

Frugivorous pigeons, stepping stones, and weeds in northern New South Wales

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Lack of continuous vegetation (i.e., corridors) does not appear to prevent rainforest frugivores, such as pigeons, from using remnants or moving long distances from high to low elevations or along the coast. Historically, rainforests in New South Wales were fragmented by eucalypt forests. As a patchwork of geographically close "habitat islands", the smaller fragments formed stepping stones between rainforest at high and low elevations. Although clearing for agriculture has reduced lowland subtropical rainforest in New South Wales to isolated remnants, the spatial distribution of remnants is not dissimilar to that of rainforest patches at higher elevations. Frugivorous pigeons cross open country and use a variety of vegetation, including exotic weeds, as stepping stones to move between remnants. While it may not be necessary to ensure habitat continuity for these species, a patchwork of vegetation may be required to facilitate movements and provide alternative feeding areas. This does not need to be native or undisturbed habitat. In the short term, introduced species that provide winter food for frugivores and stepping stones between remnant rainforests, such as camphor laurel, *Cinnamomum camphora*, should be retained to conserve rainforest frugivores in northeastern New South Wales. In the long term, they should be replaced by a network of native species.

INTRODUCTION

ONLY isolated patches remain of the subtropical and temperate rainforests that covered the river valleys and mountains of northeastern New South Wales (Baur 1976; Frith 1976; Strom 1976). At high elevations these forest patches were and, in some cases, still are surrounded naturally by eucalypt forest. In the lowlands the remaining patches are often isolated by pasture and cropland, although they are sometimes linked by corridors or strips of native or exotic vegetation. On the coast where settlement and agriculture are most intense, there are few connections between patches and isolation is most complete. To survive, fauna must be capable of moving among these scattered fragments and larger tracts of forest.

Five species of frugivorous pigeons occur in the rainforests of northern New South Wales. The wompoo, *Ptilinopus magnificus*, rose-crowned, *P. regina*, superb, *P. superbis*, and topknot pigeons, *Lopholaimus antarcticus*, are obligate fruit-eaters and the white-headed pigeon, *Columba leucomela*, which can digest seeds, includes a large proportion

of fruit in its diet. All species declined in abundance after forest clearing caused the loss of seasonally important food sources (Frith 1982). Their survival in New South Wales, particularly in coastal areas, may depend on the retention of rainforest remnants and exotic fruiting plants.

Wompoo pigeons are considered uncommon by experienced birdwatchers in northeastern New South Wales (Date and Recher 1989) and until this study they have been regarded as sedentary or locally nomadic (Frith 1982). The diet of wompoo pigeons includes a wide variety of fruit which enables them to persist at one location for long periods (Crome 1975; Innis 1989). Most rose-crowned pigeons are seasonal visitors to New South Wales and are seen more often during spring, summer and autumn than during winter (Blakers *et al.* 1984). Superb pigeons also visit New South Wales during spring, summer and autumn but are regarded as rare (Blakers *et al.* 1984; Date and Recher 1989). Rose-crowned and superb pigeons capitalize on local abundances of fruit and have a relatively broad diet (Crome 1975; Frith 1982). Topknot pigeons are common in New South

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Wales and are thought to be nomadic, appearing in large flocks (20–500 individuals) when fruit is abundant (Frith 1982; Date and Recher 1989). Flocks are frequently observed flying over eucalypt forests and open country (Frith 1982). White-headed pigeons are common where camphor laurel, *Cinnamomum camphora*, an exotic tree, is prolific (Frith 1982; Date and Recher 1989). They also fly over open country and are considered nomadic (Frith 1982). At lower elevations where the abundance of native fruits has been reduced by clearing of rainforest, the camphor laurel may well be the major winter food for topknot and white-headed pigeons (Frith 1982). Both species have increased in numbers with the spread of camphor laurel (Recher, pers. obs.).

By investigating seasonal changes in the distribution, abundance and diet of frugivorous pigeons at a series of sites in rainforests of northeastern New South Wales and recording their movements between patches, we tested the proposal that they require corridors of native vegetation to move between seasonally abundant crops in geographically dispersed remnants.

