Manaaki Whenua
Landcare Research

NVS Annual Report for the 2017/18 year

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NVS Annual Report for the 2017/18 year

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1 Overview

The National Vegetation Survey (NVS) databank continues to focus on primary data acquisition, curation and provision. The aim is to ensure ongoing, up-to-date delivery of New Zealand's vegetation plot data to enhance fundamental understanding of our biota and ecosystems, and to meet conservation and biosecurity priorities and sector needs. The NVS databank now holds data from over 107,000 vegetation survey plots, including 24,000 permanent plots. These span all major ecosystems and a diverse range of naturally uncommon ecosystems. Recent acquisitions have extended coverage into North Island frost flats, stands comprising wilding conifers, and the volcanic landscapes of Rangitoto island.

The NVS databank continues to support national initiatives for reporting on and monitoring New Zealand's biodiversity by serving as the repository for the national-scale monitoring programme of the Department of Conservation (DOC) for biodiversity, and for the Ministry for the Environment (MfE) concerning land use and carbon storage and sequestration. This year NVS archived data from 1,371 new or remeasured plots for these programmes.

Data sourced from NVS has supported publications and new knowledge gains encompassing NZ-focused themes, including i) how to integrate measurement error into biodiversity reporting to strengthen the evidence basis for interpreting pattern and change in biodiversity; and ii) vegetation-based predictions of soil carbon stocks of strategic value to the upcoming Zero Carbon Bill. Themes with a global focus have also been supported, including evolutionary-based classification of the world's tropical and subtropical forests, and efforts to understand the distinct trait syndromes of island floras.

2 New plot records archived in NVS

Twenty-five new projects[1] were added electronically to NVS in 2017/18 (year to 30 June 2018; Figure 1 and Appendix 1), with a total of 848 plots added. Of these, 707 were new plots; the remainder were remeasurements of pre-existing plots. This brings the total number of projects in NVS to 1,650, comprising 107,872 individual plots. Data additions since 2007/08 are shown in Figure 1, broken down by major provider. Recent acquisitions have extended ecosystem coverage into North Island frost flats, stands comprising wilding conifers, and the volcanic landscapes of Rangitoto island.

[1] A project is a defined sampling event undertaken over a specific period. A project may have many methods (sampling protocols) and many plot observations (visits).

