

National Park Service



Appalachian National Scenic Trail Forest Health Monitoring

Standard Operating Procedures—Version 1.00

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Summary

This SOP describes the process of data acquisition from the USDA’s Forest Inventory and Analysis (FIA) data clearinghouse into a local NETN database that supports storage, analysis, and reporting of the data.

Revision Log

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SOP 1: NETN Forest Inventory Analysis Data Import & Analysis System

Version 1.00

Introduction

The U.S. Forest Service (USFS) administers the Forest Inventory and Analysis Program to acquire inventory data on U.S. forests. The program was launched following the McSweeney - McNary Forest Research Act of 1928 (P.L. 70-466) which led to the first forests being inventoried in 1930 (USFS 2012). Data collected by the program are valuable for a variety of purposes, including timber harvest and ecological health. According to the FIA website, “...*FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership*...” FIA data are organized by state, but all state datasets conform to a consistent format¹. However, in order to use data from the APPA region, data must be re-aggregated to the APPA area of interest. This is accomplished by downloading all 14 individual state datasets, extracting data from the APPA area of interest, and appending these data to a new dataset limited to the area of interest. The required steps are outlined below.

Procedures

Periodically check for FIA data file updates. Updates are not released on a regular basis, and not all state datasets are released simultaneously. Thus it is important to proactively check to see if a new release is available. The following website will identify the current status of datasets on a state-by-state basis: https://apps.fs.usda.gov/fia/datamart/recent_load_history.html

1. Previously downloaded data files should be “zipped” and placed into a separate folder identifying the year they were downloaded, if that has not already been done. (The download year is used because FIA datasets contain data that are updated on a continuous basis which means that FIA data files contain data from all previous years, i.e., you cannot simply locate and import data from 2009).
2. All state data files from the 14-state APPA region (ME, NH, VT, MA, CT, NY, NJ, PA, MD, WV, VA, TN, NC, GA) need to be downloaded, unzipped, and stored together in the same directory. Each of the state files contains data specific to the plot location (e.g., ecoregion, protected status, and ownership) and plot-level forest metrics that will be used for data summary and analysis.
3. Data from the 14-state region are stored in MySQL, and are entered into that system with a utility called “MS Access to MySQL,” a freeware application (Figure 1). The utility is relatively self-explanatory and the appropriate import settings are stored in a file named “Import_20131112.ini.” This settings file does not contain a list of the files to be imported, and the “free” version of the application does not allow for batch processing, so it is necessary to import each state file separately.

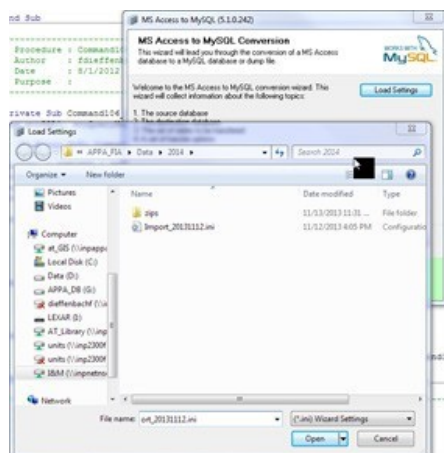


Figure 1. MS Access to MySQL.



Figure 2. Data import system.

There are a host of settings that aren't addressed by the settings file. First, as you step through the process, you will find a page that lists all tables in the selected db. All tables should be selected except those that begin with "ref" (none of these tables are used by the analysis system so they can be omitted).

4. The second change that must be made is on the last step of the process (the

page where the "run" button is located). There is an option to delete existing tables (the 'Create Tables' function drops the existing tables). This option should be selected for the first state and deselected for each subsequent state. The time it takes to import a state FIA dataset varies between states, with Georgia taking the longest. In general, each state will take about 10-15 minutes to import.

5. Navigate to the directory where the FIA database files are located and open the file named "FIA_Analysis_Data_File_Manager.

6. Before creating a new APPA specific data file, you must determine if any new plots have been added to the FIA network. This process is initiated by pressing the "Import all APPA State Plot Data" button followed by the "Export Plots for GIS Processing" button (Figure 2). This will generate an excel file that can be used to identify all FIA plots that are within the HUC10 shell in ArcMap. When the file has finished, you will see a message telling you where to look for the file, along with the name of the file.

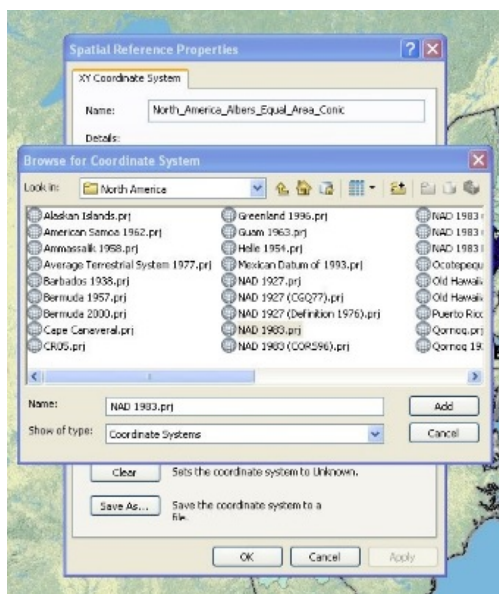
7. Follow the instructions outlined in SOP2: Associating Tabular Data in ArcMap.

8. If the map is not peppered with points after step 7 (Figure 3), you may need to de-select the option box for 'Scale symbols when a reference scale is set' (Figure 4). When plots do appear, you will see records populate a large portion of the map (the entire east coast, except Florida, South Carolina, Delaware, and Rhode Island).

9. Before you can select the records that are within the HUC10 Shell, you must turn the file you imported into a shapefile or some other geospatial file type. That is because the imported records lack a spatial index (you probably saw a dialog box explaining this following step 7. They have a spatial reference, but not all of the pieces needed to make them 'selectable.' This is accomplished by "right clicking" on the point element in the table of contents and selecting export from the list.



Figure 3. HUC10 Shell with points added.



10. To identify records that are within the HUC10 shell, use the ‘Select by Location’ function to intersect the newly created file with the HUC10 shell. The selected records can then be exported to a separate file so they may be imported back into the APPA Analysis Data File Manager. The default export is a dbf file. The dialog box will offer a default file name and file directory. Change the directory to a familiar location and shorten the file name to anything that is 8 characters or fewer.

