CHAPTER

7

Open Science

In December 2001, the Open Society Institute (now known as the Open Society Foundations) organized a meeting in Budapest, which brought together stakeholders from around the world who were working to make research articles from all disciplines freely available on the Internet. What is often credited with being the first definition of the term "open access" emerged from this meeting, in a document known as the Budapest Open Access Initiative (BOAI), released in 2002:

> By "open access" to this [research] literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution and the only role for copyright in this domain should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited. ***(Budapest Open Access Initiative: BOAI15, n.d.)***

The 16 participants in the original meeting signed the BOAI, and since then "a growing number of individuals and organizations from around the world who represent researchers, universities, laboratories, libraries, foundations, journals, publishers, learned societies, and kindred open-access initiatives" have added their names (Budapest Open Access Initiative: Background, n.d.).

Academic libraries have played a key role in supporting and promoting the open access movement, which some also refer to as the open science movement. Others see them as two distinct, but related terms and movements, with open access focusing more on journals and open science encompassing a wider array of activities. Also, the term "science" when used with open science often refers more broadly to research or knowledge production in general and can include social sciences and humanities.

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After providing an overview of the open science movement, this chapter then highlights the different ways that academic libraries can and have become engaged in this movement. The chapter ends with two case studies of libraries based on interviews and a review of online documents. In many ways, much of the content related to open data from Chapter 6 could be included in this chapter, as open data is one part of open science, but in general, I will not repeat that information here.

7.1 OVERVIEW OF THE OPEN SCIENCE MOVEMENT

Open science encompasses various distinct arenas, but much overlap also exists within these different arenas. To assist with understanding and planning activities around open science, Corrall (2016) suggests "three basic types of open…with the following aims":

- *Open Content* – making content of various sorts freely accessible and available for reuse (e.g., publications, reports, presentations, theses, dissertations, datasets, metadata, learning objects, computer code)
- *Open Process* – carrying out academic or business processes in the public arena (e.g., product and service innovation, software development, scientific work, peer review, pedagogical practices)
- *Open Infrastructure* – creating an interoperable technical environment for education, research, and administration (e.g., standards, systems) (p. 5)

In a similar vein, but with more categories, Fecher and Friesike (2014) structure a literature review of the field around five schools of thought related to open science:

> The *infrastructure school* (which is concerned with the technological architecture), the *public school* (which is concerned with the accessibility of knowledge creation), the *measurement school* (which is concerned with alternative impact measurement), the *democratic school* (which is concerned with access to knowledge) and the *pragmatic school* (which is concerned with collaborative research). (p. 17)

Examples of activities or concepts that might fall under each of these schools respectively, include: collaborative platforms, citizen science, altmetrics, open data, and cross lab/cross country research projects.

Many view the rise of the Internet, the open source software movement, and other new technologies as key elements for the rise of the open science movement (Bartling & Friesike, 2014; Fecher & Friesike, 2014; Schlagwein, Conboy, Feller, Leimeister, & Morgan, 2017). Schlagwein et al. (2017) argue, however, that it goes both ways: "Openness can be a driver for, or a consequence of, new IT" (p. 297). Bartling and Friesike (2014) define "Science 2.0" as "all scientific culture, incl. [sic] scientific communication, which employs

features enabled by Web 2.0 and the Internet" (p. 10), showing the influence technology has on the practice of science. At the same time, though, they go on to state that "Science 2.0 enables Open Science, but Science 2.0 does not necessarily have to happen in an Open Science fashion, since scientists can still employ features of the Internet, but stay very much put in terms of publishing their results" (p. 11). Technology can foster change and innovation but does not immediately imply it will occur for everyone.

Many aspects of open science are not new, rather they represent a return to the essence of science. As highlighted in the science standards discussed in Chapter 3, ultimately science is about collaboration, dissemination, and sharing of results. A disconnect has emerged, however, between the ideals of science and the reality of how science actually gets done. A survey of over 3000 scientists from across the U.S. found high levels of endorsement for various norms of science such as open sharing, skepticism, and disinterestedness over the counter-norms such as secrecy, dogmatism, and self-interestedness (Anderson, Martinson, & De Vries, 2007). Slightly lower numbers emerged when the scientists were asked to rank how well they adhered to these norms in their everyday work, but still many stated that they exhibited the norms more often than the coutner-norms. When looking at their colleagues in their discipline, however, they saw other scientists' "behavior as aligning more with the counter-norms than with the norms" (Anderson et al., 2007, p. 7). These results likely point to the fact that a climate exists where many lean towards the counter-norms because of pressures for achieving promotion and tenure or creating that novel product in the private sector (Jomier, 2017; McKiernan et al., 2016; Nosek, 2017). The current system of promotion and tenure at most institutions does not reward sharing. For example, a prestigious journal an early career scientist needs to publish in to advance her career will likely not have open access. Also, a recent survey of Association of Research Libraries (ARL) member libraries that support affordable course content (ACC) and open educational resources (OER) found that "current university-wide tenure and promotion policies do not explicitly encourage faculty adoption, adaption or creation of ACC/OER" (Walz, Jensen, & Salem, 2016, p. 5).

The current culture of science represents a major obstacle to wider implementation of open science practices. Nosek (2017) outlines ways institutions can begin to overcome this:

> One step is to show that the norms and values are actually shared, even if they are not rewarded in practice. A second step is to make it easy for people to behave according to their values, and particularly to not be punished for doing so. A third step is to surface when people are practicing the valued behaviors to signal to others that it is possible, practical, even prevalent. A fourth step is to show that the counter-norms are having negative consequences on the quality of research, providing a means of reinforcing the normative behaviors. And, a final step is to shift the cultural incentives so that they actually support and reinforce the normative behaviors. (pp. 90–91)

Several institutions have or are in the process of creating faculty open access policies, which can also help mitigate this challenge (SPARC, 2018a). At the same time, though, problems with awareness of their existence and actually implementing them can arise (Nosek, 2017; Schmidt et al., 2018). The Coalition of Open Access Policy Institutes (COAPI), an informal network of institutions that have or are creating policies, has created a toolkit that can assist with developing and implementing an institution-wide open access policy (SPARC, 2018b).

Other impediments also confront the open science movement. This includes funding, as many open science initiatives require new infrastructure and new workflows and to create these requires human and monetary resources. In the case of open access journals, someone still needs to cover the costs of creating the journal. Often these costs get shifted to the researcher or institutions through article processing fees. Another issue is that not everything can be shared. Sensitive data, such as health-related or those related to minors, cannot be as openly shared as other types of data. Not all research is funded by the government, too, and due to funding agreements, there might be limitations put on certain aspects of the research in terms of sharing. Also, researchers might have signed a contract where they have given away their rights to their publication and cannot share it as broadly.

