Today's Date: 14 December 2017

Date of Next Status Update Report:

Date of Work Plan Approval: 06/05/2018

Project Completion Date: 30 June 2021

Does this submission include an amendment request? No

PROJECT TITLE: Minnesota Biodiversity Atlas - Phase 2

Project Manager: George Weiblen

Organization: University of Minnesota

College/Department/Division: Bell Museum of Natural History, College of Food, Agricultural and Natural Resource Sciences

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Location: Statewide

Total Project Budget: $350,000

Amount Spent: $0

Balance: $350,000

Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03c

Appropriation Language: $350,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to expand the biodiversity atlas project by adding more than 800,000 records and images of Minnesota wildlife, plants, and fungi, including observations from state agencies and other museum collections, to enhance research, guide field surveys, and inform conservation planning. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

I. PROJECT STATEMENT:

We propose to double the size of a natural resource management tool, the Minnesota Biodiversity Atlas, by including state agency observations and specimen records from four additional museum collections.
The Minnesota Biodiversity Atlas (http://bellatlas.umn.edu/) is a publically accessible web application that enables users to map species distributions, create species checklists, view digital images, and search records. Phase I of this ENRTF project made accessible 630,000 records and 250,000 high-resolution digital images of Bell Museum specimens. In Phase II we propose to add:
• 300,000 observation records of animals and plants from the Minnesota Biological Survey (DNR MBS)
• 365,000 records of invertebrates and wetland plants from the Minnesota Pollution Control Agency (MPCA)
• 35,000 plant and animal specimen records from the University of Minnesota at Duluth (UMD)
• 35,000 bird and mammal specimen records from the Science Museum of Minnesota (SMM)
• 30,000 plant specimens from the College of St. Benedict/St. John's University (CSB/SJU)
• 15,000 plant specimens from Mankato State University (MANK)
• a mobile device application providing access to 1.4 million records in the field
As the state natural history museum, the Bell Museum has a statutory mandate to produce, preserve, and make biodiversity data available to the public. The Atlas complements the new Bell Museum and Planetarium in Saint Paul by serving these data online. The information is used by natural resource professionals (DNR & MPCA), educators, and the general public for activities including:
• accurate identification of species in the field (vegetation assessment, rare plant and animal surveys)
• checklists for user-defined areas (training, education, field surveys)
• species distribution maps (restoration planning, management, conservation)
The Atlas is currently limited to Bell Museum data including specimens collected by DNR and MPCA. **This work plan will make additional expert observations of DNR and MPCA accessible through the Atlas. It will also integrate other natural history collections in Minnesota. Lastly, it will expand the reach of the Atlas data by developing a mobile smart device application for offline use in the field.** With phase II, natural resource professionals will have at their fingertips an integrated data source for biodiversity collections and observations. Expanding the Atlas database and adding mobile functionality will increase accessibility to the biodiversity data that serves resource managers, professionals, educators, and citizens alike.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 31, 2019
Second Update January 31, 2020
Third Update January 31, 2021
Final Report between June 30 and August 15, 2021

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Add Expert Observations to the Minnesota Biodiversity Atlas

Description: We will expand the Atlas by adding expert observational data from the DNR MBS and the MPCA Environmental Analysis & Outcomes Division. MPCA surveys have accumulated observations of 100,000 fish, 240,000 stream and wetland macroinvertebrates, and 25,000 wetland plants. MBS survey data include more than 200,000 plant observations and 100,000 observations of birds, reptiles, amphibians, mammals, fish, mollusks and invertebrates. None of these digital records are publicly accessible online and together will dramatically improve the resolution of species distribution maps for Minnesota.
Under the supervision of Minnesota Supercomputing Institute (MSI) project manager Michael Milligan, programmer Tom Prather will implement the Atlas functionality for hosting observation records using the open source code base of Symbiota (http://symbiota.org/docs/). A graduate student assistant supervised by Bell

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Museum curators will map data from agency partners to the Atlas data model. Observational data will be uploaded to the Atlas by Prather, checked for quality by the curatorial assistant, and released publicly through the Biodiversity Atlas server within the first year of the project. Prather will commit 10% of his effort to this component of the project.

