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Carbaryl use in the Butte Field Office

Location: **BLM Lands Administered by the Butte Field Office**

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CHAPTER 1
PURPOSE AND NEED FOR ACTION

INTRODUCTION

The Bureau of Land Management (BLM) Butte Field Office (BFO) proposes to authorize the application of carbaryl, an insecticide, to BLM administered conifer habitats within the BFO. If approved, applications would start in the spring of 2011.

PURPOSE AND NEED FOR ACTION

The purpose of the proposed action is to temporarily suppress bark beetle infestations and protect conifers from direct mortality. Bark beetle populations tend to be cyclical, rising and falling throughout time. Bark beetle populations fluctuate between endemic and epidemic levels in response to environmental factors such as drought, temperature changes, and others. During times of high population levels, undesirable levels of tree mortality can occur. In any given year there can be "high value" trees that need to be protected from bark beetle infestations. Action is needed, to protect high value trees which help maintain forest stand diversity, as well as support the preservation of aesthetics, recreation, and wildlife values.

Currently, forests on the BFO administered lands are undergoing tree mortality in stands of lodgepole, ponderosa, limber, and whitebark pine due to epidemic populations of mountain pine beetle (MPB), *Dendroctonus ponderosae*. Carbaryl treatments could be used to protect individual stands of these tree species and Engelmann spruce against MPB and other bark beetles.

CONFORMANCE WITH BLM LAND USE PLAN(S)

Land Use Plan Name: Butte Resources Management Plan
Date Approved: April 2009.

The treatments that would be implemented would be consistent with and supported by the following goals and management actions in the Butte RMP, as approved April of 2009.

The first goal of the Forest and Woodland section in the RMP states that we will, "restore and/or maintain the health and productivity of public forests." Also, in the Forest and Woodland section there are management actions that relate to treatments such as carbaryl. They are: "manage vegetation to reduce the occurrence of unnaturally large forest insect outbreaks" and "stands at substantial risk to epidemic levels of forest insects will be a high priority for treatments".

Goals within the Wildlife section of the RMP also relate to carbaryl treatments. They are: "manage to provide a variety of well-distributed plant communities to support a diversity of habitats" and "conserve, enhance, restore, or minimize impacts to areas of important wildlife habitat".

RELATIONSHIPS TO STATUTES, REGULATIONS AND OTHER PLANS

The proposed action is consistent with the Federal Land Policy and Management Act of 1976 (43 U.S.C 1701 et seq.: 90 Stat. 2743; P.L.94-579), the National Environmental Policy Act of 1969

(42 U.S.C 4321 et seq.), the Standards for Rangeland Health and Guidelines for Grazing Management (43 CFR 4180), the National Historic Preservation Act of 1966, as amended, the Endangered Species Act of 1973, the Federal Noxious Weed Act of 1974, as amended in 1988, 1994, the Carlson-Foley Act of 1968 (Weed Control on Public Lands), and with BLM policies and Federal regulations. Potential decisions resultant from this document would be made under the BLM's Forest Management regulations at 43 CFR 5000.

CHAPTER 2
DESCRIPTION OF ALTERNATIVES

INTRODUCTION

This EA focuses on the Proposed and No Action alternatives. Impacts associated with the proposed action are mitigated through implementation of proposed design features; consequently, there are no issues to resolve through additional mitigation or other action alternatives. Therefore, the Proposed Action is the only action alternative considered. The No Action alternative is considered and analyzed to provide a baseline for comparison of the impacts of the proposed action.

NO ACTION

Under the No Action Alternative, BLM would not allow the application of carbaryl to high value trees which are at risk of bark beetle attack within the BFO.

PROPOSED ACTION

To prevent bark beetle infestation in currently uninfested trees, carbaryl would be applied to small stands (<50 acres) and individual high value live trees, which are at risk for bark beetle induced mortality. Carbaryl would be applied in combination with other treatments (such as reducing stand basal area to <80 sq. ft/acre) when appropriate to achieve stand objectives. All other treatments are not part of this EA and would be evaluated and proposed in separate NEPA documentation. For the purpose of this EA, high value trees shall be defined as trees which help maintain forest stand diversity, as well as support the preservation of aesthetics, recreation, and wildlife values. Also, these high value trees would have to be "at risk" to bark beetle attack in order for them to be considered for carbaryl spraying. The specialists in the BFO currently coordinate with Forest Service entomologists to determine which trees are at risk to bark beetle attack. To determine if trees are at risk to bark beetle attack a number of factors are used, such as: diameter of high value trees (many bark beetles prefer stands of mature trees), basal area of the surrounding stand, proximity to known beetle populations, level of stress high value trees are experiencing due to environmental factors. All of these factors, along with access to the area and values the trees hold would be evaluated to determine if they would be treated with carbaryl.

Tree species that would be considered for spraying include ponderosa pine(Pinus ponderosa), lodgepole pine (Pinus contorta), whitebark pine (Pinus albicaulis), limber pine (Pinus flexilis), and Engelmann spruce (Picea engelmannii). Bark beetles usually prefer to attack mature trees (>8 inch diameter at breast height outside bark (DBHOB)), but when populations are high and their food sources become limited, beetles may also attack immature, pole sized (4-8 inch

DBHOB) trees. Carbaryl treatment would primarily focus on mature trees; however, under the following circumstances immature trees would be treated: they are located in camping areas or near homes, are crucial for wildlife habitat, or are part of a limited or isolated population.

Timing of the application of carbaryl is dependent on the lifecycle and development of the bark beetles along with the effective duration of carbaryl itself. Carbaryl would be sprayed in early summer before bark beetle adults emerge, typically in the month of June on BFO administered lands. Carbaryl is effective for two flight seasons; therefore, spraying at each treatment site would probably occur every two years, depending on levels of bark beetle populations, funding, and effectiveness of previous applications. The carbaryl label recommends trees be treated with 2% solution (5 ounces per gallon) (Bayer CropScience Lp).

Areas currently identified for carbaryl treatment include the Great Divide Ski Hill and campgrounds along the Big Hole River. If implemented, carbaryl would be sprayed on high value lodgepole pine within these areas.

Additional treatment areas would be evaluated on a case by case basis. Areas would be identified by using a combination of BFO specialists and Forest Service Entomologist's advice and knowledge of stand conditions that are most likely to attract beetles in Western Montana and/or a rating system to determine if high value trees are at risk.

Annual operating plans (AOPs) would be made every year prior to carbaryl applications. The AOP would identify the areas to treat, determine which resources may be affected, and identify all the design features, listed below, that would apply.

Motorized cross-country travel, or travel on closed or seasonally restricted routes to conduct carbaryl spraying would be allowed under the Proposed Action except in designated Wilderness and Wilderness Study Areas. Typically, carbaryl is applied using a high pressure sprayer mounted on a truck or other machine. The sprayers are commonly equipped with hoses which can be up to 300' long (USDA, 2010). Carbaryl spray is applied directly to the bole of the tree. Spray height depends on the pressure of the sprayer can produce. It is recommended that the sprayer is capable of sustaining 400 psi, this allows carbaryl to be sprayed approximately 45-50 feet high (USDA, 2009).

