October 2020

# Training course on fish stock assessment: SAM and TMB (TCSAM)

**ICES TRAINING COURSE REPORT**

**ICES** INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
**CIEM** CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

# Contents

# i Training course information

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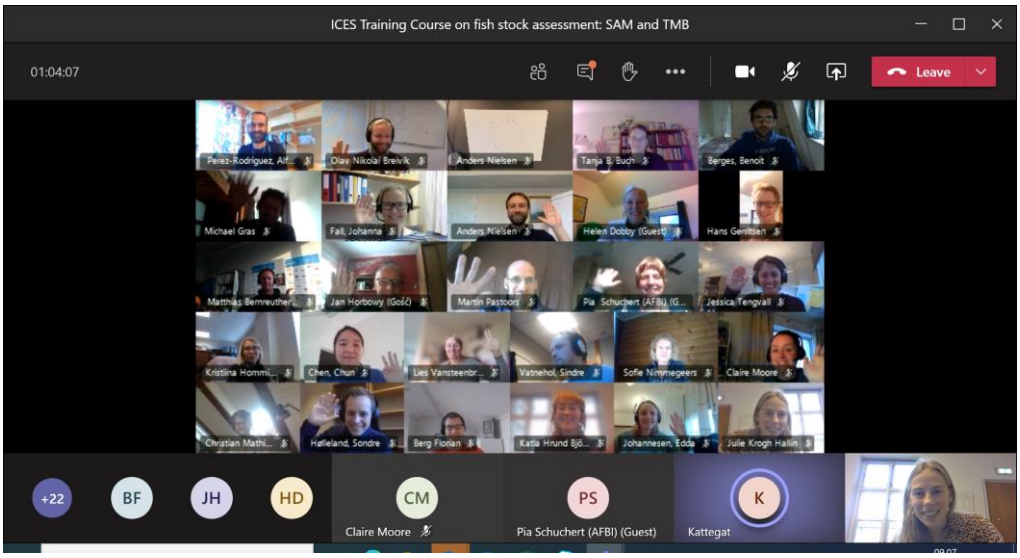
|---|---|
| **Expert group name** | Training course on fish stock assessment: SAM and TMB (TCSAM) |
| **Date** | 12-16 October 2020 |
| **Location** | Online via Teams meeting |
| **Instructors** | Anders Nielsen, DTU-Aqua, Denmark<br>Olav Nikolai Breivik, Norwegian Computing Centre, Norway |



# 1 Summary

The course was designed to give scientists all details about state-space assessment models, setting up assessments, configuring, and correctly interpret the results. This was planned and achieved by going through all details and configuration options in the state-space assessment model (SAM) and detailing exactly how each option was interpreted by the model and exactly how it translated to the actual model implementation in the code. As the title implies the focus of the course was SAM, but other formulations were also mentioned. We organized the week in the following way:

The first two days were used to give the participants the necessary introduction to the tools used to build SAM (and almost all other statistical assessment models), and briefly the statistical foundation needed. This was done by a somewhat systematic explanation of the ways to get data in and out of Template Model Builder (TMB), how to deal with model parameters, and how to quantify uncertainties. It was further explained how to deal with correlations and covariances (multivariate observations) and finally the random effects, which are the key component in state-space assessment models. All steps were explained and practiced with exercises of gradually increasing complexity, where the final one was an actual age-based assessment model (very simple one).

The next two days were used to actually build a light version of SAM (called babySAM), but it was done in very small bites, which were (by the participants seen as) almost unrelated small exercises. In the first exercise the participants were directed to implement a model for recruitment and in this exercise all other parts of the assessment model were considered known, so they could focus only on the recruitment part. They were asked to implement a few different standard options. The solution code became a small stand-alone program, which we talked about in all details. Next came a similar exercise about the survival proces (the rest of the N-matrix), then an exercise about the F-model, then an exercise about age-specific catch observations, and an exercise about survey observations. Each exercise was small, doable, and thoroughly evaluated. Then we went into a detailed demonstration about how to add correlated observations. Finally all the exercises were stitched together into a program named babySAM. BabySAM is a simplified version of the standard SAM program, but includes enough features of the real SAM to be able to run (guesstimated) about 90% of the stocks where SAM is used to provide advice. Furthermore the babySAM program has the advantage that the participants know every single line, so it is easy to refer to this when discussing all the configuration options in SAM. This led to a session where we went through all the options in the SAM configuration and talked about the meaning of each, and how to best explain those options to the user. The participants wrote down suggestions to explain each option, and this help is now part of explanation in the SAM configuration file.

