

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

7-11 March 2011



ICES

International Council for
the Exploration of the Sea

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Conseil International pour
l'Exploration de la Mer

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Participants at the “Ecosystem Modelling for Fisheries Management” Training Course 7–11 March 2011 held at ICES Headquarters in Copenhagen. The course was given by Villy Christensen, Fisheries Centre, University of British Columbia (#12 from left) and Steven Mackinson, CEFAS, UK (#9 from left).

Report of the ICES Training Course in Ecosystem Modelling for Fisheries Management, 7-11 March, 2011

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 7-11 March 2011. The course was the second of its kind, which was started in 2010 where a similar course was held during 8-12 March.

The course was focused on 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.

Recognizing strongly, 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 emphasized 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.

The course was as mentioned focused on use of the freely available (and supported) EwE approach and software. The instructors, however, allocated considerable time and effort 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, this makes 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 gained access on request during the workshop.

A total of 42 people registered for the course. Priority was given to participation from the ICES member states to optimize the impact on future ICES working groups. Of the accepted participants, one cancelled immediately prior to the start of the course due to a family emergency, and the course therefore was conducted with 25 participants. They represented 14 countries, i.e. Denmark (3), France, Germany, Greece, Ireland, Italy, Latvia, Netherlands (2), Norway (2), Poland, Spain (2), Sweden (2), UK (4), and USA (3). 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".

There were, however, only very few of the actual participants who had any prior experience with ecosystem modeling, let alone Ecopath. Recognizing this prior to the course, the programme was modified to focus more on the introductory material than originally anticipated, including preparation of a new tutorial with greater emphasis on where to obtain and how to interpret parameter estimates. It was decided, however, to maintain an introduction to 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.

The diverse background of the trainees thus presented a problem for how to set the level for the course, but based on the course evaluations the instructors 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 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 that was updated as needed, see <https://sites.google.com/site/icesecosystemmodeling/>.

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 22 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 majorities heard about the course from a variety of source, word-of-mouth and the grapevine obviously being important. This does indicate the practice of the Training Committee of not just announcing on the ICES website, but also sending out numerous emails about the courses is working. Quite a number of participants were encouraged to go on the course by colleagues who had attended the previous year, which is good demonstration of the impact and perceived value of the course.

The course was fully subscribed well advance of the actual course after only a few months' announcement, indicating both a strong interest in this course, but also that the ICES training courses are getting established as a resource that member states count on.

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 course organization was rated very good by the majority of participants, again indicating that a good balance had been 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 majority (77%) finding the helpfulness of the teachers high and the usefulness of course materials likewise high (73%). The clarity of presentations was rated good to high by 91% of the respondents.

Overall evaluation of course content was very good (50%) and good (38%), course organization had 79% in these categories and the remaining indicating it to be average. Overall quality of the teaching and of the course drew similar high ratings.

The more detailed comments for the course indicate a clear interest in a mixture of presentations, hand-on exercises, and discussions, as was prepared for the courses. More effort could be used to prepare the course material, notably the exercises before hand. The responses also make 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 very few of the participants, however, had any experience.

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 out-

standing 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, or if advanced work should and can be left to relevant ICES Working Groups (notably WGSAM). Clearly the interest in the course and the outcome from it indicates that there is a strong need and request for the introductory to intermediate type of training course conducted here.

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 Course Coordinator for the social events that were conducted; they are extremely important for creating cooperation between the participants.

2 Recommendations

- The course was double-booked prior to the application deadline, and there clearly is interest and a need for courses in ecosystem modeling among institutions in the ICES member states. The course was very successful and useful as judged from the evaluations by the participants. We therefore recommend that another introductory-intermediate level course on “Using Ecosystem Modeling for Fisheries Management” be conducted in 2012;
- The instructors are encouraged to work with the Training Coordinator to better prepare participants in future training courses to ensure that everyone has hands-on experience with the approach prior to courses;
- Training materials and reading lists should be made available to future course participants shortly after the application deadline and well ahead of the course;
- The course description should clearly outline the expected experience level for participants. Participants should be selected with this in mind to ensure that some of the very basic aspects of the modeling can be omitted from the already intense training programme;
- The course description should be edited to emphasize how ecosystem modeling is being and can be used as part of the ICES advisory work. While this was the focus for the course, an improved course description will make this clearer to scientists considering whether to participate.

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. This included an overview of how food web modeling can be integrated with economic value chain modeling. The focus was on time- and spatial-dynamic modeling, and including 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 the participants gained cursory experience with this through an exercise.

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.

