Developing a better understanding of *Hieracium* invasion in the New Zealand high country: a participatory approach

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Abstract

Given the complexity and different social perceptions surrounding many resource management issues, the challenge facing science is to develop understanding, knowledge and learning environments to better inform and support decision-makers. This paper describes one such cooperative research initiative designed to address an invasive weed problem (*Hieracium* spp.) in the tussock grasslands of the South Island high country. The cooperative and integrated process combines knowledge from both farmer experience and conventional science to provide relevant and practical strategies for action. Resulting strategies are described, and their potential and limitations within overall pastoral system approaches are discussed. The benefits of this approach for both scientists and farmers are outlined.

Keywords: community-based research, hawkweed invasion, high country, Integrated Systems for Knowledge Management, tussock grasslands

Introduction

Over the past four decades *Hieracium* species have spread significantly throughout much of the high country, and appear likely to continue to increase at the expense of both native biota and introduced forage species (Scott 1984). They are most common on pastoral lands, and have a detrimental impact on farming enterprises through an associated decrease in productive capacity. Conservation values are threatened in a similar manner.

There have been no clear explanations to account for the dramatic increase in *Hieracium* species over recent years. The two major explanations offered by scientific opinion for the increase in *Hieracium pilosella*, the most widespread species, appear to be in conflict. One explanation focuses on its aggressiveness as an invader, the other sees it as directly related to the degree of degradation caused by such pastoral impacts as grazing or fire (Rose *et al.* 1992, 1996; Treskonova 1991). The farming community was also divided and disturbed by the causes of invasion, the first explanation offering little hope and the second seeming to point the blame at current pastoral practices. These conflicting viewpoints made it difficult to identify possible solutions to the problem.

Against this background, it was evident that a new approach was required to deal with the challenges that *Hieracium* posed to sustainable land management. Such an approach required a greater emphasis on linking research with management and policy, and on maximising the use of current community knowledge. This was achieved through a participatory research initiative which allowed land managers to become directly involved in the research process (Bosch *et al.* 1996).The programme was developed and managed by a steering group of three scientists and three farmers.

Programme development

The Integrated Systems for Knowledge Management (ISKM) process (Allen *et al.* 1995; Bosch *et al.* 1996) was used to meet the requirements outlined above. This participatory approach was developed during the course of the HMP and builds on principles and concepts of experiential learning and systems thinking.

ISKM is a cyclical and highly iterative process, and can be viewed as having four main steps (Figure 1).

This paper reports on the first phase of the research (steps 1 to 3), which has been completed. This has set a base from which to establish the subsequent process of active adaptive management and ongoing feedback (step 4) outlined later.

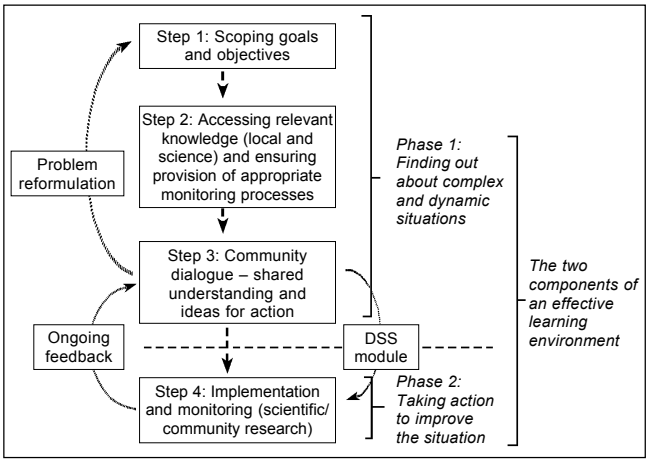
Scoping and problem formulation

An initial workshop was held which involved farmers, scientists and agency personnel. Outcomes highlighted the need to treat *Hieracium* as an important part of the

wider, more complex difficulties facing sustainable pastoral management in the high country.

Accordingly, management objectives were not focused on *Hieracium* itself. Farmers defined their goals in practical terms: how best to manage their vegetation to maximise the availability of palatable species for production purposes. This was to be done through increasing the proportion of palatable species, and reducing or controlling the rate of *Hieracium* invasion.

Figure 1 ISKM – a participatory research framework to help identify and introduce more sustainable land management practices.



Accessing available information

This emphasis on problem formulation ensures a focus on the collation and development of "relevant" information and data, from both the science and local communities. Local land managers' experience was obtained through 31 interviews and more than 300 comprehensive mail questionnaires. The farmers chosen were representative of the nine high country regions identified by Bussieres & O'Connor (1983). The interviews were carried out using a semi-structured format which enabled farmers to provide information on all the main management activities related to their enterprises. The questionnaires focused more directly on farmers' perceptions of the ecology and management of the *Hieracium* species.

Management strategies that farmers believe effective for reducing or minimising the spread of *Hieracium* were subsequently derived from this information, along with the considerations involved in implementing them.

