# The New Zealand Plant Collections Register©

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This paper outlines the creation of a plant collections register and an associated cultivated plant names resource for New Zealand. This project was officially launched at the "Up the garden path" conference in Wellington on 3 March 2015.

## WHAT IS THE PLANT COLLECTIONS REGISTER PROJECT?

The project provides a free online system to manage and deliver information on living plant collections throughout New Zealand. It is available for use by botanic gardens, arboreta, garden groups, plant societies and private collection holders for entering and updating information on plant collections. These records are viewable and shared online with anyone interested in cultivated plants, both native and exotic.

In addition to managing living (and historic) plant records, the project has provided an extensive source of cultivated plant names – more than 40,000 – including botanical names (e.g., genera, species, subspecies, varieties and cultivars), synonyms and common names. These names are sourced from New Zealand nursery catalogues and other horticultural literature.

## WHY DO WE NEED THIS PROJECT?

The collections register aims to resolve several issues surrounding cultivated plants. First and foremost, there has been a major lack of knowledge and poor cataloguing of which cultivated plants are present in New Zealand. We still don't fully know: what is in this country, what it's called, or where it's growing.

In comparison to the extensive diversity of plants found only in cultivation, New Zealand's much smaller flora of native (endemic and indigenous) and naturalised (weedy) species are well known and documented comprehensively. A running total (<www.nzflora.info>; accessed May 2015) indicates that there are about 3046 native representatives compared with about 2618 fully naturalised vascular plant taxa.

Dr. Keith Hammett, ornamental plant breeder and current President of the Royal New Zealand Institute of Horticulture (RNZIH), summed up the cultivated plants problem by saying "Managing the country without knowing everything in the flora is like managing a supermarket without knowing everything on the shelf" (Hammett in Dawson, 2010).

Lack of knowledge and ineffective cataloguing of which cultivated plants are present in New Zealand severely hampers biosecurity management, both pre- and post-border, as well as impairing effective management of living collections and horticultural practices.

Pre-border problems arise for plant-breeders and growers trying to import plants under the Hazardous Substances and New Organisms (HSNO) Act (New Zealand Government, 1996). For importation, the MPI Plants Biosecurity Index (PBI; <www1.maf.govt.nz/cgi-bin/bioindex/bioindex.pl>) is the database used to determine if a species is already in New Zealand. However, the PBI is incomplete and lists about 29,000 species out of more than 40,000 exotic plant taxa thought to already occur in New Zealand. (The estimate of the number of exotic taxa in New Zealand will become more accurate, including a breakdown into the numbers of genera, species, subspecies, varieties and cultivars, when we combine several plant names datasets generated for this project. Accurate quantification of the numerous cultivars is likely to raise the total number of taxa estimated for New Zealand.) Furthermore, the PBI lacks author authorities for plant names and seldom lists synonyms or names below the rank of species (Dickson, 2009). These shortcomings mean that importers are faced with trying to prove that a species is already in the country or else pay for what may be an unnecessary and expensive full

assessment for release through the Environmental Protection Authority (about NZ$17,250 per application). As a consequence, the importation of new plant species and germplasm have effectively ceased, severely restricting New Zealand's abilities to produce new plant selections for its agricultural, horticultural and forestry industries. In 2002/2003, exports from these three land-based plant sectors earned the country $18.5 billion (MAF, 2003). The importation difficulties for plants have been highlighted by several interest groups and authors (e.g., Cave, 2004; Douglas, 2005; Johnson, 2006; Hammett, 2009).

Post-border problems arise because the greatest source of new weeds is not new biosecurity border incursions but plants that are already here "jumping the fence" and escaping from cultivation. Many of these horticultural escapes are through the careless disposal of garden waste, and a rise in the popularity of cottage and herb gardens and wildflower plantings (Heenan et al., 2002). This is a growing problem and every year several species become new weeds in New Zealand. Inadequate knowledge of these potential new naturalisations hampers effective weed management. In 2004/2005, the cost to New Zealand of dealing with weeds was estimated to be $100 million per year (Local Government and Environment Committee, 2006).

In addition to economic values associated with pre-border biosecurity and post-border weed management, there are significant aesthetic, conservation, cultural, educational, and social values of native and exotic plant collections. As stated by the late conservationist Dr. David Given et al. (2006): "Good quality nationally important collections of plants, whether native or exotic, need to be recognised as national treasures just as much as works of art and buildings." Despite the value of these collections, there has been a lack of up-to-date, well resolved and publicly accessible information covering genus-based collections, ethnobotanical and taonga (traditionally prized) species, rare plants and heritage cultivars (on the other hand, notable trees are accommodated to a large extent by the Notable Tree Register, managed by a trust of the RNZIH, the New Zealand Notable Trees Trust, <www.notabletrees.org.nz>).

