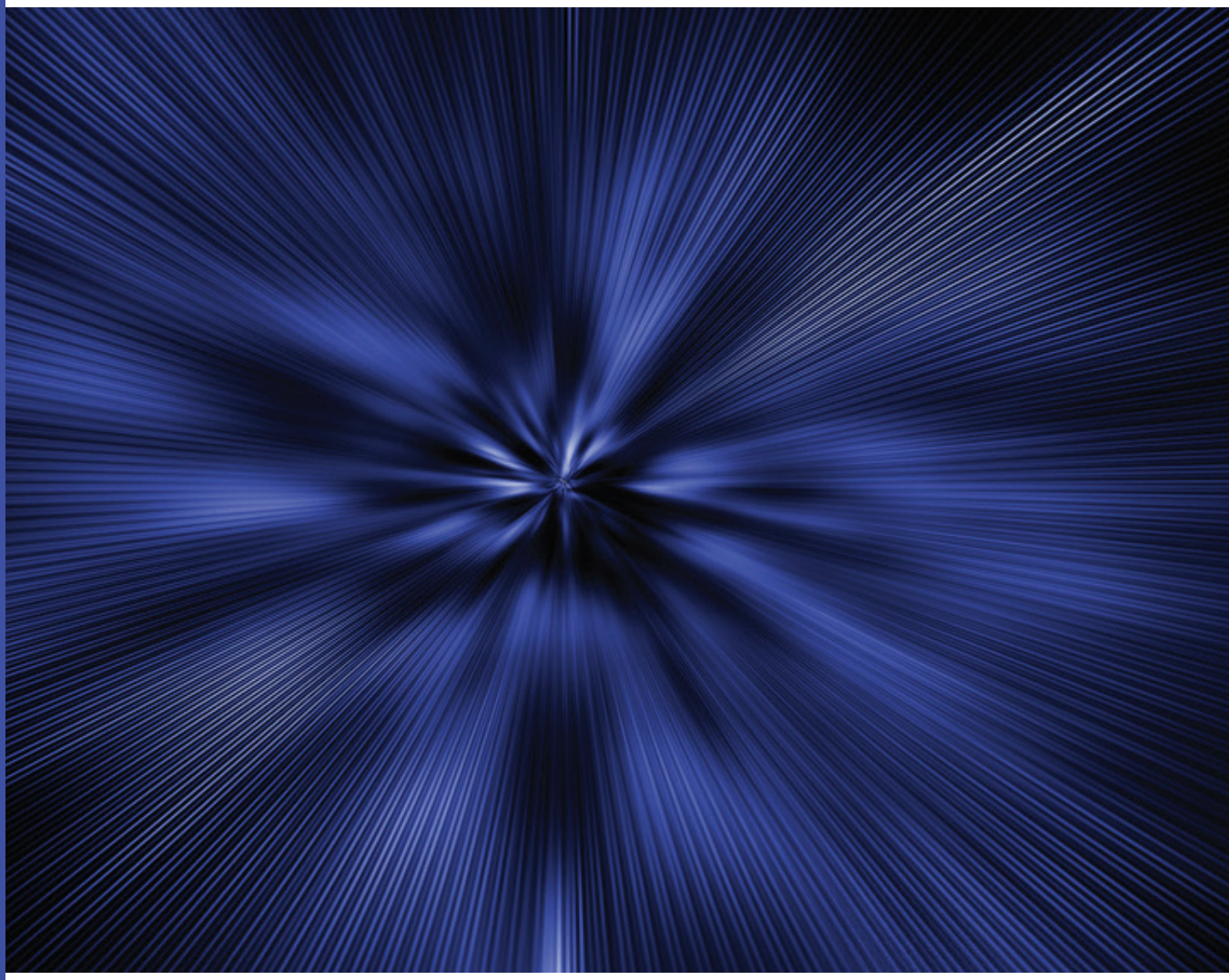
Academic Libraries and Research Data Services

Current Practices and Plans for the Future

An ACRL White Paper



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The Center for Information and Communication Studies (CICS) at the University of Tennessee is devoted primarily to research. CICS facilitates and administers applied research in the areas of information systems and database design/evaluation, information usage, effective communication, scientific communication, science publishing, and information management. CICS works with private and public organizations, governmental agencies, and corporations to provide educational materials and research expertise in information- and communication-related projects. The work of CICS has involved dozens of researchers across disciplines and across agency borders.

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Executive summary

As science becomes more collaborative, data-intensive, and computational, academic researchers are faced with a range of data management needs. Combine these needs with funding directives that require data management planning, and there is both a need and an imperative for research data services in colleges and universities. Academic libraries may be ideal centers for research data service activities on campuses, providing unique opportunities for academic libraries to become even more active participants in the knowledge creation cycle in their institution. Recently the academic library community has identified data curation as one of the top ten trends in 2012. Some academic libraries are already engaged in these activities, and others are examining ways they can best provide a range of research data services.

This study surveyed a cross section of academic library members of the Association of College and Research Libraries (ACRL) in the United States and Canada to provide a baseline assessment of the current state of and future plans for research data services in academic libraries in these countries.

Key findings and observations:

- Only a small minority of academic libraries in the United States and Canada currently offer research data services (RDS), but a quarter to a third of all academic libraries are planning to offer some services within the next two years.
- Creating web guides to help locate data is the most commonly offered or planned RDS. This is an extension of traditional library practices into the new environment.
- Libraries in larger or doctoral-granting institutions are more likely to offer a range of informational/consultative type services, although some academic libraries in all sizes of institutions are planning to offer selected RDS in the future. Some of these services expand the role of the library in the knowledge creation process.
- Libraries in larger or doctoral-granting institutions are more likely to offer or plan to offer technical/hands-on RDS. However, libraries at associate degree–granting and baccalaureate institutions should consider offering some of these services since there is value for the library in helping the institution meet its mission goals, such as promoting matriculation into four-year universities and preparing students for graduate studies.
- Libraries on campuses that receive NSF funding are more likely to offer or plan to offer RDS of any type. This suggests that funding agency requirements are driving the need for RDS. As budget decisions move towards even greater accountability, it is likely that more agencies will dictate responsible data management, so the need

for RDS on campus is likely to grow. If the library is not actively involved in providing these services, some other unit is likely to be pressed into service, which can diminish the image of the library as an important partner in the research process.

- Few academic libraries are responsible for developing research data policies. Being able to serve as a clearinghouse of ideas and to provide expertise to build these policies is an opportunity for libraries to be members of the knowledge creation process.
- Collaboration on RDS occurs most frequently with other units on campus, most often the office of research. This collaboration is an excellent way for libraries to establish the vital role they play in the knowledge creation process and to help support the valuation of the library to the campus community.
- Reassigning existing library staff is the most common tactic for offering RDS. This approach also needs to be supported with professional development for staff so they can gain the required expertise to provide the full range of RDS.
- Of libraries that provide RDS, most have reassigned, or are planning to reassign, existing staff to take on these duties. While this is likely a financial necessity, there seems to be the potential for using this confluence of events as a means for developing an argument to gain additional funding for some new positions whose responsibilities are primarily related to RDS. While this study is focused on science, it should be noted that other disciplines are also beginning to become more collaborative, data-intensive, and computational, so RDS services are likely to cross disciplinary boundaries and service a wide range of researchers.
- Libraries rely on conferences or workshops to provide RDS training for their staff. Libraries need some institutional support to send their librarians for this professional development, and it is important for professional organizations to continue to provide this training. There may be an opportunity for those libraries at the leading edge to create a mentorship relationship with peer or other associated libraries to help disperse the expertise across a wider range of librarians.

Introduction

The movement of scientific research towards a data-intensive, collaborative approach has been well documented and discussed. The advance of digital technologies has both strengthened the power and reach of data and raised new challenges for the research community. Scientists and research institutions face many challenges while attempting to preserve the vast amounts of data for long-term use, including how best to describe data in a consistent way, keep up with evolving data standards, consistently and effectively share data while allowing for some restrictions, and other, often sociological, obstacles to data sharing and data reuse, all while coping with the huge increases in the amount of data being created.[1] Academic libraries are considering ways they can be involved with helping their institutions solve the challenges surrounding research data.[2]

This new data-intensive research environment of scientific study has been called the "fourth paradigm" of scientific inquiry.[3] In reality, it encompasses all fields, not just sciences, as it is important in today's research environment for researchers to have the ability to collect, analyze, share, and effectively manage and preserve research data. Yet services related to supporting researchers in their data management, both short- and long-term, have in many cases been found to be lacking. Tenopir et al. found that one major barrier to data sharing by scientists is a lack of institutional guidance and support.[4] Lack of formal data management processes, insufficient or nonexistent training and tools, and inadequate funding can all play into the loss or misuse of research data. Libraries, in conjunction with research offices on campus, are an ideal center for supporting academic researchers in their research data management needs.

There are powerful reasons for librarians to explore how their academic libraries can better satisfy the needs of researchers in the new data-intensive research atmosphere. Funding agencies such as the National Science Foundation (NSF) have new requirements that include detailed data management plans,[5] and there are movements from funding

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1. National Research Council, *Ensuring the Integrity, Accessibility, and Stewardship of Research Data in the Digital Age* (Washington, DC: National Academies Press, 2009). http://www.nap.edu/catalog.php?record_id=12615.
2. Catherine Soehner, Catherine Steeves, and Jennifer Ward, *E-Science and Data Support Services: A Study of ARL Member Institutions* (Washington D.C.: Association of Research Libraries, 2010), http://www.arl.org/bm~doc/escience_report2010.pdf.
3.Tony Hey, Stewart Tansley, and Kristin Tolle, eds., *The Fourth Paradigm: Data-Intensive Scientific Discovery* (Redmond, WA: Microsoft Research, 2009).
4. Carol Tenopir et al., "Data Sharing by Scientists: Practices and Perceptions," *PLoS One* 6, no. 6(2011): e21101. doi:10.1371/journal.pone.0021101.
5. National Science Foundation, "NSF Data Management Plan Requirements," accessed October 12, 2012, http://www.nsf.gov/eng/general/dmp.jsp.

agencies to require data deposition. [6] Therefore, to help their institution's researchers, libraries can be actively involved in providing an infrastructure of research data tools and services.

