Manaaki Whenua
Landcare Research

Landcare Research
DISCOVERY

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What's Inside:

The information superhighway

We are entering the age of information transformation where molecular biology, mathematical modelling and information technology converge to add value to existing databases and collections. The demand for access to such value creation from end-users is increasing dramatically.

Our biosecurity system relies on knowing what organisms we have here and being able to access identification tools; our responses to climate change via carbon sequestration are based on our knowledge of soils; biodiversity management depends upon knowledge of species and ecosystem trends, threats, distribution and relationships; cultural development of Māori is supported by access to knowledge and samples of culturally significant plants (e.g. harakeke); and resource management decisions rely on knowledge of soil and water resources.

This issue of *Discovery* highlights the role of databases and collections held within Landcare Research. The Foundation for Research, Science and Technology (FRST) currently supports a number of Nationally Significant Databases and Collections through the Public Good Science and Technology fund. These were transferred to Crown research institutes at their inception to be held in trust with the requirement the information be widely available at the cost of access.

Landcare Research has vested responsibility for 7 of the 25 recognised Nationally Significant Databases and Collections. These cover our biological resources (species and ecosystems), soil resources and cultural knowledge. In this issue, we share some examples of our collections and databases and illustrate how they are delivering benefits to end-users. We also highlight our leading role in improving access to information.

We are the largest holder of collections of our terrestrial flora and fauna, providing a priceless resource that covers the historical record of changes in our biota since the time of Cook's expeditions. Not all of our collections are preserved: the International Collection of Micro-organisms on Plants (ICMP) provides living cultures of fungi and bacteria to industry, and our Flax Collection is the source of cultivars for weaving.

Collections require specialised housing (with attention to fire and pest protection) and are always expanding: our arthropod and microbial collections are moving to new facilities in Auckland and we are planning expansion of the plant herbarium at Lincoln.

Many databases support the collections, but until recently, access to these has been slow and costly. The advent of the Internet and new database management tools has created new opportunities to add value to existing data and deliver benefits to users; a single query could unlock information held by the global research community.

To release this potential we are working through our collections and databases to make them internationally compatible. We are proud of our leadership in this area and our approach is now being widely adopted by many other data holders in New Zealand.

Landcare Research is committed to playing a leading role in the digital revolution. We will continue to develop cutting-edge approaches to deliver real solutions using as a base our substantial holdings in collections and databases on significant components of our terrestrial resources.

Photo credits: left to right, Harley Betts 1, 2, 6, 8, Dave Morgan 3, Landcare Research Slide Collection 4, 5, Peter Buchanan 7, Robert Lamberts, Crop & Food Research

Dr David Penman
Research Manager
Landcare Research

Collections provide answers to life's big – and little – questions

Landcare Research holds New Zealand's most comprehensive collections of insects, plants and fungi – invaluable scientific treasure troves that are constantly being added to. These collections provide crucial answers to questions that are vital to our national biosecurity and biodiversity. The Auckland-based collections are about to make the most significant move in their existence – across the city from Mt Albert to Tamaki. We profile those shifting and those staying put.

Bugs on the move

The New Zealand Arthropod Collection (NZAC) (Ko te Aitanga Pēpeke o Aotearoa) is one of those shifting house.

It is the largest and most complete collection of land invertebrates in the country, containing about 6.5 million specimens. Some 90% of these are from New Zealand, the other 10% from Pacific Island countries held on their behalf in our controlled storage conditions. The collection's role is to provide means to identify insects and their relatives, and authenticate the presence (or absence) of species in New Zealand for conservation and biosecurity purposes.

NZAC was set up in 1920, with the establishment of the Cawthron Institute. It moved from Nelson to Mt Albert in 1973 with the former DSIR Entomology Division, and since then the number of specimens has more than doubled. Transporting 6.5 million or so insects is cause for some trepidation. But, as NZAC's curator Dr Trevor Crosby explains, the improved conditions for the collections at Tamaki will make it all worthwhile.

Birgit E. Rhode

NZAC curator Dr Trevor Crosby, with some of the pinned specimens. These are native ground beetles, one of our best-collected groups.

'We have about a million specimens pinned out, while the softer-bodied invertebrates and larvae are stored in ethanol. On arrival in Tamaki, the pinned specimens will be transferred to drawers, which is a safer long-term storage method than the A4-sized wooden boxes – shelved like books in a library - we currently use. Also, the ethanol collection will be housed at temperatures between 10 and 12°C. At the moment they are stored at normal room temperature with the likelihood that the specimens will degrade over some decades.

'We intend for the collection to keep for hundreds of years, to provide a base for further developments in insect systematics and a snapshot of time so that future generations can see what was present or absent in New Zealand in the past.'

Dr Crosby says a diverse range of agencies refer to the collection and borrow specimens from it. These include researchers throughout the world, the Department of Conservation, the Ministry of Agriculture and Forestry, the Environmental Risk Management Authority, and universities.

