

Mountain Pine Beetle Risk Assessment and Response Strategy

Wind Cave National Park
March 2012



Mountain Pine Beetle Risk Assessment and Response Strategy

Wind Cave National Park
March 2012

Prepared: _____
Botanist Date

Recommended: _____
Chief, Resource Management Date

Approved: _____
Superintendent Date

Table of Contents

Introduction.....	1
Risk Assessment	2
Data and Methods	2
Results	5
Monitoring.....	13
Management Strategy.....	15
Developed Area Zone.....	16
Boundary Zone.....	16
Back Country Zone.....	17
2011 Monitoring Results.....	18
Literature Cited	19

Introduction

Mountain pine beetle (acronym: MPB) or *Dendroctonus ponderosae* is native to pine forest ecosystems of western North America, including the Black Hills. MPB populations cycle through periods of high abundance (epidemic conditions) and low abundance (endemic conditions). Outbreaks of high abundance occur periodically. Outbreaks of native forest insect species are historically important drivers of vegetation dynamics in western pine forests (Amman 1977). Although adverse impacts of MPB on forest values have long been recognized, it has also become apparent that MPB disturbances, in concert with other natural disturbance agents, play a major role in maintaining the structure and function of healthy forest ecosystems (Mock 2006).

The first recorded outbreak of MPB in the Black Hills occurred in the late 1890s through the early 1900s and killed an estimated 1-2 billion board feet of timber. Outbreaks have also occurred in the 1930s, 1940s, 1960s and 1970s, each lasting 8 to 13 years. The 1970s outbreak was larger and caused more mortality than any of the others after the turn of the century outbreak. The Black Hills is currently experiencing an epidemic outbreak of MPB that started in the late 1990s (Beaver Park in the northern Hills, Deerfield Reservoir area in the central Hills, and east to the Black Elk Wilderness in 2003).

Wind Cave National Park (WICA) is situated near the southern edge of the Black Hills, in the transition zone between ecosystems dominated by ponderosa pine forest and those dominated by mixed grass prairie. Approximately 30% of WICA park land supports ponderosa pine forest and 60% of parklands are grasslands. Healthy and resilient forests and grasslands have been in the past, and continue to be, a primary goal of park management.

Black Hills forests are dynamic and have evolved with a variety of natural disturbances including variable and sometimes extreme weather, periodic fires, and insect and disease epidemics. Of these disturbances, fire has been one of the most prevalent (Sieg and Severson 1996). With large areas of continuous fine fuels, frequent periods of hot and dry weather, and common occurrence of lightning, the mixed grass prairie and ponderosa pine savannah ecosystems in and around WICA historically experienced fire. Fire is an integral part of the ecological processes shaping the vegetative and wildlife composition of the area. Documented reports of early pioneer settlers in the west describe how the mixed grass prairie was influenced by purposeful and accidental fires set by Native Americans. Research indicates that fire, together with climate and topography, plays a major role in maintaining the grassland ecosystem and restricting the growth of trees and shrubs to drier, rocky breaks, less frequently burned draws, and lands near streams and wetlands. Fire also shaped forested areas. Frequent fires resulted in a forest comprised of discontinuous, distinct groups of even-aged trees with a wide range of size classes represented (NPS 2005).

Records of lightning-caused fires, human-caused fires, and fires of unknown origin show a decrease in human-caused fires in the last 30 years. Fire cessation in WICA during recent decades has been most likely a direct result of fire suppression efforts by the NPS and an indirect result of livestock grazing in areas adjacent to the park reducing fine fuels (NPS 2005). In 1968, the NPS revised its fire management policy to allow for the use of prescribed fire as a substitute

for natural fires. Prescribed fire was initiated at WICA in September 1973 after an extensive public education campaign. From this beginning, the use of prescribed fire has continued in the park, often coupled with research. In 1987, the Bison Trap prescribed fire burned 2,460 acres and was the largest prescribed fire in the park until 2010, when the American Elk prescribed fire burned 3,400 acre, taking over top spot. The American Elk prescribed fire burned primarily ponderosa pine forest areas that had not seen fire in over 100 years.

In line with NPS policies, the mission of WICA is to preserve and protect natural and cultural resources for present and future generations, with an understanding that natural processes and species are evolving and will be allowed to continue to evolve with minimal influence by human actions. The park's use of prescribed fire as described above is an example of human action implemented by the park to restore a natural process supportive of healthy, resilient forests/prairies that no longer occurs naturally due to human intervention on a landscape level in the Black Hills.

The USDA Forest Service Rocky Mountain Forest Health Management group conducts aerial surveys each year during the summer and early fall to map forest insect and disease activity in forested areas of national forests and grasslands in Region 2. This survey documents tree damage related to disturbances such as insect or disease activity. Since WICA is adjacent to Black Hills NF, it is included in these aerial detection surveys. Aerial survey in 2011 detected one small site of MPB infestation within WICA and roughly a dozen small sites within 2 miles of WICA border on adjacent ownership lands to the west and north. Individual MPB green-infested trees have also been found on transect monitoring in WICA in 2011. Given that MPB is a native insect that has evolved with pine forests in North America, a large ponderosa pine forest area in the Black Hills without any MPB would be unnatural and unexpected.

Knowing that MPB is present in WICA in endemic conditions and that MPB is present in the central Black Hills in epidemic conditions, WICA managers are interested in assessing the risk that MPB poses to the park and considering what, if any, actions would be appropriate in advance of, during, or after an epidemic outbreak of MPB at WICA. The following is a preliminary assessment of MPB risk at WICA that was conducted in December 2010/January 2011 using existing vegetation data and aerial imagery.

Risk Assessment

Data and Methods

The Inventory and Monitoring Program of the NPS was created in 1991 to provide park managers with critical information on natural resources. To address part of this mission, NPS contracted with the US Geological Survey - Biological Resources Division to implement a multi-year project producing vegetation maps for 235 national parks. USGS-BRD developed various work contracts with other government and private agencies to make the project a reality. In the case of WICA, USGS contracted with the Bureau of Reclamation's Remote Sensing and Geographic Information Group and The Nature Conservancy to map vegetation occurring in and

around the park in a project that was completed in 1999. Vegetation map classes were determined through extensive field reconnaissance, data collection and analysis in accordance with the National Vegetation Classification System. The vegetation map was created initially by interpretation of 1997, 1:12,000 scale color infrared aerial photography (0.5 hectare minimum mapping unit). All vegetation and land-use information was transferred to USGS digital orthophoto quarter-quads using a combination of on-screen digitizing and scanning techniques. ArcInfo software was used throughout the project for digitizing, scanning, transforming, registering, and plotting the interpreted data. Overall map accuracy for the mapping effort was assessed initially at 73%.

