

Annual Report 2010

Part One



Landcare Research
Manaaki Whenua



2010 International Year of Biodiversity

BIODIVERSITY IS LIFE
BIODIVERSITY IS *OUR* LIFE

The United Nations declared 2010 to be the International Year of Biodiversity. It is a celebration of life on earth and of the value of biodiversity for our lives. Landcare Research was the first New Zealand organisation to register as a partner on the Convention on Biological Diversity's IYOB global website. The cover of our Annual Report represents the extensive work that we do to protect this country's biodiversity, much of which is endemic – found nowhere else in the world but New Zealand.

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(Manaaki Whenua)
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ANNUAL REPORT 2010

Our Annual Report is in two parts—together they fulfil our Annual Reporting responsibilities under the CRIs Act 1992. Detailed information about our research, operational activities and impacts, and governance is available on our website.

www.landcareresearch.co.nz

KEY HIGHLIGHTS

DOC approves the National Biodiversity Monitoring and Reporting system

Pg 11

Wildlife vector research contributes to future freedom from TB

Pg 14

Performance monitoring framework increases the effectiveness of pest management

Pg 14

Pest management decision support system strongly endorsed by regional councils

Pg 15

On-farm soil mapping increases irrigation efficiency

Pg 17

New methane mitigation technology uses soil microbes

Pg 21

Product life cycle assessments produce multiple benefits for manufacturing export firms

Pg 23

Catchment-scale economic modelling and effective stakeholder engagement benefit water governance

Pg 23

The UK Government endorses CEMARS® as being equivalent to the UK's Carbon Trust scheme

Pg 30

New invertebrate containment facility opens – will enhance our research into biocontrol of weeds research

Pg 34

LANDCARE RESEARCH AT A GLANCE

VISION:

Innovative science for a sustainable future

VALUES:

Collaboration, curiosity and clarity

CORE PURPOSE:

To drive innovation in New Zealand's management of terrestrial biodiversity and land resources in order to both protect and enhance the terrestrial environment and grow New Zealand's prosperity.

OUTCOMES FROM OUR RESEARCH:

- Improved management, measurement and protection of New Zealand's terrestrial ecosystems and biodiversity, including the conservation estate
- Improved management of pests, weeds and diseases in terrestrial ecosystems for industry benefit and biodiversity protection
- Sustainable use of land resources and their ecosystem services across catchments and sectors
- Improved measurement and mitigation of greenhouse gases from the terrestrial biosphere
- Improved positioning of New Zealand industry, business, Māori and local government to meet market and community needs within environmental limits

OUR STRUCTURE:

Landcare Research is one of eight Crown Research Institutes owned by the New Zealand Government. We have about 400 staff across four regional centres and five small district offices; our wholly owned subsidiary Sirtrack is based in Havelock North. (See the Directory for more information.) Funding is derived primarily from research contracts with Government, local government and private industry. Additional revenue comes from our branded commercial services. Our research is strongly aligned to and supports government policy, and reflects client and end-user priorities. Many of our science teams are recognised internationally for their expertise and research capability.

MANAAKI WHENUA:

OUR MĀORI NAME MEANS TO CARE FOR THE LAND IN ALL SENSES. MĀORI ARE TANGATA WHENUA, THE INDIGENOUS PEOPLE, WITH WHOM WE CONSULT AND WORK ALONGSIDE.

MANAAKI WHENUA – MANAAKI TANGATA
CARE FOR THE LAND – CARE FOR THE PEOPLE



CONTENTS

1	KEY HIGHLIGHTS
2	LANDCARE RESEARCH AT A GLANCE
4	CHAIR & CHIEF EXECUTIVE'S REPORT
7	STRATEGY & PERFORMANCE
10	BIODIVERSITY
13	WEEDS, PESTS & DISEASES
16	LAND RESOURCES
19	GREENHOUSE GASES
22	INDUSTRY, BUSINESS, IWI & LOCAL GOVERNMENT
25	KNOWLEDGE & TECHNOLOGY TRANSFER
32	OUR ORGANISATION
36	PRESTIGIOUS RECOGNITION
38	FINANCIAL PERFORMANCE SUMMARY
40	DIRECTORY

CHAIR & CHIEF EXECUTIVE'S REPORT

New Zealand's biodiversity is of great importance to the world and especially New Zealanders. Our forests, rivers, lakes and coasts provide a backdrop to our way of life; and species such as kiwi, kauri and weta have come to symbolise the special relationship New Zealanders have with the environment. But overall New Zealand's biodiversity is in decline, with growing numbers on the threatened species lists. Developing practical, cost-effective solutions to describe, protect and restore New Zealand's biodiversity represents about one-quarter of our research effort. During 2010, the International Year of Biodiversity, we worked with the Department of Conservation to design a robust measurement framework for biodiversity for guiding reporting, planning, and policy decisions. This is essential for the effective measurement of biodiversity performance.

Biodiversity is protected by the removal of pests and weeds, and regional councils (and others) need to confirm that expenditure on pest control (which nationally exceeds \$100m p.a.) is contributing towards gains in biodiversity. Our groundbreaking field trials over the past four years show tree weta are a valuable indicator of the effectiveness of different pest control strategies in reducing rats. Because the incidence of tree weta is easier to monitor than birds or other indicator species, they provide a practical means for

measuring biodiversity recovery. Our capacity to introduce control agents for major environmental and pastoral weeds such as *Tradescantia*, woolly nightshade, banana passionfruit and thistles was doubled with the opening in April of a new purpose-built invertebrate containment facility.

Finding a solution to the pathogenic *Phytophthora* threatening our iconic kauri is, however, proving challenging. Joint-agency funding was secured in September 2009 to launch a multi-pronged programme to address kauri 'dieback'. Subsequently, we improved the mapping of the incidence of the disease, promulgated early steps to help reduce its spread and commenced a research programme to address knowledge gaps.

Improving the productivity of land and water is a significant focus of our research. The award-winning work on precision irrigation we are developing with Massey University and Feilding-based company Precision Irrigation illustrates the gains that can be made by adopting a multi-disciplinary approach to natural resource management. On-farm tests show water savings of 9–26% based on trials at six farm research sites. The water saved can be redirected elsewhere, which improves overall water use efficiency. This integrative, systems approach

Chair Jo Brosnahan and Chief Executive Warren Parker.



to developing natural resource management solutions is a hallmark of our role as the 'integrating CRI'. It is manifested in our work with the Animal Health Board to test whether 'low-sow' pest control technologies can eradicate possums from large areas while concurrently significantly lowering per hectare costs. It underpins the research we are doing with five companies and BusinessNZ to identify profitable ways to reduce their environmental footprint. These life cycle management studies will help businesses to meet more stringent market and regulatory requirements for environmental performance.

These same market forces are adding momentum to our work in developing environmental technologies. Over the past 12 months, the carbonZero^{Cert}™ programme established a presence in Chile, secured new customers and a licence agreement in Australia, won recognition from the UK Environment Agency, and was awarded a 'Green Ribbon' award by the Ministry for the Environment. We acquired the global rights for Enviro-Mark[®], and Sirtrack developed a new series of standard products and secured two licence agreements for leading edge technology. Demand for ecological genetic tests through EcoGene™ grew 23% over the previous year and a new forensic test was launched to identify dogs that destroy kiwi.

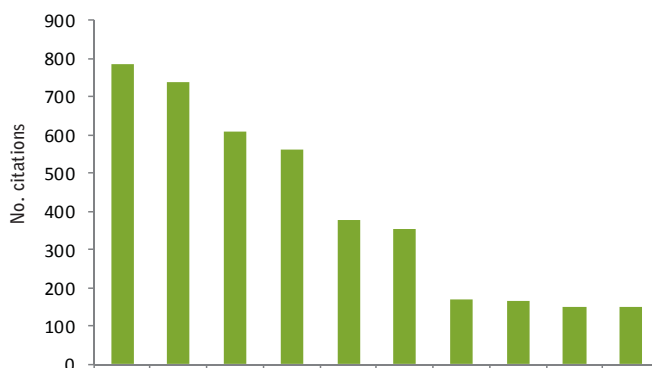
With New Zealand's economic future being more tightly linked with Asia, we worked to form networks in this region. Through the Ministry of Research, Science and Technology (MoRST) and the Chinese Ministry of Science and Technology (MOST) we have been at the forefront of initiatives with our Invasive Mammal Impacts research to develop the New Zealand – China Strategic Research Alliance.

Next year we aim to participate in international collaboration to quantify greenhouse gas emissions and removals, and develop new mitigation technologies with funding from the New Zealand initiated Global Research Alliance. This will build on the foundations laid this year with the New Zealand Agricultural Greenhouse Gas Research Centre and our leadership of new research to retain soil carbon, and participation in programmes to mitigate nitrous oxide and methane emissions.

WE HAVE A STRONG FOCUS ON MAINTAINING OUR SCIENCE EXCELLENCE. WE WERE PLEASED WITH OUR STANDING IN THE LATEST SCIMAGO INSTITUTION'S RANKINGS REPORT, SIR 2009 WORLD REPORT. THIS RANKS MORE THAN 2000 OF THE BEST WORLDWIDE RESEARCH INSTITUTIONS AND ORGANISATIONS, FROM 84 COUNTRIES ACROSS FIVE CONTINENTS, WHOSE OUTPUT IN 2007 SURPASSED 100 SCHOLARLY PUBLICATIONS.

WE WERE FIRST IN NEW ZEALAND ON SCIENTIFIC PUBLICATIONS PER SCIENTIST AND CITATIONS PER PUBLICATION, AND SECOND ON NORMALISED CITATIONS; WE ARE ALSO VERY COMPETITIVELY RANKED AGAINST AUSTRALIAN INSTITUTIONS, AND NOT TOO FAR BEHIND IN RELATION TO THOSE SCIENTIFIC POWERHOUSES, THE UNITED KINGDOM AND THE UNITED STATES.

Citations for top 10 papers published by our staff over last 10 years (2000-2010)





The Hon. Kate Wilkinson, Minister of Conservation, at the opening of our Invertebrate Containment Facility

With respect to our financial performance the Group Return on Equity target of 6.4% was met, excluding the impact of 0% building depreciation announced in the Government's May 2010 Budget. A strong performance by the Parent mitigated the operating loss by Sirtrack (which was impacted by an unfavourable exchange rate and the global financial crisis depressing demand) and additional investment into carboNZero's international expansion. The net operating cash flow of \$4.8m means the company's capital structure was strengthened further compared to last year. Next year, in addition to paying a dividend, we intend to reinvest retained earnings into improved infrastructure, better coordination of science and enhanced knowledge transfer.

During the final quarter, we worked closely with our shareholders and stakeholders to develop Landcare Research's Statement of Core Purpose and implement other recommendations in the CRI Taskforce Report. We welcome the comprehensive changes arising from the report. In addition to shaping our work over the next decade to help grow the New Zealand economy in an environmentally responsible manner, they will enable genuine strategy-led engagement with our end-users, more effective collaboration with other research providers and a longer-term focus on managing our research capabilities. The next 12 months present a rare opportunity for Landcare Research to consider, with its partners, new ways of working together to address the multi-faceted challenges arising from the natural resource constraints and ecological limits that could beset New Zealand's economic performance. This will include using our membership of BusinessNZ's Major Companies Group and the New Zealand Business Council for Sustainable Development to develop opportunities arising from the 2010 Budget package and the Primary Growth Partnership (PGP) to support increased eco-innovation in the private sector.

Our staff continued to excel, with notable achievements including a New Zealand Association of Scientists Research Medal to Thomas Buckley. The Australasian Plant Pathology Society made Ross Beever a Fellow, and long serving Research Associate Des Ross was elected a Fellow of the New Zealand Society of Soil Science. It is with considerable regret, however, that we note both passed away during the year.

Alastair Lawrence retired from the Board after an outstanding contribution over the past six years. He will continue to Chair the carboNZero programme's Transition Board. Ralph Marshall succeeds Julian Raine as Chair of the Sirtrack Board from July 2010. We thank Julian for his many contributions to Landcare Research. It is also a pleasure to welcome Professor Grant Guilford, Dean of the School of Sciences at the University of Auckland, to the Board. We thank the directors and the senior executive team for their support and commitment during the year.

Jo Brosnahan

JO BROSNAHAN
CHAIR

Warren Parker

WARREN PARKER
CHIEF EXECUTIVE

STRATEGY & PERFORMANCE

Our purpose is to drive innovation in New Zealand's management of terrestrial biodiversity and land resources in order to both protect and enhance the terrestrial environment and grow New Zealand's prosperity. This aligns with the Government's priorities for economic growth with responsible environmental management.

