

Cataloguing biological surveys within Western Australia: the Pilbara experience

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Abstract

This paper details a project that was undertaken with the aim of documenting and reviewing all past biological survey work undertaken in the Pilbara bioregion of Western Australia. Bibliographic-style information was collated for 200 reports, with a further 589 identified for the bioregion. This descriptive information was then made available to the general public through a World Wide Web interface. The project did not achieve all of its aims, but has successfully listed details of the 200 reports, provides an additional resource for government assessors and also provides some context for biological surveys being undertaken in the Pilbara. As a case study, the project is a successful prototype knowledge management tool, a proven use for Internet deployment and has identified a wide range of 'grey' literature. It also has highlighted two issues that managers of biological survey data should consider; namely those of quality and ongoing data capture.

Keywords: Biological surveys, database, Pilbara, Western Australia

Introduction

There appears to be a general desire on behalf of global, national and state organisations to integrate a range of environmental data. The United Nations "Agenda 21" document, which is proposed as a blueprint for addressing environment and development issues into the 21st century, indicates that while considerable data exists, "more and different types of data need to be collected, at the local, provincial, national and international levels" in order to increase the capacity for making informed decisions concerning the environment (UNCED 1992, Chapter 40). The United Nations have instigated a number of projects, such as the Global Resource Information Database (UNEP 1996) to help achieve that aim.

The United Kingdom Royal Society recently recommended that "The scientific community needs urgently to emphasise synthesis that makes otherwise scattered data more readily available and more useful..." (The Royal Society 2003, pg 6). In Western Australia, the Environmental Protection Authority (EPA) in Guidance Statement No. 56 (EPA, 2003) states that "...terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the particular region..." (EPA 2003, pg 4). This followed "Position Statement No. 3" (EPA 2002), which noted that a state-wide biological 'bank of data' would aid our understanding of biodiversity and the Environmental Impact Assessment (EIA) process. Specifically, the EPA indicated that such a database would lead to:

- improved decision making;
- reduced costs for EIA; and
- conservation of biodiversity (EPA 2002, page 14).

The Western Australian environmental community is aware of how important this type of database would be to the industry. At a workshop held in April 2002, coordinated by the Royal Society of Western Australia, a number of presenters spoke of the need for co-ordination between existing custodians of such biological data sources (Thompson 2002 and Thompson & Withers 2002).

In June 2000 the Pilbara Iron-ore Environmental Committee (PIEC) released a tender for a project to document and review all past biological survey work undertaken in the Pilbara region of Western Australia. PIEC is an association of private mining companies and government organisations formed to foster the exchange of environmental and sustainable development knowledge and technologies among constituent members. PIEC members in 2000 included BHP Billiton, Hamersley Iron, Hope Downs Management Services, Robe River Iron Associates as well as the Departments of Conservation and Land Management (CALM), Environmental Protection (DEP), Resource Development (DRD) and Minerals and Energy (DME).

The project aimed to create a comprehensive bibliographical-style database containing descriptive information about all biological surveys carried out in the Pilbara. It should be noted that the project did not aim to collate the results of these projects (*i.e.*, trapping results or vegetation assemblages) into a single database. The project was perceived to have a range of uses for the PIEC members and the general public, which were documented in the objectives. These objectives were to:

1. provide a regional and local context for contemporary survey work being undertaken in the bioregion;
2. minimise duplication of effort among companies undertaking surveys;
3. list historical surveys;

4. provide an additional resource for researchers and assessment officers from government departments;
5. maintain a current listing of document authors; and
6. become a one-stop reference point for the identification of all biological surveys undertaken in the Pilbara, rather than the current situation where reports are scattered throughout the libraries of PIEC members.

The project was spatially limited to the Pilbara biogeographic region as defined in the Interim Biogeographic Regionalisation for Australia (Environment Australia 2000). This was further limited to the Pilbara mainland and associated island areas above the low water mark; thereby excluding marine surveys. Consequently, all publications reporting on flora, vegetation (including mangroves) and vertebrate fauna were to be captured by this project.

