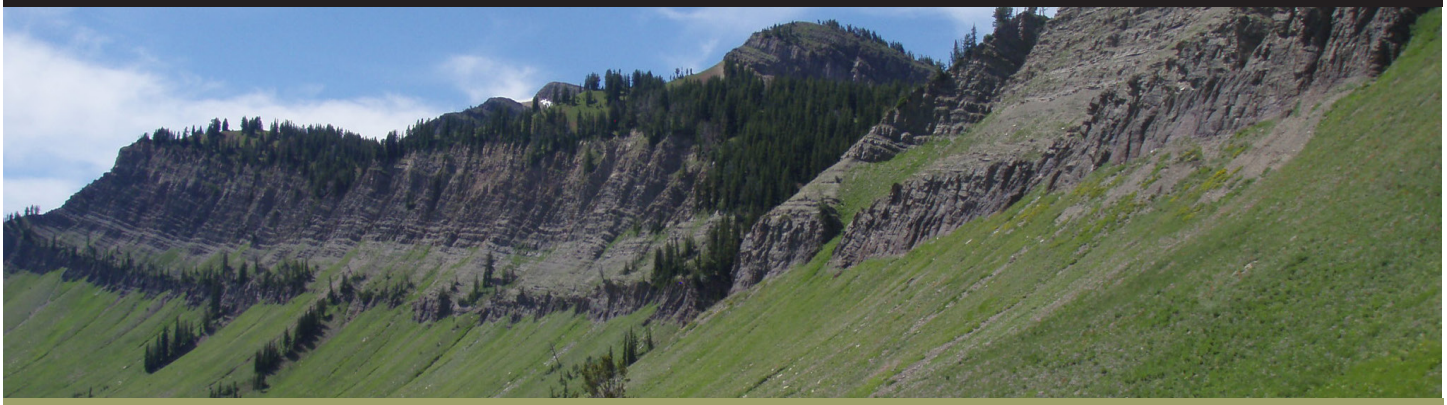
National Park Service
U.S. Department of the Interior

Inventory & Monitoring Division
Natural Resource Stewardship and Science



Five-Needle Pine Monitoring on Wyoming Bureau of Land Management Forests in the Greater Yellowstone Ecosystem: 2022 Data Summary

The Greater Yellowstone Ecosystem (GYE) is home to 2 five-needle pine species, both of which play important ecological roles: whitebark pine (*Pinus albicaulis*) and limber pine (*Pinus flexilis*). Whitebark pine is a keystone subalpine species that provides high-energy food for birds and mammals, a broad canopy that shades and prolongs spring snowmelt, and favorable habitat to support forest succession. Limber pine is an important species in montane and lower woodland ecosystems, where it provides ecosystem functions similar to those of whitebark pine.

Multiple ecological disturbances currently impact whitebark pine and limber pine. White pine blister rust (hereafter, blister rust) caused by the introduced fungus *Cronartium ribicola*, mountain pine beetle (*Dendroctonus ponderosae*), dwarf mistletoe (*Arceuthobium* spp.), wildfires, and drought all pose significant threats to the persistence of healthy five-needle populations. The severe impact of blister rust, especially, led to the listing of whitebark pine as Threatened under the Endangered Species Act by the U.S. Fish and Wildlife Service in January 2023. Limber pine are particularly vulnerable to dwarf mistletoe.

Since 2013, the National Park Service's Greater Yellowstone Network has been monitoring five-needle pine in 2 sample frames (geographic strata) per year on Wyoming Bureau of Land Management (BLM) lands of the Greater Yellowstone Ecosystem. Eight total sample frames are divided into 4 panels of 2 sample frames each. These are visited on a 4-year rotating schedule. The surveys sample permanent transects following an existing whitebark pine monitoring protocol for the region (see Methods), but include additional "rapid" transects. The objectives of this five-needle pine monitoring program are to document the current status and changes in

- Infection of five-needle pines by white pine blister rust
- Severity of white pine blister rust infection on five-needle pines
- Mortality of five-needle pines
- Recruitment into the reproducing population of five-needle pines

This brief summarizes results from sampling 2 permanent and 56 rapid five-needle pine transects in Wyoming BLM lands in the Greater Yellowstone Ecosystem in 2022.

Key Findings—2022—Panel 3 Trees

Rapid and permanent transects combined (58):

- In 2022, 627 of 1231 live trees (51%) showed signs of blister rust infection. Of these 627 infected trees, 326 (52%) had bole (trunk) infections.
- Evidence of cone production was found on 251 trees, ranging across all 4 size classes; 133 (53%) had signs of blister rust infection.
- We detected 1007 understory trees (<1.4 m tall); 52 were infected with blister rust, though blister rust status was indiscernible for an additional 40 small trees.