Motorized cross-country travel would be minimized and existing routes would be used to the extent possible. Travel through wetlands/riparian areas would be avoided to prevent rutting and resulting erosion and sedimentation. Prior to treatment, surveys would be conducted for sensitive flora. If any plants were found, measures, including but not limited to alternate routes and reduced number of passes, would be taken to mitigate possible impacts. Any additional concerns raised regarding cross-country travel issues would be addressed.

Under the Proposed Action, carbaryl treatments would be applied as needed throughout the period of time that management decisions within the Butte RMP (USDI-BLM 2009) remain valid, or unless new information about potential adverse effects on the human environment comes to light that makes the analysis contained in this EA invalid.

DESIGN FEATURES/MITIGATION MEASURES

To minimize toxic risk to humans and non-target species from carbaryl treatment, the following design features/mitigation measures would apply:

- Carbaryl would be applied using mechanized equipment (a high power sprayer, mounted on a truck or other machine).
- Off-road motorized traffic and travel on closed routes would occur only after travel variances are obtained.
- Driving equipment off of roads would be minimized and existing routes would be used to the extent possible. When possible, equipment would remain on roads and hoses would be drug to the tree. Normally hoses can reach up to 300 feet (USDA, 2010).
- Spraying would be done with strict adherence to application guidelines on the manufacturer's label (Bayer CropScience LP).
- All mixing and application of carbaryl would be done by individuals licensed in the State of Montana to apply pesticides.
- Pesticide would be applied in a narrowly focused manner specifically targeting individual tree boles single, which helps mitigate non-target effects because more than 80 percent of the chemical adheres to the bark and 18 percent of the solution falls to the soil with most deposited one meter from the tree as a result of high pressure application (Haverty et al. 1983).
- No carbaryl would be applied within 100 feet of private homes and buildings.
- No chemical would be applied within 100 feet of occupied or high value habitat for sensitive species (USDI 2009).
- No chemical would be applied within 100 feet of streams, rivers or wetlands (USDI 2009). However, care during spray operations is very important as the high pressure spray can travel substantial distance if not dissipated on the tree trunk and branches. Mixing of the carbaryl solution would not occur within 300 feet of a water source. Water is required to mix the carbaryl solution. Water may need to be pumped from nearby water sources, pumping from fishery streams would require pump hoses to be screened with 3/32 inch screens. Pumps would also be equipped with backflow prevention devices to prevent contamination.
- Application areas would be flagged and marked with signs having cautionary notices indicating that a hazardous pesticide has been applied. Signs would also include a warning not to consume vegetation and fruit within the area.
- Public use areas, such as campgrounds, would be closed prior to carbaryl application and for a minimum of 24 hours following the completion of spraying. The carbaryl label (Bayer CropScience Lp) has a restricted entry interval (REI) of 12 hours for anyone not protected by the appropriate PPE. The label also states that when treating forested areas, public use should not be allowed until treated surfaces have dried. For the BFO forested areas it should take no longer than 12 hours for the spray to dry, but for extra precaution, public use areas would be closed for at least 24 hours.
- Spraying would be done when winds do not exceed 5 mph to help reduce the degree of drift, and no treatments would occur if tree boles are wet, or if rain is anticipated within the next 4 hours (Individual Tree Protection Using Carbaryl Insecticide for Western Conifer-Infesting Bark Beetles, Forest Health Protection Manual, 2009). Wind speed would be monitored by BLM personnel to ensure carbaryl is not applied when there is

potential for drift. No application would occur when temperature is below 40 degrees Fahrenheit.

- Application areas and trees would be flagged prior to treatment, and a BLM inspector would be present in the field with the contractor, as needed.
- In public use areas, picnic tables and water spigots would be covered with plastic prior to treatment, and washed after spraying is completed. Also, public use areas may need to be closed prior to spraying carbaryl, public outreach efforts would occur prior to closure.
- In public use areas, grass/lawns that are within 100 feet of carbaryl application will be mowed prior to reopening of the area.
- Applicators would prepare a spill response plan that includes a spill response kit that would be kept on site.
- Parking or driving in weed infested areas would be avoided if at all possible. If carbaryl treatment would occur in heavily infested areas, equipment would be washed prior to moving to other areas.
- Trees would be visually searched for nest cavities and nests. Trees with nest cavities would not be sprayed. Nests would be avoided with at least a 20-foot buffer from direct spraying.
- Trees would not be sprayed if blooming flowers with bee activity are within the drift area.
- Trees designated to be sprayed with dense low foliage could have branches removed to allow the spray to reach the bole of the tree.

CHAPTER 3
AFFECTED ENVIRONMENT

INTRODUCTION AND GENERAL SETTING

The Butte Field Office administers approximately 300,000 acres of land scattered across eight counties in southwest and south central Montana. Approximately 135,000 acres of this land is forested with about 115,000 acres of dry forest types and 20,000 acres of cool/moist forest types. The dry forest types are most commonly Douglas-fir forests mixed with stands/patches of ponderosa pine. The cool/moist forest types are most commonly lodgepole pine and Douglas-fir forests. These lands spread across the Big Hole, Blackfoot, Gallatin, Jefferson, Shields, Upper Clark Fork, and Upper Missouri subbasin drainages over all or parts of Beaverhead, Broadwater, Deer Lodge, Gallatin, Jefferson, Lewis & Clark, Park, and Silver Bow counties.

Field Office-wide descriptions of resources are disclosed in the Proposed Butte Resource Management Plan and Final Environmental Impact Statement (USDI-BLM 2008), in Chapter 3, on pages 219-321.

FORESTS

Of all the BFO administered forested lands it has been estimated that less than 5 percent (6,750 acres) would be suitable for application. The suitable acres for application were estimated by using current knowledge of both identified and potential areas where high value trees exist while also identifying access and other resource concerns. Many of the pine stands within the BFO are experiencing mortality from bark beetles such as mountain pine beetle, western pine beetle, and pine engraver beetle.

Pine tree mortality seen in the Butte Field office is primarily attributed to the mountain pine beetle (MPB), *Dendroctonus ponderosae*. MPB is a native bark beetle, which attacks most native and introduced species of pines (Hagle et al, 2003). At endemic levels, the beetle typically survives in stressed, weakened, or previously damaged trees, and causes minimal mortality. However, MPB populations can build and spread quickly under favorable conditions. At epidemic levels, MPB can decimate mature forests, often killing virtually all trees over extensive areas (Worrall, 2000). Outbreaks often occur in lodgepole pine stands that contain well-distributed, large diameter trees (Amman et al, 1990).

