FIA Responses to "Review of the Black Hills National Forest 2017-2019 Augmented FIA Inventory Results" Report

September 2, 2020

For further information, contact:
Hobie Perry
Program Manager
Northern Research Station Forest Inventory and Analysis
USDA Forest Service
charles.h.perry@usda.gov
651-649-5191

Overview

The Black Hills National Forest (BHNF[1]) established a collaborative working group in June 2016 – including members from BHNF, forest industry, and state forestry agencies – to define specific information needs about the standing forest inventory. These questions were forwarded to FIA with the understanding that its protocols for establishment and collection of forest survey data meet rigorous scientific and statistical standards so that the information derived can be used to make forest management decisions with confidence. Those questions included:

1. What is the standing live volume estimate for Black Hills NF?
2. What is the annual gross growth estimate for Black Hills NF?
3. What is the annual net growth estimate for Black Hills NF?
4. What is the net growth to removal ratio on Black Hills NF?

The questions were broken out by the defined suitable base for timber production as defined in the 1997 Forest and Land Management Plan as well as land defined as Timberlands. To assist with preparing the estimates, FIA was asked to use the suitable base geospatial polygon layer provided by the Forest to assign plot-level suitability tags for all plots in the analysis.

A team of three consultants prepared a report on behalf of the Black Hills Forest Resource Association detailing concerns with the resulting custom ("augmented") analysis provided to BHNF. This document provides FIA's response to these critiques as summarized in the report's Executive Summary. The concerns are addressed substantively in sequence as they were not numbered in the report.

The majority of the report's claims reflect misunderstandings about how FIA prepared, completed, processed, and reported the BHNF inventory. Only two of the concerns and/or observations expressed in the summary's 18 concerns stand-up to further scrutiny: 1) growth rates in the augmented data do rely upon shorter remeasurement periods relative to the rest of the observations, and 2) NRS FIA does apply a consistent defect value across ponderosa pine as a species.

This review offered an opportunity to scrutinize the underlying data, processing, and analyses again. None of the concerns expressed in the report have discernable impacts on the published estimates. To the contrary, this review fundamentally validates the substance and quality of the published inventory data and summaries.

Concern 1

The report asserts that the augmented inventory is "less accurate (but more precise)" than the 2016 inventory despite the fact that the new inventory includes a greater number of and more recent sampling points. This assertion implies

[1] NRS FIA uses this abbreviation to remain consistent with published database tables.

the true value of each population attribute is known. This is contrary to the entire premise underlying inventory statistics: sampling to estimate population attributes that, in fact, are not known.

The report's fundamental and recurring assertion of inaccuracy rests upon the claim that the augmented inventory does not reproduce the area of a polygon from a geospatial layer, namely the "suitable base" of timberland within the BHNF. There are two misunderstandings embedded in this claim: (1) while the area of the polygon is known, the actual acreage of suitable base within the polygon is not known, and of greater concern (2) the authors have conflated estimates of the suitable base polygon with a published estimate of suitable timberland. Suitable timberland is the subset of timberland (as determined by FIA definition) found on a subset of NFS ownership (the suitable base as determined by the forest plan and NFMA) within the proclaimed forest.

It is important to reiterate the purpose of this inventory: to estimate forest attributes on lands within the BHNF. To that end, the target population is constrained to those lands actually owned by the National Forest System (NFS)[2]. Privately-held lands within the proclaimed boundary (inholdings) are excluded. Some of the area of the polygons identified as suitable base are not owned by BHNF and were therefore excluded from the evaluation. Consequently, the area of the estimation unit is less than the area of all the suitability polygons because they include both NFS and non-NFS lands. Furthermore, some suitable base polygon area is not timberland and not included in the suitable timberland estimate. This reinforces the point that the actual area of suitable base is not known with certainty. To understand the acreage assignments one must refer to Appendix A. – Acreage Comparisons and Appendix B. – Area Budget for FIA and FSVeg Suitable Base.

BHNF staff maintain a geospatial layer that depicts the Forest's suitable base. This geospatial layer (in ESRI shapefile or geodatabase format) shows many updates over time, and there have been numerous estimates of the total area of suitable base. FIA was provided an initial version of the layer from December of 2015 and a single updated version from February 2019.

FIA incorporated the layer into the analysis in two ways. First, the layer was used to assign plot-level suitability tags (as requested) for all plots in the analysis. Second, the layer was used to define the estimation units within the target population. Estimation units are mutually exclusive sub-populations within the target population that are individually stratified. This provides an ability to generate an area-controlled estimate of that sub-population if desired.

FIA uses the EXPALL evaluation to account for all acreage within an inventory. The expansion factors are computed based on the sample and stratification within each estimation unit.

The inventory meets the "accuracy" standard set by the report: FIA estimates the total area of suitable base as defined by the supplied suitable polygon layer (rasterized to 30 m pixels) and NFS ownership polygon layer (rasterized to 30 m pixels) (Table 1). The EU_AREA (based on rasterized version of the suitable base layer polygon and constrained to NFS-owned lands) and EST (acreage computed using the expansion factors) columns match. Appendix C. – SQL for Estimation Unit Area Calculations provides the Structured Query Language (SQL) used to calculate Table 1; Appendix D. – Calculating Expansion Factors covers the calculation of expansion factors.

[2] It is more appropriate to use the phrase "managed by the National Forest System" to make clear the fact that National Forest System lands are Federally owned and managed on behalf of the American public. However, we are using the term "ownership" to avoid confusion with Forest Service management delineations like "suitable base" on subsets of the Federal lands.

Table 1. EXPALL Estimation Unit Area Calculation

EVALID	ESTN_UNIT_DESCR	EU_AREA	EST	DIFF	PLT_CNT
561700	BHNF_NotSuitable	428,388	428,388	-	104
561700	BHNF_Suitable	817,388	817,388	-	222
561800	BHNF_NotSuitable	413,127	413,127	-	137
561800	BHNF_Suitable	836,982	836,982	-	297
561900	BHNF_NotSuitable	413,151	413,151	-	140
561900	BHNF_Suitable	836,959	836,959	-	298

Concern 2

The report claims that the presence of two groups of sampling points (PERMANENT and TEMPORARY) complicate the derivation of expansion factors for various estimates. This concern also includes the assertion that 'anomalies' exist in the data that coincide with the presence of these two groups.

Regarding the first point, the presence of groups of sampling points does not pose any challenge for FIA. FIA regularly constructs evaluations (see Appendix D. – Calculating Expansion Factors; EVALID identifies unique evaluations in Table 1) to bundle together all data required to generate unbiased estimates of specific population attributes. Each FIA evaluation is composed of two key components: a sample and a stratification of the target population.

When assembling the sample for an evaluation, each sampling point must meet certain prerequisites in order to be included. Most importantly, it must be possible to produce the desired estimate from a sampling point before it can be included in the sample. For example, one evaluation targets current estimates (the report refers to this as 'inventory'), and each plot must meet the prerequisite of being able to produce estimates of domain areas (such as timberland) as well as tree inventory estimates (such as volume or biomass). Both the PERMANENT and TEMPORARY plots meet this prerequisite and are included in this evaluation. Another evaluation targets change estimation (such as tree growth), and only plots that have been successfully sampled at two consecutive visits may be included. Only the PERMANENT and some of the TEMPORARY plots (those that are base intensity but off-panel) are included.

Once the samples (current and change) are identified, calculations are performed that compute the expansion factors and adjustment factors (to compensate for non-response) at the stratum level. The results of these calculations are unique for each sample-stratification pairing. They can be checked for internal consistency by performing the calculation shown under the response to Concern 1.

Regarding the second point, the authors assert that 'anomalies' exist, coincident with the introduction of the TEMPORARY plots. These TEMPORARY plots include a full set of 2X (intensified) plot visits with accelerated implementation over the 2017 and 2018 field seasons, as well as off-panel (accelerated) visits to base plots that would not normally be sampled by the 2017-2019 field seasons. The 2X plot visits are initial establishment of new sampling points that have never been visited before and therefore have no remeasurement information. By contrast, the off-panel base plots are accelerated remeasurement (ahead of schedule) that do have remeasurement information. The inclusion of both of these sub-groups creates a new sample. Each unique sample of a target population will naturally yield different results. What the report highlights as 'anomalies' are simply the result of collecting a new sample. Appendix D. – Calculating Expansion Factors provides detailed examples for creating expansion factors for the change evaluation and the current inventory evaluation.

Concern 3

The report observes that FIA reports an estimate of suitable timberland on the BHNF that is below the area of a polygon in a geospatial layer. It is noteworthy that the report cites two different area estimates from two different versions of this layer which is regarded as **known** [emphasis in the original].

Several steps are taken to generate an estimate, and each "filter" subsets the area into smaller and smaller totals. First, FIA used the supplied suitable base polygons to define estimation units within the BHNF target population: one for suitable land and the other for non-suitable lands. For the purpose of this inventory, these areas are constrained to lands actually owned by BHNF and excludes inholdings of private ownership. Second, FIA computed an estimate of timberland area (importantly, by FIA's definition applied on the ground) for each of these estimation units. In addition, FIA was asked to 'tag' each plot visit with a BHNF suitability tag. This was done using the geospatial layers provided (in vector format). This plot-level tag was used to further filter the results. As a result, starting with all the plots within each estimation unit (which *does* match the area of the suitable base polygon supplied by BHNF), filtering for those plots that meet the FIA definition of timberland, and then filtering further for only those that are tagged as suitable **and** owned by the BHNF, the resulting value will be less than the area of the original polygon.

Additional detail: FIA used the vector format of the provided suitability geospatial layer to tag plot visits. This was done using the best available coordinate representing Plot Center (PC) on each plot as requested. That same vector layer must then be converted to a raster layer (30m resolution) as part of the FIA's stratification methodology. The process of 'rasterization' must resolve all the fine details of lines in the vector layer into 30 m pixels. This rasterization process can result in a pixel containing a plot where the classification changes from suitable (polygon overlay) to not suitable (pixel) and vice versa, particularly with plots on the edge of a polygon. There are 9 such cases in the 2019 sample. Appendix A. – Acreage Comparison and Table 2 show the acreage represented by these 9 plots and the relationship between the rasterized suitable estimation unit and the computed suitable land acreage. The total acreage of the BHNF Suitable estimation unit is 836,959 acres (Appendix A. – Acreage Comparison and Table 3), 41 acres less than the 837,000 acres that report cites as the **known** [emphasis in the original] suitable base acreage. The estimate of all suitable land (across all land and ownership types) is 828,925 acres, which is 8,034 acres less than the BHNF Suitable estimation unit acreage (836,959-828,925 = 8,034 ac.).

Table 2. Suitable Land Discrepancies

EVALID	ESTN_UNIT_DESCR	EU_AREA	SRATUM_DESCR	STATECD	INVYR	PLT_CN	INTENSITY	BHNF_SUITABLE_LAND	ACRES	DISCREPANCY_TYPE	REMARKS
561901	BHNF_NotSuitable	413,150.50	Canopy cover 51-65	46	2017	414838809489998	1	Y	3,325.03	RASTERIZATION	11 meters from non-suitable polygon.
561901	BHNF_NotSuitable	413,150.50	Canopy cover 6-50	46	2017	414839804489998	2	Y	3,012.36	RASTERIZATION	less than 1 meter from non-suitable polygon.
561901	BHNF_NotSuitable	413,150.50	Canopy cover 6-50	46	2018	461069453489998	1	Y	3,012.36	RASTERIZATION	9 meters from non-suitable polygon
561901	BHNF_Suitable	836,958.60	Canopy cover 66-100	46	2019	563086431126144	1	N	2,499.79	RASTERIZATION	8 meters from suitable polygon
561901	BHNF_Suitable	836,958.60	Canopy cover 6-50	46	2018	461070452489998	2	N	2,740.22	RASTERIZATION	8 meters from suitable polygon
561901	BHNF_Suitable	836,958.60	Canopy cover 51-65	46	2018	461070421489998	2	N	3,763.31	RASTERIZATION	8 meters from suitable polygon
561901	BHNF_Suitable	836,958.60	Canopy cover 51-65	56	2019	659449472126144	1	N	3,763.31	RASTERIZATION	12 meters from suitable polygon
561901	BHNF_Suitable	836,958.60	Canopy cover 0-5	46	2019	563086389126144	1	N	2,117.12	RASTERIZATION	7 meters from suitable polygon
561901	BHNF_Suitable	836,958.60	Canopy cover 66-100	46	2019	511296963126144	1	N	2,499.79	RASTERIZATION	18 meters from suitable polygon

Table 3. Area Estimates by Estimation Unit and BHNF Suitability Tag

EVALID	ESTN_UNIT_DESCR	EU_AREA	BHNF_SUITABLE_LAND	EST	PLT_CNT
561901	BHNF_NotSuitable	413,150.50	N	403,800.76	137
561901	BHNF_NotSuitable	413,150.50	Y	9,349.74	3
561901	BHNF_Suitable	836,958.60	N	17,383.54	6
561901	BHNF_Suitable	836,958.60	Y	819,575.06	292

Concern 4

The report observes that area estimates begin falling starting in the 2017 reporting year which corresponds to the first inclusion of the 2X sample. However, the addition of the 2X sample combined with the existing base sample constitutes an entirely new sample, bringing new information not present in the 2016 and prior samples. A change in the population-level estimates is expected as it would be with any new sample including new observations.

Concern 5

The report cites several areas for suitable timberland taken from multiple geospatial layers. FIA estimates of lands that are both classified as Suitable (via a plot tag) and also meet FIA's timberland definition have decreased in the period between 2017 and 2019.

As observed above, each of these reporting years (2017, 2018, 2019) represents a new and unique sample of the population. In this instance, the addition of more information yields lower estimates of the area of land classified as suitable timberland owned by the NFS. Rather than interpreting this as a loss of accuracy, FIA interprets this to suggest the base sample alone presents an overly optimistic estimate of these lands; more data resulted in lower area estimates and tighter confidence intervals.

As demonstrated in Concern 1, a sample-based estimate of the area of provided polygons is a straightforward calculation but not the fundamental objective of this inventory.

Concern 6

The report offers a t-test showing that it is highly unlikely that the FIA estimate of suitable timberlands comes from the same population as the area of the suitability polygon. As explained above, FIA was not trying to reproduce the area of that polygon in the "tested" estimate. On that basis alone, the test is uninformative. Additionally, a sample-based estimate of any polygon area can be produced provided that FIA uses that polygon as the basis for an estimation unit.

Concerns 7-8

The report continues its focus on the area of the suitable base polygon and attempts to "correct" FIA's estimate of suitable timberland compared to the suitable base acres from a geospatial layer. The report asserts that all subsequent estimates cannot be trusted. Even though the report demonstrates a misunderstanding of FIA's estimate of suitable NFS timberland, an exercise was performed to see the degree to which net growth is affected if all the suitable land (identified by the suitability vector layer) was designated as NFS timberland (Appendix E. – Example Adding Net Growth for Areas which are not National Forest System Timberland). The example focuses on adding an identified maximum net growth for conditions that are not NFS timberland to the total net growth estimate of ponderosa pine growing-stock trees on NFS timberland (-5,965,376 cu. ft./ac./year), BHNF 2019. After adding the identified maximum net growth, the adjusted total net growth estimate for ponderosa pine growing-stock trees is -3,595,353 cu. ft./year. Since most areas will not attain the identified maximum net growth, this is an overly optimistic estimate.

