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Protecting New Zealand's agricultural legacy through education

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Abstract

Renowned globally as a country that produces high quality goods, New Zealand has a reputation second to none when it comes to science and research related to increasing primary produce. Hence, New Zealand's reliance on export of primary produce to drive the economy is no secret. However, education related to protecting this industry appears to be scant, including in schools.

New Zealand's primary produce driven economy is protected through maintaining biosecurity. Biosecurity plays an expansive role, from protecting the economy through stopping pests and diseases of economic significance from arriving and establishing to protecting human health and sociocultural values. Given the emphasis on education to help manage the biosecurity pandemic caused by the outbreak of Covid-19, as a society we need to look beyond legislation, including the Biosecurity Act 1993, to manage biosecurity.

The long-term prospect for biosecurity in New Zealand might be said to be relatively secure, considering that New Zealand is an island nation with biosecurity regulations that have been in place for decades. However, the critical importance of maintaining biosecurity requires a strategic long-term approach. This conceptual article advocates for biosecurity education in New Zealand schools. Maintaining biosecurity not only prevents pests and diseases from arriving, but eradicating pests and diseases already present contributes to the conservation of endemic flora and fauna.

Further, New Zealand has a reputation for providing businesses with a highly transparent and democratic environment to operate. This foundation is built upon a strong economy that, nonetheless, is susceptible because, unlike other countries, New Zealand relies on the export of primary produce to drive its economy (International Trade Administration, 2023). Primary produce industries, such as dairy farming, that heavily rely on monoculture are prone to risks posed by diseases, such as foot and mouth. Subsequently, educating future generations on biosecurity can help maintain a stable agricultural sector, critical for a robust democracy and economy.

Keywords

Education, biological invasions, public engagement, citizen science, constructivist learning

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Introduction

In 1835, the *HMS Beagle* arrived in New Zealand, and Darwin went ashore, met with settlers, and collected insects, shells, fish, rocks, and a gecko (New Zealand History, 2016). Darwin observed many unique animals which he had never seen before and noted that flora and fauna introduced by European settlers had the potential of overrunning the endemic species.

Darwin used the observations he had made on this and other voyages to propose the scientific theory of evolution by natural selection in his book *On the Origin of Species* (Darwin, 1859). Darwin's theory of evolution has since become the bedrock of evolutionary studies around the world and continues to drive research globally. What Darwin observed in New Zealand—the biosecurity threat to endemic species by introduced species—is also a key area of ongoing interest and concern globally.

New Zealand's unique geological history began as part of the super continent Pangea, which separated to form Gondwanaland, breaking away from the other land masses (Australia, Antarctica, and the Indian sub-continent) 85 million years ago (TeAra, 2007). New Zealand as a land mass was consequently isolated for millions of years until colonisation by Polynesian Māori migrants 800–1000 years ago (West & Thompson, 2013). Isolation, as Darwin theorised, is one of the key factors in promoting evolution. Consequently, New Zealand's isolation gave rise to the evolution of unique species of flora and fauna with specific adaptations. For example, birds such as kiwi (genus *Apteryx*) became flightless as there was no need to escape land-based mammalian predators because there were none.

Until human arrival, the only land-based mammals were bats, which still exist (Department of Conservation [DoC], 2022). Subsequent waves of colonisation by humans, and with them introductions of exotic plants and animals, put great pressure on native and endemic flora and fauna that were without defence systems to protect against the invaders. As Darwin (1859) observed, 'The endemic productions of New Zealand, for instance, are perfect one compared with another; but they are now rapidly yielding before the advancing legions of plants and animals introduced from Europe' (p. 162).

