Report of the ICES Training Course in Ecosystem Modelling for Fisheries Management

26–30 August 2013

ICES
International Council for the Exploration of the Sea

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Contents

Participants at the course "Ecosystem Modelling for Fisheries Management" Training Course 26-30 August 2013 at ICES Headqarters in Copenhagen.

Photo from left to right:
Steven Mackinson (instructor), Jaebong Lee, Mohsen Al-Husaini, Tiago Veiga Malta, Telmo Morato, Jen Cooper, Villy Christensen (instructor), Moritz Stäbler, Alex Tidd, Lars Ravensbeck, Paulo Fonseca, James Smith, Izaskun Preciado, Arezoo Vahabnezhad, Ulf Lindstrøm, Dennis Trolle, Karen Alexander, Jeroen Steenbeek, Eyal Ofir, Kerli Laur, Marta Coll, Esben Astrup Kristensen, Sheila Heymans.

Report of the ICES Training Course in Ecosystem Modelling for Fisheries Management,

26-30 August 2013

by

Villy Christensen and Steven Mackinson

1   Summary

Acknowledging the worldwide move toward ecosystem-based management of marine resources, and the declared intention of ICES member states to follow this trend, a training course on "Using Ecosystem Modeling for Fisheries Management" was conducted at the ICES HQ in Copenhagen during 26-30 August 2013. The course was the third of its kind, with previous courses held 8-12 March 2010 and 7-11 March 2011.

The course was built around the use of the Ecopath with Ecosim (EwE) approach and software, as this is the only ecosystem modeling software system that is adaptable, flexible, and user-friendly enough to be used for a course as contemplated. The approach is developed and supported through the Ecopath Research and Development Consortium (http://www.ecopath.org/consortium), which currently has 18 institutions as members.

Emphasizing, however, the need to use a variety of models wherever and whenever possible, the lecturers started the course with an overview of all available types of ecosystem models and of their characteristics. They stressed the need to develop the ecosystem modeling, including the selection of model types, based on clear objectives for the modeling, notably with respect to what policy questions the models are to address. As part of this, they discussed and illustrated throughout the course how one gains experience from using alternative models, and the risk of uncritically using any one model without exploration of how uncertainty in model design, parameterization and tuning, impacts the models capability to address the policy and research questions. Needless to say, this philosophy for modeling is pertinent for all kinds of modeling; ecosystem models are by no means unique in this aspect.

It was also emphasized that ecosystem modeling does not represent an alternative to the standard single species population dynamics modeling currently used widely as part of the ICES advisory machinery. Rather the ecosystem models supplements the single species models allowing us to address different research questions, notably with regard to trade-offs between fisheries due to trophic or technical interactions. Another important area relates to spatially explicit questions, e.g., in relation to marine zoning, where trade-offs often call for consideration of ecological and environmental factors in addition to the direct human impact such as through fishing.

The course was as mentioned focused on use of the freely available (and supported) EwE approach and software. The instructors, however, allocated time to present and demonstrate how researchers can modify the modeling approach by programming software modules that can interact with the underlying data and modeling approach. It is thus straightforward to develop "plug-ins" that implement alternative modeling approaches or are used to change parameters or obtain results that is not exposed through the user interface. Also, and importantly, such approaches make it straightforward to explore the impact of uncertainty on policy questions through multiple runs of the models. The users were also invited to access the source code through SVN version control, and several of the users express to gain access to this through the Ecopath Consortium.

There were 22 participants in the country representing 12 countries (Australia 1, Denmark 3, Estonia 1, Germany 1, Iran 1, Israel 1, Republic of Korea 1, Kuwait 1, Norway 1, Portugal 3 (incl. the Azores), Spain 2, and UK 6 (incl. England 3, Scotland 2, Northern Ireland 1). The participants are listed in Annex 1.

The course was planned to give the participants an introduction to some of the more advanced aspects of using ecosystem modeling for fisheries management rather than being a basic, introductory modeling

course. This was done in recognition of the need and desire to incorporate such methodologies in the ICES Working Groups' toolbox, and it indeed called for a course of a somewhat advanced character. The course description thus stated that it was "intended for scientists with some prior experience with ecosystem modeling".

