Occupancy analysis in kiwi acoustic studies

Passive acoustic monitoring is increasingly used in kiwi studies to monitor changes in kiwi populations and their response to conservation management. Usually, acoustic monitoring tends to focus on presence/absence, or detection/non-detection of kiwi calls. However, this approach suggests a perfect detection of kiwi occupying a recorder's surroundings. In most cases, the detection probability (detectability) is <1, leading to underestimating true occupancy in the studied area. Therefore, it is vital to include detection probability when interpreting results of acoustic monitoring. Occupancy analysis using acoustic data enables inferences on population status and changes throughout time without more intrusive monitoring methods. For that reason, occupancy modelling using acoustic data has great potential for assessing management outcomes for kiwi taxa.

Great spotted kiwi/roroa (*Apteryx haastii*) were reintroduced to the Nina Valley near Lewis Pass from the Hawdon Valley, Arthur's Pass, between 2011–2015. Thus far, this project was the only reintroduction attempt of roroa in the Arthur's Pass–Hurunui region. Therefore, it is necessary to assess the reintroduction outcome and possible impacts of removing birds from the source population. We used baseline data from acoustic surveys in 2012–13 from both areas and repeated the surveys in 2017–18. We deployed 21–23 recorders for three weeks in the centre of probable kiwi territories in each valley, about 1 km apart. Subsequently, we analysed the acoustic data using Kaleidoscope software for automated call detection with an additional manual confirmation.

The analysis of acoustic data yielded some interesting results. In the Nina Valley, only 14% of devices recorded kiwi in 2012. These were three sites around the area where the first subadult kiwi were released between 2011–12. The proportion of recorders detecting kiwi increased rapidly to 68% in the 2017 survey. This increase was likely a result of the successful establishment of the reintroduced population, which was further expanded by releasing more subadults and four pairs of adults from the Hawdon Valley by 2015. These birds spread throughout the valley, established territories, and – based on previous radio-telemetry monitoring – some started breeding. Kiwi in the Nina were calling only infrequently, and it took up to ten nights for a bird to be recorded at a listening site, which resulted in estimated low detection probability. Therefore, single-season occupancy models estimated true site occupancy at 20% and 72% in 2012 and 2017, respectively. These results indicate that several sites had kiwi present, but we did not detect them, and therefore such estimates are higher than naïve occupancy based on simple detection/non-detection data. A multi-season occupancy model estimated that there was a 67% probability that unoccupied sites in 2012 became occupied by 2017.

In the Hawdon Valley, 65% of recorders detected kiwi in the 2012 survey, and the proportion of devices detecting kiwi increased up to 90% by 2017. That was despite removing four pairs of adult birds from their territories in 2015. This increase was likely a result of the successful recruitment of adults and strong population growth, which has benefited from intensive predator management, mainly for orange-fronted kākāriki (*Cyanoramphus malherbi*). Because of a much higher number of calls in the Hawdon (7x more calls recorded in the Hawdon than in the Nina in 2017), and higher detectability, the estimates of true occupancy were more similar to naïve occupancy. Single-season occupancy models estimated true site occupancy in the Hawdon at 65% and 93% in 2012 and 2017, respectively. A multi-season occupancy model estimated that there was a 70% probability that unoccupied sites in 2012 became occupied by 2017. At least three out of the four territories, where birds were removed from in 2015, were reoccupied by the time of the 2017 survey. These territories were all occupied by both a male and a female, indicating a little impact of removing the birds from the donor population in the Hawdon Valley.