Evaluation of captive Kea (*Nestor notabilis)* management practices in New Zealand and their effect on behavioural repertoire.

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Journal Style

This report has been written in the style of the Zoo Biology Journal. Zoo Biology's aim and scope is concerned with the 'behaviour and husbandry of wild animals in wildlife parks and zoos' (Wiley-Liss, Inc, 2005) and as such is targeted towards the appropriate audience which my research addresses.

Contribution

Information on wild Kea activity budgets was calculated from data collected by Brejaart (1994) on her research of wild Kea in Arthur's Pass and Craigieburn Valley in the South Island, New Zealand. All other work in this report, including all data collection, is my own.

Abstract

The aim of this research is to investigate specific captive management practices of Kea (*Nestor notabilis)*, in New Zealand, with the purpose of identifying possible correlations between these practices and their effect on behavioural repertoire. Management practices under study include enrichment programmes, social composition of groups and environmental complexity. Kea origin was also considered to see if this had an effect on expression of behaviours.

This study seeks to provide baseline data which may be utilised in future captive management of this species.

This research is divided into 2 parts and includes review of present captive management of the species by holders around New Zealand through completion of a questionnaire and identification of possible correlations between the three specified management practices and group behavioural repertoire, identified through collection of observational data.

The resulting data from the questionnaire was used to choose a representative sample of the population for behavioural observations. A total of 3137 minutes of behavioural observations was recorded over 13 facilities during August – September, 2005. Subjective information on extent of stereotypic (repetitive) behaviours indicated 77.8% of the captive population showing some degree of repetitive performance.

Effect of origin on performance of repetitive behaviours, indicated that wild caught Kea exhibited minimal stereotypic performance. Therefore further analysis of the known captive bred only population was done. These results showed a significant negative correlation between frequency of repetitive behaviours and level of enrichment. Analysis of frequency of feeds given to Kea in each facility per day also showed a significantly increased level of performance of foraging and investigative/manipulation behaviours in facilities which fed their birds twice a day versus those who fed them only once and a significant decrease in body maintenance behaviours such as self preening.

Increased enclosure complexity was positively correlated to increased agonistic behaviours (displacement behaviours) over all groups and negatively correlated to time off display in those groups with an off-exhibit area.

Group composition did not appear to have any significant affect on performance of behaviours under study, however as Kea are a social species, it was concluded that this was an important variable which requires additional research.

Further study is necessary to explore these findings in depth across and outside the breeding season in order to draw conclusive results on effect of each of these management techniques on behavioural repertoire. Additional studies on public perception of Kea and their portrayal in facilities should also be undertaken so as to increase the positive advocacy opportunities which are also a requirement under the Department of Conservations (DoC) Management Guidelines (Pullar, 1996).

Introduction

Captive Management of Species

"In the very best zoos, wild animals can be seen as ambassadors for the survival of their species in the wild. In the worst zoos, they generate nothing but negative reactions". This statement by Hancock (2001) aptly highlights the importance of captive facilities roles in advocacy of wild species. However, successful management of wild animals in captivity can be difficult, requiring housing of animals in such a way that fulfils both their physical and psychological requirements (Croke, 1997; Young, 2003). This involves enormous commitment and an in-depth knowledge of species typical behaviours so that any abnormal behaviours may be recognised and appropriately managed. In order to preserve threatened species the whole animal, including learned and cultural behaviours (Croke, 1997) must be given the opportunity to be passed down through to successive generations. As such, the effect different management techniques have on behavioural repertoire of a species is extremely important to ascertain. Animals that are housed in environments which do not provide opportunity for expression of natural behaviours are often seen to develop stereotypies (Carlstead, 1998). As such psychological wellbeing of an animal is often measured by the presence of abnormal behaviours such as stereotypies (Mason, 1990) as well as normal behaviours that occur at atypically altered rates or activity cycles (International Primatological Society 1993, as cited in Shepherdson et al, 1998).

Stereotypies

Stereotypies - repetitive behaviours which appear to have no obvious goal or function (Mason, 1990) - have long been used as welfare indicators, and as they are not seen to be exhibited within wild animal populations, their development has been linked to sub-optimal captive environments which discourage expression of natural species specific behaviours (ibid).

Studies of Macaques (Mallapur et al, 2005), a primate species with a complex social system and high level of cognition, have indicated that the occurrence and level of abnormal behaviours is profoundly influenced by the animals' enclosure complexity, group composition and rearing history. Socially deprived animals in barren environments which did not allow performance of natural behaviours were found to be the most severely affected. However as an indicator of abnormal behaviour, stereotypies may not always be reliable - in this particular study they were found never to be exhibited by those animals caught from the wild, only by captive born or privately owned individuals. This is backed up by results of behavioural studies of wild caught and laboratory bred Bank Voles (*Clethrionymus Glareolus)* (Cooper & Nichols, 1995). The authors concluded that the absence of stereotypic behaviour could not be used as a reliable indicator of welfare, as performance by individuals was dependant on other factors such as origin and individual past experience.

Research on stereotypy performance of avian species (Kieper, 1969) has shown evidence that birds of wild origin do perform repetitive behaviours. However these behaviours

were expressed in different forms to their captive counterparts. Route tracing (a locomotor activity), was expressed by wild caught individuals and was effectively negated on introduction to large aviaries. It was therefore seen to be associated with physical restriction on movement imposed by the cage (ibid).

Detailed behavioural studies of captive Kea in the 1970's (Potts, 1977 & 1976), do not mention any evidence of stereotypic behaviours in this species. However unpublished observational studies on captive Kea (Auckland Zoo, 2003) and anecdotal evidence from keepers, have established initial evidence of performance of stereotypies in this species in captivity, although only by one captive bred individual. However, as social and opportunistic species are considered to require a more variable environment to prevent the performance of stereotypic behaviours (Kreger et al, 1998), the true level of stereotypies being performed in captivity may be as extensive as other species with similar exploratory requirements.

Research by Garner et al (2003) into the development of stereotypic behaviour in Orange – Winged Amazon parrots, has shown that stereotypies develop in response to the captive environment and are indicative of psychological distress and frustration. As with schizophrenic and autistic human subjects, there is evidence of disinhibition of the behavioural control mechanism of the dorsal basal ganglia (which is crucial in motor learning and control (Kao et al, 2005)) resulting in a tendency to form inappropriate repetitive motor responses. Garner et al (2003) go on to conclude that performance of stereotypies is an indicator of poor welfare and should raise ethical questions as to the appropriateness of housing of animals in barren or restricted environments.

One method of preventing and reversing the performance of stereotypies is with appropriate environmental modification (Meehan et al, 2004).

Environmental Enrichment and Effect on Behaviour

Environmental enrichment is a means by which the captive environment is enhanced through the introduction of complexity and unpredictability into the environment (Young, 2003). It aims to increase captive animals' behavioural choices to allow expression of natural behaviours, thereby enabling the animal to fulfil its motivational requirements. Through provision of a more stimulating environment, the incidence of abnormal behaviours (such as stereotypies) and stress can be reduced or eliminated thus positively impacting on animal welfare (Young, 2003).

5 types of environmental enrichment are identified by Bloomsmith et al and include social, occupational, physical, sensory and nutritional enrichment (cited in Young, 2003). Nutritional enrichment is often introduced via different modes of delivery (which includes variation in frequency and presentation), and type (eg. browse and treats) (Young, 2003), and is widely used in captive facilities to increase foraging and investigative behaviours. These behaviours have been shown to decrease stereotypic behaviours (Croke, 1997).

There have been many studies on the effects of enrichment on behaviour performance of a variety of species. Effectiveness of enrichment regimes is linked with species requirements and individual history and status. Experimental studies on Amazon parrots

by Meehan et al (2004) showed that individuals kept in environments lacking enrichment developed significantly more stereotypy than enriched individuals. Following provision of enrichment to the unenriched group, stereotypy incidence was seen to significantly reduce after an initial 4 week delay. Previous studies by Meehan & Mench (1991) also found that the provision of enrichment decreased the fear response to novel objects and unfamiliar handlers, and as a result was seen to increase both physical and psychological welfare.

Group Composition and Effect on Behaviour

Social enrichment of species is considered to be crucial for maintenance of normal species specific behaviours (Kreger et al, 1998). It is generally acknowledged that group housing of any social species is necessary for psychological health of individuals and as a form of enrichment is one of the most complex and effective, assuming group structures are appropriate (Young, 2003). Inappropriate group makeup and size can negatively impact on reproductive success of some species such as flamingos, possibly through stress levels on individuals who rely on large groups for predator protection (ibid). In studies by Schapiro et al (1996), Rhesus monkeys held in social groups or pairs were found to have increased play and decreased abnormal behaviours, self-grooming and vocalisation: patterns of behaviour which are seen to be more species typical (Lindburg, 1971 as cited in Schapiro et al, 1996). It was also concluded that the benefits of social enrichment far outweighed the benefits of any other forms of enrichment, hence its importance in captive management (Schapiro et al, 1996).

