

Introduced avian species in the Hunter Region: ecological threats or benign interlopers?

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A study of the arrival, distribution and abundance of introduced avian species in the Hunter Region identified 15 species which established populations within the region. Currently, seven of those species are locally common. The others are either uncommon or rare, and in one case, locally extinct. Twelve species established wild populations, with varying degrees of success. The three most abundant species currently are Common Myna *Acridotheres tristis*, Spotted Dove *Streptopelia chinensis* and Common Starling *Sturnus vulgaris*. Most of these species were released in the mid-19th century, mainly around Sydney, and arrived in the Hunter Region from the late 1870s to early 1980s. The population trend for one species, Common Myna has increased over the last 22 years, while the long-term population trend of the other species is either uncertain, declining or unknown.

The introduced species are mainly restricted to urban, peri-urban and agricultural areas that have disturbed habitat. There are no indications they have successfully adapted to undisturbed native habitat.

Numerous accounts have reported introduced species as having a detrimental effect on native species through aggressive competing for nest sites and food sources. However, the few scientific studies that have been conducted found detrimental effects were limited to urban areas or areas with disturbed habitat. The extent of the impact varied with the type of vegetation cover and the size of the species. These studies also suggest that efforts currently directed towards controlling Common Myna by culling in heavily urbanised environments are misdirected. The studies suggest that resources would be better directed towards improving natural habitat quality in these areas, if the purpose of control is to enhance urban bird diversity.

INTRODUCTION

Most birdwatchers pay little attention to the presence of introduced avian species in our region and very few would make the effort to follow-up on a reported sighting. However, introduced species have been reported to have had a major impact on Australia's environment, threatening our unique biodiversity and reducing overall species abundance and diversity. Additionally, introduced species are reported to have major economic and societal consequences (Baker *et al.* 2014).

Potential interactions in ecological processes between introduced and native avian species are extensive and include: competition for nesting sites; competition for food; interference competition; predation; brood parasitism; hybridisation; and disease (Baker *et al.* 2014).

In the past, bird species were introduced to provide food for domestic use, and as wild stock for recreational hunting purposes or for aesthetic reasons. For example, birds such as the House Sparrow *Passer domesticus* were introduced into

agricultural areas from the mid-1800s with the expectation that they would control insect pests. In addition to these deliberate introductions, accidental introductions have occurred through avicultural escapees and from birds hitching rides on boats and planes (Baker *et al.* 2014).

Many avian species were introduced into Australia by "Acclimatization Societies" in the mid-19th century. Those societies aimed to introduce, acclimatise and domesticate useful or ornamental birds, fish, insects, vegetables and other exotic species (Tout-Smith 2003). They espoused the Lamarckian theory that the environment could bring about evolutionary change in species as they adapted to their new surroundings. The activities of these societies, however, were also driven by the belief that Australian fauna and flora were in some way deficient or impoverished and also by an element of nostalgia amongst early settlers for the "Old Country" with a desire to see and hear familiar species. Fortunately, most of the introductions by these societies were unsuccessful, but among their more notorious successes were the introduction of

European Rabbit *Oryctolagus cuniculus* and Blackberry *Rubus fruticosus* to Australia and Common Brush-tailed Possum *Trichosurus vulpecula* to New Zealand.

The objective of this article is to review the history, status and distribution of introduced avian species in the Hunter Region and assess the extent of their threats to Australian native birds. For the purposes of this study, an introduced species is defined as one that was deliberately or accidentally introduced into an ecosystem where it previously did not occur naturally.

METHODS

Records of introduced species within the Hunter Region were extracted from Birddata (<https://birddata.birdlife.org.au/home>). The Reporting Rates (RR) for four periods from 1982 to 2022 were calculated using the combined data from all survey types. RR is defined as the number of records for a species divided by the number of surveys, expressed as a percentage. Early records were taken from *Emu*, unpublished Hunter Bird Observer Club (HBOC)

records and other publications. Recent publications were reviewed for ecological studies. Regional distribution maps were sourced for six species based on their records in the Birddata and eBird databases. Long-term population trends were taken from the Hunter Region Annual Bird Report (Williams 2020).

RESULTS

Although there are numerous reports of the release or the arrival of introduced species around capital cities, there are few reports documenting their dispersion into other areas, such as the Hunter Region. However, there are records in Birddata for 15 introduced species in the Hunter Region covering the past 41 years. As will be detailed later, three of those species have never established wild populations in the Hunter Region. The Reporting Rates for the other twelve species for four periods spanning 1982-2022 are presented in **Table 1** along with their long-term population trends. There were no records for some species over some of the periods.

