Detecting and Responding to Alien Plant Incursions

Ecologists, land managers, and policy makers continue to search for the most effective ways to manage biological invasions. An emerging lesson is that proactive management can limit negative impacts, reduce risks, and save money. This book explores how to detect and respond to alien plant incursions, summarising the most current literature, providing practical recommendations, and reviewing the conditions and processes necessary to achieve prevention, eradication, and containment. Chapter topics include assessing invasiveness and the impact of alien plants, how to improve surveillance efforts, how to make timely management decisions, and how legislation and strategic planning can support management. Each chapter includes text boxes written by international experts that discuss topical issues such as spatial predictive modelling, costing invasions, biosecurity, biofuels, and dealing with conflict species.

JOHN R. WILSON has published close to one hundred papers in peer-reviewed journals on a wide range of ecological and evolutionary topics, with a particular focus on invasion science. Based in South Africa, he is a member of the IUCN Invasive Species Specialist Group, and works across science, management, and policy.

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ECOLOGY, BIODIVERSITY, AND CONSERVATION

The world's biological diversity faces unprecedented threats. The urgent challenge facing the concerned biologist is to understand ecological processes well enough to maintain their functioning in the face of the pressures resulting from human population growth. Those concerned with the conservation of biodiversity and with restoration also need to be acquainted with the political, social, historical, economic, and legal frameworks within which ecological and conservation practice must be developed. The new Ecology, Biodiversity, and Conservation series will present balanced, comprehensive, up-to-date, and critical reviews of selected topics within the sciences of ecology and conservation biology, both botanical and zoological, and both 'pure' and 'applied'. It is aimed at advanced final-year undergraduates, graduate students, researchers, and university teachers, as well as ecologists and conservationists in industry, government, and the voluntary sectors. The series encompasses a wide range of approaches and scales (spatial, temporal, and taxonomic), including quantitative, theoretical, population, community, ecosystem, landscape, historical, experimental, behavioural, and evolutionary studies. The emphasis is on science related to the real world of plants and animals rather than on purely theoretical abstractions and mathematical models. Books in this series will, wherever possible, consider issues from a broad perspective. Some books will challenge existing paradigms and present new ecological concepts, empirical or theoretical models and testable hypotheses. Other books will explore new approaches and present syntheses on topics of ecological importance.

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Detecting and Responding to Alien Plant Incursions

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Foreword

Invasion science has a relatively short history. Islands, as the parts of our planet most conspicuously invaded by non-native biota, gave rise to the first books on invasion science (Thomson 1922; Elton 1958). However, it was immediately clear that many continental areas had been heavily invaded as well. At the end of the last century, an organised and international biological invasions research effort (Simberloff 2011) centred around four basic questions:

(1) What makes some taxa more or less invasive?
(2) What makes some individual ecosystems more or less invasible?
(3) What are the impacts of invasive taxa?
(4) What should be done if impacts are economically and/or environmentally undesirable?

The usual assumption of the last question is that impacts have already been recognised. Indeed, attempts to control or even eradicate non-native weeds and pests have a long history in agriculture, forestry, and health care. More recently, such attempts were extended to protected areas such as nature reserves and national parks. However, with enormous investment into control efforts, it very soon became clear that introduction prevention and fast eradication after early detection of new invaders represent the most cost-effective and ecologically effective strategies. Still, decisions about whether and when recently introduced taxa should be monitored, contained, or eradicated remain a grey area. To date well over 100 books have been published on plant invasions. However, how to detect and how to respond to initial stages of plant invasions have not been systematically covered in any book publication until now.

For a long time, this 'knowing–doing' gap in invasion science has been recognised (Esler *et al.* 2010; Abella 2014; Matzek *et al.* 2015). This book, by John Wilson, Dane Panetta, and Cory Lindgren, substantially helps to close this gap. Because the book does not deal with specific invasions, it does not provide a cookbook for specific situations. Instead, using many

examples, the reader is guided through the tools we have for (a) prediction of invasiveness and impacts; (b) detection and delimitation of new incursions of non-native plants; (c) eradication and/or containment feasibility; (d) evaluation of management results; (e) implementation and development of effective legislation and regulations; (f) prioritisation and development of feasible strategies; and (g) implementation of those strategies. To incorporate as much relevant knowledge as possible, 26 invited authors contributed text boxes summarising their respective expertise. These boxes provide perspectives and insights from across the globe, bringing the reader up to speed on the current state of invasion science. The Glossary and over 400 references will make this volume particularly useful.

Among books on biological invasions currently available on the market, this one is a unique achievement. I greatly look forward to using this book, and am confident that plant ecologists and managers around the world will find it both a valuable resource and a pleasure to read.