This data served as the starting point for a MPB risk assessment for WICA. The first step was to assign risk ratings to all polygons of the 1999 WICA vegetation map. The map contains 32 unique map classes, with some map classes representing multiple National Vegetation Classification types because differentiation was not possible with the imagery used. Risk level was assigned to each map class based on its defined percent cover of ponderosa pine or, if that was lacking, WICA botanical expert opinion. Four risk levels were determined:

No risk – vegetation types and map classes not including any component of ponderosa pine (grasslands, shrublands, and non-ponderosa pine forests/woodlands).

Low risk - vegetation types and map classes with widely spaced ponderosa pine (pine woodlands, grasslands and woodlands with burned pine)

Moderate risk – vegetation types and map classes with lower density of ponderosa pine

High risk – vegetation types and map classes with higher density of ponderosa pine.

Table 1. MPB risk levels assigned to vegetation types for WICA MPB risk assessment. Map classes not included in a vegetation type are listed but identified as map class.

NO RISK Sparse vegetation	Redbeds (Siltstone, Sandstone, Gypsum) Sparse Vegetation Black Hills Granite/Metamorphic Rock Outcrop Sparse Vegetation Shale Barren Slopes Sparse Vegetation White Sedimentary Rock Outcrop (map class) Recent Burn Sparse Vegetation Bison Wallows (map class)
NO RISK Graminoid and herbaceous vegetation	Northern Great Plains Little Bluestem Prairie Western Wheatgrass – Green Needlegrass Mixedgrass Prairie Big Bluestem – Little Bluestem Western Great Plains Herbaceous Vegetation Kentucky Bluegrass Herbaceous Vegetation Cheatgrass Annual Grassland Introduced Weedy Graminoid Herbaceous Vegetation Needle and Thread – Blue Grama Mixedgrass Prairie Prairie Dog Town Grassland Complex Prairie Cordgrass – Sedge Wet Meadow Creeping Spikerush Wet Meadow Western Great Plains Streamside Vegetation
NO RISK Shrubland vegetation	Mountain Mahogany/Side-oats Grama Shrubland Leadplant Shrubland (map class) Chokecherry Shrubland Beaked Willow Shrubland Western Snowberry Shrubland Creeping Juniper/Little Bluestem Dwarf-Shrubland
NO RISK Non-pine tree forests and woodlands	Cottonwood/Western Snowberry Floodplain Woodland Boxelder/Chokecherry Forest Green Ash-American Elm/Western Snowberry Forest Birch – Aspen Stand (map class) Bur Oak Stand (map class)
LOW RISK Widely spaced ponderosa pine	Ponderosa Pine/Sunsedge Woodland Ponderosa Pine/Little Bluestem Woodland Ponderosa Pine/Western Wheatgrass Woodland Grasslands and Shrublands with Burned Pine (map class) Ponderosa Pine Limestone Cliff Sparse Vegetation
MODERATE RISK Lower density ponderosa pine	Ponderosa Pine Complex II (15%-75% Cover) (map class) Ponderosa Pine/ Chokecherry Forest Young Ponderosa Pine Dense Cover Complex (map class)
HIGH RISK Higher density ponderosa pine	Ponderosa Pine Complex I (75%-100% pine cover) (map class) Ponderosa Pine/Common Juniper Woodland

Significant changes have occurred to some of the park's vegetation from 1999 to 2010. WICA staff embarked in fall 2010 on a project to update its vegetation map using available imagery and park staff expertise. WICA decided to focus first on updating the map relative to changes in forested areas resulting from prescribed and wildfire, which has proved to be useful for MPB analysis.

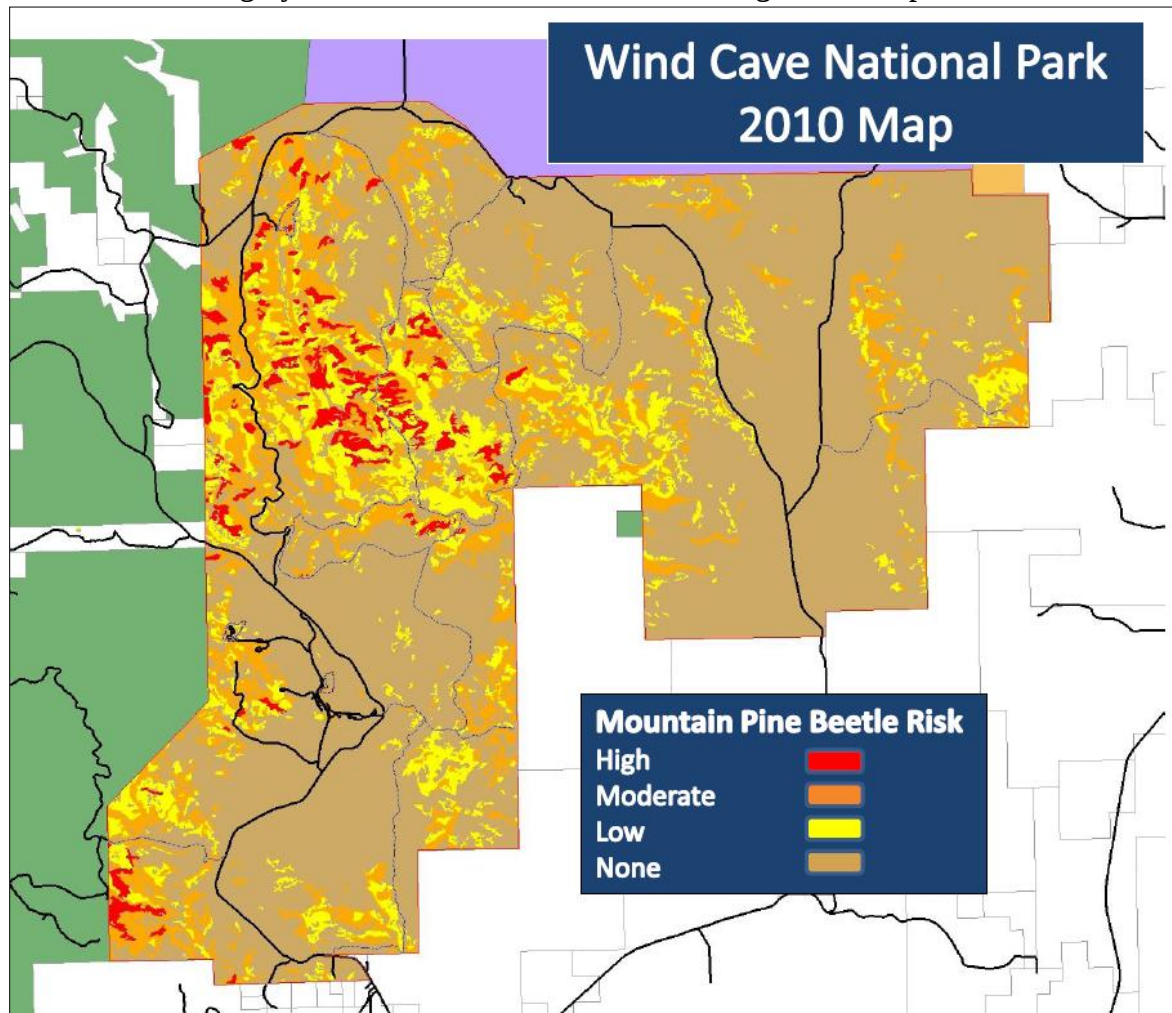
To update the 1999 WICA vegetation map, a photo-interpretation exercise similar to that of the original vegetation map project was completed using 2010 color aerial photography. The original vegetation map was overlaid with ca. 1990s black and white aerial photography and examined for calibration purposes (the original color infrared photography was not available). This calibration involved WICA staff investigating what imagery signatures were identified with what map classes on the old map, in order that identification decisions in the current process would emulate the original as closely as possible. After calibration, the original vegetation map was overlaid with 2010 color aerial photography and changes in map classes analyzed and digitized at 1:5,000 scale. Given the limitations of the current process (i.e., non-professional photo-interpreters, color photography rather than infrared), it was decided to focus on documenting substantial changes in vegetation. For example, changes from pine forest to grassland (or vice versa) or significant changes in tree density. Most of this change is the result of prescribed or wildfire (causing decreases in tree density), or lack of fire (causing increases in tree density) in the last decade.