11. Back in the MS-Access Data File Manager, open the Import & Link option specific to the type of file that contains the data. Generally, this is a dbf file. You want to import the file (not link).

12. Once the new table has been created, rename the new table to ‘Plots_in_HUC10_Shell’ (Figure 5). A table with that name may already exist. If so, you can either delete the existing table or rename it. Once the new table has been renamed, press the ‘Delete NON-APPA Plots button’.

13. You are now ready to convert the new FIA data. First, select the data extraction tab (Figure 6). This tab presents a series of buttons enabling you to download the data table-by-table, or as a single routine (“Extract All Data”). If you are importing data from a new cycle, it is easier and faster to extract all data at once with the “All” button.

14. After extracting the data, create an FIA Export Backend file by pressing the “FIA Export BE” button that will generate a file with the following naming convention:

ParkCode_FIA_Data_BE_Year_YYYY_
SwappedFuzzed_YYMMDD_#####.mdb.

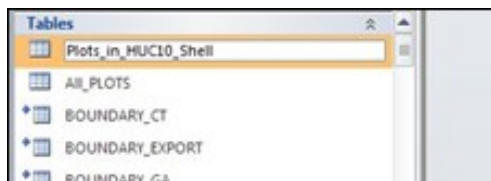


Figure 5. Renaming a table in MS Access.

The file name is decoded in the following way: ParkCode is a 4-digit combination assigned by the park service. YYYY is the year when the dataset was processed and is obtained from the value shown in the “year” field on this form (change the value if necessary). “SwappedFuzzed” indicates that the data used do not contain actual coordinates.

is a randomly generated number.

15. After the data file has been generated, open the file named: FIA_Analysis.accdb. While the

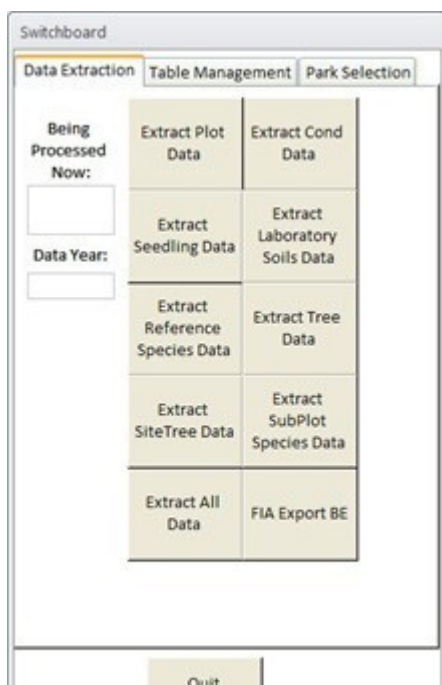


Figure 6. Data file manager showing data extraction tab.

file is opening, you will likely see the following “security warning” message (Figure 7). Select ‘options’ which will trigger the “security alert” shown in Figure 8. Select ‘enable.’

16. Open the linked table manager and then open the linked databases form (Figure 9).

17. Update the database path information for each linked database by locating the referenced files on your computer.

18. If you are changing to the APPA dataset from another park, or are changing to another park from APPA, you must open the linked table form and look for the entry named: “FIA_Locs_APPA_S/F” or “FIA_Locs_NERO_S/F.” Select the string that is appropriate for the dataset you are building. For example, if you are building an APPA dataset select “FIA_Locs_APPA_S/F,” otherwise select the “NERO” string. Do not select one of the options with a date appended to the end of the string.



Figure 7. Security warning message.

19. At this point, you can press “refresh links.” You will find the refresh button on the main table linking form, the linked database form, or the linked table form. The linking process concludes by opening a text box that indicates either that the process completed successfully, or that there was a problem. If an error is encountered, the likely reason is that some of the tables may not have linked correctly, but the message may not provide enough information to diagnose the cause of



Figure 8. Security alert.

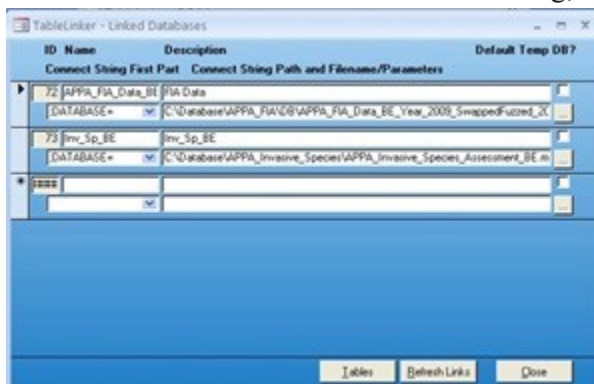


Figure 9. Linked table manager.

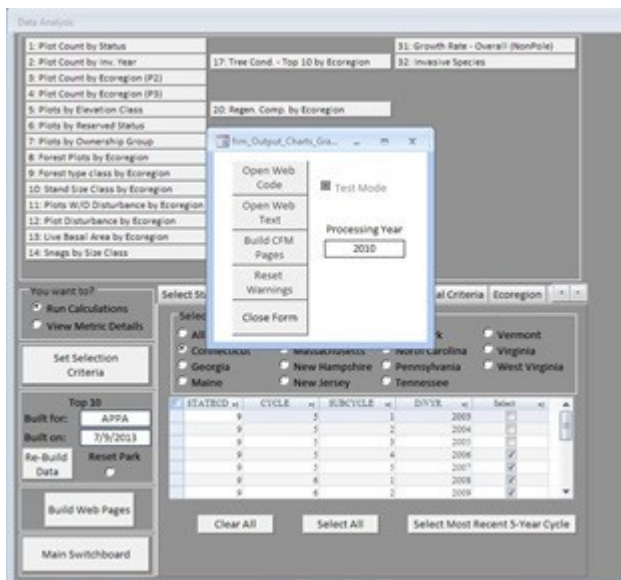


Figure 10. Data analysis form

the problem or which tables are affected. The lack of meaningful guidance notwithstanding, problems typically arise when the names of one or more of the linked tables and resident tables are the same. The utility will not overwrite tables with the same name, and does not append a ‘trailing’ character to differentiate otherwise similarly named tables. The solution to this problem is to delete all of the resident tables (those that are NOT linked) that follow this naming convention: tbl(table name)_local where “table name” is the name used in the original FIA dataset (e.g., Cond, Plot, Seedling, Soils, Tree, etc.). There are up to 5 tables that could be involved and if the aforementioned error appears, all must be deleted. After the tables have been deleted, press the “refresh links” button again. If the error appears again, verify that none of the 5 “local” tables are still present. If any are present, remove them and try again. If none of the local files are present, call the APPA Environmental Monitoring Coordinator for assistance.

