Helena and Lewis & Clark National Forests

Forest Plan Assessment

Appendix B, Vegetation Information Used and Methodologies

2015

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Appendix B. Vegetation Information Used and Methodologies

A variety of well-researched, documented, and accepted tools are used for the terrestrial vegetation analysis. This appendix describes in detail the databases and models that are used. These data sources collectively make up the *best available science* currently available for quantifying vegetation. This determination is made based upon the following qualities:

- Systematic field inventories using National and Regional field sampling protocols provide statistically based, consistent methodologies for quantifying vegetation characteristics and a high level of known accuracy. Data that meets these criteria, such as Forest Inventory and Analysis (FIA) plots are the primary sources of vegetation summaries in the Assessment.
- Vegetation mapping derived from National and Regional remote sensing protocols provide consistent methodologies for classifying and mapping vegetation characteristics, and are also assessed for accuracy so that their level of uncertainty is quantifiable. This information is inherently less accurate and detailed than systematic plot sampling, but provides valuable complementary information and allows for an analysis of the spatial distribution of vegetation.
- Other databases and map sources are used where appropriate, with a clear understanding of their purpose, accuracy, and limitations. As needed, professional judgment and interpretation are provided to frame the information found in all data sources.

Interpretation of the information draws upon the best available literature and reference citations that were found relevant to the ecosystems on the HLC NFs. Literature sources that were the most recent; peer-reviewed; and local in scope or directly applicable to the local ecosystem were selected. Uncertainty and conflicting literature was acknowledged and interpreted when applicable. In addition, local studies and anecdotal information that is not peer-reviewed is included where appropriate to provide context. New studies and literature are continually becoming available, and will continue to be incorporated throughout the forest plan revision process.

Corporate Databases and Tools

Several Forest Service databases are utilized which are housed collectively in the *Natural Resource Manager (NRM)* system. NRM is a national web-based system that ensures all databases are accurate, available, and adhere to consistent record-keeping protocols. In Region 1, vegetation data in several databases may be accessed through the NRM platform, or through the *R1 Depot,* which is a web-based user interface that contains analysis tools, reports, and utilities to assist with the consistent extraction and summarization of data. Further, in addition to the databases, mapped information for many databases is available using the *Geospatial Interface (GI)* tool. The GI tool allows users to access the spatial components of databases. The primary databases and accompanying spatial data used for the vegetation analysis are summarized as follows:

- *Forest Activity Tracking System (FACTS)* is the current activity tracking database in which all management and natural events are recorded. Information from this database is used to quantify the extent and type of management actions and wildfires that have occurred. Currently, both spatial and tabular information is required when activities occur on National Forest System lands. The GI tool was used to create the maps of past harvest, fire, and fuels activities found in appendix A. The FACTS database is the newest of several activity tracking databases developed over the years and used by the Forest Service in Region 1; older records from previous systems such as the *Timber Stand Management Record System (TSMRS)* are incorporated into FACTS. The earliest activity records date back generally to the 1940's or 1950s, when activity tracking protocols were adopted. Older records are likely not as

accurate due to improvements in modern record keeping. Site specific records of early harvest activities during the initial settlement of the area are not available or summarized quantitatively in the Assessment, but are addressed qualitatively using other information sources such as Boundary Report notes compiled when the National Forest Reserves were first proposed.

- *Threatened, Endangered and Sensitive Plants and Invasive Species (TESP-IS) Database*: The extent of weeds and TES plants is reported in this corporate database and mapped through the GI tool. This system was also used to determine which plant species to consider for potential plants of conservation concern.
- *The Field Sampled Vegetation (FSVeg)* database is a warehouse for vegetation inventory data that is collected using standard data collection protocols. Data housed in FSVeg includes FIA, Intensified Grid data, described below, and stand examination data. The R1 Summary Database, a database warehousing summarized inventory data and associated analysis tools is available to use with FIA and Intensified Grid data stored in FSVeg. Stand examinations are also housed in FSVeg, although they are not used in this assessment. Stand examinations are statistically valid samples which measure vegetation attributes at the stand-level according to R1 Common Stand Exam protocols. Stand exam data does not exist for every stand across the Forests and since the selection of stands to be examined is not objective they cannot be statistically extrapolated to represent any area other than the stand in which the data was collected. Stand exams may be useful to fill in data gaps for vegetation modeling later in the Forest Plan Revision process.

