Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2014 Work Plan Final Report Abstract

2014 Project Abstract
For the Period Ending June 30, 2016

PROJECT TITLE:	**Restoring Forest Inventory Data**
PROJECT MANAGER:	Alan R. Ek
AFFILIATION:	Department of Forest Resources, College of Food, Agricultural and Natural Resource Sciences,
MAILING ADDRESS:	University of Minnesota, 1530 Cleveland Avenue N., Rm 115
CITY/STATE/ZIP:	St. Paul, MN 55108
PHONE:	612-624-3400
E-MAIL:	aek@umn.edu
WEBSITE:	http://iic.umn.edu/project-areas/forest-inventory/historic-data
FUNDING SOURCE:	Environment and Natural Resources Trust Fund (ENRTF) Appropriation
LEGAL CITATION:	M.L. 2014, Chp. 226, Sec. 2, Subd. 05d

APPROPRIATION AMOUNT: $100,000

Overall Project Outcome and Results

Motivation and objectives: Long-term datasets have proven invaluable for understanding changing forest conditions and implications for timber supply, wildlife habitat, insect, disease, wildfire, and climate change. This history is also important to charting future investments in forest based industry, forest management and the protection of forests resources for the role they play in water quality and retention of biodiversity. The primary objective of this project was to find and restore the first (1935), second (1953) and third (1962) statewide forest inventories of Minnesota plus other forest inventory datasets we might find. A secondary object was to develop comparisons of those inventories to present day forest conditions.
Methods: The project began with review of the published literature and available notes, letters, planning and other documents) plus direct contacts with present and former USDA Forest Service inventory staff who might recall aspects of these early inventories and especially where these data might be located. With success in locating these data, we have moved to digitize and restore them, check the accuracy of the restoration, and make comparisons with the present (the 2014) statewide forest inventory. Finally, we have sought to make these data (and metadata) publically available for other analysts and researchers.
Results: We have succeeded in restoring the 1935 statewide forest inventory in considerable detail, now described in a published project report. We have also located various summary data of the 1953 inventory. However, that effort was developed as an update of the 1935 inventory with inputs of data obtained from federal, state, county and private companies in various years. Thus it lacks the geographical and temporal specificity and completeness to be very detailed and thus useful in research. The 1962 inventory records were fully digital and are thought to be much more useful, but those records are yet to be located—thus our search is continuing.
Significance: The project publication (Flanary et al. 2016) included with this report describes the restoration of the 1935 inventory and comparisons to the present. Also, figures 8, 9 and 10 of this report describe major aspects of forest change. This report is viewed by the USDA Forest Service forestry inventory leadership as a very successful effort and a model for other states in restoration of inventories from the 1930s to the 1960s that have likewise been lost in terms of their detail. The agency is now moving to establish a nationwide effort to restore these older yet very valuable inventory datasets.

Project Results Use and Dissemination

The project data have been and are increasingly used to provide an understanding of the dramatic change in our forests since 1935. E.g., we have moved from a very young forest to an older forest with 3-4 times more standing biomass per acre that in the 1930s with important implications for forest health, wildfire, productivity and habitat. These results have been presented to the Minnesota Forest Resources Council and the Minnesota Forest Resource Partnership and been made available on the Interagency Information Cooperative website at:
http://iic.umn.edu/project-areas/forest-inventory/historic-data/1936-usfs-survey.
Additional presentations, publications and reports (and popular messages) are planned for the coming months.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2014 Work Plan Final Report

Date of Report: October 15, 2016

Date of Next Status Update Report: None

Date of Work Plan Approval: June 4, 2014

Project Completion Date: June 30, 2016

Does this submission include an amendment request? _No_

PROJECT TITLE: Restoring Forest Inventory Data

Project Manager: Alan R. Ek

Organization: Department of Forest Resources
College of Food, Agricultural and Natural Resource Sciences, University of Minnesota

Mailing Address: 1530 Cleveland Avenue N., Rm 115

City/State/Zip Code: St. Paul, MN 55108

Telephone Number: (612) 624-3098

Email Address: aek@umn.edu

Web Address: http://www.forestry.umn.edu

Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$ 100,000**
	Amount Spent:	**$ 100,000**
	Balance:	**$ 0**

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 05d

Appropriation Language:
$100,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to obtain and restore statewide forest inventories of 1935, 1953, and 1966 to link with more recent data to improve understanding of historical forest trends and enhance long-term ecological monitoring.

I. PROJECT TITLE: Restoring Forest Inventory Data

II. PROJECT STATEMENT:

Long-term forest plot datasets have proven invaluable for understanding the changing conditions and ecology across Minnesota's 17.3 million acres of forestland. Major forest conditions, e.g., forest type and age class distributions, have changed dramatically in the last century. One dataset that has contributed enormously to our understanding of change is the statewide forest inventories reported on in 1935, 1953, 1962, 1977, 1990, 2003, 2008 and 2013. These data are from the USDA Forest Service Forest Inventory and Analysis (FIA) program and represent high quality data collection methods for their time and thousands of field plot observations for each survey. Unfortunately, only the data from 1977 to the present is available in detail; the earlier plot records have been lost. We propose to locate and restore and/or reconstruct the earlier data down to a level useful for ecoregion to local change analysis and thereby reestablish linkage to the 1977 and more recent data. We may also be able to locate the original field data in archives. With that data we will gain 40+ years of detailed forest dynamics—invaluable to climate, environment and habitat change understanding.

