Submission 087
Received 29 October 2012

House Climate Change, Environment and the Arts Committee at its public hearing on 12 October for the inquiry into Australia's biodiversity in a changing climate

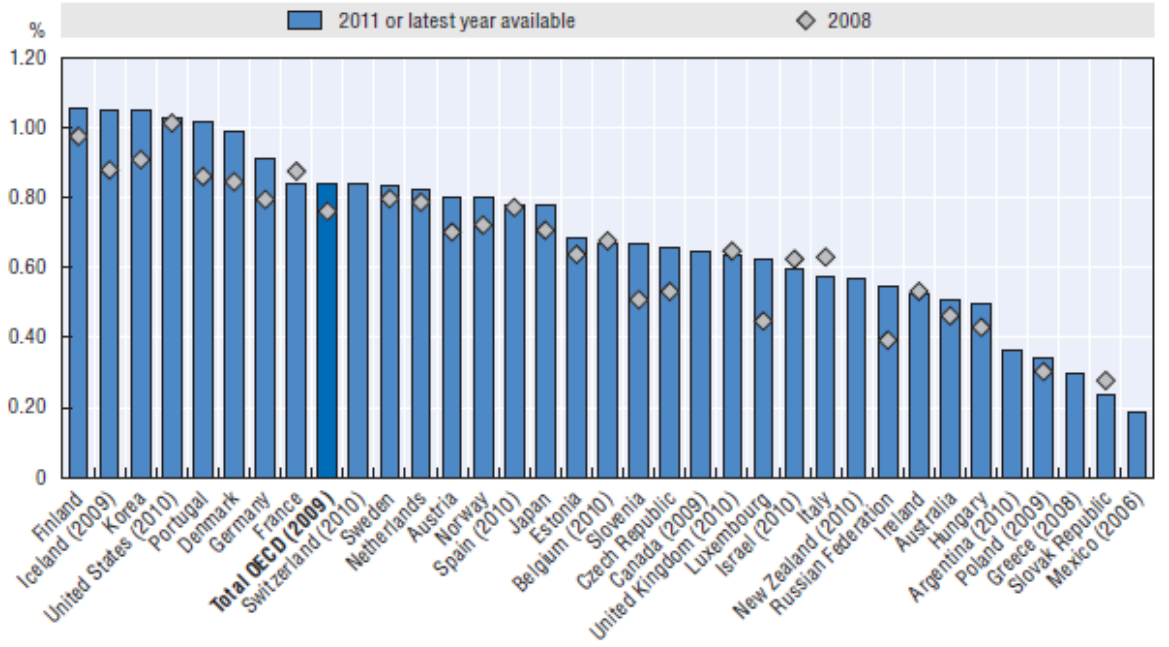
Questions on Notice to Ms Katharine Campbell, Department of Industry, Innovation, Science, Research and Tertiary Education

1. In response to a question from Dr Washer (page 9) you undertook to provide some statistics on Australia's level of public funding on research compared to OECD countries in terms of GDP.

The following figure provides details on Government budget appropriations for Research and Development (R&D) across the OECD. This figure has been sourced from the OECD Science, Technology and Industry Outlook 2012.

Figure 5.1. **Government budget appropriations and outlays for R&D, 2008 and 2011**

As a % of GDP



Source: OECD, *Research and Development Statistics (RDS) Database*, March 2012.

StatLink http://dx.doi.org/10.1787/888932689807

2. In response to questions from Ms Hall (page 10) you undertook to provide information about collaborative international climate change and biodiversity research programs supported by the Department.

Information on projects within the Australia-China Science and Research Fund and the Australia-India Strategic Research Fund that have a particular focus on climate change and biodiversity can be found at **Attachment A**.

3. In response to questions from Ms Marino (page 11) you undertook to coordinate information on the:

- ***3.a Public funds invested in research and management of myrtle rust and dieback, across portfolios, and even state portfolios;***
- ***3.b Federal funding directed towards taxonomy, collection of biodiversity data and existence of specific/collective repositories for biodiversity information; and***
- ***3.c Research infrastructure investments which go to data and e-research and how that is to support the collection.***

3.a Public funds invested in research and management of myrtle rust and dieback, across portfolios, and even state portfolios

A number of other Commonwealth portfolios provide funding and support for research into myrtle rust and dieback. This support can take the form of either direct funding for research or indirectly through programs targeted at broader environmental issues.

Department of Agriculture, Fisheries and Forestry
The Department of Agriculture, Fisheries and Forestry (DAFF) is the primary Commonwealth department responsible for providing funding for research and management of myrtle rust. Due to the time frame involved, DAFF has requested that they prepare a separate submission that provides greater detail on Commonwealth funding for research and management of myrtle rust.

Department of Sustainability, Environment, Water, Population and Communities
The Department of Sustainability, Environment, Water, Population and Communities also provides support for myrtle rust and dieback research both directly and indirectly.

<u>Caring for our Country</u>

The Australian Government has committed significant funding through Caring for our Country to reduce Phytophthora dieback in Western Australia, South Australia and Tasmania through a range of integrated biodiversity programs.

- From 2008–09 to 2010–11, a total amount of $2.174m under Caring for our Country was approved for programs which include a significant amount of activities aimed at reducing the impacts and spread of Phytophthora dieback.
- Under Caring for our Country, the Australian Government provided over $2.2 million to the South West Catchments Council to invest in protection of priority biodiversity across the South-west region between 2009 and 2012. A portion of this funding was allocated towards management of dieback (Phytophthora species). Additional funding was provided in 2008-09 to support the control of dieback to three regional bodies. These included: $483,000 to the South West Catchment Council, $244,000 to Perth Natural Resource Management Inc and $722,000 to South Coasts Natural Resource Management Inc.

- Perth Region NRM has allocated $168,140 of their Caring for our Country regional baseline funds to the Western Australian Dieback Working Group for the next two years (until June 2013). The Dieback Working Group will use these funds to ensure the Banksia food resource available to Carnaby's black-cockatoo in the Perth region is not degraded by P. cinnamomi. Banksia seed is an important component of the diet of Carnaby's black-cockatoo (an EPBC Act listed Endangered species). Perth Region NRM is a community-led regional group with responsibility for coordinating and delivering natural resource management in the Perth Region.

The Caring for our Country 11/12 Open Call project: Mitigating the impacts of Myrtle Rust disease on Queensland World Heritage Area has been awarded $283,000 of funding until June 2013. The aim of this project is to develop a long term ecosystem health monitoring program and adaptive management strategies in strategic rainforest areas in Queensland's World Heritage listed properties. Once commenced, the project will:

- identify and track the infection and impact of myrtle rust (Uredo rangelii/Puccinia psidii) in strategically selected rainforests habitats in the Gondwana, Fraser Island and Wet Tropics World Heritage Areas (WHA);
- further develop an understanding of the disease biology in Queensland rainforest conditions;
- review, liaise and support local, national and international myrtle rust research projects; and
- model the potential long term impacts of the disease on host plant species and other dependant flora and fauna.

