

Breeding and behaviour records of peafowl (*Pavo cristatus*) at Mansion House Historic Reserve, Kawau Island, New Zealand, 1992-2010

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Abstract Information was collected from a small population of peafowl living in Mansion House Historic Reserve, Kawau Island, from 1995 to 2010. Peacocks used an exploded lek breeding system, and displayed at areas where human and natural foods occurred. Mating took place between late Sep and mid Dec. Breeding was successful in the presence of a substantial North Island weka (*Gallirallus australis greyi*) population. An average of 1.4 ($SE = 0.6$, $n = 10$) young were fledged per successful clutch. In the winter of 2004, all peahens disappeared and the population thereafter comprised only males. Despite the absence of females, peacocks continued to display for 5 years after all peahens were lost. The breeding biology of this introduced population appears to be similar to that in their native range.

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Keywords Peafowl; *Pavo cristatus*; wallaby; Kawau Island; introduced population

INTRODUCTION

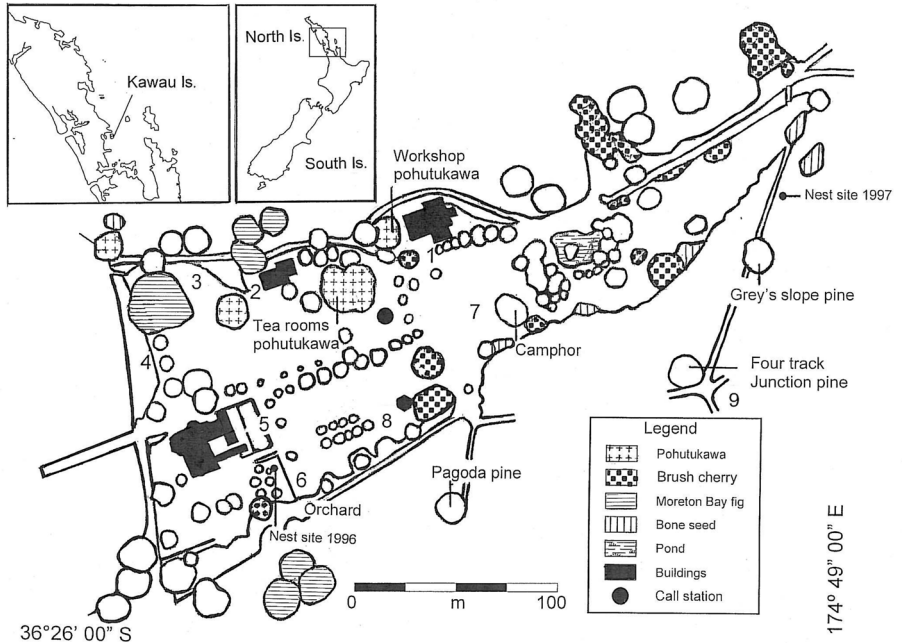
The Indian peafowl (*Pavo cristatus*), has been introduced successfully to 6 countries from their native range of India, Sri Lanka and Bangladesh (Long 1981). Peafowl were liberated into New Zealand a number of times. Peafowl were first brought to New Zealand in 1842 by Mr. Petrie (Long 1981) and then by acclimatisation societies and individuals (Lamb 1964). Peafowl came from Britain in 1842 or 1843, from India in 1854, and other locations (Long 1981). Peafowl were first released onto Kawau I by Governor George Grey in the 1860s (Long 1981; Heather & Robertson 1996).

Some releases of peafowl in New Zealand were successful and feral populations are now established on the Mahia Peninsula, and the upper Wanganui River (Fleming 1947). Populations also appear established on the south head of the Kaipara

Harbour, Pouto Lakes, Kaiwaka, Kawakawa Bay and the western Hauraki Gulf, Whakapirau, and Waipu Caves (*unpubl. data*). The range of the peafowl has expanded during the past 30 years (Robertson *et al.* 2007), but populations remain precarious because they are easily controlled (Marchant & Higgins 1993) and they have relatively low reproductive rates (Johnsingh & Murali 1978; Galusha & English 1999). Wild and feral peafowl are generally secretive but individuals can become tame when in contact with humans (Sharma 1979; Marchant & Higgins 1993).

