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

8–12 March 2010

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

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Participants at the course "Ecosystem Modelling for Fisheries Management" Training Course 8–12 March 2010 at ICES Headqarters in Copenhagen. The course was given by Villy Christensen, Fisheries Centre, University of British Columbia (#1 from left) and Steve Mackinson, CEFAS, UK (#3 from left).

Report of the ICES Training Course in Ecosystem Modelling for Fisheries Management, 8-12 March, 2010

by

Villy Christensen and Steven Mackinson

1 Summary

Acknowledging the worldwide move toward ecosystem-based management of marine resources, a training course on "Using Ecosystem Modeling for Fisheries Management" was conducted at the ICES HQ in Copenhagen during 8-12 March 2010. The course was from the early planning phases 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 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 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 de-

scription thus stated that it was "intended for scientists with some prior experience with ecosystem modeling".

The course attracted 27 participants representing 14 countries, and was filled to capacity (see listing in Annex 1). Approximately half of the participants had some prior experience with ecosystem modeling, while it was totally new to the other half. Recognizing this prior to the course, the programme was modified to include more introductory material than originally anticipated, but it was decided not to omit an introduction to the more advanced aspects of ecosystem modelling (see Annex 3). 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 atmosphere throughout the course was one of excitement and intensity, and the trainees worked long hours 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.

In addition to the numerous lectures by the instructors, Maciej Tomczak, DTU Aqua, Charlottenlund, presented work on time series fitting in the Baltic, and Mark Platts, CEFAS, Lowestoft, presented a plug-in he has constructed to extracting results from Ecosim runs in a flexible way, e.g., for use in connection with key-runs of models.

The course made good use of the ICES SharePoint for distribution of files such as presentations, reading materials, and model databases. This work 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 several times each day, see http://sites.google.com/site/icesecopath/.

A total of 24 course evaluations were received through the ICES SharePoint. The total number of participants was 27, but some left before the evaluation. 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.

Ms. Emilie Hugenholtz, WWF, Netherlands, prepared a report of the training course for distribution to WWF marine colleagues all over the world (and to Dutch NGOs, such as Greenpeace and the North Sea Foundation) in order to inform them about the lessons learned during the ICES training course. We include the report in Annex 2 (with permission) as we find that it neatly illustrates what a colleague with no prior experience with ecosystem modeling learned from and concluded about the course.

Most of the participants heard about the course through websites and recommendations from colleagues or advisors, indicating that direct information through emails had little impact or need to be improved. The overall response to the course was, however, that the course was full several months before the course, indicating both that there is a clear need or interest in this course and that a more efficient recruitment campaign could help to ensure a continued strong participation in coming years.

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 good to very good by the majority of participants, again indicating 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 majority finding the helpfulness of the teachers high and the usefulness of course materials likewise high. The clarity of presentations was rated good to high by 80% 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". Half of the participants were what some described as "virgins" with regard to this form for modeling, while a few had several years of 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 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, or if advanced work should and can be left to the ICES Working Group on Multispecies Assessment Methods. 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.

2 Recommendations

- The course was overbooked prior to the application deadline, and there clearly is interest and a need for courses in ecosystem modeling among institutions working with ICES. 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 2011;
- The instructors are encouraged to further develop notably the tutorials to be used for future training courses;
- There should be more time for tutorials and discussions built into the programme;

- Training materials and reading lists should be made available to future course participants several months 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 re-written 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 more clear 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 and demonstration of spatial optimization. We introduced the application of ecosystem-level Management Strategy Evaluation as implemented in the EwE approach and software.

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/icesecopath/

4 Course programme and instructors

The programme was circulated to all participants prior to the course, and is available for download from the ICES SharePoint. The instructors considered the program a "smorgasbord" from which the final menu could be selected based on the level and interests of the participants. To accommodate such there were minor changes to the programme 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 3.

