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A Campus Partnership to Foster Compliance with Funder Mandates

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UtahStateUniversity
MERRILL-CAZIER LIBRARY

A Campus Partnership to Foster Compliance with Funder Mandates

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A Campus Partnership to Foster Compliance with Funder Mandates

Abstract: Data from federally funded research must now be made publicly accessible and discoverable. Researchers must adhere to guidelines established by federal agencies, and universities must be prepared to demonstrate compliance with the federal mandate. At Utah State University, the Office of Research and Graduate Studies and the Merrill-Cazier Library partnered to facilitate data sharing and create an audit trail demonstrating compliance with the terms of each researcher's award. This systematic approach uses existing resources such as the grant management system, the institutional repository (IR), and the Library online catalog. This paper describes our process and the first eight months of implementation.

Introduction

A Memorandum issued by the U.S. Office of Science and Technology Policy (OSTP) in February 2013 called for increasing openness of data and publications resulting from research funded by federal agencies receiving over $100M in federal research and development funding (Executive Office of the President, Office of Science and Technology Policy, 2013). Federal agencies produced plans describing expectations for researchers receiving funding from their agency. Typically, researchers are expected to submit a data management plan describing how research data will be generated, described, stored, and made publicly available. Agencies also stipulate timelines for when publications and data resulting from funding must be made publicly available, and in some instances, suggest or provide guidelines on choosing repositories for data deposit.

The data management plan (DMP) is part of the grant proposal submitted to an agency, and becomes part of the agreement between the agency and the university upon award approval and acceptance. Thus, if a researcher states in a DMP that certain data will be produced and publicly shared in a repository, this is the expectation for successful compliance with the grant, along with deposit of corresponding publications to the agency's publication repository. Failure to comply can carry serious consequences. For the researcher, it may result in lack of future funding from the agency. If numerous researchers fail to comply, the agency may refuse subsequent grant funding to the institution.

The new data sharing requirements raise questions about how academic institutions might demonstrate compliance to an agency. More specifically, what resources can an institution deploy to help and encourage researchers to regularly monitor their DMPs and deposit data and publications in a timely manner, and how can those actions be recorded in case of audit?

Project Conception

At Utah State University (USU) the Office of Research and Graduate Studies (RGS), the Office of Information Technology (IT), and the Merrill-Cazier Library have a strong history of collaborating to address the needs of researchers. When the question arose of how to address the challenge of monitoring and assisting researchers with complying with funder mandates, a

small team from a larger campus-wide Data Task Force was formed to draft a solution. Meetings began in Fall 2015, and a solution was conceptualized, developed and formally implemented in late Fall 2016.

This project was to be completed without additional full time staff, therefore it was important that the team develop a process that was efficient and leveraged existing resources and staffing as far as possible. Working within these parameters required creative problem solving and close coordination between the staff in RGS and the Library. The framework for USU's solution was therefore built around two major software platforms already in use; Kuali Research and DigitalCommons. Kuali Research is an electronic system that USU uses to create, submit, and track grant proposals and awards. Individual researchers, academic administrators, and the RGS Division of Sponsored Programs employees have access to Kuali. DigitalCommons is a platform for institutional repositories, created and sold by the company, bepress. At USU, the Merrill-Cazier Library manages a repository instance, DigitalCommons@USU, that allows for unlimited storage. This offers a solution for researchers who are otherwise unable to find a suitable repository for data, and because it was already the institutional repository, it made sense to use it in the compliance project. One additional piece of software that was leveraged is the Library's online catalog, or ILS. Currently the Library uses Sierra for the online catalog and contributes records to OCLC, a national bibliographic service.

The Process

When a proposal is funded, the process of tracking compliance begins. Staff in the Division of Sponsored Programs (DSP) send the Principal Investigator (PI) a letter (Appendix A) congratulating the PI on his or her award and informing the PI of the requirement to complete either the Primary Metadata Document (PMD) (Figure 1) or to supply the Data Management Plan (DMP) that accompanied the award to DSP.

[Insert figure 1: Primary Metadata Document (PMD)]

The PMD is a form used to record information about the award and the products of research (data, publications) produced as a result of the award. It is a spreadsheet sent to the PI at the time of award, and annually thereafter, with a request to update it with information about any data deposited or peer-reviewed articles published.

We hope to incentivize PIs to make their DMPs public by allowing them to simply return their DMP instead of filling out the PMD form. DSP fills out the first several lines for all awards, including the researcher's name, grant title, agency, and award number. This ensures accuracy of tracking awards. The PI is told the information is used to create a public record in DigitalCommons@USU that includes their DMP. Once received, DSP sends this information to the Library. DSP staff are diligent about sending award information to the Library. A report is run at the end of each month to verify that all researchers with awards were notified and their DMPs and/or PMDs sent to the Library for record creation. Any that slipped through the cracks were immediately caught this way.

The Library uses the PMD and DMP to create a record representing the award in the series "Funded Research and Data" in DigitalCommons@USU (http://digitalcommons.usu.edu/funded_research_data/). The purpose of this record is to capture basic information about the grant such as award title, funding agency and award number, and PI, and to provide a place to attach both the data management plan and the PMD. Creating these records, which we call "Master Records" provides a publicly searchable record of the PI's work associated with the award. The DMP and the PMD also remain housed in the DSP system, Kuali, but this system is not accessible to the public.

