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Building an Effective eDNA Biosecurity Dashboard

Collins Consulting Ltd

Contents

Executive Summary

This report summarises the outcomes of a February 18, 2025, workshop convened in Wellington to explore the development of an environmental DNA (eDNA) biosecurity dashboard for New Zealand. The initiative, supported by an Envirolink Advice Grant and led by researchers from Manaaki Whenua Landcare Research and the University of Waikato, aims to improve the early detection of invasive species, enable more effective biosecurity responses, and potentially support broader biodiversity monitoring. Although eDNA is being used for biosecurity purposes now, the lack of a coordinated, interoperable, and sustainable approach to data sharing and use is limiting its effectiveness.

Three existing dashboards -- Cawthron's Pest Alert Tool, Otago Regional Council's eDNA dashboard, and Epi-interactive's Ripple platform -- were presented at the workshop and participants discussed their strengths and limitations in the New Zealand biosecurity context.

Workshop discussions highlighted four priority themes for a future-fit eDNA dashboard:

1. **Infrastructure and Technical Capability** – A robust system should allow standardised, interoperable data submission from various sources, support data sovereignty (especially for iwi and hapū), and be backed by sustainable governance and funding.
2. **Usability and Target Audiences** – The dashboard should cater to both technical and non-technical users through a layered interface, allowing for customisable data views and alerts.

Integration with national frameworks and scalability for broader biodiversity applications were also emphasised.

3. **Data Sharing Principles and Barriers** – Trust, transparency, and clearly defined access protocols are essential. Adoption of national standards and metadata protocols would help build confidence and encourage sharing.
4. **Translation and Communication** – eDNA results must be accompanied by clear confidence scores, visualisations, and explanatory guidance to avoid misinterpretation. The dashboard should support decision-making through risk-based alerting and integration with existing biosecurity policies.

Real-world examples, such as delayed responses to Senegal tea in Hawke's Bay, underscored the urgency for a coordinated and timely eDNA system. Participants agreed that a national dashboard could improve detection, reduce costs, and support conservation outcomes, provided key design and governance challenges are addressed.

Next steps include synthesising the workshop input into research funding proposals to support research that can optimise the eDNA dashboard approach for biosecurity, tailored to the needs of regional councils and central government agencies. The focus will be on increasing the utility of any dashboard for regional councils and safeguarding that data for the future. The workshop's insights will inform the next phase of development, with an emphasis on standardisation, usability, and long-term sustainability.

Background and Context

A workshop was held February 18, 2025, in Wellington as part of a research programme to develop a framework for an environmental DNA (eDNA) biosecurity dashboard that improves data sharing, increases the likelihood of early detection and reduces response times.

Over the longer term, such a dashboard could become an exemplar for nationwide biomonitoring, for example as a tool to support biodiversity monitoring or monitoring predator elimination progress.

The workshop was part of an Envirolink Advice Grant sponsored by Hawke's Bay Regional Council on behalf of the Biosecurity Working Group. Manpreet Dhami, Manaaki Whenua Landcare Research, and Ang McGaughran, University of Waikato, are the lead researchers.

Regional councils supported this initiative because they recognised that while some eDNA biosecurity data management systems already exist, they lack a coordinated approach and are not easily integrated, which means that joined-up biosecurity responses are more difficult. For example, the underlying metadata often uses different standards and has restrictions on its secondary use. This can limit opportunities for a timely and coordinated biosecurity response.

The February 18 workshop was a first step toward the development of a more coordinated dashboard to increase standardisation and improve usability for a broad range of agencies at the regional and national level. Appendix 1 is a list of workshop participants.

Existing Dashboards

Developers of three biosecurity dashboards were invited to present to the workshop. These dashboards represent a variety of approaches, data incorporation and presentation, as well as varying ability for cross-institutional sharing. The presentations are summarised below, along with comments on their strengths and weaknesses as tools to support pest management responses in New Zealand.

