

THE PEOPLE, ECONOMY, LAND, AND RESOURCES OF MISSOULA COUNTY AND POTENTIAL VULNERABILITIES TO CLIMATE CHANGE



JUNE 20, 2011

DISCUSSION DRAFT

This report is background material for participants in a community climate adaptation planning process that will take place in Missoula on June 27-28, 2011 at the Doubletree Hotel.

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ABOUT HEADWATERS ECONOMICS

Headwaters Economics is an independent, nonprofit research group whose mission is to improve community development and land management decisions in the West.

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EXECUTIVE SUMMARY

This report is intended to serve as background material for participants in a community climate adaptation planning process that will take place in Missoula on June 27-28, 2011. It is a companion report to another entitled *Future Climate Conditions in Missoula County and the Western Montana Region*. Together, the two reports provide a snapshot of current conditions and climate-related issues across Missoula County, as well as potential future conditions and issues. The process engages citizens in a broad-ranging discussion on the possible effects of climate change, identifying at-risk resources and populations, and developing strategies for adaptation.

The Economy and People

Trends and Conditions Missoula County is a growing regional trade center that is diverse, with a few large employers, such as the university, regional hospitals, and federal land management agencies, but the bulk of activity is generated by small businesses. Ninety percent of wage and salary workers work for small businesses of 20 employees or fewer, and one out of four people in Missoula County is self-employed. Missoula County is educated; 24 percent of the adult population have a bachelor's degree and another 13 percent have graduate or professional degrees.

Population, employment, and personal income have grown steadily over the last 30 years, but this has slowed recently due to the recession. The exception is population growth, which has continued, with most of the growth from in-migration, and with the baby boomer generation making up the majority. More than a third of total personal income is from retirement, investments, and other non-labor income.

Median family income has not changed much in the last decade, although the number of households in the upper earnings categories has increased. In spite of the growth in wealth, housing has become less affordable. The county has a number of vulnerable populations: more than 18 percent of individuals (9.2% of families) are below poverty level; 8 percent have no high school diploma; 20 percent are obese; 18 percent smoke; and 23 percent do not have health insurance.

According to Missoula area economists and elected officials, one of the reasons for Missoula's steady and continued growth has been its high quality of life. Economic sectors like travel and tourism (for example, downhill skiing and fishing) are important not just for the revenue they generate from visitors, but are also indicators of a high quality of life for local residents. An airport with daily access to major markets and population centers, an educated workforce, and a high quality of life have positioned the county for continued economic growth, some driven by amenity-based migration, and much of it by people who already live and play in the area.

Vulnerabilities to Climate Change The economy and people of Missoula County are potentially vulnerable to climate change in a number of ways. Climate change predictions include less snowfall; more rain-on-snow events; a higher chance of severe weather events (such as flooding); faster spring water runoff; drier, hotter summers; and increased forest fires and outbreaks of invasive species. This may impact the economy by affecting the environment, which is an essential component to the area's quality of life and a critical economic asset. Efforts to protect the environment—if they are perceived to run counter to job creation or housing affordability—may run into opposition in light of the hardship created by the recession.

The insurance industry is also concerned with climate change, in particular the increased frequency of extreme events such as wildfire and floods. These concerns may be reflected in increased rates and regulations (for example, against building in the floodplain).

As energy prices continue to increase, a number of sectors in the county will be affected. Transportation by air and road, which is key to the economy, will be more expensive. Higher import costs of food may benefit local producers, as will higher prices for food in general. The threat of higher energy prices puts a focus on supplementing imported energy with local renewable sources and on reducing demand by increasing efficiency.

Climate change, especially if it affects air and water quality, can also disproportionately affect the very young, the elderly, and people with health challenges (for example, those with respiratory ailments), as well as individuals with reduced access to health care, such as the uninsured and the poor. Native American populations with higher poverty rates may be particularly vulnerable.

The Land

Trends and Conditions Missoula County is more than 1.6 million acres in size, 76 percent forested, and more than half of the land is managed by either the state or federal government. The county's water comes from a number of sources, including rivers, streams and the Missoula Valley Aquifer, which provides water to 40,000 households and is known to be very clean. Air quality in Missoula County has improved significantly over the years, due in large part to regulations. A notable exception is the years when forest fires burned nearby. Since forest fires are expected to increase with climate change, air quality will decline. This in turn will disproportionately affect disadvantaged people, such as those with respiratory ailments, and it could decrease the overall quality of life in the valley.

Vulnerabilities to Climate Change Climate change may bring a number of other challenges to the land, water, and air resources of the county. Increased spring runoff, for example, could lead to higher rates of soil saturation and the percolation of surface contaminants into the aquifer. The regulation of septic tanks, especially in light of recent growth of development outside city limits (one of the side effects of "amenity-driven" growth), will be increasingly important.

With faster runoff, one of the challenges may be to store water at higher elevations. The county has some ability to store water, with 361 lakes and 29 dams. The dams are currently in good condition and may be able to withstand the potential pressures resulting from climate change.

Flooding of rivers could damage property and, in the case of the potentially contaminated Smurfit Stone settling ponds, spill pollution into the river, which would affect people, fish, and wildlife.

Adaptation to climate change in the county will hinge in large part on the management of public lands. Only a small portion of the federal lands is in official protected status, such as Wilderness or National Recreation areas. These lands are generally less disturbed by humans, and may be important for water storage, and for maintaining a diversity of native plant and animal species.

One area where public forest management will continue to see challenges, exacerbated by warmer and drier climate, will be forest fires, and the need to protect homes in the fire-prone, wildland-urban interface. The timber industry has suffered significant losses recently, due to a recession and national downturn in building and the closure locally of a plywood plant, sawmill, and pulp mill. Timber harvests on the Lolo, Bitterroot, and Flathead National Forests have declined by more than 300 percent since the late 1980s. In spite of this, timber harvesting continues, although at a smaller scale. This industry will play an increasingly important role in the management of forests, including helping to thin combustible material near homes, providing fuel for biomass-to-energy plants, and participating in increasingly collaborative approaches to land stewardship.

Climate change may also bring a proliferation of weeds and invasive species that, in turn, affect forests (for example, the mountain pine beetle), agriculture, open space, fish and riparian habitat, and wildlife.

I. INTRODUCTION

This report is part of a *ClimateWise* process developed by the Geos Institute. The process engages citizens in a broad-ranging discussion on the possible effects of climate change that leads to the development by the community of a local climate adaptation plan. This document provides resources that can be used by citizens of Missoula County to inform the discussion that will take place on June 27-28, 2011. This report is therefore a draft and subject to revision based on corrections and suggestions by community participants.

A companion draft report, *Future Climate Conditions in Missoula County and the Western Montana Region*, is also part of the process.

The information in this report describes the makeup of Missoula County in terms of demographics, economics, land use, and infrastructure, and identifies areas where the region may be vulnerable to the effects of climate change. The descriptions are intended to spur a conversation and are not designed to be exhaustive. The end result will be a community-based effort that identifies the possible effects of climate change, where Missoula County is vulnerable, and what actions the community can take to prepare and adapt.

Missoula County is an information-rich place, with the University of Montana, a number of non-profit organizations, and several state and federal agencies that are staffed with professionals with experience in community development, natural resource management, economic analysis, and the science of climate change. This report uses many of the existing resources in the Missoula area, supplemented with published data from state and federal sources, and from original research conducted by Headwaters Economics. Additional information needs, insights, and perspectives on the vulnerability of people and economic sectors to climate change will be uncovered at the June 27-28 workshop, and in subsequent discussions. A final report will be produced at the end of this process and is likely to contain some of the information provided in this report.

The *ClimateWise* Process for Community Engagement

ClimateWise is a process developed by the Geos Institute to help communities understand how they may be affected by climate change and to develop concrete actions to prepare for and minimize those impacts. It is a planning process that involves a broad array of local citizens, and is organized by a local steering committee and local host organization. The process follows these general steps:

1. A local organization agrees to host the process. The Clark Fork Coalition has volunteered for this role. To learn more, please see: <http://www.clarkfork.org/>.
2. A steering committee is formed to help guide the process.
3. An organization agrees to provide assistance in gathering demographic and economic information. Headwaters Economics, based in Bozeman, Montana, has agreed to play this role. For more information, see: <http://headwaterseconomics.org/>.
4. The Geos Institute, working with local, regional, and national scientists, develops a draft report that identifies the possible local impacts of climate change in terms of temperature, precipitation, vegetation, fire, and snowpack for specific communities, river basins or land management units. For more information, see: <http://www.geosinstitute.org/>. For more about Geos' *ClimateWise* process, see: <http://www.geosinstitute.org/climatewise%20AE-summary/climatewiser-summary.html>.

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5. The climate change and socioeconomic information—in the form of draft reports—are shared with the steering committee and discussed at a public workshop, where the information, plus additional resources, if needed, are used to develop an action plan for climate adaptation.
 6. Based on public comment and additional information gathered as a result of the workshop, the steering committee and the above groups finalize a climate adaptation plan. For an example of a final report that was developed in Fresno County, California, see:
<http://www.geosinstitute.org/images/stories/pdfs/Publications/ClimateWise/FresnoClimateWiseFinal.pdf>

II. VULNERABILITY TO CLIMATE CHANGE AND ADAPTATION

Vulnerability means susceptibility to harm or change. Communities can be vulnerable to climate change in a number of ways. For example, increasing temperatures may lead to increased air pollution, leading to higher risk of exposure to children, the elderly, and people with asthma. Changing rainfall patterns can affect the availability of water for irrigation. Snowpack that falls later in the year, or has higher moisture content, can affect the local ski industry. Increased water runoff in the spring can lead to the flooding of rivers, which can stress dams and levees. With higher temperatures and drought, the frequency and intensity of wildfires may increase, which in turn could endanger homes, and drive up the costs of firefighting. These are examples of vulnerabilities.

Adaptation is the ability to respond to extreme events in order to moderate negative effects and to take advantage of opportunities. For example, if one of the outcomes of a changing climate is an increased probability of floods, then an example of adaptation may include producing new types of easily accessible floodplain maps, or using incentives, planning, or regulatory tools to steer future development to higher ground. If climate change brings warmer weather, an example of adaptive opportunities may be the expectation of longer growing seasons or even a different mixture of crops.

What are the climatic changes that can be expected for the Missoula region? These are identified in a companion draft report titled *Future Climate Conditions in Missoula County and the Western Montana Region*.

In summary, research by leading climate scientists shows that the following changes already are occurring in the region:

- Rising temperatures (2 to 3°F since 1900);
- Less snow, more rain;
- Less water stored in snowpack;
- Early spring snowmelt and peak runoff;
- Lower stream flows in summer.

In the future, scientists also expect the following:

- Increased frequency of extreme weather events (e.g., winter floods, summer droughts);
- Winter and spring flooding;
- Warmer summers;
- Increased water stress;
- Larger wildfires;
- More insect infestations.

In the following sections, we identify facts about the people, economy, land, and infrastructure in Missoula County, and suggest ways in which a changing climate may increase the vulnerability of certain segments of the population, sectors of the economy, infrastructure, and land resources.

III. THE PEOPLE AND THE ECONOMY

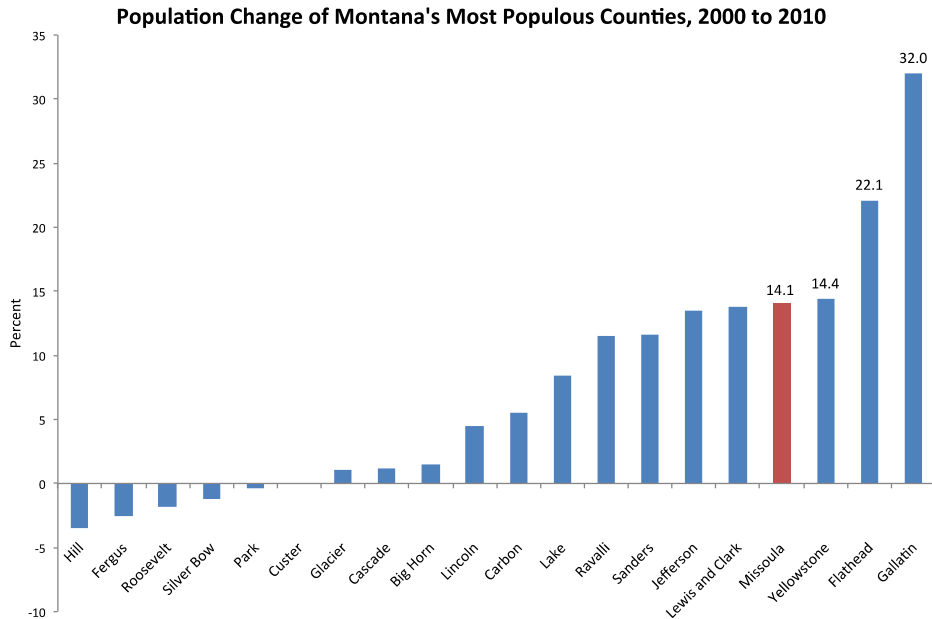
The first section of this chapter provides a general description of the people and economy of the region. A description of how people and the economy may be vulnerable to climate change is offered at the end of the chapter.

Changes in Population, Employment, and Personal Income

In 2010, 109,299 people lived in Missoula County, with 66,788 (61%) living in the city of Missoula (in 2000, 59% lived in the city.) In 2000 and in 2010 the county and city were both the second largest in the state.¹

Population rank		Geographic area	Population		Change, 2000 to 2010	
2010	2000		2000	2010	Number	Percent
2	2	Missoula County	95 802	109 299	13 497	14.1
2	2	INCORPORATED PLACE Missoula City	57 053	66 788	9 735	17.1

When compared to the most populous counties in the state (the counties represented in the figure account for 85% of Montana’s population), Missoula County was the fourth fastest-growing county from 2000 to 2010.



According to the Census Bureau, Missoula County is designated as a Central Metropolitan Statistical Area (a Central MSA). An MSA is defined as a county that has at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core, as measured by commuting ties. MSAs are classified as either Central or Outlying.

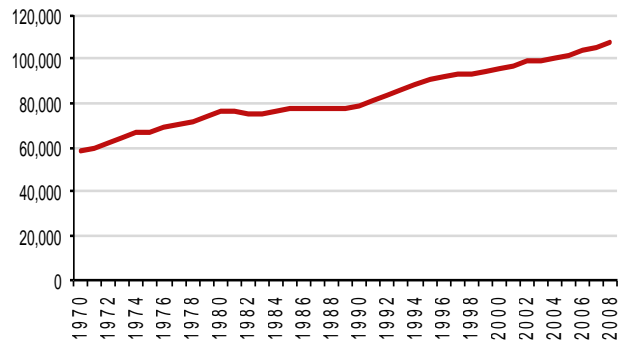
Missoula County is a *Central* MSA because it attracts people who commute in daily to work from adjacent counties. This trend has increased over time. From 1990 to 2008, outflow of earnings (money earned in Missoula County by people who live elsewhere) grew from \$97.3 million to \$228.1 million (in real terms), a 135 percent increase. In 2008, this accounted for 6 percent of total earnings. Despite the fact that people increasingly commute in from neighboring counties, earning the county its Census designation, the bulk of the personal income in Missoula County is earned by people who live in the county.²

In the last four decades, Missoula has experienced significant growth, with rapid and steady rise in population, employment, real personal income, and per capita income. Growth has slowed during two periods of national recession, in the late 1970s and early 1980s, and in the most recent recession, which started December of 2007.

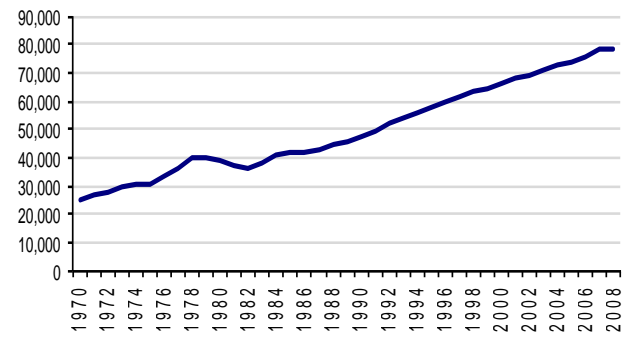
The current recession slowed down growth in employment, personal income, and per capita income, but not population, which continues to grow.³

The source of Missoula County's population growth is from natural change (births exceeding deaths) and migration. From 2000 to 2009, natural change resulted in 4,774 new people, while migration resulted in 8,520 new people. During that time, the county's population grew by 12,453 people, with 68 percent of the growth from in-migration.

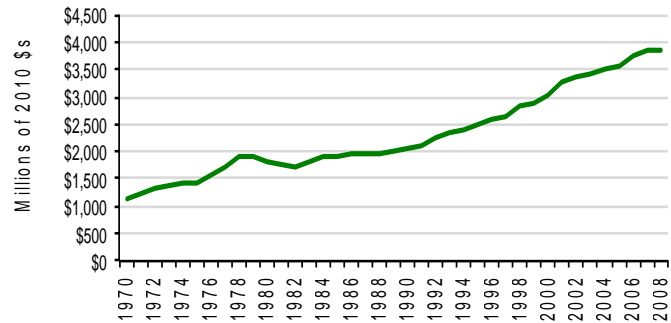
Population Trends, Missoula County



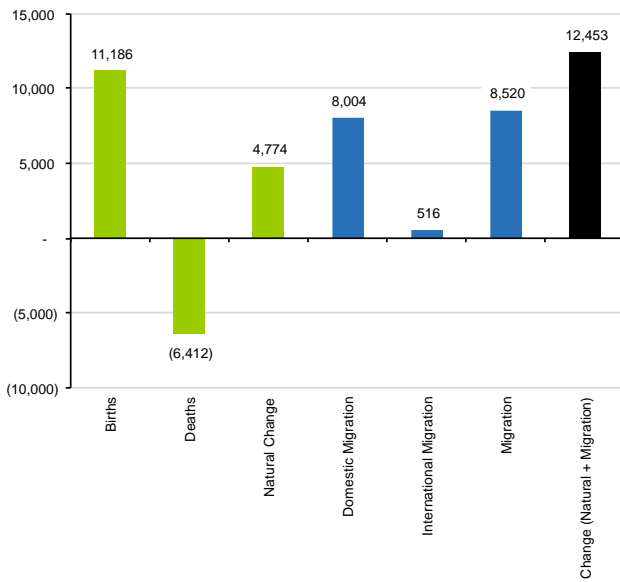
Employment Trends, Missoula County



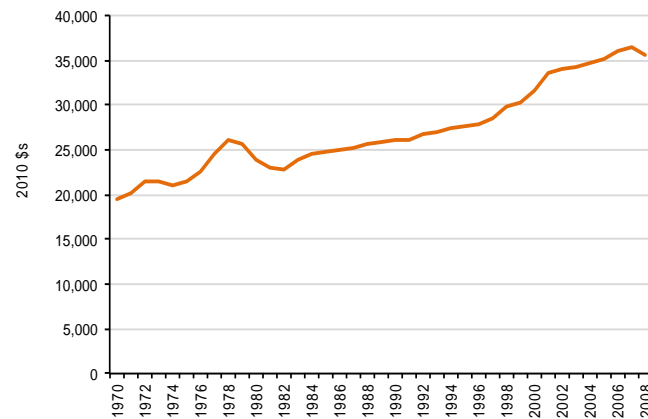
Personal Income Trends, Missoula County



Components of Population Change, Missoula County 2000-2009

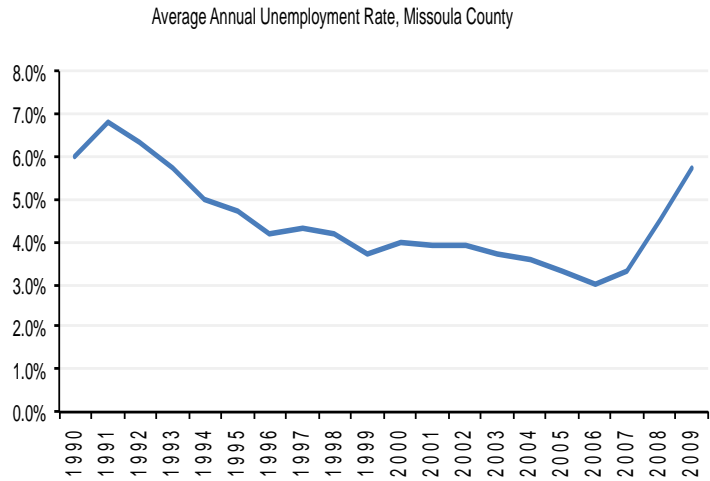


Per Capita Income, Missoula County



Unemployment

The effect of the recession can be seen most readily in the rate of unemployment, which has been in steady decline since the early 1990s, to a low of 3 percent in 2006 (before the recession) to 5.7 percent in 2009. While this trend reflects what happened all over the country, Missoula County fared relatively better than many in the first year of the recession. For example, in 2009, the unemployment rate in Montana was 6.2 percent, while in the U.S. it was 9.3 percent.⁴



