The Economic Impact of Climate Change in Montana

Prepared for

Montana Wildlife Federation

by

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Executive Summary

Climate change is real; it is largely human caused, and it continues to impact Montana. Using the Intergovernmental Panel on Climate Change 6th Assessment, the 4th National Climate Assessment, and the Montana Climate Assessment, among many other sources, we present the climate changes that Montana will see by mid-century under the "business-as-usual" scenario. Here, using the convention from the Montana Climate Assessment, we will use mid-century to mean 2040-2069 for all of the impacts discussed. This is a scenario where we do nothing globally to mitigate climate change, and impacted sectors of the Montana economy do not adapt to avoid, minimize, and mitigate the impacts of climate change. We then look at sectors of the Montana economy that will be impacted by climate change and use the best available science to look at how those sectors will be economically impacted. Specifically, we analyze the economic impacts of climate change on outdoor recreation, natural amenities, and tourism.

Climate Change in Montana

We will begin by focusing on two readily observable impacts of climate change in Montana: changes in temperature and precipitation. The general trend in Montana, like the national trend, is that Montana will get warmer. Montana is projected to see a temperature rise of at least 6° F by mid-century. This temperature increase will be greater in the winter and summer, with August seeing the largest projected change. Precipitation patterns are a little less well understood, but generally precipitation in Montana will increase. Warm air can hold more moisture than cold air, so more moisture is carried into the state during the winter, and spring months, which is not offset by the reduced moisture during the summer months. The best available science suggests that autumn through spring will be warmer and a little wetter, and spring and autumn will come earlier, while the summers will be hotter and drier.

Montana is predicted to get more annual precipitation by the middle of the century. Montana is projected to receive an increase of about two inches per year of precipitation, as well as an increase in the frequency of extreme precipitation events. This predicted increase in precipitation is not uniform over the different seasons: it's likely that autumn, winter, and spring will see increases in monthly precipitation, whereas summer will see a decrease in monthly precipitation. Scientists project 150% more two-day heavy rainfall events by mid-century. Although fewer hail days are expected, a 40% increase in damage potential from hail results from an increased occurrence of large hail in the spring months. As winter warms, there will be more rain-on-snow events, which leaves less snow in the mountains, changing the timing and intensity of annual hydrologic cycles driven by snowmelt.

How Climate Change Will Impact Recreation, Natural Amenities, and Tourism.

Hunting

Climate change already impacts hunting in Montana. In 2022, Montana saw the lowest total number of hunters as well as the lowest total harvest, which is consistent with national trends.[1] While elk and other ungulates are fairly resilient in the face of climate change, increasingly severe weather, long-term warming trends, increasing fragmentation of habitat, and human population growth and habitat loss all combine to create a challenging landscape for big game hunting in Montana. With winter coming later, warmer autumns allow deer and elk to stay in the high country longer and in some places, experience higher survival rates. This behavior could increase the cost to local landowners and tribes as larger numbers of deer and elk that stayed in the high country for hunting season move down into the valleys to winter on their land. Traditional hunting and management strategies in Montana will have to evolve. Climate-driven variability in severe winter weather also adds to wildlife stress and can increase mortality of big game species, including antelope, mule deer, and elk.

Sport Fishing

When snow melt occurs earlier in the year, and more precipitation in the wintertime comes as rain instead of snow, peak stream flows occur earlier in the year. This will leave less water in the streams during the summertime, leaving cold water fisheries subject to extended periods of stress and reducing angler opportunities. Summers are projected to become longer, more extreme, and generally hotter. As a result, streams and rivers in Montana are projected to become warmer with much lower flows and lower water depths. Montana fish will become stressed and unable to compete as well against invasive species. A 2022 comprehensive study of Montana fishing projects a fish population decline of 35% in cold-water fishing, which includes all trout fishing, with Westslope Cutthroat declining by 65%. When fish populations decline and rivers close, local residents will be forced to fish the few remaining cold streams, and tourists will either change their timing or stop coming to Montana to fish.

Winter Recreation and Snow Sports

While Montana is projected to warm by 6° F on average by mid-century, the state is projected to warm even more during the winter, particularly in the western, mountainous portion of the state. The winter will start later, end earlier, and there will be more rain-on-snow events. All of this will impact the quality of skiing in Montana. The 2011/2012 ski season was one of the warmest on record, and as a result, it saw the fewest ski days of any year between 1992-2020. New projections show that skiing in Montana will decrease

[1] Resident hunting licenses have only decreased slightly in the past seven years, but their participation in hunting, based on 2022, would indicate that resident hunters may hunt less based on conditions.

by a little more than one month (33 days) when averaged across all of the ski areas in Montana. Since other areas of the western U.S., such as Colorado and Utah, have ski areas with significantly higher elevations and significantly higher *base area elevations*, Montana will have a hard time competing for non-resident skiers. Locals will have a significantly shorter ski season due to climate change.

Wildfire: Impacts on Visitors, Residents, and Potential Residents

Wildfires in Montana are largely dictated by temperature and precipitation. Increases in temperature and decreases in summer precipitation will leave Montana forests more vulnerable to forest fires. Consecutive days of high temperatures combined with earlier snowmelt and a longer, drier summer season will likely lead to increased forest fires. Montana is projected to see an increase of 8-10 days of “extreme fire danger” by mid-century. The top five fire years in the U.S., ordered by largest acreage burned, have all occurred since 2006, with the top three since 2017. If we look at only Montana, the top five fire years in recorded history have occurred since 2004. Living with wildfires will become more common, and additional human and property losses are to be expected. In addition, smoke and particulate pollution from the fires may make Montana a more unhealthy, uncomfortable, and unattractive place to live and visit.

The Relative Importance of Different Sectors of the Montana Economy

The Economic Value of High-Quality Environments

For a long time, there has been a debate about conserving natural environments, especially relative to natural resource development. This is particularly true in Montana. Recent studies of rural counties in the Western U.S. with federally protected forests, like wilderness, wild and scenic rivers, national monuments, and national parks, show a real and measurable economic benefit associated with those protected lands. Drawing on the 37 Montana rural counties in the study shows that more than $2.3 billion in personal income was added because of the protected national forests, which comes out to $3,770 more per person per year in counties near protected areas. The average personal incomes in these counties were higher due to a change in the dominant industries in the West as citizens in these places are increasingly employed in the high-tech and healthcare industries. Companies that want high-quality employees are located in the high-quality natural environments that those employees demand.

Outdoor Recreation

Montana’s natural landscapes bring in large numbers of tourists to places like Yellowstone National Park, Glacier National Park, and other outdoor attractions. In 2021, 12.5 million non-residents visited Montana, spent an estimated $5.22 billion, and contributed 10% of all employment in Montana. If we look at a narrower set of economic indicators and focus on people traveling to Montana for outdoor recreation, then visitor spending was about $2 billion and supported almost 70,000 jobs. Serious damage to the visitor economy would have major impacts on the overall Montana economy.