Kea as a social species must be held with other con-specifics as stated by the Captive Management Plan (Pullar, 1996). As stated by Jackson (1960) and Clarke (1970), they are also a highly mobile species, forming and dissolving flock groupings depending on age of individuals and season. How this impacts on captive management of this species is not known, as there is no published literature at this stage on what constitutes effective captive group size and composition of this species.

Enclosure Complexity and Effect on Behavioural Repertoire

Physical enrichment relates directly to the physical environment/enclosure that an animal is confined within. Enclosure complexity and design is crucial for maintenance of an animal's physical and psychological wellbeing. From a physical point of view, if an enclosure does not enable a species to perform its basic form of locomotion, then it is viewed as deficient in design (Young, 2003). Inability of animals to perform basic locomotor behaviours (in this instance flight) may result in atrophy of associated muscle groups as well as manifestation of inappropriately directed behaviours – namely stereotypies. This is documented in Kiepers (1969) where stereotypic route pacing in wild birds was extinguished when birds were introduced to larger aviaries which allowed appropriate levels of flight. However, larger enclosures on their own are not necessarily better, as space within that area may not be physically or psychologically utilisable by the species concerned. Enclosure design should therefore be species specific and take into account variation in topography, substrate types (as defined by Eisenberg, 1981 as cited in Young, 2003, p 122) and include a range of utilisable space and levels.

Kea in the wild cover an extensive range and variety of ecotones (Diamond & Bond, 1999). Whether the captive environment has the ability to provide this species with the environmental challenges necessary to maintain psychological health is yet to be established.

High Priority Species

Identification of species which require a high level of complexity and variability in their captive environment has been described separately in literature by Mench and Kreger et al (1998). Mench (1998) proposes that species considered high priority are those which have complex environmental demands in their wild state. These demands potentially impact on survival probability and as such, the ability of the individual to make complex cognitive decisions is crucial for survival. Generalist species adapted to highly variable habitats, species with complex social structures and/or those which exhibit complex anti-predator behaviours, are all required to make decisions from information previously learned and interpreted (ibid).

Kreger et al (1998) concludes that long ranging opportunists have a greater requirement for enrichment as they are more likely to develop atypical behaviours such as stereotyping. To illustrate this he compares highly exploratory, opportunistic species such as bears, with dietary specialist species such as koala. The latter species is not required to explore their environment for potential novel food opportunities and therefore information gathering behaviours within their environment are not exhibited to the same extent.

Kea are considered a highly intelligent and complex social species with many of the attributes that support cognitive abilities (Gadjon, 2005). They are opportunistic feeders with an almost complete lack of neophobia, and as such fit into Kreger and Menchs respective models of a species requiring high levels of novelty and variability in their captive environment (Mench et al, 1998).

Kea

Kea (*Nestor notabilis),* are a psittacine species endemic to New Zealand's South Island alpine areas. They inhabit a highly variable environment which is both complex and demanding. They are the world's only alpine parrot and as such are unique.

Kea are a highly gregarious species which in the wild, form large flocks with non-linear hierarchies. Once adults reach breeding age they tend to leave the main flock and pair up for breeding. Males may pair with several females and help in maintenance of the hens and their broods during the breeding season. Laying begins in July and peaks in October, but can extend right through into January (Jackson, 1962; Jackson, 1960).

Territories are extensive and can cover up to 4kms² (Jackson, 1969; Elliott & Kemp, 1999). Studies by Clarke (1970), of Kea population, movements and foods in Nelson Lakes National Park, showed very definite changes in group composition and location related to different times of the year. During August - September it was observed that Kea formed flocks of 6 -8 birds which dispersed in October – December into smaller

groups of 2 – 3. In January and February large flocks of up to 13 individuals again formed. Studies by Jackson (1960) in Arthurs Pass also observed large groups of around 20 first year birds during the summer period. These large flocks in each study were then seen to disperse into groups of 2 -6 in Autumn. Movement of all groups was seasonally and food related with those birds moving to higher altitudes (4,000 – 7,000 ft) in the warmer months observed foraging for food, and retreating back to the shelter of beech forests (up to 4,000 ft) during autumn and winter. Almost 200 different food items were observed to be consumed by Kea over the year and were made up predominately of the fruits, seeds, roots, leaves, buds and flowers of native plant species, as well as insects and their larvae (Clarke, 1970). As such, Clarke highlighted the potential importance of Kea, as the only significant berry eating species in alpine areas, in the dispersal of the seeds of native alpine plant species.

Prior to 1971, a Government bounty for Kea beaks was in place. The legal culling of this species was due to a misconception that they were prolific sheep killers and therefore a menace to the New Zealand farming industry. This resulted in over 150,000 being killed between 1860 - 1970 (Pullar, 1996). Kea only gained full protection status in 1986 under the Wildlife Act, 1953. The Kea is now listed as a Nationally Endangered species by the Department of Conservation (Hitchmough, 2002) and is listed as Endangered by the IUCN. They are therefore regarded as facing a high risk level of extinction in the wild with an estimated number of 1000-5000 individuals remaining (Bond & Diamond, 1992). This uncertainty in estimates of population size is due to the extended range and behaviour of this species resulting in problems in surveying and monitoring of the

remaining population. The South Island high country areas are now under the management of the Department of Conservation, however it should not be assumed that this engenders instant protection for the wild population. Severe degradation of this environment and therefore the natural food sources of Kea through historical clearing and farming practices of settlers have already raised issues of their ability to survive in the altered landscape. The transfer of high country sheep stations to conservation estate has reduced the availability of foods which has been normally accessible through human habitation. Without such food supplementation, Kea may face one of their biggest threats yet. This is highlighted by historical studies done by Jackson (1969) which listed starvation and direct human interference as the greatest causes of death in the wild.

Captive Management Plan

The Kea Captive Management Plan objectives aim to maintain genetic diversity within the captive population, ensure minimum husbandry requirements are met by all holders and maximise advocacy and research opportunities as a means of supporting "conservation of the species in the wild" (Pullar, 1996. p 5). Consequently all permitted holders of this species in New Zealand are coordinated and their Kea monitored by the studbook keeper through completion of an annual survey.

However, at present there is very little information on how Kea are being held, or what management practices are being used by individual holders. It is also unknown as to what best practice for this species entails in order to ensure a healthy population capable of fulfilling DOC's management goals.

The captive population has been reduced over the past 10 years from 212 birds to just under the target number of 100 individuals. These include birds that are either wild caught, captive bred F1 progeny of known founders, or of unknown origin or parentage (Pullar, 1996). Now that the target number has been reached, there is the possibility of controlled breeding among those birds of known origin and parentage in the near future. Many of these birds, however, are currently held in single sex groups or are from an aging population and have not had the opportunity to interact with the opposite sex, and/or breed and successfully raise viable offspring.

Recommendations for management of *Nestor* captive populations by Seal et al, (1993) state a strong research priority for this species to enhance in-situ knowledge. This includes studying and analysis of reproductive behaviours and population dynamics and developing techniques for husbandry that may be used for enhancing wild populations or help with possible re-introduction and supplementation. Establishing the best way to hold the population of potential breeding individuals in order to maintain both physical and behavioural integrity is therefore essential in establishing a self-sustaining population with maximum genetic diversity. In addition, it is also necessary to establish how best to hold the non-breeding population to ensure best possible welfare for the remainder of their captive lives.

It is not to be overlooked that both these populations have a role to play in advocacy and research for the species as a whole. Therefore maintenance of physically and behaviourally healthy individuals is imperative.

There has been little or no study on appropriateness of current management practices of captive Kea here in New Zealand. Therefore it is premature to focus on just one aspect of husbandry practice until baseline data is identified and collated. This study seeks to provide baseline information which may be used to standardise best management and husbandry practice to meet DOC's Management Plan and Population Viability Analysis goals and recommendations. The goals stated in these two documents aim to manage a captive population that is both self-sustaining and of appropriate genetic diversity to support conservation of the species in the wild and to maximise research and advocacy opportunities (Pullar, 2006 and Seal et al, 1993).

Research Aims

The aim of this research is to investigate specific captive management practices of Kea (*Nestor notabilis)*, in New Zealand, with the purpose of identifying possible correlations between these practices and their effect on behavioural repertoire.

Specific management practices investigated included enrichment programmes, social composition of groups and environmental complexity. The degree of complexity of each of these and their effect on behavioural expression was then investigated and any trends identified. Kea origin was also considered to see if this had an effect on expression of behaviours.

Questions identified within this study include:

- What prevalence of stereotypies is evident in the captive population?

- Are stereotypies prevalent to the same degree in both wild caught and captive bred Kea?
- What is considered normal species specific behaviours?
- What management practices increase performance of these behaviours?
- What practices decrease the prevalence of abnormal stereotypic behaviours?
- What is optimal group composition of this species in captivity?