In preparation for the rollout of the observational records, we will actively seek feedback from agency partners and resource professionals through email invitations and meetings. We will work with our development team to adjust functionality and design details to maximize the utility of the product. Locality details for threatened and endangered species will be hidden from public view, with permissions for registered users granted by curators upon request. Once public data release has been made, we will seek additional feedback and re-optimize as necessary. We will communicate to registered users in how to make use of observational records in conjunction or apart from specimen records (see Section 5: Dissemination, below).

ENRTF BUDGET: $47,000

Outcome	Completion Date
1. Implementation of Atlas expert observation functionality	October 2018
2. Data mapping, uploading, & quality assurance for 665,000 observations	April 2019
3. Release of observation data to professionals for comment and public use	June 2019

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ACTIVITY 2: Add records from participating natural history collections in greater Minnesota

Description: We will expand the Atlas to include specimens housed in the Science Museum of Minnesota, University of Minnesota Duluth, Mankato State, and St. Benedict/ St. John's. Together, these collections comprise 160,000 specimen records of Minnesota plants and animals that are not yet online, and will expand the current Atlas to a total of 790,000 specimens. We will digitally photograph plant specimens, animal specimen labels and their accompanying documentation. Text from label images will be transcribed using the Biodiversity Atlas.

Image capture begins with retrieval and organization of the specimens from museum cabinets and drawers. Specimens are organized according to taxonomic group (e.g. families, genera, and species) and referenced according to a unique accession number that was assigned to the specimen at the time it was deposited in a museum collection. Accession numbers are located on the label documentation that accompanies each specimen. The next step is to associate a numerical barcode with each accession. Pre-printed barcode labels are affixed to the specimen label and captured digitally using a hand-held barcode scanner. If a specimen accession consists of multiple prepared objects stored separately (e.g. feathers, bones, eggs), unique barcodes are assigned to each object under the same accession number. Specimen labels (and specimens in the case of plants) are placed in a digital imaging station, photographed, and digital image files are named using the hand-held barcode scanner. Digital imaging stations include a lighted copy stand equipped with a neutral background, ruler, and color reference palate, and a digital SLR camera.

Sets of raw images (approx. 40 MB each) are processed in bulk using Photoshop Lightroom for quality, consistency, and generation of smaller JPEG files (approx. 5 MB). Smaller image files and corresponding associations between barcodes and accession numbers are then uploaded to the Symbiota server for

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transcription of specimen label data (often hand-written) into the database. The larger raw image files and associated data will be provided to University Libraries for archival digital preservation.

Image capture will continue as necessary throughout the course of the grant. Under the supervision of curatorial staff and a graduate curatorial assistant, undergraduate employees will capture images using two high resolution imaging systems already purchased by the University. The herbarium sheets and consequently their images include a barcode that is linked directly to the electronic image file. Subsequent to capture, internet-servable versions of these images will be made available through the Atlas portal. In addition, under the supervision of John Butler and Jon Nichols, high quality versions of these images will be stored and brought under preservation management in the digital archiving system of University of Minnesota Libraries,, which will provide: (1) a highly stable image" back up" in case of data loss, and 2) a digital "back up" of the museum specimen herbarium sheet, and (3) preservation of metadata.

Equipment and protocols will be deployed to University of Minnesota Duluth where Amanda Gruz will supervise the digitization of 35,000 museum specimens at UMD. The Bell Museum plant digitization manager will train the UMD digitization manager in the use of the equipment and protocols, who will then oversee the employment of UMD undergraduate assistants to carry out the steps described above.