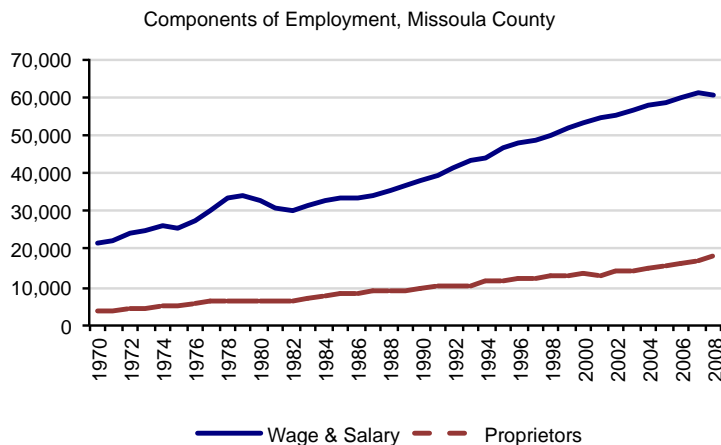
By February of 2011, Missoula County’s unemployment rate had climbed up to 8.2

percent, close to the national unemployment rate of 8.9 percent during the same time. Compared to other fast-growing counties in Montana, this is lower than Flathead County (unemployment rate of 13.2% in February of 2011; largely due to the housing bubble), but higher than Yellowstone County (6%; which is more dependent on oil and gas industries, whose prices are back up), Lewis and Clark County (5.9%; which receives much stability from government employment), Jefferson County (7.2%; many residents commute to Lewis and Clark County), and Gallatin County (7.5%; due in part to continued expansion of high tech industries). The unemployment rate in Montana during the same time was 7.4 percent.

The Self-Employed

Proprietor employment (the self-employed) represented 23 percent of total jobs in Missoula County in 2008. From 2000 to 2008, wage and salary employment (those who work for someone else) grew by 14.3 percent (7,560 new workers). In contrast, proprietor employment grew by 35 percent (4,696 new workers).

Proprietor employment is important information for several reasons. Many economic databases (for example, from the Bureau of the Census and Bureau of Labor Statistics) report only wage and salary employment. In Missoula County, this would undercount almost one out of every four workers. High proprietor employment is often a sign of entrepreneurship, and is commonly seen in communities that are desirable places with a high quality of life, where “footloose entrepreneurs” locate to live and do business. During severe recessions, proprietor employment can also rise, not because of entrepreneurial activity, but because people have to create their own jobs.



Employment and Wages by Industry

Missoula County is a regional trade center, supplying surrounding counties with a number of services, such as retail, legal, financial, and medical services.

The largest component of the economy of Missoula County is in service-related occupations, making up 74.1 percent of total jobs in 2008 (latest published data from U.S. Department of Commerce). The largest of these is retail trade (13.2% of total jobs), followed by health care and social assistance (12.4%). The average wage in service-related occupations is \$31,093 per year, but it is also highly diverse. Some service-related occupations pay high wages (e.g., \$42,275 for financial services); some pay medium wages (e.g., \$38,698 for educational and health services); and some are low-paying (e.g., \$14,566 for leisure and hospitality services).

The non-services component of Missoula County's economy consisted of 12.7 percent of total jobs in 2008. Farm (including ranch) employment accounts for less than one percent of total jobs, while jobs in construction constitute seven percent of total jobs. Manufacturing, which includes lumber and wood products manufacturing, constituted 3.6 percent of total jobs in 2008. The average wage in non-service-related occupations is relatively high, at \$42,316 per year.⁵

Government employment constitutes 14.3 percent of total employment in Missoula County. Average annual wages in government are relatively high, at \$45,213, with the highest in federal government (\$63,259).

Employment by Industry, 2001-2008

	2001	2008	Change 2001-2008
Total Employment (number of jobs)	68,068	78,700	10,632
Non-services related	8,823	10,007	1,184
Farm	691	669	-22
Forestry, fishing, & related activities	646	802	156
Mining (including fossil fuels)	63	169	106
Construction	4,346	5,514	1,168
Manufacturing	3,077	2,853	-224
Services related	49,514	58,284	8,770
Utilities	166	182	16
Wholesale trade	2,330	2,344	14
Retail trade	9,160	10,387	1,227
Transportation and warehousing	2,709	2,459	-250
Information	1,688	1,438	-250
Finance and insurance	2,468	2,738	270
Real estate and rental and leasing	2,393	4,075	1,682
Professional and technical services	4,051	5,111	1,060
Management of companies and enterprises	343	313	-30
Administrative and waste services	3,116	4,406	1,290
Educational services	735	1,017	282
Health care and social assistance	8,655	9,788	1,133
Arts, entertainment, and recreation	1,967	2,839	872
Accommodation and food services	5,441	6,505	1,064
Other services, except public administration	4,292	4,682	390
Government	9,731	10,409	678

Percent of Total

	% Change 2001-2008		
Total Employment			15.6%
Non-services related	13.0%	12.7%	13.4%
Farm	1.0%	0.9%	-3.2%
Forestry, fishing, & related activities	0.9%	1.0%	24.1%
Mining (including fossil fuels)	0.1%	0.2%	168.3%
Construction	6.4%	7.0%	26.9%
Manufacturing	4.5%	3.6%	-7.3%
Services related	72.7%	74.1%	17.7%
Utilities	0.2%	0.2%	9.6%
Wholesale trade	3.4%	3.0%	0.6%
Retail trade	13.5%	13.2%	13.4%
Transportation and warehousing	4.0%	3.1%	-9.2%
Information	2.5%	1.8%	-14.8%
Finance and insurance	3.6%	3.5%	10.9%
Real estate and rental and leasing	3.5%	5.2%	70.3%
Professional and technical services	6.0%	6.5%	26.2%
Management of companies and enterprises	0.5%	0.4%	-8.7%
Administrative and waste services	4.6%	5.6%	41.4%
Educational services	1.1%	1.3%	38.4%
Health care and social assistance	12.7%	12.4%	13.1%
Arts, entertainment, and recreation	2.9%	3.6%	44.3%
Accommodation and food services	8.0%	8.3%	19.6%
Other services, except public administration	6.3%	5.9%	9.1%
Government	14.3%	13.2%	7.0%

All employment data are reported by place of work.

While some sectors of the economy are relatively small in terms of employment, their economic contribution can still be significant. An example is agriculture. While farm employment represents less than one percent of total jobs in the county, farmland produces a number of benefits for society. These include open space and scenic vistas, wildlife habitat, a sense of pride in the state's agricultural heritage, a desirable lifestyle and increasingly, a source for healthy, low-impact locally produced foods.

Reasons for Growth and Impacts of the Recession

1990s and Early 2000s:

There are a number of reasons why Missoula County grew in the last few decades. The county is relatively diverse, with the University of Montana, a number of industries, non-profit organizations, research institutions, and state and federal agencies. Some of the largest employers in the county include the University of Montana, Community Medical Center, St. Patrick's Hospital, DirecTV, WalMart, and federal agencies, such as the U.S. Forest Service.⁶ Although there are eight establishments that employ more than 1,000 people, the county's economy is comprised primarily of small businesses. In 2008 (the latest data available), there were 37,318 establishments in the county, with more than 90 percent employing fewer than 20 people.⁷

According to Missoula economist Larry Swanson, the one of the reasons for the rapid growth of the Missoula area is because "the economy is less 'natural resource based' and more and more 'human resource based.'" A report of a 2004 *Missoula On the Move* economic development forum concluded that:

1. People are flocking to the mountains and forested parts of western Montana;
2. The livability of cities, their infrastructure, culture and environmental amenities play a critical role in drawing people and creating economic opportunities;
3. Resource commodities (mining, agriculture, and timber) are declining while human resources services (healthcare, business services, and finance, for example) are increasing;
4. Recent technological advances in information technology and communication infrastructure make it possible for people who are influenced by business, personal, educational, and recreational amenities, to move to cities like Missoula.

According to Larry Swanson,

People create economic opportunities and people are drawn to beautiful natural settings and highly livable communities; making the area's quality environment one of the region's key economic assets. Protecting and enhancing Missoula's environmental amenities is essential for sustained economic growth.⁸

As we will see in subsequent sections of this report, one of the consequences of "amenity-migration" into Missoula County is rapid home development outside of city limits, much of it in the fire-prone "wildland-urban interface."

The Importance of Air Travel

While environmental, recreational and cultural amenities are an important determinant of growth, these quality of life variables are by themselves not sufficient to ensure economic prosperity. For many occupations, in particular those seemingly "footloose" workers like engineers, architects and software developers that may choose where to live at least in part for quality of life reasons, it is also important to be able to travel outside the area to visit with clients, suppliers, and colleagues. Counties in the West that are growing the fastest are those that have a combination of high quality of life, easy access to daily commercial

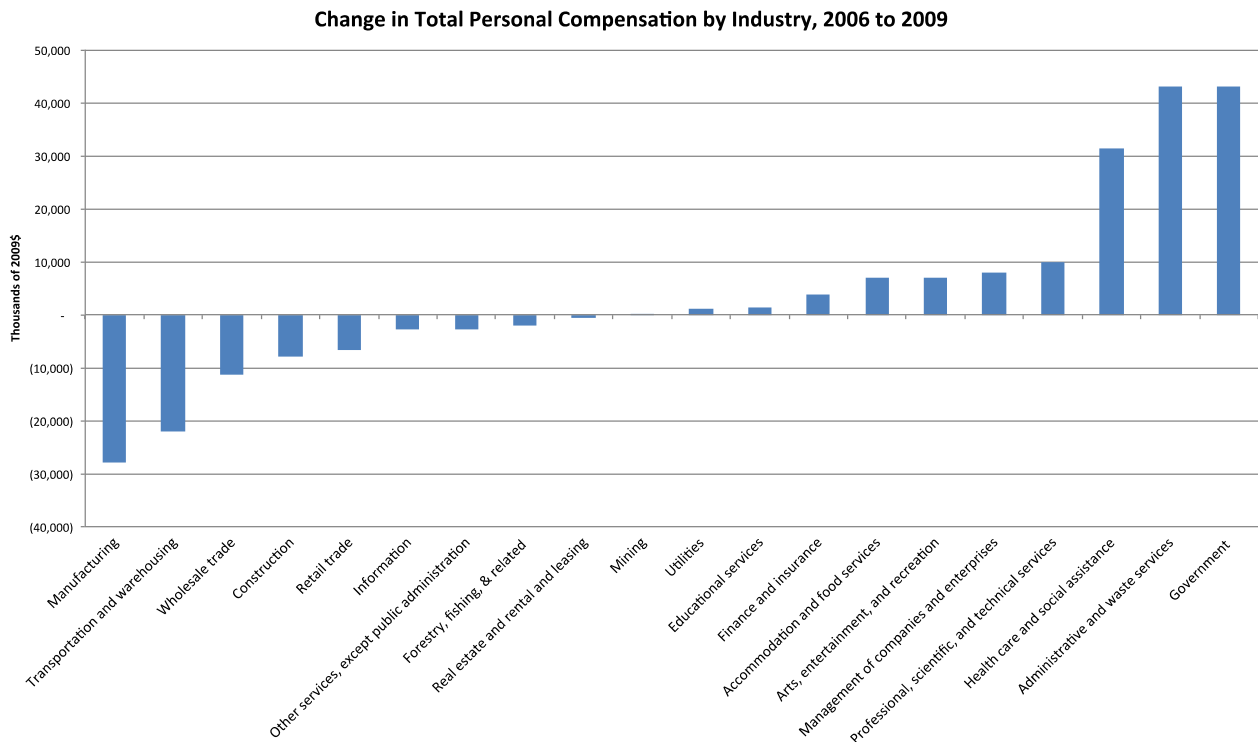
flights, and an educated workforce.⁹ Missoula County has all of these, and its airport is busy and growing (from 2000 to 2009, annual boardings at the Missoula International Airport grew by 22%—from 230,065 to 281,428 “enplanements” per year).¹⁰

Declines During the Recession

One way to measure what occurred during the recession is to plot the change in employee compensation by industry before the recession (2006) and during the recession (2007-2009; the recession officially began in December of 2007 and officially ended in June of 2009, although for some, its effects still linger).¹¹

Among the Missoula County industries that declined from 2006 to 2009 were manufacturing, transportation and warehousing, wholesale trade, and construction. Hardest hit among them was manufacturing, which includes lumber and wood products and paper manufacturing. Losses in the timber industry, with the closure of a plywood plant, a sawmill, and a pulp mill, accounted for almost all of the losses in manufacturing, despite the fact that some manufacturing sectors, such as chemical manufacturing and furniture manufacturing, continued to grow throughout the recession.¹²

A number of sectors continued to grow throughout the recession in Missoula County, led by government employment, administrative and waste services, health care and social assistance, and professional, scientific, and technical services, among others.



Prospects for Future Growth: Recovering from the Loss of Timber Jobs?

Whether Missoula County is poised for growth or not depends in large part on who is asked. According to the on-line version of *Big Sky Business*, the economy will grow despite the loss of three major timber industry employers:

The recession has been long and hard for Missoula because cyclic job losses have been exacerbated by permanent closures and shutdowns. Missoula is the only major Montana city to experience three straight years of economic declines. The downward spiral began with the shutdown of the Bonner plywood plant in 2007 and was followed by the Bonner sawmill closure in 2008. The final shoe to drop was the closing of the Smurfit-Stone pulp mill in early 2010. Growth is projected to turn to the positive in 2011 for Missoula County, after a one percent decline in 2010. The Missoula economy is projected to grow 1.7 percent in 2011, 2.1 percent in 2012, and 2 percent in 2013.¹³

Patrick Barkley, director of the University of Montana's Bureau of Business and Economic Research, was also cautiously optimistic, as quoted recently:

As you can see from some of the real estate development downtown, there's growth potential in Missoula and we're reasonably optimistic about Missoula. We don't think Missoula is going to pace the state in terms of growth, but we see steady improvement in Missoula with caveats. The challenges the University is facing with state funding is an important caveat to that.¹⁴

Missoula Mayor Jon Engen, responding to a negative report by Moody's Investor Service that predicted a double dip recession for the Missoula area because of its loss of timber-related employers, said:

It [the Moody report] says the timber industry in Missoula will be affected by slow housing starts. To me, that's a 30-year-old headline. I think as a community we have slowly and painfully—and in some cases, regrettably—had to acknowledge the timber industry in Montana, and in particular, western Montana, will never be what it once was. How do we respond? The answer of the last 30 years is we retooled, rethought and added value to what we do. Some economists would argue with me, but we've diversified what we do—especially in Missoula. We have a thriving university, a thriving medical community, we have high-quality health care and we have high quality of life here, which is an asset you can't buy and only grows in value.¹⁵

This prediction is reflected in some recent employment numbers. In 2009 and 2010, the sectors in Missoula County that grew were few, but included:

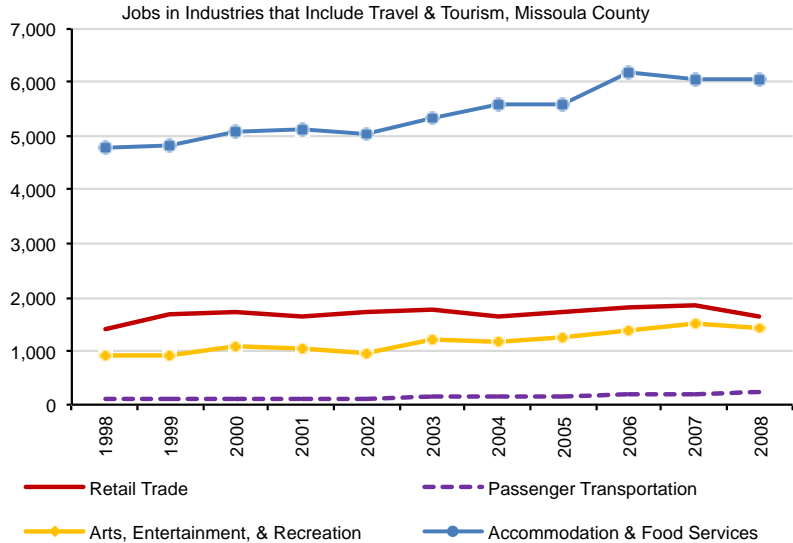
- Professional and Business Services (6.8% increase in jobs during 2009; 6.7% increase in jobs between the 3rd quarter of 2009 and the 3rd quarter of 2010);
- Health Care (5.2% job growth in 2009; 2.1% increase in jobs between the 3rd quarter of 2009 and the 3rd quarter of 2010); and
- Educational Services (1.6% job growth in 2009; 6.7% increase in jobs between the 3rd quarter of 2009 and the 3rd quarter of 2010).

While total employment in Missoula County during 2009 declined by 2.1 percent, growth picked up in 2010, although modestly. From the 3rd quarter of 2009 to the 3rd quarter of 2010, employment the county grew by 0.4 percent. There was even growth in the wood products industry of 4 percent during this time, despite a 28 percent decline during 2009.¹⁶

Travel and Tourism and Quality of Life

Another element of Missoula County's economy is the growth in sectors that are closely related to travel and tourism. These include parts of the following sectors: accommodation and food service; retail trade; arts, entertainment and recreation; and passenger transportation.

