

INDIGENOUS ENGAGEMENT WITH SCIENCE: TOWARDS DEEPER UNDERSTANDINGS

EXPERT WORKING GROUP REPORT

AUGUST 2013



Prepared by the Expert Working Group on Indigenous Engagement with Science

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Key findings

The Expert Working Group on Indigenous Engagement with Science recognises the urgency of increasing the engagement of Aboriginal and Torres Strait Islander peoples in the development and communication of sciences in Australia. An important step in achieving this is understanding and valuing Indigenous knowledge systems, acknowledging the significant contribution that Aboriginal and Torres Strait Islander peoples have already made to the development of science in Australia, and sharing this within the Indigenous community as well as with the scientific and broader Australian community.

In our preliminary scoping study of this area, the Expert Working Group agreed that the interaction between Indigenous Australians, science and the broader science community is lacking in many areas and from all sides. Aboriginal and Torres Strait Islander peoples have unique knowledge systems that can contribute to all fields of scientific endeavour, including science-based activities such as the management of Australia's natural resources. While it was evident to the Expert Working Group that Indigenous knowledge systems have contributed significantly to research in Australia in the past and continue to do so today, it was also evident that this contribution is not always acknowledged or valued appropriately as a 'scientific' contribution. While Indigenous knowledge systems contain a wealth of scientific information their development is often poorly resourced in Indigenous communities as well as in the wider community and the transfer of traditional knowledge and skills to future generations is critically threatened.

The major issue of maintaining Indigenous knowledge systems is not simply an issue of science engagement—it is an issue of national significance for all Australians. This Expert Working Group would like to emphasise the need for large, ongoing and systemic change to ensure the ongoing health of Indigenous knowledge systems.

While there was a degree of consultation and opportunity for public comment during the process of developing this report, it was strongly agreed by the members of the Expert Working Group that the interests of remote Indigenous communities would not be met by attempting a full and broad consultation within the time and resources available to the Group. Rather, it will be essential to undertake future, dedicated work to ensure that traditional knowledge holders and language speakers are able to participate in a meaningful way in augmenting and implementing the recommendations of this report.

Urgent action is therefore required across a range of initiative areas. The Expert Working Group considers these areas also present significant opportunities for government and industry to engage with Indigenous people in a way that will maximise the potential for increased productivity across a wide range of scientific activity. The most challenging recommendations refer to the urgent need to conserve and prevent further loss of Indigenous knowledge. Critical enabling actions will require urgent application of resources to: protecting Indigenous languages; recognition of knowledge holders by tertiary education institutions and industries; facilitating knowledge and skill sharing between researchers and communities; and

providing opportunities for Indigenous knowledge to generate economic benefit for Indigenous communities while protecting Indigenous cultural interests.

The Expert Working Group has made 12 recommendations to strengthen Indigenous engagement in science. To be successful, the changes and actions recommended will need to be owned by both Indigenous communities and the broader scientific communities.

Summary of recommendations

No.	Recommendation
1	<p>Resource and support the maintenance and enhancement of Indigenous knowledge systems and intergenerational transfer of Indigenous knowledge.</p> <p>This should be done in a way that protects the relationships between Indigenous people and their knowledge and skills by ensuring that engagement with Indigenous 'scientific' knowledge occurs on mutually agreed terms and through adherence to appropriate protocols.</p>
2	<p>Recognise and increase support for Indigenous languages as integral to the health of Indigenous knowledge systems. Ensure the use of Indigenous languages in science engagement.</p>
3	<p>Develop an Indigenous Australian Science Agenda that is guided by Aboriginal and Torres Strait Islander peoples. The agenda should ensure synergy with cultural, economic, social and environmental outcomes for communities.</p> <p>Establish and maintain an Indigenous Science Committee to oversee the development and implementation of the agenda.</p>
4	<p>Develop cultural competency tools and programs that enable scientific communities to:</p> <ul style="list-style-type: none"> • understand how Indigenous knowledge systems deepen the value and relevance of science in Australia; and • engage in full and equitable partnerships with Indigenous communities in scientific research and engagement. <p>Resourcing</p> <ul style="list-style-type: none"> • Funds for seed grants to assist the implementation of the strategy. • Funds to develop tools to improve the cultural competencies of scientists.
5	<p>Enable Indigenous communities to develop local and regional priorities for science engagement, research and communication.</p>
6	<p>Provide Indigenous communities with the scientific resources to build community capacity to deliver on local community priorities.</p>
7	<p>That, in developing their science engagement and research agendas, government, researchers and their organisations ensure:</p> <ul style="list-style-type: none"> • local and regional Indigenous priorities are integrated into the development of their projects • the meaningful participation and empowerment of local Indigenous knowledge holders in project design, delivery and evaluation • project outcomes deliver clear and sustainable benefits to the livelihoods of local communities.
8	<p>That governments, researchers, communicators and their organisations have research 'impact measures' that include priorities and outcomes for local Indigenous communities.</p>

No.	Recommendation
9	<p>Develop an Indigenous media and communication strategy to engage Indigenous people in science, to inform the wider community about Indigenous science achievement, and to create a new appreciation of the value of Indigenous knowledge systems amongst the Indigenous and broader scientific communities.</p> <p>Resourcing</p> <ul style="list-style-type: none"> • One full-time person to develop and implement the strategy. • Funds for communication activities.
10	<p>Develop and sponsor science awards to recognise and profile Indigenous achievements in science. This should include:</p> <ul style="list-style-type: none"> • awards for young Indigenous scientists, Indigenous knowledge holders and communities • Indigenous categories within Australia's prestigious national and state science awards • science as a category within the Deadly Awards and other relevant Indigenous awards.
11	<p>Develop educational and outreach programs that engage Indigenous young people in science, leading to professional careers in science and science-related areas.</p>
12	<p>Map and monitor Indigenous student enrolments and graduates in science and science-related areas to establish a clear picture of achievements and any 'gaps'. Develop promotional material and information for Indigenous science students and graduates to inspire, motivate and support Indigenous young people to undertake science-related careers.</p>

Introduction

Inspiring Australia is a national strategy led by the Federal Department of Innovation, Industry, Climate Change, Science, Research and Tertiary Education (DIICCSRTE) with the broad aim of realising the full social, economic and environmental benefits of investment in science and research. Expert working groups have been formed to investigate particular priorities and make recommendations proposing various ways forward. One such priority is to target Indigenous Australians in urban, regional and remote locations with measures to develop their potential and interest in science and science-based careers and thereby increase the capacity of the scientific workforce.

Aboriginal and Torres Strait Islander peoples have a unique contribution to make to Australian society. They have distinct and diverse communities and cultures, and a successful science engagement strategy must recognise and respond to this. According to Australian Bureau of Statistics (ABS) data from 2006, the estimated resident Indigenous population of Australia was 517 043, or 2.5% of the total Australian population, with approximately 24% living in remote or very remote areas, compared to about 2% for the non-Indigenous population. The Indigenous population has a different age distribution profile, with 38% of the total Indigenous population aged 15 years or younger compared to 19% of non-Indigenous Australians. At the other end of the age spectrum, only 3% of Indigenous Australians are aged 65 years or older compared to 13% of the non-Indigenous population (ABS 2006). This results in a population pyramid for Indigenous Australia more typical of a Third World population than one resident in a developed nation.

Indigenous people are less likely to be employed in Professional, Scientific and Technical Services than non-Indigenous people (approximately 2% compared to 7%). Roughly the same proportion of Indigenous and non-Indigenous Australians are employed in the Agriculture, Forestry and Fishing Industries (around 4%) (ABS 2006). The Australian Indigenous Doctors Association (AIDA) noted in 2006 that Indigenous people made up just 0.19% of medical practitioners (AIDA 2010). There is a clear need for action to graduate and employ more Indigenous Australians as scientists, engineers and doctors to reach rates of employment comparable with those of non-Indigenous people and increase the capacity of the Australian scientific workforce overall.

In order to increase the number of Indigenous Australians participating in science, education needs to provide a solid grounding in scientific literacy. Data from the OECD Program for International Student Assessment (PISA) shows that in 2009 Indigenous 15-year-old students were still underperforming compared to non-Indigenous students, with only 37.8% of Indigenous students, compared to 68.5% of non-Indigenous students, reaching the accepted level of proficiency in science literacy. The improvement in this metric since the 2006 PISA results is not statistically significant (Commonwealth of Australia 2011a). A secondary analysis of the 2006 results showed that the underperformance could largely be explained by the variability in reading literacy and that Indigenous students were shown to be just as interested (actually slightly more interested) in science as their non-Indigenous peers (McConney et al. 2011).