The birds liberated onto Kawau I by Grey died out between 1886 (Colgan 1980) and 1923 (Wilson 1980) and the current population was introduced between 1958 and 1989 (R. Mohring & J. Cook, *pers. comm.*). Peafowl occupied an area of open parkland (2.5 ha) and surrounding pine (*Pinus* spp.) forest. The parkland comprises trees that are protected from grazing by introduced dama wallaby (*Macropus eugenii*), parma wallaby (*M. parma*) and swamp

Fig. 1. Peacock display areas and roost trees in the Mansion House Historic Reserve, Kawau I. Display areas were: 1, workshop courtyard; 2, tea room's courtyard; 3, barbeque; 4, beach; 5 & 6, orchard; 7, central valley; 8, pagoda and 9, four track junction.



wallaby (*Wallabia bicolor*), as well as indigenous trees that are unpalatable to wallabies.

The only potential predators of peafowl eggs and young chicks on Kawau I are stoats (*Mustela erminea*), Australasian harrier (*Circus approximans*) and North Island weka (*Gallirallus australis greyi*). During the course of this study from 1992-2009, ship rats (*Rattus rattus*) were also common. Weka were present in the same area as the peafowl and the population was estimated to be between 10 and 20 pairs (Beauchamp & Chambers 2000; *unpubl. data*).

This study reports on some aspects of the breeding biology and breeding performance of the introduced peafowl population living on Kawau I. I also compare some aspects of their breeding biology with other populations in New Zealand and elsewhere.

METHODS

I collected information on the small population of between 2 and 14 peafowl using the Mansion House Historic Reserve gardens (Fig. 1) and surrounds (22 ha) between Sep 1992 and Dec 2009 while undertaking a more extensive study of North Island weka within the same area (Beauchamp *et al.* 2000; *unpubl. data*). Observations took place throughout the year but were limited to short (median 2, range 7 days) trips.

Between 1992 and 2001, I noted which peafowl were present, collated data about the management

that had been undertaken in the population, and gathered data on breeding performance and moult. Breeding activity was defined by the absence of a peahen at the roost site. From the 2001-02 breeding season, I noted the temporal behaviour patterns at display sites, the trees that peafowl roosted in and the times that peafowl roosted and descended from trees. All the peahens, a juvenile and 3 peacocks disappeared in winter 2004. From Aug 2006 to Dec 2010, I recorded the location and first behaviour of the 3 remaining peacocks when I encountered them and if possible what they were feeding on. Peacocks were scored as feeding when the number of pecks exceeded the number of steps. If steps exceeded pecks the bird was scored as walking. Peacocks were scored as standing when they stood still and undertook no other behaviour besides calling, but were resting if their feet were tucked under and they were sitting on the ground or on a fence. Peacocks were scored as preening if their bills were being run through feathers and no distinction was made between birds that were doing this standing or resting. Peacocks were displaying when the tail coverts were raised.

The gap between observations were at least 10 minutes and up to 4 hours and the breeding season was defined by male display activity. Peacock behaviour data was collected evenly throughout daylight hours (ANOVA $F_{1,6} = 2.56$, $P = 0.162$), and in proportion to the time spent collecting it during the breeding ($n = 431$ h) and non-breeding season ($n = 359$ h; $\theta^2 = 3.18$, $df = 2$, $P > 0.05$). The core

Table 1. Trees used by peafowl for roosting and calling during the breeding season.

Breeding season	Bunya-bunya	Moreton Bay fig	Yellow pohutukawa	Tea Rooms pohutukawa	Workshop pohutukawa	Pagoda lower pine	Pagoda upper pine	Grey's slope pine	Four track junction pine	Palms
1997-98	-	-	-	Two toes, Three toes & White	Peahens and juveniles	-	-	-	-	-
2001-02	White	Three-toes	-	Old male & Two toes	Bright ² , peahens & juveniles	-	-	-	-	-
2002-03	White	Three-toes	White ¹	Old male, Two toes & Bright	Solo ² , Peahens & juveniles	-	-	-	-	-
2003-04	-	Three-toes	-	Old male, Two toes & Solo ²	Peahens & juveniles	White	-	-	-	-
2004-05	-	-	-	Solo	Two toes	White	-	-	-	-
2005-06	-	-	-	Solo	Two toes	White	-	-	-	-
2006-07	-	-	-	Solo	Two toes	White	-	-	-	-
2007-08	-	-	-	Solo	Two toes	White	-	Two toes	-	-
2008-09	-	-	-	Solo	-	White	-	Two toes	Two toes	Solo ¹
2009-10	-	-	-	-	-	-	Solo	-	Two toes	-
2010-11	-	-	-	Solo	-	-	Solo	-	Two toes	-

¹ moved to site after displacement.

² immature males in third year.

breeding areas of each peacock were calculated as the minimum polygon enclosing the display sites used each breeding season.

