Invasive Animals Cooperative Research Centre



Lord Howe Island ducks: abundance, impacts and management options

A report to the World Heritage Unit, Lord Howe Island Board
January 2008

John Tracey, Brian Lukins and Chris Haselden
Edited by Kerryn Molloy

Invasive Animals CRC

NSW DEPARTMENT OF PRIMARY INDUSTRIES

Invasive Animals Cooperative Research Centre

"Together, create and apply solutions"

Lord Howe Island Ducks:
Abundance, Impacts and Management Options

John Tracey, Brian Lukins and Chris Haselden

Disclaimer:

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Summary

Mallard x Pacific Black Duck hybrids commonly occur on Lord Howe Island in areas of high public use in fresh, estuarine and saline water, particularly where there is abundant mown or grazed grass and where feeding occurs.

Observations of phenotype characteristics suggests that introduced Mallards are dominant and suppressing the native Pacific Black Duck, with 81% of birds classified as Mallards or Mallard-like hybrids, 17% as intermediate hybrids and only 2% as Pacific black-like hybrids. No pure Pacific Black Duck were observed. The existing population is also likely to continue to suppress new arrivals of Pacific Black Duck.

These hybrid species pose obvious direct and indirect economic, social and environmental impacts to Lord Howe Island. Impacts include the suppression of native Pacific Black Duck and unquantified negative social and economic impacts to aesthetics, natural values and tourism. They also play an unquantified role in the maintenance of avian influenza and other viruses potentially important for the wellbeing of endemic fauna and human health. Ducks are a known reservoir of influenza viruses, are more likely to carry these viruses than any other species on the island, and have a high degree of contact with humans.

A management program using trapping, shooting and opportunistic capture by hand was conducted for five days in October 2007. Standardised indices of duck abundance before and after management indicates that the duck population was reduced by 71.7% during this time, and that 28 (SE=3.3) remained after management. The majority of ducks were removed by shooting. Hand capture was most efficient but was opportunistic and limited to juveniles and chicks. Trapping was the next most efficient technique but had difficulties with disturbance by the public.

Eradication is feasible and a program of monitoring, shooting and targeted poisoning using alpha-chloralose is recommended. Reintroductions following eradication are likely to occur and ongoing management will be necessary to prevent re-establishment.

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Project information

Project Name

Managing Pacific Black Duck x Mallard hybrids on Lord Howe Island.

Details of Applicant

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Leesa Haynes	Avian Influenza Wild Bird Steering Group
Patrick Guay	University of Melbourne (DNA analysis)

Period of project

(a) Commencement date: 1 September 2007
(b) Completion date: 31 December 2007

Project objectives

1. Examine the existing and potential impacts of ducks on Lord Howe Island by:
   (a) reviewing impacts to public health, aesthetic values, and tourism
   (b) conducting counts to provide an estimate of duck abundance and distribution
   (c) investigating the epidemiology of the Lord Howe Island duck population using serological, faecal, cloacal and tracheal samples in collaboration with the National Avian Influenza Wild Bird Steering Group,
   (d) identifying the extent of hybridisation between mallards and Pacific Black ducks using phenotypic characteristics (after Gillespie 1985)
   (e) retaining blood clots and feathers samples for potential future DNA analysis for determining the degree of genetic hybridisation (Mallard/ Pacific Black Duck) evident in the duck population, via collaboration with University of Melbourne.
2. Provide training for officers of the Lord Howe Island Board, on monitoring, capture, handling, sampling and euthanasia techniques for ducks.
3. Subject to the consultation and review process, implement a management program for ducks following established protocols for capture, handling, sampling and euthanasia. Including:
   (a) a free-feeding and trapping program at targeted locations, and
   (b) targeted shooting.

1. Background

Mallard (*Anas platyrhynchos*) x Pacific Black Duck (*A. superciliosa*) Hybrids are not native to Australia or New Zealand and are therefore not protected fauna under the NSW National Parks and Wildlife Act 1974. The eradication of Mallard-Pacific Black Duck hybrids from Lord Howe Island is a priority under the Lord Howe Biodiversity Management Plan (Department of Environment and Conservation 2006).

1.1 History

Pacific Black Ducks have regularly been observed on Lord Howe Island since 1852 (Macdonald 1853). Breeding is likely to have occurred since this time although records are infrequent: 1887 (Australian Museum records cited in McAllan et al. 2004), 1941-1945 (Hindwood and Cunningham 1950) and 1971 (Rogers 1972). A flock of 100 were observed in 1956, which subsequently declined (McKean and Hindwood 1965): possibly a result of hunting. Birds were a principal source of food for early island inhabitants, especially shearwaters (flesh-footed and wedge-tailed) and sooty terns (Hindwood 1940), which continued until at least the 1970s (Hutton 1991). It is likely that Pacific Black Ducks would have also been taken for food. Feral cats and possibly pigs (by disturbance of nesting sites) are also likely to have limited duck populations, before their successful eradication from the island in 1981.

Mallards were first recorded on the island in 1963 (McKean and Hindwood 1965), then in 1972 (Ray Shick, cited in Hutton 1991), and soon after began hybridising with Pacific Black Ducks (1975: Rogers 1976). Since then reports of Pacific Black Ducks or Mallards are likely to have been hybrids between the two species. By 1978, 50 to 60 were reported to be on the island (Hutton 1991). Populations have remained relatively stable since then, probably benefiting initially by the provision of permanent water and areas of open lawn and grazing and later by feeding by visitors and residents; and probably limited by control attempts by the Lord Howe Island Board and residents.

Mallard x Pacific Black Duck hybrids were initially found to occupy areas below Mount Lidgbird and Blinky Beach swamp (Hutton 1991). They were fed by visitors and school students at Pine trees lodge in the early 1980's and in 1987 began to regularly visit Ned's beach where bread is habitually fed to fish (Hutton 1991). These hybrids are now an obvious and prominent feature of Ned's Beach and also occur in areas frequented by visitors and residents including Old Settlement, the airstrip and the golf course.

The origin of both Pacific Black Duck and Mallard on Lord Howe Island is uncertain, but there are no records of deliberate introductions, and both species have the capacity to travel vast distances to colonise new areas, either from the Australian mainland (Port Macquarie 586 km, Brisbane 740 km, Sydney 778 km), New Zealand (1304 km), Norfolk Island (898 km), New Caledonia (Noumea 1258 km) or other islands. Mallards are perhaps more likely to have arrived from New Zealand than the Australian mainland, as there abundance is higher there (Gillespie 1985) and banding records have confirmed their movements to Norfolk Island and New Caledonia (ABBBS 2007).

1.2 Movements

1.2.1 Pacific Black Duck

Pacific Black Ducks are widely distributed through-out Australia and New Zealand in fresh and brackish water. They are uncommon in marine habitats, but can utilise these areas during drought (Goodrick 1979) or when they occupy islands (eg. Horning and Horning 1974; Norman 1990). Movements on mainland Australia and New Zealand are associated with the availability of surface water (Roshier et al. 2001). Populations are more sedentary where there is deep permanent water and more dispersive in ephemeral wetlands of the arid interior. Prolonged drought and increased river regulation in Australia has resulted in drastic populations declines (Kingsford and Thomas 1995; Kingsford and Porter 2006; Porter et al. 2006). Although not as dispersive as other anatids, in times of drought birds can disperse vast distances in all directions (Frith 1963; Frith 1982). The maximum recorded distance is 2677 kilometres, where a bird banded in Griffith New South Wales (-34 deg 17 min, 146 deg 3 min) was recovered after 6 years at Walpole Inlet Western Australia (-34 deg 59 min, 116 deg 42 min) (ABBBS 2007). Movements between Australia and New Zealand are likely to occur (Frith 1982). However, this has been confirmed only once by banding, where a bird banded in Victoria was recovered 25 months later in Otago in New Zealand, a distance of 1900 kilometres (Norman 1973).

