WORKING GROUP ON CUMULATIVE EFFECTS ASSESSMENT APPROACHES IN MANAGEMENT (WGCEAM; outputs from 2021 meeting)

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International Council for the Exploration of the Sea
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H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Editors

Vanessa Stelzenmüller • Roland Cormier • Gerjan Piet

Authors

Robert Aps • Silvana Birchenough • Roland Cormier • Carolyn Faithfull • Emily Hague • Henn Ojaveer • Debbi Pedreschi • Gerjan Piet • Jennifer Rehren • David Reid • Vanessa Stelzenmüller

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Contents

i Executive summary

The Working Group on Cumulative Effects Assessment Approaches in Management (WGCEAM) has developed a common and consolidated cumulative effects assessment (CEA) framework to provide science advice as guidance for the implementation of ecosystem-based management. The framework reflects a step-wise process that aligns the prioritisation of key pressures through causal pathways within defined assessment boundaries. An algorithm was developed to calculate impact risk scores reflecting vulnerability of the ecosystem to human activities. The intent of such vulnerability profiles can provide a visual representation for setting strategic priorities for the management of human activities and their pressures.

WGCEAM undertook a case study for the North Sea and the Gulf of St Lawrence to test the framework with semi-quantitative and quantitative data and improve the framework where needed. Further work on the case studies resulted in two papers.

WGCEAM has submitted a new resolution to develop approaches to link the vulnerabilities to marine activities.

ii Expert group information

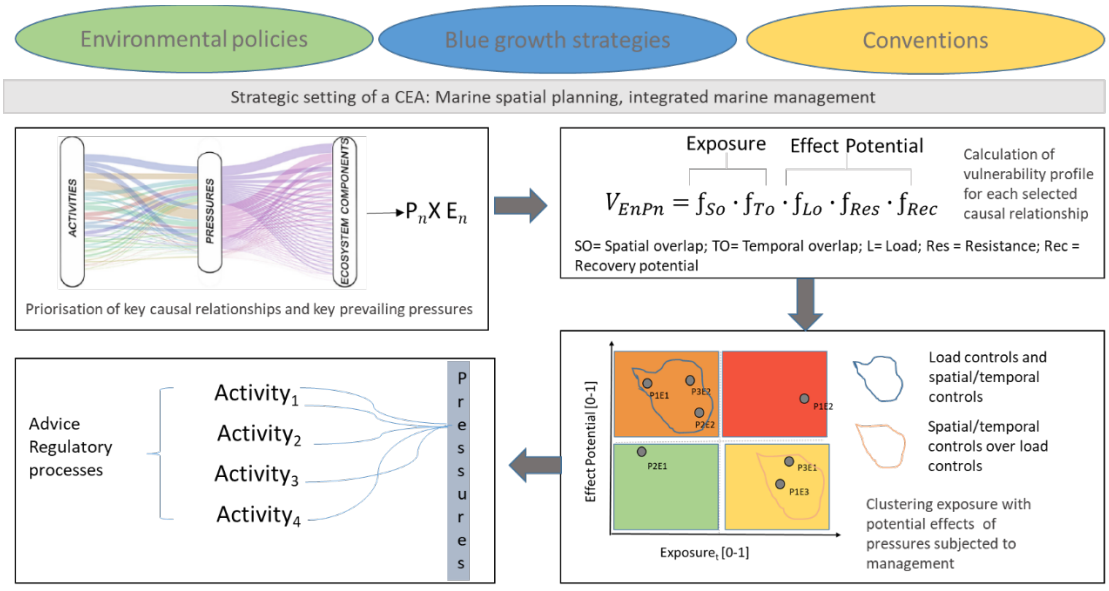
Expert group name	Working Group on Cumulative Effects Assessment Approaches in Management (WGCEAM)
Expert group cycle	Multiannual
Year cycle started	2019
Reporting year in cycle	3/3
Chairs	Vanessa Stelzenmüller, Germany
	Roland Cormier, Canada
	Gerjan Piet, the Netherlands
Meeting venues and dates	28-31 October 2019, ICES HQ, Copenhagen, Denmark (8 participants)
	21-25 September 2020, online meeting (24 participants)
	27 September - 1 October 2021, online meeting (11 participants)