For example, New Zealand is recognised as an important international repository for cool-temperate exotic biodiversity collections – species and genotypes that may be rare or endangered in their original countries (especially Asia, Europe, and North America). However, our knowledge of these exotic species and cultivars and where they are cultivated in New Zealand has been remarkably poor and there are few, if any, active conservation management strategies for them. Biodiversity management of living collections provides germplasm for plant breeding and propagation material for ensuring continuity of valuable selections.

We also need to take better stock of our long-term living collections. The total range of plants held in cultivation is much wider than stock being offered for sale from commercial plant nurseries in any given production year, especially given the current trend to market a narrow range of in-fashion plants. Sadly, several historic cultivars have already become lost to horticulture before their rarity in New Zealand became known.

Key issues that the New Zealand Plant Collections Register project aims to resolve are:

- Lack of knowledge and poor systems to catalogue the cultivated flora
- Lack of access to information
- Poor validation of plant names and identifications
- Declining or inaccessible expertise
- Lack of funding and resources to identify, describe, and catalogue cultivated plants.

## WORKSHOPS AND FUNDING

These aforementioned issues were clearly identified at a workshop held in Wellington (9 September 2009), entitled "The cultivated plant names problem: towards a multi-agency solution" (Dawson, 2010). A follow-up workshop was also held in Wellington (29 July 2010), entitled "Scoping the new Plant Collection Register" (Sole, 2010). Both workshops brought together a wide range of stakeholders to seek practical solutions. Groups represented included attendees with various roles (e.g., database developers, horticulturists, policy managers, private professionals and scientists), organisations (e.g.,

the Department of Conservation; Eastwoodhill Arboretum; the Environmental Protection Authority; Landcare Research; local government; the Ministry of Primary Industries; the Ministry of Business, Innovation and Employment; universities and polytechnics), key interest groups (e.g., Botanic Gardens Australia and New Zealand, the New Zealand Organisms Register, New Zealand Tree Crops Association, Plant Imports Action Group and the Royal New Zealand Institute of Horticulture) and several sectors (e.g., plant breeding, botanic gardens, research and the regulatory sector).

These workshops and proceedings documented the case for a funding application which was prepared by the author (MD) on behalf of the RNZIH. As a result, in November 2011 the Terrestrial and Freshwater Biodiversity Information System (TFBIS) programme provided a $175k grant for 3 years. The TFBIS Programme is funded by the Government to help achieve the goals of the New Zealand Biodiversity Strategy, and is administered by the Department of Conservation.

A co-funded project, to digitise Duncan & Davies nursery catalogues and make them available as online PDF's, is supported by the Sir Victor Davies Foundation and Peter Skellerup Plant Conservation Scholarship (2012, $10k), the George Mason Trust (2013, $5k) and a Lottery Environment and Heritage grant (2014, $28.5k). Duncan & Davies was New Zealand's largest nursery and founded in the late 1800s (Jellyman, 2011). This associated project is providing access to the historically significant series of catalogues (<www.rnzih.org.nz/pages/nurserycatalogues.html>) and is contributing a major source of cultivated plant names.

## A PIONEERING PLANT REGISTER

This project builds upon a pioneering register developed by the RNZIH from 1989 to 1993 (Hammett, 1993; Table 1). The plant collection group responsible at that time included Dr. Keith Hammett, Dr. Marion MacKay, Mike Oates and the late Winsome Shepherd.

The original register was based on questionnaires returned by collection holders throughout New Zealand. This was a well-founded initiative but limited in scope. It provided an index to collections and was a genus level survey with no cultivars or individual plants listed – although supplemental paper-based information was filed. Of course, living plant collections are always subject to change over time as old plants die and new ones are planted. Valuable collections are also lost when institutions lose interest or custodians become too old to maintain them. The 1993 register is now more than 20 years old and is consequently out-of-date.

This first register was ahead of its time now that internet technologies such as online databases and other tools have come of age. These new systems provide the best means of delivering and managing plant collection information.

## HOW HAVE WE CREATED THE NEW REGISTER?

We have followed several key concepts in this project:

- Federated data (information that draws on and is shared in different ways by component databases)
- Shared platforms (sharing pre-existing platforms and solutions)
- Open source coding (where programme code is freely available to the world community of developers for adapting and enhancing)
- Multi-contributor and collaborative (e.g., "Citizen science" and "Crowd-sourcing").

By following these concepts we have avoided creating stand-alone systems that do not interconnect, are developed by too few contributors, and which may have a short or vulnerable product life.

There are two major components to the project: the plant collections register itself and digitising of cultivated plant names.