The last day of the course was devoted to techniques for model validation and forecast. Theory and techniques for residuals, leave out and retrospective analysis, simulation validation, prediction based validation, and jitter analysis were demonstrated in simple examples and practiced for SAM models and the options for forecasting were demonstrated and exemplified.

When we learned that the course had to be moved online we modified the exercise parts the most. For a physical course an exercise taking an hour is not a problem, because the instructor can walk around interacting with everybody, so it is easy to monitor progress. This is not possible for an online course, so we choose to divide the exercises into smaller parts. This way we could make sure everybody was still following, before moving on to the next part. One thing that was actually easier with an online course was to get participants to “share screen” with the entire

group. So if we detected a difficulty shared by multiple participants we would ask one of them to share screen and then talk in plenary about how to solve the issue. This worked well. We managed to have good discussions in most sessions, which is what we aimed for.

This was the first ICES online course, so at times, we had to resort to some creative solutions. E.g. for a whiteboard, we mounted a cellphone on a tripod to view a sheet of paper, so whenever anything needed to be drawn, we could. Furthermore, we used the 'chat' facility of the teams platform as a second track, so that e.g. when Anders was lecturing, then questions could be posted in the chat and answered in the chat by Olav and reversely. Asking questions in the chat also prompted more questions, because the participants may feel that it is less daunting to ask a question this way. When lecturing we most often answered the questions from the chat in plenary anyway, but we are sure we got more interaction this way.

Timing of a live online course was an issue for participants outside Europe. We solved this by recording all lectures and allocating a specific time the following day for those participants to ask questions about the lectures from the day before. This worked well for the participants outside Europe, but all participants participated in these sessions and they turned into an extra (welcomed) chance to get some of the difficult parts of the material repeated.

The course was attended by 31 participants from 13 countries. The online format worked out well, but we would still have preferred an actual physical course. It is more difficult to monitor progress and give extra help (or extra challenges) where needed in the online format.

The following quote summarizes the comments given to us from many participants:

*"..it was the patience and creativity of the instructors which ensured that this complex subject was skillfully decomposed for the attendees, making the course content engaging and digestible. Although I missed the feeling of support you get by being physically surrounded by other learners, and the valuable connections you make during the coffee breaks."* --- Claire Moore (Irish Marine Institute).

# 2 Background

The state-space assessment model (SAM) is increasingly used for many ICES assessments and similar techniques are finding their way into other assessment models also (e.g. NCAM and WHAM). To educate the assessment practitioners in the techniques underpinning these models and how to configure and validate SAM specifically this course was requested by the training committee. The creator of SAM (Anders Nielsen, DTU-Aqua) and long time developer of SAM (Olav Nikolai Breivik, Norwegian Computing Center) agreed to develop and teach the course.

# 3 Context

## 3.1 Objectives

The course aimed (as requested) to be a practical course which would enable the participants to understand the different configuration options of the SAM model and the model diagnostics to evaluate and compare different configurations of the SAM model.

This was achieved by tasking the participants to implement all essential parts of the SAM model themselves and using this now deeper understanding of the inner workings of the model as the foundation for explaining all configuration options. This was naturally only possible by carefully partitioning the task into small separate tasks.

The understanding of each configuration option was further validated by having the participants (in a joint writing exercise) write what they would consider the most helpful description of each option. These updated descriptions are now incorporated in the SAM documentation to further help future users.

## 3.2 Level

The course level aimed at assessment practitioners in ICES expert groups. This is a high level, in terms of general knowledge of assessment methods. To get all into the statistical modelling and programming jargon, the first couple of days were used to introduce those subjects. It was clearly needed to spend time on the statistical framework.

