## Responses to Lawrence County Questions Regarding Black Hills National Forest Timber

Lawrence County submitted questions to the Black Hills National Forest on April 17, 2020, regarding the Rocky Mountain Research Station March 2020 Draft GTR "Timber Growth and Yield in the Black Hills Nation Forest: A Changing Forest" and the most recent Forest Inventory and Analysis data presented at the April 3 Stakeholders Meeting. The Black Hills National Forest staff, in collaboration with staff of the RMRS and the Northern Research Station FIA group developed the responses below. Acting Forest Supervisor Andrew Johnson and Deputy Forest Supervisor Jerry Krueger met with county and city representatives on April 10, 2020.

1. **On Table 1 of the GTR, the gross growth in 2019 is more than 25% less than what it was in 2017. How was the growth calculated?**

   - Gross Growth is defined as Gross Ingrowth + Accretion.
     - Gross Ingrowth is defined as Ingrowth (I) + Reversion (I)
     - Accretion is defined as the growth on Survivor trees ($G_s$), Ingrowth trees ($G_i$) , Reversion trees ($G_r$), Mortality trees ($G_m$), Cut trees ($G_c$) and Diversion trees ($G_d$)
   - Note that Reversion and Diversion have to do with the land basis while the other components have to do with individual trees.
   - Growth is computed as the T2 estimate minus the T1 estimate.

   **Were there any differences in the way the growth was calculated?**

   No.

2. **The FIA report does not include trees smaller than 5" in DBH. Was any data collected for this diameter class?**

   Yes. FIA classifies trees less than 1 inch DBH as *seedlings*, those trees from 1 inch to <5 inches DBH as *saplings*, and trees ≥5 inches DBH as *trees*. We only estimate volume on *trees,* and merchantable volumes are to a 4-inch top. Estimates are available using the public EVALIDator tool published as a companion with our data release (see Table 1 as an example below).

   *Table 1. Number of live ponderosa pine trees (at least 1 inch d.b.h./d.r.c.), in trees, on timberland, with additional filters for Black Hills NF Suitable Base.*

Numerator attribute number and description: 7.0 Number of live trees (at least 1 inch d.b.h./d.r.c.), in trees, on timberland
Row variable=Diameter class: 2 inch class to 29 (based on values from the Current inventory).
Column variable=All live stocking (based on values from the Current inventory).
Filtering clause(s): and (cond.owngrpcd in (10)) and (tree.spcd in (0122)) and plotgeom.bhnf_suitable_land = 'Y'
Estimate:

| | All live stocking | | | | | |
|---|---|---|---|---|---|---|
| Diameter class: 2 inch class to 29 | Total | Overstocked | Fully stocked | Medium stocked | Poorly stocked | Nonstocked |
| Total | 187,221,906 | 2,187,019 | 55,646,646 | 72,368,713 | 56,093,056 | 926,472 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.0-2.9 | 89,464,731 | 1,333,689 | 32,465,113 | 29,483,204 | 25,977,506 | 205,220 |
| 3.0-4.9 | 30,494,904 | 410,439 | 11,649,760 | 10,312,636 | 8,122,069 | - |
| 5.0-6.9 | 18,987,290 | 177,222 | 4,162,878 | 8,911,324 | 5,587,449 | 148,417 |
| 7.0-8.9 | 17,116,635 | 97,498 | 2,964,227 | 8,270,654 | 5,605,751 | 178,505 |
| 9.0-10.9 | 11,864,672 | 87,164 | 1,834,915 | 6,146,027 | 3,699,069 | 97,498 |
| 11.0-12.9 | 7,813,004 | 48,025 | 890,099 | 3,978,005 | 2,814,421 | 82,454 |
| 13.0-14.9 | 4,488,814 | 16,491 | 611,214 | 1,889,620 | 1,872,545 | 98,945 |
| 15.0-16.9 | 3,272,194 | - | 555,421 | 1,374,342 | 1,292,959 | 49,472 |
| 17.0-18.9 | 1,894,108 | 16,491 | 239,377 | 1,033,067 | 555,700 | 49,472 |
| 19.0-20.9 | 1,056,122 | - | 91,874 | 601,261 | 346,497 | 16,491 |
| 21.0-28.9 | 769,431 | - | 181,768 | 368,574 | 219,090 | - |
| 29.0+ | - | - | - | - | - | - |

**Leaving this information out of the growth calculations means that a very important piece of the growth projections is missing. This is especially true considering the number of acres that are present on the landscape. This diameter class should not be overlooked. One of the major concerns voiced by BHNF is that there are thousands of acres of dog hair on the Forest some of which is under existing live overstory or in areas where there was significant mpb mortality. How many acres of the BHNF is in this size class?**

The estimated total forest area in this size class with the associated 95% CI is 67,679 ± 24,076 acres. These numbers can be reproduced using the public EVALIDator tool published as a companion with our data release (see

*Table 2*).