20. Assuming that the linking process has completed successfully, open the data analysis form (Figure 10).
21. Before viewing any results, two additional steps must be followed to prepare the data. First, whenever a new “back-end” data file is linked, the routine triggered by pressing the “Re-Build Data” must execute (Figure 10). If the park being evaluated has also changed, check the “Reset Park” option. The process that runs when the data are re-built will take several minutes. The next step involves selecting the desired states, survey cycle, ecoregion, forest type, and other criteria. At minimum, you must view the survey cycle and select the desired values. Generally, state datasets use a 5-year cycle, so selecting the most recent 5 years of data ensures a complete survey cycle (this should be verified by checking the FIA documentation). After the desired criteria have been selected, press the “Set Selection Criteria” button. If you have not changed the back-end data file, and you are

satisfied that the selection criteria are what you want, it is not necessary to press either button (this would be the case on subsequent visits to the Analysis System). Though the state survey cycle is generally 5 years, NH, NY, and NC used a 6-year cycle through 2011 (after 2011, the cycle for each of these states is 5 years). This needs to be accommodated by selecting a sixth year for each of these states until the year 2011 is no longer within the 5-year cycle. You may also find that NC has a 9999 value checked. Presumably, this is a value for a missing date. Deselect 9999 and select another year to make the NC cycle complete.

22. Use the data analysis form to analyze data and review metric details (to view metric details, select the “view metric details” option and then press the desired button). For information on database field definitions and interpreting field values, refer to the “Forest Inventory and Analysis Database: Database Description and User’s Manual” (USFS 2011).

23. The information presented when a metric is selected will vary, but in each instance the user can view the results aggregated at the Province, Section, or Subsection level. Data may be

downloaded for each of these levels, a combination of all levels, or in “raw” format. When selecting raw data, the results are filtered according to the parameters used for the given metric but instead of being aggregated to the various levels (i.e., Province, Section, and Subsection), the data are un-summarized so the user can perform their own analysis.

24. From this form you can also build web pages by pressing the “build web pages” button. This will open another form with a series of options (Figure 11). Unless you are modifying the coding (not recommended), the only options you will need are the “build” and “close” buttons. The date that appears in the processing year represents the year when data were collected (the year on the data file currently selected minus 1). The files will be added to a directory named “MergeTest” on your desktop. If the directory does not exist, you will need to create it (or modify the code so that the files are put into another directory).

References

U.S. Department of Agriculture, Forest Service (USFS) 2011. The Forest Inventory and Analysis Database: Database Description and User’s Manual Version 5.1.2 for Phase 2. Available at http://www.fia.fs.fed.us/library/database-documentation/current/ver5-2012/FIADB_user%20manual_5-1-2_p2_07_2012.pdf (accessed 3 August 2012)

Revision History

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Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	September 2018	Fred Dieffenbach	Initial version	

SOP 2: Associating Tabular Data in ArcMap with area of interest

Version 1.00

Introduction

Prior to using FIA data to infer the condition of forest resources in the vicinity of APPA, records that are not within the area of interest must be culled from the acquired dataset. This typically means cutting the existing dataset to the new area of interest but it might also require that multiple datasets be “stitched together” and then cut to the area of interest. The following steps assume that the acquired data are in “point” format. Procedures

Methods

Importing a point file

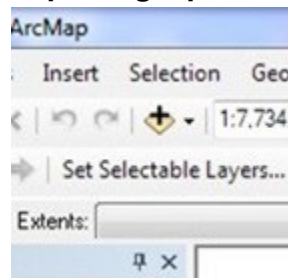


Figure 12. With ArcMap open, select the “Add data” button.

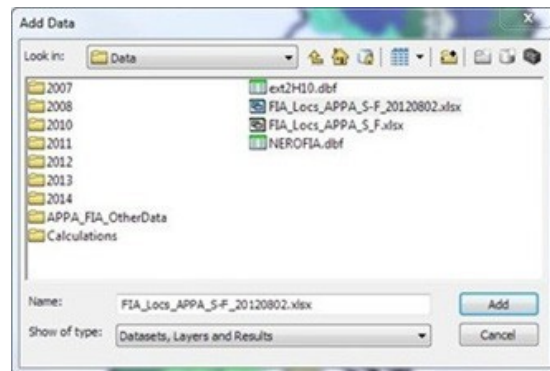


Figure 13. Navigate to the file to add.

choose will depend on how the data were stored by the organization from whom it was acquired. In some instances, there may be more than a single coordinate system and projection.

1. In ArcMap, find a project focused on the spatial area and topic of interest, or create a project with such a focus. If you use an existing project, consider renaming it to avoid corrupting the original.

2. With ArcMap open, select the “Add data” button (Figure 12) and navigate to the file you wish to add (Figure 13).

3. Once the file is added to ArcMap, the file will appear in the table of contents (Figure 14), but you will not see any of the records (points) on the screen until the “display xy data” function is launched.

4. To display the points after they have been added to the table of contents, select the item you just added and then press the right-mouse button. From the list that appears, select the “display xy data” option (Figure 15).

5. When the “display xy data” option is selected, you will need to choose the appropriate coordinate system and projection (Figure 16). The option you

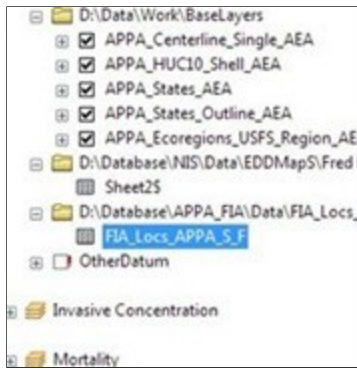


Figure 14. File will appear in the table of contents.

