

Biodiversity Data Management Project: Extending the Boundaries of Information Management in Collaboration with Life Scientists at the University of Otago

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Abstract

The Otago Biodiversity Data Management Project investigated the feasibility of managing, curating and sharing University of Otago biodiversity research data. This article discusses how the Project came about and how a mixed methods approach (including interviews, a quantitative survey and desk-based research) was used to explore the issues of data management generally, and within the Life Sciences departments at the University of Otago, in particular. This Project is unique within New Zealand and has attracted considerable interest internationally; largely as a result of the researcher-driven, collaborative approach and also the discipline focus i.e. New Zealand biodiversity.

Project background

The following question was posed to a life scientist at the University of Otago in May 2007:

‘If the Library could do one thing to better support your research, what would that be?’

This seemingly simple question resulted in the identification of a number of research and library-related concerns, some already known to Library staff and others which were new. Of even greater value, however, was the researcher’s interest in the question itself, and his recommendation that this be shared with others in the department. This recommendation led to a ‘network of conversations’

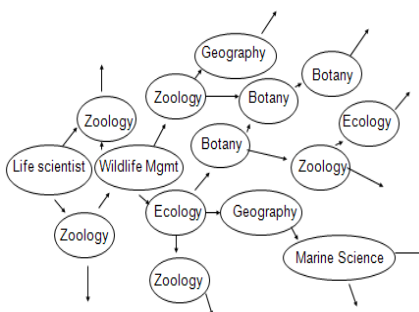


Fig. 1: Conversation network with researchers

with life scientists and also other researchers with an interest in biodiversity or ‘biological diversity of life’ (see Fig. 1).

By August 2007, the original question had been shared with more than 20 Otago researchers and almost all those interviewed identified one or more research collections which were of significance (locally, nationally or internationally) and which required more effective management. These collections (some of which are listed in Fig.2) include a range of unpublished resources, both digital and non-digital.

<i>Research collections (selected)</i>	<i>Identified information need</i>	<i>Discipline</i>
Zoology Wildlife series, Fish and Game (was Acclimatisation Society) documents, postgraduate reports and dissertations	documents to be scanned & made available	Zoology
Otago marine resources (link card index/ photos/ specimens/research), Orokonui ¹ resources, lepidoptera specimen database	databases to be created and managed	Marine Science, Geography, Botany
frog disease database, national amphibian database	databases to be managed and updated	Zoology
Dunedin land mapping project, topo-cadastral maps, Otago mollusc database national frog identification database	databases to be made available	Geography, Zoology, Science Communication
e.g. threatened species (Otago Giant and Grand Skink, Takaha, Saddleback)	species level approach to repositories	Zoology
biodiversity portal to existing biodiversity databases, Otago academic bibliographies	enhanced access, linking of established online resources	Geography, Zoology

Fig. 2: *Selected research collections identified for more effective management*

It is possible that some of these non-digital, text-based, scholarly outputs (such as Zoology postgraduate reports and dissertations) will be digitised and included in the University’s Institutional Research Repository (IRR)². However, it is less likely that the research data, i.e. the raw resources that inform all published and unpublished research outputs, will or even can be so readily accommodated and while some of this research data is already being shared informally³ this, often ad hoc, approach to data management is less than satisfactory in the increasingly digital, e-research environment. John Darby, whose research on Yellow-eyed Penguins is well regarded, highlighted at least part of the problem in an email:

Recently I handed 18 years of raw data (record sheets and field note books) together with a computer holding a relational database ‘Paradox’ (now obsolete in that it will only operate on Win 95) to Dr Phil Seddon of Zoology. I did so with some apprehension, not as it relates to Dr Seddon's care of the data, but rather my concern as to what may happen to this material when Dr Seddon leaves the University. (Personal communication, Oct 2007)

To gain a better understanding of how widespread the issue of data management might be, further research was carried out into how effectively biodiversity data is

currently managed elsewhere, both within New Zealand and also internationally. This research highlighted that:

