ICES WGINOSE REPORT 2018

INTEGRATED ECOSYSTEM ASSESSMENTS STEERING GROUP

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REF ACOM AND SCICOM

Interim Report of the Working Group on Integrated Assessments of the North Sea (WGINOSE)

16-20 April 2018

ICES Headquarters, Denmark

ICES
International Council for the Exploration of the Sea

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International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Contents

Executive summary

WGINOSE met at ICES HQ on 16–20 April, 2018. This was the second year for the group addressing its multi-annual ToRs (see below). The focus of the meeting was to continue to develop ToR D through the development of North Sea conceptual ecosystem models to support strata specific management and advice. This in part was achieved by participating in several intersessional workshops aimed at defining the structure of the models in consultation with different end-users. Work was also progressed in relation to ToR C to assess a full range of human activities and pressures.

Overall progress has been good, mainly as a result of working with other expert groups and seeking their input throughout the year, notably; WGMARS, WGNARS, WGIPEM, WGS2D, but participation at WGINOSE by individual experts continues to be low and more work is needed to convince certain relevant groups of the value, purpose, and role of WGINOSE specifically and in general the IEA groups as a whole.

Moving forward it will be important to ensure that the scope of the strata specific conceptual models and tools being developed have the endorsement through co-development of a wider group of ICES expertise. This is a task, which we intend to pursue through writing papers and presenting work at the ASC, as well as making individual representations at relevant ICES expert groups

A key outcome was the prioritization of the North Sea strata for the development of conceptual models, a process that recognized the Skagerrak as the most fishing strata. Accordingly, it was suggested that an informal workshop over two days sometime between 22 October and 2 November at ICES HQ would be useful in defining the components and model structure for the Skagerrak ecosystem. This would be achieved by inviting experts to join the workshop.

The next meeting will be held at SLU in Gothenburg on 6–10 May 2019 to further refine the Skagerrak model and to initiate a dialogue with relevant stakeholders from the region.

1 Administrative details

Working Group name

Working Group on Integrated Assessment of the North Sea (WGINOSE)

Year of Appointment within the current cycle

2016

Reporting year within the current cycle (1, 2 or 3)

2

Chair(s)

Erik Olsen, Norway

Andrew Kenny, UK

Meeting venue

Copenhagen, Denmark

Meeting dates

16–20 March 2018

2 Terms of Reference a) – e)

a) Update strata specific ecosystem trends analysis utilizing data from ICES Data Centre and other data sources, e.g. CPR, OSPAR, EEA, and Member States.

b) Identify and develop additional strata and associated monitoring programmes for the inshore/coastal areas of the North Sea and the Norwegian Trench.

c) Establish data pathways and obtain data to operationalize the integration of human activity and pressure data, distinguishing between fixed structures (e.g. pipelines, windfarms) and ongoing activities (e.g. dredging, fishing, shipping, underwater noise, litter), accidents (emergency response).

d) Develop strata specific decision support tools to support ecosystem management and advice (e.g. BBNs and expert systems, ecosystem models, ecosystem goods and services modelling) in collaboration with end-users (OSPAR, DG-ENV, DG-MARE)

e) Contribute to the coordination and integration of strata specific assessments with the development of integrated ecosystem monitoring in the North Sea, e.g. redesign of the Q3 IBTS surveys.

3 Summary of Work plan

Year 1	The first year will focus on completing the assessment of North Sea strata structure and functions analysis as well as preparing a draft paper to be submitted in a peer review journal "appropriate spatial scales for North Sea Integrated Ecosystem Assessments".
Year 2	Mapping of human activity pressures data at scales appropriate to assessment strata in the North Sea, and to operationalize processes for updating the inclusion of such data on an annual basis.
Year 3	Finalization of modelling approaches to support the provision of ecosystem based management advice.

4 List of Outcomes and Achievements of the WG in this delivery period

- Joint meeting with the Working Group on Maritime Systems (WGMARS) and the Working Group on the Northwest Atlantic Regional Sea (WGNARS) in May 2017, Woods Hole, USA.
- Contributed to the SIHD Workshop on Balancing Economic, Social, and Institutional Objectives in Integrated Assessments (WKSIHD-BESIO), 29 November-1 December 2017, The Hague, Netherlands.
- Joint stakeholder workshop with WGMARS, February 2018, Hague, Netherlands.
- Joint session with WGIPEM, April 2018, Copenhagen, Denmark.
- Conducted pressures analysis for all 14 North Sea strata evaluating extent of dredging, disposal, hard structures, and fisheries (>50% swept-area ratio).
- Revised whole North Sea conceptual model which includes all the above activities/pressures, policy/management objectives and they links to the biotic/abiotic components of the system.
- Developed a Skagerrak specific conceptual model as one of the North Sea priority strata owing to exclusively high fishing effort in this region.
- Agreed to work with WGS2D to assess climate effects (temperature) at the whole North Sea level and priority strata level of the Skagerrak.
- Agreed to organize a workshop to validate the abiotic/biotic part of the Skagerrak conceptual model in collaboration with ecosystem modellers with relevant experience of the Skagerrak ecosystem.

5 Progress report on ToRs and workplan

5.1 ToR a. Update strata specific ecosystem trends analysis utilizing data from ICES Data Centre and other data sources, e.g. CPR, OSPAR, EEA and Member States.

The IEA trend analysis carried out by WGINOSE and other IEA groups have to a great extent been based on a principal component analysis (PCA) of biological and oceanographic time-series from the North (ICES DATRAS database). In 2017, Benjamin Planque and Per Arneberg (2017) evaluated the applicability of PCA based methods for analysis of time-series for IEAs, concluding that the method was largely inappropriate due to the autocorrelation in time-series data. WGINOSE awaits the outcome of the WKINTRA (Workshop on integrated trend analyses in support to integrated ecosystem assessment) to be held in autumn 2018 for further guidance on improved methods for analysing time-series data in an IEA setting.

Thus, for the present report WGINOSE has only utilized PCA methods to order the time-series data, omitting the previous analysis of trends in principal component loadings. In addition, since WGINOSE work has moved towards integrating human impacts and developing methods for regional analysis of future scenarios, we find that for the current report we only want to present an updated trend analysis for the Skagerrak region (Figure 5.1), which was the focus of the mental model development during the WGINOSE meeting.

For the trend-analysis this year the group had available the following datasets:

- Fish CPUE index from the IBTS Q3 survey from 1984–2017;
- Oceanographic data (temperature, salinity, and nutrients) for each WGINOSE strata.

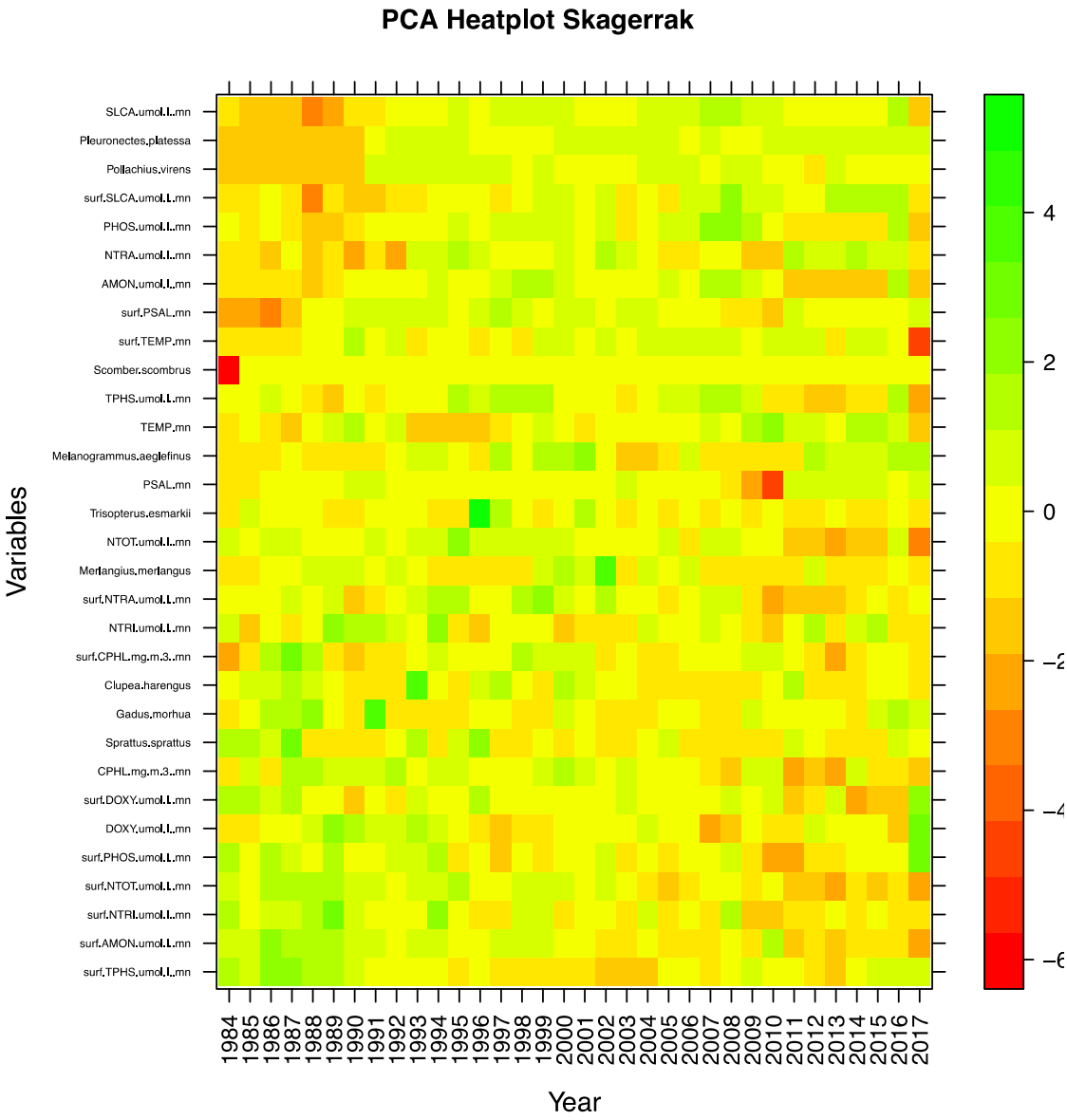

Figure 5.1. Heat plot of anomalies in the time-series of 31 biological and oceanographic variables measured each year from 1984–2017 ordered according to PC1 in a PCA analysis. For the oceanographic variables, the prefix 'surf.' Indicates surface values, while those with no prefix are bottom values.