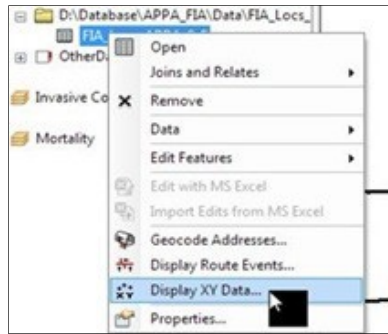


Figure 15. Select the “display xy data” option button.

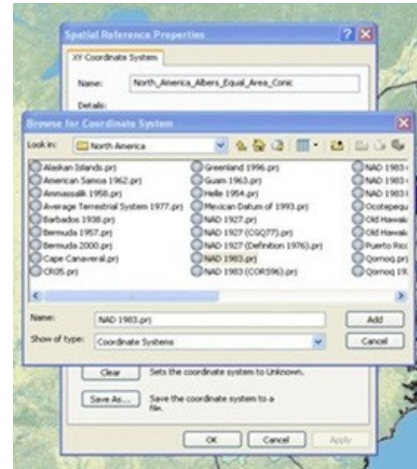


Figure 16. Coordinate systems.

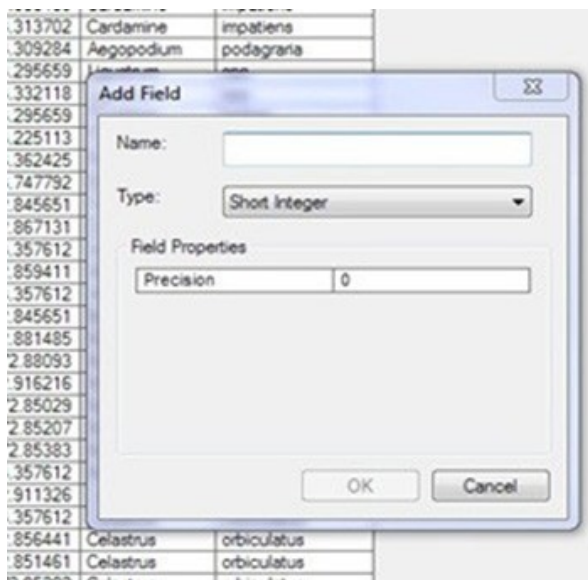


Figure 17. The field should be “text” format and 4 characters long.

6. You will repeat steps 4 and 5 for every file you have added. For example, if a dataset includes multiple coordinate systems, a file will be added for each one.

7. Once added to ArcGIS, each point record needs to be associated with features that will enable subsequent analysis.

You will probably need to add fields to store this information. At minimum, the APPA acronym will need to be identified. To accomplish, add fields to store this information (Figure 17). The field should be “text” format and 4 characters long (Figure 17). Additional fields to accommodate other “stratification” possibilities can be added as needed.

8. Do NOT add a single field into which data will be concatenated—doing so will make it more difficult, or possibly impossible, to organize the dataset at a later time.

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1.00	July 2017	Fred Dieffenbach	Initial version	

SOP 3: Analysis and Reporting of Ecological Integrity

Version 1.00

Metrics and Ratings

After data retrieval from FIA, forest plot data will be compiled and summarized at the scale of the ecoregional subsection (see Appendix A for resource brief example). For each subsection and time period, forest plot data will be summarized into the metrics listed in Table 1 of the Appalachian National Scenic Trail Forest Health narrative. Metrics and ratings are similar to those reported for the NETN forest monitoring program (Tierney et al. 2016) are presented in Table 1. In addition to the metrics calculated in Table 1, FIA plot location data is also summarized to determine the proportion of plots assigned to each protection status (Appendix A Figure A3) and land ownership category (Appendix A Figure A4).

Table 1. Metrics and ratings for evaluating the ecological integrity of forest ecosystems.

Category	Metric	Web Based Review	Calculation	Metric Ranking		
				Good	Caution	Significant Concern
Stand Structure	Structural stage (3 northern provinces ¹)	X	Determine proportion of plots per ecoregional subsection falling into each structural category (e.g., pole, mature, late successional)	≥ 70% late-successional	< 70% late-successional	< 70% combined mature and late-successional
	Structural stage (5 mid & southern provinces ²)	X		≥ 25% late-successional	< 25% late-successional	< 25% combined mature and late-successional
	Snag abundance	X	Sum snags per plot (>10cm DBH) and divide by plot area to present in stems/ ha. Calc. Avg. and StDev. among plots for each ecoregional subsection	≥ 10% standing trees are snags and ≥10% med-lg trees are snags ³	< 10% standing trees are snags or <10% med- lg trees are snags	< 5 med-lg snags/ha
	Coarse woody debris volume	X	Calculate volume of CWD and live trees for each plot. Calculate CWD to live tree volume per plot (as %) and calc. Avg. and StDev. for each ecoregional subsection	> 15% live tree volume	5- 15% live tree volume	< 5% live tree volume
	Live basal area	X	Sum basal area per plot and calculate Avg. and StDev. (m2 per ha) for each ecoregional subsection	Not Established	Not Established	Not Established
Position and Health	Tree regeneration	X	Sum seedlings by species per plot and calculate a) Avg. and	Seedling ratio	Seedling ratio < 0	Stocking index outside

Category	Metric	Web Based Review	Calculation	Metric Ranking		
				Good	Caution	Significant Concern
			StDev seedling density (seedlings/ha), b) ratio off tall (30-200cm) to short seedlings (<30 cm) following Sweetapple and Nugent (2004), and c) McWilliams et al. (2005) stocking index for each ecoregional subsection.	≥ 0		acceptable range ⁴
	Tree Composition	X	Determine the 10 most abundant species by ecoregional subsection	Not Established	Not Established	Not Established
	Tree condition		For the top 10 most abundant species in each ecoregion subsection, calc. % of individuals for each species with reported foliage damage >50%.	Foliage problem < 10% and no priority 1 or 2 pests ⁵ and BBD ≤ 2	Foliage problem 10-50% or priority 2 pest or BBD > 2	Foliage problem >50% or priority 1 pest
	Indicator species: invasive exotic plants	X	Identify species (presence only) in plot that are on an accepted list of invasive species (e.g., state noxious weed list) for each ecoregional subsection	< 0.5 key species per plot	0.5 to < 3.5 key species per plot	3.5 or more key species per plot
	Tree mortality rates	X	Identify 10 most abundant canopy tree species that perished since last plot visit and determine mortality by dividing recently deceased trees by the number of trees that were previously counted. Calc. Avg and StDev. by species or plot for each ecoregional subsection.	Mort ≤ 1.6%	Mort > 1.6%	Decrease in frequency of most and increase in frequency of browse-avoided species
	Tree growth rates	X	Calculate basal area change (%) of 10 most abundant canopy tree species. Calc. Avg and StDev by species or plots for each ecoregional subsection.	Not Established	Not Established	Not Established
1 Three northern provinces include: White Mountain, New England Piedmont, Green-Taconic-Berkshire Mountains 2 Five mid and southern provinces include: Hudson Valley, Lower New England, Northern Appalachian Piedmont, Northern Ridge and Valley, Blue Ridge Mountains. 3 Med-lg trees are ≥ 30 cm diameter-at-breast-height. 4 Tree regeneration stocking index varies by ecoregion section. Priority 1 pests are Asian longhorned beetle, emerald ash borer and sudden oak death. Priority 2 pests are hemlock woolly adelgid, balsam woolly adelgid, and butternut canker.						

