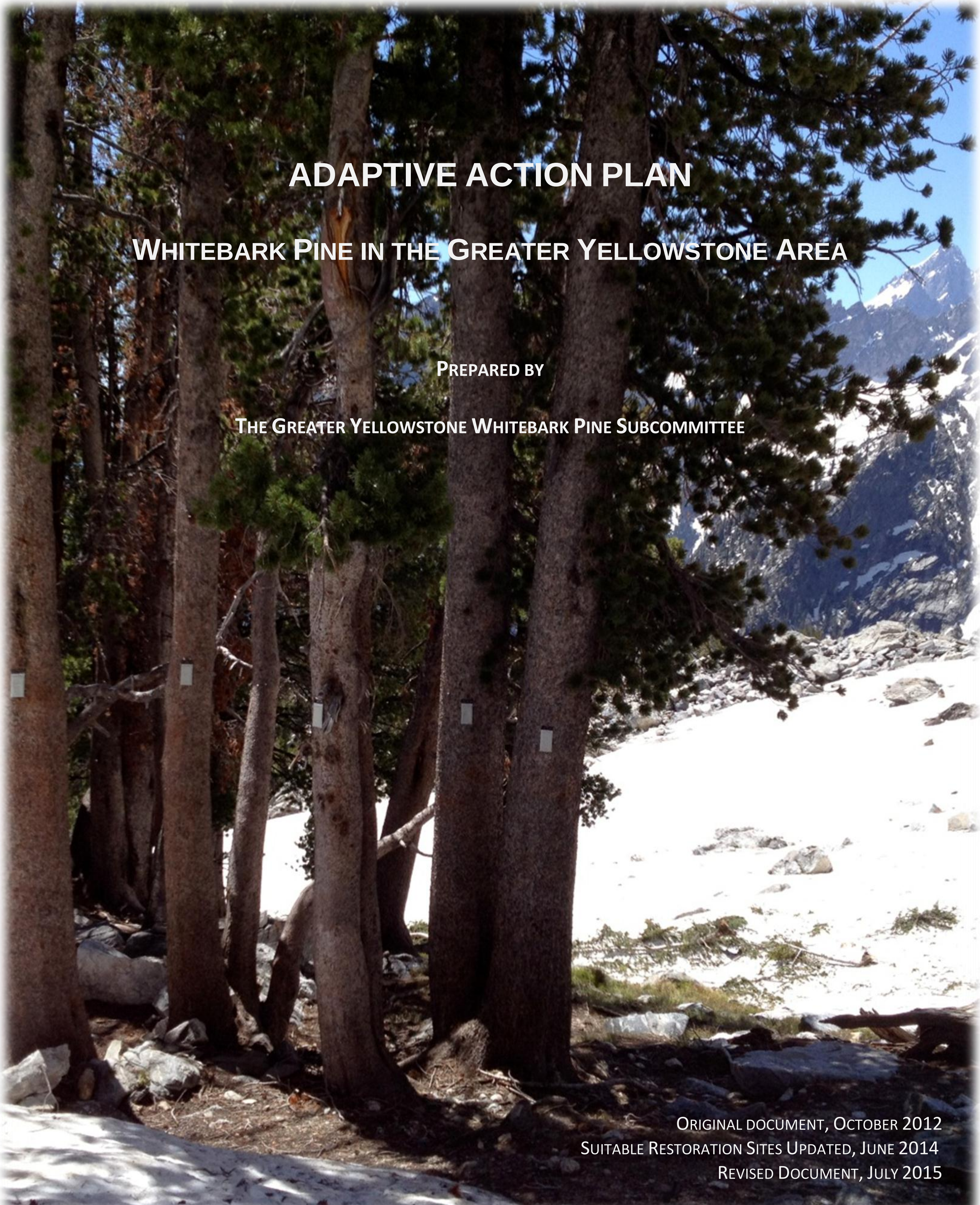


ADAPTIVE ACTION PLAN

WHITEBARK PINE IN THE GREATER YELLOWSTONE AREA

PREPARED BY

THE GREATER YELLOWSTONE WHITEBARK PINE SUBCOMMITTEE

ORIGINAL DOCUMENT, OCTOBER 2012
SUITABLE RESTORATION SITES UPDATED, JUNE 2014
REVISED DOCUMENT, JULY 2015

Overview

This document provides an action plan to guide adaptive restoration and protection of whitebark pine (*Pinus albicaulis)* in the Greater Yellowstone Ecosystem (GYE) and is based upon the2011 Greater Yellowstone Area Whitebark Pine Strategy (GYCCWBPS, 2011). Information included is based on the most up-to-date understanding and documentation of whitebark physiology, ecology, genetics, distribution, mortality, and regeneration. This Adaptive Action Plan addresses: 1) topics that have recently developed in light of increased research; and 2) updated target restoration areas that have changed since the 2011 GYE Whitebark Pine Strategy. Climate change will influence the whitebark pine ecosystem. Though it is difficult to define and predict the nature of these influences the Greater Yellowstone Coordinating Committee (GYCC) Whitebark Pine Subcommittee is committed to identifying and incorporating the best available science into the Adaptive Action Plan. The Subcommittee will update and adapt the GYE Whitebark Pine Strategy and this Adaptive Action Plan to incorporate new science, research findings, and emerging impacts related to climate change. This will include implementing adjustments to short-term management actions and long-term strategies based on both established and emerging science.

Table of Contents:

OBJECTIVES OF THE ADAPTIVE ACTION PLAN

1. Ensure natural regeneration, genetic diversity and genetic variability through protection of remaining mature and seed-producing trees on the landscape.
2. Collect and store seed for out plantings, rust resistance screening, and gene conservation.
3. Restore through promoting natural regeneration, planting nursery grown blister rust resistant seedlings and potentially direct seeding.
4. Increase blister rust resistance through participation in the Intermountain Whitebark Pine Genetic Restoration Program (Mahalovich and Dickerson 2004, Mahalovich and Foushee *in press*).
5. Monitor and document whitebark condition across the GYE over time including: mountain pine beetle (*Dendroctonus ponderosae*) mortality, regeneration density and distribution, blister rust infection levels, fire mortality and adapt restoration treatments based on monitoring results. GYE-wide monitoring has, and will continue to be accomplished by the Greater Yellowstone Inventory and Monitoring Network (GYWPWG, 2014). In addition, individual administrative units have USFS established monitoring protocols for pre and post-planting stocking densities.
6. Work collaboratively within GYE (MOU completed April 2012) and with scientists to share data, funding, plant materials, and research findings.
7. Select appropriate management goals and locations and engage in adaptive management to suitable target restoration and protection areas, as ecologically and administratively appropriate.
8. Continue to recognize agency-specific policies and federal laws guiding management actions.

CLIMATE CHANGE AND WHITEBARK PINE

While climate change was addressed in the GYE Whitebark Pine Strategy in 2011, more information on the topic of whitebark pine and climate change has been generated in the scientific community. In October 2014, numerous projects were presented at the GYCC Whitebark Pine Subcommittee meeting that addressed the impacts of climate change on whitebark pine. Below is a summary of the research presentations which provide new information, some of which is not yet published. These studies, along with previously published work, serve to inform this Adaptive Action Plan.

Research on climate change in relation to whitebark pine distribution is a relatively new area of study but one in which there are multiple on-going efforts of both short and long-term duration. The Whitebark Pine Subcommittee compiles an annual Annotated Bibliography of published research on whitebark pine and closely related topics (http://fedgycc.org/WhitebarkPinePublicationsandArticles.htm#biblio). Both the Subcommittee and the Whitebark Pine Ecosystem Foundation hold annual meetings at which whitebark pine related research findings are presented. Ongoing research is often presented in these venues prior to project completion and publication in peer-reviewed journals. Managers from the GYCC have the opportunity to discuss findings and identify issues in need of further research.

Cathy Whitlock, Montana State University, presented a paleontological perspective on whitebark pine. Whitlock and colleagues found that whitebark pine pollen is present in records ranging from over 12,000 years ago to the present (Iglesias et al. 2015). These records show that whitebark pine was more abundant 12,000 to 8,000 years ago. During that time the climate was warmer and drier in the summer, while winters were longer and colder with a larger snowpack. There were also more fires during that time period. Spruce (*Picea spp*.) was on the landscape but less abundant than today, mountain pine beetle was also present, although little is known about its abundance or level of activity. There have been changes in the abundance and distribution of whitebark pine over time. Declines in whitebark pine coincide with increases in subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), and Douglas-fir (*Pseudotsuga menzeisii*). Iglesias et al (2015) study suggests that whitebark pine is adapted to grow in a wider range of conditions than its present distribution, including higher growing season temperatures and greater fire frequencies. The component of climate change forecasts that is not consistent with an increase in whitebark pine is warmer winter temperatures. In the past when whitebark pine was more prevalent, winters were colder than at present. Krause et al. (2015) suggests that portions of forecasted climate change impacts will be beneficial to whitebark pine while warmer winters likely will not be. This work illustrates that whitebark pine has been present on the landscape over a broad range of climatic conditions.

Tony Chang, Montana State University, presented his climate envelope modeling conducted in collaboration with Andrew Hansen and N. Piekielek (MSU) (Chang et al. 2014; Hansen & Philips 2015). This research looks at the climatic conditions where a species grows at present and then uses climate modeling to determine where, within its current range, similar climatic conditions will occur in the future. Chang's work indicated that in 30 years many areas currently occupied by whitebark pine will have different climates. Chang produced models and maps identifying where future climates will be similar to those occupied by whitebark pine today. These models do not incorporate biological variables such as dispersal, competition, mountain pine beetle, white pine blister rust infection or the regeneration niche concept. Chang's map products show a decrease in future habitat that is similar to habitat currently occupied by whitebark pine with most of the similar habitat occurring above 9,800 feet, and/or in the Wind River Range. Chang's climate assessment showed that the climate in his study area (suitable whitebark habitat in the GYE) was most stable from 1950-1980.

Polly Buotte, University of Idaho, presented a study analyzing effects of temperatures on the recent mountain pine beetle infestation and whitebark pine in the GYE (Creeden et al., 2014). This work quantified warm minimum winter temperatures in the 1990s and 2000s when mountain pine beetle attacks on whitebark pine stands were high. In addition, this work indicated that future climate predictions will be favorable for mountain pine beetle survival.

Dave Thoma, National Park Service, presented findings that indicate site-level climate conditions and water balance is associated with whitebark pine adaptation to stress. Whitebark pine mortality, primarily as a result of mountain pine beetle, is directly related to tree diameter size and water deficit conditions. This work illustrates that fine-scale biophysical conditions must be understood to assess whitebark pine conditions. He concluded that micro-refugia may be necessary to manage whitebark pine for resilience and persistence.

Mary Frances Mahalovich, U.S. Forest Service, presented findings regarding genetic resistance to white pine blister rust, drought tolerance, and cold hardiness for the GYE. She also discussed the potential effects climate change will have on whitebark pine restoration. Within the GYE, whitebark pine has shown higher levels of blister rust resistance from the southeast to the northwest. Drought tolerance is shown to be high in the GYE and increases from northeast to southwest (Mahalovich et al. *in press*). The progeny of plus tree selections within Yellowstone National Park have high levels of cold hardiness and drought tolerance, but some of the lowest levels of blister rust resistance (Mahalovich et al., 2006, Mahalovich et al., *in press*, Mahalovich unpublished data).

Bob Keane, U.S. Forest Service, presented results from a modeling effort that assesses the response of whitebark pine to different levels of restoration effort under the differing levels of climate change. This project used a spatially explicit, ecological process model (FireBGCv2) to run a simulation experiment to determine the response of whitebark pine to differing levels of climate change such as warm-moist or and hot-dry scenarios (IPCC 2013) and to varying levels of management including thinning, planting, and 50% or 90% fire suppression. Predicted changes in climate could potentially exacerbate whitebark pine decline due to: i) the creation of novel environments which may not be stable or suitable for whitebark pine; ii) succession of whitebark pine to more shade tolerant species; iii) increased frequency and severity of wildland fire events and mountain pine beetle outbreaks; or iv) changes in climate that may facilitate the spread of blister rust. Their assessment of whitebark pine in western Montana habitats (Keane et al. *in press*) indicate that by planting rust-resistant seedlings and employing other proactive restoration treatments, whitebark pine can remain or become prevalent in the high mountains of western North America and can create resilient subalpine forests. In each climate scenario simulation a low to moderate level of management action was required to maintain whitebark on the landscape. Once maintained on the landscape, whitebark pine increased and displayed greater resilience than other subalpine forest species. While, this modeling effort is relatively new, and the data was presented for western Montana habitats, the primary principles of their work would be valuable to GYE managers as they address whitebark pine management strategies and climate change. Moreover, similar efforts to collect data and apply similar modeling in the GYE have been proposed. This work will be available in a general technical report titled "Restoring Whitebark Pine Under Climate Change" authored by Robert Keane, Lisa Holsinger, Mary Frances Mahalovich and Diana Tomback (Keane et al. *in review*).

ASSESSMENT FRAMEWORK

Recognizing that climate change science is constantly evolving, as new information becomes available the GYCC Whitebark Pine Subcommittee holds a meeting at which current research is presented to help inform whitebark pine adaptive restoration and protection. As part of this process, they have developed an assessment framework that takes into account current as well as future suitability given projected climate change scenarios. This framework is intended to provide guidance for specific projects as well as for monitoring and continual adaptation of overall management strategies. Each of the following variables should be considered for restoration and protection strategies.

I. Landscape-Level:

- Bio-climate envelope projections for the future from the best available peer-reviewed data.
- Bio-refugia identified safe havens for biodiversity (Keppel, et al. 2012), or habitat suitability identified by field or modeling data which incorporate biological response

II. Site Specific:

- Edaphic characteristics: slope, aspect, soil type, soil parent material, elevation, microclimate
- Available microsites – type, quantity and quality
- Appropriate blister rust resistant seedlings match to site-specific rust infection levels
- Overstory rust infection level or infection potential (low-medium-high). Also consider rust infection levels in the understory.
- Competing species – density (stems per acre by size class) and or presence/absence data
- Suitability of site for competitors
- On burned sites, time since last fire and fire severity
-

III. Planting Effectiveness:

- For all planting sites, record all above variables to be used in effectiveness monitoring framework
- Follow USFS seed planting guidelines (McCaughey et al. 2009)
- Complete first and third year survival and stocking surveys following USFS reforestation guidelines
- Analyze and share planting data and above surveys
- Extend long-term planting monitoring beyond the current 5 years
- Monitor natural regeneration as well as planting sites, including data standards, locations, assessment intervals, sampling protocols (GYWPWG 2011, 2014).

LONG-TERM GOALS

The GYCC Whitebark Pine Subcommittee will work toward achieving the following actions:

- Continue current genetic improvement efforts in the GYE, including management and funding for the long-term maintenance of plus and elite trees and established genetically diverse areas and the Little Bear seed orchard.
- Create a climate change addendum to the Whitebark Pine Strategy (GYCCWBPS May 2011) and list of climate researchers and projects
- Incorporate new and recently burned areas into suitable target restoration areas annually.
- Identify and incorporate core micro-refugia, as described above into the long-term whitebark pine strategy
- Analyze planting data using above assessment framework and adjust appropriately
- Continue to enhance monitoring strategy and sampling protocol
- Whenever possible provide feedback and/or data to modeling efforts.
- Perform a periodic ecosystem-wide aerial survey for whitebark pine canopy damage and strive toward consistent and ecosystem-wide flights
- Continue to provide annual annotated bibliography of new research and findings.
- Continue to perform natural regeneration surveys.
- Continue to assess genetic diversity among GYE whitebark pine, and incorporate phenotypic traits that lead to the success of whitebark pine given warm-cold and drought-wet adaptations under projected climate scenarios (Mahalovich and Hipkins 2011).

LAND STATUS AND MANAGEMENT

Within each administrative unit within the GYE there are multiple land status designations, each of which are regulated differently and may require management procedures specific to the designation. Sites selected as suitable for restoration or protection in the Whitebark Pine Strategy for the Greater Yellowstone Area (GYCCWBPS 2011) encompassed all status designations: National Forests, National Wilderness and Recommended Wilderness Areas, Inventoried Roadless, National Parks, Research Natural Areas and Wilderness Study Areas. At this time, there are no immediate restoration actions proposed for, and whitebark pine polygons depicted in this document are not in, National Designated or Recommended Wilderness, Research Natural Areas, Wilderness Study Areas, or National Parks.
Each administrative unit will address management procedures for their sites on an individual basis based on agency legislation, policies and guidelines. In addition, actual restoration sites chosen by each unit may differ from the maps presented in this document due to variation in site conditions and stocking levels, project funding, unit priorities or other currently unknown variables.

At this time, wilderness management policy among all federal agencies does not allow direct restoration activities in Designated or Recommended Wilderness. The GYCC Whitebark Pine Subcommittee will continue to monitor whitebark pine in these areas, encourage ecological process such as natural regeneration and wildland fire use, and promote the range-wide conservation of whitebark pine (Keane et al. 2012) and, in the future, may consider use of the minimum requirement tool. Minimum requirement is defined as utilizing the least intrusive mechanism possible in order to accomplish management objectives as well as maintain wilderness character. Conducting a minimum requirements analysis follows the direction of both law and agency policy.

COMMENTS ON MAPPING

It is important to note that for all maps presented in this document the displayed polygons and associated acres are for polygon perimeters. Actual acres of whitebark pine within each polygon are variable and less than the total perimeter. Within the perimeter of each polygon variation exists in tree species composition, density, cover, size, age, burn pattern and severity, and MPB damage. Polygon perimeters and acres do not indicate stands of pure whitebark pine. Thus, each polygon must be visited to determine natural stocking density, planting site feasibility and other edaphic characteristics. All references to and use of "high restore or protect rankings" are polygons that were previously designated in the Whitebark Pine Strategy for the Greater Yellowstone Area (GYCCWBPS May 2011). These polygons are areas that were identified in 2011 as suitable for either restoration or protection. For further information on this topic see the original document, the Whitebark Pine Strategy for the Greater Yellowstone Area. Unit-specific shapefiles and photo interpretation documentation are available for these polygons.

MANAGEMENT ACTIVITIES

Management activities to maintain whitebark pine in the GYE landscape requires an array of activities that are addressed on a site-specific basis. These include the following activities:

1. Collect Cones from proven rust-resistant donors.
   - Collections should be made as often as possible, when seed is available and consistent with seed procurement plans.
   - Collections should be designed to maintain seed in all elevation zones found in current seed inventory.
   - Collections should target whitebark pine located in rust resistant and genetically unique areas (Tables 2-4).
     - ✓ Seed should be collected from healthy trees with > 30% live green crown
     - ✓ Cone donor trees should be a minimum of 200' apart to avoid relatedness and minimize the negative consequences of inbreeding depression.
     - ✓ A minimum of 20 trees shall comprise each seed lot to ensure genetic diversity.
     - ✓ Cone-bearing donors from a given site must be within +/- 425' in elevation of each other.
     - ✓ New 100-tree blister rust and mountain pine beetle surveys should be performed to account for changes in rust infection since the initial plus tree designation. Completed survey forms shall be submitted to the Regional Geneticist and the Greater Yellowstone Network Inventory and Monitoring Program.

2. Where feasible, protect the remaining whitebark pine seed source from mountain pine beetle through the application of verbenone packets, verbenone SPLAT and carbaryl (Kegley & Gibson, 2004).
   - Areas most suitable for restoration and protection displayed in this document were established in Greater Yellowstone Area Whitebark Pine Strategy (GYCCWBPS 2011) and also through unit-specific projects.
   - Overall – maintain as many seed source trees as possible
   - Continued protection of trees identified for rust resistance (Plus and Elite Trees) in the Greater Yellowstone Grand Teton Seed Zone

3. Sow and Plant Rust Resistant Seedlings identified in the Cycle 1 and Cycle 2 blister rust screenings performed at Coeur d'Alene Nursery. Additional blister rust resistant seed sources and rankings will be identified in the ongoing Cycles 4 and 5 blister rust screenings. The lists below are subject to change.

Table 1: GYGT Seed Zone - Areas of High Genetic Diversity & Known Rust Resistance	
Location Name	**Administrative Unit**
West Fork Cabin	Beaverhead-Deerlodge National Forest
Hellroaring	Custer Gallatin National Forest
Daisy Pass	Custer Gallatin National Forest
Little Bear	Custer Gallatin National Forest
Blue Ridge	Shoshone National Forest
Union Pass	Shoshone National Forest
Bog Lakes	Shoshone National Forest
Fish Creek	Bridger-Teton National Forest
Stewarts Draw	Grand Teton National Park
Washburn	Yellowstone National Park

Table 1: GYGT Seed Zone - High Genetic Diversity/Areas of Known Resistance (As of May 2012)

Table 2: GYGT Seed Zone - Rust Resistant Families	
Location Name	**Administrative Unit**
Mica Mine	Custer Gallatin National Forest
Wheeler Mountain	Custer Gallatin National Forest
Jackson Hole Mountain Resort	Bridger-Teton National Forest
Dry Creek	Caribou-Targhee National Forest
Indian Meadows	Caribou-Targhee National Forest
Boatman Springs	Caribou-Targhee National Forest
Sylvan Pass	Yellowstone National Park
Apex Trail	Grand Teton National Park
Picket Pin Mountain	Custer Gallatin National Forest
Pine Grove	Bridger-Teton National Forest
Lake Ridge	Bridger-Teton National Forest
Squaw Basin	Bridger-Teton National Forest
Grand Targhee Resort	Caribou-Targhee National Forest
Union Pass	Shoshone National Forest
Stewarts Draw	Grand Teton National Park

Table 2: GYGT Seed Zone - Rust Resistant Families from the Phase 2 Selections in Cycle 1

Table 3: Rust Resistant Areas	
Location Name	**Administrative Unit**
Apex Trail	Grand Teton National Park
Blue Ridge	Shoshone National Forest
Boatman Springs	Caribou-Targhee National Forest
Bog Lake	Shoshone National Forest
Dead Horse/Taylor	Custer Gallatin National Forest
Deadline Ridge	Bridger-Teton National Forest
East Dry Creek	Caribou-Targhee National Forest
Fish Creek	Bridger-Teton National Forest
Flagstaff Road	Bridger-Teton National Forest
Grand Targhee Ski Area	Caribou-Targhee National Forest
Gravelly Range B, D, F, H & T	Beaverhead-Deerlodge National Forest
Gunsight Pass	Bridger-Teton National Forest
Henderson Mountain	Custer Gallatin National Forest
Indian Meadows Trailhead	Caribou-Targhee National Forest
Jackson Hole Mountain Resort	Bridger-Teton National Forest
Labarge Creek	Bridger-Teton National Forest
Labarge Spring	Bridger-Teton National Forest
Lake Fishing Bridge	Yellowstone National Park
Lake Ridge	Bridger-Teton National Forest
Little Bear	Custer Gallatin National Forest
Mary Bay	Yellowstone National Park
Mica Mine	Custer Gallatin National Forest
Miller Creek	Custer Gallatin National Forest
Moccasin Basin	Bridger-Teton National Forest
Moccasin Ridge	Bridger-Teton National Forest
Mount Washburn	Yellowstone National Park
Picket Pin Mountain	Custer Gallatin National Forest
Pine Grove	Bridger-Teton National Forest
Pine Grove Ridge	Bridger-Teton National Forest
Sawtell Mountain	Caribou-Targhee National Forest
Shoshone Point	Yellowstone National Park
Split Rock Creek	Bridger-Teton National Forest
Squaw Basin	Bridger-Teton National Forest
Stewarts Draw	Grand Teton National Park
Sylvan Pass	Yellowstone National Park
Union Pass	Shoshone National Forest
Washburn Road	Yellowstone National Park
Wheeler Mountain	Custer Gallatin National Forest

Table 3: Rust Resistant Areas (as of June 20, 2014 M. Mahalovich)

4. Adhere to Seed Transfer Guidelines (current draft FSH 2409.26 F-Seed Handbook, Chapter 200, pages 39-42)

- Because of its broad geographic range, extensive gene flow by Clark's nutcracker and wind pollination (Richardson et al. 2002a, 2002b, Mahalovich and Hipkins 2011, Mahalovich et al. *in prep*) and patterns of genetic variation largely within populations rather than among populations (Rehfeldt 1994), whitebark pine has generalist adaptive strategy with broad seed transfer across elevations and latitude and somewhat more restrictive transfer longitude. When considering late winter cold hardiness however, whitebark pine has more of an intermediate adaptive strategy with differentiation indicated at 850-foot intervals.
- Within a given mountain range, cones collected from natural stands with low blister rust infection levels (< 50%) shall not be transferred to an area with higher blister rust infection (> 50%).
- In areas of high blister rust infection (> 75%) the most critical factor in successful selection of whitebark pine is only to collect from trees with proven rust resistance.
- Where cold hardiness is an issue and the planting site is in a swale or on a slope (McCaughey et al. 2009), seed should not be moved more ± 450 feet in elevation.

5. Utilize 10-Year Seed Procurement Plans (prepared in 2011).

- Current plan: 1,219 acres of whitebark pine seedlings planted annually for 2011-2021. To-date this goal was achieved in 2014.
- Current Seed Inventory (as of March 2015) for use throughout the GYE: There is a total of 1,026.4 lbs of seed capable of producing 1,252,746 container seedlings. At 300 trees per acre (TPA) planting density that is enough to plant 4,175 acres.

6. Plant Seedlings, Document and Monitor

i. **Suitable Planting Areas** and restoration prioritization rankings, regardless of land status, were designated in the Whitebark Pine Strategy for the Greater Yellowstone Area (GYCCWBPS 2011) and updated in April 2014 through verification by photo interpretation.
   a. Areas where burns since 1999 intersect high restoration ranking = 65,542 acres of mapped polygon perimeter.
   b. Areas where the greatest mountain pine beetle canopy damage intersects high restoration rankings that are less than one mile from a road = 90,211 acres of mapped polygon perimeter.

ii. **Restoration Target Areas** are a subset of the above acres of polygons that are not in Recommended or Designated National Wilderness, Wilderness Study Areas, or Research Natural Areas. These areas are depicted on unit-specific maps in this document, the Adaptive Action Plan.
   a. 34,202 acres burned areas with high restoration ranking.
   b. 69,658 acres areas with greatest MPB canopy damage and high restoration ranking.
   c. For all units, the query for MPB canopy damage was limited by distance to roads.
   d. On the Shoshone National Forest, the query was limited by distance to roads for burned areas.
   e. Grand Teton and Yellowstone National Parks' land status is within recommended wilderness; no acres are recommended for restoration at this time.

Table 4: Restoration Target Areas: Whitebark Pine Polygons		
Unit	Acres in Burned Areas	Acres in Areas with Greatest Mountain Pine Beetle Damage
Beaverhead-Deerlodge National Forest	2,852	22,143
Bridger-Teton National Forest	14,128	13,619
Caribou-Targhee National Forest	4,929	6,182
Custer National Forest	5,032	3,833
Gallatin National Forest	3,621	9,172
Shoshone National Forest	3,640	14,709
Total	**34,202**	**69,658**

Table 4. Areas, outside of Recommended or Designated National Wilderness, Wilderness Study Areas, or Research Natural Areas, where burns since 1999 or the greatest MPB damage that is less than one mile from a road intersect high restoration ranking, by unit.

iii. Unit-specific, high resolution files for each site map are available from GYE land management agencies. Currently, information for whitebark pine distribution and restoration target area maps are compiled for the GYCC Whitebark Pine Subcommittee by Grand Teton National Park staff.

iv. Variable planting goals range from: 1) 30,000 seedlings or 100-150 acres per year in the Whitebark Strategy (GYCCWBPS 2011); 2) 1,219 acres per year in the combined GYGT 10-year Seed Procurement Plans (updated 2011); to 3) 2,000 acres per year or 400,000 seedlings for the next 18 years as recommended by the Regional Geneticist, Mary Frances Mahalovich to sustain genetic diversity, genetic variation, and to avoid functional extinction of whitebark pine within the GYGT seed zone.

v. Perform pre-planting surveys in burned areas and high MPB mortality areas to assess natural stocking density, site conditions, and other planting logistics. This will also help identify elevation targets needed for future cone collection.

vi. Reforestation prescriptions should be prepared based on guidelines established by McCaughey et al. (2009) and any subsequent research or data that improves and guides successful planting methods.

vii. Desired stocking density in the context of established blister rust resistance and long-term survival must be considering during sowing request and planting density.

viii. Current planting density suggested by the Regional Geneticist, Mary Frances Mahalovich, is 300 TPA to attain 100 TPA survival based on the blister rust resistance level in the 110-seed source study (Mahalovich et al., 2006).

ix. Units are encouraged to follow/adhere to FS Manual 2472.4 Regeneration Examination and FS Handbook 2409.17 Silvicultural Practices Handbook, Chapter 2- Reforestation, 2.73- Stocking Surveys, pages 26-45.

x. In order to provide a standardized tracking system for whitebark pine restoration, a database and GIS layer of the locations, date, and survival rates of planted whitebark pine seedlings in the GYE from 1994-present has been created and partially populated by Grand Teton National Park. This database needs to be updated and maintained.

xi. Attribute fields include: Date; Location/District; Planting Name; Compartment/Stand Number; Acres; Average Trees; Survival; Method/Type of Planting; Stock/Seedling Age; Nursery; Slope; Aspect; Elevation; Landform; Habitat Type; Burn History; Stand History Contract or Force Account; Soils Name; and any relevant items identified in the assessment checklist for planting effectiveness monitoring.

7. Intermountain West USFS Genetic Restoration Program

- Continue to support all blister rust resistance screenings, seed orchard (Konen 2014), clone bank, long-term performance (genetic) tests establishment and maintenance, and plant material collections (scion, pollen, cone, and aeciospores).
- Out plant blister rust resistance seedlings
- Collect cones from blister rust resistant and genetically unique areas (Tables 1-3; Figure V)

8. Natural Regeneration

- A GYE-wide inventory of spatial distribution, density, and rust infection is needed.
- Preplanting, project-specific surveys currently provide some of this information.
- Monitoring over time to track growth and survival.

9. Climate Change

- Ongoing coordination with researchers to help address this variable, including the Whitebark Subcommittee science meeting to ensure sharing of new research findings.
- May need to modify seed transfer guidelines in the future.

10. Fire Management

- Annually share Arc Map information (shapefiles & locations) and lists of restoration and protection target areas to fire staff officers.
- Incorporate whitebark pine polygons, elite and plus trees, seed source protection sites and target protection areas into Fire Management Plans.

11. Monitoring

- Continue support for blister rust and MPB (until recent outbreak is over) monitoring, Greater Yellowstone Network Inventory and Monitoring. Also see Bush and Kies (2012).
- Survival and growth rates post planting need to be monitored.
- Support annual accomplishment reports including: USFS planting, certifying natural regeneration, number of entries and grafts established at the orchard, genetic test establishment.

12. Mapping/Documentation Future Needs

- An updated whitebark distribution map to incorporate the above and any new unit-specific vegetation maps. Current distribution and condition assessment map source*: GYCCWBPS. 2010. 2010 whitebark pine distribution and condition assessment for the Greater Yellowstone by N. Bockino. Cooperation with USDA Forest Service - Forest Health and Protection and Grand Teton National Park.*
- Updated MPB overstory mortality mapping. The most current mortality data, which is incorporated into the above mentioned map, is a landscape assessment project completed in 2009 (Macfarlane et al. 2009).Develop a timeframe, criteria and desired variables of interest for recurring map and monitoring updates to comprehensively review whitebark pine condition.
- Work toward an updated distribution and severity of rust infection (last map completed by Helmbrecht and Keane, 2007)

13. Research

- Continued cooperation with researchers to improve ecosystem understanding such as: habitat suitability, endemic pest population dynamics, blister rust infection dynamics with climate change roles of all alternate hosts in the blister rust infection cycle, incorporating adaptive capacity (genetics and demographics/density) into climate change modes.

14. Collaboration and Partnerships

- Work toward continued agency and private partnerships and incorporate recommendations from other entities such as GYCC subcommittees (e.g., climate change subcommittee), GYCC Managers, Greater Yellowstone Network Inventory and Monitoring, Forest Health Protection, Coeur d'Alene Nursery, Great Northern Landscape Conservation Cooperative, American Forests, National Arbor Day, and the Whitebark Pine Ecosystem Foundation.
- Continued collaboration and ingenuity seeking, attaining, and sharing varying funding sources for whitebark pine research, restoration and management among all land management units and partners.

LITERATURE CITED

Bush, R., Kies, A. 2012. R1 whitebark pine inventory and monitoring protocols. USDA Forest Service, Region One, Vegetation, Classification, Mapping, Inventory and Analysis Report, Report 12-15 v2.0, 13 p.

Chang T, Hansen AJ, Piekielek N. 2014. Patterns and Variability of Projected Bioclimatic Habitat for *Pinus albicaulis* in the Greater Yellowstone Area. PLoS ONE 9(11): e111669. doi: 10.1371/journal.pone.0111669.