Methods

The June 2000 tender required the review of all previous biological surveys undertaken in the Pilbara and the collation of a range of descriptive information. The second phase involved the migration of the collated information to an on-line environment at the Western Australian Herbarium.¹

Phase One: Identification and Collection of Data

Biota Environmental Sciences (Biota) were the successful lead tendering organisation for the PIEC project. Data collection occurred during late 2000 and early 2001 and consisted of an extensive literature search, followed by the collation of descriptive information from identified and relevant reports. Reports were sourced from the libraries of Biota, Hamersley Iron, BHP Billiton and the DEP. Of particular use to the project were two publications: "A bibliography and research inventory of vertebrate fauna in Western Australia" (CALM 1984); and "Bibliography of location-based biological studies in Western Australia" (CALM 1994).

The Spatial Metadata Management System (SMMS) application, produced by Intergraph, was used to collect the descriptive information for each report in a digital format. While SMMS was designed to manage descriptive information for spatial datasets, it also had the ability to record data such as bibliographic, taxonomic and methodological data. The software utilised an underlying Microsoft Access database for data storage.

One person (the author) was responsible for data collection to ensure consistency in the capture of descriptive information. The information collected included items such as:

- bibliographic information, e.g.
 - o title,
 - o originator,
 - o publication date; and
 - o abstract;

- biological information, e.g.
 - o methodologies used; and
 - o any taxonomic references;
- spatial extents of the survey; and
- keywords identifying the nature of the survey.

A list of keywords was generated during the initial stages of the project, and supplemented through an iterative process with the PIEC membership. The keywords were collected to provide a means of searching the database for publications related to particular areas of interest, without having to either read or search through detailed information for each report.

A discussion paper was submitted to the PIEC in May 2001 (Biota Environmental Sciences 2001a) and a final report was provided to the PIEC in June 2001 (Biota Environmental Sciences 2001b). A copy of the underlying Microsoft Access database was also supplied on CD-ROM with the final report.

Phase Two: Migration to the On-Line Environment

The second phase of the project commissioned in June of 2002 with the aim of making the data available via the World Wide Web (WWW) through the existing web site of the Western Australian Herbarium (a division of CALM). The first release of data onto the WWW was aimed at demonstrating to PIEC that the data could be made web-accessible.

The descriptive information stored in the database went through a number of processing steps to meet the requirements of the existing databases at the Western Australian Herbarium. Initially the data were exported from SMMS into a plain text format file. The file was subsequently processed in Microsoft Excel to remove special characters and then exported to a text format file. Several "search and replace" operations ensured the file was properly delimited and was supplied to the Herbarium in August 2002. The data were subsequently uploaded to the Herbarium databases and were released onto the WWW in October 2003, marking the end of the second phase of the project.

Results

Phase One: Data Collection

The data collection resulted in the identification of 789 biological survey reports. All 789 had the title information included in the database, although due to time and budgetary constraints, only 200 of these reports were sourced and had descriptive information entered into the database. It is probable that these 789 reports do not represent the entirety of biological surveys undertaken in the Pilbara.

The final report (Biota Environmental Sciences 2001b) included the following recommendations:

- appointment of CALM as the data custodian;
- hosting of the data using Western Australian Herbarium infrastructure;

¹ Author's note: At the time of submission in July 2004, the project had proceeded to a third phase where additional reports were being entered by CALM staff into a purpose-built database.

- maintenance to be undertaken annually;
- no charges to be made for accessing the resultant web site;
- registration of users to be undertaken via the web site; and
- keywords to be reviewed and refined in the future.

Phase Two: Migration to the On-line Environment

In the second phase of the project, several of the recommendations of the first phase were implemented. CALM accepted its role as custodian, and commissioned a project to host the data at the Western Australian Herbarium. A subset of the descriptive information held in the database can be accessed through the web site <http://science.calm.wa.gov.au/projects/pilbaradb/> and is available to the general public free of charge.

Discussion

The project has achieved one of its objectives, partially accomplished two additional ones but has failed to meet the remaining three. Of the 789 surveys identified during the project, only 200 (25%) were sourced and had descriptive information compiled. Each of the project objectives is discussed in the following sections.

