Bæredygtigt Landbrug

General comments to the evaluation of the models

	Comments	Questions
General	**Overall consideration of the N: P ratio** It is important to remember that the water environment target for Denmark as well as EU is ”good ecological status”. Although N restrictions dominate the Danish environment strategy, it is worth mentioning that neither EU nor WFD have similar requirements. The high demands for reduced N discharge from cultivation surfaces are solely based on Danish model calculations that, besides lacking statistic quality, do not involve the other main nutrient P – an important factor according to international scientific material - and therefore have poor scientific founding. Further to this, DCE - Danish Centre for Environment and Energy, has overestimated the Danish share of N in the Danish water body areas and thus the benefit of N restrictions. On top of this, the administration has, without political approval, changed the calculation method, changing the reference level from “water environment” to “marine areas”, which means an increase in the reduction requirements of approx. 30%. **N:P Interactions** A fundamental problem in Danish water management is a lacking recognition of phosphorous (P) impact on the eutrophication status in the water bodies. Especially the well documented interaction between N and P in marine environments is completely underestimated. This has caused a disproportionate focus on the effect of nitrogen, while the effect of phosphorous has not been included in the equation. Focus has been missing on phosphorous wastewater emissions from Danish wastewater treatment plants that have lacked the efficiency of equivalent plants in our neighbouring countries. Furthermore, a series of wet weather overflow have been grossly underestimated as their occurrence exceeds the statistics with around 50%. The fact that the P emissions from city wastewater lead to requirements for substantial agricultural N restrictions based on unqualified nitrogen calculations has had great impact on the agricultural sector in Denmark and has resulted in tremendous costs **N and P in marine environments** Increased focus on the function between the two main nutrients, nitrogen (N) and phosphorous (P) and their interaction is crucial. The following statement illustrates the abovementioned approach: “Nitrogen is the determining factor for our marine environment. It is without any doubt. It is an absolute fact” (Stiig Markager, DCE, Aarhus University, who is involved in ministerial consultancy). Such statements have misled the politicians and the public. The fact is that opinions differ on this subject. Among international scientists there is a different view (please see appendixes A) Ecological	Does the reviewing group agree that "N limitation" means that the ecosystem receives too much P (from wastewater, run off and sediment) - not that nitrogen must be controlled?

Stoichiometry, p. 324-329, B) 1999 Downing Ecology 80.1157-1167, C) 1997 Downing Marine np stoichiometry).

For years, DCE has misled the public with one-track minded statements on nitrogen. This has created an artificial opposition between production and environment interests.

The resulting administration focusing solely on N restrictions has not led to the expected improvements for the water environment but has had great negative impact for the farming industry.

DCE has assessed the water environment incorrectly. The model attempting to link the spread of eelgrass with nitrogen emissions is today being called into question by most scientists but is still playing a key role for environmental targets and actions.

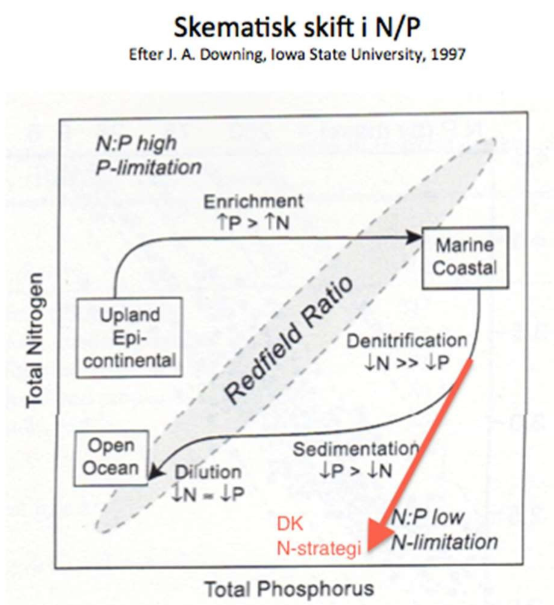
Phosphorous in wastewater creates problems

One of the world's leading scientists on nutrients in marine environments, professor John A. Downing, Iowa State University, has carried out a substantial analysis, gathering and analysing scientific studies from all over the world.

Downing documented that nitrogen sensitivity is present in phosphorous polluted water systems only. Unfortunately, almost all research regarding eutrophication problems has been done in phosphorous polluted coastal waters where the eutrophication issues are most evident. Therefore, sufficient light has not been shed on the interaction between nitrogen and phosphorous, which shows that nitrogen is only problematic in phosphorous polluted waters.

DCE at Aarhus University has not acknowledged this interaction effect.

In below schematic illustration by Downing of the N:P cycle in the water system, the red arrow shows how the Danish strategy with N restrictions counteracts/delays the natural adaption towards the Redfield Comfort Zone.



	Conclusion It has been established that P is the limiting nutrient in water environments under natural conditions. In inland rivers and lakes, it is widely recognised that P is the limiting nutrient. In the oceans, P is the limiting nutrient in most cases. Only around populated areas with wastewater emissions to fjords and coastal waters, do we have nitrogen limitation. The reason for this is wastewater with low N:P ratio, due to anthropogenic pollution. Local nitrogen limitation in fjords and coastal waters are a result of this low N:P wastewater pollution combined with natural denitrification/retention of nitrogen, that lower the N:P ratio further. None of these processes are caused by nitrogen from cultivation surfaces. Still this nitrogen limitation has caused faulty conclusions in most of the world, however most significantly in Denmark where DCE for three decades has supported a strict nitrogen strategy and lost focus on phosphorous.	

General comments to the scientific documentation

	Comments	Questions
General		

1. Prologue

	Comments	Questions
General		

2. Introduction

Chapter/section	Comments	Questions
2.1		
2.2	**Uncertain nitrogen assessment methodology behind the River Basin Management Plans** (Development of models and methods to support the establishment of Danish River Basin Management Plans) The assessment methodology used by the Ministry of Environment and Food of Denmark for river basin management in coastal waters, which is used for determining the environmental objectives and mitigation demands in the river basin management plans, is based on unsatisfactory groundwork which does not meet the Water Framework Directive (WFD). The assessment methodology is being exploited as a means to stop agricultural use of nitrate fertilisers and to force the farmers in the direction of organic farming. In the report “Development of models and methods to support the establishment of Danish River Basin Management Plans – Part 1 Methods for determination of target loads” carried out for the Danish Nature Agency (Harley Bundgaard Madsen, Stig Eggert Pedersen) by Aarhus University (Karen Timmermann, Stiig Markager, Jesper Christensen, Ciaràn Murray) 22/12/2014*, the following is stated (translation by Bæredygtigt Landbrug as no English version is available): “the ecological status in the WFD is defined in terms of three biological quality elements: Phytoplankton, benthic vegetation and benthic flora. Multiple indicators are used for each quality element. Presently in Denmark intercalibration has been done for only one indicator of each quality element. The model tools developed are focused on the two following quality elements and accompanying indicators: Phytoplankton, described by the concentration of chlorophyll Benthic vegetation, described by eelgrass depth limit The intercalibration indicator for aquatic fauna is based on species composition, which is not readily applicable in the development of the model. In addition to the quality elements, the models can describe physico-chemical supporting parameters, which are relevant to take into consideration when evaluating the ecological status. The following supporting parameters play a key role in the model tools: Nutrient loads Light conditions	

	Many other parameters are influencing the eco systems, including presence of harmful algal blooms, spread and abundance of eelgrass, lack of oxygen, organic substances in sediments, etc. However, as the intercalibrated biological indicators are primarily used in defining the River Basin Management Plans, focus is on these indicators in the model tools development." **Neglect of the WFD requirements** The WFD requires that the classification of the ecological status in costal zones is to be based on the following three biological quality elements with quantity and density as determining factors: - Phytoplankton (chlorophyll) - Benthic vegetation (eelgrass depth limit) - Benthic fauna (species composition) In the WFD, the physico-chemical supporting parameters (including limitation of nutrient loads to the marine areas) are secondary to the aim of obtaining "good ecological status". However, in the Danish implementation of the directive, the supporting parameters have been given more importance than the quality elements. The limitation of nitrates has been made the main target while two of the three biological quality elements (phytoplankton and benthic vegetation) have been made less important targets and the third indicator (benthic fauna) has been entirely eliminated because it is not "model friendly". The model uses the following calculation to determine the environmental targets (=target loads): $\text{Target Load} = 1 - \left(\dfrac{\text{mitigation demand (\%)}}{100} \right) \times \text{present status}$ Based on the nitrogen input from 2007 to 2012 (61 ktons N/year), the target load (environmental target) for all water bodies has been defined to 44.5 ktons N/year in 2021. Thus, instead of the three quality elements laid down in the directive, the environmental target/target load of the Danish water body management plans are based on one secondary supporting parameter; nitrogen reduction. This is not according to the Water Framework Directive. * http://naturstyrelsen.dk/media/131361/3_1_modeller-for-danske-fjorde-og-kystnaere-havomraader-del1.pdf - Page1	
General	**Legal comments on the International Nitrogen Assessment** The International Nitrogen Assessment originates from the Water Framework Directive (WFD), which is why we will deal with a few legal points which are relevant in connection with the assessment of the nitrogen models. The term "water services", which is defined in the WFD, has been translated incorrectly from English to Danish. This causes a limitation to the field of application in Danish law. The consequence is that the required economic analysis does not include important matters such as drainage. The principle of proportionality is a legally binding EU principle. A specific requirement in the principle is that the content and form of the	

	action must be in keeping with the aim pursued. The more far-reaching the effect of the models, the more important the accuracy, and most importantly that the responsibility for the recipient not being able to achieve “good ecological status” does indeed originate from the agricultural discharges of nitrates. **Water Services contra the Danish translation “forsyningspligtydelser”** In the English version of the Water Framework Directive, the term “Water Services” has been translated to the Danish word “forsyningspligtydelse”. The English version is as follows as in article 2.1.38: ”‘Water services’ means all services which provide, for households, public institutions or any economic activity: a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, 22.12.2000 EN Official Journal of the European Communities L 327/7 b) waste-water collection and treatment facilities which subsequently discharge into surface water.” The Danish version has the following wording: ”’Forsyningspligtydelse’: alle ydelser, som for husholdninger, offentlige institutioner eller økonomiske aktiviteter af enhver art stiller følgende til rådighed: indvinding, opmagasinering, oplagring og behandling af samt forsyning med overfladevand eller grundvand 22.12.2000 DA De Europæiske Fællesskabers Tidende L 327/7 b) anlæg til opsamling og rensning af spildevand med efterfølgende udledning til overfladevand.” The language concept of the word ”water services” is far wider than the Danish translation “Forsyningsforpligtelser”. The definition of the translation is wrong. In English, the meaning of the word “water services” is: ”‘Water services’ means all services which provide[...]any economic activity:[...]” The English definition includes any service of water for any economic activity. This wide definition also includes the sewage and drainage, as drainage quite obviously fulfills article 2.1.38 a: ”[...]distribution of surface water[...]” One of the definitions used for the Danish word “forsyningspligtydelse” is water use, see article 2.1.39. Water use has the following wording in Danish: ”’[...]Water use: forsyningspligtydelser together with any other activity as laid down according to article 5.1.II which has impact on the status of surface waters and on groundwater. This definition is applicable for article 1 and for the economic analysis to be done according to article 5.1.III. [...]” From article 5 the following can be highlighted: ”’[...]Characteristics of the river basin district, review of the environmental impact of human activity and economic analysis of water use	

	1. Each Member State shall ensure that for each river basin district or for the portion of an international river basin district falling within its territory: - an analysis of its characteristics, - a review of the impact of human activity on the status of surface waters and on groundwater, and - an economic analysis of water use is undertaken according to the technical specifications set out in Annexes II and III and that it is completed at the latest four years after the date of entry into force of this Directive. 2. The analyses and reviews mentioned under paragraph 1 shall be reviewed, and if necessary updated at the latest 13 years after the date of entry into force of this Directive and every six years thereafter. With a correct understanding of "water services", the authorities are obliged to carry out an economic analysis of the impact of different ways of water use, such as agricultural drainage, and an evaluation of how the human activities will impact surface waters and ground water. It may be that general estimates of impact sources have been carried out, but the impact sources are general and do not take human development into account, let alone drainage (water use). So to be absolutely clear; No economic analysis of the water use has been made. A correct implementation of the WFD requires that an economic analysis of the water use has been carried out. This has not happened. Nor has a correct economic consequence evaluation of the water basin management plans and the accompanying directive been carried out. Proportionality The principle of proportionality is used in most EU countries. It is however, the EU principle of proportionality that applies in connection with EU law. Hence the principle applies to the WFD including the models. The principle has been established in a range of rulings with varying wording. In T-290/12 the wording is as follows: "80. It is settled case-law that the principle of proportionality, which is one of the general principles of EU law, requires that measures implemented by acts of the European Union are appropriate for attaining the objective pursued and do not go beyond what is necessary to achieve it (see judgments of 6 December 2005 in ABNA and Others, C-453/03, C-11/04, C-12/04 and C-194/04, ECR, EU:C:2005:741, paragraph 68; of 7 July 2009 in S.P.C.M. and Others, C-558/07, ECR, EU:C:2009:430, paragraph 41; and of 8 June 2010 in Vodafone and Others, C-58/08, ECR, EU:C:2010:321, paragraph 51)." The principle underlines that 1) the content and form of the action must be in keeping with the aim pursued 2) the action must be limited to what is necessary	

