

Understanding egg trait variation and viability in kākāpō

Kākāpō (*Strigops habroptilus*) are an iconic example of New Zealand's threatened avifauna. Although critically endangered, recent efforts by the Department of Conservation's Kākāpō Recovery Programme have increased the population from a low of 51 individuals in 1995 to over 250 following the 2022 breeding season. Kākāpō breeding seasons are irregular, taking place only when there is abundant fruit from masting species such as rimu (*Dacrydium cupressinum*), and this limits the speed of population recovery. However, a further barrier to kākāpō recovery is that their eggs have an unusually high rate of hatching failure. Many of these failed eggs are undeveloped, with no visible embryo, and were previously thought to be infertile.

Thanks to work done on unhatched kākāpō eggs after the previous (2019) breeding season, we now know that while some eggs are indeed infertile, most actually contain microscopic fertilized embryos that died only a few days into development. We do not currently know why early embryo deaths are so common in kākāpō, nor whether infertile eggs and embryo deaths are caused by the same factors. The present project aimed to further illuminate why kākāpō eggs fail by determining the fertility status of unhatched eggs from the 2022 breeding season. Ultimately, these data will be combined with the 2019 dataset and information about kākāpō parents to help us identify the environmental and individual causes of poor fertilization and developmental problems in kākāpō.

Although not as productive as 2019, the 2022 breeding season was a successful year for kākāpō and the recovery programme, with a total of 142 eggs laid across Whenua Hou / Codfish Island, Anchor Island, and Te Kāhahu-o-Tamatea / Chalky Island. Of these, only 60 eggs hatched (42%), a lower fraction than in 2019, but chick survival was exceptional: 55 fledged. The remaining 82 eggs either died as visible embryos (17, 12%) or did not develop (65, 46%); these undeveloped eggs were the focus of this project.

For the 2022 breeding season we decided to preserve the undeveloped eggs for laboratory analysis by freezing them whole. Compared to preserving yolks in formalin, freezing allows for genetic material from any embryos to be isolated, without obstructing the goal of assessing egg fertility. Freezing eggs whole was also an easier sampling process during fieldwork on the kākāpō islands. We successfully froze all 65 undeveloped kakapo eggs for later analysis: 30 from Whenua Hou, 26 from Anchor Island, and 9 from Te Kāhahu-o-Tamatea.

We are working with leading experts on egg fertility in the UK to transport and analyse the undeveloped eggs. At present the laboratory work to assess fertility has not been completed, but we expect to publish these results later in 2023.

Photo: 'Ninihi' in a nest cavity on Te Kākahu-o-Tamatea / Chalky Island. By Jake Osborne.