Individual peahens were not able to be distinguished, and young could only be identified individually from their second year using neck plumage. All peacocks ($n = 6$) had feather colour patterns that made them recognisable at c. 200 m. One peacock was an autosomal recessive white (from a cohort before 1987). Two others were heterozygotes (Marchant & Higgins 1993) and had white chins and other white feathers. One individual lacked his right middle front toe (from a cohort hatched in 1989). Three males lacked any white feathers or distinguishing markings but never occurred together as adults during the study period (from cohorts in, c. 1989, 1999 & 2002). The 6 males are referred to here as: "White", "Three-toes", "Two-toes", "Old male" "Bright Male" and "Solo", respectively.

RESULTS

Nocturnal roosting and roost sites

Peafowl flew to trees on average 12.5 min ($SE = 1.17$, range = -5 - 30, $n = 42$) after sunset and reached their

roost sites within 5 minutes. Peafowl only flew to trees before sunset on wet and heavily overcast evenings. First flights were at c. 45 degrees to substantial side branches and then more limited flights up to well used sites. The initial flights were to branches 4.9 - 9.1 m high, and the final roost sites averaged 12.3 m (range 8 - 15.2 m) high ($n = 5$).

All non-breeding peahens and young < 2 years old roosted in a pohutukawa (*Metrosideros excelsa*) adjacent to the workshop at heights between 7 m and 19 m. This roost was observed in use repeatedly between 1995 and 2004. They deserted this site in 2000 for 2 months after a peacock and 2 peahens were shot at the roost site (B. Lumas, *pers. comm.*). Incubating peahens stayed on their nests at night. Peahens with young chicks roosted away from the other peafowl in trees that were apparently easier for their young to climb. One peahen used a camphor tree (*Cinnamomum camphora*), and ascended it after her chick had scaled the tree using its feet and wing claws.

Mature peacocks either roosted in the same tree with peahens and young, with another peacock, or alone (Table 1). Peacocks used the same site over an average of 3.4 years ($SE = 0.63$, $n = 10$) between

2001 and 2011. All sites were generally used in the breeding and non-breeding season. In the 2006-07 breeding season Two toes roosted at the workshop. From Jan 2007 he mixed his roosting between the workshop and the Grey's slope pine site, and then used both sites in the 2007-08 breeding season. In the 2008-09 breeding season he roosted and called from the Grey's slope pine site alone. Generally peacocks only deserted sites completely when they were damaged or when something unusual happened at the site or the only user of that site died. For example, White deserted the bunya pine (*Araucaria bidwillii*) after he crashed to the ground one evening (B. Saunders. *pers. comm.*), Solo left his roost tree when pursued by a tui (*Prothemadera novaeseelandiae*) and morepork (*Ninox novaeseelandiae*) that were defending their young near his roost site, and Two-toes left his tree after the branch that he used during his ascent was cut. Solo investigated at least 3 sites before returning to the Tea Rooms pohutukawa and then moved about these sites.

Start of diurnal activity

Diurnal activity commenced when the peacocks descended their trees on average 64 min (range 34–120, $n = 16$) min after sunrise in late-Sep – late-Dec and on average 17 min (range 14–23 min, $n = 7$) after sunrise in Apr – mid-Sep. Peahens and young left the roosts before peacocks in summer but at the same time as males at other times. Peacocks glided down from the trees onto open ground over distances of 30–50 m ($n = 17$). All peacocks typically glided from their roost directly into their core areas. The exception was Two toes from Nov 2006, who roosted 90 m from his display area and walked to it. The area became core in 2010 where he began to display and call 20 m from the roost. Peacocks were observed more frequently in the core breeding areas during the breeding period (Fig. 2, $\theta^2 = 16.135$, $df = 1$, $P < 0.001$).

Foraging

Most intensive foraging took place in the first hour after birds descended from their nocturnal roosts and the 2 hours before evening roosting (Fig. 3).

