Estimating uncertainty of data limited stock assessments
Many methods exist to assess the fishing status of data-limited stocks; however, little is known about the accuracy or the uncertainty of such assessments. Here we evaluate a new size-based data-limited stock assessment method by applying it to well-assessed, data-rich fish stocks treated as data-limited. Particular emphasis is put on providing uncertainty estimates of the data-limited assessment. We assess four cod stocks in the North-East Atlantic and compare our estimates of stock status (F/Fmsy) with the official assessments. The estimated stock status of all four cod stocks followed the established stock assessments remarkably well and the official assessments fell well within the uncertainty bounds. The estimation of spawning stock biomass followed the same trends as the official assessment, but not the same levels. We conclude that the data-limited assessment method can be used for stock assessment and that the uncertainty estimates are reliable. Further work is needed to quantify the spawning biomass of the stock.
Registrering af fangster i de danske kystområder med standardredskaber. Nøglefiskerrapport 2014-2016

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Number of pages: 134
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Publisher: Institut for Akvatiske Ressourcer, Danmarks Tekniske Universitet
Fish stock assessment under data limitations developing a new method based on a size-structured theoretical ecology framework

Fish stock assessment is an integral part of every fisheries management system. Modern assessment methods require data about the fishery and the stock, such as catches, survey estimates, aging information and life history parameters, all of which is difficult and expensive to gather. However, the majority of global fish catches come from species that lack an official assessment due to lack of data. That is true especially for small scale fisheries and fisheries in developing countries. New methods are in need that require little amount of easily attainable data and provide scientific advice for fish stocks that are not assessed. The goal of the thesis is to develop a new data-limited stock assessment method that is: rooted in theoretical ecology, requires only information about the size composition of the catch or surveys (i.e. aging is not required), and does not require time-series. The method provides estimates of fishing mortality and the FMSY reference point, it is tested and validated, and is implemented as software package making it easy to use by stakeholders of different levels.

The basis of the method is a size-based theoretical ecology framework that describes exploited fish stocks. The model parameters correspond to Beverton-Holt life history invariants, which reduces the number of parameters and allows data-limited assessments to borrow information from data-rich stocks. The mathematical formulation of the single species population dynamics is used in a maximum-likelihood optimisation framework to estimate model parameters. The data-limited method estimates at the same time the fishing mortality rate and the biological reference point FMSY. Minimum data requirements consist of a single size frequency distribution from the commercial catch or a scientific survey. If the total catch is known, important quantities about the stock (e.g. biomass of spawners, recruitment) can be quantified. The method is tested using simulated data and validated using a subset of available data from data-rich fish stocks. The implementation of the method as a software package in the R programming language is publicly available.

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Centre for Ocean Life, Department of Applied Mathematics and Computer Science
Authors: Kokkalis, A. (Intern), Andersen, K. H. (Intern), Thygesen, U. H. (Intern), Nielsen, A. (Intern)
Number of pages: 140
Publication date: 2016

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Original language: English
Main Research Area: Technical/natural sciences
Publication: Research › Report – Annual report year: 2017

Trends in marine climate change research in the Nordic region since the first IPCC report

Oceans are exposed to anthropogenic climate change shifting marine systems toward potential instabilities. The physical, biological and social implications of such shifts can be assessed within individual scientific disciplines, but can only be fully understood by combining knowledge and expertise across disciplines. For climate change related problems these research directions have been well-established since the publication of the first IPCC report in 1990, however it is not well-documented to what extent these directions are reflected in published research. Focusing on the Nordic region, we evaluated the development of climate change related marine science by quantifying trends in number of publications, disciplinarity, and scientific focus of 1362 research articles published between 1990 and 2011. Our analysis showed a faster increase in publications within climate change related marine science than in general marine science indicating a growing prioritisation of research with a climate change focus. The composition of scientific disciplines producing climate change related publications, which initially was dominated by physical sciences, shifted toward a distribution with almost even representation of physical and biological sciences with social sciences constituting a minor constant proportion. These trends suggest that the predominantly model-based directions of the IPCC have favoured the more quantitatively oriented natural sciences rather than the qualitative traditions of social sciences. In addition, despite being an often declared prerequisite to successful climate science, we found surprisingly limited progress in implementing
interdisciplinary research indicating that further initiatives nurturing scientific interactions are required

**General information**

State: Published

Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, University of Iceland, Greenland Climate Research Centre, Stockholm University, University of Oslo, University of the Faroe Islands, Åbo Academy University, University of Bergen, University of Helsinki


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- Scopus rating (2008): SJR 2.282 SNIP 1.714
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Assessing stock status instead of fishing mortality reduces the need for information on growth