In the Kuali system, a report is set to alert DSP staff to send annual reminders to PIs to update the PMD. While the report is automatic, the rest of the work is manual. Staff must pull up records and existing PMDs, then send a letter reminding the PI of the agency requirements to make data and publications public and the of University's process to provide access through DigitalCommons@USU, via metadata records. PIs are reminded of the resources available to assist them with depositing data and publications, and are they are instructed to return the updated PMD to the DSP staff (Appendix A).

DSP forwards the updated PMD to the Library. The Data Management Student Assistant verifies the information listed on the PMD. The goals at this step of the process are to verify that the data and publications listed on the PMD have been deposited, and to create records in DigitalCommons@USU representing these items.

PIs are instructed to provide information about their datasets that would help create more descriptive metadata records. In addition to the title, the PMD prompts the PI to supply the file type and a description. It is mandatory for the PI to include the URL or a DOI for the location of the dataset. If the student assistant is unable to locate the data from the information in the PMD, the Data Librarian will attempt to locate it. If neither can locate it, DSP is notified and they will contact the PI for clarification.

When the location of the data has been verified, a record is created in DigitalCommons@USU, assuming the data was not already deposited in our IR. These records, for data stored in other data repositories, capture information about the data, and the award (funding agency, award number) and provide a link to the location of the data. To maximize the discoverability of the data, the records must contain ample metadata.

Researchers have the option to store data in our IR, and may have already done so before receiving the reminder PMD notice. The Data Services Coordinator or Metadata Librarian mediate data deposit. At the time of deposit, library staff interview the researcher and capture and record as much information as is feasible about the data. We request README files to provide additional documentation of the data for future use.

We do not provide for curation of data in DigitalCommons@USU. We do, however, take some steps to ensure the integrity of the files we upload to DigitalCommons@USU. Checksums are run on all data files, and then displayed with the file. Although there is no automatic verification of file failure, the user is able to determine whether the file has become corrupt via the checksum. The files are archived up using Amazon S3, which checks for data corruption.

As with the data files, the Data Management Student Assistant verifies the location of publications in the appropriate public access repository. The student assistant determines whether a metadata record has been created in DigitalCommons@USU with the appropriate funding information. If no such record exists, the student assistant creates one. Additionally, the student assistant adds either a link to the repository copy (if available at the time), or the publisher approved version available in DigitalCommons@USU repository.

Requests for updated PMDs are sent annually to PIs until two years after the end of the award. DSP maintains a status of "closed pending data" in the Kuali system until the PI indicates all data and publications have been deposited or two years after the termination of funding has lapsed. This provides researchers time to work on processing data and write and submit manuscripts. This time period may require adjustment as we gain experience, but the initial plan is to send the reminders for two years. At the end of this time, the Research Office will consider that the work has been completed. The list of data, publications, and other research products recorded on the PMD, having been verified by the Library, will be compared to the DMP created by the PI. If it appears the PI has complied with the terms of the DMP, that is, the PI has produced the products promised in the DMP, the award will be marked as closed and considered in compliance with funder requirements. The complete workflow is represented in Figure 2.

[Insert Figure 2: Workflow diagram]

Creation of the records in DigitalCommons@USU requires close collaboration between DSP and the Library. Initially, the planning group aspired to automate much of this process. Unfortunately, the Kuali system cannot to pull the necessary information at this time to populate the PMD, so DSP staff fulfill this responsibility. Similarly, the system is not able to automatically send the reminders to the PIs to update the PMD. The DSP staff enter the first six lines of information on the PMD and manually send the emails to the PIs. At a workload of managing five to ten federal awards per month this accounts for about 20% total DSP staff time. In the Library, the work to answer questions related to DMPs and to set up the records, currently takes about 10% of the Data Librarian's time, but this should decrease as student employees are more fully trained.

Information about the data deposited by researchers comes to the Library in the PMD spreadsheet. After verifying the location of the dataset, the spreadsheet can be manipulated into an auto-upload format that can be batch uploaded into DigitalCommons. This allows the process to be streamlined once the number of submissions increases. Until the number of datasets becomes overwhelming, they will be handled individually. To estimate the scope of

work that will be involved, we consider FY16, during which about 295 new federal awards were received and 175 awards with federal flow through were funded. While not all of these will have produced data, and some awards will produce multiple datasets that require tracking.

A second set of records are created from the entries in DigitalCommons@USU and are added to the Library's online catalog and to WorldCat. These records are created via automated batch processes. Records from DigitalCommons@USU for the data and for the grants, the "Master Records," are batch exported from DigitalCommons and cross walked into MAchine Readable Catalog (MARC) records for both series. MARC records are added to our online catalog and to WorldCat. This step is important to us to improve the visibility of USU's research productivity and data generation and to make the products of publicly funded research available to a wider audience.

Metadata and mapping

We have two important reasons for providing access to the records representing the awards and the data from both DigitalCommons@USU and our integrated library system, or online catalog. As mentioned, adding these records to the online catalog places them in WorldCat, providing worldwide exposure via the OCLC interface and additional exposure to the USU campus community through our catalog. Another benefit is the robust reporting capability of the online catalog system, Sierra, which allows us to extract reports with more refinement than is possible from the DigitalCommons platform.