For 2017, we observed a decline in 18 of the 31 variables compared to 2016. Strongest declines were observed in surface temperature, bottom and surface N, bottom particulate total and organic phosphorus, and surface ammonium concentrations. The biological variables all showed slight increases or similar levels as in 2016, with the exception of *Clupea harrengus, Merlangius merlangus* and *Trisopterus esmarkii* that declined slightly compared to 2016.

References:

Planque, B., and Arneberg, P. (2017). Principal component analyses for integrated ecosystem assessments may primarily reflect methodological artefacts. ICES Journal of Marine Science 1, 512. doi:10.1093/icesjms/fsx223.

5.2 ToR b. Identify and develop additional strata and associated monitoring programmes for the inshore/coastal areas of the North Sea and the Norwegian Trench.

This ToR was finalized in 2017.

5.3 ToR c. Establish data pathways and obtain data to operationalize the integration of human activity and pressure data, distinguishing between fixed structures (e.g. pipelines, windfarms) and ongoing activities (e.g. dredging, fishing, shipping, underwater noise, litter), accidents (emergency response).

Relevant human activity data corresponding to wind farm turbines, oil and gas installations, disposal activities, aggregate dredging and fisheries, were compiled and mapped for the North Sea (Kenny *et al.*, 2017). For each of the North Sea strata an estimate of the proportion of the area occupied by each activity and pressure was determined (Figure 5.2, Table 5.1.). This information has been used to assist with the prioritization of strata to be further investigated through the development of conceptual models.

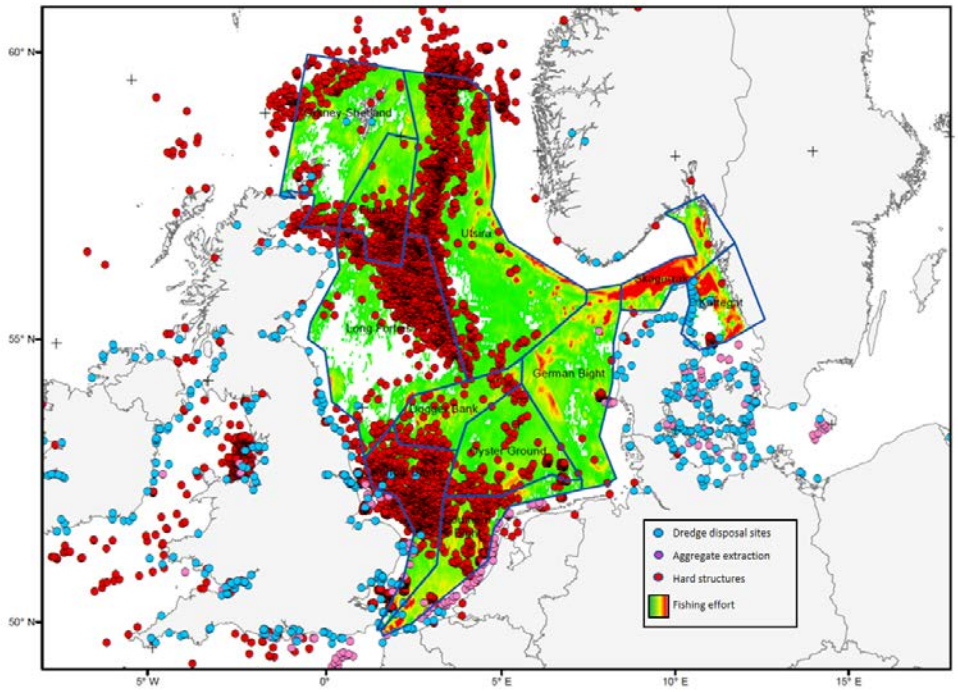

Figure 5.2. The spatial distribution and location of different human activities in the North Sea, note the symbols do not show to scale the activity or footprint except for the mapped fishing effort.

The analysis of overlap between activities and strata revealed the almost exclusive preponderance of fishing activity in the Skagerrak stratum. The Skagerrak strata was the most occupied by any human activity (45% of the total area affected) whereas the Norfolk Banks was the least occupied (at about 1% of the total area affected). These two strata have therefore been prioritized for further study using conceptual models. A third stratum has also been selected for further study, namely the Norfolk Banks as it represents a stratum which is subject to a diverse range of human activities with aggregate extraction and disposal activities being particularly prevalent.

Table 5.1. Table of human activity pressure area occupied against each North Sea strata.

ID	Strata Name	Total area km²	Fishing Effort (km2)	Dredging (km2)	Disposal (km2)	Structures (km2)	Count activities	Sum Footprint (km2)	% Footprint	Ranking Footprint
2	Skagerrak	19 348	8775				1	8775	45	1
3	Kattegat	21 778	4336	12	41		3	4389	20	2
11	Southern Bight	29 771	3638	36	5	8	4	3686	12	3
9	German Bight	47 903	5290	24			2	5314	11	4
8	Norfolk Banks	30 373	2017	134	445	25	4	2621	9	5
7	Dogger Bank	22 255	1571			3	2	1574	7	6
5	Utsira	109 995	4588			44	2	4632	4	7
10	Oyster Ground	35 487	927				1	927	3	8
4	Fladen	25 356	465			15	2	480	2	9
1	Orkney-Shetland	57 597	688		2	5	3	695	1	10
6	Long Forties	83 290	619			35	2	654	1	11

5.4 ToR d. Develop strata specific decision support tools to support ecosystem management and advice (e.g. BBNs and expert systems, ecosystem models, ecosystem goods and services modelling) in collaboration with end-users (OSPAR, DG-ENV, DG-MARE)

WGINOSE has pursued several modelling approaches to develop decision support tools in support of ecosystem-based management, specifically to aid in forward-looking trade-off analyses between different human uses. Previously (2014–2016) the group has attempted development of Bayesian network models, but in the past year the group has focused more on qualitative modelling approaches and bow-tie analysis, built around the Greater North Sea Ecoregions Conceptual model.

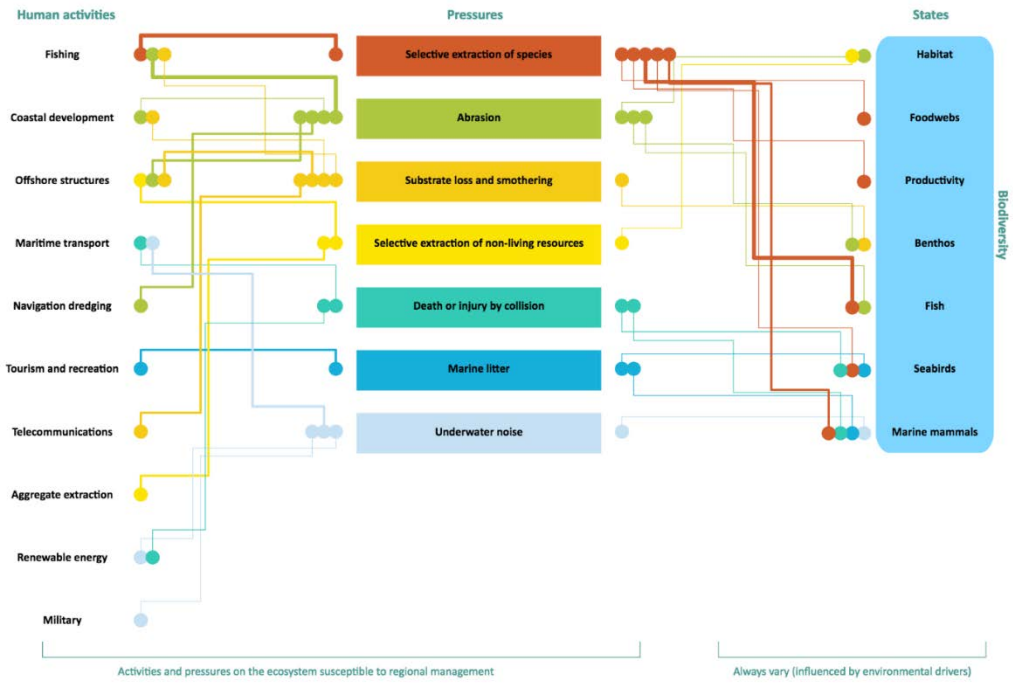

Figure 5.3. ICES Greater North Seas conceptual ecosystem model. (Interactive online version at: http://www.ices.dk/explore-us/Action%20Areas/ESD/Pages/Greater-North-Sea.aspx?diagramid=8)

QUALITATIVE MODELS

Following the development of a prototype qualitative model (www.mentalmodeler.org) for the North Sea at the 2017 WGINOSE meeting, the group has pursued this path further in the interim period and at the 2018 meeting. Chair Andrew Kenny participated at the joint WGMARS and WGNARS meeting in Woods Hole, USA, in 2017 learning more about the US experiences in developing and using a qualitative modelling approach. A refined qualitative mental model for the North Sea was developed and formed the basis for further work (Figure 5.4.).

