CHAPTER 13.

Implement Interagency Whitebark Pine Monitoring for the Greater Yellowstone Ecosystem

(Project INT-EM-F-12-01)

Kristen L. Legg
Erin Shanahan
Nancy Bockino
Kelly McCloskey
Steve Munson
Darren Blackford

INTRODUCTION

Whitebark pine (*Pinus albicaulis*) occurs on over 2 million acres in the Greater Yellowstone Ecosystem (GYE). As a keystone and foundation species, whitebark pine influences ecosystem functions such as biodiversity, vegetation structure, and hydrology. It has declined throughout its range in the Northern Rockies due to the combined effects of mountain pine beetle (*Dendroctonus ponderosae*), white pine blister rust (*Cronartium ribicola*), altered fire regimes, and climate change.

Recognizing the need to cohesively manage whitebark pine across the GYE, the Greater Yellowstone Coordinating Committee's Whitebark Pine Subcommittee (GYCC WBPSC) developed the Greater Yellowstone Whitebark Pine Strategy (GYCC WBPSC 2011), which identified monitoring, research, protection, and restoration as management objectives to conserve whitebark pine. Since 2004, the National Park Service Greater Yellowstone Network (GRYN) has implemented an interagency whitebark pine long-term monitoring program across the GYE. Since changes in fire regimes may detrimentally impact the whitebark pine resource, the GYCC WBPSC initiated a research project in 2009 to study whitebark pine regeneration in paired burned versus unburned sites where historic wildfires occurred (pre-1994).

The primary project objective was to evaluate how whitebark pine responds to wildland fire in the GYE in order to develop short- and long-term whitebark pine management strategies. This 3-year Evaluation Monitoring project resulted in the completion of the following two activities:

(1) Conducted a third visit to 176 long-term monitoring plots established in 2004–2007 to:
- Estimate the proportion of whitebark pine (> 1.4 m high) infected with white pine blister rust;
- Estimate survival of individual whitebark pine (> 1.4 m high) associated with several disturbance agents (i.e., fire, mountain pine beetle, and white pine blister rust);
- Assess whitebark pine regeneration within established plots.

(2) Revisited 6 of 10 wildland fire areas, each with 8 burned/unburned paired plots established in 2009 to:
- Determine the abundance and distribution of whitebark pine regeneration;
- Document site and stand characteristics;
- Document presence and severity of disturbance agents, including white pine blister rust and mountain pine beetle.

METHODS

Both activities described above resulted in the collection of site characteristics associated with each plot such as slope, elevation, and aspect; tree characteristics such as diameter at breast height (d.b.h.), tree status (live or dead), and presence of disturbance agents (such as

white pine blister rust, mountain pine beetle, and fire); seed reproduction (presence of cones, conelets, or cone scars); and existing whitebark pine regeneration (trees ≤ 1.4 m tall). Whenever possible, spatial burn severity data were used, although this was more difficult to do for fires that occurred before 1985.

Long-Term Monitoring Program

Details of the sampling design and field methodology are described in the Greater Yellowstone Whitebark Pine Long-term Monitoring Protocol (GYWBPMWG 2011). The basic approach is a two-stage cluster design. Stands of whitebark pine are the primary units and 10-m by 50-m monitoring plots are the secondary units. From 2004 to 2007, 176 permanent plots were established in 150 whitebark pine stands across the GYE (fig. 13.1). Within each transect, all whitebark pine trees >1.4 m tall were tagged in order to evaluate changes in blister rust infection and monitor survival rates over time. Each monitoring plot was visited once every four years and all 176 were revisited at least twice by the end of 2014.

Burned/Unburned Plot Surveys

Detailed descriptions of the methods used to establish paired plots for this survey can be found in the Whitebark Pine Monitoring for the Greater Yellowstone Ecosystem: Regeneration Study 2009–2014 summary (Bockino 2015). In 2009, baseline data were collected on 8 paired burned/unburned plots in each of 10 wildfire areas (fig. 13.2). The burned/unburned plots from six of the wildfire areas were revisited

