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A reassessment of historical records of avian introductions to Australia: no case for propagule pressure

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Abstract Introduced species are widely believed to represent a significant threat to conservation of biological diversity. A better understanding of the ecological factors associated with successful species establishment should lead to improved management and mitigation of these introductions. The "propagule pressure hypothesis", implying a greater chance of successful introduction with greater numbers introduced, has been widely accepted as a principal ecological factor in explaining establishment of exotic species. The historical record of bird introductions in a few locations, including the state of Victoria in Australia, has been advanced as the principal quantitative support for the hypothesis. We compiled lists of bird species introductions into Australia from several sources, and discovered inconsistencies in the records of introductions. In a series of comparisons, we found that the historical record of passerine introductions to Australia does not support the propagule pressure hypothesis unless superfluous introductions of already successful species are included. An additional problem with previous analyses is the inclusion of unsuccessful haphazard cage escapes.

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Introduction

Several authors have argued that propagule pressure is the primary determinant of the outcomes of species introductions (Griffith et al. 1989; Veltman et al. 1996; Cassey et al. 2004, 2005; Lockwood et al. 2005; Blackburn et al. 2009; Simberloff 2009). The essence of the propagule pressure hypothesis is that the more individuals released in an introduction—the propagule—the greater the chance that the introduction will be successful. The hypothesis is tested by asking if successful introductions involved the release of more individuals than unsuccessful introductions.

Although most species introductions are unsuccessful (e.g. Long 1981; Williamson 1996), from a conservation perspective it would be valuable to understand clearly the ecological factors that influence the outcome of species introductions. Such an understanding is essential to developing conservation practices to identify potentially harmful invasive species. Numerous examples exist of species introductions that have led to serious ecological and economic consequences (e.g. Savidge 1987; Willson et al. 2011). These consequences may include disruption of fire regimes, disease and pest problems, loss of harvested natural resources and indirect effects (Mooney 2005). Additionally an understanding of the introduction process can aid in promoting re-introductions of extirpated populations (e.g. Cassey et al. 2008; Van Houtan et al. 2009).

As noted by Duncan et al. (2003), at least three levels of factors can influence the outcome of introductions. These include species-level, site-level and event or human-level factors. Species-level factors include variables such as size of native range as an index of ecological plasticity (Moulton and Pimm 1986a, 1986b), behavioral flexibility (Sol and Lefebvre 2000), response to sexual selection (McLain et al. 1995, 1999; Moulton et al. 2009; Sorci et al. 1998), and relative brain size (Sol et al. 2005). Site-level factors include extent of habitat disturbance (e.g. Elton 1958; Diamond and Veitch 1981; Smallwood 1994; Case 1996), or the presence of competitors (e.g. Moulton and Pimm 1983, 1987; Moulton 1985, 1993; Lockwood and Moulton 1994; Gamarra et al. 2005), or predators (Wilson 1858; Thomson 1922; Blackburn et al. 2009).

Propagule pressure only represents one component of human influence on species introductions. Humans decide which species to introduce, as well as when, how and where to introduce them. A reliance only on propagule size could mislead analyses of potential invasive species. Indeed, several successful invaders originated from small propagules (e.g., Simberloff 2009; Van Houtan et al. 2009; Willson et al. 2011) and other species failed to become established despite releases of large numbers (e.g. Labisky 1961; Peacock and Abbott 2010). Such examples suggest that the propagule pressure hypothesis may lack general applicability.

For birds, three main cases have fueled support for the propagule pressure hypothesis. The first involves repeated reports that perhaps the most successful introduced bird in the world, the House Sparrow (*Passer domesticus*), required three separate introductions in the 1850s totaling to more than 100 individuals to Brooklyn, New York to gain a toehold in the New World (e.g. Robbins 1973; Long 1981; Simberloff and Boecklen 1991; Simberloff 2009). The second case deals with the introduced birds in New Zealand (e.g. Veltman et al. 1996; Duncan 1997; Green 1997). The third case involves the analysis of avian introductions to Australia (Newsome and Noble 1986).

The paradigmatic example of the importance of propagule pressure in deciding the fate of avian introductions involves the House Sparrow to North America (Simberloff and Boecklen 1991; Simberloff 2009). However, a more careful analysis has shown that the historical record does not support the usual story (Moulton et al. 2010; Schrey et al. 2011). Perhaps as few as 16 individuals may have been sufficient for the initial establishment of House Sparrows in New York, USA.

In the second case, Moulton et al. (2011) re-examined analyses of the historical records for passerine introductions to New Zealand (Veltman et al. 1996; Duncan 1997; Green 1997) and found that a clearly predominant role for propagule pressure in these studies could only be construed under a very restricted and unrealistic set of assumptions.

This leaves the record of avian introductions to Australia by Newsome and Noble (1986) as a principal support for the propagule pressure model. The propagule pressure hypothesis assumes that species introduced in high numbers were successful due to relatively large propagule sizes. However, many of the passerine introductions to New Zealand, occurred after species were already established (Moulton et al. 2011). Could this be the case in Australia as well? If so, it would argue against the notion that propagule pressure played a central role in deciding the fate of introductions. Testing this hypothesis depends on accurate data and inference from sources typically more than 100 years old.

