Greater Yellowstone Network
RESOURCE BRIEF

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: 2021 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 17 rapid five-needle pine transects in Wyoming BLM lands in the Greater Yellowstone Ecosystem in 2021.

Key Findings—2021—Panel 2 Trees

Two permanent transects:

- In 2021, 9 of 16 live, tagged trees (57%) showed signs of blister rust infection. Of these 9 infected trees, 3 (33%) had bole (trunk) infections.
- Between 2017 and 2021, 6 of 16 live trees (38%) had no evidence of blister rust infection, although 6 (38%) transitioned from uninfected to infected. Infection location did not change for any of the 3 trees infected in both 2017 and 2021.
- No newly dead trees were detected since 2017.
- No new trees were added to the tagged, >1.4 m tall population.
- Six understory trees (≤1.4 m tall) were detected; none were infected with blister rust.
- Evidence of cone production was found on 5 trees, all with a diameter at breast height (DBH) >10 cm; 4 of the 5 had signs of blister rust infection.

Seventeen rapid transects:

- In 2021, 148 of 242 live trees (61%) showed signs of blister rust infection. Of the infected trees, 37 (25%) had bole infections.
- Twenty-one dead trees were recorded, with the majority (76%) showing old sign of mountain pine beetle infestation.
- We counted 226 understory trees (≤1.4 m tall); most were not infected with blister rust.
- Evidence of cone production was found on 61 live trees; all but one had DBH >10 cm; 43 of the 61 reproducing trees (70%) had signs of blister rust infection.

Detailed Findings for Panel 2 Trees

All Panel 2 transects occur in 2 sample frames: Commissary Ridge and Clark's Fork Canyon, Wyoming (see study area map on back page).

Infection Status and Change Over Time

Permanent Transects

We examined 16 live tagged trees in 2 permanent transects for signs of blister rust infection in 2021. Of the 16 trees, 9 (57%) showed signs of blister rust infection. Of these 9 infected trees, 3 (33%) had bole infections (Figure 1). No new live trees reaching >1.4 m tall were added in 2021.

Comparing only trees surveyed in both 2017 and 2021 (16 trees), we found these changes in infection status:

- 6 (38%) remained free of blister rust infection evidence
- 3 (18%) had sign of infection in both years
- 6 (38%) developed evidence of infection over the 4 years
- 1 (6%) no longer showed evidence of infection by 2021 (this can result from observer error, a change in evidence criteria, or infected branches self-pruning)

Rapid Transects

We examined 242 live trees in 17 Panel 2 rapid transects for signs of blister rust infection in 2021. Species were positively identified when cones were present; 76 were whitebark pine and 2 were limber pine. The remaining 164 did not have cones and were recorded as "unknown." Of the live trees, 148 (61%), were documented with blister rust infection and 94 (39%) had no infection present. Bole infections were documented on 37 (25%) of the 148 infected trees (Figure 2).

Change in infection status over time is not reported for rapid transect data.

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.

Figure 1. Blister rust infection was detected on 9 live five-needle pine trees during 2021 surveys of permanent Wyoming BLM Panel 2 transects. Trees are grouped by size class and blister rust location (canopy only or bole infection).

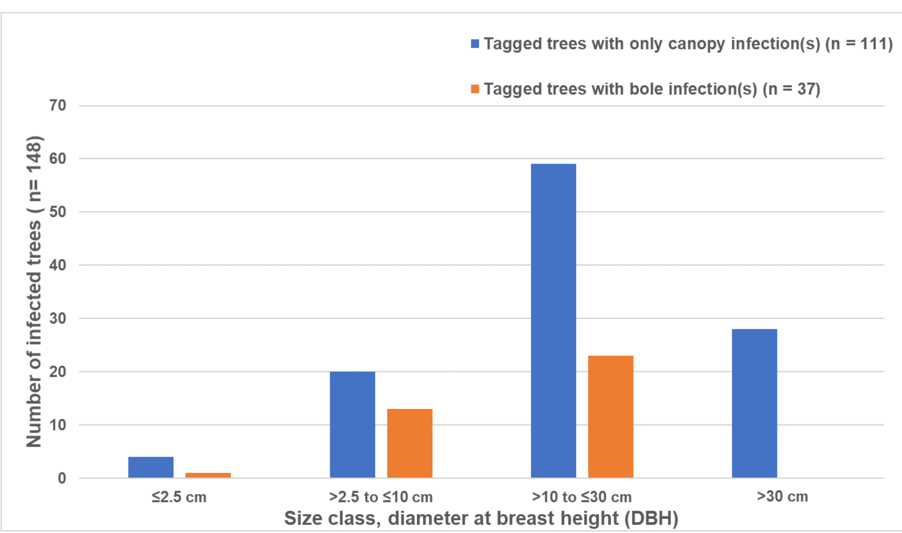

Figure 2. On the rapid assessment transects, blister rust infection was detected on 148 live five-needle pine trees during 2021 surveys of Wyoming BLM Panel 2 sampling frames. Trees are grouped by size class and blister rust location (canopy only or bole infection).

