NICE TO KNOW

Five Questions for Population Modeling

Tony Starfield

recorded: November, 2009

We're going to discuss the questions that one needs to ask for every population model.

[1] The first question one has to ask is: **Do we develop a deterministic model or a stochastic model?** Now you'll remember that, wherever possible, we want to do deterministic modeling because that is so much easier to do. The rule is, develop a stochastic model when one has to. And we've seen two examples of stochastic modeling that was absolutely essential. The first was the example where we had roc flu. Roc flu is an example of environmental stochasticity, something that comes from outside that affects the population.

In the most recent example looking at the two rocs in Saudi Arabia today, we developed a stochastic model that illustrates demographic stochasticity. That is the case when you have a very small population. And so differences between what one member of the population does, in terms of breeding for example, and what another member does become important in terms of looking at the projection of the population in the future. Demographic stochasticity is important whenever you are dealing with very small and endangered populations.

[2] The next question one needs to ask is: **Do we need a spatial model?** Do we need to divide the population up into different subsections that live in different parts of the world or in different parts of the habitat? So for example, if we had a roc population where, in the north of the Arabian Peninsula, rocs behaved differently from rocs in the south. Perhaps they had less access to sailors. Then we might want to divide them all up into two populations - a northern population and a southern population.

Again, we only develop spatial models when there's a really good reason for doing so. Once we start developing spatial models, we have to ask questions like 'Is there an interaction between the population in the north and the population in the south?' 'Do we need to look at emigration and immigration?'

[3] The next question we need to ask is: **Do we need to allow for density dependence?**

Now we thought about this right at the beginning, in the very first roc population model, where we asked whether nesting sites was going to be a limiting factor on the population. If nesting sites were limiting, then we would have to introduce density dependence into the population. Generally speaking, density dependence becomes important when populations reach higher densities. And very often in conservation problems, one's dealing with populations that are too small and so density dependence does not become a major factor. Nevertheless, it's a question you have to ask.

[4] The next question is a much more interesting one: **Are males really necessary?** Now that question didn't come up in rocs because there weren't males and females. But generally speaking, when one's developing a population model, one can very often develop a model by just modeling the female side of the population and ignoring males altogether. So asking whether one needs to separate the population into males and females becomes an important question. When one's dealing with, for example, a lion population, where the males play an important part in the sense that males might kill cubs, then it's essential to model the males. When one's dealing with a population of deer, for example, it might be totally unnecessary to model the males, unless one was interested in hunting males and asking questions about trophy bulls.

[5] And then perhaps the most difficult question to ask and answer is**: How to represent the population and how much detail do we need to go into?** And I'm going to show a number of levels of detail, going from the simplest to the most complicated.

At the top we have total population, and that is what we did in most of the roc modeling. We just said, how many rocs are there, and at each time, we recalculated the number of rocs. A slightly more complicated model might be one where we divide the population up into life stages. For example, where one might be looking at pre-nesting rocs and nesting rocs. And if there were a good reason for separating out those two populations, then one might want to go with a life-stage model. Very often when one's modeling plants, it is useful to look at life stages.

The next level of detail would be an age-based model. Now you might have thought of this right at the beginning of the roc population model. But if you had developed an age-based model, you would have probably gone with a smaller time step. And you would have had to ask yourself how you want to divide up the age classes. Do you want to model rocs aged zero to ten, ten to twenty, twenty to thirty? Or are you going to be looking at rocs aged zero to one, one to two, two to three, and all the way up to a hundred? That's a question that needs to be asked.

And then the ultimate level of detail is where you actually model every individual in the population. And we did that right at the very end when we dealt with the two rocs that were living in Saudi Arabia today. At that point, one keeps track of each individual and what it does. And that is called an individual or very often an ‘agent-based’ model.

Let's look at how the choice of representing the population ties in with the actual population model. We talked earlier on about parameters in the model - things like death rates and birth rates and clutch sizes and so on.

Another aspect of a model is a ‘variable’. A variable is something that you update at every time-step of the model. So for example, in the roc model, where we calculated R at time t + 1. From R at time t, we had one variable, that was the total population. So in a total population model, you would have one variable. If you went with a life-stage model and you had two life stages, you would have two variables.

If you went with an age-based model and you divided the roc population up into a hundred age classes, going from newborns to 99-year-old rocs that are going to die at the end of their ninety-ninth year, you would then have a hundred variables. If you are modeling each individual, you'll have one variable for each individual.

So as you make your model more detailed, so you make your model more complicated and you introduce more variables.

The heuristic again is ‘Keep it as simple as you possibly can’. So it is important to try and figure out which is the appropriate level to represent the population.

< 00:08:58 END >