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# A SURVEY OF CALIFORNIA QUAIL IN KAINGAROA STATE FOREST

**by**

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**by**

**Malcolm Harrison***

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## 1. THE OBJECTIVE

A review of gamebird research in New Zealand (Williams *et al.* 1983) highlighted an absence of any research on California quail for the best part of thirty years. Quail are, or could become, an important gamebird throughout New Zealand and that review identified several topics which warranted research if the potential of quail as a gamebird was to be realised.

It is well known that quail are found in many exotic forest plantations. These not only seem to provide suitable quail habitat but, because many are State owned, access if usually available to the public for the purposes of hunting. Exotic forestry if a rapidly expanding land use and by the nest century is likely to represent one of the principal wildlife habitats in New Zealand. The potential for an expansion of range and numbers of California quail in the wake of these forestry operations is therefore obvious.

But what are the features of exotic forest plantations to which California quail respond? This was one of the questions raised in the gamebird review and was considered to be of particular relevance for the future management of California quail as a gamebird in New Zealand.

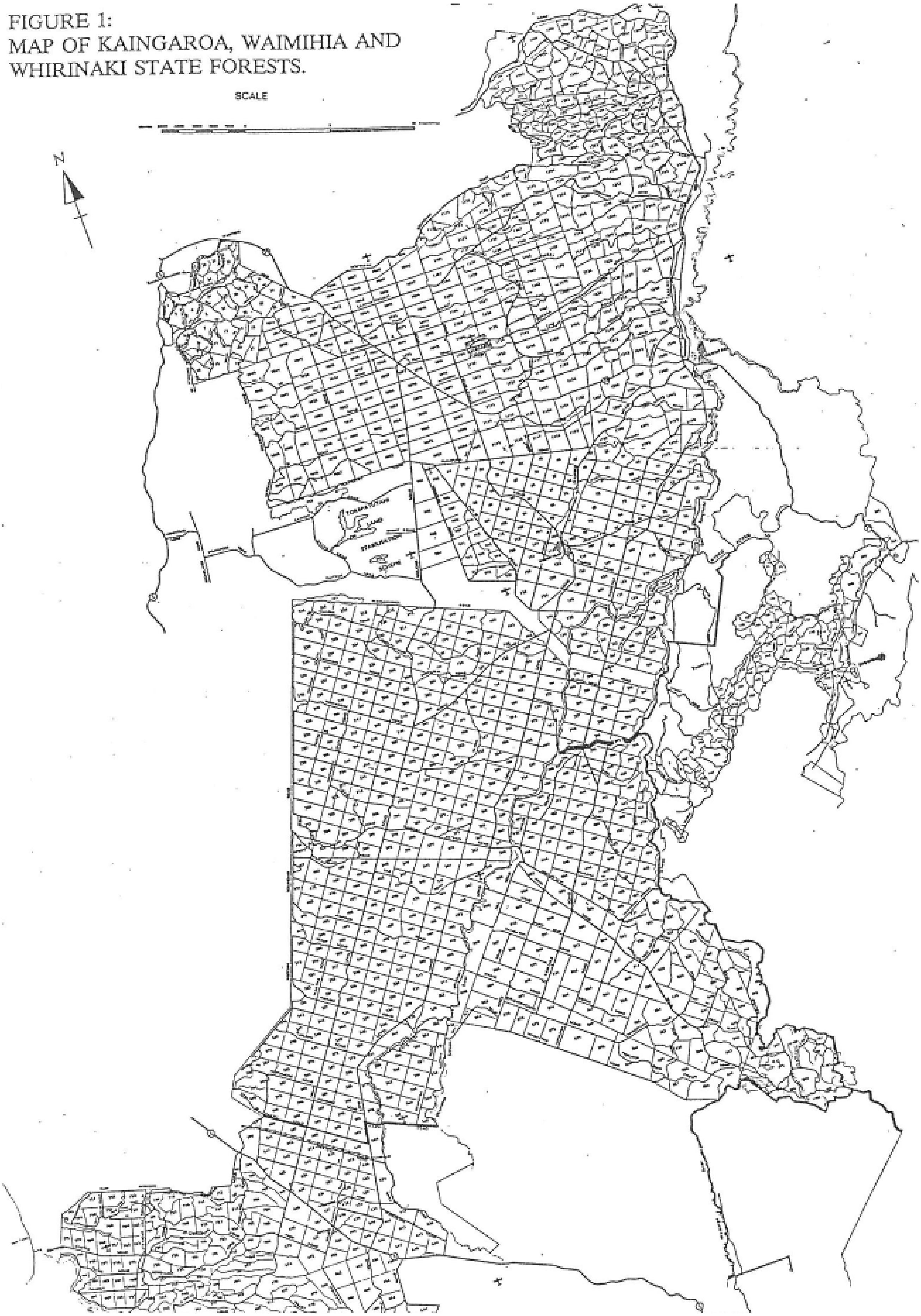
This study sought to take up and investigate this question using Kaingaroa State Forest as the venue and with two particular objectives:

1 to find where quail occurs throughout the forest

2 to determine what habitat features were important to quail.

* This report was presented at a California quail research and management seminar in Wellington, 17 October 1986 by the New Zealand Wildlife Service which is now part of the Department of Conservation.

FIGURE 1:
MAP OF KAINGAROA, WAIMIHIA AND WHIRINAKI STATE FORESTS.



## 2. KAINGAROA STATE FOREST

c.f. Fig 1. Kaingaroa State Forest is a very large man-made forest covering 138,000 ha. lying between latitudes 38° 15'S and 38° 48'S and longitudes 176° 15'E and 176° 46'E. Annual rainfall averages about 1500 mm and average daily temperatures range from a maximum of about 20°C to a minimum of about 8 °C in summer to a maximum of about 11 °C and a minimum of 2-3 °C in winter.

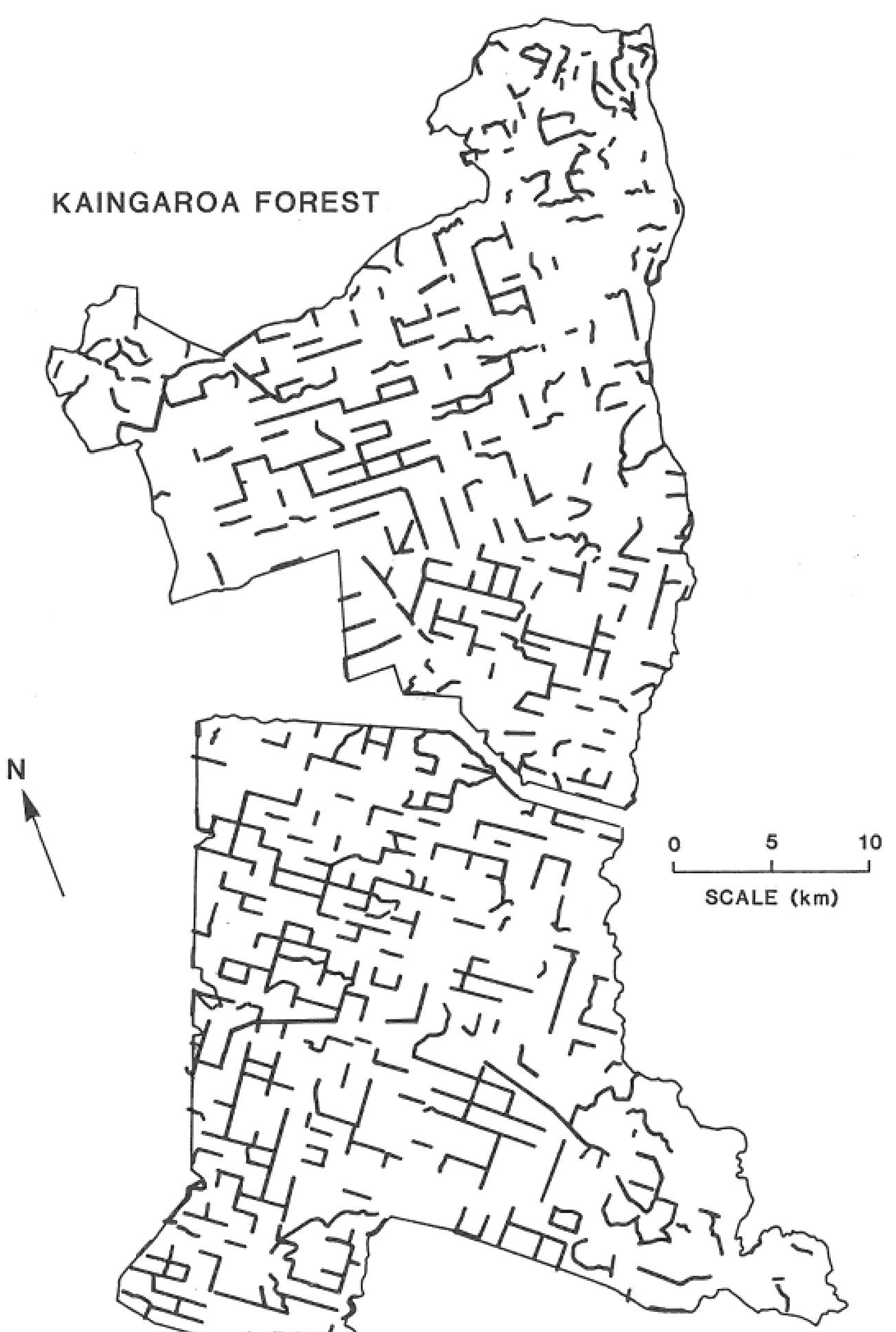
The altitude ranges from about 250m. (800 ft.) in the north-east to 730m. (2400 ft) in the south but these generalisations have local departures within these bounds. The forest is divided into about 1,400 compartments, usually rectangular in shape and typically measuring about 1.5 km by about 1 km. Compartment boundaries are normally a road of some type and these roads together with firebreaks and airstrips total about 13,000 ha. The forest has 23 species of trees under cultivation but is dominated by *Pinus radiata* and to a lesser extent by Douglas fir (*Pseudotsuga menziesii*). Other trees grown include 12 more species of *Pinus*, three of *Eucalyptus* and three of Larch (*Larix*).

Forestry operations have settled into a cycle of clear-felling, burning, pruning, thinning and then back to clear-felling. Added to these operations is the intermittent use of herbicides and fungicides as well as a variety of poisons to control rabbits and possums. The geographic pattern of these operations is not systematic but forms a seemingly random pattern throughout the matrix of compartments that makes up the forest - an important feature when considering the forest as habitat for quail. One compartment can be at one (or more) stage of the forestry cycle and each of its four (or eight) adjoining compartments may be at different stages of the cycle.

## 3. THE METHOD

It was felt that both of the study's objectives could be met by a single survey covering the whole of the forest. It was also felt that it would be safe to assume that any quail in "the vicinity" were very likely to use the roads or roadsides for dusting or to gather grit. Therefore, if the survey covered transects of roads the chances of detecting the presence of quail would probably be good, if not better, than transects of any other type. Road transects could be accurately located and they provided more quietly than ones in undergrowth and, therefore, afforded a much better chance of hearing calls or flushing birds as well as minimising scaring them. Also they could be easily and quickly sampled.

FIGURE 2: TOTAL SAMPLE DISTRIBUTION



## 4. THE DESIGN OF THE SURVEY

A survey of this type is always a compromise between collecting enough information to answer the required questions with acceptable precision and keeping costs to a minimum.