STUDY SITES AND METHODS

Ten rainforest sites in northeastern New South Wales (Fig. 1) were visited monthly from August 1988 through July 1989. The presence or absence of species of pigeons was recorded to estimate seasonal changes in distribution. Abundances were estimated by counting the numbers of individuals of each species seen or heard. Species of tree in which pigeons were observed eating fruit were identified. Selection of sites was based on elevation, vegetation and continuity with other native vegetation but was limited by the small number of rainforest remnants at coastal, low and middle elevations. Sites greater than 200 ha in area exist only at high elevations (> 300 m amsl). Four small (< 20 ha) remnants of lowland subtropical rainforest, Johnson's Scub, Booyong, Victoria Park and Davis Scrub Nature Reserves, were visited less frequently (Fig. 1). Other sightings of pigeons, and fruits eaten, including observations from a network of volunteers, were collected opportunistically.

RESULTS

The largest monthly counts of pigeons were plotted for each elevation (Fig. 2). Wompoo pigeons were not recorded at the coastal sites, which contained littoral rainforest, though one volunteer visiting Arrawarra in September observed the species in littoral rainforest. They were present most of the year at the lowland sites near Coffs Harbour, which contained subtropical rainforest. The reduced abundance of wompoo pigeons at these sites during winter coincided with sightings in the Lismore area on farmland and in small isolated remnants of lowland subtropical rainforest and eucalypt forest (e.g., Victoria Park). At other times of the year in the lowlands wompoo pigeons

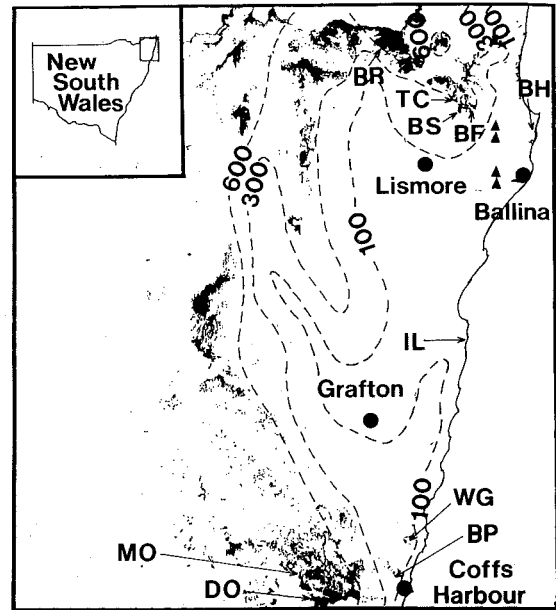
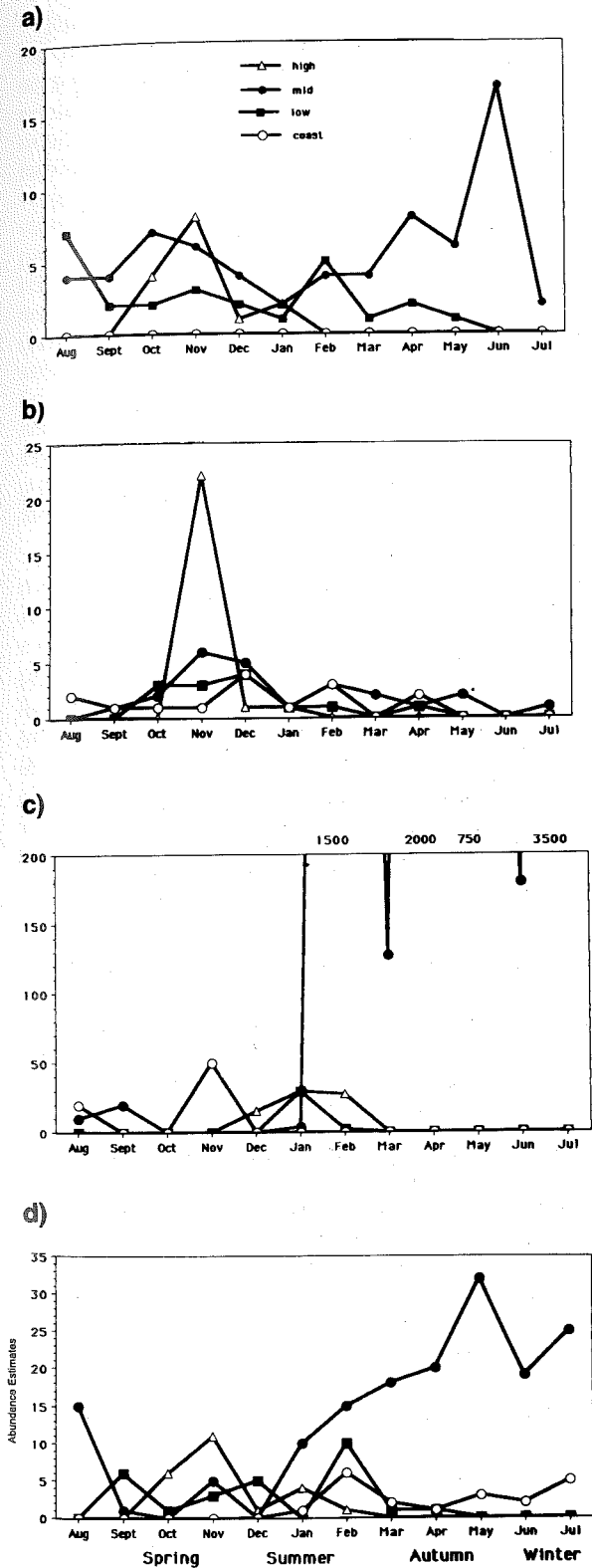


