Wikiprint Book

Title: EwEugTimeSeriesFittingInEcosimEvaluatingFisheriesAndEnvironmentalEffects

Subject: Ecopath Developer Site - EwEugTimeSeriesFittingInEcosimEvaluatingFisheriesAndEnvironmentalEffects

Version: 6

Date: 2019-08-18 01:07:19

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3.7 Time series fitting in Ecosim: evaluating fisheries and environmental effects

Ecosim can incorporate (and indeed benefits from) time series data. For many of the groups to be incorporated in the model the time series data will be available from single species stock assessments. EwE thus builds on the more traditional stock assessment, using much of the information available from these, while integrating to the ecosystem level.

When an Ecosim model is loaded, you can load time series 'reference' data on relative and absolute biomasses of various pools over a particular historical period, along with estimates of changes in fishing impacts over that period. After such data have been loaded and applied (using the Time Series form), a statistical measure of goodness of fit to these data is generated each time Ecosim is run (using the Run Ecosim form). This goodness of fit measure is a weighted sum of squared deviations (SS) of log biomasses from log predicted biomasses, scaled in the case of relative abundance data by the maximum likelihood estimate of the relative abundance scaling factor q in the equation $y = qB$ (y = relative abundance, B = absolute abundance).

Each reference data series can be assigned a relative weight using a simple spreadsheet in the search interface, representing a prior assessment by the user about relatively how variable or reliable that type of data is compared to the other reference time series (low weights imply relatively high variance, unreliable data).

The time series fitting uses either fishing effort or fishing mortality data as driving factors for the Ecosim model runs. A statistical measure of goodness of fit to the time series data outlined above is generated each time Ecosim is run. The model allows four types of analysis with the SS measure (see Fit to time series for help with implementing these analyses):

i. Determine sensitivity of SS to the critical Ecosim Vulnerability parameters by changing each one slightly (1%) then rerunning the model to see how much SS is changed, (i.e., how sensitive the time series predictions 'supported' by data are to the vulnerabilities);

i. Search for vulnerability estimates that give better 'fits' of Ecosim to the time series data (lower SS), with vulnerabilities 'blocked' by the user into sets that are expected to be similar;

i. Search for time series values of annual relative primary productivity that may represent historical productivity 'regime shifts' impacting biomasses throughout the ecosystem;

i. Estimate a probability distribution for the null hypothesis that all of the deviations between model and predicted abundances are due to chance alone, i.e. under the hypothesis that there are no real productivity anomalies.

In addition to the nonlinear optimization routines described above the fit to data can also be improved in a feedback-process by examining some of the crucial ecological parameters in the EwE model (notably total mortality rates and the settings for top-down/bottom-up control). It is important to note here that such fitting does not include any 'fiddling-factors' internal to the model, instead the type of question that is addressed after each run is "which species parameters or ecological settings are not set such that the model captures the observed trends over time adequately?"

The inclusion of time series data in EwE facilitates its use for exploring policy options for ecosystem-based management of fisheries. An important preliminary conclusion from applications to various ecosystems is that the model is capable of producing a reasonable fit, (i.e. fits that can be compared to those obtained using single species models) for all available time series related to the ecological resources of an ecosystem in one go. This indicates a capability or at least a potential to replicate the known history of the ecosystems. In turn this lends some confidence to how the model can be used for policy exploration. It is also indicated that the fitting of time series in Ecosim may be used not just for identification of ecosystem effects of fishing but also to address questions of environmental impact at the ecosystem level (as well as for individual groups of course).