Pest Alert Tool

Presented by John Pearman – Cawthron Institute

The Pest Alert Tool (PAT) was developed by the Cawthron Institute as an early detection system for marine biosecurity threats. Funded by the Ministry of Business, Innovation and Employment (MBIE), it is part of the Marine Biosecurity Toolbox programme. The tool is designed for a range of users, including government agencies, researchers and community groups. It screens eDNA data to identify invasive species from the Ministry for Primary Industries' (MPI) species risk register. The tool requires users to upload FASTA files[1] (18S and COI gene sequences), which are then compared against a curated reference database of 407 species. This database, sourced from NCBI, BOLD and New Zealand biosecurity lists, enables species identification and secondary quality assessments. However, the reference library has significant gaps, with 40% of species lacking 18S sequences and 55% missing COI data.

PAT is user-friendly, requiring limited expertise, and provides readily understandable results. It does not store user data, only recording species detections. Users can integrate PAT outputs with ExPAT, a spatial mapping tool, to track pest distributions over time. However, funding has ended, halting further development and maintenance. Other challenges include database limitations, variable confidence in results and the complexity of programming languages. A related project being developed in Saudi Arabia, built in R[2], allows broader gene searches but requires more expertise to use. Future improvements to PAT could involve integrating with global databases like GBIF to enhance usability and data sharing.

Strengths: The tool is free and easy to use with the user's own sequence data. Simple web interface, no additional infrastructure requirements in current form.

Weaknesses: Ongoing support and development are limited. Written in a non-standard language. Focus is known risk species, so it cannot flag emerging or novel species. The focus is limited to marine pests species. The database currently deployed is incomplete.

Otago Regional Council eDNA dashboard

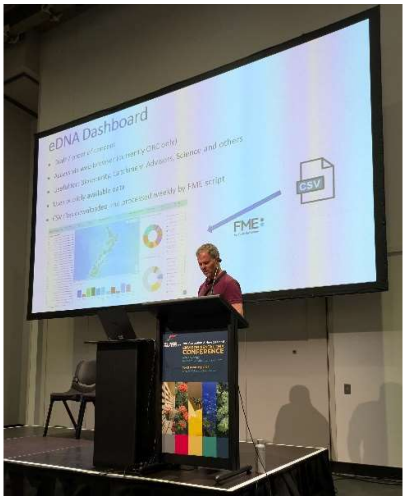
Presented by Stephen Read and Scott Jarvie – Otago Regional Council

The Otago Regional Council eDNA interactive dashboard is designed to map public datasets from Wilderlab NZ Limited. Using ArcGIS Pro software and an FME script, location and eDNA records (*.csv files with >16k GPS locations and >1.4M eDNA genus and species matches) are combined and automatically updated. The visualisations can be accessed via a web browser. The dashboard generates interactive maps, charts or tables and can be filtered for and searched with customised

[1] FASTA files are a simple text-based format commonly used to store and exchange nucleotide or amino acid sequences in bioinformatics.

[2] An open-source programming language and software environment specifically designed for statistical computing and graphics.

taxa lists, regions, target species/groups and dates. The focus of this dashboard is on custom alert species lists, such as Otago's Regional Pest Management Plan, but it can be customized for any list of targets, e.g., exclusion/eradication pests, threatened native species, biocontrol agents, etc. In addition to standard eDNA detections, the dashboard also shows the Taxon-Independent Community Index (TICI) codes for each sample.



Stephen Read, Otago Regional Council

Scott Jarvie highlighted two additional eDNA dashboards. One is a Shiny R app that also uses data from Wilderlab, but is open source, non-proprietary and focuses on threatened species. It is used to identify sample density and 'holes' (missing data) on maps and can be searched by taxonomic groups, NZ threat classification, conservation status, region or date. For example, plots could show "most common species in a selected region." The app can be used as a communication tool to send regular newsletters to subscribers. The second dashboard uses eDNA to assess water quality using TICI scores.

Strengths: Interactive map visualisations and customised search and filter tools. Automatic updates. Simple and easy to use tool. FME is an expensive software product, however most regional councils use it and it supports automated reporting.

Weaknesses: Cannot upload your own data; reliant on Wilderlab. ArcGIS Pro is not free, but ArcGIS is. Would the dashboard provide limited access via the free ArcGIS? Upscaling in scope might be limited. Unsure if the Shiny R app can be repurposed for a biosecurity focus.