1 Introduction

WGCEAM terms of reference

a) Develop a cumulative effects assessment (CEA) framework suited to guide science advice on the development and implementation of ecosystem-based management
b) Demonstrate the application of the CEA framework in one or more regional case studies. Solicit for additional case studies from other ecoregions.
c) Produce generic guidance on data and knowledge needs for CEA's including: using qualitative and quantitative data, accommodating uncertainty, identifying information gaps based on the application of the framework in the above case studies
d) Liaise with other fora or expert groups both within ICES (i.e., Secretariat, Data Centre or expert groups) as well as outside ICES (e.g. OSPAR, EEA, HELCOM, JPI Oceans, CEAF, DFO, TC, ECCC) to work towards and consolidate a common CEA framework

Conceptual CEA framework for management (ICES 2019)



ICES. 2019. Workshop on Cumulative Effects Assessment Approaches in Management (WKCEAM). ICES Scientific Reports. 1:17. 28 pp. http://doi.org/10.17895/ices.pub.5226

ICES. 2019. Working Group on Cumulative Effects Assessment Approaches in Management (WGCEAM). ICES Scientific Reports. 1:92. 23 pp. http://doi.org/10.17895/ices.pub.5759

ICES. 2020. Working Group on Cumulative Effects Assessment Approaches in Management (WGCEAM). ICES Scientific Reports. 2:101. 20 pp. http://doi.org/10.17895/ices.pub.7561

2 Case studies findings

The case studies examined during the meeting were from North Sea (Europe) and the Gulf of St Lawrence (Canada). The North Sea case study calculated exposure and effect potential for a comprehensive range of pressures and ecosystem components using both data and risk criteria from previous EU-funded projects (i.e., ODEMM and AQUACROSS).

2.1 North Sea case study

Two methodological avenues for developing a risk-based approach appropriate to guide management are pursued in the North Sea case study (NSCS):

- Based on the results of ODEMM and AQUACROSS using risk criteria and risk scores but with a more advanced methodological basis. This is at best a semi-quantitative approach but has the advantage that it is comprehensive in terms of its coverage of all the activity-pressure-ecosystem impact chains that may potentially contribute to risk. This approach is now being expanded so that it also includes the capacity to supply ecosystem services. Assessing the threats to this capacity is likely to become very relevant to guide EBM. This will be reported in a paper (Piet *et al*., in prep).
- Based on actual data. This is clearly very information-heavy and therefore currently covers only few impact chains. The methodology is reported in (Piet *et al*., 2021) and is intended to estimate risk similarly to the semi-quantitative approach so that the calculated impact risk should be comparable. This still needs to be validated but if that is the case then the comprehensive semi-quantitative risk-based approach can be piecemeal improved by replacing the impact chains initially based on risk criteria/scores with those based on actual data. This should gradually improve the quality of the assessment.

2.2 Canadian case study

Based on the results of the initial case study presented in WGCEAM 2019, work has continued to develop a quantitative approach for the CEAM framework. This includes an advisory process for the application of cumulative effects assessments in regulatory processes related to fish and fish habitat impacts. The quantitative aspects are also linked to the effectiveness and reliability of the regulatory measures for freshwater and marine habitats. Two papers are currently being drafted to frame the science to the policy regarding cumulative harmful impacts to fish and fish habitat.

Quantitative approaches being tested include Layers of Protection Analysis and Bayesian networks and influence diagrams as two of the assessment techniques of IEC/ISO 31010 to link cumulative assessment to risk management policies regarding human activities.

3 Constraints and challenges regarding the application of the CEA framework

The development, application and refinement of the CEA/CIA framework is a continuous process. In 2021, discussion focused on the applicability and transfer of the CEA output as part of science advice to guide management.

From cumulative impacts to management advice

In 2021, discussion focused on the approaches and their difficulties to derive precise recommendations on the management measures. In the context of the North Sea case study, the German project MuSSel (www.mussel-project.de) illustrated how to move from a first identification of key pressures and linkages to a risk-based assessment of cumulative effects for carefully defined ecosystem attributes in relation to the MSFD descriptor 6 (seabed integrity).

MuSSel project

The overall goal of the joint research project MuSSel is to map the impact of climate change and major human uses on the environmental status of the southern North Sea seafloor in the past (1980), present (2015), and future (2050). A part of the project is dedicated to a risk-based assessment of the main cumulative effects on the seafloor associated fish and invertebrate communities. To best describe the integrity of those communities, we approximate their community function through a set of important functional traits (risk criteria).