It showed, however, that only one third of the participants had any prior experience with ecosystem modeling, let alone Ecopath. Recognizing this, the programme was modified to focus more on the introductory material than anticipated. It was decided, however, to maintain introductions and exercises with the more advanced aspects of ecosystem modelling (see Annex 2). This was done because it is the more advanced aspects that are of interest and indeed direct use for ICES working groups and advisory bodies – and also for many of the participants, including those with prior experience.

The diverse background of the trainees presented a problem for how to set the level for the course, but based on the course evaluations and the feedback we received throughout the course, we managed to strike a suitable balance enabling the participants to follow without the more advanced losing patience. The majority found the amount covered a little too much, and the degree of difficulty average to a little too much. We, the instructors, see this as an indication that we have succeeded in giving a challenging course without going to the point where the participants would feel lost.

The atmosphere throughout the course was one of excitement and intensity, and the trainees worked long hours (9-18 all days but the last) without oversaturation or loss of interest being apparent. Clearly, the tutorials were especially successful in engaging the participants in key aspects of and questions related to ecosystem-based management.

The course made good use of the ICES SharePoint for distribution of files such as presentations, reading materials, and model databases. This worked quite flawlessly, and was a great resource for the conduction. In order to keep the participants abreast with a continuously developing program – a necessity if participant feedback is desired and encouraged – the course relied on a website with the program that was updated regularly throughout the week, see https://sites.google.com/site/icesecosystemmodeling2013/.

It showed that very few changes had to be made to the program, however. This was different from the first year's course where we had to update daily, as progress was slower than expected. We had considered this when making the program, but it does indicate that the group of participants followed along very well. We do note from the evaluations that some found the progress to be a bit too fast, but find that we have to strike a balance and move along when the vast majority of the participants indicate that they are ready to do so, and when no one asks for more clarification or for spending more time on the material at hand.

A total of 15 course evaluations were received through the ICES SharePoint. The participants were strongly encouraged to respond to the online questionnaire and time was set aside for responding during the last afternoon's evaluation session of the course. A summary of the evaluations is included in Annex 3.

The course content was rated as being average to difficult, indicating that an acceptable balance was struck between the high ambition level for the course, and the reality that most course participants came with little prior experience with ecosystem modeling. The majority felt that we covered a bit too much material, but we do think this is a necessary trade-off between covering the material that is of direct interest for fisheries management and recognizing that most of the participants came without prior experience with the field.

The course organization was rated very good by the majority of participants (73% with remaining 27% rating it good). This, again indicates that a good balance had between obtained between giving an introductory ecosystem modeling course, which would not be able to cover how ecosystem modeling can be used as part of the fisheries management process, and a more advanced course (as this course was announced to be) with focus on use for fisheries management.

The teaching and learning support was rated very favourably by the participants, with the vast majority (93%) finding the helpfulness of the teachers high and the usefulness of course materials likewise high (80%). The clarity of presentations was rated good to high by 86% of the respondents.

Overall evaluation of course content was rated very good by the vast majority (80%) of the participants, course organization had 73% in the top category, and 20% indicating it to be good. Overall quality of the teaching and of the course also were excellent with 87% indicating it to be very good.

More detailed comments were obtained from 12 of the 15 respondents, and they indicate a clear interest in a mixture of presentations, hand-on exercises, and discussions, as was prepared for the courses. The responses made clear the dilemma of selecting participants with a similar level. The course was announced as an advanced course where the participants were expected to have a "some prior experience with ecosystem modeling". Only a third of the participants, however, had any experience, and this naturally created a dilemma.

It was difficult to strike a balance so as to challenge the more experienced while at the same time not losing the newcomers. The instructors in this respect did an outstanding job according to the bulk of the evaluations, but it should indeed be considered if a more advanced type of course should be conducted focused on how to integrate ecosystem modeling in the ICES management advice.

On a final note, the course evaluation does not evaluate the support for the organization of the course and the support of the ICES staff. Let us therefore express our own opinion, which we feel is fully shared with the participants. ICES HQ is doing an outstanding job in preparing and conducting these courses. Everything functioned smoothly and pleasantly both before and during the course. We especially thank the Training Programme Coordinator for outstanding support before and throughout the course, his active engagement is very important for the success of the course.

2   Recommendations

- The fact that most of the participants in the course had no prior experience with ecosystem modelling indicates that there is a need for introductory courses, and we recommend that an introductory course be held, perhaps in 2015.
- ICES is increasingly being asked to provide ecosystem-based advice and we see a clear need for development of a new course with focus on providing support for such activities. We suggest that this could be directly focused on the need of WGs, notably WG-SAM, and potentially could cover several modelling approaches.