- **internationally**, organisations and individuals are playing significant roles in the creation of interoperable databases and infrastructures to improve management of, and access to, biodiversity data (e.g. Global Biodiversity Information Facility/GBIF⁴);
- **nationally**, Crown Research Institutes (CRIs), such as Landcare Research and government departments, e.g. Department of Conservation (DOC)⁵ are driving biodiversity data initiatives; managing biodiversity databases and ensuring access to, and interoperability between, these resources (Cooper, 2005 and Carver, 2007) and
- **locally**, particularly at the University of Otago, much biodiversity data is non-digital, locally-stored and difficult to access.

A project proposal was discussed with Library management and in November 2007 it was agreed that the Library would formally investigate the potentials and implications of managing University of Otago biodiversity research data. A 12 month project was approved, commencing 1 January 2008.

Project context and focus

The Otago Biodiversity Data Management Project is significant as it addresses the complex issue of research data management within the scholarly research environment in general, and the University of Otago Library in particular. It also addresses the issue of data management within a highly strategic, significant context; namely New Zealand biodiversity⁶.



Before discussing the activities and findings of the Project, it is therefore useful to look briefly at the broader subject areas which provide the context and focus for this Project. These are: scholarly communication and academic libraries; research data management and New Zealand biodiversity

Project focus

Fig. 3: *The Project addresses activities across three disciplines (in general) and where these disciplines intersect (in particular).*

Scholarly communication and academic libraries

The scholarly environment is becoming increasingly digitally-focussed, affecting not only the products of research (such as journal articles and books) but the entire research process:

Scholars in all fields are taking advantage of the wealth of online information, tools, and services to ask new questions, create new kinds of scholarly products, and reach new audiences. The Internet lies at the core of an advanced scholarly information infrastructure to facilitate distributed, data- and information-intensive

collaborative research. These developments exist within a rapidly evolving social and policy environment, as relationships shift among scholars, publishers, librarians, universities, funding agencies, businesses, and other stakeholders.

Scholarship in the sciences, social sciences, and humanities is evolving, but at different rates and in different ways... (Borgman, 2007, p.xvii)

At the core of these changes are the, as yet, unrealised potentials of research data:

It is exceedingly rare that fundamentally new approaches to research and education arise. Information technology has ushered in such a fundamental change. Digital data collections are at the heart of this change. They enable analysis at unprecedented levels of accuracy and sophistication and provide novel insights through innovative information integration. Through their very size and complexity, such digital collections provide new phenomena for study. At the same time, such collections are a powerful force for inclusion, removing barriers to participation at all ages and levels of education. (NSF, Sept 2005, p. 9)

...access to research data increases the returns from public investment in this area; reinforces open scientific inquiry; encourages diversity of studies and opinion; promotes new areas of work and enables the exploration of topics not envisioned by the initial investigators. (OECD, 2007, p.3)

This increasing demand for returns from public investment within the research environment, together with the growing recognition of the value and potentials of research data, can be simply illustrated using the iceberg analogy (shown in Fig.4).

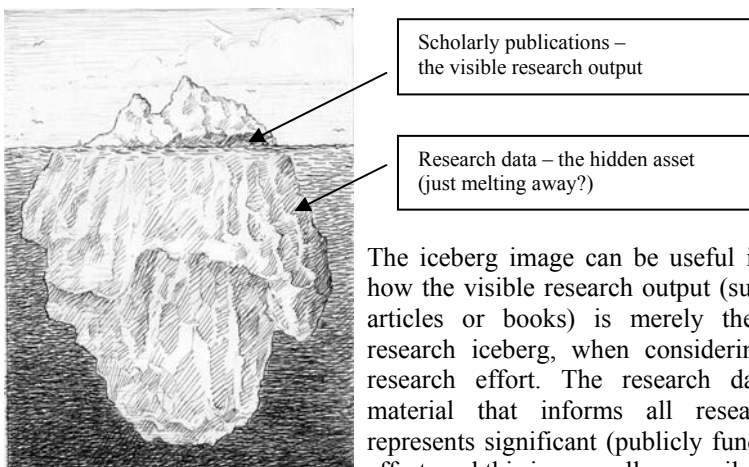


Fig. 4: *Iceberg analogy*

The iceberg image can be useful in illustrating how the visible research output (such as journal articles or books) is merely the tip of the research iceberg, when considering the entire research effort. The research data, the raw material that informs all research outputs, represents significant (publicly funded) research effort, and this is generally unavailable.