Together these sectors represented approximately 19 percent of total private sector jobs in 2008. The majority consists of accommodation and food service, which from 1998 to 2008 to grew by 26 percent.¹⁷

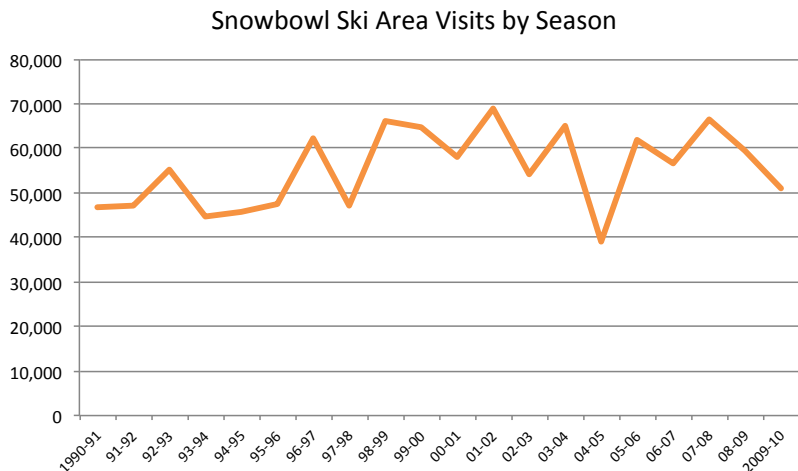


These sectors are important for a number of reasons. They service visitors to the area and therefore help to capture visitor expenditures in the local economy. According to the University of Montana's Institute for Travel and Recreation Research in 2006, visitors to Missoula County spent close to \$317 million on items like gas, restaurants, hotels, and retail stores. By 2010, this number had dropped to a little less than \$230 million, reflecting the impact of the recession.¹⁸

The health of travel and tourism sectors is also important to residents and new migrants because they constitute part of the region's quality of life. When these sectors of the economy are doing well, it is an indication that the amenities of the area, like skiing and fishing, are thriving.

Skiing

One component of the recreation economy that is important to visitors and especially to local residents is skiing. Skiing at Snowbowl, the local ski hill (12 miles northwest of Missoula), has increased steadily since the early 1990s, but has been irregular, reflecting the erratic nature of ski conditions and, more recently, a downturn in the national economy.¹⁹



A recent study showed that downhill skiing in the 2009–2010 winter season contributed \$83 million to Montana's economy. Expenditures by nonresident travelers contributed to more than 1,000 jobs and \$43 million in employee, property, and other property income.²⁰

Fishing

Fishing, in particular fly fishing, is also an important element of the local recreation economy, with four nearby well-known trout fishing destinations: the Clark Fork (which flows through the middle of town), the Bitterroot River to the south; Rock Creek to the southeast, and the Blackfoot River to the northeast.

There are a number of ways in which fishing is important to Missoula County. First, fish are the proverbial “canary in the coal mine”—indicators of the health of the region’s waterways. Fishing is important culturally and part of Missoula’s identity, and contributes to the economy. According to one estimate, recreational fishing alone created 4,556 jobs and \$23.6 million in state and local taxes in Montana in 2006.²¹ A recent report for the Crown of the Continent Region, which includes Missoula County, measured the direct and indirect jobs in the fishing industry at 457 jobs, or just about 0.2 percent of 230,397 total jobs. By these measures, jobs in the fishing industry make up a small portion of the total economy.²²

Fish also have “non-market” values. John Duffield, a Missoula-based economist, has done extensive work estimating the value of the region’s fisheries to try and understand these very real but less tangible economic benefits. In a 1987 study for Fish, Wildlife & Parks it was estimated that the total economic value, in terms of willingness to pay, was a little more than two percent of total personal income in the state.²³ By comparison, direct employment in the state from fishing is less than one percent (0.7%) of all employment. In other words, the non-market values (values not normally observable because goods are not traded in a marketplace) outweighs the direct contributions in terms of jobs.

Other non-market valuation studies have put the willingness to pay for instream flows in the Bitterroot and Big Hole rivers (what people would be willing to pay to have conditions ideal for trout) at between \$110 to \$160 per person per day for residents and between \$200 and \$600 for non-residents.²⁴ If these values are extended to 2009 (using current angler days and values adjusted to today’s dollars), the willingness to pay for instream flows that benefit trout in these rivers range between \$25 and \$50 million.²⁵

Another important study attempted to value the fishery in the Upper Clark Fork amid lawsuits over historic metals mining and smelting at Butte and Anaconda that harmed the river and its trout. The damage assessment indicated the value of a total cleanup of the upper river is between \$160 and \$200 million (in 2010 dollars) to households in the region.²⁶

Non-market valuation studies show higher values than impact studies because they include values based both on actual expenditures (travel cost studies), and also on stated preferences (contingent valuation studies) that can include existence and/or bequest value—the value people place on a resource just to know that it exists, or that their children will be able to fish for native bull and cutthroat trout in rivers and streams in Missoula County in the future.²⁷

Another way in which fish show value is in “amenity migration.” While it is relatively easy to measure the number of fishing guides (direct employment), and the number of pints they purchase from the local brewpub (indirect employment of bartenders), it is harder to know how many software developers, stockbrokers, and retirees are in Missoula at least partially due to the fishing. Just under two thirds (60%) of all anglers on the Blackfoot River are residents of Montana (the statewide average is 70%)—an indication of how many residents are anglers who either stay because of the fishing, or move to the region because of the fishing.²⁸ A growing body of literature shows that public land amenities, including fishing, are associated with rapid economic and population growth.²⁹

These sectors—skiing and fishing—are just two examples to illustrate the importance of the natural environment to the Missoula County economy. There are no doubt a number of others, such as gardening, mountain biking, sightseeing, bird watching, etc. for which economic arguments could be made.

Retirement, Investments, and Non-Labor Sources of Income

Non-labor income is an increasingly important area of growth in Missoula County. Non-labor income consists of dividends, interest, and rent (money earned from investments), and transfer payments (includes government retirement and disability insurance benefits, medical payments such as mainly Medicare and Medicaid, income maintenance benefits, unemployment insurance benefits, etc.).

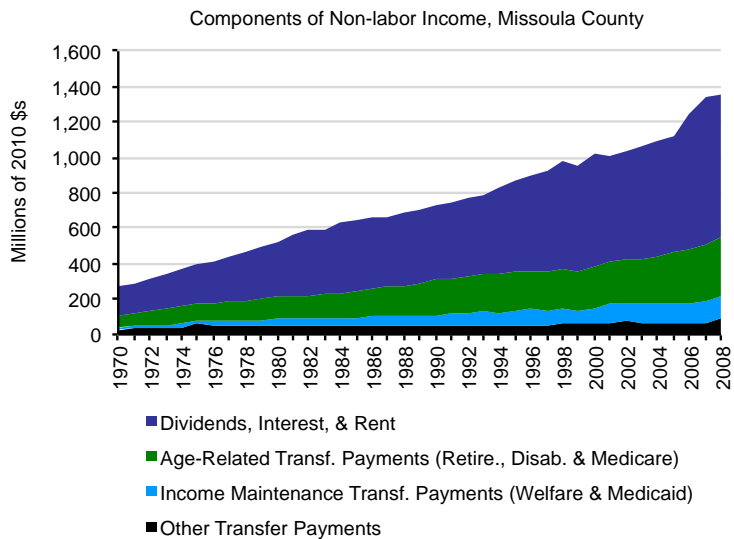
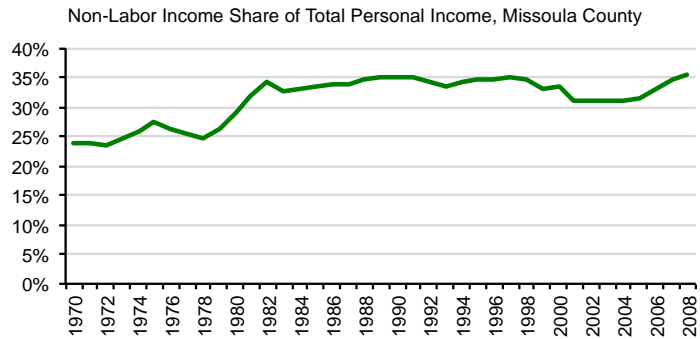
From 2000 to 2008 labor income grew by 21.6 percent, while non-labor income grew by 33.1 percent. By 2008, non-labor income sources represented 35.4 percent of total personal income (up from 29% in 1980).

The largest and fastest-growing components of non-labor income in Missoula County are money earned from investments (dividends, interest and rent), representing 59 percent of non-labor income in 2008. From 1970 to 2008, dividends, interest, and rent grew from \$168 million to \$801 million, an increase of 375 percent.³⁰ (Note: this source of income continued to grow during the recession, which started in December of 2007.)

The second largest source of non-labor income is from age-related payments, which constitutes 25 percent of total non-labor income. These payments consist of retirement and disability insurance benefits and Medicare. From 1970 to 2008, age-related transfer payments grew from \$62 million to \$339 million, an increase of 443 percent.

The non-labor measures presented here underestimate retirement income because private pensions and savings (e.g., 401Ks) are not included. Therefore, although more than 35 percent of total personal income in Missoula County is from non-labor sources, the true size of this income source is likely larger. In addition, the soon-to-retire baby boomers could push the percentage of non-labor income in Missoula County even higher. Nationwide, the 1990s saw the creation of \$33 trillion in new income—an unprecedented amount in U.S. history. By 2052, there will be a wealth transfer of \$40.6 trillion from baby boomers (including wealth inherited from their parents) to the younger generation. This in turn will stimulate other sectors of the economy, like construction, recreation and tourism, retail trade, and medical services.³¹

According to the Economic Research Service of the U.S. Department of Agriculture, baby boomers will be seeking places with a high quality of life, like Missoula County. The ERS found that from 1990 to 2000, the net migration of baby boomers was the highest in places that had the highest level of natural amenities:



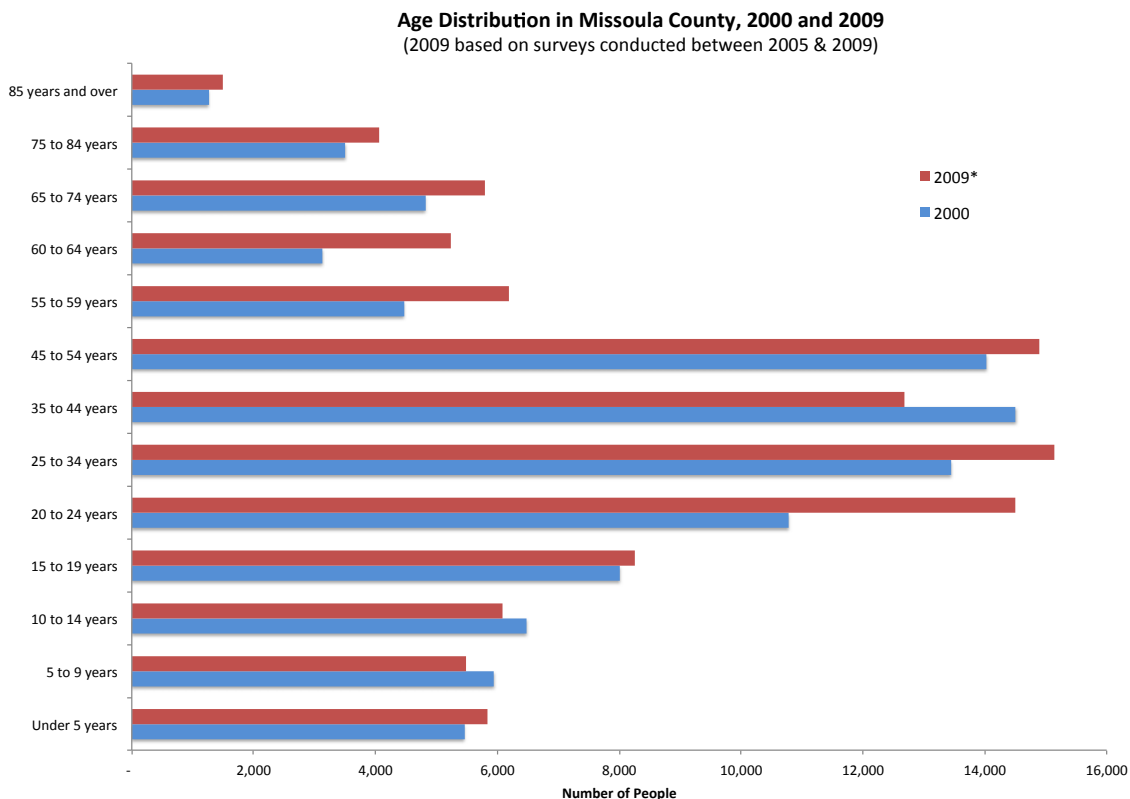
Whether adjacent to big cities or less accessible, counties with desirable physical attributes—pleasant climates, mountains, beaches, lakes—are likely to increase their already high share of baby boomer migration.³²

Demographer Bill Frey has noted that “baby boomer tsunami” will be different from the previous generation of retirees:

[It] is safe to predict that their consumer patterns, family choices and social and economic needs will differ sharply from senior proclivities of the past. After all, as this unique, postwar generation has plowed its way through the nation’s school systems, labor market, housing market and stock market, it has always broken the mold, determined to transform institutions, both public and private, in its path. Thus, there is no reason to expect that this generation will not shatter precedents with the same reckless abandon, as its members march, in large numbers, to senior-hood. This is especially the case when it comes to understanding how and where they will live; and their migration patterns — past, present and future, will be linked to their geographic spatial preferences and proclivities.³³

The Aging of the Population

The median age in Missoula County has not changed much, from 32.9 in 1990, to 35.3 in 2000, to 32.8 in 2009, reflecting in large part the presence of a university.³⁴ However, the age distribution shows that the aging of the baby boomers is occurring in Missoula County; from 2000 to 2009, people over the age of 45 represented 65 percent of all population growth. During the same time, some of the younger age classes shrank in size (for example, a loss of 847 people in the 5-14 year category, plus a loss of 1,822 in the 35-44 age category). One category that has grown significantly is the 20 to 24 college-age group, which grew by 3,724 people, which is consistent with increased college enrollment throughout the country that is due in part to the recession.



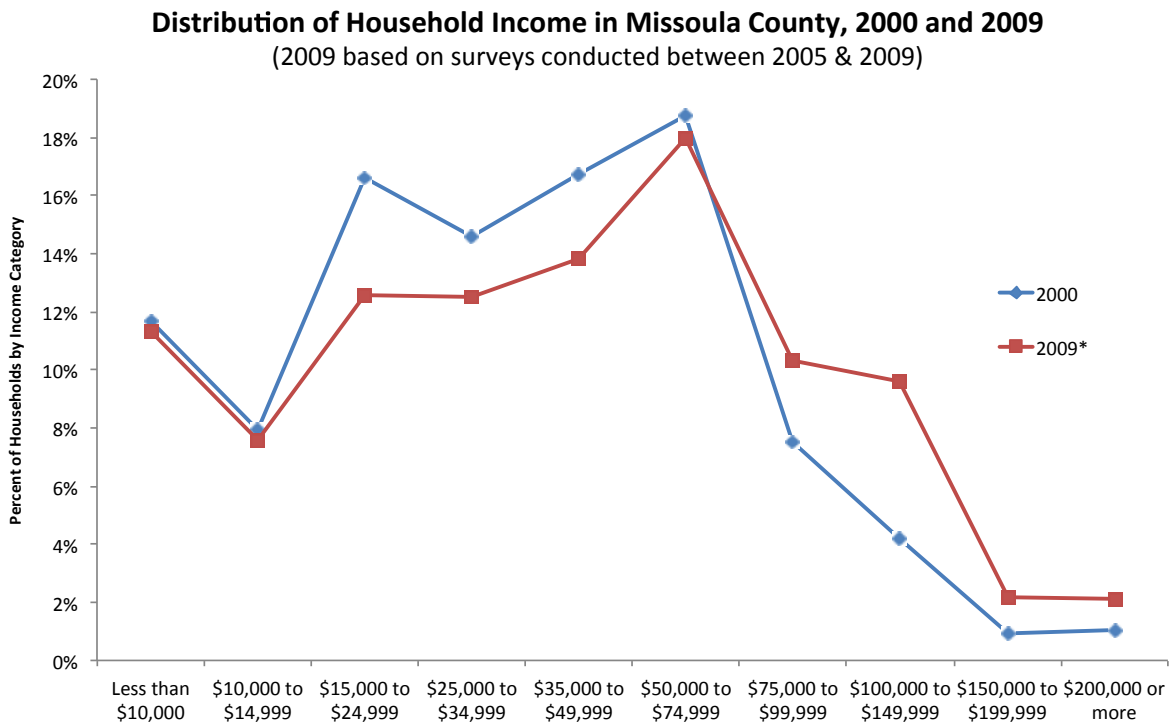
Education

One of the measures of an area's ability to grow economically and to adapt successfully to challenges like recessions is the education of the workforce. Missoula County is relatively educated, and has been getting more educated over time. In 2000, 9 percent had no high school degree. By 2009, this declined to 8 percent. In 2000, 32.8 percent of the population had a graduate degree or higher; by 2009 this increased to 37 percent. While in 2000, 22 percent had bachelor's degrees and 10.7 had graduate or professional degrees, by 2009, these numbers increased to 24 percent and 13.1 percent, respectively.³⁵

Income Distribution and Poverty

The median family income in Missoula County has not changed significantly, from \$56,081 in 2000 to \$56,267 in 2009 (both figures adjusted for inflation to 2009 dollars).

The distribution of household over time shows a shift towards increased wealth, with a decline in lower-level income categories (for example, the \$15,000 – \$24,999 category has declined) and an increase in higher-income categories (for example, the \$100,000 - \$149,999 category has increased).³⁶

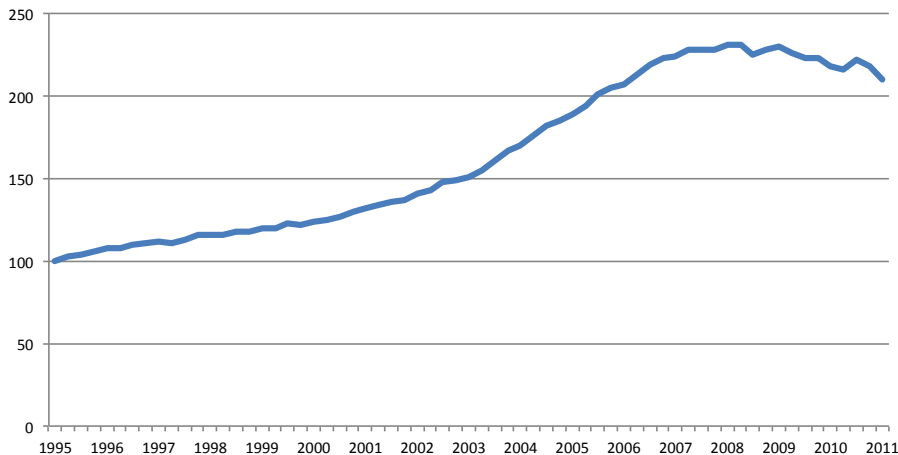


Poverty rates are increasing despite the growth in wealth. In 2000, 14.8 percent of individuals and 8.8 percent of households were below the poverty level. By 2009, 18.2 percent of individuals and 9.2 percent of families were below the poverty level.³⁷

Housing Trends and Affordability

As in the rest of the country, housing prices have dropped since the beginning of the recession, but Missoula County has fared better than most. From the first quarter of 2007 to the first quarter of 2011, the housing price index for Missoula County has declined by 6 percent. During that same time, the housing price index for Montana as a whole dropped by 31 percent, while for the U.S. it dropped by 20 percent.³⁸

**Housing Price Index (1995=100), Missoula County,
Montana 1st Q of 1995 to 1Q of 2011**



In spite of the recent decline in housing prices, housing has become more expensive relative to income. In 2000, 30.9 percent of households spent more than 30 percent of their income on their mortgage payments; by 2009, this had increased to 39 percent of households.³⁹

There is some evidence of recovery in the housing market. For example, the number of second homes in the region increased dramatically during the past decade. The high amenity values of northwest Montana, the rising number of relatively footloose retirees, the recent strong value of the Canadian dollar, and other factors combined to create dramatic increases in the second-home market from 2000-2010. While most of the growth in second homes occurred before the recent recession, researchers at the University of Montana estimate that more than 40 percent of the growth occurred in the last several years.⁴⁰

Such homes can have a large and uneven impact on communities across the region. While only one percent of homes within the City of Missoula are second residences, in Seeley Lake one out of every three homes is a vacation home—and 44 percent of homes in Condon are second residences.