Concern 9

The report expresses dissatisfaction with FIA's previous explanations about the suitable timberland area discrepancy. The responses to concerns above address this. The report's claims that FIA's responses have not explained the decline in FIA's estimates of suitable timberland are also covered in a previous response. Simply put, new samples yield new estimates. In this case, the estimates fell when additional and more current data were used. An analysis of the ecological causes of these observed changes was outside the scope of the Forest's original request which focused upon the four estimates outlined above.

The report goes on to assert that the FIA estimates are not representative of the BHNF suitable base acres. This claim is based on the observation that a "substantial proportion" of lands classified as suitable via the polygon layer are not classified as timberland by FIA. FIA does not participate in the Forest's planning process, but the Forest's intent of defining suitable base appears to be the identification of lands capable of and authorized for producing timber products. FIA has developed its definition of timberland with the same goal, but rather than being determined solely through a map exercise, FIA implements this definition as a function of field-collected observations. As with the map products, there are various sources of error in this process, and FIA reports these uncertainties by publishing standard errors for each estimate.

It is possible for a particular piece of land to be classified via a GIS exercise as suitable base and for this land to not meet the FIA definition of timberland in the field. Discrepancies could be attributed to the definitions used in the two efforts as well as errors from either or both sources. For example, FIA's calculations may conclude the site to be unproductive and therefore not timberland. If such a determination was made from observations on the FIA plot footprint, then it is very likely well below the minimum mapping unit of the polygon layer. It is misleading to construe this as "unrepresentative." This is also addressed in the area budget prepared by BHNF staff and distributed in preparation for the April stakeholder meeting (Appendix B. – Area Budget for FIA and FSVeg Suitable Base).

Concern 10

The report expresses concern over shortened remeasurement periods for the 2019 off-panel (accelerated) base plots. This is a valid concern and one that was discussed at the time of the 2019 sample selection. The determination was that FIA field crews are capable of making accurate diameter measurements at remeasurement periods of 3 years or more.

Blind checks are one quality assessment tool used by FIA where a random sample of at least 4 percent of all plots are measured independently by a quality assurance (QA) crew. Blind check measurements are used to observe how often individual field crews are meeting a set of measurement quality objectives (MQOs) that are set for every data item collected and to assess the overall compliance among all crews.

FIA is meeting the measurement quality objective (MQO) tolerance (Table 4) for diameter-at-breast height (d.b.h.). Data in the two columns labeled "All NRS states" are derived from all measurements made by Northern Research Station-FIA crews within the entire 24-state region.

The mean change in d.b.h. at approximately 3 years is 0.27 inches (Figure 1) and increases with lengthening remeasurement intervals. These changes in d.b.h. are readily measurable given the compliance to MQO tolerances. Additionally, there is not a pronounced relationship between mean annual increment and remeasurement class (Figure 1).

Table 4. Compliance to measurement quality objectives (MQO) tolerances for d.b.h. on blind check plots, Northern Research Station, 2017

			All NRS states	
Variable	**Tolerance**	**Objective**	**Data within tolerance**	**Number of observations**
D.b.h.	±0.1 inch per 20 inches	95%	96%	48,623

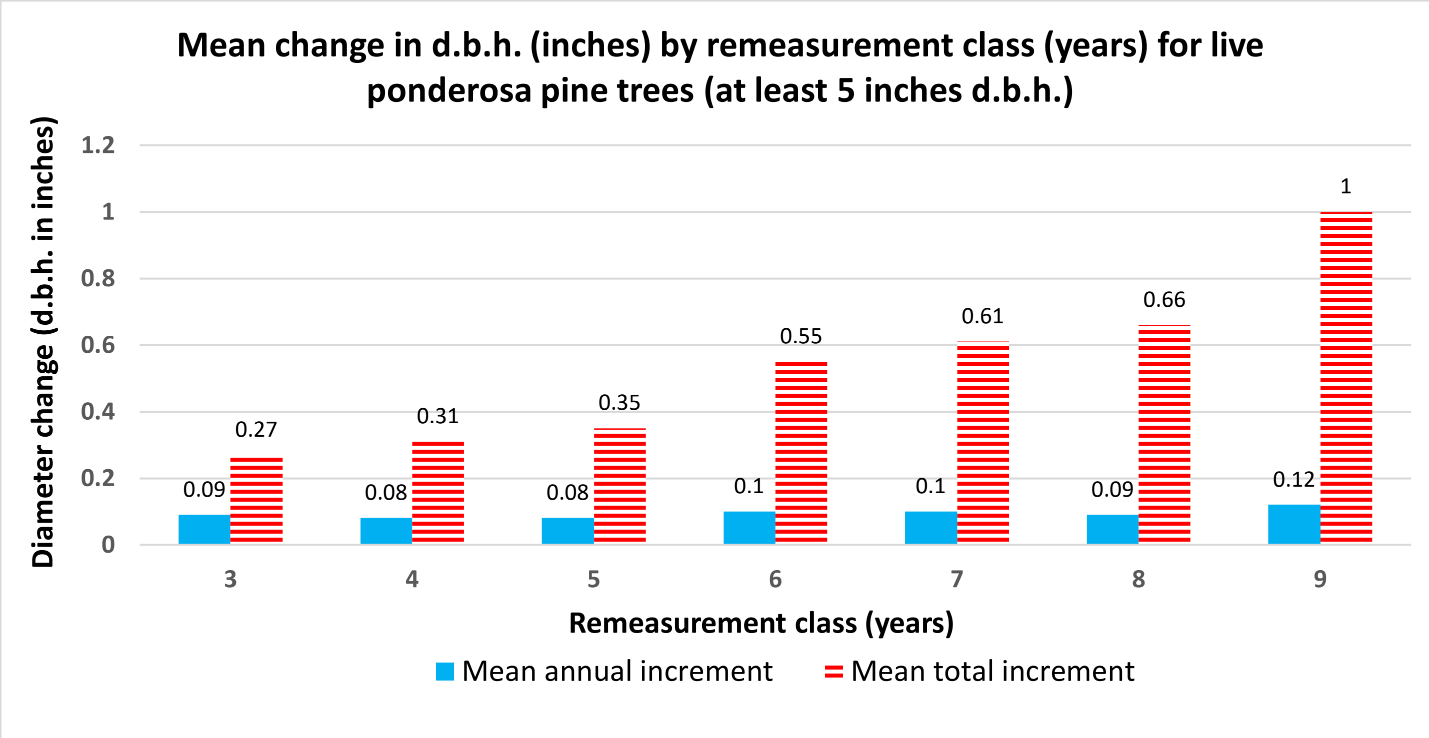

Figure 1. Mean annual and total change in d.b.h. (inches) by remeasurement class (years) for live ponderosa pine trees (at least 5 inches d.b.h.). Remeasurement class bins remeasurement period such that it is less than (down to the next class) or equal to the shown value; e.g., remeasurement periods less than or equal to three years are identified as remeasurement class 3. Remeasurement class 9 only includes two trees; whereas, the other classes have tree counts ranging from 169 to 698.

Concern 11

The report expresses concern over the implementation of the intensified sampling points. Specifically, the goal appears to be to determine if there is a bias in the establishment of these additional sampling points.

Blackard and Patterson (2014)[3] cover the topic in detail.

To summarize, the BHNF intensified sampling points were established using the following methods:

1) Create a bounding polygon around the target population (BHNF) with buffer to reduce any possible edge effects
2) Use the EPA GRID program to generate a finer point network than the base sampling frame
    a. This is the same method used to generate FIA's P2 (~6,000 acre hexagonal sampling frame) but generates a finer network
3) Convert this finer point network into a hexagonal tessellation of the landscape
4) Execute a script that implements the FIA national panels (5 values) and the 14 sub-panels.
    a. These are repeating spatial patterns orthogonal to each other
5) Break the tessellation hexagons created in step 3
    a. These finer hexagons are not constrained to the parent hexagon. They are broken at the boundary and combined such that there is the desired number of sub-polygons within the parent P2 hexagon and all these polygons are equal area.
    b. Note that some of the polygons are multi-part polygons but still have the same area as all the other sub-polygons

---

[3] Blackard, Jock A.; Patterson, Paul L. 2014. National FIA plot intensification procedure report. Gen. Tech. Rep. RMRS-GTR-329. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 63 p.

6) Update the panelization
    a. FIA never reassigns plots to panels. So the sub-polygon in which the base plot falls inherits that plot's panel information. If that conflicts with the assignment made by the script in step 4 then sub-polygons exchange panel assignments
    b. This is random relative to the underlying landscape
7) Assign spatial intensities randomly to all sub-polygons (excluding the base sub-polygon)
8) Randomly locate new sampling points within each of the new sub-polygons
    a. Each new sampling point inherits the characteristics of the sub-polygon: intensity and panel address

In this way, the intensified sample is distributed as a systematic sample with a random element; each plot location is a randomly located point within a network of equal-area polygons. This limits the degree of spatial clumping permitted. The panel assignments ensure that there is no clumping on the time axis of the sampling frame. Note: at no point are locations coerced to fall in any particular area. In fact, this sampling frame intensification work was done prior to selection of the 2017 field sample which occurred before FIA received any geospatial layers used during analysis.

Concern 12

The report highlights the large amount of uncertainty in some of inventory estimates. As analyses are conducted in finer domains within the population (for example, only sawtimber trees of a particular species on a particular land basis filtered for suitability), the uncertainty of that estimate will increase. This is referred to as the "curse of dimensionality": the more dimensions one adds to an analysis, the greater the volume of the resulting feature space, and consequently the lower the density of data available to estimate attributes within that volume of feature space.

The report also makes the point that one must always look at the uncertainty associated with any estimate. FIA completely agrees and would include areas of polygons intended to classify land characteristics under that rule.

Concern 13

The report computes growth rates (defined as gross growth divided by gross volume in CCF units) and compares the resulting growth rates of the 2019 "augmented" data set to the four most recent years available in the public FIADB. See Appendix F – SQL Estimating Growth Rate for the calculations. This analysis was constrained to only the SD side of the population (Table 5). It is possible to reproduce these estimates:

Table 5. Growth rates for BHNF, South Dakota only.

EVALID	GROSS_SL_VOL_CF	EVALID	PLT_CNT	TREE_CNT	ANN_GROSS_GROWTH	GROWTH_RATE
561901	4,589,953.80	561903	113	1019	111,578.30	2.43%
461901	4,937,990.00	461903	113	1115	158,449.30	3.21%
461801	5,104,329.20	461803	114	1152	168,800.50	3.31%
461701	5,508,451.60	461703	115	1203	174,224.20	3.16%
461601	5,874,722.00	461603	114	1194	169,747.60	2.89%

The concern is that the “augmented” 2019 gross growth estimate is lower than the corresponding estimates from the public database. There are some key differences contributing to these changes in estimated growth rates:

- The “augmented” data set uses a different sample than the 2019 public data set even though the plot counts match.
    - The “augmented” data set includes more recent observations than the public dataset. These are the off-panel (accelerated) visits to base plots.
    - Also note that there is a lower number of trees contributing to these estimates as well. This is because the more recent plot visits recorded fewer trees.
        - As an example, consider a plot that was last visited in 2013 in the public dataset but was visited in 2019 in the “augmented” data set. The 2013 visit would have observed change from the previous visit (2008), whereas the 2019 visit would have observed change from its last visit (2013).
- The “augmented” and public data sets both employ different stratifications
    - The “augmented” uses a stratification that ignores the WY/SD state line. The estimation units are defined by suitable and not-suitable areas and the BHNF boundary (actual ownership, not proclaimed). Then each estimation unit is stratified. Expansion and adjustment factors are computed for this specific sample/stratification pairing, yielding an unbiased estimate
    - The public data set uses a stratification with estimation units defined by FIA survey units and the BHNF boundary (actual ownership, not proclaimed). This stratification is geographically constrained to only SD. The expansion and adjustment factors were computed for this specific sample/stratification pairing, yielding an unbiased estimate
- The “augmented” and public 2019 estimates do represent the same reporting year but are based on different samples which observe different periods of change and employ different stratifications. As a result, the “augmented” data set shows a different, lower gross growth rate.

If the gross growth rate is computed from the “augmented” data set, without excluding WY, the rate is 2.51%.

There is no reason to suspect these lower growth rates are biased or otherwise underrepresenting the components of this attribute. As the previous concern suggests, the uncertainty of these values is an important consideration in interpreting these estimates.

Concern 14

The report builds on the previous concern, gross annual growth rate. The report states that the 3% rate is “more defensible” because it aligns more closely with the recent SD estimates from the on-line data and because it “mitigates the effects of incorrect acreage estimation…”

Regarding the first point, the 3% rate computed from the on-line data is based on older observations. It ignores the more recent observations included in the “augmented” data set (Figure 2).

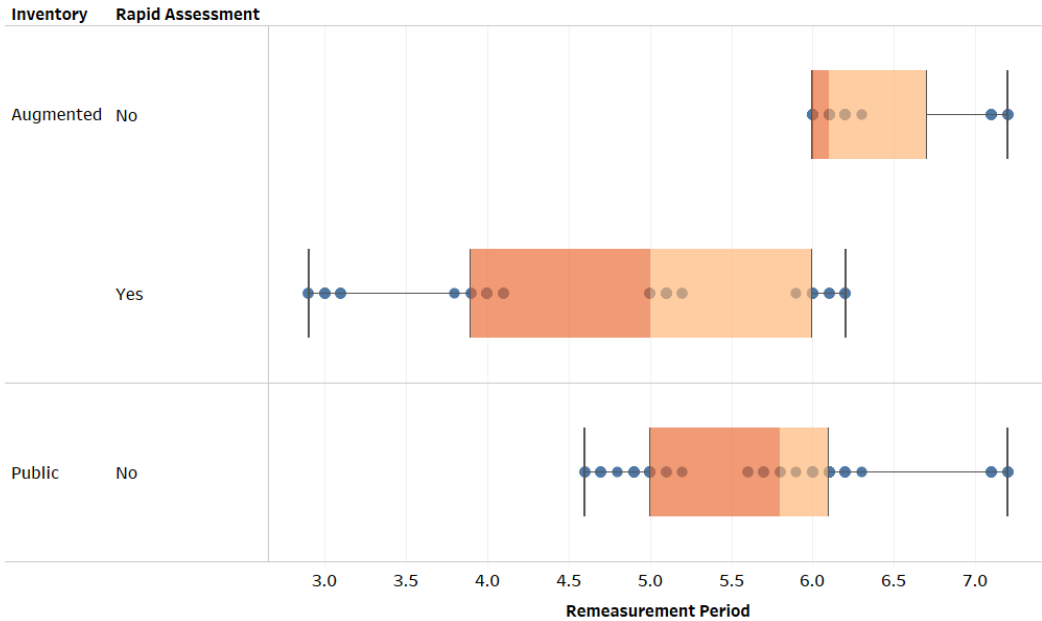

Figure 2. Distribution of plot remeasurement periods by 2019 inventories and rapid assessment status.

Regarding the second point, we have already addressed the report's concerns with acreage estimation.

Concern 15

The report acknowledges the recent mountain pine beetle outbreaks and other disturbances but state that the long-term gross growth rate is unlikely to waver from FIA estimates "from the previous 10 years." This assumes no other outbreaks or other stressors will impact growth rates in the future.