Factors included in the design calculations were an estimation of the number of coveys likely to be found, the acceptable level of precision which was 30% (i.e. a difference of 30% or greater would not be recognised as a difference but less than 30% would not be detected), the probability of being rained out during the survey period for one or more days or the whole survey period, the cost of getting the surveyors to and from the survey area and the daily cost of running the survey. The nett result of the equation was to find the combination that gave most information of acceptable quality for the least cost.

What was required to meet all these conditions was that 1,000 samples averaging 1 km each of roads throughout the forest be selected at random from a map and these samples be divided at random into five lots - each lot to be a day's sampling if the weather turned out fine enough. This approach ensured that should the weather change during the survey or if some survey days were lost altogether because of bad weather then the effect of the weather could be measured and taken into account or, at worst, there would still be a usefully large sample covering the whole forest. As expected not all the samples selected from the map proved valid when the site was visited and some samples were dropped because time ran out on a particular day. The final sample size realised was 801 but no days were lost because of bad weather. (Fig.2).

## 5. OBSERVER BRIEFING

All observers were either Acclimatisation Society or Wildlife Service officers. In order to take full advantage of the collective wit of more than twenty experienced field observers, most of whom had a deep interest in quail hunting and/or game management, they were subjected to a three day pre-survey briefing.

Firstly the forest was inspected so that observers could become familiar with the variety of habitat types that occurred, appreciate the general layout of the forest, and see the various forestry operations being carried out. The inspection also afforded an opportunity to hear quail calls and to elicit a response by using a quail caller, to see quail sign in all its forms.

This inspection was a precursor to the second stage of the briefing which was a full discussion of each and every type of item of information that would be collected during the survey. Agreement ensured that the method of recording information was the most appropriate to meet the objectives of the survey and that nothing of importance was omitted.

All observers were then subjected to practical training in data recording, categorisation of habitat features, distance and height estimation. Lastly, all observers were calibrated against each other until a uniform standard of data recording was attained.

## 6. INFORMATION COLLECTED - GENERAL

The information collected at each sample sire as of three types:

1) Information that identified the sample site and described the general condition

2) Information related to the presence of quail (this part had no relevance where quail were absent)

3) Habitat information.

6.1 Sample Site Information

**Sample number**. A unique number given to each sample site for the purposes of referencing during analysis
**Date**
**Observer.** The observer initials.
**Direction.** The direction of the road being sampled recorded to the nearest 10 degrees magnetic. In the case of curved roads the bearing of the initial part was recorded but an " X was marked in the last column to indicate that the road was a curved one.
**Start time.** New Zealand standard time recorded on the 24 hour system.
**Finish time**
**Left hand compartment number**. The number of the left hand compartment. All compartments in the forest have official numbers so not only do compartments numbers locate samples accurately but they also provide a reference to the silviculture history held in the forestry headquarters.
**Right hand compartment number** as above.
**Left hand compartment number.** A second compartment on one side of the road may occur where one compartment selected to be sampled adjoins two other compartments.
**Right hand compartment number** as above.
**Sun, Overcast, Rain/cloud**. Three mutually exclusive options:-
1 Sun shining.
2 Overcast but rain not likely.
3 Low cloud with rain threatening or actually raining.
**Calm, Windy.** Two mutually exclusive options categorised as calm when an observer would not seek shelter while taking a lunch break otherwise it would be windy. The categorisation would be influenced, and properly so, by the chill factor.
**Road surface**. Applies to the part used by vehicles.
1 Width in metres.
2 Type of surface, being one of the three mutually exclusive options that best applies - pumice, gravel or seal.

**Road Shoulders**. Applies to the edges of the road not normally driven on. Often it is different from the surface (especially in the case of sealed roads) in which case it was recorded as "gravel" or "pumice". Where it was little different from the road surface it was recorded as "none".
**Water**. Recorded as "permanent" or "temporary" when it was seen or heard and such categorisation could be reliable. When there was doubt about either of these categories it was recorded as "present". In cases where water was neither seen or heard but was very likely to be present as in the case of the bottom of a deep overgrown nearby gully it was recorded as "suspected".
**Traffic count.** The number of vehicles that passed along the sample road between the start time and the finish time.
**Sample Distance**. The distance in kilometres covered during the sample.
**Notes.** This allowed observers to record extraordinary information especially relevant to the sample site or sightings of cats or pheasants.

### 6.2 Information about quail (Fig.4)

The presence of quail was noted in three ways; seen, heard, or the recognition of sign. When quail were seen further information on their behaviour was gleaned by recording of just how they were seen.

When quail were first seen the activity of the majority was recorded in one, and one category from the following :-

**Flying** if they were seen actually in the air as opposed to:-
**Flushed** if they were first seen actually bursting-into flight.
**Running** if they were running or walking purposefully.
**Alert** if their heads were raised and they appeared ready to run or flush.
**Feeding** self explanatory.
**Resting** self explanatory.
**Dusting** self explanatory.

Whenever quail were seen the site of where the majority was first seen was recorded as one and only one of:-

-On the road
-On the road verge.
-In a compartment (in which case the compartment number was recorded.)

As for activity the location applies to the majority of the group observed.

**Covey size** was estimated and recorded only when quail were seen.

Calls are often the only indication of the presence of quail. Each observer was issued with a quail caller and these were used on all example sites where quail were neither seen or heard calling spontaneously beforehand. Any calls were recorded as "near" if they could be located within a particular compartment, in which case the compartment number was recorded.

Figure 5 HABITAT INFORMATION

| | SITE 1 | | SITE 2 | | SITE 3 | |
|---|---|---|---|---|---|---|
| | LHS | RHS | LHS | RHS | LHS | RHS |
| Undergrowth | | | | | | |
| Tree height | | | | | | |
| Species | | | | | | |
| Verge width | | | | | | |
| Verge type | | | | | | |
| (mid) | | | | | | |
| (roadside) | | | | | | |
| Amt.cover | | | | | | |
| (mid.) | | | | | | |
| (roadside) | | | | | | |
| Height cover | | | | | | |
| (mid) | | | | | | |
| (roadside) | | | | | | |
| Shoulder hgt. | | | | | | |
| Most typical site | | | | | | |

Figure 4 QUAIL INFORMATION

Quail seen: Flying

Flushed Running Alert

Feeding Resting Dusting

First seen:– on road on verge

in compt No. Covey size

Calls:– near distant spontaneous

in response compt. No.

Sign:– footprints dustings

droppings feathers

Please map exact spot

Notes:–

Figure 3 SAMPLE SITE INFORMATION

Sample No. Date

Observer Direction

Start time Finish time

LH Compt. RH Compt.

LH Compt. RH Compt.

Sun Overcast Cloud/rain

Calm Windy

Road surface:– width(mtrs.)

pumice gravel seal

Road shoulders:–

none pumice gravel

Water:– seen suspected

Traffic count Sample distance (km)

Notes

If calls could not be located to within a particular compartment they were recorded as **distant**.

All calls, whether near or distant were either **spontaneous** or **in response** to the use of a caller, and were recorded as one and only one of those two options.

Signs were recorded as one of, or a combination of, any of the following: **footprints, dustings, droppings,** or **feathers**.

Finally, if quail presence was detected the exact location was mapped as either a sighting, when they had seen or heard, or as sign if they had only been detected by the presence of footprints, dustings, droppings or feathers.

### 6.3 Habitat information (Fig.5)

Within a single sample, usually between 0.5 km and 1.5 km, it could be expected that the roadside vegetation association and/or the tree species or age could change. In some cases the change would be virtually unnoticeable but in others it could be quite dramatic. During the pre-survey briefing the criteria for recording such changes were standardised as far as possible but it was still left to the discretion of individual observers to record changes considered likely to influence quail presence. In general only where tree species, tree age, verge vegetation or verge width changed substantially was a change in habitat recorded as an additional site. Provision was made on the data recording forms for up to three different sites to be recorded under one sample.

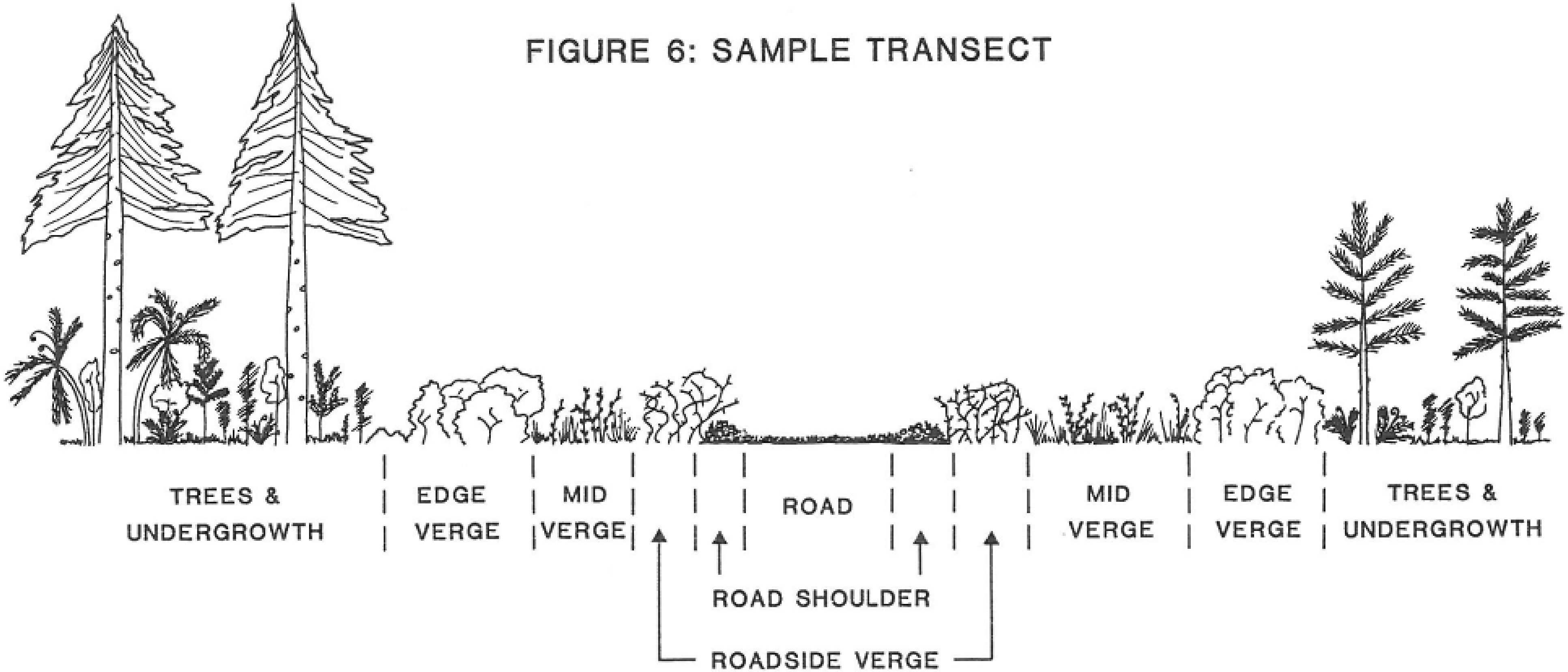
Habitat data were recorded from each of the zones identified along a transect that ran from within the compartment on one side of the road typically through a usually narrow band of verge vegetation under the shelter of the trees, out across a usually wider band of verge that may have a function as a fire-break, across a narrower band of vegetation immediately next to the road where fire-break machinery could not operate without the danger of collapsing the roadside bank, across the road and through the three verge zones and into the compartment on the opposite side. The zones identified (see Fig. 6) not only have different vegetation types but also differ in the amount of cover and the height of vegetation.

