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# Missoula County Climate Action: Creating a Resilient and Sustainable Community

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# Missoula County Climate Action: Creating a Resilient and Sustainable Community

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**Additional materials and interactive assessments from the ClimateWise process can be found at http://www.geosinstitute.org/completed-climatewise-projects/**

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# EXECUTIVE SUMMARY

Missoula County is host to a diversity of people, local industries, intact ecosystems, and dramatic scenery. Its rivers and forests provide abundant opportunity for outdoor activities while the university and bustling downtown Missoula provide culture and entertainment. When people are asked why they live in Missoula County, they often refer to the high quality of life that is available here.

Missoula County's quality of life is at risk, however, from a variety of pressures and challenges that range from population growth to energy and water demands. Unfortunately, one primary threat has the capacity to overwhelm and affect all others – the threat of climate change. Climate change is expected to have substantial impacts to the natural systems of Missoula County, including rivers, streams, forests, and wildlife. These impacts will in turn affect infrastructure, emergency response capacity, human health, tourism, agriculture, forestry, and many other facets of society.

We assessed how a changing climate might affect Missoula County using the latest science and local expertise in a community-based process called *ClimateWise*. The ClimateWise process included climate change model output, a community workshop that involved expert participation from throughout different sectors and interests, and close guidance by a local Steering Committee.

During the ClimateWise process, groups of experts and leaders from across the different sectors of the community developed a suite of strategies for "climate change adaptation" – the process of preparing for climate change to reduce overall impacts to natural and human communities. We view these strategies as a critical first step in what will need to be an ongoing process as the climate, scientific understanding of the earth's processes, and other drivers such as population growth, change over time.

By integrating adaptation strategies across the different sectors of society, county leaders will reduce conflict among diverse interests for limited resources, such as water, while increasing communication and lowering overall costs. Based on climate change model projections from three global climate models, as well as peer-reviewed scientific publications, local experts and leaders identified the following as changes that are likely to occur in Missoula County over the coming century:

- 5-10° F increase in temperature
- Lower late summer stream flow
- Earlier spring runoff
- Declines in snowpack
- Changes to precipitation patterns
- Changes in tree species for forestry
- Changes to fish, wildlife, and plant populations
- More wildfire
- Increased spread of invasive species
- More pests and disease in natural systems and human populations

Workshop participants considered climate change and on-the-ground vulnerabilities as they developed a suite of recommendations for increasing local resilience in the face of changing conditions. Working in mixed groups, they addressed five different interdisciplinary topics. Their guidance is summarized here.

## WATER SUPPLY

Participants were concerned about expected changes in water supply from loss of snowpack and declines in stream flow. Declines would impact agriculture, riparian and wetland areas, tourism, recreation, business, and residential water users.

They recommended increasing natural water storage capacity in the form of beaver dams, wetlands, riparian areas, and floodplains. They also recommended changing water ownership structures and increasing education and outreach. The group suggested supporting the agricultural industry through incentives and education. They cited a need to leverage efforts and work collaboratively across local jurisdictions and groups. Finally, they suggested showcasing successful efforts throughout the county and elsewhere as positive examples of what can be accomplished.

## WILDFIRE

The wildfire group identified many potential impacts associated with increasing frequency and severity of wildfire. These include the risk to human safety, decline in air quality, rising cost of suppression, potential increase in insurance rates, and the loss of important natural resources and carbon storage.

In response, they suggested increasing education on wildfire and providing demonstration projects for people to learn from. It was recommended that some fires be allowed to burn, thereby increasing the resilience of forest ecosystems. Mechanical fuels reduction was suggested for specific areas and forest types. Thinning could be combined with biomass production for fuel or new markets for blue stain pine and other forest products.

Reducing wildfire risk by limiting development in fire-prone areas was a primary recommendation of the group. For existing homes that border forest, they suggested supporting the creation of defensible space and fire resistant structures.

## FLOODING AND WATER QUALITY

Participants discussed the potential for larger floods from rain-on-snow events and quicker spring snowmelt. These changes could lead to increased need for government and emergency services, damage to infrastructure, a loss of recreational and tourism opportunities, and toxins in floodwaters.

Workshop participants made numerous recommendations for reducing flood risk. One included increasing communication and trust among private landowners and agencies. State or County assistance for landowners with a variety of goals related to land management and renewable energy was suggested.

Protecting and enhancing ecosystems that store and filter water was identified as an important strategy as well. The group recommended that incentives be provided for a system of

natural flood control measures (wetlands, floodplains, etc.).

Identifying and maintaining vulnerable infrastructure were recommended as ways to reduce overall risk. Increased preparedness efforts would results in greater effectiveness during emergencies.

## CHANGES TO SPECIES AND HABITATS

Natural systems, like human systems, will be disrupted during flooding, fire, pest outbreaks, and drought. Species are expected to need to shift to new areas with climate change. Declines of many species are expected. These declines could lead to a loss of ecosystems services, such as pollination, water filtration, or timber for harvest. As more people move to the area, population growth will exacerbate the impacts of climate change to native species and habitats of Missoula County.

Many recommendations were made for ways to increase the resilience of native species and habitats. One recommendation – maintaining and enhancing riparian areas and wetlands – is complementary to previous recommended strategies for maintaining water supplies or reducing flood risk. Reintroducing beavers was also suggested.

Reducing ongoing stressors that cause degradation and fragmentation was recommended to offset the additional stressors brought on by climate change. The group suggested changing forest management to focus on controlling invasive species, maintaining habitat connectivity, and maintaining diversity.

Finally, education and outreach were suggested as tools to increase awareness of our dependence on functioning ecosystems.

## GLOBAL CHANGE IMPACTS

Climate change impacts to Missoula County are expected to be far less severe than climate change impacts to many other parts of the nation. Workshop participants expected increased immigration to the area due to sea level rise, hurricanes, tornadoes, and flooding that affect other regions.

Workshop participants suggested revising the growth strategy for the county to account for climate change and potential resource scarcity. Such planning would need to weigh the needs of a variety of interests, including low-income populations, agriculture, tourism, recreation, development, and transportation.

Maintaining wildlife connectivity, intact floodplains, agricultural lands, and functional watersheds, may be most successfully achieved through regulation or zoning.

Finally, the workshop participants suggested that support for diversified business, manufacturing, and job growth, is important. Efforts to encourage business should focus on industries that use sustainable practices. New and sustainable uses of timber resources, such as biochar or blue-stain pine industries, are worth investigating and supporting. Agriculture, land conservation, and the local food movement are other economic activities that should be supported at the local level.

As climate change progresses, it is important that communities are prepared in ways that protect people and the natural resources they depend on. The ClimateWise process allowed local experts and leaders to use the latest science to assess what changes are likely across Missoula County. Recommended strategies and actions that were developed during the process can be incorporated into ongoing decision making and planning processes at many different levels. This effort represents a first step at creating a more resilient and sustainable Missoula County in the face of accelerating change.

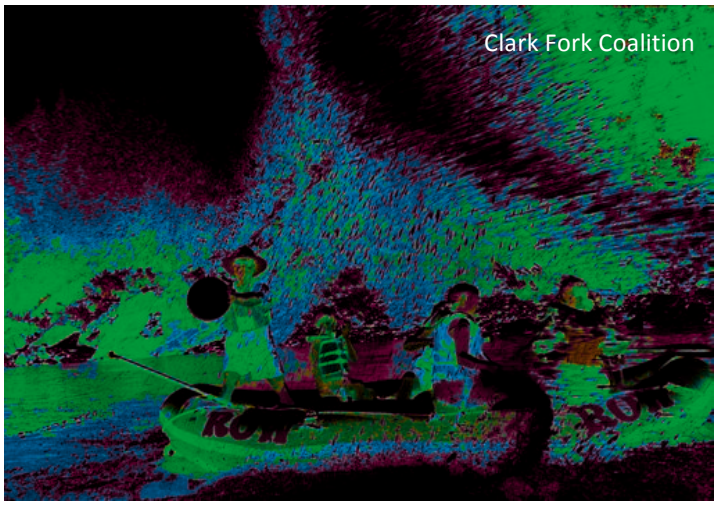
# INTRODUCTION

Montana isn't known for its major metropolitan areas. But ask almost anyone in the state, and they will refer to Missoula as the "big city." Missoula is the second-largest city in Montana after Billings, and is the main urban center between Spokane and Salt Lake City. Between the years of 2000-2010, Missoula County has grown by 14%.

Missoula's bustling city center sits squarely over a vital network of natural resources: the Rattlesnake Wilderness, a gateway to the Crown of the Continent Ecosystem, sits just a few miles from downtown. Residents regularly fish, hunt, and hike next to bears, mountain lion, wolves, bighorn sheep, elk, and deer. Scattered throughout the county—especially in its less developed areas—are healthy populations of carnivores, ungulates, and amphibians that live in near-pristine forest and riparian communities. And, Missoula County hosts an extraordinary richness in rivers: the Blackfoot, the Bitterroot, and Rock Creek all join the Clark Fork within a stone's throw of the metropolitan area, weaving in and out of rural reaches, neighborhoods, and the business district. These waters are iconic emblems of the outdoor heritage that defines Missoulians.

Yet these rivers and vital resources are at risk from changing conditions—and that risk is compounded by the impacts of a growing population. Protecting the ecological, economic, and cultural integrity of Missoula County will require integrating land and water conservation, the private with the public sector, and natural capital with built capital in a manner that protects—and enhances—our communities and natural resources in the coming decades. As changes to the climate, to local natural resources, and to the county progress throughout the coming decade and beyond, proactive planning that anticipates change, buffers communities from negative impacts, and positions citizens to take advantage of new opportunities will allow Missoula County to retain the qualities so valued by its residents.

In 2011, a series of workshops and meetings was carried out in Missoula as part of the ClimateWise process. ClimateWise is a process developed by the Geos Institute that uses science to help communities better understand what types of climate changes to expect, how the different sectors of the community will be affected, and how to prepare in ways that provide


Clark Fork Coalition

the greatest benefit across the community. The strategies that were developed through this process are intended to make Missoula County more resilient and more collaborative in its approach. These strategies are beneficial to the community regardless of the trajectory of future change.

The process brings together cross-sector leaders to develop science-based, non-partisan risk assessments aimed at helping local communities in their planning processes. The Clark Fork Coalition acted as a convening organization for the ClimateWise process. The Geos Institute provided a scientific assessment of how Missoula County is expected to change over the coming decades. Headwaters Economics assessed economic and social strengths and vulnerabilities in Missoula County, as well as potential impacts from changing conditions. The Montana Association of Conservation Districts, the Montana Watersheds Coordinating Council, and a local steering committee also served as stakeholders in this process.

Nearly 100 citizens and local experts came together for a two-day workshop in June, 2011. Dr. Steve Running, a member of the project steering committee, presented information on what types of changes to expect in Missoula County. Participants then broke into small, cross-sector groups to identify impacts to specific areas of interest and to develop strategies and actions to address those impacts and take advantage of new opportunities.

This report provides a summary of the output from the workshop and from meetings with the local steering committee. This report reflects the collective efforts of many people in Missoula County, including elected officials, county planners, public health officials, resource managers, and business leaders. The strategies outlined here reflect the conversations, values, and opinions of numerous local experts and interested citizens. Because of the group effort, the recommendations in this report should not be attributed to any individual participant, as many dissenting viewpoints and opinions were expressed and documented.

**Steering Committee**

Central to the success of this effort was the formation of a steering committee that is representative of the many varied sectors, values, interests, and regions of Missoula County. The Steering Committee acted as a guiding force throughout the process of developing sound strategies for a sustainable community. They provided balance, insight, and expertise. The Missoula County ClimateWise Steering Committee consisted of the following volunteers:

Beth Schenk, St. Patrick Hospital
Brent Campbell, WGM Group
Father Jim Hogan, Christ the King Parish
Germaine White, Confederated Salish & Kootenai Tribes
Jim Cusker, Open Lands Advisory Committee
Chase Jones, City of Missoula
Michele Landquist, Missoula County Commissioner
Dr. Steve Running, University of Montana
Tim Hall, Missoula Conservation District
Tim Love, US Forest Service, Seeley Lake Ranger District
Jim Burchfield, University of Montana
Pat O'Herren, Missoula County Rural Initiatives

Committee Advisor:
Gloria Flora, Sustainable Obtainable Solutions

# SECTION I. CLIMATE CHANGE IN MISSOULA COUNTY

## Expected Climate Change Trends for Missoula County

Climate change is a global phenomenon that has local impacts on agriculture, human health, natural resources, infrastructure, emergency response needs, tourism, and other facets of society. By identifying which sectors of society are most vulnerable to impacts from climate change, decision makers in Missoula County can increase the resilience of the community and the resources on which it depends.

