Australian National University

CSIRO

Centre for Biodiversity Analysis

cba.anu.edu.au

2015-16 Annual report

October 2016

1. Director's summary

2015-16 has been an excellent year for the CBA and I thank you all for your participation.

Highlights include the successful $4.5M bid from the National Research Collections of Australia for a three-year CSIRO Future Sciences Platform around 'Environomics'; the establishment and commencement of operations of the $2.5M SIEF-funded 'Ecogenomics and Bioinformatics Laboratory'; and a $1M investment from BioPlatforms Australia in the 'Oz Mammals Genomes Initiative'. We also welcomed Eric Stone as Director of the parallel ANU-CSIRO 'Centre for Genomics, Metabolomics & Bioinformatics', which was duly launched in late July.

All these initiatives serve to increase our capacity in applying genomics to understanding the protecting the rich and unique biota of Australia. Further, they are all about building the community of biodiversity researchers across ANU and CSIRO.

Another highlight of our fourth year was the 'Ignition Grant Symposium', during which our E-MRC Ignition grant awardees presented progress and outcomes from these small but effective CSIRO-ANU collaborative projects. I was really impressed by the breadth and quality of the science presented, which serves to remind us all of the immense creativity of CBA researchers.

Our annual conference this year was, in fact, a workshop, focused on bringing conservation policy-makers and practitioners, across government and NGOs, together with CBA scientists to explore how and when evolutionary biology can improve conservation outcomes. The aim was to explore the intersection of emerging priorities and needs from the conservation community with new concepts and capabilities from evolutionary biology – or, more simply, to establish connections and understanding across the policy-science divide. This was achieved, but there is much still to do.

Looking forwards, the CBA is now beginning its fifth year. As such, we are preparing the ground for a bid to continue our work for a second five-year period (mid 2017-2022). Discussions with senior management about continued support for the CBA have been positive to date and include the prospect of mutually beneficial interactions with the NRCA Future Sciences Platform, and broadening of our scope to include ecosystems science. For the latter, expanded interactions with the Fenner School, especially around ecosystems science and policy will be valuable. We will hold a forum of CBA members in early 2017 to discuss these and other possible directions for CBA Mk2.

Finally, as always – and it must be said – I thank Claire Stephens for all things good about the CBA. We could not have come so far without her.

Craig Moritz
CBA Director

2. Executive summary

2.1 CBA Director and Coordinator

- **CBA Director** Craig Moritz craig.moritz@anu.edu.au.
- **CBA Coordinator** Claire Stephens claire.stephens@anu.edu.au (50% position, Mon-Wed; 67% position from April 2016, Mon-Thurs).
- Located in the Gould Building (Rooms 223-224, 116 Daley Road), Research School of Biology, ANU.

2.2 CBA Liaison Committee members

- **ANU**
  - Justin Borevitz - Division of Plant Sciences, Research School of Biology.
  - Scott Keogh - Division of Evolution, Ecology and Genetics, Research School of Biology.
- **CSIRO**
  - Andrew Young - National Research Collections Australia, Facilities and Collections.
  - Andy Sheppard (2012-Nov 2013) - Biosecurity Flagship.
  - Owain Edwards (Dec 2013-July 2014) - Ecosystems Sciences.
  - Ian Cresswell (Aug 2014-current) - Biodiversity, Ecosystem Knowledge and Services, Land and Water Flagship.

2.3 CBA membership

- cba.anu.edu.au/about-us/people
- Currently 51 research scientists and the lab groups are involved with the CBA.
- Lab leaders and research scientists from ANU and CSIRO are from a range of areas relevant to the CBA's core focus of incorporating genomics and spatial ecology into the discovery, understanding and protection of Australia's biodiversity:

  CSIRO
  - Biodiversity, Ecosystem Knowledge and Services (BEKS), Land and Water Flagship.
  - Agriculture Flagship.
  - National Research Collections Australia (NRCA), Facilities and Collections (Canberra, Townsville and Hobart).

  ANU
  - Evolution, Ecology & Genetics (EEG) and Plant Science (PS) in the Research School of Biology (RSB).
  - Fenner School of Environment and Society (FSES).
  - Department of Archaeology and Natural History (ANH).
  - Centre for Aboriginal Economic Policy Research (CAEPR).
- Postdoctoral fellows and postgraduate students are considered CBA members by affiliation of their lab / research group. They are also included on the CBA email list.

2.4 CBA website

- cba.anu.edu.au
- Key role is to connect information relevant to the CBA mission and focus across CSIRO and ANU and is used to publicise CBA and other relevant events, highlight our research and advertise funding opportunities and student projects.
- Website includes:
  - Information on the CBA.
  - List of Members and links to their own institutional pages.
  - Research highlights (contributed by ECRs).
  - CBA-funded Ignition projects.
  - Opportunities, including CBA and external grants and funding, student projects and job advertisements.
  - Public policy areas (linked to relevant CBA Highlights, Projects and News and external Department of the Environment biodiversity policy pages).
  - News and events, which includes both CBA news and events (e.g. workshops and conferences) and external news and events that may be of interest to CBA members.

2.5 Hardware and equipment

- Contribution to the ANU Major Equipment Committee (MEC) proposal (awarded) for the purchase of an Illumina NextSeq500 sequencing platform for the experimental genomics facility (2015 - $15,000).
- Contribution to the RSB 2014 Equipment and Infrastructure Scheme - transcriptome analysis software (2014 - $2,000).
- Contribution to the establishment of the experimental genomics facility based at the Research School of Biology (RSB), ANU, and accessible to CBA members (2014 - $15,000).
- Purchase of a large 256 GB RAM node computing cluster located in, and operated by, the Genome Discovery Unit (ANU). Contact Cameron Jack (cameron.jack@anu.edu.au) for details on capabilities and access (2013 - $30K).

2.6 CBA activities

Further details of 2015-16 activities below (Section 3); full details of all CBA activities are listed in the Appendix.

- Joint ANU-CSIRO Projects -'Ignition grants'.
- Annual conferences.
- Workshops.
- Seminars.
- Policy, outreach and communication.
- Future planning for the CBA.

3. CBA 2015-16 activities

3.1 Ignition grants

cba.anu.edu.au/opportunities/grants-funding/ignition-projects

Each year the CBA funds a number of small pilot projects, called Ignition projects. This funding aims to 'kick-start' new ANU-CSIRO collaborative research, with the intention that results will subsequently form the basis of more substantial research proposals and collaborations.

The scope of an Ignition project needs to be within the CBA's core focus of incorporating genomics, informatics or spatial modelling into the discovery, understanding and/or protection of Australia's biodiversity.

Figure 3.1 2015-16 funded Ignition Projects (clockwise from top left): 1 Biogeography of sex reversal and the effects of climate change on reptile sex determination; (L) Arthur Georges and (R) Clare Holleley (photo UC); **2** Genomic diversity in Australian palms (photo Eric Hunt); **3** A next-generation phylogenetics approach to explore the immense diversity of Australian thynnine wasps (photo Thomas Semple); **4** Characterising the evolutionary and ecological diversity of invertebrates in the Monsoonal vine thickets of the Kimberley (photo ABC).

All proposals must show a direct, and genuine, collaboration between at least one member of an ANU and a CSIRO research group. Group leaders, postdocs and/or students may be included on up to two project submissions per funding round.

Proposals may request funding for fieldwork, sample preparation, next-generation sequencing, technical salaries or data analysis. Workshops/meetings that have significant outcomes for future ANU-CSIRO collaborative research may also be funded. For the 2012-2013 funding rounds up to $5000 per project was offered. From June 2014, $10,000 per project was made available and requests for up to this amount has continued for subsequent funding rounds.