The height of the trees was recorded in metres.

The tree species were recorded from the following:-

*Pinus radiata*
*Pinus* species
Douglas fir
Eucalyptus species
Clear-felled
Mixed
Larch
Other

FIGURE 6: SAMPLE TRANSECT



The verge width was recorded in metres.

Both the undergrowth and the types of the three verge zones were selected as one or two from the following:-

**Bare ground**
**Slash** being branches from pruned trees, thinned trees, or debris left after logging operation.
**Grass and/or weeds**
**Mixed shrubs** which included usually natives such as Tutu (Coriaria spp.) and *Coprosma* spp.
**Frost flat** a typical Draccophyllum/grass combination.
**Exotics** usually self sown crop species recognised by their different age or species from the main compartment crop.
**Blackberry/bracken** a texture of dense interwoven branches affording dense cover.
**Buddleia** an exotic non-crop plant common on the roadsides.
**Pampas**
**Broom/lupin**
**Heather/manuka**

One or two from this list were selected to best describe the verge vegetation in each of the three zones. When two were recorded the more dominant of the two was indicated.

Amount of cover was selected for each zone, for each site and for each side

**Bare** no plants up to 10% cover.
**Light** from 10% up to 50% cover
**Moderate** more than 50% cover but not complete cover.
**Dense** complete cover

Height of cover was recorded for each of the sites, zones and sides selected from five categories.

**Bare**
**Less** than 10 cm.
**More** than 10 cm but less than 30 cm (too tall to see quail).
**More** than 30 cm but less than 2 metres.
**More** than 2 metres.

Shoulder height, being the height of the road above or below the verge in metres was recorded at each site on each side. Where more than one site was recorded the most typical site was indicated.

## 7. RESULTS

### 7.1 Quail detection

Quail were recorded as present, or recently present, at 229 sample sites (29%) of the 802 surveyed. Quail were actually sighted at 70 (31%), heard calling at 56 (24%), and quail sign was recorded at 155 (68%) of these 229 sample sites.

Not surprisingly more than one indicator of quail presence was recorded at many sample sites. Quail were both seen and heard at 12 sample sites, seen and their sign recorded at 15 sample sites, heard and their sign recorded at 13 sample sites and they were heard, seen and their sign recorded at six sample sites.

Of the 70 samples where quail were seen the activity of the majority of the "covey" at the moment when they were first seen was recorded.

41 were flushing
11 were running
6 were resting
4 were feeding
4 were flying
4 were alert
0 was dusting

Of the 41 coveys that were flushing 19 did so from within a compartment, 21 from a road verge and one from the road. Of the 11 coveys that were first seen running two were on road verges, six on the road itself and three in compartments.

Of the 70 samples where quail were seen the location of the majority of the "covey" when they were first seen was recorded.

9 (13%) were first seen on the road.
27 (39%) were first seen on the verge.
34 (49%) were first seen in a compartment.

Calls were recorded as near when they could be located to within a particular compartment otherwise they were recorded as distant. Calls were further categorised as either spontaneous or as in response to the use of a quail caller. Not all observers recorded all these details however.

Of 46 samples where quail calls were recorded together with spontaneity information, 15 (33%) were spontaneous and 30 (67%) were in response to the use of a caller.

Sign was recorded at 155 sample sites:

140 sites (90%) had footprints of which 116 (74%) had footprints only.
37 sites (23%) had dustings of which 13 (8%) had dustings only.
3 sites (2%) had feathers of which none had feathers only.
2 (1%) had droppings one of which was droppings only.

### 7.1.1 Implications for hunters

Any hunter wishing to interpret these figures so as to enhance their chances of finding quail would do well to remember the methods employed by the observers on this survey. Firstly they walked down the roads, usually with a dog, which greatly increased their chances of flushing quail that would not normally be seen. Secondly, because they were walking quietly down the roads they could hear quail that could not be heard from within a vehicle.

A hunter driving around the forest looking for quail could be expected to see all the quail which were on the road, most of the quail which were on the verges and only some of the quail within the compartments. Such a hunter could not be expected to hear quail nor see sign of quail. Assuming that this survey was 100% effective in detecting quail whenever they were present a comparison with the hunter driving around the forest looking for quail shows interesting differences. A "drive around survey" would have seen the nine (13%) quail coveys which were on the road, most of the 27 (39%) which were on the verges, (say 20) and some of the 34 (49%) seen in the compartments (say 15). In total about 44 coveys would have been seen which is 63% of what could have been seen by walking. Walking takes a lot longer than driving to cover the same distance and to sight quail would not be an efficient method. However, quail seen represented only 31% of the detections and so a hunter who drives represented only 31% of the detections and so a hunter who drives around could only expect to see about 20% of the quail actually there. If however, a hunter were to stop every 500-1000 metres and listen most of the spontaneous calls could be detected and most of the 'response' calls would also; providing, of course, that a caller was used. Stopping in this manner could be expected to increase detection from about 20% to more than 30% of what is actually there. Perhaps not so useful to a hunter is the detection of sign , as sign does not necessarily indicate that the quarry is nearby but does indicate that more intense use of a caller in the vicinity would be worthwhile and if that does not locate them then perhaps a subsequent visit would.

## 7.2 Distribution

The location of all sign and sightings were mapped (Fig. 7) which showed that in general quail occurred throughout the forest. The widely-held belief that quail were scarce in the southern half of the forest cannot be supported by the results of this survey.

Local concentrations and absences are subjects meriting some careful attention before further conclusions can be drawn from the recorded distribution. A simple count of coveys seen or records of sign cannot be interpreted as an indication of quail abundance especially, but not only, in the case of sign, more than one record could originate from a single covey. A further question of what is a covey and what is a group of quail from a covey separated by a certain distance was raised by the observation of groups of several quail separated by about 200 m. Depending on whether these quail were from the same or a different covey they could be described as far apart or close together. To better understand the distribution of quail throughout the forest some rationalisation of inter-record distances was required. Therefore the distance of each and every record was measured to each and every other record and a frequency diagram of these distances was plotted (Fig. 8). Normally such a plot would show a steady increase in frequency with increasing inter-record distance. However, in this case there were more than expected inter-record distances of between about 400 m and about 1500 m. These 'extras' can be explained as the inclusion of distances between records of the same covey. As the inter-record distance increases to about 1500 m these extras no longer appear indicating that 1500 m is about the limit of a covey's radius of movement. Most of the inter-record distances of 1 km or less almost certainly are from the same "covey" whether they were sightings sign or both. Most of the inter-record distances of 1.7 km or greater almost certainly are from sightings, sign or both from different "coveys".

If a distance of between 1 to 1.7 km separates inter-and intro-covey distances such a distance could be interpreted as a generalised radius of a home range. Such a radius does not allow for irregularly shaped home ranges but is very much an average and stylised home range.

If a circle of 1.5 km radius is scribed about each sighting these stylised home ranges overlap, producing a map in which the few "holes" and "gaps" take on a new significance (Fig. 7). A reliable explanation of these "gaps" in the distribution of quail will require additional and specific work, but at first sight it suggests that quail may occur more widely throughout the forest than the plotted sightings and sign suggest.

### 7.3 The effect of the presence of water

The presence of water at each sample site was recorded as one of either permanent, temporary, suspected, or present.

As Kaingaroa is a commercial timber production forest a fire fighting water supply is required at regularly spaced intervals. In areas where rivers or other copious and reliable supplies of water are not available, or are inaccessible, fire ponds have been built. Quail, however, do not need large quantities of water but do require a permanent water supply. Therefore the categorisation of either permanent or temporary was based on whether or not the water supply could be relied upon to be present at all times. It is conceivable that a 'temporary' water supply could, in many cases, provide a continuous supply of water for quail since a mere seepage is all they require and an accurate judgement of this all important **last drop** is impossible.

In some cases water was neither seen nor heard but its presence was judged to be very likely in which case it was recorded as suspected.

The proportion of samples with quail present has been plotted for each type of water (Fig. 9) and to provide a basis for comparison so too has the survey average. Whereas 29% of the full survey's samples had quail or sign. The estimate of the proportions with quail or sign have different bounds depending on the number of samples which were appropriate for

