The eastern rosella (*Platycercus eximius*) in New Zealand

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A B S T R A C T

New Zealand records of eastern rosella (*Platycercus eximius*) show introduced feral populations first establishing in Dunedin approximately 1910. Although the Otago population has remained relatively small and isolated, the North Island populations have increased and spread to encompass most of the island, including some ecologically important forest remnants. The progress of this spread is reviewed from Ornithological Society of New Zealand records. Work needs to be done to explore any niche overlap/competition between eastern rosella and New Zealand endemic parrots such as kakariki/ yellow-crowned parakeet (*Cyanoramphus auriceps*), red-crowned parakeet (*C. novaezelandiae*) and kaka (*Nestor meridionalis*), whether they are influencing the process of vegetative regeneration through their feeding behaviour, and whether they are competing with other species for food resources and nest sites. Trials carried out with cage-traps and lures would find the most effective and cost efficient method for possible rosella control/ removal. Various other aspects of eastern rosella behaviour are discussed that will enable informed management decisions to be made in relation to conservation of other species that may be affected adversely by eastern rosella.

Keywords: eastern rosella, *Platycercus eximius,* distribution, spread, ecological impact, trapping, lures.

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1. Introduction

Eastern rosella (*Platycercus eximius*) are endemic to south-eastern Australia. New Zealand records show introduced feral populations establishing in Dunedin approximately 1910, Auckland prior to 1920 (Thomson 1922), and Wellington in the 1960s (Heather & Robertson 1996). The source of these populations is likely to be from both accidental cage escapees and intentional releases. Records of these introductions include: 'A small shipment released from a ship off Otago Heads in c. 1910, after entry refused by Customs Dept' (Higgins 1999: 344), and approximately 12 birds escaping in Dunedin after their cage was destroyed in a gale (Hamel 1970).

While the Otago population has remained relatively small and isolated, the North Island populations have increased and spread to encompass most of the island. Higgins (1999) lists North Island eastern rosella records from: Northland, Auckland, Waikato, Coromandel Peninsula, Bay of Plenty, East Cape, Hawke's Bay, Wairarapa, Volcanic Plateau, Taranaki, Manawatu, and Wellington.

Comments from conservation managers and researchers indicate that populations have recently spread to some ecologically important forest remnants such as Pureora (H. Speed and T. Greene pers. comm.), Mapara (P. Bradfield and I. Flux pers. comm.) and Te Uruwera (J. Miles pers. comm.), while established populations are known from well monitored forest remnants such as Trounson and Bream Head in Northland (R. Pierce pers. comm).

This report addresses the following questions:

1. What is the current ecological information on eastern rosella, relevant to the New Zealand context?
2. What are the main ecological questions needing to be addressed in relation to possible impacts of eastern rosella from a conservation management perspective?

2. Literature review

2.1 NEW ZEALAND IN GENERAL

Despite the large temporal and spatial distribution of the eastern rosella in New Zealand, virtually no known research has been carried out on the potential ecological impacts that these birds place on New Zealand ecosystems.

Fleming (1944) wrote of the distribution of eastern rosella within the Auckland region, stating that they were 'still advancing' in the north. He put the range as Tauhoa, Wellsford, and Leigh in the north, and the suburbs of Auckland in the south, suggesting that a southerly spread might have been slowed by the closely settled Auckland isthmus. Fleming listed eastern rosella habitats as: native bush,

Pinus plantations, farming and orchard lands with frequent relics of bush or planted shelter belts, and gumlands.

Ssome aspects of the ecology of eastern rosella in the Northland region were summarised using public surveys and field observations (Fitzgibbon & Wairau 1999). The eastern rosella was seen as an opportunistic species, posing a risk to native birds through food competition and the health and regeneration of native vegetation through seed predation and foliage browse (Fitzgibbon & Wairau 1999).

Hamel (1970) discussed the possibility of eastern rosella hybridising with small populations of crimson rosella (*Platycercus elegans*) in Wellington and Dunedin. She concluded that any interbreeding was unproven, and even if it were to happen, there would be little taxonomic significance. Heather & Robertson (1996) estimated the wild population of crimson rosella in Wellington and Dunedin at probably fewer than 20 birds.

A report on wildlife values in the Northland region lists eastern rosella as the most common and widespread parrot in Northland. The potential was stated for eastern rosella to compete with the kakariki species for nest holes and food, and it was suggested that the decline of the yellow-crowned parakeet (*Cyanoramphus auriceps)* in some Northland forests during the 1950s to 1960s coincided with the approximate time that eastern rosella arrived in the region (Ogle 1983).

The *Handbook of Australian, New Zealand and Antarctic Birds* (Higgins 1999) summarises the known biology, ecology and geography of eastern rosella in both Australia (see also Section 2.2) and New Zealand.

They are known to be sedentary and gregarious, usually in pairs, but occasionally in groups up to 50 birds. Flocks are thought not to be cohesive, instead composed of smaller parties, pairs and individuals moving independently within a short-term flock.

Their habitats are listed as: open forests and woodlands and adjacent grassland, including partly cleared farmland; paddocks and cultivated crops and orchards; urban parks and gardens.

Eastern rosella are arboreal and terrestrial feeders. Feeding observations include: seeds of grasses, shrubs and trees; also fruits, buds, flowers, nectar, and insects and their larvae.

2.2 AUSTRALIAN LITERATURE

Despite the endemic status of eastern rosella in Australia, little published literature is available on these birds. Higgins (1999) summarises the information that is available prior to the late 1990s (see also Section 2.1).

In Australia, the main breeding season is thought to be from August to January – February. The eastern rosella is a cavity nester. Nesting sites are listed as: usually in hollow in limb, trunk, fallen log or stump of tree, in fence posts, nest-boxes; occasionally in other sites such as crevices in buildings and rabbit burrows (Higgins 1999).

Mean clutch size in Australia is 5.6, with eggs layed at 1- to 3-day intervals. Females incubate for a period of 18–22 days. Fledging time is around 30–33 days (Higgins 1999).