Table 1. Introduced species that have established wild populations at different times in the Hunter Region, with their Reporting Rates from Birddata for four periods from 1992 to 2022, and their long-term Hunter Region trends as described in the 2019 Hunter Region Annual Bird Report (ABR) (Williams 2020).

| Common Name | RR% | | | | ABR Long-term Trend 1993-2019 |
|----------------------|-----------|-----------|-----------|-----------|-------------------------------|
| | 1982-1990 | 1991-2000 | 2001-2010 | 2011-2022 | |
| Mallard | 1.9 | 2.1 | 0.6 | 0.5 | Uncertain |
| Rock Dove | 6.6 | 7.0 | 3.0 | 4.7 | Uncertain |
| Spotted Dove | 13.3 | 23.3 | 11.9 | 12.2 | Uncertain |
| Long-billed Corella | - | 1.0 | 2.0 | 1.2 | Decline |
| Eurasian Skylark | - | - | < 0.1 | - | Insufficient data |
| Red-whiskered Bulbul | - | 0.6 | 0.2 | 0.1 | Decline |
| Common Starling | 22.0 | 29.7 | 12.3 | 6.6 | Decline |
| Common Myna | 10.2 | 20.9 | 12.6 | 13.2 | Stable |
| Common Blackbird | 0.4 | 0.3 | 0.2 | 0.3 | Uncertain |
| Nutmeg Mannikin | - | - | - | - | No records |
| House Sparrow | 11.7 | 14.6 | 3.7 | 1.9 | Decline |
| European Goldfinch | 1.0 | 1.4 | 0.8 | 0.1 | Decline |

Mallard

The Mallard *Anas platyrhynchos* was first released in the Royal Botanic Gardens Victoria in Melbourne during 1871-1872 (Long 1981). No accounts of its intentional release in NSW were found.

There was no mention of the Mallard in several early to mid-20th Century articles on introduced species in Australia (Chisholm 1926a; Chisholm 1950; Blake 1951). A comment by Tarr (1950) stated that the species is ‘feral on some Sydney lakes.’ Morris (1975) described the species as rare in NSW, and that records of them were of birds which possibly had escaped from domestic enclosures. Morris reported the presence of a pair at Avoca Lagoon during 1973/1974 and a male at Kooragang Island in August 1972. Hamonet (1986) documented three Hunter Region records between 1976 and 1986; at Jewells Swamp, Awabakal Nature Reserve and Stockton Borehole Swamp.

In the Hunter Region, the species is classified as an uncommon resident, with records mainly from near-coastal wetlands in the southeast (Williams 2020). The long-term trend is uncertain, in part due to many of the records being thought to be of hybrids with Pacific Black Duck *A. superciliosa* (Williams 2020).

Rock Dove

No accounts of Rock Dove *Columba livia* being intentionally introduced into NSW were found. Some arrived as domesticated birds with the early settlers and then escaped, thus becoming Australia’s first established introduced species (Long 1981). This pattern of escape from domestic enclosures has continued up until the present (Long 1981). There was no mention of the Rock Dove in several early to mid-20th Century articles about introduced species in Australia (Chisholm 1926a; Chisholm 1950; Blake 1951), apart from a comment by Tarr (1950) that the species is ‘feral in all the larger cities.’ Morris (1975) described the species as common in urban areas and man-made habitats throughout the Gosford, Wyong and Newcastle area. Hamonet (1986) described the species as invariably seen around urban and city areas of the Hunter Region.

The Rock Dove is classified as a common resident throughout the Hunter Region, found mainly around urban areas. It has an uncertain long-term trend (Williams 2020). The species’ regional distribution is shown in **Figure 1**.

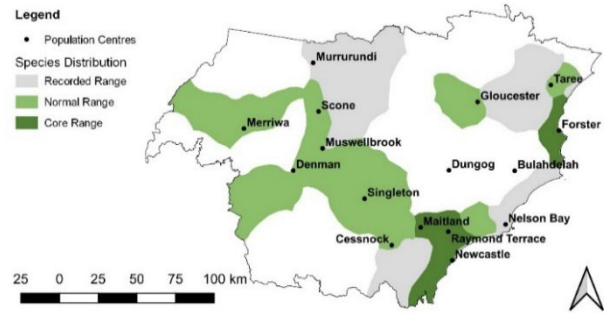


Figure 1. Distribution of Rock Dove in the Hunter Region 2022.

Spotted Dove

The Spotted Dove *Streptopelia chinensis* was introduced to Victoria during the 1860s and 1870s (Long 1981). It is not known when it was introduced into NSW but Chisholm (1926a) recorded the species as being present in the Sydney and Blue Mountains area and with its population and range increasing rapidly. Morris (1975) described the species as common in urban and modified rural landscapes in the Gosford, Wyong and Newcastle areas. Hamonet (1986) recorded the species as present mainly in the eastern sector of the region, in urban and agricultural areas and areas of altered forest. Its population remains centred mainly around urban regions in eastern areas of the Hunter Region (Williams 2020).

The Spotted Dove is classified as a common resident of the Hunter Region. Its long-term trend is uncertain (Williams 2020). The regional distribution is shown in **Figure 2**.

