



Australian Government



MURRAY-DARLING BASIN AUTHORITY

Murray Cod Modelling to Address Key Management Actions (MD745)

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1. Introduction

The importance of Murray cod as an iconic species in the MDB is exemplified at the MDBC workshop (MDBC, 3-4 June 2004) dedicated to the management of the species. Murray cod populations however, have declined and recent reviews of the conservation status (Kearney and Kildea 2001, NSW Fisheries 2002) of the species have led to its listing as vulnerable under the Environment Protection and Biodiversity Conservation Act 1999. The reasons for this listing include flow regulation, habitat degradation, lowered water quality, manmade barriers to fish movement, the introduction of alien fish species, fisheries exploitation, the spread of diseases and translocation and stocking of fish. Murray cod also sustain an important inland recreational fishery, with an estimated 123,000 tonnes captured by anglers annually. Therefore the management of this species requires a balance between actions for a threatened species (i.e. rehabilitate populations) and those to sustain a fishery.

A consequence of these reviews and the workshop was the realisation that whilst we have some ecological information for the species there is an urgent need for improved understanding of the species' population dynamics. Population models are a valuable tool for addressing gaps in understanding, whilst facilitating decision making and guiding future investment in knowledge acquisition.

This project will help meet objective 1 of the National Murray cod recovery plan: Determine the distribution, structure and dynamics of Murray Cod populations across the MDB. This is more explicitly defined in Action 1.12.: Develop appropriate decision support tools and models that allow the future management actions for Murray Cod to be evaluated within a risk management framework. This is a 'High' priority action for the recovery plan. The proponents of this project have already undertaken extensive liaison with key stakeholders to a) ensure their support and b) ascertain the particular interests and needs of their jurisdictional agencies.

2. Project Objectives

The objectives of this project are to:

- Develop a computer model (or models) to represent the population dynamics of Murray cod populations under alternate management options.
- Develop various management scenarios to relation to size and bag limits and potential recovery times from overfishing, fish kills and other management or environmental scenarios which may affect Murray cod populations.
- Document the findings of this work, and implications thereof, in developing management options for Murray cod and for research on Murray cod biology and ecology required for improving the model (or models).

3. Project Development

There is a long history of age-structured models being used to facilitate the analysis of exploited fish populations (Megrey 1989), and in more recent years including length based age-structure (Fournier et al. 1998; Hampton and Fournier 2001). In developing the age-structured model for Murray cod, both the life history and management questions were used to guide the process. The model summarises the life history of Murray cod by explicitly representing 25 age classes where entry into the first age class combines spawning, egg, larval and early juvenile survival where juveniles are defined as fish less than 1 year old. Murray cod are assumed to become sexually mature at 5 years of age with fecundity increasing to the final age class 25+ years of age. The population dynamics modelled are for females only and with an assumed even sex ratio males are included in the final tally by simply doubling the female count. The model includes stochastic processes for modelling variation in fecundity rates in all adult age classes and variation in survival in all age and stage classes each year (see for example Todd et al., 2005). Age-specific survival was estimated from otolith data collected from the Murray River and southern tributaries. No study has been undertaken to estimate egg and larval survival in the wild; however, in hatchery operations, egg and larval survival have been documented and are quite variable (cf. Cadwallader and Gooley, 1985). Incorporating variability into fecundity and survival rates simulates the process of natural variation in the environment. Also included are processes for modelling demographic variation, the effects of density-dependence, and variable growth across different age classes. The management issues that drove the development of the Murray Cod Management Model (Todd, 2009) fall in to two different categories: fishery management and habitat and flow management. Specific fishery management scenarios were developed to examine changing the minimum legal length; changing/setting the maximum legal length; a range of fishing effort/rate; reducing illegal take; outlawing set lines; having 'no take' areas; stocking of fingerlings and one year old fish. Specific habitat scenarios were developed to examine an increase or decrease in habitat; reducing the impacts of cold water pollution; providing environmental flows at differing times, durations. In addition other scenarios were developed to look at fish kills/poaching, impacts to early life history and the ability to cast the Murray Cod Management Model (Todd, 2009) for differing regions by selection of some common parameters. For the complete model description as well as the process for developing the management scenarios see Todd and Koehn (2009a; b).