	In connection with the nitrogen regulation carried out on basis of the WFD, the principle means that: 1) the nitrogen reduction must be an action that is in keeping with the aim 2) if no. 1 is applicable, the required nitrogen reductions should not supersede what is necessary to obtain "good ecological status". If other sources than nitrogen from agricultural production occur, such as wastewater, "sins of the past" (phosphorous reused year after year as opposed to nitrates), xenobiotics, climate changes, precipitation, etc., this means that it cannot be taken for granted that there is a direct connection between agricultural outlet of nitrogen and "good ecological status". Furthermore, we cannot be certain that the recipients (especially referring to the fjords on the east coast of Jutland) have ever been in a very good ecological state or that they ever will be, or that obtaining a "good ecological status" takes longer than expected and that the present limits have no environmental effect and therefore are not an action that is in keeping with the aim of obtaining "good ecological status". Furthermore, reference is made to a previous ruling from the EU Court of Justice, C-293/97 from 29th April 1999 ("Stanley"). The case is regarding the nitrates directive and includes the principle of proportionality. Based on the proportionality and "polluter pays" principles, the ruling states that the general burden of removing nitrate pollution should not be placed on agricultural production where the pollution does not come from farming. Hence, it is just as important to establish the source of the nitrates. Nitrates come from farming, but there are also other nitrate sources such as old forests, wastewater, nitrate emission from nature areas, etc. Reference is made to a new report from 2017 with the Danish title: "Landbruget og vandområdeplanerne: omkostninger og implementering af virkemidler I oplandet til Norsminde Fjord"* In English: Agriculture and the water basin management plans: Costs and implementation of actions in the catchment of Norsminde Fjord. The following extract of the conclusion** is a translation by Bæredygtigt Landbrug as no English version is available: "'[...]The costs of meeting the demands in 2021 and 2027 totals approximately DKK 800 and 2,900 per HA. Of this the costs for required catch crops, livestock catch crops, and ecological focus areas are approx. DKK 100 per HA. These requirements will mean radical changes in the farming conditions, especially in 2027 where considerable areas are appointed for fallowing. However, what has not been considered or included in the analytics, are the full economic consequences, welfare, regional, and sector wise of these changes; In terms of more nature areas, reduced husbandry breeding, loss of workplaces, and costs for land allocation etc. Therefore, especially for 2027, the calculated costs are subject to strong reservations. On the other hand it can be concluded with great certainty that the 2021 target will be considerably (three times) more expensive [than calculated] and require fallowing of vast areas in order to achieve the 2027 target. [...]" The costs are significant, probably to the extent that agricultural production in the affected areas will not be possible under those conditions. This calls for similar strict demands to accuracy and statistic	

	accuracy of the models. The more drastic the consequences will be in the end, the greater accuracy the models should have. This requires a closer analysis. *https://curis.ku.dk/ws/files/178737610/IFRO_Rapport_258.pdf **The report, page 41.	

3. Danish marine waters

Chapter/section	Comments	Questions
3.1		
3.2		
General		

4. Danish monitoring data DNAMAP (NOVANA)

Chapter/section	Comments	Questions
4.1		
4.2		
4.3		
General		

5. Overview of WFD tool development in a Danish context

Chapter/section	Comments	Questions
5.1		
5.2		
General		

6. Statistical model development

Chapter/section	Comments	Questions
6.1		
6.2		
6.3		
6.4		In more than 40% of the cases, no relation was found between N load and Kd. How is it then possible to assume that the relation is still valid by using the so-called meta model?
6.5		
General		

7. Mechanistic model development

Chapter/section	Comments	Questions
7.1		
7.2		
7.3		
7.4		
General		

8. Model application

Chapter/section	Comments	Questions
8.1	No data – only uncertain model calculations The quality element phytoplankton (measured as chlorophyll concentration) is problematic. As there are no chlorophyll measurements from the reference period around year 1900, there is no measured reference level. At the same time, there are no data for the natural load anno 1900. Therefore, the experts employed by the Ministry of Environment and Food of Denmark have – contrary to good scientific practice – constructed a reference level: The experts have in 2015 made a model calculation of a reference level in relation to the water basin management plans 2015 and going forward. Furthermore, chlorophyll measurement is a simplified operational foundation as the measurements show no information about the quality of phytoplankton and its value in the food web.	How were reference conditions for chlorophyll and Kd estimated in the mechanistic model approach? The reference conditions for chlorophyll (defined by chlorophyll concentrations more than 100 years ago?) are directly related to the target concentrations for the different water bodies, and directly builds (applying modelling?) on the level of nutrient loads required to reach target concentrations. Without (any) old measurements of nutrient concentrations or chlorophyll, the methods to estimate nutrient loads from Danish catchment areas as they were around year 1900 must have been a formidable task. Unfortunately, we cannot find information in the report how these "ancient" nitrogen and phosphorus concentrations in water courses emptying into fjords and coastal waters were estimated. We suggest it would be advisory to submit this important documentation to avoid any suspicions of data-related misconduct or other misunderstandings. If existing nutrient concentrations measured in streams draining uncultivated soil ("naturvandløb") were used to represent reference concentrations, we must remind the reviewing group that the majority of Danish land was cultivated and fertilizer (manure) was used also more than 100 years ago. Therefore, one cannot assume that conditions in "naturvandløb" directly can

		represent streams draining farmed land more than 100 years ago! If other methods were used to estimate ancient nutrient concentrations we would like to know the details. Secondly, irrespectively of the methods used to estimate “reference” concentrations of nutrients in streams 100 years ago such estimates inherently must be associated with very large uncertainties; ± 50% will not be an unreasonable uncertainty range. We would like to know the influence on reference chlorophyll of applying ± 50% nutrient concentration as reference, and how recalculated target chlorophyll and “required” nutrient reductions will be.
8.2		
8.3	The Model Tools Behind the decision of equating the WFD quality element benthic vegetation with the secondary supporting parameters nutrients and light conditions/chlorophyll for determination of environment targets and mitigation demands, is a simplified understanding that less N equals more eelgrass. As the use of nutrients was very limited around year 1900 and as by coincidence substantial historical information about the spread of eelgrass was available for the years 1883-1929, a reference value and an environment target (74% of the reference value, ref. EU intercalibration) for eelgrass spread was constructed in the 1990'ies. The undocumented chain of events, that this strategy is based upon, assumes: - that the eelgrass has disappeared due to light attenuation - that the light has disappeared due to shading phytoplankton (chlorophyll) - that phytoplankton has increased due to more nitrates in the water - and that the increase of nitrates in the water is caused by the increased use of nutrients in agricultural production since year 1900 At least two of the four prerequisites are problematic – for instance more than 80% of light attenuation is due to other factors than chloroplhyll.* Hence the model has also been rejected as steering parameter, yet the Ministry of Environment and Food of Denmark still uses it as basis for determination of environmental requirements.	It is stated that phosphorous loading has significant positive coefficients to Kd in spring-early summer in 14 out og 22 stations. Is it the opinion of the reviewing group that lack of funds and time is an acceptable reason for ignoring the phosphorous effect in the model?

	The model completely neglects the fact that the phosphorous concentration has risen dramatically in coastal areas since year 1900 due to wastewater discharge and that the cause for low secchi depth is a high concentration of phosphorous rather than nitrate. As it is, the model – the so-called Laurentius relation – does not take phosphorous into account at all. Evidently, if you do not look for a connection, you will not find it *In an article from January 2016, Recovery of Danish Coastal Ecosystems After Reductions in Nutrient Loading: A Holistic Ecosystem Approach, written by 13 scientists with professor Bo Riemann, DCE as main author: "In fact, results have shown that chlorophyll accounted for a small fraction, often less than 20 % of light absorption and attenuation". http://link.springer.com/article/10.1007/s12237-015-9980-0	
8.4		
8.5		
8.6		
8.7		
8.8		
General	Exploitation of the Water Framework Directive (WFD) Instead of ensuring "good ecological status" according to the three quality elements (phytoplankton, benthic vegetation, and benthic fauna), the EU Water Framework Directive is being exploited to enforce a limitation of agricultural use of nitrogen fertilizers. The annual NOVANA status reports from the Ministry of Environment and Food of Denmark as well as analytics carried out by the Danish Hydraulic Institute (DHI) for the years 1987-2007, have documented that a 50% reduction of the nitrogen runoff to the marine areas have had no effect on the depth limit of the eelgrass (incidentally nor on secchi depths and oxygen conditions). The Model basis is not tenable: The link	

	between nitrogen input and eelgrass abundance has not been scientifically justified. Despite this, the Ministry of Environment and Food of Denmark continues with the existing nitrogen strategy. This alternative Danish implementation of the WFD is not aiming for “good ecological status” in the marine areas as much as aiming for preventing the farmers from being able to fertilize the crops in a professional and scientifically well-grounded manner. In reality, the Ministry of Environment and Food of Denmark is working on enforcing conversion to organic farming (Although not openly). There is no legal or political basis for such a Modus Operandi in Danish legislation or the EU WFD. **Non-compliance with the Water Framework Directive** The WFD requirement that determination of references must be trough scientific objectivity has not been fulfilled. In 2002 the Danish National Environment Research Institute (DMU) stated (report no. 390 – extract translated by Bæredygtigt Landbrug as no English version is available): “It is however not possible to quantify connections between species composition of phytoplankton, aquatic plants, and benthic fauna and input of nutrients from the catchment the way it has been laid down in the Water Framework Directive”.* So DMU has not been able to describe a connection between the nutrient input from the catchment and the biological quality elements despite the fact that this connection has been the prerequisite for the strategy employed by the Danish Ministry of Environment for 30 years. The WFD requirement for a scientific and objective process apposed with the scientists’ acknowledgement that they “cannot quantify connections between species composition of phytoplankton, aquatic plants, and benthic fauna and input of nutrients from the catchment area”, documents that the Water Framework Directive is not being followed. **An example** That the nutrient models can have substantial consequences can be seen in an example from the water body area of Skive Fjord. Here the model shows that the end target of nitrogen input in 2021 is 6 kg N/HA. The background contribution from nature is 3.5 kg N/HA, which leaves 2.5 kg N/HA available for farming – the main occupation in the area. This means that the local authorities will close down farming entirely in the 144,000 HA coastal zone. It will have no improved influence on Skive Fjord. It might even be that the situation will be worsened due to declining plankton quality caused by lower N:P ratio as a result of the nitrogen limitation. This will again mean that non-edible plankton will be left to rot, thus promoting oxygen depletion. The situation is the same for many other water body areas. It is indisputable that the livelihood of thousands of families will be removed in these areas based on a scientifically uncertain model. *http://www.dmu.dk/1_viden/2_publikationer/3_fagrapporter/rapporter/FR390.pdf	

9. Discussion

Chapter/section	Comments	Questions
9.1		
9.2		
9.3		
9.4		
General		

10.-12 Conclusion, Epiloque, and References

Chapter/section	Comments	Questions
Conclusion		
Epilogue		
References		

Chapter/section	Comments	Questions
Appendix A		
Appendix B		
Appendix C		
General		

Comments and questions

to

'Development of models and methods to support the establishment of Danish River Basin Management Plan, Scientific documentation'

from

The Danish Society for Nature Conservation

Date: 30-06-2017
Written by: Lisbet Ogstrup, telephone: +45 3119 3209, mail: lo@dn.dk

General comments to the evaluation of the models

	Comments	Questions
General	We find that the models and methods used to support the establishment of Danish River Basin Management Plans and described in the Scientific documentation are sturdy, and give a scientific and objective assessment of MAI to each Danish water body.	

General comments to the scientific documentation

	Comments	Questions
General		

1. Prologue

	Comments	Questions

Danmarks Naturfredningsforening

General		

Danmarks Naturfredningsforening

2. Introduction

Chapter/section	Comm ents	Questions
2.1		
2.2	With reference to section 2.1 (page 8) saying: '… a conceptual chance has been introduced to create scientific coherence between the goals of achieving a certain – political defined – environmental quality, and the required reduction of nutrients inputs.' The essence of The Water Framework Directive (WFD) is, that all surface waters shall achieve at least good ecological and chemical status.	Do you find that the ecological status in the Danish plan period 2015-21 can be classified according to the three indicators mentioned in section 2.2.1 (page 9 – 10)? Do you find, that the ecological status in the Danish plan period 2015-21 could have been classified according to more or other indicators, than the three indicators mentioned I section 2.2.1 (page 9 – 10)? If so, do you think, that it would have had influence of the result for the maximum allowable nutrient input (MAI) due to the models for calculation?
General	We notice, that the development of the marine model tools was largely founded on the recommendations of the 'Eelgrass Working Group II'.	Do you find that the marine model tools founded on the recommendations of 'Eelgrass Working Group II' are sufficient? Can you recommend, that the marine model tools founded on the recommendation of the 'Eelgrass Working Group II' is further qualified?

