this fleet segment on the TAC unit 'MAC/2CX14-' is 15.34%, while the corresponding (or proportional) GVA produced by the fleet activity on the TAC unit is estimated at €14.39 M

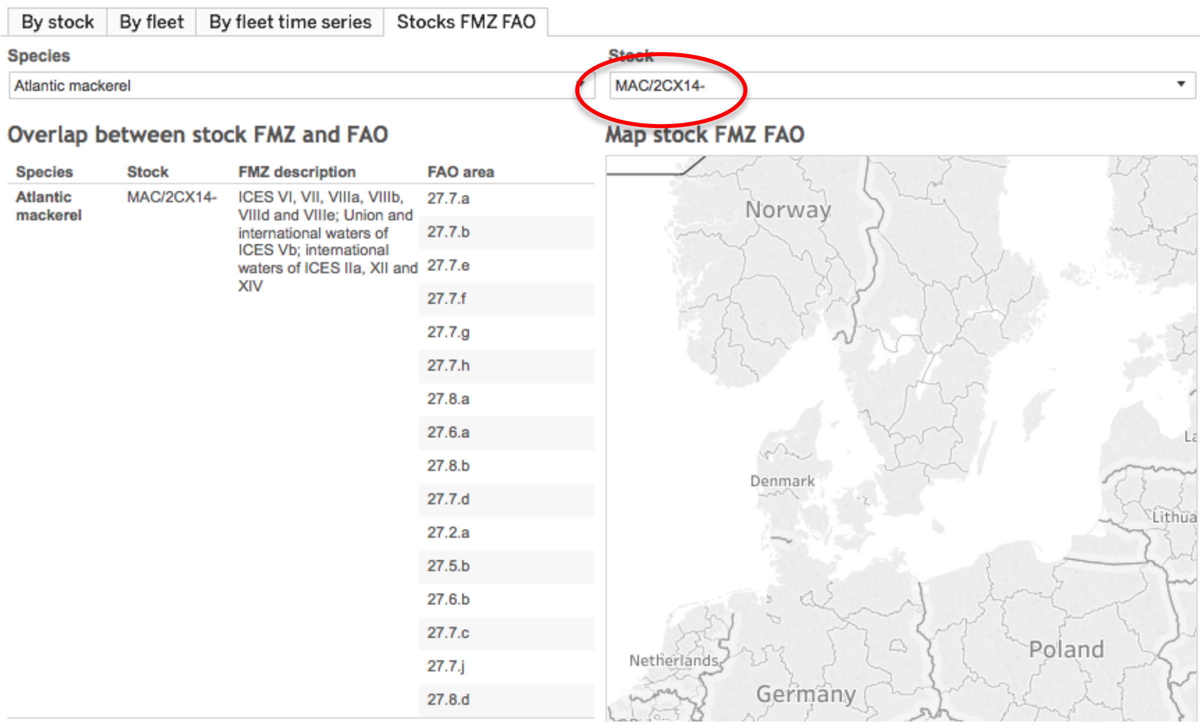


The '*By fleet*' tab enables selecting fleet segments of interest and visualising the associated TAC units and their corresponding estimated dependencies and socio-economic indicators (GVA, employment). Results can be filtered by selecting the level of dependency (>0%m >1%, >5%, >10%). Again, in the case of DNK A27 TM40XX for the TAC unit MAC/2CX14-, the dependency ratio is 15.34% with an estimated GVA of € €14.39 M

The *fleet time series* view shows the results for the TDI by fleet segment over the times series analysed and TAC unit.



The *FNZ FAO* tab provides the user with information on the TAC units and FMZs, as defined in the regulation.



- Stocks

Application example

TAC unit: SAN/2A3A4.

The ICES is advice to reduce or maintain effort and landings in 2014. The evolution of the ‘adapted’ quota and catches for this TAC unit reported by Denmark in the catch reporting system shows a 23% decrease in quota and a 27% decrease in catch in 2014 compared to 2013.

			Sum of Adapted Quota	Sum of catches
SAN/2A3A4.	**DNK**	2012	30,734	51,748
		2013	228,251	209,927
		2014	175,547	154,164
		2015	311,904	166,741
		2016	91,948	28,312

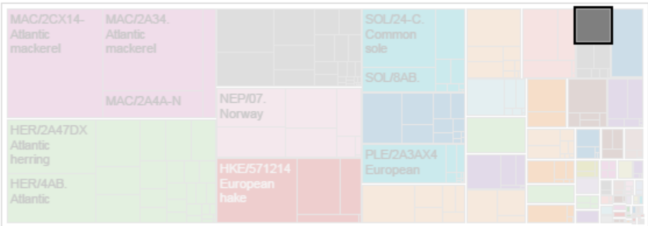
Table 2-5 Quota for SAN/2A3A4. Source: Catch reporting system - Fides

The TAC dependency tool can be used as a first step to identify fleet segments that are, to varying degrees, dependent on a TAC unit. Highly dependent fleet segments are likely to be heavily impacted by significant quota reductions.

In the ‘*By stock*’ dashboard, the fleet segment DNK A27 DTS 40XX is shown to have a dependency ratio of 27% on this TAC unit (*SAN/2A3A4*). In other words, the value of landings from this TAC unit made up 27% of the total value of landings of the fleet segment in 2014.

Other fleet segments are also somewhat dependent on this TAC unit but these are not investigated further here.

Overview stocks



Area stock

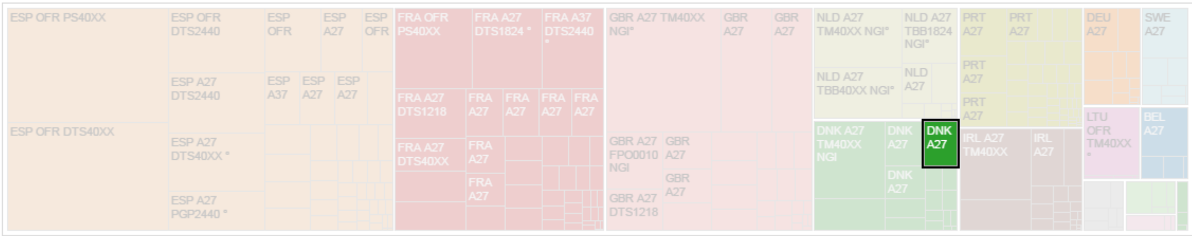
Dependency by stock

Stock	Country	Vessel length	Fishing technology	Fleet segment	Dependency	Employment tot	Landings stock	GVA tot	Landings tot	GVA stock	St dev years
SAN/2A3A4.	DNK	Large scale	Demersal trawlers and/or demersal seiners	DNK A27 DTS40XX NGI°	27.034%	70	9.315M	20.12M	34.46M	5.44M	0.07
				DNK A27 DTS2440 NGI°	8.332%	127	4.344M	28.69M	52.13M	2.39M	0.04
			Pelagic trawlers	DNK A27 TM1218 NGI	9.835%	41	0.960M	6.06M	9.76M	0.60M	0.06
				DNK A27 TM40XX NGI	6.882%	128	8.881M	93.86M	129.04M	6.46M	0.07
	SWE	Large scale	Demersal trawlers and/or dem..	SWE A27 DTS2440 NGI°	5.921%	249	3.232M	27.00M	54.58M	1.60M	0.04

The ‘*By fleet*’ dashboard shows the dependency ratio for all the TAC units for DNK A27 DTS 40XX in 2014.

How dependent the fleet segment has been on each TAC unit over the period 2008 to 2014 can be viewed in the ‘*By fleet time-series*’ dashboard. Analysing time-series may provide an indication on how adaptable the fleet segment may be when faced with a significant quota reduction, in one or more TAC units.

Overview fleets



Dependency by fleet and year

			2008	2009	2010	2011	2012	2013	2014
DNK A27 DTS40XX NGI°	HER	HER/2A47DX	14.941%	14.888%	9.400%	15.006%	35.752%	30.044%	28.322%
		HER/4AB.	14.773%	14.753%	9.182%	14.891%	35.713%	29.946%	28.295%
		HER/04A.	5.565%	4.464%	3.720%	5.365%	10.389%	16.239%	13.900%
	SAN	SAN/2A3A4.	17.623%	23.137%	24.864%	23.972%	9.889%	32.721%	27.034%
		SAN/234_1	7.562%	9.957%	10.703%	10.349%	4.257%	14.152%	11.629%
		SAN/234_2	6.759%	8.899%	9.564%	9.267%	3.805%	12.696%	10.391%
	SPR	SPR/2AC4-C	4.620%	10.061%	13.193%	9.824%	16.150%	7.336%	16.701%

Note: dependency ratios cannot be summed up by fleet segment due to the special conditions mentioned previously and may add up to more than 100%.

The socio-economic impact of quota reductions on potentially 'vulnerable' fleet segments can then be further investigated.

