Manaaki Whenua
Landcare Research

NVS Annual Report for the 2019/20 year

Prepared for: Manaaki Whenua – Landcare Research

October 2020

NVS Annual Report for the 2019/20 year

Contract Report: LC3872

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1 Overview

The National Vegetation Survey Databank (NVS) continues to focus on primary data acquisition, curation and provision 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. NVS now holds data from over 121,000 vegetation survey plots, including 26,000 permanent plots. These span all major ecosystems and a diverse range of naturally uncommon ecosystems. Recent acquisitions have:

- intensified coverage in the Auckland region, including peri-urban areas not typically sampled in the past
- provided current assessment of areas of very high conservation value (e.g. the Heaphy River area, Secretary Island)
- added new census data to the invaluable, but uncommon, large (1 hectare-plus) fully mapped natural forest stands.

NVS 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 (referred to as Tier 1 and LUCAS, respectively). This year NVS archived data from 439 new or remeasured plots for these programmes.

Data sourced from NVS have supported publications and knowledge gains encompassing a variety of New Zealand-focused themes, including:

- how vegetation plot data can inform the interpretation of satellite data when the goal is to differentiate indigenous forest types for regional and national mapping
- how climate change is likely to shift the distribution of two plant species of cultural importance to Māori, relative to their tribal boundaries, and thus reduce or extend access to these taonga
- the implications for future forest composition of differences between native angiosperms and conifers in drought vulnerability
- how the native heaths of the critically endangered frost flat ecosystem show a positive long-term response to wilding conifer control
- based on a global study of islands, that the North Island native monocot flora is highly vulnerable to threats related to climate change.

2 New plot records archived in NVS

Thirty-three new projects[1], comprising 151 data sets and their associated electronic data, were added to NVS in 2019/20 (year to 30 June 2020; see Figure 1 and Appendix 1), with a total of 1,646 plots added. This brings the total number of projects with electronic data in NVS to 1,679, comprising 121,574 individual plots. Data additions since 2000/01 are shown in Figure 1, broken down by major provider.

Major sources of new data this year include:

- the ongoing plot measurement to support a New Zealand national-scale monitoring programme (the Tier 1 programme) undertaken by DOC (539 plots measured in the 2018/19 and 2019/20 field seasons, along with their associated bird count and extended plots)
- the baseline measurement of Auckland Regional Council's biodiversity monitoring project (Auckland Regional Forest Monitoring), representing 267 plots on public land across the Auckland region
- 9 years of remeasurements of experimental silvicultural trials plots established in Granville Forest in 1994 to monitor the impacts of small-scale harvesting in hard beech (*Fuscospora truncata*) forest
- DOC's remeasurement of permanent plots in Whangamarino Wetland plots (36 plots), Secretary Island (21 plots) and the Heaphy region (19 plots) established in 2009/2010, and data from some grassland plots established in the Puketoi Range
- remeasurement of the 2 ha mapped stand in the Orongorongo Valley, which is the longest measurement of a mapped stand in New Zealand.

NVS Express software facilitated the addition of data for three projects (76 plots) to NVS during 2019/20.

