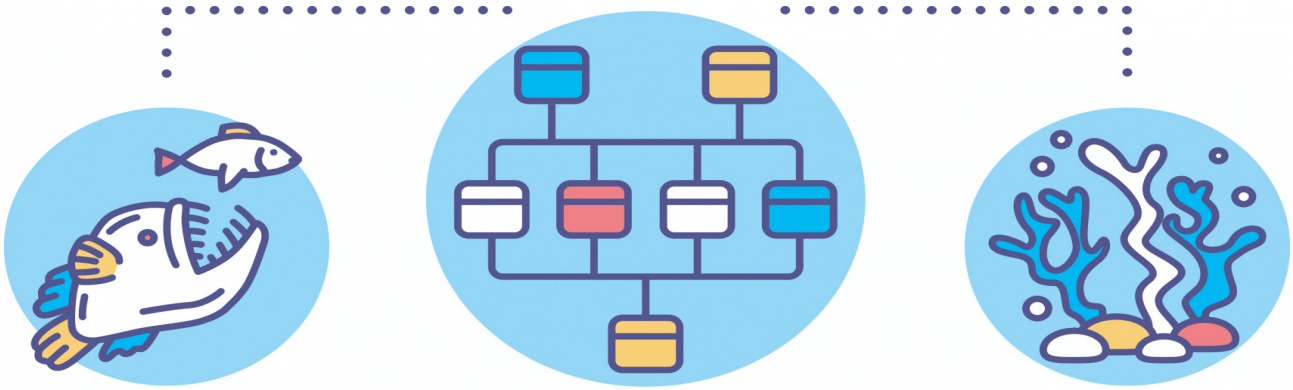
the Nansen LEGACY

Best practices for ecological model evaluation II 2019

Workshop Report



The Nansen Legacy Report Series 7/2020

Best practices for ecological model evaluation II

Oslo, September 23 - September 25, 2019

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Executive summary

The second Nansen Legacy workshop on best practices for ecological model evaluation, chaired by Benjamin Planque (IMR) was held at the University of Oslo on the 23-25th September 2019. The meeting was attended by 15 participants from five institutions. The objective of the workshop was to develop a protocol for describing the evaluation of ecological models.

The workshop started with a test of the evaluation protocol, drafted during the first workshop in 2018. For this purpose, the evaluation protocol was applied to specific applications of six ecological models (Gomperz, Norwecom, Atlantis, NDND, EwE and NorCPM/ESM). In a second phase, workshop participants engaged into open discussions about the efficacy of the protocol, how well it could be understood, and how comprehensive it was. The workshop continued with group work, during which the different sections of the protocol were revised. These were reviewed and commented in plenary, revised again, and discuss in plenary again. This iterative process led to an updated protocol.

The standard protocol for describing the evaluation of ecological models contains three main sections: Overview, Patterns and Evaluation, which are sub-divided in subsections. The draft will serve as a basis for a manuscript which is expected to be submitted in 2020.

Content

1 Opening of the meeting

Benjamin Planque opened the meeting. The agenda was accepted (Appendix 2).

All participants introduced themselves and this was followed by a short presentation of the role of the present workshop in the overall objectives of the Nansen Legacy and the objectives of the workshop. The main goal of the workshop was to develop a standard protocol for describing the evaluation of ecological models.

Raul Primicerio volunteered as rapporteur for the first day.

2 First reporting of evaluation for six model applications

For each of the six ecological models (Gomperz, Norwecom, Atlantis, NDND, EwE and NorCPM/ESM), a first attempt at reporting on the evaluation of a specific application of the model was presented. Brief summaries of these attempts are summarised below:

2.1 The Norwegian ecological model system end-to-end (Norwecom.E2E)

The NORWECOM.E2E model was used to study the *Calanus finmarchicus* stock in the Norwegian Sea. Among the main questions addressed are the interannual variability in biomass, P/B ratio and the overwintering stock. To evaluate the model, gross estimates of biomass in May was used. The observed biomass is estimated from WP2 hauls (0-200m) where the three fractions (0.18-1 mm, 1-2 mm, > 2 mm) is assumed *C. finmarchicus* with the relative proportions (50%, 70%, 0%). *C. finmarchicus* biomass is sampled in the model at the same time and positions as the observations, and the mean biomass ($gC.m^{-2}$) is compared. The main patterns to be used for the comparison is the long term mean level, and an observed decline in biomass from year 2000 onwards. As the zooplankton biomass is known to be very patchy in space and variable in time, also the modelled minimum and maximum value within a time and space window from each observation (+/- 10 days and 40 km) is estimated and used to quantify the uncertainty in the mean observed biomass. Model and observations compare well on level and trend, in addition all observations are within the estimated maximum and minimum interval given by the model.

2.2 EcoPath

EcoPath was applied to estimate trophic levels for the Barents Sea and to compare them with independent stable isotope data (delta15N) and trophic levels derived from these. An EcoPath model for year 2000 with 177 ecological groups was used to estimate trophic levels. The isotope data were from 50 publications with data for 72 EcoPath groups. Average δ15N and trophic level values were calculated from the stable isotope values given in the literature (n = 998). It was attempted to use the draft ODD-E protocol for this application.

2.3 State-space multispecies models (Gompertz)

The draft version of the ODD-E protocol was applied to an application of the Gompertz model: a dynamic capelin-krill-copepod model. The protocol seemed to work quite well on this model application, but there were a few points that were unclear. These included sections on *Assumptions related to the objectives* and the *specific deviations from the ODD of the model* and the section *Methods for evaluating model against data and evaluation criteria*. The unclear parts were worked on during the workshop and there are good hopes that the new version of the protocol will work even better. It is planned to apply the new version of the protocol to the Gompertz model in the near future.

