BIOSECURITY AND EXOTIC PESTS

BIOSECURITY IN THE BIOPROTECTION CONTINUUM: THE COMPLEXITIES FOR PASTURE

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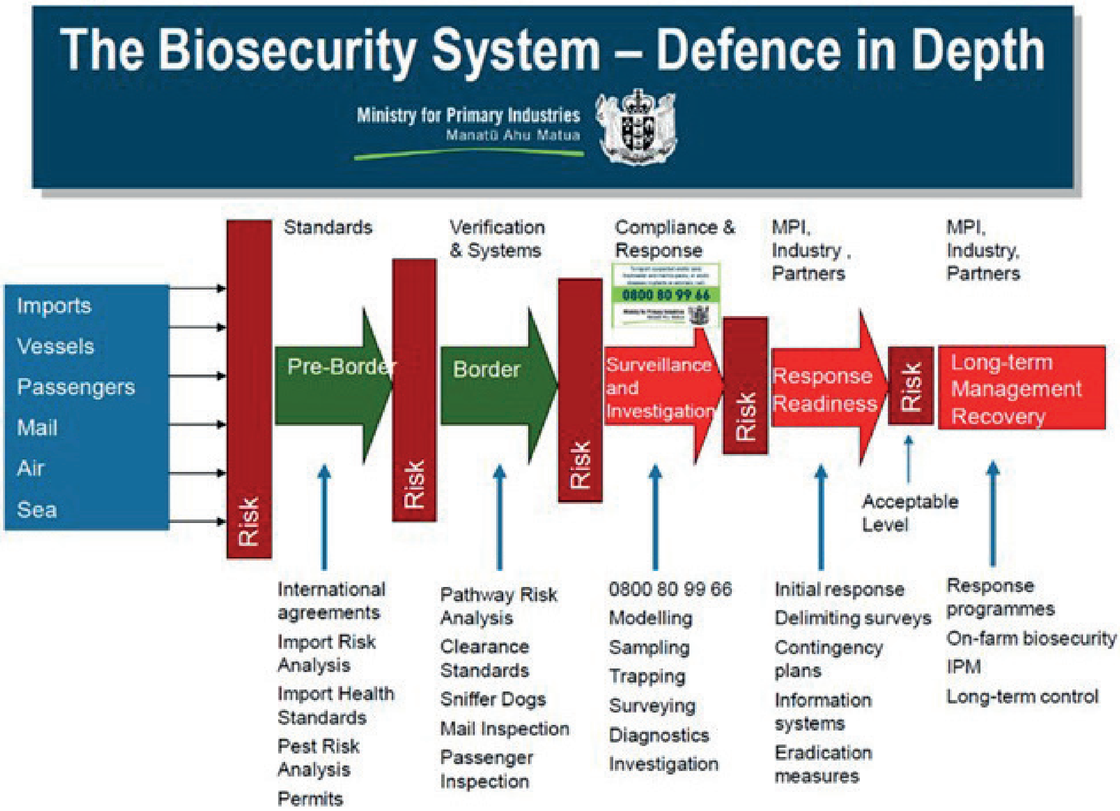
Introduction

The most effective biosecurity strategy for natural and productive ecosystems is to prevent establishment of pests and diseases at the outset. This requires effective pre- and at-border interventions. Well-developed biosecurity systems consist of a series of activities designed to sequentially reduce risk. As a continuum, they entail offshore risk assessments, pathway risk management, early detection and diagnosis, post-border surveillance and finally eradication (Figure 1, B. Gould personal communication). The last resort, eradication, is expensive and most uncertain. Failing that long-term management solutions have to be sought.

Early intervention is indeed feasible for many sectors. This applies particularly to pests of plants that in themselves are of high economic or social value, such as cereal, horticultural and forestry species. Pests associated with such plant species are typically restricted to their host plants, which are themselves of restricted distribution (e.g. orchards) both at- and post-border. They are also commonly located above-ground. Consequently, systems for surveillance and detection through to eradication can be usefully designed.

None of this translates particularly well to pasture plants and their pests. This review considers why that is so. Those characteristics that make improved pastures vulnerable to pest attack, particularly in New Zealand, and the concomitant challenges for development of effective biosecurity measures, pre- to post-border are examined. Attention is drawn to exotic invertebrate threat species that would place added pressure on pastoral sectors honed for high production, and also to the opportunities for avoiding that through enhanced biosecurity efforts.

Figure 1.
Key activities undertaken across the biosecurity system in New Zealand to reduce the risk of invasive pest species impacts on plants, animals and the environment.