Precisely predicting future conditions is not necessary for implementing sound strategies that reduce local vulnerabilities. For instance, all models predict, to varying degrees, warmer temperatures and lower snowpack, regardless of precipitation trends. Droughts are expected to be more frequent and severe. Thus, planning for increased resilience in the face of drought is considered a "no-regrets" strategy – such a strategy would benefit the County regardless of climate change and it addresses a relatively certain risk.

Similarly, floods are expected to become more common as storm systems increase in severity and rain-on-snow events become more common. Reducing the vulnerability of the county's infrastructure (homes, roads, agriculture, etc.) to flooding provides many benefits, including saving both money and lives. While climate change is the impetus for this effort, adopting the strategies recommended in this report would benefit residents of Missoula County in a variety of ways, regardless of the precise trajectory of the changing conditions.

**High certainty:**

- Up to 5° F warmer by 2035-45
- Lower and extended low stream flow in late summer
- Earlier and greater spring runoff
- Shifts in species ranges for wildlife and plants
- Greater likelihood of severe wildfire, especially during warm phase PDO
- Increased spread of invasive plants and animals

**Medium certainty:**

- Up to 10° F warmer by 2075-85
- Continued declines in snowpack at lower elevations
- Declines in aquatic species such as bull trout and cutthroat trout
- Declines in alpine and subalpine species, including subalpine fir, Engelmann spruce, big horn sheep, pika, and mountain goat
- More pest and disease outbreaks, such as mountain pine beetle

**Low certainty:**

- Decline in summer precipitation
- Increase in winter precipitation
- Greatest precipitation change at higher elevations
- High tree species turnover, but continued forest cover in many areas
- Declines in Douglas fir and lodgepole pine; potential increase in oaks or other broadleaf tree species.

## Local Climate Change Projections[1]

**Temperature and precipitation –** Average temperature is projected to increase regardless of which model is used, with accelerated increase toward the end of the century (Table 1). In contrast, model projections for precipitation in the area vary substantially – by mid-century average precipitation could decline by 29% or increase by 10%, depending on which model is consulted (Table 2). By late century (2075-85), all three models agree on slightly drier conditions in summer and slightly wetter conditions in winter (Table 2; Figure 1). Higher temperatures

**Table 1. TEMPERATURE**

Projected increase in average temperature in Missoula County, based on output from 3 different global climate models. Future temperature is shown as change in degrees Fahrenheit, as compared to historic averages (1961-1990).

| | Historic | 2035-45 | 2075-85 |
|---|---|---|---|
| **Annual** | 40.5° F | +2.5 to 4.8° F | +5.7 to 10.0° F |
| **Summer*** | 59.2° F | +2.2 to 5.5° F | +6.4 to 11.0° F |
| **Winter**** | 23.0° F | +2.5 to 5.0° F | +5.1 to 9.3° F |

*Summer value was calculated as average temperature for June, July, and August
**Winter value was calculated as average temperature for December, January, and February

**Table 2. PRECIPITATION (both rainfall and snow water equivalent)**

Projected average precipitation (and percent of historic average) across all of Missoula County, based on output from 3 different global climate models. Future precipitation is shown in inches, as compared to historic averages (1961-1990).

| | Historic | 2035-45 | 2075-85 |
|---|---|---|---|
| **Annual** | 31.1 inches* | 32.1 to 32.6 in. (103-105%) | 33.8 to 35.7 in. (109-115%) |
| **Summer**** | 5.6 inches | 4.0 to 6.2 in. (71-110%) | 3.5 to 5.6 in. (63-96%) |
| **Winter***** | 10.5 inches | 11.4 to 12.4 in. (108-118%) | 12.7 to 14.3 in. (121-137%) |

*In contrast, the average precipitation in the city of Missoula is 13.7 inches.
**Summer value was calculated as the sum of precipitation for June, July, and August
***Winter value was calculated as the sum of precipitation for December, January, and February

[1] For references and more details about local projections, please download the companion report entitled Future Climate Projections in Missoula County and the Western Montana Region at: http://www.geosinstitute.org/completed-climatewise-projects/

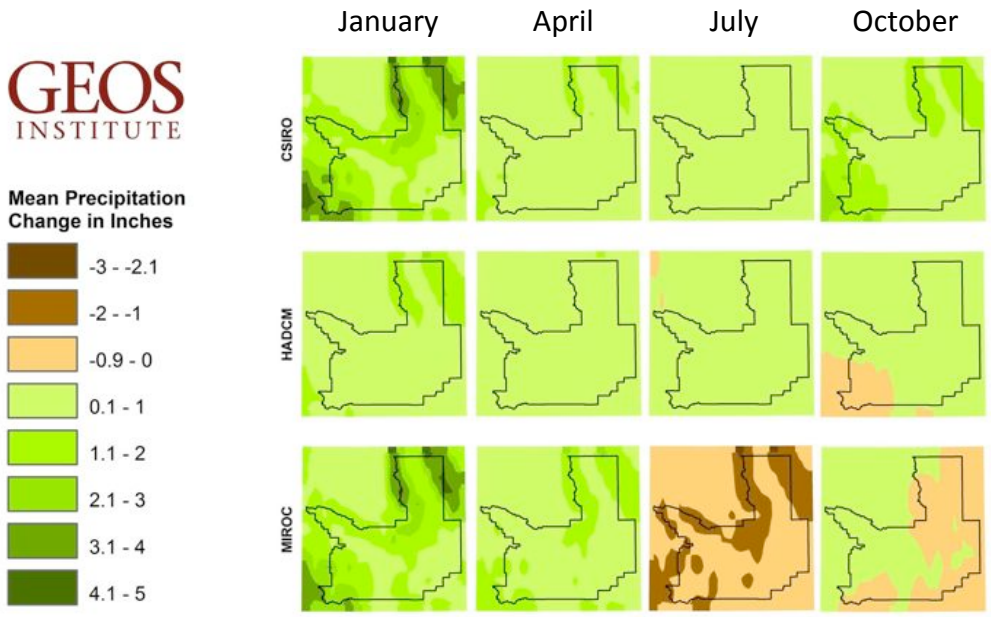



**Figure 1.** Projections for late century (2075-85) change in average monthly precipitation across Missoula County, as compared to historic (1961-1990), based on three different climate models (MIROC, HADCM, and CSIRO). Darker green indicates wetter conditions while brown indicates drier conditions.

leading to greater evaporation are likely to offset any positive change in precipitation.

**Snowpack –** A recent study has demonstrated synchronous declines in snowpack across the Rocky Mountains since the 1980s. Continued declines are expected as temperatures increase. Because many current water storage strategies rely heavily on snowpack, a substantial strain on supplies and infrastructure could result.

**Hydrology –** Missoula County has already experienced many changes in hydrology patterns. The snow water equivalent (SWE) of winter snowpack has declined, stream flow has declined (especially late summer flow), and water temperatures have increased. The timing of many events, such as average freeze and thaw dates, has also changed substantially over the last 50-100 years. Future expected trends include longer and lower summer stream flows, increasing flood risk as more precipitation falls as rain instead of snow, increasing summer stream temperatures, and declining groundwater recharge.

**Forest and vegetation change** – 76% of Missoula County is forested. Overall, U.S. forests have become more productive in the last 55 years, likely due to a longer growing season and higher $CO_2$ levels. As conditions become warmer and drier in the summer, many forests are expected to become less productive due to lower

soil moisture during the growing season, temperature stress, insect and disease outbreaks, invasive species prevalence, and wildfire.

We consulted two different vegetation models to assess future vegetation patterns in Missoula County. The functional model (MC1) projected a steep contraction of subalpine vegetation at higher elevations, in the northeastern and southwestern portions of the county, but continued coniferous forest cover in most other areas. In contrast, the climate envelope model indicated a decline in favorable conditions for many of the county's common tree species, including Ponderosa pine, lodgepole pine, Douglas-fir, and subalpine fir. Deciduous trees, such as oaks, may find more favorable conditions.

**Wildfire** – Fire severity can be expected to increase given warmer and drier conditions. An assessment of climate change and forest fires over North America projected 10-50% increases in seasonal severity rating (SSR) over most of the U.S., implying increases in area burned and fire severity. Similarly, a recent study predicts substantial increases in fire frequency in the Greater Yellowstone Ecoregion (GYE). The MC1 vegetation model that we consulted showed a 26-30% increase in wildfire in Missoula County. Increases in wildfire are primarily expected in the higher elevations.

**Storm events** – Climate change could increase the severity of individual storm events, even if average precipitation levels do not increase. As temperatures warm, more precipitation will fall as rain instead of snow, and more rain-on-snow events could occur. Heavy rainfall and rain-on-snow both increase the risk of flooding. Such storm events can be exacerbated by land use practices and infrastructure failures, making the impacts of flooding more severe. When rainfall occurs in a short period of time, most water runs off quickly without infiltrating soils or recharging groundwater aquifers.

**Air quality** – Climate and air quality are closely coupled. Conventional pollutants such as ozone and particle pollution affect public health and also exacerbate climate change. Higher temperatures cause increased ozone formation, even without additional pollutants. Increased forest fire may also affect air quality.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**Fish and wildlife change** - Wildlife will respond in many ways to a changing climate, including range shifts, changes in migration and breeding seasons, changes in population size, increases in disease, population declines, and extinction. As climate change accelerates, it is increasingly expected to outpace the ability of wildlife to respond and adapt. Approximately 30% of all species could be lost by 2100.

Wildlife in Missoula County expected to be most vulnerable to climate change includes species dependent on snow, such as wolverine, lynx, and snowshoe hare. Also vulnerable are high-elevation species such as big horn sheep, pika, mountain goat, and wolverine, as well as rosy finch and ptarmigan. Other species, such as elk, may respond favorably to warmer winter conditions and lower snowpack.

More frequent wildfires can remove the vegetation that stabilizes steep slopes, resulting in increased frequency and magnitude of landslides and debris flows, which can degrade fish habitat. Many aquatic species are especially sensitive due to their dependence on clear, cold water streams and their inability to move to new areas. These include bull trout and westslope cutthroat trout. In the Rocky Mountains, warming is projected to cause a loss of up to 42% of current trout habitat by the end of the century.

Invasive species, including noxious weeds, pine and spruce beetles, and others, are expected to continue to spread, partly due to declining or weakened native species and warmer temperatures. Warmer waters are also expected to benefit invasive aquatic species and aquatic pathogens.


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# STREAMS WITHOUT WATER?

Our rivers and streams are lifelines for people, fish and wildlife. They provide water to fuel Missoula County's economy, and support our vital network of forests and fields. Sometimes, though, competing demands for these limited water resources can dry up these lifelines.

In Missoula County, we have several streams that are listed as "dewatered" by Montana Fish Wildlife and Parks, including sections of Lolo, Ninemile, and Grant Creeks, and portions of the Clark Fork and Clearwater Rivers. "Dewatered" is defined as areas where fish habitat is inadequate due to reduced stream flow. This is often triggered in late summer when landowners use their water rights for valid out-of-stream uses, like crop irrigation.