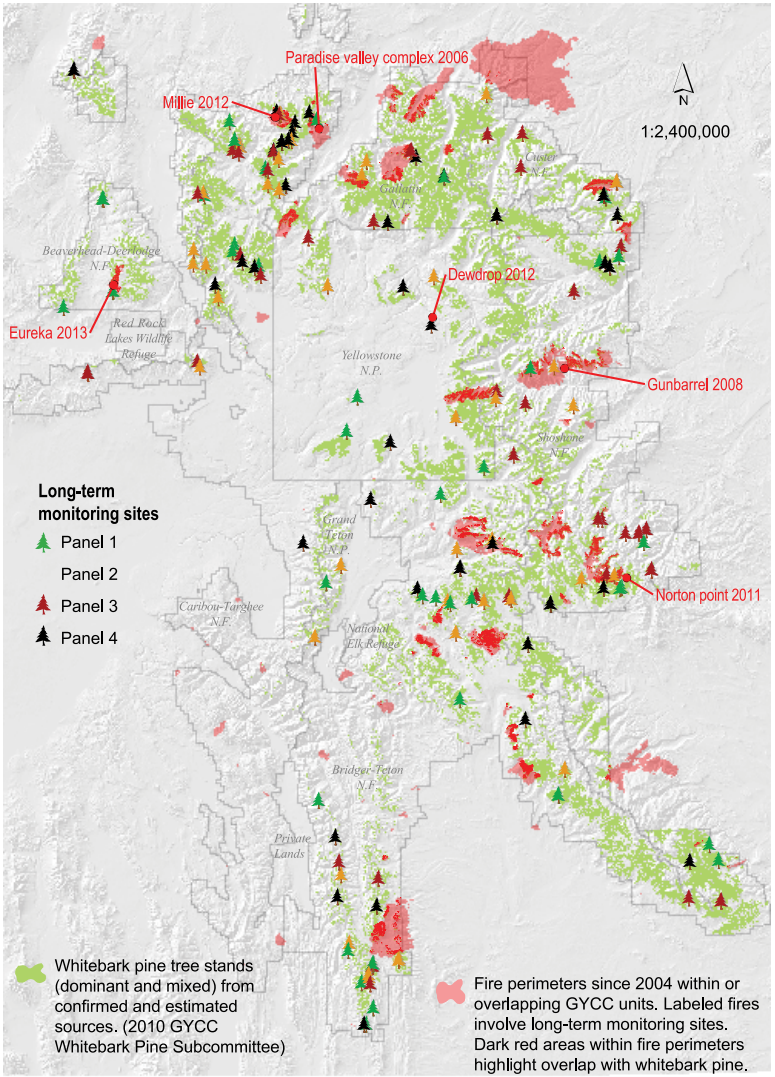

Figure 13.1—Map of the distribution of long-term monitoring plots across the Greater Yellowstone Ecosystem with current whitebark pine distribution and wildland fire perimeters that have occurred since 2004. Note: GYCC = Greater Yellowstone Coordinating Committee.

once from 2012 to 2014 (Ann's, Hidden Lake, Mountain Ash Creek, Coyote, Corral Creek, and Hellroaring wildfires); all burned before 1994. Two subplots were sampled at all sampling points:

(1) A variable-radius plot was installed to sample overstory (variable-radius "overstory" plots were sampled using a slope-corrected Speigel relaskop to estimate overstory tree composition and basal area. Depending on stand density and in order to achieve a sample of 10–15 trees per plot, the basal area factor used was 10, 20, or 40. All conifers and aspen > 1.37 m tall were included in this sample.); and

(2) A fixed-radius plot was installed to sample regeneration of whitebark pine ≤10 cm d.b.h.

Within each wildfire area the burn severity for each plot was classified as: complete burn (all overstory tree mortality), partial burn (evidence of fire, some overstory tree survival), and unburned (no evidence of wildfire).

RESULTS AND DISCUSSION

Long-Term Monitoring Program

From 2012 to 2014, all 176 monitoring plots were visited. We estimate that between 20 to 30 percent of the whitebark pine trees > 1.4 m tall are infected with white pine blister rust in the GYE, and since 2004 approximately 27 percent have died. Within the monitoring program's tagged tree population, most of the mortality was observed in trees > 10 cm d.b.h. These findings were associated with the recent mountain pine