The Bell Museum plant digitization manager will train Steven Saupe of College of Saint Benedict & Saint John's University and Matthew Kaproth of Mankato State University in Atlas database protocols. 30,000 CSB/SJU specimens and 11,000 MANK specimens will be loaned to the Bell Museum where CSB/SJU and MANK students recruited by the Bell Museum for summer internships will complete digitization. The Bell Museum plant digitization manager will oversee the student summer interns and return the loan of specimens upon completion of the work.

Equipment and protocols will also be deployed to the Science Museum of Minnesota where Laurie Fink will supervise the digitization of 35,000 museum specimens at SMM. The Bell Museum plant digitization manager will train the SMM digitization manager in the use of the equipment and protocols, who will then oversee the employment of SMM interns to carry out the steps described above. Undergraduate students from the University of Minnesota will be recruited by the Bell Museum and paid as SMM interns, providing an immersive learning experience in a professional museum setting.

ENRTF BUDGET: $256,000

Outcome	Completion Date
1. Digitization of UMD, CSB/SJU, MANK & SMM specimens	June 2020
2. UMD, CSB/SJU, MANK & SMM images and records published to the Atlas	June 2021

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ACTIVITY 3: Create a customizable, mobile field Atlas that can be used anywhere
Description: Natural resource professionals often require specimen images and data to identify species in the field or to determine whether a species is known from a particular area. The Atlas will be adapted for use on smart devices to serve as a portable field guide to Minnesota biodiversity with species lists and images. Since the complete Atlas is much too large for most mobile devices (phones or tablet computers), we will develop an application allowing users to download data and sets of images customizable by location or species similar to using Google maps offline in low data coverage areas.

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Tom Prather at the Minnesota Supercomputing Institute will modify Symbiota source code to develop an offline version of the application, named Symbiota Mobile. The functionality of the Biodiversity Atlas will be expanded to include an option to download a package of checklists, record sets, images, and coordinates for a user-defined area prior to leaving coverage. Data packages will be readable by Symbiota Mobile for searching, mapping, and viewing images of records. The graduate student curatorial assistant will work with Prather to test the application prior to beta-testing by agency partners and other natural resource professionals.

ENRTF BUDGET: $47,000

Outcome	Completion Date
1. Development of Symbiota code for data download to a hand-held application	June 2019
2. Beta-testing in the field of the offline Symbiota extension	June 2020
3. Release of the mobile, offline field guide to Minnesota's biodiversity data	June 2021

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IV. DISSEMINATION: Raising awareness of the Minnesota Biodiversity Atlas

Description: The results of this project will be communicated to three primary audiences by different means. First, we will continue to promote the availability of images and records through Bell Museum programming, the website, and an interactive kiosk in the main exhibit of the new Bell Museum. We specifically target audiences including educators, naturalists (e.g. participants in the Minnesota Master Naturalist program), paraprofessionals and hobbyists (Minnesota Native Plant Society, Minnesota Herpetological Society, Minnesota Ornithologists' Union). During phase I of the project, we recruited a volunteer group of 60 citizen scientists who participate in Mapping Change, a crowd-sourced Zooniverse project dedicated to transcription of museum specimen labels that ultimately find a home in the Atlas. In phase II, we will expand group with through training sessions. Volunteers become advocates for the Atlas, promoting its use in outdoor recreation, education, and natural resource management. Second, we will announce the first-ever publication of state agency biodiversity observation records through a University News Service press release in coordination with agency partners. Lastly, we will demonstrate the use of the Atlas to targeted user groups (DNR staff, MPCA staff, natural resource consulting agencies, state colleges and University, K-12 educators) through email announcements and workshop activities. The launching of the new Bell Museum in Saint Paul has increased public awareness of our state's official museum of natural history. The Atlas compliments our new facility by providing 24-7 access to the collections for virtual visitors across the state.

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V. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview: See attached budget spreadsheet

Explanation of Capital Expenditures Greater Than $5,000: Two digitization stations for capture of data and images of 35,000 specimens at SMM and 35,000 specimens at UMD. Each station includes a digital SLR camera,

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a lightbox, and a barcode reader connected to a computer system with image processing software. The computer system is dedicated to image acquisition and processing for the sole purpose of completing the project. ($5,000 each).

