Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2015 Work Plan

Date of Report: 15 October 2015

Date of Next Status Update Report: 31 December 2015

Date of Work Plan Approval:

Project Completion Date: 30 June 2018

Does this submission include an amendment request? __

PROJECT TITLE: Minnesota Biodiversity Atlas for Enhanced Natural Resource Management

Project Manager: Keith Barker

Organization: Bell Museum of Natural History, University of Minnesota

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Location: Statewide

Total ENRTF Project Budget:	ENRTF Appropriation:	$340,000
	Amount Spent:	$0
	Balance:	$340,000

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 03d

Appropriation Language:
$340,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Bell Museum of Natural History to create a publicly accessible, online tool and repository that will electronically integrate over 600,000 existing biodiversity records, 300,000 existing images, and future data and associated imagery pertaining to Minnesota wildlife, plant, and fungi species in order to enhance research, guide field surveys, and inform conservation planning. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

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I. PROJECT TITLE: Minnesota Biodiversity Atlas for Enhanced Natural Resource Management

II. PROJECT STATEMENT:

We will create a resource management tool, the Minnesota Biodiversity Atlas. This online, searchable interface will integrate an extensive set of data (over 600,000 records) on birds, mammals, fishes, plants, and fungi, and associated imagery (up to 300,000 high-resolution digital photographs). This interface will enhance agencies' capacity to perform a range of activities from biological surveys to conservation planning. As Minnesota's State Natural History Museum, it is our statutory mandate to preserve and make available all of our biodiversity data, including historic and ongoing contributions (both specimens and data) from the Bell Museum as well as from agency partners like the Minnesota Biological Survey and the Minnesota Pollution Control Agency. These critical data, including ~30,000 high-resolution digital photographs and more than 250,000 records currently ready to be loaded into the system, as well as nearly 450,000 currently inaccessible Bell Museum records, are the basis for the tool we seek to create.

Our agency partners have many information needs both at the office and in the field. For instance, the Minnesota Department of Natural Resources (in particular the Biological Survey) requires: 1) accurate species lists, 2) specimens confirming the identity and distribution of species, and 3) distribution data for species of critical concern and for invasive species for use in conservation planning. The Biodiversity Atlas will serve these and other needs by integrating Bell Museum and agency data into a single, easily usable tool. This tool will provide users with species lists for any geographic area based on the latest and most accurate information. Specimen imagery will allow agency biologists to check identifications and verify distributional details from the office or the field at any time, without the constraints of visiting the Bell Museum collections during business hours. Finally, updates to our specimen databases done as part of this project will allow creation of the most complete distribution information for both current and future species of conservation concern. These are critical data for planning of species recovery and management, and for environmental impact assessment.

The Pacific Northwest Herbarium (http://www.pnwherbaria.org/) illustrates what is possible but not currently available for Minnesota. This web interface enables users to search for distribution maps of plants or browse digital images and historic records from across their region. Although similar specimen data for Minnesota birds, mammals, fishes, amphibians, reptiles, fungi, and plants are stored in the Bell Museum and in cooperating agency databases, a large portion of these data are not currently available, need to be digitized, and have not been integrated into a single comprehensive source. This project will improve access to biodiversity data by making them instantly and directly available online through a tool easily usable by resource managers, researchers, and citizens alike. Once constructed, this tool will also enable future integration of data from other providers (e.g., the UMN Duluth Herbarium, MN Breeding Bird Atlas).

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of December 31, 2015**:**

Project Status as of June 30, 2016**:**

Project Status as of December 31, 2016**:**

Project Status as of June 30, 2017**:**

Project Status as of December 31, 2017**:**

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

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ACTIVITY 1:

Description: Creation of the Minnesota Biodiversity Atlas, a tool for management

We will create a centralized, online Atlas of Minnesota's biodiversity. This point of access to Minnesota animal, fungal, and plant data will integrate diverse sources of information in ways never before possible. Among other functions (see above), this Atlas will be used to: 1) dynamically generate species checklists for user defined areas, 2) create distributions of individual species over time and across the state, 3) access a rich library of imagery and species information pages (including descriptions, classification, distribution maps, field images, etc.), and 4) assist in specimen identification using interactive keys.