Even with these challenges, the benefits of open science often outweigh them. By making the research process, the data, and the final products more open, it improves science as a whole and helps address the reproducibility problem in science (Nosek, 2017). Along these same lines, science is all about collaboration and building on the work of others. By making it more open, it can help speed up this process. In addition, a movement, which seeks to improve the practice of science, can also help with the problem of maintaining an interest in science among young people. As Nosek (2017) points out, "We worry about kids losing interest in science as a cost to advancing knowledge and having an informed citizenry. To solve the problem, we look for ways to change their minds, and most efforts aren't working. Perhaps we instead need to focus on changing ourselves" (p. 96).

Open science can also make science more equitable. People that might not otherwise have access to the literature, such as institutions with less resources or in developing countries, now do. As discussed in the previous chapter, often research informs policy and clinical decisions so open access allows the general public to become better informed citizens and allows them to make evidence-based health decisions (Stodden, 2010; Zuccala, 2010). Open science can increase the broader impacts of research, as well, and lead to an increase in citations. Several research studies support the concept of the "open access citation advantage", which states that open access articles tend to get cited more frequently than those behind a paywall (Piwowar et al., 2018; Tennant, 2017; Wagner, 2010). Also, as Tennant et al. (2016) point out, "If an article has fewer restrictions for journalists,

citizens, businesses, and policy-makers, it seems logical that this would enable research to be publicly re-used. Furthermore, those parties may be more likely to promote articles which are publicly accessible into different communication channels" (p. 8).

Economic benefits also emerge. As discussed in the previous chapter, greater transparency in scientific processes can lead to greater accountability and ensuring tax dollars are being used wisely. A great deal of research occurs outside of academia in research and development divisions in the private sector so making research more widely available helps promote innovation across all sectors. It could also help leverage university and private sector partnerships leading to a wealth of other benefits from economic growth to landing jobs for recent graduates (Tennant et al., 2016).

Technological advances and tools allow researchers to mine and analyze the scholarly literature in new ways. Open access makes it possible to implement these tools. One component of open science entails the development of new infrastructure and software platforms, which have improved scientific endeavors overall. These include citation managers such as Zotero and Mendeley, social media platforms for researchers such as ResearchGate, GitHub for sharing code, and the Open Science Framework, which will be discussed in the following section.

Because the open science movement entails a variety of different activities and initiatives and requires a cultural shift in the way science is conducted, it will need a coordinated effort to be successful. Libraries, with their interdisciplinary nature, their role as connectors and commitment to collecting, preserving, and disseminating information, can lead the way to making open the default. As Schmidt et al. (2018) emphasize, "…librarians play a key role in the open science movement at they bridge the gap between policy and practice, i.e., act as mediators and enablers through translating open science policies into practice, and vice-versa" (p. 4). Much of what this chapter covers will focus on how librarians support the practice-side, but librarians can also collaborate with other groups on their campuses to shape institutional policies and broader recommendations related to these practical applications. When considering these different approaches to open science, it is important to keep in mind that:

> openness is not "all-or-nothing." Not all researchers are comfortable with the same level of sharing, and there are a variety of ways to be open. Openness can thus be defined by a continuum of practices, starting perhaps at the most basic level with openly self-archiving postprints and reaching perhaps the highest level with openly sharing grant proposals, research protocols, and data in real time. Fully open research is a long-term goal to strive towards, not a switch we should expect to flip overnight. ***(McKiernan et al., 2016, pp. 12–13)***

Librarians, too, will want to reflect on the initiatives outlined in the following sections and decide which ones make the most sense at their institutions based on researchers' needs and the resources available within their libraries.

7.2 OPEN SCIENCE FRAMEWORK

Libraries can promote the use of the Open Science Framework (OSF) by researchers at their institutions. Some librarians themselves are also using it to manage their own research or projects (Foster & Deardorff, 2017). The OSF is an open source, online tool to manage the workflow of research projects, which was developed by the non-profit Center for Open Science (COS). The flexibility of OSF allows users to adapt it to different types of projects and situations from a single article to a more complex project that might result in a variety of outputs to the work of an entire laboratory. Using a wiki layout, researchers can "manage files, data, code, and protocols in one centralized location and easily build custom organization" for their project (Center for Open Science, 2018a). Collaborators can easily be added, and you can assign different permissions to them. Users can also choose to make certain aspects of the project public, while maintaining others in a private mode. When made public, OSF provides digital object identifiers (DOIs) to enhance discoverability. It also automatically tracks version control of all documents stored within it. Other tools, such as citation managers, open cloud storage, open data repositories, and DMPTool can be integrated with OSF. Subsets of OSF include OSF Preprints, OSF Meetings, for archiving academic meetings and conference materials, and OSF Institutions, which is a way to manage research projects at an institutional rather than researcher level. Libraries can request workshops given by COS on helping researchers to make their work reproducible and more transparent, as well as an orientation to OSF, and COS also regularly offers webinars on OSF (Center for Open Science, 2018c).

In addition to OSF, COS also offers a variety of other services and tools. Through grants from the Institute of Museum and Library Services (IMLS) and the Alfred P. Sloan Foundation, COS and ARL partnered to create the SHARE platform. According to its website, "SHARE is a community open-source initiative developing tools and services to connect related, yet distributed, research outputs, enabling new kinds of scholarly discovery" (Association of Research Libraries, 2018a). An open source repository, it contains journal articles, monographs, posters and presentations from conferences, patents, and software. COS also has a Registered Reports program, which journals can adopt to have researchers submit their introduction and methodology for peer review prior to conducting the research. If approved, the researchers then move forward with their work, and their article is automatically accepted for publication regardless of the results, if they followed their proposed methodology effectively. COS has developed Transparency and Openness Promotion (TOP) guidelines, which include eight standards, that journals can implement as part of their publication process. Journals can opt to implement all or only a few of the standards in whatever way they see fit. Currently, over 850 journals

have adopted them (Center for Open Science, 2018b). Finally, they have an Open Science Badges program that journals can place on articles to highlight open science practices associated with the research. Many librarians advise faculty members and graduate students on where to publish their research. They can make faculty members aware of these programs in case they would like to publish in journals that participate in them.

7.3 OPEN EDUCATIONAL RESOURCES

With textbook costs soaring, many students forgo purchasing required texts. Libraries often provide copies of some textbooks as part of their course reserves collection, but when they do, it is generally only one copy. Often, libraries do not purchase them for every course, either; only when a professor requests them. According to a U.S. Bureau of Labor Statistics report, from January 2006 to July 2016, the Consumer Price Index for college textbooks increased 88% compared to a 63% increase for college tuition and fees (U.S. Bureau of Labor Statistics, 2016). As Crozier (2018) points out, "Students have little control over tuition and fees, so the easiest way for them to control costs is to change their textbook buying habits" (p. 146). This can have a detrimental effect on students' academic success. Studies have shown correlations between the lack of course materials and withdrawal from or poor performance in classes, as well as students taking longer to graduate (Office of Distance Learning & Student Services, 2016; Wiley, 2015). Along with these trends, higher education has seen an increase in massive open online courses (MOOCs), blended courses, online and distance learning, which require electronic resources that anyone can access.