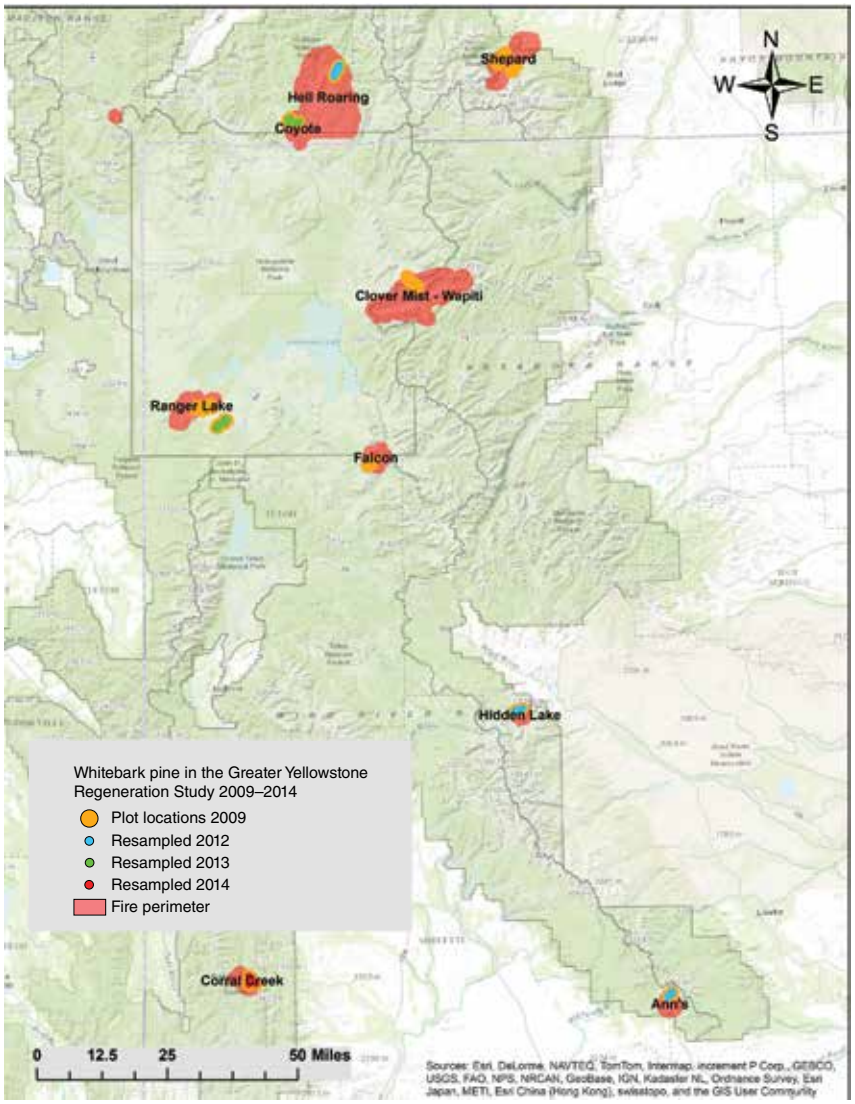

Figure 13.2—Paired burned/unburned study site locations. In 2009, baseline data were collected from 16 plots at each of 10 study sites. From 2012 to 2014, six study sites were revisited (Ann's, Hidden Lake, Mountain Ash Creek, Coyote, Corral Creek, and Hellroaring) (Source: Bockino 2015). Note: GYCC = Greater Yellowstone Coordinating Committee.

beetle outbreak and are similar to results produced from other studies (MacFarlane and others 2013). An average density of 53 understory whitebark pine trees (≤ 1.4 m tall) per plot or 500 m^2 were documented on the long-term monitoring plots (GYWBPMWG 2014, Shanahan and others 2014). Since transect establishment in 2004, wildland fire has affected 16 of the 176 transects (fig. 13.1). Of the 14 burned monitoring plots surveyed (2 of the 16 burned after our most recent site visits in 2013 and 2014), we recorded 50 percent to 90 percent of exposed ground or thick herbaceous cover depending on the time interval since the wildfire occurred. A summary of the results of these surveys for each monitoring plot is available upon request. Whitebark pine has regenerated on four plots that experienced various burn intensities (low: some trees left live to high: complete burn). One severely burned plot (214-1) in the 2007 Wicked Creek Fire Complex, Gallatin National Forest, had whitebark pine regeneration within and adjacent to the plot during the 2014 survey.