Permanent transects only (2):

- Between 2018 and 2022, 31 of 79 live, tagged trees (39%) had no evidence of blister rust infection, and 26 (33%) transitioned from uninfected to infected.
- Infection location changed for 4 of the trees infected in both 2018 and 2022, while one tree was no longer noted as infected.
- Three newly dead trees were recorded; none showed obvious signs of a mortality influencing agent.

Detailed Findings for Panel 3 Trees

All Panel 3 transects occur in 2 sample frames: Rattlesnake and Pine Grove/Deadline Ridge, Wyoming (see study area map on back page).

Infection Status and Change Over Time

We examined 1231 live tagged trees in 2 permanent and 56 rapid transects for signs of blister rust infection in 2022. Of the 1231 trees, 627 (51%) showed signs of blister rust infection. Of these 627 infected trees, 326 (52%) had bole infections (Figure 1).

Comparing only trees surveyed in both 2018 and 2022 (79 trees), we found these changes in infection status:

- 31 (39%) remained free of blister rust infection evidence
- 21 (27%) had sign of infection in both years
- 26 (33%) developed evidence of infection over the 4 years
- 1 (1%) no longer showed evidence of infection by 2022 (this can result from observer error, a change in evidence criteria, or infected branches self-pruning)

Infection Severity

We chronicled if and when infection location changed in the canopy (branches) and bole of infected, tagged trees between time-steps. A bole infection is considered more consequential than a canopy canker. A bole infection compromises not only the overall longevity of the tree, but also its functional capacity to reproduce because blister rust can lead to the loss of the cone-bearing branches above the infected site.

Because trees are only tagged on permanent transects, infection transition (change in location) cannot be reported for rapid transects. On the 2 permanent transects, infection location changed for 4 trees infected with blister rust in 2018 and again in 2022 (Figure 2). Three trees transitioned from infected in the canopy only to bole infected, one bole infected tree transitioned to canopy only infection, and one tree that was recorded as infected in 2018 was no longer observed with an infection in 2022.

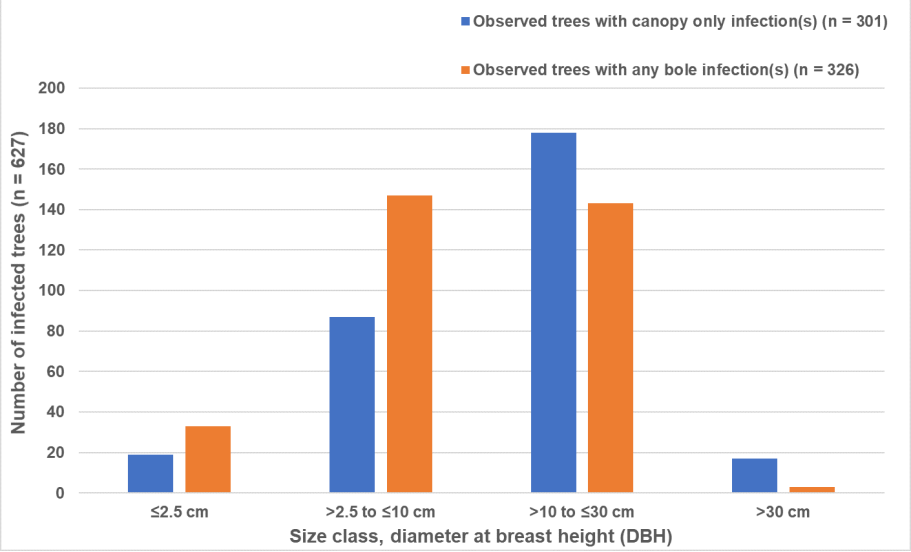


Figure 1. Blister rust infection was detected on 627 live five-needle pine trees during 2022 surveys of permanent and rapid Wyoming Bureau of Land Management Panel 3 transects. Trees are grouped by size class and blister rust location (canopy only or bole infection).