3   Course description

The course was planned as a five-day intensive activity, and was intended for scientists with some prior experience with ecosystem modeling. Participants were expected to have at least a cursory familiarity with the Ecopath with Ecosim (EwE) software, which can be downloaded freely from www.ecopath.org. We used the new version 6 of the software, which has been reprogrammed and redesigned in the .NET environment.

The course provided an introduction to the use of ecosystem modeling as a part of the fisheries management process. The focus was on time- and spatial-dynamic modeling, and included an overview of spatial optimization. Major emphasis was on evaluating fit to time series data. We introduced the application of ecosystem-level Management Strategy Evaluation as implemented in the EwE approach and software and as developed at CEFAS, and the participants gained cursory experience with this through two tutorials.

More advanced tutorials focused on the use of ecosystem modeling as done in ICES Working Groups, both to address fleet-level trade offs and optimizations, and to evaluate the impact of spatial closures.

A new habitat capacity model, which provided new facilities for spatial modelling and notably for evaluation of the impact of habitat changes, e.g., as a consequence of climate change, was presented and a new tutorial developed about this was used at the course.

Course material:

- Available from download through the ICES SharePoint.
- Notebook with EwE installed (can be freely downloaded from www.ecopath.org along with the User's Guide and other materials)
- See the course website for details and links:
  http://sites.google.com/site/icesecosystemmodeling2013/

4   Course programme and instructors

The programme (Annex 2) was circulated to all participants prior to the course, and is available for download from the ICES SharePoint. The course content was modified from previous course, and it is noticeable that we were able to move through the course with only very minor changes from the anticipated program. We started every day with an overview and summary of the previous day's programme and an introduction to what was planned for the day. The programme was updated daily on the course website, and the modified (as actually conducted) programme is included in Annex 2.

The programme was designed with a 40:60 split between lectures/discussions and tutorials. In summary form the programme was:

	Lectures	Tutorials
Monday	Welcome, introductions Ecosystem models, types and characteristics Introduction to EwE Mass-balance modeling	 Creating an ecosystem model Mass-balancing
Tuesday	Time-dynamic modeling North Sea model fitting	Fitting models to time series data
Wednesday	Fishing policy exploration, Management Strategy Evaluation	Fishing policy exploration (North Sea) MSE

Thursday	MSE follow-up,
	Intro to spatial modeling, habitat
	  capacity model,
	Ecospace applications in fisheries
	  and conservation
		
		Habitat capacity model
		
		Spatial analysis in the North Sea
		  MPA issues, closed areas

Friday	New tools for harvest control rules and management advice Using plug-ins with EwE End-to-End modeling	Demos of participants' models Question and answer session Evaluation

The course was run each day from 9-18, and ended at 16 on Friday as planned.

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Annex 1: List of participants

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Annex 2: Detailed course programme

The detailed course programme is presented below. This is the version showing the actual course progress, and it is modified from the official (pre-course) programme as the course progressed. Participants were kept up to date about the program through the course website, which was updated several times a day.

<table>
<tr><td colspan="3" align="center">Monday, 26 Aug. 2013: Ecopath and Mass-Balance</td></tr>
<tr>
<td>9.00 – 10.00</td>
<td>Welcome (ICES representatives):
-   ICES Training Programme (Søren Anker Pedersen)
-   ICES Advisory Services - What is ICES? (Poul Degnbol)
-   Practical Issues having meetings at ICES (Claire Welling)
About this course (Villy Christensen and Steve Mackinson)
Introduction of participants and lecturers; expectations: 1-2 minutes from each participant please.</td>
<td>Read from ICES SharePoint:
<u>Christensen and Pauly. Ecopath II.</u>
<u>Christensen and Walters. 2004. EwE.</u>
<u>Christensen Using EM for FM 2011</u>.pdf.
<u>EwE6 User's Guide</u></td>
</tr>
<tr>
<td>10.00 – 10.30</td>
<td align="center">Tea/Coffee
Download and install EwE6 (if not done already)</td>
<td>Download link: from www.ecopath.org for now. New version will be available before course starts.</td>
</tr>
<tr>
<td>10.30 – 12.00</td>
<td>Ecosystem models: types and characteristics