In fact, the ACRL Research Planning and Review Committee has identified library involvement in data curation, including collaboration with their research communities, as one of the 2012 top ten trends in academic libraries.[7] This trend has so much potential for academic libraries that it also intersects with two of the other top ten trends: communicating value and staffing. According to the ACRL report, data curation offers "opportunities for 'finding new ways to communicate the value of the skills librarians already possess and in developing roles that were not previously associated with librarians.'"[8]

A number of funding institutions, library organizations, and other stakeholders in the library community have seen the importance of offering research data services to academic researchers. DataONE, one of the initially funded NSF DataNet partners, has a mission to ensure the preservation and access to multi-scale, multi-discipline, and multi-national science data DataONE is helping by providing tools, education, and training in the area of data management. To better do so, a major priority of DataONE is to develop an understanding of users' perceptions, attitudes, and requirements in the world of data intensive science.[9] Users, or stakeholders, include the researchers themselves, but also the libraries and librarians that work with researchers.

Members of the DataONE team are conducting baseline and follow-up assessments of the data-sharing practices and attitudes of multiple stakeholders. This report focuses on a survey of the current research data services offered by academic libraries, as well as plans to offer these services in the future. The participants of this survey are a panel of library directors whose libraries are currently members of the Association of College and Research Libraries (ACRL). ACRL members include representatives from academic libraries in the United States and Canada in academic institutions of all sizes and types, from two-year community colleges to large research institutions. Librarians from over 800 libraries

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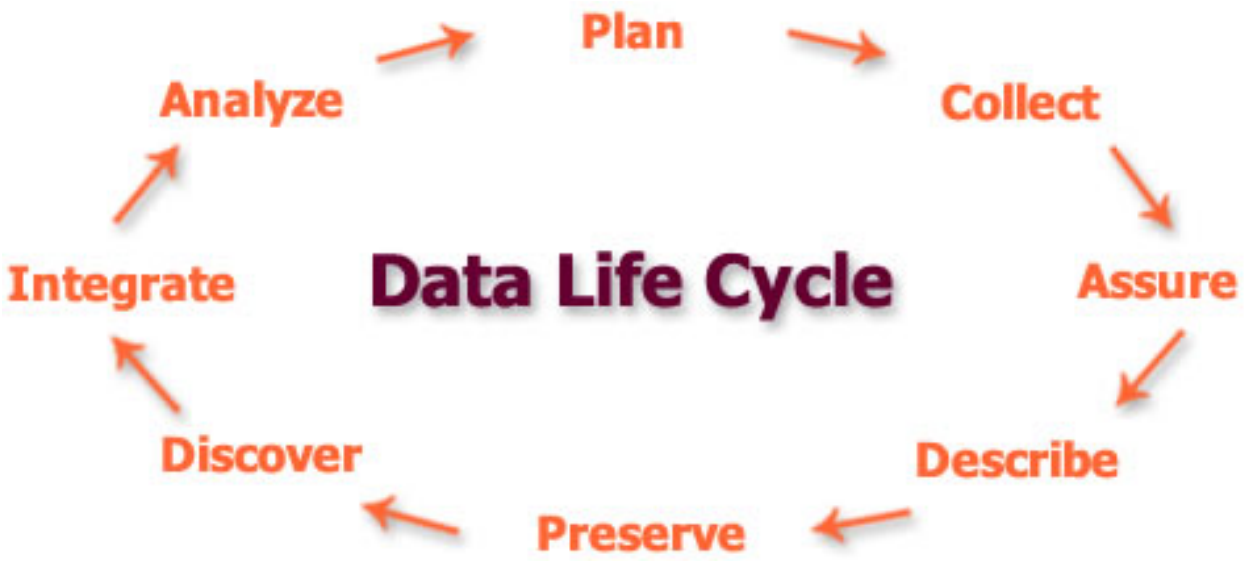
6. Office of Science and Technology Policy, "Request for Information: Public Access to Digital Data Resulting from Federally Funded Scientific Research," Fed. Reg/ Doc. 2011-32947 (December 23, 2011): 68517–68518, https://federalregister.gov/a/2011-32947.
7. ACRL Research Planning and Review Committee, "2012 Top Ten Trends in Academic Libraries," *College & Research Libraries News* (June 2012): 311–320, http://crln.acrl.org/content/73/6/311.full.pdf+html.
8. Sally A. Gore., "E-science and Data Management Resources on the Web," *Medical Reference Services Quarterly* 30, no. 2 (2010): 167–177, quoted in ACRL Research Planning and Review Committee, "2012 Top Ten Trends in Academic Libraries," 312.
9. William K. Michener et al., "Participatory Design of DataONE—Enabling Cyberinfrastructure for the Biological and Environmental Sciences, *Ecological Informatics* 11 (September 2011): XXX. doi:10.1016/j.ecoinf.2011.08.007.

currently belong to ACRL. Respondents to the survey represented their institution, with results reflecting library practices and plans, not the individual's viewpoint.

The contents of this survey focus specifically on research data services. Research data services are services that a library offers to researchers in relation to managing data and can include informational services (e.g., consulting with faculty, staff, or students on data management plans or metadata standards; providing reference support for finding and citing data sets; or providing web guides and finding aids for data or data sets), as well as technical services (e.g., providing technical support for data repositories, preparing data sets for a repository, deaccessioning or deselecting data sets from a repository, or creating metadata for data sets). Research data services, then, are services that address the full data life cycle (figure 1). The purpose of this survey was to discover what types of research data services are currently offered in each library, what research data services are in planning stages for the future, what staff capacity and leadership are devoted to research data services, and what types of staff training are allotted for research data services. The results of this survey provide a picture of what is currently being done and the direction libraries are taking in the area of research data services, with special emphasis on the level of involvement of libraries in these services according to the size and type of institution.

Figure 1. The Data Life Cycle (from http://www.dataone.org/best-practices)



Related research

The rise of data-intensive science has sparked many studies of how academic libraries can assist their institution's researchers and play a role in e-science and research data services. The Association of Research Libraries (ARL) E-Science Working Group, in its 2010 survey, strove to "build an understanding of how libraries can contribute to e-science activities in their institution."[10] The results of this survey revealed a diverse landscape of approaches taken toward e-science that appeared at times both bleak and promising. For example, the majority of respondents (23 of 42) reported no designated units to provide data curation and support for research data on their campus. However, the 19 respondents who did have designated units on their campuses for research data services reported a range of centers devoted to such services as data, disciplinary informatics, statistical analysis, digital research and curation, campus information technology, and high-performance computing. Even the respondents without such centers revealed they had an increasing understanding of data management skills, services, and resources. Additionally, a high proportion of respondents indicated that their institutions are planning to provide infrastructure or support services for e-science. The survey identified successful collaborations in support of e-science between libraries and departments, as well as collaboration between different interdisciplinary subject areas and other institutions.

Funding is often a preliminary barrier for organizations that wish to provide research data services to their researchers, particularly since the cost of handling supplementary materials such as data sets is not well known.[11] Tenopir et al. found that the two most often cited reasons by scientists for not sharing data were insufficient time and lack of funding.[12] A study conducted by the data repository Dryad surveyed 12 journals and organizations for information on their experiences working with supplementary materials, particularly data.[13] The participants reported rapid increases in the number of articles submitted with data included; however, detailed cost information for handling these materials was readily available from only one interviewee, who had previously participated in JISC's Keeping Research Data Safe, Phase 2, study.[14] Phase One of the JISC study developed a cost model

10. Soehner, Steeves, and Ward, *E-Science and Data Support Services*, 7.
11. The complex nature of the costs of data preservation requires consideration of a multitude of factors throughout the full data life cycle that must be projected into the indefinite future. The California Digital Library is in the planning stages of a project that will attempt to assess the total costs of digital preservation using a Total Cost of Preservation (TCP) analysis: http://www.cdlib.org/cdlinfo/2012/02/03/merritt-service-update.
12. Tenopir et al., "Data Sharing by Scientists."
13. Dryad, "Dryad Sustainability Plan: Interview Survey Findings" (Charles Beagrie, April 2010). http://wiki.datadryad.org/wg/dryad/images/b/bf/Beagrie_suppdata_report_apr10.pdf.
14. Neal Beagrie, Brian Lavoiie, and Matthew Woolard, "Keeping Research Data Safe (Phase 2)," JISC Report, April 30, 2010, http://www.jisc.ac.uk/publications/reports/2010/keepingresearchdatasafe2.aspx.

and identified cost variables for preserving research data in UK universities.[15] Phase Two of the study identified and analyzed sources of long-lived data and developed longitudinal data on the costs and benefits of digital data preservation. The findings highlighted the relatively low cost of archival storage and preservation for research data compared to acquisition or access activities and emphasized the importance of promoting "near term benefits" in advocating data preservation to researchers.

Researchers are aware of the rising importance of the availability of data sets, yet data is often unavailable due to various factors. In the Publishing Research Consortium's (PRC) study on access to professional and academic information in the United Kingdom, over half (62 percent) of respondents judged access to data sets as "very important," yet access to data sets came in last among the other information types in respondents' perception of their accessibility.[16] Inaccessibility is not always due to a lack of policy or structure on the part of an organization. In a study of authors of articles in PLoS (Public Library of Science) journals, Savage and Vickers found that only one out of ten researchers sent an original data set in response to requests, despite PLoS's specific data-sharing policies.[17] Clearly, the decision of researchers to share or not share data is quite often a personal choice due to many factors. These factors can include privacy concerns, concerns about publishing opportunities, and the desire to retain exclusive rights to data.