In the face of global economic recession, a primary strategic goal for 2009/10 was to strengthen our financial resilience by deepening and extending our customer relationships. Our principal non-Foundation customers are the Ministry of Agriculture and Forestry (MAF), the Department of Conservation (DOC), the Animal Health Board (AHB), the Ministry for the Environment (MfE) and local government, with much of our work supporting the development of public policy and better management of natural resources. We met regularly with these customers (across strategic and operational levels) to maximise the value of our work for them. We developed our relationships with sector organisations such as BusinessNZ and DairyNZ to find profitable technologies and services to reduce negative environmental impacts, increase operational efficiency and meet the expectations of consumers. In that regard, Enviro-Mark[®] and carboNZero^{Cert™} certifications continued to provide services that meet international standards for verifying organisations' environmental performance.

As part of our strategy to offer integrated solutions and diversify our revenue base, we continued our efforts to develop broader relationships with the primary and mining sectors, which face increasing public scrutiny of their environmental performance. Good stewardship of soil, land, water and biodiversity resources is essential to land-users' ability to

increase production, continue their social 'licence-to-operate' and retain market access. With regard to our goals to support Māori economic development, we extended our relationships with iwi, especially with respect to research on the co-management and governance of natural resources and in providing Māori with tools to improve access to information describing the attributes of the land they own.

To achieve our goal of improved science foresight and easier accessibility to our science data and new knowledge, this year we put a special focus on using new communication media such as video technology, social media and customised newsletters to increase the relevance, uptake, impact and value of our science. To stay at the forefront of the latest science and technology developments and to meet the changing future needs of our shareholders and customers, we are intimately connected with world-leading science groups. Advanced information and communication technology (ICT) is a key part of this, especially for global projects. Accordingly over the past twelve months we have continued to invest in building our internationally recognised environmental informatics capabilities. Similarly, advanced ICT systems support the development of integrated modelling capability that enables New Zealand to respond more confidently, and from a 'whole-of-system' perspective, to environmental issues such as climate change and biodiversity decline.

Finally, in light of the advice we provide to our clients and end-users, it is very important that we continue to challenge ourselves to improve our own organisational sustainability and to align to international best practice. Details of our policies, initiatives and progress are available via our website.

STRATEGIC INITIATIVES FOR 2009/10

FINANCIAL PERFORMANCE

We said we would:

- Generate greater financial flexibility and capacity to reinvest from increased revenue and productivity, with a target return on equity (ROE) of 6.4%

How we performed:

- We achieved our 6.4% ROE target excluding the impact of 0% building depreciation announced in the Government's May 2010 Budget, and have identified opportunities for reinvestment in science

CUSTOMER FOCUS

We said we would:

- Align science activity with Government priorities and emerging end-user needs
- Deepen and extend relationships to grow research revenues and deliver national outcomes (see Integrative Solutions)

How we performed:

- In an independent survey, 91% of our clients rated our overall performance as 'excellent' or 'very good' (2009: 70%, although the two customer groups were quite different); 95% rated the quality of our research work as either 'excellent' or 'very good' (2009, 85%)
- \$10.5m (17% of our revenue) contracted from government departments, local government and the Animal Health Board; private sector clients contracted \$5.6m (9% of our revenue) in research services
- We held 6-monthly CEO and senior management team meetings with each of our major clients in government to foster alignment in our work
- We produced 185 contract reports for clients
- Our staff were invited to participate in 188 technical meetings and workshops, and made 220 technical presentations to clients and stakeholders
- 60 client staff were on our advisory groups, and 41 of our staff held 66 positions on stakeholder advisory groups
- We worked on 158 collaborative research projects with end-users and stakeholders
- Across 8 of our sites, 107 client and stakeholder staff are co-located with us
- Staff were seconded part-time to AHB and Environment Canterbury

INTEGRATIVE SOLUTIONS

We said we would:

- Develop integrated solutions to the dilemmas posed by sustainable development by integrating our capabilities with those of other science providers and with our customers' expertise

How we performed:

- We worked with DOC to develop a national framework for measuring and monitoring biodiversity, and a Vital Sites model for prioritising conservation management
- We worked on three biodiversity indicator projects funded from the Cross Departmental Research Pool and managed by DOC
- We worked with MAF BNZ and multiple stakeholders to develop an outcome-focused performance monitoring framework for more effective pest management
- We worked with a consortium of MAF BNZ, DOC and several northern regional councils on kauri 'dieback', caused by an unknown *Phytophthora*; we co-hosted the Fifth IUFRO meeting on *Phytophthora* diseases for New Zealand and overseas researchers and regulators
- We established a research consortium between Ireland, Belgium and New Zealand to develop land-use management planning tools under the European Commission's Framework Plan 7
- We joined the new collaborative NZ Agricultural Greenhouse Gas Research Centre involving 5 CRIs, 2 universities, DairyNZ, and the Pastoral Greenhouse Gas Research Consortium; we are partners in 4 other collaborative research centres and 6 other formal collaborative research networks and consortia
- All our major sites are located on or close by university campuses to facilitate collaboration; 18 of our staff worked in 21 university-led research programmes spanning 5 universities; 14 of our staff were contracted to deliver lectures; another 22 staff delivered 28 sets of lectures (gratis); 28 staff hold 41 positions with New Zealand and overseas universities
- 60% of our Capability Funds were invested in cross-team projects developing transdisciplinary outcomes and integrated solutions



Kristin Flannagan & Kathryn Fitzharding-Jones with the 'Green Advantage', a joint promotion between Enviro-Mark and PrintUZ

ENVIRONMENTAL TECHNOLOGIES

We said we would:

- Create financial value from environmental technologies by developing products and services that meet both New Zealand and global needs

How we performed:

- We worked with 6 export manufacturing firms with support from MfE, MED, BusinessNZ and NZTE to show eco-innovation in product life-cycle management reduces production costs and creates market advantage
- A prototype filter reduced methane emissions from a dairy effluent pond by 60% and is now being adapted for landfill emissions
- The carbonZero^{Cert}™ programme (CEMARS) was endorsed by the UK Government, was licensed to Bureau Veritas for the Australian market, and won numerous accolades
- We secured the global rights and ownership of the Enviro-Mark[®] programme
- We have 8 prototype environmental technologies and services under development, 12 in developmental stages, and another 7 undergoing commercial testing

SCIENCE FORESIGHT AND ACCESSIBILITY

We said we would:

- Enhance the relevance, uptake and value of our science through applying foresight and advanced information technology

How we performed:

- We launched the Land Resource Information Systems (LRIS) portal enabling users to download land-use and soils data more easily
- We developed pilot interactive web portals for *Our Futures* and *Visualising Māori Futures*
- We contributed by videoconference to a European Commission Foresight 2030 exercise on Informatics in Natural Resource Governance
- We are part of the Broadband-enabled Science and Technology Grid (BeSTGRID) funded by MoRST to develop New Zealand's eResearch infrastructure
- We were elected to lead the Pacific Australasian node of the new digital Global Soil Map project
- We contributed to several national and international biodiversity informatics initiatives
- We developed decision support systems and frameworks for improved future management of biodiversity, pests, water governance and stormwater

OUR PEOPLE AND PROCESSES

We said we would:

- Attract and retain high quality staff and provide a flexible, modern work environment with best practice in organisational sustainability and smart working solutions

How we performed:

- The quality of our staff is evidenced by publication of 271 peer-reviewed research papers, 9 books, 90 book chapters, 6 books edited or co-edited, 169 conference papers or abstracts, and well over 200 non-refereed journal articles and popular publications
- We co-authored papers with authors from 34 countries other than New Zealand
- Turnover for science teams was 7.8% with zero turnover among our most senior scientists
- We completed an internal project on 'science futures' to identify science capabilities needed for the next decade
- Direct expenditure on training courses and study grants was \$613,000 (2.35% of payroll costs). In addition, \$302,000 of Capability Funds were invested in fellowships and postgraduate study
- The second cohort of staff embarked on the year-long in-house leadership development programme; we launched a similar programme for line managers
- We hosted 17 postdoctoral researchers, and supervised 74 PhD and 24 Masters students
- Our new Invertebrate Containment Facility is designed to be both water- and energy-efficient and provide more flexibility and reliability for research on biocontrol of weeds
- External audits confirmed our carbon-neutrality in accordance with protocols and processes required by the carbonZero programme, and retention of our ISO 14001 certification and our Tertiary Level status under ACC's Workplace Safety Management Practice
- We introduced InfoCentre and InfoFile software systems to rationalise and simplify reporting of science achievements and contracts



BIODIVERSITY

Outcome:

Improved management, measurement and protection of New Zealand's terrestrial ecosystems and biodiversity, including in the conservation estate.

Biodiversity is at the heart of our natural heritage and prosperity

OUR SCIENCE FOCUS

- Describing, documenting and analysing biodiversity at genetic, species and ecosystem levels
- Developing and contributing to biodiversity information networks and systems, nationally and globally
- Measuring and modelling ecological processes across a range of temporal and spatial scales
- Informing and evaluating biodiversity policies and management systems to ensure a net gain in the extent and quality of indigenous biodiversity
- Facilitating recognition of Māori as kaitiaki of indigenous biodiversity and their contribution to regional and national biodiversity management
- Fostering data-sharing and collaboration between researchers, statutory authorities, private landowners, industry, and community and iwi groups

CORE EXPERTISE

- Biosystematics and nationally significant biological collections
- Terrestrial and freshwater ecosystem processes
- National vegetation monitoring systems
- Environmental assessments and management
- Informatics and integrative modelling capability
- Policy advice and evaluation

RESEARCH HIGHLIGHTS

MEASUREMENT FRAMEWORK FOR BIODIVERSITY

In June 2010, the Department of Conservation (DOC) reached a significant milestone in the development of a national biodiversity monitoring and reporting system. DOC approved the system's general design and is now moving forward with developing detailed design and implementation options.

Over the last three years, we have worked with DOC on designing a new system that could provide a comprehensive picture of the ecological integrity of New Zealand's native species and ecosystems. In addition, Landcare Research played a significant consultative role around the potential adoption of the system. We developed responses to a comprehensive FAQ list compiled by DOC staff, produced case studies to illustrate how the system would work, and presented a series of seminars to Wellington and regional offices. One of our Capability Fund projects developed arguments as to the utility of the new system, where the old approaches were failing, and how the new system was cost-effective because it would build on the existing LUCAS network; DOC managers commented that these arguments were 'persuasive'.

Up until now, most of DOC's biodiversity monitoring has been carried out at a local level to meet specific local needs; information cannot be aggregated and there are significant gaps. Implementation of the new monitoring protocols will capture information across all of the DOC estate. Regional councils and Ngā Whenua Rāhui are also looking at adopting the system. More easily shared data will result in better decisions by all managers, leading to improved conservation outcomes. And importantly, the new system will enable New Zealand to start telling a more complete story of this country's biodiversity and meet its Biodiversity Strategy goals.

NVS EXPRESS

The National Vegetation Survey (NVS) Databank is the national repository for plot-based vegetation survey data and covers the full range of New Zealand and offshore island environments. It contains records from approximately 77,000 vegetation survey plots including over 19,000 permanent plots, with data spanning more than 50 years. The NVS Databank has a fundamental role in many national monitoring systems and underpins models of carbon sequestration.

This year, we launched 'NVS Express' — a purpose-built Windows tool for entering, summarising, and analysing vegetation data compatible with the NVS Databank. It accepts data collected using the NVS standard forest monitoring (i.e. permanent 20 × 20 m plots) and vegetation inventory (i.e. Recce) methods.

Features and benefits include built-in data validation services and a range of post-entry dataset checks that ensure data integrity. NVS Express gives users the ability to summarise data (tabulations, cross-tabulations, histograms, and summary statistics) and analyse temporal changes in permanent plot data, including growth and mortality of individually tagged trees.

PRIORITISING CONSERVATION MANAGEMENT USING THE VITAL SITES MODEL

We have developed an approach to modelling biodiversity and the threats to its viability in order to identify places ('Vital Sites') where conservation action will avert the most loss of ecological integrity. Earlier work by Landcare Research had proposed 'ecological integrity' as a way to measure progress towards the New Zealand Biodiversity Strategy goal of halting the decline of indigenous biodiversity.

