Appendix 4: Evaluation of Forest Health Monitoring Data to Support Lolo National Forest Plan Revision

Contents

1. Background

Forest health monitoring data was reviewed in support of the natural range of variation modeling for the Lolo plan revision. Joel Egan, R1/R4 Forest Health Monitoring Coordinator produced a Forest Health and Disturbance Report, MFO-TR-23-01 (Egan 2023). This appendix presents the information found in this report. Key highlights and findings include:

- Atmospheric precipitation changed from multidecadal wet to dry cycle in May-Sept months on the Lolo National Forest (LNF) from 1980-1999 to 2000-2022 periods. Dry conditions interacted with increasing temperatures to promote wildfire and bark beetle disturbances across all Geographic Areas in the LNF.
- From 2000-2022, Aerial Detection Surveys (ADS) estimated bark beetle activity occurred across 32% of Lolo National Forest (LNF) Geographic Areas with 8% having high-severity impact.
- Bark beetles were estimated to have impacted 5% of LNF Geographic Areas from 1980-1999 during prior multidecadal wet cycle. Thus, bark beetle damages were approximately 6-fold greater during recent multidecadal dry cycle relative to prior decades.
- From 2000-2022, ADS estimated insect defoliation occurred across 21% of LNF Geographic Areas, primarily in the Rock Creek and Upper Blackfoot Clearwater zones. Defoliation rarely exceeded 3 years of damage and damage primarily caused minor growth loss while significant tree mortality and decline was only rarely detected.
- Aggregate hazard ratings for bark beetle and root diseases, analyzed through 2022 Out-Year Planning project, identified just over 1 million acres or 32% of LNF area with clustered, abundant hazard susceptible to bark beetles and/or root disease.

- Wildfires impacted just under 800k acres on the LNF from 2000-2022 from limited analysis of those incidents > 100 acres. The Upper Blackfoot Clearwater and Lower Clark Fork Geographic Areas had greatest area impacted by wildfire incidents during this time period.
- Bark beetle activity co-occurred with wildfires across just over 200k acres or 26% of the wildfire incident areas within the LNF from 2000-2022.

The primary conclusion is that Lolo National Forest vegetation had chronic exposure to atmospheric precipitation levels that were reduced, primarily in May-September months, relative to mean conditions from 1948-2021, during the multidecadal dry period from 2000-2022. Combined with warming temperatures (data not shown), conditions were associated substantially elevated bark beetle and wildfire disturbances as well as their interactions. Further disturbance is anticipated, especially where dry conditions re-occur and forest vegetation is susceptible.

2. Process and Methods

2.1 Standard Precipitation Index

Standard precipitation index data were normalized from 1948-2021 and evaluated for changes in calendar year (January-December), spring (March-May), and summer (May-September) seasonal periods for recent 2000-2021 multidecadal period relative to past conditions. Data from all geographic areas were evaluated and charts are provided as example data from the Ninemile/Petty Creek geographic area (Figure A4.1, Figure A4.2, and Figure A4.3).

Evaluation of records across each Geographic Area indicated consistent findings:

- Calendar year precipitation climate was slightly less in 2000-2021 period relative to prior 1980-1999 period (Figure A4.1)
- Spring precipitation climate conditions did not deviate in 2000-2021 period relative to prior 1980-1999 period (Figure A4.2).
- Summer (May-Sept) period precipitation climate was substantially reduced in 2000-2021 relative to 1980-1999, 1960-1979, and 1948-1959 multidecadal periods (Figure A4.3).

Particularly in summer period, wet replenishing anomalies were very rare and dry anomalies frequent during recent dry cycle 2000-2021 data (Figure A4.5). This contrasts particularly with the prior 1980-1999 pluvial period during which wet anomalies were common and dry anomalies rare.

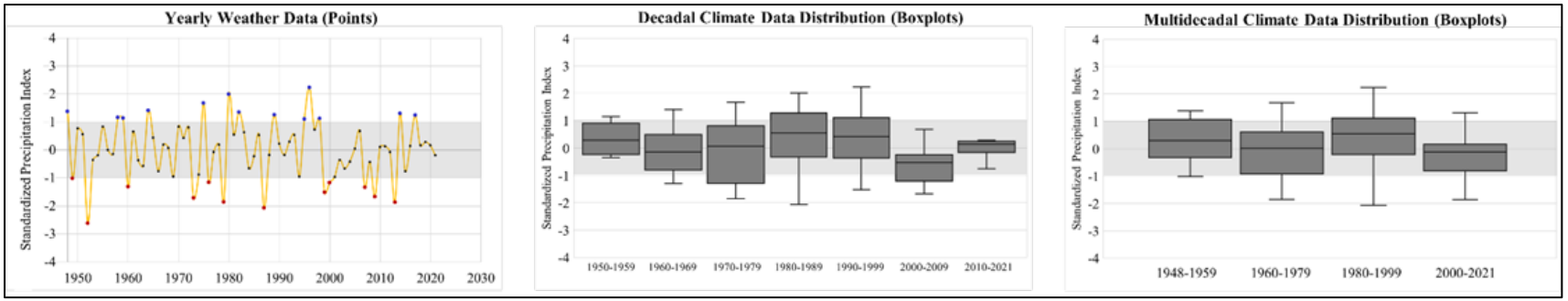

Figure A4.1—Calendar Year (January-December) Standard Precipitation Index for Ninemile/Petty Creek from 1948-2021

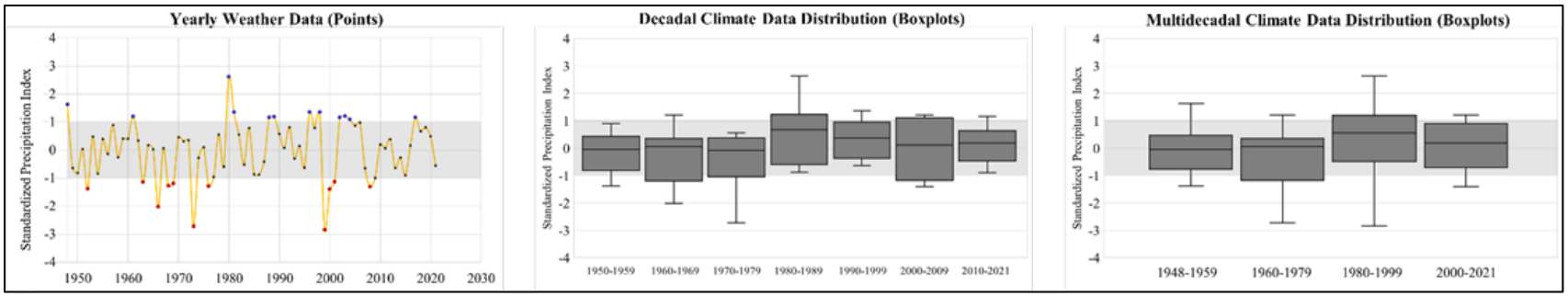

Figure A4.2—Spring (March-May) Standard Precipitation Index data for Ninemile/Petty Creek from 1948-2021