Table 3.1 outlines the four Ignition projects the CBA funded in our sixth round of grants (a full list of CBA-funded Ignition Projects is in the Appendix).

Table 3.1 2015-16 funded Ignition projects.

	Project cba.anu.edu.au/research/projects	**$**
July 2016	**Tackling the unknown – a next-generation phylogenetics approach to explore the immense diversity of Australian thynnine wasps (Tiphiidae: Thynninae)** Thomas Semple, Rod Peakall (RSB, ANU), Andreas Zwick (CSIRO NRCA)	$10,000 *library prep & sequencing*
July 2016	**Biogeography of sex reversal and the effects of climate change on reptile sex determination** Clare Holleley, Kerensa McElroy (CSIRO NRCA), Dan Rosauer, Craig Moritz (RSB, ANU), Arthur Georges (IAE, U Canberra)	$9,998 *travel, library prep & salary*
July 2016	**Genomic diversity in Australian palms** Bee Gunn (RSB, ANU), Sarah Mathews (CSIRO NRCA)	$10,000 *library prep & sequencing*
July 2016	**Characterising the evolutionary and ecological diversity of invertebrates in the Monsoonal vine thickets of the Kimberley** Russell Dinnage, Marcel Cardillo, Gavin Huttley (RSB, ANU), Owain Edwards (CSIRO L&W)	$10,000 *sequencing*

3.1.1 Ignition Grant Symposium

cba.anu.edu.au/news-events/cba-ignition-grant-symposium

From October 2012 to June 2106, the CBA had funded 26 collaborative Ignition projects over five rounds. In recognition of this, our past and current grant recipients were invited to share their progress and results in an Ignition Grant Symposium held at ANU in June (Table 3.2).

The diverse presentations, 5-10 minute 'lightning talks', by 15 ANU and CSIRO scientists and students (1 honours and 2 PhD) demonstrated the success of the Ignition grant scheme in fostering original collaborative science. Round 6 of Ignition grants were announced at the Symposium, with a closing date of 8 July, 2016 (the successful applications from this round are in Table 3.1).

Table 3.2 2016 CBA Ignition Grant Symposium Program

2 June	Ignition Grant Symposium
1.00pm	**Lunch**
1.50pm	**Welcome** - Craig Moritz **Introduction - CBA Ignition grant scheme** - Justin Borevitz
2.00pm	1. **How local is local? Landscape genomics in Yellow box** Justin Borevitz (ANU), Linda Broadhurst (CSIRO); (Funding round 1 - Oct 2012).
	2. **Eucalyptus genomics** Megan Supple, Justin Borevitz, Norman Warthmann, Jason Bragg (ANU); Linda Broadhurst, David Bush, Brendan Lepschi (CSIRO) (Round 3 - Jun 2014).
	3. **Linking genomic data to spatial biodiversity data in the Atlas of Living Australia** Caroline Chong, Justin Borevitz, Lindell Bromham (ANU), Rebecca Pirzl, John La Salle (CSIRO); (Round 5 - Sept 2015).
	4. **Genetic and demographic impacts of contemporary disturbance regimes in Mountain Ash forests** Brenton von Takach Dukai (PhD student), Sam Banks (ANU), Shannon Dillon (CSIRO); (Round 4 - Mar 2015).
	5. **Genetic characterisation of formalin preserved fish tissue** Sharon Appleyard (CSIRO) and Maxine Piggott (ANU); (Round 4 - Mar 2015).
	6. **Bill adaptation in parrots: finding loci involved in surface area increases by integrating morphometrics with NGS** Keira Beattie (Hons student), Kerensa McElroy (CSIRO), Loeske Kruuk, Janet Gardner (ANU); (Round 5 - Sept 2015).
	7. **Evolutionary processes in Billy buttons** Alexander Schmidt-Lebuhn (CSIRO), Justin Borevitz (ANU); (Round 2 - Jun 2013).
	8. **Investigating the effects of diversity, distribution and chytrid load on *Uperoleia* frog skin microbial communities** Maxine Piggott, Renee Catullo (ANU), Matt Morgan (CSIRO); (Round 5 - Sept 2015).
	9. **Effects of climate change on avian morphology** Janet Gardner, Loeske Kruuk (ANU) and Leo Joseph (CSIRO); (Round 4 - Mar 2015).
	Break
	10. **Bringing next generation approaches to conservation genomics using museum collections – Rock wallaby museum skinomics** Sally Potter (ANU), Maxine Piggott (ANU), Jason Bragg (ANU), Matt Morgan (CSIRO), Leo Joseph (CSIRO); (Round 3 - Jun 2014).
	11. **Developing new methods for using distribution data to identify taxa that can tolerate extreme conditions** Xia Hua, Lindell Bromham, Marcel Cardillo (ANU), John La Salle, Rebecca Pirzl, Lee Belbin (CSIRO); (Round 4 - Mar 2015).
	12. **Penguin ectoparasites of the Southern Hemisphere** Katherine Moon (PhD student); Ceridwen Fraser (ANU), Bruce Halliday (CSIRO); (Round 3 - Jun 2014).
	13. **Collections-based landscape genomics: Red-browed finches as a test case** Kerensa McElroy (CSIRO), Norman Warthmann (ANU); (Round 3 - Jun 2014).
	14. **Environmental Drivers of Acacia-Associated Symbiotic Microbe Diversity** Russell Dinnage, Marcel Cardillo, (ANU), Anna Simonsen, Suzanne Prober, Luke Barrett, Pete Thrall (CSIRO); (Round 5 - Sept 2015).
	15. **Curating spatial data to understand patterns and processes shaping biodiversity in New Guinea** Paul Oliver, Dan Rosauer, Eric Rittmeyer (ANU), Kristin Williams, Leo Joseph (CSIRO); (Round 5 - Sept 2015).
	16. **Species discovery and refugia in the monsoonal tropics** Craig Moritz, Scott Keogh (ANU), Justin Perry, Eric Vanderduys, Simon Ferrier (CSIRO); (Round 1 - Oct 2012).
~4.45pm	**Closing comments** - Craig Moritz

3.1.2 Honours awards

cba.anu.edu.au/opportunities/grants-funding/cba-honours-awards

The CBA liaison committee has had several discussions about increasing, and better coordinating, the recruitment of HDR students into CSIRO labs. As an initial step, we agreed to focus on ANU honours students.

From September 2015, as part of the Ignition grant scheme, the CBA has sought proposals for co-supervised ANU-CSIRO Honours projects. Our main goal with this funding is to facilitate ANU honours students spending time in CSIRO labs, providing

valuable exposure to CSIRO scientists and research. Up to a $5000 student stipend can be requested as part of these proposals. The proposed projects need to allow for students to have considerable engagement with both their ANU and CSIRO labs. RSB or Fenner honours students can be co-supervised by a CSIRO scientist from BEKS or NRCA.

To date, two honours projects have been funded (Sept. 2015 round). The students commenced their projects in January 2016 and their theses are due to be submitted November 2016:

1. Bill adaptation in parrots: finding loci involved in surface area increases by integrating morphometrics with NGS. Kerensa McElroy (CSIRO), Loeske Kruuk, Janet Gardner (RSB, ANU); Honours student: Keira Beattie (photo above).

2. A winning combination? Could seed dormancy and polyploidy be beneficial in a warmer, drier climate? Lydia Guja, Robert Godfree (NRCA, CSIRO), Adrienne Nicotra (RSB, ANU), Honours student: Amelia Stevens. (photo left).