An extensive electronic database search has found no new literature since the publication of Higgins in 1999.

2.3 ORNITHOLOGICAL SOCIETY OF NEW ZEALAND RECORDS

A literature search was carried out on all eastern rosella observations cited within the Ornithological Society of New Zealand (OSNZ) journals, *New Zealand Bird Notes* and *Notornis* from 1944 through to 2000. This was done by searching the index pages, reading the Classified Summarised Notes (CSN), and reading through any literature that had possible reference to eastern rosella.

Every observation was recorded along with any relevant comments in tabular form (Appendix 1). Feeding records are shown in Appendix 2.

From the records in Appendix 1, two maps were produced comparing presence-absence distribution of eastern rosella from *The Atlas of Bird Distribution in New Zealand* (Bull et al. 1985) and the *Notornis* records from 1970 to 1980 (Fig. 1). These maps gauge the general accuracy of the journal observations compared to the more formalised distribution records within the OSNZ bird atlas scheme.

To show the temporal and spatial spread of eastern rosella in New Zealand, a series of six maps were produced (Figs 2–7). The first five of these maps cover ten-year intervals (1944–54; 1954–65; 1966–75; 1976–85; 1986–95), with the final map recording the latest five years of *Notornis* records (1996–2000).

2.4 MAP LIMITATIONS

Although these maps are not intended to be an absolute measure of eastern rosella population distribution and spread, it is hoped that they are indicative of general trends in the temporal and spatial distribution of these birds.

For the purpose of this discussion, certain limitations and assumptions should be stated. These are:

1. The quality and quantity of eastern rosella observation records is based on levels of effort and skill of the observers. For example, the work carried out by the Ornithological Society of New Zealand (OSNZ) is generally voluntary. Over the long period of time that these records have been collected, different people in different areas will have had more opportunity and motivation to make observations.
2. Records are more likely to be made in areas where observers live or visit regularly. For example, records are more likely to be made in Auckland City or Coromandel beaches than less accessible areas such as central Te Uruwera National Park.

Figure 1. Comparison of eastern rosella distribution (presence v. absence) between (left) *Notornis* records 1970–80 (vols 17–27) and (right) those for 1969–79 from *The Atlas of Bird Distribution in New Zealand* (Bull et al. 1985).

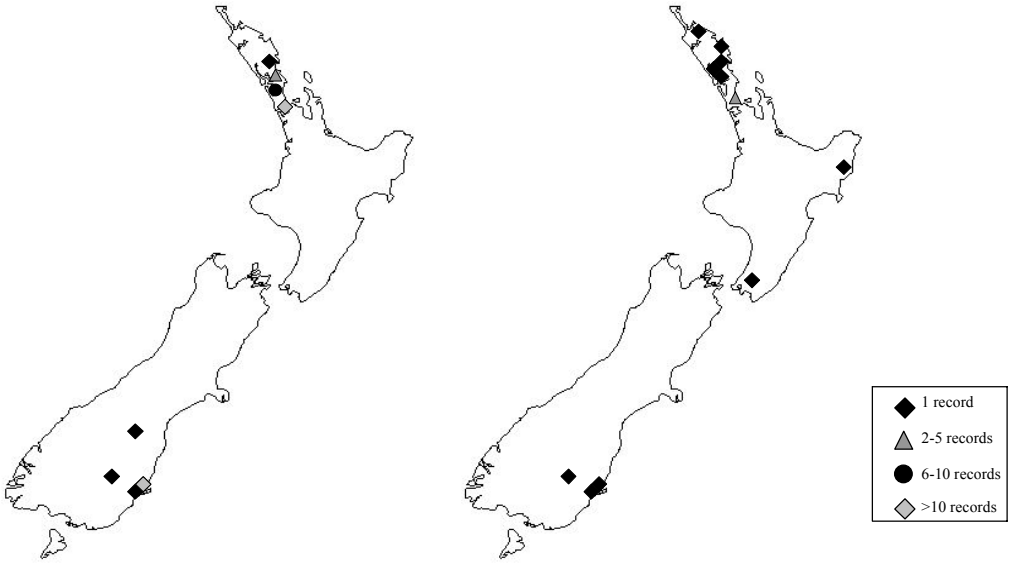

Figure 2. Records from *New Zealand Bird Notes* and *Notornis*, 1944–54 (vols 1–5).

Figure 3. Records from *Notornis*, 1954–65 (vols 6–12).

Figure 4. Records from *Notornis*, 1966–75 (vols 13–22).

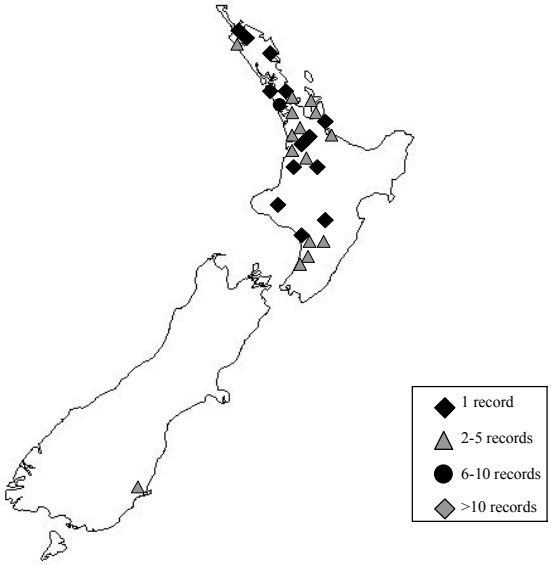

Figure 5. Records from *Notornis*, 1976–85 (vols 23–32).