1.2.2 Mallard

Mallards are native to the Palearctic (Eurasia) and Nearctic (North America) and were introduced to Australia and New Zealand in the late 1860's (Lever 1987). In New Zealand they have resulted in the decline of pure Pacific Black Duck (known as Grey Duck in New Zealand). By 1982 the percentage of pure Pacific Black Duck in Otago NZ had declined to only 4.5% (Gillespie 1985), they now are thought to persist only in isolated, non-urban areas in New Zealand. Mallards prefer shallow water close to human habitation. Urban birds are often hand fed and become tame.

In mainland Australia and New Zealand mallards appear more sedentary than Pacific Black Ducks and other species. However, long-range dispersal has been demonstrated by banding records, particularly by New Zealand mallards. For example, a bird banded in February 1989 at Karere Lagoon NZ (-40 deg 24 min, 175 deg 32 min) was recovered after 3 months at Bendameer, NSW (-30 deg 53 min, 151 deg 10 min) after moving 2432 km. Movements from other islands to NZ have also been recorded, eg. a bird banded in 1982 on Norfolk Island was recovered after 5 years at Northern Wairoa River NZ a distance of 1107 km (ABBBS 2007).

1.3 Avian Influenza

Avian influenza is an infectious disease of birds caused by type A strains of the influenza virus. Avian influenza viruses normally do not infect species other than birds, but have been recorded infrequently in a range of other animal species including humans (Hinshaw et al. 1981; Alexander 1982; Claas et al. 1998; Katz 2003).

Influenza A viruses are divided into subtypes determined by haemagglutinin (H) and neuraminidase (N) antigens. At present, 16 H subtypes and 9 N subtypes have been identified. Each virus has one of each subtype in any combination. The reservoir for all avian influenza virus H and N subtypes is aquatic birds, particularly ducks (Suss et al. 1994), in which they multiply in the gastrointestinal tract producing large amounts of virus (Webster et al. 1978; Hinshaw et al. 1980) usually without producing clinical signs (Kida et al. 1980). In this environment, new combinations of H and N genes are generated and dispersed (Scholtissek et al. 1993). This process of exchanging genes between virus strains is called re-assortment within influenza viruses and occurs when single cells of the host become co-infected with two genetically different viruses (Hinshaw et al. 1980). In wild waterbird hosts, the H and N subunits appear to be stable, and do not mutate (Sharp et al. 1997) like they do when the viruses infect domestic poultry and mammals. New virus combinations multiply readily in avian species and, in chickens and turkeys a proportion have a propensity to mutate and produce severe disease which in turn produce epizootics in poultry enterprises.

Infection in birds causes a wide spectrum of symptoms, and viruses can be divided into two groups according to their pathogenicity (Office International Epizooties. 2001). Some forms of these viruses, known as highly pathogenic avian influenza (HPAI), can cause severe illness and mortality approaching 100% (Alexander 1993; Swayne and Suarez 2000). However, most strains of the virus are non-virulent, do not produce clinical signs or cause only mild respiratory or reproductive disease. These are known as low pathogenic avian influenza (LPAI) viruses which are commonly isolated from wild birds, particularly anatids (Slemons and Easterday 1972; Stallknecht and Shane 1988). Highly pathogenic influenza viruses, however, are not maintained by wild bird populations, but are occasionally isolated from wild birds during outbreaks in domestic poultry (Nestorowicz et al. 1987). The ability of LPAI to mutate into HPAI (Perdue et al. 1998), particularly in poultry, and the diversity of viruses circulating in wild bird populations (Webster et al. 1992) emphasises the potential importance of wild birds as a primary source of infection.

Epizootics of avian influenza may occur when a HPAI virus (with either a H5 or H7 haemagglutinin) is introduced to a naïve poultry population. Severe pandemics in humans occur when a major “antigenic shift” has occurred such as when the haemagglutinin is changed in influenza viruses that infect humans. Severe disease epidemics occur when there is “drift” with significant antigenic change in the haemagglutinin gene.

The presence of avian influenza viruses in wild birds thus has significance primarily for its potential to infect domestic poultry and humans, within which it can then undergo re-assortment to produce pathogenic forms (Webster et al. 1971; Webster et al. 1973). In addition, if humans are concurrently infected with both human and avian strains of influenza there is an increased risk of a new subtype emerging, which could result in the direct transmission between humans with the possibility of a pandemic (Webster 1998; Snacken et al. 1999; Baigent and McCauley 2003; Katz 2003).

There have been five known outbreaks of avian influenza in commercial bird flocks in Australia. Outbreaks occurred in 1976 (Turner 1976), 1985 (Barr et al. 1986), and 1992 (Selleck et al. 1997) in Victoria; 1994 in Queensland (Westbury 1998); and in 1997 in Tamworth New South Wales (Selleck et al. 2003). Viruses identified have all been of subtype H7 (H7N7, H7N3 and H7N4). The 2003-2004 Asian epidemic of HPAI (subtype H5N1) commenced in August 2003 and by March 2004 was confirmed in China, Cambodia, Indonesia, Japan, Laos, South Korea, Taiwan, Thailand and Vietnam. H5N1 has also caused disease and death in humans (Claas et al. 1998; Subbarao et al. 1998; Yuen et al. 1998) via direct avian-to-human transmission.

2. Abundance, distribution and hybridisation

2.1 Introduction

There are few records of duck abundance on Lord Howe Island group: an estimate of 100 in 1956 (McKean and Hindwood 1965) and an estimate of 50 to 60 in 1978 (Hutton 1991). There is no current information on their distribution nor the extent of hybridisation. This section provides information on the abundance, current distribution, activity, habitat utilisation of Lord Howe Island ducks and degree of hybridisation between Mallards and Pacific Black Duck from observational studies conducted in October 2007.

2.2 Methods

Twenty-two systematic counts of ducks were conducted between the 8th and the 18th October 2007. All anatids were recorded on a standardised route following regularly accessible areas from Ned's Beach and Old Settlement in the north to through to Evies and South Point. The species, number, location, plumage scores, sex and age classes of anatids were recorded during counts.

More detailed observations of plumage characteristics were also conducted to quantify the degree of hybridisation between Mallards and Pacific Black Duck. This occurred both in the field and with all captured and shot individuals. Gillespie's (1985) seven point scoring system was used to differentiate phenotypic characteristics between the two species (Table 1).

Individuals with a score of 0-9 were considered Pacific Black duck; scores of 10-24 were considered hybrids; and scores of 25-35 were considered Mallard. The hybrid score was also separated into Pacific Black-like hybrids (10-14), Intermediate hybrids (15-19) and Mallard-like hybrids (20-24). The minimum number of ducks known to be alive was also calculated by differentiating, where possible, individuals and groups during repeated counts using adults (males and females), juveniles and chicks and separating birds into different plumage classes.

