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How to link people, government, and science in effective large-scale management of invasive trees

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A common limitation for the effective management of widespread non-native species is translating and implementing the latest scientific knowledge for practitioners. Non-native tree invasions are no exception to this problem. We illustrate how the National Wilding Conifer Control Programme in New Zealand has worked to overcome these limitations through a partnership approach, ensuring affected communities are connected to on-the-ground responses, and facilitating the transfer of new scientific knowledge to practitioners. By ensuring the overarching management strategy was developed collaboratively with clear, mutually-agreed goals, the programme has helped to unite diverse stakeholders with a common purpose. Although coordinated by a central government body, the governance structure is sufficiently flexible to address the specific management needs of each affected community. The programme takes an adaptive management approach that enables multiple lines of research and management to be developed together; this is essential to improve management across different regions and stages of invasion. A co-developed strategy, partnership structure, and adaptive management were each critical components of the National Wilding Conifer Control Programme. However, there are ongoing challenges to overcome, such as securing long-term funding and reducing risks of re-invasion, to meet the ultimate goal of containing conifer invasions nationally. We suggest that lessons from this programme provide general insights into how linking people, government, and science could be used to improve the effectiveness of large-scale invasive non-native species management elsewhere.

KEYWORDS

biological invasions, collective action, community engagement, landscape-scale management, pinacaeae, science-policy interface

Introduction

Non-native tree invasions are a growing problem worldwide; they threaten native biodiversity, disrupt ecosystem functions, and cost millions of dollars in damage to economic activities and livelihoods (Nuñez et al., 2017; Brundu et al., 2020). Management of tree invasions is undertaken to avoid or mitigate these impacts. For example, the Working for Water programme in South Africa carries out large-scale management of woody invasive species to support employment, maintain water supplies, and protect biodiversity. However, this programme has not achieved landscape-scale removal of invaders despite 25 years of management effort to date (van Wilgen and Wannenburgh, 2016). Large-scale invasive tree management is complicated because it necessitates working with complex biological systems and across multiple stakeholders and government agencies (Niemiec et al., 2016; Graham et al., 2019).

Although there are a growing number of studies on the drivers, impacts, and management responses to non-native tree invasions, most of this knowledge is not readily translated to management or policy (Richardson, 1998; Dickie et al., 2014; Donaldson et al., 2014; Richardson et al., 2014; Wilson et al., 2014; Funk et al., 2020). Linking research and operational management has long eluded academics and practitioners involved in large-scale environmental management. Bridging this gap requires reciprocal and iterative flows of information from both scientists and practitioners prior to research initiation and beyond its completion (Hulme, 2014). Since the needs and drivers of academics and operations managers are often different (Funk et al., 2020), engagement of scientists with key stakeholders early in management planning is crucial but rarely achieved in practice.

Here we evaluate what factors make a large-scale management programme successful in linking research and operations by examining one of the few national-scale management programmes for non-native trees: the National Wilding Conifer Control Programme (the Programme) in New Zealand. The Programme has controlled and searched for invasive non-native conifers on 2 million ha over the last 5 years with a budget of $70 million NZD (ca. $49 million USD). This extensive controlled area includes areas of land which have been managed multiple times, but there are still invaded areas which have received no management to date. Lessons from this programme provide general insights into how linking people, government, and science can be used to improve the effectiveness of large-scale invasive non-native species management.

The problem of invasive conifers

There is relatively little plantation forestry involving native tree species in New Zealand because of the difficulties and costs in establishing native trees on exposed sites and relative slow growth rates (NZ Farm Forestry Association, 2005; McGlone et al., 2022). As a consequence, non-native conifers have been planted in since the mid 1800s for timber, soil erosion control, shelter and amenity values (Froude, 2011). Unfortunately, the choice of conifer species used in plantation forestry also inadvertently selected species with high potential to escape cultivation and become invasive in New Zealand (McGregor et al., 2012). Thus, by the early 1900s, many introduced conifers had naturalised (Ledgard, 2004), and from the 1980s there were major concerns about their spread and the effectiveness of regional management efforts to contain the problem. By 2015 invasive non-native conifers were estimated to affect over 1.8 M ha of land (Howell, 2016) (Figure 1).