The aim of this course was not that all 31 should now be fully ready to implement their own models by now, but simply to understand enough of the details to understand and explain exactly what each option in SAM does, and similarly for the model evaluation techniques.

Looking at the evaluation comments we find that we managed to hit approximately the correct level. We did get some comments about parts being difficult (and it is difficult material!), but we also got one or two who wanted parts of it to go faster. This is always the challenge when teaching an inhomogeneous group of participants. Some have a background in biology and will find it challenging and some have a background in statistics and will find it a bit slow.

# 4 Course programme, product, deliverance and instructors

## 4.1 Programme

The agenda is itemized in annex 2. Further the rationale for this program is described in the summary.

## 4.2 Course product

The main course product is what the students have brought home with them, which can to some extent be evaluated by the positive course evaluations.

Further, the course material for a full week long course has been developed (lectures for 14 modules and corresponding exercises and examples). This will make a repeat of the course simpler.

The experience and solution developed to make the course work as an online course (recording videos, phone+tripod+paper whiteboard, piecemeal exercises, and use of chat as dual-track) can help further online courses..

## 4.3 Deliverables

The course was delivered as planned, covering all agreed subjects in great detail. Further the course was delivered (and had to be reorganized) to meet the added challenges of giving it in an online format.

## 4.4 Course instructors

Anders Nielsen DTU-Aqua, Denmark and Olav Nikolai Breivik Norwegian Computing Center, Norway.

## 4.5 Recommendations

The course was a pleasure to give and participants were very eager to learn. The standard maximum number of participants were increased, and still the course could not allow all interested to participate, so a repeat of this course could be considered e.g. every other year.

The basic design of the course worked well. There are naturally things to be tweaked:

- Allowing 31 participants was probably a few too many (one participant expressed that opinion in the evaluation), so the standard limit of 25 should possibly be kept - even if the online format appears to make it simpler to allow more.
- The build your own babySAM part of the course worked extremely well (experience from instructors and many evaluation comments), so that part should be kept.
- Model validation is such an important subject, so if more time could be allotted to this it would be preferable, but it is difficult to cut any other part. Hopefully moving the course to an on-site physical course will simply free up a bit more time.
- Browsing the evaluation comments we see the request for two additional courses: a) A course dedicated to the statistical foundations underpinning stock assessment. b) A

course teaching experience in practical assessment configuration (a course where we went through a number of actual assessments and talked about strengths and weaknesses and possible solutions).

## 4.6 Review of online format

The online format worked as well as can be expected. It is --- and never will be --- a substitute for a real on-site physical course. The ability to explain something complex is just helped enormously by looking directly into the eyes and faces of the participant(s).

We found good solutions to many of the practical challenges (recording videos, phone+tripod+paper whiteboard, piecemeal exercises, and use of chat as dual-track during lectures).

We provided ad-hoc recorded videos of lectures and supplied those as additional assistance to those participating from different time zones. It was our impression that this was very helpful, which is supported by this comment:

*"This was my first ICES course and I found the material to be well-organized and clearly presented. The instructors were highly responsive to our questions, and encouraged us to interrupt whenever we needed, which is important in a virtual format. I participated from overseas and the course organizers graciously made the lectures available via recorded video so I could watch them on a delay and join for questions the following day. I was very happy with the course and I would definitely consider joining an online ICES course in the future"*. --- Charles Perretti NOAA.

By agreement with ICES those videos were made available only to those in different time zones and only for a limited time period. Requests were made to make these videos generally available. However, since they were completely unedited rough recordings of the lectures and interactions with other participants we did not feel that was appropriate. If for future courses such videos were to be made publicly available, then an additional editing cycle should be budgeted for, and some agreement should be made with the contributors w.r.t. rights and distribution