Concern 16

FIA does not attempt to model mortality; it relies on empirical observation of these events. From these observations, an annualized rate of mortality is calculated. As a result, the FIA estimates empirically show the ebb and flow of forest characteristics, particularly when looking at two decades of annualized inventory. These estimates help to quantify and contextualize the ranges of growth and mortality, and, as a result, the important variable of net growth.

The report's concerns about values used by Graham et al. (2020) are outside the scope of this response.

Additionally, discussion of the report's FVS modeling results, while noted by several reviewers, is not in NRS FIA's purview aside from the observation that the low simulated mortality rates produced by the generic FVS simulation are not supported by FIA data.

Concern 17

The report correctly observes that the BHNF suitability flag is assigned at the plot level and proceeds to assert that it would be more appropriate to have this flag assigned at the subplot level on the grounds that it is really functioning as a condition-level variable.

First, FIA completed what was requested: plot-level tagging.

Second, the report states that suitability should be assigned at the subplot level. The authors presumably mean condition level based on their reference to other condition-level variables for justification.

Third, this approach is reasonable if suitability does indeed vary more at a finer spatial resolution than at the plot level. This suggestion also appears to accept that the definition of suitable base through any GIS exercise will necessarily have "inclusions" that are contrary to each polygon's classification: GIS-suitable may be field-unsuitable and vice versa.

If this variable is indeed a condition-level attribute, then there are two methods to provide this, neither of which can be completed at this point in the analysis. The first would be to request the crews to collect this information on-plot. The second is to model it in the office based on field-collected measurements. Direct field measurements would need to be developed and deployed on some test plots to assure some reliability to the field measurement. The second method requires training a model where field measurements can be associated with the "correct" answer. FIA has no such model. Given the sensitivity of this variable for the analysis, such an addition should be developed and tested before including it in the final analysis.

Concern 18

The report observes a constant defect percentage was applied to sawtimber trees for two species of concern: ponderosa pine and white spruce. Early QA/QC results for defect found it to have low repeatability across the former North Central Research Station's FIA unit. An average value is applied by TREECLCD as a way of limiting the effects of this noise at the population level. This value was applied in both the "augmented" and on-line dataset.

While there is no formal documentation for this value, the estimate applied by FIA (11.78%) is consistent with defect observed on recent BHNF ponderosa pine timber sales (11.8%, J. Krueger, pers. comm.).

Appendices

Appendix A. – Acreage Comparisons

This appendix compares area estimates of the custom BHNF 2019 inventory (generated from FIA SQLite database and MyEVALIDator) to the spatial data sets used to create estimation units for the BHNF 2019 inventory.

Estimation Unit Acreage

NFS ownership GIS vector polygon layer (10/15/18) with 1,537,519.90 total acres from NFS Enterprise Data Warehouse

A. NFS at 1,250,851.2 acres (ac.)
B. NonNFS at 286,668.7 ac.

Suitability vector polygon layer (Feb. 2019) from NFS FSVeg intersected with NFS ownership vector layer resulting in 1,250,851 total ac. delineated as

	Suitability Vector			
BHNF Ownership Vector	No	Yes	(blank)	Grand Total
NON-FS	275,941	6,679	4,047	286,668
USDA FOREST SERVICE	413,082	836,713	1,057	1,250,851
(blank)	980	325		1,305
Grand Total	690,003	843,717	5,104	1,538,824

NFS ownership and suitability vector layers are rasterized (30m pixels) and intersected with other layers to form the NFS suitable/nonsuitable estimation units as follows

A. Total 1,250,110 ac., *only NFS owned*
   a) suitable estimation unit at 836,959 ac.
   b) unsuitable estimation unit at 413,151 ac.

NFS owned ownership vector layer acreage is more than NFS owned estimation unit acreage (1,250,851 - 1,250,110 = 741 ac.)

NFS owned suitable estimation unit acreage is more than NFS owned suitable acreage of the suitability vector layer (836,959 - 836,713 = 246 ac.)

MyEVALIDator BHNF 2011-2020 Acreage (ver. 1.8.0.01, rev. Dec. 16, 2019)

Plots are tagged as suitable/unsuitable using the suitable/nonsuitable vector layer.

A. Three plots are assigned suitable but fall within the rasterized not suitable estimation unit.
   a) Accounts for 9,349.7 ac.
B. Six plots are assigned not suitable but fall within the rasterized suitable estimation unit.
   a) Accounts for 17,383.54 ac.

C. Result is more acreage assigned to not suitable than the non suitable estimation unit represents.
   a) 17,383.54 - 9,349.7 = 8,033.8 ac.

D. Suitable estimation unit acreage minus MyEVALIDator total suitable land acreage matches the difference in C.
   a) 836,959 - 828,925 = 8,034 ac.

MyEVALIDator All land

	Ownership class			
BHNF Suitability	Total	National Forest	Private	Other
Total	1,250,109	1,110,383	21,253	118,473
Suitable	828,925	783,293	5,456	40,176
Not suitable	421,184	327,090	15,797	78,297

MyEVALIDator BHNF 2011-2020 Acreage (ver. 1.8.0.01, rev. Dec. 16, 2019) continued

Nonforest, forest and timberland land use, along with ownership, are assigned to plots in the field according to FIA protocol.

The estimation units, which are delineated as NFS ownership, have inholdings of private land identified in the field. The suitable estimation unit has areas that do not meet the FIA definition of timberland.

A. MyEVALIDator estimate of all land owned by National Forest and tagged as suitable with vector layer is 783,293 ac.
B. MyEVALIDator estimate of timberland owned by National Forest and tagged as suitable with vector layer is 765,733 ac.

MyEVALIDator All Land (repeat from previous slide)

	Ownership class			
BHNF Suitability	**Total**	**National Forest**	**Private**	**Other**
Total	1,250,109	1,110,383	21,253	118,473
Suitable	828,925	783,293	5,456	40,176
Not suitable	421,184	327,090	15,797	78,297

MyEVALIDator National Forest Only

	Land use					
BHNF Suitability	**Total**	**Timberland**	**Other forestland**	**Reserved productive forestland**	**Reserved other forestland**	**Nonforest**
Total	1,110,383	1,062,776	27,556	13,214	3,012	3,825
Suitable	783,293	765,733	10,995	2,740	-	3,825
Not suitable	327,090	297,042	16,561	10,474	3,012	-

Rocky Mountain Research Station (RMRS-FIA) records ownership on nonforest land. The 3,825 acres is nonforest NFS land identified in Wyoming by RMRS-FIA. The remaining nonforest land was inventoried by NRS-FIA in South Dakota. NRS-FIA does not record ownership on nonforest land. A remaining 118,473 acres of nonforest with unknown ownership is labeled as “Other” in the MyEVALIDator All Land table.

Appendix B. – Area Budget for FIA and FSVeg Suitable Base

COMPARISON OF FOREST INVENTORY ANALYSIS AND FSVEG AREA ESTIMATES
SUITABLE AND ACCESSIBLE TIMBERLAND

Black Hills National Forest & Northern Research Station, Forest Inventory & Analysis
March 25, 2020

Background

Since the release of the online FIA data several questions have come up regarding the acreages that were reported. A comparison between the Forest Inventory Analysis (FIA) 2017–2019 inventory on the Black Hills National Forest (BHNF) land class area estimates and the 2015 forest Field Sampled Vegetation (FSVeg) Spatial layer was conducted to ensure consistency between inventories with an emphasis on suitable and accessible timberlands.

FSVeg Spatial is a geodatabase platform that combines vegetation stand data with survey information from various sources including common stand exam surveys (CSE), photo interpretation, quick plot surveys, and post-harvest updates. CSE data is collected following rigorous national protocols. Data is used to develop site-specific resource estimates to assess vegetation and site attributes, determine stand treatment needs, and develop detailed silvicultural prescriptions. Since 2015 we have collected CSE data on 20,000 plots geographically dispersed across the forest. For more information regarding CSE go to https://www.fs.fed.us/nrm/fsveg/.

Forest Inventory Analysis data are collected by professional field crews implementing national protocols and subject to quality assurance/quality control procedures. Details on field data collection are available online. The peer-reviewed statistical foundations of the FIA sample ensure that reliable, unbiased estimates are generated along with associated values of uncertainty.

A comparison between these inventory datasets is imprecise due to the differences in how area is calculated, the timing of exams, sampling intensity, and classification protocols. CSE has been collected over a longer time period in comparison with the FIA inventory. These exams are designed to sample forest stands in comparison with the landscape scale sampling intensity of FIA inventories.

The 2015 FSVeg layer was selected for comparison since this layer was provided to FIA to determine the land class of plot locations during inventory design.

The 2015 FSVeg spatial layer was compared to the timber suitability calculations in Appendix G of the 2006 BHNF Land and Resource Management Plan Phase II Amendment to assess land class area changes during this time period.

We have concluded the following:

- The net suitable and accessible timberland total area estimates for each inventory are comparable (See Table B1). The FSVeg spatial total (731,283 acres) falls within the 95% confidence interval for the FIA estimate (704,860 ± 30,808 acres).
- Differences in FIA and forest land classification are apparent regarding classification of currently non-forest areas or regenerating areas with low stocking. FIA data indicates that 44,000 acres is non-forest, presumably through a type conversion from forest to grasslands. The majority of these acres are still designated as part of the suitable and accessible timber base by the BHNF as non-stocked or marginally stocked areas (84,244 acres).
- Differences in classification of non-forest or regenerating areas with low stocking will not affect volume estimates.
- The BHNF suitable timber base decreased 2006-2015 by approximately 42,000 acres from 865,890 to 824,240 acres (See Table B2). Major changes to area estimates occurred for uneconomical areas and reserved areas such as wilderness, research natural areas, late successional reserves, and backcountry recreation areas.

Table B1. Comparison of FIA and FSVeg spatial inventory estimates of suitable and accessible timberland.

Land class or condition	FIA Inventory 2017 - 2019	FSVeg Spatial Dec 2015 Suitable Base	Comments
	acres		
Total Acres - BHNF Suitable Base	**828,925**	**824,240**	For FIA data, plot locations were derived from the forest suitable base layer
Private and other ownership	-5,456	-4,194	Includes state lands for FSVeg
Reserved productive	-2,740	0	Wilderness, already filtered from FSVeg spatial layer
Net USFS Acres	**820,729**	**820,046**	
Other forestland	-10,995	-2,471	Non-commercial stands
Non-forest	-44,000	-1,904	Other land use or vegetation type conversion
Not classified	0	-144	
Net USFS suitable timberlands	**765,734**	**815,527**	
Non-stocked	-60,873	-84,244	Canopy closure < 10% on site that is capable of growing commercial timber.
Net stocked, suitable timberland	**704,861**	**731,283**	

Table B2. Net major changes to suitable and accessible timberlands by land class category, BHNF, 2006 -2015.*

Description	Change (acres)
Increase in net NF acres	10,693
Increase in grasslands	-8,567
Expansion of wilderness	-3,490
Designation of RNAs	-1,780
Increase in inaccessible Area	-18,445
Increase in LSR	-3,876
Decrease in riparian reserved	4,134
Increase in developed recreation sites	-6,528
Decrease in backcountry recreation areas	3,129
Decrease in Spearfish Canyon acres	-3,497
Decrease in southern hills unsuitable	7,387
Increase in steep slope - uneconomical designation	-11,484
Increase in isolated patched - uneconomical designation	-6,774
Forest type conversion	-3,446
Net Change to suitable and accessible timberland (acres)	-42,543

*Comparison between land class area in 2006 BHNF Land and Resource Management Plan Phase II Amendment and the February 5, 2015 FSVeg Spatial layer. This table does not include all land class changes.

Appendix C. – SQL for Estimation Unit Area Calculations

SQL used to produce Table 1.

```
--tab=SuitableAreaEstimateAll
WITH dat AS
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.area_used AS eu_area,
         plt.statecd,
         plt.invyr,
         plt.cn AS plt_cn,
         plt.intensity,
         plt.bhnf_suitable_land,
         SUM(cnd.condprop_unadj * ps.expns * ps.adj_factor_subp) AS acres
    FROM pop_eval pe
    JOIN pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN pop_eval_grp peg
      ON peg.cn = pe.eval_grp_cn
    JOIN pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
    JOIN pop_plot_stratum_assgn ppsa
      ON ppsa.stratum_cn = ps.cn
    JOIN plot_vw plt
      ON ppsa.plt_cn = plt.cn
    LEFT JOIN plot pplt
      ON plt.prev_plt_cn = pplt.cn
    JOIN cond cnd
      ON cnd.plt_cn = plt.cn
   WHERE peg.eval_grp IN (562017, 562018, 562019)
     AND pet.eval_typ = 'EXPALL'
   GROUP BY pe.evalid,
            peu.estn_unit_descr,
            peu.area_used,
            plt.statecd,
            plt.invyr,
            plt.intensity,
            plt.cn,
            plt.bhnf_suitable_land)
----------------------------------------------
SELECT dat.evalid,
       dat.estn_unit_descr,
       dat.eu_area,
       round(SUM(dat.acres), 2) AS est,
       COUNT(DISTINCT dat.plt_cn) AS plt_cnt
  FROM dat
 GROUP BY dat.evalid, dat.estn_unit_descr, dat.eu_area
 ORDER BY evalid, estn_unit_descr;
```

Appendix D. – Calculating Expansion Factors

Calculating Expansion Factors for the Black Hills National Forest 2019 Inventory
USDA Forest Service, Forest Inventory & Analysis Program (FIA)
7/9/2020

Executive summary

The Forest Inventory and Analysis (FIA) program is responsible for generating statistically valid estimates of a wide range of forest attributes. The program employs a stratified estimation methodology to accomplish this task while improving the precision of the estimates. This methodology is based upon peer-reviewed literature[4].

The process of generating an estimate of a population attribute (such as the total number of trees) involves two “expansions”: (1) Trees Per Acre and (2) Expansion Factor. The Trees Per Acre (TPA) expansion is the number of trees per acre represented by a sampled tree. This value is determined by FIA’s fixed-radius plot footprint as follows:

- Sampled trees (sampled on 24’ subplots): 6.01846
- Sampled saplings (sampled on the 6.8’ microplot): 74.965282

To understand the Expansion Factor (EXPNS) it is important to first understand what an ‘evaluation’ is. FIA has defined the term ‘evaluation’ to mean the unique combination of a sample (set of plot visits) combined with a stratification of the target population for the purpose of generating estimates of a specific set of population attributes. The sample used for any given evaluation is filtered such that only plot visits that are capable of producing the intended estimates are included. For example, if the intended estimate is tree growth, then only plots that have been re-measured are included in the sample. The Expansion Factor (EXPNS) is a value computed at the stratum level as the area of the stratum divided by the number of sampling points (n) and is expressed in units of Acres Per Plot. This value is multiplied by whatever attribute is being estimated to expand it to the population level. For example, if the desired population attribute was total number of trees then the basic calculation would to as follows:

- Multiply each sampled tree or sapling on a plot visit by its TPA
- Sum the above products
- Multiply the above Sum by the EXPNS

The result represents that plot visit’s contribution to the population total of interest. In practice, most estimates are also subject to filters that tune the estimate to desired domain of the population (such as a particular species or forest type).

The details of this process are laid out below with sample code for the Black Hills National Forest (BHNF[5]).