The risk-based assessment starts by identifying the main drivers and pressures impacting the functional traits through expert consultation. A systematic literature review together with an expert workshop will help to better understand the linkages and direction of impact between the pressures and traits. This information will be consolidated into the conceptual Driver-Pressure-State-Impact model, allowing for the description and visualization of all cause-effect pathways (Figure 3.1).

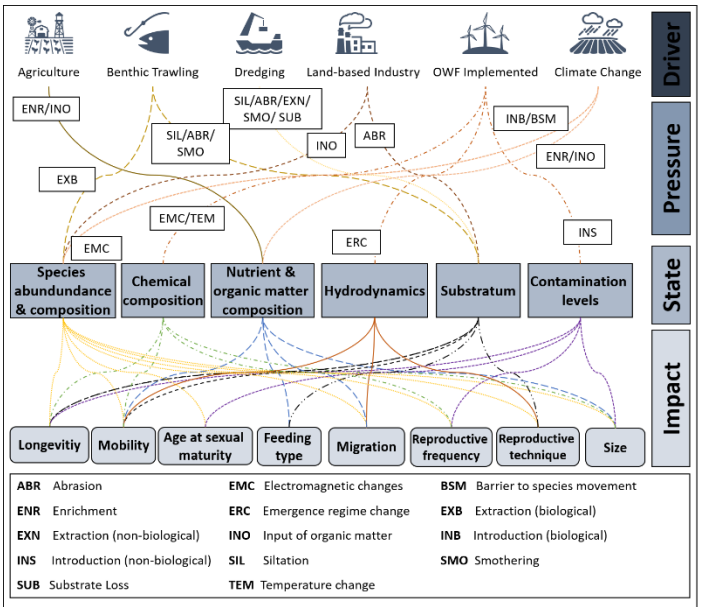


Figure 3.1. Driver Pressure State Impact (DPSI) model describing the cause-effect pathways. OWF = Offshore Wind Farm.

We then quantify the pressure load and the exposure of the traits to the different pressures using spatial distribution maps. Furthermore, using Gradient Forest analysis, we identify accumulated risk levels (tipping points) that result in adverse changes in fish and invertebrate communities (Figure 3.2).

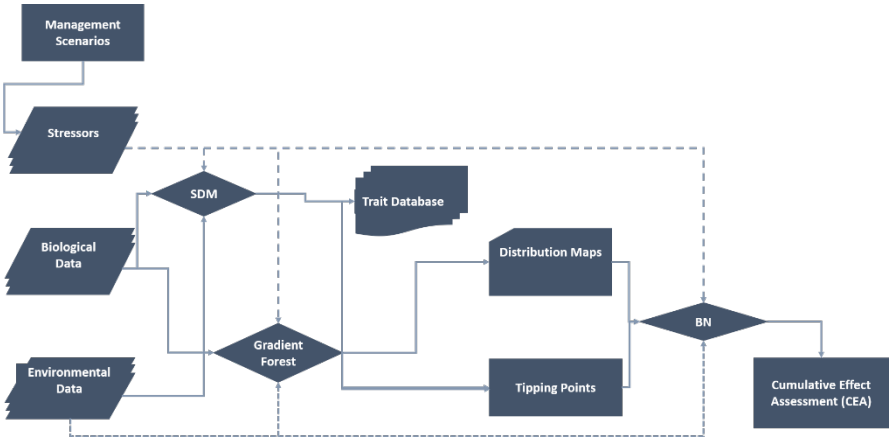


Figure 3.2. Workflow of the steps describing the preparation of the Cumulative Effect Assessment (CEA) in MuSSeL. SDM = Species Distribution Model, BN = Bayesian Network Model.

Finally, we consolidate the information from experts, literature, and statistical analysis into a Bayesian network (BN) to enable a comprehensive risk analysis and evaluation (Figure 3.3). The BN and the tipping points will be used to assess the effects of management scenarios and the risk of cumulative effects on the demersal fish and benthic community traits.

