Overview of the National Inventory and Monitoring Applications Center (NIMAC)

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Abstract: *The National Inventory and Monitoring Applications Center (NIMAC) was created by the Forest Inventory and Analysis (FIA) program in 2006. NIMAC addresses a growing need, expressed by FIA partners, for technical assistance in designing and implementing monitoring plans for forests at scales finer than that provided by the FIA standard inventory. NIMAC's goal is to develop leading-edge forest ecosystem monitoring methods and tools to help FIA and other organizations monitor forests, resulting in comparable results across the landscape. Methods and software tools are designed for use by land managers and across ownerships at landscape to national scales. To date, NIMAC has helped six states develop more specific inventories on their lands and is working with several National Forests on developing forest monitoring plans.*

NIMAC is developing a monitoring toolkit composed of a design tool, field data collection software, data storage and compilation tools, and spatial/tabular analysis tools. The toolkit will be applicable to a wide range of customers including the National Forest System, states, and FIA itself. Honduras is funding the development of a Spanish version of the toolkit. NIMAC is being funded to work with National Forest System monitoring coordinators and planners to develop the question-driven monitoring design and analysis tools to help ensure that data are collected and analyzed efficiently and in a scientifically defensible manner. NIMAC's software enhancements also will provide added flexibility to FIA customers.

Keywords: Forest, inventory, monitoring, FIA, sampling design, software.

Introduction

As a result of the 2006 combination of the North Central and Northeastern Research Stations of the U.S. Forest Service Research and Development branch, the Station's Forest Inventory and Analysis (FIA) units also were combined. This provided the opportunity to create a group dedicated to serving the forest inventory and monitoring needs of other organizations, such as states, the National Forest System, and other countries. The expertise of FIA has long been

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In: McWilliams, Will; Moisen, Gretchen; Czaplewski, Ray, comps. 2009. 2008 Forest Inventory and Analysis (FIA) Symposium; October 21-23, 2008: Park City, UT. Proc. RMRS-P-56CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 1 CD.

sought after, but FIA did not have the capacity to meet that need until the National Inventory and Monitoring Applications Center (NIMAC) was formed.

NIMAC's Mission

The mission of NIMAC is to develop leading-edge forest ecosystem inventory and monitoring methods and tools to help FIA and other organizations monitor forests, resulting in comparable results across the landscape. The emphasis is on providing expertise (consultation and training) and the tools needed for the partner organization to monitor its forests on its own in a way that is compatible with FIA estimates. NIMAC also develops new monitoring methods as problems are identified.

NIMAC's Assignments

To accomplish its mission, NIMAC works in several areas. We develop or enhance methods to make existing monitoring techniques more efficient, such as spatially balanced sampling methods (Lister and Scott 2008) and optimal plot design (Scott 1993). Similarly, we can develop new metrics or apply others' research and make their measures operational, such as for monitoring Montreal Criteria and Indicators. We also develop techniques to bridge the gap between the regional FIA survey and mid-scale planning needs, such as for developing forest plans, and even between mid-scale monitoring and stand-level inventory, such as small area estimation methods or ways to prioritize stand exams.

How NIMAC Can Help

NIMAC benefits customers in a number of ways. Forest managers benefit by having more efficient and effective forest monitoring plans. While these initially will focus on vegetation-related objectives, we hope to expand to other plot-based natural resource monitoring. The resulting methods are scientifically defensible in a court of law. The data are compatible and consistent with existing inventories, allowing comparisons with the forest matrix (context) and aggregation to ecoregion, regional, and national levels. Efficiency is also gained by building on existing FIA data and techniques. NIMAC provides the tools to implement the methods and to generate reports. NIMAC charges for its services – re-investing those funds in FIA's toolkit to speed up its development and to add new features, so everyone benefits.

NIMAC Projects

Much of the focus is on serving NIMAC customers. Most are traditional FIA partners: states, State & Private Forestry, and the National Forest System. We also work with other countries in cooperation with the International Forestry program of the U.S. Forest Service, and with nongovernmental organizations.