Under the supervision of MSI supervisor Benjamin Lynch and in collaboration with Bell Museum curatorial staff and Symbiota software developers, MSI programmer Tom Prather will implement the above Atlas functionalities using the open source code base of Symbiota (http://symbiota.org/docs/). The Atlas will be made available on University servers within 8 months of the start of scheduled work (i.e. by April 2016). Prather will commit 35% of his time to this project (as well as developing the crowdsourcing portion of the project under Activity 3, see below) during the first year (July 2015-June 2016), then 20% of his time during the second year (divided between troubleshooting the Atlas codebase and continued work on crowdsourcing), and 5% during the last year (primarily focused on troubleshooting and streamlining future maintenance), for a total of 60% FTE over three years. We have also budgeted for ongoing development support by the Symbiota project, to facilitate adaptation of existing code to our implementation, as well as to support integration of new code developed by our project into the Symbiota code base. In addition, we will train an MSI help staff contact (Tom McGowan) in use of the Atlas, in order to handle user questions and manage software problems and complaints.

In preparation for the Atlas rollout, we will actively seek feedback on beta test versions from government and other partners through email surveys, one on one interviews, and meetings with partner agency managers. As necessary, we will work with our development team to adjust functionality and design details to maximize the utility of this product. Once a full release has been made, we will seek additional feedback and reoptimize as necessary. We will work with Atlas partners to train staff in the functionalities and use of the Atlas (see Section 5: Dissemination, below).

Summary Budget Information for Activity 1:	**ENRTF Budget:** $ 104,607
	Amount Spent: $ 0
	Balance: $ 104,607

Outcome	Completion Date
1. Integrated access to >250,000 records and >30,000 images currently on hand	*April 2016*
2. Integrated access to >600,000 records and ~300,000 images	*June 2018*

Activity Status as of December 31, 2015**:**

Activity Status as of June 30, 2016**:**

Activity Status as of December 31, 2016**:**

Activity Status as of June 30, 2017**:**

Activity Status as of December 31, 2017**:**

Final Report Summary:

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ACTIVITY 2:

Description: Creating images for biodiversity data capture, verification, and identification

Among the four million specimens housed at the Bell Museum are more than 600,000 specimens of Minnesota wildlife, plants and fungi that span the entire period from the founding of our state in 1872 to the present. Although some of the data associated with these specimens are currently available, the majority are not. We will digitally photograph specimens (primarily plants and fungi) and their accompanying documentation. These photographs will be immediately useful for online verification of identifications and locality data (e.g., verifying county occurrences); in addition, they are a critical first step in subsequent data capture (see Activity 3).

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 the Museum. 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. 8 MB). Smaller image files and corresponding associations between barcodes and accession numbers are then uploaded to the Symbiota server for translation of image documentation as described in Activity 3. The larger raw image files and associated data will be provided to University Libraries for archival digital preservation.

Image capture is ongoing, and 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 in the University Libraries' digital archiving system, which will provide: 1) a highly stable image back up in case of data loss, and 2) a digital "back up" of the physical herbarium sheet, and 3) creation and management of preservation metadata for digital collection files.

Summary Budget Information for Activity 2:   ENRTF Budget: $ 66,464
Amount Spent: $ 0
Balance: $ 66,464

Outcome	Completion Date
1. Capture and addition to the Atlas of up to 300,000 digital images	*June 2018*

Activity Status as of December 31, 2015**:**

Activity Status as of June 30, 2016**:**

Activity Status as of December 31, 2016**:**

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Activity Status as of June 30, 2017**:**

Activity Status as of December 31, 2017**:**

Final Report Summary:

ACTIVITY 3:
Description: Translating specimen documentation into digital distribution data

Generating images of specimens and accompanying documentation is only the first step in enabling access to high-quality specimen data. Documentation consists of specimen label information including the name of the collector, the date of collection, the geographic location of the collection, and other associated data. Documentation must be captured, curated, and then georeferenced (assigned latitude and longitude coordinates for subsequent distribution mapping). In the case of typed specimen labels, the Symbiota platform includes a state-of-the-art optical character recognition (OCR) and natural language processing (NLP) module that automatically processes labels images and assigns label documentation to corresponding fields in the database. This step in the process will be examined for quality and accuracy by project team members. However, much of the label documentation is hand-written where data capture will require manual transcription. Crowd-sourcing, the coordination of massive volunteer effort over the web, will accelerate this work by enabling volunteer citizen scientists to efficiently enter and verify data. Our staff will then compile the data to generate coordinates using established mapping standards. In other projects, citizen scientists have identified African wildlife, discovered new planets, and mapped the surface of the moon by interpreting images and data posted online (see http://www.zooniverse.org). Natural history museums now use these same tools to process data on birds, fungi, insects, and plants (see http://www.notesfromnature.org/#/archives).