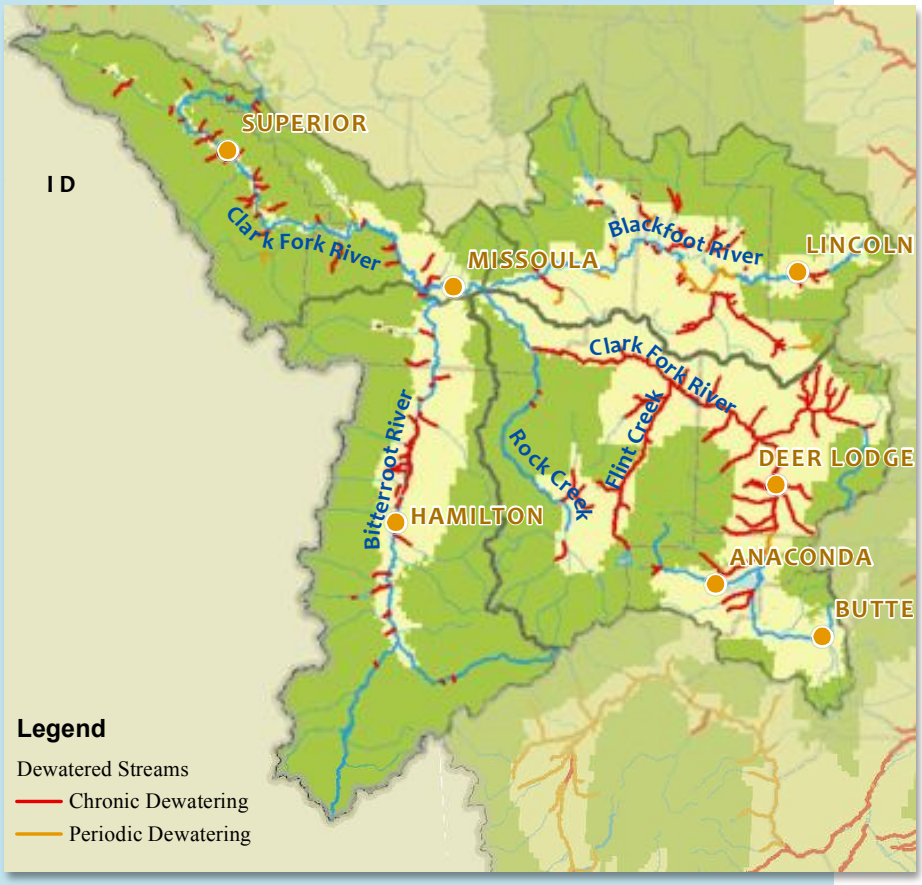
With less snowpack predicted in the future, Missoula County streams may experience more dewatering, and water users may face more competition to fulfill their water rights. Luckily, opportunities exist for partnering with landowners to improve stream flows, including irrigation efficiency upgrades, drought response plans, or leaving water in the stream during the driest months.

**BY THE NUMBERS:**

Montana has a total of 4,522 miles of chronically or periodically dewatered streams and rivers.

Missoula County is home to some of the most iconic rivers in the state. Here's how our big rivers fare (these numbers include the entire length of the river, not just portions in the County):

Clark Fork River = 98 miles dewatered
Blackfoot River = 38 miles dewatered
Bitterroot River = 17 miles dewatered



# MODELS AND THEIR UNCERTAINTY

This report provides model projections for future conditions specific to Missoula County. This information provides readers with a picture of what the future might look like, and what the magnitude of change might be.

These models provide a simplified representation of the physical, chemical, and biological processes that form the earth's climate system. Differences among models stem from differences in assumptions regarding which variables (and how many) are important to best represent overall conditions. Variation in climate model output also depends on assumptions about future emissions of greenhouse gases into the atmosphere.

In this report, we provide a range of model output from three global climate models (HadCM, MIROC, and CSIRO), all based on the A2 emissions scenario, which is often described as the "business-as-usual" scenario. We chose to present output using this scenario because it closely resembles the actual trajectory of global emissions over the last decade. A companion report provides more in-depth coverage of model types, assumptions, emissions scenarios, uncertainty, and projections for Missoula County (see link pg. 10).

Regardless of the uncertainty in these projections, the likelihood that future conditions will resemble historic conditions is very low. We encourage resource managers and policy makers to plan for an era of change, even if the precise trajectory or rate of change is uncertain.

### Why make changes if the future is uncertain?

While the models agree that average temperature will increase, projections for other factors are highly variable. Why would we invest time and resources into planning for such uncertainty? There are 3 main reasons:

**#1 – Planning for continued historic conditions sets us up for failure.** All of our current planning mechanisms use history to plan for the future – such as drought frequency and severity, dam stability, and flood risk to communities. Yet no climate models predict continued historic conditions. Relying on continued historical conditions for a community's needs, such as water for residents, length of growing season for crops, or snow for recreation, will likely lead to failure.

**#2 – We plan for uncertain conditions on a regular basis, and don't even realize it. Climate change is no different.** We harvest timber based on models of tree growth, plan new freeways based on 20-40 year projections of population growth, and buy fire insurance for the unlikely event of a fire. Planning based on the best available information—with adjustments as we gain new information—is the most effective way to move forward.

**#3 – Taking action makes the community more resilient and vibrant, regardless of the actual trajectory of climate change.** Residents of Missoula County have a wonderful quality of life, but that quality could be diminished. The County has already struggled with rapid population growth, poor air quality, competition for water, and loss of agricultural and natural lands to development. Strategies that address these problems and that benefit the county regardless of uncertain projections should be given priority.

## Climate Change "Adaptation" and "Mitigation"

This report summarizes recommended strategies and actions for preparing local communities in Missoula County for the impacts of climate change, otherwise referred to as "climate change adaptation". "Adaptation" efforts are intended to increase the resilience of our populations and resources in the face of changing conditions. These efforts result in new coping mechanisms and new opportunities for communities, based on observed and expected changes. In contrast to adaptation efforts, "mitigation" efforts aim to

**"Adaptation" efforts are intended to increase the resilience of our populations and resources in the face of changing conditions.**

reduce the long-term severity of climate change by lowering the greenhouse gas concentration in the atmosphere. Mitigation is achieved by reducing greenhouse gas emissions and increasing carbon storage.

Adaptation measures can be effective in the near-term, but may fall short over longer timeframes without effective mitigation.

The City of Missoula formed a Climate Action Task Force in 2011 assigned the task of drafting the "City of Missoula's Conservation and Climate Action Plan," which is a mitigation plan for municipal operations. Through this plan, the City hopes to reduce its greenhouse gas emissions and reach an emissions reductions goal in coming years.

**"Mitigation" efforts aim to reduce the long-term severity of climate change by lowering greenhouse gas emissions.**

There are many ways that mitigation and adaptation can work hand-in-hand. For example, planting trees in residential areas will decrease the need for energy-intensive air conditioning (mitigation), store carbon (mitigation) and increase neighborhood livability as temperatures increase (adaptation).

In some cases, adaptation and mitigation strategies may inadvertently undermine each other. For instance, use of air conditioning during a heat wave is a sound adaptation response, but it results in more greenhouse gas emissions, thereby undermining mitigation efforts. It's important to weigh potential consequences as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communities adopt climate change response strategies to avoid unintended conflicts.

Integrating adaptation or mitigation strategies across different sectors can yield cost savings and other positive synergies. For example, some strategies that reduce flood risk can also increase groundwater recharge, which can benefit agricultural producers and people with groundwater wells. Developing strategies that have benefits across many sectors requires communication and collaboration, and will increase the success of individual strategies and minimize competition for limited funding resources. Regular communication among such disparate groups as farmers, ranchers, state and federal agencies, Native Americans, public health professionals, county planners, social services professionals, land, water, and wildlife managers, and many others is vital for developing cohesive, effective, and efficient strategies.

By planning ahead and building resilience, Missoula County can increase its adaptive capacity and its ability to respond to climate change in a positive and proactive manner. One important point to remember is that increased resilience is a positive feature for any community, regardless of climate change.

## Natural Systems as a Climate Change Filter

Climate change is a global phenomenon, but many residents of Missoula County are also noticing changes at the local level. Initially, these effects will continue to be most noticeable in the natural systems in the county, including our forests, snowpack, wildlife, and waterways. If natural systems are resilient in the face of change, the impacts to human communities will be less severe. In essence, healthy ecosystems will filter the effects of climate change, resulting in less stress and continued benefits for people.

For instance, intact wetlands and meadows in the high country hold water during the winter and spring, allowing longer storage of water from spring runoff, which will supplement late-season flows in our creeks and rivers during longer, hotter summers. This will become an especially important function as snow pack levels decline and runoff occurs more quickly.

Intact floodplains and healthy riparian areas will reduce the impacts of larger, more severe storms on downstream development. Similarly, intact forests with natural fire regimes may be less likely to experience uncharacteristically severe wildfire. On the flip-side, if these forests, floodplains, or wetlands have been degraded, people are more likely to feel the effects of fires, floods, or droughts.

The benefits that we gain from functioning natural systems are often referred to as "nature's benefits" or "ecosystem services." As climate change progresses, these services will become even more important, and at the same time, they could become increasingly stressed by climate change and by increasing population pressure. By identifying and protecting key ecosystem services, our community can better prepare for a changing climate.

## Weather versus Climate

It's easy to confuse the terms "weather" and "climate," or be tempted to use them interchangeably. However, **weather** and **climate** differ in terms of the timeframe over which they are measured.

Weather is what we feel every day, including the temperature, rainfall, snowfall, humidity, or wind speed. Climate, on the other hand, is the combination of daily weather averaged over long periods of time. Changes in climate become apparent when long-term averages (30, 50, or 100 years) are updated to include more recent data. Long-term changes in climate have been documented in our region—more precipitation is falling as rain, average stream flow in August is lower, and average spring snowpack is lower. These changes result in a variety of noticeable shifts in our daily lives in Missoula County. For instance, common flowering plants are blooming earlier, forest fire seasons are lasting longer, and some areas are experiencing more frequent flood events.

Missoula County also experiences shorter-term variations in climate, which occur regionally, such as El Niño and the Pacific Decadal Oscillation (PDO). These regional patterns need to be considered when assessing changes in climate, as they can act to amplify or mute the effects of global climate change, depending on the current position of the cycle. The PDO cycles between a warm phase and a cool phase (Figure 2). Over the last century, these cycles have lasted about 20-30 years.

Some of the characteristics of the warm phase of the PDO, specific to the western part of Montana, are hot dry summers, warmer than average winters, and reduced snowpack. The warm phase of the PDO has been linked to increased wildfire and bark beetle outbreaks. Embedded within the decades-long cycles of the PDO are the one- to two-year cycles known as El Niño-Southern Oscillation (ENSO). When the warm and dry cycle of the PDO coincides with the dry years brought by ENSO, extreme drought and wildfire can occur.

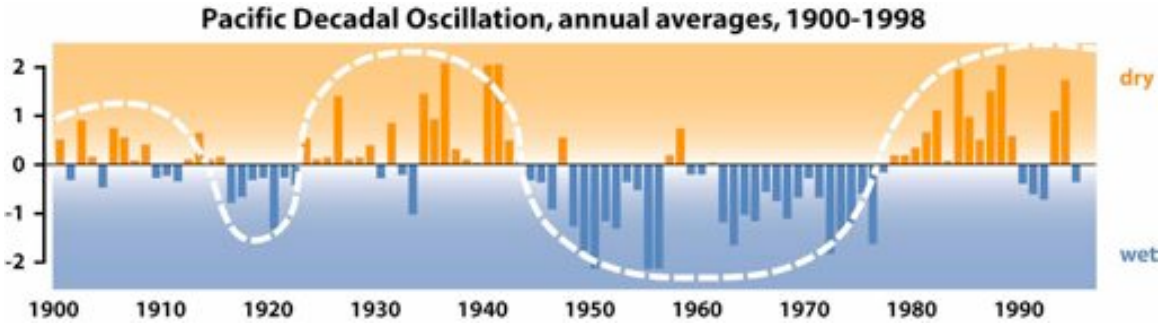


**Figure 2.** A century of Pacific Decadal Oscillation, based on the PDO index. Data collected since 1998 (not shown) indicates potential movement back toward a cool phase of the PDO.