The programme was designed with an about even split between lectures/discussions and tutorials. In summary form the programme was:

	Lectures	Tutorials
Monday	Welcomes	
	Ecosystem models, types and characteristics	
	Introduction to EwE	Simple food web, implications
	Mass-balance modeling	Mass-balancing
Tuesday	Mass-balancing (continued)	
	Time-dynamic modeling	Fitting models to time series data
	Time series fitting, Baltic	Mediation, (Alternate stable states)
Wednesday	Mediation, value chain, policy optimization	Fishing policy search
	Management Strategy Evaluation	MSE
Thursday	MSE follow-up,	Value chain demo
	Intro to spatial modeling, spatial optimization,	Introduction to Ecospace
	Ecospace applications in fisheries and conservation	Exploring the spatial North Sea model, optimization
Friday	Coupling to hydrographic and other models	
	Using plug-ins with EwE	
	End-to-End modeling	
	Using EwE for decision-support	
	The future of ecosystem modeling	Q/A, evaluations

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Annex 2: Course report, Emilie Hugenholtz, WWF

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Memo

To:	WWF Marine Team	
From:	Emilie Hugenholtz, Marine Advisor WWF Netherlands	Date:
Subject:	Lessons learned in course on Ecosystem Modelling of Fisheries Management, by the International Council for the Exploration of the Sea (8-12 March, 2010 Copenhagen)	19 March 2010

1. Various ecosystem models

There are several levels of looking at fisheries within an ecosystem:

- Single species approach
- Dynamic system models, models that attempt to represent both bottom-up (physical) & top-down (biological forces), such as OSMOSE
- Minimum realistic models, which include the dynamics of key species and target species. An example is the Multi-species Virtual Population Analysis (MSVPA), which is an extension of traditional fisheries stock assessment models designed to quantify predator-prey interactions, estimate predation and fishery mortality rates, and more effectively model the dynamics of exploited fish stocks, e.g. applied to the North Sea, the Georges Bank/Gulf of Maine, the Baltic Sea.
- Whole ecosystem models, which attempt to describe all trophic levels in an ecosystem, including e.g. abiotic features. Examples include Atlantis and EwE. Atlantis and EwE are in fact the only ones that include full-spectrum trophic interactions.

If you decide to use a model, your choice depends on the specific questions you wish to answer and what is the simplest way to get there? You never have all the needed information and often integrating a lot of information is difficult. Ecosystem models can tackle this best. There are various models; these do not compete, but rather should be seen as complementary to each other. In order to increase the robustness of your analysis, you should always seek to crosscheck with other models. Plaganyi gives a good overview of various models. When you have chosen a model, you always need to be critical about the data-input: assess the origin of each parameter and its pedigree; how well can we trust data, is it reliable, how well rooted is it and what is the time-span? What data goes in, influences what comes out. Ecosystem models are especially important to ask policy/research questions that we cannot address with the traditional single species assessment models, and they should be seen as complimentary to such models. Ecosystem models are thus not constructed to replace single species assessment models, we will still need such to address tactical management questions.

2. Ecopath with Ecosim (EwE)

EwE is a free ecological/ecosystem modeling software and is the world's most widely used tool for ecosystem modelling, with more than 6000 registered users in 155 countries. It is

designed to enable construction of data-rich ecosystem models, with a focus on their use for implementation of ecosystem-based fishery management.

The EwE software package can be used for a number of things, such as addressing ecological questions, evaluating ecosystem effects of fishing, exploring management policy options, analyzing the impact and placement of marine protected areas; predicting movement and accumulation of contaminants and tracers; modeling the effect of environmental changes. Compared to for example the Atlantis ecosystem model, EwE is more user-friendly and runs faster. You can set up a model for an ecosystem with EwE in anywhere from days to months, where Atlantis typically will take two years for that same ecosystem.

EwE has three main components:

Ecopath - a static, mass-balanced snapshot of the system;

Ecosim - a time dynamic simulation module for policy exploration;

Ecospace - a spatial and temporal dynamic module primarily designed for exploring impact and placement of protected areas.

Ecopath provides you with a snapshot of the ecosystem at a given point in time. It describes ecosystems by balancing flows between trophic groups. The principal assumption underlying Ecopath is that there has to be balance in trophic flows, so that demand by predators must be met by production by prey. When the model is balanced, this means that total input equals total output for each of the ecosystem components. Ecopath parameterizes models based on two master equations:

1. *Production*, which includes biomass accumulation fishing mortality, predation, net migration rate, other mortality

2. *Consumption*, which equals production+respiration+unassimilated food. There can be many different balances, and consequently you need to check your balance with data and reality.

