

TCTMB 2019 REPORT

ICES TRAINING COMMITTEE

Report of the TESA-ICES Training Course Template Model Building (TMB) for advanced fish stock assessment

28 January - 1 February 2019

Halifax, Nova Scotia, Canada



ICES

International Council for
the Exploration of the Sea

CIEM

Conseil International pour
l'Exploration de la Mer

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1 Background

This was the first North American offering of the training course 'Template Model Building (TMB)' under the ICES Training Programme. The course was organized in collaboration with the Technical Expertise in Stock Assessment (TESA) committee of Fisheries and Oceans, Canada and hosted by Heather Bowlby. The course was focused on using TMB for fisheries stock assessment and spatial evaluation. There were a total of 31 participants from 5 countries. Overall, the participants rated the course very positively and were actively engaged throughout.

2 Course Description

The course focused on statistical tools and methods required to estimate the non-standard models used in fisheries stock assessment. The teaching style was very hands-on, where participants were asked to modify or develop working code in a series of exercises, where each topic built on the previous one. The result at the end was that participants had built and manipulated a state-space assessment model incorporating random effects in TMB. The lecture component facilitated theoretical learning, while the exercises enabled participants to apply the theory within TMB. At the request of participants, the instructors also delivered an associated component focused on spatial/temporal modeling in TMB and spatial prediction.

2.1 Level and scope

The instructors were requested to prepare an advanced level course, and a more basic course in TMB was taken as a prerequisite. To ensure that participants were aware of this and were prepared, a "welcome message" was sent ahead of the course, reminding participants to review the content of the previous course. All of the participants had a strong background in fisheries assessment or were actively working on stock assessment questions. However, the majority used parametric statistical models in ADMB rather than state-space models in TMB for assessment. This was demonstrated by a quick survey:

- How many people have never used TMB or ADMB? - 1
- How many people have used ADMB but not TMB? - 3
- How many people have never taken a course on TMB? - 9
- How many people have never used TMB outside of a course? - 7
- The remainder used TMB in their current work environment. - 11

The majority of participants from Fisheries and Oceans, Canada, had taken the introductory course on using TMB for stock assessment the previous year and wanted to further develop their skills.

On the first day, about 3 hours were used to summarize the highlights from the previous course. This was fast, but served as a very helpful reminder for the participants who did not have a chance to work enough with TMB in the period between the first and this second course. Some participants were initially surprised by the level of the content, but had adjusted by the second day.

2.2 Instructors

Anders Nielsen

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Nova Scotia, Canada

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3 Topics

The schedule was organized to cover the subjects which were requested by ICES and DFO. These included more in-depth study of the SAM model, making better use of the online resources, dealing with different observation sources (integrated models), differences between SAM and NCAM, spatial model options in TMB, and advice on model validation.

Of these new subjects the most different and advanced subject is clearly the spatial modeling. To make the transition into spatial models as smooth as possible three things were done. A couple of hours was spent on the first day introducing the multivariate normal distribution, which is the main work horse in all the spatial models. The second and third day we focused on the co-variance matrices used in the SAM assessment model. Finally, when the spatial models were introduced, the first models were described as clean multivariate normal models with prescribed co-variances. These three steps connected the spatial models to the techniques already learned in the assessment part, so that at least the first spatial models (and the principle) should be understandable to everyone. From this foundation more advanced spatial models were introduced.

Building the 'babysam' was another highlight. A series of presentations and exercises each focusing on a special small part of SAM and conditioning of the other parts of the model allowed the participants to implement SAM. The participants implemented all essential parts of SAM, and it was stitched together to form 'babysam', which is a fairly complete version of SAM only missing a few rarely used components.