History of Indigenous engagement with science

The earliest history of Aboriginal and Torres Strait Islander peoples' engagement with Western science was one in which they were the subjects of morbid curiosity and were examined as one would examine the flora and fauna of the country. In some cases the flora and fauna were treated with greater admiration and respect than Indigenous people. The advent of Social Darwinism acted to reinforce racial hierarchies rather than improve the recognition of intrinsic human rights, and Indigenous knowledge was (and in some instances still is) dismissed out of hand as offering no genuine contribution to science.

For most of the last two centuries, Indigenous people continued to be excluded from having any status as partners or participants in scientific investigation. Prevailing colonial attitudes, reinforced by a wide range of government policies, resulted in minimal recognition and often the devaluing of Indigenous knowledge systems. Limited access to school education and almost total exclusion from participation in higher education ensured that the cultural, social, political and economic development of Aboriginal communities was at the mercy of a disinterested, often antagonistic, White Australia. For many Aboriginal and Torres Strait Islander people, this exclusion is understood as stemming from being placed in low position on the Darwinist ladder and the privileging of Western science as the 'teller of truth' (Rigney 2001).

Since the late 20th century, as Western science has become increasingly focused on environmental sustainability, climate change and global warming, there has been a significant shift towards seeking solutions within Indigenous knowledge systems in order to mitigate the impact of globalised industrialisation. Central to this is an increasing awareness of the intrinsic resilience of Indigenous communities. At the same time, Western science has also sought the knowledge of Indigenous peoples to gain insights into the properties of plants (e.g. Kakadu plum) as a source of products for medical and food research. This research collaboration has yet to significantly contribute to the livelihood of Indigenous communities and, while they may no longer be considered simply as subjects of analysis, Indigenous peoples' standing has progressed little beyond roles as informants or field assistants to researchers. The Indigenous contribution to science has become welcomed but not well recognised or rewarded.

Aboriginal and Torres Strait Islander peoples' unique access to land and sea resources as traditional owners should provide an economic base on which to build enterprise and employment. Business ventures in Australia (and across the world) that are land- or sea-based, including pastoralism, forestry, ecotourism, fishing and aquaculture, are increasingly threatened by fire, drought, flood, climate change and depletion of fish stocks. The current difficulties for Aboriginal and Torres Strait Islander people in having their diverse knowledge recognised, and in accessing and participating in scientific research, effectively limit the capacity of Australia's Indigenous cultures to contribute solutions to these challenges. At the same time, opportunities for Indigenous communities to develop sustainable livelihoods are also

curtailed, thereby maintaining or exacerbating the gap in social and economic outcomes between Indigenous and other Australians.

In recent years there has been increasing recognition of the critical contribution that Indigenous knowledge makes to biodiversity conservation, ecological processes and sustainable resource use and management. Indeed, the rapid, grassroots-driven growth of an Indigenous community ranger workforce in recent decades, especially in Central and Northern Australia, is one of the strongest areas of Indigenous engagement in science (Kennett et al. 2011; Luckert et al. 2007). However, research in these domains has been dominated by researchers operating within a Western science framework and with outcomes that are usually defined and driven by government policies, programs and funding guidelines (Lane et al. 2009), and by researchers themselves, rather than by Indigenous community interest. The politics surrounding the evaluation of projects in natural resource management has been found to be especially problematic when the parties seek differing outcomes and benefits (Robinson et al. 2009). In research contracts and agreements, government or commercial/corporate parties maintain a dominant influence which does not always give proper consideration to the provision of mutual benefits for Indigenous parties. There have been recent positive developments, such as fire research programs that are helping to create longer term livelihood opportunities based on the carbon pollution reduction benefits of Indigenous traditional burning practices (Barnsley & NAILSMA 2009); however, in the majority of cases the benefits that do accrue to Aboriginal and Torres Strait Islander peoples from ecological research have been short term—often only for the duration of the particular research—and/or dependent on future government funding on a year-to-year basis. To date, within the plethora of scientific research projects, there are few if any that can be credited with achieving sustainable outcomes for Indigenous Australians or where substantial benefits have accrued to Indigenous people.

In the rapid movement toward a knowledge-based economy in Australia and globally, it is imperative that Indigenous knowledge systems are appropriately acknowledged for the contributions that they currently make, and appreciated for their capacity to contribute even more. The acceptance of the term 'traditional knowledge', rather than Indigenous knowledge, within intellectual property law has limited and constrained the recognition of the rights of Indigenous peoples as owners of comprehensive and evolving knowledge systems and thereby has limited their rights as beneficiaries (Janke & Frankell 1998). In this way, Indigenous rights have been and continue to be constrained by government and Australian legal definitions, rather than being recognised as pre-existing and intrinsic rights and values within Indigenous law and practice. Although international covenants have been established on the protection of the rights of Indigenous peoples globally (e.g. the UN Convention on Biological Diversity (CBD), relating to genetic resources and Indigenous knowledge, and the UN Declaration on the Rights of Indigenous Peoples (UNDRIP)), there is still a failure within intellectual property law to give Indigenous knowledge its full due.

The UNDRIP and the CBD provide building blocks to legitimise the inclusion of Indigenous rights within scientific research. However, the continuing limited participation of Aboriginal and Torres Strait Islander peoples undertaking science in higher education institutions precludes Indigenous Australians from taking advantage

of the opportunities that may be afforded. Studies have shown that Western science does not allow for a range of differing cultural aspects to be expressed and valued, and where education is not culturally responsive it becomes irrelevant to those it endeavours to inform (Fleer 1997 in McKinley Jones Brayboy & Castagno 2008; McLisky & Day 2004). The specialised words and phrases used in school science education serve to hamper Indigenous engagement and participation. This too often results in limited interest or participation beyond secondary school, where students have a choice in the studies they undertake.

At the tertiary level, it has been found that the lack of Indigenous students undertaking science is based on the belief among the students that there would be 'no mentors, no role models, no future prospects for careers and no perceived positive outcomes for them or their communities' (McLisky & Day 2004). Research undertaken over the years by CSIRO, various cooperative research centres and government departments has not produced long-term employment at the level of scientific researchers. Often any Indigenous employment that has occurred has been short-term, limited by ephemeral grant funding. Such employment is often limited to short periods of 1-3 years or to the life of the particular project, and therefore does not encourage Indigenous people to look to science research as a long-term career. Within Australia's current research system, no synergies have eventuated that produce overall or sustained benefit or education and employment outcomes for Aboriginal and Torres Strait Islander peoples.

Indigenous knowledge and science— complementary systems

Globally, there has been increasing interest in and recognition of the value of Indigenous peoples' knowledge, which is referred to by various terms and acronyms—including Indigenous knowledge (IK), Indigenous environmental knowledge (IEK), traditional knowledge (TK), traditional ecological or traditional environmental knowledge (TEK)—with a range of accompanying but broadly overlapping definitions. More recently there has been a strong emphasis, particularly by Indigenous peoples, on promoting a broader understanding of Indigenous knowledge as a product of Indigenous knowledge systems (IKS).

Indigenous knowledge systems held by Aboriginal and Torres Strait Islander peoples are a unique and vital part of Australia's knowledge capital, and link to other Indigenous knowledge systems worldwide. Within Australia 'Indigenous knowledge' and 'Indigenous knowledge systems' are widely used within the higher education sector, evidenced by the number of university centres and schools with 'Indigenous knowledge' in their titles—for example, the School of Australian Indigenous Knowledge Systems at Charles Darwin University. The (Bradley) Review of Australian Higher Education in 2008 included in its findings that 'Indigenous knowledge should be embedded into the curriculum to ensure that all students have an understanding of Indigenous culture.' The report also concludes, in Section 3.2, that 'Indigenous involvement in higher education is not only about student participation and the employment of Indigenous staff. It is also about what is valued as knowledge in the academy' and that 'as the academy has contact with and addresses the forms of Indigenous knowledge, underlying assumptions in some discipline areas may themselves be challenged.' The report of the Cutler review, *Venturous Australia*, in the same year also acknowledged '...the unique value of indigenous traditional knowledge and practices within Australia's innovation system' (Recommendation 7.13).

The economic benefits of effective engagement with Indigenous knowledge systems in Australia are significantly under-recognised. These benefits have the potential to not only improve national productivity but also provide enhanced local and regional economic opportunity for Aboriginal communities if they are matched with opportunities for appropriate skills development and partnership with industry.

