

RANZ/DOC New Zealand falcon breeding survey 1994-98

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CONTENTS

Abstract	5
1. Introduction	6
2. Publicity	6
3. Responses	7
4. Results	8
4.1 Nest direction	9
4.2 Habitat	11
5. Prey	13
6. Discussion	13
6.1 Banding/radio telemetry	14
6.2 Threats	14
6.3 Advocacy	14
6.4 Reintroduction	15
7. Recommendations	15
8. Acknowledgements	15
Appendix 1	
New Zealand falcon survey form	16
Appendix 2	
New Zealand falcon data record form	17

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ABSTRACT

New Zealand falcon (*Falco novaeseelandiae*) nest sites were monitored throughout New Zealand (including those in conservation lands managed by the Department of Conservation, DOC) by people from DOC, the Raptor Association of New Zealand (RANZ), the Wingspan Bird of Prey Trust, Forest & Bird, and farmers. Twenty-eight nest sites were located and described, and surrounding habitat and proximity to human activity recorded. Breeding success was measured by counting the number of dependent juveniles soon after fledging. Ninety-two percent of pairs of the eastern falcon form fledged young compared with 60% of pairs of the bush falcon form. Eastern falcons fledged an average of 2.2 juveniles and bush falcons 1.4 juveniles per pair. Most eastern falcon nest sites were at ground level while most bush falcon nests were in epiphytes on emergent podocarps. The number of fledglings produced by bush falcon pairs was significantly influenced by the height of the nest above ground. Bush falcons preferred nest sites in trees on valley sides to those on ridges or the valley floor. Within 0.5 km of nest sites, unmodified habitat predominated for bush falcons but not for eastern falcons. Most nest sites for all falcons were found within 0.3 km of a track and within 8 km of human habitation. Future monitoring, advocacy and research of falcon are discussed.

Keywords: New Zealand falcon, nest, breeding success, habitat, juvenile, monitoring, threatened, endemic.

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1. Introduction

The survey was begun in 1994 following a discussion between Alan Saunders of The Department of Conservation (DOC) and members of the Raptor Association of New Zealand (RANZ) executive on the status of the New Zealand falcon (*Falco novaeseelandiae*). It was agreed that population trends of this threatened endemic species were not known.

It appears that the population of the eastern falcon form, which has been studied to a much greater extent than the bush form (Fig. 1), is at least stable and so emphasis was to be placed on monitoring the bush form to establish whether its population is declining, stable or increasing. It is possible that a decline in numbers of all forest birds (falcon prey) due to forest degradation and increases in predator pressure is causing a corresponding decline in falcon numbers. Predation of falcon nests by possums, stoats, cats and ferrets is another possible factor which could be affecting the population.

It was agreed that monitoring the survival and recruitment of falcon pairs at several sites (at least 3 pairs per conservancy) over a period of 5 years should indicate the current state of the population and would also indicate whether there is a need for a recovery plan or programme for the species.

2. Publicity

Nest record data sheets including methods for locating nests, identification sheets, public report forms, and a falcon photograph were sent to the DOC conservancies that agreed to participate in the survey: Auckland, Waikato, Bay of Plenty, East Coast/Hawkes Bay, Tongariro-Taupo, Wanganui, Wellington, Nelson-Marlborough, West Coast and Southland.

Figure 1. Bush falcon at its nest (on the ground).



Some conservancies carried out their own publicity with displays in field centres and newspaper releases.

The survey was advertised in 1994 and 1995 in 'Forest & Bird', the Ornithological Society of New Zealand (OSNZ) newsletter, 'New Zealand Farmer', the RANZ newsletter and 'Rod and Rifle'; which all requested that sightings of falcons be reported. RANZ and OSNZ regional representatives were contacted and asked for assistance. RANZ members gave talks to various groups and some local radios and newspapers publicised the survey.

3. Responses

For the first two years that the survey was advertised, records were kept of the groups of observers who responded to the survey. Most nests were reported by farmers, hunters and DOC employees (see Table 1).