Impacts of conifer invasions

Invasive conifers in New Zealand have well-characterised abiotic and biotic impacts, and most of these impacts are negative. For abiotic impacts, invasive conifers affect ecosystem hydrology, soil nutrient cycles, and erosion rates (Mark and Dickinson, 2008; Dickie et al., 2011, 2022). Conifers also increase fuel loading and thus fire hazard (Clifford et al., 2013; Taylor et al., 2017). For biotic impacts, invasive conifers affect biodiversity. Initially biodiversity, native plant and insect richness can increase early on in a conifer invasion, but as invasion proceeds biodiversity declines across these taxa (Pawson et al., 2010; Dickie et al., 2011). Similarly, conifers alter the composition, abundance and functioning of belowground biota and mycorrhizal fungi (Dickie et al., 2011, Nuske et al., 2021). These changes can irreversibly alter ecosystems, exerting legacy effects on community composition, structure and functioning even after invasive conifers are removed (Dickie et al., 2014). Invasive conifer impacts occur across land uses including farmland, recreational land, sites of cultural and historical importance and indigenous ecosystems. The locations invaded by non-native conifers in New Zealand also include protected areas and rare ecosystems (Bellingham et al., 2022).

Policy-context for managing conifer invasions

In New Zealand, two central pieces of legislation govern the management of conifer invasions: 1) the Resource Management Act 1991, which relates to preventing conifer invasions; and 2) the Biosecurity Act 1993, which relates to the management of conifers after they have invaded (Page, 2021). The Resource Management Act 1991 contains regulations for land-use change, including plantation forestry (Resource Management Act 1991, 1991). As part of the National Environmental Standards for Plantation Forestry under the Resource Management Act 1991,

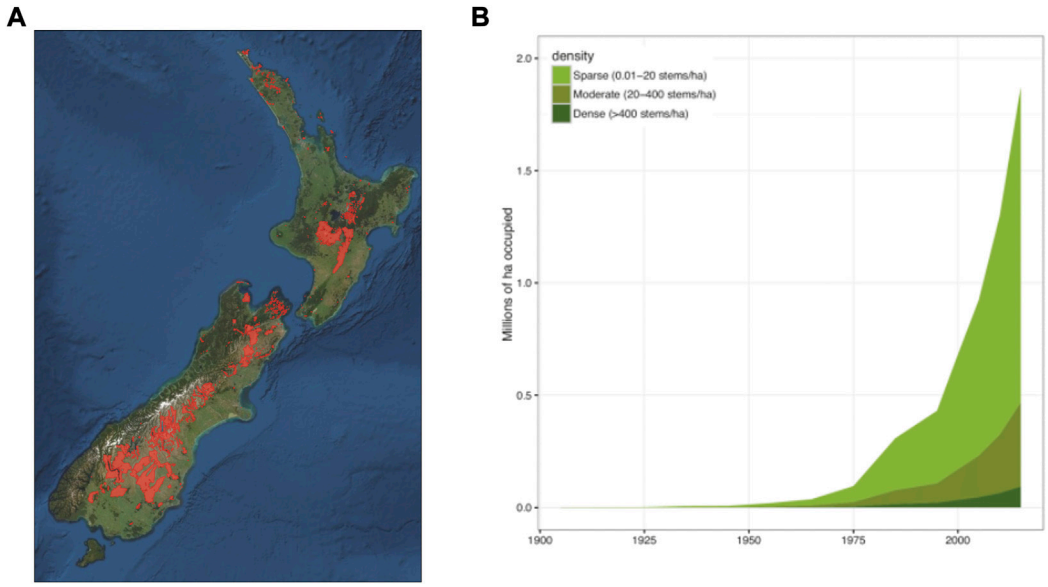

FIGURE 1
(A) Main locations of conifer invasions in New Zealand, indicated in red. Map provided by Land Information New Zealand; **(B)** Estimated spread and tree density (stems/ha) of invasive conifers in New Zealand between 1900–2015. Figure adapted from Howell (2016).