This data is then imported into *Ecosim*, which enables you to do dynamic modelling, produce various simulations and explore policy models. There are many features, parameters and functions within Ecosim; too many to put in this memo, so here are some examples of *dynamic modelling features*:

- Fit: You can make your model work when you add a specific feature, e.g. when juveniles come in and out, but you don't know how many, the model allows you to make an estimation of a feature, so that it is consistent with all patterns.
- Forcing functions: Ecosim and Ecopath describe only feeding interactions. However, forcing functions were introduced to present e.g. a physical structure or environmental parameter to influence the trophic interactions over a given period of time.
- Fisheries: you can include e.g. description of fleet, landings, discards, discard fate, technological creep, cost of fishing, market price by group, value chain including processors, etc.
- Mediation. This helps to impact a specific trophic interaction between groups, such as mangroves can be available to prey to hideout. You can enter e.g. temperature, salinity or other environmental parameters and model the relation between a species and these environmental factors. In this way, you can model e.g. the impact of trawling and its consequent nutrient resuspension having an effect on primary production.
- Vulnerability. An assumption in many models is that all prey is available to predators. However, this is not always the case; fish are smart and they can hide. This means prey behaviour limits predations. This also implies that a sample by scientist for an amount of available food for a population or stock, may in fact not be entirely available for their

predator. This idea by Carl Walters is called the 'foraging arena' and can be integrated into the EwE model through the Vulnerability parameter; meaning a limitation of the availability of a species to prey or fishery

- Ecosim can help identify ecosystem changes, e.g. regime shifts (the Baltic EwE model shows a regime shift around 1989 from a cod dominated to a sprat dominated system and its fisheries shifted effort to lower trophic levels) and trophic cascades.

Policy models:

- Ecosim includes economic parameters, e.g. cost of fishing or payment for ecological services. You can include vessel price, value of landings, a complete value chain (from sea to plate) etc and couple this with the underlying ecopath model. In this way, it models economic flows as continuations of the food web. Through 'Management Strategy Evaluation' (MSE) in Ecosim, you can consider not only ecological drivers and consequences, but also social and economic ones and work towards policy optimization. This way you can calculate trade-offs for a specific management option.
- Ecosim enables the user to apply specific weighting for optimization; for example you can tell ecosystem structure recovery is the most important objective or tell it which species to save-the outcome will tell you the implications this has for the other species, for economic yield of the fishery, impacts on jobs etc. In reverse order, you can also set boundaries for economic and social impacts and accomplish ecosystem recovery within those boundaries (e.g. exclude a fleet, because it supports a high rate of employment).
- Other features include flexible implementation for evaluating a management scenario, e.g. a phasing out of a fleet over several years.

Ecospace is the part of the model that is used for addressing spatial questions, e.g., related to protected areas. It builds on Ecopath and Ecosim. It is a grid model in which you enter data for e.g. various populations, abiotic factors (e.g. artificial reef), habitat features (e.g. rocky area) etc. You can enter location, distribution and associate it with a certain biomass, fishery etc. It enables modelling of the influence of currents, mapping of toxins, distribution of nutrients, influence of local abundance of specific feature or species. Ecospace as such can predict effects of an MPA and effectiveness over a specific time period; it can analyze alternative network designs and take ecosystem features into account. *Ecospace, Ecopath and Ecosim* all interact and feed back into each other, so a spatial assumption in Ecosim will become apparent in Ecospace and vice-versa.

3. Application and future developments of the model

The EwE model is widely used and applied to ecosystems to derive conclusions about the status of the ecosystem, and mainly its fish stocks. At the Ecopath website, you can by entering name, area, EEZ, FAO area or Large Marine Ecosystem search to find out about modelling and application to specific marine ecosystems. Scientists involved in development of EwE currently use the model to give advice to MSC about criteria for forage fisheries.