The table below shows the economic performance estimates for DNK A27 DTS 40XX analysed in the 2016 AER. These estimates show that the performance of the fleet segment has deteriorated since 2010: revenue, GVA and gross profit decreased 40%, 46% and 53%, respectively, between 2013 and 2014. Results are significantly worse when compared to 2010 estimates.

DNK A27 DTS40XX NGI°	2010	2011	2012	2013	2014	%Δ 2014-2013	%Δ 2014-2010
Revenue	187,397,333	174,682,212	34,517,519	57,955,312	34,821,196	-39.9%	-81.4%
GVA	141,652,440	130,476,900	23,647,982	37,811,693	20,461,005	-45.9%	-85.6%
Gross profit	105,754,394	98,279,717	16,198,640	25,748,604	12,062,160	-53.2%	-88.6%

Table 2-6 Economic performace estimates for DNK A27 DTS 40XX in 2016 AER. Source: 2016 AER

Data and methodology limitations

The TDI model and the online tool are **currently still under development**. The **tool is presently a prototype**, which is being updated and refined. Nonetheless, as outlined below several challenges still exist.

Structure of DCF economic data

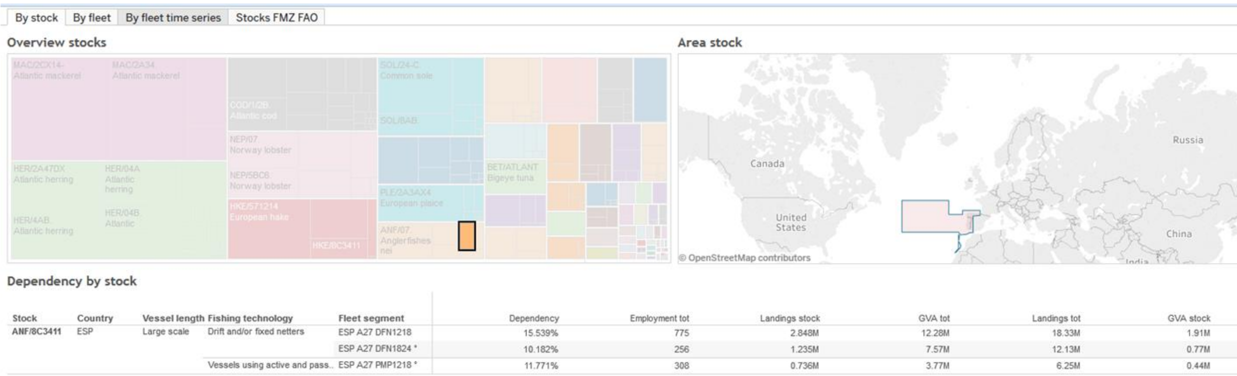
Economic data is provided by Member States at the fleet segment level. If a certain fleet segment is composed of a limited number of vessels (usually less than 10 vessels), the economic data may be provided by clustered fleet segments to preserve confidentiality requirements[6]. The interpretation of data for clustered fleet segments is difficult since such clusters may represent aggregates of vessels with different characteristics (e.g. vessel length group, fishing technique or gear group) that may have very different costs structures, and the composition of such cluster may change from one year to the other, producing a lack of consistency in the time series.

Although the notion of gear is important when considering the relation to mortality from a biological perspective, the TDI remains at the level of the economic fleet segment since this allows for a direct link to be made to the economic variables. As a result the TDI tool cannot be used to accurately identify all the fisheries targeting a certain stock. Furthermore, as several TAC units are mesh size specific currently the tool cannot be used to accurately allocate landings to these TAC units, as fleet economic transversal data is requested only at the gear level as opposed

[6] The clustered segments are identified in the AER and online tool with a degree symbol (°) at the end of the fleet segment name.

to metier. On the other hand, it is possible to calculate the TDI at the gear level by fleet segment, although the associated economic indicators can only be provided for the fleet segment.

Individual vessels are attributed to a fleet segment based on a prevalence criterion, usually determined by the level of fishing effort by gear type. Vessels classified according to a certain fleet segment may however operate with different gears types. While the DCF transversal data (fishing effort and landings) is available by gear type, the same is not true for the economic data (for example data on employment, costs and income), which are only available at the economic fleet segment level. It is therefore not possible from the DCF data to directly calculate any of the economic performance indicators by gear.



Yet, transversal data are not always provided at the correct aggregation levels in response to DCF data calls. For example, not all Member States provide data by gear-type or at the appropriate geographic stratification (FAO fishing areas level 3 or 4). Furthermore, landings data is often provided for more generic FAO 3-aplha species codes that in fact include several species, e.g. ANF (anglerfishes nei).

Geographical area mismatches

TAC regulations define TAC units as a combination of species (or species groups) and Fisheries Management Zones (FMZ). FMZ are geographical areas which have primarily been delineated with a regulatory perspective in mind, incorporating a series of specifications such as the exclusion of external territorial waters. In some cases, these specifications result in areas which do not match the fishing areas defined by FAO, ICES and other RFMOs for data collection purposes. Similarly FMZ may not correspond to stock boundaries based on a biological perspective. As a result FMZs may represent ad hoc groupings of entire FAO fishing areas, or alternatively FMZs may represent only parts of FAO fishing areas. Since transversal data is available at the level of FAO division or subdivision, depending on the region the DCF economic data calls, such geographic mismatches (in particular when FMZs only cover a portion of the FAO areas) make it difficult to accurately attribute transversal data (landings) to FMZs.

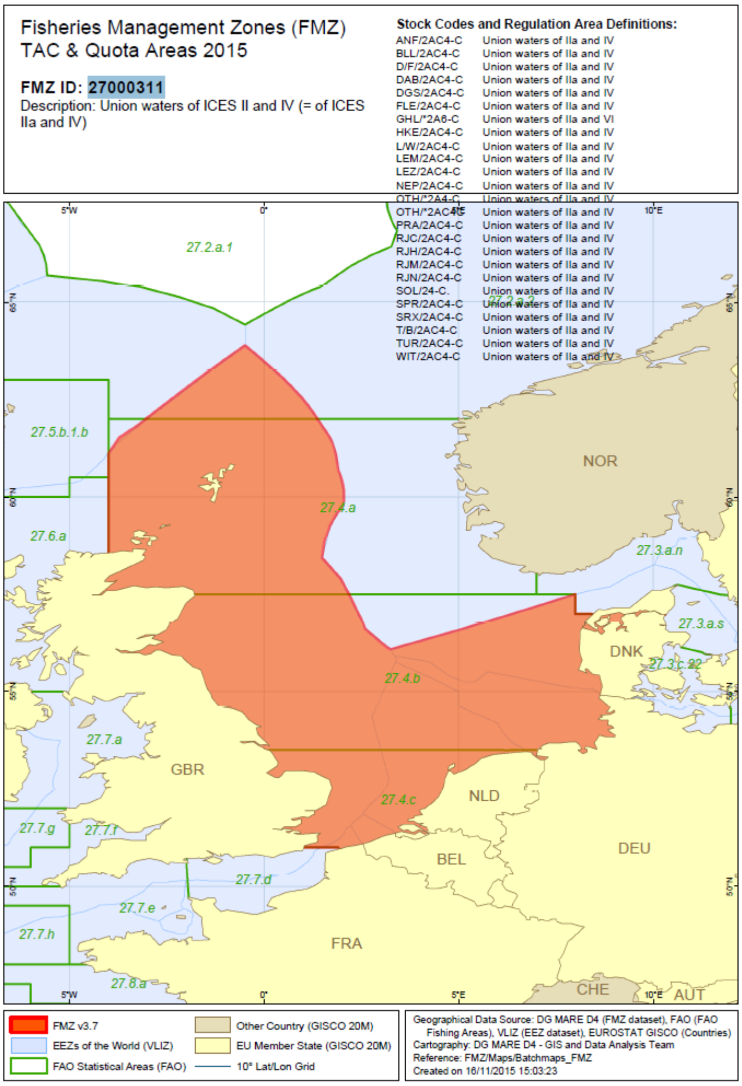


Figure 2-1 Partial overlap of FMZ 27000311 across several FAO fishing areas

In addition, the fact that the biological stock boundaries do not always correspond to the boundaries of TAC units ('regulated stocks') means that the TDI tool cannot be used to make any link between the two. For instance, it is not possible to calculate the economic dependency of fleet segments on stocks which are not being fished at rates consistent with MSY. The TDI tool is thus in fact purely designed to support policy decisions rather than bio-economic modelling per se, since the definition of stocks is from a regulatory rather than a biological perspective.

