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CONTENTS

OPINION

It's true! We're finally 'legit'!

From time to time issues arise which call for the expression of opinion. As a science newsletter we like to make space to consider these issues and the divergent points of view members of the scientific community may hold on these issues.
In this edition we have a response to Aidan Challis's thought provoking introduction to the Convention on Biodiversity and its New Zealand expression the Biodiversity strategy. Dr. Challis made the point that the Biodiversity strategy you get depends on what individual countries consider important conservation or environmental issues.
Matthew Lark's opinion is that there may be more in the Biodiversity strategy than the protection of indigenous wildlife.
Keith Johnston, General Manager DOC Conservation Policy, responds to Matthew's opinion.
If anyone else feels inclined to add to the discussion; send your contribution to us at DOC Science Publications, P O Box 10420, Wellington.
Kaye Green
Editor

Allow me to entertain you with an allegory. Picture a spring morning in the grounds of Government House, an English bumblebee is taking a break from inspecting the regal roses. He flies through the open front door of His Excellency's residence as a skylark and a cirl bunting begin arguing over who will sit on the rim of a prominent chandelier. The bumble-bee keeps flying, so he can watch another commotion on the floor, where a bell frog is performing an urgent but non-sexual amplexus on the leg of a dusty, tired-looking chukor, enticing it to fly his cold, green personage onto the back of the sambar deer, who has just come in after debarking all the garden's established trees. The sambar is a real aristocrat—pure bred and from the best Turakina stock—not like those mongrel rusa crosses up Rotorua way, but he's disgruntled because he finds he's not the only ungulate seeking a hearing. His six points visibly curl as he spies a very ordinary looking red deer wearing a mortar-board, displaying the words: 'I'm an Otago Highlander and I'm okay'. Sir Michael appears in the foyer, tripping over a baby Parma wallaby, and admits 'I was expecting you, what can I do for you all?' 'You can put up Goal post number 4, sir,' roars the sambar, 'and start signing off those Orders in Council which your new strategy guarantees for our protection.' 'That's it Mike' (the cackling chukor this time), 'goal 4 in that big green book says you are going to maintain the genetic resources of introduced species that are important for economic biological and cultural reasons. We're legit' and above board now. No more 1080, no more night-shooting on the sly or ballot hunting, no more conspiracies to annihilate the amphibians among us with fancy fungi, just sign up and let us in with those kiwi and kakapo.' Sir Michael is taken aback. 'Hang on a minute chaps, I've got to read it first, and take one of you at a time.'

Department of Conservation
Te Papa Atawhai

OPINON

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Is my picture really a flight of fancy? How many readers have considered the implications of the new biodiversity strategy, for our rare and unusual introduced animals? It seems DOC has finally struggled to a point where it can say in the open, that some, if not all naturalised animals, may be legitimised and formally acknowledged as valuable within protection policy and legislation. The sambar is right. The fourth goal of the strategy endorses the principles of protecting valuable introduced species, and further qualification of this refreshing outlook can be found in theme 4, specifically objectives 4.1, 4.3, and explicitly in 4.5. Other second-class tickets for more common species, like trout, salmon, and even the humble blackbird, have been issued at bargain prices inside objectives 2.1 (especially actions Ic, e, f) and in action b of objective 1.2, respectively. I'll leave you to visit those proclamations privately, because I want to ask some questions which trouble me.

Which species will become 'legit'? Who will take on the unenviable tasks of building the cage in which the hitherto non-mutual concepts of 'social legitimacy' and 'legal protection' must stand together? This begs the question, how on earth do DOC and its associates plan to renovate and re-invent heavily native-biased wildlife legislation to accommodate my lordly sambar and that querulous frog? Will such renovated law as this policy demands, prefer the cirl bunting or skylark, to be exported wholesale back to their native Europe because they're common enough here? Or will it demand that they are given section 3 protection in New Zealand because there's no room left at home? Will objective 4.5 allow the purest bred red stags of Otago to stay and (perish the thought) to be protected, while specimens of *Cervus elaphus* (Scoticus) of poorer breeding, are still regarded as pests elsewhere?