Under the supervision of MSI supervisor Benjamin Lynch and in collaboration with Bell Museum curatorial staff, MSI programmer Tom Prather will implement the crowdsourced capture of specimen label data in collaboration with development staff at Zooniverse, as a test case for its development of an open source platform for citizen science. The crowdsourced data entry functionality will be go online within one year from the start of scheduled work (i.e. by July 2016). The use of Prather's time is detailed under Activity 1 above.

In concert with rollout of crowdsourced specimen label capture, the Bell Museum will advertise to relevant citizen scientist groups, including amateur plant and wildlife enthusiasts (e.g., Minnesota Native Plant Society, Minnesota Ornithologists' Union, Minnesota Herpetological Society), paraprofessional groups (e.g., the Minnesota Master Naturalists' Program), University and K-12 student groups, and professionals (e.g., University faculty, DNR staff) to recruit participants. As necessary, label capture efforts will be supplemented by undergraduate employee staff time (primarily budgeted for image capture under Activity 2).

As locality descriptions are captured, their latitude and longitude coordinates will be estimated by a graduate curatorial assistant (CA), as well as by undergraduate employees trained and supervised by the CA. Coordinate capture will follow accepted georeferencing standards (http://manisnet.org/GeorefGuide.html). Locality descriptors and point coordinates will be posted to the Atlas on at least a quarterly basis.

Summary Budget Information for Activity 3:   ENRTF Budget: $ 168,929
                                                          Amount Spent: $ 0
                                                              Balance: $ 168,929

Outcome	Completion Date
1. Begin crowdsourced capture of specimen label data	*July 2016*
2. Publish georeferenced coordinates for up to 325,000 specimen records to the Atlas	*June 2018*

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Activity Status as of December 31, 2015**:**

Activity Status as of June 30, 2016**:**

Activity Status as of December 31, 2016**:**

Activity Status as of June 30, 2017**:**

Activity Status as of December 31, 2017**:**

Final Report Summary:

V. DISSEMINATION:
Description:
This project requires two major dissemination activities. First, our focus on crowdsourcing of specimen label capture will require outreach to recruit potential contributors. This recruitment will be accomplished by targeted advertising through Bell Museum and University outlets to specific groups with high potential for participation: undergraduate students, secondary school students, naturalists (e.g., participants in the University master naturalist program), paraprofessionals and hobbyists (Minnesota Native Plant Society, Minnesota Herpetological Society, Minnesota Ornithologists' Union), and others. Once up and running, the Atlas itself will disseminate museum data and images directly. However, we will also advertise and demonstrate the use of the Atlas to targeted user groups (DNR staff, MNPCA staff, and others) through email announcements and hands-on workshop activities.

Status as of December 31, 2015**:**

Status as of June 30, 2016**:**

Status as of December 31, 2016**:**

Status as of June 30, 2017**:**

Status as of December 31, 2017**:**

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:
A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 316,129	The bulk of this project involves data collection and programming by paid personnel: 15% FTE development supervisor, 60% FTE developer, 14% FTE technical support, 24% FTE digital preservation and repository development, 24% FTE digital preservation analyst, 50% FTE graduate curatorial staff, and 375% FTE

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		undergraduate curatorial staff.
Professional/Technical/Service Contracts:	$ 21,000	This contract with the Symbiota Software Project will fund support of our independent software development within the Symbiota codebase, as well as troubleshooting implementation of the Atlas using Symbiota software.
Equipment/Tools/Supplies:	$ 2,871	This line supports purchase of two workstations to increase the museum's capacity for digital coordinate capture.
TOTAL ENRTF BUDGET:	$ 340,000	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000: N/A

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 6.12

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

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State			
University of Minnesota, in kind	$41,699	$0	2% FTE for curatorial staff (Barker, Bates, Cholewa, Jansa, Simons, and Weiblen) over three years
University of Minnesota, in kind	$10,236	$0	3% FTE for Libraries management and coordination (Nichols)
University of Minnesota, in kind	$25,500	$0	Library hosting of image data
TOTAL OTHER FUNDS:	**$77,435**	**$0**	

VII. PROJECT STRATEGY:
A. Project Partners:
Bell Museum curators will contribute taxonomic expertise including Scott Bates (fungi and Symbiota software management), Keith Barker (birds), Sharon Jansa (mammals), Andrew Simons (fishes), and George Weiblen (plants). Minnesota Supercomputing Institute personnel will provide database and programming expertise including Benjamin Lynch (UMN MSI project management) and Tom Prather (software development). The University of Minnesota Library will support our image archiving needs, with experts including John Butler (UMN Library project management) and library staff under his supervision. In addition, we will be working with the *Symbiota* project (http://symbiota.org/docs/) to adapt their software platform for use in the Atlas (for a total of $21,000 ENRTF dollars).

