United States Department of Agriculture

Forest Service

Helena National Forest

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Subject: Clancy-Unionville Supplemental Information Report (FSH 1909.15 Section 18.1)-Old Growth

To: District Ranger, Helena Ranger District

Introduction

Recently, new information has come about that is relevant to environmental concerns that have been expressed related to the Clancy-Unionville Vegetation project. Two new reports concerning old growth on the Helena National Forest have been completed. The Northern Region Forest and Rangeland staff have completed two reports using data from the Forest Inventory and Analysis (FIA) program for the landscapes on the Helena National Forest. One of the reports analyzed old growth within 5th code HUCs while the other report analyzed old growth by landscape area. The landscape area report is most applicable and that report is found in Attachment A. Furthermore, a paper discussing FIA and its statistical reliability was received and is attached as Attachment B.

Results and Analysis

Forestwide Old Growth Analysis with FIA

The Forest Inventory and Analysis (FIA) Program is a nationwide grid to collect and analyze forested lands across all ownership. The program is administered by five regional programs, one for the 13 Southern States, one for the 12 Northeastern States, one for the 12 North Central States, one for the Pacific Coast States, and Interior West Forest Inventory and Analysis (IWFIA). Data collection occurs across a 5000 meter grid, with each plot representing approximately 6200 acres. Nearly 120 variables are collected at each location.

Recently, the Helena National Forest received information related to old growth across the forest using data compiled through the FIA program. The information received for old growth includes data reflecting events such as wildfire events and management activities that have modified the forestland canopy since 1996-1998 when the FIA data was collected. One hundred fifty FIA plots were established on the Helena National Forest in 1996. One hundred thirty-nine of those plots are forested land while the remaining eleven plots are nonforest land or water.

The FIA data are extrapolated for the Forest, based on the FIA random sampling grid. Confidence intervals are calculated for all analyses. Data are not represented with specific spatial locations but are related to various land masses, such as the Forest boundary or landscape analysis areas. See Attachment C for a map of the landscape areas.

An old growth analysis by Bush and Zeiler, May, 2004 (Attachment A), displays estimates of

Forest-wide old growth per landscape as well as for the whole Forest. The landscapes were identified as Big Belts, Blackfoot, Divide, (Blackfoot and Divide combined represents the Continental Divide), and Elkhorns with a 90% confidence interval (See Attachment A). The analysis included all 139 FIA plots that are considered forested on the forest. This analysis showed that the estimated percent of old growth on all forested lands on the Helena National Forest had a mean of 8.64% with a 90% confidence interval, with a lower bound of 5.90% to an upper bound of 11.51%. The following table was produced by Renate Bush and J.D. Zeiler, Northern Region Forest and Range staff (May, 2004) and shows the amount of old growth by landscape area.

Estimated percentage of Old Growth on all forested lands on the Helena National Forest by landscape area:

Landscape	**Number of Plots**	**Percent of Plots**	**Number of Missing Subplots**	**90% CI For Percent Old Growth**		
				Lower Bound	*Point Estimate*	*Upper Bound*
Big Belts	47	33.8	0	3.20%	8.09%	13.70%
Blackfoot	46	33.1	0	6.09%	11.30%	17.08%
Divide	33	23.7	0	1.54%	5.45%	10.00%
Elkhorns	13	9.3	0	1.43%	9.23%	18.67%

The above analysis shows that old growth is well distributed across the Helena National Forest.

The Clancy-Unionville project is located in the Divide landscape area which has a weighted average of 5.45% old growth with a 90% confidence interval, with a lower bound of 1.54% to an upper bound of 10.00%. The decision in the Clancy-Unionville project does not remove any field verified old growth. Seventeen acres of old growth are treated to have increased fire resistance while protecting the old growth characteristics of the stand. This analysis supports the Forest Vegetation report in the Clancy-Unionville project file and the FSEIS.

Old Growth Analysis for Third Order drainages

The Helena National Forest Plan (1986) recognized old growth as an important forest component. Forest-wide old growth standards were established in the Helena Forest Plan (pg. II/20-21) as follows:

> "Five percent of each third order drainage should be managed for old growth. The priority for old growth acres within each drainage is: first, land below 6000 feet in elevation; second, riparian zones and mesic drainage heads; and third management areas emphasizing wildlife habitat. These areas will normally be managed on a 240 year rotation and will range from 10 acres to several hundred acres.
>
> Management areas other than T-1 through T-5 will be the primary source for old growth. However, if adequate old growth area cannot be achieved then the T management areas will be considered to meet old growth objectives."

Green et al. (1992) old growth definitions were incorporated into Appendix Z of the Forest Plan on August 13, 1993, replacing the original old growth definition found in the Forest Plan glossary. The minimum stand characteristics criteria described in the Green et al. (1992) publication include live trees per acre, age and diameter at breast height for a given forest type. Additional stand characteristics such as snags and down wood are used to describe old growth quality, but are not used to determine whether or not a stand has minimum old growth characteristics (Green et al. 1992).

The Forest has consistently interpreted and represented this standard as being an attempt to provide some spatial distribution of areas to be managed for existing or future old growth characteristics. The intent of the Helena Forest Plan standard for old growth is that areas will be identified to be managed for old growth characteristics when a drainage is entered for active management that could affect forest stand characteristics. The areas to be managed for old growth, "managed old growth", are selected based on the following criteria:

> Elevation. -- Stands below 6000 feet are prioritized.
> Management Area. --- Stands that are not T-1 through T-5 are prioritized.
> Age. --- Using FSVEG and TSMRS components data (tsmrs_all_components table) the oldest stands within the drainage are prioritized. Stands with full stand exams are selected over stands with walk through or photo interpreted information.

The Clancy-Unionville FSEIS identified that the one 3rd order drainage within the project area has 10% existing field verified old growth, and 7% replacement old growth (Chapter 3—309). The decision in the Clancy-Unionville project does not remove any existing field verified old growth through harvest. The decision provides treatment of seventeen acres of old growth. These acres are treated by thinning to increase fire resistance, while protecting the old growth characteristics of the stand. As such, the 3rd order drainage within the project has well above the Forest Plan standard of 5% old growth and will remain above the standard.

Subsequent to the Clancy-Unionville decision, the Helena NF produced a map identifying the 5% managed old growth across the Forest. The map (Attachment D) shows each third order drainage on the Forest that have managed old growth. In each of those drainages the Forest has identified 5% managed old growth, which complies with the Forest Plan standard.
There are a total of 119 third order drainages on the Helena National Forest, comprising 558,885 acres. Fifty-five of these drainages, have had some timber management activity since the adoption of the Forest Plan in 1986.