INTRODUCTION

FIA has defined the term ‘evaluation’ as the unique combination of a stratification of the population and a sample for the purpose of generating a particular set of estimates. Evaluations are typically constructed for current estimates (which do not require remeasurement) or change estimates (which do require remeasurement). Each evaluation has an evaluation identifier (POP_ESTN_UNIT.EVALID) in the database.

---

[4] Bechtold, William A.; Patterson, Paul L.; [Editors] 2005. The enhanced forest inventory and analysis program - national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 85 p.

[5] The National Forest System uses the abbreviation BKNF for the Black Hills National Forest, and all of our tables use BHNF. That abbreviation is repeated here for internal consistency.

This document presents the elements required to create plot expansion factors, in acres, and the associated Structured Query Language (SQL) used to derive the elements. SQL presented in this document attempts to meet the American National Standards Institute (ANSI) standard. Data from the current and change evaluations of the Black Hills National Forest (BHNF) 2019 inventory are covered.

Process

1. Identify estimation units

Estimation units are specific geographic areas of independent sub-populations within the total target population. Each estimation unit is stratified independently from other estimation units. Each strata within an estimation unit is a non-overlapping subdivision of the population. The strata are also independent. Strata are usually based on land use or cover and other criteria such as ownership.

GIS layers from the National Forest System (NFS) are used to create estimation units for the BHNF inventory. An ownership layer (S_USA.BasicOwnership; source: USDA Enterprise Data Warehouse, 7/3/2018) and a suitable/not suitable layer (source: BHNF) identify each of the two estimation units. Estimation unit 1 is area labeled as not suitable and owned by NFS. Estimation unit 2 is area labeled as suitable and owned by NFS. In the database, estimation unit 1 is identified by POP_ESTN_UNIT.ESTN_UNIT = 1 and described as POP_ESTN_UNIT.ESTN_UNIT_DESCR = BHNFS_NotSuitable. Likewise, estimation unit 2 is identified by POP_ESTN_UNIT.ESTN_UNIT = 2 and described as POP_ESTN_UNIT.ESTN_UNIT_DESCR = BHNFS_Suitable.

The change evaluation used for BHNF 2019 inventory is identified by POP_ESTN_UNIT.EVALID = 561903. The change evaluation can also be identified by POP_EVAL_GRP = 562019 and POP_EVAL_TYP = 'EXPGROW' for net growth, by POP_EVAL_GRP = 562019 and POP_EVAL_TYP = 'EXPMORT' for mortality, and by POP_EVAL_GRP = 562019 and POP_EVAL_TYP = 'EXPREMV' for removals. The same set of remeasured plots are used for net growth, mortality and removals. There is a separate EVAL_TYP in the database for each type of change just in case a different set of plots was used among the types. In this case, and in almost all change evaluations for FIA, the same set of remeasured plots are used for every change type. In this case, the remeasured plots are from the base (1x) sample. The intensified (2x) sample has been established but not remeasured; hence, change estimates are only available for the base sample.

The evaluation for current inventory estimates is identified by POP_ESTN_UNIT.EVALID = 561901 or by POP_EVAL_GRP = 562019 and POP_EVAL_TYP = 'EXPVOL' for current volume and number of trees or by POP_EVAL_GRP = 562019 and POP_EVAL_TYP = 'EXPCURR' for current area. The same set of currently measured plots are used for current number of trees, volume and area. The current inventory plots are from the 1x and 2x intensity samples collectively.

2. Obtain area, in acres, and number of pixels for each estimation unit

The GIS layers that comprise the estimation units are rasterized (converted from polygons to 30m square pixels) and the area of the pixels comprising each estimation unit is calculated and stored in POP_ESTN_UNIT.AREA_USED. The number of pixels comprising each estimation unit is stored in POP_ESTN_UNIT.P1PNTCNT_EU. These metrics are used with others from the strata layer to calculate the plot expansion factors. The strata layer, NLCD LANDSAT 2011 Tree Canopy Cover, is a 30m resolution raster data set. The GIS layers are rasterized to facilitate the geospatial processing that identifies the strata (canopy cover classes) within each estimation unit and identify the coincident plots.

SQL identifying area of each estimation unit is as follows (replace the variable &fiadb_schema with the literal database schema):

```
select evalid, estn_unit, estn_unit_descr, area_used, p1pntcnt_eu from
&fiadb_schema.pop_estn_unit where evalid in (561901,561903)
```

Table D6. Area by estimation unit on the Black Hills National Forest.

EVALID	ESTN_UNIT	ESTN_UNIT_DESCR	AREA_USED	P1PNTCNT_EU
561901	1	BHNFS_NotSuitable	413,151	1,857,733
561901	2	BHNFS_Suitable	836,959	3,763,390
561903	1	BHNFS_NotSuitable	413,151	1,857,733
561903	2	BHNFS_Suitable	836,959	3,763,390

3. Select strata layer boundaries within each estimation unit and identify the plots and pixels by strata or canopy cover class

Actual plot locations are intersected by estimation unit and stratum layer and then assigned to their overlapping estimation unit and stratum in the database. Strata are categorized by canopy cover class. Up to five canopy cover classes are employed. Count the number of plots (POP_STRATUM.P2POINTCNT) and the number of pixels (POP_STRATUM.P1POINTCNT) by estimation unit and strata or canopy cover class. These metrics are used with others to calculate the plot expansion factor.

SQL identifying the relationship among the estimation units, strata and plots for the change evaluation is as follows (EXPGROW is for net growth; substitute with EXPMORT for mortality, EXPREMV for removals, EXPVOL for volume or EXPCURR for area):

```
SELECT PEU.*, POP_STRATUM.*, PLOT.*
  FROM &FIADB_SCHEMA.POP_EVAL_GRP PEG
  JOIN &FIADB_SCHEMA.POP_EVAL_TYP PET
    ON (PET.EVAL_GRP_CN = PEG.CN)
  JOIN &FIADB_SCHEMA.POP_EVAL PEV
    ON (PEV.CN = PET.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_ESTN_UNIT PEU
    ON (PEV.CN = PEU.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_STRATUM POP_STRATUM
    ON (PEU.CN = POP_STRATUM.ESTN_UNIT_CN)
  JOIN &FIADB_SCHEMA.POP_PLOT_STRATUM_ASSGN
    ON (POP_PLOT_STRATUM_ASSGN.STRATUM_CN = POP_STRATUM.CN)
  JOIN &FIADB_SCHEMA.PLOT
    ON (POP_PLOT_STRATUM_ASSGN.PLT_CN = PLOT.CN)
 WHERE PET.EVAL_TYP = 'EXPGROW'
   AND PEG.EVAL_GRP = 562019
```

Identify sampled plots (entire or partial) and remove entirely non-sampled plots

Use values from PLOT.PLOT_STATUS_CD to identify sampled plots (includes partially sampled plots) and nonsampled plots. Plots with values of 1 (sampled – at least one accessible forest land condition present on plot) or 2 (sampled – no accessible forest land condition present on plot) will be part of the evaluation and those with a value of 3 (nonsampled) will not. Obtain a total count of the plots with values of 1 or 2 (not separate counts for each value). These counts are stored in POP_STRATUM.P2POINTCNT.

SQL counting the number of sampled plots for the change evaluation (POP_EVAL_TYP = 'EXPGROW'; results are the same for mortality and removals) as follows:

```
SELECT Sum(CASE PLOT.PLOT_STATUS_CD
  when 3 then 0
  else 1
  end) P2POINTCNT
  FROM &FIADB_SCHEMA.POP_EVAL_GRP PEG
  JOIN &FIADB_SCHEMA.POP_EVAL_TYP PET
    ON (PET.EVAL_GRP_CN = PEG.CN)
```

```
  JOIN &FIADB_SCHEMA.POP_EVAL PEV
    ON (PEV.CN = PET.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_ESTN_UNIT PEU
    ON (PEV.CN = PEU.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_STRATUM POP_STRATUM
    ON (PEU.CN = POP_STRATUM.ESTN_UNIT_CN)
  JOIN &FIADB_SCHEMA.POP_PLOT_STRATUM_ASSGN
    ON (POP_PLOT_STRATUM_ASSGN.STRATUM_CN = POP_STRATUM.CN)
  JOIN &FIADB_SCHEMA.PLOT
    ON (POP_PLOT_STRATUM_ASSGN.PLT_CN = PLOT.CN)
 WHERE PET.EVAL_TYP = 'EXPGROW'
   AND PEG.EVAL_GRP = 562019
```

Output

P2POINTCNT for all sampled remeasured plots

225

SQL counting the number of sampled plots for the current evaluation (POP_EVAL_TYP = 'EXPVOL') as follows:

```
SELECT Sum(CASE PLOT.PLOT_STATUS_CD
  when 3 then 0
  else 1
  end) P2POINTCNT
  FROM &FIADB_SCHEMA.POP_EVAL_GRP PEG
  JOIN &FIADB_SCHEMA.POP_EVAL_TYP PET
    ON (PET.EVAL_GRP_CN = PEG.CN)
  JOIN &FIADB_SCHEMA.POP_EVAL PEV
    ON (PEV.CN = PET.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_ESTN_UNIT PEU
    ON (PEV.CN = PEU.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_STRATUM POP_STRATUM
    ON (PEU.CN = POP_STRATUM.ESTN_UNIT_CN)
  JOIN &FIADB_SCHEMA.POP_PLOT_STRATUM_ASSGN
    ON (POP_PLOT_STRATUM_ASSGN.STRATUM_CN = POP_STRATUM.CN)
  JOIN &FIADB_SCHEMA.PLOT
    ON (POP_PLOT_STRATUM_ASSGN.PLT_CN = PLOT.CN)
 WHERE PET.EVAL_TYP = 'EXPVOL'
   AND PEG.EVAL_GRP = 562019
```

Output

P2POINTCNT for all sampled current inventory plots

438

SQL identifying the number of pixels by estimation unit and canopy cover class as follows:

```
select evalid, estn_unit, stratumcd, stratum_descr, p1pointcnt from
&fiadb_schema.pop_stratum where evalid in (561901, 561903) order by evalid, estn_unit,
stratumcd
```

Table D7. Number of pixels by estimation unit and canopy cover class.

EVALID	ESTN_UNIT	STRATUMCD	STRATUM_DESCR	P1POINTCNT
561901	1	1	Canopy cover 0 - 5	256,738
561901	1	2	Canopy cover 6 - 50	1,056,128
561901	1	3	Canopy cover 51 - 65	343,873
561901	1	45	Canopy cover 66 - 100	200,994
561901	2	1	Canopy cover 0 - 5	209,432
561901	2	2	Canopy cover 6 - 50	2,297,813
561901	2	3	Canopy cover 51 - 65	786,861

561901	2	45	Canopy cover 66 - 100	469,284
561903	1	12	Canopy cover 0 - 50	1,312,866
561903	1	345	Canopy cover 51 - 100	544,867
561903	2	1	Canopy cover 0 - 5	209,432
561903	2	2	Canopy cover 6 - 50	2,297,813
561903	2	3	Canopy cover 51 - 65	786,861
561903	2	45	Canopy cover 66 - 100	469,284

4. Calculate expansion factor for each plot by stratum

The expansion factor for each plot by stratum is the area of the estimation unit multiplied by the stratum weight divided by the number of sampled plots in the stratum. Expansion factors, in acres, are stored in POP_STRATUM.EXPNS. Stratum weights are not stored directly, but calculated in each query by dividing POP_STRATUM.P1POINTCNT by POP_ESTN_UNIT.P1PNTCNT_EU.

SQL expression calculating expansion factor for each plot by stratum as follows:

```
Sum (POP_ESTN_UNIT.AREA_USED * POP_STRATUM.P1POINTCNT / POP_ESTN_UNIT.P1PNTCNT_EU /
POP_STRATUM.P2POINTCNT)
```

Full SQL statement calculating expansion factors for each plot by stratum of the change evaluation (POP_EVAL_TYP = 'EXPGROW'; results are the same for mortality and removals):

```
SELECT POP_STRATUM.EVALID,
       POP_STRATUM.ESTN_UNIT,
       POP_STRATUM.STRATUMCD,
       POP_STRATUM.STRATUM_DESCR,
       POP_STRATUM.P2POINTCNT,
       POP_STRATUM.P1POINTCNT,
       PEU.P1PNTCNT_EU,
       Sum (PEU.AREA_USED * POP_STRATUM.P1POINTCNT / PEU.P1PNTCNT_EU /
POP_STRATUM.P2POINTCNT) EXPNS
   FROM &FIADB_SCHEMA.POP_EVAL_GRP PEG
  JOIN &FIADB_SCHEMA.POP_EVAL_TYP PET
    ON (PET.EVAL_GRP_CN = PEG.CN)
  JOIN &FIADB_SCHEMA.POP_EVAL PEV
    ON (PEV.CN = PET.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_ESTN_UNIT PEU
    ON (PEV.CN = PEU.EVAL_CN)
  JOIN &FIADB_SCHEMA.POP_STRATUM POP_STRATUM
    ON (PEU.CN = POP_STRATUM.ESTN_UNIT_CN)
 WHERE PET.EVAL_TYP = 'EXPGROW'
   AND PEG.EVAL_GRP = 562019
group by POP_STRATUM.EVALID,
          POP_STRATUM.ESTN_UNIT,
          POP_STRATUM.STRATUMCD,
          POP_STRATUM.STRATUM_DESCR,
          POP_STRATUM.P2POINTCNT,
          POP_STRATUM.P1POINTCNT,
          PEU.P1PNTCNT_EU
order by estn_unit, stratumcd
```

Table D8. Expansion factors for change evaluation (EVAL_TYP = 'EXPGROW')

EVALID	ESTN_UNIT	STRATUMCD	STRATUM_DESCR	P2POINTCNT	P1POINTCNT	P1PNTCNT_EU	EXPNS
561903	1	12	Canopy cover 0 - 50	45	1,312,866	1,857,733	6,488
561903	1	345	Canopy cover 51 - 100	19	544,867	1,857,733	6,378
561903	2	1	Canopy cover 0 - 5	14	209,432	3,763,390	3,327

561903	2	2	Canopy cover 6 - 50	100	2,297,813	3,763,390	5,110
561903	2	3	Canopy cover 51 - 65	20	786,861	3,763,390	8,750
561903	2	45	Canopy cover 66 - 100	27	469,284	3,763,390	3,865

Table D9. Expansion factors for current inventory evaluation. (Users may substitute 'EXPGROW' with 'EXPVOL' in SQL; results are the same for current area using 'EXPCURR'.)