FIGURE 7: CALIFORNIA QUAIL DISTRIBUTION BASED ON NOMINAL HOME RANGE

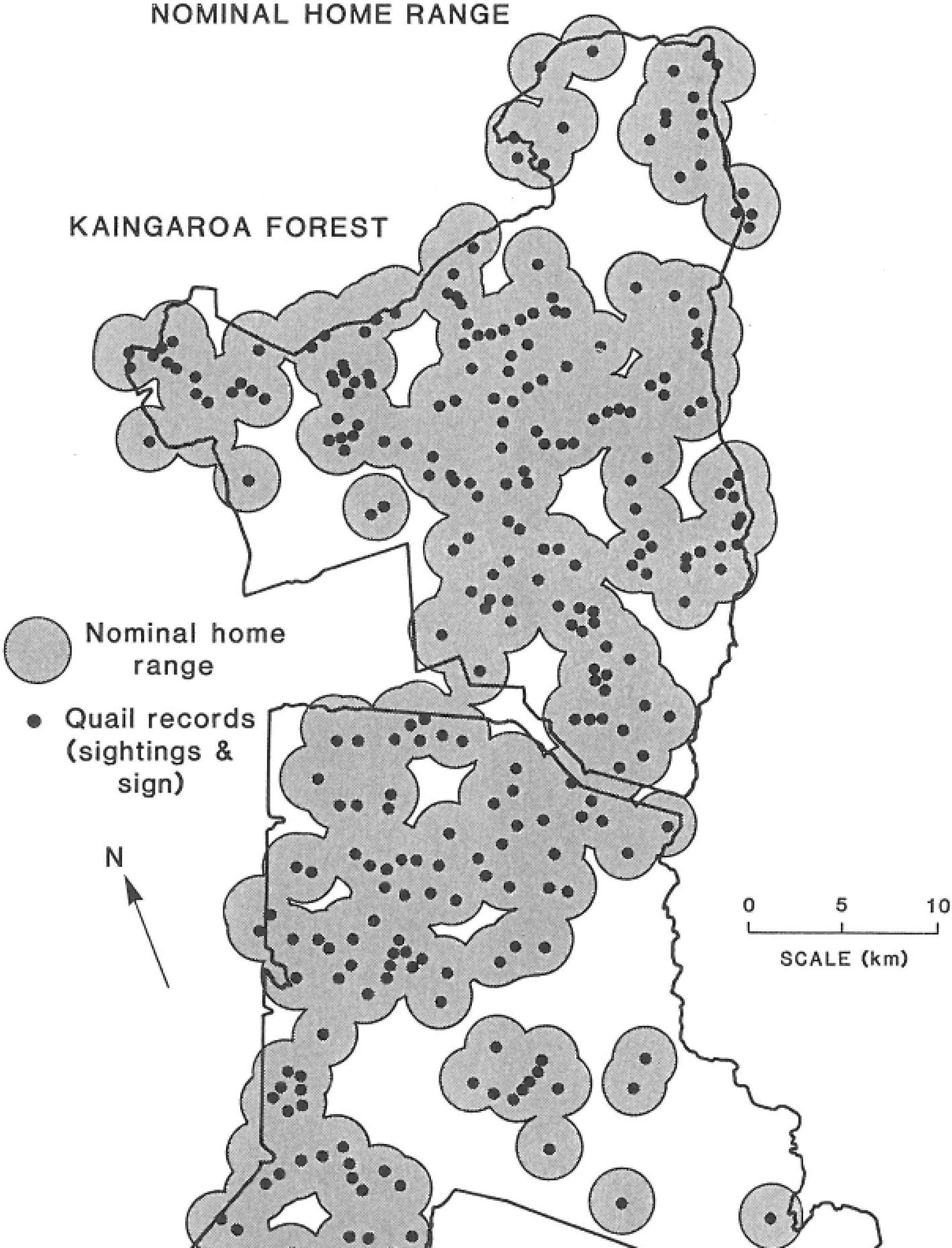


Figure 8

FREQUENCY DISTRIBUTION OF INTER-RECORD DISTANCES

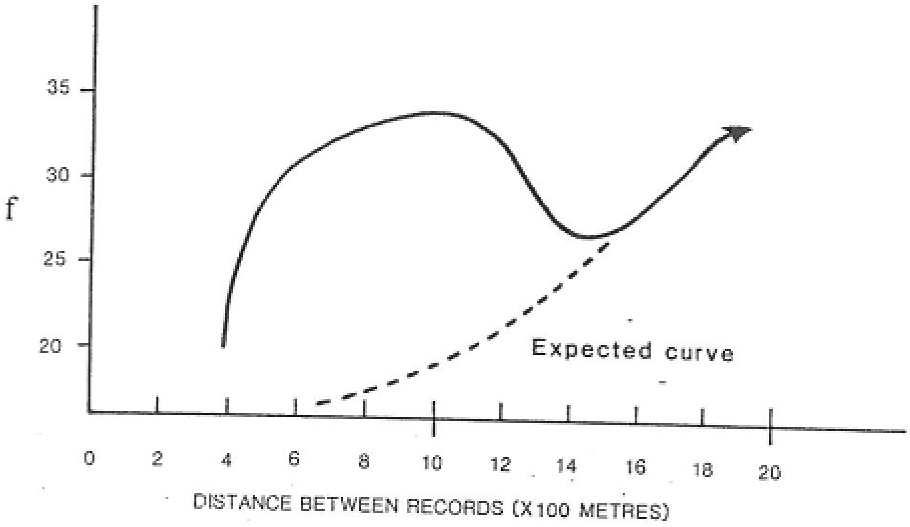
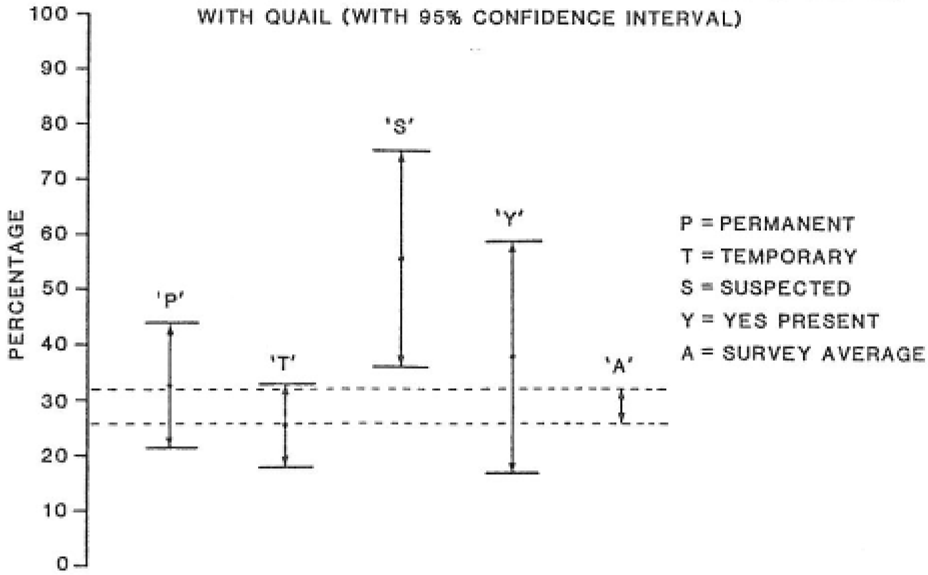



FIGURE 9: EFFECT OF WATER : ESTIMATED PROPORTION OF SAMPLES WITH QUAIL (WITH 95% CONFIDENCE INTERVAL)



analysis. The bounds shown include 95% of likely outcomes. It is very obvious from Fig. 9 that more than average samples with water 'suspected' had quail, a fact that requires further examination. Permanent water samples had a marginally higher proportion with quail present but not significantly so and those samples with a temporary water supply had a marginally, but not significantly, lower proportion with quail present.

Of the 802 samples surveyed 544 did not record water in any of the described categories indicating a great degree of difficulty in categorising water. Rather than take a guess observers properly left the option uncommitted which was the most accurate description of water. Rather than take a guess observers properly left the option uncommitted which was the most accurate description of water. The higher than average presence of quail where water was suspected could possibly be as much an attribute of the type of terrain or vegetation as one of the presence of water. Often water was suspected where a steep gully, usually heavily vegetated, could provide a small catchment with a stream in the bottom. Such a gully would be resistant to desiccation because of the vegetation and any water present would be a continuous supply or a series of seepages. Nothing conclusive can be drawn from the data relating to water as it was recorded during this survey. This is largely because of the small number of samples in which water could be positively categorised.

### 7.4 The effects of weather

Quail sightings or calls are likely to be influenced by weather factors: wind affecting the travel of sound, sun and/or rain the birds presence in a particular area. Records of sightings and calls have been examined to determine weather effects.

A significantly higher proportion of samples which were surveyed when the sun was shining had quail than the average proportion for the whole survey. Conversely, there was a significantly lower proportion of samples with quail when sampling occurred during rain or low threatening cloud.

**Table 1. The effect of sun on quail detection**

| SUN | SAMPLES WITH QUAIL (CALLS/SIGHTS) | EXPECTED NUMBER* |
|---|---|---|
| Sunshine | 48 | 38 |
| Overcast | 54 | 57 |
| Cloud/Rain | 5 | 12 |
| TOTAL | 107 | 107 |

Note:-
* The expected number is calculated by multiplying the number of samples with quail detected by the number of samples with the attribute in question and dividing the answer by the total number of samples in the table.

Wind conditions may affect quail detection for two different reasons. Firstly, wind may influence the behaviour of quail in such a way that they are not readily seen and, secondly, some calls, particularly distant ones, are less likely to be heard. The following table shows that a higher than expected proportion of samples taken in calm conditions recorded quail and that a lower than expected proportion of samples taken in windy conditions recorded quail.

**Table 2. The effect of wind**

| | SAMPLES WITH QUAIL (CALLS/SIGHTS) | EXPECTED NUMBER |
|---|---|---|
| Calm | 93 | 77 |
| Windy | 12 | 28 |
| TOTAL | 105 | 105 |

Having demonstrated that both wind and sun affect the detection of quail it is interesting to examine the combined effect as shown in the following table.

**Table 3. The effect of combinations of wind and sun**

| CONDITION | SAMPLES WITH QUAIL (CALLS/SIGHTS) | EXPECTED NUMBER |
|---|---|---|
| Cloud/rain & wind | 1 | 7 |
| Cloud/rain & calm | 4 | 5 |
| Overcast & wind | 8 | 15 |
| Overcast & calm | 46 | 41 |
| Sunshine & windy | 3 | 6 |
| Sunshine & calm | 43 | 31 |
| TOTAL | 105 | 105 |

If the sun is shining quail detection by sight and calls is increased by about 20%, but this applies only to the methods used in this survey. It most certainly does not mean there are more quail when the sun is shining. Similarly, calm conditions produced 20% more quail detections than windy conditions and the same cautions for interpretation apply. Hunters may be interested to note these findings and that in combination sun shining and calm increases detection by 30%.

### 7.5 The effect of time of day

Most species of birds show a dramatic change in behaviour during the day. Often these behavioural changes begin before dawn and continue until after dark. It was conceivable therefore that the number of 'coveys' detected would vary with the time of day, and indeed, this proved to be true.

Samples surveyed before about midday had a higher than expected proportion of quail detections, those surveyed between about midday and about 4 had fewer than expected and those surveyed after about 4 30 p.m. Twilight lasted for about half and hour outside of these times.

Because of the relatively large distances required to be travelled to reach some of the sample sites and because the strictly random nature of the sample selection there were relatively fewer samples taken early in the day than there were taken around the middle of the day. Because some surveyors finished earlier than expected and none was allowed to continue later than 5 pm, there were relatively fewer samples taken towards the very end of the day. However, there were sufficient samples taken throughout the day to substantiate the trends shown in Fig. 10.

Quail were detected by sightings and/or hearings (the detection of sign is not affected by time of day) and so changes in detectability throughout the day by each of these means was plotted.

When only coveys which were seen were plotted the pattern was very similar to that for combined sighting/hearing samples (Fig.11).

Similarly, a plot of records of quail from observations where quail were heard showed a similar pattern, although a little less pronounced and with a slightly longer middle of the day quiet period (Fig. 12).

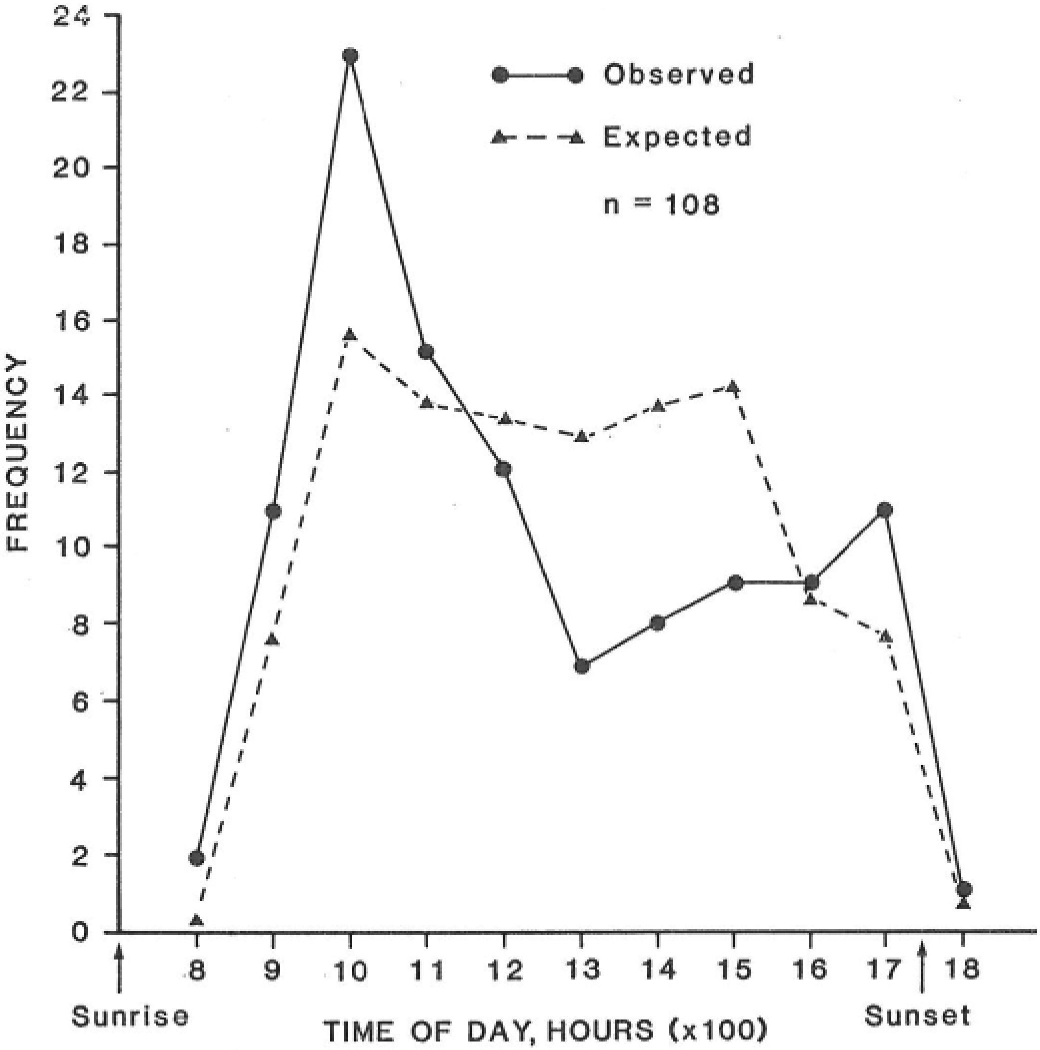
The use of callers and the importance of listening in the detection of quail is discussed in "Results - Quail Detection" but not in relation to the time of day. The diurnal pattern of spontaneous calls (and may have included other cues as well) has been plotted (Fig. 13) and shows again the typical pattern. But this contrasts strongly with the plot of records obtained by the use of a caller (Fig. 14) where the familiar diurnal pattern has been disrupted by the use of a caller. Clearly the use of a caller is a powerful aid to the detection of quail.