Facilitating this process required careful consideration of important fields to include in both DigitalCommons series: Funded Research and Datasets. The information recorded would need to facilitate access to the DMP/PMD or dataset and allow us to run reports over time. These functions would not be occurring in the same system, and we also wanted to prepare the records to allow for migration to any future system. Information captured from the DMPs and PMDs at the start of the process is recorded in DigitalCommons' qualified Dublin Core fields and ultimately mapped to corresponding MARC fields, using the crosswalk shown in Figures 3 and 4.

[Insert Figure 3: DigitalCommons Metadata fields crosswalked to MARC, Funded Research Series]
[Insert Figure 4: DigitalCommons Metadata fields crosswalked to MARC, Datasets Series]

The process for entering records into the online catalog is conceptually straightforward. At the end of every semester, records are exported from DigitalCommons into a spreadsheet. The records are examined for obvious errors, which are corrected in both the spreadsheet and in DigitalCommons. The data in the spreadsheet are then reformatted to extract only the fields outlined in Figures 3 and 4 above. Some data fields, such as the author fields, are concatenated to match cataloging record standards. The spreadsheet is then mapped into MARC records using MarcEdit, a program that makes it possible to edit MARC records in batch and convert from one metadata schema to another. In MarcEdit additional information is entered, such as consistent subject headings and note fields. This process is outlined in precise step-by-step

procedures and can be done by a library student employee. The records are passed to the Metadata Librarian for a final review prior to batch uploading into OCLC's Connexion client. Once uploaded, the records are generated and assigned OCLC numbers.[1] They are then pulled into the library's online catalog.

Unique Identifiers for Funding Agencies

After the first six months of implementation, we encountered a few issues we needed to address. Most challenging of these was the funder name. The names of funding agencies appeared in many variations in documents, publications, and in our own IR. It soon became apparent that using a controlled vocabulary for the funder name as well as a unique identifier for the funder would be beneficial for reporting and other purposes. After careful investigation and review, we chose to use both the Crossref Funder ID and the International Standard Name Identifier (ISNI) identifiers. Currently both are in schemas such as DataCite (DataCite Metadata Working Group, 2016) and RIOXX (Walk & Brown, n.d.). The Crossref Funder ID is used in the DMPTool to facilitate machine actionable DMPs (Simms, Jones, Mietchen, & Miksa, 2017). The unique identifiers in ISNI are more commonly used in catalog and metadata records. By entering both identifiers, we would avoid the need to return to records and add another identifier, should we choose the identifier not widely adopted in the future.

Finding a solution for DigitalCommons@USU that allowed us to leverage the unique identifiers (or URI) of the two controlled vocabularies, yet display meaningful human readable content to users, required creative problem solving. Neither identifier points to a record with a clean, single name that succinctly identifies the sponsoring agency. ISNI links to a record, that at first glance provides a listing of several name variants, and requires navigating through screens before displaying the official authority record. Crossref Funder ID provides succinct text with the ID, but only at the lowest level of the agency. For example, if funding is received from the National Science Foundation, Division of Environmental Biology, the FundRef URI for this division only displays "Division of Environmental Biology." The link for the Crossref Funder ID brings the user to a page of JSON script, which is useful for repositories that are capable of running a back-end script. DigitalCommons was not able to do this.

The Library decided the best practice was to develop and maintain a human readable list of agency names, solely for the sake of the people reading the records. The controlled vocabularies of the funder identifiers would be used for all reporting. The Data Librarian developed a list of funder names used to date, along with the Crossref and ISNI URIs for each name. Both the names and the URIs are mapped into the MARC record and also displayed in the DigitalCommons records. This allows all metadata records (DigitalCommons and the catalog) to be both human readable and machine actionable.

[1] To see a list of the records created to date, please visit http://www.worldcat.org/search?q=kw%3A%22Utah+State+University+Funded+Research%22&qt=advanced&dblist=638

Currently, the library implementation team is also considering a similar approach to unique identifiers for authors. We are working with bepress to implement a more automated way to include the ORCID numbers for PIs and their co-creators. Utah State University encourages faculty and researchers to have an ORCID number as part of the initial data gathering process. This information will be recorded and associated with the researcher name in DigitalCommons and exported with the data that is mapped into MARC records.

Same Data, Different Environments

Figures 5 and 6 illustrates how a record for a federal award appears in DigitalCommons@USU and in our ILS.
[Insert figure 5 and figure 6]

Figure 7 is an example of a dataset in DigitalCommons@USU and Figure 8 shows the same dataset in the USU online catalog. Note that fewer fields are represented in the online catalog for the datasets. The nature of the MARC standard is not as flexible for accommodating all aspects of data. Since we are using it to highlight and promote discovery only, we opted to include the most vital MARC fields and adhere to the standard without shoehorning additional information into notes fields.

These catalog records provide access to either the final, verified dataset or to the PMD/DMP for the federal grant award, depending on the record set. This allows for easy access by the public or other researchers. However, from the University's perspective, these catalog records include important fields that can be parsed and exported for use in reports to demonstrate the institution's track record for compliance.

Project Launch

The USU faculty were introduced to the new process in October 2016 in one of the sessions of the Training Resources for Faculty series offered by the Research and Graduate Studies (RGS) Office. Information about the workshop was sent to faculty who had signed up for the RGS listserv, and an RSVP was requested. Twenty-one people attended. The session included an overview of the federal requirements to deposit data and publications, description of the basic requirements of a data management plan, and the process we developed to track the deposits of data and publications of USU researchers. A short workshop followed about metadata and describing data.