Foraging records at random encounters found that peacocks foraged predominantly on *Hydrocotyle* spp., which was the predominant pasture plant (54%, $n = 134$), fallen flowers and fruit of tree privet (*Ligustrum lucidum*, 2%), fruit of Moreton Bay figs (*Ficus macrophylla*, 19%) and Port Jackson figs (*F. rubiginosa*, 1%), brush cherry (*Syzygium australe*, 7%), and boneseed (*Chrysanthemoides monilifera*, 0.7%). Cicadas (*Amphipsalta zealandica*) were taken from low shrubs (0.7%). Peacocks moved to and from fruit sources, by going around rather than through the immediate confines of other male's display areas. Moreton Bay figs were abundant between Sep and Nov (*unpubl. data*) and foraging bouts at

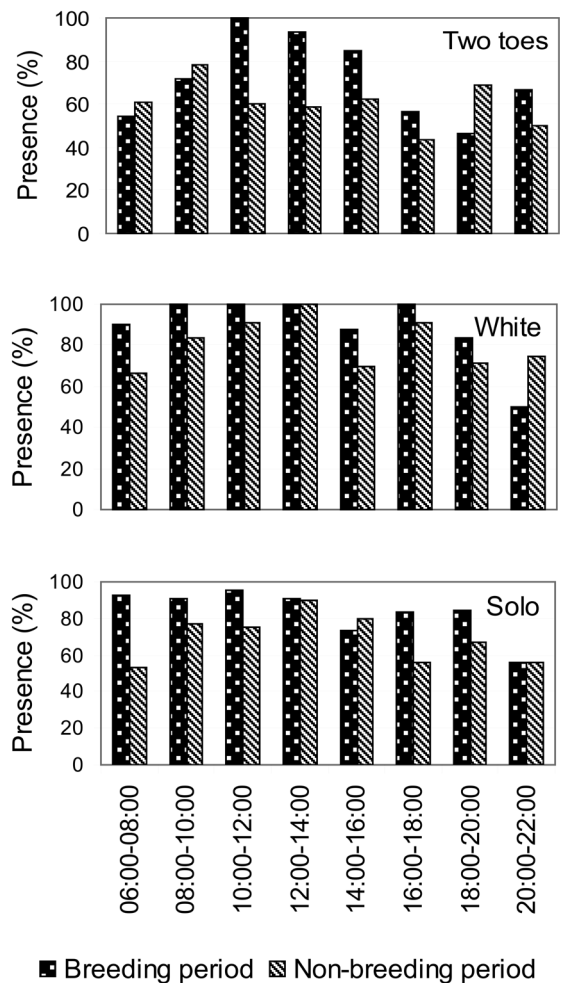


Fig. 2. The percent of time that mature peacocks were scored in their core display zones during the breeding season and the non-breeding season during Aug 2006 – Dec 2010 at Mansion House, Kawau I.

this time lasted less than 10 minutes. Most fruit and flower parts were gathered from the ground but bone seed, *Agapanthus* flowers (0.7%), and sweet pea shrub (*Polygala myrtifolia*) flowers (1.4%) were gathered from the bushes.

The Mansion House Bay anchorage was used by 5–130 pleasure craft daily and the wharf was used c. 10 times a day by ferries and water taxis. The ferry-based visitors were present between 1100 h and 1630 h and peaked at c. 500 people per day. Between Aug 2006 and Dec 2010, 10% of the feeding records of peacocks comprised human supplementary feeding.

During the Oct to late Dec display period, mature peacocks stayed within their display regions from either the time they descended from their trees, or

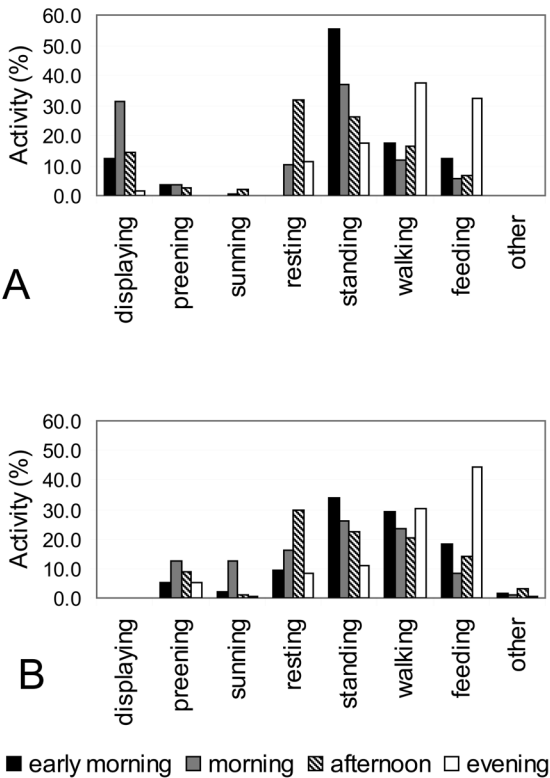


Fig. 3. Day time, non-roost site peacock behavior (Aug 2006 – Dec 2010): **A**, in the breeding season; and **B**, in the non breeding season at Mansion House Historic Reserve. Early morning = 2 hours from sunrise; morning = from 2 hours after sunrise to mid day; afternoon = from mid day until 2 hours before sunset and evening = 2 hours before sunset to sunset.

