Due to their large size and preference for perching from high vantage points, raptors are especially prone to electrocution, and mortality from electrocution on power structures is a major threat to birds of prey in human-modified landscapes around the world (Lehman et al. 2007). Globally, agricultural expansion and intensification has drastically changed landscapes (Foley et al. 2005). While some species of raptor can take advantage of the food sources available in agricultural landscapes, the low availability of natural perches and high frequency of electrical structures in these regions can lead to a high incidence of electrocution, sufficient to limit population growth (Real et al. 2001; Marchesi et al. 2002; Sergio et al. 2004; Lehman et al. 2007). Internationally, electro-utility structures with multiple conductive components close together, or those that have grounded hardware, are more likely to electrocute birds (Lehman et al. 2004).

Electricity is transported throughout New Zealand over a network of high-power (50-220 kV) transmission lines carried over 12,000 km and supported by approximately 41,000 towers and poles and 61 switchyards (Transpower 2013). Local lines companies deliver power to consumers through 85,601 km of 11-50 kV overhead distribution lines in rural, remote and rugged regions, and 18,504 km of overhead distribution lines in urban regions of New Zealand (Commerce Commission 2013). In comparison, New Zealand has 83,000 km of local roads and 11,000 km of state highways (NZ Transport Agency 2012). Distribution transformers change the current of electricity travelling across distribution lines to a current used for standard residential and business electricity. There are 124,067 pole-mounted distribution transformers in New Zealand (Commerce Commission 2013).

Following reports of New Zealand falcons (*Falco novaeseelandiae*) being electrocuted in Marlborough (Fox & Wynn 2010), I contacted a number of organisations and individuals to determine if the problem is widespread, as well as to determine if electrocution also affects non-raptor species in New Zealand. I used electronic mail to contact all...
New Zealand bird rescue centres listed on the New Zealand birds website (http://www.nzbirds.com/more/centres/html, accessed 25 February 2010). A call for reports was included in the 2010 edition of Southern Bird, and was included on the Birding New Zealand forum (http://www/birdingnz.net/forum/) on 22 February 2010. I also followed up on verbal communications from colleagues.

Table 1. Reports of birds collected dead under power lines or found after being electrocuted.

<table>
<thead>
<tr>
<th>Species</th>
<th>Year</th>
<th>Number of individuals</th>
<th>Location</th>
<th>Found beneath</th>
<th>Reported by</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Zealand falcon</strong> <em>Falco novaeseelandiae</em></td>
<td>2009</td>
<td>1</td>
<td>Glenorchy, Otago</td>
<td>Transformer</td>
<td>Barry Lawrence</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>1</td>
<td>Ngakuta Bay, Marlborough</td>
<td>Transformer</td>
<td>Dianne John; Fox &amp; Wynn (2010)</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>2</td>
<td>Glenorchy, Otago</td>
<td>Transformer</td>
<td>Barry Lawrence</td>
</tr>
<tr>
<td>Unknown</td>
<td>2013</td>
<td>1</td>
<td>Arthurs Pass, Canterbury</td>
<td>Transformer</td>
<td>Graeme Kates; Fox &amp; Wynn (2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unwin Lodge area, Aoraki/Mount Cook National Park</td>
<td>Substation</td>
<td>Shirley Slatter</td>
</tr>
<tr>
<td><strong>Australasian harrier</strong> <em>Circus approximans</em></td>
<td>2010</td>
<td>1</td>
<td>Wairau Valley, Marlborough</td>
<td>Transformer</td>
<td>Mike Bell &amp; Phil Bradfield</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>1</td>
<td>Wairau Valley, Marlborough</td>
<td>Transformer</td>
<td>Sara Kross</td>
</tr>
<tr>
<td><strong>Kea</strong> <em>Nestor notabilis</em></td>
<td>2009</td>
<td>1</td>
<td>Mt Cook Village, South Canterbury</td>
<td>Substation</td>
<td>Raoul Schwing</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>5</td>
<td>Unwin Lodge area, Aoraki/Mount Cook National Park</td>
<td>Substation</td>
<td>Shirley Slatter</td>
</tr>
<tr>
<td><strong>Kaka</strong> <em>Nestor meridionalis</em></td>
<td>2009</td>
<td>1</td>
<td>Whakatane</td>
<td>Power line</td>
<td>John Groom</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>1</td>
<td>Parua Bay, Whangerei, Northland</td>
<td>Transformer</td>
<td>Suzi Phillips</td>
</tr>
<tr>
<td><strong>Kereru</strong> <em>Hemiphaga novaeseelandiae</em></td>
<td>1998</td>
<td>1</td>
<td>Southland</td>
<td>Unknown but definite electrocution</td>
<td>Ralph Powlesland</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>2</td>
<td>Southland</td>
<td>Power pole (possible electrocution)</td>
<td>Ralph Powlesland</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>3</td>
<td>Southland</td>
<td>Transformer</td>
<td>Lloyd Esler</td>
</tr>
<tr>
<td><strong>Eastern rosella</strong> <em>Platycercus eximius</em></td>
<td>2010</td>
<td>1</td>
<td>Whakatane, Bay of Plenty</td>
<td>Transformer</td>
<td>Rosemary Tully</td>
</tr>
<tr>
<td><strong>Canada goose</strong> <em>Branta canadensis</em></td>
<td>1992</td>
<td>4</td>
<td>Auckland</td>
<td>Power line &amp; transformer</td>
<td>Graham Jones</td>
</tr>
<tr>
<td><strong>Maggpie</strong> <em>Gymnorhina tibicen</em></td>
<td>~1990</td>
<td>1</td>
<td>Invercargill</td>
<td>Transformer</td>
<td>Sally Dunston</td>
</tr>
<tr>
<td><strong>Black swan</strong> <em>Cygnus atratus</em></td>
<td>2009</td>
<td>1</td>
<td>Awatere valley, Marlborough</td>
<td>Power line</td>
<td>Sara Kross</td>
</tr>
<tr>
<td><strong>Cook’s petrel</strong> <em>Pterodroma cookii</em></td>
<td>2009</td>
<td>1</td>
<td>Whakatane, Bay of Plenty</td>
<td>Power line</td>
<td>Rosemary Tully</td>
</tr>
</tbody>
</table>