The project was launched November 1, 2016 when DSP began sending PIs the letter informing them of the requirement to submit the DMP and/or PMD in order to prepare their award funding. DSP staff are essential to the success of this project. With a large number of proposal submissions going through the DSP office, it was essential to create streamlined guidelines for the two staff members to quickly determine which awardees need to receive the notification letter outlining the USU data management requirements. A chart listing the federal agencies

with data management requirements is available on the Library's data services site (https://datamanagement.usu.edu/). This is used to guide the DSP employees to determine which PIs are placed into the tracking system.

Despite cross-checking measures, some issues may arise. Some PIs may have submitted a proposal with an exception to creating a DMP. DSP staff will not necessarily know this, and do not have time to wade through each proposal at award time to determine whether this is the case. We anticipate other challenges will arise as we work through anomalies in our work flows and attempt to create an efficient, smooth process.

As of July 17, 2017, 24 records representing grants were available, and 17 researchers chose to include their DMP. The DMPs of these records were downloaded 271 times. Our data show that most referrers came from Google Scholar, and most downloads occurred in the United States.

Anticipated Benefits

A significant benefit of this project to USU is that it demonstrates a concerted effort to meet funder compliance requirements. Our process, which is publicly documented, clearly outlines the expectations of PIs to provide access to data and publications from federally funded research, and offers support to them throughout the process. This illustrates the commitment of the university to complying with the federal mandate.

This process has additional benefits. Creating records for datasets in both the IR and the online catalog increase the exposure and discoverability of researchers' data. Furthermore, DigitalCommons@USU is harvested by SHARE, so datasets and publications reside in yet another system, that includes research products from a number of academic institutions from around the country. Locating datasets can be challenging, and increasing exposure to the research data produced by USU researchers can only help facilitate discovery and potential reuse of data.

When researchers deposit data in USU's DigitalCommons@USU, we can work with them to describe data more fully and include additional data documentation such as readme files, code books, and data dictionaries, all of which facilitate data reuse. We guide researchers to use standard file formats to increase software compatibility. These are some of the basic tips to make it easier to reuse data offered by White et al. (2013).

Anticipated Challenges

Over several years, as more grants are awarded and data is deposited for each grant, the amount of effort required to assess the information in the Primary Metadata Documents will increase. As the volume of the work increases, the Library may need to make adjustments to

staffing levels, especially if increased awareness of services offered by the library through this project brings an increased demand for more sophisticated data services.

Conclusion

By collaborating and using existing technology and expertise, the Office of Research and Graduate Studies and the Library have created a blueprint for researcher compliance with the terms of federally funded research. We have managed to create a system using minimal existing resources, and, while the project's first six months revealed a few issues we needed to address, overall it has been very successful. We anticipate facing challenges which will require workflow adjustments in the future, but we are confident that our continued communication between RGS and the Library will enable us to resolve any issues.

This endeavor strengthens the productive partnership between RGS and the Library and helps increase awareness of the data services librarians offer. We will continue to assess and modify our workflows and obtain feedback from researchers to improve and maintain the processes we have established with this project.

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Appendixes and Figures

Appendix A: Sponsored Programs Notices on Data Sharing Responsibility

1. Award Notice
Congratulations on your research award! As a recipient of external funding to support your research, you are responsible for the proper conduct and management of your project to ensure compliance with sponsor requirements.

Please be aware that federal sponsors have implemented data management policies with which you must comply. While the policies vary, they all require you to deposit publications in your sponsor's designated repository and most require you to deposit data in an appropriate, publicly accessible repository, such as Digital Commons. Please note that data storage on a locally-based server or machine will not meet sponsor requirements.

- Please take time to carefully review your sponsor's data management requirements, the terms outlined in your award notice, and any governing sponsor policies to ensure compliance. A summary of sponsor-specific data requirements can be found https://datamanagement.usu.edu/agency-requirements/data.

Before your award can be set-up at USU, you must provide Sponsored Programs with either a copy of the project's approved Data Management Plan (DMP) or a complete USU Primary Metadata Document (PMD), which you can access at http://rgs.usu.edu/spo/forms/. Once Sponsored Programs receives the DMP or PMD from you, we will set-up your award and provide USU's Merrill-Cazier Library with the information it needs to create a publicly accessible master record for your publications and data in Digital Commons.

If you have any questions about your data management obligations, please contact Betty Rozum in the Merrill-Cazier Library (betty.rozum@usu.edu; 7-2632).

We look forward to assisting you.

2. Interim Notice
This message serves as a friendly reminder that federal sponsors have implemented data management policies with which you must comply as part of your active federal award. To ensure compliance with this regulation, USU strongly recommends that you regularly update the USU Primary Metadata Document (PMD) associated with your award. You can access the PMD at http://rgs.usu.edu/spo/forms/. Please complete it and send it to sponsoredprograms@usu.edu.

If you have any questions about your data management obligations, please contact your Sponsored Programs representative. For questions related to your PMD, please contact Sponsored Programs (sponsoredprograms@usu.edu); 7-1226), or Betty Rozum in the Merrill-Cazier Library (betty.rozum@usu.edu; 7-2632).

3. Closeout Notice
Data and Publications
All data and publications that result from your award must be deposited according to the policies of the

Federal sponsor. At this time, you must provide Sponsored Programs with an update to the USU Primary Metadata Document (PMD) associated with your award and let us know if you have deposited all data and publications in compliance with the Federal sponsor's requirements.

