Australia's National
Science Agency

The value of a National Biodiversity DNA Library

Enabling the world's best environmental monitoring

A National Biodiversity DNA Library to manage Australia's environment

Environmental DNA (eDNA) is a simple and game-changing way to monitor the natural environment. From samples of water or soil, we can sequence DNA fragments shed by plants and animals, and map the species present in an area.

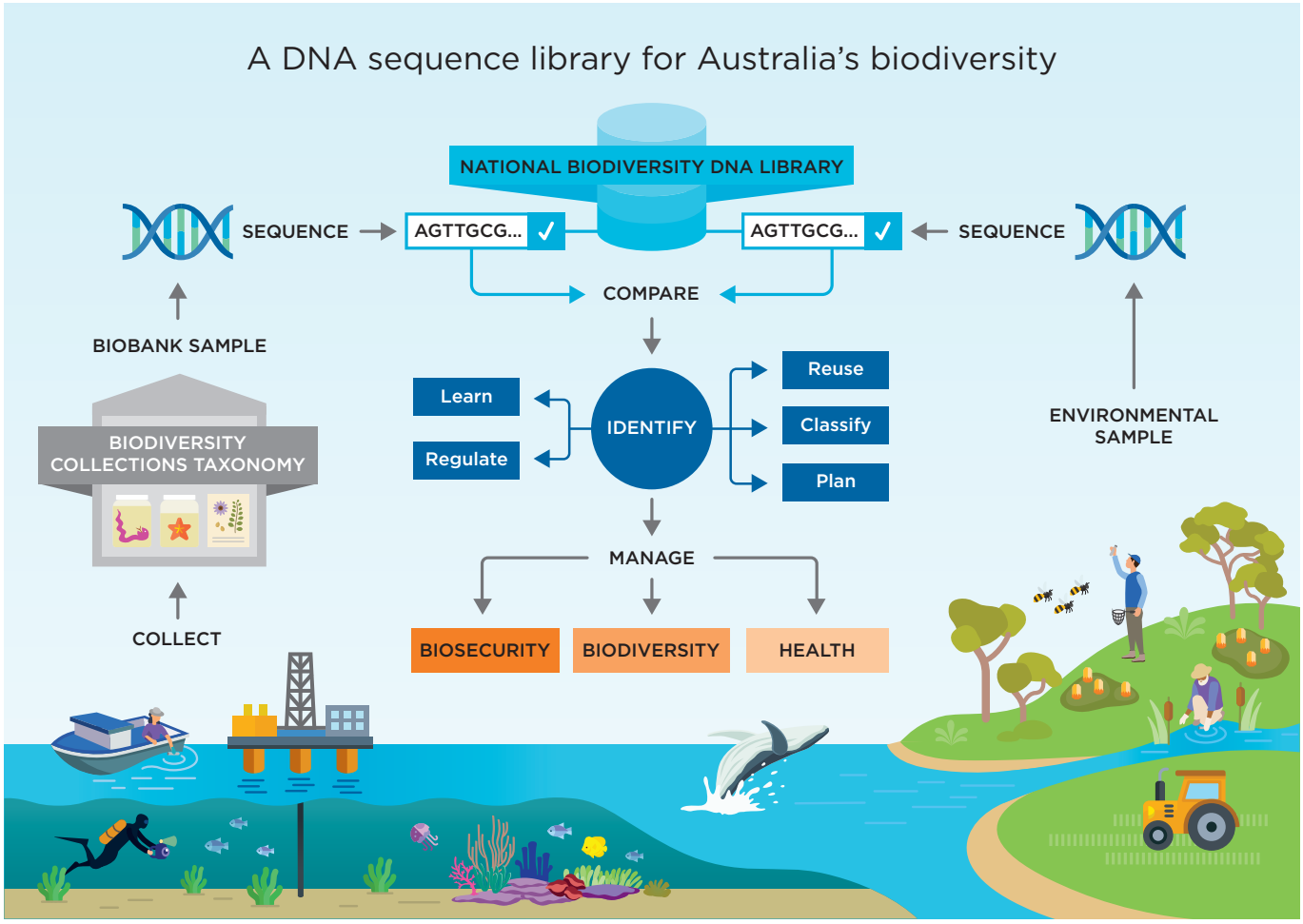
Using this method, we can survey biodiversity in remote landscapes, provide early warning of pest incursions, detect all of the fish species on a reef, and much more.

