

Lecture Notes for Biology of Wildlife Populations

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Making decisions

In Chapter ?? I defined a useful model as one that helps a manager make a decision. This means that an understanding of the process of decision making is fundamental to the process of modeling population dynamics in an applied setting, at least. In this chapter I introduce the concept of structured decision making, a simple framework for making management decisions under risk and uncertainty.

I start with a simple example of a decision: whether or not to provide supplemental food to a population of Hihi, an endangered bird in New Zealand (Figure ??). Managers at Kapiti Island want to provide nectar feeders to support recently translocated Hihi because they believe that the vegetation in the new location is not as rich in nectar sources as the island from which they came. They believe that additional food will support population growth in the translocated population by either improving adult survival or the number of offspring produced per pair. What they do not know is how much food to provide, or whether some other aspect of the environment in Kapiti Island will limit population growth despite increases in food availability. Concerns have also been expressed that Hihi will become dependent on feeders, and unable to utilize natural food sources.

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Although this is a relatively simple decision, it has all the features that make decisions complicated and difficult. There are multiple competing outcomes, multiple ways of reaching those outcomes, and uncertainty about which actions will lead to which outcomes. In the face of all this complexity, it is very human to avoid making a decision — which is itself a decision with outcomes — and focus on acquiring more information or attempting to pass responsibility for the decision onwards. Research throughout the 20th century has documented the many ways in which human cognition fails when faced with complex decisions. Psychologists have also studied ways in which to help humans make decisions in such circumstances. In this book I will introduce a simple 5 step approach to decision making (Smart Choices reference) that can help overcome the psychological traps of decision making; it has a simple easy to remember acronym ProACT, reminding you to be proactive in decision making. The five steps are: Problem, Objectives, Actions, Consequences, Tradeoffs.

3.1 Problem

The first step in making a decision is to ensure that you are in fact making the correct decision. What is the problem that has to be solved? Who has to solve that problem? Correctly identifying both the problem and the problem solver is critical to making a good decision. If the problem you think you're trying to solve is in fact a decision at a higher level of organization, then no matter how good your decision making is you will not be able to solve the problem. Someone else is making the decision. You may be able to advise that person, but that is a very different role than directly making the decision yourself.



Figure 3.1: The hihi, or stitchbird. Image by digitaltrails. <http://www.flickr.com/photos/digitaltrails/87192080/> (CC BY-NC-SA 2.0)

What is the problem to be solved in the Hihi example? Is it identifying the direct effects of food supplementation on adult survival? What kind of monitoring program should be in place? How many translocated populations should receive food supplementation? All of these are legitimate questions. The key to identifying the right problem to solve is to focus on things that are under the control of the decision maker. If the manager of Kapiti Island is the decision maker, then deciding which translocated populations should receive food supplementation is beyond her scope — that will be decided by someone else. Similarly, a management problem will typically involve a choice among alternatives, rather than a resolution of an uncertainty. Identifying the direct effects of food supplementation on adult survival, while potentially useful information, does not involve a choice between alternatives by the decision maker. Choosing what to monitor in the park, and how, is a choice among alternatives — there are many things that could be measured. Similarly how many feeders and where to place them leads to choices among alternatives by the manager of Kapiti Island.

Careful thought about who is making the decisions, and what decisions they have to make, is a critical first step in problem solving, and often the most neglected. The more effort devoted to this step the better, although it is also possible to get bogged down at this stage. Rather than attempting to solve all of the problems at once, it is useful to tackle individual decisions completely, and sequentially. Sometimes the solution to one problem turns out to depend on the solution to a different problem — the decisions are linked. Linked decisions are more complex than decisions that can stand alone, but breaking linked decisions into separate problems and tackling each independently makes it easier. In the Hihi example, the choice about what to monitor and how depends to a great extent on what choices are made about feeding stations. So first laying out the feeding station decision will provide a great deal of information about how to solve the monitoring problem.

3.2 Objectives

Once the problem has been (tentatively) decided on, the next step is to determine how to measure success. The terms used for measuring success vary widely, and different texts will argue for criteria, metrics, goals, objectives, targets and many others besides. I will try to keep it simple. An objective is an attribute of the system being managed that has some value to the decision maker. In the Hihi example, the number of adult Hihi in Kapiti Island is a measurable attribute. The annual adult survival probability is another measurable attribute. The number of feeding stations in the park is a measurable quantity as well. How do you decide which and how many objectives are necessary?

One approach to this problem is to categorize the measurable quantities into either means objectives or fundamental objectives. Distinguishing between these two is relatively easy. For each putative objective, you must ask yourself, “why does this matter?”. If the answer is simply, “because it does”, then the objective is likely a fundamental objective. In contrast, if the answer is “it helps achieve objective X”, then it is a means objective — a useful step, but not of interest in and of itself.

Take a look at the quantity “number of feeding stations in Kapiti Island”. Does the manager care about this quantity? If there were no Hihi, would having 5 or 10 stations be better than having none? If yes, then the number of feeding stations would be fundamental — more feeding stations is better, regardless of what else is happening. However, this seems unlikely. The only reason for feeding stations is to help the Hihi population, so this is a means objective rather than a fundamental objective.

In contrast, asking is 20 Hihi better than zero Hihi leads to a different conclusion — regardless of what else is happening in the park, 20 Hihi are better than none. The population size of Hihi on Kapiti Island seems like a fundamental objective, at least for this decision. The adult survival probability is an example of a more difficult objective. All other things equal, is a population with higher survival better than a population with lower survival? Imagine that there are 100 Hihi in the park, but you can have 100 birds with an annual survival of 0.85, or 100 birds with an annual survival of 0.9. Which is better? This is not so straightforward to sort out, and the answer may well depend on other vital rates of the population, and how they vary with population size. For example, what if the population of 100 with a low adult survival rate is only maintained by continued immigration from another population? The population in Kapiti Island is then a sink, and