Methods

This research was divided into 2 parts and included:

Part 1. Review of present captive management of the species by holders around New Zealand through completion of a questionnaire sent out to all holders and;

Part 2. Identification of possible correlations between these different management protocols and group behavioural repertoire identified through collection of observational data.

Data Collection

Part 1. Questionnaire (qualitative and quantitative data):

A 19 question survey was developed and trialled on Native Fauna keepers at Auckland Zoo. After final modification it was sent out to all known 35 holders of Kea around New Zealand (99 birds in total) to provide information on the following:

- Demographics of captive population (gender, age, origin)

Origin of Kea held was identified as either captive bred, wild caught or unknown.

- Social grouping (single sex, pairs only or mixed sex groups)
- Enclosure size and complexity

Enclosure features identified, included live trees and vegetation, rock outcrops, water features, substrates, perches, cut logs and others to identify. These findings were not included in the analysis of enclosure complexity, but gave general information as to the status of enclosures overall.

- Degree of enrichment and conditioning/ training in place

Subjective enrichment information was entered by the holders on type and frequency of enrichment provided. This was then measured objectively on a scale of 0-3 with 0 indicating no enrichment, 1 low enrichment (ad lib on a weekly/monthly basis), 2 moderate enrichment (provided several days per week/weekly basis) and 3 a high level of enrichment (provided consistently on a daily basis).

- Subjective data on behavioural repertoire

This required the holders to make a subjective assessment of prevalence of specific behaviours such as head-swing, route pacing, self feather plucking and aggression. Any other behaviours were also to be noted as observed during the normal working day. This information was then used to gain a general view of what behaviours were being seen and the extent of stereotypic performance in the captive population.

Information on enclosure size, enrichment complexity and group composition was then use in the analysis.

(Refer Appendix 1 for questionnaire layout).

Part 2. Behavioural Observations:

Observations included recording of information on individual enclosure complexity, number of feeds per day and behavioural repertoire. Behavioural observations were conducted throughout August - September, 2005 on selected groups of captive Kea around the North Island to show prevalence of specific behaviours within the different management practices (enrichment; social composition, enclosure complexity). Groups

were selected on the basis of group composition , varying enclosure size and complexity, and level of enrichment.

An ethogram was developed (Appendix 3) and preliminary testing was carried out on the Auckland Zoo group of 3 bachelor Kea over a period of 2 days before commencement of actual observations of the selected facilities (13 in total). The facilities housed a sample number of 37 individuals (23 male - 14 female), from a total captive population of 99 Kea. Each facility was observed over 1 day for 3 -5 hours (between the hours of 9-5pm).

Table 1: Group Composition of Observed Holders

Group composition of Selected North Island Facilities	**Number of Facilities sampled**
Single sex groups	4 (3 male only; 1 female only)
Pairs	4
Mixed sex groups	5*

**Several of the mixed groups had a paired male/female with one or more additional individuals.*

Instantaneous scan sampling at 1 minute intervals was used to show frequency spent performing the listed behaviours and frequency spent in specified locations in enclosure. Behaviours identified during recording sessions included stereotypic/repetitive behaviours; locomotive behaviours (walking/running, climbing, flying); immobility; body maintenance behaviours (self preening and bathing); social interactions (reproductive interactions, allopreening, non-reciprocal feeding and agonistic

behaviours); feeding/foraging and manipulative/investigative behaviours (refer description of behaviours in Appendix 4). Locations observed within the enclosure area included ground vs perch, water features and out of sight.

Enclosure complexity

Enclosure complexity was rated on a scale of 1-16 and was measured on variability in topography, substrates, presentation of water (still and running), live vegetation and permanent furniture such as complex artificial structures, rock walls, variable perch levels and rotten logs (refer Appendix 2 for complexity list and ratings).

Analysis of Data

Descriptive analysis of both the questionnaire and observations was conducted and then followed up by statistical analysis using SPSS to ascertain levels of significance (Pallant, 2001).

Spearman's Rank Order Correlation was used to calculate the strength of the relationship between continuous variables. This test was used to identify correlations between level of enclosure complexity and frequency of behaviours and level of enrichment and performance of behaviours.

Mann-Whitney U Tests were used to test for differences between two independent groups on a continuous measure. This test was used to look at differences between origin and

behavioural repertoire, number of feeds per day and behavioural repertoire (Pallant, 2001).

Analysis of multiple independent variables was achieved using Kruskal–Wallis H Tests. This analysis was use to look at group ID effect on behavioural repertoire.

Analyses were conducted to identify any correlations between behavioural performance and management practices taking into account specific individual and husbandry variables within the study population (sex, origin, number of feeds). Information gathered from the observations was then compared with wild time budgets.

Results

Questionnaire

A total of 27 questionnaires were completed by Kea holders and returned to Unitec (77% return rate).

Demographics

Out of a total of 70 individuals, male /female ratio was identified as 59% male (41) and 41% females (29). Of these birds 50% (35) were captive bred, 23% (16) wild caught and 27% (19) of unknown origin/parentage. This information was then checked against studbook information to make sure correct data was obtained.

Group composition was relatively evenly distributed between single sex groups (9), mixed sex groups (8) and pairs only (8). There were also 3 singly held male Kea held in private ownership. When cross referenced with studbook information it was found that out of the 8 pairs identified, only 2 were founder pairs (both well -represented in the captive population), 1 were an F1 pair, 4 had at least 1 individual of unknown origin, and 1 were paired siblings. Therefore only 3 pairings fulfilled possible breeding criteria of being either founder or F1 individuals (Pullar, 1996), although 2 of these pairs could be discounted due to the fact that they were already well represented in the captive population. Within the 5 mixed-sex groups that were observed there were at least 3 definite pairings identified (ie a pair bond going through mating, feeding and nesting behaviours). Out of these 3 possible pairings, only one was between a founder and F1 individual. All others were paired with at least 1 bird of unknown origin.

(Refer Appendix 5 for summary table of demographic information collected on the 70 Kea represented in the survey).

Stereotypic Behaviours

Subjective information received on holders' observations of Kea behavioural performances was used to broadly identify the extent of stereotypic performance across the population. 21 out of 27 facilities surveyed (77.8%) recorded Kea which displayed some level of stereotypic behaviour. A total of 43 individuals (61% of the surveyed population) performed stereotypies. These were made up of 28 males (68% of total males surveyed) and 15 females (52% of total females).

Management Information

Enclosure Size

Enclosure area was calculated by holders and ranged in size from 6.5m³ to 801m³. Three were identified as being under the minimum standard of 6mx 3mx 2.5 m (total of 45m³) per 2 birds, eight were above the minimum standard to 100m³; eight between 101 – 200m³; five between 201 – 300m³; one between 301 – 400m³; one at 540m³ and one at 801m³.

Enrichment Details

Out of the 27 holders, 22 utilised some level of enrichment. 9 holders had minimal enrichment (level 1); 11 had moderate enrichment (level 2); and 2 had a high level of enrichment (level 3).

The resulting data from the questionnaire was then used to choose a representative sample of the population for behavioural observations. Appropriate objective data from the questionnaires (demographic information, group makeup and enclosure size) was entered into SPSS along with observational data to ascertain any trends in behavioural performance associated with these variables.

Behavioural Observations

A total of 3137 minutes of observations was recorded over 13 facilities during August – September, 2005 (an average of 241 minutes per facility). Group composition consisted of 4 single sex groups, 5 pairs only and 4 mixed sex groups (a total of 37 individuals made up of 23 males and 14 females). Origin of the observed population was made up as follows: 8 wild caught, 24 captive bred and 5 of unknown origin.

Management Information

Enclosure complexity

Two of the observed facilities had enclosure complexities of 5 or less; five had ranges between 6 -8; five with ranges 9-11 and one at complexity level 13.

(Refer Appendix 2 for tabulated information on facility scores).

Enrichment Complexity

Four of the sample population had no enrichment; three holders had enrichment level 1; 4, enrichment level 2 and 2 at enrichment level 3. As part of the enrichment regime, 3 out of the 13 facilities provided feeds twice per day versus only one in all other facilities.

Behavioural Repertoire

Stereotypy Performance

Initial analysis of data did not find any significant effects of any of the management techniques on performance of stereotypies. However, it was found that this was due to the fact that wild caught birds as a subset of the captive population were found to exhibit minimal levels (if at all) of repetitive behaviours throughout the study period. Further analysis of Kea origin showed that this variable had a significant effect on performance and prevalence of repetitive behaviours ($\chi^2 = 7.716$, d.f. = 2, P= 0.021) with wild caught birds showing significantly reduced frequency of stereotypic behaviours in comparison to captive bred birds (as seen below in Fig. 1).