You get my drift don't you? Biodiversity in New Zealand, in my view, has never been simply a matter of wanting and protecting native or endemic species. Many who have not the privilege of handling black stilts, kiwi or takahe, value those Otago stags and the bell-frogs a great deal more than the unique, but untouchable natives, and finally we have some recognition of this long-held affection for 'naturalised' (not alien) species in an official policy statement. My only hope is that those like myself who care deeply about introduced fauna and flora and its place in New Zealand's social and recreational landscape, won't have to gather our furry or slimy charges for a trip to Government House, or the office of the Director-General. Here's hoping Sir Michael or Mr Logan might come and find us for a change.

Matthew Lark, Paraparaumu

Matthew Lark
Broadcaster, natural historian, conservation advocate
I am a committed natural historian, and one of few people in New Zealand who has made a meagre living out of getting conservation and its characters into people's heads, in every way conceivable. Since 1995 I have produced hundreds of radio documentaries and short features, and reported on environmental issues for Radio NZ News and Newstalk ZB. I have trained tour-guides to work in the outdoors, and have provided professional advice on public involvement with wildlife and natural interpretation to several groups up and down the country. I have produced some TV material in the past year, and my small recording studio, which I run from the Kapiti Coast, still produces natural sound and nature programming.
I am currently working on the Animals on The Brink Project which was outlined in ConScience Newsletter *issues 33 and 34.*

OPINON

Rumba over sambar

Response to Matthew Lark

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Alas, when the sambar awoke and looked around him, he discovered that he had been only dreaming. He had been led astray. It is true that the biodiversity strategy has a goal of maintaining the genetic resources of introduced species that are important for economic, biological and cultural reasons, but the goal has been deliberately constrained in its practical effects.

In his dreamy state the sambar had glossed over principle nine which gives priority to indigenous species over introduced species and objective 4.5: "Assist with international efforts to conserve threatened introduced plants and animals in New Zealand, provided that this does not conflict with conserving indigenous biodiversity."

"Ahh!" cried the sambar, I've been 4.5ed." What might have been hoped to be a clearing in a sylvan glade, a nice place to raise a family, turns out to be the same old garden path.

Amongst the actions in the New Zealand Biodiversity Strategy is one calling for a collaborative strategy to manage New Zealand's genetic resources, both indigenous and introduced. When that work is done I would expect it to continue the general recognition of the principle that the conservation of New Zealand's biodiversity will be dominated by the protection of indigenous species. I also assume this will be a key goal of a draft New Zealand biosecurity strategy. The control or management of introduced species will remain an issue where they threaten indigenous species and ecosystems. Where it is practical and affordable, control actions will be taken.

The biodiversity strategy does recognise the importance of introduced species but does not set out to provide guarantees for their protection. When dealing with a species that has been introduced into New Zealand that is threatened within its home range, the first option is to return the species to its place of origin. If this is neither practical or environmentally desirable the strategy says (p.78): "maintain small populations of threatened introduced species in facilities or clearly defined areas where their presence will not pose a threat to indigenous species..."

My message to the sambar and his mates is: "don't get your hopes up." The biodiversity strategy does not mark a significant change in policy toward introduced animals and plants that threaten indigenous biodiversity." If you want a second opinion on this, follow the money. A significant proportion of the money that was voted to implement the Biodiversity Strategy is to go on animal pest and weed control.

Keith Johnston,
General Manager Conservation Policy,
Department of Conservation

Keith Johnston
In his role as General Manager Conservation Policy for the Department of Conservation, Keith Johnston has been extensively involved in the preparation of the New Zealand Biodiversity Strategy. He has been with the Department for nearly 12 years, working as its public awareness manager and in strategy development before taking on his current role two years ago.

Report on Kaka in the far north, Waipapa Ecological District

The 1999-2000 breeding season was poor for a number of species. This was particularly so for North Island kaka, with no evidence for successful breeding anywhere on the mainland. This is in complete contrast to the situation in the south island where a second successive beech mast event resulted in substantial and successful (at least where predators were being controlled) breeding activity over a prolonged period.