Ripple dashboard (Epi-interactive)

Presented by Petra Muellner -- Epi-interactive

Ripple is a platform that aims to be independent, scalable and customisable - supporting a variety of users. Its focus is on both biosecurity and biodiversity. The ability to include metrics like TICI scores is currently in beta development. The key foundational ideas for the platform are that for biosecurity there is a high cost of doing nothing, that current systems do not support cross-agency collaboration and that the system must provide a rapid alert, early warning function to users.

Ripple is versatile in terms of searchability - users can search/categorise data results by watchlist, species, region, catchment, etc. Existing databases can be pulled in (e.g., Ripple will update automatically when new data is added to Wilderlab's public database) under a creative commons licence signed off by the data submitter and levels of quality can be identified. The system can customize the status of records, such as "confirmed" or "questionable," which is useful from a biosecurity standpoint.

The platform is set up for users who have limited technical knowledge; it runs in a ShinyApp (R) interface as a self-service dashboard, capable of producing PDF reports with graphics and statistics tailored to a particular search. The platform runs on a paid subscription model (there are different access and sharing options for individuals and organisations, users, general public) and data can be shared or kept private. Some outstanding questions include how metadata/sampling efforts will be captured, how notifiable organisms are defined and handled (e.g., reported to MPI?), how non-detections are calculated, and how incorrect detections are handled.

Strengths: Easy to use interface, interactive mapping and timeline of detections, graphing and reporting is easy, visual, versatile and flexible. Generally fit for biosecurity purposes.

Weaknesses: The paid subscription model may discourage some users. Bespoke uses would entail additional development costs.

Scoping a Fit for Purpose eDNA Biosecurity Dashboard

During the second part of the workshop, participants discussed the specific needs of New Zealand biosecurity stakeholders in order to better understand what an "ideal" eDNA dashboard would look like.

Participants were divided into four groups, each looking at four key issues:

1. The **infrastructure and technical capability** requirements for hosting and building the dashboard, including financial sustainability preferences.
2. **Usability and target audiences.** How simple or easy to use does it need to be? Consider trade-offs that might need to be made. Identify relevant stakeholders, end-users and data contributors.
3. **Data sharing** principles and barriers – Including where eDNA should be shared, sovereignty and transparency, and metadata standards and data qualities.
4. **Translation** – How to present eDNA results, how necessary are confidence scores, what metrics are most important?

Key Findings

Infrastructure and technical capability

Data integration and interoperability

The dashboard must accommodate eDNA data from a variety of sources, including government agencies, researchers, private individuals and community groups, including iwi and hapū. For data integration to be successful, standardised formats (FASTA, CSV) and best practice guidelines for data collection and curation are required to ensure compatibility and reusability. The system must support unique identifiers, such as GBIF IDs, to prevent duplication and allow for version control. Interoperability with other datasets or information also is desirable (e.g., land use types or policy data, boundaries for different land types, iwi rohe etc.) and allow users to export or overlay data onto their own platforms.

Hosting, governance and funding

Having a stable, long-term hosting solution is essential. Genomics Aotearoa could hold raw data, alternatively government agency such as MPI or the Department of Conservation might hold the data. A co-funded model, possibly with industry contributions, is another option. Governance structures should accommodate data sovereignty (e.g., allowing iwi to manage regional subsets) while ensuring central oversight to prevent data fragmentation. Funding sustainability is a challenge; options include subscription models where larger users pay more, while community groups and iwi have free or discounted access.

Usability, access and security

The dashboard should be user friendly and built on open-source or widely supported software (e.g., Shiny, ESRI). It must allow for secure data submissions, possibly with firewalls, and provide customisable reports (e.g., species presence by catchment). Users should be able to upload and modify spatial data layers (e.g., shape files). Training and mandatory adoption by regional councils, with opt-in for DOC and MPI, would ensure widespread use.

Scalability and adaptability

The dashboard should start by focusing on immediate biosecurity needs and grow over time to incorporate additional or secondary uses (such as biodiversity monitoring). Initial implementation should focus on existing data and knowledge gaps, ensuring a quick launch to secure buy-in. Regular reviews should address technology updates, funding sustainability and evolving needs. Integration with international models (e.g., GBIF, Australia/USA/EU frameworks) could improve long-term viability. A modular approach - allowing new features like phone app integration or automated reporting - would enhance adaptability.