Barriers to data sharing and preservation are often due not only to the practices and culture of the research process or to cost concerns, but to personal beliefs and views on the process of sharing or withholding data. In the study by Tenopir et al., only 14 percent of participants responded that their data should not be made available, yet the actual rate of data sharing varied considerably according to subject discipline, age, and geographic location.[18] Researchers in computer science and medicine were the least likely to share data. Other studies have also found disparities among different fields. Campbell et al. found that fields with increased opportunities for commercial applications, such as genetics, yielded the least amount of data sharing when compared to less competitive fields.[19] *How* researchers share their data is an additional concern. Researchers in fields such as

15. Neal Beagrie, Julia Chruszcz, and Brian Lavoie, "Keeping Research Data Safe (Phase 1)," JISC Report, May 12, 2008, http://www.jisc.ac.uk/publications/reports/2008/keepingresearchdatasafe.aspx.
16. Publishing Research Consortium, *Access vs. Importance: A Global Study Assessing the Importance of and Ease of Access to Professional and Academic Information: Phase I Results* (Publishing Research Consortium, October 2010), http://www.publishingresearch.net/documents/PRCAccessvsImportanceGlobalNov2010_000.pdf.
17. Caroline J. Savage and Andrew J. Vickers, "Empirical Study of Data Sharing by Authors Publishing in PLoS Journals," *PLoS ONE* 4, no. 9 (2009): e7078. doi:10.1371/journal.pone.0007078.
18. Tenopir et al., "Data Sharing by Scientists."
19. Eric G. Campbell et al. "Data Withholding in Academic Genetics: Evidence From a National Survey," *Journal of the American Medical Association* 287, no. 4 (2002): 473–480.

environmental science may have a lack of common standards that can lead to confusion, and ultimately to the loss of data.[20]

Enke et al. found a diverse mix of both technological (lack of appropriate databases/mechanisms) and sociological (time, funding, etc.) reasons that may impede scientists from sharing data.[21] The main reason for not sharing data, cited in their international survey on data sharing in the biodiversity field, was "loss of control" over the data, followed closely by the amount of time that would need to be invested in sharing data sets. Lack of community-wide standards for data sharing was another often-cited obstacle, with less than half of respondents even aware of community wide standards in their field of research. PARSE.Insight, in its 2009 survey, revealed that researchers often have major concerns with legal issues, misuse of data, and incompatible data types that interfere with the practice of sharing their data. [22] Researchers may also lack knowledge about handling data. A recent study at Georgia Tech revealed that although faculty expressed great interest in the curation of data, nearly half (47 percent) of respondents who did not have a plan for data management claimed that they did not know enough about data management plans to construct one.[23] A 2012 survey of NSF principal investigators (PIs) at Cornell University discovered an overarching uncertainty among PIs about how to meet the new NSF data management plan requirements, with the majority responding that they would welcome assistance both with planning and with NSF-required data management components.[24] This uncertainty among researchers about meeting the new requirements from funding agencies indicates a potential educational role for librarians in the area of data management concerns.

Research organizations need to provide not only structure and policies for research data preservation, but services to support and educate researchers on concepts of data management and promote the sharing of data sets that can often be vital for the continuation of research. A survey conducted at the University of Houston found that the top data services that researchers needed were primarily directional ones: assistance with data management plans and the grant proposal process, finding data-related services,

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20. Bryn Nelson, "Data Sharing: Empty Archives," *Nature* 461 (2009): 160–163. doi:10.1038/461160a.
21. Neela Enke et al., "The User's View on Biodiversity Data Sharing—Investigating Facts of Acceptance and Requirements to Realize a Sustainable Use of Research Data," *Ecological Informatics* 11 (September 2012): 25–33. doi:10.1016/j.ecoinf.2012.03.004.
22. Tom Kuipers and Jeffrey van der Hoeven, *Insight into Digital Preservation of Research Output in Europe,* survey report (PARSE.Insight, December 9, 2009).
23. Susan Wells Parham, Jon Bodnar, and Sara Fuchs, "Supporting Tomorrow's Research: Assessing Faculty Data Curation Needs at Georgia Tech," *College & Research Libraries News* 73, no. 1 (2012): 10–13, http://crln.acrl.org/content/73/1/10.full.
24. Gail Steinhart et al., "Prepared to Plan? A Snapshot of Researcher Readiness to Address Data Management Planning Requirements," *Journal of eScience Librarianship* 1, no. 2 (2012). doi:10.7191/jeslib.2012.1008.

publication support, and targeted research assistance with data management.[25] A recent study conducted by Bach et al. found that, in general, user support in biodiversity data repositories is a weak point.[26] Most repositories interviewed provided only low-level support such as impersonal e-mail help desks or text instructions. More personalized and streamlined data services are needed; however, the complexities presented by research data can make it difficult to identify researchers' specific needs.

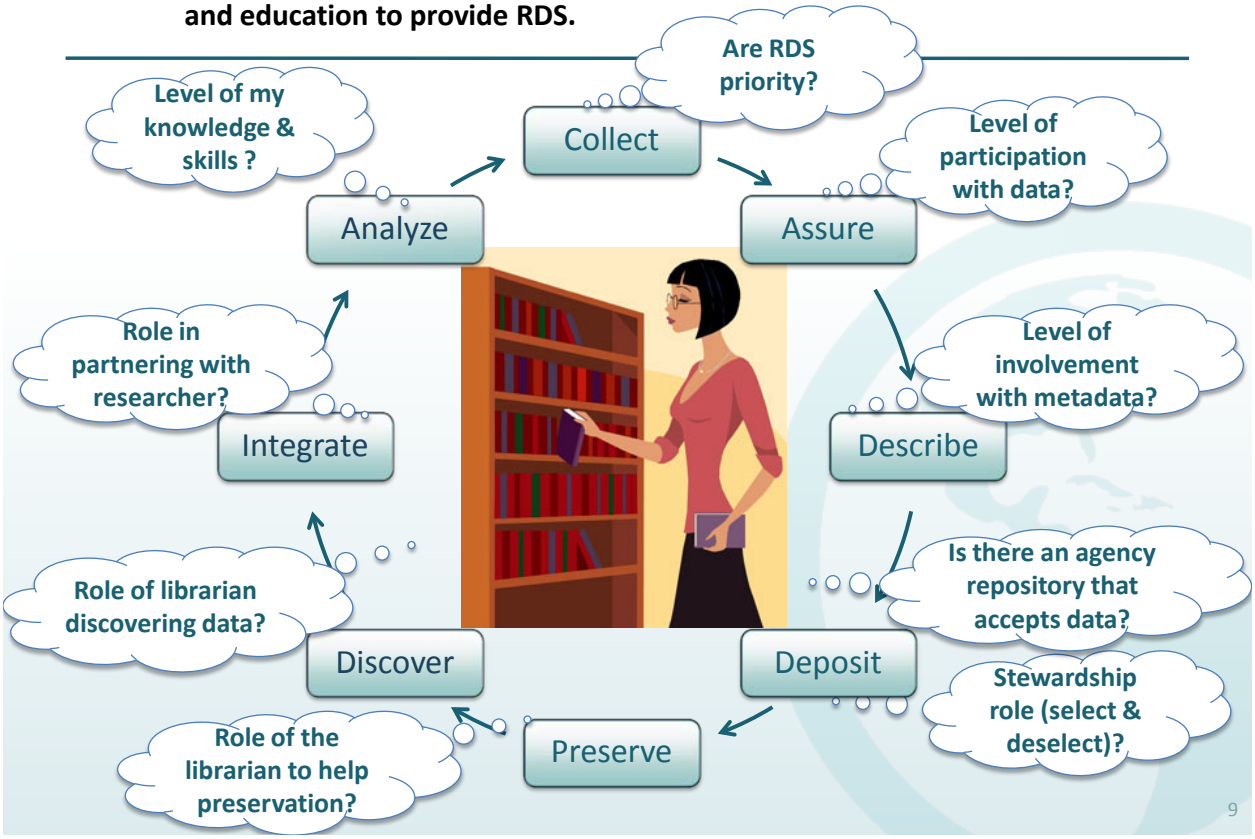
Several studies have cited the importance of library staff training in the area of data curation and management services. For example, identifying and collecting data and data sets to include in repositories has become increasingly important, leading to the need to train staff members whose collection experience may be limited to mostly traditional materials. Newton, Miller, and Bracke, in their exploration of the librarian's role in institutional data set collecting, found strong evidence that although research libraries—through their connections with faculty across campus and their expertise in developing traditional collections—are prime candidates for developing scientific data collections for universities, additional skills are required to populate an institutional repository with relevant data.[27] In particular, libraries need to make use of professional relationships and collaborations with faculty across fields and between institutions to identify materials. Creamer et al. found that of twenty needed data competency areas, the greatest need for librarians was technical hands-on training in the digital description and curation of large data sets.[28]

Perhaps one of the most important aspects of providing research data services is the ability for the librarian to communicate effectively with researchers about concepts related to data. The DataONE Usability & Assessment Working Group adapted the data life cycle to put questions that libraries and librarians may have regarding research data services into context (figure 2). A study conducted by the Purdue University Libraries found a high level of variation in data curation concepts and terminology across, or even within, fields of

25. Christie Peters and Anita Riley Dryden, "Assessing the Academic Library's Role in Campus-Wide Research Data Management: A First Step at the University of Houston," *Science & Technology Libraries* 30, no. 4 (2011): 387–403. doi:10.1080/0194262X.2011.626340.
26. Kerstin Bach et al., "A Comparative Evaluation of Technical Solutions for Long-Term Data Repositories in Integrative Biodiversity Research," *Ecological Informatics* 11 (September 2012): 16–24. doi:10.1016/j.ecoinf.2011.11.008.
27. Mark P. Newton, C. C. Miller, and Marianne Stowell Bracke, "Librarian Roles in Institutional Repository Data Set Collecting: Outcomes of a Research Library Task Force," *Collection Management* 36, no. 1 (2011): 53–67. doi:10.1080/01462679.2011.530546.
28. Andrew Creamer et al., "An Assessment of Needed Competencies to Promote the Data Curation and Management Librarianship of Health Sciences and Science and Technology Librarians in New England," *Journal of eScience Librarianship* 1, no. 1 (2012). doi:10.7191/jeslib.2012.1006.

study, which served as a barrier between librarians and researchers.[29] The study resulted in the DCP Toolkit (http://datacurationprofiles.org), a semistructured data reference interview instrument that is designed to help librarians connect with researchers and identify their data needs. The in-depth profiles available in this toolkit, created through surveys and extended interviews of researchers about their needs and preferences for preserving data, capture specific requirements for data in language articulated by individual researchers. These profiles allow librarians and others to make informed decisions while working with forms of data or subdisciplines that they may not be familiar with and have immense potential for use in helping librarians develop research data services for their individual institutions, as well as furthering understanding of the data needs of researchers and the types of data that they want to share, curate, and preserve.

Figure 2. The librarian ponders whether she has the background, skills, and education to provide RDS.



29. Jake Carlson, "Demystifying the Data Interview: Developing a Foundation for Reference Librarians to Talk with Researchers about Their Data," *Reference Services Review* 40, no. 1 (2012): 7–23. doi:10.1108/00907321211203603.

The rapid changes in the research landscape make continued research on the data services offered to researchers a necessity. A comprehensive and strategic role for libraries has been advised: besides their more obvious administrative role in supplying bibliometrics, libraries need to take an interest in all aspects of scholarly activity and actively participate in the curation, advising, and preservation of research outputs.[30] Although much of the research on research data services has been concentrated in the United Kingdom and North America, current research efforts are focusing on examining more thoroughly the data services offered in academic libraries in countries such as Australia, Ireland, and New Zealand as well.[31] New tools being developed, such as the Data Asset Framework in the United Kingdom (http://www.dcc.ac.uk/resources/tools-and-applications/data-asset-framework), are providing libraries with the means to identify, locate, describe and assess how they are managing their research data assets.