One positive result to come from this lack of breeding activity was the increased effort able to be directed at catching female kaka at Rangataua. Previous catching trips were usually in winter and invariably battled the elements and unresponsive birds. However, in the space of two short trips in November and December our target of ten radio-tagged females was met. This was a major bonus and also suggested that this population may not be as wobbly as we once thought. Unfortunately this result was tempered by the analysis of the corpse of our first female captured in the area (found in a nest hole during the previous breeding season) which strongly implies that a stoat was the culprit.

On June 30, rigorous collection of data on diet, behaviour and home-range ceased, after some 3.5 years and in excess of 20,000 observations. My thanks goes to all of those staff, past and present, which have contributed to such a wonderful result in the face of all the difficulties encountered. As an added bonus Kirsty Moran has managed to get much of the outstanding data tucked away into a computer over the course of her contract.

Certain information will continue to be collected, particularly that relating to productivity. Phenology data will also continue to be collected given the potential for fruiting and flowering cycles to influence annual reproductive success.

Terry Greene

SRU, Northern Science Group

Two for the price of one

Two SRU funded projects investigating the processes that regulate two of eastern South Island's most threatened ecosystems have led directly to the likely acquisition of a highly representative site containing both types. The first project investigated landform and associated soil factors that determine the patterns of salinity and sodicity in Otago's inland saline ecosystem. The second seeks to understand soil and vegetation relationships and threat syndromes on eastern South Island's dryland ecosystems, such as arid river terraces and outwash fans. These ecosystems have high numbers of threatened and uncommon plants. Both projects highlighted the unrivalled conservation values of Pisa Flat in the upper Clutha valley above Cromwell as an example of both. Accordingly, Otago Conservancy sought Nature Heritage Fund support to purchase the site with its highly distinctive Pleistocene outwash terrace and attendant saline ecosystem.

Geoff Rogers

SRU, Otago

Kaka in the South Island

Predator control implemented as part of the Rotoiti Nature Recovery Project has significantly improved the nesting success of kaka. Baseline research by Landcare in the adjacent Big Bush Conservation Area found that kaka had very low nesting success in the absence of predator control. Only 2 of 20 nesting attempts, monitored over an 11-year period, were successful producing only 4 young. Over the same period, predators killed 4 of 7 nesting females. In the three years since the implementation of the Rotoiti Nature Recovery Project, 10 of 12 completed nesting attempts have been successful, 30 young fledged (19 surviving to date) and there has been no predation of nesting females. This result is even more convincing in light of concurrent research at an unmanaged site at Lake Rotoroa, about 20 km from the RNRP area. At the same time as kaka were breeding successfully within the RNRP area, 9 of 10 nesting attempts at Lake Rotoroa failed due to predation on eggs, nestlings or nesting females. Predators killed 3 of 5 radio-tagged nesting female kaka at Lake Rotoroa this summer alone. This research provides compelling evidence that predator control can reverse the decline of kaka on the main islands of New Zealand.

Ron Moorhouse
SRU, Nelson

RESEARCH IN PROGRESS

Adverse consequences of single pest removals

Interaction between ship rats, mice and their predators in southern beech forests

The trophic processes that influence the abundance of introduced animals in a given environment will determine how control targeted at a single pest species affects the density of non-target pests. For example, if stoat predation regulates the density of rodents in New Zealand forests, control that targets stoats will lead to elevated densities of rats and mice.

Ship rats and mice show reciprocal patterns of abundance in New Zealand forests: more mice being found in areas that have fewer ship rats, and more ship rats being found in areas with fewer mice. This pattern could reflect differential habitat preferences of the two species, competition between the two species for food, predation by rats on mice in certain habitats, a preference by higher-order predators such as stoats for one or other of the species, or interaction between more than one of these mechanisms.