B. Project Impact and Long-term Strategy:

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The Atlas proposed here 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 Museum is committed to the creation and long-term maintenance of this tool as part of our ongoing, constructive relationship with partner agencies including the Minnesota Biological Survey and Minnesota Pollution Control Agency (see letters). We are 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 leverage grant proposals to the US National Science Foundation for improving Minnesota's biological collections.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
Hatch Fund, National Institute of Food and Agriculture: Geocoding of herbarium specimens	Current	$30,000
NSF: Digital photography of bryophyte collection	Current	$74,000
NSF: Digitization of aquatic invasive species	Current	$46,476

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S): See attached graphic.

X. RESEARCH ADDENDUM: N/A

XI. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than 31 December 2015, 30 June 2016, 31 December 2016, 30 June 2017, and 31 December 2017. A final report and associated products will be submitted between 30 June and 15 August 2018**.**

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Environment and Natural Resources Trust Fund
M.L. 2015 Project Budget

Project Title: *Minnesota Biodiversity Atlas for Enhanced Natural Resource Management*
Legal Citation: *M.L. 2015, Chp. 76, Sec. 2, Subd. 03d*
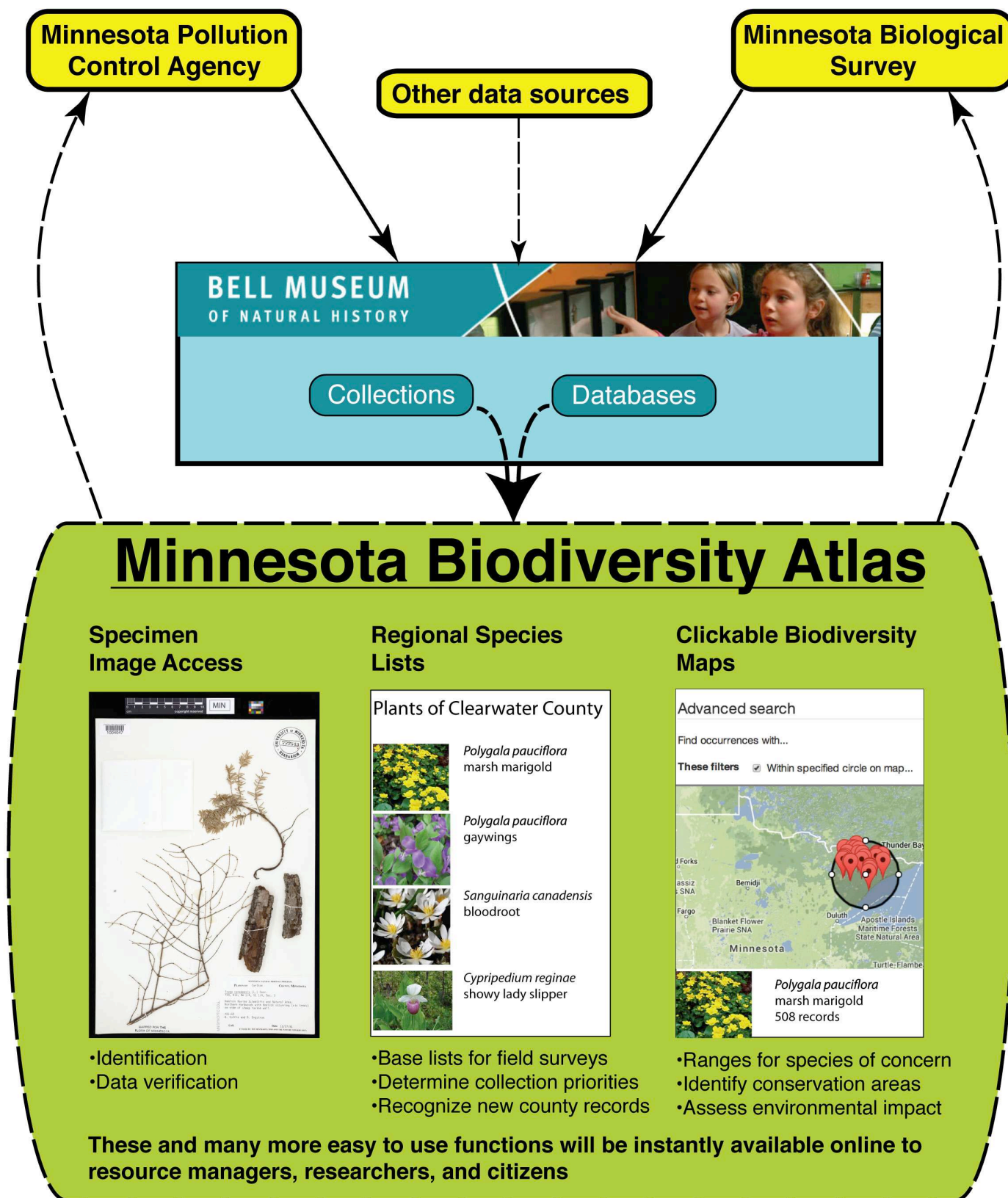**Project Manager:** *F. Keith Barker*
Organization: *Bell Museum of Natural History, University of Minnesota*
M.L. 2015 ENRTF Appropriation: *$ 340,000*
Project Length and Completion Date: *3 Years, 30 June 2018*
Date of Report: *15 October 2015*