30. John MacColl, "Library Roles in University Research Assessment," *LIBER Quarterly* 20, no. 2 (2010): 152–168, http://hdl.handle.net/10023/1677.

31. Waseem Afzal, Sheila Corrall, and Mary Anne Kennan, "Evolving Roles: Research Support Services in the Academic Libraries of Australia, Ireland, New Zealand, and the U.K." (Work in Progress poster submitted at the ALISE 2012 annual conference.

Methodology and characteristics of responding libraries

This survey serves as a baseline assessment of the research data services–related activities currently offered or being planned by academic libraries of all types in the United States and Canada. Beginning on November 17, 2011, invitations with the survey link were sent by the ACRL to its panel of 351 library directors. The survey, a copy of which is found in the appendix, was hosted on the ACRL's server.

The ACRL panel represents a valid random stratified sample of ACRL member libraries, consisting of library directors of 116 associate's degree–granting institutions, 93 baccalaureate degree–granting institutions, and 142 research and doctorate-granting universities. Each panelist agreed to serve for three years and respond to four surveys per year on a variety of topics. This survey was one of those four.

A reminder was sent on December 19, and the survey was closed on January 25 with 221 responses, a 63 percent response rate. Of those 221 responses, 68 were from associate's degree–granting institutions (59 percent response rate for this group); 54 from baccalaureate degree–granting institutions (58 percent response rate for this group); and 99 from universities (70 percent response rate from this group).

The respondents are a close match to the full panel, which is a stratified sample of academic libraries of all types and across the United States and Canada (table 1). Since the respondents are representative of the population as a whole (as represented by the full panel), results were not weighted.

Table 1. Frequencies and Percentages for Both the Full Panel and Survey Participants, by Type of Institution and Library Location (Region)

	Associate's Colleges		Baccalaureate Colleges		Research / Doctoral		Totals	
Region	**Full Panel**	**Survey**	**Full Panel**	**Survey**	**Full Panel**	**Survey**	**Full Panel**	**Survey**
South	41 (35%)	22 (32%)	15 (16%)	16 (30%)	50 (35%)	34 (34%)	106 (30%)	72 (33%)
West	21 (18%)	12 (18%)	23 (25%)	11 (20%)	17 (12%)	13 (13%)	61 (17%)	36 (16%)
Midwest	34 (29%)	24 (35%)	28 (30%)	15 (28%)	39 (27%)	26 (26%)	101 (29%)	65 (29%)
Northeast	20 (17%)	10 (15%)	27 (29%)	12 (22%)	36 (25%)	26 (26%)	83 (24%)	48 (22%)
Total	116 (100%)	68 (100%)	93 (100%)	54 (100%)	142 (100%)	99 (100%)	351 (100%)	221 (100%)

Respondents represented their institutions, rather than themselves as individuals. The unit of analysis is therefore academic libraries, and responses demonstrate the activities and plans of academic libraries as a whole. At the end of the survey, library directors were invited to provide their e-mail address and receive a link to another survey for distribution to the librarians on their staff. A total of 19 library directors took advantage of this opportunity. The librarians' survey focuses on attitudes towards and readiness for research data services among academic librarians. It was hosted on the University of Tennessee server, and results will be published separately. This report presents the results of just the libraries survey.

The libraries data set was imported into SPSS and merged with 2 responses collected on our server from a separate distribution of the same survey to library directors in the University of California system. The final data set then contained responses from 223 libraries.

Respondents represent all sizes and types of academic institutions (see tables 2, 3, and 4). Over 60 percent of the institutions have fewer than 5,000 full-time equivalent students, and over 70 percent of responding institutions employ fewer than 250 tenure-track or tenured faculty members. Most of the campuses receive no or only a few NSF grants each year. As size and type of institution are likely to have a bearing on the level of involvement of the library in research data services, all results are also analyzed by these demographic characteristics of the parent institution.

Table 2. Number of FTE (Full-Time Equivalent) Students Enrolled in the Academic Institution of Responding Libraries

	Frequency	**Percent**
Up to 1,999	66	29.6
2,000 – 4,999	71	31.8
5,000 – 9,999	34	15.2
10,000 – 24,999	37	16.6
25,000 or more	15	6.7
Total	223	100.0

Table 3. Number of Tenure-Track and Tenured Faculty Employed at the Academic Institution of Responding Libraries

	Frequency	Percent
Less than 100	82	37.4
100 – 249	75	34.2
250 – 499	28	12.8
500 – 999	19	8.7
1,000 or more	15	6.8
Total	219	100.0

Table 4. Number of NSF Grants Typically Awarded Each Year to the Academic Institution of Responding Libraries

	Frequency	Percent
None	78	37.3
1 – 19	103	49.3
20 – 29	10	4.8
30 – 39	4	1.9
40 – 49	0	0.0
50 or more	14	6.7
Total	209	100.0

Findings

Services offered now and plans for the future

Currently, a minority of US and Canadian academic libraries are offering research data services, with more planning to begin in the next year to two years. More libraries are offering or planning to offer informational/consultative-type services (see table 5A), rather than technical assistance services (see table 5B). Overall, more libraries are planning to offer research data services in the future than are offering them now, with reference-type services the most popular.

Table 5A. Research Data Services (RDS) Currently Offered by the Library or Planned to Be Offered in the Future: Informational / Consulting Services

	Yes, our library currently offers this service	No, but plan to within the next 12 months	No, but plan to within 13–24 months	No, but plan to do so in more than 24 months	No, and we currently have no plans to do so	Total
Consulting with faculty, staff, or students on data management plans	45 20.5%	15 6.8%	13 5.9%	21 9.5%	126 57.3%	220 100.0%
Consulting with faculty, staff, or students on data and metadata standards	39 17.9%	17 7.8%	18 8.3%	17 7.8%	127 58.3%	218 100.0%
Outreach and collaboration with other research data services (RDS) providers either on or off campus	24 11.0%	17 7.8%	14 6.4%	20 9.2%	143 65.6%	218 100.0%
Providing reference support for finding and citing data / data sets	97 44.1%	16 7.3%	20 9.1%	12 5.5%	75 34.1%	220 100.0%

Creating web guides and finding aids for data / data sets / data repositories	49 22.3%	35 15.9%	21 9.5%	18 8.2%	97 44.1%	220 100.0%
Directly participating with researchers on a project (as a team member)	46 21.0%	17 7.8%	10 4.6%	16 7.3%	130 59.4%	219 100.0%
Discussing research data services (RDS) with other librarians, or other people on campus, or RDS professionals, on a semi-regular frequency	41 18.8%	29 13.3%	12 5.5%	20 9.2%	116 53.2%	218 100.0%
Training co-workers in your library, or across campus, on research data services (RDS)	25 11.4%	29 13.2%	13 5.9%	18 8.2%	134 61.2%	219 100.0%

Table 5B. Research Data Services (RDS) Currently Offered by the Library or Planned to Be Offered in the Future: Technical Services

	Yes, our library currently offers this service	No, but plan to within the next 12 months	No, but plan to within 13–24 months	No, but plan to do so in more than 24 months	No, and we currently have no plans to do so	Total
Providing technical support for research data services (RDS) systems (e.g., a repository, access and discovery systems)	32 14.5%	17 7.7%	21 9.5%	22 10.0%	129 58.4%	221 100.0%
Deaccessioning / deselection of data / data sets for removal from a repository	12 5.5%	9 4.1%	14 6.4%	15 6.8%	170 77.3%	220 100.0%
Preparing data / data sets for deposit into a repository	21 9.5%	20 9.1%	19 8.6%	19 8.6%	141 64.1%	220 100.0%
Creating or transforming metadata for data or data sets	26 11.9%	8 3.7%	22 10.1%	18 8.3%	144 66.1%	218 100.0%
Identifying data / data sets that could be candidates for repositories on or off campus	24 11.0%	27 12.4%	23 10.6%	23 10.6%	121 55.5%	218 100.0%

If we look at this range of research data services currently offered or planned to be offered in the next two years by size of institution, some differences appear. Libraries in institutions that have 5,000 or more students are significantly more likely to offer a wide range of consultative type services, including training co-workers (table 6A).

Table 6A. Comparison of Informational / Consultative Research Data Services (RDS) Currently Offered, by Student Body Size

Service	Fewer Than 5,000 Students n = 134	5,000 or More Students n = 83
Outreach and collaborate	7%	18% Δ1
Train co-workers	6%	20% Δ2
Discuss RDS	14%	27% Δ3
Consult on standards	10%	30% Δ4
Consult on data management	15%	29% Δ5
Create web guides	19%	28%
Provide reference support	39%	52%

Δ = a significantly higher percentage of libraries at institutions with more than 5,000 students currently offer this service compared to libraries at smaller schools

Δ1 ($\chi^2 = 6.54$, $p = .011$), Δ2 ($\chi^2 = 10.49$, $p = .001$), Δ3 ($\chi^2 = 5.20$, $p = .023$), Δ4 ($\chi^2 = 13.11$, $p < .001$), Δ5 ($\chi^2 = 5.50$, $p = .019$)

Larger academic institutions are also more likely to offer technical or hands-on RDS services, although very few libraries from either size institution are now offering these services (table 6B). "Providing technical support" is now offered by about a quarter of libraries in institutions with 5,000 or more students, the largest percentage of any of the technical research data services.

Table 6B. Comparison of Technical / Hands-On Research Data Services (RDS) Currently Offered, by Student Body Size

Service	Less Than 5,000 Students n = 134	5,000 or More Students n = 83
Deselection of data	4%	7%
Prepare data	4%	18% Δ1
Identify data	7%	17%
Create metadata	7%	19% Δ2
Provide technical support	9%	24% Δ3
Directly participate	17%	27%

Δ = a significantly higher percentage of libraries at institutions with more than 5,000 students currently offer this service compared to libraries at smaller schools

Δ1 ($\chi^2 = 10.53$, $p = .001$), Δ2 ($\chi^2 = 6.60$, $p = .010$), Δ3 ($\chi^2 = 9.13$, $p = .003$)

Things will likely be changing soon, however, as an equal number of libraries in smaller institutions are planning to offer consultative RDS within the next two years (see tables 6C and 6D). It should be noted that still only a quarter to a third of all libraries plan to offer any of these RDS in two years. The most likely service to be offered is creating web guides for research data, a fairly traditional library service. This suggests that libraries may be facing an important decision regarding how to engage the data deluge—does the library extend traditional services into the new data-intensive environment, or does the library expand the scope and nature of its services to more intimately interact in the new data-intensive environment in completely new ways?