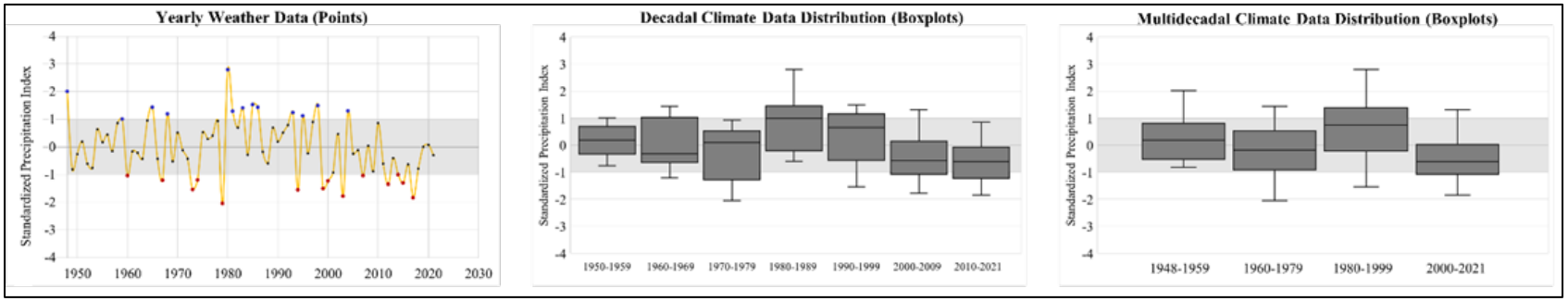

Figure A4.3—Summer (May-September) Standard Precipitation Index data for Ninemile/Petty Creek from 1948-2021

Standard Precipitation Index was used to develop a Multidecadal Repeat-Aridity Exposure Index that identifies locations that have experienced repeat-exposure to reduced atmospheric precipitation. This was created for May-Sept period that has been identified as highly influential for wildfire disturbances and associated with changed conditions in recent 2000-2021 multidecadal period (Holden et al. 2018).

The western geographic areas on the Lolo National Forest experienced the most chronic, reoccurring dry summer conditions that occurred over 80-100% of geographic areas at a severe level (>50% of years from 2000-2021) (Figure A4.4; Figure A4.5). These locations experienced elevated bark beetle-caused tree mortality and wildfire occurrence, as described below.

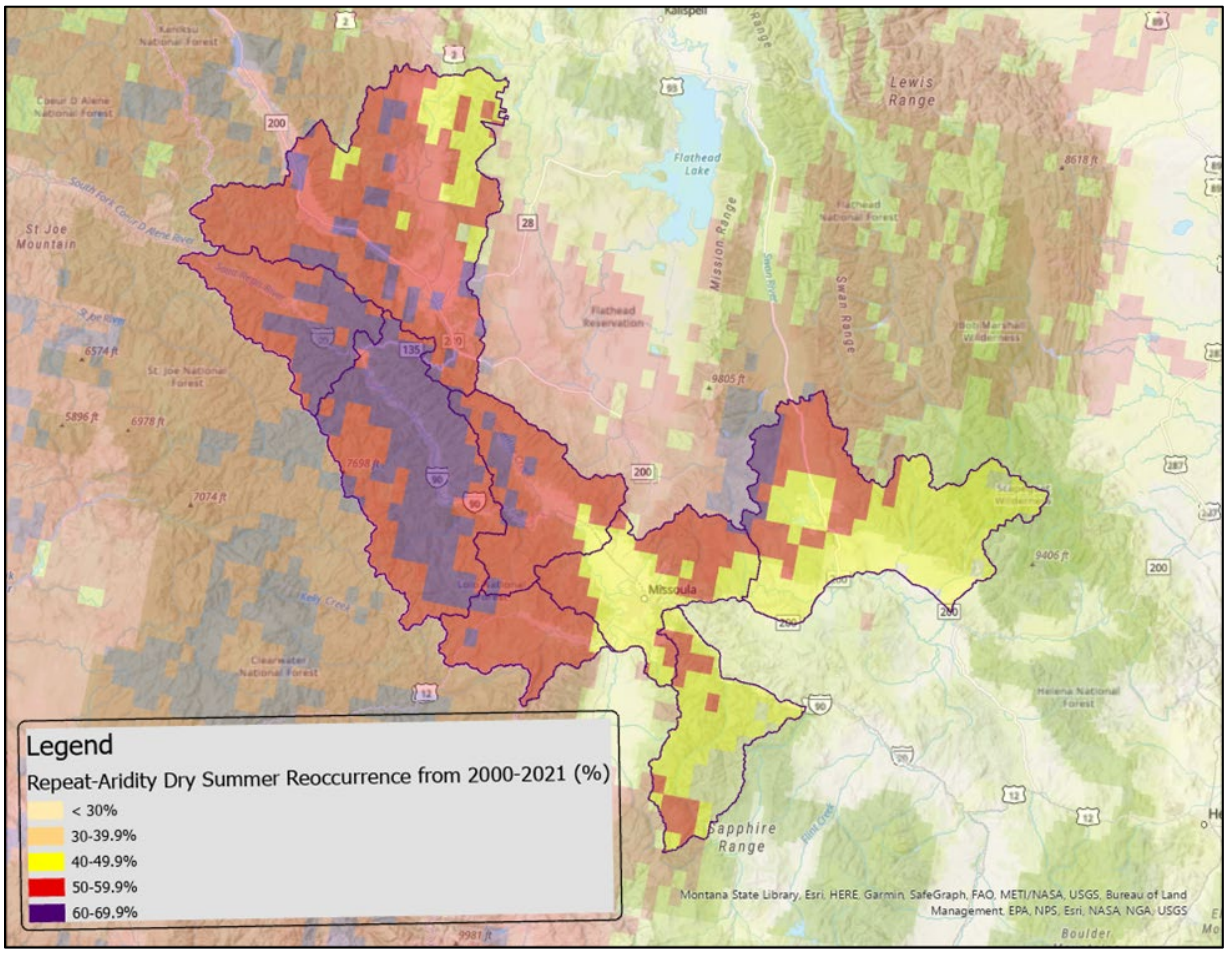

Figure A4.4—Multidecadal Repeat-Aridity Exposure by reoccurrence classes and Geographic Area from 2000-2021, Lolo National Forest