EVALID	ESTN_UNIT	STRATUMCD	STRATUM_DESCR	P2POINTCNT	P1POINTCNT	P1PNTCNT_EU	EXPNS
561901	1	1	Canopy cover 0 - 5	18	256,738	1,857,733	3,172
561901	1	2	Canopy cover 6 - 50	79	1,056,128	1,857,733	2,973
561901	1	3	Canopy cover 51 - 65	23	343,873	1,857,733	3,325
561901	1	45	Canopy cover 66 - 100	20	200,994	1,857,733	2,235
561901	2	1	Canopy cover 0 - 5	22	209,432	3,763,390	2,117
561901	2	2	Canopy cover 6 - 50	187	2,297,813	3,763,390	2,733
561901	2	3	Canopy cover 51 - 65	47	786,861	3,763,390	3,723
561901	2	45	Canopy cover 66 - 100	42	469,284	3,763,390	2,485

SQL verifying estimates from expansion factor calculation match those stored in POP_STRATUM.EXPNS as follows:

```
select evalid, estn_unit, stratumcd, stratum_descr, expns from &fiadb_schema.pop_stratum
where evalid in (561901, 561903) order by evalid, estn_unit, stratumcd
```

Output

EVALID	ESTN_UNIT	STRATUMCD	STRATUM_DESCR	EXPNS
561901	1	1	Canopy cover 0 - 5	3,172
561901	1	2	Canopy cover 6 - 50	2,973
561901	1	3	Canopy cover 51 - 65	3,325
561901	1	45	Canopy cover 66 - 100	2,235
561901	2	1	Canopy cover 0 - 5	2,117
561901	2	2	Canopy cover 6 - 50	2,733
561901	2	3	Canopy cover 51 - 65	3,723
561901	2	45	Canopy cover 66 - 100	2,485
561903	1	12	Canopy cover 0 - 50	6,488
561903	1	345	Canopy cover 51 - 100	6,378
561903	2	1	Canopy cover 0 - 5	3,327
561903	2	2	Canopy cover 6 - 50	5,110
561903	2	3	Canopy cover 51 - 65	8,750
561903	2	45	Canopy cover 66 - 100	3,865

Appendix E. – Example Adding Net Growth for Areas which are not National Forest System Timberland

What if all sampled conditions, on plots identified as suitable with suitability vector layer, are identified as NFS-owned timberland and an identified maximum net growth is assigned to those conditions which need to be changed, for the sake of the example, to NFS-owned timberland?

This example shows the addition of net growth (for areas that are not NFS timberland) to the existing total net growth estimate of ponderosa pine growing-stock trees on suitable (@ suitability layer) timberland for NFS ownership (-5,965,376 cu. ft./ac./year), BHNF 2019.

The total estimate which will be adjusted is -5,965,376 cu. ft./ac./year and is described in detail as attribute number 208 or average annual net growth of merchantable bole volume of growing-stock trees (at least 5 inches d.b.h.), in cubic feet, on timberland. Filter applied is “and cond.owngrpcd=10 and plotgeom.bhnf_suitable_land = 'Y' and tree.spcd = 122” limiting domain of interest to ponderosa pine (tree.spcd = 122), NFS owned (cond.owngrpcd = 10) and plots identified as suitable with the suitability GIS vector layer (plotgeom.bhnf_suitable_land = 'Y').

The example adds net growth for sampled conditions that are not timberland and or not owned by NFS but are on plots identified as suitable with the suitability vector layer. By definition outside of this example, this domain of sampled conditions contributes no net growth to the total estimate of NFS timberland.

1) The area of this domain is calculated using the remeasurement sample expansion and adjustment factors identified by EVALID = 561903. 2) Next, the maximum net growth per acre of ponderosa pine (for BHNF 2019 inventory) is identified for timberland owned by NFS on plots identified as suitable with the suitability layer (domain used for the total estimate of -5,965,376 cu.ft./year). 3) Then, this maximum net growth per acre is assigned to the previously calculated acreage. 4) Finally, the existing total of -5,965,376 cu. ft./year is adjusted by adding the maximum net growth.

The results show 35,268 acres (using the remeasurement sample) that does not contribute net growth by definition. A maximum net growth of 67.2 cu. ft./ac./year was identified. Assigning the maximum identified net growth to the acreage results in 2,370,023 cu. ft./year. Adding the existing total net growth of -5,965,376 cu. ft./year with the previous result, yields -3,595,353 cu. ft./year. One would need to attribute the identified maximum net growth to approximately 88,771 acres to reach a total net growth of 0 (67.2 cu. ft./ac./year * 88,771.48 = 5,965,376 cu. ft./year).

1)

```
-- Calculate area not timberland and or not owned by NFS but identified at the plot level
as suitable with the suitability GIS vector layer, BHNF 2019
SELECT SUM((COND.CONDPROP_UNADJ * CASE COND.PROP_BASIS
             WHEN 'MACR' THEN
              POP_STRATUM.ADJ_FACTOR_MACR
             ELSE
              POP_STRATUM.ADJ_FACTOR_SUBP
           END) * POP_STRATUM.EXPNS) AS Acreage
  FROM POP_STRATUM POP_STRATUM
  JOIN POP_PLOT_STRATUM_ASSGN
    ON (POP_PLOT_STRATUM_ASSGN.STRATUM_CN = POP_STRATUM.CN)
  JOIN PLOT
    ON (POP_PLOT_STRATUM_ASSGN.PLT_CN = PLOT.CN)
  JOIN PLOTGEOM
    ON (PLOT.CN = PLOTGEOM.CN)
  JOIN COND
    ON (COND.PLT_CN = PLOT.CN)
 WHERE COND.CONDPROP_UNADJ IS NOT NULL
   AND COND.COND_STATUS_CD < 5
   AND ((pop_stratum.rscd = 23 and pop_stratum.evalid = 561903))
   and (cond.owngrpcd <> 10 or cond.cond_status_cd <> 1 or
       cond.siteclcd = 7 or cond.reservcd = 1)
```

```
   and plotgeom.bhnf_suitable_land = 'Y'
   and 1 = 1
```

Result for acreage: 35,268.19 acres

2)

```
-- Identify maximum net growth per acre/year of ponderosa pine for timberland owned by
NFS on
-- plots identified as suitable with the suitability GIS vector layer, BHNF 2019
select max(netgrowth_per_acre) max_netgrowth_per_acre_and_year
  from (SELECT cn plot_cn,
               Case
                 when sum(denom) <> 0 then
                  SUM(Numerator) / SUM(DENOM)
               end Netgrowth_Per_Acre,
               SUM(Numerator) numerator,
               SUM(DENOM) denominator
          FROM (SELECT plot.cn,
                       SUM((GRM.TPAGROW_UNADJ * (CASE
                             WHEN COALESCE(GRM.SUBPTYP_GRM, 0) = 0 THEN
                              0
                             WHEN GRM.SUBPTYP_GRM = 1 THEN
                              POP_STRATUM.ADJ_FACTOR_SUBP
                             WHEN GRM.SUBPTYP_GRM = 2 THEN
                              POP_STRATUM.ADJ_FACTOR_MICR
                             WHEN GRM.SUBPTYP_GRM = 3 THEN
                              POP_STRATUM.ADJ_FACTOR_MACR
                             ELSE
                              0
                           END) * (CASE
                             WHEN BE.ONEORTWO = 2 THEN
                              (CASE
                                WHEN (GRM.COMPONENT = 'SURVIVOR' OR
                                     GRM.COMPONENT = 'INGROWTH' OR
                                     GRM.COMPONENT LIKE 'REVERSION%') THEN
                                 (TREE.VOLCFNET / PLOT.REMPER)
                                WHEN (GRM.COMPONENT LIKE 'CUT%' OR
                                     GRM.COMPONENT LIKE 'DIVERSION%') THEN
                                 (TRE_MIDPT.VOLCFNET / PLOT.REMPER)
                                ELSE
                                 0
                              END)
                             ELSE
                              (CASE
                                WHEN (GRM.COMPONENT = 'SURVIVOR' OR
                                     GRM.COMPONENT = 'CUT1' OR
                                     GRM.COMPONENT = 'DIVERSION1' OR
                                     GRM.COMPONENT = 'MORTALITY1') THEN
                                 CASE
                                   WHEN TRE_BEGIN.TRE_CN IS NOT NULL THEN
                                    - (TRE_BEGIN.VOLCFNET / PLOT.REMPER)
                                   ELSE
                                    - (PTREE.VOLCFNET / PLOT.REMPER)
                                 END
                                ELSE
                                 0
                              END)
                           END)) * POP_STRATUM.EXPNS) AS Numerator,
                       0 as denom
                  FROM BEGINEND BE, POP_STRATUM POP_STRATUM
                  JOIN POP_PLOT_STRATUM_ASSGN POP_PLOT_STRATUM_ASSGN
                    ON (POP_STRATUM.CN = POP_PLOT_STRATUM_ASSGN.STRATUM_CN)
```

```
  JOIN PLOT PLOT
    ON (POP_PLOT_STRATUM_ASSGN.PLT_CN = PLOT.CN)
  JOIN PLOTGEOM PLOTGEOM
    ON (PLOT.CN = PLOTGEOM.CN)
  JOIN PLOT PPLOT
    ON (PLOT.PREV_PLT_CN = PPLOT.CN)
  JOIN COND PCOND
    ON (PLOT.PREV_PLT_CN = PCOND.PLT_CN)
  JOIN COND COND
    ON (PLOT.CN = COND.PLT_CN)
  JOIN TREE TREE
    ON (TREE.CONDID = COND.CONDID AND TREE.PLT_CN = PLOT.CN AND
       TREE.PREVCOND = PCOND.CONDID)
  LEFT OUTER JOIN TREE PTREE
    ON (TREE.PREV_TRE_CN = PTREE.CN)
  LEFT OUTER JOIN TREE_GRM_BEGIN TRE_BEGIN
    ON (TREE.CN = TRE_BEGIN.TRE_CN)
  LEFT OUTER JOIN TREE_GRM_MIDPT TRE_MIDPT
    ON (TREE.CN = TRE_MIDPT.TRE_CN)
  LEFT OUTER JOIN (SELECT TRE_CN,
                          DIA_BEGIN,
                          DIA_MIDPT,
                          DIA_END,
                          SUBP_COMPONENT_GS_TIMBER     AS COMPONENT,
                          SUBP_SUBPTYP_GRM_GS_TIMBER   AS SUBPTYP_GRM,
                          SUBP_TPAGROW_UNADJ_GS_TIMBER AS TPAGROW_UNADJ
                     FROM TREE_GRM_COMPONENT) GRM
    ON (TREE.CN = GRM.TRE_CN)
 WHERE 1 = 1
   AND ((pop_stratum.rscd = 23 and
       pop_stratum.evalid = 561903))
   and cond.owngrpcd = 10
   and plotgeom.bhnf_suitable_land = 'Y'
   and tree.spcd = 122
   and cond.owngrpcd = 10
   and plotgeom.bhnf_suitable_land = 'Y'
   and 1 = 1
 GROUP BY plot.cn
UNION
SELECT plot.cn,
       SUM(0) AS ESTIMATED_VALUE,
       SUM(POP_STRATUM.EXPNS * COND.CONDPROP_UNADJ *
           CASE COND.PROP_BASIS
             WHEN 'MACR' THEN
              POP_STRATUM.ADJ_FACTOR_MACR
             ELSE
              POP_STRATUM.ADJ_FACTOR_SUBP
           END) AS DENOM
  FROM POP_STRATUM POP_STRATUM
  JOIN POP_PLOT_STRATUM_ASSGN
    ON (POP_PLOT_STRATUM_ASSGN.STRATUM_CN = POP_STRATUM.CN)
  JOIN PLOT
    ON (POP_PLOT_STRATUM_ASSGN.PLT_CN = PLOT.CN)
  JOIN PLOTGEOM
    ON (PLOT.CN = PLOTGEOM.CN)
  JOIN COND
    ON (COND.PLT_CN = PLOT.CN)
 WHERE COND.RESERVCD = 0
   AND COND.SITECLCD IN (1, 2, 3, 4, 5, 6)
   AND COND.COND_STATUS_CD = 1
   AND COND.CONDPROP_UNADJ IS NOT NULL
   AND ((pop_stratum.rscd = 23 and
       pop_stratum.evalid = 561903))
```

```
                and cond.owngrpcd = 10
                and plotgeom.bhnf_suitable_land = 'Y'
                and 1 = 1
              GROUP BY plot.cn)
      GROUP BY cn
      ORDER BY Netgrowth_Per_Acre, cn)
```

Result for maximum net growth ac./year: 67.2 cu. ft./ac./year

3)

Assign maximum net growth per acre/year to the suitable acreage not contributing to net growth by definition.

35,268 acres x 67 cu. ft. /ac./year = 2,370,023 cu. ft./year

4)

Adjust total net growth of ponderosa pine growing stock on suitable (@ suitability layer) timberland for the BHNF using net growth derived from maximum net growth per acre/year and suitable acreage not contributing to net growth by definition.