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

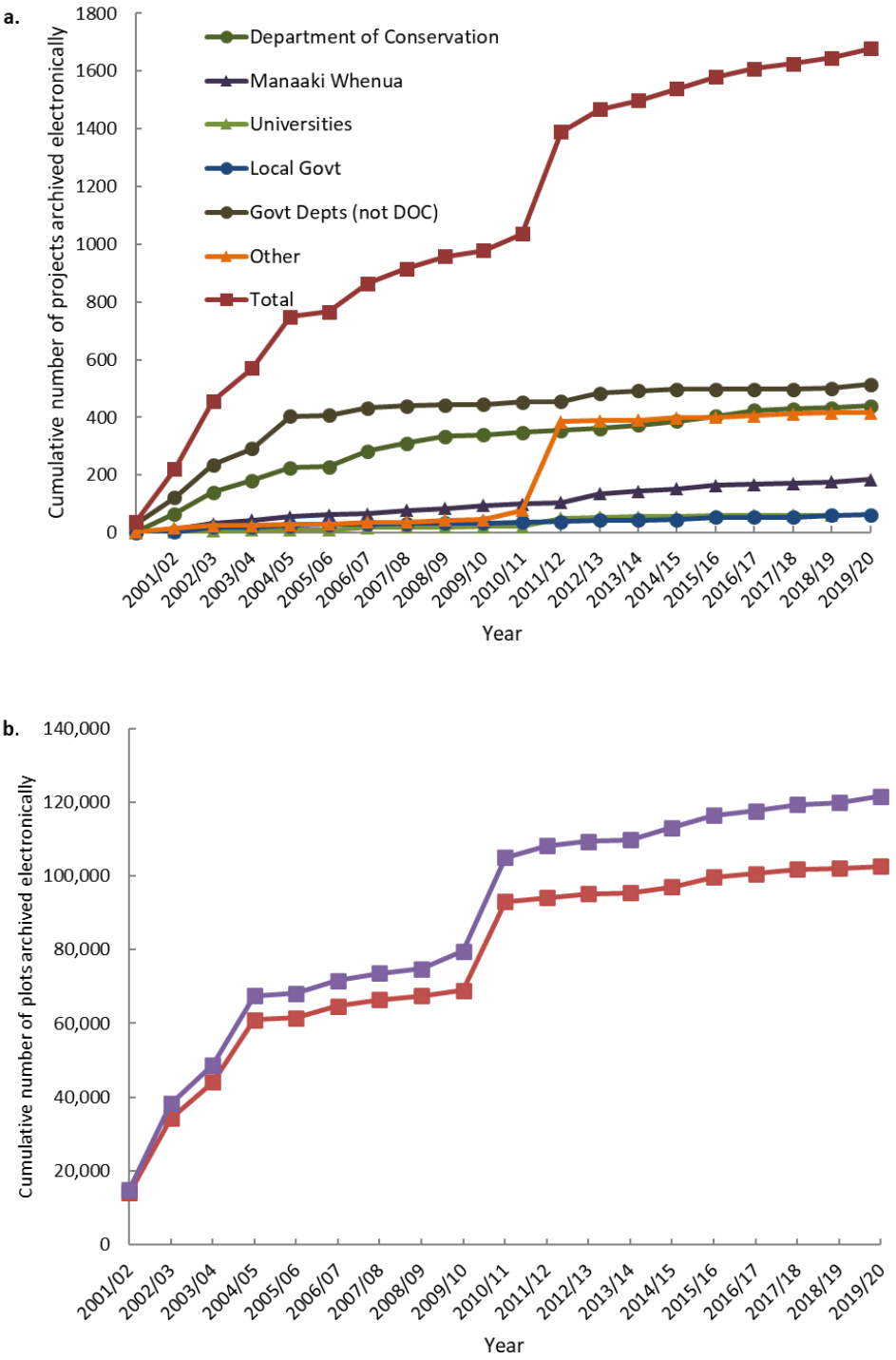

Figure 1. a. Cumulative number of projects archived in NVS, total and from five major contributors, per financial year since the current relational database was developed in 2000. b. Cumulative number of plots archived in NVS by financial year over the same period. The red line represents new plots archived; the purple line represents plot measurements archived, which shows plots that have been remeasured. Both figures include projects migrated over time from legacy data management systems used in the past (e.g. data stored as text files compatible with FORTRAN-based analytical tools) or non-NVS formats (e.g. EXCEL).

3 Improving the archiving of physical records

Electronic data are only one part of NVS. Of critical importance is the physical archive, maintained under climate-controlled conditions, which contains irreplaceable field plot sheets, annotated maps and aerial photographs, photographs of plots themselves, and other invaluable documentation. Many of these ancillary records are vital for relocating plots for future remeasurement and providing details that allow correct interpretation of electronic data.

The archive also houses original paper records of irreplaceable historical data sets that have yet to be digitised. Currently there are 131 boxes of physical records in the NVS archive whose contents require assessment for their suitability for accessioning. Once accessioned, plot records will need to be digitised to make their information more widely accessible. This year substantial efforts were made to accession data from:

- silvicultural research trials established in the late 1990s
- 1 ha natural beech forest stands where all the individuals are mapped
- a large quantity of historical data from the NZ Forest Service that was held by Timberlands West Coast until their disestablishment in 2009.

4 Technological improvements

4.1 Upgrade to the MyNVS area of the NVS website

In June 2020 we launched the beta test version of the upgraded MyNVS area on the NVS website. This is a section of the NVS website that allows registered users to view lists and details about data sets they have archived in NVS; requests for their data sets by others; requests they have submitted to use the data sets of others; and data sets they have uploaded via the website. Users can also create metadata, upload data sets, and edit their user profile.

This upgrade substantially improves the user experience.

- A redesign of layout, fonts and graphics provides a much cleaner 'look and feel' of project listings.
- Faceting provides 'drill-down' capacity so that details about projects are accessible but not overwhelming. Plus a much higher level of detail, down to the plot level, is now readily viewed online.
- Data owners can retrieve their own data without having to go through an unnecessary request process.
- More information is provided on the history of requests for data sets owned by the user, including the purpose of the request, the contact details of the requestor, and whether the owner approved the request.
- Data users can see more details of the history of their data requests, including their original purpose. They can also re-request a data set for a new use.

- Data owners can view and review any metadata records they have uploaded on the NVS website.

This upgrade implemented the suggested improvements made by data users in our 2018/19 user survey.

4.2 Other improvements to the NVS website

Work has been undertaken this year to resolve several long-standing issues in the NVS website. This has included:

- improving how data set approvals are implemented for delivering data when large numbers of data sets are requested
- ensuring that when new users register on the NVS website, a corresponding identity is created for them in the NVS databank
- improving the ability to measure usage of different NVS website components
- improving the usability of the 'Upload Datasets' service.

4.3 Enhancements to the NVS database, user interface and supporting systems

Work was undertaken that:

- improved consistency in the identification of tagged tree stems that are joined to each other
- enabled the NVS data manager to copy a project and its measures when setting up a new project, which saves time for the data manager and ensures consistency between remeasures of a project
- improved the format of pre-printed plot sheets, specifically for the Coarse Woody Debris method
- enabled linking of tags between standard-sized plots and the larger plots in which they are located, so that if a tree falls outside the standard-sized plot it can continue to be tracked through time.

4.4 Improvements to NVS Express data entry software

A new version of NVS Express was released with several improvements and bug fixes.

- More kinds of data can be entered in the site description, and pre-existing data can be modified.
- The layout of the user interface was modified to remove overlap between data fields and improve the logical flow of data entry.
- The look-up (i.e. authority) tables have been updated with new/additional taxon names and other types of category data.
- Error messages have been made easier to understand.
- Speed and performance have been improved.

5 Significant revisions of data

5.1 Enhancing the quality of existing data sets

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 develop new collaborations in New Zealand and when we engage in national and international data synthesis.

Following is a selection of corrections and revisions undertaken.

Project data

- Some projects were renamed to ensure consistency between MetaNVS (the NVS metadata repository) and the NVS databank itself.
- Inconsistencies were resolved where different plot methods were allocated to different projects.
- Several projects were split based on land tenure to streamline the process for granting permission for data access.
- Duplicate metadata records for individual projects were resolved.

Attributes of individuals

- New validation was created to ensure measured trees do not have a state of 'not found'. Seventy-six instances were corrected.

Plant names and attributes

- Processes were implemented to ensure the full range of plant name validations are run quarterly and resolved. Detailed instructions on how to resolve discrepancies have now been prepared.
- A process was implemented to ensure that attributes (e.g. palatability, growth forms) are added to all new plant names associated with records in NVS.

Discrepancies detected by queries that had never been resolved were addressed and solved. These included:

- ensuring all preferred names have an NVS code
- ensuring that designating plants as 'non-vascular' is consistent with their defined growth form
- ensuring that no more than one six-letter code links to each taxon name
- ensuring that spellings of taxon names match those in Ngā Tipu o Aotearoa – New Zealand Plants
- checking and correcting records, as appropriate, for species recorded outside their known range.