1. Providing both regional and local context

The database provides a regional and local context for biological survey efforts. Any party that is proposing to undertake a biological survey in the Pilbara can carry out a search of the database using the existing web interface. Proponents, such as the major mining companies in the Pilbara, can investigate biological survey effort already undertaken in specific areas before commissioning additional work. Since it is unlikely that any single person can be aware of the entire body of work present

in this database, this search mechanism represents an effective information management tool.

A current limitation of the database is that the entire suite of reports for the Pilbara has not been captured.

2. Removing duplication of effort

It is possible to see how the results of this project can remove duplication of biological survey efforts can be avoided through a simple search of an area prior to commissioning new surveys. However, as the database is not an exhaustive list of all biological surveys, and the level of use of this database is not known, it is not likely to be achieving this objective.

3. Listing historical surveys

There was no time limit placed on the reports that were to be entered into the database. The earliest report listed in the database is dated 1828, by A. Cunningham, entitled "A few general remarks on the vegetation of certain coasts of Terra Australia, and more especially of its north-western shores". The latest reports were sourced in the year 2000 (26 reports in the database were published in this year). Most of the reports have been published in the last two decades (Figure 1).

4. Providing additional resources for researchers and for government assessors

Achieving this objective is hampered by an incomplete data set. However, for those researchers and assessing officers that are aware of the project and the web interface, it is a quick method of accessing a substantial quantity of privately published reports that are generally not accessible using the established scientific bibliographic databases. For example, research projects such as that undertaken by Fraser *et al* (2003) could have used the database to analyse a larger cross-section of the methodologies used in biological survey reports. The project has therefore partly achieved this objective.