Reports received from members of the public were classed as probable nest sites based on 'dive bomb' attacks, regular sightings of birds carrying prey to the same location, prey transfers between birds and presence of dependant juveniles in late summer-autumn (see Appendix 1).

TABLE 1. ORIGIN OF NEST SITE REPORTS.

OBSERVER	PROBABLE NEST SITES	
	1994/95	1995/96
Hunters	19	2
DOC	12	9
RANZ	5	4
Forest & Bird	4	1
Farmers	2	22
Others	5	15

These reports were sent on to the relevant DOC conservancies and RANZ members with dates, contacts and locations of nest sites so that they could be monitored and full data collected on the nest data forms provided (see Appendix 2).

From 1996 no further advertising was undertaken in journals or newspapers; however, RANZ members continued to maintain contact with deerstalkers and landowners.

Department of Conservation conservancies were sent reminders annually in early spring to monitor known nest sites and completed nest data forms were requested in winter.

Table 2 illustrates the distribution of reported nest sites from the public survey for the first 2 years throughout the conservancies, confirming the known distribution of falcons (excluding Stewart Island and the Coromandel Peninsula which were not included in the survey). Falcons are only rarely reported from Northland and Auckland and are not known to breed there.

TABLE 2. BISTRIBUTION OF NEST SITES.

CONSERVANCY	PROBABLE NEST SITES	
	1994/95	1995/96
Auckland	0	0
Waikato	2	4
Bay of Plenty	2	5
Tongariro/Taupo	3	11
East Coast/Hawkes Bay	3	3
Wanganui	3	5
Wellington	5	4
Nelson/Marlborough	15	7
West Coast	1	2
Canterbury	4	5
Otago	5	2
Southland	1	3

In 1996 it was decided to place the emphasis on locating and monitoring nest sites in those areas of DOC-managed land where there

were the most field staff because it had not been possible for DOC to monitor nest sites elsewhere. Wherever possible, RANZ members and others continued to monitor nest sites outside these areas.

Table 3 indicates the presence or absence of falcons on DOC-managed conservation land, whether monitored or not.

It is not known whether falcons are present or breeding in Rotoehu Forest, Toatoa Scenic Reserve or Okarito Forest.

Although falcons are known to be breeding in Mapara Wildlife Management Reserve, Waipapa Ecological Area and South Branch, Hurunui Mainland Island, they have not been monitored there. Falcons have been searched for in Boundary Stream Scenic Reserve but are not breeding there. Additionally, a pair of falcons was known to breed at Burwood Bush Takahe Release Area for at least 5 years prior to 1998, but have not been found there since.

TABLE 3. FALCONS ON DOC-MANAGED CONSERVATION LAND.

CONSERVANCY	CONSERVATION AREA	FALCON PRESENT	BREEDING
Waikato	Mapara Wildlife Management Reserve	✓	✓
Waikato	Waipapa Ecological Area	✓	✓
Waikato	Mangatutu Stream Valley	✓	✓
Bay of Plenty	Rotoehu Forest		
East Coast/Hawkes Bay	Toatoa Scenic Reserve		
East Coast/Hawkes Bay	Northern Te Urewera	✓	✓
East Coast/Hawkes Bay	Boundary Stream Scenic Reserve	✓	
Nelson/Marlborough	Rotoiti Nature Recovery Area	✓	✓
West Coast	Okarito Forest		
Nelson/Marlborough	Hurunui South Branch Mainland Island	✓	✓

4. Results

Nest data collected included a description of the site, surrounding habitat, number of chicks, number of fledglings and previous history of the site. For a full description of parameters see Appendix 2.

Key data to be collected included a description of the nest site, i.e. grid reference, aspect, height above ground, description of habitat < 0.5 km of site, < 5 km of site, proximity to human tracks/habitation and number of fledglings.

Some incomplete reports were received where only dependant juveniles were found, while in some other reports a nest was recorded but a second visit was not made to record fledglings.