Table 1: An index used to differentiate Pacific Black Duck, Mallard and their hybrids using phenotypic characteristics (Braithwaite and Miller 1975 and Gillespie 1985)

Characteristic	**Description**	**Value**
FACIAL STRIPES		
Pacific Black Duck	Two clear stripes on a cream background	0-1
Hybrid	Obscured	2-3
Mallard	None to thin black eye stripe in female	4-5
ANTERIOR BORDER OF SPECULUM		
Pacific Black Duck	No white bar	0-1
Hybrid	Thin white bar (2mm)	2-3
Mallard	Broad white bar (5mm)	4-5
POSTERIOR BORDER OF SPECULUM		
Pacific Black Duck	Faint white line	0-1
Hybrid	Thin white bar (2mm)	2-3
Mallard	Broad white bar (5mm)	4-5
BILL		
Pacific Black Duck	Slate - grey	0-1
Hybrid	Grey - yellow	2-3
Mallard	Yellow- orange	4-5
NAPE		
Pacific Black Duck	Cream	0-1
Hybrid	Creamy brown	2-3
Mallard	Dark brown, varying from dark green to purple-green in male	4-5
TAIL		
Pacific Black Duck	Slate - grey	0-1
Hybrid	Grey - brown	2-3
Mallard	Creamy brown, varying from dark green to purple-green in male	4-5
LEG		
Pacific Black Duck	Grey - brown	0-1
Hybrid	Grey - yellow	2-3
Mallard	Yellow - orange	4-5

2.3 Results and Discussion

2.3.1 Abundance and Distribution

The mean number of ducks observed prior to management was 52.11 (SD=8.74, n=10). This standardised index was used for monitoring the change in population size over time and in response to management, but is not a complete count. The minimum number known to be alive prior to management was 98.

Ducks were most commonly observed on the golf course, Ned's beach and Johnsons Creek area (Figure 1). Some ducks were present on picnic lawn areas and on the roadside near Old Settlement. Ducks also regularly foraged on the large areas of mown grass and pasture paddocks surrounding the airstrip. Following significant rainfall temporary waterholes form in pasture paddocks, which attract groups of ducks to swim and feed while the water persists. Similar behaviour is observed in fresh water pools formed in drainage lines following significant rain events. Larger family groups of unfledged ducks are resident near permanent dams within the golf course, surrounded by mown grass fairways and bushland, both usable habitat for these birds.

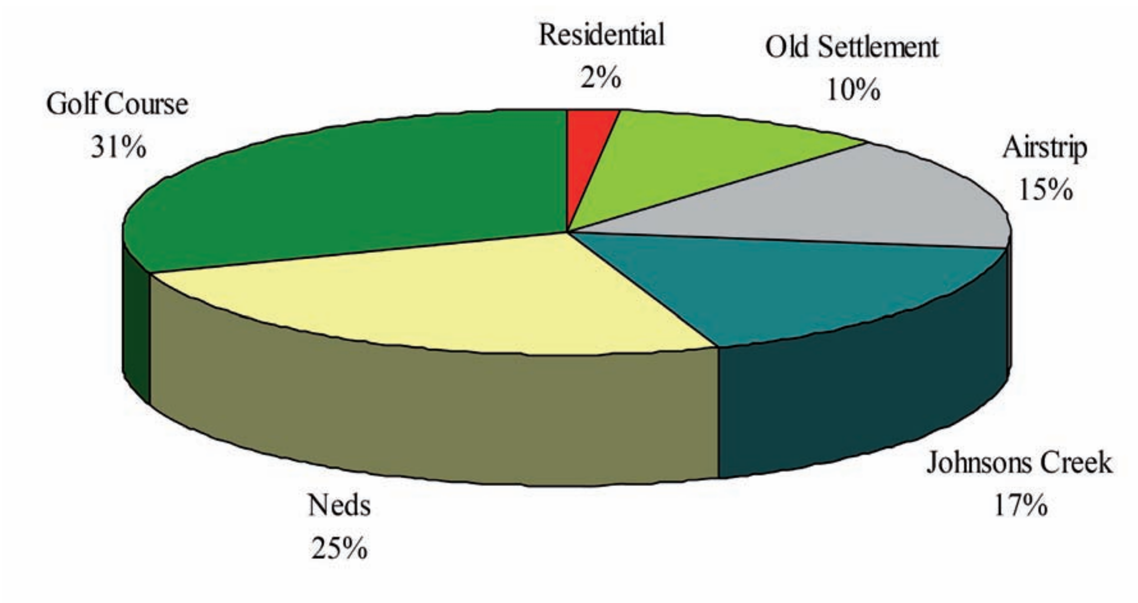

Figure 1: Proportion of Mallard x Pacific Black Duck observed in different zones

Ducks preferred mown grass (32%) to grazed grass (17%) or the revegetation area (7%) for foraging (Figure 2). Freshwater (22%) was utilised where available, but ducks also regularly occurred in more saline habitat (Ocean 5% and Estuarine 3%), which is also observed when they occur on other islands (Norman 1990). The beach was used primarily at Ned's beach where fish feeding occurs.

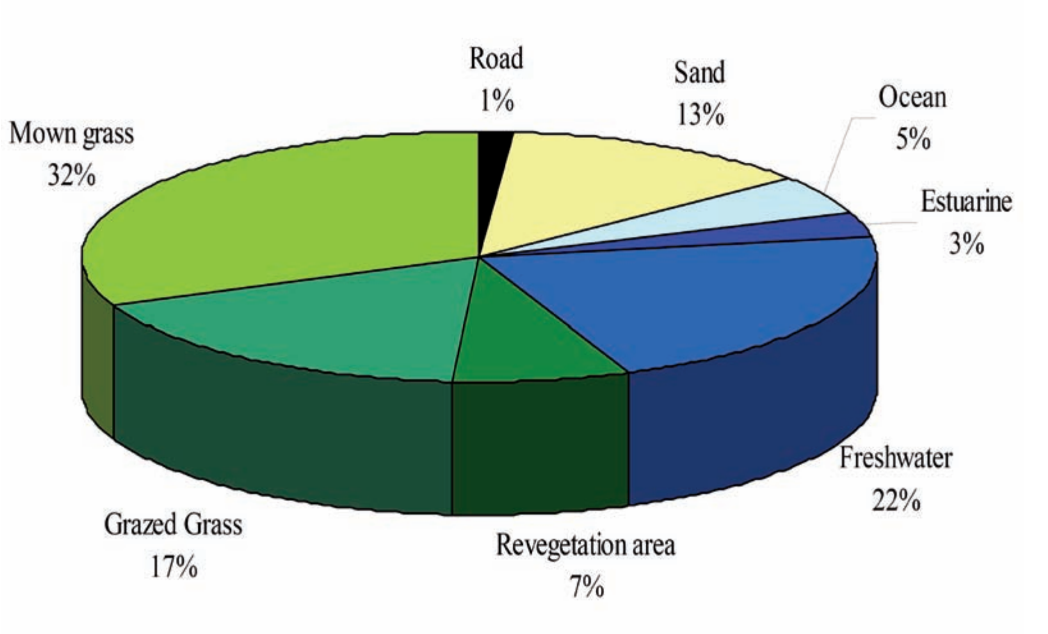

Figure 2: Proportion of Mallard x Pacific Black Duck observed in different habitat types. n = 929

Ducks spent the majority of their time standing (32%), swimming (21%) and walking (18%) (Figure 3).