On the 2 permanent transects, infection location did not change for any of the 3 trees infected with blister rust in 2017 and again in 2021 (Figure 1 above shows infection locations).

Infection transition is not reported for rapid transect data.

Mortality

Permanent Transects

In 2021, we observed no newly dead tagged trees on Panel 2 permanent transects.

Rapid Transects

Twenty-one dead trees were recorded on rapid transects in the 2 sample frames. Of these, 16 (76%) had old sign of mountain pine beetle infestation and all were trees >20 cm DBH. This mortality is consistent with mountain pine beetles' preference for attacking larger trees and were from the past outbreak spanning much of the 2000s.

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.

Permanent Transects

In 2021, we recorded evidence of cone production for 5 live, tagged trees, all with a DBH >10 cm (Figure 3). Of the trees with cone evidence, 4 (80%) had signs of blister rust infection, with 1 of those 4 (25%) infected on the bole.

In 2021, we counted 6 understory five-needle pines (≤1.4 m tall) on the 2 transects. This equates to an average density of approximately 3 small trees per transect. None of the small trees observed were infected with blister rust.

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

Rapid Transects

In 2021, we recorded evidence of cone production for 61 live trees (Figure 4). All but one of these cone-bearing trees had a DBH >10 cm. Of the reproducing trees, 43 (70%) had signs of blister rust infection.

In 2021, we counted 18 understory five-needle pines (≤1.4 m tall) on the Clark's Fork Canyon (CFC) rapid transect and 208 in the 3 Commissary Ridge (CR) rapid transects. For CFC, this equates to an average density of about 3 small trees per transect. For CR this equates to an average density of approximately 17 trees per transect. Most trees observed were uninfected.

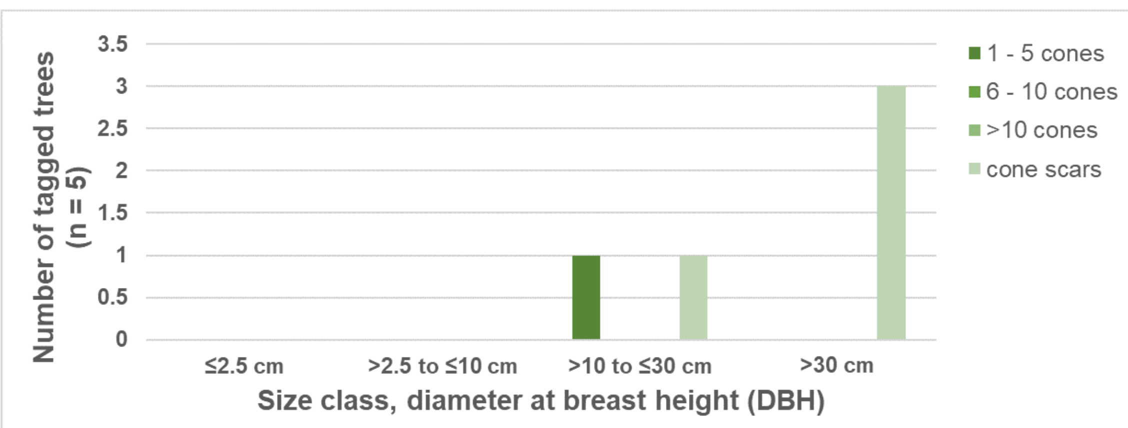

Figure 3. Number of cone-producing five-needle pine trees (5 total) grouped by number of cones visible (cone bin) and DBH category on Wyoming BLM Panel 2 permanent transects in 2021. We observed no trees ≤2.5 cm DBH with evidence of cone production.