Explanation of Use of Classified Staff: NA

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 14,600	Divide by 2,080 = TOTAL FTE: 7.0

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 1,500	Divide by 2,080 = TOTAL FTE: 0.7

B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe
Other Non-State $ To Be Applied To Project During Project Period:			
Other State $ To Be Applied To Project During Project Period:			
Bell Museum (University of Minnesota): curatorial effort including Barker, Jansa, Kozak, Simons, Weiblen, & Ya at 3% FTE and Gruz (UMD) at 3% for each for three years. Includes 3% base salary per annum plus 36% fringe.	$ 88,000	$ 0	Pending through 2021
University of Minnesota Libraries: management and coordination by J. Nichols at 3% for each of three years and digital preservation services (10TB) at $6,500 per year.	$ 31,000	$ 0	Pending through 2021
Past and Current ENRTF Appropriation:			
Integrating Minnesota's biodiversity data: a comprehensive, dynamic atlas	$ 340,000	$ 236,000	Ending June 2018
A computerized database for plants of Minnesota	$ 130,000	$ 130,000	Completed 1993
Improved Minnesota fungus collection and database	$ 79,000	$ 79,000	Completed 2001
Other Funding History:			
Hatch, National Institute of Food and Agriculture: Georeferencing of woody plant collection	$ 30,000	$ 30,000	Completed 2014
NSF: Digitization of Bell bryophyte collection	$ 74,000	$ 74,000	Completed 2015
NSF: Digitization of Bell macrofungi collection	$ 105,000	$ 105,000	Completed 2016

NSF: Digitization of Bell microfungi collection	$ 74,000	$ 74,000	Ending June 2018
NSF: Digitization of aquatic invasive species from Bell fish and plant collections	$ 46,000	$ 46,000	Ending June 2018

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Michael Mulligan	Project Manager	Minnesota Supercomputing Institute	Supervisor of application development and web services
Tom Prather	Developer	Minnesota Supercomputing Institute	Developer of applications and developer Atlas expansion
TBD	Plant Digitization Manager	Bell Museum	Coordinator of multi-institutional digitization

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
George Weiblen	Science Director	Bell Museum	Principal investigator
Keith Barker	Curator	Bell Museum	Co-principal investigator
Sharon Jansa	Curator	Bell Museum	Co-principal investigator
Ken Kozak	Curator	Bell Museum	Co-principal investigator
Ya Yang	Curator	Bell Museum	Co-principal investigator
Andrew Simons	Curator	Bell Museum	Co-principal investigator
Jon Nicols	Librarian	University of Minnesota Libraries	Co-principal investigator
Laurie Fink	Vice President of Science	Science Museum of Minnesota	Co-principal investigator
Amanda Gruz	Professor	University of Minnesota Duluth	Co-principal investigator
Stephen Saupe	Professor	College of Saint Benedict/Saint John's University	Co-principal investigator
Matthew Kaprok	Professor	Mankato State University	Co-principal investigator
Bruce Carlson	Minnesota Biological Survey Supervisor	Minnesota Department of Natural Resources	Collaborator & data provider
Hannah Texler	Plant Survey Supervisor	Minnesota Department of Natural Resources	Collaborator & data provider
Michael Bourdaghs	Environmental Research Scientist	Minnesota Pollution Control Agency	Collaborator & data provider
John Sandberg	Environmental Research Scientist	Minnesota Pollution Control Agency	Collaborator & data provider

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

Expansion of the Minnesota Biodiversity Atlas will be of immediate, practical use to a diverse community of managers and scientists including field workers, ecologists, conservation planners, and policy-makers, as described above. The Bell Museum and the Minnesota Supercomputing Institute are committed to long-term maintenance of this tool as part of ongoing, collaborative relationships with statewide academic institutions, museums, and agency partners. We are

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supported in this effort by the UMN Libraries, who will host the image data from this project according to archival standards. Outcomes from this LCCMR-funded work will continue leverage federal grant proposals to the US National Science Foundation for improving knowledge, management and use of Minnesota's biodiversity.