Table 6C. Comparison of Informational / Consultative Research Data Services (RDS) Planned to Be Offered within Two Years, by Student Body Size

Service	Less Than 5,000 Students n = 134	5,000 or More Students n = 83
Outreach and collaborate	22%	25%
Train co-workers	25%	31%
Discuss RDS	25%	33%
Consult on standards	22%	27%
Consult on data management	21%	25%
Create web guides	31%	38%
Provide reference support	20%	25%

There is no significant difference between consultative RDS planned to be offered within two years based on student enrollment at the library's institution.

Table 6D. Comparison of Technical / Hands-On Research Data Services (RDS) Planned to Be Offered within Two Years, by Student Body Size

Service	Less Than 5,000 Students n = 134	5,000 or More Students n = 84
Deselection of data	11%	27% $^{\Delta 1}$
Prepare data	24%	31%
Identify data	30%	39%
Create metadata	16%	32% $^{\Delta 2}$
Provide technical support	26%	28%
Directly participate	16%	26%

Δ = a significantly higher percentage of libraries at institutions with more than 5,000 students plan to offer this service compared to libraries at smaller schools

Δ1 ($\chi^2 = 9.28$, $p = .002$), Δ2 ($\chi^2 = 8.16$, $p = .004$)

Not surprisingly, there are also differences in the range of research data services offered or planned to be offered by research/doctoral institutions as compared to institutions that offer only associate's and baccalaureate degrees (tables 7A and 7B). Research/doctoral institutions are more likely to currently offer or plan to offer a full range of consultative and technical RDS. A majority of libraries at all types of institutions offer or plan to offer reference support for research data, however.

Table 7A. Comparison of Informational / Consultative Research Data Services (RDS) Currently Offered, and Planned to Be Offered, by Type of Institution

Service	Associate's Colleges n = 66		Baccalaureate Colleges n = 53		Research / Doctoral n = 97	
	Offered	Planned	Offered	Planned	Offered	Planned
Outreach and collaborate	4%	15%	9%	23%	16%Δ1	30%○1
Train co-workers	12%□	14%	2%	30% 1	16%⍰1	35%○2
Discuss RDS	11%	17%	11%	30%	28%Δ2⍰2	34%○3
Consult on standards	12%	10%	15%	23%	23%	34%○4
Consult on data management	15%	13%	17%	23%	26%	28%○5
Create web guides	25%	13%	13%	36% 2	25%	46%○6
Provide reference support	40%	7%	40%	19%	49%	33%○7

□ = a significantly higher percentage of associate's than baccalaureate colleges currently offer this service ($\chi^2 = 4.40$, $p = 0.036$)

= a significantly higher percentage of baccalaureate than associate's colleges are planning to offer this service

1 ($\chi^2 = 4.85$, $p = 0.028$)

2 ($\chi^2 = 8.56$, $p = 0.003$)

Δ = a significantly higher percentage of doctoral than associate's colleges currently offer this service

Δ1 ($\chi^2 = 5.73$, $p = 0.017$)

Δ2 ($\chi^2 = 7.40$, $p = 0.007$)

○ = a significantly higher percentage of doctoral than associate's colleges are planning to offer this service

○1 ($\chi^2 = 5.11$, $p = 0.024$)

○2 ($\chi^2 = 9.31$, $p = 0.002$)

○3 ($\chi^2 = 6.24$, $p = 0.013$)

○4 ($\chi^2 = 11.69$, $p = 0.001$)

○5 ($\chi^2 = 5.29$, $p = 0.021$)

○6 ($\chi^2 = 20.15$, $p < 0.001$)

○7 ($\chi^2 = 15.48$, $p < 0.001$)

⍰ = a significantly higher percentage of doctoral than baccalaureate colleges currently offer this service, ⍰1 ($\chi^2 = 6.99$, $p = 0.008$), ⍰2 ($\chi^2 = 5.72$, $p = 0.017$)

Table 7B. Comparison of Technical / Hands-On Research Data Service (RDS) Currently Offered, and Planned to Be Offered, by Type of Institution

Service	Associate's Colleges n = 67		Baccalaureate Colleges n = 52		Research / Doctoral n = 97	
	Offered	Planned	Offered	Planned	Offered	Planned
Deselection of data	7%	12%	8%	12%	3%	24%○1
Prepare data	6%	16%	4%	27%	15%▯	33%○2
Identify data	4%	24%	8%	38%	17%Δ	38%
Create metadata	7%	12%	9%	15%	16%	33%○3●
Provide technical support	10%	10%	13%	26%	18%	39%○4
Directly participate	15%	15%	17%	17%	27%	24%

= a significantly higher percentage of baccalaureate than associate's colleges are planning to offer this service ($\chi^2 = 5.40$, $p = 0.020$)

Δ = a significantly higher percentage of doctoral than associate's colleges currently offer this service ($\chi^2 = 6.19$, $p = 0.013$)

○ = a significantly higher percentage of doctoral than associate's colleges are planning to offer this service

○1 ($\chi^2 = 3.93$, $p = 0.047$)

○2 ($\chi^2 = 5.93$, $p = 0.015$)

○3 ($\chi^2 = 9.81$, $p = 0.002$)

○4 ($\chi^2 = 16.77$, $p < 0.001$)

▯ = a significantly higher percentage of doctoral than baccalaureate colleges currently offer this service ($\chi^2 = 4.28$, $p = 0.038$)

● = a significantly higher percentage of doctoral than baccalaureate colleges are planning to offer this service ($\chi^2 = 5.61$, $p = 0.018$)

Perhaps not surprisingly, if we segment the libraries into two groups—those that are on campuses that receive no NSF grants and those that receive at least some NSF grants—there are significant differences in the provision of a range of consultative RDS services through the library (table 8A). Libraries in NSF grant–active institutions are more likely to offer consultative services. They are also more likely currently to offer metadata and technical services (table 8B).

Table 8A. Comparison of Informational / Consultative Research Data Services (RDS) Services Currently Offered, by NSF Grants Awarded

Service	Typically, No NSF Grants Awarded n = 76	Typically, Some NSF Grants Awarded n = 127
Outreach and collaborate	4%	16% $^{\Delta 1}$
Train co-workers	8%	15%
Discuss RDS	5%	28% $^{\Delta 2}$
Consult on standards	9%	25% $^{\Delta 3}$
Consult on data management	10%	29% $^{\Delta 4}$
Create web guides	18%	26%
Provide reference support	34%	48% $^{\Delta 5}$

Δ = significantly more likely to be offered than at schools with typically no NSF grants

Δ1 (χ^2 = 6.41, p = 0.011)

Δ2 (χ^2 = 16.59, p < 0.001)

Δ3 (χ^2 = 7.55, p = 0.006)

Δ4 (χ^2 = 9.70, p = 0.002)

Δ5 (χ^2 = 4.26, p = 0.039)

Table 8B. Comparison of Technical / Hands-On Research Data Services (RDS) Currently Offered, by NSF Grants Awarded

Service	Typically, No NSF Grants Awarded n = 76	Typically, Some NSF Grants Awarded n = 128
Deselection of data	9%	4%
Prepare data	9%	11%
Identify data	8%	14%
Create metadata	5%	17% $^{\Delta}$
Provide technical support	6%	21% $^{\Delta}$
Directly participate	17%	24%

Δ = significantly more likely to be offered than at schools with typically no NSF grants

Δ1 (χ^2 = 6.00, p = 0.014)

Δ2 (χ^2 = 7.72, p = 0.005)

The differences in both consultative and technical service provision are likely to become even more noticeable in the future, as many more libraries on NSF research–active campuses plan to add a range of RDS within the next 24 months (tables 9A and 9B).

Table 9A. Comparison of Informational / Consultative Research Data Services (RDS) Planned to Be Offered, by NSF Grants Awarded

Service	Typically, No NSF Grants Awarded n = 76	Typically, Some NSF Grants Awarded n = 127
Outreach and collaborate	18%	28%
Train co-workers	14%	37% $^{\Delta 1}$
Discuss RDS	17%	36% $^{\Delta 2}$
Consult on standards	12%	32% $^{\Delta 3}$
Consult on data management	15%	28% $^{\Delta 4}$
Create web guides	21%	43% $^{\Delta 5}$
Provide reference support	13%	29% $^{\Delta 6}$

Δ = significantly more likely to be offered than at schools with typically no NSF grants

Δ1 (χ^2 = 12.25, p < 0.001)

Δ2 (χ^2 = 9.01, p = 0.003)

Δ3 (χ^2 = 10.31, p = 0.001)

Δ4 (χ^2 = 4.28, p = 0.039)

Δ5 (χ^2 = 10.56, p = 0.001)

Δ6 (χ^2 = 7.16, p = 0.007)

Table 9B. Comparison of Technical / Hands-On RDS Services Planned to Be Offered, by NSF Grants Awarded

Service	Typically, No NSF Grants Awarded n = 76	Typically, Some NSF Grants Awarded n = 128
Deselection of data	8%	24% $^{\Delta 1}$
Prepare data	17%	34% $^{\Delta 2}$
Identify data	24%	41% $^{\Delta 3}$
Create metadata	13%	29% $^{\Delta 4}$
Provide technical support	15%	36% $^{\Delta 5}$
Directly participate	10%	25% $^{\Delta 6}$

Δ = significantly more likely to be offered than at schools with typically no NSF grants

Δ1 (χ^2 = 8.84, p = 0.003), Δ2 (χ^2 = 6.97, p = 0.008), Δ3 (χ^2 = 6.40, p = 0.011)

Δ4 (χ^2 = 6.52, p = 0.011), Δ5 (χ^2 = 10.35, p = 0.001), Δ6 (χ^2 = 6.73, p = 0.009)

Who is providing research data services?

When libraries provide research data services related to reference, consultation, or instruction, those services are most likely to be offered by individual librarians or library staff members who are subject discipline specialists (table 10).