The model continues to be developed and improved, now for 20 years. Since it is a model, it is not perfect and EwE can produce misleading predictions about the direction of impacts of policy proposals. Erroneous predictions usually result from bad estimates or errors of omission for a few key parameters, rather than 'diffuse' effects of uncertainties in all the input information. Read about how to use EwE and its methods, capabilities and limitations.

Scientists are now working out how to integrate GIS and spatio-temporal data of other models into Ecospace, as well as geochemical, physical, economic and other models into EwE. Ecospace outputs have not yet been directly implemented in management, because it has been relatively recent that scientist have started with such analysis. Scientist keep working to improve Ecospace, to include for example assessment of climate change impacts beyond single species and ecosystem effects of invasive species. Management Strategy Evaluation

(MSE) has recently been incorporated in EwE, and it has also not been used yet used in policy. MSE is expected to be used in policy-making in the next years to help decision makers evaluate alternative management scenarios, and look for the win-win situations. In the future, this may be used for management decision visualization in Regional Advisory Councils in the EU for example.

Practical communication tools are in development to support decision-making by visualizing scenarios and outcomes. They are working on 3-D animation outputs of the model to visualize the ecosystem, different parameters, impacts of management decisions etc. Take a look at an example of Chesapeake Bay. They are also working on an interactive 3-D game, in which players can exert influence on ecosystems by controlling impacts.

4. Information about EMFM Course

The weeklong training at ICES was designed to help broaden the ICES approach to fish stock and ecosystem analysis and make relevant modelling methods available. This course was the first one on EMFM and was designed to provide an introduction to the use of ecosystem modelling as a part of the fishery management process. With about 27 participants, all scientists and one NGO (me), we explored the design, application and potential of EwE. Trainers of the course were Dr. Villy Christensen of the University of British Columbia –one of the key drivers of application and development of the model and its tools- and Dr. Steve Mackinson of CEFAS in the UK- who is currently applying the EwE model to the North Sea.

During the course, I have learned about ecosystem modelling in general and EwE in specific; what EwE includes and what it does not include in the model; what are the key features and how to use these; how to build a simple model; how to read and value outputs by the model; getting a sense of robustness of the model; learning about practical application of the model (in the Baltic); using MSE to explore policy options; learning that it is a valuable tool to come to support decision-making processes. I would highly recommend if you want to gain a general understanding of the model, and if you have some previous knowledge, the course will improve your skills. Needless to say, the weeklong course is too short to become an expert. Dr. Villy Christensen is contemplating giving courses to NGOs. I think it is highly recommendable for NGOs to learn about the strengths and weaknesses of EwE to be able to assess the potential for application in marine areas, in which we are actively working towards ecosystem based fisheries management. For those interested but unable to attend a course, I am more than willing to share the presentations, tutorials, exercises, publications etc handed out during the course. Contact me at Ehugenholtz@wwf.nl

Annex 3: 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, 8 March 2010		
9.00 – 10.00	Welcome (ICES Representatives): ▪ ICES Training Programme (Søren Anker Pedersen) ▪ ICES Advisory Services – What is ICES? (Barbara Shout) ▪ 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**	
10.30 – 11:30	Ecosystem models: types and characteristics (file: 0 EM overview.pdf) Using ecosystem modeling for fisheries management (file: 1 Using Ecosystem Modeling.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.	
11:30-13:00	*Tutorial #1. Exploring EwE; creating a simple model; straight food chain dynamics: impact of targeting piscivores vs. forage species. Food web dynamics with more detailed food webs.* *Model: Make it from scratch, also available from ICES SharePoint as: Lab1.zip, (but do try to make it yourself)*	
13:00-14:00	**Lunch**	
14.00 – 15.30	Mass-balance modeling; introduction; parameters Presentation: included in (2)	

15.30 – 16.00	**Tea/Coffee**	
16.00 – 18.00	*Tutorial #2. Mass-balancing of simple ecosystem models. ICES SharePoint: Lab2.zip*	
18.00 – 20.00	*Icebreaker (optional) in ICES lunch room*	