Special conditions

TAC regulations often include one or more special conditions for the listed TAC units. There are several types of special conditions, including sub-species (SS), sub-area (SA), extra limitation (EL), and other special conditions (SC). In order to keep track of such special condition TAC units, a distinction is made between 'parent stocks' and 'child stocks', where parent stocks are normal TAC units defined in the TAC and quota regulations, and child stocks are those TAC units that have special conditions (which are related to the parent stocks in terms of area, period, species, quantity etc.).

An example of a TAC unit with no special conditions in the TAC and quota regulation for 2015 (European Commission, 2015) is anglerfish in zones VIIIc, IX, and Union waters of CECAF 34.1.1 (TAC unit ANF/8C3411).

Species:	Anglerfish *Lophiidae*	Zone:	VIIIc, IX and X; Union waters of CECAF 34.1.1 (ANF/8C3411)
Spain	2 490		
France	2		
Portugal	495		
Union	2 987		
TAC	2 987		Analytical TAC

Table 2-7 Fishing opportunities for anglerfish (*Lophiidae*) in zones VIIIc, IX, and Union waters of CECAF 34.1.1 in 2015

An example of a TAC unit with several special conditions in the TAC and quota regulation for 2015 is herring (*Clupea harengus*) in zone IIIa (TAC unit HER/03A).

Species:	Herring (1) *Clupea harengus*	Zone:	IIIa (HER/03A.)
Denmark	18 034 (2)		
Germany	289 (2)		
Sweden	18 865 (2)		
Union	37 188 (2)		
Norway	5 816		
Faroe Islands	600 (3)		
TAC	43 604		Analytical TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply

(1) Catches of herring taken in fisheries using nets with mesh sizes equal to or larger than 32 mm.
(2) Special condition: up to 50 % of this amount may be fished in Union waters of IV (HER/*04-C.).
(3) May only be fished in the Skagerrak (HER/*03AN.).

Table 2-8 Fishing opportunities for herring in zone IIIa in 2015

In this case the mesh size of the fishery is specified so transversal data at metier level would be required to accurately identify fleet segments that depend on this TAC unit. In the absence of data at this low level of aggregation linked to economic data it is currently not possible to distinguish landings by different mesh sizes.

In addition the parent stock HER/03A has a child stock since up to 50% of the quota may be fished in Union waters of IV (HER/*04-C). Unless landings for both the parent and child stocks are considered in the analysis, the fleet segment dependency on this particular TAC will thus be underreported. It is however not straight forward to account for the herring child stock in Union waters of IV since there is overlap with other herring TAC units, for instance with herring in Union waters of IVa and IVb (HER/*4AB-C).

Implementation of the Landing Obligation

A further limitation of the TDI approach is that it is only considering TAC stocks as outputs of the system. However, after the implementation of the landing obligation, TAC units could act as constraints of the fishing effort (acting as so called 'choke species') for some fleets. That is, with the landing obligation, fleets could be dependent on stocks for which their historical value of landings has been low. This dependency is not currently being captured by the TDI.

Further development of the TAC Dependency Indicator and online tool

The TDI and the associated online tool are currently still under development. A prototype has been developed by the JRC, and is currently being updated and refined (Natale et al., 2016). Several steps are necessary to address the data and methodology limitations outlined above:

- The new Fisheries Dependent Information (FDI) data base and associated data calls (see section 3.4.1) need to be implemented so that transversal data would become available at lower levels of aggregation (by ICES rectangles / metiers), linked to economic data at fleet segment level.

- The use of a variety of special conditions when allocating TACs and quota areas currently makes it impossible to accurately calculate the economic dependency of fleet segments on stocks subject to fishing TACs which have such special conditions. Although economic dependency may be underestimated, the only practical alternative for the time being is to only calculate the TDI for parent stocks, by excluding all other related child stocks.
- In order to increase transparency of TAC allocations in general (see also ClientEarth, 2016)[7], and to facilitate the development of tools to support policy decisions such as the TDI indicator tool, efforts should be made to ensure that (i) FMZ areas correspond directly to FAO / ICES areas, or indeed to any other universally recognised system of spatial information units (e.g. c-squares), and that (ii) TAC units (regulatory stocks) correspond directly to biological stocks.

Another possibility to solve some of the issues and challenges linked to the merging the DCF fleet economic and transversal data with TAC unit definitions could be solved by availing detailed transversal data from logbooks (i.e. vessel level data). Such detailed data would allow to more accurately allocate landings (or catches) to each FMZ, and hence, TAC unit. For example, Natale et al. (2016) have developed a case study in collaboration with the Swedish Agency for Marine and Water Management (SwAM)[8], in which the dependency indicator was calculated for single ports (home and landing ports) for the Swedish national fleet. The availability of detailed log-book data allowed zooming-in on the level of geographical analysis. Calculated in this manner, it was possible to identify which coastal communities that were more likely to be affected in economic terms from the setting of TACs and quotas. The mean dependency calculated by fleet segment can hide a high variety of realities given the large segments used. However, it would not be feasible to routinely carry out such an analysis for all vessels and fishing communities in the European Union affected by fishing TACs. On the opposite end of the spectrum data from the DG MARE Catch reporting systems (FIDES)[9] could instead be used to calculate the economic dependency on stocks subject to fishing TACs at the level of EU Member States. Another informative possibility is to simply calculate the TDI for fleet segments by gear-type using the 'value of landings' (available from the transversal data) without providing associated economic indicators by fleet segment.

[7] ClientEarth (2016). Mismatch between TACs and ICES advice. Why it is an issue and how to address it. 13pp. Available from: http://www.documents.clientearth.org/wp-content/uploads/library/2016-12-02-mismatch-between-tacs-and-ices-advice-ce-en.pdf

[8] https://fishreg.jrc.ec.europa.eu/web/stockdependency/index.html

[9] http://ec.europa.eu/idabc/en/document/2254/5926.html

3 OVERVIEW ON AVAILABLE MODELS AND TOOLS FOR IMPACT ASSESSMENTS (TOR 2)

This chapter includes an overview on the available models, the gaps of the described models and the description of tools to assess the dependency of communities on fishing fleets in the Mediterranean Sea. This was included as it could be used additionally to an integrated model to assess impacts of management decisions on fishing fleets.

3.1. Application of models in STECF

This section describes the models, which were presented to the EWG. Most of these models were already used in Multiannual Plans EWG to assess alternative management options and provide advice about their impact on the ecosystem, and, to a less extend, on the economy and society. Additionally the BEMEF model is included, which was used for AER short term projections (STECF, 2016) and MACRO-FISH, which was presented for the first time.

Table A.1 (see Annex 1) describes data characteristics, technical details and applications of the models presented. The table was designed to allow the comparison of the main characteristics across models and the data aggregation each model requires, it was not designed to describe each model in full detail. ICES SGIMM (2013) presents a thorough description of several of the models included in this analysis. Some models' details were not updated due to the lack of expertises, the relevant developers will be contacted after the meeting to provide the information.

3.2.Short description of each model

3.2.1 a4a MSE

The a4a MSE is a Management Strategies Evaluation (MSE) algorithm developed in the JRC Assessment For All (a4a) initiative (Jardim et al, 2015). MSE is a complex simulation and forecasting procedure that takes into account structural and observational uncertainty on stock dynamics (growth, recruitment, maturity) and on its exploitation by fishing fleets (selectivity, effort). The MSE paradigm can lead to the articulation of the central part of a decision making framework for fisheries management under uncertainty. The a4a approach to MSE is to develop a set of common methods and procedures to build a minimal standard MSE algorithm. This has the most common elements of both uncertainty and management options. Such a toolset should allow for the development of MSE simulations for many fisheries in an operational time frame. The aFa MSE design uses a two step approach. The first step defines the 'standard' components of an MSE while the second step sets the details, for example the HCR or the OM conditioning. Currently is a single stock single fleet MSE. Adding more fleets is trivial, as long as data to describe the fleets exists. Extending to mixed fisheries and/or multi species requires further development, which is scheduled for 2017/2018.

3.2.2 BEMEF

BEMEF (Bio-Economic Model of European Fleets) is a simulation model for the economic performance of fleets based on historical data and scaled by external drivers. The model is an extension of the EIAA (Economic Interpretation of ACFM Advice) model that has previously been used to make short-term projections and analyse the short-term economic impact of TAC scenarios. BEMEF is built around the information from the DCF fleet economic data call, and scaled by external drivers. The most significant of these drivers is the change in TAC, of which 150 are currently included in the model. These TAC changes are converted through national and fleet allocations to estimate the change in TAC and landings at the fleet level. The change in TAC also impacts prices and revenues by applying a price flexibility per species. On the cost side, the change in TAC impacts the amount of effort exerted (through a Cobb-Douglas production function) and thus the variable costs (fuel, labour, other) associated with fishing effort. Other drivers include stock biomass, reported fish prices, fuel prices, vessel numbers, and real interest rates. For in-year projections, these drivers incorporate up-to-date information that is available before the economic fleet performance is reported. For short-term projections in future periods, these drivers can incorporate historical trends, estimated forecasts, or be held constant. The user-friendly dashboard contains several options and sensitivities that can be applied to model drivers in future periods. Currently BEMEF is used in the Annual Economic Report to make short-term projections that cover a large number of fleet segments (237) and Member States (15).