The remaining 64 drainages have not had management activity that affects forest stand characteristics since 1986. Of these third order drainages, 17 (66,980 acres) are within wilderness areas and are not part of lands that could be managed for timber harvest. In the remaining 47 drainages, as activities are proposed for management that may affect forest stand characteristics, an old growth inventory is conducted and 5% managed old growth is identified in each third order drainage affected. Areas where timber management has not occurred are available for old growth designation as no decisions have been made that affect old growth characteristics of forested stands.

Landscape Area** and **Foretswide Summary of Acres based** on **Stand Exams with** Old **Growth Characteristics

In addition, subsequent to the Clancy-Unionvile decision, the Forest has also completed a analysis, based on field stand exams, which identified acres with old growth characteristics.

Only approximately 30% of the Forest land base has been sampled with stand exams as stand exams are conducted generally only where timber management activities are proposed. Of the 30% of the forest sampled, approximately 15% of those acres currently have minimum old growth characteristics as defined by Green et al. (1992). Attachment E shows a map of the sampled stands, based on stand exams, that have old growth characteristics. It is reasonable to assume that further sampling and project level old growth inventories will reveal more acres with old growth characteristics.

Relationship of the New Information to the Clancy-Unionville FSEIS Analysis

Based on my review of all of the information presented in the SIR and accompanying project file I have determined that the conclusions in the Final Supplemental Environmental Impact Statement are accurate and that the project will not have adverse impacts on old growth on the Helena National Forest. The above information supports the conclusions in the vegetation report for the Clancy-Unionville project.

Recommendations

Considering the above information, it is my recommendation that the Clancy-Unionville project does not require additional environmental analysis. The effects as depicted in the Clancy-Unionville Project FSEIS and Record of Decision are still valid. It is my recommendation that a correction, supplement or revision to the FSEIS is not necessary and the vegetative management actions authorized by the Clancy-Unionville project will be consistent with the Helena Forest Plan forest-wide old growth standards and could proceed.

Submitted by:

Lois Olsen

7-13-04

Lois Olsen
Forest Ecologist
Helena National Forest

Date

References

Green, P.; J. Joy; D. Sirucek; W. Hann; A. Zack; and B. Naumann. 1992. Old Growth Forest Types of the Northern Region. Missoula, MT. United States Department of Agriculture, Forest Service, Northern Region. 61 p

USDA Forest Service, 1986. Helena National Forest Plan. Unpublished report. Available at the Helena National Forest Supervisor's Office.

Attachment A

Detailed Estimates of Old Growth By Landscapes on the Helena National Forest

Renate Bush [1]
J.D. Zeiler[2]

May 28, 2004

Analysis was done using Forest Inventory and Analysis (FIA) data, see Application of Forest Inventory and Analysis (FIA) Data to Estimate Amount of Old Growth Forest and Snag Density in the Northern Region of the National Forest System for an overview on why it is appropriate to use this data for broad-scale analysis. All forested[3] FIA plots that were located on the Helena National Forest were used to estimate the proportion of old growth by landscapes. Region One's old growth definition[4] was used in the analysis. Those FIA plots in which wildfire or harvest have occurred since the 1996-1998 inventory, were coded to not meet the old growth definition. This results in a conservative estimate of old growth as not all wildfire and harvest activities remove all old growth on the landscape. The following provides estimates of old growth for the Helena National Forest by Landscapes.

Estimates of Old Growth for the Helena National Forest by Landscapes:

Estimated percentage of Old Growth on all forested lands on the Helena National Forest by the Big Belts, Blackfoot, Divide, and Elkhorns landscapes:

Landscape	Number of Plots	Percent of Plots	Number of Missing Subplots	90% CI For Percent Old Growth		
				Lower Bound	Point Estimate	Upper Bound
Big Belts	47	33.8	0	3.20%	8.09%	13.70%
Blackfoot	46	33.1	0	6.09%	11.30%	17.08%
Divide	33	23.7	0	1.54%	5.45%	10.00%
Elkhorns	13	9.3	0	1.43%	9.23%	18.67%

Estimated percentage of Old Growth on all forested lands on the Helena National Forest by the Big Belts, Continental Divide (combination of Blackfoot and Divide), and Elkhorns landscapes:

Landscape	Number of	Percent of	Number of	90% CI For Percent Old Growth

[1] Forester, Inventory and Analysis, USDA Forest Service, Region 1, Forest and Range Management, 200 E Broadway, Missoula, MT, 59801.
[2] System Analyst, USDA Forest Service, Forest and Range Management, 200 E Broadway, Missoula, MT, 59801.
[3] "..land at least 10 percent stocked, or currently nonstocked but formerly having such stocking, with timber and/or woodland trees, and where human activity on the site does not preclude natural succession of the forest (i.e., the site will be naturally or artificially regenerated)." *Interior West Forest Land Resource Inventory Field Procedures, 1995-1996.*
[4] Green, P.; J. Joy; D. Sirucek; W. Hann; A. Zack; and B. Naumann. 1992. Old Growth Forest Types of the Northern Region. Missoula, MT. United States Department of Agriculture, Forest Service, Northern Region. 61 p

	Plots	Plots	Missing Subplots	Lower Bound	Point Estimate	Upper Bound
Big Belts	47	33.8	0	3.20%	8.09%	13.64%
Continental Divide *	79	56.8	0	5.32%	8.86%	12.75%
Elkhorns	13	9.3	0	1.54%	9.23%	18.67%

* Continental Divide is a combination of the Blackfoot and Divide Landscapes

Estimates of Old Growth for the Helena National Forest:

Estimated percentage of Old Growth on all forested lands on the Helena National Forest is 8.64% with a 90% confidence interval of 5.90% to 11.51%. There are 139 FIA plots that are considered forested on the forest.

Attachment B

Application of Forest Inventory and Analysis (FIA) Data to Estimate the Amount of Old Growth Forest and Snag Density in the Northern Region of the National Forest System

Raymond L. Czaplewski, Ph.D.[1,2]

September 15, 2003

Introduction

This report discusses valid use of data produced by the Forest Service's Forest Inventory and Analysis program and used by the Northern Region of the National Forest System to analyze the compliance of individual National Forests with their Standards and Guidelines for snag density and the percentage of forest area that meets the definition of old growth. This report does not give the results of such analyses. Rather, this report gives the rational for use of FIA data for such analyses.