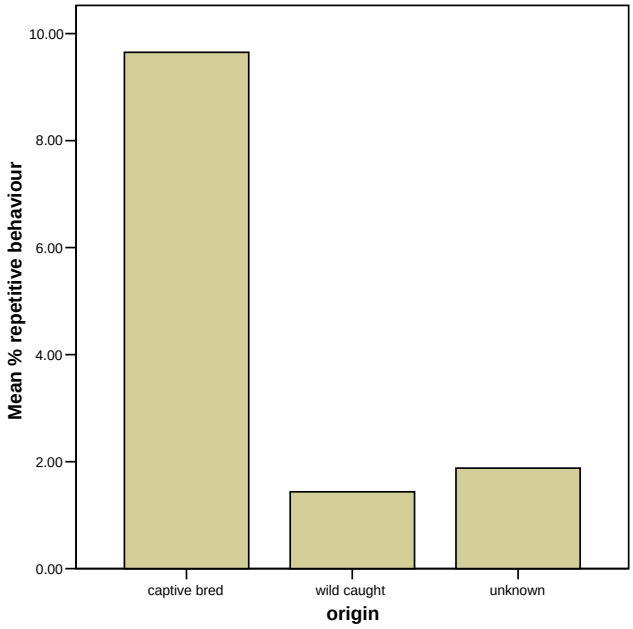

Fig 1: Kea Origin and Mean % of Repetitive Behaviours

Only 2 wild males were observed to perform low levels of stereotypic route tracing (at levels of 11% and 0.5% each). Both these males were paired with nesting females who

showed a high degree of agonistic behaviours (6% and 5.5% respectively (mean agonistic behaviours over all facilities was 4.3 %). Stereotypic behaviours identified in the captive population sampled, included route tracing, head swing/flick, and/ or self manipulation and rocking behaviour. Enrichment level was consistent over both wild caught and captive bred sub-groups whilst level of enclosure complexity was marginally greater in the captive bred subset (levels of 5-13 in captive bred birds versus 4 - 11 in the wild caught group). However overall, it was considered that these 2 variables were thought to have a limited effect on behavioural repertoire between the two origin subsets.

Effect of Enrichment on Stereotypies in Captive Bred Individuals

Level of enrichment was significantly negatively correlated to frequency of repetitive behaviours in the captive bred population ($r = -0.047$; $n = 24$; $P = 0.048$)(refer Fig 2).

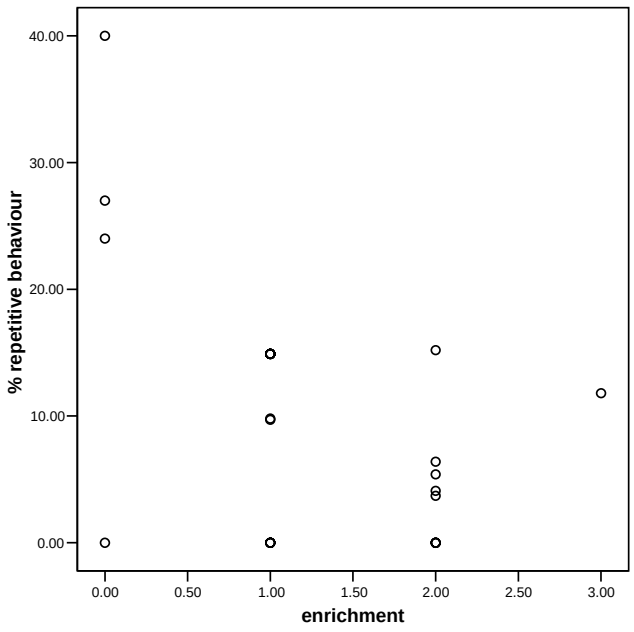

Fig 2: Effect of Enrichment on Performance of Repetitive Behaviours in Captive Bred Kea.

Additionally, analysis of number of feeds given to both captive bred and wild caught Kea in each facility, showed a significantly increased level of performance of foraging and investigative/manipulation behaviours in facilities which fed their birds twice a day versus those who fed them only once ($z = -2.163$; $n = 13$; $P = 0.034$). Those Kea fed twice a day showed over double the frequency of performance of these behaviours (as seen below in Fig 3) and a significant decrease in body maintenance behaviours such as self preening ($z = -2.318$; $n = 13$; $P=0.02$) (refer Fig 4).

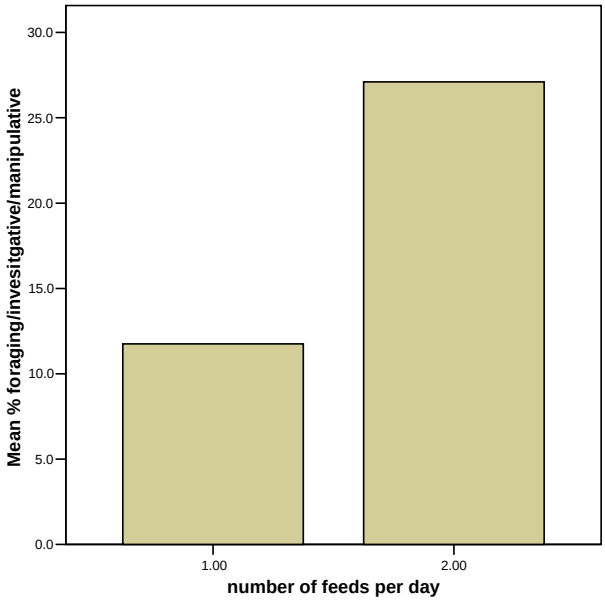

Fig 3: Effect of Number of Feeds per day on Frequency of Foraging/Investigative and Manipulative Behaviours

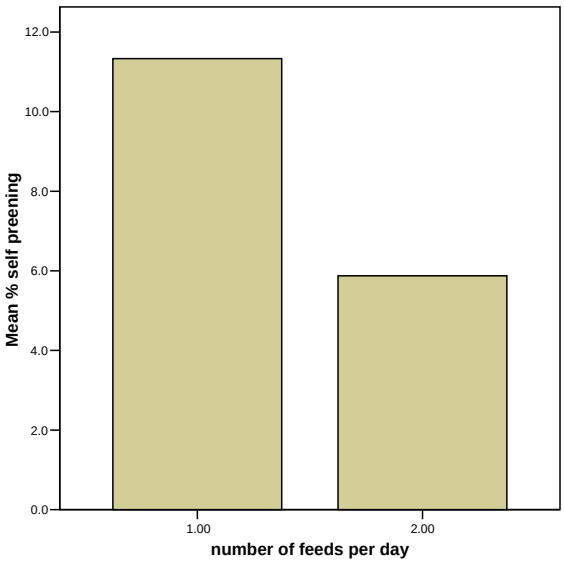

Fig 4: Number of Feeds per day and Mean % of Self Preening Behaviour

Although there was no significant level of correlation between any of the management practices and time that individuals stayed out of sight (in those facilities where there was the opportunity to do so), descriptive analysis of number of feeds per day showed a negative correlation between this variable and time spent off view (Fig 5).

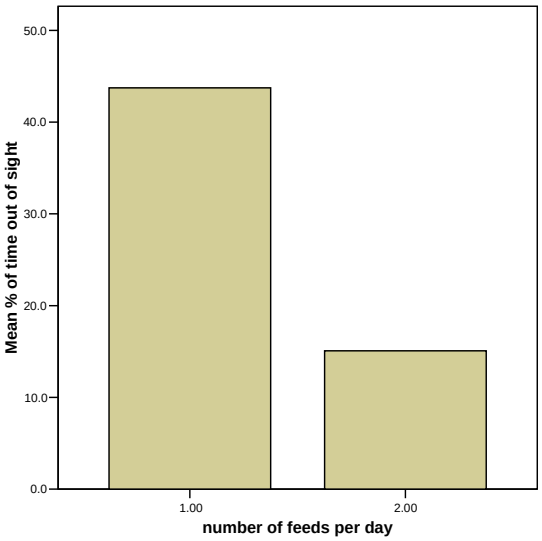

Fig 5: Number of feeds per day and time spent out of sight

Effect of Enclosure Complexity on Behavioural Repertoire

Variables which were taken into account during analysis of effect of enclosure complexity on behavioural repertoire included origin of birds, group composition and level of enrichment provided in the enclosure.

Captive bred Kea were housed in more complex enclosures ranging from a complexity level of 5-13, with wild caught Kea in enclosures with complexity levels of 4 -11.

Single sex groups were housed in enclosures of complexity 6-10, mixed groups 7-13 and pairs in 4-7 with one in an enclosure of 11 complexity rating.

The level of enclosure complexity was not seen to significantly affect performance of any behaviour under study except that of frequency of agonistic behaviours ($r = 0.504$; $n = 37$; $P=0.001$) seen below in Fig 6. As complexity increased the prevalence of agonistic behaviours increased in all Kea.