after a 10 - 30 minute feeding bout, until c. 2 hours before sunset (Fig. 2). During the breeding season peacocks fed less frequently in the morning ($\theta^2 = 10.7$, $df = 1$, $P < 0.01$), spent more time standing ($\theta^2 = 10.42$, $df = 1$, $P < 0.01$), resting ($\theta^2 = 9.14$, $df = 1$, $P < 0.01$) and displaying ($\theta^2 = 23.61$, $df = 1$, $P < 0.001$), and less time walking ($\theta^2 = 5.62$, $df = 1$, $P < 0.02$) than later in the day. Outside of the breeding season the time spent walking ($\theta^2 = 0.06$, $df = 1$, $P > 0.05$) and resting ($\theta^2 = 3.52$, $df = 1$, $P > 0.05$) was not significantly different between the morning and afternoon, while the time spent standing in the morning ($\theta^2 = 8.08$, $df = 1$, $P < 0.01$) and feeding in the afternoon ($\theta^2 = 21.46$, $df = 1$, $P < 0.001$) were still significantly greater.

After the display period ended peacocks moved between sites and foraged with other peacocks. Twice during this time in late Dec 2006, Solo and Two-toes moved from foraging to a fast parallel walk with slightly puffed necks, 3 m apart through areas not used for display, and over a distance of 120 m.

Display and breeding success

The earliest dates that tail displays were seen were 24 Sep 1994 (3 peacocks displaying) and 23 Sep 2006 (1 peacock displaying) and displays continued until mid Dec in all years. Tail fan displays took place within 10 minutes of descent from trees and peaked mid morning (Fig. 5). They lasted on average for 5.4 minutes ($SD = 6.4$, $n = 45$).

Peacocks retained display areas for period exceeding 10 years (Table 2). The overall area used by the population for displaying remained constant throughout the study until 2010 (2.28 ha), but the use of each display site by individual peacocks differed (Table 2). Between 2002 and 2005 most peacocks used only one site (mean = 1.2, $SE = 0.1$, $n = 16$) of 0.015 ha for display. Two-toes used the workshop courtyard, the White male the citrus orchard and longer grass margin behind Mansion House, Three-toes used the pagoda, and the Old male used the tea room's roof and courtyard (Fig. 1).

In 2005, Solo took over the tea room's courtyard and retained the Pagoda (0.17 ha core area) and White used the barbeque and retained use of the Mansion House orchard and garden (core area 0.21 ha). In 2006, Two-toes added the central valley to his display sites (core area 0.31 ha), and White added the beach (core area 0.38 ha). In 2007 Solo expanded his display area to include the pagoda (core area 0.21 ha; Fig. 1; Table 2). In 2010, after White was killed by a dog, Solo expanded his core area to 5 display sites adding the back of Mansion House, orchard and beach (core area 0.85 ha); and Two toes used 3 sites including Four Track Junction (core area 0.48 ha) which was near his roost and outside the previous population display area.

The display sites were out of visual contact, but within call range of each other, and peahens visited the sites as a group. In the last 2 hours of daylight peacocks left their display sites to forage, and sometimes displayed at sites where females were being fed by visitors. After 2004 when peahens were absent, peacocks continued train displays at their principal display and these food sites (Table 2). They directed displays at paradise shelducks, mixed grey/mallard ducks, weka and house sparrows (*Passer domesticus*).

No copulations were seen. Nests of 5 and 6 eggs were found on 30 Nov 1996 and 14 Nov 1997, respectively. The 1996 nest was 20 m from White's principal display site in dense tall (0.6 m high) kikuyu (*Pennisetum clandestinum*) in the orchard area of the Mansion House fenced garden. The 1997 nest was 150 m from the display region in 30 cm high kikuyu on the top of a road cutting (1.8 m high) in pine forest (Fig. 1).

Newly hatched peafowl chicks were seen between mid-Oct and mid-Jan. Twenty three chicks (mean = 2.2, $SE = 0.4$, $n = 12$) were seen in 8 of the 12 seasons

Table 2. Display sites used by mature peacocks, Mansion House, Kawau I. Bold indicates areas where peacocks spent the non-display period of daytime during the breeding period.

