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1 Introduction

The software described in the present guide is designed to help you construct a (simple or complex) model of the trophic flows in an ecosystem. Once the model is constructed you will have an overview of the feeding interactions in the ecosystem, and of the resources it contains. You will be able to analyze the ecosystem in details, and through Ecosim you can simulate effects of changes in fishing pressure, and, given time series data, evaluate the relative impact of fisheries and environment. Further, spatially explicit research or policy question can be addressed using the spatial simulation module Ecospace, also included in EwE6. Aquatic ecosystems will be emphasized because the approach presented here was initially applied to marine and freshwater ecosystems, but it can also be applied to terrestrial ecosystems, such as, e.g., farming systems (Dalsgaard et al., 1995).

The Ecopath system is built on an approach presented by Polovina (1984a; 1984b) for the estimation of the biomass of the various elements (species or groups of species) of an aquatic ecosystem. It was subsequently combined with various approaches from theoretical ecology, notably those proposed by R.E. Ulanowicz (1986), for the analysis of flows between the elements of ecosystems. In many cases, the period considered will be a given year, but the state and rate estimates used for model construction may pertain to different years. Models may represent a decade or more, during which little changes have occurred. When ecosystems have undergone massive changes, two or more models may be needed, representing the ecosystem before, during, and after the changes. This can be illustrated by an array of models of the Peruvian upwelling ecosystem representing periods before and after the collapse of the anchoveta fishing there (Jarre et al., 1991b). Several other examples for this may be found in Christensen and Pauly (1993b). We emphasize though that as time series analysis are becoming increasingly important for EwE simulations, it may be advantageous to model a specific year early at the beginning of the time series, and let Ecosim handle development over time, rather than average the model over time periods.

Once a model of the type discussed here has been built it can be used directly for simulation modelling using Ecosim. This approach is fully integrated with Ecopath, and is a complex simulation model for evaluating the impact of different fishing regimes on the biological components of ecosystems. Real ecosystems are more complicated than the mass-balance fluxes of biomass in Ecopath, however large the number of functional groups we include in our models. Real ecosystems also have dynamics far more complex than represented in Ecosim. The issue to consider, when evaluating the realism of simulation software is, however, not how complex the software and the processes are that is represented therein. Rather, the question is which structure allows a representation of the basic features of an ecosystem, given a limited amount of input variables. On such criterion, it was obvious that a major deficiency of the Ecopath with Ecosim approach was its lack of an explicit capability for addressing spatial policy questions. This has been remedied through the development of Ecospace (Walters et al., 1999), a dynamic, spatial module incorporating key elements of Ecosim simulations.

Appendix 1 presents some concepts relevant to the construction of trophic ecosystem models, as proposed or used by theoretical ecologists (notably R.E. Ulanowicz), and as commonly used by fisheries biologists.

Appendix 2 presents definitions of the major ecosystem indices presented in Ulanowicz (1986). The aim of these appendices is not to replace the book from which the definitions were extracted, but hopefully, to facilitate its comprehension.

Technical details describing a number of ?algorithms?, in which the equations used to estimate certain parameters are presented along with relevant comments and descriptions of special cases are given in Appendix 3 and Appendix 4.