Description of the national Forest Inventory and Analysis Program

Since 1930, the Research and Development Deputy Area of the USDA Forest Service has been responsible for conducting the Forest Inventory and Analysis (FIA) program. The Research and Development Deputy Area is directly accountable to the Chief of the Forest Service, which makes it administratively independent from the National Forest System. By design, FIA is conducted by the Research and Development Deputy Area to assure impartiality and scientific credibility.

FIA is the only Congressionally mandated, comprehensive, field-based forest inventory for each of the 50 States, Puerto Rico, and Trust Territories. The McSweeney-McNary Forest Research Act of 1928 specifies the FIA mission[3] to "*Make and keep current a comprehensive inventory and analysis of the present and prospective conditions of and requirements for the renewable resources of the forest and rangelands of the United States*."

[1] USDA Forest Service; Research and Development Deputy Area; Rocky Mountain Research Station; Forest Inventory and Monitoring Environmetrics, Research Work Unit RMRS-4804; 2150 Centre Ave. Bldg. A., Fort Collins, CO 80526. 970-295-5945. http://www.fs.fed.us/rm/ftcol/rwu4804.htm
[2] Project Leader, Research Mathematical Statistician, 970-295-5973; rczaplewski@fs.fed.us
[3] See http://fia.fs.fed.us/about.htm for an overview of the FIA program.

FIA is the nation's census of its public and private forestlands[3]. In a study commissioned by the White House Office of Science and Technology Policy, the RAND Corporation found that "FIA is the nation's most ambitious forest monitoring program[4]." FIA produces statistical reports and analytical information on status and trends in forest area and location; species, size, and health of trees; total tree growth, mortality, and removals by harvest; wood production and utilization rates for various products; and forest land ownership. This information supports policy analyses of sustainable forestry at the federal and state levels; better management planning and assessments of land management practices; investigations of changes in forest ecosystems; formulation of business plans in the private sector that are economically and ecologically sustainable; and information to inform citizens about the health and sustainability of the nation's forests.

Users of FIA data come from many groups, including State and Federal forestry agencies, private industry, academia, environmental organizations, and anyone else who wants reliable information about the Nation's forests. FIA data serve many internal needs within the Forest Service, such as status reports on international Criteria and Indicators of Sustainable Development, and special assessments, such as the United Nation's Food and Agriculture Organization (FAO) global Forest Resource Assessment. The Forest and Rangeland Renewable Resources Planning Act of 1974, P.L. 93-378, as amended, directed the Secretary of Agriculture to prepare a Renewable Resources Assessment every 10 years. These assessments include "an analysis of present and anticipated uses, demand for, and supply of the renewable resources, with consideration of the international resource situation, and an emphasis of pertinent supply, demand and price relationships trends." FIA data provides the foundation for many of the analyses used in each decadal assessment.

The Agricultural Research, Extension, and Education Reform Act of 1998 (P.L. 105-185) mandates that FIA data be consistently collected and summarized across all land ownerships, including public lands managed by the National Forest System, with reports for each State produced at five year intervals.[5,6]

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[4] Peterson, D.J.; Resetar, Susan; Brower, Jennifer; and Diver, Ron. 1999. *Forest Monitoring and Remote Sensing: A Survey of Accomplishments and Opportunities for the Future*. MR-1111.0-OSTP. Arlington, VA. Science and Technology Policy Institute, RAND Corporation. 90 p. http://www.rand.org/publications/MR/MR1111.0/

[5] Gillespie, Andrew J. R. and W. Brad Smith. 2000. Introduction to the Forest Inventory and Analysis Program. USDA Forest Service, National FIA Program Staff, Washington, DC http://fia.fs.fed.us/library/fia_for_nfs.rtf

[6] 1999 FIA Strategic Plan for Forest Inventory and Monitoring, http://fia.fs.fed.us/library/strategy.pdf

As an example of its scientific stature, FIA maintains a bibliographic database[7] of over 1,400 reports and scholarly papers dealing with FIA field surveys for the United States and its territories for the period 1975 through July 2001. These citations include integrated assessments and multi-disciplinary surveys, representative citations associated with timber resource assessments, and all known M.S. theses and Ph.D. dissertations associated with FIA data since 1975, regardless of topic.

FIA is a large, national program. In Fiscal Year 2002[8], total funds available to FIA were $55,919,830, which as approximately 22% of the total national budget for Forest Service Research and Development. In 2002, FIA measured 14,827 forested field plots in the USA, which is 12.4% of the total. The Interior West FIA Research Work Unit[9], which is responsible for covering the Northern Region of the National Forest System, measured 1,651 plots, which represents about 4% of the total FIA plots maintained by this Unit. The average direct cost of measuring a single FIA forested field plot in 2002 was $3,274 in the Interior West.[10]

The FIA program is responsible for the scientific integrity of its forest statistics. FIA exercises this responsibility, in part, through scientific peer review and other reviews, both internal and external. At the request of FIA, the Society of American Foresters[11] regularly convenes a national Blue Ribbon Panel on FIA[12]. The panel has representatives of FIA partners and external customers from the Forest Service, other federal agencies, universities, states, industry, trade associations, environmental organizations, and professional societies. The Panel reviews FIA performance and results, and has reported its major findings in 1992, 1998 and 2001.[12]

FIA has a national Executive Team and a separate national Management Team. Both teams are jointly responsible for appropriate actions that maintain and protect the scientific integrity and quality of the FIA program.[13] The FIA Management Team is chaired by the National FIA Program Leader, and it is composed of six program managers in the Forest Service Research and Development Deputy Area who are responsible for the FIA Research Work Units, two representatives from the Forest

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[7] *A Quarter Century of Multipurpose Forest Inventories in the United States*, Victor Rudis, http://www.msstate.edu/dept/forestry/biblio.html
[8] http://fia.fs.fed.us/library/FIA_Annual_Report_2002.pdf
[9] http://www.fs.fed.us/rm/ogden/index.html
[10] Includes field support, field crews, QA crews, field/QA crew travel, vehicles, field equipment, partner contributions, and grants and agreements for field-related activities. All costs prorated to forested P2 field plots. See http://fia.fs.fed.us/library/FIA_Annual_Report_2002.pdf
[11] The Society of American Foresters (SAF) is the national scientific and educational organization representing the forestry profession in the United States. See http://www.safnet.org/
[12] Reports of the Blue Ribbon Panel on FIA are available at http://fia.fs.fed.us/library.htm#Business.
[13] ftp://socrates.lv-hrc.nevada.edu/fia/mteam/

Service State and Private Forestry Deputy Area, two representatives from the National Forest System Deputy Area; and a representative of State Foresters from each of the Northeastern, Southern, and Western Associations of State Foresters (appointed by the Chair of the of the National Association of State Foresters.[14] The FIA Executive Team is chaired by the Washington Office Staff Director for Science Policy, Planning, Inventory, and Information in the Research and Development Deputy Area[15]; other members include the five Directors of those Research Stations[15] that supervise FIA Research Work Units, two Regional Foresters from the National Forest System[16], a State Forester from each of the Northeastern, Southern, and Western Associations of State Foresters (also appointed by the Chair of the of the National Association of State Foresters[14], a Washington Office Staff Director from the National Forest System, and a Washington Office Staff Director from the State and Private Forestry (SPF) Deputy Area.

