

## Hybridisation between mallard (*Anas platyrhynchos*) and grey duck (*A. superciliosa*) on Lord Howe Island and management options

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**Abstract** Introduced mallards (*Anas platyrhynchos*) occur on many islands of the South Pacific, where they hybridise with the resident grey duck (*A. superciliosa*). In October 2007, we conducted systematic surveys of Lord Howe Island to estimate the abundance and distribution of grey ducks, mallards, and their hybrids. Hybrids were common in areas of high public use, particularly where there was mown or grazed grass. Phenotypic characteristics suggest that mallards are now dominant and have supplanted the native grey duck, with 81% of birds classified as mallard or mallard-like hybrids, 17% as intermediate hybrids and only 2% as grey duck-like hybrids. No pure grey duck were observed. These hybrids pose direct and indirect economic, social and environmental impacts to Lord Howe Island. A management program to remove mallards using trapping, shooting and opportunistic capture by hand was conducted in October 2007. Standardised indices of duck abundance before and after management indicates that the total population was reduced by 71.7%. Eradication of mallard and hybrids from Lord Howe Island is considered achievable with a program of education, monitoring, and continued control to prevent re-establishment.

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**Keywords** mallard; grey duck; hybridisation; control; Lord Howe Island

### INTRODUCTION

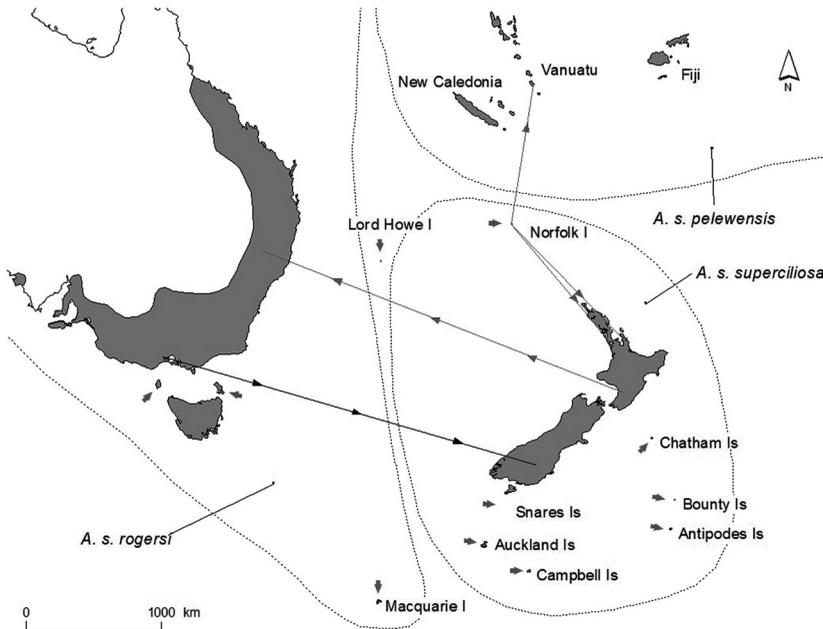
Grey duck (*A. superciliosa*) are widely distributed throughout the South Pacific (Marchant & Higgins 1990). They favour fresh and brackish water and are uncommon in marine habitats, except during drought (Goodrick 1979), or on oceanic islands (Horning & Horning 1974; Norman 1990). Movements on mainland Australia and New Zealand are associated with the availability of surface water (Roshier *et al.* 2001). Populations are sedentary near permanent water, and more dispersive in ephemeral wetlands and in times of drought (Frith 1963, 1982).