Energy Resources

Energy resources in Missoula come from a number of providers. NorthWestern Energy provides gas and electricity to the city of Missoula, while the Missoula Electric Cooperative (MEC) supplies much of the power to the rural portions of the county. Northern Energy also sells some customers propane.

An example of the consequence of rising energy prices can be seen in the rural portions of the county. MEC receives its power via a contracted share of the Bonneville Power Administration's Tier 1 generating system. According to Mark Hayden, MEC's General Manager, the Tier 1 allocation will not be sufficient to meet 100 percent of the cooperative's needs through the end of its BPA contract, in 2028. If additional power is needed (perhaps after growth continues following a recovery from the recession), MEC will have to negotiate for additional power from BPA, through what is called Tier 2. Tier 2 power will be based on

market rates. If the county's energy use increases to the point where MEC needs to negotiate a Tier 2 rate, costs could rise 2 to 5 times compared to current rates.⁴¹ There is therefore a significant incentive for developing alternative sources and increasing efficiency.

A number of alternative energy sources are being developed in Missoula County, including a proposal for a biomass gasification plant on the university campus, solar panels on homes and business, small-scale wind turbines, and others. There are also a number of efforts underway to conserve energy and increase efficiency. The county's Greenhouse Gas Energy Conservation Plan is a guidance document that focuses on a number of efforts, including: recycling; increasing the efficiency of city operations; encouraging the building of energy-efficient homes and insulating existing ones; investing in renewable energy; and supporting local agriculture.⁴²

Vulnerable Populations and Health

Segments of the population that are more in need of assistance and special consideration are the very young, the old, and the poor. In Missoula County, 5.5 percent of the population are 5 years or younger, 10.7 percent are older than 65 years, and 18.2 percent of individuals live below the poverty level. For "families with a female householder, no husband present," 28.1 percent are below poverty; if the same type of household includes a child under 5 years of age, the poverty rate is 42.2 percent.⁴³

Other vulnerable populations include those with poor health and barriers to health care. Although Missoula County is ranked 4th in the state in terms of a combined health measure ranking, 10 percent of the county's population are estimated to be in poor or fair health, 20 percent are obese, 18 percent smoke, and 22 percent admit to excessive drinking. An estimated 23 percent of the population under age 65 have no health insurance.⁴⁴

Other measures of vulnerability include those that have no high school diploma (8%, or 5,200 people); are unemployed (6.5%, or 6,325 people); are severely work disabled (1.3%, or 1,402 people); and have major depression (6.6%, or 7,000 people).⁴⁵

Tribal Resources

The Confederated Salish and Kootenai Tribes include the Bitterroot Salish, Pend d'Oreille and Kootenai tribes. The Flathead Reservation is 1.3 million acres in northwest Montana, partially in Missoula County (5.6% of Missoula County consists of tribal lands). The tribal government provides a range of services, including tribal health, education, and housing, as well as fish and wildlife and environmental management.

The tribal government also has concerns about the impact of climate change on tribal resources and people. For example, the American Indian Alaska Native Climate Change Working Group recently hosted a workshop at the University of Montana entitled "Climate Change, Indigenous Peoples and Adaptation." The purpose of the symposium was to "introduce and discuss the issues of climate change and the impacts, both potential and real, affecting indigenous peoples in the northern hemisphere including the United States, Canada, and Norway. The symposium explored the issues of adaptation from Native American cultural perspectives."⁴⁶ While it is beyond the scope of this report to address specific tribal resources and concerns related to climate change, it is clear that there is a wealth of knowledge and experience within the tribes that can be helpful to the all residents of Missoula County

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The next section discusses the above economic and demographic indicators in the context of vulnerability to climate change.

Discussion: Potential Vulnerabilities to Climate Change

The Stern Review, a well-respected analysis of the economics of climate change, concluded with this sober assessment:

The scientific evidence is overwhelming: climate change is a serious global threat, and it demands an urgent response. Climate change will affect the basic elements of life for people around the world—access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms.⁴⁷

Discussions of some of the ways the people and economy of Missoula County may be vulnerable to climate change are presented below. The purpose of the discussion is to generate ideas for the June workshop, to highlight areas where additional research or discussion is needed, and to develop ideas for how to adapt to climate change.

The economy:

Missoula County's economy has evolved significantly, and currently there is not much dependence on the traditional resource extraction sectors of the economy, such as timber. Rather, the Missoula area can be characterized as an economy that is diverse and dominated by small businesses and with a population that is growing, a majority of it from in-migration. Much of the draw, for people and their businesses, is the area's quality of life. This was made possible by the changing structure of the global economy and the development of modern telecommunications and transportation infrastructure that have allowed some people and their businesses to locate in relatively smaller cities in a rural setting. In addition, the "baby boomer tsunami" is also attracted to Missoula County because of its clean air, recreation opportunities, and healthy, outdoor lifestyle.

This has several implications in the context of a changing climate. Because much of the land in the county is public and forested (discussed in more detail in the next chapter), adaptation to climate change will hinge to a large extent on forest management practices. Protection of public lands, such as Wilderness lands that retain native plant species and biodiversity, may be necessary for a number of reasons, such as holding water at higher elevation for longer periods, thereby lessening the effects of late summer drought conditions. This form of public lands management is today entirely consistent with people's desire to be surrounded by pristine landscapes.

Missoula County is also fortunate to still have a timber industry. People who know how to work in the woods are going to be necessary under some climate change conditions. For example, if the trend continues to build homes in the wild-land urban interface (one of the by-products of "amenity-based" growth), then thinning of forest to reduce fuels in going to be increasingly important. This is especially the case if forest fires are more frequent or intense.

Agriculture is also an area where the economy has grown and evolved around it to the point where, from an employment perspective, it is a small contributor. However, agricultural lands have important economic values, ranging from an increased trend in community-supported agriculture (often referred to as CSAs) to the preservation of open space, scenic vistas and wildlife habitat. Increased late-summer drought conditions are going to be important to consider as this sector adapts to changing conditions.

Demographic shifts:

One of the most significant developments for Missoula County is the aging of the population and the attractiveness of the place to retirees, both existing residents newcomers seeking a high quality of life. The ability of the county to attract and retain an older population will depend to a large extent on access to health care and housing that is both affordable and of the right type. It is also possible that as it becomes warmer in some parts of the country (the southwest, for example) that counties like Missoula, with relatively milder summer weather, will attract “climate refugees,” including retiring baby boomers.

As the U.S. Department of Agriculture’s Rural Information Center notes: “Rural retirement is a booming business,” and the ability of Missoula County to attract and retain an older population will depend to a large extent on access to health services and affordable housing.⁴⁸

By this year, more than half of all homeowners in the U.S. will be over age 50, but few communities have the housing type needed to attract the baby boom generation of 75-80 million Americans. As this group retires, many will be moving to smaller, more-accessible, and retiree-friendly units. Seniors also are likely to move freestanding homes into attached housing structures, and from owning to renting.⁴⁹

In addition to housing stock, communities may be considering policy reforms such as promoting accessory dwelling units and policies that promote neighborhood nodes of development that place housing within walking distance of services such as health care, shopping, groceries, or public transit.

Air travel:

In any modern economy, the role of natural and recreational amenities in attracting (and retaining) people and their businesses is well known and documented. What is less well known is that while amenities are a necessary condition for economic prosperity, they are by themselves not enough. Also needed are an educated workforce and access to larger markets via daily commercial air service. In the future, climate change, potential legislation to stem CO2 emissions, and rising gas prices may have an impact on the airline industry and therefore the future growth of the economy.

The recession:

Like the rest of the nation, the recession significantly affected Missoula County. The impacts have been mixed. While population continued to grow, the unemployment rate shot up dramatically. And, while some sectors, like health care, continued to grow during the recession, others declined. The most dramatic of these was wood products manufacturing, which experienced significant declines with the closure of wood fiber and paper mills.

One of the challenges of climate adaptation will be to make sure that it does not disproportionately affect the elderly, the poor, the lesser educated, and any other relatively disadvantaged population.

In general, Missoula County is educated and getting older, and wealthier. At the same time, housing is becoming less affordable and the number of individuals and families below the poverty level is increasing.

Climate adaptation plans, such as efforts to set aside land for open space and conservation purposes, could run into opposition if there is perception that doing so would exacerbate economic problems or drive up housing prices.

Health and vulnerable populations:

A recent article in *Nursing Administration Quarterly* stated, “Climate change needs to be reframed as a public health issue.” The authors point out that “intense, longer lasting, and more frequent heat waves,” can “aggravate chronic health conditions such as cardiovascular, renal, and respiratory disease; diabetes; and nervous system disorders.” Other effects can include heat cramps, heat exhaustion, and heat stroke, “particularly in vulnerable populations.” In addition, increased ozone and poor air quality can lead to “reduced lung function and lung tissue damage, increased risk of asthma attacks, and aggravation of other lung diseases.”⁵⁰

A comprehensive literature review on the effects of climate change points to a number of health effects that come from warmer temperatures. These include increases in ambient concentrations of ozone and fine particulate matter and a longer pollen season, which could lead to a number of serious health effects such as asthma, lung cancer, cardiovascular disease, and low birth weight or prematurity in newborns.⁵¹

There are populations that are vulnerable that may be disproportionately affected by climate change. These include the poor, unemployed, and undereducated, as well as those with poor health, including the obese, smokers, and people with respiratory and other ailments. About one in four people in the county does not have health insurance.

A recent symposium at the University of Montana entitled “Climate Change, Indigenous Peoples and Adaptation” shows that tribes are one of the segments of the area’s population concerned about the effects of climate change and the need to adapt.⁵² Indigenous people are also potentially proportionately disadvantaged. The Missoula County website describes the situation as follows: “The largest minority population in Missoula County is American Indians,” and “[t]hey fare worse than the average Missoulian regarding income, education level, housing, and employment, and they have a higher than average rate of some chronic diseases associated with overweight, tobacco use and alcoholism.”⁵³

Another important growing component of Missoula County’s economy is related to an aging population and therefore the economy is relatively heavily reliant on investment and retirement-related income (today accounting for more than a third of total personal income in the county). With the baby boomers retiring, and with a well-developed regional health care sector and a high quality of life, the county is poised for the continued growth of an older population. If climate change brings with it warmer temperatures, more inversions, and poor air quality from increased forest fires, then this important part of the population could be affected in a number of ways. The elderly are more susceptible to respiratory ailments, and these could increase. And, economically, this important sector of the economy could be discouraged from retiring in the area if air quality decreases.

Until now, Missoula has been fortunate to have clean drinking water. As the following section explains, another possible effect of climate change is related to water. With a smaller snowpack, faster spring runoff, and drier and hotter summer conditions, there is the possibility that Missoula’s aquifer could reduce in size and become contaminated.

Quality of life:

The quality of life of an area, and measuring what constitutes an “amenity,” can be a complex subject. The travel and tourism sector of the economy is one area of the Missoula economy that represents at least a good portion of the region’s “quality of life.” The same amenities that attract tourists – clean air, free-flowing rivers, skiing, fishing, etc. – are those that attract new people and business, and keep many locals from leaving.

Two elements of the “amenity economy” are worth exploring in more detail because they are “snowpack dependent.” Some of the changes that are predicted to accompany climate change include a smaller snowpack, more rain-on-snow events, increased rainfall, floods and faster runoff in the spring, followed by warmer temperatures and drought condition in the summer.

Skiing:

Climate change may affect the skiing industry in a number of ways as a result of climate change. These include less snow; more unpredictable and unreliable snow patterns; wetter, denser snow and more rain-on-snow events; and changing avalanche conditions. There could also be more extreme events like landslides resulting from changing vegetation and a higher incidence of diseased forests and forest fires.

Management changes may include the need to use water to make artificial snow, resulting in increased need to create water transportation and storage facilities. Without these changes, ski seasons may start later and end sooner.

A recent report on the effect of climate change on the skiing and fishing industry in the Crown of the Continent region concluded:

Ski resorts in the Crown that attempt to adapt to rising temperatures and changing climate conditions will likely face higher operating costs. Some ski areas may be forced to “climb up the mountain,” pushing into higher alpine environments in search of consistently suitable snow conditions. Because of the close relationship between snow conditions and skier days, most ski areas will have to expand artificial snow making, which may require purchasing new snow making technology and adding water infrastructure and storage facilities.

Resorts already are looking at ways to diversify their recreational offerings. Many resorts now offer mountain biking, mountaineering, hiking, and events in the summer, and activities requiring less snow—such as snowshoeing, cross country skiing, and terrain parks—in the winter.

Another important economic contribution of downhill skiing, which is difficult to quantify but widely supported by published literature, is that it is part of the overall “quality of life” package that attracts and retains people (and their businesses) to the Crown region.

If winter recreation is an important draw for people who choose to live and work in mountain communities, at least in part because of the skiing opportunities, then there could be a ripple effect through other sectors of the economy. The most obvious concern is that poorer ski conditions will negatively affect the real estate market. But the complex economic linkages that this report reveals mean that fewer migrants, retirees, and second homebuyers—that is, less amenity migration—also will affect the finance, construction, retail, utility, transportation, and health care sectors.

Fishing:

A decline in the general quality of the regional fishery due to climate change can have a significant impact on the local angling industry. Three examples illustrate the impact on fishing under a “resource damage” scenario where the impacts of climate change are unmitigated, a “status quo” scenario that shows current trends, and a “resource protection” scenario that shows the potential of improving the unique fishing experience southwest Montana has to offer.⁵⁴

To the north, bull trout and kokanee salmon in Flathead Lake and the Flathead River are significantly depleted as a result of competition with mysis shrimp and lake trout predation in Flathead Lake.⁵⁵ As a

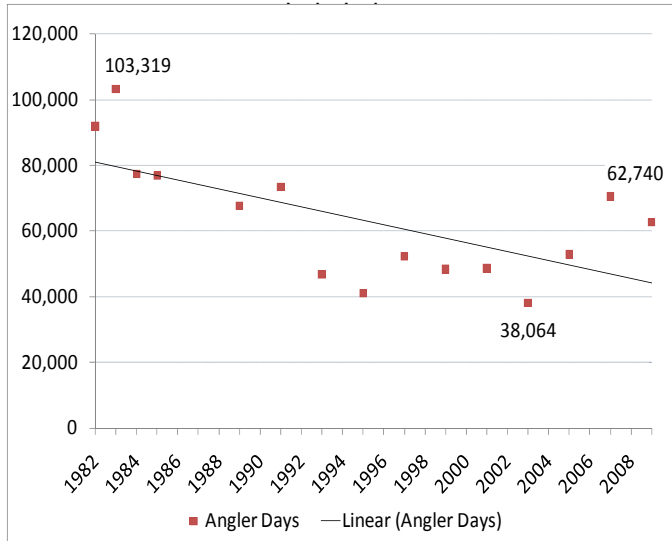
result, fishing in the region has declined precipitously over the last 25 years, from a high of over 100,000 angler days in 1983 to a low of only 38,000 in 2005. Although the proliferation of non-native lake trout in the Flathead drainage is not a result of climate change, this example illustrates the potential impact of non-native species (which is predicted to increase with climate change). More to the point, it illustrates what may happen if a quality fishing experience declines.

The Blackfoot River shows a more consistent, although volatile, trend in fishing pressure. The Blackfoot is legendary in fishing circles and receives heavy angling pressure. However, voluntary and mandatory fishing restrictions in 2000, 2001 and 2007 due to drought and high water temperatures caused angling pressure to fall in those years. In 1999, there were more than 22,000 angler days spent on the Blackfoot. Angler visits dropped to 13,000 angler days in 2001 and 2007 with fishing restrictions in place. In the intervening years, angler numbers had recovered to around 18,000 angler days annually, and were up to 23,000 again in 2009. Trends on the Blackfoot River are what may be considered the “status quo” with generally increasing fishing pressure that swings with annual variability in water, hatches, and the economy.

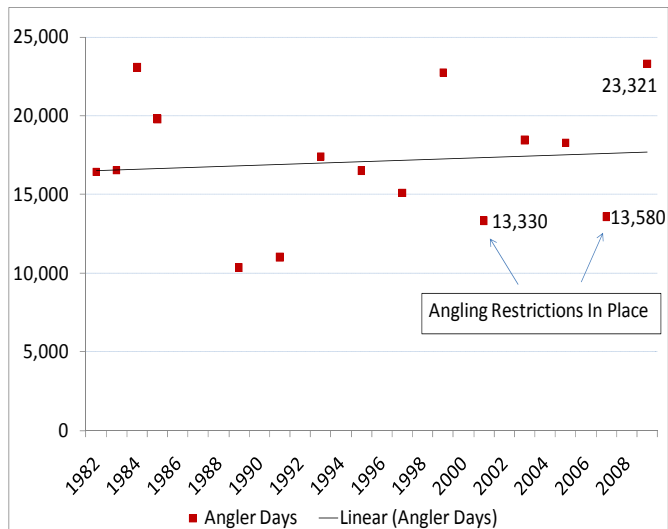
Perhaps more important to the fishing industry is the potential of restoring unique and special angling experiences. For example, as Flathead Lake suffered from a loss of native fish and lower angling effort, fishing on the South Fork of the Flathead River has more than doubled over the same period (from an average of 4,500 angler days annually in the 1980s to an average of 11,000 angler days annually in the 2000s). The South Fork is isolated from Flathead Lake by Hungry Horse Dam, and bull trout and cutthroat trout are still prolific. In fact, the South Fork Flathead is the only place in the state where anglers can legally target bull trout, and the increase in fishing pressure is largely due to the quality of the fishery and the unique experience it provides.

How will climate change affect fish and fish habitat? As a result of climate change, the

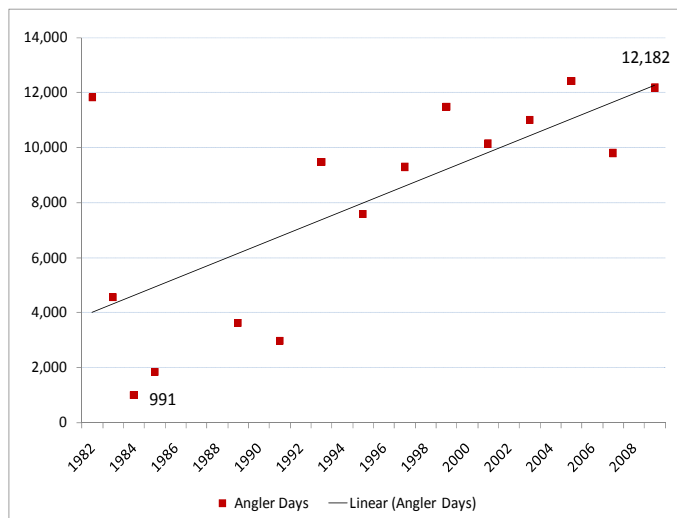
Angling Pressure on Flathead Lake



Angling Pressure on the Blackfoot River



Angling Pressure on the South Fork Flathead River



fishing industry may face a number of challenges that include restricted fishing seasons and seasonal closures and increased conflicts among irrigators, anglers, fishing guides, and municipalities over increasingly scarce water. There might also be degradation and loss of habitat due to warming water temperatures, post-fire sediment and debris flows, and increased frequency of extreme events such as floods and late summer drought. This could lead to smaller fish stocks and smaller fish, increased disease, displacement and cross-breeding of native trout with non-native species, and negative economic impacts on fishing guides, stores, restaurants, hotels, and other businesses that sell goods and services to anglers.

