ACCESS TO

SCIENCE INFORMATION

PRODUCED IN NEW ZEALAND

a research report

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FOREWORD

We are pleased to present this research on the issues relating to access to New Zealand science information.

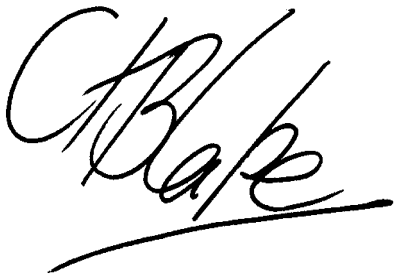
This research was commissioned by the Trustees Library Resources Committee, in response to a growing concern among the library and wider information community, researchers and others, about 'providing equity of access to information', particularly access to science information produced in New Zealand. This has been a joint project between the Trustees Library Resources Committee and the National Library, supported by a grant from the Trustees of the National Library of New Zealand.

The aim of this research was to assess the availability and accessibility of science information produced in New Zealand for all New Zealanders by:

- Describing the current state of collection, preservation and access to science information produced in New Zealand.
- Identifying gaps in collection and preservation, and barriers to accessing science information produced in New Zealand.
- Analysing the information to address issues of collection, preservation and access in relation to the objective of New Zealanders having good access – now and into the future – to science information produced in New Zealand.

The research has provided a solid basis for understanding the issues relating to access to New Zealand produced science information. This information will be of interest to a wide range of producers and users of science information in New Zealand as well as information specialists.

This joint research has been an exciting project and is another step in the achievement of the purpose of the National Library of *Informing New Zealand: forging links between information and people*.



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- The research participants who participated in the initial research and workshops at the National Library – the information that was required was at times difficult to obtain. However the research participants always did their best and the quality of the research reflects their efforts.
- Tim Leyland of the National Library who commented on aspects of this research.

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EXECUTIVE SUMMARY

1.1 Introduction

Both the National Library of New Zealand and Government have crucial roles to play in establishing the information rich society necessary for economic growth, enterprise and innovation, education and training. The National Library is concerned about:

- providing equity of access to information
- balancing public interest and private advantage
- protecting privacy
- protecting national and cultural identity

This research was commissioned by the Library Resources Committee of the Trustees of the National Library, given their perception of a growing concern among the library and wider information community, researchers and others, about 'providing equity of access to information', particularly access to science information produced in New Zealand.

The research involved three phases, running more or less sequentially. The three phases included:

- **Phase One** involved an environmental scan that focused on the broad issue of availability of science information. Information was collected on the current state of collection, preservation and access to science information generally and that produced in New Zealand in particular.

- **Phase Two** focused on the broad issue of access to information by identifying gaps in collection and preservation, and barriers to accessing science information.

- **Phase Three** focused on resolving the issues identified in the previous phase - around the collection, and preservation of science information, and ensuring ease of access, now and in the future.

Methods used in these research phases included analysis of existing information and collecting of new information by way of surveys, interviews and a workshop.

1.2 Key Findings

1.2.1 Producers of Science Information in New Zealand

Most science providers perceived that increasingly, in New Zealand, science outputs are subject to restrictions because of commercial sensitivity.

Some providers believe there has been a decrease in the number of New Zealand produced published scientific papers. There are two concerns related to the decrease in scientific papers. First, scientific papers are an important source of publicly available science information. Second, scientific papers are important because they remain the basis upon which scientists are judged in the international arena.

Some science purchasing agents and providers believe there has been an increase in the number of New Zealand produced science outputs overall. Purchasing agents have demanded more innovative science outputs in the belief that availability of science information (for instance, published scientific papers) does not necessarily equate with its accessibility. Science providers are increasingly generating outputs such as conference papers and presentations, field day presentations and articles aimed at more general audiences.

1.2.2 Collection and Preservation of Science Information Produced in New Zealand

Science information produced in New Zealand is primarily collected and preserved by libraries. However, it is not possible for libraries to readily quantify and describe in any comparable way the amount and type of science information produced in New Zealand that they hold. This is because the vast majority of published science outputs of science producers in New Zealand are in the form of scientific papers published overseas in international journals. Another factor is the lack of an up-to-date index of New Zealand science, which limits libraries' ability to identify science information that is published in New Zealand.

The perception of respondents is that the proportion of New Zealand science in libraries has not changed, and is not expected to change over the next few years. However, some libraries reported that, given the difficulty in identifying New Zealand science information, they could not be sure if there had been changes, or if there would be changes in the future.

Libraries believe that the commercialisation of science production in New Zealand has resulted in a reduction in the free flow of information. More information is defined as commercially sensitive, and, therefore, only available on a restricted basis.

Concerns about access to science information centred on both the availability of science information (both generally and New Zealand science information specifically) and the accessibility of that information to New Zealanders.

In general, the size of science holdings from all sources, continues to grow, because of the effects of cumulative increases and expansion of holdings to meet user demand.

Reduced finances have a significant impact on science collections in general. Decreases in finances have often been the result of budget capping or budget cuts. The budgetary constraints are compounded by the steadily increasing costs of science information. However, a number of libraries attributed their decreased science information to the lack of an up-to-date New Zealand science index, rather than funding difficulties.

Reasons for expected increases in science holdings from all sources, are related to new technology. Increased Internet usage and the increasing availability of electronic resources will mean more science information will be available from both New Zealand and overseas. Technology changes, particularly increased electronic formats, are expected to result in a reduction in paper holdings. Increased user demand may drive the use of technology.

The format of science information in libraries has not significantly changed in the last few years. However, there is a general expectation that electronic formats will increase in the next few years.

It is difficult to assess any changes in the quality of New Zealand science outputs. Most librarians linked quality with availability, suggesting that the quality of science may improve with improved access to information through international databases or as its usefulness increases. However, quality of New Zealand science outputs may diminish if scientists cannot access other science outputs, or may diminish with the emphasis on user friendly outputs, because there is less 'pure science' around.

1.2.3 Science Information: Comprehensiveness and Gaps

Libraries tend to use a range of tools to identify science information from all sources, for purchase. They refer to indexing publications or databases, publicity from publishers, and journal reviews. Most libraries expect little change in the future, other than more use of indexing or databases and some minor changes in their reliance on blurbs and reviewing of journals.

Comprehensiveness of the science information from all sources in the libraries surveyed, varies widely. Recent and anticipated changes to the mix of science types represented in libraries' science collections reflect influences such as new research developments, changes in business focus, technological changes and new business directions. These and other changes shape users' interests and information needs.

Libraries indicated gaps in their overall science collections across all areas, although the more specialised libraries tended to report fewer gaps. Public libraries and some university libraries tend to have science collections that are comprehensive, rather than specialised. Therefore, they tended to have more gaps in particular science areas compared with libraries that specialise in those areas. Reasons for gaps varied. Changes in publishing practices, budgetary cuts and the ever expanding business of science institutions were three reasons cited.

1.2.4 Access to Science Information

There are a number of factors that inhibit people's access to science information both New Zealand produced and overseas sourced. These factors include: the lack of search mechanisms to identify science information, the physical location of science information collections, the cost of information which restricts its availability, the confidential nature of some science information, and the specialised nature of some science information collections.

The lack of an up-to-date New Zealand science index was the single most commonly identified barrier to people accessing New Zealand science. This lack of an up-to-date index means that people have to search other sources to identify New Zealand science, which usually involves searching international indexes.

Some librarians considered that a remedy was not difficult. There should be an index of New Zealand produced science information that is accessible to researchers and librarians and includes, as a minimum, the indexing of all publicly funded research on a database. The schools involved in this research also noted the lack of a New Zealand science index. Some science teachers claimed that the lack of a New Zealand science index has important implications for young people considering science as a career.

The most common methods for making science information available to users, is through loans and reference. Almost all of the libraries surveyed make science information available through interlibrary loan. Just over half the libraries expected some change in the way information is to be made available to users over the next five years. The main type of change expected is an increase in the use of electronic access.

For all libraries other than public libraries, principle users of science information are their internal staff and, in the case of universities, students. In public libraries, in contrast to their main users overall - the general public - the most frequent users of science information are students – particularly school students. The secondary school science teachers interviewed verified students' heavy reliance on public libraries.

Various factors continue to expand the demand for science information. Libraries report that their overall science collections are developed to meet these expanding needs. There is a general match between the distribution of holdings and issues across science areas. However, there is growing concern amongst librarians that it is becoming increasingly difficult for them to develop science collections that continue to meet user needs.

The rising costs of science outputs overall limits access. This is because libraries are increasingly unable to purchase a comprehensive range of information.

1.2.5 Good Access to Science Information: Issues of Production, Collection, Preservation and Access

Most New Zealand scientists publish in overseas journals, some of which are becoming prohibitively expensive to purchase. There is no requirement for publicly funded New Zealand science outputs to be made freely, or inexpensively, available.

Concerns about access to New Zealand produced science information centred on both the availability of science information and the accessibility of that information to New Zealanders.

Most research participants are concerned that the availability of science information in general and New Zealand science information in particular is diminishing. This is due to a perceived drop in the numbers of scientific papers, a diversification of science outputs at the expense of papers, an increase in the amount of grey information, the rising costs of science information and the influence of electronic technologies on science collections.

The production of science outputs in electronic formats only, is still relatively rare. At present, most such science information is duplicated in paper format. But, expected acceleration in the adoption of electronically based science information is likely to impact on the size of science collections in libraries.

There are also a number of factors identified as affecting users' access (both positively and negatively) to the science information that is available. The factors identified as undermining access include the lack of indexing of New Zealand science information, restrictions on the use of libraries and the adoption of electronic formats. On the other hand, more New Zealand produced science information is in user friendly formats and, therefore, is more accessible to users.

INTRODUCTION

2.1 Background

Both the National Library of New Zealand and Government have crucial roles to play in establishing the information rich society necessary for economic growth, enterprise and innovation, education and training. The National Library is concerned about:

- providing equity of access to information
- balancing public interest and private advantage
- protecting privacy, and
- protecting national and cultural identity

This research was commissioned by the Library Resources Committee of the Trustees of the National Library, given their perception of a growing concern among the library and wider information community, researchers and others, about 'providing equity of access to information', particularly access to science information produced in New Zealand. Julie Warren and Ruth Fraser from the Centre for Research, Evaluation and Social Assessment (CRESA) carried out the research. Staff from CRESA worked in collaboration with the Research Unit of the National Library to develop the methodology and manage the research.

The Trustees have a statutory role to provide advice to the Minister responsible for the National Library.

Government remains the major investor in science. In other countries there tends to be far more private investment in research and development (R&D). Of the total R&D expenditure in 1996/97, 42% of the purchased science was carried out by the government sector, particularly the nine Crown Research Institutes (CRIs), 30% was carried out by the university sector and 27% was carried out by the private sector[1]. The Foresight Project aims to set the agenda for Government's future investment in research, science and technology and will take effect from July 2000.

The past decade has seen considerable change in the structures, management schemes and funding of research in New Zealand. One area of considerable change has been the restructuring of Government funding to public good science - current funding on a contestable basis has replaced the direct allocation of funds by Parliament to the former Department of Scientific and Industrial Research (DSIR), the Ministry of Agriculture and Fisheries (MAF), the Ministry of Forestry (MoF), the Meteorological Service and research associations such as New Zealand Institute of Economic Research (NZIER). Public good science funding is now allocated across a number of science areas (organised under a Science Output Classes structure)[2]. As an analysis of the 1997/98 allocation round shows, most funding is allocated to Crown Research Institutes (around 86%)[3]. Other recipients of PGSF funding include research associations (around 6%), universities (around 6%) and private researchers/organisations (around 2%).