Creeden, E.P. , Hicke, J.A., Buotte, P.C. 2014. Climate, weather, and recent mountain pine beetle outbreaks in the western United States. Forest Ecology and Management. 312: 239–251.

Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee (GYCCWBPS). 2011. Whitebark Pine Strategy for the Greater Yellowstone Area, 41 pp.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 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. National Park Service, Fort Collins, Colorado.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2011. Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem, Version 1.1. Greater Yellowstone Coordinating Committee, Bozeman, MT. https://irma.nps.gov/App/Reference/ Profile/660369

Hansen, A.J.; Phillips, L.B. 2015. Which tree species and biome types are most vulnerable to climate change in the US Northern Rocky Mountains? Forest Ecology and Management 338: 68-83.

Helmbrecht, D.; Keane, R. E. 2007. Mapping blister rust infection across the range of whitebark pine. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO, USA, poster.

Iglesias, V., Krause, T.R., Whitlock, C. 2015. Complex response of white pines to past environmental variability increases understanding of future vulnerability." (2015): e0124439.

IPCC, 2013: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp

Keane, R.E., Tomback, D. F., Aubry, C. A., Bower, A. D., Campbell, E. M., Cripps, C. L., Jenkins, M. B., Mahalovich, M. F., Manning, M., McKinney, S. T., Murray, M. P., Perkins, D. L., Reinhart, D. P., Ryan, C., Schoettle, A. W., Smith, C. M., 2012. A range-wide restoration strategy for whitebark pine (*Pinus albicaulis*). Gen. Tech. Rep. RMRS-GTR-279. Fort Collins, CO: UDSA Forest Service, RMRS 108 p.

Keane, R.E.; Holsinger, L.M.; Mahalovich, M.F.; Tomback, D.F. *In Review.* Restoring whitebark pine ecosystems in the face of climate change. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station Gen. Tech. Rep. RMRS-GTR-XXX. Fort Collins, CO: XXX p,.

Kegley, S.; Gibson, K. 2004. Protecting whitebark pine trees from mountain pine beetle attack using verbenone. Forest Health Protection Report 04-8, USDA Forest Service Northern Region, Missoula, MT, USA.

Keppel, G.; Van Niel, K.P.; Wardell-Johnson, G.W.; Yates, C.J.; Byrne, M.; Mucina, L.; Schut, A.G.T.; Hopper, S.D.; Franklin, S.E. 2012. Refugia: identifying and understanding safe havens for biodiversity under climate change. Global Ecology and Biogeography 21: 393-404.

Konen, K. 2013. Little Bear 10-Year Seed Orchard Management Plan. USDA Forest Service, Custer-Gallatin National Forests, 44 p.

Krause, T.R., Yanbin Lu, Y., Whitlock, C., Fritz, S.C., Kenneth L. Pierce, K.L. 2015. Patterns of terrestrial and limnologic development in the northern Greater Yellowstone Ecosystem (USA) during the late-glacial/early-Holocene transition, Palaeogeography, Palaeoclimatology, Palaeoecology, (422): 46-56.

Mahalovich, M.F., Kimsey, M.J., Fortin-Noreus, J., Robbins, C.T. *in press*. Isotopic heterogeneity in whitebark pine (*Pinus albicaulis* Engelm.) nuts across geographic, edaphic and climatic gradients in the Northern Rockies (USA). Forest Ecology and Management.

Mahalovich, M.F., Kimsey, M.J., Fortin-Noreus, J., Robbins, C.T. 2014. *Submitted in review* Isotopic heterogeneity in whitebark pine (*Pinus albicaulis* Engelm.) nuts across geographic, edaphic and climatic gradients in the Northern Rockies (USA). Forest Ecology and Management. .

Mahalovich, M.F.; Foushee, D.L. Submitted. *Pinus albicaulis* Engelm. Genetic Restoration Program for the Inland West (USA): a First Generation of Improvement. *In*: Schoettle, A. and Sniezko, R. eds. 2015. Challenges and opportunities in genetics of five-needle pines and rusts of forest trees research: conservation, evolution and sustainable management in a changing climate. Proceedings of the IUFRO Joint Conference 2.02.15 Breeding and Genetic Resources of Five-Needle Pines, 7.02.05 Rusts of Forest Trees and Strobusphere. 15-20 June 2014; Fort Collins, CO. Proceedings RMRS-P-XX. Fort Collins, CO: U.S. Department of Agriculture.

Mahalovich, M. F; Hipkins, V. D. 2011. Molecular genetic variation in whitebark pine (*Pinus albicaulis* Engelm.) in the Inland West. Pages 124-139 *in:* Keane, Robert E.; Tomback, Diana F.; Murray, Michael P.; Smith, Cyndi M., editors. 2011. The future of high-elevation, five-needle white pines in Western North America: Proceedings of the High Five Symposium; 28-30 June 2010; Missoula, MT. Proceedings RMRS-P-63. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO, USA.

Mahalovich, M.F., Burr, K.E., Foushee, D.L. 2006. Whitebark pine germination, rust resistance and cold hardiness among seed sources in the Inland Northwest: Planting Strategies for Restoration. In: National Proc.: Forest and Conservation Nursery Assoc., 2005 July 18-20, Park City, UT, USA. Proc. RMRS-P-43. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station: 91-101.

Mahalovich M.F., Dickerson, G.A. 2004. Whitebark pine genetic restoration program for the Intermountain West (United States). Proc. IUFRO Working Party 2.02.15 Breeding and genetic resources of five-needle pines: growth, adaptability and pest resistance, 23-27, July 2001, Medford, OR, USA. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO, USA, Proc. RMRS-P-32, pp. 181-187.

Macfarlane W.W., J.A. Logan, and W.R Kern. 2009. Using the landscape assessment system (LAS) to assess mountain pine beetle-caused mortality of whitebark pine, Greater Yellowstone Ecosystem, 2009. Project report prepared for the Greater Yellowstone Coordinating Committee, Whitebark Pine Subcommittee, Jackson, Wyoming. 69 p

McCaughey, W.; Scott, G. L.; Izlar, K. L. 2009. Whitebark pine planting guidelines. Western Journal of Applied Forestry 24:163-166.

Rehfeldt, G.E., 1994. Evolutionary genetics, the biological species, and the ecology of the Cedar-Hemlock forests. In: Baumgartner, D.M., Lotan, J.E., Tonn, J.R. (Eds.), Interior Cedar-Hemlock-White Pine Forests: Ecology and Management, March 2-4, 1993, Spokane, WA, Washington State University Cooperative Extension, pp. 91-100.

Richardson, B. A.; Brunsfeld, S. J.; Klopfenstein, N. B. 2002a. Assessing Clark’s nutcracker seed-caching flights using maternally inherited mitochondrial DNA of whitebark pine. Canadian Journal of Forestry Research 32:1103-1107.

Richardson, B. A.; Brunsfeld, S. J.; Klopfenstein, N. B. 2002b. DNA from bird-dispersed seed and wind-disseminated pollen provides insights into postglacial colonization and population genetic structure of whitebark pine (*Pinus albicaulis*). Molecular Ecology 11:215-227.

USDA Forest Service Manual 2472.4 Regeneration Examination

USDA Forest Service Handbook 2409.17 Silvicultural Practices Handbook, Chapter 2- Reforestation, 2.73- Stocking Surveys, pages 26-45.

USDA Forest Service 2409.26f Draft combined Seed Handbook, Northern, Rocky Mountain, Southwestern and Intermountain Regions, Chapter 200, pages 39-42.

GREATER YELLOWSTONE COORDINATING COMMITTEE, WHITEBARK PINE SUBCOMMITTEE

Current Chair and Co-chair:

Shoshone National Forest, Ellen Jungck, Whitebark Subcommittee Chair
Dillon Bureau of Land Management, Emily Guiberson, Whitebark Subcommittee Co-Chair

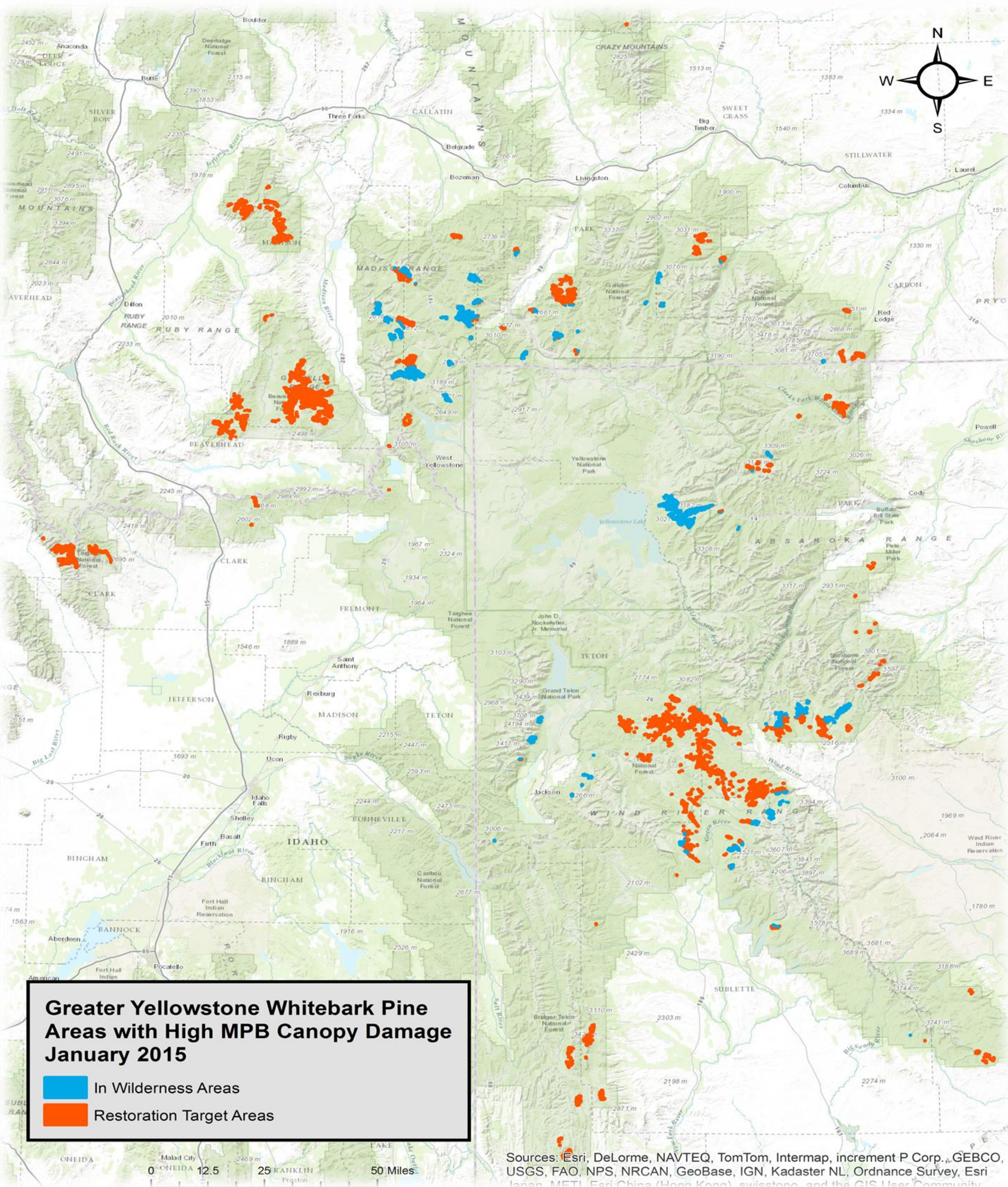
Current members:

Beaverhead Deerlodge National Forest, Robert Gump
Bridger-Teton National Forest, currently unfilled (detail position: Avery Beyer)
Caribou Targhee National Forest, Avery Beyer
Custer Gallatin National Forest, Keith Konan and Jodie Canfield
Wind River/Bighorn Basin District Bureau of Land Management, Jim Gates
Grand Teton National Park, Dan Reinhart, Kelly McCloskey & Nancy Bockino
Greater Yellowstone Inventory and Monitoring Network, Kristin Legg and Erin Shanahan
Shoshone National Forest, Tanner Shuler
United States Forest Service Regional Geneticist, Mary Frances Mahalovich
Wyoming Bureau of Land Management, State Office, vice-Bob Means in spirit
Yellowstone National Park, Roy Renkin

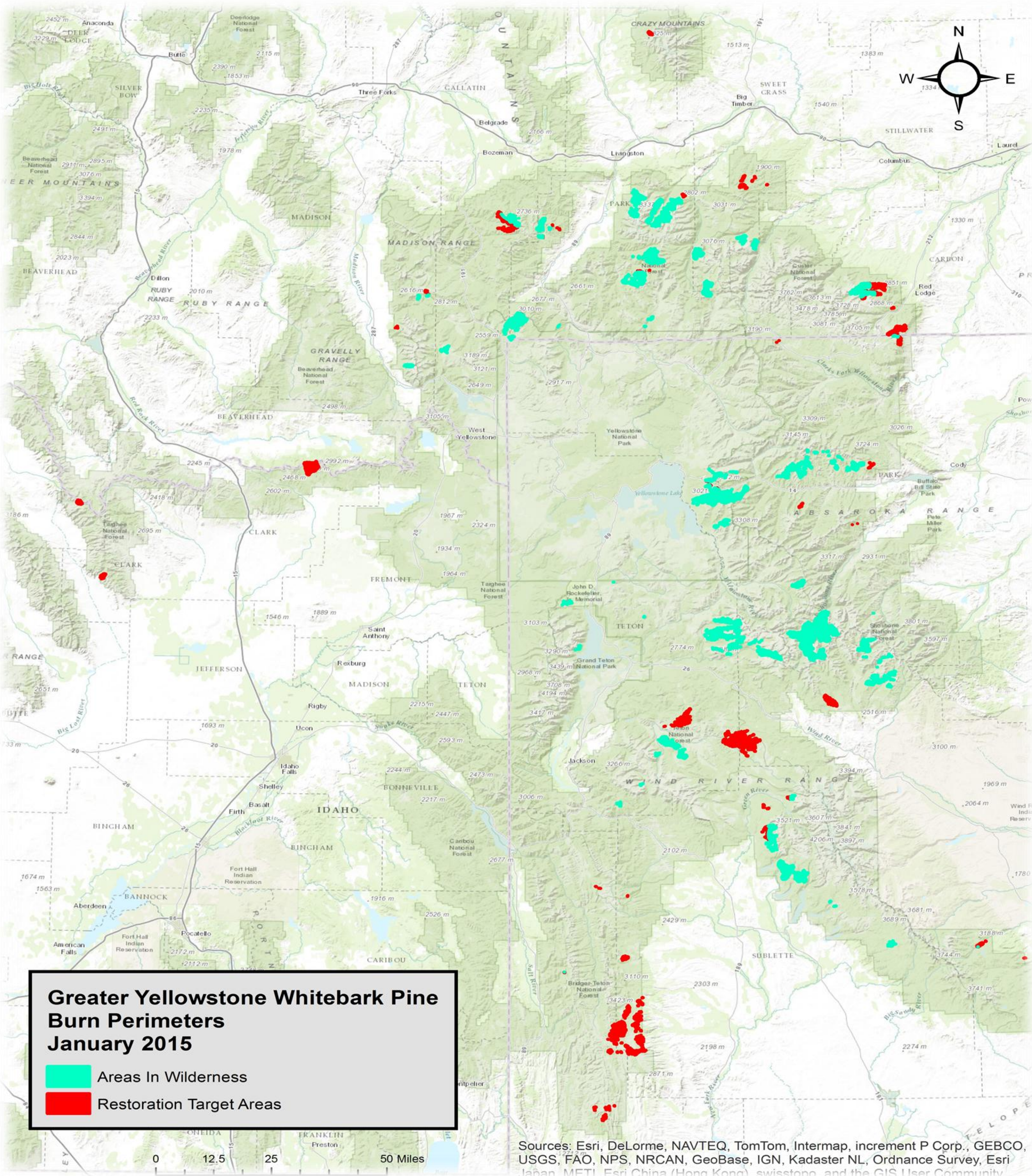
Special Thanks To:

American Forests for supporting work on this document and the GYCC Whitebark Pine Subcommittee members, past and present, for all your hard work, dedication and passion.

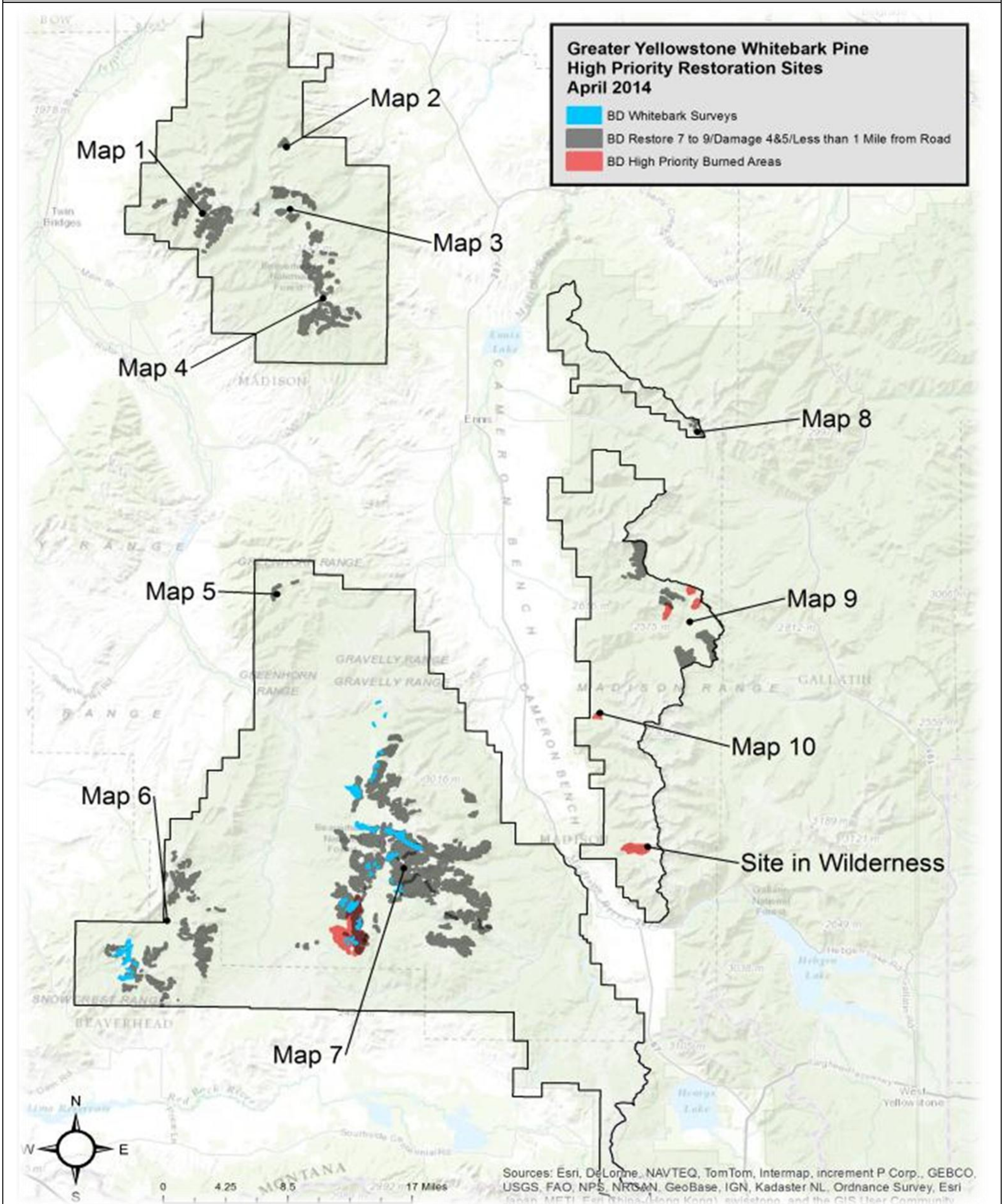
MOUNTAIN PINE BEETLE CAUSED CANOPY MORTALITY: Whitebark polygons with greatest MPB canopy damage within one mile of a road that intersect high restoration ranking (GYCC 2011). Areas within these polygons will need to be survey for natural regeneration and planting suitability. Polygon perimeters are displayed; whitebark pine density, cover, and MPB damage are NOT homogeneous within each polygon.



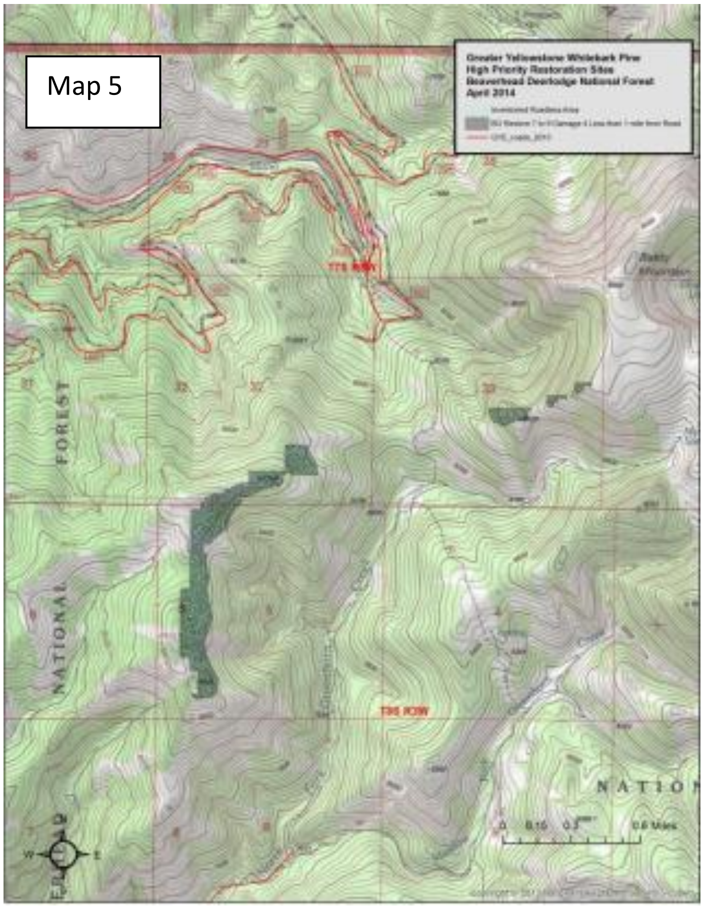
FIRE PERIMETERS Whitebark polygons within fire perimeters that intersect high restoration ranking (GYCC 2011) and fire perimeters since 2005. This map and estimated acres is burn perimeter, not acres of burned whitebark. Planting site selection and surveys for natural regeneration within will need to be performed within burned perimeters.

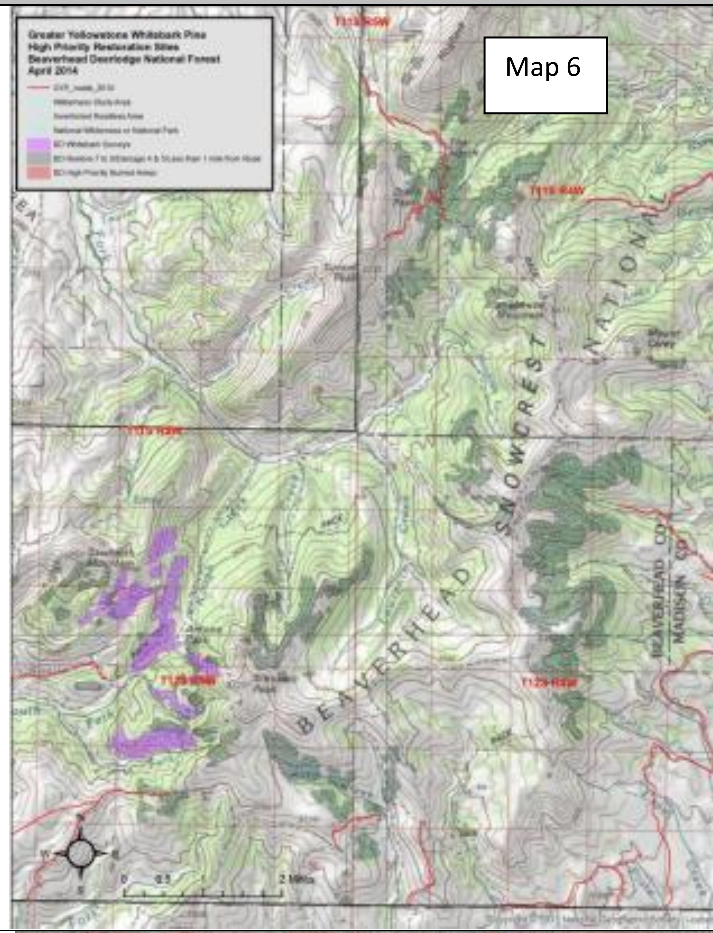


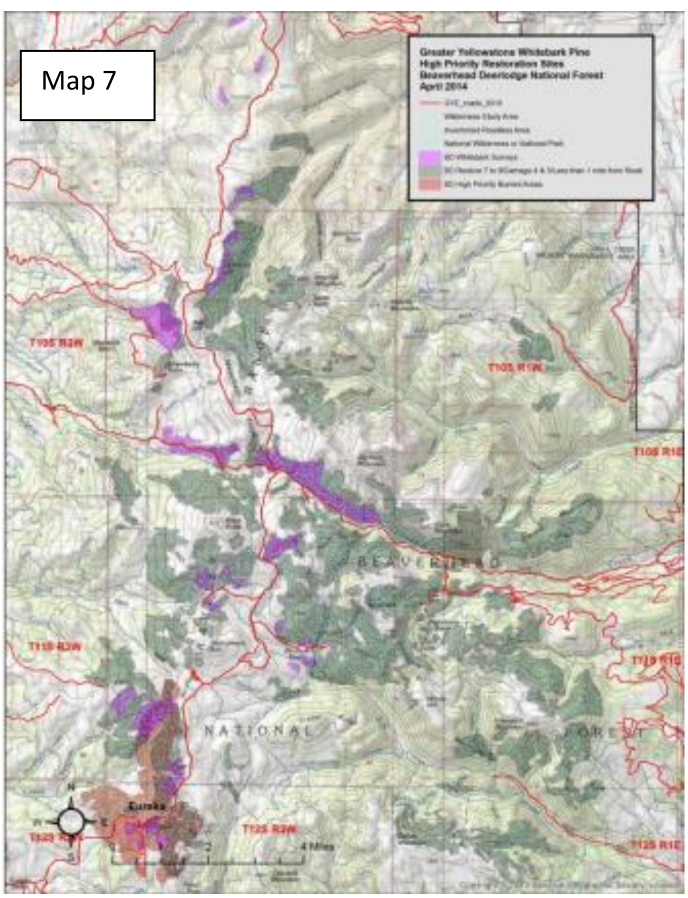
Restoration Target Areas –
Beaverhead Deerlodge National Forest Vicinity Map



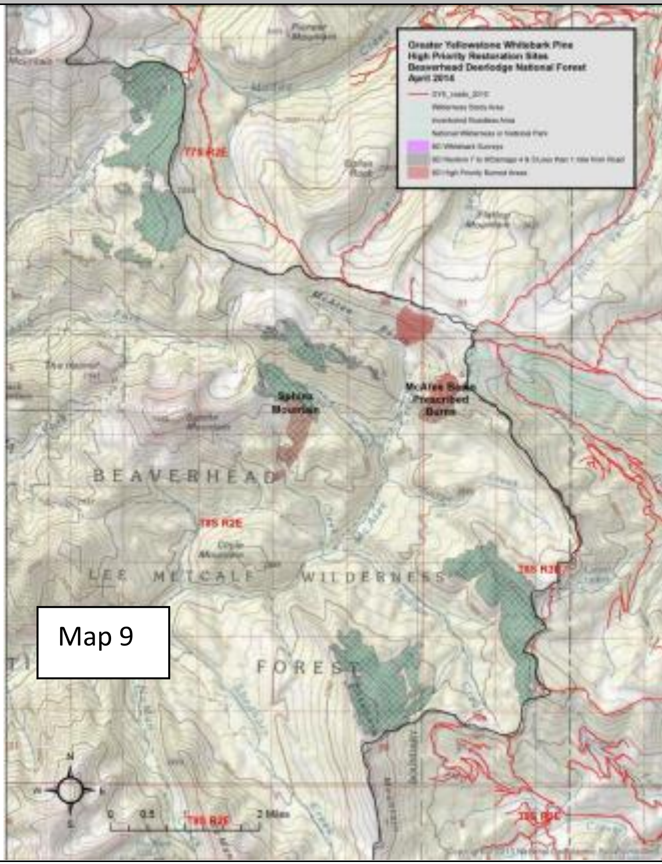
Restoration Target Areas – Beaverhead Deerlodge National Forest