'Across the board, the most common questions asked about the collection are what, where, when and how. For example: What insect is this? What species occur in New Zealand, and what is their status? Are these insects endemic, or are they pests? Where can they be found? When did they arrive, when are they active, and what do they eat? What are their natural enemies?'

Dr Crosby says the collection underpins quarantine and border control decisions, through verifying the presence or absence of species. It has even helped to save exporters money.

'For instance, some years ago a New Zealand milk powder exporter was told by a US warehouse to send product free of 'plaster beetles'. When we examined specimens contaminating the product in the US, we found through NZAC that the beetles in question were of a species not occurring in New Zealand, and therefore that the contamination of New Zealand product had occurred elsewhere - in the US warehouse. As a result, New Zealand exporters were not faced with potential fumigation costs, as we demonstrated the problem did not originate in New Zealand.'

Dr Crosby says the international relevance of

the collection stretches way beyond this example. 'As well as New Zealand agencies, NZAC is used by researchers throughout the world.

'About 90% of New Zealand arthropod species are endemic, found only in New Zealand, so overseas researchers take a keen interest in our unique forms.

'Only about 20% of New Zealand's insects have been adequately described so far, and we are continually making new discoveries.'

Future plans for the collection include the continued uptake of information into the *Fauna of New Zealand* monograph series, which has been widely acclaimed for its role in presenting New Zealand's unique invertebrate fauna to the world.

An increased amount of information will be placed on the collection's website. In addition, Landcare Research staff will continue to work with the Global Biodiversity Information Facility or GBIF (see p.12) to improve how this information links with overseas online databases.

Birgit E. Rhode

Softer-bodied invertebrates and larvae are stored in ethanol.

Documents about NZAC and its holdings: www.landcareresearch.co.nz/research/biodiversity/invertebratesprog/

Funding: FRST (Foundation for Research, Science and Technology)

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Bright future for fungi at new premises

Another collection on the move is the New Zealand Fungal Herbarium (PDD), the world's foremost collection of New Zealand fungi, and one of the few sizeable collections of fungi in the Southern Hemisphere.

The herbarium was established in 1920 by G.H. Cunningham, New Zealand's first resident professional mycologist; and was transferred to DSIR Plant Diseases Division in 1936. Today it contains more than 70,000 specimens, including 6,000 from the Pacific Islands and almost 20,000 from other countries.

The PDD's curator, Landcare Research mycologist (fungal scientist) Dr Eric McKenzie, says the new Tamaki premises sport improved storage conditions, including lowered temperature and humidity to reduce the risk of insect contamination. 'There will also be more space to accommodate growth.

'The herbarium is growing by about 2,000 specimens per year. All major groups of fungi are represented, with an emphasis on plant pathogens, other microfungi, and wood-decaying fungi.

'The collection includes some New Zealand material dating back to the early 1800s. We have some of the strangest fungi found in New Zealand such as the native vegetable caterpillar fungus *Cordyceps robertsii*, which mummifies its host caterpillar and fruits out of the caterpillar's head. But perhaps most importantly, we have many of the 50 'nationally critical' species listed in the Department of Conservation's highest conservation category. These are extremely rare and valuable specimens.'

Dr Peter Buchanan, who also works at the herbarium, says mycologists, plant pathologists, and government and research agencies around the world use the Herbarium.

'They refer to the herbarium and its staff for information on identifying and correctly naming fungi, determining which fungi are found on particular plants, their distribution and life cycles.

'Our Ministry of Agriculture and Forestry and Department of Conservation refer to the herbarium for answers to key biosecurity questions. Our economy is based on plants, and plant diseases are caused mainly by fungi or bacteria. Fungi can also cause deterioration of products and food. On the

plus side, however, other kinds of fungi are beneficial to plants, with over 90% relying on fungi associated with their roots to help absorb nutrients.

'Knowledge about fungi, their origins and their distribution is absolutely crucial to this country's economic welfare, and the fungal herbarium provides this information.'

Dr Buchanan says New Zealand has a high number of native fungal species, and fungi remain among the least known members of New Zealand's biota. 'Only about 6,000 species have been recorded and described, out of an estimated 20,000. This is mainly due to the traditional shortage of mycologists in this country.

'There is much room for exciting new discoveries.'

All data contained in the fungal herbarium can be accessed through the electronic database:
NZFUNGI:
http://nzfungi.landcareresearch.co.nz/
(see p.7)

Funding: FRST (Foundation for Research, Science and Technology)

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Birgit E Rhode

Landcare Research mycologist Dr Eric McKenzie in the fungal herbarium at Mt Albert, Auckland.

The International Collection of Micro-organisms from Plants is based in Auckland and is an intriguing store of live plant pathogens and other plant-associated fungi and bacteria.

