Foreword

Imagine a pond without ducks and swans, a garden without robins and song thrushes, a park without sparrows and pigeons, and perhaps, also, a fridge without eggs. Since antiquity, these descendants of soaring dinosaurs have captured humans' imagination for wilderness and freedom. Simply put, we cannot imagine living in a world without birds. Introductions of alien birds, and other domesticated animals, have accompanied the footprint of early humans. Fowls were in canoes while the Polynesian islanders colonized the vast span of the Pacific. Domesticated in South Asia, the red jungle fowl was introduced via the ancient trade route to Greece around 500 bce and has now reached a global population of nearly 20 billion. Parrots, starlings, mynas and canaries, with their chanting acoustics, have been popular in homes and palaces of Eurasia for centuries. Shakespeare writes in Henry IV, 'I'll have a starling shall be taught to speak.' Subsequently, early European settlers such as Eugene Schieffelin, Cecil John Rhodes and Eastham Guild attempted to 'acclimatise' the colonies using the birds of Shakespeare. John Long (1981) recorded more than 1000 introductions of about 420 bird species mainly during the European Diaspora from the 18th to the 20th century; this has been expanded in the Global Avian Invasion Atlas (Dyer *et al*., 2017), which documents 971 alien bird species introduced to 230 countries since 6000 bce.

Following Charles Elton's (1958) book, invasion ecology has grown into a mainstream research field on the patterns and processes of human-mediated translocation of alien organisms. As probably the most iconic taxa in conservation, birds provide an ideal natural experiment to test many theories and hypotheses in invasion ecology. Biodiversity conservation requires a solid ground to justify the action of management. Unfortunately, this remains controversial for introduced and invasive birds. This is partly because most exotic birds were introduced deliberately by acclimatization societies or through the pet trade. Such human-mediated introductions add difficulties when we try to identify the environmental determinants and biological traits that are responsible for avian species' invasiveness and the invasibility of recipient ecosystems. Invasion scientists are often divided in their justification of management and control action. For instance, although exotic birds could impose a strong impact on recipient ecosystems, many native birds that are undergoing a rapid range shift from human activities and environmental changes could cause more damage. The impact also often varies from case to case with no general principles. Research priorities should reflect such diversity of opinions and the wind of change.

Biological invasion is a complicated process and can be considered as species breaking geographical, environmental and biotic barriers along the invasion pathway. This naturally classifies species into: (i) those belonging to the regional native species assemblage; (ii) those transported, mainly intentionally, for different purposes; (iii) those having established viable feral populations; and (iv) those starting to spread and expand their range into the recipient areas. Knowledge gained so far has concentrated on the early stages of introduction and naturalization. For instance, the purposes of avian introductions are limited (e.g. food, hunting and ornamental) and primarily deliberate. As such, the taxonomy, localities and time of introductions are selected purposefully, with comparably large and widespread species from only a few families introduced significantly more frequently (e.g. Phasianidae, Passeridae, Psittacidae, Anatidae and Columbidae). For instance, early introductions of game birds of Galliformes in the 1800s were surpassed by the introduction of cage birds in the 1900s (e.g. parrots of Psittaciformes) (Blackburn *et al*., 2009). The most important predictor of the establishment success is the propagule pressure, specifically the number of individuals released, although its importance often differs among different taxa and cases, signalling the role of other important factors, such as habitat, diet breadth and relative brain size, as well as climate matching. Moving to the last stage of invasion (i.e. spread), we are facing increasing knowledge gaps (Hui and Richardson, 2017), albeit with a few well-observed patterns (Blackburn *et al*., 2009): (i) a lag phase experienced by most invasive birds before rapid range expansion; (ii) spatial variation in the spreading velocity; (iii) range contraction in those boom-and-bust species; and (iv) the small extent of spread of most invasive birds.

Detailed examinations of current knowledge have revealed a number of research priorities. At the introduction stage, we must distinguish those species that have been selected (or preferred) by humans for translocation from those species that preferred humans. The success of species that are intentionally introduced (i.e. those selected by humans) is probably very much dependent on propagule pressure (also reflecting cultural trends), while the success of species that are introduced unintentionally probably depends on the niche breadth of the species and environmental suitability of the recipient areas (e.g. Indian House Crow, *Corvus splendens*, requires a low propagule size to establish and also benefit from the human-dominated and disturbed landscapes). At the naturalization stage, more emphasis is perhaps needed for those species that failed to establish. For instance, the Yellow Canary

(*Serinus flaviventris*) persisted for more than 100 years in Mauritius only to be wiped out by a single hurricane. The Song Thrush (*Turdus philomelos*) was successfully introduced in 1890 in South Africa but became extinct 45 years later. Showing which traits favour introduction success is not equal to showing that introduced species without these traits will most likely fail. At the spreading stage, we need to identify the determinants of which established species will spread, unveil the mechanisms behind these boom-and-bust species, identify factors determining spread extent, quantify the structure of species distribution, and reveal the mechanisms behind range dynamics.