We realize some data and publications may be deposited and/or published after award closeout. Please notify Sponsored Programs (sponsoredprograms@usu.edu) if you anticipate producing any data or publications after closeout. If data or publications will be produced after closeout, Sponsored Programs will send you reminders to update your Primary Metadata Document (PMD) until all data and publications have been deposited in compliance with the Federal sponsor's requirements.

If you have any questions about your data management obligations, please contact your Sponsored Programs representative. For questions related to your PMD, please contact Betty Rozum in the Merrill-Cazier Library (betty.rozum@usu.edu; 7-2632).

Figure 1. Primary Metadata Document (PMD)

Constant Data- Fill out at time of award	
1st Author/Researcher listed (Principal Investigator)	
Title/Name assigned to grant	
Place where data originated	
Primary institution name	
Project start and stop dates	
Granting Agency, grant award	
Subject of research data	

Agency Progress and Final Report Location (URL) (for example, USDA REEport site)	

FILL THIS OUT AFTER YOUR FIRST PUBLICATIONS OR DATA ARE DEPOSITED

Publications	
Publication Citations (repeatable)	

Data Deposited (or Other Associated Data)	
Title/Name assigned to data set	
Description (100 word limit)	
URL or DOI for location of	
Year of publication/deposit	
File type (ex. Txt,XML,PDF)	
Is a special program or software needed to access this data ? If yes what is it?	
Link to associated Journal Article (repeatable)	

Title/Name assigned to data set	
Description (100 word limit)	
URL or DOI for location of	
Year of publication/deposit	
File type (ex. Txt,XML,PDF)	
Is a special program or software needed to access this data ? If yes what is it?	
Link to associated Journal Article (repeatable)	

Title/Name assigned to data set	
Description (100 word limit)	
URL or DOI for location of	
Year of publication/deposit	
File type (ex. Txt,XML,PDF)	
Is a special program or software needed to access this data ? If yes what is it?	
Link to associated Journal Article (repeatable)	

Figure 2. Workflow Diagram

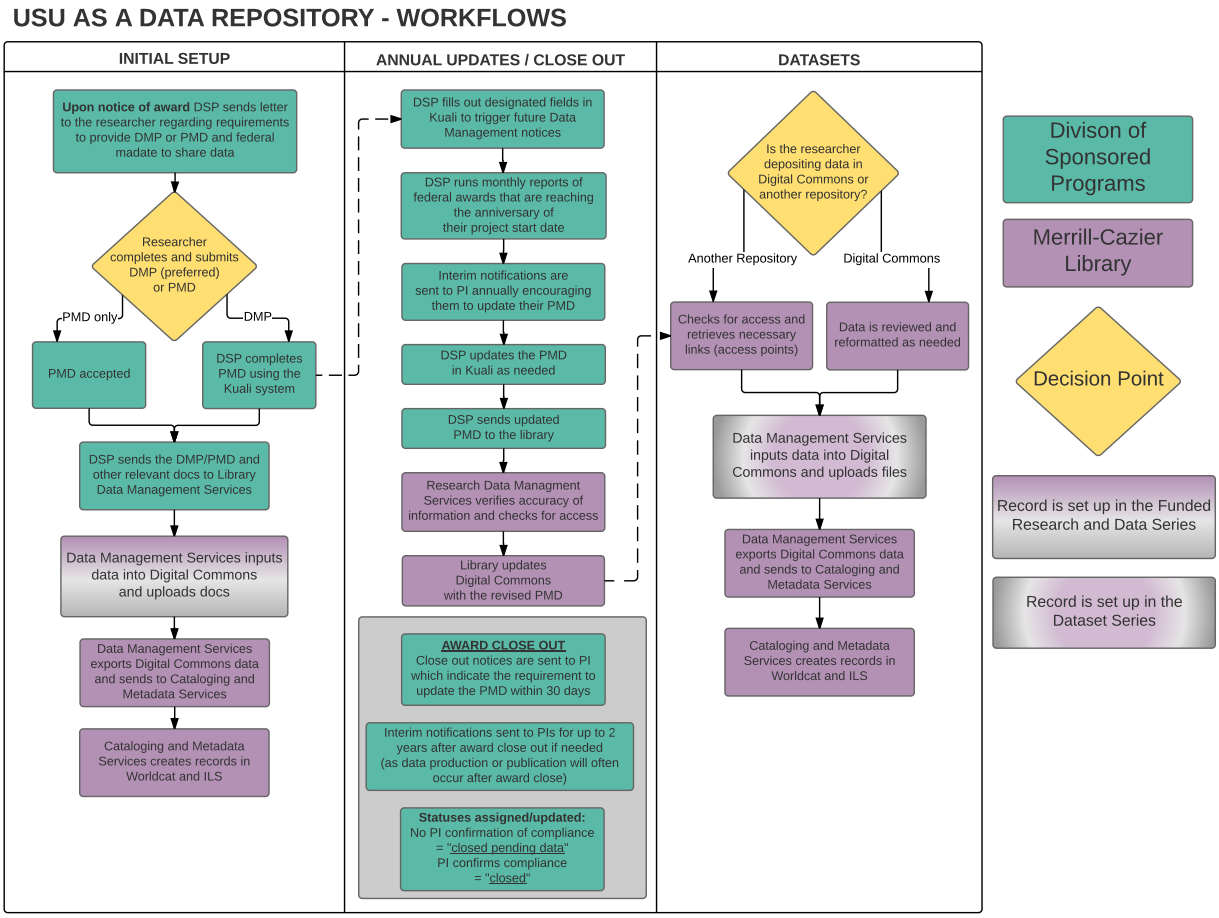

Figure 3. Digital Commons metadata fields crosswalked to MARC, Funded Research Series

