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Landcare Research
Manaaki Whenua

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CEO's UPDATE

>> OCTOBER 2011 WAS A MONTH THAT WILL GO DOWN IN NEW ZEALAND SPORTING HISTORY FOR THE ALL BLACKS VICTORY, BUT ALSO IN OUR HISTORY OF NATIONAL DISASTERS.

Thankfully the Rugby World Cup wasn't one of them; but the oil spill from the ship Rena, grounded on the Astrolabe reef off Tauranga, is a tragedy for that area, the people and the ecosystem. It is good to know that we have been able to offer help to the authorities and local organisations around issues of oil contamination and impacts on birds and other fauna.

National science capability

The disasters that have beset New Zealand in the last 18 months have demanded a great diversity of skills from the science sector. It is one of the challenges of running a Crown Research Institute (CRI) that we should maintain national science capability in a wide range of disciplines in spite of the ebbs and flows of revenue from government and industry sources. The core funding that we now receive from government will be an asset in maintaining that capability. In Landcare Research's case this is 40% of our total revenue. But we will continue to face choices and the need to balance capability investment between the here-and-now priorities with the over-the-horizon predictions and opportunities that derive from foresight.

Strategic Science Advisory Panel

To help us with this task of prioritisation our Board of Directors has appointed a Strategic Science Advisory Panel. Members are Professor Jan Bebbington, St Andrews University, Scotland; Professor Mark Burgman, Melbourne University; Professor Andrew Campbell, Darwin University, Australia; Professor Mark Kibblewhite, Cranfield University, England; and Professor Basil Sharp, University of Auckland. The panel will be chaired by Professor Steve Goldson, AgResearch, New Zealand.

Science excellence

We have taken our focus on science capability and excellence one step further to create a new role of Chief Scientist, with responsibility for our scientists (of which we have around 250) and our interactions with other science providers, both in New Zealand and overseas. The inaugural Chief Scientist at Landcare Research is Dr. David Whitehead. His role is to ensure the delivery of excellent science, fit for purpose, and with seamless access to collaborators to build best teams. He will be supported by our Science Team Leaders.

Science outcomes

It has been very instructive for me to visit the World Resources Institute in Washington, DC, this month. The WRI has a global reputation for making a difference in the environmental agenda. For example, it co-developed the Greenhouse Gas Protocol, used by hundreds of organisations to assess their emissions. The WRI has a clear focus on achieving outcomes with its research; and it makes a clear distinction between its research outputs (e.g. reports and tools) and the outcomes that the WRI contributes to achieving. Outcomes may be changes in government policy or industry practice, and they have significant local or global impact in addressing environmental issues. Landcare Research, like other CRIs, is renewing its focus on outcomes and the contribution it can make through its research targets and outputs. We are pleased to be working with WRI on a number of projects including an ecosystem services assessment tool for industry.

Marsden Fund successes

It is a real pleasure to acknowledge the Marsden Fund successes of bids led by Janet Wilmshurst and Dan Tompkins. Dan will lead a project on infectious disease transmission, emergence and persistence and Janet will research plant and animal evidence for the early human colonisation of Rekohu (Chatham Islands). Marsden Fund grants are highly prized and sought after; so we were delighted to win two from three full proposals. One of our directors, Associate Professor Emily Parker, Canterbury University, was also successful in winning a Marsden grant for her work on enzymology.

This issue of Discovery looks at several research highlights from our four outcomes. We hope you enjoy.

Dr Richard Gordon
Chief Executive

LAND RESOURCES

OUTCOME: SUSTAINABLE USE OF LAND RESOURCES AND THEIR ECOSYSTEM SERVICES ACROSS CATCHMENTS AND SECTORS

Installing lysimeter casings at the large scale array near Lake Taupo.

THE FATE OF NUTRIENTS IN SOILS

We have three complementary projects focused on understanding the fate of nutrients in the soil. Understanding and quantifying of leachates are essential to managing runoff and reducing the nutrients reaching groundwater, waterways and lakes.

We have some appreciation of how different soils transmit the microbial load in dairy shed effluent applied to the soil's surface. Landcare Research produced a general map for all of New Zealand showing where soils are either 'leaky' to or retain microbes within their structure, but this map revealed a lack of knowledge about what happens in stony soils, many of which are being converted to dairying.