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2019) ranks biosecurity or the "impact from invasive alien species" (para 12) on native species as one of the five key drivers of negative change in nature. "Invasive pests and diseases are a major threat to agriculture, natural ecosystems and society in general" (Penn State, 2016 para 2). China and the U.S. have been identified as countries that could spread invasive species to other countries due to large agricultural production capabilities and broad export markets (Paini et al., 2016). However, as the two leading trading nations, these leviathans have paid the price of economic progress. Both the U.S. and China are now infested with fire ants (*Solenopsis invicta*) which are native to Argentina, Paraguay, and Brazil and fall within the category of one hundred of the world's worst invasive alien species (Lowe et al., 2000). It is through U.S. and China via the container trade pathway that fire ants arrived in Australia in 2001, 2013, and 2019. After the most recent detection of fire ant nests in 2023 on Minjerribah (North Stradbroke Island) for the first time, Australia initiated a multimillion-dollar response to eradicate fire ants (Invasive Species Council, 2024). The container trade pathway between New Zealand and China is on the rise (imports from China to New Zealand are around NZ$17.16 billion, comprising $16.27 billion in goods and $887 million in services) [New Zealand Foreign Affairs and Trade, 2023]), and this presents a risk for fire ant introduction in New Zealand.

Like native flora and fauna, New Zealand's primary produce industries are vulnerable to biosecurity threats. Biosecurity initiatives to protect vulnerable industries are being set with future focused goals, including, for example, the goal for New Zealand to be predator free by 2050 (Key, 2016). A predator-free stance not only benefits primary produce industries by eradicating pests like possums that can transmit bovine tuberculosis to cattle (Predator Free New Zealand, 2018), but also the tourist industry, and consequently the economy, by increasing the chances of tourists encountering native animals like kiwis in the wild, which is only possible through eradication of invasive predator species.

Poisoning, shooting, and trapping are some of the many ways pestilent animals are controlled in New Zealand, with varying results. The downsides to such means of control include opposition to the use of poison from the public (Russell, 2014; SPCA, 2019). Other arguments against labelling and

eradicating pest animals include sociocultural arguments about racism (Ram, 2019) and animal cruelty (Morris, 2021). Education has been purported by the New Zealand government (Guy, 2016) as one way of teaching the public about the need for, and value of biosecurity. The goal of Ministry for Primary Industries (MPI) is for all New Zealanders to participate in strengthening the biosecurity system by 2025 (MPI, 2016a).

In this article, I make a case for biosecurity education to be considered for inclusion in the Social Sciences curriculum. Research that I have carried out and reported on (Ram, 2022) showed that using a bottom-up approach using biosecurity as context for teaching and learning purposes at Level 8 of the Social Science learning area of The New Zealand Curriculum (NZC) engaged Year 13 students and prompted students to act (Ministry of Education, 2007). These students, after learning about biosecurity in social studies, individually approached their local member of Parliament with formal letters, communicating their views about biosecurity management in wider New Zealand. Further, results showed that Year 13 students who had biosecurity experiences, such as encounters with sniffer dogs at international airports, advocated for better education about biosecurity in New Zealand. In what follows, I begin by describing the scope and narratives of biosecurity in the public domain, followed by a discussion of methods for engaging citizens, including initiatives like citizen science and educational programmes in schools. Finally, I revisit the case for raising awareness about biosecurity by taking a bottom-up approach using constructivist learning theory (Taylor et al., 1997).

What is biosecurity?

In New Zealand biosecurity refers to 'the protection of New Zealand's economy, environment, human health, and social and cultural values' (MPI, 2016b, para 1). From a global perspective, biosecurity is related to protecting an environment, place, and/or population from many different threats. For example, the UN Biological Weapons Convention, which 'prohibits the development, production, acquisition, transfer, stockpiling and use of biological and toxin disease-causing organisms to harm or kill humans, animals or plants,' and aims to prevent the spread of biological weapons (UN, 2021). Also classed as biosecurity are endeavours to contain the spread of infectious zoonotic diseases. These exist in animals and can either be transmitted directly through contact with bodily fluids of animals or through a vector leading to a severe illness and/or death of humans. Examples include diseases like the 2009 pandemic caused by the H1N1 strain of the swine flu. Biosecurity responses were of course more recently evidenced in national and international initiatives to managing the Covid-19 epidemic.