National Environmental Research Program (NERP)

The National Environmental Research Program (NERP) funding does not encompass research on myrtle rust or dieback. However, NERP funding supports broader landscape research, of which myrtle rust and dieback are two recognised threats.

Community Action Grants

There are 2 projects relating to Phytophthera dieback (see **Attachment B**). There are no Community Action Grants projects relating to myrtle rust.

Biodiversity Fund

Round one of the Biodiversity Fund is providing $270 million (excluding GST) over six years for a diverse range of projects that will revegetate, rehabilitate and restore significant parts of the Australian landscape. Some of these projects may include activities to address myrtle rust and/or dieback. Compiling a list of such projects and associated funding for these activities would require more time. If more information is required, the Department of Sustainability, Environment, Water, Population and Communities would be happy to undertake further analysis.

Other activities

In 2012-13, $33,000 has been provided for the Council of Heads of Australian Botanic Gardens, (through the Australian Seed Bank Partnership), to collect seed for ex situ

conservation of threatened Australian plant species. The Partnership includes Australia's nine capital city conservation seed banks, which are managed by Australian and state/territory botanic gardens and the Department of Environment and Conservation of Western Australia.

The Australian Government is revising the *Environment Protection and Biodiversity Conservation Act 1999*'s threat abatement plan for *P. cinnamomi*. When in place, the revised threat abatement plan will provide a national framework for directing threat abatement activities across a range of government agencies and other organisations. However, threat abatement plans are not funding programs and allocation of Australian Government funding to threat abatement varies according to government priorities and the activities of other relevant organisations.

3.b Federal funding directed towards taxonomy, collection of biodiversity data and existence of specific/collective repositories for biodiversity information

A number of Commonwealth portfolios provide funding and support for taxonomy, collection of biodiversity data and for repositories for biodiversity information.

Department of Industry, Innovation, Science, Research and Tertiary Education
Funding contributing towards collection and storage of taxonomic and biodiversity data

Project / lead agency	DIISRTE funding excl GST	Source
Atlas of Living Australia / CSIRO	$38.23 million	National Collaborative Research Infrastructure Strategy (NCRIS) ($8.23m) Super Science Initiative ($30m)
Global Biodiversity Information Facility / CSIRO	$345,000	Departmental funds $180,000 (FY 2010-11) $165,000 (FY 2011-12 – via CSIRO)
Scientific Collections International / South Australian Museum	$122,000	Departmental funds including $42,500 from the International Sciences Linkages program
Terrestrial Ecosystem Research Network / University of Queensland	$45.63 million	$20m NCRIS / $25.63m Super Science
Integrated Marine Observing System / University of Tasmania	$102 million	$50m NCRIS / $52m Super Science
Tropical Marine Research Facilities / Australian Institute of Marine Science (AIMS)	$55 million	Super Science
Daintree Rainforest Observatory / James Cook University	$9.37 million	Super Science
Hawkesbury Institute for the Environment / University of Western Sydney	$40 million	Education Investment Fund (EIF) Round 2

Department of Sustainability, Environment, Water, Population and Communities
The Department of Sustainability, Environment, Water, Population and Communities provides support for taxonomy, collection of biodiversity data both directly and indirectly through the following schemes.

National Environmental Research Program (NERP)
Taxonomy research is not directly funded by the NERP program, however, each of the hubs research will include collection of new biodiversity data information. A requirement of NERP funding is that resultant data and information is publicly available which assists in ensuring that biological data is appropriately stored, described and accessible. Much of the data generated from NERP and Commonwealth Environment Research Facility (CERF) is being utilised by other data repositories including Atlas of Living Australia (ALA), Integrated Marine Observing System (IMOS) and Terrestrial Ecosystems Research Network (TERN). Some taxonomy research has previously been funded under the CERF program which supported the Taxonomy Research and Information Network.

Environmental Stewardship
In 2010, the Australian National University was contracted ($2 million over four years) to commence a large-scale monitoring project of the ecological and management effectiveness of the box gum grassy woodland funding rounds under the Environmental Stewardship Program. Long-term monitoring plots have been established on 152 contracted sites, most of which have paired controls. Baseline surveys have revealed that several threatened species and two new reptiles were present in the managed sites.

Australian Collaborative Rangelands Information System (ACRIS)
ACRIS collates, analyses and reports on data including biodiversity and climate change. Recent reports can be found at: http://www.environment.gov.au/land/rangelands/acris/index.html. Since 2002 the Commonwealth has invested $2,733,743 (GST exclusive) in ACRIS.

ACRIS is currently undertaking a national trial of a biodiversity monitoring framework in the Australian Rangelands. The framework focuses on monitoring target species and broader systematic surveillance monitoring at landscape scale. Each of the rangeland states (NSW, QLD, SA and WA) and jurisdictions (NT) have been allocated $80,000 (GST exclusive) to participate in the trial. The completion of the trial in June 2013 will inform future on-going monitoring of biodiversity in the rangelands at a scale that is relevant to regional, state and national jurisdictions, noting that the rangelands comprise 81% of mainland Australia.

Other activities
The National Biological Resources Study within the Department of Sustainability, Environment, Water, Population and Communities provides funding for taxonomy research through the National Taxonomy Research Grants Program.

Australian Research Council (ARC)

Taxonomy

Since 2008 $7.3 million in ARC funding has been awarded to 21 proposals that indicated that the research falls partially within the following Field of Research (FoR)[1] and Research Fields, Courses and Discipline (RFCD)[2] codes:

- FoR 060301 Animal Systematics and Taxonomy
- FoR 060310 Plant systematics and Taxonomy
- RFCD 270401 Plant Systematics, Taxonomy and Phylogeny
- RFCD 270501 Animal Systematics, Taxonomy and Phylogeny

Note that some Phylogeny projects not directly relevant to the field of Taxonomy may be included in the dataset among projects that fall within RFCD codes 270401 and 270501. Projects that fall within FoR 060309 Phylogeny and Comparative Analysis are not included in the dataset.

Researchers can indicate up to three fields of research and an apportionment for each one. For all but two of the 21 projects, less than 50 per cent was apportioned to the codes relevant to Taxonomy. Details of the 21 projects are provided at **Attachment C.**

Collection of biodiversity data

Data on ARC funding for biodiversity has previously been provided to the panel and further information is being provided in response to Questions on Notice directed to the ARC. The ARC is unable to provide specific data relating to ARC support for the collection of biodiversity data, as their data is not categorised in this way.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

CSIRO is custodian of, and manages, the Australian National Biological Collections Facility which consists of four national collections (Australian National Insect Collection (ANIC), Australian National Wildlife Collection (ANWC), Australian National Fish Collection (ANFC) and Australian National Herbarium (ANH)) and over twenty smaller collections. The budget for the Facility is roughly $10.3 million for the 2012-13 financial year.