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Kokkalis, A. (Intern), Andersen, K. H. (Intern)
Number of pages: 1
Publication date: 2015
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Limits to the reliability of size-based fishing status estimation for data-poor stocks
For stocks which are considered “data-poor” no knowledge exist about growth, mortality or recruitment. The only available information is from catches. Here we examine the ability to assess the level of exploitation of a data-poor stock based only on information of the size of individuals in catches. The model is a formulation of the classic Beverton–Holt theory in terms of size where stock parameters describing growth, natural mortality, recruitment, etc. are determined from life-history invariants. A simulation study was used to compare the reliability of assessments performed under different information availability scenarios, from data-limited, where none of the parameters are known beforehand, to different degrees of information availability cases where one or more parameters are known. If no parameters are known it is possible to correctly assess whether the fishing mortality is below Fmsy in more than 60% of the cases, and almost always correctly assess whether a stock is subject to overfishing. Adding information about age, i.e., assuming that growth rate and asymptotic size are known, does not improve the estimation. Only knowledge of the ratio between mortality and growth led to a considerable improvement in the assessment. Overall, the simulation study demonstrates that it may be possible to classify a data-poor stock as undergoing over- or under-fishing, while the exact status, i.e., how much the fishing mortality is above or below Fmsy, can only be assessed with a substantial uncertainty. Limitations of the approach are discussed

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources
Authors: Kokkalis, A. (Intern), Thygesen, U. H. (Intern), Nielsen, A. (Intern), Andersen, K. H. (Intern)
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Journal: Fisheries Research
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What are the major global threats and impacts in marine environments? Investigating the contours of a shared perception among marine scientists from the bottom-up

Marine scientists broadly agree on which major processes influence the sustainability of marine environments worldwide. Recent studies argue that such shared perceptions crucially shape scientific agendas and are subject to a confirmation bias. Based on these findings a more explicit engagement with scientists' (shared) perceptions of global change in marine environments is called for. This paper takes stock of the shared understanding in marine science of the most pertinent, worldwide threats and impacts that currently affect marine environments. Using results from an email survey among leading academics in marine science this article explores if a shared research agenda in relation to global change in marine environments exists. The analysis demonstrates that marine scientists across disciplines are largely in agreement on some common features of global marine change. Nevertheless, the analysis also highlights where natural and social scientists diverge in their assessment. The article ends discussing what these findings imply for further improvement of interdisciplinary marine science.
Marine climate change research in Nordic regions: recent trends and current state

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Organisations: Department of Applied Mathematics and Computer Science, National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, Section for Marine Living Resources
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Size-based estimation of the status of fish stocks: simulation analysis and comparison with age-based estimations

Estimation of the status of fish stocks is important for sustainable management. Data limitations and data quality hinder this task. The commonly used age-based approaches require information about individual age, which is costly and relatively inaccurate. In contrast, the size of organisms is linked to physiology more directly than is age, and can be measured easier with less cost. In this work we used a single-species size-based model to estimate the fishing mortality (F) and the status of the stock, quantified by the ratio F/Fmsy between actual fishing mortality and the fishing mortality which leads to the maximum sustainable yield. A simulation analysis was done to investigate the sensitivity of the estimation and its improvement when stock specific life history information is available. To evaluate our approach with real observations, data-rich fish stocks, like the North Sea cod, were investigated and our estimations were compared to the ICES advice. Only size-specific catch data were used, in order to emulate data limited situations. The simulation analysis reveals that the status of the stock, i.e. F/Fmsy, is estimated more accurately than the fishing mortality F itself. Specific knowledge of the natural mortality improves the estimation more than having information about all other life history parameters. Our approach gives, at least qualitatively, an estimated stock status which is similar to the results of an age-based assessment. Since our approach only uses size-based catch data, it is a suitable tool for data-limited situations.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Marine Living Resources
The aim of this project is to improve the knowledge basis, data, and methodology for providing robust stock assessment and short term forecast according to MSY for data limited fish stocks with importance for Danish commercial fishery.

Background
A number of fish stocks in the Baltic, Skagerrak-Kattegat and North Sea area with importance for Danish commercial fishery either as target species, commercially important by-catch species, or as unintended by-catch species are data limited stocks with no analytical stock assessment. More than 60% of fish stocks that ICES gives advice on are category 3 and 4. These categories include stocks for which the data and knowledge are insufficient to conduct a full analytical assessment of their state and exploitation. Until now, ICES has not been able to assess their state relative to the objective of achieving MSY (Maximum Sustainable Yield) sustainability. A major task of fisheries management is broadening from the narrow analysis of few main commercial species toward accounting for by-catches, i.e. the great range of species and sizes of lesser importance caught at the same time in non-selective fisheries (mixed-fisheries). This unwanted part of catches is becoming politically important because it may trigger restrictive management decisions for the commercial fisheries, both as part of the ecosystem-based marine management (EU MSFD), and because of the potential of these species to become limiting for some fleets in the frame of the landing obligation (=discard ban) of the EU CFP, i.e. when a fishery can be closed because it has reached the authorized catch quantity (quota) of a low-value species even though it still has some quota left for more valuable commercial species (so-called “choke species” effect).