ICMP contains more than 12,000 strains of micro-organisms. While there are many other international collections of fungi, ICMP is one of just four major international collections of plant pathogenic bacteria. It is an international repository for reference cultures of all bacterial pathogen-host combinations, receiving and sending out cultures from around the globe. The cultures are grown on sterile agar and stored in suspended animation over liquid nitrogen, at temperatures around -200°C. Because of the potential quarantine implications of the numerous cultures that originated from overseas, ICMP is housed within a locked containment facility. Access is limited to accredited personnel, and a MAF permit is required before any non-New Zealand culture can be removed from the facility.

Collection curator Dr Shaun Pennycook says ICMP is constantly in use for biosecurity enquiries. 'Agencies such as the Ministry of Agriculture and Forestry and the Environmental Risk Management Authority often request ICMP staff to advise on fungi and bacteria present in New Zealand or likely to be encountered as border interceptions.

Birgit E Rhode

Maureen Fletcher, ICMP Collections Manager, removing a rack of cultures from one of the liquid nitrogen storage tanks.

'The reference cultures held in ICMP are an important means of verification for identifications of intercepted micro-organisms. Considerable research in plant disease control in New Zealand and elsewhere is based on strains sourced from or deposited in ICMP.

'Other cultures held in ICMP support research in ecology and conservation – for example, the collection of strains of nitrogen-fixing rhizobial bacteria isolated from root nodules of New Zealand native legumes and introduced leguminous weeds such as gorse and broom.'

The culture collection began in 1952 as the personal collection of plant pathogenic bacteria and rhizobia of Auckland-based DSIR bacteriologist D.W. Dye. Fungal cultures have been included in ICMP since 1961.

Data on ICMP's cultures are accessible on the Landcare Research website:
ICMP: www.landcareresearch.co.nz/research/biodiversity/fungiprog/icmp.asp

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Plant collection sticks to its roots

Landcare Research's Allan Herbarium (CHR) is by far the largest plant herbarium in New Zealand – and because it is growing by up to 8,000 specimens each year there are long-term plans for it to expand. However, after a somewhat nomadic past, there are no plans for it to move!

The herbarium was founded in 1928 with the appointment of eminent botanist Dr H.H. Allan to the Plant Research Station, Palmerston North. It was relocated to Wellington in 1937, then to Christchurch in 1954, and then in 1960 to its current home, a purpose-built facility at nearby Lincoln. In 2001, it was named the Allan Herbarium to acknowledge its founder's contribution to New Zealand botany.

The herbarium now holds more than 550,000 plant specimens, including specimens collected by Banks and Solander on Captain Cook's first voyage to New Zealand in 1769 (see p.6). It contains species from around the world, but specialises in plants (indigenous and exotic) of the New Zealand region and the Pacific.

The Herbarium Keeper Dr Ilse Breitwieser says the herbarium's function is to collect and record the unique flora of New Zealand, and make this vital information readily available to researchers.

'The herbarium is the permanent repository for scientific vouchers, kept mainly as press-dried plant specimens, so that plant material used for any scientific study or plant list for a site can be confirmed at a later time. The herbarium has a special archival function to preserve records of plants occurring in habitats that have now been destroyed.

"Herbarium specimens are the basis for our understanding of the pattern of variation in nature. They are used by botanists to identify species accurately. Botanists can elucidate the relationships and evolution of species by extracting and sequencing DNA from herbarium specimens.

'The herbarium is used by ecologists to determine the geographic distribution of species, by biosecurity officers wanting to identify weeds, and by conservationists seeking knowledge to help protect plant biodiversity.

'Other enquiries come from a wide range of user groups including regional and district councils, museums, universities, and polytechnics. We also get visits from local schools, and natural health practitioners and students. And of course we handle enquiries from many overseas herbaria, including loaning specimens.

'In short, the herbarium benefits through correct identification and correct knowledge of species, and assists with border control programmes and conservation efforts.'

Several databases are associated with the Allan Herbarium. Two of the most important are:

- The **Allan Herbarium Specimens Database**, which is used to store and retrieve information on specimens, and generate specimen labels. It currently contains about 120,000 entries, about 20% of the specimens in the herbarium.
- **Ngā Tipu o Aotearoa – New Zealand Plants**, which provides the names of plant taxa that are wild in New Zealand (see p.7–8).

Dr Breitwieser says plans for the herbarium involve continuing to add specimens and keep specimen names up to date based on newest research results. There will be work on the databases associated with the herbarium to better link them with other New Zealand and even international databases. In the long term, there will also be work on rearranging herbarium cabinets to allow for expansion of the collection!

Funding: FRST (Foundation for Research, Science and Technology)

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Diana Leufkens

Dr Ilse Breitwieser in the Allan Herbarium with Landcare Research botanist Dr Steve Wagstaff, sampling plant specimens for DNA analysis.

The Banks and Solander Collection is a special taonga of the Allan Herbarium.