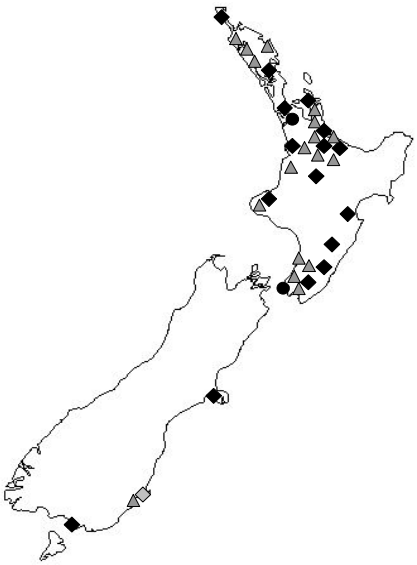

Figure 6. Records from *Notornis*, 1986–95 (vols 33–42).

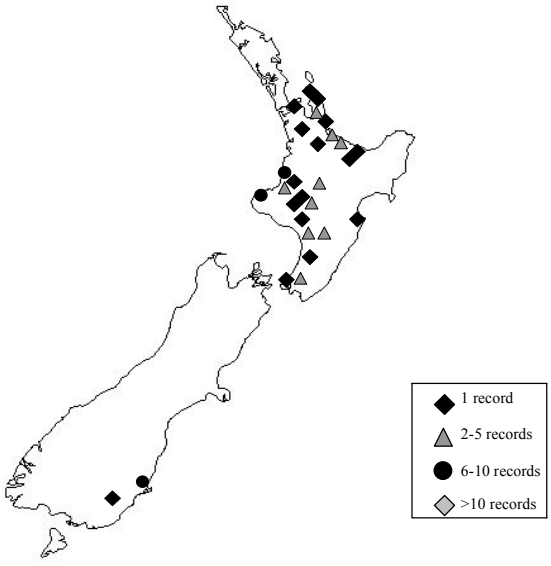

Figure 7. Records from *Notornis*, 1996–2000 (vols 43–47).
Note: only covers a five-year period.

3. It is assumed that there will be a general trend of a high ratio of casual observation records per bird present for a rare species, with the ratio declining as it becomes more common (i.e. it was assumed that the number of records for rare sightings was higher than the number of sightings for a well established population).

3. Results

3.1 COMPARISON OF JOURNAL RECORDS AND OSNZ BIRD ATLAS

Figure 1 indicates a similar pattern in eastern rosella distribution between the 1970–80 *Notornis* records and the 1969–79 bird atlas records. The main differences include:

The Atlas of Bird Distribution in New Zealand

- a wider distribution within the Northland, Auckland and Coromandel regions
- a record from Hauturu/Little Barrier
- observations in the Bay of Plenty, Gisborne region, the north-west edge of Lake Taupo, north-east of Stewart Island and inland Otago.

Notornis

- more observations in the western side of the central North Island, particularly in the Taranaki and Wanganui/Manawatu regions.

3.2 EASTERN ROSELLA DISTRIBUTION MAPS

Northland

Records indicate a general rapid spread in the eastern rosella population in Northland during the 1960s to 1970s (Figs 3, 4).

Fleming (1944) places Wellsford as the known northern limit. In 1950, a record of birds beginning to spread north of Wellsford/Leigh to Mangawhai/Kaiwaka appears, corresponding to the first record in the Whangarei region between 1952 and 1954 (*Notornis 6*). From this point on, various comments record this 'northward spread' (e.g. *Notornis 6*: 217).

Records from the 1970s include some of the larger forest blocks such as Waipoua and Puketi (Figs 4, 5), corresponding to five-minute bird counts in 1979 carried out by Pierce et al. (1993), recording eastern rosella at Raetea, Puketi, Mataraua, Russell, Omahuta and Waipoua forests.

Ogle (1983) maps eastern rosella distribution throughout the whole of Northland from around Houhora south, as does Bull et al. (1985).

The fact that no records exist for the period from 1996 to 2000 in Northland (Fig. 7) is unlikely to indicate a decline in eastern rosella population, but may be due to the commonality (pers. obs.) of these birds (refer above – limitation 3).

Auckland

Oliver in 1930 (from Fleming 1944) places the range of eastern rosella in Auckland as the Waitakere Ranges. By the mid 1940s, it had certainly spread to at least Warkworth/Wellsford in the north and Clevedon in the south. During 1975, the first sighting on Waiheke Island appears (Fig. 4) within 20 km of mid Coromandel Peninsula.

At present, eastern rosella appear common throughout the whole Auckland region (pers. obs).

Islands around Auckland

A small population of around 4–8 birds has been present on Tiritiri Matangi Island for a number of years, but does not appear to be increasing (S. Taylor and B. Walter pers. comm.)

Despite an observation of eastern rosella on Hauturu/Little Barrier in *The Atlas of Bird Distribution in New Zealand* (Bull et al. 1985), the island appears to be free of the species at present, as does Aotea/Great Barrier (T. Greene & H. Macgregor pers. comm.).

Eastern rosella have spread to most of the inner Hauraki Gulf islands such as Waiheke (*Notornis 22*) and Motutapu (pers. obs.).

Waikato

The first record of eastern rosella in the Waikato appeared at Waingaro in 1970 (Fig. 4), about 15 years after the movement of birds into Northland. From this time, the spread appears to be rapid.

Coromandel

Records appear at the southern end of the Coromandel Peninsula in 1975 (Fig. 4) corresponding to the spread through the Waikato. Within one year, records were appearing half way up the Peninsula as far north as Te Rerenga. By the mid-1980s, birds were recorded at Stony Bay on the northern tip of the Peninsula and the recently formed kiwi sanctuary at Moehau (Fig. 6). However, at present, eastern rosella appear to be uncommon in the reserve (J. Roxburgh pers. comm.).

Bay of Plenty

The first record in the Bay of Plenty appears in 1985 (Fig. 5) and shows a steady spread to the east and south. Recent comments observe that the Bay of Plenty population appears to be increasing (eg *Notornis 32*: 135).

Volcanic Plateau

Records for the Volcanic Plateau begin in the mid-1990s at Atiamuri (Fig. 7), and are still sparse.

