Australia's National
Science Agency

Public perceptions of using synthetic biology to restore the Great Barrier Reef

Synthetic biology technologies, such as genetic engineering, could make coral more tolerant to warming oceans

Synthetic biology at CSIRO

Synthetic biology is an emerging field of research that combines genetics, chemistry and engineering. Scientists working in synthetic biology design, build, and test DNA to enable plants, animals and other organisms (e.g. bacteria, fungi, algae) to function in different ways. These organisms could then be used to help in the management of environmental and societal problems such as pollution, waste, land degradation and biodiversity loss.

The CSIRO Synthetic Biology Future Science Platform has developed a range of synthetic biology techniques, such as genetic engineering, gene editing and gene marking. But what do Australians think about these techniques? Involving the public is a critical step in the development of any new technology. By understanding Australians' needs, researchers can develop technology that is both fit-for-purpose and impactful for the community.

This brochure is part of a series that explores people's views towards several synthetic biology tools to help solve environmental, industrial and health challenges facing Australia. The full brochure series can be viewed at: **www.csiro.au/synbiosurvey**

We surveyed the Australian public, asking for their initial impressions on using synthetic biology to restore the Great Barrier Reef:

- What do people **think and feel** about this new technology?
- What **risks** do they perceive?
- How would people want to be **engaged** in decision-making in the future?

Assessing a technology's suitability

CSIRO has adopted a three-pronged process to explore the development and application of new technology. These three aspects include (1) problem assessment, (2) technical feasibility and (3) social feasibility.

1. Problem assessment

Identification and conceptualisation of a problem and how it fits within the broader human-environment system.

Example: Why is the Great Barrier Reef experiencing significant coral loss and why is this a concern?

2. Technical feasibility

Assessment of current solutions to the problem and proposed new solutions (strengths, weaknesses, opportunities and threats).

Example: What is being done to manage the problem and how effective are these strategies?

3. Social feasibility

Assessment of user and stakeholder perceptions, and acceptability of a range of solutions.

Example: What do communities think of the proposed solutions and what are their views on how the problem is best managed?

Restoring the Great Barrier Reef using synthetic biology

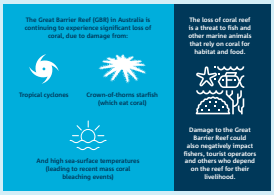
The Great Barrier Reef provides an essential service for many Australians. It acts as a storm and surge break for hundreds of kilometres of the east coast, and is a source of livelihood for local communities through the fishing and tourism industries. The Reef provides habitat for many marine species and protection for species dwelling in calmer waters closer to shore. It is also a place of significant cultural and heritage value, especially for Aboriginal and Torres Strait Islander peoples, who are the Traditional Owners of the Reef and have an important connection with the ocean that dates back more than 60,000 years. Covering 344,400 square kilometres and about 2,300 kilometres long, the Great Barrier Reef is the longest barrier reef in the world.

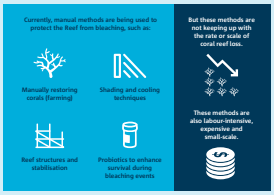
The Great Barrier Reef faces many natural and climate- or human-induced threats. For example, recent events have led to more frequent outbreaks of crown of thorns starfish, a native species that feeds on coral. Tropical cyclones can also cause major physical damage. Increases in sea-surface temperatures lead to mass bleaching events, where coral dies because it is intolerant to warmer water. Water quality and coral health are also affected by modern agricultural and industrial practises when water with high amounts of sediment, pesticides and nutrients, runs into the ocean.

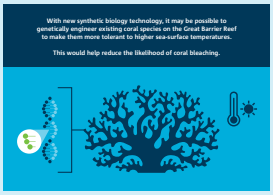
Restoration activities to protect the Reef include coral farming, building reef stabilisation structures, and shading and cooling coral reefs. Coral are also fed probiotics to increase their survival chances during bleaching events.