FIA publications are reviewed and approved in compliance with Forest Service Manual FSM 1630[17] and Forest Service Handbook FSH 1609.11[18]. The Research Station[15] Director is responsible for the review process of FIA publications (FSM 1630.42a). The Assistant Station Director for Research and Development is responsible for the formal review of each FIA publication (FSM 1630.42b). The FIA Program Managers supervise the writing of planned manuscripts and ensures the objective review of each FIA manuscript (FSM 1630.42c). The author of each FIA publication is responsible for preparing factually accurate reports, and obtaining objective peer and administrative reviews of their FIA publications (FSM 1630.43). The FIA Program Managers must also ensure that authors of FIA publications solicit written comments from at least two peers competent in the subject matter (not located in the author's immediate office); solicit statistical review when appropriate; and supply the Assistant Director for Research who is to perform the final review with a revised manuscript, along with review comments and reasons for any rejection of review comments (FSM 1631.15; FSH 1611.14.2). Research Stations maintain lists that contain mailing information for any individual who has expressed interest in receiving FIA publications (FSM 1633.22). FIA publications are available from the Publications Section at each Research Station at no direct cost to the public.

The FIA Management Team commissions technical teams[19] that help FIA deliver a consistent, efficient, and complete core national program. There are currently six teams[20]

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[14] http://www.stateforesters.org/
[15] http://www.fs.fed.us/research/
[16] http://www.fs.fed.us/contactus/regions.shtml
[17] http://fsweb.wo.fs.fed.us/directives/fsm/1600/1630.doc
[18] http://fsweb.wo.fs.fed.us/directives/fsh/1609.11/1609.11,10_contents.rtf
[19] http://fhm-server.lv-hrc.nevada.edu/fia/band_overview.htm

that address the following subjects: Data Acquisition; Analysis and Reporting; Information Management and Compilation; Remote Sensing, Statistics, and Indicator Advisors. Each technical team is composed of representatives from the six FIA Research Work Units; one representative from a State Forester agency in each of three regions of the USA (south, north, and west); two representatives from the National Forest System; one representative from the State and Private Forestry Deputy Area; and a non-voting liaison member from the FIA Management Team. Other scientists and technical specialists from universities or public agencies may participate on a temporary or permanent basis.

The *Data Acquisition* team develops, tests, and documents standard approaches to collecting core FIA data collected in the field. This includes documentation, training programs, and quality assurance approaches, as well as identifying problems for analysts or Indicator Advisors to address. The current national FIA field manual for national core variables has undergone external peer review[21].

The *Information Management and Compilation* team develops and maintains data base management systems for core FIA data, including systems for data editing and validation, internal and external databases, and web applications for allowing outside users to access and analyze FIA data.

The *Statistics* team develops and documents national standards for the statistical techniques, conceptual details, and technical specifics of collecting and analyzing FIA core data. The FIA statistical documentation is currently under extensive review by an independent and external panel of experts.

The *Remote Sensing* team focuses on modeling the remote sensing business requirements for FIA operations, and explores ways in which remote sensing can enhance FIA program delivery, including development of new information products.

The *Analysis and Reporting* team develops statistically defensible approaches to summarizing core FIA data, including identification of new variables needed by FIA customers.

The Indicator Advisors team focuses on developing the processes for implementing FIA indicators of forest health and condition, from documentation

[20] http://socrates.lv-hrc.nevada.edu/fia/band_links.htm
[21] http://fia.fs.fed.us/library.htm#Manuals

and training through analysis and reporting. Members of each team are technically competent in the applicable subject area.

These teams identify any weaknesses in the FIA approach to core technical issues, and they recommend solutions to the FIA Management Team.[19]

FIA Sampling, Measurement and Estimation Techniques

FIA uses a standardized plot configuration, which is designed to measure a diverse spectrum of forest conditions, ranging from seedling/sapling stands to mature stands, in tropical, temperate and boreal forests, and within public and private ownerships. The National Forest System applies its definition of old growth forest using data collected according to FIA standards and maintained in the FIA database.

It is not feasible to measure every tree or every acre within the 749-million acres of forestland in the USA. Therefore, FIA draws a representative sample of field plots, and uses data from those plots to estimate the condition of all 749-million acres of forestlands. FIA uses a probability sample, which by design allows FIA to quantify the uncertainty in its estimates that are caused by random sampling.

FIA maintains a base federal sample of about 360,000 field plots in the United States, which is approximately one sample plot for every 6,000 acres[22]. Of these sample plots, about 120,000 have forest cover. The same survey protocols and uniform systematic sampling frame are used in all of the nation's forests regardless of public or private ownership (**Figure 0**).

Each FIA field plot is located at randomized point within a regular, systematic cell in a standardized grid[23] across the entire United States. By design, this provides a representative sampling frame for the nation[24]. Each FIA plot is a cluster of sub-plots that collectively cover an area that is nominally one acre in size, and FIA measures a probability sub-sample of trees at each sub-plot within this cluster. Each forested field plot is typically measured in the course of a single day by a two-person crew. A sub-sample of FIA plots is independently re-measured for quality assurance.

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[22] See http://fia.fs.fed.us/library.htm#factsheets
[23] See http://fia.fs.fed.us/
[24] This has been a standard practice in forest inventories for over 50 years. See Osborne, J. G. 1942. Sampling errors for systematic and random surveys of cover type areas. *Journal of the American Statistical* Association. 37:256-264; and Bickford, C. Allen. 1952. The sampling design used in the forest survey of the Northeast. *Journal of Forestry* 50:290-293.