In conjunction with this problem is the phenomenon of releasing very small numbers of a species, either as accidental escapes or as intentional releases. For example, just two Nightingales (*Luscinia megarhynchos*) were released in Victoria (Wilson 1858). Such small releases risk including individuals of just one sex (in the case of monochromatic species), extinction by predation such as described by Wilson (1858), or release of individuals in sub-optimal health. Newsome and Noble (1986) included a number of species that were either accidental escapes or introduced in extremely small numbers in their analysis. Moreover, because Newsome and Noble (1986) did not categorize introductions by location or state, it is impossible to assess whether all of the introductions were spatially and temporally associated, or needed for the establishment of introduced species in Australia. For a given species, the historical record often includes records of releases widely separated in space and time.

Here we present a detailed re-examination of early introductions of passerine birds to Australia. We show that the report by Newsome and Noble (1986), based on historical records of bird introductions to Australia, contains numerous inconsistencies and inaccuracies with respect to the numbers of individuals released/species, the dates of introduction, and in some cases even the identities of the species released. Moreover, a re-analysis shows that, as in New Zealand (Moulton et al. 2011), the introduced passerines of Australia fail to support the propagule pressure model except when questionable data and assumptions form the basis of the analysis.

Materials and methods

A principal concern in assessing support for the propagule pressure model is the inclusion of superfluous releases—those that had no bearing on the outcome of the introduction. In New Zealand, for example, it is not clear if introductions were successful because large numbers of birds were released or if large numbers were released because the early releases were successful (Moulton et al. 2011). Thus, if colonists believed that a species from their home country could be a control agent for insect pests they would likely be motivated to release additional individuals.

Newsome and Noble (1986) relied on the compendium of Long (1981) for compiling their list of passerine species introduced to Australia, adjacent islands, and distant territories. Newsome and Noble (1986) apparently summed for each species the numbers of individuals released throughout Australia. Thus, it is possible that many of the releases included in these sums were not needed for a species to be successful.

We compiled lists of passerine introductions presumably released into the wild by state, from several sources. We started with Long (1981), who included the mainland of Australia, adjacent offshore islands and Tasmania. We also consulted Jenkins (1977), Ryan (1906), and Balmford (1978), as these studies were cited frequently by Long (1981). Jenkins (1977) limited his analysis to acclimatization societies in Victoria, South Australia, Western Australia, New South Wales, Queensland and Tasmania, whereas Balmford (1978) and Ryan (1906) limited their studies to the state of Victoria. In addition, we examined records from other references cited by Newsome and Noble (1986) and Long (1981), including Wilson (1858), Hardy (1928), Lawson (1949), Tarr (1950), and McCance (1962). For all scientific names, we followed the Howard and Moore checklist of birds of the world (Dickinson 2003).

We compared numbers of successful species with those of unsuccessful species using Kruskal–Wallis tests. Exact numbers were not listed for 22 of the 29 species listed by Newsome and Noble (1986). There was no numerical information for eight species and estimates for 14 species. To account for this, we scored the estimates of the numbers of individuals released following the system used by Green (1997), Cassey et al. (2005) and Moulton et al. (2011). We scored the sums/species within each state. In this scheme, propagules of 2–10 individuals are assigned a score of 0; those of 11–100 individuals are scored as 1; and those with more than 100 are scored as 2.

Results

We re-analyzed Newsome and Noble (1986) using just their passerine species (Table 1). For this analysis, following Newsome and Noble (1986), we excluded three species: the House Crow (*Corvus splendens*), on grounds that the species was likely eradicated; the Redpoll (*Carduelis flammea*), as it was only on distant Macquarie Island (Selkirk et al. 1990); and the Wood Lark (*Lullula arborea*), as these may not have actually been released (Long 1981).

We also excluded the Hawfinch (*Coccothraustes coccothraustes*), as we were unable to find corroborating evidence for this introduction in any reference other than McCance (1962). There are newspaper reports of sightings this species and the Bullfinch (The Sydney Morning Herald 10.4.1909, 11; The Sydney Morning Herald 26.3.1910, 8; The West Australian 11.12.1935, 16), but the first two of these reports apparently refer to captive individuals and the last to a single dead individual. The Hermit Thrush (Newsome and Noble 1986) was probably never introduced to Australia—Jenkins (1977) stated that "Virginian Nightingales" had been introduced to Victoria, and whereas Long (1981) imagined these could be Hermit Thrushes, Coues (1875) noted that "Virginian Nightingales" was the common name used for Northern Cardinals (*Cardinalis cardinalis*). Thus, Newsome and Noble (1986) apparently counted a single unsuccessful species twice. We further argue that the Red-billed Leiothrix (*Leiothrix lutea*), introduced to Western Australia (Jenkins 1977) and the Rook (*Corvus frugilegus*), introduced to Victoria and Queensland (Chisolm 1919; Jenkins 1977) should be included.