### 7.6 The effect of tree species

Tree species were recorded at each sample site and in many instances more than one tree species was present. Not only were there plantations on either side of the road which were often different but even within a compartment there could be more than one tree species.

Of the tree species recorded *Pinus radiata* comprised 68% and Douglas fir was the second most abundant at 12%. The forest had 13 species of Pinus under cultivation but because precise identification of each could not be guaranteed, and because some distinction between *Pinus radiata* and the other Pines was considered to be worthwhile, all pines other than *Pinus* radiata were lumped together as *Pinus* spp. and these made up 11% of the records.

FIGURE 10: QUAIL SEEN AND/OR HEARD



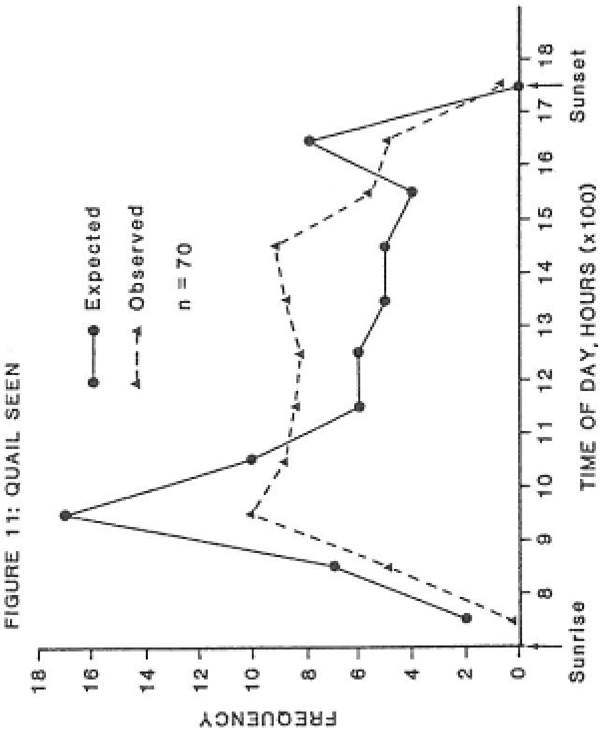


FIGURE 11: QUAIL SEEN

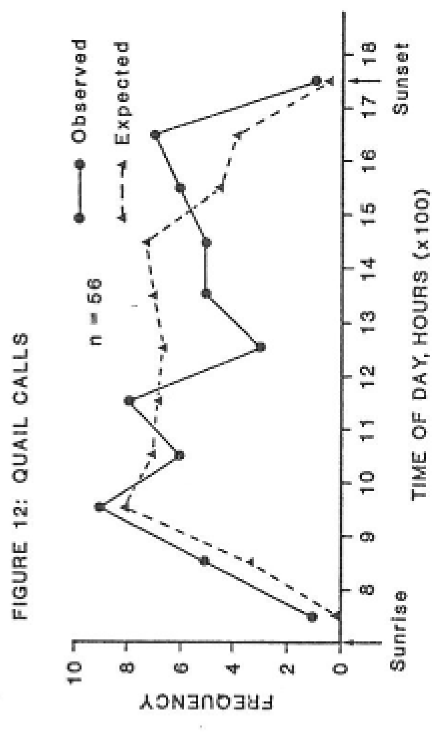


FIGURE 12: QUAIL CALLS

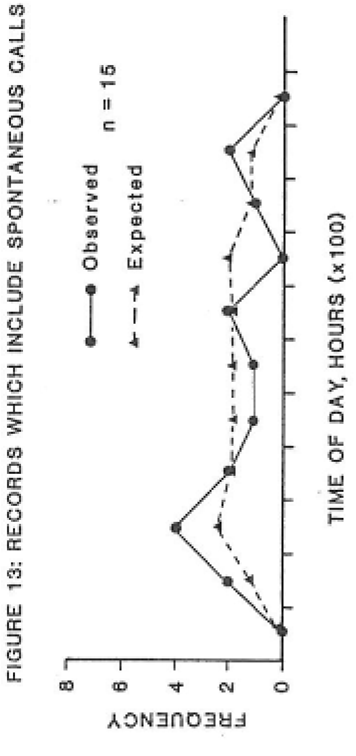


FIGURE 13: RECORDS WHICH INCLUDE SPONTANEOUS CALLS

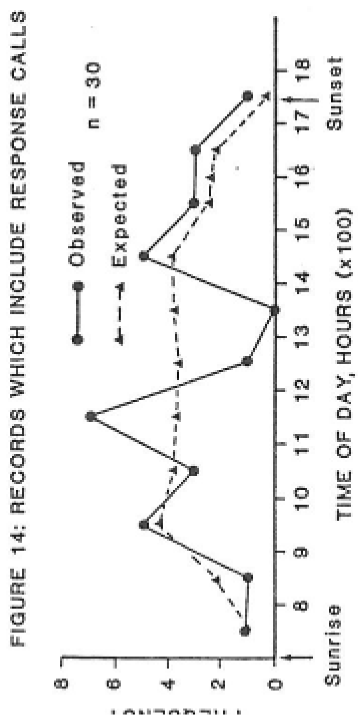


FIGURE 14: RECORDS WHICH INCLUDE RESPONSE CALLS

Another tree category which, while not exactly a tree species but rather a distinctive stage in the cycle, was recorded for convenience as a tree species and analysed accordingly. This was clear-felled or no crop and made up 5% of records.

The three Eucalyptus species under cultivation in the forest collectively made up 2% of the records and all other cultivated species including the three larches made up 3% of the records.

The possibility of association of quail with a particular tree species requires initial examination at three levels.

1) Where the tree species is present on either or both sides of the sample site.

2) Where the tree species is exclusively present, i.e. present on both sides of the sample site.

3) Where the tree species occurs on only one side of the sample site and not on both sides.

In the first instance (Table 4) the presence of a particular tree species on one side of the road or the other or on both sides was examined.

**Table 4. The effect of tree species present on either or both sides of the sample site**

| | NO. SAMPLES WHERE QUAIL WERE DETECTED | |
|---|---|---|
| TREE SPP. | OBSERVED | EXPECTED |
| *Pinus radiata* | 200 | 212 |
| Douglas fir | 52 | 38 |
| *Eucalyptus* | 6 | 5 |
| Clear felled | 10 | 16 |
| *Pinus* species | 31 | 34 |
| Other | 14 | 8 |
| TOTAL | 313 | 313 |

Table 4 shows relative differences between the presence of the various tree species and the average for all the samples. What is average is very much dominated by *Pinus radiata* which made up 68% of the entire sample. Eucalypts and other species of Pine showed no significant association with quail detection. Douglas fir was associated with quail detection more than could be expected at a highly significant level, 'clear-felled' had fewer than expected associations and 'other species' had a higher than average association. 'Other species' often indicated more of a mixed habitat than usual because they were often planted as small experimental plots or compartment windbreaks etc.

A second level of initial examination (Table 5) included samples where each crop species was exclusively present. In particular the categories required the specified tree species to have been present on both sides of the sample.

**Table 5. The effect of tree species when present on both sides of the sample site**

| TREE SPP. | NO. SAMPLES WHERE QUAIL WERE DETECTED OBSERVED | EXPECTED |
|---|---|---|
| *Pinus radiata* | 154 | 157 |
| Douglas fir | 21 | 15 |
| *Eucalyptus* | 2 | 1 |
| Clear felled | 0 | 3 |
| *Pinus* species | 8 | 8 |
| Other | 0 | 1 |
| TOTAL | 185 | 185 |

Table 5 has a similar pattern of association of tree species with quail detection as Table 4 but the differences between the tree species in Table 5 are more subdued. One possible explanation is that the "exclusive" presence of the particular crop indicates a reduced variety in the habitat. In particular, no quail were detected in 'clear-felled' areas indicating the possibility that the absence of "escape cover" on both sides of the sample is intolerable. Another explanation is simply that there are only about half the number of samples in Table 5 compared with Table 4 and accordingly there is a reduction in significance that can be attached to the trends indicated by a smaller sample.

The third level of initial examination (Table 6) examines samples where crops occur on only one side of the sample and not on both.

**Table 6. The effect of tree species present on only one side of the sample site**

| TREE SPP. | NO. SAMPLES WHERE QUAIL WERE DETECTED OBSERVED | EXPECTED |
|---|---|---|
| *Pinus radiata* | 48 | 50 |
| Douglas fir | 31 | 22 |
| *Eucalyptus* | 4 | 4 |
| Clear felled | 9 | 13 |
| *Pinus* species | 23 | 26 |
| Other | 0 | 0 |
| TOTAL | 115 | 115 |

Again the same tendencies occur but with a lack of significance that can be attributed mostly to the small sample size. There were no samples which had 'Other species' on one side only.

The interpretation of these three tables requires consideration of some important points. Firstly the association (or lack of association) of quail with a particular tree species really an association of that crop species along with many other associated attributes and habitat types. For instance, clear felling is a temporary stage of silviculture when compared with a 30 metre high crop of Douglas fir. Mature stands are likely to have a much more stable associated habitat than young crops or crops currently being logged. Douglas fir takes about twice as long to reach a given height as  radiata. Douglas fir tends to be left to grow taller and, therefore, much longer than radiata because it is more often grown for timber than for pulping. Pines are grown for both timber and pulp and, therefore encompass a wider range of growth stages and sizes and have a faster silvicultural cycle. Therefore, while it is reasonable to note the association of quail detection with the given tree species it would not be reasonable to attach great importance to it.

### 7.7 The effect of tree height

Like many other habitat features, tree height may not be related directly to quail abundance. Tall trees are associated with a more stable habitat than are short trees but they also provide escape cover or roosting sites depending on the type of trees and their height. Strong sunlight can reach the floor of a forest of short trees planted in the normal density allowing grasses to flourish whereas some tall forests have a completely closed canopy and the forest floor is bare of small plants.

The effect of tree height on the proportions of sampled sides where quail were detected was analysed in two ways: Firstly to determine the effect of tree height where it was the same on both sides of the sampled a road (Fig. 15); and secondly to determine the effect of tree height on one side of the road.