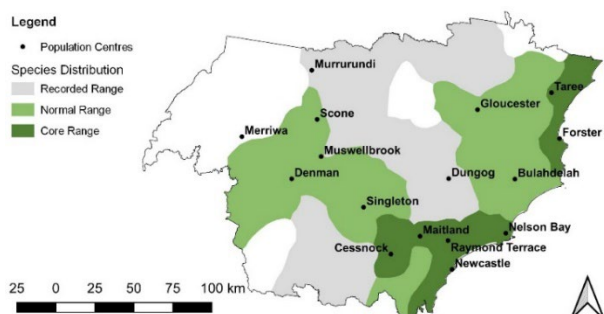


Figure 2. Distribution of Spotted Dove in the Hunter Region 2022

Long-billed Corella

The Long-billed Corella *Cacatua tenuirostris* is an endemic species normally found in the south-east of South Australia and from western Victoria to southern New South Wales. However, it has established populations in other parts of eastern Australia, probably by escapees from domestic enclosures (Marchant *et al.* 1999). It was first reported in the Hunter Region at Buttaba in 1982 (HBOC records). These records suggest the species possibly was released from Blackbutt Reserve. It was recorded as a newly-established local resident in 1993 (Stuart 1994). Today, the species' population is mainly centred around Newcastle, Maitland, Raymond Terrace and Lake Macquarie.

It is classified as resident in the Hunter Region and its long-term trend indicates a possible decline in the local population (Williams 2020).

Eurasian Skylark

The Eurasian Skylark *Alauda arvensis* was first introduced in Victoria in the 1850s (Long 1981). In NSW, birds were introduced near Sydney in 1866, then subsequently from 1870 to 1872 and again in the 1880s (Ryan 1906; Tarr 1950; Long 1981). Some birds were released at West Maitland in 1879 (Cooper *et al.* 2020). By the 1950s it was common in coastal districts and the central western areas of the state (Long 1981). Morris (1975) reported the species as being present at The Entrance in 1957 and with one bird recorded at Kooragang Island in 1970. Hamonet (1986) reported a single record from near the Myall Lakes. There are records of some birds at Deep Pond, Kooragang Island in 1994, 1996, 2003 and 2005-2007 (Stuart 2008).

There have been no confirmed sightings in the Hunter Region since 2007. The species is now classified as an accidental visitor (Williams 2020).

Red-whiskered Bulbul

The Red-whiskered Bulbul *Pycnonotus jocosus* was introduced into NSW by the NSW Acclimatization Society in 1880 (Tarr 1950). By 1919-1920 it was well-established around Sydney (Long 1981). However, Barrett (1945) stated that the species was not introduced intentionally and that birds were descendants of early escapees from domestic enclosures. By the 1950s and 1960s it had been reported up to 100 km from Sydney (Long 1981). The species was first recorded in the NSW Central Coast in 1973 (at Kincumber and Tumby Umbi), with numbers thought possibly to be

increasing (Morris 1975). It became established in the lower Hunter Region within another ten years (Blakers *et al.* 1984). Hamonet (1986) reported birds as having been present in Maitland in 1982 and Martinsville in 1983. Birddata records indicate that the local population is currently concentrated around Belmont and Caves Beach on the eastern side of Lake Macquarie.

The species is classified as an uncommon resident in the Hunter Region. Its long-term trend indicates a possible decline in the local population (Williams 2020).

Common Starling

The Common Starling *Sturnus vulgaris* was imported into Victoria by private individuals from 1856 to 1858 and small numbers were released by the Victorian Acclimatization Society between 1863 and 1871 (Ryan 1906). The species had become established in Victoria by 1862 (Long 1981). In NSW, birds were released in 1880 and they spread rapidly (Long 1981). They were present throughout settled parts of the state by 1926 (Chisholm 1926a). In the Hunter Region birds were recorded at Belltrees in 1909 and a large number were present in the Muswellbrook-Quirindi area in 1921 (Stuart 2009). Morris (1975) described the species as a common resident in the Gosford, Wyong and Newcastle areas, occurring most commonly in agricultural lands, suburban parks and gardens and around the margins of wetlands. Hamonet (1986) described the species as widespread throughout the region. Birddata records indicate the species is now distributed through all areas of the Hunter Region. Most records are from urban centres and surrounding cleared agricultural areas. The regional distribution is shown in **Figure 3**.

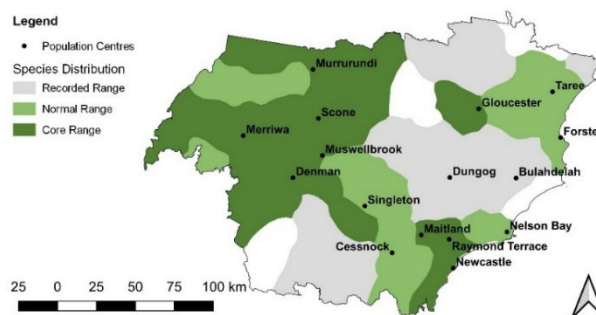


Figure 3. Distribution of Common Starling in the Hunter Region 2022

The Common Starling is classified as a common resident of the Hunter Region although the long-term trend suggests a possible decline in the local population (Williams 2020).

