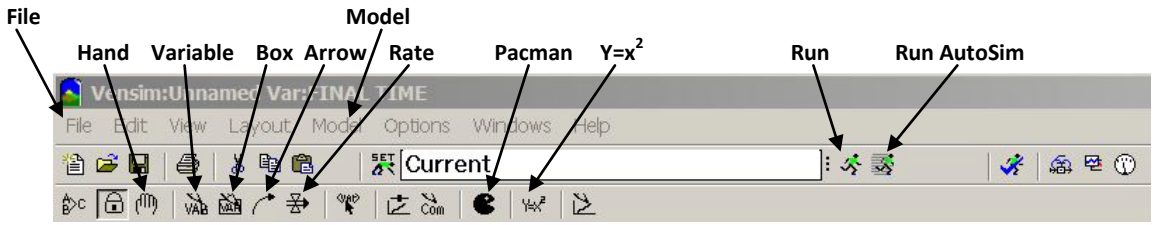
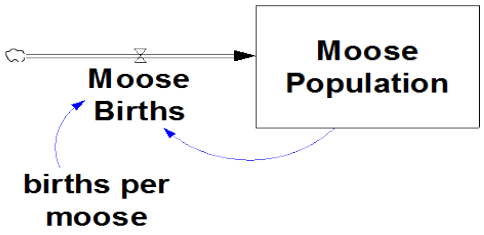
Building the Moose Model

Stage 1: Starting with Births



- Open Vensim. If a previous model appears, under the **File** menu, select **New Model**.
- If the Model Settings window opens, enter these values, then click OK.
    - INITIAL TIME = 0
    - FINAL TIME = 50
    - TIME STEP = 1
    - Units for Time Year
    - Integration Type Euler
- There are two very important icons on the menu bar – the **hand** and the **pacman**. The hand is the icon to use when you want to browse, move or resize the model. The pacman is used to delete a mistake. The pacman doesn't ask for confirmation of the delete – it assumes that you mean what you say.
- To build the model shown below



    - Click and release on the **Box** icon, click in the white space, type Moose Population in the rectangle that appears, hit Enter. Use the tiny circle in the lower right hand corner of the box to adjust the box size so the words are easy to read.
    - Click and release on the **Rate** icon. Move to the left of the Moose Population box, click and release, move the mouse into the Moose Population box, click and release again. In the rectangle that appears, type Moose Births and hit Enter.
    - Click and release on the **Variable** icon. Move under the Moose Births rate, click and release, and type births per moose in the rectangle that appears. Hit Enter.
    - Click on release on the **Arrow** icon. Move the mouse over the words 'births per moose' and click and release. Then move the mouse over the words 'Moose Births', and click and release. A blue arrow should appear. The head of the arrow should be pointing to Moose Births.
    - Using the same action, connect Moose Population to Moose Births with a blue arrow.
    - You can make the blue arrows curve by pulling on the tiny circle attached to each arrow.

The Numbers behind the Model

Let's start with 100 moose, 50 male and 50 female. Let's assume that each female has one calf. That means 100 moose generate 50 births. If calves mature in one year, there are 150 moose capable of mating the next year. And so on as seen in the table.

Year	Moose Population	Moose Births
1	100	50
2	150	75
3	225	112
4	337	168

Putting the math in the model

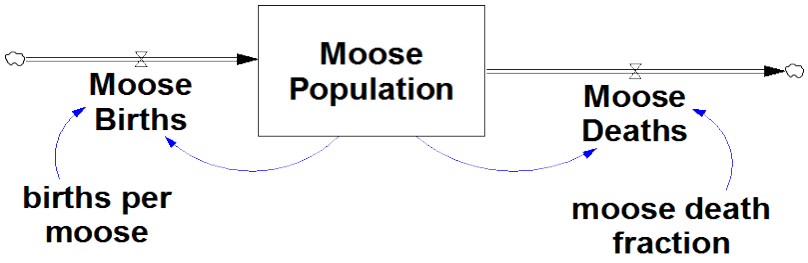
Click on the **Y=x^2** button, the same one we used in the Money Model.

- Start with 100 moose.
- Use 0.5 as the births per moose.
- Moose Births = births per moose * Moose Population

Running the Model

- **Run** the model.
- To see the output, click on Moose Population, then click on the **Graph** icon  on the left sidebar. Notice there are over 60 billion moose at the end of 50 years.
- To vary the births per moose, open the equation window using **Y=x^2**, and set the Minimum to 0, the Maximum to 1, and the Increment to 0.1. Click OK.
- **Run AutoSim** the model. Note the mini-graphs that appear in Moose Population and Moose Births. Use the slider bars to vary the births per moose.
- Click the Stop Sign  to return the model to its neutral state.