Australian Institute of Marine Science (AIMS)

The Australian Institute of Marine Science collects biodiversity data as part of its mapping and monitoring of marine ecosystems. This currently totals $15.6million for mapping and monitoring marine biodiversity

[1] *Australian and New Zealand Standard Research Classification (ANZSRC)*, 2008, Australian Bureau of Statistics

[2] *Australian Standard Research Classification (ASRC)*, 1998, Australian Bureau of Statistics

3.c Research infrastructure investments which go to data and e-research and how that is to support the collection.

There are a number of research infrastructure investments, funded by a number of portfolios, which support the collection and storage of biodiversity data.

Department of Sustainability, Environment, Water, Population and Communities
National Environmental Research Program (NERP)
NERP does not provide funding for infrastructure directly. However, NERP investment is an important part of the total funding base for a large number of researchers and research institutions. As such, NERP investment indirectly contributes to research infrastructure.

Department of Industry, Innovation, Science, Research and Tertiary Education
Atlas of Living Australia (Atlas)
Lead agency: CSIRO.
The Atlas is information infrastructure which enables researchers to find, access, combine and visualise data on Australian plants and animals. The Atlas will support biological and ecological research by improving the accessibility and usability of Australia's biodiversity and ecological data. It aims to enable anyone to locate, access and combine information on all aspects of Australian biodiversity online.

By combining distribution data for Australian plants, animals and microorganisms with images, literature, maps, identification tools and molecular data, researchers and the public can explore and analyse this information in novel ways. Biodiversity information includes reference lists of species in different groups; databases of information on specimens held in natural history collections; databases of field observations from ecologists, naturalists and others; images and other multimedia; published literature; molecular data sets; identification keys; and a wide range of other databases and web sites.

A key part of the Atlas' work is collaborating with Australian museums, herbaria and other biological collections to digitise, publish and share their specimen data online.

The Atlas is developing close collaborations with other related national research infrastructure projects, in particular the Terrestrial Ecosystems Research Network (TERN), the Integrated Marine Observing System (IMOS), the Australian Biosecurity Intelligence Network (ABIN), the Australian Phenomics Network (APN) and the Australian Plant Phenomics Facility (APPF).

The Atlas is a participant node of the Global Biodiversity Information Facility (GBIF) and an overseas partner of the Encyclopedia of Life, the Biodiversity Heritage Library, the European Union's Distributed Dynamic Diversity Databases for Life (4D4Life) and the Data Observation Network for Earth (DataONE).

Funding amounts are provided in the table on page 4 of this response.

Global Biodiversity Information Facility (GBIF)
Lead agency: CSIRO.

GBIF was established by governments in 2001 to encourage free and open access to biodiversity data via the internet. Through a global network of countries and organisations, GBIF promotes and facilitates the mobilisation, access, discovery and use of information about the occurrence of organisms. Australia has been a financial (voting) member since 2001.

On 6 September 2012, Minister Chris Evans signed the 2012 GBIF MoU, to ensure Australia's continued full participation as a voting member. The current MoU is non-binding and open-ended, intending to provide ongoing participation. Participants may disassociate themselves from the MoU at any time by advising the Governing Board in writing.

CSIRO, through the Atlas, administers GBIF's Australian node. Dr Joanne Daly, Strategic Advisor, Science, Strategy and People, CSIRO is currently Chair of the GBIF Governing Board. Dr Daly is also on the Atlas Steering Committee.

Funding amounts are provided in the table on page 4 of this response.

Scientific Collections International (Sci Coll)
Lead agency: South Australian Museum

SciColl is a coordinating mechanism for object-based scientific collections, developed under the auspices of the OECD Global Science Forum since 2006. SciColl members are government ministries or agencies and research institutions that contain scientific collections. Members make up a General Assembly which elects an Executive Board. The Assembly and Board set priorities that are implemented by the Secretariat Office.

Australia is a member of the interim Executive Board of SciColl and provided a letter of intent to join SciColl as a national member. An annual investment of US$25,000 membership fee and approximately AUD $12,000 for participation in the Executive Board will be required if Australia is to continue its involvement in SciColl.

The South Australian Museum manages these funds on behalf of Australia's involvement in SciColl. Professor Suzanne Miller, Director of the Museum, and Dr John LaSalle, Director of the ALA, are Australia's representatives on the SciColl steering committee.

Funding amounts are provided in the table on page 4 of this response.

Terrestrial Ecosystem Research Network (TERN)
Lead agency: University of Queensland

TERN is developing a set of dedicated observation sites, standardised measurement

methodologies, equipment, and data and information services which collectively will contribute to meeting the needs of terrestrial ecosystem research and natural resource management in Australia. There are 13 major TERN Facilities, each of which works in one or more ecosystem science domains, forming a national network of scientists and data collection, storage and sharing infrastructure. These facilities currently have over 1100 monitoring sites around Australia, a figure which is expected to grow to over 10,000 as sites are developed and state-based partners join TERN and share their infrastructure.

Funding amounts are provided in the table on page 4 of this response.

Integrated Marine Observing System (IMOS)
Lead agency: University of Tasmania

At the forefront of international collaboration and cooperation in ocean observing in the southern hemisphere, IMOS also functions as a lynch-pin for collaborative marine and climate research in Australia. The IMOS operating model is recognised internationally as best practice for collaborative research infrastructure, being integrated from the open ocean into the coast, and across physics, chemistry and biology.

IMOS Facilities, operated by ten different institutions within the National Innovation System, are funded to deploy equipment and deliver data streams for use by the entire Australian marine and climate science community and its international collaborators. Operational since 2009, the IMOS Ocean Portal allows marine and climate scientists and other users to discover and explore data streams coming from the facilities.

IMOS leads Australia's engagement on the Australia-New Zealand Arrangement on Marine Observation.

- On 6 December 2011, Australia and New Zealand (represented by the former Science Minister Kim Carr and New Zealand's high commissioner Major-General Martyn Dunne) signed an agreement on marine science observation intended to improve knowledge of regional climate and ocean systems, effectiveness of marine resource and environmental management and enhance food security.
- To support the arrangement (similar to a MoU), the Department of Industry, Innovation, Science, Research and Tertiary Education provided $79,000 to IMOS through the University of Tasmania to host a joint Australia-New Zealand marine observation symposium in Hobart on December 2011. The symposium aimed to enhance international cooperation in the development, operation and use of marine infrastructure.
- The inaugural meeting of the Steering Committee is on 26 November 2012. IMOS continues to be deeply involved in this process.

Funding amounts are provided in the table on page 4 of this response.

Tropical Marine Research Facilities project
Lead agency: Australian Institute of Marine Science (AIMS)

The research infrastructure investment will upgrade and provide facilities at AIMS in Townsville and Darwin that will deliver research on the sustainable use and protection of the marine environment and improve understanding of the impact of change (including climate change and coastal impacts) on marine ecosystems. Research infrastructure constructed includes:

- ocean Simulator and seawater infrastructure upgrade in Townsville;
- implementation of new technologies to reduce energy consumption in Townsville;
- expansion of Darwin Coastal Environmental Research Laboratories; and
- a vessel berthing and operations facility in Townsville.