Additional datasets exist beyond FIA that can also be effective to extend our capability to assess and analyze long term forest change. An example is the 400 forest plot inventory on the University's 3,500 acre Cloquet Forestry Center—measured 7 times from 1959 to 2000 and with an 8th measurement scheduled for 2014. Other research or simply long-term monitoring datasets exist on a smaller scale than FIA but may have important utility regionally. This project will seek out those offering the most promise for restoration and understanding environmental change.

Research hypothesis: We recognize the increasing value of large, long-term and intensive forest inventory datasets for examining a wide range of ecological, habitat and economic issues. We anticipate that today's search, database management, scanning, digitizing, interpolation, extrapolation and imputation methodologies are sufficient to complete databases with gaps or missing data such that truly useful detail can be restored and linked to the more recent records. Further, we anticipate that informed searching of published records, internal agency reports and data archive sites can provide sufficient information and perhaps original data to allow nearly complete and highly useful dataset restoration

III. PROJECT STATUS UPDATES:

Project Status as of January 15, 2015:

A search for reports and publications describing the 1935, 1953 and 1962 FIA inventories has been conducted and results have provided all known reports in the form of work plans, working papers, analyses, special studies and summary reports. To this point the most detailed reports from 1935 consists of large format summaries of data from the six FIA survey units at that time, including all unit summaries. These have since been digitized in the form of 280 Excel spreadsheets organized by unit, covertype, 25 species, tree diameter class, timber volumes, ownership and more for each of the six survey units. These have also been checked successfully against published reports at that time. Additionally, we have been in contact with the FIA Washington Office for (1) permission to visit and search the Federal Records Center and (2) to collaborate with a project there focusing on software development to bring older FIA data into a reporting capability that will match current reporting formats, i.e., similar tables. Finally, we have made contact with former (now retired) FIA employees who have some knowledge of the 1935, 1953 and 1962 records. These contacts have helped refine our search for the FIA records and data files. We have also been making contacts to identify and assemble plot records from various forests inventories and studies dating back to the early 1900s.

Project Status as of June 30, 2015:
The 1935 FIA Forest inventory data has been restored with detail down to survey unit for tree numbers within 1-2-inch diameter classes. This breakdown is further by species by covertype by stand size class by product (cubic feet and board feet), etc. This will now allow comparison of tree species, covertype and size class composition statewide and by survey unit from 1935 to the present. These data have also been processed converted from paper to a digital database.

The 1962 FIA survey data has been more elusive. We have been working with the USDA Forest staff in FIA and the Federal Records Center staff in Kansas City to identify potentially instructive records. We anticipate an investigative visit to the Federal Records Center soon to carry this effort further. Other long-term forest plot measurement records recovered to date include the permanent forest inventory / research plots on the University of Minnesota's Cloquet Forestry Center permanent plot database. These records encompass eight measurements taken from 1959 to 2014. Additionally, recently remeasured red pine study plots from the early 1900s have been recovered from the Cloquet Forestry Center and the North Central Research and Outreach Center at Grand Rapids. More such plot measurement record findings are anticipated.

Project Status as of January 15, 2016: The 1935 FIA Forest inventory data have been incorporated in a Microsoft Access database, which is a format used today by the FIA in making their inventory data available to the public. We have also developed SQL (Structured Query Language) queries for checking the accuracy of the 1935 database and for making a range of comparisons of that inventory and forest conditions with the FIA inventory data collected since, notably from 1977 up to 2014. These comparisons are being developed and described in reports to be finalized and published later this year. We see these comparisons as being very instructive in climate change impact analysis, assessing long term carbon sequestration and in the study of biodiversity dynamics.

For the 1962 FIA inventory data, we have continued to expand our contacts with former and current FIA employees and especially staff of the Federal Records Center in Kansas City. Because of Forest Service concerns for data security, an MOU for this project with the Forest Service FIA and an associated data security plan have been developed and should allow an actual project team visit (by Alan Ek) to the Federal Records Center soon. This trip should reveal, in detail, the extent of 1962 FIA records that will be available for the project. Unfortunately, the time taken to gain official and physical access to Federal Records Center data has taken longer than expected.

In addition to FIA data, numerous smaller long-term forest inventory records have been recovered, and we have continued to search for more. We have also been compiling, quantifying and analyzing the long-term growth and change in these data. These analyses are being developed and described in draft reports…to be finalized and published later this year.