We have set up a study in Fiordland National Park to determine the nature of the interaction between rats and mice in beech forest. The study is based around what can be regarded as two classical competition experiments, in which the density of mice or rats is 'pressed' by continuous removal, in a controlled and replicated design. However, while one of these experiments has been imposed on sites in an area where DOC control predators (mostly stoats) of mohua and kaka (the Eglinton Valley), the other has been imposed on sites where predators are not controlled (the Hollyford Valley). The specific hypotheses that we plan to evaluate are:

1. Interaction between rats and mice is neutral
2. Rats and mice compete for shared food resources (exploitation competition)
3. Rats inhibit access of mice to food resources (interference competition)
4. Rats are significant predators of mice
5. Suppression of mice by rats (through competition or predation) is tempered in some habitats by risk-sensitive foraging in the presence of stoats

Neutral interaction between mice and rats would indicate that their densities differ simply because they prefer different habitats. In terms of the experiment, neutral interaction would mean that selective removal of one species would have no effect on the density of the other. Experimental outcomes for competitive interactions are more complicated because of the different ways in which mice and rats might compete. If competition is due to a high degree of overlap in the food that mice and rats require to successfully survive and reproduce, competition between the two species is exploitative. In this case, removal of one species will always favour the other, and increases in density will be reciprocal. However, if competition occurs because one species dominates the food resources that are available by physically inhibiting access by the other species, the basis of competition is interference. In this case, while removal of the species that dominates food resources will increase the density of the species that does not, removing the species that is physically displaced from food resources will have little effect on the dominant species.

Rats are known to prey on mice, particularly juveniles. However, whether this has a significant influence on how the species interacts is unknown. Predation by rats could either regulate mouse density or limit mouse density. If mouse populations are regulated by rat density, removing rats will lead to an increase in mice. If rat predation simply limits mouse density, removal of rats may increase the rates at which mice increase when they have plenty of food, but their ultimate density should not be affected. We think it is unlikely that rats would be able to regulate mice, and that they are much more likely to act as a limiting factor.

If rats do suppress the densities of mice through either competition or predation, mice may occur at higher densities in some habitats if some characteristic of those habitats makes them less favourable to rats than they are to mice. For example, if some habitats provide rats and mice more protection from their predators (e.g. stoats) than others, rats may be more inclined to avoid the high-predation habitats simply because their superior competitive ability means they have less need to take such risks than mice do. The same pattern of habitat use would emerge if other factors made rats less willing than mice to trade off predation risk against foraging opportunities. These could include rats having a higher intrinsic susceptibility to predation than mice, or being less able to exploit predation refuges in particular habitats because of their body size. Any of these mechanisms can produce patterns of habitat use by mice and rats that have the appearance of competition. If interaction between rats and mice reflects the effect that higher-order predation has on patterns of habitat use, we would expect the responses indicating competition or predation by rats to be much stronger in the Eglinton Valley where predators are being pressed, than in the Hollyford Valley where they are not.

What has happened so far

The experiment started in May 1999 and live-trapping of rats and mice will continue each season (August, November, February, May) until May 2002. In each of the two valleys, six rodent-trapping grids have been established and treatments randomly assigned to each. Each grid comprises 81 Elliot live-traps spaced at 20 m in a 9- * 9 design. Trapping occurs for 5 consecutive nights each session. On two of the grids in each valley, all rodents caught are individually tagged and released. On two other grids, all rats caught are removed and mice are tagged and released. On the final two grids, all mice caught are removed and rats are marked and released. Population sizes of the species left on each grid are estimated using the program CAPTURE.

On each grid, four seed traps are used to estimate seedfall each season, and nine tracking tunnels baited with peanut butter to monitor predator activity. Red beech, and to a lesser extent silver beech, appeared to 'mast' in 1999, and mouse populations attained high peak densities over that winter. Beech seeding was patchier this year, and mouse populations do not appear to be increasing at the same rate. However, ship rat populations have increased this year in both the Eglinton and Hollyford valleys though they had stopped breeding by May 2000. Whether this increase in rat numbers is due to increased food supply last spring (mice) leading to increased summer breeding, lack of competition for food (mouse numbers are down this year), lack of predation by stoats (in Eglinton at least), or a combination of these things, is unknown at this early stage. However, by late summer/ autumn 2000, DOC's removal of stoats in the Eglinton Valley had resulted in a large difference in the number of stoats tracked between the two valleys. We expect the magnitude of this difference to have a major influence in interaction between rats and mice on our experimental grids. However, because we are unable to replicate the stoat removal treatment, our ability to attribute any differences we observe to the effects of predation is limited. In order to provide corroborating evidence that predation is indeed influencing the dynamics of rodent populations, we plan (1) to estimate predation risk directly by measuring rates of predation for radio-tagged rats and mice, and (2) possibly to implement a stoat press in the Hollyford Valley in the future. The press in the Hollyford Valley will allow us to directly test predictions from the initial phase of the study.