The Role of Different Segments of the Outdoor Recreation Sector in the Montana Economy

Montanans and the people who visit Montana recreate in a variety of ways, as evidenced by the top three sectors in the Montana outdoor industry, which are the purchase of multiuse apparel, boating/fishing, and RVing. The people who are employed in Montana because of outdoor spending facilitate these activities by staffing the places where people stay, eat, and spend their money on gear, as well as curate experiences, such as conducting guided explorations of Montana's robust public and private lands.

The Role of the Yellowstone and Glacier National Parks in the Montana Economy

If we focus on Yellowstone and Glacier National Parks as "travel regions," then we see that these regions, of which there are 6 in Montana, received the highest percentage of non-resident travel spending in 2019 and 2021, with 32% and 27%, respectively, which added up to more than $2.5 billion. In Glacier Country, a travel region consisting of 8 northwestern Montana Counties, non-resident travel expenditures supported almost 12,000 jobs, and garnered almost $315 million in labor earnings in 2021, and in Yellowstone Country, a travel region consisting of 6 south-central Counties, non-resident travel supported more than 13,000 jobs and garnered almost $400 million in labor earnings.

The Role of Wildlife Viewing in the Montana Economy

Nationally, the number of wildlife watchers[2] increased by about 20% when comparing 2011 to 2016. The days away from home watching wildlife increased by about 15% from 2011 to 2016, and the total wildlife-watching expenditures increased by almost 30% from 2011 to 2016. The data on Montana wildlife-watching suggests that about half of Montanans view wildlife annually. The estimated economic impacts on Montana of wildlife viewing in 2021 (including multiplier impacts) were about 11,100 jobs and $295 million in salaries and wages.

The Role of Hunting in the Montana Economy

Big game hunting nationally decreased by 16% in terms of number of hunters, 35% in terms of number of hunting days, and 26% in terms of hunting expenditures. Montana Fish, Wildlife, and Parks produced a survey in 2016 that estimated that big game hunting in Montana produced 3,300 jobs and $324 million in expenditures annually (about $366 million in 2021 dollars).

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[2] "Wildlife watching" is defined by The Fish and Wildlife Service: "The 2016 Survey uses a strict definition of wildlife watching. Participants must either take a "special interest" in wildlife around their homes or take a trip for the "primary purpose" of wildlife watching. Secondary wildlife watching, such as incidentally observing wildlife while pleasure driving, is not included. Two types of wildlife-watching activity are reported: (1) away-from-home (formerly nonresidential) activities and (2) around-the-home (formerly residential) activities. Because some people participated in more than one type of wildlife-watching, the sum of participants in each type will be greater than the total number of wildlife watchers. Only those engaged in activities whose *primary* purpose was wildlife watching are included in the Survey." U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

The Role of Sport Fishing in the Montana Economy

Sport fishing in Montana in 2020 (including multiplier impacts) supported about 6,282 total jobs. The salaries and wages associated with those jobs were about $205.3 million. Nationally, the number of anglers in the U.S. increased from 2013 to 2023 by 15% and within Montana by 16%.

The Role of Winter Sports in the Montana Economy: Skiing, Snowboarding and Snowmobiling.

Winter outdoor recreation in Montana extends beyond downhill skiing, snowboarding, and snowmobiling. It includes cross-country skiing, snowshoeing, backcountry skiing and camping, ice climbing, and other winter activities. There is very compelling data to support the idea that as winter gets shorter and warmer, with more rain-on-snow events, people will recreate less in Montana during the winter. Montana winter recreation, in 2016, was the source of 5,093 jobs and $342 million in value added in 2021 dollars.

Estimated Impacts of Climate Change on the Recreation-Tourism Economy

In the analysis below, we combine the best available quantitative information with expert judgment to produce estimates of the likely economic costs associated with climate change in Montana if no steps are taken to reduce human greenhouse gas (GHG) emissions. That expert judgment is tied to a half-century of experience analyzing the Montana economy, the role that natural and social amenities have played in contributing to economic vitality in Montana, and long-run economic trends within the state and region. We now turn to the estimation of the potential economic impact of a “business-as-usual” policy strategy that makes no attempt to moderate or reduce the cumulative impact of GHG pollutants on those natural landscapes, wildlife, recreation, and tourist activities they support.

Visitation to Yellowstone and Glacier National Parks

One of the most disruptive impacts of climate change on Montana’s recreation and tourist activities is wildfire. Wildfires are expected to be larger, more intense, and more frequent, and to burn in more months of the year than just July and August. We project the impact of a 15% decline in visitation to Yellowstone and Glacier National Parks due to wildfire and wildfire smoke. The impact of forest fires and climate change results in the loss of more than 3,800 jobs and $107 million in labor earnings (Table ES-1).

Wildlife Viewing and Other “Sight-Seeing” Activities

Wildlife viewing will be affected by all of the climate change impacts that are likely to reduce visitation to Montana’s National Parks: active fires, fire suppression activity, and heavy smoke, reducing visibility and making it unhealthy to engage in outdoor activity. With a larger range of alternative sites in Montana to visit for wildlife-watching, we have reduced the percentage impact from what we projected for Montana’s National Parks to 15%. The loss associated with

climate change is projected to be more than 1,600 jobs and more than $44 million in labor earnings annually (Table ES-1).

Hunting

As discussed above, climate change and other human impacts will make late October to late November big game hunting season more difficult and, over time, perhaps less productive. Warmer temperatures and greater variability of snowfall during that period will lead to elk and other ungulates staying in the high country more distant from roads, making tracking animals quite difficult, and making it more difficult to protect meat from spoilage. Hunters will be forced to change their behavior in response to ecological conditions, and many may quit hunting entirely. Absent changes in human behavior and hunting regulations, we project that big game hunting could decline by a fifth to a quarter. This impact is associated with a decline of 495 jobs and a loss of almost $15 million in labor earnings annually (Table ES-1).

Angling and Sport Fishing

As discussed above, lower winter snowpack, rain-on-snow events during the winter and spring, and warmer springs and early summers will shift peak streamflow to earlier in the year, leaving summer streamflow lower while summer temperatures are generally hotter and extreme for longer periods of time. Water temperatures in streams and lakes will rise, stressing native fish populations. This will lead to more limitations on fishing, such as regulations that reduce daily hours when fishing is allowed or the closure of certain water bodies to fishing. We estimate that as a warmer, drier spring and summer climate continues to develop, at least 30% of angling activity may be lost. We project a loss of almost 1,900 jobs and a decline of more than $60 million in labor earnings annually, occurring by mid-century (Table ES-1).