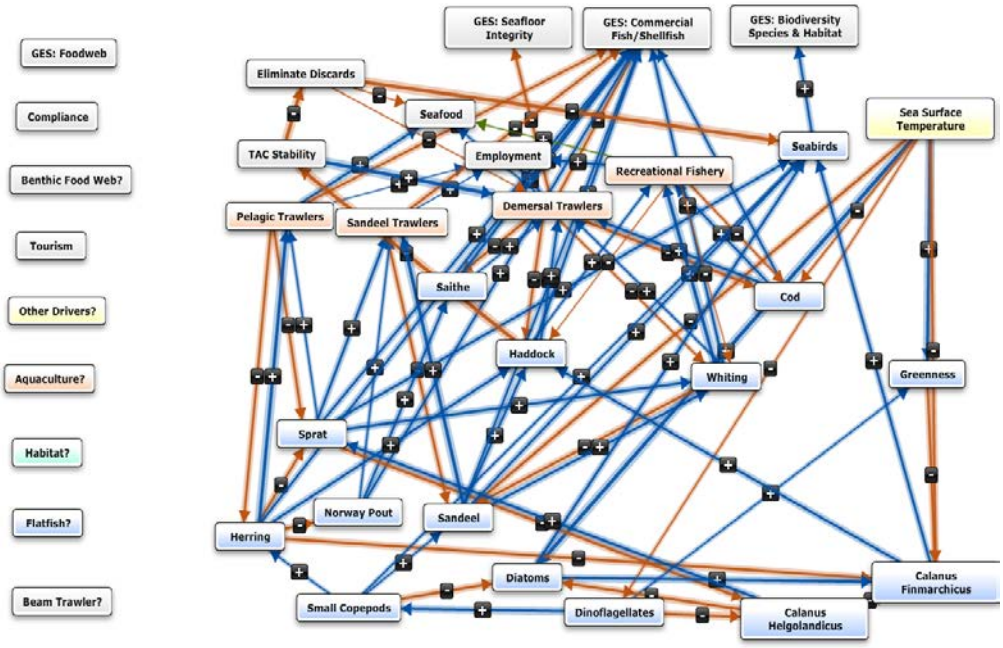

Figure 5.4. Refined mental model for the entire North Sea.

A close working relationship has been established with WGMARS to involve stakeholders in model development and interpretation leading to a joint session at the 2018 WGMARS meeting where stakeholders from Holland were invited to a one-day seminar to learn about and develop a qualitative model and a linked bow-tie analysis of main management issues identified from the model development. At the seminar, a mental model for the Dutch area of the Southern North Sea was developed (Figure 5.3), together with a joint bow-tie analysis of "failure to meet renewable energy targets" (Figure 5.4).

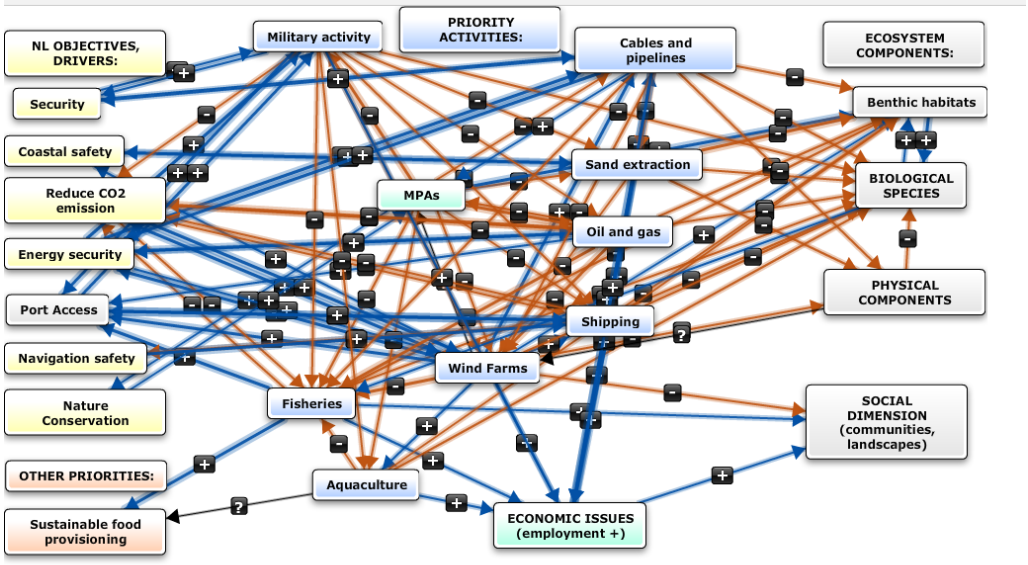

Figure 5.3 Mental Model of the Dutch area of the southern North Sea developed at a workshop with Dutch government stakeholders at the joint WGMARS-WGINOSE stakeholder workshop. .

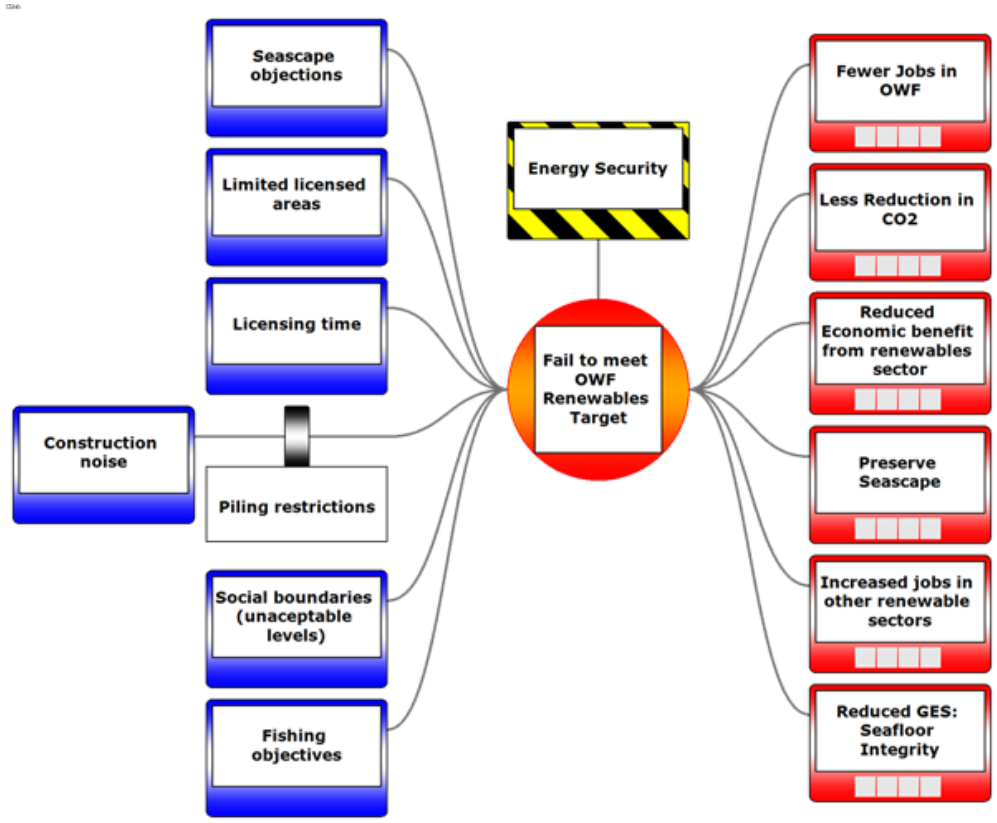

Figure 5.4. «Bow Tie» created in workshop with Dutch government stakeholders at joint WGMARS-WGINOSE stakeholder workshop. "OWF" refers to "Offshore Wind Farm"-"Threats" are found to the left of the model, consequences to the right.

The main conclusions from the seminar were that the stakeholders saw the usefulness of a qualitative modelling approach, being impressed by the ease of development and understanding. Including management objectives in building these models were also seen as very useful as one could trace how a management decision on a sector would contribute or undermine the objectives.

REGIONAL MODEL DEVELOPMENT AT WGINOSE 2018 MEETING

Based on the intersessional experience on developing the qualitative mental model WGINOSE started development of separate mental models for each of its 14 subregions. Based on the analysis of human impacts (ToR-c) it was decided that for 2018 the EG would focus development on one template model that would serve as a basis for all 14 regional models. Furthermore, the EG would develop three models, one for the Skagerrak, one for the Norfolk Banks and one for the Long Forties region. These three regions were chosen based on very different levels of human impacts (footprint analysis). The Skagerrak was the most heavily affected, but only from fisheries, while Norfolk bank had impacts from all sectors (fishing, oil/gas, wind, extraction, and deposition), while the Long Forties were among the least impacts with low levels of fishing and other human uses. Only the Skagerrak model was developed in time for the report, but the models for Long Forties and Norfolk Banks will be developed and presented at the ASC in Hamburg in September 2018. Development of the models for the remaining 11 regions will be done interim to the WGINOSE 2019 meeting.

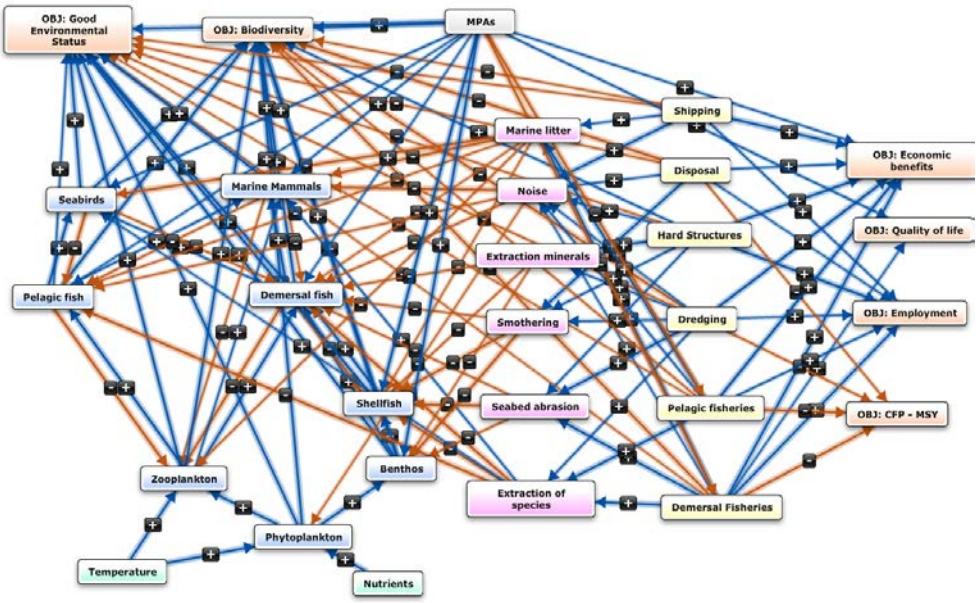

Figure 5.7. Template mental model for the North Sea, to be used as basis for all regional models.