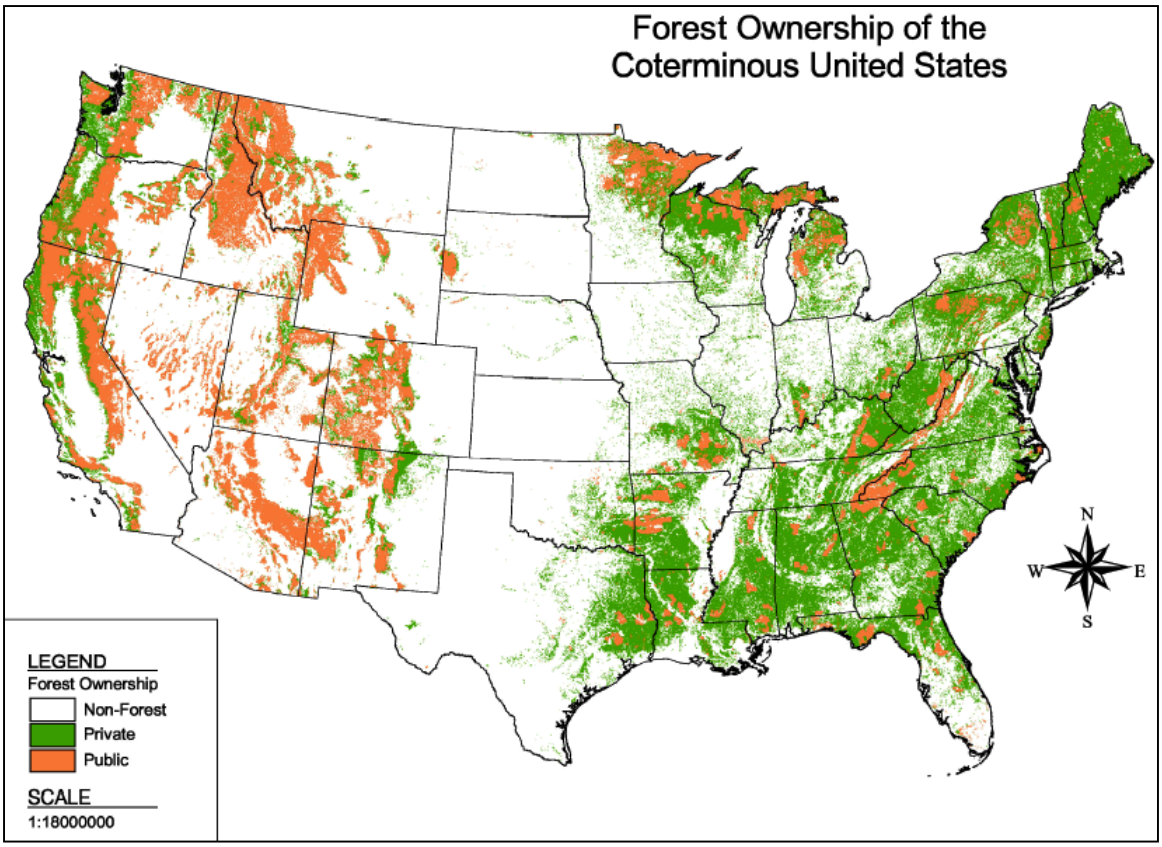

Figure 0 The FIA program surveys the all of the 413-million acres of our nation's private forests, and all 336-million acres of its public forests, with a nationally consistent sample of 120,000 forested field plots, each nominally 1-acre in size. The average National Forest of 1.2-million acres can be expected to have approximately 200 of these 120,000 FIA plots, and FIA sample data can provide reliable estimates for geographic areas as small as 0.2-million acres[5], depending on the required estimation precision. (Illustration courtesy of Brad Smith, FIA Washington Office staff.)

Each National Forest is covered by the same FIA sampling frame that exists on all other public and private lands. For example, The Lolo National Forest is covered by 347 of these 360,000 FIA plots (Figure 1). The FIA sampling grid provides an equal-probability sample of each National Forest. This sampling grid uniformly covers any Wilderness Areas and roadless areas as well as lands managed for other purposes, regardless of their suitably for timber production. Therefore, the FIA sampling frame is appropriate to make scientifically defensible and reliable inferences regarding the condition of forests within sufficiently large areas[5], regardless of their management regime. These inferences include estimation of snag density and the proportion of all forested areas in a National Forest that meets its definition of old growth forest.