3.1.3 Progress reports (from Ignition grant recipients)

Can adaptation in 'ecosystem engineers' drive fire regime feedbacks?
Annabel Smith, Justin Borevitz (ANU), Shannon Dillon (CSIRO)
cba.anu.edu.au/research/projects/can-adaptation-'ecosystem-engineers'-drive-fire-regime-feedbacks

- 400 samples have been collected of the two target invasive plant species (*Hypericum perforatum* and *Cytisus scoparius*) across fire frequency gradients in Victoria and NSW.
- GBS libraries have been constructed in the Borevitz lab, which were sequenced at the ACRF Biomolecular Resource Facility (BRF).
- Preliminary analysis identified > 3000 SNPs per species and further population genetics analysis is underway. The data and/or sample taxonomy wasn't what we expected - it may be likely that there have been multiple introductions or cryptic species.
- AS (currently based at Trinity College Dublin) has submitted applications for further funding to sample individuals in their native range across Europe. This will allow us to identify the sources of the Australian samples and determine if genomic variation is related to fire history and other environmental variables.

Curating spatial data to understand patterns and processes shaping biodiversity in New Guinea
Paul Oliver, Eric Rittmeyer, Dan Rosauer (ANU), Kristen Williams and Leo Joseph (CSIRO)
cba.anu.edu.au/research/projects/curating-spatial-data-understand-patterns-and-processes-shaping-biodiversity-new

- We have also completed comprehensive screens of mitochondrial diversity in five target genera in collaboration with researchers in both Australia, and overseas.
- We have now assembled a comprehensive database of distributional records and genetically typed specimens for five target genera from New Guinea.
- We are now using this genetic and distributional data to test different approaches to mapping diversity across New Guinea.
- One exciting preliminary result is strong evidence of an previously unrecognised hotspot of endemics diversity in the increasingly threatened forests at the south-eastern tip of New Guinea.

Diversity and distribution of *Uperoleia* frogs and their skin-associated microbial communities in far north Queensland

Matt Morgan (CSIRO), Maxine Piggott (ANU) Renee Catullo (Western Sydney University)

cba.anu.edu.au/research/projects/investigating-effects-diversity-distribution-and-chytrid-load-uperoleia-frog-skin

- Swabs and tissue samples collected from 63 frogs from 16 species at 23 sites across far north Queensland.
- Chytrid assessment performed for all samples. All swabs returned negative results for chytrid infection at the time of collection.
- Metagenomic DNA sequences awaiting analysis and incorporation with phylogeographic data.

Effects of climate change on avian morphology

Janet Gardner, Loeske Kruuk (ANU), Leo Joseph (CSIRO)

cba.anu.edu.au/research/projects/effects-climate-change-avian-morphology

The work is nearing competition with submission of a revised manuscript to the journal Climate Change Responses, as an invited contribution to be published in the themed issue 'Mechanistic models of climate change impacts on endotherms': Gardner JL, Symonds MRE, Joseph L, Ikin K, Stein J, Kruuk LE (in review). Spatial variation in avian bill size is associated with humidity in summer among Australian passerines. *Climate Change Responses*.

Genetic characterisation of formalin preserved fish tissue: trial application of mini-barcodes and RAD-tags for species delineation

Sharon Appleyard, John Pogonoski, Daniel Gledhill (CSIRO), Maxine Piggott (ANU)

cba.anu.edu.au/research/projects/genetic-characterisation-formalin-preserved-fish-tissue

Outcomes to date:

- Silica based column DNA extractions (Promega, Qiagen, FFPE) better than salting out for formalin preserved tissues.
- DNA is amplifiable; smaller mtDNA amplicon fragments are potentially more useful if they can distinguish species - but error rate is large and success rate so far very low.
- No data yet on the single sample analysed in WGE pipeline.
- Given lack of progress in developing successful mtDNA sequencing for species identification, NGS/GBS has not yet been undertaken nor has the cost effectiveness of NGS v Sanger for taxonomy assessment.

Progress to date:

- SA, MP and JP sampled 198 muscle tissues (from 66 species, 3 replicate tissues per specimen) from the ANFC in September 2015 (Figure 3.2a).
- Samples divided into recently preserved and older samples (e.g. Figure 3.2b). MP analysed the recent samples; SA analysed the older samples. Confirmed COI barcodes for recently preserved specimens are in hand as tissues were barcoded prior to preservation in formalin.
- Alternate DNA extractions methods (silica columns; phenol: chloroform; kits specific for formalin fixed-paraffin embedded tissues sections; salting out) trialled all tissue samples (see Figure 3.2c). All extractions preceded by 1-2 day wash in PBS; extra Proteinase K steps also included.
- DNA extractions quantified (Qubit or Nanodrop). Concentrations from 1.57–147.0 ng/ul however A260/A280 ratios highly variable and indicated degraded DNA (e.g. 0.041-1.84)
- Variety of mtDNA primers trialled on DNA extracts including:
    - combinations of standard and mini-barcoding COI fish primers(FishF1/F2 & R2; BCL and BCH; mini SH-D and mini SH-E; amplicons ranging from 150-650bp)
    - 16S (16sBRL and 16sBRH; degenerate 16S primers; amplicons ranging from 230-560bp)
    - Cytochrome B primers; amplicons 350bp

- different PCR conditions (i.e. varying annealing temperatures, touch-down cycles, spiked PCRs)

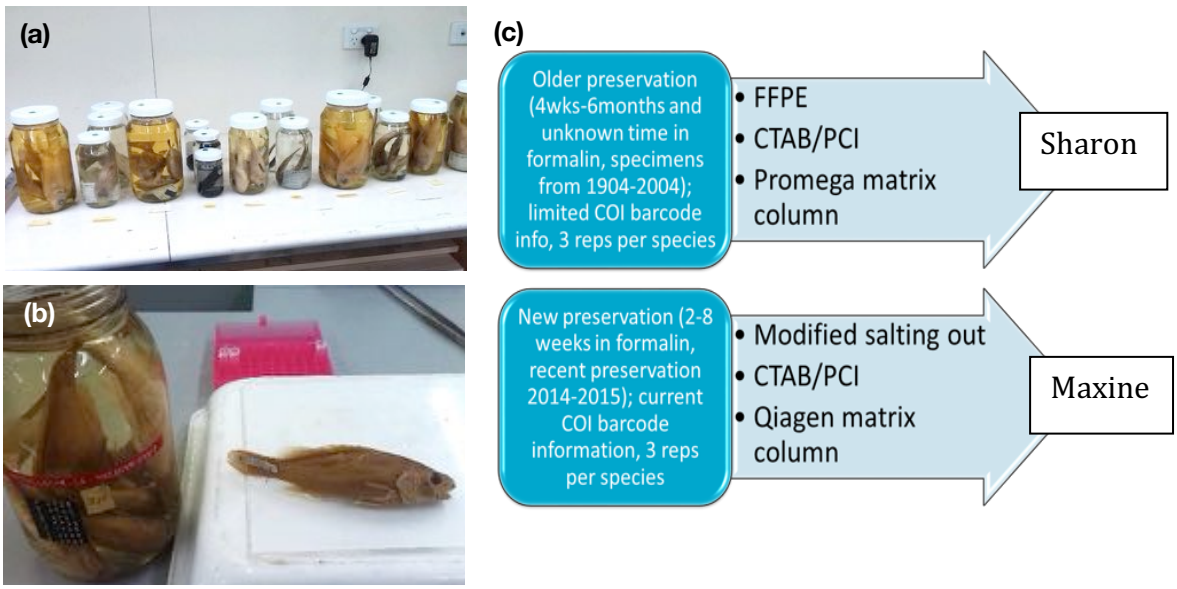


Figure 3.2 (a) Specimens from ANFC sampled for preserved tissues; **(b)** Oldest specimen sampled: *Maccullochella macquariensis*, preserved 1904; **(c)** Experimental design for DNA extractions of new and older preserved specimens.