Common Myna

The Common Myna *Acridotheres tristis* was introduced from India (Long 1981). There were several introductions around Melbourne in the period between 1863 and 1872 and it had become well-established in Melbourne by 1883 (Ryan 1906). It is not known how the species arrived in NSW but they were common in Sydney by 1896 (Chisholm 1926a). The first record for the Hunter Region was from the Newcastle Steel Works in the 1950s and by 1970 the species had colonised the Cardiff and Edgeworth areas (Horne 1978). Horne also predicted that the range of the birds would probably increase considerably in New South Wales as suitable habitat occurs in coastal resorts, in the Hunter Valley and on the tablelands.

Morris (1975) described the species as being regularly reported around St Albans-Wisemans Ferry and in the Newcastle area. Morris *et al.* (1981) recorded the species as widespread on the Central Coast by 1960 and extending to Wallis Lake, Raymond Terrace and Allyn River. Hamonet (1986) reported it was mainly confined to the eastern part of the region, but apparently spreading westward into the Hunter Valley. The species is now widespread throughout the Hunter Region with populations concentrated in the Lower Hunter and around rural towns, and throughout agricultural districts. A study by Old *et al.* (2014) showed Common Myna in Greater Sydney to be restricted to urban and peri-urban areas. The species is now considered to have become commensal with human settlement (Wilson 1973; Higgins *et al.* 2006).

The Common Myna is classified as resident in the region and its long-term trend is reported to be stable (Williams 2020). However, across NSW its population is increasing (Cooper *et al.* 2020). The species' distribution in the Hunter Region in 2000 is shown in **Figure 4** and the current distribution in **Figure 5**. These two maps reveal that there was a considerable increase in the extent of distribution and population in the western and coastal parts of the region over the intervening period.

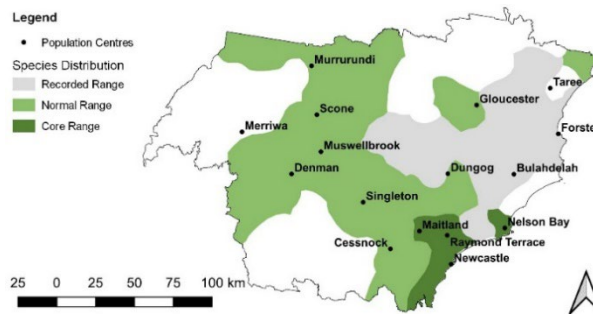


Figure 4. Distribution of the Common Myna in the Hunter Region 2000

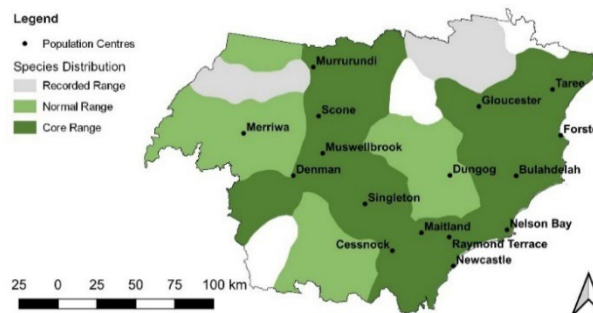


Figure 5. Distribution of Common Myna in the Hunter Region 2022

Common Blackbird

The Common Blackbird *Turdus merula* was first released around Melbourne between 1864 and 1872 (Ryan 1906). A release at Sydney in 1872 reportedly failed (Long 1981). The present population in NSW is thought to have originated from a release from a domestic enclosure in 1940 (Long 1981). Chisholm (1926a) reported that the only sightings of the species in NSW were from Albury and the Sydney Botanic Gardens. A few birds were reported in inner Sydney suburbs and parts of the Blue Mountains from 1952 onwards (Hindwood & McGill 1958). Some birds appeared in the Canberra district in 1949 and by 1959 they were widespread through the Sunraysia district along the Murray River (Long 1981). Morris (1975) made no mention of the species in the Gosford, Wyong and Newcastle area, but subsequently he reported the species as having established on the Central Coast by the 1940s and as being present at Dungog in 1959-60 (Morris *et al.* 1981).

The Common Blackbird has a localised distribution around many inland towns in the Hunter Region, in particular around Maitland and Cessnock, and the central regional areas of Merriwa, Scone and Muswellbrook. It is classified as resident around inland towns but with an uncertain long-term trend (Williams 2020). The regional distribution is shown in **Figure 6**.