Significantly more than expected associations with quail occurred where the tree height on both sides of the road was between one or two metres and seven or eight metres. A log scale (unit distances along the scale represent 10 fold increases in tree height) has been used to enable detail to be shown at shorter heights yet encompass the full range of heights that were sampled.

In a similar manner the tree height on at least one side of the road was plotted (Fig. 16) and the same pattern of more than expected associations between tree heights of one or two metres and seven or eight metres emerged. Again a log scale has been used.

The distribution of tree heights of Douglas fir was plotted (Fig. 17) against the average for the whole sample and this revealed a need for a little caution in interpreting figures 15 and 16. Figure 17 showed more than expected Douglas fir in the height categories between just under three metres and just over eight metres. It was shown earlier (Table 4) that quail were detected at more samples with Douglas fit than expected. These twin associations required further investigation and a similar plot of the number of samples observed to have quail and a plot of the number of samples expected to have quail was made from all samples which did not include Douglas fir (Fig. 18). The same pattern was apparent.

FIGURE 15: THE EFFECT OF TREE HEIGHT ON BOTH SIDES OF THE SAMPLE

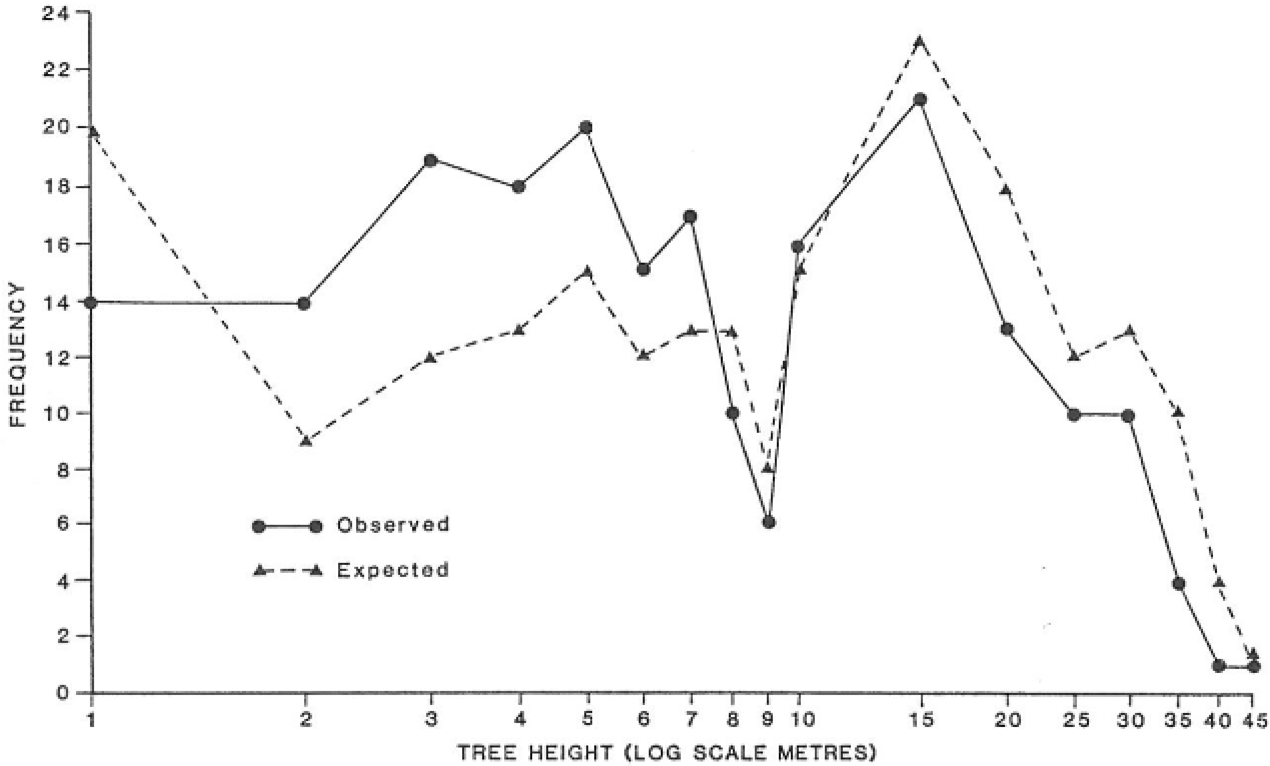



FIGURE 16: THE EFFECT OF TREE HEIGHT ON AT LEAST ONE SIDE OF THE SAMPLE

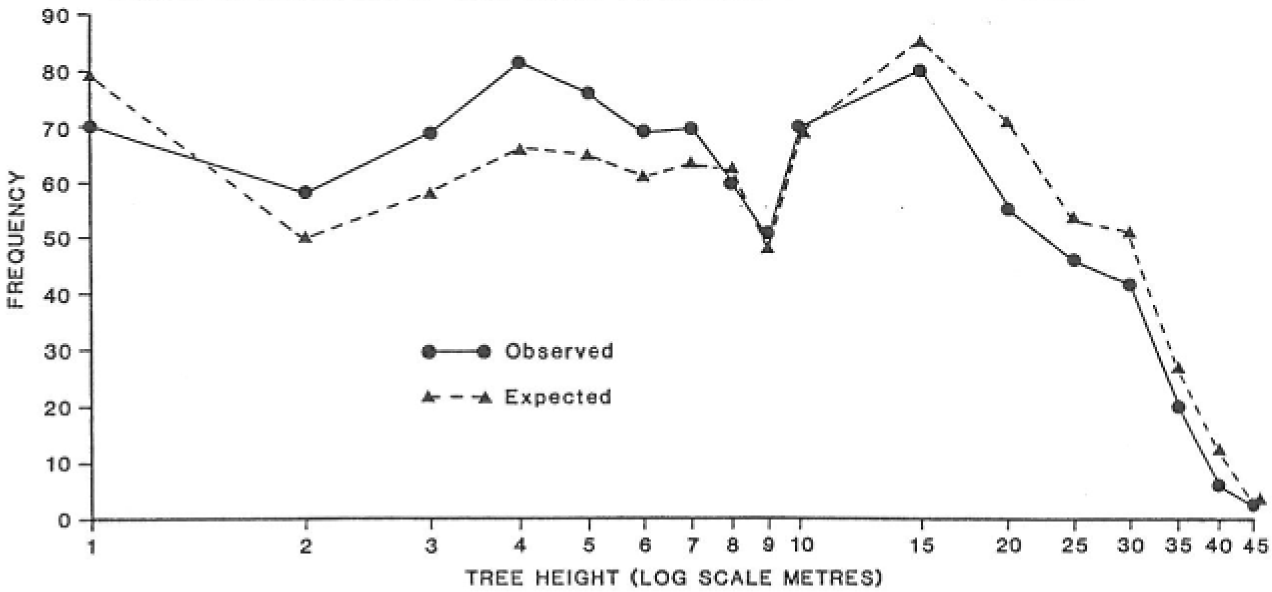


FIGURE 17: DISTRIBUTION OF DOUGLAS FIR HEIGHTS ON BOTH SIDES OF THE SAMPLE

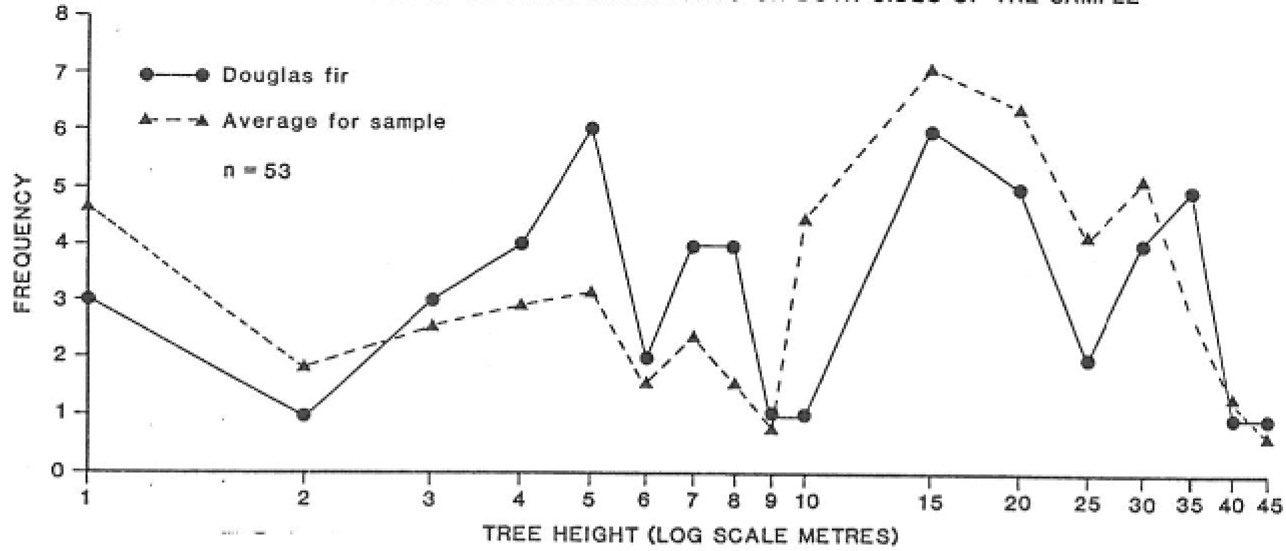
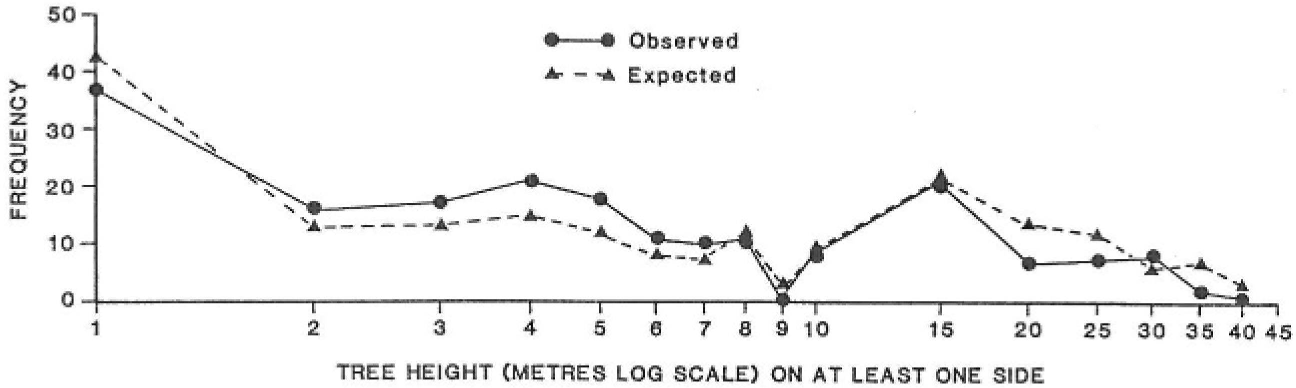



FIGURE 18: QUAIL DETECTIONS AT SAMPLES WITHOUT DOUGLAS FIR



Thus, where tree heights on one or both sides of the road were between about three and seven metres quail were detected in up to 50% more samples than expected.

### 7.8 The effects of road surface and shoulder type

One of the basic assumptions of the survey was that quail are very likely to use roads for dusting, sunning, and to gather grit. It follows, therefore, that the type of road and/or type of road shoulders could influence the detection of quail on any sample. While sealed roads could hardly be expected to show footprints the road shoulders may, depending on the material from which they were made. It was also conceivable that small pumice roads had less traffic and therefore had more quail sign because there was less traffic to obliterate it and/or to disturb quail.