The Vital Sites Model integrates distribution maps of native species with maps of weed and animal pest threats, and environmental and land cover information, to identify significant sites and priority sites for conservation management. Outputs include maps of biodiversity significance and maps of areas of high priority for conservation action. The model can also be used to report on the conservation gains achieved by management actions. A sobering conclusion from a trial run of this model, using a limited dataset, was that New Zealand is probably investing 9 to 25 times less money than it needs to in order to halt the decline of indigenous biodiversity.

The Vital Sites Model is part of our ongoing work to support DOC's Natural Heritage Management System (NHMS). In addition, the work has considerable application to other uses, such as the design of biodiversity offsets, and we anticipate rapid development of this model over the next few years.

CLIMATE CHANGE AND CONSERVATION IN NEW ZEALAND

In another collaborative project with DOC, we examined the potential impacts of climate warming and accompanying extreme weather events on New Zealand's biodiversity over the next few decades. We recommend conservation managers should focus on:

- Coasts, where rising sea levels will squeeze native ecosystems against developed, hardened landscapes
- Freshwater ecosystems, where dams and water abstraction have left biodiversity vulnerable to drought and high temperatures
- Alpine regions, where increased woody growth and increased pest pressure is likely to threaten a diverse, species-rich biota
- Invasive weeds and pests, which are likely to be increasingly advantaged by warmer, less-frost-prone winters.

From a practical conservation point of view, the best response to climate change is to ensure current efforts continue, or even strengthen, in order to preserve biodiversity. Increased biodiversity monitoring of vulnerable ecosystems (especially alpine and freshwater), increased surveillance of warm-temperate weeds and pests, and establishment of climate stations in high altitude and remote regions is desirable.

NEW ZEALAND ORGANISMS REGISTER

Surprisingly, scientists understand how many stars are in the galaxy better than how many species exist on Earth – estimates vary from 2 to 100 million, but fewer than 2 million have been named so far. A number of interlinked global projects are attempting to catalogue named biodiversity to support better information management. Work by Landcare Research underpins the New Zealand contribution of around 100,000 names of organisms of relevance to our research, conservation and biosecurity agencies.

We have been contracted by the Terrestrial and Freshwater Biodiversity Information System programme (TFBIS) to develop the informatics infrastructure for the New Zealand Organisms Register (NZOR), the first national digital 'catalogue of life'. The project is a partnership between key national data providers (initially Landcare Research, NIWA and the Museum of New Zealand Te Papa Tongarewa, and data consumers (initially MAF Biosecurity New Zealand, DOC, the Environmental Risk Management Authority (ERMA) and Environmental Bay of Plenty).

RESTORING BELLBIRDS & TŪI TO HAMILTON CITY

Since 2003, we have studied tūi movements, diet and nesting success around Hamilton. Tūi were scarce, only visiting Waikato towns in winter to feed on nectar of native and exotic trees. They nested in nearby native forest remnants but with poor (c. 25%) success due to predation by ship rats and possums. With our support, Environment Waikato started rat and possum control around nesting areas in 2007, with additional control effort coming from Hamilton City Council and local conservation groups. As a consequence, unprecedented numbers of tūi visited urban and rural areas in the wider Waikato during winter 2009. This success led to a huge outpouring of public support for the project, including ongoing planting of nectar-producing species, and continued pest control.

This year, we collaborated with Waikato University, Auckland Regional Council, Environment Waikato and Hamilton City Council to translocate 200 bellbirds (the largest translocation ever attempted in New Zealand) from Tiritiri Matangi and Tawharanui to Hamilton and three Auckland sites. The release had the approval of Tainui, and the cooperation of Ngā Mana Toopu o Kirikiriroa.

WEEDS, PESTS & DISEASES



Carlos Rouco Zufiaurre checking a Sirtrack radio collar that has just been fitted on an anaesthetised possum

Helene de Warrigo

Outcome:

Improved management of pests, weeds and diseases in terrestrial ecosystems for industry benefit and biodiversity protection.

CORE EXPERTISE

- Mammal pest monitoring, control and eradication
- Multi-species impacts
- Wildlife diseases
- Molecular forensic tools for pest management
- Quantifying success
- Weed biocontrol
- Policy advice and evaluation

OUR SCIENCE FOCUS

- Developing cost-effective, efficient and environmentally sensitive tools against vertebrate pests
- Reducing the prevalence of wildlife-vectored bovine TB in farm herds
- Establishing comprehensive biocontrol programmes for widespread intractable weeds
- Monitoring invasive weeds, invertebrate pests and wildlife diseases and assessing risk to biodiversity, human health and primary industries
- Advising pest management agencies, statutory authorities, rural and urban communities, conservation groups, primary producers and iwi

RESEARCH HIGHLIGHTS

FUTURE OF PEST MANAGEMENT PROCESS

During 2009/10, Landcare Research scientists played a substantial role in a process, instigated by MAF Biosecurity New Zealand (MAF BNZ), to identify the best, future directions for pest management. Our staff were involved in three of the working groups, including the lead drafting group. The process culminated in the release, in June 2010, of a discussion paper proposing a new national plan of action for pest management for 2010–2035. Our input was both strategic and technical, providing the ‘reality checks’ between high-level-policy aspirations and what is actually achievable within the constraints of pest ecology and pest management in practice.

CONTRIBUTING TO FUTURE FREEDOM FROM BOVINE TB

New Zealand has made major progress in reducing the levels of bovine tuberculosis (TB) in farmed cattle and deer. There are now fewer than 100 infected herds compared to about 1,700 just 15 years ago. The Animal Health Board (AHB) has therefore proposed a new national pest management strategy (NPMS) for TB that aims for local and regional eradication of TB from both livestock and possums (the main wildlife host) by 2026. This goal is endorsed by farmers, industry and local and central government who want to protect our reputation as a supplier of safe, high quality meat and dairy products.

Landcare Research’s work for the AHB has contributed substantially to the success of the current NPMS, which is on track to achieve fewer than two in a thousand herds (0.2%) infected by 2013. The emphasis now is on local eradication of TB from wildlife – decreasing the cost of reducing possums to very low density while also reducing the amount of poison used, developing alternative methods for breaking the TB cycle, and developing new tools for quickly showing TB has been eradicated locally so that possum control can be stopped.

Significant projects are being conducted in two remote high country stations, the last areas in northern Canterbury where TB levels in cattle and wildlife had been high. A large-scale aerial poisoning operation in 2008 piloted two new approaches – targeting high-possum-density areas predicted to have the highest risk of TB-infected animals, and a new low-cost,

low-toxin approach to 1080 poisoning. This year, the number of infected cattle has dropped by 88%, very pleasing after 18 months. In addition pigs, which are highly susceptible to infection when TB-infected possums are present, have been deliberately released in the area as sentinels for detecting TB. Few sentinel pigs inside the managed areas have become infected, compared with most of those in an unmanaged area.

In an additional management approach, which is being developed in collaboration with AgResearch and Otago Innovation, a vaccine (BCG) used to protect humans from TB is also showing promise in protecting free-ranging cattle from the natural sources of TB in this area. For one group of study animals, none of the 86 cattle in the vaccinated group tested positive for TB a year after vaccination, compared with 5 (10%) of 53 that were not vaccinated. Vaccination of cattle may therefore be useful as an interim tool for reducing TB in livestock in areas where it is impractical to undertake effective control of possums.

OUTCOME-FOCUSED PERFORMANCE MONITORING

We have been working with MAF BNZ to develop an effective outcome-focused performance monitoring framework for pest management because it had become increasingly obvious that current approaches are highly inconsistent, often with poorly defined outcomes and little in the way of robust monitoring to determine actual benefits of control programmes. Following 20-plus stakeholder-engagement meetings around the country with MAF BNZ, pest control agencies and end-users, work focused on developing structured performance indicators for high-level national pest management outcomes and implementing the early stages of a framework for goal setting, monitoring and data standards.

We also lead a technical advisory group that is developing performance indicators aligned with the Department of Conservation’s (DOC) Natural Heritage Management System (NHMS) and other measurement systems. The group is made up of DOC, AHB, MAF BNZ, Statistics NZ, regional councils and experts in economics and social indicators.

A new project with MAF BNZ will extend the ‘Performance Measurement Framework’ project to review performance

measures, and develop new performance indicators for the *Didymo* national management programme, and a monitoring and evaluation strategy for a new long-term management programme for kauri dieback. Both of these involve working with multiple agency/stakeholder groups.

DEVELOPING A PEST MANAGEMENT DECISION SUPPORT SYSTEM

A new pest management Decision Support System (DSS) is being developed with Envirolink Tools funding. The draft version of the web-based DSS, released earlier this year, was strongly endorsed by the regional councils' Biosecurity Managers Group. While the development was initially driven by the needs of local authorities, the tool will be freely available. It is likely to find use throughout the pest 'sector'. The DSS takes account of operational aims, previous control, land tenure, farming practice, public and environmental safety, community views and involvement, and landowner views. Simple 'yes/no' responses at each step make the system intuitively easy to understand and provides unambiguous options for the most appropriate control.

All recommendations are linked to best-practice advice in accordance with DOC and National Possum Control Agencies (NPCA) guidelines, and supported by research findings. New information from research, field practice and manufacturers will be incorporated on an ongoing basis.

MONITORING WETA HIGHLIGHTS THE EFFECTIVENESS OF PEST CONTROL

Introduced pest mammals pose a significant threat to biodiversity conservation in New Zealand. To understand the benefits of controlling individual pest species, a greater ecosystem-level understanding of interactions between multiple pest species is required.

This year, we completed a large, four-year research programme into species interactions and the consequences of pest control at the ecosystem level. One of the indicators chosen to measure the effectiveness of pest control, especially sustained rat control, was numbers of tree weta. Initial control of possums and rats using 1080, then ongoing ground-based rat control using Ditrac (diphacinone) in bait stations, prevented rat populations



Tree weta indicate the effectiveness of sustained rat control

bouncing back (as happened in sites with no ongoing control). Tree weta flourished in the continued absence of rodent predation making them a good alternative to monitoring birds to show biodiversity benefits from pest control. Weta are engagingly iconic, easy to monitor, and respond reasonably quickly to reduced rat populations.

KAURI DIEBACK – CAUSED BY *PHYTOPHTHORA TAXON AGATHIS* (PTA)

Dieback of kauri trees is associated with an as yet undescribed species of *Phytophthora* – a microscopic group of fungus-like, plant pathogens. Our research indicated the pathogen could be transferred from diseased to healthy trees in soil (including that on shoes, tyres, and plant equipment), and that Trigene II Advance[®] was the most effective disinfectant against the pathogen.

This year, in our surveillance work to map the disease, we found it in Northland's Waipoua Forest close to Tāne Mahuta (New Zealand's most iconic and venerable tree). Additional funds were allocated by Cabinet to be overseen by a consortium of MAF BNZ, DOC and several northern regional councils. Our research for the consortium is focused on developing robust, reliable, diagnostic techniques (both tree- and soil-based detection), surveillance, a greater understanding of how the pathogen is spread, appropriate management and containment strategies, and finding an effective control.

The *Phytophthora* group of pathogens are of immense economic and environmental significance around the world. In March 2010, we co-hosted the Fifth International Union of Forest Research Organisations (IUFRO) meeting on *Phytophthora* Diseases. The conference provided a very useful forum for researchers, regulators and end-users to discuss and debate PTA and its implications on kauri forest ecology and management.

LAND RESOURCES



Mapping irrigation management zones increases the effectiveness of variable rate irrigators and water-use efficiency



'On-the-go' mapping of soil water-holding capacity

Outcome:

Sustainable use of land resources and their ecosystem services across catchments and sectors.

CORE EXPERTISE

- Soil characterisation and processes
- Land-use capability and effects
- Catchment management and hydrology
- Erosion processes
- Nutrient and contaminant fate
- Land resource economics and ecosystem services
- Mātauranga Māori and societal values in land resource decision-making

OUR SCIENCE FOCUS

- Understanding and mapping our soil natural capital to improve its resilience (including Antarctica and Pacific countries)
- Mapping land cover, land use and ecosystem services and understanding the value of those services
- Matching land use to the capacity and characteristics of land resources to improve their sustainability
- Understanding soil and erosion processes to reduce sediments, nutrients and other contaminants entering water bodies
- Integrative modelling of terrestrial ecosystem services to enhance policymaking processes
- Improving consideration of economic, social and Māori perspectives in the stewardship of terrestrial resources

RESEARCH HIGHLIGHTS

ASSESSING ENVIRONMENTAL TRADE-OFFS BETWEEN SOIL, CARBON AND WATER

Policymakers in the Ministry of Agriculture and Forestry (MAF) and regional councils need more sophisticated and integrated methods for assessing the environmental benefits of forests in terms of three important ecosystem services for New Zealand: climate change regulation, erosion control, and water provision. To help inform debate about the combined value of ecosystem services, we have developed national-scale models for forest growth rate, catchment water yield, and erosion rate as functions of forest cover, annual rainfall, and soil type.

