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

**CSDMS 2020 – Linking Ecosphere and Geosphere**

**Exercise 1: Anchovy Bay ecosystem model**

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The purpose of this exercise is to introduce you to the Ecopath with Ecosim software, version 6 (EwE6), explore what data are required, and build a simple model. Have the modeling software installed using the instructions in the ‘getting ‘started’ document. Open this exercise that were just emailed to you. This will be a hands-on exercise that I would like everybody to complete using these instructions. You can use the raise your hand feature if you need help. Type ‘done’ in the chat when you’ve finished a section that ends with a highlighted sentence1.1include this number.

Anchovy Bay is a popular tourist attraction due to its century-old fishing port and its newer whale-watching industry. The fisheries have declined over the last decades, and have shifted from a focus on groundfish to being dominated by shrimp and pelagic fisheries.

The bay covers an area of 100 km2 and is rather isolated from other marine systems, and we can assume that the populations stay in the bay year-round. We here create a model of the bay in 1970, with the following 12 groups:

Whales, seals, cod, whiting, mackerel juv., mackerel ad., anchovy, shrimp, benthos, zooplankton, phytoplankton, detritus.

Start by opening EwE6, select File, New model. Browse to your preferred file location, and enter a name for the model. For instance, “Anchovy Bay”. Now navigate on the Navigator (left panel) to Input data, Basic Input. The model will have one group, Detritus. All models must have a detritus group, so we have entered it for you. Why? We need to be sure there is a group where we can send excreted and egested material as well as dead organism. By default they go to the detritus group.

On the Basic input form, select “Define groups” (also available from the menu on top: Ecopath, Define groups). Click Edit, Insert on the right side of the form that pops up. Continue clicking till you have 12 groups; then enter the group names, i.e., Whales in first row, Seals in second, etc. We will make mackerel an age-structured (“multi-stanza”) group, therefore enter “Mackerel” under the “Multi-stanza group name” for Mackerel juv., then use the down arrow in the row for Mackerel ad. and select “Mackerel” from the drop-down menu (this is to make sure that the stanza name is spelled the same way). Also set the Stanza age to 0 months for the juveniles and 3 months for the older stanza, (here called “adults”). When you have entered all, click the Producer check mark in the phytoplankton row. On the right panel, you may also want to click the Colors, Alternate all, to change the group colors to your liking. Click OK.

We now should enter the basic input parameters.

The biomasses must be entered with the unit: t/km2. Biological surveys may not always report their results in t/km2, so be aware that you may need to think about converting, and need to think about the size of your ecosystem.

For example: A whale survey in Anchovy Bay estimated the population at 10 individuals with an average weight of 800 kg. What value do you complete for biomass? Enter it.

Now enter the following: Seals: 0.609 t/km2; Cod: 3 t/km2; Whiting 1.8 t/km2; Anchovy: 7 t/km2; Shrimp: 0.8 t/km2; Zooplankton: 14.8 t/km2, Phytoplankton 9 t/km2.

Next are production/biomass ratios (P/B). When you build your own models, these ratios, or parameters to calculate these ratios, can generally be found on fishbase.org.

There is a close relationship between size and P/B; the bigger animals are, the lower the P/B. Here we have: Whales: P/B = .05 year-1; Seals: 0.154 year-1; Cod: 0.31 year-1; Whiting: 0.581 year-1; Anchovy 1.149 year-1; Shrimp P/B = 3 year-1; Benthos P/B = 3 year-1; Zooplankton P/B = 35 year-1; Phytoplankton P/B = 240 year-1.

Consumption/biomass (Q/B) ratios for the non-fish groups: for whales use 9 year-1, and for seals 15 year-1. For fish use 2.58 year-1 for Cod, 3.1 year-1 for Whiting, and 9.13 year-1 for Anchovy. For the invertebrates (Shrimp, Benthos, Zooplankton) enter a P/Q ratio of .25 instead of entering a Q/B.

Next we parameterize the age-structured model for mackerel. For this click Edit multi-stanza on the Basic input form. Set the growth curvature parameter to 0.3 year-1 for mackerel (= the average k value from FishBase). “Leading” should be checked for Mackerel ad. for both Biomass and Consumption/biomass. Biomass for mackerel ad. is 1.2 t/km2, total mortality for Mackerel juv. is 4 year-1, and 0.723 year-1 for mackerel ad. The consumption/biomass ratio for Mackerel ad. is 4.4 year-1. the Spawning proportion for mackerel juv is 0 and for mackerel ad. Is 1. Click “Calculate”, and the model should parameterize the age structured model.