[1] Taken from Ministry of Research, Science and Technology 1997: *New Zealand Research and Experimental Statistics.* Private sector includes organisations such as, the Building Research Association of New Zealand (BRANZ).
[2] The Science Output Classes structure has undergone considerable change since it was established (eg. Output Classes have been progressively rationalised from 40, to 24 to 17 output classes).
[3] Based on analysis by Research Consultants Ltd.

2.2 Research objectives

This research was designed to assess the availability and accessibility of science information produced in New Zealand for all New Zealanders by:

- Describing the current state of collection, preservation and access to science information produced in New Zealand.
- Identifying gaps in collection and preservation, and barriers to accessing science information produced in New Zealand.
- Analysing the information to address issues of collection, preservation and access in relation to the objective of New Zealanders having good access – now and into the future – to science information produced in New Zealand.

The research questions, which were developed to answer the objectives, are as follows:

With reference to publishers and producers:

- Who are publishers and producers of science information in New Zealand?
- What is the quality and nature of the material being produced?
- What is the direction in the publication and production of science information?

With respect to organisation and access:

- Who is collecting and preserving (including cataloguing and indexing) science information produced in New Zealand?
- Who is providing access to science information produced in New Zealand, at what cost and under what conditions, immediately or at a later date?

With respect to clients:

- Who are the users of science information produced in New Zealand (eg. scientists, tertiary students, school students, the general public) and what are their particular needs in terms of level and format of information?
- What type and timing of access do the different client groups require?
- What disparities are there between the level of access required and that available to the different client groups?

2.3 Methodology

Introduction

The research involved three phases, running more or less sequentially. The three phases included:

- **Phase One** involved an environmental scan that focused on the broad issue of availability of science information. Information was collected on the current state of collection, preservation and access to science information generally and that produced in New Zealand.

- **Phase Two** focused on the broad issue of access to information by identifying gaps in collection and preservation, and barriers to accessing science information.

- **Phase Three** focused on resolving the issues identified in the previous phase - around the collection, and preservation of science information, and ensuring ease of access, now and in the future.

Methods used in these research phases included analysis of existing information and collecting of new information by way of surveys, interviews and a workshop.

Analysis of existing research/data

Analysis of existing data included: a review of relevant legislation, including the National Library Act 1965 and its amendments, a review of Foundation for Research, Science and Technology documentation, with regard to funding allocation and contracting requirements, and a review of previous research undertaken or contracted by the National Library on science indexing.

Surveys of libraries

The fieldwork for this project began only after the Chief Executive of the National Library formally notified potential participants of the research objectives and programme – by way of a letter to Chief Executives of science organisations, University Vice Chancellors and librarians of public, CRI, university and other science organisation libraries. The research did not proceed until these potential participants agreed to co-operate – usually by way of a telephone conversation with CRESA, although some organisations also wrote to the National Library expressing their co-operation. Only one CRI chose not to participate in the research.

After agreement was given by management for the organisations to participate, and a management representative had been interviewed, targeted questionnaires were posted to libraries. These questionnaires were developed with the assistance of National Library librarians.

To ensure maximum participation, libraries were telephoned before the questionnaire was sent out, and reminder letters, telephone calls and e-mails were sent out in subsequent weeks. Letters were also sent out to further clarify some questions that some librarians found confusing.

Results were analysed using SPSS, a statistical package for the social sciences.

Surveys were sent to:

- seven university libraries
- eight CRI libraries
- seven other science organisations (BRANZ, Coal Research Association of New Zealand, New Zealand Tourism Board, New Zealand Dairy Research Institute, the Royal Society of New Zealand, Meat New Zealand, and EECA)
- a cross section (nine) of urban and provincial public libraries

Survey returns were received from five universities, seven CRIs, six other science organisations and six public libraries.

The survey gathered information about the respondents:

- information collection, preservation and access practices, costs and conditions
- client base and information requests
- perceptions of changes in science information deposited with them (type, quality, quantity, availability)
- perceptions of changes in clients' requests and expectations
- perceived expectation of changes in future collection, preservation and access practices, costs and conditions and client needs

Interviews with science providers, funders and users

Science providers (either chief executives, science managers, information managers or heads of department) were interviewed about science publishing policy and practices. These interviews were semi-structured and usually conducted by telephone. The interview guide included questions about:

- the research output focus of the organisation, whether unpublished information for clients, publicly available information (eg. reports) and the degree to which these were deposited with the Legal Deposit Office
- publishing policies around science information generated from research
- levels that exist in the organisation
- description and previous and expected changes to publishing policies
- typical publishing practices
- effect of science reforms on publishing
- science information outputs percentages and previous and expected changes
- monographs/reports in paper format
- articles and papers in paper format
- monographs/reports or articles/papers in electronic formats
- unpublished (grey information) monographs, reports, articles or papers

Other interviews

Other interviews were also held with:

- Foundation for Research, Science and Technology (FRST) personnel, National Library staff and others: to collect specific information (for instance, about specific databases, contracting requirements, etc)
- CRI and public library information managers: to seek clarification of some information and discuss the meaning of survey and interview data
- teachers: to discuss their (and their students) need for and use of science information, how they access it and any changes in its accessibility

Workshop

A one day workshop was held at the National Library. The workshop format was as follows:

- Presentation of results and discussion to:
  - add clarification
  - verify research findings
  - add any new information

- Identify main issues underpinning problems
  - present findings
  - add clarification
  - sort into priority order

- Seek solutions
  - present findings of past research
  - outline desired change
  - identify barriers to change
  - identify feasible change
  - identify next steps

Workshop participants verified research results and discussed the relative importance of the factors identified as contributing to the decreasing accessibility of science information. The final outcome of the workshop was the identification of key recommendations to address what was perceived to be an urgent need – improve access to science information for all New Zealanders.

Producers of Science Information in New Zealand

3.1 Introduction

The major producers of science information in New Zealand are Crown Research Institutes (the major providers of PGSF funded research), universities, and other science organisations[4]. These organisations are commonly referred to as providers within the science community. This section[5] of the report describes the current nature of the science outputs and the publishing policies and practices of these science providers. This section also discusses expected future directions in their science output production and publication.

3.2 The nature of science outputs

CRIs, universities and other research organisations agree that science outputs are largely shaped by the requirements of science purchasing agents – those providing the funding. As a generalisation, FRST funded research tends to result in published scientific papers and commercially funded work tends to result in unpublished reports.

Science purchasing agents in general are demanding more accessible science outputs, whether those outputs are in the public sphere or for restricted use. Science providers report that these changing requirements have significantly changed the nature of their science outputs and they would expect these changes to intensify in the future. That there is a great deal of consistency in science outputs amongst different types of science providers suggests that purchasing agents' requirements are beginning to have a significant impact on the format of science outputs.

Crown Research Institutes

For CRIs, the research output focus tends to be publicly available information, given the importance of FRST as a source of funding. That is not to say that FRST funding always requires public access to science outputs. On the contrary, the requirement to make the primary results of research available to the public and stakeholder groups is tempered when a contractor demonstrates that such access could undermine the results being exploited for the benefit of New Zealand. For instance, access to results could be restricted if it prejudices a commercially sensitive contract or is contrary to the benefit of New Zealand. Nevertheless, a balance in favour of publicly available information is still the norm, with a 70:30 ratio between that and unpublished information for clients the most commonly cited norm. Exceptions include one CRI that carries out very little FRST funded research and produces a majority of unpublished science outputs, another that produces more or less equal proportions of published and unpublished information reflecting the mix of funding sources, and another for which the outputs vary according to the requirements of the clients. The unpublished information for clients is often referred to by these science providers as 'grey'[6] material or information.

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[4] Other science organisations include a range of other public and private organisations that work in or hold science information. For instance, the New Zealand Tourism Board.

[5] Most of this section of the report is based on interviews with people who could provide informed comment on the production of science outputs in the range of science providers. These people included chief executives, heads of department, information managers, scientists and librarians.

[6] The definition of grey material varies. Grey literature is defined as - 'semi-published' material, for example, reports, internal documents theses etc. not formally published or available commercially, and consequently difficult to trace bibliographically (Harrod's Librarian's Glossary 8th ed. 1995). Grey material refers to information that is not publicly available, many librarians interpreted grey material to mean unpublished information.

The most common format for science outputs remains scientific papers published in journals or presented at conferences or seminars. In most CRIs, this format accounts for more than half the science outputs – up to a high of more than 70%, but usually between 50% and 60%. In one case, the balance is reversed with the majority of science outputs being unpublished grey material. Only a quarter of this institute's outputs are articles and papers in paper format.

Monographs and published reports are relatively rare formats for science outputs in CRIs – if they occur at all, they account for less than 10% of outputs.

Grey material comprises a significant proportion of science outputs and, for each CRI, it tends to reflect the organisation's level of reliance on commercial clients from the private and public sectors. Two CRIs report that grey material comprised between 20 and 30% of their outputs. In these cases around 70% of their funding is through FRST. One CRI, which relies heavily on commercial clients for funding, reports that 60% of its outputs are in the form of unpublished reports.

Electronic formats are also relatively rare as the primary format, although some CRIs report a duplication of papers on their web pages. While electronic formats currently make up only a small proportion of science outputs, almost all CRIs expect the trend towards electronic publishing and dissemination to increase in the near future. Some note the increasing international prevalence of electronic formats, and the potential to extend this to include the whole publication process. One CRI information manager, while noting this trend, raised questions about New Zealand's capacity to accommodate this shift in information management given a lack of government investment in establishing a robust electronic infrastructure. The information manager referred to the Australian government's investment in such infrastructure, for instance establishing standards that will enable the development of databases that will lead to the development of geographic information systems. This manager argues that New Zealand's capacity to join the rest of the international science community in electronic information distribution is further hampered by the number of different pieces of legislation and guiding documents shaping information distribution. The range of legislation includes: the Official Information Act, the Archives Act, the Commerce Act, the Crown Research Institutes Act, and the State Services Commission's framework for information distribution.

Universities

In universities, the science output focus is clearly on publicly available information, usually in the form of published scientific papers in national and international refereed journals, articles[7], abstracts and conference papers. Around two thirds of papers are published in international journals. While publishing in journals remains the output focus, some universities reported a shift in emphasis, with an increase in the proportion of unpublished reports. For instance, one science department estimated that 20% of its science outputs are now in the form of unpublished reports. The focus on refereed papers in reputable journals (usually international journals) can be in part explained by the imperative for scientists to publish in these forums to establish and maintain their scientific credibility amongst the scientific community (which is international rather than national).

[7] Scientists commonly differentiate between papers and articles. Articles tend to be written for less technical, more general audiences and may appear in a range of publications including stakeholder and popular magazines, newsletters and bulletins.

Scientific papers remain the primary format for science outputs in universities, although the prevalence of grey material has increased with the increase in commercial clients. Although the proportions vary across universities, within universities, and across different departments, they tend to average around 70%, with the lowest at 60% and the highest at 84%. Monographs or books (including chapters in books), averaging at about 13% of science outputs, are more prevalent in universities and more prevalent in some departments. Unpublished information is far less prevalent, the usual proportion being around 10% in most departments. However, the proportions are increasing at the expense of refereed papers.