Taranaki

The movement of eastern rosella into Taranaki first appears in 1972 (Figure 4), with sparse sightings until the mid 1980s. From this point steady increases in bird observations appear.

East Cape/Hawke's Bay

Sightings of eastern rosella in Gisborne are rare. They include; a record in 1954/56 (Fig. 3), a record in *The Atlas of Bird Distribution in New Zealand* (Bull et al.1985), and a recent sighting by Department of Conservation staff (J. Geritzlehner pers. comm.)

The first record from Hawke's Bay appeared in the CSN notes in 1989 at Puketiritiri with the comment: 'Species is new to HB as far as we know' (*Notornis 38*: 308) (Fig. 6). Since that time, one other sighting has been made at Hastings in 1998 (*Notornis 45*) (Fig. 7).

Manawatu/Wairarapa

Eastern rosella records first appear in the Manawatu and Wairarapa in the early 1970s (Fig. 4) corresponding to the probable establishment and spread of the Wellington population in the 1960s.

Wellington

The Wellington population appears to have become established during the 1960s (Fig. 3) and spread steadily northwards into the Manawatu and the Wairarapa.

Both Kapiti and Mana Islands appear to be free of eastern rosella (C. Miskelly pers. comm.)

Otago

Early records show eastern rosella around Dunedin from at least 1910, and well established by the 1930s (Hamel 1970). Early OSNZ records suggest a growing population, with sightings of 30–50 birds at one time in the 1940s to 1950s (*New Zealand Bird Notes 3*: 100, *Notornis 5*: 231). During this early period, the eastern rosella population appears to have been spreading across Otago (Fig. 2).

However, a marked drop in observations in the late 1950s to 1970s (Figs 3–5) indicates a possible sudden decline in population spread.

Canterbury and Southland

Sightings of single birds have been made at Lyttleton Harbour near Christchurch in 1989 (Fig. 6), Sandy Point near Invercargill in 1990 (Fig. 6), and Stewart Island in *The Atlas of Bird Distribution in New Zealand* (Bull et al. 1985). To date, no evidence exists within the records of any permanent populations forming in these areas.

4. Discussion

4.1 COMPARISON OF JOURNAL RECORDS AND OSNZ BIRD ATLAS

Despite the limitations of using the historical records from these journals (Scetion 2.4), the similarities between the journal records from 1976 to 1985 and the bird atlas records from 1969 to 1979 (Fig. 1) display sufficient similarity to support a general trend in spatial spread of eastern rosella in New Zealand (Figs 2–7).

Because *The Atlas of Bird Distribution in New Zealand* (Bull et al. 1985) only shows presence/absence, trends in eastern rosella abundance are unable to be determined.

4.2 EASTERN ROSELLA DISTRIBUTION MAPS

The maps (Figs 2–7) show a general expansion trend in the historic distribution of eastern rosella in the North Island.

The maps also indicate the formation of three distinct major populations in Auckland, Wellington and Dunedin. This notion of distinct population dispersal nodes is based on a spatial and temporal separateness and continuity of records in these three centres, and a low probability that birds will have dispersed the distances between centres (i.e. sightings of the same birds in Auckland and Wellington). These three sites are also listed in the existing literature (e.g. Heather & Robertson 1996, Higgins 1997). However, periodic individual sightings in remote areas, such as Lyttleton, Invercargill, and Stewart Island, suggest that releases have occurred in other parts of the country. Although there is no evidence to suggest that populations of eastern rosella have established at these localities, it is possible that these sightings may have originated from small populations outside the three main centres.

The following discussion is therefore based on the assumption that the New Zealand meta-population of eastern rosella has been derived from the three nodes of establishment, Auckland, Wellington and Dunedin.

Auckland population

A general progression in the spread of the Auckland eastern rosella population can be seen from the records to encompass the majority of the mid to upper North Island.

In the 1960s the population moved into Northland and within a decade had progressed northwards to cover the majority of the region.

The later occurrence of records in the Waikato (1970s) may back up Fleming's theory that the Auckland population was slowed from moving south by the closely settled Auckland Isthmus (Fleming 1944).

Following the colonisation of the Waikato, records show a steady spread of eastern rosella into Coromandel, the Bay of Plenty, and Taranaki.

The consecutive records of eastern rosella in mid Coromandel and Waiheke Island in 1975/76 are of interest. Although the records show that eastern rosella were more likely to have spread up the Coromandel Peninsula from the Waikato, the possibility that birds might have flown or been blown the 20 km over water between Waiheke and Coromandel could have implications for future research and management. The eastern rosella-free Hauturu/Little Barrier Island lies within 20 km from an established mainland population. If, therefore, eastern rosella were able and willing to fly this sort of distance over coastal water, as has been recorded for the smaller endemic yellow-crowned parakeet between the mainland and the Poor Knight Islands (Sagar 1988), these eastern rosella-free habitats may be at risk of invasion. However, one must ask why, if eastern rosella do fly this distance, they have not established there already. This question needs further investigation. At present, it may be that eastern rosella do not need to fly to these islands, as resources in relation to population size may be adequate for them to take the 'safe' alternative and continue to spread on the mainland. However, if this were the case, it is possible that in the future as the population of eastern rosella grows, it may be beneficial for some of these birds to look for alternative sites, such as offshore islands like Hauturu and Aotea.

During the early colonisation period in Taranaki, records are notably more frequent in the Waikato than Manawatu, so it is more likely that the Taranaki population is derived from the southward expansion from Auckland. If this is true, it is probable from the recent continuous records in the western North Island in Fig. 7, that the Wellington and Auckland populations have joined around Manawatu and Taranaki.

Sparse records from East Cape/Hawke's Bay and the Central Plateau indicate that eastern rosella may be only beginning to establish in these regions. It is unclear whence these populations are derived. The East Cape/Hawke's Bay birds may either have arrived from Auckland via the Bay of Plenty, Wellington via Wairarapa, or have established independently from escapes or releases. Birds in the Volcanic Plateau could also be from Auckland or Wellington, or a possible mixture of both from Taranaki/Manawatu.