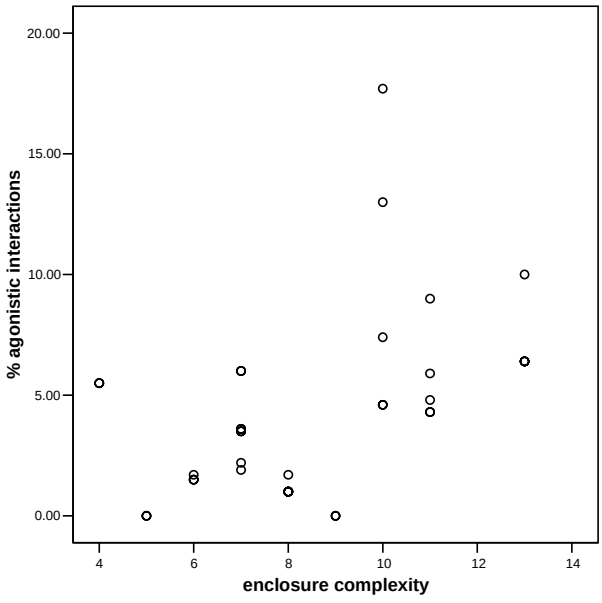

Fig 6: Enclosure Complexity and Frequency of Agonistic Behaviour in Captive Kea.

Also those enclosures with high complexity were predominantly mixed sex groups with a dominant pair-bond. Pair bonded females were more likely to displace other unpaired birds (particularly unpaired females).

Time spent out of sight was significantly negatively correlated to increasing enclosure complexity ($r = -0.829$; $n= 6$; $p= 0.042$) as seen below in Fig 7.

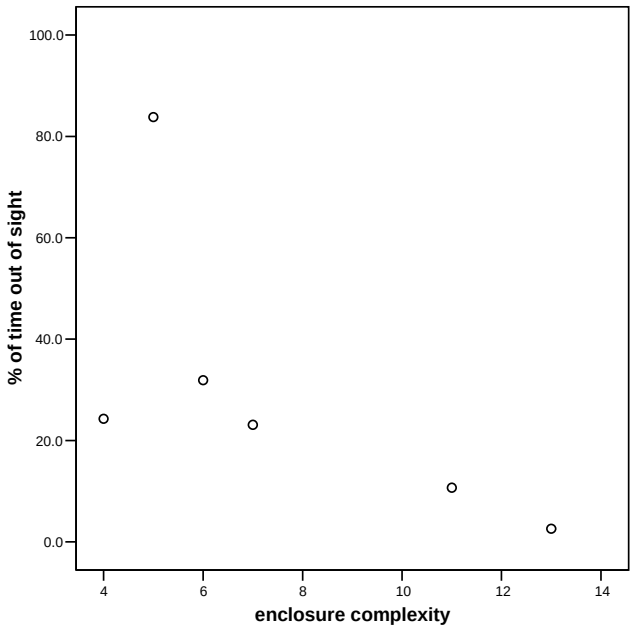

Fig 7: Time spent out of sight and enclosure complexity

Effect of Social Composition on Behavioural Repertoire

Group composition was not seen to have any significant effect on performance of behaviours, inclusive of stereotypies, under study. However there was a degree of variability in level of enrichment and enclosure complexity over the different social groups which should be taken into account during this analysis.

Single sex groups were distributed evenly over the different enrichment levels (0-3) whilst mixed groups had enrichment levels of 0-2 and pairs either no enrichment or moderate (level 2). In relation to enclosure complexity, single sex groups were housed in levels of 6 - 10 complexity, mixed groups in 9 – 13 complexity and pairs in 4-7 with one of level 11 complexity. Mixed groups (with a dominant pair bond), spent the most time in agonistic displacement activities (6% versus pairs at 4% followed by single sex groups at 3%) (refer Fig 8). Paired birds going through courtship and/or nesting activities, showed less overall interaction with their environment (<10% versus > 20% in mixed sex groups as seen below in Fig 9) and more time vocalising (Fig 10).

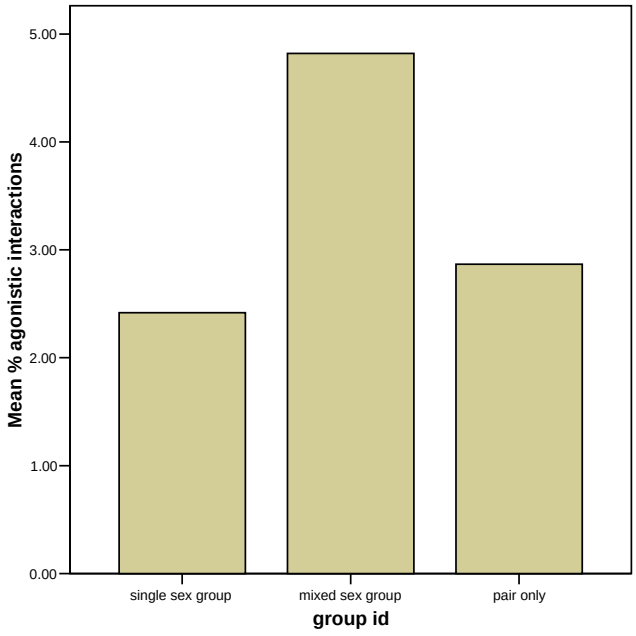

Fig 8: Group ID and Frequency of Agonistic Interaction

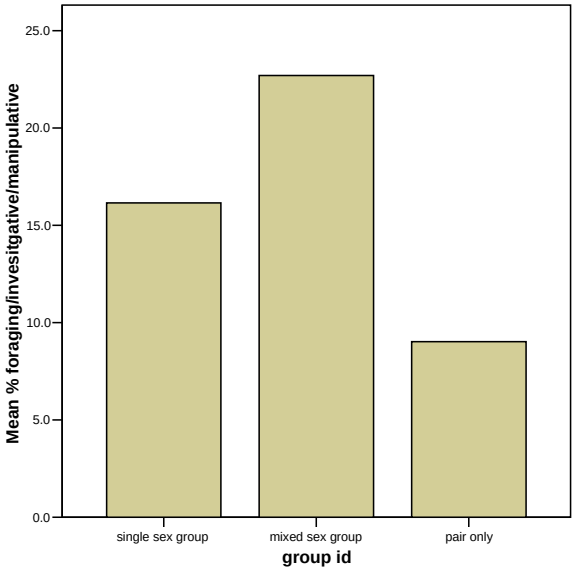

Fig 9: Social Composition and Frequency of Foraging/Investigative/Manipulative Behaviours

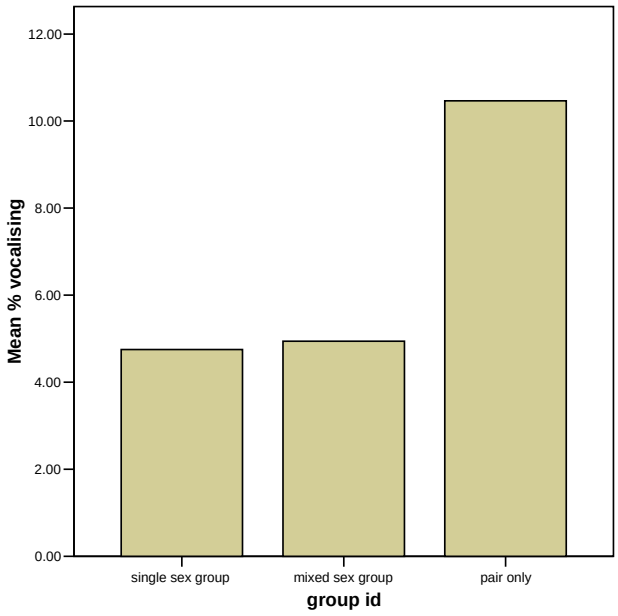

Fig 10: Social Composition and Frequency of Vocalising

Females were never observed to feed males or pair up with each other as was the case in all observed male–male groups. In those groups with off view areas, pair bonded birds able to engage in normal courtship behaviours during this period, were seen to spend a much larger proportion of their time out of sight than single sex or mixed sex groups (over 50% versus less than 30% and 10% respectively) and were engaged in courtship activities (refer Fig 11).

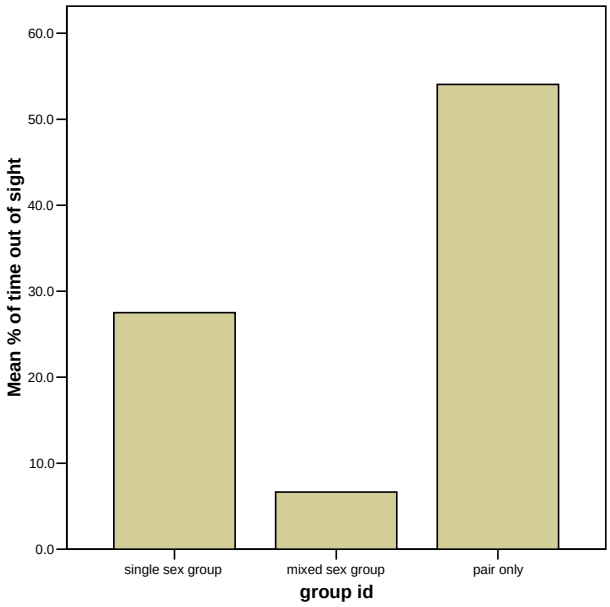

Fig 11: Social Composition and Time Spent Out of Sight

Time spent off view was an issue in relation to ability to observe behavioural repertoire. Off display areas were considered those that had an appropriate perching area under cover out of view of the public. Out of the 13 facilities, 6 had off display areas with group composition consisting of 2 pair-bonds, 2 mixed-sex with dominant pair-bonds and 2 single-sex (with equal ratio of male: female). Within 4 of these groups, individual birds

with comparatively higher frequencies of time off display (between 20 -71% of observed time), were made up of paired individuals involved in reproductive behaviours (particularly females nesting), or single sex males in enclosures of complexity ratings of 7 or less. Those individuals in the remaining 2 groups were observed to be off display 1 % of the time in enclosure complexity level 13 and 16% of the time in an enclosure with complexity rating of 11.