-5,965,376 cu. ft./year + 2,370,023 cu. ft./year= -3,595,353 cu. ft./year

Appendix F. – SQL Estimating Growth Rate

```
-- These first two scripts generate the components of "growth rate"
-- from the 2019 "augmented" dataset
----------------------------------------------------------------------------------------
--tab=TimberlandGrossGrowthSL
--  Script was taken from a TreeSketchWork script and modified
WITH std AS -- A list of plots assigned to the RAPID_ASSESSMENT study
 (SELECT m.nppt_cn
    FROM fs_nims_nrs.nims_prefield_study_mtx_vw m
    JOIN fs_nims_nrs.psd_study s
      ON m.psds_cn = s.cn
   WHERE s.study_name = 'RAPID_ASSESSMENT'),
agtcd AS -- Look-up values for agent codes (cause of death)
 (SELECT r.category,
         r.code,
         r.abbr,
         regexp_substr(r.meaning, '[A-z]*', 1, 1) AS meaning,
         r.manual_start,
         r.manual_end
    FROM nims_ref_category_code r
   WHERE r.category = 'CAUSE_DEATH_CD'
     AND r.manual_end IS NULL),
distb AS -- Look-up codes for condition-level disturbance codes
 (SELECT r.category, r.code, r.abbr, r.meaning, r.manual_start, r.manual_end
    FROM nims_ref_category_code r
   WHERE r.category = 'DISTURBANCE'
     AND r.manual_end IS NULL),
trt AS -- Look-up codes for condition-level treatment codes
 (SELECT r.category, r.code, r.abbr, r.meaning, r.manual_start, r.manual_end
    FROM nims_ref_category_code r
   WHERE r.category LIKE '%STAND_TREATMENT%'
     AND r.manual_end IS NULL),
pop AS -- Assemble the stratification data for estimation
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.cn              AS peu_cn,
         ps.cn               AS ps_cn,
         peu.area_used       AS estn_unit_area,
         peu.p1pntcnt_eu,
         ps.p1pointcnt,
         ps.p2pointcnt,
         ps.expns,
         ps.adj_factor_subp,
         ps.adj_factor_micr
    FROM pop_eval pe
    JOIN pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
   WHERE pet.eval_typ = 'EXPGROW'
     AND pe.evalid IN ( /*561703, 561853,*/ 561903)),
cnddstblst AS -- Assemble the condition-level disturbance codes on each condition with
labels
 (SELECT cnd_cn,
         nvl("Weather damage", 0) AS "Weather damage",
         nvl("Vegetation", 0) as"Vegetation",
         nvl("Disease", 0) as"Disease",
         nvl("Insect", 0) as"Insect",
         nvl("Animal Damage", 0) as"Animal Damage",
         nvl("Fire", 0) as"Fire",
```

```
        nvl("Human", 0) as"Human"
    FROM (SELECT cnd_cn, distb.abbr, val
           FROM (SELECT cond.cn AS cnd_cn,
                        1 AS val,
                        trunc(cond.dstrbcd1 / 10) * 10 AS dstrbcd1,
                        trunc(cond.dstrbcd2 / 10) * 10 AS dstrbcd2,
                        trunc(cond.dstrbcd3 / 10) * 10 AS dstrbcd3
                   FROM cond) unpivot(dstrbcd FOR distb IN(dstrbcd1,
                                                           dstrbcd2,
                                                           dstrbcd3)) t
           JOIN distb
             ON t.dstrbcd = distb.code
          WHERE dstrbcd > 0)
  pivot(MAX(val)
     FOR abbr IN('Weather damage' AS "Weather damage",
                'Vegetation' AS "Vegetation",
                'Disease' AS "Disease",
                'Insect' AS "Insect",
                'Animal Damage' AS "Animal Damage",
                'Fire' AS "Fire",
                'Human' AS "Human"))),
cndtrtlst AS -- Assemble the condition-level treatment codes on each condition with
labels
 (SELECT cnd_cn,
        nvl("None", 0) AS "None",
        nvl("Cutting", 0) AS "Cutting",
        nvl("Site prep", 0) AS "Site prep",
        nvl("Art regen", 0) AS "Art regen",
        nvl("Nat regen", 0) AS "Nat regen",
        nvl("Other", 0) AS "Other"
    FROM (SELECT cnd_cn, trt.abbr, val
           FROM (SELECT cond.cn     AS cnd_cn,
                        1           AS val,
                        cond.trtcd1,
                        cond.trtcd2,
                        cond.trtcd3
                   FROM cond) unpivot(trtcd FOR trt IN(trtcd1,
                                                       trtcd2,
                                                       trtcd3)) t
           JOIN trt
             ON t.trtcd = trt.code
          WHERE trtcd > 0)
  pivot(MAX(val)
     FOR abbr IN('None' AS "None",
                'Cutting' AS "Cutting",
                'Site prep' AS "Site prep",
                'Art regen' AS "Art regen",
                'Nat regen' AS "Nat regen",
                'Other' AS "Other"))),
trees AS -- Assemble tree and condition data and pre-filter trees
 (SELECT tre.plt_cn,
        decode(std.nppt_cn, NULL, 'N', 'Y') AS rapid_assessment,
        plt.measyear,
        plt1.measyear AS measyear_t1,
        plt.remper,
        tre.condid,
        tre.cn AS tre_cn,
        tre.spcd,
        tre.statuscd,
        tre.agentcd,
        nvl(cnddstblst."Weather damage", 0) AS "Weather damage",
        nvl(cnddstblst."Vegetation", 0) AS "Vegetation",
        nvl(cnddstblst."Disease", 0) AS "Disease",
```

```
        nvl(cnddstblst."Insect", 0) AS "Insect",
        nvl(cnddstblst."Animal Damage", 0) AS "Animal Damage",
        nvl(cnddstblst."Fire", 0) AS "Fire",
        nvl(cnddstblst."Human", 0) AS "Human",
        nvl(cndtrtlst."None", 0) AS "None",
        nvl(cndtrtlst."Cutting", 0) AS "Cutting",
        nvl(cndtrtlst."Site prep", 0) AS "Site prep",
        nvl(cndtrtlst."Art regen", 0) AS "Art regen",
        nvl(cndtrtlst."Nat regen", 0) AS "Nat regen",
        nvl(cndtrtlst."Other", 0) AS "Other",
        tre.dia,
        tre1.dia AS dia_t1,
        rs.common_name,
        rs.sftwd_hrdwd AS CLASS
   FROM plot_vw plt
   LEFT JOIN std
     ON plt.cn = std.nppt_cn
   JOIN tree tre
     ON plt.cn = tre.plt_cn
   JOIN cond cnd
     ON tre.plt_cn = cnd.plt_cn
    AND tre.condid = cnd.condid
   JOIN ref_species rs
     ON tre.spcd = rs.spcd
   LEFT JOIN tree tre1
     ON tre.prev_tre_cn = tre1.cn
   LEFT JOIN plot plt1
     ON plt.prev_plt_cn = plt1.cn
   LEFT JOIN cnddstblst
     ON cnddstblst.cnd_cn = cnd.cn
   LEFT JOIN cndtrtlst
     ON cndtrtlst.cnd_cn = cnd.cn
  WHERE tre.spcd = 122 -- only Ponderosa pine
    AND cnd.owngrpcd = 10 -- only forest service conditions
  /* AND (cnd.cond_status_cd = 1 AND cnd.reservcd = 0 AND cnd.siteclcd < 7)*/ --
timberland only
  ),
grm AS -- Combine tree-condition data with change data and apply analysis parameters
 (SELECT grm.plt_cn,
        grm.tre_cn,
        trees.rapid_assessment,
        trees.measyear,
        trees.measyear_t1,
        trees.remper,
        trees.spcd,
        trees.statuscd,
        trees.agentcd,
        trees.dia,
        trees.dia_t1,
        trees."Weather damage",
        trees."Vegetation",
        trees."Disease",
        trees."Insect",
        trees."Animal Damage",
        trees."Fire",
        trees."Human",
        trees."None",
        trees."Cutting",
        trees."Site prep",
        trees."Art regen",
        trees."Nat regen",
        trees."Other",
        trees.common_name,
```

```
         trees.class,
         grm.component,
         grm.subptyp_grm,
         grm.tpagrow_unadj,
         grm.tparemv_unadj,
         grm.tpamort_unadj,
         grm.ann_net_growth,
         grm.mortality,
         grm.removals,
         grm.est_begin,
         grm.est_midpt,
         grm.est_end,
         (grm.g_s + grm.i + grm.g_i + grm.g_m + grm.g_c + grm.r + grm.g_r +
         grm.g_d) / grm.remper AS gross_growth,
         grm.g_s,
         grm.i,
         grm.g_i,
         grm.m,
         grm.g_m,
         grm.c,
         grm.g_c,
         grm.r,
         grm.g_r,
         grm.d,
         grm.g_d,
         grm.cd,
         grm.g_cd,
         grm.ci,
         grm.g_ci
    FROM tree_grm_estn grm
    JOIN trees
      ON trees.tre_cn = grm.tre_cn
   WHERE grm.land_basis = 'TIMBERLAND'
     AND grm.estn_type = 'SL'
     AND grm.estn_units = 'CF'
     AND grm.estimate = 'VOLUME'
     AND grm.component != 'NOT USED')
-----------------------------------------------------------------------------------------
-- MAIN SQL LOGIC STARTS HERE
-----------------------------------------------------------------------------------------
SELECT pop.evalid,
       COUNT(DISTINCT grm.plt_cn) plt_cnt,
       COUNT(DISTINCT grm.tre_cn) tree_cnt,
       /*to_char(*/
       round(SUM(grm.gross_growth * grm.tpagrow_unadj *
                 decode(grm.subptyp_grm,
                        1,
                        pop.adj_factor_subp,
                        2,
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,

'999,999,999.9')*/ AS ann_gross_growth,
       /*to_char(*/
       round(SUM(grm.ann_net_growth * grm.tpagrow_unadj *
                 decode(grm.subptyp_grm,
                        1,
                        pop.adj_factor_subp,
                        2,
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,
```

```
'999,999,999.9')*/ AS ann_net_growth,
       /*to_char(*/
       round(SUM((grm.ann_net_growth * grm.tpagrow_unadj -
                 grm.removals * grm.tparemv_unadj) *
                 decode(grm.subptyp_grm,
                        1,
                        pop.adj_factor_subp,
                        2,
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,

'999,999,999.9')*/ AS ann_net_change
  FROM pop
  JOIN pop_plot_stratum_assgn ppsa
    ON ppsa.stratum_cn = pop.ps_cn
  JOIN plot_vw plt
    ON ppsa.plt_cn = plt.cn
  JOIN grm
    ON grm.plt_cn = plt.cn
  LEFT JOIN agtcd
    ON grm.agentcd = agtcd.code
 WHERE plt.bhnf_suitable_land = 'Y' -- filter for only suitable lands
   AND plt.statecd = 46
 GROUP BY pop.evalid
 ORDER BY pop.evalid;

--tab=TimberlandGrossInventorySL
WITH pop AS -- Assemble the stratification data for estimation
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.cn              AS peu_cn,
         ps.cn               AS ps_cn,
         peu.area_used       AS estn_unit_area,
         peu.p1pntcnt_eu,
         ps.p1pointcnt,
         ps.p2pointcnt,
         ps.expns,
         ps.adj_factor_subp,
         ps.adj_factor_micr
    FROM pop_eval pe
    JOIN pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
   WHERE pet.eval_typ = 'EXPCURR'
     AND pe.evalid IN ( /*561703, 561853,*/ 561901)),
trees AS -- Assemble tree and condition data and pre-filter trees
 (SELECT tre.plt_cn,
         plt.statecd,
         plt.measyear,
         plt1.measyear AS measyear_t1,
         plt.remper,
         tre.condid,
         tre.cn AS tre_cn,
         tre.spcd,
         tre.statuscd,
         tre.agentcd,
         tre.dia,
         tre1.dia AS dia_t1,
```

```
         rs.common_name,
         rs.sftwd_hrdwd AS CLASS,
         tre.volcsnet * tre.tpa_unadj AS volcsgrs_exp
    FROM plot_vw plt
    JOIN tree tre
      ON plt.cn = tre.plt_cn
    JOIN cond cnd
      ON tre.plt_cn = cnd.plt_cn
     AND tre.condid = cnd.condid
    JOIN ref_species rs
      ON tre.spcd = rs.spcd
    LEFT JOIN tree tre1
      ON tre.prev_tre_cn = tre1.cn
    LEFT JOIN plot plt1
      ON plt.prev_plt_cn = plt1.cn
   WHERE tre.spcd = 122 -- only Ponderosa pine
     AND tre.statuscd = 1 -- live trees only
     AND cnd.owngrpcd = 10 -- only forest service conditions
     AND (cnd.cond_status_cd = 1 AND cnd.reservcd = 0 AND cnd.siteclcd < 7) -- timberland
only
     AND plt.bhnf_suitable_land = 'Y' -- retrict to only suitable lands
  )
-----------------------------------------------------------------------------------------
-- MAIN SQL LOGIC STARTS HERE
-----------------------------------------------------------------------------------------
SELECT trees.spcd,
       trees.statuscd,
       round(SUM(trees.volcsgrs_exp * pop.expns * pop.adj_factor_subp) / 100,
             1) AS gross_sl_vol_cf
  FROM trees
  JOIN pop_plot_stratum_assgn ppsa
    ON trees.plt_cn = ppsa.plt_cn
  JOIN pop
    ON ppsa.stratum_cn = pop.ps_cn
 WHERE trees.statecd = 46
 GROUP BY trees.spcd, trees.statuscd;

----------------------------------------------------------------------------------------
-- These next two script generate the components from the on-line data.
--tab=TimberlandGrossGrowthSL
--  Script was taken from a TreeSketchWork script and modified
WITH std AS -- A list of plots assigned to the RAPID_ASSESSMENT study
 (SELECT m.nppt_cn
    FROM fs_nims_nrs.nims_prefield_study_mtx_vw m
    JOIN fs_nims_nrs.psd_study s
      ON m.psds_cn = s.cn
   WHERE s.study_name = 'RAPID_ASSESSMENT'),
agtcd AS -- Look-up values for agent codes (cause of death)
 (SELECT r.category,
         r.code,
         r.abbr,
         regexp_substr(r.meaning, '[A-z]*', 1, 1) AS meaning,
         r.manual_start,
         r.manual_end
    FROM nims_ref_category_code r
   WHERE r.category = 'CAUSE_DEATH_CD'
     AND r.manual_end IS NULL),
distb AS -- Look-up codes for condition-level disturbance codes
 (SELECT r.category, r.code, r.abbr, r.meaning, r.manual_start, r.manual_end
    FROM nims_ref_category_code r
   WHERE r.category = 'DISTURBANCE'
     AND r.manual_end IS NULL),
trt AS -- Look-up codes for condition-level treatment codes
```

```
 (SELECT r.category, r.code, r.abbr, r.meaning, r.manual_start, r.manual_end
    FROM nims_ref_category_code r
   WHERE r.category LIKE '%STAND_TREATMENT%'
     AND r.manual_end IS NULL),
pop AS -- Assemble the stratification data for estimation
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.cn              AS peu_cn,
         ps.cn               AS ps_cn,
         peu.area_used       AS estn_unit_area,
         peu.p1pntcnt_eu,
         ps.p1pointcnt,
         ps.p2pointcnt,
         ps.expns,
         ps.adj_factor_subp,
         ps.adj_factor_micr
    FROM fs_fiadb.pop_eval pe
    JOIN fs_fiadb.pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN fs_fiadb.pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN fs_fiadb.pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
   WHERE pet.eval_typ = 'EXPGROW'
     AND pe.evalid IN (461603, 461703, 461803, 461903)),
cnddstblst AS -- Assemble the condition-level disturbance codes on each condition with
labels
 (SELECT cnd_cn,