Table 10. Provider of Research Data Reference / Consultation / Instruction Services to Researchers

	Frequency	Percent
Individual discipline librarians / staff	148	71.1
Dedicated data librarian(s) / specialists	12	5.8
Other	48	23.1
Total	208	100.0

Very few libraries overall as yet have dedicated data librarians who offer research data consultation services, and there are no differences in who provides services based on size or type of library (tables 10A, 10B, and 10C). Individual discipline librarians or staff members are likely to provide RDS in all cases.

Table 10A. Provider of Research Data Reference / Consultation / Instruction Services to Researchers, by Student Enrollment

Service	Less Than 5,000 Students N = 95	5,000 or More Students N = 65
Individual discipline librarians / staff	94%	91%
Dedicated data librarian(s) / specialists	6%	9%
Total	100%	100%

There is no significant difference between providers of RDS services to researchers based on student enrollment at the library's institution.

Table 10B. Provider of Research Data Reference / Consultation / Instruction Services to Researchers, by Faculty Size

Service	Less Than 100 Faculty N = 49	100 or More Faculty N = 109
Individual discipline librarians / staff	94%	92%
Dedicated data librarian(s) / specialists	6%	8%
Total	100%	100%

There is no significant difference between providers of RDS services to researchers based on faculty size at the library's institution.

Table 10C. Provider of Research Data Reference / Consultation / Instruction Services to Researchers, by Type of Institution

Service	Associate's Colleges n = 66	Baccalaureate Colleges n = 53	Research / Doctoral n = 97
Individual discipline librarians / staff	95%	95%	90%
Dedicated data librarian(s) / specialists	5%	5%	10%
Total	100%	100%	100%

There is no significant difference between providers of RDS services to researchers based on type of institution.

For those libraries that offer or plan research data services, responsibility varies. An equal number of libraries report that a single individual or a group, committee, or team is responsible, with most saying a combination of individuals and groups work on research data services planning (table 11). There are few differences on responsibility based on size or type of institutions (tables 11A, 11B, and 11C).

Table 11. Library Entity with Primary Leadership Responsibility for Plans and Programs for Research Data Services (RDS)

	Frequency	Percent
A single individual is responsible	20	9.9
A group / committee / team is responsible	20	9.9
A department / unit is responsible	5	2.5
A combination of the above	31	15.3
Other	5	2.5
My library is not involved in RDS	122	60.1
Total	203	100.0

Table 11A. Comparison of Library Entity with Primary Leadership Responsibility for Plans and Programs for Research Data Services (RDS), by Student Enrollment

Service	Less Than 5,000 Students n = 123	5,000 or More Students n = 75
A single individual is responsible	10%	11%
A group / committee / team is responsible	8%	13%
A department / unit is responsible	2%	3%
A combination of the above	13%	20%
My library is not involved in RDS	67%	53%
Total	100%	100%

There is no significant difference between library entities with primary leadership responsibility for plans and programs based on student enrollment at the library's institution.

Table 11B. Comparison of Library Entity with Primary Leadership Responsibility for Plans and Programs for Research Data Services (RDS), by Faculty Size

Service	Less Than 100 Faculty n = 72	100 or More Faculty n = 124
A single individual is responsible	6%	13%
A group / committee / team is responsible	7%	12%
A department / unit is responsible	6%	1%
A combination of the above	11%	19%
My library is not involved in RDS	71% •	56%
Total	100%	100%

• = significantly more libraries with less than 100 faculty members at their institution are not involved with RDS compared with libraries with 100 or more faculty members at their institution ($\chi^2 = 4.43$, $p = 0.035$)

Table 11C. Comparison of Library Entity with Primary Leadership Responsibility for Plans and Programs for Research Data Services (RDS), by Type of Institution

Service	Associate's Colleges n = 66	Baccalaureate Colleges n = 53	Research / Doctoral n = 97
A single individual is responsible	7%	11%	12%
A group / committee / team is responsible	9%	11%	11%
A department / unit is responsible	2%	2%	3%
A combination of the above	17%	9%	18%
My library is not involved in RDS	66%	68%	56%
Total	100%	100%	100%

There is no significant difference between library entities with primary leadership responsibility for plans and programs based on type of institution.

For those libraries that have staff who support RDS, most have reassigned or plan to reassign existing staff. There are emerging changes, however, as some libraries are hiring or plan to hire new staff members to support RDS (table 12). This may also change in the future. Although it did not look at library job ads specifically, a 2009 study assessing job advertisements for bioinformatics employees revealed that the number of opportunities posted to bioinformatics.org has increased dramatically in recent years, with a large portion of those opportunities coming from academia and research institutions.[32] Although only a small number of these positions emphasized preserving (as opposed to gathering and interpreting) research data, it is expected that the need to preserve these materials will become more urgent as the volume of data continues to grow, bringing a new demand for professionals with specific expertise in the area of data curation.

32. Jennifer I. Hill, John MacMullen, and Carole L. Palmer, "Characteristics of Bioinformatics Employment Advertisements," *Proceedings of the American Society for Information Science and Technology* 46, no. 1 (2009): 1–17.

Table 12. Methods Used in Developing Staff Capacity for Research Data Services (RDS)

	Frequency
Hired staff specifically to support RDS	13
Reassigned existing staff	31
Planning to hire staff	15
Planning to reassign existing staff	21
Other	12
Not applicable	141

Libraries at larger institutions or doctoral institutions are more likely to reassign or hire staff for RDS (tables 12A, 12B, and 12C).

Table 12A.Comparison of Methods Used in Developing Staff Capacity for Research Data Services (RDS), by Student Enrollment

Method	Less Than 5,000 Students n = 137	5,000 or More Students n = 86
Hired staff specifically to support RDS	6%	6%
Reassigned existing staff	8%	23% $^{\Delta 1}$
Planning to hire staff	5%	9%
Planning to reassign existing staff	6%	15% $^{\Delta 2}$
Not applicable	74% •	45%

Δ = significantly more libraries with 5,000 or more students enrolled at their institution have used, or are planning to use, this method

Δ1 ($\chi^2 = 10.23$, $p = 0.001$)

Δ2 ($\chi^2 = 5.33$, $p = 0.021$)

• = significantly more libraries with less than 5,000 students enrolled at their institution have not developed, and are not planning to develop, staff capacity for RDS ($\chi^2 = 19.25$, $p < 0.001$)

Table 12B.Comparison of Methods Used in Developing Staff Capacity for Research Data Services (RDS), by Faculty Size

Method	Less Than 100 Faculty n = 82	100 or More Faculty n = 137
Hired staff specifically to support RDS	6%	6%
Reassigned existing staff	10%	17%
Planning to hire staff	2%	9% Δ1
Planning to reassign existing staff	4%	13% Δ2
Not applicable	78% ●	54%

Δ = significantly more libraries with 100 or more faculty at their institution are planning to use this method

Δ1 ($\chi^2 = 4.00$, $p = 0.046$)

Δ2 ($\chi^2 = 5.32$, $p = 0.021$)

● = significantly more libraries with less than 100 faculty at their institution have not developed, and are not planning to develop, staff capacity for RDS ($\chi^2 = 12.71$, $p < 0.001$)

Table 12C.Comparison of Methods Used in Developing Staff Capacity for Research Data Services (RDS), by Type of Institution

Method	Associate's Colleges n = 68	Baccalaureate Colleges n = 54	Research / Doctoral n = 101
Hired staff specifically to support RDS	6%	2%	8%
Reassigned existing staff	7%	7%	22% ○1
Planning to hire staff	0%	7%	11% ○2
Planning to reassign existing staff	3%	6%	16% ○3
Not applicable	78% ●	67%	51%

○ = a significantly higher percentage of doctoral than associate's colleges have used, or are planning to use, this method

○1 ($\chi^2 = 6.30$, $p = 0.012$)

○2 ($\chi^2 = 7.92$, $p = 0.005$)

○3 ($\chi^2 = 7.11$, $p = 0.008$)

 = a significantly higher percentage of doctoral than baccalaureate colleges have used this method ($\chi^2 = 5.21$, $p = 0.022$)

 = a significantly higher percentage of baccalaureate than associate's colleges are planning to use this method ($\chi^2 = 5.21$, $p = 0.022$)

● = significantly more libraries at associate's colleges than at doctoral universities have not developed, and are not planning to develop, staff capacity for RDS ($\chi^2 = 12.09$, $p = 0.001$)

Researchers are facing barriers such as lack of time and funding for responsible data management and someone or some unit on campus will need to take a lead role in providing research data services. Will that be the library or, more likely, collaboration between the library and other units on campus or across campuses? Currently, just a few libraries are involved with developing policies and procedures associated with RDS or managing technological infrastructure (table 13). Collaboration with other units on campus is a strategy employed by over one third of academic libraries, however.

Table 13. Library Engagement with Research Data Services (RDS)

	Frequency	Percentage
Development of policies and procedures associated with RDS?	218	100.0
Yes	10	4.6
No	208	95.4
Management, or participation in management, of technology infrastructure that supports RDS?	216	100.0
Yes (table 14)	43	19.9
No	173	80.1
Provision of opportunities for staff to develop skills related to RDS?	215	100.0
Yes (table 15)	50	23.3
No	165	76.7
Collaboration with other units or offices on campus regarding RDS?	214	100.0
Yes (table 16)	80	37.4
No	134	62.6
Collaboration with other institutions regarding RDS?	214	100.0
Yes (table 17)	30	14.0
No	184	86.0

Libraries in larger institutions are no more likely to be responsible for developing policies, but are more likely to provide opportunities for library staff to develop RDS skills and provide technical infrastructure support for RDS (tables 13A, 13B, and 13C).