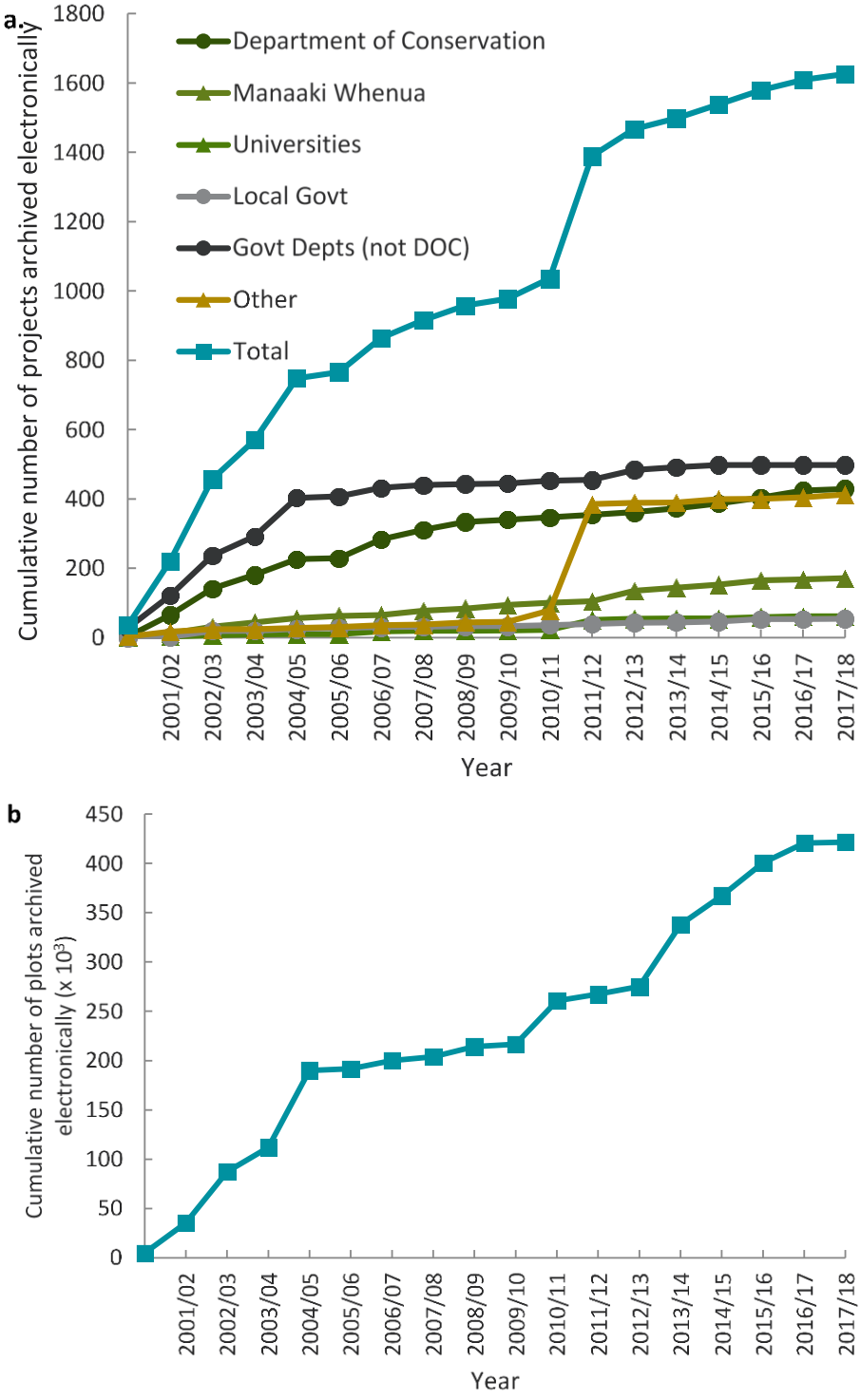

Figure 1. a) Cumulative number of projects archived in the National Vegetation Survey databank, total and from five major contributors, per financial year since NVS was developed in its current form in 2000. These figures include projects migrated over time from 'legacy' data management systems used in previous years. The sharp increase in 2011/12 was the result of incorporating (funded by the Terrestrial and Freshwater Biodiversity Information System, TFBIS) the former Crown leasehold lands vegetation monitoring dataset collection (see the NVS annual report for 2011/12). b) Cumulative number of plots archived in the National Vegetation Survey databank per financial year since NVS was developed in its current form in 2000. These figures include projects migrated over time from 'legacy' data management systems (e.g. data stored as text files compatible with FORTRAN-based analytical tools) used in previous years.

Fifty-one plots were established in a trial investigating wilding pine (particularly *Pinus contorta*) impacts on high-country grassland. The plots were established in different densities of pines close to the invasion front. These plots will also be utilised for future studies, including the detection of pine seedlings, soils, hydrology, fungal communities and biodiversity.

In the early 1970s the Botany Department of the University of Otago established 89 plots in a project following trends in vegetation condition and flora associated with differences in the density of red deer in Mt Aspiring National Park. The plots were photographed and had abbreviated reconnaissance ('recce') plots recorded several times until 2007.

NVS Express software, our customised software package for digitising and summarising New Zealand vegetation plot data, facilitated the addition of data for 13 projects (672 plots) to NVS during 2017/18.

3 Technological improvements

3.1 Web-based data deposit and retrieval

A new web-based metadata and dataset entry process was released in September 2017. Users can access this via the NVS website, and it is a simple process to fill in the metadata form and attach data files and other associated digital artefacts. Upon submission this information is passed on to the NVS curator, who approves the submission for entry into the central NVS database. The use of controlled vocabularies in this online form increases the consistency and quality of data being submitted, and the digital process greatly reduces the likelihood of user error when entering data.

A new interface has been developed to improve the ability to search the NVS database online. This is currently in a beta release. It includes a more comprehensive, map-based spatial search and a faceted project result list, which allows users to quickly and easily refine their results and identify data suitable to their needs. As part of this re-development, we have moved to using the Apache Solr search server to create and manage an optimised search index, which will result in a faster and more responsive interface. This index is more detailed than our previous one, allowing a more accurate, refined search experience.

3.2 Management of NVS components

We are investigating the use of new message queuing technology to manage the relationship between the various components of the NVS system. This will reduce the manual effort required to keep data transactions, including data uploads and requests by end-users, in sync. This will improve the end-user experience and increase system reliability. Message queuing will also support the integration of NVS data services with other stakeholder needs; for example, DOC's electronic field data capture programme.

3.3 Accommodating more data types

The NVS databank also continues to expand its ability to make vegetation data collected using increasingly diverse data collection methods interpretable and accessible, with a focus on significant historical datasets. One of the oldest sets of permanent plots in New Zealand was established in 1930 by the godfather of New Zealand vegetation ecology, Leonard Cockayne, and his student, JW Calder, to document vegetation regeneration after the 1893 Arthur's Pass fire. Plant cover of individual species was mapped to a high level of detail on each of 10 transects. Mapping was repeated in 1960 and 2000.

However, mapped data had always remained in hard copy making them impervious to analysis and interpretation. Insights could only be gained by subjective descriptions. We developed a technique to digitise these data using scanning and polygon delimitation and identification. In this form, species presence and abundance can be readily quantified, and can provide the basis for the development of a much-streamlined and objective remeasurement approach trialled in 2018. This ensures the archiving of this historically significant dataset in a usable form to enable us to learn from its unparalleled long-term record of recovery after disturbance in a sensitive and highly iconic New Zealand landscape. The frequency and intensity of wild fires are predicted to increase over the coming decades, and these data – now liberated from their original format – can provide a comprehensive insight into the rate and direction of vegetation recovery after fire.

4 Significant revisions of data

4.1 Digitising new components of existing datasets

Although the quality of the data in NVS is high, NVS staff continue in their efforts to enhance existing datasets by digitising new data components and detecting and correcting errors, where possible. For example, the National Forest Survey (1945–1955) data quantifying the composition and structure of New Zealand indigenous forests have been widely used over the years to meet a broad range of needs. When the survey was conducted, records were also made of birds observed on the study plots, but these records were never digitised. These represent an invaluable record of bird distributions at that time, exemplified by the observation of riflemen in a Northland forest, a range extension that was only corroborated in 2016. In 2018 we digitised bird records from 11,850 NFS plots to underpin stakeholder research on changing distributions of native birds in the last 60 years, and to derive more value from this previously largely inaccessible biodiversity data resource. Importantly, these data provide an explicit connection between vegetation and bird communities, which allows mechanistic, habitat-based analyses of bird community dynamics that can now be used to predict outcomes of management under the goals of Predator-Free NZ management.

4.2 Enhancing the quality of existing datasets

This year we continued to devote resources to addressing much-needed data corrections and revisions across historical data held in the NVS databank. Consistency and high-

quality data are especially important when we engage with international data synthesis efforts. Corrections and revisions were made in the following areas.

Temporal consistency in long-term datasets

- Misspecification of plots as permanent, or not, on selected projects was corrected, and permanent plots in these projects were linked to earlier or subsequent measurements.