'Indigenous knowledge' and 'Indigenous knowledge systems' currently do not exist as recognised disciplinary areas in any of Australia's tertiary education institutions and should not be confused or conflated with 'Indigenous Studies', which historically has more often been *about* rather than *by* Indigenous people and is primarily located within a Western knowledge disciplinary framework. Australia's Indigenous knowledge systems are by their very nature complex holistic and interdisciplinary systems that cannot be viewed merely as potential subsets of Australia's Western knowledge system. The cognitive mining of Indigenous knowledge systems for the 'useful bits' can often miss the broader understandings and complex relationships that underpin them, leading to research outcomes that provide a quick fix rather than sustainable solutions. While there can be tension between Indigenous knowledge

systems and Western science, increasingly there are examples of projects that combine the two as complementary, rather than competing, systems to produce highly successful and innovative outcomes. A good example of this from health has been the employment of Ngangkari (traditional Aboriginal healers) by the Ngaanyatjarra, Pitjantjatjara and Yankunytjatjara (NPY) Women's Council in Central Australia. The achievement of the Ngangkari in connecting traditional practices with modern medicine was recognised when they were awarded the International Sigmund Freud Award in 2011.

Indigenous languages—storehouses of knowledge

The threat to Australian Indigenous languages cannot be overstated. In general, Indigenous languages have been in catastrophic decline since first European contact (Henderson & Nash 1997). It is estimated that at the time of early European contact there were 250 languages spoken in Australia, with most languages having a number of distinct dialects. Today, less than 20 are considered 'strong', with a number of these languages showing signs of endangerment due to a small group of surviving older speakers (DEEWR 2008; McConvell & Thieberger 2001). There are many reasons that language loss has occurred. From the beginning of European colonisation, Indigenous people have suffered dispossession from traditional lands, violence, various epidemics that decimated local populations, family dislocations, and a myriad of exclusions and social controls (Zubrick et al. 2006).

Language loss has been characterised as being 'at the heart of many of the negative aspects of black/white relations in Australia since colonisation' (Ash et al. 2003, p. v).

Despite this rapid decline, language continues to play an important role in Aboriginal people's lives, and the knowledge embedded in language is highly valued—something to be handed on to future generations. It is a common occurrence throughout Australia for Indigenous people to introduce themselves firstly by identifying their language group. Language maintenance and revival efforts are increasing and there is widespread recognition of the urgent need to record and document Indigenous languages and associated cultural knowledge (Johnson 2006). Many Indigenous groups throughout Australia are working hard to maintain or revive their local languages, and language programs in schools are increasingly requested (DEEWR 2008; Hartman & Henderson 1994).

Language and Indigenous ecological knowledge

Indigenous language is inseparable from people's connection to country, kinship, ceremony and law (Rose 2005). It is increasingly recognised that sociocultural and linguistic knowledge are interdependent and embedded within relationships to country, natural resources and each other (Ochs 1985; Maffi 2001). Language is inextricably bound to how people relate to each other and their environments and lies at the very heart of Aboriginal identity, cultural beliefs and the way knowledge is managed and transmitted (Smallacombe et al. 2006; Maffi 2005). Indigenous groups around the world do not distinguish between the environment and their social and spiritual beliefs (Berkes 1999; Turner 2004). The United Nations report *Spiritual and cultural values of biodiversity* (Posey 2000) is a compilation of independent case studies and statements by Indigenous people that outline these connections. Indigenous groups from the local to the international levels continually maintain the importance and interdependence of language, country, kinship and ceremony to local knowledge systems, ecological understandings and wellbeing (Burgess et al. 2009; Millennium Ecosystem Assessment 2005).

Aboriginal languages—economic value

In Australia, English and migrant languages are 'widely regarded as being economically useful languages as opposed to Aboriginal languages' (Mühlhäusler & Damania 2004). Dockery (2009) advocates that a new approach must be developed based on an assumption that Aboriginal knowledge and language are equally valid for promoting development outcomes. Indigenous languages and associated knowledge are important assets in natural and cultural resource management, biodiversity conservation, art and creative industries, new and emerging economies (such as carbon farming) and the knowledge economy generally (including research, linguistics and climate change adaptation). In remote Australia it is reported that Indigenous ecological knowledge is critical to linking Aboriginal people with market economic activity associated with the use, management and knowledge of the natural environment (Altman 2003; Walsh & Douglas 2009; Cunningham et al. 2009; CRC-REP 2011). Acknowledgment and valuing of Aboriginal languages is an essential precursor to realising economic benefits for knowledge holders and for appropriate sharing of knowledge through partnerships with industry.

Intergenerational learning—the importance of language to Indigenous knowledge

In a fast-changing world, the maintenance of language and cultural values is more important than ever before. Indigenous people place a high priority on language maintenance, especially in light of the delicate relationship between loss and generational change and difference (Cristancho & Vining 2009). Senior Indigenous people have experienced profound and rapid change during the course of their lifetime and know exactly what the losses are, although such losses remain largely unaccounted for by Australian society at large.

For Indigenous people, language and its specialised vocabulary encapsulate the depth and breadth of cultural understanding and show respect for the Jukurrpa/Dreaming. As Veronica Dobson, a senior Eastern Arrernte woman, explains:

Language is important for maintaining all traditional knowledge. Everything on the land has Arrernte names and stories about them in Arrernte. If language is lost, the knowledge is lost and it can't be handed down to younger generations. For example, many younger Arrernte people nowadays believe that a particular butterfly (intelyapelyape) is connected to the ayeparenya caterpillar, when it is really the butterfly from the caper bush grubs. In actual fact, the ayeparenya caterpillar turns into a moth, called arrellyapelyape, but most Arrernte people don't know that word anymore. So with the word forgotten, so too is the moth's connection to the lifecycle of the ayeparenye caterpillar. This is one of the main totems for Alice Springs and the loss of this knowledge is a very significant thing for our people. (Veronica Dobson, quoted in Johnson 2006, p. 32)

Changing cultural paradigms

Cultural competency is rapidly emerging as a significant issue across policy, research and service provision and is particularly important as a tool for responding to the challenges of improving Indigenous engagement with science. Cultural competence has been usefully defined as a system that acknowledges and incorporates—at all levels—the importance of culture, assessment of cross-cultural relations, vigilance toward the dynamics that result from cultural differences, expansion of cultural knowledge, and adaptation of services to meet culturally unique needs' (Betancourt et al. 2003).

Improving the cultural competency of those involved in program development and delivery is a key strategy in addressing *sociocultural barriers* to equity in participation and in changing racial or ethnic disparities in outcomes across health, education, employment and, indeed, most social and economic indicators.

Universities Australia has recently completed a project in association with the Indigenous Higher Education Advisory Council to provide Australian universities with tools to embed cultural competency at an institutional level, to provide encouraging and supportive environments for Indigenous students and staff, and to produce well-rounded graduates with the skills necessary to provide genuinely competent services to Aboriginal and Torres Strait Islander peoples. Pilot projects at Edith Cowan University and the Universities of Wollongong, Newcastle and Western Australia were successfully completed and a best practice framework was adopted in November 2011. This framework comprises five principles:

- Indigenous people should be actively involved in university governance and management.
- All graduates of Australian universities will have the knowledge and skills necessary to interact in a culturally competent way with Indigenous communities.
- University research will be conducted in a culturally competent way in partnership with Indigenous participants.
- Indigenous staffing will be increased at all appointment levels and, for academic staff, across a wider variety of academic fields.
- Universities will operate in partnership with their Indigenous communities and will help disseminate culturally competent practices to the wider community.

Role and composition of the Expert Working Group

The Expert Working Group on Indigenous Engagement with Sciences is a diverse group of experts from the research, education and community development sectors. The full list of Expert Working Group members is in Appendix 1.

The role of the group was to review the state of Indigenous engagement with science in Australia and develop a set of recommendations that could help strengthen the scientific community's role in increasing Indigenous participation in and engagement with science. The group held four face-to-face meetings and one teleconference during the period June 2011 to February 2012. The group also undertook an indicative review of current programs to gain a snapshot view of the nature and range of Indigenous engagement in science (see Appendix 2).

The group was acutely aware of the absence of a Torres Strait Islander in its membership and acknowledges the need for further consultation to ensure that Torres Strait Islander issues and interests are adequately considered in implementing relevant elements of the Inspiring Australia initiative.

Recommendations

Theme 1. Indigenous knowledge systems

While there are a number of recommendations in the report, the critical underpinnings upon which their success is dependent are the key recommendations made in this section. These recommendations are urgent and need immediate and sustained action in order to maintain and develop existing Indigenous knowledge systems. Significant, incremental progress in implementing these recommendations must be maintained in the long term in order to maximise the viability and success of other recommendations in this report.

To be able to see their own reflection in Australia's knowledge systems is critical to the future aspirations of young Indigenous Australians and the regeneration of Indigenous communities. The Indigenous knowledge systems of Australia are both ancient and unique to this continent. Unlike their Western knowledge system counterparts, if they are not maintained, practised and developed in Australia as vibrant living knowledge systems they will not exist anywhere else in the world.