Similar trends towards increasing electronic formats are expected in universities in the future, along with some increase in grey information. However, given the nature of academic careers and the international dimension of recruitment processes, there is an expectation that the 'publish or perish' imperative will still provide incentives for scientists to focus on published science outputs. In the short term at least, this trend is likely to continue because the basis of university promotion and scientific credibility still depends on publishing and citation records.

Other science organisations

The experience of other science organisations is similar to that of universities and CRIs - they emphasise the importance of the funding source in determining science outputs. If the research is funded by FRST, then the research output focus tends to be refereed journals[8]. On the other hand, if research is funded by industry, then outputs are designed to meet the needs of the industry users. This may mean, at one extreme, that the results are restricted to a single user. As one industry-focused research organisation pointed out, the commercial advantage, 'even if it is only for two weeks' is worth protecting. At the other extreme, research results may be widely disseminated, for instance to a large number of industry users. However, only one of the six other research organisations described its focus as unpublished information for clients – the others stress public availability.

Other science organisations also stressed the impact of funding sources on the format of science outputs. They produce science outputs in the form of papers and articles, usually in association with small proportions of monographs/reports and grey information. Three organisations reported that, all their science outputs are in the form of papers and articles. In another, 90% are papers and articles, and in another, 63% are papers and articles. These organisations describe their outputs as very widely disseminated, either through publishing in academic or popular journals and magazines, or through dissemination to a wide range of users (for instance, farmers). Outputs in the form of grey information are very rare, as are electronic outputs.

In general, these organisations report little change over the last five years but are gearing themselves up to produce more outputs in electronic formats in the future. These organisations and others note that one of the advantages of electronic formats is that they allow graduated access to science information such as databases and maps.

3.3 Science information publishing policies and practices

Publishing policies

It is difficult to make any generalisations about publishing policy amongst science providers other than to say that they all have some form of publishing policy. Variations amongst the institutions relate to the level at which there is policy and the nature and objectives of that policy.

[8] However, this is likely to change with FRST funding recognising the usefulness of other science outputs.

In some cases, there is policy at an organisational level, in others it is at a divisional or departmental level, in others, policy tends to be tied to individual programmes or projects and, in some, there is an individualistic basis to publishing policy and practice. In general, universities are more likely to have departmental rather than organisation-wide publishing policies. In contrast, CRIs and other research organisations are more likely to have organisation-wide policies, although often there are also other policy tiers at divisional and/or programme level.

Variations in the essential elements of the policies and their intended objectives, to some extent, reflect the nature of individual research organisations. The variations are also explained by factors such as the nature of funding sources, the imperative for organisations to generate revenue, the career structures and incentives of individual scientists, the editing policies of international journals and the policies of parent organisations that existed before the restructuring of science.

In general, CRIs have organisation-wide publishing policies with a quality assurance focus. In some cases these have been inherited from parent organisations, for instance DSIR, and in others they have been specifically developed to meet the needs of the new organisation. These policies tend to relate to scientific papers although they are also relevant to reports. When policies have been adopted from the parent organisation, it is because they have been seen to work and produce academically sound science outputs, and they have remained essentially the same over a number of years. Some CRIs have developed their own quality assurance policies and others report impending development of organisation-wide quality assurance policies.

Typically, CRIs have internal review panels that referee papers before they are signed off as ready to submit to journals. These internal review panels are sometimes supplemented by external reviewers, including international reviewers. Papers are then subjected to the particular refereeing and editing processes of the journals to which they are submitted. In general, these practices are not expected to change in the near future, although one or two CRIs report a reduction in the size of their review panels. These reductions largely reflect reduced numbers of scientists and increasing workloads for those who remain.

CRIs, other research organisations and, to a lesser extent, universities have developed policies to protect intellectual property. These policies (referred to as IP policies) are almost always at an organisational level and have been developed in response to the increasing imperative for research organisations to generate revenue from their science. These IP policies are generally new and, in almost all cases, there is an expectation that they will be more fully developed in the future. Those organisations without explicit IP policies are either developing them currently or expect to do so soon.

There is also a general appreciation that the nature of science careers often gives rise to individual publishing practices, regardless of organisational, divisional or departmental publishing guidelines. Individual scientists' credibility and promotion opportunities largely ride on their publishing and citation record in international journals. Thus, their imperative is to submit papers to prestigious journals in their field of science and comply with the standards and publishing policies of these journals rather than with those of their current employer. Given the concept of academic freedom, this tendency is more prevalent in universities. One university reports that there is little intervention in individual publishing processes.

However, given FRST requirements for more relevant and, therefore, more applied research, some scientists are finding it more difficult to publish results. Scientists in some fields report that it is becoming more difficult to get the results of applied research published in prestigious journals because the journals tend to favour more fundamental research. One scientist described his department's research effort as increasingly technological at the expense of pure science. It is difficult to generate scientific papers from such research because of the requirements of some journals. However, for the department to maintain its credibility, it needs to be seen to do pure science.

Most science providers reported changes in publishing policy over the past five years. Most of these changes relate to the recent necessity to develop IP policy. The CRIs with the greatest potential to generate revenue from their intellectual property have had the greatest incentive to develop appropriate protective IP policy. However, some providers also described subtle changes in the implementation of quality assurance policy. While policies have remained the same, organisations' abilities to implement them have sometimes diminished given fewer resources and increased pressure for resources to be used to generate revenue. There is the almost universal expectation that, given increasing commercial focus, IP policy will continue to evolve as organisations increase their emphasis on preserving intellectual property. Some are concerned about the pressure that the commercial emphasis will put on quality assurance practices.

Publishing practices

The process of producing science outputs in the past was fairly standardised. In most science organisations, the bulk of expected research programme or project outputs was in the form of scientific papers. These outputs were defined at the time that a project or programme was planned. These would be written, submitted to internal review panels, amended as appropriate and submitted to appropriate journals with their own refereeing and editing processes. The intended outcome of the process was the publication of quality papers in reputable journals, particularly international journals.

One university department described a hierarchy of research outputs, led by refereed papers in international journals. Nevertheless, different disciplines and departments are likely to have different orders of prestige attached to output types. A generally accepted order is: refereed papers in international journals, books published by independent publishers, chapters in books, papers in non-refereed journals, in-house publications, conference papers and abstracts, and popular papers.

Expected future direction of science information publication

Publication practices are expected to remain essentially unchanged for the publication of scientific papers in reputable journals. However, the focus on publication of papers is changing, principally because the funding of science is changing. As a consequence, science outputs, which reflect the needs of clients, are changing. Some of the expected changes and the impetus behind them are described below.

There is an increasing expectation by those that purchase science, especially FRST, that outputs are 'user friendly' and accessible to end-users. Already, some CRIs report a drop in the number of papers published and an increase in other technology transfer mechanisms such as field days, booklets and articles in industry magazines. They would expect this trend to continue.

The boundaries between PGSF and commercially funded science are becoming more defined. One CRI reported that, as a consequence, 'back to back' publishing is no longer occurring because the commercial funder of the research is concerned about keeping the results confidential. In the past, in cases of joint commercial/FRST funded science, it was not uncommon for the commercial party to receive a purpose written report and for the same results to be published in a scientific journal. That is no longer occurring. It was pointed out that keeping results of PGSF science confidential is not necessarily contrary to contractual requirements if that is seen as necessary to capture benefits for New Zealand.

With reference to science outputs, there is often a tension between the expectations of science purchasing agents (both FRST and the private sector) and the professional imperatives of individual scientists. Because some purchasing agents want science outputs to be accessible, they are increasingly requiring alternative outputs. However, scientists' international credibility is still judged on their publishing records, and any changes to the expectations of science purchasing agents in New Zealand is unlikely to change how scientists are expected to demonstrate their achievements to the international science community. It leaves scientists in a potentially difficult position – they are not necessarily funded to produce scientific papers but must do so to maintain their international and national standing in their field – which is also required for them to continue to attract funding.

3.4 Summary

Most science providers perceived that there are more science outputs that are subject to restrictions because of commercial sensitivity. As well as this growth in science outputs that are defined as commercially sensitive, some providers believe there has been a decrease in the number of scientific papers. There are two concerns related to the decrease in scientific papers. First, scientific papers are an important source of publicly available science information - when a paper is published in a journal it is available for public consumption. A drop in the number of scientific papers potentially means a drop in the availability of science outputs. Second, scientific papers are important because they remain the basis upon which scientists are judged in the international arena. A drop in the number of scientific papers potentially affects the credibility of scientists, individually or collectively.

While the number of scientific papers may have decreased, some science purchasing agents and providers believe there has been an increase in the number of science outputs. Purchasing agents have demanded more innovative science outputs in the belief that availability of science information (for instance, published scientific papers) does not necessarily equate with its accessibility. To make science information more accessible, science providers are increasingly generating outputs such as conference papers and presentations, field day presentations and articles aimed at more general audiences. Some purchasers and providers suggested that this increase in science outputs, and the demand for more accessible outputs, seems to be at the expense of refereed papers and, in their view, sometimes at the expense of quality science outputs.

There is a conundrum for CRIs and others seeking FRST funding. It is in the interests of scientists and science organisations to distribute science results amongst their peers to demonstrate their expertise and maintain their credibility. At the same time, it is the perception of science organisations that their bids will be judged more favourably if they have commercial partners. However, the involvement of commercial partners usually means that there are restrictions on the availability of the science results.

COLLECTION AND PRESERVATION OF SCIENCE INFORMATION PRODUCED IN NEW ZEALAND

4.1. Introduction

Science information produced in New Zealand is primarily collected and preserved by libraries. Some of these, particularly public and university libraries, have more comprehensive information, including science information. Others, particularly CRI and other science organisation libraries, provide more specialised science collections. Science information is also held in other institutions, the most notable being Te Papa. The Hector Library in Te Papa is strong on documentation (mainly of 19th and 20th century material) related to the systematics (taxonomy, classification) of animals and plants.

Thirty-two libraries were surveyed (of which 23 responded) as a basis for describing the current state of science information collection and preservation. These included public libraries, CRI libraries, university libraries and libraries in other science organisations.

4.2 Science information produced in New Zealand

It is not possible for libraries to readily quantify and describe in any comparable way the amount and type of science information produced in New Zealand that they hold. There are a number of reasons for this inability to quantify and describe holdings. Firstly, as discussed in section two, the vast majority of published science outputs of science providers are in the form of scientific papers in international journals. Libraries do not generally quantify the New Zealand originated components of the international science journals they collect and preserve. Secondly, libraries quantify their science information holdings in different ways. Most libraries could provide information about the number of science information titles they hold, while others could provide information by physical volume only. In most cases, libraries could provide accurate counts (whether by title or volume) but some could provide only best estimates. Some of the public libraries reported difficulties in differentiating science holdings from other holdings. Thirdly, as some libraries also pointed out, the lack of an up-to-date index of New Zealand science limits their ability to identify science information that is published in New Zealand. STIX,[9] which has been the main index of New Zealand science, was last up-dated in 1997. One university library suggested that it could roughly estimate the science information sourced in New Zealand by comparing two elements of total expenditure – that spent using foreign exchange and that using New Zealand dollars. But the estimation would be meaningless because most of the New Zealand science outputs are found in international journals anyway.