Academic libraries have always been inherently part of the research environment, but what their long term role will be, in this new e-research environment, is still being debated:

The system of scholarly communication – which allows research results and scholarship to be registered, evaluated for quality, disseminated, and preserved – is rapidly evolving. Academic libraries and their parent institutions are adopting strategies, making plans, and taking action to respond to the changing environment and to influence its development... Libraries need to seek out new methods and means of supporting scholars in this changing environment, including collaborative approaches to funding, new service definitions, and facilitation of emerging models. (ACRL Scholarly Communications Committee, 2007, pp.1, 6)

Research data management (RDM)

The value of research data within this new e-research environment and the need for more effective management of this data cannot be overstated. This was recently articulated by the Canadian Research Data Strategy Working Group in their *Gap Analysis*:

The need for a coordinated approach to the stewardship of research data in Canada has been well documented in a series of reports published over the last decade. During this same period, billions of dollars have been invested in research in Canada, generating huge volumes of digital data. Collectively, these data represent a significant asset with virtually limitless opportunities to develop new knowledge through their re-use, if they are managed appropriately. (2008, p.1)

Other countries, particularly the USA, the UK, Australia and many European nations are coming to similar conclusions and are investing substantial effort and funding, at the highest level, into the establishment of effective research data management solutions:

We envision a digital scientific data universe in which data creation, collection, documentation, analysis, preservation, and dissemination can be appropriately, reliably, and readily managed. This will enhance the return on our [U.S.] nation's research and development investment by ensuring that digital data realize their full potential as catalysts for progress in our global information society. (Interagency Working Group on Digital Data, 2009, p.1)

In the UK, five of the seven Research Councils have data management/sharing strategies, and early last year the Higher Education Funding Council for England sponsored a feasibility study⁷ into managing research data on a national shared services basis.

Closer to home, the establishment of the Australian National Data Service will “provide the essential meeting place where the Australian path forward for research data management can evolve and where a vision can be achieved.” (ANDS, 2007, p.3)

Within New Zealand, CRIs and some government departments are already managing research data and the Kiwi Advanced Research and Education Network (KAREN⁸) provides a national ‘data highway’ for sharing research data.

However, there is, as yet, no national approach to the formal management of research data in New Zealand and research libraries have yet to fully recognise the potentials of effectively engaging with this new information environment⁹. Searle (2007) discussed the issue of libraries and RDM in her informative article on KAREN:

The KAREN *Capability Building Roadmap* (REANNZ, 2007) has identified data storage, management and re-use as some of the most serious issues for New Zealand e-research development and KAREN uptake. The potential role of libraries in this environment is not yet clear. The Digital Content Strategy, ICT Framework for Education, and the National Library's National Digital Heritage Archive¹⁰ all promote the development of institutional repositories for research outputs and repositories of digital content, but the scope of these to date has been limited to published knowledge rather than datasets and other products of the research process. (Searle, 2007, p.257)

New Zealand biodiversity

New Zealand is an internationally recognised ‘biodiversity hotspot’ with a high number of globally unique and threatened species¹¹, some of which are represented below:



Fig. 5: Selection of New Zealand's biodiversity

“New Zealand’s native biodiversity [biological diversity] is unique, born of long isolation as small islands in a vast ocean. The high percentage of endemic species (those found nowhere else in the world), make New Zealand’s native biodiversity both special and highly vulnerable. For example, both species of New Zealand bat are found only here in New Zealand, as are all four frogs¹², all 60 reptiles, more than 90 per cent of insects and marine molluscs, about 80 percent of vascular plants, and a quarter