Project Status as of June 30, 2016:
After numerous communications by phone and email with the USDA Forest Service FIA and Federal Records Center administration and security processes, the project manager was able to visit the Federal Records Center in Kansas City, KS in March, 2016. This visit was a major step in finding and inspecting the contents of approximately 70 boxes of Forest Service records, largely relating to forest surveys from the 1930s to the 1960s. Given that, we finalized and published our report on the 1935 inventory restoration as a Staff Paper Report (citation below, electronic copy attached, and three copes of the report will be delivered to the LCCMR).

Flanary, M. H., B. D. Anderson, D. C. Wilson and A. R. Ek. 2016. *Restoration of the 1936 statewide forest survey of Minnesota: Data description and comparisons with 2014 forest conditions.* St. Paul, MN: University of Minnesota, Department of Forest Resources, Staff Paper Report No. 241. 30 p. plus 3 Appendices. (also available at http://www.forestry.umn.edu/our-department/publications)

Notable in this report is documentation that the forest age class distribution of the forest has changed dramatically since 1935—from a preponderance of young forest acreage to a predominately older forest, with 3-4 times as much standing biomass as in the 1030s.

This report has since been disseminated to the MN DNR Division of Forestry, the USDA Forest Service FIA offices in St. Paul and Washington D.C. and others. A journal article and research notes on aspects of forest change from 1935 to 2014 are also being drafted. The Staff Paper report is viewed by the Washington Office (per Brad Smith, FIA Associate National Program Leader) as the most thorough restoration of a 1930s era statewide forest inventory to date. That office has further indicated they will provide staff support for further digitizing efforts with inventory restoration efforts.

The 1935 Forest Survey report, system description, metadata and data (together with user guide and query capability) are also available to researchers and the public via the Interagency Information Cooperative (IIC) website in conjunction with the University of Minnesota Library Digital Conservancy. The direct website link is http://iic.umn.edu/project-areas/forest-inventory/historic-data/1936-usfs-survey

For the 1962 FIA inventory data, no data beyond published summary records were found through the Kansas City Federal Records Center visit. However, we did identify some computer tapes that will be examined for their content. Fortunately, the visit also uncovered some early and complete records of Minnesota forest surveys from the 1940s and 1950s; we and many others were unaware of their existence. These will be brought back to St. Paul. Also, a trip to the Federal Records Center in Chicago is being planned for later this year to continue the search for the 1962 FIA Inventory data.

Additionally, the University of Minnesota Cloquet Forestry Center (CFC) permanent sample plots (known as the CFC Continuous Forest Inventory (CFI)) have been assembled as a Microsoft Access database of 400+ field plots measured eight times since 1959. For this collection, we have also developed metadata plus sample queries. These data are described in a report as:

Shrestha, M., D. C. Wilson, J. M. Zobel and A. R. Ek. 2016. *Cloquet Forestry Center Continuous Forest Inventory Update for 2014*. St. Paul, MN: University of Minnesota, Department of Forest Resources, Staff Paper Report No. xxx. 22 p. plus Appendices. In review.

An additional dataset to be included is the 100 plus year observation record of the Chapman Plantation located on the University's North Central Research and Outreach Center in Grand Rapids, MN. Like the 1935 FIA forest survey documentation, the CFC and Chapman data will be made available on the Interagency Information Cooperative website in conjunction with the University of Minnesota Library Digital Conservancy. We expect to complete this step by early 2017.

Overall Project Outcomes and Results: October, 2016: Major statewide forest inventory datasets have been identified, restored and/or captured in the project, with more likely to be added soon. The smaller ones typically include but a few plots but can be very instructive locally or for specific research questions. As the Flanary et al (2016) report suggests, there is much utility in these datasets for understanding long term forest dynamics and implications. Among these implications are those for timber supply, wildlife habitat, insect, disease, fire risk and climate change. Given that, our efforts to find and fully restore the 1962 FIA Statewide forest survey of Minnesota will be continued as other funding allows.

The project has been successful in restoring the 1935 FIA Forest Survey. Its details and potential research value is now described in a published report. Additionally, in large part on the basis of our efforts, the USDA Forest Service FIA Washington Office is now seeking to create an archivist position and organization to bring back ALL

of the forest survey data from the federal records centers for local (in each of the four FIA regions nationally – Northern (includes Minnesota), Southern, Interior West and Pacific Northwest) storage and restoration of these earlier surveys. Finally, the FIA is working to establish regional centers to focus on restoration of their earlier surveys, primarily those prior to the 1970s. We (the University of Minnesota) will likely play a lead role in the Upper Great Lakes portion of the Northern Region FIA.

Restoration of the 1962 FIA forest inventory for Minnesota remains elusive. The same is true for many early forest surveys in other states. However, this project and its efforts in Minnesota have provided an example of success and motivated the FIA to expand their efforts at restoration. For the 1962 FIA Inventory, we are continuing the search for these data in paper and electronic formats. Should either be found, we will seek University, USDA Forest Service and possibly other support for their restoration.