Wellington population

The first *Notornis* records from Wellington during the early 1960s correspond to the population description by Heather & Robertson (1996) and Higgins (1999). The population appears to have spread rapidly northwards since its establishment and appears relatively common.

Otago population

The decline in Otago observations during the 1950s to 1970s corresponds to the population decrease noted by Hamel (1970), Heather & Robertson (1996), and Higgins (1999). Hamel (1970:126) attributed this probable decrease to: 'Rabbit poisoning with grain and strychnine is thought to be the most probable cause of

their decline, and steady trapping for local aviaries may also have been effective.'

Increased reports from the 1980s onward indicate a probable recovery in the eastern rosella population around Dunedin.

From this concept of three nodes of dispersal, a generalised map of eastern rosella spread is illustrated in Fig. 8. Due to the uncertainty of the origin of the Volcanic Plateau and East Cape/Hawke's Bay birds as described above, these areas of spread have been left off the map.

4.3 REASONS FOR POPULATION EXPANSION

From the available literature from Australian studies of eastern rosella, it would appear that land clearance, and supply of preferred foods (eg. grass seeds) have greatly benefited the spread of eastern rosella in New Zealand.

The climate of the North Island of New Zealand is not too dissimilar to that of the current natural southern mainland distribution of eastern rosella in Victoria, and the North Island population of this species is probably pre-acclimatised to Auckland and Wellington. It is hard to ascertain if the Otago population is limited by climatic conditions, due to the decline of the population following the poisoning of rabbits in the 1950s to 1960s. In Tasmania, the eastern rosella have shown large population decreases over the past one hundred years (Green 1983), while the mainland populations have increased (Higgins 1999). Thus, a cold climate may be detrimentally linked to eastern rosella population dynamics. It is possible that a cold climate may place stress on eastern rosella, and in synergy with some other agent of decline (e.g. rabbit poison, or interspecific competition) lead to a decrease in their populations.

Figure 8. Probable spread of three eastern rosella populations.

5. Research needed

5.1 IMPACTS OF EASTERN ROSELLA ON ECOSYSTEM STRUCTURE AND FUNCTION

1. Is there a direct issue of niche overlap/competition between eastern rosella and New Zealand endemic parrots such as kakariki/yellow-crowned parakeet (*Cyanoramphus auriceps*), red-crowned parakeet (*C. novaezelandiae*) and kaka (*Nestor meridionalis*)? All other questions of the impact of eastern rosella on ecosystem function and structure may be directly influenced by this question (e.g. if there is direct niche overlap, are eastern rosella only fulfilling a niche left vacant by localised extinctions of kakariki?).

   Are eastern rosella competing with these species for the same limited food resources and suitable nesting sites? If so:

   - What are the implications to future parrot reintroduction programmes?
   - What are the implications to areas with existing parrot populations?
   - If eastern rosella are occupying a general niche left empty by localised extinctions of parrot, what other differences in this species biology/ecology may potentially impact on New Zealand ecosystems? For example, will potential higher reproduction rates/breeding success in eastern rosella lead to higher and faster growing populations than that of kakariki (e.g. r-selected strategies), thus placing increased pressure on ecosystems that have adapted to kakariki ecology?

2. Are eastern rosella influencing the process of vegetative regeneration through their feeding behaviour?

   - Seed predation. Are eastern rosella destroying some/all seeds eaten, or are seeds able to be passed through the birds? In other words, are high numbers of eastern rosella in a forest impacting on certain tree species, and thus altering the forest structure?
   - Seed dispersal. If some/all seeds are passed through eastern rosella, what distances are seeds being spread? Are eastern rosella as efficient seed dispersers as certain endemic birds?
   - Cross-pollination. Puriri (*Vitex lucens*) flowers and nectar have been identified as a food source of eastern rosella (refer Appendix 1)—is the level of flower loss significant enough to impact on the pollination process of puriri?
   - Flower predation. If eastern rosella are taking the flowers of plant species such as puriri, what are the impacts on seed production of that plant?

3. What are the competition issues between eastern rosella and other endemic fauna?

   - What levels of pressure are eastern rosella placing on other species/guilds through direct competition for food resources (e.g. fruit for lizard species, nectar with birds and invertebrates)?
   - Does this impact indirectly through the food web (e.g. reduced lizard numbers through direct competition equals less food resources for raptors)?

- Do eastern rosella place potential competition pressure on cavity nesters such as kotare/kingfisher (*Halcyon sancta*) and hihi/stitchbird (*Notiomystis cincta*), and cavity roosters such as bat species?

4. What other forms of inter-specific impacts do eastern rosella place on endemic fauna? The rainbow lorikeet (*Trichoglossus haematodus*) has been identified as a potential threat to New Zealand endemic fauna through aggressive behaviour (T. Greene 1998 unpublished)—is this an issue with eastern rosella? Also is the possibility of aggression influenced by any flocking and breeding behaviour?

5.2 EASTERN ROSELLA CONTROL

1. Trials should be carried out to find the most effective and cost efficient method for possible rosella control/removal. This should be at a small scale (e.g. forest remnant) and be of use to community groups (i.e. cheap, low-tech).
   - Cage-type traps have been effective for rainbow lorikeet control by the Department of Conservation in Auckland (P. Keeling pers. comm). Trials of similar trap types could be carried out for eastern rosella. A good reference for trap design is Bub (1991).
   - Trials can be done of lures, such as live call birds (male and female), with different call recordings played back through amplified speakers, as well as food lures such as seeds and local foods that rosella are known to eat.
   - These trials could be carried out over different seasons/behavioural periods. For example, eastern rosella have been found to show increased levels of intra-specific aggressive behaviour during the breeding season, so are they more likely to respond to a live call bird/recording during this period?
2. If localised control/removal is to be successful, more information on eastern rosella home range and rates of immigration/emigration will be needed. For example, if birds are removed from a forest remnant, what is the likely speed of re-invasion from the surrounding population/s?
3. If the control of eastern rosella is for the re-introduction of endemic parrot species, is there a level of density that parrots need to reach to exclude eastern rosella from re-invading a habitat or will the management control of eastern rosella need to be ongoing?