Stands most susceptible to attack from MPB are pure, mature lodgepole pine that are densely stocked (Sturdevant 2009). Mortality caused by MPB is extremely variable throughout the BFO both at the landscape and stand level. Epidemic MPB activity is causing mortality of many of the mature lodgepole and ponderosa pine stands in the BFO. In some areas of the BFO, MBP induced mortality is also being seen in the younger sapling and pole sized lodgepole and ponderosa pine. (Sturdevant 2010, Steed 2010)

MPB is also infesting and killing limber and whitebark pine. Limber and whitebark pine are scattered throughout the BFO and most commonly occur on BLM lands in small groups (< 1 acre) or as incidentals within forests dominated by other species. Whitebark pine is a slow growing and long-lived tree of high elevations. Warming temperatures have allowed pine beetles to move higher in elevation, where they can successfully attack whitebark pine. Unlike lodgepole, whitebark pine is not expected to regenerate and recover in many places after beetle populations decline. The loss of this keystone species has adverse effects on snow pack retention, wildlife and fisheries, as well as the function and structure of our entire western subalpine ecosystem. (Six 2010)

Western pine beetle (WPB), *Dendroctonus brevicomis,* is another native bark beetle that can also attack and kill ponderosa pine. Western pine beetle preferentially attack weakened, old, and stressed trees but can also reach outbreak levels in apparently healthy stands (Montana DNRC, 2011). Group killing of trees is common in dense, overstocked stands of pure, even-aged, young sawtimber, but also occurs among dense clumps of pine in stagnating mixed-conifer stands (DeMars and Roettgering 1982). Minimal mortality due to WPB has been observed in the BFO forested lands, but if WPB are found near high value ponderosa pine, these trees may need to be treated with carbaryl.

In addition to MPB and WPB, pine engraver beetles (PEB), *Ips pini*, may also kill pine trees. Although considered only moderately aggressive, pine engraver can kill pole-sized trees or tops of larger trees when populations are high or trees are stressed (Kennedy 1969, Furniss and Carolin 1977, Livingston 1979, Kegley *et al*. 1997). PEB populations most often build in logging decks, blowdowns, or when trees are stressed. Low spring moisture (< 75 percent of normal) is one stressor that is noted as an inciting factor for outbreaks (Kegley *et al*. 1997). With 2-3 generations per year, under favorable conditions PEB populations can increase rapidly. Mortality and top kill is more common in ponderosa pine than in other pine species although all pine species can be attacked by PEB. Minimal mortality due to PEB has been observed in the BFO forested lands, but if PEB populations build near high value pine trees, these trees may need to be treated with carbaryl.

Carbaryl applications could occur in areas commonly used by people such as recreation sites, areas near or adjacent to private land, and trails. Trees may be of high value simply because they are found within these kinds of areas.

Carbaryl applications, applied correctly, are effective for two flight seasons following treatment (24+ months on lodgepole pine; 24+ months also expected on limber pine, and whitebark pine; 18 months on ponderosa pine) (Gibson and Bennett 1985, Shea and McGregor 1987, Haverty et al. 1998, Fettig et al. 2006a & 2006c). Carbaryl would provide the trees the protection they need while the bark beetle populations are high. At risk high value trees have only been identified in two areas in lodgepole pine stands where MPB is active. Therefore, current proposals for treatments include spraying carbaryl onto lodgepole pine trees to protect them from the mountain pine beetle.

WILDLIFE

The Proposed Action would take place in forested habitats, initially in Big Hole River campgrounds and Great Divide Ski Area, but could potentially occur on any forested land managed by BFO. Wildlife in these areas are typical of western Montana. Big game species include elk, deer, moose, and bighorn sheep. Predators include coyote, bobcat, bear, gray wolf, and mountain lion. Small mammals include squirrel, mice, vole, mustelid species, and bats. Birds include grouse, several hawk species, owls, and numerous migratory bird species. Reptiles and amphibians that inhabit forests include Columbia spotted frog, western toad, rubber boa, and garter snake.

Federally Listed Species

The following species are those listed under the Endangered Species Act that may occur on BFO lands:

Grizzly bear (*Ursus arctos horribilus*) (Threatened): Grizzly bear habitat use is highly variable, but the species mostly uses remote forest habitats with low road density and minimal human disturbance. The species' range in BFO is generally confined to southern Park and Gallatin Counties and northern Lewis and Clark County. However, transient grizzly bears could be found anywhere on BFO lands.

Canada lynx (*Felis lynx*) (Threatened): Lynx habitat is considered to be the cool, moist conifer zone above 4000 feet elevation with healthy snowshoe hare populations. They avoid large openings but often hunt along edges of openings. Shrub-steppe type habitats can be important linkage habitats for migration between primary habitat areas (Ruediger et al 2000).

Gray wolf (*Canis lupus*) (both Endangered and Endangered but Experimental Non-essential populations occur in BFO): Gray wolves may occupy any habitat type with suitable prey populations. The species may occur anywhere on BFO lands. Pack locations are monitored by Montana Fish, Wildlife, and Parks. Currently there are no known active packs on BFO lands but packs could become established.

Wolverine (*Gulo gulo*) (Candidate): Wolverine habitat is generally limited high elevation forests and alpine tundra. However, individuals are known to be wide-ranging and may occur far from their preferred habitat. No confirmed wolverine sightings have been made on BFO lands.

Bull trout (*Salvelinus confluentus*) (Threatened): Bull trout occur in the Blackfoot and Upper Clark Fork River drainages but are not known to occur on BFO lands.

Arctic grayling (*Thymallus arcticus montanus*) (Candidate): The fluvial (river dwelling) Distinct Population Segment of this species is listed as Candidate. Only the Big Hole River and its' tributaries are included in this designation on BFO lands.

Greater sage-grouse (*Centrocercus urophasianus*) (Candidate): Sagebrush is the preferred habitat for this species. Areas of habitat considered suitable for this species is scattered across BFO lands. However, there are currently no known leks on BFO land.

Sprague's pipit (*Anthus spragueii*) (Candidate): On BFO lands this species could occur as summer residents of grassland habitat types.

Mountain plover (*Charadrius montanus*) (Proposed): Mountain plovers are summer residents of Montana and prefer shortgrass habitat types and prairie dog colonies.

Sensitive Species

Species listed as Sensitive by the BLM in Montana that prefer forested habitats and could occur on BFO lands where the Proposed Action may be implemented include:

Mammals: fisher (*Martes pennanti*), fringed myotis (*Myotis thysanodes*), long-eared myotis (*Myotis evotis*), long-legged myotis (*myotis volans*), Townsend's big-eared bat (*Corynorhinus townsendii*).

Birds: bald eagle (*Haliaetus leucocephalus*), black-backed woodpecker (*Picoides arcticus*), flammulated owl (*Otus flammeolus*), golden eagle (*Aquila chrysaetos*), great gray owl (*Strix nebulosa*), northern goshawk (*Accipiter gentiles*), Swainson's hawk (*Buteo swainsoni*), three-toed woodpecker (*Picoides tridactylus*).