Plot attributes and site data

- Habitat information was added for all plots where this attribute was previously missing and where it could be determined by examining plot sheets and other information.
- Attributes indicating that plots were exclosures or controls were added for projects where the name indicated exclosures were included but this information had been missing in the plot data.

Plant names

- Errors caused by commonly misspelled species codes or by misinterpretation of species codes were corrected.
- Specific epithets were added for monotypic genera where the original record was only recorded to the genus level.
- Inconsistent species names, diameters, tags, etc. that had emerged following plot remeasurement were corrected in permanent forest plots (Moehau 1991, Hokitika 1971/72).

Individual trees

- Inconsistent tree tags on repeated measures of the same plot were corrected and linked.
- Subplot location was added for trees in selected projects where these had been identified as missing.

5 Increasing end-user awareness and capability

5.1 Increasing end-user capability

NVS provides the primary indigenous forest data repository for the DOC Tier One biodiversity monitoring and reporting system[2] and the NZ Land-use and carbon analysis system run by MfE[3] programme. Regular engagement and collaboration between the

[2] See DOC's monitoring and reporting system https://www.doc.govt.nz/our-work/monitoring-and-reporting-system/

[3] See https://www.mfe.govt.nz/sites/default/files/measuring-carbon-emissions.pdf

parties ensures the services provided by NVS are always being optimised to meet the needs of these two programmes and to support data quality. Examples this year include:

- working with MfE to improve the methods of recording taxonomic names and associated name codes linkages used in LUCAS
- maintenance of remote connections to primary data for both DOC and MfE for data editing and quality checking
- collaborating to further optimise data extraction and import processes from NVS into the MfE LUCAS reporting system.

DOC and Manaaki Whenua – Landcare Research (MWLR) maintain a long-term partnership in the NVS repository, based on MWLR's capability and existing expertise in data management and data services. DOC recently approached NVS/MWLR to assist with aspects of their electronic data capture programme for forest plot surveys. We will leverage the existing relationship and connections to help ensure that data flows and authoritative data sources supported by NVS function well for the electronic data capture programme. This will add value through maintaining data quality and improving ease of use of data and services for DOC, LUCAS and the wider vegetation monitoring community.

5.2 New NVS users

There are currently 431 registered NVS users, with 48 new users registering between 1 July 2017 and 30 June 2018.

6 Data-sharing agreements, data exchange, journal repositories

We collaborate with numerous domestic and international initiatives to broaden the impact of data held in the NVS databank. These collaborations facilitate the use of NVS data by a wider range of users who otherwise may have remained unaware of these data and their potential.

Internationally, NVS contributes data to:

- the sPlot initiative (https://www.idiv.de/?id=176&L=0), the largest repository for plant community data in the world, with the goal of understanding global patterns in plant diversity across facets, biomes and scales
- the Global Forest Biodiversity Initiative (http://www.gfbinitiative.org/), which supports cutting-edge research and policy making in forest science and related initiatives
- the Global Biodiversity Information Facility (GBIF; https://www.gbif.org/), aimed at providing anyone, anywhere, with open access to data about all types of life on Earth; access to GBIF data has been vastly accelerated by the development of an R package (*rgbif*) (Figure 2).

NVS data also continue to be used in numerous 'one-off' global collaborations.

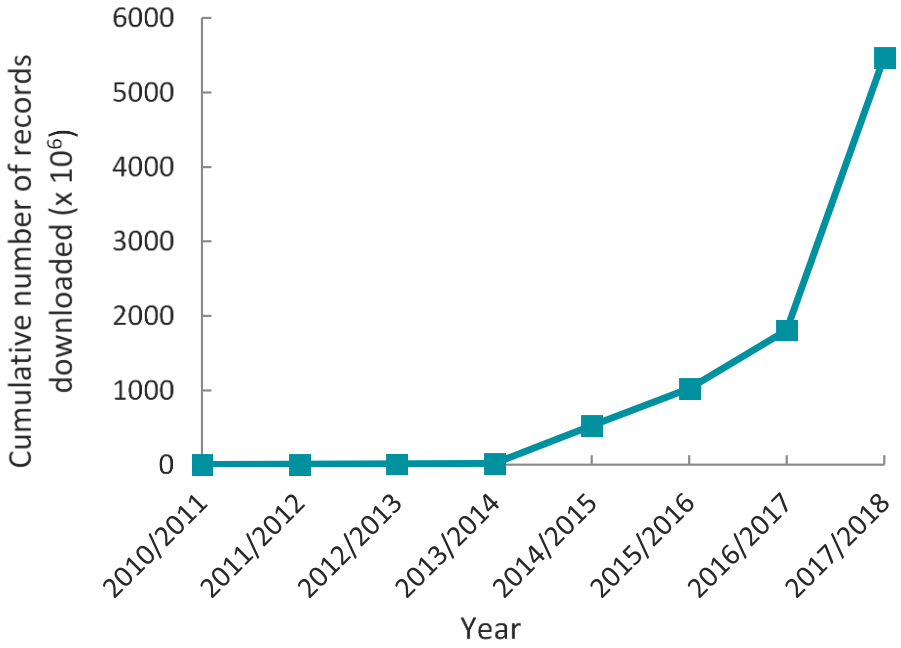

Figure 2. Cumulative number of species occurrence records supplied by the NVS databank that have been downloaded from the GBIF portal since 2010.

6.1 Use of NVS data through the GBIF portal

An updated set of 1,530,883 species occurrence records from the NVS public domain (Open Access) data were uploaded to the GBIF portal in June 2018[4]. NVS provides a refreshed dataset to GBIF every month. Between 1 July 2017 and 30 June 2018 there were 4,750 downloads of species occurrence data, incorporating 3,663,294,217 records, accessed via the GBIF website (Figure 2). The 2014/15 year showed an order of magnitude increase in the rate of species occurrence downloads, and this trend has continued since then.

