Revising the Common Assessment Methodology based on the BENTHIS Project

Bachelor Thesis

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GOOD FISH FOUNDATION

van hall larenstein university of applied sciences

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A Bachelor thesis in the fourth year of Coastal and Marine Management at Van Hall Larenstein University of Applied Sciences to fulfil the graduation requirements.

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Preface

The current thesis “Revising the Common Assessment Methodology based on the BENTHIS Project”, is a literature study on the effects of the BENTHIS project on the Common Assessment Methodology. It has been written to fulfil the graduation requirements of the Coastal and Marine Management programme at Van Hall Larenstein University of Applied Sciences (VHL). We were engaged in researching and writing this thesis from February 2017 to June 2017.

The project was undertaken at the request of the Good Fish Foundation. The research question was formulated in consultation with the Good Fish Foundation and VHL University of Applied Sciences. Sometimes the research was difficult because of a lack of information, access to published work or a gap in the knowledge of the authors, but thorough research and determination have allowed us to answer the identified questions.

We would like to thank our tutors at VHL (J. Rippen & D. Goldsborough) for their excellent guidance, support and constructive feedback. We also wish to thank the opponent (P. Hofman) for his critical look and constructive feedback. Without the Good Fish Foundation this project would not have existed therefore we would like to thank the Good Fish Foundation. Especially our supervisor (L. van Walraven) who was always willing to answer our questions, send vital documents or was willing to hear us out and challenge us.

This thesis was written by a team of two students. Two friends who decided to work on the final project of a four year study. Sometimes it was difficult, boring or hard work but our sense of humour, bond and peer review kept us on track. The research benefitted from our critical view of each other’s work that was discussed until the best solution remained. If one of us ever lost interest, the other kept us motivated. Lastly our family and friends deserve a particular note of thanks: your wise counsel, moments of ease in a turbulent period and willingness to debate issues have served us well.

Jelle Reitsma & Bauke de Vries

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Abstract

Approximately 20% of the global landings of wild-captured fish and shellfish are caught using dredges and bottom trawls. These types of fisheries are impacting the seafloor and disturb the benthic ecosystem. The EU funded project BENTHIS, on Benthic Ecosystem Fisheries Impact Studies, has provided new insights and knowledge on bottom impacting fisheries and its effects on ecosystems and habitats. The Common Assessment Methodology (CAM) relies on insights and knowledge on demersal and pelagic fisheries and consists out of three Categories, the Category 2 questions focus on the ecological effects of the fishery. It is important to update the CAM to make sure that the fishery assessments are based on the most recent and scientific knowledge. A revised CAM affects fishery assessments worldwide. It is unclear to what extent and how the knowledge of the BENTHIS project will affect the CAM. This research was designed to assess how and to what extent the knowledge of the BENTHIS project affected the Category 2 questions in the CAM and provided the Good Fish Foundation with an advice on a revision of the CAM based on BENTHIS publications.

A literature study on the produced work of the BENTHIS project was used to gather knowledge in order to revise the CAM based on the BENTHIS project. Based on the produced work of the BENTHIS project, new Category 2 questions were designed and then tested in a sensitivity study. During the sensitivity study four assessments were carried out with both the current and the revised version of the CAM on four different gears: Midwater Otter Trawl, Demersal Otter Trawl, Beam Trawl and Pulse Trawl.

The results showed that the knowledge in the BENTHIS publications underpin and/or affect the Category 2 questions of the CAM in 20 of the 59 BENTHIS publications. The revisions of Category 2 entailed: improvement of the documented scientific evidence base of the questions in the CAM (including the Guidance Document), adjustments/adding of scoring possibilities and adjustment of a question on its own. The sensitivity study showed two assessed fisheries changed in scoring of which one assessed fishery changed in colour. The revised version does not affect the outcomes of the CAM Assessments in a considerable way.

This research improved and created a first documented scientific evidence base to the CAM and is an important step to ensure the reliability and credibility of the CAM. Unfortunately, this research only focused on the BENTHIS project which means that only the parts of the CAM focussing on demersal fisheries have been updated. BENTHIS did not give any comprehensive information on pelagic fisheries. Based on those two issues, it is recommended to create a documented scientific evidence base for the whole CAM and focus on transparency of the assessment process.

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1 Introduction

As a result of overfished stocks in the past, the EU introduced the Common Fisheries Policy (CFP) in 1970. The CFP is a policy paper for managing European fishing fleets and fish stocks (European Parliament & The Council, 2013). The main goal of the CFP is to ensure the sustainable development of fishing activities. This has to be done from an environmental, economic and social point of view (Piet & De Vos, 2014). The CFP focusses on fishing on Maximum Sustainable Yield or MSY, which is: "the largest average yield (catch) that can theoretically be taken from a species' stock over an indefinite period under constant environmental conditions" (PEW Charitable Trusts, 2015, p. 57).

Approximately 20% of the global landings of wild-captured fish and shellfish are caught using dredges and bottom trawls (Kaiser et al., 2015). These types of fisheries are impacting the seafloor and disturb the benthic ecosystem (Queirós, Hiddink, Kaiser, & Hinz, 2006; Polet & Depestele, 2010). Therefore Kaiser et al. (2015) state that bottom impacting fishery is unsustainable which leads to calls for banning some types of trawling. However, different gears are considered to have different impacts on the bottom (Kaiser et al., 2015; Polet & Depestele, 2010; Piet, Van Hal, & Greenstreet, 2009). The effect of bottom impacting fisheries depends on the geology, bathymetry and ecology of the fishing areas combined with the fishery intensity and the weight of the gear (Kaiser et al., 2015; Polet & Depestele, 2010). The EU funded BENTHIS project (2013 - 2017) on Benthic Ecosystem Fisheries Impact Studies has increased the available knowledge on the impact of bottom impacting fisheries on different spatial scales and provided many new insights that can be used in the Common Assessment Methodology (CAM) of the World Wildlife Fund and the Good Fish Foundation (see 1.2).

The Good Fish Foundation carries out desk-based assessments to indicate the relative sustainability of a fishery (The North Sea Foundation & WWF, 2016[b]). "The Good Fish Foundation is a non-governmental organization which aims to accelerate the transition to a sustainable seafood sector by promoting market demand for sustainable seafood and by assisting consumers and businesses throughout the seafood supply chain in making informed and responsible buying decisions" (Good Fish Foundation, 2017[a]). The Good Fish Foundation targets producers, processors, traders, retailers, consumers and the government of the Netherlands and European countries to achieve their main goal: sustainable fisheries.

The World Wildlife Fund and the Good Fish Foundation assess fisheries worldwide using a desk-based, standardised method called the Common Assessment Methodology (CAM). The process of using this CAM to asses a certain fishery is called: the CAM Assessment. The CAM was designed to create awareness amongst consumers. This was and is done by using e.g. traffic light cards and public facing seafood databases (The North Sea Foundation & WWF, 2016[a]). To make the results of the CAM assessments usable for consumers in the Netherlands, the final results per assessment are translated into the FISHguide of the Good Fish Foundation (The Good Fish Foundation, 2017[c]).

1.1 The FISHguide

The main tool for the advice of the Good Fish Foundation is the FISHguide (in Dutch: VISwijzer) which shows the relative sustainability of wild captured fish and farmed fish (Good Fish Foundation, 2017[b]). The FISHguide is a seafood guide to help consumers in their responsible buying decisions at, among others, PLUS retail, JUMBO, Dirk van den Broek and restaurants with the 'Good Fish' label (The Good Fish Foundation, 2017[d]). It makes the results of the CAM usable for consumers/ the industry and is displayed in the FISHguide-app as a coloured fish. The partners above change the fish products they offer based on the FISHguide. The PLUS supermarket also displays the coloured fish on the packages. The colour can be either green, yellow, red or blue (Good Fish Foundation, 2017[c]). These colours are linked to the total results of the CAM Assessments. Figure 1 shows the colours and their meaning.

Figure 1 Colours of the FISHguide explained (derived from: Good Fish Foundation, 2017[c])

"The FISHguide presents a powerful communicative instrument which has succeeded in fostering more face-to-face interaction and deliberation on sustainable fisheries between otherwise disparate actors" (De Vos, 2011, p. 127). De Vos (2011) stated that previously, the government and the industry set the standards for sustainability but this has changed. NGO's are now one of the leading partners in setting standards for sustainability (De Vos, 2011). Secondly she states that the current market based tools may be better understood as communicative instruments between the actors in the industry which facilitate interaction, rapprochement and increase of trust (De Vos, 2011).

In 2004, the first FISHguide was published by Wouter Klootwijk (Dutch journalist) and Christien Absil of the North Sea Foundation (De Vos, 2011; Good Fish Foundation, 2017[e]). It was managed by the North Sea Foundation. Since November 2014 the FISHguide is managed by the Good Fish Foundation (Good Fish Foundation, 2017[e]).

1.2 The Common Assessment Methodology

The Common Assessment Methodology (CAM) consists of two documents: The Common Wild Capture Fishery Methodology (Common Methodology) and the Guidance Document. The Common Wild Capture Fishery Methodology is added to this report in Appendix I. The CAM is a global used desk-based assessment methodology to indicate the relative sustainability of a fishery, relying on the best available, most recent knowledge. The used knowledge must be scientific and no older than five years (The North Sea Foundation & WWF, 2016[a]). The methodology is not a certification of sustainability, nor does it allow the fishery or retailer to make any claims about the species, stock or a certain product (The North Sea Foundation & WWF, 2016[b]). The assessments are available to the Good Fish Foundation and WWF offices worldwide through a database managed by WWF Germany, who also coordinates the updates of the assessments. The CAM is applied in the following countries: Austria, Belgium, Denmark, Finland, Germany, Hong Kong, Indonesia, Italia, Malaysia, the Netherlands, Norway, Poland, Russia, Singapore, Spain, South Africa, Sweden and Switzerland (World Wildlife Fund, 2017).

The CAM consists of questions divided into three categories. The current research will focus on the questions in Category 2. The categories are: 1) stock status and biology, 2) ecological effects of the fishery and 3) management (The North Sea Foundation & WWF, 2016[b]). Each question gives a certain score to a specific aspect of the fishery e.g. life history characteristics that are vulnerable to fishing pressure, precision of available fishery-specific information, rate of bycatch/discards and MSC certification. This score can be either negative, neutral or positive and the scoring possibilities differ per question (ranging from -5 to 2). The fishery under assessment will receive a score per category which can be red (=negative), yellow (=neutral) or green (=positive). Table 1 (next page) shows the possible total scores and corresponding colour per category.

Table 1 Scoring possibilities per Category of the Common Wild Capture Fishery Methodology. As can be seen, the total scores can differ per Category and can be a negative value (The North Sea Foundation & WWF, 2016[b]).

Category	Red	Yellow	Green
1. Stock Status, Biology	≤(-3)	(-2)-2	≥3
2. Ecological Effects of Fishery	≤(-3)	(-2)-1	≥2
3. Management	≤(-2)	(-1)-1	≥2

As can be seen in table 2, the scores of the three categories combined will give a score for the total CAM assessment. The total score is the sum of the scores of the three categories and can result in red (=negative), light red (=slightly negative), yellow (=neutral), light green (=slightly positive) or green (=positive) (The North Sea Foundation & WWF, 2016[b]). The score i.e. colour displays an indication of the relative sustainability of the fishery under assessment (The North Sea Foundation & WWF, 2016[b]). The final result or goal of the CAM assessment is to provide a rating of the risk of the negative impacts on stocks and the marine ecosystem of a fishery targeting a certain species or stock in a certain area using a certain capture method (The North Sea Foundation & WWF, 2016[b]).

Table 2 Scoring possibilities of the total Common Wild Capture Fishery Methodology. The final score will be translated into an advice in the FISHguide (The North Sea Foundation & WWF, 2016[b]).

	Red	Light Red	Yellow	Light Green	Green
Total Assessment Score	≤(-8)	(-4)-(-7)	(-3)-3	4-6	≥7

The assessments based on the CAM are carried out by a qualified team of (fisheries) biologists. To ensure that every assessor uses the same methods, the Common Methodology is supported by the so called Guidance Document. The Guidance Document provides detailed information on how to interpret the questions (The North Sea Foundation & WWF, 2016[b]). This ensures that all assessors will use the same methods and that differences in specific results between assessors will be kept to a minimum. Besides that, the Guidance Document provides useful links and references to relevant literature (The North Sea Foundation & WWF, 2016[b]).

At the start of this research it was assumed that the justification and the origin of the CAM were available on paper. Based on a consultation with the Good Fish Foundation it became clear that this assumption was not correct (L. van Walraven & C. Absil, personal communication, March 13, 2017). The origin of the CAM is based on expert judgement and made in a deliberative and iterative process. The last update of the CAM dates from 2014. While the results of the BENTHIS project have already been used on some recent assessments, new insights and knowledge gained in the BENTHIS project might be used to improve the CAM. Therefore it is possible that the CAM needs a revision based on this knowledge.

1.3 BENTHIS project

The EU directive on the marine environment, the Marine Strategy Framework Directive (MSFD), has adopted the Ecosystem Approach as central and important focus point to protect the marine environment across European waters more effectively, thus achieve a Good Environmental Status by 2020 (European Parliament & The Council, 2008). However, more knowledge on bottom impacting fisheries was needed to achieve the goals of MSFD, therefore the BENTHIS project was initiated (Wageningen University & Research, 2017[d]). BENTHIS is an acronym for the EU funded project on Benthic Ecosystem Fisheries Impact Studies that provided a science base to assess the impact of current fishing practices worldwide. Essentially, the aim of BENTHIS was to enlarge the knowledge base on benthic ecosystems and bottom impacting fisheries. The project had 33 partners from twelve different countries and had a duration of five years (October 2012 – July 2017) (Wageningen University

& Research, 2017[d]). The partners in the consortium had different backgrounds such as: science, the fish industry and marine policy (IMARES Wageningen UR, 2013).

The BENTHIS project provided necessary knowledge to further develop the Ecosystem Approach to Fisheries Management (Wageningen University & Research, 2017[a]). To come to such an approach quantitative tools to assess the impact of fisheries on the benthic ecosystems had to be developed. To do so, BENTHIS was divided in different building blocks called work packages. These work packages provided knowledge on mapping, stakeholder participation, the benthic ecosystem, fishing impact, economy and fisheries management (Wageningen University & Research, 2017[b]). In work package seven the information from work package 1-6 was used to study a couple of existing fisheries in five regional seas in Europe. These regional seas are: the Baltic Sea, the North Sea, the Western Waters, the Mediterranean Sea and the Black Sea. In the case studies BENTHIS focussed on specific fisheries that are well known for their impacts on the benthic ecosystem (Wageningen University & Research, 2017[c]). BENTHIS followed a multi-disciplinary approach with strong stakeholder involvement. For example, fishermen and researchers conducted trials with innovative fishing gears such as pelagic otter boards and pulse trawls (Wageningen University & Research, 2017[d]).

The BENTHIS project is almost finished and this means that the knowledge, displayed in deliverables and scientific articles, are being published. The latter are based on the first but have a specific focus (e.g. areas or topics). So far the project has produced a large amount of information on bottom impacting fisheries and the effects on the environment that can be used worldwide. This information can be relevant for fishery assessments such as the CAM.

1.4 Research- objectives & questions

The EU funded research project BENTHIS has produced a large amount of knowledge and insights on the effects of bottom impacting fisheries on benthic ecosystems. Therefore the Good Fish Foundation wanted to know how and to what extent the knowledge of the BENTHIS project could change the Common Assessment Methodology (The Common Wild Capture Fishery Methodology & the Guidance Document). It is important to update the CAM to make sure that the fishery assessments are based on the most recent and scientific knowledge. A revised CAM affects fishery assessments worldwide. Based on the publications of the BENTHIS project, it is possible that the advice in seafood guides as the FISHguide will change. The FISHguide is an important tool for fisheries managers, consumers, fisherman and policy makers to make fisheries sustainable. Eventually this will have (possible) positive effects on the ecosystem (De Vos, 2011). The CAM is the basis of the FISHguide and therefore contributes to interaction between actors and improvement of sustainable fisheries.

This research focused only on the questions of Category 2 (ecological effects of the fishery) of the CAM, because Category 1 & 3 are focussed on other aspects (stock status and management).

Problem statement
It is unclear to what extent and how the knowledge of the BENTHIS project will affect the Common Assessment Methodology.

Aim
The aim of this research is to provide the Good Fish Foundation with an advice on a revision of the Common Assessment Methodology to include the knowledge from the BENTHIS project.