*Table 2. Area of timberland on Black Hills NF Suitable Base, in acres*

Numerator attribute number and description: 3.0 Area of timberland, in acres
FIADEF as the forest land definition.
Statecd/EVALID(s):
Wyoming 562019
Page variable=None (based on values from the Current inventory).
Row variable=Stand-size(field call) (based on values from the Current inventory).
Column variable=All live stocking (based on values from the Current inventory).
Filtering clause(s): and (cond.owngrpcd in (10))and plotgeom.bhnf_suitable_land = 'Y'
Estimate:

| | All live stocking | | | | | |
|---|---|---|---|---|---|---|
| Stand-size (field call) | Total | Over-stocked | Fully stocked | Medium stocked | Poorly stocked | Non-stocked |
| Total | 765,733 | 9,195 | 86,384 | 268,563 | 340,125 | 61,467 |
| Large diameter (20.0 to 39.9 inches) | 15,764 | - | 2,740 | 9,598 | 2,740 | 685 |
| Large diameter (9 to 19.9 inches for softwoods) | 516,456 | 6,872 | 39,908 | 186,560 | 253,642 | 29,475 |
| Medium diameter (5 to 8.9 inches for softwoods) | 131,289 | - | 13,859 | 51,626 | 59,906 | 5,898 |
| Small diameter (0.1 to 4.9 inches) | 67,679 | 2,324 | 27,490 | 18,661 | 16,159 | 3,046 |
| Nonstocked | 34,545 | - | 2,387 | 2,117 | 7,678 | 22,363 |

**What are stocking levels and how much of these sites have been precommercially thinned and to what spacing?**

Stocking levels vary between hundreds to thousands of seedlings per acre. Since 2011 annual needs have increased by an average of 10,000 acres while annual treatments have averaged 10,000 acres. Residual densities vary depending upon resource goals and objectives. The most common residual densities are 222 (14 x 14 average spacing) and 300 trees per acre (16 x 16 average spacing).

**Gross growth appears low in FIA for 5” dia class if it is capturing ingrowth.**

The growth calculations have ingrowth, and these are accounted for in the attached Excel file (components of growth.xlsx).

**Do stage 2 Inventory Stand Exam plots inventory seedlings and saplings?**

For Common Stand Exam Inventories, an extensive exam collects accurate tree measurements to tolerance standards tighter than a quick plot, but not as tight as an intensive exam. Trees on the large plot are recorded individually, but trees on the small plot may be recorded in groups. Diameters are measured to the nearest 1-inch class. Some tree defect information is collected. The main uses of an extensive exam are:

- Minimum data required to execute growth and yield models
- Exams in multi-storied stands
- Silvicultural prescriptions

For FIA Inventories, Phase 2 inventories measure trees <5.0 inches dbh/drc on 6.8-foot radius microplots (1/300th acre) nestled within standard plots. Standard plot consists of four 24.0-foot radius subplots (approximately 1/24 acre) on which trees 5.0 inches dbh/drc are measured.

**An example of why including this size class in the projected growth over the next 20 years is important is laid out in the following scenario: 10,000 acres of saplings averaging 3" diameter, stocked at 300 trees per acre (12 by 12 spacing) growing at 3" in diameter (1.5" radial growth) every decade will grow into 50 million board feet of merchantable (9") in 20 years. Basal area would be around 130 square feet per acre assuming no mortality.**

Comment/assertion. We estimate that it would take a minimum of 40 years for 3 inch diameter trees, stocked at 300 trees per acres, to grow into a 9 inch diameter class on a productive site on the Black Hills National Forest. Annual growth rates may meet or exceed 1.5" per year initially but would not stay at this level during this time period or longer. An assumption of no mortality is unrealistic.