Table 1. The first 20 records of the 1993 Plant Collections Register (genus listing).

| No | Collection | Spp. | Cvs. | Records* | Holder | Town | AIS** |
|---|---|---|---|---|---|---|---|
| 1 | *Abies* [1] | 59 | 6 | | MacKay Survey '90 | Countrywide | |
| 2 | *Acacia* | 31 | 1 | P/Cp | Dunedin Bot Garden | Dunedin | + |
| 3 | *Acaena* | | | C/Cp | Landcare | Lincoln | - |
| 4 | *Acca* | | | | Hort Research Inst | Palmerston Nth | |
| 5 | *Acer* | 25 | | | Dennis Schwarz | Wanaka | - |
| 6 | *Acer* | | | | Harrisons Trees | Palmerston Nth | + |
| 7 | *Acer* | 16 | 19 | | New Plymouth DC | New Plymouth | - |
| 8 | *Acer* | 23 | 17 | C/H | Timaru Bot Gardens | Timaru | + |
| 9 | *Acer* | 7 | 14 | C/H | Tupare QEII Trust | New Plymouth | + |
| 10 | *Acer* [1] | 90 | 63 | | MacKay Survey '90 | Countrywide | |
| 11 | *Actinidia* | | 155 | | Hort Research Inst | Palmerston Nth | |
| 12 | *Adiantum* | 6 | | | Mrs A. Lau | Paraparaumu | + |
| 13 | *Aesculus* | | | | Harrisons Trees | Palmerston Nth | |
| 14 | *Aesculus* [1] | 16 | 10 | | MacKay Survey '90 | Countrywide | |
| 15 | *Agapanthus* | | | P/H/Cp | Auckland Bot Gdn | Auckland | - |
| 16 | *Agapanthus* | | | | Bill Dijk | Tauranga | + |
| 17 | *Agathis australis* | | | | Cornwall Park Trust | Auckland | - |
| 18 | *Agave* | 55 | | | Martin Walker | Port Charles | + |
| 19 | *Agave* | | | | S. Miehe | Rotorua | - |
| 20 | *Albizia* | | | | Harrisons Trees | Palmerston Nth | |

*Records: C = Complete, P = Partial, H = Hand records, Cp = Computer records.
**AIS = Additional information supplied (+).

**Plant Collections Register**

This part of the project provides a comprehensive and easy to use system for the New Zealand horticultural community to manage and share their collections online for free. Some of the larger datasets of living plant collections in New Zealand include:

- Auckland Botanic Gardens (>44,000 records)
- Eastwoodhill Arboretum (>17,000 records)
- Hamilton Gardens (>15,000 records)
- Wellington Botanic Gardens (>8000 records).

Rather than providing just a list of names, the New Zealand Plant Collections Register delivers a collection management tool. The register provides plant collection curators, from major botanic gardens to private collection holders, a free set of tools to manage and share their collections and images online. The platform used is vastly superior to the limited choices available to most collection holders. Until now, many plant inventories held by private collectors relied on non-networked PCs and inadequate software such as spreadsheets or stand-alone databases. These records were seldom backed up on servers and were vulnerable to loss.

The New Zealand Plant Collections Register has been created by using the open source codebases for NatureWatch NZ (<http://naturewatch.org.nz>) and its international, US-derived parent iNaturalist (<www.inaturalist.org>). Both of these resources are primarily for natural history observations that include plant, animal and insect sightings in the wild, but they also accommodate cultivated plants and have the full functionality needed for this plant collection subset (Figs. 1-4). Current functionality is rich and includes, to name but a few features:

- Project creation and description. A project in the Plant Collections Register corresponds to a particular collection
- Locality information, integrated mapping and user-defined area polygons. Polygons provide the ability to draw a defined area such as the boundaries of a garden on a map
- Pre-defined and custom (user created) observation fields, both text (e.g., dead or alive, wild or planted) and numeric (e.g., number of individuals)

- Image upload (from hard-drive or using a Flickr interface)
- Public contributions or an "invite-only" facility
- Community identifications and comments
- Spreadsheet import and export
- Inbuilt mail client for contacting others.

