

# WHAT SHOULD WE EXPECT FROM OUR NATIONAL INVENTORY AND MONITORING PROGRAM

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**ABSTRACT.**—Forest and rangelands provide significant commodity and noncommodity values for the citizens of the United States. Playing an important and substantial role in ensuring the continued health, productivity, and sustainability of these resources is a reliable and credible inventory and monitoring program. The Forest Inventory and Analysis (FIA) program of the USDA Forest Service has been monitoring the nation's forests for 70 years, and the Forest Health Monitoring (FHM) program has been operating for the last 10 years. Recent efforts by the White House Committee on Environment and Natural Resources (CENR) to integrate inventory and monitoring networks in conjunction with the need to deliver Montreal Process Criteria and Indicators data are reshaping how FIA and FHM will operate in the future. These programs are expected to supply scientifically sound, critical base data for as many as 18 of the 28 biological indicators to monitor and report on U.S. forest sustainability.

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One-third of the U.S. landscape is forested, and monitoring the nation's 737 million acres of forest is a big job. The Forest Inventory and Analysis (FIA) and Forest Health Monitoring (FHM) programs within the Forest Service are the only inventory and monitoring programs in the U.S. that carry out large-scale descriptive forest vegetation inventory and monitoring across all forest land ownerships with consistent, compatible protocols for landscape-scale information reporting. As resource issues become more complex and globally oriented, FIA's and FHM's roles in reporting on the forest resource have been redefined.

## HISTORICAL PERSPECTIVE

Early attempts to estimate the nation's forest resource (Egleston 1885, Kellogg 1907, Zon 1910) were remarkable in their scope, considering the available tools, but lacking in statistical rigor (U.S. Senate 1933). Since 1928, FIA has had a congressional mandate under what is now called the Forest and Rangeland Renewable Resources Research Act (PL 95-307) to monitor the nation's forests with a simple goal to "...make and keep current a comprehensive survey and analysis of the present and prospective conditions of and requirements for renewable resources of the forests and rangelands of the United States." And while the FHM program is much younger, a mere 10 years or so old, it too has a rich history of contributions to our resource knowledge. The passage of the Forest Ecosystems and Atmospheric Pollution Research Act of 1988 (PL 100-521) directs us to "...conduct such surveys

*as are necessary to monitor long-term trends in the health and productivity of domestic forest ecosystems."*

During FIA's first 50 years, inventory focus was primarily on the timber resource (Powell *et al.* 1994, Van Hooser *et al.* 1992). However, events of the last 20 years have brought successive reshaping of this interpretation of the original mandate into a more holistic goal of ecosystem monitoring. The FIA program, in conjunction with the FHM program, is expected to become the linchpin for supplying data for the Montreal Process Criteria and Indicators for the forest resources of the United States.

Both the FIA and the newer FHM already have a rich history of delivering some of the best available information on the nation's forest ecosystems. Some important facts about these programs bear mentioning at this point to demonstrate the magnitude of the infrastructure that is already in place within the Forest Service.

### ***Since 1930, FIA has provided:***

- 200 Statewide forest inventories
- 7 National Assessments (USDA 1958, 1965, 1973, 1982, Waddell *et al.* 1989, Faulkner *et al.* 1993, 1999 in process)
- 2 National biomass studies (USDA 1981, Cost *et al.* 1990)
- 2 National forest land ownership studies (Lewis 1980, Birch 1996)
- 1 National satellite forest cover map of the U.S.
- 100's Primary mill, utilization, and residential fuelwood studies (May 1998)
- 1000's Reports and publications on forest resources
- 300+ Nontimber reports and articles since 1980 (Rudis 1991)
- \* INTERNET access at [www.srsfiaufs.msstate.edu/wo/wofia.htm](http://www.srsfiaufs.msstate.edu/wo/wofia.htm)

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*Since 1990, FHM has:*

- ◆ Established FHM detection monitoring plots in 32 states with annual measurements covering 70% of the nation's forest lands
- ◆ Established FHP/FHM aerial pest surveys with annual coverage of 85% of the nation's forest lands
- ◆ Developed several state and regional Forest Health Assessments
- ◆ Established and supported continuous research on forest health indicators
- ◆ Begun research on linking indicators at intensive or index sites

Criteria and Indicators are the physical outcome of a process that has been incubating in the resource community for many decades. The following are brief summaries of other processes that have moved FIA and FHM in a similar direction and are reshaping our natural resource inventory and monitoring.