In terms of dissemination of results, publication is underway and protocols for electronic distribution are in place and in use. The primary project report on the restoration of the 1935 forest inventory of Minnesota is already serving as a motivating example for the USDA Forest Service Forest Inventory and Analysis leadership in addressing the restoration of older (than 1970) inventories nationwide. Additional reports based on the 1935 data are also underway.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Collect, assemble and recover information on and details of the 1935, 1953 and 1966 statewide forest inventories.

Description: The 1935, 1953 and 1962 FIA data are available only in summary reports on a statewide and sometimes regions and counties. We have sought further documentation describing these data and also interviewed individuals who designed and/or executed these surveys, including past and present survey project leaders. Here we extend those efforts further to restore the subject datasets. The attached graphic suggests the geographic extent of the project.

We anticipate documentation and actual summary and field plot records exist in various federal, state, university, industry and individual survey crew or supporting scientist files in various formats. Operationally, we will further develop our contact list from currently employed and retired individuals likely to be familiar with these data. Subsequently, we will contact them to narrow the search. Questions for these contacts will seek their knowledge of the documentation of these survey designs, the location of plot records and related data and maps, and the names of other contacts who might be helpful. We will also explore library and publication archives, federal archives in Washington, D.C. and Kansas City, MO and existing research compilations, electronic and otherwise, to identify promising leads and/or key portions of the FIA records. Once located, these data would be processed per the activity steps described below to make them useable and readily available.

If we are unable to locate the full datasets in the form of detailed plot records, then various statistical approaches would be used to impute existing data to provide useful plot, survey line, section, township, county or survey unit results and associated map characterizations. Note there are 4-6 survey units in Minnesota depending upon the year of the survey.

The priority in restoration will be the 1962 and then 1935 datasets. It is possible the 1962 plot data still exists in punch card or electronic format or in a form that can be scanned and digitized. Even though the 1935 plot data and some tree data was summarized and transferred to IBM cards, it is less likely that these would still be readable or even found. The 1953 Survey was compiled from inventories conducted by federal, state, county, and industry entities and is perhaps the most problematic for reconstruction at the plot level.

Summary Budget Information for Activity 1:	**ENRTF Budget:**	**$ 85,830**
	Amount Spent:	**$ 85,830**

Balance: $ 0

Activity Completion Date: March 2016

Outcome	Completion Date	Budget
1. Collection and synthesis of documentation, summaries, maps and field data records from individuals, agencies, and federal archives for the subject inventories.	January 2015	$22,000
2. Digitization, processing, and recovery of data down to survey unit, county, township and plot levels; verification of restoration by comparison with published summary reports.	January 2016	$60,000
3. Database formatted to link for analysis with datasets for 1977 to present and reporting.	March 2016	$4,830

Activity Status as of January 15, 2015: A search for reports and publications describing the 1935, 1953 and 1962 FIA inventories has been conducted and originals have been obtained (or copies thereof). This includes all known reports in the form of work plans, working papers, analyses, special studies and summary reports. Most of these are USDA Forest Service documents, but some are state and other documents, often in the form of grey literature. To this point the most detailed from 1935 consists of large format summaries of data from the six FIA survey units at that time, including all unit summaries. These have since been digitized in the form of 280 Excel spreadsheets organized by covertype, 25 species, tree diameter class, timber volumes, ownership and more for each of the six survey units. These have also been checked successfully against published reports indicating they represent the entire statewide inventory at that time. Additionally, we have been in contact with the FIA Washington Office for (1) permission to visit and search the Federal Records Center and (2) to collaborate with a project there focusing on software development to bring older FIA data into a reporting capability that will match current reporting formats, i.e., similar tables. However, it appears we have the most detailed records of the 1930 surveys of anywhere in the U.S. Finally, we have made contact with 5 former (now retired) FIA employees who were likely to have had direct knowledge of the 1935, 1953 and 1962 records. These contacts have helped refine our search for the subject records and data files.

Activity Status as of June 30, 2015: The 1935 FIA Forest inventory data has been restored with detail down to survey unit for tree numbers within 1-2 inch diameter classes x species x by covertype x stand size class x product (cubic feet and board feet), etc. The digitization in this effort was accomplished by transferring early handwritten records to an Excel spreadsheet format. We now have these data in the form of 100+ spreadsheets. This will now allow comparison of tree species, covertype and size class composition statewide and by survey unit from 1935 to the present. These data have also been processed to a format for developing past to present comparisons via an Access database.

The 1962 FIA survey data has been more elusive. We have been working with the USDA Forest staff in FIA Washington, D.C. and St. Paul and the Federal Records staff in Kansas City to identify potentially instructive records, if not a complete copy of this survey in some form. We anticipate a site visit to the Federal Records Center soon to carry this effort further. So far we have only summary records to various levels of detail for major variables of interest, most from FIA reports.