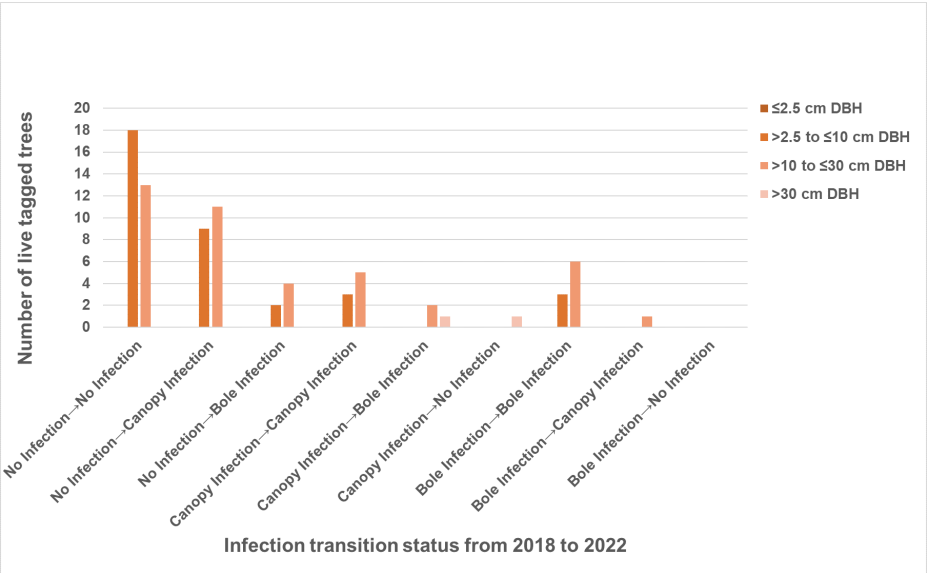


Figure 2. Infection transition status by DBH (diameter at breast height) category for live, tagged five-needle pine trees on Panel 3 transects surveyed in 2018 and again in 2022. The total count of live, tagged trees surveyed in both years was 79.

Mortality

In 2022, we observed 3 newly dead tagged trees on Panel 3 permanent transects. Dead trees are no longer recorded on rapid assessment survey transects.

Recruitment and Understory Individuals

We assessed recruitment for five-needle pines by the presence of cone-bearing trees (reproduction), seedlings and saplings in the understory (regeneration), and, for permanent transects only, newly tagged trees surpassing 1.4 m in height.

Recruitment data are also collected inside 1/300 acre recruitment subplots but are currently under review. Summary information will be part of future updates.

Cone Production

On permanent and rapid transects in 2022, we recorded evidence of cone production for 251 live trees, ranging across the 4 size classes (Figure 3). Of the trees with cone evidence, 133 (53%) had signs of blister rust infection.

Understory Trees

In 2022, we counted 1007 understory five-needle pines (≤1.4 m tall) on 58 transects. This equates to an average density of approximately 17 small trees per transect. Fifty-two of these small trees were infected with blister rust, but blister rust status was indiscernible for an additional 40.

No new trees had surpassed 1.4 m tall since the last survey.

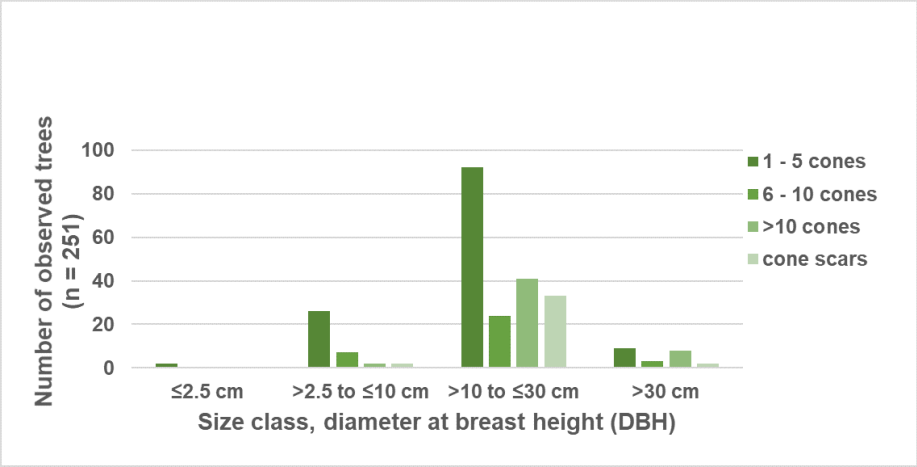


Figure 3. Number of cone-producing five-needle pine trees (251 total) grouped by number of cones visible (cone bin) and DBH category on Wyoming Bureau of Land Management Panel 3 transects in 2022. The majority of trees, 212 (84%), were >10 cm DBH.

Study Area and Methods

The study area encompasses portions of BLM lands in Wyoming within the GYE that were initially identified by ground surveys as suitable habitat. (Figure 4).

Each year we sample 1 permanent transect and 5–10 rapid transects distributed across map units in each of 2 sample frames (geographic strata). Two sample frames compose a panel (Table 1). The Panel 3 transects surveyed in 2022 were last surveyed in 2018.