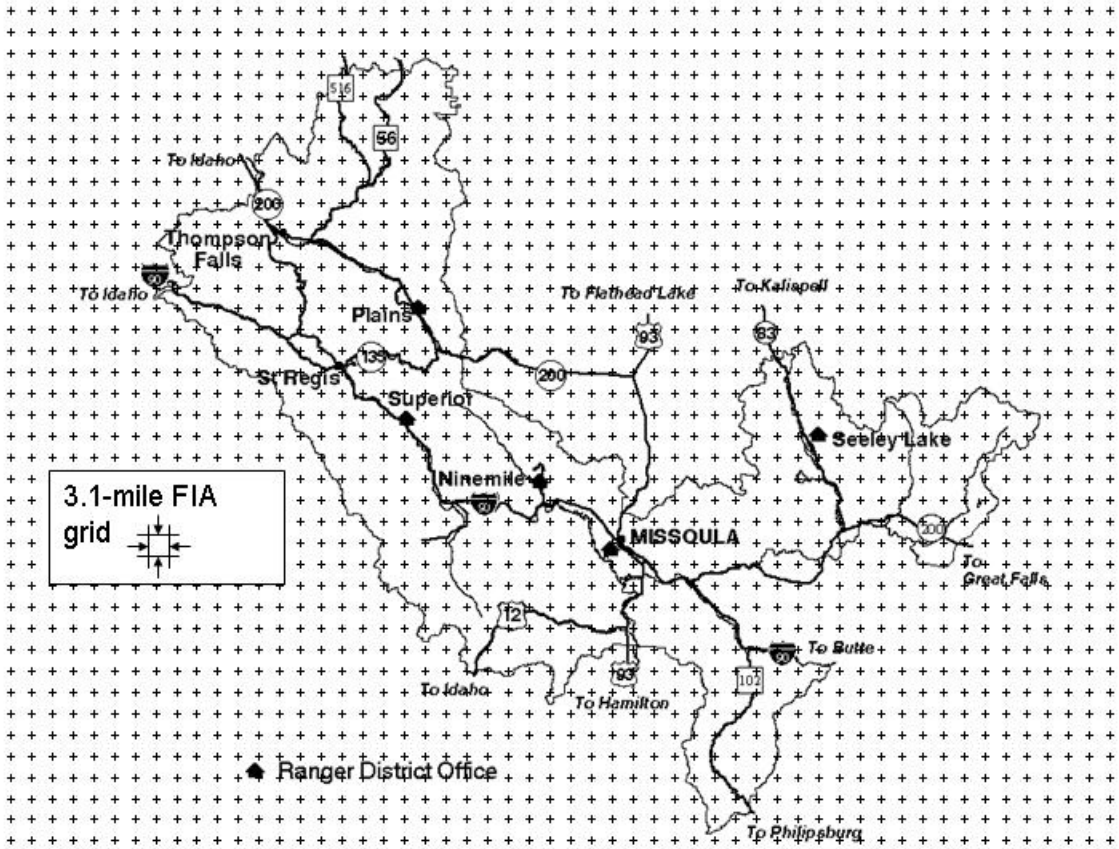

Figure 1 Representative map (to scale) of FIA sampling grid in the vicinity of the Lolo National Forest. An FIA field plot is systematically located with a sampling intensity indicated by the cross marks. In the 1995-1996 inventory of lands managed by the Lolo National Forest, there were 347 FIA sample locations, of which 327 locations were classified as forested, 17 locations were classified as either non-forest or water, and 3 locations were inaccessible.

The FIA Sample Covering the National Forests in Region One

The forest inventories for the Northern Region in the FIA database had used a cluster plot composed of five variable-radius sub-plots, each with a Basal Area Factor of 40. This plot configuration was the standard protocol at that time in the Interior West. Each of the five FIA sub-plots in the FIA cluster matches the plot configuration used to develop the definition of old growth forest[25]; therefore, the scale and extent of each FIA sub-plot is

[25] Green, P.; J. Joy; D. Sirucek; W. Hann; A. Zack; and B. Naumann. 1992. Old Growth Forest Types of the Northern Region. Missoula, MT. United States Department of Agriculture, Forest Service, Northern Region. 61 p

well suited to apply the definition of old growth forest used throughout the Northern Region of the National Forest System. FIA currently uses a cluster of four subplots, each encompassing 1/24th of an acre, and together cumulatively covering 1/6th of an acre. These four subplots are uniformily distributed within a nominal area of 1-acre.

Uncertainty in Estimates from a Forest Inventory

Like any forest inventory of a large geographic area, FIA uses sampling, and there is some uncertainty in estimates for an entire population that are based upon a sample of that population. The role of the forest survey scientist is to make defensible estimates and characterize the degree of this uncertainty. The role of the decision-maker is to use those estimates to help make an informed decision in the presence of uncertainty.

It is possible to quantify the degree of uncertainty for any scientifically rigorous probability sample. One common metric is the "confidence interval." Sampling in forest inventory has some similarities to sampling in the familiar opinion poll. Assume a scientific poll estimates the proportion of the sampled population who are in favor of a proposition is "53% with a margin of error of ±3%." The "±3%" is an example of a confidence interval. The upper limit is 53%-3%=50%, and the lower limit is 53%+3%=56%. Assume that the "confidence level" is 90%. Some might explain this as a 90% probability that the true proportion is between 50% and 56%. However, a more precise explanation follows. If independently replicated 100 times, the procedure used in this opinion poll, which allows us to state that the true proportion lies between 50% and 56%, is expected to result in a correct statement for 90 out of 100 polls, on the average.[26] If we state that the true proportion is less than the lower limit of the confidence interval, *i.e.,* 50%, then we will be correct for 5 out of 100 polls; and if we accept that the true proportion exceeds 56%, then we will be correct in another 5 out of 100 polls, on average.

Estimates for a National Forest in the Northern Region

FIA plots[21] that are located on a National Forest can be used to estimate the proportion of old growth forest and the average number of snags per acre within that National Forest. Any FIA plot in which wildfire and harvest have occurred since the latest FIA inventory can be coded to: (1) does not meet the old growth definition; and (2) represent that there were no snags remaining at these plot locations. This inexpensive protocol might underestimate the quantities of old growth and snags as these plots have not been re-measured, but are merely assumed to have no remaining old growth or snags.

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[26] Steel, Robert G.D. and James H. Torrie. 1960. *Principles and Procedures of Statistics*. McGraw-Hill, New York. 480p.

Using measurements of field plots made by FIA crews, the definition of old-growth[25] can be applied by the Forest Service Regional Office in Missoula, MT to classify the old growth status for each FIA sub-plot. These classifications are sent to the Forest Service Inventory and Monitoring Institute in Fort Collins, CO, where a standard statistical estimator is applied.[27] The confidence intervals can be computed with the bootstrap method[28], which is a robust technique that is well suited for complex sampling designs. [29] This application was developed under the direction of Dr. Hans T. Schreuder[30]. These procedures can produce a scientifically defensible estimate of the proportion of forest within a National Forest that meets the Northern Region's definition of old-growth. Similarly, these procedures can produce a scientifically defensible estimate of the number of snags within a National Forest.

Summary

FIA data are collected with a probability sample that objectively characterizes forest resources over large geographic areas, including a measure of the uncertainty of this characterization caused by sampling. Of the 360,000 FIA plots that systematically cover the United States, several hundreds of plots will fall within the lands managed by a single National Forest. FIA provides a representative sample of all forest conditions within a National Forest, regardless of their old growth classification. FIA plots cover lands both suitable and not suitable for timber production, Wilderness Areas and roadless areas. FIA sample data provide a scientifically valid basis to estimate snag density and apply the Forest Service definition of old growth forest.