Sir Joseph Banks (1743–1820) and Daniel Solander (1733–1782) were scientists on board the Endeavour *during Captain James Cook's first expedition (1769–1770). Banks was just 25 and Solander was a talented ex-pupil of the grandfather of modern botany, Carl Linnaeus.*

The specimens Banks and Solander collected are the oldest herbarium specimens of New Zealand flora. Landcare Research holds 89 of these specimens in special fireproof vaults.

Allan Herbarium curator Dr Aaron Wilton says the specimens are in 'phenomenally good condition.'

'Banks and Solander did a remarkable job of preserving their specimens so well, especially considering the cramped and sometimes damp conditions on the Endeavour*. Visitors are astonished at just how well preserved the specimens are.*

*'The specimens include many common plants such as pīngao (*Desmoschoenus spiralis*) and mānuka (*Leptospermum scoparium*).*

'Perhaps the only difference from modern collection methods is that localities were not clearly specified. The accompanying Latin notes list a range of different places where the plant was seen.'

Dr Wilton says the specimens are scientifically valuable as a record of the vegetation present at the time.

'They may capture variation, or record plant populations that are no longer present. This, along with their historical value, is why we treasure them so highly.'

Funding: *FRST (Foundation for Research, Science and Technology)*

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Debby Redmond

Specimen of an epiphytic orchid (*Earina mucronata*), collected by Banks and Solander during Captain James Cook's first voyage.

The National New Zealand Flax Collection is maintained at Landcare Research in Lincoln. It comprises many cultivars of *Phormium tenax* (harakeke), and is an important scientific, historical and cultural resource.

The heart of the collection is the Rene Orchiston Collection, which was donated to the government in 1987. Landcare Research ethnobotanist Sue Scheele is kaitiaki (guardian) of the collection. Ms Scheele says Rene Orchiston's foresight in preserving flax varieties deserves special credit.

'Rene had seen that her friends were using poor quality plants for their weaving,' Ms Scheele says. 'She swapped divisions of plants older weavers favoured, grew them at her home and carefully documented them.

'Her collection is a taonga and forms the nucleus of the National New Zealand Flax Collection. The collection has been steadily extended and includes historic varieties planted on sub-Antarctic islands by sealers and Māori in the 1840s.'

The collection is much used for research on fibre qualities, in partnership with Te Roopu Raranga Whatu o Aotearoa (the national Māori weavers association). Landcare Research provides divisions of the flax to weavers, community groups and schools.

'There is also interest in using fibre in building materials and gums and gels in neutraceutical products,' Ms Scheele says.

It is perhaps appropriate that this relic of a major past industry is providing incentive to industry for the future. Flax was once our biggest export earner. Now most areas where flax grew have been drained.

'The flax that remains in the wider environment is not always the best for weaving or fibre. However, the flax collection is a priceless genetic storehouse of plants of known origin and reliability.'

Nadia Zviagina

Rene Orchiston and Sue Scheele among the flax at Lincoln.

Also:

Landcare Research is updating and revamping its unique database of traditional uses of New Zealand native plants, e.g. medicines, food and dyes.

Ngā Tipu Whakaoranga (sometimes called Peopleplants) is undergoing technical upgrades including a new server and improved links with other Landcare Research databases. New information is being added, and there are plans to add images.

The site features knowledge on more than 900 plants. All items of information are sourced and fully referenced.

Sue Scheele oversees the site. 'The wealth of knowledge contained in this database has been built up over centuries of careful observation and experimentation.

The site's main users include other Crown research institutes, the Waitangi Tribunal, Te Taura Whiri I Te Reo Māori (Māori Language Commission), researchers and students.

Ngā Tipu Whakaoranga: http://peopleplants.LandcareResearch.co.nz

The National New Zealand Flax Collection and Ngā Tipu Whakaoranga are funded by FRST (Foundation for Research, Science and Technology).

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New board chairman sows fertile ground for clean, green future

Prominent environmental businessman Rob Fenwick has been appointed as the new chairman of Landcare Research's board.

Mr Fenwick co-founded Living Earth, a company best known for converting biological waste into high quality compost. The company has played a lead role in a number of national waste reduction initiatives, and is a founding member of the New Zealand Business Council for Sustainable Development.

Mr Fenwick is a member of the ministerial task force for the national waste strategy, and a trustee of WWF and the Motutapu Island National Trust. He is also deputy chairman of TVNZ and chairman of the Antarctic Heritage Trust. For ten years he was chairman of Ngāti Whatua's successful broadcasting company Mai FM, and was a founder of the bottled water business, NZ Natural. In addition to all of this, Mr Fenwick is also a Commander of the Order of St John!

Mr Fenwick lives in Auckland with his wife and three daughters. The family have covenanted their 1000 acre Waiheke Island property to the Department of Conservation to protect its ecological values.

Mr Fenwick was named one of *North & South* magazine's New Zealanders of the Year in 2001, in recognition of his diverse achievements and his adherence to environmental principles.