Funding amounts are provided in the table on page 4 of this response.

Daintree Rainforest Observatory (DRO)
Lead agency: James Cook University.

The DRO will establish a unique, world-class research, education and outreach facility in Australia's wet tropics. The Daintree Rainforest has among the highest biodiversity anywhere in Australia and has a unique Gondwanan flora (pattern of distribution of living organisms, typically restricted to regions that were once part of the Gondwana supercontinent, including the Antarctic flora).

Located on Cape Tribulation, the DRO will include a research station for scientists, with laboratory, accommodation and conference facilities, an education centre for students and an elevated boardwalk for domestic and international tourists. A network of tracks connecting observing, monitoring and data collection points in the rainforest surrounding the DRO will be constructed, this will include communications infrastructure to link these sites to the DRO wirelessly.

Funding amounts are provided in the table on page 4 of this response.

Hawkesbury Institute for the Environment
Lead organisation: University of Western Sydney (UWS).

The Hawkesbury Institute for the Environment was established in late 2010 by UWS. It fills a unique niche in the Australian research landscape. Through the development of five co-ordinated, cross-disciplinary programs in 2011, the Hawkesbury Institute is generating unprecedented insights about the response of complex landscapes and ecosystems and how they adapt to environmental change.

The research ranges in scale, from the smallest soil microbes and insects, the vast grasslands and the animals that inhabit them, to natural forests and plantations, and ultimately to our landscapes. This approach is possible because of the array of new-generation field and laboratory facilities made available through the Institute that

allow for scientific exploration and innovative discoveries from genes to ecosystems.

The Institute will provide accurate and reliable data to assess the impact of climate change on Australia's land and water resources and assist the nation to adapt to a carbon-constrained economy, transforming climate change research in Australia.

Funding amounts are provided in the table on page 4 of this response.

Additional information around the research infrastructure investments which go to data and e-research

The Australian Government invests in a range of research infrastructure measures that support the optimal access to and use of research data by researchers primarily. These include over $500 million in eResearch infrastructure measures, funded through the National Collaborative Research Infrastructure Strategy (NCRIS) and the Super Science Initiative, that provide advanced information and communications technologies (ICT) used by researchers to:

- collect, move and manipulate ever larger amounts of data;
- perform ever larger and more complex computational analyses of the research data; and
- speed up and expand research collaboration, including through enhanced sharing of data.

These technologies are creating new avenues for establishing research findings, and are thereby allowing:

- newer and far more complex problems to be addressed; and
- entirely new fields of research to emerge.

eResearch infrastructure investments to date have enabled the research sector to address the need for data management, data sharing, access and availability of data between and across research institutions. They have also enabled the sector to deal with issues associated with data capture, aggregation, transmission, storage and re-use.

Consideration is also given to enabling the sharing of data between the research sector and other sectors, such as government. For instance, the Australian National Data Service (ANDS) has been working with some public sector agencies to promote access by researchers to public sector data sets, while also contributing its expertise in data management towards the goals of the National Plan for Environmental Information. ANDS also promotes and enables data to be transformed from unmanaged, disconnected, invisible and single-use data to structured collections that managed, connected, findable and reusable.

Details of particular eResearch infrastructure funded under NCRIS and Super Science, that may be relevant to the Committee's question, are noted below.

Australian National Data Service (ANDS)

The Australian National Data Service project was established in 2009 to enable Australian researchers to easily publish, discover, access and use research data. The project is led by Monash University and has received $24.5 million of funding through NCRIS and $48 million from the Super Science Initiative.

ANDS is supporting numerous projects that advance environmental research such as:

- the Tropical Data Hub – an online portal which brings together tropical data from across research disciplines and across the planet;
- the Climate Change Adaptation Information Hub - a software system that acts as a central information hub for researchers in the Climate Change Adaptation research domain;
- species Distribution Records - a tool that reuses data available through the Atlas of Living Australia and the Tropical Data Hub to explore the potential impacts of climate change on a wide range of species in Australia; and to engage in improving understanding of the species and the modelling of species distributions;
- primary production in space and time - this project will fuse disconnected data sources—weather, remotely sensed land-surface observations, CO2 and water flux measurements, hydrograph data and remotely sensed CO2 concentrations—to generate a time-varying field of gross primary production (GPP, the most fundamental function of all ecosystems) across the Australian continent.

Research Data Storage Infrastructure Project

As part of the eResearch infrastructure investment in data, the Super Science Initiative $50 million Research Data Storage Infrastructure (RDSI) project is building a national network of distributed data stores, or 'Nodes', to enable research data to be readily accessed, analysed and re-used.

The RDSI project will allow researchers and institutions to more effectively use, manage, share and preserve much larger amounts of research data and will support a national data environment at a scale that will enable new questions to be asked on topics and at scales not previously possible.

The project will establish six primary and two additional data storage "Nodes" distributed around Australia. All Australian universities and research agencies are currently affiliated or have been invited to participate in at least one Node.

Access to infrastructure created by the RDSI project will be open to all Australian Universities, research institutions and individual researchers who will be able to access the data stored at the RDSI Nodes.

Data stewards, including those from the biodiversity research community will have the opportunity to have their data collections hosted at a RDSI Node via a merit allocation process.

The storage capacity provided to the research sector by the RDSI project is expected to grow to 100 Petabytes over the life of the project.

Australian Research and Education Network

The Australian Government has provided $128 million in grants since 2002 to support the development of the Australian Research and Education Network (AREN), including most recently under the Super Science Initiative, via the $37 million National Research Network (NRN) Project.

The AREN interconnects universities, research institutions and precincts in all capital cities and many regional centres, as well as isolated research facilities such as radio telescopes at very high speeds, well beyond those provided by existing commercial networks.

The AREN also connects to the USA, Singapore, Frankfurt and wider Asian and European national research networks. AARNet Pty Ltd, VERNet Pty Ltd and SABRET Pty Ltd deliver the network.

The connections that AREN provides are essential to the movements of environmental and biodiversity research data, including those collected through other NCRIS and Super Science capabilities such as the Integrated Marine Observing System and the Terrestrial Ecosystem Research Network.

Climate High Performance Computing Centre

High Performance Computing (HPC)—or supercomputing—is a key element of the eResearch fabric in Australia, which enables researchers to construct digital models, undertake analyses and perform data intensive computations not possible on less powerful computing systems.

As part of the Australian Government's investments in eResearch infrastructure, the Super Science Initiative has provided $50 million in funding for the development of the Climate HPC Centre. This facility comprises a purpose built data-centre housing an internationally significant petascale HPC system and associated data infrastructure. The Climate HPC Centre project is being delivered by the Australian National University (ANU).