Reptiles and Amphibians: western toad (*Bufo boreas*).

Fish: westslope cutthroat trout (*Oncorhynchus clarki lewisi*), Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). These fish species may inhabit waters adjacent to proposed carbaryl treatments.

SOIL, WATER, AIR QUALITY

In the Butte Field Office (BFO), soils that correlate to forested sites are highly variable, derived from a variety of parent material, primarily limestone, granite and argillite. They cover a wide range of climatic conditions, ranging from wet/hydric soils in riparian areas and wetlands, to semiarid chaparral, to forested mountain sides. They are primarily frigid and cryic (cold) mollisols (rich organic matter surface horizon), with an ustic moisture regime (limited moisture, but available during a season suitable for plant growth). Generally, a mollic epipedon is overlain with an organic layer comprised of needles and leaves in states of decomposition that are not yet incorporated into the mineral profile. Exceptions, under the scope of high value trees that could be treated, are found in recreation sites, or along scenic byways, which may be altered to some degree, or paved over. Prime Farmlands are found within the BFO, but generally are not tree covered, so would not be treated under the scope of the proposed action (NRCS, 2011).

In the BFO, streams in forested sites range from ephemeral to perennial, and may be fish bearing and non-fish bearing. Most streams within the BFO have been assessed by the Montana Department of Environmental Quality (DEQ) for water quality as part of the Total Maximum Daily Load (TMDL) determination effort in keeping with the Clean Water Act (DEQ, 2011). TMDL Watershed Restoration Plans, the final documents in the TMDL process that set goals for upland management to improve water quality, have been completed for the Middle and Lower Big Hole River and Lake Helena watersheds, in the BFO (DEQ, 2009). Carbaryl and insecticides are not specifically mentioned in waters within the BFO as part of the TMDL process.

Carabaryl has a low vapor pressure, therefore does not easily volatilize and pose airborne impacts after application (Cornell, 2011).

SPECIAL STATUS PLANTS

Of the nine special status plants in the BFO four have the possibility to be found in open ponderosa pine forest types. Three species have the possibility of being found in more open areas where vehicle travel from the proposed action could have an effect. The remaining two species are found in wetland/riparian areas.

Sensitive Species

Species listed as Sensitive by the BLM in Montana that prefer forested habitats and could occur on BFO lands where the Proposed Action may be implemented include:

Sitka columbine, (Aquilegia Formosa): Sitka columbine is found on moist soil of open coniferous, cottonwood, or aspen forests in the montane to subalpine zone.

Sapphire rockcress, (Arabis fecunda): This species occurs on moderate to steep slopes with warm (SE, S, SW, W) aspect and relatively sparse vegetation. In Beaverhead and Silver Bow counties, it grows in Cercocarpus ledifolius, Juniperus scopulorum or Pinus flexilis woodland, very open Pseudotsuga meniesii forest, or sparse Elymus spicatus grassland.

Lesser rushy milkvetch, (Astragalus convallarius var. convallarius): This species occupies grassland and open ponderosa pine woodlands in the valleys and foothills. Festuca scabrella, Festuca idahoensis, and Elymus spicatus are common bunchgrass associates.

Lemhi beardtongue, (Penstemon lemhiensis): Lemhi beardtongue occurs on moderate to steep, east- to southwest-facing slopes, often on open soils. In Beaverhead County, it typically grows below or near the lower extent of Douglas-fir and/or lodgepole pine forests. Associated vegetation is typically dominated by big sagebrush and bunchgrasses, including western wheatgrass and Idaho fescue. Within these habitats, Lemhi beardtongue prefers areas that are more sparsely vegetated. In the northeastern Pioneer Mountains, it inhabits forb-dominated openings in lodgepole pine, and to a lesser extent Douglas-fir, forests; big sage is typically not present, and prominent forbs include *Astragalus miser*, *Pedicularis contorta* and *Townsendia parryi*.

Species listed as Sensitive by the BLM in Montana that prefer open habitats and could occur on BFO lands where the Proposed Action may be implemented include:

Linear-leaf fleabane, (Erigeron linearis): This fleabane occurs in dry, often rocky soil from the foothills up to moderate elevations, frequently with sagebrush. Dominant species in its habitat include bluebunch wheatgrass (Pseudoroegneria spicata) and mountain big sagebrush (Artemisia tridentata ssp. vaseyana). In the Scratchgravel Hills near Helena, it occupies two distinct habitats - one a midslope opening on a steep east-facing timbered hillside, and the other a gently southwest facing lower slope in open rolling plains. In Beaverhead County it was found in rolling sagebrush steppe, where it occupied a disturbed opening dominated by Agropyron smithii, along with other species characteristic of disturbed areas, including Arenaria kingii, Bromus tectorum, Chrysopsis villosa, Haplopappus acaulis, Oxytropis sericea and Phlox bryoides.

Prostrate hutchinsia, (Hornungia procumbens): Hutchinsia grows best in vernally moist, alkaline soil of sagebrush steppe in the valley to lower montane zones. Findings are most commonly in subalpine-montane riparian shrublands, and montane sagebrush steppe.

Dwarf purple monkeyflower, (Mimulus nanus): This monkeyflower is found on dry, open, often gravelly or sandy slopes in the valleys and foothills. Only one occurrence is known within the BFO.

Species listed as Sensitive by the BLM in Montana that prefer wetland/riparian habitats and could occur on BFO lands where the Proposed Action may be implemented include:

Idaho sedge, (Caraex idahoa): Idaho sedge occurs in moist, alkaline meadows, often along streams. It most often occupies ecotonal areas between wet meadow and sagebrush steppe (Lesica 1998), and appears to be restricted to nearly level sites in the high valleys of southwest Montana.

Slender-branched popcorn flower, (Plagiobothrys leptocladus): This species is found in drying mud on the shores of ponds in the plains and foothill zone. No known populations occur within the BFO though possible habitats do occur.

CRITICAL ELEMENTS:

The critical elements have been considered and impacts to each element as a result of the proposed project have been analyzed. The following chart lists the critical elements and shows whether or not each element will be affected by the proposed action.

CRITICAL ELEMENTS		
Determination*	**Resource**	**Rationale for Determination**
PI	Air Quality	Effects would be localized and temporary. Design features would limit potential exposure of the product to people and the environment.
NP	Areas of Critical Environmental Concern (ACEC)	No ground disturbance will occur with this activity, therefore, ACEC's will not be affected.
NI	Cultural Resources	Because no ground disturbance will occur with this activity, cultural resources are not affected.
NI	Environmental Justice	No alternative considered in the course of this analysis resulted in any identifiable effects or issues specific to any minority or low-income population or community as defined in Executive Order 12898.
NI	Farmlands (Prime or Unique)	Farmlands are not proposed for treatment
NI	Floodplains	No impact to floodplain function is anticipated.
NI	Invasive, Non-native Species	No ground disturbance will occur with this activity, therefore, invasive, Non-native species would not be affected, with exception to vehicles that may be driven off road. In this instance all vehicles will be free of weeds before entering the proposed sites.
NI	Native American Religious Concerns	Native American Religious Concerns would be affected by the application of this pesticide. Certain plants and other materials are gathered at specific locations and times of the year. Posting treated areas would prevent tribal members from exercising their resource procurement guaranteed by treaty. However, the treatment is intended to enhance forest health and wildlife habitat, which are vital for long-term resource availability.
NI	Threatened, Endangered or Candidate Plant or Animal Species	Listed animal species would leave the treatment area, not inhabit the area, or be protected by design features. Plants: Nine Special Status Plants are found within the BFO boundaries. Mitigation measures have been outlined so as not to impact existing populations.