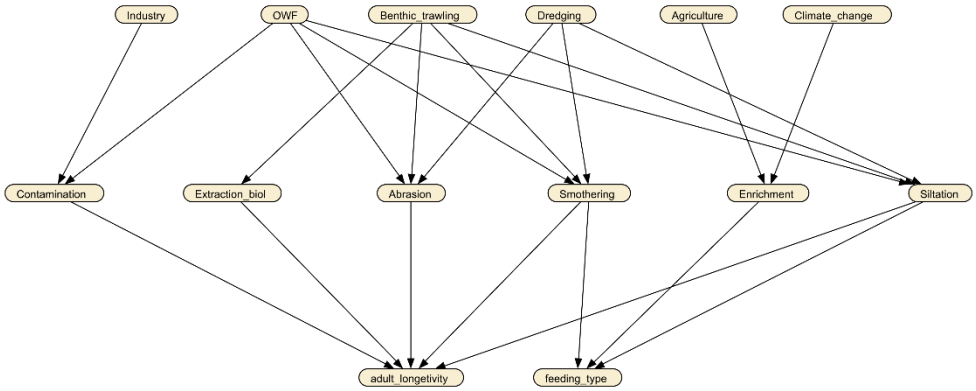


Figure 3.3. Example Bayesian Network (BN) developed in Netica, describing cause-effect pathways of human drivers exerting pressure on ecosystem functions and processes, affecting demersal fish traits such as adult longevity or feeding type. OWF = Offshore Wind Farm.

Such an operational model framework will be made available via a web-based application to provide an online decision support tool to stakeholders and interested users. The tool can be used on demand to visualise risks of cumulative effects in the North Sea and to test the effects of management measures and future use scenarios.

Embedding the CEA framework into the ICES ecosystem advisory processes

Through the case study applications, it became clear that the guidance of the CEA framework should be able to contribute to the advancement of ecosystem advice provided by ICES. Discussions centred around the capability of the CEA framework to be embedded in ICES ecosystem advisory processes. Several ongoing ICES processes provide the context for this development; the risk assessment framework of the Ecosystem Overviews; the ICES Advice Framework, newly expanded to be fit for purpose also for ecosystem advice; the ACOM/SCICOM Benchmark Oversight Group (BOG) that oversees the development of benchmarks for approaches used for ecosystem advice; and finally, the ongoing discussion in ACOM and SCICOM on establishing an EBM Oversight Group, to support the development of ICES science and advise for Ecosystem Based Management.

The short-term contribution of the WGCEAM outputs into the ecosystem advice provided by ICES is by providing an improved methodology to construct the wire diagrams (or human activity-pressure-ecosystem state component network figures) that are at the basis of the Ecosystem overviews. This can be based on the existing information for the respective ecosystems but also provides direction to (further) develop the knowledge base required for ecosystem advice that can feed into the pipeline process and shape the interactions with the appropriate WGs and experts.

These wire diagrams and the WGCEAM risk-based approach that allows prioritization the main pressures present in each ecoregion can also be at the basis of two of the WKTRANSPARENT recommendations to further advance the Ecosystem Overviews:

- Incorporate ecosystem services. The capacity to supply ecosystem services depends on the functioning of the ecosystem components for which we can assume that any threat (cause of impact risk) on the state of the ecosystem components is likely to affect that capacity. And these relationships will probably not be linear but depend on specific functioning aspects.
- Inclusion of foodweb information. This would allow an extension of the CEA to also include relevant indirect effects.

4 Concluding remarks and next steps

- Intersessional meetings will be used to further develop the Canadian case study in collaboration with the participants that generated the North Sea case study. In addition, a Celtic Sea case study will support the further development of the CEA framework. The North Sea as well as the Canadian CS will continue its process to improve the CIA through the application of quantitative information.
- The most basic CEA does not require actual data but can be based solely on expert judgement. This allows its application in every ecoregion to identify the main pressures but limits its use to actually guide ecosystem-based management. The challenge in improving the CEA is to advance its capacity to guide EBM in more data-rich ecoregions by including more quantitative information but without compromising its application in the more data-poor regions. In both of those areas, it can be used to identify knowledge gaps and advance scientific research.
- The further development of CEA framework and its application in a management context is the focus of future work and this needs to be embedded in the ICES ecosystem advisory process. The practical aspects of such synergies with other ICES products and working groups need to be elaborated. Therefore, liaising with expert groups and other fora within ICES but also beyond remains a distinct future WGCEAM ToR (2022–2024).

References

Piet, G. J., Tamis, J. E., Volwater, J., de Vries, P., van der Wal, J. T., and Jongbloed, R. H. 2021. A roadmap towards quantitative cumulative impact assessments: Every step of the way. Sci Total Environ, 784: 146847.

Piet, G. J., Tamis, J. E., de Vries, P. and Jongbloed, R. H. In prep. Assessing the cumulative impacts on the North Sea capacity to supply ecosystem services.