Winter Sports: Skiing, Snowboarding, and Snowmobiling

Lower snowpack and no snow at lower elevations, combined with warmer winters with more precipitation falling as rain, threatens to undermine the attractiveness of downhill skiing and snowboarding in Montana. Additional snowmaking equipment may be used if the temperature is low enough, but this is unlikely at many ski areas' lower elevation bases. At higher elevations, more snowmaking may be possible, but is costly and may require additional water rights. As a result of this loss of reliable snow cover, we project the loss of 19% of skiing and snowmobiling days and spending. We project that almost 1,000 jobs will be lost and a decline in labor earnings of $35 million annually (Table ES-1).

Table ES-1

Projected Economic Losses Due to Climate Change in Compnents of Montana Recreation and Tourism Activities		
	Jobs	**Labor Earnings (millions $)**
Glacier and Yellowstone NP Visitation	3,831	$107
Wildlife Watching	1,665	$44
Big Game Hunting	495	$15
Fishing	1,885	$62
Skiing and Snowmobiling	968	$35
Total	**8,843**	**$263**

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Structure of this report

This report opens with the most up-to-date climate projections available for the state of Montana. This is the backbone of how climate change is projected to change Montana, and it is applied to sectors of the economy that we analyzed associated with outdoor recreation, natural amenities, and tourism.

Global Climate Change and Montana Impacts

The Intergovernmental Panel on Climate Change (IPCC) released their Sixth Assessment Report in March 2023.[3] In the 6th assessment, the IPCC made clear that human-caused greenhouse gas (GHG) emissions were the dominant cause of the observed warming of the earth since the mid-20th century. On July 3, 2015, at the Lindau Nobel Laureate Meetings, a group of 39 Nobel Winners from different scientific fields signed a declaration warning that the world faces a threat that is comparable to the nuclear threat of nearly 60 years ago for which a similar group of Nobel Laureates signed a warning declaration.[4] In the declaration, the Nobel Laureates expressed their confidence in the fifth IPCC report, calling it the "the best source of information regarding the present state of knowledge on climate change."[5]

What has become increasingly clear is that there is no longer a credible debate among scientists who study climate change. Climate change is happening; the primary driver of climate change is human GHG emissions, and unless humans collectively do something about it, every inhabitant of earth will be affected by it. In this report, we seek to understand what the likely impacts of climate change will be on tourism and outdoor recreation in Montana.

The Fourth National Climate Assessment (NCA4) was published in 2018 by the U.S. Global Change Research Program.[6] In that assessment, the state of Montana was grouped with the Northern Great Plains states (MT, WY, ND, SD, NE).[7] While this is an improvement over the Third National Climate Assessment – the northern plains were broken out – it still leaves

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[3] IPCC. AR6 Synthesis Report (SYR).https://www.ipcc.ch/report/sixth-assessment-report-cycle/
[4] Mainau Declaration 2015 on Climate Change. http://www.lindau-nobel.org/wp-content/uploads/2015/07/Mainau-Declaration-2015-EN.pdf
[5] Ibid.
[6] USGCRP. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.
[7] Conant, R.T., D. Kluck, M. Anderson, A. Badger, B.M. Boustead, J. Derner, L. Farris, M. Hayes, B. Livneh, S. McNeeley, D. Peck, M. Shulski, and V. Small, 2018: Northern Great Plains. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 941–986. doi: 10.7930/NCA4.2018.CH22 The eastern two-thirds of Montana is part of the Great Plains geographic region. The western and southwestern third, from the eastern foothills of the Rocky Mountains to the Montana-Idaho border is often classified as part of the Pacific Northwest or Northern Rocky Mountain geographic region.

Montana grouped with a fairly large and diverse geographic portion of the U.S. However, the Montana Climate Assessment (MCA) released in 2017 is Montana-specific,[8] and we use these projections of future climate change in Montana as a basis for our analysis. These predictions were made using the same climate models and the same scenarios that the IPCC reports use but apply them to much smaller geographic regions.

The scenario on which we are focusing our study is "RCP 8.5" in the MCA and NCA4 mentioned above. Scenario RCP 8.5 is the closest to what is traditionally called the "business-as-usual" scenario. It is a scenario that "is generally associated with higher population growth, less technological innovation, and higher carbon intensity of the global energy mix,"[9] which means that these models assume that the citizens of the world do not come together to try and abate the collective emissions of the many different countries. The result is a mean U.S. temperature rise of 9° F or more by the year 2100.[10] These projections are especially extreme for Montana, as with most of the northern latitudes of the U.S. To see what is in store for Montana, we must examine more specific regional climate models. It should be noted that the dates that we are looking at do not always align. In a perfect world, all the scientists would choose to look at the same dates for their different climate change predictions. However, in practice, they do not all choose the same dates. Wherever possible, we choose to present the projections that are as close to 2055 as possible. Although the dates of the different projections do not always match up, the trend of the change is consistent.

In some sectors of the economy, this "business-as-usual" approach makes a lot of sense because of the unknown reliability of decentralized adaptations and their costs. In other sectors of the economy, there appear to be recognized adaptations that may help avoid, minimize, or mitigate the impacts of climate change at an affordable cost. Because the predicted impact of climate change can be mitigated to some degree, any forward projections that incorporate the impact of climate change always make assumptions. This does not mean that analysis of those "business-as-usual" impacts is not useful.[11] This report is meant to highlight what will likely happen if nothing is done to address climate change and adaptation is either not possible or is

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[8] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. 2017.

[9] USGCRP. 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4. 2018. Page 6.

[10] USGCRP. 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Page 42

[11] Projections that are often made about the negative economic impacts of reducing the use of coal or other fossil fuels suffer from the same weakness: They assume, for instance, that if a coal mine or an electric generator is shut down that all associated jobs and earnings are lost forever. The adaptation of the economy to provide those energy services from other sources, e.g. renewable resources, improved energy efficiency, less carbon intensive fuels, etc., and the reemployment of the now under-utilized labor and capital resources in other valuable economic activities are typically ignored when projecting job and payroll losses.

perceived to be too expensive. It is within this complex backdrop of future climate conditions and the economic implications of those climate changes that we investigate the potential economic cost of climate change in Montana.

Climate Change in Montana

We will begin by focusing on two readily observable impacts of climate change in Montana: changes in temperature and precipitation. The general trend in Montana, like the national trend mentioned above, is that Montana gets warmer. Precipitation patterns are a little less well understood, but generally precipitation in Montana increases. Warmer air can hold more moisture than cold air and will likely allow more moisture to be carried into the state during the autumn, winter, and spring months. Scientists predict that this increase in precipitation will not be offset by reduced moisture during the summer months, and Montana will receive a net increase in precipitation.