- Discrete bands for most DNA samples (column based, PCI, FFPE); several salting out samples did not work for any marker.
- Sanger sequencing of positive COI PCRs resulted in a range of sequencing outcomes (from no sequence to full length amplicons) but no sequence matched the expected species sequence. In fact, sequences did not even match other fish species and were closer to *Homo sapiens* and *Bradyrhizobium japonicum.*
- Reduced length 16S amplicons sequenced for two recent DNA samples (scalloped hammerhead *Sphyrna lewini* and eel *Conger* sp.) matched presumptive species but other recent DNA sequencing not successful and or matched highly to other taxa, i.e. *Homo sapiens* and *Bradyrhizobium japonicum*. Poor 16S and COI sequencing in older DNA samples.
- Kerensa McElroy (CSIRO, Australian National Wildlife Collection) included a single *Macruronus novaezelandiae* extraction in her WGE project to determine whether this method is suitable for formalin preserved samples.
- Restorase (Sigma) DNA polymerase PCRs commenced (Oct 2016) on older DNA samples. Restorase may help to repair damaged DNA. Trials currently undertaken using COI primers and 16S. Resulting bands not yet been sequenced for species confirmation.
- Initial discussions with ANU - BRF (Stephanie Palmer, April 2016) suggested fragmented/degraded DNA might be usefully applied to their NGS pipeline but not for species identifications. Our main challenge here is to develop repeatable and accurate fish and elasmobranch genetic identification protocols for a wide range of species, genera and families.
- Ongoing literature searches for relevant protocols and methods.

3.2 CBA annual conference

The interface of evolutionary biology and policy impact

cba.anu.edu.au/news-events/interface-evolutionary-biology-and-policy-impact

Our 2016 conference was a workshop for research providers (scientists) and research users (policy makers and managers) on **The interface of evolutionary biology and policy impact**.

The two-day workshop held at ANU Commons (6-7 September) aimed to address the gap between academic research, where the majority of new biodiversity data is generated, analysed and interpreted, and the current and future needs of practical policy development and real-world management. The workshop also considered the 'push and pull' dilemma information agenda setting that often shapes the relationship between researchers and policy makers.
Accordingly, the meeting had a considerably different approach and format to previous CBA conferences. Rather than sessions of traditional conference talks (e.g. science 'push'), the meeting was a facilitated, two-day engagement and dialogue workshop.

The workshop was designed by Wendy Russell (Double Arrow Consulting), in collaboration with Craig Moritz and Claire Stephens (CBA) and the CSIRO/ANU conference steering committee: Dan Rosauer (RSB, ANU), Simon Ferrier (BEKS, CSIRO), Kristen Williams (BEKS, CSIRO), Linda Broadhurst (NRCA, CSIRO), Stephanie Von Gavel (ALA, CSIRO), Margaret Byrne (WA Dept. Parks and Wildlife) and Peter Cochrane (State of the Environment; ex-Director National Parks). Wendy facilitated the workshop, with co-facilitation from Vicky Darling (Kintsugi Alliance).

Invited speakers (Table 3.3) provided context and highlighted challenges and successes. All workshop participants were involved in exploring the issues and finding solutions. A session of contributed Lightning Talks (10 minute talks) by early/mid career researchers showcased their current research and its connections to conservation and management outcomes.

Table 3.3 2016 CBA conference - invited speakers

Speaker	Affiliation
Gregory Andrews	Threatened Species Commissioner, Department of the Environment and Energy
Sam Banks	Research Fellow, Fenner School of Environment and Society, ANU
Linda Broadhurst	Director, Centre for Australian National Biodiversity Research/Australian National Herbarium, NRCA, CSIRO
Margaret Byrne	Director, Science and Conservation Division, WA Department of Parks and Wildlife
Emma Campbell	Assistant Secretary, Landcare and Biodiversity Policy Branch, Department of the Environment and Energy
David Coates	Program Leader, Flora Conservation and Herbarium Program, WA Department of Parks and Wildlife
Sue Fyfe	Director, Biodiversity Science, Parks Australia, Department of the Environment and Energy
John Kanowski	National Science and Conservation Manager, Australian Wildlife Conservancy
Adrian Manning	Professor, Fenner School of Environment and Society, ANU
Cate McElroy	Terrestrial Threatened Species Section, Dept. Environment and Energy
Craig Moritz	Professor, Research School of Biology, ANU; Director, Centre for Biodiversity Analysis
David Salt	Editor 'Decision Point', Fenner School of Environment and Society, ANU
Carla Sgro	Associate Professor, School of Biological Sciences, Monash University
Cameron Slatyer	Head of Natural Science Collections, Australian Museum
Andrea Taylor	Adjunct Senior Research Fellow, School of Biological Sciences, Monash University
Stephanie von Gavel	Business Development Manager, Atlas of Living Australia, CSIRO
Andrew Weeks	Senior Research Fellow, School of BioSciences, University of Melbourne; Director, cesar Pty Ltd
Kate Wilson	Executive Director, Science Division, NSW Office of Environment and Heritage

There were 54 participants at the workshop including a significant proportion of research users (37%), which is considerably more compared to our previous, more typical, scientific conferences (Table 3.4).

Table 3.4 Workshop attendance - participants' affiliations.

Research providers	N	%	Research users	N	%
ANU	14	26	Australian Wildlife Conservancy	1	2
University of Canberra	2	4	Decision Point	1	2
Monash University	3	6	Bioplatforms Australia	1	2
Western Sydney University	1	2	Dept. of Environment and Energy	9	17
University of Melbourne	1	2	NSW Office of Environment and Heritage	1	2
Western Australian Museum	1	2	WA Dept. of Parks and Wildlife	2	4
Australian Museum	2	4	SA Dept. of Environment, Water and Natural Resources	2	4
CSIRO	10	19	ACT Environment and Planning Directorate	3	6
Total	**34**	**63%**	**Total**	**20**	**37%**

The value of incorporating the concepts and tools of evolutionary biology into environmental policy development and decision-making was universally accepted, for example in understanding species responses to climate change and for habitat restoration and species translocations. Challenges, such as accessibility of scientific information by policy makers and mangers, and the lack of a reward system for scientists who engage with policy and management, were discussed (Figure 3.3).

Future engagement strategies were jointly developed, such as The Conversation/Decision Point articles, policy keywords and definitions for evolutionary biology publications, case study-based fact sheets for policy and management and an evolutionary biology vision statement (Figure 3.3). These will be progressed further over the next 6-12 months.

Figure 3.3 Summary from workshop report. Communication and cultural constraints shape the 'gap' between research users and researchers (PROBLEM FEATURES). Evolutionary biology and genetic data are relevant but often misunderstood or overlooked in conservation/ environmental decision-making. Conversely, researchers often do not appreciate the context and drivers for this decision-making. This evident disconnect provides an opportunity for developing an EFFECTIVE two-way SYSTEM of engagement and knowledge transfer that will (i) Enhance outcomes for science-based decision making; and (ii) Increase the impact of research investment. During the workshop, several short-medium term STRATEGIES were identified for progressing towards this effective system.

The full workshop report is available on the CBA website: cba.anu.edu.au/public-policy

An editorial based on discussions arising from the workshop, led by Sam Banks (ANU) in collaboration with Decision Point's editor David Salt, was published in the October edition of the ARC Centre of Excellence for Environmental Decisions' (CEED) magazine 'Decision Point':

Evolutionary biology – what is it good for?

decision-point.com.au/article/evolutionary-biology-what-is-it-good-for/

Table 3.5 2016 Conference budget

Expenses	$	Income	$
Speaker costs (flights, accom. etc.)	7,336	CBA	30,000
Workshop design and facilitation	12,715	Registration ($135)	3375
Catering and venue hire	10,400		
Program, name tags	400		
TOTAL	**30,851**	**TOTAL**	**34,200**

Figure 3.4 Workshop 'speed dating' session. Participants were asked to share their experience of making or using data for policy. Photo: Tangyao Zhang.