3.2.3 BEMTOOL

BEMTOOL is a multi-species multi-gear bio-economic simulation model, which resumes and integrates the different bio-economic models and biological modelling tools developed in the past (until 2013) for Mediterranean fisheries. It consists of six operational modules characterized by components communicating by means of relationships and equations: Biological, Impact, Economic, Behavioural, Policy and Multi Criteria Decision Analysis (MCDA). BEMTOOL follows a multi-fleet approach simulating the effects of a number of management trajectories on stocks and fisheries on a fine time scale (month). The model accounts for length/age-specific selection effects, discards, economic and social performances, effects of compliance with landing obligation and reference points. The implementation of a decision module (Multi-Criteria Decision Analysis and Multi-attribute utility theory) allows stakeholders to weight model-based indicators and rank different management strategies. The model can simulate management scenarios based on changes in selectivity, fishing effort, fishing mortality and TAC. A wide set of biological, pressure and economic indicators is the default output. The uncertainty (process error) is implemented in the model following Monte Carlo paradigm.

3.2.4 DISPLACE

DISPLACE is a spatial impact assessment tool (Bastardie et al 2014) that can be used to evaluate the consequences of spatial fisheries closures on the sustainability and the economy of fisheries. The model simulates individual vessels (agent-based model) and how they will redistribute their fishing effort given spatial or temporal closures under the current fisheries management. The model is designed to assist optimal decision-making in reaction to harvested fish and shellfish stock fluctuations, changes in available space for fishing, and fisheries management actions, at the finest scale available, and, by conducting scenarios analysis, it offers a detailed level of understanding of how stable profits and more energy-efficient fisheries may be achieved, even in a situation where zonation reduces the spatial extent of the fishing opportunities and the number of fishing grounds due to other uses of the sea such as offshore windmill farms, large marine constructions, NATURA 2000 areas, transport routes of commercial shipping, fish farming sites, etc. By applying the model that fit the local fisheries of some ecoregion, practitioners could further develop tailored applications to their area for both understanding the fine dynamic of the interlinked fish and fisheries here, and, in the meantime, acquire a helicopter view of the outcomes when the small-scale fishing operations at sea are aggregated (e.g. at the DCF level, or by fishing harbor communities, etc.). Ultimately, the framework applied so far to Danish fisheries of the North Sea (Bastardie et al 2014), International Baltic Sea fisheries (Bastardie et al 2015, 2016), Northern Adriatic Sea Italian fisheries (Bastardie et al 2017), and Eastern Ionian Sea, with ongoing development in some other areas should analyze and provide data with thematic reports/scenario on which the practitioners can rely on to project the fish stock population levels and fishery economy relevant to the ecoregion. The model contributes to the coordination and integration of different spatial activities in marine areas and reduces potential inefficient management and use of space in accordance with the aims of the EU MSP and other Directives. Further information is available on http://displace-project.org/blog/overview/.

3.2.5 FLBEIA

FLBEIA is an MSE bio-economic model oriented to conduct bio-economic impact assessments of multi-annual management plans (García et al., 2016; García et al., 2013; Prellezo et al., 2016). It is multi-stock, multi-fleet and seasonal and uncertainty can be introduced using Monte Carlo simulation. The stocks can be age structured, aggregated in biomass or fixed with no dynamics. There are no trophic interactions between stocks and the interactions occur through the catch at metier level. The fleets' activity is divided in métiers which are formed by fishing trips or operations that share the same catchability and catch profile. Four processes are modeled at fleet level, how much effort is allocated along métiers in each time step, the stock price, the catch production and the entry and exit of vessels into the fishery. Furthermore, there is a module that simulates the exemptions of the landing obligation policy. The management procedure is divided in three components, the observation, the assessment and the management advice modules. In the observation module all the observable variables can be subject to uncertainty and to perform the assessment any model coded in R/FLR can be used. Finally the management advice is generated using an HCR. The HCRs can be divided into two groups, the model-free HCRs which rely on an abundance index and the model-based HCRs which use the output of an assessment model, if there is no assessment model the real biomass of the stock is used adding an observation and estimation error. Technical management measures are simulated at métier level through changes in the selectivity or temporal constraints in the effort share. The model has been coded modularly and new models can be incorporated to simulate new processes or describe existing ones in an alternative way. FLBEIA was used in the evaluation of multiannual management plans in the Demersal Fleets operating in Iberian Waters (García et al., 2016), in the Southern Bay of Biscay (Prellezo et al., 2016) and in the Celtic Sea (DAMARA Project). At present it is being conditioned in the North Sea, in the framework of DrumFish project, to evaluate management strategies for mixed fisheries including data poor stocks. Besides, there is a preliminary implementation for the Spanish inshore fleet that harvest small pelagic stocks in the Bay of Biscay. The model has been used in several other case studies.

3.2.6 IFRO-Fishrent

The IFRO-Fishrent model is a management strategy evaluation tool developed in the EU-funded project 'Renumeration of spawning stock biomass'. The aim of the tool is to assess potential resource rent in chosen EU fisheries (comprising multiple fleets and stocks), given set management scenarios, comprising output as well as input based measures, from TACs and other quota regimes to effort based management. IFRO-Fishrent comprises five integrated modules, biological (stocks), economic (costs, earnings and profits), market (prices), behaviour (investment) and policy (TACs, effort and access fees). The model is run over a time period set by the user, and can be simulation based (providing projections based on historical catch patterns) or optimisation based (bringing the fishery to economic optimal equilibrium, given the management restrictions). A key element to Fishrent is that fleet and economic data has been structured on data collected as part of the Data Collection Framework. This enables consistent analysis to be conducted ensuring that best available national data is used. However, where possible the data relating to specific fleets can be updated to provide more in depth analysis. The biological module is founded on ICES published data for the key stocks where parameters are estimated offline to populate the necessary biological functions in the model that track the status of the stocks. Fishrent uses a Cobb-Douglas production function to estimate catch year-on-year. A landings obligation (LO) module has recently been added to the model (in connection with the EU-funded project Discardless), making it possible to assess the economic effects of the LO, and of exemptions and mitigation strategies. This work is still in progress.

3.2.7 IAM (Impact Assessement Model for fisheries management)

IAM is an integrated bio-economic model that has been developed in IFREMER since 2009. The model assesses biological and socio-economic impacts of management strategies such as alternative TACs, multi-annual management plans, alternative governance systems (co-management, Individual Transferable Quotas), selectivity improvement scenarios and landings obligation or decommissioning schemes (Macher et al. 2016; Guillen et al., 2013). The model was developed in a partnership approach that brought together fishers representatives, researchers in biology, economics and sociology, and managers as part of an integrated process for impact assessment. It is a simulation and optimization model with a modular structure. It is multi-species, multi-fleet/multi-vessel and multi-métier and stochastic. The model represents management procedures and institutional arrangements, biological dynamics, harvesting dynamics, short and long term fleets behaviours of effort allocation and entry/exit in the fishery and market through estimated price demand function when possible (Merzéréaud et al., 2011). It provides outputs on stocks status, fleets/vessel profitability and economic viability, employment and wages, distribution of impacts between vessels/fleets, owners/crew, and efficiency of scenarios based on cost-benefit analysis considering opportunity costs of labour and capital. The model was applied to the Bay of Biscay demersal fisheries, the Mediterranean gulf of Lion hake fishery and the Bay of Saint-Brieuc scallop fishery. It was developed and used in national and European research projects (the partnership bio-economic working group project (2009-2015) funded by the French Directorate of Sea Fisheries and Aquaculture, SOCIOEC, …) and for national and European requests (STECF IA of sole management plan and SW MAP, and ICES special request on sole).

3.2.8 MACRO-FISH

Macro-Fish a dynamic general equilibrium model with heterogeneous agents that can be used for assessment of the economic consequences of different EU policies. These include, stock rebuilding strategies, comparison between input/output management options, capital malleability and macro-economic effects of subsidies. The model takes into account the price system, which plays the crucial coordinating and equilibrating role in the economy. It is based on the fact that everyone in a given economy faces the same prices generates the common information needed to coordinate individual decisions. Prices (i.e. wages) balance demand and supply so that all the buyers who want to buy at the current price, and similarly, all the sellers who want to sell at the current price, can and do it, with no excess or shortages on either side. The results provide both individual and aggregate data. It provides a set of aggregated economic and social indicators (wages and household utility), capital indicators (number of vessels) and macroeconomic aggregate indicators (gross value added -GVA- and wealth). It allows the endogenous consideration of capital dynamics which provides an index of over-capitalization. Given that the model is based on heteregenous agents it also provides an index (Gini) of the inequality of these indicators.