Activity Status as of January 15, 2016: The 1935 FIA Forest inventory data have been incorporated in a Microsoft Access database, which is a format used today by the FIA in making their inventory data available to the public. We have also developed SQL (Structured Query Language--a special-purpose programming language designed for managing data held in a relational database management system) queries for checking the accuracy of the 1935 database and for making a range of comparisons of that inventory and forest conditions

with the FIA inventory data collected since, from 1977 up to 2014. These comparisons are being developed and described in draft reports…to be finalized and published later this year.

For the 1962 FIA inventory data, we have continued to expand our contacts with former and current FIA employees and especially staff of the Federal Records Center in Kansas City. Because of Forest Service concerns for data security, an MOU for this project with the Forest Service FIA and an associated data security plan have been developed and should allow an actual project team visit (by Alan Ek) to the Federal Records Center soon. This trip should reveal, in detail, the extent of 1962 FIA records that will be available for the project.

Activity Status as of June 30, 2016: After numerous communications by phone and email with the Federal Records Center in Kansas City for identification of potentially useful records and the development of data security approval by the USDA Forest Service, permission to visit the Federal Records Center in Kansas City, KS was granted in February, 2015. The project manager visited this center in March, 2016 and inspected the contents of approximately 70 boxes of Forest Service records, largely relating to forest survey from the 1930s to the 1960s. This inspection confirmed various aspects of the 1935 inventory, but did not include the sought after field tally sheets. Given that, we finalized and published our report on this inventory restoration as a Staff Paper Report (citation below, electronic copy attached, and three copes of the report will be delivered to the LCCMR).

Flanary, M. H., B. D. Anderson, D. C. Wilson and A. R. Ek. 2016. *Restoration of the 1936 statewide forest survey of Minnesota: Data description and comparisons with 2014 forest conditions.* St. Paul, MN: University of Minnesota, Department of Forest Resources, Staff Paper Report No. 241. 30 p. plus 3 Appendices.

This report can also be found at http://www.forestry.umn.edu/our-department/publications.

This report has since been disseminated to the MN DNR Division of Forestry, the USDA Forest Service FIA offices in St. Paul and Washington D.C. and others. A journal article and research notes are also being drafted. The report is viewed by the Washington Office (per Brad Smith, FIA Associate National Program Leader) as the most thorough restoration of a 1930s era statewide forest inventory to date. That office has further indicated their staff support for any further digitizing efforts with these data.

The 1935 Forest Survey report, system description, metadata and data (together with user guide and query capability) are also available to researchers and the public via the Interagency Information Cooperative website in conjunction with the University of Minnesota Library Digital Conservancy. The direct website link is http://iic.umn.edu/project-areas/forest-inventory/historic-data/1936-usfs-survey

For the 1962 FIA inventory data, no data beyond published summary records (which we already have) were found through the Federal Records Center Visit. However, we did identify some computer tapes that are scheduled to be examined for their content. Fortunately, the visit also uncovered some early records that we and many others were unaware of their existence…including:

1. A 1946-53 Forest Survey of most Minnesota counties with apparently complete and detailed records, including field tally sheets, stand maps and aerial photos.
2. A 1950s set of permanent plots established across Northern Minnesota Counties (never remeasured) including field tally sheets.

Given the information gleaned from our study, a trip to the Federal Records Center in Chicago is now being planned for later this year to continue the search for the 1962 FIA Inventory data.

Final Report Summary: October 15, 2016: The project has been successful in restoring the 1935 FIA Forest Survey. Its details and research value is now described in a published report. Additionally, in large part on the basis of our efforts, the USDA Forest Service FIA Washington Office is now seeking to create an archivist position

and organization to bring back ALL of the forest survey data from the federal records centers for local (in each of the four FIA regions – Northern (includes Minnesota), Southern, Interior West and Pacific Northwest) storage and restoration of these earlier surveys. Finally, the FIA is working to establish regional centers to focus on restoration of their earlier surveys, primarily those prior to the 1970s. We (the University of Minnesota) will likely play a lead role in the Upper Great Lakes portion of the Northern Region FIA.

Restoration of the 1962 FIA forest inventory for Minnesota remains elusive. The same is true for many early forest surveys in other states. However, this project and its efforts in Minnesota have provided an example of success and motivated the FIA to expand their efforts at restoration. For the 1962 FIA Inventory, we are continuing the search for these data in paper and electronic formats. Should either be found, we will seek USDA Forest Service support for their restoration.

ACTIVITY 2: Identify and restore additional long-term forest plot datasets.
Description: Seek out and recover additional long-term datasets that have potential for understanding forest change. Key criteria are that these datasets (a) describe ecologically important conditions over a large area, (b) have detail for meaningful change analysis, and (3) describe timeframes in excess of 30 years. These datasets will focus on naturally occurring forest conditions, though some portion may have a history of management treatments.

These datasets will include the eighth remeasurement of the permanent forest inventory / research plots on the University of Minnesota's Cloquet Forestry Center permanent plot database, to be conducted in the summer of 2014 with funds obtained from the University's Office of the Vice President of Research. Earlier measurements of these 400 plots were taken in 1959, 1964, 1969, 1976, 1982, 1990, 2000. Note the initial project proposal included an activity that sought funding for the 2014 measurement of the Cloquet dataset. This measurement activity has now been deleted from the work plan as it is no longer needed. However, we have included that dataset to be treated under this revised activity.