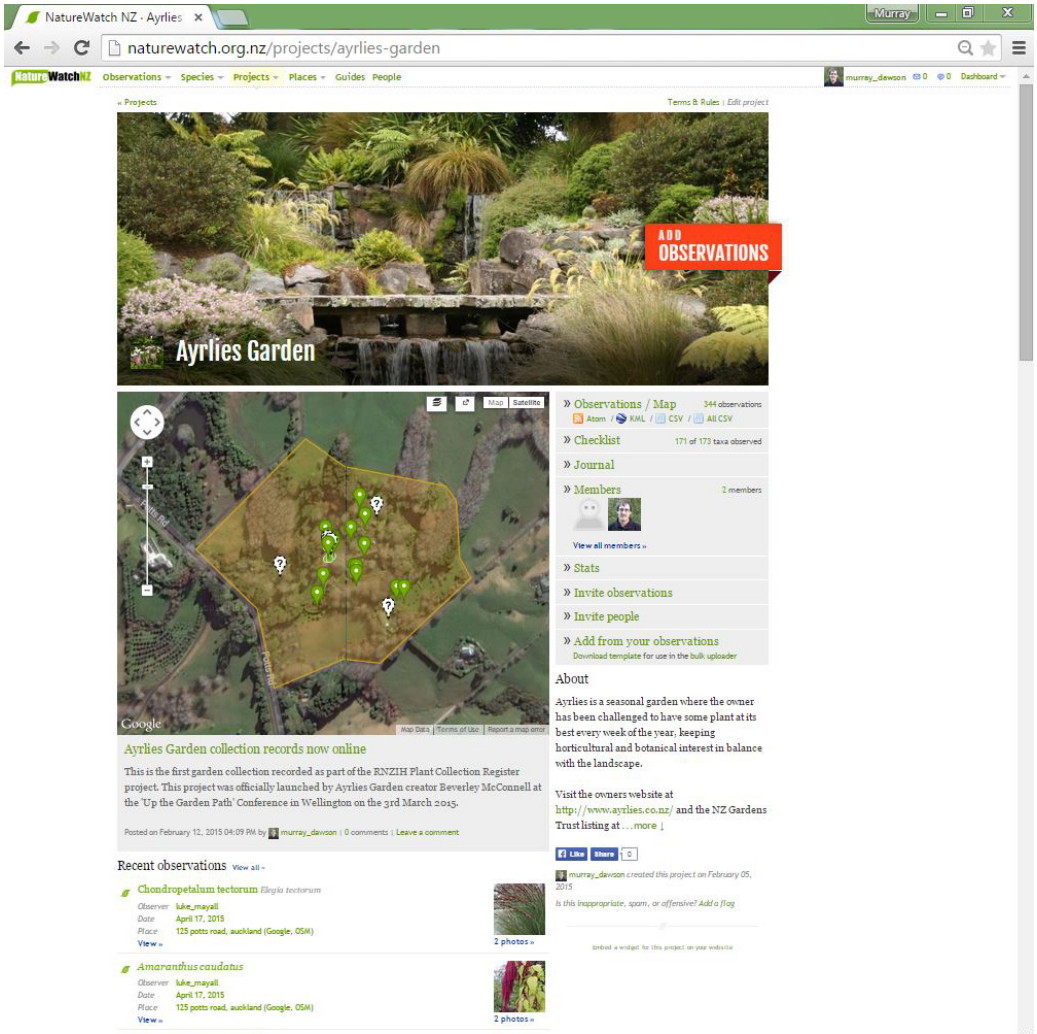


Fig. 1. Screenshot of the Ayrlies Garden collection, the first recorded as part of the New Zealand Plant Collections Register project. Note the polygon which has been drawn to define the area for the project, "pins" on the map that show individual observations, and a list of plants with images. Additional functionality appears on the right hand side.