The 2010 update product is not as rigorous as the original vegetation map for several reasons. Firstly, the color infrared photography used in the original 1999 vegetation map allowed for more detailed photo interpretation of different vegetation classes due to the additional spectra available. Secondly, WICA staff lack the level of photo-interpretation experience of those remote sensing professionals who conducted the original 1999 photo-interpretation. Thirdly, the interpretation of 2010 photography has not been ground-truthed yet, so the accuracy level of 2010 map class determinations is currently unknown.

Results

While there is work to be done relative to uncertainties, WICA now has a best estimate of acres and areas of different risk relative to MPB in 2010 (before American Elk prescribed fire in October 2010). There are an estimated 729 acres of the park at High Risk for MPB (2.5%), 4306 acres at Moderate Risk (15.3%), 3095 acres at Low Risk (11%), and 20103 acres at No Risk (71.2%). For distribution of these areas around the park see Figure 1.

Figure 1. Distribution of mountain pine beetle risk in Wind Cave National Park as of October 1, 2010, using risk categories based on vegetation map classes updated through photo-interpretation of 2010 aerial imagery relative to the 1999 USGS/NPS Vegetation Map.



The analysis process also allows comparison of the current 2010 MPB risk condition to 1999 MPB risk condition. This provides some insight into the change in condition over the last 10 years. It is estimated there was an increase by 502 acres in the No Risk category and decreases of 68 acres, 237 acres, and 196 acres respectively for the High Risk, Moderate Risk, and Low Risk categories.

Table 2. Change in acreages in Wind Cave NP in mountain pine beetle risk categories between 1999 and 2010, based on analysis of 1999 USGS/NPS WICA Vegetation Map and update in 2010 based on photo-interpretation of 2010 aerial imagery.

Risk Category	Acres in 1999	Acres in 2010	Change (acres)
No Risk	19601	20103	+502
Low Risk	3292	3096	-196
Moderate Risk	4543	4306	-237
High Risk	797	729	-68

The disturbance dynamic causing substantial change in ponderosa pine density in Wind Cave NP in the last decade has been fire, both wildfire and prescribed fire. As an illustration, Figures 2 and 3 provide visual comparisons of the Highland Creek Fire area in Wind Cave NP from 1999 to 2010. The Highland Creek Fire was a lightning-caused wildfire that occurred in the park in 2001. The area of High Risk for MPB was reduced to zero as a result of the vegetation changes caused by the wildfire; Low Risk and Moderate Risk areas were also significantly reduced, while No Risk acres increased.

Figure 2. Comparison of mountain pine beetle risk category acreages before and after Highland Creek Wildfire of 2001 in Wind Cave National Park. Note that risk category acreages outside the fire boundary did not change between 1999 and 2010.