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Preface

Alien plants can be managed most cost-effectively either before they have begun to spread or in their earliest stages of invasion, what we call in this book 'incursions'. When distributions are small in extent, it is possible, through coordinated control strategies, to achieve eradication or prevent further spread (i.e. containment). There has been an increasing focus on these management goals from a theoretical perspective and in relation to on-ground management, but much of the theoretical work either does not support current on-ground practice or fails to address the needs of managers and decision makers. A major aim of this book is to draw together the scattered literature and provide recommendations for how the management of incursions can be improved.

In this book we argue that incursions can be managed effectively, provided a few simple steps are taken. First, there is a need to predict, prevent, and prepare. This will help reduce the rate of new arrivals, and increase the rate at which incursions are detected. Second, when an incursion is detected, it is important not to wait, but to make an initial decision regarding whether or not to act. If the decision is to act, management options should be evaluated in a structured manner. Finally, for management to be effective it needs to be properly monitored so that performance can be evaluated and goals revisited if required. The success of an incursion response also depends on a host of facilitating activities and mechanisms – for example, legislation, strategies, action plans, and organisational structures.

The reader should not be overly concerned with the large number of alien plants that occur in different parts of the world. Most alien plant incursions pose a negligible threat and do not need to be managed (nor could they be, given the limitations on resources available). The first component of incursion response is deciding whether or not to act, and a proper response often will not involve on-ground management. A major motivation for writing this book has been to provide tools to help with this decision.

The book has been written for a range of potential readers, including land managers, policy makers, students, and researchers. While it is generally aimed at the science–policy interface, some parts review key emerging principles (e.g. assessing which species pose the greatest threat), while elsewhere we focus on outlining existing protocols (e.g. how to assess progress towards eradication). In some cases the discussion might therefore be too esoteric to be of direct value to land managers, and in other cases, where the state of knowledge is more advanced, the focus will be on how to do things in practice without discussing the fundamentals at length. We hope the reader will benefit from at least a cursory examination of all chapters, but as a rough guide: Chapters 2 and 3 address why and where plant invasions happen; Chapters 4 and 5 focus on deciding on the goal of an incursion response and how to monitor progress towards that goal; and Chapters 6, 7, and 8 discuss the policy and enabling environment in terms that often apply to all plant invasions.

Plant invasions are context-dependent – spatially, temporally, and socio-economically. Hence management needs to be adaptive. As such, we try to avoid being prescriptive and address the theories and management practices as we know them. We do, however, end each chapter with some general recommendations. Throughout the book international experts have contributed text boxes that elucidate particular topics of interest. These text boxes are vignettes that highlight real examples of what has, and has not, worked.

There are a couple of things that the book does not address. First, it is not going to 'make the case'. Invasive plants are a serious global threat to biodiversity, the environment, economies, trade, and human health. If you need convincing, there are some excellent reports available (e.g. Boy and Witt 2013; Box 7.2). Second, we elected not to discuss classical biological control as a management option. Classical biological control can provide substantial benefits in terms of reducing rates of spread and so should be used where and when practical. There is also much to be said about the proactive development and testing of agents. But, to date, biocontrol is only implemented once an incursion has become a widespread invasion. Finally, we do not discuss restoration. Invasions can sometimes be passengers rather than drivers of global change, and control efforts will only have long-term benefits if substantial effort is placed into restoring ecosystems, as otherwise the area treated might simply be recolonised by the same or another alien plant. However, the theory and practice of restoration is well discussed elsewhere. Moreover, if the impact of an invasion is such

that restoration is required, the opportunity for coordinated control will have likely well and truly passed.

The book would, of course, not have been possible without the support of our friends, colleagues, and families. We are indebted to S. Raghu, Marcel Rejmánek, Dave Richardson, Brian van Wilgen, and Bruce Wilson for their comments and insights on earlier versions of the book; to the Invasives in the Cape Discussion Group, SANBI's Invasive Species Programme, and the past and present staff, students, and post-docs of the Centre for Invasion Biology for useful insights, enthusiasm, and debates; to the text box authors for providing much needed colour and poetry to the prose; to Michael Usher for encouragement and advice on writing a book; and to the publishers at Cambridge University Press. Finally, Dave Richardson provided the impetus for the book – without his enthusiasm it would not have been written.

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Abbreviations

AWRA: Australian Weed Risk Assessment scheme, see Gordon *et al.* (2010) for an overview

CBD: Convention on Biological Diversity, a global agreement addressing all aspects of biological diversity (www.cbd.int)

CWMA: Cooperative Weed Management Area (Box 8.1)

EDRR: Early detection and rapid response

EICAT: Environmental Impact Classification for Alien Taxa, see Hawkins *et al.* (2015)

EPPO: European and Mediterranean Plant Protection Organisation (www.eppo.int)

FAO: Food and Agriculture Organisation of the United Nations (www.fao.org)

IPPC: International Plant Protection Convention (www.ippc.int), overseen by the FAO

ISPMs: International Standards for Phytosanitary Measures, produced by the IPPC

IUCN: International Union for Conservation of Nature (www.iucn.org)

RPPO: regional plant protection organisation