THE SKAGERRAK MODEL

Based on the template (Figure 5.7.) a region specific mental model was developed for the Skagerrak region (Figure 5.8.). Due to importance of fishing in this region, the biological components of the model were further refined, with fish to the species level, and in the zooplankton *C. finmarchicus* and *C. helolandicus* were split out to provide the detail necessary to achieve realism of the model. Aquaculture was also added as a human activity, as it is important in the region.

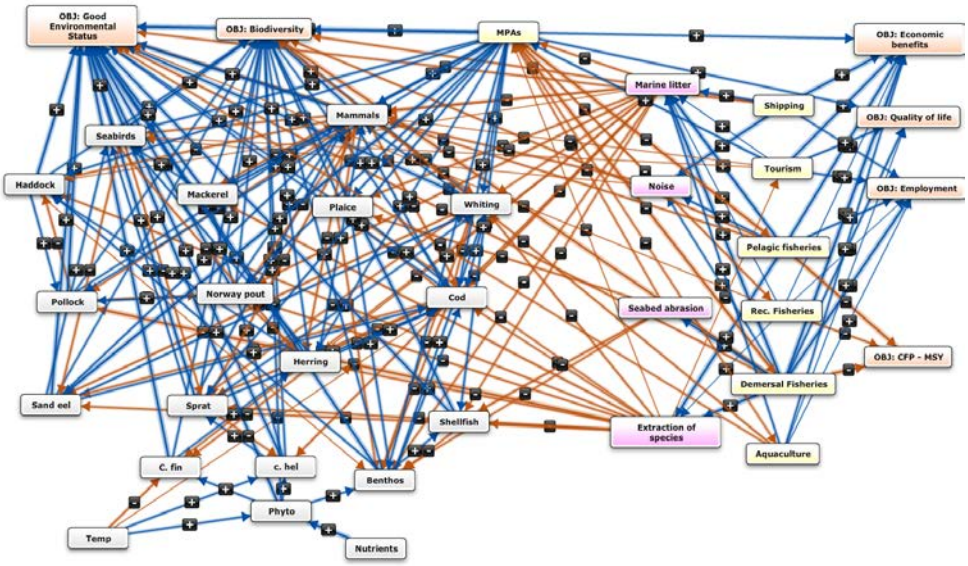

Figure 5.8. Provisional mental model for the Skagerrak region

EXAMPLES OF SCENARIOS

MentalModeler allows the testing of simple scenarios where the levels of any component can be changed positively or negatively, plotting the responses on the other components in the system. This feature both allows the testing of management options, but also works as function to evaluate the design of the model. Responses to a management action that are illogical indicate a failure in model design, leading to an evaluation of the model structure and a redesign of the links between the components.

Nine management scenarios were developed for the Skagerrak model (see Annex C for plots):

1. Increase in all fisheries
2. Decrease in all fisheries
3. Decrease in demersal fisheries
4. Decrease in pelagic fisheries
5. Increase in recreational fisheries
6. Increase in MPAs
7. Increase in MPAs and all fisheries
8. Increase in MPAs and decrease in fisheries
9. Increase in temperature

These preliminary scenarios show how mental models can be used to screen the strongest responses of the systems to perturbations. These responses can then be further analysed using more quantitative/deterministic models and analysis. Thus, the modelling approaches WGINOSE proposes, are to be considered a screening step, and not a replacement for the quantitative approaches taken by groups like WGIPEM and WGSAM.

FURTHER GROUND-TRUTHING AND REFINEMENT OF THE MENTAL MODELS AND BOW-TIE ANALYSIS

The mental models developed at the WGINOSE 2018 meeting are to be considered provisional. There model structure and linkages need to be verified by experts and stakeholders so that the models can be considered to be based on best available knowledge. WGINOSE therefore plans to convene a Workshop in autumn 2018 with relevant ecological, fisheries, and modelling expertise to set the model structure for the biophysical part of the 14 regional models. Further, at the WGINOSE meeting in 2019 there will be a one-day stakeholder Workshop similar to the one in Holland, to set the structure and linkages for the socio-economic and management part of the models.

5.5 ToR e. Contribute to the coordination and integration of strata specific assessments with the development of integrated ecosystem monitoring in the North Sea, e.g. redesign of the Q3 IBTS surveys.

To carry out a full IEA of the entire Greater North Sea ecoregion, there is a need for establishing regular fish survey stations in the Norwegian Trench (one of the WGINOSE regions). WGINOSE chair Erik Olsen participated at the IBTSWG in March 2018 where the issue of expanding the survey into the Norwegian Trench to achieve a coverage of the entire Greater North Sea ecoregion was discussed. For the IBTS Q3 survey in 2018 and the Q1 survey in 2019 it was suggested that experimental tows should be carried out at stations deeper than 250 m in the Norwegian Trench if time permitted. Maximum trawling depth for standard stations was expanded to 250 m, which will also allow more coverage of the slopes of the Norwegian trench. Further expansion of the survey area to include the Norwegian Trench requires further analysis and deliberations in the IBTSWG and in the survey planning groups.

RECOMMENDATION:

WGINOSE recommends to IBTSWG to evaluate how and expansion of the IBTS Q3 survey into the Norwegian Trench are could be designed, and what this requires in extra survey time. Evaluation of experimental trawl in hauls in the trench area in 2018 should form a basis for this.

6 Revisions to the work plan and justification

None

7 Next meetings

The next meeting of WGINOSE will take place on 6–10 May 2019 at the Swedish Institute for the Marine Environment (SIME), University of Gothenburg, Sweden.

Annex 1: List of participants

Name	Address	E-mail
Andrew Kenny	Cefas, UK	Andrew.kenny@cefas.co.uk
Erik Olsen	IMR, Norway	Eriko@hi.no
Jon Egil Skjæraasen	IMR, Norway	jones@hi.no
Mark Payne	DTU-Aqua, Denmark	mpay@aqua.dtu.dk
Adrian Judd	Cefas, UK	Andrian.judd@cefas.co.uk
Daniel Wood	Cefas, UK	Daniel.wood@cefas.co.uk
Andrew Belgrano	SLU, Sweden	Andrea.belgrano@slu.se

Annex 2: Recommendations

Recommendation	Adressed to
1.WGINOSE requests that WGS2D generate a time-series of SST (another parameters e.g. nutrients) for the North Sea out to 2050	WGS2D
2.WGINOSE recommends to IBTSWG to evaluate how and expansion of the IBTS Q3 survey into the Norwegian Trench are could be designed, and what this requires in extra survey time. Evaluation of experimental trawl in hauls in the trench area in 2018 should form a basis for this.	IBTSWG

Annex 3: Report of the Stakeholder workshop on management objectives and analysis for Integrated Ecosystem Assessments

WGMARS-WGINOSE, Thursday 22 February 2018, 9h00-17h00, The Hague, Netherlands

A3.1. Introduction

The joint WGMARS-WGINOSE workshop on management objectives and analysis for Integrated Ecosystem Assessments took place on 22 February 2018 at Wageningen Economic Research in The Hague, The Netherlands. Members of ICES WGMARS, WGINOSE and stakeholders attended the workshop, including the chairs of both WGMARS and WGINOSE. At this still relatively early stage of interdisciplinarity regarding IEA for the North Sea, the workshop organizers had decided to initially target interested North Sea stakeholders from the management side only, rather than a broader, cross-sectoral audience of marine/maritime practitioners. This because managers need to be on board, otherwise there can be little progress made. Therefore, stakeholders came primarily from Rijkswaterstaat, which is the Dutch national body responsible for roads, waterways, and water systems and part of the Ministry of Infrastructure and Water Management. A list of attendees is attached.

There were three, interrelated goals for the workshop: 1) To further the understanding of the important management questions for Dutch government stakeholders (representatives of management authorities); 2) to explore the use of two conceptual modelling approaches (tools) that may be used to facilitate a truly interdisciplinary approach to integrated ecosystem assessments; and 3) to discuss the models usefulness with both stakeholders and working group members. Because the workshop conveners sought to capture the knowledge and frank assessments of the stakeholders, the workshop was conducted under "Chatham House rules", that is to say, stakeholders were advised that comments would not be attributed to any particular speaker.

The workshop began with a welcome by host and WGMARS co-chair Christine Röckmann, briefly outlining the ICES strategic view in relation to regional IEAs. WGMARS co-chair Patricia Clay spoke about the benefits of including social and economic sciences and involving stakeholders in integrated assessments, highlighting and exemplifying that all management is based on societal objectives (social, cultural, economic, and environmental). This was followed by a presentation by Gerjan Piet about the "AQUACROSS Linkage Framework" of the marine Social-Ecological System; by WGINOSE chairs Andrew Kenny and Erik Olsen on "Developing Integrated Ecosystem Assessment in Support for Management Advice: A Roadmap for the North Sea"; by Eric Olsen who provided "A brief introduction to the tools and methods of IEA, showing the synergies to MSP"; and by Daniel Wood who provided an overview of the "Bow Tie" method. Through these presentations, participating stakeholders were acquainted with the goal of making Integrated Ecological Assessments (IEAs), the difficulties that this presents for ICES groups (and others) and the approaches that WGINOSE was using to deal with these challenges. Eric Olsen subsequently led the workshop in using the Mental Modeler tool to identify key management goals (as drivers) and the linkages between those goals, human activities related to those goals and the interactions among human activities. Daniel Wood then led the workshop in trying out the "Bow Tie" Analysis. The day ended with a discussion of the usefulness of the tools.