Table 1 List of 29 introduced passerine species from Newsome and Noble (1986)

Species	Fate	Number	Score
Alauda arvensis	1	>700	2
Pycnonotus jocosus	1	?	0
Pycnonotus cafer	0	?	0
Erithacus rubecula	0	47	1
Luscinia megarhynchos	0	2	0
Catharus guttatus[a]	0	3	0
Turdus merula	1	>150	2
Turdus philomelos	1	>70	1
Emberiza citrinella	0	>15	1
Emberiza hortulana	0	16	1
Cardinalis cardinalis	0	?	0
Fringilla coelebs	0	<200	2
Fringilla montifringilla	0	<80	1
Serinus canaria	0	18	1
Carduelis chloris	1	<150	2
Carduelis spinus	0	80	1
Carduelis carduelis	1	<500	2
Carduelis flammea[b]		?	–
Carduelis cannabina	0	<50	1
Pyrrhula pyrrhula	0	14	1
Passer domesticus	1	>>100	2
Passer montanus	1	>70	1
Euplectes orix	0	?	0
Euplectes albonatus	0	?	0
Lonchura punctulata	1	?	0
Lonchura malacca	0	?	0
Lonchura oryzivora	0	>>100	2
Sturnus vulgaris	1	>450	2
Acridotheres tristis	1	>350	2

Number is the number of individuals listed by Newsome and Noble (1986). A '?' indicates that the authors believed the species was released but the propagule size was unknown, so assumed to be <10. Fate: successful = 1; unsuccessful = 0; "Score" is 0 for 2–10 individuals released; 1 for 11–100 individuals; 2 for >100 individuals. Scientific names follow Dickinson (2003)

[a] Misidentified actually refers to *Cardinalis cardinalis*

[b] Not introduced to mainland Australia, Tasmania, or adjacent islands

In our first test, we compared the scores of successful to unsuccessful species listed in Newsome and Noble (1986) (Fig. 1a). The result of this comparison supported a positive effect of propagule pressure (Lockwood et al. 2005, Blackburn et al. 2009). Of the 29 species, 18 were unsuccessful and 11 successful (Newsome and Noble 1986). Here we also assigned a score of '0' to each of the eight species with no propagule information. The mean score for unsuccessful species was less than half that of the successful species (0.67—unsuccessful; 1.45—successful), a statistically significant difference (Kruskal–Wallis approximate $X^2 = 6.14$, $P = 0.013$).

Thus, at first glance the data appear to support the propagule pressure model that species introduced in higher numbers have increased chances for successful establishment (Cassey et al. 2004, Lockwood et al. 2005). However, by using sums of all introductions to all of Australia for each species Newsome and Noble (1986) likely included introductions that occurred after a species was successfully established. For instance, the 265 Eurasian Skylarks (*Alauda arvensis*) introduced by the South Australia Acclimatization Society starting in 1879 probably were unneeded for establishing this species. In fact, Balmford

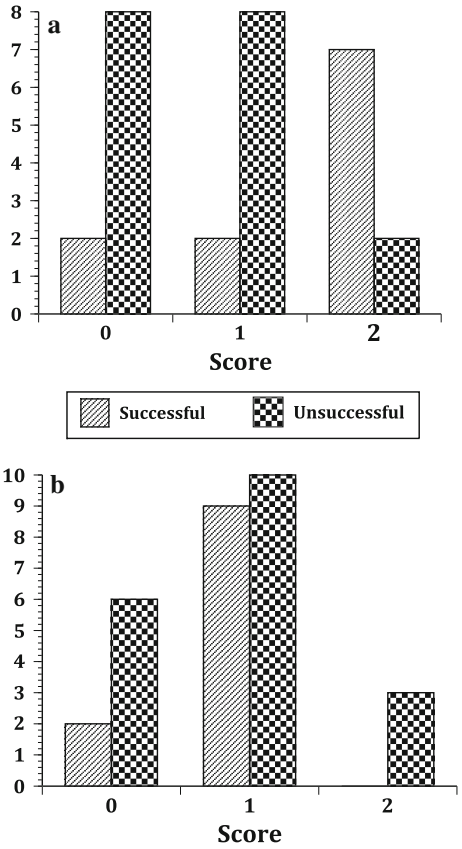

Fig. 1 **a** Comparison of categories for numbers of individuals released (*0* 2–10, *1* 11–100, *2* >100) for successfully and unsuccessfully introduced species listed by Newsome and Noble (1986). **b** Comparison of categories for numbers of successfully and unsuccessfully introduced passerines from the expanded list (see text): scores as in (**a**)

(1978) suggested Eurasian Skylarks, as well as other species, were likely already established in Victoria following introductions in the 1850s. Also, Newsome and Noble (1986) counted both the Hermit Thrush and Northern Cardinal in their list of 29 passerines, but as noted above, Hermit Thrushes were likely not introduced to Australia.

In our second test, we attempted to compare successful and unsuccessful species in each of the different states (Table 2; Appendices 1, 2). When listed by state however, it becomes clear that most of the introductions and most species were released in Victoria (Table 2). Moreover, in most cases, introductions to Victoria preceded those in other states (Lucas and Le Souef 1911; Fig. 2).