References

- McWilliams WH, Bowersox TW, Brose PH, Devlin DA, Finley JC, Gottschalk KW, Horsley S, King SL, LaPoint BM, Lister TW, McCormick LH, Miller GW, Scott CT, Steele H, Steiner KC, Stout SL, Westfall JA, White RL (2005) Measuring tree seedlings and associated understory vegetation in Pennsylvania's forests. In: McRoberts, RE, GA Reams, PC Van Deusen, WH McWilliams. CJ Cieszewski, (eds) Proceedings of the fourth annual forest inventory and analysis symposium, 2002, November 19–21. New Orleans. General technical report NC-252. US Department of Agriculture, Forest Service, North Central Research Station, St. Paul.
- Tierney, G., B. Mitchell, K. Miller, J. Comiskey, A. Kozlowski, and D. Faber-Langendoen. 2016. Northeast Temperate Network long-term forest monitoring protocol: 2016 revision. Natural Resource Report NPS/NETN/NRR—2016/1184. National Park Service, Fort Collins, Colorado.
- Sweetapple, P. J., & Nugent, G. (2004). Seedling ratios: a simple method for assessing ungulate impacts on forest understories. *Wildlife Society Bulletin*, 32(1), 137-147.

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Appendix A: Web-Based Resource Brief, an Example

Forest Resources in the Hudson Highlands (221Ae) Subsection.



Figure 1. Appalachian National Scenic Trail showing HUC10 shell and area of focus (dark blue).

Background

The region through which the Appalachian National Scenic Trail (APPA) passes is predominantly covered by temperate deciduous forest, but the region includes several less common habitats such as grassy and heath balds, mountain bogs, cliffs and rock outcrops, talus slopes, and beech gaps that help to define the APPA corridor. Many of these habitats provide “openings” that provide vantage points for enjoyment of the greater Trail landscape. The temperate deciduous forests that dominate the APPA region are characterized by broadleaf trees, including oak, hickory, maple, beech, and birch, often with a mix of conifers such as hemlock, spruce, fir, and pine on drier or higher elevation sites. Other noteworthy terrestrial habitats include alpine vegetation, rocky outcrop woodlands, and old-field successional habitats and plantations. Though less common, a variety of wetland and aquatic habitats are distributed throughout the Appalachian region. These include forested and shrub swamps, marshes, wet meadows, fens and bogs, lakes, rivers, ponds, and vernal pools.

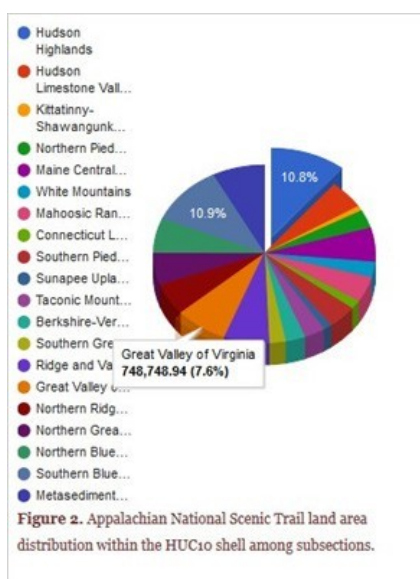
Worldwide, temperate deciduous forests have been highly altered and possess the highest index of human disturbance of any major biome (Hannah et al. 1995) as well as high fragmentation indices (Ritters et al. 2000). The eastern United States and the area surrounding the APPA is no exception, where temperate deciduous forests have been heavily used for timber, cleared for agriculture, or converted into towns and cities. In some locations, the APPA corridor may be the only remaining segment of protected land on the landscape, so while the corridor itself is protected from development, land use change and habitat fragmentation continue to affect the forested land surrounding the corridor. Other key concerns for forests in the Appalachian region include the impact of invasive exotic species, atmospheric deposition and ozone pollution, climate change, and visitor impacts (Dieffenbach 2011).

Our overall goal with respect to forest health is to assess the current status of forest resources along the Appalachian Trail using freely available data, and to create a process that will promote

monitoring of those resources. The portion of the APPA that is the subject of the current report is shown in figure 1 (dark blue).

Methods

We analyzed recent data from the US Forest Service (USFS) Forest Inventory and Analysis (FIA) program, the nation's forest census. The FIA program collects and reports data on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth and mortality; and in forest land ownership. Data are collected from permanent plots at a scale of about 1 plot per 6,000 acres (2,400 ha) in Trail states. A subset of plots are analyzed for additional forest health variables, such as soil chemistry, vegetation structure and woody debris -- these data are collected on about 1 plot per 96,000 acres (39,000 ha).

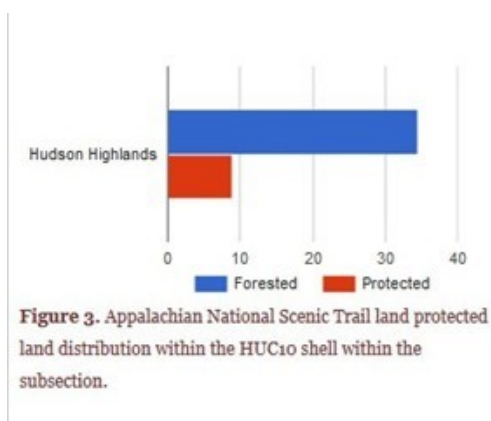


Protected Status

The APPA trail corridor is nominally 1,000 ft wide, spans approximately 2,100 miles from Maine to Georgia as it follows nearly the entire Appalachian Mountain range, and repeatedly traverses the major elevational, latitudinal, ecological and cultural gradients found in the eastern States. About two-thirds of the entire HUC-10 shell is forested but individual subsections vary widely (Figure 3).

