

**Environment and Natural Resources Trust Fund
2012-2013 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 016-B

Rapid Forest Ecosystem and Habitat Inventory by Imputation

Topic Area: B. Forestry/Agriculture/Minerals

Total Project Budget: \$ 523,000

Proposed Project Time Period for the Funding Requested: 2 yrs. July 2013 - June 2015

Other Non-State Funds: \$ 0

Summary:

We will evaluate a new approach to forest inventory, based on imputation of statewide Forest Inventory and Analysis (FIA) data, to speed updates, improve usability, and dramatically reduce costs.

Name: Alan Ek

Sponsoring Organization: U of MN

Address: 1530 Cleveland Ave N
St. Paul MN 55108

Telephone Number: (612) 624-3098

Email aek@umn.edu

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

Location

Region: NW, NE, Central

County Name: Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Cook, Crow Wing, Hubbard, Itasca, Kanabec, Koochiching, Lake, Lake of the Woods, Mahnommen, Mille Lacs, Morrison, Pine, Roseau, St. Louis, Wadena

City / Township:

| | | | | | | | |
|--------------------------|--------------------|--------------------------|-------------------|--------------------------|-----------------------|--------------------------|----------------------------------|
| <input type="checkbox"/> | Funding Priorities | <input type="checkbox"/> | Multiple Benefits | <input type="checkbox"/> | Outcomes | <input type="checkbox"/> | Knowledge Base |
| <input type="checkbox"/> | Extent of Impact | <input type="checkbox"/> | Innovation | <input type="checkbox"/> | Scientific/Tech Basis | <input type="checkbox"/> | Urgency |
| <input type="checkbox"/> | Capacity Readiness | <input type="checkbox"/> | Leverage | <input type="checkbox"/> | Employment | <input type="checkbox"/> | TOTAL <input type="checkbox"/> % |

PROJECT TITLE: Rapid Forest Ecosystem and Habitat Inventory by Imputation

I. PROJECT STATEMENT

Minnesota has 15.8 million acres of timberland managed in large part by county, state and federal agencies. Management is for diverse purposes including timber, wildlife habitat, and ecological considerations. Yet much of the forest inventory data for management is too far out of date for efficient operations and effective planning for sustainability. Why, because forests are continually changing through natural and human processes--succession, growth, mortality, harvesting, etc. This proposal examines a new approach to forest inventory to speed updates, improve usability, and dramatically reduce costs.

Three types of forest inventory efforts are common in practice:

(1) *Statewide strategic inventories*—such as the US Forest Service Forest Inventory and Analysis (FIA) program which has established and re-measures a large number of permanent field plots on an annual basis across each state annually. In Minnesota the FIA program has 6,139 such plots with 1/5th remeasured annually. Further, this data is readily available and free. FIA describes overall forest conditions and FIA plots are the gold standard for field data. However, FIA does not provide for localized map detail.

(2) *Map based inventories*—DNR or county inventories map each forest stand (a polygon) and describe them by covertype, site quality, age or size class, ecological conditions plus timber characterizations, as determined by several to many field plot measurements in most if not all stands. These inventories provide the operational detail needed for ownership wide forest management for sustainability and diverse other purposes. However, it has become increasingly difficult for agencies to fund such efforts.

Because of their large size and considerable tree, stand and ecological detail, FIA field measurement costs are typically \$200-\$300 plot. While individual map based inventory field plots are smaller and cost much less (\$30-\$60 each), each agency may employ thousands of these plots. This reality has slowed the frequency of updates for map based inventories.

Research hypothesis:

This project recognizes that the map based inventories can be broken into two parts: (1) updating maps and (2) measurements on field plots. Further, we *hypothesize* the latter can largely be replaced using FIA data correlated with stand map classifications by covertype, site quality, age or size class, etc. Here we assume state of the art and practice remote sensing and GIS inputs. In fact, FIA data provide stand classifications in much the same way that map based inventories classify stands. Thus the detailed measurement data from FIA plots may be imputed to “similar” stands classified and mapped on specific ownerships. Additional sources of data for imputation are timber sale appraisals and past inventory stand classifications. Such imputation is possible because per acre averages for many covertype, site quality, and stand age classifications, will not change appreciably with time. The key question is the precision and accuracy of the imputation for various management and planning purposes. Should these results prove truly useful, the savings in field data collection efforts would dramatically reduce map based inventory costs and allow for much more frequent inventory updates. The attached graphic illustrates the concept. Finally, forest covertype and size class are often key predictors of forest habitat values and ecological conditions.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Assemble map based forest stand inventory data from cooperating county agencies and FIA data statewide, including timber, habit and ecosystem data. Budget: \$121,000