Methods for monitoring five-needle pines on Wyoming BLM forests follow the *Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem* (https://irma.nps.gov/DataStore/Reference/Profile/660369), with the exception that rapid transects are added. These "rapid" transects differ slightly in methodology from permanent transects because trees and transect boundaries are not permanently marked, and fewer data are collected at each tree to expedite the survey. Otherwise, the same detailed methods apply as described in the NPS.gov article, "Methods for the Interagency Whitebark Pine Monitoring Program in the Greater Yellowstone Ecosystem" (https://www.nps.gov/articles/000/methods-for-the-interagency-whitebark-pine-monitoring-program-in-the-greater-yellowstone-ecosystem.htm).

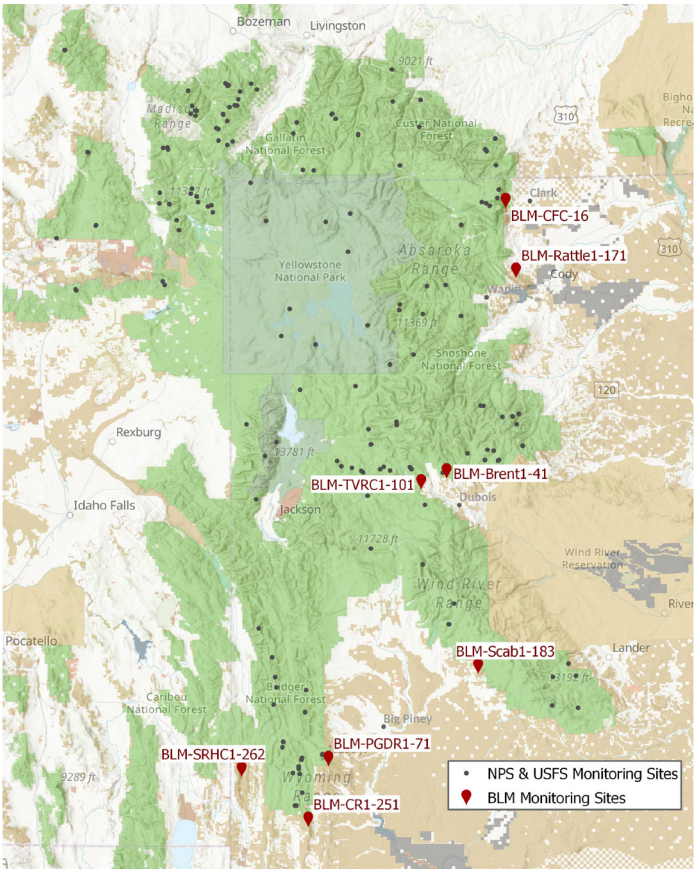


Figure 4. Wyoming Bureau of Land Management (BLM) five-needle pine study sites, also showing National Park Service (NPS) and US Forest Service (USFS) whitebark pine monitoring sites in the region. Site abbreviations for each sample frame/geographic stratum are Brent Creek (Brent), Teton Valley Ranch Camp (TVRC), Rattlesnake (Rattle), Clark's Fork Canyon (CFC), Pine Grove/Deadline Ridge (PGDR), Commissary Ridge (CR), Scab Creek (Scab), and Sublette Range/Hull Creek (SRHC).

Past monitoring reports are available on the Greater Yellowstone Network website: https://www.nps.gov/im/gryn/whitebark-pine.htm.

Monitoring data are available from the NPS Integrated Resource Management Applications portal at https://irma.nps.gov/DataStore/Reference/Profile/2209186.

Table 1. Panel 3 sample frames surveyed for five-needle pines in Wyoming Bureau of Land Management forests in 2022.

Geographic Stratum/ Sample Frame	Map Unit and Number of Transects Sampled within It	Number of Transects Visited but Not Sampled	Number of Transects Not Visited
Pine Grove Deadline Ridge	PGDR1 = 4*	0	6
Pine Grove Deadline Ridge	PGDR2 = 3	0	7
Pine Grove Deadline Ridge	PGDR3 = 3	0	7
Pine Grove Deadline Ridge	PGDR4 = 3	0	7
Pine Grove Deadline Ridge	PGDR5 = 3	0	7
Pine Grove Deadline Ridge	PGDR6 = 3	0	7
Rattlesnake	Rattle1 = 5*	0	6
Rattlesnake	Rattle2 = 4	2	4
Rattlesnake	Rattle3 = 4	0	6
Rattlesnake	Rattle4 = 4	1	5
Rattlesnake	Rattle5 = 4	1	5
Rattlesnake	Rattle6 = 4	0	6
Rattlesnake	Rattle7 = 4	0	6
Rattlesnake	Rattle8 = 3	1	6
Rattlesnake	Rattle9 = 4	0	6
Rattlesnake	Rattle10 = 3	0	7

* Includes one permanent transect.

More Information

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