1. Temperature Changes in Montana

Montana is projected to see a temperature rise of at least 6° F by mid-century.[12] This temperature increase will be greater in the winter and summer, with August experiencing the largest projected change.[13]

Montana is predicted to see an increase in the number of days when the temperature exceeds 90° F. The western portion of the state will see the lower end of the extreme heat (mainly due to the mountains), while the central and eastern portions of the state see the higher end of the extreme heat days. By mid-century, northwestern and north-central Montana will experience 11 more days at or above 90° F, and south-central and eastern Montana will see 33 more days.[14]

Montana is predicted to have fewer extreme cold days where the temperature drops below 10° F. In the southwestern parts of the state, there will be 20-30 fewer days, while the rest of Montana will see 15-25 fewer days.[15]

Montana is predicted to have fewer days where the temperature drops below 32° F, which are labeled “frost-free days.” The western portion of Montana will see an increase of 41 days, and

[12] Here, mid-century is taken to mean 2040-2069. Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 46.
[13] Ibid. Figure 2-11, Page 49.
[14] Ibid. Page 50.
[15] The time period for these projections is slightly altered and “mid-century” here is 2041-2070. Kunkel, Kenneth & Stevens, Laura & Stevens, Scott & Sun, Liqiang & Janssen, Emily & Wuebbles, Donald & Kruk, Michael & Thomas, Devin & Shulski, Martha & Umphlett, Natalie & Hubbard, Kenneth & Robbins, Kevin & Romolo, Luigi & Akyuz, Adnan & Pathak, Tapan & Bergantino, Antony & Dobson, J. Regional climate trends and scenarios for the US National Climate Assessment: Part 4. Climate of the US Great Plains. NOAA Technical Report NESDIS 142–4. 2013. Figure 18, Page 45.

the eastern portion seeing an increase of 32 days.[16] Pederson suggests that these predictions about the direction and magnitude of temperature trends in Montana have already begun:

> "With a demonstrated increase in number of "hot" days (≥32.2◦C) experienced per year across western Montana, it follows logically that a reduction in number of "cold" days per year should be evident. With few exceptions, western Montana meteorological stations have experienced a decrease in annual number of freeze/thaw days (Tmin ≤0◦C), and extremely cold days (Tmin ≤ −17.8◦C). The average loss of number of days at or below the freeze/thaw threshold (Tmin ≤0◦C) in western Montana is approximately 16 days, declining from an average of ∼186 to ∼170 days−yr. The sharpest decline in the number of freeze/thaw days has occurred within the last 20 years."[17]

The overall trend for Montana is that the autumn through spring will be warmer and a little wetter, while the summers will be hotter and drier. This trend has already begun and is increasing, as Pederson points out. The distribution of temperature changes is not homogenous: the northeastern portion of the state receives the most severe changes, and the mountainous west receives slightly less dramatic changes.

2. Precipitation Changes in Montana

As noted above, the predicted change in precipitation is a little less certain within the more geographically detailed Global Climate Models (GCM). This uncertainty is largely related to the models' ability to capture multi-year cyclical events that can have large influences on the moisture that Montana receives as well as the precipitation increases associated with elevation. With respect to the elevation changes, this primarily impacts western Montana.[18] The Pacific Decadal Oscillation, El Niño, and La Niña are examples of multi-year cycles that impact Montana but are poorly represented in the climate change models.[19] Because of the lack of clarity associated with these cyclical events and, in part, because detailed climate records only go back 60 years (which doesn't capture enough of the multi-year cycles to make the projections as precise as we would wish), precipitation is modeled with less confidence than temperature going forward.

Montana is predicted to get more precipitation by the middle of the century. For the "business-as-usual" scenario (RCP8.5), Montana is projected to receive an increase of around

[16] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. 2017. Page 52.
[17] Pederson et al. A Century of climate and ecosystem change in Western Montana: what do temperature trends portend? *Climate Change*. 98:133-154. 2010.
[18] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 54.
[19] Ibid. Page 9.

two inches per year of precipitation.[20,21] The western half of the state is projected to receive slightly more (an additional 0.2 inches) precipitation compared to the eastern half of the state. The increased precipitation is not uniform over the different seasons. Autumn, winter, and spring will see increases in monthly precipitation, while summer will see a decrease in monthly precipitation.[22] There will be an increase of about 50% of two-day heavy rainfall events by mid-century. Although fewer hail days are expected, a 40% increase in damage potential from hail "due to more frequent occurrence of larger hail is predicted for the spring months."[23] As was discussed earlier, the increase in winter precipitation is closely linked to the temperature changes that are predicted for Montana's winters. As the winters become warmer, more moisture can be carried into Montana in part because warm air can carry more moisture.

As Montana's winters become warmer, more precipitation will fall as rain than snow. Headwater Economics, in its report on the climate impacts on the Montana skiing and sport fishing industry, sums up the predicted changes in precipitation succinctly:

> "Changes in precipitation patterns are predicted to include a greater proportion of winter precipitation falling as rain than snow, decreased snow season length at most elevations, decreased spring snowpack, earlier snowmelt runoff and peak streamflow, increased frequency of droughts and low summer flows, and amplified dry conditions due to increased evapotranspiration, even in places where precipitation increases, as mentioned above. These changes have important implications. Historically, moisture delivered through snowmelt provided inputs to aquifers, rivers, and streams gradually throughout the summer."[24]

This recap of winter changes is echoed by Lackler who projects a change in the median number of skiable days at Montana ski areas to drop by as much as 51 days (at Great Divide) and by an average of 33 days for all ski areas in Montana.[25] How the different sectors of the Montana economy will deal with the temperature and precipitation changes in the future is an open

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[20] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 55.
[21] USGCRP. 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Page 954.
[22] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 58.
[23] USGCRP. 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Page 954.
[24] Headwater Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. January, 2011. Page 19.
[25] Lackler, C Geerts, B, and Wang, Y. Impact of Global Warming on Snow in Ski Areas: A Case Study Suing a Regional Climate Simulation over Interior Western United States. American Meteorological Society. February 2021. Table 2.

question. The ability of many industries in Montana to adapt is unknown. In this report, we take the same approach as the climate modeling that we relied on for the temperature and precipitation changes. That is, we assume a "business-as-usual" approach to the Montana economy and assume that some portion of the impacted sectors will decline due to a changing climate to which they cannot adapt.

We will begin this section by examining how the conditions described above will likely impact different sectors of the Montana economy that may be vulnerable to climate change. Climate change will not affect all industries equally and climate change will be experienced differently across Montana. We have focused on a group of sectors of the Montana economy that are potentially more vulnerable to climate change. We will begin by looking at how the climate changes projected for Montana by the best available science are likely to impact those industries. Then we will look at the potential economic implications of those impacts.

We will focus on sectors of the Montana economy that are tied to Montana's unique natural resource base: recreation/natural amenities (winter sports, fishing, and nature-based tourism), and forested landscapes and wildfire.