There are 3 subspecies of grey duck (Amadon 1943; Rhymer *et al.* 2004; cf. Marchant & Higgins 1990): the nominate *superciliosa* found in New Zealand, and on Chatham, Bounty, Antipodes, Snares, Auckland and Campbell islands; *rogersi*

found in Australia, New Guinea and Indonesia; and *pelewensis* found in New Guinea, Vanuatu, New Caledonia, Fiji, Solomon Islands and French Polynesia. The subspecies *pelewensis* is markedly smaller (Amadon 1943), but *superciliosa* and *rogersi* cannot be differentiated morphologically. However, recent DNA analyses have found 2 divergent lineages in these latter two taxa: one found only in New Zealand, the other found throughout Australia and New Zealand (Rhymer *et al.* 2004). Grey ducks on Lord Howe Island (159°05' E, 31°33' S) occur at the geographic intersection of all 3 subspecies (Fig. 1) and their lineage is unknown. Grey duck have been observed on Lord Howe Island since 1852 (Macdonald 1853). Breeding is likely although records are infrequent: 1887 (Australian Museum records cited in McAllan *et al.* 2004), 1941-1945 (Hindwood & Cunningham 1950) and 1971 (Rogers 1972). A flock of 100 grey ducks were observed in 1956, but this population subsequently declined (McKean & Hindwood 1965).

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**Fig. 1** Movements and distribution of mallard (grey lines with arrows; grey shading) and grey duck (black lines with arrows; dotted lines) in the South Pacific. Source: Norman 1973; Hermes *et al.* 1986; Marchant & Higgins 1990; Barrett *et al.* 2003; Robertson *et al.* 2007; ABBBS 2008. Distribution of *A. superciliosa* subspecies was taken from Rhymer *et al.* (2004). Note that Amadon (1943) and Frith (1982) included the birds of Macquarie Island within the distribution of *A. s. superciliosa*.

Mallard (*Anas platyrhynchos*) are native to the Holarctic and were introduced to Australia and New Zealand in the late 1860's (Lever 1987). Hybridisation between grey duck and mallard is common throughout New Zealand (Gillespie 1985) to the extent that the genetic integrity of the grey duck has been compromised (Rhymer *et al.* 1994). By 1982 only 4.5% pure grey duck remained in Otago (Gillespie 1985), and they now are thought to persist only in isolated, non-urban areas in New Zealand. Rhymer *et al.* (2004) suggested mallard should be eradicated from the Chatham Islands, and pure grey duck be introduced to preserve its genetic integrity. Although rarely quantified outside New Zealand, hybridisation between these two species also occurs elsewhere in the South Pacific, with the mallard implicated as a threat to the grey duck wherever they co-occur (Williams & Basse 2006, cf. Braithwaite & Miller 1975).

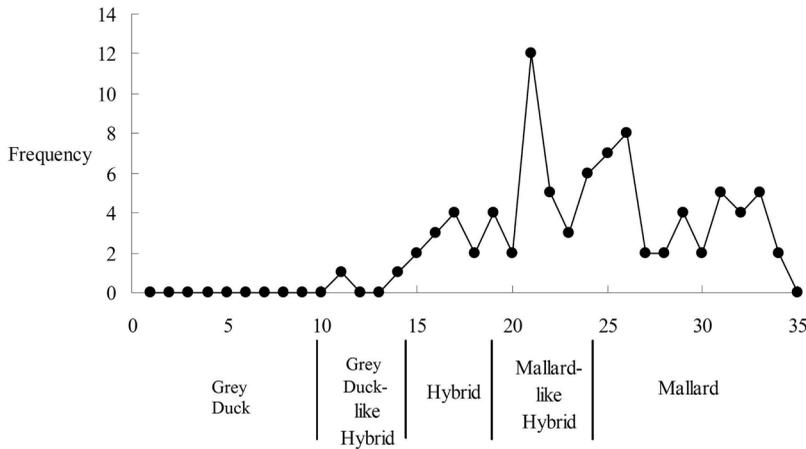
Mallard were first recorded on Lord Howe Island in 1963 (McKean & Hindwood 1965), and soon began hybridising with grey duck (Rogers 1976). The initial sightings of mallard coincide with major attempts to introduce this species to New Zealand: by 1963 over 20,000 mallard were released throughout the North and South Islands (McDowall 1994). Mallard appear more sedentary than other ducks, although banding records demonstrate some long-range dispersal (Fig. 1), and it is possible mallards on Lord Howe originated from New Zealand. Since 1975 reports of grey duck on Lord

Howe Island are likely to have been hybrids with mallards (Hutton 1991).