Digital Commons Metadata	MARC Mapping	Field Description
author1	100	1st Author/Researcher listed
title	245 $a	Title/Name assigned to award
author1, author2, etc.	245 $c	All authors/researchers listed
publisher	264 $b	Indicate Utah State University as the publisher
publication date	264 $c	Year of publication/deposit
file format	347 $b	Digital characteristics - file type (input "PDF" for all awards)
award title	500	Include the name of the funding award
funder	536 $a / 710 $a	Name of funding agency
award number	536 $ac	Grant award number
open with	538	Include information about the characteristics of the files, noting mode of acccess, softward or computer access.
keywords	690	Local keywords supplied, if any. Include one consistent subject term "Utah State University--Research dataset"
author2, etc.	700	Name(s) of additional researchers
isni	710 $0	Identifier for the funding agency, as listed in ISNI.
fundref	710 $0	Identifier for the funding agency, as listed in CrossRef. Must be in http protocol without additional text.
agency report	856 $u	Link to the agency report for this grant
Digital Commons DOI	856 $u	URL for the Digital Commons record (minted URI)

Figure 4. Digital Commons metadata fields crosswalked to MARC, Datasets Series

Digital Commons Metadata	MARC Mapping	Field Description
author1	100	1st Author/Researcher listed
Title	245 $a	Title/Name assigned to data set
author1, author2, etc.	245 $c	All authors/researchers listed
publisher	264 _ 2 $b	Indicate where the data set is housed as the distributor
publication date	264 $c	Year of publication/deposit
file format	347 $b	Digital characteristics - file type, refer to the file extension
award title	500	Include the name of the funding award.
comments	500	Additional information about the data set or related publications
abstract	520	Include any summary information about the content of the dataset, such as an abstract.
funder	536 $a / 710 $a	Name of funding agency
award number	536 $c	Grant award number
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isni	710 $0	Identifier for the funding agency, as listed in ISNI. Must be in http protocol without additional text.
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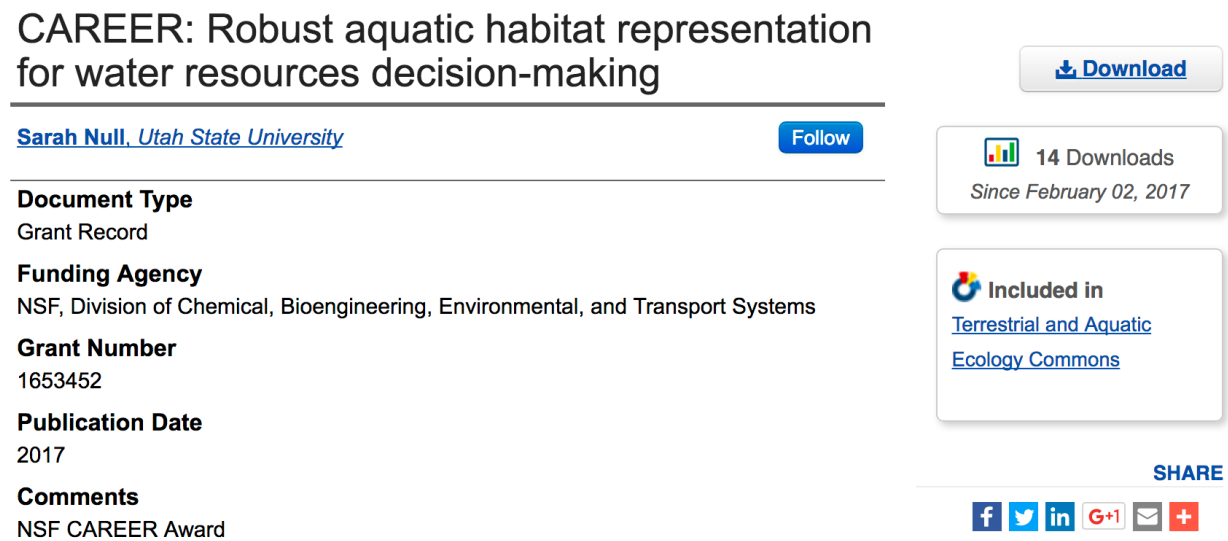
Figure 5. Records from DigitalCommons@USU for a federal award



CAREER: Robust aquatic habitat representation for water resources decision-making