The models are being used to generate maps of New Zealand showing economic value based on direct valuation of marginal benefits of land. In one simulation, eroded soil had an associated cost of \$1.50 per cubic metre, water had an irrigation benefit of \$1 per cubic metre (where there is demand for irrigation), and sequestered carbon was assumed to have a market value of \$73 per tonne.

The simulation showed the net benefit for planting trees was spatially variable and sometimes negative in water-short locations. The best places to plant trees would be in erosion-prone land in catchments with little high class land.

INCREASING THE EFFECTIVENESS OF THE EAST COAST FORESTRY SCHEME

A project, commissioned by MAF, examined erosion processes on soft rock hill country on the East Coast that has a history of severe gully erosion. Rivers, particularly in the Waipaoa catchment, carry huge sediment loads. Forestry has been the principal strategy for remediating gully erosion, but there was little in the way of quantifiable data.

By taking empirical data on gully shutdown through forestry, we were able to indicate how different reforestation strategies could affect gully erosion and hence sediment generation in the Gisborne District. Without historical afforestation in the Waipaoa catchment, sediment yields would have been 35% higher than at present. However, the research showed that considerable improvements could be made by more effectively prioritising

the most active gully systems for targeted planting. MAF staff were pleased to have quantitative data that reinforced the environmental importance and economic value of the East Coast Forestry Scheme.

UNDERSTANDING EFFECT OF SOIL EROSION ON CARBON ACCOUNTING

Soil is a major carbon sink, so erosion can have a significant effect on soil carbon. Rivers in the North Island may carry particularly high sediment loads, exporting an estimated 1.9 million tonnes of particulate organic carbon per year to the sea. Regenerating soils sequester an estimated 1.25 million tonnes of carbon per year from the atmosphere. These losses and gains have yet to be systematically measured but it is essential that they are incorporated within the New Zealand Carbon Monitoring System (CMS). We are working with the Ministry for the Environment (MfE) to review current erosion data and models, including the New Zealand Land Resource Inventory (NZLRI), to determine the best way of including the effects of mass movement (erosion) within the CMS. This work draws on our extensive capability in understanding and modelling of erosion processes and many years of developing nationally significant databases in the land resources area.

UNDERSTANDING SOIL VARIABILITY FOR IRRIGATION EFFICIENCY GAINS

Presently, irrigation needs are usually based on regional evapotranspiration rates (water loss from soil and vegetation) with no allowances for soil differences. As a result, water may be wasted and the risk of water runoff and nutrient leaching increased within the over-irrigated parts of the field.

We have designed a new system to measure the soil's water-status directly through sensors installed in the field so that variable-rate irrigators can deliver water to where it is needed, when it is needed – 'precision irrigation'. On-the-go soil electromagnetic induction surveying enables us to map the soil's available-water-holding capacity and delineate irrigation management zones, which are uploaded to the central controller of the automated variable-rate irrigation system. Wireless sensor networks monitor soil moisture in each of the management zones with data telemetered to a

phone or computer advising when to turn an irrigator on or off, and how much water is needed.

We are continuing pilot trials (Canterbury, Manawatu and Ohakune) in collaboration with farmers, the Foundation for Arable Research (FAR), DairyNZ, Massey University, Precision Irrigation (the award-winning, Feilding-based company), and MAF's Sustainable Farming Fund. Results indicate potential water savings of 9–26% – water that could be diverted elsewhere for improved water use efficiency.

Typically, for New Zealand, each millimetre of water saved for a 100-ha area reduces irrigation water application costs by about \$200. Across the 750,000 ha of irrigated land in New Zealand, this amounts to \$1.5 million (assuming average cost of irrigation is \$2/mm/ha) and 7.5 million cubic metres of water saved.

MAPPING IRRIGABLE LAND ACROSS NEW ZEALAND

We applied our modelling and spatial scaling expertise to produce a national map of irrigable land at a 5-km-grid resolution. This map (a data layer in geographic information systems) is based on resource consent data for Horizons, Hawke's Bay, Wellington, Canterbury and Otago regional councils. Further work will produce a refined version based on remote sensing mapping. Both MAF Policy and regional councils have expressed strong interest in the data layer as it will help in assessing the current state of land under irrigation, and the potential for new irrigated land.

IMPROVING WATER QUALITY IN ICONIC NORTH ISLAND LAKES

We are assisting Environment Bay of Plenty to improve water quality in the iconic Rotorua Lakes, which are important to both tourism and local iwi. Our environmental economist and policy analysts provided a robust assessment of the value derived from different interventions, ranging from different land-use practices to regulation, for improving lake health. The analysis has been used as the basis for discussions with stakeholders and to help resolve the problem of eutrophication and pollution of the lakes.

While not as severely affected, the once pristine waters of Lake Taupo are also beginning to suffer from nutrient-laden runoff, largely from farms. During the year, we began another innovative project, led and funded by the Lake Taupo Protection Trust (LTPT), to assess the impact of cut-and-carry forage as a viable and flexible farming option to reduce nutrients in runoff. The project will be on an operational scale not used elsewhere in New Zealand or the world, and will use custom-built wick-activated lysimeters (*in situ* soil tanks) to collect leachate. The LTPT represents the broad community of farmers, landowners, Māori trusts and incorporations in the region.

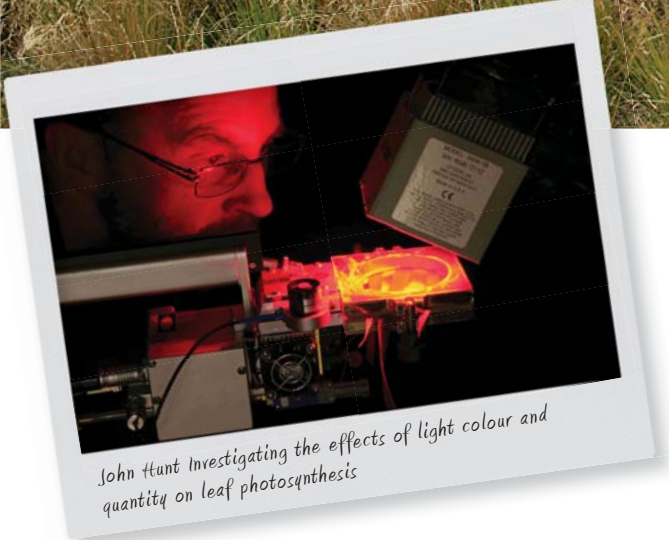
The research data will provide essential refinements to the widely used, on-farm N-budgeting model Overseer®. Better understanding of forage regimes as part of N-budgeting will also be relevant to other regions where discharges from farming threaten water quality (e.g. Southland, Manawatu and Rotorua).

REHABILITATING MINED LAND

We have provided research and advice on mine site rehabilitation for over 30 years. In 2009/10 this involved reviewing rehabilitation outcomes, helping design trials to develop new rehabilitation methods and developing protocols for rehabilitation to native ecosystems, farmland, and plantation forests, for coal and gold mines from Waikato to Westland and Southland.

Seeing mined land transformed from barren pits to living indigenous ecosystems and productive farms and forests can be inspirational. A continuing challenge is encouraging the collection and use of data to quantify progress towards mine closure.

GREENHOUSE GASES



John Hunt Investigating the effects of light colour and quantity on leaf photosynthesis

Scott Graeme (PhD student) measuring effects of increased soil temperature on soil respiration, Cass

Outcome:
Improved measurement and mitigation of greenhouse gas emissions from the terrestrial biosphere.

CORE EXPERTISE

- Land use impacts on net greenhouse gas emissions
- Carbon sequestration (sinks) in soils and vegetation
- Regional- and national-scale emissions estimation
- Emissions inventory for major agricultural greenhouse gases
- New mitigation strategies and technologies
- Policy advice and evaluation

OUR SCIENCE FOCUS

- Developing methods for improved inventory of carbon stored in soils and vegetation, nitrous oxide and methane
- Modelling emissions and impacts of climate change to anticipate future change
- Assessing economic and environmental implications of climate change policies
- Providing methods for certification of greenhouse gas emissions inventory and management
- Developing innovative technologies to mitigate greenhouse gas emissions
- Advising government and primary sector on strategies to manage risks and opportunities in climate change mitigation and adaptation
- Contributing to national and international greenhouse gas and climate change research

RESEARCH HIGHLIGHTS

IMPROVING GLOBAL UNDERSTANDING OF SOIL CARBON DYNAMICS

Organic soil carbon is a dynamic ecosystem. Each year, soil respiration sends about 10 times more carbon into the atmosphere than that from burning fossil fuels. For soils in carbon-balance, losses from soil respiration are balanced by inputs from vegetation. This has important consequences for the regulation of atmospheric carbon dioxide (CO₂) and thus the rate of global warming.

Various global climate models generally agree that warming is expected to lead to a loss of soil organic carbon, while increasing CO₂ is expected to stimulate plant net primary productivity and increase carbon stocks. However, predictions of the combined effect of both increased CO₂ and climate change on carbon stocks vary between models.

Our research indicates that for global applications, consideration of seasonal temperature variations is critical. Short-term measures of temperature dependence cannot be applied at different temporal scales without explicitly considering the variability of temperature over the longer temporal scale. Using short time-steps in simulations results in more positive changes in soil carbon (sequestration), especially in cold regions, than would be predicted in simulations at the more commonly used annual time-steps that ignore seasonal temperature variations. These results help to reconcile some of the apparent differences in predictions obtained by different models.

MEASURING SOIL RESPIRATION *IN SITU*

As a means of detecting changes over time, direct measurement of soil organic matter is very insensitive. Methods that facilitate a more detailed understanding and quantification of the biological processes underlying soil carbon balance hold much greater potential to help understand how soils respond to extraneous influences.

With our tunable diode laser, we can now measure very small differences in the isotopic carbon signature of CO₂. This helps us distinguish between old carbon (in soil organic matter) and recently fixed carbon (in plant tissue) as soil respiration sources, without disturbing the ecosystem. We

found that the proportion of old to new carbon used in respiration is markedly influenced by soil fertility. In a low-fertility soil with actively growing plants, more than 80% of the total soil respiration originated from newly fixed carbon. As temperature increased, the respiration rate also increased but loss of old carbon did not increase as expected. In contrast, an increase in temperature of a high-fertility soil increased both the rate of respiration and the proportion originating from old carbon sources. Results suggest that warming of fertile soils increases the loss of the older stored carbon but in less fertile soils the increased respiration is mainly derived from recently fixed carbon.

VISUALISING CARBON STORED IN NEW ZEALAND'S FORESTS

Projections of expected changes in the amount of carbon stored in our forests are required for New Zealand's ongoing climate change negotiations. This year, we led a project with Scion to produce a 'first-edition layer' of mean annual growth rates (carbon storage) of exotic forest for all of New Zealand. The mean annual growth of *Pinus radiata* over 50 years was mapped using regional estimates published by the Ministry of Agriculture and Forestry (MAF) in their Guide to Look-up Tables for the Emission Trading Scheme. The map will enable users to visualise trends in carbon sequestration following afforestation in some areas of the country. Future work will refine the map using forest growth estimates from current modelling work. While detailed empirical data and models exist for exotic production forests, the information for indigenous forests is much less clear. One of our new research projects for MAF will quantify 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.

MANAGING-TO-MITIGATE NITROUS OXIDE EMISSIONS

Nitrous oxide (N₂O) comes principally from on-farm animal urine and fertiliser use, and is around 200 times more potent than CO₂ in its global warming potential. Intensification in dairying and increased production of farm dairy effluent has raised concerns about gaseous nitrogen losses and their

environmental implications. Recent FRST-funded research showed that the rate of N_2O emissions from dairy-grazed pasture increases after effluent is applied to the pasture. However, a longer delay between grazing and effluent irrigation reduces the amount of surplus nitrogen and labile carbon, and hence N_2O emissions. Combined with other effluent irrigation studies, these results also suggest that application of effluent in dry summer and autumn seasons would result in fewer N_2O emissions than application at other times of the year.