I. How Climate Change Will Physically Impact Recreation, Natural Amenities, and Tourism

1. Wildlife: Hunting and Fishing

A. Hunting

Comprehensive economic data on hunting in Montana is increasingly hard to find. Although we do not have the same detailed Census Bureau data that has been available in the past, on the spending of hunters in Montana, we can look at the sale of hunting licenses and fishing licenses in Montana.[26] While there is no detailed state data, the Census Bureau does, however, produce national data on hunting. That data shows a decrease in the number of people who hunt overall and hunt big game, as well as a decrease in both total spending and spending per hunter.[27] What the Montana hunting license data show is that resident licenses are declining slightly, but that the increased revenue from out-of-state licenses more than makes up this gap with respect to Montana hunting license fees.

> "For fiscal years 2019 through 2022, [Montana] Fish Wildlife and Parks (FWP) has seen a slight decrease in resident license sales in both hunting and fishing licenses. The primary contributor of revenue to the General License Account (GLA) continues to

[26] Montana Fish Wildlife and Parks. LICENSE FEE INCREASE AND RESTRUCTURE LEGISLATIVE REPORT 2015 LEGISLATIVE SESSION – HB 140. September 2022 https://fwp.mt.gov/binaries/content/assets/fwp/aboutfwp/legislature/2023/hb140report-25-biennium-update.pdf

[27] Census Bureau. National Survey of Fishing, Hunting, & Wildlife-Associated Recreation: 2016. October 2018. Page 6. https://www.census.gov/library/publications/2018/demo/fhw-16-nat.html

be the Non-Resident Combination licenses (Big Game, Elk Combination, and Deer Combination)."

Nationally, at the same time that there has been a decrease in the number of hunters, the number of people who watched wildlife increased 20% while their expenditures increased 29%.[28] Although the Census no longer reports on big game hunting at the state level, Montana Fish Wildlife and Parks, in 2016, did.[29] Big game hunting typically starts in Montana with archery hunting in September and rifle hunting in the last week of October. Rifle hunting season has historically coincided with the beginning of reliably cooler weather and the first snowfall of the year.

White-tailed deer and elk appear to be resilient in the face of climate change since they possess the ability to adapt to a variety of different environments. The impact of climate change on mule deer is far less certain. Geographic differences show large variations in the health of mule deer populations in the U.S. and Canada, and their ability to remain resilient with respect to climate change is an open question.[30] For white-tailed deer and elk, climate change may reduce stress during their critical spring fawning and calving seasons, which will likely be warmer and begin earlier. Warmer temperatures may move elk farther into the high country for longer periods of the year.[31] This means that hunters will have to travel farther to find the game that they are pursuing. Scientists also predict autumn in Montana will be warmer and winters will be shorter. This means that there will be less fresh snow on the ground that allows hunters to track big game. It also means that big game will stay longer in the high country when, in the cooler past, they would have been pushed toward the valley floor in search of better foraging as snow accumulated in the high country. All these changes will make successful big game hunting more demanding in terms of time and effort, which may discourage some hunters and cause others to quit hunting entirely. Although the deer and elk may be able to survive in a changing world, the hunting tradition that Montanans have grown up with for many generations may be dramatically altered. This takes on special significance to the indigenous people of Montana, who rely on the harvest of native game, fish, and plants to maintain a spiritual and cultural relationship to the land. Several species may be found in different locations than they have historically been because of climate change.[32]

The lack of cold temperatures and the implications of climate change on big game hunters in Montana have not gone unnoticed by the Montana hunting population. In fact, 2022 saw the

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[28] Census Bureau. National Survey of Fishing, Hunting, & Wildlife-Associated Recreation: 2016. October 2018. Page 6. https://www.census.gov/library/publications/2018/demo/fhw-16-nat.html
[29] Montana Fish Wildlife and Parks. The Economics of Big Game Hunting in Montana. 2016. https://mtfwp.maps.arcgis.com/apps/Cascade/index.html?appid=0fa1de4222074cdeb7dbf0710ecb2ee0
[30] Durkin, P. Are Mule Deer Going Extinct? MEATEATER. 9.10.2020. https://www.themeateater.com/hunt/big-game/are-mule-deer-going-extinct
[31] The Wildlife Management Institute. Beyond Seasons' End: A Path Forward for Fish and Wildlife in the Era of Climate Change. 2009. Page 76.
[32] The Confederated Salish and Kootenai Tribes. Climate Change Strategic Plan. August 2020. Page 61. https://drive.google.com/file/d/1q6eBDCrBz3kxcdgFtxLxpqf8qeK89Oth/view?pli=1

lowest total number of hunters as well as the lowest total harvest, despite being called “ideal” hunting conditions with a high success rate at the Augusta check station.[33] This result, that the lowest total number of hunters was found in 2022, since the early 1980s, although anecdotal, is one that should be critically examined.[34] There are many factors influencing the decision to hunt and the success of the hunt. Because of these factors, a much more sophisticated analysis needs to be completed before conclusions can be drawn about how hunting in Montana has changed due to climate change. For example, the number of hunters that put in for special elk permits in 2022 was at an 8 year low, but the total harvest for the state of Montana for elk in 2022 was above the 19 year average for which data is available.[35]

One consequence of the predicted shorter period of cold weather and snow in Montana is that more elk calves and deer fawns will survive cold spring weather. This may help to explain the growth in overall elk and deer populations in Montana.

> “The statewide elk objective is 92,138 animals. The Department of Fish, Wildlife, and Parks estimates there were 170,000 elk in Montana in 2020. Montana law requires that FWP manage elk populations in a way that reaches sustainable population objectives.”[36]

It is outside the scope of this study to comment on the population and distribution of elk and other big game species in Montana, however, the authors note that any analysis of this issue must include considerations of population size in both time and space. Often, issues arise when agricultural producers are in conflict with elk or when hunters are unable to access the ungulates due to land ownership. If, in the face of climate change, elk and other ungulates change their behavior in ways that make them less accessible to hunters on public and private land, hunters will be discouraged and their economic benefits to the state will decrease.

Reduced hunter success may mean the expansion of elk and deer populations such that they cause increased conflict with landowners and reduce the social carrying capacity for their existence on the landscape.[37] This may mean that more large herds of elk move on to ranch- and farmland during the peak of the shorter winter after hunting season (again, assuming hunting seasons and regulations do not change). We understand this is a specific concern on

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[33] Murray, D. Despite ‘ideal’ conditions, 2022 sees record low hunting numbers. Great Falls Tribune 12.6.2022. Accessed 3.21.2023. https://www.greatfallstribune.com/story/news/local/2022/12/06/lack-of-hunters-drives-down-big-game-harvest-despite-ideal-conditions/69704682007/

[34] The number of Montana residents that purchased hunting licenses from 2019-2021 only declined slightly, and the numbers for 2022 were reported on a fiscal basis instead of a calendar year basis which dramatically deflates the data. It is possible that the low hunter numbers were related to climatic conditions that discouraged hunters from using their licenses. The license data does not present the same decrease as the Hunting Check Station data.