Given these data, in this test we compared numbers of successfully versus unsuccessfully introduced species in Victoria alone. No species that was unsuccessful in Victoria was successful in any other state (Jenkins 1977; Long 1981). Although the analyses of Balmford (1978); Jenkins (1977) and Ryan (1906) presumably were based on the same acclimatization society records, they frequently did not agree on the numbers of individuals released and identities of certain species (Table 3). Thus, Balmford (1978) included just 14 species; Ryan (1906) listed 16; and Jenkins (1977) 17 species. Ryan (1906) listed the Ortolan Bunting (*Emberiza hortulana*) as did Lucas and Le Souef (1911). However, neither Balmford (1978) nor Jenkins (1977) included this species. Newsome and Noble (1986) included the Ortolan Bunting as well as the Hawfinch (*Coccothraustes coccothraustes*) but we excluded the latter species because we could find no corroborating evidence

Table 2 Numbers of species and releases of passerines in seven states in Australia from Long (1981)—numbers in parentheses from Jenkins (1977)

State	Releases	Species
VIC	88 (58)	26 (18)
SA	19 (36)	14 (12)
NSW	19 (18)	13 (7)
QLD	9 (12)	7 (9)
WA	6 (5)	6 (5)
ACT	2 (NA)	1 (NA)

States are: *VIC* Victoria, *SA* South Australia, *NSW* New South Wales, *QLD* Queensland, *WA* Western Australia, *ACT* Australian Capital Territory

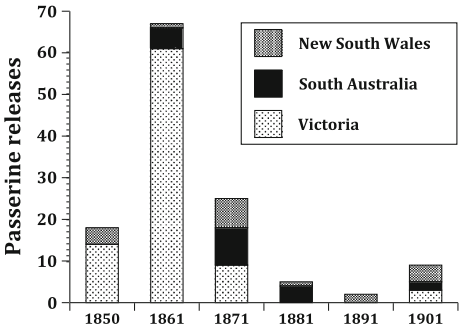

Fig. 2 Passerine releases by decade for Victoria, South Australia and New South Wales

for this introduction—moreover their reference for this listing was McCance (1962) who actually listed 'Chinese Hawfinch', not *Coccothraustes coccothraustes*, so the true identity of the species is uncertain. Neither Jenkins (1977) nor Ryan (1906) included the Nightingale (*Luscinia megarhynchos*) of Newsome and Noble (1986) although Balmford (1978) reported that five individuals were listed in the Melbourne Argus as having been imported in 1857. Wilson (1858) detailed the fate of five Nightingales that could refer to the record listed by Newsome and Noble (1986) and Balmford (1978). Based on Wilson's (1858) report we included the Nightingale in our expanded list (see below).

Differences between median numbers of successful and unsuccessful species listed by Balmford (1978) and Ryan (1906) for Victoria were not significant although for the list of Jenkins (1977) the difference was nearly significant (Table 4).

In a third test, we expanded the list to include introductions of species to Australia outside of Victoria. In this test, we compared the median of the minimum propagule sizes of successful species with the median of maximum propagule sizes for unsuccessful species (Table 6). The reasoning here is that for successful species clearly the minimum propagule was sufficient for establishment success whereas the maximum propagule sizes of unsuccessfully introduced species were presumably not large enough (Moulton et al. 2011).

In compiling this expanded list, we noted that Jenkins (1977) also reported that 100 Eurasian Skylarks and 200 European Goldfinches were unsuccessfully introduced to Western Australia in 1899. Since these introductions were widely separated from introductions of these species in South Australia and Victoria, these introductions should be counted independently. Elsewhere, Jenkins (1959) reported that the first successful

Table 3 Comparison of introduction records for passerines to Victoria: R = Ryan (1906); B = Balmford (1978); J = Jenkins (1977)

Species	Fate	R	B	J
Acridotheres tristis	1	152	70	170
Alauda arvensis	1	140	39	141
Cardinalis cardinalis[a]	0	*	*	*?*
Carduelis cannabina	0	*	*	19
Carduelis carduelis	1	54	*	12
Carduelis chloris	1	110	20	20
Carduelis spinus	0	60	20	20
Corvus frugilegus	0	*	*	3
Emberiza citrinella	0	30	15	15
Emberiza hortulana	0	16	*	*
Erithacus rubecula	0	11	31	47
Fringilla coelebs	0	130	40	40
Lonchura oryzivora	0	535	255	255
Passer domesticus	1	345	65	130
Passer montanus[b]	1	65	20	60
Serinus canaria	0	18	18	18
Sturnus vulgaris	1	77	12	168
Turdus merula	1	45	28	50
Turdus philomelos	1	28	30	67

A '*' means that the species was not mentioned; a '?' indicates that the species was recorded but the propagule size was not listed

[a] Jenkins (1977) listed "Virginian Nightingales"

[b] Ryan (1906) and Balmford (1978) all identified "chinese sparrows" as *Passer montanus*

Table 4 Comparison of the number of individuals introduced to Victoria for successful and unsuccessful species

	B	R	J
Mean unsuccessful (*n*)	63.2 (6)	114.3 (7)	52.1 (8)
Mean successful (*n*)	35.5 (8)	124 (9)	90.9 (9)
X^2	0.02	1.75	3.17
$P > X^2$	0.90	0.19	0.07