Comparisons of Captive Time Budgets with Wild Kea

Wild male kea activity percentages were calculated from research by Brejaart (1994) taking averages of winter (June-August) and spring (September-November) data over two locations in the South Island (Arthurs Pass and Craigieburn). Averages were taken over these periods as observations of the captive facilities occurred across the two seasons (August-September).

Captive observational data was used only from unpaired males to proximate the sampled wild Kea population as close as possible. This information was collected from 4 facilities which had very little time spent off display. Resulting information can be seen in Fig 12. Average captive Kea behaviours over all facilities showed an increased level of locomotor and foraging/manipulative behaviours (with corresponding less time spent inactive) and lowered levels of body maintenance activity by comparison with the wild Kea samples.

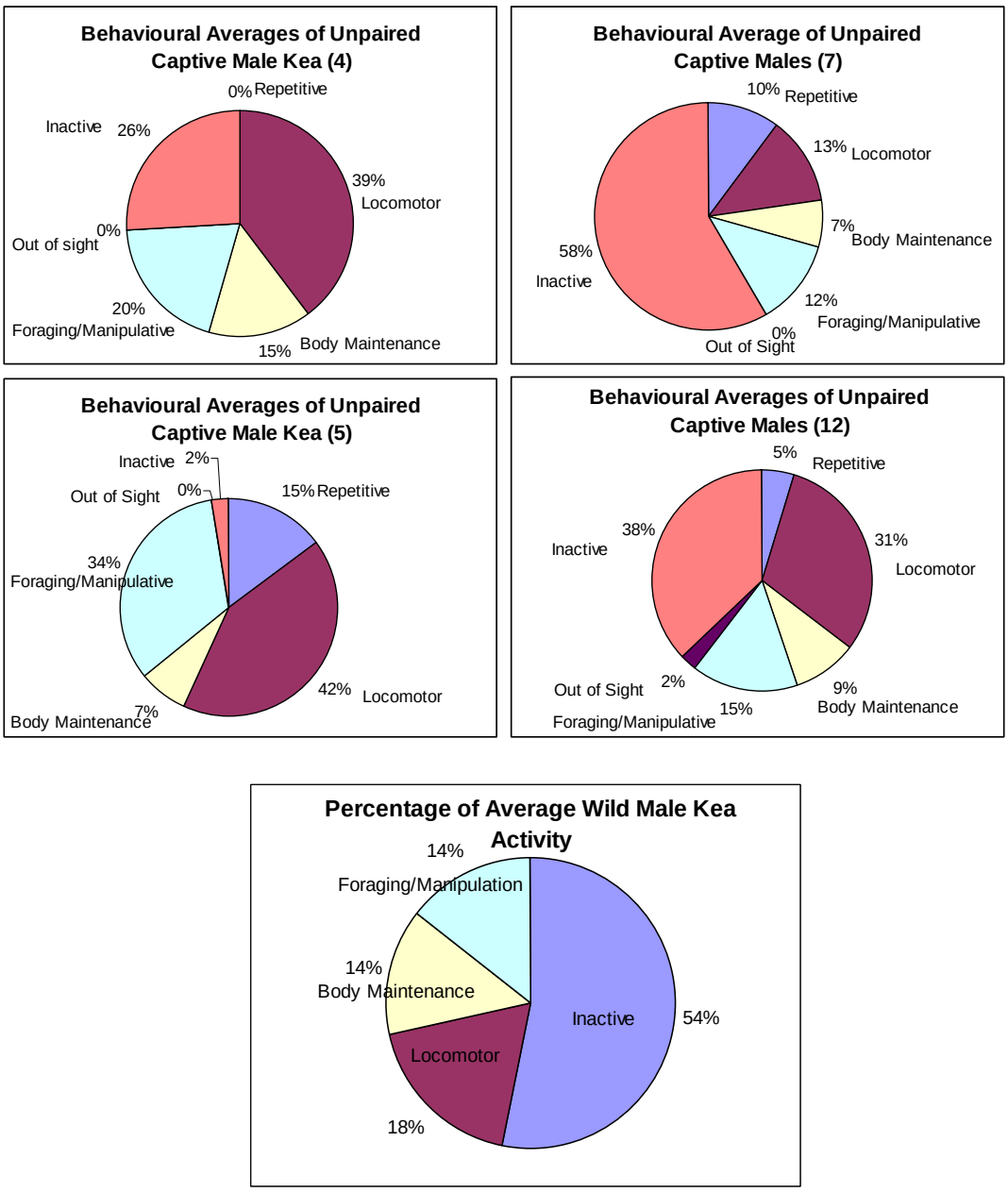

Fig. 12: Comparison of Wild versus Captive Male Kea Activity Budgets

Facilities had varying ratings for enclosure complexity, number of feeds per day and enrichment levels. All facilities observed were mixed sex except for number 4 which was a single sex group (Refer Appendix 7 for details of captive male group makeup).

Discussion

Questionnaire Information

The results from the survey information provided useful information on demographics and group composition of the captive population, prevalence of stereotypies, and enclosure and enrichment complexity details. This allowed some insight into whether or not holders were fulfilling the objectives of the Kea Captive Management Plan (Pullar, 1996).

The first objective of the Plan, aims to "manage the captive population to be self-sustaining and maintain adequate genetic diversity" (ibid, p.5) through reduction of the population to under 100 kea in the short-term, and, in the medium to long-term, through selective breeding of unrepresented founder stock and F1 progeny only. From the results of the questionnaire information with additional information on numbers overall (Pullar, pers.com) it can be seen that the first of these outcomes has been achieved with the reduction of the captive population to the stated number within the stated time period (5 - 10 years). The captive population group composition as regards suitable breeding pairs has not been an issue during this period due to the moratorium on breeding. However, as highlighted in the questionnaire results (cross referenced with the studbook information), it can be estimated that out of the surveyed and observed captive population there are only 2 appropriate pairings that are as yet unrepresented in the population. The 2 additional mixed sex groups of surveyed holders that were not in the observational study did not hold any animals which would be useful if any pairings were established (ie. birds were either related or were held with birds of unknown origin). However there were

several potential founders which could be useful elsewhere within any future breeding programme. As such, looking at present holding dynamics, there are very few viable pairings which could be immediately utilised if the moratorium were to be lifted. This is an issue as regards maintenance of genetic diversity which, as stated by Frankham et al (2002), is recognised by the IUCN as one of three global conservation priorities. Without this variability, it is acknowledged that the ability of populations to evolve in response to the changing environment may be compromised, leading to inbreeding of populations and a reduced reproductive fitness (ibid, 2002).Therefore moving of important potential breeding individuals, particularly those unrepresented female founders (Pullar, 1996) at present paired with males of unknown origin, should be a priority in order to meet the medium to long-term aims of the Management Plan.

The second objective of the Management Plan is to "ensure that all Kea in captivity are held in facilities which meet set minimum aviary requirements" (Pullar, 1996, p.7). The questionnaire information identified that the majority of holders fulfilled the requirements of enclosure size, minimum grouping and general husbandry guidelines (such as diet and shelter). Those holders that did not conform to the minimum guidelines and held birds singly or in enclosures under the minimum size requirement or appropriate dimensions included 2 private and 1 public holder. Several holders did not include variation within their environment in the form of additional substrates and enrichment. There appeared to be a certain hesitancy associated with the introduction of artificial enrichment items into several of these facilities due to the perception that they would detract from an appropriately naturalistic environment for the species. However, other natural enrichment

sources or management practices to increase enclosure complexity and variability were often not introduced as an alternative to artificial enrichment items, resulting in a potentially unstimulating environment. As stated by Pullar (1996), variation and complexity within the captive environment is important for the physical and psychological well-being of this species and is a requirement under the Management Plan. As such, an enrichment manual specifically designed for Kea (Freeman, Jenkinson, 2003) was designed after a deficit in this area relating to the Management Plan objectives was identified by Fraser (2002). This manual has been made available to all Kea holders in New Zealand by the studbook keeper in an effort to increase captive complexity and reduce levels of abnormal behaviours. As highlighted in the results, stereotypies were recorded in 78% of the surveyed facilities and 61% of all captive individuals. This indicates that present management practices implemented by holders may not fully address the needs of this species.