[35] Montana Fish Wildlife and Parks. Harvest Estimates. Accessed 9.25.2023. https://myfwp.mt.gov/fwpPub/harvestReports and Montana Fish Wildlife and Parks. Drawing Statistics. Accessed 9.25.2023https://myfwp.mt.gov/fwpPub/drawingStatistics

[36] Denworth, C. Elk Population counts at “crisis level” in Montana. Northern Ag Network. 6.3.2021. https://www.kbhbradio.com/news/elk-population-counts-at-crisis-level-in-montana Accessed 4.10.2023.

[37] Op. cit. “Beyond Season’s End,” pp. 76-77.

the Confederated Salish and Kootenai Reservation where producers experience increased deer and elk depredation on crop land, and increased fence damage in general on their reservation.[38] Landowners across the state experience similar conflicts. The risks of disease transmission (e.g., brucellosis in the Greater Yellowstone region) and game damage to crops and forage will be elevated, resulting in greater pressure on wildlife managers to implement late season, as well as early season, hunts to move the elk off ranchland.[39]

New shoulder season regulations for elk hunting in Montana now allow hunting in special districts both before and after normal "rifle" season in Montana. There are 11 "fundamental objectives" that the Montana Fish, Wildlife, and Parks use to guide this change in hunting access which include:

- Manage elk populations to objective as rapidly as possible.
- Increase harvest of elk, where appropriate.
- Address problematic distributions of elk and elk harvest.
- Enhance free public access to bulls and cows on private land during the general seasons.
- Reduce exclusive access to elk.
- Reduce hunter impacts on landowners.
- Simplify rules and regulations.[40]

We spend time on the changing regulations associated with elk hunting in Montana because it is exactly those sorts of the changes in Montana big game hunting regulations that were evident in our 2015 version of this report.[41] Just as Montana agriculture has adapted to more winter wheat, the use of pulse crops, changing their stocking volumes of cattle, etc., so, too, has Montana Fish, Wildlife, and Parks. Adaptation is a critical strategy for mitigating climate change in Montana, but at some point, adaptation will no longer be possible. This is why combating climate change is so critical.

B. Sport Fishing

Many of the climatic changes that are projected for future winters will spill over into summer recreation activities. One of the most profound changes is projected to be instream flows. Currently, streams in Montana are predominately fed by melting snowpack in the mountains. When the melting occurs earlier in the year and more precipitation in the wintertime is coming as

[38] The Confederated Salish and Kootenai Tribes. Climate Change Strategic Plan. August 2020. Page 75. https://drive.google.com/file/d/1q6eBDCrBz3kxcdgFtxLxpqf8qeK89Oth/view?pli=1
[39] FWP Montana. Elk Shoulder Seasons. Accessed 4.10.2023. https://fwp.mt.gov/hunt/elk-shoulder-seasons
[40] FWP Montana. Elk Shoulder Seasons. Final Elk Season Guidelines. Accessed 4.10.2023. https://fwp.mt.gov/hunt/elk-shoulder-seasons
[41] Power, T. and Power, D. The Impact of Climate Change on Montana's Outdoor Economy. December 2015, prepared for the Montana Wildlife Federation by Power Consulting.

rain instead of snow, the peak stream flows will come earlier in the year.[42,43] This leaves less water in the streams during the summers, which are projected to be longer and hotter. As a result, the streams and rivers in Montana are projected to become warmer with much lower flows and lower water depths.

Cline summed up the potential for climate change to impact cold, freshwater fishing in this way:

> "Freshwater fisheries (commercial, subsistence, and recreational) have enormous social, ecological, and economic importance worldwide, yet the natural systems that support them (e.g., climate, weather, and ecosystems) are being rapidly transformed by global climate change. Shifts in species distributions in response to climate change have been documented for a broad range of organisms, especially ectothermic species like fishes that are strongly tied to water temperature. Such climate-induced range shifts may change the distribution of fishing opportunities across landscapes, requiring fishers to adapt by catching different species or fishing in new locations. Globally, extreme climatic events (e.g., droughts, storms, heat waves, and wildfires) are increasing in frequency and severity and may also affect fishing opportunities by affecting fishers' decisions on where and when to fish."[44]

In fact, as the first version of this report[45] was being prepared at the beginning of July 2015, river restrictions for anglers were already being put into place in July rather than in mid- or late-August. This was the earliest that river restrictions for anglers had ever been put into place in Western Montana.[46] Since 2015, more scientific studies have been carried out on fishing in Montana, and the results are disheartening. A comprehensive study of Montana fishing was conducted in 2022, and that study projects a decline of 35% in cold-water fishing habitat, which includes all trout fishing.[47] Because of the timing of the spawning of Bull Trout, which are currently listed as a threatened species and cannot be fished for in Montana,[48] the combination of warming water and the seasonality and timing of streamflow, Bull Trout populations are

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[42] Saunders, S. and Easley, T. Glacier National Park In Peril The Threats of Climate Disruption. Prepared by the Rocky Mountain Climate Organization and National Resource Defense Council. April, 2010. Page 14.

[43] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 123.

[44] Cline, T. et al. Socioeconomic resilience to climatic extremes in a freshwater fishery. *Science Advances*. September 2022. https://www.science.org/doi/10.1126/sciadv.abn1396

[45] Op. cit. Power consulting, December 2015, prepared for the Montana Wildlife Federation.

[46] Chaney, R. 'Hoot-owl' restrictions limit fishing time on Bitterroot, Blackfoot, Clark Fork. Missoulian, July 1, 2015. Accessed 4.10.2023. http://missoulian.com/news/local/hoot-owl-restrictions-limit-fishing-time-on-bitterroot-blackfoot-clark/article_e80d722a-0779-5f0b-9562-456cbf7994f5.html

[47] Cline, T. et al. Socioeconomic resilience to climatic extremes in a freshwater fishery. *Science Advances*. September 2022. https://www.science.org/doi/10.1126/sciadv.abn1396

[48] U.S. Fish and Wildlife Service. Bull Trout. General Information. Accessed 9.25.2023. https://ecos.fws.gov/ecp/species/8212#:~:text=Bull%20trout%20are%20currently%20listed,%2C%20Nevada%2C%20Oregon%2C%20Washington.

projected to fall by as much as 90%.[49] Westslope Cutthroat trout are also projected to decline by as much as 65%.[50]

As streams become warmer and the runoff comes earlier in the year, native Montana fish will become stressed and unable to compete as well against invasive species.[51] As the earlier timing of high water flows, higher water temperatures, the timing of the hatches that the fish feed on, and an increased incidence of disease impact the native fish of Montana that have evolved in Montana streams, other invasive species that are more suited to the "new normal" will be able to outcompete native Montana fish. For fish like Westslope Cutthroat, it may not be simply competition but the interbreeding with Rainbow Trout (non-native) that ultimately leads to their decline. Since the two can interbreed and because the "hybridization spread rapidly and was strongly linked to interactions between climatic drivers—precipitation and temperature,"[52] the Westslope Trout now occupies less than 10% of its historic range.