A3.2. Mental Modeler

The Mental Modeling session led by Eric Olsen led to a particularly lively discussion. The focus of the group was the southern North Sea. Stakeholders themselves identified the key objectives/drivers in their management system, anchoring these in six priorities of the Dutch North Sea policy: Oil and gas, CCS, safe shipping, sand exploitation for coastal safety/protection, renewable energy production, and defence/ military use. An additional priority from The North Sea 2030 process was also entered into the model: sustainable food provisioning. Stakeholders pointed out that fisheries as such were not a priority goal in their work, because fisheries make up only a small part of the Dutch economy. Nevertheless, they recognized the importance of fisheries for specific communities and employment. Several priority human activities were identified: military activities, cables and pipelines, sand extraction, MPAs, Fisheries, Aquaculture, Wind Farms, Shipping, Oil and Gas. Wind Farms and Sand extraction (to enhance coastal security) stood out as particularly important activities, Fisheries and Aquaculture as significantly less so. Attempts were made to explore the effects of these activities on some ecosystem components such as benthic habitats, biological species, and physical components of the area. Some preliminary links were made to social and economic dimensions, although the workshop ran out of time to explore these further. It was clear that "economic" and "social" dimensions needed further specification (as did other ecosystem components), but there was not enough time to do this. The mental modeler approach allows for specifying the strength of relationships and for the characterization of the degree of certainty with respect to the relationship and its strength, and preliminary efforts were made to specify the strength of relationships in particular Figure A3.1). In exploring the model, some time was spent in the process to discuss the exact terminology (objectives, priorities, drivers, activities) and the level of precision needed to establish the strength of the linkages between model nodes (1 or 0.5 – what does it mean?, how can it be remembered? etc.).

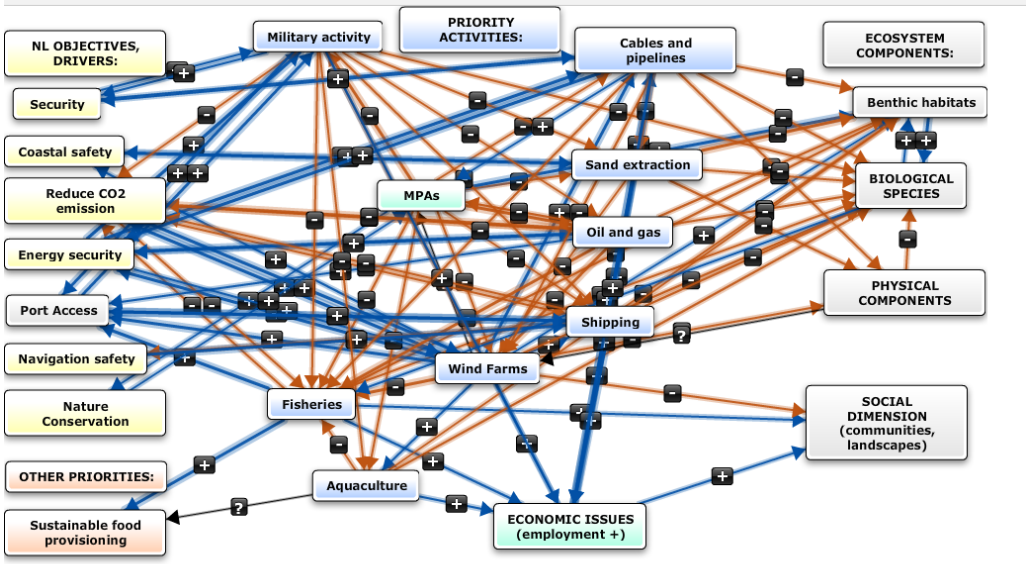

Figure A3.1. Mental Model produced in workshop with Dutch government stakeholders.

Stakeholders noted the links and interactions between the priority goals and associated human activities: the importance of wind farms in the area became particularly evident, in particular when the North Sea 2030 process was taken into account. As noted, sand extraction was important to coastal security. It was clear that aquaculture is a

minor use at present, and stakeholders did not seem to worry much about the military use of the area: it seems to be relatively unobtrusive with respect to other uses of marine space.

A3.3. Bow Tie Analysis

Daniel Wood led the work session on Bow Tie Analysis. This approach is intended to "untangle cumulative effects". It starts by identifying a top event, and then, identifying "threats" to (displayed on the left) and consequences (displayed on the right) of the top event. "Escalators" can be added with respect to threats, and "barriers" that affect consequences can also be added. In this way, the factors affecting and affected by top events and associated activities can be followed in detail. The mapping of individual "top events" can be subsequently connected via variables/factors that different "top events" have in common.

The Bow Tie workshop session began with two "top events" as the starting point for the discussion: (1) meeting the offshore wind energy target for Energy security, and (2) meeting the MPA target for nature conservation. Since top events in Bow Tie Analysis are described as hazards that one wants to prevent, the phrasing in the Bow Tie is negative, i.e. NOT meeting the target. Stakeholders actively worked to identify threats and consequences relating to these two top events. The discussion about energy security covered wide variety of issues around offshore wind farms, such as the length of the licensing process, noise levels from construction and whether wind farms can work to protect the sea floor. It was quickly noted that limits set, for example, for underwater noise were social constructs. The discussion on the creation of MPAs revealed the complexity of the task: the success of MPAs depends on who creates them and for what reason. One of the complexities being that species are often distributed in different areas at different life stages.

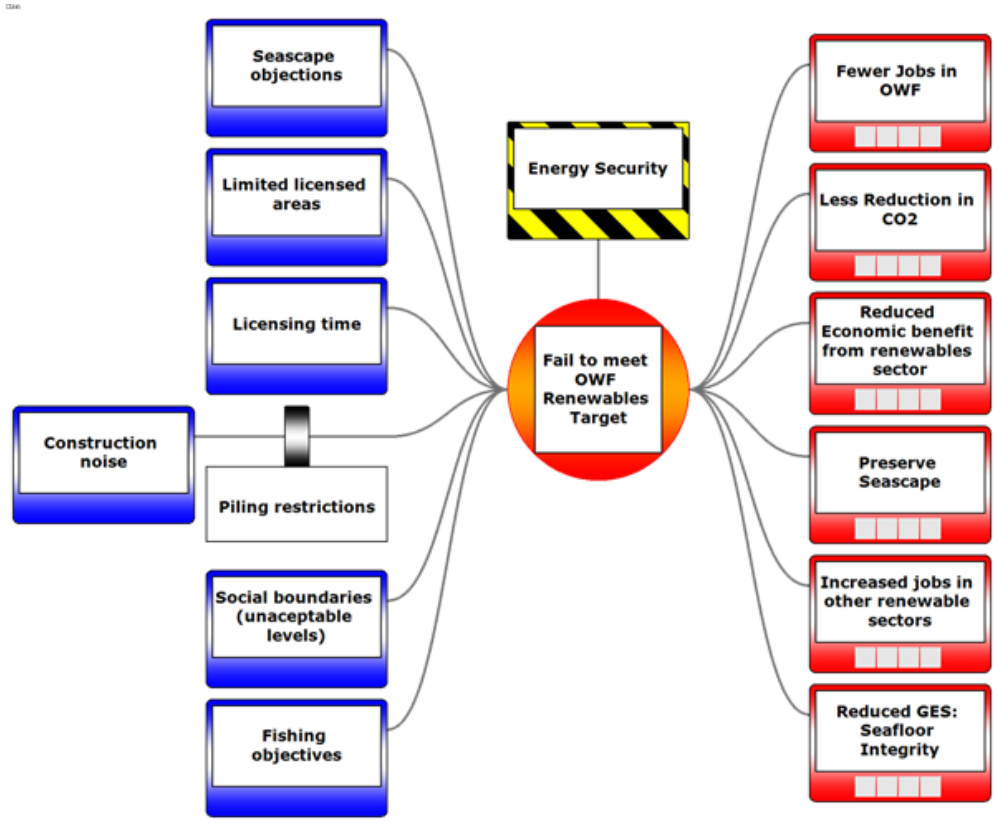

Figure A3.2. «Bow Tie» created in workshop with Dutch government stakeholders. "OWF" refers to "Offshore Wind Farm"- "Threats" are found to the left of the model, consequences to the right.

A3.4. Conclusions

Stakeholders engaged actively throughout the workshop, suggesting and jointly discussing potential components and interactions between them for building the conceptual models. They gained an appreciation for how the two models worked, how WGINOSE proposed to use these and how they might use them themselves.

Both tools (Mental Modeler, MM, and Bow Tie Analysis, BTA) were considered very useful in particular for the visual representation aspect of conceptual models, as they help to organize and create an overview of the more - and less important components/drivers in the system. Both tools are considered attractive for communication with stakeholders, in particular using them in a "screening exercise" or for assessing consequences of scenarios. Conceptual models are useful to provide insights into connections (between model nodes/ ecosystem components) that may not have been identified before and help the different stakeholders to understand how to proceed in further analysis. If carried out systematically, a participatory process of building a conceptual model is a useful scientific method/tool from the social sciences to systematically gather perceptions, information, knowledge, etc. If the links/interactions between the model nodes/components that are created can be 'backed up' by scientifically established facts (i.e. triangulation of information/data), conceptual models become even useful as product in itself. However, they might probably end up too complex to understand as a stand-alone end product. The stakeholders pointed out that the final "picture" of a participatory conceptual model building process should rather not be used as a communication tool on its own, since the communication value lies in the participatory process of building the model together, and not in presenting the final outcome.

The scientific depth of a conceptual model certainly depends on the time limit for developing it, as well as on the expertise present in the group developing the model. Outcomes of a conceptual model cannot and should not be compared to highly specific, quantitative models/model results, but they are useful to identify areas for further analysis, e.g. more in-depth (quantitative) modelling. The conceptual model tools were not seen as competition to the "MSP challenge", a spatial game to explore MSP, as this game is foremost an educational tool.