DEVELOPING NOVEL METHANE MITIGATION TECHNOLOGIES

Methane (CH_4) has 25 times the global warming potential of CO_2 , and accounts for over 40% of all New Zealand's greenhouse gas emissions.

Our research has shown that soil can be a significant CH_4 'sink', and we are demonstrating the potential to use New Zealand soils in new mitigation technologies. Following the success of our prototype filter to reduce CH_4 emitted (down by 60%) from a dairy effluent pond, we have begun designing similar biofilters to oxidise CH_4 emissions from landfills. Emissions from currently operating landfills that do not have gas collection and management systems in place could be worth \$28m per year in reducing emissions liabilities. In addition, about 250 landfills closed after 1995 but will continue to emit greenhouse gases for over 30 years. Waste sector emissions will come into the Emissions Trading Scheme in 2011, so this technology will help landfill operators (largely local bodies) reduce liabilities resulting from greenhouse gas emissions from landfills. The project has support from MAF, with collaboration from Taupo District Council and the School of Engineering and Advanced Technology, Massey University.

LINKING WITH THE GLOBAL RESEARCH ALLIANCE

Following the inaugural meeting of the new Global Research Alliance on Agricultural Greenhouse Gas Research in Wellington this year, senior officials and delegates visited the new Agricultural Greenhouse Gas Research Centre, in which we are a partner, at Palmerston North. The visit included Landcare Research's laboratory and field experiments on N_2O emissions from pastures and the potential for CH_4



oxidisers in waste treatment. Lively discussions ranged across mitigation of enteric emissions, measurement techniques and spatial-temporal variability in N_2O emissions, the potential for mitigation technologies and their level of uptake in New Zealand, and new approaches to mitigation. Contacts made during the visit – particularly between New Zealand and The Netherlands, who will jointly coordinate a livestock research group – will facilitate collaborative projects to mitigate global agricultural greenhouse emissions.

MANAGING CLIMATE CHANGE (MC²) CONFERENCE

This year, we were the principal organiser of the 2-day conference 'Managing Climate Change (MC²)'. This brought together about 130 representatives from 14 countries to share the latest data and information on the processes that generate greenhouse gases, and technologies to measure, model and mitigate emissions. The conference facilitated the exchange of information and ideas between widely dispersed groups involved in managing greenhouse gas emissions. It also aimed to remove barriers between policy, science and industry and to foster dialogue among researchers, academics, students, environmentalists, engineers, land managers, and officials of industry and government.

MC² was organised in cooperation with AGMARDT, AgResearch, AGROTAIN International, Ballance Agri-Nutrients, the Global DNDC Network, GNS, the Livestock Emissions Abatement Research Network (LEARN), Massey University, MAF Policy, NIWA, PGgRC, Ravensdown Fertilisers, Summit-Quinphos (NZ) and Quinspread Technologies.

INDUSTRY, BUSINESS, IWI & LOCAL GOVERNMENT



Robyn Simcock checking trial green roofs used for reducing storm water and providing biodiversity benefits

Outcome:

Improved positioning of New Zealand industry, business, Māori and local government to meet market and community needs within environmental limits.

CORE EXPERTISE

- Strategic foresight thinking in government and business
- Sustainability as a factor in business competitiveness
- Integrating economy, society, culture and environment in policy making
- Mātauranga Māori in Māori business development
- Resilience, adaptiveness and eco-innovation in communities and infrastructure
- Strategies for social and organisational adaptation to climate change

OUR SCIENCE FOCUS

- Foresight and futuring to develop robust corporate and community strategies
- Integrated economic, social and environmental assessment to support policy making
- Incorporating mātauranga Māori in corporate and community strategies for natural resources
- Life cycle and environmental performance assessment to improve product, service and infrastructure design
- Advising government on collaborative learning to promote adaptation to climate change

RESEARCH HIGHLIGHTS

ENHANCING BUSINESS COMPETITIVENESS

Eco-innovation is being driven by demand for products and services that reduce risk or harm to the environment and society. This can be achieved by reducing greenhouse gas emissions during manufacture or in the product's use, avoiding waste, toxic materials or the use of non-renewable resources. Issues of biodiversity and water use are also gaining more public attention. Life cycle management (LCM) quantifies (in order to minimise) the environmental impacts of products and services throughout their life cycle – from raw material extraction to design, manufacturing, distribution, use and disposal or recycling.

In a two-year pilot study (funded by the Ministries for the Environment and of Economic Development and supported by BusinessNZ and NZ Trade & Enterprise), we are undertaking life cycle assessments with six manufacturing-export firms (AHI Roofing, Comvita, David Trubridge, Mastip Technology, Nufarm and Verda). The aim is to develop in-house expertise in each company so that life cycle thinking is thoroughly and efficiently integrated into every aspect of the business and its supply chain. Life cycle assessments produce multiple benefits – almost always reducing the firm's production costs as well as the environmental costs, and delivering on customer expectations. Following the pilot study, we will be working with companies and BusinessNZ to champion LCM 'best practice' throughout the economy.

ASSESSING THE VIABILITY OF ENVIRONMENTAL MARKETS

Environmental markets are among an array of intervention options available to policymakers to reduce environmental degradation or improve environmental quality. While markets are not always an appropriate policy response, they are often promoted as a more flexible option than regulation.

Our senior economists and ecological researchers joined forces to investigate the potential for successful markets in New Zealand. They found that environmental markets are not suitable for all commodities and all situations. Greenhouse gases, water quality and water quantity markets are likely to be the most straightforward to establish in New Zealand but

nevertheless face numerous legal, resource and information constraints. Markets for biodiversity are more complex and are probably not feasible at present.

Environmental markets require particular conditions to work well. While markets could be successful for some commodities and in some regions of New Zealand, our environmental law, administration and data arrangements are all barriers to success. To overcome these barriers, the researchers recommended a number of actions such as amending the Resource Management Act, establishing an independent oversight committee or ombudsman, supporting market infrastructure, and developing market design and implementation guidance to assist Government and stakeholders.

INCREASING THE EFFECTIVENESS OF WATER GOVERNANCE

Our research on governance of water resources in New Zealand has focused on the needs of policymakers – particularly at the national level supporting the Land and Water Forum and central government work programme; and at the regional level underpinning implementation of the Canterbury Water Management Strategy. The latter is a very dramatic shift in the development of new governance mechanisms to deal with the impact of resource constraints on economic growth and environmental impacts. We have shown that catchment-scale economic modelling has considerable value in supporting planning and decision-making, especially when the implications of policies and land-use factors affecting water quantity and quality are integrated into the model.

Sustainable water governance also depends on effective engagement and consensus between all water stakeholders within an increasingly politicised community. We investigated the effectiveness of participation processes and water-user groups across five existing irrigation schemes (ranging in age, size, history) in Canterbury and Otago. This showed effective operation of voluntary water-sharing or communal irrigation schemes depends on five 'conditions': community-based leadership, local identity, shared knowledge and experience, reliable and up-to-date information, and good relationships with regulators. High levels of mutual trust between those directly

involved, regulators and third-party stakeholders shortened the consent process and reduced risk of litigation. Careful consideration of these five 'conditions' will benefit proposed and future schemes. We have already been approached by regional councils and the irrigation industry about future research in the area of water scheme development.

VISUALISATION TOOLS FOR MĀORI FUTURES

In June 2009, Te Puni Kōkiri contracted us to develop a web-based 'visualisation' tool that would allow Māori land owners access to data held by us and other agencies. Working with Te Puni Kōkiri, the Ministry of Justice/Māori Land Court, and with feedback from groups of Māori land owners, we developed an alpha version web-based tool that will allow all Māori land owners to view their land blocks (and surrounding land blocks) using highly detailed satellite imagery and aerial photography, with a statistical summary of its land-use capability, soil characteristics, terrain, vegetation/landcover and climate data in a user-friendly format. This will provide landowners with an idea of the land-use potential of their land blocks and its suitability for horticulture, cropping, pastoral farming, forestry and areas for protection.

The web-based tool was presented at a national Māori land conference in July 2010 (Whenua Conference) organised by Massey University, AgResearch and Landcare Research. The tool is expected to be fully functional and publicly launched in conjunction with Te Puni Kōkiri when the project comes to completion in December 2010.

PAPAKĀINGA IN URBAN DEVELOPMENT

Poor understanding of Māori perspectives and knowledge (mātauranga Māori) in local government, limited resources in iwi and hapū, and lack of effective enabling practices have severely limited Māori participation in local government decision-making. An overwhelming proportion of the Māori population are urban dwellers, who increasingly want to re-establish traditional values through communal and cluster-type settlements (papakāinga) incorporating cultural principles. These principles emphasise the interconnectedness of communities, hospitality, spiritual and physical well-being, healthy water and land, and the inextricable links between healthy environments and healthy people.

We have been developing systems and processes to facilitate the integration of these traditional Māori values into modern urban design and development across single-unit dwellings, subdivisions, communities or town centres. Sustainability issues are also being considered, e.g. alternative energy for self-sufficiency, eco-friendly materials with low embodied energy, and less dependence on reticulated water and stormwater systems.

COSTING STORMWATER TREATMENT IN NEW ZEALAND

COSTnz (Cost of Stormwater Treatment in New Zealand) is a simple, easy-to-use computer tool that allows users to compare the relative life-time costs of various stormwater management devices. It was developed by Landcare Research using New Zealand data, asset managers, consultants, developers, designers and regulators. It covers acquisition and ownership costs of an asset from design, manufacturing, usage and maintenance through to disposal. It is helping to encourage low impact urban design and development by enabling decision-makers to make more cost-effective choices at the project scoping phase and providing a platform for negotiations between councils and developers regarding financial contribution.

Modules are available for ponds, rain gardens, wetlands, swales, filter strips, rain tanks, sand filters and infiltration trenches; and a generic module enables the same analysis for various proprietary devices. In each case, users can select from a range of default values for each cost element, or input data from their own suppliers or historical information. The Web application (commercially available at www.costnz.co.nz) follows a logical approach with consistent layout, and is designed to be flexible and easy to use. Results are delivered in a PDF report format or as a Microsoft Excel spreadsheet that enables users to develop the costing of a full treatment-train or input data into other systems.

KNOWLEDGE & TECHNOLOGY TRANSFER



Cissy Pan

CORE EXPERTISE

KNOWLEDGE SHARING

- Joint research centres
- National and international networks
- Global initiatives
- Fellowships

TECHNOLOGY TRANSFER

- Effective end-user partnerships
- Advisory groups
- Secondments
- Publications and workshops

BRANDED COMMERCIAL SERVICES

- Environmental verification and certification services
- Carbon credits from native forest regeneration
- DNA diagnostic laboratory services
- International consultancy services for invasive species
- Wildlife tracking solutions

OfficeMax is the first New Zealand business of its type to achieve Enviro-Mark® Diamond certification

OUR FOCUS

- Building extensive research partnerships with other leading science agencies in New Zealand and overseas
- Building connectivity through informatics infrastructure and technology
- Establishing strong, long-term partnerships with end-users of our research
- Translating complex science into practical advice, services and applications for rapid uptake
- Establishing commercially viable, internationally recognised business units for branded services in the absence of early-stage commercial partners

KNOWLEDGE SHARING - HIGHLIGHTS

Our intent is to continually strengthen collaboration with other research organisations in New Zealand and overseas so that our teams are at the forefront of new knowledge and are well-positioned to broker that knowledge for New Zealand.

COLLABORATIVE RESEARCH CENTRES

We are formal partners in several collaborative research centres:

- The newly formed New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC). We will lead the Centre's soil carbon research as one of six Principal Investigators, and are contributing to research strategies for methane and nitrous oxide
- The New Zealand Climate Change Centre
- The Centre for Biodiversity and Biosecurity
- The Centre for Urban Ecosystem Sustainability
- The New Zealand Centre for Sustainable Cities

We are also members of several other national networks and consortia, which are described more fully in Part 2 of our Annual Report and on our website.

INTERNATIONAL PARTNERSHIPS

Most of our research programmes have some degree of international collaboration. Our staff regularly discuss their research with colleagues through informal and formal networks, meetings and conferences, and exchange visits. This year, our staff collaborated with more than 250 authors from 34 countries to co-author peer-reviewed scientific publications.