Source: Big Sky Institute, Montana State University

# SECTION II. THE PEOPLE, ECONOMY, AND LAND OF MISSOULA COUNTY

Similar to natural systems, local residents and economic systems of Missoula County will experience less stress if they are more resilient in the face of changing conditions. Current strengths and vulnerabilities will dictate how the community responds to extreme events. Here, we present a snapshot of Missoula County's socioeconomic systems[2] in order to assess likely impacts and available strategies for retaining the high quality of life that Missoula's residents enjoy.

## A High Quality of Life and a Diverse, Fast-growing Economy

Missoula County (with more than 109,000 people) and the City of Missoula (population around 67,000) are part of a growing regional trade center that is diverse. It is composed of a few large employers, such as the university, regional hospitals, and federal land management agencies, and numerous small businesses. Ninety percent of workers work for small businesses of 20 employees or fewer, and one out of four people in Missoula County are self-employed. Missoula County is educated; 24% of the adult population has a bachelor's degree and another 13% have graduate or professional degrees.

Employment, and personal income have grown steadily over the last 30 years, but have slowed recently due to the recession. However, population growth, fueled mainly by in-migration, has continued. More than a third of total personal income is from retirement, investments, and other non-labor income. This form of income is likely to grow in Missoula County as the baby-boomer generation continues to retire.

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. Missoula County is more than 1.6 million acres in size, 76% forested, and more than half in public ownership. The City of Missoula is surrounded by some of the most spectacular mountain ranges in the state. The region supports summer recreation in the form of boating, fishing, and hiking, as well as winter skiing and snowboarding.

Economic sectors like travel and tourism 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.

[2] For references and more details about local conditions, please download the companion report entitled The People, Economy, and Land of Missoula County at: http://www.geosinstitute.org/completed-climatewise-projects/

## Vulnerabilities to Climate Change

**The importance of healthy forests, clean air and clean water –** Healthy forests and clean air and water are key to future economic prosperity in Missoula County, yet these are areas where the county is vulnerable to climate change. While air quality has improved over time due to regulations and a changing mix of industries, particulate matter has increased dramatically during years when forest fires burned nearby. With increasing forest fires, air quality could be reduced, affecting human health and future economic well-being.

Another vulnerability is in the development of homes on fire-prone forested lands—the wildland-urban interface (WUI), defined here as private lands within 500 meters of forested public lands. The increased frequency and severity of forest fires that is expected with climate change underscores the benefits of managing the pace, scale and pattern of future development on fire-prone forested lands, and of educating landowners on the dangers of forest fires.


Wikimedia commons

Increased rural residential development also presents challenges to water quality, in particular to the Missoula Valley Aquifer. The top of the aquifer, where septic systems exist, feeds into the area's waterways, which in turn feed fish, wildlife, farms and ranches. Heavier rain in the spring and faster surface runoff could cause the washing of contaminants into the aquifer. Another consequence may be the lowering of groundwater stores as runoff occurs more quickly.

**Some people are more vulnerable –** Climate change, especially if it affects air and water quality, may 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, and those with low education levels. Native American populations with higher poverty rates may be particularly vulnerable.

With 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. Warmer temperatures, more inversions, and poor air quality from increased forest fires could affect the health and safety of this population.

# SECTION III. IMPACTS AND RECOMMENDED STRATEGIES

## Community Participation: The ClimateWise Workshop

In June of 2011, nearly 100 local experts and community members came together for a two-day workshop to discuss the potential impacts of climate change in Missoula County, and to identify adaptation strategies and implementation actions. A primary goal of the workshop was to develop recommended strategies that support local values in an integrated manner, across different sectors and interests of the community. Because actions taken in one sector can influence adaptation strategies and efforts in other sectors, integration is vital for success.

We specifically asked participants for strategies that would have the greatest synergies and efficiencies across groups and interests. This approach is not only expected to increase the likelihood of success, but also to decrease tensions and conflict in the county.

The Clark Fork Coalition convened the workshop, along with partners from the Montana Association of Conservation Districts, the Montana Watershed Coordination Council, Geos Institute, and Headwaters Economics.

For more quantitative and interactive results from the workshop, please visit the following web link: http://www.geosinstitute.org/completed-climatewise-projects/

In order to guide adaptation strategies toward the features of the community that are most valued by local residents, we asked workshop participants what they value most about living and working in Missoula County. Their responses are summarized here.

| What Missoulians value most: | Votes |
|---|---|
| Ecosystem services | 18 |
| clean, inexpensive water (13) | |
| clean air (3) | |
| carbon storage in trees (1) | |
| Outdoor recreation | 14 |
| Positive compassionate, open community | 13 |
| Native fish, wildlife, plants | 11 |
| Recreational viewing (6) | |
| Hunting (1) | |
| Spiritual (1) | |
| Mental health (1) | |
| Tribal culture (1) | |
| Overall quality of life | 9 |
| Local food/agriculture | 7 |
| Scenery | 6 |
| Safe for kids, family friendly | 5 |
| Culture, arts, entertainment | 4 |
| Sustainable living | 3 |
| University | 3 |
| Forest products | 3 |
| Quality education | 2 |
| Climate/weather/seasons | 2 |
| Jobs, NGOs | 2 |
| Tribal culture | 2 |
| Infrastructure | 1 |

# Water Supply

## Expected Changes to the Local Hydrology

Future changes in the amount and timing of precipitation are highly uncertain. Model projections for the Missoula County region show slight increases in precipitation in winter, especially at higher elevations. Summer projections are more variable, with some models showing drier conditions and others showing slightly wetter conditions. On average, precipitation is expected to increase, but not enough to offset the increase in evaporation from higher temperatures. Thus, soil moisture and water levels are likely to decline.

Declines in average snowpack due to higher temperatures and earlier spring warm up are highly certain, especially at lower elevations. As more precipitation falls as rain instead of snow, runoff is expected to occur more quickly, providing less infiltration into soils and ground water stores. Snowpack is an important mechanism throughout the west for storing water into summer months, and as that function is diminished, less water availability in late summer can be expected. With earlier spring runoff and longer hotter summers, late summer stream flow is expected to be lower and warmer.

## Climate Change Impacts

The breakout group working on water quantity issues identified the following as the top concerns:

a. Increased competition and conflict over water. Competition among local uses includes agriculture, fish and wildlife, and residential use. Competition with outside uses and selling of water to outside markets could drive up prices. Low income populations and aquatic species are especially at risk. Farmers and landowners might sell off water rights. New dams might be built, causing negative impacts to fish populations.
b. Declining stream flows and changing runoff timing, and the resulting impacts to riparian and wetland areas, aquatic connectivity, tourism, recreation, business, agriculture, and residential users
c. Warming water temperatures and pollution that affect people, cold water fishes, and other wildlife. Warmer water also causes an increase in aquatic invasive species.
d. Lack of capacity to address problems because the current system of laws and rules is not adequate, especially because there is little capacity, especially with DNRC, for enforcement of current laws and standards.

Some sectors are more vulnerable to changes in water availability during certain parts of the year. Local agriculture, for instance, is likely to become more reliant on irrigation as climate change progresses, and could become less viable with lower water supplies. Areas where all the water is already legally appropriated—such as Lolo, Missoula urban area, and the Blackfoot area—may see more conflict between water users for diminishing water resources.

Missoula County may be pressured to export water to other areas, and costs could rise from an increase in competition, inordinately affecting farmers, residential users, and low-income populations. Higher water competition and lower flows might lead to the construction of new dams, which in turn could have serious impacts to native fish populations and the tourism and recreational industries that rely on those fish populations. Missoula County is at an advantage compared to some other areas, however, because much of the snowpack is found at high enough elevations that it will continue to function, although to a lesser extent, as a valuable water storage mechanism even as temperatures continue to rise.


Clark Fork Coalition

## Recommended Strategies, Actions, and Integration Points

Missoula County residents value clean water and available water to a great extent. Water is a way of life in Missoula County – rivers and lakes provide abundant recreation, sustain local food production, support Native American culture, and provide a scenic backdrop that affects quality of life. Many of the actions that were suggested by local residents, decision makers, and experts at the workshop can work in concert to prevent increased conflict over water and a loss of important services provided by the waterways of Missoula County. Diverse groups such as state and county agencies, city government, conservation organizations, and NGOs might want to partner on such an effort to maximize outreach efforts and overall efficacy.

Each recommended strategy in the following list is supplemented with a suite of actions that can be taken to achieve the given strategy. The groups also identified where synergies can occur, and where conflict may arise, specific to the recommended actions.

While climate change is a new threat, many adaptation strategies can be incorporated into existing planning and management efforts without additional resources. We provided a list of "integration points." These integration points are ongoing efforts and existing groups that can potentially be leveraged or tasked with implementing some or all of the actions that were recommended.

The recommended strategies with the highest level of group support, as well as some suggested actions to achieve those strategies, include the following:

**Strategy #1: Protect, restore, and create floodplains, wetlands, riparian areas, and spawning habitat**

Action 1. Reintroduce beavers into select areas to increase late summer flow, provide natural flood abatement, increase biological diversity, and enhance groundwater recharge.

**Synergies:** increase late summer flows for fish, anglers, and farmers; reduces downstream flood risk, enhances water quality, increases biological diversity

**Conflicts or barriers:** Beavers prone to dispersing to areas where they are not wanted; damage to trees; damage to agricultural infrastructure

Action 2. Create small high elevation dams or beaver-like structures that fulfill the same functions as above. These structures would need to be shown to not impede fish passage and should be placed strategically for maximum groundwater recharge and maintenance of late summer stream flows.

**Synergies:** similar to benefits above

**Conflicts or barriers:** Could impede fish passage if not well-designed

Action 3. Create new wetlands or wetland banks for water storage and filtration purposes.

**Synergies:** Similar to benefits above

**Conflicts or barriers:** None identified

Action 4. Engage with local community, farmers/ranchers, and government officials to increase understanding of the value of wetlands and riparian areas in storing water, providing flood abatement, filtering out pollutants, and providing wildlife habitat.

**Synergies:** Similar synergies as wetland restoration above

**Conflicts or barriers:** Could limit some types of economic development and landowner rights

Action 5. Better protection for floodplains, wetlands and riparian zones, as well as disincentives for developing in these areas.

**Synergies:** Can combine with other outreach efforts on fire risk, water conservation, land stewardship, and other topics

**Conflicts or barriers:** None identified

**Integration points:** Missoula Co. Rural Initiatives: stewardship awards for landowners that protect natural resources. Restoration efforts on public and private land: Trout Unlimited, Clark Fork Coalition, Wildlands CPR, U.S. Forest Service, Blackfoot Challenge. Milltown Restoration and Redevelopment: restoring Clark Fork and Blackfoot floodplain and developing a riverside part near Bonner. National Forest Plan updates and revisions. Neighborhood and community councils. Open Lands Committee.

**Strategy #2: Change water ownership to protect Missoula County values and livelihoods**

Action 1. Prioritize certain uses of water in specific areas, such as residential, agriculture, and in-stream flows for fish. These uses should be prioritized in a sustainable manner, using a legal framework that replaces the current water rights system.

**Synergies:** Water rights might reflect local values and needs; water competition would be minimized, allowing prices to stay lower

**Conflicts or barriers:** Some current water users could lose their water rights

Action 2. Complete ongoing adjudication efforts that will address outdated water rights issues.

**Synergies:** Water competition minimized, allowing prices to stay lower

**Conflicts or barriers:** Some important values might not be represented, such as tourism and recreation

Action 3. Create a system of water trusts and water banks to encourage redistribution and conservation. Water trusts would work similarly to land trusts, with trust holders purchasing an easement on their water rights in exchange for limiting their use of those water rights. Water banks would provide a voluntary mechanism for users to reallocate water where it's most needed through either a credit system or by exchanging water rights.

**Synergies:** Increases landowner control; reduces competition; allows for market adjustments

**Conflicts or barriers:** Land values could decline if water rights are treated separately or sold off

Action 4. Obtain public ownership of municipal water.