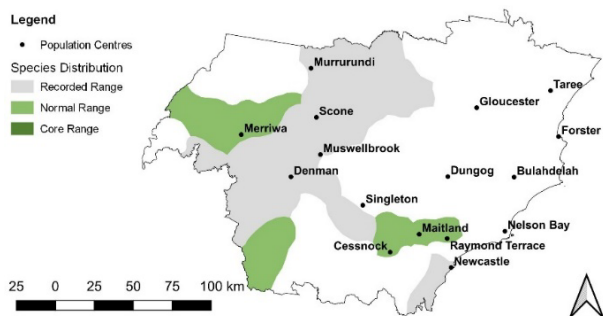


Figure 6. Distribution of Common Blackbird in the Hunter Region 2022

Nutmeg Mannikin

There are conflicting reports as to when the Nutmeg Mannikin *Lonchura punctulata* was first recorded in NSW. The species was seen at Chester Hill in the late 1920s and there were sightings in the Sydney area in the 1930s and 1940s (Cooper *et al.* 2020). However, other sources claim the initial population was established in the Sydney area by aviary escapees in about 1950 (Long 1981; Morris *et al.* 1981). Before 1960, all records were from suburban Sydney, but by 1962 it had been found on the NSW north coast at Taree, Glenreagh and Grafton (Gosper 1976). In the Hunter Region, the earliest records were from Speers Point and Shortland in 1965 (HBOC records). Recher (1975) recorded the species as present in the Myall Lakes area. Subsequently, it was regularly recorded at Cockle Creek, Speers Point, Teralba, Garden Suburb, Shortland, Cooranbong and Myall Lakes (Hamonet 1986).

The Nutmeg Mannikin is classified as possibly extinct in the Hunter Region (Williams (2020). There have been no reports from the region since 1991 apart from an eBird record of a single bird at Cooranbong in May 2022 (<https://ebird.org/checklist/S108793587>). The Cooranbong bird was considered to be an aviary escapee (M. Roderick pers. comm.).

House Sparrow

The House Sparrow *Passer domesticus* was first released in Melbourne in 1863. There were subsequent releases in Melbourne and elsewhere in Victoria by the Victorian Acclimatization Society from 1864 to 1872 (Long 1981). The birds were sourced from China, England and Java (Long 1981). By 1906 the species had spread widely into southern NSW (Long 1981) and was described as ubiquitous in the state in 1925 (Chisholm 1926a). Hamonet (1986) reported the bird as widely

distributed throughout the urban and country areas of the Hunter Region.

Today, the House Sparrow is present throughout the Hunter Region with higher numbers reported around populated areas. It is classified as resident although its long-term trend suggests a recent decline (Williams 2020). The regional distribution is shown in **Figure 7**.

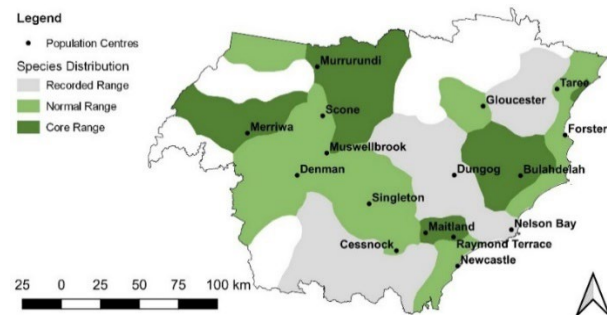


Figure 7. Distribution of House Sparrow in the Hunter Region 2022

European Goldfinch

The European Goldfinch *Carduelis carduelis* was introduced around Melbourne in 1863 and 1864 by the Victorian Acclimatization Society (Long 1981). There are no records of early introductions in NSW but some birds were released in 1880 (Long 1981) and the species was recorded as being present before 1886 (Chisholm 1926a). Their range expansion in NSW was very rapid; by 1926 birds were present near Comboyne to the north of the Hunter Region (Chisholm 1926b). In the Central Coast and the Hunter Region, small flocks were regularly recorded at The Entrance, Kooragang Island, St Albans and the Upper Hunter (Morris 1975). Hamonet (1986) reported sightings at Kooragang, Morpeth, Cockle Creek, Hexham Swamp, Myall Lakes, Broke, Widden Valley and Barrington Tops. The local population has been in decline over the past 20 years (**Table 1**) and today there are only occasional sightings from the Maitland area and Ash Island.

The species is classified as an uncommon resident in the 2019 HBOC Annual Bird Report (Williams 2020). The HBOC Records Appraisal Committee is currently considering reclassifying the species as a vagrant in the Hunter Region (A. Stuart pers. comm.).

Other Species

Three other non-endemic species have been recorded in Birddata in the Hunter Region; Helmeted Guineafowl *Numida meleagris*, Indian Peafowl *Pavo cristatus* and Red Junglefowl *Gallus gallus*. These birds are considered to have escaped from domestic enclosures rather than being part of self-sustaining wild populations (Stuart 2018). They are also classified as exotic escapees in eBird (<https://ebird.org/australia/explore>). They are recorded infrequently in peri-urban areas, mainly near the coast.

DISCUSSION

The majority of the above species were originally introduced in Australia for aesthetic reasons. Common Starling, Common Blackbird and House Sparrow were introduced with the intent of assisting agricultural interests by controlling insects. The Common Myna was introduced into urban areas for aesthetic reasons and for insect control in agricultural regions (Horne 1978). The following discussion reviews some relevant aspects of the ecology of introduced species and briefly discusses their impact on native species. Research on the impact of two of the most-abundant species, Common Myna and Common Starling, is summarised. Species with little or no research or reported data are not discussed.

Colonisation of the Hunter Region

The introduction of avian species into Australia has been documented in some detail for Melbourne and Sydney (Long 1981), but information about the range-expansion into other areas is fragmentary. For the Hunter Region, records provide first observation dates which only indicate broad arrival timeframes.