Introduction to Ecopath with Ecosim (vers. 6); the approach and software</td>
<td><u>1 EM overview.pdf</u>
Read: <u>Plaganyi</u>, <u>FAO</u>, <u>Robinson</u>
<u>2 EwE6 introduction.pdf</u></td>
</tr>
<tr>
<td>12.00 – 13.00</td>
<td><u>Tutorial 1</u>: Build and parameterize an ecosystem model of Anchovy Bay</td>
<td></td>
</tr>
<tr>
<td>13:00 – 14:00</td>
<td align="center">Lunch</td>
<td></td>
</tr>
<tr>
<td>14.00 – 15.30</td>
<td><u>Tutorial 1</u>: cont.
Mass-balance modeling; introduction; parameters.</td>
<td><u>3 Ecopath parameters.pdf</u></td>
</tr>
<tr>
<td>15.30 – 16.00</td>
<td align="center">Tea/Coffee</td>
<td></td>
</tr>
<tr>
<td>16.00 – 18.00</td>
<td><u>Tutorial 2</u>. Mass-balancing of simple ecosystem models</td>
<td></td>
</tr>
<tr>
<td>18.00 – 20.00</td>
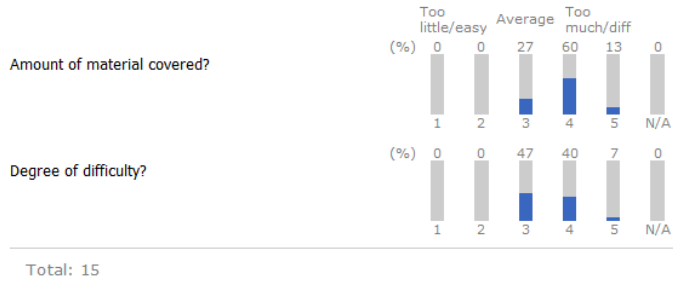<td>Icebreaker (optional) in ICES lunch room</td>
<td></td>
</tr>
</table>

Tuesday, 27 Aug. 2013: Ecosim Theory and Time Series Fitting		
09.00 – 10.15	Summary of mass-balancing, Q/A The foraging arena: modeling predator-prey interactions; time-dynamic modeling; Ecosim; density-dependence and carrying capacity.	4 Ecosim.pdf Read: Ahrens
10.15 – 10.45	**Tea/Coffee**	
10.30 – 13.00	Time series fitting, mediation, and environmental forcing. Modeling environmental impact. Primary production anomalies. Using climate drivers. *Tutorial 3*: *Fitting ecosystem models to time-series data*	5 Time series.pdf
13.00 – 14.00	**Lunch**	
14.00 – 15.30	*Tutorial 3*: *cont.* *Tutorial 4: Model fitting and performance testing: the North* Sea	Tutorial 4 - Introduction Tutorial 4 - Model fitting performance.zip Read: CJFAS MS
15.30 – 16.00	**Tea/Coffee**	
16.00 – 18.00	*Tutorial 4*: *cont.*	
Wednesday, 28 Aug. 2013: Using Ecosystem Modeling for Management		
09.00 – 10.15	Summary of time-dynamic modeling. Q/A	
10.15 – 10.45	**Tea/Coffee**	
10.45 – 13.00	Prerequisites for using EM for management: Quality control, PreBal, key runs, ICES, … Fishing policy exploration, objective function *Tutorial 5: Policy exploration, North Sea*	6 Models and multi-species issues in management.pdf 7 Modelling support for LTMPs.pdf Tutorial 5 - Introduction Tutorial 5 - Objective optimisation.zip (SM)
13.00 – 14.00	**Lunch**	
14.00 – 15.00	Management Strategy Evaluation. Modeling multi-species fisheries regulations (weakest stock, strongest stock with discarding, selective	8 MSE.pdf Wiki: MSE implementation

	fishing quota); fleet quotas; target fishing mortality policy. Fleet size dynamics	
15.00 – 15.30	**Tea/Coffee**	
15.30 – 18.00	*Tutorial 6: Management Strategy Evaluation and fishery regulations in Anchovy Bay.*	