6 Increasing end-user awareness and capability

6.1 Increasing access and end-user capability

NVS provides the primary indigenous forest data repository and user interfaces for the DOC Biodiversity Monitoring and Reporting System (Tier 1) and MfE Land Use Carbon Analysis System (LUCAS) programmes. Regular engagement with and collaboration between the parties ensures the services provided by NVS are always being optimised to meet the needs of these two programmes and to support data quality.

To streamline the process for granting access for data use, the LUCAS and Tier 1 projects from 2015 to 2018 were split into separate projects based on land tenure and who grants permission for data use. Associated metadata records were completed for these new projects.

The Tier 1 programme plans to replace the use of hard-copy field sheets with an electronic data capture system in the 2020/21 field season. NVS staff have contributed expertise and documentation to support the development of electronic data capture capacity.

NVS staff completed a comparison between the protocols defined in the widely used vegetation plot sampling manuals (Hurst & Allen 2007a & b[2]) and the Tier 1 plot sampling protocols. Revisions to both ensured the methods are harmonised and unambiguous.

6.2 New NVS users

There are currently 604 registered NVS users, with 111 new users registering between 1 July 2019 and 30 June 2020.

7 Data-sharing agreements, data exchange and journal repositories

We collaborate with numerous domestic and international initiatives to broaden the impact of the data held in NVS. 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
- Global Forest Biodiversity Initiative (http://www.gfbinitiative.org/, which supports cutting-edge research and policymaking in forest science and related initiatives

[2] Hurst J, Allen R 2007. The Recce method for describing New Zealand vegetation: field protocols. Lincoln, New Zealand, Landcare Research New Zealand; Hurst J, Allen R 2007. A permanent plot method for monitoring indigenous forests: field protocols. Lincoln, New Zealand, Landcare Research New Zealand.

- Global Biodiversity Information Facility (GBIF; (https://www.gbif.org/)), which is aimed at providing anyone, anywhere, 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), released in September 2017 (Figure 2). NVS data also continue to be used in numerous one-off global collaborations.

This year we developed a new collaboration with the Nature Map Earth / BIEN consortium. Nature Map Earth (https://naturemap.earth) aims to produce an integrated global map of biodiversity, carbon storage, and other nature services to support decision-making on national, regional and global targets. BIEN (the Botanical Information and Ecology Network; https://bien.nceas.ucsb.edu/bien/) has developed a repeatable workflow to produce global-scale species range maps from species occurrence data. We contributed records from NVS, the New Zealand Virtual Herbarium, and iNaturalist New Zealand to inform species range maps for New Zealand plants. These maps will contribute to an analysis describing global patterns of biodiversity, carbon dynamics, and other ecosystem properties with the aim of identifying areas of significance for conservation and restoration. NVS will also receive copies of these maps, which can be used for additional analyses/reference.

7.1 Use of NVS data through the GBIF portal

An updated set of 1,566,262 species occurrence records for NVS public domain (Open Access) data were uploaded to the GBIF portal in June 2020. These records can be viewed here: http://www.gbif.org/dataset/788439f0-3b56-11dc-8c19-b8a03c50a862. NVS provides a refreshed data set to the GBIF every month. Between 1 July 2019 and 30 June 2020 there were 5,260 downloads of species occurrence data, incorporating 1,215,370,921 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.

We have improved the quality and interpretability of the occurrence data we provide to the GBIF by excluding species identified by 'tag' names (e.g. *Coprosma* 'small-leaved') or names constructed to reflect lack of taxonomic resolution in the past and changes in taxon concepts (e.g. *Nothofagus* species now is best interpreted as *Lophozonia/Fuscospora*). Such records are of little use and may necessitate data 'cleaning' before geographical data syntheses can be undertaken

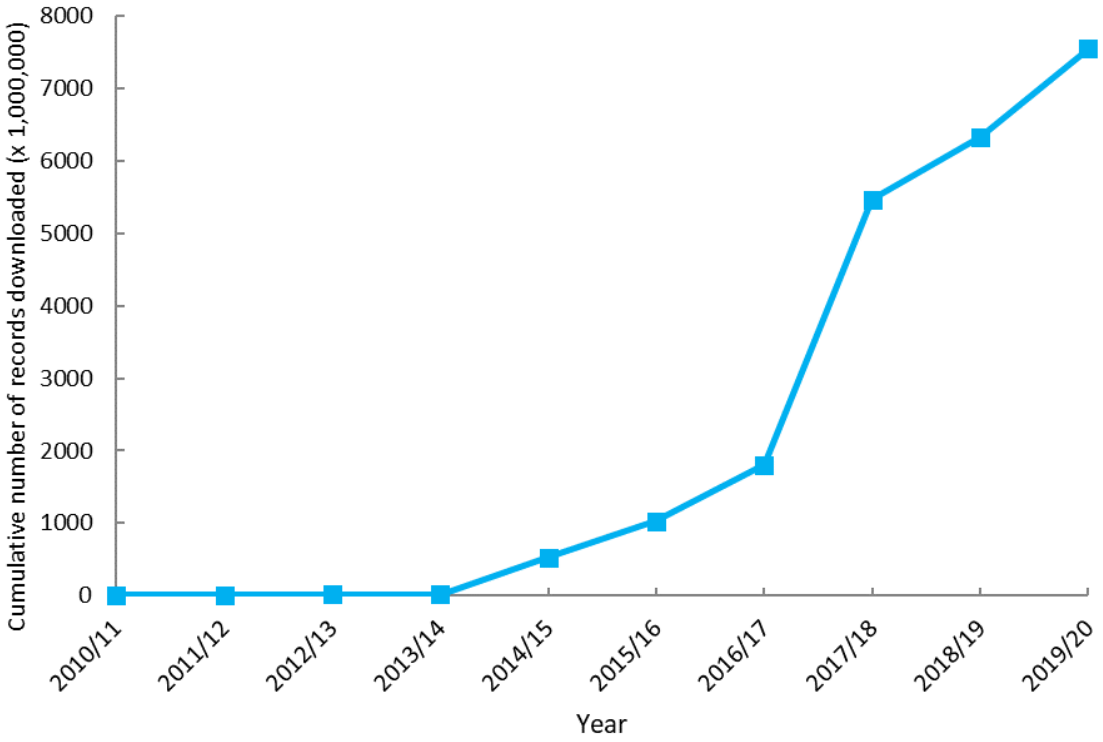

Figure 2. Cumulative number of species occurrence records supplied by the NVS databank that have been downloaded from the GBIF portal since 2010.