Additionally, we will seek out and attempt to recover additional long-term datasets that have potential for understanding forest change. Key criteria are that these datasets (a) describe ecologically important conditions over a large area, (b) have detail for meaningful change analysis, and (3) describe timeframes in excess of 30 years. These datasets will focus on naturally occurring forest conditions, though some portion may have a history of management treatments. We anticipate such datasets exist in various federal, state, university, industry and individual files in various formats.

Operationally, we will develop a contact list from currently employed and retired individuals likely to be familiar with such datasets. Subsequently, we will contact them to narrow the search. We will also explore library and publication archives and existing research compilations, electronic and otherwise, to identify promising datasets that suggest they include long-term records. Once located, these datasets would be processed per the activity steps described below to make them useable and readily available.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 14,170
Amount Spent: $ 14,170

Balance: $ 0

Activity Completion Date: March 2016

Outcome	Completion Date	Budget
1. Identification and **c**ollection of documentation and existing field data for the subject inventories.	October 2015	$ 4,000
2. Digitization, processing, and restoration of data with recompilation to compare and verify against official reports.	March2016	$ 8,000

3. Databases and data formatted for forest change analysis and reporting consistent with USDA Forest Service FIA and MN DNR data specifications.	June 2016	$2,170

Activity Status as of January 15, 2015: We have been making contacts to find old forest plot records and data files. To date we have identified records of 100+ year old permanent sample plots at the University of Minnesota's Cloquet Forestry Center and the North Central Research and Outreach Center at Grand Rapids. Both of these sets are in digital format. The search for more 100 year records is continuing.

Activity Status as of June 30, 2015: Long-term forest plot measurements records recovered now include the permanent forest inventory / research plots on the University of Minnesota's Cloquet Forestry Center permanent plot database. These records encompass eight measurements taken from 1959 to 2014. Additionally, red pine study plots from the early 1900s and recently remeasured have been recovered from the Cloquet Forestry Center and the North Central Research and Outreach Center at Grand Rapids. All of these are now in an Access database format. More such plot measurement record findings are anticipated.

Activity Status as of January 15, 2016: While the above note records have been recovered, we have continued to search for more. Additionally, we have been writing SQL queries to quantify and analyze the long-term growth and change in these data. These analyses are being developed and described in draft reports…to be finalized and published later this year.

Activity Status as of June 30, 2016: As noted above under Activity 1**,** Alan Ek traveled to the Federal Records Center in Kansas City, KS in March 2016 for search and inspection of USDA Forest Service records of Minnesota Forest Surveys. This led to knowledge of FIA datasets 1 and 2 described under Activity 1 above. Working with the USDA FIA unit in St. Paul, we are in the process of bringing those data back to Minnesota for further inspection and potentially full restoration.

Additionally, the University of Minnesota Cloquet Forestry Center (CFC) permanent sample plots (known as the CFC Continuous Forest Inventory (CFI)) have been assembled as a Microsoft Access database of 400 plots measured 8 times since 1959. For this collection, we have also developed metadata plus sample queries. These data are described in a report as:

Shrestha, M., D. C. Wilson, J. M. Zobel and A. R. Ek. 2016. *Cloquet Forestry Center Continuous Forest Inventory Update for 2014*. St. Paul, MN: University of Minnesota, Department of Forest Resources, Staff Paper Report No. xxx. 22 p. plus Appendices. In review.

An additional small dataset to be included is the 100 plus year observation record of the Chapman Plantation located on the University's North Central Research and Outreach Center in Grand Rapids, MN. Like the 1935 FIA forest survey documentation, the CFC and Chapman data will be made available on the Interagency Information Cooperative website in conjunction with the University of Minnesota Library Digital Conservancy. We expect to complete this step by early 2017.

Final Report Summary: October 15, 2016: Major datasets have been identified, restored and/or captured in the project, with several more possibly added soon. The smaller ones typically include but a few plots on small areas but can be locally very instructive. As the Flanary et al (2016) report suggests, there is much utility in these datasets for understanding long term forest dynamics and implications. Among these implications are those for timber supply, wildlife habitat, insect, disease, fire risk and climate change. Given that, our efforts to find and fully restore the 1962 FIA Statewide forest survey of Minnesota will be continued as other funding may allow.

V. DISSEMINATION:

Description: The project plans to provide restored databases in electronic formats together with data descriptions for other users. These results and dataset restoration methodology will also be described in paper and electronic reports to be made available to ecologists, inventory specialists, and resource analysts through publications and web access (via the Department of Forest Resources and the Forest Resources Interagency Information Cooperative (IIC) websites). Additionally, we are planning on technical journal articles and webinars to describe the datasets and restoration methodology for potential use by those in other regions. The data is intended to in convenient data formats including those compatible with current statewide forest inventory data. These datasets will be employed as soon as they become available for examination of long-term forest change, specifically for their implications for climate change (resilience, adaptation), for understanding long-term carbon sequestration in forests statewide, and for habitat change, e.g., for ruffed grouse, moose and forest health and biodiversity implications as well. We anticipate our own (other) projects in these subject areas will provide the funding for using these data further. We also see these data as an important and publicly available datasets to be made available for applications by others within and beyond the University and Minnesota on funding they may have available.