Research question
To what extent does the knowledge of the BENTHIS project underpin and/or affect the Category 2 questions in the Common Assessment Methodology (CAM) of the Good Fish Foundation and how will the revised questions affect the outcome of the CAM Assessments?

To find an answer on this research question it has been divided in sub questions:

- Which knowledge of the BENTHIS project underpin and/or affect the Category 2 questions of the Common Assessment Methodology?
- What needs to be changed in the Category 2 questions of the Common Assessment Methodology to include the knowledge of the BENTHIS project?
- What is the effect of the revised Category 2 questions of the Common Assessment Methodology on the outcome of the assessed fisheries?

1.5 Thesis outline

For the readers convenience, this thesis is not written in a chronological way and therefore this paragraph will briefly explain how to read this report and how to see the results in time. Chapter two begins by explaining the used methods and can be considered as a plan of approach for the third chapter. The third chapter presents the findings for this research. This is shown per question from Category 2 from the CAM. For example, Chapter 3.1 begins with the answers of the first sub question after which the answers to the second sub question are presented. This then is repeated in the four chapters after 3.1. Chapter 3.6 is presenting the results of the Sensitivity study and shows the answers of the third sub question. Chapter four is the discussion and reviews the methods and results critically. Chapter five is the conclusion and shows the answers of the research question as described in Chapter two. The last chapter is the advice to the client and includes recommendations for the Common Assessment Methodology.

Throughout this report ‘questions’ or ‘Q (*number*)’ refer to the Category 2 questions of the CAM. The term ‘sub questions’ refers to the research questions in the second Chapter.

2 Methods

This research was designed to find out to what extent the knowledge of the BENTHIS project did underpin and/or affect the Category 2 questions of the CAM and to find out how the revised questions did affect the outcome of the CAM assessments of assessed fisheries. The research took place in the Netherlands in five months (February 2017 – June 2017) and is considered as an applied desk research combined with a sensitivity study. This report includes an advice to the Good Fish Foundation on adjustments of the CAM based on a proposed revision of the Category 2 questions. Figure 2 shows the steps taken in this research.

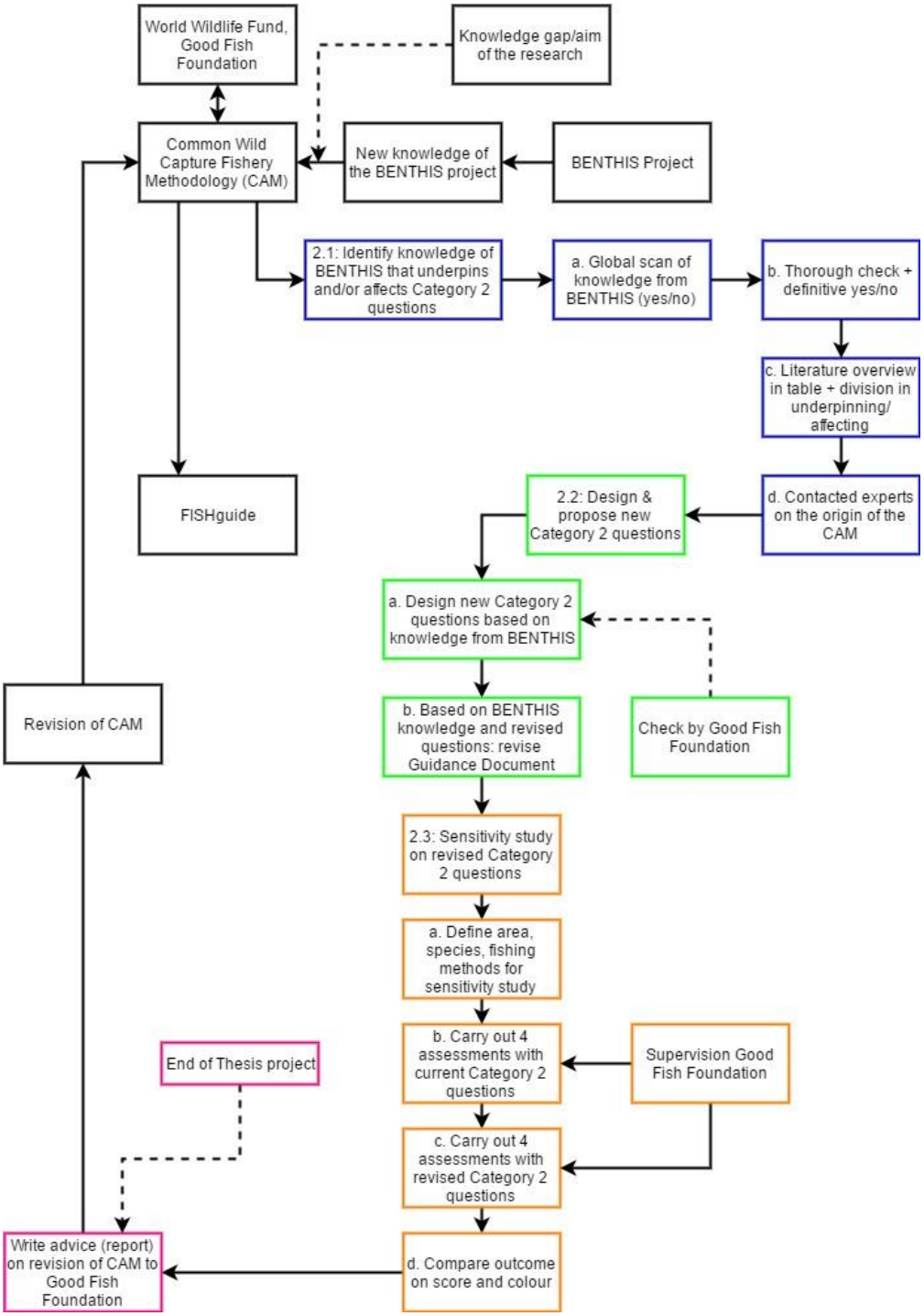

Figure 2 The conceptual model gives an overview of the research described in this chapter. The colour in brackets [Colour] in each paragraph corresponds with the colours in this model.

Contrary to our expectations the CAM was not solely based on scientific studies, but rather based on expert judgement and made in a deliberative and iterative process. This resulted in the fact that the first sub question had to change during the writing of this report. Instead of comparing the knowledge base of the current CAM to the knowledge of the BENTHIS project, it was decided to compare the knowledge of the BENTHIS project to the current CAM. In consultation with the Good Fish Foundation and VHL University of Applied Sciences it was decided to take the current CAM as basis and underpin and/or improve it with the knowledge of the BENTHIS project. In this way it was still possible to design new questions based on the first and second research question.

2.1 Knowledge of the BENTHIS project that underpin and/or affect the CAM

Research question: Which knowledge of the BENTHIS project underpin and/or affect the Category 2 questions of the Common Assessment Methodology?

[Blue] To answer the first sub question the BENTHIS publications were reviewed on knowledge that could underpin and/or affect the Common Assessment Methodology (up to the 21st of April 2017 BENTHIS has produced 59 scientific articles and deliverables in total). This was done in three steps.

1. The first step consisted out of a global scan of all the BENTHIS publications on a match with the topics of the Category 2 questions. The total amount of produced work was divided into two equal parts and each team member scanned their part. For each publication a short summary and a 'yes/no' on relevance/importance was given and collected in table 3 (next page). During this global scan of the publications, the following search terms were used (bibliographic method). All the terms match the topics of the Category 2 questions:
   Q7: 'ETP', 'ETP species', 'overfished', 'vulnerable', 'threatened', 'endangered'.
   Q8: 'discard', 'discarded', 'survival', 'survival rate'.
   Q9: 'retained catch', 'retained', 'catch', 'juveniles', 'target species', 'species', 'non-target species', 'non', 'target'.
   Q10: 'negative ecosystem changes', 'ecosystem changes', 'ecosystem', 'predators', 'cascade effects', food chain', 'community', 'destruction', 'depletion', 'diversity'.
   Q11: 'gear', 'beam trawl', 'beam', 'pulse trawl', 'pulse', 'TBB', 'Pulse', 'dredge', 'demersal', 'negative habitat effects', 'effect on benthic habitat', 'habitat', 'negative'.
   The produced work of BENTHIS was retrieved from the databank on the BENTHIS website and in an email exchange with Oscar Bos of Wageningen Marine Research (manager of the BENTHIS project).
2. In the second step, the team members switched their parts, checked the work of the other team member and studied the relevant information thoroughly. After that it was definitely decided whether produced work was usable, thus relevant for this research. The relevance of produced work was determined on the basis of similarity of the topics in text and the topics in the Category 2 questions (see step 1).
3. In the third step the relevant publications were studied thoroughly on specific knowledge/statements that underpin/affect the CAM. This information was added to tables. Table 4 (next page) was used for the publications of the BENTHIS project that underpin the Category 2 questions of the current CAM. The BENTHIS publications that affect the CAM were processed in a similar table.

As can be seen in step one, the Category 2 questions were guiding during this part of the research. Besides this literature study, a consultation of experts on the CAM and the origin of the CAM took place. The experts that were consulted are: L. van Walraven (GFF) & C. Absil (GFF). The results of this research question can be found in Chapter 3.1 - 3.5 and Appendix II. Final product of sub question one was a starting point for revised questions of the CAM in the second sub question.

Table 3 Used for collecting knowledge and to decide whether a publication was relevant for this research or not. In the first column the source in full notation is given. The second column shows a short summary of the publication followed by 'yes' or 'no' on relevance for this research. The third row is showing which question of the CAM might be underpinned or affected by the publication.

BENTHIS Publications		
Sources	**Why relevant for our research**	**Underpin or affect?**
Full notation (APA)	Short summary of publication + yes/no on relevance	e.g. underpin Q8

Table 4 Used for collecting the knowledge needed for sub question 1 per question of the CAM. In the first column the source in full notation is given. The second column shows the specific statements from the publications which interact with the topics in the CAM. The third row (part of sub question 2) is showing which specific part of the CAM might be affected/underpinned by the statement in the second column.

BENTHIS Publications that Underpin		
Sources	**Knowledge/statements**	**Underpin this part of the CAM:**
Full notation (APA)	Statement/quote	e.g. underpin goal Q8

2.2 Design and revision Category 2 questions of the CAM

Research question: What needs to be changed in the Category 2 questions of the Common Assessment Methodology to include the knowledge of the BENTHIS project?

[Green] Sub question two was answered with information that was retrieved from sub question one in combination with expert judgement. The following steps were used to revise the Category 2 questions:

1. Based on expert judgement the specific knowledge/statements from 2.1 step 3 were used to determine which specific parts of the CAM were underpinned/affected by those statements followed by a detailed description in the third column of table 4. For Q8 an extra search in the produced work was done on 'high grading', 'mitigating effects', 'mitigating' and Q11 'natural disturbance', 'disturbance', 'bottom trawl impact', 'fisheries impact', 'impact'. These terms were processed as described in 2.1.
2. The actual revision of the questions and/or the Guidance Document based on knowledge from the BENTHIS publications and expert judgement.

The revisions entailed: improvement of the documented scientific evidence base of the questions in the CAM (including the Guidance Document), adjustments/adding of scoring possibilities and adjustment of a question on its own. The new scores were balanced based on expert judgement and scientific literature. Lastly, the Guidance Document has undergone a major change because the current texts in the Guidance Document were confusing. Every question had another structure or had other headings which was confusing. Therefore a new format was designed based on common sense and the headings in the current Guidance Document. The following structure was made: Goal, Definitions, Interpreting data, Instructions/scoring and useful literature. In the list below the content of each heading is shortly explained.

Goal What is the aim or the purpose of the question and why is it in the CAM?

Definitions (only if necessary) What is the meaning of certain terms and how are they used/interpreted in the CAM? This is important to minimize errors between assessors.

Interpreting data (only if necessary) How to interpret data with respect to the accompanying question? This is important to minimize errors between assessors because it is vital to interpret data in the same way.

Instructions for scoring How to fill in this question, what score might be given in difficult/data poor cases and how to use custom scoring? This is important to minimize errors between assessors.

Useful literature (only if available) List of publications that can be used by the assessor to give the right score for a question. The idea is that the list will be a living document so new literature will be added and old literature will be removed in time.

It has to be noted that the newly designed questions, have been made based on expert knowledge/-judgement and the best available scientific knowledge. The results of this research question can be found in Chapter 3.1 – 3.5.

2.3 Sensitivity study on the effects of revised Category 2 questions of the CAM

Research question: What is the effect of the revised Category 2 questions of the Common Assessment Methodology on the outcome of the assessed fisheries?

[Orange] To answer the last sub question a sensitivity study based on the results of the first and second sub question was carried out. For both the current and the revised version of the CAM, the Category 2 questions have been carried out on four different gears. In consultation with the Good Fish Foundation it was decided that four partial CAM assessments would be sufficient to test the sensitivity of the outcomes based on the revised Category 2 questions and scorings. A partial CAM assessment means that only the Category 2 questions have been carried out during the assessments (on current and revised CAM). It was decided to do so because it was not possible that the scorings of Category 1 and 3 would change during the sensitivity study because nothing was changed in these categories during this research.

The areas and species of the assessments were chosen in consultation with the Good Fish Foundation. To find out the effect of the Category 2 revisions on the CAM assessments, the following species, fishing gear and areas were chosen to be assessed:

- Atlantic cod *(Gadus morhua)* – Midwater Otter Trawl – Baltic Sea
  - To test the effect of the revisions on pelagic fishery (there should be no difference because revisions were made based on demersal fishery studies).
- Atlantic cod *(Gadus morhua)* – Demersal Otter Trawl – Baltic Sea
  - To test the effect of the revisions on a bottom impacting fishery (verification group of beam trawl).
- European plaice *(Pleuronectes platessa)* – Beam trawl – North Sea & Skagerrak
  - To test the effect of the revisions on a bottom impacting fishery.
- European plaice *(Pleuronectes platessa)* – Pulse trawl – North Sea & Skagerrak
  - To test the effect of the revisions on the newly added pulse trawl.

The partial CAM assessments were carried out based on the most recent scientific knowledge which was gathered from the BENTHIS project, the FAO database, the EMODnet dataset, ICES and other published scientific articles. The scores were added according to the Text File Template (in Guidance Document). The original assessments obtained from the GFF were scored by the Application. Because the new questions were not added to the application, it was decided to score both the current and revised CAM with the Text File Template to prevent a bias in scoring. The Text File Template gives the same score for both the current and revised CAM as the Application, only the colour is more progressive (yellow and green instead of red and yellow). For example: in a random assessment, the application scores 4 and yellow. The Text File Template scoring gives 4 but green as corresponding colour. The scoring is just a simple mathematic summation of all the independent scores, no interpretation of scoring is needed. The assessments are available on request.

After the CAM assessments were carried out the results were added to Table 5. To get the total score (the score of a complete CAM) the scores of the provided Category 1 and 3 questions were added to the Category 2 scores. The colours were determined with help of the scoring table in the appendix of the CAM. After that, the results were compared to find out how the revised questions in the CAM led to changes in the results of the CAM assessments exactly. This comparison was done with support of the filled in table (see table 5). The results of this research question can be found in Chapter 3.6. [Pink] The gathered knowledge and outcomes of the sub questions were used to answer the research question and thus to write this report for the Good Fish Foundation with an advice on changing the Category 2 questions in the CAM.

Table 5 Example of the scoring table that was used to compare the scores of the revised CAM to the current CAM. The first two columns describe the area (FAO +ICES +Geographical name) and fishery (species +gear). The third and fourth column show both the score of Category 2 and the Total assessments together with the accompanying colour. The last two columns show the same as the third and fourth column but for the revised CAM. Scores and colours were compared to each other (current vs. revised) because both could change.

Area	Fishery	Current CAM	Score/Colour	Revised CAM	Score/Colour
Area X	Species X Gear X	Category 2		Category 2	
		Total		Total	
Area X	Species X Gear X	Category 2		Category 2	
		Total		Total	
……	……	Category 2		Category 2	
		Total		Total	

3 Results

Chapter 3.1 - 3.5 show the results of sub question one and two per question of the CAM. Firstly, the question in the current CAM with its accompanying text in the Guidance Document is shown. Secondly, the proposed adjustment of the CAM and the Guidance Document are shown. Adjustments in the questions and answer possibilities were made red in the revision to make clear what changes were made. This was not done for the Guidance Document because the whole structure of the Guidance Document was changed. Chapter 3.6 shows the results of the sensitivity study carried out based on the current vs. the revised version of the CAM to see how the results of both Category 2 and the total assessment will change based on the new questions.