Recommendation 1

Resource and support the maintenance and enhancement of Indigenous knowledge systems and intergenerational transfer of Indigenous knowledge.

This should be done in a way that protects the relationships between Indigenous people and their knowledge and skills by ensuring that engagement with Indigenous 'scientific' knowledge occurs on mutually agreed terms and through adherence to appropriate protocols.

Recommendation 2

Recognise and increase support for Indigenous languages as integral to the health of Indigenous knowledge systems. Ensure the use of Indigenous languages in science engagement.

Reasoning

Government, universities and science organisations need to make major financial and infrastructural investments in supporting and maintaining Indigenous knowledge systems as healthy, vibrant and living knowledge systems, while recognising and supporting Indigenous custodians and knowledge holders as expert educators in their communities. Indigenous peoples' knowledge systems are embedded in country, with knowledge held by senior custodians. Traditional ecological and environmental knowledge is essential to Australia's future but will not exist without Indigenous communities, who face continuous threats from mining and development, government planning, limited community resources, weak heritage protection regimes and inadequate intellectual property rights and protections. Despite these, perhaps

the greatest challenge for Indigenous communities is the loss of Indigenous custodians and knowledge holders at relatively young ages. Less than 3% of the Aboriginal population is aged 65 years or older (ABS 2006), and with an increasingly younger Indigenous population there are fewer and fewer elders to pass on knowledge to the next generation.

While these problems have been recognised by many people, they have also often been coupled with an underlying assumption that Indigenous knowledge systems mainly benefit Aboriginal people and that therefore Indigenous people are the only ones who need to protect and maintain them. In fact Indigenous knowledge systems have and will continue to add significant benefit to all Australians (Cutler 2008). The Bradley Review states (p. 33) that 'It is critical that Indigenous knowledge is recognised as an important, unique element of higher education, contributing economic productivity by equipping graduates with the capacity to work across Australian society and in particular with Indigenous communities.' However, Aboriginal people no longer have the resources to protect, sustain and continue to develop their knowledge systems. There is also a strong assumption that the intergenerational transmission of knowledge or the Indigenous 'education' system can function without resources and infrastructure, on the expectation that it is something Aboriginal families and communities can deliver in their spare time, holidays and weekends. In stark contrast, Australians recognise the massive systems and infrastructure within which Western knowledge is achieved (the 'collective' of Australian state and territory education systems). There are no similar plans or infrastructure to enable Indigenous knowledge systems to contribute to education at the same level as their Western counterparts. Indigenous languages rely on living speakers, who are often key knowledge holders and need significant support to maintain and teach languages.

Theme 2. A National Indigenous Science Agenda

Recommendation 3

Develop an Indigenous Australian Science Agenda that is guided by Aboriginal and Torres Strait Islander peoples. The agenda should ensure synergy with cultural, economic, social and environmental outcomes for communities.

Establish and maintain an Indigenous Science Committee to oversee the development and implementation of the agenda.

Recommendation 4

Develop cultural competency tools and programs that enable scientific communities to:

- understand how Indigenous knowledge systems deepen the value and relevance of science in Australia
- engage in full and equitable partnerships with Indigenous communities in scientific research and engagement.

Resourcing

- Funds for seed grants to assist the implementation of the strategy.
- Funds to develop tools to improve the cultural competencies of scientists.

Reasoning

Achieving Recommendation 3 will also support Indigenous knowledge preservation.

With more than 370 million Indigenous people worldwide, understanding and valuing Indigenous knowledge and its relationship to science in Australia is a building block to the development of global cultural competence in professional scientific contexts. Developing a National Indigenous Science Agenda not only engages more Indigenous people in science at significantly higher levels but is likely to produce better research and research outcomes for Indigenous people.

The Expert Working Group noted that in New Zealand the Treaty of Waitangi is a significant driver of the science agenda. There is a need in Australia for a similar driver. This may be found through the COAG National Indigenous Reform Agreement.

While considerable work has been undertaken around cultural competency in health sciences, the extent to which this is a part of other science areas is not clear. However, in 2011 Universities Australia (UA) released the *National Best Practice Framework for Indigenous Cultural Competency in Australian Universities* to 'provide the higher education sector with a framework for embedding Indigenous cultural competencies within and across the institution' (UA 2011a). The Framework was one of two major outcomes of the Indigenous Cultural Competency in Australian Universities Project, undertaken by UA and the Indigenous Higher Education Advisory Council from July 2009 to October 2011. In announcing the completion of the project, UA noted that 'Indigenous cultural competency refers to the ability to understand and value Indigenous perspectives. It provides the basis upon which Indigenous and non-Indigenous Australians may engage positively in a spirit of mutual respect and reconciliation' (UA 2011b). This provides a key role for the sciences in not just recognising the value of Indigenous knowledge but questioning long held assumptions within their own fields of study and avoiding the compartmentalisation and deconstruction of Indigenous knowledge systems into 'useful' and 'less useful' parts.

It is widely known that Indigenous people suffer a high burden of illness and die 15-20 years earlier than their non-Indigenous counterparts. There are also countless examples where Western scientists attempting to study the causes or epidemiology of disease within Indigenous communities have failed to inform or seek appropriate consent from the Indigenous communities. This history has served to cause further divide between Western and Indigenous communities. Today, we have begun a new wave of scientific research, the genetic revolution. Indigenous peoples are seen as an untapped source for genetic biodiversity studies, a high priority for scientific research. While a 'best practice framework' may exist, there is currently no capacity or funding system for scientists to adequately engage with Indigenous communities to

participate in adequate community consultation in regard to research conducted within that community.

Theme 3. Indigenous priorities

Recommendation 5

Enable Indigenous communities to develop local and regional priorities for science engagement, research and communication.

Recommendation 6

Provide Indigenous communities with the scientific resources to build community capacity to deliver on local community priorities.

Recommendation 7

That, in developing their science engagement and research agendas, government, researchers and their organisations ensure:

- local and regional Indigenous priorities are integrated into the development of their projects;
- the meaningful participation and empowerment of local Indigenous knowledge holders in project design, delivery and evaluation; and
- project outcomes deliver clear and sustainable benefits to the livelihood of local communities.

Recommendation 8

That governments, researchers, communicators and their organisations have research 'impact measures' that include priorities and outcomes for local Indigenous communities.

Reasoning

Indigenous communities are interested in science and in working collaboratively with scientists across Western and Indigenous knowledge domains. For example, Indigenous land and sea management, in particular, is a growth area in which the demand for scientific knowledge, tools and expertise is increasing. To meet this demand and to enhance scientific and community outcomes, initiatives are needed to increase the placement of scientists within Indigenous organisations such as land and sea management organisations.

Similarly, Indigenous land and sea managers are pursuing access to research funding and research partnerships in order to secure scientific expertise. Indigenous perceptions of the value of science are greatly enhanced in programs where there is a dedicated effort by research organisations to ensure Indigenous participation in

decision making about research design, conduct and outcomes, and to create post-hoc evaluation frameworks that consider benefits to Indigenous peoples.

Consequently, it is important for communities to have a clear understanding of what their local priorities for science are. To ensure these are both clarified and captured in research projects, project activities need to be developed in local settings and designed in ways that ensure local knowledge and expertise will be both embraced and improved. This should engender community-wide science engagement and will also equip community members to better interact with and participate in those research activities.

It is important that the benefits for Indigenous people from scientific research activities are assessable. This means developing assessment criteria, evaluation mechanisms and longitudinal studies to fully measure the impact of research outcomes and their value to particular communities. Project grants must therefore provide for measures to identify and quantify benefits, and to report these to the communities involved. However, while there is some requirement for such accountability measures in various research grants, there are seldom any real compliance checks. If done, these rarely consider Indigenous viewpoints. The longevity of some projects (over five years) makes it difficult for Indigenous communities, often located in remote areas, to maintain oversight and control of research processes and outcomes.

Further, research and development projects receiving finance from sources other than research grant providers are often funded on the basis of 'return on investment'. In such projects it is important to ensure that Indigenous community and cultural development are properly valued as *valid* returns, and this should be articulated in terms of 'science impact areas' and research expectations. Too often, research outputs that are of value to Indigenous communities but that don't fit narrow assessment criteria (e.g. a focus on conventional peer-reviewed articles) are undervalued in existing science 'impact' assessments. In reviewing 'impact measures' consideration of the benefit/impact/success to Indigenous communities should be taken into account.

Theme 4. Communication

Recommendation 9

Develop an Indigenous media and communication strategy to engage Indigenous people in science, to inform the wider community about Indigenous science achievement, and to create a new appreciation of the value of Indigenous knowledge systems amongst the Indigenous and broader scientific communities.