Stage 2: Adding Deaths



Add the new components to the model.

Caution: The rate called Moose Deaths must be drawn so it points away from Moose Population. That will tell the model to subtract deaths. Therefore, when you click and release the Rate icon, your first click in the model space should be inside the Moose Population box. Then move the mouse to the right and click again.

Add the data and equations for the new components. Consider reasonable bounds for the moose death fraction. We let the births per moose go from 0 to 1 (allowing for females to have twins). What bounds will you choose for moose death fraction? Set the Minimum, maximum, and Increment in the equation window also.

Run AutoSim, using the scroll bars to manipulate the moose death fraction.

Identify 3 distinctly different behaviors in the Moose Population graph and the conditions that generate those behaviors. Describe the behaviors and conditions in the space below.

1.

2.

3.

A Second Look at the Math

Let's go back to our 100 moose, 50 male and 50 female. Let's assume that each female has one calf. That means 100 moose generate 50 births. Let's assume that 1/10th of the moose die each year.

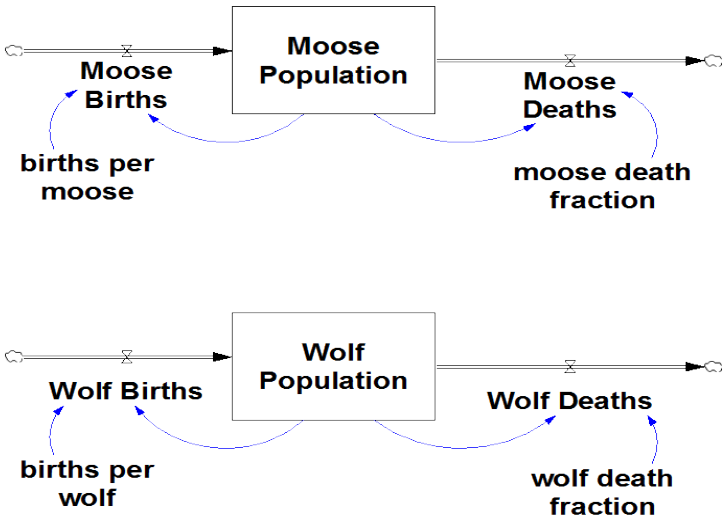
Year	Moose Population	Moose Births	Moose Deaths
1	100	50	10
2	140	70	14
3	196	98	20
4	274	137	27

After running the moose model with 0.5 as the births per moose and 0.1 as the moose death fraction, click on the Moose Population to highlight it. Then click on the Table Time Down icon  on the left-hand bar.

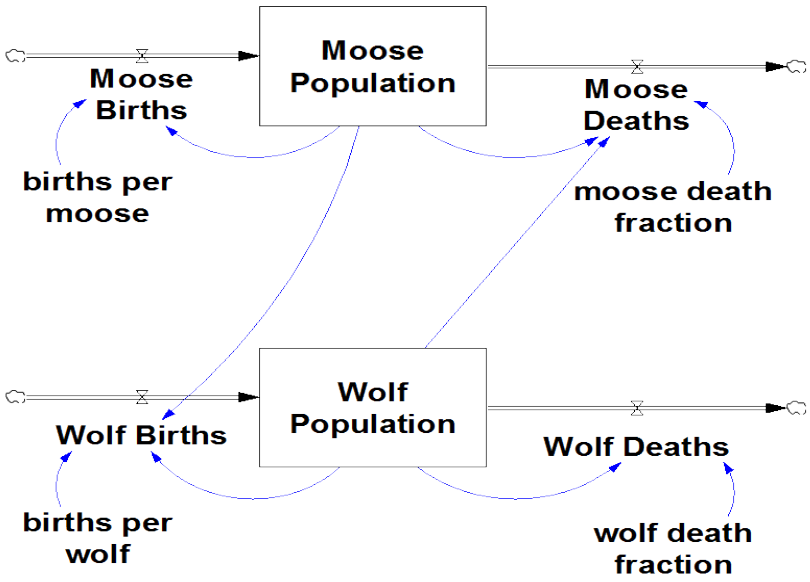
Do the model numbers agree with our numbers?

You've just built and validated your first model.