B Balmford (1978), *R* Ryan (1906), *J* Jenkins (1977)

European Goldfinches in Western Australia appeared in 1933 and concluded that these birds had come from aviary escapes. We have excluded this record from our analyses in keeping with our view that it represents an extemporaneous introduction, as at least 60 years had passed since the European Goldfinches had been successfully introduced to Australia. With this in mind, we conducted statistical tests on our expanded list with and without these two introductions. In the first case (including the two Western Australia introductions), the median for successful species was not significantly different from that of the unsuccessful species (Table 5, Case 1). In the next test of this list, we excluded the unsuccessful introductions of the 200 European Goldfinches and 100 Eurasian Skylarks

Table 5 Comparison of the number of individuals introduced for successful and unsuccessful species from the expanded list of passerine introductions to Australia

	Case 1	Case 2
Mean unsuccessful (*n*)	90.1 (15)	80.9 (13)
Mean successful (*n*)	32.9 (9)	32.9 (9)
X^2	0.70	0.11
$P > X^2$	0.40	0.74

Case 1 includes introductions of 100 Eurasian Skylarks and 200 European Goldfinches to Western Australia, case 2 excludes these two introductions

to Western Australia. In this case the medians also were not significantly different (Table 5, Case 2).

Discussion

There are two general results from our analysis of passerine introductions to Australia. First, the historical record for Australia, as in New Zealand, is riddled with inconsistencies and errors. Second, the record of passerine introductions to Australia does not support the propagule pressure model unless all introductions for each species are summed, ignoring sizable intervening gaps between introductions in time and space.

We found numerous inconsistencies in the historical record of introductions to Australia (Tables 3 and 6). The studies by Balmford (1978), Ryan (1906) and Jenkins (1977) only agree on the number of individuals released for one species (*Serinus canaria*). For all other species, their numbers are different, and sometimes very different. These differences coupled with discrepancies in the roster of species that were actually introduced paint a rather different picture regarding the clarity of the introduction record that has become paradigmatic (i.e. Blackburn et al. 2009). Additionally, Balmford (1978) challenged introductions listed by Ryan (1906) and noted that numerous introductions to Victoria occurred before the acclimatization society formed. Indeed, she noted that it might be impossible to say with certainty when any of the successful species were first released.

Duncan et al. (2003) listed three main categories of variables that could influence the outcome of species introductions: species-level traits, location-level traits and event-level traits. To this, we suggest the addition of a fourth category: individual-level traits. This level encompasses the condition of the actual individuals that are released. In the nineteenth century, birds that were imported to Australia from afar came by ship. The death rate for birds in transit was often staggering. Jenkins (1977) recounts that of the first recorded shipment of House Sparrows in 1862 all 60 birds perished en route. Chisolm (1919) noted that all the individuals in two consignments of "English Wood-Pigeons" died en route through the Suez Canal and Red Sea. Wilson (1858) describes health issues among Nightingales intended for release in Victoria. Such examples suggest that the health and physical condition of the birds that arrived by sea was important in influencing the fates of introductions, regardless of how many individuals were shipped, how embracing the new environment was, or how pre-adapted the species might have been for the new environment.

Finally, we emphasize that the only possible way we could find to interpret the historical record of passerine introductions to Australia as supporting the propagule pressure model

Table 6 Expanded list of species and propagule sizes for three studies of avian introductions to Victoria

Species	Fate	R	B	J
Acridotheres tristis	1	152	70	170
Alauda arvensis	1	140	39	141
Alauda arvensis (WA)[a]	0	–	–	100
Cardinalis cardinalis[b]	0	–	–	?
Carduelis cannabina	0	–	–	19
Carduelis carduelis	1	54	–	12
Carduelis carduelis (WA)[a]	0	–	–	200
Carduelis chloris	1	110	20	20
Carduelis spinus	0	60	20	20
Corvus frugilegus	0	–	–	3
Emberiza citrinella	0	30	15	15
Emberiza hortulana	0	16	–	–
Euplectes albonotatus (NSW)[c]	0	–	–	?
Euplectes orix (SA)[d]	0	–	–	?
Erithacus rubecula	0	11	31	47
Fringilla coelebs	0	130	40	40
Fringilla montifringilla (SA)[a]	0	–	–	78
Leiothrix lutea (WA)[a]	0	–	–	100
Lonchura malacca (NSW)[c]	0	–	–	?
Lonchura oryzivora	0	535	255	255
Lonchura punctulata (QLD, NSW)[a,c]	1	–	–	?
Luscinia megarhynchos[e,f]	0	–	–	2
Passer domesticus	1	345	65	130
Passer montanus	0	65	20	60
Prunella modularis (QLD)[a]	0	–	–	?
Pycnonotus jocosus (NSW)[a]	1	–	–	?
Pycnonotus cafer[g,h]	0	–	–	?
Pyrrhula pyrrhula (SA)[a]	0	–	–	14
Serinus canaria	0	18	18	18
Sturnus vulgaris	1	77	12	168
Turdus merula	1	45	28	50
Turdus philomelos	1	28	30	67