3.3 Visiting scientists, training workshops and seminars

cba.anu.edu.au/opportunities/grants-funding/visiting-scientist-support
cba.anu.edu.au/opportunities/cba-grants-funding/training-support

A major objective of CBA is to enhance collaboration and training opportunities via external visitors who conduct a workshop and/or present a seminar during their visit to ANU and CSIRO. We encourage direct input from post docs and PhD students regarding the types of training activities they need to address their specific research requirements and interests.

CBA workshops and seminars are open to ANU and CSIRO staff and students, and are also attended by students and researchers from the University of Canberra and interstate universities, museums and CSIRO sites. The workshops are funded by CBA (up to $5000), usually with a nominal registration fee that goes towards catering, and helps ensure attendance after registration.

3.3.1 Training workshops

cba.anu.edu.au/news-events/cba-workshops

In our fourth year we supported three visiting scientists (in addition to our invited conference speakers) who presented the following workshops:

1. Scott Edwards (Harvard University) **Phylogenomic analyses using the multispecies coalescent model** (Dec 2015). Sponsorship of the Australasian Systematic Botany Society's annual conference. One day workshop. Registrations: 30 (ANU: 12; CSIRO: 10; HDR students: 4).
2. Gurutzeta Guillera-Arroita and José Lahoz-Monfort (School of BioSciences, Univ. Melbourne) **Hierarchical occupancy-detection modeling** (Nov 2015). Proposal led by ECR Alex Bush (BEKS, CSIRO). Two day workshop. Registrations: 20 (ANU: 10; CSIRO: 4; ACT Gov: 2; HDR students: 1).

Workshop topics survey

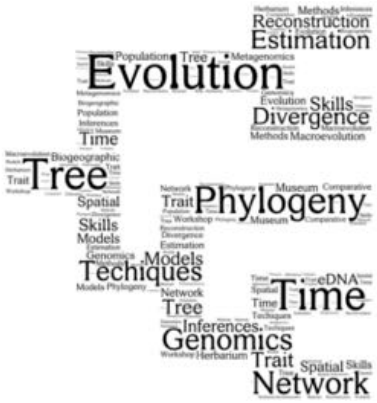
To help gauge interest and demand a survey was sent out to CBA members in December 2015 asking to rank their preferences (top three) from six workshop topics that continue with CBA's core focus of incorporating genomics, informatics and spatial modelling into biodiversity analysis (Table 3.4).

Of the 16 responses (9 ANU, 7 CSIRO), 'Museum genomics' was the most popular, followed by 'Phylogenomics' and 'Adaptation genomics'.

Table 3.6 Workshop topics and survey results.

	Phylogenomics - above and below the species level	Adaptation genomics	Museum genomics - technical methods & bioinformatics	Modelling biodiversity	Genome assembly	ABC Modelling
1st preference	3	3	4	1	1	2
2nd preference	1	3	4	1	3	1
3rd preference	2	2	4	1	0	2
Total N responses	6	8	12	3	4	5

TEA Talks: Techniques in Evolutionary Analysis
cba.anu.edu.au/news-events/tea-talks



In November 2016 the CBA will start a new monthly workshop series that aims to introduce a range of emerging concepts and techniques in evolutionary analysis. These short 'TEA Talks' (Techniques in Evolutionary Analysis) are targeted at ANU and CSIRO evolutionary biologists and ecologists (HDR students and researchers) who want to improve their understanding of current methods and analytical approaches in phylogenetics, bioinformatics and macroevolution. They were developed to complement Research School of Biology's 'Techniques in Computational genomics (TIC)' meetings.

TEA Talks will be held on the first Friday of each month at ANU from 12-2pm with free registration. Scientists from both ANU and CSIRO have been approached to present, and continued invitations for presenters will be made throughout the year to the CBA community, especially Early/Mid Career Researchers. Our eventual aim for the TEA Talk program is for it to become a regular annual series of workshops, and more formalised, such that participants will be able to obtain some sort of credit/recognition on completion, potentially as part of a course-work Masters program. TEA Talks also have the potential to provide valuable teaching experience to E/MCRs, along with reimbursement from the CBA for their work.

Further to the survey sent in late 2015, the TEA Talks will also help us assess which topics are of most interest and value such that further, more detailed 'hands-on' workshops in these areas can be developed.

Proposed TEA Talk topics include:

- Molecular phylogenetic inference
- Tree and network thinking
- Macroevolutionary inferences from phylogenies
- Spatial and biogeographic models
- eDNA and metagenomics
- Population genomics
- Trait evolution and comparative methods
- Museum/herbarium genomics

3.3.2 Seminars

cba.anu.edu.au/news-events/cba-seminars

In 2015-16 we hosted seven CBA special seminars, including our Ignition Grant Symposium:

1. Hugh Possingham (Univ. of Queensland) **Why monitor or do research in conservation?** (July 2016).
2. Hilary Martin (Wellcome Trust Centre for Human Genetics, Oxford) **Insights into sex chromosome evolution and population dynamics and history from whole-genome sequencing of platypus** (July 2016).
3. **Ignition Grant Symposium** (June 2016).
4. Andrew Robinson (Co-Founder, QuestaGame) **QuestaGame: How a Multiplayer Mobile Game Can Raise the Value of Biodiversity Knowledge** (April 2016).
5. Owain Edwards (Environmental Genomics, CSIRO Land & Water) **Should gene drives be considered for applications in biodiversity and conservation?** (March, 2016).
6. Rick Harrison (Ecology and Evolutionary Biology, Cornell University) **Differential Introgression and the "Genic View" of Species** (Feb, 2016).
7. Vicki Funk (Smithsonian) **Origin and patterns of evolution in Pacific Compositae (Asteraceae)** (December 2015). Sponsorship of the Australasian Systematic Botany Society's annual conference.

3.4 Policy, outreach and communication

3.4.1 The interface of evolutionary biology and policy impact

cba.anu.edu.au/news-events/interface-evolutionary-biology-and-policy-impact

The CBA's 2016 annual conference addressed the gap between academic research, where the majority of new biodiversity data is being generated, analysed and interpreted; and the current, and future, needs of practical policy development and real-world management. See **CBA Annual Conference (Section 3.2)** for more detail.

3.4.2 The Modern Outback and Country Needs People - Pew Charitable Trusts

pewtrusts.org/en/projects/outback-australia and countryneedspeople.org.au

'The Modern Outback' is a campaign being run by Pew Charitable Trusts that aims to (re-)engage the Australian public with the 'Outback' such that its issues (and their solutions) can be discussed and supported. Pew are incorporating the support of Indigenous owners, natural resource management and conservation agencies, government, media, universities and the general public.

Pew's 'Modern Outback' campaign closely aligns with several CBA's activities, such as CBA Director Craig Moritz's research on reptile diversity and evolution in northern Australia on IPA lands, and the CBA co-funded Atlas of Australia Two-way Indigenous Engagement Case Study. We have also had discussions with Pew's partnerships manager Patrick O'Leary about providing "good news" case studies for 'Country Needs People', their campaign to support land and sea country management by Aboriginal and Torres Strait Islander peoples.

3.4.3 QuestaGame

portal.questagame.com

QuestaGame is a digital app developed by a local, Canberra-based software company that uses social gaming technologies to engage people worldwide in the natural environment by submitting wildlife sightings and earning points to compete with other players.