A review of articles published in the *Emu* between 1901 and 1925 revealed an absence of records for introduced species apart from the Common Starling (Stuart 2009). However, a review by Chisholm (1926a) documented eleven introduced species in NSW at that time. Chisholm did not include Mallard or Rock Dove. Early 20th century ornithologists referred to these as 'feral species', perhaps recognising that they had not been intentionally released.

Nine species have documented arrival timeframes in the Hunter Region: Eurasian Skylark in 1879 (Cooper *et al.* 2020); European Goldfinch in 1926

(Chisholm 1926b); Common Myna in the 1950s (Horne 1978); Mallard 1972 (Morris 1975); Common Blackbird 1959-60 (Morris *et al.* 1981); Long-billed Corella 1982 (HBOC records); and Red-whiskered Bulbul 1982 (Hamonet 1986). The Common Starling arrived sometime prior to 1909 (Stuart 2009). The House Sparrow was described as ubiquitous in NSW by 1925 (Chisholm 1926a). It can be inferred that the Rock Dove, Spotted Dove and House Sparrow arrived in the region in the first half of the 20th century.

Distribution

The most widely-distributed introduced species in the Hunter Region is the Common Myna, followed by the Common Starling and House Sparrow. All three are distributed to varying extents from coastal areas to the western limit of the region. The population of most introduced species is greatest around urban areas, peri-urban districts, and in cleared agricultural districts. The only introduced species with a limited local distribution are Long-billed Corella and Red-whiskered Bulbul.

Habitat destruction disadvantages most native birds but can provide suitable habitat for introduced avian species (Baker *et al.* 2014). The development of peri-urban districts around Sydney has been shown to support introduced species population growth (Leishman 1994). The distribution pattern for many introduced species in the Hunter Region reflects the pattern of habitat loss and modification.

Population trends

The only introduced species with an increasing population trend in the region is the Common Myna. All other species have declining or uncertain trends, or are locally extinct (Williams 2020). A study of population trends of introduced species in Brisbane, Sydney, Melbourne and Perth by Campbell *et al.* (2022), using Birddata records, demonstrated mostly similar trends to those for the Hunter Region. The Mallard, Spotted Dove, Common Starling, Common Blackbird, House Sparrow and European Goldfinch populations were declining. Conversely, the population trend for Rock Dove was increasing in Brisbane, Melbourne and Sydney, but declining in Perth.

Competition with other species

Competition between introduced and native avian species is extensive and includes competition for nesting sites, competition for food, and interference competition (Baker *et al.* 2014). Interference competition is a direct form of competition, in which individuals of one species actively dominate a resource, preventing or decreasing the access of another species to that resource. While there are numerous documented reports of competition, few studies have attempted to determine the magnitude of the impact.

Grarock *et al.* (2012), found that following the establishment of the Common Myna in four urban regions around Canberra between 1989 and 1993, the long-term abundance (birds per km²) of three cavity-nesting species declined. These were Sulphur-crested Cockatoo *Cacatua galerita*, Crimson Rosella *Platycercus elegans*, and Laughing Kookaburra *Dacelo novaeguineae*. The long-term abundance of eight small species (Striated Pardalote *Pardalotus striatus*, Rufous Whistler *Pachycephala rufiventris*, Willie Wagtail *Rhipidura leucophrys*, Grey Fantail *Rhipidura albiscapa*, Magpie-lark *Grallina cyanoleuca*, House Sparrow, Silvereeye *Zosterops lateralis*, and Common Blackbird) also declined. However, the long-term abundance of three larger species, Australian King-Parrot *Alisterus scapularis*, Eastern Rosella *Platycercus eximius* and Common Starling, increased following the establishment of Common Myna. The degree of decline in abundance was shown to vary with vegetation type. The largest decline occurred in dry forest and urban grassland, while areas with tree cover had the least decline. Two of the species with declining abundance, House Sparrow and Common Blackbird, were established introduced species.

Lermite & Griffin (2018) conducted a study to determine whether the provision of artificial nest boxes supported breeding by cavity-nesting native birds in urban areas, or whether competition from introduced cavity-nesting species such as Common Myna offset the benefits. While native species and Common Myna both nested in the boxes, over time native parrots exhibited greater breeding success than Common Myna.

These studies indicate that competition between introduced species and native avian species is complex and that factors such as the type of habitat, type of species and change in species richness and diversity have to be considered. Both of the above studies (Grarock *et al.* 2012; Lermite & Griffin

2018), were conducted in urban areas where Common Myna was more abundant.

Predation

A review of studies investigating predation of native bird species by introduced ones (Baker *et al.* 2014) identified examples of predation by Common Myna and Red-whiskered Bulbul. However, none of the studies demonstrated that predation was a major threat to native birds. Conversely, it is probable that the decline in the population of the Eurasian Skylark is the result of predation by introduced mammals. As a ground-nesting species, it is easy prey for feral Cat *Felis catus* and the Red Fox *Vulpes sp.* The vulnerability of Eurasian Skylark was recognised by Chisholm nearly 100 years ago. He commented that its chance of long-term survival was poor (Chisholm 1926a).

