

POPULATION MODELS

Elephant Management Model - Part 1

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In this video, we're going to start building the contraceptive model. And the contraceptive model for elephants is going to be an expansion of the model that you developed in our last module. So you'll need to open up that module on your spreadsheet and make sure that your settings are set as follows. The calving interval is 3.1; the proportion of offspring that are female is 0.5; the survival rate of calves is 0.9; and the survival rate of all other age classes is 0.99.

Tony told us that we want to start this model by having 3,500 individuals. So our goal here is to enter entries into these green-shaded cells in row 10, and make sure that the sum is 3,500. But we also want to make sure that the population is in a stable age distribution. Let's go back to this lambda graph that we had looked at before.

We said that when a population has age classes, that the initial dynamics can be pretty unwieldy. But if you run this model over many time steps, eventually it starts to level off. At this point, when lambda no longer changes, then we know that the population from time step (t) to time step (t + 1) will have the same lambda as it did in the previous time step, and the proportion of animals that are in any one of these age classes will be the same. That's called a 'stable age distribution'.

So our goal to begin with is to find numbers that go into these green cells that sum to 3,500 and that are in a stable age distribution. Tony walked through this process in lecture, so let's go ahead and repeat that process down in our spreadsheet. We're going to head down to the very bottom row of our simulation. And we'll be entering those values in row 91.

Now the first thing that Tony did was to note the sum of the animals in the last time step, so if we scroll over, we can see that the sum of animals in the last time step is in cell BJ90. That's the total. Let's go ahead and shade that some color so that we can find it more quickly. This is our total now; we want this total to be 3,500. Tony provided us that formula, and he said that it's equal to the number of animals in this time step. Multiply that by 3,500, divided by our current population size, BJ90. We're going to copy this formula all the way through, so we need to anchor BJ90 and then press Enter. And we see that when the population has stabilized, as it

has in year 80, we would end up with 248 animals, if the sum is going to be 3,500. We'll just copy this formula all the way through, and now if we drag this equation down, we see that our population now is at 3,500, and we know it's in a stable age distribution because the ratio between this number and this number is the same as the ratio between this number and that number.

Let's go ahead and select these cells, and we'll copy them through every single age class. And head up to the Copy button. And then we'll head up to our year one simulation and we'll choose Paste/Paste Special, and we'll paste those values. Then we'll press Okay; and again, we can hide the decimal points so that we don't see the decimals. But again, they are being used in these calculations.

When you start the population in a stable age distribution, you should notice that the graph no longer has any of these inconsistencies with lambda at the beginning of the simulation. Now we have a stable age distribution for year zero, and we're able to start building our contraceptive model.

Before we do that though, I just want to point out that in the last series of videos, Tony mentioned that you could go back to the managers and say, "I'll bet you that this is the age distribution of elephants, given that this particular population has been treated the same way year after year after year". So there is reason to believe that we are someplace in this asymptotic lambda area, and when you are there, then this is the distribution of animals that would be in each age class given that the population size is 3,500.

The next thing we want to do is add in a new parameter to our model, and this is going to be the proportion of females that receive a contraceptive. So this is proportion that are contracepted. This is going to be a model input; we'll shade that green. Proportions go between zero and 1, so if we enter 0.1, this indicates that 10 percent of the females that are breeding have received some sort of contraceptive and are no longer able to reproduce for that particular time step. To include this proportion contraceptive in our model, we need to make one small adjustment to one equation in the model.

PAUSE the video: Go ahead and put your video on pause, and work on that equation. Then we'll come back and we'll see how we handled it.

To make this small adjustment, we'll need to click on cell B11. This is the equation that calculates the number of calves that would be in the next time step. Let's just refresh our

memory here. This is the sum of all of the breeding adults that were alive in time step one who are able to actually deliver those offspring, those calves, in time step one. We know that not all of them are able to reproduce. So we're first going to sum those, and then we'll multiply those by the term (1 minus the proportion that were contracepted).

We'll then continue along. This gives us now, the number of breeding females that are not contracepted. To that, we multiply their fecundity rate, and then we multiply that, in turn, by the proportion of those offspring that are female. This whole term gives us the number of female calves that we expect to be observed and counted in year one. We just press Enter, and now we can copy this formula down. Before we do that, though, we need to anchor the reference to cell B6, so we'll add dollar signs to make that an absolute reference, and then we can copy this equation down by just double-clicking.

Let's look at what happened when we applied a contraceptive to 10 percent of the population. With zero percent contracepted, we had our original model and our final lambda was 1.057. If we apply contraceptives to 10 percent of the female population breeders, then we're able to reduce that final lambda a little bit - it's dropped to 1.0529.

Now let's head back over to Tony, and we'll hear more about what we can do with this spreadsheet model.

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