As the first company to begin 'scoring' species data dynamically, QuestaGame is becoming a leader in biodiversity economic modelling. The citizen-science data collected are added to ALA/GBIF. Other partners include the Office of Environment and Heritage NSW, the ACT Government, the Global Information Biodiversity Facility, and others.

QuestaGame developer Andrew Robinson approached CBA seeking collaborations with biologists, firstly for taxonomic expertise to assist with wildlife identifications; and secondly, working on potential research questions, such as the reliability and use of citizen-science observation data.

Recognising its value as a potential biodiversity outreach and education tool, over the past 12 months CBA has collaborated with QuestaGame by:

1. Putting the call out to CBA members who may be interested in being involved as specialists for QuestaGame's "Bio-Expertise Engine (BEE)" to identify sightings.
2. Promoting to our HDR students a 3-month internship (with stipend) that QuestaGame have developed to give students the opportunity to work with them. Currently two interns are working with QuestaGame.
3. Hosting a special CBA seminar by QuestaGame developer Andrew Robinson (See section 3.3.2).

Craig Moritz is also discussing with Andrew Robinson the possibility of a Visiting Fellow position at ANU (for AR) to facilitate further collaborations with the CBA, such as research on the use and value of citizen-science data for both scientific purposes and community engagement and education.

3.4.4 Research School of Biology's alumni newsletter

cba.anu.edu.au/research/highlights/alumni-newsletter

The CBA was invited to contribute an article to the inaugural issue (March 2016) of the Research School of Biology's alumni newsletter 'Snowgum'.

The article introduced the Centre and highlighted our projects and training initiatives, such as our ECR-led workshops and visiting scientist scheme.

3.4.5 Big questions in biology: Australia's biodiversity, its past, present and future

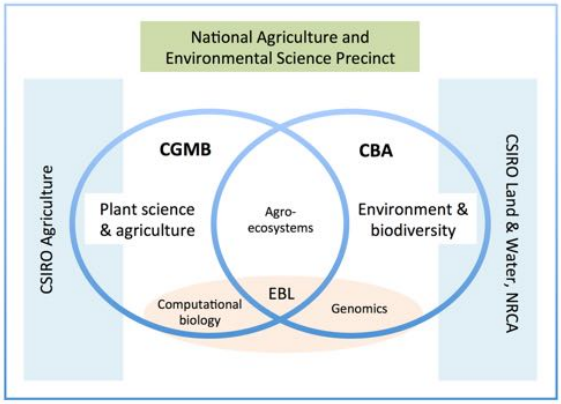
cba.anu.edu.au/news-events/big-questions-biology-australia's-biodiversity-its-past-present-and-future

In August, CBA Director Craig Moritz presented a public lecture in the Research School of Biology's Forum - Big questions in biology: Australia's biodiversity, its past, present and future.

Craig spoke on the value of evolutionary biology in answering the big questions facing biodiversity conservation and environmental management and the vast underestimation in much of Australia diversity using recent research from the Monsoonal Tropics as an example. This work is revealing new hotspots of unique diversity that need to considered to find the balance between conservation and development of the north. It also highlights the importance of Indigenous Protected Areas, and the ecological management done by Indigenous Rangers across the region.

CBA members Adrienne Nicotra, Marcel Cardillo and Carsten Külheim also presented (pictured right).

3.5 The future of the CBA



The CBA's current 5 year funding is due to finish at the end of June 2017.

Craig Mortiz has been developing a CBA Futures document that explores the potential role the CBA can play in the National Agriculture and Environment Science Precinct.

The CBA represents a hub for 'Environment' oriented research and training within the National Agriculture and Environment Science Precinct. In the next iteration it is intended to broaden the CBA to include components of the Institute for Applied Ecology at UC and stronger connections with local industry (e.g. DArT; Questagame). We would also aim to build a stronger connection with the Fenner School of Environment and Society at ANU in relation to ecosystem ecology/management and translation of ecological/evolutionary science to policy.

Funding options for the renew bid are currently being explored.

A survey will be sent out in November 2016 to assess CBA members' levels of engagement and views on the CBA's value and future to help with our bid for renew.

4. Summary of discoveries made, or other achievements, including Project IPR, other IPR and Confidential information.

Nothing to report other than that above.

5. Interactions and developing interactions with third parties.

5.1 Science and Industry Endowment Fund (SIEF)

Craig Moritz, on behalf of the CBA, was involved in the successful $18 million bid for SIEF Research Infrastructure (SIEF RI) funding to establish the **National Agricultural and Environmental Sciences Precinct** (NAESP) that was launched in December 2014.

The SIEF grant is being used for:

- The **Centre for Genomics, Metabolomics and Bioinformatics** (CGMB);
- A collaborative ecogenomics lab and computer facility that will accessible to ANU and CSIRO researchers - the **Ecogenomics and Bioinformatics Laboratory** (EBL); and
- A new life sciences building at CSIRO Black Mountain.

The EBL (pictured right) is now fully operational and available to ANU and CSIRO staff and students for bookings. It includes both experimental ('wet-lab') and computational components to support data generation and analysis.

Craig Moritz is directly involved in the management of the EBL and is in discussions with Eric Stone, the new Director of the CGMB, regarding the role the CBA may play in the delivery of EBL and CGMB training workshops.

The establishment of the EBL and CGMB will further facilitate biodiversity science collaborations across ANU and CSIRO.

5.2 Oz Mammal Genome Initiative: building genomics resources to understand and protect Australia's mammals.

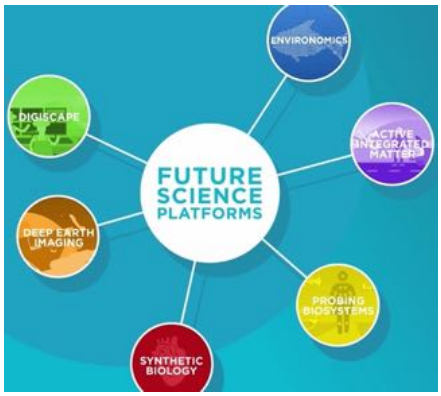
In 2016 the collaborative **Oz Mammal Genome Initiative** was formed. Led by CBA Director Craig Moritz and representatives from all the Australian museums (including NRCA, CSIRO), several universities and the Western Australian Department of Parks and Wildlife, it was developed to help address Australia's high mammal extinction rates.

The initiative aims to better understand the diversity and evolution of Australia's globally unique mammals by building a foundation of genomic data and develop ways for end-users in government and non-government agencies to more effectively manage these and other mammal species, both in Australia and elsewhere, into a rapidly changing future. The initiative also aims to establish genomics as a key capacity across Australian museums and government agencies, and build the community to sustain it.

Bioplatforms Australia (BPA) is committing $1M towards the newly formed initiative over the coming 2-3 years through the Commonwealth Government NCRIS program to sequence and analyse the genomic variation across Australian mammal species.

To enable the appointment of a Project Coordinator for two years, the CBA and six partners (including NRCA, CSIRO), are providing ~$120K that has been matched by $100K from BPA (the CBA contributed $20,000 in September 2016). The Project Coordinator position has been advertised and will be based at ANU in the Biomolecular Resource Facility (BRF) and co-supervised by Stephanie Palmer (BRF) and Craig Moritz.

5.3 CSIRO 'Environomics' Future Science Platform



In June 2016, the bid for a **CSIRO Future Sciences Platform on Environomics – an 'omics-based platform for next-generation environmental science**, led by Andrew Young (CSIRO, Director NRCA) was successful, with indicative funding of ~$4.5M over 2-3 years. CBA Director Craig Moritz led discussions with ANU to support the bid.

The FSP envisages strong interactions across CSIRO and ANU via the CBA and the SIEF-funded Ecogenomics and Bioinformatics Laboratory (EBL).