Activity Status as of January 15, 2015: This activity is slated largely for the second year of the project, however, we are adapting the Interagency Information Cooperative website for this effort as well as working with the University of Minnesota Library for the possibilities for data archiving and access available in that repository.

Activity Status as of June 30, 2015: This effort is now in development in terms of computing basic "restoration methodology" and "past versus present" comparison reports to highlight the data availability and potential usage. This includes making the data available in electronic formats with appropriate metadata. We are also seeking funding to extend this work as further research on the issues that the data now allow us to address.

Activity Status as of January 15, 2016: The activities described for June 30, 2015 are continuing.

Activity Status as of June 30, 2016: The activities described above are continued with protocols for communication and data access now well developed.

Final Report Summary: October 15, 2016: The documentation and communications efforts and data access are now in place for several historic datasets and are being extended to include additional datasets as they become available and are restored. The project has achieved national level recognition with but modest communications so far.

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Explanation
Personnel:	$ 96,800	**Research Support:** Research Associate John Zobel @ 25% time for one year to assist project team in developing statistical approaches for restoring data sets, notably to address gaps in data, as necessary. Total: $17,000. Research Fellow David Wilson@ 65% time for two years to assist project team in the collection and synthesis of the subject long-term forest inventory plot datasets. Total $79,800.
Travel Expenses in MN:	$1200	To dataset and or archive sites outstate

Other: Travel expenses beyond MN	$2,000	To federal archives in Washington D.C. and Kansas City, MO.
TOTAL ENRTF BUDGET:	**$100,000**	

Explanation of Use of Classified Staff: NA

Explanation of Capital Expenditures Greater Than $5,000: NA

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 1.6

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

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State	$		
University of Minnesota In-kind Services During Project Period: Project manager (Ek) will contribute 1% time to the project; other University co-PI (Burk) will contribute 1% time to working with project employees.	$6,594	$6,594	Project manager faculty time providing project research leadership
University of Minnesota Unrecovered indirect costs @ 52% of modified total direct cost base of $100,000	$52,000	$52,000	
TOTAL OTHER FUNDS:	**$58,594**	**$58,564**	

VII. PROJECT STRATEGY:

A. Project Partners: The University of Minnesota will receive the funding and also contribute substantial faculty time and effort to the project. Project team members (PIs) are from the University's Department of Forest Resources and include Professors Alan Ek and Thomas Burk, Research Associate John Zobel and Research Fellow David Wilson. A key cooperator is the USDA Forest Service Northern Research Station Forest Inventory and Analysis unit in St. Paul and related Federal Archive sites (in Washington, D.C. and Kansas City, MO), plus the MN DNR Division of Forestry and other individuals that have been involved with collection of MN FIA and other data in the past.

B. Project Impact and Long-term Strategy: A two-year project length is needed to be able to identify, locate and restore existing datasets. This includes the development of statistical imputation methodology as needed, and to digitize and make the datasets available for improving the analysis of forest change for ecological, habitat and economic interests.

C. Spending History: The project manager and his research teams have been been using long-term forest datasets in research for several decades. However, we have only recently sought to improve on the data available through the restoration of "lost" forest inventory records. However, no ENRTF anf MRRF funds have been in used in those efforts.

Funding Source	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13	M.L. 2013 or FY14

VIII. ACQUISITION/RESTORATION LIST: NA

IX. VISUAL ELEMENT or MAP(S): To be developed from the datasets restored in the course of this project

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: NA

XI. RESEARCH ADDENDUM:

XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than January 15, 2015, June 30, 2015, January 15, 2016, and June 30, 2016. A final report and associated products will be submitted between June 30 and August 15, 2014.

GRAPHIC: History of Statewide Forest Inventories in Minnesota from 1935 to 2013.

- **2013:** The figure below describes the location of the latest Forest Inventory and Analysis (FIA) field plots in Minnesota (6,139 plots, each consisting of four 1/24th acre subplots) and examples of data collected.