We signed four new high-level international MoUs: one with the University of the South Pacific to support science collaboration and a science-based strategic partnership; one between Grupo de Ecología y Conservación de Islas (GECI) of Mexico and our invasive species group; and one with the Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment (Victoria, Australia) and one with Murdoch University (Perth, Australia) to collaborate on research projects and training.

GLOBAL CLIMATE CHANGE PROCESSES

Our Global Processes Team is recognised internationally for its innovative approaches to quantifying carbon budgets of whole ecosystems. The Research Leader for this team was recently appointed as one of the two New Zealand representatives on the Soil Carbon and Nitrogen Cycling Cross Cutting Theme for the Global Research Alliance.

A Marsden-funded project involves collaboration with the University of Canterbury and the Macaulay Land Use Research Institute (Aberdeen, UK), with a staff member seconded to work with us for two years. The project is centred on a unique field experiment to determine the impact of soil warming on the turnover and loss of soil carbon. This work relies on the use of our tunable diode laser absorption spectrometer, allowing us to make accurate real-time measurements of naturally occurring stable isotopes of carbon in air respired from soil. The results will help improve models that predict the rate of global climate change.



The Rt. Hon. John Key, Prime Minister, opening the New Zealand Agricultural Greenhouse Gas Research Centre

GLOBAL SOIL MAP

A global consortium has been formed to create a digital soil map of the world using state-of-the-art technologies. The new high-resolution map will be supplemented by interpretation and functionality options to assist in a range of global issues like food production and hunger eradication, water security, climate change and environmental degradation. The project has support from the Bill & Melinda Gates Foundation. One of our senior soil scientists (the architect of S-map, the digital soil map for New Zealand) was elected to lead the Oceania node (Australia, New Zealand, Pacific and associated territories).

'Let there be no mistake about the significance of this wonderful project' *Kofi Annan, Secretary-General of the United Nations 1997–2006, and co-recipient of the 2001 Nobel Peace Prize.*

GLOBAL BIODIVERSITY INFORMATICS

Landcare Research is recognised internationally as 'one of the world centres of biodiversity informatics' and we were represented at the first-ever global meeting of this young and growing field by one of our senior scientists who is a member of the Species2000 global committee, and the New Zealand node manager for GBIF. The *e-Biosphere 09 International Conference on Biodiversity Informatics* brought together 503 participants from 69 countries and we were invited to take part in a workshop of 40 invited participants to develop a 10-year roadmap for biodiversity informatics research.

The New Zealand Organisms Register (NZOR) is key to New Zealand being a regional hub in Species2000, a project currently funded through new €5.9m EU projects 4D4Life & i4Life that are attempting to complete the global Catalogue of Life; we are a partner in these projects. We are also a partner in the Global Biodiversity Information Facility (GBIF) and the Encyclopaedia of Life (EOL) project that is helping develop the Global Names Architecture (GNA) to provide the informatics 'glue' between globally distributed biodiversity databases.

NEW ZEALAND – CHINA STRATEGIC RESEARCH ALLIANCE

The first initiative in the New Zealand – China Strategic Research Alliance was a workshop in Xinjiang involving staff from Landcare Research's Invasive Mammals Impacts (IMI) programme, the Institute of Ecology and Geography in Xinjiang, and the Partner Institute for Computational Biology in Shanghai. The workshop was supported by New Zealand's Ministry of Research, Science and Technology and the Chinese Ministry of Science and Technology. The aim is to develop a collaborative project in Xinjiang that can be matched with research across a similar cross-section of natural and modified landscapes in the IMI programme.

An exceptionally strong altitudinal gradient at Fukang Station of Desert Ecology in Xinjiang has potential to provide a unifying theme linking research projects between the two countries on pest management, climate and land-use change. The gradient ranges from permafrost at 5000 m to alpine meadows and through forested valleys to agricultural land bordering arid dune systems at 800 m, to desert at 100 m below sea level (the second-lowest place on earth). This is an ideal 'natural laboratory' for understanding how climatic factors, interacting with ecological processes and extensive land use (nomadic pastoralism) and intensive land use (irrigated crops), limit the distribution and persistence of species, communities and ecosystems.



TECHNOLOGY TRANSFER - HIGHLIGHTS

This year we undertook \$17.2 million worth of research contracts for international clients, government departments, local government and the business sector. In essence, these contracts are about technology transfer – from investigative research to the end-users.

For each of the last four years, we have commissioned an independent survey of clients from these sectors to assess their perceptions of our performance. Overall, perceptions of us were very favourable with 91% of participants rating our performance as either ‘excellent’ or ‘very good’ (2009:70%) and positive feedback was received on our partnership-based relationships. Some clients also provided constructive ideas for improvement, which we will respond to over the coming year.

SECONDMENTS, CO-LOCATIONS AND JOINT APPOINTMENTS

We seconded staff to the Animal Health Board (to assist in developing operational procedures, and designing and running trials), Environment Canterbury (to provide a critical overview of how their soil, land and water datasets could be better integrated and used in understanding the effects of land use change), and Lincoln University (to assist with furthering the Te Matapuna Kaupapa Māori Unit initiative, including developing Māori research capacity, lecturing and supervising students).

This year, Landcare Research and Ngā Pae o Te Māramatanga jointly appointed a project leader for research aligned with Tainui’s 2050 tribal strategy, specifically to build capacity in Māori economic development, information and technology transfer, and to develop links with iwi, hapū and Māori land owners.

At our Auckland, Hamilton, Palmerston North, Wellington, Dunedin and Alexandra sites, we are co-located with client agencies and other CRIs. Our larger sites are all located next to universities, with one of our staff holding a joint Professorial appointment with Massey University.

STRATEGIC PARTNERSHIPS WITH IWI

During the year, we developed high-level strategic relationships with three iwi. We are working with Te Kotahi-a-Tūhoe, responsible for leading the Tūhoe Treaty claim, to provide a range of advice including models for the management of natural resources that would cater for social, cultural, environmental and economic aspirations.

We established an oversight group with senior executives of Te Rūnanga o Ngāi Tahu to provide strategic leadership for research collaboration, including opportunities around the ETS, Canterbury water management, and alternative land-use options. And we have reached a preliminary agreement with Te Kauhanganui o Waikato/Tainui to develop collaborative research opportunities that would help restore the mauri of the Waikato River and build capacity in kaitiakitanga development.



Discussing growth of 2-year old pines on rehabilitated mined land with Solid Energy staff

BIOCONTROL OF WEEDS – PARTNERING DIRECTLY WITH END-USERS

Our biological control of weeds research exemplifies best practice in partnering directly with end-users. New Zealand has an escalating weed problem costing many millions of dollars in lost production and ongoing herbicide use. For widespread and entrenched weeds, biocontrol is potentially a cost-effective, low-impact, long-term solution. We are one of the most successful organisations globally in introducing and establishing new biocontrol agents on a wide range of weeds. This year we made 52 releases of 10 species of insect against six different weeds.

We work closely with overseas counterparts to locate and extensively test potential agents before importing any into quarantine. New Zealand stakeholders are consulted before any agents are approved for release. Then we mass-rear, distribute and later monitor establishment and impact of the agents with support from regional councils, DOC, farming groups and others. A large measure of our ongoing success is due to the funding and direct involvement of these end-users. To assist stakeholders and end-users with understanding and managing biocontrol programmes, we run an annual two-day introductory training course interspersing indoor sessions with practical activities in the field. We also provide an advanced workshop each year. Organisations that are part of the National Biocontrol Collective can attend these courses free of charge.

'BIOSECURITY BONANZA' PROVES POPULAR WITH STAKEHOLDERS

Biosecurity Bonanza was a free, one-day workshop in Christchurch to present research highlights from our 'Beating Weeds II', 'Small Mammal Pest Control' and 'Invasive Mammal Impacts' programmes to some of our stakeholders. We had an overwhelming response with 130 people attending from all over New Zealand. Feedback was very positive, and with a really tangible buzz during the catering breaks on the day with considerable enthusiasm for this style of workshop to be repeated. Hence we will run similar annual workshops at different locations around New Zealand.



TEAM HOUSEWISE SHOWS RETROFITTING CAN PROGRESS SUSTAINABLE HOUSING

Team Housewise won the retrofit section of the nationwide Sustainable Habitat Challenge (SHAC) for innovation in sustainable design. The team was a partnership between our staff, University of Auckland's School of Population Health, Housing New Zealand and the New Zealand Housing Federation. For the SHAC Challenge, teams were given less than two years to design, fund and build their vision for more sustainable housing. Many teams opted for new buildings but Team Housewise worked closely with a Glen Innes family to retrofit their classic 1950s state house into a more comfortable, healthy and sustainable living space, as an example of what could be achieved with New Zealand's most common house type. In presenting the award, the judges commented on 'the inspiring potential of the project to make a difference to New Zealand.'

HATCHED, AN e-BOOK ON SUSTAINABLE DEVELOPMENT IN NEW ZEALAND

This year, we published *Hatched*, a comprehensive collection of interdisciplinary research findings, stories and case-studies from 30 authors covering all aspects of sustainable development research. It was designed primarily for practitioners in the public, business and community sectors but has also been enthusiastically received by universities internationally. In the first 3 ½ months there were over 4,000 visits to the *Hatched* web pages, and the entire book was downloaded by over 600 people; it has continued to get positive reviews.

BRANDED COMMERCIAL SERVICES

- HIGHLIGHTS

Business and industry are increasingly demanding credible and reliable solutions to a range of environmental and biodiversity protection issues. We have continued to commercialise and extend our range of world-leading services via dedicated branded businesses in response to climate change, environmental performance, wildlife tracking, pest management and wildlife forensics.

These commercial businesses continue to be a means of rapid technology transfer in highly dynamic market and regulatory environments adding significant value to New Zealand domestic and internationally focussed businesses.

OUR CARBONZERO^{Cert}™ PROGRAMME RECOGNISED INTERNATIONALLY

The carboNZero programme is now operating in four countries (New Zealand, Australia, Chile and the UK). This year, we signed an international licensing agreement with Bureau Veritas – the world's second largest certification business that manages a 5,500 client base – for the Australian market. Net revenue grew by 20% and total certifications by 51% compared with the previous year. The programme had 6.32 million tonnes of CO₂e under active management (5.57 Mt CO₂e in 2008/09).

CEMARS[®] has been recognised by the UK Environment Agency as a Carbon Trust Equivalent scheme under the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme. The recognition has been awarded for CEMARS as operated by our partner Achilles Information Limited who operate the scheme in the UK under licence to Landcare Research. Endorsement by the UK Government's environmental regulator means that UK organisations participating in the CRC Energy Efficiency Scheme now have a choice between approved providers when seeking certification of reductions in greenhouse gas emissions.

The carboNZero programme continues to win national accolades. It was ranked as the 11th fastest growing business in the Deloitte Top 50, won two categories in the Sustainable 60 awards, and was recognised by the Ministry for the Environment with a Green Ribbon Award for 'its efforts in reducing greenhouse gas levels'.

ENVIRO-MARK[®] NZ ACHIEVES 40% GROWTH

Enviro-Mark is an environmental management and certification programme. It performed well with 40% net revenue growth from last year. This year we secured the global rights and ownership of Enviro-Mark, which better positions us to strengthen and grow the programme for New Zealand businesses. We also worked with Telarc to increase the programme's auditor capacity, and secured more uptake in the printing industry through working in partnership with PrintNZ.

EBEX21[®] SIMPLIFIES THE COMPLEX ISSUE OF CARBON FARMING

Landcare Research set up EBEX[®] to facilitate land-use change, typically of marginal land, by landowners so that they can earn an income from the credits associated with regenerating native bush. In addition to emissions-offsetting, there are other environmental benefits such as biodiversity restoration, erosion control and moderation of water runoff. EBEX has focused on the PFSI as its preferred option for ensuring high quality credits that will provide better returns to landowners.

In a pilot programme with four landowners, the Ministry of Agriculture and Forestry (MAF) is expected to approve the first EBEX credits under the PSFI – a total of 1700 ha or 5100 credits (using the MAF default sequestration rate for indigenous forests of 3 tonnes CO₂e per hectare per year). Credits generated under the PFSI are Assigned Amount Units or AAUs, which are Kyoto-compliant and therefore recognised internationally.