The numbers of fledglings/nest/year for eastern and bush falcons are shown in Tables 4 and 5.

Overall success rate was 75% of pairs fledging at least one offspring. Eastern falcon nests were 92% successful compared with 60% for bush falcons. These estimates of success rates for nests are likely to be optimistic, as some nests which failed early in the breeding cycle would not be discovered.

Eastern falcons fledged a mean of 2.2 juveniles per pair compared with a mean of 1.4 juveniles per pair for bush falcons. There was no significant difference between numbers of juveniles fledged per nest for eastern pairs and bush pairs (Mann-Whitney Test: $P = 0.082$ adjusted for ties, $W = 181.0$). However, P is close to significance and, in future, if more nests are recorded, eastern falcons may prove to be more successful than bush falcons (Tables 4 & 5).

TABLE 4. NUMBER OF FLEDGLINGS/NEST/YEAR FOR EASTERN FALCONS.

LOCATION	OBSERVER	NEST SITE NUMBER	FLEDGLINGS/NEST				
			1994/95	1995/96	1996/97	1997/98	1998/99
Nelson Lakes	Farmer	1	2		2	2	1
Mt. Cook	RANZ	2	3	3	3		
Otago	RANZ	3		3			
Burwood Bush	DOC	4			3		
Lake Rotoiti	DOC	5					1
Lake Rotoiti	DOC	6					0
Lake Rotoiti	DOC	7					3
Lake Rotoroa	DOC	8					2

TABLE 5. NUMBER OF FLEDGLINGS/NEST/YEAR FOR BUSH FALCONS.

LOCATION	OBSERVER	NEST SITE NUMBER	FLEDGLING/NEST				
			1994/95	1995/96	1996/97	1997/98	1998/99
Taupo	Wingspan	9	0				
Takaka	DOC	10	0				
Mangatutu	RANZ	11			2		
Wellington	RANZ	12	2		0		
Wellington	RANZ/F&B	13				2	0
Wellington	RANZ	14					0
Upper Hutt	RANZ	15			4	2	3
Upper Hutt	RANZ	16					2
Cobb Valley	Photographer	17				2	0
Wairarapa	RANZ	18					2

4.1 NEST DIRECTION

Most nests (83%) faced between north and southeast, generally away from the prevailing weather (Fig. 2). There was no significant correlation between nest site direction and fledgling success (Kruskal-Wallis Test: d.f. = 3, $P = 0.396$).

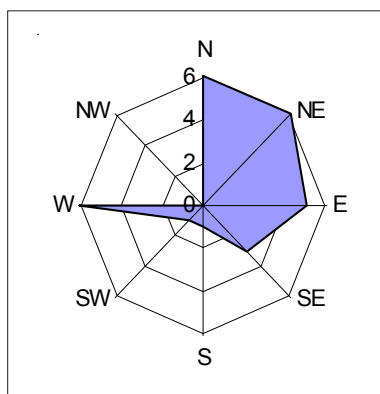


Figure 2. Direction faced by eastern and bush falcon sites combined.

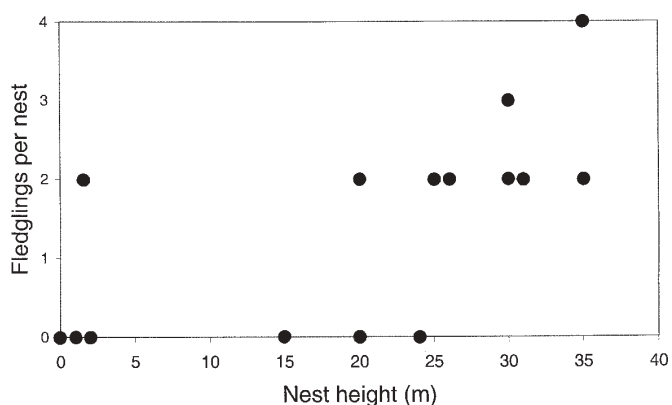
As expected, most eastern falcon nests were generally on the ground, (albeit commonly on steep sites) and bush falcon nests were generally in trees. Rimu (*Dacrydium cupressinum*) trees were favoured by bush falcons and nests in trees were found in epiphytes. No nests were recorded in beech (*Nothofagus* spp.) trees. Two bush falcon nest sites were recorded on the ground—one in beech forest and one in *Pinus radiata* plantation forest. The bush falcon site in beech forest was under a rock outcrop but the site in pine forest had no overhead shelter.