Tasks and Deliverables
- Develop assessment and forecast models and methods for stocks in the categories 3-4 and integrate them as standard models and software in the ICES advisory framework in relation to method development and assessing data poor stocks in special working groups (ICES WKLIFE V-VI, ICES WKPROXY) and in standard stock assessment working groups covering the Skagerrak-Kattegat, Baltic Sea and North Sea areas (ICES WGNSSK, ICES WGBFAS).
- Apply the models to selected fish stocks with importance for Danish fishery with the aim of promoting analytical and benchmark assessments to assess stock status relative to MSY objectives. Application of these methods mean that the status of those category 3 and 4 stocks can be classified as desirable or undesirable in relation to MSY objectives, and the stocks can be lifted to category 2 or 1 stocks with analytical assessments. The stocks are selected in close collaboration and agreement with the Ministry of Environment and Food (several directorates), the fishing industry and associations (DF), NGO environmental stakeholders and Science (DTU Aqua).
- The work includes estimation of fish stock growth parameters, performing yield per recruit analyses, and conducting stock assessments with application of a stochastic stock production model and/or a length based stochastic assessment
model, as well as where possible a stochastic age based VPA stochastic assessment model.
- Management Strategy Evaluation (MSE) for selected stocks: Establishment of biological (biomass- or fishing mortality based) reference points for each of the selected stocks involving growth models and logistic models (ogives). MSE for establishing output-based harvest control rules according to short to medium term forecasts for the selected stocks. This includes provision and further development of model software to carry out MSE of the selected stocks.
This project is coordinated by DTU Aqua.
The project is funded by the Danish Ministry of Environment and Food (under Framework Contract with DTU).

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Period: 01/07/2015 → 01/03/2017
Number of participants: 5
Research areas: Fisheries Management & Marine Living Resources
Project participant:
Pedersen, Martin Wæver (Intern)
Berg, Casper Willestofte (Intern)
Kokkalis, Alexandros (Intern)
Phd Student:
Bossier, Sieme (Intern)
Project Coordinator:
Nielsen, J. Rasmus (Intern)

Sustainable bycatch in Danish fishery - Reasonable management under the landing obligation (39028)
he project facilitated a more robust advice of by-catch species in the Danish fishery in the Skagerrak by suggesting and testing stock assessment approaches for data poor stocks as well as providing guidance for various options to reduce by-catch without limiting the target fishery.

The approach applied in the projects was suggested to be adopted for other areas where the landing obligation potentially can be restrictive for target fisheries (mixed-fish cases). Through thorough exploration of existing data in survey time-series it was possible to provide size-based life-history models to gauge the sensitivity of stocks in relation to fishing pressure.

The models were used to determine relevant biological reference points for the most relevant by-catch species and the resulting assessment and stock status was then compared to the prevailing ICES/RGLIFE classification. Finally, the project suggested upgrading the stocks to a higher and less restrictive ICES category for management purposes where possible.

This project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

National Institute of Aquatic Resources
Section for Marine Living Resources
Danish Fishermen's Association
Danish AgriFish Agency
Period: 01/06/2012 → 31/01/2014
Number of participants: 5
Research areas: Marine Living Resources & Fisheries Management & Marine Populations and Ecosystem Dynamics
Project participant:
Gislason, Henrik (Intern)
Andersen, Ken Haste (Intern)
Jørgensen, Ole A. (Intern)
Phd Student:
Kokkalis, Alexandros (Intern)
Project Manager, academic:
Worsøe Clausen, Lotte (Intern)
Project
Grey-box methods for size-based estimation of fish stocks

National Institute of Aquatic Resources
Period: 01/03/2012 → 02/06/2016
Number of participants: 7
Phd Student:
Kokkalis, Alexandros (Intern)
Supervisor:
Nielsen, Anders (Intern)
Thygesen, Uffe Høgsbro (Intern)
Main Supervisor:
Andersen, Ken Haste (Intern)
Examiner:
Mosegaard, Henrik (Intern)
Fernández, Carmen (Ekstern)
O'Brien, Carl Michael (Ekstern)

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Source: Internal funding (public)
Name of research programme: Eksternt finansieret virksomhed
Project: PhD

Press clippings:

An Expedition covering covering the Danish Coast's from the 18th July - 22nd August, 2016
Elliot John Brown, Ole Henrksen, Aurelia Pereira Gabellini, Asbjorn Emil Wilken Andreasen & Alexandros Kokkalis
31/08/2016
National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Monitoring and Data

Media contribution (1)

An Expedition covering covering the Danish Coast's from the 18th July - 22nd August, 2016
31/08/2016
YouTube (International), Denmark, Web
Kasper Due Bække
05:35
https://www.youtube.com/watch?v=NaFccdjFuNs
Elliot John Brown, Ole Henrksen, Aurelia Pereira Gabellini, Asbjorn Emil Wilken Andreasen & Alexandros Kokkalis
National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Ecosystem based Marine Management, Section for Monitoring and Data

Relations
Projects:
Habitat Suitability for Recreationally Important Finfish of the Inner Danish Waters
Flatfish nursery grounds (38176)
FishHab-II (39345)
Press / Media