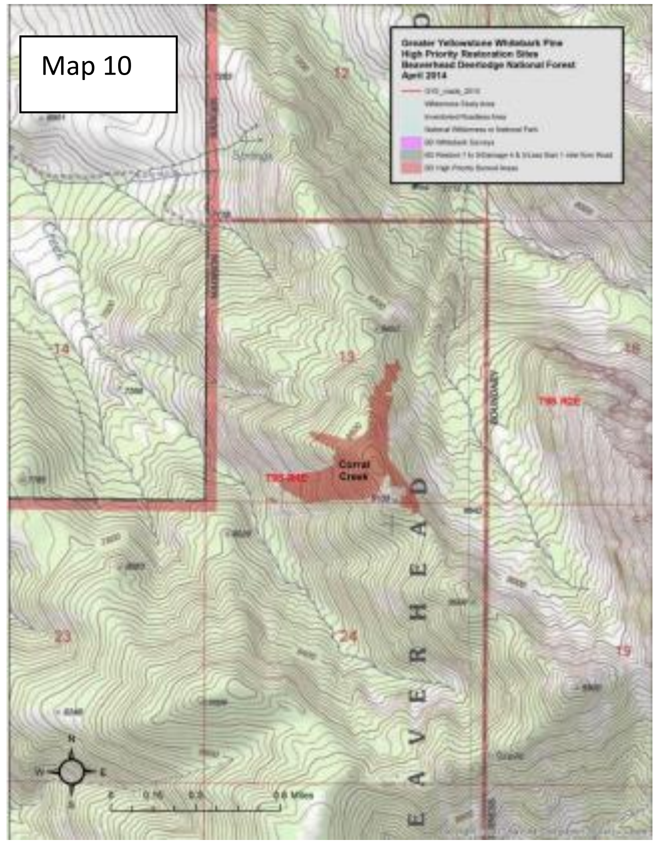




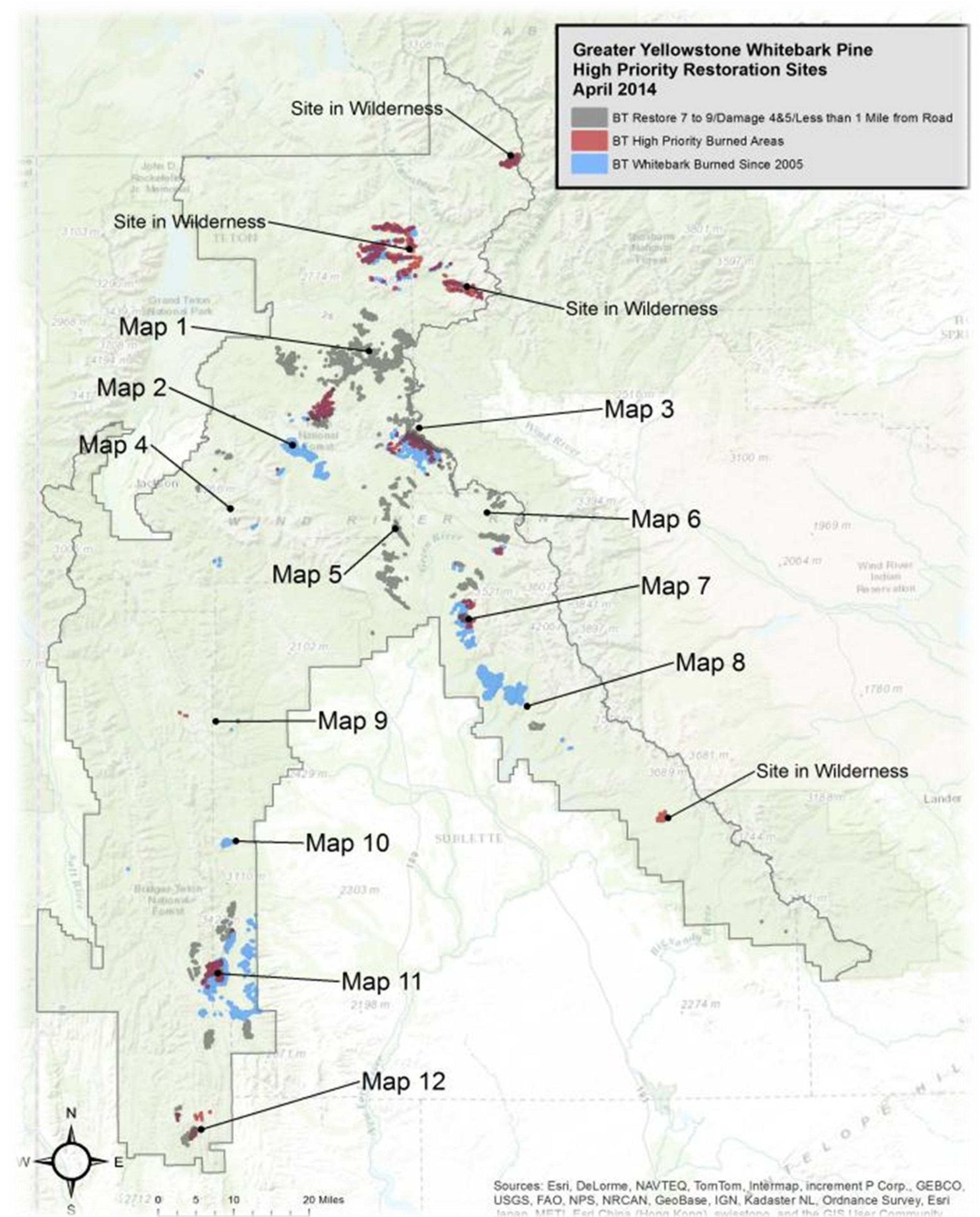


Restoration Target Areas – Beaverhead Deerlodge National Forest

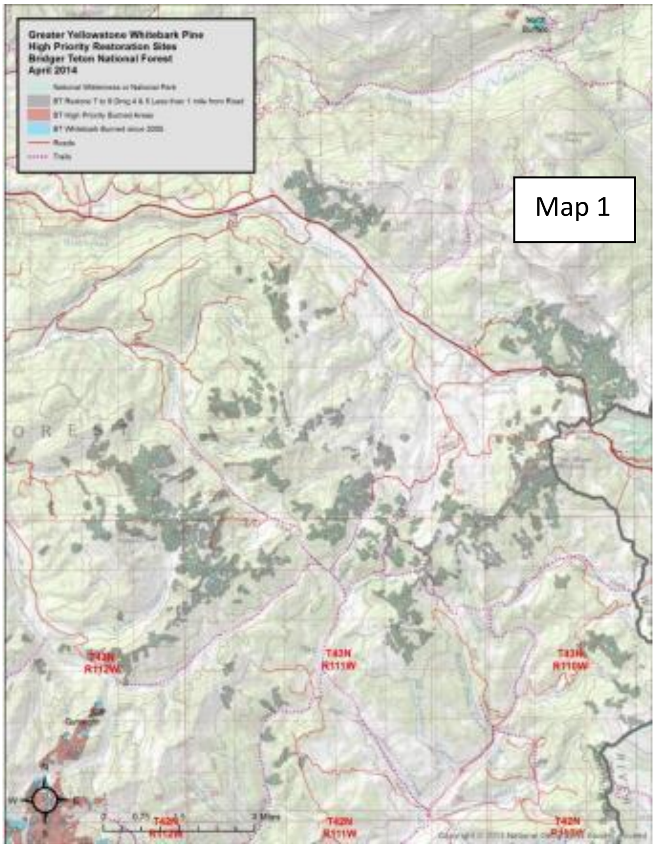


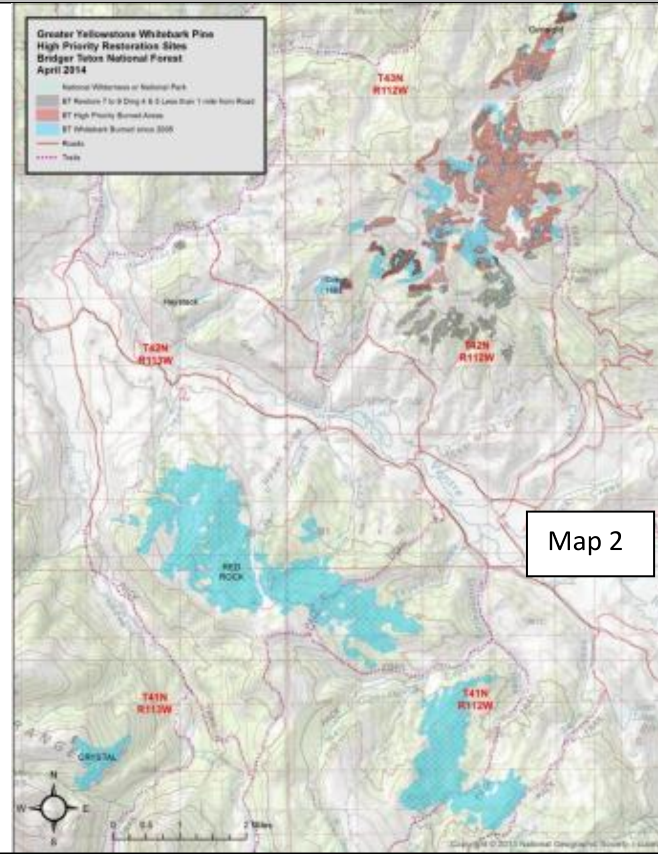


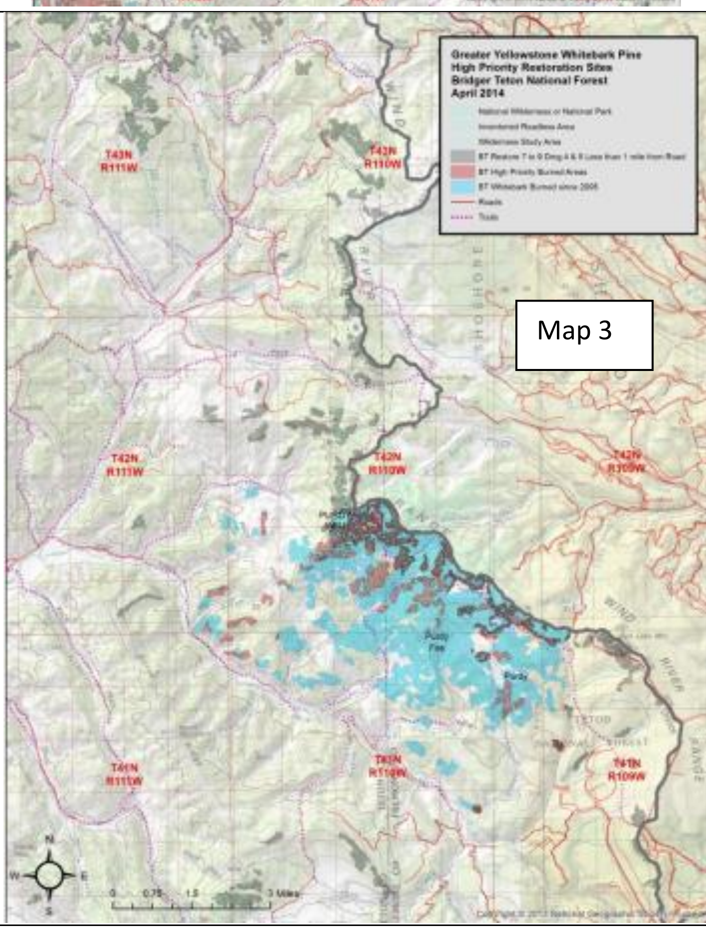
Restoration Target Areas –
Bridger Teton National Forest Vicinity Map

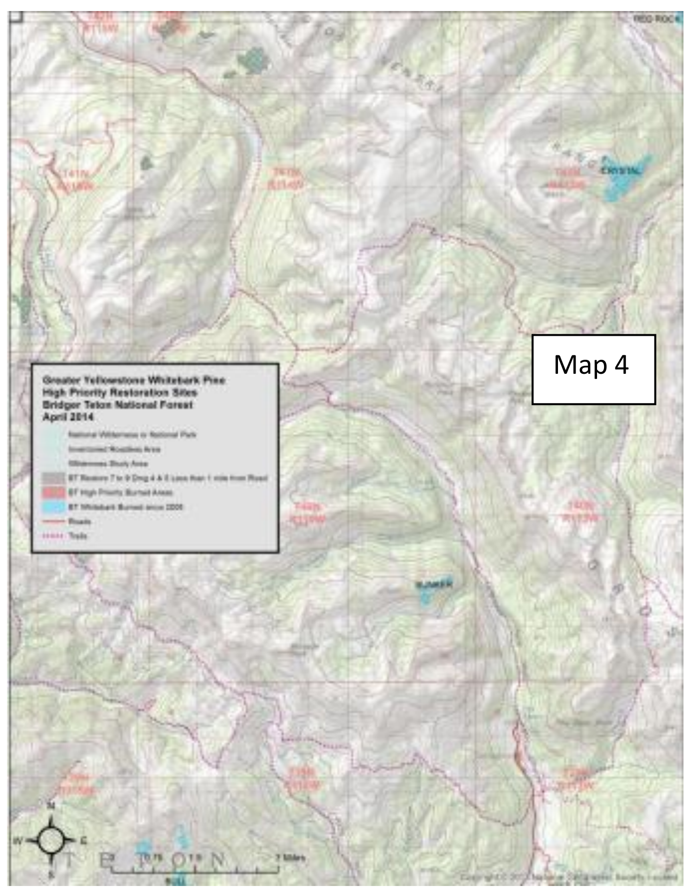


Restoration Target Areas – Bridger-Teton National Forest

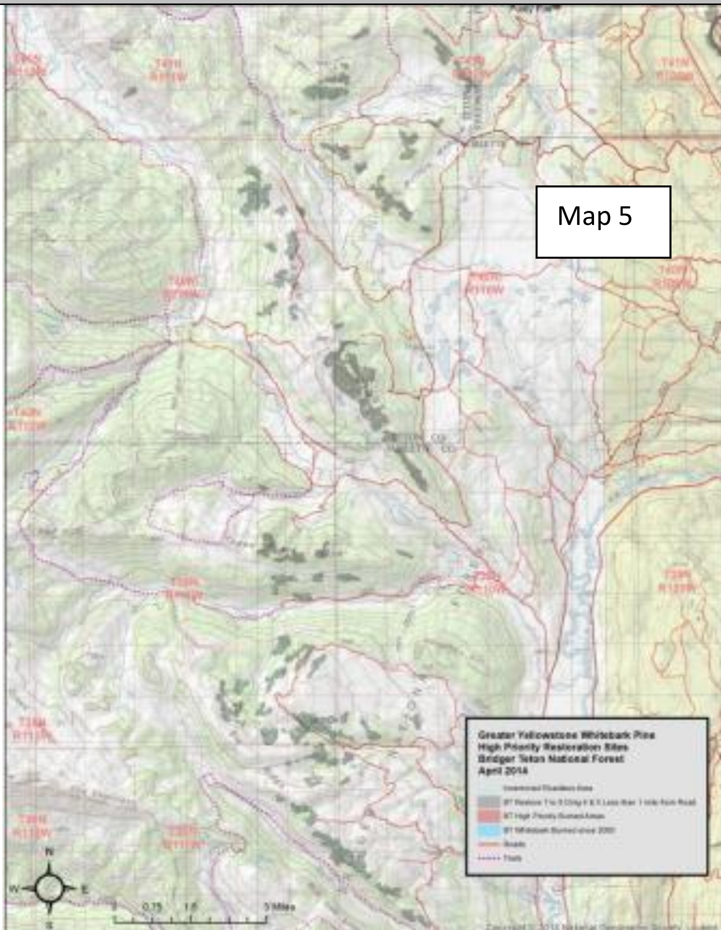


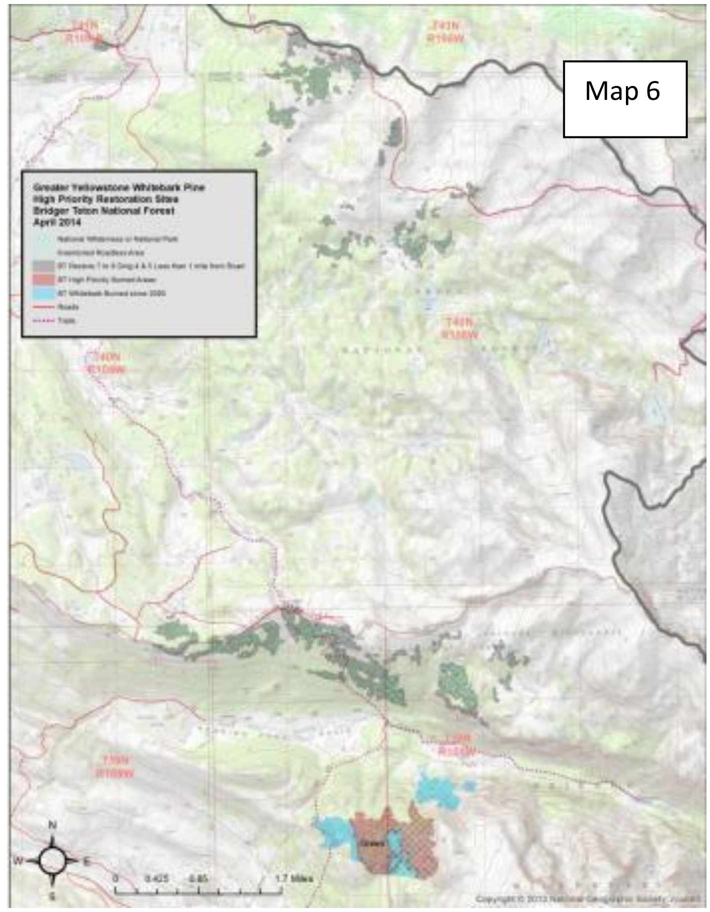


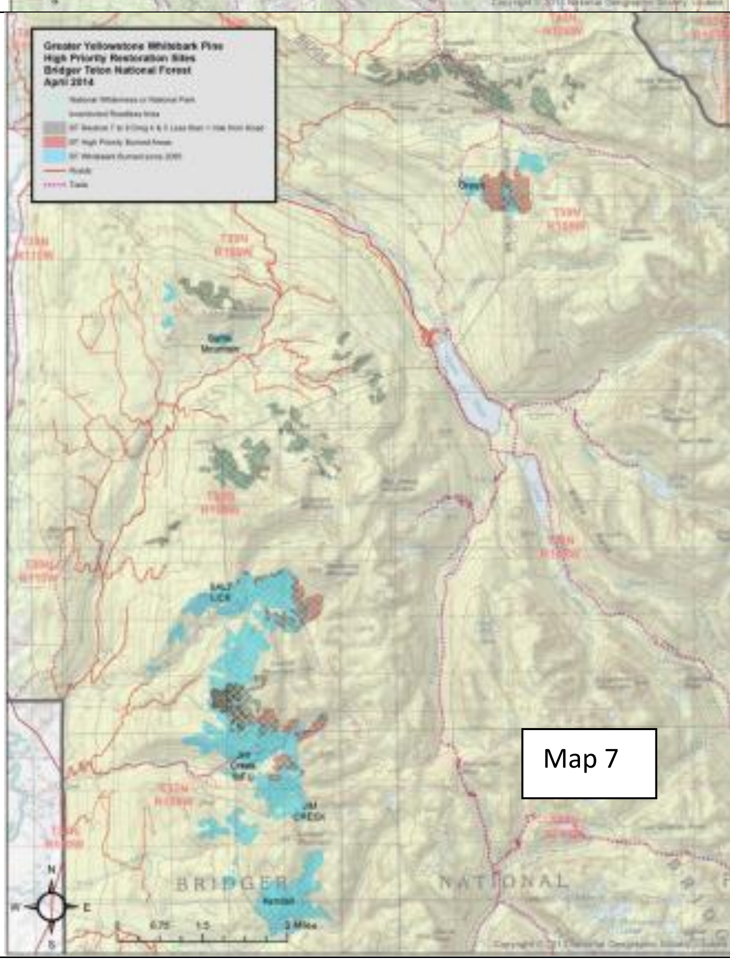


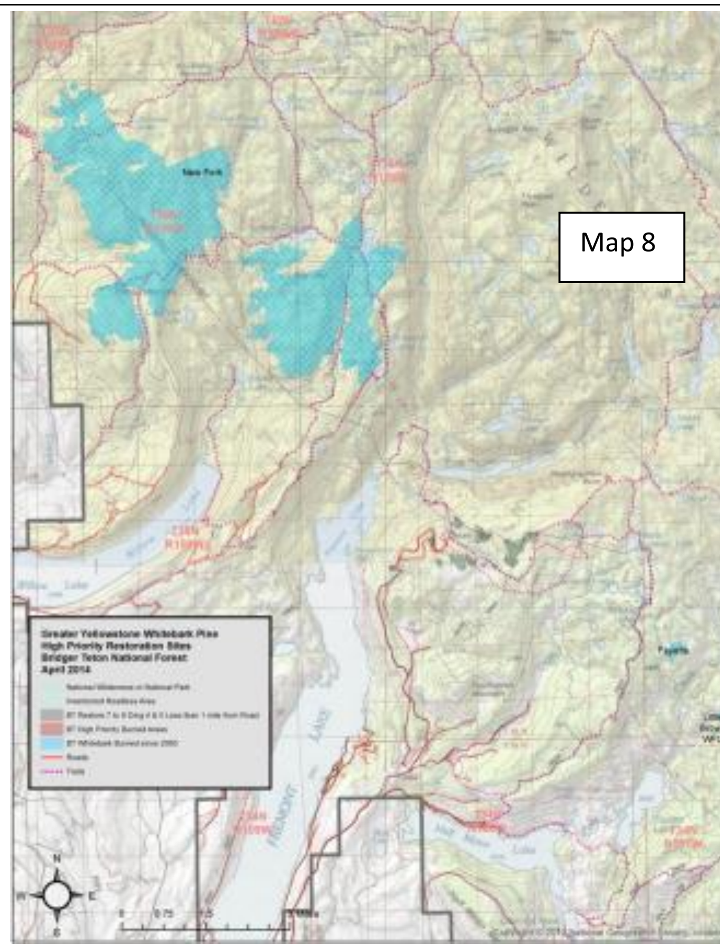


Restoration Target Areas – Bridger Teton National Forest

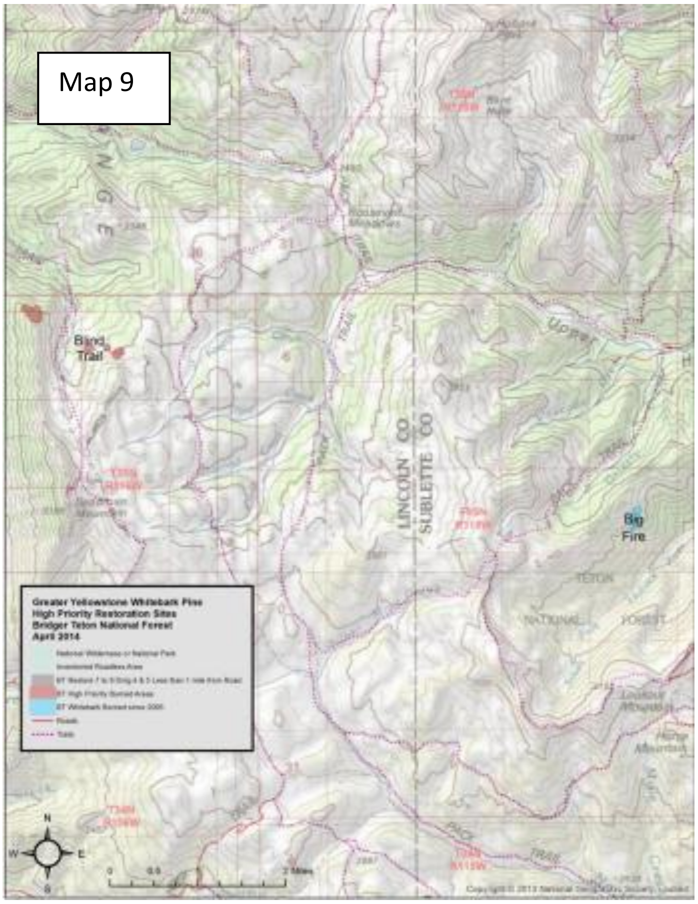


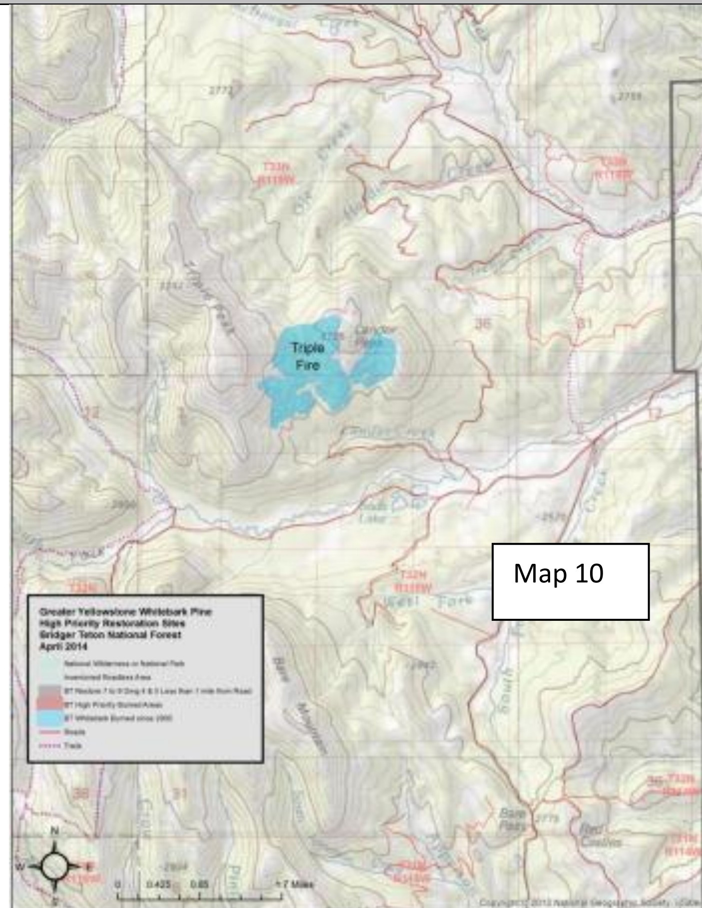


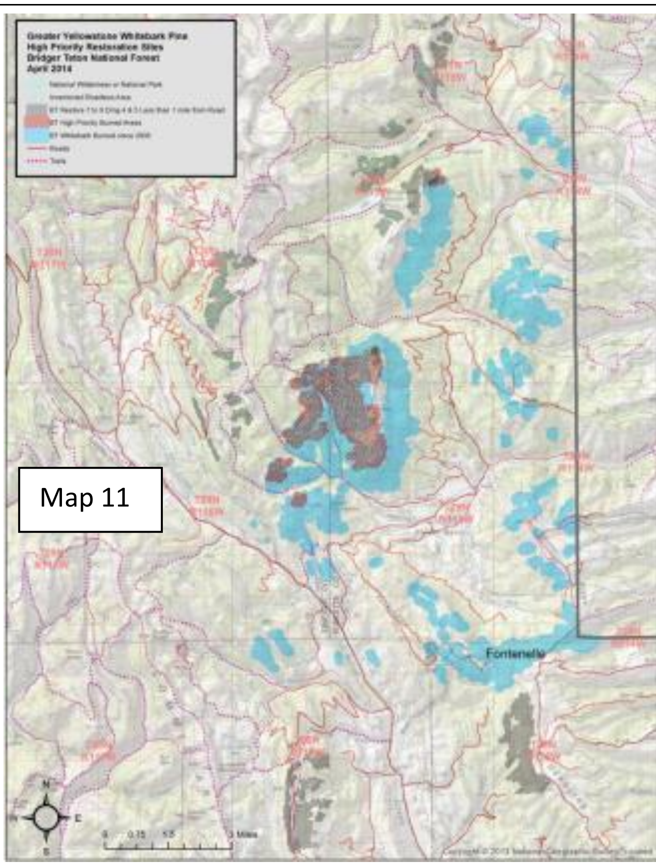


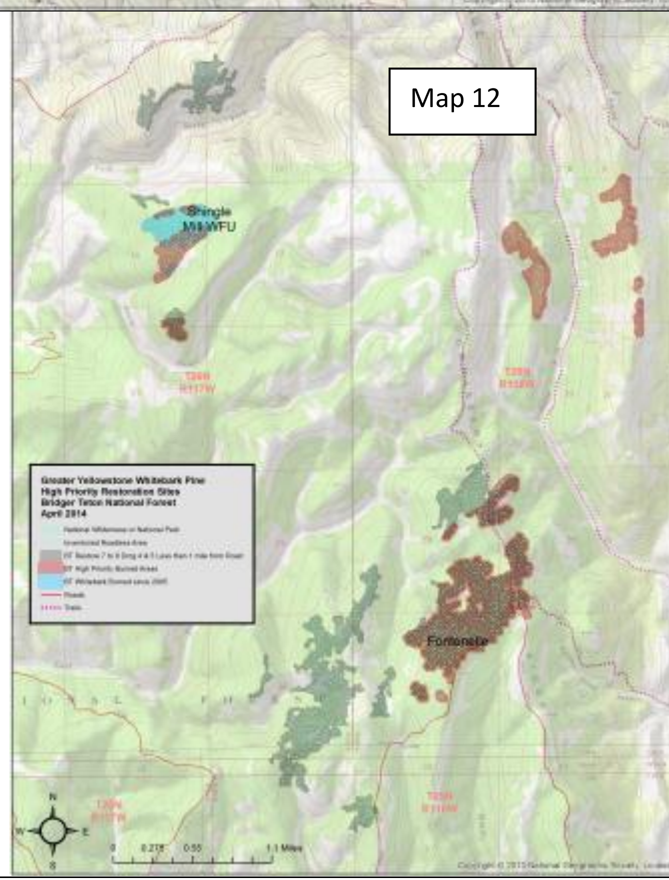


Restoration Target Areas – Bridger Teton National Forest

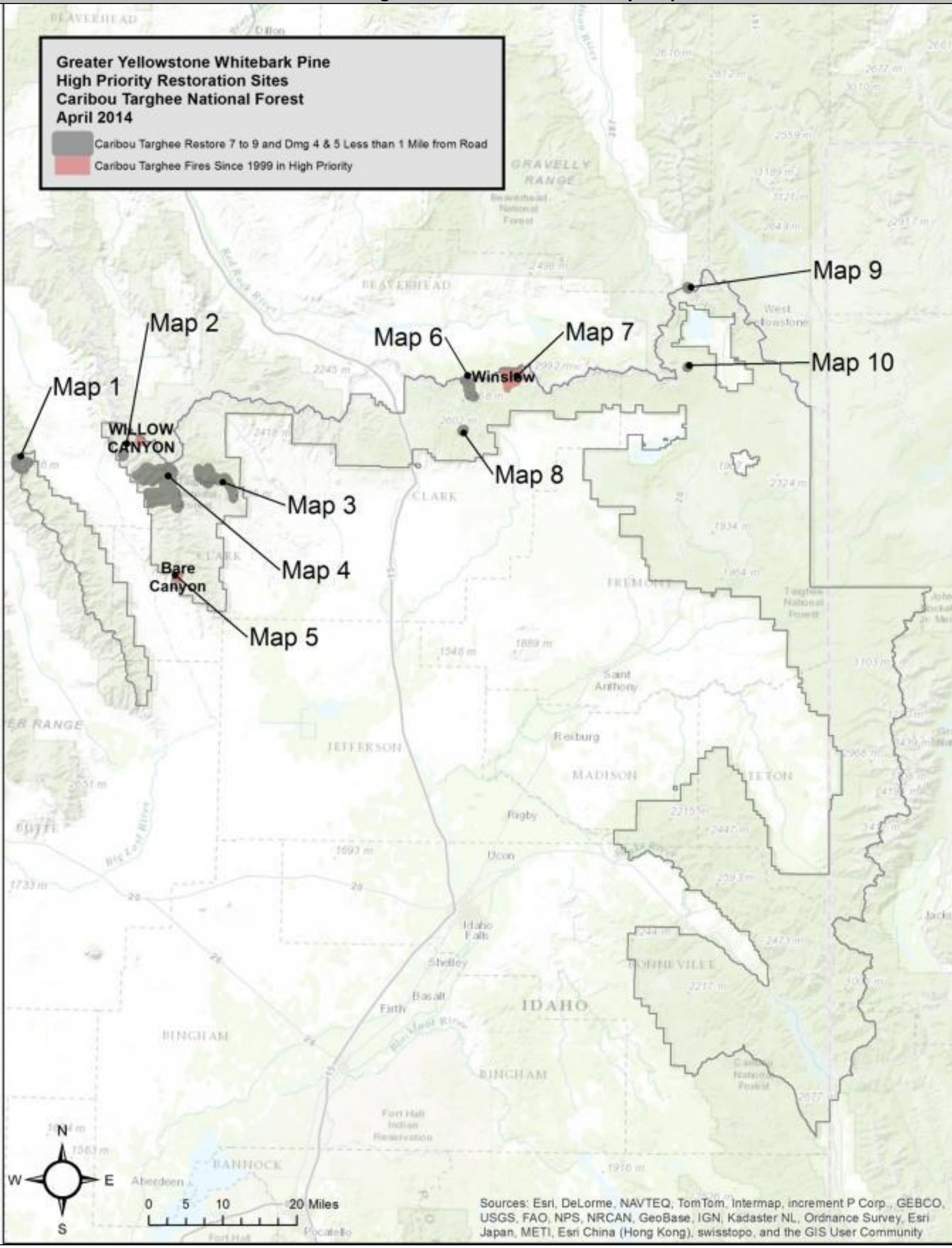




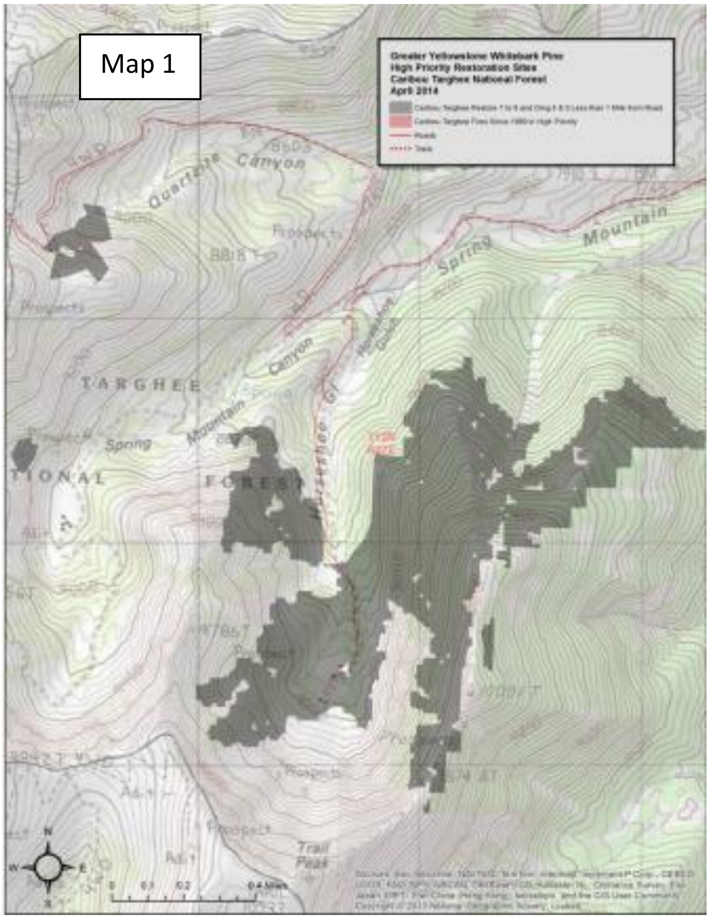


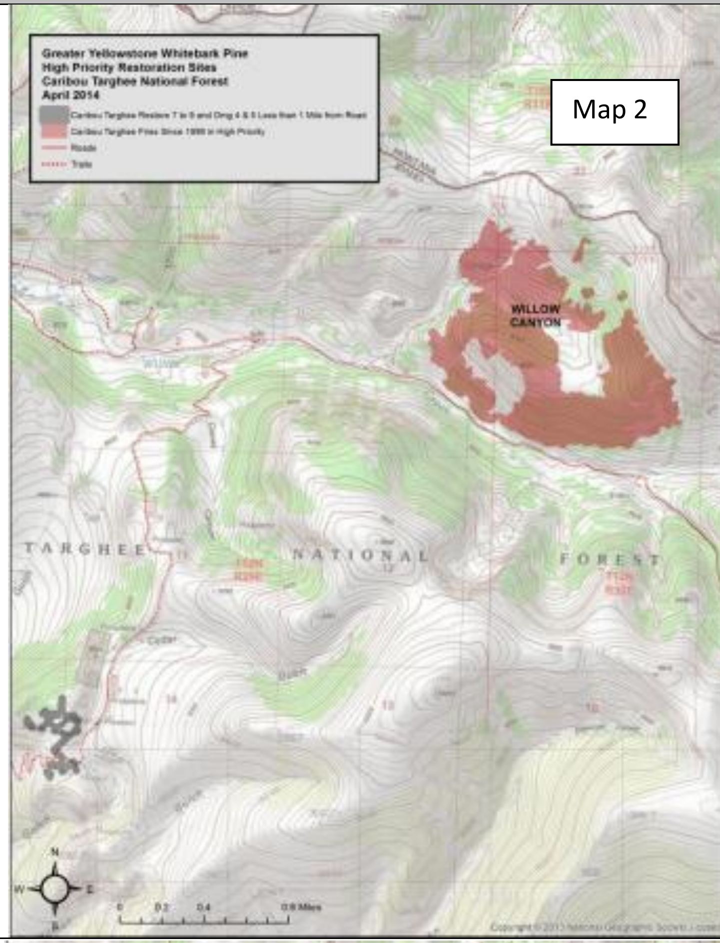


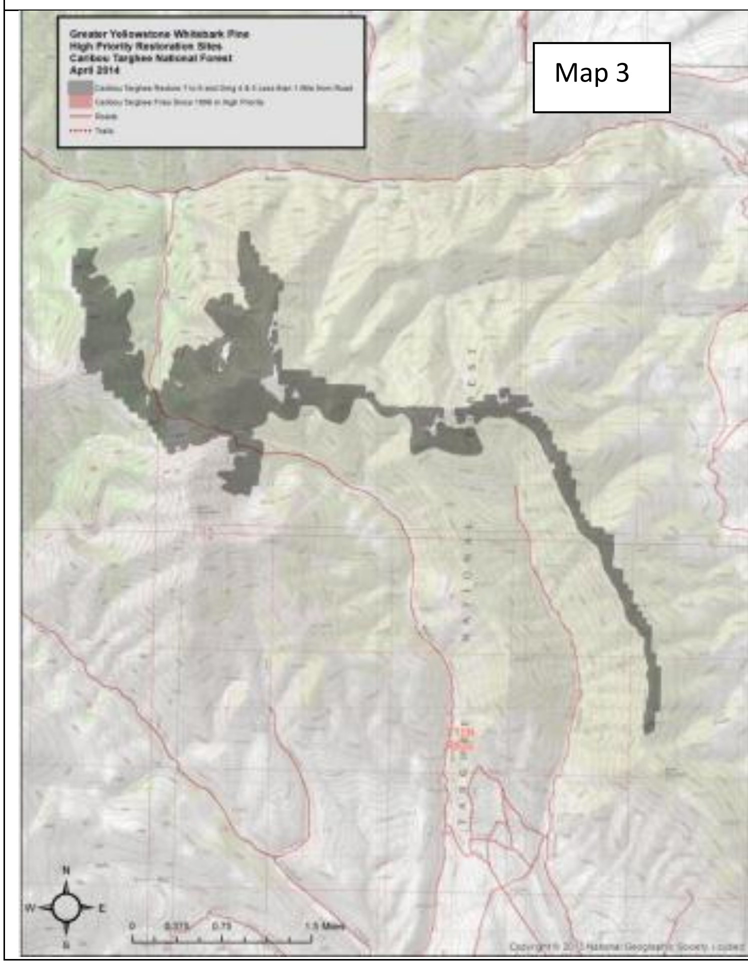
Restoration Target Areas – Caribou Targhee National Forest Vicinity Map