Past and recent forest inventory and appraisal data from cooperating agencies will be assembled for a large county, a small county and state lands in northern Minnesota. Additionally, data from an additional

but distant county will be sought. FIA data to be used will include all such data statewide from inventory dates encompassing 1977-2012. As an added test of methodology, 1959-present permanent plot inventory data from the University of Minnesota Cloquet Forestry Center (CFC) will be included.

| Outcome | Completion Date |
|---|-----------------|
| 1. Collect county, state, university and FIA data files for inventories and appraisals, etc. for the subject study areas and dates. | November 2013 |
| 2. Data processing/organization and preparation of these data for subsequent trials. | February 2014 |

Activity 2: Evaluate the precision and accuracy of imputation for forest ecosystem and habitat description, including additional map attributes that may improve imputation. Budget: \$182, 00
 Imputation trials will be conducted to test the statistical precision and accuracy of imputation of FIA, past inventory, appraisal data and other data sources to the mapped polygons on county and state lands. Precision and accuracy will be compared to actual field plot data results for the subject polygons for a range of measurements or observations that might be desired as part of the field data.

| Outcome | Completion Date |
|--|-----------------|
| 1. Trials of imputation from FIA to map based inventories. | June 2014 |
| 2. Incorporation of appraisal, past inventory data, etc. to further improve imputation. | September 2014 |
| 3. Evaluation of existing and potential map data that can improve imputation ((including remote sensing (e.g., lidar) and thematic map inputs) | December 2014 |

Activity 3: Evaluate the practical utility and savings of imputed inventory data. Budget: \$220,000
 The analysis would examine results for forest planning across the subject county, CFC, and state areas (e.g., for a MnDNR Sustainable Forest Management Planning (SFRMP) area. Comparisons would be made for planning results with actual field data for subject polygons and alternatively with imputed data. The utility for habitat description would utilize a recently developed forest wildlife habitat model for state species. This evaluation would also include agency staff evaluations of feasibility, utility and costs.

| Outcome | Completion Date |
|---|-----------------|
| 1. Identification of cost savings and practical utility of imputation for inventory | February 2015 |
| 2. Identification of cost savings and practical utility of imputation for planning | April 2015 |
| 3. Final report submitted, development of further outreach and technology transfer. | June 2015 |

III. PROJECT STRATEGY

A. Project Team/Partners

The University of Minnesota will receive the funding and contribute substantial time and effort to the project. Project team members are from the University’s Department of Forest Resources and include Professors Alan Ek, Thomas Burk and Howard Hoganson and Assistant Professor Joseph Knight. Cooperators include three TBD county land departments and a state agency. The cooperators will provide their respective ownership forest inventory data, supporting map and data compilations, and user review in the evaluation of project outputs. The project will also compensate the cooperators for their efforts in making detailed data available and for evaluations of feasibility, utility and costs savings of the new inventory approach.

B. Timeline Requirements

A Two-year project length is needed to be able to collect existing agency data, develop imputation methodology and trials, and to identify the utility and costs savings of these approaches for timber inventory, ecological assessments, habitat characterization and planning purposes.

C. Long-Term Strategy and Future Funding Needs

It is anticipated that the project will be completed within a Two-year period beginning July 2013.

2012-2013 Detailed Project Budget
Overall Project Budget

IV. TOTAL ENRTF REQUEST BUDGET: 2 years

| <u>BUDGET ITEM</u> | <u>AMOUNT</u> |
|---|----------------------|
| Personnel: One month of summer salary and fringe (0.397) for two years (University of Minnesota Co-PI faculty on 9-month appointments - Burk, Hoganson, and Knight; 0.1 FTE each); Research Fellow D. Wilson for two years, 1 FTE. | \$ 208,340 |
| Salary and fringe (0.8636) for three University of Minnesota graduate students for 2 years, each at 50% time (20 hours/week). Graduate fringe is budgeted at 0.87 of salary load and includes tuition for the academic year, health care for the fiscal year, and social security and Medicare for summer pay periods. Work be conducting imputation trials under guidance of PIs and Research Fellow with a focus on planning and improving map information, respectively. | \$ 243,100 |
| Salary and fringe (0.0743) for four University of Minnesota undergraduate students for 3 months for field data collection at the Cloquet Forestry Center. | \$ 25,060 |
| Contracts: To three TBD county land departments and a state agency for costs of preparing and providing inventory databases and in review of project output utility. | \$ 35,000 |
| Equipment: Expendable field equipment and supplies for data collection at the Cloquet Forestry Center and as necessary on cooperator sites. | \$ 4,100 |
| Travel: To collect field and test data at the Cloquet Forestry Center and on cooperator sites and to work with cooperators on making databases available and in review of the utility of project outcomes. | \$ 7,400 |
| TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST = | \$ 523,000 |