Standard lysimeters to measure the fate of effluent on stony soils:

Standard lysimeters – hand-carved cores of undisturbed soil in purpose-built barrels – have been collected from the Mackenzie Basin. In the laboratory, these have been irrigated with dairy effluent and artificial rainfall, and the leachate analysed for bacterial indicators.

Large scale in situ lysimeter array near Lake Taupo:

This is a more direct approach quantifying the impacts of land-use practices and amelioration treatments, such as use of biochar, on reducing nutrients entering Lake Taupo. Water in the lake is deteriorating due to nitrogen, of which 30–40% comes from pastoral farmland. Waikato Regional Council has a target of reducing manageable nitrogen entering the lake by 20%, and is exploring nitrogen trading markets as a mechanism to help achieve this.

Researcher Malcolm McLeod says cut-and-carry lucerne may be an economically viable, low-nitrogen-loss option but its effectiveness needs to be quantified. To provide these data, a specially designed and manufactured lysimeter array has been installed on the western side of Lake Taupo. Each of the 12 lysimeters contains an undisturbed 1-m-diameter soil core 1.5 m high, which weighs about 1.2 tonnes, with the surface of each planted and treated in four different combinations of lucerne, industry standard fertilisers, biochar, and ryegrass/clover. Leachate is analysed for nitrate, ammonium and phosphate. Rainfall, air temperature, soil temperature and level of leachate in the tanks are being telemetered hourly back to Landcare Research at Hamilton. The research will extend for at least three years.

Channel lysimeters: These are another innovative in situ design with the potential to provide direct feedback to farmers enabling them to modify irrigation schedules, optimising water use and minimising water leaching down into groundwater. Channel lysimeters are inserted horizontally into soil about 1.5 m below the ground surface and just above the water table.

Following a prototype developed and tested at Lincoln, four channel lysimeters have recently been installed, with Otago Regional Council

support, on two dairy farms with stony soils in Central Otago. Researcher Sam Carrick says irrigation efficiency, both in terms of water and effluent application and impact on leachates, will be monitored through summer. The lysimeters and soil moisture sensors are connected to a wireless sensor network supplying real-time data over the Internet, which will enable farmers to tune the efficiency of their irrigation systems. The data will also aid Otago Regional Council in developing policy and resource consenting, and add to research knowledge about the fate of effluent in stony soils.

S-MAP ONLINE

Researchers recently unveiled a new online tool to make it easier and more effective for land managers, business, scientists and the public to better understand the soils that underpin New Zealand's economy, land use and ecology.

S-map Online (http://smap.landcareresearch.co.nz) is a web browser service that provides easy access to information on the soils likely to be found at a location of interest. It is based on 'Google Earth' style navigation to make it easy to search, view and query, and allows users to:

- Explore interactive maps of soil properties such as soil drainage and available water
- Learn about the soil in their backyard or paddock
- View detailed information about soil classes or attributes
- Create custom PDF soil maps for printing
- Download soil factsheets that provide more detailed knowledge of soil properties for specific locations and information relevant to a variety of potential uses.

S-map Online is a digital system for providing soil spatial information. It is being populated with data to provide consistent and comprehensive national soil data layers, to support applications at local, regional and national scales. It improves on previous soil mapping, fills gaps with new mapping, and upgrades the associated soil property information to meet a new national standard.

As well as giving access to detailed soils information, the S-map Online web service has excellent, high quality base maps, including maps based on LINZ topographic data. These not only allow the user to locate an area of interest with a high degree of accuracy but also provide a geographic context for the soils data.

S-map coverage is not yet complete and work is underway to extend S-map to the Environment Waikato and Canterbury territorial areas, the soft-rock hill country in the central North Island, and parts of Northland, Gisborne, Hawke's Bay, Manawatu, Wairarapa, Golden Bay and the West Coast.

'We also have plans to further develop S-map Online so users can increase their soil knowledge and ultimately make better informed and more reliable land use decisions and we'll keep users informed of these developments,' Informatics Team Manager Dr Medyckyj-Scott says.

S-mapOnline
Fast, simple access to New Zealand soils data

Researchers Trevor Webb, Sam Carrick and Jagath Ekanayake - the team behind channel lysimeters.

SUSTAINABLE INDUSTRY

OUTCOME: NEW ZEALAND INDUSTRIES AND ORGANISATIONS HAVE INCREASED ABILITY TO DEVELOP WITHIN ENVIRONMENTAL LIMITS AND MEET MARKET AND COMMUNITY REQUIREMENTS

BEECH TIMBER PRODUCTION SYSTEMS

Almost 20 years on from legislative changes to the way indigenous beech forests are harvested, a Landcare Research review has found that, with appropriate management systems, harvesting can take place without affecting the health of remaining trees.