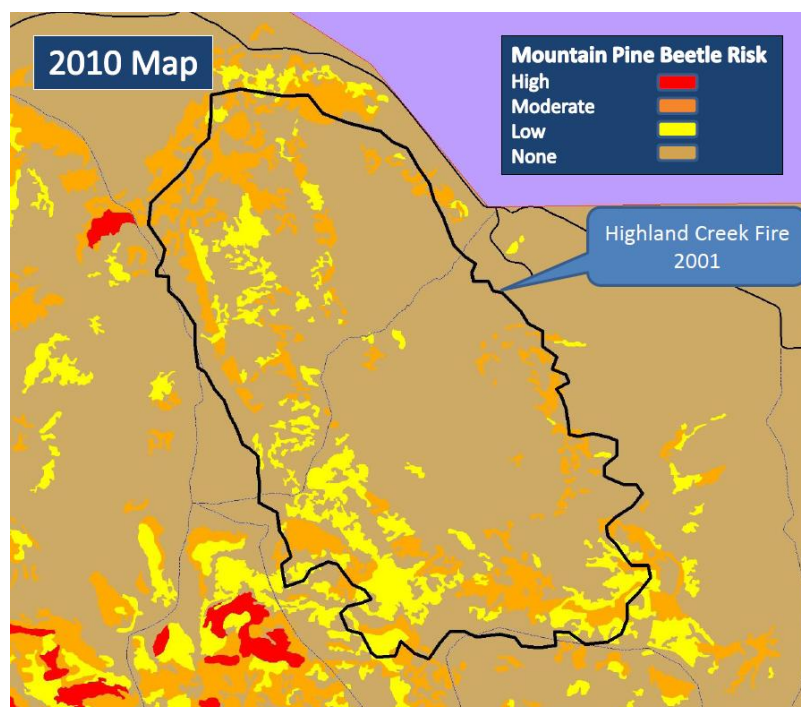
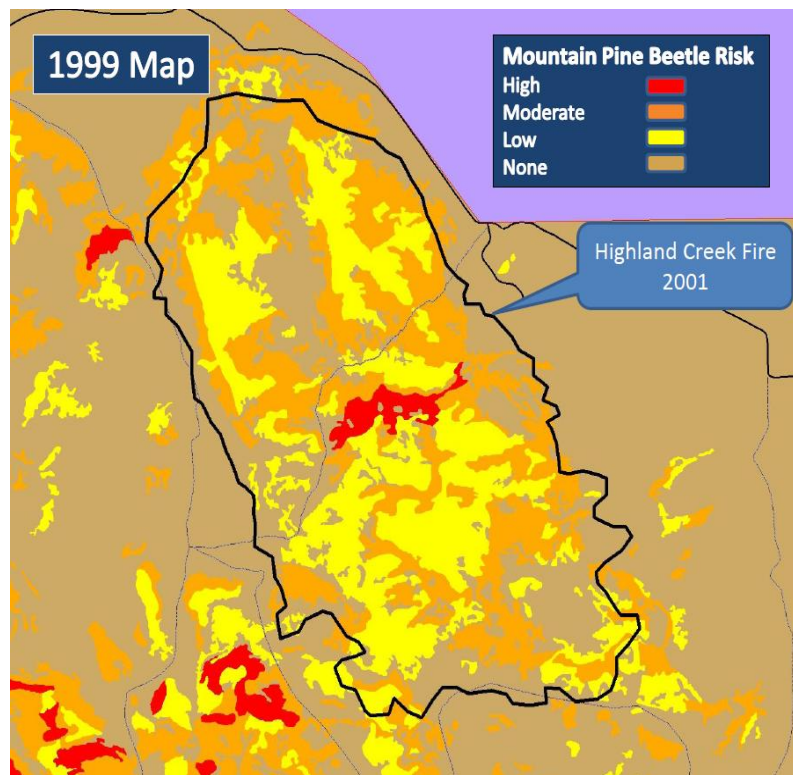
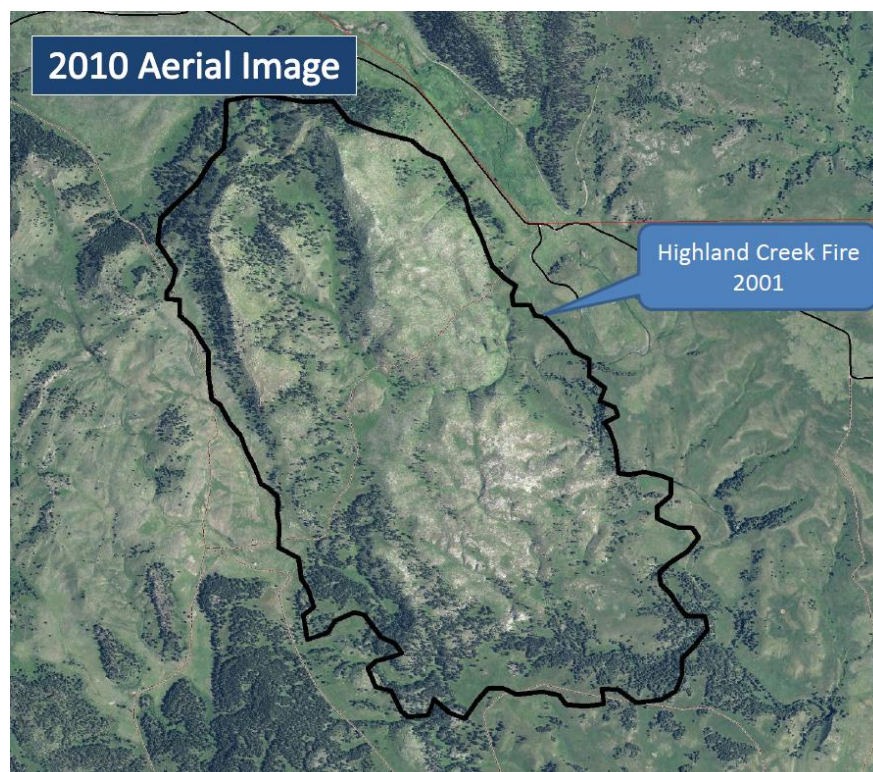
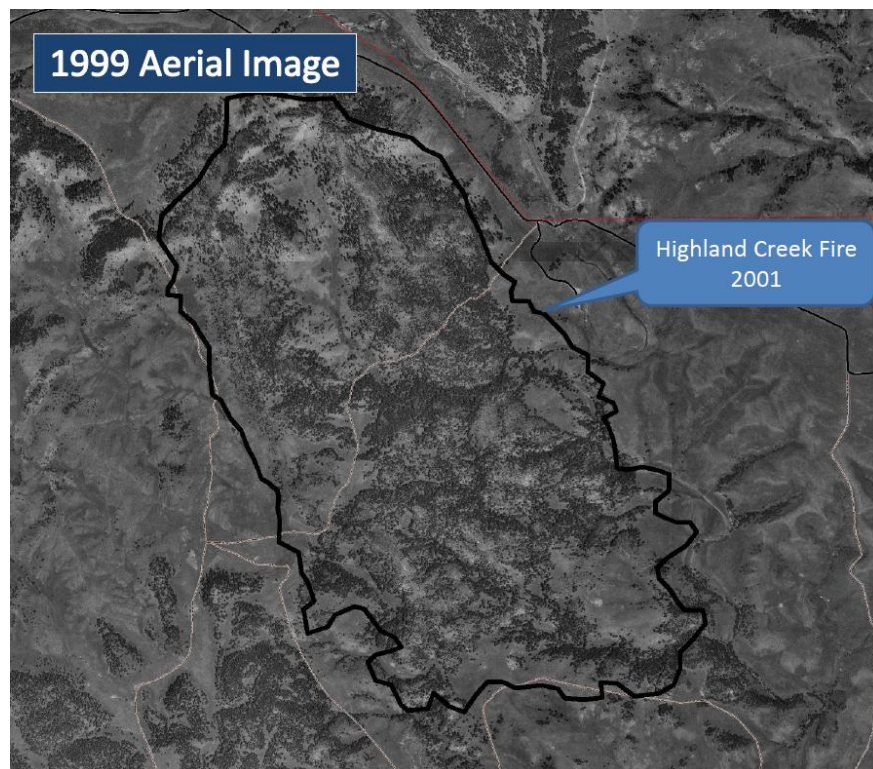
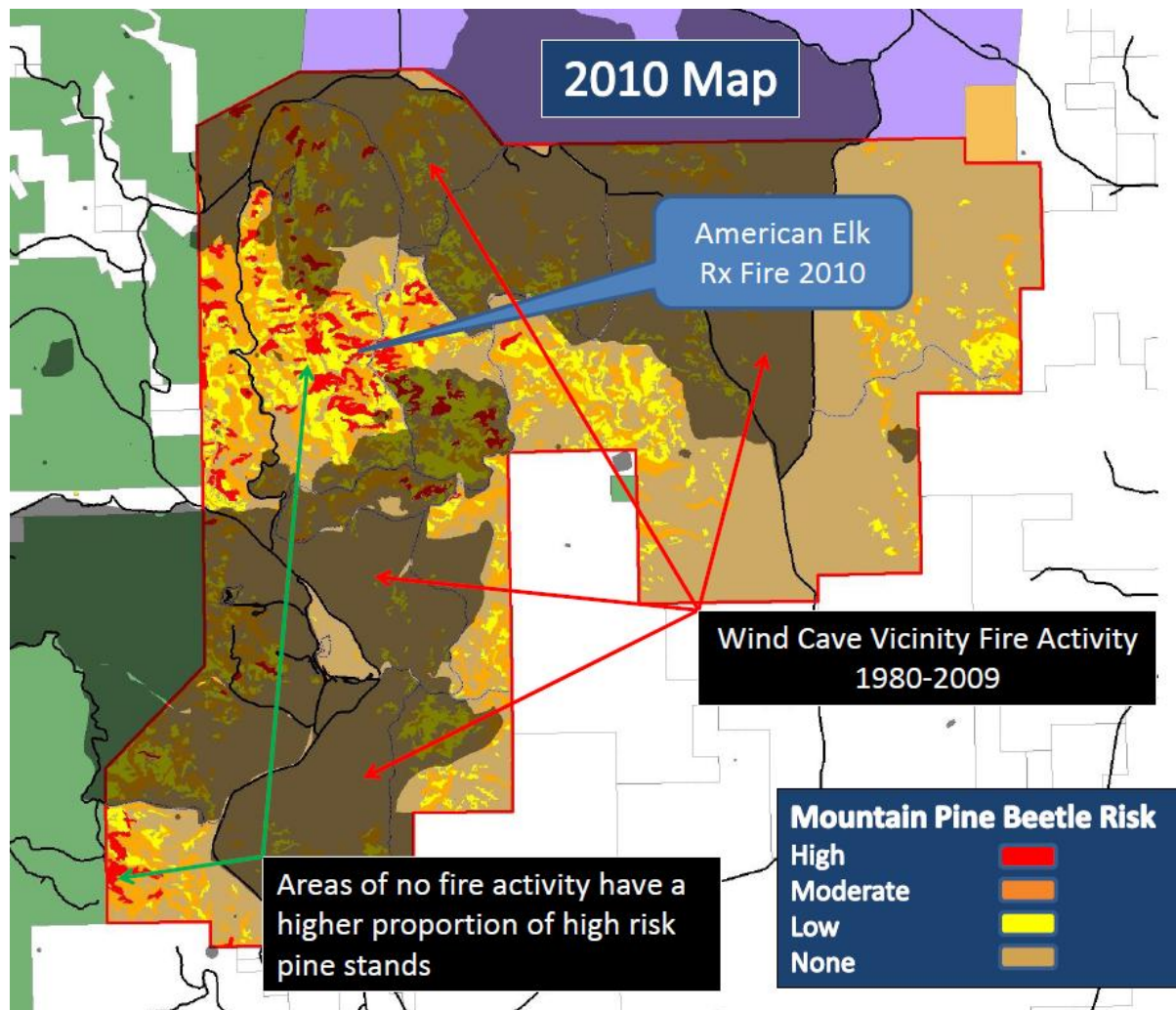