Eastern falcon nests were commonly up to 9 m high on rocky outcrops. In less steep locations eastern falcon nests were under logs or rock overhangs.

For bush falcons, numbers of fledglings produced was significantly influenced by the height of the nest above ground (Pearson Correlation = 0.605, $P = 0.009$) (Fig. 3).

This may be explained by nests at lower levels being more likely to be preyed on by possums and stoats.

Figure 3. Number of bush falcon fledglings produced per nest compared with height above ground.



Most sites (17/28) (Table 6) were on the sides of valleys where good views of the surroundings and opportunities for nest defense could be expected. Fledgling success from nests on valley sides was greater than for nests on valley floors (Kruskal-Wallis Test: d.f. = 2, $P = 0.016$ adjusted for ties). Nests on the valley floors may be more susceptible to predation because of predators using the valley floors as access routes, thus increasing the chance of contact with nest sites.

TABLE 6. NEST LOCATION COMPARED WITH FLEDGING SUCCESS FOR FALCONS.

NEST LOCATION	NUMBER OF NESTS	NUMBER OF FLEDGLINGS	MEAN NUMBER OF FLEDGLINGS/NEST
Ridge	3	5	1.67
Valley side	17	36	2.12
Valley floor	8	5	0.62

4.2 HABITAT

Habitat types were recorded within 0.5 km and 5 km radii of nest sites. These distances were chosen to obtain data on habitat requirements for breeding falcons within the maximum defended territory (0.5 km) and the approximate maximum hunting territory (5 km) they use (Tables 7 & 8).

Unmodified habitat within 0.5 km of nest sites formed a significantly greater proportion of the total habitat for bush falcons than eastern falcons (Mann-Whitney Test: $P = 0.031$ adjusted for ties, $W = 264.0$). It is generally known that eastern falcon territories are often in modified habitat.

Modified habitat, scrub and farmland proportions were not significantly different between bush and eastern falcon territories.

There was no significant difference in proportion of unmodified habitat between bush and eastern falcons within 5 km radii of nest sites (Mann-Whitney Test; $P = 0.315$ adjusted for ties, $W = 239.5$); nor was there any significant

TABLE 7. NUMBER OF NESTS AND PERCENTAGE OF HABITAT TYPE WITHIN 0.5 km RADIUS OF NEST FOR BUSH (B) (N=15) AND EASTERN (E) (N=13) FALCON FORMS.

HABITAT	FALCON TYPE	AMOUNT OF HABITAT TYPE WITHIN 0.05 km OF NEST				
		0-20%	21-40%	41-60%	61-80%	81-100%
Unmodified	B	2	0	0	4	9
	E	5	1	3	1	3
Modified	B	14	0	0	0	1
	E	12	1	0	0	0
Scrub	B	12	2	1	0	0
	E	9	2	2	0	0
Farmland	B	15	0	0	0	0
	E	9	3	1	0	0

TABLE 8. NUMBER OF NESTS AND PERCENTAGE OF HABITAT TYPE WITHIN 5 km RADIUS OF NEST FOR BUSH (B) (N=15) AND EASTERN (E) (N=13) FALCON FORMS.