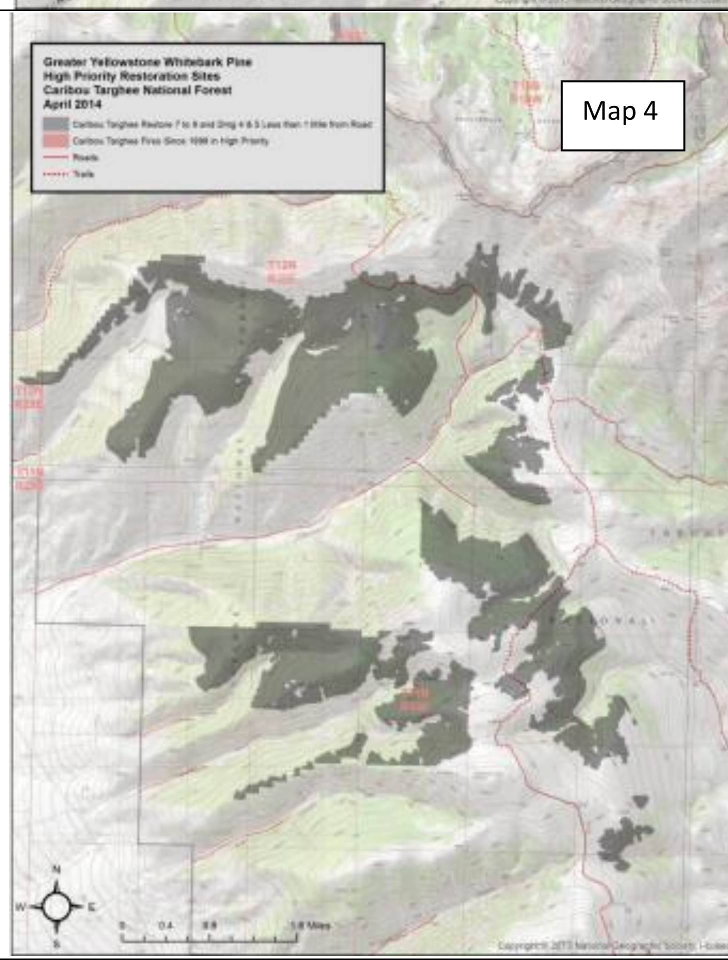


Restoration Target Areas – Caribou Targhee National Forest

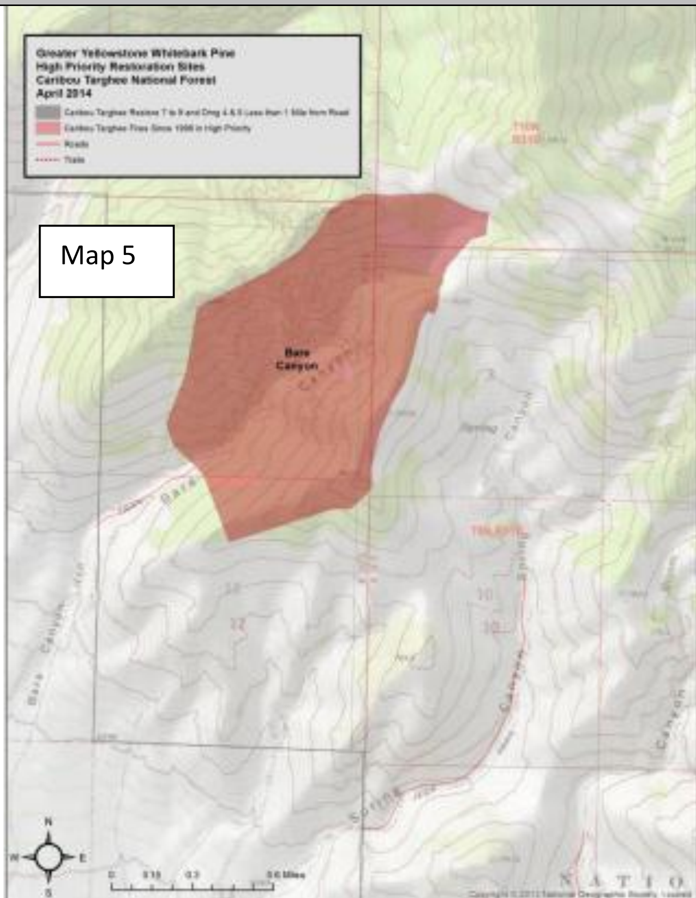


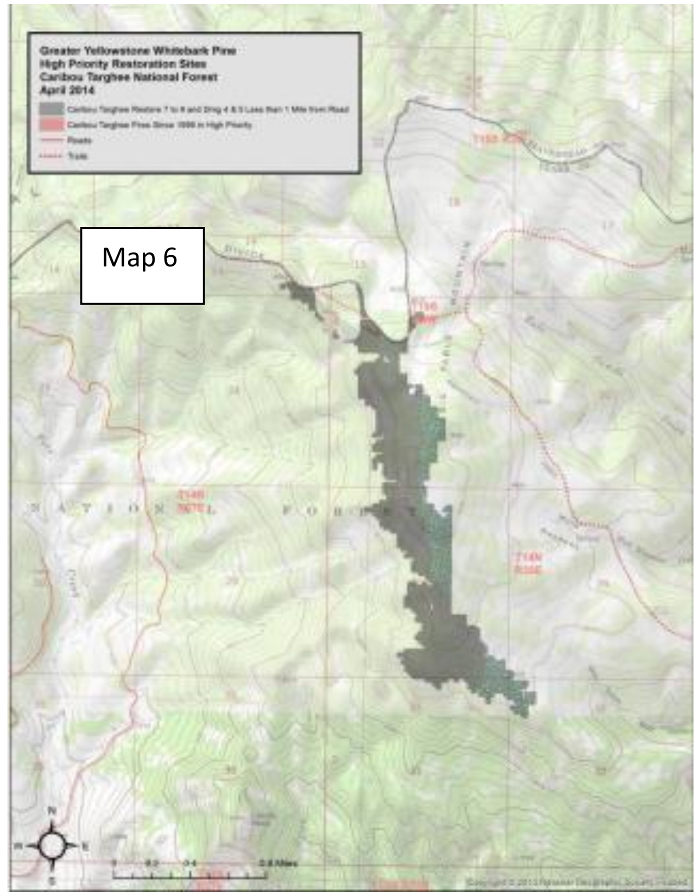


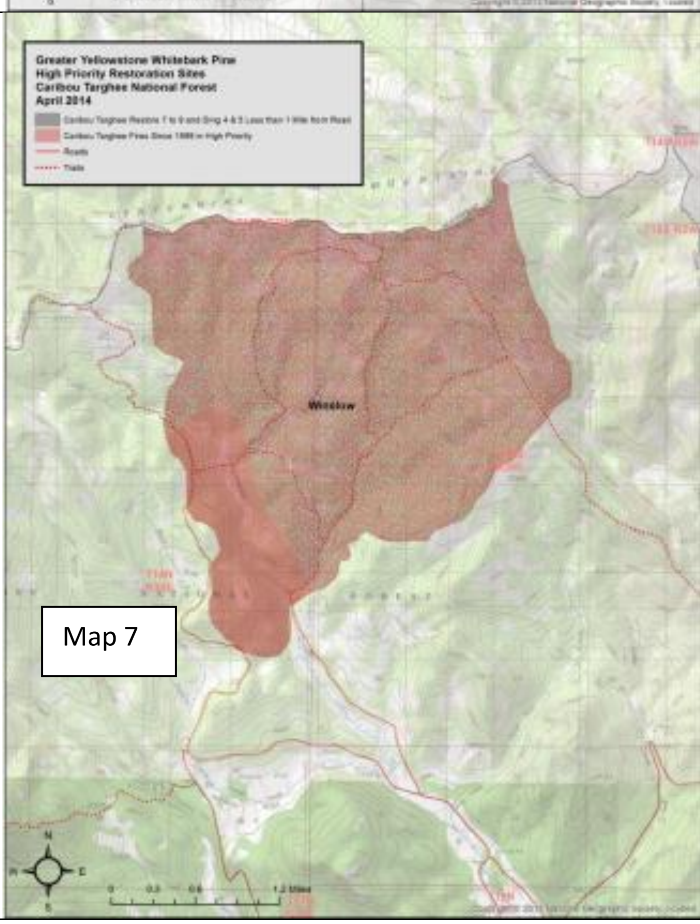


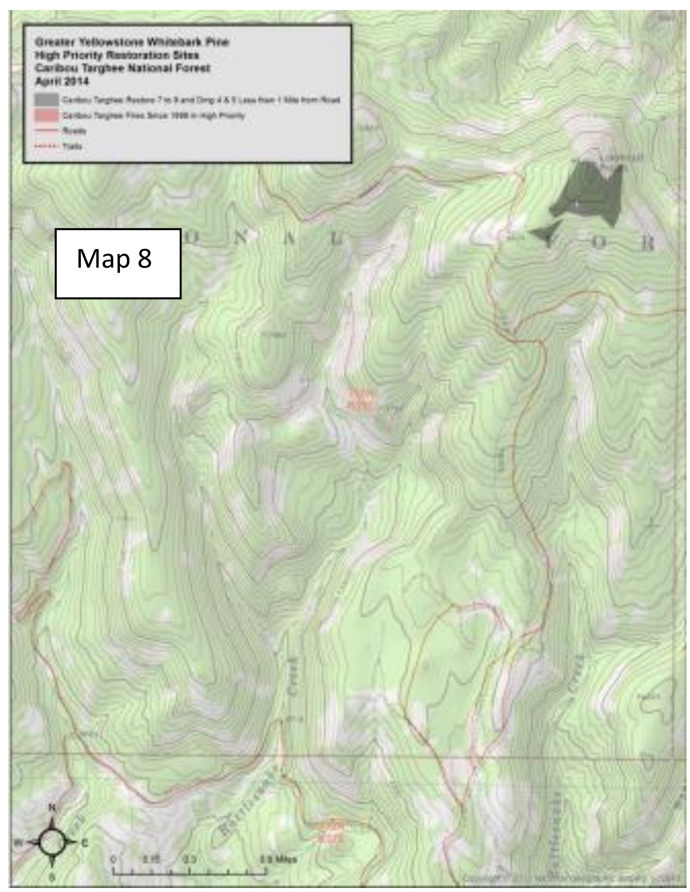


Restoration Target Areas – Caribou Targhee National Forest

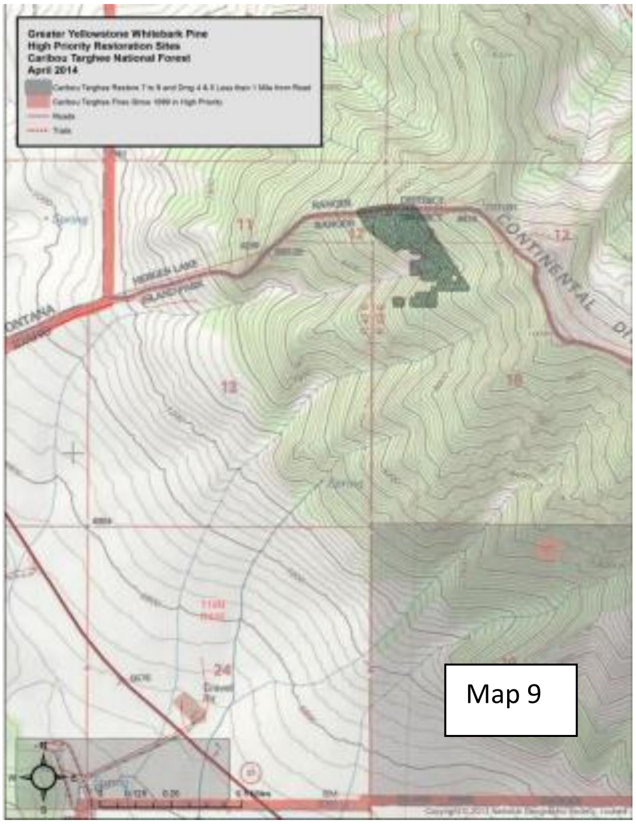


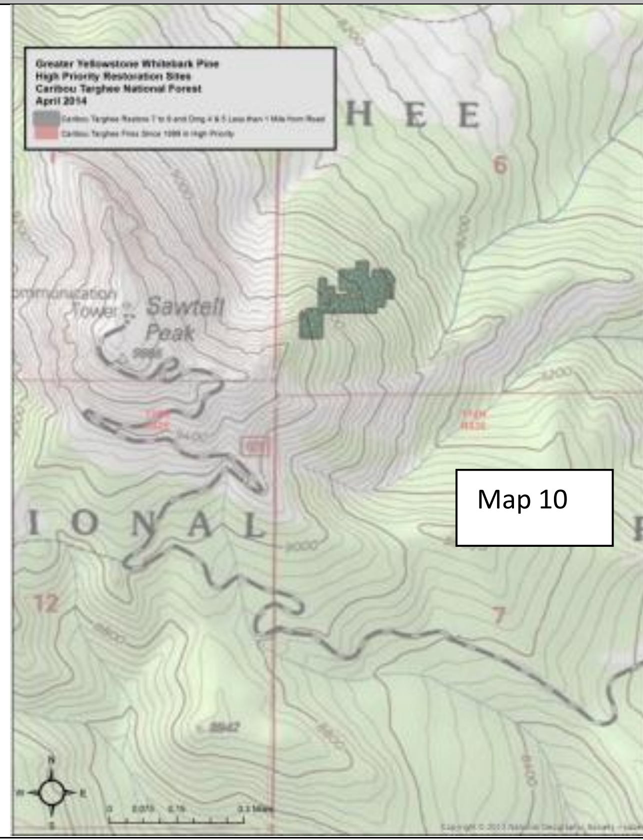




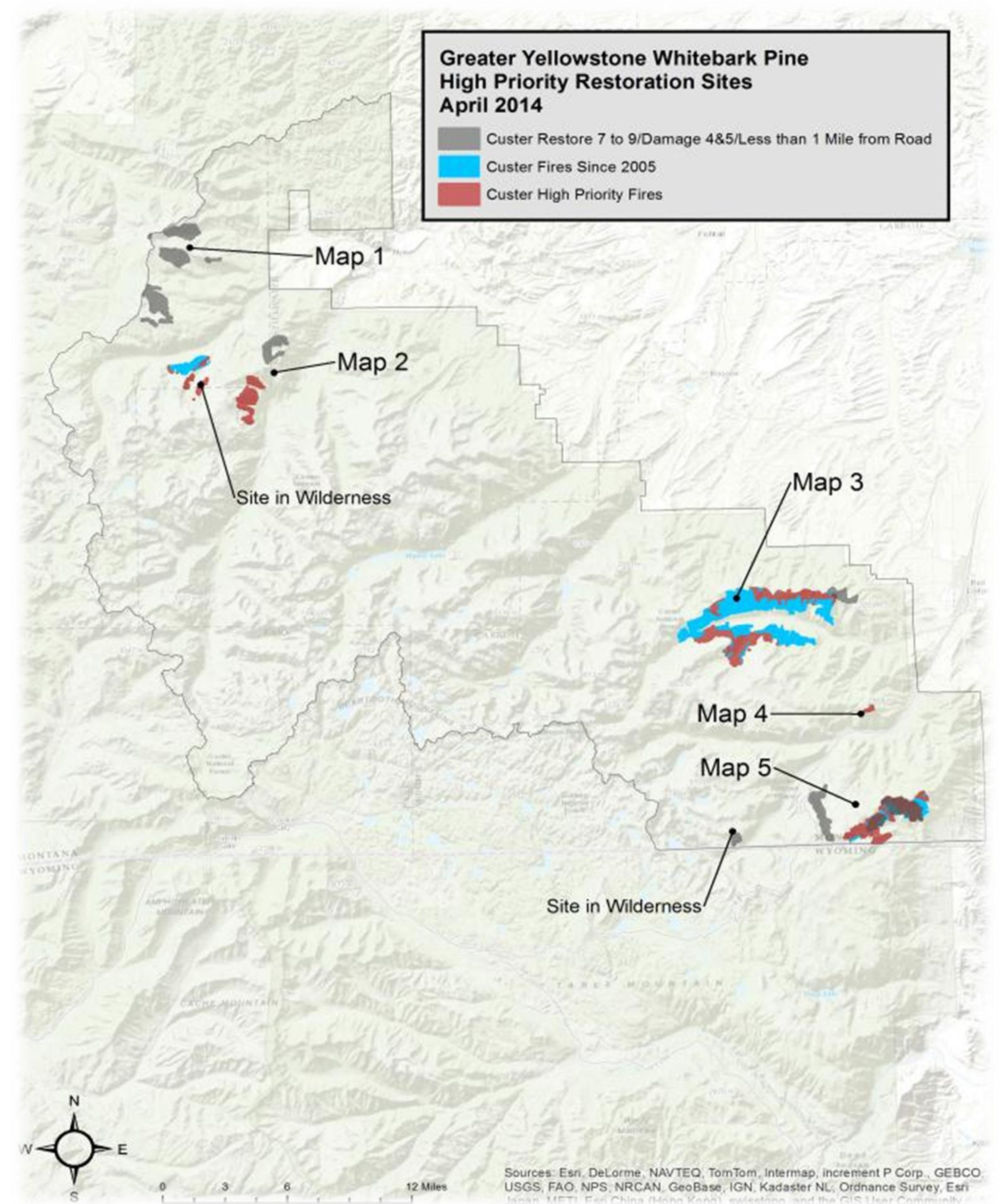


Restoration Target Areas – Caribou Targhee National Forest

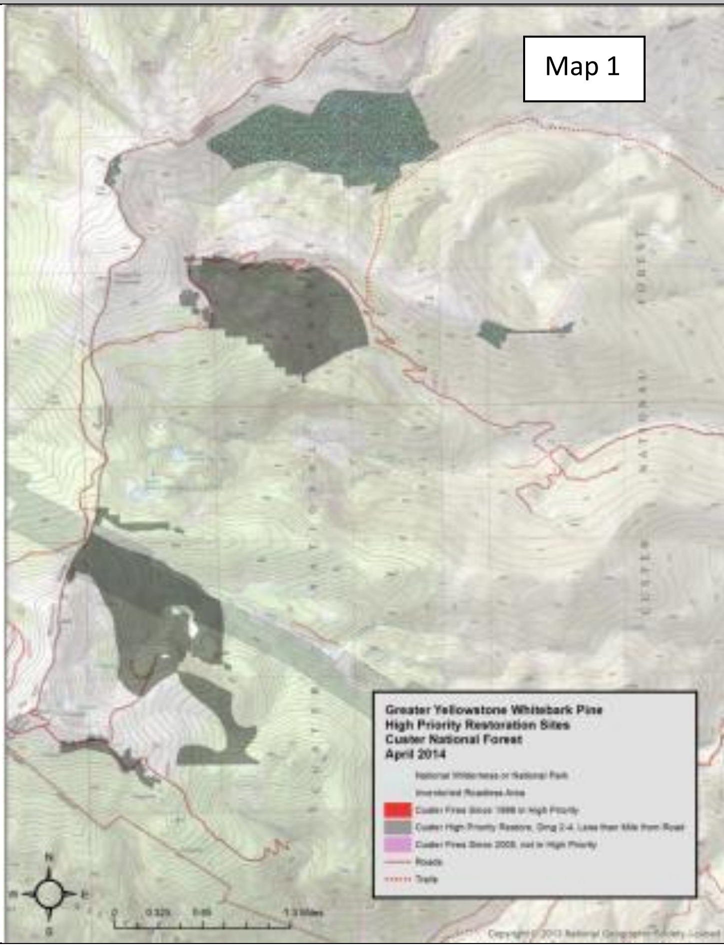


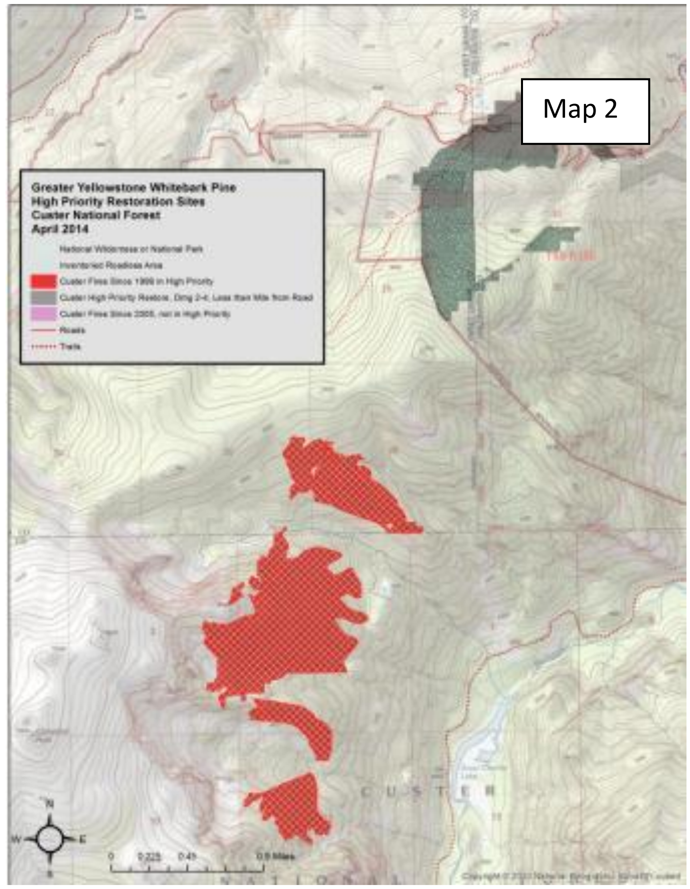


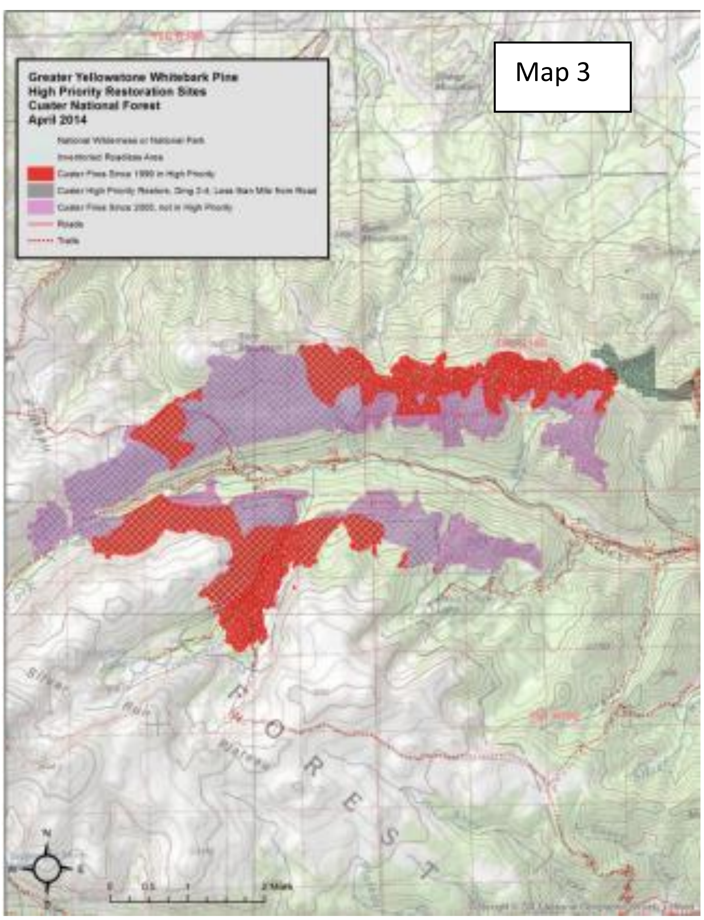
Restoration Target Areas – Custer National Forest Vicinity Map

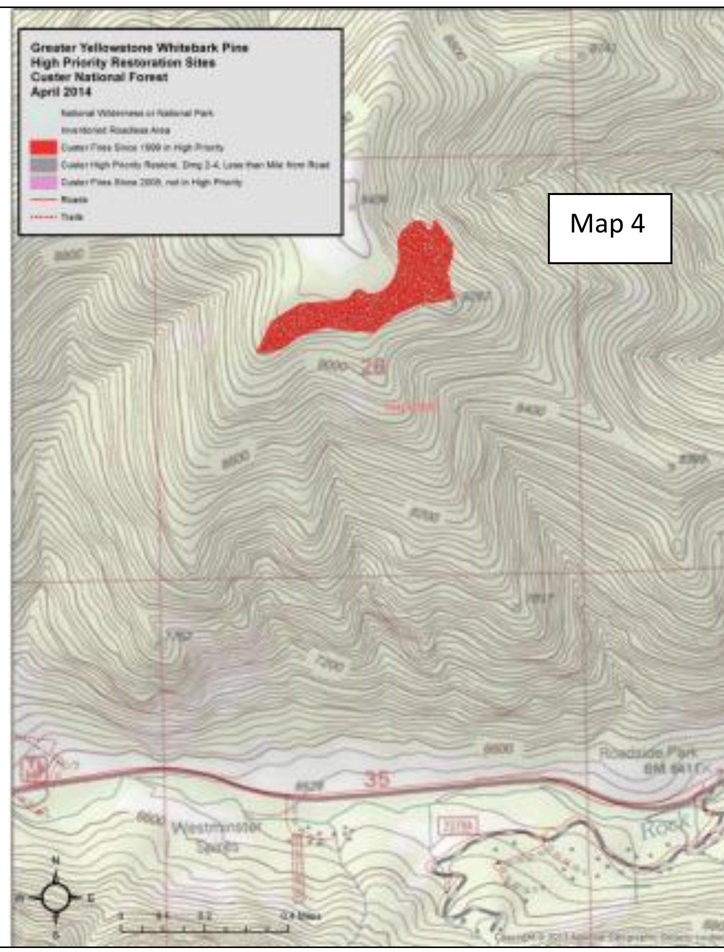


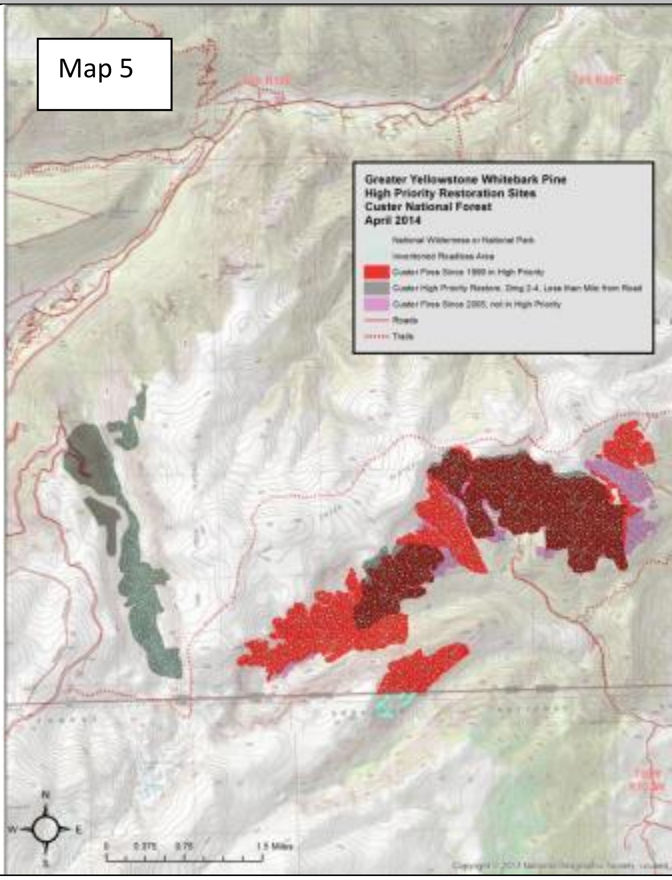
Restoration Target Areas – Custer National Forest