For the above reasons, this report's description of New Zealand's science information collection and preservation is usually at a general level, with a focus on all science information unless otherwise specified.

Although libraries could not readily measure the proportions of their science collections that originated in New Zealand they could provide some general estimations. The range of New Zealand material varied widely: from 1-95% and often reflected the topic area of the information. For instance, some areas such as agricultural science comprise higher proportions of New Zealand material. Four libraries were unable to provide data on the origin of their science collection.

[9] A description and history of STIX are provided later in this section.

- It is estimated that 5-33% of university science information originates in New Zealand. The University of Canterbury's library estimates that 95% of its science information originates from overseas (and most is published overseas as well). One indication of the amount of science information that is published in New Zealand is expenditure in New Zealand currency. Around 14% of the information for the library is bought using New Zealand currency.

- For most CRIs the bulk of their science holdings also originates overseas. For science information originating in New Zealand, most CRI libraries fall into a range from 5-30%. Overseas material accounts for 70-95% of science holdings in six CRIs. One reports the majority of its collection (90%) originates in New Zealand, and only 10% is international.

- In public libraries, science information originating in New Zealand also accounts for only a small amount on average: the range is from 1-40%.

- Other science organisation libraries are more likely to have science information originating in New Zealand. The proportion of New Zealand information ranges from 5-95%. In three out of five libraries, the proportion is 50% or more. One library reported that 3% of its collection is from collaborative efforts between domestic and international researchers.

In general the proportion of New Zealand science in libraries has not changed, and is not expected to change over the next few years. However, around one in three of the libraries reported that, given the difficulty in identifying New Zealand science information, they could not be sure if there had been changes or if there would be changes. Some typical comments included:

- *"While I have no figures to back this up, the perception is that the NZ proportion is diminishing"* – CRI

- *"New Zealand has decreased; stopped subscribing to NZ general science journals"* – science library

- *"New Zealand material that used to be free, and published for the public good, is no longer available, or too expensive to purchase"* – university

- *"Less is being published in NZ. Former science publishers like DSIR, Soil Bureau, NZGS, etc. are no longer in existence. Much NZ science information is now being published by NZ scientists in overseas publications*" – university

- *"Less New Zealand science is available free or at an affordable cost"* – public library

- "*Continuing lack of co-ordination of research results and publications. CRIs are producing more specialised works, which is not always relevant. The broad spectrum material once produced, before restructuring, isn't getting published"* – university

- *"Expect NZ science info to be made more easily available – via will of government"* – public library

Although they could not necessarily back up their concerns with comparative data, some librarians expressed concern about a perceived reduction of New Zealand science and research publishing. They itemised the loss of some science outputs, such as the bulletins that DSIR used to publish, and the restricted basis of other outputs, for instance maps, that used to be freely available and are now only available on request, and confidential information that is not available because of perceived commercial sensitivity. The school teachers interviewed also noted the loss of DSIR bulletins, which were seen as very important sources of information for school science. They provided around 5–10% of science information overall, and 100% in some areas.

Though school teachers report still getting some similar information from some CRIs, they recognise that CRIs are not funded to provide educational resources.

4.3 The quantity of science information

There is a huge variation in the numbers of science holdings (usually measured by numbers of titles) reported by libraries. The number of holdings range from 500 in a science organisation's library to 606,000 holdings in a university library.

- the range in university libraries is the broadest, ranging from 85,500 to 606,000
- the range in CRI libraries is 8,830 to 297,875
- total public library science holdings also varied widely, ranging from 2,680 to 122,000
- other science libraries (i.e. in other science organisations) recorded the lowest numbers of holdings, ranging from 500 to 7,212

As librarians pointed out, total numbers of titles do not necessarily give a meaningful indication of the amount of science information available. In science, most information is in the form of journals (one title but many volumes). For example, in chemistry, one university library has 100 journal titles and 3,000 books, but the journals make up the bulk of the information.

A university librarian suggested that a bibliometric study of his library's holdings (that is, measuring shelf space) would probably show that journals outnumber books three to one (space wise). The University of Canterbury estimates that 60% of science and engineering holdings (in terms of expenditure) are in the form of journals and 40% are books. Given the cost of journals, the total cost of science information is high compared with disciplines such as history.

Also, journals are generally perceived as containing more current information, especially in the most recent years, when the information is more up-to-date. In subsequent years the value of journal articles tends to diminish, although that is not always the case. Some library users, particularly in disciplines such as the biological sciences, wish to refer to original articles in subsequent years. Also increasing interest in the history of science means that the original papers remain valuable.

4.4 Current trends in science information quantity

In general, the size of science holdings continues to grow. All but one of the university libraries reported increases, as did four of the seven CRI libraries, five of the six public libraries and three of the five other science libraries.

The most common explanations for increases in the number of science holdings included cumulative increases and expansion of holdings to meet user demand. By cumulative increases, libraries were referring to the inevitable increase in science collections as new material is added to existing holdings - even when the amount of new material purchased is decreasing.

All types of libraries explained increases in terms of cumulative increase. Despite subscription cancellations and budget cuts, collections tend to continue to grow. Typical statements include:

- *"Additions outnumber withdrawals"* - university
- *"Ongoing subscriptions and monograph purchasing with limited de-selection. Some journal cancellations but not significant in relation to total holdings*." - university
- *"New titles are acquired regularly"* - CRI
- *"Historic collections grow exponentially over time – weeding removes less than the number of new items received"* - CRI
- *"We keep most older material. This has a cumulative effect on stock numbers. Newer areas are also being purchased in larger quantities – eg. computer science, genetics."* - public library

Increases are to be expected for as long as collections reflect user needs. Within budget constraints, libraries strive to meet the demands of users by providing popular or requested material and up-to-date information on relevant topics. Most libraries outlined how the development of new research and new technology requires continual information expansion to ensure collections remain current.

Not all libraries reported increases in the size of science holdings. Libraries of all types reported decreases. Reasons given for decreases included the commercialisation of science coupled with the cost of science information, lack of storage space, budgetary constraints and the lack of a current New Zealand science index.

Libraries believe that the commercialisation of science provision has resulted in a reduction in the free flow of information. More information is defined as commercially sensitive, and, therefore, only available on a restricted basis. A typical comment is:

"CRI commercialisation has cut off public access" - university

Some libraries described how a lack of space resulted in their collections being reduced, causing older material to be dumped.

- *"Moved to a smaller building"* - CRI
- *"Dumped some low use foreign language material due to space restrictions. Duplicate titles cut"* - university
- *"Space constraints"* - CRI
- *"Older, redundant material disposed of; several journal subscriptions cancelled"* - other science library

Reduced finances also have a significant impact on collections. Decreases have often been the result of budget capping or budget cuts. The budgetary constraints are compounded by the steadily increasing costs of science information.

- *"Current journal subscriptions have been cut by 20% over the period due to budgeting restraints and journal price increases"* - university
- *"Purchasing fund reductions"* - CRI
- *"Generally my buying has had to be more selective – budget drain"* - other science library

A number of libraries attributed their decreased science information to the lack of an up-to-date New Zealand science index – presumably because the discontinuation of STIX makes the identification of material for purchase more difficult.

STIX, run by the National Library, began in the mid 1980s and ran as a parallel database to SIRIS, a DSIR database set up around 1980 (SIRIS records were transferred to STIX on a regular basis). When SIRIS was established, many records were also added retrospectively – mostly from the 1970s but also as far back as the last century. STIX provided access to scientific journals, conferences, reports and monographs published in, or about, New Zealand, including unpublished or semi-published reports. It covered all scientific disciplines except medicine.

STIX was updated monthly until 1997, at which point it had approximately 80,000 records[10]. This indexing system, however, has had a rather chequered career since the dissolution of DSIR and the restructuring of

[10] The number of records on STIX was approximately 5,000 less than those on SIRIS as some confidential entries were not transferred. Although the last transfer from SIRIS was 1997, entries continued to be added to the IRL holdings by CRIs and, as at March 1998, it held approximately 83,000 records.

science, and is no longer up-dated. When STIX ceased, all its records were transferred to the Knowledge Basket, a privately owned database.

One university comment is typical of the concern about STIX:

> *"STIX discontinued end of 1997* [sic], *although it now exists on Knowledge Basket, continuation is not ensured. DSIR catalogue LIBRA ceased 1998".*

4.5 Future trends in science information quantity

In general, librarians expect science holdings to continue to increase in size. The only exceptions are public libraries, which have more mixed expectations. Some expected increases, some expected decreases and some were uncertain. Specialist science libraries were more likely to expect decreases than university libraries.

Expectations of future growth were principally attributed to affects of accumulative growth of collections and the impacts of technology. For most libraries, even though budget cuts mean subscription cancellations and fewer book purchases, yearly purchasing of titles and journals means holdings continue to increase. Also, the number of new titles added tend to outnumber those withdrawn. Comments include:

- *"Because we will purchase additional books, receive additional journals volumes, and possibly subscribe to additional journals titles and/or full-text electronic databases"* - university
- *"We purchase items all the time. We have also incorporated a number of collections from libraries or offices"* - CRI
- *"Limited weeding; more information added to collection in similar or new fields to meet the needs of this research organisation"* - CRI
- *"Purchasing still likely to exceed de-selection. Journal cancellations will affect quality of information more than quantity"* - university
- *"Will continue to add more than we withdraw"* - university
- *"Normal collection growth to support teaching and research"* - university

Other reasons for expected increases in science holdings are related to new technology. Increased Internet usage and the increasing availability of electronic resources will mean more science information will be available. Technology changes, particularly increased electronic formats, are expected to result in a reduction in paper holdings. Increased user demand may drive the use of technology.

- *"Move towards access to information from the desktop (gradual) for new material. Electronic services will increase number of titles"* - CRI
- *"Expect that interest in the sciences generally will increase"* - public library
- *"Increase expected in computer area"* - public library
- *"Increased use of on-line sources e.g. Internet. On-line journals. Fewer print journals"* - CRI
- *"Items held in hard copy will decrease, budget cuts anticipated plus access to electronic information resources will increase"* - public library
- *"Move to electronic access rather than physically holding material"* - science library

Reasons for future decreases also revolve around budgetary constraints, along with the competitive environment many science libraries now operate in, the weakening New Zealand dollar and the lack of government investment in information resources. The following comments describe these concerns:

- *"Price increases mean selections have to be made – instead of getting several titles can now only get what we consider to be the best one"* - science library
- *"Government policies on commercialisation of the tertiary education sector is turning 'information resources into a competitive advantage'. No Government investment in information infrastructure. Institutions (tertiary) have a lack of financial resources. Weak New Zealand dollar"* – university

4.6 Science holdings as a proportion of total holdings

Amongst the wider focused libraries, science information holdings as a proportion of their total science holdings are changing. Amongst the libraries surveyed, both university and public libraries provide for a wider range of science and non-science users, while the specialised science libraries tend to cater more exclusively for their own scientists. In general science holdings in university libraries account for a significantly higher proportion of total holdings than is the case in public libraries - in university libraries the proportion of science holdings ranges from 28-52%. The proportions in public libraries varies from 4-27%. While libraries generally reported little change over the past five years and expect little change in the near future, they expected the interest in science to remain and the acquisition of science information to become more difficult:

- *"Expect that interest in the sciences generally will increase".*
- *"Subscriptions costs plus weak NZ dollar"*
- *"A high proportion of our sciences expenditure is on journals, which increase in price at a much higher rate than books".*

4.7 The format of science information

The format of science information in libraries has not significantly changed in the last few years, despite the development of electronic technologies. In all but one library, over three-quarters of their science collections are in paper format monographs/books and journals. Any increases in electronic material tend to be as duplication of paper based information (usually journals) rather than as replacement. Although 10 libraries reported having other material in electronic formats, these proportions were very small (1-5%). One exception was the CRI library with 60% of its science information in electronic formats - as databases. One public library reported that 2% of its science collection was in other formats including videos and audio-cassettes.

