Report of the ICES Training Course: Introduction to Bayesian Inference in Fisheries Science (TCBIFS)

11–15 June 2012

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

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Contents

Participants at the course "Introduction to Bayesian Inference in Fisheries Science" Training Course 11–15 June 2012 at ICES Headquarters in Copenhagen. The course was given by Samu Mäntyniemi, Fisheries and Environmental Management Group, University of Helsinki, Finland (#1 from left) and Ray Hilborn, School of Aquatic & Fishery Sciences, University of Washington, USA (#10 from left).

Report of the ICES Training Course Introduction to Bayesian Inference in Fisheries Science, 11-15 June, 2012

by

Ray Hilborn and Samu Mäntyniemi

1 Summary

This was the second offering of the training course "Introduction to Bayesian Inference in Fisheries Science" under the ICES Training Programme 11-15 June 2012 at ICES Headquarters in Copenhagen. 18 students from 11 countries participated in the course (Annex 1). From the perspective of the instructors, the course was a success although some adjustments can improve the knowledge and skill transfer to the trainees (see 2 Recommendations).

Feedback from students was solicited using a course evaluation questionnaire (Annex 2). Results indicate that the amount of material covered was "average" to above "average", degree of difficulty was "average" to "difficult", course organization and the course description were "average" to "very good," helpfulness of teaching staff, usefulness of course materials and clarity of presentation were "average" to "high." Overall, the course content, organisation and quality of teaching were "good" to "very good." Individual feedback from trainees to the question "Good features of this course/suggestions for improvement":

- The instructors were quite accessible and taught the course at a level that allowed a sense of advancement. As well, there were practical examples and histories presented by the instructors that demonstrated the scientific method and connection to historical fishery problems which were quite useful. On the other hand it would have been good to see some examples using AD model builder.
- Of course the level of teaching is really high and most of the presentations are quite clear, however, sometimes it is too fast to follow some of the explanations and complex concepts
- For Ray's part, a more detailed solution of the examples in plenary may be helpful
- It was a very good introduction to the Bayesian technique, using OpenBUGS. The basics and basic model setup was very well covered. Unfortunately, I do not feel very prepared for beyond the basics - there is much that isn't readily apparent, both in coding the model and dealing with errors. It would be fabulous to have a more advanced course
- An introduction to using BUGS or JAGS with R would have been helpful. Otherwise I really liked the course and enjoyed taking it.

2 Recommendations

In this second offering we provided background material before the course and spent some more time on it in the beginning, which seemed to pay off. It seems that this is an approach worth keeping. However, based on feedback during the course some of the students felt that the jump from the most simple examples to a population dynamics happened a bit too quickly.

- Logistic growth model is good to have in the course program. However, it would probably be best to have it in the end of the course. We could also use a bit more time explaining the model and have example solutions easily available.
- Ray´s real life examples about meta-analyses and stock assessments around the world really put the course into its context. We should make sure to have enough time for those examples.
- We might consider looking in detail at one or two Bayesian stock assessments and the difference between the Bayesian assessment and what one would get from a maximum likelihood analysis of the same data set. If students are going to do it by themselves, then continuing with the logistic growth model might work. If this would be a demonstration or presentation, then an age or size structured model might be interesting.

3 Course description

Management advice provided by ICES has its roots in the work of stock assessment working groups comprising of experts on the stocks to be assessed. In addition to their expertise on the stock of concern and the population models of the stock, another important part of the expertise is the knowledge about the population dynamic parameters and their relationships derived from other stocks and the historical experience in fisheries. Traditional stock assessment methods can only use the data available for the stock of interest, which means that all other knowledge has to be left out from the quantitative analysis. The Bayesian approach to scientific reasoning provides a mechanism to incorporate this other knowledge and experience. The Bayesian approach is a mathematical logic for quantifying and processing expert knowledge, which enables direct integration of the prior information possessed by experts and their interpretation of the observed data.