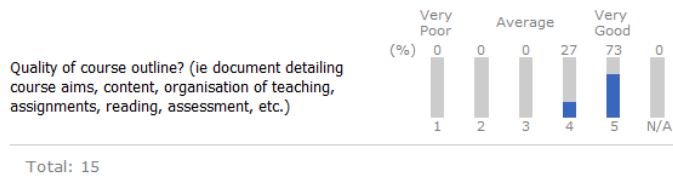| **Thursday, 29 Aug. 2013: Spatial modeling**		
9.00 – 10.15	Summary, Q/A Introduction to spatial modeling in EwE: Ecospace.	10 Ecospace basics.pdf
10.15 – 10.45	**Tea/Coffee**	
10.45 – 13.00	Introduction to habitat capacity modeling, zoning & MPAs. Spatial optimization: objectivity function; optimizations approaches; linkages to Marxan *Demo: Introduction to Ecospace interface and running spatial models.* *Tutorial 7: Habitat capacity model*	
13.00 – 14.00	**Lunch** & Group photo	
14.00 – 14:45	Ecospace: Applications in fisheries and conservation	11 Ecospace application in fisheries and conservation.pdf 12 North Sea - Spatial analyses.pdf
14:45-15:00	Introduction to Tutorial 8	Tutorial 8 Intro_closed areas_North Sea.pdf
15.00 – 15.30	**Tea/Coffee**	
15.30 – 18.00	*Tutorial 8: Spatial analyses in the North Sea (focus on MPA issues).*	Tutorial 8_ Closed areas_North Sea.zip
18.00 – 22.00	Course dinner (optional, expenses to be covered by participants)	

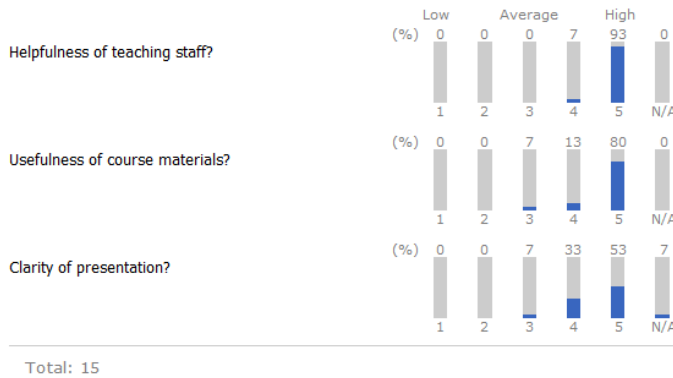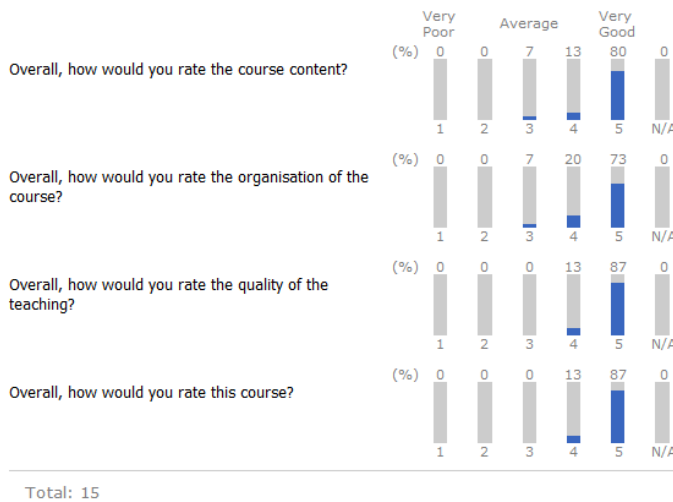| Friday, 30 Aug. 2013: Your Models		
9.00 – 10.15	Summary, questions Plug-ins: make your own models Lecture: New tools for harvest control rules and management advice. Intro to Uncertainty Routine (CEFAS) Discussion: Coupling to hydrographic, climate, ERSEM, MSE models, and incorporation of alternative modeling approaches within the EwE6 modeling framework and software	9 New tools for assessing model uncertainty on policy.pdf
10.15 – 10.45	**Tea/Coffee**	
10.45 – 13.00	*Participants' models: issues and solutions.* *We will discuss models that participants have worked with, and examine them together* *Question and answer session and discussion*	
13.00 – 14.00	**Lunch**	
14.00 – 16.00	Q&A: continued *Evaluation (written). Consider: what training should ICES conduct?*	
16.00	Closing	

Annex 3: Course evaluations

2. Course Content

	Too little/easy	Average	Too much/diff	
	(%)	1	2	3	4	5	N/A

Amount of material covered? (%) 0 0 27 60 13 0 (1 2 3 4 5 N/A)

Degree of difficulty? (%) 0 0 47 40 7 0 (1 2 3 4 5 N/A)