foresters are required to assess tree spread risk from plantations and if the risk of spread from plantations is estimated to be high, either a mitigation plan to reduce spread risk or a different land use is required (Paul, 2015). This risk assessment process, widely used for plantation species internationally, is driven largely by expert opinion rather than underlying data, calling into question the objectivity of this approach (Wyse and Hulme, 2021). Moreover, the National Environmental Standards only apply to plantations, but not to permanent conifer forests or small woodlots (<1 ha) that can also act as source populations for non-native tree invasions.

The Biosecurity Act 1993 addresses the management of invasive trees after they have spread outside of cultivation and each regional council (similar to a state or local government) has a Regional Pest Management Plan, in which non-native invasive species can be declared as pest organisms (Biosecurity Act 1993, 1993). Once a species is declared a pest, this enables councils to require landowners to contain or remove the species. A complication is that some conifer species both underpin plantation forestry whilst occurring as invaders in other land uses (e.g., *Pinus radiata*, *Pseudotsuga menziesii*), so these species are only considered pests in certain locations. Due to property law in New Zealand, the Biosecurity Act 1993 cannot enforce a 'polluter pays' rule, since the Act cannot require that someone enters a private property to remove a pest species. Additionally, Regional Pest Management Plans have inconsistent definitions of conifer pests and differing rules for requiring conifer control; these inconsistencies create gaps in the management response across regions (Page, 2021; Upton, 2021). The Programme operates in this policy landscape, but due to the gaps in legislation and inconsistency of rules across regions and land uses, the current framework is insufficient to prevent future invasions and effectively coordinate national-scale management of tree invasions.

Invasive conifer management in New Zealand

Developing an invasive conifer management strategy

In response to the accelerating invasion by non-native conifers, the New Zealand Ministry for Primary Industries (MPI), the central government agency responsible for national biosecurity responses, commissioned a report in 2011 that concluded invasive conifers were spreading by ca. 5% per year despite ongoing regional management efforts, and alarmingly, that management costs would grow exponentially by ca. 30% per year (Froude, 2011). This evidence-based report recommended that a national strategy was needed to assist government organisations, landowners, researchers, and communities to better coordinate management across political and geographic boundaries. The development of the subsequent national strategy was led by MPI (Ministry for Primary Industries, 2014).

A stakeholder working group comprised of central government agencies (i.e., the Department of Conservation, Land Information New Zealand, New Zealand Defence Force), local government, foresters, farmers, landowners, community groups, and researchers was convened to help develop the national strategy. Each of these disparate groups had direct involvement in conifer management. Discussions amongst participants were robust on contentious issues such as who should bear the responsibility and costs of management. However, through facilitated debate and negotiation, mutual agreement was reached on high-level objectives that were acceptable to all parties. The process to develop, draft and complete the strategy took about 2 years, and in early 2015, 'The Right Tree in the Right Place: The New Zealand Wilding Conifer Management Strategy' was released (Ministry for Primary Industries, 2014).

The strategy provided a national framework for how to effectively eliminate or contain the spread of invasive conifers from 2015 to 2030. Since non-native weed management programmes can often be seen as endless and unachievable (Hulme, 2020), specific aims and an explicit timeframe set this strategy and management programme apart from other weed management efforts (Upton, 2021). In addition to developing time-bound goals, the strategy also described the roles and responsibilities of all major organisations and parties involved in conifer management; this both empowered and defined how organizations fit into the management framework and contributed to national-scale goals. A cost sharing structure was developed to clearly determine how exacerbators and beneficiaries would contribute to the cost of controlling conifers and generally, landowners were expected to pay 20% of management costs.