The impact is then not only on the native species of fish in Montana but also on the people of Montana and the people who come to Montana to fish on the rivers. As mentioned above, when rivers become too warm, the fish become stressed and can die from a combination of heat and stress. The high temperatures of the rivers and streams in Montana are caused by a combination of low water and high heat (prolonged warm weather events) that are typical of August in Montana. Or they can be caused by prolonged high heat events beginning in July or earlier. This was the case in 2016:

> "In 2016, Montana Fish Wildlife and Parks closed a 184-mile (296-km) stretch of the Yellowstone River because increased water temperatures led to a massive fish kill. The die-off was attributed to a proliferative kidney disease caused by the warmer temperatures."[53]

As one would expect, when there are closures and/or restrictions put on fishing, the number of angler days of fishing decreases. A report by Headwaters Economics[54] found that when there were angling restrictions in place on the Blackfoot River (Western Montana) in 2001 and 2007, the angler days of fishing activity dropped by 42% in 2001 compared to 1999 and by 26% in 2007 compared to 2005. In the years when there were no fishing restrictions, the angling days

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[49]Headwater Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. Page 22. January, 2011. And Saunders, S. and Easley, T. Glacier National Park In Peril The Threats of Climate Disruption. Prepared by the Rocky Mountain Climate Organization and National Resource Defense Council. April, 2010. Page 19.

[50] Ibid. page 19.

[51] Headwater Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. January 2011. Page 23.

[52] Muhlfeld, C., Kovach, R., Jones, L. *et al.* Invasive hybridization in a threatened species is accelerated by climate change. *Nature Climate Change* 4, 620–624. 2014. https://doi.org/10.1038/nclimate2252

[53] Adams, A., Byron, R., Maxwell, B., Higgins, S., Eggers, M., Byron, L., Whitlock, C. Climate change and human health in Montana: a special report of the Montana Climate Assessment. Bozeman MT: Montana State University, Institute on Ecosystems, Center for American Indian and Rural Health Equity. 216 p. https://doi.org/10.15788/c2h22021. 2021. Page 18.

[54] Headwater Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. Page 35.

on the Blackfoot largely recovered to a more stable value of about 18,000 angling days[55] from the 13,000 angling days in the years with angling restrictions in place.

In the 2022 Cline study on the socioeconomic resilience of fisheries in Montana, researchers projected a 30% decline in cold water habitat that will be available for trout by 2080 and an accompanying decline of $192 million in associated spending (30% of the 2017 spending on fishing in Montana).[56] Again, this does not account for adaptation within the industry, merely the potential for lost spending if conditions change as predicted. In the Cline study, they point out that non-resident spending on fishing is driving the recreational fishing industry in Montana. On average, non-residents spend $690 a day compared to residents who spend only $90 per day. The FWP data on fishing licenses shows that non-resident licenses have been at the same level or exceeded resident licenses in the last seven years.[57] If the rivers cannot support the fish, then non-resident money will simply go someplace else. Currently, when there are fishing restrictions on rivers in Montana, those non-residents can and do simply fish for trout at other rivers that hold cold water and do not have restrictions on them. However, if all of the rivers in a specific region are restricted, out-of-state anglers may choose to go somewhere else. In fact, non-residents fished cold water sections of river – that hold trout – at 10 times the rate that they fished other cool water stretches, which speaks to the appetite for out-of-state trout fishing preferences.[58] If those cold-water rivers either have restrictions, or no longer have trout, then the out-of-state anglers will seek outdoor recreation opportunities somewhere else.

Naturally, the health of a fishery is the main driver of fishing activity, and a collapse of a popular fishery will reduce fishing activity. When the introduction of Mysis shrimp into Flathead Lake led to the loss of the Kokanee salmon fishery there, fishing on that lake fell precipitously to 40% of its previous level, from a high of over 100,000 angler days in 1983 to a low of 38,000 in 2005.[59]

The impacts of climate change on the fishing industry in Montana were summed up by Headwater Economics:

- Restricted fishing seasons and seasonal closures.

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[55] "Estimates of angling days by waterbody are developed biannually from a systematic survey of anglers conducted by MT FWP. The estimation system defines an angler day as one angler fishing one body of water for any length of time in a given day." Headwater Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. Page 64.
[56] Cline, T. et al. Socioeconomic resilience to climatic extremes in a freshwater fishery. *Science Advances*. September 2022. https://www.science.org/doi/10.1126/sciadv.abn1396
[57] Montana Fish Wildlife and Parks. LICENSE FEE INCREASE AND RESTRUCTURE LEGISLATIVE REPORT 2015 LEGISLATIVE SESSION – HB 140. September 2022 https://fwp.mt.gov/binaries/content/assets/fwp/aboutfwp/legislature/2023/hb140report-25-biennium-update.pdf
[58] Cline, T. et al. Socioeconomic resilience to climatic extremes in a freshwater fishery. *Science Advances*. September 2022. https://www.science.org/doi/10.1126/sciadv.abn1396
[59] Headwater Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. p. 33. By 2007, angling days on Flathead Lake had begun to rebound.

- More conflicts among irrigators, anglers, fishing guides, and municipalities for increasingly scarce water.
- Degradation and loss of habitat due to warming water temperatures, post-fire sediment and debris flows, and increased frequency of extreme events such as floods and late summer drought.
- Smaller fish stocks and smaller fish.
- Increased disease.
- Displacement and cross-breeding of native trout with non-native species.
- Negative economic impacts on fishing guides, stores, restaurants, hotels, and other businesses that sell goods and services to anglers.[60]

2. The Winter Recreation Season: Snow Sports

As discussed above, Montana is projected to have warmer winters and those winters changes will be greater than the average change across the entire year. By mid-century, scientists predict there will be more than 40 additional frost-free days in western Montana and at least an additional 30 frost- free days for the state as a whole.[61] These additional frost-free days indicate a pronounced shift in the length of winter. With at least 30 more frost-free days, the winter season is projected to be at least a month shorter. Warmer, shorter winters mean that the modest increase in precipitation will be falling as rain instead of snow. A study on the climate impacts on the winter tourism economy in the U.S. clearly spells out what this could mean to winter recreation in Montana:

> "By the end of the current century, winter temperatures are projected to increase an additional 5° F to 7° F under a higher emissions scenario if delays in development of renewable energy continue. As a result, snow depth is expected to decline 50% to 100% in the southwestern mountains and between 10% and 50% in the northwestern part of the state relative to 1960–1990 averages. The severe declines in winter snowpack will undoubtedly stress water resources, which will limit the viability of snowmaking as an adaptation strategy."[62]

