

## **Status of Mountain Pine Beetle Populations in Lodgepole Pine Stands in Northern Colorado and Southern Wyoming, LSC-07-06**

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The Colorado Bark Beetle Cooperative (CBBC) was formed to pursue a cooperative effort to address bark beetle epidemics and develop a comprehensive program to manage mortality and projected mortality and forest conditions across landscapes and multiple jurisdictions in Colorado. The five-county core project area includes all land ownerships in Eagle, Grand, Jackson, Routt, and Summit Counties. The CBBC has expanded its project area to also include Clear Creek, Garfield, Lake, Park, and Pitkin Counties. The CBBC project area includes all or part of the Arapaho, Routt, and White River National Forests.

The following report was prepared to assess the status of mountain pine beetle, Dendroctonus ponderosae, populations in lodgepole pine stands on national forest lands within two specific areas: (1) the five-county (Eagle, Grand, Jackson, Routt, and Summit) core CBBC Project Area, which includes all or portions of the Arapaho, Routt, and White River National Forests; and (2) Albany and Carbon Counties in southern Wyoming, which includes portions of the Medicine Bow National Forest (hereafter referred to as the southern Medicine Bow National Forest) and are located adjacent to the northern boundary of the core CBBC Project Area. The analysis presented in this report provides the technical basis for determining whether mountain pine beetle populations are at epidemic levels within the core CBBC Project Area and adjacent Albany and Carbon Counties, WY, as defined under Section 102(a)(4) of the Healthy Forest Restoration Act.

The current mountain pine beetle infestations and their impact on lodgepole pine forests in northern Colorado and southern Wyoming have very likely been influenced by a number of factors: (1) an abundance of older, dense, large diameter lodgepole pine stands; (2) prolonged drought, where the onset of increasing mountain pine beetle infestation overlaps the onset of an extended and severe drought from 1998 – 2003; (3) earlier melting of the smaller, drought-influenced snowpacks, resulting in extended and more severe drought conditions that reduced the tree's defenses during the summer when bark beetle flight and attack of hosts occurs; (4) higher temperatures, allowing for an expansion of the one-year mountain pine beetle lifecycle into areas of lodgepole pine forests at higher elevations (>9,500 feet elevation) where, traditionally, the two-year life cycle was the norm (Tishmack et al. 2005); and (5) greater survival of mountain pine beetle brood in these high elevation lodgepole pine forests due to their completion of development within a single year rather than the two-year life cycle typical at these elevations. Over the past eleven years (1996 – 2006) mountain pine beetle populations have increased to

levels that have not been witnessed in northern Colorado or southern Wyoming in our recorded history of the area. Both the intensity of tree mortality and the extent of high levels of tree mortality are significant.

The analysis of mountain pine beetle impacts on lodgepole pine stands presented in this report relies on two separate sources of data: (1) Forest Health Management aerial survey data gathered over an eleven-year period from 1996 through 2006; and (2) Biological Evaluations and Service Trip Reports prepared between 2002 and 2007 by Forest Health Management entomologists and biological technicians containing ground survey data of mountain pine beetle populations and impacts in a number of different Arapaho, Routt, and White River National Forest analysis areas within the core CBBC Project Area and on the southern Medicine Bow National Forest.

### **Aerial Survey Results and Discussion**

Aerial surveys of Eagle, Grand, Jackson, Routt, and Summit Counties in Colorado and Albany and Carbon Counties in Wyoming conducted annually over the past eleven years were utilized to examine the increase of acres of lodgepole pine forests that contain trees killed by the mountain pine beetle. Not all county acreage was completely surveyed in every year. In particular, there are gaps in the 1990s aerial survey data coverage; however, there is relatively complete coverage of all areas from 2003 through 2006. The aerial survey data are summarized in Appendix A – County and National Forest Mountain Pine Beetle Impacts, 1996 – 2006, Tables 1-5.

The cumulative acreage impacts of mountain pine beetle-caused lodgepole pine mortality over the eleven-year time interval by County for all ownerships are presented in Table 1a; the cumulative acreage impacts for private forest lands and National Forest lands are presented in Table 1b. For private landowners in Eagle, Grand, Jackson, Routt, and Summit Counties, CO, approximately 51%, 68%, 59%, 23%, and 29%, respectively, of the lodgepole pine forest cover type acreage has some measure of mountain pine beetle-caused mortality present; on the National Forests, approximately 25%, 70%, 49%, 32%, and 50%, respectively, of the lodgepole pine forest cover type acreage has various levels of tree mortality caused by the mountain pine beetle. For Albany and Carbon Counties, WY, the figures are 1% and 6%, respectively, of privately owned lodgepole pine forest cover type acreage and 2% and 19%, respectively of National Forest lodgepole pine forest cover type acreage.

These percentage figures of lodgepole pine acreage impacted by mountain pine beetle are significant and readily visible across the CBBC Project Area and on the associated National Forests (Table 1a, Table 1b). Close proximity of mountain pine beetle populations also increases the risk for future tree mortality in susceptible lodgepole pine stands (Shore and Safranyik 1992). Increasing mountain pine beetle populations will likely spread to susceptible lodgepole pine stands within this broad geographic area over the next five to ten years, further increasing the percentages of lodgepole pine forest cover type affected by the mountain pine beetle reported in Table 1a and Table 1b. The data for annual aerial survey acres containing trees killed by mountain pine beetle for the core CBBC Project Area are presented in Table 2 (Appendix A) and the data for Albany and Carbon Counties, WY, are presented in Table 3. For example, in 2006

alone, 58,800 acres in Eagle County (5% of all County acreage) contain lodgepole pine trees killed by mountain pine beetle; the figures for Grand, Jackson, Routt, and Summit Counties were 288,000, 150,000, 79,500, and 39,100 acres, respectively, (24%, 14%, 5%, and 10% of all County lands, respectively). For Albany and Carbon Counties, WY, the figures were 3,440 and 73,400 acres, respectively (<1% and 1% of all County lands, respectively).

Summary figures concerning acres containing lodgepole pine trees killed by mountain pine beetle on all or portions of the Arapaho, Routt, and White River National Forests, within the core CBBC Project Area, are presented in Table 4 (Appendix A). For example, in 2006 mountain pine beetle killed trees on 132,000 acres on the Arapaho National Forest (Grand County only), 223,000 acres on the Routt National Forest, and 86,800 acres on the White River National Forest (Eagle and Summit Counties only). Table 5 provides figures for the southern Medicine Bow National Forest, where 75,000 acres contained trees killed by mountain pine beetle in 2006 (Albany and Carbon Counties, only).

Appendix B contains County maps of the aerial survey data for lodgepole pine mortality caused by the mountain pine beetle from 1999 – 2006. These figures reveal the rapid expansion of acres infested by mountain pine beetle in each County over the seven-year time interval. The mountain pine beetle infestations across the core CBBC Project Area are impacting the vast majority of lodgepole pine forests in the area (Table 1) and in adjacent Albany and Carbon Counties in Wyoming.