NI	Wastes (hazardous or solid)	Licensed contractors would handle the product. No storage, constituting a reportable quantity of the product on BLM land is proposed. Contractor must provide a spill prevention plan. Design Features would prevent impacts from spills.
PI	Water Quality (drinking/ground)	Treatments are not proposed near surface water, and design features would be employed to limit potential exposure of surface water to the product.
NI	Wetlands/Riparian Zones	Treatments are not proposed in wetlands/riparian zones. Mitigation measures ensure that the wetlands/riparian zones that are encountered would not be affected.
NP	Wild and Scenic Rivers	No spraying will occur within
NP	Wilderness	No spraying will occur within wilderness areas.

*Possible determinations:
NP = not present in the area impacted by the proposed or alternative actions
NI = present, but not affected to a degree that detailed analysis is required
PI = present and may be impacted to some degree. Will be analyzed in affected environment and environmental impacts. (NOTE: PI does not necessarily mean impacts are likely to be significant). ‘

CHAPTER 4
ENVIRONMENTAL IMPACTS

FORESTRY

Direct and Indirect Impacts of the No Action Alternative

The No Action Alternative would not meet the objectives identified in the proposed action. There would be no environmental impacts from the proposed action because it would not be implemented.

Under the No Action Alternative, carbaryl would not be used to protect high value live trees or habitats. Trees would not be treated with carbaryl and would continue to be attacked by bark beetles, causing mortality and also allowing bark beetle populations to persist in the areas. As a result, tree mortality from bark beetles would be greater under the No Action Alternative than under the Proposed Action. More tree mortality would contribute to decreasing forest stand diversity. Also, more trees and habitats that have aesthetic, recreation, and wildlife values could be lost.

Direct and Indirect Impacts of the Proposed Action

Under the proposed action, carbaryl would be applied to high value live trees on BLM administered forest land throughout the Butte Field Office. Carbaryl application would not be effective in killing bark beetles already residing within infested trees. Where carbaryl is applied to uninfested trees or slightly infested trees that may survive if protected from additional beetle infestation, emerging adult bark beetles from previously infested trees would be deterred from attacking these trees. As a result, management objectives and goals would be more closely met which include: restoring and maintaining the health and productivity of public forests, reducing the occurrence of unnaturally large forest insect outbreaks, managing to provide a variety of

well-distributed plant communities, and conserving, enhancing, restoring, or minimizing impacts to areas of important wildlife habitat. Small stands (<50 acres) and individual high value trees would persist on the landscape as important features of forested stands within the BFO. Forest stand diversity would be maintained and trees which support the preservation of aesthetic, recreation, and wildlife values would be protected.

WILDLIFE

Direct and Indirect Impacts of the No Action Alternative

Under this alternative high value trees would be left susceptible to attack from bark beetles. Large trees that may provide nests for raptors and passerines, roosting habitat for bats, and hiding or thermal cover for mammals could die and become snags. Snags also have numerous wildlife values, albeit different values from live trees. In the high human use areas most likely to receive carbaryl treatments, snags are often considered hazard trees and removed, thus losing all wildlife values.

Direct and Indirect Impacts of the Proposed Action

Carbaryl works by attacking the nervous system. Specifically, it inhibits the essential action of the enzyme acetylcholinesterase (AChE). AChE works to break down another chemical, acetylcholine, which is essential in transmitting impulses between nerves. Therefore, when carbaryl is used, AChE becomes unable to break down acetylcholine, which consequently accumulates in nerve cells. This abnormal acetylcholine build-up can ultimately result in death. However, when carbaryl was compared with other chemicals that are used against bark beetles, it was least disruptive toward soil arthropod communities. Some of the recently developed pyrethroids are being evaluated as replacements for carbaryl, but carbaryl remains among the safer and most effective insecticides used in controlling bark beetles (Hastings et al 2001). Carbaryl dissipates in the environment by abiotic and microbially mediated degradation. It is moderately mobile in the environment and is not expected to bioaccumulate (EPA 2004).

It is not anticipated that carbaryl treatments would be widespread across BFO lands. Treatments would likely focus on areas receiving high recreational use with good vehicle access.

Federally listed species: The Federally listed mammals are highly mobile species and would likely avoid areas of carbaryl treatment during the treatments and for long enough after treatments for the chemical to dry. An individual may be temporarily disturbed and displaced if it is at the treatment site when workers arrive. The design features requiring treatments to be 100 feet from water and not being conducted if wind is over 5 mph would eliminate impacts to listed fish species. The Federally listed bird species inhabit sage and grassland habitat types and would not be affected.

Mammals: Large mammals would move away from treatment areas during application. Most mammals, including humans, quickly break down carbaryl and excrete it in urine and feces (NPIC, undated). Thus, large mobile mammals would likely not be affected. Field studies in published literature do not provide a clear association between carbaryl applications and effects

on mammalian wildlife (Durkin and King 2008). Literature is particularly lacking on effects to smaller, less mobile mammals such as gophers and voles. Additionally, individual bats could be roosting in trees during treatments and inadvertently sprayed. There could be detrimental health effects to these individual smaller mammals exposed directly to the chemical.

Birds: Carbaryl is considered practically nontoxic to pheasants, quail, and ducks. Data do suggest that smaller passerine species may be significantly more sensitive to carbaryl exposure than non-passerine birds. The chemical may cause passerine species to produce fewer eggs, have a higher number of cracked eggs, and be less fertile (EPA 2004, 2003). Zinkl (1979) found that carbaryl inhibited cholinesterase activity slightly in only a few birds, mainly canopy dwellers. The design features of not spraying trees with nest cavities and visually scanning and avoiding nests would reduce the chances of detrimental effects to birds. Populations of insect species that birds prey on could be reduced.

Fish: Carbaryl can be slightly to highly toxic to fish, depending on the species. It is highly toxic to freshwater invertebrates (EPA 2004), the main prey of fish. However, the design features of not conducting treatments within 100 feet of water or when wind is over 5 mph would eliminate impacts to fish.

