

# ADMB

## Automatic Differentiation Model Builder

**ADMB Foundation  
newsletter**

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### Inside this issue:

*Stock Synthesis: ADMB application wins prestigious award* 2

*Non-fish ADMB applications* 2

*PBSadmb: linking ADMB with R* 3

*Reading ADMB default output into R* 3

*Recent ADMB based publications* 4

## First ADMB Foundation ADMB Course

The ADMB Foundation ran its first ADMB course at the National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, on the 9th and 10th of March, 2009. The instructors were Foundation members Anders Nielsen, Johnnoel Ancheta, and Mark Maunder. There were about twenty participants with diverse backgrounds ranging from participants that had coded their own models in R or BUGS to those that had no programming experience. The course was targeted at ecologists who had no ADMB experience. It was a grueling two days for the participants as they grappled with a new programming language, likelihoods, and modeling concepts. However, it all fell into place as they created a complete ADMB program from scratch on the afternoon of the second day. Topics covered in the course included: installation, first example, likelihood based inference, what happens internally, parameter setup, data input, outputting results, simulation, estimating uncertainty (including Bayesian MCMC), and random effects.

By most accounts the course was a success and one of the partici-

pants was even heard saying that after seeing the power of ADMB, they wish they had never learned WinBUGS. This was the first course taught by the Foundation and the instructors learned from the experience and will use it to improve future courses.

The course materials can be downloaded at <http://admb-project.org/documentation/courses/march-2009>

Two additional training workshops are scheduled. The first at AZTI Technalia in San Sebastian, Spain, on July 6-7 and the second at the Danish Institute for Fisheries Research in Copenhagen, Denmark, on August 17-18. A one-day mini-workshop is scheduled for the August, 2009 Ecological Society of American Annual Meeting in Albuquerque, New Mexico, USA.

### AFS Alaska Chapter Course

The Alaska Chapter of the American Fisheries Society organized a four-day ADMB workshop held in Juneau Alaska from April 6-9th. Jim Ianelli of the Alaska Science Center was the instructor. The 17 participants included mostly state and federal fisheries

scientists, some graduate students, and a private consultant. The course made use of the PBSadmb package for R (see page 3). After spending some practice time using this R package, about half felt that this helped with application development whereas the others appreciated the interface but were more comfortable with a more traditional model-



ADMB Foundation member Anders Nielsen helping participants at the first Foundation ADMB course held in Santa Barbara

development process. At this point nearly all adopted the readList() function for writing models and naming variables in the output from ADMB. Part of the course involved converting a WinBugs model into ADMB and making some comparisons. The course was similar in content to the Foundations, but with a fisheries focus.

## Milestone: Over 2000 downloads!

Since putting the ADMB binary files on the [admb-project.com](http://admb-project.com) website in December 2008, they have been downloaded close to 2500 times. This has far exceeded our expectations and illustrates the success of the

project. Even after making conservative assumptions about test downloads, duplicated downloads, and downloads not installed, the number of downloads has a market value greater than the total value of

the Moore Foundation grant used to purchase ADMB. There has still been little promotion of ADMB and as ADMB becomes known outside fisheries, we expect the number of downloads to increase even more.

"To make the ADMB a free software is the best thing that could have happen for fisheries and ecology modeling in this new century!" Carolina Minte-Vera, Professor, Universidade Estadual de Maringá, Brasil.

The ADMB Foundation would like to add that Carolina's comment also suggests that the creation of ADMB by Dave Fournier was the best thing that happened for fisheries and ecology modeling last century.