Fig. 1. Northeastern New South Wales showing the distribution of remaining rainforest and the location of study sites. Highland (> 300 m) sites were Border Ranges (BR) and Dorrigo (DO) National Parks and Mobong Flora Reserve (MO); middle elevation (200–300 m) sites were Terania Creek (TC) in Nightcap National Park, Big Scrub (BS) and Boomerang Falls (BF) Flora Reserves; lowland (100–200 m) sites were Bruxner Park (BP) and Woolgoolga Creek (WG) Flora Reserves; coastal (< 100 m) sites were Iluka (IL) and Broken Head (BH) Nature Reserves. Triangles mark the four isolated lowland remnants.

were recorded in eucalypt forest with rainforest understorey and in rainforest trees on otherwise cleared creek banks. Wompoo pigeons were recorded in subtropical rainforest at the middle elevation sites throughout the year and at the high elevation sites in spring and summer (Fig. 2a).

Rose-crowned pigeons were present most of the year at the littoral sites. At the lowland sites they were present from spring to autumn but at the isolated lowland sites further north they were also present in winter. Rose-crowned pigeons were common at middle and high elevation sites in spring and summer, but occurred at only one middle elevation site in autumn and winter (Fig. 2b). Superb pigeons were observed at only one site (Boomerang Falls Flora Reserve), where they occurred during spring and summer.

Topknot pigeons were infrequent visitors to the coastal sites in spring and to the lowland sites in summer. In winter they were observed flying over and roosting in isolated lowland rainforest and eucalypt forest remnants and roosting and foraging in camphor laurels throughout the lower Richmond River valley. Topknot pigeons were present in early spring at the middle elevation sites, absent during late spring and early summer, and abundant during autumn and winter. They were recorded at the highland sites only during summer (Fig. 2c).



Abundance Estimates

Fig. 2. Relative monthly abundances of frugivorous rainforest pigeons in northeastern New South Wales at four elevational ranges; coastal (< 100 m), lowland (100–200 m), middle (200–300 m), highland (> 300 m). The highest count at any site was reduced to plot the numbers of (a) wompoo, (b) rose-crowned, (c) topknot and (d) white-headed pigeons for each elevation.

White-headed pigeons were absent from littoral rainforest from late winter to early summer and present in low numbers from late summer to early winter. They occurred at the lowland sites near Coffs Harbour during spring, summer and autumn and were absent in winter, whereas they were present in the isolated lowland remnants in the Lismore area only during autumn and winter. At middle elevations white-headed pigeons were uncommon during spring and early summer, but were abundant from late summer through winter. They were present during spring and summer at the highland sites, but were common only during spring (Fig. 2d). However, they were common in the highland rainforest remnants and surrounding farmland and camphor laurels of the Dorrigo plateau.