Key aims of the Environomics FSP are to:

- Develop capability for genomic analyses of non-model species, including accessing genomic data from specimens in CSIRO's National Research Collections;
- Advance methods and applications in environmental DNA, including improved bioinformatics; and
- Develop visualisation and modelling tools with which to intersect and interpret the deluge of genomic, specimen and environmental data.

5.4 Pew Charitable Trusts

See above (Policy, outreach and communication Section 3.3.2)

5.5 QuestaGame

See above (Policy, outreach and communication Section 3.3.3)

6. Financial statement

Table 6.1 Budget summary. The core CBA budget is $200K/year, shared equally by CSIRO and ANU. Budget allocations are set annually by the CBA Liaison Committee.

	Yr 4 (15-16) Budget	2015/16 Actuals	WOL Budget	LTD Actuals 31.12.16	Jan-Jun 2017 Budget	Notes for Yr5
Income						
ANU Contributions	100,000	75,000	500,000	500,000		
CSIRO Contributions	100,000	211,241	500,000	594,232		
Total Income	200,000	286,241	1,000,000	1,094,232		
Expenditure						
Coordinator: C Stephens (50%)	42,616	50,767	207,056	206,030	68,000	68% to 12/17
Outreach & promotion - includes research impact, policy engagement	5,000	0	25,000	1,427	20,000	Actions from 2016 Policy Workshop
Projects (now includes fieldwork, travel, salaries & Hons projects)	40,000	94,678	190,000	265,606	38,822	
Hardware & equipment	0	109	40,000	47,697		
Bioinformatics support: J Bragg (24%)	30,000	0	147,000	127,087		
Field work & Travel	30,000		140,000	980	10,000	
Annual symposium & training workshops	20,000	7,659	100,000	228,022	40,000	2017 Conference + $20K new training workshops
Short term visiting fellowships	30,000	11,973	150,000	35,561	5,000	
Total Expenditure	**197,616**	**165,185**	**999,056**	**912,410**	**181,822**	
Surplus/Deficit	**2,384**	**121,055**	**944**	**181,822**	**-181,822**	

Appendix

CBA activities: August 2012-October 2016

Joint ANU-CSIRO Projects - 'Ignition grants'

1. **Tackling the unknown – a next-generation phylogenetics approach to explore the immense diversity of Australian thynnine wasps (Tiphiidae: Thynninae)** Thomas Semple (PhD student RSB, ANU), Rod Peakall (RSB, ANU), Andreas Zwick (CSIRO NRCA) (July 2016).
2. **Genomic diversity in Australian palms** Bee Gunn (RSB, ANU), Sarah Mathews (CSIRO NRCA) (July 2016).
3. **Biogeography of sex reversal and the effects of climate change on reptile sex determination** Clare Holleley (CSIRO NRCA), Kerensa McElroy (CSIRO NRCA), Dan Rosauer (RSB, ANU), Craig Moritz (RSB, ANU), Arthur Georges (IAE, U Canberra) (July 2016).
4. **Characterizing the evolutionary and ecological diversity of invertebrates in the Monsoonal vine thickets of the Kimberley** Russell Dinnage (RSB, ANU), Marcel Cardillo (RSB, ANU), Gavin Huttley (RSB, ANU), Owain Edwards (CSIRO Land & Water) (July 2016).
5. **A winning combination? Could seed dormancy and polyploidy be beneficial in a warmer, drier climate?** (Hons Project) Lydia Guja (NRCA, CSIRO), Robert Godfree (NRCA, CSIRO), Adrienne Nicotra (RSB, ANU), Amelia Stevens (RSB, ANU Hons student) (Sept 2015).
6. **An exome capture system for phylogenetic and evolutionary studies in the hyperdiverse orchid tribe Diurideae (Orchidoideae)** Katharina Schulte (NRCA, CSIRO), Mark Clements (NRCA, CSIRO), Lars Nauheimer (NRCA, CSIRO), Rod Peakall (RSB, ANU), Celeste Linde (RSB, ANU), Ryan Phillips (RSB, ANU) (Sept 2015).
7. **Investigating the effects of diversity, distribution and chytrid load on Uperoleia frog skin microbial communities** Matt Morgan (Land & Water, CSIRO), Maxine Piggott (RSB, ANU), Renee Catullo (RSB, ANU) (Sept 2015).
8. **Bill adaptation in parrots: finding loci involved in surface area increases by integrating morphometrics with NGS** (Hons Project) Kerensa McElroy (NRCA, CSIRO), Loeske Kruuk (RSB, ANU), Janet Gardner (RSB, ANU), Keira Beattie (RSB, ANU Hons student) (Sept 2015).
9. **Can adaptation in 'ecosystem engineers' drive fire regime feedbacks?** Annabel Smith (Fenner), Justin Borevitz (RSB, ANU), Shannon Dillon (Agriculture, CSIRO) (Sept 2015).
10. **Curating spatial data to understand patterns and processes shaping biodiversity in New Guinea** Paul Oliver (RSB, ANU), Dan Rosauer (RSB, ANU), Eric Rittmeyer (RSB, ANU), Kristin Williams (CSIRO Land & Water), Leo Joseph (ANWC, CSIRO).
11. **Environmental Drivers of Acacia-Associated Symbiotic Microbe Diversity** Russell Dinnage (RSB, ANU), Marcel Cardillo (RSB, ANU), Anna Simonsen (Land & Water CSIRO), Suzanne Prober (Land & Water CSIRO), Luke Barrett (Land & Water CSIRO), Pete Thrall (Land & Water CSIRO) (Sept 2015).
12. **Linking genomic data to spatial biodiversity data in the Atlas of Living Australia** Caroline Chong (RSB, ANU), Justin Borevitz (RSB, ANU), Lindell Bromham (RSB, ANU), Rebecca Pirzl (NCRA, CSIRO), John La Salle (NCRA, CSIRO) (Sept 2015).
13. **Genetic characterisation of formalin preserved fish tissue** Sharon Appleyard (NCRA, CSIRO) and Maxine Piggott (RSB, ANU) (Mar 2015).
14. **Developing new methods for using distribution data to identify taxa that can tolerate extreme conditions** Xia Hua (RSB, ANU), Lindell Bromham (RSB, ANU), Marcel Cardillo (RSB, ANU) and ALA (NCRA, CSIRO) (Mar 2015).
15. **Effects of climate change on avian morphology** Janet Gardner (RSB, ANU), Loeske Kruuk (RSB, ANU) and Leo Joseph (NRCS, CSIRO) (Mar 2015).
16. **Genetic and demographic impacts of contemporary disturbance regimes in Mountain Ash forests** Brenton von Takach Dukai (Fenner, ANU PhD student), Sam Banks (Fenner, ANU) and Shannon Dillon (Agriculture, CSIRO) (Mar 2015).
17. **Eucalyptus genomics project** Linda Broadhurst (NRCS, CSIRO), David Bush (NRCS, CSIRO), Brendan Lepschi (NRCS, CSIRO), Justin Borevitz (RSB, ANU), Norman Warthmann (RSB, ANU), Megan Supple (RSB, ANU) and Jason Bragg (RSB, ANU) (Jun 2014).
18. **Bringing next generation approaches to conservation genomics using museum collections – Rock wallaby museum skinomics** Sally Potter (RSB, ANU), Maxine Piggott (RSB, ANU), Jason Bragg (RSB, ANU), Matthew Morgan (Land & Water, CSIRO), Leo Joseph (NRCA, CSIRO) (Jun 2014).
19. **Collections-based landscape genomics: Red-browed finches as a test case** Kerensa McElroy (NRCA, CSIRO), Norman Warthmann (RSB, ANU) (Jun 2014).
20. **Penguin ectoparasites of the Southern Hemisphere** Katherine Moon (Fenner, ANU PhD student), Ceridwen Fraser (Fenner, ANU), Bruce Halliday (NRCA, CSIRO) (Jun 2014).