The co-development and subsequent co-implementation of the national strategy represented one of the cornerstones of its success. Although the strategy is a non-statutory document (i.e., not legally binding), broad support across government, industry, and landowners has occurred. When the strategy was developed, there was recognition that working collaboratively and across organisational and land tenure boundaries was the only way to address the national-scale issue of conifer invasions. One year following the publication of the strategy, in 2016, the New Zealand government provided initial funding of $16 million to support management over the next 3 years, and the National Wilding Conifer Control Programme was established to deliver the objectives laid out in the national strategy and coordinate conifer management across the country.

Implementing a National Wilding Conifer Control Programme

The National Wilding Conifer Control Programme (hereafter, the 'Programme') is structured as a partnership, which means that government agencies, regional councils, landowners, and community groups work collectively to control conifers. Coordination of the Programme rests with central government agencies: MPI, the Department of Conservation (DOC), the government agency tasked with protecting and managing Crown conservation land, and Land Information New Zealand (LINZ), the government department responsible for managing Crown pastoral leases (land under long-term leases predominantly used for grazing) and riverbeds. The New Zealand Defence Force is also involved in the Programme since much of the land under its jurisdiction is invaded by conifers. Most regional councils are also part of the Programme; these organisations are responsible for the integrated management of the natural and physical resources within a region.

The creation of the Programme represented a step change in funding and coordination of management efforts. Prior to the Programme, regional councils, DOC, and private landowners were collectively spending ca. $11 million NZD/year on control, but the lack of coordination meant that conifer invasions were continuing to expand including into new areas of the country.

To date, the Programme and its partners have managed conifer invasions on >2 M ha, and this success has enabled the Programme to secure additional funding. The New Zealand government allocated $37 million for conifer management between 2016–2020 (an initial $16 million in 2016 and a further $21 million in 2019). In May 2020, the government announced a further $100 million over 4 years for conifer management. Most (>95%) of this funding is allocated to on-the-ground management.

Supporting an applied research programme

As control operations scaled up, it has become increasingly clear that management required integrative and multi-disciplinary science to improve management and generate societal benefits. Researchers worked closely with the Programme and managers to identify and develop research topics and determine how new knowledge could help meet the long-term goals in the national strategy. As a consequence, in 2016 the 'Winning Against Wildings' research programme received $16 million over 5 years to understand where and how management could minimize the spread of invasive conifers, reduce control costs and avoid adverse environmental effects through early detection and prevention of conifer spread. This research also quantified spread risk and identified the impacts and legacies of invasive conifers on biodiversity and ecosystems (e.g., Sapsford et al., 2020; Wyse and Hulme, 2021; Dickie et al., 2022). Subsequently, additional funding from the Ministry of Business, Innovation and Employment (MBIE) has been secured for a further 5 years to