# Annex 1 List of participants

| Name | Country | Organization |
|---|---|---|
| Adriana Nogueira-Gassent | Greenland | Greenland Institute of Natural Resources |
| Alfonso Perez Rodriguez | Norway | Institute of Marine Research |
| AnnDorte Burmeister | Greenland | Greenland Institute of Natural Resources |
| Benoit Berges | Netherlands | Wageningen University & Research |
| Camilla Sguotti | Germany | Institute for Marine Ecosystem and Fishery Science - University of Hamburg |
| Charles Perretti | United States | NOAA, NMFS Northeast Fisheries Science Center Population Dynamics Branch |
| Christian Kiær | Denmark | DTU Aqua National Institute of Aquatic Resources |
| Chun Chen | Netherlands | Wageningen Marine Research |
| Claire Moore | Ireland | Marine Institute Rinville |
| Divya Varkey | Canada | Fisheries and Oceans Canada |
| Edda Johannesen | Norway | Institute of Marine Research |
| Florian Berg | Norway | Havforskningsinstituttet |
| François Turcotte | Canada | Fisheries and Oceans Canada (DFO) |
| Hans Gerritsen | Ireland | Marine Institute Rinville |
| Helen Dobby | United Kingdom | Marine Scotland - Science Scottish Government Marine Laboratory |

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| Ioannis Thasitis | Cyprus | Fisheries Resources Sector |
| Jan Horbowy | Poland | National Marine Fisheries Research Institute |
| Jessica Tengvall | Norway | University of Bergen |
| Jie Cao | United States | North Carolina State University |
| Johanna Fall | Norway | Institute of Marine Research |
| Kristiina Hommik | Estonia | Estonian Marine Institute, University of Tartu |
| Lies Vansteenbrugge | Belgium | Research Institute for Agriculture, Fisheries and Food |
| Martin Pastoors | Netherlands | Pelagic Freezer-trawler Association (PFA) |
| Matthew Damiano | United States | North Carolina State University - Department of Applied Ecology |
| Matthias Bernreuther | Germany | Thünen Institute of Sea Fisheries |
| Michaël Gras | Ireland | Marine Institute Rinville |
| Pia Schuchert | United Kingdom | Fisheries and Aquatic Ecosystems (FAEB) |
| Sindre Vatnehol | Norway | Institute of Marine Research |
| Sofie Nimmegeers | Belgium | Research Institute for Agriculture, Fisheries and Food |
| Sondre Hølleland | Norway | Institute of Marine Research |
| Tanja Buch | Greenland | Greenland institute of natural resources |

# Annex 2 Agenda

The agenda for the course was the following:

**Day 1: Intro and basics**

• ICES presentation

• Intro (what is TMB, what is SAM)

• First simple TMB example along with basic statistical intro

• Parameters (how to define, transform, bound …)

• Data (getting data into program and results out)

• Basic parametric assessment model (study basic model implementation, add small improvements)

**Day 2: SAM basic use and foundation**

• Ways to run SAM (basic sam, web, R, git)

• Multivariate normal distribution (correlated observations and estimates)

• Intro to random effects (what are they, why do we need them, and how to handle)

**Day 3: Processes in SAM**

• Recruitment & Survival (a) Explain, (b) Implement, (c) Study SAM configuration

• Fishing mortality (a) Explain, (b) Implement, (c) Study SAM configuration

**Day 4: Observations in SAM**

• Catches, total catches, Biomass indices

• Surveys, tagging, missing, and correlations

**Day 5: Validation and forecast**

• Validating assessment models (e.g. observation and process residuals, leave out, retrospective, simulation, prediction based, jit)