Forest Inventory and Analysis (FIA) and Intensification Data

FIA Base Grid

Forest Inventory and Analysis (FIA) data consists of a set of points established on a nationwide systematic grid across all ownerships. The National FIA grid plots are referred to as the "*base grid*". These plots record a multitude of vegetation attributes, including but not limited to species, height, diameters, habitat type, age, physical defects, insect and disease, ground cover, fuel loading, understory species and ground cover. FIA plots provide a systematic, spatially balanced, statistically reliable inventory using national protocols appropriate for use at broad scales. These plots were designed to measure forested plots; non-forest plots are established but no data are recorded. Base grid plots are re-read on a 10 year cycle, meaning that 10% of the plots are re-read each year. Each plot represents about 5,000 acres. There are 145 base FIA plots on the Helena National Forest; 3 on the Beaverhead-Deerlodge National Forest portion of the Elkhorns; and 299 on the Lewis and Clark National Forest, resulting in 447 base FIA plots for the entire plan area.

Starting with the FIA annual plots collected in 2006, the Northern Region has been contracting with IW-FIA to collect the "*All Condition Inventory*" (Bush and Reyes 2014). This inventory supplements the base FIA plots by measuring "FIA protocols" on those plots and portions thereof that do not meet FIA's definition of "forested". This effort is providing additional information regarding nonforested vegetation on the Forests.

The base grid is used to display estimates pertinent to the entire planning area, and to represent geographic areas (GAs) that do not have an FIA intensification completed. There are two things to keep in mind with this dataset:

1. Many base grid plots were installed prior to the mountain pine beetle infestation and have not been re-measured since. Therefore, conclusions drawn from base grid estimates are tempered by additional information regarding the changes caused by this disturbance event.

2. At this time, only a subset of the base FIA grid plots have information collected on conditions that are not forested. As new FIA data is available, more of the non-forested information will be available and included in the forest plan revision process.

Grid Intensification

To enhance analysis capabilities at multiple scales, the base FIA grid has been intensified by four times (4x) on the HLC NFs. This dataset is designed to capitalize on the powerful statistical design of the base grid, and adding additional plots allows for more accurate estimates as well as analysis at smaller scales. The Intensified Grid dataset uses data collection protocols established for the Northern Region that are compatible with national protocols (Bush and Reyes 2014, USDA 2008). This dataset is referred to as "*Intensified Grid*", or "*4x Grid*". Plots are established on all lands, regardless of whether they are forested or not. On the Helena NF, the initial installation occurred from 2006-2008. This inventory installation is complete and contains plots across the Helena NF administrative area; however, there are no plots (so is not representative) on the portion of the Elkhorns GA that lies on the Beaverhead-Deerlodge National Forest. On the Lewis and Clark NF, the installation of the 4x grid is not fully completed; some plots were not measured and available for analysis in the Snowies GA, and a substantial quantity of plots have not been installed in the Rocky Mountain Range GA. Because of these gaps in the 4x grid, estimates are made using the base FIA grid for the Elkhorns, Rocky Mountain Range, and Snowies GAs and for the HLC NFs plan area as a whole. On landscapes where the 4x intensification is complete, 4x plots are added to the base FIA to create an analysis dataset.

The Intensified Grid plots are on a 10-year remeasurement cycle. However, during and shortly after installation the HLC NFs experienced wide-spread tree mortality due to a mountain pine beetle outbreak which created the need for remeasurements on plots that could have been impacted. Initially, plots on the Helena NF that had at least 20 square feet basal area per acre of live pine trees at the time of installation were partially remeasured to determine changes in status (live/dead) and assess mountain pine beetle damage, if it occurred. In addition, full remeasurements have been conducted in some geographic areas on both forests. The status of all Intensified Grid plots is shown in the table below. The analysis datasets used to make estimates contain a "hybrid" of the most recent measurement of all plots.