V. OTHER FUNDS

| <u>SOURCE OF FUNDS</u> | <u>AMOUNT</u> | <u>Status</u> |
|---|----------------------|----------------------|
| Other Non State \$ Being Applied to Project During Project Period: | \$ - | NA |
| Other State \$ Being Applied to Project During Project Period: | \$ - | NA |
| In-kind Services During Project Period: Project manager (Ek) will contribute 10% time to the project; other PI's from the University of Minnesota faculty (Burk, Hoganson and Knight) will contribute 10% time to working with project employees and county and state cooperators. | \$ 114,580 | Secured |
| Other in-kind Services During Project Period. | \$ - | NA |
| Remaining \$ from Current ENRTF Appropriation (if applicable): NA | \$ - | NA |
| Funding History: None. However, project PI's have experience with practice and research on imputation for forest inventory back to 1997. | \$ - | NA |

GRAPHIC: Rapid Forest Ecosystem and Habitat Inventory by Imputation

Intro: Map based forest inventories typically involves two efforts:

- (1) Development or updating a base map of forest stands (polygon boundaries) and descriptions (e.g., cover type, age, tree size class, site quality, habitat type, ecological classification)
- (2) Field plots to describe the per acre stand characteristics at the inventory time (confirmation of classifications in (1) plus tree species, sizes, product potentials, and ecological observations)

The figure below describes the location of the 6,139 FIA plots in Minnesota (each consisting of four 1/24th acre subplots)...data that can be used to impute the characteristics of the forest stand polygons in map based inventories...potentially saving the cost of much of the field plot effort (2). Imputation is the substitution of known values from an existing dataset to another which lacks some of the existing dataset details.



Figure 1: FIA plots in Minnesota. Plots are remeasured every 5 years on a rotating basis thus providing annually updated statewide estimates of forest area, cover type area, and including ecological conditions, habitat indicators, and numerous other measures.

Project Activity: Correlate the large FIA dataset to a subset of similar stand data in map based inventories and conduct trials of imputation precision and accuracy for timber, wildlife habitat, and ecological conditions. Additionally, the project would synthesize available remote sensing and thematic map data to examine ways to increase the speed, precision and accuracy in updating based maps.

Results: Improved timeliness of map based forest inventories for assessment, planning and management and dramatically reduced the cost of such inventories.

PROJECT TITLE: Rapid Forest Ecosystem and Habitat Inventory by Imputation

Project Manager Qualifications/Organization

Alan R. Ek, Professor and Head

Department of Forest Resources, College of Food, Agricultural and Natural Resource Sciences
University of Minnesota, 1530 Cleveland Avenue N., St. Paul, MN 55108
Ph 612-624-3098; Email ae@umn.edu

Background: He has B.S. and M.S. degrees from the University of Minnesota in forestry and a PhD from Oregon State University in forest measurements. He joined the faculty at Minnesota in 1977 after service with the Canada Department of Fisheries and Forestry and the University of Wisconsin. He is the author of 150+ research and technical papers on forest inventory design, resource analysis and planning. He was elected a Fellow of the Society of American Foresters (SAF) in 1991 and has served as chair of the SAF Forest Science and Technology Board; from 1990-1994 he served as the Study Group Coordinator for the Generic Environmental Impact Study of Timber Harvesting and Forest Management in Minnesota. In 1997, he worked in Finland as a Fulbright Scholar. In the late 1990s he served on the USDA Forestry Research Advisory Council, including two years as chair. He has also served several terms as Research Chair for the National Association of University Forest Resource Programs. In the recent past he served as a member of the Governor's Task Force on the Competitiveness of Minnesota's Primary Forest Products Industry. He is also a member of the Minnesota Forest Resources Council and director of the Interagency Information Cooperative.

Responsibilities for the proposed project: Supervision of project budget, faculty, staff and activities including developing details for project operations, details for activities 1-3 and associated tasks and timelines, development of research protocols, including data handling, cooperator communications, plus oversight for hypothesis testing and details in the development of deliverables. He will also serve as a co-investigator for all three project activities, specifically by providing expertise in inventory design. For activities 1-3, corresponding lead investigators will be Ek, Burk and Hoganson, respectively.