By 2014, approximately 1,440 tagged trees had died since initiation of the monitoring program (2004–2007). Figure 13.3 shows the

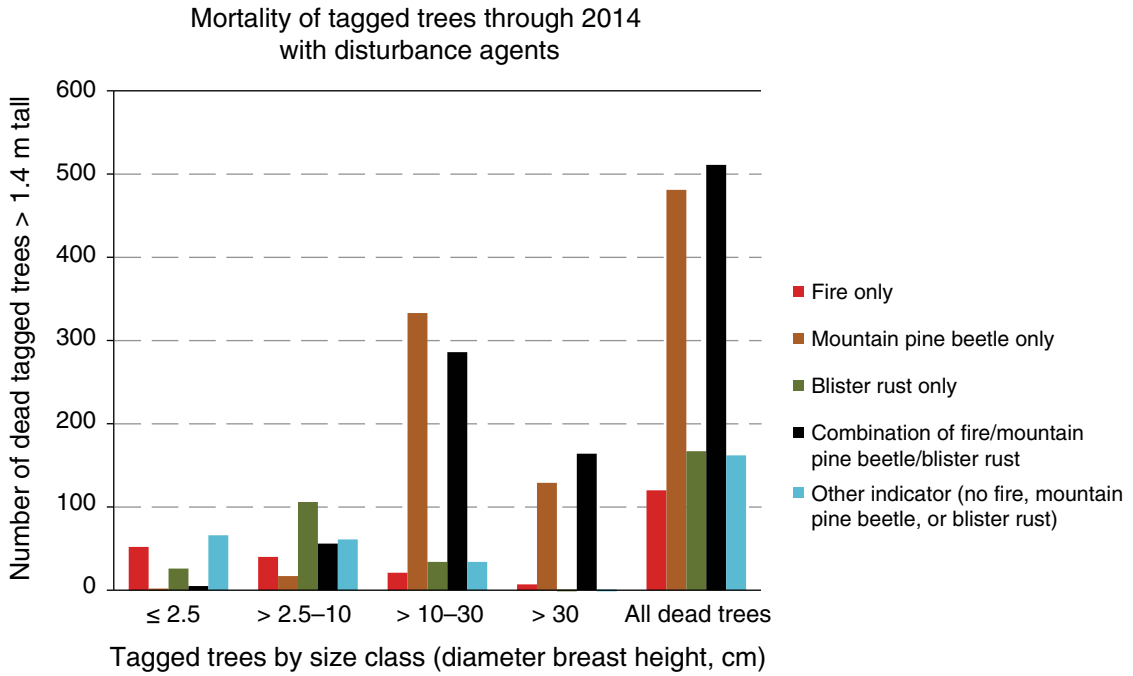

Figure 13.3—Tagged tree mortality since transect establishment through 2014 and disturbance agent. Evidence associated with fire, mountain pine beetle, white pine blister rust, a combination of the three, or other were recorded for each dead tagged tree by diameter breast height size class (≤ 2.5 cm, > 2.5–10 cm, > 10–30 cm, and > 30 cm). Two hundred and forty-eight dead tagged trees had evidence of fire damage.

distribution of whitebark pine mortality by disturbance agent (fire, mountain pine beetle, white pine blister rust, a combination of the three, or other) in four d.b.h. size classes. We recorded a total of 248 dead, tagged trees with evidence (scorched to completely burned) of recent wildfire damage and of those 170 were burned in the 2012 Millie Fire on the Gallatin National Forest. All reports related to this effort may be found at http://science.nature.nps.gov/im/units/gryn/monitor/whitebark_pine.cfm (accessed April 14, 2015).

Burned/Unburned Plot Surveys

Preliminary results for the eight paired burned/unburned plots from each of the six wildland fire areas are described in detail in a summary report (Bockino 2015). A preliminary evaluation of these data indicates that there are several long-term successional trajectories for whitebark pine post-fire disturbances. Figure 13.4 depicts this trajectory for the wildfire sites measured in 2009 and again in 2012. The abundance of whitebark pine regeneration by size class, burned or unburned, and length of time since burn varied among the study sites. These data on regeneration dynamics—establishment, survivorship, growth, and disturbance interactions—will be analyzed in the near future.