### ENHANCING THE MANDATE

After the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests ("Montreal Process") was formed in Geneva in June 1994 to advance the development of internationally agreed upon criteria to monitor sustainable forests. A set of indicators of sustainable forests was then set forth in Santiago, Chile in February 1995. This set of seven criteria and 67 indicators is known as the "Santiago Declaration" (CFS 1995).

The first five criteria contain 28 biological indicators. The combined FIA and FHM programs of the USDA Forest Service are expected to supply critical base data for as many as 18 of the 28 biological indicators to monitor and report on U.S. forest sustainability. These programs currently provide data to respond to eight of the indicators, six are being developed (money is the biggest constraint here), and four need work including policy as well as technical refinements. For those indicators that are not fully available, the general constraint is not technology but funding.

Following is the full list of indicators in the first five criteria and the expected capability of the FIA/FHM program to supply the data.

### Conservation of Biodiversity

#### ECOSYSTEM DIVERSITY

- \*\*\* 1 area of forest by type
- \*\*\* 2 area of forest by type and age
- \* 3 area of forest by type and IUCN category
- \* 4 area of forest by type, age, and IUCN
- \* 5 fragmentation by forest type

#### SPECIES DIVERSITY

- \*\*\* 6 number of forest-dependent species
- 7 status of forest-dependent species

#### GENETIC DIVERSITY

- 8 number of forest-dependent species in restricted range
- 9 population levels of representative species

#### Maintenance of Productive Capacity of Forest Ecosystems

- \*\*\* 10 area of forest land and timberland
- \*\*\* 11 all live and growing-stock volume
- \*\*\* 12 area and growing stock in plantations
- \*\*\* 13 annual removals for products vs. sustainable volume
- 14 removals of nontimber products vs. sustainable levels

#### Maintenance of Forest Ecosystem Health and Vitality

- \*\*\* 15 area and percent forest damaged by insect, disease, fire, flood, etc.
- 16 area and percent forest affected by airborne agents (nitrate, ozone, etc.)
- 17 area and percent forest with diminished biological components

#### Conservation and Maintenance of Soil and Water Resources

- \*\* 18 area and percent of forest with significant soil erosion
- 19 area and percent of forest managed primarily for protective functions
- 20 percent of stream kilometers in forested catchments
- \*\* 21 area and percent of forest with significantly diminished soil organic matter
- \* 22 area and percent of forest with significant soil compaction
- 23 percent of water bodies in forested areas with significant change in biodiversity
- 24 percent of water bodies in forested areas with significant change in hydrologic character
- \*\* 25 area and percent of forest area experiencing significant accumulation of toxic substances

#### Maintenance of Forest Contribution to Global Carbon Cycles

- \*\* 26 total forest biomass and carbon pool by type and age
- \*\* 27 contribution of forest to total global carbon budget
- \*\* 28 contribution of forest products to global carbon budget

\*\*\* FIA/FHM have protocols, \*\*FIA/FHM developing protocols, \*FIA/FHM can develop protocols

## DRIVERS OF CHANGE

What is driving the process to gather this information and who should do it? FIA and FHM scientists realized long ago that proliferation in the volume and access to resource information in concert with considerably more complex resource questions would drive demand for data that were compatible and able to be integrated both spatially and temporally. Efforts to standardize reporting formats began in FIA in the early 1980's and culminated in the Eastwide and Westwide databases, which are currently accessible on the world wide web. We did this in something of a vacuum, feeling we must first get our house in order before moving to the inter-agency realm. By the early 1990's, the interagency integration pot was at full boil. The major events reshaping the inventory and monitoring community are summarized briefly below.

**Committee on the Environment and Natural Resources (CENR)**—FIA and FHM scientists joined a White House effort to develop a framework for integrating environmental monitoring programs to provide more compatible resource information. The White House National Science and Technology Council (NSTC) stated that a goal for ecosystem science is “*to understand, predict, and manage our ecological systems for sustained use and enjoyment.*”— specifically, “*a focused research and monitoring program that improves the information base needed to*

*conduct regional, national, and international syntheses, and periodic regional and national environmental syntheses that integrate and evaluate information.*” Over a 2-year period from 1995 to 1997, an interagency group of scientists set out, under the auspices of the CENR, to propose that “*A conceptual framework that effectively addresses the multiple scales and processes of the environment can be assembled largely from existing methods that have been designed to monitor various aspects of the environment in the most effective manner possible. Logistical limitations impose inherent trade-offs between the number of variables that can be measured, the frequency at which they can be measured, and the number of sites involved. These constraints lead to a hierarchical structure for the monitoring framework, which can be represented by a triangle, with the measurements that can be made at the greatest number of sites at the base of the triangle.*” (OSTP 1996)

