Non-breeding ecology of New Zealand falcon (*Falco novaeseelandiae*) in a pine plantation forest

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ABSTRACT

Deforestation and conversion to intensive agriculture historically caused a large reduction in numbers of the New Zealand falcon or Kārearea (*Falco novaeseelandiae*), resulting in its current classification as Nationally Vulnerable. Several studies in plantation forests have documented the ecological benefits of limited timber harvesting on diversities of avian species through providing habitat heterogeneity. New Zealand falcons occur in managed plantation forests. To date, however, detailed information regarding falcon prey abundance, habitat use, home-range size, and breeding behaviour has been limited to their breeding season. Little is known about their winter use of managed forests and how forest operations affect their survival and reproductive ability by restricting their mating system.

I investigated a falcon population living in a large plantation forest, Kaingaroa forest through addressing the following questions: (1) how changes in forest structures influence falcons' habitat use and home-range size in relation to winter prey abundance and availability, (2) how the reduction in habitat heterogeneity by large-scale harvesting affects falcon's home-range size and overlap, (3) the risk of secondary poisoning from 1080 operations and falcon annual survival, and (4) how constraints by changes in the forest structure and compositions shape the mating system of the Kaingaroa falcon population. I used radio-tracking data to establish the extent and habitat composition of winter home-ranges, and monitoring survival of falcons before and after 1080 poisoning operations. I used transect surveys to assess the availability

of potential prey birds, and behavioural observation to measure pair breeding activities.

I found that falcons used the ecotone between mature-pine stands and young-pine stands (the edge-habitat) most frequently followed by their hunting ground (young-pine stands – 0–3-year-old pine trees). Total prey abundance was similar across all habitats and sizes of open fields. The dynamic changes to forest structure created by clear-cutting and its effect on prey accessibility are the most profound factor influencing falcon space use. Winter home-range sizes of forest falcons (used Kaingaroa exclusively) were smaller than those of farmland falcons, which used farmland > 10 % of total tracking duration. I found that falcons used smaller home ranges when the forest provided the edge-habitats that were concentrated among mature-pine stands through creating open-patches less than 3 km^2 that are distributed closely (< 3 km apart). Results indicate that timber forests could hold a greater number of falcons with these forest compositions. Thirty-seven adult New Zealand falcons were exposed to carrot bait 1080 poison during the three winter months (May–August), and 17 adult falcons were exposed to cereal bait 1080 poison by aerial droppings in 2013 and 2014, and all these falcons except one survived. One radio-tagged male died and although a toxicology test found not 1080 residues, however, the possibility of 1080 secondary poisoning was not entirely cleared. The survival rate of adult Kaingaroa falcons was 80% and that of juveniles was 29%. All divorces (40%) were initiated by females leaving their territories regardless of reproductive outcomes, while males exhibited greater mate and site fidelity. A high rate of extra-pair interaction occurred by females (71%) but was absent in males. Female's extra-pair interaction implemented as their strategy for securing breeding opportunities. In

contrast, the mate-guarding strategy may be the most effective male's mating strategy in the Kaingaroa falcon population. Male's vigilant personality likely enhanced mate-guarding performance. Home-range overlap was greater in pairs that retained partners than pairs that divorced. Winter courtship displays were used for pair formation (the process of establishing a social bond) rather than pair bonding (the process of maintaining a social bond), and also used for intra-sexual competition over females. A rapid rotation of habitat quality and sufficient prey availability in the area may shape falcons' various mating systems.

A further long-term continual monitoring that includes the juvenile falcons is required to measure the effects of 1080 poison on the Kaingaroa falcon population. A well-designed harvesting regime could enable the timber industry to contribute importantly to the conservation of this threatened New Zealand raptor.

This dissertation is dedicated to

my parents and my second mother

who taught me to follow my dreams

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