Endemic (native species, unique to NZ)	
Bats (only native mammals)	100%
Frogs (world's most endangered list)	100%
Lizards (largest vertebrate group)	96%
Insects & marine molluscs	90%
Vascular Plants	80%
Birds	25%

percent of vascular plants, and a quarter

of all our bird species. By comparison, Great Britain, which separated from continental Europe only 10,000 years ago, has only two endemic species – one plant and one animal.” (DOC, 2008)

While the aesthetic or intrinsic value of New Zealand’s biodiversity (valued for its own sake) is compelling, the economic potentials (new market and business opportunities such as enhanced resource use¹³ and ecotourism) and also costs (including biosecurity risks) of New Zealand’s environment and biodiversity are substantial:

Invasive alien species (IAS) are one of the most significant drivers of environmental change worldwide, causing damage to infrastructure, amenity and human health values... (De Poorter, 2008)

These potentials and risks are increasingly attracting interest and funding from government agencies, including the Ministry of Research, Science and Technology (MoRST) and DOC, through its TFBIS Programme.

Project established

The Otago Biodiversity Data Management Project (Jan–Dec 2008)¹⁴ is driven by the interests of researchers and is a collaboration between the Library and the University of Otago’s Life Sciences Departments, in association with the Ecology Teaching Programme and the Conservation and Biodiversity Research Group.¹⁵ It is also firmly aligned with one of the University of Otago’s 12 Emerging Research Themes, ‘Ecology, Conservation and Biodiversity in New Zealand’.

The vision of this Project is: to establish robust mechanisms for creating and managing interoperable and sustainable biodiversity research data repositories; to liberate Otago biodiversity research data to empower research and to inform conservation practice; and to connect with national/international biodiversity strategies and information sharing initiatives.

I carried out the initial interviews with Otago life scientists in mid 2007, before the start of the Project. In January 2008, I was seconded from my position, as Remote Services Librarian to the position of Biodiversity Project Co-ordinator for the duration of the Project.

Initially, identification of existing University of Otago biodiversity collections and making recommendations about how best to digitally manage these collections were high Project priorities. However, communication and raising awareness and understanding around the issues of data management, both within and beyond the Library, increasingly became (out of necessity) the focus of this Project.

Project methodology

A mixed methods research approach was used, both before and during the Project (see Fig: 6)

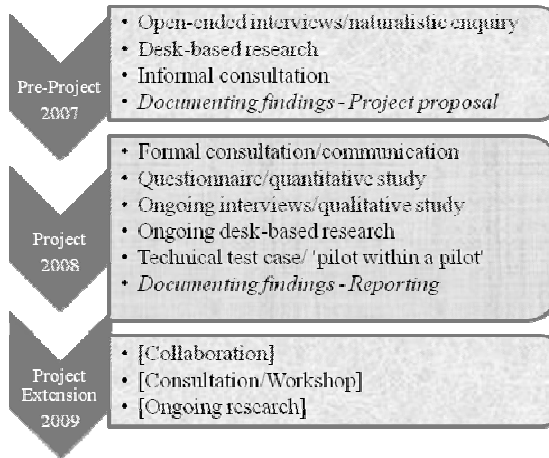


Fig. 6: Project methodology

Pre-Project 2007

As outlined in the Project Background (p.1-3), this Project has its genesis in a series of **open-ended interviews** with life scientists; where both the interviewer (myself) and the interviewees were free from “predetermined constraints” (Patton, 2002, p.40). Patton further describes this process of ‘naturalistic inquiry’ within the context of qualitative analysis¹⁶:

Observations take place in real-world settings and people are interviewed with open-ended questions in places and under conditions that are comfortable for and familiar to them... a “discovery-orientated” approach that minimizes investigator manipulation of the study setting and places no prior constraints on what the outcomes of the research will be. (2002, p.39)

