

Campbell Davies visit to JRC under the scope of the a4a  
initiative  
Ispra, 16-18/December/2013 and 07-10/January/2014

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## 1 Introduction

The a4a visiting scientists program has so far given very good results, by allowing the a4a network to grow sustainability and simultaneously creating the opportunity to have independent revisions of the methods being developed.

The visit of Campbell Davies (CSIRO, Australia), Principal Research Scientist and Team Leader of Pelagic Population Ecology and Dynamics was very productive in getting external expert cooperation and review of the initiative's tasks and progress.

In 2014 the Initiative's objectives include disseminating and testing the methods developed during the last year. The visit of Campbell Davies was instrumental to these objectives, allowing direct collaboration with Australian scientists which, due to the long distance, are not easy to establish.

The Terms of Reference for Mr. Campbell's visit were:

- Revise the MSE algorithm being developed by Iago Mosqueira for the IOTC.
- Present CSIRO work on genetic tagging.
- Discuss the a4a stock assessment method.
- Discuss MSE algorithms and the standard being developed within the scope of a4a.
- Explore generic HCRs that consider distinct indicators of stock status, based on stock assessment methods or not.
- Present CSIRO involvement in the Australian management system.

## 2 Agenda

- Day 01
  - Presentation by Iago Mosqueira of the work being done for the IOTC regarding the management plan of Albacore.
  - Discussion about the key subjects to be further developed.
  - Discussion of major factors of risk carrying out the MSE analysis and implementing the management plan.

- Day 02
  - Seminar "Close-kin approaches and next generation genetics in fisheries science and management: is the promise of modern genetics coming to fruition?".
  - Discussion about genetic tagging and how it can be included in MSE.
  - Discussion about collaboration with FISHPOPTRACE and AQUATRACE projects.
- Day 03
  - Hands-on with the stock assessment method developed in the scope of a4a.
  - Discussion about it's use and applicability to Australian stocks.
  - Discussion about using stock assessment methods within MSE MP evaluations vs. mimicking the use of those statistical methods.
- Day 04
  - Presentation by Ernesto Jardim of the recent developments of a4a's generic HCR implementation.
  - Discussion about generic HCR and implementation in R.
- Day 05
  - Seminar "The fisheries management and science advisory interface in Australia: Experience with the implementation of a formal harvest strategy policy" by Campbell Davies.
  - Presentation by Hendrik Doerner and Fabrizio Natale about STECF and scientific advice to the European Commission.
  - Discussion about governance in Australia and Europe, comparing governance systems and practices regarding the role of scientific advice.
- Day 06
  - Working on generic HCR.
- Day 07
  - Working on generic HCR.

## 3 Major subjects discussed

### 3.1 Implication of CSIRO on the work of IOTC WPM

The research group led by Dr. Davies has a long experience in the development of management plans for tuna stocks, for example for Southern Bluefin tuna and West Pacific tuna stocks. Although fishing in Indian Ocean waters is less of a priority for the Australian authorities, CSIRO is keen on taking part in the process of development of MSE simulations for IOTC stocks. Possible avenues for this involvement were discussed, including possible funding opportunities coming from the GEF ABNJ project. The experience of Dr. Davies in particular will be very useful in guiding the dialogue between managers and scientists, which is likely to be key in the success of this process.

The possible involvement of JRC on the various training and capacity building initiatives on MSE in which Dr Davies is involved was also discussed and should be determined in detail in the near future.

### 3.2 Genetic tagging and close-kin approaches

The discussion around the genetic methods presented by Campbell Davies (see presentations) focused on the extent to which modern population genetics had delivered on its potential to directly contribute to the assessment and management of fisheries, in particular the development of a novel approach to estimation of absolute spawning biomass using paternity analysis [3]. The close-kin approaches include a suite of methods that use the frequency of closely related individuals (e.g. parent-offspring, siblings) in a sample to estimate abundance and other vital rates of populations. The Parent-offspring pair method [3] is the most appropriate because it provides an estimate of the absolute biomass and/or the trend in biomass, which can be directly used in a stock assessment [4] or harvest control rule [2]. As with other genetic methods the cost-effectiveness depends on the availability of suitable samples, the costs of developing appropriate markers and sufficient understanding of the life-history of the species. The rapidly reducing costs in both marker development and processing, particularly for SNPS, is likely to make these methods much more cost-effective for a wider range of species in the near future.

The method was tested and used in southern bluefin tuna [3] and performed very well and is now being considered as a method for routine long-term monitoring of the spawning stock. The method requires that the stock structure is well known and that juveniles from known spawning populations can be collected. This is likely to be a constraint of the application of the approach for for most European stocks that show a large overlap between spawner and juveniles. However, an interesting application may be for stocks of deep sea species, which have a more local behaviour and are unlikely to be amenable to traditional stock assessment methods, due to the long time series required. Cephalopod stocks may be another potential candidate because the biology of these species makes it very difficult to use the traditional stock assessment methods.

Separate to the close-kin abundance estimation methods, Campbell Davies, Jann Matinsohn and Ernesto Jardim discussed the potential for collaboration in the use of next generation sequencing methods and high through put genetics processes to significantly enhance understanding of stock structure and assist in the elimination of IUU fishing via enhanced chain of custody procedures and catch documentation schemes (for highly migratory stocks, in particular). This is an area of joint interest and expertise which may have significant science and applied benefits through closer collaboration.

### 3.3 Stock assessment and operating model conditioning

The a4a stock assessment methods implemented in the FLa4a R package were presented and discussed. The methods were considered interesting for Australian stocks and the following were identified for testing the approach: southeast flathead, southwest Pacific striped marlin, southwest Pacific swordfish and southern rock lobster.