States

Wisconsin Continuous Forest Inventory: The Wisconsin Department of Natural Resources asked FIA to help conduct a continuous forest inventory (CFI) on 518,650 ac of State Forest lands so that they could monitor invasive plants and address the requirements for forest certification. NIMAC took this on as its first project. Wisconsin provided funds for NIMAC's technical guidance to help determine the objectives, monitoring questions, attributes to observe, precision, sampling and plot design, and plot locations. We modified the regional FIA field manual and data recorder program to meet their needs. Since the sampling intensity was increased to one plot per 166 ac, the number of 1/24-ac subplots was reduced to two so that multiple plots could be visited in a day. The proportion of Phase 3 (forest health) plots was increased from 1/16th to 1/3rd. Contractors were used to collect the data and to modify the FIA compilation program (NIMS) and the web-based analytical tool (FIDO). Some of the first season's data are available at: http://131.216.27.117/fido/mastf/index.html. The monitoring tools developed for Wisconsin are now being used to help other customers plan, conduct, process and analyze their own surveys, to the extent that they choose.

Indiana Continuous Forest Inventory: Based on the Wisconsin CFI experience, the Indiana Department of Natural Resources (DNR) asked NIMAC to help with a similar effort on their 157,211 ac of State Forests. Because the emphasis was on forest certification, only Phase 2 (tree) plots were selected. Another objective was to provide results at the analysis unit level – roughly 6,000 ac. Thus the sampling was increased to a single subplot every 40 ac. One concern with this design is the small number of sample trees on a plot with which to classify forest type. After considering different options, it was decided to rely only on the field crew classification. James Westfall conducted a study of the implications of reducing the number of subplots on the consistency of classification (Westfall 2008, this publication). Indiana DNR contracted the fieldwork to the same contractor currently measuring the statewide FIA plots. The first field season was completed in the fall of 2008. Indiana DNR staff will process the data using PC-based tools developed by NIMAC and funded by Indiana DNR.

Great Plains Initiative: The four states with the highest proportion of ash trees, relative to the total number of trees in the state, are North and South Dakota, Nebraska, and Kansas. Out of concern for the threat posed by the emerald ash borer, these States partnered with State & Private Forestry to fund a study of the potential ecological and economic impacts of this pest. As part of that study, they asked NIMAC for assistance in conducting a one-time inventory of trees outside of forests, including shelterbelts, riparian areas, scattered trees, and urban areas. In order to focus the field sampling effort, NIMAC developed a stratified two phase sampling system that used a percent tree cover layer from satellite imagery, a large subsample of aerial photographs, and ground samples. The allocation of samples to strata was optimized to efficiently sample plots with tree cover in areas

outside of what FIA calls forestland. Using PC-based tools, NIMAC will process the data, and provide the states with an analysis tool. The urban data will be processed by the urban forestry unit of the Northern Research Station.

National Forest System

NIMAC's assistance to the National Forest System started with a pilot project on the Mark Twain National Forest in 2006. We collaboratively identified the vegetation-related objectives, monitoring questions, metrics, and precision requirements. NIMAC then developed the sample size alternatives and resulting costs. The optimal solution was to continue doubling the intensity of the Phase 2 sample and to increase Phase 3 by seven times – much less than expected. Both Region 8 and 9 were encouraged by the pilot, so they asked NIMAC to work with several more National Forests. The ultimate objective is to apply NIMAC's 15 monitoring steps to all 30+ National Forests and Grasslands in the east over the next few years. The end result will be adequate forest-level information to monitor the vegetation-related aspects of their forest plans and to fulfill annual and 5-year reporting requirements under the 2008 Planning Rule. NIMAC is also providing assistance to the Spring Mountain National Recreation Area in Nevada (Region 4).

International

At the request of International Programs of the U.S. Forest Service, NIMAC is providing technical assistance to Honduras and Russia. For more than 75 years, Russia has been inventorying managed stands across the country. However, these stand data are difficult to roll up to national estimates and are representative of only managed forests. They have asked the United States and other countries for assistance in developing a national forest inventory (NFI). During several visits NIMAC has provided advice on NIMAC's monitoring steps and on the methods that FIA uses. The NFI will be critically important for sustainable forest management of these climate-sensitive areas which represent roughly 25 percent of the world's forests.