The review shows New Zealand has a wealth-creation opportunity through building an industry based upon the sustainable management of a portion of our 1.5 million hectares of privately owned indigenous forests, including 300,000 ha owned by Māori. However, perceived difficulties around stand stability and regeneration following harvesting have long limited the development of a beech timber industry, says Ecosystem Processes Science Team Leader, Rob Allen.

'Indigenous forestry has long been a controversial issue. A key issue is whether timber can be extracted while maintaining or even enhancing the non-extractive benefits of these forests, such as biodiversity, water quality, carbon and cultural identity,' he says.

Dr Allen assessed and summarised studies of seven trials where beech species have been harvested in accordance with 1993 legislation.

'We studied what was known about the direct influences of harvesting on tree recruitment, growth and mortality, and, where studied, on other natural values. Some general conclusions can be made about the management systems used,' Dr Allen says.

The research found that in most places beech regenerates following harvest and that residual beech stands are usually stable.

Beech trees grow slowly, and stands regenerating from past felling develop into dense even-aged thickets of saplings and pole-sized trees where individual stem diameter growth rates are in the order of 2 mm per year, with expected rotations of more than 120 years. However, beech saplings respond well when freed from neighbouring competition.

'Quantitative assessments show that, with the exception of coupes harvested in black beech, the systems have not so far dramatically impacted on residual tree mortality.'

The assessment contrasted with reviews of beech harvesting prior to 1993, where extraction intended to be low-impact caused limited regeneration and significantly elevated tree mortality.

Dr Allen says harvesting since 1993 has typically led to prolific forest regeneration at a range of locations, especially following group or coupe harvesting. The > 4 m height requirement for adjacent harvesting has often been achieved in about 10 years.

'Prolific regeneration in homogeneous patches favours the development of long clean straight trunks by natural competition but, eventually, it can lead to stagnant growth of individual trees and compromise stand stability. Thus there is currently some interest in improving tree growth and product quality through thinning and pruning the dense regenerating stands.

'So far these management systems outlined have only been assessed over a small part of the beech management cycle, and further issues will be resolved through time. For example, whether the group-selection system in red–silver beech forest, or the selection harvest in silver beech forest, will provide adequate canopy openings for a regenerative response to reach the canopy, in the face of lateral expansion of the residual tree crowns, remains unresolved.

'This could have important consequences for coexistence of canopy tree species in red–silver beech forests. Superimposing small-coupe and group management systems on relatively even-aged second-growth beech forest may well lead to some attributes of old-growth forest such as structural complexity, presence of several cohorts of trees, and variation in tree size. However, there is also some evidence that these systems create opportunities for short-lived early successional species (e.g. tree fuchsia and wineberry) rather than the late successional, shade-tolerant species often associated with old-growth forest.'

Dr Allen says that, to some degree, the varying responses to different types of management reflect the context within which the management was applied, rather than the management itself.

'For example, trees found on fertile soils, where canopies intercept much of the light, exhibit strong competition with neighbouring trees when compared with trees found on infertile soils.

GREENHOUSE GASES

OUTCOME: IMPROVED MEASUREMENT AND MITIGATION OF GREENHOUSE GAS EMISSIONS FROM THE TERRESTRIAL BIOSPHERE

MODELLING THE CARBON SINK POTENTIAL OF NEW ZEALAND'S EXOTIC FORESTS

In a significant project for Ministry of Agriculture and Fisheries, our researchers modelled wood productivity of Pinus radiata across New Zealand in response to the wide range of environmental variables that affect tree growth and carbon accumulation.

The CenW model generates 'productivity surfaces' (similar to a contour map) for the whole country, showing in great detail the regions with expected high and low productivity. Measurements came from stands of different ages of up to 32 years, grown at different stockings, and subjected to thinning and pruning at various stages throughout their growth. Predicted growth rates corresponded extremely well with actual measurements in these stands across the wide range of conditions.

Stand productivity was found to be particularly sensitive to annual air temperature and total annual precipitation, with optima reached at 12–15°C and 1500–2000 mm, respectively.