The greater proportions of monographs/books in public libraries (92-100%) and university libraries (34-95%) can be partly explained by their social science holdings which are more likely to be book based. Public libraries also reported users' preference for information in books rather than journals. However, books tend to be more uncommon in specialised science libraries in CRIs (10-77%) and other science organisations (10-45%).

Journals make up larger proportions of science information in specialist science libraries compared with more generalist libraries (90% in one CRI library compared with one percent in three public libraries). Generally, though, there were no clear trends within the different categories of libraries, 5-48% in universities, 12-90% in CRIs and 40-60% in other science organisations. Public libraries were the exception. Journals were consistently rare (ranging from 0-5%). Journals in electronic form are still very rare and tend to duplicate rather than replace paper based information. But many libraries forecast a growth in this area. The proportion of journals in electronic formats ranges from 0-2% in all but one case - one university reports that 17% of its science information holdings are in this format.

This mix of science information format types varies according to the subject area, as two examples from the University of Canterbury illustrate. In terms of expenditure:

- In the life sciences, 60% of expenditure comprises monographs/books and 40% comprises journals.
- In physics, 10% of expenditure comprises monographs/books and 90% comprises journals.

The proportions of grey material amongst science information are generally higher in CRI and other science organisation libraries compared with libraries that are open to wider user populations - university and public libraries. The higher proportions of grey material are consistent with the type of science outputs these science providers generate. As discussed earlier in the report, these science providers tend to generate higher proportions of confidential reports. However, the proportions overall are low: between 1-10% (and generally

nearer to 1%) in the two universities, five CRIs, two other science organisations and two public libraries that report having any. One CRI and two of the other science organisation libraries report holding more grey information (between 20 and 40%).

4.8 Trends in formats of science information

There is a general expectation that electronic formats will increase in the next few years, as the range of comments illustrates:

- *"Increased electronic formats, especially journals and 'short loan' articles"* – university
- *"More new information in electronic journals. We already have a number of information databases and expect this area to grow"* - CRI
- *"I envisage CD ROM and Internet/Electronic formats will become more readily accessible"* – public library
- *"Expect more material in digital format"* – public library
- *"Electronic delivery – particular articles rather than whole journals"* – science organisation library

One university librarian explained some of his concerns about this shift to electronic publishing:

- The potential cost savings from electronic publishing will be undermined if journal titles are packaged together in ways that require libraries to purchase more titles than they did previously. There are already signs that the publishing companies are packaging titles rather than selling them singly – so libraries may be forced to purchase more than they need.

- There are likely to be some cost savings to libraries because storage costs will fall when they do not have to store paper back-copies.

- But there may be problems around access to back-copies – what happens when libraries cancel electronic subscriptions? The purchasing of electronically published material involves purchasing of access – does cancellation mean that back-copies up to the time of cancellation would still be available?

- Electronic licensing conditions often preclude interlibrary loans as only licensed users are given access. In universities that licence is usually limited to registered users of the library – students and staff. Other users will have no access to that information. Already some indexes are only available electronically – and therefore only available to internal users.

4.9 Cataloguing and indexing of science information

While most libraries do their own cataloguing and add their holdings to Te Puna (the National Library computer system that supports the National Union Catalogue), fewer are indexing information. Universities report the most comprehensive cataloguing practices, including original cataloguing, copy cataloguing and adding holdings to Te Puna. CRIs also have comprehensive cataloguing practices, using original cataloguing and adding their holdings to Te Puna. Four out of the seven CRIs also use copy cataloguing. Nearly all public libraries report the use of original cataloguing and the addition of holdings to Te Puna but only two out of six use copy cataloguing. Science organisation libraries report less cataloguing. Three out of five do original cataloguing. Two out of five add their holdings to Te Puna and only one out of the five uses copy cataloguing.

Indexing of science information is less prevalent. Public libraries do not index their science information at all. CRI libraries and science organisation libraries are most likely to index their science information. In both cases more than half of these libraries report indexing.

Three out of seven university libraries report that they undertake indexing of science information in their libraries. One library explained how internal policies make it difficult for them to index for themselves –

instead it purchases indexes such as those within Knowledge Basket. Given the demands on current funding, expenditure on indexing is not a priority area for a number of libraries.

4.10 The quality of science information

It is difficult to assess any changes in the quality of science outputs. Most librarians linked quality with availability, suggesting that the quality of science information:

- may improve, with improved access to information through international databases. Sometimes the abstracts available on databases provide enough information for researchers to keep generally up-to-date in their field. Public libraries in particular noted how improved search tools have allowed users access to a wider range of materials;

- may improve as its usefulness increases, given the emphasis on science outputs that are more user friendly;

- may diminish if scientists cannot access other science (for instance, scientists may have difficulty in accessing even standard journals). The lack of a New Zealand science database is to the significant detriment of science accessibility;

- may diminish with the emphasis on user friendly outputs, because there is less 'pure science' around;

- is becoming more difficult to judge, given the increasing blurring between disciplines.

4.11 Collection and preservation of science information policy trends

Libraries reported on past and likely future policy changes and the predicted effect of these on their science collections.

Almost all libraries reported recent changes related to budgets, with CRI libraries apparently least affected. Four out of seven universities, four out of six public libraries and three out of seven other science organisation libraries reported decreased collection budgets, compared with one out of seven CRI libraries. However, two of the CRI libraries and three of the other science organisation libraries reported capped budgets. Smaller budgets were accommodated through a range of mechanisms including more selective purchasing generally, fewer purchases in some areas, cancellations of some journals and a move towards more electronic resources.

Increased budgets were also reported, most commonly by CRI (four out of seven) and other science organisation (three out of seven) libraries. Around half the CRI libraries expect budgets to continue to increase to match inflation and the rising costs of journals. Others also comment that increases in the collection budgets simply correspond with increasing journal prices, resulting in little overall impact on the science collection. Only two out of the six public libraries expect increases in their budgets - some predict future policy changes that may see a move to more electronic formats as a cheaper alternative to hard copy.

Other policy changes:

- One of the university libraries reported the creation of a New Zealand/Pacific collection changing the nature of the science collection. Now science relating to New Zealand and the Pacific is in the New Zealand/Pacific collection – so it is physically divorced from other science information.

- Another reported a change in the way that science information purchases are organised. Now they are based on subject matter rather than being departmentally based. This may change the level of purchasing in some areas.

Few policy changes are expected in future. Most libraries expect cuts to, or capping of, their budgets and the one anticipating an increase sees it as a temporary measure to facilitate an upgrade to electronic access.

4.12 Summary

Science information produced in New Zealand is primarily collected and preserved by libraries. However, it is not possible for libraries to readily quantify and describe in any comparable way the amount and type of science information produced in New Zealand that they hold. This is because the vast majority of published science outputs of science providers are in the form of scientific papers in international journals, and also libraries quantify their science information holdings in different ways. Another factor, as some libraries also pointed out, is that the lack of an up-to-date index of New Zealand science limits their ability to identify science information that is published in New Zealand.

In general the proportion of New Zealand science in libraries has not changed, and is not expected to change over the next few years. However, some libraries reported that, given the difficulty in identifying New Zealand science information, they could not be sure if there had been changes or if there would be changes.

In general, the size of science holdings continues to grow. This is because of the effects of cumulative increases and expansion of holdings to meet user demand.

Libraries believe that the commercialisation of science provision has resulted in a reduction in the free flow of information. More information is defined as commercially sensitive, and, therefore, only available on a restricted basis.

Reduced finances have a significant impact on collections. Decreases have often been the result of budget capping or budget cuts. The budgetary constraints are compounded by the steadily increasing costs of science information.

Reasons for expected increases in science holdings are related to new technology. Increased Internet usage and the increasing availability of electronic resources will mean more science information will be available. Technology changes, particularly increased electronic formats, are expected to result in a reduction in paper holdings. Increased user demand may drive the use of technology.

The format of science information in libraries has not significantly changed in the last few years, however, there is a general expectation that electronic formats will increase in the next few years.

It is difficult to assess any changes in the quality of science outputs. Most librarians linked quality with availability, suggesting that the quality of science information may improve, with improved access to information through international databases or as its usefulness increases. However, quality may diminish if scientists cannot access other science outputs, or may diminish with the emphasis on user friendly outputs, because there is less ‘pure science’ around.

Few policy changes are expected in the future. Most libraries expect cuts to, or capping of, their budgets.

SCIENCE INFORMATION: COMPREHENSIVENESS AND GAPS

5.1 Acquisition of science information

Libraries tend to use a range of tools to identify science information for purchase. They refer to indexing publications or databases, publishing blurbs and journal reviews. However, across the board, they reported little contact with other libraries and, with the exception of CRIs (who still reported little contact) no libraries reported direct contact with science providers.

Most libraries expect little change in the future, other than more use of indexing or databases and some minor changes in their reliance on blurbs and reviewing of journals. However, both university and CRI libraries anticipate more collaboration with other libraries. Some university libraries mentioned the need for collaboration to achieve better purchasing deals with publishing companies. However, one CRI went against the trend by claiming an expected reduction in direct contact with other science providers and collaboration with other libraries.

There is a general perception amongst librarians that science information is becoming more difficult to identify as a basis for their purchasing. Eleven of the libraries indicated that information at a national level is becoming more difficult to identify and obtain. Six indicated that they perceived no change and only two (one public library and one CRI library) reported that it had become easier.

5.2 Comprehensiveness of science information: science types

It is difficult to comment on the comprehensiveness of the science information in the libraries surveyed because they vary so widely in their levels of speciality. Some, such as university libraries, are general libraries catering for a wide range of staff and students, including scientists with specialised science information needs. Some, such as public libraries, are catering for a wider range of users, some of whom still require specialised science information. Others, for instance CRI and other science organisation libraries, are specialised libraries for scientists in more specific areas of science.

Accordingly, the science collections of these different categories of libraries have been developed to meet the needs of their users (which might range from the highly eclectic to the highly specialised). The general libraries, as would be expected, have science information collections that cover the range of science areas although there may still be some heavier emphasis on particular sciences. For instance, a university with a strong agricultural research and teaching tradition may have a science collection that favours the agricultural sciences. More specialised libraries have far narrower collections of science information, reflecting the business of the institution it serves.

5.3 Trends in the mix of science types

Recent and anticipated changes to the mix of science types represented in libraries' science collections reflect influences such as new research developments, changes in business focus, technological changes and new business directions. These and other changes shape users' interests and information needs.