5.3 ADDITIONAL RESEARCH

1. What is the ability of eastern rosella to travel distances over water? Many of New Zealand's offshore island sanctuaries lie close to areas where eastern rosella populations appear to be increasing and spreading (e.g. Kapiti, Mana (Wellington) and Hauturu/Little Barrier (Auckland)). Future management decisions may require greater knowledge on eastern rosella's ability to reach these islands.

2. How far into forest areas do eastern rosella move? According to Higgins (1999), eastern rosella's main forest habitat occurs at the edge of forest remnants, but birds have been seen up to 2 km within some forests. If birds are moving into forest areas, is this seasonal (e.g. for nesting sites)?

3. Management control of rainbow lorikeet has taught that some people in the community view colourful species such as eastern rosella as an asset to the New Zealand environment. It would be prudent for conservation managers/groups to research the general feeling of the community in an area where any control measures may be carried out.

4. The decline in population of many of New Zealand's hole-nesting bird species has been linked to mammalian predators (O'Donnell 1996). Why then are rosella still spreading, and what implications does this have to ecosystem management in New Zealand? Will predator control on offshore and mainland islands affect the population dynamics of eastern rosella?

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Appendix 1

ORNITHOLOGICAL SOCIETY OF NEW ZEALAND RECORDS OF EASTERN ROSELLA

Sources: **New Zealand Bird Notes 1–3* (1944–50); *Notornis 4–47* (1950–2000).

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
*1**	44-46	26	Warkworth	Auckland	
			Dunedin	Otago	
		60	Waitakerei Ranges	Auckland	All from Fleming (1944)
			Eastern suburbs	Auckland	'I have no reports from south of Manukau Harbour'
			Dairy Flat	Auckland	
			Kaukapakapa	Auckland	
			Tauhoa	Auckland	
			Wellsford	Auckland	
			Warkworth	Auckland	
			Leigh	Auckland	
		77	Dunedin City	Otago	
			Maori Hill	Otago	
		132	Clevedon	Auckland	
			Dunedin	Otago	'Appears to be spreading in suburbs of Dunedin'
*2**	46-48	49	Dunedin	Otago	
			Wakari	Otago	
		170	Dunedin	Otago	
			St Bathans	Otago	
*3**	48-50	100	Dunedin	Otago	
			Waipori	Otago	'c. 50 feeding in fields of ripening grain'
			Mount Allen	Otago	
			Maungatua	Otago	
		214	Warkworth	Auckland	
			Wakari	Otago	
			Waitati	Otago	
			Leith Valley	Otago	
			Maori Hill	Otago	
4	50-52	7	Rodney District	Auckland	"Beginning to spread north of Wellsford/Leigh to Mangawhai/ Kaiwaka"
		52	Bethell's Beach	Auckland	
			Pinehill	Otago	
			Woodside	Otago	
		190	Bethell's Beach	Auckland	
			Karekare	Auckland	
			Huia	Auckland	
			Orere	Auckland	
			Clevedon	Auckland	
			Dunedin City	Otago	
			Maori Hill	Otago	

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
5	52–54	98	Whangarei	Northland	
			Takapuna	Auckland	
			Dunedin	Otago	
		231	Remuera	Auckland	"First sighting in Remuera"
			Leith Valley, Dn	Otago	"Flock of c. 30 birds in Leith Valley"
6	54–56	102	Whangaparaoa	Auckland	
			Clevedon	Auckland	
			Michies Crossing	Otago	
			Waipori	Otago	
		207	Whangarei	Northland	"The northward spread continues"
			Gisborne	East Coast	
			Cave Creek	Otago	
8	58–60	211	Kaeo	Northland	
9	60–62	79	Whangaruru	Northland	"Still spreading northward"
			Parore	Northland	
			Whiteman's Valley	Wellington	
12	65	77	Tinopai – Kaipara	Northland	
17	70	126–129	Palmerston	Otago	"This range is not significantly different from that given by
			Waipori Flats	Otago	Oliver in 1955 but there has been a marked decrease in
			Waitati	Otago	numbers … Rabbit poisoning with grain and strychnine is
			Leith Saddle	Otago	thought to be the most probable cause of their decline, and
			Pigeon Flat	Otago	steady trapping for local aviaries may also have been
			Sawyers Bay	Otago	effective" (taken from Hamel 1970).
			Ross Creek	Otago	
			Whare Flat	Otago	
			Berwick	Otago	
			Waipori Falls	Otago	
			Woodside Glen	Otago	
		212	Waingaro	Waikato	Observed close to spotless crake (*Prozana tabuensis*) nest (no observed disturbance)
18	71	129	Mt Camel, Houhora	Northland	
19	72	359	Kohekohe	Northland	
			Awhitu	Auckland	
			Papakura	Auckland	
			Orere	Auckland	
			Moumoukai	Auckland	
			Leith Valley	Otago	Small number of birds (refer *Vol. 5;* 231)
	Supp.	64–65	Ngataki	Northland	
			Puketi	Northland	
			Omahuta	Northland	
			Waipoua	Northland	
			Woodhill	Auckland	
			Aotea	Waikato	"increasing in Waikato"
			Whatawhata	Waikato	
			Mt. Pirongia	Waikato	

(continued)