7.2 NVS collaboration with sPlot

The sPlot initiative (https://www.idiv.de/?id=176&L=0) is the largest repository for plant community data in the world, with the goal of understanding global patterns in plant diversity across different habitats, biomes and scales. NVS provides plant composition data from 19,018 plot locations spanning forests, shrublands and grassland ecosystems. There are currently 12 global research collaborations involving New Zealand data and New Zealand researchers. Manaaki Whenua staff are currently collaborating with other members of the sPlot consortium on 12 different research projects using these data.

7.3 Use of NVS data via the Manaaki Whenua – Landcare Research DataStore

The NVS databank has joined with the Manaaki Whenua – Landcare Research Datastore (https://datastore.landcareresearch.co.nz/) to provide a means for authors of scientific publications to meet journal open access requirements. NVS data are provided in the cleaned and aggregated form that transparently links to publication results. These data sets are resolved via DOIs provided with the original publication or by searching.

To provide an indication of use, between 1 July 2019 and 30 June 2020 the 13 data sets associated with NVS were viewed 788 times.

Over the last year the Waitutu data set was again the most visited in the NVS collection, followed by the New Zealand Forest Plot Data in the Global Forest Biodiversity Initiative data set. The former data set documented an individual-based forest dynamics model supporting a study demonstrating century-scale effects of invasive deer and rodents on the dynamics of forests growing on soils of contrasting fertility. The latter data set summarised data from two consecutive forest inventories of permanent sample plots located throughout New Zealand for inclusion in a global study demonstrating positive biodiversity–productivity relationships in forests globally.

8 Meeting emerging policy and management needs

The impact of NVS data is demonstrated by the ongoing data contributions to and use of NVS data by agencies, environmental consultants, and researchers working on both basic scientific and applied problems. Because contract reports are commissioned by agencies and organisations to meet their immediate needs, they provide more specific indicators of how NVS data are making an impact. Examples include:

- highlighting key hotspots for protection, restoration, and long-term monitoring to ensure the longevity of taonga species in an area being managed by a consortium of hapū groups
- providing the basis for MfE to incorporate historical human disturbance into their reporting on forest carbon stocks and change to the Intergovernmental Panel on Climate Change (IPCC)
- identifying significant natural areas in Southland to support Environment Southland in their responsibilities under the Resource Management Act 1991
- using registered Emissions Trading Scheme (ETS) / Permanent Forest Sink Initiative (PFSI) sites to improve the accuracy and realism of forest sequestration rates used in ETS look-up tables underpinning the value of units given to landowners who join the scheme.

Further, the plot data held in NVS were highlighted in a submission by the Banks Peninsula Native Forest / Climate Change group on the Climate Change Response (Emissions Trading Scheme) Amendment Bill. Data in NVS were viewed to be an important part of the information sources that could support Banks Peninsula, serving as a test bed to gather data and develop a new methodology and predictive model for underpinning carbon stock change.

9 Use of the NVS website

9.1 Web statistics

From 1 July 2019 to 30 June 2020 the NVS website was visited 6,375 times, up 53% from the 2018/19 year (4,164 visits), and there were 28,699 page views, up 97%.

There were 3,752 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 (62%), followed by North America (12%), China (9%), the Netherlands (5%), Germany (2%), Japan (2%), Australia (1%), South Korea (1%) and the United Kingdom (1%). The website was also visited by people from another 69 countries.

9.2 Document and software downloads

Various documents and software are available to download from the NVS website, and during 2019/20 a total of 1,156 documents were downloaded, the most popular of which are listed in Table 1.

Table 1. Number of unique document downloads from the NVS website during 2019/20 (compiled using Google Analytics)

Item	Number of unique downloads (Google Analytics)
NVS Plant Names List	399
Forest Plot pro forma data sheets (Recce, Stem Diameter and Sapling etc.)	216
Grassland Recce data sheets	67
DOC Tier 1 pro forma data sheets	59
Reconnaissance (Recce) plot manual *	56
NVS Express software package	51
DOC Tier 1 Inventory & Monitoring and LUCAS plots field manual	41
Permanent plot manual *	41
Foliar browse index pro forma data sheets and foliage cover scale	36
NVS Express data entry manual	31
VegX Schema v1.5.1	16
Recent publications list	15
NVS Excel data entry template	13
Using VegX with NVS – and example export	12
Grassland permanent plot manual	11

*Combined totals for 2007, expanded and field guide manuals.

The most popular items downloaded from the website were the NVS Plant Names List, which includes six-letter NVS codes, blank data sheets associated with forest and grassland plot measurement, Recce and permanent plot survey manuals, the NVS Express software package, and documents supporting the DOC Tier 1 monitoring programme.

10 Access to NVS data

10.1 Direct requests for NVS data

This year NVS provided 9,264 data sets to meet 140 individual requests (Figure 3a & b). This reflects the continuing trend of users, particularly in the New Zealand research community, to conduct data syntheses at both the New Zealand and international scale. Fifty-three percent of data sets requested were supplied via the NVS website, and 47% were custom requests, with data manually extracted from NVS.