The Climate HPC Centre's petascale system will provide supercomputing support to Australian researchers, and will provide prioritised support for research in climate change, earth system science, and national water management.

The Climate HPC Centre system will draw heavily on climate change and earth system science data – including biodiversity data – to perform computations. These computations will in turn generate significant volumes of data in the forms of models and analyses which will support research in many fields, including biodiversity research.

National eResearch Collaboration Tools and Resources (NeCTAR)

The National eResearch Collaboration Tools and Resources (NeCTAR) Project is being created with $47 million funding under the Super Science Initiative.

The project is providing specific ICT tools and virtual environments for researchers across disciplines to manipulate and analyse data and provide access to a multitude of research resources. The project is also providing cloud computing technologies and national server infrastructure to provide Australian researchers with access to a full suite of digitally enabled data, analytic and modelling resources, relevant to their research, at their desktop.

The University of Melbourne is the lead agent for the NeCTAR project and is delivering the infrastructure in collaboration with institutions and organisations.

Several NeCTAR sub-projects are supporting research in biodiversity in a changing climate including:

- a Weather Science laboratory to integrate existing infrastructure to support a complex Earth-System Simulator that allows scientists to simulate and analyse climate and weather phenomena;
- a Marine Virtual Laboratory which aims to create a virtual and integrated environment for researchers to access a complex suite of models to better answer and explore questions in marine and ocean science; and
- an eResearch tool known as Oztrack for the storage, analysis and visualization of animal tracking data to assist researchers in understanding the impact of changing environmental factors on species movement and behaviour.

4. In response to questions from the Chair and Ms Marino (pages 11-12) you undertook to have a look at OECD data for the breakdown of government (federal and state) versus private sector research funding, in comparison with other countries, and provide information if you find something useful.

The following chart provides a comparison between business and government expenditure on research and Development across the OECD and selected countries.

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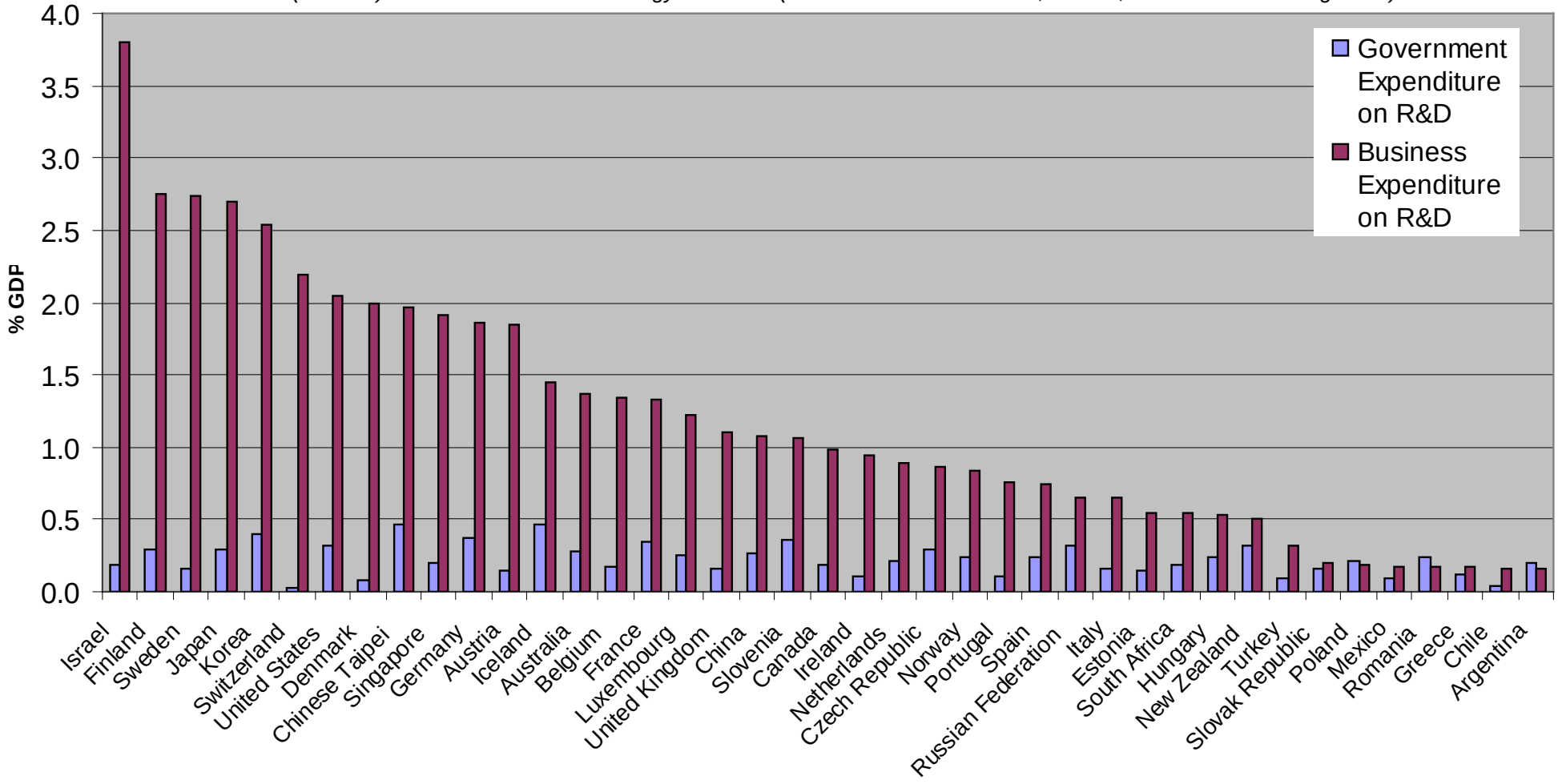
Business vs Government Expenditure for OECD and Selected Countries (2008)

Source: OECD (2011-12) Main Science and Technology Indicators (2007 data used for Greece, Mexico, New Zealand and Argentina)



Attachment A

Australia-India Strategic Research Fund grants related to climate change and biodiversity

Project/Workshop Title	Australian partner	Indian partner	Summary	Funding (GST Exclusive)	Financial Year
Does climate change drive evolution?	Griffith University	Environment Protection Training and Research Institute	Environmental change in particular temperature change is thought to be a significant factor driving evolution. This research programme is aimed at estimating any changes in the rate of evolution in Adélie penguins in the Antarctic. Large numbers of ancient sub-fossil bone samples of Adélie penguins provide a unique opportunity to compare the tempo of evolution in a single species over this period of dramatic environmental change. This research will improve understanding of the likely long-term genetic responses of animals to climate change.	$194,635	2008-2009
Managing change in Soil Moisture and Agricultural Productivity under a Global Warming scenario using a Catchment Scale Climate Change Assessment Framework	The University of New South Wales	Indian Institute of Science	Global warming is projected to have significant impacts on temperature, precipitation and run-off. The effect of climate on soil moisture and agriculture is related to variabilities in local patterns. Consequently, assessment of the effects of local climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production. This study will assess changes in soil moisture and agricultural production in a major agricultural catchment in India, with the aim of evaluating the suitability of current agricultural practices in the region and providing suggestions on modifications that are necessary.	$208,500	2008-2009