Other objectives stated in the Plan (Pullar, 1996) outline a commitment to advocacy and research on this species in captivity (also stated by Seal et al, 1993). Subjective information gathered from the questionnaire on the advocacy potential of the animals held showed varying response in the understanding of this requirement. Several of these birds were effectively held as household pets and were therefore not on public display, and a majority of facilities had only impromptu talks regarding their kea and/or very little signage to alert the public to conservation issues. As such there appears to be a need to push this requirement of holders to maximise the advocacy opportunities as described in the Plan.

As stated previously, there appears to be little research on this species as a whole particularly as regards captive management. As such it would be useful to set up research opportunities with appropriate tertiary and research institutions to meet the recommendations and objectives of the DOC as outlined in Seal et al (1993) and Pullar (1996).

Overall due to the subjective nature of the questions in the survey, additional information and observations would need to be carried out to get a clear idea of how birds were being managed as regards the objectives of the Management Plan. However, it can be stated that as the Plan itself is almost 10 years old and the short term goals have been fulfilled, a review of the captive population and holders may be necessary to update present goals to bring these closer in line with the long-term plans of DOC as stated in Seal et al (1993) and Pullar (1996).

Behavioural Observations

Stereotypic Behaviours

Stereotypies were found to be prevalent in 50% of individuals observed. As any degree of stereotypic performance has been linked with a deficit in the captive environment (Mason, 1991), it may be concluded that there are potential welfare issues in the holding of this species in captivity that have not yet been identified and managed appropriately. Kea fall into the category of a high priority species as described by Kreger et al (1998) and as such are considered to require high levels of complexity and novelty in their environments to prevent performance of stereotypies.

Effect of Origin on Stereotypies

Because stereotypies were anecdotally observed to be exhibited in captive bred rather than wild caught birds, data was analysed to take this variable into account. It was discovered in this study that, as in other research on captive versus wild born individuals (Mallapur et al, 2005; Cooper & Nichols, 1995), stereotypies were either non-existent or exhibited to minimal levels in wild caught versus captive bred individuals. Both Mallapur et al (2005) and Cooper & Nichols (1995) whose studies of Macaques and Bank Voles respectively showed that wild caught animals were not observed to perform stereotypic behaviours, concluded that the absence of stereotypic behaviour could not be used as a reliable indicator of welfare in individuals of wild origin as the absence of this behaviour was not necessarily indicative of overall well-being. Additional research on Bank Voles by Schoeneker et al (2000) supported this finding, with results showing that founder animals did not perform stereotypies whereas their F1 offspring did. It was therefore concluded that the formation of stereotypies was dependent on frustrative experiences early on in life. However interestingly enough, both captive bred and wild caught bank voles both developed polydipsia (excessive drinking) and it was concluded that this may well have been related to diabetes mellitus caused by prolonged stress. This suggests that as an indicator of stress, polydipsia in bank voles could be a common indicator of compromised welfare (Schoeneker et al, 2000). These results may indicate that other stress indicators (behavioural or physiological) could be used to measure welfare in species such as Kea and it would therefore be useful to follow up on this initial study to see what behaviours may be linked with stereotypic performance in captive bred individuals which may also be evident in the wild caught subset of the population.

Effect of Enrichment on Stereotypic Behaviours

Due to the results of origin on performance of stereotypies, the effect of enrichment on performance of this behaviour was restricted to the captive born population only. The results showed a negative correlation between this management practise and frequency of stereotypic behaviours with Kea observed to perform stereotypies of up to 40% frequency during the study period in the 13 facilities. All stereotypies involved some form of locomotor activity (flying, running, hopping or rocking from one leg to the other) and anecdotally were linked to pre-feed times. Carlstead (1998) maintains that the form in which stereotypies are expressed often indicates what wild behaviour is being frustrated. Therefore stereotypic locomotor activities may indicate a need to forage for food, search for mates or fly long distance - all high energy activities in the wild. Stereotypies that are linked to a food motivation may be observed to increase prior to feeding episodes (Carlstead, 1998). This has been observed in species which expend much time and/or energy in procurement of their food source and may be reduced by varying temporal feeding patterns and providing in a form which more closely replicates the natural situation (ibid). This was found to be evident in this situation as provision of additional feeds during the day as a form of nutritional enrichment in 3 of the 13 facilities significantly increased foraging, investigative and manipulative behaviours across all groups and decreased body maintenance behaviours such as self-preening. Therefore it can be surmised that complex, daily enrichment was found to increase species typical behaviour patterns (Lindburg, 1971 as cited in Schapiro et al, 1996) and decrease abnormal behaviours particularly in captive bred birds. This highlights the benefits and rationale for increasing enrichment frequency and variability in the captive environment

for high priority species (Mench, 1998; Kreger et al, 1998) and shows as a management tool, enrichment can be useful for this species.

Effect of Social Composition on Behavioural Repertoire

Although there were no significant results obtained from observations relating to this management technique, several interesting findings concerning group composition and gender differences as regards stereotypies were observed that would be useful to investigate in further studies.

Out of the captive bred subset, it was found that males were more likely to perform stereotypies than females (10 out of 11 males versus only 6 out of 11 females). The majority of paired females were not observed to perform any stereotypies during the sample time probably due to the fact that they were observed to be engaged in some form of courtship, soliciting, nest building or incubating behaviour as would be expected at this time of the year in the wild (Jackson, 1963). In this respect, their basic instinctual drives were probably being met, and as such, levels of stereotypies would be expected to be reduced in this subset (Mason, 1990). These findings are supported by Schapiro (1996), whose research on primate group composition showed that those animals housed in pairs or appropriate social groups were found to have decreased levels of abnormal behaviours. Of all the female kea observed throughout the study, only those paired females in situations where they were unable to nest as well as unpaired females were ever observed to perform stereotypies. For example, a female only group, showed higher combined frequency of route tracing stereotypies than all other groups (24% and 27% for

each bird) and, in addition, social interaction in this group was non-existent. This may be directly attributable to the breeding season rather than the management practices in this facility, and does raise the question of whether female only groups may be more prone to undue stress than other groups as a consequence of their inability to perform reproductive behaviours at this time of the year. This is supported by research on Amazon parrots (Garner et al, 2003), which showed that stereotypies were indicative of psychological distress and frustration caused by the captive environment.

Group composition and dynamics may also have had an effect on performance of stereotypic behaviours by wild caught males. A total of 8 wild caught males were in pair only groups with 2 of these seen to perform low levels of stereotypies compared to their captive bred counterparts. Both these males were paired with females who showed higher than average displacement behaviours. Agonistic behaviours by the females towards their mates occurred when soliciting feeding behaviours were ignored by the males. In the wild situation, paired females are fed by the males during the nesting, incubation and chick rearing periods (Jackson, 1963). Males' refusal to feed the nesting females may have been due to the comparative lateness in the season in relation to other facilities (observations were within three days of each other at the end of September/ beginning of October) and/or the fact that eggs had been removed from the nests. These females were not seen to feed themselves at any time during the observation periods, even though males were seen to feed. Results of courtship feeding studies by Helfenstien (2003), on the black-legged kittiwake, *Rissa tridactyla*, suggested that the role of mate feeding has specific reproductive fitness advantages for both the male and female of the species. For

males, mate provisioning directly relates to an increased clutch size (and as such the males effective reproductive fitness), whereas for the female it was seen to be a test of male quality and therefore was directly correlated to male re-mating success in successive years. How these findings may be associated with kea behaviour and how this may impact on future male success in the captive kea population is an important factor to consider particularly in light of a potential lift in the breeding ban. In addition, the fact that males in this situation were exhibiting stereotypies is an indication that there was some associated level of stress or frustration (Garner et al, 2003).

Overall, although social composition showed no statistically significant effect on behavioural repertoire, we can conclude from previous studies on effects of social grouping (Schapiro et al, 1996; Mallapur et al, 2004) that provision of appropriate social environment in the captive situation is necessary to allow for performance of natural behaviours by this captive social species. Schapiro et al (1996) concluded, in studies of Rhesus monkeys, that the benefits of social enrichment far outweighed the benefits of any other form of enrichment. It was therefore considered to be an extremely important tool in captive management of social species.

The level of importance of different group compositions on behavioural repertoire is difficult to ascertain from this study due to the many confounding factors and variables within the study group. However, it is appreciated that social interactions are an important facet of wild population dynamics in Kea (Diamond & Bond, 1999), and as such, additional research into appropriate grouping of this species is not only important to

realise the management goals and recommendations as stated by Pullar (1996) and Seal et al (1993), but also to ensure optimum physical and psychological health of captive Kea in general.