HABITAT	FALCON TYPE	AMOUNT OF HABITAT TYPE WITHIN 5 km OF NEST				
		0-20%	21-40%	41-60%	61-80%	81-100%
Unmodified	B	2	0	10	2	1
	E	4	1	4	1	3
Modified	B	12	2	0	0	1
	E	12	1	0	0	0
Scrub	B	14	1	0	0	0
	E	7	3	1	2	0
Farmland	B	15	0	0	0	0
	E	8	5	0	0	0

difference for the remaining habitat types between bush and eastern falcons. This may indicate that bush falcons are able to form breeding and hunting territories which include modified habitat, but require unmodified habitat in the immediate vicinity of the nest, i.e. within 0.5 km.

This is supported by observations that bush falcons include a significant quantity of introduced passerines in their diet while breeding.

Most nest sites were within 0.3 km of a track or road and 8 km of human habitation (Figs 4 & 5). There was no significant correlation between numbers of juveniles fledged and distance to a track or road for bush falcons (Pearson Correlation = 0.373, $P = 0.209$) or for eastern falcons (Pearson Correlation = 0.050, $P = 0.859$). This suggests that falcons are sufficiently tolerant of human presence on tracks within the known nest defense area to breed successfully. However, the frequency of human use on tracks near sites was not measured. It has been reported that falcons are more defensive when nesting on the ground than in trees and this has been the experience of RANZ members. It is likely that more nests are found near tracks simply because they are easier to locate and so the proximity of nests to tracks is not representative of the falcon population as a whole.

Fledging dates were not recorded for all nests. Those that were recorded ranged from 25 November to 1 March with a median date of 15 January (Fig. 6).

Figure 4. Frequency of nest sites versus distance to a track or road.

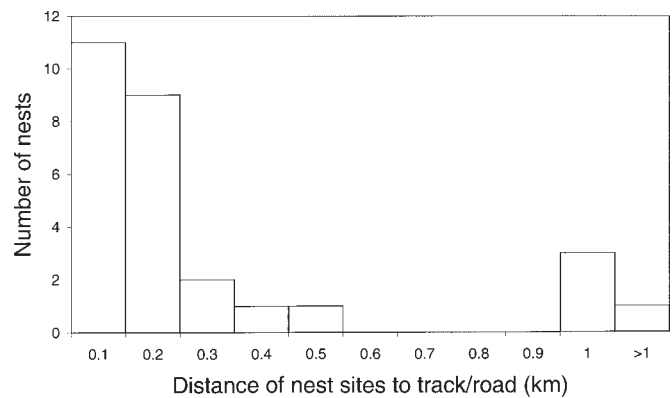


Figure 5. Frequency of nest sites versus distance to human habitation.

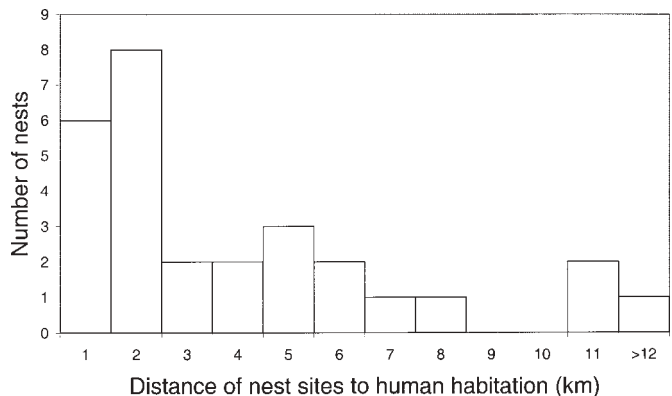
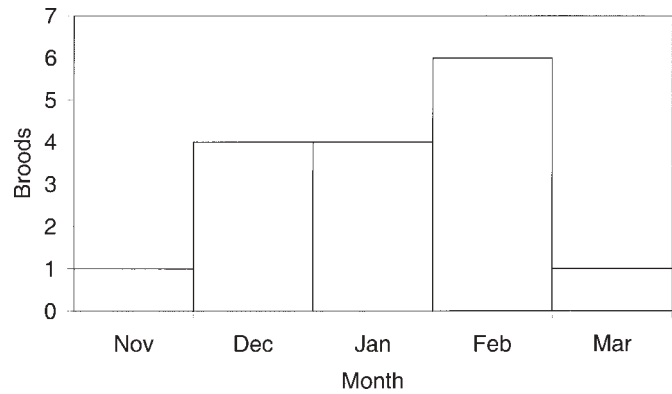


Figure 6. Fledging dates for eastern and bush falcon (N = 16).