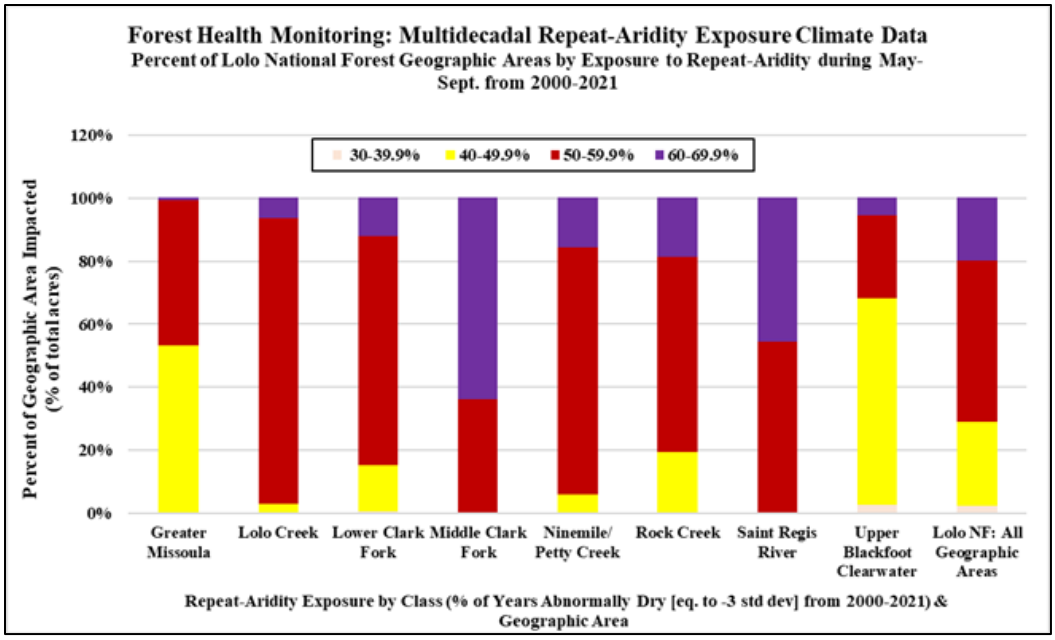

Figure A4.5—Percent of Geographic Areas by Multidecadal Repeat-Exposure Aridity Index Classes, Lolo National Forest

Appendix A of Egan (2023) provides detailed methods and metadata for the Forest Health Protection GIS layers used to build multidecadal repeat-aridity index based on standard precipitation index.

2.2 Bark Beetles

Bark beetle-caused mortality is surveyed annually through Forest Health Protection aerial detection survey missions (USDA Forest Service 2019). Within the Lolo National Forest, bark beetle activity was elevated from 2000-2022 in conjunction with multidecadal dry cycle that occurred from 2000-2022 (Figure A4.5). Most damages were detected in the St Regis River and Lolo Creek geographic areas; however, all areas were impacted.

In total, just over 1 million acres or 32% of all geographic areas were impacted by bark beetles from 2000-2022. The severity estimated within damage polygons was used to scale areas into an aggregate, high-severity mortality (>30%) equivalent based on methods described in Egan et al. (2019) and validated in Hicke et al. (2020), Bright et al. (2020), and Egan et al. (2020). High-severity mortality occurred across an equivalent 8% of all Lolo National Forest geographic areas.

Aerial survey data protocols were standardized in 1999 for consistency and data prior to this date were collected coarsely (USDA Forest Service 2005). Thus, severity of mortality estimates during this time period are not comparable to estimates prior to 1999 standardization. Thus, years of repeat-mortality observed from aerial surveys are depicted (Figure A4.7).

General comparisons of total area mapped with bark beetle-caused mortality are reasonable. In total, aerial survey data from 1980-1999 estimated 5% of the total geographic areas impacted by bark beetles. This represents 6-fold less area impacted during the multidecadal wet cycle relative to the 32% area impacted during current 2000-now dry cycle. From 1980-1999, the Lower Clark Fork geographic area had small amounts of area impacted which was primarily lodgepole pine killed by mountain pine beetles. Outside of that damage, bark beetle impacts across remainder of the Lolo National Forest and surrounding areas during the pluvial wet period was substantially limited as were wildfires (data not shown).

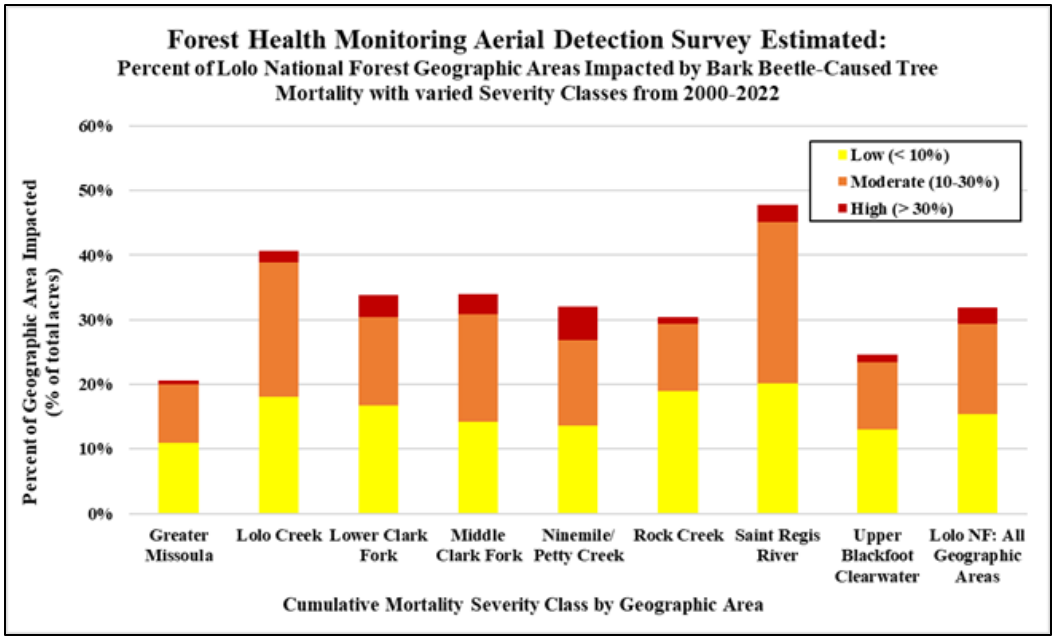

Figure A4.6—Percent of Geographic Areas impacted by bark beetles from 2000-2022, Lolo National Forest