Typically, the interviews took place either in the researcher’s own office or at a nearby coffee outlet. As I had little prior knowledge of any of the interviewees or their research, I first introduced myself and enquired about their research interests, before asking how the Library might better support this research. I originally suggested these interviews would take no more than 10 to 15 minutes (researchers are understandably reluctant to give time to an unknown individual, for an unspecified purpose), however most interviews lasted an hour or more¹⁷. To encourage free flowing conversation, I took minimal notes during the interviews, but documented as much of the discussion as possible as soon as I returned to my desk. These detailed notes were then collated in EndNote, together with details of the interview time, place and other information.

After interviewing more than 20 researchers, a number of recurring themes or categories began to emerge. Some of these, such as digitisation of theses and IRRs, were already known to Library staff, but others, relating to improved

storage, access and sharing of research data, were outside the parameters of normal Library business. To better understand the implications of these findings, further **desk-based research**, into academic libraries and the scholarly research environment, data management and New Zealand biodiversity, provided a context for the Project. Some of the findings of this background research are included in the previous section (Project context and focus). EndNote was again used to collate and annotate these resources (see Fig. 7, below).

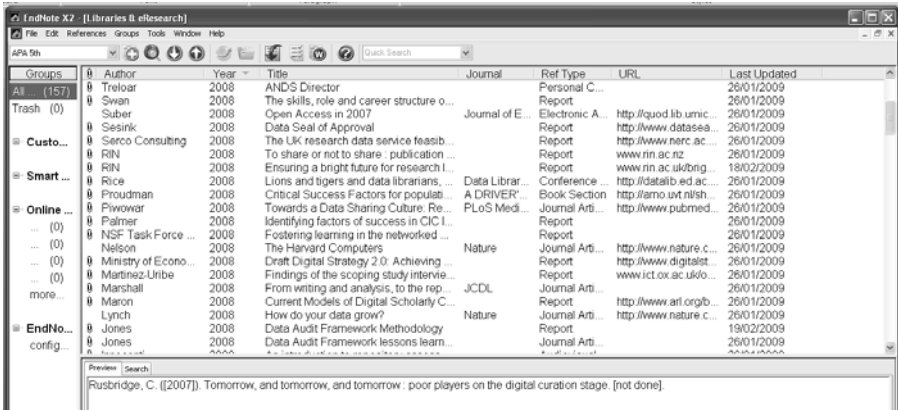


Fig. 7: EndNote Library: Libraries and eResearch

A third strategy was also important in this pre-project phase, i.e. **consultation** with experts in the fields of biodiversity and/or data management and a number of phone and email conversations were held with senior staff from GBIF, DOC and Landcare Research. Encouraged by these conversations, I put forward a project proposal (Elliot, 2007) to Library management and the Otago Biodiversity Data Management Project was approved for 2008.

Project phase 2008

While this Project was initiated and funded by the Library, **formal consultation and communication** with University of Otago researchers, other University departments, local iwi and external researchers and funders, was recognised as being essential for the ongoing relevance and sustainability of this initiative.

A Library Reference Group was established and met monthly to advise and reflect on the Project and presentations about the Project were made to wider Library staff. To ensure the Project remained relevant to the needs of the Otago research community a Library/Faculty Advisory Group¹⁸ was established, and met four times during the year. The Project was also shared with the University's Research Committee and the eResearch Advisory Group.

It was important that Māori, in particular Kai Tahu, be kept informed throughout all stages of this Project, especially as this Project was planning for better management of information about New Zealand endemic species. Meetings were

held with several key University Māori staff members and there was Māori representation on both the Library Reference Group and the Library/Faculty Advisory Group.

Further meetings were also held with a wide range of digital management and biodiversity experts around New Zealand, from a range of governmental and non-governmental organisations¹⁹. Those within government departments and CRIs²⁰ generally had a greater understanding of the value of (and the issues around) managing research data. Many of these conversations formed the basis for ongoing communication and may lead to active collaboration and funding opportunities in future.