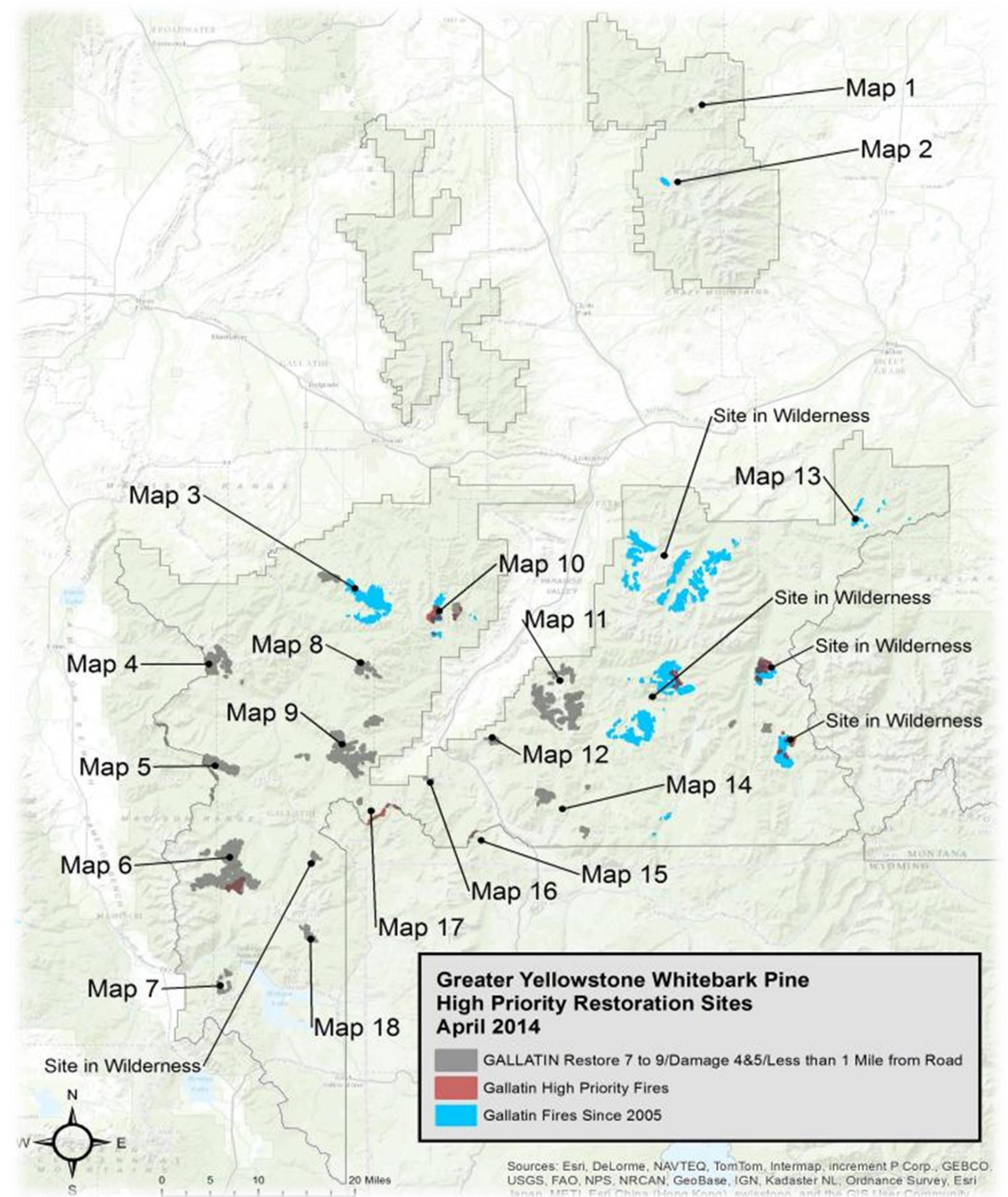




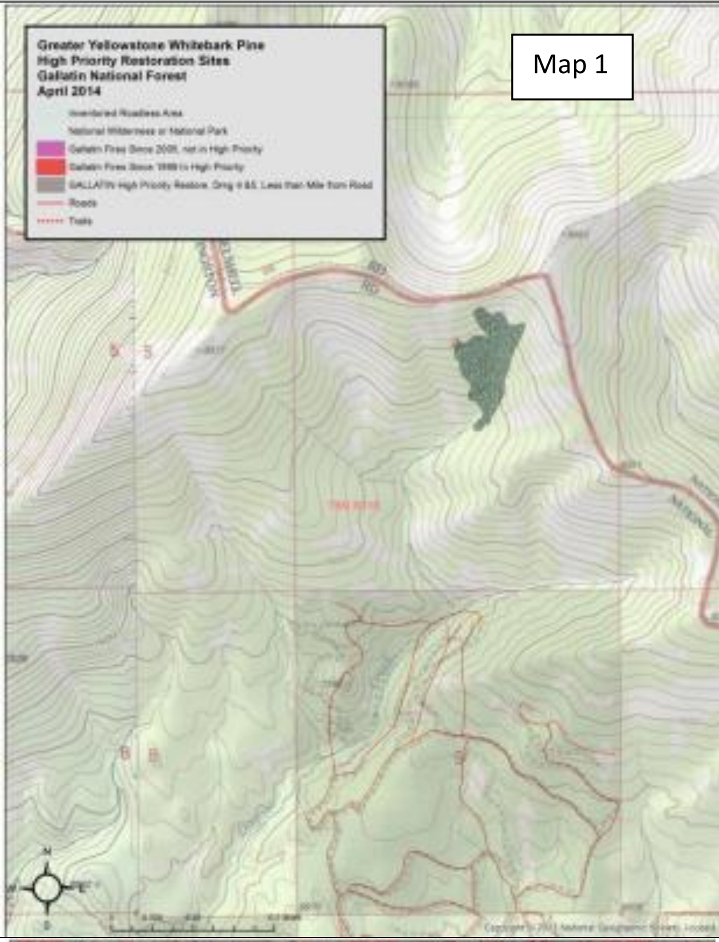


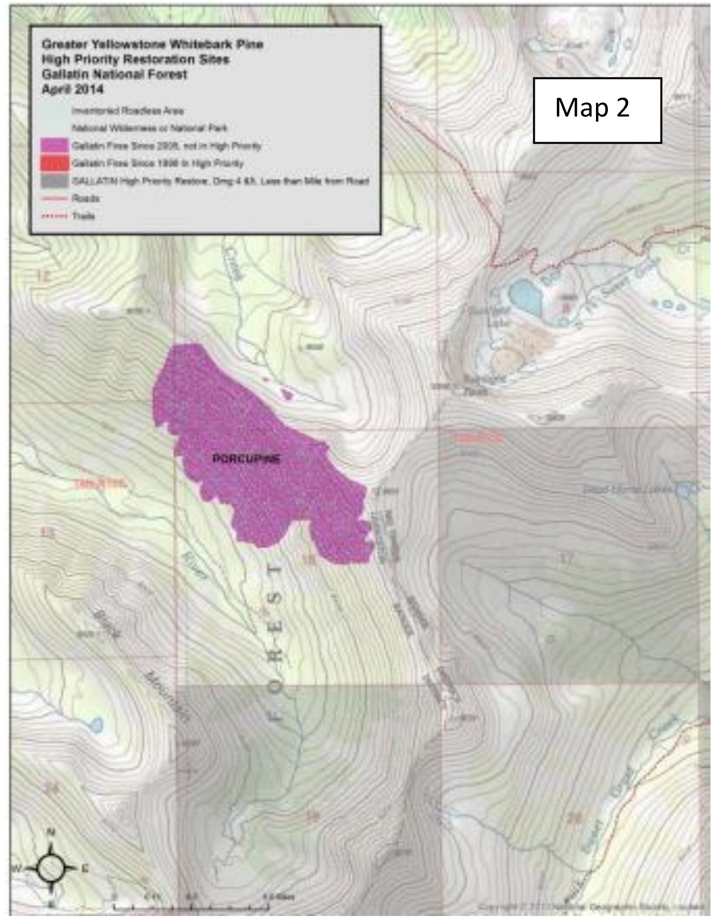
Restoration Target Areas – Custer National Forest	
	

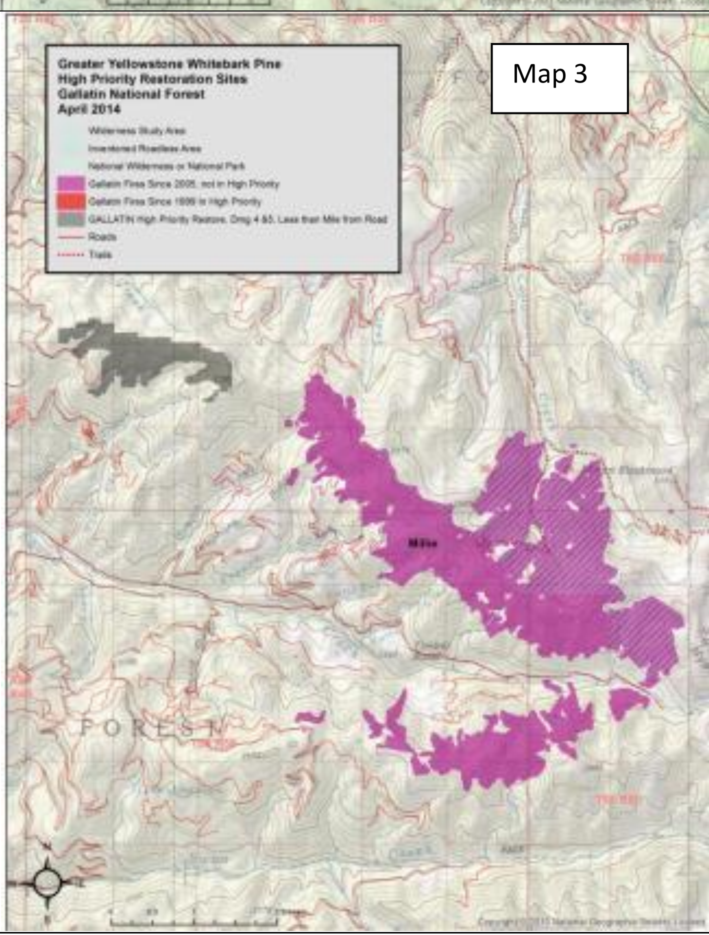
Restoration Target Areas –
Gallatin National Forest Vicinity Map

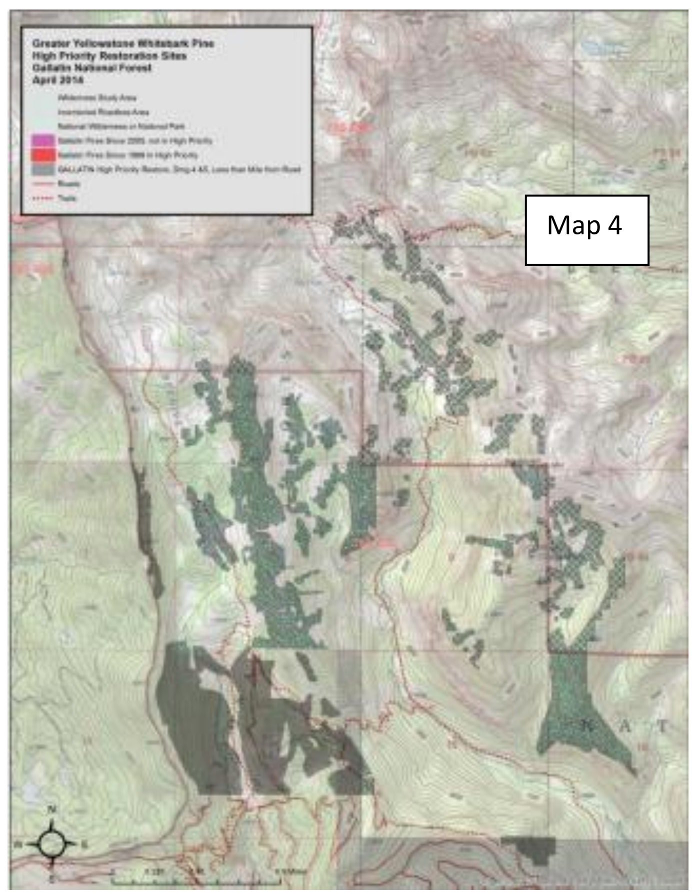


Restoration Target Areas – Gallatin National Forest

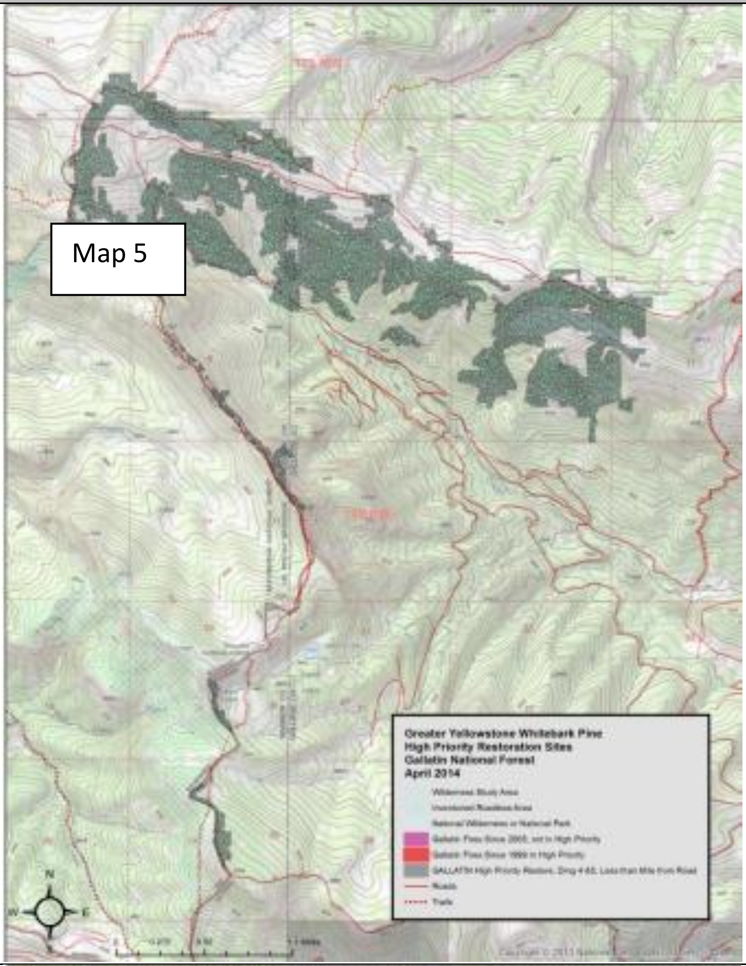


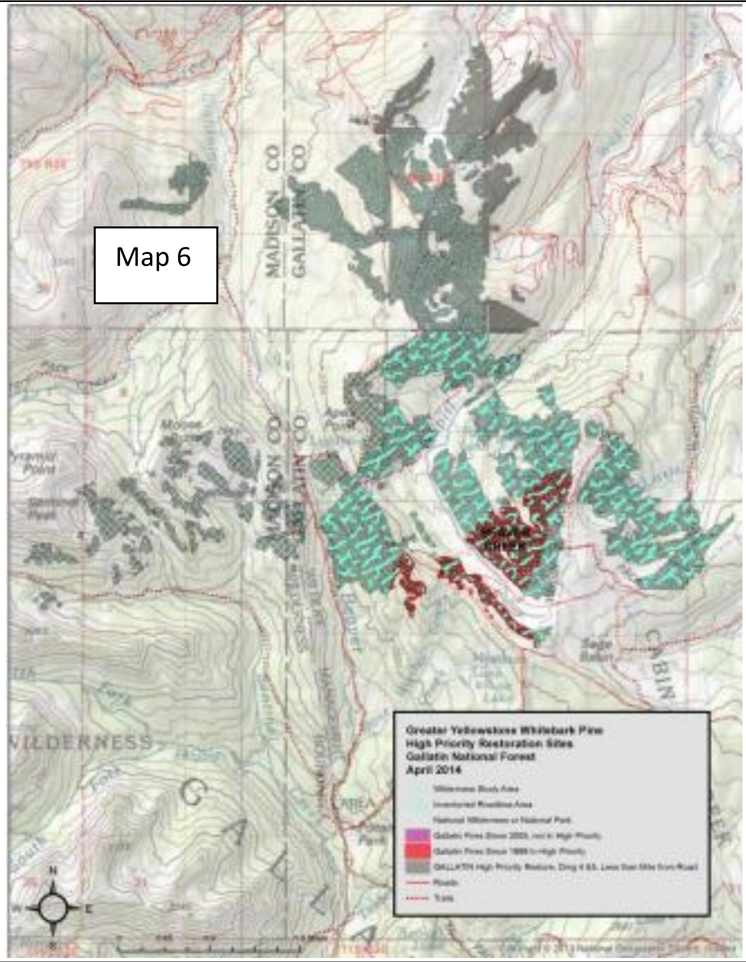


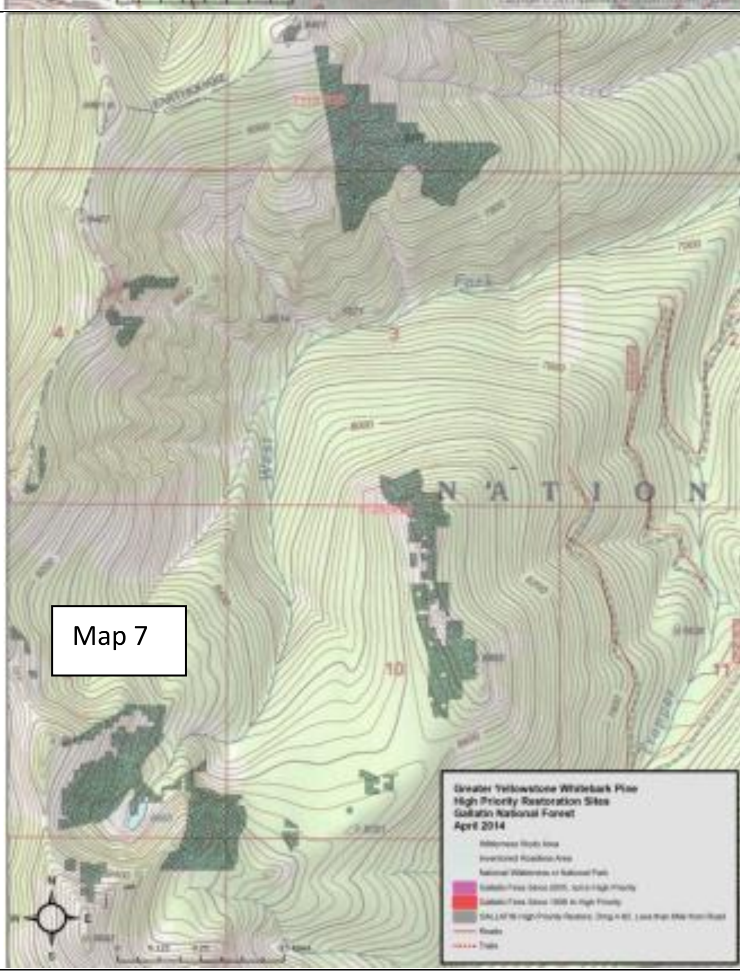


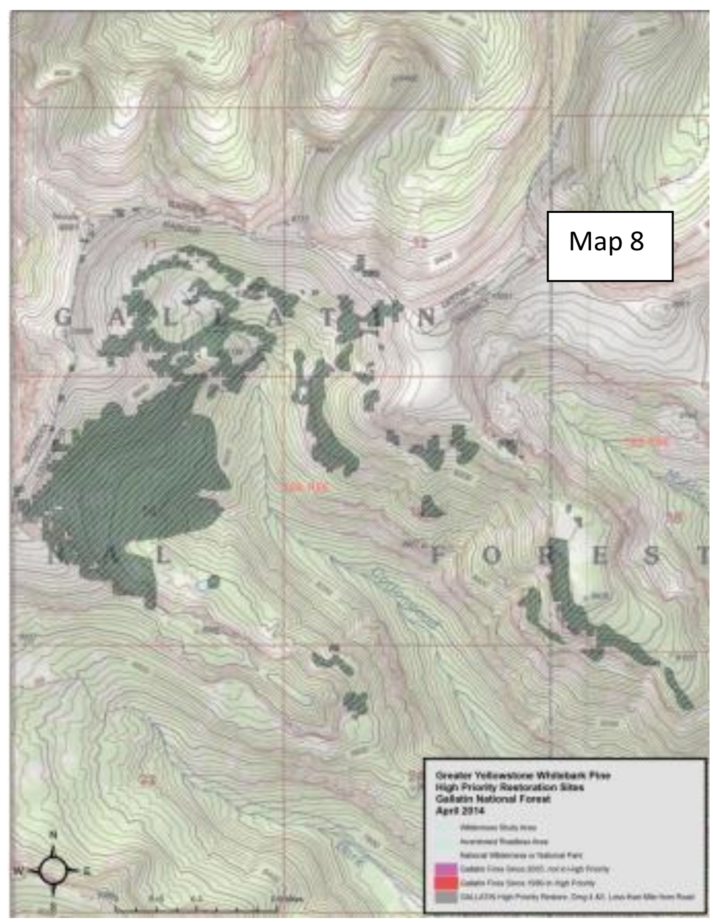


Restoration Target Areas – Gallatin National Forest

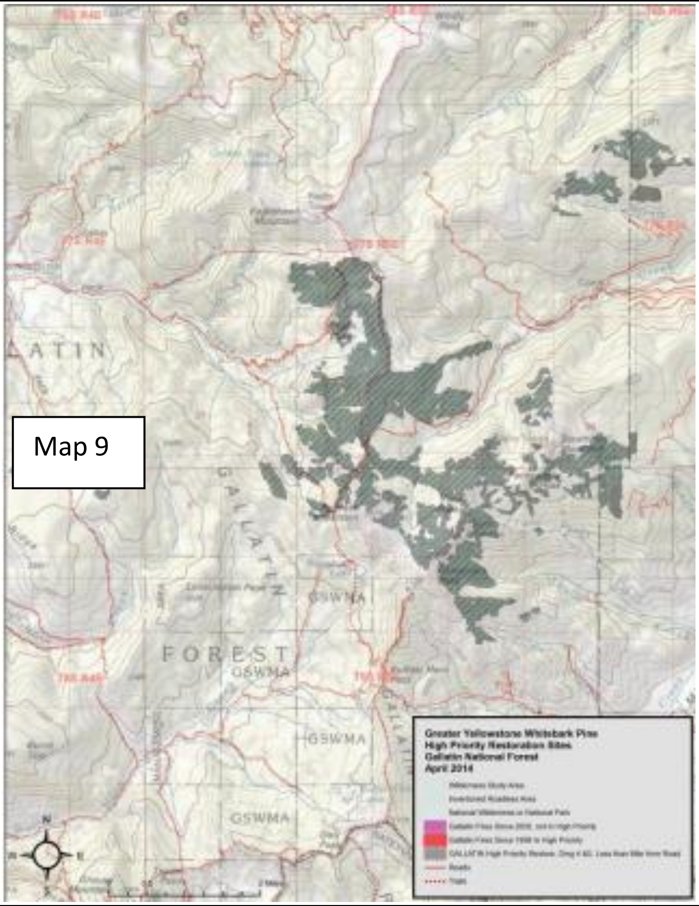


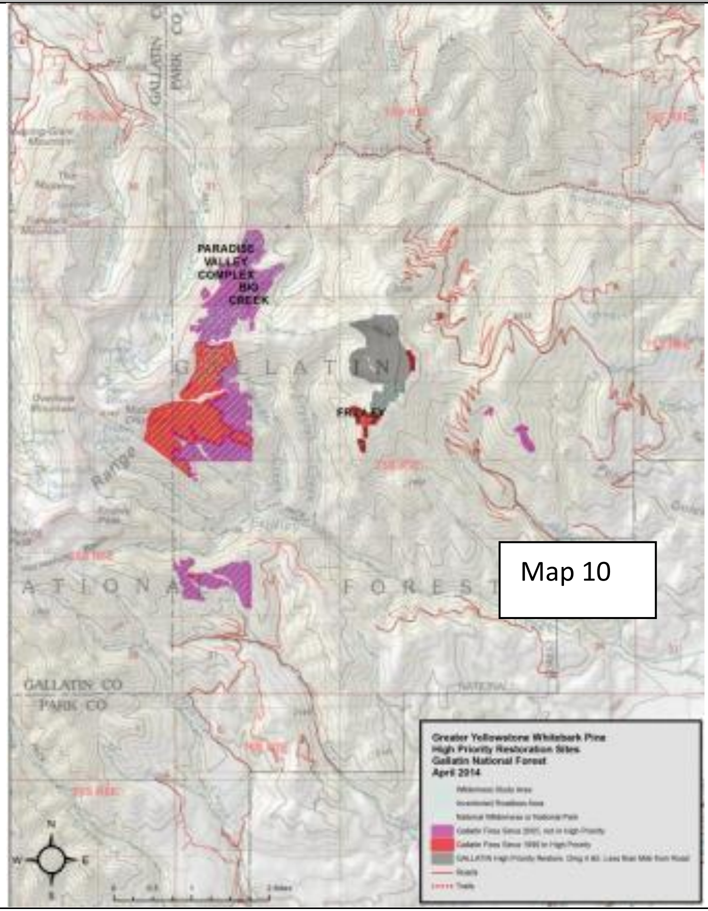


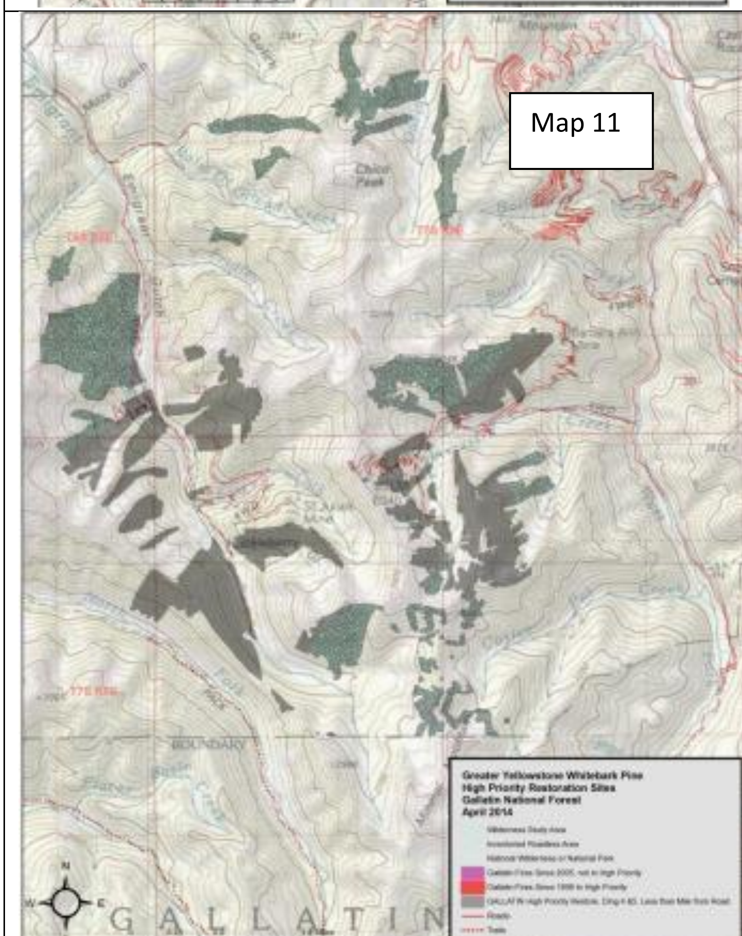


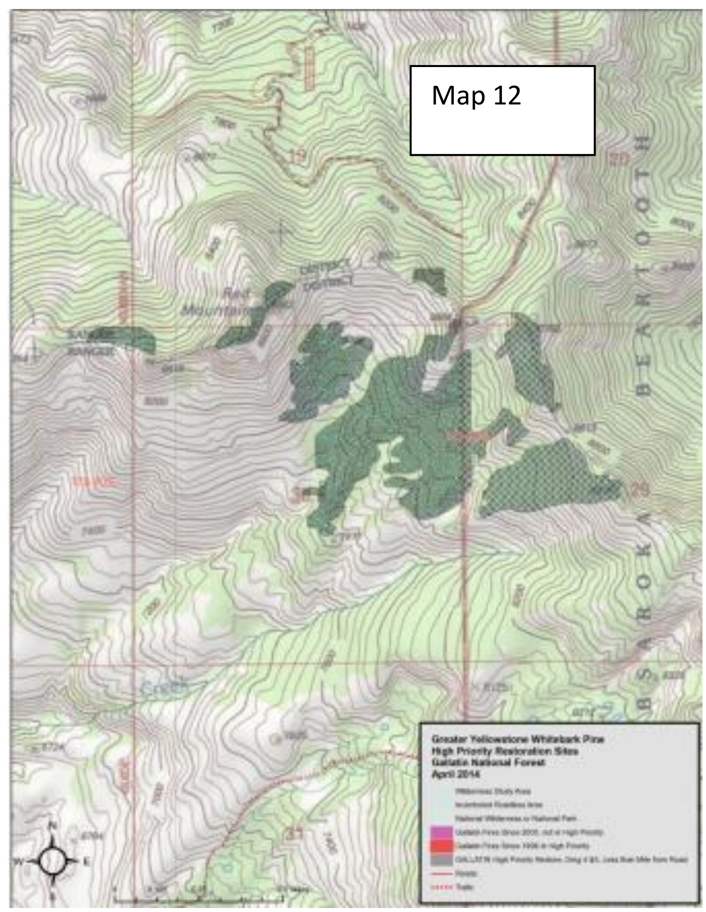


Restoration Target Areas - Gallatin National Forest

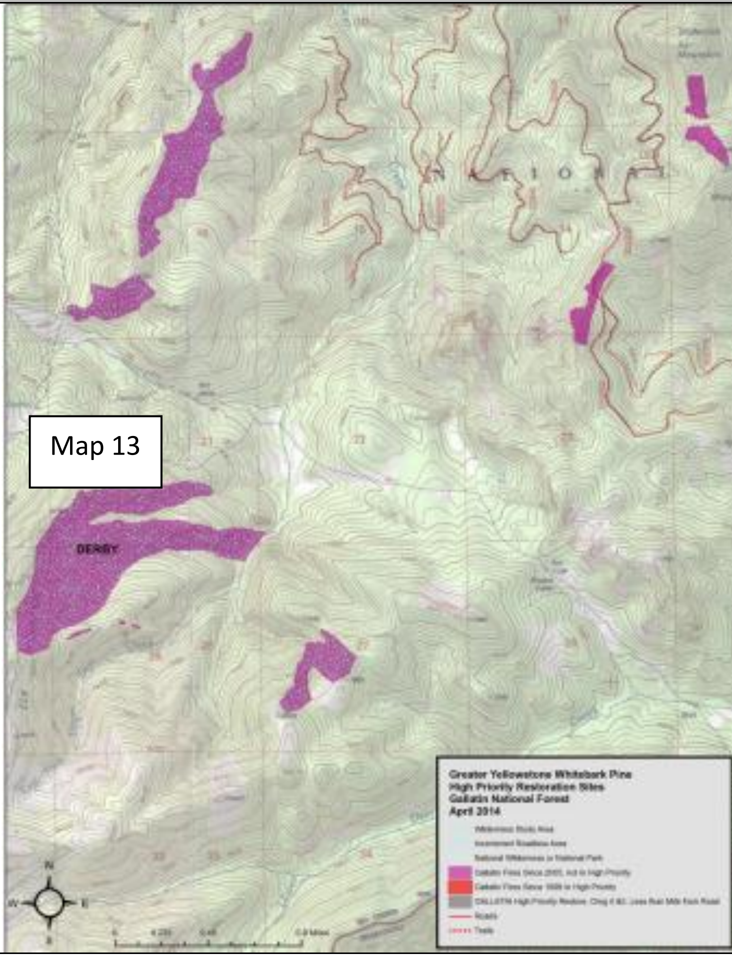


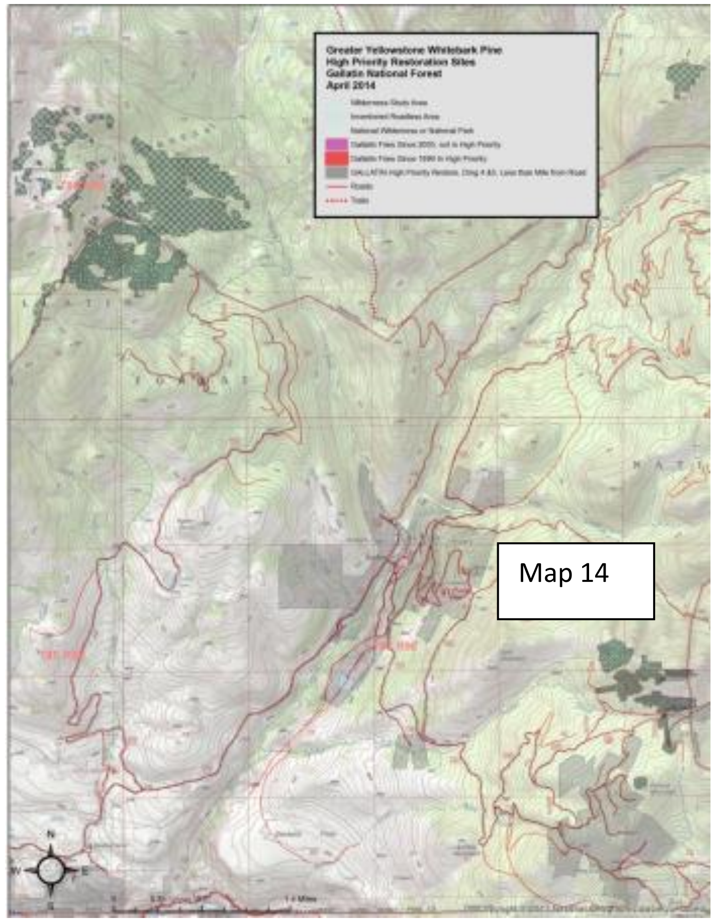


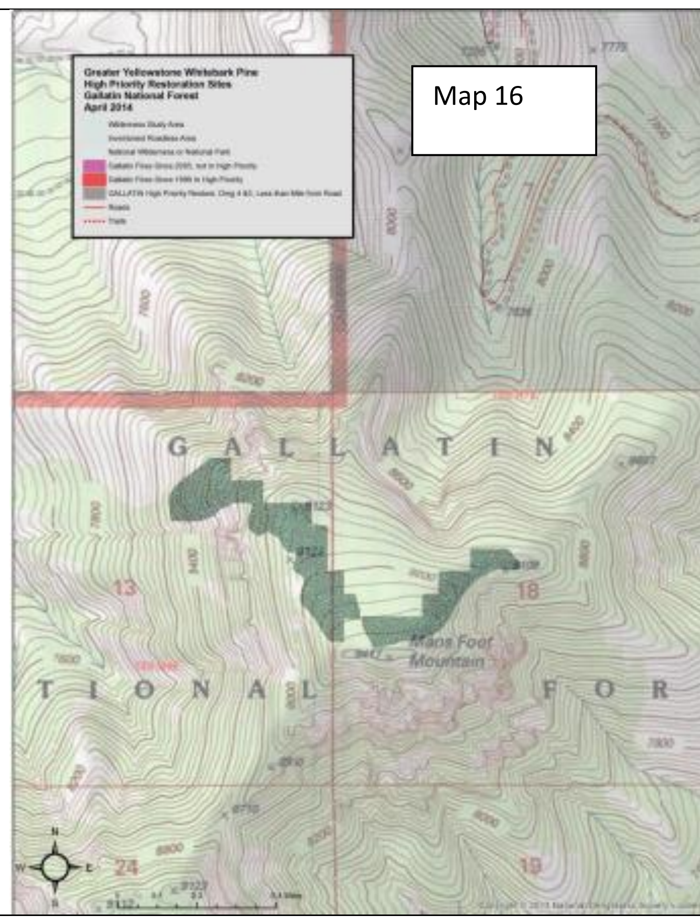




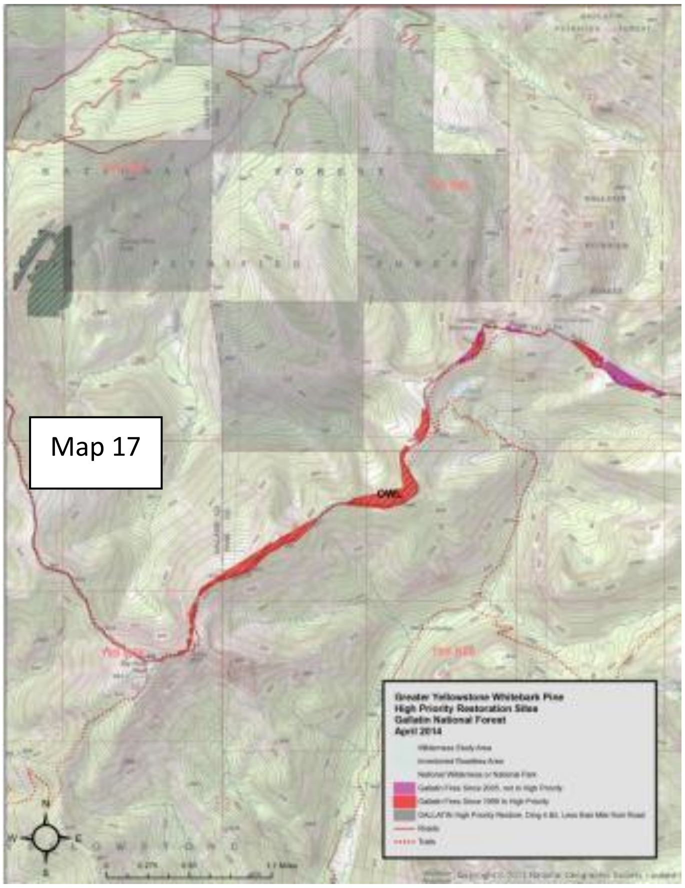
Restoration Target Areas - Gallatin National Forest