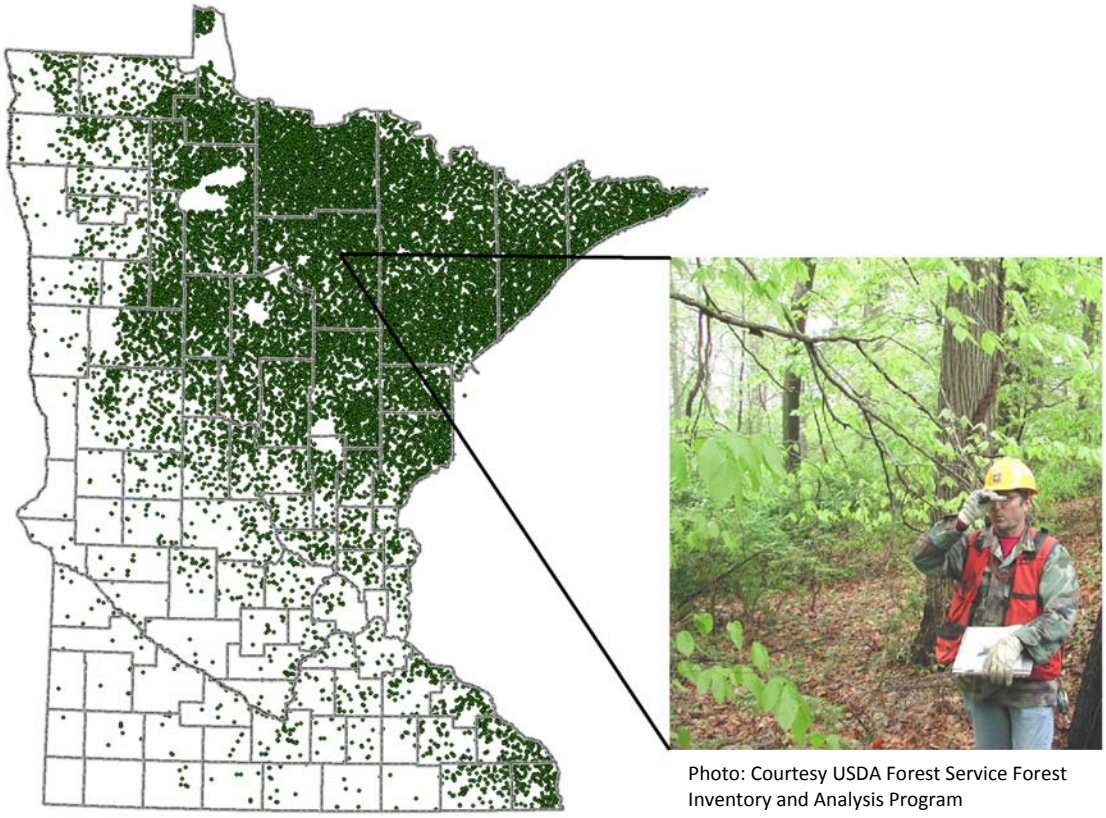

Photo: Courtesy USDA Forest Service Forest Inventory and Analysis Program

Figure 1: FIA plots in Minnesota in 2013. The plots were measured over a 5 year period (2009-2013) and provide estimates of forest area, ownership, cover type, stand tree and site description, numerous ecological descriptors, habitat indicators, and numerous other measures.

- **2008:** Same sample plot grid layout and measurement as 2013
- **2003:** Same sample plot grid layout and measurement as 2008
- **1999:** Same sample plot grid layout and measurement as 2003
- **1990:** Similar sample plot grid layout and measurement as 1999
- **1977:** Same sample plot grid layout and measurement as 2013
- **1966:** Data lost…
- **1953:** Data lost…
- **1935:** Data lost…

Project Activity: Locate, collect and restore the lost inventory data and compilations.
Results: Extension of forest and related ecological monitoring data and compilations for 40+ years, thus greatly strengthening historic detail on forest dynamics—invaluable to climate, environment and habitat change understanding.

Environment and Natural Resources Trust Fund

M.L. 2014 Project Budget

Project Title: Restoring Forest Inventory Data

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 05d

Project Manager: Alan R. Ek

Organization: University of Minnesota

M.L. 2014 ENRTF Appropriation: $ 100,000.

Project Length and Completion Date: 2 years, June 30, 2016

Date of Report: October 15, 2016

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Collect, assemble and recover information…***			***Identify and restore additional…datasets***				
Personnel (Wages and Benefits)	$83,130	$83,130	$0	$13,670	$13,670	$0	$96,800	$0
John Zobel, Research Associate: $17,000. (66.4% salary, 33.6% benefits); 25% FTE for one year. Work: To assist project team in developing statistical approaches for restoring data sets, notably to address gaps in data, as necessary.								
David Wilson, Research Fellow: $79,800. (66.4% salary, 33.6% benefits); 65% FTE for two years. Work: to assist project team in the collection and synthesis of the subject long-term forest inventory plot datasets.								
Travel expenses in Minnesota *Mileage, lodging and meals to locate and collect restorable datasets in Minnesota*	$700	$700	$0	$500	$500	$0	$1,200	$0
Other *Air fare, lodging, and meals to locate and collect restorable datasets from federal archives in Washington, DC and Kansas City, MO.*	$2,000	$2,000	$0	$0	$0	$0	$2,000	$0
COLUMN TOTAL	**$85,830**	**$85,830**	**$0**	**$14,170**	**$14,170**	**$0**	**$100,000**	**$0**