Reptiles and amphibians: Numerous studies have shown detrimental effects of carbaryl exposure to tadpoles, salamanders, and newts. Effects to these aquatic-dwelling species and life stages would be eliminated by the design features that also eliminate impacts to fish. Literature is lacking in studies on effects to terrestrial-dwelling species and life stages such as snakes and adult toads. The skin of adult amphibians is known to be absorptive and individual toads that may be exposed could experience detrimental health effects.

Invertebrates: Carbaryl is used because it is toxic to pine beetles. It is also toxic to non-target beneficial species such as bees and ladybugs. A 14-day study of the effects on earthworms found no earthworm mortality after seven days. Details of the study are classified as supplemental since EPA currently does not require earthworm testing (EPA 2003). The only field study with specific information concerning the toxicity of carbaryl to earthworms found reduced numbers and biomass of earthworms in Kentucky bluegrass with significant effects lasting at least 20 weeks (Potter et al 1990). Populations of beneficial insects and invertebrates in the immediate area of treatments could be temporarily reduced.

SOIL, WATER, AIR QUALITY

Direct and Indirect Impacts of the No Action Alternative

Under this alternative tree mortality would continue, needing to be removed as hazard trees in populated places. Dead trees can pose a risk of wildfire, which could result in soil erosion and sedimentation into surface water.

Direct and Indirect Impacts of the Proposed Action

Implementing design features would result in a low likelihood of carbaryl entering surface water where it can impact fish and aquatic insects. Carbaryl mobility and longevity in soil is variable, largely dependent on pore space and organic matter content. Organic matter, particularly forms high in humic acid, has the greatest adsorptive potential (Farenhorst, 2006, Leenheer & Ahlrichs, 1971, Aly et al, 1980, Nkedi-Kizza & Brown, 1998) to bind carbaryl, thereby preventing it from migrating to ground and surface water. High ph, and the presence of calcium carbonate, present in BFO limestone derived soils, similarly will bind carbaryl (Aly et al, 1980)

Cornell University's Extension Toxicology Network (Cornell, 2011), notes carbaryl having a ½ life of approximately 7 days in aerobic soil and 28 days in anaerobic soil, and 1 to 32 days in pond water. Degradation of the chemical in the soil is primarily due to sunlight, bacterial action (Cornell, 2011) and is metabolized by soil fauna including earthworms and enzymes, which could cause localized temporary stunted growth rates, but limit transport and bioavailability of carbaryl in the environment (Benitez et al, 1999).

Actions proposed to limit spraying, incorporating a 100' buffer, in combination with implementation of design features and natural attenuation would prevent carbaryl from entering the aquatic environment, and exposing people who could frequent treated areas. The buffers would greatly reduce risk for delivery of chemical to surface waters from over ground transport during rainstorms. Risk of drift is considered to be nil with the 100 foot buffers given Haverty's et al (1983) findings, which indicated drift beyond 40 feet was undetectable.

Implementing design features would mitigate potential impacts to soil erosion, compaction and productivity resulting from overland travel to apply carbaryl. Because application is not proposed near surface water, sedimentation or contamination of surface water associated with travel to apply the carbaryl would not be expected.

Overland travel to apply carbaryl could pose risk of soil compaction or erosion and sedimentation into surface water. Design features to limit off road travel would minimize this risk. Compaction would be temporary and would recover naturally. Limiting off road travel, not applying carbaryl in riparian areas, and the low frequency of travel proposed because treatments would be effective for two years, result in a low risk of erosion and sedimentation.

SPECIAL STATUS PLANTS

Direct and Indirect Impacts of the No Action Alternative

Under this alternative trees would continue to be susceptible to bark beetles. The increase in tree mortality could either increase or decrease habitat for one or some of the nine special status plants in the BFO. The possibility of decreased diversity would have the greatest impact on creating niches for these species to develop.

Direct and Indirect Impacts of the Proposed Action

With the focused rather than widespread application of the proposed action and included design features, impacts to special status plants would be minimized. With little to no ground disturbance within the immediate area of confirmed occurrences, direct impacts of the application would be mitigated.

The impacts of a reduced number of pollinators would have its greatest impact on prostrate hutchinsia, the only annual of the nine special status plants in the BFO. Any other impact would be short lived coinciding with the temporary reduction in number of pollinators.

HUMAN HEALTH AND SAFETY

Carbaryl is one of the most widely used broad-spectrum insecticides in agriculture; professional turf management and ornamental production; and residential pet, lawn, and garden markets. Although dietary (food and drinking water) exposures are not of concern, carbaryl does pose risks of concern from uses where people may come into direct contact with the chemical. With mitigation measures discussed in the carbaryl label and throughout this EA, potential exposure will be minimized and therefore application would not pose significant aggregate risk concerns. Carbaryl also poses risks of concern to occupational handlers who mix, load, and apply the pesticide but with the use of the appropriate PPE identified on the label, workers should not be affected. (EPA, 2004)

Even with the precautions and mitigation measures, there is a chance for human exposure. Carbaryl is a direct neurotoxin that inhibits acetylcholinesterase (AChE) activity. For all vertebrates, AChE is essential for normal nervous system functions. This inhibition, however, is rapidly reversible in mammals. Carbaryl is rapidly absorbed after oral exposure and more slowly absorbed after dermal exposure. Since carbaryl is also rapidly metabolized and eliminated from the body, its potential to accumulate with repeated exposure is low (Durkin, 2008). The EPA has also classified carbaryl as a “possible human carcinogen” based on an increased incidence of vascular tumors in a chronic study of male mice exposed at 46 milligrams/kilogram/day (mg/kg/day) (1000 ppm) (EPA, 2004).

If carbaryl is applied on BFO administered lands the appropriate precautions would be used to minimize the potential for human exposure to the chemical. As seen above, applicators would have to follow the label directions, using the appropriate precautions and personal protective equipment. Applicators would also have to follow the more stringent rules that have been identified in this EA. All treatment areas would be closed prior to spraying and for an additional 24 hours once spraying is completed. The carbaryl label (Bayer CropScience Lp) has a restricted entry interval (REI) of 12 hours for anyone not protected by the appropriate PPE. But to ensure that the chemical has had time to dry, the BFO would close the areas for an additional 12 hours. Application areas would also be flagged and marked with signs having cautionary notices indicating that a hazardous pesticide has been applied. Signs would also include a warning not to consume vegetation and fruit within the area. In public use areas, lawns that are within 100 feet of carbaryl application would be mowed prior to reopening of the area.

Potential exposures to the general public from conventional application rates are infrequent and of low magnitude. These low exposures to the public pose no risk of direct toxicity,

carcinogenicity, neurotoxicity, genotoxicity, reproductive toxicity, or developmental toxicity. Immunotoxic effects from carbaryl exposure are generally expected at concentrations much higher than those from bark beetle applications, but individuals with allergic or hypersensitive reactions to the insecticide or other chemicals in the formulated product could be affected. This should not be a substantial concern because areas would be closed until insecticide has had time to dry. (USDA 2002)

CUMULATIVE IMPACTS

Cumulative impacts are those impacts resulting from the incremental impact of an action when added to other past, present, or reasonably foreseeable actions regardless of what agency or person undertakes such other actions.