Further, the process of building conceptual models is considered useful for facilitating the discussion between, and integration across, multiple disciplinary and sectoral (or departmental – within government) viewpoints. It can also help to identify available management options, thus helping in scenario development and for assessing consequences of scenarios. Identifying model components, interactions between the "nodes," and their directions and strengths for different management options (scenarios) can help both scientists and stakeholders to visualize the potential consequences of the different scenario choices, i.e. trade-offs.

Thus, the process of building such conceptual models can give clear direction of where an IAE can/should go and what issues are most important in a management context, thus leading IEA to a practical application. At the moment, IEAs in ICES are rather abstract and constrained by computational complexities with long run times (Atlantis type models) and limited economic and, especially, social, and cultural data.

Stakeholders appreciated the fact that the Mental Modeler software does allow for characterizing the degree of certainty about the relationships it captures. However, this can lead to too much focus on the existence of quantifiable data at the expense of relative relationships and possibly the downgrading of qualitative data. The stakeholders furthermore expressed to prefer a visual geographic presentation of multi-use conflicts (maps); images of these models were seen to be too complex. Modellers noted that this is also possible and that linkages between maps and MM were possible (to explore linkages). In addition it was mentioned that in the Dutch context, a small country with many stakeholders who meet each other regularly, application of these modelling tools were not seen as necessary in most cases. However at the regional level or in meetings with new stakeholders (for instance relativly new departments resulting from to the restructuring of government) it was seen as a useful approach. WGINOSE will continue to further explore the use of MM and BTA in participatory stakeholder workshops, and aims to potentially build several conceptual models, one for each of the WGINOSE-defined subregions of the North Sea. Setting boundaries will be very important with respect to which stakeholders should be included, but also with respect to what set of goals are to be included in any given workshop. Different goals pertain to different geographical areas. Also, marine areas can contain "pockets" with distinctly different characteristics and/or use: it would be important to be able to bring these into the analysis as well.

Focusing on specific questions is important to prevent getting caught up in overly complex details. One idea for a future focus was to explore multiple-use questions. Having a specific topic/question sets boundaries that aid in identification of which stakeholders to invite/ include and what set of goals to discuss in any given participatory IEA scoping workshop, since different stakeholders and goals often pertain to different geographical areas.

The conceptual modelling tools are also useful purely from a scientific perspective, to identify knowledge gaps and thus contribute to the research agenda. Clearly, there are knowledge gaps concerning the social, cultural, and economic aspects of North Sea

management. Note that the stakeholder workshop did show, however, that on the policy side, lots of work has been done on these aspects (especially economics). However, publication channels are different for policy and science; efforts to increase research cross-fertilization are needed. Transdisciplinary workshops are thus also an important opportunity to exchange knowledge/findings/facts.

One important final note: Once science engages with stakeholders it is important to maintain a relationship, to keep up the contact and keep each other informed. IEA work will take many rounds with a wide variety of stakeholders over a period of several years. This is an anticipated finding, but was also confirmed and made very clear from the workshop.

A3.5. Annexes

A3.5.1. List of participants

	Name	Affiliation	Email
1	Ana Fraga	National Maritime Authority PT	anaritafraga@gmail.com
2	Andrew Kenny	CEFAS UK, WGINOSE	andrew.kenny@cefas.co.uk
3	Arya Seldenrath	HVHL	arya.seldenrath@hvhl.nl
4	Christine Röckmann	WEcR NL	Christine.Rockmann@wur.nl
5	Daniel Wood	CEFAS UK	daniel.wood@cefas.co.uk
6	Erik Olsen	IMR NO, WGINOSE	erik.olsen@imr.nl
7	Gerjan Piet	WMR NL	gerjan.piet@wur.nl
8	Henk Merkus	Min NL, DGRW	Henk.Merkus@minienm.nl
9	Jennifer Bailey	Uni Trondheim NO	jennifer.bailey@svt.ntnu.no
10	Johanna Ferretti	Thünen Rostock DE	johanna.ferretti@thuenen.de
11	Maartje de Vries	HVHL	maartje.devries@hvhl.nl
12	Marina Santurtun	AZTI ES	msanturtun@azti.es
13	Marloes Kraan	WMR NL	marloes.kraan@wur.nl
14	Martine Graafland	RWS NL, ZD	martine.graafland@rws.nl
15	Patricia Clay (via webex)	NOAA USA	Patricia.M.Clay@noaa.gov
16	Rob Gerits	RWS NL, ZD	rob.gerits@rws.nl
17	Rob van der Veeren	RWS NL, OSPAR	rob.vander.veeren@rws.nl
18	Rolf Groeneveld	WU NL	rolf.groeneveld@wur.nl
19	Ronald Rense	RWS NL, WVL	ronald.rense@rws.nl
20	Vasco Pinto Nunes Nogueira Diogo	WEcR NL	Vasco.diogo@wur.nl
21	Xander Keijser	RWS NL, WVL	xander.keijser@rws.nl

A3.Workshop presentations

Christine Röckmann

North Sea Stakeholder workshop on management objectives and analysis for Integrated Ecosystem Assessments (IEAs) – Welcome and brief intro to ICES strategic view

Patricia Clay and WGMARS

Insights into stakeholder management interactions for IEA

Gerjan Piet

Integrated Ecosystem Assessments – The socio-ecological system (EU AQUACROSS)

Erik Olsen

Tools and methods for IEA and synergies with MSP

http://prezi.com/mkfev1woqsgs/?utm_campaign=share&utm_medium=copy

Andrew Kenny and Erik Olsen

Developing ICES IEAs in Support of Management Advice – A roadmap for the North Sea (ICES, WGINOSE)

Daniel Woods

Untangling Cumulative Effects with Bow Ties

7.1.1.1 Workshop agenda

WGMARS-WGINOSE, Thursday 22 February 2018, 9h00-17h00

09:00 – Welcome, brief intro to ICES strategic view, introductions (Christine Röckmann)

Introduction to concepts and goals

09:20 – What benefits can inclusion of social and economic sciences bring? (Patricia Clay)

9:35 –AQUACROSS linkage framework (CEA and Social-ecological system approach) (Gerjan Piet)

09:45 –Developing Integrated Ecosystem Assessment in support for management advice. A roadmap for the North Sea (WGINOSE) (Andy Kenny and Erik Olsen)

10:00 – A brief introduction to the tools and methods of IEA, showing the synergies to MSP (Erik Olsen, Daniel Wood)

10:15 Coffee break

A North Sea case study– interactive discussions facilitated by MentalModeler

10:45 – What are the important drivers and management objectives for the North Sea? Linking to the Dutch North Sea strategy 2030 (Moderator: Andy, Christine, Erik)

- Management /policy objectives
- Relevant human activities
- Drivers: social, economic, environmental, and institutional
- others

12:00 – Lunch break

13:00 – Setting up the NS mental model to the management objectives (selecting the model components from the pre-lunch brain-storm) (Andy, Erik)

- Connecting the components and setting the direction and strengths of their connections (defining the model structure)
- Defining management scenarios
- Generate results from management scenarios

14:30 – Coffee break

15:00 – Setting up and carrying out a comparable bow-tie analysis (Daniel, Erik, Andy)

16:00 - Discussing results from the mental model and the bow-tie analysis (Andy, Erik, WGMARS)

16:45 – Way forward

17:00 - Meeting close

Main workshop goals

1. Advance our understanding of Integrated Ecosystem Assessments (IEA) by incorporating social, economic and institutional aspects:

- What are the driving management questions – on national and EU level?

2. Test two tools for such interdisciplinary analysis:

a) Conceptual modelling using the "Mental modeler" software

b) Bow Tie Analysis

3. Discuss the tools' usefulness, and the relation between IEA and marine spatial planning (MSP).

The ICES Working Group on Integrated Ecosystem Assessments for the North Sea (WGINOSE) serves as our case study; WGINOSE will use the workshop's outcomes to set the scope and focus of its future IEA work.