Project/Workshop Title	Australian partner	Indian partner	Summary	Funding (GST Exclusive)	Financial Year
Preparing for climate change on marine systems in Australia and India	University of Tasmania	Central Marine Fisheries Research Institute	Marine resources in both southern India and southeastern Australia provide substantial social and economic benefits which flow into many rural communities. Both regions have been identified as global warming hotspots with the rate of climate warming predicted to be greater than 90% of the global average. This project, based on two workshops, brings together inter-disciplinary researchers from both India and Australia with expertise in physical, biological, social, economic and governance climate change research to develop a strategic research plan for future collaborative research.	$78,930	2010-2011
Improving our ability to predict plant distributions under changed climates: incorporating dispersal into predictions of species and community distributions	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Indian Institute of Science	Before planning and action for climate adaptation can commence reliable predictions of the likely climate-induced changes in species and assemblage distributions are required. This project uses the opportunity of an Australia-India scientific collaboration to improve modelling of future plant distributions and to identify methods for incorporating accessible ecological information when detailed dispersal information is not available.	$288,342	2010-2011
			TOTAL	*$770,407*	

Australia-China Science and Research Fund grants related to climate change and biodiversity

Project/Workshop Title	Australian partner	Chinese partner	Summary	Funding (GST Exclusive)	Financial Year
Building resilience to health impacts due to climate change/extreme heat among the elderly community	University of Adelaide	Shandong University	The project will provide a holisitic perspective to assist governments, service providers, researchers and other stakeholders in their capacity building to prepare for, and better respond to the adverse health and well-being impacts from climate change and extreme heat.	$45,000	2011-2012
Research partnerships in climate science, agricultural systems and sustainable water resources	University of Southern Queensland	Nanjing University	The project will formalise multi-disciplinary, multi-partner research collaborations with Chinese organisations in the field of sustainable agriculture systems; develop the capacity for research into resilient agricultural practices that can improve farm productivity and build business confidence in regional communities; and develop the capacity for research into improved methods for decision making and risk analysis, with relevance to the management of water resources and impacts of climate change.	$45,000	2011-2012

Attachment B

Department of Sustainability, Environment, Water, Population and Communities projects relating to Phytophthera dieback

State	2010 Electoral Division	Nearest town	Funding Recipient	Community Group	Project Title	Project Description	Approved budget (GST exclusive)
WA	Canning	Armadale	ROLEYSTON DIEBACK ACTION GROUP	ROLEYSTON DIEBACK ACTION GROUP	Protect Roleystone bushland from Phytophthora dieback (PD)	This project will focus on education in regard to, and treatment methods for, Phytophthora cinnamomi. Residents will be educated about Phytophthora cinnamomi so that they know how to minimise its spread. A focus of the project will be protecting trees growing in the Midgegooroo National Park. Field treatment days will be run at which affected trees will be injected with an environmentally friendly fungicide. These field days will demonstrate to residents how easy it is to treat Phytophthora cinnamomi once it is identified. Additionally an information pamphlet will be delivered to all residents and schools locally and presentations made to community groups. Treatment kits will be bought and these will be made available to residents.	$9,200.00
WA	Perth	Perth	Eastern Metropolitan Regional Council	Dieback Working Group	Save OUR bushland from Phytophthora Dieback	This project will run phytophthora dieback sessions for teachers in schools near high conservation reserves. Teachers will be trained to implement the discovering dieback education kit. Teachers will run the ten week course with help from the Dieback Working Group during which time they will visit local bushland. At the end of the course an on-ground working group will be organised by the Dieback Working Group where school pupils will get hands-on experience treating trees with a safe fungicide for phytophthora dieback. Later the Dieback Working Group and the pupils will organise another field day for neighbours of the reserve. The pupils will drive the volunteer day to maximise volunteer numbers.	$20,000.00

Attachment C

ARC -funded projects in the RFCD/FOR codes specified below (since 2008):

Data prepared 22/10/2012

FoR 060301 Animal Systematics and Taxonomy;
FoR 060310 Plant systematics and taxonomy;
RFCD 270401 Plant Systematics, Taxonomy and Phylogeny; and
RFCD 270501 Animal Systematics, Taxonomy and Phylogeny

Projectid	AdminOrgNm	All Investigators	Startyr	Endyr	Scheme	Total funding	ProjectTitle	NatBenTxt	6-digit RFCD / FOR	ClassPct	Primary Code Typ	Primary 4-digit RFCD / FoR	Primary Code Description
DP0878014	The Australian National University	Dr SY Ho	2008	2010	Discovery - Projects	$245,944	Analysing and modelling molecular rate variation among nuclear and mitochondrial genomes	My research will have important practical benefits for bioinformaticians and evolutionary biologists, because existing analytical methods will be rigorously tested and new tools will be developed. Australia has a comparatively high concentration of researchers in this field, so my research will foster domestic collaboration and import international expertise. The research will provide important insights into the rates and patterns of genetic changes associated with domestication, and into variation in evolutionary rates among the primate ancestors of humans. In addition to developing new software, which will be made publicly available, I will develop new evolutionary models to supplement existing software packages.	270501	20	RFCD98	2702	GENETICS
DP0878741	The University of Adelaide	Dr MS Lee; Dr MN Hutchinson	2008	2010	Discovery - Projects	$264,000	Insights into macroevolution using a model adaptive radiation of lizards (Lerista)	Australia has arguably the greatest diversity of lizards in the world. This research will investigate how this diversity arose, using Lerista, a radiation of skinks with over 80 species spanning fully limbed to totally legless forms. We will investigate how development, geographic distribution and morphological features have influenced the evolutionary diversification of Lerista. We will also map the biodiversity of Lerista across Australia using (and thus testing) several alternative methods of quantifying biodiversity. Such knowledge is important as many hotspots of Lerista diversity are coming under increasing human pressure (e.g. mid-coast of WA), and many species have very localised ranges.	270501	50	RFCD98	2705	ZOOLOGY