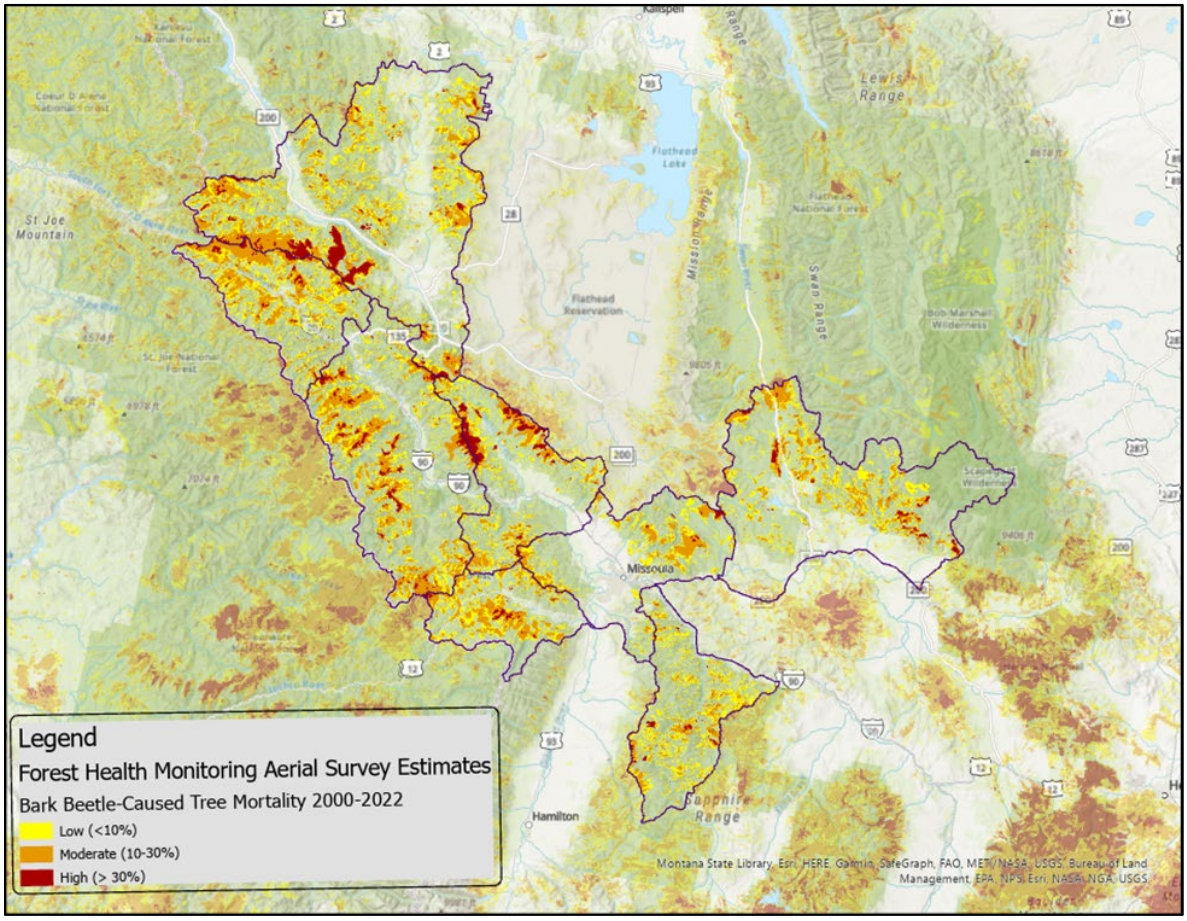

Figure A4.7—Forest Health Monitoring Aerial Survey detected bark beetle-caused mortality cumulative severity classes from 2000-2022, Lolo National Forest