• Forecast scenario options

All subjects were taught by a combination of lectures and exercises

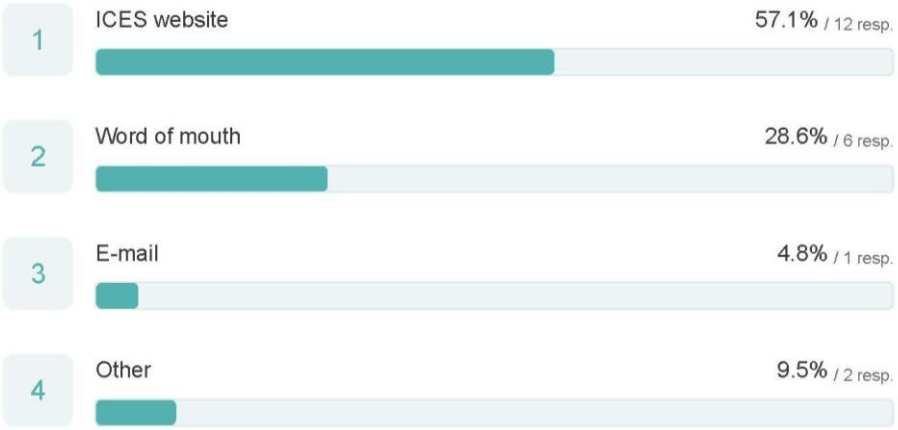
# Annex 3 Results of the survey

## TCSAM2020

21 responses

How did you hear about this course?

21 out of 21 answered

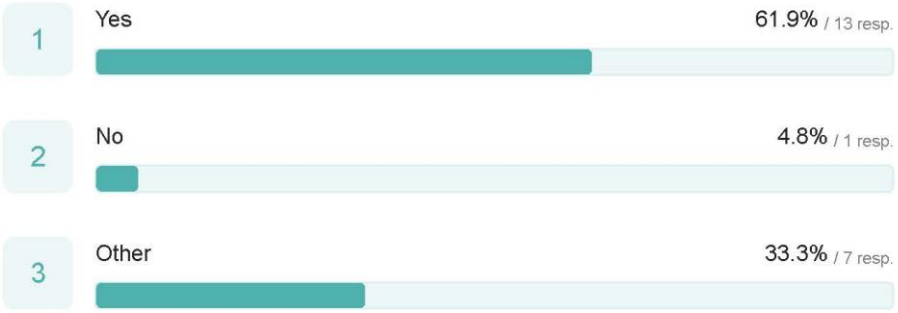


Did the training course meet your expectations?

21 out of 21 answered

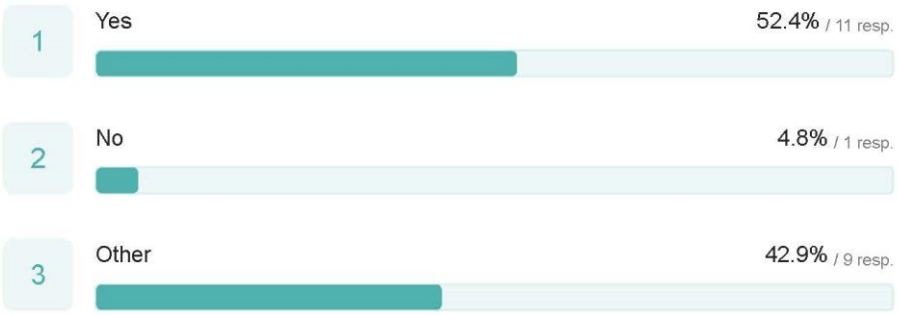

Was the level of instruction appropriate?

21 out of 21 answered



Was the level of difficulty appropriate?

21 out of 21 answered




Inscription to the training course and communication with organizers were efficient

21 out of 21 answered

The instructors were helpful, informative, and approachable.