He is optimistic about the future of efforts to conserve New Zealand's natural features.

'The age when environmentalists had to be militant to achieve change is largely over. Most big battles against exploitative behaviour by governments and industry have been won.

'The challenge now is to ensure the values of protecting biodiversity and promoting sustainable development become mainstream components of New Zealand's economic and social landscape.

'Landcare Research has a pivotal role in demonstrating to New Zealand the value of being clean and green, and the importance of investing wisely to ensure it remains so.'

Mr Fenwick regards his appointment as an honour. 'I am very fortunate to have an outstanding group of directors on the board to support me and a great management team under the direction of the chief executive, Dr Andy Pearce.'

Mr Fenwick replaces Ian Donald, who has retired.

Databases key to managing biosecurity and biodiversity

New Zealand's plants, fungi and bacteria are gaining an increasing Internet profile, as Landcare Research extends its searchable web-based databases.

The databases, **Ngā Tipu o Aotearoa – New Zealand Plants** and **Ngā Harore o Aotearoa – New Zealand Fungi**, provide crucial information about plants, bacteria and fungi, and are proving to be key biosecurity aids.

Scientific names are key to accessing information about our plants and fungi, yet these names often change as our understanding of a species and its family relationships improve. This creates difficulties searching for information because the user may not know all the names under which these data are stored. Therefore an accurate and up-to-date source of scientific names is required that links old

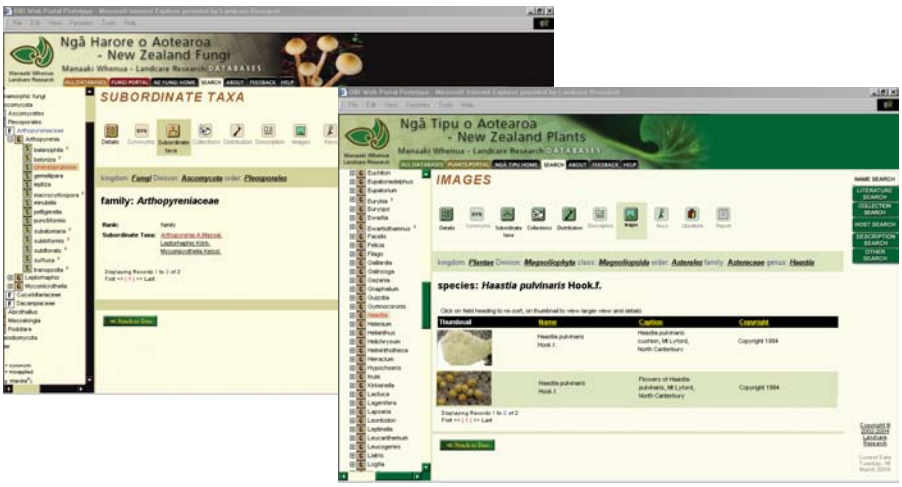
(synonyms) and new names. New Zealand Plants and New Zealand Fungi are providing users with this information.

Beginning in 1999, Landcare Research has gathered over 33,000 names of seed plants, ferns, lichens, liverworts, mosses and freshwater algae together in one database. This has been achieved through valuable collaborations with the Museum of New Zealand Te Papa Tongarewa, University of Canterbury, and Department of Conservation. New Zealand Plants has been available on the Internet since 2000 and is continually being updated by staff of the Allan Herbarium.

The database also includes over 10,000 vernacular and Māori names, and information on associated literature. Landcare Research botanist Dr Aaron Wilton, who manages the database, says many different people and organisations use the database including the Department of Conservation, MAF, regional councils, Te Taura Whiri i te Reo Māori (Māori Language Commission), botanical societies, university staff and students, overseas researchers, and members of the public.

Dr Wilton says the database is a key building block towards the aim of an online Flora of all New Zealand's plant species.

New Zealand Fungi provides New Zealanders with a comprehensive electronic catalogue of their country's known fungi – one of the first in the world. It contains crucial information for understanding the biology of fungi and the likely impact of exotic fungi on host plants. The collation of this information in readily accessible form aids the recognition of harmful exotic species that cross our borders and helps reduce the chances of their establishment.



Examples of pages from the Ngā Tipu o Aotearoa – New Zealand Plants and Ngā Harore o Aotearoa - New Zealand Fungi websites.

Based on core data from the New Zealand Fungal Herbarium (PDD), New Zealand Fungi was established in 2000 and documents over 6,000 New Zealand species and many from other countries. It lists all 70,000 fungal specimens in PDD and all 12,000 bacterial and fungal cultures in ICMP (International Collection of Micro-organisms from Plants), along with their collection data.

Landcare Research mycologist Dr Peter Buchanan says New Zealand Fungi is becoming a 'one-stop shop' for accessing information about New Zealand fungal and plant-associated bacterial species. Among its many features, the database has a bibliography, distribution maps for fungi, images and identification keys for some groups of fungi.