While grey duck and mallard have been observed on Lord Howe Island since 1963 (McKean & Hindwood 1965), there is no current information on their distribution and abundance, and few attempts have been made to manage these populations. This paper quantifies the extent of hybridisation between grey duck and mallard on Lord Howe Island, provides information on their abundance, current distribution, habitat use, and investigates the potential for their management.

## METHODS

Twenty-two systematic surveys of ducks were conducted in October 2007. All ducks were recorded along a standardised route from Ned's Beach and Old Settlement through to Evies and Kings Beach (Fig. 3). Flock size, habitat type, location, activity, sex and age classes of birds were recorded. Detailed observations of plumage on 86 ducks were used to quantify the degree of hybridisation. This occurred both in the field ( $n=32$  ducks) and with captured and shot individuals ( $n=54$  ducks). Gillespie's (1985) seven point scoring system was used to differentiate phenotypic characteristics of the two species. Individuals with a score of 0-9 were considered grey duck; scores of 10-24 were considered hybrids; and scores of 25-35 were considered mallard. The hybrid score was also separated into grey duck-like



**Fig. 2** Frequency of phenotypic scores used to evaluate hybridisation between mallard and grey duck on Lord Howe Island.

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, when possible, individuals and groups during repeated counts using differences in age and plumage.

To trial methods for future management of ducks on Lord Howe Island we removed mallards and hybrids by trapping, shooting and hand capture according to ethics approval (Animal Research Authority ORA 05/019) and standard operating procedures (Sharp & Saunders 2004a, b, c). Surveys of duck abundance and distribution were conducted before ( $n=10$ ), during ( $n=5$ ) and after ( $n=7$ ) control measures were implemented. The timing and frequency of operation, and costs and labour was also recorded. Eight funnel entrance cage traps (approximately 1800 x 900 x 900 mm) and a pull net were used. Baiting with bread and poultry layer mash occurred for 6 days prior to setting the traps. Trapped birds were removed and placed in a plastic holding box. Non-target species were released at the capture location. To avoid dispersing flocks, a .22 calibre rifle with silencer was used for shooting. Juveniles and chicks were also opportunistically captured by hand or handheld net.

The percent reduction in mallards and mallard hybrids was estimated using 2 indices (standardised counts and minimum number alive) before and after management. An additional abundance estimate was calculated using index-manipulation-index (Riney 1957; Caughley 1980), with Eberhardt's (1982) variance estimate. Pearson's chi-squared tests were used to test habitat preferences separately for terrestrial and aquatic environments, using expected numbers estimated from the proportions of each habitat available within the searched area.