As a result of NIMAC's efforts, Honduras now has a monitoring system for its national forests in their highly productive pine regions. Initial work has begun on monitoring mahogany and other broadleaves. A high proportion of the harvests in these forests are illegal, so efforts are being made to foster sustainable forest management in cooperation with local communities. With funding from Honduras, NIMAC also is collaborating on the development of a Spanish version of the monitoring toolkit. These tools should then be useful in other Spanish-speaking countries.

Inventory and Monitoring Toolkit

The genesis of the development for a monitoring toolkit was the result of a meeting between FIA and The Nature Conservancy, NatureServe, the National

Park Service, and the state of New York, focused on how to more consistently monitor the forests of New York. The concept of a monitoring toolkit originated as a means of developing and fostering the use of consistent methods, based on a suite of tools that had been developed by the author. The vision was to first create a monitoring design tool for identifying consistent and efficient sampling methods. Then, develop data recorder, data compilation, and data analysis tools that all rely on those methods to integrate all steps and help foster consistency. Each of the tools would allow some flexibility, but would provide a common framework and a starting point that was consistent with FIA.

NIMAC has built upon that initial idea by adding functionality to the monitoring toolkit as needed for each new customer. The toolkit is applicable to a wide range of customers, including the National Forest System, states, and FIA itself. NIMAC is being funded to work with National Forest System monitoring coordinators and planners to develop question-driven monitoring design and analysis tools. The ultimate objective is to help ensure that data are collected and analyzed efficiently and in a scientifically defensible manner.

Design Tool

The Design Tool for Inventory and Monitoring (DTIM) is being developed to assist those who plan forest monitoring to work through the first 9 of the 15 monitoring steps. NIMAC has developed a working prototype to help:

1. Identify users and broad objectives of the monitoring.
2. Identify the monitoring questions to be asked.
3. Identify the tables of estimates (and their metrics and attributes) needed to answer the questions.
4. Assess whether existing data are sufficient to answer the questions, or to assess their variability if they are not adequate.
5. Set cost and/or precision constraints for collecting additional data
6. Develop an efficient plot and sampling design to balance cost and precision in order to address monitoring questions.
7. Select the plot locations in a spatially balanced way.
8. Generate field manual text for selected attributes
9. Generate training materials for selected attributes.

Based on a knowledge base from monitoring experts, users will be presented with lists of choices to guide the development of the monitoring system that best suits their needs. These steps are largely done within a spreadsheet. The version NIMAC is developing for the National Forest System will be more complete and will link with the other monitoring tools, especially the analytical tool (step 4 above).

Portable Data Recorder Tool

The use of portable data recorders with data collection software provides several important benefits. By not re-entering the data in the office, the data are available sooner and transcription errors are avoided. The data can be checked for completeness, for valid codes, and for cross checks between data elements in the field, where the data are most easily and accurately corrected.

Since late 2006, NIMAC customers have been using the Field Data Manager (FDM) system developed by the FIA unit in the North Central states. The new national system, Mobile Integrated Data Acquisition System (MIDAS), will soon replace FDM. It is highly flexible and more closely integrated with other FIA data processing software.

Data Storage and Compilation Tool

The data recorder software transfers the field data to servers via the Internet. These field data must then be loaded into the database and error checked again, including some checks that cannot be done on the data recorder. Once the data are determined to be clean and complete, then the data can be loaded into the main database and calculated fields added, such as volume per tree and forest-type class. In addition, the estimation methods used by FIA (Bechtold and Patterson 2005) require additional information about the stratification and population sizes. This information must be loaded into the various "population" tables.

FIA developed and uses the National Information Management System – Compilation System (NIMS-CS) to store and compile the data. NIMAC members have adapted the system for use in Wisconsin, since NIMAC is processing the data for this State. NIMAC has funded the development of the protocol sample design, which includes detailed metadata about each FIA or NIMAC inventory, the attributes collected, and their protocols. Once fully developed and integrated into NIMS, this will add the flexibility needed for NIMAC customers and for FIA to load past survey data into NIMS.

