Dryland Intermediate Outcome Newsletter #5
March 2008

The summer months have been busy and productive. But in the last 6 months we also met the inevitable funding wall – our resources are declining in real terms as chargeout rates and operating costs increase. So, just as we begin to find our feet and learn some interesting stuff, we also have to prioritise more carefully and cut back on our ambitions. The good news is that our direct cofunding and aligned funding continues to help out – we mention some aligned projects in this newsletter. We also report on progress in, and lessons learned from, our experimental work, plans for future experimental work, and preliminary results from our biodiversity surveys across varying amounts of woody vegetation. But first:

****<u>We are looking for a postgraduate student to work with us on seed ecology</u>****

We would like to work with one or more MSc (or PhD) students on the seed (and seedling) ecology of dryland indigenous woody plants. If you know of a keen and energetic ecology student looking for a challenge, please let us know or put them in touch with us.

Delicate helping hands in our experiments this spring: Maia Mistral, Dean Richards and Rebecca Lawrence.

Strand 1: Succession to native woody communities

In September and November IO researchers met with DOC Conservancy and Area technical staff to elicit feedback on the working experimental plan we mentioned in the last newsletter. The plan describes the rationale for our chosen approach, the contexts we will work in, and planned experiments. DOC's feedback endorsed the overall direction we plan to take, and provided many helpful suggestions on specific issues and planned experiments. We will keep the plan a working document. We promised to reveal more in this newsletter and here it is.

Rationale and aims

In drylands, we see the short- to medium-term seed and seedling *establishment* phase as critical to successful woody restoration, and the point where management intervention is most likely to be required. This phase is not well catered for by existing understanding and models, and is where we will place most of our effort.

Our first aim in Strand 1 is therefore:

1) To identify and quantify the major limitations of indigenous woody species establishment in drylands.

We will focus our attention first on those factors with the largest expected effect size – namely the seed/seedling ecologies of the species, climate/soils, competition and herbivory.

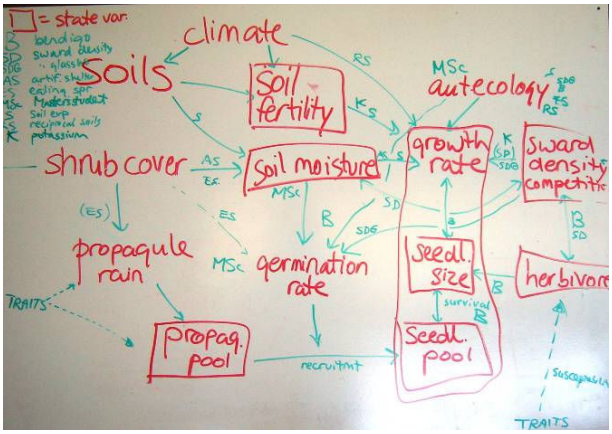
We believe we have to understand limitations *before* we can develop management tools to facilitate establishment. In some instances and where possible, we will use potential low-intensity management tools to manipulate the environment (in which case tool development and identification of limitations will proceed in parallel), but this will often not be the case.

Therefore, a secondary aim is:

2) To develop and test practical low-intensity management interventions that ameliorate the limitations identified in 1.

Our third and ultimate goal is:

3) To parameterise a model that will allow us to predict the likelihood of successful establishment at a given site, for a particular suite of species, given a set of management interventions.



This step sounds quite pointy-headed (and looks it, see the whiteboard draft at right!) but is just an explicit, useful way to organise understanding about what factors affect what, and information from our experiments on how much they matter. Ultimately the model will help us predict where and what management tools will and won't lead to successful woody seedling establishment. But we are beginning to develop the model *now* (ahead of testing management interventions). This is because the model and experiments are a chicken and egg scenario: experiments inform the model, but we need to ensure we collect the data in such a way that it is usable in a model – in other words, so it can help us predict outcomes. We anticipate the formulation of our model will evolve according to the discoveries in our research.

There are existing suitable models to predict vegetation trajectories into the distant future that could be adapted to include dryland species (e.g. LINKNZ, Hall & Hollinger 2000[1]). This frees us up to focus on the establishment information gap.

Contexts

As mentioned in the last newsletter, we plan to work in three contexts where information on establishing indigenous woody species in drylands is lacking: (1) native wood into grassland (primary woody succession); (2) native wood into exotic wood (secondary succession); and (3) native wood into primary native wood (also secondary succession). Most experiments will focus on grassland and exotic wood (1&2), and address questions about seed and seedling ecology and environmental tolerances that apply regardless of the type of vegetation woodies are establishing into. We aim to study secondary succession in native wood (3) with plot-based field survey and age-size calibrations (to work out how old woody stands are).