The term biosecurity is also used in endeavours to control agricultural pests and diseases and attempts to reduce the effects of invasive species on indigenous flora and fauna. The focus on the former is related to farm-management practices. Take, for instance, the actions taken after the discovery of Mycoplasma bovis, a bacterium that causes mastitis, pneumonia, and arthritis in cattle. Strict regulations from New Zealand government authorities prevented farmers from moving infected stock (MPI, 2019). This form of biosecurity measure is well known around the world. For instance, the outbreak of foot and mouth disease in the UK in 2001 resulted in strict measures to contain and control the virus, first through farm-based practices, such as hygiene techniques, and then using disinfectants and restrictions on the movement of animals. However, even these measures failed to contain the spread of the virus, which led to the slaughter of over four million animals to eradicate the virus (Davies, 2002).

Another form of biosecurity work is the struggle to reduce the effects of invasive species on indigenous species. In New Zealand, the Australian brush tail possum, a marsupial mammal (*Trichosurus vulpecula*) has been labelled as an invasive alien species by the DoC (2009) and targeted for eradication. Similarly, restrictions are currently in place around New Zealand forest parks to halt the spread of a fungus-like pathogen (*Phytophthora agathidicida*) that infects and eventually kills mature kauri (*Agathis australis*) trees (Beever et al., 2010).

Biosecurity narratives: Public domain

The expansive role of the biosecurity system in New Zealand reflects its importance. The well-being and livelihood of all New Zealanders is connected to biosecurity because biosecurity measures protect the primary industries that are so important to the economy. Consider this, despite the global economic challenges brought on by the outbreak of Covid-19, exports of produce derived from New Zealand's primary industries continued to outperform all other sectors of the economy (MPI, 2021) and reached NZ$56 billion, $1.2 billion higher than the forecast of $55 billion projected in December 2022 (Beehive, 2023). An industry so vital to the economy demands protection.

A review conducted by prominent New Zealand pest-management and conservation scientists from many different research institutes (Goldson et al., 2015) recognised ongoing pressure from land-based and aquatic pests that threaten the country's ecosystem. The review postulated that research was needed that looks at how to engage citizens emotionally and argued that countering threats from exotic species will require the "public" to be engaged quickly. They claimed that more "citizen involvement" will lead to better surveillance and quicker detection of pest species in New Zealand.

Nonetheless, education about biosecurity in the public domain appears to be scant. It appears that biosecurity is only given prominence when the need arises, such as during management of the pandemic caused by Covid-19 or during the 2015 outbreak of the fruit fly in Grey Lynn, Auckland (Ram, 2020b). The belief appears to be that people living in New Zealand already know and understand the different biosecurity threats or that biosecurity protocols are sufficient, and the public do not need to do anything. However, a survey conducted by MPI revealed that only 2% of New Zealanders (MPI, 2018) who responded to questions about familiarity with biosecurity perceived that a biosecurity outbreak would affect them personally (O'Connor, 2018). Nevertheless, awareness regarding biosecurity's role in pest control, and monitoring, both at the border, and within New Zealand, was relatively high. One biosecurity threat frequently mentioned was that posed by myrtle rust, likely due to extensive media coverage since its arrival in May 2017 (MPI, 2018). For New Zealanders to support biosecurity initiatives, more people need to see the significance of biosecurity to their personal lives.

Currently, biosecurity information in New Zealand appears to mainly exist in government silos, such as the MPI website, regional websites, and the DoC website. Other sources of biosecurity information accessible to the public can be found in daily newspapers and television programmes. One such television programme is *Border Patrol* (Christie, 2004 – present), a New Zealand-based reality television series about biosecurity seizures at major ports of entry in New Zealand, screened during prime time (7–9pm). Footage from *Border Patrol* focuses on management of different biosecurity pathways, including the passenger pathway, explaining why people travelling from different parts of the world are stopped and checked for risk goods at international airports around New Zealand. Another reality television programme screened in New Zealand, showing similar footage to *Border Patrol* but from Australia, is called *Border Security: Australia's Front-Line* (Marks, 2004–present). It can be said that the television can educate people about border biosecurity, but reality television is created for entertainment and seldom education (Ferguson et al., 2013). Price and Nethery (2012) reported that people learn from watching reality television. Participants in their research who watched *Border Security: Australia's Front Line* perceived the programme as factual and felt they learned something from it.