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	*Creation of the Minnesota Biodiversity Atlas*			*Creating images for biodiversity data*			*Translating specimen documentation*				
Personnel (Wages and Benefits)	$83,607	$0	$83,607	$66,464	$0	$66,464	$166,058	$0	$166,058	$316,129	$316,129
Benjamin Lynch, Atlas Development Supervisor; $20,028 (74.7% salary, 25.3% fringe) 5% FTE for 3 years (Total: 15% FTE)											
Tom Prather, Atlas Developer; $76,837 (74.7% salary, 25.3% fringe) 20% FTE for 3 years (Total: 60% FTE)											
Tom McGowan, Atlas support specialist; $14,611 (74.7% salary, 25.3% fringe) 7% FTE for 2 years (Total: 14% FTE)											
Digital Preservation and Repository Developer; $27,295 (74.7% salary, 25.3% fringe) 8% FTE for 3 years (Total: 24% FTE)											
Digital Preservation Analyst; $20,231 (74.7% salary, 25.3% fringe) 8% FTE for 3 years (Total: 24% FTE)											
Graduate Curatorial Assistant; $75,752 (51% salary, 49% fringe) 50% FTE for 2 years (Total: 100% FTE)											
Undergraduate Curatorial Assistants; $81,375 (100% salary) 25% FTE for 3 years (Total: 375% FTE)											
Professional/Technical/Service Contracts											
Symbiota Software Support; Symbiota Software Project	$21,000	$0	$21,000	$0	$0	$0	$0	$0	$0	$21,000	$21,000
Equipment/Tools/Supplies											
Computer Workstations for Georeferencing	$0	$0	$0	$0	$0	$0	$2,871	$0	$2,871	$2,871	$2,871
COLUMN TOTAL	**$104,607**	**$0**	**$104,607**	**$66,464**	**$0**	**$66,464**	**$168,929**	**$0**	**$168,929**	**$340,000**	**$340,000**

Minnesota Pollution Control Agency

Other data sources

Minnesota Biological Survey

BELL MUSEUM OF NATURAL HISTORY

Collections   Databases

Minnesota Biodiversity Atlas

Specimen Image Access

Regional Species Lists

Plants of Clearwater County

Polygala pauciflora
marsh marigold

Polygala pauciflora
gaywings

Sanguinaria canadensis
bloodroot

Cypripedium reginae
showy lady slipper

Clickable Biodiversity Maps

Advanced search

Find occurrences with...

These filters   ☑ Within specified circle on map...

Thunder Bay

d Forks

assiz
s SNA   Bemidji

Fargo   Blanket Flower   Duluth
Prairie SNA   Apostle Islands
Maritime Forests
Minnesota   State Natural Area

Turtle-Flambe

Polygala pauciflora
marsh marigold
508 records

•Identification
•Data verification

•Base lists for field surveys
•Determine collection priorities
•Recognize new county records

•Ranges for species of concern
•Identify conservation areas
•Assess environmental impact

These and many more easy to use functions will be instantly available online to resource managers, researchers, and citizens

—— Solid lines represent existing agencies and relationships
-- -- Dashed lines represent services and relationships to be developed in the proposed work