6.2 NVS collaboration with sPlot

Data from grassland transects were provided by NVS to the sPlot consortium in 2014. We are now collaborating with other members of the sPlot consortium on 11 different research projects using these data.

6.3 Use of NVS data via the Landcare Research NZ DataStore

Many scientific journals now require data supporting publications to be made publicly available in an appropriate online archive. The NVS databank has joined with the Landcare Research Datastore (https://datastore.landcareresearch.co.nz/) to provide a way for authors of scientific publications to meet these requirements. NVS data are provided in

[4] These can be viewed here: http://www.gbif.org/dataset/788439f0-3b56-11dc-8c19-b8a03c50a862

the cleaned and aggregated form that transparently links to publication results. These datasets are resolved via DOIs provided with the original publication, or by searching.

Over the last year the 'Waitutu' dataset was again the most visited in the NVS collection (and indeed was in the top five pages across all Landcare Research datasets). The next-most-visited NVS dataset was 'Biodiversity Uncertainty' (http://dx.doi.org/10.7931/V1G081). The most resolved NVS DOI was for the 'New Zealand Forest Plot Data in Global Forest Biodiversity' dataset, which was viewed 78 times in November 2017 (http://dx.doi.org/10.7931/V13W29), followed by the 'Waitutu' dataset (http://dx.doi.org/10.7931/V1WC75).

6.4 Incorporation of data sourced from the NVS databank into software packages

A subset of permanent plot records from the NVS databank has been incorporated for demonstration purposes into the R packages *vegclust* (see https://cran.r-project.org/web/packages/vegclust/vegclust.pdf) and *vegx*, which is being developed by Miquel De Cáceras (CEMFOR-CTFC, Solsona, Spain).

7 Meeting emerging policy and management needs

New Zealanders (the public, iwi, business leaders and governments) are deeply concerned by the recent arrival of myrtle rust into the country and the infection of trees in natural populations. Diseases of native tree species have been devastating to indigenous forests elsewhere in the world, but to date New Zealand has largely been spared. The extensive temporal and spatial coverage by vegetation plot data in the NVS databank puts New Zealand in a strong position to predict and anticipate the potential spread and impact of such diseases.

NVS holds several datasets of individual tree demographic responses to historical dieback of dominant myrtles, which provide the only opportunity to forecast likely ecosystem-scale consequences. Further, this year NVS provided a large volume of data on the presence and absence of all native taxa from the Myrtaceae plant family to develop preliminary distribution maps to help DOC in the detection, monitoring and potential management responses to the myrtle rust incursions in our native forests.

We have prioritised the accession of datasets from regions that are currently poorly represented in the NVS databank and where data could improve the ability to depict distributions of Myrtaceae species. We developed a protocol to detect suspect geographic locations (i.e. geographic outliers) for individual taxa and have manually checked (and corrected, where needed) these records.

We have also developed approaches to tackle the challenges of shifting taxonomy among component taxa. These data are now being incorporated into a cross-CRI initiative, funded by the Ministry for Primary Industries (MPI), to produce high-quality distribution maps for all native Myrtaceae species. In recent years we have also prioritised accession of datasets

where kauri (*Agathis australis*) has been recorded to support the understanding of and management of kauri dieback disease.

NVS is well positioned to provide data on tree distributions to support interest from the One Billion Trees project to plant the 'right tree in the right place' and to provide data on tree numbers in naturally regenerated forests, as these will be contributing to the total 'billion'.

NVS data are being used to provide more information to the native plant-based honey industry. In addition to the need to understand the distribution of mānuka and kānuka because of the myrtle rust threat, NVS data are being used to ensure the manuka- and kānuka-based honey industries are environmentally sustainable by evaluating the impacts of these apiaries on native invertebrate communities. Also, NVS data are being used to assess spatial patterns of nectar and pollen availability as a resource for honey bees (and native pollinators).

8 Meeting needs specific to Māori entities

We have begun to provide landowners with summaries of all data held in NVS for specific parcels of land. This is of interest to Māori entities, who may have been previously unaware that such information even existed. Data summaries have been provided to the Wakatū Incorporation, Tuhoe Tuawhenua Trust and Ngāti Maru.

NVS continues to provide primary data to provide underpinning information for emerging opportunities for Māori organisations. Recent examples include:

- identifying the opportunities provided to sustainably harvest tree ferns for the nursery trade (Tuhoe Tuawhenua Trust)
- using historical Protected Natural Areas data to inform the development of restoration plans for the forested areas of the rohe of Maungaharuru Tangitū and Te Kōpere o te iwi o Hineuru trusts
- locating rewarewa populations on Māori land for genetic analysis, with the aim of maximising the value of honey exports.

9 International collaborations

Susan Wiser (MWLR) procured funding from the International Association of Vegetation Science to enable Miquel De Cáceres (CEMFOR-CTFC, Solsona, Spain) to visit New Zealand and collaborate with her and Sebastian Schmidtlein (Julius von Haast Fellow, Karlsruhe Institute of Technology, Germany) to develop an R package enabling users to easily migrate their data in the Veg-X exchange standard for vegetation plot data. Veg-X was designed in 2011, with support from the NZ Terrestrial Freshwater and Biodiversity Information System Programme. Veg-X was implemented in an XML schema (extensible markup language) and designed to be compatible with the most commonly used vegetation databases.

One of the impediments to the adoption of Veg-X has been its complexity, which is required to accommodate the wide variety of ways vegetation plot data are collected and stored. To ensure the Veg-X standard is adopted by a large community of users, it is important to develop tools to facilitate interoperability, the integration of documents, harmonisation of units, etc. Through the 2018 collaboration we began to develop an R package to perform these tasks. It contains functions to import, integrate, harmonise and export vegetation data using the Veg-X standard. The development of the package, inventively also called *vegx*, has been carried out in parallel with a major revision of the standard itself to simplify it. The files conforming the Veg-X XML schema (version 2.0) and the R package *VegX* can be downloaded from an open-source GitHub repository (https://github.com/miquelcaceres/VegX). A detailed description of the schema and a user manual of the package can be found at https://miquelcaceres.github.io/VegX/.