5. Prey

Prey items were recorded from 7 nests and included the following native and introduced species:

Introduced

Chaffinch (*Fringilla coelabs*)
 Song thrush (*Turdus philomelos*)
 Blackbird (*Turdus merula*)
 House sparrow (*Passer domesticus*)
 Starling (*Sturnus vulgaris*)
 Greenfinch (*Carduelis chloris*)
 Mouse (*Mus musculus*)
 Rat (*Rattus* spp.)

Native

Bellbird (*Anthornis melanura*)
 Tomtit (*Petroica macrocephala*)
 Morepork (*Ninox novaeseelandiae*)

6. Discussion

The original aim of monitoring 3 nest sites per conservancy per year for a period of 5 years has not been achieved; however, a total of 6 sites nationally have been monitored for at least 2 years.

DOC-managed land where falcon sites are known but have not been monitored are: Mapara Wildlife Management Reserve, South Branch, Hurunui Mainland Island, Northern Te Urewera Mainland Restoration Project (partial report), and Waipapa Ecological Area.

DOC-managed land where falcons have not, as yet, been found breeding are Boundary Stream Scenic Reserve, Toatoa Scenic Reserve, Okarito Forest and Rotoehu Forest.

There are some regions where falcons are known to breed but which have not yet been monitored: Rotorua (monitoring planned), Gisborne (monitoring planned), Taranaki (monitoring planned), Volcanic Plateau, West Coast South Island and Central Otago. If some sites in the above regions were to be monitored this would give good coverage over most of New Zealand.

Falcons are apparently very rare on the Coromandel Peninsula and Stewart Island, and a public survey may be useful to determine the likelihood of their being present as a breeding species.

6.1 BANDING/RADIO TELEMETRY

Falcons in the Wellington region have been banded whenever possible and this has proved worthwhile, with reports of colour-banded juveniles from pigeon keepers and records of a pair banded in 1996 still breeding in 2000. Monitoring of banded birds can indicate pair fidelity and recruitment of juveniles into the adult population. Such long-term monitoring in intensively-managed areas, such as mainland islands, could provide useful information on the biology and behavior of falcons. The use of radio-telemetry to track falcons fitted with long-life transmitters could improve our knowledge on the dispersal of juveniles, hunting territories, and habitat use by adults and juveniles. In rugged hill country, however, it is likely to be difficult to obtain accurate fixes on falcons, particularly when they disperse after the breeding season.

6.2 THREATS

There is very little documentation of predation of falcon nests, other than a confirmed possum predation of eggs at a nest at Nelson Lakes. Video monitoring of sites, particularly those which have failed in the past, could yield valuable information.

Poisons used in pest control operations have the potential to enter the food chain, ultimately affecting falcons. Falcons, being wide-ranging predators, are useful bio-indicators of the environment and of the success of pest control operations for possums, mustelids, cats and rodents. The subsequent increase in numbers of all birds following pest control means that falcons should be more able to obtain sufficient prey to breed successfully, and the reduction in predators should lead to less predation of their eggs and chicks. Thus improved breeding of falcons is likely to be an indicator of an improvement in the health of their environment. Rodents appear in low numbers in falcon diets, so a decrease in rodent numbers in poisoned areas is unlikely to affect the breeding success of falcons. However, poisoned moribund rodents visible to falcons in daylight pose a risk to them through secondary poisoning. So far there is no evidence for breeding falcons being adversely affected by poisoning operations in their breeding territories.