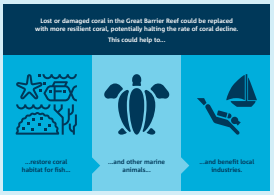
Synthetic biology technologies, such as genetic engineering, have the potential to increase coral's thermal tolerance to higher sea-surface temperatures. Genetic engineering involves changing an organism's genetic information by deleting, replacing or inserting a DNA sequence, and can enable new abilities. Altering coral genetics to make them more tolerant of higher sea surface temperatures could help to reduce the likelihood of bleaching.

Story board sequence shown to survey participants, before they were asked their thoughts about synthetic biology to restore the Great Barrier Reef.









Public attitudes towards using synthetic biology for restoring the Great Barrier Reef

Awareness of coral loss

Our research found most Australians (92%) were at least moderately aware that coral is being lost in the Great Barrier Reef. The majority of people (94%) also considered this a moderate to very big problem in Australia.

Initial impressions of genetic engineering in coral

After viewing a storyboard presentation on the use of genetic engineering to restore coral, Australian participants reported being moderately-to-strongly supportive of the development of this technology.

The majority of Australians (~90%) at least moderately supported the development of the technology. Australians also generally agreed that this introduction should happen sooner rather than later, when there is more original reef remaining. The survey further asked participants to

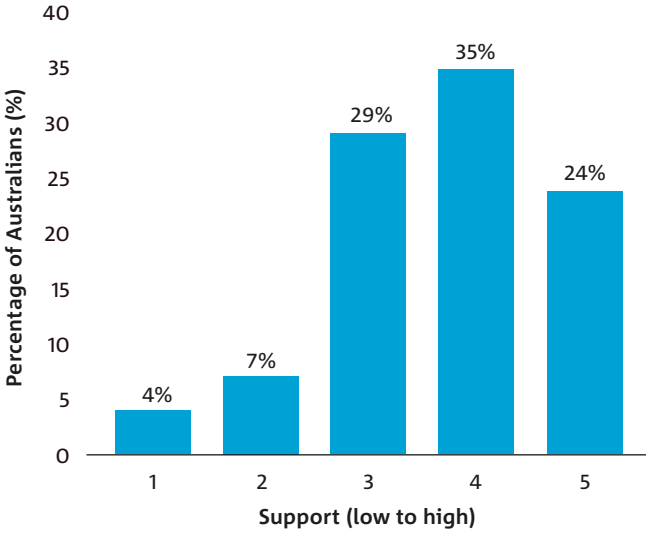
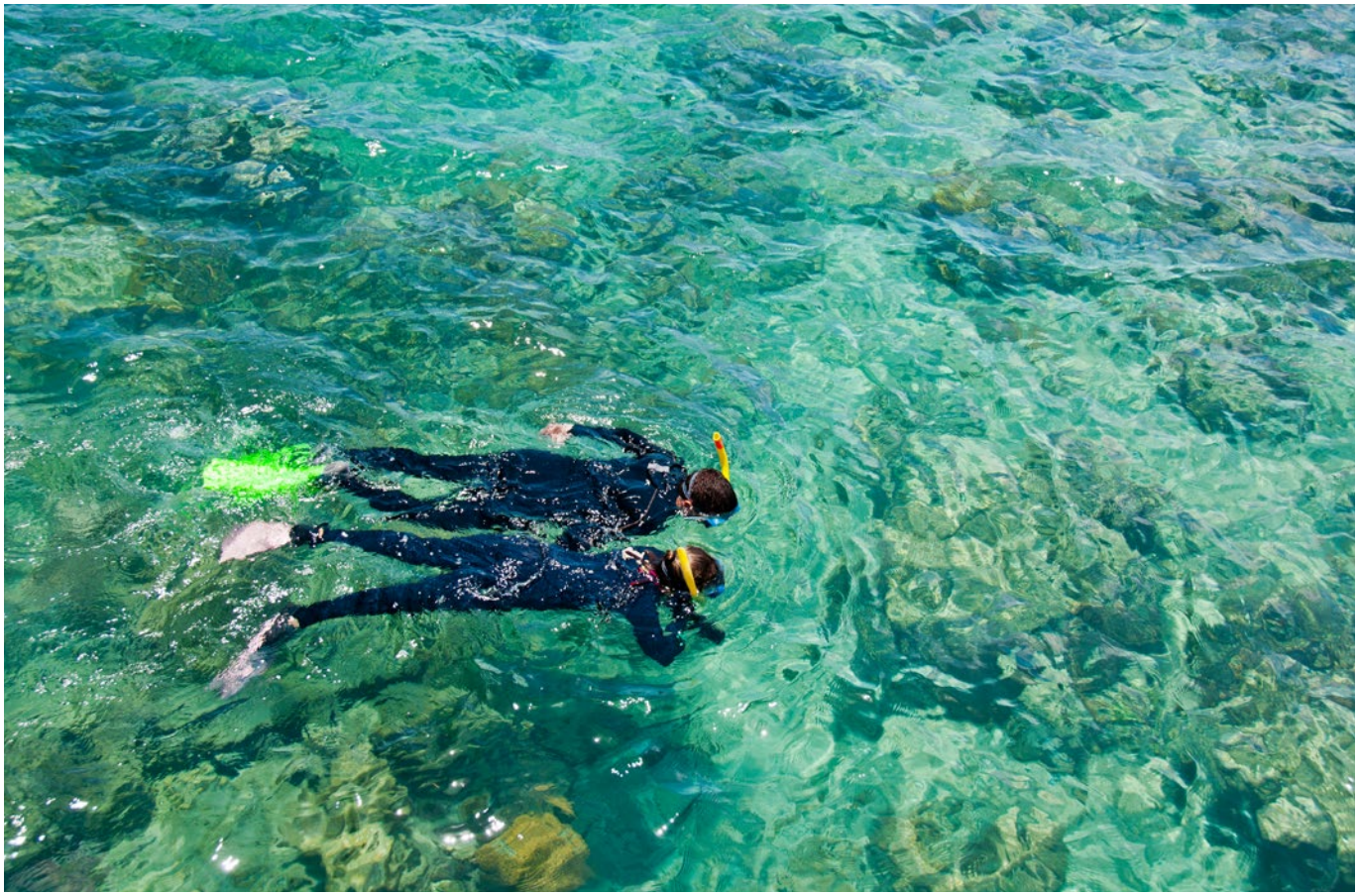