If we are able to partition the influence that food availability, predation and interaction with other rodents have on the dynamics of mice and ship rats, we will be better able to judge the broader effects of focussed pest control. For example, does intensive control of stoats elevate rat density in beech forests, or intensive control of rats elevate mouse density? If so, what are the consequences for our capacity to manage ecological processes in these environments? The nature of this work goes beyond the simple understanding of how to better manage the direct impacts that introduced mammals have in our forests. While it is true that introduced mammals in New Zealand forests have formed functional communities, with some component guilds containing multiple species, these assemblages are tightly enmeshed in the trophic networks that bind our natural ecosystems together. This project will provide important insights into how rats and mice, and the native and introduced species with which they interact, influence these networks.

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RESEARCH IN PROGRESS

Overlap in diet, impacts, and habitat use of introduced mammalian herbivores in New Zealand

As the Department moves towards multi-species management of introduced herbivores it is important to understand how managing the impacts of one herbivore may affect the behaviour and impacts of other herbivores.

In most New Zealand natural areas indigenous biodiversity is threatened by more than one introduced mammalian herbivore. However, our understanding of the consequences of focussing our management on individual herbivores, in terms of the effect this might have on other co-occurring herbivores, is poor. Hence, this research aims to characterise how similar the diets, impacts and habitat use of introduced mammalian herbivores are, so as to identify potential interaction effects that can be taken into account in future herbivore management.

A total of 62 populations of introduced mammalian herbivore diet studies have been reviewed to investigate diet overlap (Table 1). Analysis of diet at the genus level between the herbivores suggests that the widest range and greatest overlap in diet occurs between deer, feral goats and possums. This reflects both their wide distributions within New Zealand forests relative to other introduced herbivores and the lumping of several deer species into a single category for analysis (because of the small number of diet studies for individual deer species).

When diet is compared at a broad ecosystem level, herbivores exhibit considerable overlap in diet within forest ecosystems, less overlap within the alpine/subantarctic ecosystem type, and the least overlap within the heavily modified ecosystems. These patterns reflect several factors:

- that diet studies within forest ecosystems in New Zealand have concentrated on broadly similar forest types (hence diet tends to be restricted to similar plant genera);
- that diet studies within forests tend to focus on possums, deer, and goats (although pigs, wallabies, and chamois have also been studied within forest ecosystems, but to a lesser extent);
- a wider range of animal digestion systems have been studied in

TABLE 1. TOTAL NUMBER OF FOOD ITEMS PER STUDY RECORDED FOR INTRODUCED MAMMALIAN HERBIVORES FROM 62 POPULATIONS. NUMBER OF STUDIES PER ANIMAL IS INDICATED IN BRACKETS.

HERBIVORE	NO. OF STUDIES	TOTAL FOOD ITEMS
Possum	19	238
Deer	12	221
Goat	8	163
Wallaby	6	85
Pig	4	60
Chamois	3	49
Hare	3	47
Sheep	2	45
Rabbit	1	37
Thar	4	13

modified systems (lagomorphs, ungulates, and marsupials).

As part of the review of diet and impacts of introduced mammalian herbivores a preliminary database has been compiled and is undergoing development to allow searching (by animal, region, food type) of specific studies. The database is currently based within Excel' and has the following features:

1. a study summary allowing searching of author, herbivore and conservancy using a simple auto-filter function of Excel';
2. a two-way table of herbivore populations and the food types that they have been recorded as consuming;
3. a conservancy summary that lists the conservancies and the introduced herbivores studied, showing how many populations have been studied conservancy by conservancy;
4. an orderable list of food taxa that have been recorded in 25% or more of the populations sampled for any herbivore species;
5. a bibliography of studies used within the database.