         nvl("Weather damage", 0) AS "Weather damage",
         nvl("Vegetation", 0) as"Vegetation",
         nvl("Disease", 0) as"Disease",
         nvl("Insect", 0) as"Insect",
         nvl("Animal Damage", 0) as"Animal Damage",
         nvl("Fire", 0) as"Fire",
         nvl("Human", 0) as"Human"
    FROM (SELECT cnd_cn, distb.abbr, val
            FROM (SELECT cond.cn AS cnd_cn,
                         1 AS val,
                         trunc(cond.dstrbcd1 / 10) * 10 AS dstrbcd1,
                         trunc(cond.dstrbcd2 / 10) * 10 AS dstrbcd2,
                         trunc(cond.dstrbcd3 / 10) * 10 AS dstrbcd3
                    FROM fs_fiadb.cond) unpivot(dstrbcd FOR distb IN(dstrbcd1,
                                                                     dstrbcd2,
                                                                     dstrbcd3)) t
            JOIN distb
              ON t.dstrbcd = distb.code
           WHERE dstrbcd > 0)
  pivot(MAX(val)
     FOR abbr IN('Weather damage' AS "Weather damage",
                'Vegetation' AS "Vegetation",
                'Disease' AS "Disease",
                'Insect' AS "Insect",
                'Animal Damage' AS "Animal Damage",
                'Fire' AS "Fire",
                'Human' AS "Human"))),
cndtrtlst AS -- Assemble the condition-level treatment codes on each condition with
labels
 (SELECT cnd_cn,
         nvl("None", 0) AS "None",
         nvl("Cutting", 0) AS "Cutting",
         nvl("Site prep", 0) AS "Site prep",
         nvl("Art regen", 0) AS "Art regen",
         nvl("Nat regen", 0) AS "Nat regen",
```

```
         nvl("Other", 0) AS "Other"
    FROM (SELECT cnd_cn, trt.abbr, val
            FROM (SELECT cond.cn     AS cnd_cn,
                         1           AS val,
                         cond.trtcd1,
                         cond.trtcd2,
                         cond.trtcd3
                    FROM fs_fiadb.cond) unpivot(trtcd FOR trt IN(trtcd1,
                                                                 trtcd2,
                                                                 trtcd3)) t
            JOIN trt
              ON t.trtcd = trt.code
           WHERE trtcd > 0)
  pivot(MAX(val)
     FOR abbr IN('None' AS "None",
                 'Cutting' AS "Cutting",
                 'Site prep' AS "Site prep",
                 'Art regen' AS "Art regen",
                 'Nat regen' AS "Nat regen",
                 'Other' AS "Other"))),
bhnf AS -- bring in suitability tags
 (SELECT cn, bhnf_suitable_land FROM plot_vw),
trees AS -- Assemble tree and condition data and pre-filter trees
 (SELECT tre.plt_cn,
         bhnf.bhnf_suitable_land,
         decode(std.nppt_cn, NULL, 'N', 'Y') AS rapid_assessment,
         plt.measyear,
         plt1.measyear AS measyear_t1,
         plt.remper,
         tre.condid,
         tre.cn AS tre_cn,
         tre.spcd,
         tre.statuscd,
         tre.agentcd,
         nvl(cnddstblst."Weather damage", 0) AS "Weather damage",
         nvl(cnddstblst."Vegetation", 0) AS "Vegetation",
         nvl(cnddstblst."Disease", 0) AS "Disease",
         nvl(cnddstblst."Insect", 0) AS "Insect",
         nvl(cnddstblst."Animal Damage", 0) AS "Animal Damage",
         nvl(cnddstblst."Fire", 0) AS "Fire",
         nvl(cnddstblst."Human", 0) AS "Human",
         nvl(cndtrtlst."None", 0) AS "None",
         nvl(cndtrtlst."Cutting", 0) AS "Cutting",
         nvl(cndtrtlst."Site prep", 0) AS "Site prep",
         nvl(cndtrtlst."Art regen", 0) AS "Art regen",
         nvl(cndtrtlst."Nat regen", 0) AS "Nat regen",
         nvl(cndtrtlst."Other", 0) AS "Other",
         tre.dia,
         tre1.dia AS dia_t1,
         rs.common_name,
         rs.sftwd_hrdwd AS CLASS
    FROM fs_fiadb.plot plt
    LEFT JOIN bhnf
      ON bhnf.cn = plt.cn
    LEFT JOIN std
      ON plt.cn = std.nppt_cn
    JOIN fs_fiadb.tree tre
      ON plt.cn = tre.plt_cn
    JOIN fs_fiadb.cond cnd
      ON tre.plt_cn = cnd.plt_cn
     AND tre.condid = cnd.condid
    JOIN fs_fiadb.ref_species rs
      ON tre.spcd = rs.spcd
```

```
    LEFT JOIN fs_fiadb.tree tre1
      ON tre.prev_tre_cn = tre1.cn
    LEFT JOIN fs_fiadb.plot plt1
      ON plt.prev_plt_cn = plt1.cn
    LEFT JOIN cnddstblst
      ON cnddstblst.cnd_cn = cnd.cn
    LEFT JOIN cndtrtlst
      ON cndtrtlst.cnd_cn = cnd.cn
   WHERE tre.spcd = 122 -- only Ponderosa pine
     AND cnd.owngrpcd = 10 -- only forest service conditions
  /* AND (cnd.cond_status_cd = 1 AND cnd.reservcd = 0 AND cnd.siteclcd < 7)*/ --
timberland only
  ),
grm AS -- Combine tree-condition data with change data and apply analysis parameters
 (SELECT grm.plt_cn,
         grm.tre_cn,
         trees.bhnf_suitable_land,
         trees.rapid_assessment,
         trees.measyear,
         trees.measyear_t1,
         trees.remper,
         trees.spcd,
         trees.statuscd,
         trees.agentcd,
         trees.dia,
         trees.dia_t1,
         trees."Weather damage",
         trees."Vegetation",
         trees."Disease",
         trees."Insect",
         trees."Animal Damage",
         trees."Fire",
         trees."Human",
         trees."None",
         trees."Cutting",
         trees."Site prep",
         trees."Art regen",
         trees."Nat regen",
         trees."Other",
         trees.common_name,
         trees.class,
         grm.component,
         grm.estn_units,
         grm.subptyp_grm,
         grm.tpagrow_unadj,
         grm.tparemv_unadj,
         grm.tpamort_unadj,
         grm.ann_net_growth,
         grm.mortality,
         grm.removals,
         grm.est_begin,
         grm.est_midpt,
         grm.est_end,
         (grm.g_s + grm.i + grm.g_i + grm.g_m + grm.g_c + grm.r + grm.g_r +
         grm.g_d) / trees.remper AS gross_growth,
         grm.g_s,
         grm.i,
         grm.g_i,
         grm.m,
         grm.g_m,
         grm.c,
         grm.g_c,
         grm.r,
```

```
        grm.g_r,
        grm.d,
        grm.g_d,
        grm.cd,
        grm.g_cd,
        grm.ci,
        grm.g_ci
    FROM /*fs_fiadb.tree_grm_estn grm*/ fs_nims_nrs.nims_grm_estn_debug grm
    LEFT JOIN trees
      ON trees.tre_cn = grm.tre_cn
   WHERE grm.land_basis = 'TIMBERLAND'
     AND grm.estn_type = 'SL'
     AND grm.estn_units = 'CF'
     AND grm.estimate = 'VOLUME'
     AND grm.component != 'NOT USED')
------------------------------------------------------------------------------------------
-- MAIN SQL LOGIC STARTS HERE
------------------------------------------------------------------------------------------
SELECT pop.evalid,
       COUNT(DISTINCT grm.plt_cn) plt_cnt,
       COUNT(DISTINCT grm.tre_cn) tree_cnt,
       /*to_char(*/
       round(SUM(grm.gross_growth * grm.tpagrow_unadj *
                 decode(grm.subptyp_grm,
                        1,
                        pop.adj_factor_subp,
                        2,
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,

'999,999,999.9')*/ AS ann_gross_growth,
       /*to_char(*/
       round(SUM(grm.ann_net_growth * grm.tpagrow_unadj *
                 decode(grm.subptyp_grm,
                        1,
                        pop.adj_factor_subp,
                        2,
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,

'999,999,999.9')*/ AS ann_net_growth,
       /*to_char(*/
       round(SUM((grm.ann_net_growth * grm.tpagrow_unadj -
                 grm.removals * grm.tparemv_unadj) *
                 decode(grm.subptyp_grm,
                        1,
                        pop.adj_factor_subp,
                        2,
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,

'999,999,999.9')*/ AS ann_net_change
  FROM pop
  JOIN fs_fiadb.pop_plot_stratum_assgn ppsa
    ON ppsa.stratum_cn = pop.ps_cn
  JOIN fs_fiadb.plot plt
    ON ppsa.plt_cn = plt.cn
  JOIN grm
    ON grm.plt_cn = plt.cn
  LEFT JOIN agtcd
```

```
    ON grm.agentcd = agtcd.code
 WHERE grm.bhnf_suitable_land = 'Y' -- filter for only suitable lands
   AND plt.statecd = 46
 GROUP BY pop.evalid
 ORDER BY pop.evalid DESC;

--tab=TimberlandGrossInventorySL
WITH pop AS -- Assemble the stratification data for estimation
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.cn              AS peu_cn,
         ps.cn               AS ps_cn,
         peu.area_used       AS estn_unit_area,
         peu.p1pntcnt_eu,
         ps.p1pointcnt,
         ps.p2pointcnt,
         ps.expns,
         ps.adj_factor_subp,
         ps.adj_factor_micr
    FROM fs_fiadb.pop_eval pe
    JOIN fs_fiadb.pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN fs_fiadb.pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN fs_fiadb.pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
   WHERE pet.eval_typ = 'EXPCURR'
     AND pe.evalid IN (461601, 461701, 461801, 461901)),
bhnf AS -- bring in suitability tags
 (SELECT cn, bhnf_suitable_land FROM plot_vw),
trees AS -- Assemble tree and condition data and pre-filter trees
 (SELECT tre.plt_cn,
         plt.statecd,
         plt.measyear,
         plt1.measyear AS measyear_t1,
         plt.remper,
         tre.condid,
         tre.cn AS tre_cn,
         tre.spcd,
         tre.statuscd,
         tre.agentcd,
         tre.dia,
         tre1.dia AS dia_t1,
         rs.common_name,
         rs.sftwd_hrdwd AS CLASS,
         tre.volcsnet * tre.tpa_unadj AS volcsgrs_exp
    FROM fs_fiadb.plot plt
    LEFT JOIN bhnf
      ON plt.cn = bhnf.cn
    JOIN fs_fiadb.tree tre
      ON plt.cn = tre.plt_cn
    JOIN fs_fiadb.cond cnd
      ON tre.plt_cn = cnd.plt_cn
     AND tre.condid = cnd.condid
    JOIN fs_fiadb.ref_species rs
      ON tre.spcd = rs.spcd
    LEFT JOIN fs_fiadb.tree tre1
      ON tre.prev_tre_cn = tre1.cn
    LEFT JOIN fs_fiadb.plot plt1
      ON plt.prev_plt_cn = plt1.cn
   WHERE tre.spcd = 122 -- only Ponderosa pine
     AND tre.statuscd = 1 -- live trees only
     AND cnd.owngrpcd = 10 -- only forest service conditions
```

```
     AND (cnd.cond_status_cd = 1 AND cnd.reservcd = 0 AND cnd.siteclcd < 7) -- timberland
only
     AND bhnf.bhnf_suitable_land = 'Y' -- retrict to only suitable lands
  )
-------------------------------------------------------------------------------------------
-- MAIN SQL LOGIC STARTS HERE
-------------------------------------------------------------------------------------------
SELECT ppsa.evalid,
       trees.spcd,
       trees.statuscd,
       round(SUM(trees.volcsgrs_exp * pop.expns * pop.adj_factor_subp) / 100,
             1) AS gross_sl_vol_cf
  FROM trees
  JOIN fs_fiadb.pop_plot_stratum_assgn ppsa
    ON trees.plt_cn = ppsa.plt_cn
  JOIN pop
    ON ppsa.stratum_cn = pop.ps_cn
 WHERE trees.statecd = 46
 GROUP BY ppsa.evalid, trees.spcd, trees.statuscd;

-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------
-- The following script performs a tree-to-tree comparison on the 2019 data set to
-- explore the differences in estimates at the atomic level.
-------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------

-- tab=CombinedSet
WITH -- The first set of objects pull data from the ANL
-- "Augmented" data set
std AS -- A list of plots assigned to the RAPID_ASSESSMENT study
 (SELECT m.nppt_cn
    FROM fs_nims_nrs.nims_prefield_study_mtx_vw m
    JOIN fs_nims_nrs.psd_study s
      ON m.psds_cn = s.cn
   WHERE s.study_name = 'RAPID_ASSESSMENT'),
pop AS -- Assemble the stratification data for estimation
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.cn              AS peu_cn,
         ps.cn               AS ps_cn,
         peu.area_used       AS estn_unit_area,
         peu.p1pntcnt_eu,
         ps.p1pointcnt,
         ps.p2pointcnt,
         ps.expns,
         ps.adj_factor_subp,
         ps.adj_factor_micr
    FROM pop_eval pe
    JOIN pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
   WHERE pet.eval_typ = 'EXPGROW'
     AND pe.evalid IN ( /*561703, 561853,*/ 561903)),
trees AS -- Assemble tree and condition data and pre-filter trees
 (SELECT tre.plt_cn,
         decode(std.nppt_cn, NULL, 'N', 'Y') AS rapid_assessment,
         plt.statecd,
         nbp.countycd,
         nbp.plot_fiadb AS plot,
```

```
         plt.measyear,
         plt1.measyear AS measyear_t1,
         plt.remper,
         tre.condid,
         tre.cn AS tre_cn,
         tre.subp,
         tre.tree,
         tre.spcd,
         tre.statuscd,
         tre.agentcd,
         tre.dia,
         tre1.dia AS dia_t1,
         nvl(tre.actualht, tre.ht) AS ht,
         nvl(tre1.actualht, tre1.ht) AS ht_t1,
         rs.common_name,
         rs.sftwd_hrdwd AS CLASS
    FROM plot_vw plt
    JOIN nims_plot_tbl nplt
      ON plt.cn = nplt.cn
    LEFT JOIN std
      ON std.nppt_cn = plt.cn
    JOIN fs_nims_nrs.nims_base_plot nbp
      ON nplt.nbp_cn = nbp.cn
    JOIN tree tre
      ON plt.cn = tre.plt_cn
    JOIN cond cnd
      ON tre.plt_cn = cnd.plt_cn
     AND tre.condid = cnd.condid
    JOIN ref_species rs
      ON tre.spcd = rs.spcd
    LEFT JOIN tree tre1
      ON tre.prev_tre_cn = tre1.cn
    LEFT JOIN plot plt1
      ON plt.prev_plt_cn = plt1.cn
   WHERE tre.spcd = 122 -- only Ponderosa pine
     AND cnd.owngrpcd = 10 -- only forest service conditions
  /* AND (cnd.cond_status_cd = 1 AND cnd.reservcd = 0 AND cnd.siteclcd < 7)*/ --
timberland only
  ),
grm AS -- Combine tree-condition data with change data and apply analysis parameters
 (SELECT grm.plt_cn,
         grm.tre_cn,
         trees.rapid_assessment,
         trees.statecd,
         trees.countycd,
         trees.plot,
         trees.subp,
         trees.tree,
         trees.measyear,
         trees.measyear_t1,
         trees.remper,
         trees.spcd,
         trees.statuscd,
         trees.agentcd,
         trees.dia,
         trees.dia_t1,
         (trees.dia - trees.dia_t1) / trees.remper AS dia_chng,
         trees.ht,
         trees.ht_t1,
         (trees.ht - trees.ht_t1) / trees.remper AS ht_chng,
         trees.common_name,
         trees.class,
         grm.component,
```

```
         grm.subptyp_grm,
         grm.tpagrow_unadj,
         grm.tparemv_unadj,
         grm.tpamort_unadj,
         grm.ann_net_growth,
         grm.mortality,