3.1 Schedule

Day 1:

Introduction and review

- Non-standard models
- Minimizers in R, ADMB and TMB
- Automatic differentiation
- Laplace approximation
- Random effects (Exercise: Poisson model with Gamma random effects)

Multivariate normal specifications

- Normal distribution
- A multivariate normal to describe two normal random variables
- Covariance and correlation (Exercise: classification from a multivariate normal)
- Specification in TMB (Exercise: Code an AR1 process multiple ways in TMB)

Day 2:

Implementing SAM process

- Recruitment processes (Exercise: Alternate S-R functions)
- Survival (Exercise: Random walk recruitment model)
- Fishing mortality (Exercise: Alternate correlation structures)

Running MCMC

- MCMC in TMB; STAN and library tmbstan

Observations in SAM

- Catch at age (Exercise: Predict catches)

Day 3**Observations in SAM continued**

- Surveys (Exercise: Adding two survey fleets)
- Configuration, missing values, blocking
- Irregular grid AR
- unstructured covariance US

babySAM

- Stock assessment.org (Exercise: baserun online)
- 'stockassessment' R package (Exercise: Running the example)

NCAM – Northern Cod Assessment Model

- Similarities/differences with SAM
- Censored likelihood for total catch (Exercise: implement a censored likelihood)

Day 4**Spatial models**

- Directly specifying covariance
- Matern correlation (Example: Implement the matern correlation)
- Inverse covariance models
- Space/time models (Exercise: Extend a spatial model to include time)
- Irregular grids using R-INLA (Exercise: Apply INLA grid in a spatial model)

SAM model validation

- One-obs-ahead residuals – discrete and continuous (Exercise: Calculate)
- Process residuals; joint sample approach
- Retrospective patterns and leave-out-fleet runs
- Jitter analysis and simulation
- Prediction and cross-validation

Day 5**Integrated models**

- Adding other data types (e.g. tag data)
- Adding indices (Exercise: Add a total stock biomass index)

Spatial prediction (Exercise: Spatial prediction)**Participant requests**

4 Recommendations

There were few specific recommendations on how to improve the course content or delivery. Several participants suggested that it would have been better to have more structured breaks or an earlier course dinner to facilitate networking opportunities. Indeed we did not spend much time on breaks, because we had a lot of material to cover. A suggestion could be to order a common lunch to everyone on the first day, so we could sit together.

Annex 1: List of participants

Name	Institute
Alejandro Yañez	Instituto de Fomento Pesquero, Chile
Alejandro Zuleta	Centro de Estudios Pesqueros, CEPES
Andrea Perreault	Marine Institute of Memorial University
Arnaud Mosnier	DFO Canada
Benjamin Folliot	Dalhousie University
Brad Hubley	DFO Canada
Brooke Davis	DFO Canada
Catarina Wor	DFO Canada
Cornelia den Heyer	Fisheries and Oceans Canada, Science
Daisuke Goto	IMR
Daniel Ricard	DFO Canada
David Keith	DFO Canada
Doug Swain	DFO Canada
Elisabeth Van Beveren	DFO Canada
Heather Bowlby	DFO Canada
Hugues Benoit	DFO Canada
Jin Gao	Marine Institute of Memorial University of Newfoundland
Jonathan Babyn	Science Branch at DFO/Dept. of Mathematics and Statistics at Dalhousie
Juliette Champagnat	Ifremer Port en Bessin
Klaas Sys	ILVO
Mariano Koen-Alonso	NAFC DFO
Patricia Ruiz	Centro de Estudios Pesqueros, CEPES
Paul Regular	DFO Canada
Raphael McDonald	Dalhousie University
Ross Tallman	Fisheries and Oceans Canada Arctic Region
Sean Anderson	Pacific Biological Station, Fisheries and Oceans Canada
Tobie Surette	Government of Canada Department of Fisheries and Oceans
Vania Henriquez	School of Resource and Environmental Management
Xinhua Zhu	DFO Canada
Yanjun Wang	DFO Canada
Yuan YAN	Dalhousie University

Annex 2: Evaluation and questionnaire

General comments:

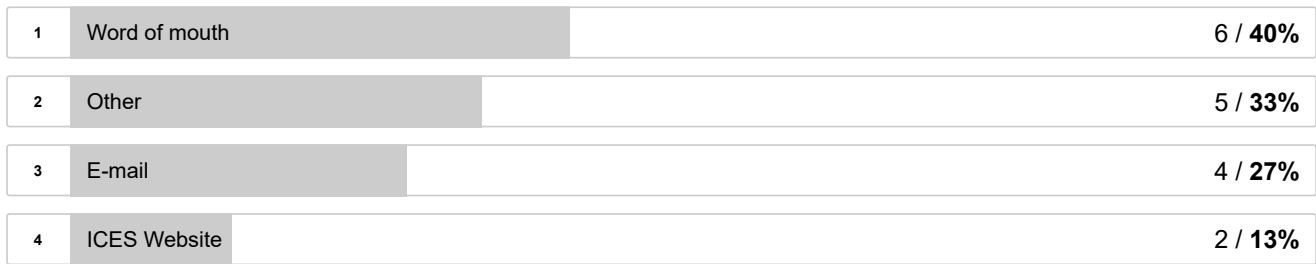
- Enthusiasm by the instructors is contagious and really helps promote learning.
- Learned new skills but also tips and tricks for running more efficient code.
- The hands-on exercises (particularly building babySAM) were extremely useful. They really helped solidify the concepts we were learning. [multiple participants]
- I appreciate the collaborative approach provided by TMB and the stockassessment.org page.
- I want a TMB shirt!!
- The exercises were challenging and really forced us to think about the models and the coding. This really enhanced learning.
- The course struck a good balance between lectures and highly useful exercises.
- Anders is a great teacher and he makes everything as clear as possible without dumbing down while Ethan was extremely helpful during the exercises.
- Networking after the training course among the participants for Q/A and collaborations would be useful.
- I'm not sure how valuable going through the stockassessment.org, stockassessment R package stuff was, at least for me. I would have rather had an extra TMB exercise or two.
- The last module on spatial prediction quite hard to understand and it was difficult to change format (of the slides, text and equations) so late in the course.
- I learned a lot about random effects and how I could incorporate that into my assessment models.
- Perhaps, one suggestion would be to have an entire day to work on our models, obviously knowing about that before the course, so we can go prepared with very clear questions.

This was an advanced TMB course, and hence, a lot of things were assumed known. That's perfectly fine, so some of my comments here may be more relevant for the basic course, but still applicable to this one. It would be nice to:

1. Have a list of all the R packages that will be used during the course to allow installing them before the course.
2. A cheat-sheet/summary of key/basic TMB/C++ commands and/or syntax elements to allow maximizing the exercise time (i.e. no time wasted in trying to find out the simple coding stuff).
3. The examples use graphical displays (from the R side); it could help having that code also included in the R scripts to fully follow the examples.
4. This is as personal preference, but the course is intense and covers a lot of material in a short period of time. I could have used a "free" afternoon in the middle (at the course site and with the instructors available), to catch-up on whatever I couldn't finish properly, and/or digest the material better. A break in the middle of the training to collect my ideas, make sure I had understood everything properly, and practice/ask questions on the elements I was unsure about would have been nice. Again, this is just a personal preference (maybe it's just that I am getting old...).

How did you hear about this course?

15 out of 16 people answered this question



Course content

Did the Training course meet your expectations?

16 out of 16 people answered this question



4.75 Average rating



Was the level of instruction appropriate?

16 out of 16 people answered this question



4.69 Average rating



Was the length of the training course appropriate?

16 out of 16 people answered this question



4.94 Average rating



Course Organization

Inscription to the training course and communication with organizers were efficient.

16 out of 16 people answered this question



4.88 Average rating



Teaching and Learning Support

The instructors were helpful, informative, and approachable.

16 out of 16 people answered this question



5.00 Average rating



The working documents were presented in a way that facilitated learning.

16 out of 16 people answered this question



4.75 Average rating



Overall Evaluation

How would you rate this training course?

15 out of 16 people answered this question



4.80 Average rating



How would you rate the quality of the teaching?

16 out of 16 people answered this question



4.94 Average rating

1	☆☆☆☆☆	15 / 94%
2	☆☆☆☆	1 / 6%

Have you taken any other ICES training courses?

16 out of 16 people answered this question

1	No	13 / 81%
2	Yes	3 / 19%
3	Not with ICES, but I have attended other training courses related to my expertise.	0 / 0%

Would you be interested in another training course within ICES?

16 out of 16 people answered this question

1	Yes, both physical and online training courses	15 / 94%
2	Yes, but not an online training course	1 / 6%
3	Maybe	0 / 0%
4	No	0 / 0%

Social Event

Do you feel that you have benefited from networking opportunities on the course?

16 out of 16 people answered this question

1	Yes	13 / 81%
2	No	3 / 19%
3	Somewhat	0 / 0%