'Current temperatures are therefore generally sub-optimal for growth in all regions other than Northland, and precipitation is close to optimal. Soil fertility was also generally found to be adequate for most sites. Highest productivity was modelled for the moderately wet and warm northern and western regions of the North Island. Lowest growth rates were modelled for cold sites at higher elevation, for the dry eastern areas of the South Island, and also for the extremely wet sites on the West Coast of the South Island,' says researcher Dr Miko Kirschbaum.

The model also allowed researchers to assess the likely growth rates under future climatic conditions. They ran model simulations under three different greenhouse gas emissions scenarios and under climate-change predictions from 12 different global circulation models.

When researchers ran the model holding CO_2 concentrations constant, they found slight growth reductions in the warmer north of the country and increases in the cooler south. For the country as a whole, there was only a minor change in predicted wood productivity, Dr Kirschbaum says.

'When increasing CO_2 concentration was also included, productivity responses were generally positive, with average increases in wood production of 19% by 2040 and 37% by 2090. These responses varied regionally, ranging from relatively minor changes in the north of the country to very significant increases in the south, where the beneficial effect of increasing CO_2 combined with the beneficial effect of increasing temperatures. These relatively large positive responses to CO_2, however, can only be realised if the current high fertility levels in most commercial plantations can be maintained. There is also still some scientific uncertainty with respect to the extent of the CO_2 response, especially under water-limited conditions.'

MANAGING AND PROJECTING CHANGES IN CARBON STORAGE BY NATIVE FORESTS

Meanwhile, MAF contracted our researchers to improve understanding of carbon currently stored in native vegetation, the rate at which carbon accumulates at present ('business as usual'), and how 'management' options could optimise carbon sequestration in native forests.

This is because projected changes in the amount of carbon stored in our forests are required for New Zealand's ongoing climate change negotiations, and while detailed empirical (observed) data and supporting modelling exist for exotic production forests, there is little known about indigenous forests.

Researcher Fiona Carswell says human-induced disturbance – such as logging, clearing, and burning – has produced a significant shift in the age-structure and composition towards young or regenerating forest types. Such forests are currently active sinks of carbon dioxide. MAF is interested in whether they can be managed to absorb more carbon dioxide.

LUCAS (Land Use Carbon Analysis System) data from the National Vegetation Survey Databank (NVS) was used to quantify the actual carbon stocks by current vegetation type and by region. Calculations take into account carbon in the live biomass of tree stems, branches and roots; standing dead stems; coarse woody debris; and shrubs. Each of the 1300 plots was measured between 2002 and 2007.

Dr Carswell says the effect of human disturbance on total carbon content is being quantified with a complementary mix of plot measurements and satellite data. Plot-based variables include the presence/absence of grazing (managed stock only), clearing, mining, fire, logging, and the presence of tracks. From the data we can assess the level of 'naturalness' of the vegetation cover at each location.

Data are being integrated to model potential carbon stocks in the absence of all such disturbances. Our research will consider the scale at which optimal management could maximise gains or minimise losses in carbon sequestration (beyond current management) over the next couple of decades. This will help MAF to make an informed decision about 'business as usual' sequestration in indigenous forests, what actions are needed to increase the sequestration to optimal levels, and what the risks of reversals are.

BIODIVERSITY

OUTCOME: IMPROVED MEASUREMENT, MANAGEMENT AND PROTECTION OF NEW ZEALAND'S TERRESTRIAL ECOSYSTEMS AND BIODIVERSITY, INCLUDING IN THE CONSERVATION ESTATE

REGIONAL COUNCILS' BIODIVERSITY MONITORING FRAMEWORK

Following collaboration with the Department of Conservation to develop a national biodiversity monitoring and reporting framework, adopted by the Department in June 2010, our researchers have been working with regional councils to agree on a suite of indicators for a regional-scale monitoring of the condition and trend in terrestrial biodiversity.

'Regional councils have been under pressure to meet their biodiversity reporting obligations under the Resource Management Act (1991) and they want an effective system to quantify biodiversity trends,' says Ecosystem Processes Science Team Leader Rob Allen.

An Envirolink grant is funding the design and implementation plan for the framework. Once in place the framework will assist councils to assess the effectiveness of different policy and regulatory approaches, decide where to allocate limited resources and provide greater accountability for rates expenditure, and make improvements to the protection of indigenous biodiversity.

Over the next two years, researchers will begin developing the tools that enable all regional councils to report consistently on terrestrial biodiversity, contributing to a more scientifically sound and informative picture at the regional scale, with data integrated more readily with the Department of Conservation's work at the national scale and State of the Environment reporting by the Ministry for the Environment.

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