**Explain why the mortality numbers are so much higher in 2017 and 2019 than in 2011? Is this due to the lag in FIA data – MPB mortality peaked around 2011-2012? Why does the mortality increase between 2017 and 2019?**

*There are a couple of ways we can interpret this question. We interpret the question as an examination of individual measurement years within the evaluation: 561903.*

FIA generates estimates of Growth, Mortality and Removals by observing sampling points at two consecutive points in time. Growth is a rate that is estimated from empirical observations. Both Mortality and Removals are stochastic events that are observed.

A draft 2017 evaluation (561703) was shared at a public meeting in 2018 to show progress; it provided estimates to-date. The 2019 evaluation (561903) is intended to be the final analysis because it constitutes the most recent observations on all qualifying sampling points. This is shown starkly by the concentration of T2 MEASYEARs dropping to only three (

Table 3). The 2017 evaluation included T1 observations from all the way back to 2005, and those are no longer included in the 2019 evaluation. This was the strategy from the beginning; the temporal intensification focused remeasurement upon more recent years.

*Table 3. Counts of remeasurement plots by EVALID, T2 MEASYEAR, and T1 MEASYEAR.*

| | T1 MEASYEAR | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T2 MEASYEAR | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Grand Total |
| 561703 | 20 | 3 | 38 | 45 | 40 | 37 | 38 | | | | | | 221 |
| 2011 | 20 | 3 | | | | | | | | | | | 23 |
| 2012 | | | 38 | | | | | | | | | | 38 |
| 2013 | | | | 45 | | | | | | | | | 45 |
| 2014 | | | | | 29 | | | | | | | | 29 |
| 2015 | | | | | 11 | 17 | 2 | | | | | | 30 |
| 2016 | | | | | | 20 | 7 | | | | | | 27 |
| 2017 | | | | | | | 29 | | | | | | 29 |
| 561903 | | | | | | | 56 | 38 | 45 | 29 | 30 | 27 | 225 |
| 2017 | | | | | | | 29 | | | | | | 29 |
| 2018 | | | | | | | 15 | 20 | | | | | 35 |
| 2019 | | | | | | | 12 | 18 | 45 | 29 | 30 | 27 | 161 |

The 2019 (final) evaluation includes plots that were initially measured (T1) between 2011 and 2016 and re-measured (T2) between 2017 and 2019 (Table 4). Note the re-measurement period is compressed relative to the initial measurements. Furthermore, the plots re-measured in 2019 included both on-panel plots (which would have been visited normally) and off-panel plots (which were visited ahead of their official schedule). Thus, the concentration of T2 observations in 2019.

*Table 4. GRM plots by T1 and T2 MEASYEAR.*

| | T2 MEASYEAR | | | |
|---|---|---|---|---|
| T1 MEASYEAR | 2017 | 2018 | 2019 | Grand Total |
| 2011 | 29 | 15 | 12 | 56 |
| 2012 | | 20 | 18 | 38 |
| 2013 | | | 45 | 45 |
| 2014 | | | 29 | 29 |
| 2015 | | | 30 | 30 |
| 2016 | | | 27 | 27 |
| GRAND TOTAL | 29 | 35 | 161 | 225 |

FIA defines Mortality as trees that were present and within the domain of interest at T1 but were observed as dead at T2. The exact time of death is not known, and so we assume it occurred at the midpoint in time between T1 and T2. This is a simplifying assumption.

Mortality estimates can be summarized in many ways. Two common approaches are to sum them by either T1 or T2, In the case of T1, the sums represent trees that were last observed as alive as of T1 (regardless of when they were re-measured). In the case of T2 the sums represent trees that have died since the previous observation (regardless of how long ago that was).

FIA also codes a cause of death when a mortality tree is observed. This is the field crew's best guess of what caused the mortality at the time they observed it (T2). Mortality can be additionally summed or filtered by this information.

Table 5 presents Annual Net Change (ANC) of only Mortality trees by T2 MEASYEAR, T1 MEASYEAR, and Cause of Death. Note that the sum for T2 MEASYEAR = 2019 is largest because most of the T2 observations are concentrated in that year. This should not be interpreted as most of the trees actually died in 2019. The peak of INSECT mortality is actually for trees last observed alive in 2013. Those trees died somewhere between 2013 and 2019. But, also note that there were 45 plots that observed the period between 2013 and 2019; the most of any period. So, a higher total value is expected.