'Fate' is the introduction outcome. *B* Balmford (1978), *R* Ryan (1906), *J* Jenkins (1977). All introductions are for Victoria, except where indicated in parentheses after the species name: WA = Western Australia; SA = South Australia; NSW – New South Wales; QLD = Queensland. A '?' indicates that the species was likely introduced in small (i.e. < 10 individuals). A '–' indicates that the author did not record the species

[a] Jenkins (1977)

[b] Jenkins listed only the common name "Virginian Nightingales"

[c] Tarr (1950)

[d] Condon (1962)

[e] Wilson (1858)

[f] Hardy (1928)

[g] Le Souef (1918)

[h] Lendon (1952)

was to include superfluous introductions of successful species and to inflate the roster of unsuccessful species by including accidental escapes and releases of very small numbers of individuals (as listed in Table 1). Our results argue that future analyses of introductions should more carefully evaluate the role of propagule pressure in influencing introduction outcomes. Moreover, consistent methodologies for tabulating releases are essential.

A useful evaluation of potential invasive species should be part of a risk-consequence analysis framework. A simplified model of the invasion process that overemphasizes the risk from large introduction events, or underemphasizes the risk from small introduction events, makes rational management of invasive species more difficult. There is more to the invasion process, and much more to predicting establishment success, than can be found by simply summing propagule sizes.

Appendix 1

See Table 7.

Table 7 List of passerines introduced to Australia and surrounding islands, from Long (1981)

Species	Place	Number	Fate	Date
ACT				
Turdus philomelos	Canberra	?	0	1935
Turdus philomelos	Canberra	?	4	?
NSW				
Acridotheres tristis	Sydney	?	1	<1896
Alauda arvensis	Sydney	?	1	1866
Alauda arvensis	Sydney	?	1	1880
Alauda arvensis	Sydney	?	1	1870–1872
Carduelis cannabina	?	?	0	1880
Carduelis carduelis	?	?	1	<1886
Carduelis chloris	?	?	1	<1896
Emberiza citrinella	?	?	3	1880
Euplectes albonotatus	?	?	4	1931
Lonchura malacca	Sydney	?	0	<1929
Lonchura punctulata	?	?	1	<1960
Pycnonotus cafer	Sydney	?	5	1917
Pycnonotus jocosus	?	?	1	1880
Turdus merula	Sydney	?	1	1857
Turdus merula	Sydney	?	1	1858
Turdus merula	Sydney	?	1	1859
Turdus merula	Sydney	?	1	1860
Turdus merula	?	?	0	1872
Turdus philomelos	Sydney	?	0	1872
QLD				
Acridotheres tristis	?	?	1	1883
Alauda arvensis	?	?	0	1869

Table 7 continued

Species	Place	Number	Fate	Date
Lonchura punctulata	Townsville	?	1	1950
Lonchura punctulata	Innisfail	?	1	1955
Lonchura punctulata	Brisbane	?	1	<1937
Passer domesticus	Brisbane	?	1	1869–1870
Sturnus vulgaris	Brisbane	?	6	1869–1870
Turdus merula	?	?	3	1869
Turdus philomelos	Brisbane	?	0	1869
SA				
Carduelis cannabina	?	?	0	1879
Alauda arvensis	Enfield	18	1	1879
Alauda arvensis	Dry Creek	44	1	1879
Alauda arvensis	?	147	1	1881
Carduelis carduelis	Adelaide	43	1	1879
Carduelis carduelis	Adelaide	110	1	1881
Carduelis chloris	Royal Park	20	1	1863
Carduelis spinus	Royal Park	20	0	1866
Euplectes orix	?	?	4	1926
Fringilla coelebs	?	?	0	1879
Fringilla montifringilla	?	78	0	1879
Passer domesticus	?	?	1	1863
Pycnonotus jocosus	?	?	1	<1950
Pyrrhula pyrrhula	?	14	0	1879
Sturnus vulgaris	Adelaide	89	1	1881
Turdus merula	?	?	1	1863
Turdus merula	?	4	1	1879
Turdus merula	?	45	1	1881
Turdus philomelos	Adelaide	?	0	1879
TAS				
Acridotheres tristis	?	?	0	1900
Acridotheres tristis	?	?	6	1914
Alauda arvensis	?	36	1	1899
Alauda arvensis	?	?	1	1862
Alauda arvensis	?	?	1	1887
Carduelis carduelis	?	?	1	1827
Carduelis chloris	?	?	6	<1945
Passer domesticus	?	?	1	1863–1873
Passer montanus	?	?	0	<1950
Sturnus vulgaris	?	75	1	1860
Turdus merula	?	?	6	1919
VIC				
Acridotheres tristis	Melbourne	100+	1	1862
Acridotheres tristis	Melbourne	42	1	1863
Acridotheres tristis	Melbourne	40	1	1864