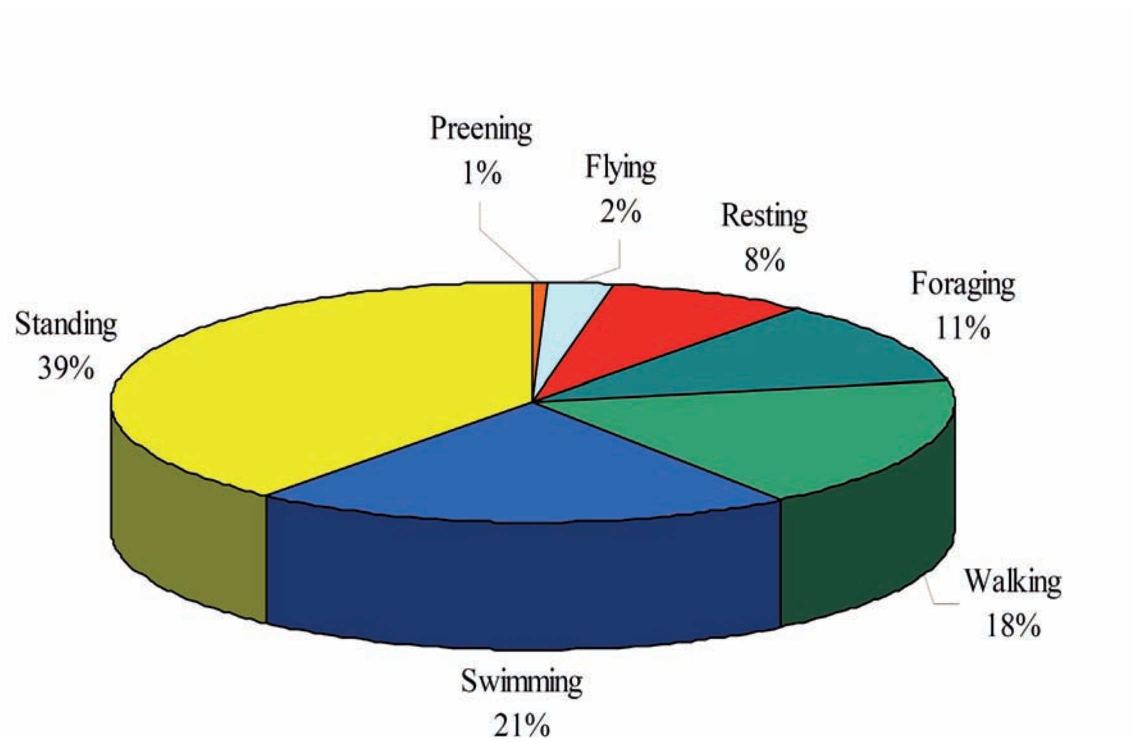

Figure 3: Activity of Mallard x Pacific Black Duck observed

2.3.2 Hybridisation

Of importance, no birds were classified as Pacific Black Duck, despite 86 classifications being undertaken. Evidence suggests that Mallards are suppressing Pacific Black Duck traits, with only 2% classified as Pacific black-like hybrids, 17% as intermediate hybrids, 41% as Mallard-like hybrids and 40% as Mallards. The mean score was 24.2 (range 11-34, SE=0.59, n=86), which is the upper limit of Mallard-like hybrids (Figure 4).

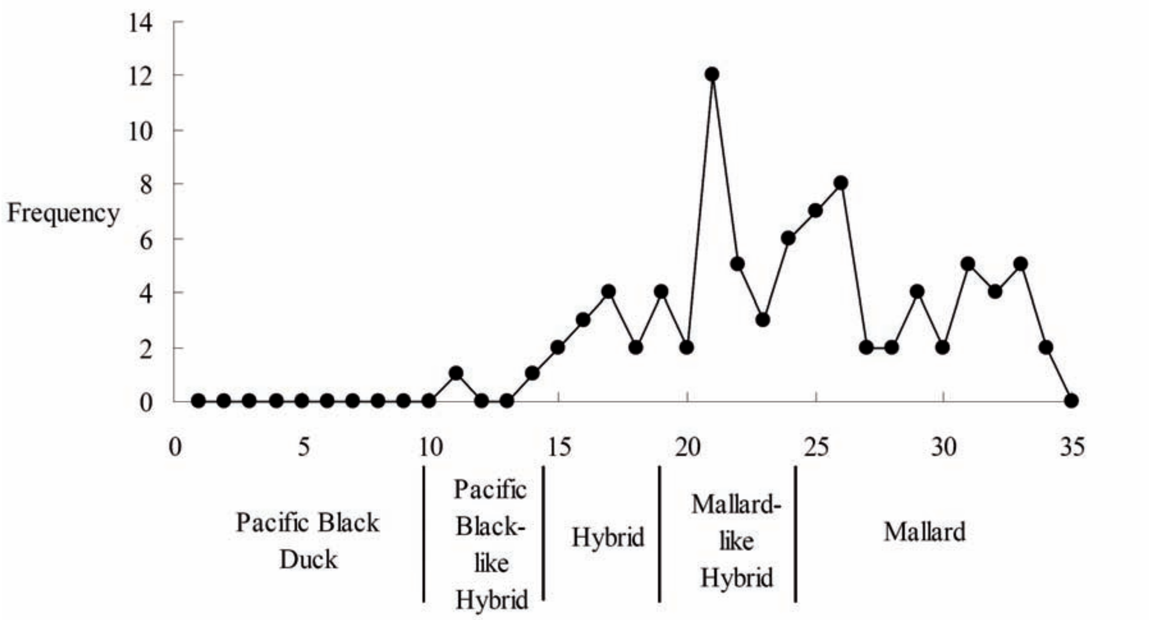

Figure 4: Frequency of phenotypic scores used to evaluate hybridisation between Mallard and Pacific Black Duck on Lord Howe Island

3. Review of Impacts

3.1 Impacts on aesthetics, natural values and tourism

The Lord Howe Island Group was inscribed on the World Heritage List in 1982 for its outstanding natural values. Of importance the group contains 'features, formations and areas of exceptional natural beauty and aesthetic importance' – a world heritage value (Criteria iii) upheld by the Lord Howe Island board and residents. 'The bird life of Lord Howe Island is one of its most notable features' (Australian National Parks and Wildlife Service 1981). The prominent presence of a clearly introduced species is likely to detract from the natural values of the island.

Of the wildlife present on Lord Howe Island few are as obvious as the Mallard x Pacific Black Duck hybrids. In particular these ducks have become a very visible daily presence at Ned's Beach, using the edge of the ocean, beach and lawns adjacent to the beach. The birds exhibit domestic duck type behaviour as they congregate and wait for humans to arrive and place feed. They follow humans into the waters edge and aggressively attempt to take the feed placed for native fish, despite attempts by these people to chase them away. Unusually for a freshwater species, quite large groups of hybrid ducks use the bay at Ned's beach to swim.

Ducks are regularly observed in areas of high public use (Section 2.3.1): searching for feed on lawn areas in close proximity to outdoor restaurants and along roadsides. A high level of interaction with visitors and faecal contaminant in these areas is commonly observed, which raises concerns for aesthetics particularly relevant for Ned's beach, as previously identified as Australia's cleanest beach.