3. Danish marine waters

Chapter/section	Comments	Questions
3.1		
3.2		
General		

Danmarks Naturfredningsforening

4. Danish monitoring data DNAMAP (NOVANA)

Chapter/section	Comments	Questions
4.1		
4.2		
4.3		
General	In the chapter it is mentioned, that originally The Danish National Aquatic Monitoring and Assessment Programme (DNAMAP) probably was the most comprehensive programmes in the world (page 19).	Do you find, that The Danish National Aquatic Monitoring and Assessment Programme (DNAMAP) probably no longer is the most comprehensive programmes in the world? Do you overall find, that the DNAMAP is sufficient according to numbers of stations and monitoring land-based loadings of N and of P in Denmark? Do you overall find that the data from DNAMAP can be used to develop the marina modeling tools as done in the project? Do you overall find that if the land-based loadings of N and P in Denmark had been monitored further in DNAMAP in the period used, it would have result in a greater strength of linear relationship between modeled and observed data, than shown in the project? If so, how much more should there have been monitored in order to get a greater strength of linear relationship between modelled and

Danmarks Naturfredningsforening

		observed data, than shown in the project?

5. Overview of WFD tool development in a Danish context

Chapter/section	Comments	Questions
5.1	We notice the recommendation given by the Eelgrass Working Group II about which models, there should be in focus (page 24). We notice, that both the budget and the time schedule was taking into account when it was adopted an approach involving development of four mechanistic biogeochemical models and statistical models (page 24).	Are those models and methods – or similar models and methods - used to support the establishment of Danish River Basin Management Plans – been develop and used in other countries/water bodies? Are the models and methods used to support the establishment of Danish River Basin Management Plans generally scientifically accepted? Should there have been developed more than four mechanistic biogeochemical models and statistical models (if the budget and the time had not to be taking into account) calculating nutrient reduction requirement and corresponding MAI to obtain GES? Considering the Danish water bodies do you assess, that the four mechanistic biogeochemical models and statistical models developed sufficient covers the Danish water bodies?
5.2	We notice, that it is mentioned, that for the Danish plan period 2015-21, ecological status is classified to three indicators (chlorophyll-a, eelgrass depth limit and a fauna index (DKI). We furthermore notice, that not all of these indicators can be linked to the model toolbox (page 25).	Do you agree that it was necessary to make the adjustments as described in section 5.2 (page 25 – 26)? What is your assessment of the adjustment described in section 5.2 (page 25 – 26)? Could the adjustment have influence on the result of linear relationship between modeled and observed data?

General		

6. Statistical model development

Chapter/section	Comments	Questions
6.1		Do you agree, that the PLS regression models are an appropriate tool taking the argument for the chose mentioned in section 6.1 in to consideration (page 27)? Do you in overall find, that it would have been inadvisable, if PLS regression models had not been chosen as a tool?
6.2		
6.3	We notice, that the predictors was selected due to their known ability to act as forcing factors on the indicators (see table 6.2 at page 30).	Please comment figure 6.1 according to the numbers of official stations compared to the Danish water bodies and their individual characteristics (page 29). Do you find it correct, that only monitoring stations within the zone of WRD and data series with at least 15 years of data during the period 1990 to 2012 with a minimum of one bimonthly observation, has been used (page 29)? Do you assess, that the selected predictors are the right predictors in order to developed statistical models in the project? Could there have been chosen fewer predictors without influencing the project statistical models and the project result of linear relationship between modeled and observed data? To what extent can it have influenced on the statistical models, that all data series have not been analyzed for outliers individually (page 32)? Do you agree, that in order to balance the two aspect of the predictor variables described (page 33) it is correct to specify, that the predictors variables should not start earlier than the year before the responding variable? And do you find, that the rules for predictor variables are sufficient (se also figure 6.3 at page 34)? Do you agree that the additional analyses used to identify the most likely variable in those cases, where different sets of predictor variables described the selected responding variable almost equally, is sufficient (see also page 38)?

6.4	We notice, that it is referred, that a closer autocorrelation analysis revealed, that the historical signal for TN have different effect to different water bodies, but due to the relative short time series available.	Do you access, that there could have been done quantification of autocorrelation in order to improve the models based on time series available? Please comment the two last sections at page 43. Do you agree in the arguments and the assessments in these two sections?
6.5	We notice, that the aim of the project is to provide a model-based management tools for estimation Maximum allowable loadings (MAI) for each of the 119 marine water bodies covered by the WFD in Denmark (page 46).	Do you agree that there is overwhelming evidence in the scientific literature, that nutrient loadings do have an impact on selected response variables (page 46)?
General		

7. Mechanistic model development

Chapter/section	Comments	Questions
7.1		
7.2		
7.3	We notice, that the modelling work, where the focus was on the inner Danish waters did not experience any systematic errors and therefore it could be concluded that the official data on loadings were valid for the purpose of the modeling page 59).	Referring to, that the project found, that the specific acceptance criteria were lower for the coastal areas and enclosed water bodies as specific bathymetric details and local conditions become increasingly important, do you find, that there are scientific evidence for this (page 62)?

Danmarks Naturfredningsforening

7.4		
General		

Danmarks Naturfredningsforening

8. Model application

Chapter/section	Comments	Questions
8.1		
8.2		
8.3	We notice, that there is referred to the principle 'one-out-all-out' in the WFD and the project considers one pressure factor (nutrient loadings) (page 91).	While nutrient loadings are a major pressure factor do you agree that the set up of the project using several indicators to describe the effect of this pressure factor is reasonable and correct? And do you agree that though not taken the principle 'one out all out' into consideration MAI estimated in project is sturdy? Do you agree in the assumption, that a weighted average approach provides a more correct estimate of the maximum allowable load and making it less susceptible to random variation in the data parameters (page 91)? Do you agree in the use of each of six indicators and arguments for the modifications and values of the constant involved (an overview is given in table 8.7 at page 100 – 101))? Do you agree in the approach to handle the described off-sets and thus the assumption, that it is a valid approach as the overall calibration seems strong (page 103)? Do you find that the percentage chosen for 'Categorized in case of time Lag' are correct in order to the estimated GES (see table 8.7 at page 100 – 101)?
8.4		Do you find that the methodology described is sturdy, and combined with the reference values from section 8.1 can be used to estimate the part of the individual indicator that can be regulated from Danish land-based N loadings alone (page 102)?
8.5		Do you agree, that even though the nature of the model types differs pronouncedly, the slopes are very similar, and thus support both the use of models for defining MAI and the application of water body types (page 119)?
8.6		

8.7		
8.8		
General	It should be mentioned, that the year 1900 is chosen as the historical reference conditions in Denmark mainly founded on historical observations documenting eelgrass depth distribution and light penetration at that time. See also section 8.1. This decision is provided in the models. It should be mentioned, too that the historical observation is not used directly, even though there are observations for several Danish water bodies. Instead, it is decided to use the 90 pct-percentil of the historical observations. Furthermore it is decided, that the reference for GES is defined as 25-30 pct. deviation from the reference. This means there has been used a principle saying that despite the historical data shows otherwise it is assumed that GES for Danish water bodies can be estimated at a lower level.	Can the decisions of how to use the historical observation together with the handling of the model uncertainty and sensitivity result in an underestimated nutrient reductions requirement in one or more of the 119 Danish WFD water bodies to fulfill GES according to the WFD?

9. Discussion

Chapter/section	Comments	Questions
9.1		
9.2		

9.3		
9.4		
General		

10.-12 Conclusion, Epiloque, and References

Chapter/section	Comments	Questions
Conclusion		
Epilogue		
References		Do you find the references used in the project are sufficient (page 144 – 163)? Do you find the references support the tool development and application, the specific use for setting chlorophyll-a targets and calculating the load reduction requirements from Danish catchments in the project?

Danmarks Naturfredningsforening

Chapter/section	Comments	Questions
Appendix A		
Appendix B		
Appendix C		
General		

Ramme for kommentarer og spørgsmål til evalueringsrapporten om de danske kvælstofmodeller

Formålet
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General comments to the evaluation of the models

	Comments	Questions
General		

General comments to the scientific documentation

	Comments	Questions
General		

1. Prologue

	Comments	Questions
General		

2. Introduction

Chapter/section	Comm ents	Questions
2.1		
2.2	Per 1: The eel grass tool ”However, though the best availably tool at that time, it…” Ell grass tool was not the best tool at that time. There were models (DHI) which were much better developed.”	
General		

3. Danish marine waters

Chapter/section	Comments	Questions
3.1		
3.2		

General		

4. Danish monitoring data DNAMAP (NOVANA)

Chapter/section	Comments	Questions
4.1		
4.2	An aquaculture plant in Smålandshavet is mentioned as increasing the load here. The discharge of nutrients is very low compared to other sources. Therefore it is incorrect and misleading and should be removed. There hasn't been any new aquaculture farm here in many years. Sentence: " Despite the efforts to reduce the diffuse loads, Danish agriculture remains the major source of both N (80%) and P (50%) in Danish streams, lakes and coastal waters (Kronvang et al. 2005)." is not correct for coastal waters, as external sources are far more important here.	

4.3		
General		

5. Overview of WFD tool development in a Danish context

Chapter/section	Comments	Questions
5.1		

5.2	p. 26 par 2: Is it a lack that biodiversity not is included.	
General		

6. Statistical model development

Chapter/section	Comments	Questions
6.1	p.27 par 1: Statistical linear models with multiple predictors (MLR, mixed models, PLS etc.) have previously been applied in several studies of marine eutrophication published in international peer-reviewed journals (Conley et al. 2007;….” These models are as far as we know not pre-reviewed but only used in reports. There should be a clear discussion of the advantages, as well as the disadvantages of using the statistical models.	Is it right that these models are not pre-reviewed? The models should be pre-reviewed if they are used, and it should be clear that the models are not pre-rewired.
6.2		
6.3		
6.4		

6.5		
General		

7. Mechanistic model development

Chapter/section	Comments	Questions
7.1		
7.2		
7.3	Following sentence is very important: "As can be seen, there is a strong correlation between especially the Danish and the German N loads, but also a rather strong correlation between the Danish and the Swedish loads." It verifies that models only calculating Danish loads are misleading.	

7.4		
General		

8. Model application

Chapter/section	Comments	Questions
8.1	p.73. 8.1.4: Important to discuss the reasonableness of using 1900 as historical reference year in relation to data and natural changeability and fluctuation.	Is it optimal to choose 1900 as historical reference your, or was it better to use an other periode?
8.2		
8.3		
8.4		
8.5	It is important to underline that the statistical models (vs. mechanistic models) overestimate the Danish contribution to the eutrophication in the marine waters.	
8.6		
8.7		
8.8		

General		

9. Discussion

Chapter/section	Comments	Questions
9.1		
9.2		
9.3		
9.4		
General		

10.-12 Conclusion, Epiloque, and References

Chapter/section	Comments	Questions
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Dansk Sportsfiskerforbund

General comments to the evaluation of the models

	Comments	Questions
General	The work with the models started late in the process. The WFD was signed in 2000. This first Danish plan covered the period from 2010-2015	Do you find that the Danish surveillance is sufficient and is this data good enough to support the models? Do you find that there had been the necessary finance and time for the development of the models? Is there the necessary continuity in the model work?

General comments to the scientific documentation

	Comments	Questions
General		

1. Prologue

	Comments	Questions
General		

2. Introduction

Chapter/section	Comments	Questions
2.1		
2.2	**In Denmark the required reduction of nutrients inputs is political defined. And the reduction have been changed in the period – and prosponed.** **We find that The Water Framework Directive (WFD), demands that all surface waters shall achieve at least good ecological and chemical status.**	**Section 2.2.1** **It is possible to classiefi the ecological status in the Danish plan period 2015-21, according to the three indicators mentioned?** **Could the plan have been classified according to other indicators?** **Is the three indicators representative?** **Could that have had influence of the result for the maximum allowable nutrient input due to the models for calculation?**
General	The development of the marine model tools was founded on recommendations of the 'Eelgrass Working Group II'.	Are these tools qualified? Are they sufficient?

3. Danish marine waters

Chapter/section	Comments	Questions
3.1		
3.2		
General		

Dansk Sportsfiskerforbund

4. Danish monitoring data DNAMAP (NOVANA)

Chapter/section	Comments	Questions
4.1		
4.2		
4.3		
General	In the chapter it is mentioned, that originally The Danish National Aquatic Monitoring and Assessment Programme (DNAMAP) in the start was the best programme.	Do you agree? The Danish National Aquatic Monitoring and Assessment Programme (DNAMAP) probably no longer is the best programme in the world? Do you agree? Is the numbers of stations and monitoring land-based loadings of N and of P in Denmark sufficient?