[1] Hall GMJ, Hollinger DY 2000. Simulating New Zealand forest dynamics with a generalized temperate forest gap model. Ecological Applications 10: 115–130.

Lessons learned so far – our pilot experiments

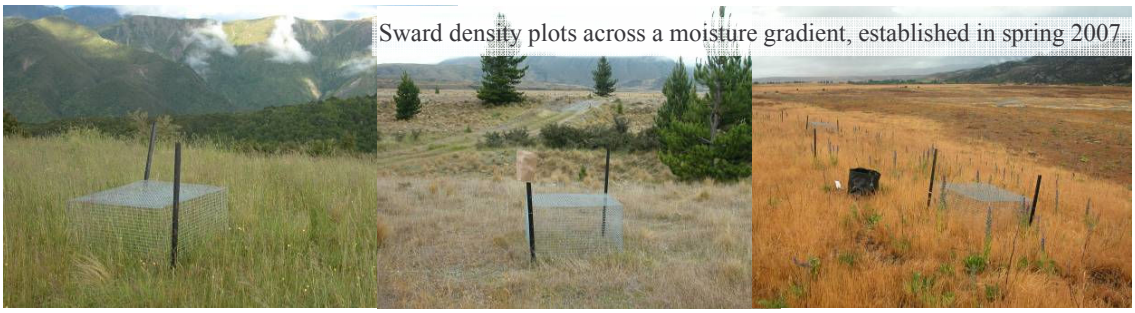
Seeds sown in the field at Bendigo resulted in complete germination failure, though three of the four species germinated enthusiastically in a Dunedin glasshouse. This was Lesson 1: Our poor understanding of seed ecology of dryland native species is a big barrier for our research, and ultimately for developing low-intensity methods to encourage native woody species back into dryland landscapes. And we'd like to work alongside a postgraduate student (or two) to make some progress in this area.

This spring we planted small (see Page 1) seedlings of the three enthusiastic germinators (kānuka, a native broom and tauhinu) into the experimental plots. Very high proportions survived transplant. Recent measurement (January) showed impressive survival where grazing and competition were both removed, but little survival with grazing and/or competition from grass swards. Lesson 2: If you want woody seedlings to survive, remove the rabbits *and* the competing sward. But (and any-old gardener *couldn't* have told us this) additional water has made no significant difference to seedling survival – at least so far. We will measure surviving seedlings in autumn to estimate growth rates. Next year we plan to repeat this with different species. We may also initiate a potassium (K) treatment as overseas experiments show K may confer drought tolerance to woody seedlings.

The pilot soils experiment asked how soil characteristics interact with moisture to affect the growth of woody seedlings (an indicator of invasion potential and competitive ability). Data analysis shows that all treatment (i.e. 14 species, 2 moisture levels and 8 soils) and interaction effects had significant effects on seedling growth! This may sound like an experimenter's dream but can be an interpretation nightmare. Nevertheless Larry Burrows and Ellen Cieraad have found some intriguing patterns. For example, seedling biomass varied across soil types, and relative ranks of exotic species were unpredictable. But the same two native species were among the top six on every soil. Any guesses which two?[2]

The sward experiment

Our 'sward experiment' asks how sward density changes across moisture and nutrient gradients with cessation of herbivory, and was established at 22 sites across rainfall gradients in Marlborough, Canterbury and Otago this spring. Treatments are ±herbivory, and ±fertilisation. We will measure species composition and sward density over time (3–4 yrs), and add seeds or plant seedlings into the developed swards in year 3.



Sward density plots across a moisture gradient, established in spring 2007.

Ealing Springs: Native woody establishment into exotic woody weeds:

Seedlings of six native species are being grown at Opuha Nursery, Geraldine, for an experiment measuring native woody species establishment as seeds (establishment) and seedlings (growth) in woody weeds (mainly broom dominant) on the Rangitata floodplain at Ealing Springs. Much of the funding for the experiment has been raised from the community

[2] The eight native species in the trial were *Carmichaelia petriei* (native broom), *Coprosma propinqua* (mingimingi), *Discaria toumatou* (matagouri), *Kunzea ericoides* (kānuka), *Olearia odorata* (tree daisy), *Ozothamnus leptophyllus* (tauhinu) and *Pittosporum tenuifolium* (kōhūhū or black matipou).

and national agency sources through the efforts of Nick Head and Kennedy Lange (DOC). An ambitious and very blokey set of replicated (3×) manipulations is planned, including spraying, machine crushing, and mulching. IO researchers have been involved in experimental design and will be helping out with measurement and analysis. The IO may expand the experiment to other sites and weeds, though probably at a more modest scale!