4. The Murray Cod Management Model

The Murray Cod Management Model (Todd, 2009) was developed using the software package Essential (Todd and Lovelace, 2009), a platform for writing stochastic population models and is available as freeware. The model and the software are distributed together and can be installed on to any PC by executing the install file *Murray Cod Management Model Install.exe*. The installation of this software does not access or modify the computer's registry and can be safely installed on any PC.

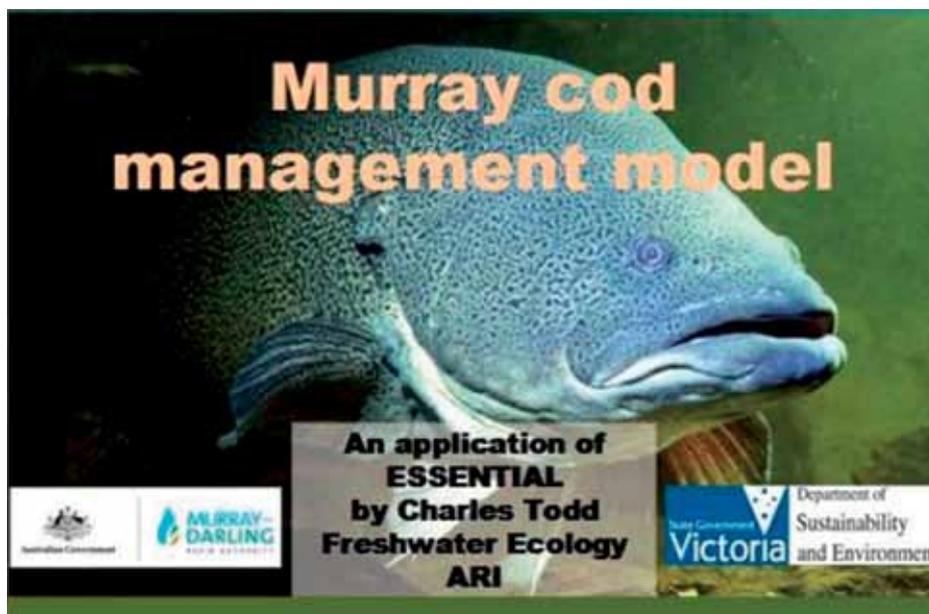


Figure 1: Splash screen for the Murray Cod Management Model.

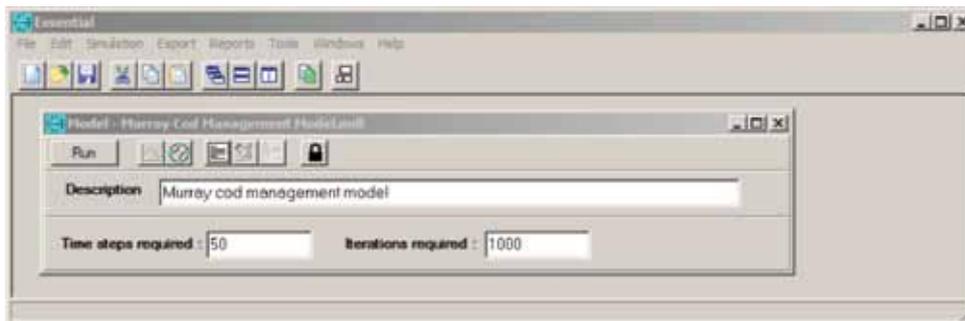
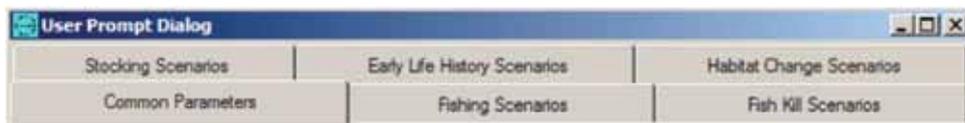


Figure 2: The Murray Cod Management Model within the *Essential* interface.

Clicking the Run button opens the User Prompt Dialog window where the options to choose the variety of biological/ecological and management scenarios are displayed. There are six categories for scenario development which are expanded upon in section 3. Note that the view of the User Prompt Dialog window may change depending on the users settings.



Clicking on the various tabs reveals the parameters associated with the tab heading. Altering the available parameters allows the user to create alternate scenarios for exploration and analysis. Once the user's selection is made click on the OK button at the bottom of the User Prompt Dialog window.