Dansk Sportsfiskerforbund

5. Overview of WFD tool development in a Danish context

Chapter/section	Comments	Questions
5.1	Development of four mechanistic biogeochemical models and statistical models had a budget and time schedule, that set the frame.	Do you find that the necessary money and time was given to the development of the models? Are the models and methods used to support the establishment of Danish River Basin Management Plans generally scientifically accepted? Do you find that the Danish water bodies is sufficient covered, with the used of the mechanistic biogeochemical models and statistical models? Should there have been developed more models calculating nutrient reduction requirement and corresponding MAI to obtain GES?
5.2	**In the Danish plan period 2015-21, ecological status is classified to three indicators.**	**Section 5.2:** **Do you find it was necessary to make the adjustments as described?** **What is your assessment of the adjustment described?** **Will you comment the influence on the result of linear relationship between model and observed data with these adjustments?**
General		

6. Statistical model development

Chapter/section	Comments	Questions
6.1		
6.2		
6.3	We notice, that the predictors was selected due to their known ability to act as forcing factors on the indicators.	Please comment figure 6.1 according to the numbers of official stations compared to the Danish waterbodies and their individual characteristics. Do you find it correct, that only monitoring stations within the zone of WRD and data series with at least 15 years of data during the period 1990 to 2012 with a minimum of one bimonthly observation, has been used? Do you assess, that the selected predictors are the right predictors in order to developed statistical models in the project? Could there have been chosen fewer predictors without influencing the project statistical models and the project result of linear relationship between modelled and observed data? To what extent can it have influenced on the statistical models, that all data series have not been analyzed for outliers individually? Do you agree, that in order to balance the two aspect of the predictor variables described (p. 33) it is correct to specify, that the predictors variables should not start earlier than the year before the responding variable? And do you find, that the rules for predictor variables are sufficient (se also figure 6.3)? Do you agree that the additional analyses used to identify the most likely variable in those cases, where different sets of predictor variables described the selected responding variable almost equally, is sufficient?
6.4	We notice, that it is referred, that a closer autocorrelation analysis revealed, that the historical signal for TN have different effect to different water bodies, but due to the relative short time series available.	Do you access, that there could have been done quantification of autocorrelation in order to improve the models based on time series available?

6.5	The aim is to provide a model-based management tools for estimation Maximum allowable loadings (MAI) for each of the 119 marine water bodies covered by the WFD in Denmark.	Is there evidence, that nutrient loadings do have an impact on selected response variables?
General		

7. Mechanistic model development

Chapter/section	Comments	Questions
7.1		
7.2		
7.3		
7.4		

General		

8. Model application

Chapter/section	Comments	Questions
8.1		
8.2		
8.3	It is well documented that hypoxia or anoxia in the bottom water will accelerate the negative effects of eutrophication, such as loss of macro vegetation, release of both nitrogen and phosphorus from the sediment, fish kills and, ultimately, direct release of hydrogen sulphide to the atmosphere.	Do you agree, that if the low oxygen concentrations are restricted to a deep hole in an estuary, it may not have a significant impact on the estuary as a whole, whereas comprehensive hypoxia covering a large-sized area will most likely result in notable derived negative effects.
8.4		
8.5		
8.6		
8.7		
8.8		
General	The year 1900 is chosen as the historical reference conditions in Denmark founded on historical observations documenting eelgrass depth distribution and light penetration at that time. The historical observation is not used directly, even though Denmark have the data. It was decided to use the 90 pct percentil of the historical observations. The	Do you agree, that the use of the historical data together with the handling of the model uncertainty, result in underestimating the requirement of nutrient reductions in more of the 119 Danish WFD water bodies, just to fulfill GES according to the WFD?

	reference for GES was defined as 25-30 pct. deviation from the reference. Thus you have the data it was decided to assumed that GES for Danish waterbodies can be estimated at a lower level.	

9. Discussion

Chapter/section	Comments	Questions
9.1		
9.2		
9.3		
9.4		
General		

10.-12 Conclusion, Epiloque, and References

Chapter/section	Comments	Questions
Conclusion	To obtain more certain MAI estimates, it is important to continuously monitor the ecosystems as they approach GES and to evaluate, update and improve the models and methods accordingly based on new knowledge. Thus, themodel tools and methods developed in this project should be regarded as part of an ongoing process towards better understanding and improved predictability of the behaviour of marine ecosystems in a changing world.	Do you find that the Danish surveillance is sufficient and is this data good enough to support the models? Do you find that there had been the necessary finance and time for the development of the models? Is there the necessary continuity in the model work?
Epilogue		
References		

Chapter/section	Comments	Questions
Appendix A		
Appendix B		
Appendix C		
General		

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General comments to the evaluation of the models

	Comments	Questions
General	The EU Water Framework Directive (WFD) prescribes all water bodies to attain "good ecological status". In Denmark, River Basin Management Plans (RBMP) are developed to ensure that this goal is achieved. However, considering coastal waters and the framework in which they are used, the models forming the basis for these plans contain a number of flaws and unsupported assumptions. This may cause one of three highly undesirable situations: 1. Doing too little 2. Doing the wrong thing 3. Doing too much Doing too little or doing the wrong thing both means non-compliance with the WFD. Doing the wrong thing or doing too much will also be at a high cost. The RBMP have a unilateral focus on agricultural nitrogen leaching. Omitting all other stress factors may hamper the process towards good ecological status, and unnecessary expenses are likely to occur. This practice hardly lives up to the requirement of the WFD of "*identifying the cost-effective and proportionate level and combination of controls*", and it may result in enormous economic challenges for Danish agriculture. Already in 2012, the EU Commission responded to the first RBMP recommending that "*Appropriate methods for assessing <u>all potential pressures</u> need to be developed"* (SWD, 2012). This is still not addressed, and the RBMP still focus on nitrogen as the only pressure for coastal waters despite overwhelming scientific evidence that numerous other stress factors are important. The purpose of the present comments is to emphasize the major problems in the modeling work forming the basis for the RBMP, hopefully leading the way for management plans comprehensively targeting all relevant stress factors directly. The overall aim must be to live up to the WFD requirements through RBMP based on solid science, thus ensuring that only *necessary* and *effective* measures are imposed.	

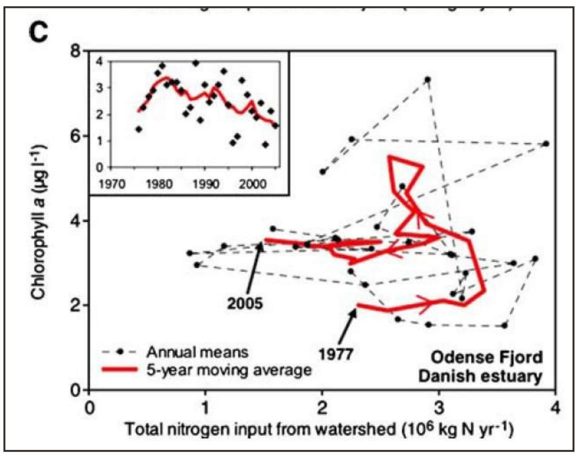
General comments to the scientific documentation

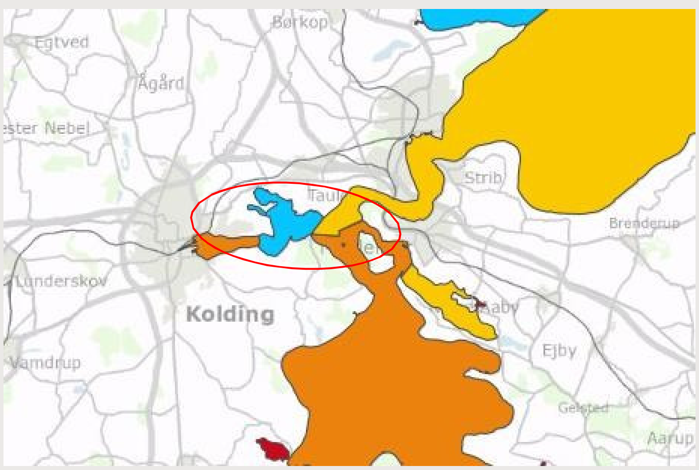
	Comments	Questions
General	The report from Aarhus University (AU) and DHI ”*Development of models and methods to support the establishment of Danish River Basin Management Plans, Scientific documentation*” is a summary of at least nine different reports (in Danish) from the two institutions describing the methods used in this model work. When evaluating scientific work, peer-reviewed papers should be the main focus of the evaluation and only if no such are available, un-reviewed, published reports may be consulted instead, considering the possible reasons for the lack of peer-reviewed publications. In the case of the statistical models, *no peer-reviewed, scientific papers have been published* based on this work. The present comments will in detail describe the numerous problems in the modeling approach, thereby creating an understanding of why publishing of the work most likely has not been possible. In several central points, the English report, developed for the international evaluation, does not include all relevant information. In these cases we will refer to the original reports in Danish, enclosing relevant figures or tables in appendix.	Should eco-system models supporting RBMP build on scientific documentation, i.e. peer-reviewed articles? Can grey literature (reports) provide an adequate basis for the ongoing review? The panel is strongly encouraged to request additional information regarding peer-reviewed articles describing the modeling approach from both DHI and AU.

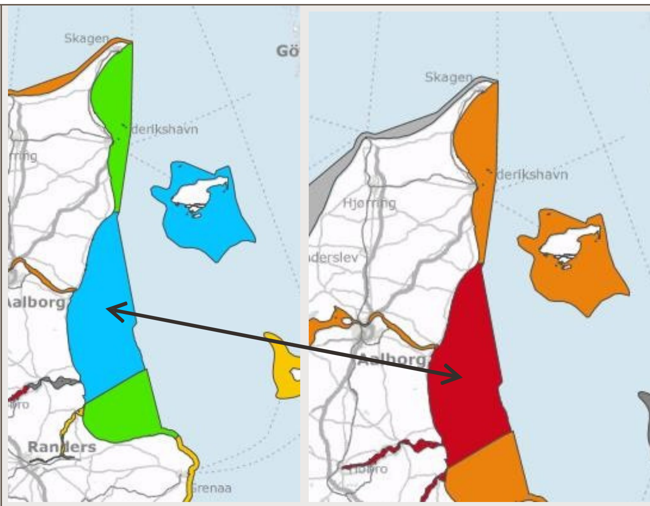
1. Prologue

	Comments	Questions
General		

2. Introduction

Chapter/section	Comments	Questions
2.1	The text in section 2.1 does not touch the central issue in the WFD – returning to good ecological status. Already in 2009, Duarte *et al.* (2009) described the problems with returning to an earlier status. It is obvious that the knowledge of shifting baselines is not used in this work. Marine ecological systems are very complex and the model work and hence the RBMP end up addressing just one stress factor; nitrogen. The complexity as described by Duarte *et al.* (2009) is neglected. Duarte *et al.* (2009) use an example from Odense Fjord in Denmark to illustrate the point with shifting baselines:  *Sample trajectory of annual means of chlorophyll* a *concentrations, as a proxy of ecosystem status, versus total nitrogen loading of Odense Fjord that experienced significant eutrophication followed by significant oligotrophication after management actions. The full black symbols show the annual average values and the red line follows the trajectory of a 5-year moving average. Initial and final years of the time series are indicated. Insert shows the time series and 5-year running average of total nitrogen inputs to the ecosystems.* The figure demonstrates that following elevated nitrogen input levels, a reduction does not result in a complete reversion of chlorophyll *a* levels. Instead, chlorophyll *a* levels remain elevated, even though nitrogen input has decreased significantly. A very important learning from this is that the ecosystem has changed fundamentally and entered a new steady state. Models addressing nitrogen as the only stress factor, thus, are unable to describe the ecosystem well. The Danish RBMP contain no answers to this challenge, as no other stress factors than nitrogen are addressed. This critique is consistent with feedback from the EU Commission (SWD, 2012) presenting the following recommendation to the first RBMP: *"Appropriate methods for assessing **all** potential pressures need to be developed".* The statistical models and meta models do not address other stress factors. The more advanced mechanistic models are	It is clearly demonstrated that returning to good ecological status is not merely a question of reducing nitrogen loads to previous levels. Does the panel agree that several stress factors must be taken into account? Does the panel agree that understanding feedback mechanisms is important in order to implement the right measures for achieving good ecological status?