Table 13A. Comparison of Library Engagement with Research Data Services (RDS), by Student Enrollment

Type of Engagement with RDS	Less Than 5,000 Students n = 131	5,000 or More Students n = 81
Development of policies and procedures associated with RDS?	2%	8%
Management, or participation in management, of technology infrastructure that supports RDS?	13%	31% Δ1
Provision of opportunities for staff to develop skills related to RDS?	15%	37% Δ2
Collaboration with other units or offices on campus regarding RDS?	30%	50% Δ3
Collaboration with other institutions regarding RDS?	11%	18%

Δ = significantly more libraries with 5,000 or more students enrolled at their institution practice this type of engagement

Δ1 ($\chi^2 = 9.76$, $p = 0.002$)

Δ2 ($\chi^2 = 14.39$, $p < 0.001$)

Δ3 ($\chi^2 = 9.04$, $p = 0.003$)

Table 13B. Comparison of Library Engagement with Research Data Services (RDS), by Faculty Size

Type of Engagement with RDS	Less Than 100 Faculty n = 77	100 or More Faculty n = 132
Development of policies and procedures associated with RDS?	4%	5%
Management, or participation in management, of technology infrastructure that supports RDS?	15%	23%
Provision of opportunities for staff to develop skills related to RDS?	13%	30% Δ1
Collaboration with other units or offices on campus regarding RDS?	27%	44% Δ2
Collaboration with other institutions regarding RDS?	11%	16%

Δ = significantly more libraries with 100 or more faculty at their institution practice this type of engagement

Δ1 ($\chi^2 = 7.54$, $p = 0.006$)

Δ2 ($\chi^2 = 5.84$, $p = 0.016$)

Table 13C. Comparison of Library Engagement with Research Data Services (RDS), by Type of Institution

Type of Engagement with RDS	Associate's Colleges n = 65	Baccalaureate Colleges n = 51	Research / Doctoral n = 96
Development of policies and procedures associated with RDS?	5%	2%	6%
Management, or participation in management, of technology infrastructure that supports RDS?	12%	17%	27% Δ1
Provision of opportunities for staff to develop skills related to RDS?	17%	16%	31% Δ2
Collaboration with other units or offices on campus regarding RDS?	30%	35%	44%
Collaboration with other institutions regarding RDS?	9%	13%	18%

Δ = a significantly higher percentage of doctoral than associate's colleges are practicing this type of engagement

Δ1 ($\chi^2 = 4.79$, $p = 0.029$)

Δ2 ($\chi^2 = 4.26$, $p = 0.039$)

 = a significantly higher percentage of doctoral than baccalaureate colleges are practicing this type of engagement ($\chi^2 = 4.27$, $p = 0.039$)

Only a few libraries are currently involved with managing technological infrastructure for RDS. For those that are, components offered vary, with data storage, followed by tools for data analysis, the most commonly offered (table 14). Respondents were allowed to check all components that they manage.

Table 14. Components of Technology Infrastructure Managed in Support of Research Data Services (RDS)

	Frequency
Data storage	36
Tools for data analysis	24
Virtual community support	16
Other	5

For those libraries that offer some of the components of technological infrastructure, there are some differences in what they offer by size and type of institution. Smaller institutions and associate's institutions are more likely to offer virtual community support (tables 14A, 14B, and 14C.) Perhaps there are fewer alternatives in those institutions, making the library's role unique and essential for RDS technological infrastructure.

Table 14A. Comparison of Components of Technology Infrastructure Managed in Support of Research Data Services (RDS), by Student Enrollment

Component of Technology Infrastructure	Less Than 5,000 Students n = 18	5,000 or More Students n = 25
Data storage	14 (78%)	22 (88%)
Tools for data analysis	11 (61%)	13 (52%)
Virtual community support	9 (50%}	7 (28%)

There is no significant difference between the percentages of libraries that manage these components, based on student enrollment

Table 14B. Comparison of Components of Technology Infrastructure Managed in Support of Research Data Services (RDS), by Faculty Size

Component of Technology Infrastructure	Less than 100 Faculty n = 12	100 or More Faculty n = 31
Data storage	8 (67%)	28 (90%)
Tools for data analysis	12 (100%) $^{\Delta 1}$	12 (39%)
Virtual community support	9 (75%) $^{\Delta 2}$	7 (23%)

Δ = a significantly higher percentage of libraries with less than 100 faculty at their institution manage this component of technology infrastructure
Δ1 ($\chi^2 = 13.18$, $p < 0.001$)
Δ2 ($\chi^2 = 10.17$, $p = 0.001$)

Table 14C. Comparison of Components of Technology Infrastructure Managed in Support of Research Data Services (RDS), by Type of Institution

Component of Technology Infrastructure	Associate's Colleges n = 8	Baccalaureate Colleges n = 9	Research / Doctoral n = 26
Data storage	6 (75%)	8 (89%)	22 (85%)
Tools for data analysis	6 (75%)	5 (56%)	13 (50%)
Virtual community support	6 (75%) $^{\Delta}$	3 (33%)	7 (27%)

Δ = a significantly higher percentage of associate's than doctoral colleges are managing this component of technology infrastructure ($\chi^2 = 5.99$, $p = 0.014$)

Since so few libraries are hiring new positions for RDS, training of existing staff could be seen to be essential, yet only a quarter of academic libraries currently provide these opportunities. Of those that do, staff development opportunities at any size or type of institution are most likely in the form of providing support for conferences or workshops relating to RDS and held elsewhere (tables 15, 15A, 15B, and 15C). This shows the need for these workshops by professional societies and conferences, as libraries are relying on conferences to provide needed training. Wider institutional support for attending these conferences is warranted as well, as RDS benefit the entire institution.

Table 15. Opportunities Provided for Staff to Develop Skills Related to Research Data Services (RDS)

	Frequency
In house staff workshops or presentations	24
Support for staff to take courses related to RDS	27
Support for staff to attend conferences or workshops elsewhere related to RDS	44
Collaboration with an academic program to develop professionals with skills related to RDS	12
Other	1

Table 15A. Comparison of Opportunities Provided for Staff to Develop Skills Related to Research Data Services (RDS), by Student Enrollment

Opportunity	Less Than 5,000 Students n = 19	5,000 or More Students n = 31
In house staff workshops or presentations	7 (37%)	17 (55%)
Support for staff to take courses related to RDS	9 (47%)	18 (58%)
Support for staff to attend conferences or workshops elsewhere related to RDS	17 (89%)	27 (87%)
Collaboration with an academic program to develop professionals with skills related to RDS	7 (37%)	5 (16%)

There is no significant difference between the percentages of libraries that provided these opportunities, based on student enrollment

Table 15B. Comparison of Opportunities Provided for Staff to Develop Skills Related to Research Data Services (RDS), by Faculty Size

Opportunity	Less than 100 Faculty n = 10	100 or More Faculty n = 40
In house staff workshops or presentations	7 (70%)	17 (43%)
Support for staff to take courses related to RDS	5 (50%)	22 (55%)
Support for staff to attend conferences or workshops elsewhere related to RDS	7 (70%)	37 (93%)
Collaboration with an academic program to develop professionals with skills related to RDS	3 (30%)	9 (23%)

There is no significant difference between the percentages of libraries that provided these opportunities, based on faculty size

Table 15C. Comparison of Opportunities Provided for Staff to Develop Skills Related to Research Data Services (RDS), by Type of Institution

Opportunity	Associate's Colleges n = 11	Baccalaureate Colleges n = 8	Research / Doctoral n = 31
In house staff workshops or presentations	8 (73%) Δ	2 (25%)	14 (45%)
Support for staff to take courses related to RDS	5 (45%)	4 (50%)	18 (58%)
Support for staff to attend conferences or workshops elsewhere related to RDS	8 (73%)	7 (88%)	29 (94%)
Collaboration with an academic program to develop professionals with skills related to RDS	2 (18%)	2 (25%)	8 (26%)

Δ = a significantly higher percentage of associate's than baccalaureate colleges are providing this opportunity ($\chi^2 = 4.23$, $p = 0.040$)

Of those universities that collaborate with other units on campus regarding RDS, the campus office of research is the most common collaborator, followed by academic departments such as science departments (table 16).

Table 16. Other Units or Offices Collaborated with Regarding Research Data Services (RDS)

	Frequency
Office of research	57
Science departments	30
Social science departments	23
Engineering departments	9
Humanities / arts departments	16
Other	24

Larger institutions are more likely to collaborate with other units on campus, particularly the office of research (tables 16A and 16B), yet associate's degree libraries are also building these collaborations (table 16C).

Table 16A. Other Units or Offices Collaborated with Regarding Research Data Services (RDS), by Student Enrollment

	Less Than 5,000 Students n = 39	**5,000 or More Students n = 41**
Office of research	21 (54%)	36 (88%) Δ1
Science departments	18 (46%)	12 (29%)
Social science departments	14 (36%)	9 (22%)
Engineering departments	1 (3%)	8 (20%) Δ2
Humanities / arts departments	12 (31%) •	4 (10%)

Δ = significantly more libraries with 5,000 or more students enrolled at their institution collaborated with this unit or office
Δ1 (χ^2 = 11.25, p = 0.001)
Δ2 (χ^2 = 5.75, p = 0.016)
• = significantly more libraries with less than 5,000 students enrolled at their institution collaborated with this unit or office (χ^2 = 5.52, p = 0.019)

Table 16B. Other Units or Offices Collaborated with Regarding Research Data Services (RDS), by Faculty Size

	Less Than 100 Faculty n = 21	**100 or More Faculty n = 58**
Office of research	13 (62%)	43 (74%)
Science departments	6 (29%)	24 (41%)
Social science departments	6 (29%)	17 (29%)
Engineering departments	1 (5%)	8 (14%)
Humanities / arts departments	9 (43%) •	7 (12%)

• = significantly more libraries with less than 100 faculty at their institution collaborated with this unit or office (χ^2 = 5.52, p = 0.019)

Table 16C. Other Units or Offices Collaborated with Regarding Research Data Services (RDS), by Type of Institution

	Associate's Colleges n = 20	Baccalaureate Colleges n = 18	Research / Doctoral n = 42
Office of research	17 (85%) •	7 (39%)	33 (79%) Δ
Science departments	4 (20%)	7 (39%)	19 (45%)
Social science departments	3 (15%)	5 (28%)	15 (36%)
Engineering departments	0 (0%)	1 (6%)	8 (19%) □
Humanities / arts departments	4 (20%)	6 (33%)	6 (14%)

Δ = a significantly higher percentage of doctoral than baccalaureate colleges have collaborated with this other unit or office ($\chi^2 = 8.93$, $p = 0.003$)

□ = a significantly higher percentage of doctoral than associate's colleges have collaborated with this other unit or office ($\chi^2 = 4.37$, $p = 0.036$)

● = a significantly higher percentage of associate's than baccalaureate colleges have collaborated with this other unit or office ($\chi^2 = 8.66$, $p = 0.003$)

Only a few libraries indicate that they collaborate with other institutions regarding RDS services. What collaboration there is sometimes cuts across types of institutions, however (table 17).