'It helps to answer questions like: What fungus is that? What is its correct name? What fungi have been recorded on a particular host plant? What is the known distribution of a specific fungus?'

The database is used by mycologists and bacteriologists around the world, as well as by MAF Biosecurity, DOC, plant pathologists, university students and the general public.

It is constantly being updated to maximise its relevance and comprehensiveness. Plans include building various user-specific interfaces to make the information more easily accessible by field workers, plant pathologists and biosecurity managers.

Ngā Tipu o Aotearoa - New Zealand Plants: http://nzflora.landcareresearch.co.nz/
Ngā Harore o Aotearoa - New Zealand Fungi: http://nzfungi.landcareresearch.co.nz/

Funding: FRST (Foundation for Research, Science and Technology) , New Zealand Biodiversity Strategy TFBIS project

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Living record of New Zealand's vegetation proving to be priceless

A unique databank containing detailed vegetation measurements over six decades has survived the perils of civil service restructuring to save the country millions of dollars today.

The National Vegetation Survey Databank (NVS, pronounced 'Nivs') is curated by Landcare Research. It provides a unique record of indigenous and exotic plants from Northland to Stewart Island, as well as the Chatham and Kermadec islands. NVS contains detailed measurements of vegetation from about 52,000 'plots'. The data show the abundance of particular plant

species, plant size, location variables, and other measurements.

An early form of NVS began in the 1950s as an archive for data collected by the former New Zealand Forest Service, and some data were stored electronically from the 1970s. But as NVS manager Dr Peter Bellingham explains, the late1980s was a dark time.

'During civil service restructuring, data collection languished, and valuable historical data were lost forever. Fortunately, some of these irreplaceable records were rescued from rubbish tips.

'Today NVS comprises a computer database and a physical archive, with files stored in fireproof vaults at Landcare Research.'

Dr Bellingham says a conservative estimate of NVS' current economic value would be around $60 million.

'Much of its value lies in historical information that can not be collected again.

'NVS helps to answer questions that could not have been foreseen at the time of collection. For example, data from permanently marked plots established in the 70s and 80s allowed New Zealand to construct a 1990 estimate of carbon for Kyoto, without any new fieldwork, saving nearly a million dollars.

'We will continue to see new issues arise for which NVS data will be useful.'

Dr Bellingham says NVS has helped answer common questions of land managers concerning changes in plant species composition. 'Are certain trees and shrubs becoming less common? Is the composition of vegetation changing? Are our native forests and grasslands being invaded by more weeds, and which are the most widespread?

'In New Zealand, unlike many other countries, questions concerning population growth and mortality of plant species and the extent of exotic invasions can be answered with statistical confidence. This can allow a rational assessment of where best to target protection efforts.

Claire Newell

Landcare Research technicians measuring coarse woody debris on a 20 x 20 metre permanent NVS plot in Fiordland.

'For example, kāmahi has been regarded as a species under threat by possums. But using data from NVS, we could see that kāmahi populations are, on the whole, in balance. In contrast, Hall's tōtara replaces itself at a slower pace, and is becoming rare.'

'This type of information helps managers target their conservation efforts, to increase effectiveness and reduce costs. NVS has underpinned DOC's interpretation of the effects of introduced herbivorous animals. DOC is also using NVS data to design a long-term research programme examining deer impacts in forests.'

DOC is the major user of NVS data and the key contributor of new information, followed by Landcare Research. Other users include the Ministry for the Environment, the Ministry of Agriculture and Forestry, regional councils and university staff and students.

Such widely sourced information collated in one databank is part of NVS's value. There is increasing interest in accessing NVS data for global databases. At the same time, the interests of data providers are protected through written agreements that determine access rights. Dr Susan Wiser of Landcare Research has been appointed to an international working group to set best-practice standards for vegetation data management and exchange.

A major plan, funded by TFBIS (see p.12) will increase the amount of information available and improve data entry and retrieval processes. The plan includes direct links to the authoritative database for New Zealand Plant Names: Ngā Tipu o Aotearoa - New Zealand Plants (see pp. 7-8).

Plans for improved conditions for NVS' physical archives are also in discussion.

Internationally renowned ecologist Professor Mark Westoby from Australia's Macquarie University describes NVS as 'the world's best vegetation database.' As University of Cambridge lecturer in ecology Dr David Coomes says, 'the sheer size and geographic scope of NVS is an immense asset.'

NVS: http://nvs.LandcareResearch.co.nz

Funding: FRST (Foundation for Research, Science and Technology); Department of Conservation TFBIS fund; Ministry for the Environment

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Database 'dishes the dirt' on New Zealand soils

Priceless information from Landcare Research's soil database has for years been helping to boost primary production, and is now yielding answers to emerging questions on pollution and climate change.