Up to the 21st of April 2017 BENTHIS has produced 59 scientific articles and deliverables in total. 20 of those 59 BENTHIS publications proved to be useful during this research. From the relevant articles and deliverables 7 did underpin the CAM, 5 did affect the CAM and 8 publications did both underpin and affect the CAM (see Appendix II for an overview per question). It has to be stated that a lot of the research within the BENTHIS project was testing of ideas (so no peer reviews of existing theories). The evidence in several publications was therefore anecdotal and inconclusive (and did not prove to be useful for this research).

3.1 Question 7: ETP-, Overfished- or Highly vulnerable species

Q7 **Does the fishery negatively impact* any species (fish and non-fish) that is listed** as threatened, endangered or protected (ETP) OR overfished OR biologically highly vulnerable***?**

** Impacts only to be considered on population level*

*** List examples as of QC2*

**** Highly vulnerable species: e.g. selected species of elasmobranchs, demersal deep sea finfish (e.g. of the families Macrouridae, Sebastidae, Trachichthyidae)*

2		NO - The fishery under assessment does not cause significant damage to any listed, overfished, or highly vulnerable species
0		NO - The fishery under assessment is not likely to cause significant damage to any listed, overfished, or highly vulnerable species
-1		There is no OR conflicting information concerning the effects on listed, overfished, or highly vulnerable species
-2		YES - The fishery under assessment is likely to cause significant damage to some listed, overfished, or highly vulnerable species
-3		YES - The fishery under assessment causes significant damage to any listed, overfished, or highly vulnerable species

Text current Guidance Document

Note This question pertains to all free-moving species caught by the fishery other than the species under assessment (assessment of habitat effect: Q11). Use best available Information to assess the level of damage.

Definition Impacts are only to be considered on population scale, i.e. killing or damaging at a rate that causes or furthers the population's decline or prevents its recovery.
Please refer to Table 8 (see question 8 C2) for the interpretation of classification schemes of different lists/databases.

Instruction Management measures to avoid or mitigate possible impacts are dealt with in the management section.

As a first indication on the damage a certain fishery causes on which fraction of the marine life please use the "Unknown bycatch matrix" by "Seafood Watch Criteria for Fisheries" (MBA, 2016)

Note

The highest (+2) and lowest (-3) scores are exclusively for situations where direct scientific evidence exists to justify these scorings. Circumstantial evidence (ETP species occurring in the Area-of-assessment and being vulnerable to the gear of assessment OR evidence from other areas, etc.) must not be scored +2 or -3. When ETP species do occur in the area of assessment (e.g. according to the IUCN red list) it is also a good idea to check the range of occurrence. In the case where certain ETP species are only marginally present in the area of assessment (i.e. when their main distribution area is somewhere else) an impact on population level appears unlikely. Distribution maps of species can be found for example at fishbase.org or sealife-base.org.

3.1.1 Proposed revision(s)

Based on the BENTHIS publications, the goal of the question could get a scientific evidence base. Brcic, Herrmann, De Carlo, and Sala (2015) stated that in some fisheries the bycatch of ETP species is still a problem.

3.1.2 Revised Question 7

Q7 **Does the fishery negatively impact* any species (fish and non-fish) that is listed** as threatened, endangered or protected (ETP) OR overfished OR biologically highly vulnerable***?**

2		NO - The fishery under assessment does not cause significant damage to any listed, overfished, or highly vulnerable species
0		NO - The fishery under assessment is not likely to cause significant damage to any listed, overfished, or highly vulnerable species
-1		There is no OR conflicting information concerning the effects on listed, overfished, or highly vulnerable species
-2		YES - The fishery under assessment is likely to cause significant damage to some listed, overfished, or highly vulnerable species
-3		YES - The fishery under assessment causes significant damage to any listed, overfished, or highly vulnerable species

** Impacts only to be considered on population level*

*** List examples as of QC2*

**** Highly vulnerable species: e.g. selected species of elasmobranchs, demersal deep sea finfish (e.g. of the families Macrouridae, Sebastidae, Trachichthyidae)*

Guidance Document:

Goal

Ensure fishing activity does not significantly impact species negatively that is listed as threatened, endangered or protected (ETP) or overfished or biologically highly vulnerable. In some fisheries this is still a problem as for example Brcic et al. (2015) state about the occurrence of bycatch of ETP species.

Definitions

N.A.

Interpreting data

N.A.

Instructions for scoring This question pertains to all free-moving species caught by the fishery other than the species under assessment (assessment of habitat effect: Q11). Use best available information to assess the level of damage.

Impacts are only to be **considered on population scale**, i.e. killing or damaging at a rate that causes or furthers the population's decline or prevents its recovery. Please refer to Table 8 (see question 8 C2) for the interpretation of classification schemes of different lists/databases.

The highest (+2) and lowest (-3) scores are exclusively for situations where direct scientific evidence exists to justify these scorings. Circumstantial evidence (ETP species occurring in the Area-of-assessment and being vulnerable to the gear of assessment OR evidence from other areas, etc.) must not be scored +2 or -3. When ETP species do occur in the area of assessment (e.g. according to the IUCN red list) it is also a good idea to check the range of occurrence. In the case where certain ETP species are only marginally present in the area of assessment (i.e. when their main distribution area is somewhere else) an impact on population level appears unlikely. Distribution maps of species can be found for example at fishbase.org or sealife-base.org.

Useful literature Management measures to avoid or mitigate possible impacts are dealt with in the management section. As a first indication on the damage a certain fishery causes on which fraction of the marine life please use the "Unknown bycatch matrix" by "Seafood Watch Criteria for Fisheries":
Monterey Bay Aquarium. (2016). *Seafood Watch Standard for Fisheries F3.2.* Retrieved from http://www.seafoodwatch.org/-/m/sfw/pdf/criteria/mba_seafood%20watch_fisheries%20standard_version%20f3.2.pdf?la=en

3.2 Question 8: Discards and Survival rates

Q8 **Does the fishery generate discards?**

Note to assessor: Only use the categories "low", "moderate" or "high" when no other information is available

… by weight	<5%	5-15%	15-30%	>30%	unknown
…referenced in a scientific report as:	low	moderate	high	very high	
High survival rate*	1	0	-1	-2	-1
Low** or unknown survival rate	0	-1	-2	-3	-2

** High survival rate: over 75% of each discarded species survive*
*** Low survival rate: less than 75% of discarded species survive*

Text current Guidance Document

Goal Discards are a humongous waste of resources. Furthermore, most discards are unaccounted and thus impair the quality of stock estimates. Additionally they might have implications for the food web. With very few exceptions discards should be avoided in any responsible and sustainable fishery.

Definitions The term discard describes any organism that is caught during the fishing activity and which is NOT landed (i.e. discarded at sea). Besides fish, this also explicitly includes invertebrates caught and discarded e.g. in demersal trawl fisheries. Baitfish should also be considered as dis-cards as long as they have

not been accounted (i.e. derive from a different fishery). Consequently, the discard rate (DR) is the proportion of all discards in relation to the entire catch. Discards are measured in weight units; the discard rate is expressed as percentage. Mathematically the discard rate is expressed as:
DR=(discarded catch)/(retained catch + discarded catch)

Interpreting data

There are two common mistakes made when interpreting available data and/or publications. First it is important to look at the scope of the data source. Often stock assessments mention discards, however these often refer only to the species under assessment. This is the case e.g. with the discards mentioned in ICES advices. These data must not be used when answering Q8 as it can result in large misinterpretations. (Example: In a hypothetical fishery 90t whiting and 10t cod is caught. All cod is discarded. Then the discard rate for cod as mentioned in ICES advice will be 100% discard rate. In reality the overall discard rate of this fishery is only 10%.)

The second big problem with available data is that often not all discarded species are considered. Some reports only consider the most frequently discarded species and (demersal) invertebrates are often neglected completely. (BENTHIS, 2015), a comprehensive report from the Northeast Atlantic shows that for some gears the discard of invertebrate Benthos is significant and can be in the same magnitude as discards of fish. Unfortunately there are very few comprehensive reports available for other regions worldwide. It is therefore important to try to judge in the best possible manner according to the (few available data) and to score conservatively when assessing towed demersal gear.

Instruction

If no detailed information on discard rates of the fishery under consideration is available, the FAO Fisheries Technical Paper 470 (Kelleher, 2005) may be used for a rough estimation. However, specific in-formation should always be preferred. The typical score ranges for the most frequent gears as assessed in the past (based on most available literature) is shown in Table 8 These scores must not be used without supporting evidence. It only provides a rough idea which scores are normally assigned to each fishing gear. (The default score in data-poor situations would be -2 “unknown”. Obviously there should still be a difference between a demersal trawl fishery and hand line fishery, each with unknown discard rates).

Table 3: typical discard scores

Gear	Score range
Towed demersal gear (DOT, BT, DS, FS, D)	-3 to -2
Demersal Longline and Gillnets (BLL, BGN)	-2 to -1
Pelagic gear (MOT, PS, LL, GN)	-1 to 0
Artisanal/single line fisheries (e.g. HL, H&L)	0 to +1

Discard ban

In some areas, a discard ban or landing obligation has been established. These (measures) however differ greatly worldwide with respect to efficiency, control and compliance. There-fore it does not suffice to mention a discard ban as scoring justification. As in all other fisheries the score should be based on data/literature.

3.2.1 Proposed revision(s)

Wording of the question

The wording of the current question could be improved, because the answering possibilities do not match the question (strictly speaking: the answer to Q8 can only be yes or no). The proposed question is matching the answering possibilities, still has the same content and is based on common sense. Because the answers in the current CAM are all stating that there are discards in the assessed fishery, the following question was proposed: What is the amount of discards and the survival rates of these discards in this fishery?

Mitigating measures

The second improvement could be an extra scoring option (+1) for fishing methods that try to mitigate the amount of discards in the assessed fisheries. Recent research showed (Walker, Maxwell, Le Quesne, & Jennings, 2017) that certain gear may be more efficient in preventing catching unwanted catch, hence prevent bycatch and thus discards. Also Guillen, Macher, Merzéréaud, Fifas, and Guyader (2014) stated that it is important to improve selectivity in fisheries, for both target and by-catch species to avoid discards. Based on the work of Walker et al. (2017) and Guillen et al. (2014) it was proposed that progressive gears that prevent unwanted catch resulting in bycatch can be rewarded. However, the progressive gear needs to be scientifically reviewed and within the borders of the law. Progressive gears could entail escape hatches for unwanted/undersized fish or a panel that will keep out big fish (e.g. from another species). These bycatch preventing measures are affecting the total amount of discards. Therefore an extra plus one score may be given to create an incentive for sustainable fisheries with a minimum in bycatch and thus, discards. For example a fishery with low discards without mitigating measures has the same score as a fishery with low discards because of mitigating measures. Although it was known that the results of these mitigating measures are already measurable in the upper part of the table it was proposed to reward fisheries with those measures in place with a bonus point.

High-grading

A recent report on high-grading in discards (Batsleer, Hamon, Van Overzee, Rijnsdorp, & Poos, 2015) stated that high-grading is taking place worldwide in both pelagic and demersal fisheries. Most of the fisheries in which high-grading was observed are mixed fisheries managed under individual catch quota systems. This is not surprising given that individual quotas allow individuals to maximize the economic return on their quota by high-grading the cheaper parts of the catch and increasing the average return per unit quota (Batsleer et al., 2015). According to the FAO high-grading is the process of discarding less valuable fish (which is already processed) to make room for fish that has more value. This often has to do with size (I. Clucas, 1997). In high-grading the survival rate is very low because most of the time the discarded fish is already dead when it is discarded. This practice affects the survival rate and therefore it was proposed to give a minus one (-1) score on top of the score in the scoring table to fisheries where high-grading is highly likely. Although it was known that the results of high-grading are already partially measurable in the upper part of the table it was proposed to punish fisheries with high-grading because high-grading is a reprehensible action. It has to be noted that high-grading is prohibited in the European Union under the CFP, this score may only be used when no applicable regulation on high-grading is in place (Weissenberger, 2013).

Guidance document and Goal

Table 8 (typical discard scores per fishing method) in the Guidance Document is not up-to-date anymore. Pulse trawl is not included and according to Batsleer, Rijnsdorp, Hamon, Van Overzee, and Poos (2016) this new type of trawling should be considered in fisheries management. Based on this article pulse trawl could be added to table 8 in the Guidance Document.

Lastly the text in the Guidance Document could get a scientific evidence base. Batsleer et al. (2015) and Batsleer et al. (2016) did underpin the goal of this question. Discards are indeed a waste of resources. Discards need to be avoided as much as possible because they might have implications for the food web (Depestele, Rochet, Dorémus, Laffargue, & Stienen, 2016). Seabirds but also marine mammals and benthos are taking advantage of discards. This alters the ecosystem. Besides Batsleer et al. (2016) did underpin the goal of this question it is giving a definition of discards that is corresponding with the definition of discards in the current CAM.

3.2.2 Revised Question 8

Q8 **What is the amount of discards and the survival rates of these discards in this fishery?**

Note to assessor: Only use the categories "low", "moderate" or "high" when no other information is available

… by weight	<5%	5-15%	15-30%	>30%	unknown
…referenced in a scientific report as:	low	moderate	high	very high	
High survival rate*	1	0	-1	-2	-1
Low** or unknown survival rate	0	-1	-2	-3	-2
Mitigating measures bycatch in place***	+1				
High-grading highly likely***	-1				

** High survival rate: over 75% of each discarded species survive*

*** Low survival rate: less than 75% of discarded species survive*

**** This scores are extra and are added to the score of the upper part of the table of Q8 – only use the high-grading option when no regulation on it is in place*

Guidance Document:

Goal

Discards are a humongous waste of resources (Batsleer et al., 2015; Batsleer et al., 2016). Furthermore, most discards are unaccounted and thus impair the quality of stock estimates (Batsleer et al., 2016). Additionally they might have implications for the food web (Depestele, Rochet et al., 2016). With very few exceptions discards should be avoided in any responsible and sustainable fishery (Batsleer et al., 2016).

Definitions

The term discard describes any organism that is caught during the fishing activity and which is NOT landed (i.e. discarded at sea). Besides fish, this also explicitly includes invertebrates caught and discarded e.g. in demersal trawl fisheries (Batsleer et al., 2016). Baitfish should also be considered as dis-cards as long as they have not been accounted (i.e. derive from a different fishery). Consequently, the discard rate (DR) is the proportion of all discards in relation to the entire catch. Discards are measured in weight units; the discard rate is expressed as percentage. Mathematically the discard rate is expressed as: DR=(discarded catch)/(retained catch + discarded catch)

Interpreting data

There are two issues to keep in mind, based on common made mistakes, when using available data and/or publications. First it is important to look at the scope of the data source. Often stock assessments mention discards, however these often refer only to the species under assessment. This is the case e.g. with the discards mentioned in ICES advices. These data must not be used

when answering Q8 as it can result in large misinterpretations. (Example: In a hypothetical fishery 90t whiting and 10t cod is caught. All cod is discarded. Then the discard rate for cod as mentioned in ICES advice will be 100% discard rate. In reality the overall discard rate of this fishery is only 10%.)

The second issue with available data is that often not all discarded species are considered. Some reports only consider the most frequently discarded species and (demersal) invertebrates are often neglected completely. (Nielsen et al., 2014)[1], a comprehensive report from the Northeast Atlantic shows that for some gears the discard of invertebrate Benthos is significant and can be in the same magnitude as discards of fish. Unfortunately there are very few comprehensive reports available for other regions worldwide. It is therefore important to try to judge in the best possible manner according to the (few available data) and to score conservatively when assessing towed demersal gear.

Instructions for scoring If no detailed information on discard rates of the fishery under consideration is available, the FAO Fisheries Technical Paper 470 (see (Kelleher, 2005) in "Useful literature") may be used for a rough estimation. However, specific information should always be preferred. The typical score ranges for the most frequent gears as assessed in the past (based on most available literature) is shown in Table 8. These scores must not be used without supporting evidence. It only provides a rough idea which scores are normally assigned to each fishing gear. (The default score in data-poor situations would be -2 "unknown". Obviously there should still be a difference between a demersal trawl fishery and hand line fishery, each with unknown discard rates).