Figure 1 Australians' support of genetic engineering to restore coral.



indicate at what point they believed it was appropriate to introduce genetically modified coral. On average, people thought the technology should be introduced when there was between 50-70% of the original reef remaining (on a scale from 0-100% reef remaining). However, it is important to note that normal or 'best case' coral coverage on the Great Barrier Reef (or on any reef) is typically less than 100% cover. Therefore, on a scale of 0-50%, Australians are most willing to implement a genetically engineered coral solution in the Great Barrier Reef, when there is between 25% and 35% coral cover remaining.

When asked if they would visit areas of the Great Barrier Reef where genetically modified coral had been introduced, approximately 25% of Australians sampled were moderately willing and over half (63%) were willing or very willing to do so. About 12% indicated they were less willing to visit the Reef once genetically modified coral had been introduced. These public perspectives are important to know and understand, as it helps scientists shape how the technology will be developed.

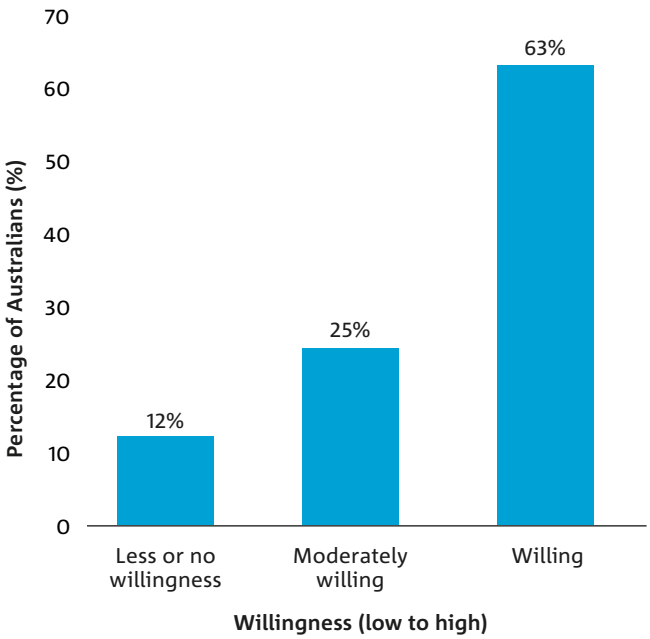
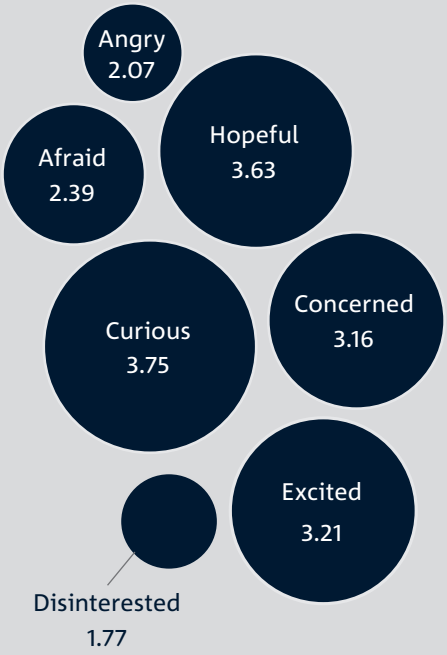


Figure 2 Australians' willingness to visit the Great Barrier Reef where genetically engineered coral has been introduced.

How do Australians feel about synthetic biology?

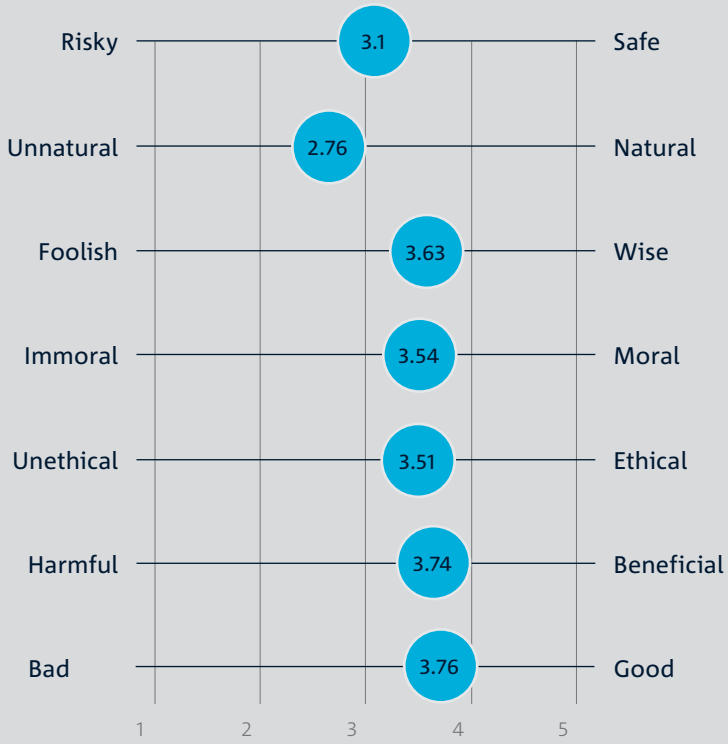
Genetically engineering heat-tolerant coral

Emotions indicated by Australians*



*Data range: 1 – 5

Attitudinal pairs*



Perceptions of benefits and risks associated with the technology

The majority of Australians (around 91%) rated this synthetic biology technology as moderately to very helpful in managing the restoration of the Great Barrier Reef. Most Australians (52%) also agreed, or strongly agreed, that this technology would be better than continuing with current reef restoration strategies.

Despite their support, Australians did have some reservations about the technology. Most were concerned that genetic engineering could have negative long-term consequences:

- 84% were at least moderately concerned about consequences for humans and animals
- 86% were at least moderately concerned about risks to the natural environment
- 89% were at least moderately concerned about whether consequences arising from this technology could be controlled or managed.