DP0879971	The Australian National University	Dr M Cardillo	2008	2012	Discovery - Projects	$710,571	Anatomy of a biodiversity hotspot: investigating the evolutionary and ecological basis of high plant diversity in southwestern Australia.	Southwestern Australia - Australia's only global biodiversity hotspot - has an exceptionally rich flora but has suffered extensive habitat loss, so many rare plants are threatened with extinction. Further, this region is expected to suffer severely under projected climate change scenarios, lending urgency to efforts to describe and understand the regions plant biodiversity. This project will provide the first description and analysis of an important but hitherto little-known aspect of biodiversity, the evolutionary structure of ecological communities. This will enhance our understanding of how communities are assembled, providing a stronger scientific basis for sustainable management of the southwest's biodiversity.	270401	20	RFCD98	2707	ECOLOGY AND EVOLUTION
DP0985054	The Australian National University	A/Prof JS Keogh	2009	2011	Discovery - Projects	$230,000	Climate change and cryptic biodiversity in the Australian arid-zone: Molecular phylogeny-based assessment of conservation priorities	Australia's arid zone comprises two thirds of the country yet from a climate change, biodiversity, and conservation point of view it has received little attention relative to eastern Australia. The project will address broad questions in evolutionary biology with unique Australian systems, make a world class contribution to the fields of phylogeography, molecular phylogenetics and conservation genetics and contribute substantially to the continued training of high quality research students and postdoctoral fellows. The project directly addresses two National Priority Research Areas and will supply of critical information to the eight biggest of the 57 Natural Resource Management Regions.	270501	50	RFCD98	2705	ZOOLOGY
DP0985473	The Australian National University	Prof MD Crisp; Dr LG Cook	2009	2011	Discovery - Projects	$280,000	Distinguishing among patterns of extinction and speciation through geological and climatic change: a molecular modelling approach	This research will enhance our understanding of the ancient origins of Australia's unique floral heritage. By developing new molecular modelling methods, it will strengthen Australia's position at the cutting edge of evolutionary phylogenetics. When Australia separated from Gondwana by continental drift 32 million years ago, the changed ocean circulation patterns triggered global climate change. The result was turnover of biota world-wide and dramatic changes within Australia. We will develop new insights into the rate and mode of these changes that will have international significance. Understanding the long-term turnover of flora from previous global climate changes will help to predict the impact of current and future climate change.	270401	40	RFCD98	2799	OTHER BIOLOGICAL SCIENCES

DP0987620	The University of Adelaide	Dr K Sanders; Dr MS Lee	2009	2012	Discovery - Projects	$289,943	Sea Snake Diversification: Why Are Certain Taxa And Regions Species-Rich?	By generating new knowledge of ecologically and medically important Australasian organisms, this project will benefit biodiversity management, snakebite therapy and pharmaceutical research. Sea snakes reach peak diversity in the Indo-Australian hotspot and are threatened by habitat degradation, fisheries bycatch and rising sea temperatures. Sea snake conservation and marine reserve management strategies will directly benefit from a better understanding of local endemism, species boundaries and possible cryptic species. Sea snakes are highly venomous and pose a significant health risk in fishing communities; venom variation has a strong phylogenetic component and is of vital importance in antivenom preparation and bioprospecting.	270501	60	RFCD98	2705 ZOOLOGY
DP0988863	The University of Adelaide	Prof A Cooper; Dr KP Aplin; Prof SC Donnellan	2009	2011	Discovery - Projects	$390,000	Phylogeography, evolution and taxonomy of humanity's greatest pest, Rattus rattus: Epidemiological, archaeological and conservation implications	This project will characterise a major threat to Australian biosecurity and health, and identify the range of likely disease risks associated with introductions of different 'strains' of black rat. It will provide critical data for management efforts around the world, especially for strategic partners in neighbouring Southeast Asian nations, as well as for conservation efforts within Australia. The data will also provide novel means to track the timing and routes of human prehistoric movements throughout the area. It will establish strategic research collaborations between researchers in zoological, medical, epidemiological, genetics, and conservation fields in a unique multi-disciplinary study.	270501	40	RFCD98	2705 ZOOLOGY
DP1092870	The Australian National University	A/Prof GC Young; Prof JA Long; A/Prof TJ Senden; Dr KM Trinajstic; Dr CJ Burrow; Prof Dr M Zhu; Prof CR Marshall	2010	2012	Discovery - Projects	$370,000	Origin of jaws - the greatest unsolved mystery of early vertebrate evolution	The 2008 discovery of an unborn embryo in the 380 million-year-old "Mother Fish" from the famous Gogo fossil deposit in NW Australia has attracted a collaboration of Australian, American and Chinese scientists to a new international collaboration. The team will study spectacular new fossils from central Australia and southern China, the oldest known back-boned animals with jaws and a hard skeleton. Innovative 3D X-ray computer tomography, and the Australian synchrotron, will be used to investigate ancient cells and preserved soft tissue structures, to search for evidence that copulation and internal fertilization, as in modern mammals, might have originated when jaws first evolved.	270501	20	RFCD98	2601 GEOLOGY

DP1095637	The Australian National University	Dr GA Huttley; Dr V Yap	2010	2012	Discovery - Projects	$243,000	Improving the accuracy of phylogenetic reconstruction by improving models of sequence divergence	Phylogenies describe the relationships among species and provide the essential framework for understanding evolutionary processes. They are an essential tool in the identification of functionally important regions in DNA sequences. An important aspect of identifying phylogenies is measuring how DNA sequences change in time. The proposed research will develop sophisticated, practical models of sequence divergence and make them freely available in open source software. The software and models will positively impact on studies seeking to understand Australian biological diversity. The proposed resolution of the eutherian mammal orders will further significantly impact on utilisation of rodents as a model organism for human biology.	270501	10	RFCD98	2702	GENETICS
DP110103168	The Australian National University	Dr Marcel Cardillo; Dr Lindell Bromham	2011	2013	Discovery - Projects	$390,000	Origins of a biodiversity hotspot flora: diversification of the Australian Proteaceae	Why does Australia's only biodiversity hotspot, with nearly 3000 endemic plant species, occur in an area with poor soils and low rainfall? This project will analyse DNA sequences from over 1000 plant species of the Australian Proteaceae, many found only in this hotspot, to help us understand the evolutionary and ecological origins of this iconic flora.	60310	20	FoR08	603	EVOLUTIONARY BIOLOGY
DP120104146	The Australian National University	Prof Stephen Donnellan; Prof J. Scott Keogh; Dr Conrad Hoskin; Asst Prof Daniel Rabosky	2012	2014	Discovery - Projects	$320,000	Diversification and conservation of Australian frogs	Australia's 216 known species of frogs are exceptionally diverse, 98 per cent are found nowhere else in the world and many of them are in trouble. This project will test ideas concerning the tempo of Australian frog diversification, identify previously cryptic new species and provide information critical to the conservation of Australia's declining frogs.	60301	25	FoR08	603	EVOLUTIONARY BIOLOGY
DP120104251	Macquarie University	Dr John Paterson; A/Prof Glenn Brock	2012	2014	Discovery - Projects	$300,000	Fossils, rocks and early Cambrian clocks: calibrating body plan assembly and lineage splits in ancestral animals from Gondwana	The precise timing of when animal body plans evolved and rapidly diversified during the Cambrian Explosion remains mysterious. This project will investigate vast collections of exquisitely preserved early-middle Cambrian fossils from Australia to determine the precise order of evolutionary events at the root of the animal tree of life.	60301	30	FoR08	603	EVOLUTIONARY BIOLOGY
DP120104365	The University of Adelaide	Dr Michael Lee; Dr Adam Skinner	2012	2014	Discovery - Projects	$264,000	The developmental genetics of major evolutionary transitions: a multidisciplinary investigation of limb reduction and loss in lizards	The five-toed limb is an iconic evolutionary innovation of land vertebrates, yet has been lost repeatedly. This project will use anatomical, developmental and genetic approaches to understand how vertebrates lose their legs, whether limbs can be reacquired, and the degeneration of limb genes after they lose their function (analogous to 'vestigial organs').	60301	34	FoR08	608	ZOOLOGY