### **Ground Survey Results and Discussion**

To further augment the analysis of aerial survey data presented above, data were summarized from bark beetle ground surveys conducted by entomologists and biological technicians between 2002 and 2006. These bark beetle ground surveys were reported in twelve Biological Evaluations and one Service Trip Report by the Lakewood Service Center of Forest Health Management (LSC-FHM) from 2002 through 2007. The Biological Evaluations and the Service Trip Report were prepared at the request of resource staff on the National Forests to provide up-to-date information concerning the status of mountain pine beetle populations and impacts in lodgepole pine stands in areas that were under analysis with regard to the implementation of management actions as required by the National Environmental Policy Act (NEPA) and USDA Forest Service regulations.

The Biological Evaluations and the Service Trip Report span a period of four years and include National Forest lands in Grand, Jackson, Routt, and Summit Counties in Colorado and Albany and Carbon Counties in Wyoming (Cain and Howell 2005abc; Cain and Jorgensen 2003; Cain, Jorgensen, and Sullivan 2003; Costello 2007; Costello and Howell 2006abc; Costello and Howell 2007abc). The ground surveys were conducted to determine the level of mountain pine beetle infestation (infested trees per acre) and the rate of change of mountain pine beetle populations over a two year period (the number of currently infested trees per acre at the time of survey divided by the number of trees per acre infested the previous year – expressed as a ratio). A value for this ratio that is greater than one indicates an infestation that is on the increase and a value that is less than one indicates an infestation that is on the decline.

Cole and Amman (1980) measured mountain pine beetle infestations in Regions 2 and 4 of the Forest Service and described the following pattern of an outbreak that is helpful for determining the current status of an infestation based upon ground survey data. Infested trees numbered from 0.5 to 5.0 trees per acre in the early years of an outbreak, increased to as many as 26 to 31 trees per acre during the peak of an outbreak, and declined to 2 to 3.5 trees per acre following the peak of an outbreak. Cole and Amman found that most of the large diameter trees were killed by the time an outbreak subsided. They also reported that an epidemic averages six years to run its course in a given stand, but emphasized that once infestations build up, a large amount of migration may occur. This migration leads to more rapid tree losses and shorter epidemic periods in adjacent stands.

The Biological Evaluations and the Service Trip Report document the epidemic mountain pine beetle conditions in lodgepole pine stands in the areas surveyed (Appendix A, Tables 6 and Table 7). In all cases, mountain pine beetle populations exceeded endemic levels ( $< 0.5$  infested tree per acre), and ranged from 2.8 to 89.4 newly infested trees per acre, with an average of 24.5 newly infested trees per acre. Each of these infestations of mountain pine beetle was increasing rapidly, with ratios of increase ranging from 1.2:1 to 10.1:1 (the ratio of increase is: number of newly infested trees per acre : number of last year's newly infested trees per acre), with an average for these thirteen reports of 3.6 newly infested trees for every tree infested the previous year. Based on Cole and Amman's (1980) description of a mountain pine beetle outbreak, infestation data collected by the LSC-FHM personnel indicates clearly that a mountain pine beetle epidemic was underway in the thirteen analysis areas surveyed.

In addition to the presence of epidemic populations of mountain pine beetle, stand conditions, as they relate to the potential for fostering a mountain pine beetle epidemic, were assessed by gathering variable plot data for stands surveyed the bark beetle ground crews (Table 6 and Table 7). Amman *et al.* (1977) developed a risk rating system for classifying lodgepole stand susceptibility for mountain pine beetle epidemics based on average diameter at breast height (dbh), average age, and stand elevation and latitude. Lodgepole pine stands that are highly susceptible to mountain pine beetle typically have the following characteristics: average dbh  $> 8$  inches; average age  $> 80$  years; and occur in a suitable climate for beetle development as determined by elevation and latitude. Characteristics of the stands sampled during the bark beetle surveys (Cain and Howell 2005abc; Cain and Jorgensen 2003; Cain, Jorgensen, and Sullivan 2003; Costello 2007; Costello and Howell 2006abc; Costello and Howell 2007abc) indicated that they were generally of large diameter at breast height ( $\geq 8$  inches DBH), older-aged stands ( $\geq 80$  years of age), and occurred at elevations suitable for mountain pine beetle development. In addition, surveyed stands had high stand basal areas ( $\geq 120$  square feet of basal area per acre), which is associated with more severe losses of lodgepole pine during a mountain pine beetle epidemic (McGregor and others 1987). Similar stand conditions were reported by Mask and Eager (1997) for the Vail Valley area. These stand conditions favor population increase when mountain pine beetle populations are on the increase and above endemic levels.

## Conclusions

The aerial survey data and available ground survey results indicate that the mountain pine beetle is at epidemic levels in lodgepole pine forests across northern Colorado, including Arapaho, Routt, and White River National Forest lands in Eagle, Grand, Jackson, Routt, and Summit Counties in Colorado, and southern Medicine Bow National Forest lands in Albany and Carbon Counties in southern Wyoming.

The building mountain pine beetle epidemic on the above-mentioned National Forests and other land ownerships in the associated Counties is not likely to depart from the projected rapid increase in losses to lodgepole pine stands unless a period of prolonged and severe low temperatures (<-30° F) occurs during late fall-winter-early spring months. An extremely severe cold weather event may result in the death of large numbers of the developing bark beetle brood and bring the epidemic to an end, as happened during the mountain pine beetle outbreak in Grand and Summit Counties, CO, in 1984 – 1985 (Lessard *et al.* 1987) and during the spruce beetle epidemic in the Flat Tops Wilderness on the White River National Forest in 1951 (Schmid and Frye 1977).

Based on the above analysis there is adequate evidence to recommend to the Deputy Regional Forester that he declare that an epidemic of mountain pine beetle exists in lodgepole pine forests on the Arapaho, Routt, White River, and southern Medicine Bow National Forests in Eagle, Grand, Jackson, Routt, and Summit Counties, CO, and Albany and Carbon Counties, WY. If the Forest Supervisors for these National Forests find that there are threats to ecosystem components in analysis areas within these Counties, then the streamlined NEPA authorities offered by the Healthy Forest Restoration Act are available for their use.

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## Appendix A – County and National Forest Mountain Pine Beetle Impacts, 1996 – 2006

**Table 1a.** Cumulative (1996 through 2006) acres of lodgepole pine containing trees killed by the mountain pine beetle (MPB) by County in the Northern Colorado Bark Beetle Cooperative Project Area and in Albany and Carbon Counties, WY, in the lodgepole pine forest cover type and in other forest cover types.