## RESULTS

### Current extent of hybridisation

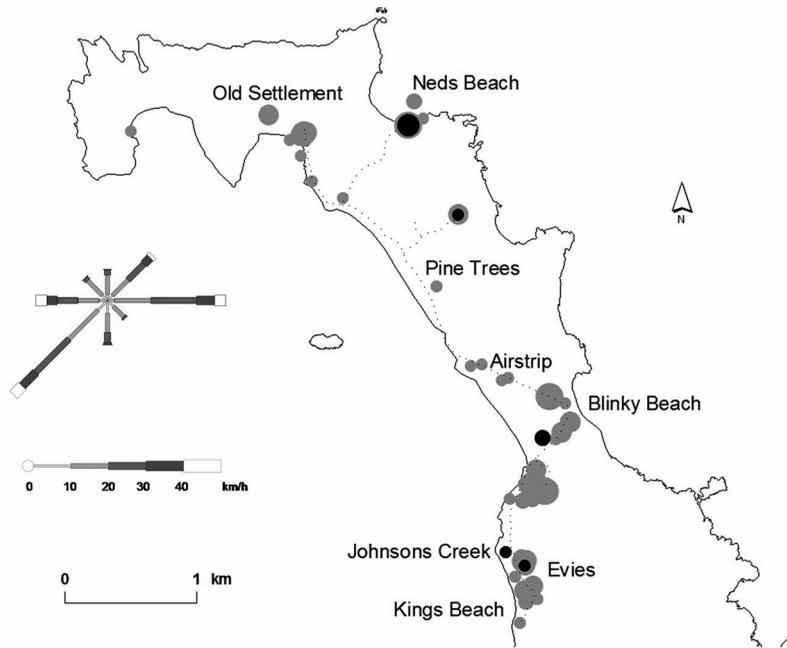
No birds were classified as pure grey duck, despite sampling over 90% of the entire population (86 birds classified out of approximately 100 ducks present, see below). Grey ducks appear to have hybridised extensively with mallards, with only 2% of birds classified as grey-like hybrids, 17% as intermediate hybrids, 41% as mallard-like hybrids and 40% as pure mallard. The mean phenotypic score was 24.2 ( $se = 0.59$ , range 11-34,  $n = 86$ ), which is the upper limit of mallard-like hybrids (Fig. 2).

### Abundance, distribution and ecology of ducks on Lord Howe Island

Prior to management, the mean number of ducks observed per survey was 52.1 ( $se = 8.7$ ,  $n = 10$  surveys) and the total number estimated using the index-manipulation-index method was 100.4 ( $se = 11.7$ ). The minimum number known to be alive prior to culling was 98 ducks.

Ducks were most commonly observed on the golf course (31%,  $n = 906$  groups of ducks), Ned's Beach (25%) and Johnsons Creek area (17%; Fig. 3). They also occurred in the vicinity of Old Settlement (10%) and occasionally in residential areas and along roads (2%). Ducks regularly foraged on mown grass and pasture paddocks surrounding the airstrip (15%). None were observed in forested habitat, despite 1.58 km<sup>2</sup> (67%) of forest occurring within the search area. Following rainfall, temporary waterholes in pastures attracted groups of ducks. Similar behaviour was observed in fresh water pools formed in drainage lines. Larger family groups of unfledged ducks were resident near permanent dams within the golf course.

When classified according to terrestrial habitat use, ducks preferred areas with mown grass (45%,



**Fig. 3** Distribution and abundance of mallard x grey duck hybrids on Lord Howe Island before (●) and after (●) control in October 2007. Flock size: ● 1-3, ● 4-6, ● 7-11, ● 12-18, ● 19-26. Observation route: (.....). The wind rose shows the long term average wind speed and direction from records taken at Lord Howe Island airport between 1989-2006 (Source: Australian Government Bureau of Meteorology).

$n = 654$  groups of ducks,  $P < 0.001$ ,  $\chi^2 = 3254.7$ ) to grazed grass (25%) or the revegetation area (11%). The beach was also used (18%), primarily at Ned's Beach where people feed fish. Observations of ducks on water indicated a strong preference for freshwater (72%,  $n = 275$  groups of ducks,  $P < 0.001$ ,  $\chi^2 = 11,586$ ), but ducks were also regularly observed in the ocean (17%) and estuaries (11%). Ducks spent the majority of their time standing (32%,  $n = 692$ ), swimming (21%) and walking (18%). Other activities included foraging (11%), resting (8%), flying (2%) and preening (1%).

Breeding was observed in October, with 10 clutches observed (mean = 7.7 eggs per clutch,  $se = 0.78$ , range 4-12,  $n = 10$ ): nests were built close to fresh water in dense clumps of long grass. Recorded weights for mallard (male: mean = 1040 grams,  $se = 23.7$ , range 910-1170,  $n = 12$ ; female: mean = 930 grams,  $se = 42.9$ , range 800-1040,  $n = 6$ ) were larger than those of the hybrids (female: mean = 897 grams,  $se = 19.6$ , range 730-990,  $n = 13$ ).