Tourism is the primary source of income for the majority of island residents. Visitors are attracted to Lord Howe Island because of its pristine condition and unique native fauna. Board staff expend considerable effort maintaining these features on land areas open for public use. The direct and indirect economic and social costs of ducks are difficult to quantify, but these are not in-consequential. The presence of an obvious introduced species detracts from the unspoilt presentation and is likely to significantly reduce its appeal to ecotourists and bird enthusiasts.

3.2 Threat to native species

The most direct and immediate threat of Mallards on Lord Howe Island is the decline and evident extinction of resident Pacific Black Ducks. Evidence suggests that the introduced Mallard has eliminated the Pacific Black Duck which were present (Section 2.3.2). Existing hybrids are likely to continue to suppress new arrivals. Hybridisation between Pacific Black Ducks and Mallards has been also observed in New Zealand (Gillespie 1985), Campbell Island (Bailey and Sorensen 1962), Pitt Island (Tupuangi, Chatham Islands) (Tennyson 1998), Norfolk Island, Auckland Island, Macquarie Island (Norman 1990) and other places where the two species co-occur.

3.3 Reservoirs for disease

Ducks (anatids) are a major known reservoir for several avian diseases, including avian influenza, which have the potential for very serious and rapid spread, which are of serious socio-economic and public health concern.

Wildlife, including anatids, play an important role in the maintenance and transmission of zoonotic and livestock diseases. Importantly, the majority of emerging diseases affecting human health and agricultural production are believed to have a wild animal source. An understanding of the associated risks, and an ability to respond rapidly to disease outbreaks where wildlife are potential vectors, is important for the economy of Lord Howe Island and the welfare of its fauna and residents.

Although several extensive sampling programs for avian influenza have been conducted in Australia and New Zealand there remains considerable uncertainty as to the role of wild birds in the transmission and maintenance of avian influenza (Bunn 2004; Turner 2004; Tracey et al. 2004; Arzey 2004a; Arzey 2004b). The risks associated with wild birds introducing H5N1 or other subtypes from overseas and their function in maintaining endemic strains is difficult to quantify with current information. Avian influenza viruses are also highly unpredictable and have a documented propensity for mutation.

The potential transmission of H5N1, and other influenza A viruses from Asia to other countries via wild birds is of concern. There are many bird species known to undertake movements between Asia, mainland Australia and Lord Howe Island; the species involved, their movement behaviour, ecology and susceptibility to disease are all of importance when assessing the risk of introducing foreign disease.

The role of Mallard x Pacific Black duck hybrids in the maintenance of avian influenza subtypes, Newcastle Disease virus and other viruses on Lord Howe Island is unquantified and is the subject of on-going investigations. However, ducks are a known reservoir of avian influenza and Newcastle disease viruses, are more likely to carry these viruses than any other species on the island, and have a high degree of contact with humans.

4. Management options

Ducks on Lord Howe Island can be managed using a variety of options. This section reports the results of an initial trial using cage traps, a pull net, hand capture and shooting. A review of alpha-chloralose and issues specific for Lord Howe Island is also included.

4.1 Methods

Mallard x Pacific Black Duck were targeted by trapping, shooting and hand capture between 14th- 18th October 2007. Capture, handling and euthanasia of ducks was conducted according to ethics approval (Animal Research Authority Approval Number ORA 05/019), NSW Department of the Environment, Conservation and Climate Change scientific licence (Project S11728), and nationally endorsed standard operating procedures–available at:

www.environment.gov.au/biodiversity/invasive/publications/humane-control/index.html.

Counts of duck abundance (Section 2.1) were conducted before, during and after management was implemented. Detailed information on the timing and frequency of operation, and costs and labour (including bait material, number of days free-feeding) was recorded.

4.1.1 Trapping

Traps used in this trial included eight Australian duck traps (funnel entrance cage traps, approximately 1800 x 900 x 900 mm), and a pull net. Free-feeding with bread and poultry layer mash occurred for 6 days prior to setting the traps.

Trapped birds were removed from the trap by hand and placed in a plastic holding box. Non-target species captured were released at the capture location.

4.1.2 Shooting and hand capture

Shooting was carried out by board staff abiding by standard operating procedures. Shooting was conducted in a manner which maximised its effect thus causing rapid death. This involved the use of a .22 calibre rifle within an optimum range of 25 metres. The shooter did not shoot at a bird unless it was clearly visible and were confident of killing it with a single shot. Only one bird was targeted at a time. Wounded birds were located as quickly and humanely as possible and euthanased.

Juveniles and chicks were also opportunistically captured by hand or handheld net: both in conjunction with shooting and during independent capture events. For juvenile birds this involved a small team to prevent escape into shrubby habitat and to run down birds and capture with a hand-held net.

4.1.3 Sampling and euthanasia

Morphometric measurements and blood samples were taken, prior to euthanasia for live captured birds. Plumage scores, cloacal and tracheal swabs were taken immediately after euthanasia. Cloacal, oropharyngeal and blood sampling procedures used were those described by Rose (2006). Cloacal and oropharyngeal samples were placed viral transport media and stored at 4ºC. Serum was separated from blood clots using a centrifuge and pipetted off into Epindorfs. Blood clots and feather samples were retained for possible future DNA work. Feathers were placed in paper bags and stored at room temperature. Cold storage at 4ºC was maintained for all other samples while on the island and during transport to the mainland. Once returned to Orange NSW all samples were stored in the -80ºC freezer.

Recommended methods of euthanasia were used (Sharp and Saunders 2004) including; cervical dislocation (which involves separation of the skull and the brain from the spinal cord by pressure applied posterior to the base of the skull), shooting or in restrained or immobile birds, a blow to the rear of the skull, or use of carbon dioxide using a regulator.

4.1.4 Laboratory Testing

To provide information on existing avian influenza viruses present in wild birds on Lord Howe Island 445 cloacal, oropharyngeal, faecal and serum samples were taken from a variety of species (Table 2). Samples were transported to the Elizabeth MacArthur Agricultural Institute for testing. PCR tests for Influenza A will be conducted on cloacal, oropharyngeal and faecal swabs. An ELISA antibody test will carried out on the serum samples. Results are pending.

Table 2: Samples taken for avian influenza testing

Common name	Number of samples
Buff-banded Rail	16
Common Blackbird	2
Fleshy-footed Shearwater	104
Lord Howe Woodhen	6
Magpie-lark	4
Mallard x Pacific Black Duck hybrid	183
Providence Petrel	8
Purple Swamphen	22
Sooty Tern	50
Total	**445**

4.1.5 Analysis

The percent reduction was estimated using two indices (standardised counts and minimum number alive) before (I1) and after (I2) management. An additional abundance estimate was calculated using index-manipulation-index (Riney 1957; Eberhardt 1982; Caughley 1980). This method can be used to estimate population abundance when standardised indices are collected before and after the removal or addition of a known number of animals. The notation of Caughley (1980) is used here for estimating population size (N) before a removal (C) and Eberhardt's (1982) variance estimate:

$$\hat{N} = \frac{I_1 C}{I_1 - I_2}$$

with a variance of

$$V(\hat{N}) \approx \hat{N}^2 \left(\frac{q}{p}\right)^2 \left(\frac{1}{I_1} + \frac{1}{I_2}\right)$$

from which the standard error (s.e.) of $\hat{N}$ is

$$s.e.(\hat{N}) = \sqrt{V(\hat{N})}$$

where,

N population size before removal

I_1 index before

I_2 index after

C number removed

p proportion removed, $(I_1 - I_2) / I_1$

q proportion of those remaining, 1 – p.