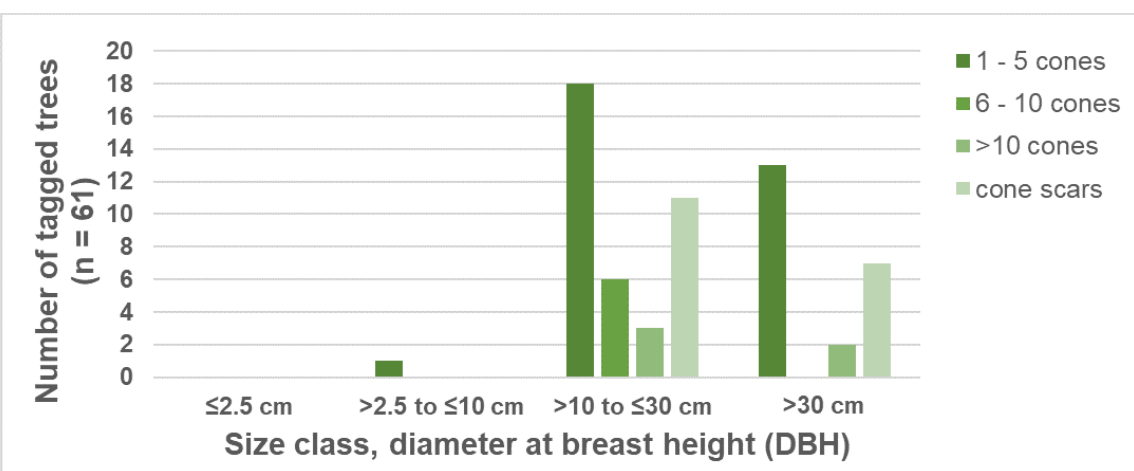

Figure 4. Number of cone-producing five-needle pine trees (61 total) grouped by number of cones visible (cone bin) and DBH category on Wyoming BLM Panel 2 rapid assessment transects in 2021.

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 5).

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 2 transects surveyed in 2021 were last surveyed in 2017.

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).

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.

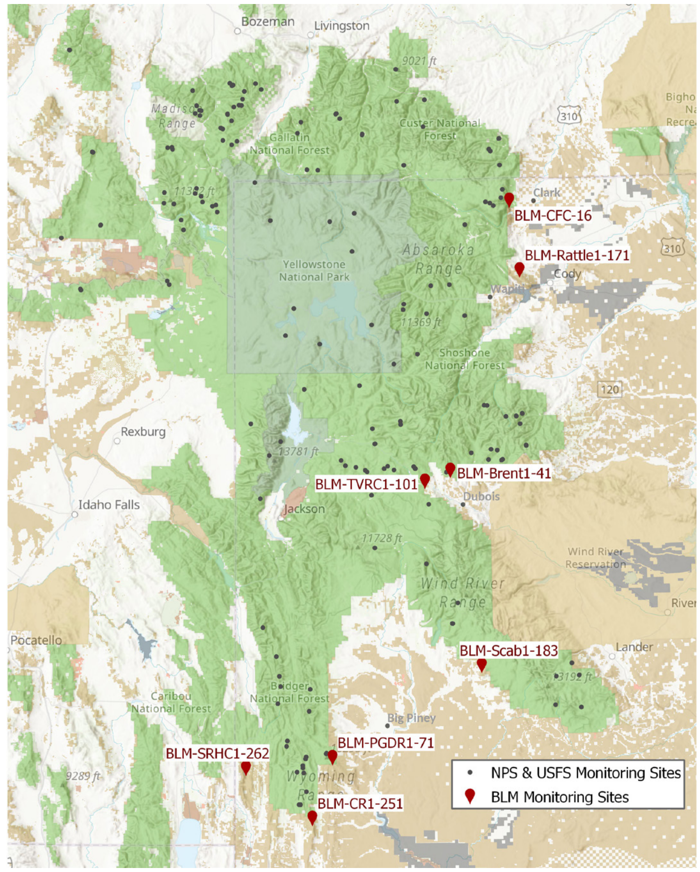

Figure 5. Wyoming Bureau of Land Management (BLM) five-needle pine study sites, also showing National Park Service (NPS) and US Forest Service (USFS) whitebark pine monitoring sites in the region. Site abbreviations for each sample frame/geographic stratum are Brent Creek (Brent), Teton Valley Ranch 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).

Table 1. Panel 2 sample frames surveyed for five-needle pines in Wyoming Bureau of Land Management forests in 2021.

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
Commissary Ridge	CR1 = 4	0	6
	CR2 = 5	1	4
	CR3 = 3	0	7
Clark's Fork Canyon	CFC1 = 5	1	4

More Information

Erin Shanahan, National Park Service
Greater Yellowstone Network I&M Program
erin_shanahan@nps.gov, 406-581-0398