Transformer electrocutions are for birds that were found dead under power poles mounted with transformers, but it is possible that another connection on the same pole caused the electrocution. Birds found under power poles may actually have been found under a transformer pole but the collector did not note it. Importantly, in cases where birds were found below power lines cause of death may have been collision rather than electrocution. The kea in 2009 was seen to be shocked while within an electrical substation.
A total of 28 individuals of 11 different species were either found dead under electrical structures or were found with burns to their feet or bodies (Table 1). This number is in addition to the 12 electrocutions of New Zealand falcons previously reported in Fox & Wynn (2010). The reports were geographically spread between Northland and Southland (Table 1), and suggest that power lines and transformers are dangerous to a wide range of species including native psittacines, raptors, waterfowl, and large passerines (Table 1). However, because this study is based on retrospective, opportunistic observations, and not a systematic survey of electrical structures, it is unlikely to reveal the true scale of the impact of electrocution on bird populations throughout New Zealand. Studies of bird electrocutions that rely on opportunistic collection of dead birds, such as this one, are confounded by decomposition and scavenging rates, ‘crippling’ of birds by electrocution, and can be biased toward larger species which are more likely to be seen, or to areas and habitats where people are more likely to come across or notice dead birds (Lehman et al. 2007).

Aside from being found under power lines or poles, some electrocuted individuals show no physical signs of electrocution, and some birds that have been shocked but not killed may display subtle signs of injury such as minor burns to the feet (Dwyer 2006). For example a 3-year-old kaka (Nestor meridionalis) in Northland (Table 1) was found dead under a power pole mounted with a transformer, and was autopsied and found to be in good condition with a full-crop and no signs of trauma (S. Phillips, pers. comm.). Similarly, only some of the falcons reported as electrocuted in Fox & Wynn (2010) suffered from obvious burns. In other cases, signs of electrocution can be obvious. For example, a kereru (Hemiphaga novaeseelandiae) in Southland was found with both legs burnt off and burn marks over much of its body (R. Powlesland, pers. comm.). Birds that are electrocuted are not always killed immediately (Dwyer 2006; Fox & Wynn 2010), as was the case for a fledgling kea (Nestor notabilis) at Aoraki/Mount Cook village. This bird was electrocuted at an electrical substation, causing a power blackout. It was located 3 days later alive, but with necrotic flesh wounds, and was later euthanised (R. Schwing, pers. comm.).

Retrofitting dangerous structures can be a successful means of mitigating the issue of bird electrocutions (López-López et al. 2011). Transformers appear to be the most dangerous structures for perching birds in New Zealand, although substations may be localised sources of danger for birds such as kea and falcon (Table 1). Transformers have a number of different designs, but many are connected to overhead distribution lines via high transmission drop leads. These are un-insulated wires that taper in towards each other to join the bushings on top of the transformer, which is grounded. Birds can form a circuit by perching on the transformer box and touching any one of the wires, or by making contact with 2 wires when landing on the transformer. Because of these features, transformers appear to be the biggest concern for native birds in New Zealand, and have been attributed to most of the mortalities in Table 1. In 2011, Marlborough Lines, the company that owns and maintains the electrical distribution network in Marlborough, put a policy in place to insulate the high-voltage drop leads and bushings on all new and replaced transformer boxes within a designated ‘bird protection zone’ around the main grape-growing areas in the Wairau and Awatere valleys and in part of the Flaxbourne district (W. Stronach, pers. comm.).

Due to the scale of the electricity network across rural areas in New Zealand and the possibility of scavenging or decomposition prior to birds being located (Lehman et al. 2007), the number and widespread geographical range of the reports in Table 1 is likely to be indicative of a larger problem. More effort is needed to quantify the danger of electro-utility structures to New Zealand’s avifauna, ideally through larger-scale prospective studies to search for deceased birds under power poles. Further research in conjunction with electrical network companies is needed to determine the importance of electrical substations as a source of bird electrocutions. At a minimum, a national database of bird electrocutions should be kept, and the Marlborough Falcon Conservation Trust has volunteered to administer and report on this database. Anyone picking up a dead bird under power structures should contact the Marlborough Falcon Conservation Trust, noting the species, location, the nearby power structure, and the likely cause of death.

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LITERATURE CITED


Keywords electrocution; falcon; kaka; kea; kereru; mortality; transformer