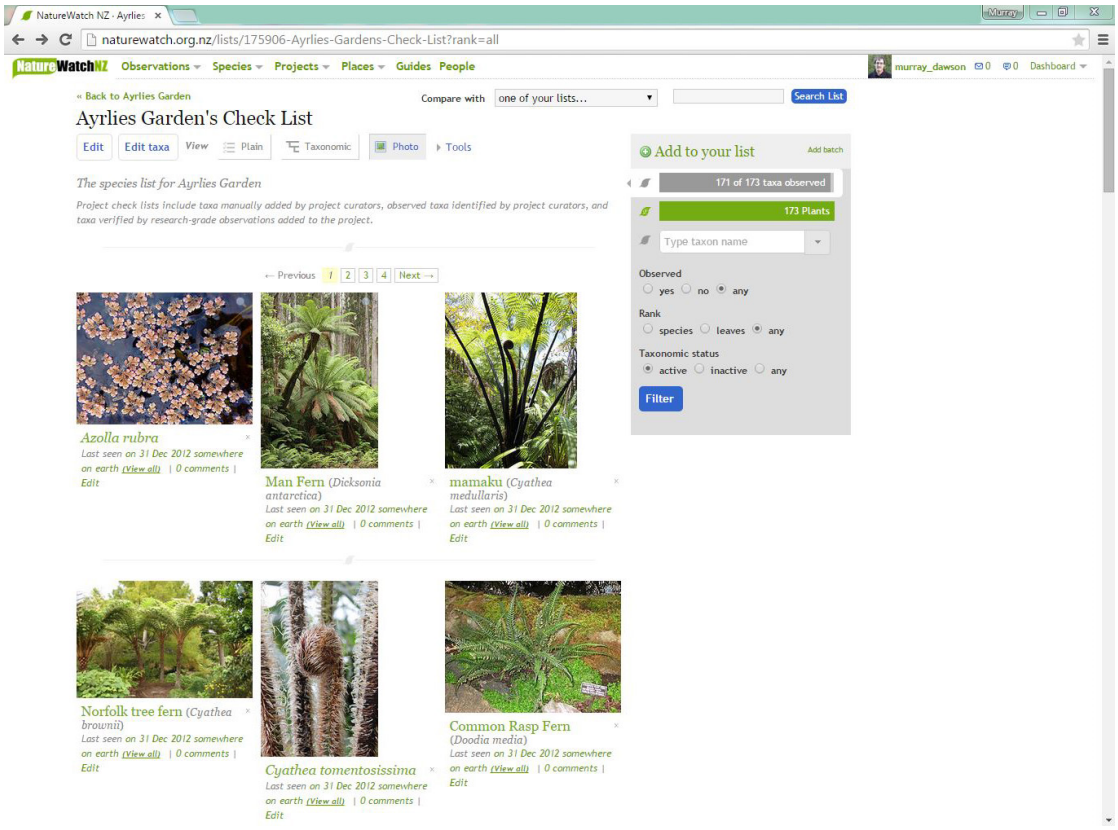


Fig. 2. Screenshot of the Ayrlies Garden Check List, showing verified species and stock (Creative Commons) images for them.

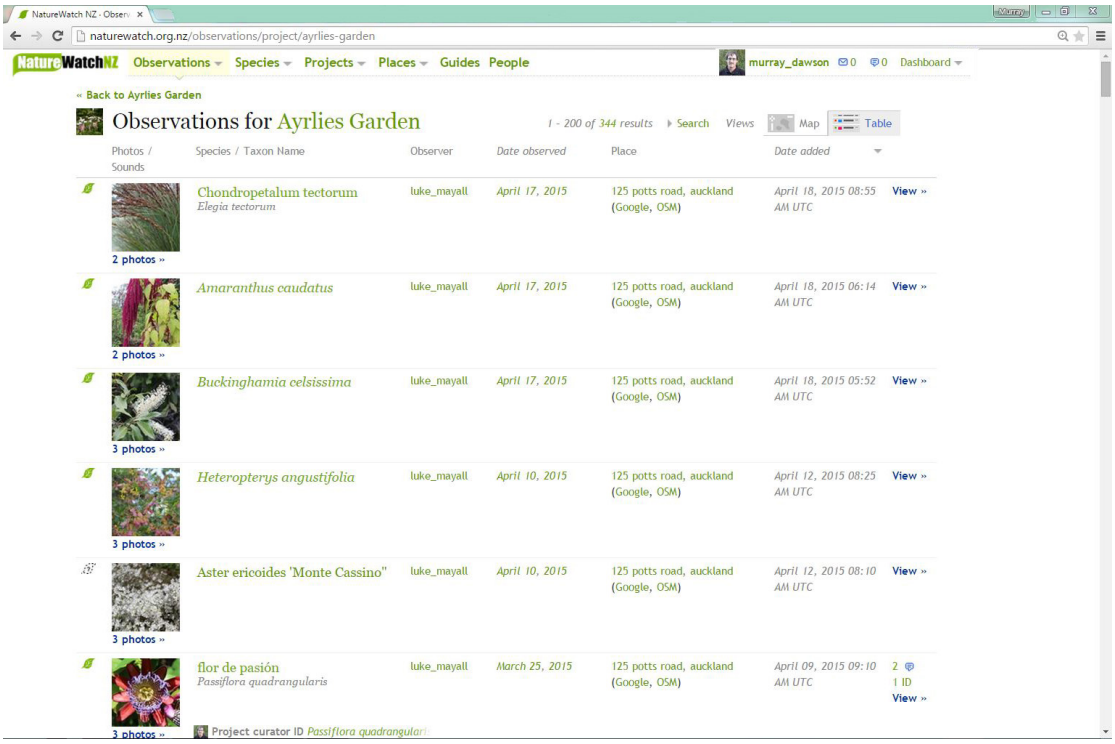


Fig. 3. Screenshot of observations within the Ayrlies Garden collection.