## Stock Synthesis:ADMB application wins prestigious award



Some of the early ADMB applications involved the assessment of snapper off the coast of New Zealand

### Converting your stock assessment model to use random effects for recruitment

- 1) Change the recruitment deviates from an `init_vector` to a `random_effects_vector` and put it at the bottom of all the estimated parameters
- 2) Make the standard deviation of the recruitment deviate penalty (use the full log-likelihood) an estimated parameter
- 3) Compile using the `-re` option
- 4) Use the `-mno` command line option when running the program, if needed

Simple as that



As ADMB becomes more widely used, hopefully we will see more applications of animals other than fish

There are numerous ADMB applications around, but none of them compare in size to Stock Synthesis (SS). SS is a general fisheries stock assessment model created using 15,000 lines of ADMB code. It allows for the inclusion of a variety of data (e.g. indices of abundance, catch-at-age, tagging, ...) and has numerous choices for assumptions about the population dynamics, fishery dynamics, likelihood functions, and other model characteristics. SS has mainly been used for groundfish assessments on the west coast of the United States, but it is starting to become popular for assessing other fisheries as well. It is commonly used in Australia for a variety of assessments and is used for several tuna, billfish, and small pelagic assessments.

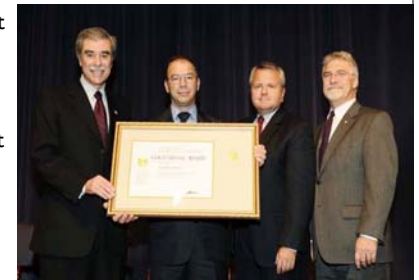
There are other general fisheries models around such as extended survivors analysis, which is extensively used in Europe, but none compare to the flexibility of SS. Much of this flexibility comes from the power of ADMB. There have been numerous other general fisheries models developed in ADMB. One of the first general fisheries models that included the facility to conduct Bayesian decision analysis, Coleraine, was programmed in ADMB.

The first general model to integrate tagging data into a stock assessment, MULTIFAN-CL, was developed using AUTODIF, the C++ library that underlies ADMB. One general model that compares to the flexibility of SS, CASAL, is based on concepts borrowed from ADMB.

There are many benefits of having a flexible and powerful general model. Maunder et al. (2000) summarize the benefits as "A general package offers a streamlined development path for implementing stock assessments. It eliminates the need for developing customized code that must be debugged and tested. End users need not be highly skilled programmers or analysts who work at the forefront of method development. However, they still must have an adequate understanding of fisheries stock assessment methods to ensure that they apply the general model appropriately. If the model receives consistent use for numerous assessments, the interest groups will gain a better understanding and ac-

cepted the results more readily. Presumably, general models have already been tested in multiple applications, with a much lower risk of programming errors than in custom models." However, Maunder et al. also warn about the misuse of general models by inexperienced users.

SS has been so successful that the creator, Rick Methot of NOAA, has been awarded the US Department of Commerce Gold medal, the highest honorary award granted by the Secretary, for developing SS. The foundation congratulates Rick for his award winning use of ADMB



Rick Methot (second from left) accepting his award for the development of Stock Synthesis at the U.S. Department of Commerce 2008 Gold and Silver Medal Award Ceremony, November 18, 2008, Washington, D.C.

## Non-fish ADMB applications

ADMB has historically been used for fisheries stock assessment. However, ADMB is a general purpose tool for any nonlinear parameter estimation problem and can be used in any field of research. There have been several ADMB applications outside fisheries. Many of these are fisheries related such as modeling the dynamics of marine mammals (e.g. Breen et al. *Can. J. Fish. Aquat. Sci.* 60: 527-541) and seabirds. ADMB is starting to make its way into the wildlife literature and this is probably the

next field of research that ADMB will take over. For example, Fenichel and Horan (*Amer. J. Agr. Econ.* 89: 904-920) use ADMB to model disease dynamics in a deer population. Maunder et al. (*Environmental and Ecological Statistics* 3: 917-948) applied hierarchical mark-recapture models to bird populations. ADMB has also been used in economic and medical research. Meyer et al. (2003) [*Econometrics Journal*, 6: 407-419] used ADMB to model pound/dollar exchange rates

using stochastic volatility models. Jostein et al (2008) [*Mathematics and Economics* 43: 121-133] used ADMB to model insurance damages using a linear mixed model with left truncated data. Lunde et al (2007) [*American Journal of Epidemiology* 165: 734-741] used ADMB to model fetal and genetic effects and shared sibling environmental effects on birth weight and gestational age using path analysis and mixed linear models.