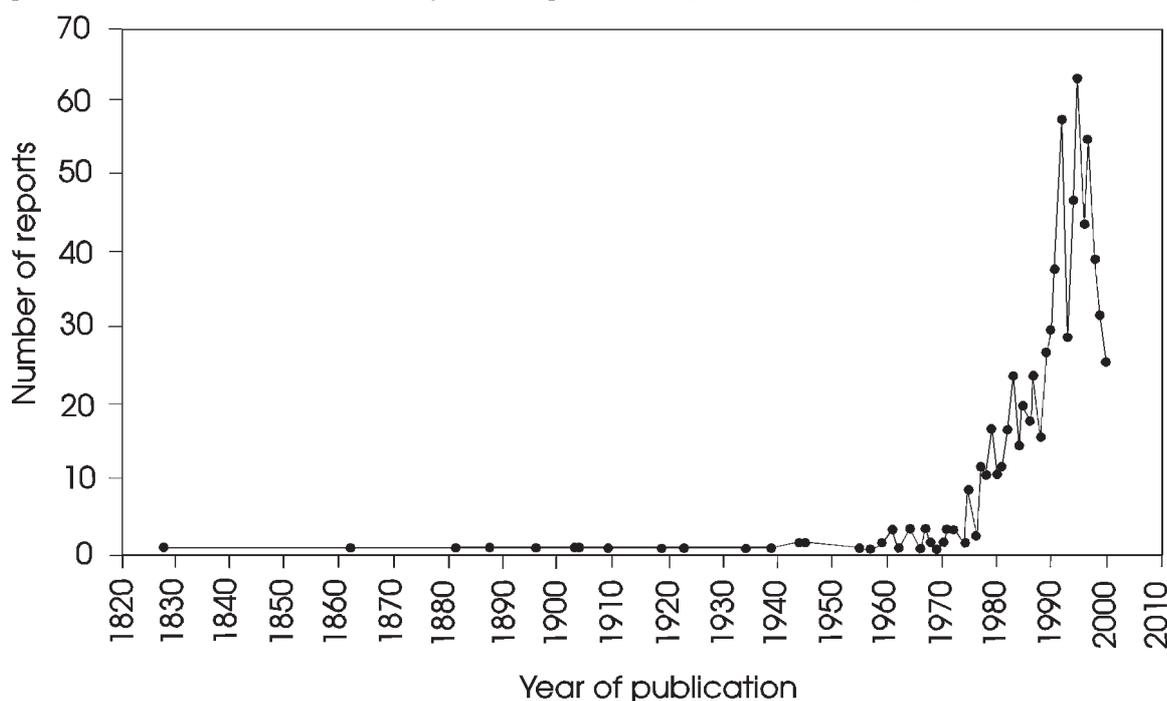


Figure 1. Reports captured during the project by year of publication

5. Maintaining a current listing of the authors of these documents

The maintenance of a contact list for any industry is a significant task. The database collated a range of contact details for reports. However, there has been no maintenance of the database since the end of the first phase of the project (June 2001), and as a consequence the information is already outdated. Therefore, the project has not met its objective of maintaining a current listing of the contacts.

A method for keeping the contact lists up to date is by registering visitors to the web site. The project recommended that registration should be free. Once a contact list was generated, it would be possible to automate an annual registration e-mail that included a hyperlink to the person's record within the database. Since the database employs relational structures, rather than update every single report, individuals would simply update a 'master' record and all reports with a link to this record would reflect any changes that the person has made. Of course, such development would attract a cost that would have to be borne at some point by the custodial organisation (currently CALM).

It should be noted that there are other alternative contact lists available to interested parties – such as the Environmental Consultants Association of Western Australia contact list, available on the WWW at <http://www.eca.org.au/>. Replicating the maintenance of a number of contact lists is not an ideal solution and it seems that it may be more efficient to remove this objective from further work on the project.

6. Becoming a one-stop reference point for all surveys undertaken in the Pilbara

Although listed as the final objective, this is perhaps the most important objective. Had the project managed to source and collate descriptive information for all identified reports, the database would have a much greater value. Additional reports listed in the references for these 589 reports would have added to the number of relevant reports for the Pilbara region.

While the project has not fulfilled all of the objectives that PIEC set for it, there is still value in the project. The fact that the project has captured information about the areas that have been surveyed in the Pilbara is of value. The project also enhanced the understanding of the issues associated with data management, data capture and data maintenance, and proved that a web-based deployment could be undertaken. One of the most encouraging results of the project is that a wide range of literature that would otherwise be closeted in private libraries (the 'grey' literature) is made publicly available.

Two major issues are of importance to the future of this project:

- quality – assessing the quality of biological surveys was not addressed during the project; and
- data capture requirements – who and how will the data be maintained.

Each of these future issues is discussed below.

Quality

The project originally had a requirement to rate the

quality of the survey undertaken and documented in each report. As the organisation undertaking the work (Biota) was a private commercial organisation, a potential conflict of interest was identified early on in the project. It was seen as undesirable to have a commercial organisation develop a quality ranking system and subsequently rate a competitor's work, without some form of appeal or input from the authoring organisation. Professional societies such as the Ecological Society of Australia (ESA) acknowledge this hindrance to quality assurance in the biological/ecological consulting industry (ESA, n.d.). As a potential solution to this problem, the ESA advocates peer review as a means of quality control. A specific proposal for the WA environmental community is currently being prepared by Teale & Higgs (unpublished data).

The issue of devising both quantitative and qualitative assessment criteria in a stand-alone project was seen by PIEC as problematic. As studies such as Fraser *et al* (2003) have shown, there is no standard methodology for assessing the quality of surveys. While the quality of an environmental survey can to some extent be determined from quantitative assessment of the methodology used, other qualitative aspects need to be taken into account, such as the experience of the biologists performing the survey. Once a best practice standard can be agreed upon and set in place by the regulatory agencies, it is more likely that the quality of biological surveys can be adequately assessed.

Data capture requirements

Given that no data collection has occurred since May 2001, the database does not include any information from contemporary reports produced for the Pilbara since this time. Therefore, apart from the 589 reports that still need to be sourced and have descriptive information captured, there are potentially many additional reports that have not even been identified by this project. If the project was broadened in scope to include invertebrate surveys, which are often ignored in biological survey efforts (Bisevac & Majer 2002), then this is likely to include many more surveys.