Table B.1 Intensified grid plots on the HLC NFs, and status of measurements as of January 2015

Geographic Area	Installation	4x Plots installed	4x plots not installed	Total Plots (4x plus base FIA)	Partial Re-Measurement	Fully Re-measured
Big Belts	2006-2007	192	0	238	82 (2008-2010)	0
Castles	2010	44	0	53	0	35 (2012)
Crazies	2010	32	0	40	0	0
Divide	2007-2008	142	0	178	85 (2012)	96 (2009-2010)
Elkhorns[3]	2006-2007	72	0	88	72 (2012)	3 (2008)
Highwoods	2010	28	0	35	0	0
Little Belts	2009-2010	588	0	719	0	365 (2012)
Rocky Mountain Range	2012-Ongoing	514	413	130[2]	0	0
Snowies	2012-2014	82	6[1]	15[2]	0	0
Upper Blackfoot	2007-2008	228	0	276	100 (2009-2010)	0
HLC Total				***1,772***		

[1] plots have been measured but were not available in the dataset at the time of the Assessment.

[2] the dataset only includes base grid plots because the 4x is incomplete.

[3] Helena National Forest portion only; does not include Beaverhead Deerlodge administrative area.

In addition to the improved accuracy provided by having a much larger sample size, one of the primary benefits of the 4x Intensified Grid is that the data reflect the changed condition caused by the recent mountain pine beetle outbreak. Further, non-forested plots are measured. The primary weakness of this dataset is that the complete dataset, at the writing of this assessment, is not available for all GAs. Another consideration in the use of Intensified Grid data is that plots are only installed on National Forest System Lands; therefore, the geographic extent of plots is less than the total administrative boundary area which includes inholdings of other ownerships. Further, the expanses of private lands in between the HLC NFs geographic areas are not represented by plot data.

R1 Summary Database and Estimator Tool

The R1 Summary Database (**R1 SDB**) is developed by the Northern Region Inventory and Analysis staff to summarize plot data (Bush 2014). Based on the measured data, a suite of standardized classification algorithms populate attributes of interest to the Northern Region (Bush 2014, Barber et al. 2011, and USDA 2015). The R1 SDB includes:

1. **Oracle Tables -** 51 Oracle tables reside at the data center which warehouse summarized and attributed data based on inventory data residing in FSVeg. The Oracle tables contain:

    a. Attributes collected at the site such as slope, aspect, elevation, habitat type, etc.
    b. Calculated information such as trees per acre, basal area per acre, board-foot volume, etc.
    c. Derived attributes or classifications such as the R1 Existing Vegetation Classifications (Barber et al. 2011), R1 Wildlife habitat models, and old growth (Bush 2012).
    d. Associations to spatial datasets used in R1 for broad- to mid-level analysis.

2. **Access Database**– an Access database that houses a subset of the data in the Oracle Tables for a specified set of inventory data, called an Analysis Dataset. This database contains queries and reports that are built off of the Oracle Tables.

3. **The R1 Estimator Form** – a stand-alone program that derives estimates and confidence intervals for data in the R1 SDB Access Database that is selected (Bush et al. 2014). The form is essentially a front-end application which allows users to derive estimates for attributes residing in the database. The associated reports are stored in the Access Database. This form also includes custom estimate reports such as the R1 Diversity Matrix. Reports include the mean, standard error and confidence intervals. Estimates made for this assessment include 90% confidence intervals and are available as .pdf files in the project record.