Figure 3. Comparison of aerial imagery before (1999 - black and white) and after (2010 - color) Highland Creek Wildfire of 2001 in Wind Cave National Park. Note changes to ponderosa pine density.



The portions of WICA that have the greatest concentration of High Risk for MPB correspond with those areas that have not experienced fire within the last 30 years. In Figure 4, WICA fire history is overlain on the WICA 2010 MPB risk map. The largest area of the park showing High Risk for MPB was burned in the American Elk prescribed fire in late October 2010. Data on vegetation changes after fire will not be available until data collection begins in the summer of 2011.

Figure 4. Wind Cave National Park 2010 mountain pine beetle risk map overlain with park fire history from 1980 to 2009. Note the area of the American Elk prescribed fire that was burned October 20-21, 2010. This included a large concentration of High Risk MPB acreage and is an area of the park that experienced no fire activity during the last 30 years.



While the WICA vegetation map classes are described based on canopy cover of ponderosa pine, basal area is a common field measurement of ponderosa pine density.

Figure 5. Comparison of pre-fire photograph of fire effects monitoring plot in Centennial Block 1 prescribed burn unit in 2006 (ponderosa pine basal area of 97 ft²/acre; moderate risk for MBP) with post-fire photograph at same location in 2008 (ponderosa pine basal area of 16 ft²/acre; low risk for MPB).

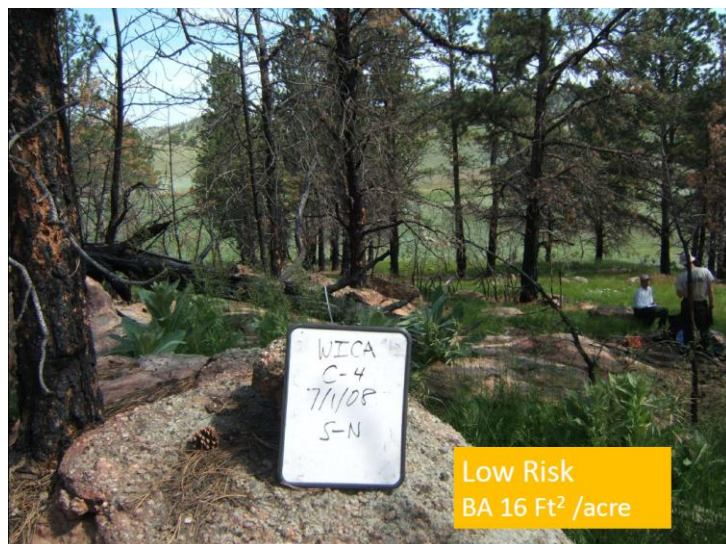


Figure 6. Comparison of pre-fire photograph of fire effects monitoring plot in Centennial Block 1 prescribed burn unit in 2006 (ponderosa pine basal area of 97 ft²/acre; moderate risk for MBP) with post-fire photograph at same location in 2008 (ponderosa pine basal area of 16 ft²/acre; low risk for MPB).