3.2.9 MEFISTO

The latest version (MEFISTO 4.0.1), released in January 2017, is similar to other bioeconomic models applied elsewhere in European Atlantic fisheries in the sense that it includes a population dynamics submodel and an economic submodel, with for example harvest costs, fishing effort dynamics, investment/disinvestment functions. An important difference is in the economic submodel, which is specifically tailored to Mediterranean fisheries, where the retribution system follows a "share" system (wages proportional to gross revenues minus "common costs"). Another difference is the lack of TAC or quota as possible management tool because Mediterranean fisheries are traditionally managed with input measures (effort limitations; technological restrictions). The biological component of the model is based on a standard age-structured population model, using stock assessment data. Some additional, optional parameters can be added to the simulation conditions, such as stochastic variability around the natural mortality values or uncertainty in the stock / recruitment dynamics. The link between the biological submodel and the economic submodel is modelled by the relationship between fishing effort and fishing mortality. Fishing effort can be expressed in terms of capacity or activity or a combination (i.e. GT x days-at-sea). Fishing mortality can include the fishing mortality of landings as well as discards. The economic submodel operates at the level of the fishing firm or unit. The gross economic profit of each vessel is computed from the difference between income and costs (see Lleonart et al. 2003 for list of costs). The model is programmed in Python 2.7 and is distributed as an executable with a user friendly interface, available at www.mefisto.info. The model MEFISTO has been used in several scientific publications, as well as a decision support tool for the analysis of fisheries management plans in the Western Mediterranean (Maynou et al. 2014 and Spedicato 2016).

3.2.10 SIMFISH

SIMFISH is an integrated bio-economic model developed by Wageningen Economic Research in EU projects VECTORS and SOCIOEC (amongst others) based on the FISHRENT model. The model is used to test alternative management measures (TACs, target Fs, effort limitations, landing obligation, biological safeguards, area closures). It considers multiple fleets and several fish stocks being exploited by different metiers and is spatially explicit. The model integrates short and long-term fleet dynamics and population dynamics in a full feedback loop running at the annual level. Long-term behaviour includes entry-exit of vessels in the different active fleets. Short-term dynamics include allocation of effort to the different metiers/areas, quota trading (lease) and price formation. The model is currently applied to the North Sea flatfish and shrimp fisheries with sole, plaice and brown shrimp explicitly modelled and beamtrawl fleets of the Netherlands, Britain and Germany exploiting the three species. It has been used to evaluate the North Sea Flatfish management plan (ex-post) and the North Sea Multi-Annual Plan (ex-ante). The model is currently parameterised with 2010 fleets (Bartelings et al. 2015 and Kempf et al. 2016) and will be updated to 2015 in H2020 project CERES in 2017-2018.

3.2.11 TI-FishRent

TI-FishRent is a spatially explicit bioeconomic model for fisheries management evaluations (Simons et al., 2014a). It is based on the original FishRent version that was developed in the EU funded project "renumeration of spawning stock biomass" (Salz et al., 2011). The TI-FishRent is a dynamic feedback model and integrates economics of fleets, the impact of fishing on stock development and their spatio-temporal interplay (Simons et al., 2014b). TI-FishRent considers a possible effort redistribution and accounts also for the fact that economic conditions (e.g. revenues and fishing costs) will determine fishing effort and that management regulation itself will alter profitability and hence subsequent effort decisions by fleets, which in turn will impact the commercial fish stocks. The economic performance of individual fleet segments can be compared with each other over a short and long period of time (e.g. 40 years). Seasonal or annual time steps can be used, including independent procedures for the dynamic, age-structured stock development (e.g. growth, recruitment and mortality), the catch, the effort distribution, and the entry and exit of vessels. It can be used to assess the consequences of current or alternative management strategies (e.g. TAC proposals, effort limitations, biological safeguards, target fishing mortality rates, area closures, temporal closures or landing obligation policy) and changing economic and environmental conditions in the North Sea saithe fishery. TI-FishRent includes four fish stocks (saithe, cod, haddock and whiting) and 20 fleet segments from Germany, the UK, Belgium, the Netherlands, France and Denmark. As part of the CERES Project it is planned to extend the model for the demersal fishery in the North Sea (including cod, saithe, haddock and hake) and the pelagic fishery in the Northeast Atlantic (including herring, mackerel and horse mackerel) and to analyze the impact of climate change on fleets and fish stocks. TI-FishRent has already been applied in other EU Projects such as COEXIST, VECTORS and SOCIOEC. TI-FishRent has been used to evaluate the multi-annual plan for the North Sea.

3.3. Gaps in coverage of the models (regions, fisheries, stocks, fleets)

The BEMEF model, is the only model of those evaluated by the EWG which currently has a wide coverage of TACs (150). Integrated bioeconomic models are typically regionally-focussed and, therefore, each model may address only a limited number of TACs. When viewed cumulatively, existing integrated bioeconomic models cover a majority of the most significant TACs in terms of catches and value.

A multi-model approach is possible for most geographic regions given the spatial overlap of individual models and TACs covered. The recent analysis carried out to evaluate multi-annual management plans showed some gaps regarding the availability of models, in some areas. The West of Scotland, Irish Sea, Ionian and Aegean Seas and the Black Sea, no models were available/parameterized to evaluate management proposals for demersal stocks. Regarding small pelagics, except in the Adriatic, the gaps are unclear since MAPs proposals were not evaluated yet. Deep sea stocks are also not covered by the models' currently conditioned. In some cases, only a single integrated bioeconomic model is in development (e.g. Celtic Sea, FLBEIA).

3.4. Dependency of local communities on fisheries in the Med

Even though the implementation of management measures can significantly affect the social dimension, fisheries management is generally focused on biological and economic objectives. Collecting information on social variables would allow policy-makers to take decisions more efficient and acceptable by the fishing sector. A first step in this direction is represented by the new EU Multiannual Programme, which introduced for 2018-2019 a number of social variables to be collected within the DCF by MSs.

Management plans in the Mediterranean fisheries are aimed at reducing fishing effort to achieve the objective of Fmsy in 2020. As reported in preliminary studies for the multiannual management plans in the Mediterranean and the Black Sea (Project MARE/2014/27), this objective would be achieved by reducing fishing activity and capacity for a number of fisheries.

The reduction in fishing effort can be applied differentiating the impact for different fleets and different areas by taking into account the impact that different choices would have from a social point of view.

A first step would be to consider the dependency of local communities on the fishing sector and their economic conditions. Reducing fishing opportunities in an area with many chances of diversification and opportunities in other economic sectors is preferable to doing the same in areas strongly dependent on fisheries and without alternative job opportunities.

The dependency of communities on fisheries may not only be economic. It can also be based on social and cultural values. However, this is an issue for anthropologists and sociologists.

From an economic perspective, the local community dependency on fisheries can be assessed by joining information on

1) the relevance of the fishing sector in the local economy, and
2) the ability of local economies to adapt.

Indicators on the ability of adapt to change, like a potential reduction of the local fishing sector, can be used by policy-makers to direct the management measures towards specific geographical areas.

Studies following this approach were carried out within the studies for carrying out the Common Fisheries Policy in 2013 (Project MARE/2011/07) on 18 local communities in the four regions of Shetland, Brittany, Galicia and Sicily. These studies were mainly intended to provide a contribution to the understanding of local processes of development and diversification and the role of fisheries in coastal communities through the collection of primary data at the local level.

The relevance of the fishing sector is generally estimated in terms of GVA and/or employment (Natale et al., 2013; Salz and Macfadyen, 2007). The relevance of fisheries on the local communities includes the catching and related sub-sectors, like the local fish processing, the shipbuilding industry, the fish market and other ancillary economic activities. The aquaculture sector is also generally included in these analyses.

Natale et al. (2013) identified EU coastal communities relying on fisheries using accessibility analysis, principles at the basis of gravity models and disaggregated population and employment statistics. The dependency on fisheries is calculated comparing estimated employment from fisheries at each port with general employment in the areas of accessibility surrounding the port (at less than 25 minutes from the port). The importance of fishing activities for coastal communities is highlighted when considering spatially disaggregated statistics. In this study, a total of 388 fisheries dependent coastal communities (with dependency ratios above 1%) were identified. Moreover, around 54% of the total EU fishery employment was estimated to be based in these fisheries dependent coastal communities.

An online tool[10] is available providing maps and indicators on fisheries employment and GVA at the level of fishing ports and provinces for the entire EU. The calculation of these indicators is based on the number of fishing vessels from the EU fleet register and coefficients on number of persons employed per vessel and labour productivity from the DCF. Fisheries employment and fisheries GVA are compared with general employment and general GVA estimated from ESTAT data to derive dependency ratios in respect of the areas surrounding each port and the totals in the provinces.