**Table 1b.** Cumulative (1996 through 2006) privately owned and National Forest acres of lodgepole pine containing trees killed by the mountain pine beetle (MPB) by County in the Northern Colorado Bark Beetle Cooperative Project Area and in Albany and Carbon Counties, WY, in the lodgepole pine forest cover type and in other forest cover types.

**Table 2.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year as a result of mountain pine beetle infestation in the Colorado Bark Beetle Cooperative Project Area from 1996 through 2006.

**Table 3.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year as a result of mountain pine beetle infestation in Albany and Carbon Counties, Wyoming, from 1996 through 2006.

**Table 4.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year as a result of mountain pine beetle infestation on portions of the Arapaho, Routt, and White River National Forests within the Colorado Bark Beetle Cooperative Project Area, from 1996 through 2006.

**Table 5.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year as a result of mountain pine beetle infestation on portions of the Medicine Bow National Forest<sup>2</sup>, from 1996 through 2006.

**Table 6.** Ground survey results from eleven Forest Health Management Biological Evaluations concerning the status of mountain pine beetle in lodgepole pine stands in analysis areas on the Arapaho, Routt and White River National Forests within the core Colorado Bark Beetle Cooperative Project Area, 2002 – 2006.

**Table 7.** Ground survey results from one Forest Health Management Biological Evaluation and one Service Trip Report concerning the status of mountain pine beetle in lodgepole pine stands in analysis areas in Albany and Carbon Counties, WY, on the Medicine Bow National Forest, 2002 – 2006.

**Table 1a.** Cumulative (1996 through 2006) acres of lodgepole pine containing trees killed by the mountain pine beetle (MPB) by County in the Colorado Bark Beetle Cooperative Project Area and in Albany and Carbon Counties, WY, in the lodgepole pine forest cover type<sup>1</sup> and in other forest cover types<sup>2</sup>.

County, State	All Forest Ownerships				
	Acreage in Lodgepole Pine Cover Type <sup>1</sup>	Acreage in Lodgepole Pine Cover Type Impacted by MPB	Percent of Lodgepole Pine Cover Type Impacted by MPB	Acreage in Other Forest Cover Types <sup>2</sup> Impacted by MPB	Acreage of Lodgepole Pine Impacted by MPB in all Forest Cover Types
Eagle, CO	28,300	6,460	23%	90,100	96,560
Grand, CO	452,000	318,000	70%	125,000	443,000
Jackson, CO	307,000	158,000	51%	53,000	211,000
Routt, CO	167,000	53,000	32%	89,500	142,500
Summit, CO	107,000	50,000	47%	32,100	82,100
Albany, WY	279,000	5,290	2%	440	5,730
Carbon, WY	446,000	74,500	17%	39,300	113,800

<sup>1</sup> Lodgepole pine forest cover type characterized in the Colorado Gap Analysis Project, United States Geological Survey, 2000.

<sup>2</sup> Other forest cover types where lodgepole pine makes up a variable but small portion of the overstory trees. These forest cover types may be classified as spruce-fir, aspen, or mixed conifer.

**Table 1b.** Cumulative (1996 through 2006) privately owned and National Forest acres of lodgepole pine containing trees killed by the mountain pine beetle (MPB) by County in the Colorado Bark Beetle Cooperative Project Area and in Albany and Carbon Counties, WY, in the lodgepole pine forest cover type<sup>1</sup> and in other forest cover types<sup>2</sup>.

County, State	Private Forest Ownership				National Forest Ownership			
	Acreeage in Lodgepole Pine Cover Type <sup>1</sup>	Acreeage in Lodgepole Pine Cover Type Impacted by MPB	Percent of Lodgepole Pine Cover Type Impacted by MPB	Acreeage in Other Forest Cover Types <sup>2</sup> Impacted by MPB	Acreeage in Lodgepole Pine Cover Type <sup>1</sup>	Acreeage in Lodgepole Pine Cover Type Impacted by MPB	Percent of Lodgepole Pine Cover Type Impacted by MPB	Acreeage in Other Forest Cover Types <sup>2</sup> Impacted by MPB
Eagle, CO	1,430	730	51%	8,300	22,700	5,580	25%	79,520
Grand, CO	83,200	56,300	68%	23,000	314,000	221,000	70%	68,000
Jackson, CO	32,000	19,000	59%	14,200	222,000	109,000	49%	21,000
Routt, CO	15,800	3,650	23%	20,350	139,000	44,600	32%	65,400
Summit, CO	15,400	4,450	29%	6,450	90,600	44,900	50%	25,100
Albany, WY	35,400	200	1%	50	221,000	5,030	2%	300
Carbon, WY	21,600	1,370	6%	3,980	384,000	71,500	19%	32,500

<sup>1</sup> Lodgepole pine forest cover type characterized in the Colorado Gap Analysis Project, United States Geological Survey, 2000.

<sup>2</sup> Other forest cover types where lodgepole pine makes up a variable but small portion of the overstory trees. These forest cover types may be classified as spruce-fir, aspen, or mixed conifer.

**Table 2.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year<sup>1</sup> as a result of mountain pine beetle infestation in the Colorado Bark Beetle Cooperative Project Area from 1996 through 2006.

<b>Colorado Bark Beetle Cooperative Counties<sup>1</sup></b>					
<b>Year</b>	<b>Eagle</b>	<b>Grand</b>	<b>Jackson</b>	<b>Routt</b>	<b>Summit</b>
1996	524	626	120	168	216
1997	2,220	3,170	0	0	496
1998	4,560	6,390	1,380	1,770	997
1999	6,800	13,100	3,270	2,410	1,300
2000	8,660	18,700	3,930	2,840	2,220
2001	9,610	25,100	12,100	1,440	1,620
2002	7,890	51,400	12,600	3,890	5,480
2003	14,100	83,200	37,500	14,600	9,810
2004	25,300	199,300	60,300	59,200	38,500
2005	35,500	211,600	75,600	47,800	45,200
2006	58,800	288,000	150,000	79,500	39,100

<sup>1</sup> These acreage figures represent the number of acres mapped by aerial surveyors for each individual year that contain red-crowned trees that died during the year of survey only; these numbers do not reflect the cumulative impact of mountain pine beetle infestation over the course of the epidemic in the surveyed area because they do not tally beetle-killed defoliated trees or currently infested green trees. As a result, an individual acre may be mapped multiple years as the mountain pine beetle epidemic developed over this eleven-year time span. These figures cannot be summed over the time interval for each County to determine the cumulative impact of mountain pine beetle on lodgepole pine stands within these Counties.

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**Table 3.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year<sup>1</sup> as a result of mountain pine beetle infestation in Albany and Carbon Counties, Wyoming, from 1996 through 2006.