Stage 3: Adding Wolves



Stage 4: Adding Interactions



- Moose Deaths = moose death fraction * moose population * wolf population
- Wolf Births = wolf birth fraction * wolf population * moose population

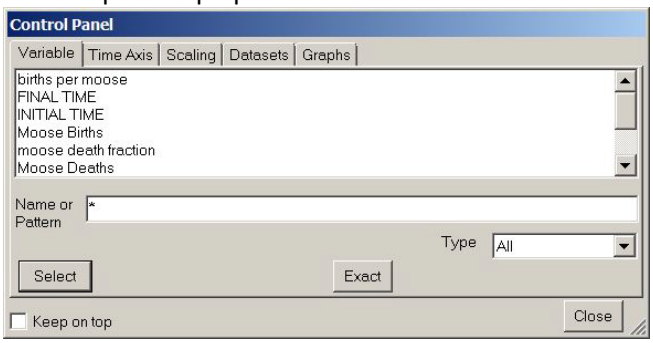
Stage 4 Model Testing

- Set initial Moose Population = 500.
- Set initial Wolf Population = 20.
- Set both birth fractions to 0.5 and both death fractions to 0.1.
- Under the **View** menu, select Show Behavior.
- **Run** the model.
- Observe the error – floating point overflow.
- How to fix? Start by making the **time step** smaller. Try 0.125 in **Settings** under the **Model** menu.
- **Run** the model.
- Error still exists. Let's try adjusting our parameters.
- Try these parameter values and slider bar settings (min, max, increment)
    - Births per moose = 0.2; (0, 1, 0.05)
    - Moose death fraction = 0.003; (0, 0.1, 0.001)
    - Births per wolf = 0.001; (0, 0.1, 0.001)
    - Wolf death fraction = 0.5; (0, 1, 0.05)

Stage 4 Making a Custom Graph

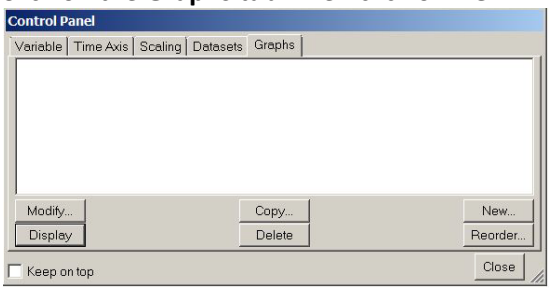
Step 1

Click on the **Control Panel icon**  at the far right end of the top bar top open this window.



Step 2

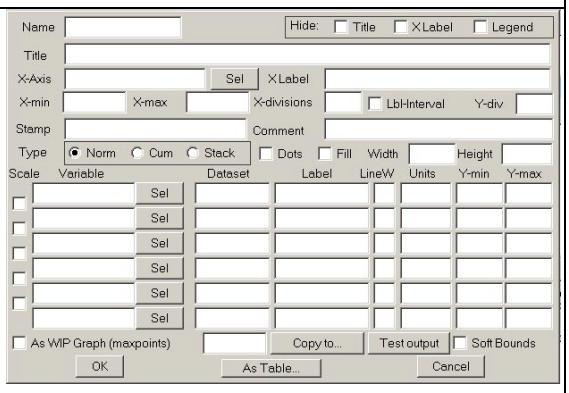
Click on the **Graphs** tab. Then click on **New**.



Step 3

In the window shown to the right:

- Enter a Title – this will allow you to identify this graph. I suggest Population.
- Click inside the first variable box. Click on the Sel button, then select Wolf Population from the list shown. Click OK.
- Click inside the second variable box. Click on the Sel button, then click on Moose Population. Click OK.
- Close the window by clicking on OK at the bottom of the window.



Step 4

Click Display in the Control Panel window (see Step 2). Note that both populations are on the same graph with 2 scales on the y-axis. Close the graph.

Step 5

Click Modify in the Control Panel window (see Step 2). Note the white boxes in the column next to the Variable column. Click on the first white box to check it. That will lock the scales for Moose Population and Wolf Population so both are on the same scale. Click OK.

Step 6

Click Display and you should get a graph with a single scale on the y-axis.

Step 7

To attach the graph to the white space, click on the Input Output Object  . Click in the model white space to bring forth a window.

Step 8

Click in the circle by Output Custom Graph. Then use the drop-down menu at the bottom of the box to select the name of the graph you wish to display (Population). Click OK and a graph box will appear on the screen. You may resize it by dragging on the small circle in the lower right-hand corner of the box. Run the model to make the graph appear.