**Synergies:** Increases ability to plan for growth and development in a sustainable manner

**Conflicts or barriers:** Water rates may increase

**Integration points:** Grass Valley French Irrigation District: pilot project to "market" water to offset new water uses. Flow restoration programs to change consumptive water rights to in-stream flow: Clark Fork Coalition, Trout Unlimited, MT Fish Wildlife and Parks. Controlled Groundwater Area: petition through the Dept. of Natural Resources and Conservation. Montana Water Policy Interim Committee: creates draft legislation and options for water management for the 2013 Legislature. Mountain Water Company sale: encourage public ownership by offering to buy utility from Carlyle Group. Clark Fork Task Force: updating the state water plan.

**Strategy #3: Education on stewardship and conservation**

Action 1. Provide education to local residents about the finite nature of resources in Missoula County and the need to conserve water and energy, especially as the population grows and climate change progresses. Some suggestions for outreach efforts included (1) informal community gatherings, potentially tied to dances, barbeques, and other engaging events (2) youth-targeted positive and inspiring communications; (3) engagement led by local leadership; and (4) communication coming from local utilities.

**Synergies:** Can combine with other outreach efforts on fire risk, water conservation, land stewardship, and other topics

**Conflicts or barriers:** None identified

Action 2. Communicate with local landowners on stewardship that affects water quality and quantity. Some suggestions for outreach efforts included (1) partnerships among diverse groups to develop local stewardship outreach materials and messages; (2) informal community gatherings with a forum on natural resource management; (3) education that encourages maintenance and development of riparian areas, wetlands, floodplains, and intact forest, for their ecosystem services values.

**Synergies:** Improved land management practices can save money due to water, energy, and other efficiencies; communication could be coupled with communication on forest stewardship, wildfire, and renewable energy

**Conflicts or barriers:** None identified

**Integration points:** Local watershed groups: Rattlesnake, Ninemile, Lolo, Clearwater. Current education programs through Missoula County Rural Initiatives, Missoula Water Quality District, Clark Fork Coalition, Watershed Education Network, Montana Natural History Center. Big Sky Watershed Corps: 3 new AmeriCorps positions in Missoula County working with watershed groups and local landowners on protecting water resources.

**Strategy #4: Provide support to agriculture**

Action 1. Provide education and incentives to improve irrigation methods; reduce sediment, fertilizer, pesticide, and herbicide runoff into waterways; and to buffer riparian zones, conserve native species and habitats, and improve grazing and farming methods to better protect waterways.

**Synergies:** Better working relationships and more compatible messaging; lower prices for local foods

**Conflicts or barriers:** None identified

**Integration points:** Blackfoot River Drought Management Plan. Natural Resource Conservation Service: Farm Bill incentive programs. Community Food and Agriculture Coalition. Local food supporting efforts: community supported agriculture, farmers markets, Farm to School/Farm to College programs. Land and water transactions that provide incentives to landowners for conserving valuable lands or restoring streamflows.

**Strategy #5: Leverage efforts and work collaboratively**

Action 1. Connect groups, locally and regionally, to encourage smart growth, water conservation, and sustainable approaches to land and water management. City government, University management, elected leaders, non-profits, state agencies, and others can come together to develop a whole community approach to water distribution, water use, and water conservation.

**Synergies:** Better working relationships and more compatible messaging

**Conflicts or barriers:** None identified

**Integration points:** Missoula Open Lands Committee. Community and neighborhood councils. Watershed groups, conferences, workshops. Missoula Conservation District.

**Strategy #6: Showcase success stories**

Action 1. Projects should be carried out and used as examples of positive change so local residents can better understand cost savings, ecological benefits, best management practices, and positive stewardship.

**Synergies:** Motivate independent groups and landowners to take effective action

**Conflicts or barriers:** None identified

**Integration points:** Regular conferences, events and workshops around the county, hosted by a variety of groups. Websites: county, partners, non profits, University of Montana.

# Wildfire

## Expected Changes to Wildfire

Wildfire is a natural part of the landscape in Missoula County, and the community has experience with its impacts on human communities, businesses, and infrastructure. Although wildfires will always occur seasonally, climate change is expected to lead to more frequent, larger, and more severe wildfires.

The projections report prepared for Missoula County (see link on pg. 10) describes how climate change is expected to lead to an increasingly early onset of spring—an occurrence that is highly correlated with active wildfire seasons. Other climate change impacts, such as higher average temperatures and more severe drought, will also contribute to larger fire seasons. Some research also points to increased lightning activity due to increased carbon dioxide in the atmosphere, leading to an increase in the frequency of natural fire occurrence.

Higher winter low temperatures (fewer severe cold snaps) have also facilitated bark beetle spread, which many believe will exacerbate fire severity, although the majority of studies have not found increased fire risk subsequent to beetle outbreaks. Human factors also play a part in exacerbating the threat of severe wildfire. Human activities are responsible for 90% of wildfires in the U.S. Decades of residential growth in the Wildland-Urban Interface (WUI) have placed more people and property in harm's way, raising the stakes both in terms of cost and politics of wildfire suppression and forest management.

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## Climate Change Impacts

The breakout group working on forest and wildfire issues identified the following as the top concerns:

a. Increased risk to human safety, especially in the WUI and rural communities, in relation to recreation (camps and trails), and due to loss of access or escape routes during emergencies
b. Declines in air quality that could lead to increased respiratory illness and asthma, especially among the young, elderly, and those with compromised health
c. Rising costs associated with fire suppression, especially as development continues in the WUI
d. Damage to infrastructure and property from extreme fire with disproportional impact on rural communities; Increased insurance cost and declines in property values
e. Loss of economic activity from loss of timber resources, tourism, and recreation
f. Natural resource damage and management challenges due to changes in plant composition, large scale habitat change, loss of soil capacity to hold water causing more sedimentation and runoff, and change in management priority and flexibility
g. Carbon release from forests that exacerbates the magnitude of climate change

The biggest concern with the potential for more severe wildfire is for human health and safety for those directly in the path of wildfire, and from the acute effects of smoke on at-risk populations. Also of concern was insufficient planning capacity, services, and infrastructure that may leave Missoula County vulnerable in the case of increasing frequency or severity of wildfire.

The potential impact on local economic activity and on natural systems was also a concern. The potential loss of timber resources was important to some members, particularly as the timber industry struggles to retain infrastructure and a skilled workforce amid declining logging across the region. Past experience has also shown significant declines in tourism activity during more severe fire years. Wildfire and the associated threats to air quality and natural systems can also dampen the quality of life in Missoula County, an important factor attracting families, businesses, and retirees to the County.

Extreme fires can affect natural systems. Loss of vegetation can cause loss of important habitats for wildlife, species declines and destabilization of soils. Increased runoff and

sedimentation into streams can impact fisheries. While wildfire is a natural and important component of forest ecosystems in the West, uncharacteristically severe wildfire brought on by climate change is expected to release additional carbon into the atmosphere, increasing the magnitude of climate change.

Finally, workshop participants described the potential difficulties with implementing adaptation strategies, and how these challenges can actually become threats themselves. For example, conflict in the community over development restrictions, fees or other financial incentives or disincentives, and over forest management goals may be exacerbated to the point that community services are cut instead of bolstered, and forests are less resilient to fire, rather than more so.

## Recommended Strategies, Actions, and Integration Points

While wildfire is a natural and accepted part of the Missoula County landscape, action is needed to reduce disruptions, costs, and health impacts that could occur with an increase in severity and frequency of wildfire. Many of the actions that were suggested by local residents, decision makers, and experts at the workshop can work in concert to improve land use planning, energy efficiency, water quality, and economic diversity. The list below outlines where synergies can occur, and where conflict may arise, specific to the recommended actions.

The recommended strategies with the highest level of group support, as well as some suggested actions to achieve those strategies, include the following:

**Strategy #1: Integrate education to address multiple aspects of wildfire (Safety, WUI, risk, ecosystem dynamics, behavior, etc.)**

Action 1. Increase access to education about wildfire and the dynamic nature of ecosystems, fire (ecology, history, culture).

**Synergies:** Education on climate change and wildfire can be integrated with other education topics. Education is the top strategy across all threats

**Conflicts or barriers:** None identified

Action 2. Provide demonstration projects and areas.

**Synergies:** Better prepared citizens during emergencies; improved land management practices that lead to lower stress

**Conflicts or barriers:** Budget limitations

**Integration points:** University of Montana College of Forestry: Lubrecht Forest has on-going restoration treatments and fire surrogate studies/demos. Collaborative Forest Landscape Restoration - Southern Crown of the Continent (private land

owners, land management agencies, timber companies, conservation organizations, extension service). Montana Natural History Center education programs.

**Strategy #2: Reduce fire severity**

Action 1. Allow some fires to burn.

**Synergies:** Could result in improved ecosystem health and wildlife habitat

**Conflicts or barriers:** Public resistance to letting fires burn; air quality

Action 2. Use mechanical fuels reduction (thinning) specific to fire risk, forest type, and past management. Apply management in low to mid-elevation forests that mimics natural fire to increase resilience (eg. Biometric fire - Arno's book Mimicking Nature's Fire).

**Synergies:** Using ecological and mechanical techniques to restore natural fire and protect resources will integrate with other strategies to maintain ecological resilience and diversity (fuels reduction reduces insect infestation)

**Conflicts or barriers:** Conflict over appropriateness of thinning

Action 3. Reduce competition within forests for water and nutrients to increase resilience.

**Synergies:** None identified

**Conflicts or barriers:** Human demand for forest resources

**Integration points:** Missoula County budgeting process: incorporate fire costs into annual budget parameters, look for funding opportunities for restoration projects on forest lands. Fuels for schools: wood biomass as a renewable energy or heating source in local schools and the University of Montana (proposed biomass boiler). Good neighbor agreements between federal and private landowners, including federal matching funds for private lands fuel reduction.

**Strategy #3: Limit development in the WUI**

Action 1. Raise tax rates in the WUI to discourage development

**Synergies:** The revenue could be used to protect public health and safety during wildfire events and/or other natural disasters (firefighting, provision of health services related to poor air quality, etc.)

**Conflicts or barriers:** It is politically difficult to raise tax rates.

Action 2. Raise insurance rates in the WUI and/or impose a fire surcharge

**Synergies:** Imposing a fire surcharge would generate funds for wildfire emergency response.

**Conflicts or barriers:** It may not be economically advantageous for insurance companies to raise rates in the WUI.

Action 3. Introduce building and subdivision regulations that limit new subdivisions in the WUI

**Synergies:** Less subdivision in the WUI may limit sprawl and associated factors such as long commutes that increase emissions and subdivision of open space that degrades natural amenities.

**Conflicts or barriers:** It will be difficult to achieve consistency in development standards across the county with many jurisdictions in charge of permitting/review (cities, county, state, and insurance requirements). Also, building and subdivision regulations are sometimes construed as impinging upon private property rights.

Action 4. Conduct research on risk and fire starts associated with the WUI

**Synergies:** Results could be used for education on wildfire and climate change issues.

**Conflicts or barriers:** Funding

Action 5. Map ingress and egress and require multiple options

**Synergies:** Important for emergency response in general

**Conflicts or barriers:** Funding

Action 6. Conduct an analysis of trade offs (homes vs. timber)

**Synergies:** Results could be used for education on wildfire and climate change issues.

**Conflicts or barriers:** Some of the trade offs are related to values and not easily quantified

**Integration points:**
Missoula County subdivision regulations: ensure WUI is incorporated as a consideration in new projects. Research Efforts: Rocky Mountain Research Station, Missoula Fire Lab, University of Montana departments.


Wikimedia commons

**Strategy #4: Improve existing conditions for human health and safety in WUI**

Action 1. Create defensible space and fire resistant homes while maintaining wildlife habitat and visual qualities – Integrate Firewise with local regulations; Provide rebates for fire resistant construction and defensible space; Conduct monitoring of defensible space in WUI.

**Synergies:** Firewise education could be combined with education on other climate change issues.

**Conflicts or barriers:** Expense to landowners. Expenses for local government programs associated with providing incentives and regulations.

**Integration points:** Missoula County subdivision regulations: ensure WUI is incorporated as a consideration in new projects.