The similarity of sites within elevation categories in relation to monthly changes in pigeon community composition was assessed using presence/absence data. Hierarchical cluster analysis using a simple matching similarity metric and agglomeration schedule grouped the highland sites and two of the middle elevation sites, but separated the coastal and lowland sites (Fig. 3). Except for one highland site, Border Ranges, and one middle elevation site, Terania Creek, sites dissimilar in latitude were grouped separately (Figs 1, 3).

Fruits eaten by the wompoo, rose-crowned, topknot and white-headed pigeons are seasonal (Table 1). Most species ripen early during a season near the coast and later in the same season at higher elevations. Species of lilly pilly (*Acmena*, *Syzygium*) are eaten through the spring, summer and autumn. Native laurels (*Cinnamomum*, *Cryptocarya*, *Endiandra*) were eaten in summer, whereas the introduced camphor laurel fruited abundantly in autumn and winter. Fruit of the pepper vine, *Piper novae-hollandiae*, was eaten in spring at low and middle elevations and in summer at high elevations. Ripe pencil and white cedar fruits, *Polyscias murrayi* and *Melia azedarach*, were eaten in autumn at low and middle elevations whereas crab apple, *Schizomera ovata*, was an abundant food in the highlands in summer. Unripe bangalow palm

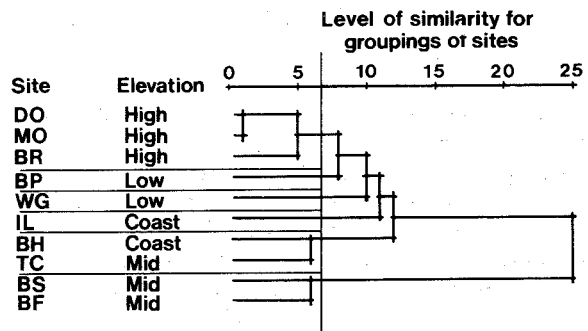


Fig. 3. Dendrogram of sites based on monthly similarities of pigeon communities using presence/absence data. The scale (0–25) is an index of similarity between groups of sites.

Table 1. Tree species from which fruit was taken in spring, summer, autumn and winter by wompoo, rose-crowned, topknot and white-headed pigeons at high, middle, low and coastal elevation sites and agricultural areas nearby.

	High	Middle	Low	Coast
Spring	[..... <i>Archontophoenix cunninghamiana</i> (unripe).....] [..... <i>Piper novae-hollandiae</i>] <i>Diploglottis australe</i>	<i>Elaeocarpus grandis</i>	<i>Ficus watkinsiana</i> <i>Syzygium coryanthum</i> <i>Diploglottis australe</i>	<i>Acmena hemilampra</i>
Summer	[..... <i>Archontophoenix cunninghamiana</i> (ripe).....] [..... <i>Syzygium crebrinerve</i>] <i>Piper novae-hollandiae</i> <i>Endiandra</i> sp. <i>Schizomera ovata</i>		<i>Piper novae-hollandiae</i> <i>Endiandra</i> sp. <i>Ficus obliqua</i>	
Autumn	<i>Ligustrum sinense</i>	[..... <i>Archontophoenix cunninghamiana</i>] [..... <i>Ficus obliqua</i>] <i>Ficus macrophylla</i> <i>Polyscias murrayi</i>	<i>Melia azedarach</i> <i>Cinnamomum campbora</i>	
Winter		[..... <i>Syzygium coryanthum</i>] [..... <i>Cinnamomum campbora</i>] [..... <i>Ficus watkinsiana</i>] <i>Ficus macrophylla</i> <i>Ficus obliqua</i> <i>Acmena brachyandra</i>		<i>Ficus rubiginosa</i>

fruit, *Archontophoenix cunninghamiana*, were eaten in spring at low, middle and high elevations, ripe fruit were eaten at all elevations in summer and at low and middle elevations in autumn. Individual figs (*Ficus*) fruited at different times of year but fruiting activity was concentrated in winter (Table 1).