Given this landscape, many institutions have begun to develop and implement open educational resources (OER), and libraries have been playing a role in this. Often OER get associated with electronic textbooks, but that is not all they are. They can include other types of resources such as entire courses, syllabi, video tutorials, tests, and discussion questions. It can also refer to innovative approaches to teaching and learning. For example, there are the open textbooks provided by OpenStax (https://openstax.org/) and video tutorials or full courses, such as Khan Academy (https://www.khanacademy.org/), MIT OpenCourseWare (https://ocw.mit.edu/index.htm) and Coursera (https://www.coursera.org/). OER Commons is "a public digital library of open education resources" for all ages from preschool to higher education and life-long learning (OER Commons, 2018). OER Commons also offers tools for educators to collaborate and create their own OER, which they can then publish and share more broadly on their website.

In addition to the immediate benefit of students having access to their course materials, OER also offer other advantages. Since they are digital,

supplementary interactive material, such as short videos, visualizations, or links to websites can easily be added. Educators can also easily create more customized materials for specific courses. With textbooks, the modular nature of them can allow professors to adopt and use certain sections and/or reorganize them to suit their needs. Anyone can access the resources that are developed, too. This proves to be invaluable for lifelong learning or for someone who might be transitioning back into college at a later age (Bossu, Bull, & Brown, 2012).

Even though many professors recognize the burden placed on students due to increased textbook costs, widespread adoption of OER has not occurred for several reasons. A recent survey of over 2700 U.S. faculty members found that lack of awareness of OER was one of the main reasons for not implementing them (Seaman & Seaman, 2017). Only 10% reported that they are "very aware" and 20% are "aware" of OERs. Locating OER can also be a problem since they are not always included in library catalogs, they are available on a variety of websites, and there is a lack of good discovery tools to search only for OER (Allen & Seaman, 2016; Porcello & Hsi, 2013). Also, OER often are held in repositories or government websites that might disappear over time due to loss of funding or changes in priorities in certain administrations (Hess, Nann, & Riddle, 2016). Along these same lines, faculty members might feel that it takes too much extra time to find and evaluate materials because they might need to use a combination of materials rather than only one textbook (Allen & Seaman, 2016). The lack of teaching aids and supplemental material in many OER that professors get with traditional textbooks, such as homework exercises/questions, quizzes, and tests, can also be a deterrent to using them (Woodward, 2017). Lack of clarity on the Creative Commons licenses associated with many OER can also cause problems, leading to faculty members being unsure of how they can reuse or combine different OER (Hess et al., 2016). Some have questioned the quality of OER, and as mentioned previously, many faculty members do not get credit for creating OER, making them less likely to spend time creating them.

Libraries and librarians can help meet many of these challenges. A report based on a survey of ARL member institutions on their involvement with supporting ACC and OER contains useful information for librarians wanting to get involved in this realm, including descriptions of various initiatives, sample websites, information on governance, policies, and funding, and the types of content that have been created (Walz et al., 2016). Subject librarians work closely with faculty members in developing information literacy sessions for their classes and often have a strong awareness of the curriculum for the departments with whom they liaise. Many also subscribe to various listservs and keep abreast of the literature on OER so they can let faculty members know at the point of need about a specific resource, rather than a more general push to get them to adopt

OER, which can be more effective (K. Deards, personal communication, July 6, 2017). Librarians can introduce OER in departmental curriculum, assessment, and retention meetings, if already a part of these through their work in information literacy (Woodward, 2017). Librarians can also work with faculty members on developing class projects that focus on creating, curating, or evaluating open educational resources, such as the Wikipedia case study described in Chapter 3 of this book. Librarians can develop and deliver workshops related to OER creation and use, or if their institution is a member of the Open Textbook Network, they can bring in facilitators to offer a workshop. In addition to these workshops, members of the Open Textbook Network can take advantage of other benefits, including an *Authoring Open Textbooks* guide and a *Guidebook to Research on Open Educational Resources Adoption*, for those institutions wanting to undertake research projects related to OER (Center for Open Education, n.d.). Librarians can also advise faculty members on copyright and licensing of OER, either when faculty members want to reuse or remix OER or when they are creating their own. In addition to helping faculty members locate materials, librarians can get involved with indexing and creating discovery tools for OER. For example, the State University of New York (SUNY) Geneseo recently developed an OER search tool called Openly Available Sources Integrated Search (OASIS), which includes open content from 52 different sources and contains 155,375 records (The State University of New York Geneseo, n.d.). Finally, some libraries have established an OER fund, similar to an open access fund that faculty members can tap into to assist with creating OER (Alpi, Cross, Raschke, & Sullivan, 2017; Walz et al., 2016). Others are working with other departments at their institution, such as the Provost's Office or an office for excellence in teaching and learning on crafting and adopting an institution-wide policy, which might include an incentive program with funds from the larger institution (L. Collister, personal communication, June 1, 2018; Walz et al., 2016).

Librarians can also take a student-centered approach when promoting OER. At the University of Wisconsin-Milwaukee, librarians put questions on whiteboards in the library asking students to share the "cost of their textbooks for a semester, the cost of their textbooks for a single course, and their most expensive textbook" (Woodward, 2017, p. 208). With these prompts, students also added alternative approaches to purchasing textbooks that they use. The librarians followed this up with bringing bound copies of OpenStax books to student orientations as a conversation starter about OER. All of this created an interest among students to do something about the issue of textbooks costs, so the librarians hosted a meeting facilitated by the Open Textbook Network where they invited members of student government and other interested students to develop strategies to work on this issue. At the University of Maryland, College Park (UMD), the libraries have worked closely with the UMD Student Government

Association to encourage more instructors to incorporate OER in their classes, and they also partnered to start the Top Textbook Reserve program, where required textbooks for the 98 largest courses on campus are automatically purchased by UMD Libraries and put on course reserves (University of Maryland Libraries, 2018). Librarians can also use student performance data to see in which classes students are struggling the most, and then investigate what course materials are used for those classes (Woodward, 2017). If they are expensive textbooks, librarians could recommend some OER to the faculty members who teach the classes.

No matter what approach librarians take to promote the use and creation of OER, it will likely entail collaboration. Libraries can partner with campus centers that support teaching and learning, and faculty member development, as well as the President's or Provost's Offices, on initiatives. This can include crafting institution-wide OER policies or conducting assessments on the effectiveness and adoption of OER. For example, a librarian at The Ohio State University collaborated with staff from the Office of Distance Education and eLearning to assess students' satisfaction with OER (Jaggars, Folk, & Mullins, 2017). Some libraries are publishing OER in partnership with faculty members and other units on campus. Many OER textbooks tend to be in STEM fields (science, technology, engineering, and mathematics) since these courses rely more heavily on textbooks than the humanities. For example, Oregon State University Libraries partner with their University Press and Open Educational Resources and Emerging Technologies unit to publish textbooks focusing on signature areas of the university, such as natural resources, geosciences, marine biology, agricultural sciences, and environmental sciences, as well as courses with high enrollment (Sutton & Chadwell, 2014). Other libraries host OER developed in their own institution and from other universities in large digital repositories. This will be discussed further in a following section.