**Strategy #5: Foster economic development**

Action 1. Provide replacement areas if recreation providers are shut out of an area due to wildfire, and provide wildfire related ecotourism opportunities.

**Synergies:** Tours of active fires, restoration work as work vacation, bird watching, mushroom picking, medicinal herbs, and other tourist activities in burn areas can be coordinated with tourism ideas for other ecological assets at risk from climate change.

**Conflicts or barriers:** Coordination between land managers.

Action 2. Develop market for biomass energy.

**Synergies:** Economic development integrates with renewable energy strategy.

**Conflicts or barriers:** Biomass energy might conflict with mitigation goals if it results in higher emissions of greenhouse gases.

Action 3. Develop employment programs to remove biomass in a sustainable and ecologically sound manner – Examples include AmeriCorps training and stewardship contracting especially in WUI and areas accessible by road.

**Synergies:** Using ecological and mechanical techniques to restore natural fire and protect resources will integrate with other strategies to maintain ecological resilience and diversity (fuels reduction reduces insect infestation).

**Conflicts or barriers:** Funding

Action 4. Develop value-added markets for restoration products – Examples include blue stain pine, biochar/bio-oil.

**Synergies:** Value-added materials from biomass can reduce transportation (for example, shavings for particle board).

**Conflicts or barriers:** None identified

**Integration points:** Montana Conservation Corps and AmeriCorps programs: provide cost-share for human resources to address forest landscapes, policy, and planning in the County. Fuels for schools: wood biomass as a renewable energy or heating source in local schools and the University of Montana (proposed biomass boiler).

**Strategy #6: Improve forest management**

Action 1. Maintain diversity of habitat and provide displacement habitat to increase overall species resilience.

**Synergies:** Education, incentives, and regulations aimed at directing development away from climate related hazards could also improve habitat. Enhanced tourism and recreational opportunities.

**Conflicts or barriers:** Measureable outcomes need be identified so the effect on species of interest can be assessed.

Action 2. Rehabilitate burned areas – Post fire loss of vegetation and hydrophobic soil contribute to flash flooding and erosion.

**Synergies:** Rehabilitation of burned areas is part of planning for more frequent flood conditions that may result from climate change.

**Conflicts or barriers:** Funding

Action 3. Integrate management of roaded and roadless areas.

**Synergies:** Coordination of land management objectives integrates with objectives for recreation opportunities in the face of climate change and habitat management for climate sensitive species.

**Conflicts or barriers:** Coordination between land managers.

Action 4. Support and invest in Fire Lab; Conduct research on re-burn impacts and on the carbon footprint of firefighting and forest management.

**Synergies:** Results could be used for education on wildfire and climate change issues. The Fire Lab could be an important partner in investigating other questions such as risk associated with the WUI.

**Conflicts or barriers:** Funding

**Integration points:** Collaborative Forest Landscape Restoration project with USFS funds in the Clearwater/Blackfoot. Blackfoot Community Conservation Area (BCCA): includes forest restoration, rotational grazing, educational tours, and more. Research Efforts: Rocky Mountain Research Station, Missoula Fire Lab, University of Montana departments.

**Strategy #7: Improve air quality and reduce exposure to smoke health hazards**

Action 1. Continue air quality alerts throughout the year, and provide smoke-free areas and public transportation to these areas.

**Synergies:** Providing services to at risk populations related to air quality will integrate with other health services related to climate impacts. Public transportation to recreation centers, museums, indoor pools, etc. reducing emissions. Work at home programs designed for smoke emergencies will also reduce emissions.

**Conflicts or barriers:** Funding

Action 2. Use prescribed fire (to reduce fire risk) when inversion days are less common.

**Synergies:** Could result in improved ecosystem health and wildlife habitat.

**Conflicts or barriers:** Public resistance to prescribed fires.

Action 3. Reduce other air quality stressors during fires using emergency response action.

**Synergies:** Public health and safety integrates with strategies for avoiding other natural hazards and extreme events.

**Conflicts or barriers:** Coordination.

**Integration mechanisms:** None identified

**Strategy #8: Store carbon**

Action 1. Use re-growth and large trees to store carbon. Avoid conversion of forest lands to grasslands or shrublands with lower carbon storage potential.

**Synergies:** Forests have significant economic and ecological value as a provider of ecosystem services.

**Conflicts or barriers:** Conversion of forested lands may depend heavily on global greenhouse gas emissions and the magnitude of climate change.

**Integration points:** Climate Solutions University: partnering on a model forest policy program for Missoula County. Missoula County budgeting process: incorporate fire costs into annual budget parameters, look for funding opportunities for restoration projects on forest lands. Collaborative Forest Landscape Restoration project with USFS funds in the Clearwater/Blackfoot. Blackfoot Community Conservation Area (BCCA): includes forest restoration, rotational grazing, educational tours, and more. Research Efforts: Rocky Mountain Research Station, Missoula Fire Lab, University of Montana departments. Montana Conservation Corps and AmeriCorps programs: provide cost-share for human resources to address forest landscapes, policy, and planning in the County.

## Expected Changes to Missoula County Water Quality and Flooding

Climate change is expected to cause changes in hydrological patterns, making future snowfall, runoff, and extreme storm patterns associated with floods less predictable. Model projections for precipitation are less certain than those for temperature, but most models agree on a drier future for Missoula County, especially over the longer term. Despite drier conditions, more extreme weather is expected, including both larger storms and longer, more severe droughts. The risk of flooding could increase as more precipitation falls at once in larger storms with more moisture and energy. A second concern is the potential for increased rain-on-snow events in spring, due to warmer temperatures, which could cause significant spikes in runoff and flooding.

Water quality concerns associated with flooding include an increase in sediment and pollutants washing into streams and rivers during large flood events. These concerns are heightened by infrastructure and industrial development in floodplains, creating potential contamination risks.

## Climate Change Impacts

The breakout group working on water quality and flooding issues identified the following as the top concerns:

a. Larger floods and increased cost associated with floods
b. Increased need for government and emergency services, especially in certain vulnerable areas
c. Infrastructure loss from floods
d. Loss of recreational opportunity and tourism from water quality declines
e. Toxins in the floodwater that affect peoples' health
f. Unprotected floodplains that are open to development, potentially exacerbating issues associated with emergency response and water quality

The biggest concern with the potential for larger and more frequent flooding is for human health and safety, and the costs associated with property damage and emergency response.

Some parts of the County thought to be most vulnerable to flooding impacts included rural areas where floodplains are often not delineated, including the Rattlesnake area, River Road neighborhood, Tower Street, Bitterroot, Seeley Swan, and Jocko. People living in floodplains are especially at risk, as are low-income populations. Insufficient escape routes in certain areas during flood events also exacerbate the risk.

Another major concern is the risk of contamination from residential septic systems and from industrial sites, such as the Smurfit Stone containment ponds, releasing pollutants into raised groundwater and/or surface water during floods, exacerbating the risk to peoples' health.

Fish and wildlife populations are expected to decline as episodic disturbances, including fire and floods, increase. This could lead to a loss of outdoor opportunities such as hunting and fishing if angling resources are damaged, or access becomes more difficult. In turn, tourism could decline, with economic impacts to the local community. Quality of life for local residents who enjoy outdoor activities is also expected to decline, also reducing the attraction for businesses to relocate to or attract workers to Missoula County.

With bigger storms and more rain rather than snow, there is a concern that water will run off more quickly rather than recharging groundwater stores. Channelized streams, disconnected floodplains, and land management that causes compacted soils all exacerbate the threat of more rapid runoff and less groundwater recharge. Increasing wildfires are also expected to reduce infiltration and increase sedimentation, highlighting the need to address multiple threats simultaneously.

## Recommended Strategies and Implementation Actions

Water quality is highly valued in Missoula County. Yet lower late-summer stream flow levels coupled with higher, faster runoff in spring could challenge the efforts to maintain water quality. The recommended strategies for addressing this issue, with the highest level of group support, as well as some suggested actions to achieve those strategies, include the following:

**Strategy #1: Craft a culture of landowner control and education while increasing trust, collaboration and communication between agencies (federal, state) and private landowners**

Action 1. Increase collaboration and reduce redundancy.

**Synergies:** Increased level of trust; cohesive land and water management across boundaries; better coordination during emergencies

**Conflicts or barriers:** Less autonomy for private landowners that participate

Action 2. Education and outreach – Continue advertising and utilizing the PLACE project, and update with new maps, tools, and data on water resources in the County; Use parks, trails, and common areas as examples of how to improve "ecosystem services" like water quality by restoring and protecting riparian areas, native plants, and wetlands.

**Synergies:** Better prepared citizens during emergencies; improved land management practices that lead to lower stress

**Conflicts or barriers:** Budget limitations

Action 3. Assist landowners with goals, such as renewable energy production, land management to reduce erosion and sedimentation of waterways, water conservation, etc.

**Synergies:** Would work well in concert with education and outreach; Could result in reduced emissions, better water quality, improved health and safety, improved wildlife habitat, and better landowner relationships

**Conflicts or barriers:** Budget limitations; trust in government

**Integration points:** Grants for riparian improvements: Missoula Conservation District, Future Fisheries and Dept. of Environmental Quality grants for landowners. Missoula Water Quality District: education, data and technical resources for landowners. Land and water transactions that provide incentives for landowners who conserve land or restore streamflows: Clark Fork Coalition, land trusts, Open Space Bond. Community councils, watershed groups, homeowners associations, and Open Lands Committee: volunteer collaborative boards of local landowners.

**Strategy #2: Retain and enhance natural systems and ecosystem services**

Action 1. Bring diverse groups together to partner and carry out showcase projects and use these projects to educate others. Examples might include: (1) beaver reintroduction in strategic locations, such as headwater streams away from agricultural land, (2) restoration of floodplains to hold high water, (3) wetland creation to increase groundwater recharge, (4) protect and increase spawning habitat.

**Synergies:** Increased understanding of the value of functioning systems such as wetlands and floodplains; Increased public safety; Improved water quality; Increased public involvement in natural resource management

**Conflicts or barriers:** None identified

Action 2. Delineate floodplains for rural communities to assist in better land use and emergency services planning.

**Synergies:** Improved planning and preparedness for emergencies; Improved ability to plan for development that does not exacerbate flood risk; Improved opportunity to protect floodplains for their ecosystem services

**Conflicts or barriers:** Potential increase in insurance rates in certain areas

Action 3. Change forest management policy to increase ecosystem services and natural systems resilience.

**Synergies:** Improved quality of life for outdoor recreationists; Lower cost for providing clean water, flood abatement, fisheries, water storage, etc.; More resilient wildlife populations

**Conflicts or barriers:** Some forestry, grazing, and mining practices may be limited due to their impacts to ecosystem services.

**Integration points:** Channel Migration Zone maps or LIDAR mapping through County or the Missoula Water Quality District. Streamside Management Zone (SMZ) rules for Montana forestry: update to include climate change research. Restoration efforts on working lands with public and private partners: Blackfoot Challenge (Potomac/Greenough), Trout Unlimited (Ninemile), Clark Fork Coalition (Lolo), and National Wildlife Federation (Evaro). Army Corps of Engineers Stream Mitigation Program and Wetland Mitigation Programs.

**Strategy #3: Provide economic incentives for a system of natural flood control**

Action 1. Revenues would need to be created, but would be offset by savings in emergency services. Some revenue streams could come from fees or taxes on tourism in the area.

**Synergies:** Lower cost than traditional water storage and flood control systems; Improved wildlife habitat; Reduced flood risk to communities; Improved ground water recharge

**Conflicts or barriers:** Economic impacts to tourism industry or other targeted population bearing the taxes and fees

Action 2. Study the value of developing in certain areas versus others using a valuation model. Consider transferring development rights (TDR) to promote development in the most appropriate areas.

**Synergies:** Reduced health and safety risk during floods, fires, and other extreme events; Increased efficiency in emergency response; Increased resilience of natural habitats and wildlife

**Conflicts or barriers:** None identified

**Integration points:** Riparian improvement grants through local and state agencies. Missoula subdivision regulations update or revision. Army Corps of Engineers Stream Mitigation Program and Wetland Mitigation Programs. Natural Resource Conservation Service: Farm Bill programs provide incentives for landowners to protect wetlands and riparian areas.