4.2 Results

Seventy-two birds were captured and euthanased between the 14th and the 18th October. The majority of these birds were shot (Table 3). Hand capture was the most efficient technique ($3.48/bird), but was opportunistic, limited to juveniles and chicks and was often associated with shooting of adults. Trapping would likely to have been significantly more efficient without the continual disturbance of traps by the public. At Johnsons Creek North and South and Evies ducks did not become acclimatised to traps. Feed from inside and surrounding traps in these areas was being consumed by non-target species, including Lord Howe Island woodhen, Buff banded Rail and Purple Swamphen. Thirty-two birds of 5 non-target species were captured in traps, sampled for avian influenza and released at the capture location (Tables 2 and 4).

Table 3: Total birds captured and relative efficiency of methods used to capture ducks

	Time (Hours)	Persons required	Person hours	Captures				$ labour	$ / adult	$ / bird
				Adults	Juveniles	Chicks	Total			
Shooting	13.6	2	27.2	23	8	0	31	680	29.57	21.94
Hand captures	1.67	2	3.34	0	5	19	24	84	NA	3.48
Cage traps	13#	1	13	12	5	0	17	325	27.08	19.12
Pull net	4	2	8	0	0	0	0	200	NA	NA
Sampling	10	2	20					500		
Monitoring	43	2	86					2150		
TOTAL	**72.27**		**157.54**	**35**	**18**	**19**	**72**	**3938.50**		

includes setting (2 hrs), free-feeding (6 hrs) and checking (5 hrs) for 8 traps. Costs exclude upfront costs of equipment.

* assumes $25 per person per hour.

Table 4: Non-target species captured during trapping

Common name	Number of birds trapped
Buff-banded Rail	15
Common Blackbird	1
Lord Howe Woodhen	3
Magpie-lark	2
Purple Swamphen (Pukaka)	11
Total	**32**

(a)

(b)

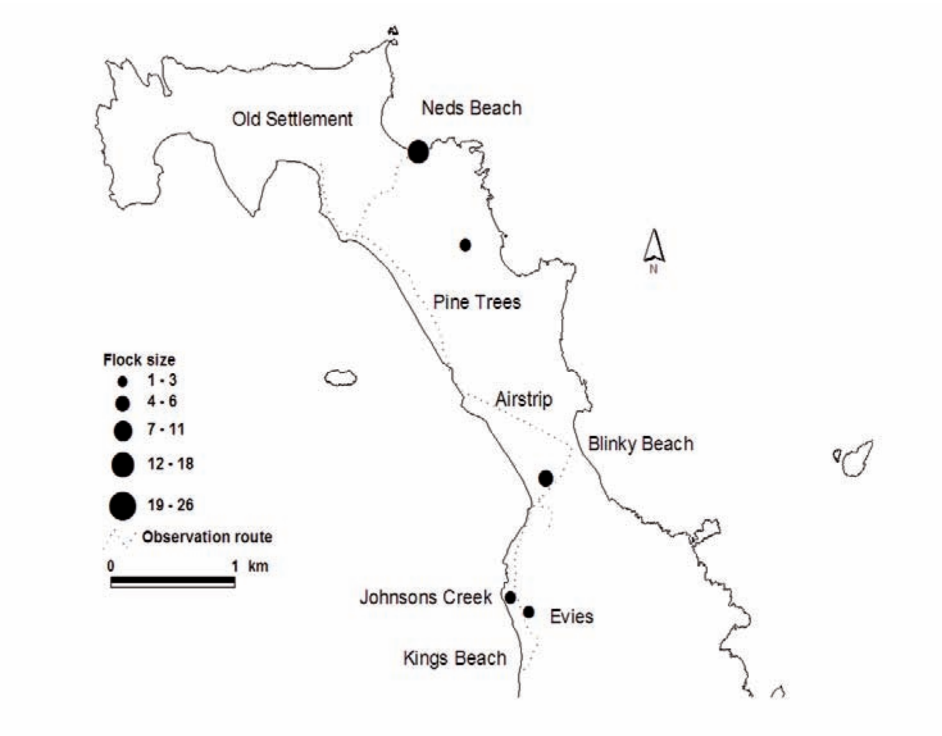

Figure 5: Distribution of Mallard x Pacific Black Duck (a) before and (b) after control 8th to 18th October 2007. Dots represent the number of birds observed in each flock (1-26).

Using the Index-manipulation-index method the abundance before management was 100.43 (SE=11.69) and after 28 (SE=3.3). Management significantly reduced the distribution of ducks (Figure 5). The minimum number of individuals known to be alive after management was 26. This comprised 13 adults (6 males, 7 females) at Ned's Beach, 4 (2 adults- 1 male and 1 female, and 2 chicks) in Residential areas, 5 adults (3 females and 2 males) in the Johnson Creek/ Evies area and 4 (1 adult female and 3 juveniles) near the Weather Station. Using the mean number of ducks observed after management of 14.75 (SD=6.18, n=4), the reduction was estimated as 71.7%. Using the minimum number of ducks known to be alive (98 Before, 26 After) the reduction was estimated as 73.5%.

4.2.1 Review of alpha-chloralose

Alpha-chloralose is a drug used for birds and rodents that induces unconsciousness. Variously classified as a soporific or narcotic, alpha-chloralose is generally considered the most humane of the available avicides (Tracey et al. 2007), as it depresses the central nervous system and eliminates the sense of pain. It is often also used to immobilise birds or mammals at sublethal levels. Alpha-chloralose is currently registered in New South Wales, Queensland, South Australia, Western Australia and Tasmania for introduced birds, including Mallards in Tasmania. It is also used successfully for the management of waterfowl overseas (e.g. Woronecki et al. 1990). For use on Mallard x Pacific Black duck hybrids by the Lord Howe Island Board it is recommended that a minor use permit be obtained through the Australian Pesticides and Veterinary Medicines Authority (APVMA). The following information is based on Hone and Mulligan 1982, Agriculture Protection Board of Western Australia (1994) and the current APVMA permit issued in Tasmania; and includes a description of alpha-chloralose (including toxicity and pharmacology), it's health effects, first aid, treatment of non-target species, environmental concerns, symptoms of poisoning and outlines a free-feeding strategy relevant to Lord Howe Island.

Physical description

Alpha-chloralose is a white crystalline powder, with melting point 187deg C and low solubility in cold water. It may be dissolved in hot water and is much more soluble in alcohol. It is converted by acids and alkalis into glucose and chloral.

Health effects

Swallowed: poisonous if swallowed

Eye: avoid contact with eyes

Skin: avoid contact with skin

Inhaled: harmful if inhaled, use a respirator.

First aid

If poisoning occurs call a doctor or poisons information centre, get to a doctor or hospital quickly.

If swallowed: induce vomiting if patient is conscious

Eye: immediately flush with plenty of water for 15 minutes

Skin: wash skin thoroughly with soap and water.

If inhaled: remove to fresh air. If not breathing give artificial respiration. If breathing is difficult give oxygen.