In universities, if social sciences are excluded, there tends to be no change over the last five years. But with university restructuring and new subjects, changes are expected in the future. One library reported a push to include more biochemistry, human biology, health/human sciences and medicine. Less than half the university libraries reported changes in the mix of science information over the past five years and even fewer expected it to change over the next five years.

Most CRIs said changes had occurred over the past five years, but fewer expected changes over the next five years. Changes have generally been due to shifts in research focus and other business related matters. As one CRI says:

"Acquisition is driven by strategic direction of research and consultancy".

Three out of the six public libraries reported the mix of science information had changed over the past five years. Among other things, all three reported increases in the proportion of computer science material. Only one public library predicted changes to the mix in the next five years - to meet the changing requirements of library users.

Two science organisation libraries reported on previous and expected changes to the proportions of science information in their collections. In both cases the changing focus of the organisation's work was responsible for changes to the collection. The remainder reported no previous change or that they were unsure of any changes.

5.4 Gaps in science information

Libraries were asked to comment on gaps in their science collections and reasons for these gaps. In general, libraries indicated gaps across all areas although the more specialised libraries tended to report fewer gaps. Public libraries and some university libraries tend to have science collections that are comprehensive, rather than specialised. Therefore, they tended to have more gaps in particular science areas compared with libraries that specialise in those areas. The other libraries are specialist science libraries, providing information for particular disciplines or areas of science. Gaps in science information were also reported, given the increasing breadth of information available, but were less pronounced.

Universities reported gaps in all categories of science information except Mäori science. One library identified having Mäori science and another commented that the lack of gaps may be attributed to the lack of published material on Mäori science. CRI libraries tended to report fewer gaps, with the biological sciences most frequently reported as a gap. Others included agriculture, chemistry, engineering and technology, mathematics, social sciences, and areas such as environmental and business science. Public libraries most often reported gaps in chemistry, mathematics and computer science. Other science libraries indicated gaps in Mäori science, mathematics, and social sciences.

Reasons for gaps varied. Changes in publishing practices, budgetary cuts and the ever expanding business of science institutions were three reasons cited:

- Science information gaps are, to some extent, manufactured by publishers through the way they establish new journals. Often, when new (perhaps more specialised spin-off) journals are established they are, for a short period, provided free with a related journal that the library subscribes to. Up till this period the original journal may have covered the whole topic area. The new journal eventually has a separate price attached to it. If the library decides not to subscribe to it separately, its new users will consider there is another gap in information. The publishers are creating their own demand – for instance, three specialised journals might cover what the previous more general journal used to cover.

- The rising cost of science information is a significant problem for libraries. Budget constraints limit the material that can be purchased. Public libraries in particular find it difficult to justify purchasing expensive science material when users of such information are often only a small proportion of their total users.

- Budget cuts compound problems of cost. Gaps are increasing as a consequence of budgetary cuts. For instance, universities report that in some areas of science, cancellation of journals outnumber the acquisition of new titles.

- Libraries that may have provided relatively comprehensive coverage in the past now struggle to keep ahead of changes in the research focus of their users and developing technologies. Therefore, gaps in information are increasing.

- Libraries cannot, for practical reasons such as space and cost, hold information on every area of science. Therefore, gaps are inevitable.

5.5 Summary

Libraries tend to use a range of tools to identify science information for purchase. They refer to indexing publications or databases, publishing blurbs and journal reviews. Most libraries expect little change in the future, other than more use of indexing or databases and some minor changes in their reliance on blurbs and reviewing of journals.

The comprehensiveness of the science information in the libraries surveyed varies widely according to their levels of speciality. Recent and anticipated changes to the mix of science types represented in libraries' science collections reflect influences such as new research developments, changes in business focus, technological changes and new business directions. These and other changes shape users' interests and information needs.

Libraries indicated gaps in their science collections across all areas although the more specialised libraries tended to report fewer gaps. Public libraries and some university libraries tend to have science collections that are comprehensive, rather than specialised. Reasons for gaps varied. Changes in publishing practices, budgetary cuts and the ever-expanding business of science institutions were three reasons cited.

ACCESS TO SCIENCE INFORMATION

6.1 Provision of access

The most common methods for making information available to users is through loans and, for particular categories of science information, reference. Around half the libraries also listed 'other' ways information is made available to their users.

- All libraries, except for one science organisation library, make science information available for loan.
- All libraries, except for one science organisation, have reference only material available.
- Just under half the libraries also make science information available through other means, including:

    - electronic access to databases, journals etc
    - interlibrary loans
    - CD ROM and Internet access for searches
    - photocopying

6.2 Interlibrary loan policies

All of the libraries surveyed, with the exception of one science organisation library, make science information available through interlibrary loan.

- All university libraries provide an interlibrary loan service. The loaning of reference material is discretionary, but most are willing to photocopy sections that are needed. The only real restriction on interlibrary loan material is material which is in high demand from the libraries' own users. Charges are based on 'standard' charges. Two universities said this is around $14.00 per interlibrary loan request from external users with a $5.00 subsidised charge for their own users.

- All CRI libraries provide interlibrary loan. The general interlibrary loan policy is the same as that for university libraries, although confidential or restricted access material is not available for interlibrary loan. The charges for interlibrary loan from CRIs also appear to be around $14.00 for a standard request. However, two CRIs indicated they have reciprocal arrangements with some libraries, for instance :

  "If the interlibrary loan library charges more or less (e.g. $30.00, or $0.00) we reciprocate".

- All the public libraries provide interlibrary loan. The policy is the same as for other libraries. Interlibrary loans will only be made to other libraries. Anything can be interlibrary loaned, although there may be restrictions on reference or high demand material. Public libraries also charge for interlibrary loans. One library charges $6.00, suggesting interlibrary loan costs from public libraries may be cheaper. However, as no other public library listed charges, this could not be verified.

- Four out of the five science organisation libraries allow interlibrary loan. Little detail is given regarding their interlibrary loan policies, but there is some indication policies may be more restrictive than other libraries. For instance one library states they:

  "Restrict lending of one report series to members and associate members of CRANZ (Coal Research Association of New Zealand) and to interlibrary loan libraries [and] don't lend standards or other reference material".

Another science organisation library reports it has "*no formal policy*" on interlibrary loans and instead allows interlibrary loans on a "*case by case basis*". Two science organisation libraries do not charge for access to their information.

6.3 Expected changes to provision of access

Just over half the libraries expected some change in the way information is to be made available to users over the next five years.

- All universities expect changes to the way they make information available.
- Four out of the seven CRIs expect changes in access options.
- Three out of the six public libraries expect changes in methods of access.
- One out of the five science organisation libraries expects changes to methods of access.

The types of changes expected are illustrated by the comments below. In general libraries are expecting increases in the use of electronic access and some CRIs expect to close their doors to external users (interlibrary loan would still be available as a means of access).

- *"Electronic access, stronger controls on external users"* – CRI
- *"Increase in electronic full-text delivery"* – university
- *"Increase in CD ROM – Internet access"* – public library

6.4 Use of science information

This section of the report provides information about the use of science information in libraries. It describes the users themselves and the sort of science information that they use (either as issues or as reference).

Users of science information

For all libraries other than public libraries, principal users of science information are their internal staff and, in the case of universities, students. In public libraries, in contrast to their main users overall - the general public - the most frequent users of science information are students – particularly school students.

Students' heavy reliance on public libraries was verified by secondary school science teachers that were interviewed. They stressed the importance of these science collections for their students, given the inability of individual schools to provide the science information required by teachers and students to achieve curriculum outcomes.

Universities principally cater for their staff and students, although staff from other universities are also frequent users. CRI scientists are also frequent users in cases where CRIs are located close to universities.

Both CRI and other science organisation libraries also cater principally for their internal staff. While outsiders, especially from other CRIs and science organisations, are also users, their use is limited. Some libraries indicated that use by people outside of their institutions is likely to become more restricted in the future.

Special needs of science information users

Research results suggest that science information users do not have special needs that distinguish them from other users. Only three libraries (two public and one CRI) indicated that science information users require more assistance than other users. However, two additional libraries (one public and one CRI) identified some factors that cause difficulty for their users.

The factors most often identified as causing problems for science information users included: users' unfamiliarity with indexing in general (five in total); users having difficulty with science indexing (five in total);

the indexing system they used (three in total); users' unfamiliarity with libraries in general, and science collections in particular (three in total); and, for one public library, the "general illiteracy among students".

Other science information users are particularly skilled information users. For universities, their particularly knowledgeable users included: soil scientists and entomologists, academic staff, researchers, PHD students, and sport science information users. For CRIs, their most knowledgeable users tended to be their internal users and science staff. Science organisation libraries also identified their internal staff and researchers. The public libraries' list of knowledgeable users is interesting for two reasons. The list includes environmental scientists employed by local authorities, social science researchers, retired scientists, university students, and professionals in particular fields. It is interesting because it gives an indication of the range of users of their science information and because it does not include one of their most frequent users of science information – secondary school students.

The influence of these knowledgeable users suggests that science collections can develop in rather esoteric ways. Some libraries indicated that these users have an influence on the way their science collections develop. These users often identify gaps in collections, suggest purchases and provide advice on which journals should be continued. These users are often heavy users of the interlibrary loan system. One university library says these users:

> *"Assist in collection development through suggestions for material selection".*

A CRI says such users have a significant effect on their collection. They:

> *"Help to guide it, they encourage it and generally oversee it".*

The science information that is used

Use of science information can be assessed by looking at both issues (including interlibrary loans) and reference use. The latter use is more difficult to assess, however, as there is seldom any record of the reference use. The use of science information is influenced by similar factors to those that shape the nature of the science collections themselves.

In general, distribution of issues across science types is similar to the distribution of the science types available – that is, the proportions of issues are generally consistent with the proportions of total holdings these science types comprise.

There were exceptions to the overall pattern of consistency between information use and availability identified by the libraries surveyed or visited. In universities, issuing of science information is influenced by inter-related factors such as subject matter, the seniority of students and the format the information is in. For instance, in the more applied areas such as agricultural sciences, under-graduate students demand more up-to-date information, which is more generally available in journals. Therefore, issuing levels may be lower because these students can only use the information as reference. They cannot 'take out' journals. By the same token, issuing is less frequent in science areas where journal-based information predominates. So, issuing is lower in chemistry because journals predominate, but is higher in the social sciences where monographs/books predominate. In general, the seniority of students defines their lending rights. In some universities, only post-graduate students and staff can have journals issued, so their areas of research could distort any issue-based assessment of science information use.

For most libraries, the patterns of library use have remained the same over the past few years and are expected to remain the same in the next few years. There is a certain logic in this. The patterns of science information use more or less parallel the mix of science types in each science collection. Given that science information collections tend to be developed to meet actual and anticipated need, such a consistency would be expected – and demonstrates to some extent that libraries are generally succeeding in developing appropriate collections.

Five libraries reported change in the use of science information over the last few years, and a few anticipated future change. Previous change was usually attributed to changes in the needs of users, although two libraries also pointed out the influence that new, and more restrictive, lending policies had had on library use. Future change was attributed to both changing needs of users (because of new business and research directions) and changing technology:

- *"Less chemistry issues"* – CRI library
- *"Computer science has risen slightly"* – public library
- *"More material has been bought on computing"* – public library
- *"Borrowing is less"* – science organisation library
- *"Charging reduced interlibrary loan lending by our CRI from average of 1064 to 596 and also for borrowing 558 in 1987 to 351 in 1998"* – CRI library
- *"Electronic document delivery provides end user with more options. Electronic access to library collection will provide a better result to the user"*. - university
- "*It will depend on the way our business changes in response to the market-place*" – CRI library.