**Strategy #4: Reduce flood impacts to infrastructure**

Action 1. Build new partnerships to increase efficiency and effectiveness of preparedness measures while diversifying available resources.

**Synergies:** Decreased conflict; Increased efficiencies in meeting multiple goals through cohesive planning

**Conflicts or barriers:** None identified

Action 2. Build new revenue streams to support infrastructure maintenance and upgrades to better withstand climate change impacts.

**Synergies:** Increased human safety; Increased water quality; Higher quality of life for residents; Improved long term planning

**Conflicts or barriers:** Potential for economic impacts if resources or populations are taxed

Action 3. Identify vulnerable infrastructure, including wastewater treatment plants, Smurfit Stone ponds, transportation corridors, Stimson lumber, and wells and water lines.

**Synergies:** Increased human safety; improved human health; improved water quality; long-term savings

**Conflicts or barriers:** Increased potential short-term cost to landowners and business for preparing for emergencies

**Integration points:** Missoula County Rural Initiatives PLACE Project: database of existing landscapes and conditions in Missoula County

## Expected Changes to Missoula County Species and Habitats

As the local climate continues to change, species of fish, wildlife, and plants are expected to respond in many different ways. Because changes to natural systems are so complex, it is difficult to predict with certainty how any one species will respond. Yet we know that many species are closely tied to certain types of habitats, and we can use our knowledge of their life history to estimate their potential response. Many approaches to predicting wildlife and plant response to climate change have been developed, including quantitative approaches, such as climate envelope modeling, and qualitative approaches, such as the Adaptation for Conservation Targets (ACT) Framework, which uses a conceptual model and collective knowledge to make management decisions.

For the Missoula County climate change workshop, a group of natural resource managers and scientists were tasked with identifying the likely changes to Missoula County fish, wildlife, and plants. This group used their expertise to develop some general predictions for species and habitats of Missoula County. A more thorough assessment will need to be carried out in order to determine the potential impacts to a whole suite of native species. Such an assessment would allow informed management of many species, including those of economic, recreational, cultural, or management priority.


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## Climate Change Impacts

The breakout group working on species and habitat issues identified the following as the top concerns:

a. Changes to episodic disturbances, such as flooding, wildfire, pest outbreaks, and drought are expected to cause changes in habitat and population declines for many species of fish, wildlife, and plants.
b. Species declines are expected to result in a loss of ecosystem services, including water filtration, flood abatement, pollination, game for hunting, wildlife for recreational viewing, wild food resources, cultural resources for Native Americans, and forest cover for timber harvest and recreation.
c. Water quality and quantity are both expected to decline, resulting in loss of coldwater fishes, other aquatic species, riparian and wetland dependent species, and others.
d. An influx of "climate refugees" (people moving to find more desirable conditions) from other areas is expected to contribute to fragmentation of habitat and additional loss of species and habitats from development.
e. An increase in invasive species and disease due to warmer conditions (especially warmer winters), stressed populations, and less competition from native species.
f. Shifts in habitat as conditions change. Many shifts will be northward or higher in elevation, but others will be less predictable. As habitats shift, fish and wildlife will need corridors and connectivity in order to move to new areas.

Some of the species thought to be most at risk include riparian and wetland dependent species. Higher temperatures will cause increased evaporation, and longer, hotter summers could lead to increasingly dewatered riparian and wetland habitats. Yet these habitats inordinately support high biological diversity, with 95% of species in the area using wetlands and riparian areas. Some representative species include pintails, swans, cranes, hooded merganser, and Lewis' woodpecker. Many amphibians are also at risk.

Alpine species are also at risk as temperatures rise. Alpine habitats are already found at the highest elevations, so upward shifts are not a possibility. Many mountaintop species, including wolverine, pika, and hoary marmot, are already declining throughout the west, and they could disappear as temperatures continue to rise and snowpack declines.

Lower elevation coniferous forest, including Douglas fir and ponderosa pine, was identified as at risk due to increasing wildfire. Some species likely to be affected include flammulated owl, porcupine, lynx,

fisher, gray jay, Clark's nutcracker, and spruce grouse.

Declines in keystone species, such as Clark's nutcracker and Lewis' woodpecker, would have cascading effects on ecological communities because of their important behaviors that provide other species with food or shelter. Declines in predators, such as the lynx and fisher, can also have severe cascading effects. Declines in bats and birds not only can affect other wildlife, but also can have serious effects on crops and gardens because they provide insect control.

Increasing pests, disease, and invasive species were all concerns due to the cost associated with controlling invasions and outbreaks. Also of concern are the potential loss of wood products to beetles and other pests, wildlife declines from disease, and the increasing cost of weed and pest control in agriculture. People are also at increased risk from vector borne disease with warmer temperatures.

## Recommended Strategies and Implementation Actions

Fish, wildlife, and plants are expected to respond to a changing climate, often in unexpected ways. Many of the recommended strategies for climate change adaptation for natural resources are simply to reduce some of the current stressors to these species and habitats in order to increase their resilience as climate change progresses. If we maintain or increase intact habitat, connectivity, species diversity, and population size, we expect that many species will be able to shift and adapt rather than disappear. The recommended strategies with the highest level of group support, as well as some suggested actions to achieve those strategies, include the following:

**Strategy #1: Maintain and enhance intact riparian, wetland, and forest habitat by encouraging land use planning. Maintain intact grassland and forest habitat to decrease invasive species spread.**

Action 1. Identify key areas that are important for high biological diversity, current population strongholds, future potential strongholds, corridors, connectivity, buffers, ecosystem services, rare and endangered species, and important ecological function. Increase protection of these areas.

**Synergies:** Maintain ecosystem services; increase species and habitat resilience; maintain outdoor quality of life; support tourism industry

**Conflicts or barriers:** Budget limitations; development or land use could be limited in certain areas

Action 2. Replicate Blackfoot Challenge effort of bringing together different groups to improve community cohesiveness, collaboration, and conservation.

**Synergies:** Reduces conflict over limited resources; Increases community cohesiveness; Leads to sustainability; Increases land, water, and energy conservation

**Conflicts or barriers:** None identified

Action 3. Restore native species and habitats by reducing stressors that cause degradation.

**Synergies:** Maintain ecosystem services; common area restoration and landowner involvement; increase species and habitat resilience; maintain outdoor quality of life; support tourism industry

**Conflicts or barriers:** Limits activities on private and/or public lands

Action 4. Restore wetlands and improve stream flow by reintroducing beavers at high elevations.

**Synergies:** Maintain ecosystem services; increase species and habitat resilience; maintain outdoor quality of life; support tourism industry; reduce flood risk

**Conflicts or barriers:** Beaver control efforts may become necessary if they disperse to undesirable areas

Action 5. Remove incentives for subdivision while increasing incentives for conservation. Institute an impact fee for activities with negative impacts to wetlands and riparian areas.

**Synergies:** Allows for better land use planning. Potentially reduces tendency to build in high risk or sensitive areas such as floodplains and fire-prone slopes

**Conflicts or barriers:** Prices of rural homes could rise

**Integration points:** Restoration efforts on working lands with public and private partners: Blackfoot Challenge (Potomac/Greenough), Trout Unlimited (Ninemile), Clark Fork Coalition (Lolo). Voluntary drought response plan: Blackfoot River. Missoula County subdivision regulation update or revision process. Missoula Weed District: incentives for removing noxious weeds and surveys of aquatic invasive species. Land conservation efforts through local land trusts and the Missoula County Open Space bond. Bull Trout Recovery Plan: U.S. Fish and Wildlife Service plan to restore or maintain critical bull trout habitat in rivers and streams.

**Strategy #2: Manage forest lands (public and private) to enhance and maintain diversity, complexity, and connectivity**

Action 1. Monitor and control invasive species – Regulate nursery distribution of invasive species; Regulate and inspect boats for invasive aquatic species such as zebra mussels; Increase detection of noxious weed spread; Improve grazing practices to decrease invasive species spread; Follow principles of

Integrated Weed Management; Enhance and protect desirable native plant communities from invasion; Develop new biocontrols.

**Synergies:** Improves range quality for cattle; Can reduce wildfire risk; Increases resilience of native species; Prevents substantial future cost of control and loss of natural resources

**Conflicts or barriers:** Requires substantial funding and staff resources

Action 2. Increase land use planning for communities

a. Plan for wildlife connectivity (crossing structures, blocks of intact habitat, higher density residential development to maintain open space, etc.).

b. Leverage conservation efforts by connecting groups locally and regionally (CFC, Missoula OLC, Smart Growth, MWCC) and integrating efforts. Reach out to sporting groups, stock growers, health professionals, alternative energy leaders, etc.

**Synergies:** Increases options for providing wildlife connectivity and large blocks of open space; Reduces flood and fire risk to residents; Reduces cost of public services, including fire control, schools, sewer, etc.; Reduces water quality issues from septic systems

**Conflicts or barriers:** Could limit options for development on private land

Action 3. Incorporate climate change, and specifically the increased need for maintaining diversity, complexity, and connectivity, into existing planning processes – Lolo National Forest Plan and Region 2 MT FWP/State FWP Comprehensive Plan.

**Synergies:** Low cost because planning already occurs; More realistic and achievable goals; Maintain quality of life for local residents; Supports tourism industry

**Conflicts or barriers:** Difficult topic to discuss within agency groups

**Integration points:** National Forest Plan Updates. Missoula County Open Lands Committee. Rocky Mountain Research Station studies and projects. Lubrecht Experimental Forest through the University of Montana's College of Forestry.

**Strategy #3: Foster and maintain healthy and compatible socioeconomic conditions**

Action 1. Increase economic resilience of the region by working with agriculture, tourism, recreation and other sectors.

**Integration points:** Community Food and Agriculture Coalition: mitigation programs for preserving productive ag lands. Missoula Redevelopment Agency and local community development corporations: tools to renovate existing structures and land, rather than using new land for development. Neighborhood councils and community councils.

**Strategy #4: Increase education and outreach**

Action 1. Interact with local food growers to work in concert with wildlife/biodiversity maintenance, incorporate native plants, maintain and enhance riparian habitat, reduce sediment runoff and erosion, etc.

Action 2. Interact with tourism industry to enhance conservation efforts and work collaboratively to create new conservation and recreational opportunities.

Action 3. Develop and communicate local stories that illustrate economic, natural systems, and lifestyle impacts (Five Valleys Land Trust example); develop showcase projects with positive messaging.

Action 4. Increase communication and outreach to elected officials and increase funding streams for conservation through taxes, easements, Land and Water Conservation Fund, and other avenues.

Action 5. Link climate change mitigation efforts to climate change adaptation efforts.

Action 6. Link to conservation and climate change curriculum for Confederated Salish and Kootenai Tribes.

**Integration points:** Missoula County Rural Initiatives PLACE Project: online database of existing landscape and habitat conditions. University of Montana and Rocky Mountain Research Station: link students and citizens to ongoing science and reports in the region. Confederated Salish and Kootenai Tribes' education programs.

## Expected Changes to Missoula County due to Global Change

Many of the impacts to Missoula County from climate change are expected to originate outside the region. In an increasingly globalized economy, global market forces can have substantial local effects (both positive and negative). Climate change is expected to affect many of the nation's food growing centers, for example, causing disruptions in food supplies due to severe heat, drought, storms, or flooding. This, in turn, will affect local food prices and competitiveness of local farmers in the larger market. Similarly, climate change is expected to increase the need for air conditioning in summer, which could in turn lead to higher energy prices.

While the likely impacts of climate change to Missoula County are severe, they pale in comparison to many of the impacts being faced by other parts of the nation. Many low lying coastal areas, for instance, will be inundated or battered by storm surges as sea level rises. Some parts of the arid Southwest could soon run out of water. Still other parts of the nation are expected to experience more severe hurricanes, heat waves, and other natural disturbances.