Annex 1: List of participants

WGCEAM 2021 meeting

Name	Institute	Country (of institute)	Email
Carolyn Faithfull	Swedish University of Agricultural Sciences	Sweden	carolyn.faithfull@slu.se
Dave Reid	Marine Institue	Ireland	david.reid@marine.ie
Debbi Pedreschi	Marine Institue	Ireland	debbi.pedreschi@marine.ie
Emily Hague	Heriot-Watt University	Scottland	elh2001@hw.ac.uk
Gerjan Piet	Wageningen Marine Research	Netherlands	gerjan.piet@wur.nl
Henn Ojaveer	ICES secretariat	Denmark	henn.ojaveer@ices.dk
Jennifer Rehren	Thünen Institute	Germany	jennifer.rehren@thuenen.de
Robert Aps	University of Tartu	Estland	robert.aps@ut.ee
Roland Cormier	DFO/Hereon	Germany	roland.cormier@hereon.de
Silvana Birchenough	Cefas	UK	silvana.birchenough@cefas.co.uk
Vanessa Stelzenmüller	Thünen Institute	Germany	vanessa.stelzenmueller@thuenen.de

WGCEAM 2020 meeting

Name	Institute	Country (of institute)	Email
Vanessa Stelzenmüller	TI Institute of Sea Fisheries	Germany	Vanessa.Stelzenmueller@thuenen.de
Roland Cormier	Helmholtz-Zentrum, Geest-hacht	Germany	Roland.Cormier@hgz.de
Gerjan Piet	Wageningen Marine Research	The Netherlands	Gerjan.Piet@wur.nl
Adrian Judd	Centre for Environ-ment Fisheries & Aquaculture Science	United Kingdom	Adrian.Judd@cefas.co.uk
Alain Mallet	Fisheries and Oceans Canada	Canada	Alain.Mallet@dfo-mpo.gc.ca
Alicia Cassidy	Fisheries and Oceans Canada	Canada	Alicia.Cassidy@dfo-mpo.gc.ca

Brad Firth	Fisheries and Oceans Canada	Canada	Brad.Firth@dfo-mpo.gc.ca
Carole Godin	Fisheries and Oceans Canada	Canada	Carole.Godin@dfo-mpo.gc.ca
Christine Sabean	Fisheries and Oceans Canada	Canada	Christine.Sabean@dfo-mpo.gc.ca
Daniel Wood	Fisheries and Oceans Canada	Canada	David.Wood@cefas.co.uk
Darcy Pickard	ESSA	Canada	DPickard@essa.com
Fernand Savoie	Fisheries and Oceans Canada	Canada	Fernand.Savoie@dfo-mpo.gc.ca
Hilary White	Fisheries and Oceans Canada	Canada	Hilary.White@dfo-mpo.gc.ca
Kelly Code	Fisheries and Oceans Canada	Canada	Kelly.Code@dfo-mpo.gc.ca
Melanie Boivin	Fisheries and Oceans Canada	Canada	Melanie.Boivin@dfo-mpo.gc.ca
Matthew Gubbins	Marine Scotland	United Kingdom	Matthew.Gubbins@gov.scot
Mette Skern-Mauritzen	Institute of Marine Research	Norway	mette.skern-mauritzen@hi.no
Niel Fisher	Fisheries and Oceans Canada	Canada	Niel.Fisher@dfo-mpo.gc.ca
Robert Apt	Estonian Marine Institute	Estonia	Robert.Aps@ut.ee
Silvana Birchenough	Centre for Environment Fisheries & Aquaculture Science	United Kingdom	Silvana.Birchenough@cefas.co.uk
Sophie Cormier	Fisheries and Oceans Canada	Canada	Sophie.Cormier@dfo-mpo.gc.ca
Stacey Rehel	Fisheries and Oceans Canada	Canada	Stacey.Rehel@dfo-mpo.gc.ca
Terry Melanson	Fisheries and Oceans Canada	Canada	Terry.Melanson@dfo-mpo.gc.ca
Tyler Tunney	Fisheries and Oceans Canada	Canada	Tyler.Tunney@dfo-mpo.gc.ca