<b>Southern Wyoming Counties<sup>1</sup></b>		
<b>Year</b>	<b>Albany</b>	<b>Carbon</b>
1996	1	9
1997	4	277
1998	8	32
1999	29	1,310
2000	18	670
2001	43	5,070
2002	217	6,660
2003	86	10,500
2004	608	23,200
2005	1,600	39,400
2006	3,440	73,400

<sup>1</sup> These acreage figures represent the number of acres mapped by aerial surveyors for each individual year that contained red-crowned trees that died during the year of survey only; these numbers do not reflect the cumulative impact of mountain pine beetle infestation over the course of the epidemic in the surveyed area because they do not tally beetle-killed defoliated trees or currently infested green trees. As a result, an individual acre may be mapped multiple years as the mountain pine beetle epidemic developed over this eleven-year time span. These figures cannot be summed over the time interval for each County to determine the cumulative impact of mountain pine beetle on lodgepole pine stands within these Counties.

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**Table 4.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year<sup>1</sup> as a result of mountain pine beetle infestation on portions of the Arapaho, Routt, and White River National Forests within the Colorado Bark Beetle Cooperative Project Area, from 1996 through 2006.

<b>Colorado Bark Beetle Cooperative National Forests<sup>1</sup></b>			
<b>Year</b>	<b>Arapaho NF<sup>2</sup></b>	<b>Routt NF</b>	<b>White River NF<sup>2</sup></b>
1996	229	231	532
1997	1,680	0	2,110
1998	3,530	1,770	5,760
1999	5,560	4,830	7,032
2000	6,830	7,880	9,510
2001	8,410	16,800	10,300
2002	23,300	22,400	11,600
2003	38,500	52,600	21,600
2004	89,100	138,000	57,200
2005	94,200	135,000	72,200
2006	132,000	223,000	86,800

<sup>1</sup> These acreage figures represent the number of acres mapped by aerial surveyors for each individual year that contain red-crowned trees that died during the year of survey only; these numbers do not reflect the cumulative impact of mountain pine beetle infestation over the course of the epidemic in the surveyed area because they do not tally beetle-killed, defoliated trees or currently infested green trees. As a result, an individual acre may be mapped multiple years as the mountain pine beetle epidemic developed over this eleven-year time span. These figures cannot be summed over the time interval for each County to determine the cumulative impact of mountain pine beetle on lodgepole pine stands within these Counties. See Table 1 for these figures.

<sup>2</sup> Arapaho National Forest acreage includes Grand County only; White River National Forest acreage includes Eagle and Summit Counties only.

**Table 5.** Annual aerial survey estimates of forested acreage containing lodgepole pine trees that died each given year<sup>1</sup> as a result of mountain pine beetle infestation on portions of the Medicine Bow National Forest<sup>2</sup>, from 1996 through 2006.

<b>Southern Wyoming<sup>1</sup></b>	
<b>Year</b>	<b>Medicine Bow NF<sup>2</sup></b>
1996	10
1997	265
1998	27
1999	1,010
2000	586
2001	4,700
2002	6,620
2003	9,910
2004	22,600
2005	39,200
2006	75,000

<sup>1</sup> These acreage figures represent the number of acres mapped by aerial surveyors for each individual year that contain red-crowned trees that died during the year of survey only; these numbers do not reflect the cumulative impact of mountain pine beetle infestation over the course of the epidemic in the surveyed area because they do not tally beetle-killed, defoliated trees or currently infested green trees. As a result, an individual acre may be mapped multiple years as the mountain pine beetle epidemic developed over this eleven-year time span. These figures cannot be summed over the time interval for each County to determine the cumulative impact of mountain pine beetle on lodgepole pine stands within these Counties. See Table 1 for these figures.

<sup>2</sup> Medicine Bow National Forest acreage includes Albany and Carbon Counties only.

**Table 6.** Ground survey results from eleven Forest Health Management Biological Evaluations concerning the status of mountain pine beetle in lodgepole pine stands in analysis areas on the Arapaho, Routt and White River National Forests within the core Colorado Bark Beetle Cooperative Project Area, 2002 – 2006.

<b>Mountain Pine Beetle Analysis Area (N. Colorado)</b>	<b>County</b>	<b>Ground Survey Date</b>	<b>Current Year Average Number of Trees Infested per Acre</b>	<b>Previous Year Average Number of Trees Infested per Acre</b>	<b>Ratio Current to Previous Year</b>
Blue Ridge	Grand	2006	89.4	53.8	2.2:1
Larson II	Routt	2006	10.0	2.1	4.7:1
Keystone	Summit	2006	21.2	5.9	3.6:1
Dillon Reservoir <sup>1</sup>	Summit	2005	42.5	17.6	2.4:1
Lower Blue <sup>1</sup>	Summit	2005	48.4	12.0	4.0:1
Upper Fraser <sup>1</sup>	Grand	2004	15.3	3.1	4.9:1
Little Snake <sup>1</sup>	Routt	2004	10.7	3.5	3.1:1
Sierra Madre <sup>1</sup>	Jackson	2004	2.8	1.3	2.1:1
Rock Creek <sup>1</sup>	Grand	2004	2.8	1.2	2.8:1
Green Ridge	Jackson	2002	4.0	3.4	1.2:1
Arapaho National Recreation Area	Grand	2002	12.4	3.9	3.2:1

<sup>1</sup> Mountain pine beetle epidemic determinations under the Healthy Forest Restoration Act.

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**Table 7.** Ground survey results from one Forest Health Management Biological Evaluation and one Service Trip Report concerning the status of mountain pine beetle in lodgepole pine stands in analysis areas in Albany and Carbon Counties, WY, on the Medicine Bow National Forest, 2002 – 2006.

<b>Mountain Pine Beetle Analysis Area (S. Wyoming)</b>	<b>County</b>	<b>Ground Survey Date</b>	<b>Current Year Average Number of Trees Infested per Acre</b>	<b>Previous Year Average Number of Trees Infested per Acre</b>	<b>Ratio Current to Previous Year</b>
French Creek <sup>1</sup>	Carbon	2004	6.2	2.3	2.7:1
Devils Gate	Albany	2006	52.6	5.2	10.1:1

<sup>1</sup> Mountain pine beetle epidemic determinations under the Healthy Forest Restoration Act.