While the narrow Trail corridor is protected from development and harvest, in general, little of the surrounding forestland is protected. While the land owned and managed by the APPA may represent a small portion of the area used for the current analysis, the protected corridor may provide significant conservation value. This is particularly true for provinces where the proportion

of protected land is low. Percent of lands that are forested and protected in the current province are shown in figure 3.



Land Ownership

Lands owned and managed by the National Park Service (NPS) as part of the APPA measure approximately 270,000 acres, making APPA one of the largest parks in the east. In fact, a recent analysis by APPA staff found that the exterior boundary length (perimeter) of all lands that are federally owned and administered by APPA is second only to Wrangell-St. Elias National Park in Alaska (the single largest NPS unit with a land area that is approximately the same as the combined size of Connecticut and Massachusetts). This long but narrow ribbon on the

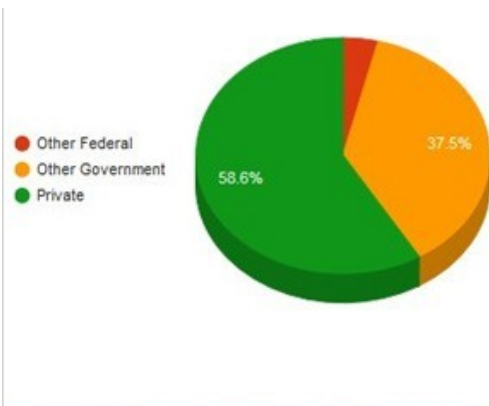


Figure 4. Appalachian National Scenic Trail land ownership distribution within the HUC10 shell within the province.

landscape helps to protect significant resources, but also exposes the APPA to potential threats along its entire length.

The majority of lands through which the APPA passes are forested, and are owned by a combination of Federal, state, and local agencies as well as private owners (figure 4). The distribution of ownership varies widely between ecoregions, but in all instances at the province level the largest ownership group is “Private” (figure 4). This is not unanticipated because the HUC10 shell incorporates lands that may be 15 or more miles from the APPA.

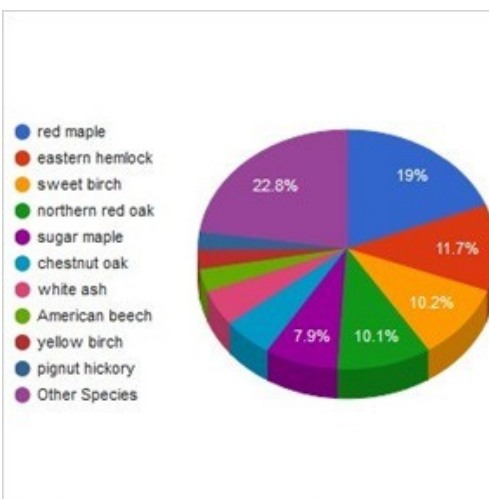


Figure 5. Appalachian National Scenic Trail species composition showing the 10 most common species.

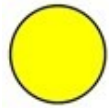
Species Composition

Forests along the northern sections of the Appalachian Trail, from Maine through the higher elevations of New Hampshire and Vermont, are generally dominated by red spruce, balsam fir, and northern hardwoods (sugar maple, American beech and yellow birch). Figure 5 shows the ten most common tree species observed in the current province.

Moving south along the APPA through Massachusetts and into Connecticut, the species composition transitions from northern hardwood to central hardwood forests where species like hickory and oak begin to replace maple and birch. Further south into the Hudson Valley, the Appalachian Trail is primarily located on ridgelines where

the species composition fully transitions and Oak-hickory forests are dominant.

In the southern Appalachians, spruce-fir forests are a unique ecosystem type that consists of a forest dominated by populations of red spruce (*Picea rubens*) and Fraser fir (*Abies fraseri*). The Southern Appalachian spruce-fir forests are similar in structure to the boreal forests found in Maine and eastern Canada, but are typically located at higher mountain elevations (> 4,000 feet), and occur in a series of island-like stands on mountains in North Carolina, Tennessee, and Virginia. While similar in structure, the northern spruce-fir community is dominated by balsam fir, whereas the southern spruce-fir community is characterized by Fraser fir. The southern Appalachian spruce-fir forest is isolated from its northern counterpart by the Central Appalachians that are characterized by lower-elevation peaks too low for the species to expand northward. While present, the southeastern spruce-fir forest community (red spruce and Fraser fir) is not well represented in the FIA dataset we used for our analysis.



Caution

Forest Structure

At landscape scales, forest structure affects the maintenance of biological diversity, particularly for species that are dependent upon specific structural stages.

In many instances, mature and late structural stages are the most ecologically relevant stages because sensitive species are generally more dependent on those stages than less mature stages. Standing dead trees (snags) and coarse woody debris (CWD), discussed later, are important structural features of forest stands that also provide habitat for wildlife and fungi.

Rank	Category Considered	Percent (%)
Good	Late Successional	≥ 25
Caution	Late Successional	< 25
Significant Concern	Late Successional + Mature	< 25

Figure 6. Forest structure threshold ranges for assessing ecological health.

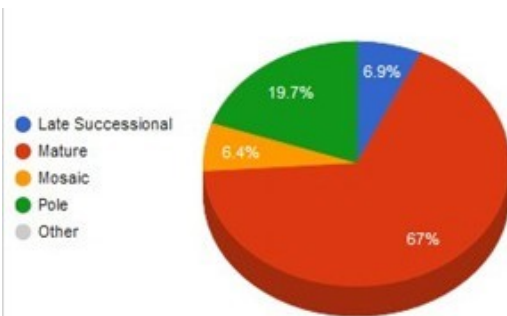


Figure 7. Appalachian National Scenic Trail forest structure showing breakdown between 4 successional stages.

