**Clinic 2.1 - Introduction to Ecopath with Ecosim**

**CSDMS 2020 – Linking Ecosphere and Geosphere**

## Exercise 2: Time series fitting in Anchovy Bay

## Adapted from Villy Christensen, UBC Institute for the Oceans and Fisheries

We use the ecosystem model of Anchovy Bay that we constructed. The purpose of this exercise is to fit the model to time series data. For this, we use a comma-separated value (CSV) file that can be read by the time-dynamic module of EwE, Ecosim.

Save the anchovy bay\_temp.csv file provided to you on your computer. In your model, click Ecosim > Input > Time series in the Navigator on the left. You will be prompted to either create a new Ecosim scenario or open an existing if you already have created one. Then on the time series pop-up form, select Import at the top, and browse to the anchovy bay\_temp.csv file.

When the time series tab opens, check out each of the time series (see thumbnails at the bottom). We have effort, relative biomasses, and a catch series6.

When you do this for your own model, note that the CSV file must have a specific format, see the table below for an example based on the model we use here.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Title | Sealers | Seal B | Trawlers | Cod | Whiting | Shrimp | dummy |
| Weight | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| Pool code | 1 | 2 | 2 | 3 | 4 | 8 | 4 |
| Type | 3 | 0 | 3 | 0 | 0 | 6 | 2 |
| 1970 | 1 | 1 | 1 | 10 | 1 | 0.03 | 1 |
| 1971 | 1 |  | 1.05 |  |  |  |  |
| 1972 | 1 |  | 1.103 |  |  |  |  |
| 1973 | 0.75 |  | 1.158 |  |  |  |  |
| 1974 | 0.5 |  | 1.216 |  |  |  |  |
| 1975 | 0.25 | 0.8 | 1.276 |  |  |  |  |

The first row gives titles of the time series, the second the weights that will be used for the estimation of summed squared residuals. The pool code is the fleet number (for effort, here Sealers and Trawlers), the functional group number (for biomasses and mortalities, here Seal, Cod, Whiting, and Shrimp), or a forcing function number, (here “temperature” and “dummy”). The type is a code, which is explained in the EwE6 User’s Guide and the Help-system of the software. The following rows give the information by year. Notice that drivers (effort and fishing mortalities) should be given for all years, (or effort will be set to 0 for missing years), while reference (or observations) time-series can be for some years only.

Before you start fitting the model, make a run of Ecosim (Time dynamics, Run Ecosim, click “Run”). Examine the plots and notably work your way through each of the “Ecosim group plots”. To illustrate what to look for, look at the seals. You’ll see that Ecosim (line) shows a small increase in seal biomass, while the time series (small circles) indicates that seals have quadrupled. This indicates that the vulnerability setting for seals is too low, i.e. that seals with the default vulnerability of 2 are assumed to be too close to their carrying capacity.

You can try to increase vulnerability for seals as predators and see what happens, and you should go back to run Ecosim ever so often, while doing the fitting to find out what is happening. [Hint: “show multiple runs” options to compare the scenarios]7.

In Ecosim now do the following:

1. Vulnerability tab, click the top left cell to select all cells. Then enter 2 in the top right field where it says “Set:” Click Apply, to reset all vulnerabilities to the default 2.
2. Click Tools, below Output, then “Fit to time series”, select “vulnerability search” only, set the “No of blocks” to 1, then click “Sensitivity of SS to V” (V is vulnerability). Leave “by predator” checked, then click Search. The search routine will find the group for which the vulnerability parameter has the biggest impact on the SS (summed squared residuals). Click OK, and this information will be passed on to the search form.
3. On the search form, click Search, wait till the search routine has converged, click no to further searching. Check out the SS and AIC estimates.
4. Check out the vulnerabilities form and check out was has changed
5. Uncheck “Reset V’s on Run” at the top left panel of the search form
6. Select ‘no’ when asked to reset V’s to 2

*Repeat the steps above with increasing number of search blocks until you are searching for all predators (columns).*

Go to Ecosim Output, Run Ecosim. Check out Ecosim all fits.

Go back to “Fit to Time Series’; you see how each run performed under output. Check out the Sum of Squares and Akaike Information Criteria. Which model performed best according to each metric?8

It is easy to overfit models if you include all groups, including the ones you don’t have data for. When there is no time series information there is no penalty for the fitting procedure, so for such groups there is no stopping it. While you may not see it in the fit, if you now use the fitted model in future Ecosim or Ecospace scenarios, the vulnerability changes not based on data may make the groups behave unexpectedly with knock-on effects on other groups.

Go to Ecosim parameters, set Duration of simulation (years) to 100, enter. Run Ecosim and look at the groups over 100 years.

Having more data is better, and when you don’t have data, it is best to search for groups with time series only. Let’s use a slightly different approach:

1. Go to Fit to time series, click ‘search groups with time series’
2. When asked to reset vulnerabilities to a default value of 2 select yes (or click reset V’s on the run when not prompted)
3. Click search (under iterations)
4. Select one block less than what you have time series for (so 2 in our case) in no. of blocks
5. Click ‘sensitivity of SS to V, but now select ‘by predator/prey’, search, OK
6. Search (under iterations)
7. Repeat step 5 and 6 until either your SS or AIC doesn’t get lower9

Go to Ecosim Output, Run Ecosim. Check out Ecosim all fits.

Go to Ecosim parameters, set Duration of simulation (years) to 100, enter. Run Ecosim and look at the groups over 100 years.

Tip 1: if you try different search routines, you can save the resulting vulnerabilities in excel. When you reset vulnerabilities and start fitting and changing, you can always go back to that fit by pasting in the vulnerabilities.

Tip 2: After vulnerabilities are changed with a fit to time series routine, you can still end up with very high V’s even for groups with time series. There are ways to cap those at ecological relevant levels.

## Other parameters

We have here fitted to vulnerability. There are other factors that impact the fittings, here are some examples of parameters of importance:

**Anomaly Search:** You can include primary productivity as a forcing function, then use the anomaly search to determine if (forced) changes in primary production help explain changes in secondary production. This is a very accepted approach, but as a model coupler I generally load a primary productivity forcing function that is output of another model (or field data), and do not like to make changes in those data to create a better fit.

### Ecosim, Group info

**Feeding time adjustment rate**: does a consumer change the amount of time it spends feeding when feeding conditions change? Most fish tend not to, so we usually set this parameters to 0 for all but marine mammals and birds, top predators, and juvenile/larval fish.

**Density-dependent catchability**: For schooling fish and for species showing range-contraction, the CPUE from fisheries are often misleading with regards to abundance. A corollary of this is that the catchability will change with their abundance (“density-dependent”). If you have reason to think that may be the case for a group, use this parameter.

**Switching power**: If a predator shows a type-III functional response, you can set this here. So, if the predator stops eating things as they become rare and switches to feed relatively more of them as they become abundant, use this parameter.