## PBSadmb: linking ADMB with R

Jon Schnute and Rowan Haigh of the Pacific Biological Station in Nanaimo Canada have developed a set of R functions and a related GUI to facilitate the use of ADMB and to interface ADMB with R. PBSadmb comes with a version of ADMB and uses Rtools to install a free C++ compiler (GCC), which facilitates the installation of ADMB. Menus on the GUI call the R functions to carry out the translation to C++, compilation, linking, and running of the

ADMB code and configuring run options. The GUI brings up your choice of editor so you can create or edit the ADMB files (e.g. tpl, dat, and pin). The output can be loaded from the ADMB created text files into R with a click of a button on the GUI or by calling the R functions directly from R. The GUI includes a library of examples files to help guide new users. PBSadmb includes several features that aid the use of ADMB within R such as ensuring that

variable names match between the source file for ADMB (called a template) and a corresponding source file for R. It also has several features to aid in the development of Bayesian MCMC models such as plotting posterior traces, densities, and pairwise correlations.

PBSadmb can be downloaded at: <http://code.google.com/p/pbs-software/>

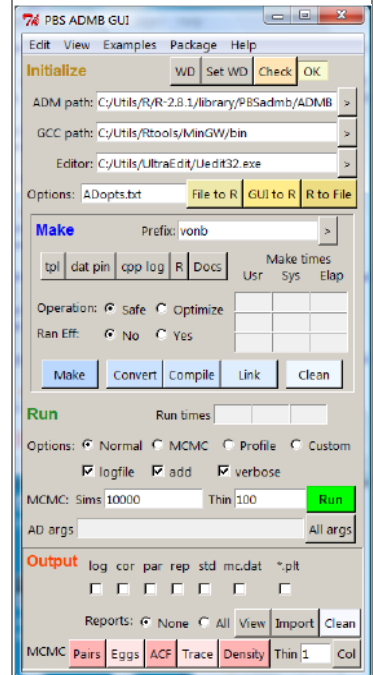
## Reading ADMB default output into R

This R function written by Anders Nielsen will read in the default ADMB output files. (The "file" argument is the directory and root of the ADMB program e.g. file="C:/ADMB/examples/simple")

```
read.fit<-function(file){
  # Function to read a basic AD Model Builder fit.
  # Use for instance by:
  #   simple.fit <- read.fit('c:/admb/examples/simple')
  #
  # Then the object 'simple.fit' is a list containing sub-objects
  # 'names', 'est', 'std', 'cor', and 'cov' for all model
  # parameters and sdreport quantities.
  #
  ret<-list()
  parfile<-as.numeric(scan(paste(file,'.par', sep=''),
    what='', n=16, quiet=TRUE)[c(6,11,16)])
  ret$nopar<-as.integer(parfile[1])
  ret$loglik<-parfile[2]
  ret$maxgrad<-parfile[3]
  file<-paste(file,'.cor', sep='')
  lin<-readLines(file)
  ret$npar<-length(lin)-2
  ret$logDetHess<-as.numeric(strsplit(lin[1], '=')[1][2])
  sublin<-lapply(strsplit(lin[1:ret$npar+2], ' '),function(x)x[x!=''])
  ret$names<-unlist(lapply(sublin,function(x)x[2]))
  ret$est<-as.numeric(unlist(lapply(sublin,function(x)x[3])))
  ret$std<-as.numeric(unlist(lapply(sublin,function(x)x[4])))
  ret$cor<-matrix(NA, ret$npar, ret$npar)
  corvec<-unlist(sapply(1:length(sublin), function(i)sublin[[i]][5:(4+i)]))
  ret$cor[upper.tri(ret$cor, diag=TRUE)]<-as.numeric(corvec)
  ret$cor[lower.tri(ret$cor)] <- t(ret$cor)[lower.tri(ret$cor)]
  ret$cov<-ret$cor*(ret$std%o%ret$std)
  return(ret)
}
```