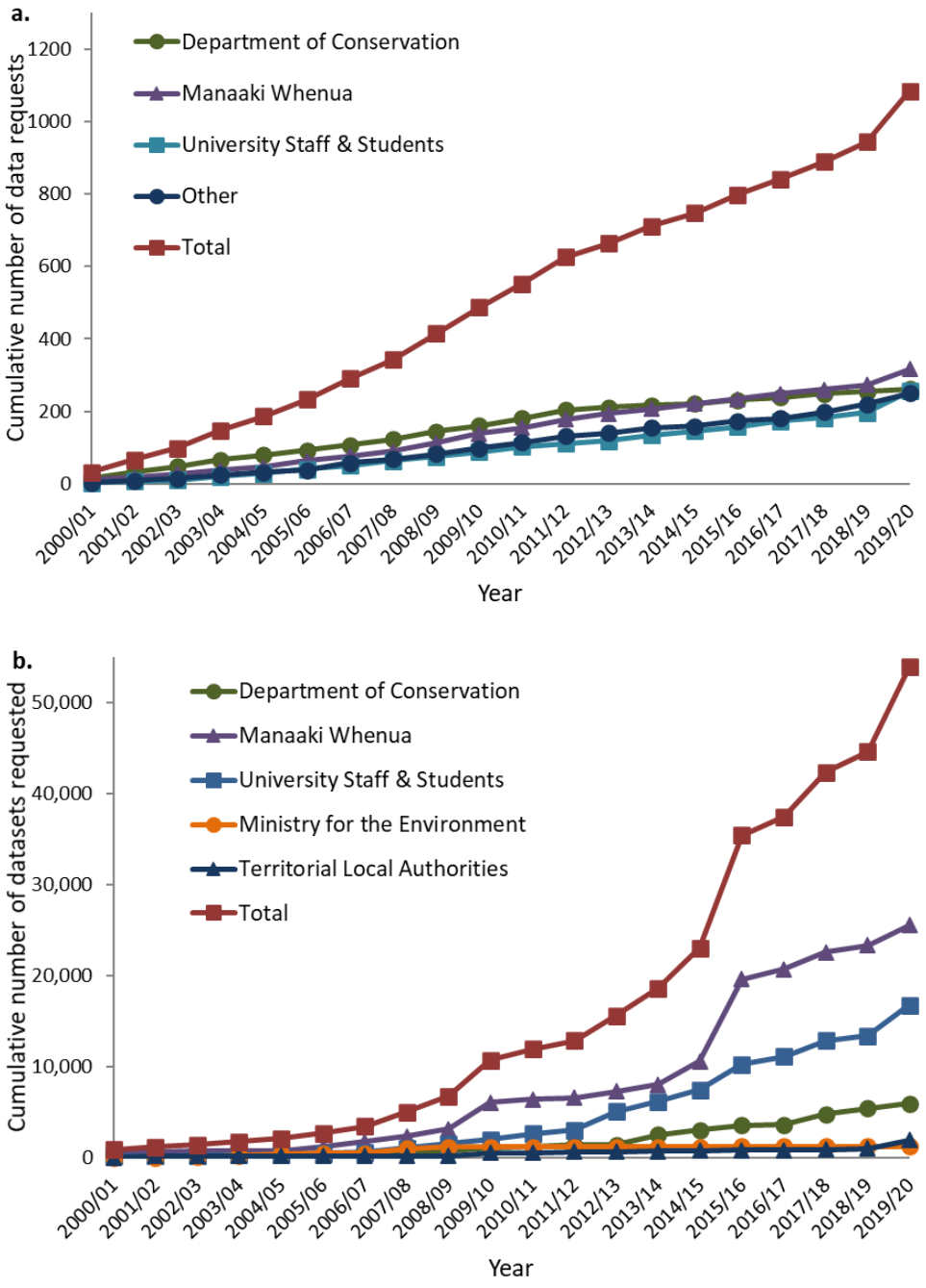

Figure 3. Trends in number of requests for NVS data since 2000, broken down by end-user type. a) cumulative number of requests; b) cumulative number of data sets requested (and delivered).

Here are some examples of intended uses of these data.

- A PhD student requested data to construct a model of the mean canopy height across New Zealand to determine the locations of seabird breeding colonies.
- A person writing a book on the vascular flora of the Rotorua Lakes Ecological District requested species data from plots located within the ecological district.
- A large request for Recce inventory data from across New Zealand was made as part of a project to examine how weed species occurrence and abundance have changed over time, and how their functional forms, habitat types, disturbance, residence time since introduction, and co-occurring exotic species affect these patterns.
- A university student working on a project obtaining forest biomass from remote-sensing images requested data to calculate field biomass to compare with results obtained from remote-sensing images.
- A private consultant requested data from the Abel Tasman National Park to be used in an innovative project to develop a mark–recapture method for assessing large land-snail populations.
- A university researcher requested data for species distribution modelling of five beech species, mānuka and kānuka.
- A researcher at a regional council requested data to analyse forest health and change across time for a watershed health assessment.
- A Manaaki Whenua researcher requested data to use in a project to integrate ground-based data with remotely sensed data (both airborne LIDAR and Sentinel imagery) to differentiate vegetation types at a higher level of thematic resolution than has been achieved so far in the Land Cover Database.
- A private consultant working for the Endangered Species Foundation requested data to build a map of threatened plant species in New Zealand.
- A researcher from Statistics New Zealand requested data to create plant species diversity indices for indigenous forests with the aim of using them as ecosystem condition indicators, in a set of experimental ecosystem accounts (under the System of Environmental-Economic Accounts, produced by Stats NZ).
- Weta Digital requested data for modelling and simulating plant distributions as part of a visual effects project.
- A collaboration of international university researchers requested data with the aim of modelling the temporal dynamic of grasslands using functional traits and developing new theoretical models to do so.
- A private consultant requested data to use as baseline data prior to field surveys to inform a resource consent application for a development.
- Manaaki Whenua researchers requested data to test the hypothesis that vegetation community composition responds to the age of glacial surfaces, modified by slope angle and soil erosion.
- DOC staff requested data to use as a starting point to understand kauri biomes in the Coromandel region for a new project called Kauri Protection Forest Health.

11 Building internal capability

We continue to invest in people to ensure an appropriate level of succession planning, including:

- involving an early career programmer in NVS informatics developments to enable the transfer of senior staff knowledge about the complexities and nuances of the NVS database and related systems
- training a staff member who had returned from 9 months of parental leave to share the duties of the NVS database manager.

This year we also oversaw the data entry of the Tier 1 project, which strengthened the relationship with the data entry staff and provided opportunities to enhance our capability in this area in future.

12 Publications associated with the NVS databank

12.1 Published papers

Publications provide an indicator of scientific excellence. This year they ranged in their geographical scope from specific New Zealand locations, to national and global scales. Specific topics are highly diverse and range from the development of new quantitative methods, to applied problems such as the potential risks to biodiversity posed by invasive plants, climate change and changing land cover, and increasing our fundamental understanding of the ecology of native plants and their associated ecosystems.

The following 37 documents published in 2019/20 used data archived in NVS.