Usability and target audiences

Fit of data to users

Users and target audiences ultimately depend on project scope. For example, many citizen science and community groups involve non-specialists in eDNA and/or science more generally. This suggests that a two-level approach may work best: (i) a more broad/basic visualisation level; and (ii) a more specific second layer focused on experts (MPI, DOC, councils, etc.). These two layers could have different interfaces for different audiences as the first step, although this might increase development costs as more options are included. More complexity also could potentially attract users who might be willing to pay more for a targeted analysis that allows for broader interpretations (i.e., a link to additional data). Potential paying groups could include the aquaculture industry, government (e.g., councils) and universities. Other value-add options might include linking with biosecurity 'credits' for some users (e.g., goods could sell for a premium if a farmer has eDNA accreditation for positive actions they have taken, such as riparian planting or enhanced pest control.) Simple or more basic versions could be free for community groups.

Target audiences

In thinking about end-users, we also must consider who the data contributors are (they will not always be the same). Most data contributors will likely consist of researchers, regional councils, bioblitz-type groups etc. But end-users and data submitters also will include schools/education groups, outreach groups, etc., whose interests will likely be broader than biosecurity. Given this diversity of end-users, we need to make sure the dashboard does not exclude biodiversity-specific data and that users can define their own areas of interest.

Useability

Users will want a range of capability from a dashboard. This includes identifying gaps in the data, mapping by catchment, interactive graphics that enable them to include factors like biocontrols, visualising spatial and temporal trends (e.g., to predict how a pest may spread over time or to look for species where they shouldn't be), customisable alert processes and links to conservation outcomes.

Consideration of iwi and hapu desires will be important at the design stage. Users will want the dashboard to highlight priorities for action, support social licence and communicate with non-scientists. This lends itself to making sure that data can easily be uploaded, updated, searched (e.g., Latin or common name, an ability to search for specific species or phrases) and extracted from the dashboard. A common and, ideally, free programming language is likely the best option, with flexibility to add in new amplicons or methods (e.g., eRNA).

Communication

There will be some end-users who might be reluctant to have samples taken or others who are unaware of the potential benefits of collecting eDNA information. Thus, communication of the dashboard to a variety of audiences will be important, especially showcasing positive examples.

Data sharing principles and barriers

Encourage sharing through customisation and control

While there are existing relationships between regional councils and MOUs with MPI and DOC, effective data sharing is often limited by a lack of effective internal and external communications, legal and political considerations, different scopes of interest and lack of resources. These issues could be addressed by having a centralised dashboard with customisable levels of access to different classes of data, e.g., metadata, biosecurity or conservation records, private or public sources, geographic regions and Māori data. For transparency, the dashboard users could be asked to sign an agreement about data use/re-use, purpose of access and sharing policies (e.g., reasons for not sharing).

Encourage sharing through confidence

To build trust, different organisations need to see that data sharing is providing benefits without increasing risks to their reputation or productivity. One concern is about the reliability of detections and the consequences of misidentifications. Confidence and consistency can be improved by developing and enforcing standard procedures (such as National Environmental Monitoring Standards, Laboratory Information Management Systems or StatsNZ guidelines) regarding:

- Sampling protocols
- Laboratory methods
- Internal and external controls
- Data processing methods (including reference database versions)
- Data storage and security protocols
- Sequencing depth
- Quality control
- Data formats
- Metadata
- Confidence indices for the reliability of detections
- Notification procedures.

Technical considerations

A common problem across agencies is mixed terminology. A glossary would ensure that people are using the same language. The dashboard should enable the storage of older database versions to enable tracking and reviewing over time. The biggest issue is the question of where the data should be stored and how the dashboard would be resourced. The Global Biodiversity Information Facility (GBIF) has been suggested as an ideal solution to host or align the dashboard with. It is open access, is a global network, has standardised data, already has good data sovereignty standards (including an active working group on indigenous data management with NZ/Māori contributors) and is linked with other sources, such as iNaturalist.