ECOGENE[™] CONTINUES TO GROW

EcoGene provides DNA-based diagnostic services for applications in biodiversity and biosecurity. In 2009 EcoGene expanded its services to international users within Australasia and the USA. Highlights for the year include the development of four new services: murine typhus diagnostics, kiwi paternity analysis, testing for rodenticide resistance, and individual predator identification. For example, individual dogs can be identified from forensic material like saliva on predated native birds (domestic dogs are responsible for many kiwi deaths).

EcoGene is now New Zealand's core provider of wildlife forensic testing for Customs, the Department of Conservation, and MAF to help the fight against illegal trade of wildlife and biosecurity breaches.

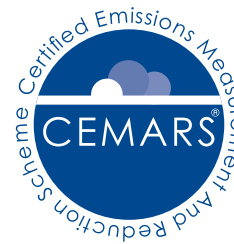
A new genome sequencer will be operational this coming year to increase throughput and expand the suite of genetic analyses on offer.

INTERNATIONAL CONSULTANCY SERVICES FOR INVASIVE SPECIES

Invasive Species International (ISI) consultancy services leverage off both New Zealand's and Landcare Research's reputations as leaders in pest management. Business has grown in the core markets of the Americas and Australia with a steady increase in the number of new projects secured or proposed; 19 projects were undertaken during the year. Four projects have already been secured for the 2010/11 year. Partnerships with Grupo de Ecología y Conservación de Islas (Mexico) and the Wildlife Conservation Society (Chile) were formalised. Further collaboration with the US-based not-for-profit organisation Island Conservation (IC) was a feature, with ISI providing independent advice to IC in several feasibility studies and project reviews. As a result of its activities and collaborations, ISI has emerged as a global leader in the provision of high-quality independent advice in invasive species management issues.

SIRTRACK® – WILDLIFE TRACKING SOLUTIONS

The export-focused business experienced a tough trading year with unfavourable exchange rates and the global credit crisis affecting the funding of wildlife conservation and research projects. Despite this, Sirtrack secured three international licence agreements for new technology and completed development of a new range of superior-performing products that are also much simpler to manufacture. These are expected to replace 80% of current business over the coming year, underpinning a major shift from a technology-led to a market-led business in accordance with their three-year business transformation and development programme.



OUR ORGANISATION



Robert Lamberts, Plant & Food Research

Landcare Research has won the national BikeWise Challenge for the last three years

LANDCARE RESEARCH IS A KNOWLEDGE ORGANISATION

People – talented researchers and innovators – are our lifeblood; and our values – clarity, curiosity and collaboration – underwrite our science success. Many of our senior scientists and their teams are recognised internationally as being leaders in their fields. We are also committed to fostering career development opportunities for our younger scientists, the leaders of tomorrow.

We provide a flexible and modern work environment that reflects best practice in organisational sustainability and smart working solutions. Our ongoing programme of investing in infrastructural improvements ensures the workplace is conducive to creative scientific thought and rigorous experimental programmes as well as enhancing our capacity for data management and sharing, and supports best practice in health, safety and environmental management.

As befitting an environmental research organisation, we continue our efforts to reduce the negative environmental effects of our own operational activities, processes, assets and supply chain.

Some key highlights only are presented here. We report comprehensively on our performance via our sustainability web pages (www.landcareresearch.co.nz/sustainability).

CERTIFICATIONS

ENVIRONMENTAL MANAGEMENT: ISO 14001

We maintained our ISO 14001 certification. This year's audit report stated: 'Since their last assessment, the company appears to have continued on a path of achievement. The management system was found to be well implemented and maintained, especially considering the diversity of competencies.'

HEALTH & SAFETY: ACC WSMP

For the seventh year running, we have attained tertiary-level accreditation under ACC Workplace Safety Management Practices. The auditor reported that staff and managers 'had a good understanding of the health and safety system and all spoke favourably on the proactive approach by Landcare Research'.

INVESTING IN PEOPLE

KNOWLEDGE & PROFESSIONAL DEVELOPMENT

We spent \$1,610 per FTE (equivalent to 2.35% of our payroll) on direct training, which includes conferences, training courses and further postgraduate study for our staff (but excludes travel allowances). This year we supported seven staff studying for their PhD and one who is completing an additional Masters. We also awarded an internal postdoctoral fellowship to one of our staff.

BUILDING LEADERSHIP SKILLS

Following enthusiastic feedback from the first cohort through our year-long Leadership Development Programme, we offered the course to another group this calendar year. The programme was developed in-house specifically to suit Landcare Research's needs, with a series of 1- or 2-day workshop modules conducted by internal and external facilitators. We also introduced a Line Managers Programme, with a similar modular structure to the Leadership Development Programme but specifically to support and improve operational management skills at this level. Participants have been consistently positive about both programmes.

WORKFORCE PLANNING

As part of our workforce planning processes, we regularly review our mix of capabilities, expertise and skill sets, and how this mix should be managed to best ensure Landcare Research's ongoing success. Workforce plans for key areas and talent management plans for key staff underpin retention, recruitment and talent management initiatives such as the Leadership Development Programme.

TURNOVER & RECRUITMENT

This year turnover for key senior scientists was zero and 7.8% across all science staff (12.5% in 2008/09), a pleasing result given the international competitiveness for high-calibre scientists. It has been increasingly difficult to attract candidates with specialist modelling capabilities in high growth areas such as greenhouse gas mitigation research. Of 21 new scientists recruited during the year, eight were women and eight were from overseas.

About two-thirds of our total staff self-identify as New Zealanders. The other third represent a very wide range of nationalities,

reflecting the global nature of science. Staff from overseas contribute significantly to establishing links with research institutes and universities in their home countries.

ENCOURAGING NEW SCIENTISTS

We continue to provide opportunities for postdoctoral researchers, attracting early-career scientists from many parts of the world (New Zealand, Australia, USA, UK, Ireland, Europe, Korea and Japan). Five commenced during the year bringing the total with us during the year to 17. Our staff also supervised 74 PhD and 24 Masters students.

TRAINING FOR GOOD WORKPLACE PRACTICES

Thirty-three staff participated in our annual Field Forum, with 12 staff joining in via videoconference from other sites. Topics covered included Field Intentions notifications, emergencies, Search and Rescue responses, personal locator beacons, dealing with anaphylactic reactions to wasp and bee stings, and posture and fitness for injury prevention. In addition 88 staff completed First Aid Training this year, including 14 who undertook Outdoor First Aid courses. During November/December, 58 staff attended internal Health, Safety and Environment Compliance Workshops at our four major sites. We continue to provide a range of IT training courses that are delivered to small groups in relaxed, hands-on tutorials. Courses are tailored to the needs of all Landcare Research staff, and are repeated at regular intervals throughout the year to maintain high skill levels and efficient use of computing resources.



Gwen Grelet, a visiting scientist from Aberdeen University

INFRASTRUCTURE SUPPORTING SCIENCE

SMART ICT SYSTEMS

Information and Communication Technologies (ICT) are integral to the way a science organisation works. We are part of the ultrafast Kiwi Advanced Research and Education Network (KAREN), which allows us to routinely move multi-GB files between sites quickly and efficiently. This is key to developing new ways of working and delivering high-tech data management, processing, modelling and visualisation applications from our research and databases. KAREN has also allowed us to extend our videoconferencing capability to connect with up to 10 or 12 other university and CRI sites simultaneously. This is of significant benefit for researchers working on collaborative projects that span national and international boundaries, and is opening up new opportunities such as real-time remote microscopy to improve access to NZAC primary type specimens. This has the potential to improve the speed and accuracy of biosecurity identifications, and facilitate biosystematics research without having to send the fragile specimens themselves.

We have continued to refine and improve internal e-management systems such as collaborative workspaces, a system developed in-house specifically to deliver multiple benefits for improved project tracking and reporting, and easy-to-use administration tools such as online approvals for company credit cards. Our library now has many electronic resources and online journals that staff can access via our intranet. Remote access to our systems now allows staff to be more flexible in when and where they work, including travelling overseas, in the field or working from home.

NEW INVERTEBRATE CONTAINMENT FACILITY (ICF)

The new facility was opened by the Minister of Conservation, the Hon. Kate Wilkinson, at Lincoln in April 2010. Investing in the construction of a new containment building was essential for the continuation of our biocontrol of weeds programme and other research. The old, leased facility was expensive to run and maintain, and increasingly unreliable. The new



facility is designed to be resource-efficient and provide more flexibility to meet research needs.

Before commencing the project, our Lincoln Site Manager completed Green Star training. We used draft material from the Ministry for the Environment's green building toolkit (www.Build360.org.nz) to guide design and construction stages, including materials use and waste management. Operational functionality includes rainwater-harvesting and energy-efficient design.

ENERGY MANAGEMENT AT OUR AUCKLAND SITE

Despite significant investment in Building Management System upgrades, energy usage at our Auckland building continued to exceed design targets. This year, in partnership with Energy Solution Providers, we installed further energy meters that enabled us to identify problem areas and significantly reduce our energy use. Given this success, we plan to roll out a similar system across our other major sites in 2010.

BACK-UP ELECTRICITY GENERATORS

This year, we installed back-up generators at both our Lincoln and Auckland sites to provide security of service, including phones and computer networks, during power outages. This was a major investment in ensuring business continuity during short-term outages through to major civil emergencies.

BUILDING REFURBISHMENTS

This year we upgraded the entrance and reception areas at our Palmerston North site. As with all facility refurbishments, we used sustainable furnishings and fittings including Resene paints, Life fabrics and Interface carpet tiles.

OUR ENVIRONMENTAL PERFORMANCE

CARBON-NEUTRALITY

We actively manage our activities and materials use to achieve a reduction in greenhouse gas emissions, and offset all remaining greenhouse gas emissions each year. This year we developed a Greenhouse Gas Emissions Management Policy to complement our Sustainability Policy.

We participate in the carboNZero^{Cert™} programme to measure, manage and reduce our emissions then purchase verified carbon credits to offset the remaining unavoidable emissions. Telarc, approved verifiers to the carboNZero programme, again reviewed our systems and records to verify that our carbon-neutrality claims reach carboNZero certification equivalency across all sites including Sirtrack. As this external verification report could not be completed in time for inclusion in our Annual Report, data presented at this time are unverified emissions; 2564 carbon credits (VERs from Meridian Gold Standard Windfarm and a PRE landfill project) have already been purchased through the carboNZero programme to offset these. As in previous years, any additional emissions identified during the audit process will be offset through the purchase of further carbon credits to ensure we are indeed carbon-neutral for the year. Updated, verified data will be presented on our sustainability web pages.

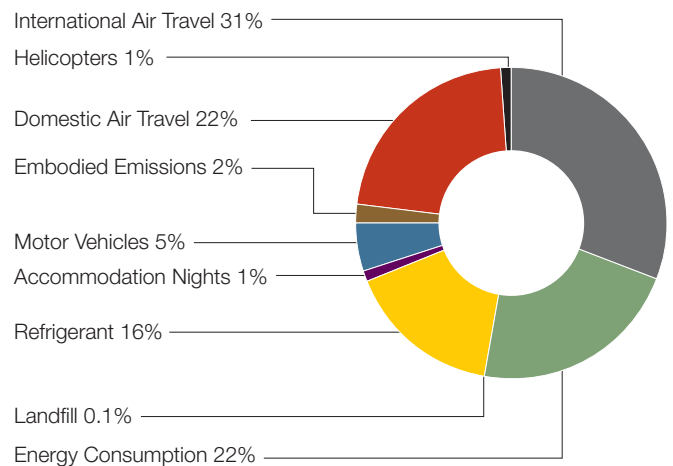
WASTE MINIMISATION

Since the baseline audit in May 2007 (22.54 kg total waste per FTE), we have been steadily reducing our waste with further improvements this year (4.54 kg total waste per FTE) compared to the previous year (6.18 kg). The avoidable (compostable or recyclable) component of our landfill waste has also shown a similar steady decline. This has been achieved through a continual focus on waste minimisation supported by evidence from twice-yearly skip audits.

ZERO ACCIDENTAL BY-CATCH OF NATIVE ANIMALS

Each year, we undertake a number of research programmes that involve routine trapping of vertebrate pests. While this

Source of our greenhouse gas emissions



type of work does not require Animal Ethics Committee (AEC) approval, we are committed to reducing accidental by-catch of non-target species, particularly native species. This is achieved largely through research that has enabled incremental improvements in types of traps used and trap-setting strategies. Results are reported to MAF each calendar year as studies are completed. In 2009, during 13 studies we caught 3,866 target animals (mostly possums and rodents) but only eight non-target native species, all of which were released unharmed.