As one of the many indicators of quality of life—an important element of Missoula County’s economy—this example illustrates how climate change can have different effects on different parts of the county, with some areas healthier and more resilient, and others in need of restoration.

Energy Resources:

As mentioned above, one of the keys to Missoula’s economic success and its ability to attract high-wage occupations is its airport with daily connections to larger population centers and markets. In the future, the rising cost of energy may hamper future economic growth. For airlines, fuel now accounts for 30 percent of all costs, up from 13 percent in 2001.⁵⁶ Some communications technologies, such as video conferencing, are reducing the need for travel in some instances, and this technology will improve as gas prices increase and people look for ways to avoid travel. However, for many there will be no substitute for in-person communication, and the rising cost of air travel will have to be factored into the cost of doing business; it is unlikely cheap fares will return.

Roads are also important to the economy and Missoula County sits at the intersection of a number of important highways: Interstate 90, U.S. Route 12, U.S. Route 93, and Montana Highway 200. With rising gas prices, it will be more expensive to bring in supplies (food, for example), ship products, or travel for business or pleasure.

The threat of higher energy prices (for example, MEC having to negotiate a Tier 2 rate with BPA) and concerns over greenhouse gas emissions place a clear focus on the need for greater efficiency and reducing the demand for energy. These factors also place more emphasis on the need to consider alternative energy sources, such as wind, geothermal, solar, biodiesel, and biomass conversion.

One such effort is the city of Missoula’s Renewable Energy Certificate (REC) campaign. Customers can purchase the certificates, known as Green Tags, with 20 percent of the proceeds going towards the Greenhouse Gas and Energy Conservation Team, who in turn invest in local energy efficiency and renewable energy development.⁵⁷

Another effort underway is the proposal by the University of Montana to develop a effort of the University of Montana to develop development by the University of Montana of a \$16 million woody biomass gasification plant. However, this proposal is not without controversy. On the positive side, renewable resources, such as forest slash and beetle-killed trees, would fuel the plant. On the negative side of the debate, not everyone is convinced that biomass is a clean fuel as the process can result in significant emissions of pollutants. There is also no guarantee that the fuel source will be readily available, or that future harvesting of trees for this purpose will be supported by the public.⁵⁸

An efficient way to assess the vulnerability of Missoula County to climate change from the perspective of energy use, and to plan for adaptation, has already been accomplished via the county’s Greenhouse Gas Energy Conservation Plan. While intended only as guidance, the document clearly lays out ways in which the county can conserve energy to reduce greenhouse gas emissions. The document also details the history behind the county’s commitment (for example, via city council resolution) to energy efficiency and reducing greenhouse gases.⁵⁹

A number of energy efficiency measures can be a net benefit to the community. Homes that are more efficient save money. Alternative transportation, such as increased bike paths, passive cooling techniques, such as planting shade trees, and supporting local agriculture, are consistent with the county's reputation for a high quality of life.

Insurance:

The insurance industry is reeling from a string of natural disasters, from hurricanes in the Gulf of Mexico, tornados in the Midwest, and wildfires in the West, particularly Southern California and recently in Arizona. The industry is concerned that climate change will increase the intensity and frequency of these events that impose significant costs on the industry.⁶⁰ The result could be higher rates, more difficulty in securing insurance, and new conditions imposed on landowners in Missoula County due to industry changes nationwide, and from events specific to Missoula County. For example, in Montana some carriers require that homes in the wildland urban interface be “fire-wise” by using fire-resistant building materials, clearing trees and brush, and ensuring proper access and water for firefighting and evacuation.⁶¹

Standard homeowner insurance does not cover floods, and homeowners in federally designated floodplains are required to obtain flood insurance from the National Flood Insurance Program. The Federal Emergency Management Agency (FEMA) recently updated Missoula County's Flood Insurance Rate Maps—the first update since 1988. The maps identify flood risk and are used to establish flood insurance rates and by local government to update floodplain regulations.⁶² The update will affect homeowner and business insurance rates and potentially regulate new development in newly designated areas.

For example, Greg Robertson, public works director for Missoula County noted that since Hurricane Katrina, FEMA has assessed flood risks regardless of flood-control structures.⁶³ As a result, even though Missoula County completed a \$5 million flood control project on Grant Creek, nearby residents may still have to buy flood insurance. Residents of the area were permitted to build basements and septic tanks in an area that later flooded. They won a settlement with the City of Missoula, and the city subsequently undertook the \$5 million project to avert future flooding.

The new floodplain maps should reduce the future risk. However, in many rural areas no floodplains are designated on some streams, and homeowners may be at risk if flood events become more common and severe and they have no insurance. The county, which is responsible for floodplain regulation, may also be at risk if they permit development in areas that flood. According to FEMA, one fifth of all flood damage claims nationally occur outside designated floodplains.

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The following chapter explores the potential effects of climate change on the land, water, and air resources of Missoula County. The chapter begins with a description of conditions, and concludes with a discussion of potential vulnerabilities to climate change.

IV. RESOURCES: LAND, WATER, AIR, AND THE ENVIRONMENT

The first section of this chapter provides a general description of the land, water and air resources and some elements of the built environment, such as dams. A description of how these may be vulnerable to climate change is offered at the end of the chapter.

Land Ownership and Cover

Missoula County is 1,672,852 acres in size. Federal lands constitute 49.1 percent of the land (821,952 acres) and private lands another 35 percent. The remainder of the area is made up of state lands (9.2%), tribal lands (5.6%), water (0.6%) and city, county and other lands (0.2%).⁶⁴

More than half of the land in the county is managed by either the state or federal government.

The majority of the land base in Missoula County is forested (76%), followed by grassland (10%), and shrubland (9%). Cropland makes up 2 percent of the land base.

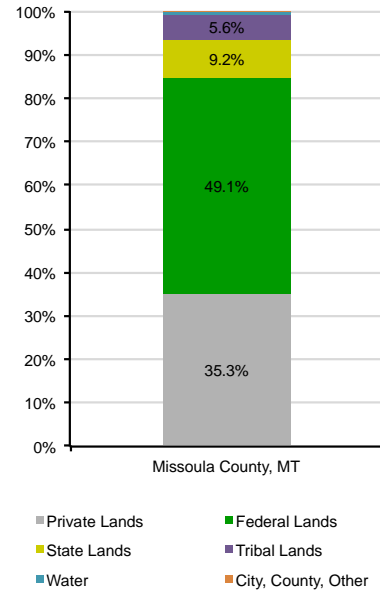
Land Ownership (Acres)

Missoula County,	
Total Area	1,672,852
Private Lands	590,741
Federal Lands	821,952
Forest Service	801,188
BLM	20,731
National Park Service	na
Military	34
Other Federal	na
State Lands	154,335
State Trust Lands*	105,935
Other State	48,400
Tribal Lands	93,794
Water	9,354
City, County, Other	2,675

Percent of Total

Private Lands	35.3%
Federal Lands	49.1%
Forest Service	47.9%
BLM	1.2%
National Park Service	na
Military	0.0%
Other Federal	na
State Lands	9.2%
State Trust Lands*	6.3%
Other State	2.9%
Tribal Lands	5.6%
Water	0.6%
City, County, Other	0.2%

Land Ownership, Percent of Land Area



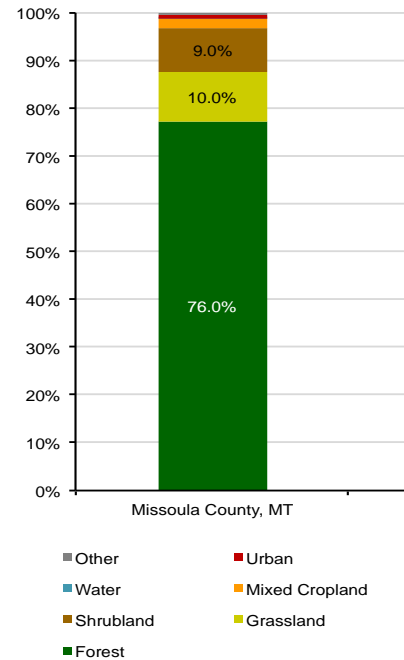
Land Cover (Acres), 2006

Missoula County, MT	
Total Area	1,673,703
Forest	1,272,015
Grassland	167,370
Shrubland	150,633
Mixed Cropland	33,474
Water	1,726
Urban	13,561
Other	4,192

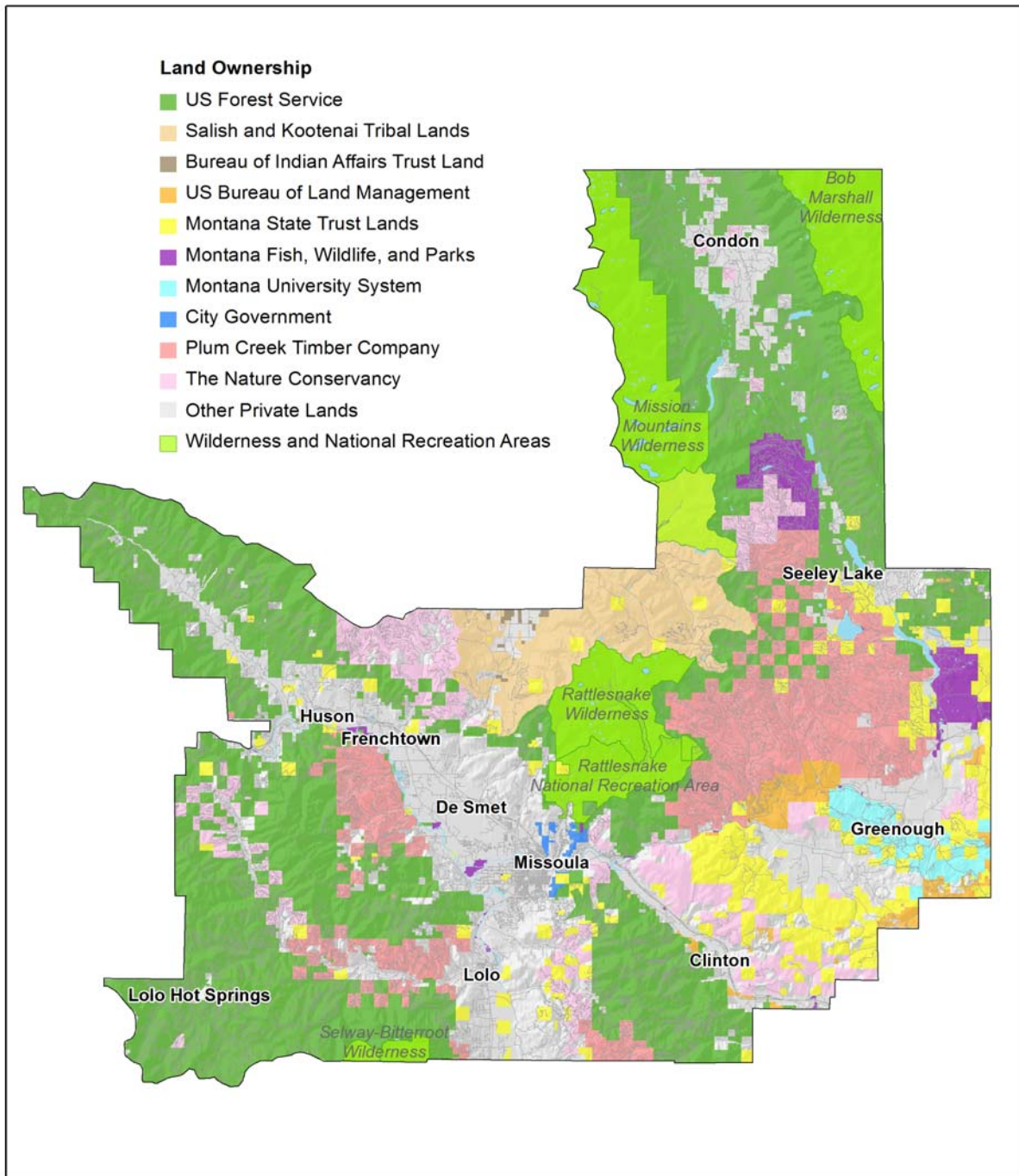
Percent of Total

Forest	76.0%
Grassland	10.0%
Shrubland	9.0%
Mixed Cropland	2.0%
Water	0.1%
Urban	0.8%
Other	0.3%

Land Cover, Percent of Land Area, 2006



Land Ownership in Missoula County, Montana



Water – the Aquifer

Surface and groundwater are very interconnected in the county: the Bitterroot, Blackfoot, and Clark Fork rivers charge the underground supply, just as the groundwater moves beneath the surface to recharge streams and rivers. For instance, in the cold and frozen winter months and the driest summer months when snowmelt is gone, groundwater helps to keep area streams and rivers flowing.

Water resources in Missoula County exist in two forms: surface water (rivers, streams, and lakes, which constitute 0.1% of the land base) and underground water, or aquifer. Most water comes from underground wells that are typically small, permit-exempt domestic wells in rural reaches, which are unregulated and unmonitored.⁶⁵ The City of Missoula has a water utility that provides drinking water from permitted groundwater wells. Until the early 1980s, all of urban Missoula's drinking water came from Rattlesnake Creek. However, after an outbreak of *Giardia*, Mountain Water Company switched to groundwater wells, which pump water from the aquifer.

Missoula is lucky enough to have a very deep aquifer, considered one of the purest natural sources of water in the country. According to the Missoula Valley Water District, the only source of water for residents of the Missoula Valley is the Missoula Valley Aquifer, and more than 40,000 households depend on it every day.⁶⁶

However, the aquifer is also a "sole source," meaning if it gets polluted, there is no way to clean it up (the backup water supply for the city is Rattlesnake Creek in case of an emergency, such as polluted groundwater). According to the Missoula Valley Water District, the soil is very porous and the aquifer is already being polluted by contaminants such as solvents, gasoline, mine waste, and nutrient and pharmaceutical pollution from septic tanks. Septic tanks are of particular concern given the pattern of residential development over the last decades into larger, exurban lots, and the exemptions many of these developments have under Montana law regarding the lack of regulation of septic systems.

The top of the aquifer, where wells are typically drilled and where septic systems exist, feeds into the area's river, springs and streams, which in turn feeds our fish and wildlife, farms and ranches. In certain areas where the groundwater is very shallow or near a stream, pumping a lot of water from underground wells may deplete the flows in that stream, or even draw down the groundwater level for neighboring wells.

There are 9,800 different ground water rights in the county,⁶⁷ and about 40 percent of the homes in the Missoula Valley are on a septic system.⁶⁸ According to a recent study by the Tri-State Water Quality Council, 157,000 people (52%) in the Clark Fork River Basin use septic systems. Studies on the impact of septic systems on the Missoula Valley Aquifer and from there into the Bitterroot and Clark Fork rivers estimate that the total load of nutrients (nitrogen and phosphorous) discharged by groundwater in the Missoula Valley is estimated to be at 40 percent of total maximum daily load (TMDL; a measure of the assimilative capacity).⁶⁹

Water – Surface Water, Dams, and the Floodplain

One of the challenges for any mountainous area is to store surface water. Missoula County has the following bodies of water that can serve this purpose: 361 lakes (123 named lakes, the rest are mostly in high mountain ranges) and 29 dams (many with reservoirs; some are diversion dams for agriculture).⁷⁰

The large number of people using water further complicates the management of surface water; there are 3,500 surface water rights (in addition to the 9,800 ground water rights mentioned in the previous section).⁷¹

Another challenge is whether dams are built to withstand possible added pressure from high water buildup in the winter and spring. According to staff at the Montana Department of Natural Resources and Conservation, the dams in the county can withstand the sort of pressure that would come with climate

change, such as increased rain-on snow events. A more important consideration in the context of climate change is the capacity of the spillways and whether dam managers can release pressure off the dams fast enough. On-stream dams with large downstream populations with under-built spillways would be a problem, but DNRC staff does not think those exist in Missoula County.⁷²

Smurfit Stone Lands

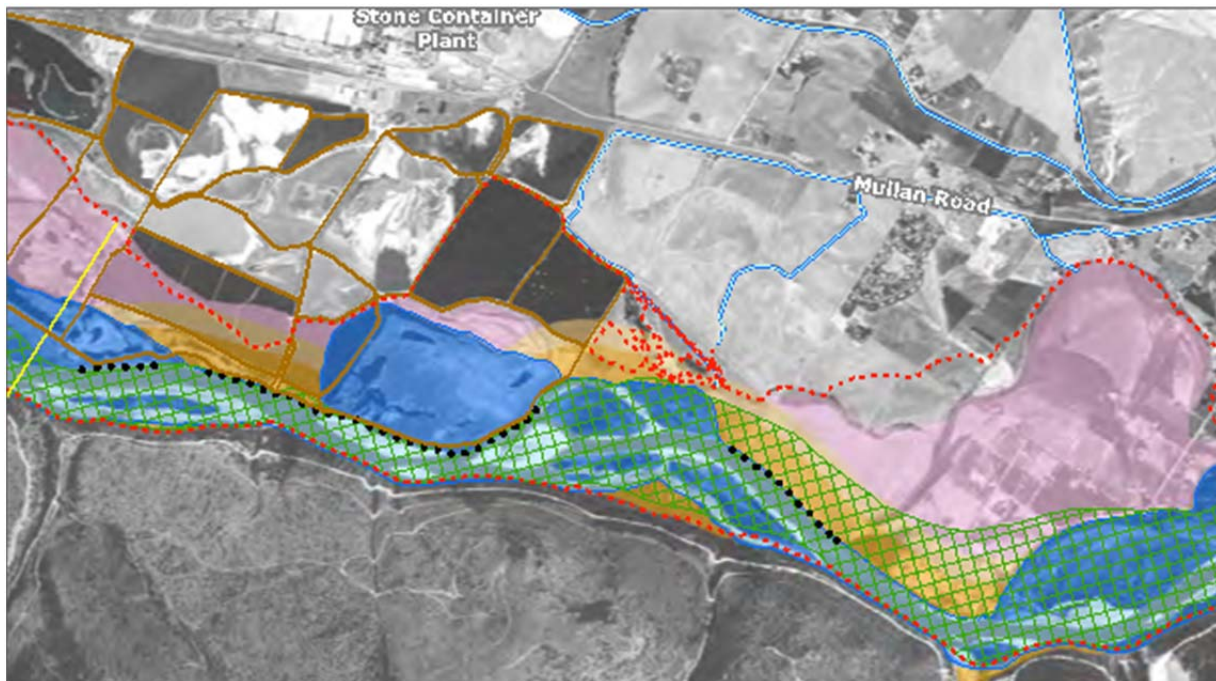
One issue facing Missoula County is the potential flooding of the former Smurfit Stone Container lands along the edge of the Clark Fork River.⁷³ The 100-year channel migration zone map shows the dynamic nature of the Clark Fork River, and highlights the diked settling ponds (in brown) that extend into the river's floodplain.

The Smurfit Stone pulp and paper mill closed in January of 2010 after operating for 53 years, leaving behind a number of ponds near the floodplain, whose contents are likely to be contaminated (the plant used a variety of petrochemicals, some that could have contained PCBs, as well as chlorine, which contains dioxins). Flooding of these ponds would lead to contaminated water washing downstream, which could have significant health and economic consequences, as well as impacts on fish and wildlife.