Resourcing

- One full-time person to develop and implement the strategy.
- Funds for communication activities.

Reasoning

The *Inspiring Australia* report states (p. xiii), 'If the communication of science is to be effective it needs to recognise the audiences to be engaged.' This is particularly true for Indigenous peoples. Aboriginal and Torres Strait Islander communities are diverse communities, with a significant proportion of Indigenous people living in remote and very remote areas with limited access to the range of media available in larger urban areas.

Indigenous media is a thriving and important means of communication for Indigenous peoples and includes national newspapers such as the *Koori Mail*, the *National Indigenous Times* and *Land Rights News*, and Indigenous radio stations in most capital cities, in regional areas and in remote communities, broadcasting in English and in local Indigenous languages.

While there are stories about Indigenous engagement in science across mainstream and Indigenous media, in many cases these are not explicitly identified or perceived as stories about 'science' but more often seen as having a cultural or community interest focus. The broader Australian community needs to become more informed about Indigenous achievements in science and the relationship between Indigenous knowledge and science, and some thought and research needs to be focused on how this is best achieved.

The development of Indigenous-specific awards within Australia's premier science awards may be an important means to recognise and highlight Indigenous knowledge and scientific achievement (see also Recommendation 11).

Recommendation 10

Develop and sponsor science awards to recognise and profile Indigenous achievements in science. This should include:

- awards for young Indigenous scientists, Indigenous knowledge holders and communities
- Indigenous categories within Australia's prestigious national and state science awards
- science as a category within the Deadly Awards and other relevant Indigenous awards.

Reasoning

National and state awards recognising Indigenous scientific achievements will bring these to the attention of the wider Australian community, challenging long held assumptions and stereotypes as well as providing important role models for Indigenous young people. Indigenous science categories should be included in all major awards, such as the Eureka prizes, and recognise a diverse range of scientific achievements by individuals and communities as well as programs that provide pathways into science courses for Indigenous secondary students.

The Deadly Awards are national Indigenous awards that include a number of categories such as Arts, Sport, Music and Community (including Education). There is currently no specific category for Science. Development of awards in this category would be an important step in communicating the science message to Indigenous communities and young people.

Theme 5. Engage Indigenous young people in the sciences

Recommendation 11

Develop educational and outreach programs that engage Indigenous young people in science, leading to professional careers in science and science-related areas.

Reasoning

It is well recognised that Indigenous Australians are under-represented in higher education overall and in science courses especially. The Indigenous community widely acknowledges an urgent need for more well-educated and qualified leaders in the sciences. According to Department of Education, Employment and Workplace Relations (DEEWR) statistics, in 2010 only 11% of total Indigenous enrolments (1236 Indigenous students) in higher education were in the broad education fields of Natural and Physical Sciences, Information Technology, Engineering and Related Technologies, Agriculture, Environmental and Related Studies and Architecture and Building, compared to 33% (3623 Indigenous students) in Society and Culture alone. While enrolments are better in Health, with 20% of Indigenous higher education enrolments (2119 Indigenous students), Indigenous students are still significantly under-represented in key professional health areas such as Medicine and Dentistry (DEEWR 2011).

The Indigenous population is essentially a youthful one, with 38% of Indigenous people aged 15 years or under. This is double the proportion in the non-Indigenous population (ABS 2006). With this figure expected to rise, it is important that programs are developed to enable Indigenous students to develop their full potential in the sciences.

A number of universities and scientific organisations already offer outreach programs and activities. The ongoing success of the Indigenous Australian Engineering Summer School (IAESS) at Curtin University and the University of New South Wales, and the University of Western Australia's Indigenous Science and Engineering Camp in attracting participants has demonstrated that Indigenous students are interested in science. For many Indigenous students, such programs provided the first occasion where anyone had said to them that they could become a scientist or engineer and shown them the pathways to get there. Programs often include Indigenous science activities as well as meeting Indigenous science students and graduates, recognising that cultural relevance, peer support and role models are critical to Indigenous educational success. The Aspiration Initiative academic enrichment program, run by the Sydney-based Aurora Project, includes a science program and is committed to supporting and inspiring Indigenous students to go to university. Currently this project

is mostly funded from corporate, philanthropic and higher education sources. With high numbers of Indigenous students in regional, remote and very remote areas, the delivery of outreach programs is costly and ongoing funding support is required.

Recommendation 12

Map and monitor Indigenous student enrolments and graduates in science and science-related areas to establish a clear picture of achievements and any 'gaps'. Develop promotional material and information for Indigenous science students and graduates to inspire, motivate and support Indigenous young people to undertake science-related careers.

Reasoning

While individual universities and other organisations develop such material, there needs to be a national, coordinated approach to looking at the achievements across the sector as a whole. This is critical if planning for an Indigenous professional workforce in science is to be a serious objective. While significant development has been done in relation to the Indigenous health workforce, other areas of science have received limited, if any, attention. Such information, particularly graduate and student profiles, could also contribute to the development of a media and communication strategy to engage Indigenous students and communities in science. As an example, the Australian Indigenous Doctors' Association publication *Journeys into medicine* profiles 15 Indigenous medical graduates and 15 students (AIDA 2009). The Aspiration Initiative releases a handbook every year listing scholarships available for Indigenous students and profiling Indigenous graduates.

Appendix 1 Expert Working Group composition

Name and affiliation	ATSI	Discipline	Bio
<p>Winthrop Professor Jill Milroy AM (Chair)</p> <p>Dean, School of Indigenous Studies, University of Western Australia</p>	Y	Science Education (Medicine/ Engineering)	Palyku, Pilbara. Dean of the School of Indigenous Studies at UWA, developing preparatory and support programs for Indigenous students in Law and Medicine. Currently working on a project to design Indigenous curriculum in Engineering.
<p>Dr Peter Radoll</p> <p>Director, Tjabal Indigenous Higher Education Centre, ANU</p>	Y	Information Technology	Anaiwan People, Northern Tablelands, NSW. Director of the Tjabal Indigenous Higher Education Centre. His PhD examined the adoption and effective use of Information Communication Technologies in Australian Indigenous Communities. Taught Information Systems in the College of Business and Economics at the ANU. Research interests: information systems, information technology adoption and information technology development projects in Australian Indigenous communities.
<p>Dr Misty Jenkins</p> <p>Research Scientist, Peter MacCallum Cancer Centre</p>	Y	Immunology and Cell Biology	Gunditjmara Nation, Victoria. Research scientist. Completed her PhD with Nobel Laureate Peter Doherty at the University of Melbourne. Post-doctoral fellowship in Oxford and Cambridge with Prof. Gillian Griffiths. Studies killer T cells and mechanisms for killing virus-infected and cancer cells.

Name and affiliation	ATSI	Discipline	Bio
Dr Rod Kennett North Australian Indigenous Land and Sea Management Alliance	N	Biology	Manager of Saltwater Country Management Program. Has worked in marine and terrestrial science and management in tropical north Australia for over 25 years. Initiated the NAILSMA I-Tracker Program securing resources and partnerships, tools and training for Indigenous rangers to combine scientific knowledge with traditional knowledge to manage traditional estates.
Josie Douglas Aboriginal Research Fellow, CSIRO	Y	Science Education/ Research/ Indigenous Environmental Knowledge	Wardaman, Katherine. Previously an Aboriginal Research Fellow at Charles Darwin University. Research examining environmental, economic, social and cultural sustainability of bush food harvesting and micro-enterprise in Central Australia, remote Aboriginal education and relationships between Indigenous ecological knowledge (IEK), sustainable livelihoods and community school based education. Current PhD research project: 'Indigenous Ecological Knowledge: Continuity and Change across Generations in Central Australia'.
Dr Anne Poelina Managing Director of Madjulla Inc.	Y	Health/language/ sustainable community development	Nyikina, Kimberley. Remote area nursing, academic and community education and training, Australian language maintenance, Indigenous publishing, empowerment evaluation and research consultancy.
Graeme Gower Edith Cowan University/Scitech	Y	Science education	Former Head of Centre for Indigenous Australian Knowledges, Edith Cowan University. Currently researching engagement of Aboriginal students and teachers with science in cooperation with Scitech.