Bayesian methods also provide a mechanism for the quantification and computation of uncertainty that is directly applicable to decision making. Traditional statistical methods only describe the sampling process while assuming known state of nature; (stock size for instance) there is no measure of uncertainty about the state of nature itself. Thus, the scientists are not able to make probabilistic statements of uncertainty about the status of the stock or the population dynamic parameters. Bayesian analysis results in clear probability statements such as "there is a 90% probability the stock is between 1200 and 3000 tons", and these probabilities can then be directly used in decision analysis to inform the management advice.

The objective of this course is to familiarize the participants with the basic concepts of Bayesian inference and to provide skills for solving simple problems. The participants will have hands on experience about using MS Excel and OpenBUGS software for Bayesian computation. The topics to be covered include:

- Principles of the Bayesian reasoning
- Differences and similarities between the Bayesian approach and conventional statistics
- Numerical integration methods: Markov chain Monte Carlo (MCMC) and Sampling importance resampling (SIR)
- Bayesian regression analysis (or estimation of a mean)
- Bayesian Mark-Recapture analysis

4 Course programme and instructors

The programme was circulated to all participants prior to the course, and is available for download from the ICES Share Point Site.

The programme was designed with an about even split between lectures/discussions and tutorials. (Annex 3).

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Annex 1: List of participants

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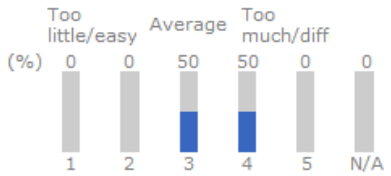
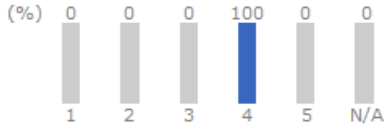
Annex 2: Course Evaluation

2. Course Content

Amount of material covered?



Degree of difficulty?



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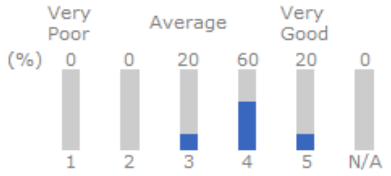
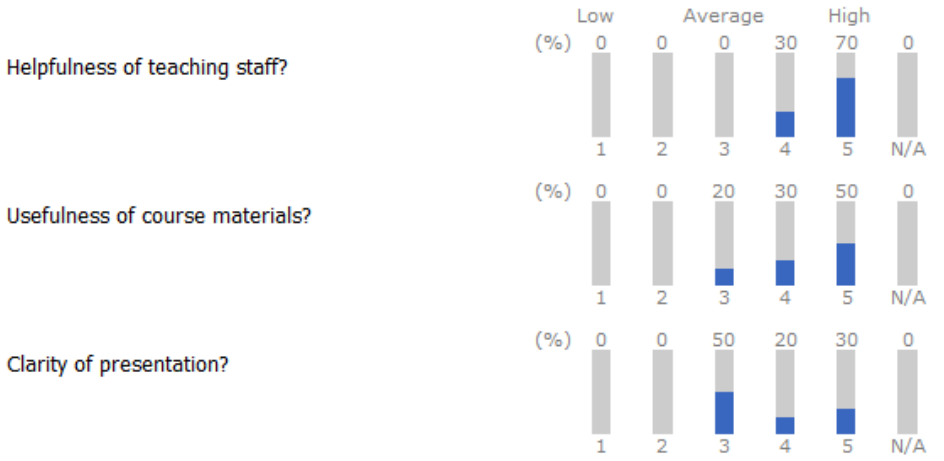
3. Course Organization

Quality of course outline?