The ability to adapt is more difficult to be estimated and is linked to a number of features of the local social and institutional context. Hamilton (2003) identified 6 social and political conditions that affect the ability to adapt of a community, including human capital, social capital (inclusive social institutions), communities with long-standing habits of cooperation and participation, the level of access to local resources by the community.

As reported by the project MARE/2011/07, analysing the social and institutional context of local communities requires the collection of primary data. Interviews through focus groups and with key local informants in the community are essential for collecting detailed quantitative and qualitative information. Secondary data at local level should be also collected to evaluate trends in demographics, employment by sector, institutions and services.

[10] https://fishreg.jrc.ec.europa.eu/web/coastalcommunities/index.html

4 METHODOLOGICAL APPROACH FOR PROJECTIONS IN THE AER (TOR 3)

As information collected through the economic data call of the DCF is dated by nearly two years by the time the Annual Economic Report (AER) is published, 'in-year projections' have been made in several editions of the AER for both the year of publication and the preceding year. There has not been a consistent format in how the projections have been incorporated in the report. Different editions of AER have varied in whether projections are included for the largest fleet segments or just Member States, whether projections for Mediterranean fleet segments and Member States are included, and whether the projections are incorporated into the main data tables of the report or included as a separate section of the Member State chapters. In the 2015 AER, estimates of MSY and BMSY were applied to segments in a static approach to estimate economic variables, as had previously been the approach in some of the short-term assessments of TAC advice.

Historically, the EIAA model (Economic Interpretation of ACFM Advice) was used for the projections in the AER. In the previous two reports (2015 and 2016), the BEMEF model, an extended version of the EIAA model, was used.

The BEMEF model, like the EIAA model, is an economic simulation model that uses the performance of fleet segments in the three most recent years and simulates the changes in future periods based on exogenous changes. The most significant of these drivers is the change in TAC, as these quota limits constrain output. The TAC is known for both the preceding year and the year of publication – subject to any in-year revisions. The change in TAC (using 150 TACs) is converted through national and fleet allocations to estimate the change in TAC and landings at the fleet segment level. The change in TAC also impacts prices and revenues by applying a price flexibility per species. On the cost side, the change in TAC impacts the amount of effort exerted (through a Cobb-Douglas production function) and thus the variable costs (fuel, labour, other) associated with fishing effort.

In addition to the change in TAC, other in-year drivers with available data are incorporated in BEMEF. Fish prices, fuel prices, vessel numbers, real interest rates are available from frequently updated sources. As information on some variables is available through the economic data call before the economic indicators (most often the quantity of landings, value of landings, number of vessels by segment, and days at sea), this information is used in BEMEF to replace the estimated values for these variables and to estimate other variables using historical correlations. The equations used in BEMEF are available in an annex of the Annual Economic Report.

Given the importance of the change in TAC to the BEMEF modelling, only those fleet segments with activity in Area 27 (North Atlantic, North Sea and the Baltic Sea) are modelled. Currently this covers 237 fleet segments from 15 Member States. The outputs of BEMEF are the same economic indicators used in the AER. Results at calculated at the fleet level and are combined to calculate the change at the Member State level.

4.1. Proposal for projections for fisheries in area 27

For the following description the notation year-1, year 0 and year+1 was used, to refer to the year before the EWG took place, the year when the EWG took place, and the year after the EWG took place, respectively.

For projections over years 0 and +1, economic data is not available and so an integrated model has advantages over the BEMEF model. For year -1, which will be 2016 in the AER 2017, it is, however, possible to apply the BEMEF as for this year the data required to parameterize the model should be already available (e.g. transversal data, data on fuel prices, etc.).

EWG 16-20 suggests adding to the TOR for the first AER working group the following requests:

The AER-EWG should work on improvements of the BEMEF for the following limitations of the model:

- Uncertainty estimates
- Robustness of outputs given model structure (sensitivity analysis)
- The possibility of incorporating technical interactions at the metier level

For the year 0, which means 2017 for the AER 2017, the BEMEF model can also be applied but the limitations should be made transparent. These projections should be critically assessed and commented on by the experts.

4.2. Methodological Approach for projections in the AER (Mediterranean MS)

Projections on socio-economic indicators by segment for some Mediterranean MSs were carried out through a modelling tool named HDA0.2 in the 2013 AER and the 2015 AER. Projections were done for Italy, Malta and Slovenia in the 2013 AER and only for Italy and Slovenia in the 2015 AER. Insufficient data on transversal and/or economic variables did not allow producing projections for the other Mediterranean countries. On the contrary, JRC produced projections in the 2014 AER by using equations derived from the conclusions of the STECF 11-19.

The equations used in HDA0.2 are based on those generally included in the bio-economic models for the Mediterranean. Using the same notation described above for year-1, year 0 and year+1, projections on socio-economic indicators for year -1 are carried out through linear relationships with the transversal data available for that year. For year -1, most of the equations are identical or very similar to those used in the JRC database for projections. JRC equations are reported in Chapter 6.5 of the 2015 AER report. The tables below shows the differences between the equations used by the JRC database and those used by HDA0.2 for year -1 projection.

Unlike projections for year -1, which mainly depends on the selection of the linear equations, projections for year 0 through HDA0.2 require additional inputs from the MSs experts to overcome the lack of transversal data. HDA0.2 was not developed to substitute MSs experts in producing projections, but to support them in this activity. In particular, for year 0 projections, MSs experts are required to provide the following inputs:

- number of vessels by fleet segment in year 0;
- changes in the average days at sea by fleet segment from year -1 to year 0;
- changes in total landings per unit of effort by fleet segment from year -1 to year 0;
- changes in the average price of total landings by fleet segment from year -1 to year 0;
- values of fuel price in year 0;
- values of interest rate and inflation rate in year 0.

Possible approaches to collect this information are reported in the description of the HDA0.2 model in the 2015 AER report.

Variables projected/imputed	**JRC Projections**	**HDA0.2 Projections**
Crew wage costs (totcrewwage) Unpaid labour (totunpaidlab)	$X_t = (\frac{X_{t-3} + X_{t-2} + X_{t-1}}{DAS_{t-3} + DAS_{t-2} + DAS_{t-1}}) \times DAS_t$ Notes: When days at sea (DAS) is unavailable, value of landings (VaL) is used.	Crew wage costs and Unpaid labour are calculated by HDA0.2 as Labour costs. Labour costs: HDA0.2 uses a combination of two approaches: 1) the difference between Landings value or (Landings income) (R) and the variable costs (energy costs + other variable costs) instead of DAS or VaL; 2) total employed (EM) instead of DAS or VaL. The calculation is based on the last available year instead of the average on the last three years:

		$LC'_t = \frac{(R_t - EC_t - OVC_t)}{(R_{t-1} - EC_{t-1} - OVC_{t-1})} LC_{t-1}$, $LC''_t = \frac{EM_t}{EM_{t-1}} LC_{t-1}$, $LC_t = \alpha LC'_t + (1-\alpha) LC''_t$, where α is a coefficient between 0 and 1. Energy costs, other variable costs and total employed are estimated as reported below.

Variables projected/imputed	**JRC Projections**	**HDA0.2 Projections**
Other non-variable costs (totnovarcost)	Estimation based on the change in capacity, i.e. number of vessels (N): $X_t = \frac{N_t}{N_{t-1}} \times X_{t-1}$	Other non-variable costs: HDA0.2 uses GT instead of N: $X_t = \frac{GT_t}{GT_{t-1}} \times X_{t-1}$.
Depreciated replacement value (totdeprep)		Depreciated replacement value: HDA0.2 uses GT instead of N: $X_t = \frac{GT_t}{GT_{t-1}} \times X_{t-1}$.
Depreciated historical value (totdephist)		Depreciated historical value: not calculated in HDA0.2.
Total employed (totjob)		Total employed: HDA0.2 uses the same equation as the JRC database.
Annual depreciation (totdepcost)		Annual depreciation: HDA0.2 uses GT instead of N: $X_t = \frac{GT_t}{GT_{t-1}} \times X_{t-1}$.
Other income (tototherinc)		Other income: HDA0.2 uses Landings value or Landings income (R) instead of N: $X_t = \frac{R_t}{R_{t-1}} \times X_{t-1}$.