Total: 15

3. Course Organization

| | Very Poor | Average | Very Good | |

Quality of course outline? (ie document detailing course aims, content, organisation of teaching, assignments, reading, assessment, etc.) (%) 0 0 0 27 73 0 (1 2 3 4 5 N/A)

Total: 15

4. Teaching and Learning Support

| | Low | Average | High | |

Helpfulness of teaching staff? (%) 0 0 0 7 93 0 (1 2 3 4 5 N/A)

Usefulness of course materials? (%) 0 0 7 13 80 0 (1 2 3 4 5 N/A)

Clarity of presentation? (%) 0 0 7 33 53 7 (1 2 3 4 5 N/A)

Total: 15

5. Overall Evaluation

| | Very Poor | Average | Very Good | |

Overall, how would you rate the course content? (%) 0 0 7 13 80 0 (1 2 3 4 5 N/A)

Overall, how would you rate the organisation of the course? (%) 0 0 7 20 73 0 (1 2 3 4 5 N/A)

Overall, how would you rate the quality of the teaching? (%) 0 0 0 13 87 0 (1 2 3 4 5 N/A)

Overall, how would you rate this course? (%) 0 0 0 13 87 0 (1 2 3 4 5 N/A)

Total: 15

- I suggest that you get some tutorial videos for the starting points, it might be easier because some people (including me) lost some time just with the initialization of the models. And that way people could easily practice EwE models at home. Overall i liked the course. And I'll be suggesting this course to everyone that might be interested.

- I really enjoyed the workshop and the way it was organised. I liked the option to have tutorials to play with the tools. It could be useful to have a two week course, one week to cover the basics oc Ecopath with Ecosim, and another week to cover more advanced tools for fisheries management. It could also be useful to organise a programing course for plugins.

- I think there was too much covered in the course, therefore not enough time to fully digest all the material. However, the course was very informative and worthwhile.

- The tutorials were very helpful, and the time allocated to these was appropriate. On the very first day, it would have been helpful with a little more in depth introduction to the core of EwE equations.

- Would be useful to have food on site. The course is quite expensive (so sandwiches could be covered) and the time is quite short for lunch to go out and get something.

- It should be advertised more clearly as an 'Advanced' course. This course was difficult for the people with no Ecopath experience, and there were a few people who came with little experience.

- I enjoyed the coverage of the course. It did cover a lot of material (the three 'E's), but I wouldn't have wanted to do less. Perhaps a small hands on with the base code (and how to alter it) would've been good.

- Thanks for the nice course, very professional.

- Prerequisite for participants they should tried the EwE before attending the course. A lot of materials covered but the five days is not enough to assimilate of these materials.

- Excellent medium/advanced course on EwE. Villy and Steve were very inspiring. The material covered was just enough. The only suggestion (and I know is not that easy to implement) would be to have half a day for playing with our models. And therefore benefit from the experts in the room. They can easily spots non-senses in our models and easily help fixing conceptual problems. The only less points of the course were some of the logistics. Room too small for the number of participants, coffee breaks not that good, and course dinner could have been better (and included in the course fee perhaps).

- Very usefull to have so many tutorials.

- Teaching was very good, lots of explanations to problems. Highlights were ECOSPACE. Could have spent longer on the focus of the course which was MSE. Clarity of slides when running through the applications of ecosim/ecopath/ecospace could be improved. A lot of clicking very quickly so if you were at back of room very difficult to see.

- The ICES training course "Ecosystem Modelling for Fishery Management" constituted an invaluable opportunity for a first approach to Ecopath with Ecosim modelling framework. However, it must not be forgotten that the main goal of the course, as clearly stated both in its designation and in the 'context 'description', is to support the ICES implementation of Ecosystem-Based Approach to Fisheries Management'. As such, the courses' evaluation must take into account the formal objective and how its organization allows for the attainment of that goal.

  To increase the effectiveness of the ICES Training Programme concerning ecosystem modelling for EBAFM, I strongly suggest that the present course is split into two: an introductory course (related to EwE basic features and underlying ecological assumptions, and data collecting and organization) and an advanced course (directed to the issues of main interest to ICES –advisement).

  Nonetheless, I do not consider that my time was wasted, although I doubt of my capacity for an independent implementation model without a strong support. Further than that, it was a privilege to contact with one of the scientists that were part of the software development since the first beginning, and also with the new generation of experts.