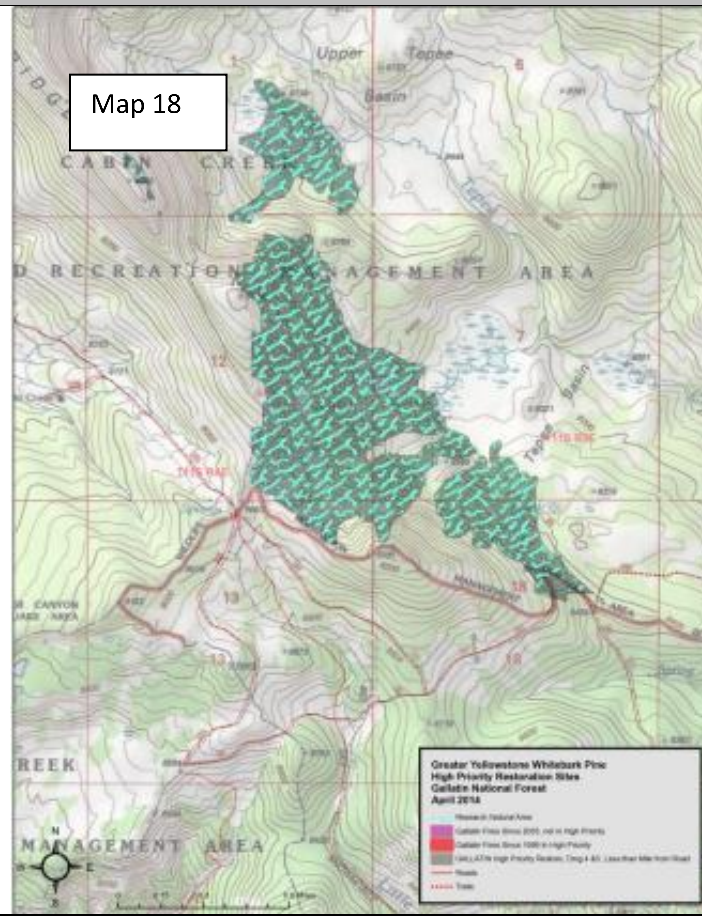




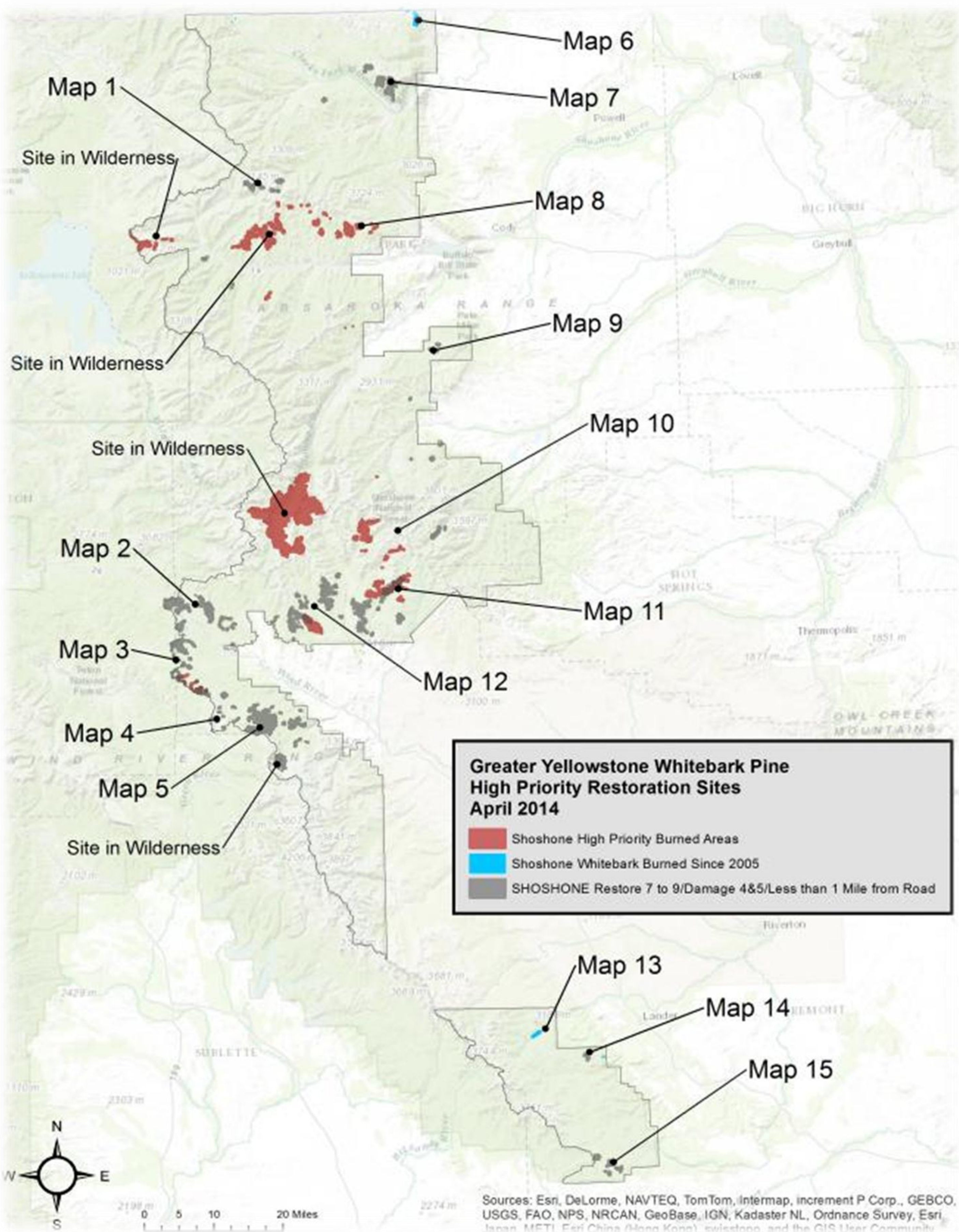


Restoration Target Areas - Gallatin National Forest

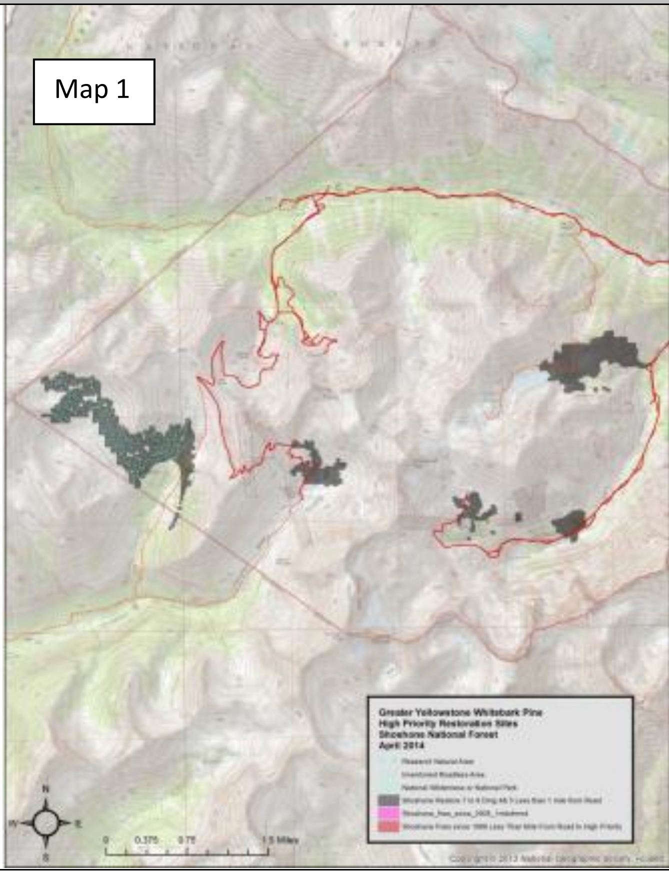


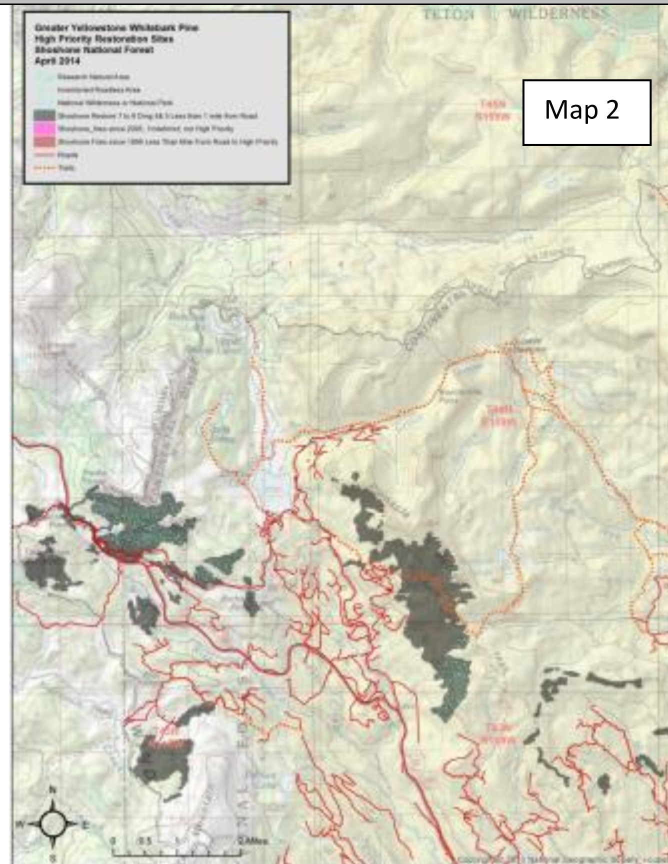


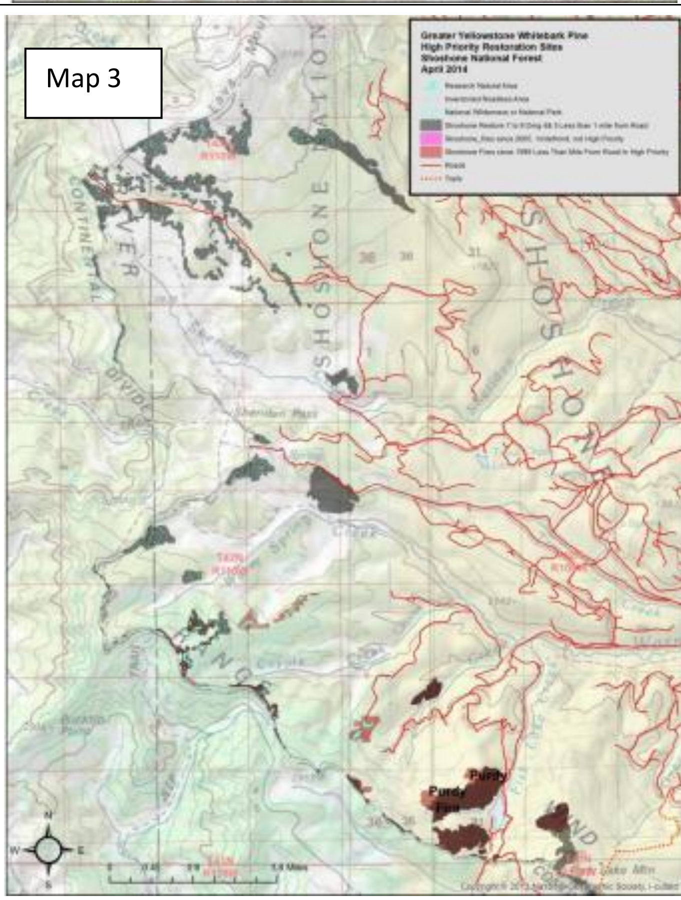
Restoration Target Areas –
Shoshone National Forest Vicinity Map

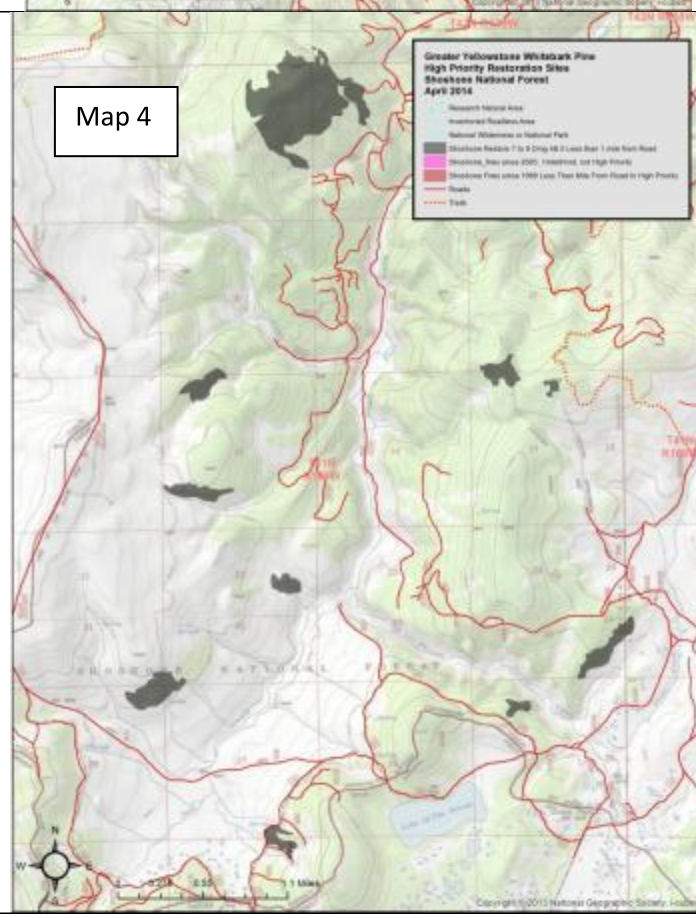


Restoration Target Areas – Shoshone National Forest

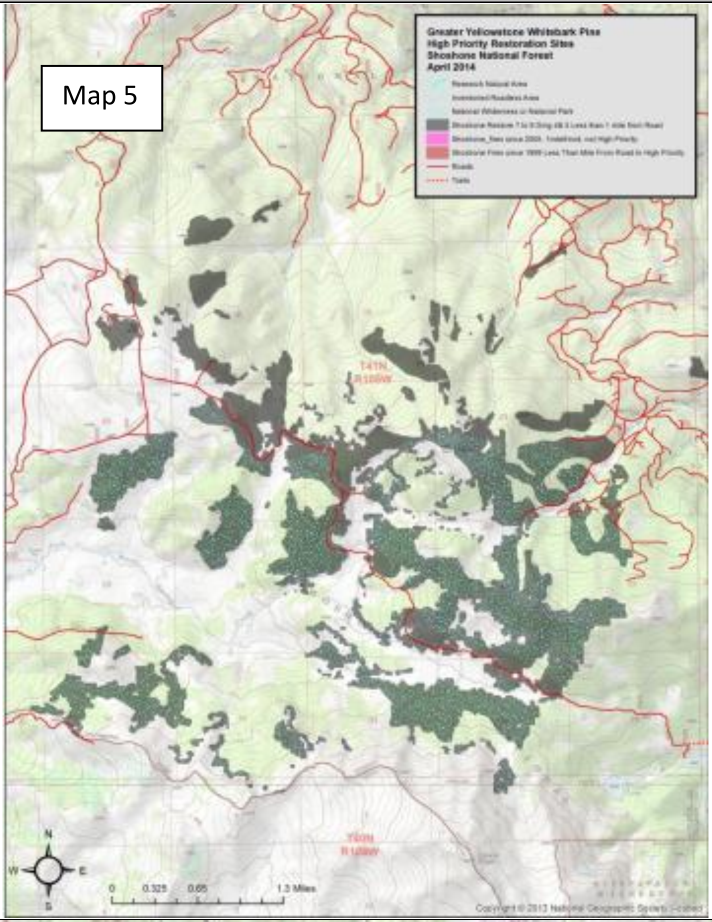


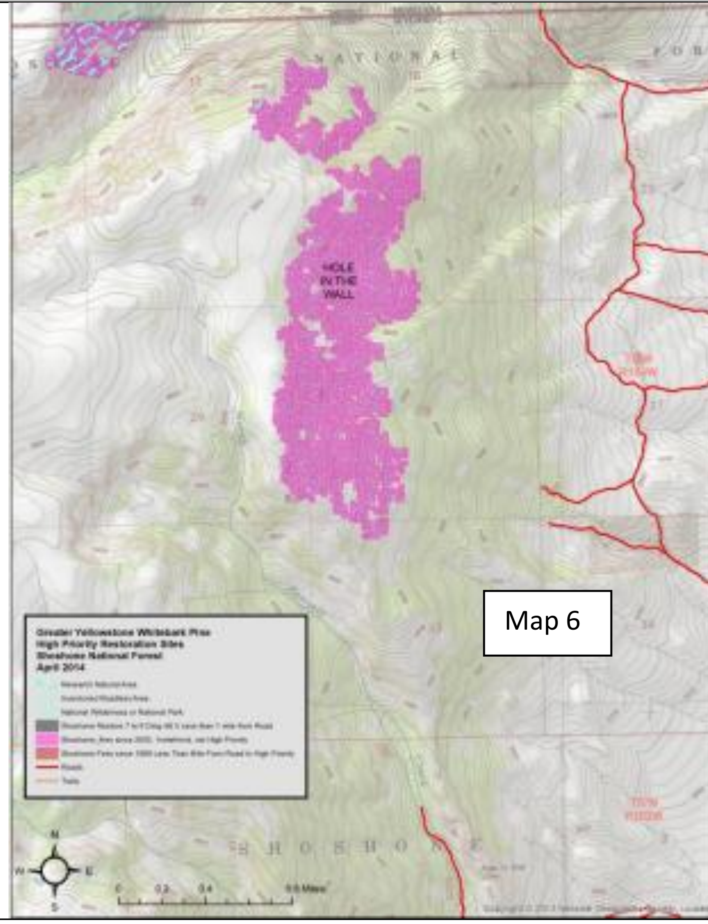


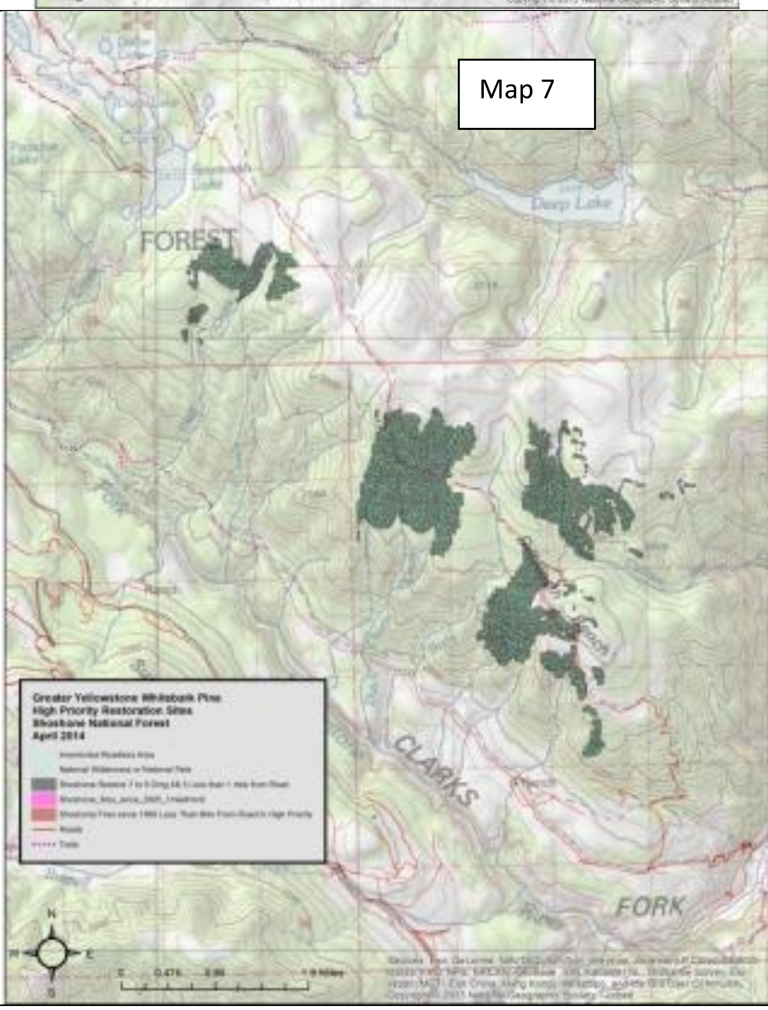


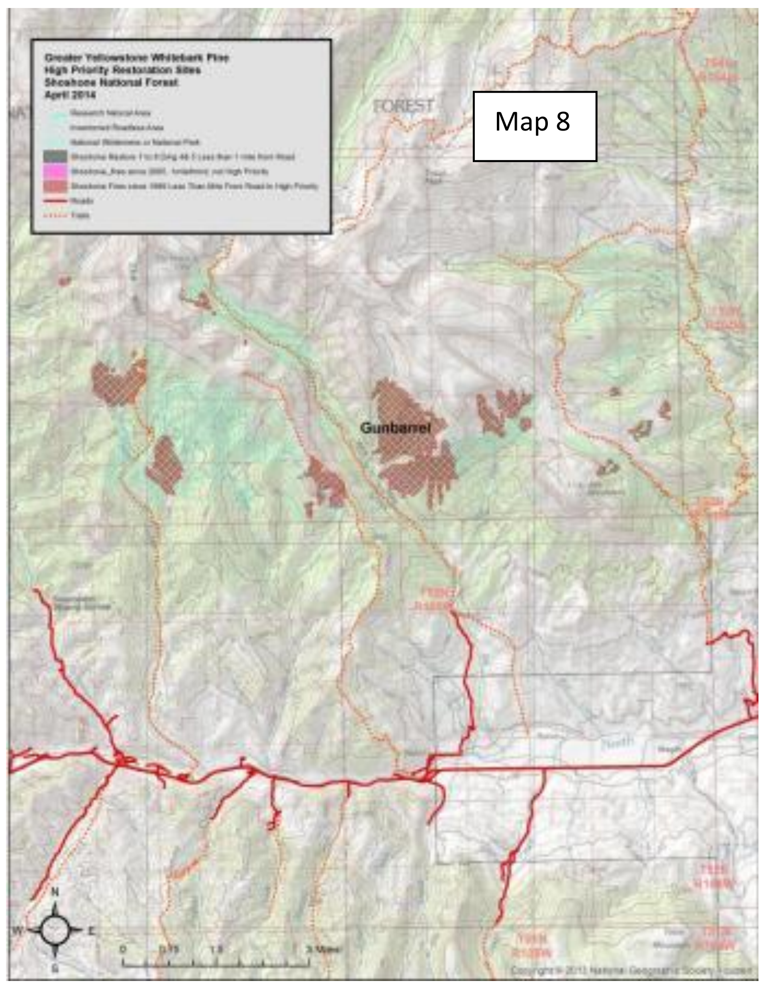


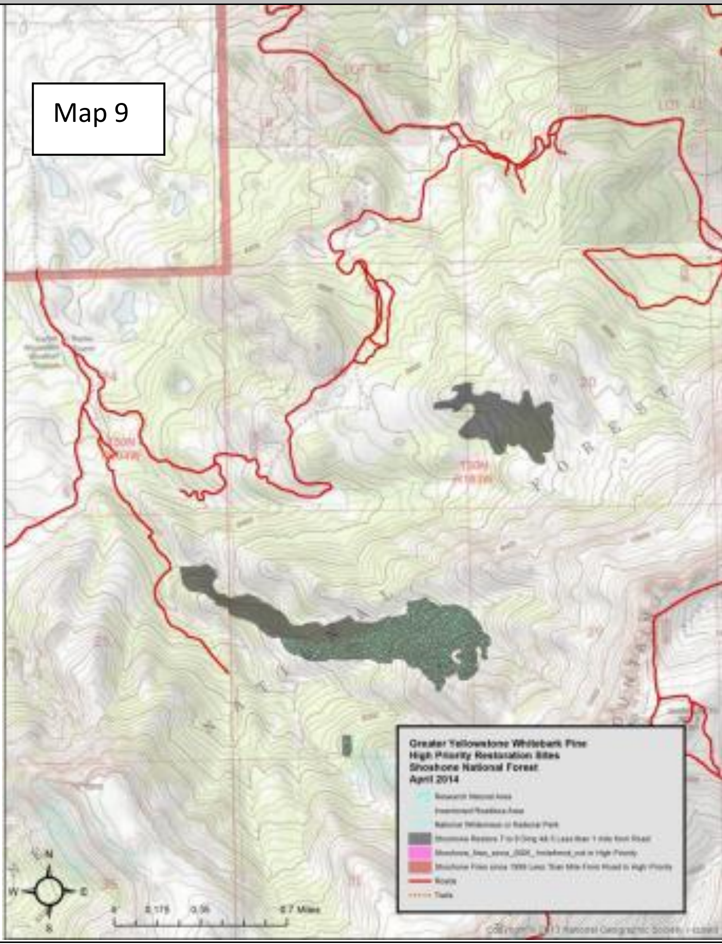
Restoration Target Areas – Shoshone National Forest

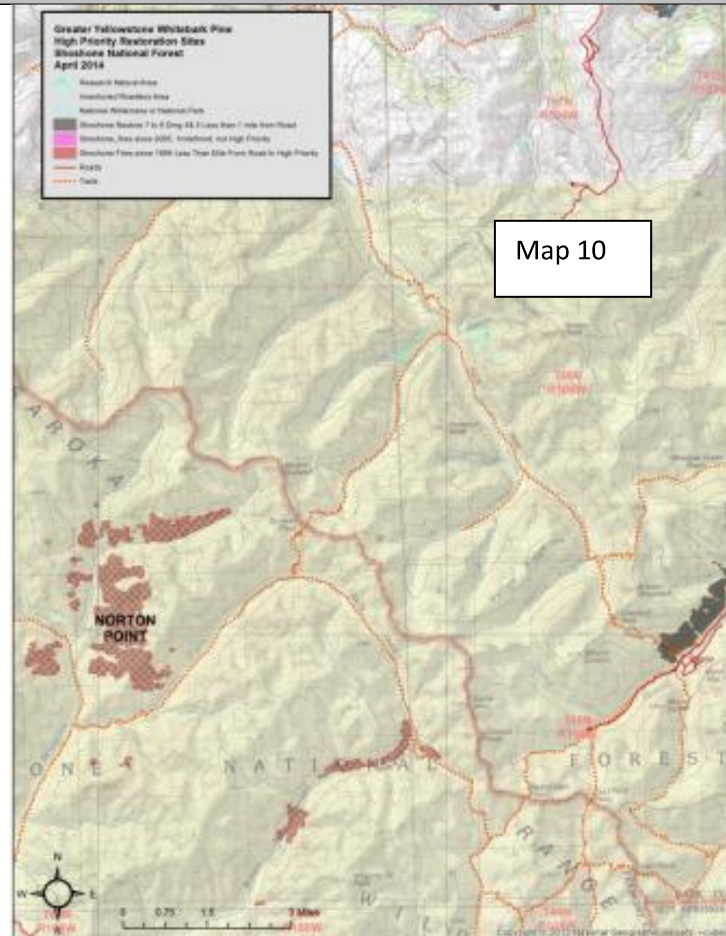


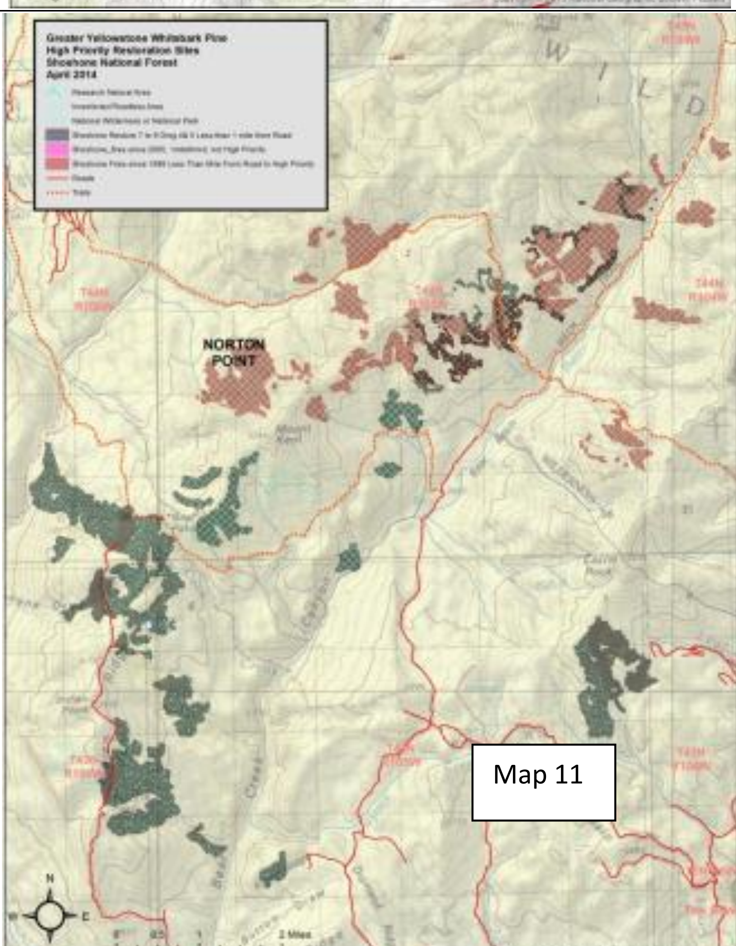


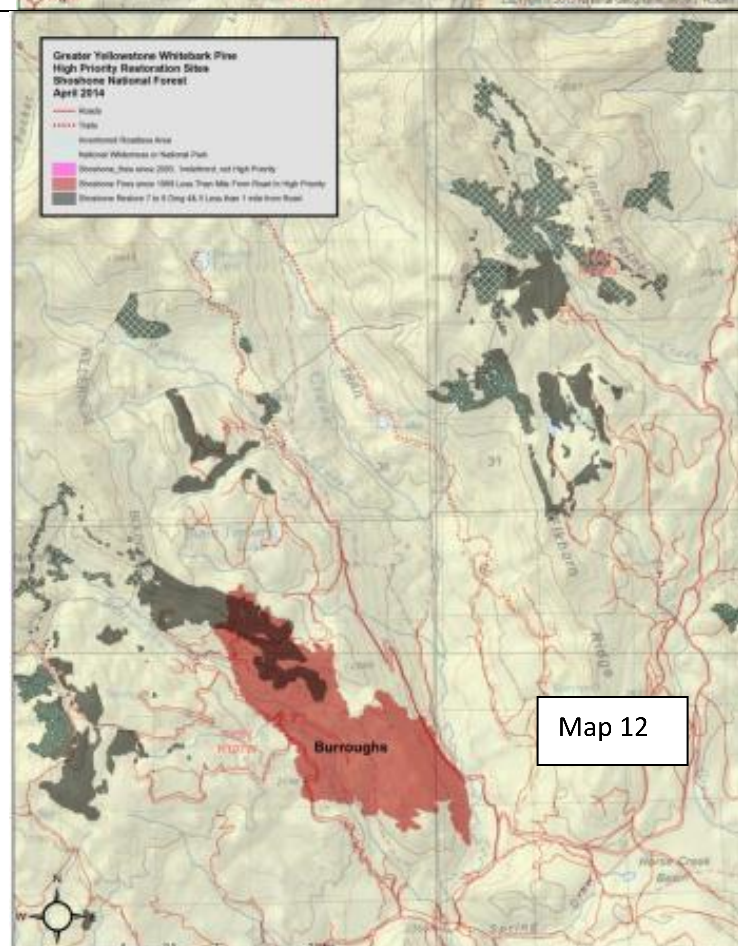




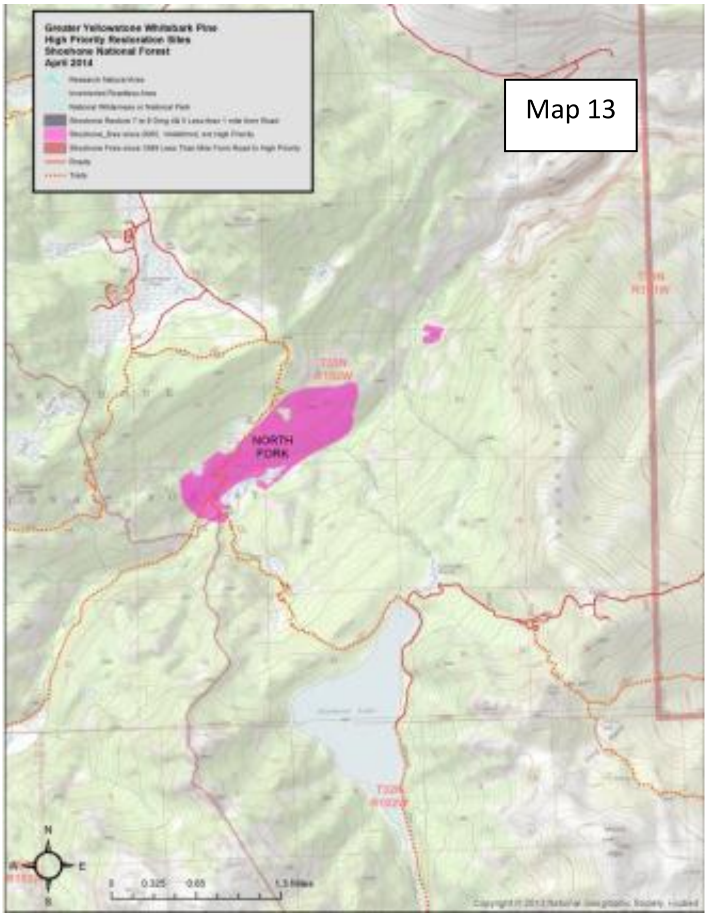

Map 9
Greater Yellowstone Whitebark Pine
High Priority Restoration Sites
Shoshone National Forest
April 2014