Table 7 continued

Species	Place	Number	Fate	Date
Acridotheres tristis	Melbourne	?	1	1866
Acridotheres tristis	Melbourne	70	1	1872
Alauda arvensis	Melbourne	7	1	1854
Alauda arvensis	?	32	1	1866
Alauda arvensis	?	30	1	1870
Alauda arvensis	?	100	1	1874
Alauda arvensis	?	80	1	1863–1867
Alauda arvensis	?	?	1	1950a
Cardinalis cardinalis	?	?	0	1860s?
Carduelis cannabina	?	19	0	1865
Carduelis cannabina	?	7	0	1860s
Carduelis carduelis	Melbourne	?	1	1857
Carduelis carduelis	Melbourne	?	1	1858
Carduelis carduelis	Melbourne	20	1	1863
Carduelis carduelis	Melbourne	34	1	1864
Carduelis chloris	Melbourne	50	1	1863
Carduelis chloris	Melbourne	40	1	1864
Carduelis chloris	Melbourne	20	1	1872
Carduelis chloris	?	?	1	1860s
Carduelis spinus	?	40	3	1864
Carduelis spinus	?	20	3	1872
Coccothraustes coccothraustes	?	?	3	1860
Corvus splendens	?	?	v	1960s
Emberiza citrinella	Melbourne	15	0	1863
Emberiza citrinella	Melbourne	15	0	1864
Emberiza hortulana	Melbourne	16	0	1863
Erithacus rubecula	?	16	0	1863
Erithacus rubecula	?	14	0	1866
Erithacus rubecula	?	17	0	1870
Fringilla coelebs	Melbourne	40	0	1863
Fringilla coelebs	Melbourne	220	0	1864
Fringilla coelebs	Melbourne	235	0	1872
Catharus guttatus	?	?	0	1860s?
Lullula arborea	?	?	3	1857
Luscinia megarhynchos	?	2	0	1857
Luscinia megarhynchos	?	?	0	1858
Lonchura oryzivora	Melbourne	235	0	1863
Passer domesticus	Melbourne	120	1	1863
Passer domesticus	G. Sprigg	80	1	1863
Passer domesticus	?	30	1	1863
Passer domesticus	Melbourne	125	1	1864
Passer domesticus	Melbourne	?	1	1866
Passer domesticus	Ararat	14	1	1867

Table 7 continued

Species	Place	Number	Fate	Date
Passer domesticus	Ballarat	?	1	1867
Passer domesticus	Beechworth	?	1	1867
Passer domesticus	Benalla	?	1	1867
Passer domesticus	Castlemaine	?	1	1867
Passer domesticus	Daylesford	?	1	1867
Passer domesticus	Geelong	?	1	1867
Passer domesticus	Gisborne	?	1	1867
Passer domesticus	Heathcote	?	1	1867
Passer domesticus	Kyneton	?	1	1867
Passer domesticus	Maryborough	?	1	1867
Passer domesticus	Melbourne	?	1	1867
Passer domesticus	Meredith	?	1	1867
Passer domesticus	Portland	?	1	1867
Passer domesticus	Somerton	?	1	1867
Passer domesticus	St. Arnaud	?	1	1867
Passer domesticus	The Murray	?	1	1867
Passer domesticus	Warrnambool	?	1	1867
Passer domesticus	Winchelsea	?	1	1867
Passer domesticus	Melbourne	100	1	1872
Passer montanus	?	45	1	1863
Passer montanus	?	20	1	1864
Pycnonotus cafer	Melbourne	?	5	1917
Pycnonotus jocosus	?	?	1	?
Pyrrhula pyrrhula	?	?	0	1856
Serinus canaria	Melbourne	18	0	1859
Serinus canaria	Melbourne	?	0	1856
Sturnus vulgaris	?	36	1	1863
Sturnus vulgaris	?	6	1	1864
Sturnus vulgaris	?	15	1	1866
Sturnus vulgaris	?	20	1	1871
Sturnus vulgaris	Melbourne	?	3	1856
Turdus merula	?	6	1	1864
Turdus merula	?	45	1	1864
Turdus merula	?	17	1	1866
Turdus merula	?	22	1	1872
Turdus merula	Melbourne	?	1	<1862
Turdus philomelos	Melbourne	?	1	1857
Turdus philomelos	Melbourne	48	1	1858
Turdus philomelos	Melbourne	37	1	1860
Turdus philomelos	?	4	1	1866
Turdus philomelos	?	6	1	1866
Turdus philomelos	?	12	1	1880

Table 7 continued

Species	Place	Number	Fate	Date
WA				
Aegintha temporalis	Perth	?	1	1958
Alauda arvensis	?	?	0	1912
Carduelis carduelis	Perth	?	0	<1912
Corvus splendens	?	?	0	1967
Leiothrix lutea	?	?	0	<1912
Passer montanus	Perth	?	0	<1966

Key to States; *VIC* Victoria, *ACT* Australian Capital Territory, *NSW* New South Wales, *SA* South Australia, *QLD* Queensland, *TAS* Tasmania, *WA* Western Australia, 'Place' refers to the specific site of the introduction; Number = number of individuals released; Key to Fates; 0 = failed; 1 = successful; 3 = imported but not released?; 4 = initially established but failed later; 5 = exterminated; 6 = natural range extension; *v* vagrant. Date = date of the introduction

Appendix 2

See Table 8.