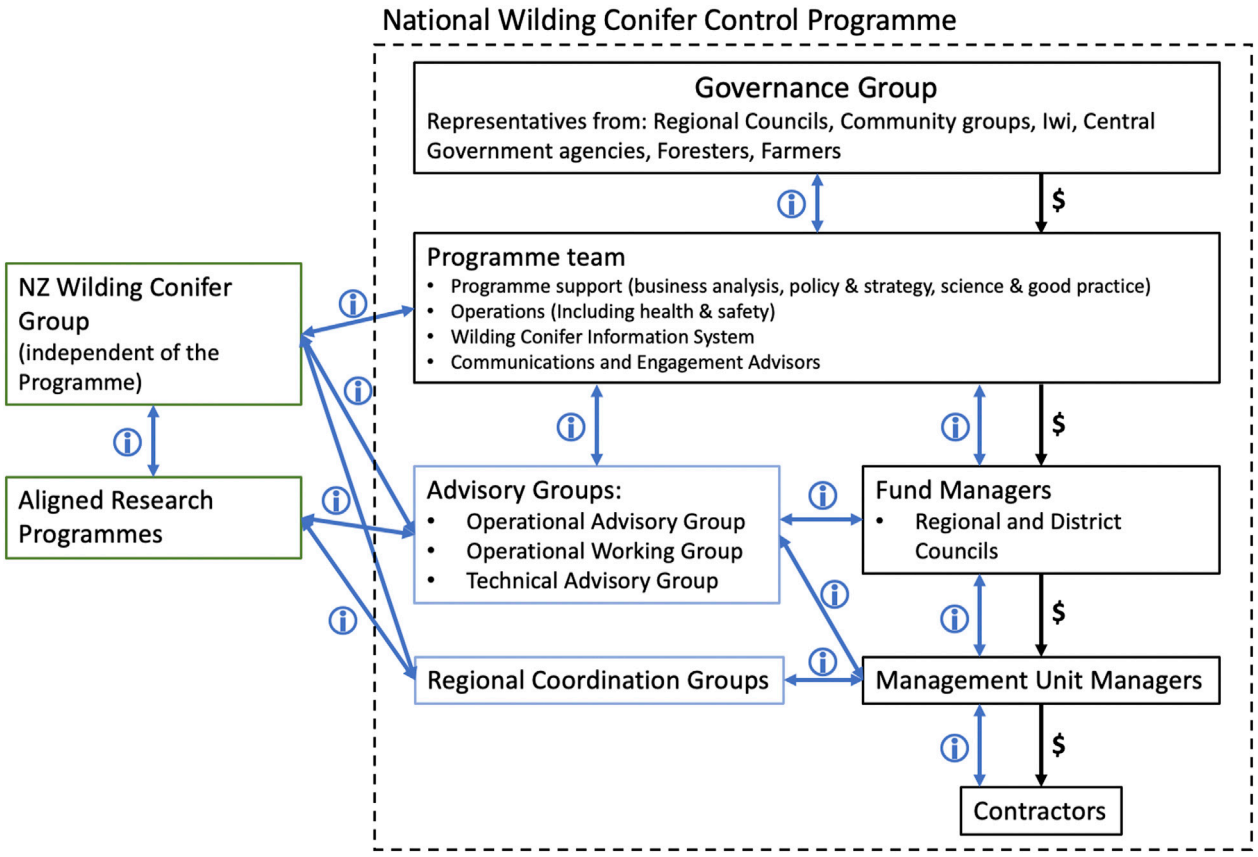

FIGURE 2
Structure of the Programme, showing the operational delivery structure (right side of the figure) and the flow of information and advice (left side of the figure). Allocation of funding (black arrows) flows from the Governance Group through to contractors. Information and advice (blue arrows) flows between all groups through regular meetings and workshops, enabling members of the Programme to raise and respond to potential challenges quickly. The membership and roles of each of the groups are described in Table 1.

assess the effectiveness of control operations and the drivers of reinvasion at previously-managed sites.

Successfully linking communities, research, and operations

Programme structure

The Programme was designed to better link people, science, and management (Figure 2; Table 1). Its partnership structure enables the collaboration across government agencies and communities to control conifer invasions collectively at local and regional levels (Peltzer et al., 2019).

A critical aspect of this structure is that operational decisions are not dictated by the Programme team. The Programme team coordinates and prioritises management efforts at a national scale, and regional operational priorities and strategy are developed collaboratively with Regional Coordination Groups comprised of regional councils, central government representatives, and local communities. The Regional Coordination Groups demonstrate the Programme's implementation of collective action theory and cross-boundary coordination and participation (Epanchin-Niell et al., 2010; Graham et al., 2019). They are an important pathway for involving local expertise, encouraging landowner buy-in, and instilling a sense of community responsibility for controlling invasive conifers. The groups meet at least quarterly, disseminate information to local stakeholders, and provide crucial feedback to regional and central government agencies. Members of Regional Coordination Groups can also assist with uptake of research, for example, by trialing alternative management options.