*Table 5. Annual Net Change of only Mortality trees by T2 MEASYEAR, T1 MEASYEAR, and Cause of Death, in cubic feet. Negative values are reported in parentheses.*

| | T2 MEASYEAR | | | |
|---|---|---|---|---|
| T1 MEASYEAR | 2017 | 2018 | 2019 | Grand Total |
| DISEASE | | (395) | | (395) |
| 2011 | | (395) | | (395) |
| FIRE | | | (1,192) | (1,192) |
| 2013 | | | (106) | (106) |
| 2014 | | | (685) | (685) |
| 2015 | | | (402) | (402) |
| INSECT | (1,616) | (3,425) | (9,242) | (14,284) |
| 2011 | (1,616) | (1,974) | (235) | (3,825) |
| 2012 | | (1,451) | (1,250) | (2,701) |
| 2013 | | | (4,341) | (4,341) |
| 2014 | | | (2,872) | (2,872) |
| 2015 | | | (544) | (544) |
| UNKNOWN | - | (41) | | (41) |
| 2011 | - | (41) | | (41) |
| WEATHER | | (126) | (720) | (845) |
| 2011 | | - | | - |
| 2012 | | (126) | (40) | (165) |
| 2013 | | | (304) | (304) |
| 2015 | | | (376) | (376) |
| GRAND TOTAL | (1,616) | (3,986) | (11,154) | (16,756) |

Note, the following predicates were used to generate the above ANC estimates:

- LAND_BASIS: TIMBERLAND
- ESNT_TYPE: SL (Saw log)
- ESTN_UNITS: CF
- ESTIMATE: VOLUME
- SPCD: 122
- OWNGRPCD: 10
- BHNF_SUITABLE_LAND: 'Y'

**Please explain how the 2019 FIA inventory collected mortality since it did not re-measure the 2017 inventory points?**

The 2019 "inventory" (FIA might call this an "evaluation") is composed of base sampling points that were observed initially (T1) between 2011-2016 and re-measured (T2) between 2017 and 2019. Table 4 in the previous response summarizing plot counts.

Mortality was estimated by observing trees that were alive and in the domain of interest at T1 that were dead as of the T2 visit. As the table shows, these re-measurements observe several different and distinct periods of time. For example, 12 sampling points observed the specific period between 2011 and 2019 and 18 observed the period between 2012 and 2019. These plot counts can alternatively be presented by this period of change which FIA calls the *re-measurement period* (REMPER). *Table 6* presents plot counts by T2 MEASYEAR, T1 MEASYEAR, and REMPER.

*Table 6. Plot counts by T2 MEASYEAR, T1 MEASYEAR, and REMPER*

| | T2 MEASYEAR | | | |
|---|---|---|---|---|
| T1 MEASYEAR | 2017 | 2018 | 2019 | Grand Total |
| 2011 | 29 | 15 | 12 | 56 |
| 6.0 | 17 | | | 17 |
| 6.1 | 6 | | | 6 |
| 6.2 | 3 | | | 3 |
| 6.3 | 3 | | | 3 |
| 6.8 | | 1 | | 1 |
| 6.9 | | 1 | | 1 |
| 7.0 | | 6 | | 6 |
| 7.1 | | 6 | | 6 |
| 7.2 | | 1 | | 1 |
| 7.7 | | | 1 | 1 |
| 7.8 | | | 5 | 5 |
| 7.9 | | | 3 | 3 |
| 8.0 | | | 2 | 2 |
| 8.1 | | | 1 | 1 |
| 2012 | | 20 | 18 | 38 |
| 6.0 | | 7 | | 7 |
| 6.1 | | 6 | | 6 |
| 6.2 | | 7 | | 7 |
| 7.1 | | | 12 | 12 |
| 7.2 | | | 6 | 6 |
| 2013 | | | 45 | 45 |
| 5.9 | | | 2 | 2 |
| 6.0 | | | 19 | 19 |
| 6.1 | | | 15 | 15 |
| 6.2 | | | 9 | 9 |
| 2014 | | | 29 | 29 |
| 4.9 | | | 1 | 1 |
| 5.0 | | | 9 | 9 |

| | | | | |
|---|---|---|---|---|
| 5.1 | | | 16 | 16 |
| 5.2 | | | 3 | 3 |
| 2015 | | | 30 | 30 |
| 3.8 | | | 2 | 2 |
| 3.9 | | | 4 | 4 |
| 4.0 | | | 15 | 15 |
| 4.1 | | | 7 | 7 |
| 4.2 | | | 2 | 2 |
| 2016 | | | 27 | 27 |
| 2.8 | | | 2 | 2 |
| 2.9 | | | 5 | 5 |
| 3.0 | | | 13 | 13 |
| 3.1 | | | 7 | 7 |
| GRAND TOTAL | 29 | 35 | 161 | 225 |