## Global Change Impacts

The breakout group working on global issues identified the following as the top concerns:

a. More people moving to the area due to sea level rise and other climate change impacts in other parts of the nation
b. Increased demand for domestically produced energy, leading to increased land use for local production and new transmission corridors
c. Increased demand for water from a growing population
d. Higher land prices making it more expensive to produce local food
e. Disproportionate effect of climate change on low-income populations

Missoula County, with its high mountains and bountiful clean rivers, is likely to be resilient in the face of climate change. Much of the snowpack will be retained because of the high elevation of surrounding peaks, allowing for continued water storage in the form of snowpack. The topographic complexity of the area will allow many native wildlife and plant species to shift to new areas and continue to find suitable habitat in the area. Coniferous forest is expected to persist into the future, providing a long-term source of wood products and recreational opportunities. Missoula is already an attractive place for people to move to, and it is expected to increasingly attract new residents, especially as other areas in the nation that are less resilient are hit by droughts, floods, high temperatures, or rising sea levels.

Many workshop participants were concerned about more people moving to the County and overtaxing local resources, including water, local food production, wood products, energy, land, and health and emergency services. In turn, quality of life for individuals may be reduced as the area becomes more crowded. Greater competition for land, water, and energy could lead to higher prices and this could affect local businesses, agricultural producers, rural residents, and others. Low-income populations would be especially at risk if prices for many day-to-day necessities were to rise substantially. Many retirees are attracted to the area and more expensive energy coupled with higher temperatures may cause health risks for elderly people who cannot afford air conditioning.

Increasing national energy demand is likely to lead to an increase in local production of renewable and carbon-based energy in Missoula County. As lands are used for energy production and transmission, native wildlife and plants are expected to become stressed and decline, with especially severe impacts to protected and sensitive species, such as birds, native trout, or amphibians. This can lead to unintended conflicts between different adaptation priorities. While local renewable energy production and transmission can be positive, the production facilities and transmission lines may reduce wildlife habitat, fragmenting populations already stressed by current land use, water

use, land management, and residential and energy development.

Some areas especially at risk include rural areas (such as Seeley Lake, Frenchtown, Potomac, Huson, Lolo), agricultural lands, and private lands. A lack of land use planning in rural areas is expected to exacerbate the impacts of a growing population. Public lands (USFS and BLM) and conserved lands (Montana Legacy Project, for example) are expected to be less at risk from global change impacts. There could be pressure, however from the growing population to undo current conservation efforts like easements and open space, and to increase energy development on public lands.

Floodplains and fire prone hillsides are increasingly at risk from development, and the cost of protecting homes from floods and fire is expected to rise substantially as natural disasters become more severe or more frequent. Public systems in rural areas, including emergency services, schools, health services, water distribution systems, septic and sewer systems, and transportation systems are vulnerable.

## Recommended Strategies and Implementation Actions

As climate change progresses at the global and national level, people are likely to move to areas of lower stress and greater resources. Recommended strategies to prepare for population growth could experience wide support because the County has already experienced fast growth over the previous decades. The recommended strategies with the highest level of group support, as well as some suggested actions to achieve those strategies, include the following:

### Strategy #1: Revise growth strategy for the County and improve land use planning

Action 1. Establish a broad based working group that reviews and suggests revisions to the County growth strategy. Factors to take into consideration include (1) expected climate change impacts, (2) low income populations, (3) local values, (4) water resources, (5) likely versus desired rates of population growth, (6) agriculture, (7) wildlife, and (8) long term transportation needs.

**Synergies:** Would incorporate new knowledge on climate change impacts; Could reduce conflict among different groups

**Conflicts or barriers:** Could limit options on some private lands

Action 2. Use Smart Growth principles to develop density designs that are attractive and highly functional; Provide incentives for cluster development, community water and sewer systems; bring realtors and developers on board.

**Synergies:** Benefits efforts to maintain open space and habitat connectivity; Reduces water quality impacts; Increases walkability and human health

**Conflicts or barriers:** Could be more expensive than traditional development

Action 3. Use land use planning and tools, including zoning and other regulation, to maintain habitat connectivity for wildlife, maintain agricultural lands, and protect riparian areas, floodplains, and watersheds.

**Synergies:** Maintains water supply and quality; Maintains habitat connectivity for fish, wildlife, and plants; Protects homes from flooding; Preserves agricultural lands for food security

**Conflicts or barriers:** Limits options on some private lands

Action 4. Remove incentives for some subdivisions

**Synergies:** Reduces cost of emergency services in rural areas; Maintains habitat connectivity for fish, wildlife, and plants

**Conflicts or barriers:** None identified

**Integration points:** Open Lands Advisory Committee: appointed county citizens advising Commissioners on open space and agricultural issues. Montana Water Policy Interim Committee: exploring options for encouraging community water/sewer systems before the 2013 Legislature; Missoula County subdivision regulation revision opportunities.

**Strategy #2: Develop education and incentives program around saving energy, water, and natural resources. Provide education on climate change. Become a sustainable community.**

Action 1. Help households conserve energy through free energy audits and consultations.

**Synergies:** Reduces impacts to low income residents from energy cost increases

**Conflicts or barriers:** None identified

Action 2. Include energy consumption as a factor when considering competing bids for County and city projects.

**Synergies:** Supports sustainable business

**Conflicts or barriers:** Potentially higher cost

Action 3. Target youth with positive messages and education on conservation of water, energy, and natural resources. Use science and technology to increase efficacy.

**Synergies:** Reduces impacts to low income residents from energy cost increases

**Conflicts or barriers:** None identified

Action 4. Work with utilities to develop outreach and communication materials on energy and water conservation.

**Synergies:** Reduces impacts to low income residents from energy cost increases

**Conflicts or barriers:** None identified

Action 5. Replicate Blackfoot Challenge model of outreach and collaboration across the community for effective conservation.

**Synergies:** Reduces impacts to low income residents from energy cost increases

**Conflicts or barriers:** None identified

Action 6. Reframe the message of "zoning" – develop new approach and terminology that allows for sustainable land use planning while supporting individual rights. Work collaboratively.

**Synergies:** Maintains water supply and quality; Reduces conflict; Protects homes from flooding; Preserves agricultural lands; Maintains habitat connectivity for fish, wildlife, and plants

**Conflicts or barriers:** None identified

**Integration points:** Missoula Co. Rural Initiatives: stewardship awards for landowners that protect natural resources. Non-profit Community: provide educational courses through MUD, Clark Fork Coalition, Watershed Education Network, Montana Natural History Center, etc. Northwestern Energy: free audits and weatherization kits. Green Blocks and Cool Green Home Awards: incentives for homeowners on energy and water efficiency. City of Missoula Conservation and Climate Action Plan for Municipal Operations: a mitigation plan. Incentives through Missoula Conservation District or Missoula Weed District for landowners.

**Strategy #3: Support diversified business, job growth, services, and manufacturing**

Action 1. The Best Place Project has already begun to work to attract and retain jobs. This effort should also consider how it can best integrate with the other needs and strategies outlined in this report. For instance, businesses that use a lot of energy and/or water might be lower priority compared to those that bring in renewable energy or promote local agriculture.

**Synergies:** Increases collaboration across sectors; Incorporates climate change into ongoing planning processes

**Conflicts or barriers:** None identified

Action 2. Develop an association of local businesses that can act as "business incubators". They could identify needs and offer funding and training for individuals interested in starting new businesses.

**Synergies:** Could coordinate with efforts to increase sustainable timber products and renewable energy

**Conflicts or barriers:** Could lead to more energy, water, and land use with negative impacts to tourism, native species and local quality of life

Action 3. Promote and support outdoor recreation and tourism; develop adaptation tools for continued tourism when wildfires occur – identify backup areas in case of wildfire, develop activities like mushroom picking and bird watching in burned areas, and encourage restoration work in burned areas.

**Integration points:** Best Place Project: economic coalition formed to attract new, diverse businesses to Missoula. Sustainable Business Council: membership organization promoting sustainable events and opportunities. Missoula Downtown Association: membership organization supporting a livable, viable urban community.

**Strategy #4: Develop new, sustainable, and wise uses for timber resources, including products and energy; Support renewable energy technology and development in a sustainable way that maintains quality of life for local residents.**

Action 1. Provide start-up loans, remove barriers to entry, and help develop markets for businesses that provide value-added wood products, such as small diameter timber products, blue stain pine, biochar, biofuel, etc.

**Synergies:** None identified

**Conflicts or barriers:** None identified

Action 2. Expand technologies for micro-hydro energy production (need to assess feasibility, timing for flows, impacts, etc.).

**Synergies:** None identified

**Conflicts or barriers:** None identified

Action 3. Provide incentives, streamline permitting processes, and remove barriers for renewable energy production. The County could work with NCAT and AERO on the issue.

**Synergies:** None identified

**Conflicts or barriers:** None identified

**Integration points:** University of Montana and local school biomass heating projects. National Forest Plan updates. Collaborative Forest Landscape Restoration Project in the Blackfoot/Clearwater.

**Strategy #5: Support agriculture, land conservation, and the local food movement**

Action 1. Help develop local food processing to address future transportation costs and support local agricultural production.

**Synergies:** Brings in new business while reducing greenhouse gas emissions

**Conflicts or barriers:** None identified

Action 2. Provide incentives and other support for Community Supported Agriculture, farm-to-market programs, downtown gardens, etc.

**Synergies:** Brings in new business while reducing greenhouse gas emissions

**Conflicts or barriers:** None identified

Action 3. Increase future food security by conserving lands for agriculture, similar to conserving open space and park lands.

**Synergies:** None identified

**Conflicts or barriers:** None identified

Action 4. Support efforts on farms and ranches to protect riparian zones, provide wildlife habitat, improve grazing methods, improve irrigation efficiency, and other sustainable practices.

**Synergies:** None identified

**Conflicts or barriers:** None identified

**Integration points:** Community Food and Agriculture Coalition: farmland mitigation proposal. Expand or support Farmer's Markets, Farm to College, Farm to Schools, and Community Supported Agriculture programs. CFAC (Community Food and Agriculture Coalition).

# CONCLUSIONS AND NEXT STEPS

Missoula County is home to storied rivers, landscapes, and wildlife—as well as nearly 110,000 people. Residents recreate, work, and live alongside unparalleled natural beauty, and the majority of citizens cite quality of life as the reason they live in Missoula. This quality of life is highly dependent on functioning natural systems that provide clean water, wildlife, protection from wildfire and floods, and aesthetic qualities.

Despite having some of the healthiest populations of fish and wildlife in the West, Missoula County is faced with increasing stressors from land use, population increase, and climate change. The region is already experiencing disturbances from climate change, as measured by higher temperatures, reduced snowpack, lower stream flows, flashier floods, and thirstier forests.

The ClimateWise process allowed residents, leaders and experts of Missoula County to use science to assess what changes are most likely and how they might impact people and the natural resources they rely on. The group identified some of the greatest threats to be increasing wildfire, changing species and habitats, lowered water availability and water quality, increased risk of floods, the spread of disease, pests, and invasive species, and local impacts from global change.

Because climate change is a relatively new threat to the region, it is important to incorporate the latest information and projections for change into our ongoing planning structures and processes. By doing so, we can move away from planning for continued historic conditions and instead, begin to plan for changing and

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more variable conditions. Such an approach increases the robustness of the planning effort regardless of actual future trajectories, thereby resulting in a more resilient citizenry, economic base, and natural environment.

We hope this integrated report offers a first step towards brokering climate change planning for resource-rich and socioeconomically diverse Missoula County. Actions that will benefit the people of Missoula County go hand-in-hand with the actions that will keep our water and land clean and healthy: preventing residential flooding by restoring floodplains, meadows, and wetlands; protecting the recreation economy by keeping water in streams; keeping people safe from wildfire by improving development practices in the Wildland-Urban Interface; and preventing cost increases for insurance and public services by improving land use practices.

Continued efforts related to this report include development of a more detailed implementation summary, discussions with County officials about ongoing planning processes for integrating this work, communication with elected leaders on climate change impacts and strategies, and other outreach activities. Through this effort, we plan to build a durable constituency in Missoula County dedicated to protecting our community, economy, and invaluable natural resources for the long haul.