#### Control of mallards and hybrids

Seventy-two birds were captured and euthanased between 14 - 18 October 2007. The majority of these birds were shot (43%). Hand capture was the most cost-efficient technique (AUS\$3.50/bird, cf. trapping AUS\$19/bird and shooting AUS\$22/bird) but was only used to capture juveniles and chicks when shooting adults. Trapping was hampered by the disturbance of traps by the public, and ducks did not become acclimatised to traps in some locations

or bait was consumed by non-target species. Thirty-two birds of 5 non-target species were captured in traps, sampled for diseases and released at the capture location including banded rail (*Gallirallus philippensis*) (15), pukeko (*Porphyrio porphyrio*) (11), Lord Howe woodhen (*Gallirallus sylvestris*) (3), magpie-lark (*Grallina cyanoleuca*) (2), and blackbird (*Turdus merula*) (1).

Using the index-manipulation-index method the combined duck population before management was estimated to be 100.4 birds ( $se = 11.69$ ,  $n = 10$  surveys), with an estimate of only 28 birds after the cull ( $se = 3.3$ ). Management significantly reduced the distribution of ducks (Fig. 3) and the minimum number alive after management was 26 birds. Using the mean number of ducks observed after management of 14.8 birds ( $se = 6.18$ ,  $n = 4$ ), 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%.

#### DISCUSSION

##### Abundance – past and present

The decline in number of grey duck on Lord Howe Island reported after 1956 may have been a result of hunting by humans and/or predation by cats, and was concomitant with the first records of mallard on the island in 1963 (McKean & Hindwood 1965). Birds, including ducks, were a principal source of food for early island inhabitants, and hunting

continued until at least the 1970s (Hutton 1991). It is likely that grey duck were hunted although it is unknown how many were killed. Feral cats (*Felis silvestris catus*) and possibly introduced pigs (*Sus scrofa*), may also have limited duck populations, although both were subsequently eradicated by 1981 (Hutton 1991). Pukeko, king fish (*Seriola lalandi*) and Lord Howe Island Currawong (*Strepera graculina crissalis*) are also known to prey upon ducklings and may also limit recruitment (C. Haselden, *unpubl.*; Hutton 1991).

Hybridisation between grey duck and mallard on Lord Howe Island was first reported in 1975 (Rogers 1976). The total number of ducks has gradually increased from 50 to 60 birds reported in 1978 (Hutton 1991) to the current prior-control population of about 100 birds, probably due to the provision of permanent water, creation of open lawn and grazing, and feeding by visitors and residents. Our survey revealed that all of these ducks are either mallards or hybrids. The extent of hybridisation on Lord Howe Island is thus even more advanced than in New Zealand (51% hybrids, 4.5% pure grey duck; Gillespie 1985). Mallard x grey duck hybrids on Lord Howe Island were initially found to occupy areas below Mt Lidgbird and Blinky Beach swamp (Hutton 1991). They were fed at Pine Trees Lodge and by 1987 began to regularly visit Ned's Beach where bread is fed to fish (Hutton 1991). These hybrids are now an obvious and prominent feature across the entire island.

The origin of both grey duck and mallard on Lord Howe Island is uncertain, but there are no records of deliberate introductions, and both species have the capacity to colonise new areas, either from the Australian mainland (Port Macquarie 586 km), New Zealand (1304 km), Norfolk Island (898 km), or New Caledonia (1258 km). Mallards are more likely to have arrived from New Zealand or Norfolk Island than the Australian mainland, as they are abundant in New Zealand (Gillespie 1985) and banding has confirmed their movements from Norfolk Island to New Zealand, Vanuatu and New Caledonia (Fig. 1). However, the prevailing wind on Lord Howe Island is from the south-west during winter and spring (Fig. 3), and it is possible either species could also travel from mainland Australia at this time of year.