21. **Genome skimming with degraded DNA from herbarium specimens** Alexander Schmidt-Lebuhn (NRCA, CSIRO), Adrienne Nicotra (RSB, ANU) (Jun 2014).
22. **Molecular phylogeny of *Helicoverpa* from museum specimens** Andreas Zwick (NRCA, CSIRO), David Yeates (NRCA, CSIRO), Tom Walsh (NRCA, CSIRO), Karl Gordon (NRCA, CSIRO), Craig Moritz (RSB, ANU), Dave Rowell (RSB, ANU) (Jun 2014).
23. **Palaeoecological indicators of biodiversity change through time** Simon Haberle (Culture, History & Language, ANU), Geoff Hope (Culture, History & Language, ANU), Dan Rosauer (RSB, ANU), Kristen Williams (Land & Water, CSIRO) (Aug 2013).
24. **Future ecosystem states: linking ecophysiological cues and thresholds to climatic regimes, variability and weather extremes** Kristen Williams (Land & Water, CSIRO), Simon Ferrier (Land & Water, CSIRO), Craig Moritz (RSB, ANU) (Jun 2013).
25. **A curation community for coral environmental genomics** Alexie Papanicolaou (Land & Water, CSIRO), Owain Edwards (Land & Water, CSIRO), Sylvain Forêt (RSB, ANU) (Jun 2013).
26. **A test of the power of genotype by sequencing (GBS) for delimiting species boundaries among incipient species of Australian orchids** Rod Peakall (RSB, ANU), Celeste Linde (RSB, ANU), Mark Clements (NRCA, CSIRO) (Jun 2013).
27. **Evolutionary processes in Billy buttons** Alexander Schmidt-Lebuhn (NRCA, CSIRO), Justin Borevitz (RSB, ANU) (Jun 2013).
28. **Species discovery and refugia in the monsoonal tropics** Craig Moritz (RSB, ANU), Scott Keogh (RSB, ANU), Justin Perry (Land & Water, CSIRO), Eric Vanderduys (Land & Water, CSIRO), Simon Ferrier (Land & Water, CSIRO) (Oct 2012).
29. **Hybrid history: deep sequencing of the Tasmanian blue gum** Carsten Kulheim (RSB, ANU), Joe Miller (NRCA, CSIRO) (Oct 2012).
30. **How local is local? Landscape genomics in Yellow box** Justin Borevitz (RSB, ANU), Linda Broadhurst (NRCA, CSIRO) (Oct 2012).

Annual conferences

1. **The interface of evolutionary biology and policy impact** (Sept 2016).
2. **Species delimitation in the age of genomics** (Apr 2015).
3. **Understanding biodiversity dynamics using diverse data sources** (Apr 2014).
4. **Biodiversity genomics** (Apr 2013).

Workshops

1. Scott Edwards (Harvard University) **Phylogenomic analyses using the multispecies coalescent model** (Dec 2015).
2. Gurutzeta Guillera-Arroita & José J. Lahoz-Monfort (School of BioSciences, Univ. Melbourne) **Hierarchical occupancy-detection modeling** (Nov 2015).
3. Alexander Xue (City Univ. New York) **Demographic inference for comparative phylogeograpy using Next-Gen sequence data** (Sept 2015).
4. Olivier Loudet (INRA Versailles) & Justin Borevitz (ANU) **Genomic and phenomics tools to identify the genetic basis underlying natural variation and adaptation** (June 2015).
5. Oliver Niehuis (Zoologisches Forschungsmuseum Alexander Koenig) **DNA target enrichment in phylogenomics - molecular and bioinformatic principles** (Oct 2014).
6. Dan Rabosky (Univ. Michigan) **Computational macroevolution and phylogenetic comparative methods** (Sept 2014).
7. Matteo Fumagalli (UC Berkeley), Anders Goncalves da Silva (Monash), Rose Andrew (UNE), Justin Borevitz (ANU) & Kevin Leempoel (École Polytechnique Fédérale de Lausanne) **Population and landscape genomics** (Mar 2014).
8. Australian Bioinformatics Network **R Bootcamp** (Oct 2013).
9. Alexei Drummond (Univ. Auckland) **Phylogenomics using BEAST2** (July 2013).
10. Rod Peakall (ANU) & Peter Smouse (Rutgers Univ.) **GenAlEx: Genetic analysis for population studies** (July 2013).
11. Steve Stones-Havas (Biomatters) **Geneious** (Apr 2013).
12. Joseph Heled (Univ. Auckland) **BEAST2** (Apr 2013).

Seminars & symposia

1. Hugh Possingham (Univ. of Queensland) Why monitor or do research in conservation? (July 2016).
2. Hilary Martin (Wellcome Trust Centre for Human Genetics, Oxford) **Insights into sex chromosome evolution and population dynamics and history from whole-genome sequencing of platypus** (July 2016).
3. **Ignition Project Symposium** (June 2016).
4. Andrew Robinson (Co-Founder, QuestaGame) **QuestaGame: How a Multiplayer Mobile Game Can Raise the Value of Biodiversity Knowledge** (April 2016).
5. Owain Edwards (Environmental Genomics, CSIRO Land & Water) **Should gene drives be considered for applications in biodiversity and conservation?** (March, 2016).
6. Rick Harrison (Ecology and Evolutionary Biology, Cornell University) **Differential Introgression and the "Genic View" of Species** (Feb, 2016).
7. Vicki Funk (Smithsonian) **Origin and patterns of evolution in Pacific Compositae (Asteraceae)** (December 2015).
8. John Woinarski (Charles Darwin University) and Barry Traill (Pew Charitable Trusts) **Making a Modern Outback - the future of nature and people in remote Australia** (Sept 2015).
9. Emilie-Jane Ens (Macquarie Univ.) **ALA Two-way Indigenous Engagement Case Study** (Mar 2015).
10. Jérôme Chave (Evolution et Diversité Biologique, Université Paul Sabatier) I**n-situ diversification versus migration patterns in the assembly of Neotropical plant lineages** (Mar 2015).
11. Matthew Barrett (Botanic Gardens and Parks Authority & UWA) **Diversity and diversification of the Kimberley flora** (Jun 2014).
12. Eddie Holmes (Univ. Sydney) **The Greatest Experiment in Evolution: Viral Biocontrol of Rabbits** (Mar 2014).
13. Alan Andersen (CSIRO) **Historical biogeography shapes community ecology** (Feb 2014).
14. Alexei Drummond (Univ. Auckland) **Developing Darwin's computer** (Jul 2013).

Policy, outreach and communication

1. Editorial in CEED's Decision Point: **Evolutionary biology – what is it good for?** (Oct 2016)
2. Annual Conference: **The interface of evolutionary biology and policy impact** (Sept 2016).
3. Public seminar: **Big questions in biology: Australia's biodiversity, its past, present and future** Craig Moritz (Aug 2016).
4. Article in the Research School of Biology's **Alumni newsletter** (March 2016)
5. Conference session: **Public communication and policy issues associated with species delimitation** (Apr 2015).
6. Conversation article: **Remote Indigenous communities are vital for our fragile ecosystems** Craig Moritz, Emilie-Jane Ens and Jon Altman (Mar 2015).
7. Project: **Atlas of Living Australia Two-way Indigenous Engagement Case Study** (2014-15).
8. Evening science discussion: **Current practices and future goals for conservation planning based on the increasing availability of new, large-scale biodiversity data** (Apr 2014 conference).
9. Conference workshop: **The contribution of biodiversity genomics to policy and management** (Apr 2013).