

**JIMAR, PFRP ANNUAL PROGRESS REPORT
FY 2005**

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Project Proposal Title: Addition of multi-species capability, sex structure and other enhancements to the length-based, age structured modeling software MULTIFAN-CL.

Funding Agency: Pelagic Fisheries Research Program

1. Purpose of the project and indicative results.

MULTIFAN-CL (Fournier et al. 1998¹) is a spatially-explicit, length-based, age-structured model, which uses time-series of catch, effort, length-frequency and tagging data to obtain estimates of various population parameters, including: recruitment and biomass time-series, natural mortality rates, selectivity and catchability coefficients for defined fisheries, growth parameters and movement rates. The software is now routinely used for tuna stock assessments reported each year to the Standing Committee on Tuna and Billfish (SCTB). Several applications to Pacific pelagic fisheries have been reported in the scientific literature (Hampton and Fournier 2001²; Kleiber et al. 2003³; www.multifan-cl.org).

In collaboration with agencies involved with the scientific work of the SCTB, this PFRP project provides support for further development of MULTIFAN-CL to enhance its assessments of tuna stocks in the western and central Pacific Ocean and elsewhere, and to extend its applicability to species having biological characteristics and data support different than tunas. The proposed software enhancements are:

1. Incorporation of enhanced parallel processing capability
2. Incorporation of a modified size-frequency likelihood function
3. Addition of alternative parameterizations of fishery selectivity
4. Formalization of a population projection procedure
5. Addition of sex structure
6. Addition of multi-species capability

2. Progress during FY 2005. Provide a thorough discussion of accomplishments and problems.

¹ Fournier, D.A., Hampton, J., and Sibert, J.R. 1998. MULTIFAN-CL: a length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore, *Thunnus alalunga*. *Can. J. Fish. Aquat. Sci.* **55**: 2105–2116.

² Hampton, J., and Fournier, D. 2001. A spatially-disaggregated, length-based, age-structured population model of yellowfin tuna (*Thunnus albacares*) in the western and central Pacific Ocean. *Mar. Freshw. Res.* **52**: 937–963.

³ Kleiber, P., Hinton, M., and Uozumi, Y. 2003. Stock assessment of blue marlin (*Makaira nigricans*) in the Pacific using MULTIFAN-CL. *Mar. Freshw. Res.* **54**: 349–360.

During FY 2005 significant progress was made on the first four items above. The first objective, parallel processing, is being incorporated to improve the efficiency of the software to fill the demand for more intense computation as complicating factors are added, such as the last two items above. Some parts of the model can now function as parallel processes, and more possibilities for parallelizing remain. Items 2 and 3 implement alternative formulations of the model and have been undertaken with a view also to improved computational efficiency as well as stability of the fitting process. The results of these changes are now being evaluated. The fourth item has been undertaken in answer to demands from the new Western and Central Pacific Fishery Commission (WCPFC) which wishes to consider various management measures for dealing with evident overfishing in recent years of bigeye tuna. Population abundance and catches by various fleets can now be projected into the future with uncertainty bounds under various hypothetical management regimes so that the efficacy and possible side-effects can be evaluated.

3. Plans for the next fiscal year.

This PFRP project lives for only one year, and its funds are now spent. However, it is part of a wider collaboration from which funds are in place for next fiscal year. During the remainder of FY 2005 and FY 2006 the enhancements already achieved (primarily objectives 1 – 4 above) will be carefully evaluated and modified as needed. We view these items as a foundation for further enhancements, particularly for objectives 5 and 6, which feature in the title of this project. We expect these items to be difficult computer programming exercises, but we anticipate that they will have big payoffs, first for improving assessments of fishes, such as marlins, with pronounced sexual dimorphism in growth and behaviour, and then for moving into the realm of multi-species assessments which may form a bridge between traditional single-species assessments and ecosystem-level models such as ECOSYM.

4. List of papers published in refereed journals during FY 2003.

none

5. Other papers, technical reports, meeting presentations, etc.

none

6. Names of students graduating with MS or Ph.D. degrees during FY 2002. Include title of thesis or dissertation.

none