Toxicity

Acute oral LD50 for rats 400mg/kg, mice 32 mg/kg, cats 100 mg/kg, dogs 600 to 1000 mg/kg (Cornwall 1969). The compound is often more toxic to birds than most mammals. Oral LD50 for starling 75 mg/kg, redwing blackbird 32 mg/kg, yellow headed blackbird 133 mg/kg, crow 42 mg/kg, pigeon 178 mg/kg, house finch 56 mg/kg, house sparrow 42 mg/kg, mallard duck 42 mg/kg, mourning dove 42 mg/kg, white crowned sparrow 56 mg/kg (Schafer 1972). Secondary poisoning as a result of eating a bird that has ingested alpha-chloralose should be considered, however it is probably impossible for domestic animals to receive a fatal dose in this manner, as the quantity consumed is too small.

Pharmacology

Central nervous system: alpha-chloralose is described as both a depressant and stimulant on the CNS.

Cardiovascular system: It is generally agreed that anaesthesia with alpha-chloralose is associated with little change in blood pressure or a reduction in heart rate.

Body temperature: It is probable that hypothermia always accompanies anaesthesia with alpha-chloralose in all species of animals. The deeper the level of anaesthesia the greater the fall in body temperature. This explains why lethal toxicity is more likely when ambient temperature is below 15 deg C.

Metabolism: Alpha-chloralose is metabolised in the body to chloral, which in turn is largely converted to trichloroethanol. The latter compound is a CNS depressant, which combines with glucouronic acid in the liver to form a pharmacologically inactive urochloralic acid. This derivative is readily excreted in urine.

Treatment for non-target animals

If bait is consumed by non-target animals the following treatments are recommended to maximise the chance of a full recovery:

1. The animal should be gently restrained to prevent self-injury. Place the animal in a well padded cage or box. The easiest way to handle birds of prey is to gently wrap them in a thick towel or cloth and place them in a warm dark box.

2. As the hypothermic action of the drug contributes to its toxicity, sufficient warmth should be applied to keep the animal close to normal temperature level (25 to 28deg C).

Affected animals will need to be kept under the above conditions for anything from 6 to 10 hours.

Environmental concerns

Alpha-chloralose is very stable in sunlight and treated feed can remain toxic for several weeks. Treated feed left out may dry and harden and appear unpalatable to birds, but will readily re-soften when exposed to dew or light rainfall. It is important to carefully collect all uneaten treated feed and dispose of it properly. Uneaten treated feed should be buried under at least 500mm of soil in a non-crop or non-pasture area away from water sources and homes.

Symptoms of poisoning

Narcosis with alpha-chloralose in birds may proceed through the following four stages:

1. Cesssation of activity – birds fail to perch properly, and stagger in a 'drunken' manner if disturbed. Eyes remain open, they cannot be readily caught.
2. The bird stands in a hunched position, eyes closed or flickering. Does not move if approached quietly, but does move if touched. Can be caught with care.
3. The bird lies down, head drooping and eyes closed, remains still except for periods of mild convulsions with wings and tail flapping. It moves when touched or handles, and may be picked up easily.
4. The bird remains motionless, even when touched. If reached, this stage usually leads to death.

Birds in the early stage of narcosis seem to fly quite normally, even though they generally neither stand upright or judge distances for landing. Ducks disturbed during the first stage may fly to water and will need to be retrieved to avoid drowning when they enter the second or third stages. Sublethal dosing resulting in ducks reaching the second or third stages after leaving the site (but staying on land) will increase the risk of some birds escaping. Ducks may display the first symptoms of narcosis within 30 minutes of the first feed, but this may extend to from 2 to 5 hours in some individuals.

Proposed baiting and feeding strategy

An APVMA permit allows a person as stipulated by that permit to use an AGVET chemical product in the manner specified in the permit in the designated jurisdictions (locations).

Thorough observations of ducks are essential to determine:

- the number of ducks present
- their feeding habits
- their preferred location
- daily behaviour patterns
- the presence of non-target species.

On the basis of these observations desirable baiting locations may be determined. For Lord Howe Island, Ned's Beach represents an ideal situation for hand feeding and subsequent poisoning.

Feed should be placed in protected areas where wind will not blow it away, and where remains may be collected up and removed. Feed should be spread in several bands rather than a single heap, to maximise the number of birds feeding at one time.

The key to success for toxic feed is feed acceptance. Pre-feeding with untreated feed before using treated feed is essential. This may take a few days or as long as two to three weeks for some individuals. When placing untreated feed the same routine should be followed each day – at the same time of day, preferably by the same person or someone wearing the same coloured clothes. The quantity of feed consumed should be recorded daily. Before placing treated feed, all untreated feed should be collected and removed.

1. Pre-feeding: Feed ducks with good quality untreated bread thinly sliced, and cut into pieces small enough to be readily swallowed by ducks. Ducks have limited ability to bite or chew off pieces of food, and rely on side to side shaking of their head and bill to break up bread pieces that are too large to swallow whole. For areas where ducks are naive to hand feeding, a minimum period of 10 to 14 days is recommended, but a longer period may be necessary until it is apparent that all birds are feeding. Be patient. Allow about 50g of feed per bird per day, then increase as necessary. When treated feed is given, the alpha-chloralose will be applied to margarine spread between two slices of bread as a sandwich. At Ned's beach free feeding will be less, however, it may be an advantage to pre-feed ducks with this same sandwich form but without treatment with alpha-chloralose, to familiarise them with eating the treated feed when it is later offered. Lay the untreated feed at the same time each day, and try to wear the same coloured clothing each time so that birds quickly recognise the feeder as their 'friend' and supplier of food. On the last day before the treated feed is given, collect and remove all untreated feed after ducks have finished feeding. Frequent monitoring of the number of ducks feeding and recording of these observations will allow an estimate of the total population size and the quantity of feed required from day to day. Carefully monitor any non-target bird visitors and be prepared to make decisions in the program to avoid non-target poisoning.

2. Preparing the treated feed: The most effective dose for mallard hybrid ducks is expected to be 45 mg alpha-chloralose per kg bodyweight. This equates to 45 mg alpha-chloralose for a 1 kg mallard. Prepare treated bread feed so that each piece contains at least a single dose (most effective dose) for each bird. Bread is suitable for where ducks can be individually fed, such as Ned's Beach. Distribute treated feed by hand in front of ducks in the same way that they have become accustomed to being fed untreated feed, during the pre-feed period. 2% of alpha-chloralose (20g per kg bait material) is recommended for consistency with the existing permit. It is best to prepare treated feed fresh just prior to placing it for ducks.

3. Laying the treated feed: If possible place the treated feed on days when no rain is expected and the temperature low. Ideally the general public and other people should be excluded from the feeding area and close surrounds. Warn any workers at the site not to touch treated feed. Lay the treated feed at the same time of day as the untreated feed was being put out. Do not apply treated feed to water or allow it

to fall into water. Do not place treated feed if significant numbers of non-target species are present and are likely to take the feed. Maintain supervision while feed placement is underway, monitoring any non-target birds or animals taking the feed and following up on their fate.

