This model simulates the settlement and growth of two barnacle species on an initially barren rock in the intertidal zone. One species, *Chthamalus*, is smaller and can survive in a wider range of depth (shown as white in the model). The other species, *Balanus*, is larger and out-competes *Chthamalus* by growing under it and popping it off the rock. *Balanus*, however, cannot survive being exposed to air at low tide as long as *Chthamalus*, so it is restricted to lower areas of the rock. Connell (1961) used this system to demonstrate how the **fundamental niche** of *Chthamalus* (all of the resources it is biologically capable of exploiting) is restricted to a narrower **realized niche** by competition with *Balanus*.

Figure 1. Screen shot of the Barnacle Competition model
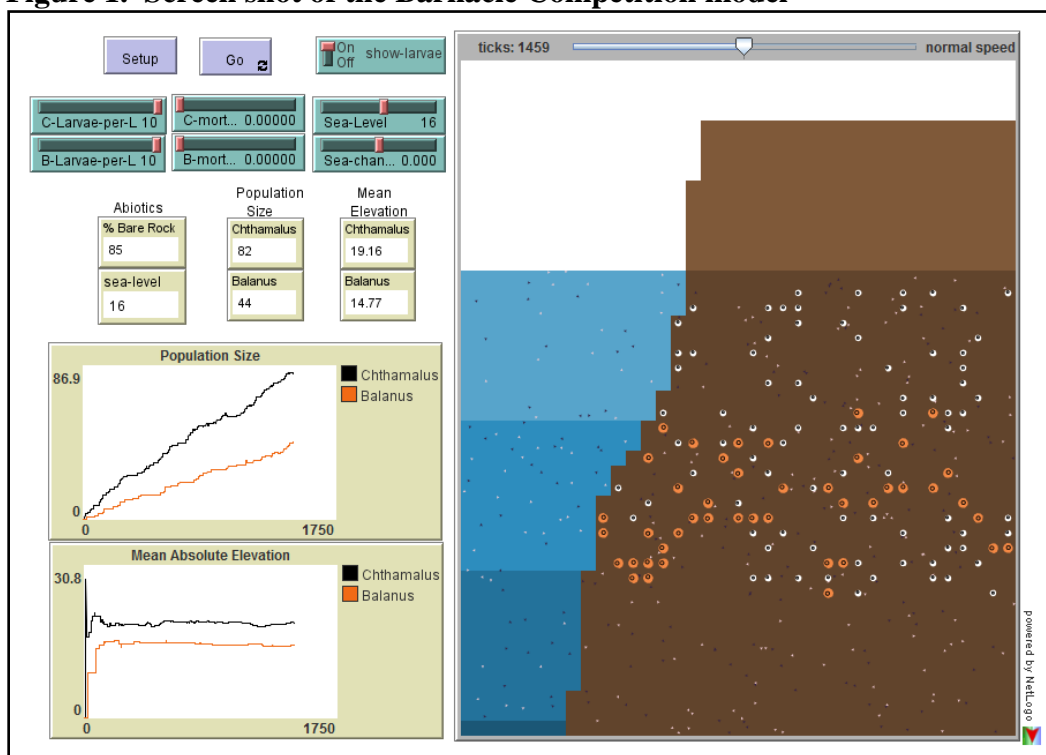
Model Details

When the model is opened you will see a section of intertidal rock which is partially underwater, and partially exposed to air (Fig. 1). There are a variety of graphs and numerical reporters giving updated information on the system (Table 1). In the world view you will see small specks of white and black, representing the free-swimming larvae

of the barnacles. By clicking 'Go' you will see the larvae move around and occasionally settle and grow into adults on the rock. Notice how *Balanus* settles and grows on a wider range of rock than does *Chthamalus*. How is this difference reflected in their growth rates? What do you predict will be the long-term stable population sizes? With the various controls (Table 2) you can affect each species settlement rate and mortality. You can also simulate the potential effects of climate change by setting lea level to increase over time.

Table 1: Reporters for the Barnacle Competition model

Reporter	Description
World-view window	This is an animation of an intertidal rock showing the growth of the two barnacle species. You can speed up the simulation with the slider above this window.
Population Size (graph/numeric)	Plot of the population sizes of the two species over time
Mean Absolute Elevation (graph/numeric)	This shows the average elevation of each species, which can fluctuate with changes in sea level
Abiotic reporters (numeric)	These show the % of bare rock (not encrusted with barnacles), and the current sea level

Table 2: Controls for the Barnacle Competition model

Control	Action
Setup (button)	Clicking clears all values, resets model to current parameter settings
Go (toggle button)	Clicking sets the model in motion (clicking again will stop it)
Show-Larvae (switch)	Determines if the free-swimming barnacle larvae are visible (the model will run faster if switched off)
Larvae-per-L (slider)	Sets the density of larvae for each species (Higher values increase settlement rate)
Mortality (slider)	Sets the likelihood of adults dying for each species
Sea-Level (slider)	Sets the initial sea level
Sea-Change (slider)	Sets the rate and direction of sea level change over time