Analysis Datasets

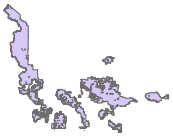
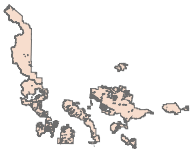
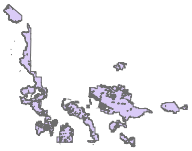
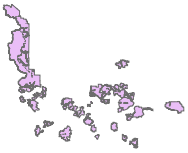
Within the R1 Summary Database, the appropriate Analysis Dataset must be selected. For this assessment, the following datasets were utilized:

- *F12_F15Partial_IntGrid_4x_Hybrid_2013* includes the latest measurements of the FIA intensified grid plus base FIA plots in areas with a completed intensified grid. This dataset includes only the southern portion of the Rocky Mountains GA; the Little Snowies portion of the Snowies GA; and the HNF administrative portion of the Elkhorns. This dataset is used for GAs where the intensified grid installation has been completed.
- *R1 Hybrid 2007* includes the most recent available measurements of base FIA grid plots, and the sample covers the entire HLC NFs plan area. The Hybrid 2007 was used to depict estimates for the Rocky Mountains, Snowies, and Elkhorns GAs. It was also used in estimates for the entire HLC NFs.

Spatial Analysis Boundaries

The HLC uses a variety of spatial boundaries to summarize data. These datasets are enabled in the R1 Summary Database (USDA 2013). The boundaries of interest are clipped to the inventory *Area of Inference* – that is, the area across which the plots were designed. The analysis areas used for the Assessment are shown in the table below, along with the applicable analysis dataset. The boundary of interest is selected in the Estimator to generate statistical reports.

Table B.2 Spatial and Analysis Datasets for Analysis

Spatial Boundary	Analysis Dataset	Area Represented	Thumbnail of Extent
SD_HLC_FOREST_ALL_FIA	R1 Hybrid 2007	Entire HLC, including B-D Elkhorns, Snowies, & Rocky Mtns.	
SD_HLC_GEO_AREAS_4X_2013	F12_F15Partial_IntGrid_4X_Hybrid_2013	Each GA; Several GA's only partially represented (Little Snowy portion of Snowies; southern part of Rocky Mountains; and HNF part of Elkhorns).	
SD_HLC_GEOAREA_ALL_FIA	R1 Hybrid 2007	Each GA in its entirety	
SD_HLC_NOTWILD_ALL_FIA	R1 Hybrid 2007	Non-wilderness across entire HLC, including B-D portion of Elkhorns	
SD_HLC_NOTWILDROADLESS_ALL_FIA	R1 Hybrid 2007	Non-wilderness or roadless across entire HLC, including B-D portion of Elkhorns	
SD_HLC_WILD_ALL_FIA	R1 Hybrid 2007	Wilderness across entire HLC, including B-D portion of Elkhorns	
SD_HLC_WILDROADLESS_ALL_FIA	R1 Hybrid 2007	Wilderness or roadless across HLC, including B-D Elkhorns	

Analysis Elements

The HLC NFs use the R1 Summary Database, Estimator Tool, and specialized queries to derive estimates at the various spatial extents. For each estimate, the appropriate analysis dataset and spatial boundary is selected. Estimates are reported with 90% confidence intervals. The information is used to describe the abundance and

distribution of each attribute of interest. Estimates are also associated with various map products to provide information in a spatial context. The following attributes were estimated for the assessment:

- Acres by Potential vegetation type groups (habitat type groups)
- Acres by forested Cover type (groups based on the dominance groups found in the R1 Classification system, as defined in Milburn 2014b)
- Acres by Forest size class
- Acres by Forest density class (canopy cover class)
- Acres by Forest vertical structure class
- Acres by Forest age class
- Acres by Insect hazard ratings (mountain pine beetle, Douglas-fir beetle, and western spruce budworm)
- Tree species presence/absence
- Large live trees
- Old growth
- Snags
- Coarse woody debris
- Wildlife habitats
- Plants presence/absence (ad-hoc summaries using spreadsheets to summarize the presence of plant species of interest)
- Canopy cover of grass, forb, graminoids, and
- Vegetative lifeform

Most of the attributes listed above are considered to be *key ecosystem characteristics*, and were estimated for Potential Vegetation Types groups to characterize ecosystem diversity. The Potential Vegetation Type groups for the HLC NFs were selected in the Estimator based on the grouping of habitat types shown in chapter 2, Terrestrial Ecosystems (Milburn 2014b). Estimates are run for the entire HLC NF's using the Hybrid FIA Analysis dataset because the 4x is incomplete in some areas. The Beaverhead-Deerlodge National Forest portion of the Elkhorns is excluded, because it was not readily possible to separate this area from the rest of the Beaverhead-Deerlodge National Forest without the ability to group the estimates by GA.