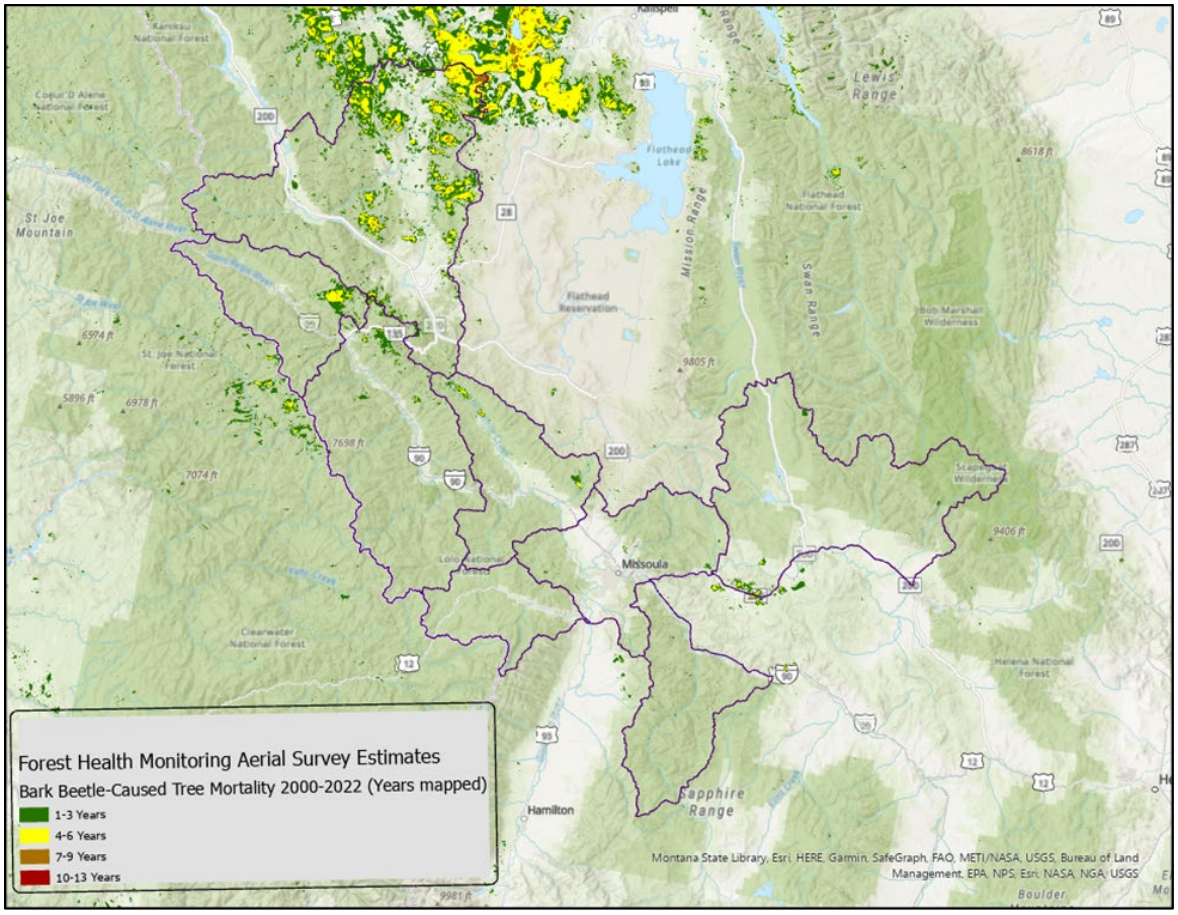

Figure A4.8—Forest Health Monitoring Aerial Survey detected bark beetle-caused mortality cumulative severity classes from 1980-1999, Lolo National Forest

2.3 Defoliators

Defoliation activity from 2000-2022 is denoted by repeat-defoliation years during current multidecadal dry cycle (Figure A4.10). Virtually no geographic areas had repeat-defoliation that exceeded 6 years during this period. Locations which sustain chronic defoliation >6 years can have crown decline/topkill, growth loss, and/or tree mortality resulting from defoliation. The Upper-Blackfoot Clearwater geographic area had the greatest recurrence of defoliators with areas experiencing 4-6 years of damage (Figure A4.9). Overall, defoliators were not a major disturbance agent identified for Lolo National Forest during the current multidecadal dry period. Evaluation of 1980-1999 indicated greater defoliation recurrence during multidecadal pluvial period from 1980-1999 versus the current dry period. Damage was greatest during that period within the Lower Blackfoot and Rock Creek Geographic areas (data not shown).

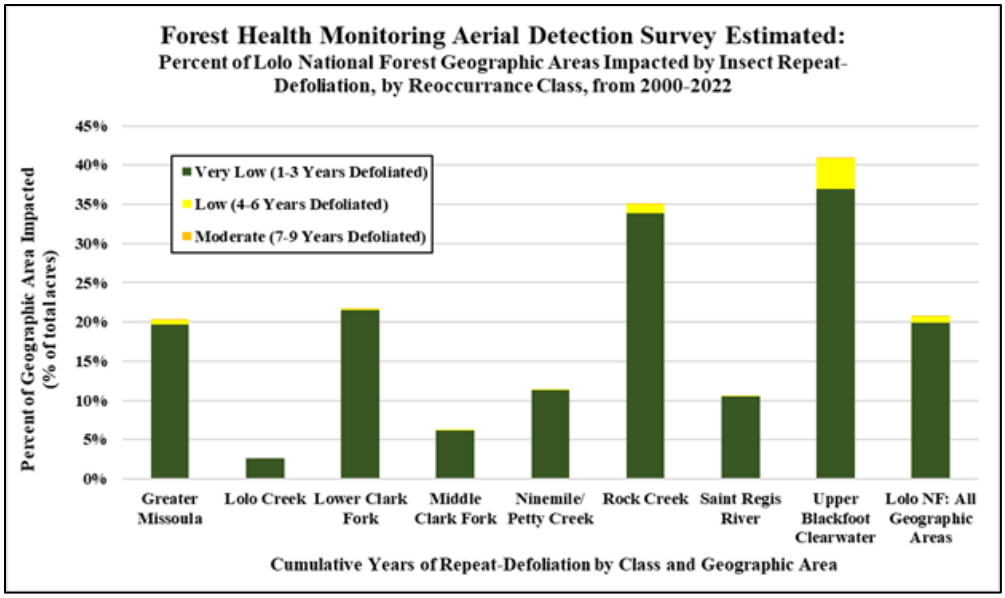

Figure A4.9—Percent of Geographic Areas impacted by insect defoliators, by repeat-defoliation classes, from 2000-2022, Lolo National Forest