International conferences²¹ and meetings provided further opportunities to share information about the Project and also to meet with international experts who are leading the charge with biodiversity and other research data management initiatives²². There was significant interest in the Otago Project and many senior managers have been keen to offer guidance and support, to encourage ongoing investment in the aims of the Project.

A key strategy towards better understanding of the data management interests and requirements of Otago researchers was the development of a data management **questionnaire**, based on recent surveys from the UK, USA and Australia²³. This multi-choice questionnaire was made available both online and in-print, between April and August 2008. 170 Otago researchers, with an interest in biodiversity, were invited to participate and there was a 42% response rate.

Both quantitative and some qualitative responses were received from over 70 life scientists, confirming some of the earlier anecdotal comments about why (or why not) data management is important to researchers and also providing further additional information about researchers' interests and concerns about managing, sharing and accessing data. Selected key findings from this questionnaire include:

The full report of this questionnaire (*Questionnaire Report*) is available online, on the University of Otago Library Projects website: www.dlj.frlj.cpl.org/v32745B ; :

There is considerable interest in formal research data management among Otago researchers (70% of respondents wish to stay in touch with this Project and further developments)

The issues of data management are not widely understood by all researchers (indicated by the high number of 'don't know' responses and also through free text comments)

The majority of Life Science researchers have relatively small amounts of data (<1 terabyte) and this data typically has a long life (>10 years)

The majority of researchers manage their own data and apply their own metadata

Most researchers indicate interest in sharing data with others but typically do so informally only (email, personal contact and direct face-to-face data sharing remain popular)

Practical considerations (time/support) are barriers to sharing data (along with intellectual property/ownership)

Notes from more than 70 interviews, with Otago (and other) researchers and administrators, together with documented phone and email conversations, were collated and will inform a second **qualitative report** (*Survey Report*), soon to be available on the Library Projects website. Many of these conversations highlighted a general lack of awareness of data management issues, although almost all those interviewed were interested in knowing more about the implications of research data management for their own research²⁴.

There will be some overlap between the Questionnaire and Survey reports, i.e. some researchers were interviewed and also did the Questionnaire. In addition, some of the themes included in the Questionnaire (the current Project, questions about metadata and accessing/sharing data) also emerged in the less structured interviews. However, additional (generally) unprompted issues about data management also emerged during these unstructured conversations. These included: the role of the Library in data management; the research process generally and at Otago in particular; understanding the issues of data management and also collaboration and funding models.

Ongoing **desk-based research** continued to build understanding of the wider issues and challenges of managing biodiversity and other research data.

A Library '**pilot within a pilot**' group was established to examine some of the technical and other challenges of managing a real life biodiversity research data collection, using a selection of frog-related digital images (and one sound file), generously loaned by Otago life scientist and national frog expert, Dr Phil Bishop²⁵.



Research data can include a wide range of information types and formats (Pryor, 2006, p.19). Scientific research images were deliberately selected by the Library as an initial test collection for several reasons including: library staff already have experience in managing digital images (see Digital Collections, <http://digital.otago.ac.nz>); scientific data present as yet untested challenges for the Library (such as applying appropriate taxonomic and geospatial information); research data present, as yet, untested challenges in Rights Management (such as ownership and intellectual property) and finally, image data may not be clearly identified and this issue could be tested (context of scientific data is critical).

The 49 digital images and one sound file which were selected represent a range of differing technical, legal and cultural challenges and while some preliminary work has been done (concerning format, storage, standards, linking and access),

technical recommendations have yet to be made. A full report (*Pilot Project Report*) will be made available in the near future.

Findings from the literature, the questionnaire, the upcoming qualitative survey (interviews with researchers) and other Project communication informed the final Project report, *Final Project Report*. This report, which also includes recommendations for going forward, was presented to Library management in November 2008.

