Please note: the substantive content of the 2026 NRI Roadmap Survey begins at Question 20 (with prior questions dealing with administrative and other information).

As such all submissions that are published include the responses submitted from Question 20 onwards only.

Q20.

Part 2: Research themes

2.1 NRI comprises the assets, facilities and associated expertise to support leading-edge research and innovation in Australia and is accessible to publicly and privately funded users across Australia and internationally. We are seeking your input on possible directions for future national-level investment - i.e., where the requirements are of such scale and importance that national-level collaboration and coordination are essential.

The 2021 Roadmap used a challenge framework to support NRI planning and investment. With this in mind, consider likely future research trends in the next 5 - 10 years, and with respect to one or more of the 8 challenge areas identified in the 2021 Roadmap as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or not at sufficient scale and
- describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities.

Q21.

Resources Technology and Critical Minerals Processing

Q22.

Food and Beverage

Q23.
Medical Products

Q24.
Defence

Q25.
Recycling and Clean Energy

Q26.
Space

Q27.
Environment and Climate

The criticality of maintaining healthy and resilient landscapes through the identification, description, conservation, and restoration of biodiversity has received increasing recognition in recent years owing to the unprecedented impacts of climate change, the devastation caused by a series of devastating bushfires, and the increasing ecological and economic importance of biosecurity in Australia. Understanding the critical role of biodiversity to human health and provision of ecosystem services to industries (such as agriculture and tourism), have generated a suite of pressing research challenges. Despite these drivers, it is estimated that only 30% of Australia's estimated 420,000 species have been named and documented thus there also remains a major biodiversity discovery and taxonomic science challenge ahead for Australia. Collectively these research, policy and management programs demand enhanced access to the comprehensive national biodiversity data infrastructure provided by the Atlas of Living Australia (ALA), and partner projects under the National Collaborative Research Infrastructure Strategy. However, there's a pressing need for enhanced national biodiversity data infrastructure to address future research and decision-making needs, in an environment where biodiversity loss continues to be one of the nation's most pressing policy challenges. Enhanced infrastructure is required to address the emergence of transformational biodiversity monitoring technologies that are becoming ubiquitous within research, government, NGO and industry. These include: • Environmental DNA (eDNA) derived biodiversity data • Camera Traps • EcoAccoustics These biodiversity monitoring technologies demand the following research infrastructure to support harmonisation of biodiversity data to a national capability such as the Atlas of Living Australia: • Increased capability for digital image processing and storage • Development of AI/ML based workflows to support information retrieval from remotely deployed camera traps, or EcoAccoustic technologies • Enhanced national taxonomic names index able to deliver to multiple national monitoring programs, and updated • Ability to manage sensitive species data across a number of applications including conservation and restoration ecology, industry data, biosecurity & Indigenous data. • An enhanced biodiversity information model that can integrate the data emerging from such transformational technologies into a single data architecture. • Evolve the ALA data model to support AI/ML applications, including from research, industry and government. Collectively these enhancements will be fundamental in supporting the aspirations under the National Science and Research Priorities Priority 4 to Protect and Restore Australia's Environment, and specifically about supporting the research that will underpin the development of tools and techniques to collect and analyse environmental data.

Q28.

Frontier Technologies and Modern Manufacturing

Q29.

2.2 The 2024 statement of National Science and Research Priorities (NSRPs) includes outcomes linked to each priority to assist in identifying critical research needed in the next 5 to 10 years.
Consider the priority statements and, with respect to one or more of the 5 priority areas as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or
- not at sufficient scale and describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities, and where relevant, refer to the underpinning outcomes and research identified in the NSRPs document.

Q30.

Transitioning to a net zero future

Q31.

Supporting healthy and thriving communities

Supporting healthy and thriving communities - critical research needs - anticipating and responding to future pandemics and infectious disease outbreaks - The ALA provides the principal resource for locating specimen information on all living organisms - and through international partners - links to global systems. Pandemic and infectious disease response is based on the rapid identification of organisms, sources and hosts and the ALA is uniquely placed to rapidly provide answers. The ALA is routinely used as a source of data on hosts and sources in a range of biomedical research and there's potential to expand this function beyond current capabilities, for example with regard to understanding the risk of future zoonotic diseases.

Q32.