DISCUSSION

Some rose-crowned pigeons move into highland rainforest during the spring and early summer. Rose-crowned and possibly a few superb pigeons also move into rainforests at lower elevations during the spring and summer and migrate north in winter, though some individuals remain (Blakers *et al.* 1984; this study). Wompoo pigeons are present most of the year at middle and low elevations, but only in spring and summer at the higher sites. This indicates some altitudinal and latitudinal movement. Sightings of wompoo pigeons in eucalypt forest and farmland in winter support the idea of local and widespread movements and indicate the willingness of the species to cross open country, and to use degraded habitat and native habitat other than rainforest.

White-headed and topknot pigeons were abundant at the mid-elevation sites from late summer to winter. Both were more common at high elevations in spring and summer than in autumn and winter. Few topknot pigeons were seen at low elevations but white-headed pigeons were present at the sites near Coffs Harbour in spring and summer at the littoral sites in autumn and winter. Both species are regarded as nomadic (Blakers *et al.* 1984), though our data indicate that there could be regular altitudinal or latitudinal movements, or both. These altitudinal and latitudinal movements are probably the overall effect of many interpatch movements of individuals foraging independently.

The differences in monthly pigeon community composition between coastal, low, middle and high elevation sites (Fig. 3) correlate with differences in the fruiting phenology of tree communities at different elevations (Table 1). Differences in pigeon community composition between sites at similar elevations may correlate with fruit availability and latitude, and may underline the importance of retaining remnants that are different floristically, but close geographically or linked by similar vegetation (Boecklen and Bell 1987). For example, wompoo pigeons were recorded at both lowland sites near Coffs Harbour during autumn. They were present in March at Bruxner Park, though foraging was not observed, but they were not recorded at Woolgoolga Creek. In April and May, wompoo pigeons were present at Woolgoolga Creek where white cedars were in fruit whereas they were apparently absent from Bruxner Park where white cedars were not present (Fig. 2, Table 1). Topknot pigeons were recorded at both lowland sites near Coffs Harbour during the summer foraging on bangalow palm fruit (Fig. 2, Table 1). At the more northerly site, Woolgoolga Creek, the fruit ripened in January and topknot pigeons were present there but were not detected at Bruxner Park. In February at Bruxner Park ripe fruit were abundant and topknot pigeons were present whereas they were apparently absent from Woolgoolga Creek. Thus conservation and management of frugivorous pigeons in northeastern New South Wales also requires the retention of suitable habitat along the elevational gradient from coast to highland and from north to south. Current reservations of rainforest national parks and nature reserves at high elevation and on the coast (littoral rainforest) are insufficient by themselves for the long-term survival of rainforest pigeons, and probably other frugivores, as they are too far apart and the latter do not sample the full ranges of plant communities.

The observations of pigeons in small isolated patches of rainforest and farmland and the broad seasonal movements between geographically dispersed forests indicate that they do not require continuous corridors of vegetation to move between habitat remnants. Remnant native vegetation, road verges, creek edges, and exotics on farmland provide "corridors of stepping stones" linking remnant patches with areas of continuous forest. Wompoo, rose-crowned, topknot and white-headed pigeons are able to use these remnants as stepping stones (*sensu* MacArthur and Wilson 1967) between larger areas of rainforest. Other rainforest birds in New South Wales are capable of locating or surviving in remnant native vegetation isolated by farmland and exotics (Howe *et al.* 1981). This reflects the historical pattern of fragmentation of rainforest patches among extensive eucalypt forests.

We do not know whether some species, such as the wompoo pigeon, will only move among remnants that are close. Remnants and degraded or exotic vegetation not only increase mobility of fruit pigeons, favouring gene flow, but they also provide food. The exotic camphor laurel is especially important in this respect. A reduction in size and number of stepping stones or their degradation by grazing, herbicides or fire would increase the distances between patches reducing the number of links between remnant rainforests. Any restriction of movement between remnants or reduction in shelter and food supply could be disproportionate to the area and number of remnants lost (Boecklen and Bell 1987).

Passage for migrants can be aided by retaining rainforest along gullies, stream banks, fencelines and road verges. Even degraded patches and gardens of exotics and native vegetation may provide continuity of habitat or stepping stones across agricultural land. The importance of exotics to the short-term survival of fruit pigeons in northeastern New South Wales should not be underestimated. Patches of camphor laurel and other fruit-bearing exotic species should be retained, until substantial links of native vegetation have been re-established.

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