Name and affiliation	ATSI	Discipline	Bio
<p>Dr Michael Fletcher Research Fellow, School of Culture, History and Language, Australian National University (ANU)</p>	Y	Paleoecology	<p>Postdoctoral Research Fellow at the Institute of Ecology and Biodiversity, Universidad de Chile (2009-11); Indigenous Research Fellow in Archaeology and Natural History, ANU (current).</p>
<p>Jim Walker Indigenous Engagement Officer, CSIRO</p>	Y	Science engagement, natural resource management	<p>From the Yiman and Goreng Goreng peoples of Central Queensland. One of two Indigenous Engagement Officers within CSIRO. Development of intellectual property protocol on Indigenous engagement; development of Indigenous science education pathways; increasing Indigenous employment within CSIRO; provision of science study awards for Indigenous tertiary students; and assisting researchers engage with Indigenous communities. Previously ATSI State Manager in Tasmania, Victoria and Northern Territory and Coordinator of the National Indigenous Forestry Strategy.</p>
<p>Greg Lehman (Convener) Visiting Indigenous Research Fellow, AIATSIS</p>	Y	Natural and cultural heritage management and interpretation	<p>Palawa, Tasmania. Former Director of Riawunna, Centre for Aboriginal Education, University of Tasmania. Current Director, Board of Skills Tasmania and Board of Natural Resource Management South, Tasmania. Previous research in Indigenous weather knowledge and fire management, co-management of Tasmania's Wilderness World Heritage Area.</p>

Appendix 2 Education through consultation, recognition and access

Building the interest of Indigenous students in science offers fertile ground for enhancing the engagement of Indigenous people. Many organisations are already delivering a wide array of initiatives and programs that aim to engage Indigenous people in science. In order to account for the critical importance of education in improving Indigenous engagement, this Appendix presents results of an indicative survey of initiatives and programs to underpin the Working Group's analysis of the current situation and to identify key stakeholders and issues.

Consultation emerged as a significant way Indigenous people are engaged in science, and programs appeared to fall into two categories: consultation that was externally driven and involved Indigenous people in response to a necessity; and consultation that was community initiated, in which Indigenous people took a proactive role in all decisions and implementation from the outset. The next theme was apparent in programs that encompassed recognition and respect for Indigenous knowledge. These programs were vast and included strategies such as making formal commitments through Reconciliation Action Plans and engagement strategies, providing training for staff who engage Indigenous people in science in many contexts, providing employment opportunities, and building understanding of Indigenous knowledge through collaborations. The third category of programs could all be linked through their approach to supporting Indigenous people in engaging with science in education, training and employment. These programs raise awareness for Indigenous engagement in science through direct promotion and through the media. They provide bridging opportunities to further science study or training in science, and they provide support to access and ensure retention in initiatives. Finally, many programs specifically target Indigenous school students with programs that reach out to schools through either visits to schools or the hosting of school students at organisations (such as through camps and activities).

The current picture of Indigenous engagement in science is complex. While all programs surveyed by this project fell under these four broad themes, some used multiple strategies. The number of organisations involved in engaging Indigenous people in science is large and the number of strategies they employ even larger.

In attempting an indicative study, the Expert Working Group considered only programs that were currently operating and appeared to be ongoing. In line with the national approach, this review adopted a broad notion of science, which includes natural and physical sciences (e.g. biology, physics, chemistry and geology), applied sciences (e.g. engineering, medicine and technology), emerging fields of science (e.g. environmental science and nanotechnology) and mathematics. The social sciences and humanities, which are seen as an interface between science and society, were omitted.

There are many currently available programs promoting mainstream science engagement that may be effective for many Indigenous people, but a critical

examination of these was considered beyond the scope of this project. Only programs that specifically targeted Indigenous participation were considered.

The four themes noted above emerged in these programs. These are considered, along with examples of the programs employing such strategies, to provide a snapshot of current approaches to Indigenous engagement in science in Australia.

Consultation

A significant way in which Indigenous people engage in science is through a process of consultation with external organisations. Consultation occurs when groups come together to develop and implement programs. As a process, it can be undertaken in different ways. One approach sees the consultation process externally controlled—driven by professional knowledge and priorities. In this way, the consultation process can be characterised as more instrumental in nature, as Indigenous engagement in science is seen as a means of achieving professional ends. Alternatively, consultation can be community initiated. This is a bottom-up approach in which consultation is driven by the knowledge and priorities of the Indigenous community. As such, consultation becomes a more developmental process in which Indigenous engagement with science is a key outcome.

Externally controlled, top-down consultation can involve organisations simply telling or informing Indigenous people about a particular scientific issue. Smith (2007) describes a case in which a scientific organisation, the Queensland Parks and Wildlife Service, informed a local Indigenous community in the township of Coen about the risks associated with flying foxes because of an outbreak of the Hendra virus through a public meeting. The author noted there was some confusion over the issue because members of the Aboriginal audience were alienated by the scientific language used and because of a discrepancy between scientific and local knowledge about the origins of flying foxes.

Another example of externally controlled consultation comes from Canada, where scientists involved in forest management looked at implementing a realistic 3D mapping technique to visualise future landscapes so that the indigenous community could comprehend the information and have more meaningful input into discussions about future possibilities (Lewis & Sheppard 2006). While in this second example the organisation was facilitating the capacity of indigenous people and hence giving them a voice in the discussion, ultimately the end goals were those of the organisation rather than those initiated by the community.

A higher level of consultation occurs when Indigenous people are the drivers of a project. This kind of consultation is a necessary feature when groups successfully co-manage projects, examples of which are highlighted through a series of case studies about the management of the Great Barrier Reef. Here Indigenous communities drove the development of the program, including facilitating the contribution of other external resources from programs such as the Community Development Employment Program. These resources assisted the work of planning how the communities would eventually negotiate the outsourcing of management services to their own people (Ross et al. 2004).

The following are examples of Indigenous engagement in science through consultation, either externally controlled or community initiated.

Externally controlled consultation

- Fortescue Metals Group—Pilbara Iron Ore and Infrastructure Project. According to their own report, consultation was undertaken with landowners and relevant parties in the design of a rail corridor, and heritage surveys were conducted. The aim of the project was to build a rail corridor, and consultation was a necessary step to reach the aim (Fortescue Metals Group 2008).
- Horizon Power—Aboriginal and Remote Communities Power Supply Project (ARCPSP). This project was to improve power supply to remote communities. Sessions were held for Horizon Power staff to explain the use of pre-paid power cards and electrical safety (Horizon Power 2010).

Community-initiated consultation

- CRC Reef Research Centre—cooperative co-management of the Great Barrier Reef. Three case studies demonstrated that long-term observational knowledge can inform projects and enable Indigenous communities in making decisions about the directions and implementation of projects (Ross et al. 2004).
- Natural Resource Management—Bundjalung Nation. Members of the community identified issues with externally controlled consultation and recommended two-way cultural competency training to increase Indigenous peoples' understanding of the 'white' processes so they could have a more significant voice in consultation, including effectively communicating traditional knowledge to facilitate genuine co-management. Training was also undertaken to increase understanding of non-Indigenous participants so they could more effectively communicate with traditional owners (Lloyd & Norrie 2004).
- CSIRO and Bushfire CRC—Aboriginal wetland burning in Kakadu. This project is led by Indigenous research officers working for the CSIRO in partnership with traditional owners of the land. They utilise their knowledge to implement the program of burning (CSIRO 2011a).
- Booderee National Park (Jervis Bay Territory). This is a co-management initiative by the Wreck Bay Aboriginal community and Parks Australia (Commonwealth of Australia 2011b).
- The North Australian Indigenous Land and Sea Management Alliance runs projects in natural and cultural resource management across north Australia (North Australian Indigenous Land and Sea Management Alliance 2011). It supports community consultations to identify Indigenous research priorities and fosters strategic partnerships with government, industry, non-government organisations and research organisations to secure funds, resources and scientific expertise.

Recognition of and respect for Indigenous knowledge

Science organisations can engage Indigenous people when they act upon strategies that value and respect Indigenous knowledge. These strategies are diverse and can include making commitments through formal Reconciliation Action Plans or engagement strategies, providing training for staff to effectively engage Indigenous people in science, providing employment opportunities for Indigenous people, or including Indigenous knowledge in the production of new understanding through research, collaborations, conferences or professional associations.

Indigenous knowledge is also clearly valued when it is used to generate new understandings. The CSIRO, for example, has a program to record traditional wetland burning knowledge that aims to 'create models to help integrate Indigenous Australians' wealth of ecological knowledge with Western knowledge systems' (CSIRO 2011c). These new understandings also come from collaborations such as the Australian Aboriginal Astronomy Project at Macquarie University and professional bodies such as the Australian Indigenous Doctors' Association, which publishes materials and hosts symposiums and conferences (Hamacher 2011; AIDA 2011).

The strategy to respect Indigenous knowledge employed by the College of Physical and Mathematical Sciences at the Australian National University (ANU) is a Reconciliation Action Plan that commits to improving Indigenous and non-Indigenous engagement through other strategies. This includes seeking to employ Indigenous people, training staff in cultural competency and becoming engaged in outreach programs to attract Indigenous students (ANU 2011).