WGCEAM 2019 meeting

Name	Institute	Country (of institute)	Email
Vanessa Stelzenmüller	TI Institute of Sea Fisheries	Germany	vanessa.stelzenmueller@thuenen.de
Roland Cormier	Helmholtz-Zentrum, Geesthacht	Germany	Roland.Cormier@hgz.de
Gerjan Piet	Wageningen Marine Research	The Netherlands	Gerjan.Piet@wur.nl
Matthew Gubbins	Marine Scotland	United Kingdom	Matthew.Gubbins@gov.scot
Robert Apt	Estonian Marine Institute	Estonia	Robert.Aps@ut.ee
Mike Elliott	University of Hull	United Kingdom	Mike.Elliott@hull.ac.uk
Tyler Tunney	Fisheries and Oceans Canada	Canada	Tyler.Tunney@dfo-mpo.gc.ca
Sophie Cormier	Fisheries and Oceans Canada	Canada	Sophie.Cormier@dfo-mpo.gc.ca

Annex 2: WGCEAM resolution

2018/MA2/HAPISG09 The **Working Group on Cumulative Effects Assessment Approaches in Management** (WGCEAM), chaired by Vanessa Stelzenmüller, Germany, Roland Cormier, Germany, and Gerjan Piet, the Netherlands, will be established and will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2019	28 October – 1 November	ICES HQ, Copenhagen, Denmark		
Year 2020	21–25 September	by corresp/ webex		physical meeting cancelled - remote work
Year 2021	27 September – 1 October	Online meeting	Final report by 15 November to SCICOM	

ToR descriptors

ToR	Description	Background	Science plan codes	Duration	Expected Deliverables
a	Develop a cumulative effects assessment (CEA) framework suited to guide science advice on the development and implementation of ecosystem-based management	While the need for CEAs is widely accepted, their actual implementation in marine planning and management processes is yet to be seen. A common framework requires a review of the differences in the factors (data, knowledge, decision-process) being considered regarding cumulative effects assessment (CEA) in relation to environmental policies, an ecosystem approach to marine spatial planning (MSP) and regulatory processes. The framework should clearly outline: a) Science Requirements b) Advisory Requirements c) Requirements from other EGs	6.1, 6.2, 6.6,	Year 1	CEA framework suited to guide science advice on the development and implementation of ecosystem-based management.
b	Demonstrate the application of the CEA framework in one or more regional case studies	To advance the development of a generic CEA methodology and identify real research gaps one or more case studies will be used as a proof of concept. The initial focus should be on the North Sea and a Canadian bioregion where the CEA is conducted	6.1,6.2	Years 2	Scientific paper describing the application of the CEA framework in one or more regional case studies.

		with the available knowledge base..			
c	Produce generic guidance on data and knowledge needs for CEA's including: using qualitative and quantitative data, accommodating uncertainty, identifying information gaps based on the application of the framework in the above case studies	The application of the framework in case studies allows to i) indicate useful tool(s) for each step, ii) show the indicative datasets and types of data required in carrying out a CEA, iii) develop straight forward visualization tools for pressures, and iv) demonstrate end products and engage with potential clients. The latter point is essential to scope the potential usefulness of CEAs as part of ecosystem advice provided by ICES	6.1, 6.2,	Year 3	Generic guidance on data and knowledge needs for CEA's.
d	Liaise with other fora or expert groups both within ICES (i.e. Secretariat, Data Centre or expert groups) as well as outside ICES (e.g. OSPAR, EEA, HELCOM, JPI Oceans, CEAF, DFO, TC, ECCC) to work towards and consolidate a common CEA framework	The consolidation of a common CEA framework requires a continuous collaboration and exchange of expertise with other groups and fora working on CEAs	6.2, 6.4, 6.5	Year1-Year 3 (ongoing)	Consolidated common CEA framework.

Summary of the Work Plan

Year 1	During the first year the linkages to other groups working on CEAs have to be identified and established. The main goal is the development of a common and consolidated CEA framework allowing to implement CEA in different settings regarding data, knowledge, and decision-processes.
Year 2	In the second year the work will focus on the application of the CEA framework in case study areas. The North Sea and a Canadian bioregion will be the first case studies since data availability and relevant scientific knowledge is most advanced.
Year 3	Emphasis will be on the provision of guidance on data and knowledge needs when applying the common framework. This guidance will lead into a final recommendation on the usefulness of CEAs as part of ecosystem advice provided by ICES.

Supporting information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of all marine human activities including fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 20–25 members and guests.

Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There is a very close working relationship with all the groups under HAPISG. It is also very relevant to WGINOSE.
Linkages to other organizations	There are strong linkages to the OSPAR and HELCOM work on CEAs.