But using eDNA relies on reference libraries of DNA sequences ('DNA barcodes') which are used to match eDNA fragments in soil or water to the species that shed them.

Yet we know the DNA barcodes of only a small fraction of Australia's 700,000 plants and animals. Until we resolve this, we'll be unable to realise the potential of eDNA in Australia and the results of eDNA surveys will be patchy and incomplete.

That's why we are working with our partners to initiate a National Biodiversity DNA Library for Australia's most important species.

The library would create enormous national benefit, supporting industries across fisheries, mining, agriculture, biosecurity, environmental management and tourism. The need for DNA-based sampling and analysis services would also create jobs in private sector industries and for Indigenous business and Sea Country rangers.



An illustration of the process for creating and then using a DNA sequence library of Australia's biodiversity

Traditional survey methods are costly and time-consuming.

Marine biosecurity value proposition

Over 80 per cent of Australia's population lives within 50 kilometres of the coast. Marine and coastal ecosystems play a valuable part in Australia's society and blue economy, including tourism and marine industries worth over $68 billion p/a.[1]

Marine pests are a major threat to Australia's blue economy and can have significant environmental, economic, cultural and social impacts.[2]

Once established, eradication of marine pests is difficult and costly. Prevention is better than cure!

DNA-based surveys such as eDNA are emerging as crucial tools for protecting marine assets because of their reliability and cost-effectiveness.[3] Many jurisdictions and industry proponents currently undertake DNA-based surveillance of ports and harbours and high priority areas like marine parks and commercial fish nurseries.

But the effectiveness of surveillance is limited by the lack of reference DNA sequences for pest species. This means pest species often can't be reliably distinguished from native species[4] until they have established a substantial foothold.

Marine pests are a major threat to Australia's blue economy. The predator *Asterias amurensis*, the Northern Pacific seastar, was accidentally introduced into Australia in the 1980s. It threatens native species, wild fisheries and aquaculture.

What difference would a complete DNA barcode library make?

- Rapid, sensitive pest detection systems could be standardised Australia-wide.
- A complete DNA barcode library would tell us what DNA sequences we need to 'look' for to identify pests, thus improving the accuracy of pest detections.
- Sensitive DNA-based diagnostic tests for pests could be developed quickly.

Benefits for Australia

- Reduced risk of pest incursions through timely interventions and management.
- Lower costs of monitoring pest species.
- Reduced economic, environmental, cultural, and social impacts of pests.

Biodiversity monitoring value proposition

Australia's biodiversity is a unique national asset valued in the hundreds of billions of dollars. Monitoring its condition is key to good management and sustainable use.

Because knowledge of many Australian species is poor,[5] baseline biodiversity surveys and monitoring are expensive and rely on experts to identify animals and plants. This expertise is in short supply and diminishing.

Field surveys are time-consuming, logistically challenging, potentially dangerous and expensive (costing nearly $100M p/a in Western Australia alone[6,7]).

Governments, industry, Indigenous Australians and citizen scientist are rapidly adopting innovative tools like eDNA to survey and monitor biodiversity. eDNA can provide accurate and detailed identifications in a timely manner.

However, even in the best-case scenarios, typically fewer than 50% of eDNA sequences detected can be assigned to a species.[8] This reflects the incompleteness of DNA barcode libraries.

We have created a miniaturised high-throughput genome skimming platform that can generate DNA barcodes for any type of organism.

What difference would a complete DNA barcode library make?

- Accurate and comprehensive DNA-based biomonitoring.
- Increased interoperability of datasets completed independently and by different means (observation, capture, eDNA).
- New applications of DNA technology for natural resource managment, such as assessment of seed bank integrity for land restoration and studies of dietary preferences of threatened species.

Benefits for Australia

- Comprehensively and consistent monitoring of Australia's biodiversity assets at greater speed and scale than is currently possible.
- Effective biodiversity management based on detailed information.
- Fit-for-purpose tailored interventions to address environmental damage.
- Greater certainty about potential environmental impacts.

Australia's biodiversity is a unique national asset valued in the hundreds of billions of dollars.
Photo by Mark Galer on Unsplash

The RV *Investigator* provides Australia with an impressive multi-disciplinary marine research capability.