Elevating Aboriginal and Torres Strait Islanders knowledge systems

Indigenous land and sea managers possess invaluable insights gained over generations, essential for sustainable land management and ecological practices. Recognising and integrating this knowledge into research infrastructure challenges current discourse, allowing Indigenous communities to actively shape narratives about their lands and cultures. This empowerment fosters pride and agency among Indigenous researchers and community members. Enhancing access to Indigenous data contributes to a more comprehensive understanding of Australia's diverse ecosystems. By merging Indigenous ecological knowledge with other research data, there is an opportunity, and responsibility to deliver better outcomes for researchers and decision-makers. Engaging with Indigenous Ranger programs will be critical given the fundamental role they play role in monitoring native and non-native species in remote regions of Australia. With approximately 13.5% of the continent managed as Indigenous Protected Areas, such partnerships should become a fundamental component of Australia's biodiversity monitoring capability Moreover, bringing greater visibility to Indigenous data fosters collaborative research between Indigenous communities, academic institutions, and government organisations. Such partnership ensures that platforms are designed with Indigenous input, respecting cultural protocols and governance frameworks, ultimately enhancing data quality and building trust. The Atlas of Living Australia has pioneered a model around Indigenous engagement through its Indigenous Ecological Knowledge Program, which partners with Indigenous Language Centres and Traditional Knowledge Holders. The goal is to document biodiversity, including Indigenous languages and knowledge, alongside western science. The partnership and co-design model have been successful in building trust, cultural competency and delivering outcomes that are valued by our Aboriginal and Torres Strait Islander partners. Extending this pattern of partnering with Language Centres should be expanded to other NRI, particularly those operating in the environment domain. Critical Research Infrastructure Requirements include to: • Develop an Indigenous-led biodiversity data access and sharing platform to support Indigenous Ranger Programs operating across Australia's Indigenous Protected Areas. • Expand the Atlas of Living Australia's Indigenous Ecological Knowledge program to other environmental domains including marine, earth science, air, and urban systems. The backbone of this program will include expanding partnerships with Australia's Indigenous language groups through the continue adoption of CARE principles. • Develop an Indigenous-designed and hosted secure data enclave to supply multiple research applications across the current NRI system.

Q33.

Protecting and restoring Australia's environment

This priority calls to Protect and Restore Australia's Environment to monitor, restore and preserve biodiversity, landscapes and ecosystems. Fundamental to achieving this goal is trusted national biodiversity available at national scales and providing spatial and taxonomic coverage of species of significant conservation, and biosecurity concern. The ALA underpins all the critical research needs under this priority. As the only publicly available Australian source of data on biodiversity incorporating national and international resources on Australian species, the ALA covers 151,000 species with over 150 million observations and grows at the rate of around 15 million records per annum. It is the only national source of data on invertebrates and non-vascular plants, comprising 99% of Australia's biodiversity. It is used by over two hundred government agencies and 500 businesses and has over 5,000 downloads per annum for use nationally in planning and assessment. The ALA has industry users across seven of the Australian Bureau of Statistics Business categories, with green energy technologies one of the fastest growing new users. The ALA has a massive footprint across research, education and the public, with over 140,000 registered users nationally. However, current innovative biodiversity data monitoring programs are generating rich biodiversity data using techniques such as Environmental DNA, ecoaccoustics and camera traps. Collectively these data types are exceeding the ALA's ability to ingest data from these monitoring programs owing to the volume, variety and velocity of data being generated and critical biodiversity will be lost without research infrastructure enhancement. Critical Research Infrastructure Requirements will require an expansion of the Atlas of Living to Australia (ALA) to: • Increase capability for digital image processing and storage • Enable of AI/ML based workflows and infrastructure to support information retrieval from remotely deployed camera traps, or EcoAccoustic technologies • Support enhanced national taxonomic names index able to deliver to multiple national monitoring programs, and be updated frequently. • Enhance existing biodiversity data infrastructure to manage sensitive species data across a number of applications including conservation and restoration ecology, industry data, biosecurity & indigenous data. • Deliver an enhanced biodiversity information model that can integrate the data emerging from such transformational technologies into a single data architecture. • Evolve the ALA data model to support AI/ML applications, including from research, industry and government. Examples include digital biodiversity trait extraction, monitoring plant phenology by data mining larger biodiversity data and image stores and automating the identification of species of biosecurity concern.

Q34.