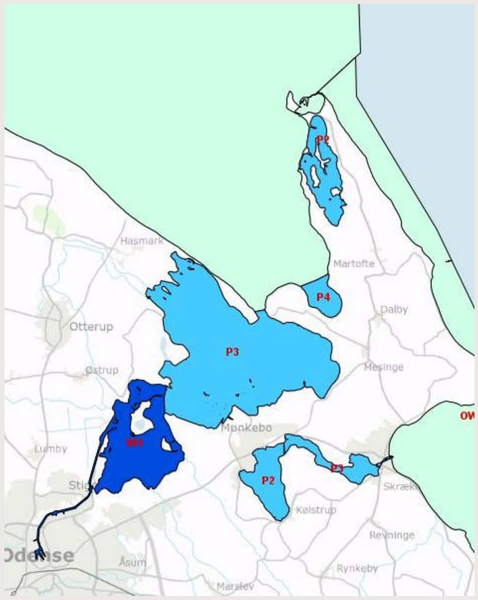
	able to do so, but it has been chosen to focus on nitrogen alone. See further remarks concerning this in section 7.	
2.2	Figure 2.3, page 10 (status of chlorophyll *a*) demonstrates that the targets for Chlorophyll *a* are scattered and random. The reference values for chlorophyll *a* are determined based on model calculations using a very coarse typologization. The problems with this approach will be explained in more detail in sections 3.2 and 8.1. Examples of curious status levels are found e.g. in some fjords, where the inner and outer parts are assigned different status. This is seen for instance in Horsens and Kolding:   It is also demonstrated that there is a poor correlation between the two quality elements eelgrass depth limit and chlorophyll *a*, as can be seen e.g. by comparing Figures 2.3 and 2.4 (eelgrass depth limit) for the Northern East coast of Jutland (see below). Eelgrass depth limit is assigned poor status, but in the same area chlorophyll *a* is in high status. This clearly demonstrates that other factors than chlorophyll *a* impact eelgrass depth limit.	Abrupt changes in ecological status between neighboring water bodies frequently occur, as demonstrated in the comments. Does the panel agree that biologically it does not make sense to see such changes? Do the abrupt changes indicate problems for instance with the typologization being too coarse?

		
General		

3. Danish marine waters

Chapter/section	Comments	Questions
3.1	Many of the 119 Danish water bodies have estuary character and therefore should have been designated "transitional waters" according to the WFD. The EU commission report (SWD, 2012) evaluating the 1st Danish RBMP has the following comments on this subject: *"Transitional waters are not designated, and no justification is given as to why this water category has not been used. Denmark should review its designation of at least some coastal waters, notably those referred to as inner coastal fjords water, and consider transitional water designation, considering physical and chemical factors that determine the characteristics of transitional waters and hence the biological population structure and composition."* Concerning hydromorphology in general, we find that this issue has not been sufficiently described. This is in line with the EU Commission response to the first RBMP recommending that "*Denmark needs to extend its classification system for lakes and coastal waters to address hydromorphological QEs* " (SWD, 2012)	Has hydromorphology for Danish coastal waters been sufficiently described? Why have no Danish water bodies been designated "transitional water", given the description in the WFD? Would it be relevant to re-consider the designation of certain water bodies – in particular the inner, coastal fjords, as suggested by the EU commission?
3.2	The typology is central for the classification of reference conditions and ecological status. What is important to understand is that the original typology description (Dahl *et al.*, 2005) is modified in this work to include only very few. Out of all 119 Danish water bodies, 48 are classified as one type (estuarine type 2) and 23 as another type (estuarine type 3). This means that approximately 60 % of all Danish water bodies are classified as only two different types. This is a major problem because the water bodies do have characteristics covering a much broader spectrum. Already in 2012, the commission (SWD, 2012) made this recommendation to the first RBMP: *"Denmark needs to further develop water typologies which are tested against biological data, and develop and provide further information on reference conditions for all water types."* Since 2012, the applied typology has been simplified to a highly problematic point. Examples of this are: Odense Fjord at Funen (Fyn): At the figure below, it is seen that the original typology is named M4 for inner Odense Fjord (darkest blue	The European Commission has requested that Denmark further develops water typologies. Is it acceptable to simplify typologization to a degree where highly different water bodies must live up to similar environmental threshold values? Physical modifications, such as dams and bridges, are not taken into account in the typologization. Does the panel agree that dams and, to some extent, bridges may impact the exchange of water? Only in two cases are fjords with a sluice designated the "sluice fjord" typology. Does the panel agree that as a basic premise, the presence of a sluice should require an individual assessment of the impact of the modification, and if necessary specific threshold values for the given fjord?

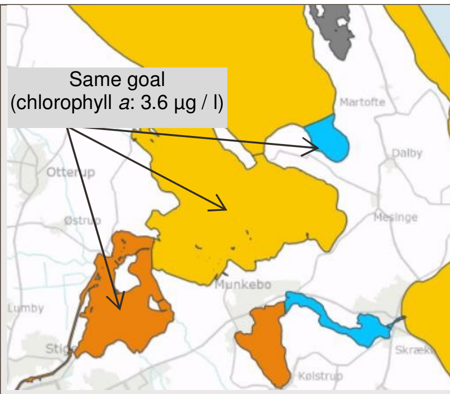
color), P3 for outer Odense Fjord and P4 for the small bay (Dalby Bugt) just east of the fjord. These names refer to the typology as defined by Dahl *et al.* (2005) (see Table 3.1, page 16).



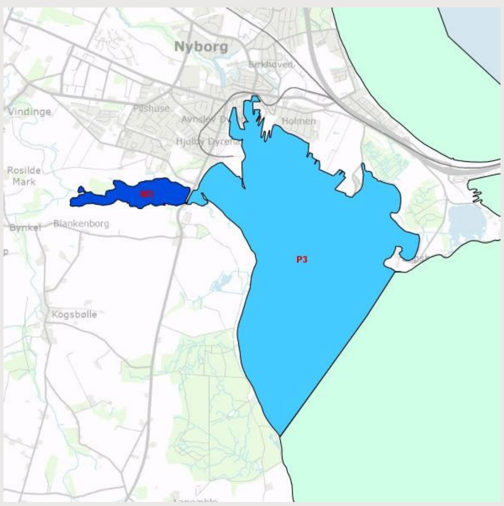
However, with the current typologization, the three water bodies belong to the same type, type 3, and thereby the same model complex determining chlorophyll *a* threshold values. This is shown in Table 3.1.

The inner part of Odense Fjord receives freshwater from a catchment half the size of the island of Funen (Fyn) and is, thus, naturally exposed to high nutrient levels. Dalby Bugt, on the other hand, receives freshwater from only a small catchment and given the large opening towards open water, water exchange is rapid. Because of the simplification, all three water bodies, however, share the same chlorophyll *a* threshold value of 3.6 µg / l

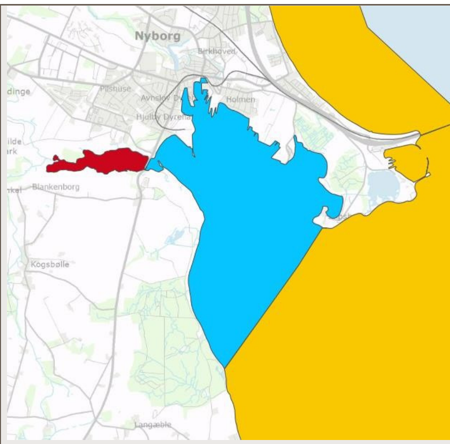
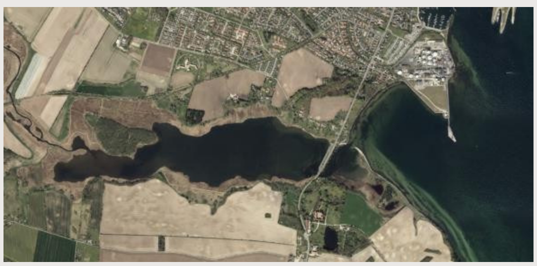
This of course results in big differences in status of the water bodies, ranging between high and poor status as shown in the figure below.



Nyborg Fjord at the east cost of Funen (Fyn):
As seen below, the original typologies are M3 and P3, but in the simplified version used in the RBMP, both are classified as type 3 (Table 3.1).



The figure illustrates how big the difference of the water bodies is, as the M3 water body is almost closed behind a dam, while the P3 water body has an open boarder to Great Belt, an area with strong currents and, hence, rapid water exchange. Again, the threshold between good and moderate status is 3.6 µg / l for both. This means that status changes from bad in the inner part to high in the outer, open, part of the fjord, as seen below.

	 The dam is clearly seen in the photo below, and the existence of the dam likely explains much of the problems using the same, type 3, typology:  In addition to the simplification of typologies, specific choices during typologization are difficult to understand. Most obviously, when a sluice, type 5, is present, then why is the water body in question not classified as type 5? An example of this is Norsminde Fjord, which is classified as type 3. However, a sluice is obviously present, as seen in the photo below. 	
General		

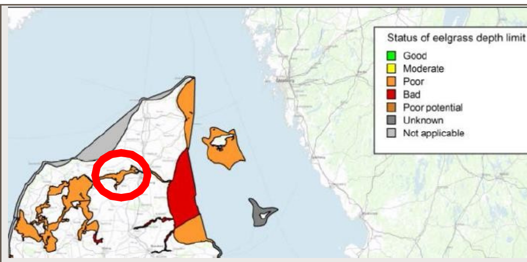
4. Danish monitoring data DNAMAP (NOVANA)

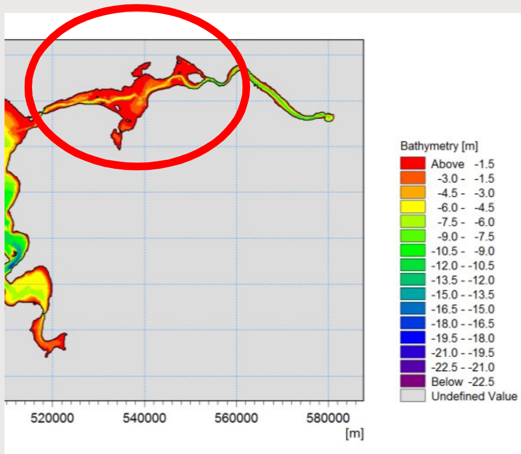
Chapter/section	Comments	Questions
4.1	The monitoring carried out in Danish marine waters does not cover all water bodies with specific nitrogen reduction targets. Only very few typologies are applied to the 119 Danish marine water bodies (see section 3.2). It would be of interest to the panel to be presented with an overview of data categories and the extent of monitoring to compare with the original typology (Dahl, 2005) as described in section 3.2 In addition, the monitoring of seagrasses has not been presented. Being a key indicator of the WFD, eelgrass monitoring is of high importance. Traditionally, monitoring has mainly been focusing on depth limit instead of area cover. It could, therefore, be of interest to the panel to be presented with the actual seagrass monitoring program.	Considering the extensive use of models, does the panel find the ongoing monitoring program sufficient? Meta models are used when modeling data is insufficient. As meta models are developed in different water bodies than where applied, they often produce result of high uncertainty. Should the monitoring program be extended in order to reduce the use of meta models?
4.2	Nitrogen loading, on an annual basis, is the target of action in the Danish RBMP. A new analysis carried out in Karrebæk Fjord indicates that this approach is problematic for water bodies with low residence time. The new analysis demonstrates that winter and spring land-based loading of nitrogen only play a minor role for the summer (May - September) chlorophyll *a* concentration due to the low residence time for water in Karrebæk Fjord. In winter, 90 % of the water has been exchanged within 10-16 days (see Appendix 1). These results are of great importance to all water bodies with little or medium residence time. Instead of focusing on annual land-based nitrogen loads, focusing on loads at relevant points in time may have a dramatic impact on the required load reductions. Figure 4.4, where annual loads (kg N / water body ha / year) are presented, will then not give a relevant picture. Generally, water bodies with high loads have little or medium residence time because it is small water areas compared with the catchment.	See questions regarding this point in section 9.1
4.3		

General	The monitoring program has been decreased at the same time as the government introduced different reduction targets for each water body. In total, Denmark has 119 water bodies more or less affected by Danish nutrient loads. However, the monitoring program does not cover all water bodies, and even very ambitious reduction targets are introduced in water bodies with no monitoring program. This is highly problematic, because without data there would be no models. This problem is solved by introducing meta models; however, as will be elaborated in section 8.6, this approach introduces other problems.	