Vegetation Mapping

Vegetation mapping is a primary source of information regarding the spatial distribution of vegetation characteristics. Several of the most current spatial datasets were utilized in the analysis, which complement the statistical estimates of vegetation attributes provided by field inventory data.

R1 VMap

Mapping of current vegetation is based on the Region 1 Vegetation Map (VMap), which is a spatially explicit, thematic, polygon-based product derived from remotely sensed data that contains information about the extent, composition, and structure of vegetation across National Forest System lands (Vanderzanden et al 2009). Satellite imagery and airborne acquired imagery is refined through field sampling and verification. This geospatial dataset includes all watershed areas that intersect with National Forest System Lands on the HLC NFs; private lands within these watersheds are included, so the map shows "wall to wall" coverage of all GAs. The information is grouped into vegetation that is alike and organized by polygon-based map units. Each polygon has a life form, canopy cover, vegetation type, and size class assigned consistent with the Region 1 Existing Vegetation

Classification System (Barber et.al. 2011). Additional information is attached to each polygon, using a digital elevation model, which includes the majority elevation, slope, and aspect. Substantial additional data is delivered with the VMap product, including continuous variables for tree size and canopy cover, probabilities of species occurrence, and additional data attributes estimated by associating VMap classes to inventory plots.

R1-Vmap attributes have been assessed for accuracy through a process outlined for Region 1 (Vanderzanden et al 2009). An accuracy assessment for the VMap product developed for the HLC NFs in 2014, based on the collection of reference data, was conducted (Brown 2014). This accuracy assessment includes the following results, which provide the bounds for conclusions that are reached using this data source. In general, the accuracies exhibited in the VMap 2014 database are exceptional (Brown 2014).

Table B.3 Accuracy of VMap 2014 Attributes, from Brown (2014)

Attribute	Overall Accuracy
Lifeform	91%
Dom40	70%
Tree Canopy Cover	79%
Tree Size Class	69%

Mapped Potential Vegetation

The Potential Vegetation Type map used for this assessment was developed by the Northern Region Forest Service in the early 2000s; the most current version of this product was refined in 2005. Sources of data included field plots and remote sensing (e.g. satellite imagery, DEMS). Lands with no field data were populated by extrapolation of plot data and the use of models that integrated site factors influencing vegetation, such as precipitation, slope and elevation. This layer, referred to as R1 Potential Vegetation Types (PVT) or the "Jones PVT" map, was incorporated into VMap to create the HLC's Vegetation layer. The R1 PVT map is considered to be the best available potential vegetation layer, although its level of accuracy is unknown. It is the only consistently mapped depiction of potential vegetation that covers the entire planning area. VMap is the best available polygon delineation and spatial depiction of existing vegetation, and has a known level of accuracy.

In order to have potential vegetation and existing vegetation attributes applied to the same polygons for analysis, the R1-PVT data was joined into the R1-VMap product. R1-VMap polygons are the best delineations for vegetation; therefore, a single potential vegetation label was applied to each R1-VMap polygon based on the majority of the PVT labels that occurred. Because R1-PVT is raster-based and the R1-VMap is polygon-based, illogical combinations of potential vegetation (R1 PVT) and existing vegetation (R1-VMap) were inevitable. It was therefore necessary to refine the PVT attributes in a logical fashion to improve accuracy and be consistent with VMap. Because it has a known level of accuracy and is based on the most current information available, the VMap product was considered to be correct when illogical combinations occurred.