The Advisory Groups of the Programme (Figure 2) are a central hub for problem-solving operational and technical issues as well as sharing best practice for control techniques. The Technical Advisory Group also serves as a two-way interface between science and operations, allowing the Programme to identify and scope future research to meet

TABLE 1 Membership, roles and responsibilities, and communication channels of the parties and groups involved in the National Wilding Conifer Control Programme.

Group	Members	Role or responsibility	Frequency and type of communication
Governance Group of the National Programme	Senior officials representing the partnering government agencies	Approval of annual work programme, horizon scanning of risks to programme, assessing how well the programme is tracking to meet its 2030 goals	Bi-monthly meetings with the National Programme team
National Programme team	Employees of MPI and Land Information New Zealand	Coordination and prioritisation of control work across regions, financial and control data collection, communications and engagement advice	
Regional Fund Managers	Regional and District councils involved in the National Programme—currently there are 10 regional and district councils involved in the Programme	Coordinate regional delivery of work programme; allocate regional funding	Bi-monthly meetings with National Programme team; representation on advisory groups
Management Unit Managers	Project managers for specific operational areas, often either employees of the regional council or the Department of Conservation—there are currently 33 active Management Units	Set up contracts with contractors to control wildings on the ground; gather control and financial data	Bi-weekly meetings with Fund Managers; representation on advisory groups
Regional Coordination Groups	Local and regional representatives from community groups, government agencies, contracting companies	Advice on regional delivery of work programme—local risks, expertise, and priorities; persuade landowners to join the National Programme	Regular meetings (sometimes monthly, sometimes quarterly) with Management Unit Managers
Operational Advisory Group	Regional councils; government agencies: DOC, LINZ, NZDF; NZWCG	Develop and advise on annual control work programme; identify high-level needs of management such as monitoring and data collection improvements	Report regularly to National Programme team after bi-monthly meetings
Operational Working Group	Project managers in regional councils, Department of Conservation, and contracting companies	Work through risks and operational challenges to delivery; ensure that proper health and safety obligations are met	Report regularly to National Programme team after bi-monthly meetings
Technical Advisory Group	Researchers from Crown Research Institutes and government agencies	Problem-solve technical issues encountered in control; Advise on use of new technologies such as remote detection and drones; Work with researchers from Winning Against Wildings programme to share findings through workshops with end-users; Revise Good Practice Guides	Report to National Programme team after bi-annual meetings and quarterly workshops
NZ Wilding Conifer Group	Community groups, iwi (indigenous peoples), NGOs, farmers, foresters, regional councils, government agencies, Crown Research Institutes	Information sharing; advocacy for funding; providing feedback on communications and engagement, operational and technical challenges faced on the ground	Regular (weekly) meetings with members of National Programme team; representation on Governance Group; representation on advisory groups; bi-monthly catch-ups with Regional Coordination Groups

management needs. The Operational Advisory Group and the Operational Working Group both identify challenges in management, and the Operational Advisory Group develops the annual control work package and national priorities for management.

The New Zealand Wilding Conifer Group (NZWCG) sits alongside the Programme as an independent advisory group, representing a diversity of voices and experiences in invasive conifer management. Funded by central government agencies, regional councils, industry, and community groups, the NZWCG facilitates information sharing through an annual conference, workshops, newsletters, and monthly webinars. Additionally, the NZWCG mobilises community groups through support on funding applications and connecting with technical experts.

Adaptive management approach

Large-scale programmes to manage invasive species should be informed by evidence and risk-based assessments (Kopf et al., 2017). The Programme uses an adaptive approach to manage invasive conifers by adjusting the management response depending on the invaded site and surrounding community

FIGURE 3
Illustrative examples of how research, management and communities adapt as conifer invasions proceed: **(A)** early invasion from a nearby plantation, demonstrating the need for prevention and early control; **(B)** a community workday in which volunteers tackle local invasions of small-sized trees; **(C)** a contractor in action, controlling a moderate density invasion; **(D)** large-scale management, in which helicopters are used to aerially spray herbicides on dense invasions. Photos in panels **(A)** and **(B)** credit to Rowan Sprague. Photo in panel **(C)** credit to Biosecurity New Zealand. Photo in panel **(D)** credit to Nick Ledgard.

through consultation with Regional Coordination Groups and public meetings where needed. The Programme also integrates latest research into operational management.