The aim of the database is to provide information to managers about where (at this stage) diet has been studied within New Zealand, which introduced herbivores have been studied, and which foods they are consuming. To date our results suggest that there is considerable diet overlap between introduced mammalian herbivores in New Zealand, and between those with similar and dissimilar digestive physiology. This may mean that where control of specific herbivores occurs, and other introduced herbivores are sympatric, non-target herbivores may expand their diet range and intake to include food types previously consumed by the targeted herbivore. This is of particular concern where deer species, feral goats, and brushtail possums co-occur. This emphasises the need for a multi-species approach by conservation managers when controlling introduced herbivores.

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RESEARCH IN PROGRESS

Thermal infrared imaging for counting deer

Introduction

At present, the only ways we can measure deer abundance in N.Z. forests is either by using hunter kill returns, or by counting faecal pellet groups. Both methods are imprecise and inaccurate. Landcare Research scientists were therefore keen to see if a thermal infrared (TIR) imaging video camera could be used to generate a count index for wild deer in open forest. If successful, an affordable and more precise deer census method would be available.

Overview of TIR Imaging

Objects on the Earth's surface are heated daily by the sun. In turn, they lose heat through conduction, convection, and radiation. It is this radiant heat loss we are measuring in TIR imaging; and this is determined by the difference between an object's surface temperature and that of its surroundings.

A TIR video camera works much like a standard video camera. It contains detectors that convert thermal energy to an electrical signal in proportion to the amount of thermal energy detected. This output signal can be processed as a normal video signal, stored on video tape, and displayed on a video screen as a grey-scale image of the scene. The brightness of each pixel[1] in the image represents the amount of thermal energy detected: warmer temperatures are usually displayed as lighter tones, and colder temperatures as darker tones.

Animals maintain optimum body temperatures by balancing metabolic activity with their energy demands from activity and heat loss. It is this heat loss that is detected by TIR imaging. An animal can regulate its heat loss by changing its exposed surface area through standing, lying down, muscular activity, varying its feeding habits or its hair insulation, and by sheltering. If the radiant temperature of the animal is several degrees above that of the local surroundings it can be detected by TIR imaging, provided it is not hidden from view by vegetation.

Thermal imaging methods for animal detection and census have not been investigated much in New Zealand. There are only four previous studies: two on possums, one on seals and one on thar. Overseas, TIR imaging has been used extensively to detect a range of animal species—deer, bats, squirrels, hares, mice and birds. Some early overseas work reported that counts of white-tailed deer were accurate in non-forest conditions, but less accurate in forest because infrared radiation does not penetrate green leaf canopy. Others found that detecting white-tailed deer in non-forest conditions depended on the time of day, season, camera height and the thermal wavelengths involved. Night-time imaging was favoured as it maximised the radiant temperature differences between the deer and their surrounds.

Our study

A Prism™ DS thermal infrared camera, manufactured by FLIR Systems Inc. Portland, Oregon, USA, was used for our study.

We used a deer-proof 15-ha paddock in the upper Waitotara Valley about 50 km north-north-west of Wanganui, containing both pasture and open indigenous forest (tawa, rewarewa,

[1]A very small picture element that makes up an image.

kawakawa, kamahi, tree ferns and some scattered manuka) that held 80 fallow deer. We obtained GPS co-ordinates for the corner points of the paddock and compiled a set of flight lines without either overlap or gaps for each of three flying heights: 550 ft, 1100 ft, and 1650 ft above ground level (a.g.l.).

We videotaped TIR imagery in early summer from 3 separate flights: at dawn, late morning and dusk, using a helicopter fitted with differential GPS. This was done to determine the best imaging time, as the ground heated after sunrise until mid-afternoon and then cooled until the next sunrise. We counted the deer shown on the video tapes, then repeated the dawn flights at 550 ft and 1100 ft a.g.l. during winter, and counted the deer shown on the second tape. Deer were recognised on the tapes from their brightness and size (Figure 1).