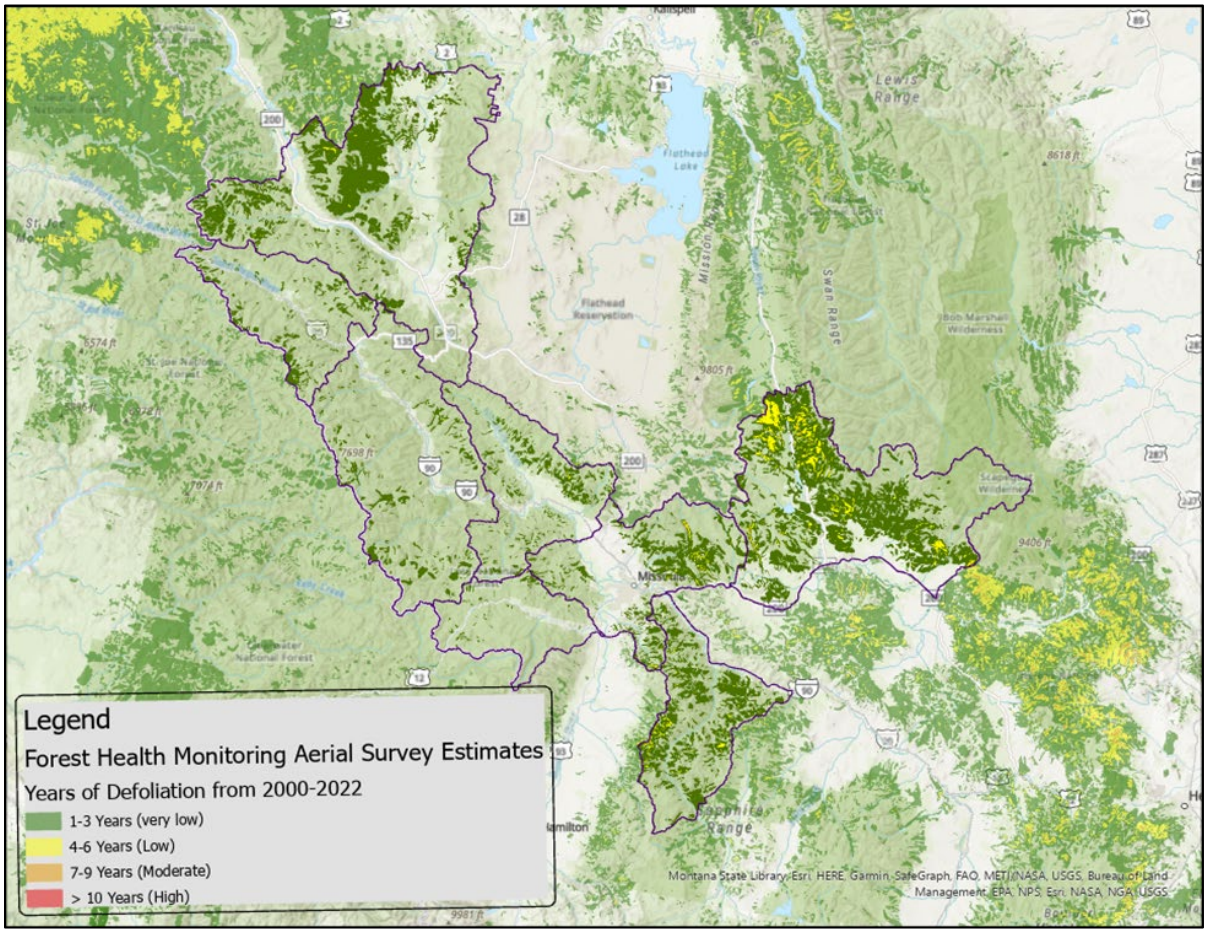

Figure A4.10—Forest Health Monitoring Aerial Survey detected insect defoliation, by repeat-year defoliation classes, from 2000-2022, Lolo National Forest

2.4 Forest susceptibility (hazard) to bark beetles and root disease

Forest Health Protection staff worked with the National Forest System outyear planning team to develop multi-agent aggregate hazards that were scored through 1-mile moving windows analysis to identify where bark beetle and root disease susceptible forested areas were spatially aggregated. All geographic areas showcased clustered aggregate hazard with Lolo Creek, Lower Clark Fork, Middle Clark Fork, Rock Creek, and Saint Regis River having near or >50% of area in moderate to highly susceptible states to disturbance (Figure A4.11; Figure A4. 12). In total, just over 1 million acres or 33% of all Lolo National Forest geographic areas were rated as having aggregated moderate to high hazard (Figure A4. 13). Specific outyear planning analysis methodology for mapping aggregate bark beetle and root disease hazard can be found in Appendix B of Egan (2023).

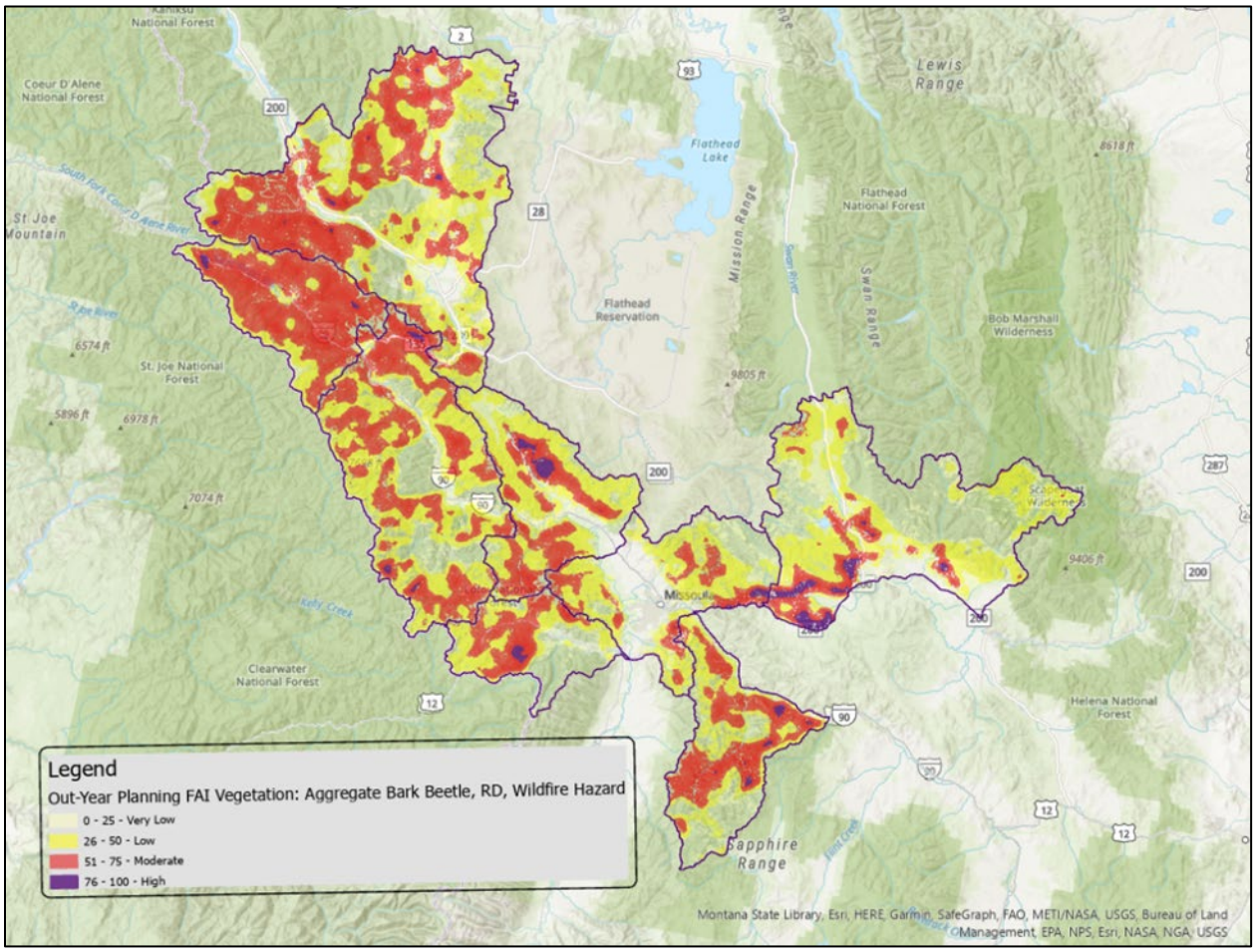

Figure A4.11—Aggregate hazard for bark beetles and root disease assessed through Out-Year Planning Analysis in 2022, Lolo National Forest

