POPULATION MODELS

Age Structure with Management - Part 3

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What value did you decide best fitted 'p'? Was it .80, .81, .82? Almost certainly, it was in that range. At long last, we can now start talking about darting, because what we have shown is that approximately 80 percent of the breeding female population needs to be prevented from breeding at all time to keep the population constant. How you are going to accomplish that with darts is then a completely separate question. And if the dart is effective for two years, then that's telling you that at least 40 percent of the adult breeding population has to be darted every year.

There could be two reactions to this. The one reaction could be, "That is such a large number, we're not going to be able to do it." The other reaction might be, "It's a large number. Perhaps what we can do is have a combination of darting and removing elephants."

And notice, by the way, before we do that, that that large number is if every dart works perfectly. So it's at this point, too, that you would have the discussion about how efficient or how effective the darting is going to be.

Well suppose management says, "Can we have a combination of darting and removing animals? Can we do this, perhaps, by darting 20 percent of the population every year?" Is this an experiment that you did before you came back to this lecture? Because it's very easy to do. All you have to do is vary p from 0 up to about .8.

These are the results we got for the parameters that we used. So at p equals 0, our population is growing at a rate of 5.7 percent. Lambda's 1.057. And then as we varied it up to .6, even if we had p equals .6, we would have the population growing at 2.3 percent per annum. So if we were darting at least 30 percent of the breeding population every year, we would still have to remove approximately 2.3 percent of 7,000. So that's something like 160 animals every year.

What happens if we graph this? We get a graph that looks like this. Here is the lambda we want. Here is the lambda where we start. And we you can see, it crosses the 1.00 line at something close to .8. At this point, it might be useful to do a sensitivity analysis, because how robust is the shape of that graph, and how robust is our value of .8 and .81?

We have to be a little bit careful when we talk about doing a sensitivity analysis here. You can't, for example, just change the adult survival rate, because if you do that, you might end up with an unrealistic long-term lambda if you don't have any darting at all.

So, perhaps, what you need to do is come up with two scenarios. One could be a scenario where a population's growing a little bit faster than it is at the moment. So you might want to go for a lambda with p equals 0 of .6 -- of 6 percent, so lambda's 1.06. And you could do this by reducing the calving interval, perhaps put it at a lower value; increasing the calf survival, push that up to .9; and then figuring out what adult survival gives you a value of 1.06.

And the other scenario you might look at is a slightly lower scenario. So you might want to go for a lambda of 1.055, in which case you could take the upper value of the calving interval, the lower value of the calf survival, and you could adjust your adult survival to give you a lambda of 1.055.

And if you were to do that and graph it for a number of different p's, as on the graph we just looked at, this is what you might get.

You might get, for the higher lambda, something that looks like that, and for the lower lambda, something that looks like that. That's really telling us is that things are very robust. That value of .8 is much closer to .8, .81, or .82 than it is to .7 or .6 or .9. And notice whether it's .8 or .81 is kind of irrelevant when it comes to talking about how effective the darts are.

Okay. So we've pretty much sewn up this problem. But before we leave it, is there any other information that your spreadsheet could tell you? Is there something else we could give back to management that will be useful to them? I can think of at least two useful points. See if you can think of them.

PAUSE the video: Write down two additional points the spreadsheet can help identify.

My first point is that we haven't talked about the short term yet. Remember, management said they were mainly interested in the long term, but what about the short term? And what you will have noticed in using your spreadsheet is that in the short term, the population changes.

Well, one of the things you could do with your spreadsheet is actually try and suggest to management how they could manage the population over, say, the next 10 or 20 years to keep the population constant. Maybe they could have a varying value for p, or maybe they could have, again, a mixture of darting and removing. So you can address the short-term management question as well as the long-term management question if our assumption that we've come up with a pretty good age structure is a good one.

The second point that you could've got very readily from your spreadsheet is that the age structure of the population in the long term has now changed quite drastically from what it was in the short term and quite drastically from what you've started with and got used to in the Kruger Park. So a consequence of controlling the population by contraception is going to be a change in the age structure. And you will notice it is a flattening of the age structure. Instead of having approximately half of your elephants under the age of 20, you now are having more like 30 percent of the elephants under the age of 20.

And this has implications for all sorts of things. It has implications for the elephants themselves. Elephants are very social animals. What are they going to do when their age structure is changed? Just think about what the changing age structure is doing to us in the United States. Think of the implications for Social Security.

So age structure has an effect on a population and the way in which it behaves. And is it going to be possible that elephant cows are going to fight with each other over calves? Or are they going to smother their calves with attention?

It also has implication for tourists. Tourists love taking pictures of a whole herd coming to drink with a few babies and a few slightly older elephants and that whole age structure showing up in one wonderful picture. It's not going to look the same anymore. People need to be aware of this before they implement a long-term management strategy.

Well we've learned a lot from this spreadsheet. And, perhaps, the biggest take-home exercise from all of this is that there's a kind of magic when you get a spreadsheet actually working. Or when you get any model actually working, and you're able to manipulate it and argue from it. Because you come up with all sorts of ideas that you mightn't have thought of in the first place, and you come up with all sorts of insights. And this, by the way, is true even if you make a mess of it. If you make a mistake, or if the model isn't the right model, you still end up learning.

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