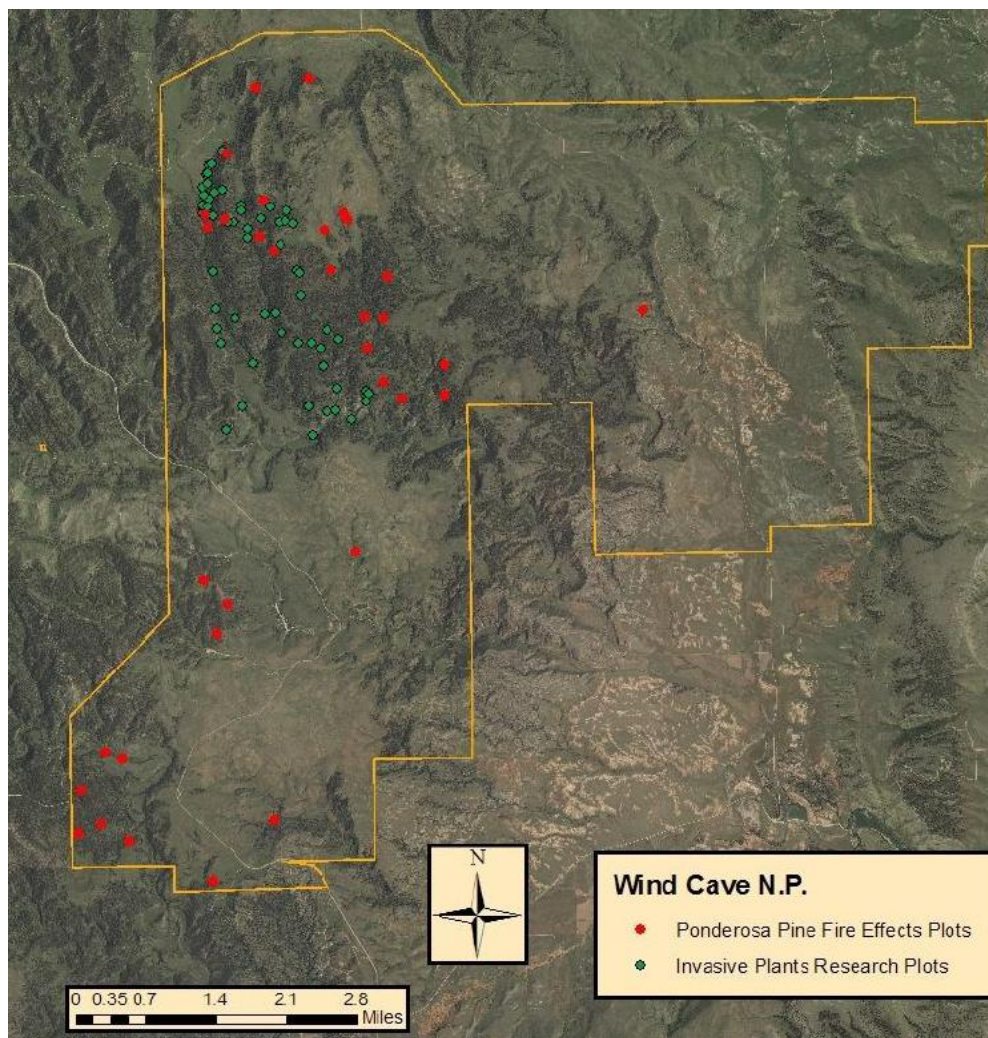


Monitoring

WICA has multiple sources for data on forested land in the park, generated by NPS networks as well as the park.

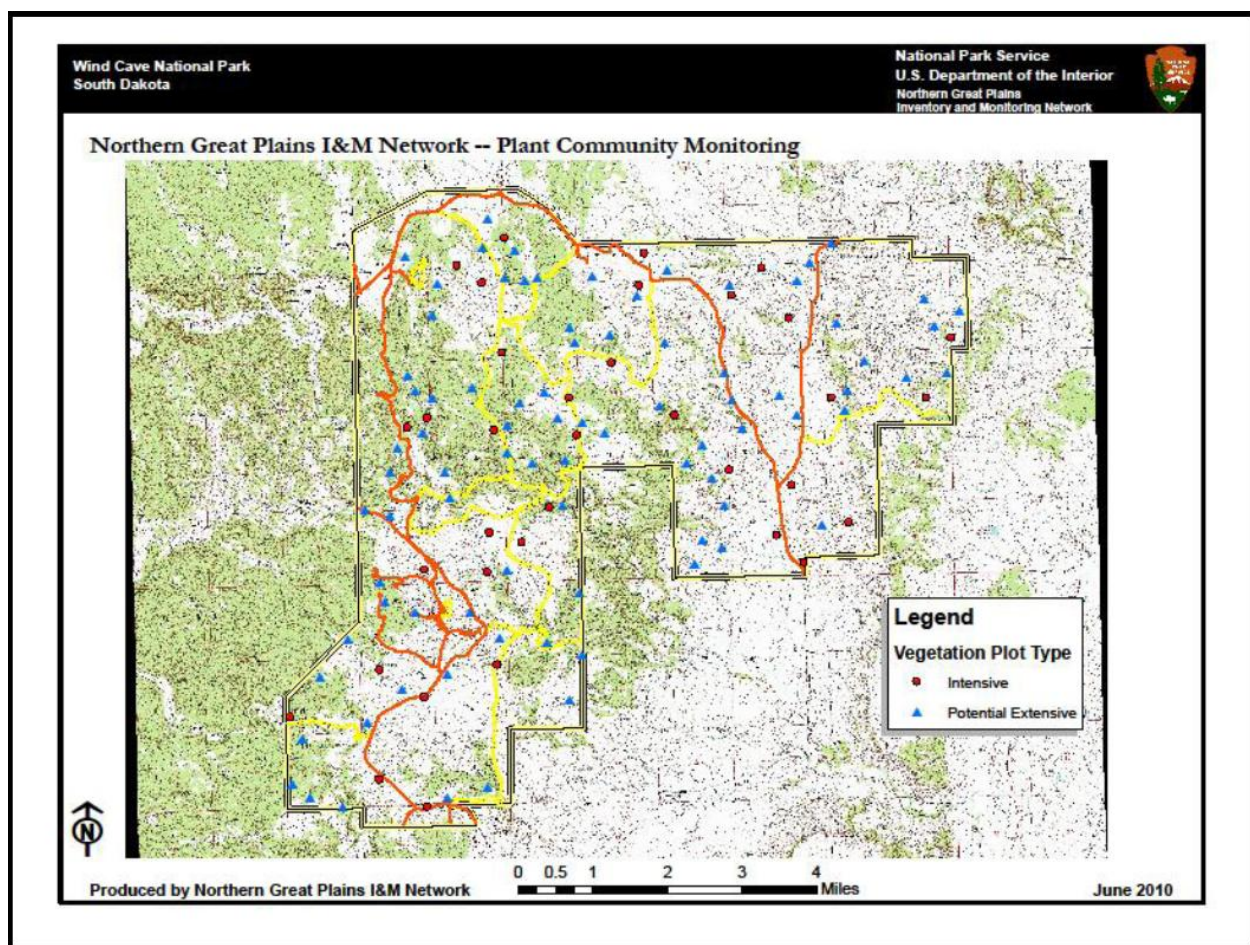
- 1) The Northern Great Plains Fire Network accomplishes fire effects monitoring in 13 NPS units in the Northern Great Plains area. Data on fuels and live trees is collected. Plots are monitored preburn and postburn in years 1, 2, 5 and 10. This program has been underway in WICA for more than 10 years, with data collected relative to all prescribed burns.
- 2) The Northern Great Plains Fire Network initiated a 3-year research project in 2010 for the main purpose of investigating invasive plant species establishment after prescribed fire. Data on fuels and live trees is collected.

Figure 7. Northern Great Plains Fire network collects data on WICA forest lands in plots established for fire effects monitoring (ongoing project) and for a research project on early detection of invasive plant species after prescribed fire (3 years).