Recently the 3,200-acre Smurfit Stone lands were purchased by the Illinois-based Green Investments Group, Inc., which plans to develop the land. While future plans for the land are not clear, in the past this company has redeveloped similar lands for a number of different purposes, including residential, and light industrial purposes, including recycling and alternative energy production.⁷⁴

Clark Fork River Channel Migration Zone Showing Smurfit Stone Container Plant

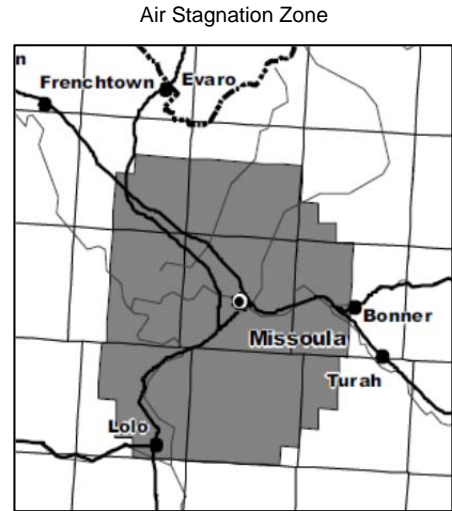
Smurfit Stone levees outlined in brown. Floodway = hashed green; historic migration zone = blue; 11-year erosion buffer = yellow; avulsion potential zone = pink.



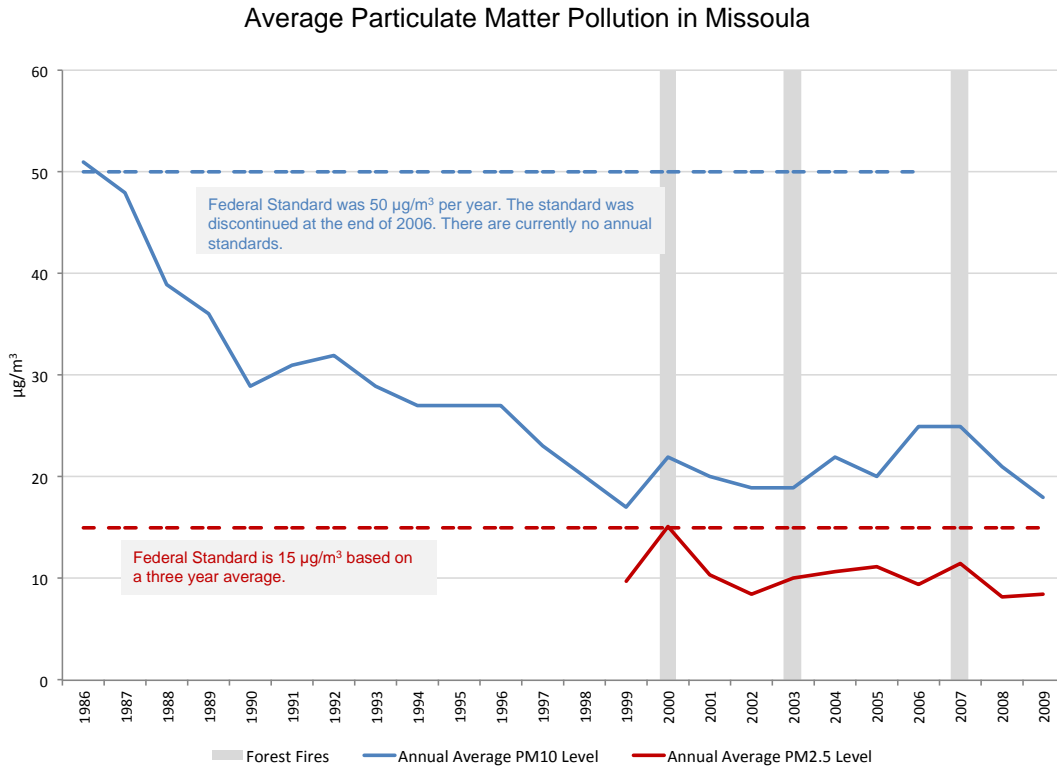
Air

Because of Missoula’s geographical location and industrial mix, air quality has been a concern for a number of years. Temperature inversions, particularly in winter, are common and can create an air stagnation effect throughout the valley.⁷⁵ Due to this stagnation effect, pollution from solid fuels burning devices (e.g., wood-burning stoves) can contribute to levels of particulate matter and carbon monoxide that are harmful to human health and potential violations of the Federal Standard for PM_{2.5} (particles smaller than 2.5 micrometers) in the Clean Air Act.⁷⁶

In response, the Missoula City-County Air Pollution Control Program was established to mitigate adverse health effects associated with pollution, ensure compliance with federal air quality standards, and generally maintain a high quality living environment.⁷⁷ As one of the chief sources of air pollution, regulations were created to curtail emissions from residential solid fuels burning, specifically from wood-burning stoves in an area referred to as the Air Stagnation Zone.

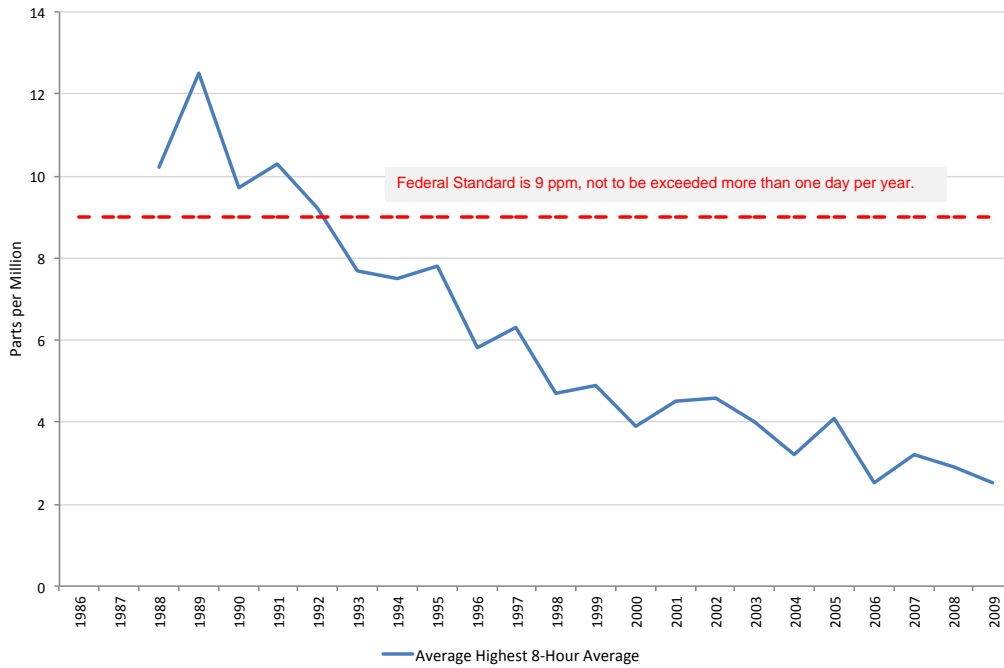


Air quality in the county has been improving. Both particulate matter and carbon monoxide have been falling consistently since measurements began; the same time burning regulations took effect.⁷⁸ As of 2009, the county had met all national air quality standards for carbon monoxide, nitrogen oxide, sulfur dioxide, ozone, lead and particulate matter.⁷⁹ (It is important to note that these standards were met within the limited area in the map depicted above and that there are parts of the county where air quality is still a concern and where there are few restrictions aimed at limiting emissions.)



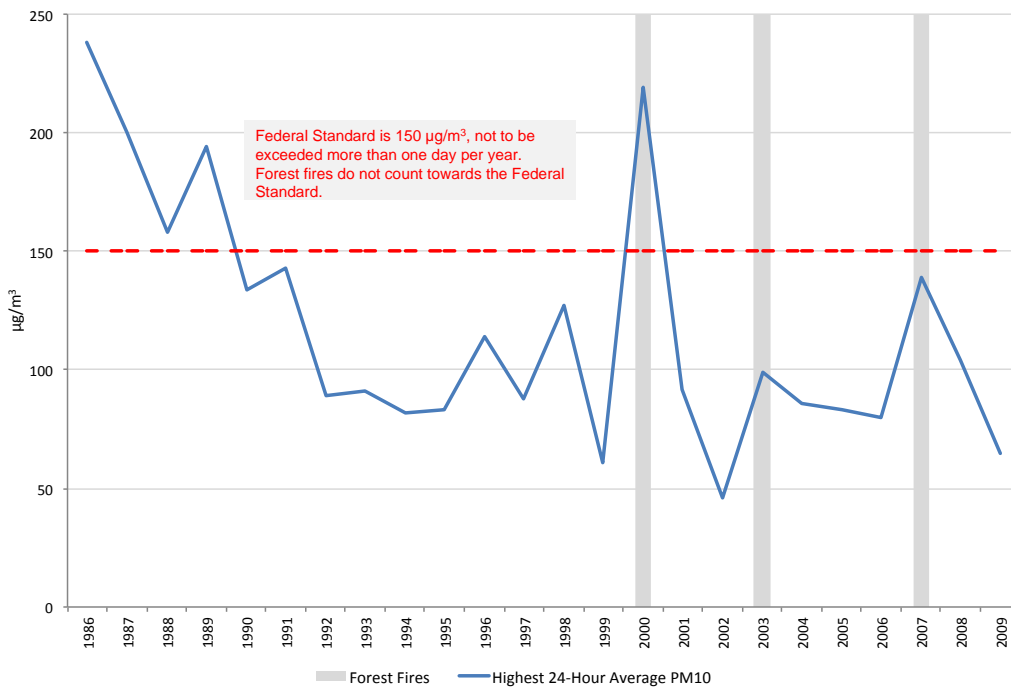
Note higher particulate matter for some years due to forest fires (shown in vertical gray bars).

Carbon Monoxide Levels, Highest 8-Hour Average for Missoula



Though the Missoula area has made tremendous progress toward improving their air quality, the region is still susceptible to external pollution sources, such as forest fires. As shown in the figure below (gray vertical bars), years with forest fires show a marked increase in 24-hour particulate pollution levels. According to the EPA, adverse health effects can start to manifest at 150 micrograms per cubic meter and can cause or exacerbate respiratory health problems including bronchitis, decreased lung functionality, or premature death.⁸⁰

Highest 24-Hour Average Particulate Matter Less than 10 Micrometers



Management of Federal Lands

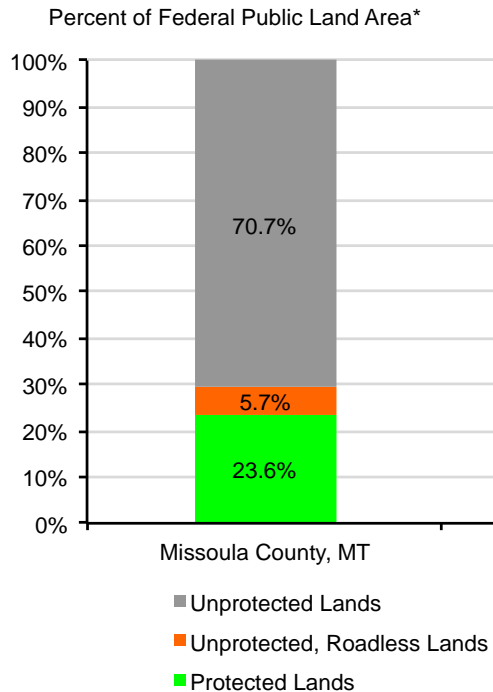
Federal lands constitute 43 percent of the land base. This land can be classified according to three general groups based on their degree of protection from resource development such as logging and mining. Of the federal lands in Missoula County, 23.6 percent are protected, while 70.7 percent do not have an official protection designation, such as Wilderness.⁸¹

Of the Forest Service land in the county, 143,745 acres (8.6% of the county land base) are Wilderness and 59,119 acres (3.5% of the land base) are in a National Recreation Area (NRA).

The protected lands in Missoula County include portions of the Bob Marshall Wilderness, Mission Mountain Wilderness, Selway-Bitterroot Wilderness, and the entirety of the Rattlesnake Wilderness and Rattlesnake National Recreation Area.

Relative Management Designations of Federal Lands (Acres)*

Missoula County, MT	
Total Area by Type of Federal Land	
Protected Lands	171,044
Unprotected, Roadless Lands	41,144
Unprotected Lands	513,224
Percent of Total	
Protected Lands	23.6%
Unprotected, Roadless Lands	5.7%
Unprotected Lands	70.7%



* Definitions:

Protected Lands are those that have restrictions against commercial development (e.g., logging, mining, energy development). Nationally, these include National Parks and Preserves (NPS), Wilderness (NPS, FWS, FS, BLM), National Conservation Areas (BLM), National Monuments (NPS, FS, BLM), National Recreation Areas (NPS, FS, BLM), National Wild and Scenic Rivers (NPS, FS, BLM), Waterfowl Production Areas (FWS), Wildlife Management Areas (FWS), Research Natural Areas (FS, BLM), Areas of Critical Environmental Concern (BLM), and National Wildlife Refuges (FWS).

Unprotected, Roadless Lands are lands generally not used for commercial development, but that have not yet received official designations as protected lands. They include Wilderness Study Areas (NPS, FWS, FS, BLM), and Inventoried Roadless Areas (FS).

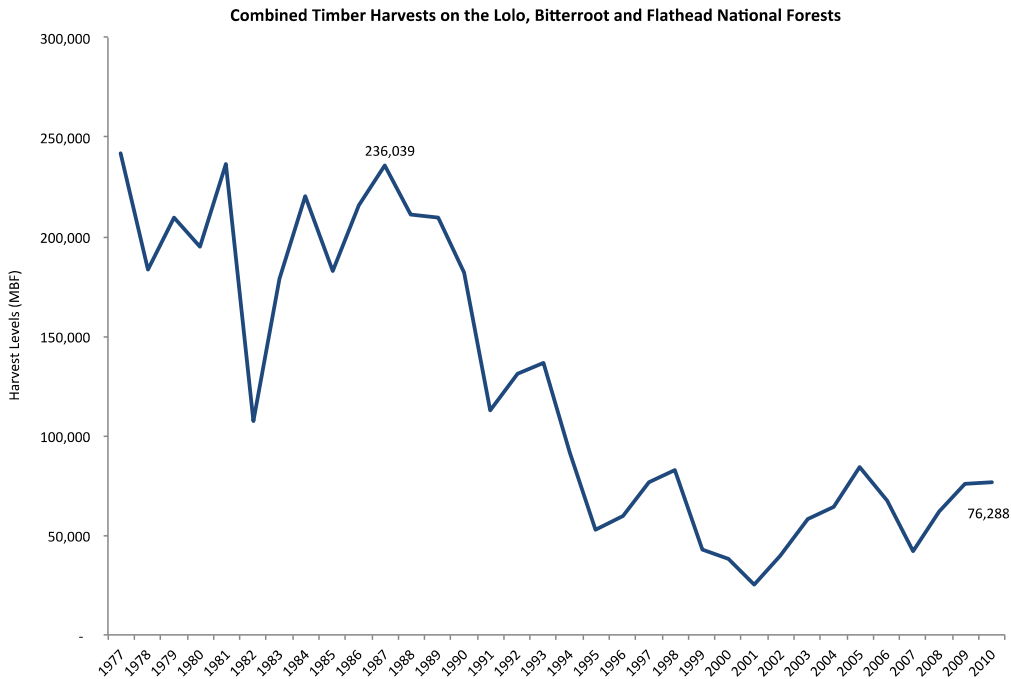
Unprotected Lands are lands that are more readily available for commercial activities (e.g., logging, mining) than protected lands. They include Public Domain Lands (BLM), O&C Lands (BLM), and National Forests and Grasslands (FS).

Abbreviations: NPS = National Park Service; FS = Forest Service; BLM = Bureau of Land Management; FWS = Fish and Wildlife

Timber Harvest Levels

Public timber land in Missoula County is managed by four agencies: the USDA Forest Service, Bureau of Land Management, Department of Natural Resources and Conservation, and the University of Montana's Lubrecht Experimental Forest.

An important source of lumber for local mills has been the national forests, and timber harvests on National Forest lands in the region have changed dramatically. The combined harvest volume on three of the region's national forests—the Lolo, Bitterroot and Flathead—declined from a high of more than 236 MMBF (million board feet) in 1987 to just a little over 76 MMBF in 2010. From 1977 to 1993 annual timber harvests on these National Forests averaged 188 MMBF. In contrast, from 1995 to 2010 the average annual timber harvest was 59 MMBF.⁸²



A recent report by the Bureau of Business and Economic Research (BBER) summarized the outlook for the timber industry as follows:

As a whole, Montana's forest industry faces a high degree of uncertainty in the near-term. The purchaser and fate of the Smurfit-Stone mill are still unknown. Attempts to locally develop a woody biomass energy industry are being hampered by a confusing and often contradictory mix of federal laws, incentives, and agency policies. Continued increases in domestic housing and foreign demand for lumber could benefit Montana's forest industry by improving markets for wood products, provided mills in the state can overcome the chronic shortage of available timber. Continued increases in activity on federal timber lands, however, are not expected, as most of the pipeline of shovel-ready projects was depleted with 2009 and 2010 stimulus activities and federal budget cuts expected. Despite these uncertainties, many in Montana's forest industry remain optimistic and eager to capitalize on new opportunities.⁸³

(Note: since BBER's report, the Smurfit Stone lands have been purchased for redevelopment by the Green Investment Group, who state they will eventually invest \$40 million on the project).⁸⁴

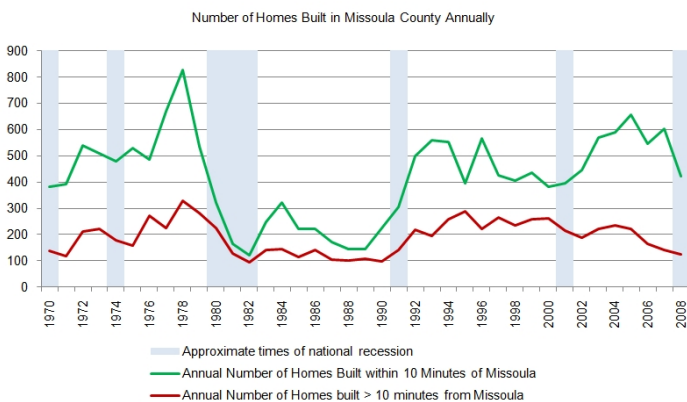
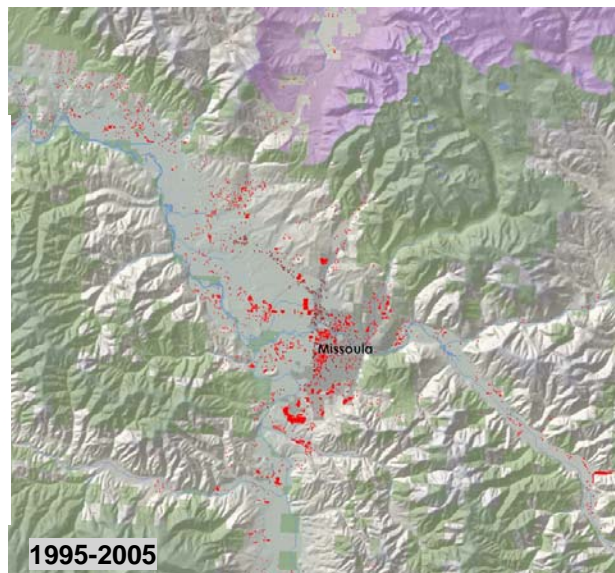
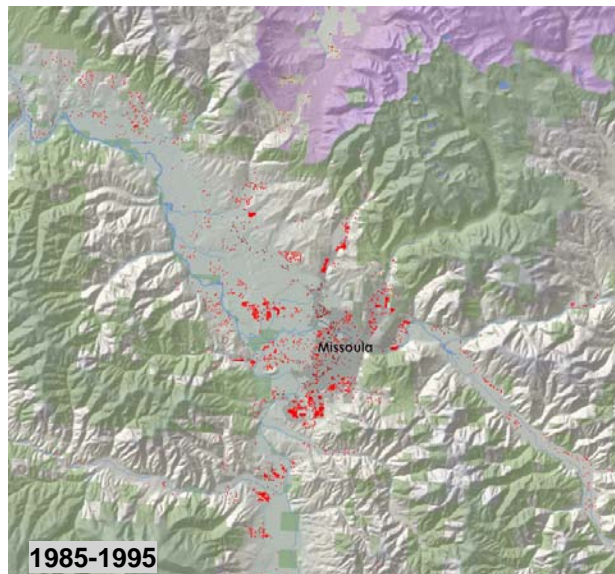
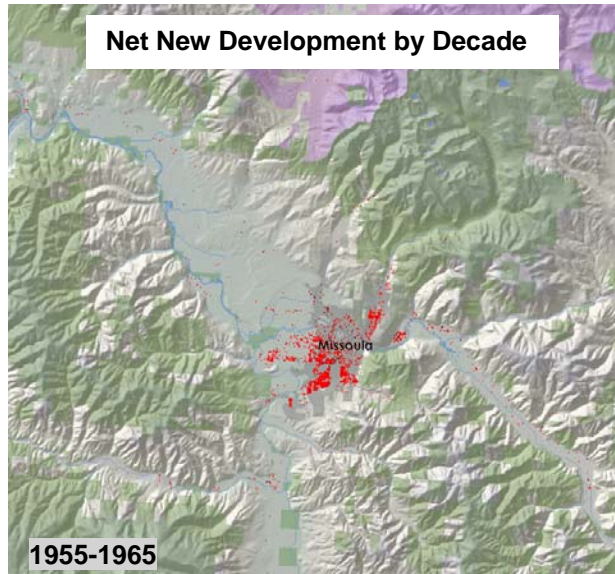
Residential Development

Over the decades, an increasing number of homes and other buildings have been built in the countryside and outside of town boundaries. According to tax assessor records, there were 36,548 homes in Missoula County in 2008, 37 percent of which were outside incorporated towns or census-designated places (Missoula, Orchard Homes, Lolo, East Missoula, Bonner-West, Riverside, Seeley Lake, Frenchtown, Clinton, Wye, and Evaro).