We compare our results to a hypothetical distribution that might occur under natural disturbance regimes, thereby providing an indicator of altered disturbance regimes throughout the subsection. The result of this comparison is the “green,” “yellow,” or “red” forest structure ecological integrity (EI) symbol above (figure 6). The threshold values used to ascribe an ecological integrity value differ by region, with 75% being used for northern subsections and 25% for central and southern subsections. Our analysis assesses the structural stage distribution of forest plots using FIA data (figure 7). It is important to understand that the results we present are for an area substantially larger than the APPA land area

itself. For this reason, resource conditions may be different along the APPA, where the forest is not actively managed, than the subsection in general where lands are frequently managed.

However, because the APPA land area is relatively small compared to the surrounding area, and because many species dependent on mature and/or late structural stages also require relatively large and intact tracts of land, the potential for more desirable habitat along the APPA compared to the subsection as a whole may not be sufficient to sustain dependent species.

As multiple stressors including global change and exotic pest and pathogen outbreaks alter disturbance regimes (Dale et al. 2001), structural stage distributions are likely to shift. This is a key reason for monitoring structural change along the APPA, even if conditions are less impacted than the surrounding region, any negative trend occurring in the surrounding area may have a disproportionately strong influence on conditions along the APPA.

Basal Area

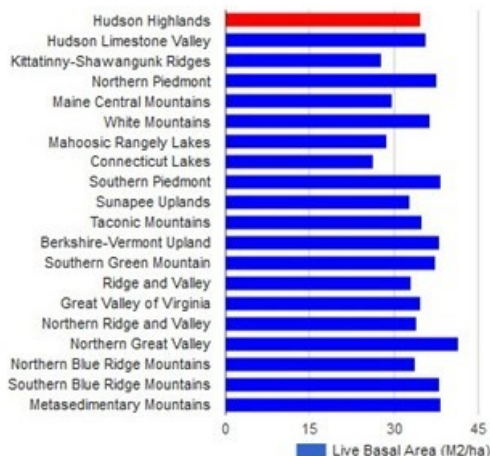


Figure 8. Appalachian National Scenic Trail Live Basal Area (LBA; the current Subsection is highlighted in red).

Live basal area (LBA) is a measure of the amount of live woody biomass (i.e., trees) on the landscape and is a key part of measuring tree growth rate. LBA is influenced by the dominant structural stage of the forest and may vary in response to different stressors. Because LBA is a measure of live trees only, LBA may decrease following a harvest or die-off. For lands like the APPA, which are protected from harvest, a decrease in LBA would presumably be a result of natural mortality, disease, or some form of disaster (e.g., storm events, fire, etc.).

As trees grow, annual growth rings are added and result in a gradual increase in LBA over time.

Exhibits showing examples of tree cross-sections with annual growth rings visible are commonplace, and it is relatively easy to see that during periods of stress (e.g., drought periods, fire, and insect infestation), annual growth rings are typically smaller than during non-stress periods. When smaller rings are added, the LBA may still increase but at a slower rate than during non-stress periods.

Conversely, when larger rings are added, LBA would increase more rapidly. LBA for the current province is shown in figure 8, though threshold values used to assess ecological integrity for LBA have not been developed.

Snags

Caution Dead wood, in the form of standing dead trees (snags) is an important structural feature of forest stands that provides habitat for arthropods, herptiles, small mammals, fungi, and are particularly important for cavity-nesting birds. Large diameter snags typically persist longer than smaller diameter snags (Morrison and Raphael 1993, Garber 2005) and provide habitat for a greater number of vertebrate species (Cline et al. 1980, DeGraaf and Shigo 1985). Silviculture, land management and hazard tree removal can reduce the quantity or quality of these features; however, thoughtful land management can maintain or enhance snags (Keeton 2006). This metric assesses the density of snags in relationship to live tree density and volume.

Density of snags in mature and late-successional stands varies substantially across ecosystems and with site conditions (Tyrrell et al. 1998). However, positive relationships between live and dead tree density and volume can be

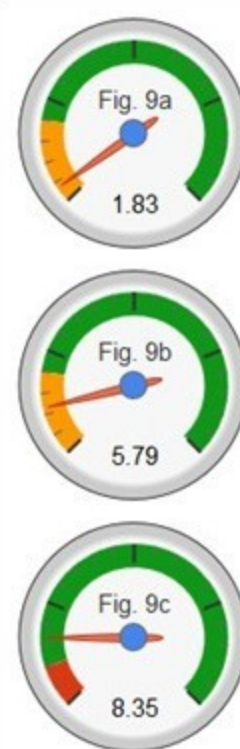


Figure 9. Appalachian National Scenic Trail snag gauges: (a) snags as % of medium-large live tree density; (b) snags as % total live tree density; (c) medium-large snags/hectare.

used to indicate expected snag levels (Sippola et al. 1998, Ferugson and Archibald 2002, Stewart et al. 2003).

A thorough review of scientific studies (Nillson et al. 2003; Goodburn and Lorimer 1998; Garber 2005; and, Spetich et al. 1999) suggests that snag density should be at least 10% of overall and medium-large live tree density. Subsections with 10% or greater density are considered “Good,” those with less than 10% but 5 or more med-large snags per hectare are “Caution,” and subsections with fewer than 5 med-large snags per hectare are “Significant Concern” (figure 9).

Coarse Woody Debris (CWD)



Significant
Concern

As with snags, fallen coarse woody debris (CWD) is an important structural feature of forest stands that provides important habitat for arthropods, herptiles, birds, small mammals, fungi, and CWD (DeGraaf and Rudis 1986, Petranks et al. 1994). This metric

assesses the volume of CWD in relationship to live tree density and volume.

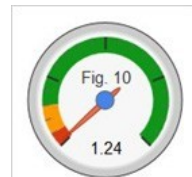
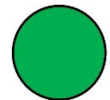


Figure 10. Coarse woody debris as % of live tree volume.

CWD debris continues to be used by wildlife as it breaks into smaller pieces over time, thus CWD volume can be a useful indicator of habitat availability. However, because CWD volume varies between successional stage, site condition, and across ecosystems (Tyrrell et al. 1998), precise threshold values for CWD volume do not exist. Based on available recommendations, provinces with CWD greater than 15% of live tree volume are “Good,” 5 - 15% is “Caution,” and less than 5% is “Significant Concern” (figure 10).