Biosecurity news that does appear in New Zealand media typically focuses on unusual events or depicts potential dangers to the public. For example, media reported that five snakes were found in New Zealand in 2023 (Swift, 2023). Considering this perspective, it appears that biosecurity threats posed by dangerous medium to large animals are more likely to make headline news and subsequently become part of an individual's memory. Editors of news outlets choose to report about such incidents because they could be aware that modern humans' views are based on perceptions developed in ancient primates who were subject to predation given our evolutionary history (Yorzinski et al., 2014). Consequently, headlines that include snakes and other dangerous animals would intuitively attract attention, but New Zealander's did not need to worry, as Swift (2023) deftly stated, "All but one of the snakes was dead when discovered." While it appears that some form of sensationalism is often employed to get people to read biosecurity news, the question remains: how can young school-aged people be engaged with

such news when research shows that 15–17-year-olds are more likely to accidently stumble upon biosecurity news while on social media rather than intentionally search for it (Klopfenstein Frei et al., 2024).

Biosecurity is critical to New Zealand, and therefore so is finding ways to give the people of New Zealand a conceptual understanding of biosecurity (Ram, 2020a). Conceptual understanding can allow a transformation in thinking about biosecurity, and not only enable the public to distinguish between biosecurity news packaged for entertainment and real biosecurity news but also understand how flora and fauna from overseas countries can pose a biosecurity threat to New Zealand. A transformation in thinking through conceptual understanding will allow people to understand the significance of biosecurity to their lives and help people understand biosecurity regulations and why biosecurity rules need to be enforced. Further, conceptual understanding could potentially enable people to be part of biosecurity decisions that affect them by contributing ideas and taking part in public debates.

Looking to the future: Engaging citizens

Biosecurity in New Zealand does not exist in a vacuum but is interconnected with other areas of society. The economy, environment, and human health are all at risk from breaches in biosecurity. The interconnection between biosecurity and other areas of New Zealand society highlights the importance of understanding threats to maintaining biosecurity and people's responsibilities in relation to these. Biosecurity 2025 (MPI, 2016a) is a direction statement, released by MPI, with a future-focused goal to strengthen New Zealand's biosecurity system. This direction statement brings into perspective the interrelationships between biosecurity and protection of the economy, environment, people's health, and cultural and social well-being, and the pressure on the biosecurity system from global trade, climate change, and increased movement of people.

To recruit "a biosecurity team of 5 million" (MPI, 2016a, para. 5) and to allow all New Zealanders to be able to effectively participate in the biosecurity cause, education about biosecurity will be needed. Biosecurity education could be a major tool to involve larger proportions of New Zealanders in actively helping to manage biosecurity risks. Intuitively, a community that is educated and informed about biosecurity is likely to be more receptive to the government's biosecurity concerns when tackling existing and/or new biosecurity incursions that involve community cooperation. The need for this understanding is supported by empirical evidence. For example, a study commissioned by MPI, and completed by a nationally representative sample of New Zealanders aged 18+ (n = 1,150), found that the majority (88%) of the people surveyed perceived that they played no role in maintaining biosecurity. Further results from the same study showed that young people, particularly 18–24 years old, which made up 13% of the cohort that were under 30 years old, saw government agencies, including councils, as responsible for maintaining biosecurity and were less likely to see themselves as playing an important role in biosecurity (Colmar Brunton, 2018).

In an earlier study using a mixed method approach, my colleagues and I demonstrated that young New Zealander's lack biosecurity knowledge (Ram et al., 2016). Further, young people (14.5–15.5 years old) claimed that a lack of knowledge of biosecurity was one reason they were unable to correctly interpret posters highlighting the invasive nature of organisms, such as didymo (*Didymosphenia geminata*), a freshwater alga (Ram, 2019). I have recently demonstrated that biosecurity education in schools can help young people better understand biosecurity from a regional, national, and global perspective (Ram, 2022). My thesis is that a holistic understanding of biosecurity is necessary for more New Zealanders to see themselves as "biosecurity risk managers".