The percent of "out of town" (exurban) homes has increased substantially during the past several decades. In 1970, for example, only 16 percent of homes were outside incorporated towns or census designated places. During this same time period, the area of exurban development, defined as homes on 10 to 40 acre lots, more than tripled. The acreage of exurban homes increased from 22,880 in 1970 to 71,840 in 2008.⁸⁵

The figures to the right show examples of three periods of development, with net new homes developed during a time period represented with red dots. In the decade 1955-1965 most homes constructed in the valley were in and around the city of Missoula. By the late 1980s, new residences were built further and further away from the city—in exurban areas. This trend continued into the 1990s and the first half of the 2000s.

Recently, there has been discussion about whether the economic downturn of the late 2000s and higher gasoline costs may increasingly discourage out of town development and long commutes.⁸⁶ Historically in Missoula County, slowdowns in construction have coincided with the approximate timing of the most significant national recessions—in the early 1980s and today.⁸⁷



The Wildland-Urban Interface and Wildfire

One of the consequences of rapid exurban development is an increase in the number of homes that are in danger from forest fires.⁸⁸

Seventy six percent of the land base in Missoula is forested and homes are being built in fire-prone, wildland-urban interface (WUI). The WUI is defined here as private forestlands that are within 500 meters of public forestlands. We focus on adjacency to public forests since the Forest Service manages much of the forested land in the county and because wildfire is a natural disturbance in these forests, creating a potential risk to adjacent private lands.

By 2000, Missoula County had 385 square miles of land in the wildland-urban interface. Of that, 34 square miles (8.9% of the WUI) had homes. This means the remaining 91.1 percent, or 351 square miles, is potentially open for new development. In 2000, there were 41,454 homes in Missoula County, with 5,109 (12.3%) in the wildland-urban interface. About 12 percent (642 homes) were second homes.

The average home lot size in Missoula County in 2000 was 2.2 acres, with more than 92,000 acres developed with residences. The average lot size in the wildland-urban interface was 4.3 acres, more than twice the size of the average lot size outside of the WUI of 1.9 acres. The total number of residential acres in the wildland urban interface is more than 21,800 acres.

Development of homes on fire-prone lands is a challenge throughout the West. When Missoula County is ranked against other counties in the West in terms of existing risk (the number of acres of forested land where homes have already been built next to public lands), it ranks in the 93rd percentile. When ranked in terms of potential risk (the number of undeveloped WUI acres), Missoula County ranks in the 99th percentile compared to other western counties. In other words, the county has a lot of existing homes in the WUI that need to be defended against wildfire, and it also still has a lot of undeveloped land in the WUI that, if developed, would drive up the risk even further.

The Cost of Defending Homes from Wildfires and the Effect of Climate Change

Some recent fires help underscore the challenges of homes development near on fire-prone public lands. On behalf of the Montana State Legislature, Headwaters Economics (HE) conducted a detailed analysis of the costs of protecting homes from wildfire in the state of Montana.⁸⁹ HE analyzed daily fire suppression costs across 18 large fires that burned in Montana during 2006 and 2007, systematically distilling out the portion of total fire suppression costs directly associated with housing.

Wildland-Urban Interface (Square Miles), 2000

Missoula County, MT	
Total WUI Area	385
WUI Area with Homes	34
WUI Area without Homes	351

Percent of Total

WUI Area with Homes	8.9%
WUI Area without Homes	91.1%

Total Homes and WUI Homes, 2000

Missoula County, MT	
Total Number of Homes	41,454
WUI Homes	5,109
Second Homes in WUI	642

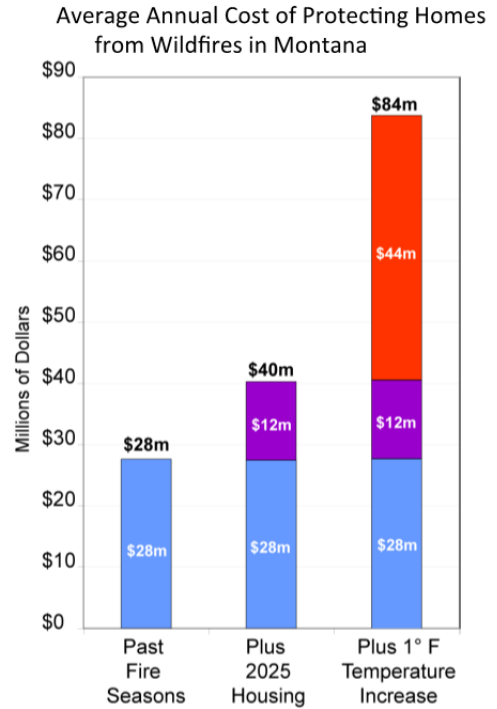
Percent of Total

WUI Homes as % of Total Homes	12.3%
Second Homes as % of WUI Homes	12.6%

Average Lot Sizes (Acres/Home), 2000

Missoula County, MT	
Average Lot Size	2.2
Total Number of Homes	41,454
Total Residential Acres	92,099
Average Lot Size in WUI	4.3
WUI Homes	5,109
WUI Residential Acres	21,880
Average Lot Size in Non-WUI	1.9
Non-WUI Homes	36,345
Non-WUI Residential Acres	70,219

The study discovered that the average annual cost of protecting homes from forest fires in Montana in recent years was \$28 million. If no restrictions are placed on future home construction in Montana, similar fire seasons to those experienced in recent years could cost an additional \$12 million by 2025, bringing the state’s total fire suppression costs associated with homes to \$40 million. If, in addition to increased housing in fire-prone areas, average spring and summer temperatures increased by one degree Fahrenheit, home protection costs in Montana would, on average, grow by another \$44 million. This means that with future home construction and warmer temperatures, the average cost of protecting homes in Montana could rise from \$28 million per year to \$84 million per year.



Two recent examples of wildfires near Missoula are the Black Cat and Jocko Lakes fires, which burned in 2007. The Black Cat fire cost a total of \$7.4 million. More than 11,400 acres of land within one mile of the fire were developed with homes and the cost of defending homes was \$4.4 million, or 59 percent of total firefighting costs. The Jocko Lakes fire cost \$26.8 million to fight. More than 2,800 acres within a mile of the fire were developed with homes, and the cost related to home protection was \$1.3 million, or 5 percent of total costs.

These two examples illustrate that fires vary greatly in their costs, and that the protection of homes can be a significant contributor to overall costs for some fires. For the study HE conducted for the Montana legislature, it was discovered that, on average, 30 percent of total firefighting costs are related to the defense of homes. This equaled, on average, a little less than \$8,000 per home within one mile of the fire, and \$1,240 per home within 6 miles of the fire.

Examples of Forest Fires Near Missoula in 2007



Fire Name	Total Cost	Number of days of firefighting	Average Daily Cost	Homes within 1 mi.	Developed acres within 1 mi.	Average daily costs related to homes within 1 mile	Percent of daily costs related to homes within 1 mile	Costs related to home protection
BLACK CAT	\$7,378,111	17	\$434,007	803	11476	\$256,056	59%	\$4,352,955
JOCKO LAKES	\$26,756,246	33	\$810,795	123	2895	\$39,222	5%	\$1,294,311

Phrased a little differently, defending homes from wildfire in Montana cost approximately \$664 per residential acre, and the average lot size in the wildland-urban interface in Montana is 12 acres. This is important because the pattern of development matters—not just how many homes the firefighters have to protect. In Missoula County, the pattern of development in the last few decades has been toward larger, exurban lots.

Insect Outbreaks and Forest Fires

A number of recent climatic conditions have resulted in a significant expansion of the mountain pine beetle, both northward, and into higher elevations. These conditions include higher minimum winter temperatures (prolonged low temperatures kill beetle larvae), reduced summer precipitation and higher summer temperatures.⁹⁰

Widespread tree mortality caused by forest insect outbreaks may elevate future fire-suppression costs. Will insect outbreaks like these lead to more frequent fires and higher fire suppression costs? The answer is not simple, especially because of the relatively recent outbreak of beetles and the difficulty of conducting experiments on forest fire behavior.

One theory holds that as needles dry out but remain on the trees, the trees become highly susceptible to crown fires. Eventually, as dead trees lose their needles, crown fires can be less likely. Beetle-killed trees eventually will fall to the forest floor, adding fuels that may increase the probability of high intensity fires, but fallen trees that do not ignite will gain moisture and slowly decompose, decreasing their flammability. In other words, changes in fuels caused by insect kill after an epidemic are complex, at times leading to higher fire intensity and at other times leading to lower fire intensity.⁹¹

Another theory is that—because beetle-killed trees hold ten times less moisture and have a different chemical composition compared to healthy trees—infected trees can ignite up to three times faster, burn more intensely than a typical forest, and have burning embers carried farther in the air than those of healthy trees.⁹²

Pests, Noxious Weeds, and Aquatic Invasive Species

Besides pests that invade area forests, such as the mountain pine beetle, one of the management challenges for Missoula County is the control of noxious weeds that compete with native vegetation and crops. These include scotch broom, tansy ragwort, yellow starthistle, and Russian knapweed, among many others.⁹³ The economic impact of noxious weeds can be substantial. Weeds displace native vegetation, reducing forage production on rangelands and wildlands, imposing costs on ranchers, farmers, and public land managers. One estimate of spotted knapweed in Montana put the statewide impact at \$42 million annually in 1996 (\$58 million in 2010 dollars).⁹⁴

Aquatic invasive species, including zebra mussels, European milfoil, and whirling disease among others, also impose significant costs on Montana's economy. According to the Montana Aquatic Nuisance Species Management Plan, aquatic invasive species displace native species, clog waterways, impact municipal and industrial irrigation and power systems, degrade ecosystems, reduce or threaten recreational and commercial fishing opportunities, and can cause wildlife and public health problems.⁹⁵ These impacts impose costs on power producers, farmers and ranchers, and result in the loss of tourism dollars to retailers, hotels, and guides. The costs of education, planning, and control also impose costs on taxpayers and individuals.

Few specific costs are known for Montana, but the state of Idaho estimates the cost of zebra mussels alone at \$94.5 million annually. In the mid 1990s, the town of Ennis on the Madison River was significantly hurt by a sharp reduction in the number of anglers fishing the Madison River over fears that whirling disease had ravaged the trout population.

The Montana legislature appropriated \$150 million in the current biennium (\$75 thousand annually), with some funds coming from the state general fund, to control aquatic invasive species, including zebra mussels in Montana.

Wildlife

Missoula County is home to a number of threatened and endangered species, such as the grizzly bear, Canada lynx, and bull trout, and some species of concern, including bald eagles, loons, and westslope cutthroat trout. Common in the county are deer and elk and, in the higher elevations, mountain goat and bighorn sheep.

Bull trout, found in the Clark Fork and Flathead Rivers drainages, is a species that has been recognized as threatened under the Endangered Species Act. This native trout requires pristine conditions with cold water and low sediment.

Agricultural Lands and Open Space

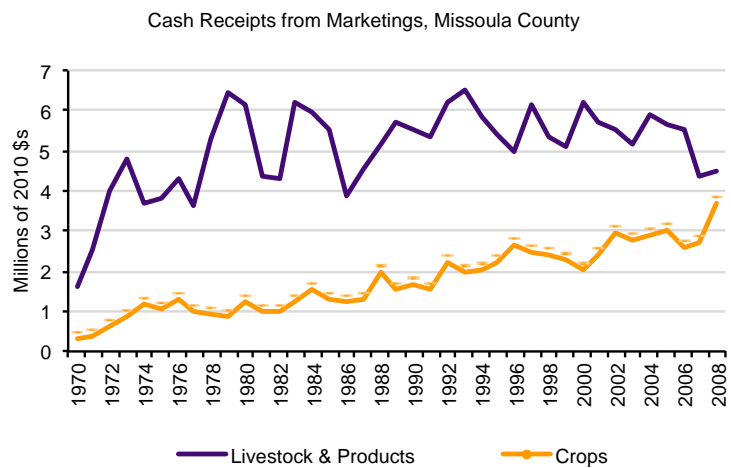
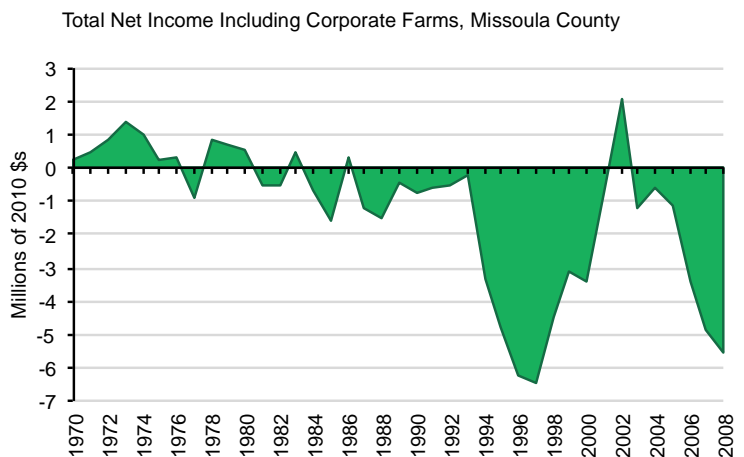
Although agriculture is relatively small in Missoula County, representing less than one percent of all jobs, it is important in a number of other ways. Croplands covers 2 percent of the land base, and grasslands cover another 10 percent; together representing 12 percent of the land. These are low elevation lands in the valley that are valuable for food production, wildlife habitat, scenic vistas and overall quality of life for local residents, and also represent an important component of the county's agrarian history and culture. The preservation of these lands is an important buffer against the rapid increase in out-of-town residential development over the last few decades.

The Community Food and Agriculture Coalition of Missoula County estimates that only eight percent of the soil in the county is suitable for agriculture and that the preservation of farm and ranch land is essential for the growing movement toward support of locally produced foods. The group estimates that in the last 25 years 29,000 acres of agricultural land have been lost to development.⁹⁶

The fact that open spaces and farm and ranchlands are important is reflected in the Open Space Bond. In 2006, Missoula County voters approved a \$10 million open space bond for the purpose of preserving open space. Among the purposes of the bond are the protecting of working farms and ranches; the preservation of rivers, streams, and lakes; managing growth; and protecting scenic vistas.⁹⁷

Community supported agriculture and the sale of conservation easements as a way to protect farms and ranches is going to be increasingly important, given the challenges of remaining profitable.

In aggregate, agriculture has been a money-losing enterprise in the county since the early 1980s. A bright spot, however, is the growth of crops. Gross earnings from the sale of crops has increased from \$0.3 million in 1970 to \$3.7 million in 2008 (receipts from the sale of livestock have declined).⁹⁸



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The next section discusses the above land use indicators in the context of vulnerability to climate change.

Discussion: Potential Vulnerabilities to Climate Change

Richard Opper, Director of the Montana Department of Environmental Quality, has summarized the challenge of climate change as follows:

Climate change will affect all of Montana's major economic sectors: agriculture, forestry, transportation and tourism, and energy supply. We may be challenged with decreased crop yields, longer forest fire seasons, reduced snowpack, and declining hydropower. The environmental costs may include reduced wildlife habitat and diminished water quality and stream flow. It is imperative that we all begin to do what we can to address this crucial issue for our own sake and the sake of the generations of Montanans to come.⁹⁹

Discussions of some of the ways in which Missoula County may be vulnerable to climate change are presented below. The purpose of the discussion is to generate ideas for the June workshop, to highlight areas where additional research or discussion is needed, and to develop ideas for how to adapt to climate change.

Land cover and forest management:

More than half of the land in Missoula County is managed by the state or federal government. This means strategies to adapt to climate change are going to rely heavily on cooperative work between the community and these agencies. Most of the land (76%) is forested, which means adaptation to climate change strategies rely largely on forestry practices.

Healthy, well-managed forests are going to be essential for the county's ability to reduce its vulnerability to climate change. With climate change, there may be higher incidences of weeds, diseases, and invasive species. Drought and wildfires are likely to be more severe and frequent. And, if quality of life continues to draw people to the valley, there will be continued home building in the wildland-urban interface. All of these threats will require intensive, hands-on and collaborative approaches to forest management.

Protected public lands:

Protected public lands, such as Wilderness, may play an increasingly important role in the context of climate adaptation. These lands may offer a higher degree of resilience to climate change because many of the natural processes and native species continue freely with little or no interference from humans. Noxious weeds, which tend to proliferate in areas that have been disturbed, may have a more difficult time establishing themselves on landscapes that have been protected, and that have native species.

One of the expected climatic changes will be faster runoff of moisture during the spring, and drought in the summer, which means one of the challenges, is to retain moisture in high elevations. Protected areas, assuming these are managed for a full range of biodiversity and native species, can play an important role in controlling the rate of runoff, which can in turn benefit fish, as well as municipal water supplies and the recharge of aquifers used for irrigation. Currently only a small portion of the land base in Missoula County is in official protected status.