Mortality



Good

Mortality rate provides a quantitative metric of tree health and vitality. Annual mortality rate (% stems/year) is calculated from repeat FIA data observations.

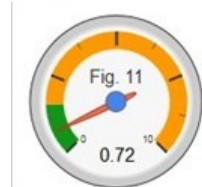


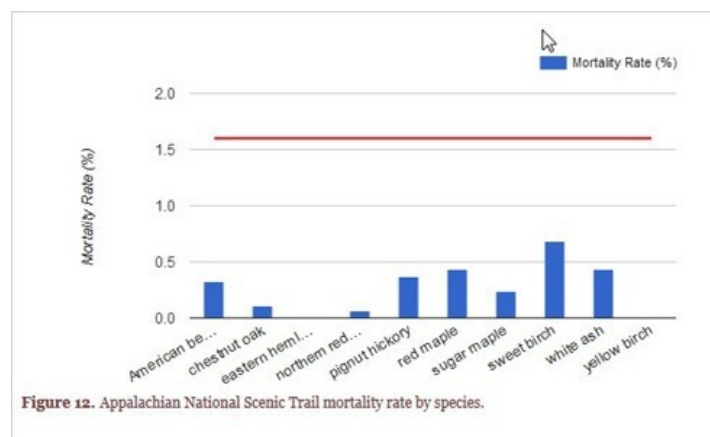
Figure 11. Overall mortality expressed as % of stems that die annually.

Tree growth rates can decline in response to environmental factors or anthropogenic stress, and tree mortality is often preceded by some years of reduced tree growth (Ward and Stephens 1997, Pedersen 1998, Dobbertin 2005). Decreased growth or elevated mortality rate in trees of a particular species can indicate a particular health problem for that species, such as sugar maple decline (Duchesne et al. 2003, Hyink and Zedeker 1987); while altered vital rates for multiple species across a region may indicate a regional environmental stress (Steinman 2004, Dobbertin 2005).

Typical mortality rates vary by site, structural stage and by tree species, size and crown class (i.e., tree position in the canopy). For this reason, mortality rates are calculated for species as well as by subsection.

Annual mortality rate (MR; % stems/year) for the entire subsection (figure 11), as well as by species for the 10 most common species (figure 12), is calculated from successive observations as the percent of stems that died during an interval converted to an annual basis.

Typical annual tree mortality rates in old-growth forest range from 0.3% to 1.6% (Busing 2005, Runkle 2000, Woods 2000). We rely on this range to say that a mortality rate equal to or less than 1.6% is ‘Good,’ and greater than 1.6% is considered ‘Caution.’ A threshold for ‘Significant Concern’ has not been established.

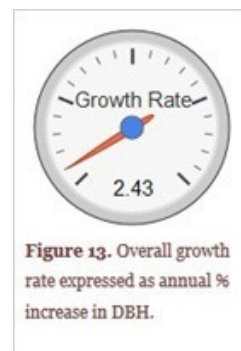
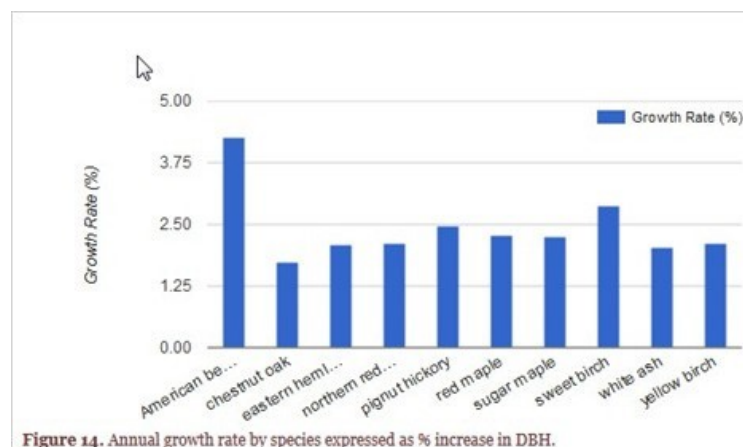


Tree Growth

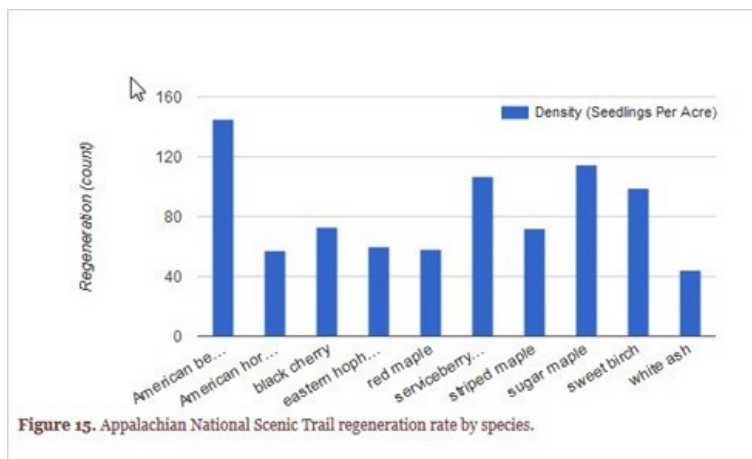
Tree growth rate provides a quantitative metric of tree health and vitality, and is calculated from repeated bole DBH measurements. Like all other forest health metrics for the APPA, growth rate is calculated from available FIA data.

Growth rates can decline as trees mature, or in response to environmental factors or anthropogenic stress (Ward and Stephens 1997, Pedersen 1998, Dobbertin 2005). Decreased growth rate in trees of a particular species may indicate a particular health problem for that species, such as sugar maple decline (Duchesne et al. 2003, Hyink and Zedeker 1987); while altered vital rates for multiple species

across a region may indicate a regional environmental stress (Steinman 2004, Dobbertin 2005).



Typical growth rates vary by site, stand structural stage and by tree species, size and crown class (i.e., tree position in the canopy). For this reason, growth rates



regeneration will impact future canopy structure and composition. Regeneration can be affected by a variety of stressors, including air pollution and climate change. Figure 15 shows seedling density (seedlings per acre).

are reported both by subsection (figure 13) and by species (figure 14). Ecological thresholds for growth rates calculated from existing FIA data are not currently available.

Regeneration

This metric assesses the quantity and composition of advance tree regeneration in the forest understory using available FIA data. The quantity and species composition of advance

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