Another example of training provided to improve engagement is professional development for teachers of Indigenous students. The Australian Academy of Science has produced science teaching resources that incorporate Indigenous perspectives, as well as training for teachers in applying these perspectives (Bull 2008). Researchers indicate that teachers need explicit instruction about how to incorporate Indigenous knowledge in science materials, and that doing so is a way of capitalising on Indigenous student interest in science (McConney et al. 2011).

Many science organisations provide employment opportunities for Indigenous people. The NSW Department of Primary Industries does this through the use of an Indigenous Employment Strategy, which aims to increase Indigenous employment and to train and upskill employees (New South Wales Government 2011). A number of science organisations, including private resource company Rio Tinto, utilise the Australian Government's Indigenous Cadetship Support to provide employment opportunities for Indigenous students studying in relevant tertiary areas (Commonwealth of Australia 2011c; Rio Tinto 2011). These programs value Indigenous knowledge by recognising the value Indigenous employees can bring to companies or organisations.

Other employment strategies, such as traineeships, provide a means to prepare Indigenous people for the workplace rather than to value the skills they already have, and are discussed below in the 'Access' section of this appendix.

Commitment to Indigenous knowledge

- CSIRO—an engagement strategy that aims to ethically research issues that impact the quality of life of Indigenous peoples, increase Indigenous employment, engage in educational outreach and broaden the staff understandings of Indigenous issues (CSIRO 2011b).
- College of Physical and Mathematical Sciences, ANU—Reconciliation Action Plan developed to build respect for Indigenous people among staff, consolidate ANU's position of leader in Indigenous research, give students an understanding of Indigenous knowledge and perspectives, and attract and support Indigenous students as well as Indigenous general and academic staff (ANU 2011).
- Australian Defence Force—Defence Reconciliation Action Plan (ADF 2011).
- Department of Innovation, Industry, Science and Research—Reconciliation Action Plan that commits to building science and research capacity (DIISR 2010).

Training in Indigenous knowledge

- Australian Academy of Science, Primary Connections Indigenous perspectives—resources that incorporate Indigenous knowledge into the science curriculum and give web links for further information and training on their implementation (Australian Academy of Science 2011).
- Scitech Aboriginal Education Program—training and resources for teachers and Aboriginal and Islander education workers in remote schools in WA on running experiential and discovery activities with students (Byrne et al. 2008; Scitech 2011).
- RoleM, Australian Catholic University (ACU)—a professional learning program for teachers of mathematics that is run as a collaborative partnership with the community to implement culturally appropriate maths activities (ACU 2009).
- Living Knowledge resource, ANU—a comparison of Indigenous and Western science, including advice on how to embed Indigenous knowledge in science curricula (The Living Knowledge Project 2008).
- The Kimberley Indigenous Management Support Service (WA)—technical and management skills development for Indigenous directors, managers and workers on Indigenous-owned Kimberley cattle stations (Indigenous Land Corporation, n.d. -b).
- Centre for Cultural Competence Australia, which lists the following science-related organisations as their current clients (Centre for Cultural Competence Australia 2010):
 - Alzheimer's Australia
 - Australian Diabetes Council
 - Australian General Practice Network

- Australian Sports Commission
- Autism Association of WA
- Cairns Audiology Group
- Department of Ageing, Disability and Home Care
- Department of Defence
- Department of Employment, Economic Development and Innovation Queensland
- Department of Health and Ageing
- Department of Health NSW
- Department of Health Queensland
- Department of Health Victoria
- Department of Health WA
- Department of Natural Resources, Environment, the Arts and Sport
- Forests NSW
- General Practice NSW
- GP Down South
- North and West Queensland Primary Health Care
- Perth Zoo
- Rio Tinto Iron Ore
- The Pharmacy Guild of Australia
- WA General Practice Network
- West Sydney Area Health Service
- Wheatbelt General Practice.

Employment opportunities for Indigenous people

- NSW Department of Primary Industries, Indigenous Employment Strategy—The strategy's aims include increasing Indigenous employment and training and upskilling employees (New South Wales Government 2011).
- Gunbalanya Station and Meats (NT)—This pastoral business and meat works being developed by the Indigenous Land Corporation (ILC) provides employment to Indigenous people (Indigenous Land Corporation, n.d. -a).
- Rio Tinto Indigenous Cadetships—Students studying science or engineering at university can receive financial support, paid vacation employment, career development and mentoring (Rio Tinto 2011). Cadetships have helped increase the proportion of Indigenous employees at Rio Tinto from 0.5% to 8% (Commonwealth of Australia 2011a).

- Other science organisations providing Indigenous cadetship programs are:
 - Woodside
 - BHP Billiton
 - Defence Indigenous Cadetship Project (DICP)
 - NSW Allied Health Aboriginal Cadetship Program.

Building understandings with Indigenous knowledge

- CSIRO, recording traditional wetland burning knowledge—This project aims to build new understandings based on Indigenous knowledge of the ecosystem (CSIRO 2011c).
- Aboriginal Astronomy Project, Macquarie University—Researchers are collaborating in studying Indigenous astronomy knowledge and traditions (Hamacher 2011).
- The Australian Indigenous Doctors' Association—This not-for-profit, non-government group supports Indigenous students and doctors and produces knowledge through publications and symposiums (AIDA 2011).

Access

A number of organisations provide opportunities to increase Indigenous engagement in science by providing access. These initiatives and programs include promoting awareness of opportunities and inspiring Indigenous people to engage; providing the training and skills that students may need to engage in science; and providing support for students to participate in such training programs. Robertson et al. (2002) cite an Information Technology (IT) program at the University of Technology, Sydney (UTS) as an example of how to facilitate Indigenous access to IT programs generally. The UTS program included building awareness through school outreach, consulting with Aboriginal land councils, involving Indigenous IT professionals as role models and developing promotional materials. A dedicated four-week pre-IT course was designed to provide students with the skills necessary to access IT study at university. It included Indigenous perspectives in the IT curriculum and provided appropriate support for students in the program, which included tutoring, ensuring home computer access, employing and training Indigenous staff to run the program, setting up mentoring programs, providing culturally appropriate spaces for staff and students and providing a range of scholarships and cadetships (Robertson et al. 2002).

Another popular strategy is to use web presentations, such as the Living Knowledge project and Edith Cowan University's Australian Indigenous Health *InfoNet* (Living Knowledge project 2008; ECU 2011a). The online resources enhance further engagement in science by providing a flexible and highly accessible way to raise awareness of science issues and knowledge among Indigenous people. TV, radio, publications, blogs, and bulletins et cetera also play a significant role in awareness-raising and can be better aimed at engaging Indigenous people in science.

The University of Western Australia offers a general science bridging program through the Aboriginal Orientation Course, which is a one-year course that prepares students to go on to studies in any scientific discipline of their choosing, including medicine and engineering (UWA 2011b). Private companies also use this strategy to help Indigenous students access careers in science—for example, Argyle Diamonds has an extensive range of programs that includes pre-employment training, accelerated training, flexible traineeships and apprenticeships, new entry points and 'alternative' employment (Rio Tinto 2009). These strategies all aim to build skills and capacities of Indigenous people from communities near Rio's mines to access careers in science. To ensure students succeed in training initiatives, many forms of support can be offered to increase access, including financial support such as the BHP Billiton Iron Ore Indigenous Scholarships Program for Indigenous university students at UWA and Curtin University to study engineering or relevant sciences (e.g. geology) (The Good Universities Guide 2011).

Academic support is by culturally competent maths tutors in the bridging program at Central Queensland University's Indigenous Learning, Spirituality and Research Centre (Makuwira 2008). Other forms of support include the provision of safe learning spaces and pastoral care programs. Student Services at the School of Indigenous Studies at UWA concentrate on being responsive to students and tailoring specific programs to meet their individual needs (UWA 2011c; Andersen et al. 2008).

Awareness

- Living Knowledge resource—This online resource compares Indigenous and Western science. It is a flexible and accessible strategy to promote science engagement to Indigenous people (Living Knowledge project 2008).
- Edith Cowan University, Australian Indigenous Health *InfoNet*—The *HealthInfoNet* provides information about health issues that affect Indigenous people (ECU 2011a).
- Indigenous Science Network Bulletin—This is a web-based exchange of information and ideas on Indigenous science engagement, a form of media that builds awareness and inspires Indigenous engagement in science (Michie 2011).
- National Centre of Indigenous Excellence Indigenous Innovation blog—This blog includes regular updates about Indigenous innovation, which is an example of a strategy to inspire participation (National Centre of Indigenous Excellence 2011).
- The University of Western Australia School of Indigenous Studies—The school's website provides profiles of Indigenous science, engineering and medicine graduates, which can be an inspirational way to engage the next generation of Indigenous scientists (UWA 2011a).
- Bureau of Meteorology Indigenous Weather Knowledge website—The website has information about seasonal weather from cultural regions across Australia. It can be used as a tool to promote science engagement (BOM 2011).