         grm.removals,
         grm.est_begin,
         grm.est_midpt,
         grm.est_end,
         (grm.g_s + grm.i + grm.g_i + grm.g_m + grm.g_c + grm.r + grm.g_r +
         grm.g_d) / grm.remper AS gross_growth,
         grm.g_s,
         grm.i,
         grm.g_i,
         grm.m,
         grm.g_m,
         grm.c,
         grm.g_c,
         grm.r,
         grm.g_r,
         grm.d,
         grm.g_d,
         grm.cd,
         grm.g_cd,
         grm.ci,
         grm.g_ci
    FROM tree_grm_estn grm
    JOIN trees
      ON trees.tre_cn = grm.tre_cn
   WHERE grm.land_basis = 'TIMBERLAND'
     AND grm.estn_type = 'SL'
     AND grm.estn_units = 'CF'
     AND grm.estimate = 'VOLUME'
     AND grm.component != 'NOT USED'),
dat_aug AS -- Estimates from the augmented 2019 data
 (SELECT pop.evalid,
         grm.plt_cn,
         grm.tre_cn,
         grm.rapid_assessment,
         grm.statecd,
         grm.measyear,
         grm.measyear_t1,
         grm.measyear || '-' || grm.measyear_t1 AS meas_period,
         grm.remper,
         grm.countycd,
         grm.plot,
         grm.subp,
         grm.tree,
         grm.component,
         grm.dia,
         grm.dia_t1,
         grm.dia_chng,
         grm.ht,
         grm.ht_t1,
         grm.ht_chng,
         SUM(grm.gross_growth) AS gross_growth_raw,
         /*to_char(*/
         round(SUM(grm.gross_growth * grm.tpagrow_unadj *
                   decode(grm.subptyp_grm,
                          1,
                          pop.adj_factor_subp,
                          2,
```

```
                        pop.adj_factor_micr,
                        0) * pop.expns) / 100,
             1) /*,

'999,999,999.9')*/ AS ann_gross_growth,
         /*to_char(*/
         round(SUM(grm.ann_net_growth * grm.tpagrow_unadj *
                   decode(grm.subptyp_grm,
                          1,
                          pop.adj_factor_subp,
                          2,
                          pop.adj_factor_micr,
                          0) * pop.expns) / 100,
               1) /*,

'999,999,999.9')*/ AS ann_net_growth,
         /*to_char(*/
         round(SUM((grm.ann_net_growth * grm.tpagrow_unadj -
                   grm.removals * grm.tparemv_unadj) *
                   decode(grm.subptyp_grm,
                          1,
                          pop.adj_factor_subp,
                          2,
                          pop.adj_factor_micr,
                          0) * pop.expns) / 100,
               1) /*,

'999,999,999.9')*/ AS ann_net_change
    FROM pop
    JOIN pop_plot_stratum_assgn ppsa
      ON ppsa.stratum_cn = pop.ps_cn
    JOIN plot_vw plt
      ON ppsa.plt_cn = plt.cn
    JOIN grm
      ON grm.plt_cn = plt.cn
   WHERE plt.bhnf_suitable_land = 'Y' -- filter for only suitable lands
     AND plt.statecd = 46
   GROUP BY pop.evalid,
            grm.plt_cn,
            grm.tre_cn,
            grm.rapid_assessment,
            grm.statecd,
            grm.measyear,
            grm.measyear_t1,
            grm.remper,
            grm.countycd,
            grm.plot,
            grm.subp,
            grm.tree,
            grm.component,
            grm.dia,
            grm.dia_t1,
            grm.dia_chng,
            grm.ht,
            grm.ht_t1,
            grm.ht_chng),
-- This second set of objects pulls data from the public FIADB data set
pop_fiadb AS -- Assemble the stratification data for estimation
 (SELECT pe.evalid,
         peu.estn_unit_descr,
         peu.cn              AS peu_cn,
         ps.cn               AS ps_cn,
         peu.area_used       AS estn_unit_area,
```

```
         peu.p1pntcnt_eu,
         ps.p1pointcnt,
         ps.p2pointcnt,
         ps.expns,
         ps.adj_factor_subp,
         ps.adj_factor_micr
    FROM fs_fiadb.pop_eval pe
    JOIN fs_fiadb.pop_eval_typ pet
      ON pet.eval_cn = pe.cn
    JOIN fs_fiadb.pop_estn_unit peu
      ON peu.eval_cn = pe.cn
    JOIN fs_fiadb.pop_stratum ps
      ON ps.estn_unit_cn = peu.cn
   WHERE pet.eval_typ = 'EXPGROW'
     AND pe.evalid IN ( /*461603, 461703, 461803,*/ 461903)),
bhnf_fiadb AS -- bring in suitability tags
 (SELECT cn, bhnf_suitable_land FROM plot_vw),
trees_fiadb AS -- Assemble tree and condition data and pre-filter trees
 (SELECT tre.plt_cn,
         bhnf.bhnf_suitable_land,
         decode(std.nppt_cn, NULL, 'N', 'Y') AS rapid_assessment,
         plt.statecd,
         plt.countycd,
         plt.plot,
         plt.measyear,
         plt1.measyear AS measyear_t1,
         plt.remper,
         tre.condid,
         tre.cn AS tre_cn,
         tre.subp,
         tre.tree,
         tre.spcd,
         tre.statuscd,
         tre.agentcd,
         tre.dia,
         tre1.dia AS dia_t1,
         nvl(tre.actualht, tre.ht) AS ht,
         nvl(tre1.actualht, tre1.ht) AS ht_t1,
         rs.common_name,
         rs.sftwd_hrdwd AS CLASS
    FROM fs_fiadb.plot plt
    LEFT JOIN bhnf_fiadb bhnf
      ON bhnf.cn = plt.cn
    LEFT JOIN std
      ON std.nppt_cn = plt.cn
    JOIN fs_fiadb.tree tre
      ON plt.cn = tre.plt_cn
    JOIN fs_fiadb.cond cnd
      ON tre.plt_cn = cnd.plt_cn
     AND tre.condid = cnd.condid
    JOIN fs_fiadb.ref_species rs
      ON tre.spcd = rs.spcd
    LEFT JOIN fs_fiadb.tree tre1
      ON tre.prev_tre_cn = tre1.cn
    LEFT JOIN fs_fiadb.plot plt1
      ON plt.prev_plt_cn = plt1.cn
   WHERE tre.spcd = 122 -- only Ponderosa pine
     AND cnd.owngrpcd = 10 -- only forest service conditions
  /* AND (cnd.cond_status_cd = 1 AND cnd.reservcd = 0 AND cnd.siteclcd < 7)*/ --
timberland only
  ),
grm_fiadb AS -- Combine tree-condition data with change data and apply analysis
parameters
```

```
 (SELECT grm.plt_cn,
         grm.tre_cn,
         trees.rapid_assessment,
         trees.statecd,
         trees.countycd,
         trees.plot,
         trees.subp,
         trees.tree,
         trees.bhnf_suitable_land,
         trees.measyear,
         trees.measyear_t1,
         trees.remper,
         trees.spcd,
         trees.statuscd,
         trees.agentcd,
         trees.dia,
         trees.dia_t1,
         (trees.dia - trees.dia_t1) / trees.remper AS dia_chng,
         trees.ht,
         trees.ht_t1,
         (trees.ht - trees.ht_t1) / trees.remper AS ht_chng,
         trees.common_name,
         trees.class,
         grm.component,
         grm.estn_units,
         grm.subptyp_grm,
         grm.tpagrow_unadj,
         grm.tparemv_unadj,
         grm.tpamort_unadj,
         grm.ann_net_growth,
         grm.mortality,
         grm.removals,
         grm.est_begin,
         grm.est_midpt,
         grm.est_end,
         (grm.g_s + grm.i + grm.g_i + grm.g_m + grm.g_c + grm.r + grm.g_r +
         grm.g_d) / trees.remper AS gross_growth,
         grm.g_s,
         grm.i,
         grm.g_i,
         grm.m,
         grm.g_m,
         grm.c,
         grm.g_c,
         grm.r,
         grm.g_r,
         grm.d,
         grm.g_d,
         grm.cd,
         grm.g_cd,
         grm.ci,
         grm.g_ci
    FROM /*fs_fiadb.tree_grm_estn grm*/ fs_nims_nrs.nims_grm_estn_debug grm
    LEFT JOIN trees_fiadb trees
      ON trees.tre_cn = grm.tre_cn
   WHERE grm.land_basis = 'TIMBERLAND'
     AND grm.estn_type = 'SL'
     AND grm.estn_units = 'CF'
     AND grm.estimate = 'VOLUME'
     AND grm.component != 'NOT USED'),
dat_fiadb AS -- Estimates from FIADB
 (SELECT pop.evalid,
         grm.plt_cn,
```

```
        grm.tre_cn,
        grm.rapid_assessment,
        grm.statecd,
        grm.measyear,
        grm.measyear_t1,
        grm.measyear || '-' || grm.measyear_t1 AS meas_period,
        grm.remper,
        grm.countycd,
        grm.plot,
        grm.subp,
        grm.tree,
        grm.component,
        grm.dia,
        grm.dia_t1,
        grm.dia_chng,
        grm.ht,
        grm.ht_t1,
        grm.ht_chng,
        SUM(grm.gross_growth) AS gross_growth_raw,
        /*to_char(*/
        round(SUM(grm.gross_growth * grm.tpagrow_unadj *
                  decode(grm.subptyp_grm,
                         1,
                         pop.adj_factor_subp,
                         2,
                         pop.adj_factor_micr,
                         0) * pop.expns) / 100,
              1) /*,

'999,999,999.9')*/ AS ann_gross_growth,
        /*to_char(*/
        round(SUM(grm.ann_net_growth * grm.tpagrow_unadj *
                  decode(grm.subptyp_grm,
                         1,
                         pop.adj_factor_subp,
                         2,
                         pop.adj_factor_micr,
                         0) * pop.expns) / 100,
              1) /*,

'999,999,999.9')*/ AS ann_net_growth,
        /*to_char(*/
        round(SUM((grm.ann_net_growth * grm.tpagrow_unadj -
                  grm.removals * grm.tparemv_unadj) *
                  decode(grm.subptyp_grm,
                         1,
                         pop.adj_factor_subp,
                         2,
                         pop.adj_factor_micr,
                         0) * pop.expns) / 100,
              1) /*,

'999,999,999.9')*/ AS ann_net_change
    FROM pop_fiadb pop
    JOIN fs_fiadb.pop_plot_stratum_assgn ppsa
      ON ppsa.stratum_cn = pop.ps_cn
    JOIN fs_fiadb.plot plt
      ON ppsa.plt_cn = plt.cn
    JOIN grm_fiadb grm
      ON grm.plt_cn = plt.cn
   WHERE grm.bhnf_suitable_land = 'Y' -- filter for only suitable lands
     AND plt.statecd = 46
   GROUP BY pop.evalid,
```

```
          grm.plt_cn,
          grm.tre_cn,
          grm.rapid_assessment,
          grm.statecd,
          grm.measyear,
          grm.measyear_t1,
          grm.remper,
          grm.countycd,
          grm.plot,
          grm.subp,
          grm.tree,
          grm.component,
          grm.dia,
          grm.dia_t1,
          grm.dia_chng,
          grm.ht,
          grm.ht_t1,
          grm.ht_chng)
-------------------------------------------------------------------------------------------
-- MAIN SQL LOGIC STARTS HERE
-------------------------------------------------------------------------------------------
SELECT dat_aug.evalid AS aug_evalid,
       dat_aug.plt_cn AS aug_plt_cn,
       dat_aug.tre_cn AS aug_tre_cn,
       dat_aug.rapid_assessment AS aug_rapid_assessment,
       dat_aug.statecd AS aug_statecd,
       dat_aug.measyear AS aug_measyear,
       dat_aug.measyear_t1 AS aug_measyear_t1,
       dat_aug.meas_period AS aug_meas_period,
       dat_aug.remper AS aug_remper,
       dat_aug.countycd AS aug_countycd,
       dat_aug.plot AS aug_plot,
       dat_aug.subp AS aug_subp,
       dat_aug.tree AS aug_tree,
       dat_aug.component AS aug_component,
       dat_aug.dia AS aug_dia,
       dat_aug.dia_t1 AS aug_dia_t1,
       dat_aug.dia_chng AS aug_dia_chng,
       dat_aug.ht AS aug_ht,
       dat_aug.ht_t1 AS aug_ht_t1,
       dat_aug.ht_chng AS aug_ht_chng,
       dat_aug.gross_growth_raw AS aug_gross_growth_raw,
       dat_aug.ann_gross_growth AS aug_ann_gross_growth,
       dat_aug.ann_net_growth AS aug_ann_net_growth,
       dat_aug.ann_net_change AS aug_ann_net_change,
       dat_fiadb.evalid AS fiadb_evalid,
       dat_fiadb.plt_cn AS fiadb_plt_cn,
       dat_fiadb.tre_cn AS fiadb_tre_cn,
       dat_fiadb.rapid_assessment AS fiadb_rapid_assessment,
       dat_fiadb.statecd AS fiadb_statecd,
       dat_fiadb.measyear AS fiadb_measyear,
       dat_fiadb.measyear_t1 AS fiadb_measyear_t1,
       dat_fiadb.meas_period AS fiadb_meas_period,
       dat_fiadb.remper AS fiadb_remper,
       dat_fiadb.countycd AS fiadb_countycd,
       dat_fiadb.plot AS fiadb_plot,
       dat_fiadb.subp AS fiadb_subp,
       dat_fiadb.tree AS fiadb_tree,
       dat_fiadb.component AS fiadb_component,
       dat_fiadb.dia AS fiadb_dia,
       dat_fiadb.dia_t1 AS fiadb_dia_t1,
       dat_fiadb.dia_chng AS fiadb_dia_chng,
       dat_fiadb.ht AS fiadb_ht,
```

```
       dat_fiadb.ht_t1 AS fiadb_ht_t1,
       dat_fiadb.ht_chng AS fiadb_ht_chng,
       dat_fiadb.gross_growth_raw AS fiadb_gross_growth_raw,
       dat_fiadb.ann_gross_growth AS fiadb_ann_gross_growth,
       dat_fiadb.ann_net_growth AS fiadb_ann_net_growth,
       dat_fiadb.ann_net_change AS fiadb_ann_net_change,
       dat_aug.gross_growth_raw - dat_fiadb.gross_growth_raw AS gross_growth_diff,
       CASE
         WHEN sign(dat_aug.dia_chng) = 1 AND sign(dat_fiadb.dia_chng) = 1 THEN
          dat_aug.dia_chng - dat_fiadb.dia_chng
         WHEN sign(dat_aug.dia_chng) = -1 AND sign(dat_fiadb.dia_chng) = 1 THEN
          dat_aug.dia_chng + dat_fiadb.dia_chng
         WHEN sign(dat_aug.dia_chng) = 1 AND sign(dat_fiadb.dia_chng) = -1 THEN
          dat_aug.dia_chng + dat_fiadb.dia_chng
         WHEN sign(dat_aug.dia_chng) = -1 AND sign(dat_fiadb.dia_chng) = -1 THEN
          dat_aug.dia_chng - dat_fiadb.dia_chng
         ELSE
          dat_aug.dia_chng - dat_fiadb.dia_chng
       END AS dia_chng_diff,
       CASE
         WHEN sign(dat_aug.ht_chng) = 1 AND sign(dat_fiadb.ht_chng) = 1 THEN
          dat_aug.ht_chng - dat_fiadb.ht_chng
         WHEN sign(dat_aug.ht_chng) = -1 AND sign(dat_fiadb.ht_chng) = 1 THEN
          dat_aug.ht_chng + dat_fiadb.ht_chng
         WHEN sign(dat_aug.ht_chng) = 1 AND sign(dat_fiadb.ht_chng) = -1 THEN
          dat_aug.ht_chng + dat_fiadb.ht_chng
         WHEN sign(dat_aug.ht_chng) = -1 AND sign(dat_fiadb.ht_chng) = -1 THEN
          dat_aug.ht_chng - dat_fiadb.ht_chng
         ELSE
          dat_aug.ht_chng - dat_fiadb.ht_chng
       END AS ht_chng_diff
  FROM dat_aug
 RIGHT JOIN dat_fiadb
    ON dat_aug.statecd = dat_fiadb.statecd
      --AND dat_aug.measyear = dat_fiadb.measyear
   AND dat_aug.countycd = dat_fiadb.countycd
   AND dat_aug.plot = dat_fiadb.plot
   AND dat_aug.subp = dat_fiadb.subp
   AND dat_aug.tree = dat_fiadb.tree
--AND dat_aug.measyear = 2019 AND dat_aug.measyear_t1 = 2013
 ORDER BY dat_aug.statecd,
          --dat_aug.measyear,
          dat_aug.countycd,
          dat_fiadb.countycd,
          dat_aug.plot,
          dat_fiadb.plot,
          dat_aug.subp,
          dat_fiadb.subp,
          dat_aug.tree,
          dat_fiadb.tree,
          dat_fiadb.statecd
--dat_fiadb.measyear,
;
```