As a data contributor, steering committee member and presenter, Susan Wiser attended the inaugural Global Forest Biodiversity Initiative (GFBI) conference held in Beijing, China, in September 2017. The GFBI is an international multi-stakeholder team of foresters and forest scientists which supports cutting-edge research and policy making in forest sciences and related areas. GFBI is dedicated to the service of global, regional and local communities and provides a platform for international forest education and research dissemination. It also supports a portal to global forest inventory data and services, for which NVS is a data contributor. The theme of the conference was 'Forest Research in the Big Data Era', and it provided a forum for the group to meet, share research ideas, and plan new initiatives. The conference was attended by 168 GFBI members and guests from 32 countries, and was covered by Guangming Online, one of the largest media outlets in China.

Susan Wiser continues to serve as a scientific advisor to the New South Wales Office of Environment and Heritage Vegetation Information and Mapping Programme, and on the Steering Committee of the International Association for Vegetation Science Working Group for Ecoinformatics. She was invited to serve in these positions in recognition of her expertise with the NVS databank and other scientific expertise.

10 Web statistics

- From 1 July 2017 to 30 June 2018 the NVS website was visited 4,667 times, up 14% from the 2016/17 year (4,083 visits), and there were 22,533 page views.
- There were 2,053 unique visitors to the site over this period. Of the current year's hits that could be traced to origin, most visits were from New Zealand (58%), followed by the USA/Canada (13%), France (6%), the UK (4%), South Korea (4%), Australia (3%), India (2%) and China (1%). The website was also visited by people from another 70 countries.
- The data discovery and request component of the website continues to prove popular, accounting for 25% of page views. The data search tool attracted around half of those. The Index page received 16% of all page views, and resources (downloadable content of NVS codes for plant names, field techniques, manuals, and field forms) were also popular with 9% of page visits. Apart from the number of

website visits and visits to the resources (down from 14%), these numbers are similar to last year.

- Access via search engines remains the most frequent pathway to the NVS website (41%). Direct traffic accounted for 29% of the navigation to the NVS website, indicating that frequent users bookmark the website.
- Referrals from other sites accounted for 30% of page views. Apart from the MWLR website, the NVS website receives the most referrals from the NZ Plant Conservation Network (NZPCN), MfE and DOC websites. Other common sources of referrals are links arising from publications that have used NVS data (e.g. *New Zealand Journal of Ecology*, *Oikos*, *Journal of Ecology*, Research Gate and the Landcare Research DataStore); from large-scale data synthesis project websites with which we collaborate (e.g. the Botanical Information and Ecology Network and GBIF); and from registers of data repositories (e.g. the IAVS Ecoinformatics working group, the Global Index of Vegetation Databases and the Registry of Research Data Repositories).

11 NVS data requests

This year the NVS databank provided access to 4,875 datasets to meet 49 direct data requests (Figure 3). This reflects the continuing trend of users, particularly in the New Zealand research community, to conduct data syntheses at both New Zealand and international scales. Thirty-four requests were made via the NVS website, and 15 were custom requests, with data manually extracted from NVS. Note that these figures do not include the large quanta of data accessed through GBIF and other online portals that cannot be easily tracked.

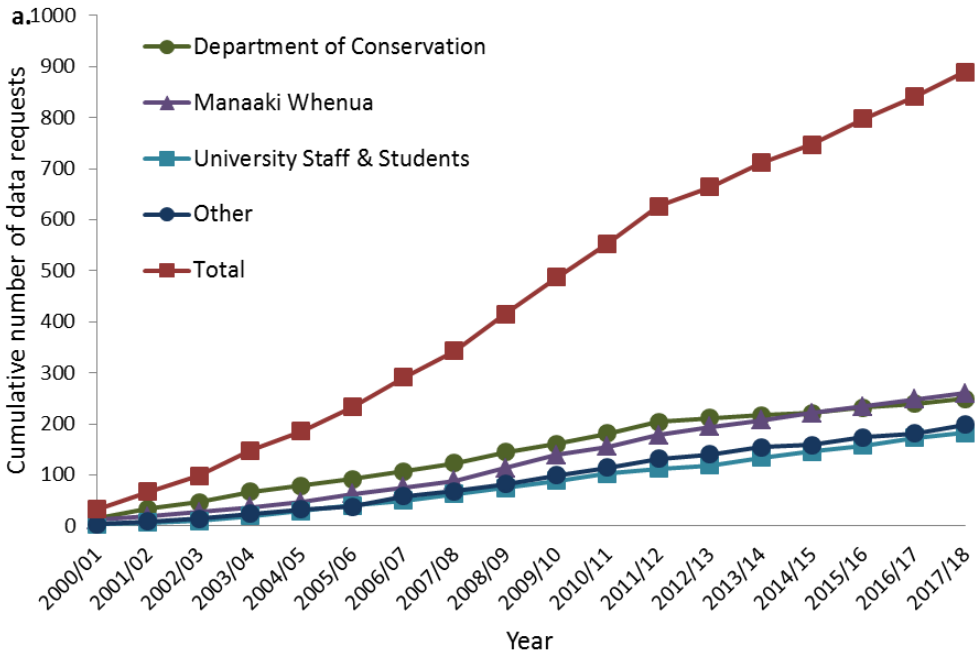

Figure 3: Trends in number of requests for NVS data since 2000/2001, broken down by end-user type. a) cumulative number of requests.