Table 4: typical discard scores

Gear	**Score** range
Towed demersal gear (DOT, BT, DS, Pulse, FS, D)	-3 to -2
Demersal Longline and Gillnets (BLL, BGN)	-2 to -1
Pelagic gear (MOT, PS, LL, GN)	-1 to 0
Artisanal/single line fisheries (e.g. HL, H&L)	0 to +1

Discard ban: In some areas, a discard ban or landing obligation has been established. These (measures) however differ greatly worldwide with respect to efficiency, control and compliance. There-fore it does not suffice to mention a discard ban as scoring justification. As in all other fisheries the score should be based on data/literature.

Recent research shows (Walker et al., 2017) that certain gear may be more efficient in preventing catching unwanted catch, hence prevent bycatch and thus discards. Also Guillen et al. (2014) state that it is important to improve selectivity in fisheries, for both target and by-catch species to avoid discards. Therefore an extra plus one score may be given to create an incentive for sustainable fisheries with a minimum in bycatch and thus, discards.

According to the FAO high-grading is the process of discarding less valuable fish (which is already processed) to make room for fish that has more value. This often has to do with size (I. Clucas, 1997). In high-grading the survival change is very low because most of the time the discarded fish is

[1] (Nielsen et al., 2014) was already used in the current Guidance Document and is still useful. Therefor it was decided to keep it in the revised Guidance Document. In the current Guidance Document (Nielsen et al., 2014) was displayed as (BENTHIS, 2015).

already dead when it is discarded. Therefore an extra minus one score may be given to create an incentive for sustainable fisheries. It has to be noted that high-grading is prohibited in the European Union under the CFP, this score may only be used when no applicable regulation on high-grading is in place.

Only give a (+1) score for mitigating measures or a (-1) score for high-grading if this score can be based on scientific evidence.

Useful Literature

Kelleher, K. (2005). *Discards in the world's marine fisheries. An update*. FAO Fisheries Technical Paper. No. 470. Rome: FAO. Retrieved from http://www.fao.org/docrep/008/y5936e/y5936e00.htm

Nielsen, R., Bastardie, F., Buhl-Mortensen, L., Eigaard, O., Gümüş, A., Hintzen, N., . . . Zengin, M. (Eds.). (2014). *DELIVERABLE 7.6 Report on assessing trawling impact in regional seas*. IJmuiden, the Netherlands: BENTHIS/IMARES.

3.3 Question 9: Composition of Retained catch

Q9 **Does the retained catch contain juveniles* or non-target species?**

**Juveniles = individuals (target AND non-target species) which are smaller or younger than the length or age where 50% of the individuals of that specific stock are considered mature.*
Percentage of catch is by weight. Assessors should be conservative when looking at juveniles given low weight relative to adults.

1		NO - The retained catch contains no (or <5%) juveniles AND no (or <5%) non-target species *[selective catch method]*
0		YES - The retained catch contains 5-30% juveniles AND no (or <5%) non-target species OR the landed catch contains 5-30% non-target species AND no (or <5%) juveniles
-1		YES - The retained catch contains 5-30% juveniles AND 5-30% non-target species OR there is not enough information for evaluation
-2		YES - The retained catch contains >30% juveniles AND/OR non- target species *[non-selective catch method, e.g. trawling, dredging, FAD associated seine]*

Text current Guidance Document

Goal

All retained species should be accounted for according to existing management plans. Bycatch of juvenile species should be in a magnitude that does not alter/endanger the stock structure and/or long term productivity of the stock.

Definition

Please note that in this question only unaccounted bycatch is considered. (Unaccounted) by-catch refers to all landed non-target species which are not appropriately managed in a species specific manner. This explicitly means that only species which do not have a quota and which are not counted against this quota are bycatch in this question. This differs from the usual definition of bycatch in the literature (i.e. all unwanted/unintended catch) and has thus led to many misunderstandings. For example, in a mixed fishery, fisher-man might have received quotas for more than one species, being often the case in rather unselective fisheries (e.g. demersal trawls).

Juveniles

Catch of juvenile fish can cause growth overfishing (=depleting the young part of the stock be-fore it has reached its full biological and economic potential) and recruitment overfishing (= depleting the reproductive part of the stock by

so much that their recruitment is impaired), but it does not necessarily have to do so. In a well-managed stock, the catch of a proportion of juvenile fish does not necessarily harm the reproductive capacity of the stock. However the pro-portion that is considered acceptable for each stock is rarely known.

Following a conservative and simplified approach, all species should be allowed to spawn prior to their capture, i.e. the proportion of juveniles in the catches should be low. Nevertheless it should be noted that the impact of juvenile bycatches differs greatly between species. For species where there is no correlation between recruitment and SSB (i.e. where stock size is influenced by other, e.g. abiotic, climatic factors) a large proportion of juveniles in the catches (e.g. many small pelagics) are a minor problem than for long-lived, late maturing species with a clear yield-per-recruit dependence. This may be considered by assigning custom scores. See e.g. (Lowerre-Barbieri, et al., 2016) for more information.

Extreme cases are semelparous species (i.e. species that decease shortly after spawning). In this case almost 100% of the landed individuals are considered juvenile, thus leading to a score of -2.

Scoring

To prevent double penalization, only juveniles of the species under assessment should be considered. Use the best available data and calculation method when assessing juvenile pro-portions of the catch. Please note that the proportion considered are per weight and not by count.

3.3.1 Proposed revision(s)

A scientific evidence base could be added to the scoring table of this question. At score -2 is stated that trawling is a non-selective catch method. Batsleer et al. (2016) stated that mainly in mixed fisheries this is still a large problem, for example in the Sole and Plaice targeting fisheries. In this fishery small mesh size is required to catch the slender Sole which results in the catch of large numbers of undersized/juvenile Plaice (Batsleer et al., 2016).

3.3.2 Revised Question 9

Q9 **Does the retained catch contain juveniles* or non-target species?**

1		NO - The retained catch contains no (or <5%) juveniles AND no (or <5%) non-target species *[selective catch method]*
0		YES - The retained catch contains 5-30% juveniles AND no (or <5%) non-target species OR the landed catch contains 5-30% non-target species AND no (or <5%) juveniles
-1		YES - The retained catch contains 5-30% juveniles AND 5-30% non-target species OR there is not enough information for evaluation
-2		YES - The retained catch contains >30% juveniles AND/OR non- target species *[non-selective catch method, e.g. trawling (Batsleer et al., 2016), dredging, FAD associated seine]*

**Juveniles = individuals (target AND non-target species) which are smaller or younger than the length or age where 50% of the individuals of that specific stock are considered mature.*
Percentage of catch is by weight. Assessors should be conservative when looking at juveniles given low weight relative to adults.

Guidance Document:

Goal

All retained species should be accounted for according to existing management plans. Bycatch of juvenile species should be in a magnitude that does not alter/endanger the stock structure and/or long term productivity of the stock.

Definitions

Please note that in this question only **unaccounted** bycatch is considered. (Unaccounted) bycatch refers to **all landed non-target species which are not appropriately managed** in a species specific manner. This explicitly means that **only species which do not have a quota** and which are **not counted against this quota** are bycatch in this question.

This differs from the usual definition of bycatch in the literature (i.e. all unwanted/unintended catch) and has thus led to many misunderstandings. For example, in a mixed fishery, fisherman might have received quotas for more than one species, being often the case in rather unselective fisheries (e.g. demersal trawls).

Interpreting data

N.A.

Instructions for scoring

Catch of juvenile fish can cause growth overfishing *(=depleting the young part of the stock before it has reached its full biological and economic potential*) and recruitment overfishing *(= depleting the reproductive part of the stock by so much that their recruitment is impaired*), but it does not necessarily have to do so. In a well-managed stock, the catch of a proportion of juvenile fish does not necessarily harm the reproductive capacity of the stock. However the proportion that is considered acceptable for each stock is rarely known.

Following a conservative and simplified approach, all species should be allowed to spawn prior to their capture, i.e. the proportion of juveniles in the catches should be low. Nevertheless it should be noted that the impact of juvenile bycatches differs greatly between species. For species where there is no correlation between recruitment and SSB (i.e. where stock size is influenced by other, e.g. abiotic, climatic factors) a large proportion of juveniles in the catches (e.g. many small pelagics) are a minor problem than for long-lived, late maturing species with a clear yield-per-recruit dependence. This may be considered by assigning custom scores. See (Lowerre-Barbieri et al., 2016) in “Useful literature” for more information.

To prevent double penalization, **only juveniles of the species under assessment** should be considered. Use the best available data and calculation method when assessing juvenile proportions of the catch. Please note that the proportion considered are per weight and not by count.

Extreme cases are semelparous species (i.e. species that decease shortly after spawning). In this case almost 100% of the landed individuals are considered juvenile, thus leading to a score of -2.

Useful literature

Lowerre-Barbieri, S., DeCelles, G., Pepin, P., Catalán, I. A., Muhling, B., Erisman, B., . . . Paris, C. B. (2016). Reproductive resilience: a paradigm shift in understanding spawner-recruit systems in exploited marine fish. *Fish and Fisheries*, *18*(2), 285-312. doi:10.1111/faf.12180

3.4 Question 10: Effect of Fishery on the Ecosystem

Q10 **Does the intensity of the fishery result in significant negative ecosystem changes*, such as cascade effects, major food chain effects, or community changes**? *[Ecosystem Effect]*

**Examples of significant ecosystem changes:* Significantly increased abundance of species with a low trophic level caused by depletion of predators. OR Depletion of top predators as a result of the decrease of key prey species. OR Truncated size composition of the ecological community. OR Major changes in the species biodiversity of the ecological community. OR Changes in the genetic diversity of a stock that lead to changes of e.g. growth or reproduction of the species. OR Destruction of key biogenic/habitat-forming species.*

1		NO - The fishery is not causing significant negative ecosystem changes
0		Negative ecosystem changes caused by the fishery are unlikely OR the likelihood of impact cannot be determined because there is conflicting, inconclusive, or insufficient information
-1		YES - Significant negative ecosystem changes are likely *[circumstantial evidence]*
-2		YES - The fishery is causing significant negative ecosystem changes *[direct evidence]*

Text current Guidance Document

Goal

Ensure fishing activity does not significantly reduce ecosystem services provided by any fish species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity.

Definition

The term "significant changes" is used within the meaning of nature conservation legislation, e.g. EU Habitats Directive. "Significant" is not meant in its statistical sense!

Sessile fauna/flora

Also consider endangered sessile fauna and flora (these are not accounted for in Q7). Apart from their habitat forming characteristics (dealt with in Q11) they contribute to the biodiversity and trophic structure of the ecosystem and their exposure to the fishery under assessment must also be factored.

Cumulative effects

There is an ongoing discussion how (and if) to consider cumulative effects by the gears, i.e. how to account for the individual fishing pressure of the fishery under assessment. It has been accepted that this issue will likely be subject to future methodology reviews. Preliminarily it has been decided to NOT consider the fishing pressure, i.e. the number of vessels/fishermen engaged in the particular fishery under assessment. This decision is based on the following reasons.

- Considering the goals described above it becomes clear that conservative fishing gears/methods are to be promoted while destructive gears are to be penalized.
- The choice of UoA (Unit of assessment) has a large influence on this question if individual fishing pressure was to be considered. Example: If a group of 100 beam trawlers is broken down into smaller groups (e.g. by assessing single nations or single target species) the individual contribution to ecosystem damage is less. Hypothetically, if each single beam trawler is to be assessed separately, one could say that it is unlikely that a single beam trawler causes significant ecosystem changes (=score 0 each), while the bulk of all beam trawlers is very likely to cause ecosystem changes.
- It is often infeasible to assess the individual fishing pressure exerted by the one particular fishery under assessment.

Scoring

To answer this question, all affected elements of the ecosystem are to be considered. These are for example removed target species, removed bycatch and killed/destroyed benthos organisms.

Consider especially the stock status of species that play key roles in the ecosystem; the removal of top predators like cod or wasp-waist species like sprat can cause severe ecosystem changes. However when these species are still abundant (healthy stock status) trophic cascades are unlikely.

"The fishery causes significant damage/change" (pt. -2) means that direct evidence exist to support this statement. "The fishery is likely to cause significant damage" (pt. -1) means that circumstantial evidence exist to support this statement, e.g. investigations of a comparable species in the same area, or investigations of the species under consideration, but in a different area, have proven the harmful effect of the fishing method. As a rough orientation the scorings and publications below have been used in the past, depending on the aspects listed above:

Demersal Otter Trawl: -1 (Norse & Watling, 1999) (Rogers & Gianni, 2009) (Rogers, Clark, Hall-Spencer, & Gjerde, 2008) (Hinz, Prieto, & Kaiser, 2009) (Tillin, Hiddink, Jennings, & Kaiser, 2006) (Jennings, et al., 1999) (Kaiser, Ramsay, Richardson, Spence, & Brand, 2000) (OSPAR, 2010) (Rossi, 2013)

Beam trawl / Dredge: -2 (Lengkeek & Bouma, 2010)

3.4.1 Proposed revision(s)

Creating a documented scientific evidence base

A scientific evidence base could be added to the goal of this question as well as new examples of significant ecosystem changes. Eigaard et al. (2013) did underpin the importance and the goal of this question. Trawl fisheries are affecting marine life by catching species or damaging other species while fishing. This can alter predator-prey relations, length at age of fish and the competition for food and space (Eigaard et al., 2013; Johnson, Gorelli, Jenkins, Hiddink, & Hinz, 2015). Overall it can be stated that these fisheries have negative impacts on abundance of species and availability of prey (Johnson et al., 2015). Lambert, Jennings, Kaiser, Davies, & Hiddink (2016) and Collie et al. (2016) stated that bottom trawling causes a high level of local mortality to benthic fauna. It can lead to changes in the feeding and growth of demersal flatfish and to changes in predator prey relations.

A scientific evidence base could be added to the goal of this question and to an example of significant ecosystem changes in the question itself. Pommer, Olesen, and Hansen (2016) stated that impacts from trawl fisheries change the faunal community. As a result, fauna destruction due to trawling affects specific ecosystem functions. When the trawl fishery targets a very specific habitat, it also targets a specific faunal community. Not only the individual species risk extinction, but, more importantly, also their functional role in the ecosystem. The loss of functional roles within the ecosystem can have far greater effects on a community than declines of single species (Pommer et al., 2016).

A scientific evidence base could also be added to the goal of this question and to a part of the instruction/scoring, and to an example of significant ecosystem changes in the question itself. Hiddink et al. (2016) stated that bottom-trawl fisheries cause mortality of benthic invertebrates. Because of this, fish productivity may increase with exploitation because of a reduction in competition over food and other resources. However, fish productivity may also decline with exploitation because of a decline in prey abundance. Whether fish productivity increases or decreases is highly dependable on the specific fishery its fishing pressure (Hiddink et al., 2016).

A scientific evidence base could be added to a part of the examples of significant ecosystem changes and to a part of the instruction/scoring. Recent research (Scriberras et al., 2014; Hiddink et al., 2016)

stated that bottom fishing results in significant negative impacts on total benthic community abundance. If functional diversity is reduced by depletion or deletion of a functional group, then certain resources would be under exploited or unexploited relative to undisturbed communities, or redirected to other compartments. This would lead to a reduction in the productivity of the ecosystem.

Johnson et al. (2015) also stated that ecosystems with long lived and specialized species have more problems with recovery than ecosystems with short lived species. This means that the same fishery intensity has much higher negative ecosystem changes for ecosystems with long lived species than for ecosystems with short lived species. This could create a scientific evidence base to one of the examples of significant ecosystem changes.

Lastly two publications (Nielsen et al., 2014; Eigaard et al., 2016) on fishing intensity could be added to the 'useful literature' of this question. The information of these publications was not added to the question itself because they only describe this subject in European waters.

3.4.2 Revised Question 10

Q10 **Does the intensity of the fishery result in significant negative ecosystem changes*, such as cascade effects, major food chain effects, or community changes**? *[Ecosystem Effect]*

1		NO - The fishery is not causing significant negative ecosystem changes
0		Negative ecosystem changes caused by the fishery are unlikely OR the likelihood of impact cannot be determined because there is conflicting, inconclusive, or insufficient information
-1		YES - Significant negative ecosystem changes are likely *[circumstantial evidence]*
-2		YES - The fishery is causing significant negative ecosystem changes *[direct evidence]*

**Examples of significant ecosystem changes:* Significantly increased abundance of species with a low trophic level caused by depletion of predators OR increased abundance of predators caused by reduction in competition over food and other resources (Hiddink et al., 2016) OR Depletion of top predators as a result of the decrease of key prey species (Hiddink et al., 2016; Johnson et al., 2015; Eigaard et al., 2013) OR Truncated size composition of the ecological community (Collie et al., 2016; Scriberras et al., 2014; Lambert et al., 2016) OR Major changes in the species biodiversity of the ecological community (Johnson et al., 2015; Scriberras et al., 2014) OR Changes in the genetic diversity of a stock that lead to changes of e.g. growth or reproduction of the species (Collie et al., 2016) OR Destruction of key biogenic/habitat-forming species OR the loss of functional roles within the ecosystem (Scriberras et al., 2014; Pommer et al., 2016).*

Guidance Document

Goal

Ensure fishing activity does not significantly reduce ecosystem services provided by any fish species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Eigaard et al. (2013) and Johnson et al. (2015) state that mainly trawling has impacts on the predator-prey relations, the competition for food and space and the abundance of species. Also Pommer et al. (2016) Collie et al. (2016) and Lambert et al. (2016) state that trawling changes the faunal community. Besides that Hiddink et al. (2016) and Collie et al. (2016) state that bottom-trawl fisheries cause mortality of benthic invertebrates.