VIII. REPORTING REQUIREMENTS:

- **The project is for 3 years, will begin on 07/01/2018, and end on 06/30/2021.**
- **Periodic project status update reports will be submitted 01/31 and 06/30 of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2021.**

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

    A. Budget Spreadsheet
    B. Visual Component or Map
    C. Parcel List Spreadsheet NA
    D. Acquisition, Easements, and Restoration Requirements NA
    E. Research Addendum NA

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Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2018 Budget Spreadsheet

Project Title: Minnesota Biodiversity Atlas - Phase 2
Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03c
Project Manager: George Weiblen
Organization: University of Minnesota
College/Department/Division: CFANS-Bell Museum
M.L. 2018 ENRTF Appropriation:
Project Length and Completion Date: 3 years/ June 30, 2021
Date of Report: February 18, 2018

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits) - Overall	$328,000	$0	$328,000
Atlas development supervisor (75% salary, 25% fringe) 5% FTE for 3 years (Total: 15% FTE) (Total estimated amount - $18,000)			
Atlas developer (75% salary, 25% fringe) 10% FTE for 3 years (Total: 30% FTE) (Total estimated amount - $45,000)			
Plant digitization manager (67% salary, 33% fringe) 13.5% FTE for years 2 and 3 (Total: 27% FTE) (Total estimated amount - $18,000)			
Mankato State student digitizer interns at UMN ($10/hour, $1/specimen, 10 specimens/hour, 11,000 specimens): 2 Students (Total estimated amount - $11,000)			
College of Saint Benedict/Saint John's University summer digitizer interns at UMN ($10/hour, $1/specimen, 10 specimens/hour, 30,000 specimens): 6 Students (Total estimated amount - $30,000)			
Undergraduate student digitizers (UMN interns at SMM) ($10/hour, $1/specimen, 10 specimens/hour, 35,000 specimens): 6 students (Total estimated amount - $35,000)			
Undergraduate student digitizers (UMD) ($10/hour, $1/specimen, 10 specimens/hour, 35,000 specimens): 6 Students (Total estimated amount - $35,000)			
Graduate curatorial assistant (43% salary, 57% fringe) 25% FTE for years 2 and 3 (Total: 50% FTE) (Total estimated amount - $22,500)			
Science Museum of Minnesota digitization manager (59% salary, 41% fringe) 35% FTE for years 2 and 3 (Total: 70% FTE) (Total estimated amount - $41,000)			
University of Minnesota-Duluth digitization manager (79% salary, 21% fringe) 35% FTE for years 2 and 3 (Total: 70% FTE) (Total estimated amount - $33,000)			
Professional/Technical/Service Contracts	$10,000	$0	$10,000
Data hosting at MSI (3TB/year at $750/year) (Total estimated amount $2,000)			
Server support at MSI ($2,600/year)(Total estimated amount $8,000)			

Equipment/Tools/Supplies			
140,000 specimen barcode labels (50,000 SMM; 10,000 MANK; 30,000 CSB/SJU; 50,000 UMD)	$1,000	$0	$1,000
Capital Expenditures Over $5,000			
Two digitization stations for capture of data and images of 35,000 specimens at SMM and 35,000 specimens at UMD. Each station includes a digital SLR camera, a lightbox, and a barcode reader connected to a computer system with image processing software. The computer system is dedicated to image acquisition and processing for the sole purpose of completing the project. ($5,000 each)	$10,000	$0	$10,000
Other			
specimen shipping costs (MANK and CSB/SJU to UMN and return)	$1,000	$0	$1,000
COLUMN TOTAL	$350,000	$0	$350,000