Adhikari S, Burke IC, Eigenbrode SD 2020. Mayweed chamomile (Anthemis cotula L.) biology and management: a review of an emerging global invader. Weed Research. https://doi.org/10.1111/wre.12426. [Data sourced from GBIF]

Allen R, MacKenzie D, Bellingham P, Wiser S, Arnst E, Coomes D, Hurst J 2020. Tree survival and growth responses in the aftermath of a strong earthquake. Journal of Ecology 108: 107–122. DOI: 10.1111/1365-2745.13238

Bond MO, Anderson BJ, Henare THA, Wehi PM 2019. Effects of climatically shifting species distributions on biocultural relationships. People and Nature 1: 87– 102. https://doi.org/10.1002/pan3.15

Chidawanyika F, Chikowore G, Mutamiswa R 2020. Thermal tolerance of the biological control agent *Neolema abbreviata* and its potential geographic distribution together with its host *Tradescantia fluminensis* in South Africa. Biological Control 104315. [Data sourced from GBIF]

Conradi T, Slingsby JA, Midgley GF, Nottebrock H, Schweiger AH, Higgins SI 2020. An operational definition of the biome for global change research. New Phytologist. https://doi.org/10.1111/nph.16580 [Data sourced from GBIF]

Cornwell WK, Pearse WD, Dalrymple RL, Zanne AE 2019. What we (don't) know about global plant diversity. Ecography 42(11): 1819-1831. [Data sourced from GBIF]

Dymond JR, Zörner J, Shepherd JD, Wiser SK, Pairman D, Sabetizade M 2019. Mapping physiognomic types of indigenous forest in New Zealand using space-borne SAR, optical imagery and air-borne LiDAR. Remote Sensing 11: 1911. DOI: 10.3390/rs11161911

Easdale TA, Richardson SJ, Marden M, England JR, Gayoso-Aguilar J, Guerra-Cárcamo JE, McCarthy JK, Paul KI, Schwendenmann L, Brandon AM 2019. Root biomass allocation in southern temperate forests. Forest Ecology and Management 453: 117542.

Enquist BJ, Feng X, Boyle B, Maitner B, Newman EA, Jørgensen PM, Roehrdanz PR, Thiers BM, Burger JR, Corlett RT, et al. 2019. The commonness of rarity: global and future distribution of rarity across land plants. Science Advances 1;5(11): eaaz0414. [Data sourced from GBIF]

Hock M, Hofmann R, Essl F, Pyšek P, Bruelheide H, Erfmeier A 2020. Native distribution characteristics rather than functional traits explain preadaptation of invasive species to high-UV-B environments. Diversity and Distributions 26: 1421-1438. DOI:10.1111/ddi.13113 [Data sourced from GBIF]

Jahanshiri E, Mohd Nizar NM, Tengku Mohd Suhairi TAS, Gregory PJ, Mohamed AS, Wimalasiri EM, Azam-Ali SN 2020. A land evaluation framework for agricultural diversification. Sustainability 12(8): 3110. [Data sourced from GBIF]

Kattenborn T, Eichel J, Wiser S, Burrows L, Fassnacht F, Schmidtlein S 2020. Convolutional neural networks accurately predict cover fractions of plant species and communities in unmanned aerial vehicle imagery. Remote Sensing in Ecology and Conservation (early view 5 February 2020). https://doi.org/10.1002/rse2.146.

Klages JP, Salzmann U, Bickert T, Hillenbrand C-D, Gohl K, Kuhn G, Bohaty SM, Titschack J, Müller J, Frederichs T 2020. Temperate rainforests near the South Pole during peak Cretaceous warmth. Nature 580(7801): 81–86. [Data sourced from GBIF]

Laughlin DC, Delzon S, Clearwater MJ, Bellingham PJ, McGlone MS, Richardson SJ 2020. Climatic limits of temperate rainforest tree species are explained by xylem embolism resistance among angiosperms but not among conifers. New Phytologist 226: 727–740.

Li K, Wang J, Qiao L, Zheng R, Ma Y, Chen Y, Hou X, Du Y, Gao J, Liu H 2020. Diversity of reproductive phenology among subtropical grasses is constrained by evolution and climatic niche. Frontiers in Ecology and Evolution 8: 181. [Data sourced from GBIF]

Lindberg CL, Hanslin HM, Schubert M, Marcussen T, Trevaskis B, Preston JC, Fjellheim S. 2020. Increased above ground resource allocation is a likely precursor for independent evolutionary origins of annuality in the Pooideae grass subfamily. New Phytologist 228: 318-329. [Data sourced from GBIF]

Luebert F, Lörch M, Acuña R, Mello-Silva R, Weigend M, Mutke J 2020. Clade-specific biogeographic history and climatic niche shifts of the southern Andean-southern Brazilian disjunction in plants. In: Rull V., Carnaval A. (eds) Neotropical Diversification: Patterns and Processes. Fascinating Life Sciences. Springer, Cham. https://doi.org/10.1007/978-3-030-31167-4_24 [Data sourced from GBIF]

Lusk CH, Wiser SK, Laughlin DC 2020. Macroclimate and topography interact to influence the abundance of divaricate plants in New Zealand. Frontiers in Plant Science 11(507). https://doi.org/10.3389/fpls.2020.00507

Marconi L, Armengot L 2020. Complex agroforestry systems against biotic homogenization: the case of plants in the herbaceous stratum of cocoa production systems. Agriculture, Ecosystems & Environment 287: 106664. [Data sourced from GBIF]

Mungi NA, Qureshi Q, Jhala YV 2020. Expanding niche and degrading forests: key to the successful global invasion of Lantana camara (sensu lato). Global Ecology and Conservation: e01080. [Data sourced from GBIF]

Nomura M, Ohlemüller R, Lee WG, Lloyd KM, Anderson BJ 2019. Can we predict which species win when new habitat becomes available? PloS One 14(9).

Ohashi H, Hasegawa T, Hirata A, Fujimori S, Takahashi K, Tsuyama I, Nakao K, Kominami Y, Tanaka N, Hijioka Y 2019. Biodiversity can benefit from climate stabilization despite adverse side effects of land-based mitigation. Nature Communications 10(1): 1–11. [Data sourced from GBIF]

Peralta G, Perry GLW, Vázquez DP, Dehling DM, Tylianakis JM. Strength of niche processes for species interactions is lower for generalists and exotic species. Journal of Animal Ecology (in press).