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/icesecosystemmodeling/>

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 the first-year 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 planned program as the course progressed, and these were discussed daily with the participants, with an overview presented at the start of each day, and a summing up at the end. 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	Creating an ecosystem model
	Mass-balance modeling	Mass-balancing
Tuesday	Mass-balancing (continued)	
	Time-dynamic modeling	Fitting models to time series data
	Results-extractor	North Sea model fitting
Wednesday	Time series fitting, mediation, value Chain, policy optimization	Fishing policy exploration (North Sea)
	Management Strategy Evaluation	MSE
Thursday	MSE follow-up,	Extracting results from North Sea
	Intro to spatial modeling, spatial optimization,	Spatial analysis in the North Sea
		MPA issues, closed areas
	Ecospace applications in fisheries and conservation	Exploring the spatial North Sea model, optimization
Friday	Coupling to hydrographic and other models	Demos of participants' models
		Question and answer session
	Using plug-ins with EwE	Evaluation
	End-to-End modeling	
	Using EwE for decision-support	
	The future of ecosystem modeling	

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 per day.

Monday, 7 March 2011		
9.00 – 10.00	Welcome (ICES Representatives): <ul style="list-style-type: none"> ▪ ICES Training Programme (Søren Anker Pedersen) ▪ ICES Advisory Services – What is ICES? (Poul Degnbol) ▪ Practical issues having meetings in ICES (Claire Welling) About this course (Villy Christensen and Steve Mackinson) Introduction of participants and lecturers; expectations – 1-2 minutes from each participant please	
10.00 – 10.30	Tea/Coffee Ecopath with Ecosim 6/3/11	
10.30 – 13:00	Ecosystem models: types and characteristics (file: 1 EM overview.pdf) Introduction to Ecopath with Ecosim (vers. 6); the approach and software (file: 2 EwE6 Introduction.pdf) Read: Christensen and Pauly. Ecopath II. Ecol. Modelling ; Christensen and Walters. 2004. EwE. Ecol. Model ; EwE6 Sequel . EwE6 manual: download From ICES SharePoint: ChristensenWaltersUseOfEM.pdf.	
13:00-14:00	Lunch	
14.00 – 15.30	Tutorial 1 : <i>Build and parameterize an ecosystem model of Anchovy Bay.</i> Mass-balance modeling; introduction; parameters (file: 3 Ecopath parameters.pdf)	
15.30 – 16.00	Tea/Coffee	
16.00 – 18.00	Tutorial 2 . <i>Mass-balancing of simple ecosystem models.</i> ICES SharePoint: Lab2.zip	
18.00 – 20.00	<i>Icebreaker (optional) in ICES lunch room</i>	

Tuesday, 8 March 2011		
9.00 – 10.15	Mass-balancing in Ecopath (continued)	
10.15 – 10.45	Tea/Coffee	
10.45 – 13.00	<p>The foraging arena: modeling predator-prey interactions; time-dynamic modeling; Ecosim; density-dependence and carrying capacity.</p> <p>Modeling environmental impact. Primary production anomalies; Using climate drivers. (file: 4 Ecosim.pdf) (paper: Ahrens ... FAT Fish and Fisheries in press.pdf)</p> <p>Presentation: Using plug-ins in EwE6; Results-extractor (Tools menu on top). (File: 5 ResultsPlugin.pdf)</p>	
13.00 – 14.00	Lunch & Group photo	
14.00 – 15.30	<u>Tutorial 3</u> . <i>Fitting the Anchovy Bay model to time series data. (Time series file: anchovybay.csv; in attachments below)</i>	
15.30 – 16.00	Tea/Coffee	
16.00 – 18.00	<u>Tutorial 4</u> : <i>Model fitting and performance testing: the North Sea</i>	

Wednesday, 9 March 2011		
9.00 – 10.15	<ul style="list-style-type: none"> ▪ Summary of Ecosim, questions? 	
10.15– 10.45	Tea/Coffee	
10.45 – 13.00	<p>Presentations:</p> <ul style="list-style-type: none"> ▪ Time series fitting, mediation, environmental forcing (file: 6 Time series.pdf) ▪ From sea to consumer: from food web through the economic value chain. (File: 7 EwEconomics.pdf). Read: Value chain.pdf; MEY=MSY.pdf ▪ Fishing policy exploration; objective function; 	
13.00 – 14.15	Lunch	
14.15 – 15.00	<i>Tutorial #5: Fishing policy exploration (North Sea)</i>	

15.00 – 15.30	Tea/Coffee	
15.30 – 18.00	<p><i>Tutorial #5: Fishing policy exploration (North Sea), continued.</i></p> <ul style="list-style-type: none"> ▪ Management Strategy Evaluation. Modeling multi-species fisheries regulations (weakest stock, strongest stock with discarding, selective fishing quota); fleet quotas; target fishing mortality policy. Fleet size dynamics (file: 7 MSE.pdf) <p><i>Tutorial 6: Management Strategy Evaluation and fishery regulations in Anchovy Bay</i></p>	