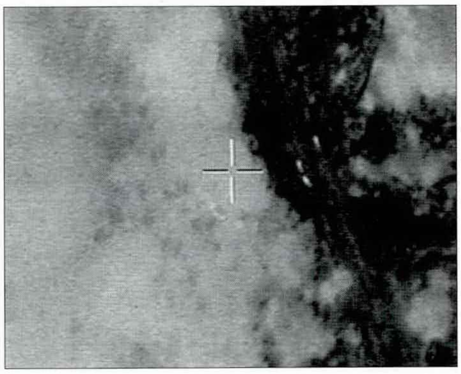

Figure 1: Deer in a grassy clearing from a flying height of 550 ft a.g.l. The three small bright objects to the right of the cross hairs are deer. The dark tones represent grass and the mid grey tones represent the forest canopy.

What we found

It was the dawn flight that gave the clearest images and the highest average deer counts of the 3 flight times (Table 1). The ground is coldest at dawn, providing the maximum temperature difference between deer and their background. Moreover, deer will move out of the forest and feed on the pasture around dawn and therefore are more readily detectable by the camera. During the late morning and evening flights, fewer deer were observed. During the day, deer usually shelter beneath the canopy and are undetected by the camera. Also, the radiant heat loss from the warm ground during the day will mask the radiant heat from the deer, making them hard to detect. An expected slight increase in counts from the early evening flight, as the ground cooled, is not shown by our results.

TABLE 1: DEER COUNTS FOR THREE TIMES OF DAY (EXPRESSED AS A PERCENTAGE OF THE NUMBER OF ANIMALS PRESENT WITHIN THE ENCLOSURE). EACH IMAGING TIME IS REPRESENTED BY THREE FLIGHTS.

IMAGING TIME	DEER SIGHTED (% OF TOTAL ANIMALS PRESENT)	
	MEDIAN	RANGE
Late morning	56	24-88
Early evening	55	12-98
Dawn	80	14-146

The numbers of deer counted increased as flying height was lowered, with obvious overcounting occurring for the 550 ft a.g.l. flight (Table 2). Overcounting may result from overlapping flight lines, with some animals being imaged more than once. This can occur when navigational errors arise if reception of the GPS differential correction signal is blocked by surrounding hills. Another cause of overcounting is confusion of deer with other warm objects such as rocks, logs, small pools of water and bare soil. On average, deer appear 2.3°C warmer than their immediate background temperature at a flying height of 550 ft a.g.l., with the difference dropping to

TABLE 2: DEER COUNTS FOR THREE FLYING HEIGHTS (EXPRESSED AS A PERCENTAGE OF THE NUMBER OF ANIMALS PRESENT WITHIN THE ENCLOSURE). EACH IMAGING HEIGHT IS REPRESENTED BY THREE FLIGHTS.

IMAGING HEIGHT (ft a.g.l.)	DEER SIGHTED (% OF TOTAL ANIMALS PRESENT)	
	MEDIAN	RANGE
1650	19	12B25
1100	58	31B85
550	116	87B146

TABLE 3: TEMPERATURE DIFFERENCES BETWEEN DEER AND THEIR SURROUNDS, MEASURED FROM THE WINTER FLIGHTS. EACH RESULT IS A MEAN OF SIX MEASUREMENTS.

IMAGING HEIGHT (ft a.g.l.)	MEAN TEMPERATURE DIFFERENCES (°C) BETWEEN DEER AND BACKGROUND	
	MEAN	RANGE
1100	1.9	1.2-2.5
550	2.3	1.9-2.9

1.9 °C at 1100 ft a.g.l. (Table 3). This is because the closer the camera is to an animal, the more animal and the less background it detects in a pixel, so the warmer and brighter the animal appears (Figure 2). As the camera gains altitude, the opposite applies and the brightness of the animal is reduced and appears closer to that of its background.