Within the library itself, collaboration will likely also occur. In many institutions, both scholarly communication and subject librarians work on OER initiatives, but depending on the project, library IT staff might also get involved (Walz et al., 2016). Some libraries have also hired OER librarians that solely work in this area. The most recent EDUCAUSE and New Media Consortium *Horizon Report* listed the proliferation of OER as one of six key educational technology trends in higher education over the next 3–5 years (Becker et al., 2018). As the report states, "Adoption of OER has been driven largely by efforts to reduce the costs associated with higher education, though perhaps the most powerful potential outcome of OER is the opportunity for institutions to develop a broader set of investments in course development and infrastructure" (p. 9). Libraries are and will likely continue to be at the forefront of this trend, which can also serve to demonstrate the value of libraries in supporting teaching and learning on campuses.

7.4 OPEN ACCESS PUBLISHING

With the rising costs of journal and database subscriptions, libraries have been forced to become creative with managing their collections' budgets while still supporting the needs of faculty members and students. One of the key arguments for open access journals is that a large portion of the research at public universities is paid for through federal grants. Scientists then submit research to journals as articles. Other scientists serve as peer reviewers, free of charge, to help ensure that only quality research is disseminated. Then, libraries at these same institutions pay subscriptions to journals and databases to make that information available to the public. Taxpayers are in essence paying twice for research. This is one of the reasons libraries strongly support open access journals.

Two main types of open access journal publication exist: gold and green. Gold is when the article is born-open access—published directly in an open access journal. Instead of charging subscription fees, open access journals pay for their operating costs using methods like author fees, advertisements, and sponsorship. Some journals that charge author fees offer fee waivers to authors that cannot cover the charges, and other journals have implemented an alternative model where institutions or authors can pay a membership fee annually and then publish for free (Tennant et al., 2016). In green open access, authors retain the rights to their works or "grant non-exclusive rights to their institutions before publishing any works" (Tennant et al., 2016, p. 4). This allows the authors or institutions to self-archive journal articles elsewhere such as in an institutional or disciplinary repository or on a personal website. In some cases, they can post the final, peer-reviewed version, while in others it is a pre-print version. This depends on the journal's publishing policies, which might also include an embargo period before authors can deposit their article in a repository or post it elsewhere. Other terms used to describe open access journal articles relate to those published on subscription-based journal platforms: hybrid open access, which includes a clear license for sharing and bronze, without any clear license (Piwowar et al., 2018).

The number of open access journals and researchers publishing open access articles have been steadily increasing over the past few decades. A recent study of 100,000 journal articles "found 27.9% (95% CI [27.6–28.2]) of all DOI-assigned journal articles [in the sample] are OA [open access]" (Piwowar et al., 2018, p. 10). The amount of open access publishing varies by discipline, however. In this same study, 100,000 DOI-assigned journal articles indexed in the database Web of Science were analyzed, and "more than half of the publications are freely available in biomedical research and mathematics, while in chemistry and engineering & technology less than 20% of the papers are freely available" (Piwowar et al., 2018, p. 13). Piwowar and her colleagues also found variations by type of open access

with more than 20% of physics and mathematics articles published as green open access. They found that "hybrid articles are particularly prevalent in mathematics (9.4%), biomedical research (8.1%) and clinical medicine (6.3%), while authors in biomedical research (15.3%), health (11.7%), mathematics (11.2%), and clinical medicine (10.3%) often publish in gold journals" (Piwowar et al., 2018, p. 13). These findings can help guide librarians by showing with which disciplines they might have success in promoting and supporting open access, as well as where they might need to try to reach out more or in a different way.

Libraries promote and support open access journal publication in various ways. They can direct researchers to open access journals and help them navigate publisher's editorial policies related to open access. Librarians also help graduate students and faculty members to avoid predatory publishers by educating them about their existence and giving advice about solicitations that researchers might receive to publish in particular journals. Many libraries offer open access publishing funds to encourage the adoption of open access, but they cannot serve everyone. Also, in some ways this is only transferring the cost from subscriptions to something else, so they might also encourage researchers to write the costs of publishing open access into grants. Some libraries are also working with other groups on campus, such as the office of research or the office of the Provost to devise other ways to support open access publishing by researchers.

Some libraries have also moved into the realm of becoming publishers themselves of open access journals and/or hosting those published by other organizations. The 2018 *Library Publishing Directory* includes 125 institutions in the U.S., Canada, the UK, Australia, Brazil, Germany, Ireland, and Sweden (Library Publishing Coalition Directory Committee, 2018). An older, 2012 survey of library deans from approximately 43 academic libraries in institutions of varying sizes found that 55% had or were interested in starting library publishing services (Mullins et al., 2012). From that same survey, about 75% published journals and about half published conference proceedings, monographs, and technical reports, mainly electronically, but with a small amount of print-on-demand, as well. The survey also found that "the most prevalent journal publishing platforms reported were Open Journal Systems (57%), DSpace (36%), and BePress's [now Elsevier] Digital Commons (25%)" (Mullins et al., 2012, p. 7). DSpace and Digital Commons are often also used by libraries for hosting their institutional repositories. DSpace and Open Journal Systems (OJS) are both open source and Digital Commons is fee-based. When libraries act as the publishers of journals, they oversee many of the technical aspects of publishing a journal, such as designing the website for the journal, assigning metadata and DOIs, and copyediting articles. They generally leave the editorial decisions up to the journal's board, however. For those libraries

that host journals, this entails simply hosting them and very little if any involvement in the publication process. Libraries generally charge fees for these services, but they are much lower than what it would cost to publish them commercially (Hahn, 2008).

Several libraries have also begun to publish monographs. For both open access journals and monographs, many of them otherwise would not get published. As Schmidt et al. (2018) point out:

> As monograph publishing mostly takes place in small to medium-sized publishing houses heavily relying on print sales (including most Anglo-American university presses), these presses tend to be highly selective when taking up titles into their publishing program, resulting in scarce publishing options, especially for niche topics, early career authors or those willing to publish open access. (p. 7)

The sciences tend to focus more on publishing open access journal articles, so open access monographs tend to be in the social sciences or humanities, with textbooks being an exception, as mentioned previously (Association of Research Libraries, 2018b; Schmidt et al., 2018). Several libraries use a hybrid model for monographs where they provide on-demand or small print runs and then a digital open access version can be accessed through an institutional repository (Royster, 2017; Schmidt et al., 2018).