Thursday, 10 March 2011		
9.00 – 10.15	MSE follow-up. Questions? <i>Tutorial 7: Results plug-in</i>	
10.15 – 10.45	Tea/Coffee	
10.45 – 13.00	<p><i>Tutorial 7: Result plug-in (continued)</i></p> <p>Presentation : Introduction to spatial modeling in EwE. Including: Spatial optimization: objectivity function; optimizations approaches; linkages to/from Marxan; comparative studies. (file: 9 Ecospace basics.pdf) Demo: <i>Introduction to Ecospace interface and running spatial models</i></p>	
13.00 – 14.00	Lunch	
14.00 – 15.00	Presentation: Ecospace: Application in fisheries and conservation (files: 10 Ecospace Application to MPAs.pdf; 11 North Sea - Spatial analysis.pdf)	
15.00 – 15.30	Tea/Coffee	
15.30 – 18.00	<i>Tutorial 8. Spatial analyses in the North Sea (focus on MPA issue). File: Lab_Closed areas.pdf</i>	
18.15 – 22.00	Course dinner (optional, expenses to be covered by participants)	

Friday, 11 March 2011		
9.00 – 10.15	<p>Summary, questions? <i>Tutorial #9: Participants' models: issues and solutions.</i> We will pick one or two models that participants have worked with, and will examine them together Question and answer session and discussion Evaluation (written). Consider for this: what training should ICES be doing?</p>	
10.15 – 10.45	Tea/Coffee	
10.45 – 13.00	<p><i>Lab: continued.</i> Presentation: Coupling to hydrographic, climate, ERSEM, MSE models, and incorporation of alternative modeling approaches within the EwE6 modeling framework and software. (Covered in EwE6 presentation earlier) End-to-end modeling: On coupling models. (File: 12 North Sea – Coupling and Plugins.pdf)</p>	
13.00 – 14.00	Lunch	
14.00 – 15.00	<p>The future of ecosystem modeling. Using EwE as a decision-support system (presentation: 13 Ecopath in progress.pdf) Discussion</p> <ul style="list-style-type: none"> ▪ Ocean Summits ▪ Ecopath online ▪ Monkey business 	
15.00 – 15.30	Tea/Coffee	
15.30 – 16.00	Closing	

Annex 3: Course evaluations

- Day 1 might benefit from a little more of a walk through relating to a simple model. This need to be balanced with introduction, which was excellent in this course, but might help conceptualize/crystallize some of the challenges ahead
- I think the teachers have excellent knowledge about the work they presented. Sometimes things did go a bit too fast, which made it more difficult to follow.
- In my opinion the initial task, introducing the EwE6 (Tutorial 1, Tutorial 2), should be carried a little slower. Their level of understanding depends on whether it is possible to understand more tasks and functions EwE6 (Tutorial 3, 4 etc.).
- Break some of the lectures with activities that get participants to a certain point in the software, resume the lecture, break again, etc. Might help to keep everyone with you more effectively than after a longer, more extensive introduction.
- Many thanks, I really enjoyed and benefited from the course.
- Villy and Steve were extremely knowledgeable, and made all efforts to tailor the course to the participants (i.e., us). Being new to the topic, I found the material difficult; of course, this has no bearing on the instructors. I was impressed with Villy and Steve's ability to adapt and overcome minor issues as they arose. Overall, I was very pleased with the instructors and the course.
- This course is really useful for me because it help me understanding EwE and its applications. It also helps me connecting with those who have the same interest in ecosystem modeling for fisheries management. My suggestion is that we should keep in touch after this course and we should have cooperation in the future because it is really difficult for an individual to work efficiently with EwE.
- I am generally very satisfied with my experience at this training. I will leave the ICES with the introductory knowledge I was willing to acquire. Having no experience with Ecopath models at all before the training, I gained enough confidence to understand the principles and possibilities this application offers, and eventually participate in a collaborative effort to build a model for our study area. I also realized the immense capabilities of this tool, which I was not expecting. The course was very well organized, with a very nice ambiance, and very efficient and available instructors. I really appreciated the dinner, and kindness and availability of the organizing committee all week.
- Clearly the organizers know their stuff so we are getting this material from the people who know it best. However, an upfront statement that EwE is a work in progress would perhaps have helped prepare us for some of the problems arising and some of the issues could probably have been avoided by better preparation

- I would have preferred more focus on the model equations behind EwE. Perhaps too much time was devoted to MSE, which the majority of participants would not be able to use without further support.
- Ecospace appears useful but also requires further development/documentation.
- Overall I was very impressed by the versatility of EwE and the usefulness of the model.
- A pity that EwE 6 gives so much trouble depending on the computers.
- I liked the course a lot, but I thought it went a little too fast. Maybe that is okay. I liked that we dabbled in a bit of everything. I just could not follow the explanations for why we were doing some things. I am not very good at learning from lectures, maybe it's just me. I feel bad to say this, but I had trouble understanding both the Danish and British accent! Sometimes it felt like words were just being mumbled :) I guess just speak as clearly as possible.
- Check some of the software like version of MS office compatibility with EwE
- It gave me a nice knowledge of the software, and I hope to use it in the future