Trust and regulation

The majority of Australians (88%) moderately-to-strongly trusted scientists to develop this technology responsibly. However, 68% of people were at least moderately concerned about the possibility of the technology being used for 'bad' purposes. Additionally, 79% were at least moderately concerned that technology misuse could lead to unintended negative consequences.

Most Australians (70%) held at least moderate trust towards the government agency responsible for approving and regulating the technology. On average, people moderately agreed that legislation and regulation would ensure the technology would be developed in a safe way – 38% agreed strongly that the technology would be well regulated, and 39% also agreed strongly, that legislation and regulation would ensure its safe development.

Public engagement in future

Most Australians (about 86%) indicated they were keen to know more about this synthetic biology technology. They said they wanted to know more about:

- the possible risks
- what is being done to regulate and control the technology
- the scientific processes and techniques being used.

Most Australians (84%) also indicated that the public should have access to an easy-to-read summary of scientific results, and 75% agreed that risk documentation should be made available.

About 44% of Australians thought it was important to consult the public, so their opinions could be considered when making decisions about this technology. Fewer people (37%) thought it was necessary for the public to be kept informed of decisions made about synthetic biology. Around 14% of Australians indicated that they did not need, or want, to know anything more about this technology than was already provided within the storyboard presented.

Our survey also suggests that people may be more interested in understanding the risks and the process of managing these risks, than understanding the benefits of the technology.