- 3) Northern Great Plains Inventory and Monitoring Network is in the process of initiating long-term plant community monitoring in the 13 NPS units in the Northern Great Plains area. Thirty-five intensive plots have been established in WICA, some in forests/woodlands and some in grasslands. First data collection is scheduled for 2011. Eighty extensive plots will also be established in WICA in forests/woodlands – first data collection is scheduled for 2012. The protocols for intensive and extensive plots involve collecting data on live trees and fuels in all plots that have trees. The plots are read on a staggered schedule, so any individual plot is monitored 2 consecutive years out of every 5 years.

Figure 8. Northern Great Plains Inventory and Monitoring Network will be collecting long-term plant community monitoring data in WICA forest lands from intensive and extensive plots. Tree data will be collected from all 80 extensive plots and all of the 35 intensive plots that have trees in them. First data collection is scheduled for 2011 and 2012, respectively.

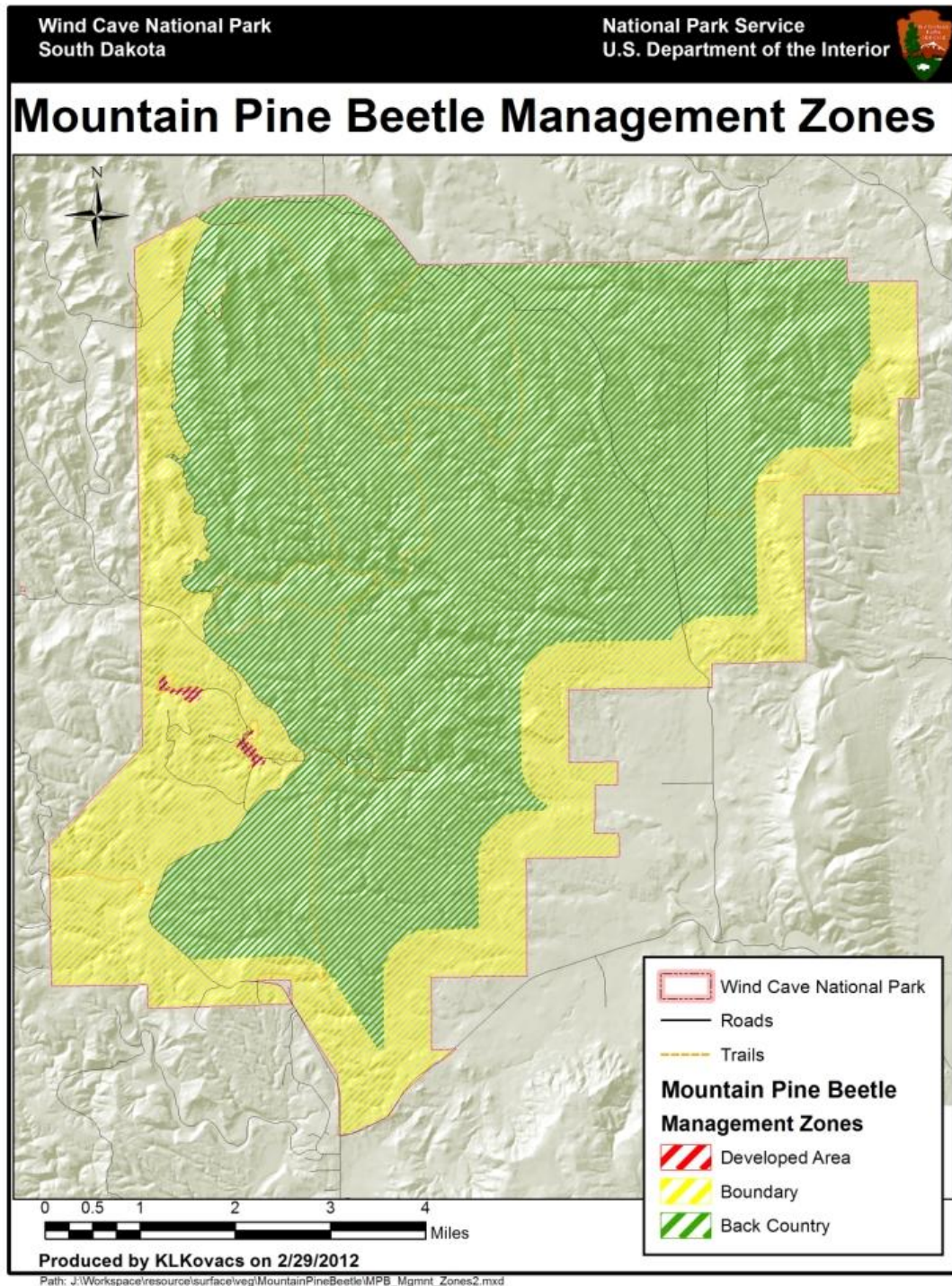


- 4) WICA staff (all divisions) actively work throughout the park. By providing training to employees, they can all become avenues for observing, recording, and reporting any MPB green-infested or MPB-killed tree to WICA-Resource Management.

Management Strategy

WICA was divided into three management zones for developing strategies for MPB response: Developed Area, Boundary, and Back Country (Figure 9).

Figure 9. Mountain pine beetle management zones in WICA.



Developed Area Zone

Description:

This area encompasses all locations of high human use (e.g., Elk Mountain Campground, Visitor Center area, housing area, roadsides, wayside parking areas) (Figure 9).

Special Concerns:

Risk of MPB in this area is low because the trees are isolated geographically and do not cover a large area. Ponderosa pine trees in the Visitor Center area planted by the Civilian Conservation Corps are of high value. Consideration will be given to planting young ponderosa pine to succeed historic plantings as they die. Use of strong chemicals to protect individual trees from MPB is not desirable, given the age of the trees and the proximity of Wind Cave to ground surface in the Visitor Center area (potential route for chemical introduction into the cave).

Treatment Recommended:

All MPB green-infested trees will be treated as hazard trees and removed for safety reasons. Trees will be cut into pieces and placed in the open to dry (off site).

Actions Planned:

WICA will continue to monitor trees in this zone and take appropriate removal action as needed.

Boundary Zone

Description:

This area encompasses the areas between the west boundary of the park and HWY 385 or HWY 87, as well as one-half mile from the park boundary into the park on the south and east boundaries (Figure 9).

Special Concerns:

This zone contains pockets of ponderosa pine trees in the high risk category, mostly in close proximity to the west boundary of WICA. Monitoring will occur within this zone annually. Any green-infested trees will be documented and additional monitoring will be initiated. If >15 green infected trees are located in close proximity, action may be initiated to reduce MPB spread. This may include tree removal from site, trees cut into small pieces left on site to dry, live-tree thinning, or additional appropriate action.

Treatment Recommended:

Use prescribed fire to return these portions of WICA to a natural, healthy condition.

Actions Planned:

WICA will continue to monitor trees in this zone and take appropriate action as needed.