Annex 4: Skagerrak mental model management scenarios

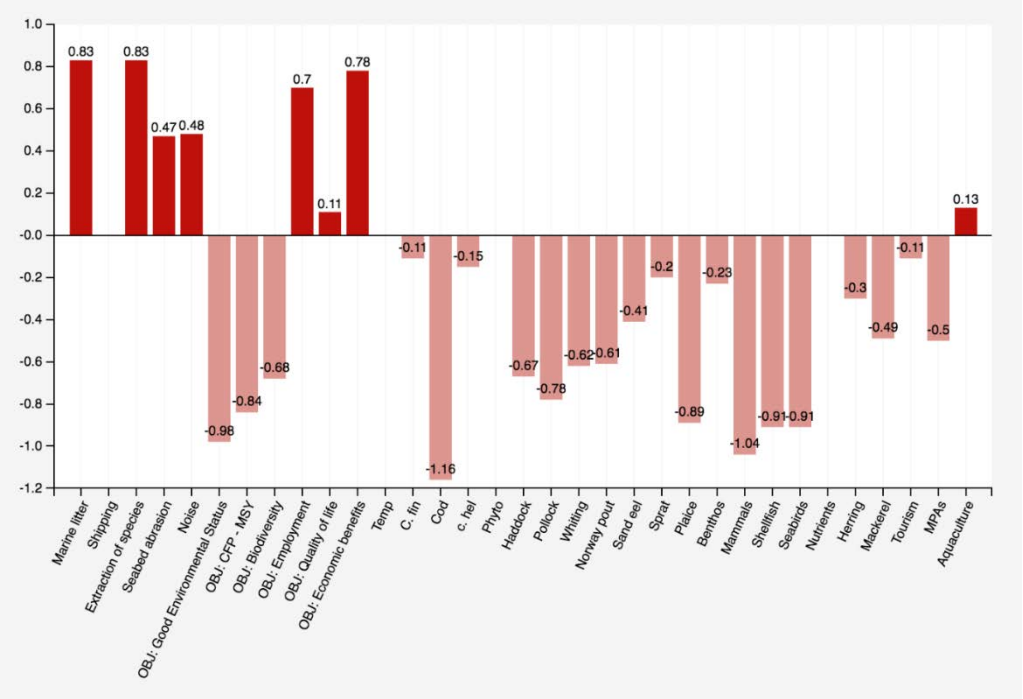

Figure A4.1. Increase in all fisheries

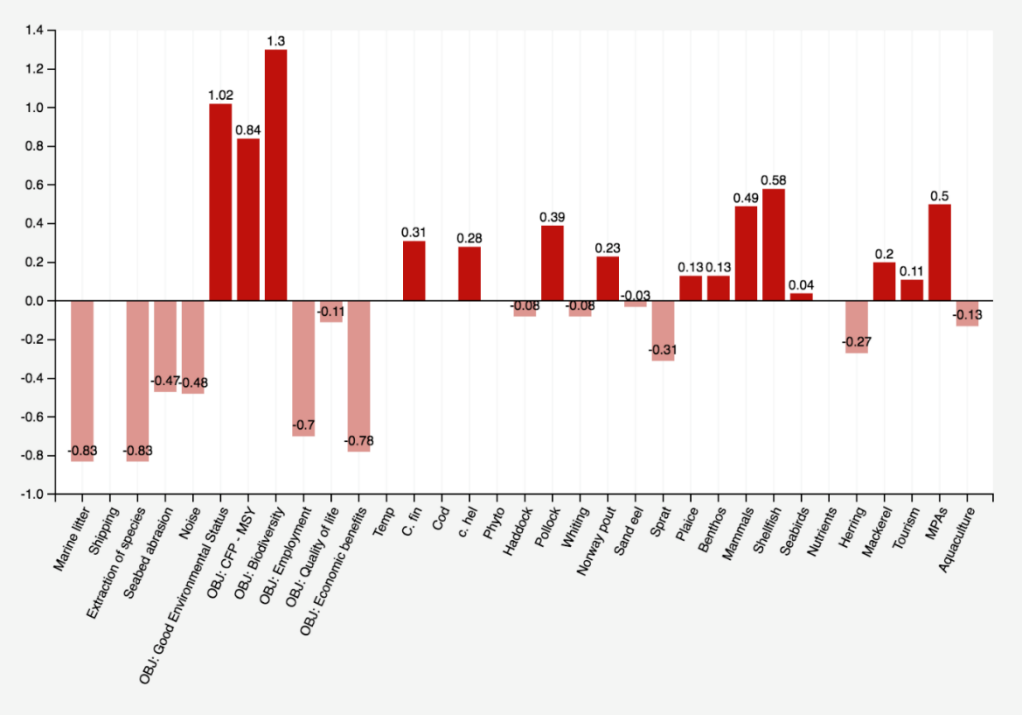

Figure A4.2. Decrease in all fisheries

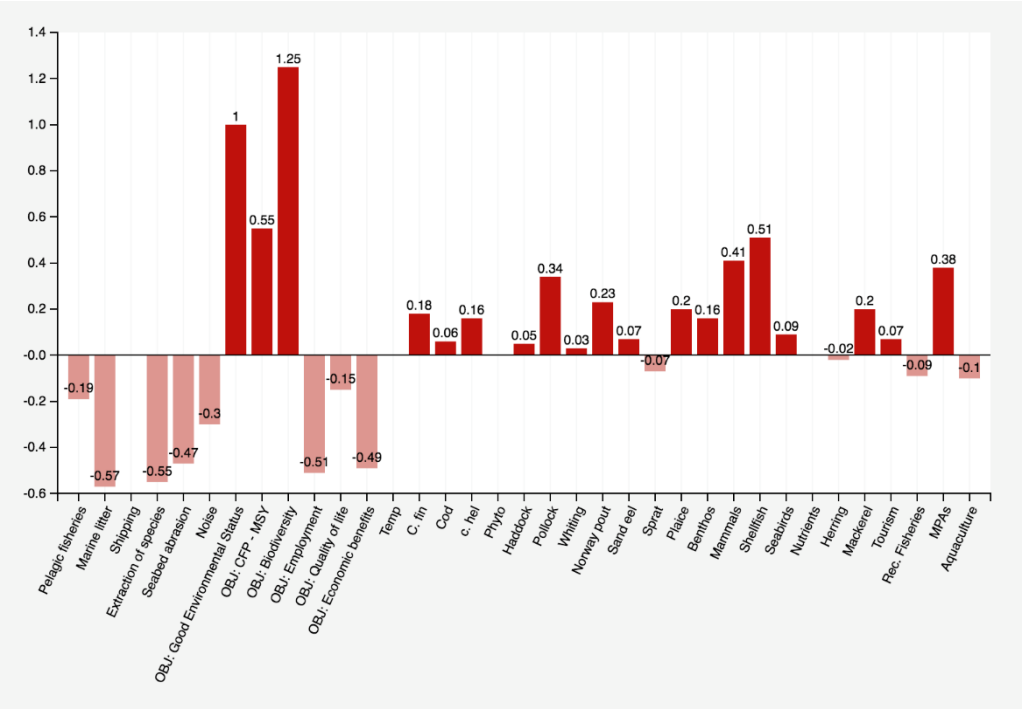

Figure A4.3. Decrease in demersal fisheries

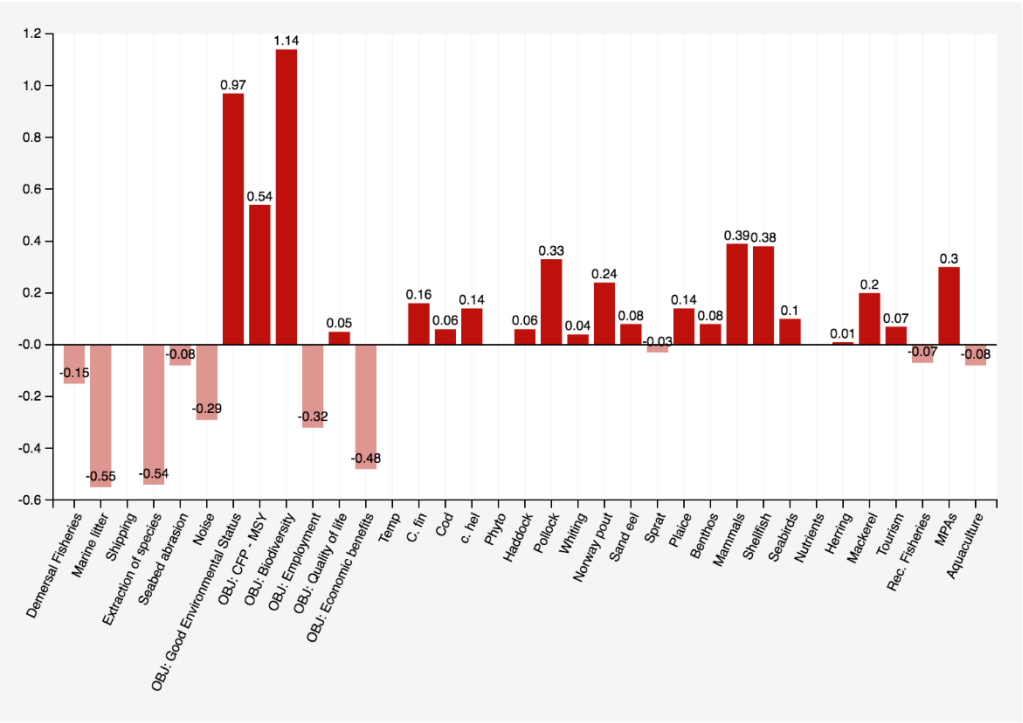

Figure A4.4. Decrease in pelagic fisheries