Biosecurity governance

The current system for biosecurity awareness in New Zealand is government-led, managed through the Biosecurity Act 1993, which sets out a sophisticated system of rules, regulations, acts, and laws in what can be described as a top-down approach. Top-down approaches are said by some (e.g., Fraser et al., 2006) to be democratically unaccountable and elitist and stifle participatory input. Others (Avery & Hoxhallari, 2017) argue that top-down approaches drive citizens to think along government policy lines

by closing avenues through which citizens can communicate their preferences to policy makers. Yet others say top-down approaches tend to decontextualise problems, changing people's knowledge of the issue and, consequently, the actions they take to remedy problems (Blue, 2016). To support the top-down approach, citizens need to be able to make the connections between biosecurity and their social, cultural, and personal well-being. However, there are currently very few to no provisions in place to move the biosecurity agenda from governance levels into (young) people's everyday lived realities. An implication is that citizens may not prioritise biosecurity because they perceive it to be the Government's concern. Thus, formal education about biosecurity could provide an avenue through which citizens have opportunities to develop understanding and agency about their potential contributions to biosecurity threats.

An educational bottom-up strategy offers an alternative to top-down approaches. An educational bottom-up approach strives to develop knowledge, skills, and dispositions to address and, in this case, issues associated with biosecurity (Međugorac & Schuitema, 2023). A bottom-up approach can produce an informed community that can ultimately contribute to the biosecurity debate (Blue, 2016; Rayner, 2010). However, critiques of bottom-up approaches, including those from the climate-change lobby, state that education practices focus too much on problems at the grassroots level and fail to address problems arising from ineffective policies at the governance levels (Rayner, 2010). In relation to biosecurity in New Zealand, this is not the case: the Biosecurity Act 1993 allows biosecurity responsibility to be shared down to the regional council level, giving the government's biosecurity agenda a platform in all areas in New Zealand. Evidently, a community that is educated and informed about biosecurity is likely to be more receptive to the government's biosecurity concerns when tackling existing and/or new biosecurity incursions that involve community cooperation. Next, we look at two bottom-up approaches that could be considered for biosecurity education.

Citizen science

Citizen involvement and "citizen science" have recently become buzz terms as a result of authorities and scholars realising the untapped potential of citizens' contributions to conservation (and other science) through their curiosity and genuine willingness to help. In relation to biosecurity, citizen help can be as simple as ringing a hotline to inform authorities of unusual looking animals in the backyard. Or as Metcalf (2019) stated, the role of an extreme citizen scientist involves being part of a research project with scientists from start to finish, including reporting the results.

Education has been identified as a key contributor to the recruitment of potential citizen scientists. Piria et al. (2017) mentioned that in Europe, the invasive alien species problem has been exacerbated by a lack of policies and legislation in some European countries, such as Slovakia and Croatia. They recommended workshops to help educate citizens about invasive alien species, which could create an army of citizen scientists working with scientists to report any new outbreaks of invasive species around Europe. In New Zealand, Peters et al. (2015) reported that citizen science data were valued and used by project organisations to support funding applications. However, concerns raised by project partners included whether data from citizen scientists were "meaningful" as citizens appeared to have little understanding of experimental design.

Other studies have shown that education about specific scientific processes is necessary for data gathered by citizen scientists to be meaningful. For example, Bos et al. (2019) trained volunteers (three per site) to collect samples to monitor the quality of water in two different lakes in Saskatchewan, Canada. The results showed that citizen data about the lake water trophic status, toxin levels, total dissolved solids, and transparency were similar to those collected by trained limnologists. However, citizen scientists reported pH levels over 14. This misreporting was narrowed down to unfamiliarity with how to correct the settings on the pH meter and a lack of knowledge about the general concept of pH. It appears that relevant education related to the topic may be important for enabling valid, reliable contributions by citizen scientists.

Ram (2019) posited that a lack of education in New Zealand about how to deal with invasive species led to teenage volunteers taking young joeys from dead possum mothers and drowning them. Further, fundraising events held by some primary and intermediate schools have been centred on games,

such as throwing carcases of dead possums and skinning and dressing-up dead possums. More recently cats (*Felis catus*) have been targeted in New Zealand for eradication. Domesticated cats that have been abandoned by their owners have become prevalent in the wild, leading to self-sustaining populations that are now causing extinction of species around the world (Dorph et al., 2024). To mitigate against feral domestic cats, a cat hunting competition was organised in North Canterbury, New Zealand; young school-aged children were encouraged to shoot feral cats and rewarded with cash if they bagged a haul. However, the competition was reorganised to exclude children under 14 years old after backlash from the wider New Zealand community about the effects of encouraging children to kill (Clark, 2023). While possums and feral cats are regarded as pest animals in New Zealand, the gruesome, macabre acts condoned by parents and teachers at fundraising events are not supported by invasive animal management authorities. It can be said that a lack of education about invasive species management has led to confusion amongst impressionable young people and those with responsibilities for them about the appropriateness of different pest management techniques. Considering this, biosecurity education may help young people make up their own minds about how they can support biosecurity measures in New Zealand.