There were three major types of road surface in the forest; sealed, gravel and pumice but not always was any particular road completely one of these types. Observers recorded the most applicable category. The 739 examples which had sample distances and road type recorded provided a summary of the road types sampled. Pumice type roads were recorded at 552 samples and totalled 575 km (Average 1.04 km), gravel type roads were recorded at 161 samples and totalled 174 km (Average 1.08 km) and sealed roads were recorded at 26 samples sites and totalled 29.2 km (Average 1.12 km).

There were negligible differences between observed and expected numbers of samples at which quail were detected for all three road surface types (Table 7) and road shoulder types (Table 8).

**Table 7. The effect of road surface type**

| | NO. SAMPLES WITH QUAIL | |
|---|---|---|
| ROAD TYPE | OBSERVED | EXPECTED |
| Pumice | 168 | 167 |
| Gravel | 48 | 49 |
| Seal | 8 | 8 |
| TOTAL | 224 | 224 |

**Table 8. The effect of road shoulder type**

| | NO. SAMPLES WITH QUAIL | |
|---|---|---|
| ROAD TYPE | OBSERVED | EXPECTED |
| Pumice | 111 | 100 |
| Gravel | 35 | 39 |
| Seal | 73 | 80 |
| TOTAL | 219 | 219 |

While pumice shoulders showed slightly more quail than expected the difference was not significant.

Finally, the combinations of road surface and shoulder types were examined.

**Table 9. The effect of combinations of road surface and shoulder types**

| ROAD/SHOULDER | NO. SAMPLES WITH QUAIL | |
|---|---|---|
| | OBSERVED | EXPECTED |
| Pumice/None | 67 | 75 |
| Pumice/Pumice | 99 | 91 |
| Gravel/None | 6 | 8 |
| Gravel/Pumice | 15 | 12 |
| Seal/Gravel | 7 | 8 |
| TOTAL | 194 | 194 |

The combination Seal.None had a total of only two samples and there were no samples with the combination Seal/Pumice so they both have been left out of the table. The slight differences between the observed and expected number of samples at which quail were detected was not significant.

### 7.9 The effect of non-silviculture vegetation

Vegetation types were recorded from within compartments as undergrowth, and Between the road and the edge of the plantation as each of three verge types; roadside verge, mid-verge, and edge verge. Vegetation types were based on structure rather than food attributes since food preferences of quail in Kaingaroa were the subject of a separate study. Twelve vegetation types were used and these are described elsewhere under habitat information collected. Analysis of the effect of vegetation types was made for each of the road verge areas and undergrowth, and for combinations of these. Analysis included an examination of the effects of the presence of each vegetation type and an examination of the effects of each vegetation type where it was the dominant vegetation type. Vegetation type had a highly significant effect on the proportion of samples at which quail were detected. Pampas and broom/lupin were the two most influential types, both having a positive effect on the proportion of samples with quail detected (Table 11). Lucerne was omitted because it is a crop of the verges and fire-breaks and does not occur as undergrowth.

**Table 11. The effect of vegetation types present in the undergrowth**

| VEGETATION TYPE | NO. SAMPLES WITH QUAIL DETECTED OBSERVED | EXPECTED | % WITH QUAIL |
|---|---|---|---|
| Bare | 102 | 108 | 30 |
| Slash | 137 | 147 | 30 |
| Grass/weeds | 131 | 126 | 33 |
| Mixed Shrubs | 127 | 139 | 29 |
| Frost flat | 3 | 3 | 27 |
| Exotics | 16 | 19 | 27 |
| Lucerne | 0 | 0 | 0 |
| Blackberry/bracken | 132 | 129 | 32 |
| Buddleia | 6 | 3 | 55 |
| Pampas | 36 | 26 | 44 |
| Broom/lupin | 33 | 23 | 46 |
| Heather/manuka | 21 | 21 | 31 |
| TOTAL | 744 | 744 | 32 |

Compartments with pampas or broom/lupin as undergrowth generally had an open canopy or very short tree height and were associated with a wide variety of other plants, especially grasses and weeds. The spectacularly high proportion of quail detections at samples with Buddleia in the undergrowth does not have an equally spectacular significance level because the proportion is based on so few samples. The high proportion is, however, worthy of note.

Road verges were another important source of non-silviculture plants throughout the forest especially since many compartments had a closed canopy which prevented undergrowth. The effect of the presence of each of the vegetation types anywhere on the verges has been examined (Table 12).

**Table 12. The effect of vegetation types anywhere on the verges**

| VEGETATION TYPE | NO. SAMPLES WITH QUAIL DETECTED OBSERVED | EXPECTED | % WITH QUAIL |
|---|---|---|---|
| Bare | 188 | 201 | 29 |
| Slash | 89 | 95 | 29 |
| Grass/weeds | 195 | 193 | 31 |
| Mixed Shrubs | 86 | 103 | 26 |
| Frost flat | 1 | 1 | 25 |
| Exotics | 54 | 63 | 26 |
| Lucerne | 10 | 6 | 50 |
| Blackberry/bracken | 139 | 119 | 36 |
| Buddleia | 11 | 8 | 42 |
| Pampas | 40 | 32 | 38 |
| Broom/lupin | 47 | 32 | 45 |
| Heather/manuka | 37 | 44 | 26 |
| TOTAL | 897 | 897 | 31 |

Lucerne has a very high proportion of samples at which quail were detected but the small number of samples involved suggests a little caution is required when considering these results. Mixed shrubs have significantly fewer than expected samples where quail were detected and may reflect a less varied and old established habitat type which influences quail detection rather than an effect of the shrubs themselves. The five most influential vegetation types present anywhere in the verges were broom/lupin, blackberry/bracken, mixed shrubs, lucerne and pampas. Of these five lucerne shows a spectacularly high proportion of samples at which quail were detected and the broom/lupin type is a close second.

An examination of the presence of the vegetation types anywhere on the verges or in the undergrowth (Table 13) shows, again, highly significant differences in the proportion of samples at which quail were detected. These differences are similar to those of Table 11 and 12.

**Table 13. The effect of vegetation type present on verges or in the undergrowth**

| VEGETATION TYPE | NO. SAMPLES WITH QUAIL DETECTED OBSERVED | EXPECTED | % WITH QUAIL |
|---|---|---|---|
| Bare | 194 | 208 | 28 |
| Slash | 150 | 158 | 29 |
| Grass/weeds | 208 | 207 | 31 |
| Mixed Shrubs | 135 | 142 | 29 |
| Frost flat | 4 | 4 | 31 |
| Exotics | 58 | 67 | 27 |
| Lucerne | 10 | 6 | 50 |
| Blackberry/bracken | 161 | 152 | 32 |
| Buddleia | 13 | 9 | 42 |
| Pampas | 59 | 44 | 42 |
| Broom/lupin | 51 | 37 | 42 |
| Heather/manuka | 40 | 49 | 25 |
| TOTAL | 1083 | 1083 | 31 |

The fact that the total vegetation presence includes lucerne which is a crop of the verges and pampas which has been shown in Table 12 to be less important on the verges than in the undergrowth indicates that the wise interpretation of the presence of these vegetation types is to consider them as typical of a type of habitat rather than being important for their own type. Further to this approach is an examination of these vegetation types where they are the dominant vegetation type rather than merely being present, and an examination of the different influences they may have depending on where they occur. Since the verges have been divided into three parts it would seem worthwhile to examine the relative influence of each vegetation type depending on where in the verges it occurs.

Later the effect of dominance in each of the verge areas and the undergrowth will be examined.

**Table 14. The influence of verge vegetation type next to plantations**

| VEGETATION TYPE | NO. SAMPLES WITH QUAIL DETECTED | | % WITH QUAIL |
|---|---|---|---|
| | OBSERVED | EXPECTED | |
| Bare | 112 | 128 | 28 |
| Slash | 86 | 94 | 29 |
| Grass/weeds | 159 | 152 | 33 |
| Mixed Shrubs | 82 | 99 | 26 |
| Frost flat | 0 | 1 | 0 |
| Exotics | 35 | 42 | 26 |
| Lucerne | 3 | 2 | 43 |
| Blackberry/bracken | 133 | 117 | 36 |
| Buddleia | 10 | 6 | 56 |
| Pampas | 31 | 23 | 42 |
| Broom/lupin | 42 | 27 | 49 |
| Heather/manuka | 28 | 30 | 29 |
| TOTAL | 721 | 721 | 32 |

The major contributors to the significance of the differences between the vegetation types in this table are Broom/Lupin, Buddleia, Pampas and Blackberry/Bracken. Lucerne has a very small sample size which detracts considerably from the high proportion of association with samples at which quail were detected. Buddleia too has a rather small sample size. Lucerne rarely extends across the whole width of the verge but is usually confined to the mid-verge. Where lucerne was recorded on either of the edges of the verge it was usually present in the mid-verge as an important fire-break crop.

The mid-verge area is usually the widest part of the verge and often is managed as a fire-break.

**Table 15. The influence of mid-verge vegetation**

| VEGETATION TYPE | NO. SAMPLES WITH QUAIL DETECTED OBSERVED | EXPECTED | % WITH QUAIL |
|---|---|---|---|
| Bare | 155 | 164 | 29 |
| Slash | 47 | 46 | 32 |
| Grass/weeds | 168 | 158 | 33 |
| Mixed Shrubs | 58 | 67 | 27 |
| Frost flat | 0 | 1 | 0 |
| Exotics | 34 | 43 | 24 |
| Lucerne | 7 | 4 | 50 |
| Blackberry/bracken | 80 | 76 | 33 |
| Buddleia | 9 | 5 | 53 |
| Pampas | 16 | 15 | 33 |
| Broom/lupin | 29 | 20 | 45 |
| Heather/manuka | 26 | 30 | 27 |
| TOTAL | 629 | 629 | 31 |

Broom/lupin, buddleja and lucerne were the most important vegetation types influencing quail detection. Pampas does not seem t have much influence where it occurred in the mid-verge, probably because of the unvaried habitat and the lack of a fire-break it indicates.

Perhaps the smallest area of the verge is that next to the road where fire-break machinery does not venture least the verge should collapse onto the road. For the same reasons it is rarely planted with trees and, therefore, represents a narrow strip of vegetation that is different from the rest of the verge.

**Table 16. The influence of roadside verge vegetation**

| VEGETATION TYPE | NO. SAMPLES WITH QUAIL DETECTED OBSERVED | EXPECTED | % WITH QUAIL |
|---|---|---|---|
| Bare | 176 | 176 | 29 |
| Slash | 20 | 18 | 33 |
| Grass/weeds | 145 | 143 | 30 |
| Mixed Shrubs | 40 | 43 | 27 |
| Frost flat | 1 | 1 | 33 |
| Exotics | 21 | 28 | 22 |
| Lucerne | 4 | 1 | 80 |
| Blackberry/bracken | 50 | 47 | 31 |
| Buddleia | 4 | 4 | 33 |
| Pampas | 11 | 10 | 31 |
| Broom/lupin | 21 | 14 | 44 |
| Heather/manuka | 13 | 21 | 18 |
| TOTAL | 506 | 506 | 29 |

The overall effect of roadside verge vegetation on the detection of quail (Table 16) was barely significant probably because of the relatively small area it comprised compared with the rest of the verge. Those vegetation types that seem most influential are probably so because of associated vegetation in other parts of the verge rather than for their own sake. Lucerne, for example, is usually cropped in the mid-verge so the presence of Lucerne in the roadside verge indicates that it is also likely to occur in the mid-verge. The higher than average detection of quail at samples with lucerne in the roadside verge is most likely to be a reflection of the effect of a mid-verge lucerne crop. Broom/lupin showed higher than average quail detections and heather/manuka showed lower than average quail detections. All the other vegetation types did not show significant differences from average quail detection rates.