Larry Burrows contemplates the blokey experiments planned for Ealing Springs.

Strand 2: Biodiversity of dryland woody communities


Landcare Research
Manaaki Whenua

DISCOVERY

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Protecting a Diverse Environment

CONTENTS

This strand aims to discover what different plant communities contribute to the indigenous biodiversity of drylands. We hope to inform a vision of the types of dryland communities that could develop (with help from low-intensity management) and how they would enhance under-represented and regionally threatened elements of the 'full range' of biodiversity. We have been focusing on intensive surveys at local scales. Quantitative data for lizards, invertebrates, birds, rodents and vegetation have been collected across one-kilometre-square 'megaplots' and smaller (10 × 10 m) grids representing three stages across a gradient of woodiness. This work was given a high profile in Landcare Research's latest *Discovery* newsletter. See http://www.landcareresearch.co.nz/publications/newsletters/discovery/DiscoveryIssue20.pdf

The team completed two further surveys in dryland Otago this spring and summer (at Blackstone Hill and near Cambrians). Preliminary data analyses indicate grasslands and shrublands represent distinct assemblages of biodiversity, and that shrublands contribute distinctive and relict species (e.g. for birds, fantails, tomtits, and falcons were recorded only in woodiest sites). But even with this survey-effort intensity, we know our methods undersample (or do *not* sample) rare and woody-specialist species (e.g. arboreal geckos, shrubland and forest birds and invertebrates) and identifying ground invertebrates just to order- and family-levels (as we have done so far) will underestimate the distinctive contribution of woody communities to the total biodiversity of the area.

A further (perhaps larger) issue is how to scale up from this high-quality, site-specific information to understand how changes in woody vegetation through long-term succession might change the representation and range of biological diversity present at landscape scales. We think the time has come to address this. In the coming financial year, Deb Wilson and Grant Norbury plan to step back and shift to a broader focus: figuring out how to estimate the contribution of woody communities to the total representation of biodiversity at landscape scales. Assessing biodiversity at this scale is well outside the scope of our funding, but we will draw on existing data, perhaps supplemented with new survey. Intensive surveys in other South Island dryland regions may recommence later, depending on our information needs.

Aligned funding

Brief notes on progress in two relevant and aligned projects follow (next newsletter we will attempt updates on two more projects aligned to the IO within Landcare Research):

1) CDRP projects. The good news for the next phase of Strand 2 (above) is that a great deal of the digitised biodiversity information that exists for the South Island (including drylands) has recently been collated in two CDRP (Combined Departmental Research Pool: a FRST research fund that govermnent agencies can bid for) projects, led by Ellen Cieraad ('How much indigenous biodiversity remains on "land under indigenous vegetation"?') and Adrian Monks ('Does 'environmental representation' indicate species security?'). Ellen and Adrian recently produced contract reports on the pilot phases of their research for their central agency governance board. Contact us for pdf copies: they are well worth reading.

2) Grassland loss to intensive development. Rapid land-use intensification is evident to those who have driven or flown across South Island drylands in recent years. In Newsletter #3 we mentioned a proposal to the Miss E.L. Hellaby Indigenous Grasslands Research Trust to fund a PhD student to quantify where, and how fast, remaining grasslands are being replaced by lifestyle blocks, viticulture and irrigated pastures across eastern South Island. The application was successful, and Emily Weeks is now 6 months into her PhD, supervised by Professor Bruce Clarkson (University of Waikato), and Drs John Dymond , James Shepherd, and Susan Walker (all Landcare Research scientists).

To date, researchers have been unable to quantify these changes credibly, particularly in grasslands, because of inadequate spatial information and techniques. This has changed, suddenly. The new government-purchased SPOT satellite imagery (summer 2007/08) and preliminary ground truthing clearly shows the rapid, major changes in land use, particularly in drylands. The quality of new imagery gives us confidence that Emily can achieve her goal to quantify intensive development. In the remainder of her study, Emily will also address drivers of change, estimate and predict vulnerability of different indigenous grassland types to loss (and hence priorities for future protection), and the consequences of grassland loss for indigenous species.