Breeding season	Workshop	Tea Rooms	Barbeque & Fig	Front Beach	Mansion back door	Mansion Orchard	Camphor Tree	Pagoda	Four track junction
Fig. 1 number	1	2	3	4	5	6	7	8	9
2001-02	Two toes	Old male	-	-	-	White	Two toes	Three toes	-
2002-03	Two toes	Old male	Old male	-	-	White	-	Three toes	-
2003-04	Two toes	Old male	Old male	-	White	White	-	Three toes	-
2004-05	Two toes	Solo	White	White	-	White	-	-	-
2005-06	Two toes	Solo	White	White	-	White	-	-	-
2006-07	Two toes	Solo	-	White	-	White	Two toes	-	-
2007-08	Two toes	Solo	-	White	White	White	-	Solo	-
2008-09	Two toes	Solo	-	-	White	White	-	Solo	-
2009-10	Two toes	Solo	-	-	Solo	Solo	Two toes	Solo	-
2010-11	Two toes	Solo	-	Solo	Solo	Solo	Two toes	Solo	Two toes

Table 3. Population size and breeding performance of the peafowl population at Mansion House Historic Reserve.

Breeding season	Cocks >2 years old	Hens >2 year old	Hens assumed to have laid*	Hens with young	No. young/clutch with hens at < 14 days old	Male young reared to >9 months	Female young reared to >9 months	Unsexed young raised to 9 months ¹
1992-93	6	4	1	0	0	0	0	0
1993-94	6	4	1	1	2	0	0	0
1994-95	6	4	1	0	0	0	0	0
1995-96	6	4	0	0	0	0	0	0
1996-97	5 ²	3 ^{2,3}	3	3	4 & 1 & 1	0	3	0
1997-98	5	3	4	2	1 & 1	1	0	0
1998-99	5	6	2	2	1 & 2	1	0	0
1999-00	5	6	2	1	3	1	0	2
2000-01	3 ⁴	4 ⁴	2	2	3	2	1	0
2001-02	4	4	0	0	0	0	0	0
2002-03	5	4	2	2	5	2	0	0
2003-04	6	4	2	2	1 & 3	0	0	1
2004-05	3 ⁵	0 ⁵	-	-	-	-	-	-
Mean, se	5, 0.3	4.2, 0.3	1.6, 0.3	1.3, 0.3	2.2, 0.4	0.6, 0.2	0.3, 0.3	0.3, 0.2

* absence from roost trees indicating nesting (Galusha & English 1999); 1, young were caught and removed before they could be sexed; 2, cull and transfer of older birds caused change in roost site; 3, peahen killed due to head and eye injury; 4, progressive capture and removal to lower numbers; 5, loss of 3 peacocks, 4 peahens and 1 juvenile.

that peahens were present, and 14 young were raised during 7 of these seasons (Table 3). Breeding failed or was not attempted in the dry springs and summers of 1992, 1994, 1995 and 2001. All pre-fledgling losses took place within a month of chick appearance. The tails of chicks were obvious at 4 months old and when chicks were a third adult size ($n = 3$ clutches). All young neared adult size at 8 months old and the plumage in their first year resembled peahens. In the

second year male young had more coloured throats and fore-necks. Four peahens, 7 peacocks and 3 young of unknown sex were raised to 9 months or more, and there was no evidence of a biased sex ratio ($\chi^2 = 0.82$, $df = 1$, $P > 0.05$). The age that peahens first breed was not determined. Peacocks left the group of females and young and practiced tail displaying at 3 years old, and mastered adult vocal and train displaying at 6 years old.

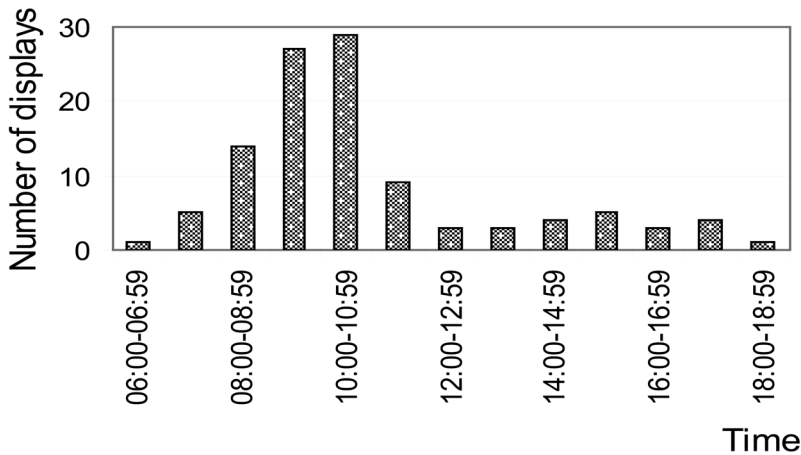


Fig. 4. Peacock tail fan display times (Sep 2006 – Dec 2010) at Mansion House Historic Reserve.