4. Collecting affected ducks: After the treated feed has been placed, watch the area from a concealed position. Do not frighten the birds and ensure that there is no interference from other people or dogs. Record the number of ducks feeding and the direction that any fly off. Do not attempt to collect drugged birds until at least 30 minutes after the birds began feeding. It is best to wait at least 45 minutes before collecting birds. As birds will remain drugged for 10 to 20 hours there is no hurry. If you attempt to remove birds before they are immobile they will fly off. However, any birds that fly off prematurely and land on the water will need to be recovered to prevent drowning as narcosis proceeds further, but this will need to done without disturbing other birds which may have fed for a shorter time. If any birds have flown off search the whole area. Pick up all affected birds. Any native birds affected should be kept in warm darkened containers until they recover and can be released. Any ducks should be killed quickly and humanely by cervical dislocation or a sharp blow to the nape. Dispose of dead ducks by deep burial or incineration. Ensure that no birds are removed for human or animal consumption. Carefully collect and remove all uneaten treated feed, and dispose of it by burying under at least 500mm of soil in a non-crop, non-pasture area away from water sources and homes. Make a final search of the feeding area 45 minutes after the feed has been removed. It is possible that treated feed will need to be placed more than once, but allow at least two days between successive placements of treated feed.

Occupational Health and Safety

Precautions for use of pure product: Handle in a well ventilated area, using a fume hood where possible. Avoid contact with skin and eyes. When preparing treated feed wear long pants, long sleeves (or equivalent coveralls) a washable hat, elbow-length PVC gloves, effective eye protection and a respirator fitted with dust particle cartridge. After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water. After each day's use, wash clothing , gloves and safety equipment.

General considerations: All persons handling alpha-chloralose in pure form or as a treated feed must use all the protective clothing and equipment listed in the material safety data sheet. It is unknown what diseases ducks might carry or transmit, so as a precaution people collecting and disposing of narcotised ducks may wear suitable equipment including coveralls, rubber gloves and dust mask. Once dead birds have been disposed of, all equipment should be thoroughly washed. Pure alpha-chloralose and treated feed should be safely stored in a dry locked container. The container should be stored in a secure area and be clearly labelled.

4.3 Discussion and recommendations

Eradication of the resident population is feasible and should be pursued, but will not be straight forward. In particular, disturbance by the public and the tendency of birds to become flighty will make removal of the last few problematic, labour intensive and therefore expensive. Continued monitoring and a combination of shooting and targeted poisoning using alpha-chloralose is recommended to remove the last individuals.

4.3.1 Monitoring

The continuation of regular standardised counts and recording time spent shooting and trapping to monitor management success is recommended. Standardised counts indicate changes in duck numbers and distribution, which is useful for targeting control. Reintroductions of Mallards are likely to occur (Section 2.2) hence ongoing monitoring will be required, even if eradication of the resident population is successful.

4.3.2 Shooting

Shooting is a two person task to avoid conflict with the general public. One person to shoot, the other to look out for the approach of people and to identify potential hazards behind the line of sight.

Eradication is feasible if ongoing efforts are directed to controlling ducks. After the initial population reduction it becomes a situation of observing and removing individual ducks or small groups of ducks. Ducks which frequent back yards and other concealed areas on private property are more difficult to pursue. Opportunities to shoot individual ducks or pairs of ducks happen sporadically and it is helpful to have a firearm readily available to quickly capitalise on these when they occur. Regular monitoring of the island over time will provide the best opportunity to both detect and remove remaining birds.

Firearms

A reliable and accurate .22 calibre rifle with silencer is essential for efficiently removing ducks from Lord Howe Island. The purchase of a good quality rifle and scope is recommended as a basic requirement, to minimise missed shots and odd malfunctions allowing birds to leave before being shot. A priority is to maximise the chance of the first shot at a duck being lethal, both from the animal welfare perspective and to maintain the efficacy of removing birds. This will minimise subsequent behavioural disturbance of the target bird and nearby birds. Subsonic ammunition is quiet and effective over distances up to approximately 25 metres. Head shots to ducks cause instant death, but are more difficult to achieve on such a small target under field conditions. A good rest point for the rifle and sufficient time are required for this type of shot. Body shots are easier to achieve consistently, but on a duck are less likely to be lethal from a single shot using subsonic ammunition.

Ducks frequent very public areas and if disturbed are very mobile and quickly disperse to other parts of the island. Trapping would be favoured to capture larger groups, while shooting and the associated disturbance is best reserved for smaller groups.

4.3.4 Trapping

Trapping is problematic as a result of regular and ongoing disturbance of traps by the public. It is therefore not recommended at this stage. Trap interference not only disturbs the ducks and trapping success on the day, but undermines the effort expended and progress made during the free feeding period. Failing the success of other methods, trapping could be conducted in concealed areas, such as within the revegetation area of Old settlement, or in conjunction with more intensive observations in high public use areas such as Neds beach. If pursued free-feeding for longer periods prior to activating is recommended: up to 10 days to allow birds to enter and acclimatise to the trap.

4.3.5 Hand capture

Capture of chicks and juveniles before fledging, when they are less mobile, is a priority as subsequent control is much more expensive and time consuming. There appeared to be a pulse of duck breeding in October, and during one week we were able to remove four entire clutches of chicks and juveniles, as well as partial removal of others, by hand capture and shooting. This was most successfully done where the mother/parent bird was first shot, as that restricted subsequent movements of the young. One adult and a clutch of five young evaded capture on several occasions, between which they walked significant distances. At several weeks age these birds were already skilled at using vegetation cover to escape capture. The earlier that clutches are detected and removed the better, as their ability to walk and evade capture increases with age. Older juveniles are also more likely to survive to adulthood following the removal of parents. The presence of a second person increases the chance of capturing a whole clutch of young. Ongoing monitoring is an advantage when capturing young. In mid October we discovered three clutches of six to eight juveniles of similar ages using the golf course. We were able to target these and knew when all the young had been removed, some requiring more than one session. In this instance capture was a combination of trapping, hand capture around open fairways and dams using a hand net, and shooting. Juveniles and young ducks are also slightly easier to attract into traps.

4.3.6 Labour

The ranger is best placed to remove and eradicate ducks from the island, having knowledge of where ducks occur and their behaviour. He is uniquely able to utilise shooting and other control methods in public areas as well as on private land. Ongoing control of ducks will require a regular commitment of a small percentage of the ranger's time for monitoring and control. In addition an assistant will be required on regular occasions to ensure the efficiency and safety of control efforts, when shooting and using hand capture.

4.3.7 Euthanasia

We recommend use of a blow to the back of the head for euthanasia of hand captured ducks on Lord Howe Island. The use of carbon dioxide and cervical dislocation is effective but is not as instantaneous and requires practice to master.

4.3.8 Poisoning

Ned's beach presents a unique situation: birds are regularly fed; there is likely to be on-going disturbance of traps by the public; birds quickly become flighty when disturbed or following shooting; and some birds that readily feed from the hand are reluctant to go into traps.

Poisoning specifically targeted at Ned's Beach offers an effective means of removing these individuals. A specific hand delivered poisoning campaign using alpha-chloralose (Section 4.2.1) following free-feeding is feasible, and is likely to be the most effective option to achieve eradication at Ned's Beach. This would involve obtaining a minor use permit from the APVMA and the NSW Department of Conservation and Climate Change.

This method is currently being used by the Department of Primary Industries, Water and Environment in Tasmania for Mallards, hybrids and introduced geese. Non-target species do not present a problem at Ned's beach, where the food would be specifically targeted to individuals. The Beach would be closed on the day that the toxin is introduced. Alpha-chloralose, a soporific, is the most humane of the avicides, but requires adequate doses to reduce the likelihood of birds vacating the feeding site. A proposed baiting strategy is outlined in section 4.2.1.

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