Since NIMS is designed for internal use, NIMAC chose not to try to transfer it to other NIMAC customers for their use yet. Instead, the Formatter program was written to transfer the data from the field tables (Oracle) to a Microsoft Access database that is an enhanced version of the FIADB (FIA Data Base) version available on the FIA website (http://fiatools.fs.fed.us/fiadb-downloads/fiadb3.html "Microsoft Access Database file ready for loading all of the FIADB data"). Currently, Formatter has no editing capabilities and limited ability to compute calculated fields. Enhancements will be added based on customer needs.

Spatial and Tabular Analysis Tools

Once the data are ready in the FIADB format (fia.fs.fed.us/library/database-documentation/FIADB_user_manual_v3-0.pdf, Forest Inventory and Analysis

2008), the data analysis can begin. FIA's primary analytical tool is Forest Inventory Data Online, or FIDO, (Wilson and Ibes 2005) and can be accessed at: http://www.fia.fs.fed.us/tools-data/. With it, the user can select the area of interest (state and counties), the survey years, the summary metric (e.g., area, volume, and biomass), the row and column categories, and apply data filters, if any. The results are presented as tables with associated sampling errors. Some results can also be displayed as maps.

NIMAC modified FIDO somewhat to analyze the Wisconsin inventory (as noted above). The Indiana DNR and Great Plains data will be analyzed using the EVALIDatorPC reporting tool (http://fiatools.fs.fed.us/fiadb-downloads/fiadb3.html). EVALIDatorPC uses the Microsoft Access database mentioned above to compute tables using the same estimation methods used by FIDO. NIMAC is enhancing EVALIDatorPC in order to provide some of the features, such as ratio estimation, included in NIMAC's TabGen analytical tool (Scott and Klopfer 1999).

NIMAC is also cooperating with Wisconsin on the development of a spatial intersection tool to select subsets of plots based on the mapped location. Analysts can use a geographic information system (GIS) to identify areas (polygons) of interest, such as broad buffer zones along streams or roads. These areas are then intersected with the plot locations to identify all the sample plots within those zones. Note that there are locational errors for both plots and map features, so this needs to be factored in when defining the polygon of interest. The plot list is then submitted along with the polygon area to FIDO for analysis. The tool will also be able to associate mapped categories with each plot so that these categories can be used in making the tables of estimates. If available, information on stratification for variance reduction can also be sent to FIDO.

The National Forest System has funded NIMAC to develop the Analytical Tool for Inventory and Monitoring (ATIM). ATIM will build on the strength of FIDO, focus on NFS inventory data, add GIS capabilities for input and output, and will add data query functionality. It will also give the user the flexibility to apply their own algorithms for calculated fields, such as volume equations.

Conclusions

NIMAC has been working on two primary areas: providing technical assistance to a variety of customers and developing inventory and monitoring software.

Technical Assistance

NIMAC continues to work with several states on intensifying their inventories on state-owned lands (IN and WI) or more targeted, specialized inventories (Great Plains). The work with the National Forest System is expanding, especially in the east. With the increasing emphasis on forest certification, carbon monitoring and on local estimates, the demand for NIMAC's assistance will likely increase both within and outside the United States.

Inventory and Monitoring Tools

While continuing to enhance the PC-based tools, Formater and EVALIDatorPC, much of NIMAC's focus will be on the development of the Design and Analytical Tools for Inventory and Monitoring. Although originally designed to meet the needs of National Forest System, many of the new features added will also be applicable to FIDO, thus enhancing FIDO's capabilities for all FIA customers.

It is the goal of NIMAC to assist customers (who are often already cooperators with FIA) in meeting their needs. This collaboration further strengthens the partnerships. In addition, the enhancements that NIMAC customers fund are then made available for use by FIA and other NIMAC customers. NIMAC's goal is to make more efficient and comparable estimates across the landscape, contributing to the sustainable use of our forest resources.

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