Effect of Enclosure Complexity on Behavioural Repertoire

The result of this management technique on performance of agonistic behaviours was unexpected. Possible reasons as to why increasing complexity was found to correlate with increasing displacement behaviours may be due to social composition of these groups and increased foraging opportunities with a corresponding increase in resource competition. Resources which may motivate agonistic interactions include territories, food resources or potential mates and are explained by game theory models of aggression which examine behavioural evolution of species (Dugatkin, 2004). These theories seek to identify what resources are important for various species and therefore what motivates aggressive interactions between (in this case) con-specifics. Social composition of these facilities which displayed higher levels of agonistic behaviour consisted of a pair bond with dominant females more likely to displace other unpaired birds (particularly unpaired females). Sandell & Smith's (1997) findings, which showed female starlings exhibiting more agonistic behaviour towards other females particularly in the pre-lay period, support these results.

The results also showed that as enclosure complexity increased there was a correspondingly significant decrease in the amount of time those birds who had access to off viewing areas, stayed out of sight. This may have been related to the group dynamics

as specified above or be due to location of food sources or objects of interest. In the case of one of these facilities, a public walk through aviary, Kea were seen to have the lowest time spent out of view and were seen to actively interact with their environment and the public. This may be an important management technique to not only increase novelty and complexity into the environment for the captive population, but also to aid in exhibiting of this species in a way that is both interactive and exciting to the public.

Additional research into these results is required to make conclusive statements as to reasons for these findings.

Wild Kea Activities

The natural habitat and range of *Nestor notabilis* is extensive, complex and demanding. As a consequence Kea have evolved to take advantage of any opportunity that comes their way. This has resulted in a species which displays intelligence, curiosity and an almost complete lack of neophobia (Gajdon, 2005). Those factors which are considered to favour cognitive abilities in a species are an extended juvenile period and overall lifespan, complex social interactions, opportunism, exploratory behaviours and iteroparity (ibid); all characteristics of Kea. However intense periods of exploratory and foraging activities must by necessity be balanced with periods of rest and observation as shown in wild data collected on this species by Brejaart (1994). Data collated from the observational studies, showed that captive un-paired males showed lower levels of inactivity and self preening and higher interaction with the environment by comparison with their wild counterparts (Brejaart, 1994). These results are surprising in that captive

environments are generally thought to discourage active behaviours. This has been found in research on ocelots where captive time budgets showed animals spending significantly less time active than their wild counterparts (Weller & Bennett, 2001).

Although no definitive conclusions can be made from the time observed, there may be issues related to energy requirement of different behaviours in the wild versus captive environments. Therefore additional study into time budgets and potential energy deficits incurred in both in-situ and ex-situ populations would need to be undertaken before conclusions could be reached. Energy costs associated with foraging, coping with climatic conditions, mate selection, guarding of territories and raising of young are likely to be much higher in the wild situation (Dugatkin, 2004) than the captive one, where potential competition for these resources and threat of predation are minimal.

At present there is a lack of literature available that compares wild time budgets of this species with their captive counterparts and as such additional study into this area could prove useful particularly if supplementation or breed-to-release programmes are considered in the future as has been recommended by the Department of Conservation (Seal et al, 1993).

Conclusion

In conclusion, the behavioural repertoire of captive Kea was seen to be significantly effected by provision and complexity of enrichment and enclosure complexity. Although there were no significant findings regarding social compositions effect on behavioural repertoire, it was concluded that as Kea are a social species with complex and fluctuating social interactions, additional research should be conducted to fully investigate this factor.

Wild Behaviour

Kea are an intelligent, social species that live in dynamic groups covering an extensive range in alpine and lowland regions of the South Island. They are an opportunistic, exploratory, foraging species which has evolved in a highly variable, complex and demanding environment where few other native species inhabit (Jackson, 1960; Diamond & Bond, 1999). It can therefore be concluded that in captivity, this species requires variability and complexity through provision of any of the 5 types of environmental enrichment: social, physical, nutritional, occupational, accessory and sensory (Bloomsfield as cited in Young, 2003), to as close as possible replicate the challenges faced in the wild situation.

Performance of Stereotypies

Stereotypies were found in 78% of surveyed population and 50% of observed population. However, wild-caught individuals were observed to either not perform stereotypies at all or perform them at a lower level than captive-bred individuals. As such origin was seen

to significantly influence performance of stereotypies over this period with wild caught birds exhibiting low levels of repetitive behaviours in comparison to captive bred individuals. Therefore stereotypy performance may not be a reliable measure of welfare in wild caught birds and another related behavioural or physiological indicator should be identified for this subset.

Enrichment

Enrichment was found to impact most significantly and obviously on the captive bred population, with an increased complexity of enrichment and frequency in feeds per day significantly lowering performance of stereotypic behaviours. As such enrichment in the form of nutritional enrichment and accessories (toys, puzzles etc) may be considered an important management technique, particularly in the case of captive bred individuals. This is not to say that it should be discounted for the wild subset of the captive population and as such should be used for all kea groups until further research indicates otherwise.

Enclosure Complexity

A significant correlation between increased enclosure complexity and increased displacement (agonistic) behaviours may be related to either dominance hierarchies in selected groups or increased activity due to increasing investigative behaviours in a more complex environment. Further study is required to limit variables and ascertain relative importance of enclosure complexity outside of the breeding season.

Additionally, in those enclosures with off- display areas, less time was spent off view by individuals who were housed in more complex enclosures, particularly in one walk

through aviary. Additional research into reasons why this was the case needs to be undertaken before any conclusions can be reached.

Social Composition

Although there were no significant correlations found in relation to social composition and behavioural performance of the captive population, the impact that this management practice may have on overall well-being of the captive population should not be discounted. Social enrichment is considered by behavioural researchers to be one of the most beneficial and complex of all enrichment forms for social species (Schapiro et al, 1996; Young, 2003) and as such additional study is required to better understand appropriate holding dynamics of captive Kea.

Research Limitations

The breeding season was considered to introduce many confounding factors into the study. Additional study over different times of the year would therefore be useful to provide a clearer picture of captive behaviours overall and would be particularly important to ascertain whether origin was still found to significantly effect performance of stereotypies.

Brief behavioural snapshots (approximately 4 hrs) only of each facility under study, may have confounded the results as timing of feeds, enrichment and weather related differences between facilities may have excluded certain behaviours and highlighted others (both favourably or unfavourably). To limit this happening, additional time spent

on each group would have given clearer indication of behavioural patterns over time and taken into account any skewed results (eg. abnormal occurrences of particular behaviours from exposure to unusual external or internal factors).

Off display time was also a factor in that it was not known what behaviours these individuals were exhibiting. Additional studies that had some means of simultaneously viewing off display areas would be advantageous and provide useful information as to why these birds preferred to stay out of sight.

Small sample sizes in relation to social composition were also another factor in the observations with associated variability in management and enclosure types across social groups. This may well have introduced additional variables into the study that could have skewed results. Additional studies should therefore be done on each group type to get a better representation of behavioural repertoire.

Identification and categorisation of behaviours was difficult in that many of the behaviours were linked or held some element of other behaviours. This was particularly true of stereotypic behaviours which often took some time to identify repetitive elements. As such additional time to observe individual birds/group would have made recording of behaviours easier.

Limitations associated with the Questionnaire included wording of some of the questions which had the potential to be misconstrued by holders. Many of the holders were

unfamiliar with specialist terms and although definitions were included in the questionnaire pack, there may have been confusion as to what was expected of them. Also many of the questions were subjective in nature which allowed for a wide range of answers to be given by the holders which were difficult to interpret during analysis. Both these issues could be corrected through conducting of interviews to clarify information and additionally to observe all holders birds in order to check facility details. This would then provide more accurate and consistent data that would provide useful information on how birds were being managed in regards to the objectives of the Management Plan.

Further Research

Due to the fact that very little study has been conducted on the captive population of Kea in New Zealand facilities, additional in-depth and long-term studies on all aspects of management techniques (particularly that of social composition of captive groups and effects on behavioural repertoire), should be undertaken both within and outside of the reproductive season. In relation to the broad area of social composition, the effect of group size on behavioural repertoire is one variable of particular interest particularly in regards to comparisons of natural group dynamics in the wild. All groups involved in this study consisted of between 2 – 6 birds which were stable throughout the year. Observations by Clarke (1970) and Jackson (1960), show that Kea seasonally adjust flock size from 2 – 20 individuals; a direct contrast to historically small, static groupings in captivity. How these groups impact on overall well-being of this species and what would constitute an optimum captive group dynamic would be of great interest to find out and potentially beneficial for management of this species long-term.

Additionally there is a lack of literature available that compares wild time budgets of this species with their captive counterparts and as such additional study into this area could prove useful, particularly if supplementation or breed to release programmes are considered in the future as has been recommended by the Department of Conservation (Seal et al, 1993).

Another area of study outside of behavioural studies of the kea themselves, would be how public perception is effected by the different facility and enclosure types and what message the public are going away. Advocacy is a core goal of the DOC Management Plan (Pullar, 1996) and recommendations (Seal et al, 1993) and as such should be considered an important topic of research.

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