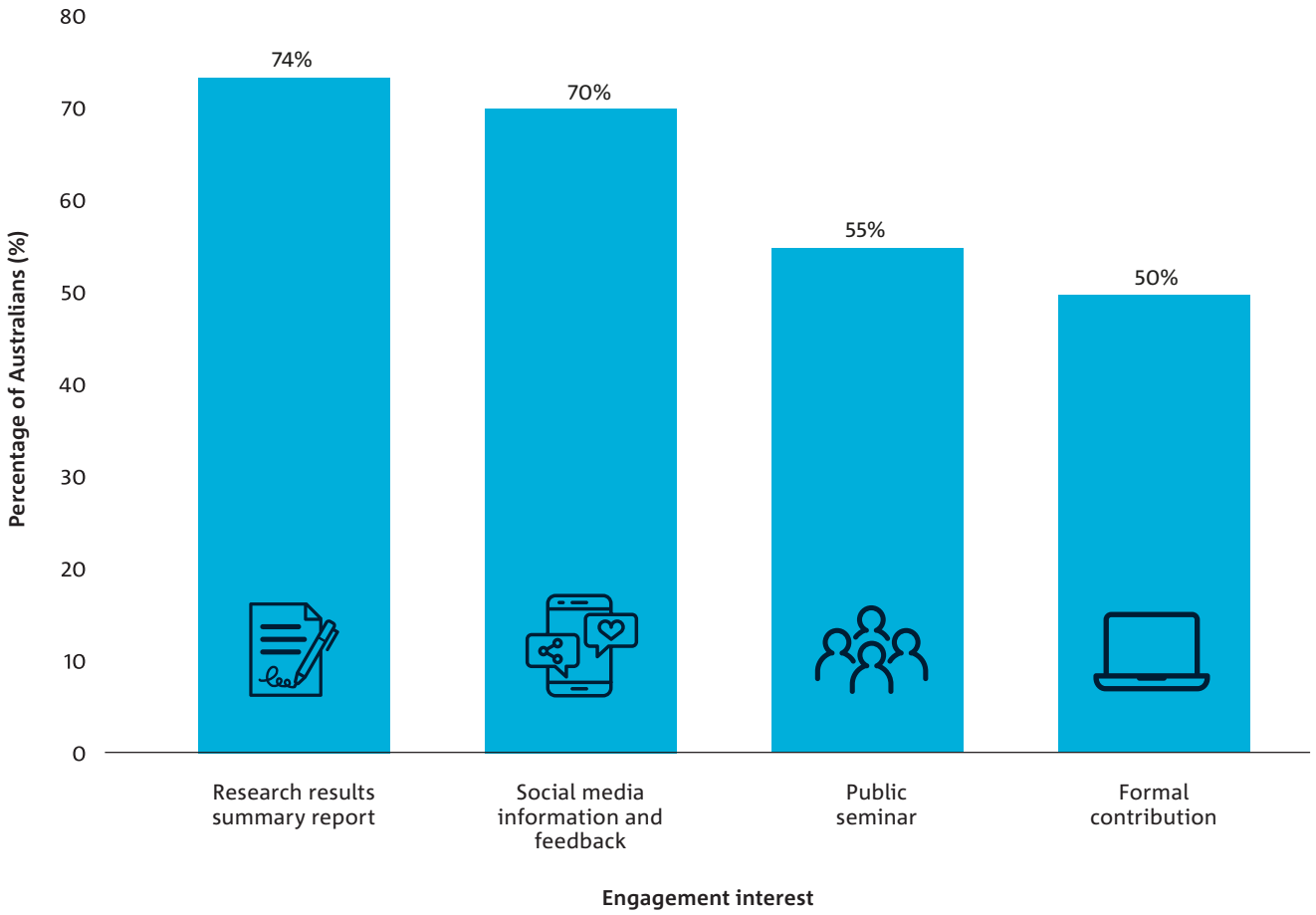


Figure 3 Personal preferences for further engagement with technology development.

Impact

Understanding Australians' attitudes to synthetic biology can help scientists and research organisations decide how to approach the development and implementation of new technologies.

Our survey findings have many applications and can be used in a variety of ways.

1. By government: to inform policy and regulatory decision-makers on how new technologies will be perceived by the public and how best to engage people.

2. By the science community: to inform scientists on how they can develop and plan future science activities in ways that address users' needs. This approach supports a responsible science agenda and acts as a quality-control measure to ensure that technology is being developed in a worthwhile and meaningful way. The survey findings also build the capacity of scientists to reflect on the social and ethical considerations of their work. Understanding the science and technology needed by Australians to solve current issues can lead to greater and more effective scientific innovation.

3. To benefit society: surveys provide insights into the public's understanding and perceptions of Australian science. Survey data can highlight the extent of society's trust in science and identify knowledge gaps. Increased understanding can shape future science directions and inform better ways for communities and scientists to work together.

This is one of the world's first comprehensive national surveys examining public perceptions across a range of synthetic biology technologies.

Research methods

The study involved presenting an online public opinion survey to a representative sample of 8,037 Australians. It examined how novel synthetic biology technologies could help address a range of important issues facing Australia.