All other projects involving handling of animals must have prior approval from our AEC. Last year, 21 new research applications and 11 amendments were approved. Usage is reported to MAF on completion of the projects.

COMPLIANCE WITH LEGISLATION

Our operations are subject to a broad range of legislation covering environmental, good employer, human rights and financial issues. There were no material instances of non-compliance during 2009/10.

PRESTIGIOUS RECOGNITION

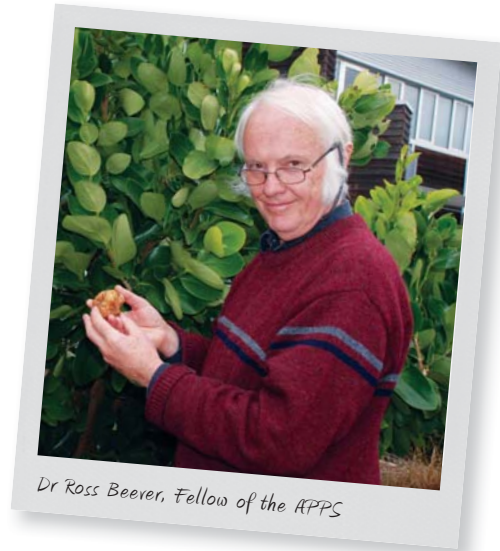
AWARDS TO INDIVIDUALS

GARY BARKER:

Invited *visiting curatorship* in malacology at Muséum national d'Histoire naturelle, Paris.

ROSS BEEVER:

Fellow of the Australasian Plant Pathology Society (APPS) in recognition of his significant contributions to plant pathology during a long and highly eminent career. His research on pathogens that cause diseases of economic crops and indigenous plants has advanced plant pathology, fungal and phytoplasma biology, fungal taxonomy and botany. Ross died of cancer in 2010, and is much missed by colleagues.



THOMAS BUCKLEY:

New Zealand Association of Scientists Research Medal, which is awarded each year to a young scientist aged under 40-years for outstanding research work, principally undertaken in New Zealand during the three preceding years.

Marsden Funding for Research Excellence for the project 'Evolution of cold tolerance in alpine stick insects'.

IAN DICKIE:

Marsden Funding for Research Excellence for the project 'Do ectomycorrhizal fungi determine ecosystem fate?'

DAVE MORGAN:

ANZCCART Award for Outstanding Service to Animal Ethics Committees (ANZCCART is the Australian and New Zealand Council for the Care of Animals in Research and Teaching).

ROGER PECH & ANDREA BYROM:

Chinese Academy of Sciences Fellowship to work with Chinese colleagues on pika outbreaks on the Tibetan Plateau. (Pika are small rodent-like burrowing animals.)





Dr Des Ross (left), Fellow of the NZSSS

DES ROSS:

Fellow of the New Zealand Society of Soil Science (NZSSS) in recognition of his impact on soil science over six decades. He was the first in the world to clearly show that elevated atmospheric carbon dioxide can cause soil organic matter to increase through its effects on plant growth. Des was a Research Associate and, despite being officially retired for more than 20 years, he continued working full time publishing a regular flow of papers until his death in 2010.

DAVID WARDLE:

Recipient of a Swedish 2010 Wallenberg Scholars Award (one of 10 awarded and the only one in the environmental sciences). David is a Landcare Research Associate with several collaborative New Zealand-based projects.

GUODONG YUAN:

Japan Society for the Promotion of Science Invitation Fellowship for collaborative research on soil carbon.

Several other staff were awarded *travel grants* from the International Relationships Fund (previously called the International Science and Technology (ISAT) Linkages Fund) administered by RSNZ, the NZ–Japan Scientist Exchange Programme, and the New Zealand–Hawaii Conservation Exchange Initiative.

COLLABORATIVE PROJECTS

TEAM HOUSEWISE (see page 29):

Won the retrofit section of the nationwide *Sustainable Habitat Challenge (SHAC)* for innovation in sustainable design.

CENTRAL OTAGO ECOLOGICAL TRUST (COET):

Won the *Regional Award for Heritage and Environment* in the TrustPower Community Awards, for its work in involving the community in restoring native lizard and plant populations in Central Otago. Landcare Research is a key partner and a Trustee in COET.

COMPANY AWARDS

THE CARBONZERO^{Cert}™ PROGRAMME:

Green Ribbon Award: (reducing our emissions category) from the Ministry for the Environment

2009 Deloitte Fast 50 Awards: Canterbury and Upper South Island's regional winner for the 'Fastest Growing Business Services' category; listed as the 11th fastest growing business in the Deloitte Top 50

Sustainable 60 Awards: the carboNZero programme won the 'marketplace' and 'strategy and governance' categories

LANDCARE RESEARCH:

Sustainable Business Network's Central/Southern Regional Awards: Winner of the 'Trailblazer Large and Corporate Business' category for businesses that have been actively implementing sustainability actions for more than two years, and demonstrating leadership by embracing sustainable practices into their day-to-day operations.

Sustainable 60 Awards: Landcare Research was a finalist in each of the 'workplace', 'environment', 'strategy and governance' and 'overall large exemplar' categories.



Kathryn Hailes & Prof. Ann Smith (carboNZero) with Amy Adams (MP for Selwyn, centre) at the Green Ribbon Awards

FINANCIAL PERFORMANCE SUMMARY

The accounts (for Parent and Consolidated Group) and audit report are in Part Two of our Annual Report and also available in full on our website. Part One and Part Two together constitute our statutory annual reporting responsibilities.

SUMMARY TABLE OF GROUP FINANCIAL PERFORMANCE INDICATORS

	2008	2009	2010 ^{1,2}	2010 ²	2011 ²
	Achieved	Achieved	Target	Achieved	Target
Revenue, \$m	56.07	60.25	62.26	61.66	64.29
Net revenue, \$m	49.52	53.13	55.07	54.82	57.57
EBIT, \$m	1.43	2.36	2.28	2.19	3.05
EBIT margin	2.5%	3.9%	3.7%	3.6%	4.7%
Total assets, \$m	44.58	48.35	45.98	50.31	49.24
Return on equity ³	2.5%	5.3%	6.4%	6.4%	7.0%
Equity ratio ³	60%	58%	62%	58%	61%
Dividend \$m	0.1	0.1	0.5	0.5	0.7
Gearing	13%	13%	6%	0%	0%
Interest cover	3.4	7.2	9.7	11.1	10.2



¹ Target as per 2009/10 Statement of Corporate Intent (SCI).

² 2010 and 2011, gearing is calculated based on net debt and return on equity excludes extraordinary restructuring costs.

³ Return on equity and the equity ratio exclude the impact of 0% building depreciation announced in the Government's 2010 Budget, \$3.7m for 2010. The return on equity and the equity ratio adjusted for the depreciation impact are -6.9% and 51% respectively.

Revenue:

Includes science research, contract work for government and commercial clients, royalties, licence fees etc., plus income from the sale of product and the lease of assets. It excludes income from interest on investments and from finance leases, \$0.3m for 2010.

EBIT:

Earnings before interest and tax, and after committed business development expenditure and commercialisation expenditure. It excludes restructuring costs.

Return on equity:

NPAT ÷ average shareholders' funds, expressed as a percentage. NPAT is net profit after tax. Shareholders' funds include share capital and retained earnings.

Equity ratio:

Average shareholders' funds ÷ average total assets.

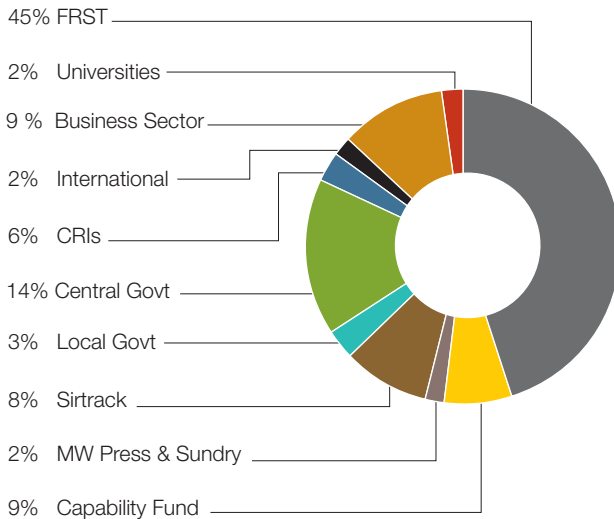
Gearing:

Financial debt includes all interest-bearing liabilities. Gearing = financial debt ÷ financial debt plus shareholders' funds, expressed as a percentage. (The Minister of Finance and the Minister of Research, Science and Technology each hold 50% of the shares on behalf of the public.)

Interest cover:

Interest is the cost of debt and financial leases. Interest cover = EBIT ÷ interest.

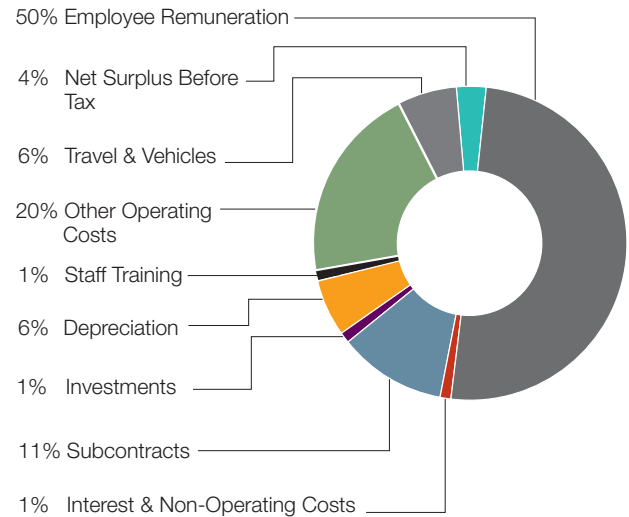
Where our revenue comes from



WHERE OUR REVENUE COMES FROM

- Foundation for Research, Science and Technology (FRST) 45% – contestably funded research programmes, negotiated funding and long-term OBIs
- Universities 2% – contracted services, some paid lecturing by our staff, and rentals for university staff located in our buildings
- Private & business sector 9% – principally contracted work for businesses and private organisations
- International 2% – development projects funded by donor agencies, international consultancy projects
- CRI 6% – research subcontracted to us in collaborative programmes
- Central government 14% – services contracted by government departments including DOC, MfE and MAF
- Local government 3% – contracted work for regional, district and city councils
- Sirtrack 8% – wholly owned subsidiary, which develops and produces telemetry equipment for tracking wildlife
- MW Press & sundry 2% – Manaaki Whenua Press is our natural history and science book publishing and retailing business centre
- Capability Fund 9% – MoRST funding used to maintain existing and develop new science & technology capability

Where our revenue goes



WHERE OUR REVENUE GOES

- Employee remuneration 50% – includes staff in management, science, support roles, commercial business and Sirtrack
- Travel & vehicles 6% – all vehicle and air travel by our staff, including the cost of leased vehicles. Landcare Research runs a mixed fleet of vehicles including 4WD and quad bikes for fieldwork, and cars and vans for road use
- Other operating costs 20% – includes electricity, carbon credits, software licences, insurance, consumables, and lease costs
- Staff training 1% – includes conferences, training courses and support for postgraduate study (2.2% of the total payroll)
- Depreciation 6% – includes accounting depreciation on buildings, science equipment and computers
- Investment 1% – support for technologies and services including those advancing through our commercialisation pipeline
- Subcontracts 11% – research subcontracted to other research providers, including CRI and universities in collaborative research programmes
- Interest & non-operating costs 1%

DIRECTORY

DIRECTORS

Jo A Brosnahan (Chair)
Graeme S Boyd
W Grant Guilford (From 1 July 2010)
Alastair R Lawrence (Deputy) (Retired 30 June 2010)
Hon. M John F Luxton
Robin Pratt
Peter M Schuyt (From 1 Sept 2009)
Tania J Simpson
Victoria A Taylor (From 1 Sept 2009)

SENIOR MANAGEMENT TEAM

Dr Warren J Parker: Chief Executive Officer
Carol R Bellette: Chief Financial Officer
Katrina F Direen: General Manager People & Performance
Mike S Lee: General Manager Business
Dr David P Choquenot: General Manager Biological Systems
Dr Richard FS Gordon: General Manager Environment & Society

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AUDITORS: Audit New Zealand on behalf of the Auditor-General
SOLICITORS: Buddle Findlay

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Landcare Research
Manaaki Whenua

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