Table 8 List of passerines introduced to Australia and surrounding islands by state taken from Jenkins (1977)

Species	Number	Date
VIC		
Passer domesticus	60	1860
Passer domesticus	40	1860
Passer domesticus	25	1860
Passer domesticus	5	1860
Passer domesticus	?	1867
Passer domesticus	?	1867
Passer domesticus	?	1867
Passer domesticus	?	1867
Sturnus vulgaris	6	1860
Sturnus vulgaris	36	1863
Sturnus vulgaris	120	1865
Sturnus vulgaris	6	1866
Alauda arvensis	6	1866
Alauda arvensis	12	1866
Alauda arvensis	6	1866
Alauda arvensis	4	1866
Alauda arvensis	4	1866
Alauda arvensis	4	1866
Alauda arvensis	80	1867
Alauda arvensis	25	1870
Alauda arvensis	?	1880
Turdus philomelos	14	1860
Turdus philomelos	4	1860

Table 8 continued

Species	Number	Date
Turdus philomelos	24	1866
Turdus philomelos	4	1866
Turdus philomelos	6	1866
Turdus philomelos	9	1866
Turdus philomelos	2	1866
Turdus philomelos	4	1866
Turdus merula	?	1860
Turdus merula	?	1860
Turdus merula	18	1866
Turdus merula	4	1866
Turdus merula	10	1866
Turdus merula	6	1866
Turdus merula	12	1880
Passer montanus?	20	1860
Passer montanus?	30–40	1863
Fringilla coelebs	40	1866
Cardeulis carduelis	12	1863
Carduelis cannabina	19	1865
Carduelis chloris	20	1863
Emberiza citrinella	15	1863
Acridotheres tristis	100	1862
Acridotheres tristis	50	1866
Acridotheres tristis	?	1865
Acridotheres tristis	20	1865
Carduelis spinus	20	1866
Lonchura oryzivora	35	1863
Lonchura oryzivora	200	1863
Lonchura oryzivora	20	1863
Erithacus rubecula	16	1863
Erithacus rubecula	4	1866
Erithacus rubecula	10	1866
Erithacus rubecula	17	1870
Serinus canaria	18	1859
Corvus frugilegus	3	?
Cardinalis cardinalis	?	?
SA		
Acridotheres tristis	?	1957
Alauda arvensis	?	1862
Alauda arvensis	18	1879
Alauda arvensis	44	1879
Alauda arvensis	18	1879
Alauda arvensis	147	1879
Alauda arvensis	36	1881

Table 8 continued

Species	Number	Date
Alauda arvensis	2	1879
Carduelis carduelis	?	1862
Carduelis carduelis	5	1879
Carduelis carduelis	43	1879
Carduelis carduelis	30	1881
Carduelis carduelis	50	1881
Carduelis carduelis	30	1881
Carduelis chloris	4	1879
Carduelis chloris	10	1879
Euplectes orix	?	1926
Fringilla coelebs	3	1879
Fringilla montifringilla	78	1879
Passer domesticus	?	1863
Pyrrhula pyrrhula	11	1879
Pyrrhula pyrrhula	3	1879
Sturnus vulgaris	?	1860s
Sturnus vulgaris	44	1881
Sturnus vulgaris	45	1881
Sturnus vulgaris	?	1860s
Turdus merula	2	1879
Turdus merula	2	1879
Turdus merula	15	1879
Turdus merula	30	1879
Turdus merula	?	<1878
Turdus philomelos	4	1879
Turdus philomelos	1	1879
Turdus philomelos	20	1879
Turdus philomelos	1	1879
Turdus philomelos	2	1879
WA		
Carduelis carduelis	200	1899
Leiothrix lutea	100	1899
Alauda arvensis	100	1899
Passer domesticus	?	?
Sturnus vulgaris	?	?
Tas		
Alauda arvensis	?	?
Alauda arvensis	36	1899
Passer domesticus	?	?
Passer domesticus	?	1870
Carduelis carduelis	?	?
Sturnus vulgaris	?	?
Sturnus vulgaris	?	1800

Table 8 continued

Species	Number	Date
Acridotheres tristis	?	?
Carduelis cannabina	<12	1907
Turdus merula	?	?
Carduelis chloris	?	1945
NSW		
Emberiza citrinella	15–20	1880
Emberiza citrinella	15–20	1880
Emberiza citrinella	15–20	1880
Emberiza citrinella	15–20	1880
Emberiza citrinella	15–20	1880
Emberiza citrinella	15–20	1880
Sturnus vulgaris	?	1880
Alauda arvensis	70	1880
Alauda arvensis	70	1880
Alauda arvensis	70	1880
Carduelis carduelis	32	1880
Carduelis carduelis	32	1880
Carduelis carduelis	32	1880
Carduelis carduelis	32	1880
Carduelis chloris	15–20	1880
Carduelis chloris	15–20	1880
Pycnonotus jocosus	?	1880
Lonchura punctulata	?	1950
QLD		
Prunella modularis	?	
Alauda arvensis	?	
Alauda arvensis	?	1869
Turdus merula	?	
Turdus merula	?	1869
Sturnus vulgaris	?	
Sturnus vulgaris	?	1869
Acridotheres tristis	?	<1919
Corvus frugilegus	?	1869
Turdus philomelos	?	1869
Passer domesticus	?	1869
Lonchura punctulata	?	1940s

Key to States and column headings as in Appendix 1

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