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**Appendix B – County Aerial Survey Maps, Mountain Pine Beetle Impacts, 1999 – 2006**

**Figure 1. Eagle County, Colorado**

**Figure 2. Grand County, Colorado**

**Figure 3. Jackson County, Colorado**

**Figure 4. Routt County, Colorado**

**Figure 5. Summit County, Colorado**

**Figure 6. Albany County, Wyoming**

**Figure 7. Carbon County, Wyoming**

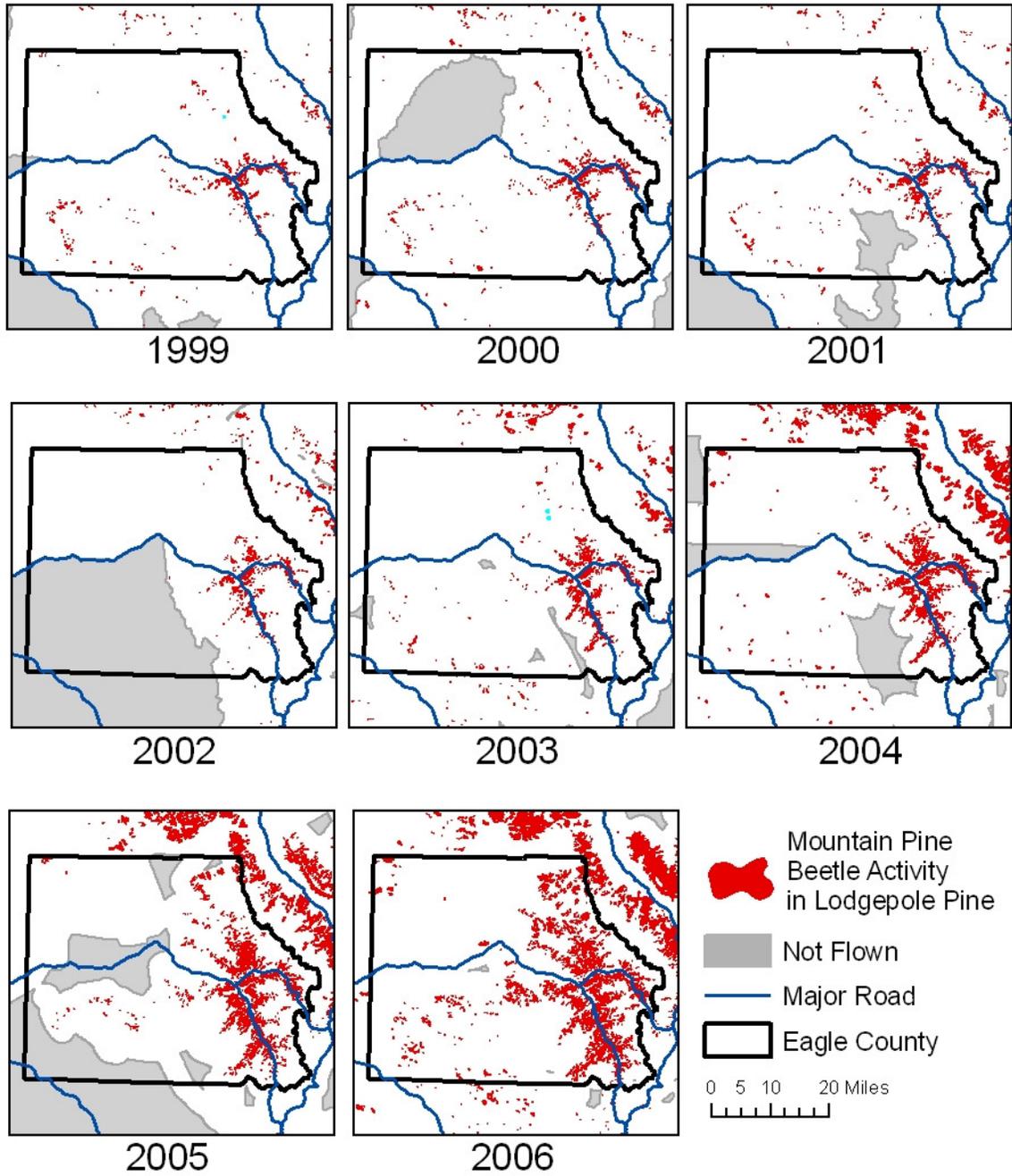


Figure 1. Eagle County, Colorado.

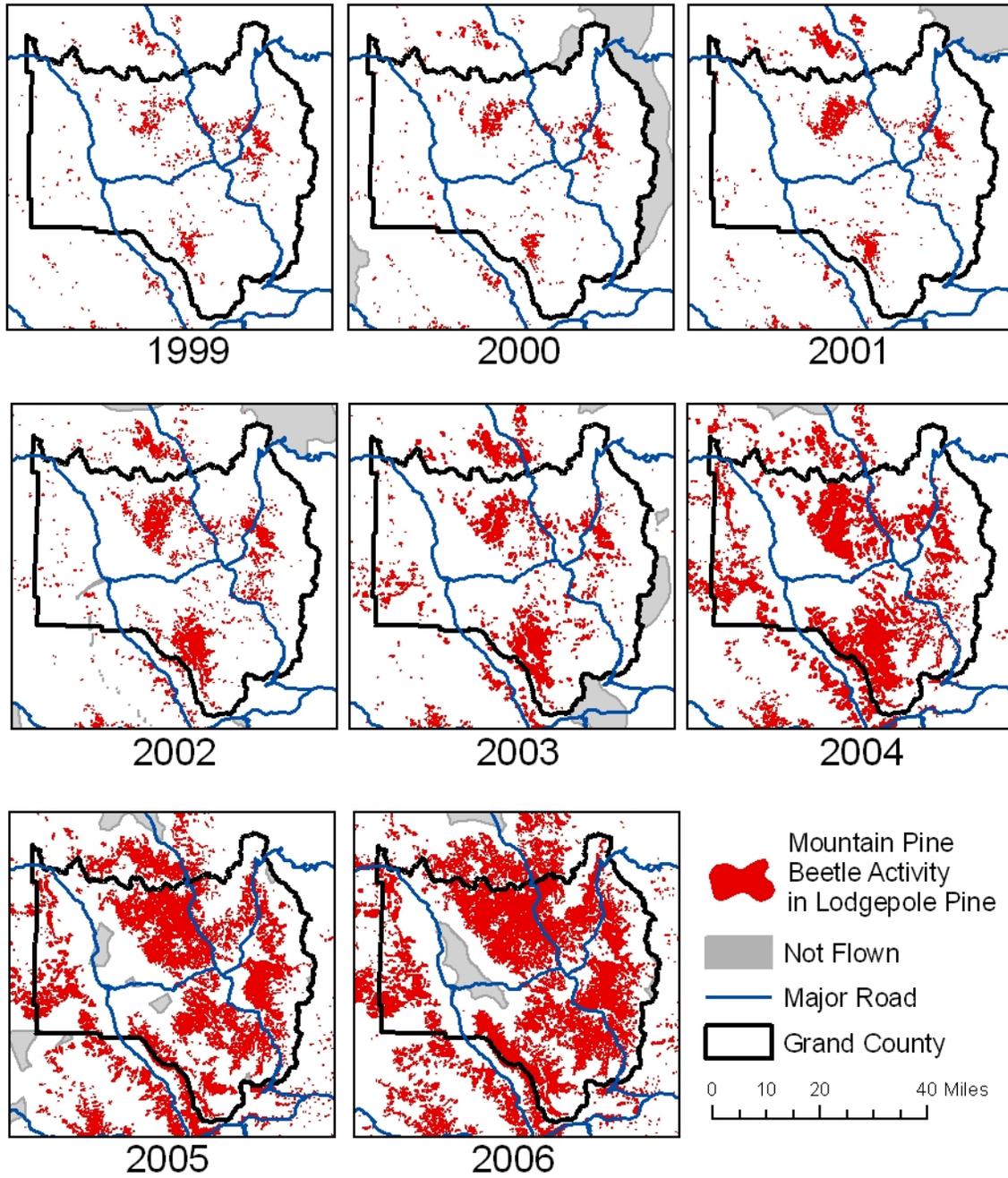


Figure 2.. Grand County, Colorado.

