**Exploring mathematics: a powerful tool**

*How maths helps dolphins*

**Carmen Pryce:**
Here's a situation in which statistical modelling has an important role to play: conservation. Around the shores of New Zealand there are maybe three or four thousand Hector's Dolphins which are vulnerable to extinction. Many dolphins live around the Banks Peninsula of the South island, which has a sizeable fishing industry. However the gillnets the fishermen have been using can be potentially fatal to a dolphin. Since the late 1980's a sanctuary has been set up around the Banks Peninsula within which gillnetting is tightly restricted and hopefully that measure will help the dolphin population to survive. But how can you tell? Survival rates in animals are often estimated using annual recordings of individuals over a number of years. The full set of observations can be used to predict the survival rate from one year to the next in a combined effort between mathematicians and biologists. There are several ways in which an animal can be identified but for this endangered species the observations of individual dolphins have relied on photos of distinctive fin markings. The study was initiated in the mid-1980's by the Zoology and Marine Science departments at the University of Otago in Dunedin, and this work is being continued by marine biologist Stefan Bräger.

**Stefan Brager, University of Otago:**
My work depends very much on the weather. That means I try to go out as often as possible, which is on average every other day, and I always need someone to come along to help me because while I take the photos someone else needs to drive the boat. In theory one could mark these dolphins but their small population size and their endangered status prohibits any kind of invasive research, therefore taking photos of live dolphins are the only ways available.

**Carmen Pryce:**
David Fletcher is a bio-statistician who was brought in to assist the biologists. There were several years of observational data to work on, but to determine whether the sanctuary is proving to be effective or not needed the input of a specialist who could work on the modelling assumptions.

**David Fletcher:**
One of the interesting aspects about doing this work for me is that this sort of modelling is usually done in conjunction with my biological colleagues, and I will suggest certain things we can do and they will tell me whether it's realistic or not.

**Stefan Brager:**
I need the statistical input of a mathematician because the data that I gather in the field are very sparse and sometimes I don't see an individual for a long time. And if I want to make any inference from these few individuals to the entire population it requires a statistical model, and that's where David comes in.

**David Fletcher, University of Otago:**
You can build in functions to relate this probability of sighting or not sighting to weather and the behaviour of the dolphins, and this can be based on information such as how often an individual has been sighted in the past and also, importantly, how much effort has been put into the fieldwork in different areas in different years. One aspect of the type of model we use here is that sightings of dolphins are independent. We know this is not going to be true because we know that the behaviour of dolphins is such that it seems more likely that if one is seen in a particular year, then there may be one or more others that are also with it.

**Carmen Pryce:**

In fact other studies, together with this data from Akaroa, have established that the common pairing of individuals won't upset the validity of the model. So just what have the statistics been able to say about the dolphins' plight so far?

**David Fletcher:**
The analyses we've carried out on these data that have been collected over the last ten years suggest that the survival rate is around 86 percent for the adults. That means, in other words, 14 percent are dying each year. Given that the birth rate is not sufficient to compensate for this, it suggests that the population is in trouble. Ideally, that survival rate should be around the 90/91 percent mark for the population to be safe.

**Carmen Pryce:**
As the assumptions about the model are fine-tuned, then the predictions about the fate of the dolphins should become more and more reliable. From then on it's up to the conservationists.