In total, four major Project reports are either in progress or have already been completed. These are: *Otago Biodiversity Data Management Project Part 1: Questionnaire Report*; *Part 2: Survey Report*; *Part 3: Pilot Project Report* and *Part 4: Final Project Report*.

Project extension 2009

In December 2008, it was agreed to extend the Otago Biodiversity Data Management Project for a further six months, until 30 June 2009. During this extension a number of key data management activities are planned including: a collaborative application for academic research funding²⁶ (to research technical solutions for RDM); ongoing dialogue with Library colleagues (investigating strategies towards more effective academic liaison, particularly in the area of e-research) and a data management workshop, co-hosted by the Library and the University's Ecology, Conservation and Biodiversity Research Group.

The findings of these, and other activities, will inform the future of this Project and also wider e-research support strategies at the University of Otago Library.

Conclusions

Managing information (includes data)

Libraries around the world are already managing and sharing digital information; online databases, electronic books and e-journals are now commonplace in most libraries. Unpublished print resources are also being shared more widely, as research institutions (together with their libraries) manage and make available their own scholarly research outputs, via Institutional Research Repositories. Librarians are increasingly adapting to this new digital environment; taking on new responsibilities, forming new collaborations, learning new skills and creating new information solutions. However, managing digital and digitised print resources is only part of the information challenge in the 21st century, particularly for those working within the rapidly changing e-research environment. The long-term management, curation and sharing of research data is arguably the most significant and complex challenge facing all research organisations (and their libraries) today.

While there is little evidence, as yet, of formal research data management within New Zealand universities and their libraries, there is a growing awareness of the

issues and potentials of managing data among many researchers, including those at the University of Otago.

Effective communication (includes listening)

This Library Project has its origins in largely unstructured conversations with University researchers, only some of whom would readily describe themselves as library-users. Indeed, a number of these conversations began with '*oh, you're from the Library, I'm sorry I don't go there anymore...*' and '*I never visit the Library, everything I need is online these days...*' While these comments are not quite as worrying as they first appeared (all the researchers were routinely accessing the Library's resources and services, albeit remotely), the comments, and ensuing conversations, did highlight the importance of connecting with the (widest possible) library community and being prepared to *listen* to their changing information needs. Genuine communication can (as was demonstrated by this Project), open up fresh dialogue, lead to new opportunities and build unexpected collaborations and synergies; it can create new potentials for moving forward into the digital information future.

Project potentials and outcomes

Project activities (conversations, interviews, surveys and presentations) have brought the Library into the offices of life scientists and other researchers at the University of Otago. Many, within and also beyond the University, have been reminded of the Library's potential in the emerging e- research environment, '*I'd forgotten about the Library, what a good idea...*' In making these connections, the Project has enabled Library staff to reaffirm connections within the research community and some, recognising new potentials, are already building on these foundations. As one Library staff member remarked, '*this has been a real unscaling of our eyes*'.

Finally, this Project has firmly established that researchers require better support to manage and share their data more effectively and this finding is well supported by the international literature. Debate, however, continues regarding *who* is to provide this support and, if libraries, how this might be achieved, both now and in the long term.

Acknowledgements

I wish to thank the University of Otago Library for recognizing the potential of this biodiversity data initiative. I would also like to thank all the researchers, data management and biodiversity experts who have given freely of their time over the last 18 months, generously providing insight, support and guidance to myself and to my Library colleagues. I would especially like to thank Dr Phil Bishop (and his wonderful frogs), Prof Kath Dickinson (for her ongoing encouragement and support) and GBIF Director, Prof David Penman, who inspired me to proceed with this initiative.