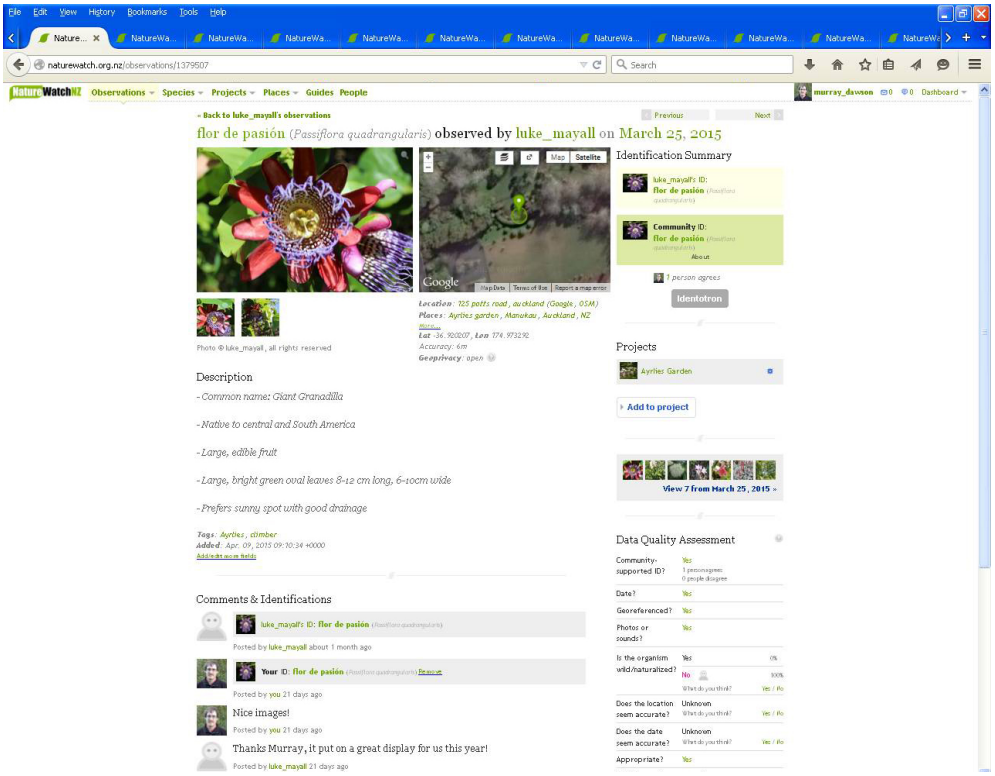


Fig. 4. Screenshot of an individual observation of *Passiflora quadrangularis* within the Ayrlies Garden collection, with description, tags, and identification comments. When there is a consensus in identifications, the data quality changes from a casual observation to research grade.

Other functionality includes the ability to add "widgets" (embedded previews) of individual projects onto other websites to usefully interconnect resources (Fig. 5). While cultivated plant records from all collections are centralised on one platform, widgets allow them to also appear on the contributors own websites and third party websites. For example, widgets are used for a working list of plant collections held throughout New Zealand (<www.rnzih.org.nz/pages/plantcollections.html>). This page is intended to provide an overview of the collections.

Rather than relying on the more broadly focussed NatureWatch NZ (and iNaturalist) front-end, it is possible to build a custom API (Application Programming Interface) front-end aggregating the New Zealand cultivated plants projects together on one dedicated website. If we implement an API for this purpose, the website address will be <www.plantcollections.org.nz>. Plant collection projects on this new API would also propagate through the NatureWatch NZ and iNaturalist websites.

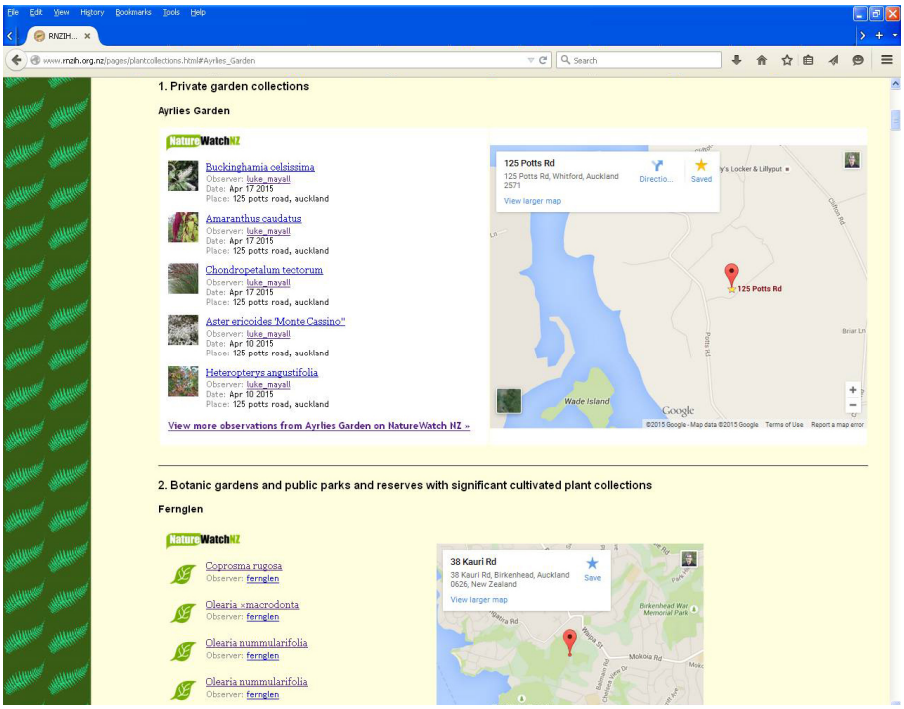


Fig. 5. An example of a "widget" of the Ayrlies Garden collection added to the RNZIH plant collections page (<www.rnzih.org.nz/pages/plantcollections.html>). This embedded preview could be added to other related websites – in this case the owners' website (<www.ayrlies.co.nz>) and the NZ Gardens Trust listing (<www.gardens.org.nz/auckland-gardens/ayrlies>).