Back Country Zone

Description:

This area encompasses all other locations (generally east of HWY 385 & HWY 87 and interior of WICA) (Figure 9).

Special Concerns:

After the American Elk Prescribed Fire, this zone contains few, if any, areas that are considered high risk for MPB epidemics. MPB will be allowed to function as a natural ecosystem process.

Treatment Recommended:

None.

Actions Planned:

WICA will continue to monitor trees in this zone and document MPB. If ponderosa pine densities increase, WICA will readdress and take appropriate action as needed.

MPB is a natural disturbance in ponderosa pine forests in the Black Hills and Wind Cave NP. WICA park management strategy for MPB at the present time is to use results from ongoing monitoring in the park to track MPB activity in the park and make an annual evaluation. WICA-Resource Management will receive all data from park MPB monitoring and coordinate with relevant monitoring by other entities in the park. If MPB infestations occur and expand in the park in the future, WICA staff will determine if the situation has changed and appropriate response will be initiated.

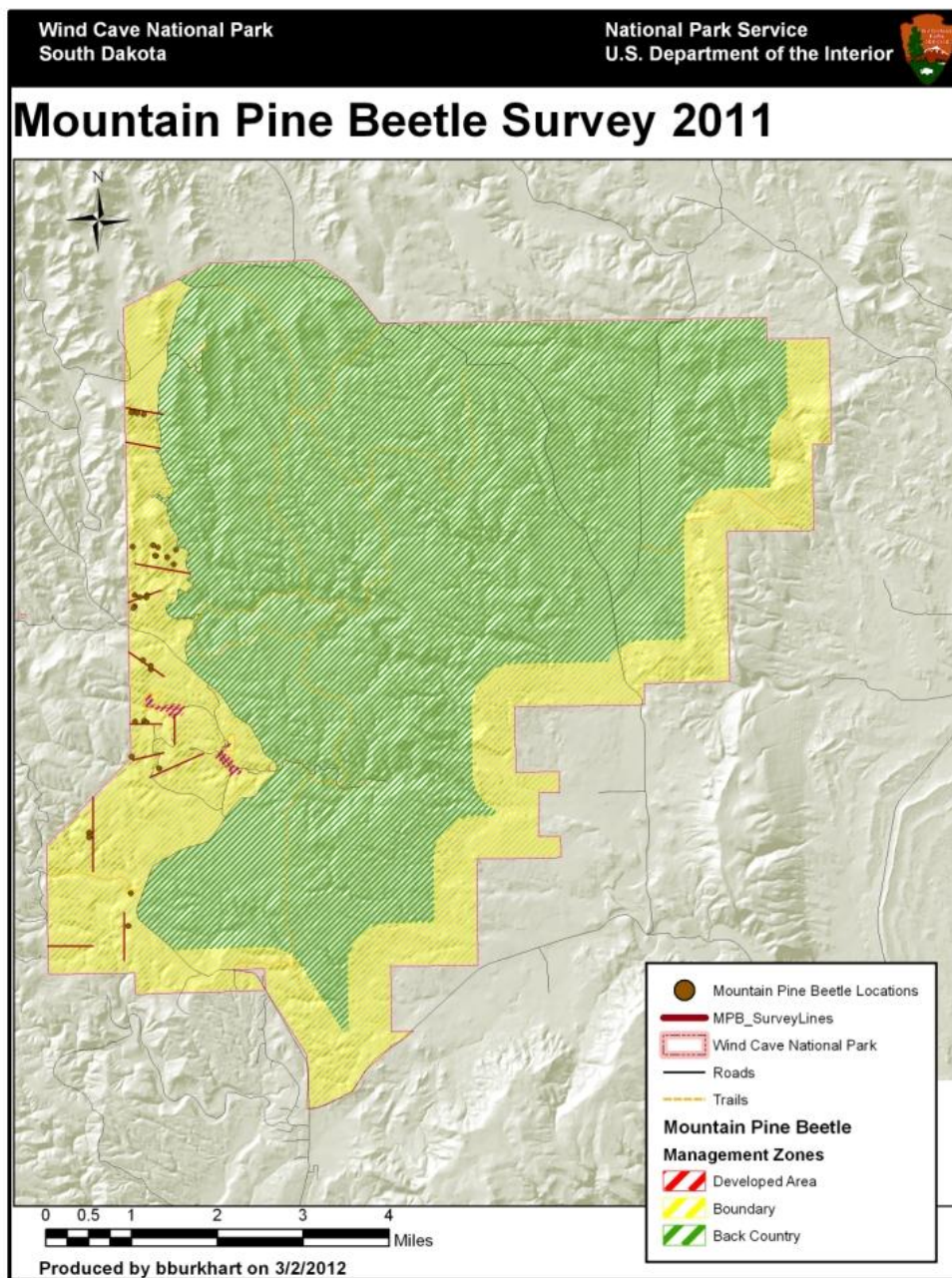
All specific treatment actions implemented (on a particular site) will go through National Environmental Policy Act (NEPA) and Section 106 compliance process to determine potential impacts to other park resources (such as archeological sites).

2011 Monitoring Results

Information on the status of MPB in WICA in 2011 includes:

- 1) Twelve transects and one area (Headquarters) in the Boundary Management Zone were surveyed for MPB green-infested trees in spring 2011 (Figure 10). Individual green-infested trees were found on 9 of the 12 transects; no MPB trees were found in the area surveyed. Trees were marked with biodegradable survey tape and will be revisited in 2012 to monitor changes.

Figure 10. WICA 2011 mountain pine beetle survey – survey transects and areas and MPB points.



- 2) No MPB trees were detected in Northern Great Plains Network Inventory and Monitoring plots in WICA in 2011.
- 3) No MPB trees were reported from Northern Great Plains Fire Network fire effects monitoring plots or invasive species/fire research plots in 2011.

Literature Cited

- Amman GD 1977. The role of mountain pine beetle in lodgepole pine ecosystems: impact on succession. In: *The Role of Arthropods in Forest Ecosystems, Proceedings of the 15th International Congress of Entomology; 1976 August 19-27, Washington, D.C.* (ed. Mattson WJ), pp. 3-18. Springer-Verlag, York.
- Mock KE, BJ Bentz BJ, EM O'Neill, P Chong, J Orwin, and ME Pfrender 2007. Landscape-scale genetic variation in a forest outbreak species, the mountain pine beetle (*Dendroctonus ponderosae*). *Molecular Ecology* (2007) 16, 553-568.
- National Park Service 2005. Wind Cave National Park Fire Management Plan. Wind Cave National Park. U.S. Department of Interior, National Park Service.
- Sieg CH, and KE Severson. 1996. Managing habitats for white-tailed deer in the Black Hills and Bear Lodge Mountains of South Dakota and Wyoming. U.S. Forest Service General Technical Report RM-GTR-274, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.