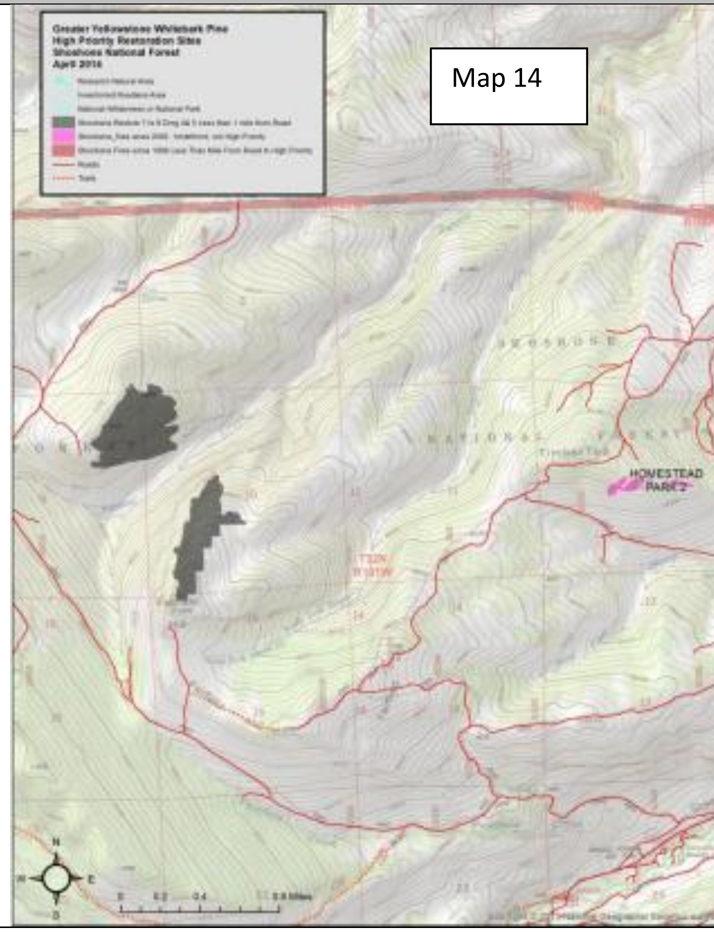

Greater Yellowstone Whitebark Pine
High Priority Restoration Sites
Shoshone National Forest
April 2014
Map 10
NORTON POINT

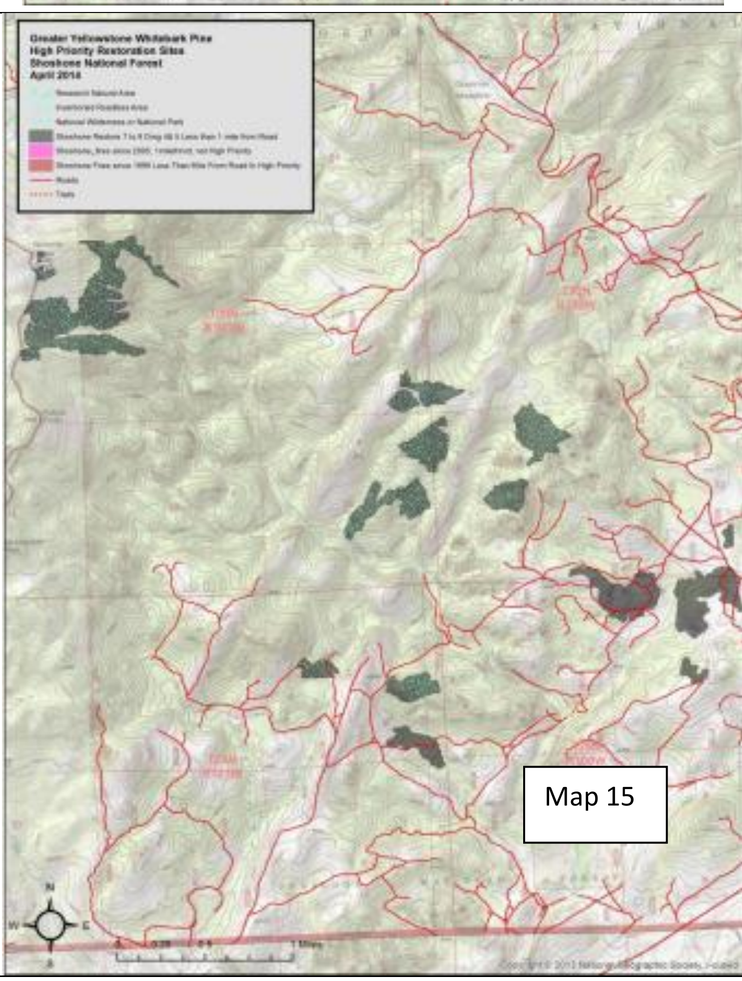

Greater Yellowstone Whitebark Pine
High Priority Restoration Sites
Shoshone National Forest
April 2014
NORTON POINT
Map 11


Greater Yellowstone Whitebark Pine
High Priority Restoration Sites
Shoshone National Forest
April 2014
Burroughs
Map 12

Restoration Target Areas - Shoshone National Forest

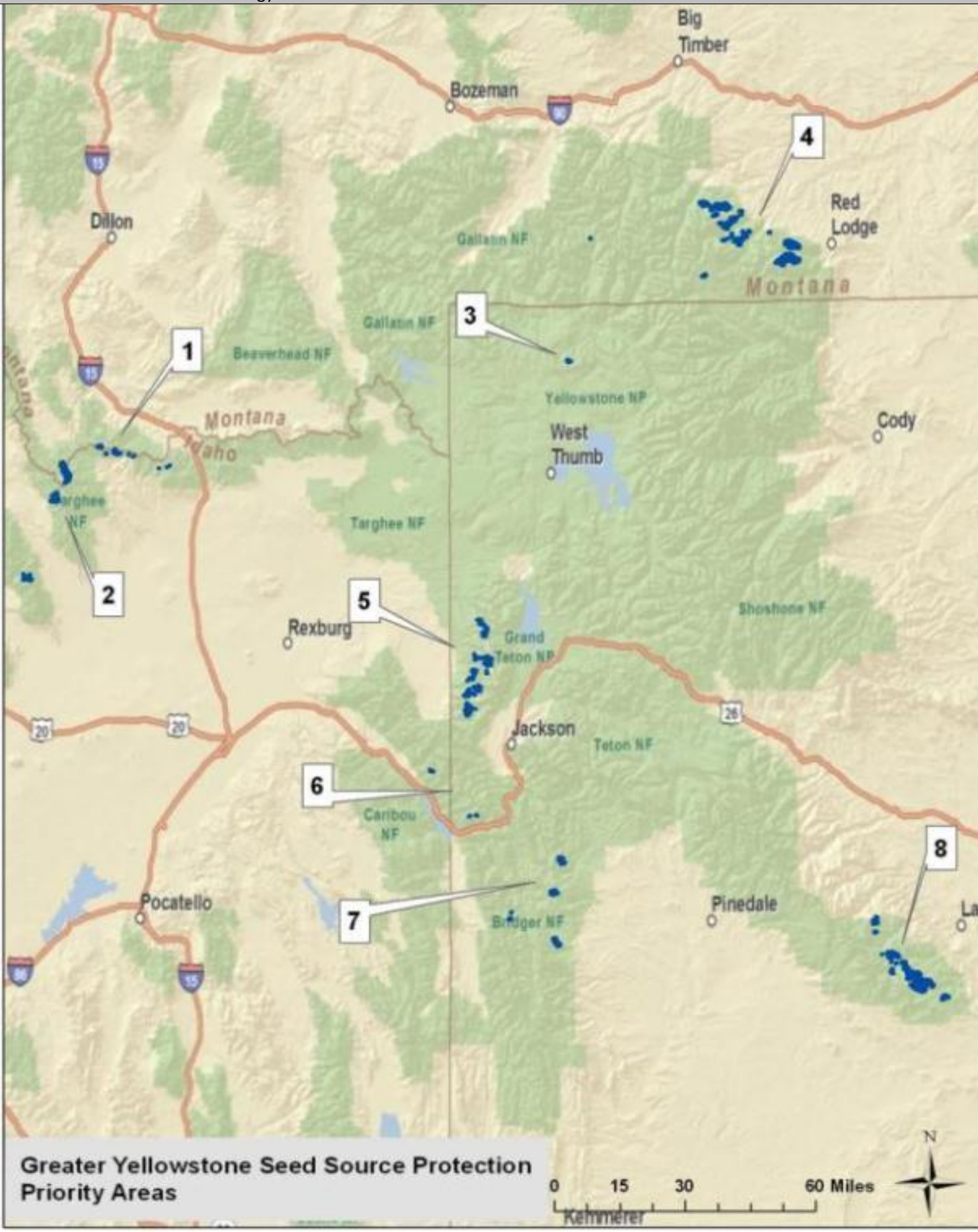






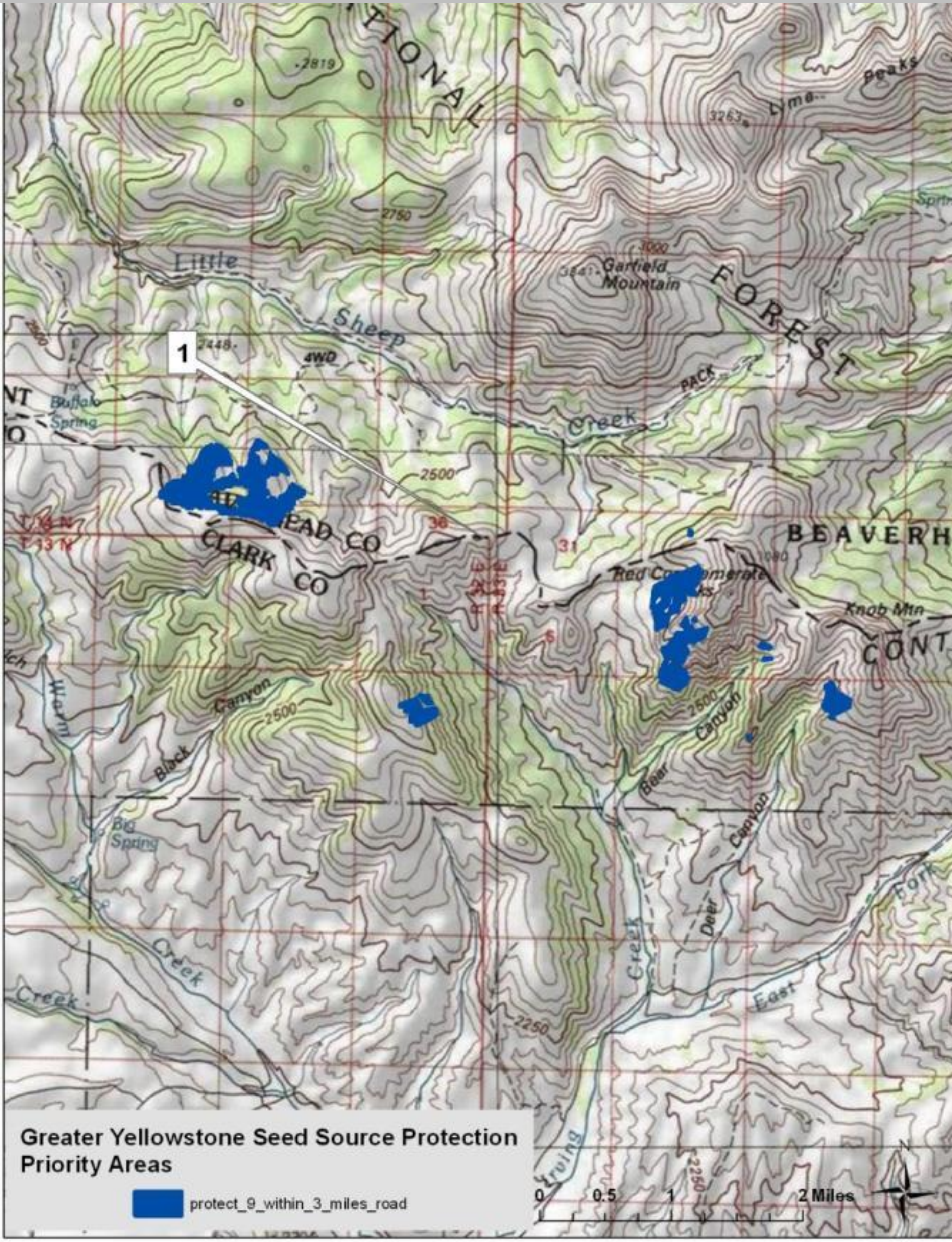
II. Remaining Seed-Producing and Mature Whitebark Pine

Whitebark polygons are those with remaining green cone bearing whitebark that are within 3 miles of a road and delineated in the Whitebark Pine Strategy for the Greater Yellowstone Area.