**Explain how FIA dealt with mortality with the intensified plots?**

FIA did not use any plots that were not re-measured in any estimates of Growth, Removals, or Mortality (GRM). The intensified (2X) plots were established in 2017 and 2018 and participated only in "current" estimates of area and volume. BHNF has the option to remeasure the intensified sampling points starting in 2024, and this will begin to reduce the sampling error on GRM estimates at that time. The base plots (both on and off-panel) were re-measurements from some previous visit that occurred between 2011 and 2016. As such, the base plots did participate in GRM estimates as observations of change over this period.

The following are summaries of the 561903 evaluation used to generate all 2019 estimates of GRM (*Figure 1*, *Figure 2*).

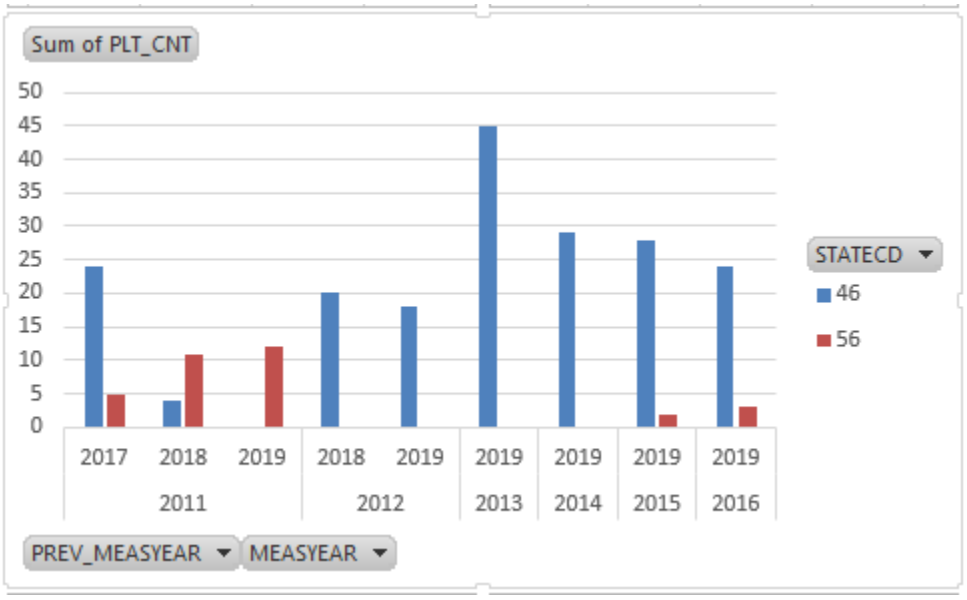


*Figure 1. Count of plots from Evaluation 561903 by STATECD, T1 MEASYEAR (lower labels on x-axis) and T2 MEASYEAR (upper labels on x-axis).*