Building a secure and resilient nation

Historically, Australia's and the ALA's data priorities have focused on native species. This focus has been cemented through the growing contribution of citizen science–acquired data to the ALA from platforms such as iNaturalist, which also focuses on native species. The ALA's strength has therefore been in addressing research questions related to natural systems, such as restoration ecology, evolutionary ecology and native species distribution modelling. Australia's biosecurity sector has a pressing need for national biodiversity data regarding species of biosecurity concern. Dodd et al (2021) noted that Australia operates one of the world's most comprehensive biosecurity systems globally estimated to be worth $314 billion highlighting the criticality of biosecurity to Australia's landscapes, agricultural systems, people and ultimately economy. Biosecurity is a key theme of Australian Government's Ag2030 policy agenda which seeks to grow agriculture to $100 billion by 2030. From a biosecurity perspective, the ALA provides over 14 million new records every year including a citizen science capability that now exceeds 12 million new records per annum. This is linked to alerts that go to biosecurity agencies automatically. It is backed up by links to all digital collections data in Australia and globally, including the location of sequence data. This massively improves the national capacity to detect and respond (through identification and the development of rapid genomic detection) to biosecurity risks. However, there is no national mechanism to exchange and interrogate confidential trusted biosecurity data. This offers an important opportunity to leverage ALA expertise to directly support the biosecurity sector. The ongoing and increasing importance of biosecurity risk in Australia to native plants and animals, agriculture and human health and wellbeing demands a more structured and purposeful approach to engaging with the sector for the purpose of supporting alien and invasive species data. Roles the ALA should play to deliver impact in this science and decision-making sector are as follows. Critical Research Infrastructure Requirements include: • Enhancing ALA biodiversity informatics capability to provide national and state biosecurity surveillance and alert system for decision-makers. • Partnering with state government agriculture departments and related citizen science programs to build a national database of exotic pests and diseases.

Q35.

2.3 The case for a new NRI capability, or enhancements to existing capabilities, typically emerges through advocacy from research communities clustering around rigorously identified needs and goals. Such a concept could respond to a requirement for novel or expanded capacity within a domain, or across domains, and must be such that it could only be made available with national-level investment.

If you have identified such a requirement, briefly describe the need, the proposed infrastructure capability, the medium-term goals, impacted research communities, and the timeframe over which you advocate its establishment. Your response can include links to relevant existing reports.

The Atlas of Living Australia provides biodiversity data and related services to over 120,000 users a year across research, industry, government, and the public. It supports programs in taxonomy, biodiversity, ecosystem science, biosecurity, contributes to major natural resource management programs and supports the international community as the Australian node of the Global Biodiversity Information Facility (GBIF) and the code base for the successful international Living Atlases community. The ALA was established on open-access principles, with data publishers by default using Creative Commons licences and with an open-source code base. This approach has encouraged re-use and maximised the value of data, especially for data that have been funded, produced or collected by public institutions in Australia. However, innovative approaches to biodiversity monitoring are increasing the variety, volume and velocity of data expected to be managed by the ALA which requires a major re-architecture of core infrastructure. Data types include: • Digital extended specimen' concept from the biological collections sector to make data globally discoverable, interoperable, and accessible, which will allow users to generate new insights into the status, evolution and function of biodiversity. • Biodiversity survey data acquired by major research programs, government, and industry to underpin cutting-edge longitudinal biodiversity monitoring, species distribution modelling, and related ecological analyses. • Transformational advances in genomics-based biodiversity identification and monitoring such as environmental DNA which allow users to identify, describe and monitor species and population genetic distributions. • Sensor network data (e.g., camera traps, ecoaccoustics) which provide the capability to monitor species in near real-time. New Capability - The 2021 NRI Roadmap proposed a Step Change around a National Approach to Collections, including with respect to biological (biodiversity) collections. In response to this call for a Step Change, in 2024 Australia's biological collections community, end users and research infrastructure partners came together to realise a future vision for a national biological collection. Accelerating discovery and access to Australia's biological collections was recognised as providing a remarkable opportunity to transform science across a suite of disciplines including environmental monitoring, genomics, health, biosecurity, agriculture and artificial intelligence. The importance of biological collections has been recognised through strategies including the National Research Infrastructure Roadmap's call for a 'step change' around a national approach to collections, Taxonomy Australia's Decadal Plan (Discovering Biodiversity: A decadal plan for taxonomy and biosystematics in Australia and New Zealand 2018–2027), the CHAFC National Collection Strategy 2021, the National Plant Pest Reference Collections Strategy 2018 and major investments in digitising our biological collections in several major state collections and CSIRO. In Australia, significant national investment has been made in new collections infrastructure within museums, herbaria, and CSIRO, supported by innovative digitisation programs to ensure physical specimens are databased, documented according to international standards, and imaged. This investment, however, hasn't covered all of Australia's significant biological collections. When combined with the extant data capability provided by the Atlas of Living Australia, Australia is well placed to harness these digital assets, making them accessible nationally and internationally through the Global Biodiversity Information Facility (GBIF). Capability and coordination gaps exist across the sector for building a world-class biological collections system. Yet, the number of users is rapidly increasing, and domains are driven by innovations in deriving information from biological collections. These uses include providing the sequences for a reference library to identify eDNA samples, biosecurity surveillance and AI approaches to species identification and monitoring. Increasingly, users expect rapid access to integrated data. These efficient and powerful technological advances present challenges and opportunities in defining a national approach. The context for this new capability into Australia's biological collections is driven by four factors: • Australia is a mega biodiverse continent with many species found nowhere else. Only 30% of our biodiversity has been identified and described. • Biological collections provide the fundamental infrastructure that underpin all we know and understand about species. • New technologies including genomics, advanced imaging, and artificial intelligence and machine learning are massively expanding the potential of biological collections and the role they will play in supporting science and decision-making. • Australia's biological collections are a remarkable national asset; however, their full benefit is not being realised due to a lack of national coordination and access to skills. A national approach would parallel international trends, for example, the European Union's Distributed System of Scientific Collections (https://www.dissco.eu/), the largest global formal agreement between natural history museums, botanic gardens, and collection-holding universities. The iDigBio (https://www.idigbio.org/) program in the United States delivers a similar ambition focusing on digitisation and data infrastructure. A national workshop hosted by Australia's biological collections community, end users, and research infrastructure partners in May 2023 identified the following five transformations required to deliver on this vision: • Sectoral leadership • Collection digitisation, storage, and management • Digital infrastructure, data access and integration • Emerging transformational technologies • Skills and workforce