Tuesday, 9 March 2010		
9. 00 – 10.15	Mass-balancing in Ecopath (continued)	
10.15 – 10.45	**Tea/Coffee**	
10.45 – 13.00	*Modeling predator-prey interactions; time-dynamic modeling; Ecosim; the foraging arena: density-dependence and carrying capacity. Mediation: non-trophic impacts.* *Modeling environmental impact. Primary production anomalies; Using climate drivers* *Presentation: 3 Ecosim.pdf*	
13.00 – 14.00	**Lunch**	
14.00 – 15.30	*Tutorial #3: Fitting ecosystem models to time-series data*	
15.30 – 16.00	**Tea/Coffee**	
16.00 – 18.00	Time series fitting in the Baltic (Maciej Tomczak). File: Baltic food-web changes.pdf *Optional: Tutorial #5: Alternate stable states* *Optional: Tutorial #6: Mediation*	

Wednesday, 10 March 2010		
9.00 – 10.15	EwE5 is still alive and doing well. Status. Use new version of EwE6, download from Sharepoint	

	(EwE.0309.setup), unzip, install. ▪ Mediation: introduction ▪ From sea to consumer: from food web through the economic value chain. Presentation: 4 EwEconomics.pdf Read: Value chain.pdf; MEY=MSY.pdf ▪ Fishing policy exploration; objective function;	
10.15–10.45	**Tea/Coffee**	
10.45 – 13.00	*Tutorial: Fishing policy search (North Sea)*	
13.00 – 14.15	**Lunch**	
14.15 – 15.00	*Tutorial: Fishing policy search (North Sea), continued*	
15.00 – 15.30	**Tea/Coffee**	
15.30 – 18.00	▪ *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* ▪ *Presentation: 5 MSE Peru.pdf* ▪ *Read: No EwE papers about this yet, but find general descriptions about MSE on the web.* *Tutorial #4: MSE. Download database from ICES SharePoint: Peru.zip* Postponed: ▪ Using ecosystems models for fisheries management: North Sea models; use in regional management councils; policy questions and objectives; (Steve) ▪ Presentation: 2_North Sea_Mixed fisheries issues.pdf	

Thursday, 11 March 2010		
9.00 – 10.15	MSE follow-up. Value chain demo. Presentation : Introduction to Ecospace: Spatial modeling in EwE. Including: Spatial optimization: objectivity function; optimizations approaches; linkages to/from Marxan; comparative studies. file: Ecospace basics.pdf	
10.15 – 10.45	**Tea/Coffee**	
10.45 – 13.00	Presentation: Ecospace: Application in fisheries and conservation (), files: 1_Ecospace_Application to MPAs.pdf; 1_North Sea - Spatial	

	analysis.pdf *Tutorial. Introduction to Ecospace interface and running spatial models*	
13.00 – 14.00	**Lunch** & Group photo	
14.00 – 15.00	Spatial analyses in the North Sea (focus on MPA issue). File: Lab_Spatial Analysis_North sea.pdf	
15.00 – 15.30	**Tea/Coffee**	
15.30 – 18.00	Demonstration: Exploring the North Sea models, optimization. ()	
18.15 – 22.00	Course dinner (optional, expenses to be covered by participants)	

Friday, 12 March 2010		
9.00 – 10.15	Coupling to hydrographic, climate, ERSEM, MSE models, and incorporation of alternative modeling approaches within the EwE6 modeling framework and software. (presentation: 7 EwE Coupling.pdf) Using plug-ins in EwE6. Presentation (with demo): Mark Platts. (file: ResultsPlugin.pdf)	
10.15 – 10.45	**Tea/Coffee**	
10.45 – 13.00	End-to-end modeling: On coupling models. File: 3_North Sea-Coupling and Plugins.pdf Using EwE as a decision-support system (presentation: 8 Ecopath in progress.pdf)	
13.00 – 14.00	**Lunch**	
14.00 – 15.00	The future of ecosystem modeling. Demo's and discussion ▪ Ocean Summits ▪ Ecopath online ▪ Monkey business Question and answer session; discussion; evaluation (written). Consider for this: what training should ICES be doing?	
15.00 – 15.30	**Tea/Coffee**	
15.30 – 16.00	Closing	