5. Overview of WFD tool development in a Danish context

Chapter/section	Comments	Questions
5.1	It is explained that meta models are used for "too small" water bodies and when data availability is limited. As described in the original reports in Danish, also a third way leads to meta models: When nitrogen load was not selected by the MLR-method as input variable for a given statistical model. In these cases, the actual model was discarded and replaced by a meta model. (See Appendix 3, Table 6, comment marked with *). This will be further commented in section 8.6.	Have scientific criteria for identification of 'too small' water bodies been established / provided?
5.2	The WFD operates with three "biological quality elements", of which angiosperm distribution is one. In the Danish context, eelgrass depth limit is used to describe the angiosperm distribution and is intercalibrated as such. However, eelgrass is not the only angiosperm to be found in Danish, marine waters, and the substitution is therefore unacceptable. Shallow areas with a healthy angiosperm distribution fulfilling the requirements of "good ecological status" may be assigned with an inferior ecological status, if eelgrass is not the dominating species. An example of this is Ringkøbing Fiord, which has a healthy population of other angiosperms than eelgrass due to brackish water. However, using Kd as an indicator for eelgrass depth limit, a nitrogen reduction demand of 75 % has been assigned this area. According to the procedure described in section 8.3, and our comments to the same, this refers to a calculated reduction demand above 200 %. This is in contrast to the fact that other species, such as spiral tasselweed (*Ruppia cirrhosa*) and sago pondweed (*Potamogeton pectinatus*), already not only cover huge areas of shallow water but also reach the depth limit set for good ecological status. Another example is found in a specific area in Limfjorden, where approximately 80 % of the area is covered with eelgrass. However, the eelgrass does not reach a specific depth in the narrow channel through the area. Because of this, the area is designated poor ecological status in spite of the widespread distribution of eelgrass. The example is illustrated in the figures below.	Is it acceptable to disregard species of angiosperms other than eelgrass, e.g. spiral tasselweed, even though specific areas have abundant populations of these? Is it reasonable to assign poor ecological status, concerning "other aquatic flora", to areas with a widespread eelgrass population, but where eelgrass is not found at the bottom of e.g. an artificial channel in the fjord?





Kd is a physico-chemical quality element; basically the transparency of the water.

Even though light is indispensable for growth of eelgrass, lack of light is very far from being the only reason that eelgrass populations may not increase. The Danish research projects REELGRASS and NOVAGRASS (ongoing) and a large amount of peer-reviewed papers have for the last 15 years pointed at very specific stress factors, which have to be addressed for eelgrass to recover.

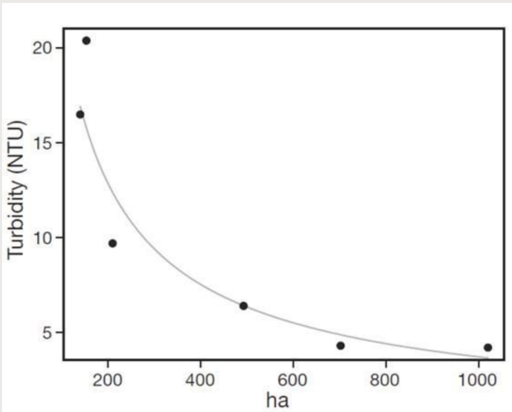
In the Danish context, important stress factors in addition to nutrient load are:

- Organic matter
- High organic content in sediment (inner fjords)
- European green crab. International literature from the last five years describes how these crabs prevent recovery or even cause decline in seagrass cover
- Sand transport has been a great stress factor in many Danish waters preventing eelgrass recovery since a massive decline in the 1930ies, caused by disease.

Eelgrass in itself is also a measure to increase water transparency and thereby increase depth limit for eelgrass or other seagrasses.

Numerous factors influence the eelgrass depth limit. Is it reasonable to focus exclusively on Kd as a proxy?

Is it possible, maybe even likely, that eelgrass will not, even after a time lag, spread to the required depth limit if only one stress factor is addressed?

	At the east coast of the USA, a recovery of eelgrass beds of more than 2000 ha have been made by harvesting and sowing eelgrass seeds. This recovery has had a positive impact on the ecosystem and has lowered the turbidity dramatically (see figure below) along with the nutrient concentration in water.  *Relation between turbidity and area of eelgrass (ha) recovered by human restauration efforts. From Orth* et al. *(2012).* The way to recover eelgrass and to have better ecosystem functioning is therefore not only a question of reducing nitrogen but to address the interaction between land loads and recovery in coastal waters.	
General		

6. Statistical model development

Chapter/section	Comments	Questions
6.1	The cited ”earlier work on MLR” (Markager *et al.* 2006, 2008) are non-peer reviewed reports. Thus, both previous work and the present reports have not passed a scientific peer-review. Peer-reviewed papers are the only acceptable reference for any scientific work. For the statistical models in the present report, and similar models in previous reports, no peer-reviewed papers have been published. It must be questioned why no publishing has taken place.	
6.2	According to this section, PLS models were developed “*with the main purpose of quantifying the relationship between nutrient loadings and the selected response variables”*. Thereby presuming that there is a direct relationship between them, unaffected by other factors. This approach is repeated in section 6.3. As commented in Appendix 2, the main problem of selecting factors in advance is that some factors might be overlooked and thus not included in the model and, hence, in the conclusions. A PLS model will highlight the specific factors that are important to the model, thereby allowing a quantification of their relationship. Selecting factors in advance means that the model will be biased towards the selected factors.	Does the panel agree that selecting input variables in advance is a problematic approach, which is unnecessary given the many advantages of PLS regression?
6.3	“Four responding variables (…) were chosen as environmental indicators due to their well-documented response to nutrient enrichment”. The panel is kindly reminded that the WFD aims at improving the ecological status of water bodies, not at reducing nutrient inputs. Selection of predictor variables is described in section 6.3.1 (page 29), and it is stated that the purpose of the regression models is to “*quantify the relationship between the responding variable and the predictor variables especially the nutrient loading which can be managed*”. At no point do the authors address the fact that only part of the nutrients in Danish coastal waters derives from Danish land-based nutrient load. This is a serious point of critique, as not accounting for all nutrient input, along	Is choosing responding variables based on which factors they respond to an acceptable method in accordance with scientific standards? Should non-Danish contributions to the total nutrient load in Danish marine waters be taken into account when developing regression models describing the ecosystems in these waters?

	with other stress factors, will reduce the model's ability to explain the response variable.	
	According to equation 6.2, detrending was used for preprocessing data. The exact settings for the detrending are not stated in the paper, why the strength of the detrending is unknown to the reader. However, as the climate has changed significantly since the reference year (1900), as described later in section 9.1.3, it is curious that a "normal climate" is used for calculations.	Should the trend in climate change be included in the model work?
	As commented in Appendix 2, it is unusual to use MLR for variable selection, followed by PLS for the actual modeling. MLR is unable to handle correlated variables, as it is actually noted on page 36. PLS on the other hand is perfectly able to handle correlated variables, and it is therefore curious why MLR is used at any point. Imagine two (or more) correlated predictor variables, which describe a given factor in a quantitative manner through their correlation, and only through their correlation. By excluding certain factors beforehand, such a correlation and the relationship to the responding variable will not be found. Several variable selection methods are available for PLS, easily accessible in the specific PLS program package from Eigenvector® that was used in the modeling.	Has variable selection been carried out in a satisfactory way? Could important information potentially be lost through the applied procedures, specifically the use of MLR for variable selection before PLS modeling?
	Specific comment to page 36: "*we experienced that the parameters (PLS coefficients) were still sensitive to small variations in the data set when highly intercorrelated predictors (r > 0.9) were used, making use of highly correlated data sets problematic even in PLS regressions*". As already described, PLS is able to handle intercorrelated predictors very well. Excluding correlated variables therefore means that important information could be lost. It is unclear in which way highly correlated data sets turned out "problematic". This is elaborated in Appendix 2.	Does the panel agree that omitting intercorrelated variables, which are very well handled by PLS regression, might mean that important information is lost?
6.4	It is noted that the Kd models do not describe data very well. This is explained by influence of light absorption by dissolved organic matter and detritus as well as scattering of light by particles. This clearly shows that the wanted Kd level cannot be obtained by acting on nitrogen load alone.	When the ecological status of Kd is determined by several factors in addition to N loading, is it then scientifically correct to investigate and address only N loading? Is good ecological status obtainable when other variables of significance are not addressed?

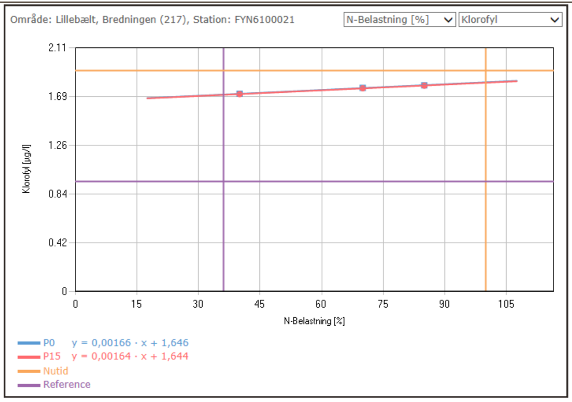
	When assessing the target nitrogen loads, and thereby the required nutrient reduction, the developed models are extrapolated down to the desired nitrogen load level. This extrapolation is highly questionable as in most cases it will reach far out of the defined range of the correlation. It is argued that due to substantial year-to-year variations, the lowest values in the extrapolations are nearly encompassed by the models. However, this point is made based on national data. Extrapolation of correlations to determine required nutrient reductions are carried out for each model, and as required reductions frequently exceed 100 % (Appendix 3, Tables 6 and 7 from the original report); this is hardly within the defined range of the correlation.	Is it problematic to extrapolate a correlation far out of its defined range, as is done in the statistical model approach?
6.5		
General	It is unfortunately necessary to inform the panel that the described approach of modeling seems to have changed from the original reports, in Danish, to the English report forming the basis for the present evaluation. A phrasing such as "…we have assumed that nutrient loadings do have an impact on the selected response variables and we therefore designed the method to provide the *most likely coefficient* for this response" (section 6.5) is in contrast to page 7 of the original report no. 3 (translated): "The main principle in developing the statistical models is selecting the explanatory variables (nutrient loading, climate etc.), which best describe a given indicator (i.e. chlorophyll *a*, Kd, TN and TP)."	The panel is kindly requested to reflect and comment on the evaluation report differing from the original, Danish reports, which form the basis for RBMP. What is the value of an international evaluation, if the background reports have been altered at critical points?

7. Mechanistic model development

Chapter/section	Comments	Questions
7.1		
7.2		
7.3		
7.4	The calibration and validation of mechanistic models, like that of statistical, is crucial. If the models do not react like expected it is often because the ecosystem is not fully understood and action should be taken to fully understand the processes of the ecosystem to highlight the important pressures.	It does not seem that the mechanistic models are used for studying all relevant aspects of the ecosystem. Would it have been relevant to use mechanistic models for analyzing other scenarios than reducing nitrogen and phosphorus?
General	Different aspects of the various water bodies' ecosystems could have been investigated by using the models. One example is oxygen depletion, which is a major problem for the central Limfjord. Oxygen depletion is linked very closely to stratification and warm summer days with no wind. Solutions for this could have been highlighted with different scenarios but have not been done. Only reducing nitrogen from land has been proposed. As already described, eelgrass cover has important feedback mechanisms in the ecosystem, including increased nutrients uptake and decreased resuspension. Measures such as eelgrass restauration and change in sluice practice could therefore be included in scenarios using the mechanistic models, and knowledge on the effect of this could be obtained.	Why are only scenarios of nitrogen and phosphorus load reductions included in the modeling work? Alternative scenarios, focusing on different stress factors, would support the work towards finding the most promising solutions.

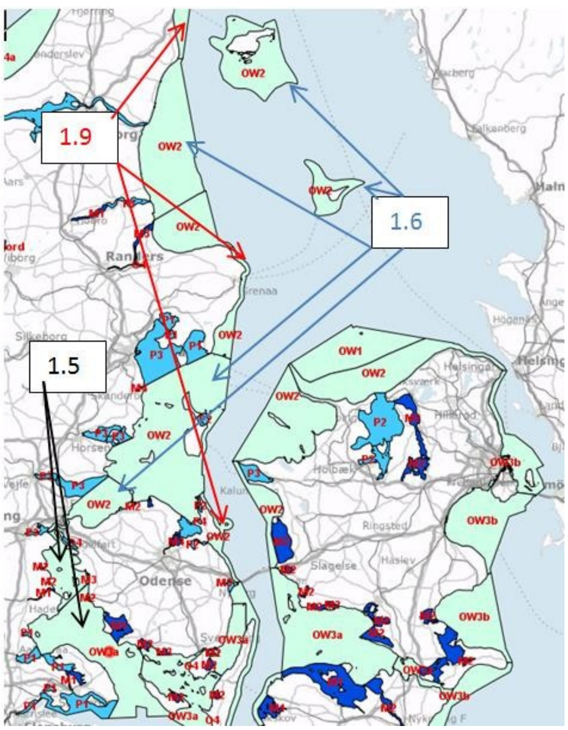
8. Model application

Chapter/section	Comments	Questions
8.1	The chlorophyll *a* reference value is central in the modeling work. Finding a value for that can be approached in several ways. As stated in the report, no data was available for the reference year, 1900, and hence, a model approach was chosen, using models correlating nitrogen and chlorophyll *a*. Using a model describing the relationship between nitrogen load and chlorophyll *a* and using this relation to determine the reference value means that determining the threshold value of chlorophyll *a* (moderate to good status) becomes solely dependent of nitrogen. Thus; all other stress factors are deemed irrelevant with no reference to the biological complexity. In this work, water body typology plays a central role. It is stated on page 71 that: *"In order to reduce (some of) the uncertainties, we have applied a typological approach where site-specific model results were used to establish robust type-specific reference and target values transferable to Danish water bodies."* What is stated is not the case. The typology is far too simple, as explained in section 3.2. Ending up with only two different type specific reference values covering 71 water bodies out of 119 is a major problem. Threshold values for open waters are presented in Table 8.6. It is seen that the "type-specific GM target value" varies between 1.5 and 1.9 µg / l. Two issues should be noted here: 1) Only very minor changes in the chlorophyll *a* target value make a big difference in the nitrogen reduction target because the response curves are almost flat. The figure below shows the correlation between Danish nitrogen loads (X-axis) and chlorophyll *a* (Y-axis). It is clear that changing the target value from 1.5 to 1.9 would mean significant changes in required nitrogen reductions. The weak response in chlorophyll level to reductions in nitrogen load indicates that chlorophyll concentrations are likely to depend more significantly on other factors than on Danish land-based nitrogen loads.	Does the panel agree that the almost flat response curves describing the correlation between nitrogen load and chlorophyll *a* result in large uncertainties on the estimated nitrogen load reductions? Does the panel find that the certainty of the reference load in 1900 has been satisfactorily accounted for? And does the panel find that it falls within an acceptable range?