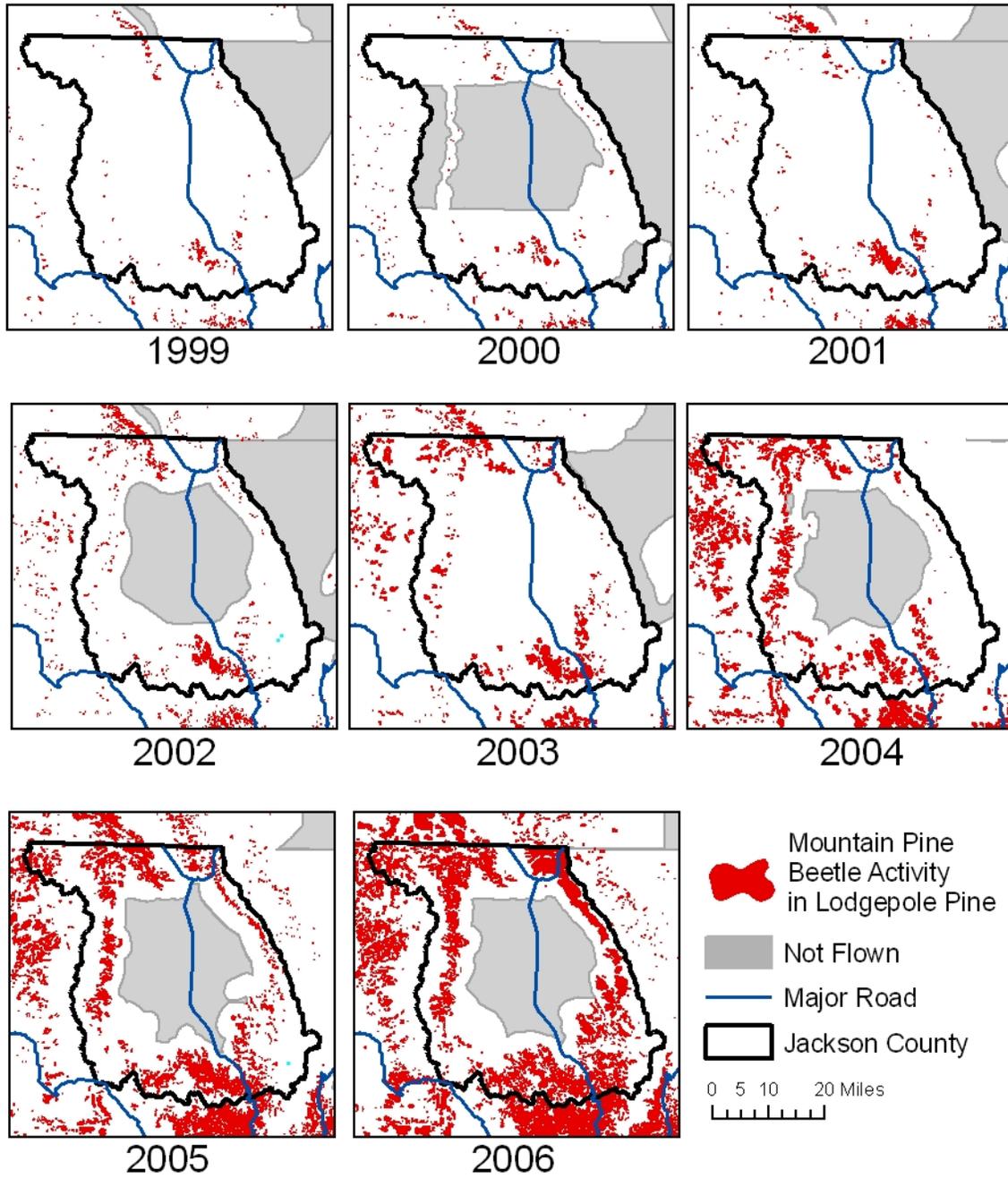


Figure 3. Jackson County, Colorado.