The **National Soils Database (NSD)** was set up 50 years ago, and now contains information on soil from more than 2,500 New Zealand sites, as well as sites in the Pacific Islands and the Ross Sea Dependency (Antarctica). The information is obtained from excavated pits, usually up to 1.5 metres deep but sometimes deeper, from which soil scientists collect samples for chemical and physical analyses. A rich data set is kept, with more than 500 soil and site attributes for each soil profile.

Landcare Research programme leader Dr Allan Hewitt says the database was set up with the aim of providing an understanding of the chemical and physical soil properties to underpin the development of New Zealand agriculture, horticulture and forestry.

However, a shift in research goals from production to sustainable development and environmental protection has required new investment in the database.

'For example, our ability to report internationally on our Kyoto greenhouse gas obligations depends on NSD data. Researchers need these data to produce an inventory showing how much carbon there is in New Zealand soils, and the rate that carbon levels are changing.

'Researchers also use the NSD to answer questions as diverse as: How well do soils absorb specific pollutants? What areas are sensitive to nitrate leakage through the soil to groundwater? What areas are suitable for a new crop? What areas are most susceptible to the spread of a new weed?

'Also, for urban development, where are soils with high shrink-swell properties that require special building foundation design'?

Ian Lynn

Landcare Research soil scientist measuring soil colour at an NSD sample site near Middlemarch, Otago.

In addition, the NSD underpins NIWA's **Topnet** model, which predicts the effects of changing land use on river flow. The soil data are a crucial component of this model.

The NSD also underpins Landcare Research's award-winning **Land Environments of New Zealand** (**LENZ**) classification system, which is now widely applied in biodiversity management (see *Discovery, Issue 7*). 'LENZ could not have been developed without the soil data to underpin it,' Dr Hewitt says.

NSD users also include universities, regional councils, the Ministry for the Environment and other central government agencies, and rural servicing agencies and agribusiness (e.g. Fonterra).

Dr Hewitt says work is continuing, to further increase the NSD's value as a national asset.

'It is becoming increasingly integrated with related databases. This will greatly assist in making efficient analyses across soil, land, climate and biotic systems.

'We will shortly provide Web access to the database, and we are also developing various related information products.'

Meanwhile, work at 'grass roots' level is also steady.

'We are continuing to collect and analyse soil samples, selecting sites according to particular projects and to fill gaps in the national coverage.'

The National Soils Database: www.landcareresearch.co.nz/databases/nsd.asp

Funding: FRST (Foundation for Research, Science and Technology)

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Databases – more than the sum of their parts

Information scientist Dr Jerry Cooper is leading Landcare Research's project to integrate databases, within the company, around New Zealand and even around the world. Dr Cooper explains the background to the project, the philosophies behind it, and the progress made so far.

Some years ago John Burley, a Landcare Research Hayward Fellow from Harvard, worked with Landcare Research staff to develop a vision for the future of our seven Nationally Significant Databases. These represent a rich data source spread across many disciplines. As a result the Database Integration Project began in 1999.

The continuing revolution in ICT (Information and Communication Technologies) creates ongoing challenges in the maintenance and development of these databases. How do we

ensure the systems capture what we need now, and what we might need in five or ten years' time? How do we manage security whilst simultaneously facilitating access to these resources by end-users working at their computers, either here or on the other side of the world? How do we manage the rapid developments in ICT that can make our systems obsolete, whilst keeping within a sensible budget? How do we ensure individual scientists are acknowledged for their effort in adding value to these increasingly important digital assets?

Integration and Interoperability

Historically, information resources were created to serve one or a few specific purposes, and little thought was given to how they might operate in unison. However, their utility increases remarkably as we link information resources together. New patterns appear and new syntheses become possible as more data are pooled – the human genome project is just one example. New technologies and increasing efforts toward standardisation are enabling and driving this global data networking activity.

Within New Zealand we have high-level initiatives such as the E-Government Interoperability Framework (E-GIF) addressing this issue. At Landcare Research we are involved in the international effort in a number of specialist areas, for example the Global Biodiversity Information facility (GBIF – see p.12) and the Taxonomic Databases Working Group.

Effective engagement in these activities requires skills in the subject discipline together with a good understanding of the information-enabling technologies. This broad combination of skills is the relatively new discipline called **Informatics**, and increasingly we will see references to the terms **Bioinformatics**, **Ecoinformatics, Geoinformatics, Biodiversity Informatics** etc. The development of skills in these disciplines doesn't commonly form part of current higher education curricula, and neither do people with these skills generally work in the IT industry.

Image: Mark Fuglestad

Five heads are better than one:
Key members of Landcare Research's Database Integration team pool their resources to expand access to scientific data.
From left: Jerry Cooper, Mark Fuglestad, Nick Spencer, Michael Wilson and Michael Cochrane.