FT0990983	Macquarie University	Dr MA Kosnik	2009	2013	ARC Future Fellowships	$686,400	Quantifying the effects of western colonisation on Great Barrier Reef molluscan communities	Dead shells provide a record of the pre-colonisation Great Barrier Reef (GBR) ecosystem. Using this record this research will determine what the GBR looked like before James Cook and the first fleet arrived in Australia. This study will also sample living molluscs to quantify the current state of these communities. Together these data will provide environment managers and stakeholders with the first quantitative estimates of human impacts on this world heritage ecosystem. This project will address the questions: Do protected areas return to a pre-colonial state or do they represent another non-natural state? What type of management scheme results in communities most similar to the pre-colonial state?	270501	10	RFCD98	2707 ECOLOGY AND EVOLUTION
FT0992161	Macquarie University	Dr J Alroy	2009	2013	ARC Future Fellowships	$788,800	Quantifying the Tree of Life's Diversity with the Paleobiology Database	The Paleobiology Database is the Internet's key source of scientific data on the fossil record. It records names and classification of fossil organisms and the ages, locations, and environments of the places that yield these fossils. It has often been used to estimate the number of species existing at different points in geological time. Macquarie will house the Database as it is expanded to record evolutionary relationships of many species. This information will help to estimate dates of origination for major groups such as mammals and birds. It will also help to show whether mass extinctions tend to target old groups with few surviving species, which will help to predict which groups will survive the current mass extinction.	270501	30	RFCD98	2707 ECOLOGY AND EVOLUTION

LE110100134	The University of New South Wales	Prof Stephen Simpson; Prof Robert Brooks; Prof Bill Ballard; Prof Benjamin Oldroyd; Dr Darrell Kemp; Dr Angela Moles; A/Prof Phillip Taylor; A/Prof Peter Banks; A/Prof Michelle Leishman; A/Prof Marie Herberstein; A/Prof Madeleine Beekman; A/Prof Gregory Sword; A/Prof Clare McArthur; A/Prof Alistair Poore	2011	2011	Linkage - Infrastructure Equipment and Facilities	$160,240	Sydney basin multi-purpose spectral analysis facility for evolutionary and ecological studies	This near infrared spectroscopy facility at The University of New South Wales will serve the Sydney area biological research community. Near infrared spectroscopy provides quick and robust estimates of key properties of animal and plant tissues, such as age, species and chemical composition.	60301	20	FoR08	603	EVOLUTIONARY BIOLOGY
LP0883711	University of Wollongong	Dr JF Wallman; Dr M Dowton; Dr MS Archer; Dr SL Cameron	2008	2011	Linkage - Projects	$240,000	Improving Insect-based Technology for Minimum Death Time Estimates in Forensic Investigations in Australia	This research will provide more accurate, narrower death time estimates for Australia. Focusing enquiries more accurately around the death time will result in significant financial savings in homicide investigations. Court evidence based on insects will become more robust, thus improving prosecution success. Partnerships will also be enhanced between laboratories with common aims, but different experience and expertise, thereby avoiding research duplication and producing synergistic effects of collaboration. Casework methodology in Australia will become better aligned, thus avoiding courtroom conflicts between practitioners. Finally, high quality graduate students will be trained in entomological and forensic sciences.	270501	20	RFCD98	2705	ZOOLOGY

LP0990713	The University of Adelaide	Prof AD Austin; Dr PG Allsopp; Dr MN Sallam	2009	2012	Linkage - Projects	$265,000	Phylogeography and host specificity of stemborer parasitoids: essential components for the pre-emptive biocontrol of sugarcane pests in Australia	Stemboring insects cause huge economic losses to the sugar industry world-wide but fortunately these pests are largely absent from Australia, in part because quarantine measures have prevented their introduction. However, given their proximity, incursion of foreign stemborers from Asia pose a serious threat to Australian sugarcane. To prepare effective pest management plans that can be adopted promptly in a worst-case scenario, this study will 1) develop molecular diagnostic tools to select wasp biocontrol agents that are suitable for the control of specific foreign stemborer pests, and 2) evaluate whether any Australian native wasps have the ability to kill foreign stemborers.	270501	40	RFCD98	2705	ZOOLOGY
LP100200494	The University of Adelaide	Prof Mark Harvey; Prof Andrew Austin; Dr Mark Stevens; Adj/Prof William Humphreys; A/Prof Steven Cooper	2010	2013	Linkage - Projects	$320,000	Biodiversity and population genetics of groundwater calcrete ecosystems of central Western Australia	This project will lead to documentation of a unique subterranean ecosystem of world acclaim, representing a significant component of the biodiversity of the Australian arid zone. It will further contribute to sustainable management of groundwater ecosystems and provide information that can be used to predict and monitor how future water use and climate change may impact on these ecosystems. Results generated will provide the knowledge base required to improve the efficiency and scientific rigour of the environmental review process for major resource projects, leading to economic benefits to the mining and environmental consultancy industries, and to Australia in general.	60301	40	FoR08	603	EVOLUTIONARY BIOLOGY
LP120100081	The University of Melbourne	Dr Paul Oliver; Dr Paul Doughty; Dr Michael Lee	2012	2014	Linkage - Projects	$195,000	Islands of rocks: geckos as a model system to understand patterns of biodiversity, endemism and speciation in the Kimberley	Australia is renowned for its diversity of lizards, yet a plethora of new "cryptic" gecko species continue to be discovered. The project will densely sample the complex Kimberley to understand the evolution of its geckos, which will shed light on true levels of species diversity and the geological and environmental history of this biodiversity hotspot.	60301	60	FoR08	603	EVOLUTIONARY BIOLOGY
LP120200063	The Australian National University	Prof Stephen Donnellan; Prof J. Scott Keogh; Prof Craig Moritz; Dr Paul Doughty; Dr Margaret Byrne; Dr David Coates; A/Prof Kevin Thiele	2012	2015	Linkage - Projects	$360,056	Phylogenomic assessment of conservation priorities in two biodiversity hotspots: the Pilbara and the Kimberley	This project applies new sequencing and analytical methods to measure how much unique genetic diversity is represented in current and planned reserves across two biodiversity hotspots – the Pilbara and Kimberley of north-west Australia. It combines university, museum and conservation agency researchers to improve ongoing conservation planning.	60301 / 60310	10 / 10	FoR08	603	EVOLUTIONARY BIOLOGY