Several challenges exist related to libraries taking on the work of open access publishing. Staffing-related issues can emerge. Often library-publishing operations have a small staff whose members also have other duties. Institutions included in the 2018 *Library Publishing Directory* average 2.1 professional staff dedicated to library publishing (Library Publishing Coalition Directory Committee, 2018). As with data management services, a demand for publishing support services that are outside of librarians' knowledge and skills will require professional development in these areas or the need to hire new staff. Many library schools do not currently have courses on library publishing, but some are beginning to include this.

Establishing financial sustainability for these types of services can also prove challenging. In the 2012 survey of library deans previously mentioned, many programs were currently funded through library budget reallocations, temporary funding from the larger institution or grants, but many of the respondents hoped to find alternative funding streams in the future, such as through "services fees, product revenue, charge-backs, royalties, and other program-generated income" (Mullins et al., 2012, p. 6). Starting to charge for services is not something that libraries have historically done, and some do not feel comfortable moving towards this model. Whatever model libraries decide to follow, it is important to keep in mind that "subsidizing locally managed open access publishing is an alternative to subsidizing subscription models with inherent access restrictions" (Hahn, 2008, p. 6).

Libraries might also seek guidance when developing and implementing policies and procedures since although it is becoming more widespread, it is still a relatively new area for libraries. Policies can include both internal policies related to strategic objectives, budget, editorial parameters, and types of services offered, as well as external policies or agreements that outline details of collaborations between the library and the clients they are serving (Mullins et al., 2012). As the number of library publishers increases, though, librarians are creating communities of practice to support each other in this work. The Library Publishing Coalition is "an independent, community-led membership association of academic and research libraries and library consortia engaged in scholarly publishing" (Library Publishing Coalition, 2018a). They host an annual Library Publishing Forum, offer regular webinars, and also have many resources on their website, including, but not limited to, sample policies and procedures documents, their own publications, and a list of publishers and service providers interested in working with the library community (Library Publishing Coalition, 2018b). The body of literature on library publishing is also growing, as demonstrated by the Zotero library maintained by the Library Publishing Coalition (Library Publishing Coalition, 2018b). State university systems and library consortiums can also work together on library publishing initiatives. For example, Lever Press is a consortium of liberal arts colleges that have recently established a scholarly publishing program (Lever Press, n.d.). Some library coalitions partly fund the operations of existing publishers, such as the Luminos program under the University of California Press (University of California Press, 2015). As with many other initiatives described throughout this book, library publishing is very much a collaborative effort.

7.5 INSTITUTIONAL REPOSITORIES

In 2002, the Scholarly Publishing and Academic Resources Coalition (SPARC) came out with a position paper advocating for universities to implement institutional repositories and encouraging libraries to take the lead in establishing and managing them (Crow, 2002). It argued that they "provide a compelling response to two strategic issues facing academic institutions" since they:

- Provide a critical component in reforming the system of scholarly communication—a component that expands access to research, reasserts control over scholarship by the academy, increases competition and reduces the monopoly power of journals, and brings economic relief and heightened relevance to the institutions and libraries that support them; and

- Have the potential to serve as tangible indicators of a university's quality and to demonstrate the scientific, societal, and economic relevance of its research activities, thus increasing the institution's visibility, status, and public value (p. 4).

In the early 2000s, technological developments aided in the rapid growth of institutional repositories in academic libraries. This included the development of the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), which allows for information to be easily exchanged between repositories, and the creation of OAI-PMH compliant software platforms such as DSpace (Massachusetts Institute of Technology) and EPrints (University of Southampton) for the establishment of institutional repositories (Lynch, 2003; Pinfield et al., 2014). Pinfield and his colleagues conducted an analysis of records from the Directory of Open Access Repositories (OpenDOAR), which is maintained by the University of Nottingham in England to track the global growth of digital repositories (many, but not all are institutional repositories) (Pinfield et al., 2014). Starting in December 2005, the year OpenDOAR was first established, through to December 2012, the total number of repositories listed grew from 128 to 2253, which is a 1660% increase. The rate of growth, however, fluctuated throughout this time period with "rapid growth in the first year (from 128 to 855 repositories between December 2005 and December 2006) and a slowing down of growth in the final year (from 2,185 to 2,251 [sic] between December 2011 and December 2012)" (Pinfield et al., 2014, p. 2409). OpenDOAR's statistics for September 2018 show 3777 repositories worldwide so growth still occurs, although continuing to do so at this steadier rate (Jisc, n.d.). Looking only at the U.S. in September 2018, OpenDOAR lists 410 institutional repositories.

In many ways, institutional repositories intersect with the other arenas of open science already discussed in this chapter. Like the OSF, institutional repositories are technological infrastructure to organize, disseminate, and preserve scholarship. As Lynch states, an institutional repository is "a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members" (Lynch, 2003, p. 328). When institutional repositories first became established in academic libraries, often they were used to house green open access journal articles from faculty members, as well as dissertations, master's theses, and undergraduate capstone papers. Libraries that have begun publishing e-books will often host them in their institutional repositories. With the rise of OER, many now include different types of resources created by faculty members, staff, and students (Ferguson, 2017). By hosting OER in an institutional repository, not only does it make them available to a broader audience, it also ensures their long-term preservation and it allows for version control.

Often people customize and remix OER each time it is used, "effectively creating a new version to be archived" (Ferguson, 2017, p. 36). As mentioned in the previous chapter, some libraries include datasets in their institutional repositories. They can also house conference proceedings or materials from events hosted by departments or research centers at the institution.

Obviously, because they represent the entire institution, the content in an institutional repository is multidisciplinary. A study that looked at content uploaded by faculty members from various disciplines into institutional repositories in 107 academic institutions in the U.S. found that over 60% of the content was from STEM fields, which included biology, computer science, engineering, and mathematics (Dubinsky, 2014). Institutional repositories can serve as a powerful way to disseminate scientific information. They also host materials that can be useful to others, but do not fit into traditional publishing outlets, meaning they otherwise would not reach that audience.

Even when faculty members recognize the value of institutional repositories for dissemination and long-term preservation of their scholarly products, various studies have shown that self-archiving by faculty members in general remains minimal (Royster, 2007, 2008; Salo, 2008). There are some disciplines, however, such as physics, which have a history of sharing, and have shown greater participation in institutional repositories (Royster, 2008). Some barriers to faculty members depositing their work include lack of awareness of the existence of the institutional repository, copyright restrictions (they did not retain their rights for works published elsewhere), preferring to deposit in disciplinary repositories, and concerns about plagiarism (Dubinsky, 2014). To overcome this challenge, many institutional repositories offer mediated archiving in addition to a self-archiving option. With mediated archiving, the institutional repository staff or subject liaisons might request publication lists from faculty members of items that they would like to add. In some cases, graduate students or departmental administrative assistants might provide these lists and/or files of items to be deposited. Institutional repository staff then do the work of archiving the publications. Some subject liaisons monitor faculty member publications and then get in touch with them to see if they would like to deposit any of their recent publications. A survey of institutional repository administrators found that often they prefer mediated archiving to ensure that they get accurate metadata and that rights are in order (Dubinsky, 2014). This same survey found that personal interactions with faculty members, such as presentations at departmental meetings or one-on-one consultations, were the most effective way to increase faculty member submissions.