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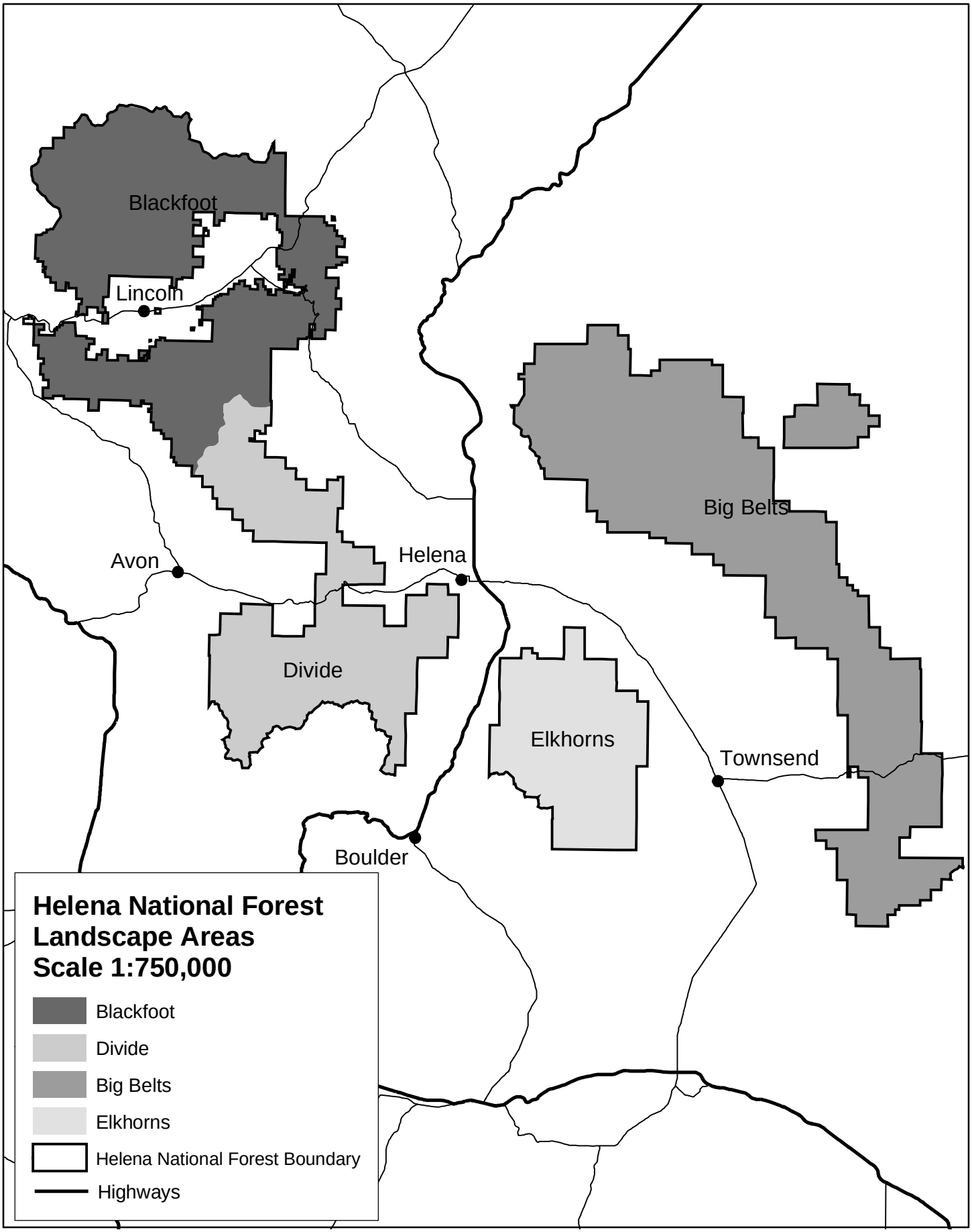
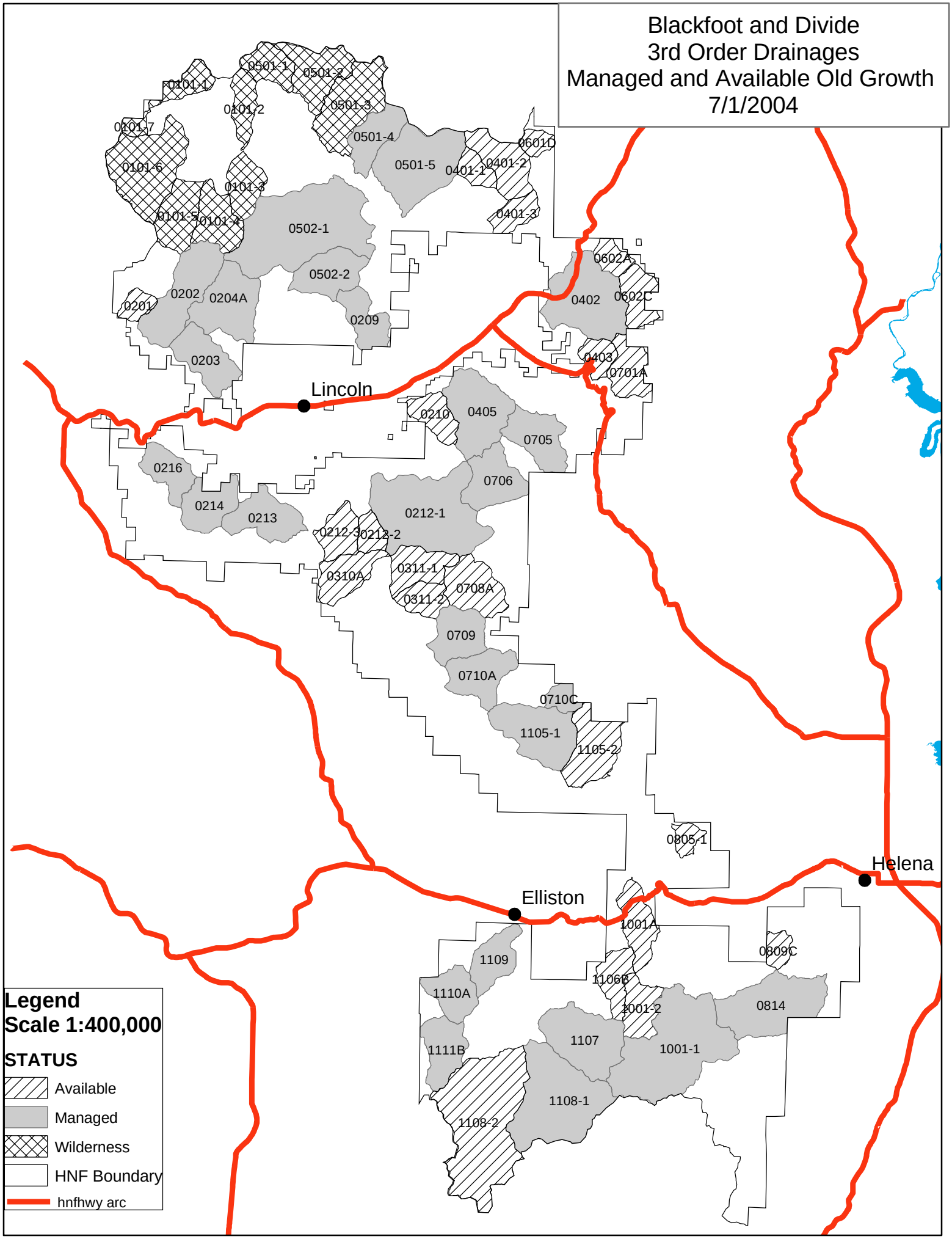
[27] Schreuder, H.T., T.G. Gregoire and G.B. Wood. 1993. *Sampling Methods for Multiresource Forest Inventory*. John Wiley & Sons, Inc. New York. 446 pp.