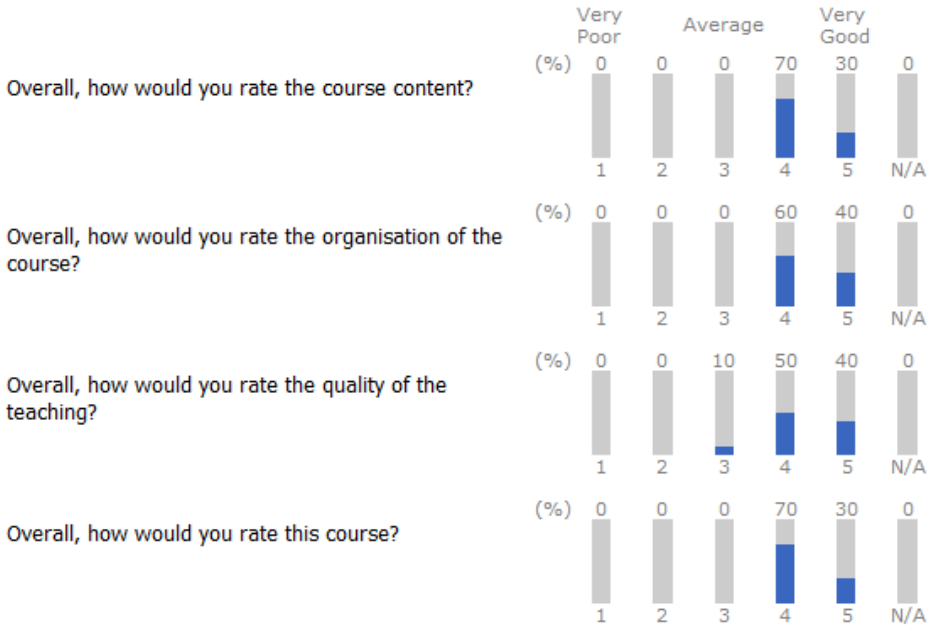


4. Teaching and Learning Support



Total: 10

5. Overall Evaluation



Total: 10

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 share point site.

Time	Event
Monday, 11 June 2012	
9.00 – 10.00	Welcome ICES Staff -About this course (Samu and Ray) Introduction of participants and lecturers; expectations
10.00 – 10.30	Tea/Coffee
10.30 – 11:30	Lecture Samu: Modes of inference: compare Bayesian concepts to p-values, likelihood profiles and confidence intervals
11:30-13:00	Lecture Ray: Introduction to decision analysis
13:00-14:00	Lunch
14.00 – 15.30	Lecture Samu: Modes of inference continued: probably spills over from the morning due to introdcuctions, household issues etc Lab Ray: Bayesian computation part I: Excel grid
15.30 – 16.00	Tea/Coffee
16.00 – 18.00	Continuation of afternoon lab
18.00 – 20.00	Icebreaker
Tuesday, 12 June 2012	
9. 00 – 10.15	Samu Lecture: Bayesian computation II: Introduction to MCMC: -Estimation of a mean - Convergence criteria
10.15 – 10.45	Tea/Coffee
10.45 – 13.00	Lecture Samu Introduction to MCMC and WinBugs and convergence issues
13.00 – 14.00	Lunch
14.00 – 15.30	Lecture Ray: OpenBUGS: linear regression
15.30 – 16.00	Tea/Coffee
16.00 – 18.00	Continuation of OpenBUGS: linear regression

Wednesday, 13 June 2012	
9.00 – 10.15	Lab Samu: simple mark recapture model using MCMC
10.15– 10.45	Tea/Coffee
10.45 – 12.30	Lecture Samu: mark recapture continued
12.30 – 13.30	Lunch
13.30 – 14.40	Lecture Ray: Hierarchical stock recruitment model : Ideas and examples, "shoulders of giants"?
15.00 – 17:30	Lectures Ray and Samu: Danish fishermen and stakeholder meeting at Danish Design Centre
Thursday, 14 June 2012	
9.00 – 10.15	Lecture Ray: hierarchic stock recruitment models
10.15 – 10.45	Tea/Coffee
10.45 – 13.00	Continuation of hierarchic modelling in lab
13.00 – 14.00	Lunch & Group photo
14.00 – 15.00	Continuation of hierarchic modeling, Importance sampling and SIR, Bayesian model uncertainty
15.00 – 15.30	Tea/Coffee
15.30 – 18.00	modelling in lab, starting to discuss the research problems of participants
18.15 – 22.00	Course dinner (optional, expenses to be covered by participants)
Friday, 15 June 2012	
9.00 – 10.15	Reserved for lecture material left incomplete earlier in week
10.15 – 10.45	Tea/Coffee
10.45 – 13.00	Student problems: each student will do a Bayesian analysis of a data set they know well
13.00 – 14.00	Lunch
14.00 – 15.00	Question and answer session; discussion; evaluation (written)
15.00 – 15.30	Tea/Coffee
15.30 – 16.00	Closing