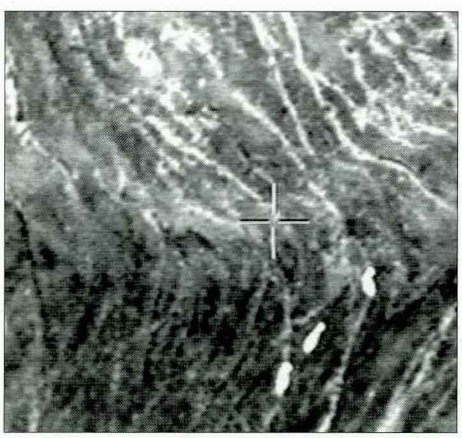

Figure 2: Three fallow deer within pasture, imaged from 50 ft a.g.l. At this low level, where many pixels lie on each animal, the deer appear very bright as well as large. Other bright patches in the image are areas of bare ground including sheeptracks.

In conclusion

While good at detecting the presence of animals and showing trends related to time and height a.g.l. of imaging, this method is unlikely to provide a count index except in some well-defined situations, because of the high level of variability between counts. Success of this method depends on the deer browsing in open forest clearings. If animal detection and counting by TIR imaging is to be successful within forest or scrublands, the canopy must be sufficiently open for a good proportion of the deer to be detected.

We found the best time to count deer using TIR imaging was shortly after dawn when both the ground and vegetation were still cold, and there was a significant temperature difference between the deer and their background. We also found that the best flying height to maximise deer sightings was 550 ft a.g.l.

More advanced thermal cameras are unlikely to improve TIR imaging in forested areas, as the greatest constraint with the method is vegetation that prevents transmission of thermal energy and obscures the animal. For animal census in non-forested environments, however, gains in technology such as smaller pixel size and better camera stabilisation will improve detection rates.

R. H. Wilde
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INFORMATION TRANSFER

Conservation Corps volunteers have been fundamental in improving the habitat of a localised moth in South Taranaki (North Island)

Figure 1: A female *Notoreas* "Taranaki" moth ovipositing on the food plant, *Pimelea* cf. *urvilleana*. Photo: Jim Clarkson.

Notoreas "Taranaki" (Figure 1) is a brightly coloured, day-flying moth whose caterpillars feed on leaves of *Pimelea* cf. *urvilleana*, a prostrate shrub that grows amongst salt-tolerant herbfields above sea cliffs. In Taranaki, all of this habitat occurs at the edge of pasture, on private land. Many patches are under severe threat from trampling by cattle, weed encroachment, and associated human use (e.g. quarrying, informal car parks for coastal access etc). Through the efforts of Stratford Area Office staff the future of the *Notoreas* moth and its food plant is improving. Careful survey and monitoring since 1996 has extended the range of the food plant, and moths are now known from 6 of these patches. Moths were recently found in Northwest Nelson coastal herbfields, which reinforces the biogeographic link between the North and South Islands.

In Taranaki, farmers and iwi have been enthusiastic and supportive of efforts to conserve the herbfields and the moths, with spinoff benefits to other locally threatened taxa. DOC has undertaken weed management at several of the herbfield remnants.

At one site, Conservation Corps volunteers have successfully controlled weed invasion into the most sensitive areas amongst patches of tiny forget-me-nots. These are quite rare plants in the North Island (but more abundant elsewhere). In Figure 2, Lisa Sinclair (centre) shows a volunteer some of these pen-nib sized plants that can be carefully avoided during the weeding process.

Figure 2: Lisa Sinclair (right) shows a Conservaton Corps volunteer rare forget-me-not plants. Photo: Jo Priestly.

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OTHER PUBLICATIONS

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P.D. Champion; W.B. Shaw. 2000. *NIWA Client Report DOC80217.* 111 p.

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Visitor information as a management tool. A review.

P. MacLennan. 2000. *Science & Research Internal Report 180.* 48 p. $22.50 incl. GST.

Review of satisfaction research and measurement approaches

T.M. Latu; A.M. Everett. 2000. *Science & Research Internal Report 183.* 47 p. $22.50 incl. GST.

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