It was agreed to allocate some time to fitting the a4a methods to these (or alternative candidates) stocks in order to compare with the methods used by the experts working groups. This task is considered of major relevance to validate the a4a approach, gain additional user feedback and disseminate the methods.

Furthermore, the model averaging methodology promoted for a4a, the development of which is now stalled due to lack of expertise, was presented and discussed. In particular the idea of incorporating model structural uncertainty in stock assessment results is appealing and of central importance for robust MSE. CSIRO developed a similar procedure for the management procedure of south blue fin tuna and there's interest in cooperating on the development and implementation of these methods.

### 3.4 Generic Harvest Control Rule

An exercise was carried out to test if harvest control rules used by Australian management authorities could be set within the generic HCR being developed for the a4a initiative. Most HCRs were possible to be configured with the a4a framework. The limitations arose in rules that have an unspecified number of options. However, these were formulated for theoretical reasons and there are no examples of their use in real cases.

The exercise also allowed debugging and testing some of the existing code. As such, a number of rules were coded in R and loosely tested. For example the "up-down" rule [1] could be implemented as  $F_{trg} * (1 + \text{sign}(b) * d)$  where  $b$  is an indicator of the stock trends, like a the slope of a CPUE series, and  $d$  defines the symmetric change in the management variable (e.g. 0.1).

Additionally, the general a4a HCR framework could accommodate the tier system used by Australia [5]. The results were very positive and we're able to fit the framework to all the tiers, although further tests are needed to fully test the functioning of the code. An interesting discussion arose from the exercise, in the SE groundfish fishery in Australia stocks are allocated to one of four tiers based on expert opinion about the quality of the assessment, and afterwards the HCR is applied for a period of time without having the possibility of changing tiers until a new evaluation of the quality of the assessment is performed. In Europe, management plans that rely on unstable assessments may require a fallback option to account for years that stock assessment results are not available for some reason (unstable assessment, lack of survey data). In that case the HCR will have two branches (analogous to the tiers used in Australia) and the decision about which branch to use is taken every year, contingent on the whether or not a satisfactory assessment is available. To test such cases the decision must be based on objective information, e.g. high residuals, non-convergence of the model, etc, not on expert's opinion, and the generalized framework in a4a would allow this to be done by MSE.

## 4 Feedback by Campbell Davies

### 4.1 a4a stock assessment software

The a4a (Assessment for All) software has been designed to provide a more accessible and flexible stock assessment program that can be used by fisheries scientists (and others) who are not stock assessment specialists. It works with FLR (Fisheries Libraries in R), so requires a certain level of understanding of the R statistical programming language, but does not require the ability to code complex scripts and the software has been designed in such a way that the structure is quite intuitive for an experienced fisheries biologist or scientist. The functional form and parameterization of the primary biological processes (e.g. growth, natural mortality, size at maturity and stock recruitment relationship, selectivity) and fishing mortality model are selected and specified from predefined, but flexible, functions, which include a range of options for including uncertainty. Similarly, there is a range of diagnostics and parameter estimation reports that provide for examination of model fits, residuals etc and the necessary inputs for harvest control rules, in the case of its use for an operating model for MSE.

### 4.2 a4a Management Strategy Evaluation

Seminar (valuable feedback): Understanding of current governance arrangements (including formal Management Plans in EU) and science policy interactions. Campbell Davies gave a seminar to FISHREG staff on the governance and fisheries management arrangements in Australia, with a focus on the background and implementation of the federal Harvest Strategy Policy and the science-management advisory arrangements. Dr Hendrick Doerner and Fabrizio Natale gave

complimentary presentations on the EU arrangements, in particular the role of STECF and the development of the new DCF. There followed a very interesting discussion on the contrasts and similarities between the arrangements in the two jurisdictions, in which it was noted that there was a) considerable similarity between the EU fisheries management plans and HCR and benchmark assessment process in ICES and the Operating model, Management procedure and meta-rules implementation framework in CCSBT, and b) shared interest in the areas of assessment and HCR development for multi-species fisheries and critical evaluation of the current approach to assessment and management of data poor stocks.

## 5 Further collaboration

While the a4a and the FLR initiative are designed and intended for use in EU/ICES fisheries, the flexibility of the programs for stock assessment and the relative ease of use (given their implementation in the open source R language), means there is considerable scope for their use, refinement and extension in other contexts, including for domestic fisheries in Australia. While CSIRO has excellent capability in fisheries stock assessment and MSE, there is a recognized need for software platforms, such as a4a, for use by non-population dynamics/stock assessment specialist, for routine stock assessments and MSE. CSIRO has used and has explored the use of a range of these, ADMB, SS3, CASAL. However, with the exception of SS3 for the SE ground fisheries, all the assessments are based on bespoke assessment models usually coded in ADMB, or C, and other platforms. Hence, there is considerable scope for collaboration with the a4a initiative in the following areas:

- Beta-testing of the stock assessment model of a4a by experienced stock assessment and fisheries scientists at CSIRO Marine and Atmospheric Research on stocks with established assessments (e.g. ground fish in SE fishery; toothfish; Indian Ocean tuna species; coastal species);
- Continuing initial collaboration on the MSE model in areas such as refinement of the general formulation of Harvest Control Rules,
- Contributing to the model averaging methods for MSE.
- Beta testing of MSE modules with Australian stocks by experienced MSE analysts and non-MSE specialist fisheries scientist through workshops or Resource Assessment Groups.
- Further Explore the potential and opportunities for pilot study of close-kin abundance estimation for EU stocks, in particular, un-assessed, deep sea species.
- Explore potential for collaborative projects using next generation genetics to assess and study stock structure and connectivity of highly migratory sharks.
- Training on a4a methods.

These subjects will be further developed and the possibility of moving forward explored depending on the interest and budget of both CSIRO and JRC.

## References

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