Table 17. Other Types of Institutions Collaborated with Regarding Research Data Services (RDS), by Type of Institution

	Associate's Colleges n = 6	Baccalaureate Colleges n = 7	Research / Doctoral n = 17
Associate degree–granting institution(s)	5 (83%) •	3 (43%)	5 (29%)
Baccalaureate degree–granting institution(s)	3 (50%)	5 (71%)	8 (47%)
Master's / comprehensive degree–granting institution(s)	2 (33%)	3 (43%)	10 (59%)
Research / doctoral degree–granting institution(s)	0 (0)%	2 (29%)	14 (82%) Δ▯

● = a significantly higher percentage of associate's than doctoral colleges have collaborated with this type of institution ($\chi^2 = 5.25$, $p = 0.022$)

Δ = a significantly higher percentage of doctoral than associates colleges have collaborated with this type of institution ($\chi2 = 12.63$, $p < 0.001$)

▯ = a significantly higher percentage of doctoral than baccalaureate colleges have collaborated with this type of institution ($\chi2 = 6.45$, $p = 0.011$)

Actions for library directors

The results of this baseline assessment of research data services support in academic libraries suggest several actions that can be taken by library directors now and in the immediate future to support the research data needs on their campus. These actions include:

1. Recognize that the new e-science environment means that research data services will be needed by researchers in the institution. Consider how or if those services can be centered in the library.
2. Determine the course your library will take—building a new profile in your research community by creating new research data services that expand the role of the library or strengthening the existing profile by extending traditional services into the new environment.
3. Consider a range of research data services to build the suite of services that make the most sense for your campus community and your library.
4. Identify those areas that RDS for science can also provide support for research in other disciplines.
5. Support library faculty and staff in their professional development to gain knowledge of RDS even if there is not a formal program in the library.
6. Consider creating a data librarian position that will spearhead the RDS initiative in the library.
7. Connect with the research offices on campus to collaborate and to identify the library as the center for RDS.

Conclusions

Data-intensive science creates challenges for researchers and demands a data management skill set that likely was not part of the scientist's education and for which scientists likely do not have time or training. Funding agency requirements have formalized the need for advanced data management skills. Several initiatives, such as NSF's DataNet program, are working to address the need for this skill set.

This situation presents a unique opportunity for academic libraries to play an even more active role in the research process in several ways. First, academic libraries can provide consulting services related to research data management and curation. Second, academic libraries can provide the infrastructure, or at least the front end, for data storage and curation. Third, academic libraries can support librarians becoming active members on research and grant proposal teams as data curation consultants.

The convergence of data-intensive science, technological advances, and library information expertise provides academic libraries with the opportunity to create a new profile on campus as a partner in knowledge creation, helping it expand beyond the traditional roles of libraries. This new environment allows libraries to take a more active and visible role in the knowledge creation process by placing librarians at all stages in the research planning process and by providing expertise to develop data management plans, identify appropriate data description, and create preservation strategies.

RDS are important for libraries at each of the three levels of institutions—associate's degree–granting, baccalaureate, and doctoral degree–granting/research. Our research indicates that the doctoral degree–granting/research institutions are most active in the area of providing RDS—which is commensurate with the level of external funding and the institutional mission. However, the need for RDS at the other two levels is also indicated. Many baccalaureate institutions are pursuing external funding from organizations such as NSF for educational programs, and they are facing the same demands for data management plans. In addition, baccalaureate institutions often have a strong focus on placing their graduates in graduate programs at doctoral-granting institutions. A baccalaureate graduate will be more competitive in the graduate school process if s/he has data management skills. So libraries can play a vital role in helping the baccalaureate institution meet its graduate school goals by providing RDS training to students. At the associate's degree–granting institutions, RDS still play a vital role in providing students with the skill sets they need to matriculate into four-year programs of science, engineering and health.

While e-science is the driving force behind a focus on data-intensive research and is the focus of this research, other disciplines have a growing interest in data management. Therefore, developing RDS could have reach beyond science and serve other disciplines as well.

Currently only a small number of libraries are offering research data services, with more planning to introduce these services within the next two years. More libraries should be

considering offering these services since research data services create the opportunity to enhance the library's visibility and expand the role of the library in the academic life of the institution's faculty, researchers, and students. Research data services may also enhance the library's role in helping the institution create intellectual capital through improved knowledge creation and improved ability to meet funding agency directives.

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Appendix

Survey - Research Data Services (RDS) in Academic Libraries: Building an Understanding of Library Data Management Practices

How many FTE (full-time equivalent) students are enrolled in your academic institution?

- Up to 1,999
- 2,000 - 4,999
- 5,000 - 9,999
- 10,000 - 24,999
- 25,000 or more

Web Page 2

How many tenure-track and tenured faculty are employed at the academic institution you are working for?

- Less than 100
- 100 - 249
- 250 - 499
- 500 - 999
- 1,000 or more

Web Page 3

How many NSF grants are typically awarded on your campus each year?

- None
- 1 - 19
- 20 - 29
- 30 - 39
- 40 - 49
- 50 or more

Web Page 4

Which of the following research data services (RDS) does your library currently offer or plan to offer in the future?

	Yes, our library currently offers this service	**No, but plan to within the next 12 months**	**No, but plan to within 13-24 months**	**No, but plan to do so in more than 24 months**	**No, and we currently have no plans to do so**
Consulting with faculty, staff, or students on data management plans	●	●	●	●	●
Consulting with faculty, staff, or students on data and metadata standards	●	●	●	●	●
Creating or transforming metadata for data or data sets	●	●	●	●	●
Outreach and collaboration with other research data services (RDS) providers either on or off campus	●	●	●	●	●
Identifying data / data sets that could be candidates for repositories on or off campus	●	●	●	●	●

Web Page 5

Which of the following research data services (RDS) does your library currently offer or plan to offer in the future?

	Yes, our library currently offers this service	**No, but plan to within the next 12 months**	**No, but plan to within 13-24 months**	**No, but plan to do so in more than 24 months**	**No, and we currently have no plans to do so**
Providing technical support for research data services (RDS) systems (e.g., a repository, access and discovery systems)	●	●	●	●	●
Providing reference support for finding and citing data / data sets	●	●	●	●	●
Creating web guides and finding aids for data / data sets / data repositories	●	●	●	●	●
Deaccessioning / deselection of data / data sets for removal from a repository	●	●	●	●	●
Preparing data / data sets for deposit into a repository	●	●	●	●	●

Web Page 6

Which of the following research data services (RDS) does your library currently offer or plan to offer in the future?

	Yes, our library currently offers this service	**No, but plan to within the next 12 months**	**No, but plan to within 13-24 months**	**No, but plan to do so in more than 24 months**	**No, and we currently have no plans to do so**
Directly participating with researchers on a project (as a team member)	●	●	●	●	●
Discussing research data services (RDS) with other librarians, or other people on campus, or RDS professionals, on a semi-regular frequency	●	●	●	●	●
Training co-workers in your library, or across campus, on research data services (RDS)	●	●	●	●	●

Web Page 7

Who in the library provides research data reference/consultation/instruction services to researchers?

- ● Individual discipline librarians / staff
- ● Dedicated data librarian(s) / specialists
- ● Other (please specify) _____

Web Page 8

If your library is involved in any research data services (RDS), who in the library has **primary leadership responsibility** for plans and programs for research data services (RDS)?

- A single individual is responsible
- A group / committee / team is responsible
- A department / unit is responsible
- A combination of the above
- Other (please specify) _____
- My library is not involved in RDS.

Web Page 9

Does your library have policies and/or procedures associated with research data services (RDS)?

- Yes (please specify) _____
- No

Web Page 10

Does your library manage, or participate in managing, technology infrastructure that supports research data services (RDS)?

- Yes **[If yes, go to Web page 12]**
- No **[If no, or no answer, go to Web page 13]**

Web Page 11

You have indicated that your library manages, or participates in managing, technology infrastructure that supports research data services (RDS). Please check all of the technology infrastructure components that apply.

- ☐ Data storage
- ☐ Tools for data analysis
- ☐ Virtual community support
- ☐ Other (please specify) _____

Web Page 12

How has your library developed staff capacity for research data services (RDS)? **(Check all that apply)**

- ☐ Hired staff specifically to support research data services (RDS)
- ☐ Reassigned existing staff
- ☐ Planning to hire staff
- ☐ Planning to reassign existing staff
- ☐ Other (please specify) _____
- ☐ Not applicable

Web Page 13

Has your library provided opportunities for staff to develop skills related to research data services (RDS)?

- ● Yes **[If yes, go to Web page 15]**
- ● No **[If no, or no answer, go to Web page 16]**

Web Page 14

You have indicated that your library has developed opportunities for staff to develop skills related to research data services (RDS). Which of the following opportunities has your library provided? Please check all that apply.

- ☐ In house staff workshops or presentations
- ☐ Support for staff to take courses related to research data services (RDS)
- ☐ Support for staff to attend conferences or workshops elsewhere related to research data services (RDS)
- ☐ Collaboration with an academic program to develop professionals with skills related to research data services (RDS)
- ☐ Other (please specify) _____

Web Page 15

Does your library collaborate with **other units or offices in your college or university** regarding research data services (RDS)?

- ● Yes **[If yes, go to Web page 17]**
- ● No **[If no, or no answer, go to Web page 18]**

Web Page 16

You have indicated that your library collaborates with other units or offices regarding research data services (RDS). Please indicate the unit(s) / office(s) with which you have collaborated (check all that apply).

- ☐ Office of research
- ☐ Science departments
- ☐ Social Science departments
- ☐ Engineering departments
- ☐ Humanities / Arts departments
- ☐ Other (please indicate the unit or office) _____

Web Page 17

Does your library collaborate with **other institutions** regarding research data services (RDS)?

- ● Yes **[If yes, go to Web page 19]**
- ● No **[If no, or no answer, go to Web page 20]**

Web Page 18

You have indicated that your library collaborates with other institution(s) regarding research data services (RDS). Please indicate the other type(s) of institution(s) with which your library collaborates (check all that apply).

- ☐ Research / doctoral degree-granting institution(s)
- ☐ Master's / comprehensive degree-granting institution(s)
- ☐ Baccalaureate-degree granting institution(s)
- ☐ Associate-degree granting institution(s)
- ☐ Government agencies or government laboratories
- ☐ Other not-for-profit organizations
- ☐ Other (please specify) _____

Web Page 19

Thank you for your participation.

We are also interested in the **perspective of other librarians** on research and data in libraries. If you would like to provide your staff with the opportunity to share their perspectives on librarians, research, and data, you may provide your contact information by clicking on the link below. **We will send you a cover letter and a link to the librarians' survey for distribution to the librarians on your staff.** Your contact information will be stored separately from this survey. None of the information you have already provided in this survey can be associated with you in any way.

To provide your contact information click on the following link:
xxxxxxxxxxxxxxxxxxxxx

Web Page 20