Fishes of Australia value proposition

Fish are a significant economic, cultural and social resource for Australia, valued at over $3 billion dollars annually.[9]

Many fish are culturally significant to Indigenous Australians. Fish are also used as bioindicators for broader ecosystem condition and function.

Fish are the most common target for eDNA studies, however, typically only 50% of fish eDNA sequences can be assigned to a species because of the incompleteness of DNA barcode libraries.[8]

This limits the potential to use eDNA for fast and accurate monitoring of fish populations, environmental impacts and Australia's marine conservation estate.

Australia's fishing industry is valued at over $3 billion dollars annually.

What difference would a complete DNA barcode library make?

- Accurate, fast, comprehensive DNA-based biomonitoring and assessment of Australia's marine resources.
- Reliable species identifications and biomonitoring datasets based on authoritative DNA reference sequences.
- Fewer false positive or false negative detections of important species.

Benefits for Australia

- Cost-effective monitoring of fish stocks.
- Responsive management strategies to changes in fish populations and environmental health.

Assessments of environmental assets and potential impacts prior to, during and after developments is a statutory requirement.
Photo by Stefan Jurgensen, Flickr, CC-BY-SA-2.0

Pilbara biodiversity value proposition

Mineral extraction in Australia's Pilbara region is an economic powerhouse for the nation valued at over $70 billion annually.[10]

Assessments of environmental assets and potential impacts prior to, during and after developments is a statutory requirement. This is expensive, costing nearly $100M annually.[6,7]

Environmental surveys are difficult to conduct in the Pilbara because of the remoteness, relatively poorly known biota, outdated identification tools and specialised expertise required to identify many species.[11]

eDNA and other DNA-based methods of species identification have been adopted as part of best practice environmental assessments for over ten years.[12]

However, without access to a comprehensive and authoritative library of DNA barcodes, identifications can be ambiguous and inconsistent between surveys.

The Pilbara region is a national hotspot for unique plants and animals.

What difference would a complete DNA barcode library make?

- Fast, cost effective species identifications, which would be potentially automatable.
- Reliable species identifications based on authoritative DNA reference sequences.
- Less reliance on domain experts to identify species.
- Accurate species identification irrespective of organism age, time of year, or morphological features.

Benefits for Australia

- Fast, cost-effective eDNA-based environmental impact assessments.
- Improved environmental planning strategies, especially with respect to rare, threatened and poorly known species and the communities they occupy.

Great Barrier Reef value proposition

The World-Heritage listed Great Barrier Reef (GBR) is a prized international asset that annually provides $6.4 billion of economic, social and environmental value.[13]

The GBR is subject to many pressures. Federal and Queensland State governments put enormous resources into tracking its health and threats.[14] This is difficult to do because of the scale and diversity of the reef.

eDNA biodiversity and biosecurity surveys offer a scalable means to monitor reef health and are already deployed by Queensland State agencies. However, the richness of available information from eDNA is limited by the patchiness and incompleteness of the DNA barcode library.[15]

What difference would a complete DNA barcode library make?

- eDNA could be deployed as a routine biological survey and species inventory method by non-experts to deliver consistent and highly accurate censuses of biodiversity as well as highly sensitive, accurate detection of pest species.
- National ocean observation programs (e.g. the Integrated Marine Observing System) could confidently provide standardised long-term data biological streams within the GBR.

Benefits for Australia

- The potential for Australia to adopt global best practice for ocean observation, such as that prescribed by the International Marine Biodiversity Observing Network and endorsed by the United Nations.[16]
- Responsive management of the GBR to emerging threats and to measures of the effectiveness of management strategies.
- Management strategies that ensure economic, cultural, social, and environmental values of the GBR are maintained and sustainably managed.
- Adoption of analogous eDNA sampling and analytical methods across other marine World Heritage properties (e.g. Shark Bay, Ningaloo) and Australia's marine protected areas estate to build a truly National DNA Biodiversity Library to serve the needs of government, business, and civil society.

The Great Barrier Reef is a prized international asset.

eDNA biodiversity and biosecurity surveys offer a scalable means to monitor reef health.

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For further information
Environomics Future Science Platform
Olly Berry
Director
+61 8 9333 6584
oliver.berry@csiro.au
research.csiro.au/dnalibrary

B&M | 21-00301