Variables projected/imputed	**JRC Projections**	**HDA0.2 Projections**
Other variable costs (totvarcost)	Estimation based on the change in effort, i.e. Days at Sea (DAS):	Other variable costs: HDA0.2 uses the same equation as the JRC database.
Repair costs		

(totrepcost) FTE (totnatfte) FTE harmonised (totharmfte)	$X_t = \frac{DAS_t}{DAS_{t-1}} \times X_{t-1}$	The only difference is the possibility for model user to select fishing effort in terms of GT (or KW) times average days at sea instead of DAS. <u>Repair costs</u>: HDA0.2 uses GT instead of DAS: $X_t = \frac{GT_t}{GT_{t-1}} \times X_{t-1}$. <u>FTE</u>: HDA0.2 uses N (number of vessels) instead of DAS: $X_t = \frac{N_t}{N_{t-1}} \times X_{t-1}$. <u>FTE harmonised</u>: not calculated in HDA0.2.

Variables projected/imputed	**JRC Projections**	**HDA0.2 Projections**
Energy costs (totenercost)	Estimation based on the change in effort (DAS) and change in average fuel price (P): $X_t = \frac{DAS_t}{DAS_{t-1}} \times \frac{P_t}{P_{t-1}} \times X_{t-1}$	<u>Energy costs</u>: HDA0.2 uses the same equation as the JRC database. The only difference is the possibility for model user to select fishing effort in terms of GT (or KW) times average days at sea instead of DAS.

Table 4-1 Differences between equations used by JRC database and those used by HDA0.2 for year -1 projection.

5 CONCLUSIONS

5.1. ToR 1 - assessment of social and economic impacts of TAC and quota proposals

The EWG concluded that, in their present state of development, no single model is able to assess the social and economic impacts of the EC's TAC and quota proposal.

Although over the last years several integrated models to assess biologic and socio-economic impacts were developed, which can be applied to assess short and long-term effects, these complex models not easily usable for a quick assessment of the EC's TAC and quota proposal.

Given the high amount of personal resources needed to maintain the models up to date, without a specific objective and a regular funding to do so, it's very unlikely these models can be updated on an annual or bi-annual basis.

Alternative models focused on short-term projections (e.g. BEMEF), which benefit from the AER data preparation and could be applied quickly, lack important/mandatory features to provide a proper scientific/quantitative evaluation of the EC's TAC proposal (see section 3.2.1). Major limitations of these models identified by the EWG were the 3 year gap between the AER data and the TAC proposal, missing feedback between economy and biology which impairs the assessment of the longer-term effects of the TAC proposals, the use of economic fleet segments which limits the inclusion of technical interactions and missing uncertainty estimates.

A general economic dynamic equilibrium model was presented, Macro-Fish. This model has the advantage of being based on macro economic theory, and the disadvantage of not including a feedback model between economics and biology. Its usage on this process was not clear but it was considered an interesting path of development.

The EWG suggests a mixed approach, where a quick overview using short term forecasts could be complemented by a zooming into critical TAC changes using integrated models. The EWG discussed this option, including a protocol proposal, which should be further developed if to be followed.

The EWG concluded that in order to apply any of the above mentioned methodologies, DG Mare needs to provide basic assumptions (on fuel prices, fish prices, etc.).

A set of tools under development was presented, the New FDI and the TAC dependency tool (see section 3.4). The EWG concluded that these tools can be valuable assets to this process, once fully developed and tested.

5.2. ToR 2 - Assessment of social and economic impacts of fisheries management options

The EWG built a list of models which can be used for quantitative analysis of impact assessments. Most of the models presented were already used in Multiannual Plans EWG, with the addition of the BEMEF model, which was used for AER short term projections and a new model presented to the EWG, MACRO-FISH. The characteristics of the models were compiled in a table, to allow the comparison of the main characteristics across models and the data aggregation each model requires.

The EWG identified gaps in models' spatial coverage based on the recent EWGs. The West of Scotland, Irish Sea, Ionian and Aegean Seas and the Black Sea, no models were available/parameterized for demersal fisheries. Regarding small pelagics, except in the Adriatic, the gaps are unclear since dedicated EWG didn't take place yet. Deep sea stocks are not covered.

5.3.ToR 3 – standard methodology for AER projections

For the AER 2015 and 2016 the BEMEF model was applied to do the short-term projections for two situations, (i) updating economic variables 1 year ahead to match the transversal variables (referred as Y-1 in the report), and (ii) to forecast the economic performance of the fleets to the year of the AER evaluation (Y 0 in the report).

Considering the availability of data (landings, fuel prices, fish prices, effort, etc.) the application of the BEMEF model for Y-1 is unproblematic.

For Y 0 the application of integrated models would be advisable, although the requirements of those models make it impractical for the EWG.

If the limitations described in in the report are resolved, the BEMEF model could be applied for Y 0, as long as the limitations and assumptions are clearly stated.

The projections for the Mediterranean are done with alternative models. The EWG concludes that one single approach should be applied.

5.4. Other

EWG 16-20 stresses the need for another bio-economic methodological workshop to support the development of a coherent multi-model approach. Such an approach would allow for the challenges of providing operational decision support to be addressed (in terms of the required data, common assumptions to be made, common outputs and interface to be developed etc.) and underline the need to create a framework for annual integrated assessment of TAC options, considering resources and time needed.

EWG 16-20 concludes that there will never be one model to cover all fisheries and be applicable for all management measures.

EWG 16-20 concludes that a common database with stock assessment results and DCF data should be available for the scoping meeting. Development of calibration methods based on an integrated database gathering main data needed for bio-economic parametrisation would improve the ability to perform impact assessments in a short interval.

6 References

Bartelings, H., Hamon, K. G., Berkenhagen, J. & Buisman, F. C. 2015. Bio-economic modelling for marine spatial planning application in North Sea shrimp and flatfish fisheries. Environmental Modelling & Software, 74 – 156-172.

Bastardie, F., Nielsen, J.R, and Miethe, T. 2014. DISPLACE: a Dynamic, individual-based model for spatial fishing planning and effort displacement – integrating underlying fish population models. Can. J. Fish. Aquat. Sci. 71: 1-21. dx.doi.org/10.1139/cjfas-2013-0126

Bastardie, F., Nielsen, J.R., Eigaard O., Fock O.H., Jonsson, P., and Bartolino V. 2015. Competition for marine space: modelling the Baltic Sea fisheries and effort displacement under spatial restrictions. ICES J. Mar. Sci. 72(3): 824-840. doi:10.1093./icesjms/fsu215.

Bastardie, F., Nielsen, J.R., Eero, M., Fuga, F., and Rindorf, A. 2016. Impacts of changes in stock productivity and mixing on stock sustainability and fishery economic viability. ICES J. Mar. Sci. doi:10.1093/icesjms/fsw083.

Bastardie, F., Silviana, S, et al. 2017. Spatial planning for fisheries in the Northern Adriatic: working towards viable and sustainable fishing. Ecosphere, *In Press*. DOI:10.1002/ecs2.1696

Castro Ribeiro, C., Holmes, S., Scott, F., Berkenhagen, J., Demaneche, S., Prista, N., Reis, D., Reilly, T., Andriukaitiene, J., Aquilina, M., Avdič Mravlje, E., Calvo Santos, A., Charilaou, C., Dalskov, J., Davidiuk, I., Diamant, A., Egekvist, J., Elliot, M., Ioannou, M., Jakovleva, I. Kuzebski, E., Ozernaja, O., Pinnelo, D., Thasitis, I., Verlé, K., Vitarnen, J., Wójcik, I..Report of the 2nd Workshop on Transversal Variables. Nicosia, Cyprus. 22-26 February 2016. A DCF ad-hoc workshop

European Commission (2015) 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

ICES. 2013. Report of the Study Group on Integration of Economics, Stock Assessment and Fisheries Management (SGIMM). ICES CM 2013/SSGRSP:08. 107 pp.

Frost H., Andersen J. L., Hoff A., Thøgersen T. 2009. The EIAA model. Institute of Food and Resource Economics Report no. 200.

García, D., Prellezo, R., Sampedro, P., Da-Rocha, J. M., Castro, J., Cerviño, S., García-Cutrín, J., et al., 2016. Bioeconomic multistock reference points as a tool for overcoming the drawbacks of the landing obligation. ICES Journal of Marine Science: Journal du Conseil.

García, D., Urtizberea, A., Diez, G., Gil, J., and Marchal, P., 2013. Bio-economic management strategy evaluation of deepwater stocks using the FLBEIA model. Aquatic Living Resources, 26: 365-379.

Guillen J., MacherC., Merzéréaud M., Bertignac M., Fifas S., Guyader O., 2013. Estimating MSY and MEY in multi-species and multi-fleet fisheries, consequences and limits: an application to the Bay of Biscay mixed fishery. Marine Policy, 40, 64-74. Publisher's official version : http://doi.org/10.1016/j.marpol.2012.12.029 , Open Access version : http://archimer.ifremer.fr/doc/00129/24000/

Jardim, E., Millar, C., Mosqueira, I., Scott, F., Osio, G., Ferretti, M., Alzorriz, N., Orio, A. 2015. What if stock assessment is as simple as a linear model? The a4a initiative. ICES Journal of Marine Science 72 (1), 232–236.