Translation

Confidence scoring and uncertainty management

Confidence scores are essential for interpreting eDNA results but deriving them is complex. Factors that may shape confidence scoring include incomplete taxonomy level information, detection frequency, sampling methodology and reference database completeness. Different species require different confidence thresholds, particularly cryptic or novel species. Machine learning or AI-powered methods could help assign probability scores and all results should be labelled as ‘provisional’ until validated. Transparent caveats and disclaimers are necessary to avoid misinterpretation.

Decision-support and risk-based alerts

The dashboard should support decision making by linking confidence scores to recommended actions. A tiered alert system (e.g., high risk species triggering immediate response) would enhance usability. Predictive modelling -- incorporating spatial and temporal data -- could forecast pest spread, thereby informing proactive management. Integration with existing biosecurity frameworks (e.g., RPMPs, National Pest Plant Accord, MPI risk register/notifiable organisms list) would ensure alignment with regulatory needs.

Data interpretation and communication

eDNA data must be communicated effectively to end users, balancing simplicity with scientific rigour. Visual tools (e.g., colour-coded catchments, historical trends, ‘wheel of life’ outputs) could improve accessibility. Tailored interfaces, more basic for general users or advanced for expert users, would ensure usability for different stakeholders. Clear guidance on limitations (e.g., eDNA is not a standalone diagnostic tool) would prevent misapplication.

Integration, standardisation and future proofing

Interoperability with regional and national databases is important for maintaining data integrity and avoiding duplication. Standardised data formats and accredited lab processes could enhance credibility. Future-proofing the system by designing it for broader biodiversity applications would maximize long-term values of the tool. The ability to export raw data for downstream analysis ensures flexibility and adaptability to evolving needs.

Conclusions and Next Steps

The workshop demonstrated the applicability of eDNA dashboards to biosecurity and pest management, as well as the key issues that need to be addressed in order to deliver the maximum value to end users.

For example, Hawke’s Bay Regional Council noted that it used eDNA as a surveillance tool for the first time in 2022. This resulted in the discovery of an alligator weed incursion and triggered an immediate eradication response. This incursion might have remained undetected without eDNA surveillance. A separate review of an eDNA database also uncovered a sample for Senegal tea, an aquatic weed that is an exclusion pest in Hawke’s Bay. Unfortunately, that data was two years old when it was discovered and a Senegal tea population had already become established. The delay was significant. If an effective eDNA dashboard had been in place the response would have been quicker and less costly.

Each of the existing dashboards discussed at the workshop has its own strengths and weaknesses in the context of pest management in New Zealand. Overall, the lack of a coordinated approach to eDNA means that agencies tasked with biosecurity responses cannot respond as efficiently and effectively as they should.   End-users at the workshop identified a number of ways that these challenges could be resolved.

For example, an ideal eDNA dashboard would automatically collate data on priority species and alert the appropriate organisation(s). Having a stable, long-term hosting solution also is essential for any dashboard, as is the ability to communicate eDNA data effectively, balancing simplicity with scientific rigour. Interoperability with regional and national databases is another key consideration.

Next Steps

In the short-term, researchers will synthesise and consider all of the discussions from the workshop to inform a funding application(s) to support research that can optimise the eDNA dashboard approach for biosecurity. The focus will be on increasing the utility of any dashboard for regional councils and safeguarding that data for the future. Understanding the challenges faced by councils that want to use eDNA data in their biosecurity management programmes, such as a lack of standardised practices, is another potential research question.

Many similar issues also will apply to central government's approach to eDNA biosecurity and biodiversity data. We will consider those issues too as much as we can in developing our research proposals.

The discussion from this workshop will form the basis for much of the next phase of our work and we thank all of the participants and presenters for sharing their thoughts and expertise.

-ENDS-

Appendix 1 – Workshop attendees

Dianne Gleeson	ANU Canberra
Neil Gemmell	Otago University
Jeremy Thompson	MPI
Shaun Wilkinson	Wilder Lab
Mike Bunce	Ripple/Minderoo
Dave West	DOC
Michael Bates	MFE
Fiona Hodge	MFE
Scott Jarvie	ORC
John Pearman	Cawthron Institute
Petra Muellner	Epi-interactive
Kevin Collins	Facilitator
Manpreet Dhami	MWLR
Ang McGaughran	Waikato University
Mark Mitchell	HBRC
Warren Pegley	HBRC
Claudia Lange	MWLR