2.4 Non Deterministic Network Dynamics (NDND) model

The Non-Deterministic Network Dynamic (NDND) model is a food web model based on stochasticity and constraints instead of functional responses. Following the Mullon et al. (2009) claim, we want to evaluate the performance of the NDND model at reproducing patterns of variability using simple structural constraints. We applied the original ODD-e protocol draft (from the workshop in October 2018) to our objective. In the case of the NDND, no major issue was encountered when filling the different sections of the protocol. In fact, the challenges for the evaluation of the NDND model are more technical (e.g. gathering all the data for the evaluation, define the metrics for each observed pattern, combining metrics to estimate a global performance index of the model in relation to the modelling application objective).

2.5 NorCPM

The draft protocol was tried on a (imaginary) test case with NorCPM, where the objective was to investigate the interannual to decadal predictability of sea surface chlorophyll. The test went overall well and no obvious problems in the structure of the protocol were detected, except that some points needed clarification and to be more elaborated.

2.6 Nordic and Barents Seas Atlantis (NoBa)

The presentation was the first attempt of applying the ODD-E protocol at an NoBa Atlantis case study. The objective of the case study was to forecast the biomass and catch for the demersal, pelagic and lower trophic levels (harvested + non-harvested) for the period 2055-2065 and compare these to hindcast (2005-2015). We were able to follow the seven steps in the protocol to a large degree, reporting on assumptions (changes in fisheries, no adaptation, no discharges), deviations (14 replicates, each following a different time series of mesozooplankton), data (assessment time series, individual weights, diets), patterns (biomass, catches), evaluation method (overlap, trend) and sensitivity (local sensitivity study performed previously). While doing this, we discovered that describing the data was more difficult than anticipated. This was due to the 'sanity checks', which are always performed but rarely reported on

3 Iterative elaboration of the model evaluation protocol

Workshop participants use a variety of model types, have different modeling culture and practices, use different vocabularies and aim at different goals with their models. As a result, jointly developing a standard protocol for describing the evaluation of ecological models is not an easy task. To ease the process, the workshop adopted an iterative process during which the protocol was applied to specific models, then discussed in plenary, revised in groups, applied again, and so on. Due to time constraints, it was not possible to apply the protocol to specific case studies several times, but the plenary discussions were repeated once before and twice after the groups work.

At the end of the third day, the group reach a consensus on the name of the protocol, its structure, the naming of its main sections and the text that should be included in each section. The latter will need further editing and is not presented in this report.

Name: *A standard protocol for describing the evaluation of ecological models*

This is abbreviated as the *OPE protocol* to reflect its structure: Overview, Patterns, Evaluation

Overview	Objective(s) of the model application
	Specific model setup
Patterns	Ecological patterns
Evaluation	Data used for evaluation
	Evaluation methodology
	Sensitivities

4 Future work

The main task envisaged following the workshop is to develop the protocol into a manuscript to be submitted to a peer-reviewed journal during 2020.

For this purpose, the existing draft will be edited, and several model applications will be evaluated to illustrate how the reporting protocol can be applied.

Annex 1: List of participants

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Annex 2: Agenda

23 September

11:00 – 12:00 lunch

12:00 – 13:00 Welcome, rapporteur, intro presentation, discussion

13:00 – 14:15 case study presentation (Norwecom: Morten)

case study presentation (EwE: Torstein)

case study presentation ('Gompertz': Øystein L)

case study presentation (NDND: Elliot)

14:15 – 14:30 break

14:30 – 15:00 case study presentation (NorESM: Filippa)

case study presentation (Atlantis: Cecilie)

15:00 – 16:00 Discussion

19:00 joint dinner

24 September

09:00 – 09:30 summary form day 1

09:30 – 11:30 Group work on drafting the ODD-E protocol

11:30 – 12:15 lunch

12:15 – 14:15 plenary presentation of revised ODD-E

14:15 – 14:30 break

14:30 – 16:00 group work on applying the new protocol to case studies

19:00 joint dinner

25 September

09:00 – 09:15 summary from day 2

09:15 – 11:00 report from case study & discussion

11:00 – 11:45 lunch

11:45 – 14:00 plenary discussion of the ODD-E protocol, Way forward

The Nansen Legacy in numbers

6 years

The Nansen Legacy is a six-year project, running from 2018 to 2023.

200 people

Currently, there are 204 persons involved in the project. By the end of the project period, the Nansen Legacy will have educated a total of 50 PhD students and postdoctoral fellows.

1 400 000 km² of sea

The Nansen Legacy investigates the physical and biological environment of the northern Barents Sea and adjacent Arctic Ocean.

10 institutions

The Nansen Legacy unites the complimentary scientific expertise of ten Norwegian institutions dedicated to Arctic research.

>10 fields

The Nansen Legacy includes scientists from the fields of biology, chemistry, climate research, ecosystem modelling, ecotoxicology, geology, ice physics, meteorology, observational technology, and physical oceanography.

50/50 financing

The Nansen Legacy has a total budget of 740 million NOK. Half the budget comes from the consortiums' own funding, while the other half is provided by the Research Council of Norway and the Ministry of Education and Research.

Norwegian Ministry of Education and Research

With funding from The Research Council of Norway

>350 days at sea

The Nansen Legacy will conduct 15 scientific cruises and spend more than 350 days in the northern Barents Sea and adjacent Arctic Ocean between 2018 and 2022. Most of these cruises are conducted on the new Norwegian research icebreaker RV *Kronprins Haakon.*

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