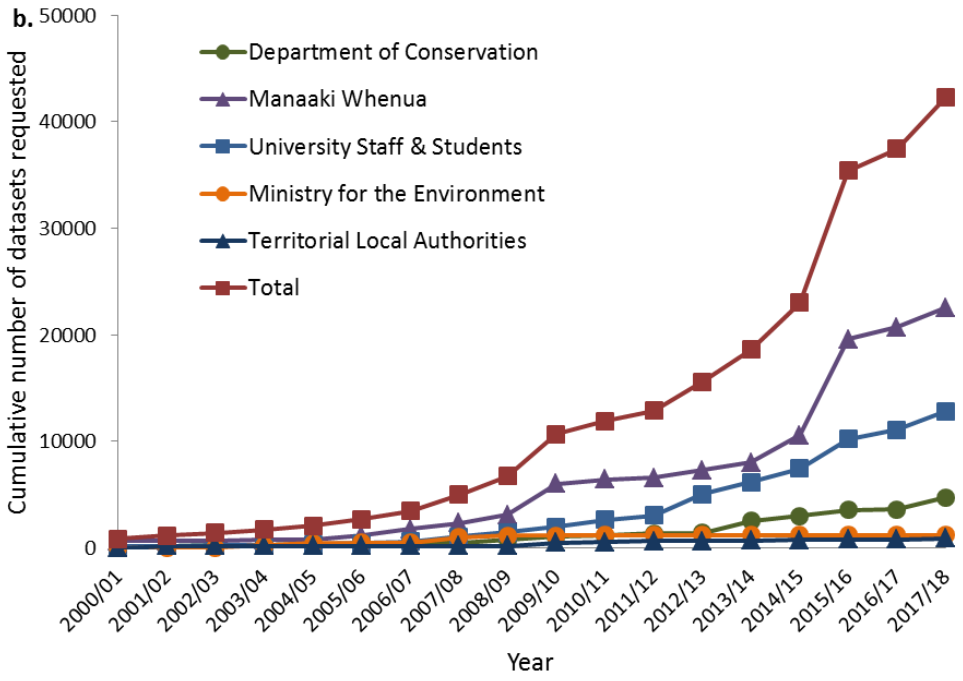

Figure 4: Trends in number of requests for NVS data since 2000/2001, broken down by end-user type. b) cumulative number of datasets requested (and delivered).

Some examples of the intended uses of these data are summarised below.

- A researcher from Harvard University used species distribution data in a study of the phenology and distribution of rimu (*Dacrydium cupressinum*).
- An MWLR researcher used data for site selection in a project evaluating the impacts of apiaries on native invertebrate communities in mānuka and kānuka in the North Island.
- A student from the University of Knostanz in Germany requested data to use in their bachelor's thesis looking into naturalisation and invasion processes of alien plants.
- In another invasive plant species project, a researcher from MWLR used NVS data for her research into differences in plant species composition across an invasion gradient as part of a wider project investigating wilding conifers in New Zealand.
- A researcher from the Christchurch City Council was interested in vegetation data from Christchurch city and Banks Peninsula to see if they could fill any information gaps in constructing an interactive map of biodiversity assets.
- A researcher from the Auckland University of Technology requested NVS vegetation data to inform ecological aspects in a project investigating the social, economic and ecological impacts of restoration and management of biodiversity on sheep and beef farms in New Zealand. They aim to model the landscape-scale impacts of farm-scale restoration on fragmentation and biodiversity on three study farms in Hurunui, the Central North Island, and Kaipara.
- A researcher requested data collected from the Wellington area to help inform vegetation restoration efforts in the Zelandia Ecosanctuary.
- The recent myrtle rust incursion prompted a few activities and research programmes using NVS data. Location data for Myrtaceae species were used to inform a seed

collecting exercise, the design of a monitoring system for target Myrtaceae species, and the development of national-scale species distribution models for all native Myrtaceae species, which will provide predicted species occurrence ranges suitable for mapping and down-stream analysis (e.g. in pathogen spread models).

- A researcher from MWLR, working with Maungaharuru Tangitū and Te Kōpere o te iwi o Hineuru trusts, requested NVS vegetation composition data from the area to inform the development of restoration plans for the forested areas across their rohe.
- An evidently knowledgeable tramper requested data from the Kaimanawa/Tiraki area as they were going tramping in the area and were curious about its biodiversity.

12 Building internal capability

This year we utilised a recently hired, but highly experienced, programmer for the development of our new web-based search facility (described in section 3.1, above). Plans to expand the scope of his involvement in the NVS databank are part of our succession planning to ensure continuity of the informatics expertise that NVS requires. We have also engaged a new early-career plant ecologist to develop a data pipeline to allow direct access to the back-end NVS databank using the universally adopted R package *RODBC* for data management, summary and statistical analysis. This will facilitate direct access for synthetic research using 10s, 100s or even 1,000 individual datasets. This represents another component of our succession planning, as a high level of expertise is required to navigate the complexities of the back-end database and to ensure data extracts are suitable for the intended applications.

13 Publications associated with the NVS databank

13.1 Published papers

The following 2017/18 publications (23 in total) used data archived in the NVS databank. This list includes earlier publications that were not reported in previous annual reports.

Affeld K, Wiser SK, Payton I, DeCáceres M 2018. Using classification assignment rules to assess land-use change impacts on forest biodiversity at local to national scales. Forest Ecosystems 5: 13. https://doi.org/10.1186/s40663-017-0121-z

Ausseil AG, Dymond JR, Newstrom L 2018. Mapping floral resources for honey bees in New Zealand at the catchment scale. Ecological Applications 28: 1182–1196. https://doi.org/10.1002/eap.1717

Brummer TJ, Byrom AE, Sullivan JJ, Hulme PE. 2016. Alien and native plant richness and abundance respond to different environmental drivers across multiple gravel floodplain ecosystems. Diversity and Distributions 22 (7): 823–835.