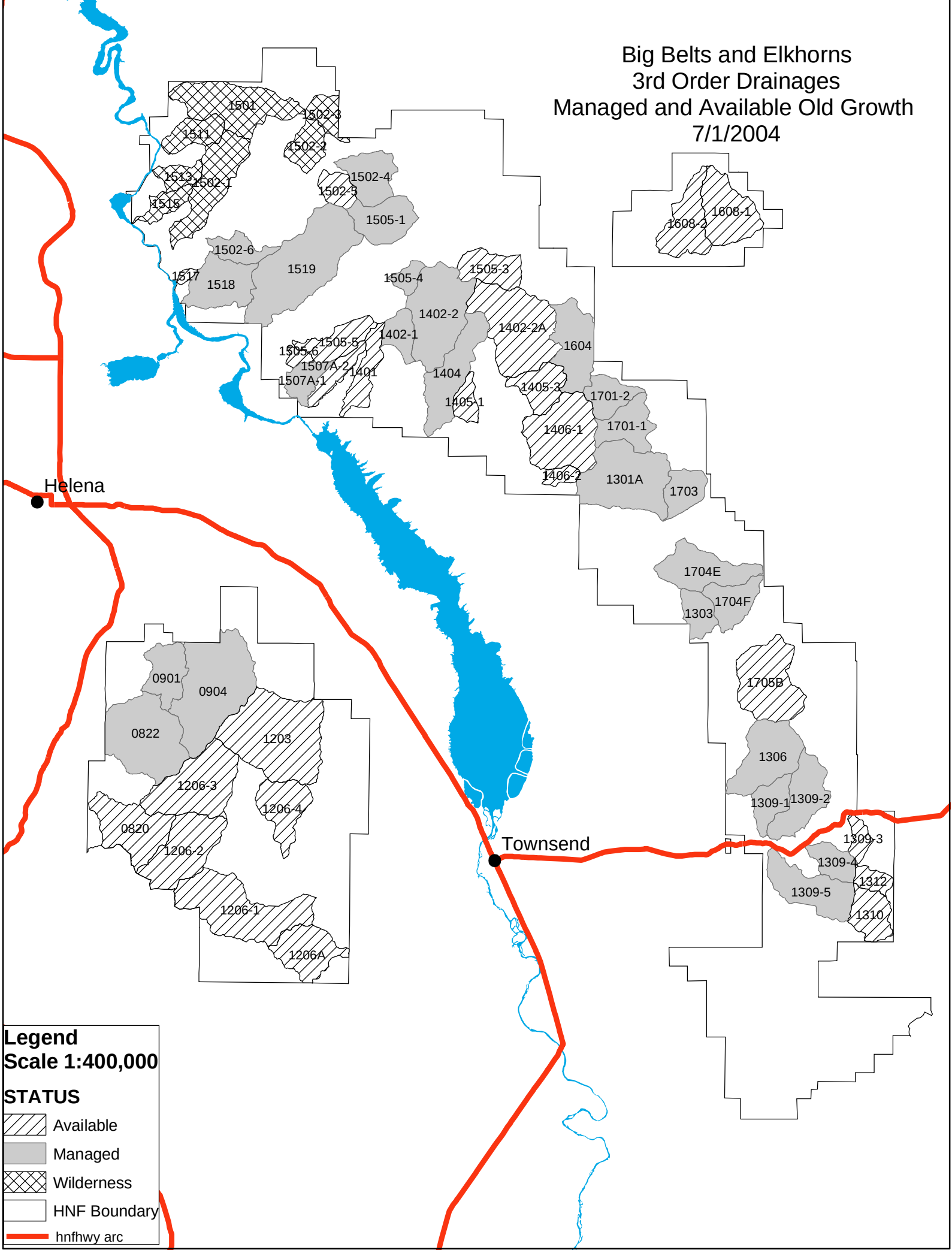
[28] DiCiccio, T.J. and B. Efron, B. 1996. Bootstrap confidence intervals. *Statistical Science* 11:189-228.

[29] Schreuder, H.T. and M.S. Williams. 2000. Reliability of Confidence Intervals Calculated by Bootstrap and Classical Methods using the FIA 1-Ha plot design. General Technical Report RMRS-GTR-57. Fort Collins, CO. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station. 6 p.

[30] Dr. Hans T. Schreuder is the senior mathematical statistician with the Forest Inventory and Monitoring Environmetrics Research Work Unit RMRS-4804 at the Forest Service Rocky Mountain Research Station in Fort Collins, CO. Since 1968, Dr. Schreuder has been author or coauthor of 136 scientific works, most of which deal with the mathematical statistics of forest inventories. Dr. Schreuder is lead author for a seminal reference on sampling methods for forest inventories[27], and he has published an assessment of the bootstrap confidence interval.[29]


Blackfoot
Lincoln
Big Belts
Helena
Avon
Divide
Elkhorns
Townsend
Boulder
Helena National Forest
Landscape Areas
Scale 1:750,000
Blackfoot
Divide
Big Belts
Elkhorns
Helena National Forest Boundary
Highways


Blackfoot and Divide
3rd Order Drainages
Managed and Available Old Growth
7/1/2004
0101-1
0101-2
0101-3
0101-4
0101-5
0101-6
0101-7
0501-1
0501-2
0501-3
0501-4
0501-5
0601D
0401-1
0401-2
0401-3
0502-1
0502-2
0209
0202
0204A
0201
0203
0602A
0602C
0402
0403
0701A
Lincoln
0210
0405
0705
0706
0216
0214
0213
0212-1
0212-3
0212-2
0310A
0311-1
0311-2
0708A
0709
0710A
0710C
1105-1
1105-2
0805-1
Helena
Elliston
1001A
0809C
1109
1106B
1110A
1001-2
0814
1107
1001-1
1111B
1108-1
1108-2
Legend
Scale 1:400,000
STATUS
Available
Managed
Wilderness
HNF Boundary
hnfhwy arc


Big Belts and Elkhorns
3rd Order Drainages
Managed and Available Old Growth
7/1/2004
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1502-3
1511
1502-2
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1502-4
1502-5
1505-1
1608-1
1608-2
1502-6
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Helena
1704E
1704F
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0904
1705B
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Townsend
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1310
1206A
Legend
Scale 1:400,000
STATUS
Available
Managed
Wilderness
HNF Boundary
hnfhwy arc