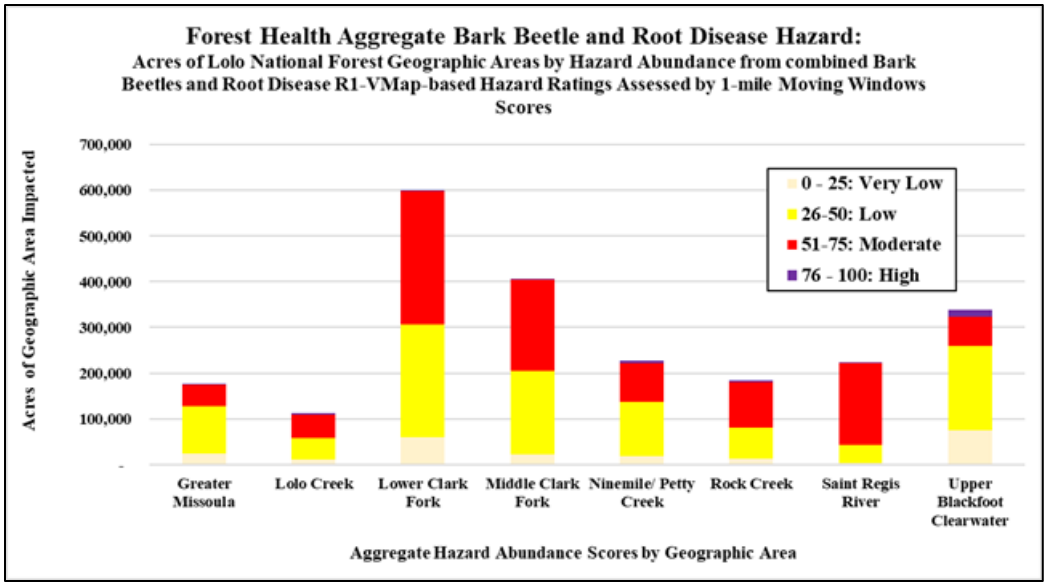

Figure A4. 12—Aggregate bark beetle and root disease hazard within Geographic Areas depicted through 1-mile moving windows scores, Lolo National Forest

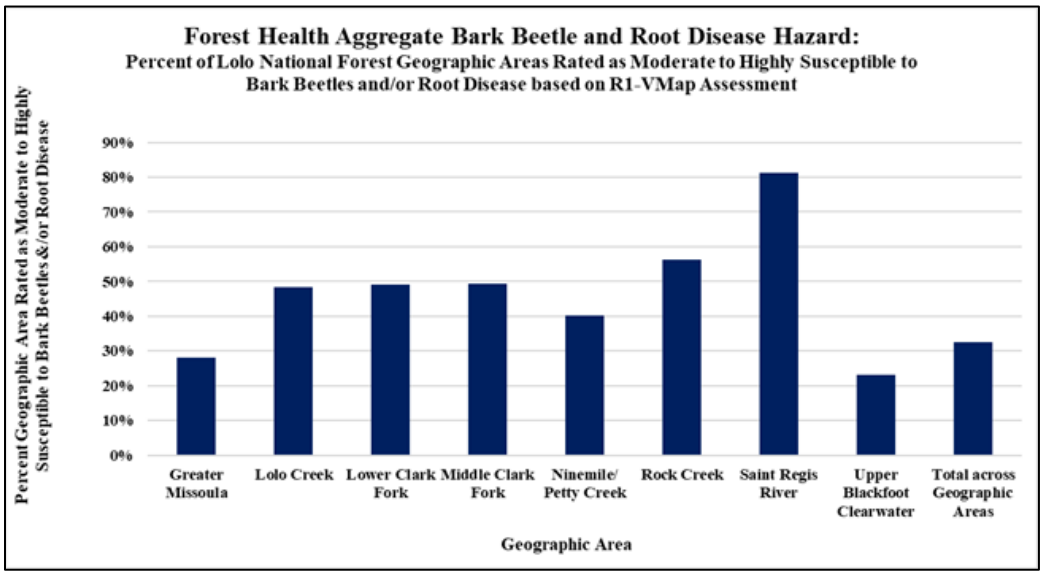

Figure A4. 13—Percent of Geographic Areas rated as moderate to high susceptibility to bark beetle and root disease disturbance agents, Lolo National Forest

2.5 Wildfire and Bark Beetles

Wildfire incident perimeter data was obtained from the National Interagency Fire Center's Wildland Fire Interagency Geospatial Service Group and filtered to include only those wildfire incidents that exceeded 100 acres from 2000-2022 (NIFC, 2022). Across the Lolo National Forest, approximately 800,000 acres or 24% of all geographic areas were impacted by wildfires >100 acres from 2000-2022 (Figure A4.14). The Upper Blackfoot Clearwater and Lower Clark Fork geographic areas had most area impacted by wildfires while the Saint Regis River area did not experience any wildfires from 2000-2022 (Figure 8).

Interactions between bark beetle and wildfire impacted areas on the Lolo National Forest occurred across 206,000 acres that had both disturbance agents identified from 2000-2022 (Figure A4.15). Virtually all

wildfire incidents that occurred on the Lolo National Forest during this period had some level of bark beetle activity either before or following the wildfire incident. Some areas, including the Rice Ridge fire incident in the Upper Blackfoot Clearwater geographic area, had extensive bark beetle activity that was likely promoted by beetles building populations within fire-injured trees following the wildfire incident (Figure A4.16).