A summary of these farmer-derived strategies was used as a framework to collate and synthesise relevant science information. A group of scientists conducted a literature survey of current available conventional science to assess to what degree the strategies were corroborated, modified or contested by the scientific record (O'Connor & Duncan 1996). Additional, sometimes unpublished, information was obtained through personal interviews with scientists currently involved in *Hieracium* research.

Community dialogue

Given the complexity and different perceptions that surround the *Hieracium* problem, the next essential step was actively to support improved communication flows among those involved to develop the "useful knowledge" needed for practical decision support. Farmer–scientist workshops were held at several locations throughout the high country to seek active co-operation in developing a common understanding of the context in which any individual piece of information becomes relevant.

A decision tree framework was used to site how individual pieces of information linked together. This framework helped participants collectively define goals and management targets, the strategies to achieve these targets, and which factors to take into account (situations where strategies would be applicable).

Outcomes of information exchange and dialogue

The main outcomes of these workshops were a shared understanding of the main ecological factors and the management implications that arise from these. The factors included: (i) differences among *Hieracium* species in distribution; (ii) differences between some *Hieracium* species in their interaction with grazing; (iii) the general pattern of historical influence of pastoralism on tussock grassland structure and their susceptibility to *Hieracium* invasion; and (iv) the stage of invasion of *Hieracium*. The focus of this phase of the HMP and the discussion which follows is largely on the unimproved tussock grasslands. It concentrates further on the ecology and management of *H. pilosella*, the most common species to occur on 83 percent of the properties surveyed.

Ecological factors: *Hieracium* species, invasion stages, and tussock grassland dynamics

Four principal *Hieracium* species have been identified: *H. pilosella, H. lepidulum, H. praealtum* and *H. caespotosum*. At present there is little understanding of why these four species differ in their current regional

distribution. What is known about the relationships of the *Hieracium* species with environmental and management factors, is best illustrated by reference to *H. pilosella.* This species is a strongly stoloniferous perennial herb with a ratio of root biomass to top biomass which often exceeds 5:1, and exhibits its most expansive and dominant behaviour in the tussock grasslands used for pastoral farming (600–1000 mm rainfall zone). The leaves sit close to the ground and so are less readily grazed by livestock than other species, while its flower-heads and stems are accessible to stock and readily eaten.

In developing management strategies to reduce or avoid *Hieracium* invasion it became clear that the amount of *Hieracium* currently present in any particular area is an important factor to be considered. The problem was that individual descriptions of *Hieracium* spread and abundance differed according to plant communities. Rephrasing this question to account for the "stage of invasion" rather than "spread and abundance" provided all those involved with a common concept (language) applicable to *Hieracium* dynamics in most plant communities.

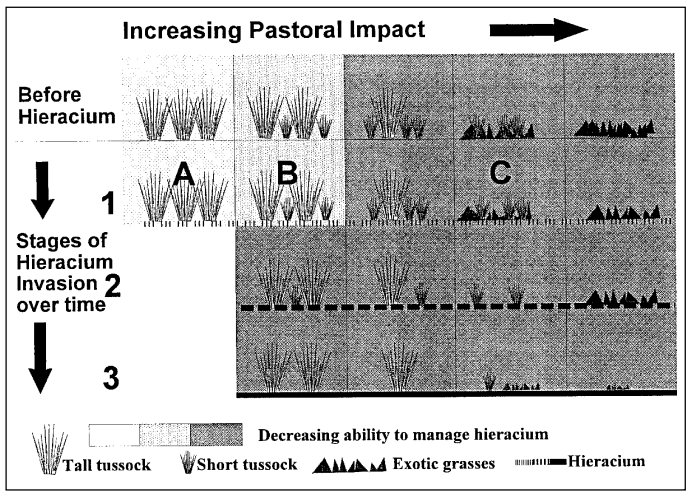
The pattern of *Hieracium* invasion is similar to that of most invader species, and can be thought of as comprising three stages. During stage 1 the invader initially enters the new habitat and is present at low levels. The second stage is characterised by a rapid increase in invader abundance, and is triggered in the tussock grasslands by an opening up of the plant community or an increased instability in the system (e.g., development of short tussock communities). The third stage is reached when the abundance of the invader no longer increases, but exerts dominance on the plant community.

Although the third stage implies a complete dominance of *Hieracium*, it must be recognised that environmental factors (soil type, rainfall zone, etc.) will affect the dynamics of the vegetation, and therefore the relative abundance at which stability occurs.

Developing a shared understanding of the dynamics of tussock grassland vegetation was made possible by developing a series of simple "pictures". Combining these with the stage of invasion integrates our understanding of vegetation dynamics in several dimensions (Figure 2).

From left to right, the composition of tussock grasslands is represented as it would have changed under the impact of historical pastoral practices (Connor 1964; Gibson & Bosch 1996). This can be summarised as successive downward steps from tall tussock grasslands (vegetation state A) through mixed (B) and short tussock grasslands to weed communities (C). *Hieracium* invasion adds another dimension to the picture. While low incidences of *H. pilosella* (the first stage of invasion) can occur in all these states, the second and third stages are more likely to develop in the more modified communities characterised by a high proportion of short tussocks and/or exotic grasses.