Peralta G, Schon NL, Dickie IA, St John MG, Orwin KH, Yeates GW, Peltzer DA 2019. Contrasting responses of soil nematode communities to native and non-native woody plant expansion. Oecologia 190(4): 891–899.

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(11): 2971–2987.

Peralta G, Perry GL, Vázquez DP, Dehling DM, Tylianakis JM 2020. Strength of niche processes for species interactions is lower for generalists and exotic species. Journal of Animal Ecology 89: 2145–2155

Pouteau R, Trueba S, Isnard S 2020. Retracing the contours of the early angiosperm environmental niche. Annals of Botany 125(1): 49–57. [Data sourced from GBIF]

Prevéy JS, Parker LE, Harrington CA 2020. Projected impacts of climate change on the range and phenology of three culturally-important shrub species. PloS One 15(5): e0232537. [Data sourced from GBIF]

Renner SS, Barreda VD, Tellería MC, Palazzesi L, Schuster TM 2020. Early evolution of Coriariaceae (Cucurbitales) in light of a new early Campanian (ca. 82 Mya) pollen record from Antarctica. TAXON 69:87–99. [Data sourced from GBIF]

Smith AL, Hodkinson TR, Villellas J, Catford JA, Csergő AM, Blomberg SP, Crone EE, Ehrlén J, Garcia MB, Laine A-L 2020. Global gene flow releases invasive plants from environmental constraints on genetic diversity. Proceedings of the National Academy of Sciences 117(8): 4218–4227. [Data sourced from GBIF]

Smith JR, Hendershot JN, Nova N, Daily GC 2020. The biogeography of ecoregions: descriptive power across regions and taxa. Journal of Biogeography. https://doi.org/10.1111/jbi.13871 [Data sourced from GBIF]

Staude IR, Navarro LM, Pereira HM 2020. Range size predicts the risk of local extinction from habitat loss. Global Ecology and Biogeography 29(1): 16–25. [Data sourced from GBIF]

Staude IR, Waller DM, Bernhardt-Römermann M, Bjorkman AD, Brunet J, De Frenne P, Hédl R, Jandt U, Lenoir J, Máliš F 2020. Replacements of small-by large-ranged species scale up to diversity loss in Europe's temperate forest biome. Nature Ecology & Evolution 4: 802–808. [Data sourced from GBIF]

Valencia E, de Bello F, Lepš J, Galland T, E-Vojtkó A, Conti L, Danihelka J, Dengler J, Eldridge DJ, Estiarte M 2020. Directional trends in species composition over time can lead to a widespread overemphasis of year-to-year asynchrony. Journal of Vegetation Science 31: 792–802.

Veron S, Haevermans T, Govaerts R, Mouchet M, Pellens R 2019. Distribution and relative age of endemism across islands worldwide. Scientific reports 9(1): 1–12. [Data sourced from GBIF]

Veron S, Mouchet M, Govaerts R, Haevermans T, Pellens R 2019. Vulnerability to climate change of islands worldwide and its impact on the tree of life. Scientific Reports 9(1): 1–14. [Data sourced from GBIF]

12.2 Contract reports

The following ten 2019/20 contract reports used data archived in NVS.

Bellingham PJ, Wiser S, McCarthy J, Arnst E, Innes J, Fitzgerald N 2020. Baseline information about vegetation and birds to guide kaitiakitanga in Warawara ngahere. Manaaki Whenua – Landcare Research Contract Report LC3671 for Te Rarawa Anga Mua and the Komiti Kaitiaki for Warawara ngahere.

Easdale T, Burrows L, Bellingham P, Carswell F 2019. Rates of carbon sequestration in naturally regenerating indigenous forests. Manaaki Whenua – Landcare Research Contract Report LC3530 for Scion.

Easdale T, Richardson S, Wiser S 2020. Consistency in classifications of pre-1990 natural forest as tall versus regenerating. Manaaki Whenua - Landcare Research Contract Report LC3754 for the Ministry for the Environment.

Etherington T, Fergus A, Richardson S, Wiser S, Burrows L, Bellingham P, Carswell F 2019. Predicting woody vegetation state at 1990 in the Marlborough region. Manaaki Whenua – Landcare Research Contract Report LC3583 for the Ministry for Primary Industries.

Fitzgerald N 2020. Legacy effects of conifer invasion and control in frost flats: monitoring design. Manaaki Whenua – Landcare Research Contract Report LC3790 for Bay of Plenty Regional Council.

Mason N, Price R 2019. Power to detect change in forest composition and populations of individual tree species in the Bay of Plenty region. Manaaki Whenua – Landcare Research Contract Report LC3433 for Bay of Plenty Regional Council.

Maule H 2020. Botanical survey of apiary sites. Manaaki Whenua – Landcare Research Contract Report LC3804 for Ministry for Primary Industries.

Monks A, Schlesselmann A, Brownstein G, Burrows L 2020. Draft monitoring of shoreline vegetation at Lakes Manapouri, Te Anau and Hauroko 2020. Manaaki Whenua – Landcare Research Contract Report LC3802 for Meridian Energy.

Uys R 2019. Terrestrial Ecology State of the Environment monitoring programme: annual data report, 2018/19. Wellington, Greater Wellington Regional Council.

Wildland Consultants 2019. Potential natural ecosystems and significant natural areas for indigenous biodiversity in Southland Region. Wildland Consultants Contract Report No. 4580. Prepared for Environment Southland.

12.3 Conference presentations

The following thirteen 2019/20 conference presentations (or earlier conferences not reported) used data archived in NVS. Note that this is unlikely to be a comprehensive list as it is very challenging to track such presentations.

Allen K, St John M, Bellingham P, Richardson S, Peltzer D 2019. [Poster] Impacts of ungulate exclusion on forest C stocks in NZ. New Zealand Ecological Society Conference, Lincoln, New Zealand, 1–5 December 2019.