The correlation between chlorophyll concentration (µg / l) and nitrogen load (%) in Lillebælt. Figures covering all of Denmark are available at: http://vandplan.dhi.dk

2) In some cases the "type-specific GM target value" seems to decrease from open water towards land. This is opposite of what would be expected. For example, the threshold value is 1.6 µg / l at the islands in the middle of Kattegat (Læsø, Anholt) while it is 1.5 µg / l closer to the shore and thereby closer to Danish land-based loads. Se threshold values indicated on the map below.



8.2		
	Quoting the report page 90: "…this implies a restriction to indicators for which a reference condition and an EQR value for good-moderate status have been established." It is important to notice that the *mechanistic* models are restricted exactly to such indicators, namely chlorophyll *a* and Kd. The statistical models, on the other hand, include the four "supporting indicators" as described. None of these four indicators have a defined reference condition or EQR value, and there are no scientific references indicating any previous usage of this approach anywhere.	Can the two model approaches be compared directly, given that the statistical modeling approach requires the inclusion of four supporting indicators, whereas the mechanistic approach does not?
	The one-out all-out principle means that the ecological status of a water body is governed by the *biological quality element* of lowest status. Comparing the one-out all-out principle with the weighting approach used for the statistical models therefore makes little sense. In addition, the supporting indicators are used in a highly questionable way, which will be elaborated below.	Does the panel find that using a weighted average is in acceptable compliance with the WFD?
8.3	**The indicator "chlorophyll *a*-concentration"** It is reported that 17 out of 28 chlorophyll *a* models have a significant nitrogen coefficient. In Table 6.3, which presents the various models, only 24 chlorophyll *a* models are presented, of which 16 include nitrogen load as a predictor variable, six include phosphorus (one has both N and P) and three have neither nitrogen nor phosphorus as a predictor variable. Thus, only 67 % of the presented models have nitrogen as the first selected predictor variable, why focusing exclusively on reducing nitrogen loads to obtain good ecological status seems like a curious choice. 88 % of the models have either nitrogen or phosphorus as a predictor variable – not 93 % as noted in section 8.3. It is noted that percent load reductions (PLR) range between zero and 134 % for the chlorophyll *a* indicator, and that values above 100 % are most frequently found in open areas of Kattegat and the Belt Sea, where statistical models are not used. This is, however, not the case. Enclosed, as Appendix 3, are Table 6 and Table 7 from the original, Danish reports showing the occurrence of values above 100 %. Values above 100 % frequently occur, definitely also in closed, coastal water bodies, such as Stege Nor and Holckenhavn Fjord, to mention just two examples. It occurs most frequently and with the highest numbers, but not only, for water bodies where meta models have been used for assessing	When only 67 % of the developed models have nitrogen as a predictor variable, is it reasonable to focus exclusively on nitrogen regulation? Or should other factors be taken into account? Percent load reductions above 100 % frequently occur for models on the chlorophyll *a* indicator. Not only in open waters, also indeed in closed fjords. Numbers as high as 135 % (Haderslev Fjord) are included in the weighted average to give the final PLR. Is including unrealistic model results in further calculations acceptable, scientific practice? Or should it be considered that maybe the model is not optimal if yielding unrealistic results?

PLR.	
The indicator "light attenuation" The problem with eelgrass being the only angiosperm included in the Danish RBMP has been elaborated in section 5.2, but it is likewise relevant when discussing the indicator "light attenuation". A direct correlation between nitrogen load and Kd is assumed. The correlation is, however, not that simple. The most important elements determining light attenuation are particles, dissolved matter and phytoplankton, of which only the latter is to some extent related to nitrogen load. From 1989 to 2013, nitrogen load in coastal areas in Denmark was reduced by 50 %; however, Secchi depths (and thereby Kd) remained unaltered (Hansen, 2015), demonstrating a lack of correlation. It is also stated in the modeling report that eelgrass will not necessarily reach the depth limit even if nitrogen load is reduced as requested, as re-inhabitation is delayed. When the eelgrass is lost, the physical conditions at the bottom may change and thereby prevent that re-inhabitation takes place at all; the habitat is lost (Flindt *et al.* 2011). Complementary actions are not addressed nor included in the RBMP. A "transformation" of data is described, "to overcome the effects of this time lag on the estimated load reductions". However, what is actually done, as seen in Table 8.7 on page 101, is that calculated values are changed into arbitrarily selected values. If PLR is between 25 and 100 %, it is changed into 25 %. 100 – 200 % is changed into 50 %, and calculated values above 200 % are presented as 75 %. By consulting the tables in Appendix 3, it is clear that calculated PLR values above 200 % are very frequent! In other words: The developed Kd models calculate nitrogen load reductions of up to more than twice the present nitrogen load. To make up for these impossible results, *calculated* values are replaced by *chosen* values.	Is it reasonable to link nitrogen load and angiosperm distribution directly, without considering other stress factors? Is it acceptable scientific practice to replace clearly erroneous results with values that are *chosen*, based on no scientific evidence or calculations?
Occurrence of Hypoxia / Ecological Signs of Hypoxia Occurrence of low oxygen conditions, or ecological signs of the same, is directly translated into a demand of 25 % reduction of total nitrogen (TN), which is again translated into nitrogen reduction demand by using a TN model (page 96 of DHI/DCE report). No calculations of any form are carried out to assess the 25 %, and there is no argumentation or any references for this choice. In the Danish reports, the choice is explained by saying that "it has to be sufficiently high to move the system"	Is it common, scientific practice to simply choose a nitrogen reduction demand? Is it acceptable to base regulation on numbers chosen without any scientific basis, calculations or references? Could the TN reduction demand just as well have been 20 %? 30 %? Or 15 %?

	(report no. 3, “Statistiske modeller og metoder til bestemmelse af indsatsbehov”, DCE 2015, page 18), with no reference to locations where different levels of nitrogen reduction have been tested.	
	Nitrogen limitation of phytoplankton growth Again, please be advised that this indicator is not used in the calculations using mechanistic models. As for Kd models, the calculated values are changed according Table 8.7, though the change is less dramatic than for Kd.	
	Weights – as noted in Table 8.7 According to the table, chlorophyll and Kd model results are each given the weight 2, “occurrence of hypoxia” and “N limitation” are each given the weight 1, and the two “ecological signs of hypoxia”-indicators each have the weight 0.5. For most water bodies, chlorophyll and Kd model results, thus, make up 4/7 = 57 % of the final result. When using meta models, only chlorophyll, Kd and “occurrence of hypoxia” are included, using the same weights. This means that for these water bodies, chlorophyll and Kd make up 4/5 = 80 % of the final result. The table below demonstrates how the supporting indicators affect the final results of the statistical model approach by making up part of the weighted average. The table shows weighted averages with and without the supporting indicators.	Is it acceptable to include supporting indicators which, in almost all cases, lead to lower required reductions – in the statistical and not in the mechanistic models? Is it acceptable to include four supporting indicators which, in almost all cases, lead to lower required reductions in the designated statistical models - and including only one supporting indicator in the meta models?

Water body no.	Chl a	occurrence of hypoxia	Ecological signs of hypoxia	N limitation of phytoplankton growth	Kd	Average with extra indicators	Average without extra indicators
	Indicators used in statistic modeling						
2	13	0	23	31	0	11	7
44	19	26	13	0	25	18	22
92	54	0	16	10	25	26	40
96	103	0	0	0	50	44	77
102	59	79	0	6	75	50	67
147	7	0	0	0	0	2	4
156							
157	91	68	34	20	50	58	71
214	66	39	0	11	50	40	58
216	66	38	0	7	25	32	46
224	134	0	0	37	50	58	92

It is obvious that including the supporting indicators in most cases reduces the final PLR substantially.

8.4

8.5

It is noted in this section that "…statistical models are "black-box" models with a direct link to observations but without any descriptions of causal links"

This, unfortunately, is not consistent with the actual modeling approach. Discarding models when nitrogen is not selected as an input variable (see Appendix 3, comments to Table 7 marked with *) is a choice, not something that happens in a "black box".

Likewise, the "black box" – approach also seems inconsistent with the statement in section 6.2 that the PLS models were developed "*with the main purpose of quantifying the relationship between nutrient loadings and the selected response variables"*

In other words, focusing exclusively on nutrient loadings was a choice made in advance of the actual modeling

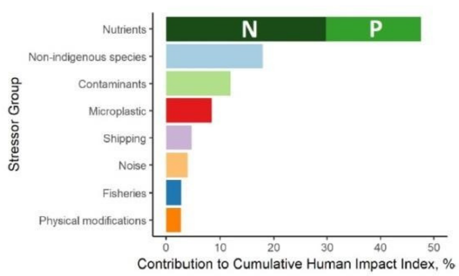
Is it acceptable to describe a modeling approach as a "black-box" approach, when in fact input variables to some extent are selected in advance?

8.6	Meta models are used for water bodies where no mechanistic or statistical model has been developed, for various reasons. However, for the statistical models, meta models are also used, if nitrogen load was not selected as an input variable. This is not clearly described in the English text, but by consulting Appendix 3, it is seen that for nine out of the 28 water bodies (32 %) presented in the pictured Table 6 from the original report, nitrogen load reduction based on chlorophyll was calculated using a meta model, because nitrogen load was not selected as an input variable in the original model. The same is the case for eight of the Kd models, still out of 28 (equal to 29 %).	Is it acceptable scientific procedure to omit results that differ from the expected? In this case meaning when nitrogen load is not selected as an input variable.
	The idea in meta models is to apply models from different water bodies to a water body of the same type. A great part of the problem with meta models is, thus, the rough typologization, assigning highly different water bodies to the same type, as explained in section **Fejl! Henvisningskilde ikke fundet.**. As discussed in section 8.3, nitrogen load reduction demands frequently surpass 100 %. This problem is especially relevant when using meta models, as can be seen in the pictured Table 7 in Appendix 3. This supports the arguments that the criteria for using meta models are not acceptable and that meta models do not describe the water bodies, where they are applied, sufficiently well.	Would a more differentiated typologization possibly improve the applicability of meta models?
	One specific example of the implications of problematic use of meta models is Stege Nor, a small water body with very limited opening towards open water. A satellite image of Stege Nor is presented in Appendix 4. A final nitrogen load reduction demand of 77 % is calculated for Stege Nor using meta models, without addressing the 122 % reduction based on chlorophyll as part of the average. In a Natura 2000 report (Naturstyrelsen, 2013), Stege Nor is described as a water body with a healthy vegetation and beds with eelgrass in the deepest parts. Large specimens of the pollution sensitive stoneworts (Charophyceae) are found in smaller beds around the cove, and the fauna in and around the cove is described as “well developed”. In other words, nitrogen load reductions of 77 % are demanded in the catchment area, even though the water body is described as healthy and with a thriving flora and fauna. A most likely explanation for the special case of Stege Nor is a deviating value in reference chlorophyll concentrations. As seen in Appendix 4, summer chlorophyll concentrations are generally below 5 µg/l. However, in 2011 as much as 30 µg/l	Is it reasonable to include a measured value so clearly deviating from the general level? Should it be expected that input data for models of this type are comprehensively screened for outliers?