Figure 2 Pictorial model of vegetation change in unimproved tussock grasslands indicating the stages of *Hieracium pilosella* invasion in different vegetation states.



Management implications:

State A

Although the intact tall tussock communities of this state are relatively rare in the high country, especially at lower altitudes, they appear to be the most resistant to *H. pilosella* invasion. Based on field studies and observation it appears that *H. pilosella* invasion of these plant communities may not progress beyond the first stage. There appears to be general agreement to minimise disturbance through grazing or burning in order to retain or enhance this type of vegetation.

State B

In communities where *H. pilosella* is absent, or present in low numbers (stage 1), the removal of grazing pressure may result in a predominantly tall tussock community (State A). Where these grasslands are used for production purposes, and *H. pilosella* is present in low numbers, it was suggested that grazing during flowering can reduce the numbers of seed-heads. However, whether *H.*

pilosella is present or not, workshop participants stressed the importance of appropriate management to ensure the balance of the vegetation is not opened up through disturbance. There was total agreement that this requires light grazing.

It was further acknowledged that there are a number of considerations for such a grazing strategy to be practical. In many cases subdivision would be required to provide the level of stock control necessary. Land managers need to adopt a deliberate strategy to maintain appropriate stock classes (e.g., wethers) that can be run on this type of country from early summer. These issues highlight the balance between ecologically sound and economically viable systems required for the sustainable use of undeveloped tussock grasslands.

State C

In areas where tussock cover has disappeared and *H. pilosella* is already highly visible and dominant there is general agreement that this land has no pastoral productive value. Although the comment is often made that the presence of *H. pilosella* in these conditions has a useful conservation benefit for the protection of soil and water, there appears to be some evidence that these soils may be still erosion prone. This seems to be especially true for areas where frost heave occurs. In terms of restoration options it was also recognised that grazing management will have no effect on *H. pilosella* in stages 2 and 3 of invasion. There are a number of development options which can replace these *H. pilosella* dominant communities with other, more productive pastoral systems. Other possible options include alternative land uses such as forestry and tourism.

In contrast, where short tussock cover is still the dominant vegetation and *H. pilosella* is only in the first stage of invasion, management becomes more critical. Although these communities are at risk from rapid invasion, it appears possible that with careful management they may be maintained in this condition for long periods of time. The most likely strategy suggested was light grazing over the flowering period to reduce seed production, while not overgrazing the balance of vegetation. The relative instability of these induced short tussock grasslands implies that summer grazing of these grasslands may well disappear over the next couple of decades.

The ongoing process

If the Hieracium Management Programme were to finish at this point it would only have achieved the development of some workable hypotheses. The ISKM approach recognises this, and has been designed so that this first phase (Figure 1) forms a base for an ongoing process of monitoring, adaptive management and critical reflection (learning by doing). As land managers measure the outcomes of their management they continually gain new "experimental results". These results will provide new information that, in collaboration with scientists and other stakeholders, will re-evaluate and expand the community-derived knowledge base developed through the third step of the ISKM process .

As demonstrated above, this ongoing community dialogue provides all those directly involved with an environment in which "useful knowledge" is developed. This knowledge must be used to benefit all those who have not been directly involved. Where appropriate this can be done through a range of presentation techniques such as manuals, posters or decision trees on paper. However, to help deal with the complexity in environmental decision-making, computer-based decision support systems are not only appropriate in many cases, but essential. The prototyping approach inherent in the ISKM framework encourages an interactive process where DSS developers and users collaboratively discover new requirements and refinements that are then incorporated in succeeding versions.

Further information will also become available through the range of ongoing research initiatives in the high country. Knowledge gaps identified during the workshops include the need to develop low input, cost effective development options, greater understanding of the effect of grazing strategies on *Hieracium* dynamics, and the role of burning on *Hieracium* spread.

Despite a growing acknowledgement that integrated, participatory processes are needed to address natural resource issues successfully, the development of this programme has highlighted the lack of appropriate methodologies and guidance to involve the community. A high priority should therefore be placed on continuing action research initiatives to develop an understanding of such processes.

Concluding remarks

This paper has outlined how the ISKM framework has been used to help the community find practical land management strategies to address the problem of *H. pilosella*. However, as this approach has been used to look at the problem from the point of view of management, it has also served to highlight how ecological, social and economic issues are inexorably linked. No one manages for *H. pilosella* alone: farmers are primarily concerned with managing for increased stock production or available forage supply. As farmers shared this information with researchers through the HMP, they also pointed out the links between the long-

term achievement of production goals and wider issues such as watershed and landscape management. Accordingly, the ISKM process is now being used in the high country to address related issues such as conservation, grazing management, burning and water quality.

Participatory research offers an educational experience that serves to determine community needs, as well as motivate commitment to the solution of community-specific problems. Providing greater understanding of the system helps the community adapt to change, and can also help determine what components are most affected by change, to target research priorities better. In turn, this understanding allows the scientist to shift from a reactive to a proactive position. Participatory research, therefore, places new demands on individual land managers, the community and science.

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