Definitions

The term "significant changes" is used within the meaning of nature conservation legislation, e.g. EU Habitats Directive. "Significant" is not meant in its statistical sense!

Interpreting data

N.A.

Instructions for scoring

Also consider endangered sessile fauna and flora (these are not accounted for in Q7). Apart from their habitat forming characteristics (dealt with in Q11) they contribute to the biodiversity and trophic structure of the ecosystem and their exposure to the fishery under assessment must also be factored.

There is an ongoing discussion how (and if) to consider cumulative effects by the gears, i.e. how to account for the individual fishing pressure of the fishery under assessment. It has been accepted that this issue will likely be subject to future methodology reviews. Preliminarily it has been decided to NOT consider the fishing pressure, i.e. the number of vessels/fishermen engaged in the particular fishery under assessment. This decision is based on the following reasons.

- Considering the goals described above it becomes clear that conservative fishing gears/methods are to be promoted while destructive gears are to be penalized.
- The choice of UoA (Unit of assessment) has a large influence on this question if individual fishing pressure was to be considered. Example: If a group of 100 beam trawlers is broken down into smaller groups (e.g. by assessing single nations or single target species) the individual contribution to ecosystem damage is less. Hypothetically, if each single beam trawler is to be assessed separately, one could say that it is unlikely that a single beam trawler causes significant ecosystem changes (=score 0 each), while the bulk of all beam trawlers is very likely to cause ecosystem changes.
- It is often infeasible to assess the individual fishing pressure exerted by the one particular fishery under assessment.

To answer this question, all affected elements of the ecosystem are to be considered. These are for example removed target species, removed bycatch and killed/destroyed benthos organisms (Hiddink et al., 2016; Lambert et al., 2016; Scriberras et al., 2014; Collie et al., 2016). Consider especially the stock status of species that play key roles in the ecosystem; the removal of top predators like cod or wasp-waist species like sprat can cause severe ecosystem changes (Eigaard et al., 2013; Johnson et al., 2015; Hiddink et al., 2016). However when these species are still abundant (healthy stock status) trophic cascades are unlikely.

"The fishery causes significant damage/change" (pt. -2) means that direct evidence exist to support this statement. "The fishery is likely to cause significant damage" (pt. -1) means that circumstantial evidence exist to support this statement, e.g. investigations of a comparable species in the same area, or investigations of the species under consideration, but in a different area, have proven the harmful effect of the fishing method.

Useful literature

As a rough orientation the scorings and publications below have been used in the past, depending on the aspects listed above:

Demersal Otter Trawl: -1

- Hinz, H., Prieto, V., & Kaiser, M. J. (2009). Trawl disturbance on benthic communities: chronic effects and experimental predictions. *Ecological Applications, 19*(3), 761-773. doi:10.1890/08-0351.1

- Jennings, S., Alvsvåg, J., Cotter, A., Ehrich, S., Greenstreet, S., Jarre-Teichmann, A., . . . Smedstad, O. (1999). Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. 1999, III. International trawling effort in the North Sea: an analysis of spatial and temporal trends. *Fisheries Research, 40*, 125-134. Retrieved from https://www.researchgate.net/profile/Adriaan_Rijnsdorp/publication/216900291_Fishing_effects_in_northeast_Atlantic_shelf_seas_patterns_in_fishing_effort_diversity_and_community_structure_III_International_trawling_effort_in_the_North_Sea_An_analysis_of_sp
- Kaiser, M. J., Ramsay, K., Richardson, C. A., Spence, F. E., & Brand, A. R. (2000). Chronic fishing disturbance has changed shelf sea benthic communities. *Journal of Animal Ecology, 69*, 494-503. Retrieved from http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2656.2000.00412.x/epdf
- Norse, E. A., & Watling, L. (1999). Impacts of mobile fishing gear: the biodiversity perspective. In R. Benaka (Ed.), *Fish habitat: essential fish habitat and rehabilitation.* (pp. 31-40). American Fisheries Society, Symposium Bethesda, Maryland. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.467.461&rep=rep1&type=pdf
- OSPAR. (2010). *Background document for seapen and burrowing megafauna communities.* OSPAR Biodiversity series. Retrieved from http://qsr2010.ospar.org/media/assessments/Species/P00481_Seapen_and_burrowing_megafauna.pdf
- Rogers, D., & Gianni, M. (2009). *The Implementation of UN Resolution 61/105 in the Management of Deep-Sea Fisheries on the High Seas.* International Programme on the State of the Ocean, London. Retrieved from http://www.savethehighseas.org/publicdocs/Implementation_of_UN_GA_61_105_North_Atlantic_Nov2009.pdf
- Rogers, A. D., Clark, M. R., Hall-Spencer, J. M., & Gjerde, K. M. (2008). *The Science behind the Guidelines: A Scientific Guide to the FAO Draft International Guidelines (December 2007) For the Management of Deep-Sea Fisheries in the High Seas and Examples of How the Guidelines May Be Practically Implemented.* IUCN, Switzerland. Retrieved from https://www.sprfmo.int/assets/Recycle-Bin/Review%20of%20the%20FAO%20Guidelines-SPRFMO.pdf
- Rossi, S. (2013). The destruction of the 'animal forests' in the oceans: towards an over-simplification of the benthic ecosystems. *Ocean & Coastal Management, 84*, 77-85. Retrieved from https://www.researchgate.net/profile/Sergio_Rossi/publication/255983053_The_destruction_of_the_%27animal_forests%27_in_the_oceans_Towards_an_oversimplification_of_the_benthic_ecosystems/links/00b495213f2f5109bc000000.pdf

- Tillin, H. M., Hiddink, J. G., Jennings, S., & Kaiser, M. J. (2006). Chronic bottom trawling alters the functional composition of benthic invertebrate communities on a sea-basin scale. *Marine Ecology Progress Series, 318*, 31-45. Retrieved from http://www.int-res.com/articles/meps2006/318/m318p031.pdf

Beam trawl / Dredge: -2

- Lengkeek, W., & Bouma, S. (2010). *Impacts of beam trawl fisheries in the North Sea: A summary of fifty-five publications.* report nr. 10-048 Stichting de Noordzee and Greenpeace the Netherlands. Retrieved from http://assets.ocean2012.eu/publication_documents/documents/10/original/Impacts_of_beam_trawl_fisheries_in_the_North_Sea.pdf

Fishing intensity

- Eigaard, O. R., Bastardie, F., Breen, M., Dinesen, G. E., Hintzen, N. T., Laffargue, P., . . . Rijnsdorp, A. D. (2016). Estimating seabed pressure from demersal trawls, seines, and dredges based on gear design and dimensions. *ICES Journal of Marine Science*, *73*, 27-43. doi:10.1093/icesjms/fsv099
- Nielsen, R., Bastardie, F., Buhl-Mortensen, L., Eigaard, O., Gümüş, A., Hintzen, N., . . . Zengin, M. (Eds.). (2014). *DELIVERABLE 7.6 Report on assessing trawling impact in regional seas*. IJmuiden, the Netherlands: BENTHIS/IMARES.

3.5 Question 11: Effect of Fishery on the Habitat

Q11 **Is the fishing method destructive to particular benthic habitats or habitat forming species within the benthic habitat?** *[Habitat Effect]*

Notes to assessor: Provide references for definition of habitat type.
In case the habitat types are mixed, scores are to be averaged.
In case the fishing grounds are known to include at least one sensitive habitat, score accordingly.

Habitat type / Capture method	Sand/ gravel/ mud	Rocky	Biogenic reefs, sponge-beds, seagrass	Seamounts, cold water corals, hydrothermal vents
Pelagic (midwater) trawl, pelagic long-line, spear, harpoon, purse seine, midwater gillnet, pole & line, trolling, hook-and-line	2	2	2	2
Hand-picking	2	2	1	n.a.
Hand raking	1	1	-1	n.a.
Pots, traps	1	0	-1	n.a.
Bottom long-line, bottom set gillnet	1	0	-1	-2
Danish seine, demersal seine, fly-shooting	0	-1	-3	-3
Beam trawl/beam trawl rollers, demersal otter trawl	-1	-2	-3	-3
Beam trawl/tickler chains or chain mats	-2	-3	-3	-3
Dredge	-2	-3	-3	-3
Explosives, chemicals & other illegal operations	-5	-5	-5	-5

Text current Guidance Document

Instruction

Under this question, the physical destruction of habitats by fishing gear is rated. Other impacts such as e.g. food chain effects resulting from this physical impact are to be rated under Q10 (Ecosystem Effect). Read habitat type and fishing method from the grid to determine the score.

Scoring

In case the habitat types are mixed, and some sensitive habitats are known to occur, scores have to be averaged. If the majority of a fishery operates over a particular habitat, then the corresponding score is to be used.

If a sensitive habitat (e.g. cold water corals as bycatch, or wide distribution of seagrass beds) is impacted, err on the side of caution and give the more conservative score. This is also applicable if no information on the distribution of fishing effort with respect to habitat type is available, but circumstantial information indicates that it is highly likely that fishing takes place over sensitive habitats (e.g. Norwegian coastal waters, where complete seafloor mapping is lacking, but the existing maps show substantial occurrence of cold water corals).

In the case where a present gear modification or use of gear is eligible to mitigate the habitat damage compared to the standard (i.e. unmodified) gear, or when evidence exists that the gear is used in a particularly destructive way (e.g. when purse seines are dragged over the seafloor because bottom trawling is prohibited in this area), please consider this by assigning custom scores. (See 1.3 General assessment instructions -> Custom scores1.3). Keep in mind that these occurrences must be evidenced by adequate by providing scientific references. However, temporal or regional area closures must not be rated here, since they usually do not cover the entirety of a present vulnerable habitat. Only in cases where a complete seafloor mapping is present and any damage to sensitive habitats is prevented by management measures, a mitigated custom score might be applicable.

3.5.1 Proposed revision(s)

Changes in number of gears

In Q11 a number of gears could be added to the answering table. According to Batsleer et al. (2016) pulse trawling is a less impacting fish method than conventional beam trawl. They also stated that pulse trawling is resulting in less discards (Batsleer et al., 2016). Another recent research stated that the electrodes of a pulse trawl penetrated approximately half as deep than conventional tickler chains (Depestele, Ivanovic et al,. 2016). Depestele, Ivanovic et al. (2016) do however have some remarks on the pulse trawl. They stated that the effect of the pulse trawl vs tickler chains is dependent on the rest of the gear configurations. “The overall impact of a pulse trawl was predicted to be lower over the full swept area than of a tickler-chain trawl, but the trawl shoes of the pulse trawler penetrated much deeper than those of the tickler-chain trawl. The modelled penetration depths of the gear components indicated that the configuration of the tested gears, either tickler-chain or pulse trawl, complicates our ability to generalize the physical impacts of a certain gear type”(Depestele, Ivanovic et al., 2016, p.25; Eigaard et al., 2015). Eigaard et al. (2015) focused on the impact of different gears and the supplementary data shows that every gear composition of TBB (beam trawling) has another effect on the penetration depth or sediment displacement. Eigaard et al. (2015) distinguished four different gear components for TBB: whole-gear, beam shoes, tickler chains/mats, ground gear. They showed that the impact of gear differs hugely depending on sediment and configuration (Eigaard et al., 2015; Van Denderen, Hintzen, Rijnsdorp, Ruardij, & Van Kooten 2014). Van Denderen et al. (2014) wrote that Beam trawling impact is highly dependable on the area where it is used and the research of Eigaard et al. (2015) did underpin this. This information is in sync with the current Q11 table. However, there is a missing gear: pulse trawl.

Restructure gears

Besides adding new gears, the gears that are already present in the table could be restructured based on research on the impacts of bottom gear. Eigaard et al. (2016) showed an image of the bottom impacts of several gears (figure 3). Otter trawl with a multi-rig clump is impacting the seabed more than e.g. a beam trawl with tickler chains. They have the same score in the current scoring table. Based on scientific evidence it is more likely that Otter Trawl has the same impact as a demersal seine than as a beam trawl (Eigaard et al., 2016). Scriberras et al. (2014) suggested that dredging causes more severe impacts and potentially more profound effects on ecosystem functioning than otter trawling. Based on those publications and an earlier publication of Eigaard et al. (2015) it was proposed to change the order of the ‘capture methods’ of Q11.

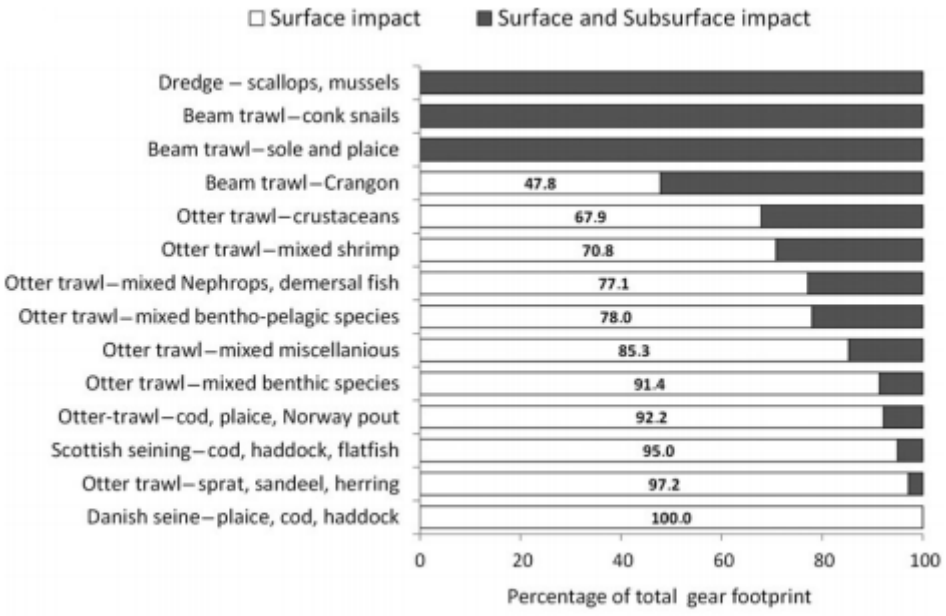

Figure 3 Proportion of total gear footprint with impact at both the surface and the subsurface level for the 14 BENTHIS metiers (Eigaard et al., 2016).

Changes to ranking of gear impact on habitat

A study of Scriberras et al. (2014) showed that the effect of bottom impacting gears are bigger than previously expected especially if it comes to biogenic habitats which was endorsed by Rijnsdorp et al. (2016). They stated that the significant negative impacts were most severe for benthic communities in biogenic habitats and coarse and mixed sediment relative to sandy and muddy sediments (Scriberras et al., 2014; Rijnsdorp et al., 2016). This is in line with the current table of Q11 but later they stated: "Biogenic habitats undergo the biggest loss in abundance on impact with bottom-towed gear, and the damage in these habitats may be irreversible as recovery did not appear to take place at any point after the disturbance." (Scriberras et al., 2014, p.95). This means that a disturbance of biogenic habitats is more dangerous than previously thought and can have a lower score because the damage on these habitats seems to be irreversible. In the same year Van Denderen et al. (2014) found a negative relationship between trawling intensity and species richness. Richness is also negatively related to sediment grain size and primary productivity, and positively related to biomass (Van Denderen et al., 2014). Analysis of their data showed that the negative effects of trawling on richness were limited to relatively species-rich, deep areas with fine sediments. No effect of bottom trawling on species richness in shallow areas with coarse bottoms were found (Van Denderen et al., 2014). Based on expert judgement and the literature mentioned in this paragraph the scores of the last two columns were revised.