So how has this big picture influenced database development at Landcare Research? Over the course of the project we have built a team skilled in the appropriate informatics disciplines. We were early adopters of some of the new technologies, many of which have emerged and matured during the project. We developed standards for data and metadata (description of your data) and made a substantial investment in developing the databases and other information resources described in this issue of *Discovery*. This robust information infrastructure is allowing us to deliver information through new web interfaces and these will continue to be refined in response to user needs.

For efficient data management we needed to design systems to physically integrate some resources, while ensuring the interoperability of other resources that will continue to be maintained separately. For example, indexes of names of organisms can be used to cross-link, and thus integrate, many datasets. To serve our community of taxonomists it is essential to have a robust system for managing these data. Taxonomic information systems are notoriously complex and much global effort in Biodiversity Informatics research has gone into this area. These systems can't currently be bought off the shelf and the taxonomic information system we have developed is 'state of the art'.

Geospatial data are another fundamental integration point between datasets and Landcare Research has a parallel **Spatial Data Integration** project to facilitate this. Another parallel spin-off project has been the development of our **Research Data Repository**. In addition to the databases, much data generated by scientists reside in spreadsheets, documents, and 'one-off' MS-Access databases. It isn't cost effective to design database solutions for all this 'semi-structured data' but neither should we ignore it. The RDR provides an accessible and secure archive for these digital assets.

Increasingly the skills developed by the team in creating these solutions are being used for new and exciting developments outside database integration, including many TFBIS-funded projects (see p.12).

Landcare Research has made substantial financial and physical investment in its information infrastructure through developments like the Database Integration Project.

The primary product of any research organisation is information, and without such investment organisations risk becoming marginalised in the global information marketplace. The longer these developments are delayed, the more expensive will be the investment to become part of the bigger information community that will drive the emerging knowledge economy.

Funding: FRST (Foundation for Research, Science and Technology)

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GBIF and TFBIS – acronyms for the future

GBIF: acting globally

Landcare Research is leading New Zealand's contribution to GBIF – the Global Biodiversity Information Facility. The aim of GBIF is to make the world's biodiversity data freely and universally available. New Zealand scientists have been helping with the groundwork of GBIF, and will soon be linking in information.

GBIF was established in late 2000 by an OECD working group on biological informatics. Its terms have been signed by 24 participating countries, 15 associated countries and 22 associated organisations, such as IUCN (International Union for Conservation of Nature), UNEP (United Nations Environment Programme), Species 2000 and others. The GBIF vision is to contribute to economic growth, ecological sustainability, social outcomes and scientific research, by freeing up and sharing vast quantities of information on living things. GBIF will eventually provide access on the current state of knowledge on the 'what, where and when' of all known organisms.

Dr Jerry Cooper manages New Zealand's contribution to GBIF. 'GBIF is basically a technical framework for mobilising and integrating biodiversity data locked up in natural history museums and collections, and species databases. GBIF is to biodiversity data what Napster was to disseminating music files over the Internet – except GBIF is legally encouraged!

'Already, much effort has been invested in developing data access and interoperability standards to allow the global system to operate. Also, species information that was not previously stored electronically has been entered onto computers, and the first global Names Indexes created.

"GBIF is quickly evolving as an interoperable network. It already provides access to 13 million records from 34 data providers around the world.'

Dr Cooper says New Zealand is about to make its first contribution to GBIF. 'This will come from selected databases, such as NVS, at Landcare Research and NIWA within the next few months.

'There are plans to expand the GBIF data provider network to organisations across New Zealand from the end of this year.'

Dr Cooper says GBIF will also provide 'virtual repatriation' of historical data about New Zealand species currently stored only in Northern Hemisphere institutions. 'Likewise, it gives New Zealand the chance to provide access to the wealth of data we hold about species from across the Pacific Islands.'

GBIF: http://www.gbif.org

TFBIS: acting locally

*Landcare Research manages 15 projects designed to increase New Zealanders' access to knowledge of this country's flora and fauna, as part of the **TFBIS** programme.*

*In early 2000, the Government adopted the **New Zealand Biodiversity Strategy** to halt the decline in the variety of naturally occurring plants, animals and ecosystems in New Zealand. TFBIS stands for **Terrestrial and Freshwater Biodiversity Information System Programme**, and is an important part of the Strategy. The purpose of TFBIS is to support the conservation of New Zealand's indigenous biodiversity by increasing awareness of and access to data and information about indgenous biodiversity and how to conserve it.*

Dr Cooper says the current TFBIS projects run by Landcare Research will unlock a wide variety of information. 'Our collections contain historical data on occurrence and distribution of organisms and many specimens represent "types", which are the unique collections on which a species name is based.

'Many of these valuable data are not yet available electronically and TFBIS is supporting our efforts to digitise this enormous back-catalogue.

'Another project will display the relationships between organisms being uncovered by modern molecular biology techniques, whilst still other projects will deliver online descriptions and images of thousands of species described in the literature together with dynamically generated distribution maps.'

TFBIS: http://biodiversity.govt.nz/land/nzbs/information/tfbis/index.html

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