This management approach demonstrates how the Programme manages the intersection between management, community involvement, and science throughout different stages of invasion (Figure 3). Prevention of future conifer spread is the most effective management strategy (Figure 3A), but in order to be successful, community support from owners of plantation forest and other landowners is crucial. Research from the 'Winning Against Wildings' programme has evaluated risk assessment tools used to quantify spread risk of conifer species (Wyse and Hulme, 2021) and the invasibility of different land (Wyse et al., 2022); these findings are now being integrated into recommendations to amend afforestation policies. Furthermore, knowledge of how the distributions of non-native conifers and risk of spread could change with climate change is vital for prevention of future invasions. Research on the future distributions of several non-native conifers has found wide suitability under future climate scenarios (Etherington et al., 2022) including for *Pinus radiata*, the most widely planted non-native conifer in New Zealand that has spread from cultivation (Bellingham et al., 2022). These results have been shared with the Programme to include in their future prevention strategies.

If an invasion is not prevented, early action is the next most effective response, and provides opportunities for local volunteer groups to become involved in control efforts (Figure 3B). Predicting the likely population trajectory of existing invasions is crucial to prioritise control efforts regionally (Sprague et al., 2021). Research from the 'Winning Against Wildings' programme supports this approach, as findings on the impacts and legacies of invasive conifers suggest that even at low densities, conifers can start to alter an ecosystem (Sapsford et al., 2020; Dickie et al., 2022). Monitoring and surveillance are critical at this invasion stage as well. However, due to long-distance dispersal, non-native conifer species can spread significant distances from a seed source (Wyse et al., 2022), making the monitoring of all establishment infeasible.

As invasion proceeds, professional contractors are used to control sites (Figure 3C), and applied research on control techniques as well as prioritisation of control sites informs operational management plans (Rolando et al., 2021). Once tree density forms a closed canopy, aerial herbicide application or mechanical ground-based control are deployed (Figure 3D). Research on increasing the efficacy of herbicides

TABLE 2 Current challenges and recommendations in invasive conifer management.

Challenge	Recommendation	Responsibility	Risks
Sustaining management to contain or eradicate invasions when funding cycles are 3–4 years	Need long-term (10 + year) operational management plans with budgets, as well as advocacy for long-term funding	Operational managers and Regional Coordination Groups develop long-term management plans Community groups and landowners advocate for support and funding	Few opportunities for long-term funding are available
Reinvasion requires ongoing management	Within site management monitored; research to understand and minimise reinvasions	Programme to monitor management efficacy Researchers to understand and identify pathways to reduce reinvasions	Management of reinvasion requires different or multiple interventions
Difficulties in achieving post-invasion land use	Advocate for restoration funding and policy which reduces re-invasion; more research on effective ways to achieve desired outcomes	Community groups and landowners to advocate for land-use outcomes Researchers to examine ecosystem resilience strategies	Different interventions needed for conservation and agricultural sectors
Management success is poorly defined, and lack of evidence to demonstrate management success	Use literature on ecological and economic indicators to determine measures of success; develop spatial tools for outcome measurement	Technical Advisory Group in collaboration with researchers	Could be difficult to identify what data are needed to measure success
Ongoing afforestation of spread-prone species presents a future invasion risk	Research which quantifies spread risk should inform afforestation policy Support research on low fecundity cultivars and gene editing to reduce fecundity	Researchers to understand and forecast future risks Community groups and landowners to advocate for policy changes Community groups and landowners advocate for low-fecundity cultivars	Currently no policy tools to enforce a 'polluter pays' rule Lack of public support for gene editing in New Zealand

while lowering the costs is needed at this stage. Across all operations, communities are consulted through the Regional Coordination Groups to determine post-control land use, and the management approach is adapted accordingly to achieve the agreed end goal.