Sarah Null, *Utah State University* Follow

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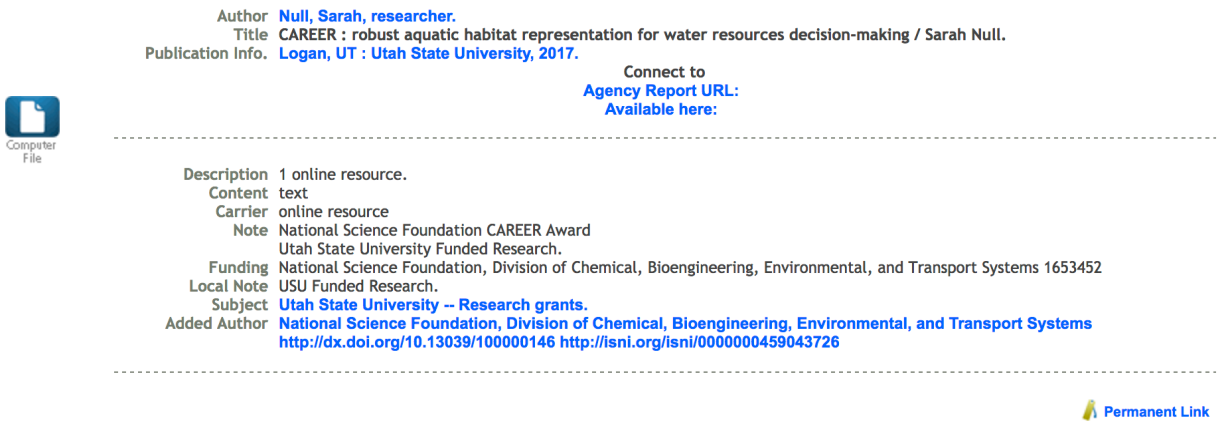

Author Null, Sarah, researcher.
Title CAREER : robust aquatic habitat representation for water resources decision-making / Sarah Null.
Publication Info. Logan, UT : Utah State University, 2017.

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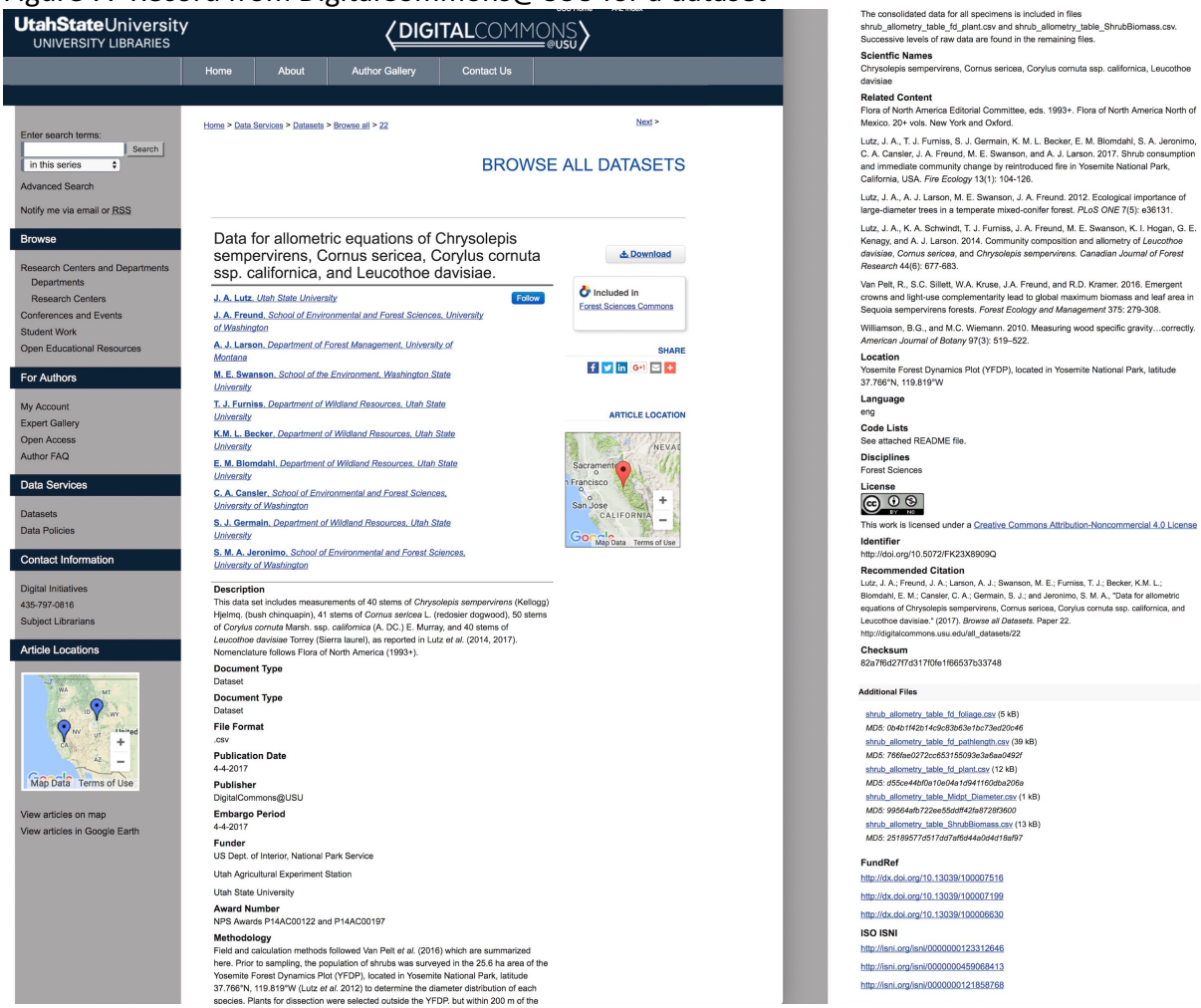