In addition to institutional repositories, many libraries also support disciplinary repositories or other types of open access digital repositories. Many libraries have archives and special collections containing non-digital

materials, which they are digitizing and making available to a broader audience, some of which include science-related content. Started in 1991, arXiv.org is one of the earliest open access disciplinary repositories for articles in the fields of physics, mathematics, computer science, nonlinear sciences, quantitative biology, statistics, electrical engineering, and economics (Cornell University Library, n.d.). Cornell University Library maintains arXiv.org with guidance from the arXiv.org Scientific Advisory Board and Member Advisory Board. Another science-related open digital repository is the Biodiversity Heritage Library (BHL), which was first introduced in Chapter 5 due to its connections to citizen science. A collaboration of a number of libraries and natural history, botanical, and research institutions, BHL seeks "to make biodiversity literature openly available to the world as part of a global biodiversity community" (Smith & Rinaldo, 2015, p. 212). Partner institutions have digitized over 140,000 titles from their collections, many of which in the past researchers would have had to travel to the institutions themselves to access (Biodiversity Heritage Library, 2018; Smith & Rinaldo, 2015). Much of BHL's content is in the public domain, but they also negotiate with publishers to include more recent and/or copyright-restricted literature. Some libraries also host repositories of OER. For example, "the University of Minnesota's Open Textbook Library; the California Open Online Network for Education (Cool4Ed), supported in part by the California State University System; and The Orange Grove, Florida's Open Educational Resource Repository" all host OER from institutions from across the country (Ferguson, 2017, p. 35). Other examples of open digital repositories are discussed in the case study of the University Library System at the University of Pittsburgh that follows.

7.6 CASE STUDIES

7.6.1 A Library as Publisher: University Library System (ULS), University of Pittsburgh

In 2007, the ULS at the University of Pittsburgh (Pitt) began publishing open access journals, one of the first academic libraries to do so. Starting small by collaborating with people and organizations at Pitt or that had close associations with researchers at Pitt, the program quickly grew, and currently the ULS is the "publisher of record" for around 40 electronic, open access journals from both the U.S. and around the world (L. Collister, personal communication, June 1, 2018). The majority are in the social sciences and humanities, but they have several health-related titles, including *Dentistry 3000*, *Health, Culture and Society*, the *International Journal of Telerehabilitation*, the *Journal of the Medical Library Association*, the *Pittsburgh Journal of Environmental and Public Health Law*, and *The Cleft Palate Journal*.

The ULS outlines several of the benefits of publishing with them on their website (University Library System, 2018). One major benefit is that they represent a low-cost alternative to publishing an open access journal with a major publisher, without sacrificing services and support. As Lauren Collister, Director of the Office of Scholarly Communications and Publishing, pointed out, "We heavily subsidize it, but we do charge. It is a thousand dollars a year, which…is much less than what commercial publishers charge…and we give a fifty percent discount to folks at the University of Pittsburgh to give some incentive for our folks locally" (L. Collister, personal communication, June 1, 2018). The ULS handles all the technical aspects of publishing the journal using the Open Journal Systems (OJS) platform (https://pkp.sfu.ca/ojs/). It includes several features that allow the institutions or societies that produce the journal to retain management and control of various processes, such as online submission and management of content, their chosen peer review process, and automatic email notifications to authors and reviewers. On this webpage, they also provide links to information for potential partners to explore whether OJS is the right platform for their needs. Finally, the ULS also designs the website for the journal and article templates to ensure consistency in formatting.

The ULS has not had to do much marketing of the program to gain new journals. As Collister shared, "people just seem to find us and get referrals from their colleagues in the field" (L. Collister, personal communication, June 1, 2018). The only more proactive approach to marketing they have taken is that they review the annual list of journals with University of Pittsburgh faculty members as editors, which is compiled by the on-campus faculty newsletter, and if they notice a print-only journal listed or one with a small circulation, then they reach out to the editor letting them know about the publishing program. When someone shows interest in publishing with the ULS, this is the general workflow to get things started according to Collister:

> We have a meeting where we learn about their journal or their idea for a journal. Sometimes it's a brand new journal, sometimes it's one that already exists in some form. We learn about what they do and what their process is like. We share with them our process and the services that we offer. If they are interested, we have a journal proposal form that they fill out, and we help them with that. That gets run by our Publications Advisory Board. We have an international team of folks in the scholarly publishing and open access world along with some others like the director of our university press is on there, and we often ask subject specialists to review it as well. The Advisory Board makes sure that the peer review process is solid, the journal has a sustainable model, and there's actually a need for this journal if it's new. If the journal gets approved by the board, we sign a service agreement with them which spells out our relationships, the cost, who's going to be responsible parties on each side and the terms. ***(L. Collister, personal communication, June 1, 2018)***

Once all the above is in place, the ULS creates the journal in OJS—setting up the website and creating article templates in consultation with the

editorial team. The organization works on the content for the website, including the description of the journal and their policies and procedures. Once everything is set up, they can issue a call for papers, which remains the purview of the journal editors, not ULS. As Collister described:

> We leave all the editorial decisions to the editors. We don't really get involved in that because we figure they are the subject experts and they know the most about their field. However, if they need something like an erratum or publishing special issues or reprints, we are there to help. We also do quality control with metadata. Before an issue is released they send a draft of it to us, and our specialist checks it over to make sure it's got all the necessary information, that DOI is assigned correctly, everything matches up between the PDF and the metadata, and then she publishes it. ***(L. Collister, personal communication, June 1, 2018)***

This represents a typical workflow for publishing a journal with the ULS, but as Collister also mentioned, "it is an evolving practice," and there might be tweaks or changes to the process depending on the situation and/or as they continually evaluate the process (L. Collister, personal communication, June 1, 2018).

As can be seen from these descriptions, the ULS Office of Scholarly Communications and Publishing, which oversees the program, has several collaborators in these endeavors. Obviously, they work closely with the editors/producers of the journals themselves. Staff from the ULS Communications Office do the graphic design for the journals' websites. A developer in the ULS Information Technology Department helps with software updates and any other technical problems they might encounter. There is the Publications Advisory Board that reviews new journal applications. They also work with subject liaison librarians, especially when establishing a new journal. As mentioned above, the subject specialists can provide insight into what other journals exist in a particular area and assist with indexing and abstracting. Currently, staffing is lean for the journal publishing program. They have one full time person who spends "one hundred percent of her time" on journals (L. Collister, personal communication, June 1, 2018). They also have a staff assistant who is a generalist/project-based person for the entire Office of Scholarly Communications and Publishing who might spend part of her time assisting with journals. Also, Collister oversees the library publishing program along with the other activities of the Office of Scholarly Communication and Publishing.