Recent research found that different benthic habitats respond differently to a given fishing pressure and that biogenic habitats are most sensitive to fishing, thus the effect of fisheries impact on the ecosystem depends on the level of natural physical disturbance (wave action, tidal currents, etc.) (Bolam et al., 2014; Rijnsdorp et al., 2016). Stable and sheltered systems are more profoundly affected by fishing activity then areas with a high natural disturbance which can result in long term community changes as a result of fisheries. Fisheries in the sheltered areas or areas with low natural disturbance has a larger impact on the ecosystem with a longer recovery time than in areas that are "used" to disturbance from natural causes (Bolam et al., 2014; Rijnsdorp et al., 2016). In addition to Bolam et al. (2014) and Rijnsdorp et al. (2016), Scriberras et al. (2014) made similar statements. Van Denderen et al. (2015) wrote that their results support the hypothesis that trawl and natural disturbance affect benthic communities in similar ways. Both sources of disturbance cause declines in long-living, hard bodied (exoskeleton) and suspension-feeding animals and these effects are likely to affect community

function (Van Denderen et al., 2015). They conclude that high levels of natural disturbance that affect soft-sediment habitats will lead to community compositions and functions that are more resilient to a given level of trawling disturbance than those found in areas with less natural disturbance (Van Denderen et al., 2015). Based on the statements in the articles it was proposed to incorporate the component 'natural disturbance' into Q11. The scores between brackets are the scores to be given in areas with low natural disturbance. It is thought that the fishery action will affect those areas more negatively. Fisheries in areas with a high natural disturbance still got the old score although these systems can cope better with disturbance because fishing is still a stress factor.

Different fishing gears have different impacts on habitats, thus the effect of a certain gear on a certain area highly depends on the area where the gear is used (Van Denderen et al., 2014; Eigaard et al., 2013; Eigaard et al., 2015). These publications did underpin the goal of this question.

3.5.2 Revised Question 11

Q11 **Is the fishing method destructive to particular benthic habitats or habitat forming species within the benthic habitat?** *[Habitat Effect]*

Notes to assessor: Provide references for definition of habitat type.
-In case the habitat types are mixed, scores are to be averaged.
-In case the fishing grounds are known to include at least one sensitive habitat, score accordingly.

Habitat type / Capture method	Sand/ gravel/ mud	Rocky	Biogenic reefs, sponge-beds, seagrass	Seamounts, cold water corals, hydrothermal vents
Pelagic (midwater) trawl, pelagic long-line, spear, harpoon, purse seine, midwater gillnet, pole & line, trolling, hook-and-line	2	2	2	2
Hand-picking	2	2	1	n.a.
Hand raking	1	1	-1	n.a.
Pots, traps	1	0	-1	n.a.
Bottom long-line, bottom set gillnet	1	0	-1	-2
Danish seine, demersal seine, fly-shooting	0 (-1)*	-1	-4	-4
Demersal otter trawl/pulsewing	0 (-1)*	-1	-4	-4
Beam trawl/beam trawl rollers/pulsetrawl	-1 (-2)*	-2	-4	-4
Beam trawl/tickler chains or chain mats	-2 (-3)*	-3	-4	-4
Dredge	-2 (-3)*	-3	-4	-4
Explosives, chemicals & other illegal operations	-5	-5	-5	-5

** The scores between brackets are the scores to be given in areas with low natural disturbance.*

The scores of the lower six rows are based on: (Eigaard et al., 2013; Eigaard et al., 2015; Eigaard et al., 2016; Scriberras et al., 2015; Rijnsdorp et al., 2016; Bolam et al., 2014; Batsleer et al., 2016; Depestele, Ivanovic et al, 2016).

Guidance Document

Goal

Under this question, the physical destruction of habitats by fishing gear is rated to create an incentive for more environmentally friendly fisheries. Different fishing gears affect habitats in different ways and therefore need to be scored differently (Van Denderen et al., 2014; Eigaard et al., 2013; Eigaard et al., 2015). The effect of a certain gear highly depends on the area where it is used (Van Denderen et al., 2014; Bolam et al., 2014).

Definitions

N.A.

Interpreting data

N.A.

Instructions for scoring

Other impacts such as e.g. food chain effects resulting from this physical impact are to be rated under Q10 (Ecosystem Effect). Read habitat type and fishing method from the grid to determine the score.

In case the habitat types are mixed, and some sensitive habitats are known to occur, scores have to be averaged.

If the majority of a fishery operates over a particular habitat, then the corresponding score is to be used.

If a sensitive habitat (e.g. cold water corals as bycatch, or wide distribution of seagrass beds) is impacted, score on the side of caution and give the more conservative score. This is also applicable if no information on the distribution of fishing effort with respect to habitat type is available, but circumstantial information indicates that it is highly likely that fishing takes place over sensitive habitats (e.g. Norwegian coastal waters, where complete seafloor mapping is lacking, but the existing maps show substantial occurrence of cold water corals).

In the case where a present gear modification or use of gear is eligible to mitigate the habitat damage compared to the standard (i.e. unmodified) gear, or when evidence exists that the gear is used in a particularly destructive way (e.g. when purse seines are dragged over the seafloor because bottom trawling is prohibited in this area), please consider this by assigning custom scores. (See 1.3 General assessment instructions -> Custom scores1.3). Keep in mind that these occurrences must be evidenced by adequate by providing scientific references.

However, temporal or regional area closures must not be rated here, since they usually do not cover the entirety of a present vulnerable habitat. Only in cases where a complete seafloor mapping is present and any damage to sensitive habitats is prevented by management measures, a mitigated custom score might be applicable.

The scores between brackets are the scores to be given in areas with low natural disturbance. It is thought that the fishery action will affect those areas more negatively (Bolam et al., 2014; Scriberras et al., 2014; Van Denderen et al., 2015).

Useful Literature

N.A.

3.6 Sensitivity study

The scoring procedure and determination of the colours have been explained in chapter 1.2 of this report and is shortly explained again in the caption of Table 6.

Table 6 Results of the sensitivity study. Score for Category 2 is made by re-assessing the Category 2 questions (for current and revised CAM). Total score is a sum of the redone Category 2 questions and the score for Category 1 & 3 provided by the Good Fish Foundation. All of the scores have been added together according to the Text File Template Only in the Guidance Document (chapter 1.4). The corresponding colour is determined with the help of the scoring tables in the appendix of the CAM (also showed in chapter 1.2 of this report).

Area	Fishery	Current CAM	Score/Colour	Revised CAM	Score/Colour
FAO 27, ICES 25-32, Baltic Sea	*Gadus morhua*; Midwater Otter Trawl (MOT)	Category 2	2	Category 2	2
		Total	2	Total	2
FAO 27, ICES 25-32, Baltic Sea	*Gadus morhua*; Demersal Otter Trawl (DOT)	Category 2	-3	Category 2	-2
		Total	-3	Total	-2
FAO 27, ICES 3A&4, North Sea & Skagerrak	*Pleuronectes platessa*; Beam Trawl (BT)	Category 2	-9	Category 2	-10
		Total	-4	Total	-5
FAO 27, ICES 3A&4, North Sea & Skagerrak	*Pleuronectes platessa*; Pulse Trawl (Pulse)	Category 2	-5	Category 2	-5
		Total	0	Total	0

The results of the first assessment (MOT) showed that the scores of Category 2 did not change nor did the colour. The total score in the revised version remained the same and so did the colour. MOT is a pelagic trawl and the changes in the revised CAM have been made based on BENTHIS (a project on demersal fisheries). Therefore, a change in score of the assessment based on a pelagic fishing method was unexpected.

The results of the second assessment (DOT) showed that the scores of Category 2 did change by one point (+). The colour turned from red to yellow. The total score went from -3 to -2, the colour however remained yellow because the score was still in the yellow range. DOT is a demersal trawl and the +1 score in the revised version relative to the current version has its origins in Q11 of the CAM. The Baltic sea is an area with high natural disturbance so the effect of fisheries disturbance is considered low (ICES, 2008). Therefore a score of 0 was given in the revised assessment instead of the -1 in the current assessment.

The results of the third assessment (BT) showed that the scores of Category 2 did change by one point (-). The colour however remained red because the score was still in the red range. The total score went from -4 to -5, the colour however remained light red because the score was still in the light red range. BT is considered as a destructive demersal gear and the minus one score in the revised version relative to the current version had its origins in Q8 of the CAM. In conventional beam trawling, there is almost no selectivity. Beam trawling causes a lot of unwanted catch which has to be brought on-board (European Commission, 2011). Therefore a lower score was given.

The results of the fourth assessment (Pulse) showed that the scores of Category 2 did not change. The total score in the revised version remained the same and so did the colour. In theory it was expected that the pulse trawl would change a lot in the scoring. However, it turned out that pulse trawl is not that revolutionary and still impacts the seafloor substantially with for example beam shoes.

4 Discussion

According to the research proposal, the first research question should be: Which knowledge is the base of the Category 2 questions in the current Common Assessment Methodology? The answer to this question was fairly simple: none. During the research it turned out that the research as proposed was not in accordance with the reality of the CAM. This was due to the fact that the expected knowledge base on the origin of the CAM did not exist. There was no documented scientific evidence base because the content of the CAM is based on negotiations between several NGO's. Therefore it was decided to take the current CAM as it is, change the first sub question and find out to what extent the knowledge from the BENTHIS project did underpin/affect the Category 2 questions of the CAM. By doing this it was still possible to see how the knowledge of the BENTHIS project could affect the current CAM.

The results of this research are an important step for the CAM. This research added the results of one of the biggest scientific projects on the impacts of demersal fisheries to the CAM. Besides that, this research made a first step in creating a documented scientific evidence base for the CAM. This ensures that the CAM becomes a more reliable and credible assessment document. The Monterey Bay Aquarium manages the Seafood Watch Standard for Fisheries which is a good example of an assessment document which has a comprehensive documented scientific evidence base (Monterey Bay Aquarium, 2016). Besides the documented scientific evidence base they are also transparent by stating that the document is created and changed in cooperation with a multi-stakeholder group (Monterey Bay Aquarium, 2016). Also the Marine Stewardship Council could be taken as an example for transparency and a credible documented scientific evidence base. MSC meets international standards on sustainable fisheries and sets their own standard in an open, transparent and participatory process (Marine Stewardship Council, 2017). Lastly, both MSC and the Seafood Watch Standard publish their assessments on a website. In this way the public/the consumer can see which steps are taken to come to a certain certification or label. The Seafood Watch standard publishes their assessments in the section of their own Seafood guide. The consumer can see the colour and a short summary of the species or click a link and view the complete assessment. As for the CAM and its transparency: during the research it was hard to find documents which contained general information on the CAM (e.g. what was the last revision and what is exactly the scientific evidence base of it/why exactly these changes). Based on those observations it is evident that the Good Fish Foundation needs to be more open and transparent about their processes and link the CAM directly to the FISHguide. Because the origin of the CAM is based on negotiations and transcripts are not available, it is all the more important to at least underpin the chosen topics and designed questions and be open about these choices.

During the literature research and in the selection of knowledge from the BENTHIS publications, the research has been affected by the knowledge of the researchers. Although the researchers have done their utmost best to be precise and consistent, it might be possible that other researchers with more or less expertise on the subject would have made different choices and select different knowledge from the BENTHIS publications. By double checking and peer-reviewing, the above stated problem was mitigated. Both researchers always verified, checked and comprehensively discussed the results of each other with each other.

The results of the literature research showed that out of the five Category 2 questions, the knowledge in the BENTHIS publications did underpin and/or affect three questions the most (Q8, Q10 & Q11). Just one source did underpin each Q7 and Q9. This was as expected because BENTHIS gave a lot of information about the impacts of bottom impacting fisheries including the impacts on habitats, ecosystems and discards and less information on ETP-species or juveniles. It has to be noted that the added scoring options in Q8 could have been scored already through the custom score option in the current CAM, but a more standardised scoring table however is always better to avoid differences in

scoring between assessors. The extra scoring option for high-grading may only be used when no applicable regulation on high-grading is in place. The revised questions of the CAM and the added/changed scores were mainly based on literature. However it is also partly based on expert knowledge and -judgement. When this research would be performed again it is possible that the questions will be revised a little different. To mitigate those problems the revisions were always discussed comprehensively.

The results of the sensitivity study showed that the outcomes of the revised CAM assessments only changed for the assessments on Demersal Otter Trawl and Beam trawl. Nothing changed for the assessments on Pulse Trawl and Midwater Otter Trawl. The changes in outcomes for Demersal Otter Trawl and Beam Trawl were expected because the revisions of the CAM were based on knowledge on bottom impacting/demersal fisheries. Therefore it was thought that the recent knowledge of the BENTHIS project would affect the revised assessments in one way or the other. After reading the publications that were used for Q11 it was already clear that the most affected gears would be Demersal Otter Trawl and Beam Trawl, because BENTHIS had put a lot of effort in those gears already. Also the result for Midwater Otter Trawl was expected because the questions were not revised based on knowledge on pelagic fisheries so a change in a pelagic gear based on knowledge on demersal fisheries would be odd (but not impossible due to the extra scoring options for high-grading and mitigating measures). The outcomes for Pulse Trawl however were not completely as expected because Pulse trawl was absent in the current CAM and thus added to the revised CAM. It was expected that the score would be different based on the new and different scores for Pulse Trawl compared to Beam Trawl (in the current assessment Pulse Trawl was scored under Beam Trawl). It is thought that the positive effect of Pulse Trawl on the environment was overestimated when the sensitivity study was started. The effect of pulse trawl on the environment does differ compared to Beam trawl (heavy tickler chains vs. light electrodes) but not enough to change the score and receive another colour (Pulse Trawl still has the heavy beam shoes for example) (Eigaard et al., 2015; Van Denderen et al., 2014; Depestele, Ivanovic et al., 2016).

It appeared that when the outcomes of the revised assessment changed, these changes were minimal. It can be concluded that the added scoring options (high-grading and mitigating measures) to Q8 are only applicable to assessments of some fisheries. The main reason is lack of information or data in general on these topics. There is, as could be expected almost no specific information available on high-grading within fisheries (only general information). Besides that, scientific literature is not describing any mitigating measures to fisheries in most cases. The main reason might be the fact that mitigating measures are mostly applied on individual scale. However these two scoring options are still of added value. When enough information is available it is good to reward fisheries with lots of mitigating measures and to punish fisheries with high-grading extra. The added examples of significant ecosystem changes to Q10 did not have any effects on the outcomes of the different assessments. It appeared that the added examples were already taken into account in current assessments. However, it still adds to the completeness of the question and might be helpful to junior assessors. The changes made to Q11 had the largest effect on the outcomes of the revised CAM assessments compared to the current CAM assessments. Mainly because a lot of scores in this question changed.

The results of this research just revised the Category 2 questions based on BENTHIS publications. This meant that only knowledge on bottom impacting fisheries was taken into account in revising Category 2 of the CAM. No knowledge on pelagic fisheries was used. Therefore Category 2 of the CAM now has a partial documented scientific evidence base and was revised partially. For this reason this research is a none complete revision of Category 2 of the CAM nor the CAM as a whole (Category 1, 2 and 3). From that point of view it might be right to say that the effectiveness of this research was limited by the BENTHIS project because it focusses solely on demersal fisheries. This research would have been more effective and time efficient if besides the knowledge on demersal fisheries from BENTHIS, also pelagic knowledge was used to revise the Category 2 questions. In this way Category 2 was revised

during one research/revision. With the research in its current form a follow up study is necessary to revise Category 2 as a whole.

Lastly, two possible additions for the CAM were mentioned in the BENTHIS publications but not used to revise the CAM. These two publications were experimental and based on anecdotal evidence. It was decided not to use this during the research. However, the publications are relevant for the CAM and especially useful if more evidence is available in the future. Therefore these possible additions are mentioned briefly below.

- Topic- recovery rates: At the moment there is general information on recovery rates but in the future these specific rates will be a topic of research (ICES, 2016). It is thought that in the future specific recovery rates will be found. In order to specify the sustainability of a fishery it is important to know the recovery of a species or ecosystem after the impact of fishing. A report that might be useful is the ICES 'Report of the Workshop on guidance on how pressure maps of fishing intensity contribute to an assessment of the state of seabed habitats (WKFBI)'. If there is more information on specific recovery rates available, it is thought that recovery rates could be added to the CAM.
- Tool- RBS: A recent study of Pitcher et al. (2016) developed a quantitative method for assessing the risks to benthic habitats by towed bottom-fishing gears. "The method is based on a simple equation for relative benthic status (RBS), derived by solving the logistic population growth equation for the equilibrium state. Estimating RBS requires only maps of fishing intensity and habitat type — and parameters for impact and recovery rates, which may be taken from meta-analyses of multiple experimental studies of towed-gear impacts" (Pitcher et al., 2016). This tool can help assessing the impact of fisheries on the benthic ecosystem and it is thought that RBS could be added to the CAM to examine the sustainability of a fishery in more detail.