Because the Proposed Action would occur in locations throughout the Butte Field Office, the scale for cumulative impacts analysis is the entire Butte Field Office. Cumulative effects of past, present, and reasonably foreseeable future activities on resources and resource uses field office-wide were recently addressed, described, and documented on pages 496-511 of the Proposed Butte Resource Management Plan and Final Environmental Impact Statement (USDI-BLM 2008). That analysis has been reviewed and has been found to still be valid. It is hereby incorporated by reference into this EA. Because the Proposed Action would be effective throughout the timeframe that decisions in the Butte RMP remain effective, the timeframe for cumulative effects associated with this project would be for up to 25 years, the timeframe addressed in the cumulative effects analysis described in USDI-BLM (2008). Additional elaboration on contributions of this project to cumulative effects for the resources described above is disclosed below.

Impact of No Action Alternative

The forested lands within the project area have been affected by many factors, most notably the current bark beetle outbreaks, past timber harvesting activities, and the exclusion of fire in these complex ecosystems. Under the No Action Alternative, no carbaryl treatment to high value trees would be implemented. Instead verbenone and other pheromones may be used to help deter bark beetles from attacking the trees but the protection these pheromones provide can be limited, especially when beetle populations are high. Tree mortality would be greater under this alternative. With greater mortality, there may be a need to remove beetle hit and dead trees which constitute a safety hazard, especially in campgrounds. Trees would likely be removed by firewood cutters and timber sales. The use of mechanical equipment may be needed if timber sales were implemented. Also, with the loss of high value trees, unwanted species conversions could occur in some areas.

Impact of Proposed Action Alternative

The forested lands within the project area have been affected by many factors, most notably the current bark beetle outbreaks, past timber harvesting activities, and the exclusion of fire in these complex ecosystems. Under the Proposed Action Alternative, carbaryl would be sprayed onto

high value trees. Tree mortality would be less under this alternative. High value trees would remain on the landscape and unwanted species conversions would be less likely.

The USGS has found carbaryl to be a pesticide that accumulates in surface water, but was found primarily in watersheds where it broadcast applied to deal with pests in an agricultural setting (Vogel et al, 2008). Insecticide use in watersheds in the BFO is limited because most crop land is dedicated to forage production or small grains (NASS, 2011). Because the use of carbaryl in the proposed action is limited to localized ground based applications, involves direct application to trees, would employ design features to prevent Carbaryl from entering surface water, and considering the limited use outside the BLM in BFO watersheds, no cumulative effects in surface water would be expected.

Known cumulative effects with other pesticides are limited to co-application of Diuron, which is phytotoxic (Nash, 1967). Carbaryl would not be applied in areas where Diuron was also applied.

Airborne drift during application poses the greatest impact to the human environment. Using localized, ground based application methods, under low wind conditions will limit airborne transport to non-target vegetation and streams, or pathways to surface water.

CHAPTER 5
PERSONS, GROUPS, AND AGENCIES CONSULTED

List of Preparers

Team Member	Roles and Responsibilities
Michael O'Brien	Project Lead
MaryLou Zimmerman	Forestry
Scot Franklin	Wildlife
Carolyn Kiely	Cultural
Lacy Decker	Weeds
Roger Olsen	Riparian
Roger Olsen	SS Plants
Tim LaMarr	NEPA
Corey Meier	SWA
Brad Rixford	Recreation
Brad Colin	Travel

REFERENCES

Aly, M.I., N. Bakry, F. Kishk, & A.H. El-Sebae. 1980. Carbaryl Adsorption on Calcium-Bentonite and Soils. Soil Sci. Am. J., 44:1213-1215.

Amman, G.D., M.D. McGregor, and R.E. Dolph Jr. Mountain pine beetle. Forest Insect & Disease Leaflet 2, 1990. U.S. Department of Agriculture, Forest Service. Available: http://www.barkbeetles.org/mountain/fidl2.htm [2011, February 1].

Benitez, E., R. Nogales, C. Elvira, G. Masciandaro, and B. Ceccanti. 1999. Enzyme and Earthworm Activities during Yermicomposting of Carbaryl-Treated Sewage Sludge. J. Environ. Qual. 28:1099-1104

Cornell, 2011. Extension Toxicology Network (Extoxnet). Cornell University. http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/carbaryl-ext.html

DEQ. 2009. Middle and Lower Big Hole Planning Area TMDLs and Water Quality Improvement Plan. Montana Department of Environmental Quality. http://www.deq.mt.gov/wqinfo/TMDL/finalReports.mcpx

DEQ, 2011. Montana DEQ Clean Water Act Information Center. Montana Department of Environmental Quality, Water Protection Bureau. http://cwaic.mt.gov/

DeMars, C.J.Jr., B.H. Roettgering. 1982. Western Pine Beetle. Forest Insect & Disease Leaflet 1, 1982. U.S. Department of Agriculture, Forest Service. Available: http://www.forestpests.org/acrobat/fidl1.pdf [2011, March 29].

Durkin, Patrick R. and C. King. 2008. Carbaryl human health and ecological risk assessment revised final report. Syracuse Environmental Research Associates, Inc. USDA Forest Service Contract: AG-3187-C-06-0010. www.fs.fed.us/foresthealth/pesticide/pdfs/052-01-05aCarbaryl.pdf

Environmental Protection Agency. 2004. Interim registration eligibility decision for carbaryl. Case 0080. http://www.epa.gov/oppsrrd1/REDs/carbaryl_ired.pdf

Environmental Protection Agency. 2003. Environmental fate and ecological risk assessment for the re-registration of carbaryl. www.epa.gov/espp/litstatus/effects/carb-**risk**ass.pdf

Farenhorst, A. 2006. Importance of Soil Organic Matter Fractions in Soil-Landscape and Regional Assessments of Pesticide Sorption and Leaching in Soil. Soil Sci. Soc. Am. J. 70:1005-1012.

Fettig, C.J.; Munson, A.S.; McKelvey, S.R.; Bush, P.B.; and Borys, R.R. 2008. Spray deposition from ground-based applications of carbaryl to protect individual trees from bark beetle attack. J. Environ. Qual. 37:1170-1179.

Fettig, C. J., McMillin, J. D., Anhold, J. A., Hamud, S. M., Borys, R. R., Dabney, C. P., and S. J. Seybold. 2006a. The effects of mechanical fuel reduction treatments on the activity of bark beetles (Coleoptera: Scolytidae) infested ponderosa pine. For. Ecol. and Manag. 230: 55-68.

Fettig, C.J., T.E. DeGomez, K.E., Gibson, C.P. Dabney, and R.R. Borys. 2006c. Effectiveness of permethrin plus-C (Masterline®) and carbaryl (Sevin SL®) for protecting individual, high-value pines from bark beetle attack. Arboriculture & Urban Forestry 32: 247-252. Available: http://www.bioone.org/doi/pdf/10.1603/0022-0493-99.5.1691 [2011, March 22].