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
19 *(continued)*	Supp.	64–65	Hamilton	Waikato	
			Te Kowhai	Waikato	
			Tahora	Taranaki	
			New Plymouth	Taranaki	
			Makomako	Manawatu	
			Mt. Holdsworth	Wairarapa	
			Otaki	Wellington	"Tararuas, [sic] in the foothills at Otaki and elsewhere, reaching their limit at the confluence of Waikatikei and Hutt rivers"
			Whitemans Valley	Wellington	
			Dunedin	Otago	
			Ross Creek	Otago	
			Puketeraki	Otago	
20	73	369	Waipu	Northland	"Common in bush"
			Waiotira	Northland	
			Auckland	Auckland	
			Awhitu	Auckland	
			Aramiro	Waikato	
			Karakariki	Waikato	
			Wellington	Wellington	"Becoming more widely distributed in suburban areas around Wellington" "Present at entrance to Rimutaka Forest Park"
21	74	370	Waipu ('hills behind')	Northland	
			Tararua foothills	Wellington	Observed on the eastern side at the head of the Hutt Valley, and west at Reikorangi.
22	75	332	Pakotai	Northland	
			Maungatapere	Northland	
			Broadwood	Northland	
			Waiheke	Auckland	
			Awhitu	Auckland	
			Kaurenga Valley	Coromandel	
			Tairua	Coromandel	
			Mt Cargill	Otago	"Numbers of birds increasing"
			Silverstream	Wellington	
23	76	345	Wharekawa	Coromandel	"Apparent increase in Coromandel Peninsula"
			Coroglen	Coromandel	
			Te Mata Creek	Coromandel	
			Hikuai	Coromandel	
			Te Rerenga	Coromandel	
24	77	272	Hihi	Northland	
			Kohukohu	Northland	
			Paraparaumu	Wellington	
			Maungakotukutuku	Wellington	
26	79	110–15	Hunua Ranges	Auckland	"Small flocks occurring mostly about or near the bush edge, but seen throughout"
		416	Orere	Auckland	"Advancing in the Hunua and Colville ranges"
			Pirongia	Waikato	"In the Pirongia foothills, south to Oparau"
			Waipori Falls	Otago	

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
27	80	331	Levin	Manawatu	
28	81	77	Te Kuiti	Waikato	"continues to spread"
			Tararua Ranges	Wellington	
			Paekakariki	Wellington	
29	82	70	South Hokianga	Northland	
			Browns Bay	Auckland	
			South Auckland	Auckland	"Becoming more numerous in outer suburban areas, as well as scrubby edges of farmland and bush"
			Waihi	Coromandel	
30	83	61	Opuawhanga	Northland	
			Tahekeroa	Auckland	
			Oyster Point–Kaipara	Auckland	
			Waiheke	Auckland	
			Clevedon	Auckland	
			Waharau Reserve	Auckland	
			Ramarama	Auckland	
			Kaueranga Valley	Coromandel	
31	84	73	Hokianga	Northland	In mangroves.
			Mt William	Auckland	
			Puketui–Hikuai Valley	Coromandel	
			Ngaruawahia	Waikato	
			Rukuhia	Waikato	
			Kawhia	Waikato	
			Awaroa	Waikato	
			Te Kuiti	Waikato	
			Putara	Manawatu	
			Holdsworth	Wellington	
			Lake Ponui	Wellington	
			Paekakariki	Wellington	
			Mangaroa Valley	Wellington	
32	85	135	Auckland City	Auckland	
			Papakura	Auckland	"Becoming common in South Auckland"
			Karakariki	Waikato	
			Raglan	Waikato	
			Waitomo	Waikato	
			Bennydale	Waikato	
			Te Kuiti	Waikato	
			Ahuroa	Taranaki	
			Katikati	BOP	"Numbers increasing"
			Tuapiro	BOP	"Becoming more common"
			Pohangina Valley	Manawatu	
			Foxton	Manawatu	
			Levin	Manawatu	
			Berwick	Otago	
		149	Waipori	Otago	

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
33	86	115	Clevedon	Auckland	
			Papakura	Auckland	
			Stony Bay	Coromandel	
			Hamilton	Waikato	
			Levin	Manawatu	
		132	Dunedin	Otago	
34	87	142	Kaitaia	Northland	"Common on the reservoir hill throughout the year."
			Orere	Auckland	
			Papakura	Auckland	
			Mt Karioi	Waikato	
			Levin	Manawatu	
		162	Berwick Forest	Otago	
35	88	306	Awhitu	Auckland	
			Papakura	Auckland	"Increasing."
			Kaueranga Valley	Coromandel	
			Glen Massey to Kiritehere	Waikato	"Common in bush country."
			Gordonton	Waikato	
			Te Marua	Wellington	
			Wilton	Wellington	
36	89	85–86	Auckland Domain	Auckland	"R.A. Falla saw birds in late 1920s in Domain."
		218	Manurewa	Auckland	
				Waikato	"Waikato region, now widespread and still increasing."
			Tauranga	BOP	
		243	Lyttleton Harbour	Canterbury	Single bird observed.
			Whare Flat	Otago	
37	90	228	Kerikeri	Northland	
			Clevedon	Auckland	
			Papaaroha	Coromandel	
			Kaitake Ranges	Taranaki	
			Paraparaumu	Wellington	
			Plimmerton	Wellington	
			Sandy Point	Southland	
38	91	308	Wenderholm	Auckland	
			Whatipu	Auckland	
			Waihi	Coromandel	
			Tuapiru	BOP	
			Puketiritiri	Hawke's Bay	"Species is new to HB as far as we know"
			Highbury	Wellington	
39	92	202	Motuopao Island	Northland	
			Coromandel	Coromandel	
			Karapiro	Waikato	
			North Kaimai	Waikato	
			Waitawheta Stream	Waikato	
			New Plymouth	Taranaki	"First seen since 1989."
			Oakura	Taranaki	