Also available "off the shelf" is a handy smartphone app for recording onsite observations that synchronises to the platform. This tool is available from Google play (<https://play.google.com/store/apps/details?id=org.inaturalist.android>) and iTunes (<https://itunes.apple.com/us/app/inaturalist/id421397028?mt=8>). It allows users to take photos of individual plants in their collection with a smartphone or tablet, look up the plant name and add notes (Fig. 6). The GPS data is automatically added from the smartphone location and the observation data can then be uploaded onto the platform.

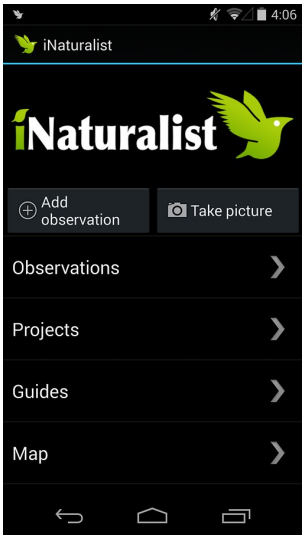


Fig. 6. A screenshot of the smartphone app for recording observations.

A selection of cultivated plant collection projects (currently through the NatureWatch NZ interface) for New Zealand includes:

- Ayrlies Garden (<http://naturewatch.org.nz/projects/ayrlies-garden>)
- Fernglen Native Plant Gardens (<http://naturewatch.org.nz/projects/fernglen-native-plant-gardens>)
- H.E. Hart Arboretum (<http://naturewatch.org.nz/projects/h-e-hart-arboretum>)
- Plants cultivated in the Canterbury Agriculture and Science Centre (CASC) grounds (<http://naturewatch.org.nz/projects/casc-gardens>)
- National NZ Flax Collection, Lincoln (<http://naturewatch.org.nz/projects/national-nz-flax-collection>)
- Magnoliaceae Collection at Lincoln University (<http://naturewatch.org.nz/projects/magnoliaceae-collection-lincoln>).

Many other projects are actively being created throughout New Zealand.

**Cultivated Plant Names Resource**

The second major part of the project is to generate cultivated plant names. These names provide an extensive "pick-list" for those using the Plant Collections Register to enter their collection records.

This is being achieved by digitising and assembling cultivated plant names from the New Zealand horticultural literature (Figs. 7-8), including authoritative plant books (e.g., Gaddum, 2001; Palmer, 2007; Vogan, 2003), cultivar checklists (e.g., Metcalf et al., 1963; Heenan, 1991a, b; Metcalf, 2001; Dawson and Heenan, 2010) and nursery catalogues (e.g., the Duncan and Davies nursery catalogues). Copyright is being respected because we are only providing bibliographic indexing to the plant names – i.e., citing a plant name, page number, and the title of the reference. The exception is the Duncan and Davies catalogue collection, for which we have express permission to fully digitise and make them available as online PDF's (<www.rnzih.org.nz/pages/nurserycatalogues.html>) for non-commercial purposes.

Nursery catalogues in particular could be considered as "grey literature" because of their limited print runs, restricted availability, and seasonal focus. However, beyond their short term original purpose, they provide an invaluable resource for documenting when and where cultivars and species were first recorded in cultivation and how rare or common they became. Until recently, the most notable New Zealand nursery catalogue collection was housed in the Plant & Food Research library at Mt Albert, Auckland (Boyd, 1992). In 2014, these catalogues were relocated to the Lincoln University library to ensure their long-term security. This collection remains available to the New Zealand Plant Collections Register project.