The framework as depicted by this triangle (fig. 1) would be made up of three basic elements: (1) index sites where very intensive cause and effect measures might be monitored, (2) national/regional resource surveys such as FIA, FHM, and the National Resources Conservation Service's Natural Resources Inventory (NRI) that are very broad scale, and (3) management inventories and remote sensing programs, which tend to be used to provide very localized information. We actually see this last layer as

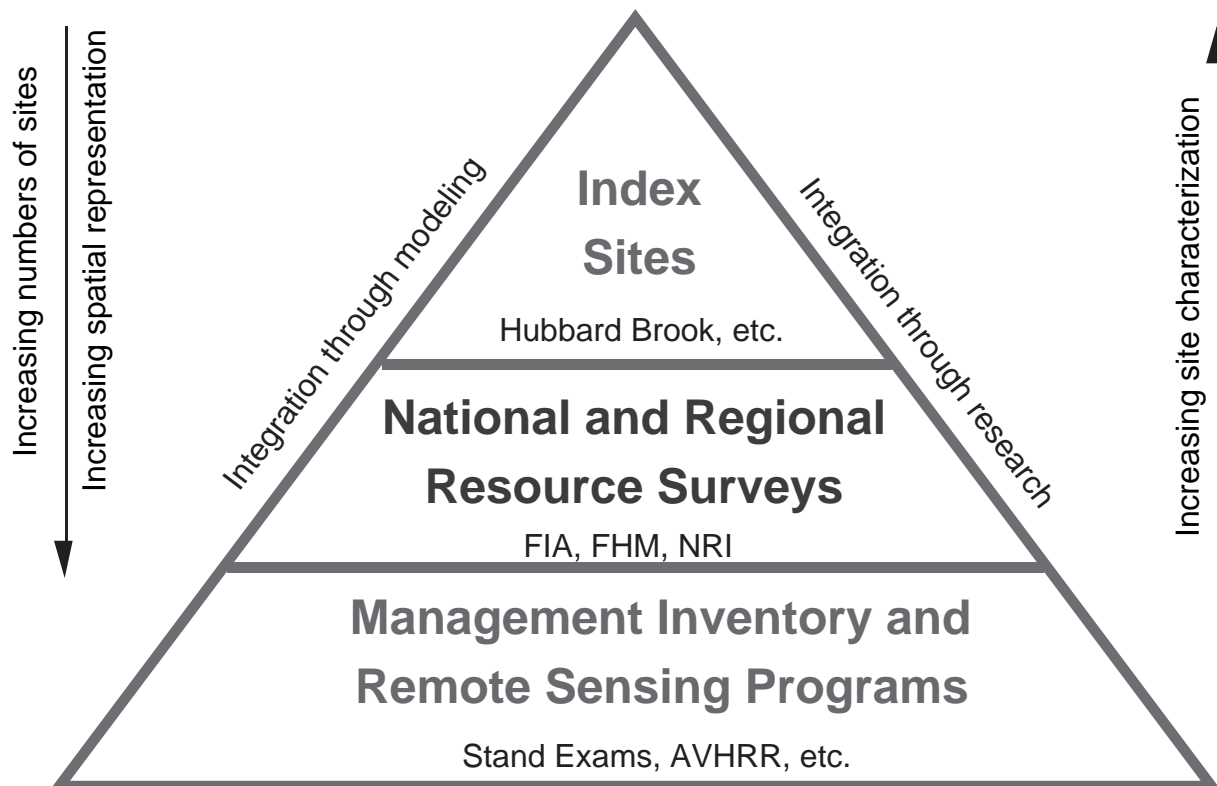


Figure 1.—Framework for integrating environmental networks.

two layers because the remote sensing can be at many scales.

This is really a mom and apple pie concept—to efficiently monitor the resource, you need to develop a framework that encourages the linking of information at various spatial scales through common definitions, protocols, and measurement procedures. All of the new initiatives and mandates that are driving change in FIA and FHM fit neatly within this conceptual framework and support our vision of developing an integrated inventory and monitoring program capable of providing scientifically sound, reliable indicators of sustainable forestry including measures of the extent, condition, and trends in forest ecosystem status and health in a timely and consistent manner across all ownerships.

How does this look in the real world of the systems we have in place now? The Forest Service has vegetative monitoring systems operating at all scales of the CENR framework.