Furniss, R. L. and V. M. Carolin. 1977. Western forest insects. U.S. Dep. Agric. For. Serv. Misc. Pub. No. 1339, Washington, DC.

Gibson, K.E. and D.D. Bennett. 1985. Carbaryl prevents attacks on lodgepole pine by the mountain pine beetle. J. of For. 83: 109-112. Available: http://www.ingentaconnect.com/content/saf/jof/1985/00000083/00000002/art00012 [2011, February 22].

Hagle, S.K., K.E. Gibson, and S. Tunnock. 2003. Field Guide to Diseases and Insect Pests of Northern and Central Rocky Mountain Conifers. USDA Forest Service, Northern and Intermountain Regions. Report R1-03-08, Missoula, MT. Available: http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/ [2011, February 11].

Hastings, F.L, E. H. Holsten, P. J. Shea, and R. A. Werner. 2001. Carbaryl: a review of its use against bark beetles in coniferous forests of North America. Environ. Entomol. 30(5): 803-810.

Haverty, M. I., Shea, P. J., Hoffman, J. T., Wenz, J. M. and K. E. Gibson. 1998. Effectiveness of esfenvalerate, cyfluthrin, and carbaryl in protecting individual lodgepole pines and ponderosa pines from attack by *Dendroctonus* spp. Res. Pap. PSW-RP-237. Albany, CA: U. S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 12 p. Available: http://www.treesearch.fs.fed.us/pubs/6926 [2011, February 11].

Kegley, S. J., Livingston, R. L. and K. E. Gibson. 1997. Pine engraver, *Ips pini* (Say), in the western United States. U.S. Dep. Agric. For. Serv. For. Insect Dis. Leafl. No. 122. Washington, DC.

Kennedy, P. C. 1969. Causes of the 1966 *Ips pini* outbreaks. Mich. Acad. 2: 87-92.

Leenheer, J.A. & J.L. Ahlrichs. 1971. A Kinetic and Equilibrium Study of the Adsorption of Carbaryl and Parathion upon Soil Organic Matter Surfaces. Soil Sci. Soc. Amer. Proc. 35:700-705.

Livingston, R. L. 1979. The pine engraver, *Ips pini* (Say), in Idaho; life history, habits and management recommendations. Idaho Dept. of Lands, For. Insect Dis. Cond. Report 79-3.

Mincemoyer, S. 2005. Surveys of Significant Plant Resources and Related Vegetation Types for the Butte Office of the Bureau of Land Management. Report to the USDI Bureau of Land Management, Butte Field Office. Montana Natural Heritage Program, Helena, MT. 11 pp. + appendices.

Montana DNRC, 2011. Western Pine Beetle. Available: http://dnrc.mt.gov/forestry/Assistance/Pests/westernpinebeetle.asp [2011, March 29].

Nash, R.G. 1967. Phytotoxic Pesticide Interactions in Soil. Ag. J. 59:227-230.

NASS, 2011. Montana Reports. USDA National Agricultural Statistics Service, Montana Office. http://www.nass.usda.gov/Statistics_by_State/Montana/index.asp

National Pesticide Information Center's fact sheets. Undated. http://npic.orst.edu/az.html#C

Nkedi-Kizza, P. & Brown, K.D. 1998 Sorption, Degradation, and Mineralization of Carbaryl in Soils, for Single-Pesticide and Multiple-Pesticide Systems. J. Environ. Qual. 27:1318-1324

NRCS, 2011 Soil Data Mart. Natural Resources Conservation Service. http://soilsdatamart.nrcs.usda.gov/

Potter DA; Buxton MC; Redmond CT; Patterson CG; Powell A; 1990. Toxicity of pesticides to earthworms (Oligichaeta: Lumbricidae) and effect on thatch degradation in Kentucky bluegrass turf. J Econ Entomol. 83:2362-2369

Ruediger, B., et al. 2000. Canada lynx conservation assessment and strategy, 2nd edition. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53. Missoula, Montana. 142 pp.

Shea, P. J. and M. D. McGregor. 1987. A new formulation and reduced rates of carbaryl for protecting lodgepole pine from mountain pine beetle attack. Western J. App. For. 2: 114-116. Available: http://www.fs.fed.us/r1/helena/resources/insects_diseases/MPB_control_techniques.pdf [2011, March 22].

Six, D. L. 2010. *Dendroctonus* the Destroyer: How pine beetles are changing the face of North American forests. Kelseya Volume 24, No. 1.

Steed, B. 2010. Butte Area BLM Insect and Disease Conditions and Review of Possible FHP-funded Projects, Trip Report MFO-TR-10-35. Forest Health Protection, USDA Forest Service, Missoula, MT 22pp.

Sturdevant, N. 2010. Mountain pine beetle activity in thinned areas ad Great Divide and Deep Creek, Trip Report MFO-TR-10-08, Forest Health Protection, USDA Forest Service, Missoula, MT. 5pp.

USDA, 2000. Assessment and response to bark beetle outbreaks in the Rocky Mountain area. Report to congress from Forest Health Protection, Washington Office, Forest Service, U.S. Department of Agriculture.

USDA, 2002. Rangeland Grasshopper and Mormon Cricket Suppression Program, Final Environmental Impact Statement. U.S. Department of Agriculture.

USDA, 2009. Individual Tree Protection Using Carbaryl Insecticide for Western Conifer-Infesting Bark Beetles. Available: http://www.fs.fed.us/r1-r4/spf/fhp/publications/byregion/carbaryl_insecticide_2.pdf [2011, March 22].

USDA, 2010. B-D MPB Spray Contract 2010. USDA Forest Service, Butte, MT.

United States Department of the Interior - Bureau of Land Management (USDI-BLM). 2008. Proposed Butte Fresource Management Plan and Final Environmental Impact Statement. Bureau of Land Management, Butte Field Office, Butte, Montana, September 2008.

USDI-BLM. 2009. Record of Decision and Approved Butte Resource Management Plan. Bureau of Land Management, Butte Field Office, Butte, Montana. April 2009.

Vogel, J.R., M.S. Majewski and P.D. Capel. 2008. Pesticides in Rain in Four Agricultural Watersheds in the United States. J. Environ. Qual. 37:1101-1115

Worrall, J. 2000. Mountain Pine Beetle Management Guide. U.S. Department of Agriculture Forest Service, Rocky Mountain Region, Forest Health Management. Available: http://www.fs.fed.us/r2/fhm/bugcrud/silvmpb.htm [2009, December 1].

Zinkl, Joseph G., C.H. Henny, and P.J. Shea. 1979. Brain cholinesterase activities of passerine birds in forests sprayed with cholinesterase inhibiting insecticides. Pp 356-365 from Animals as monitors of environmental pollutants. National Academy of Sciences, Washington, D.C. ISBN 0-309-02871-X.