Key questions on the geographical range dynamics of introduced birds include the following (Hui and Richardson, 2017):

1. *Native and alien concordance.* The range dynamics of the regional avifauna present a complicated picture. Some species show a conserved range, while others are expanding, retracting or shifting their current ranges. In general, the range dynamics of native species reflect the spatial dynamics of their suitable habitat. In contrast, the range dynamics of introduced species depict spread into potentially suitable habitat. For instance, two invasive species in South Africa (Common Starling, *Sturnus vulgaris*, and Common Myna, *Acridotheres tristis*) are expanding their ranges northwards, completely against the flow of most natives (towards the south or west). Two kinds of concordance between native and introduced species can be examined. First, whether expanding invasives share common traits with expanding natives (trait concordance): identifying such traits could be important to understand how species with and without such traits respond differently to the regional environmental changes, which helps conservation managers to pinpoint those species that are more vulnerable to environmental changes. Second, whether introduced and native species expand or shift their ranges into same areas, while withdrawing from other areas (locality concordance): this would highlight areas for conservation management and the environmental factors characterising these areas.

2. *Forms of dispersal*. To produce efficient conservation management, we need to assess the connectivity of spreading populations via dispersal. First, we need to pinpoint the environmental conditions that are responsible for enhanced dispersal capacity in introduced species, and thus their tendency to spread and become invasive. Second, many invasive birds exhibit a fat-tailed dispersal kernel (i.e. the frequency distribution of dispersal distance). When estimating such dispersal kernels, the 'tail' often contains much uncertainty because long-distance dispersal is extremely rare, yet the rate of spread (i.e. the speed of range expansion) is largely determined by these rare events of long-distance dispersal.

3. *Variations in spreading rates*. Although dispersal is an important determinant of the spreading rate, it is not the sole factor. The velocity of advancing range margins also depends on the ability to establish front populations as stepping stones for further spread and traits affecting the rate of producing propagules (e.g. age of maturity, clutch size and breeding success). The spreading rate of introduced birds often has high temporal and spatial variation. A comprehensive understanding of the mechanisms and environmental factors behind this high variation provides an estimate of the rate of response to environmental changes. A main feature of the temporal variation in the spreading rates of introduced birds is the two-phase range expansion, or the existence of a lag phase in some introduced species before the rapid range expansion. Theoretical advances are needed to understand the population structure and dynamics that cause the lag phase. It is also important for conservation management to identity the key environmental factors and the key population structure (e.g. whether the lag is caused by the Allee effect threshold of population density or certain levels of genetic diversity required). By manipulating certain environmental conditions and control strategies to reduce the density under the threshold, we will be able to prevent the rapid expansion of birds.

4. *Human geography*. Our planet has rapidly moving from nature- to human-dominated environments. The role of humans in environmental changes has changed from enduring during the early-mid Holocene (10,000–3000 bp) to an innovative response (from the 17th to the early 20th century) to dominating (especially post-1950). Natural processes have been significantly altered by human activities through, for instance, agriculture, hydrology and urbanization. The way that we alter and interfere with the functioning and processes of natural ecosystems differs dramatically from the self-regulation processes in the pristine natural ecosystem, suggesting a completely different mode of invasibility in human-dominated novel ecosystems. Regional variations in culture, history, legislation and governance will further compartmentalize the response to biological invasions, inevitably affecting how regional ecosystems respond to the new arrivals. Clearly, human geography has become one of the most dominant forces in global change biology and plays a key role in forecasting the future distributions of introduced birds. Many bird species (native and introduced) evolved via allopatric speciation in isolated populations. Little is known about how these species interact in the long term in highly disturbed and connected novel systems, and how these transformed novel ecosystems will change over time. This calls for a systematic assessment of the exposure, sensitivity and adaptive capacity of introduced (and native) birds to human-dominated novel ecosystems.

Plagued by such great knowledge gaps in our understanding of avian invasion and its management, it is such a pleasure to see this massive volume of 45 chapters, edited by Colleen T. Downs and Lorinda A. Hart, with contributions from 78 established ornithologists worldwide, in an attempt to address some of the questions and data gaps in global trends and impacts of alien invasive birds. The book covers the biology, ecology, impact and management of 34 common alien invasive species, with reviews on the history and context of avian introductions and invasions in five major regions (Oceania, Africa, Europe (including the Middle East, Asia and South America), as well as management challenges and the potential of citizen science for monitoring alien birds. The book pitches at the introductory level and is ideal for readers to gain a quick and comprehensive

view of the current status of global avian invasions. It has brought the records and research of avian invasion one step ahead of other alien invasive animal taxa. Many chapters contain distribution maps and data tables on the diet and morphology of the species, providing a good reference for the species and its management issues. Each chapter also contains a rich list of references that could help readers dive further into the topic. I hope that readers will use this book as a generic reference on avian invasions and read it with specific questions in mind.

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Invasive Birds

Global Trends and Impacts

Edited by **Colleen T. Downs** and **Lorinda A. Hart**

Examining globally invasive alien birds, the first part of this book provides an account of 32 species (as listed by the Invasive Species Specialist Group, ISSG, and some additional species). It acts as a one stop reference volume; it assesses the current invasive status for each bird species and includes details of their physical appearance, diet, introduction and invasion pathways, breeding behaviour and natural habitat. It also looks at the environmental impact of each species, as well as current and future control methods. Full colour photographs assist with species identification and global distribution maps give a visual representation of the current known distributions of these species.

The second part of the book discusses the biogeographical aspects of avian invasions, highlighting current and emerging invasive species across different regions of the world.

Finally, the third section considers the impact of invasive species on native communities, problems associated with invasive bird management, and the use of citizen science in the study of invasive birds.

The book:

- Provides species accounts written by experts
- Assesses invasive species by their current biogeographic status
- Presents contemporary knowledge of avian invasive ecology

This book will particularly appeal to researchers and students of invasion ecology, and conservation managers and government officials involved in research, management and risk assessments of invasive bird species around the world.