Water – the aquifer:

Because residents in the Missoula Valley derive their water from an aquifer, keeping the water free of contaminants is key to smart water management, regardless of changes that may occur as a result of climate change. For example, one key management strategy is to monitor and regulate septic tanks through sewer districting, such as the Lolo Water and Sewer District.

If climate change brings with it heavier rain in the spring and faster surface runoff, one of the consequences may be the washing of contaminants, such as fertilizer, pesticides, antifreeze and motor oils, into the relatively porous soils of the valley and into the aquifer. This puts a premium on pollution prevention and education, which is something that is already being worked on by organizations such as the Missoula City-County Health Department and Missoula Valley Water Quality District.

Mountain Water (the water utility for City of Missoula) is currently for sale to a prospective buyer—the global investment firm The Carlyle Group. Missoula County will need a clear signal from the new owner, if the sale goes through, about their intentions for future water management.

One of the challenges with climate change will be that there will be less surface water towards the end of the summer, and streams and rivers will be recharged through groundwater. This groundwater may also eventually drop. In addition, with less groundwater, soils will dry, and with higher desiccation, forest fires may be more frequent and more severe.

Water – the Floodplain:

If climate change means a higher probability of spring floods, then an assessment is needed to establish the worst-case scenarios for flooding. (Flooding may mean spring flooding, but could also mean earlier breakup of ice jams during the winter.)

There is no finer point on this issue than the settling ponds of the now defunct Smurfit Stone plant along the edge of the Clark Fork River. With new owners and the promise of redevelopment, it is critical to get an accurate assessment of what contaminants may be present at the site, and how the dams and levees will behave in a flood. If flooding washes contaminants into the river, it will affect people, fish, and wildlife.

A recent study published in the journal of the American Meteorological Society on the declining mountain snowpack in the West began with the following statement:

Mountain snowpack in western North America is a key component of the hydrological cycle, storing water from the winter (when most precipitation falls) and releasing it in the spring and early summer, when economic, environmental, and recreational demands for water throughout the West are frequently greatest.¹⁰⁰

The authors found that:

It is becoming ever clearer that [the] projected declines in [snow water equivalent], which is already well underway, will have profound consequences for water use in a region already contending with the clash between rising demands and increasing allocations of water for endangered fish and wildlife.

One of the challenges in the future may be the need to store water at higher elevations. Otherwise, there may be faster runoff than historically, with much of the water washing downhill early in the year, followed by drought conditions in the summer. Missoula County has a number of natural lakes and reservoirs, and the condition of these dams will be an increasingly important issue, especially if they need to hold more water than normal.

A recent article in the Idaho Statesman entitled “Columbia River Dam Managers to Adapt to Warmer Weather” pointed out that temperatures on the Columbia River Basin have risen by 2 degrees (F) in the past hundred years and could climb another 6 or 7 degrees this century. These changes may mean higher flows in

the spring—resulting in stress on the dams—and less water available for farms, cities, fish, and wildlife later in the summer.¹⁰¹

An important consideration for Missoula County is assessing the condition of the dams, and in particular the spillways. This is especially the case for dams that are on-stream and uphill from major population centers.

Air:

Air quality in the Missoula area has improved, largely as a result of regulations and the disappearance of some polluting industries. However, because most of the population lives in a valley where inversions are common, and the possibility exists that on average temperatures will increase, continued vigilance is important to ensure success in improving air quality. This is important for health reasons, in particular for relatively more susceptible populations such as the elderly, the poor, and people with respiratory illnesses.

It is also important to point out that while the Missoula area has made improvements in air quality, there remain parts of the county with little or no controls over emissions and where air quality is still impacted.

One area of concern is the potential for increased or more intense forest fires as a result of changing climatic conditions, and a resulting deterioration of air quality. Historical records show a significant decrease in air quality during years when forest fires have burned nearby. Another area of concern is the university's proposal to burn woody biomass to generate energy which, while a move away from fossil fuels dependence, has raised concerns by the Missoula Air Quality Advisory Council and others.¹⁰²

Air quality is not only important for health reasons. It is also essential for quality of life, which in turn is a significant driver of the economy; people and their businesses move to Missoula (and stay in the area) in large part for quality of life reasons. Finally, air quality is also important to tourists and the sectors that depend on Missoula County's relatively clean environment.

Residential development:

If out-of-town residential development continues as it did in the 1990s and the early part of the 2000s, there are two areas where this represents a problem, particularly in the face of climate change. The first is continued expansion of homes on dangerous, fire-prone forested lands—the wildland-urban interface. If climate change brings with it drought, more frequent and/or more intense wildfires, then the cost of defending the homes, and the potential losses in terms of lives and property damages, will escalate.

Another area of concern is the continued development of septic tanks, especially if these are outside of a sewer district and therefore not regulated. More homes also bring additional lawns, and with them fertilizers and pesticides. Homeowners also release onto the land a variety of toxic substances, like antifreeze and motor oil. With faster spring runoff and heavier rains in the spring, these substances can leak into the soil and eventually into the aquifer.

There is some discussion about whether high gasoline prices may discourage people from wanting to build new homes out of town, but the evidence suggests that housing follows closely with national recessions; i.e., when the economy is booming, people build more homes; when there is a slow-down, home building slows down too.

Will gas prices (perhaps eventually increased through a tax on carbon emissions) ever rise high enough to discourage exurban development? A recent article in the *New Yorker* put this into perspective: even with gasoline prices at 85 cents per gallon higher than last year, this translates into \$500 more per household per year, on average. While increases in prices disproportionately affect the poor, for most it is still a relatively

small portion of the overall family budget. (The average increase in the amount Americans have to pay for gasoline is estimated to be less than the increased income they will get this year as a result of the new payroll-tax cut.)¹⁰³

Forest fires:

Increased stress on the forests resulting from climate change will likely increase the likelihood of large fires. Earlier snowmelt, warmer springs, and drought during the summer increase the probability of fire. Tree mortality resulting from diseases and pests that proliferate under warmer conditions add to the fuel sources.¹⁰⁴ In addition, the changes of extreme events, such as increased flooding that causes most of the moisture to flow off the forest early in the year, coupled with severe droughts, can increase the chances of large, dangerous, and expensive forest fires in the region.

Forest fires and their costs:

The federal government spends \$3 billion per year annually on fire-related expenses, twice the amount of a decade ago, and firefighting is estimated to constitute at least 40 percent of the Forest Service's budget.¹⁰⁵ As a result, the agency has fewer funds available for other activities, such as maintaining trails, fish and wildlife habitat management, and fuels reduction.

The rising cost of fighting wildfires, the increased chances of severe fires, and the unpredictable nature of future climate changes and their influence on fire are also problems for local and state governments. For example, in 2007 the Montana legislature had to meet out of session because it ran out of firefighting funds. Currently one third of annual firefighting costs in Montana go towards protecting homes.¹⁰⁶

The increased threat of fires also puts private property at risk and, in some cases, can cost lives. As Roger Kennedy, former head of the National Park Service, notes: "In the last half century, about one-fifth of the American people have moved into flame zones, insufficiently aware of the perils awaiting them and inadvertently testing the limits of nature's tolerance."¹⁰⁷ An example is the 1910 fire season, which still lives in recent memory, especially for the firefighting community. In that year, three million acres were burned from the Bitterroot Mountains to almost the Canadian border, costing 85 lives.¹⁰⁸

In addition, more frequent and severe fires will affect air quality, which in turn will affect citizens of Missoula County, disproportionately affecting the elderly, the young, and people with respiratory and other ailments. Decreased air quality can also affect tourism, as well as the quality of life for local residents, including those who moved with their businesses to the area to enjoy nature.

Increased or more severe forest fires can impact county and city budgets, as firefighting, police, and other safety and emergency services are allocated to fight fires, protect homes, direct traffic, and evacuate neighborhoods.

Finally, while the Missoula area has recently lost three major timber-related employers, the timber industry remains part of the makeup of the economy, and wildfires reduce the amount of commercial timber available for the timber industry.

One management option that is already underway is to thin trees in the wildland-urban interface. There is also increased interest in converting forest biomass into energy. Both of these will require a continued presence of a wood products industry in the Missoula area, with skilled forest workers and their equipment.

Pests, Weeds and Invasive Species:

One response to the mountain pine beetle is to log affected forests. For example, the proposed Lion Creek Mountain Pine Beetle Project would consist of logging close to 250 acres of National Forest lands north of Condon. The project is aimed at reducing the density of trees to reduce the spreading beetle activity while creating conditions for larger tree growth.¹⁰⁹ Besides preventative thinning, other options include pheromones and spraying with chemicals. However, the reality of the mountain pine beetle is that it is a cyclical event exacerbated by climate change, and large tracks of forest have already turned brown.

One area where climate change can have a significant impact is the increase in invasive species. Climate change is generally expected to increase the spread of invasive species through direct effects on habitat suitability and indirect effects on nutrient availability and disturbance regimes.¹¹⁰ For example, plant and animal species, both native and invasive, will generally migrate upslope and northward. Also, changes in precipitation will likely drive the expansion of invasive plants.

Warmer stream temperatures and a reduction in ice cover will also facilitate the spread of aquatic invasives and may increase their impacts. Changes in the timing of snowmelt and a subsequent increase in disturbance caused by spring floods may increase the risk of aquatic and riparian invasions. Warmer temperatures may change human visitation patterns to natural areas and increase the pathways for the spread of many invasive species (for example, the spread of invasive weeds or whirling disease).

One of the reasons weeds may proliferate under climatic change is that they have greater genetic diversity than crops (and also efficient seed dispersal systems), and are therefore faster at evolving to adapt to changes in the environment. As with the mountain pine beetle, there will be increased attempts to control the spread of noxious weeds, which will be expensive for city, county, and federal land managers.

Fish and wildlife:

Native fish species may be disproportionately affected by climate change, especially the timing of runoff and increases in flooding. For example, bull trout spawn in the winter when increased flood flows can scour redds (nests for spawning fish). One study suggests that a combination of warming water, and changing seasonality and timing of streamflows may reduce bull trout populations by 90 percent.¹¹¹

The bull trout is a species that needs to travel large distances upstream for annual feeding and spawning migrations, and can move up to 150 miles within a river basin.¹¹² One way to help this species adapt to climate change is to remove impediments to upstream migration, such as dams. Ironically, some of these dams may be necessary to counter the expected faster spring runoff by storing water at higher elevations.

Wildfires can result in increased sediment in rivers and streams, which can negatively affect threatened species, such as the bull trout, which require clear, cold, sediment-free rivers.¹¹³ Loss of canopy vegetation following fires often increases stream temperatures; although these impacts are typically short-lived, more frequent fires may alter vegetation structure in ways that reduce shading, further increasing water temperatures.¹¹⁴ Importantly, more frequent wildfires can remove the vegetation that stabilizes steep slopes, resulting in increased frequency and magnitude of landslides and debris flows, which can fill streams with sediment slurries and scour channels, degrade fish habitat, and in some cases cause extirpation of local fish populations.¹¹⁵

Another example of a wildlife species that could be affected by climate change is the wolverine, who den in deep snow. Changes in snow type and decreases in snow cover could reduce denning sites. Other species that may be affected by climate change include deer and elk, which may see higher survival rates if winters

prove to be warmer than in the past (i.e., less “winter kill”). Concurrently, species that predate on deer and elk, such as cougar, may also be impacted if prey population numbers change.

On the other hand, bird species may suffer under warmer conditions and increased drought, and according to one estimate 90 percent of all bird species in Montana depend on wetlands and streamside vegetation to survive.¹¹⁶ Protecting and restoring wetlands and waterways will be a key climate adaptation strategy.

Agriculture:

In the context of climate change, with faster water runoff and heavier rains in the spring and drought in the summer, there are a number of implications for agriculture and, by extension, the preservation of farm and ranch land, open spaces, and the values they bring to the community. One of the challenges may be delayed planting if the spring season is abnormally wet. On the positive side, milder winters and warmer summer weather could mean a longer growing season and even a change in the mix of crops. Some of the potential challenges during the drier months include more competition for scarce water resources, and a higher threat from weeds and invasive species.

Higher energy prices can contribute to higher food prices because oil is used in production and transportation. Agriculture has become increasingly mechanized, with energy being used to operate machinery; heat, cool and light buildings; and indirectly in the production of fertilizers and pesticides. However, there are other contributing factors to the cost of food. International and national demand and supply for commodities, weather, finance costs, input costs (fertilizer, equipment, etc.), crop yields, disease, and competition for land (including urbanization and more land used for biofuels) all play a role.

The Economic Research Service (ERS) estimates that 3.5 percent of the cost of food is attributable to energy expenses.¹¹⁷ ERS estimates that in 2011 food prices will rise 3 to 4 percent, due to “higher food commodity and energy prices, along with strengthening global food demand.”¹¹⁸

As energy prices rise, there are a number of implications for agriculture in Missoula County. Higher transportation costs will mean it is more expensive to import food, and this may give a comparative advantage to local farms and ranches. Higher gas prices also mean higher production costs for farmers and ranchers, both nationally and locally, but this may be balanced against increased global demand for food and rising prices, which could benefit local producers.

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V. DISCUSSION

This report describes the people, economy, and resources of Missoula County and begins a discussion on ways in which the county may be vulnerable to the effects of climate change. The discussion is not intended to be comprehensive, but instead is designed to contain enough information to stimulate an informed discussion at the June 27-28 workshop. The purpose of that workshop is to begin the process of developing a climate adaptation strategy for the county.

Missoula County is complex, both in terms of human activity and its ecology, and there is a good chance some important elements of the discussion have been left out of this document. Those can be identified in the June workshop and incorporated into the final climate adaptation plan.

Climate change is also complex and there too exists danger of oversimplification. For example, climate scientists already know that, compared to the past, the Missoula area is receiving less snow and more rain, and that temperatures have risen. They can predict with some confidence what the future may bring in general terms, such as flooding in the spring and drought in the summer. However, climate scientists are also discovering that in the future there may be much higher variability in climatic conditions, and one of the take-home messages from their work is that in the future, climate will be more and more difficult to predict.

Because it is impossible to have a perfectly clear view into the future, the climate adaptation effort is largely an effort at risk management. We don't know the exact probability of certain events, but if we plan for a reasonable range of expected scenarios, we will be better prepared than if we simply take a passive "wait and see" approach.

Missoula County has the chance to develop a well thought-out adaptation plan because it has a high degree of "human capital," with many informed, concerned, and dedicated citizens.

CITATIONS

¹ Source: U.S. Census Bureau, Census 2000 Redistricting Data (Public Law 94-171) Summary File, Table PL1, and 2010 Census Redistricting Data (Public Law 94-171) Summary File, Table P1.

² Data source for cross-county income flows: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Tables CA30 & CA91.

³ Data source for population, employment, personal income and per capita income: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Table CA30. Data source for elements of population growth: U.S. Department of Commerce. 2010. Census Bureau, Population Division, Washington, D.C.

⁴ Data source for rate of unemployment: U.S. Department of Labor. 2010. Bureau of Labor Statistics, Local Area Unemployment Statistics, Washington, D.C. Note: February 2011 numbers are preliminary.

⁵ Data source for employment by industry: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Table CA05. Data source for wages by industry: U.S. Department of Labor. 2010. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, Washington, D.C. Note: these two sources use slightly different methods for classifying industries. For example, educational and health services are reported separately by the U.S. Department of Commerce, but are reported as one sector by the Bureau of Labor Statistics.

⁶ Missoula Chamber of Commerce. <http://www.missoulachamber.com/community/employment.asp>

⁷ U.S. Census Bureau. 2008 County Business Patterns (NAICS). Washington, D.C.

<http://www.census.gov/econ/cbp/index.html>.

⁸ Summary of the Missoula on the Move Forum. May 27, 2004. Center for the Rocky Mountain West.

<http://www.crmw.org/>

⁹ Rasker, R., P.H. Gude, J.A. Gude, J. van den Noort. 2009. The Economic Importance of Air Travel in High-Amenity Rural Areas. *Journal of Rural Studies* 25(2009): 343-353; Rasker R. and A. Hansen. 2000. "Natural Amenities and Population Growth in the Greater Yellowstone Region." *Human Ecology Review*. Vol. 7(2): 30-40.

¹⁰ Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports:

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¹¹ The beginning and end of recessions are officially measured by the National Bureau of Economic Research (NBER),

<http://www.nber.org/cycles.html>

¹² Source: U.S. Department of Commerce. 2010. Bureau of Economic Analysis, Regional Economic Information System, Washington, D.C. Table CA06N.

¹³ Big Sky Business. February 19, 2011. As Hub, Yellowstone County Reaps Benefits of Oil, Mining. Evelyn Pyburn.

http://www.bigskybusiness.com/index.php?option=com_content&view=article&id=1769:as-hub-yellowstone-county-reaps-benefits-of-oil-mining&catid=29:montanabusiness&Itemid=114

¹⁴ KPAX.com January 20, 2011. UM Study Sees Strong Economic Growth Ahead. Dennis Bragg.

<http://www.kpax.com/news/um-study-sees-strong-economic-growth-ahead/>

¹⁵ Missoulian. August 18, 2010. Engen to Nation: Missoula Economy Rosier than Moody's Double-Dip Recession Prediction. Betsy Cohen. http://missoulian.com/news/local/article_f6a3f59e-aaf9-11df-ae84-001cc4c03286.html

¹⁶ Data from Bureau of Business and Economic Research, University of Montana, based on figures from U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

<http://www.bber.umt.edu/econ/county/Missoula/covemp.htm> Note: these figures only include wage and salary workers and do not count the self-employed or government employment.

¹⁷ Data source: U.S. Department of Commerce. 2010. Census Bureau, County Business Patterns, Washington, D.C.

Travel and tourism consists of sectors that provide goods and services to visitors to the local economy, as well as to the local population. These industries are: retail trade; passenger transportation; arts, entertainment, and recreation; and accommodation and food. It is not known, without additional research such as surveys, what exact proportion of the jobs in these sectors is attributable to expenditures by visitors, including business and pleasure travelers, versus by local residents.

¹⁸ Institute for Travel and Recreation Research, University of Montana, Nonresident Travel Survey Reporting System:

<http://www.itrr.umt.edu/NonResident2005/ITRRSearch.aspx>

¹⁹ Ski visitation data from: Montana Ski Area Trends 1990 - 2010. The Institute for Tourism and Recreation Research, The University of Montana, Missoula; USDA Forest Service; and Montana Ski Areas and Resorts:

<http://www.montanaskiareas.com>

²⁰ Nickerson, N. and K. Grau. 2010. 2009-10 Ski Season: Economic Impact and Skier Characteristics: Montana. Institute for Tourism and Recreation Studies. Research Report 2010-3. University of Montana. http://www.itrr.umt.edu/research10/MTAlpineSkiReport0910RR2010_3.pdf

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⁷² Personal communication with Michele Lemiux, lead person responsible for dam safety at DNRC. We also spoke with Larry Schock, DNRC regional engineering specialist for Missoula/Kalispell. According to him, there is only one dam in Missoula County with a high risk rating (based on downstream population, not safety), on Six Mile Creek. It recently had work on it, and he thinks there are no problems. He said there are three state water project dams that DNRC regulates upstream from Missoula that could be impacted by climate change. They are in Darby, Philipsburg and Helmville. Each spillway is designed to accommodate a 5000-year event, and he's not concerned about the safety of any one. The dam safety folks at DNRC are not planning explicitly for climate change—they don't think it's a problem for Missoula County in terms of dam safety.

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