From the experience of the first phase of the project, between 15 minutes and one hour is required to adequately collect descriptive information and enter it into a database for each report. The duration of data capture varies according to the length of the report being reviewed, but would average at 30 minutes per report. Therefore, between 400 and 650 person hours would be required to complete the data gathering for the Pilbara bioregion.

In addition to capturing the already identified but not assessed biological survey reports, the future of this project must consider the ongoing capture of newly produced reports. One option is to capture new reports on an annual cycle, as recommended by the final report of this project (Biota Environmental Sciences 2001b). If this occurs, it is estimated that approximately 30 to 40 reports per year would be produced for the Pilbara. From an initial analysis of the reports contained in the database, the majority of reports were published early in the calendar year (January – May). An annual update cycle in June would capture a large number of these reports within an acceptable timeframe. Additional time

would be required to update the Western Australian Herbarium database, which is in the order of 30 person hours per year.

The process of maintaining these data is not currently part of any existing business process but has been considered to instead be an annual commercial tender. It is well established in efficiency and performance literature that piecemeal approaches, such as annual tendering, can return little, if any, returns (e.g., Rummler & Brache 1995). In order to avoid a piecemeal approach, it is suggested that existing, established business procedures are used (with modifications) to maintain this database. There are two business processes that appear to be ideal for capturing this information:

- The Environmental Impact Assessment and ongoing licensing processes undertaken by the Department of Environment (DOE)
- The Wildlife Licensing process undertaken by the CALM

Each is briefly discussed below.

The EIA and ongoing licensing processes

The EIA process relies upon biological survey reports to function. Organisations undertaking an EIA process produce reports, such as Public Environmental Reviews, Environmental Review and Management Plans and Consultative Environmental Reviews, that are provided to the EPA for assessment. Since the assessment officers must review these documents as part of the assessment, it is possible that this existing process could be modified to include data collection. This would involve the assessment officers at the DOE capturing descriptive information about the report, that is stored within an appropriately designed database.

In another process, Annual Environmental Reports are generated by organisations for the purposes of licensing. These reports provide environmental information in relation to their operations, which can include ongoing monitoring and other biological survey data. The DOE also reviews these reports, and the process could be modified in a similar manner to the EIA process.

The wildlife licensing process

The wildlife licensing process requires the submission of any reports relating to licences. When studies that include collection of animals are to be undertaken, a licence is required from CALM. This licence includes the condition that copies of any reports must be delivered to CALM within one month of the licence expiry. This is a second potential process for modification to include collection of descriptive information.

Wildlife licensing only requires reporting on fauna surveys under the *Wildlife Conservation Act 1950*. Flora licensing (under the CLM59 licence "Scientific or Other Prescribed Purposes Licence to take protected flora from Crown Land for non-commercial purposes") does not require specific reporting as it is a blanket licence for an individual for a period of 12 months. This licence requires lodgement of specimens to the Western Australian Herbarium. The wildlife licensing process in its current form will not capture biological survey data on non-threatened or protected fauna, or on general flora or vegetation surveys. Unlike the EIA process, it may

capture a range of academic research as licences are routinely issued for many of these studies. One of the issues that is raised with this process is that copies of reports or specimens are not provided to CALM as specified on the licence, and this is poorly enforced (S van Leeuwen, pers. comm.)

It is not probable that any change, no matter which processes are involved within either organisation, will be able to capture descriptive information about every single biological survey undertaken. Research or theses completed by research institutions such as universities, or reports commissioned by mining companies that are not as a result of the environmental legislative requirements are two examples of reports that will not be captured. However, by making changes to existing processes, such as the EIA or wildlife licensing processes, it may be possible to capture a significant proportion of the biological survey reports produced within Western Australia.

It may be that other organisations, such as the Western Australian Land Information System (WALIS), would be ideally suited to accept responsibility of this database and co-ordinate the efforts of other organisations. WALIS, who manage a range of descriptive databases, could also deliver a significant economy of scale, and can provide considerable expertise in managing this data, despite a relative lack of expertise in the biological sciences.