Bellve, A. 2019. Resolving the niche space of native perching lilies to match habitats with habitat formers. New Zealand Ecological Society Conference: 'Ngā koiora o konei / Biodiversity where we are', Lincoln, 1–5 December 2019. https://confer.eventsair.com/nzes2019/

Burge O, Arnst A, Bellingham P, Boot K, Burrows L, Ford K, Richardson S, Wilmshurst J, Wiser S 2019. 128 years of post fire succession records in the New Zealand Alps. IAVS Annual Symposium, Bremen, Germany, 14–19 July 2019.

Eger A, Burge O, Almond P 2020. Soil erosion rejuvenates vegetation community composition. Goldschmidt Conference, 21–26 June 2020 [virtual].

Kattenborn T, Eichel J, Wiser S, Burrows L, Schmidtlein S 2019. Combining convolutional neural networks and high-resolution UAV imagery: a powerful tool for vegetation mapping. 62nd Annual Symposium of the International Association for Vegetation Science, Bremen, Germany, 14–19 July 2019.

McCarthy J, Richardson S, Bellingham P, Beresford R, Campbell R, Turner R, Wiser S 2019. Mapping Aotearoa's Myrtaceae. Myrtle Rust Science Symposium, Auckland, 9–10 September 2019.

McCarthy J, Richardson S, Bellingham P, Beresford R, Campbell R, Turner R, Wiser S 2019. Using spatial models to identify refuguia and guide restoration as part of Aotearoa's response to myrtle rust. New Zealand Ecological Society Conference: 'Ngā koiora o konei / Biodiversity where we are', Lincoln, 1–5 December 2019. https://confer.eventsair.com/nzes2019/

Sapsford S 2019. Pine invasion drives loss of soil fungal diversity. Environmental DNA Workshop, University of Otago, Dunedin, New Zealand.

Sapsford S 2020. Pine invasion drives loss of soil fungal diversity. New Zealand Microbial Consortium, Auckland, New Zealand.

Schmidtlein S, Wiser S, Burrows L, Kattenborn T 2019. A top-down perspective on forest canopy traits in a soil chronosequence. 62nd Annual Symposium of the International Association for Vegetation Science, Bremen, Germany, 14–19 July 2019.

Vanderhoorn J, Perry G, Wilmshurst J, Richardson S 2019. [Poster] A sighting of a ghost taxon: modelling the distribution of Beilschmiedia tawa in indigenous forests through co-occurring species and pollen signals, New Zealand. New Zealand Ecological Society Conference, Lincoln, New Zealand, 1–5 December 2019.

Wiser SK, Lusk C, Laughlin D 2019. Macroclimate mediates the distribution of plant functional types across topographic gradients: the case of New Zealand's divaricate plants. 62nd Annual Symposium of the International Association for Vegetation Science, Bremen, Germany, 14–19 July 2019.

Wiser SK, McCarthy J, Bellingham P 2019. Revising a vegetation map for Warawara ngahere. Presentation to a wānanga of Te Rarawa Anga Mua and the Komiti Kaitiaki for Warawara ngahere, Te Rūnanga o Te Rarawa, Kaitaia, 13 November 2019.

12.4 Theses

The following 2019/20 thesis used data archived in NVS.

Innes S 2020. Adaptation to climate in space and time. MSc thesis, University of Toronto, Canada. [Data sourced from GBIF]

Appendix 1 – New electronic data sets in NVS, 2019/20

Data sets digitised by Manaaki Whenua – Landcare Research

FIORDLAND LAKES 2015
Franz Josef Chronosequence 2019
MANAWATAWHI 2019
NORTHERN HAWKES BAY ECOLOGICAL SURVEY: MAIN 2017
NORTHERN HAWKES BAY ECOLOGICAL SURVEY: RESTRICTED 2017
ORONGORONGO ISA MAPPED STAND 2019
Puketoi 1988
Regenerative Agriculture 2020
SOUTH ISLAND WETLANDS 2018
Te Paki Tapotupotu 2018
Ten 'Private' projects [Confidential, archived in NVS predominantly for data security]

Data sets entered using NVS Express and migrated into NVS

HEAPHY 2020
SECRETARY ISLAND FOREST 2017
Whangamarino Wetland Monitoring 2018

Data sets migrated from other formats into NVS

AUCKLAND REGIONAL FOREST MONITORING 2009
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 1995
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 1996
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 1997
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 1998
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 1999
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 2001
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 2003
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 2005
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 2010

Hard-copy plot sheets accessioned and archived

Arthurs Pass chart quadrats 1930-2001
BEN LOMOND RESERVE DOUGLAS FIR INVASION 1982
GRANVILLE FOREST SMALL COUPE HARVESTING TRIALS 2000
HARPER/AVOCA FOREST 1959-1960
HARPER/AVOCA FOREST 1965-1966
HARPER/AVOCA GRASSLAND 1955-1956
LONGWOOD RANGE - NORTH EAST 1978
Maruia canopy gaps 1987
Maruia canopy gaps 2003
Maruia dieback transect 1990
Maruia dieback transect 1991
Maruia mapped 1ha stands 1986-1987
Maruia mapped 1ha stands 1987-1988
Maruia mapped 1ha stands 1988
Maruia mapped 1ha stands 1989
Maruia mapped 1ha stands 1990
Maruia mapped 1ha stands 1991
Maruia mapped 1ha stands 1992
Maruia mapped 1ha stands 1993
Maruia mapped 1ha stands 1994
Maruia mapped 1ha stands 1995- Jan
Maruia mapped 1ha stands 1995- Nov
Maruia mapped 1ha stands 1996
Maruia mapped 1ha stands 1997
Maruia mapped 1ha stands 1998
Maruia mapped 1ha stands 2001
Maruia mapped 1ha stands 2009
Maruia mapped 1ha stands 2009-2010
Maruia mapped 1ha stands 2010
Maruia mapped 1ha stands 2011
Maruia mapped 1ha stands 2012
STATION CREEK SMALL COUPE HARVESTING TRIALS FOREST 1996
STATION CREEK SMALL COUPE HARVESTING TRIALS FOREST 1997
STATION CREEK SMALL COUPE HARVESTING TRIALS Post-harvest FOREST 1995
Tawhiwhi Seedlings 2019
Waingake-Waterworks bush 2019