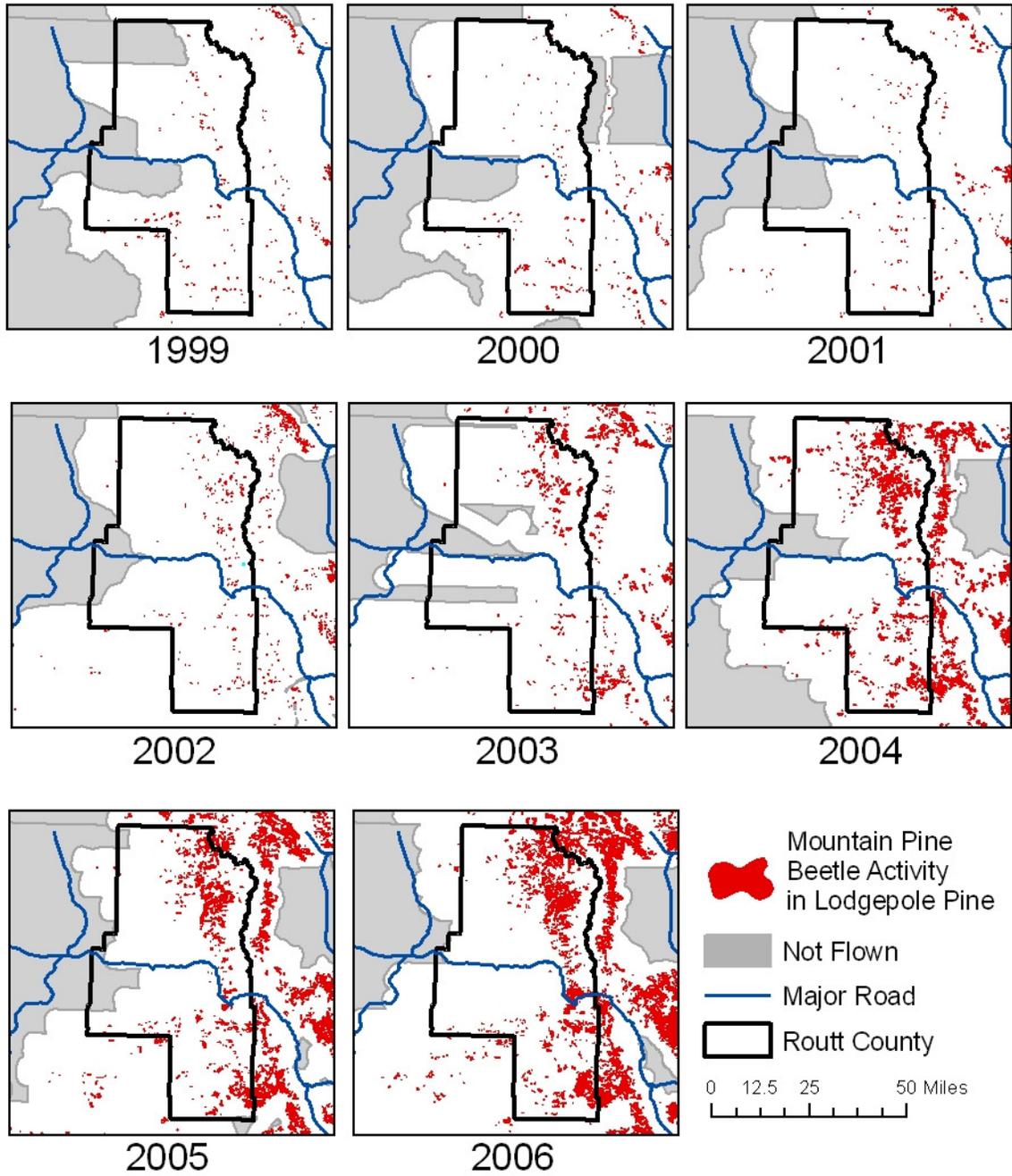


Figure 4. Routt County, Colorado.

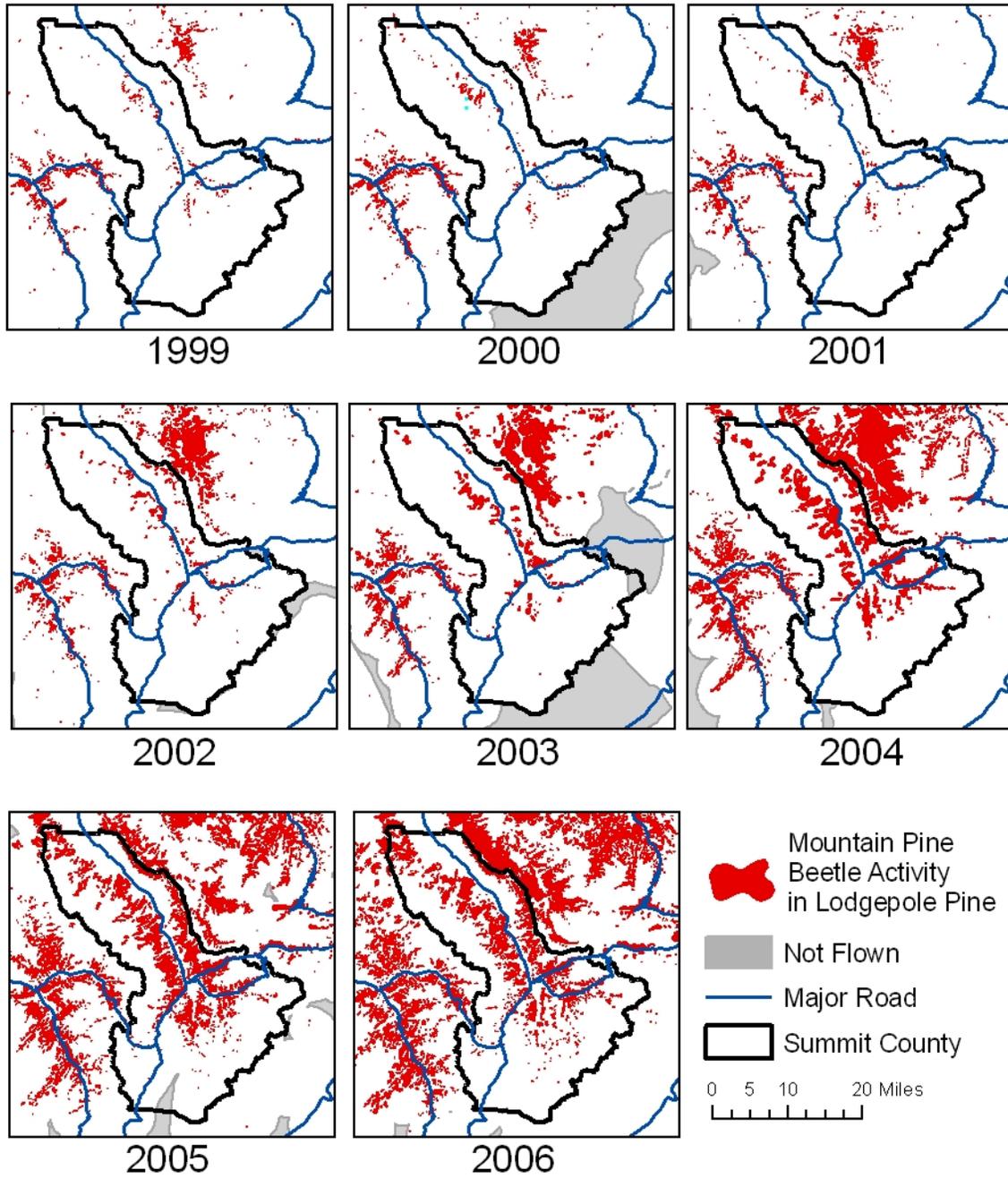


Figure 5. Summit County, Colorado.