Q36.

Part 3: Industry perspectives

This section is seeking input specifically from industry-based respondents. Other respondents can skip this section.

Recommendation 6 of the 2021 Roadmap related to improvements in industry engagement with NRI. To complement work on this topic that has occurred since then, we are seeking additional advice on NRI requirements as perceived by current or potential industry-based users.

Q37.

3.1 Have you (or your organisation) interreacted with or used Australia's NRI?

- ○ Yes
- ◉ No

Q38.

3.2 If so, please briefly outline the NRI capabilities you (or your organisation) have interacted with or used. Do not limit your response to NCRIS capabilities.

This question was not displayed to the respondent.

Q39.

3.3 Please indicate your (one or more) primary reasons for interacting with NRI:

This question was not displayed to the respondent.

Q40.

3.4 If you answered no, please indicate your (one or more) primary reasons:

- ☐ I did not know about it
- ☐ Other facilities suit my needs better
- ☐ I would like to, but cannot get access due to geographical location
- ☐ I would like to, but believed that access was only available to academic researchers
- ☐ I am not aware of any capability that meets my needs
- ☐ Other (please specify) [ ]

Q41.

Part 4: Other comments

4.1 Please elaborate on any of your above responses or add any other comments relevant to the development of the 2026 Roadmap. Your response can include reference or links to existing reports that you recommend be considered during the 2026 Roadmap development process.

The criticality of maintaining healthy and resilient landscapes through the identification, description, conservation, and restoration of biodiversity has received increasing recognition in recent years owing to the unprecedented impacts of climate change (Hoffman et al 2015), the devastation caused by a series of summer bushfires (Godfrey et al, 2021, Saunders et al. 2021), and the increasing ecological and economic importance of biosecurity in Australia (Dodd et al. 2020). Understanding the critical role of biodiversity to human health (Bratman et al. 2019) and provision of ecosystem services to industries (such as agriculture and tourism), has generated a suite of pressing research challenges. Australia's environmental policy landscape continues to invest significant resources into biodiversity conservation, restoration, and planning, in addition to building a world-class national biosecurity system to maintain the health of our natural, agricultural, and economic systems. The recently announced Agriculture Stewardship Package provides $32.1 million to promote biodiversity stewardship, wildlife and habitat funding totalling $200 million in response to 2019-20 bushfires, and the Regional Land Partnership that is investing $450 million in species recovery and protecting threatened ecological communities. Australia's investment in biodiversity management extends to many billions of dollars annually – when state and territory government programs and the activities of NGOs such as Bush Heritage Australia and Greening Australia are included – demanding trusted national biodiversity data to support planning, management, monitoring and evaluation. These research, policy and management programs demand continued access to Australia's most comprehensive biodiversity data infrastructure provided by the Atlas of Living Australia. Trusted and harmonised national biodiversity data available under an open licence is fundamental to supporting applied and foundation science, and to support major biodiversity conservation programs. Data provides the evidence-base for understanding, monitoring, planning, and predicting. Key Commonwealth and international science and policy drivers for these investments and enhancements include the following: • Australia's draft National Science and Research Priorities • Convention on Biological Diversity • Data and Digital Government Strategy • Decadal Approach to Australia's Biological Collections • Decadal Plan for Taxonomy and Biosystematics in Australia & New Zealand • National Biosecurity Strategy • National Plant Pest Reference Collections Strategy • National Research Infrastructure Roadmap 2021 • Nature Positive Plan • Research Translation and Commercialisation Agenda • Taskforce for Nature-Based Financial Disclosures • Threatened Species Action Plan