In the survey, we presented information on one of seven environmental, industrial or health challenges in Australia:

- **Restoring the Great Barrier Reef**
- **Changing the properties of natural fibres**
- **Eliminating the culling of male chicks in the egg-laying industry**
- **Protecting endangered species**
- **Managing invasive pest species**
- **Reducing pollution in waterways**
- **Reducing mosquito-borne diseases**

The survey sample was representative of the Australian population in key demographics including age, gender, and location, including representation of Aboriginal and Torres Strait Islander peoples.

The research methodology for this CSIRO study was externally reviewed by a panel of three Australian social and behavioural science experts:

- Professor Kelly Fielding (The University of Queensland)
- Professor Catherine Waldby (Australian National University)
- Professor Iain Walker (Australian National University)

Information was presented to participants in the form of a PowerPoint-style slideshow, known as a 'storyboard'. The storyboards had a standard format with similar sequencing of information, language, use of visuals and length.

Social scientists teamed up with biotechnology scientists and professional science communicators to develop the storyboard content and visuals. The storyboards were validated and tested in seven public focus groups to ensure they were easy to understand and included the necessary information.

The Online Research Unit (ORU) hosted the online surveys throughout October and November 2018 and recruited a representative sample of Australians. Participants received a small standard payment from the ORU for participation. Research participants were randomly assigned to view just one of the seven storyboards.