Clarke AG, Lord JM, Hua X, Ohlemüller R 2018. Does current climate explain plant disjunctions? A test using the New Zealand alpine flora. Journal of biogeography. 45(7): 1490–1499. [Data sourced from GBIF]

Coomes DA, Šafka D, Shepherd J, Dalponte M, Holdaway R 2018. Airborne laser scanning of natural forests in New Zealand reveals the influences of wind on forest carbon. Forest Ecosystems 5(1): 10.

Dickie IA, Boyer S, Buckley H, Duncan RP, Gardner P, Hogg ID, Holdaway RJ, Lear G, Makiola A, Morales SE, Powell JR 2018. Towards robust and repeatable sampling methods in eDNA based studies. Molecular Ecology Resources 18(5): 940–952.

Holdaway RJ, Wood JR, Dickie IA, Orwin KH, Bellingham PJ, Richardson SJ, Lyver PO, Timoti P, Buckley TR 2017. Using DNA metabarcoding to assess New Zealand's terrestrial biodiversity. New Zealand Journal of Ecology 41: 251–262.

Larcombe MJ, Jordan GJ, Bryant D, Higgins SI 2018. The dimensionality of niche space allows bounded and unbounded processes to jointly influence diversification. Nature Communications 9:1–9. DOI: 10.1038/s41467-018-06732-x. [Data sourced from GBIF].

Laughlin DC, Lusk CH, Bellingham PJ, Burslem DF, Simpson AH, Kramer-Walter KR 2017. Intraspecific trait variation can weaken interspecific trait correlations when assessing the whole-plant economic spectrum. Ecology and Evolution 7: 8936–8949.

Mason NW, Holdaway RJ, Richardson SJ 2018. Incorporating measurement error in testing for changes in biodiversity. Methods in Ecology and Evolution 9: 1296–1307.

Nepia RE, Clarkson BD 2018. Biological flora of New Zealand (15): Ixerba brexioides, tāwari. New Zealand Journal of Botany 56: 2–5.

Ondei S, Brook BW, Buettel JC 2018. Nature's untold stories: an overview on the availability and type of on-line data on long-term biodiversity monitoring. Biodiversity and Conservation 27:2971–87.

Ramsey DSL, Forsyth DM, Veltman CJ, Richardson SJ, Allen RB, Allen WJ, Barker RJ, Bellingham PJ, Jacobson CL, Nicol SJ, Robertson AW, Todd CR 2017. A management experiment reveals the difficulty of altering seedling growth and palatable plant biomass by culling invasive deer. Wildlife Research 44: 623–636. doi.org/10.1071/WR16206

Richardson SJ, King S, Rose AB, McGlone MS, Holdaway RJ. 2018. Post-fire recovery of a dryland forest remnant in the Wither Hills, Marlborough. New Zealand Journal of Ecology 42(2): 1–7.

Rodríguez-Merino A, García-Murillo P, Cirujano S, Fernández-Zamudio R. Predicting the risk of aquatic plant invasions in Europe: How climatic factors and anthropogenic activity influence potential species distributions. Journal for Nature Conservation. 2018 Sep 1;45:58-71 [Data sourced from GBIF]

Serra-Diaz JM, Enquist BJ, Maitner B, Merow C, Svenning JC 2017. Big data of tree species distributions: how big and how good?. Forest Ecosystems 4(1): 30. [Data sourced from GBIF]

Simonsen AK, Dinnage R, Barrett LG, Prober SM, Thrall PH 2017 Symbiosis limits establishment of legumes outside their native range at a global scale. Nature Communications 8: 14790. [Data sourced from GBIF]

Slik JWF, Franklin J, Arroyo-Rodríguez V, Field R, Aguilar S, Aguirre N, Aiba S-I, … Zang R 2018. A phylogenetic classification of the world's tropical forests. Proceedings of the National Academy of Sciences of the USA 115(8): 1837–1842. doi: 10.1073/pnas.1714977115

Smith JR, Letten AD, Ke P-J, Anderson CB, Hendershot JN, Dhami MK, Dlott GA, Grainger TN, Howard ME, Morrison BML, et al. 2018. A global test of ecoregions. Nature Ecology & Evolution 2(12): 1889–1896. [Data sourced from GBIF]

Tanentzap AJ, Lloyd KM 2017. Fencing in nature? Predator exclusion restores habitat for native fauna and leads biodiversity to spill over into the wider landscape. Biological Conservation 214: 119–126.

Wiser SK, De Cáceres M 2018. New Zealand's plot-based classification of vegetation. Phytocoenologia 48(2): 153–161. doi: 10.1127/phyto/2017/0180

Wood JR, Holdaway RJ, Orwin KH, Morse C, Bonner KI, Davis C, ... Dickie IA 2017. No single driver of biodiversity: divergent responses of multiple taxa across land use types. Ecosphere 8(11):e01997.

Yoo KO, Crowl AA, Kim KA, Cheon KS, Cellinese N 2018. Origins of East Asian Campanuloideae (Campanulaceae) diversity. Molecular Phylogenetics and Evolution 127:468–74. [Data sourced from GBIF]

13.2 Contract reports

The following eight 2017/18 contract reports used data archived in the NVS databank.

Brandt AJ, Easdale T, Monks A, Bellingham P 2017. Summary of results for DOC state of environment report 2017. Manaaki Whenua – Landcare Research Contract Report for Department of Conservation.

Factsheet on *Podocarpus totara* var. *totara*. Montreal Process´s reporting on sacred trees in temperate and boreal forests. Manaaki Whenua – Landcare Research contribution to international reporting via the Department of Conservation, Nov 2017.