5 Conclusion

The BENTHIS project has produced 59 publications of which 20 proved to be useful for this research. Fifteen publications did underpin the CAM especially on the topics of discarding, retained catch, impact on the ecosystem and impact on the habitat. Thirteen publications did affect the CAM. New insights on mixed fisheries, discards, gear efficiency, impacts of gears and biological traits of certain species did affect the CAM. Some of the publications did both underpin and affect the CAM. To include the knowledge of the BENTHIS project, several adjustments to the Category 2 questions were made. Q7 and Q9 were not changed (content wise) based on results of the BENTHIS project. Q8 has got two extra scoring options to enlarge the incentive for sustainable fisheries. Several publications from the BENTHIS project did underpin Q10. Lastly, Q11 has got extra scoring options and the already existing scoring options have been restructured. The guidance document was also restructured to enlarge clarity. The results of the sensitivity study showed not much differences between the current and revised versions of the CAM. The Category 2 scoring of Demersal Otter Trawl changed (from -3 to -2) and the total scoring of Beam Trawl changed (from -4 to -5). The scorings for Midwater Otter Trawl and Pulse Trawl remained unchanged. The effect of the changes in the revised CAM on the scorings are therefore marginal. Because there is no documented scientific evidence base for the CAM, and the process of assessing fisheries is not publicly available, the transparency and credibility of this assessment methodology are affected. Also the research was affected by the absence of this documented scientific evidence base and one of the sub questions had to change during the research. However, this did not mean that this research could not deliver what it promised to deliver: revise the CAM based on the BENTHIS project. Based on the current research it can be concluded that, BENTHIS publications did underpin and/or affect the Category 2 questions of the CAM in 20 of the 59 publications. The sensitivity study showed two assessed fisheries changed in scoring of which one assessed fishery changed in colour. The revised version did not affect the outcomes of the CAM Assessments in a considerable way.

6 Recommendations

In order to revise the Common Assessment Methodology based on the BENTHIS project, several recommendations can be made. It is believed that these recommendations can lead to a satisfying way of revising the CAM and to resolve the presented issues in this report.

It is recommended to take the transparency and participatory processes of the Seafood Watch Standard for Fisheries and the MSC Standard as an example for the CAM. Those two seafood standards are transparent about their work, have documented scientific evidence bases and rely on stakeholder forums. To make this recommendation more manageable, it is split up in sub recommendations.

1. First and foremost it is recommended to create a documented scientific evidence base for the complete CAM and make this publicly available, rather sooner than later. Without a documented scientific evidence base or open communication about the origin of the CAM, the credibility of the CAM is undermined.
2. Secondly it is recommended to make the process of revising the CAM more transparent by publishing the earlier versions of the CAM on the website and explain why changes were made.
3. Thirdly it is recommended to make the results of the CAM visible and transparent. Publish the results of the CAM assessments on the website and link them to the FISHguide. Consumers and retailers are using the FISHguide so why not informing them in more detail about the origin of the colours in the FISHguide and the scoring process in the CAM.
4. Fourthly it is recommended to establish a multi-stakeholder forum which is engaged in future revisions of the CAM. In establishing this multi-stakeholder forum, the transparency and credibility of the CAM will enlarge because all the sectors (e.g. NGO's, fishermen, the industry, retailers and policy makers) are contributing to the CAM instead of one sector (NGO's). Discussions or negotiations in this multi-stakeholder forum should be documented and published together with the future revisions of the CAM. In this way it is clear based on which criteria or negotiations the revisions were made.

Fifthly it is recommended to revise the Category 2 questions based on the proposal in this report. These revisions entail all the important results of the BENTHIS project. However, BENTHIS focuses on demersal fisheries and the CAM focuses on both demersal and pelagic fisheries. Therefore: include a review of the pelagic part of the Category 2 questions.

Sixthly it is highly recommended to structure the Guidance Document in the manner that is proposed in chapter 2.2 (and already been incorporated in Chapter 3 in the 'Revised Guidance Document' sections). As stated earlier in chapter 2.2: the Guidance Document is confusing. Every question has another structure or has other headings which is confusing.

Lastly it is recommended to add recovery rates as a new topic to the CAM and to add RBS (relative benthic status) as a new tool to the CAM. This topic and tool are based on BENTHIS publications but have only anecdotal evidence of prove. These suggestions might be important/useful in the future when more evidence is available.

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The Common Wild Capture Fishery Methodology

Methodology developed with scientific advice from Thünen Institute of Baltic Sea Fisheries

Version 4.01

Unit of Assessment

Scientific Name	
English Name	
(FAO) Area of capture	FAO
Country, Province, State (within EEZ)	
Stock, ICES Area	
Capture method	
Management authority	

Picture	*[place for species picture]*

Score: Total Assessment Score*:

**Scoring guidepost: see APPENDIX. Please insert scoring points and corresponding colour in the respective boxes*

Individual Category Score*:

1. Target Stock		2. Ecological Effects of Fishery:		3. Management:	

MSC available?	Yes/No/in certification	*Details*
FIP available?	Yes/No	*Details*

Assessment Details

Current Assessment	Status	DRAFT / FINAL	Date		
Assessor (Name/Organisation)					
Cross-checker (Name/Organisation)					
Previous Assessment	Date:		Score:		

Assessor (Name/Organisation)	
Cross-checker (Name/Organisation)	

Summary	[place for summary / text must comply with master list]

Main references	[place for references which are cited in more than one question]

Preamble

A Guidance Document with comprehensive additional information as well as useful links and references is available as a separate document. The Guidance Document provides detailed information on the interpretations of the questions.
PLEASE NOTE: Assessors **must** take **the entire Guidance Document** into due consideration!

Disclaimer

This assessment is carried out by a qualified assessment team composed of experienced fisheries biologists from the nature conservation organizations WWF, NSF, and associated institutions. The information provided in this assessment has been collected according to high scientific standards. All judgments are delivered independently of commercial interests. This is an assessment methodology to indicate the relative sustainability of a fishery. This methodology is not a certification of sustainability, nor does it allow the fishery or retailer to make any claims about the species or stock or a certain product. This is a desk-based assessment. Each assessment undergoes a quality control (cross-check) regarding consistency by a member of the assessment team. However, no rights whatsoever can be based upon the advice. This methodology is not to be used by third parties without consulting the WWF Global Seafood Coordinator.

Note to assessor: Place for background information on Unit of Assessment you might want to add, like biology, stock status, fishery, catches/landings

CATEGORY 1: **STOCK STATUS AND BIOLOGY**

Depending on the available amount of information, there are 3 possible tracks on which the stock status is rated. Question 1 sets the course which track is applicable.

Q1 Are adequate* stock assessments of the target stock available?

**Adequate = State of the art stock assessment not older than 3 years*
If the current assessment is older than 3 years, go to Track B.

0		Detailed fishery data is available AND a reliable quantitative stock assessment is conducted on a regular basis AND reference points are defined	→ **Track A** (QA2-A6)
0		Substantial fishery data is available, but no reference points are defined OR reference points are defined but a recent quantitative stock assessment is lacking	→ **Track B** (QB2-B5)
0		Little or no fisheries data AND no stock assessment AND no reference points are available OR [*Bycatch*]: Species is not targeted directly - it is taken as bycatch which is retained/landed**	→ **Track C** (QC2-C5)

***Bycatch species which are not appropriately managed in a species-specific manner. If fishery data is available, go to track A or B, respectively.*

Annotations

References

TRACK A*/data-rich.* *Scientific assessments available and reference points defined.*

QA2 Are limit AND target reference points for fishing mortality (F) and spawning stock biomass (SSB) implemented by the responsible management authority?

TRACK A

1		YES - Limit reference points (LRPs)* AND target reference points (TRPs)** or proxies for these are implemented
0		NO – Either target OR limit reference points are not implemented

**e.g. Bmsy-trigger, Fmsy OR Bpa, Blim, Fpa, Flim*
***e.g. Bmsy, Fmgt, Ftarget*

Annotations

References

QA3 Is the target species` spawning stock biomass (SSB) above reference points?

TRACK A

2		Spawning stock biomass is above target level: SSB>Bmsy
1		Spawning stock biomass is above trigger (ICES sense): SSB>Bmsy-trigger
0		Spawning stock biomass is above precautionary reference point: SSB>Bpa
-1		Spawning stock biomass is below trigger (SSB<Bmsy-trigger) if no precautionary reference points are defined, OR between limit and precautionary reference points (Blim≤SSB≤Bpa) [*At increased risk**]
-2		Spawning stock biomass is below limit reference point: SSB<Blim OR SSB<0,5 Bmsy as a proxy if Blim is not defined [*Suffering reduced reproductive capacity**]

** According to ICES definition*

Annotations

References

QA4 Is the fishing mortality (F) of the target stock below reference points?

TRACK A

2		Fishing mortality is around F target (if that is lower than Fmsy)
1		Fishing mortality is below Fmsy OR - if Fmsy is not defined or equal to Fpa - below precautionary reference point: F<Fpa [*Harvested sustainably**]
0		Fishing mortality is above Fmsy but well below limit reference point (if no Fpa is defined): Fmsy≤F<<Flim OR: F≈Fpa
-1		Fishing mortality is between limit and precautionary reference points (ICES sense) (Fpa<F<Flim) [*At increased risk **]
-2		Fishing mortality is above limit reference point: F≥Flim [*Harvested unsustainably*, overfishing occurring]*

** According to ICES definition*

Annotations

References

QA5 Is the scientific advice adequately defined and, if implemented, will likely ensure to maintain the long-term productivity and/or the recovery of the stock?

TRACK A

0		YES – The scientific advice is adequately defined	→ Proceed to QA6
-2		NO – The scientific advice is not adequately defined and/or will likely lead to stock decline	→ Do not continue with other questions in Category 1

Annotations

References

QA6 Are the regulatory measures to control fishing mortality or stock size* determined in accordance with the corresponding scientific advice** AND met by the current catches?

TRACK A

** This may be either TAC/quota or an effort management system of temporal and/or spatial closures, effort restrictions, etc. Consider existing long term management plans (LTMP) and/or Harvest Control Rules (HCR)*

***State of the art scientific advice not older than 3 years.*

2		YES – Measures are in accordance with the scientific advice AND effectively implemented AND compliance is evidenced
1		Measures are in accordance with the scientific advice AND will likely ensure to maintain the long-term productivity and/or the recovery of the stock
0		Regulatory measures to control stock size are not defined OR measures are implemented but effectiveness is uncertain OR stock status is healthy despite the absence of specific management measures
-1		NO – Measures are not in accordance with the scientific advice but effectively implemented, OR measures are in accordance with the scientific advice but not

		effectively implemented, OR a LTMP is in place but is unlikely to ensure the long-term productivity of the stock, OR catches in relation to regulatory measures and/or scientific advice are unknown
-2		NO – Measures are not in accordance with the scientific advice AND measures are not effectively implemented (e.g. target values are exceeded by the fishery)

Annotations

References

TRACK B/*data-moderate.* *Substantial fishery data available, but no reference points defined.*

QB2

TRACK B

How precise is the available fishery-specific information*?

**E.g. landings, total catch (including CPUE), fishing effort, size/age distribution.*
Note to assessor: Consider only data sources that are relevant for the UoA (e.g. no CPUE for pelagic stocks)

1		The available data is detailed enough to allow for a solid and comprehensive description of the stock
0		Not all of the above mentioned parameters can be described with sufficient accuracy

Annotations

References

QB3

TRACK B

Do fishery-specific data indicate that the target stock is in good condition with regard to biomass?

1		YES - Stock is in good condition or underfished
0		YES - Stock is appropriately used or fully fished
-1		Stock size is uncertain OR unknown
-2		NO - Stock is overfished

Annotations

References

QB4

TRACK B

Do fishery-specific data indicate that the fishing rate is appropriate to sustain the long-term yield in the future?

1		YES – Stock is fished at a rate likely to maintain stock at, or increase stock towards, good condition *[overfishing is not occurring]*
-1		Stock is fished at a rate that risks maintaining stock at, or decreasing stock towards unsustainable levels *[at risk of overfishing]* OR fishing rate on the target stock is unknown
-2		NO – Stock is fished at a rate that is reducing stock to unsustainable levels, OR is preventing recovery of depleted stock *[overfishing is occurring]*

Annotations

References

QB5

TRACK B

Do management measures* exist that will likely ensure the long-term productivity and/or the recovery of the stock?

**Management measures could be e.g. Total allowable catch (TAC), fishing effort, technical measures*
Note to assessor: Please account for Table 7/Guidance Document

2		Management of target stock is fully effective

0		Management of target stock is partly effective OR stock status is healthy despite the absence of specific management measures
-1		Management of target stock is marginally effective OR: Effectiveness of management of target stock is unknown
-2		Management of target stock does not exist OR is not effective

Annotations

References

TRACK C/*data-deficient.* *Very limited or no fishery specific data is available on target fish stock* ***OR (Bycatch):*** *Species is only caught incidentally (non-target species) and retained/landed*

QC2

TRACK C

Is there credible, up-to-date evidence that the stock is at biological risk?

0		NO - The species is not listed as Threatened or Endangered* on any international or domestic list** AND there are no other indications that the species is at biological risk
-1		YES - The species is listed as Threatened* on at least one list**
-2		YES - The species is listed as Endangered* on at least one list**

**For Categories Threatened or Endangered, please refer to Table 8/Guidance Document*

***List Examples: IUCN Red List, CITES Appendices, OSPAR, China Red List, US Endangered Species Act, Canadian Species at Risk Act, European Habitat Directive, national or domestic lists.*

Annotations

References

QC3

TRACK C

Does the species have a growth rate, age at maturity, or maximum age that makes it particularly vulnerable to fishing pressure?

Note to Assessor: Use preferably stock specific information rather than species specific information

Parameters for evaluation (only valid for fish species):

Vulnerability	*VB*-growth parameter K (*yr^{-1})*	*Age at first maturity (tm)*	*Maximum age (tmax)*
Low	*K≥ 0,30*	*<3 years*	*< 8 years*
Moderate	*0,15 < K < 0,30*	*3-6 years*	*8-20 years*
High	*K ≤ 0,15*	*>6 years*	*> 20 years*

1		NO - Species has a low vulnerability to fishing pressure
0		YES - At least 2 of the listed factors indicate that the species is moderately vulnerable to fishing pressure
-1		YES - At least 1 of the listed factors indicate that the species is highly vulnerable to fishing pressure OR the details of species` biology are not available
-2		YES - At least 2 of the listed factors indicate that the species is highly vulnerable to fishing pressure

** VB: von Bertalanffy*

Annotations

References

QC4

TRACK C

Does the species exhibit any inherent life history characteristics* that make it particularly vulnerable to fishing pressure?

**Traits to consider: (1) Schooling, (2) other temporary aggregations (spawning, feeding, or diurnal), (3) Geographic distribution – a very limited range or scattered distribution or patchy distribution or isolated subpopulations or restricted mobility, (4) Diadromous (anadromous or catadromous), (5) Semelparous or viviparous reproduction, (6) Sequential hermaphrodit , (7) Other (e.g. high natural population variability (for example: El Nino or decadal oscillations), naturally rare, highly migratory, complex life cycle).*

1		NO - The species exhibits none or 1 of the listed parameters *[Species is resilient to fishing pressure]*

0		YES - The species exhibits 2 of the listed parameters *[Species is moderately vulnerable to fishing pressure]*
-1		YES - The species exhibits 3 of the listed parameters *[Species is vulnerable to fishing pressure]* OR there is insufficient evidence that the species exhibits any of the listed characteristics
-2		YES - The species exhibits more than 3 of the listed parameters *[Species is particular vulnerable to fishing pressure]*

Annotations

References

QC5 **TRACK C**

Will the current fishing practice likely reduce the stock to unsafe levels*?