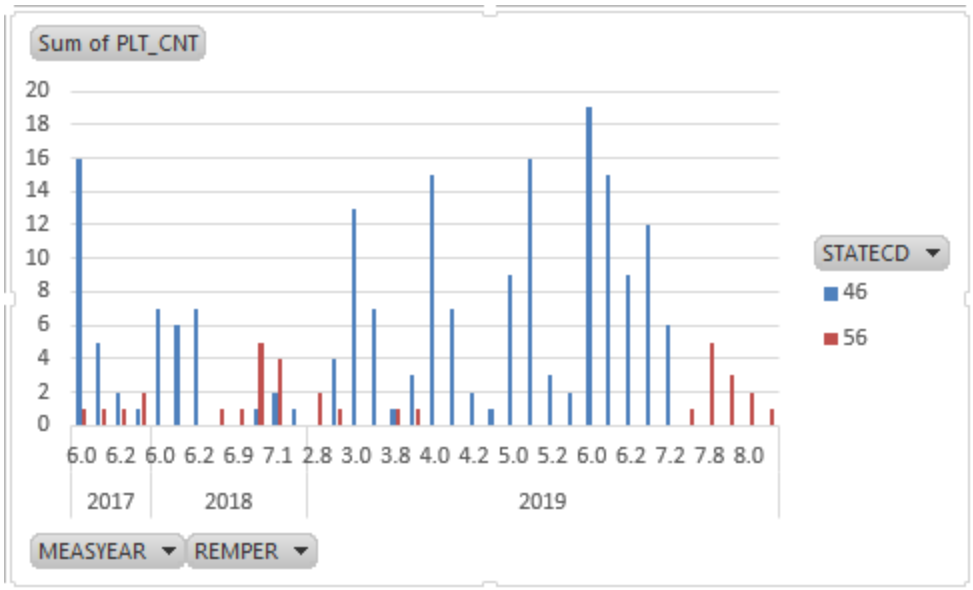


*Figure 2. Count of plots from Evaluation 561903 by STATECD, T2 MEASYEAR (lower labels on x-axis) and REMPER (upper labels on x-axis).*

**3. What is the radial growth of each of the cross sections for each tree spacing distance that was illustrated in GTR?**

Commenter may have eluded to Graham et al. 2019. This work is not completed peer review, but is from a current study with Dr. Wade Tinkham (CSU). However, is some preliminary data from that study.

| Spacing (ft) | Dbh (in) at 45 years | Diameter (inch) per year |
|---|---|---|
| 3 x 3 | 4 | 0.09 |
| 7 x 7 | 6 | 0.13 |
| 12 x 12 | 9.6 | 0.21 |
| 17 x 17 | 11.5 | 0.26 |

**4. How many acres are designated as suited in the Forest Plan, and what process did the BHNF use to determine those acres?**

See 'Comparison of 1997 Forest Plan Revision Phase II and FSVeg inventory area estimates, Black Hills National Forest'. Land classes are assigned at the stand level in the forest vegetation inventory database (FSVeg, RMRIS in 1997). This database is used to derive suitable and unsuitable totals. Timber program levels are determined through the Forest Land Management and Resource Planning Process and are dependent upon the total area considered suitable for timber production and other factors such as existing market conditions and likely forest budgets. This database is updated on an annual basis to incorporate changes prompted by land exchanges, new inventory information, changes conditions due to disturbance, etc. Changes to suitable and unsuitable area are ultimately incorporated into Forest Plan Revisions or Amendments.

5. **What effort has been made to ensure other local government agencies understand the impacts these decisions will have on their constituency? How do you plan to ensure they are included as stakeholders?**

   We have held and will continue to engage with county and municipal governments as stakeholders in evaluating the science and incorporating their voice in the discussion. We held a specific county/city stakeholder meeting on 10 April and will schedule a follow up in the near future.

6. **Jerry Krueger has stated that the BHNF has had no contact or influence over the GTR and yet on page 15 (page 1 is the abstract page) under ··scenarios" second paragraph the GTR states "To that end, we the authors, in consultation with the Leadership of the BHINF and Rocky Mountain Region created six scenarios that directly and/or indirectly addressed the above questions." This appears to be a contradiction, no?**

   The BHNF asked RMRS to respond to the sustainability questions and the Forest leadership provided suggestions on harvest options. This interaction was part of a routine clarification of tasking early in the process. Once clarified, Forest leadership did not direct how RMRS to conduct an analysis of sustainability.

7. **Given the current structure of the stakeholder meetings, how will the Forest include additional time for discussion among stakeholders, BHNF staff, researchers, and FIA staff?**

   We include time in each meeting to focus on discussion, for the 1 May meeting we hope to devote as much as 1.5 of the 2 hours to dialog.

9. **How will the FS and researchers incorporate concerns from stakeholders on certain aspects of the FIA analysis and GTR before reaching any conclusions or further discussion about the limber sale program level?**

   Anyone can submit specific comments on the content of the GTR. Comments must be sent in via the published process to RMRS by 15 April, which has been extended to 1 May. The draft document, the process, and the template for submitting comments is available at: ***https://www.fs.usda.gov/rmrs/bhnftimberreport***

   Questions that have come up during Forest meetings or from stakeholder's letters will not be part of the GTR review process, unless those comments are submitted according to the outlined process above. RMRS researchers will consider the comments, reconcile the comments, and provide the final report.