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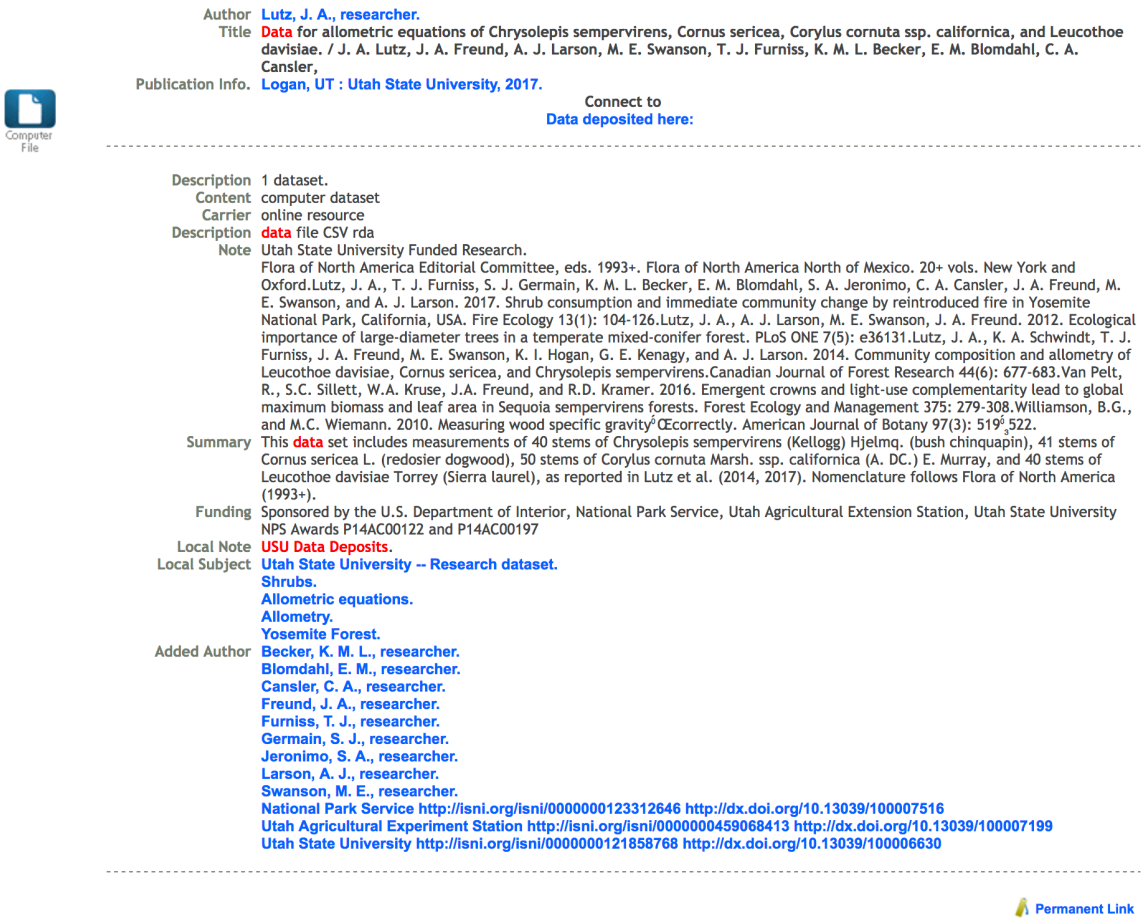

Author Lutz, J. A., researcher.
Title Data for allometric equations of Chrysolepis sempervirens, Cornus sericea, Corylus cornuta ssp. californica, and Leucothoe davisiae. / J. A. Lutz, J. A. Freund, A. J. Larson, M. E. Swanson, T. J. Furniss, K. M. L. Becker, E. M. Blomdahl, C. A. Cansler,
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Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 20+ vols. New York and Oxford.Lutz, J. A., T. J. Furniss, S. J. Germain, K. M. L. Becker, E. M. Blomdahl, S. A. Jeronimo, C. A. Cansler, J. A. Freund, M. E. Swanson, and A. J. Larson. 2017. Shrub consumption and immediate community change by reintroduced fire in Yosemite National Park, California, USA. Fire Ecology 13(1): 104-126.Lutz, J. A., A. J. Larson, M. E. Swanson, J. A. Freund. 2012. Ecological importance of large-diameter trees in a temperate mixed-conifer forest. PLoS ONE 7(5): e36131.Lutz, J. A., K. A. Schwindt, T. J. Furniss, J. A. Freund, M. E. Swanson, K. I. Hogan, G. E. Kenagy, and A. J. Larson. 2014. Community composition and allometry of Leucothoe davisiae, Cornus sericea, and Chrysolepis sempervirens.Canadian Journal of Forest Research 44(6): 677-683.Van Pelt, R., S.C. Sillett, W.A. Kruse, J.A. Freund, and R.D. Kramer. 2016. Emergent crowns and light-use complementarity lead to global maximum biomass and leaf area in Sequoia sempervirens forests. Forest Ecology and Management 375: 279-308.Williamson, B.G., and M.C. Wiemann. 2010. Measuring wood specific gravity Œcorrectly. American Journal of Botany 97(3): 519–522.
Summary This data set includes measurements of 40 stems of Chrysolepis sempervirens (Kellogg) Hjelmq. (bush chinquapin), 41 stems of Cornus sericea L. (redosier dogwood), 50 stems of Corylus cornuta Marsh. ssp. californica (A. DC.) E. Murray, and 40 stems of Leucothoe davisiae Torrey (Sierra laurel), as reported in Lutz et al. (2014, 2017). Nomenclature follows Flora of North America (1993+).
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Yosemite Forest.
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