21 out of 21 answered


The length of the training course was

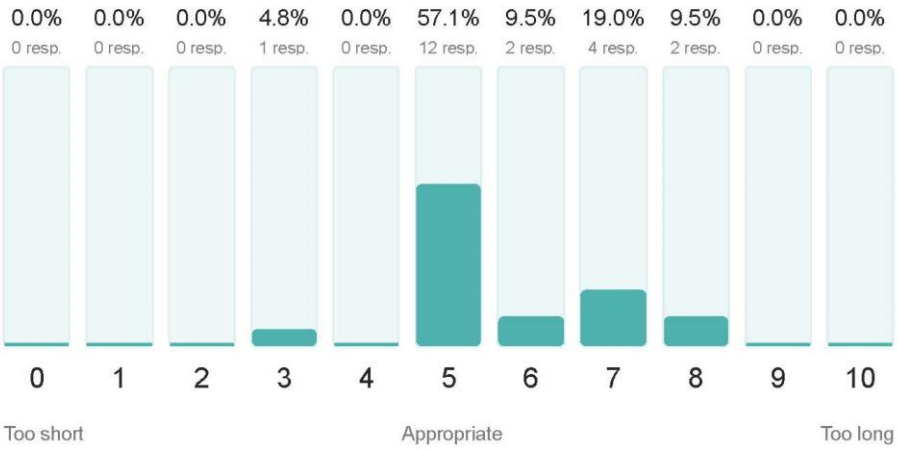
21 out of 21 answered

5.1 Average rating

The length of the lectures were

21 out of 21 answered

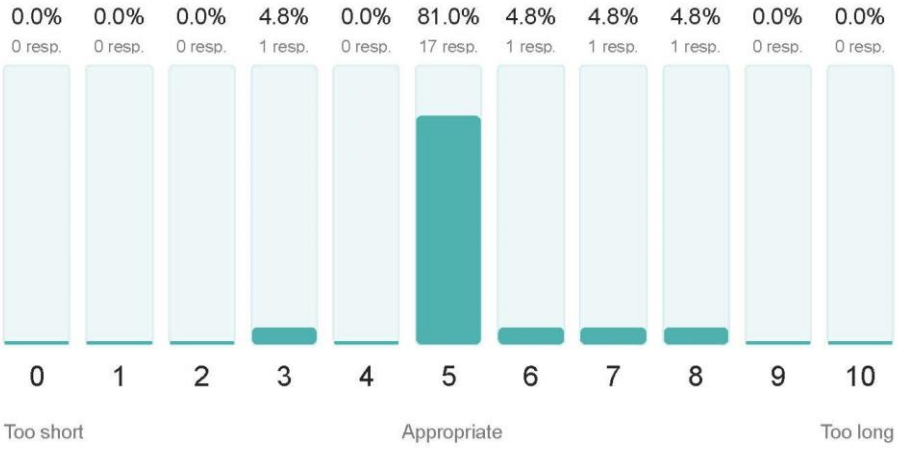
5.7 Average rating




The length of the Q&A sessions were

21 out of 21 answered

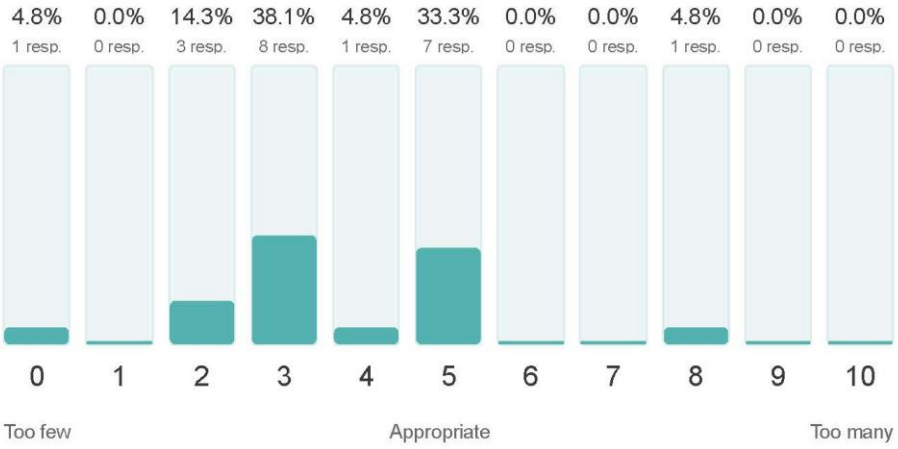
5.2 Average rating



The amount of breaks during the course were

21 out of 21 answered

3.7 Average rating




Did you receive sufficient support regarding platform testing and set-up?

21 out of 21 answered

Have you previously used Microsoft Teams for meetings or online courses?

21 out of 21 answered


Would you have been able to join this course if it had not been online (without COVID travel restrictions affecting)?

21 out of 21 answered

Have you attended any other ICES training courses?

20 out of 21 answered


Would you be interested in another training course within ICES?

21 out of 21 answered