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
			Uruti	Taranaki	
			Levin	Manawatu	
			Otaki Forks	Manawatu	
			Mt Bruce	Wairarapa	
			Kaitoke	Wairarapa	
			Heretaunga	Wellington	
			Waitati	Otago	
			Dunedin × 2	Otago	
			Waipori Gorge	Otago	
40	93	285	Raetea Forest	Northland	Five minute bird counts by Pierce et al. show eastern rosella present in these forests in 1979 and 1993.
			Omahuta Forest	Northland	
			Puketi Forest	Northland	
			Waipoa Forest	Northland	
			Mataraua Forest	Northland	
			Russell Forest	Northland	
41	94	42	Coroglen	Coromandel	
			Whitianga	Coromandel	
			Pureora	Waikato	
			Putaruru	Waikato	
			Tauranga	BOP	
			Kaharoa Forest	BOP	
			Oakura	Taranaki	
			Kaitake	Taranaki	
			Tararua Sth Crossing	Manawatu	
			Waikanae	Wellington	
			Days Bay	Wellington	
			Vogeltown	Wellington	
			Purakaunui	Otago	
			Waitati	Otago	
			Dunedin	Otago	
			Broad Bay	Otago	
		268	Hamilton	Waikato	"Still uncommon in city."
			Kaharoa	BOP	"First record for this region."
			New Plymouth	Taranaki	
			Foxton	Manawatu	
			Rangitumau	Wairarapa	
			Wellington	Wellington	
			Hutt Valley	Wellington	
42	95	170	Matamata	Waikato	
			Omokoroa	BOP	
			Te Puke	BOP	
			Kaharoa	BOP	
			Kukumoa	BOP	
			Levin	Manawatu	
			Mt Climie	Wellington	
			Dunedin × 3	Otago	
			Turnbull's Bay	Otago	

VOL	YEAR	PAGE	LOCATION	REGION	COMMENTS
43	96	139	Whangapoua	Coromandel	
			Opoutere	Coromandel	
			Pongakawa Valley	BOP	
			Kukumoa	BOP	
			Atiamuri	Volc. Plateau	
			Kimberly Scenic Res.	Manawatu	
			Upper Hutt	Wellington	
		182	Brooklyn	Otago	
			Dunedin × 4	Otago	
44	97	104	Oputere	Coromandel	
			Te Kouma	Coromandel	
			Whangamata	Coromandel	
			Taumaranui	Manawatu	"flocks of >30 in summer"
			Te Puke	BOP	
			Wellington	Wellington	
45	98	25	Dunedin × 3	Otago	
			Otago Peninsula × 2	Otago	
		211	Waingaro	Waikato	
			Hamilton	Waikato	
			Matahui Point	BOP	
			Te Puke	BOP	"Through year always in twos"
			Waitaanga Forest	Taranaki	
			Okato	Taranaki	
			Pukehou	Manawatu	
			Hastings	Hawke's Bay	
			Te Marua	Wellington	
		231	Mt Ruapehu	Volc. Plateau	"Two birds seen in beech forest."
			Waimarino Forest	Volc. Plateau	First records for both areas.
			Waitaanga × 2 obs	Taranaki	
			Makou	Taranaki	
			Mt Taranaki	Taranaki	
			Okato	Taranaki	
			Pohangina Valley	Manawatu	
			Feilding	Manawatu	
			Te Marua	Wellington	
47	00	211	Te Henga	Auckland	
			Ohauiti	BOP	
			Te Puke	BOP	"Increasing."
			Papamoa	BOP	"First for area."
			Rotoehu	Volc. Plateau	
			Mokau	Taranaki	
			Mohakatino	Taranaki	
			Waitaanga State Forest	Taranaki	
			Okato	Taranaki	
			Otaki		
		231	Mt Ruapehu	Volc. Plateau	
			Waimarino	Volc. Plateau	
			Waitaanga × 2	Taranaki	
			Mokau	Taranaki	
			Mt Taranaki	Taranaki	
			Okato	Taranaki	
			Pohangina Valley	Manawatu	
			Feilding	Manawatu	
			Te Marua	Wellington	

Appendix 2

ANECDOTAL OBSERVATIONS OF FOOD OF EASTERN ROSELLA IN NEW ZEALAND

Sources: *New Zealand Bird Notes* 1–3; *Notornis* 4–47; Fitzgibbon & Wairau 1999 (unpublished).

VEGETATIVE FOODS

Exotic		***Native***	
Thistle heads	*Cirsium*	Mangrove shoots	*Avicennia marina*
Gum tips	*Eucalyptus*	Flax seeds	*Phormium tenax*
Wattle shoots	*Acacia*	Totara fruits	*Podocarpus totara*
Oak buds	*Quercus*	Kahikatea fruits	*Dacrycarpus dacrydioides*
Apples	*Malus*	Rewarewa fruits	*Knightia excelsa*
Pears	*Pyrus*	Manuka	*Leptospermum scoparium*
Oranges	*Citrus*	Kanuka	*Kunzea ericoides*
Mandarins	*Citrus*	Puriri flowers	*Vitex lucens*
Hawthorn berries	*Crataegus*	Pohutukawa flowers	*Metrosideros excelsa*
Cotoneaster	*Cotoneaster*	Makomako fruit	*Aristotelia serrata*
Plantain seed	*Plantago*	Kotukutuku	*Fuchsia excorticata*
Gooseberries	*Ribes*	Tanekaha	*Phyllocladus trichomanoides*
Blackberries	*Rubus*	Five-finger seeds	*Pseudopanax* sp.
Raspberries	*Rubus*	Rimu fruit	*Dacrydium cupressinum*
Ragwort flowers	*Senecio*	Ti kouka fruit	*Cordyline australis*
Pine seeds	*Pinus*	Kauri seed	*Agathis australis*
Washingtonia	*Cryptomeria*		
Privet	*Ligustrum*		
Virgilia	*Virgilia*		
Poplar buds	*Populus*		
Willow buds	*Salix*		
Willow flowers	*Salix*		
Silver birch cones	*Betula*		
Groundsel flowers	*Senecio*		
Daisy flowers	*Bellis*		
Peach fruit	*Prunus*		
Nectarine fruit	*Prunus*		
Banana passionfruit	*Passiflora*		

INVERTEBRATE FOOD

Case moth
- females
- eggs
- contents of cases