The importance of dominance rather than mere presence was examined in this same manner and in all cases there were negligible differences between the levels, with the single possible exception of bracken/blackberry which seemed to have more than usual samples with quail detections where it was dominant in the mid- verge region.

### 7.10 The effect of the amount of verge cover

The amount of cover on the verges was recorded from a range of four options; bare, light, medium, and dense. These are described elsewhere under habitat information collected. The influence of each of the four categories was examined for each of the three verge regions.

In the roadside verge the amount of cover had negligible effect on the proportion of samples at which quail were detected (Table 17).

**Table 17. The effect of roadside verge-cover**

| AMOUNT COVER | NO. SAMPLES WITH QUAIL | |
|---|---|---|
| | OBSERVED | EXPECTED |
| Bare | 131 | 134 |
| Light | 115 | 114 |
| Medium | 95 | 90 |
| Dense | 69 | 72 |
| TOTAL | 410 | 410 |

The amount of cover had a negligible effect in both the mid-verge and the edge verge (Tables 18 & 19 respectively).

**Table 18. The effect of the amount of mid-verge cover**

| AMOUNT COVER | NO. SAMPLES WITH QUAIL | |
|---|---|---|
| | OBSERVED | EXPECTED |
| Bare | 102 | 114 |
| Light | 122 | 112 |
| Medium | 123 | 117 |
| Dense | 112 | 116 |
| TOTAL | 459 | 459 |

**Table 19. The effect of the amount of edge-verge cover**

| AMOUNT COVER | NO. SAMPLES WITH QUAIL | |
|---|---|---|
| | OBSERVED | EXPECTED |
| Bare | 64 | 78 |
| Light | 94 | 84 |
| Medium | 134 | 128 |
| Dense | 162 | 164 |
| TOTAL | 454 | 454 |

The effects of cover in both these tables is not significant but there is sufficient difference to suggest that further examination of various combinations of cover in the mid and edge verges would be required for thoroughness. The roadside verge has been omitted since it has shown no indication of differences and its inclusion would only add unnecessary complication (Table 20). Each combination was included in the analysis as it occurred on one side of the road, the other, or on both sides.

**Table 20. The effect of the amount of verge cover combinations**

| AMOUNT OF COVER | | NO. OF SAMPLES WITH QUAIL | |
|---|---|---|---|
| EDGE | MID | OBSERVED | EXPECTED |
| Bare | Bare | 61 | 77 |
| Bare | Light | 20 | 24 |
| Bare | Medium | 16 | 14 |
| Bare | Dense | 8 | 12 |
| Light | Bare | 53 | 51 |
| Light | Light | 69 | 63 |
| Light | Medium | 27 | 23 |
| Light | Dense | 24 | 20 |
| Medium | Bare | 55 | 57 |
| Medium | Light | 71 | 72 |
| Medium | Medium | 85 | 80 |
| Medium | Dense | 46 | 43 |
| Dense | Bare | 51 | 51 |
| Dense | Light | 80 | 66 |
| Dense | Medium | 96 | 97 |
| Dense | Dense | 112 | 124 |
| TOTAL | | 874 | 874 |

There is nothing to indicate that the amount of cover, the location on the verges of the various amounts of cover, nor any of the combinations of the amount and location of cover has any effect on the proportion of samples where quail were detected.

## 7.11 The effects of verge vegetation height

Vegetation height in the three areas of the verges was recorded in one of four categories. These categories are described elsewhere under habitat information collected.

The effect of roadside verge vegetation height was examined (Table 21) and no significant differences were found.

**Table 21. The effect of roadside-verge vegetation height**

| VEG. HEIGHT | NO. OF SAMPLES WITH QUAIL | |
|---|---|---|
| | OBSERVED | EXPECTED |
| 0 - < 10 cm | 159 | 157 |
| 10 - < 30 cm | 110 | 106 |
| 30 cm – 2 m | 78 | 81 |
| > 2 m | 14 | 17 |
| TOTAL | 361 | 361 |

The mid verge region is usually the largest of the three verge regions but examination of the effects of vegetation height in this part of the verge (Table 22) did not show any significant effects on the proportion of samples at which quail were detected.

**Table 22. The effect of mid-verge vegetation height**

| VEG. HEIGHT | NO. OF SAMPLES WITH QUAIL OBSERVED | EXPECTED |
|---|---|---|
| 0 - < 10 cm | 145 | 136 |
| 10 - < 30 cm | 111 | 111 |
| 30 cm – 2 m | 137 | 135 |
| > 2 m | 48 | 54 |
| TOTAL | 436 | 436 |

The height of vegetation at the verge edge (where it merges with the compartment crop) also had no significant effect on the proportion of samples at which quail were detected (Table 23).

**Table 23. The effect of edge-verge vegetation height**

| VEG. HEIGHT | NO. OF SAMPLES WITH QUAIL OBSERVED | EXPECTED |
|---|---|---|
| 0 - < 10 cm | 177 | 170 |
| 10 - < 30 cm | 90 | 93 |
| 30 cm – 2 m | 177 | 180 |
| > 2 m | 95 | 96 |
| TOTAL | 539 | 539 |

The overall effect of vegetation height anywhere in the verges does not seem to affect the proportion of samples at which quail were detected. The sample sizes were more than adequate to show significance at quite small differences had there been any. Further examination of all 64 possible combinations of verge vegetation heights was attempted but such a high number of combinations reduced the sample size of most categories to a level where significance could not be attached to other than substantial differences and there were no such substantial differences.

### 7.12 The effect of direct sun

Quail have generally been regarded as birds which seek sunny locations in which to feed, roost or dust and that their daily movements are determined by the presence of sunshine. It was considered that this would be a worthwhile factor to examine but there were only 36 samples at which quail were actually seen on or near the road.

Examination of the orientation of the roads in relation to the sun did not reveal any relationship with the detection of quail even when sign was included in the analysis. If indeed quail do seek sun, the sites for doing this were too small to be recognised as sunning places from the habitat information that was collected in this survey.

## 8. CONCLUSION

The method of analysis adopted in this report has been to relate features of the habitat as recorded at sample sites to the detection or non-detection of quail, and the philosophy of this merits a little explanation. Firstly the detection of quail means that some tangible evidence was detected that quail were at the sample site or that they had been there within the past few days. Such evidence does not mean that they necessarily live there nor that quail favoured that site, hut merely that they were in the area. Secondly, the non-detection of quail at a sample site does not mean that quail were not present either there or nearby. Finally, the information recorded which is shown to be related to quail detection is not necessarily directly related to the presence or absence of quail. Often a habitat feature has many other habitat features typically associated with it. It is with this collection of associated features that any association with quail detection or non-detection is really made. The analytical approach has also been to express quail presence as more than or less than expected, outlining the probability of detecting quail relative to some other category. This does not allow a statement of the certainty "that quail will be found in certain habitats" but instead that quail are more likely to be found under some circumstances than others.

The finding that quail have a larger home range than was anticipated has justified this approach. With such a wide home range and such a variable habitat it becomes difficult to positively associate certain features with the presence or absence of quail but it is unlikely that a more encompassing survey and/or more samples would have solved that problem. That is a subject for a more detailed study of how quail spend their time and where they spend it.

With foresight the survey was designed to be repeatable so that the whole survey could be done again in a different year or at a different time of year. It is an important limitation of the survey that it applies only to a four day period (actually in the samples involving sign the period is extended by a few days previously) during one particular year. Another survey or more data from the sample sites of this survey would answer questions that may be better answered by different methods.

The effectiveness of the survey in finding quail which were present could not be properly tested because of the size of the 'home range' which made it impossible to distinguish a survey detection from a previously known record even when separated by more than a kilometre. Similarly it was unreasonable to conclude that the non-detection of quail at a particular sample indicated that they were not present rather than merely elsewhere within their 'home range' as much as two or more kilometres away.

In the typical style of a random sample survey it is the recognition of general trends that are the feature of the results and not individual interpretation. These general trends are summarised below.

Quail are found throughout the forest.

Estimated home range radius is about 1.5

Most quail were detected by the presence of sign.

Most quail which were seen were seen flushing.

Most quail which were seen were seen within compartments.

The use of callers greatly increased the rate of detection.

No conclusion could be drawn from the apparent presence or absence of water because of the widespread occurrence of fire-fighting water and the difficulty of detecting the very small water supplies that are nevertheless adequate.

More quail than expected were detected when the sun was shining and fewer when there was heavy cloud or rain.

More quail than expected were detected before 10.30 a.m. and after 4.00 p.m.

More quail than expected were associated with Douglas fir.

Fewer quail than expected were associated with clear-felled areas.

More quail than expected were associated with crop trees between about two metres and seven metres high.

Pinus radiata was the dominant crop recorded at 68% of samples and Douglas fir was the next most abundant at 12% of samples.

Road and shoulder types showed no influence on quail detection.

More quail than expected were associated with the presence of undergrowth vegetation types Pampas and Broom/Lupin.

More quail than expected were associated with the presence of broom/lupin, Blackberry/Bracken, Lucerne, or Pampas anywhere in the road verges.

Fewer quail than expected were associated with the presence of mixed shrubs anywhere in the road verges.

No association of quail presence or absence with the amount or location of vegetation cover was detected.

No association of quail presence or absence with the height of verge vegetation or the location of particular verge vegetation heights was detected.

Direct sunlight had no measurable effect on the detection of quail because suitable 'sunning' sites are too small and localised to be recorded as such. The orientation of sampled roads in relation to the sun showed no association with the detection of quail.

## 9. REFERENCE

Williams, M.J. (chairman); Westerskov, K.E.; Johnson, W.B. 1983: Gamebird research in New Zealand. *Wildlife Research Liaison Group, Research Review Number 1.*

## APPENDIX I -SURVEYORS

Those who took part in the survey not only collected the information hut contributed many ideas towards the type of information collected and suggested likely factors for analysis.

The surveyors were:-

| | |
|---|---|
| J.S. Adams | (Wildlife) |
| J. Andrew | (Wildlife) |
| I.M. Buchanan | (Wellington Acclimatisation Society) |
| T.A. Caithness | (Wildlife) |
| M.E. Crombie | (Wildlife) |
| D.J. Delaney | (Wellington Acclimatisation Society) |
| R.G. Frost | (Marlborough Acclimatisation Society) |
| M. Harrison | (Wildlife) |
| C.J. Hodgsel | (Wildlife) |
| P. Howard | (Auckland Acclimatisation Society) |
| G.D. Maris | (Wildlife) |
| J.J. McDonald | (Wildlife) |
| S. McGill | (Wildlife) |
| A.D. Moore | (Auckland Acclimatisation Society) |
| J.M. Neilson | (Wildlife) |
| M.R. Poynter | (Northland Acclimatisation Society) |
| C.S. Robertson | (Wildlife) |
| A.J. Roxborough | (Wildlife) |
| R.C. Salisbury | (Wildlife) |
| A.J. Saunders | (Wildlife) |
| S.A. Sutherland | (Southland Acclimatisation Society) |
| M.R. Sutton | (Southland Acclimatisation Society) |
| C.C. Tonkin | (West Coast Acclimatisation Society) |
| R. van Mierlo | (Wildlife) |
| B.T. Williams | (Wildlife) |
| M.J. Williams | (Wildlife) |