Birds classified as mallard were heavier than hybrids, but unusually were lighter than both mallard and grey duck in New Zealand (Balham 1952), Australia (Miller 1971; Braithwaite & Miller 1975), and North America (Kortright 1942). This may indicate that the original source of *A. superciliosa* was from the north rather than west or south. The weights recorded for *A. superciliosa pelewensis* were considerably lighter (Amadon 1943) than the weights of mallard or hybrids in the current study.

The most direct and immediate threat of mallard on Lord Howe Island is the decline and evident extinction of resident grey duck. Evidence from this study suggests that the introduced mallard has eliminated the grey duck previously present. Existing hybrids are also likely to continue to suppress any arriving grey ducks. Williams & Basse (2006) suggest that mallard will soon permanently displace the grey duck throughout New Zealand as a consequence of the mallard's greater survival, fecundity, physical domination, and willingness to exploit disturbed environments. Hybridisation with mallard has also been implicated as a major threat to anatids in other countries, including Canada and the United States (American black duck, *A. rubripes*, Ankney *et al.* 1987), Mexico (Mexican duck, *A. platyrhynchos diazi*; Hubbard 1977; cf Scott & Reynolds 1984), Hawaii (Hawaiian duck, *A. wyvilliana*), and Madagascar (Meller's duck, *A. melleri*, Jones 1996). In the South Pacific co-occurrence of mallard and grey duck has also been observed on Campbell Island (Bailey & Sorensen 1962), Chatham Islands (Tennyson 1998), Snares Islands (Miskelly *et al.* 2001), Auckland Island (Marchant & Higgins 1990), Norfolk Island (Hermes *et al.* 1986) and Macquarie Island (Norman 1990).

### Management Options

After our control program, a minimum of 21 adults (comprising 1 grey duck-like hybrid, 3 intermediate hybrids, 9 mallard-like hybrids, and 8 mallard), 3 juveniles and 2 chicks were known to be alive. Bomford & O'Brien (1995) outline 6 criteria for successful eradication of a vertebrate pest. We believe that 5 of these criteria can be satisfied for mallard on Lord Howe Island: all animals are at risk by at least one method of control, rate of removal can exceed the rate of increase at all densities, the population can be monitored at all densities, discounted benefit-cost analysis is likely to favour eradication, and there is a suitable socio-political environment conducive to eradication. There is limited information on the benefits and costs of control, which are likely to increase as the population decreases. However, we believe the benefit-cost criteria are justified on the basis that control options are relatively inexpensive (currently AUS\$3.50-\$22/bird) compared with the potential benefits of the re-establishment of the native grey duck. The remaining criterion, which stipulates that immigration is zero, is unlikely to be met for mallard or hybrids. However, on the basis of previous records of introductions (McKean & Hindwood 1965; Ray Shick, cited in Hutton 1991; Rogers 1976), immigration is likely to be infrequent and preventing their re-establishment is considered manageable.

Although we consider the eradication of mallards and their hybrids on Lord Howe Island

as feasible, it is not straight-forward. In particular, disturbance of traps by the public and the tendency of birds to become flighty may make removal of the last few individuals problematic, labour intensive and therefore expensive. For these reasons, a hand delivered poisoning campaign following free-feeding may be a feasible option, and as an adjunct to targeted shooting, is likely to be the most effective option to achieve eradication. Alphachloralose, a soporific, is the most humane avicide (Tracey *et al.* 2007), and has a proven track record for anatids in the United States (Woronecki *et al.* 1990, 1992) and is currently registered for use in Tasmania. On welfare grounds, control should be implemented before breeding (Oct, this study; Jul-Nov, Hutton 1991; Sep-Oct, McAllan *et al.* 2004). If breeding has commenced, hand capture of ducklings and juveniles before fledging, when they are less mobile, is a priority as subsequent control is more expensive and time consuming. Given the current distribution of mallard in the South Pacific and their capacity to travel large distances, re-colonisations following eradication are likely to occur. On-going monitoring and management will be necessary to prevent the re-establishment of mallards and to protect the genetic integrity of any future population of grey ducks.

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