Hybridisation

The only introduced species that is thought to pose a threat through hybridisation with local species is the Mallard. Its presence has caused the decline or extinction of some populations of Pacific Black Duck *A. superciliosa* in New Zealand, Lord Howe Island and Macquarie Island (Guay & Tracey 2009). Mallard and Pacific Black Duck are closely related and can interbreed easily, frequently producing fertile hybrid offspring (Taysom 2016). Furthermore, Mallard are readily-domesticated birds that then become non-migratory. The domestication process has resulted in highly variable genomic changes that enhance their ability to interbreed and produce fertile, stable offspring (Lavretsky *et al.* 2023).

A Mallard is bigger and more aggressive than a Pacific Black Duck and other members of the genus *Anas*. Where there is a stable food supply and water source, they out-compete their endemic relatives. This has occurred in New Zealand where Pacific Black Duck (Grey Duck)/Mallard hybrids have become well adapted to the local habitat and are better suited to the increasingly agricultural and urban landscapes of the region.

A study of hybridisation between Mallard and Pacific Black Duck in Victoria found that the overall frequency of hybridisation was just 1.5% (Taysom 2016). The study also revealed that the frequency of hybridisation tended to be higher in urban areas than in rural areas. Williams (2020) states the majority of Mallard records in the Hunter Region are probably of hybrid birds. However, the

work of Taysom (2016) indicates this may be an overstatement.

Introduced species as pests

The Hunter-Central Rivers Natural Resource Management Region has 24 avian species listed as pests, the second highest number for any region in Australia. This list includes 14 of the 15 introduced species described in this article plus a number of other species that have not been recorded in the immediate Hunter Region. Long-billed Corella is not listed. Species are listed because they have significant agricultural and environmental impacts as well as causing damage to social amenity and infrastructure (West 2011). Two of these species are listed among the 100 world's worst invasive alien species by the Invasive Species Specialist Group of the Species Survival Commission of the World Conservation Union (Lowe *et al.* 2000). The Common Myna is third on the list and the Common Starling is ninetieth.

In Australia, Common Myna, Common Starling, House Sparrow and Common Blackbird cause damage in horticulture, viticulture and grain crops by eating fruit and newly-sown and newly-germinated grain. Rock Dove deface buildings with their droppings and spread bird lice which has human health consequences (West 2011). Red-whiskered Bulbul and Common Blackbird spread seeds of noxious and exotic weeds in their droppings (West 2011; Mo 2015).

Common Starling may also carry parasites and diseases which are of concern in food production and livestock industries. They are implicated in carrying, and in some cases transmitting, Salmonella, Cryptococci, Newcastle Disease and transmissible gastroenteritis, although the risk of transmission to humans has not been quantified (West 2011).

Common Myna

Of the 15 introduced species, Common Myna appears to present the greatest threat to the native avian population. It is also the species which has been subject to the most research. It is considered to be a threat to native species biodiversity due to its territorial behaviour and nest cavity competition (Centre for Invasive Species Impacts 2013). Trapping programmes to control the species are widespread in NSW where they are supported by Local Land Services (Local Land Services 2018).

Common Myna has the widest distribution of the introduced species across the Hunter Region. It is also the most abundant (**Table 1**). Over the past 22 years its population and distribution has expanded considerably (**Figures 3 and 4**). However, its distribution is restricted to urban and semi-rural areas within its range (Old *et al.* 2014). It is very well adapted to modified habitats (Higgins *et al.* 2006). It forages on the ground and mostly eats invertebrates or fallen fruit, although occasionally it also eats the eggs or nestlings of other avian species. It nests in tree hollows or cavities in urban structures. The species is aggressive, and agonistic behaviour has been recorded towards Silver Gull *Larus novaehollandiae*, Black-billed Gull *Larus bulleri*, Rock Dove, Spotted Dove, Eastern Rosella, Superb Parrot *Polytelis swainsonii*, Red Wattlebird *Anthochaera carunculata*, Australian Magpie *Gymnorhina tibicen*, House Sparrow, Common Blackbird and Common Starling. The birds often usurp the nest-hollows of other species, destroy nests and eggs, and kill nestlings (Higgins *et al.* 2006).

However, its perceived impacts are often based on anecdotal or generalised information, and there is a limited amount of scientific research that has studied the actual impacts. As the abundance of native species frequently changes because of habitat clearing, fragmentation and urbanisation, it is hard to separate the effects of Common Myna from the prevailing environmental factors (Centre for Invasive Species Impacts 2013).

The previously mentioned study of the impact of Common Myna on the abundance of native species in an urban environment (Garrock *et al.* 2012), indicated that Common Myna primarily take advantage of habitat change when colonising a new area. High numbers, in combination with habitat change, had a negative impact on some cavity-nesting species and smaller birds, but not on larger species. However, tree density strongly influenced the abundance of Common Myna which were far more abundant in urban areas with fewer trees than in nature reserves. There were no negative associations identified between Common Myna abundance and total species abundance and richness, or large native bird abundance and richness (Garrock *et al.* 2012).