Biosecurity education in schools

Published research about biosecurity education happening in schools in New Zealand is scant. One space for such education is within the Enviroschools programme, an initiative supported by regional councils that champions sustainable living practices with primary and intermediate school age students (Enviroschools, 2017). Another programme that can support biosecurity education in schools is outdoor education, which has been part of New Zealand school education for over 150 years (Lynch, 1999), although best practice and the concept of outdoor education in schools can be vague in relation to the NZC (Remington & Legge, 2017). Education for Sustainability (EfS) offers yet another platform from which biosecurity could be taught in schools. EfS is a thread that runs across the eight learning areas of the NZC (Ministry of Education, 2007) and offers teachers an opportunity to include biosecurity contextually in any learning area. EfS is based on an approach that aims to engender environmental action competence in young people (Morgensen & Schnack, 2010). However, Parry and Metzgar (2023) posit that many teachers struggle with the interdisciplinary nature of sustainability and feel ill-equipped in both content knowledge and student-centred teaching approaches to effectively deliver EfS to students.

Social construction of knowledge (Adams, 2006) that aims for transformative learning provides a solid base from which biosecurity issues can be explored in the classroom. A knowledge rich curriculum will provide students with a conceptual understanding of biosecurity The use of critical pedagogy can help young people identify and critique power structures that influence biosecurity policies in society, including non-government organisations (NGOs) like Predator Free New Zealand. A critical approach to biosecurity education would allow approaches such as poisoning, shooting, and trapping techniques to be critiqued, along with critiquing how animal labels are used; for example, labelling animals as alien, unwanted and/or exotic.

Ultimately, as the next generation that will take-up the bastion of conservation and protecting biodiversity as well as protecting the valuable primary industry, young people must be given the opportunity to understand the need for biosecurity education and actively participate in the implementation of biosecurity initiatives. This is vitally important given, as reported earlier, research has found that 88% of 1,150 people surveyed perceived that they played no role in maintaining biosecurity in New Zealand (Colmar Brunton, 2018).

Conclusion

Biosecurity represents a very real risk to people, the environment, society, and the economy of New Zealand. The risks, and consequently the need to mitigate them, have been accelerated through developments in globalisation of trade and travel.

Biosecurity policies in New Zealand are extensive and in place to not only stop but also control plant, animal, and harmful microorganism pests present in New Zealand (New Zealand Biosecurity Institute, 2020). With more initiatives that address emerging threats brought on by climate change and free trade global agreements being put in-place, such as that with the European Union that comes into effect from 2024 (New Zealand Foreign Affairs and Trade, 2024), additional strategies to manage biosecurity are needed.

The first strategic point in New Zealand's "Biosecurity 2025 Direction Statement" is to have everybody living in New Zealand to become a "biosecurity risk manager" (MPI, 2016a). For this to be enacted, methods to inform people about biosecurity are needed. Biosecurity education could be a major tool to involve everybody in New Zealand in managing biosecurity risk. Biosecurity education in schools can help young people better understand biosecurity from a regional, national, and global perspective. A conceptual understanding of biosecurity is an important contributor to the vision of everyone in New Zealand becoming a "biosecurity risk manager".

A transformation in thinking about biosecurity responsibilities could lead to better engagement with biosecurity initiatives. It can also lead to young people questioning accepted discourse about biosecurity and problematising solutions offered by organisations for managing biosecurity and, where practicable, offer solutions (Sass et al., 2020; Eames, 2009; Greene, 2001). Transformative learning can become a powerful motivator for young people to seek more knowledge about biosecurity issues they become passionate about and lead to relevant action to mitigate it.

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