Given this situation, the growth of the program and related staffing and funding for it represent their biggest challenges. As Collister pointed out:

> Staffing is tough, and we get support from the library with resources beyond staffing. For example, the graphic designers also do the work on the [ULS] website and marketing materials, so we have to get in the queue of all the other things that they have to design, but then the whole library benefits from their expertise and work. Another example is Library IT, who have a million other things that they have to be doing all the time, so that becomes a challenge as the journal publishing operation

> gets bigger. One way we have found to be sustainable is setting some parameters on the journals that we take in to avoid new and time-consuming work, with examples like custom programming or extensive website design. The question becomes whether we are able to continue to grow the program with support and resources from the library also growing in kind, or do we set more limits to growth that align with the resource and support that we have available? ***(L. Collister, personal communication, June 1, 2018)***

Since most of their business comes through word of mouth, the more journals they publish, the more people come to them interested in working with them.

Although in some ways the program's successes can be seen as future obstacles to overcome, they do have much on which to commend themselves. As Collister shared:

> The fact that the program exists and is growing is a success in itself because library publishing is still a new field that is evolving. The Library Publishing Coalition, which started just in the last few years, was a catalyst for more libraries getting involved in publishing because we could share resources and expertise with each other. We're on the older side of library publishing programs, and we're so excited to see more and more libraries get involved and do many different things and innovate in this space. We view the development and growth of this work in all kinds of libraries as a success in itself because nobody knew where this was going to go when libraries started this work. ***(L. Collister, personal communication, June 1, 2018)***

The ULS was a pioneer in this area and continues to be a leader, but they also have a larger community with whom they can share experiences and knowledge to promote open access across the country, as well as globally. Another success of the program is that they often publish journals that would not otherwise exist. For example:

> We have a journal, the *International Journal of Telerehabilitation*, when they started telerehabilitation was a relatively new field and not a lot was written about it. But now this journal is in PubMed Central…and there's all kinds of new research from this field. It's no longer really as niche as it was, and we really like seeing things like that happen where this kind of research can be open and builds a growing field and growing movement. ***(L. Collister, personal communication, June 1, 2018)***

Journals from emerging fields or produced by smaller societies or organization might not have the resources to work with a commercial publisher, but they can work with academic libraries to the benefit of scholarship as a whole. "It also increases equitable participation [in science and scholarship] because often you hear these stories about researchers who want to do a project, but they don't have access to the journals that publish the studies, or they can't get the data because they're not affiliated with a major university" (L. Collister, personal communication, June 1, 2018). With an open access journal, anyone from anywhere in the world can access the research and data.

Besides the e-journal publishing program, the ULS also supports the open science movement in other ways. The Office of Scholarly Communications and Publishing has a journal hosting program called Scholarly Exchange (https://www.scholarlyexchange.org/), which also uses the OJS platform, but the ULS is not as involved in the journal publication processes. They do not take on the official title of publisher; instead they facilitate access to the software for the organization or group to publish it on their own. They have "had some journals from under-resourced institutions or areas that want to be able to publish a journal but don't have access to the technology resources to have the storage or server space" so this service takes care of that for them (L. Collister, personal communication, June 1, 2018). They oversee the University of Pittsburgh institutional repository and several subject-based archives, including the PhilSci-Archive (http://philsci-archive.pitt.edu/), a pre-print archive for the field of the philosophy of science, and The Aphasiology Archive, which houses conference proceedings from the Clinical Aphasiology Conference (http://aphasiology.pitt.edu/). Through a DOI assignment service, they "support projects at Pitt that are doing open work," such as the Pitt Quantum Repository (http://pqr.pitt.edu/), which is an "interactive database of [3D] chemical molecules" (L. Collister, personal communication, June 1, 2018). They also offer financial support to Pitt faculty members, students, and staff to help cover the article processing costs for publishing in an open access journal through an open access author fees fund. The library has participated in data rescue events focused on federal data "to ensure continued access to vulnerable data in the public interest through trustworthy archives" (Data Rescue Pittsburgh, 2017). Finally, the library is beginning to get more involved with open education, including "working with the Provost's Office to develop recommendations for campus-wide adoption of open textbooks and encouraging the creation of open educational resources" through collaboration with other on-campus groups like the University Center for Teaching and Learning (L. Collister, personal communication, June 1, 2018). Liaison librarians would work closely with faculty members to help them develop these resources.

Collister stressed, however, that while all these initiatives are valuable and important work, libraries and librarians also need to get involved with organizations working in the open science realm beyond the campus. In one case, she explained that "we are development partners with the Public Knowledge Project which is the organization that develops, promotes, and maintains the software for Open Journal Systems Publishing, and they also do a lot of advocacy and education…[As development partners], we can participate in the conversations but also support them and the work that they do" (L. Collister, personal communication, June 1, 2018). The ULS has also been active with the Open Access Scholarly Publishing Association, which is an international consortium of open

access publishers that develops guidelines and best practices, so they have a voice internationally, too. "One of the most important things that we're doing is not just doing work locally with our faculty and students, but also trying to contribute to the broader discourse and movement around Open," emphasized Collister. "Many library publishers, which was easy to see at the recent Library Publishing Forum, are thinking about the ways that they can consolidate their efforts and expertise and make a bigger difference on the national or global scale. So, I think that's a very important thing to consider for libraries is that what you do locally can also help globally" (L. Collister, personal communication, June 1, 2018).

7.6.2 Increasing the Reach of Research: University of Nebraska-Lincoln Libraries

During its first year of operation, the institutional repository (IR) at the University of Nebraska-Lincoln (UNL), known as DigitalCommons@University of Nebraska-Lincoln, experienced several fortuitous events that helped to quickly build up its collection, while also disseminating otherwise hard to access materials (Royster, 2007). Many of these materials were also from STEM fields. Launched in July 2005, the newly-hired Coordinator for Scholarly Communications, Paul Royster, began reaching out to faculty members to encourage them to deposit materials in the IR. During a visit to the Harold Manter Laboratory of Parasitology at the UNL State Museum "among racks and cases of tens of thousands of pickled worms in glass jars—the CSC [Royster] noticed a large stack of what appeared to be a manuscript" (Royster, 2007, p. 185). Dr. Scott Gardner, Curator of the Manter Lab, working with a colleague from the University of California-Davis, Dr. Arman Maggenti, had compiled and edited what indeed was a manuscript of *The Dictionary of Invertebrate Zoology*. It had been slated to be published through the University of California Press, but that had fallen through. Having exhausted their options, Dr. Gardner and Dr. Maggenti decided to look into self-publishing it online. Royster stepped in and offered to help, and in a short time the book was online, hosted on the IR. It "became an instant online success, averaging over 30 downloads daily" (Royster, 2007, p. 185). The e-book has since been reformatted so that users can download either the entire work as a PDF or individual letters. As of August 1, 2018, since its initial posting, the complete work has been downloaded 51,196 times (Online Dictionary of Invertebrate Zoology, 2005).