- Indigenous Allied Health Australia—This website promotes the work of Indigenous professionals in allied health to inspire others to who are interested in contributing to improved Indigenous health (Indigenous Allied Health Australia 2011).

Bridging

- Argyle Diamonds Indigenous partnerships—The Argyle Diamond Mine offers pre-employment training, accelerated training, flexible traineeships and apprenticeships, new entry points and 'alternative' employment (Rio Tinto 2009).
- The University of Western Australia Aboriginal Orientation Course—This is a one-year course that prepares students to go on to studies in any scientific discipline of their choosing, including medicine and engineering (UWA 2011b).
- Other universities that offer bridging units for Indigenous students into science-related tertiary study include:
 - The University of Newcastle, Yapug—The Yapug program offers four streams: Health Science; Engineering and Science; Business, Law, Commerce and IT; and Education. It is a year-long program with intake in first and second semester (University of Newcastle 2011).
 - The University of New South Wales, Nura Gili—The Centre offers year-long enabling programs to enter degree areas, one of which is Science, Engineering and Technology (University of New South Wales 2011).
 - The Australian Centre for Indigenous Knowledges and Education (ACIKE)—This is a joint initiative between Charles Darwin University (CDU) and the Batchelor Institute of Indigenous Tertiary Education (BIITE) offering Preparation for University Studies (PTS). PTS provides general preliminary units and then mathematics and introductory science units (Batchelor Institute 2011).
 - Central Queensland University (CQU), Nulloo Yumba—The Centre's Tertiary Entry Program (TEP) is a full-year program that offers core units plus electives, including: Numeracy Concepts and Applications, Introductory Applied Science, Preparing for Health Sciences, Preparing for Biology, Preparing for Chemistry, Preparing for Physics and Advanced Numeracy Concepts and Applications (CQU 2011).
 - James Cook University—James Cook's School of Indigenous Australian Studies offers a Tertiary Access Course, which can be studied full-time for six months and prepares students for a range of undergraduate degrees (James Cook University 2011).
 - University of Tasmania, the Riawunna Centre—The centre offers a Murina Preparation Pathway for Indigenous students across all faculties according to individual student aspiration (University of Tasmania 2011).
 - Curtin University of Technology Centre for Aboriginal Studies—The Aboriginal Bridging Course (ABC) is a two-semester, full-time program. It

includes core literacy and communications skills and electives in the Humanities, Sciences or Arts streams. The Indigenous Tertiary Enabling Course is a six-month (second semester only) program that is almost identical to the second semester of the ABC (Curtin University 2011).

- Edith Cowan University, Kurongkurl Katitjin—The centre offers a one-year full-time Indigenous University Orientation Course that includes some maths and computing skills but no other science (ECU 2011b).

Support

- BHP Billiton Iron Ore Indigenous Scholarships Program—financial support for Indigenous university students at UWA and Curtin University to study engineering or relevant sciences (e.g. geology) (The Good Universities Guide 2011).
- The University of Queensland Indigenous Science Scholarship (The University of Queensland 2011).
- South Australian Research and Development Institute (SARDI) Science Bursary for Aboriginal Students—\$1500 to an Aboriginal or Torres Strait Islander graduate to undertake postgraduate study in science at a tertiary institution in South Australia (SARDI 2011).
- Murdoch University, Waardong—support and pastoral care for Indigenous students studying veterinary science, biomedical science and chiropractic at Murdoch (Murdoch University n.d.).

Reaching out

There are a number of organisations that run programs for and in schools to specifically engage Indigenous school students in science. A common strategy for engagement includes visiting schools with outreach programs, such as those that deliver science and maths activities. Scitech's Aboriginal Education Program takes hands-on science activities to schools in remote Aboriginal communities in WA (Byrne et al. 2008), while the Queensland University of Technology's YuMi Deadly Maths program works in six schools in regional Queensland and includes delivering an Australian Government program intended to accelerate Indigenous student learning in mathematics (Queensland University of Technology 2010). Kulig et al. (2010) recommend the hands-on approach adopted in these strategies, as it allows for experiences and observational learning that can enhance student engagement in science. Additionally, many smaller one-off visits to schools occur, such as those supported by National Science Week grants that are held throughout any given year (Commonwealth of Australia 2011d).

Many organisations adopt the strategy of hosting students. Indigenous science camps, like the University of Western Australia's Indigenous Science, Engineering and Health Camp (UWA 2011d) and the Aboriginal Summer School for Excellence in Technology and Science (RiAus 2011) offer residential camp programs that aim to promote and raise awareness in a way that will enhance Indigenous students' engagement in science, build self-esteem and motivation and break down perceived

barriers. Features of these programs include using Indigenous role models and making sessions relevant by linking them back to Indigenous culture and anthropology (Aldous et al. 2008).

Rather than visiting or hosting Indigenous school students directly, other organisations were found to provide support for programs that made use of these strategies. One example of this is Woodside's sponsorship and in-kind support of the UWA Science, Engineering and Health Camp, providing financial assistance to help students access a program that includes engineering and geology activities (UWA 2011d).

Other support includes providing opportunities for Indigenous students to participate in existing mainstream programs, such as the Indigenous Scholars program, which provides at least five scholarships to Indigenous students to attend the University of Sydney's Professor Harry Messel International Science School (University of Sydney 2011).

Visits

- Scitech's Aboriginal Education Program visits schools in remote Aboriginal communities in WA with hands-on science activities that aim to increase interest and participation in science (Scitech 2011).
- The Indigenous Science Education Program at Macquarie University (NSW) works with four high schools in NSW and uses science as a motivator for students to stay at school and consider further study (Macquarie University 2011).
- Queensland University of Technology's YuMi Deadly Maths program works in six schools in regional Queensland and includes delivering a Federal Government program aimed at accelerating Indigenous student learning in mathematics (Queensland University of Technology 2010).
- Townsville Intercultural Centre's 'Townsville Dreaming' is a one-off National Science Week event examining the night sky over Townsville and picking out Indigenous and conventional star constellations. Two storytellers, Indigenous and/or professional actors, will tell stories of the constellations drawn from both Indigenous and non-Indigenous myths (Commonwealth of Australia 2011d).

Hosting

- The University of Western Australia's Indigenous Science, Engineering and Health Camp—This is a one-week residential camp held annually in July for around 50 Indigenous school students from Western Australia in years 9-11 (UWA 2011d).
- Aboriginal Summer School for Excellence in Technology and Science (ASSETS)—This is an annual national program designed to engage 30 Aboriginal and Torres Strait Islander students in science education. The program provides opportunities to participate in a science, cultural and leadership program. It is conducted by educators and scientists at the University

of South Australia, SA Water, RiAus and the Australian Science and Mathematics School (RiAus 2011).

- Indigenous Australian Engineering Summer School—This is an annual event, established in 1998 by Engineering Aid Australia, and is open to Aboriginal and Torres Strait Islander students from around the country. It is a seven-day live-in summer school featuring a combination of engineering and social activities. For the past three years there have been two summer schools, one in Perth at Curtin University and the other in Sydney with the University of Sydney (Engineering Aid Australia 2011).
- Indigenous National Youth Science Forum—There is currently no information available online, but the first week-long residential camp ran in October 2011 in Perth, focusing on Indigenous high school students from the Pilbara region. It utilised Follow the Dream coordinators as supervisors. Activities were held at UWA and Curtin (anecdotal).
- University of New England (UNE) 'Science in the Bush' for National Science Week—This is a one-off event held at UNE for primary and secondary students from Indigenous and remote areas, who participate in a day of science activities including hands-on experiments, quizzes and lively presentations (Commonwealth of Australia 2011d).

Support

- Indigenous Scholars Program, Professor Harry Messel International Science School (ISS)—The ISS is a free science education program created by Professor Harry Messel in 1962, funded by the Science Foundation for Physics and held at the University of Sydney for students in years 11 or 12. It is run every second year. Scholarships for a minimum of five Indigenous science students were introduced in 2005. In 2011 the program took eight Indigenous students on scholarships that covered all expenses (University of Sydney 2011).
- National Youth Science Forum—This university-based residential program for top Australian science students is held in Canberra and Perth each year. It does not traditionally get much Indigenous participation. In 2011 an Indigenous NYSF was run in Perth to encourage Indigenous participation (NYSF 2011).
- Woodside sponsorship of the UWA Indigenous Science, Engineering and Health Camp— Woodside provides financial assistance to help students access the program and run engineering and geology activities relevant to its industry to further enhance the program's value (UWA 2011d).

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