Finally, the Programme recognises that early engagement of researchers with policy-makers and managers is needed to overcome the lags between research findings and deployment (Funk et al., 2020). The Technical Advisory Group of the Programme runs targeted workshops to bring practitioners and scientists together to match operational needs and research. Additionally, the NZWCG works with researchers and the Regional Coordination Groups to identify challenges in management that could be addressed through research.

Public support and funding

Public awareness and support of invasive species management programmes are vital to their success (Graham et al., 2019; Peltzer et al., 2019). The public can advocate for funding at a local, regional, and even national level and participate in the programme as volunteers. With public support, programmes can also more easily engage with and encourage landowners to control invasive species on their property (Mason et al., 2020). For example, a national survey of landowners in New Zealand reported 23% of landowners stated that invasive conifers were more beneficial than harmful in 2015, but by 2017, only 7% expressed this view (Edwards et al., 2020). Both public involvement as volunteers and landowner participation can ensure local buy-in, thereby instilling a sense of collective responsibility for the issue (Graham et al., 2019).

Some species of non-native conifers are also still planted in New Zealand for forestry because they still provide benefits such as timber. Therefore, public awareness and support of invasion management is also needed to ensure non-native conifers are not planted in vulnerable areas and are managed responsibly (Brundu et al., 2020).

Challenges and recommendations for improving large-scale invasive species management

Although conifer invasions are a global problem (Essl et al., 2011), their management response is more advanced in

New Zealand than elsewhere, and thus provides insights into how landscape-scale invasion management can be improved (Nuñez et al., 2017; Hulme, 2020). Here, we summarise some of the ongoing challenges faced by invasive conifer control and identify who and how to address them (Table 2). Coordination of researchers, communities and managers is an overarching feature across these issues.

Discussion

The management of large-scale tree invasions is difficult because they span geopolitical boundaries, involve diverse stakeholders, and are complex biological systems (Niemiec et al., 2016; Brundu et al., 2020). However, these invasions provide opportunities to better link research with policy, management, and communities (Hulme, 2014) and offer insights into how to collectively confront complex environmental issues.

Lessons from the National Wilding Conifer Control Programme in New Zealand demonstrate that the following components are critical to success: a clear strategy outlining roles and responsibilities as well as actionable objectives; a partnership structure which facilitates engagement across government, communities, and research; a management approach which integrates latest research and adapts to challenges and learnings; and finally, public support which advocates for ongoing management and funding. More generally, partnership and co-management models have been identified as the most effective approach to join together stakeholders, managers, and researchers and to work across boundaries for large-scale invasive species management (Graham et al., 2019; Mason et al., 2020).

The Programme's partnership structure is central to its ability to link people across all levels. Strong communication, information sharing, and integration among diverse communities of people enable collaboration and flexibility in the Programme, rather than imposing a top-down approach (Peltzer et al., 2019). The advisory groups of the Programme enable the uptake and application of research and the ability of science to inform the long-term management goals of the Programme.

Finally, the Programme has been successful because it has brought together a wide base of support from the public and stakeholders. The development of the management strategy ensured that the goals of the strategy had consensus. This broad-based involvement and support has made it possible for the Programme to work across boundaries and control thousands of hectares of invasive conifers. It has also encouraged the government to continue to invest in the management response. There still remain challenges for this Programme including the need for ongoing research to understand pathways to restoration and preventing re-invasion. Overall, this Programme demonstrates important principles about how to better integrate across the science-policy-practitioner divide to improve landscape-scale management of invasive non-native species Dickie et al., 2014b.

Author contributions

All authors conceived the ideas and structure of this study; RS led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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