The top tier of the triangle represents selective sites that are monitored very intensively. The agency has identified 20-25 index sites representing the various major ecosystems throughout the U.S. These are in various stages of activation, from Hubbard Brook and Coweeta that are operational to southern pine and juniper sites that are on the drawing board. No intensive site is fully implemented yet or funded for integrated monitoring.

The middle tier represents regional/national scale probabilistic surveys such as FIA and FHM detection monitoring surveys and the NRI program. The FIA and FHM programs locate field plots on systematic random grids. Across the entire U.S., FIA has a plot approximately every 3 miles and FHM has a plot approximately every 16 miles.

At the lowest level are the management inventories such as stand exams conducted by the National Forest System (NFS) and other management level inventories. There are literally tens of thousands of sites where these data are collected. Although remote sensing is shown at this level in the CENR report, it is in fact probably a separate entity that permeates every level. Field data from all other levels, collected in a consistent and compatible manner, become validation data for these remote sensing platforms. The big payoff attained by “fusing” or linking reliable ground data to remote sensing data is that we not only produce pretty pictures, but more importantly we also produce pretty, accurate pictures. Quality assurance is paramount!

**RPA**—The Forest Service has relied upon the FIA program to supply most of its baseline data for national assessments since the early 1950’s. Five-year timing was

made a legal mandate in an amendment to the 1978 Forest and Rangeland Renewable Resources Research Act passed in June of 1998 as part of the Research Title of the Farm Bill. Additionally, the 1997 RPA Assessment will be restructured to follow the framework of the Montreal Process Criteria and Indicators.

**FIA Blueprint for the 90’s**—In the early 1990’s, the FIA/FHM strategic monitoring programs developed a visioning document. “A Blueprint for Forest Inventory and Analysis Research and Vision for the Future,” (USDA 1993) to chart a course for the Forest Inventory and Analysis program throughout the 1990’s. FIA managers realized that as mandated responsibilities grew and the client base became more diverse, they had to become even more responsive to the public’s information needs.

Long-term issues such as increasing pollution, dwindling resources, increasing population, and information proliferation would directly affect the FIA program. Short-term issues such as a changing forest land base, rising noncommodity uses of forests, and environmental health concerns would drive current policy development.

In addition to striving for more consistency and compatibility in current program areas, we needed to increase collaboration with other agencies and partners and move aggressively to develop protocols to monitor ecosystems in a more holistic way, including noncommodity values and information on the urban/wildland interface.

Specific FIA program goals for the 1990’s are: FIA must work with cooperators including Forest Service- National Forest System, Forest Service-State & Private Forestry, states, forest industry, Natural Resources Conservation Service, Bureau of Land Management, Environmental Protection Agency, conservation groups, universities, and concerned citizens to concentrate on attaining these general, high-priority program goals:

As we look back we find this document to be pretty much “on target” with its increased emphasis on noncommodity, urban interface, and forest health issues as well as its maintenance of the strong elements of the existing programs. The only significant change in this blueprint is be that recent legislation has mandated that inventories should be completed every 5 years with data in every state every year instead of the 10-year periodic approach.

**Blue Ribbon Panels On Forest Inventory And Analysis**—In early 1991, the American Forest Council’s Forest Resources Research Committee led a Blue Ribbon Panel reviewing the FIA program (AFC 1991). This panel, formed of high-level leaders from the full forestry

community—federal and state agencies, industry, academia, environmental organizations, and other groups—developed a national vision and strategy for a better forest inventory. The panel also developed goals and objectives for meeting the present and future needs for forest resource inventory information. The BRP1 reached consensus among panel members on six items identified as “the highest priority for insuring continuous improvement of FIA.” The items were:

1. Improve and expand information on ecosystem and noncommodity values
2. Recognize and identify ownership, regulatory, and social impacts on forest productivity
3. Produce the most current resource data possible
4. Implement a uniform approach on all ownerships
5. Increase consistency and compatibility among FIA units and
6. Enhance coordination between FIA units and public agencies.

A second Panel (AF&PA 1998) was formed in October 1997 to: (1) evaluate Forest Service response to the First Blue Ribbon Panel’s (BRP1) recommendations, issued in 1992; and (2) to recommend additional improvements in FIA to meet users’ needs in the 21st century. The panel re-iterated most of the findings of the first panel and chided the agency on its slow progress and limited commitment.

In addition, the BRP2 report recommended additional national level control, authority, and accountability for inventory and monitoring (I&M) progress; more funding; quick merger of FHM and FIA; more coordination with I&M stakeholders; careful consideration of which Montreal Process criteria and indicators can be measured with I&M programs and which cannot; and the creation of a process to monitor progress in implementing the BRP2 recommendations.