Kempf, A., Mumford, J., Levontin, P., Leach, A., Hoff, A., Hamon, K. G., Bartelings, H., Vinther, M., Stäbler, M., Poos, J. J., Smout, S., Frost, H., van den Burg, S., Ulrich, C. & Rindorf, A. 2016. The MSY concept in a multi-objective fisheries environment – Lessons from the North Sea. Marine Policy, 69 – 146-158.

Lleonart, J., F. Maynou, L. Recasens and R. Franquesa. 2003. A bioeconomic model for Mediterranean Fisheries, the hake off Catalonia (Western Mediterranean) as a case study. Scientia Marina 67 (suppl. 1): 337-351. In: Fisheries stock assessments and predictions:

Integrating relevant knowledge, Ø. Ulltang, G. Blom [eds.] http://dx.doi.org/10.3989/scimar.2003.67s1337.

Macher, C., Manuel B., Olivier G., Merzéréaud M., Le Grand, C., 2016. A bio-economic agent-based model to investigate trade-offs between alternative fisheries quota governance systems. MSEAS, May 30-June 3, 2016. Brest, France

Maynou, F. 2014. Co-viability analysis of Western Mediterranean fisheries under MSY scenarios for 2020. ICES Journal of Marine Science, 71(7): 1563 – 1571. doi: http://dx.doi.org/10.1093/icesjms/fsu061.

Merzéréaud M., Macher C., Bertignac M., Fresard M., Le Grand C., Guyader O., Daures F., Fifas S. 2011. Description of the Impact Assessment bio-economic Model for fisheries management (IAM). https://w3.ifremer.fr/archimer/doc/00067/ 17808/15337.pdf

Natale, F., Carvalho, N., Harrop, M., Guillen, J., & Frangoudes, K. 2013. Identifying fisheries dependent communities in EU coastal areas. Marine Policy, 42, 245–252.

Natale F., Carvalho N., Guillen J., Gibin M., Kruiderink S. 2016. Economic dependency to stocks subject to fishing TACs. JRC Science for Policy Report. Internal draft

Prellezo, R., Carmona, I., and García, D. 2016. The bad, the good and the very good of the landing obligation implementation in the Bay of Biscay: A case study of Basque trawlers. Fisheries Research, 181: 172-185.

Salz, P., Buisman, E., Frost, H., Accadia, P., Prellezo, R., and Soma, K. 2011. Fishrent:bio-economic simulation and optimization model for fisheries. LEI Report, 2011: 024.

Salz, P. and Macfadyen, G. 2007 Regional dependency on fisheries. IP/B/PECH/ST/IC/2006-198 http://www.framian.nl/our_publications/ (accessed September 2012), 162 pp

Simons, S., Bartelings, H., Hamon, K., Kempf, A., Döring, R., and Temming, A. 2014a. Integrating stochastic age-structured population dynamics into complex fisheries economic models for management evaluations: The North Sea saithe fishery as a case study. ICES Journal of Marine Science: Journal du Conseil., In press.

Simons, S. L., Döring, R., and Temming, A. 2014b. Modelling the spatio-temporal interplay between North Sea saithe (Pollachius virens) and multiple fleet segments for management evaluation. Aquatic Living Resources, 27: 1-16.

Spedicato, M.T. (coord.) 2016. Study on the evaluation of specific management scenarios for the preparation of multiannual management plans in the Mediterranean and the Black Sea. EASME/EMFF/2014/1.3.2.7/SI2.703 193. CALL MARE/2014/27. European Union Bookshop.

STECF 2010. Report of SGECA 10-01 working group on the on the discussion of methodologies, indicators and format of the 2010 Annual Economic Report (AER) Luxembourg: Office for Official Publications of the European Communities.

STECF 2016, The 2016 Annual Economic Report on the EU Fishing Fleet (STECF 16-11); Publications Office of the European Union, Luxembourg; ISBN 978-92-79-64633-1

7 CONTACT DETAILS OF EWG-16-20 PARTICIPANTS

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

STECF members			
Name	Address[1]	Telephone no.	Email
Döring, Ralf	Thünen Bundesforschungsinstitut, für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei - AG Fischereiökonomie, Palmaille 9, D-22767 Hamburg, Germany	+04038905185	ralf.doering@thuenen.de
Knittweis-Mifsud, Leyla	University of Malta, MSD2080, MSIDA, Malta	+35699093065	leyla.knittweis@um.edu.mt
Prellezo, Raúl	AZTI -Unidad de Investigación Marina Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	+34 667174368	rprellezo@azti.es

Invited experts			
Name	Address	Telephone no.	Email
Accadia, Paolo	NISEA, Via Irno 11, 84135, SALERNO, Italy	+393288941719	accadia@nisea.eu
Bastardie, Francois	DTU-Aqua, Charlottenlund Castle, 2920, CHARLOTTENLUND, Denmark	+4525470494	fba@aqua.dtu.dk
Brigaudeau, Cecile	Des requins et des hommes, Impasse Kerjacob, 29810, LAMPAUL-PLOUARZEL, France	+33(0)61438 6001	cecile@desrequinsetdeshommes.org
Carpenter, Griffin	New Economics Foundation, 10 Salamanca Place, SE17HB, LONDON, United Kingdom	+4552678756	griffin.carpenter@neweconomics.org

Garcia, Dorleta	Azti, Txatxarramendi Ugartea, z/g, 48395, SUKARRIETA,Spain	+349465740 00	dgarcia@azti.es
Hamon, Katell	Wageningen Economic Research, Alexanderveld 5, 2585DB DEN, HAAG, Netherlands	+31683943264	katell.hamon@wur.nl
Hoff, Ayoe	University of Copenhagen, Department of Food and Resource Economics, Rolighedsvej, 251958, FREDERIKSBERG, Denmark	+4535336800	ah@ifro.ku.dk
Macher, Claire	IFREMER, UMR 6308, AMURE-IUEM, Rue Dumont d'Urville, 29280, PLOUZANE, France	0033 (0)290915626	claire.macher@ifremer.fr
Maynou, Francesc	Marine Science Institute, Psg Marítim de la Barceloneta 37-49, 8003, BARCELONA, Spain	+34628410421	maynouf@icm.csic.es
Rodgers, Philip	Erinshore Economics Ltd, 125 Mill Lane, Saxilby, LN1 2HN, LINCS, United Kingdom	+441522 03203	phil@erinecon.com
Taylor, Marc	Thünen Institute of Sea Fisheries, Palmaille 9, 22767, HAMBURG, Germany	+49 151 5555 0921	marc.taylor@thuenen.de

JRC experts			
Name	Address	Telephone no.	Email
Carvalho, Natacha	European Commission, DG Joint Research Centre, Directorate D – Sustainable Resources, Unit D.02 Water and Marine Resources, via Enrico Fermi 2749, 21027, Ispra (VA), Italy	+390332786713	natacha.carvalho@jrc.ec.europa.eu
Guillen, Jordi	European Commission, DG Joint Research Centre, Directorate D – Sustainable Resources, Unit D.02 Water and Marine Resources, via Enrico Fermi 2749, 21027, Ispra (VA), Italy	+390332786402	jordi.guillen@jrc.ec.europa.eu
Jardim, Ernesto	European Commission, DG Joint Research Centre, Directorate D – Sustainable Resources,	+390332785311	ernesto.jardim@jrc.ec.europa.eu

	Unit D.02 Water and Marine Resources, via Enrico Fermi 2749, 21027, Ispra (VA), Italy		
Scott, Finlay	European Commission, DG Joint Research Centre, Directorate D – Sustainable Resources, Unit D.02 Water and Marine Resources, via Enrico Fermi 2749, 21027, Ispra (VA), Italy	+390332789610	finlay.scott@jrc.ec.europa.eu

European Commission			
Name	Address	Telephone no.	Email
Scott, Finlay	DG Joint Research Centre JRC, STECF secretariat		Stecf-secretariat@jrc.ec.europa.eu
Calvo Santos, Angel	European Commission, DG Fisheries and Maritime Affairs, Rue Joseph II 3/25, B-1049 Brussels, Belgium	+32 22993630	Angel-Andres.CALVO-SANTOS@ec.europa.eu

8 LIST OF ANNEXES

Electronic annexes are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1620

List of electronic annexes documents:

Annex 1. Data characteristics, technical details and applications of the models

9 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1620

List of background documents:

STECF EWG 16 20_Declarations of interests (see also section 7 of this report – List of participants)

XX-NA-xxxxx-EN-N

STECF

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

JRC Mission

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

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

Joint Research Centre

EU Science Hub

doi:xx.xxxx/xxxxx

ISBN xxx-xx-xx-xxxxx-x

Publications Office