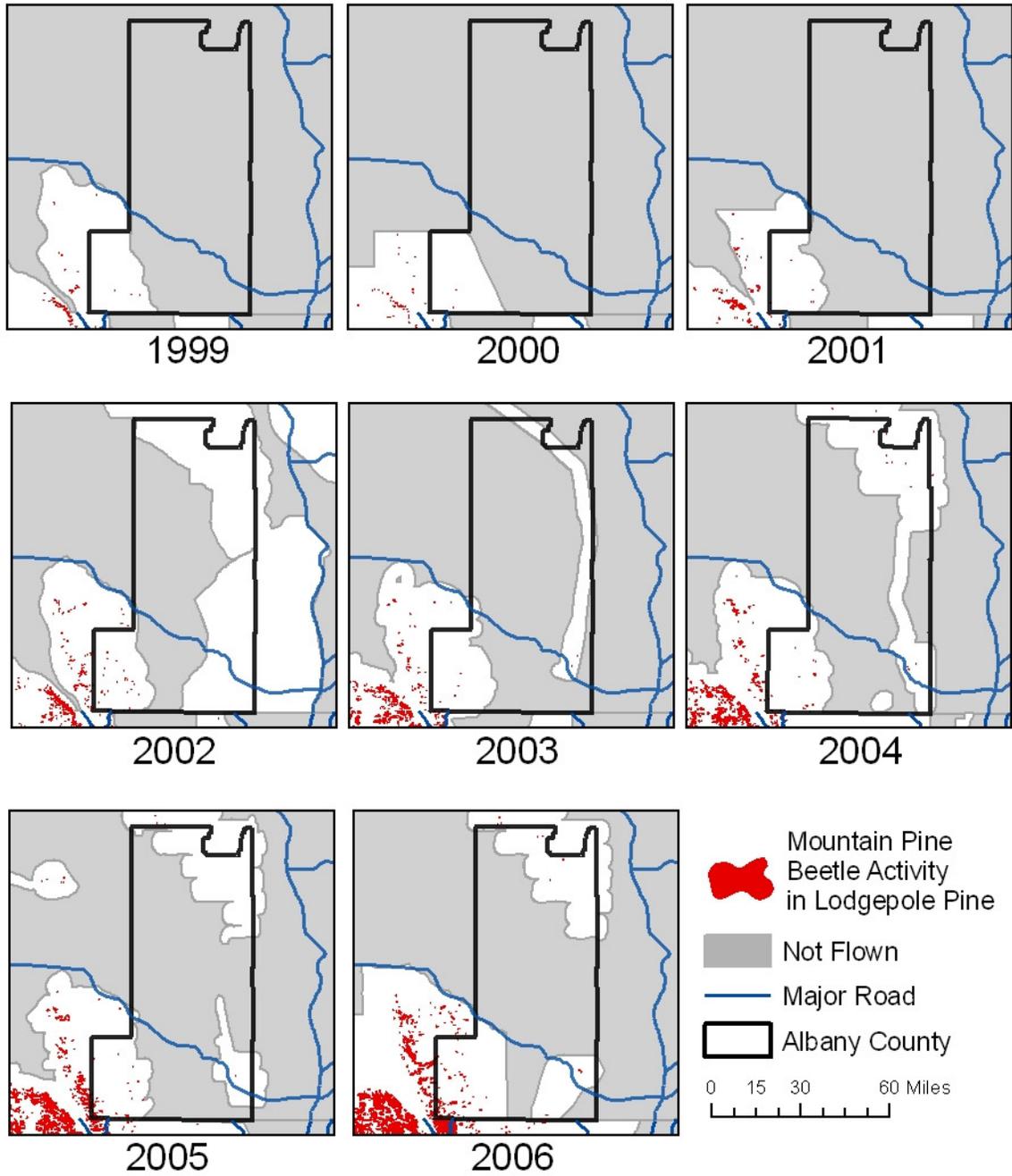


Figure 6. Albany County, Wyoming.

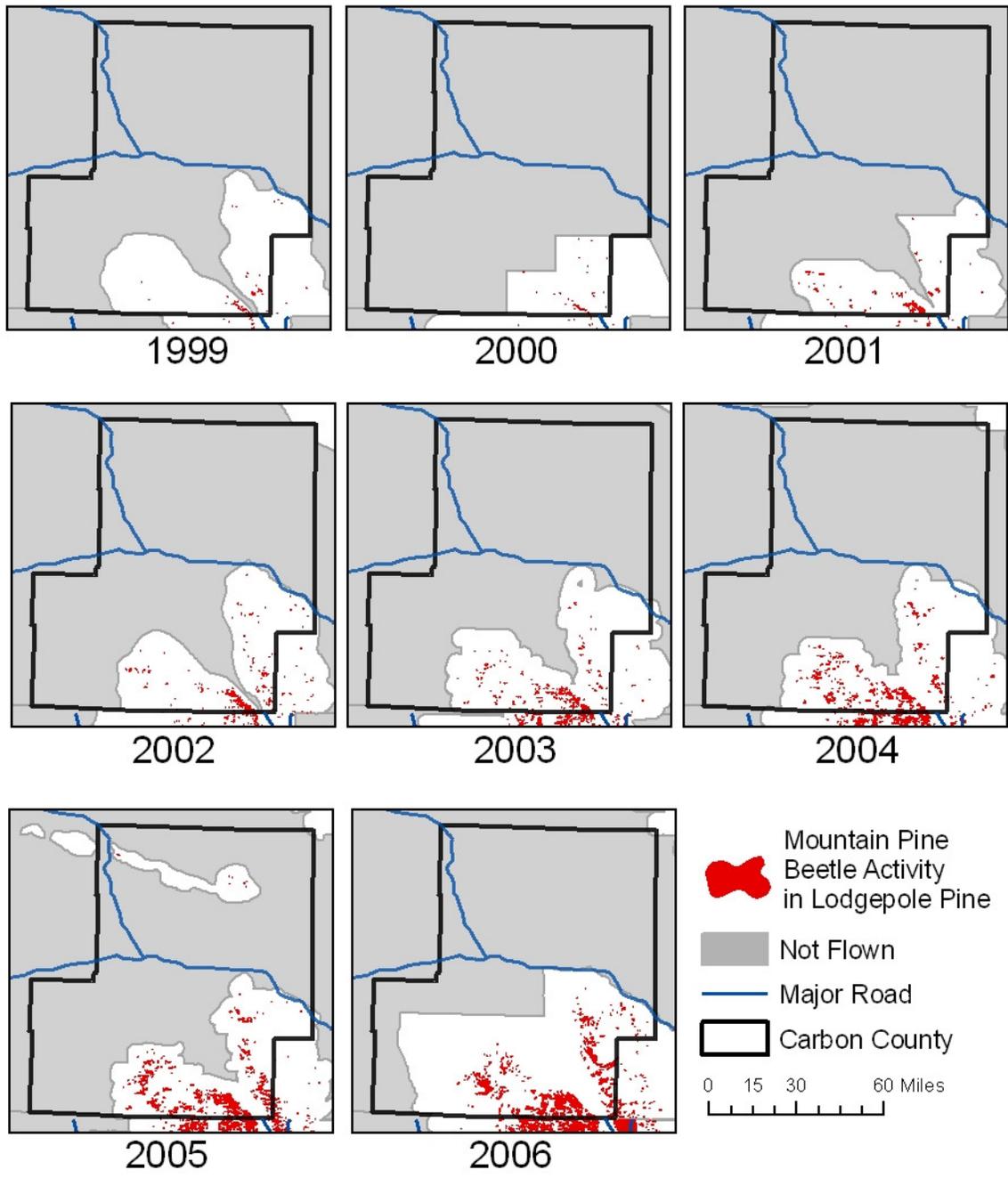


Figure 7. Carbon County, Wyoming.