Strand 3: Community and agency awareness

In Strand 3 of our IO (*community and agency awareness*) we are working to raise the profile of dryland indigenous biodiversity and to support community groups and those working with willing private landowners to achieve conservation outcomes. But even the most preliminary glance at Emily's data indicates we are losing the battle to halt the decline of indigenous biodiversity in South Island dryland ecosystems. Voluntary approaches to biodiversity protection favoured and adopted by dryland councils may be achieving some gains in some places. But these approaches appear to be making little headway against the tide of economic drivers and lifestyle choices driving clearance and fragmentation of remaining habitats for indigenous species across New Zealand drylands. In other words, the data indicate a combination of altruism, unenforceable voluntary guidelines, and vague biodiversity strategies is not sufficient to prevent acceleration of biodiversity loss in New Zealand drylands. We aim to use these new data, and reliable understanding about the impacts of current land-use trends on indigenous biodiversity (from Strand 2), to help win the mandate for central government and councils to revisit their approaches and introduce the clear rules that are needed to effectively protect indigenous biodiversity.

Other things to read

Researchers in Landcare Research, DOC and Otago University recently contributed an invited chapter[3] to an international book (currently *in press*). We will do our best to make the dryland chapter available to all once it is printed later this year, but here's a brief summary:

Our chapter highlights that (1) management approaches and efforts to restore transformed ecosystems are influenced by assumptions about their dynamics, and (2) restoration goals seeking to return modified ecosystems to desired or 'original' states may not be realisable if irreversible thresholds have been crossed. We describe pre-settlement dryland vegetation and the creation of non-forest communities; a process involving two regime shifts corresponding to two waves of human settlement that irreversibly altered flora and fauna. We argue it may be more feasible to rebuild physically and biologically complex woody communities in the inherently woody New Zealand drylands (e.g. through reduced disturbance such as control of fire) than to attempt to restore degraded unstable grasslands to the herbaceous states induced by human settlement. Based on our distributions database, we conclude the woody communities that replace current unstable grassland communities will be mixtures of native and exotic species unprecedented in ecological history, but we also show that native species may be prominent components in emerging seral woody vegetation. We conclude the opportunity to restore woody states (albeit mixtures of native and exotic species) is important for the survival and future recovery of native fauna and flora.

A recent publication that may be of interest is: Grant B. Douglas, Mike Dodd, Ian L. Power 2007. Potential of direct seeding for establishing native plants into pastoral land in New Zealand. New Zealand Journal of Ecology 31: 143–153.

Upcoming workshop

Landcare Research is hosting a Drylands Workshop at the Kingsgate Hotel, Dunedin, (just up from the Octagon) on 29 May. The focus is on multiple pest dynamics in dryland ecosystems (when, where and what combination of pest species need to be controlled for greatest conservation benefit). Dr Chris Jones is organiser-in-chief: please contact Chris (jonesc@landcareresearch.co.nz) for enquiries about the day.

Many thanks!

Again we have many people to thank for advice and logistic and practical help to the IO in the last six months. Yet again we thank DOC Central Otago Area Office, for providing accommodation for the 'dryland gradient' work at Blackstone Hill and Cambrians, and many Area Office staff for ad hoc and in-kind assistance, especially Tim Whitaker and Rob Wardle. We also thank Doug Maxwell for piloting, Chris Stowe, Robert Andrews, Brian Lemm and George Legard for setting up pitfall grids, and Ian Cooney and Thomas Murray for help with survey. Rebecca Lawrence worked with us on a summer scholarship and helped out with many and various experiments and much data entry. We also thank Maia Mistral and Dean Richards for extensive and painstaking field and lab assistance. We thank John Barkla, Mike Thorsen, Bruce McKinley, Shirley McQueen (Otago Conservancy Dunedin), Craig Wilson (Central Otago Area Office, Alexandra) Geoff Rogers and Theo Stephens (DOC RD&I, Dunedin) for helping our thinking on the Strand 1 experimental plan and on biodiversity surveys. Many LCR colleagues have assisted with aspects of the IO. Special thanks to Duane Peltzer for helpful input into our planning and for furthering our links with the 'Weeds IO'.

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[3] Susan Walker, Ellen Cieraad, Adrian Monks, Larry Burrows, Jamie Wood, Robbie Price, Geoff Rogers and Bill Lee 2008. Chapter 7: Long-term dynamics and rehabilitation of woody ecosystems in dryland South Island, New Zealand. In: Richard Hobbs and Katherine Suding (eds) New models for ecosystem dynamics and restoration. Society for Ecological Restoration in association with Island Press (in press).