1		NO - Current fishing practice is likely to maintain maximum productivity of the stock
0		NO - Current fishing practice does not threaten the target stock
-1		YES - There are indications that current fishing practice might threaten the target stock OR not enough information for evaluation
-2		YES - Current fishing practice threatens the target stock

** E.g. due to the gear used or the range or the coverage of the fishing activity.*

Annotations

References

CATEGORY 2: **ECOLOGICAL EFFECTS OF THE FISHERY**

Q7

Does the fishery negatively impact* any species (fish and non-fish) that is listed as threatened, endangered or protected (ETP) OR overfished OR biologically highly vulnerable***?**

** Impacts only to be considered on population level*

*** List examples as of QC2*

**** Highly vulnerable species: e.g. selected species of elasmobranchs, demersal deep sea finfish (e.g. of the families Macrouridae, Sebastidae, Trachichthyidae)*

2		NO - The fishery under assessment does not cause significant damage to any listed, overfished, or highly vulnerable species
0		NO - The fishery under assessment is not likely to cause significant damage to any listed, overfished, or highly vulnerable species
-1		There is no OR conflicting information concerning the effects on listed, overfished, or highly vulnerable species
-2		YES - The fishery under assessment is likely to cause significant damage to some listed, overfished, or highly vulnerable species
-3		YES - The fishery under assessment causes significant damage to any listed, overfished, or highly vulnerable species

Annotations

References

Q8

Does the fishery generate discards?

Note to assessor: Only use the categories "low", "moderate" or "high" when no other information is available

… by weight	<5%	5-15%	15-30%	>30%	unknown
…referenced in a scientific report as:	low	moderate	high	very high	
High survival rate*	1	0	-1	-2	-1
Low** or unknown survival rate	0	-1	-2	-3	-2

** High survival rate: over 75% of each discarded species survive*

*** Low survival rate: less than 75% of discarded species survive*

Annotations

References

Q9

Does the retained catch contain juveniles* or non-target species?

**Juveniles = individuals (target AND non-target species) which are smaller or younger than the length or age where 50% of the individuals of that specific stock are considered mature.*

Percentage of catch is by weight. Assessors should be conservative when looking at juveniles given low weight relative to adults.

1		NO - The retained catch contains no (or <5%) juveniles AND no (or <5%) non-target species *[selective catch method]*

0		YES - The retained catch contains 5-30% juveniles AND no (or <5%) non-target species OR the landed catch contains 5-30% non-target species AND no (or <5%) juveniles
-1		YES - The retained catch contains 5-30% juveniles AND 5-30% non-target species OR there is not enough information for evaluation
-2		YES - The retained catch contains >30% juveniles AND/OR non- target species *[non-selective catch method, e.g. trawling, dredging, FAD associated seine]*

Annotations

References

Q10

Does the intensity of the fishery result in significant negative ecosystem changes*, such as cascade effects, major food chain effects, or community changes? *[Ecosystem Effect]*

**Examples of significant ecosystem changes:* Significantly increased abundance of species with a low trophic level caused by depletion of predators. OR Depletion of top predators as a result of the decrease of key prey species. OR Truncated size composition of the ecological community. OR Major changes in the species biodiversity of the ecological community. OR Changes in the genetic diversity of a stock that lead to changes of e.g. growth or reproduction of the species. OR Destruction of key biogenic/habitat-forming species.*

1		NO - The fishery is not causing significant negative ecosystem changes
0		Negative ecosystem changes caused by the fishery are unlikely OR the likelihood of impact cannot be determined because there is conflicting, inconclusive, or insufficient information
-1		YES - Significant negative ecosystem changes are likely *[circumstantial evidence]*
-2		YES - The fishery is causing significant negative ecosystem changes *[direct evidence]*

Annotations

References

Q11

Is the fishing method destructive to particular benthic habitats or habitat forming species within the benthic habitat? *[Habitat Effect]*

Notes to assessor: Provide references for definition of habitat type.
In case the habitat types are mixed, scores are to be averaged.
In case the fishing grounds are known to include at least one sensitive habitat, score accordingly.

Habitat type / Capture method	Sand/ gravel/ mud	Rocky	Biogenic reefs, sponge-beds, seagrass	Seamounts, cold water corals, hydrothermal vents
Pelagic (midwater) trawl, pelagic long-line, spear, harpoon, purse seine, midwater gillnet, pole & line, trolling, hook-and-line	2	2	2	2
Hand-picking	2	2	1	n.a.
Hand raking	1	1	-1	n.a.
Pots, traps	1	0	-1	n.a.
Bottom long-line, bottom set gillnet	1	0	-1	-2
Danish seine, demersal seine, fly-shooting	0	-1	-3	-3
Beam trawl/beam trawl rollers, demersal otter trawl	-1	-2	-3	-3
Beam trawl/tickler chains or chain mats	-2	-3	-3	-3
Dredge	-2	-3	-3	-3
Explosives, chemicals & other illegal operations	-5	-5	-5	-5

Annotations

References

CATEGORY 3: **MANAGEMENT**

Q12 Is there a management system* in place for the fishery under assessment?

**A management system may be anything ranging from fully regulated to completely voluntary and/or small scale.*

0		YES - A management system is in place	→ Proceed to Q13
-2		NO - A management system is not in place OR a management system is in place, but the details are not available	→ Do not continue with other questions in Category 3
-4		NO - A management system is not in place but there are indications that it would be urgently required	→ Do not continue with other questions in Category 3

Annotations

References

Q13 Are the established management measures for the fishery under assessment effective in maintaining the integrity of the habitat and ecosystem AND in maintaining the long-term productivity of all impacted species?

Procedure: Highlight the appropriate box for each issue. ***The points don´t go directly in the total assessment score****, but they are aggregated in the* ***"score" section*** *below.*

ISSUE	**1. Relevance**		**2. Effectiveness**				
	Is this issue relevant to the fishery under assessment?						
(Q no. relates to question above)	**No** *[Do not continue in this row]*	**Yes** *[Proceed to column 2]*	Fully effective	Largely effective	Partly effective	Marginally effective OR effectiveness unknown	Not effective
ETP species* *(Q7)*			100	75	50	25	0
Discard (*Q8)*			100	75	50	25	0
Unwanted bycatch *(Q9)*			100	75	50	25	0
Ecosystem effect** *(Q10)*			100	75	50	25	0
Habitat effect*** (*Q11)*			100	75	50	25	0
Monitoring/data availability****		**X**	100	75	50	25	0
Mixed fishery			100	75	50	25	0
IUU, misreporting			100	75	50	25	0
Compliance, enforcement			100	75	50	25	0
Transparency, participation			100	75	50	25	0
Others (*please specify*)			100	75	50	25	0

* *Endangered, threatened or protected OR overfished OR biologically highly vulnerable species*

** *Ecosystem effect: refer to definition given in Q10*

*** *Habitat effect = Impact on habitat and habitat forming animals, e.g. corals*

*****Issue must be rated mandatorily*

SCORE: *Notes to Assessor: Determine the score by calculating the arithmetic mean (i.e. add the points from above and divide the sum by the number of relevant issues chosen. [Example: 4 issues chosen with 75+75+75+25=250 points. 250/4=62,5 → SCORE 0]. Insert the result in the respective box below.*

4		SCORE 90-100: Management is effective
2		SCORE 65-89: Management is largely effective
0		SCORE 40-64: Management is partly effective
-2		SCORE 15-39: Management is marginally effective OR there is insufficient information to a assess effectiveness
-4		SCORE 0-14: Management is not effective

Annotations

References

Q14 **Is there an ecosystem-based management (EBM)* plan or approach in place?**

** For the definition of EBM, please refer to the Guidance document.*

1		YES - An EBM is implemented effectively
0		YES - An EBM is currently at the state of implementation OR singular measures aiming specifically at the integrity of the ecosystem are in place and effective
-1		NO - Steps have not been taken to implement an EBM

Annotations

References

FISHERY IMPROVEMENT MEASURES

The following questions do not count to the overall scoring. Data are needed for informational purposes only.

FIP **Is the fishery under assessment taking part in a Fishery Improvement Program (FIP)?**

	YES - The fishery/a part of the fishery is taking part in a FIP	Indicate share of the fisherv in FIP (e.g. as percentage or number of vessels)
	NO - The fishery is not taking part in a FIP	

Annotations

References

MSC **Is the fishery under assessment applying for MSC certification?**

	YES - The fishery/a part of the fishery is MSC certified	Indicate landings of the certified fishery as percentage of the total landings in the UoA
	The fishery/a part of the fishery is in the full assessment process for MSC certification	
	NO - Efforts to apply for MSC-certification have not been taken OR a pre-assessment has been undertaken, but no further steps have been taken	

Annotations

References

APPENDIX: Scoring Guidepost

Individual Category Scoring

Category	Red	Yellow	Green
1. Stock Status, Biology	≤(-3)	(-2)-2	≥3
2. Ecological Effects of Fishery	≤(-3)	(-2)-1	≥2
3. Management	≤(-2)	(-1)-1	≥2

Total Assessment Scoring

	Red	Light Red	Yellow	Light Green	Green
Total Assessment Score	≤(-8)	(-4)-(-7)	(-3)-3	4-6	≥7

Appendix II BENTHIS publications (underpin/affect)

D = Deliverable
A = Peer reviewed publication

Question 7

BENTHIS publications that Underpin
Brcic, J., Herrmann, B., De Carlo, F., & Sala, A. (2015). Selective characteristics of a shark-excluding grid device in a Mediterranean trawl. *Fisheries Research*, *172*(2015), 352-360. doi:10.1016/j.fishres.2015.07.035 **(A)**

BENTHIS publications that Affect
N.A.

Question 8

BENTHIS publications that Underpin
Batsleer, J., Rijnsdorp, A. D., Hamon, K. G., Van Overzee, H. M. J., & Poos, J. J. (2016). Mixed fisheries management: Is the ban on discarding likely to promote more selective and fuel efficient fishing in the Dutch flatfish fishery? *Fisheries Research*, *174*(2016), 118-128. doi:10.1016/j.fishres.2015.09.006 **(A)**
Batsleer, J., Hamon, K. G., Van Overzee, H. M. J., Rijnsdorp, A. D., & Poos, J. J. (2015). High-grading and over-quota discarding in mixed fisheries. *Reviews in Fish Biology and Fisheries*, *25*, 715-736. doi:10.1007/s11160-015-9403-0 **(A)**
Depestele, J., Rochet, M. J., Dorémus, G., Laffargue, P., & Stienen, E. W. M. (2016). Favorites and leftovers on the menu of scavenging seabirds: modelling spatiotemporal variation in discard consumption. *Canadian Journal of Fisheries and Aquatic Sciences*, *73*(9), 1446-1459. doi:10.1139/cjfas-2015-0326 **(A)**

BENTHIS publications that Affect
Batsleer, J., Rijnsdorp, A. D., Hamon, K. G., Van Overzee, H. M. J., & Poos, J. J. (2016). Mixed fisheries management: Is the ban on discarding likely to promote more selective and fuel efficient fishing in the Dutch flatfish fishery? *Fisheries Research*, *174*(2016), 118-128. doi:10.1016/j.fishres.2015.09.006 **(A)**
Walker, N. D., Maxwell, D. L., Le Quesne, W. J. F., & Jennings, S. (2017). Estimating efficiency of survey and commercial trawl gears from comparisons of catch-ratios. *ICES Journal of Marine Science*, *2017*, 1-10. doi:10.1093/icesjms/fsw250 **(A)**
Guillen, J., Macher, C., Merzéréaud, M., Fifas, S., & Guyader, O. (2014). The effect of discards and survival rate on the Maximum Sustainable Yield estimation based on landings or catches maximisation: Application to the nephrops fishery in the Bay of Biscay. *Marine Policy*, *50*, 207-214. doi:10.1016/j.marpol.2014.06.005 **(A)**
Batsleer, J., Hamon, K. G., Van Overzee, H. M. J., Rijnsdorp, A. D., & Poos, J. J. (2015). High-grading and over-quota discarding in mixed fisheries. *Reviews in Fish Biology and Fisheries*, *25*, 715-736. doi:10.1007/s11160-015-9403-0 **(A)**

Question 9

BENTHIS publications that Underpin
Batsleer, J., Rijnsdorp, A. D., Hamon, K. G., Van Overzee, H. M. J., & Poos, J. J. (2016). Mixed fisheries management: Is the ban on discarding likely to promote more selective and fuel efficient fishing in the Dutch flatfish fishery? *Fisheries Research*, *174*(2016), 118-128. doi:10.1016/j.fishres.2015.09.006 **(A)**

BENTHIS publications that Affect
N.A.

Question 10

BENTHIS publications that Underpin
Eigaard, O. R., Breen, M., Mortensen, L. B., Dinesen, G., Sørensen, T. K., Jonsson, P., . . . Rijnsdorp, A. D. (Eds.). (2013). *Deliverable 1.1b Benthic impact from the perspective of the fisheries*. IJmuiden, the Netherlands: BENTHIS/IMARES. **(D)**
Scriberras, M., Hiddink, J. G., Hughes, K. M., Kneafsey, B. M., Kaiser, M. J., Bolam, S., . . . Kalogeropoulou, V. (Eds.). (2014). *Deliverable 4.3 Predicting the effect of trawling based on biological traits of organisms and functional correlates of these traits to predict which functions may be disproportionally affected*. IJmuiden, the Netherlands: BENTHIS/IMARES. **(D)**
Johnson, A. F., Gorelli, G., Jenkins, S. R., Hiddink, J. G., & Hinz, H. (2015). Effects of bottom trawling on fish foraging and feeding. *Proceedings of the Royal Society B*, *282*(1799), 1-10. doi:10.1098/rspb.2014.2336 **(A)**
Pommer, C. D., Olesen, M., & Hansen, J. L. S. (2016). Impact and distribution of bottom trawl fishing on mud-bottom communities in the Kattegat. *Marine Ecology Progress Series*, *548*, 47-60. doi:10.3354/meps11649 **(A)**
Lambert, G. I., Jennings, S., Kaiser, M. J., Davies, T. W., & Hiddink, J. G. (2014). Quantifying recovery rates and resilience of seabed habitats impacted by bottom fishing. *Journal of Applied Ecology, 51,* 1326-1336. doi:10.1111/1365-2664.12277 **(A)**
Collie, J., Hiddink, J. G., Van Kooten, T., Rijnsdorp, A. D., Kaiser, M. J., Jennings, S., & Hilborn, R. (2016). Indirect effects of bottom fishing on the productivity of marine fish. *Fish and Fisheries*, *17*(4), 1-19. doi:10.1111/faf.12193 **(A)**
Hiddink, J. G., Moranta, J., Balestrini, S., Sciberras, M., Cendrier, M., Bowyer, R., . . . Hinz, H. (2016). Bottom trawling affects fish condition through changes in the ratio of prey availability to density of competitors. *Journal of Applied Ecology*, *53*(5), 1500-1510. doi:10.1111/1365-2664.12697 **(A)**

BENTHIS publications that Affect
Pommer, C. D., Olesen, M., & Hansen, J. L. S. (2016). Impact and distribution of bottom trawl fishing on mud-bottom communities in the Kattegat. *Marine Ecology Progress Series*, *548*, 47-60. doi:10.3354/meps11649 **(A)**
Hiddink, J. G., Moranta, J., Balestrini, S., Sciberras, M., Cendrier, M., Bowyer, R., . . . Hinz, H. (2016). Bottom trawling affects fish condition through changes in the ratio of prey availability to density of competitors. *Journal of Applied Ecology*, *53*(5), 1500-1510. doi:10.1111/1365-2664.12697 **(A)**

Question 11

BENTHIS publications that Underpin
Eigaard, O. R., Breen, M., Mortensen, L. B., Dinesen, G., Sørensen, T. K., Jonsson, P., . . . Rijnsdorp, A. D. (Eds.). (2013). *Deliverable 1.1b Benthic impact from the perspective of the fisheries*. IJmuiden, the Netherlands: BENTHIS/IMARES. **(D)**
Eigaard, O. R., Bastardie, F., Dinesen, G. E., Sorensen, J. R. N. T. K., Hintzen, N. T., Rijnsdorp, A. D., . . . Zengin, M. (Eds.). (2015). *Deliverable 2.2 Peer review paper on definition and parameterisation of impact proxies based on gear and vessel data from Industry surveys*. IJmuiden, the Netherlands: BENTHIS/IMARES. **(D)**
Scriberras, M., Hiddink, J. G., Hughes, K. M., Kneafsey, B. M., Kaiser, M. J., Bolam, S., . . . Kalogeropoulou, V. (Eds.). (2014). *Deliverable 4.3 Predicting the effect of trawling based on biological traits of organisms and functional correlates of these traits to predict which functions may be disproportionally affected*. IJmuiden, the Netherlands: BENTHIS/IMARES. **(D)**

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