Reference use of library holdings is not necessarily expected to be consistent with patterns of issues, or with the nature of the collection itself. University librarians described how the same factors that shape issuing, also influence the patterns of reference use:

- Journals are usually only available for reference, except by post graduate students and staff.

- More applied areas of science often require under-graduate students to access journal articles, which are only available to them for reference.

- Some disciplines (e.g. chemistry) discourage undergraduate students from using journal articles until higher levels of study. Their use of reference material may be lower because they are able to take the required books out of the library.

- There may be lower levels of reference use in the social sciences because much of the information is contained in books/monographs that can be taken from the library.

Most libraries could not describe changes in reference use by science type. Over three-quarters of libraries reported either no change or uncertainty about change in the past five years or expected change over the next five years. Only CRI libraries reported that there had been changes in patterns of reference use:

- *"Increase in tertiary student use"* – CRI library
- *"Increase in business information requests"* – CRI library
- *"Less chemistry"* – CRI library

In the final case the change was the result of a merger with another library.

Two CRI libraries expect the pattern of reference use to change over the next five years. For both, this expected change was attributed to anticipated changes in the sector they worked in/with.

6.5 Problems accessing science information

There was general agreement amongst the different types of libraries that there are a number of factors that inhibit people's access to science information. These factors influence people's access to New Zealand science information in particular and science information in general. These factors include: lack of search mechanisms to identify science information, the physical location of science information collections, the cost of information which restricts its availability, the confidential nature of some science information, and the specialised nature of some science information collections.

There is no one place that users can identify New Zealand science information. There is no New Zealand science index. Locating New Zealand science on international science indexes is difficult. There is no national repository for New Zealand science.

The lack of an up-to-date New Zealand science index was the single most commonly identified barrier to people accessing New Zealand science:

- The lack of a database means that people have to search other sources to identify New Zealand science. Other sources usually include international indexes. It is sometimes the case that New Zealand science is also not indexed in the international indexes, or references to it are difficult to locate.

- Often these international indexes are highly specialised rather than comprehensive. Therefore, identification of science outputs requires time-consuming searches of several databases, which may also require specialised search skills.

- The full range of international indexes may not be readily available to all potential users since they are expensive to purchase and are often more suited to specialist and dedicated science libraries – for instance, their licensing conditions often exclude external users.

- There are particular groups that have less access to international science indexes. They include public library users and schools (both teachers and students). Public libraries and schools principally rely on INNZ, which does not include science.[11]

- New Zealand science is part of the country's heritage, yet there is no comprehensive database of its existence.

- There is no way to ensure that there is a comprehensive national New Zealand science collection, because there is no way to identify gaps in collections at an individual library or national level.

Some librarians considered that a remedy was not difficult. There should be an index[12] accessible to researchers and librarians that includes, as a minimum, the indexing of all publicly funded research on a database. Some librarians suggested that there were various options available to protect commercial sensitivity and other factors that may limit users – for instance, 'open' and 'closed' access to different sets of users. Libraries from all four sectors agreed that the lack of indexing is a significant factor in making access to science information difficult. A couple of comments illustrating the concern included:

- *"The absence of an index to NZ science publications is a major problem. Its absence limits the availability of the knowledge of our science production to the rest of the community".*

- *"Limited indexing, restricted access".*

The school teachers interviewed also noted the lack of a science index. Some science teachers claimed that the lack of New Zealand science index has important implications for young people considering science as a career:

- *"seems that there is nothing available about New Zealand science"*
- *"it seems that there is nothing exciting happening"*

[11] INNZ does index some articles classed as "popular science" for instance articles in "Forest & Bird".
[12] A database which indexes at the article level, not at the journal level.

Librarians also pointed out the shortcomings of international science indexing mechanisms. The location of science information references across a number of different international databases undermines access. In many areas of science, there is no one database that includes all the published material. Consequently libraries have to purchase a number of databases with overlapping and different information.

- Given the current Legal Deposit[13] requirements, the National Library cannot act as a repository of New Zealand science. Most science outputs are not deposited in the National Library because:

    - there is no requirement to deposit material published overseas
    - there is no requirement to deposit commercially sensitive and other grey material
    - there is no provision for electronic material

The highly specialised nature of some science collections can also constrain access. One CRI commented:

> *"Specialist research collections not suited to use by students or the general public".*

The location of libraries is another inhibiting factor. Many CRI libraries are in remote locations and not all are accessible through the Internet. Librarians felt this, combined with the costs of interlibrary loan, may prevent easy access for some users. Users' lack of experience and skills in on-line searching inhibits their access to and utilisation of electronic resources.

The rising costs of science outputs limit access because libraries are increasingly unable to purchase a comprehensive range of information. Most New Zealand scientists publish in overseas journals, which are becoming prohibitively expensive to purchase. New Zealand does not have the economies of scale to negotiate better deals with the publishing companies, and these publishing companies are highly commercial and their products are very expensive. The increasing costs of journals, and the inability of libraries to purchase them, will mean that New Zealand scientists will be at a disadvantage. They will not have easy access to the material that they need to keep ahead in their field.

There is no requirement for publicly funded science outputs to be made freely, or inexpensively, available. Some librarians referred to other places where there are government requirements for publicly funded science outputs to be made freely available to the public. One example given is the United States, where full-text outputs of publicly funded science are available free of charge by way of the Internet.

Some science providers and school teachers talked about the potential effects of poor access to science information on scientists and science (now and in the future) and on New Zealand's social and economic development. They identified a number of interrelated consequences that include:

- the increasing difficulty scientists will face in keeping up-to-date in their fields
- a potential reduction in the quality of the science when scientists cannot access relevant information
- a potential decrease in the reputations of both individual scientists and science organisations amongst their international peers (if the quality of science declines)
- a potential threat to New Zealand's future science capacity – current difficulties in accessing New Zealand science information may act as a further disincentive for young people to choose science as a career

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[13] New Zealand publishers are legally obliged by the National Library Act 1965 (Section 30A, amended 1994) to lodge three copies of their works with the Legal Deposit Office (LDO). The LDO is located in the National Library of New Zealand. One copy of the deposited work is made available to the public to use through the National Library, another is placed in the Parliamentary Library and a third copy is permanently preserved in the Alexander Turnbull Library as part of New Zealand's documentary heritage. The National Library reports that more than 4,000 new book titles and 80,000 issues of serials are deposited annually.

- New Zealand's diminished capacity to maximise the commercial and other advantages of investment in science given constraints in the performance of scientists

6.6 Summary

The most common methods for making information available to users is through loans and, for particular categories of science information, reference. Almost all of the libraries surveyed make science information available through interlibrary loan. Just over half the libraries expected some change in the way information is to be made available to users over the next five years. The main type of change expected is an increase in the use of electronic access

For all libraries other than public libraries, principal users of science information are their internal staff and, in the case of universities, students. In public libraries, in contrast to their main users overall - the general public - the most frequent users of science information are students – particularly school students. Students' heavy reliance on public libraries was verified by the secondary school science teachers interviewed.

There are a number of factors that inhibit people's access to science information. These factors include: the lack of search mechanisms to identify science information, the physical location of science information collections, the cost of information which restricts its availability, the confidential nature of some science information, and the specialised nature of some science information collections.

The lack of an up-to-date New Zealand science index was the single most commonly identified barrier to people accessing New Zealand science. This means that people have to search other sources to identify New Zealand science, which usually involves international indexes.

Some librarians considered that a remedy was not difficult. There should be an index of New Zealand produced science information that is accessible to researchers and librarians and includes, as a minimum, the indexing of all publicly funded research on a database. The schools involved in this research also noted the lack of a science index. Some science teachers claimed that the lack of New Zealand science index has important implications for young people considering science as a career.

The rising costs of science outputs limit access because libraries are increasingly unable to purchase a comprehensive range of information. Most New Zealand scientists publish in overseas journals, which are becoming prohibitively expensive to purchase. There is no requirement for publicly funded science outputs to be made freely, or inexpensively, available. There are potential effects of poor access to science information on scientists and science (now and in the future) and on New Zealand's social and economic development. These effects include the increasing difficulty scientists will face in keeping up-to-date in their fields with the potential reduction in the quality of the science when scientists cannot access relevant information. This could result in a potential decrease in the reputations of both individual scientists and science organisations amongst their international peers if the quality of science declines. This could lead to a potential threat to New Zealand's future science capacity, and lead to a diminished capacity to maximise the commercial and other advantages of investment in science given constraints on the performance of scientists.

GOOD ACCESS TO SCIENCE INFORMATION: ISSUES OF PRODUCTION, COLLECTION, PRESERVATION AND ACCESS

7.1 Introduction

This report, thus far, has been based on information collected from surveys, interviews and site visits to libraries. The research has revealed the scope and complexity of problems around accessing science information in New Zealand. The focus of the research had initially been on New Zealand science information. However, results have revealed both the difficulties of collecting accurate information about the availability and accessibility of New Zealand science information and the difficulties of accessing science information per se. Some of the factors affecting access are generic and influence access to both New Zealand and other science information, and some are specific to accessing New Zealand science.

The main issues are described below, and were used to inform the final stage of this research. This final stage involved a workshop of key stakeholders who sought to identify feasible responses by the National Library to the elements of the research that were relevant to its roles and responsibilities. The workshop outcomes are discussed in Section 8.

7.2 Key issues from the research

Concerns about access to science information centred on both the availability of science information (both generally and New Zealand science information specifically) and the accessibility of that information to New Zealanders.

7.3 Availability of science information

Various factors continue to expand the demand for science information. Libraries report that their science collections are developed to meet these expanding needs. To meet user needs, library acquisition and cancellation decisions need to be informed by factors such as changes in the business and research focus of parent organisations, changes in teaching programmes, developments in science and technology and changing interests of users. As measurements of library use (particularly, library issues) show, libraries have generally succeeded in meeting user needs. There is a general match between the distribution of holdings and issues across science areas. However, there is growing concern amongst librarians that it is becoming increasingly difficult for them to develop science collections that continue to meet user needs.

Most research participants are concerned that the availability of science information in general and New Zealand science information in particular is diminishing. While the demand for science information seems to be ever expanding, the capacity for libraries to meet that need is diminishing. The major issues they highlighted were a perceived drop in the numbers of scientific papers, a diversification of science outputs at the expense of papers, an increase in the amount of grey information, the rising costs of science information and the influence of electronic technologies on science collections.

The quantity and form of science outputs seem to be changing. There was some disagreement about changes in the numbers of science outputs overall, with some believing that the total number of science outputs has increased and some believing the reverse. However, the majority of research respondents perceived a decrease in the number of published scientific papers and an increase in the number of confidential reports (usually related to commercially funded research).

The apparent small shift in emphasis away from scientific papers, is part of a general diversification of science outputs, which is largely a reflection of demands by science purchasing agents for science to be more relevant and science outputs to be more accessible to end-users. Nevertheless, scientific papers in paper format still predominate despite the increase in alternative outputs such as field days, user-friendly articles, brochures, conference presentations and outputs in electronic formats. Although there is a general expectation that electronic formats will increase in the future, scientific papers are still expected to make up the bulk of science outputs.