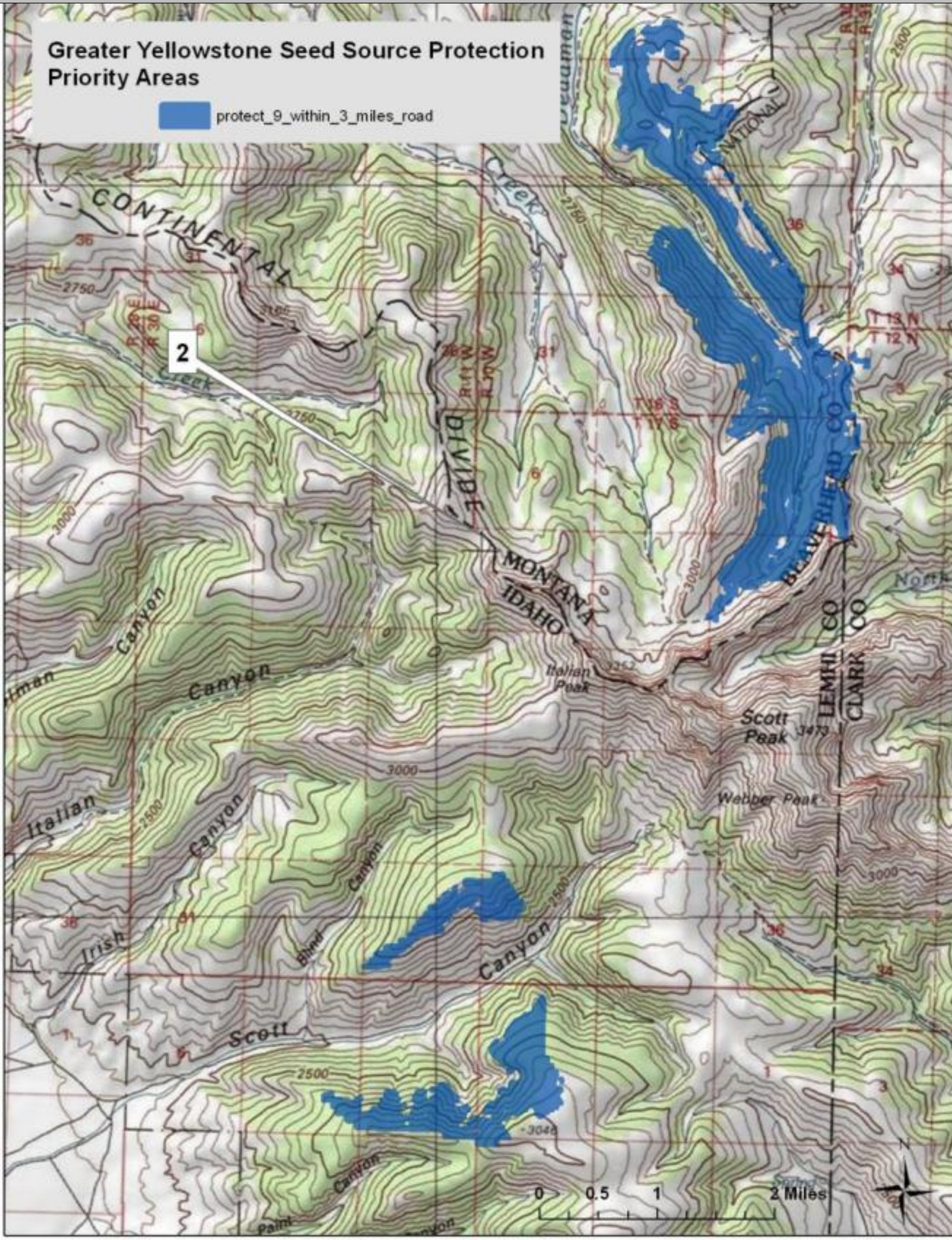


Total Acres	18,900

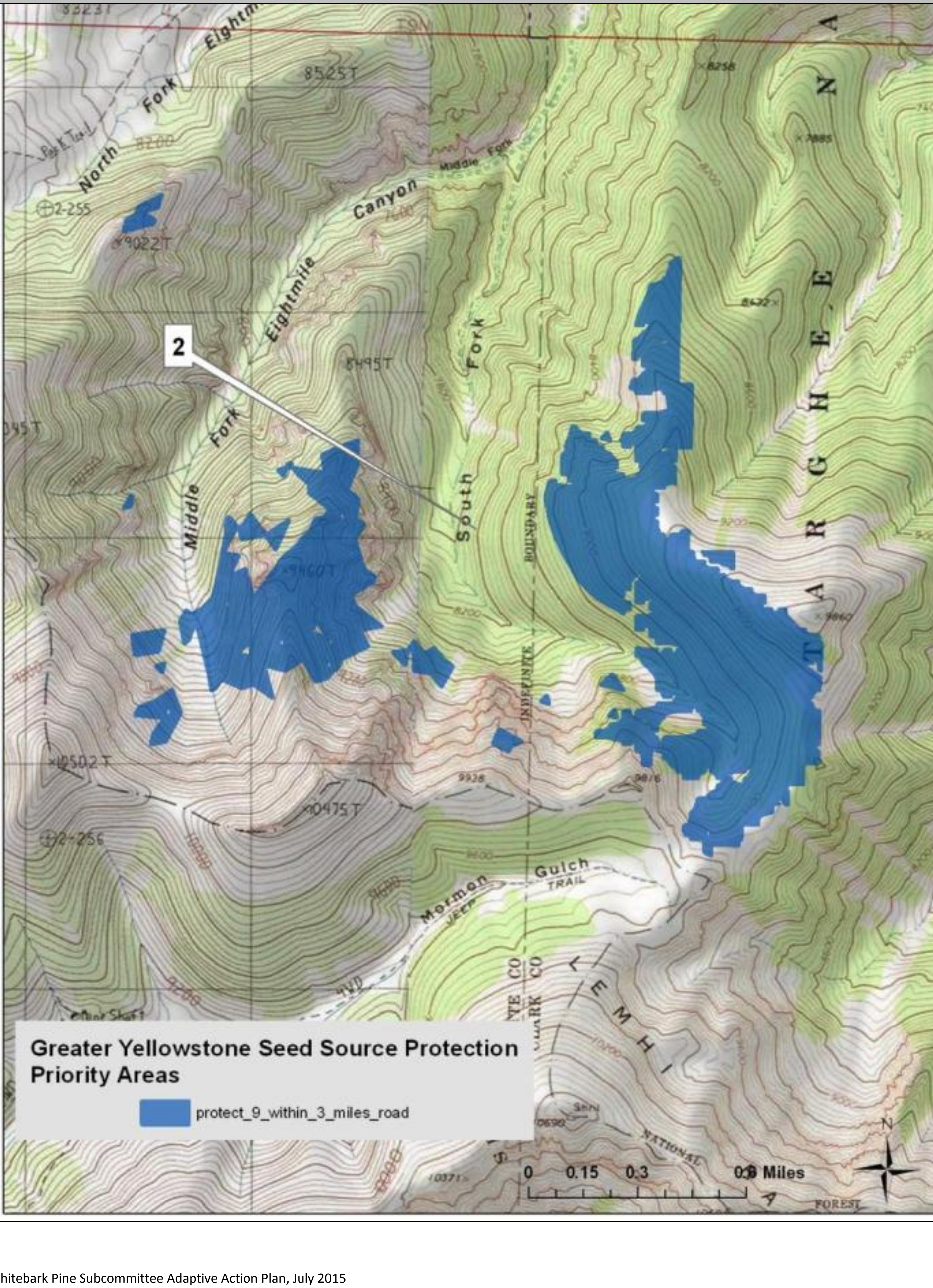
Suitable Seed Protection Areas



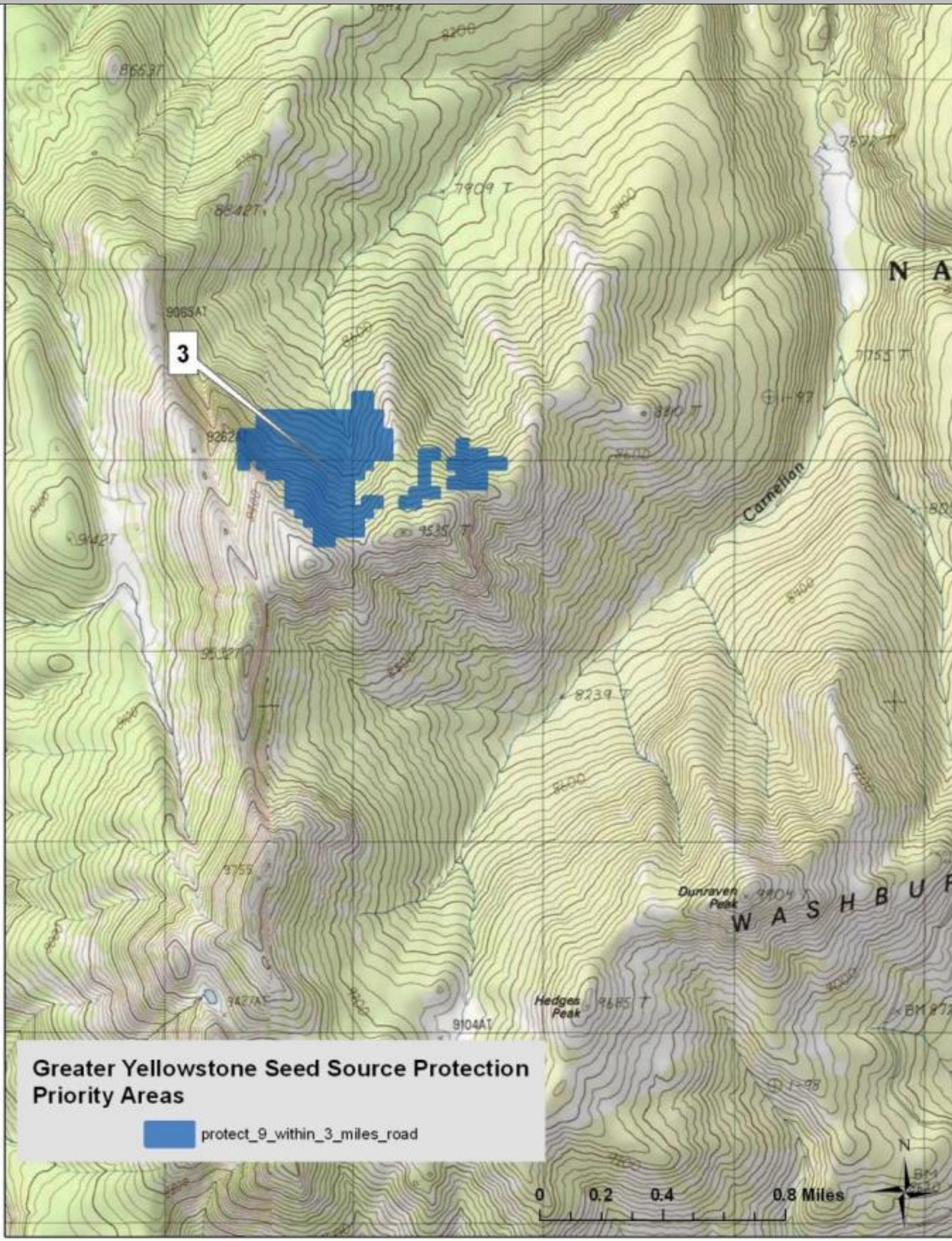
Suitable Seed Protection Areas



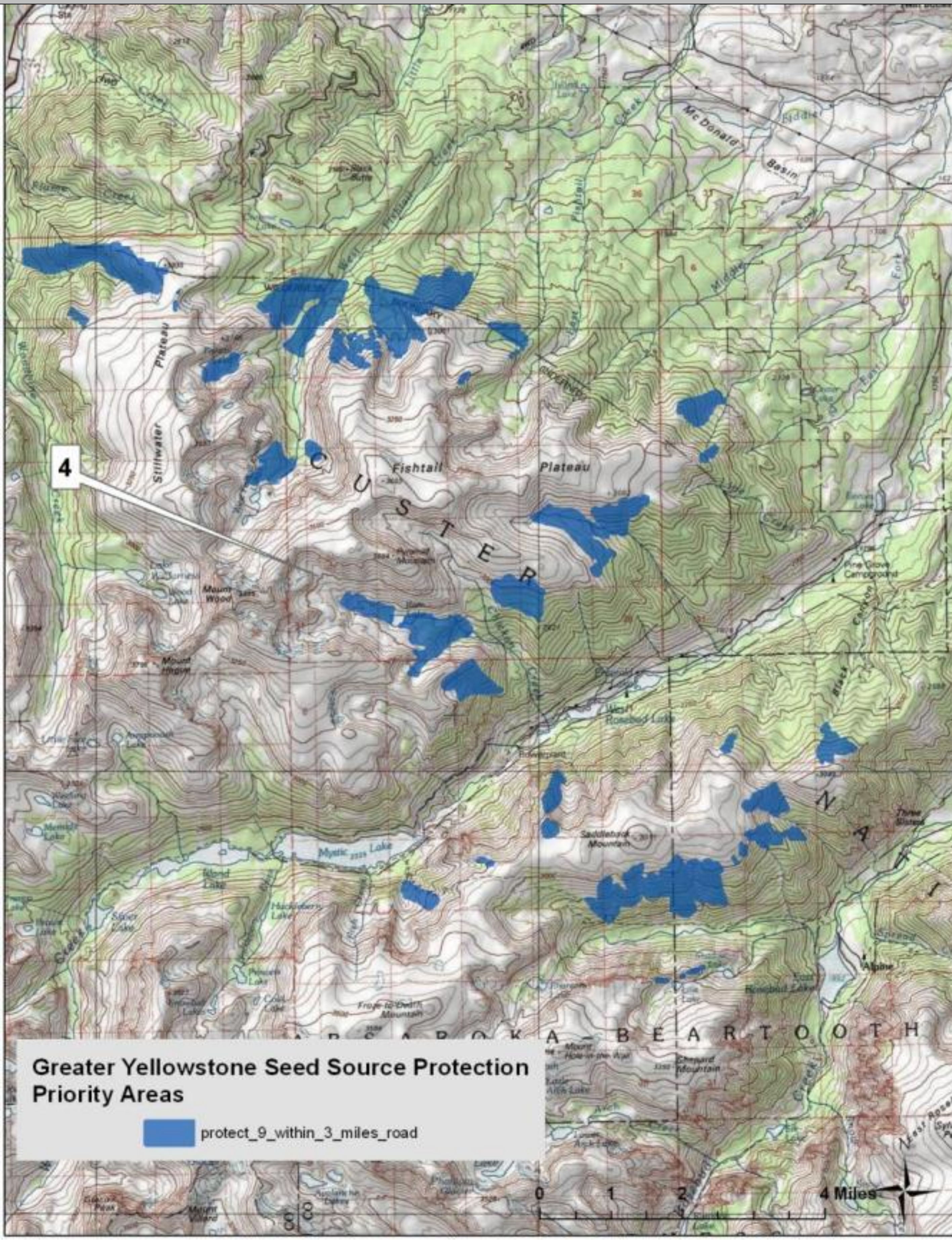
Suitable Seed Protection Areas



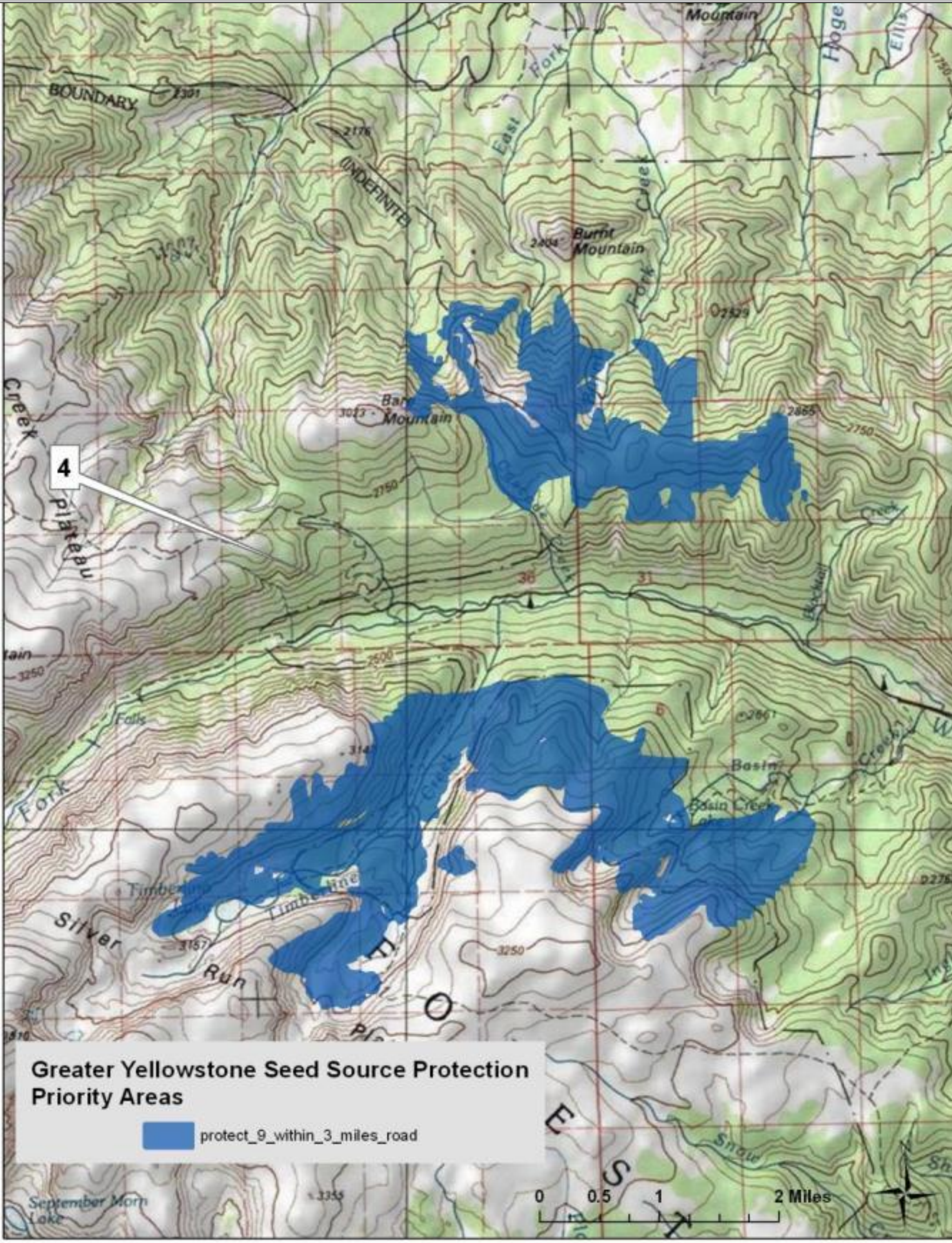
Suitable Seed Protection Areas



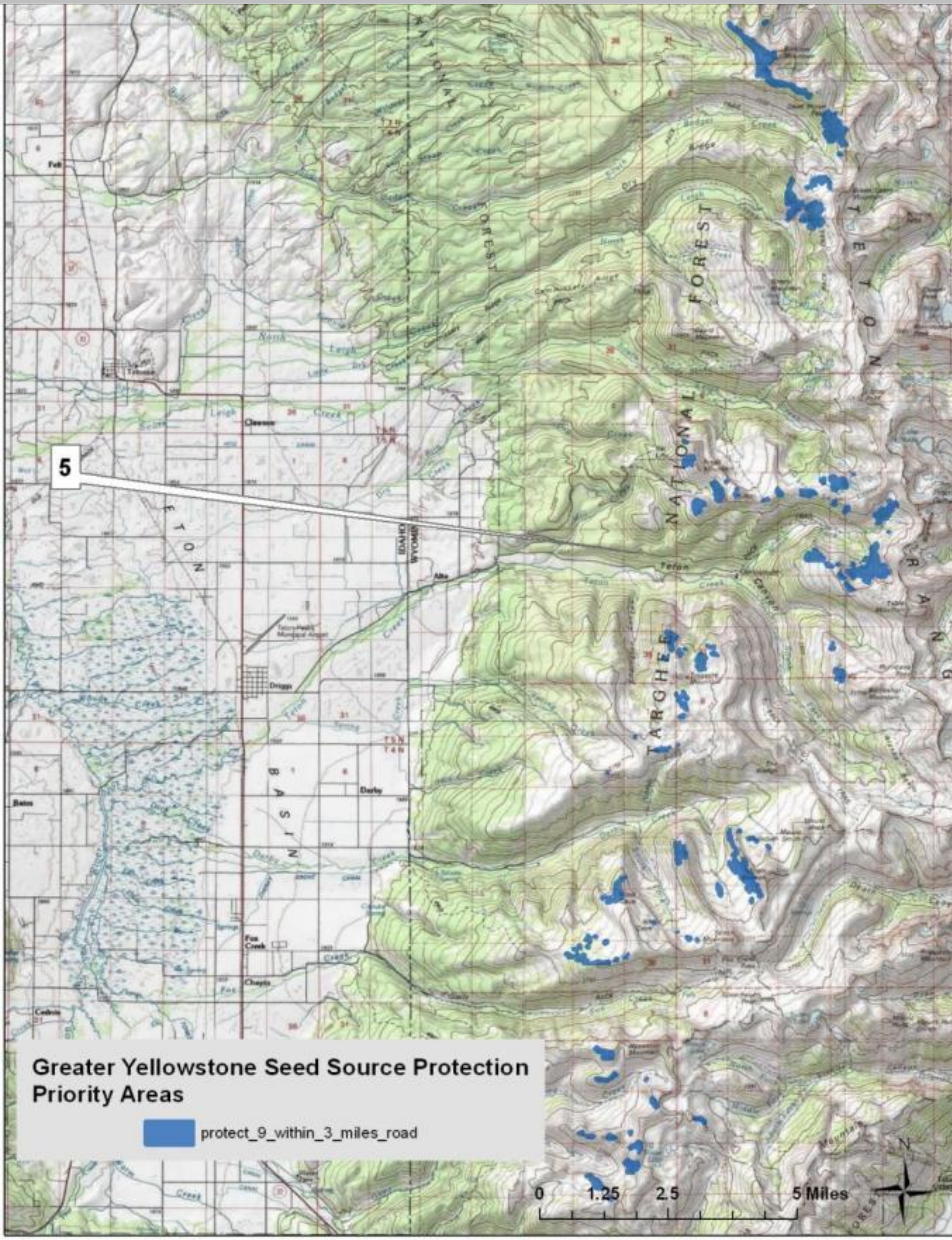
Suitable Seed Protection Areas



Suitable Seed Protection Areas

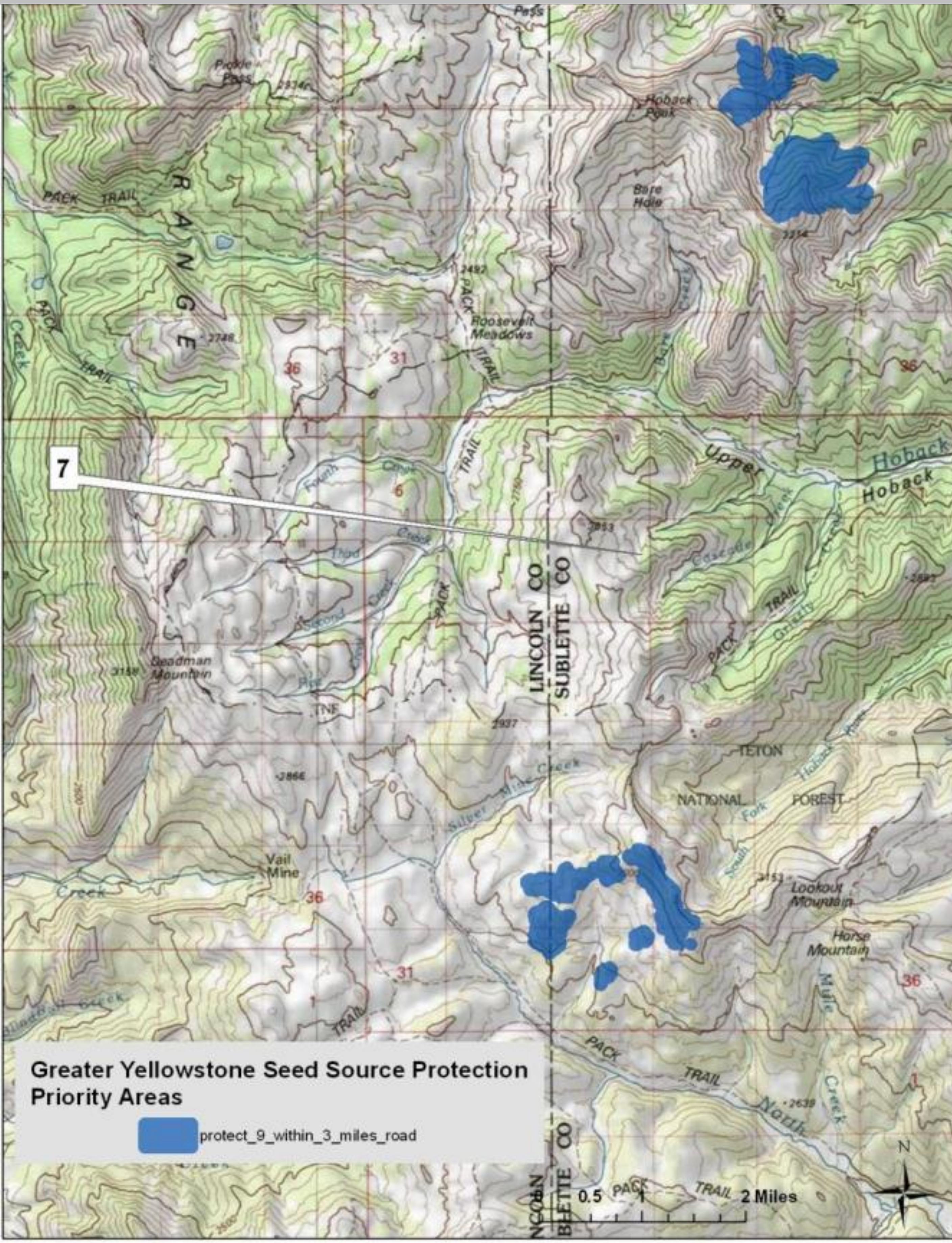


Suitable Seed Protection Areas

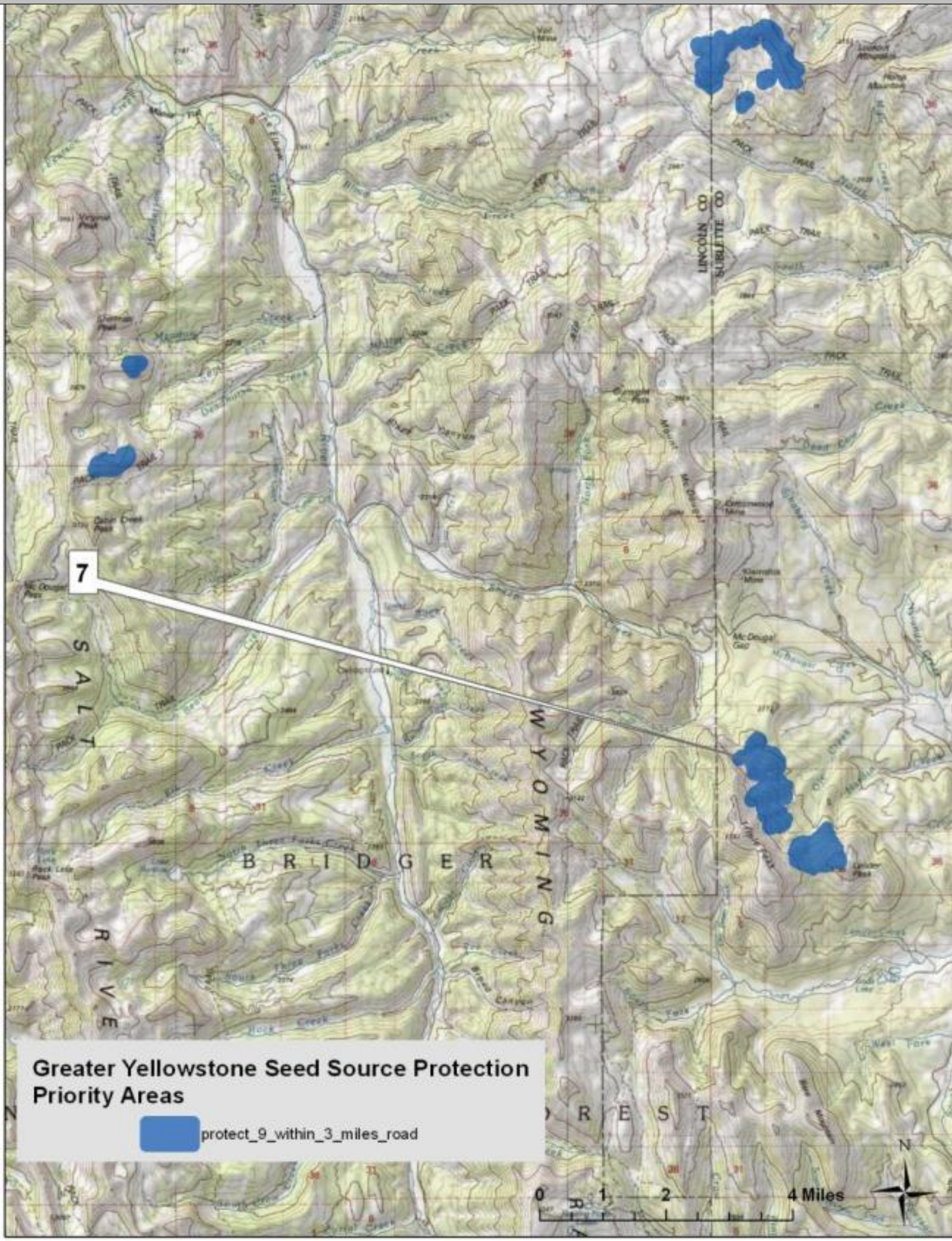


Suitable Seed Protection Areas

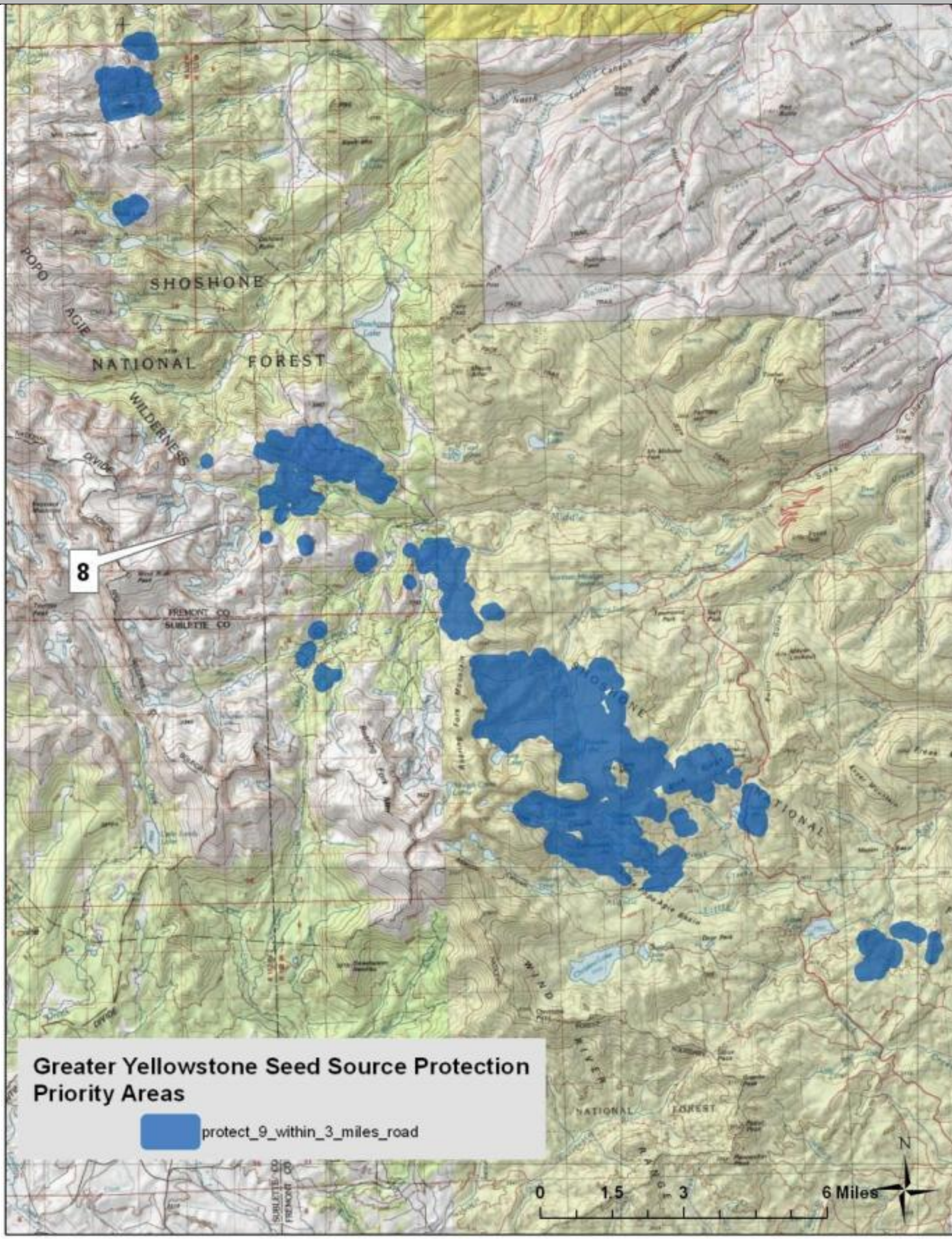
Suitable Seed Protection Areas



Suitable Seed Protection Areas

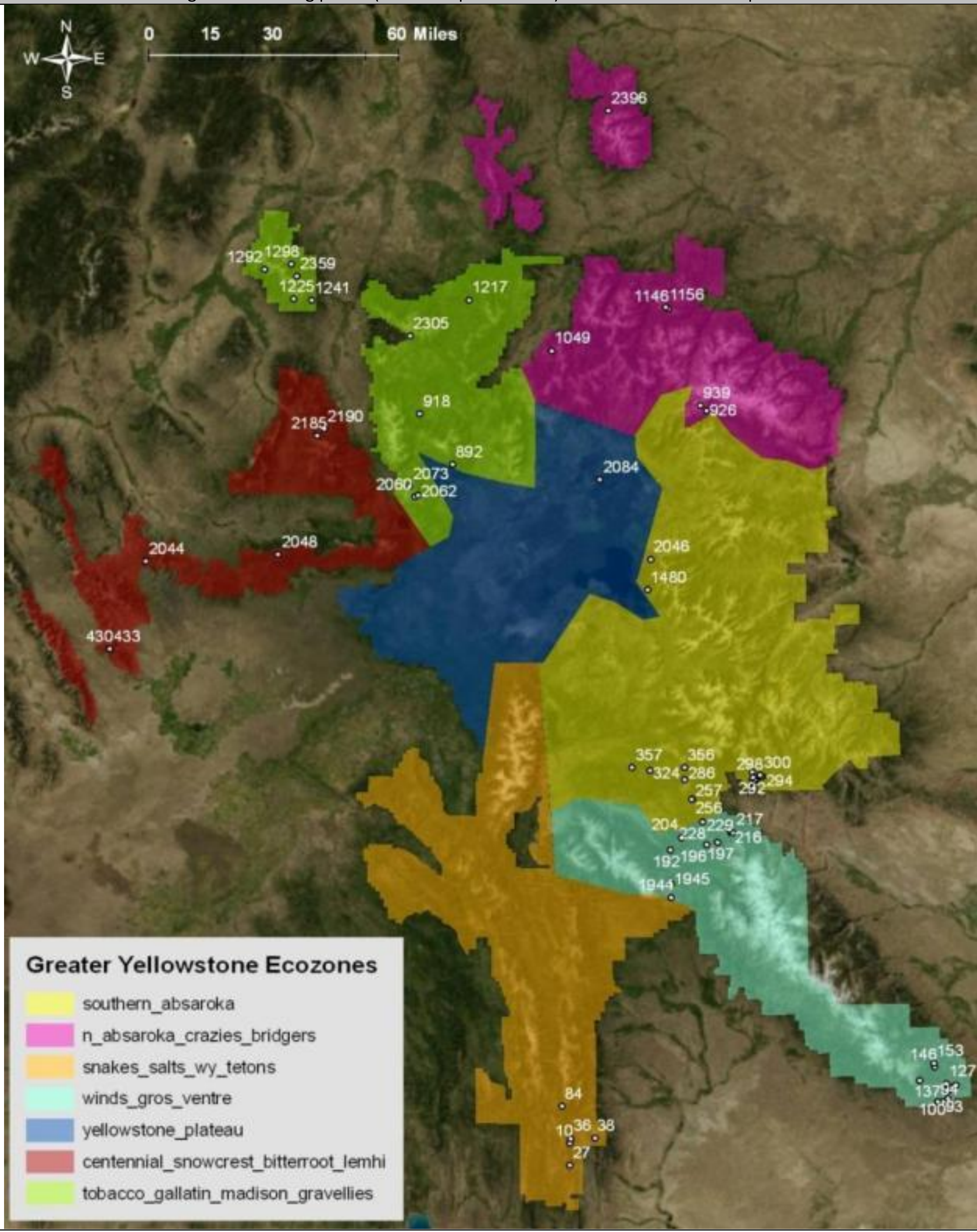


Suitable Seed Protection Areas



III. Ecozones of The Greater Yellowstone

The ecozones were delineated using a combination of geographic data and analysis data layers including: Hydrologic Units at 1:250K scale, Digital Elevation Models, NAIP imagery Interpretation (N.Bockino). Surface geology and a latitudinal gradient were used to estimate the approximate elevation of whitebark presence and dominance across the GYE. A subset of ground truthing points (see description above) are overlaid on this map.



IV. Ground Truthing Data

In 2010, in order to ensure the efficient use of funds and personnel during implementation of projects on suitable sites, and whitebark pine map accuracy, a portion of these stands were selected for ground truthing by the Whitebark Pine Subcommittee.

Ecozone: Southern Absaroka

Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL < 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
287	29	5500	Y	ABLA	208	< 1 mile	9727	Non-designated	Restore 8 Protect 6
257	11	1200	Y	PIEN/VASC	294	< 1 mile	9213	Non-designated	Restore 8 Protect 6
286	60	2650	Y	ABLA/ARCO	71	< 1 mile	9224	Non-designated	Restore 8 Protect 6
263	100	0	Y	ABLA/ARLA	192	< 1 mile	8768	Non-designated	Restore 8 Protect 6
271	17	0	Y	ABLA/ARLA	196	< 1 mile	9599	Non-designated	Restore 8 Protect 6
292	25	0	Y	ABLA/ARLA	185	< 1 mile	9848	Non-designated	Restore 8 Protect 6
285	22	450	Y	ABLA/JUCO	18	< 1 mile	9569	Non-designated	Restore 8 Protect 6
357	None present	900	Y	ABLA/VAGL	298	< 1 mile	8430	Non-designated	Restore 8 Protect 6
356	0	1700	Y	ABLA/VASC	127	< 1 mile	9516	Non-designated	Restore 8 Protect 6
324	19	800	Y	ABLA/VASC	140	< 1 mile	8966	Non-designated	Restore 8 Protect 6
256	0	10300	Y	PIAL/CAGE	204	< 1 mile	9153	Non-designated	Restore 8 Protect 6
294	14	13000	Y	PIAL/JUCO	115	< 1 mile	9296	Non-designated	Restore 8 Protect 6
298	43	2300	Y	PIAL/JUCO	175	< 1 mile	9154	Non-designated	Restore 8 Protect 6
300	0	6000	Y	PIAL/JUCO	145	< 1 mile	9355	Non-designated	Restore 8 Protect 6
200	6	1100	Y	PIAL/JUCO	180	< 1 mile	10019	RNA/OCD/NWA or proposed NWA	Restore 8 Protect 6
1480	100	15400	Y	PIAL/VASC	300	< 1 mile	8133	RNA/OCD/NWA or proposed NWA	Restore 8 Protect 6
2046	None - burned	30	Y	PIAL/VASC	140	< 1 mile	8588	IRA or non-wilderness National Park	Restore 8 Protect 6

Ecozone: Southern Absaroka

287

257

263

271

292

285

Ecozone: Southern Absaroka

357

356

324

256

294

298

Ecozone: Southern Absaroka	
	
300	**200**
	
1480	**2046**

Ecozone: Northern Absaroka, Crazies, Bridgers									
Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL < 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
926	None found	0	Y	ABLA/VASC-PIAL	104	O.1 miles	8938	Non-designated	Restore 8 Protect 5
939	100	0	Y	ABLA/VASC-PIAL	42	0.1 miles	9155	Non-designated	Restore 8 Protect 6
1049	None found	0	N	unknown	0	on site	6889	Non-designated	Restore 7 Protect 5
1146	0	1800	Y	ABLA/VASC-PIAL	45	0.5 miles	9140	Non-designated	Restore 8 Protect 5
1156	0	670	Y	ABLA/VASC-PIAL	130	1 mile	9182	Non-designated	Restore 7 Protect 5
2396	30	20	Y	ABLA/JUCO	244	1 mile	8120	IRA or non-wilderness National Park	Restore 4 Protect 7

Ecozone: Northern Absaroka, Crazies, Bridgers

926

939

no photo –
Big Sky/Chico site with no PIAL present,
very low elevation

1049

1146

Ecozone: Northern Absaroka, Crazies, Bridgers	
	
1156	**2396**

Ecozone: Salts, Snakes, Wyoming Range, Tetons									
Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL < 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
27	100	1300	Y	ABLA/VASC	104	< I mile	9129	Unmapped	Unmapped
10	100	3400	Y	ABLA/RIMO	72	< I mile	9184	Non-designated	Restore 5 Protect 7
36	100	0	Y	UNKNOWN	266	< I mile	9069	Non-designated	Restore 8 Protect 6
38	0	70	Y	ABLA/CAGE	194	< I mile	10047	Non-designated	Restore 5 Protect 8
84	0	90	Y	ABLA/THOC	85	< I mile	9299	Non-designated	Restore 5 Protect 7

Ecozone: Salts, Snakes, Wyoming Range, Tetons

27

10

36

38

Ecozone: Salts, Snakes, Wyoming Range, Tetons

84

Ecozone: Yellowstone Plateau									
Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL< 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
2084	100	130	Y	ABLA/ARCO	260	< 1 mile	9048	IRA or non-wilderness National Park	Restore 5 Protect 8

Ecozone: Yellowstone Plateau

2084

Ecozone: Wind Rivers, Gros Ventres									
Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL < 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
93	100	0	Y	PICO/CAGE	74	None visible	8427	Non-designated	Restore 8 Protect 6
94	100	0	Y	PIFL	328	< 1 mile	8733	Non-designated	Restore 5 Protect 8
100	67	1500	Y	PIFL/JUCO	107	< 1 mile	8542	Non-designated	Restore 8 Protect 6
107	100	0	Y	PIFL/JUCO	184	< 1 mile	8858	Non-designated	Restore 5 Protect 8
108	100	100	Y	PICO/JUCO	212	< 1 mile	8911	Non-designated	Restore 5 Protect 8
113	100	0	Y	PIAL/CARO	187	< 1 mile	8760	Non-designated	Restore 5 Protect 8
123	100	400	Y	PIAL/CAGE	178	< 1 mile	8696	Non-designated	Restore 5 Protect 8
127	100	0	Y	PIAL/JUCO	285	< 1 mile	9219	Non-designated	Restore 5 Protect 8
137	100	3500	Y	PIAL/VASC	112	< 1 mile	9942	Non-designated	Restore 5 Protect 8
146	100	5500	Y	PIAL/JUCO	234	< 1 mile	9490	Non-designated	Restore 4 Protect 9
153	90	0	Y	PIAL/PICO	240	< 1 mile	9884	Non-designated	Restore 5 Protect 8
1944	100	1200	Y	ABLA/CAGE	326	< 1 mile	9823	IRA or non-wilderness National Park	Restore 8 Protect 6
1945	60	4200	Y	ABLA/CACA	347	< 1 mile	9445	IRA or non-wilderness National Park	Restore 8 Protect 6
192	No PIAL	200	Y	ABLA/ARCO	41	< 1 mile	9393	Non-designated	Restore 8 Protect 6
196	0	0	Y	PIAL/JUCO	241	< 1 mile	9139	Non-designated	Restore 8 Protect 6
197	No PIAL	700	Y	PIEN/ARCO	175	< 1 mile	9172	Non-designated	Restore 8 Protect 6
204	7	7000	Y	PIAL/CARO	256	< 1 mile	9375	Non-designated	Restore 8 Protect 6
216	0	0	Y	PIEN/VASC	332	< 1 mile	9849	Non-designated	Restore 8 Protect 6
217	0	1050	Y	PIEN	68	< 1 mile	9603	Non-designated	Restore 8 Protect 6
221	83	0	Y	PIEN/VASC	123	< 1 mile	9762	Non-designated	Restore 8 Protect 6
228	11	650	Y	PIAL/FEID	200	< 1 mile	9756	Non-designated	Restore 8 Protect 6
229	0	1700	Y	PIAL/JUCO	170	< 1 mile	9868	Non-designated	Restore 8 Protect 6

Ecozone: Wind Rivers, Gros Ventres	
	
93	**94**
	
100	**107**
	

<table>
<tr><th>108</th><th>113</th></tr>
<tr><td colspan="2">Ecozone: Wind Rivers, Gros Ventres</td></tr>
<tr><td></td><td></td></tr>
<tr><td>123</td><td>127</td></tr>
<tr><td></td><td></td></tr>
<tr><td>137</td><td>146</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>153</td><td>1944</td></tr>
</table>

Ecozone: Wind Rivers, Gros Ventres

1945

192

196

197

no photo

<table>
<tr><td>204</td><td>216</td></tr>
<tr><td colspan="2">Ecozone: Wind Rivers, Gros Ventres</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td>217</td><td>221</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td>228</td><td>229</td></tr>
</table>

Ecozone: Centennials, Snowcrest, Bitterroot, Lemhi									
Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL < 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
430	50	0	Y	PIFL/JUCO	212	None visible	8883	Non-designated	Restore 5 Protect 8
433	100	2500	Y	PIEN/JUCO	338	None visible	9026	Non-designated	Restore 5 Protect 8
2044	75	50	Y	ABLA/PIEN	182	< 1 mile	9400	not mapped	not mapped
2048	11	200	Y	ABLA/PERA	110	< 1 mile	8897	IRA or non-wilderness National Park	Restore 9 Protect 5
2185	0	80	Y	ABLA/RIMO	264	< 1 mile	9339	IRA or non-wilderness National Park	Restore 8 Protect 6
2190	43	80	Y	ABLA/ARCO	252	< 1 mile	9005	IRA or non-wilderness National Park	Restore 8 Protect 6

Ecozone: Centennials, Snowcrest, Bitterroot, Lemhi

430

433

<table>
<tr><th>2044</th><th>2048</th></tr>
<tr><td colspan="2">Ecozone: Centennials, Snowcrest, Bitterroot, Lemhi</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2185</td><td>2190</td></tr>
</table>

Ecozone: Tobacco Roots, Gallatins, Madison, Gravellies									
Ground Truthing Point	% PIAL or PIFL ≥ 138 cm tall Dead	Rust Free PIAL < 137 cm tall (TPA)	PIAL present (overstory or understory)	Habitat Type	Aspect	Distance to Seed Source	Elevation	Land Status	Strategy Ranking
892	No PIAL	5500	Y	ABLA/VASC	350	None visible	8359	Non-designated	Restore 5 Protect 8
918	60	700	Y	ABLA/VASC	228	< 1 mile	8604	Non-designated	Restore 8 Protect 6
1217	No PIAL	0	Y	ABLA/CAGE	200	< 1 mile	8813	Non-designated	Restore 5 Protect 7
1225	20	0	Y	ABLA/LUHI	160	< 1 mile	8986	Non-designated	Restore 8 Protect 6
1241	No PIAL	0	Y	ABLA/VASC	244	None visible	7788	not mapped	not mapped
1292	100	900	Y	ABLA/VASC	270	< 1 mile	8147	Non-designated	Restore 8 Protect 6
1298	10	0	Y	ABLA/JUCO	210	< 1 mile	8763	Non-designated	Restore 8 Protect 6
2060	0	0	Y	ABLA/ARLA	62	< 1 mile	8905	IRA or non-wilderness National Park	Restore 5 Protect 8
2062	100	0	Y	ABLA/THOC	60	< 1 mile	8483	IRA or non-wilderness National Park	Restore 4 Protect 7
2073	100	1400	Y	ABLA/VASC	132	< 1 mile	9279	IRA or non-wilderness National Park	Restore 5 Protect 7
2305	0	1150	Y	ABLA/THOC	248	< 1 mile	8971	IRA or non-wilderness National Park	Restore 8 Protect 6
2359	50	0	Y	ABLA/VASC	126	< 1 mile	8982	IRA or non-wilderness National Park	Restore 7 Protect 5

Ecozone: Tobacco Roots, Gallatins, Madison, Gravellies

892

918

1217

1225

1241

1292

Ecozone: Tobacco Roots, Gallatins, Madison, Gravellies

1298

2060

2062

2073

2305

2359

V. Genetically Unique Areas and Rust Resistant Elite Tree Locations

Results from rust screening from regional geneticist, M. Mahalovich. These areas should be targeted for cone collection.