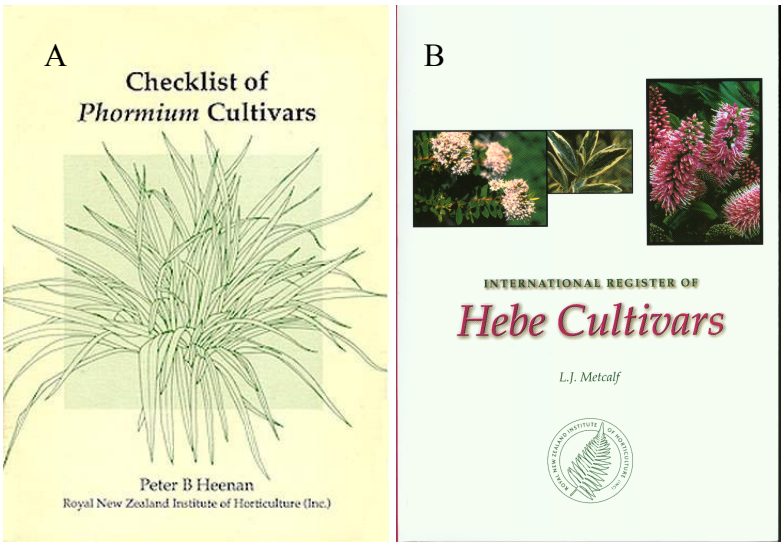


Fig. 7. Book covers of cultivar checklists on *Phormium* (Heenan, 1991a) (A) and hebes (Metcalf, 2001) (B). These technical books were published by the RNZIH as part of the Institute's International Cultivar Registration Authority responsibilities. They are valuable and authoritative compilations indicating the correct names of cultivars up to the time of publication.

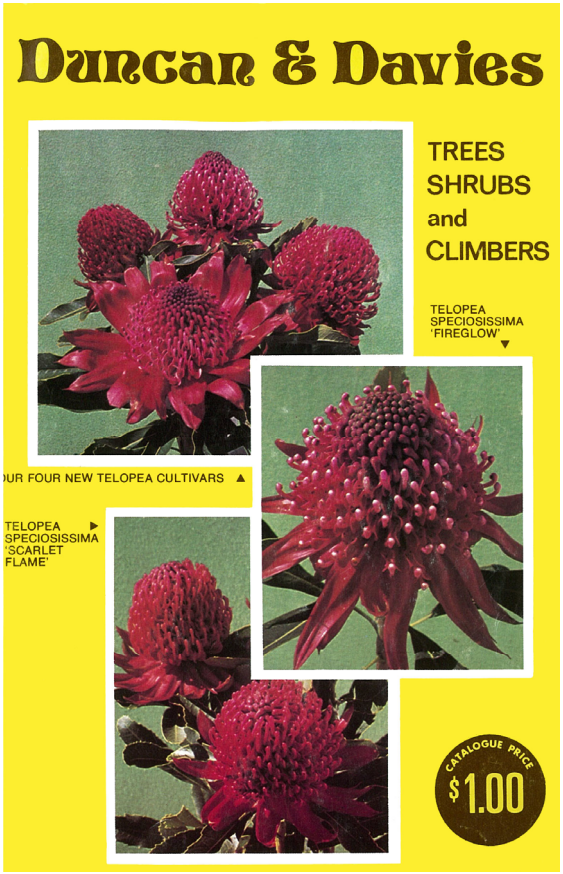


Fig. 8. Cover of a 1978 Duncan & Davies nursery catalogue, one of more than 240 catalogues dating from c. 1916 to 2004. Available catalogues are currently being digitised to produce online PDF versions.

Assembling plant names has been time consuming because of the numerous names involved, extensive proof reading required, and the need to resolve them into accepted names, synonyms, orthographic errors and misapplications.

Following the concept of federated data, cultivated plant names generated from this project are being mobilised and exchanged with the New Zealand Organisms Register (NZOR; <www.nzor.org.nz/search>) and international database initiatives (e.g., Species 2000, Catalogue of Life and the Global Biodiversity Information Facility).

Like the New Zealand Plant Collections Register, NZOR was also funded by TFBIS. NZOR provides a "names clearing house" that focuses on the wider biota (e.g., plants, animals, fungi and bacteria). Cultivated plants have been one of the largest data gaps in NZOR. The vision for NZOR is to create an accurate, authoritative, comprehensive and continuously updated catalogue of the c. 140,000 names applied to New Zealand biota. NZOR has two fundamental components, the network of data providers and the information infrastructure to collate and deliver data to end-users.

**SUMMARY**

The New Zealand Plant Collections Register provides important new resources allowing better management of plant collections and their names. By providing clarity to New Zealand's cultivated flora, both native and exotic, the project will assist in conservation of rare plants and heritage cultivars, and facilitate plant exchange and availability of germplasm for plant breeding. It will also assist in the management of potential weed escapes and should allow better importation and biosecurity decisions.

For the first time, we are building a freely accessible and accurate record of New Zealand's cultivated plant stock, how common or rare a plant is in cultivation, and where it is (or was) growing. Custodians of plant collections are able to log-on and directly manage their records online. This is supported by an authoritative and comprehensive database of cultivated plant names that indicates accepted names and their synonyms.

Although this is a New Zealand funded initiative, the Plant Collections Register draws upon open source software and could show a way forward for future Australian and international projects which have the same challenges in managing and sharing cultivated plant collection records.

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