Moult

Peacocks started to moult feathers in their crest in Dec and displays ceased in late Dec, a week before the moult of the first tail overcoverts (train). The earliest that a mature peacock moulted his tail train was 30 Dec and in all seasons the mature peacocks lost the display feathers of their train before 18 Jan. Many feathers were discarded by roosting peacocks at night. The last proximal eye feathers were lost in early Apr. All other major body tracts and the remiges commenced moult with train loss, and head crest and body plumage replacement continued until Jun. Preening was significantly more frequent in the non-breeding season (Fig. 3, $\theta^2 = 24.9$, $df = 1$ $P < 0.001$). In mid Jul 2007, all 3 peacock's tail overcoverts were approximately 400 mm short of maximum length (based on a retained feather on Solo's train) and maximum length was obtained by early Sep.

DISCUSSION

This study reports on an introduced and relatively tame peafowl population in a parkland habitat. The small population bred at a low rate in the presence of a weka population and despite living in a habitat that is highly modified by wallabies. The population was culled periodically to control its expansion, and this provided means of examining how this impacted on the distribution and behaviour of individuals. Peacocks were remarkably stable in the locations that they roosted and displayed within. They continued to display 5 years after all peahens were removed and showed no indication of moving to find peahens. The period of display and moult remained unchanged.

Peacocks are flexible in the way they use space, and reach far greater densities in forested areas of India than in drier rural parts (Yasmin 1997; Veeramani & Sathyanarayana 1999). Wild forest

dwelling peafowl in India forage and drink most actively at dawn and dusk (Avi & Ripley 1980; Veeramani & Sathyanarayana 1999). They tend to move about in flocks, as flocking allows greater foraging due to shared vigilance for threats (Yasmin & Yahya 2000).

Detailed time-budget studies of 3 wild peacocks lacking human interaction during the breeding season on Protection I (Galusha & Hill 1996) was generally consistent with that found at Mansion House. Standing and display were more frequent in the morning and feeding and walking took place more in the evening. Peahens that were not breeding fed for the first hour and then moved between peacock display sites, alternating between feeding, preening, sitting and standing. They spent the last 2 hours before sunset feeding (Galusha & English 1999). Peahen dominance hierarchies, seen in other populations (Galusha & English 1999) were not obvious at Mansion House.

In India, peafowl spend the heat of the day in thickets and peahens often place their nests in these areas (Avi & Ripley 1980). On Kawau Island, peafowl often roosted under verandas and on roofs in shade, in the more undisturbed locations but still near people.

On Protection I all of the peafowl roosted in a number of different trees during the breeding season (Galusha & Hill 1996; Galusha & English 1999). At Mansion House the peafowl showed greater night roost site fidelity. The peahen group used the same tree between at least 1991 and 2004, and the males returned to the same tree for many years. At many other locations peafowl also use tall trees for roosting (Avi & Ripley 1980; Veeramani & Sathyanarayana 1999) and where predators were present, like large cats, these trees had thorny undergrowth and climber thickets (Trivedi & Johnsingh 1996). At Mansion House most of the trees chosen had limited understoreys, lacked climbers, and had large side branches

and expansive crowns and the peacocks roosted in the mid to upper branches. However, a temporary site used by Solo immediately after displacement from his normal sites was placed over Indian date palms (*Phoenix rupicola*) with thorns. At Kawakawa Bay, Auckland, peafowl roost in kanuka (*Kunzea ericoides*) less than 5 m from the ground (*unpubl. data*).

The breeding season and dispersion of birds appears to be adjusted to climatic conditions. In the Kurukshetra district of Haryana, India, display occurred during the pre-monsoon period in mid May to late Jun. Egg laying took place from late Jul to mid Aug and the first young were seen in mid Sep, long after display ceased. There was evidence of peacocks displaying in leks, as well as male female pairings and nest building (Chopra & Kumar 2010). At the Izu Cattus Park at Shizuoka, Japan, peacocks displayed in leks between Apr and Jun, and laying took place after late Jun, during the rainy season (Takahashi & Hasegawa 2008). On the temperate Protection I, Washington, USA, in a mixed forest and meadow area of 4.8 ha, 3 peacocks had single display areas of a few square metres and a home range system with a combined peacock and peahen loafing area, but no overlap in foraging zones (Galusha & Hill 1996). The breeding season there was Feb - Jun and the first clutches were laid in Apr (Galusha & Redd 1982). The timing of the display and lying period was similar to that on Kawau I, where the appearance of young overlapped the display period, and young were generally present during peak invertebrate and fruit availability in summer and autumn.