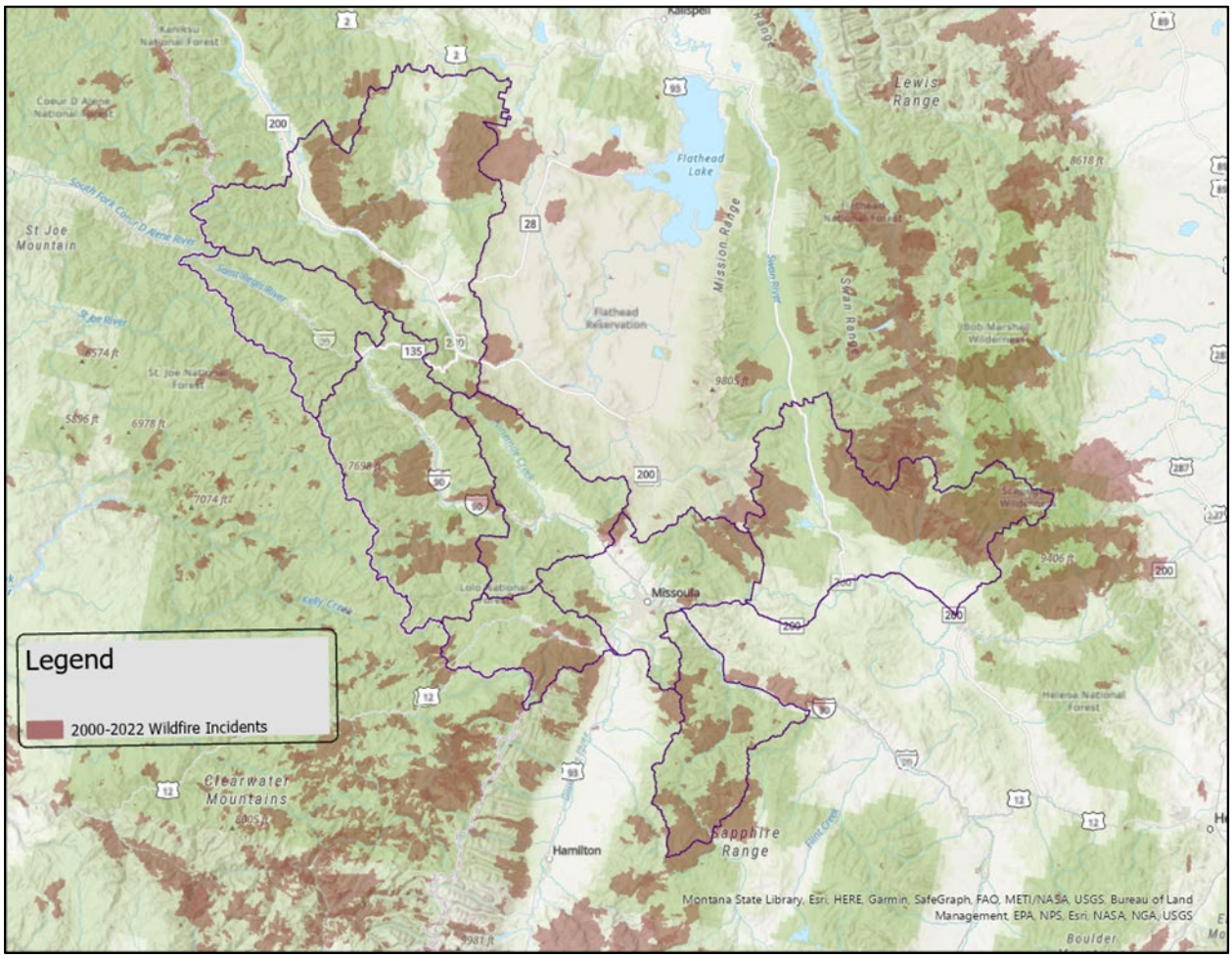

Figure A4.14—National Interagency Fire Center wildfire incidents that exceeded 100 acres from 2000-2022, Lolo National Forest

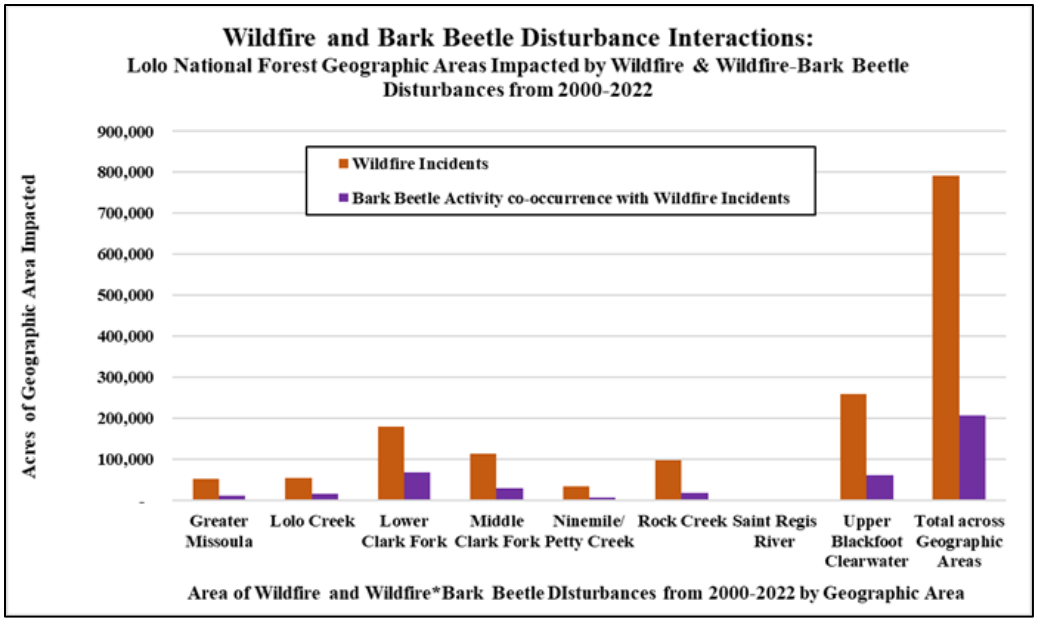

Figure A4.15—Total area of wildfire incidents and interaction with bark beetles by Geographic Area from 2000-2022, Lolo National Forest

Figure A4.16—Aerial Detection Survey mission photo of southeast corner of Rice Ridge 2017 wildfire incident with Douglas-fir beetle outbreak occurring just outside fire perimeter. Photo by Jessica Jenne, FHP Aerial Survey Specialist

3. Literature Cited

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