6.3 ADVOCACY

Falcons are spectacular predators, leaving a lasting impression on the few members of the public fortunate enough to see them in the wild. Many New Zealanders are unaware of the existence of our endemic falcon and the species would benefit from some advocacy work, particularly at intensively managed

areas such as the mainland island sites. It should be possible to allow the public to view falcons at some nest sites from hides outside the defended area or by the use of video links.

6.4 REINTRODUCTION

It may be possible to introduce falcons to intensively managed areas where they are presently absent. Falcons have been successfully reintroduced to areas in other countries, and techniques learnt elsewhere with different species could be adapted for the New Zealand falcon.

7. Recommendations

1. Continue monitoring of existing nest sites.
2. Increase monitoring effort to include all mainland islands/intensively managed areas where falcons are present.
3. Falcons should be included as a key species to monitor if and when established in mainland islands/intensively managed areas.
4. Begin monitoring 2 nest sites in each of the following regions: Taranaki, Rotorua, Gisborne, Volcanic Plateau, West Coast South Island, and Central Otago.

The nest sites fully monitored so far have indicated trends in the relationships between data collected and breeding success, and possible differences in requirements for the two forms of falcon. More monitored sites and/or continued monitoring of existing sites should confirm whether these relationships are significant.

8. Acknowledgements

I would like to thank the Raptor Association members, Department of Conservation field officers, Wingspan Bird of Prey Trust, Forest and Bird Protection Society and members of the public who have contributed to the survey. I also thank Hugh Robertson and Ralph Powlesland for their comments on an earlier draft.

Appendix 1

NEW ZEALAND FALCON SURVEY FORM



Falcon Survey

A survey is presently underway to locate, and monitor the breeding success of, pairs of N.Z. falcon (Karearea, Sparrowhawk). This information will assist in determining the habitat preferences and population status (eg. are the numbers declining?) of this native bird.

Your assistance in completing this form would be greatly appreciated.

Please tick as appropriate:

1. Can you distinguish the N.Z. falcon from the harrier hawk? YES__ NO__
2. Have you sighted a N.Z. falcon in the past? YES__ NO__
3. During this sighting were you:
 - A. "divebombed" by the falcon(s)? YES__ NO__
 - did you: B. observe falcons regularly carrying prey to the same location? YES__ NO__
 - C. observe the transfer of prey between falcons? YES__ NO__
 - D. observe a group of two or more falcons at the same location during late summer-autumn? YES__ NO__

Name:

Contact telephone no.:

Location/approximate date of observations/additional comments:

Appendix 2

NEW ZEALAND FALCON DATA RECORD FORM

1. OBSERVER
 - a) Name
 - b) Address
 - c) Phone
2. LANDOWNER
 - a) Name
 - b) Address
 - c) Phone
3. NEST SITE
 - a) Locality
 - b) Map No
 - c) Grid reference
 - d) Tree Species.....Ground Cliff Slip
Other
 - e) Scrape site e.g. epiphyte
 - f) Height above ground.....m.
 - g) Aspect N S E W
 - h) Ridge top Valley side Valley floor
 - i) Proximity to human habitation.....km.
 - j) Proximity to track or road.....km.
 - k) Proximity to last years site (if known).....km.
4. HABITAT DESCRIPTION
 - a) Within 500 m of nest site

Unmodified forest	[%]
Modified forest	[%]
Scrub/shrubland	[%]
Farmland	[%]
Bluff	[%]
 - b) Between 500 m and 5 km radius of nest site

Unmodified forest	[%]
Modified forest	[%]
Scrub/shrubland	[%]
Farmland	[%]
Bluff	[%]

8. PREVIOUS HISTORY OF SITE

a) Unknown []

b) Known [] Comments e.g. breeding success etc.
.....
.....

9. Any dead falcons, chicks or addled eggs should be collected and sent to Noel Hyde.

10. Where permitted banders are available, an attempt should be made to trap and band adults and juveniles each year to obtain additional information on longevity, pair fidelity and population turnover.

For any queries contact Steve Lawrence,
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Upper Hutt.
Phone 04 5266818
or 04 5286089 (work)