Groenteman R, Probst C, Bellgard S, Prebble J 2017. Feasibility for biological control of horehound, *Marrubium vulgare* L. Landcare Research Contract Report LC3040 prepared for the Horehound Biocontrol Group.

Mason N, Bellingham P 2018. Evaluating optimum measurement of biodiversity indicators Manaaki Whenua – Landcare Research Contract Report LC3298 for Department of Conservation.

Singers N 2017. Assessment of ecological effects – vegetation. NZES Ltd Technical Report 7a.

Uys R 2017. Terrestrial ecology state of the environment monitoring programme: annual data report 2016/17. Greater Wellington Regional Council, Publication No. GW/ESCI-T-17/102, Wellington.

Wiser SK, Cooper JA, Arnst EA, Richardson SJ 2017. Mapping of native Myrtaceae in New Zealand. Landcare Research Contract Report LC3065 for Department of Conservation.

Wright S 2017. The impact of dama wallaby (*Macropus eugenii*) and red deer (C*ervus elaphus*) on forest understorey in the Lake Okataina Scenic Reserve – 2017 update. Unpublished report, Department of Conservation, New Zealand. DOC-3223478.

13.3 Conference presentations

The following two 2017/18 conference presentations (or earlier conferences not reported) used data archived in the NVS databank.

Affeld K, Wiser S, Payton I, De Cáceres M 2017. Using classification assignment rules to assess land use change impacts on national and regional biodiversity. Inaugural Global Forest Biodiversity Initiative Conference & GFBI-FECS Joint Symposium 2017. Forest Research in the Big Data Era, 6–9 September 2017, Beijing, China.

Bellve A 2017. The distribution of epiphytic *Astelia* spp. and their role in habitat formation for other vascular epiphytes. New Zealand Plant Conservation Network, 14–21 November 2017, Hokitika, New Zealand.

13.4 Theses

The following 2017/18 theses used data archived in the NVS databank.

Greer PA. Novel habitats, rare plants and root traits. Master's thesis, Lincoln University.

Appendix 1 – New electronic datasets in NVS 2017/18

Datasets digitised by Landcare Research

ARTHURS PASS TRANSECTS 2018

CANTERBURY HIGH COUNTRY - CORA LYNN DOUGLAS FIR SEED TRAP PLOTS 2017

DOC Tier 1 2016

Franz Josef Chronosequence 2017

MOLESWORTH-JOLLIES WILDING PINES 2017

OMAHUTA 1988

OMIHI SOUTHERN RATA 2018

RANGITAIKI FROST FLAT 2013

RANGITOTO ISLAND EXCLOSURES 1987

RANGITOTO ISLAND EXCLOSURES 1989

RANGITOTO ISLAND EXCLOSURES 1991

RANGITOTO ISLAND EXCLOSURES 1986

RUAHINE GRASSLAND 2007

WAIPAKIHI HABITAT INVENTORY 2013

WHENUAKITE KAURI TRIAL 1986

WHENUAKITE KAURI TRIAL 1971

Datasets entered using NVS Express and migrated into the NVS Databank

Aramahoe Goat Monitoring 2015

Lake Okataina Exclosures 2017

Mt Aspiring Photo Points 1986

Mt Aspiring Photo Points 2007

Mt Aspiring Photo Points 1981

Mt Aspiring Photo Points 1999

Mt Aspiring Photo Points 1970

Mt Aspiring Photo Points 1973

Mt Aspiring Photo Points 1977

Mt Aspiring Photo Points 1991

National Biodiversity Monitoring and Reporting System: Main 2015

POMONA ISLAND 2005

STAFFORD 2018

TARARUA FOREST - PROJECT KAKA 2010

Thornton Kanuka 2017

Hard-copy plot sheets accessioned and archived:

DTZ CATTLE CREEK TRANSECTS 1995

DTZ LEANING ROCK TRANSECTS 1987

DTZ MT PISA TRANSECTS 1986

DTZ ROCK BURN TRANSECTS 1991

DTZ SOLDIERS SYNDICATE TRANSECTS 1993

DTZ STONEHAVEN TRANSECTS 1985

DTZ THE POPLARS TRANSECTS 1989

DTZ TREBLE CONE TRANSECTS 1993

DTZ WAIMANGAROA TRANSECTS 1997

IANTHE STATE FOREST 42 TIMBER CRUISE 1978-1983

IANTHE STATE FOREST 42 WINDFALL & REGEN 1970-1980

Ianthe State Forest Timber appraisals 1980-1985

KAIMANAWA KAMAIHI 2013

LAKE OKATAINA EXCLOSURES 2007

LUCAS UNCERTAINTY 12-20 MARCH 2012

LUCAS UNCERTAINTY 1-30 MARCH 2012

LUCAS UNCERTAINTY 19-28 MARCH 2012

MAHINAPUA - FOWERAKER PLOTS 1921-1925

MAHINAPUA - FOWERAKER PLOTS 1926-28

MAHINAPUA - FOWERAKER PLOTS 1930

MAHINAPUA - FOWERAKER PLOTS 1934

MAHINAPUA - FOWERAKER PLOTS 1937

MAHINAPUA - FOWERAKER PLOTS 1939-1941

MAHINAPUA - FOWERAKER PLOTS 1953

MAHINAPUA - FOWERAKER PLOTS 1975

MT IDA BIODIVERSITY MONITORING 2016-2017

National Biodiversity Monitoring and Reporting System: Main 2016-2017

NORTHERN HAWKES BAY ECOLOGICAL SURVEY 2017 - 2018

OXFORD BEECH FOREST 1995

PUREORA EXCLOSURES 2011-2012

Ruatahuna Unlogged Forest Seedling Survey 2008-2009

STEWART ISLAND - ROBERTSON RIVER 1987

TONGARIRO HOROPITO LAHAR PLATEAU 1986