**Research Bill Revisions and Strategic Plan**—The Agricultural Research, Extension, and Education Reform Act of 1998 amended the Forest and Rangeland Renewable Resources Research Act of 1978 (PL 95-307) and directed the Forest Service to establish a program to inventory and analyze, in a timely manner, public and private forests and their resources in the United States, measuring annually 20 percent of all sample plots that are included in the inventory in each state. Reports are due for each state every 5 years, which include analysis of the status and health of the forest.

The law states that the Forest Service, in carrying out this task, prepare a strategic plan describing necessary (1) financial resources, (2) personnel, (3) organization and procedures, (4) schedules for measurements, (5) core variables and tables, and (6) process for employing

advanced technologies. This plan is due to Congress by December 20, 1998.

**Global Assessments**—Within the last two decades, there has been an increasing awareness of global forestry issues. Forest ecosystem sustainability is being viewed as an indicator of social as well as environmental health. The Committee on Forestry, FAO, has formulated a comprehensive Forest Resources Assessment (FRA) program consisting of four components: (1) country capacity building, (2) assessments of the multiple benefits of forests, (3) assessment based on existing reliable information, and (4) remote sensing survey. The Forest Service FIA program has provided information for global assessments for many years and is committed to providing statistically reliable information that is compatible with global reporting protocols (USDA 1998).

It has been a valuable process to coordinate assessment activities internationally to make sure our data systems can produce compatible data globally. Participation in the first Approximation process with 10 other countries for Montreal Criteria and Indicators (CFS 1997) and the Temperate and Boreal Forest Resource Assessment (TBFRA) has been very revealing. The first Approximation helped us see what we had and the TBFRA helped us see how our information fit into the Pan-European and Helsinki protocols. The key to bridging gaps is convergence on common protocols and definitions by successive clarification/refinement or harmonization.

## CONCLUSION

Perhaps the most significant driver of change from a policy perspective is the CENR Framework, which provides a generic vision to develop an integrated inventory and monitoring program that relies on collaboration and resource data that can be linked across scales. The Montreal Process Criteria and Indicators fit neatly within this framework both nationally and internationally.

The FIA and FHM programs of the Forest Service will play a significant role in supplying indicators of forest sustainability, not only for the Montreal criteria and indicators, but also for a broad contingent of local regional and national clients. With this infrastructure firmly in place, the United States is able not only to provide data for the indicators but also to assess their accuracy.

The Farm Bill instructed FIA to develop core variables and protocols, and the Criteria and Indicators identified at least a partial list of what those should be and put a bit of flesh to the bones of what a “comprehensive inventory” should contain. Support by the Blue Ribbon Panels and interested users of resource data has done a great deal to further the FIA/FHM mission to report on the extent,

condition, and trends in forest ecosystem status and health in a timely and consistent manner across all land ownerships.

The FIA and FHM programs endorse the CENR framework as a sound strategic approach for forest inventory and monitoring activities. Within this framework, FIA and FHM will pursue research and development that will assist us in complying with the Montreal Process Criteria and Indicators for monitoring sustainable forestry. We will continue to build an I&M program that can integrate across scales. The actions needed will require contributions from all parts of the agency. It will also make it possible to integrate our data internally so we can serve external I&M stakeholders more effectively.

FIA/FHM will provide “wall-to-wall” coverage across all land ownerships and develop strategies to integrate data seamlessly across all spatial scales. Summaries of I&M information will include interpretive analyses and maps and projections of future conditions, not just tabular information.

FIA/FHM will continue to expand and develop core variables for reporting conditions. Initially the core variables would be those collected in the FIA program because we have consensus on these nationally. Then, as part of merging the FHM and FIA programs, ecological information from the FHM suite of variables and other critical ecological information would be added to the core. A published field manual will document the protocols and quality assurance parameters for core data. Regional field units would still be free to augment the core with additional data to serve specific local needs.

You are invited to review all of the exciting new things going on in FIA by visiting us on the world wide web at : [www.srsfia.usfs.msstate.edu/wo/wofia.htm](http://www.srsfia.usfs.msstate.edu/wo/wofia.htm) [to link to national and regional FIA data and information] or our temporary RPA sites at [www.srsfia.usfs.msstate.edu/rpa/inv](http://www.srsfia.usfs.msstate.edu/rpa/inv) [for national inventory data] [www.srsfia.usfs.msstate.edu/rpa/tpo](http://www.srsfia.usfs.msstate.edu/rpa/tpo) [for national forest products data]

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