The default set of graphs are displayed when the model has completed the specified number of time steps and iterations. While there are six types of graphs available in the Murray cod management model only three types are used in the default set: trajectory and statistics; minimum population distribution; and trajectory.

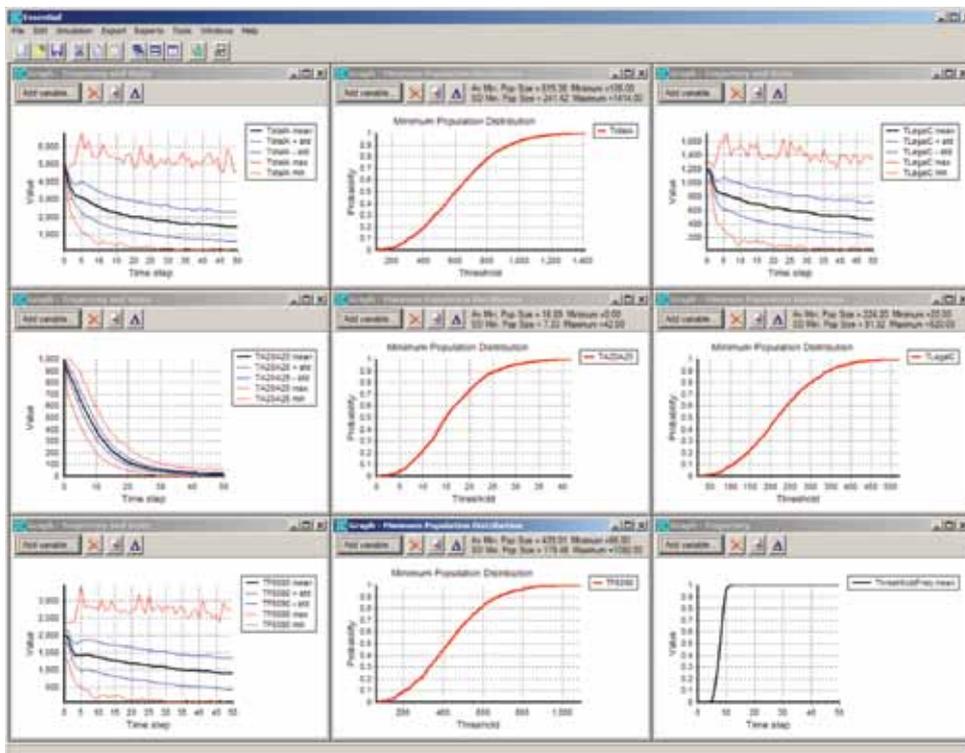
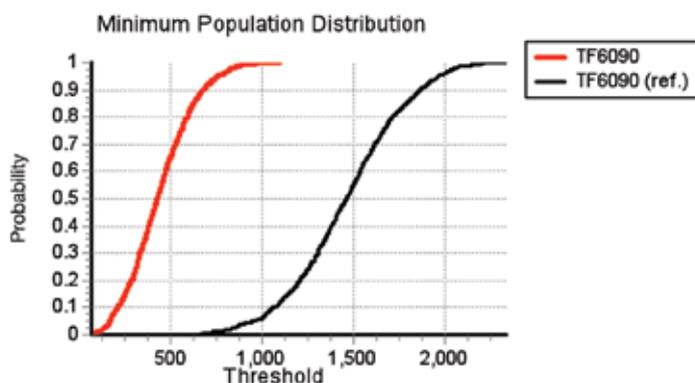


Figure 3: Default set of graphs used for the Murray cod management model producing in this case output from a fishing scenario.

For a description of the default set of variables, risk curve analysis as well as how to run and compare scenarios, see Todd and Koehn (2009a; b).

Figure 4: Risk curve comparison for different scenarios for the variable TF6090 – total number of fish in the size class 60 to 90cm.



Statistics on age or length can be easily graphed to examine the consequence of different management options on both the age structure and size structure of a population.

5. Murray Cod Management Model Software

It is anticipated that the software will be available from both the MDBA and Arthur Rylah Institute website in the near future. The MDBA is finalising the publications *Murray Cod Management Model: User Manual* (Todd and Koehn 2009a) and Murray cod modelling to address key management actions: final report for project MD745 (Todd and Koehn, 2009b). Once these publications are released, they will be packaged up with the install file for the software and be downloadable as one file from <http://www.dse.vic.gov.au/ari/software> (cf Todd, 2009)

6. References

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