Image acknowledgements

1. Fig. 4: *Iceberg illustration* (page 4) by David Elliot
2. Fig. 5: *Selection of New Zealand's biodiversity* (page 6) Images kindly made available by University of Otago researchers: left to right, top to bottom:
 - Torrentfish by Bruno David (courtesy of Dr Gerry Closs)
 - Mollymawk by Dr Keith Probert
 - Saddleback by Dr Ian Jamieson
 - Brown Tree Frog by Dr Phil Bishop
 - Takahe by Dr Ian Jamieson
 - Serolis (deep sea isopod) by Dr Keith Probert
 - Snares Island Penguins by Ursula Ellenberg
3. Frog image: *Southern Bell Frog* (page 10) by Assoc Prof Russell Poulter

¹ Orokonui Ecosanctuary (wildlife reserve being established close to Dunedin city): www.oroikonui.org.nz/

² Otago's research outputs are available via the Kiwi Research Information Service (KRIS): nzre-search.org.nz/

³ typically between individual researchers working on collaborative projects

⁴ Lane (2003) and Penman (2007) provide useful overviews of GBIF and the management of biodiversity data from an international perspective.

⁵ Largely through the activities of its funding programme, the Terrestrial and Freshwater Biodiversity Information System Programme (TFBIS): www.biodiversity.govt.nz/land/nzbs/tfbis/tfbis/

⁶ 'Ecology, Conservation and Biodiversity in New Zealand' is one of the University of Otago's 12 key Research Themes or "areas of research in which the University is pre-eminent and to which it gives particular recognition and support." (University of Otago, 2009)

⁷ *The UK Research Data Service Feasibility Study* (2008) will inform the establishment of a National Research Data Service for the UK.

⁸ KAREN "is a high-speed network that connects research organisations around New Zealand" (Searle, 2007)

⁹ An exception is the NZ Social Science Data Service, based at the University of Auckland: www.nzssds.org.nz/links

¹⁰ The more recent Draft *Digital Continuity Strategy* (Sept 2008) does acknowledge the need for greater management and storage solutions for research information, including research data (7.2.6 Research Information). However it does not go as far as to recommend how this might be achieved.

¹¹ Conservation International *Biodiversity Hotspots*: www.biodiversityhotspots.org/

¹² "New Zealand's Archey's Frog is the world's most evolutionarily distinct and globally endangered amphibian" [out of more than 6,240 species] (University of Otago, 2008)

¹³ See: *Transformational Research, Science and Technology* (2007)

¹⁴ The Project has been extended and will continue to at least 30 June 2009

¹⁵ ERG: <http://www.otago.ac.nz/erg/>

¹⁶ “Qualitative research is conducted in a more interpretive and contextual fashion and goes beyond the “facts and figures” gathered by objective measures. ...” Retrieved from: planning.nmsu.edu/taskforce/glossary.html

¹⁷ Many of those interviewed were interested in talking for longer than 15 minutes, and I was guided by their interest.

¹⁸ Biodiversity Data Management Advisory Group

¹⁹ These included: the New Zealand Electronic Text Centre; Royal Society of New Zealand; DOC; TFBIS; Landcare Research; MoRST; Ministry of Fisheries; the Universities of Canterbury and Auckland; Orokonui Ecosanctuary and the Yellow-eyed Penguin Trust.

²⁰ CRIs, particularly Landcare Research and NIWA, build and manage most of New Zealand’s biodatabases

²¹ I presented on the Project at two international conferences and these presentations are available online at: http://www.apsr.edu.au/data_management_plan/presentations.html and <http://prdl.ucmercedlibrary.info/past-meetings/2008-singapore/page/2/>

²² Communication was established with experts within: the UK’s Digital Curation Centre and UKOLN; the Smithsonian Museum of Natural History; GBIF; Biodiversity Heritage Library; the University of Illinois; the Australian National Data Service and a number of Australian universities.

²³ Pryor (2006), Cragin (2008) and the University of Queensland (2007)

²⁴ Only two senior researchers expressed a lack of interest in RDM and both have since revised their positions

²⁵ More information about Dr Bishop’s research is available on the NZ Frog website: www.nzfrogs.org/Frog+Research/University+of+Otago+Frog+Group.html

²⁶ This University of Otago Research Grant application, led by Dr Nigel Stanger (Information Science), was successful and will run between April and October 2009.

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