NICE TO KNOW

Simulation Models: Monk Seals, Part 1

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We've looked at a number of different problems all related to decision analysis. And along the way, we've collected a number of techniques and a number of tools for our modeling toolkit. What I want to do is try and put them into some kind of perspective. And a very useful way to do that is in the diagram shown here.

I've divided problems up along two axes. First, I have the idea that some problems are essentially deterministic. Chance doesn't play a role. And others are essentially stochastic. Chance does play a role. And then we have problems where there are single objectives and where there are multiple objectives. And what we're going to do is try and fill in the techniques we've learned in the appropriate box.

So, for example, if you go right back to the problem we considered where we were betting, and we had to choose between a red and a blue booth, that would be a single objective stochastic problem. And what we found was that modeling, in particular, simulation modeling, was very useful there, and of course, it will be stochastic modeling. And we also found that decision trees were useful there.

Then we moved on to problems like how much land to buy in Erewhon to save plants. And the tool we developed there was linear programming, L.P. Now linear programming is essentially a single-objective deterministic tool. Remember our objective there was to try and save as many plants as possible within budget and other constraints. But that was the model world. If you think about it, the real world for that problem was really a multiple-objective deterministic problem.

And what we did to get it down to linear programming was we finessed some of the objectives by turning them into constraints. So, in a sense, you can use linear programming up in the top there.

And the same can be true in the portfolio problem that we moved on to where we ended up looking at integer programming. Again, you could finesse a multi-objective problem and turn it into an integer-programming problem. And, in fact, there are a whole lot of tools like binary programming that we also looked at, which all fit into the general idea of optimization tools that are essentially single-objective tools but can be used for multiple objectives.

The one tool that we developed that definitely was designed for multiple deterministic problems was the SMART technique. Remember when we are trying to decide what car to buy? And those are, essentially, the tools we've developed so far.

But notice something. We don't have anything in the stochastic, multiple-objective section of the table. And if you stop to think about where most conservation problems fit, they are multiple objective, and very often, chance is important, and so they fit there. And the way we're going to talk about this segment is by looking at a real problem where we struggled to get to an appropriate technique. And when we've discussed that, we'll come back and fill this in. The real problem we're going to talk about is the problem of mobbing amongst the Hawaiian Monk Seals on Laysan Island.

And you have a paper, which is called just that, *"Mobbing in Hawaiian Monk Seals: The Value of Simulation Modeling in the Absence of Apparently-Crucial Data."* It's a paper by myself, James Roth and Katherine Ralls.

PAUSE the video: Read the Hawaiian Monk Seals paper.

And what I want to do here is, not so much repeat what's in the paper, because you've read it and can read it again, but rather, talk about the problem and how we dealt with it and how we eventually worked our way to a technique for solving it.

The problem, you will recall, was how to deal with mobbing on the Island of Laysan. At the time we're talking about, which was the early 1990s, there were a total of about 1,200 Hawaiian Monk Seals scattered across various colonies in the Hawaiian Archipelago. Some of the islands had larger populations. Some of them had smaller ones. Laysan was an important island, but it only had 200 seals.

Now if there were only 1,200 Hawaiian Monk Seals in the world, obviously, this was an endangered species. And the management goal was to try and push the population up as quickly as possible to 2,000 seals.

Unfortunately, on some of the smaller islands, or smaller populations, the sex ratio went skew. On Laysan, the sex ratio went skew in favor of males. Again, at the time that we were working on this, there were approximately 1.3 males for every female in the population. On some islands, the sex ratio went skew in favor of females. And when that happened, there was absolutely no problem. But when the sex ratio went skew in favor of males, very often, mobbing developed. And to understand how this developed, one needs to understand a little bit more about Hawaiian Monk Seals.

Normally, when you think of seals, you think of a dominant male surrounded by his harem of females, and you think of the male defending those females. Hawaiian Monk Seals don't work like that. Their love life is much more like the bar scene. The males cruise the beach looking for receptive females. When they find a receptive female, they go out to sea. They have a quick honeymoon. They come back to the beach, and the male moves on.

When the sex ratio is not skewed in favor of males, this works very well. The dominant males cruise the beach, and the dominant males mate with the females. But when the sex ratio is skewed in favor of males, it turns out that there are a lot of sub-dominant, disgruntled males. And they get into the habit of forming gangs following the dominant males and following the dominant males out to sea when the dominant males take the female for the honeymoon. And very often, in the process, the female gets attacked, sometimes hurt and sometimes killed. And if you look at this possibility, you realize you have the possibility here of an extinction vortex. It's one where, because you have too many males, females are getting killed, and so this could perpetuate itself.

Now, obviously, this is of concern to management. You're trying to build up the population, and you have this destructive behavior on an important island, which is actually reducing the population. What do you do about it? And as per usual, there were lots of arguments about what to do about it. One view was that the mobbing males just happened to be from an age class where, by chance, there were too many male pups born and that they would work their way through the system, as it were, until they became dominant males, and the problem would go away. So if you took that view, your attitude was probably to wait and see what was going to happen.

The other viewpoint was that females were being killed and hurt, and this, in itself, irrespective of its effect on the population, was a very bad thing to happen. And so you ought to do something about it straight away. And there were all sorts of ideas out there about what to do if you were going to do something.

So, for example, one idea was if, on some of the islands there are too many females, solve the problem by bringing females from those islands to the islands where there are too many males. It sounds logical, but to remove a female from an island, you need to do so before she's reached the age of one. She becomes difficult to handle. And chances are, if you move her after the age of one, she will go back to the island of her birth.

Now think of taking a spoiled little princess from an island where there are too many females and moving her to this hell hole where there are mobs, where mobbing's occurring, and there's gangs of angry males patrolling the beach. And she's got to survive until the age of about five before she can even start reproducing. And when mobbing gets really bad, the gangs not only attack adult females, they actually mob sub-adult females on the beach. Nevertheless, that was an option that was on the table.

The other options on the table were to remove males in various numbers and take them away to some remote island and leave them there and hope that they wouldn't come back. And a set of eight options are spelled out in the paper.

Now we were asked to try and develop a structured decision approach, some decision analysis tool to help choose amongst the various ideas that were out there. And we started looking at our toolkit, and we started talking through the problem, and we got nowhere. And if you recall the diagram we looked at earlier in this lecture, you will realize why we got nowhere because this is, essentially, a stochastic problem. And it's a multi-objective problem because there are concerns about mobbing, and there are concerns about the population, and, as we'll discover later, there are concerns about money as well. And we don't have any tools there.

So out of frustration, perhaps, we started looking for something useful to do and we came up with that tested heuristic of if you're concerned about the management of a population, build a population model. So we thought it might be useful to develop a Monk Seal model.

Now we thought this with a bit of a worry that this might be a displacement activity. We didn't know how to do the decision analysis. We wanted to do something useful. We knew how to model. So let's build a model. And we put this idea out there, and people came back at us and said, "No point in trying to build a model. We don't have good enough data." And that kind of comment is like a red flag to a bull, as far as I'm concerned, and that flipped it. Obviously, we needed a model. So we set out to develop a Monk Seal model.

Now I'm going to describe the model to you shortly, and you've probably read the paper, so it's kind of a giveaway. But if you're going to build a model, you've got to go back to all the issues about the population and what type of model to build that we discussed when we were talking about elephant contraception.

So what I'd like to do is take a break here and have you go back and review the issues we discussed and looked at when we were talking about elephants and run through them and decide what type of Monk Seal model we need to be developing.

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