Other projects also emerged during that first year. Royster connected with the manager of the Internet Center for Wildlife Damage Management, which at the time was based in UNL's School of Natural Resources. They had undertaken a project to digitize conference proceedings from their field, including the Bird Control Seminars, the Vertebrate

Pest Conferences, the Wildlife Damage Control Conferences, among others, but had not found a good solution for posting them on the web. The IR became a valuable resource to upload this and other content from the center (Royster, 2007). As of August 1, 2018, papers from the Bird Control Seminars have been downloaded 202,424 times, with 9042 downloads in 2017, and the Wildlife Damage Control Conferences have seen 177,739 downloads overall of papers, with 17,270 downloads in 2017 (Internet Center for Wildlife Damage Management, 2018a, 2018b). Also, this same year, the Department of Chemical and Biomolecular Engineering hired a graduate student to gather and upload faculty member publications to the IR. The student received training from Royster to upload the items himself, and "this proved to be a successful way for the department to achieve its aim of increasing their web presence and online reputation" (Royster, 2007, p. 185).

As its name suggests, the IR at UNL uses the Digital Commons platform. This system was originally developed by a group of professors at the University of California, Berkeley, who formed the company bepress to distribute and manage it (bepress, 2017). In August 2017, Elsevier acquired bepress, which has raised concerns among some current users about the future of the product, its features, the technical support provided by the company, and any possible shifts in the overall mission of the company (Elsevier, 2018; Royster, Weaver, Billings, Fitzsimmons, & Fishel, 2018). In a panel discussion of Digital Commons users at the 2018 Library Publishing Forum, Royster who continues to oversee the IR, outlined several of the valuable features of Digital Commons organizing them into what he called the "4 S's": software, services, separation, and strength (Royster et al., 2018, p. 12). During the talk, Royster shared, as Digital Commons users, "we get the expertise and benefits of their 15 years of experience and training. Bepress has always had really good people, and those employees have remained" (Royster et al., 2018, p.12). He also stressed that other platforms might already or could in future replicate some of these features, "but none would match the Digital Commons in aggregated content and gravitational pull" (Royster et al., 2018, p. 14). From this, it appears that for the foreseeable future, the IR will continue to use Digital Commons.

The IR is mainly for faculty members, students, and staff associated with UNL. Nonaffiliated users who would like to deposit items in the IR are handled on a case-by-case basis. Depositors can upload items themselves, but this is not heavily promoted because they have had more success with getting materials into the repository and better metadata if library staff do it for faculty members (K. Deards, personal communication, July 6, 2017; Royster, 2007). Often liaison librarians act as an intermediary by requesting publication lists or CVs from faculty members with the items marked that they would like to have uploaded. As Kiyomi Deards, a science librarian at UNL, shared:

> One of the things that we do that not everybody does is that we do all of the uploading for them. You can do it yourself, but we try and discourage that. We don't even tell people that that's an option unless they discover it themselves because… the people in charge [of the IR] have massive spreadsheets so they keep track of all the rights…and if it needs to be re-typeset or anything like that, we do all that for them. So, what we try to do is get people to give us their most recent list, and if they have a bunch of their pdfs, that's great, too. As a liaison, sometimes they'll send it to me through Box [a cloud-based, file-sharing resource], or sometimes I'll just walk it over on a flash drive. Then it goes into the queue to be processed by students, and then gone over again by our staff, depending on what it is that needs to be done. ***(K. Deards, personal communication, July 6, 2017)***

The website for the IR includes an online tutorial, written instructions, and author FAQs for those that want to upload items themselves (UNL Libraries, n.d.). They encourage people who submit items to create an ORCHID ID if they do not already have one, and then they associate it with all of the records in the IR. They also have a service for assigning a DOI to items not published elsewhere. These features make the items more easily discoverable and help ensure authors receive credit if their items are used by other researchers. Digital Commons also has a feature where it automatically sends monthly reports to any authors who have deposited material in the IR on total number of downloads of their work, the types of institutions accessing the resources, and the country of the requestor. Faculty members appreciate this, particularly when putting together their tenure package, or "they just really enjoyed seeing how much their paper is being used," according to feedback Deards regularly receives (K. Deards, personal communication, July 6, 2017). In addition, "when faculty realize that people are actually downloading their papers, they become much more enthusiastic and often come forward with more obscure and difficult-to-find content" (Royster, 2007, p. 187).

According to the collection development policy for the IR, they accept a variety of material including published and unpublished documents from UNL-affiliated authors, which include posters, presentations, reports, white papers and theses, administrative and historical documents relating to UNL, and journals or books identified by UNL affiliates as germane to subjects of research interest at UNL (Allison et al., 2018). As Deards pointed out, "it's not just journal articles, I have several [conference] posters and educational handouts that I've made…Sometimes the handouts get downloaded more than anything else. I have one handout that has had over a thousand downloads" (K. Deards, personal communication, July 6, 2017). In the overall Digital Commons Network, which includes more than 500 institutions, the IR is seventh in overall number of downloads in 2017 of materials from the life sciences, the physical sciences, and mathematics (Digital Commons Network, 2018a, 2018b). They have a separate repository for data and another for images and multimedia.

UNL Libraries also post books from its electronic and on-demand book publishing operation, Zea Books, on its IR. Formally launched in 2011, Zea Books seeks to publish scholarly works that might not fit other publication outlets (Royster, 2017). Currently, they have 84 books in the collection, several of which fall within STEM, particularly natural history. Since its start, e-books from this collection have been downloaded 219,310 times and 36,423 times in 2017 (UNL Libraries, n.d.).

As several of the examples above show, institutional repositories can serve as an ideal way to open science and make resources available to a broader audience. Challenges do exist, though, with institutional repositories and open science in general, as discussed at the beginning of this chapter. Not everything related to science can be shared widely, such as medical research, due to privacy concerns. Also, as Deards pointed out:

> …not all science research is funded by the federal government. A lot of it is actually funded by private corporations that have intellectual property rights because of their funding, so you can be limited by [what you can share]…Some things are on different terms, too. There are some grants, some through the federal government and some through local governments, which are to help people create things for start-ups. So those, a lot of that information is proprietary. The other issue that people don't always realize is that there is this thing called "export-control," and it applies a lot in the sciences because there's certain scientific information…that the government can decide at any point in time, with or without telling you, should not be shared with people from certain countries. So, it doesn't apply to everything that people do, obviously, but there are more considerations. So, saying that everything should be open is a little too general when you're talking to people in the sciences. ***(K. Deards, personal communication, July 6, 2017)***

This is something to keep in mind when encouraging people to deposit their research in an institutional repository. Funding and staffing are always a challenge, as well. UNL Libraries only has "three full time people and…student workers" dedicated to the institutional and data repositories, "but they get a lot done" (K. Deards, personal communication, July 6, 2017). If they had more funding, they could hire more people and get even more done. Overall though, they demonstrate how a small group of people can make a mighty contribution to the open science movement.

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