A study of the foraging aggression of the Common Myna in an urban environment indicated they did not display significantly more aggression than other species, and displayed significantly less aggression than the Australian Magpie. Furthermore, the presence of Common Myna at a

feeding resource had no greater effect on the abundance of heterospecific individuals than the presence of any other species (Haythorpe *et al.* 2012).

These studies suggest that efforts to cull Common Myna numbers in heavily urbanised environments with the objective of enhancing the diversity and survival of some native species are misdirected. Resources would be better directed towards re-establishment of habitat suitable for native species in these areas. This is more likely to achieve a positive permanent outcome (Lowe *et al.* 2011).

While Common Myna are widespread throughout eastern Australia, their true effect on the environment and agriculture is largely unknown. A study on the impact of the species in Greater Sydney showed the species prefers urban habitats or areas with human habitation, and does not appear to penetrate into large areas of native bushland when preferred habitat is available (Old *et al.* 2014). The authors further stated: “The social behaviour and population dynamics of males and females in rural and urban areas require further study, particularly because management of birds in rural fringes of cities may be redundant if the birds captured are subordinates to the actual breeding population in urban areas”.

Common Starling

The Common Starling is the third most abundant introduced species in the region. The species is stated as having a detrimental effect on native ecosystems, particularly through the tendency to out-compete native bird species for food and nest sites (Lowe *et al.* 2000; Centre for Invasive Species Impacts 2013). It was initially introduced to agricultural areas due to its reputation for eating insect pests and larvae. However, it rapidly became a pest in fruit orchards, around feedlots for intensive livestock production, and in areas of newly germinated grain (Higgins *et al.* 2006).

Common Starling mainly inhabits built-up areas and farmland, usually where trees or artificial structures are available for roosting and nesting, and where there are open grassy areas for foraging. It forages mainly on the ground for invertebrates, as well as fruit and nectar from plants. Outside of the breeding season, Common Starling can form flocks of hundreds and sometimes thousands of birds. Many of the problems created by Common Starling stem from their presence in large flocks. When a large flock settles onto a field or orchard, they can do considerable damage in a short time.

Their abundance can also lead to reduced avian diversity.

The birds are aggressive, and agonistic behaviour towards native species is common, particularly around nest hollows. They will usurp occupied hollows, if possible, occasionally killing the occupants (Higgins *et al.* 2006). Agonistic behaviour has been recorded towards Australian Ringneck *Barnardius zonarius*, Crimson Rosella *Platycercus elegans*, Bluebonnet *Northiella haematogaster*, Swift Parrot *Lathamus discolor*, Mulga Parrot *Psephotellus varius*, Orange-bellied Parrot *Neophema chrysogaster*, Blue-winged Parrot *Neophema chrysostoma*, Sacred Kingfisher *Todiramphus sanctus*, Striated Pardalote, Black-faced Cuckoo-shrike *Coracina novaehollandiae*, House Sparrow and Common Myna (Higgins *et al.* 2006).

Although there are numerous records of competition with native species, there do not appear to be any studies that demonstrate detrimental effects on the abundance or species richness of native species. It should also be noted that the areas habituated by Common Starling tend to be highly altered habitats with reduced species diversity.

CONCLUSIONS

Twelve introduced avian species have been identified as having established wild populations in the Hunter Region. They became established in the region from the late 1870s up to the early 1980s and today are dominantly resident in urban, peri-urban and agricultural areas. Seven species are common; the others are uncommon or rare, and in one case, locally extinct. Increasing urbanisation plus habitat loss and modification has aided expansion and population growth of some introduced species by reducing competition from native species. Although distribution maps show many species are widespread through the region, none of the species have successfully colonised undisturbed, well-structured native forests or woodlands.

The population of one species, Common Myna, has increased over the past 22 years, while the long-term population trend of the other species is either uncertain, declining or unknown. Competition with native species appears limited to those areas that have been impacted by human habitation or agricultural activity. However, the impact and extent of competition is complex and has not been extensively researched. As a result, the negative

impacts of introduced species on the native avian population may have been overstated. More research is required in order to demonstrate the influence of introduced species on the abundance and species richness of impacted populations. There is a limited amount of research on Common Myna and Common Blackbird; the impact of the Spotted Dove, which is the second most abundant introduced species in the region, has not been studied. Lavretsky *et al.* (2023) highlighted the importance of understanding the impact of introduced species: “Although considered paradoxical to biological conservation, understanding the capacity for wildness among feral and feral admixed populations in human landscapes is critical as such interactions increase in the Anthropocene.”

Our towns, cities and peri-urban areas are now recognised as an essential habitat to support the survival of the many native species that have adapted, with varying degrees of success, to this modified habitat. While the effective management of introduced species that also prefer these habitats may assist in ensuring the survival of some native species, the re-establishment of habitat more suitable for native species in urban and peri-urban areas is more likely to achieve a positive permanent outcome.

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