The extent to which there has been a reduction or increase in the number of New Zealand science outputs is difficult to assess, given that no one organisation has the responsibility to capture such information. For instance, New Zealand no longer has an up-to-date national science database to capture outputs published in New Zealand. Also, there is no current mechanism for capturing the outputs of New Zealand scientists who publish their work in international journals. For instance, there is no requirement to deposit internationally published material with the Legal Deposit Office. Some librarians estimate that around 80-90% of science information in their libraries is in the form of papers in international journals. Science organisations concur – they report that most of their outputs comprise articles in international journals. There are some exceptions – in some disciplines (e.g. agriculture and horticulture) much of the science information produced in New Zealand is published in New Zealand journals.

There was a general concern that the availability of science information is diminishing. The diminishing availability of New Zealand science information was, in part, attributed to the shift in emphasis from published scientific papers to a more diversified mix of science outputs. The shift, people claimed, has lead to a growth in the number of confidential science outputs, often at the expense of publicly available published papers. On average, grey information comprises around 30% of CRI science outputs and, according to a range of science departments, around 10-20% of university science outputs.

Other factors were also implicated in the diminishing availability of science information. Despite the accumulative effect of continuing subscriptions and new purchases on the size of library collections, they may be becoming less comprehensive and, therefore, effectively smaller. Libraries are increasingly unable to purchase information that meets user demand and reflects the breadth of information that is available, because of budget constraints and the increasing cost of science information. Given that this trend is expected to continue, it is generally expected that the comprehensiveness of individual science collections will continue to diminish. In the absence of any co-ordinated cancellation and purchasing decisions amongst libraries, the comprehensiveness of science information at a national level is also expected to diminish.

One important change in the collection and preservation of science information is the adoption of electronic formats. The adoption of electronic formats is still relatively rare in libraries and, at present, most such science information duplicates paper format. But expected acceleration in the adoption of electronically based science information is likely to impact on the size of science collections. Some believe the size of science collections will become larger because electronic formats will be more cost effective and take up less room. Others believe that, despite the potential for electronic formats to be cheaper, publishers' practices will make science information more expensive and undermine libraries' ability to be selective in their purchasing. Larger collections do not necessarily mean more useful collections.

7.4 Accessibility of science information

There are also a number of factors that participants identified as affecting users' access (both positively and negatively) to the science information that is available. The factors identified as undermining access include the lack of indexing of New Zealand science information, restrictions on the use of libraries and the adoption of electronic formats. On the other hand, more science information is in user friendly formats and, therefore, is more accessible to users.

The most commonly identified factor undermining access to New Zealand science information is the lack of an up-to-date national science index. Other search mechanisms, usually international indexes, have a number of shortcomings. New Zealand science is not always indexed in the international indexes, or references to it are difficult to locate, and the indexes are expensive and often have restrictive licensing conditions. For these reasons, particular groups, for instance public library users and schools (both teachers and students), are often precluded from using them.

Science libraries are increasingly catering for their internal users. Currently, external users are discouraged (for instance, through increased charging for interlibrary loans) and some of the more specialised science libraries anticipate that restrictions on external users are likely to increase in the future. Some of these more specialised libraries also see their specialisation, and therefore the specialised skills users need to identify information, and their location, which is sometimes remote, as barriers to some groups of users.

There are also factors that potentially improve users access to science information. Electronic information has the potential to enhance access to information by, for instance, improving search mechanisms, enabling people to identify and sometimes access information from their desktops and enabling libraries to expand their science information collections. However, there is also some concern amongst libraries that electronic publishers will make science information more expensive and the use of electronic databases more restrictive, hence restricting access.

Science information is often available in more user friendly formats, given the requirements of purchasing agencies such as FRST. These formats are intended to make the information more accessible to end-users. Providers report an increase in other technology transfer mechanisms such as field days, booklets and articles in industry magazines and expect this trend to continue.

7.5 Summary

Concerns about access to science information centred on both the availability of science information (both generally and New Zealand science information specifically) and the accessibility of that information to New Zealanders.

Various factors continue to expand the demand for science information. Libraries report that their science collections are developed to meet these expanding needs. There is a general match between the distribution of holdings and issues across science areas. However, there is growing concern amongst librarians that it is becoming increasingly difficult for them to develop science collections that continue to meet user needs.

Most research participants are concerned that the availability of science information in general and New Zealand science information in particular is diminishing. This is due to a perceived drop in the numbers of scientific papers, a diversification of science outputs at the expense of papers, an increase in the amount of grey information, the rising costs of science information and the influence of electronic technologies on science collections.

However, the majority of research respondents perceived a decrease in the numbers of published scientific papers and an increase in the numbers of confidential reports. The apparent small shift in emphasis away from scientific papers, is part of a general diversification of science outputs, which is largely a reflection of demands by science purchasing agents for science to be more relevant and science outputs to be more accessible to end-users. Although there is a general expectation that electronic formats will increase in the future, scientific papers are still expected to make up the bulk of science outputs.

The extent to which there has been a reduction or increase in the number of New Zealand science outputs is difficult to assess, given that no one organisation has the responsibility to capture such information. However, there was a general concern that the availability of science information is diminishing. The diminishing availability of New Zealand science information was, in part, attributed to the shift in emphasis from published scientific papers to a more diversified mix of science outputs.

One important change in the collection and preservation of science information is the adoption of electronic formats. The adoption of electronic formats is still relatively rare in libraries and, at present, most such science information duplicate paper format. But expected acceleration in the adoption of electronically based science information is likely to impact on the size of science collections.

There are also a number of factors that participants identified as affecting users' access (both positively and negatively) to the science information that is available. The factors identified as undermining access include the lack of indexing of New Zealand science information, restrictions on the use of libraries and the adoption of electronic formats. On the other hand, more science information is in user friendly formats and, therefore, is more accessible to users.

FINDING SOLUTIONS

8.1 Introduction

The research process included a workshop of key stakeholders to search for feasible responses by the National Library to the issues identified in the research that were relevant to its roles and responsibilities. The workshop format included:

- presentation of the results of the surveys and interviews – to check findings
- identification of the main issues underpinning the problems identified
- seeking of solutions

The group agreed that the findings of the research were consistent with their own experiences. There was also general consensus that the research shows that access to science information is likely to further deteriorate if some of the contributing factors are not addressed. The principal factors contributing to a continuing deterioration of access to science were identified as:

- The lack of an information policy framework to underpin science information management (such as Australian national database quality standards and, in the USA, full text facilities on the Internet to access all publicly funded science).
- A lack of leadership and ownership of science information management.
- A lack of mechanisms for managing science information, in particular a national science information index.

The participants also noted the escalating costs of science information and the particular problems New Zealand faces in maintaining a comprehensive science collection, given factors such as the lack of economies of scale. One possible approach to addressing these increasing costs is through more library collaboration. Library resources could be maximised through more co-operative collection development and minimising of duplications. One outcome could be a distributed science collection with individual libraries focused on developing particular areas of strength. A resource sharing network would be needed with individual libraries having the responsibility to make their holdings known.

Unfortunately, the capacity for libraries to achieve cost savings through collaboration is limited. Some university libraries are currently developing collective purchasing agreements with Australian universities to gain some economies of scale in the market. However, it is difficult for other libraries, especially specialised libraries like those of CRIs, to develop such purchasing relationships. Even if they managed to overcome the inherent logistical problems of co-ordinating library acquisition planning, libraries' attempts to co-ordinate would be constrained by user needs and demands. As most science libraries report, users want information in-house. Some university and CRI libraries that are in close proximity have managed limited co-ordination in their acquisitions. However, given the attitudes and needs of users, further co-ordination is probably limited.

8.2 Development of a New Zealand science database

There was unanimous agreement amongst workshop participants that the most urgent issue with regard to accessing New Zealand science information was the lack of a national science index that provides references to New Zealand science information. Although workshop participants also discussed the need for a science information policy framework and leadership and co-ordination in science information management, they agreed that the development of a database of New Zealand science information was the most feasible response in the short-term. New Zealand science information[14] includes: New Zealand science material produced in New Zealand; New Zealand science material produced overseas; overseas science material produced in New Zealand.

Previous related research findings

Findings from previous research on the development of a science database were re-evaluated by the group for their current relevance. Previous research included studies by Insight Research Ltd (1992), National Library of New Zealand (1993) and BECA (1996).

Previous research found strong support for the establishment of a national science database as it would provide access to science information and contribute to economic development and protection of the New Zealand environment. However, support was not universal. Participants in those studies were concerned about things such as:

- resourcing
- the limited use of a New Zealand focused database
- its best 'home'
- the extent to which it should serve 'all New Zealanders' or the scientific and research community
- problems with existing databases
- the interface between the proposed database and other databases such as Index New Zealand (INNZ). INNZ is a tool for finding journal and newspaper articles and conference papers containing social science, arts, selected applied science or general interest material about New Zealand or the South Pacific.

Participants in the workshop as part of the current research also identified barriers to the development of a database. These included:

- lack of continuity of funding in science organisations that could take responsibility for developing and maintaining a database
- the high number of science providers and others that would need to contribute to the database
- a comparatively small market for the database
- the variety of potential users, for instance in terms of their ability to pay, level of specialisation, search skills, interests and needs, knowledge level
- technical constraints to combining data
- problems around ensuring continuity and quality in data inputting, including attitudes of scientists and resources

[14] There was a general consensus at a workshop held near the end of this research that New Zealand science included these elements. Participants rejected a definition that also included overseas science material produced overseas and written by a New Zealander on secondment from a New Zealand organisation.

What is currently needed in a New Zealand science database

Taking account of these barriers, participants in the workshop identified the main elements of the recommendations made in previous research that are still relevant to setting up a national science database in the current science structure. They selected the elements of previous research that were still relevant and feasible and supplemented these with further refinements that would make any database development responsive to the current science environment.

They agreed with past findings that a science database should hold bibliographic references to New Zealand science, defined as:

- New Zealand science material produced in New Zealand
- New Zealand science material produced overseas
- overseas science material produced in New Zealand
- be user-friendly – to ensure accessibility
- be accessible in public libraries (including consideration of appropriate access costs)
- be adequately resourced, without reliance on the voluntary placement of records
- be based on minimum record contribution standards to ensure successful searching and portability of data
- be based initially on an amalgamation of existing New Zealand science databases

There should be a financial recognition to contributors – either free or concessionary access.

There should be further detailed consultation with Mäori on their specific needs and requirements.

Workshop participants also recommended that the database should:

- be integrated across all disciplines/areas
- encompass all science journals
- include grey material as appropriate (for example, when no longer commercially sensitive)
- include significant work in practice
- be accessible on-line
- include a sophisticated search engine with different levels of indexing
- include abstracts and higher level indexing
- have web links to full-text
- have links to full bibliographic records and document supply
- include a tiered charging system
- be retrospective - capture information to fill the gap from when STIX ceased to be up-dated

Workshop participants were confident that the creation of a New Zealand science index would provide a substantial solution to many of the access issues outlined in this report. It is now up to the various interested parties to discuss the issues further and map out a solution. This solution will need to allow for the many varying needs of science information providers, users, and collectors, but access by those who need it, to New Zealand science information can only assist the further development of the information rich society New Zealand is striving for.

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