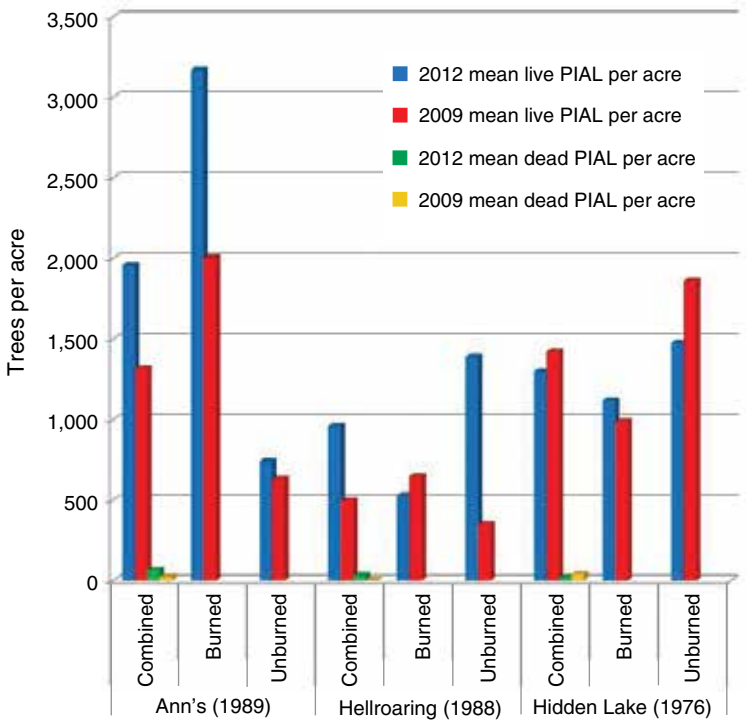

Figure 13.4—An example of comparing data from three wildfire study areas read in 2009 and again in 2012 with summary of live and dead whitebark pine (Pinus albicaulis—*PIAL) per acre. Combined are the mean of the burned and unburned data. This is for trees of all sizes. (Source: Bockino 2015)*

CONCLUSIONS

Evaluation Monitoring program funds provided the necessary resources to enable data collection for short (< 10 years) and long-term (decades) evaluation of the status of whitebark pine after wildfire events in the GYE. Ongoing surveys of these sites will determine whitebark pine response in burned areas and provide an evaluation of the effects of previous, current, and future disturbance agents (i.e., disease, insects, and climate change). Further analysis will include the addition of other parameters such as water balance (the integration of temperature, precipitation, and a site's physical characteristic), competition from other species, and distance to mature whitebark pine (potential seed source) that may affect successful whitebark pine regeneration and survival within post-fire event sites. This information will be useful to resource managers responsible for whitebark pine conservation and to the Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee as they adapt the whitebark pine strategy.

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CONTACT INFORMATION

Kristin Legg: kristin_legg@nps.gov.

LITERATURE CITED

Bockino, N.K. 2015. Whitebark pine monitoring for the Greater Yellowstone Ecosystem: regeneration study 2009–2014 summary [unpublished report]. 44 p. Available from Greater Yellowstone Network, 2327 University Way, Suite 2, Bozeman, MT 59715.

Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee (GYCC WBPSC). 2011. Whitebark pine strategy for the Greater Yellowstone Area. Bozeman, MT: Greater Yellowstone Coordinating Committee. 45 p. http://www.fedgycc.org/wp-content/uploads/2015/06/WBPStrategyFINAL5.31.11.pdf. [Date accessed: February 28, 2015].

Greater Yellowstone Whitebark Pine Monitoring Working Group (GYWBPMWG). 2011. Interagency whitebark pine monitoring protocol for the Greater Yellowstone Ecosystem, version 1.1. 141 p. Bozeman, MT: Greater Yellowstone Coordinating Committee. http://science.nature.nps.gov/im/units/gryn/monitor/whitebark_pine.cfm. [Date accessed: February 28, 2015].

Greater Yellowstone Whitebark Pine Monitoring Working Group (GYWBPMWG). 2014. Summary of preliminary step-trend analysis from the Interagency Whitebark Pine Long-term Monitoring Program—2004–2013: prepared for the interagency grizzly bear study team. Natural Resource Data Series NPS/GRYN/NRDS–2014/600. Fort Collins, CO: National Park Service. http://science.nature.nps.gov/im/units/gryn/monitor/whitebark_pine.cfm. [Date accessed: February 28, 2015].

MacFarlane, W.W.; Logan, J.A.; Kern, W.R. 2013. An innovative aerial assessment of Greater Yellowstone Ecosystem mountain pine beetle-caused whitebark pine mortality. Ecological Applications. 23: 421–437.

Shanahan, E.; Irvine, K.M.; Roberts, D. [and others]. 2014. Status of whitebark pine in the Greater Yellowstone Ecosystem: a step-trend analysis comparing 2004–2007 to 2008–2011. Natural Resource Technical Report NPS/GRYN/NRTR–2014/917. Fort Collins, CO: National Park Service. http://science.nature.nps.gov/im/units/gryn/monitor/whitebark_pine.cfm. [Date accessed: February 28, 2015].