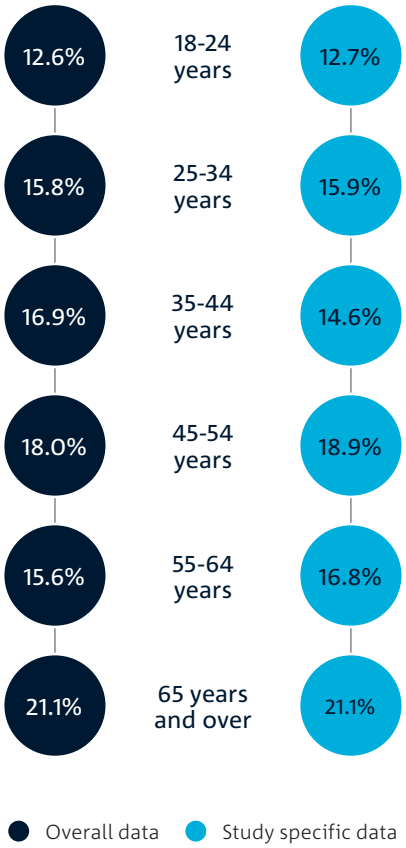
The survey asked participants how they felt about the development of the synthetic biology technology, what concerns they had about the technology, and if they would like to receive more information and be involved in further surveys.

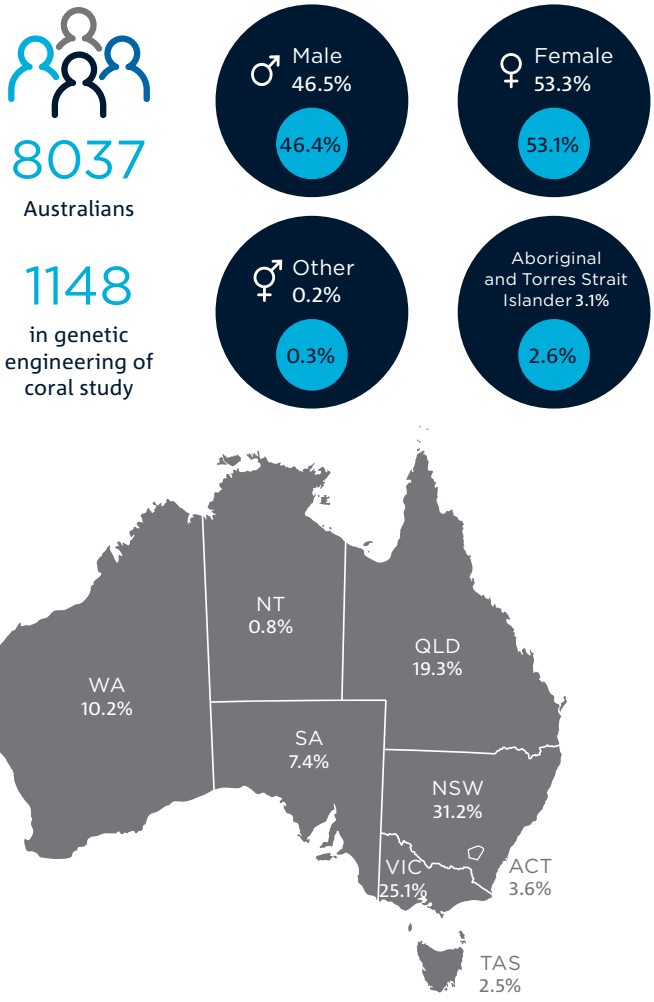
The survey has provided CSIRO with important insights into Australian attitudes. It is a powerful new contribution to decision making in Australia about issues facing the country.

This research was approved by the CSIRO Social and Interdisciplinary Research Human Research Ethics Committee (Ethics Clearance 013/18).

Australian demographic data

All surveys and this specific survey





Next steps in understanding public perceptions of synthetic biology

Our study incorporated a representative sample of the Australian public. However, some topics may be more relevant to particular communities. Future community- or place-based research will therefore be more targeted. It will involve identifying places where a particular synthetic biology technology could help in addressing a problem.

Researchers would engage with local people to understand their views about using new technologies to tackle problems directly affecting them.

This direct engagement will help communities, government and researchers decide whether, and how best, to deliver evidence-based programs to manage the Great Barrier Reef.

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