Next parameter is Ecotrophic Efficiency (EE), this is the part of the production that is used in the system (or rather for which the model explains the fate of the production). In this model, we are missing a biomass estimate for benthos. Entering an EE value allows the model to estimate biomass. When doing so, think of what the proportion of the production is of the group that you need to estimate EE for, which can also be looked up in literature. For our Benthos group we estimate EE = 0.6. For the other groups, we let Ecopath estimate the EEs, but bear in mind the definition of EE when you evaluate the estimated parameters2.

We also need to define our fishing fleets. Click Fishery on the Navigator to the left. Then click Define fleets, and then Edit fleets above the spreadsheet (or click Ecopath on the top menu, and then Edit fleets). We need five fleets: sealers, trawlers, seiners, foragers, and shrimpers. Click OK. We can enter landings of the fleets under Landings; unit is t/km2/year. The sealers caught 0.0045 t/km2/year. The fisheries catches were 0.45 t/km2/year of cod and 0.2 t/km2/year of whiting for the trawlers, 0.4 t/km2/year of mackerel ad. for the seiners, and 1.4 t/km2/year of anchovy for the foragers, and 0.1 t/km2/year of shrimp for the shrimpers.

The off-vessel landing prices are seals 6 $/kg; cod: 10 $/kg; whiting $4/kg; mackerel ad: 4 $/kg; anchovy is 3 $/kg for foragers. Shrimps are 20 $/kg. Enter this under Off-vessel price.

If you lack catch or price information for your own models later, then check [www.seaaroundus.org](http://www.seaaroundus.org).

In the Ecopath baseline year, the whale population had started to recover after whaling, but the seal population was still declining, so the Ecopath baseline model is not in steady state. We specify this on the Input data “Other production” form by entering a biomass accumulation rate of 0.02 year-1 for whales, and -0.05 year-1 for seals3.

Now it’s time for diets. The model includes a diet matrix that allows you to complete the proportion of the prey (rows) that is consumed by each predator (columns). You’ll notice that these are the groups you specified in the model, so after doing a diet analysis (lab studies such as stomach content analyses using visual identification and DNA and/or a literature search), make sure that all important predators/prey species are included in your model. For Anchovy Bay, click Diet composition and complete:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Prey \ predator | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Whales | - | - | - | - | - | - | - | - | - | - |
| 2 | Seals | - | - | - | - | - | - | - | - | - | - |
| 3 | Cod | 0.10 | 0.04 | - | 0.05 | - | - | - | - | - | - |
| 4 | Whiting | 0.10 | 0.05 | 0.05 | 0.05 | - | - | - | - | - | - |
| 5 | Mackerel juv. | - | - | - | - | - | - | - | - | - | - |
| 6 | Mackerel ad. | 0.20 | - | - | - | - | - | - | - | - | - |
| 7 | Anchovy | 0.50 | - | 0.10 | 0.45 | - | 0.55 | - | - | - | - |
| 8 | Shrimp | - | 0.01 | 0.10 | 0.10 | - | - | - | - | - | - |
| 9 | Benthos | 0.10 | 0.90 | 0.75 | 0.35 | - | - | - | 1.00 | 0.10 | - |
| 10 | Zooplankton | - | - | - | - | 1.00 | 0.45 | 1.00 | - | 0.10 | - |
| 11 | Phytoplankton | - | - | - | - | - | - | - | - | 0.10 | 0.90 |
| 12 | Detritus | - | - | - | - | - | - | - | - | 0.70 | 0.10 |

With this we have the information that is needed to mass-balance the model. Select Output, Basic estimates, and check out the outcome. Save the model4.

Click Output > Tools to see Ecopath output generated such as the Ecopath flow diagram, Statistics (various parameters calculated based on your model), and the various Network Analysis metrics.

Try changing some of the input and see what happens. Don’t save afterwards.

Go to Time dynamic (Ecosim), Output, Run Ecosim. Click Run, and see what happens5.