To inform the logic for fixing illogical combinations, a series of pivot tables were created to compare the R1-PVT to R1-VMap as well as the information found on FIA and FIA intensification plots (Milburn 2014a). A comparison of lifeform showed that grass, shrub, and urban lifeforms tended to be under-represented in the R1-PVT map. The PVT was updated to be consistent with VMap lifeforms. The abundance of potential vegetation types found on FIA Intensification plots was also compared; while in most cases the R1-PVT map showed an abundance of PVT within the confidence intervals of the plot estimates, in a few cases the quantity was below or above this range. Finally, all combinations of potential and existing vegetation were explored. Detailed logic was written to correct all potential illogical combinations between potential and existing vegetation (Milburn 2014a). Additional PVT calibrations are ongoing to improve the product, which will be utilized in the Forest Plan revision process.

Groupings of existing and potential vegetation were developed that are consistent with other analysis efforts in Region 1. Labels for these groups were also added to the R1-VMap product. These groups were used for this Assessment, and will further be utilized for vegetation modeling throughout the revision process (Milburn 2014b).

Wetland and Riparian Areas

It was determined early in the process that the mapping of wetland and riparian areas was important for multiple resources. Vegetation classifications, both cover types and potential vegetation types, include types that usually correspond to wetland and riparian areas; however, additional wetland and riparian areas occur that are not depicted by vegetation alone. The Wetland and Riparian Mapping Center (WRMC) of the Montana Natural Heritage Program (MTNHP) is creating digital wetland and riparian maps with the support of multiple project partners (MTNHP 2014). Mapped wetlands are classified using the Cowardin classification system of the National Wetlands Inventory (NWI), and riparian mapping follows the U.S. Fish and Wildlife Service's system for mapping riparian areas. This mapping is ultimately incorporated into the NWI, and is completed through interpretation of aerial imagery, topography maps, digital elevation models, soils data, and other map sources (MTNHP 2014). The delineations from the MTNHP were incorporated into the VMap product for the HLC NFs so that these areas can be summarized in the context of the other attributes of interest, including potential and existing vegetation.

Aerial Detection Survey (ADS)

Aerial Detection Surveys (ADS) are maps of visible insect and disease damage generated annually in the Northern Region based on visual observations taken during survey flights. Surveys include estimates of trees and acres affected, and the data is published by Forest Health and Protection. There are aerial survey standards for this data (USDA 1999; USDA 2003). The following considerations apply to the use of this data:

- Not every area is flown every year; therefore, the lack of damage data in an area does not necessarily mean that no damage exists. Since 1999, maps of "no fly" areas accompany ADS data. Prior to 1999, it is not explicitly documented which areas were flown. Therefore, damage acres and maps do not capture all of the areas potentially impacted by insect and disease. Routinely, wilderness areas are excluded.
- The acres reported yearly for damages are not necessarily cumulative because the survey may map the same area again and again if it is repeatedly affected.
- Trees infested by bark beetles often retain a green crown for a full season after being attacked; ADS therefore reflect the previous year's beetle infestation by detecting the changing tree colors.
- When ADS data is summarized in a published report at scales useful for the analysis, the acres found in those reports are used. This was primarily used for recent bark beetle infestations. In the reports, estimates are split out between federal and non-federal land; the acres on federal land are used.
- When data desired for this analysis is not published for the pest of interest or at the desired scale, the ADS GIS data housed in the GIS library was utilized to extract the information. The estimates derived from this method encompass the reporting areas for the Helena and Lewis and Clark National Forests, including nonfederal lands.

Vegetation Modeling - SIMPPLLE

Vegetation modeling to characterize the natural or historic range of variability of vegetation components was done with a stochastic model called SIMPPLLE (SIMulating Patterns and Processes at Landscape scaLEs) (Chew 2012). This assessment draws upon work done for the east side of Region 1 in 2003 until a new NRV analysis can be completed. The analysis areas used in 2003 are not identical to the GAs currently delineated. The data in

the 2003 analysis were generated by running SIMPPLLE for 500 years, and the range of variation for each variable is represented by a maximum, minimum, and average percent of the acres of forested habitat types (USDA 2003). A multitude of model calibrations are possible in SIMPPLLE. The best available science will be utilized in calibrating the model for new NRV runs to be conducted to support forest plan revision. The new modeling may estimate conditions as far back as 1,000 years. Further, it is anticipated that a newer version of the SIMPPLLE model, version 3.0, may be available for use later in the process.

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