At Nuncham Courtney, England, 4 previously gregarious adult peacocks established fully defended territories at the start of the breeding season and defended them against other mature males. The central and smaller territories were considered to be the better placed and more defensible, and displacement of a male occurred after a fight. The largest territory was peripheral and held by a newly mature male (Rands *et al.* 1984).

During this study the peacock population on Kawau I was repeatedly disrupted by removal of individuals, but the birds maintained the same display sites over time. Peacocks stayed at display sites during the morning and early afternoon, and seldom did another mature peacock approach them. However, when this occurred the intruder was driven away. In the mid afternoon, looping and foraging areas were used in common and peacocks often foraged gregariously in the evening. Parallel walking took place between 2 males then but did not appear to be directed at defining a boundary.

Nest locations in India are often within grass below thorn bushes (Chopra & Kumar 2010). On Kawau I, peahen used the tracks near the extensive

thickets on the southern ridgeline which included shrub pea (*Polygala myrtifolia*), lantana (*Lantana camara*) and dense agapanthus (*Agapanthus praecox*) but were never seen within the thickest areas. The 2 peafowl nests located at Mansion House Historic Reserve were both within the only moderately high kikuyu, and were placed in shorter grass than those found on Protection I (Galusha & English 1999). No other nest sites were found during extensive coverage of the 22 ha area surrounding the display zones.

On Protection I females were absent from roost sites once incubation began and spent only 5% of the daylight foraging in 1 or 2 feeding periods (Galusha & English 1999). At Mansion House the peahen absence at roosting sites was used to define breeding attempts. New chicks appeared between late Oct and mid Jan (c. 70 days) indicating successful mating took place from late Sep to Dec (Avi & Ripley 1980; Galusha & English 1999). The breeding season duration was similar to that at Tanil Nadu, and other places in India (Avi & Ripley 1980; Subramanian *et al.* 2001) and on Protection I (Galusha & Hill 1996).

Peahens are reported to incubate from the last egg of what can be a 5 - 10 egg clutch and desert their nests after 1-2 days when only part of the clutch had hatched (Johnsingh & Murali 1978). Consequently, the small 1 - 4 chicks per clutch less than 14 days old seen with females on Kawau I, and the subsequent raising of 2 young maximum per female is not unusual (Galusha & English 1999). The breeding success seen at Mansion House in 1992 - 2003 (average 1.4 young per season), exceeded that on Protection I in 1980 (none of 19 chicks; Galusha & McGinley-Redd 1992), and 1998 (Galusha & English 1999). On Protection I, peafowl left weak chicks behind when they had stronger young (Galusha & English 1999). The complete failure of breeding was more likely to be due to avian predators and poor quantity of arthropod foods. At Mansion House peafowl eggs left after females deserted eggs were taken by weka. Weka were seen with young peafowl chicks but it was unknown if these were taken as healthy chicks or were deserted by peahens (B. McKenzie, *pers. comm.*). There was no evidence that the highly modified environment caused by wallabies led to poor peahen condition at mating and favoured female embryos (Pike & Petrie 2005).

The lek breeding system of peafowl has had much attention (Petrie *et al.* 1996; Pike & Petrie 2005; Loyau *et al.* 2005a; Roberts *et al.* 2006). In some populations, peacocks display in visual contact with each other (Petrie *et al.* 1999; Loyau *et al.* 2005b) while in others they are only in vocal contact (Galusha & Hill 1996). Release experiments have found that closely related peacocks appear to recognise each other and form kin groups at these display sites which is independent of their upbringing (Petrie *et*

al. 1999). Removal experiments have also shown that peacocks favour displaying in sites where peahens forage (Loyau *et al.* 2005b, 2007).

At Mansion House the peacocks used the vocal contact display strategy described as an 'exploded lek' (Galusha & Hill 1996). All sites chosen by peacocks in the Mansion House gardens were those where human food supplements were most available, and 1 site was near the remaining area of long grass favoured by females as a nest site. No site appeared to provide greater overall access to food and when peacocks were removed from any site, there was site expansion but former display sites were not deserted.

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