	was reported.	
8.7		
8.8	As a comment to the calculations of model uncertainty, it is important to know that the calculations presented here, to the international panel, are completely different from the original calculations which were presented to Danish politicians and the public. The original calculations are erroneous and have been strongly criticized. Researchers from the Technical University of Denmark (DTU) have made a thorough description of these problems. This has been translated into English and is enclosed with these comments as Appendix 5. The DTU researchers suggested an alternative calculation, which has been presented to Aarhus University, DCE. This calculation, also found in Appendix 5, is what is shown in the present report for the international evaluation. The DTU researchers have not been quoted for the suggestion. The panel is kindly advised to take note of this and include in the final report that the original calculations are erroneous and based on problematic assumptions, whereas the calculations presented here derive from the specific DTU paper presented in Appendix 5.	
	The analysis of variance results in a minimum confidence interval of ± 13.3 %-points. Thus, for three out of the 11 water bodies in question, no required load reduction has been demonstrated, as the mean reduction is less than 13.3 %. It is important to note that the ± 13.3 %-points are a *minimum* uncertainty, and no maximum uncertainty can be calculated. On page 130 it is stated that "*the assumption of independency might not be fulfilled. Especially the neighbouring water bodies (water body 156 and 157) might be correlated*". It should be very clear that neighboring water bodies in all cases will be correlated, and the non-independence of water bodies is the reason why no maximum uncertainty can be determined.	Given that neighboring water bodies are definitely correlated, does the panel find that a confidence interval of ± 13.3 %-points *based on an assumption of independence* provides useful information on the actual uncertainty? See further questions in section 8, General

	Quantification of model uncertainty The presented analysis of variance shows, by a very narrow margin (P = 0.06), no significant difference between required nitrogen load reductions calculated by mechanistic and statistical models. However, as previously discussed, the final result using mechanistic models is an average between results based on a chlorophyll model and on a Kd model. For statistical modeling, one or three further indicators are taken into account in the average. Instead of comparing final results, it is therefore relevant to compare results based on chlorophyll and Kd models, respectively. The calculations are presented in detail in Appendix 6. In brief, percent required load reduction based on chlorophyll models were compared using a two-way analysis of variance (carried out in Excel). The outcome was a P-value of 0.038 for the effect of model type, i.e. model results differ significantly between mechanistic and statistical models. For Kd, a similar calculation resulted in P = 0.05, meaning the models are just significantly different. However, if inserting the lowest value in the interval of *actual* model results, i.e. the results before assignment of new values (as described in section 8.3), the result is P = 0.026. Thus, results based on Kd models also differ significantly between mechanistic and statistical models. Based on these results, the two-way analysis of variance cannot be reduced to a one-way analysis of variance as in the presented report.	The panel is kindly requested to comment on the statistically significant differences between model results using the mechanistic and the statistical approaches, respectively.
General	All calculations of uncertainty are based on the final results concerning required nitrogen load reductions. It is shown that the available data are insufficient for determination of the maximum confidence interval. Furthermore, no investigations are carried out concerning uncertainty of model input. Throughout both statistical and mechanistic modeling procedures, assumptions, choices and calculations add uncertainty to the final results. This is further elaborated in Appendix 5. No attempt is made at quantifying these uncertainties at any point. In effect this means that the actual uncertainty of the final model results is largely unknown.	No attempt is made to quantify the uncertainties arising from model input and through modeling procedures, using both mechanistic and statistical approaches. Does the panel agree that a solid assessment of uncertainties of the models is missing?

9. Discussion

Chapter/section	Comments	Questions
9.1	The WFD requests that each member state ensures "a review of the impact of human activity on the status of surface waters" (article 5 (1)). In the Danish RBMP, no thorough review of all relevant stress factors was performed, and N is the only stress factor addressed. However, a thorough cumulative impact assessment of stressors caused by human activity in Danish marine waters has recently been carried out by NIVA Denmark. This analysis will be published before September 2017, and it is attached here in full as Appendix 7. A scientific paper based on the report has been drafted and will be submitted to Journal of Marine Systems before September 1st, 2017, for consideration, peer-review and publication. The analysis is based on a data set including 35 human stressors and their impact on 47 ecosystem components. The human stressors are pooled in eight groups for easier interpretation. In the figure below (on page 86 of Appendix 7) an overview is provided for stressor contributions in percent of total cumulative impact in the WFD area. Effects of climate change have not been included in this figure. Locally, the distribution of stressors may differ widely, as elaborated in the report. Stressor impact distribution along transects going from open water to the bottom of fjords is presented in the report for more detailed insight.  *Figure A6.2 in Appendix 7* The figure shows that N is responsible for approximately 30 % of the total pressure on Danish coastal waters. It is, thus, aggravating that 100 % of the measures are directed towards this single stress factor. Non-indigenous species and their impact on marine ecology so far have not been considered at all in Danish RBMP. A species such as the round goby (*Neogobius*	The goal of the RBMP is to obtain good ecological status, as stated in the WFD, not to reduce nutrient loads. Should other stress factors than nitrogen load therefore be taken into account in the RBMP? Is it realistic that acting solely on a single stress factor will be the best way to attain good ecological status for all required elements? Is it possible that if acting only on a single stress factor, the need to reduce impact from this will be higher than by using a combined effort on several stress factors? The WFD has a requirement of applying a cost-effective approach. When leaving out clearly relevant stress factors from the modeling, can it be claimed that the RBMP live up to this requirement?

	melanostomus) is already established in several Danish water bodies. It feeds, amongst other things, on mussels. Areas with dense populations of the round goby may experience a sharp decline in mussel population leading directly to high levels of chlorophyll in the water, as filtration will be at a minimum. Thus, the effect of non-indigenous species may be misinterpreted as an effect of land-based nitrogen loads. With the present modeling approach, non-indigenous species will directly affect both Kd and chlorophyll models. But a great part of the actual problem will not be addressed. The stressor groups shipping, noise, fishery and physical modifications are of lower importance; however, locally they may have significant influence on the marine environment (Appendix 7, page 26-27). The enclosed report (Appendix 7) therefore provides substantial evidence that focusing exclusively on nitrogen as a stress factor and directing all measures towards nitrogen is an insufficient approach to obtaining good environmental status in Danish coastal waters.	
	The impact of future climate changes is briefly discussed, and climate changes in the form of increased temperature and precipitation since 1875 are mentioned. It is noted that these changes have not been taken into account in the modeling work. Please be advised that effects of climate changes since the reference year (1900) have been actively removed from the statistical models, as discussed in comments to section 6.2. The thorough analysis carried out in Appendix 7 includes climate change on an overall level, but not in the local analyses along the described transects. It is shown (Figure 3.6, page 23) that climate change makes up as much as 15 % of the total stress of the Danish marine environment. The effects of climate change, hence, cannot be overlooked in RBMP, and actively removing the effect will seriously deteriorate the quality of the models.	Does the panel find that climate change can be omitted when estimating which ecological status can be obtained in Danish coastal waters?

	The hydraulic residence time in a water body is of great significance to the biological effect of nutrients released into the water. This is not taken into account in the Danish RBMP. Timing of nutrient release is yet another factor that is not included. The growing season for algae is from spring to fall (March – September). The main part of nitrogen loss from fields takes place during winter months. No attention has been given to time periods of nitrogen loads in mechanistic nor in statistical models of the RBMP. The mechanistic models simply use the annual nitrogen load. For the statistical models, various time periods were tested. However, it was not investigated which time periods ended up being included in the models. Apparently, a list of selected time periods was made recently; however, this has not been released. Hence, the reader is not informed whether the selected time periods appear meaningful in a biological sense. Karrebæk Fiord is a shallow and relatively closed lagoon with a hydraulic residence time of about two weeks. Most of the nutrients entering the fjord during winter months are, thus, likely to have left again before the onset of the growth season for algae and phytoplankton. This notion was investigated thoroughly by DHI using mechanistic modeling. The report describing the analysis is attached as Appendix 1. Four scenarios were tested. One scenario reducing N load with the amount required in the RBMP, reductions distributed evenly over the year. This scenario was compared to three other scenarios with reductions concentrated in winter months, late winter and in summer months. The conclusion is that the impact of winter reductions on summer chlorophyll and Kd is negligible. Reductions in late winter likewise have minor impact on summer chlorophyll and Kd. Reducing nitrogen load in summer months, on the other hand, directly lead to improvements in chlorophyll and Kd. Reducing nitrogen load at the correct time also means that the required reductions are much smaller than when reductions are distributed over the year. Hence, taking period of nutrient loss and time of algal growth season into account is crucial in order to obtain the optimal effect of nutrient load reductions.	It is known that the nitrogen lost during winter months in many water bodies with short residence time will be gone (washed to sea) before the onset of the algal growing season. Based on this, should timing of nitrogen reductions be included in the modeling work? Various time periods are selected for input variables in the statistical models, but the periods are not included in the public reports. Should this information be included in order to evaluate the models better from a biological perspective?

9.2	**Chlorophyll *a* targets** It is described how reference values are determined according to type of water bodies, instead of based on the individual water bodies. As discussed in section 3.2, the applied typology is very coarse, with the majority of Danish coastal water bodies classified in only two types, and hence, given only two different chlorophyll *a* targets. This leads to a situation where type-specific reference values are hardly more precise than site-specific values **Chlorophyll *a* as indicator** The discussion mentions high grazing pressure and high density of benthic filter feeders as cases where chlorophyll *a* levels do not increase in spite of high nutrient loads. It is curious that the authors do not mention the opposite cases, e.g. when benthic filter feeders are almost absent because of stressors different from land-based nutrient loads. This is discussed in more detail in section 9.1 and in the report attached as Appendix 7.	Do more data lead to more accurately determined reference values for a specific water body, if the data derive from widely different water bodies assigned to the same type?
9.3	The statistical model approach is again described as built solely on monitoring data “without including any process descriptions or mechanisms”. The panel is kindly reminded that in all cases where nitrogen load was not selected as an input variable, the model has been discarded and replaced by a meta model.	
	For the statistical models it is repeated that “*a suite of ecological[ly] relevant indicators […] was introduced in order to obtain a more holistic approach*”. Again, the panel is kindly reminded that no suite of ecological indicators was introduced to support model results from the mechanistic modeling approach. Comparing the final results from the two approaches directly is therefore a questionable procedure.	
	The comparison of results from the two modeling approaches “*revealed an overall satisfactory agreement between the two model approaches*” according to the presented report. This, unfortunately, is not true. In section 8.8.1, page 129, it is described that a two-way analysis of variance gives P = 0.06. The estimated percent load reductions are, thus, very close to being significantly different between the two modeling approaches. As described further in our comments to section 8.8, comparing model results on	

	chlorophyll *a* and Kd models, respectively, clearly shows that the two modeling approaches yield significantly different results. Tables 8.3 and 8.4 (on page 79) are further mentioned as proof that results only deviate slightly between approaches. However, this is not the case. In the table below, differences, numerical and in percent, between the chlorophyll *a* reference values calculated by mechanistic and statistical models as presented in Table 8.3 are shown: **WB no.** / **Mech.** / **Stat.** / **Diff.** / **Diff (%)** **165** / / 2 / - / - **1** / 1 / / - / - **102** / 1 / 1.1 / 0.1 / 10% **147** / 1 / 1.3 / 0.3 / 30% **2** / 2.5 / 2.2 / -0.3 / -12% **92** / 1.3 / 4.1 / 2.8 / 215% **123** / 1.4 / 1.7 / 0.3 / 21% **156** / 1.8 / 2.4 / 0.6 / 33% It is clear that large and very large deviation between results from mechanistic and statistical models are common.	
9.4	Regime shifts are mentioned and briefly discussed. Such shifts are central to the critique of extrapolating correlations between chlorophyll *a* and nitrogen load far beyond the defined range. For instance the “eelgrass disease” in the 1930ies, which killed a vast part of the Danish eelgrass population, very likely caused a regime shift. The same could be the case of stone fishing, significantly altering bottom conditions in many larger water bodies; to mention just two examples.	
General	It is mentioned that model development should be based on “state-of-the-art knowledge”. The panel is, once again, advised to pay attention to the lack of peer-reviewed publishing of the statistical models. A report alone cannot be accepted as scientific documentation!	

10.-12 Conclusion, Epiloque, and References

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List of Appendices

Appendix 1: Dannisøe, J.G. & Erichsen, A., 2017. Optimisation of the Nitrogen Loadings to Karrebæk Fjord. Seasonal Effects from Nitrogen Reductions. DHI.

Appendix 2: Skov, T., 2017. Comments to data analysis part in the report “Development of models and methods to support the establishment of Danish River Basin Management Plans”.Chemometrics and Analytical Technology, University of Copenhagen.

Appendix 3: Tables 6 and 7 from the original reports in Danish.

Appendix 4: Additional information about Stege Nor.

Appendix 5: Møller, J.K. & Christiansen, L.E., 2016. Memorandum regarding “Modeller for danske fjorde og kystnære havområder”. DTU Compute, Technical University of Denmark.

Appendix 6: Alternative Analysis of Variance.

Appendix 7: Andersen, J.H., Harvey, T., Kallenbach, E., Murray, C., Al-Hamdani, Z. & Stock, A., 2017. Under the surface: A gradient study of human impacts in Danish marine waters. NIVA Denmark Water Research.