Given the fact that significant time has passed since any data collection has been undertaken, it is highly recommended that the project is thoroughly reviewed (using holistic models such as the Information Technology Interaction Model proposed by Silver *et al* 1995) in order to consider changes made to organisations, processes and any relevant projects before any further resources are committed to it. It is likely that there have been significant changes to the capabilities of the Western Australian environmental community, which may have ramifications to future phases of the project.

Conclusions

This project has raised important considerations for the practitioners of biological data management in Western Australia and future developers of similar or related systems should consider the issues of data quality and ongoing data capture. In particular, it highlights how an investment in technology, without an appropriate consideration of related business processes, cannot be entirely successful. However, as a case study for the management of biological data and information, it provides useful information. It has partially captured information about the types and extents of biological surveys in the Pilbara, and, should the project continue to further phases, would continue to capture and document this information.

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References

- Biota Environmental Sciences 2001a. Pilbara Biological Survey Review Database: Discussion Paper. Unpublished report prepared for the Department of Resource Development, May 2001.
- Biota Environmental Sciences 2001b. Pilbara Biological Survey Review: Final Report. Unpublished report prepared for the Department of Resource Development, June 2001.
- Bisevac L & Majer J 2002. Cost effectiveness and data-yield of biodiversity surveys. *Journal of the Royal Society of Western Australia*, 85: 125–127.
- Department of Conservation and Land Management 1984. A bibliography and research inventory of vertebrate fauna in Western Australia. CALM, Perth, Western Australia.
- Department of Conservation and Land Management 1994. Bibliography of location-based biological studies in Western Australia. CALM, Perth, Western Australia.
- Environment Australia 2000 Revision of the Interim Biogeographical Regionalisation of Australia (IBRA) and Development of Version 5.1 – Summary Report. Last accessed on 3rd September, 2003 from <http://www.ea.gov.au/parks/nrs/ibra/version5-1/summary-report/index.html>.
- Environmental Protection Authority 2002. Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3. Perth, Western Australia.
- Environmental Protection Authority 2003. Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986): Terrestrial fauna surveys for environmental impact assessment in Western Australia. Guidance Statement No. 56 (Draft) February 2003. Perth, Western Australia
- Environmental Protection Authority 2004. Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986): Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 51 June 2004. Perth, Western Australia.
- Ecological Society of Australia (no date). Ecological Factors in Environmental Impact Assessment: Position Statement by the Ecological Society of Australia. Last accessed on 4th September, 2003, from <http://www.ecolsoc.org.au/documents/EcologicalFactorsInEnvironmentalImpactAssessment.pdf>.
- Fraser J L, Thompson G G, & Moro D 2003. Adequacy of terrestrial fauna surveys for the preparation of Environmental Impact Assessments in the mining industry of Western Australia. *Ecological Management & Restoration*, 4: 187–192.
- Gioia P 2002. Database Ownership and Access Issues – A Discussion Paper. *Journal of the Royal Society of Western Australia*, 85: 147–150.
- Rummler G A & Brache A P 1995. Improving Performance: How to Manage the White Space on the Organisation Chart. Jossey-Bass Inc., California.
- Silver M S, Markus M L & Beath C M 1995. The Information Technology Interaction Model: A Foundation for the MBA Core Course MIS Quarterly 19: 362– 390.
- The Royal Society 2003. Measuring biodiversity for conservation: Summary. Policy document last accessed on 3rd July, 2003 from <http://www.royalsoc.ac.uk/>.
- Thompson G G 2002. Do we need a terrestrial fauna survey database in Western Australia? *Journal of the Royal Society of Western Australia*, 85: 115–117.
- Thompson G G & Withers P C 2002. Summary of the Workshop. *Journal of the Royal Society of Western Australia*, 85: 151.
- United Nations Conference on Environment & Development 1992. Agenda 21. Document last accessed on 1st July, 2004 from <http://www.unep.org/Documents/Default.asp?DocumentID=52&ArticleID=49>.
- United Nations Environment Programme 1996. Global Resource Information Database. Last accessed on 1st July, 2004 from <http://www.unep.org/newdraft/unep/eia/ein/grid/home.htm>.