   Forest Service Research staff will continue to move forward to complete the GTR based on public comments and the scientific peer review process. In parallel, the stakeholder dialog has and will continue to include opportunities to voice concerns and include these in decisions about future timber program levels.

10. **What is the specific timeline for future meetings, and when is a decision from these stakeholder meetings expected?**

    Forest Service leadership is committed to a shared stewardship approach involving all stakeholders in order to move toward a decision. There is no stated timeline.

**Supplemental Questions**

1. **How does the BHNF/FIA assign the bhnf_suitable_land flag to FIA plots, and has the process changed since 2016?**

   The BHNF has been supplying FIA with the most up-to-date geospatial data layers since this process began. An email was sent on 2/11/2019 from BHNF to FIA identifying the proper FSVEG (polygon geospatial layer) to use to assign both the SUITABLE LANDS and HABITAT STRUCTURAL STAGE variables via spatial intersection. This was the last such update regarding spatial layers received by FIA. FIA used this layer to complete the final, 2019, evaluation.

   The best available coordinates for FIA plot locations were used for the intersection. Both the FIA plot locations and the polygon geospatial layer provided by BHNF were projected from their original geospatial reference into Albers Conic Equal Area (USGS version) projection prior to performing the intersection.

   The HABITAT STRUCTURAL STAGE variable was captured as-is from the HAB_STRUCT_STAGE_CODE variable within the BHNF-provided spatial layer. The SUITABLE LANDS variable was taken (as instructed) from the TIMBER_SUITABILITY_CODE variable from the provided geospatial layer and then decoded. Values ranging from 500 to 699 were classified as 'Y' (meaning suitable) and all other values were classified as 'N' (not suitable). The results of the geospatial intersection were uploaded into the custom analysis database and included in the final product.

   The process has not changed since 2016.

2. **What was the protocol for layout of the intensified plots?**

   FIA established the intensified (2X) sampling points by first generating a hexagonal tessellation of the landscape composed of finer (smaller) hexagons used to establish the base (1X) sampling points. In essence, the finer hexagonal frame was partitioned by the base FIA hexagons, forming smaller equal-area hexagonal sampling polygons. Specifically, there are 28 smaller sampling areas within each standard FIA base hexagon. Each of these smaller polygons was randomly assigned an intensification level (after removing the one containing the base FIA plot). A sampling point was randomly located within each of the smaller sampling areas. This generates a sample that is partially systematic and partially random. Only the sampling points generated within the "2X" polygons were selected for deployment in the field sample as part of the intensified sample.

3. **The 1.04% mortality factor seems unrealistically high especially comparing it to the 37 years from 1962 thru 1999?**

   **The authors seem to downplay this period but it likely represents fairly average conditions and also there were significant mortality factors during this period.**

   **The period of 1962 to 1983 included the third largest mpb epidemic in the last 120 years and about 30,000 acres of wildfire damage.**

   **The period of 1984 to 1998 included about 94,000 acres of wildfire damage and minimal mpb damage.**

   **These numbers seem to contradict the statement by the authors that the period between 1962 and 1999 had low mortality rates due to minimal wildfire and mountain pine beetle occurrence.**

**See below statement: the weighted average mortality figure from 1962 to 1999 (37 years) is .23%**

**From the GTR. "The low (0.16 to 0.26%) ponderosa pine mortality rates from 1962 to 1999 reflect the low (endemic) levels of MPB activity (fig. 1) and minimal wildfire occurrence (fig. 2), leaving weather as the primary mortality agent."**

1.04% annual mortality rate is one of several mortality rates (0.26 to 2.98%), we used in the potential timber harvest futures displayed in the scenarios. Therefore, the authors do not advocate a particular mortality rate but provide a range of mortality scenarios from which the BHNF and its stakeholders can use to inform the future timber management program for the Forest. The scenarios are not meant to be management alternatives but illustrate how different volumes will vary based on different mortality rates.

However, there is considerable amount of uncertainty going into the future because of changing climates that has the potential of getting warmer and drier adding stress to the vegetation making them vulnerable to a range of disturbances. Thus, it is difficult to assume, that past mortality 40 years ago that lasted only 20 years will again return and continue to be stable for the next 80 years. Thus, the authors selected a range of mortality rates to account for this uncertainty.