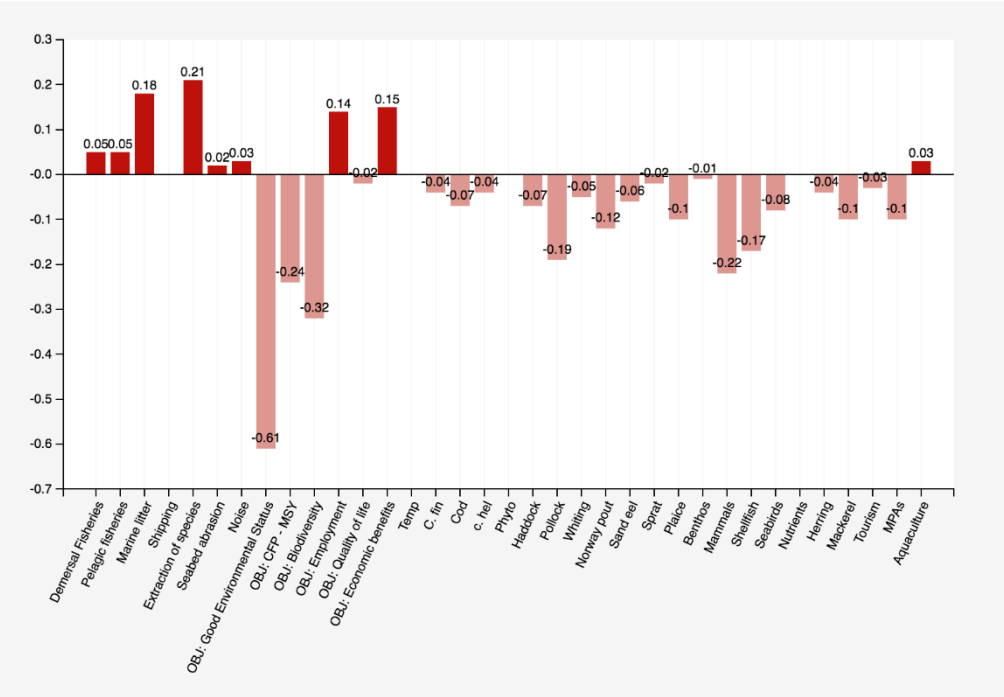

Figure A4.5. Increase in recreational fisheries

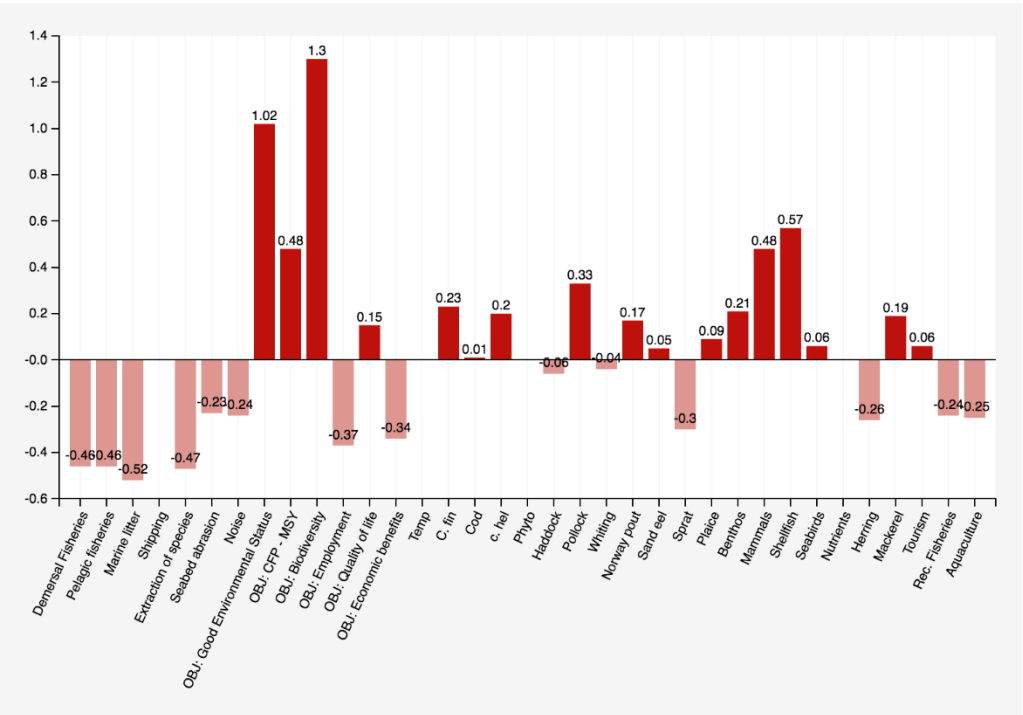

Figure A4.6. Increase in MPAs

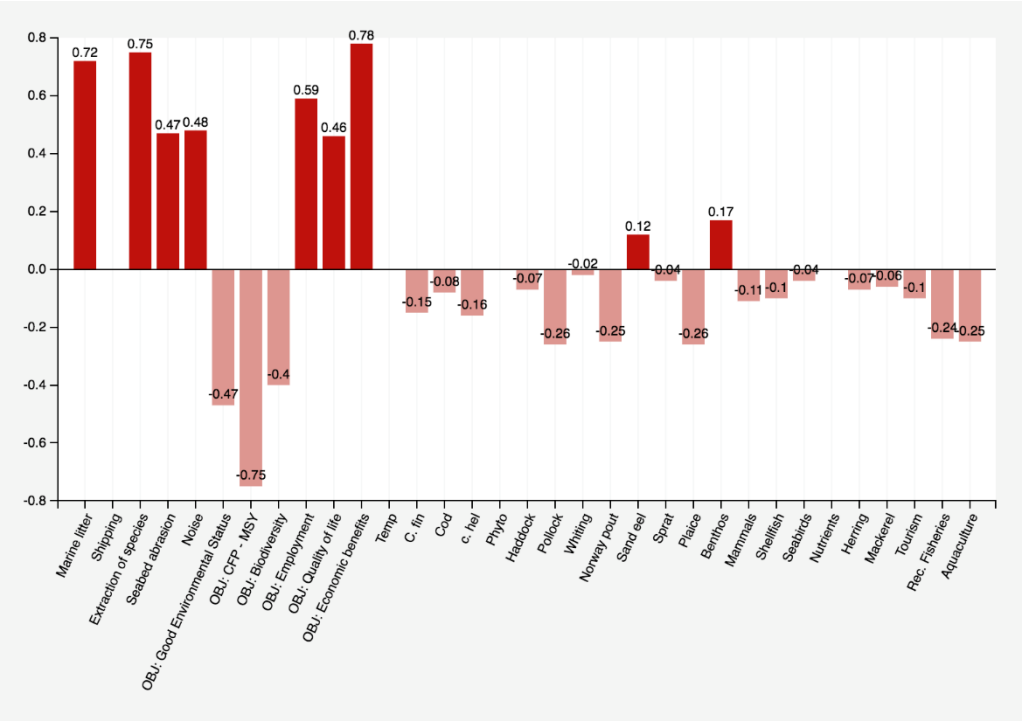

Figure A4.7. Increase in MPAs and all fisheries

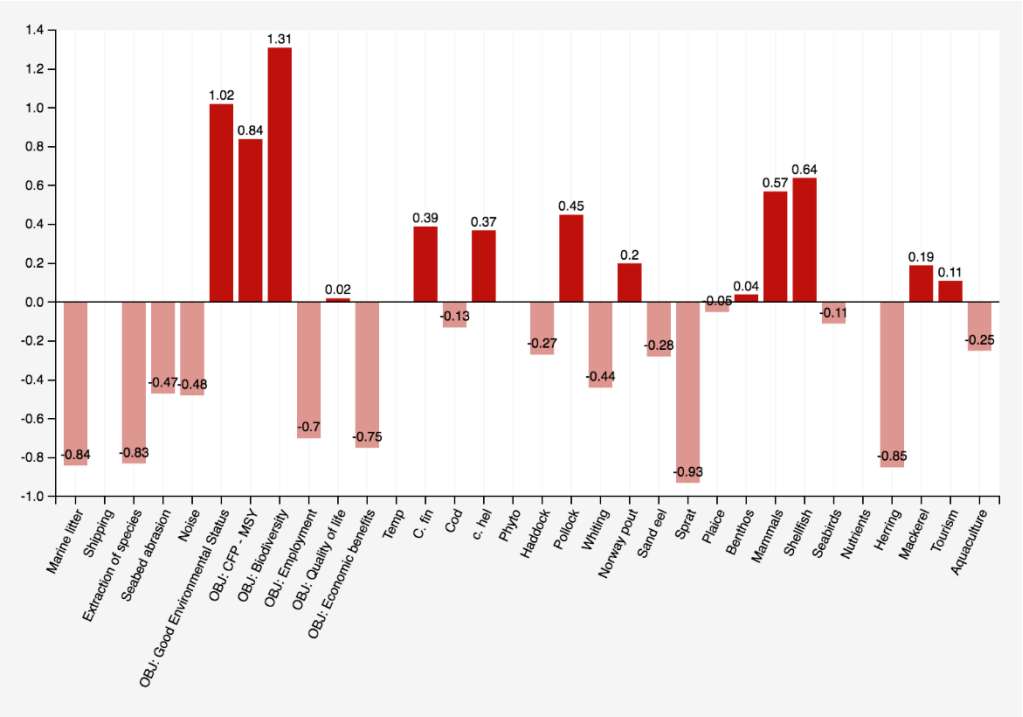

Figure A4.8. Increase in MPAs, decrease in fisheries

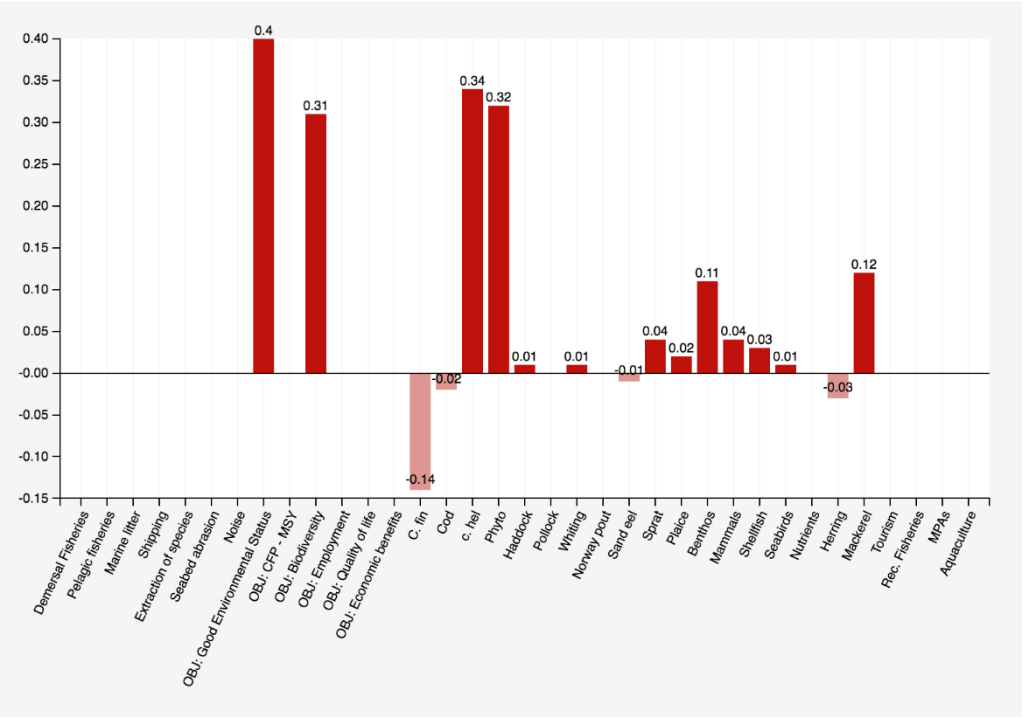

Figure A4.9. Increase in temperature