Impediments of pasture to preventative biosecurity

Composed principally of ryegrass (*Lolium* spp.) and clover (*Trifolium* spp.) improved pasture landscapes are characterised by low plant diversity, low diversity of indigenous invertebrate predators and parasitoids, minimal niche competition and lack of refugia (e.g. Goldson et al., 2014). These attributes result in an extremely invasible ecosystem with little biotic resistance. Consequently, species of minor or nil damage potential elsewhere can create severe pest problems in New Zealand pastures. The risk from such species is extremely hard to predict. They also often arrive as hitchhikers and, as such, pathways are difficult to define or monitor. Therefore readiness for their invasion is problematic. Compounding this, the openness and expansiveness of the pastoral ecosystem make the presence of newly introduced insect species, including airborne adults, difficult targets for surveillance. This is exacerbated by the largely subterranean habit and cryptic morphology of the damaging immature life stages of some damaging species making them difficult to detect. Thus active surveillance systems become less feasible than for other sectors where product-associated pathways are easier to define. Perhaps unique to pasture is the fact that, although pasture plants underpin a significant economic sector, the plants in themselves are of low value and little aesthetic interest. Essentially little attention is paid to their condition *per se*, so by the time damage is noticed as caused by something other than poor environmental conditions or pasture mismanagement, the pest can be well established. Eradication is rarely an option, not least because of the persistence of fossorial life stages. Ultimately, to prevent establishment is difficult, apart from some seed treatments available at sowing, as protection using pesticides is impractical because of the sheer area and costs involved.

Pest threats

Generally, there is sparse mention of pest threats to rangeland, meadows or improved pasture beyond species currently present (e.g. Moot et al., 2009). In New Zealand, however, the potentially serious consequences of increased pest pressure on the sector and the national economy has been recognised. Effort has therefore been made to identify new hazards (Toy, 2013). Different methods, that combine current knowledge of impacts on pasture plant species with potential entry pathways plus likelihood of establishment and predicted impact, have resulted in several exotic insect species being evaluated as high hazard. Of these the largest group were Coleoptera (beetles and weevils). Interestingly, while hazard is not the only element of risk (Toy, 2013), this is consistent with the trend of pasture pest invasion to New Zealand apparent since the 1920s. Increased movement of people, animal feed and modern machinery since that time has resulted in arrival of nine highly damaging species, five of which are Coleoptera. All are likely to have arrived as hitchhikers as no identifiable pathway has ever been established. The pressure imposed by hitchhiker pathways is also unlikely to diminish with arrival now each year of 600,000 containers, 90,000 used vehicles and machinery and 17,000,000 tonnes of cargo.

Oversight in threat assessments are of course unavoidable due to inevitable knowledge gaps about species that present low or no pest profile. For instance root-feeding scarab beetles and weevils could be an obvious group to consider according to the assessment above. Unfortunately, as an example, while all *Sitona* (Curculionidae) weevils feed on legumes (Fabaceae), and some such as *S. discoideus* and *S. obsoletus* in New Zealand have become serious adventive pests of pasture, the large majority of the c.100 *Sitona* species have low or no pest status in their native ranges (Velázquez de Castro et al., 2007). Therefore where to focus attention is difficult to decide.

Prospects for improved pasture biosecurity

Given the nature of challenge, significant step-changes in pasture-targeted biosecurity are unlikely. Nevertheless opportunities do exist. Building on initiatives developed elsewhere for pests of a range of sectors may be the most effective strategy in the medium term. Preparedness could be improved by incorporating of knowledge of insects with potential pasture pest characteristics on the various pest lists and databases, or participation in off-shore sentinel plant initiatives (http://www.plantsentinel.org/). Generic pre- and at-border intervention methodologies being implemented for dealing with imported plant material and inanimate objects are also relevant to surveillance for pasture pests (Clark, 2013). For *Sitona* species, acknowledged as a group of particular concern, enhanced detection may be feasible through existing pheromone trap technology (Toshova et al., 2009). Social tactics to increase industry and farmer awareness are also being realised as a valuable near-term surveillance and response strategy. To this end, the recent impact of clover root weevil (*S. obsoletus*) in the south of New Zealand has usefully raised sector awareness of the need for biosecurity vigilance and response (Basse et al., 2015).

Technologies on the horizon could also be beneficially targeted. For example, current research into insect volatile organic compounds in confined spaces such as containers, building on the founding work of More et al. (2007), could improve at-border detection. Metapopulation modelling exploiting improved knowledge of pest population biology, dynamics and dispersal (Parry et al., 2013) could permit more relevant pasture surveillance systems to be developed. Remote sensing, for example by hyperspectral imaging, has obvious advantages for scanning large areas such as pasture for early signs of plant damage. This has shown some potential for detection of cockchafers (Cosby et al., 2013), although difficulties distinguishing that from disease or grazing damage could be problematic. Conversely, development of rapid in-field molecular diagnostic methods such as LAMP (e.g. Hsieh et al., 2012) are entirely possible for high risk pasture pest species and should be encouraged. In the future, smarter approaches to eradication may also be possible through gene-editing techniques which have shown potential to cause huge reductions in pest populations (Burt, 2014).

Beyond this, targeted post-border approaches to prevent establishment via 'pest-proofing' of pastures will remain an important strategy. This could be realised through plant diversification to break population cycles, improve resilience and enhance existing generic biocontrols, as well as manipulating soil microbiology and cultivar genetics for insect herbivore resistance.

Conclusion

Without further innovation the relatively limited opportunity to implement biosecurity measures in New Zealand's broad acre pasture is likely to continue. The consequences of this threatens to result in an accumulating guild of damaging species, adding to the ever increasing stressors of intensification and climate uncertainty on the pastoral sector. Mindfulness and potential adoption of generic approaches and technologies developed for pests of other sectors will likely serve as the most effective improvement to biosecurity for pasture.

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