### Coding tip: outputting the phase

```
BETWEEN_PHASES_SECTION
cout<<"*****"<<endl;
cout<<"* Phase = "<<current_phase()<<"*"<<endl;
cout<<"*****"<<endl;
```



The PBSadmb GUI makes it easy to create and run ADMB models and then transfer the results into R for further analysis and graphing.

**Most of the information contained in the newsletter articles is available online with additional details. See:**

**[admb-foundation.org](http://admb-foundation.org)  
and  
[admb-project.org](http://admb-project.org)**

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The objectives of the ADMB Foundation are to (a) advance the ADMB project for improving data analysis and non-linear statistical modeling; (b) act as an official voice for the ADMB project, providing means of communication with the press, commercial and noncommercial organizations interested in the ADMB software; (c) coordinate development and promote use of ADMB.

The ADMB Foundation is a non-profit organization working in the public interest for charitable, educational and scientific purposes under section 501(c)(3) of the United States Internal Revenue Code.

President: John Sibert

Treasurer: Mark Maunder

Secretary: Anders Nielsen

**American Fisheries Society's William E. Ricker Resource Conservation Award.** If you would like to provide a letter of support for Dave Fournier's nomination for this award, please send the letter to mmaunder@iattc.org by the due date of May 15. Dave was runner up last year so hopefully, with the recent recognition represented by the Moore funding and the Stock Synthesis Gold Medal Award, he will win this time.

## Recent ADMB based publications

Adkison, M.D. (2009) Drawbacks of complex models in frequentist and Bayesian approaches to natural-resource management. *Ecological Applications* 19: 198-205.

Arteaga I, M. and Cubillos, L.A. (2008) An analysis of changes in sardine (*Strangomera bentincki*) abundance: calendar versus biological year structure. *Lat. Am. J. Aquat. Res.*, 36: 137-151.

Edwards, C.T.T, Rademeyer, R.A. Butterworth, S.S. and Plagányi, E.E. (2009) Investigating the consequences of Marine Protected Areas for the South African deep-water hake (*Merluccius paradoxus*) resource. *ICES Journal of Marine Science* 66: 72-81

Eveson, J.P. Laslett, G.M. and Polacheck, T. (2009) A Spatial Model for Estimating Mortality Rates, Abundance and Movement Probabilities from Fishery Tag-Recovery Data. D.L. Thomson et al. (eds.), *Modeling Demographic Processes in Marked Populations*, Environmental and Ecological Statistics 3: 987-1010.

Korman, J. Yard, M. Walters, C. and Coggins, L.G. (2009) Effects of Fish Size, Habitat, Flow, and Density on Capture Probabilities of Age-0 Rainbow Trout Estimated from Electrofishing at Discrete Sites in a Large River. *Transactions of the American Fisheries Society* 138: 58-75.

Maunder M.N., Schnute, J.T., and Ianelli, J. (2009) Computers in Fisheries Population Dynamics. In: Megrey, B.A. and Moksness, E. [eds.]. *Computers in Fisheries Research*. Springer, pp: 337-372.

Methot, R.D. Jr. (2009) Operational models in support of fisheries management. In: *The Future of Fisheries Science in North America*. By R. J. Beamish, Brian J. Rothschild. *Fish and Fisheries Series*, 137-165

Wang, S.-P., Maunder, M.N., and Aires-da-Silva, A. (2009) Implications of model and data assumptions: An illustration including data for the Taiwanese longline fishery into the eastern Pacific Ocean bigeye tuna (*Thunnus obesus*) stock assessment. *Fisheries Research* 97 (2009) 118-126.