# Impacts of invasion on community structure: habitat and invertebrate assemblage responses to *Calluna vulgaris* (L.) Hull invasion, in Tongariro National Park, New Zealand

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## ABSTRACT

Invasion ecology, disturbance and successional ecology, and conservation biology are four areas of increasingly realised importance in the maintenance and understanding of the world's remaining 'natural' ecosystems. The impacts of biological invasions and the role of physical disturbance on whole communities is difficult to comprehensively study, but can often be best viewed via invertebrate assemblages and their plant habitats. In this thesis I have taken the opportunity to study these concepts in an area where conservation is of national importance, Tongariro National Park (New Zealand). The Park, for the last 80 years, has and is, suffering from invasion by *Calluna vulgaris* (European heather), which radically changes the plant composition of many of the landscapes in the Park and thus the resource base of the invertebrate communities. This is a community-based study focusing on the structures of invertebrate assemblages, their ability to adapt and be resilient in relation to their changing habitat and resources. It primarily compares features between invaded (disturbed) and 'normal' communities (i.e: their structures, adaptations/impacts caused by the invader, and community cohesiveness before and after invasion).

The vegetation composition was investigated in a range of selected communities of lowland tussock grassland and heathlands in Tongariro National Park, Central North Island, New Zealand. These varied in their developmental history and conspicuous native species. Sites were partnered with adjacent communities of comparable composition, but invaded by *Calluna vulgaris*. Ecosystem resources were measured through attributes of the invader such as biomass, mineral content, and architectural complexity, and were compared with conspicuous indigenous shrubs. Pair-wise comparisons of uninvaded and invaded communities showed that species richness changed very little with invasion, although the percent cover of the conspicuous indigenous component declined from 90% to 40%. *Calluna* was found to add architectural complexity to the indigenous plant communities, many features of which may provide novel invertebrate living space. I conclude that *Calluna* has modified the indigenous communities, lowering the obviousness of indigenous plants, and providing a structural form that occupies a greater volume of space with stem and foliage than the indigenous shrubs.

To ascertain if invasion and dominance by *Calluna* caused local extinctions, reductions, or other modifications to indigenous invertebrate fauna, the impact on the invertebrate assemblages in the invaded indigenous vegetation habitats was explored and compared to similar, uninvaded, habitats. Basic descriptive statistics are presented for each assemblage and compared, as are diversity measures, abundance distributions, and feeding guilds. Cluster analysis and ordinations are used to illustrate the assemblage groupings. Seasonal variation is briefly examined, as are relationships with plant architecture, nitrogen levels, and successional rank of the habitats (vegetation resource). The tussock grasslands and flax wetland assemblages in particular appeared to lose their original 'character' after invasion. The phytophagous group, Homoptera, had noticeably greater abundance in summer and

spring in tussock and manuka habitats than their partnered invaded habitats. There are positive correlations of abundance with plant architecture and successional rank. None of the taxa caught were recognised as exotic, implying *Calluna* has not provided a resource for exotic invertebrate species. Tongariro's *Calluna* fauna has not nearly the number of herbivores and associated invertebrates as seen in Europe, implying 'free niche space'. The changes found in this study appear subtle, and in line with successional changes that one might expect normally from an indigenous successional progression.

Feeding on *Calluna* by some native invertebrates was seen to be possible, and does impact on *Calluna* performance, but this is unlikely to cause interference to the proposed biological control agent. Laboratory trials were done involving two prominent herbivores (alpine grasshopper (*Sigaus piliferus*) and manuka beetle (*Pyronota festiva*)). Their performance (weight change), preference for, consumption of, and damage to, *Calluna* was measured and compared to that of indigenous food plants, *Hebe stricta* and two varieties of manuka (*Leptospermum scoparum*). It was obvious that there are some native fauna able to incorporate new hosts, but there is still a large food resource (ie.*Calluna*) under-utilised. The two herbivores are estimated to consume ~ 0.6 to 3 % of a year's *Calluna* shoot crop. Addition of the biological control agent (a Chrysomelid beetle: *Loachmaea suturalis*) is predicted to increase this figure to around 20 % and though this figure is below suggested herbivory levels that cause serious damage to *Calluna*, prolonged damage at this level in combination with the climate at the Park may result in control of *Calluna*.

Browse impacts were manipulated in field experiments where areas of *Calluna* had either their roots protected from insect attack (using insecticide granules) or the entire plant protected (through the use of a systemic insecticide). An additional treatment simulated the damage level expected by a large population of the prospective biological control agent. These exclusion trials showed that shoots in the protected treatment grew more than the control shoots, though the difference was not statistically significant (C.I. 95%). Defoliating *Calluna*, to simulate the potential biocontrol agent's damage, resulted in a positive growth response.

Measuring the effects of physical disturbance, not the ability to resist (withstand) a disturbance, but the ability to recover from a disturbance, and thus the ability of a community to persist, either as the original or as a new entity, informs us of the 'character' of a community and its likely responses to future disturbances. Two communities were chosen as being the most important in the Park: one, the most vulnerable, tussock grassland, and the other, the problem, *Calluna* heathland. Measures of community complexity, resilience, persistence, and consistency (i.e. fidelity) in these two assemblages allowed insight into assemblage stability of invaded and indigenous invertebrate assemblages. The measures involved assessments of the rate of return and the composition of returning fauna after an applied disturbance. Complexity based on number of species, connectence (food web links), and evenness of abundance in feeding guilds was greatest in *Calluna* heathland invertebrate assemblages. Resilience, the time taken for the return to a similar 'functional' state, was fastest in *Calluna* heathlands. Consistency, the adherence of the returning taxa to the original composition, was best in tussock grasslands. The evidence suggests that the strategy of 'survival' of the tussock grassland's invertebrate assemblage leans more towards resistance than resilience, though resistance was not tested. The community found on *Calluna* appears more 'plastic' (capable of rapid restructuring) than the tussock grassland.

No local extinctions were recognised in this study; the bio-diversity remained relatively constant. The 'new' assemblages were still indigenous and may be viewed as assemblages that represent a successional stage similar to native heathlands (*Dracophyllum* and manuka serial stages), indicating that the natural processes continue. Differences were found, but it is my belief that the differences are not, for conservation (in an ecosystem sense), significant. The key features are, that the indigenous 'integrity' is still intact, and that stability (i.e. maintenance of an ecologically functioning community) and persistence is, if anything, better. However, if *Calluna* continues to spread, the mosaic of habitats that now exist may disappear; then so too will elements of the invertebrate fauna, resulting in a decline in species diversity with flow-on effects to the ecosystem. Conservation of biological diversity, *per se*, is less successful in the long term than protection of native ecosystems, indigenous processes, and natural landscapes. By protecting these structures (habitat diversity) the components, and processes within, will also continue to exist.