A study on the potential for climate disruption in Glacier National Park, which is adjacent to Whitefish Mountain Resort, Montana's second largest ski area, appears worse for the winter and Glacier's winter snowpack. By 2089, Glacier National Park's winters are projected to be more than two months shorter and we can assume the similar patterns across the entire Crown of the Continent area.[63] Snowpack is projected to melt 41 days earlier and have 70 fewer days where

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[60]Ibid. Page 23.
[61] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 53.
[62] Burakowski, E. and Magnusson, M. Climate Impacts on the Winter Tourism Economy in the United States. Prepared for Protect Our Winters (POW) and the National Resource Defense Council. December, 2012.Page 26.
[63] Saunders, St., and Easley, T. Glacier National Park In Peril The Threats Of Climate Disruption. Prepared for the Rocky Mountain Climate Organization and the National Resource Defense Council. April, 2010. Page 13.

snow covers the ground. When snow does not cover the ground, the albedo, or light-reflecting ability, of the ground fundamentally changes and more heat can be absorbed by the far darker bare earth and rock. This creates a positive feedback loop that amplifies the melting and the warming of the snowpack, accelerating snowmelt while also providing a longer period for soils and vegetation (future fuels) to dry out.

The impact of shortened winters in places that have winter tourism economies can be profound. The 2011/2012 ski season was one of the warmest on record, and as a result it saw the fewest skier days of any year between 1992-2020.[64] The causal link between winter snow and ski area visits is not surprising, but it is important. It is not mere speculation that when snow conditions at ski areas are poor, ski activity falls dramatically. A comparison of skier days during high snow years and low snow years at ski areas around the nation documents this impact. The historical difference between good and bad snow conditions was estimated at over a billion dollars in ski area revenues and 13,000 to 27,000 jobs nationwide.[65] This is very likely an underestimate of what the impact of worsening snow conditions at ski areas due to climate change would be. Many skiers make reservations at ski areas in advance of knowing what snow conditions will be and travel to the ski areas even when snow conditions are not good. As snow conditions systematically deteriorate due to climate change, skiers are unlikely to gamble that ski conditions will be good and will not make the reservations in advance. The result will be a systematic decline in skiing due to the more frequent and chronic poor snow conditions.

Lackler, in his 2021 study, lays out all of the changes that are likely to be seen at ski areas in the western U.S. Those changes are magnified at ski areas that have lower elevations, like ski areas in Montana. There will be a shift in the season that will almost certainly cut out Thanksgiving skiing in Montana and will encroach on Christmas as winter snow comes later in the year and turns to rain before spring comes.

> "The decrease is larger at the base elevations of the ski areas compared to the top elevations in all weeks shown. In most cases where snow decreases, the relative difference is larger in the weeks in December and April, relative to the February weeks… This indicates that snow at lower elevations and early and late season snow is impacted more by climate change. The largest relative decrease is found in ski areas in Idaho, northwestern Montana, and northern Utah, where the ski areas have the lowest elevations."[66]

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[64] Lackler, C Geerts, B, and Wang, Y. Impact of Global Warming on Snow in Ski Areas: A Case Study Suing a Regional Climate Simulation over Interior Western United States. American Meteorological Society. February 2021.

[65] "Good" and "Bad" ski years were measured as the top five snow years compared to the bottom five snow years. Burakowski, E. and Magnusson, M. Climate Impacts on the Winter Tourism Economy in the United States. Prepared for Protect Our Winters (POW) and the National Resource Defense Council. December, 2012., table 3. Page 40 and Appendix I.

[66] Lackler, C Geerts, B, and Wang, Y. Impact of Global Warming on Snow in Ski Areas: A Case Study Suing a Regional Climate Simulation over Interior Western United States. American Meteorological Society. February 2021.

In fact, Lackler finds that skiing in Montana will decrease by a little more than one month (33 days) when averaged across all of the ski areas in Montana. Whitefish will see the largest change at 48 days and Maverick will see the smallest change at 22 days.[67] Lackler points out that tourists are very responsive to marginal skiing and will travel to other areas that have better skiing, will ski during periods of better snow, or will substitute skiing for a different activity altogether. Since other areas of the western U.S., like Colorado and Utah, have ski areas with significantly higher elevations, and, most importantly, significantly higher *base area elevations*, Montana may be particularly placed to lose out due to climate change.

Clearly, winter in Montana is projected to change dramatically. The result of these changes was summed up by Headwater Economics into a series of bullet points:

- Less snow.
- More unpredictable and unreliable snow patterns.
- Wetter, denser snow and more rain-on-snow events.
- Changing avalanche conditions.
- More extreme events like landslides resulting from the melting of permafrost and changing vegetation.
- Increased use of water to make artificial snow.
- Increased need to create water transportation and storage facilities.
- Ski seasons that start later and end earlier.
- Closure of low elevation ski terrain.[68]

This does not only have negative implications for skiing activity. Other important and popular winter recreation activities, such as snowmobiling will also be negatively impacted. Given the much more dispersed character of snowmobile recreation, snowmaking is not a practical way of maintaining winter activity at lower elevations and during a significantly shorter period with snow on the ground.

3. Wildfire: Impacts on Visitors, Residents, and Potential Residents

Not all recreation and tourist activities in Montana are focused on hunting, fishing, and skiing. Montana has the oldest National Park in the U.S. (Yellowstone National Park), one of the most visited National Parks (Glacier National Park), the seventh largest amount of wilderness in the U.S.,[69] and a thriving tourist economy. In 2022, Yellowstone National Park saw more than 3 million visitors, making it the seventh most visited National Park in the country.[70] While this is a

[67] Lackler, C Geerts, B, and Wang, Y. Impact of Global Warming on Snow in Ski Areas: A Case Study Suing a Regional Climate Simulation over Interior Western United States. American Meteorological Society. February 2021.
[68] Economics. The Effects of Climate Change on the Downhill Skiing and Recreational Fishing Economy in the Crown of the Continent. Page 20. January, 2011
[69] Wilderness.net. Wilderness Statistics Report. Accessed on 3.22.2023. https://wilderness.net/practitioners/wilderness-areas/summary-reports/acreage-by-state.php
[70] Brown, F. The top 10 most visited US National Park sites in 2022 are…CNN. 3.1.2023 https://www.cnn.com/travel/article/most-visited-us-national-park-sites-2022/index.html

drop from where it has historically been among the top three to five most visited National Parks, it is important to remember that large portions of the park were unavailable for visitation for much of 2022 due to historic flooding (the largest on record).[71] Glacier National Park saw just under 3 million visitors, making it the tenth most visited National Park in the country.[72] The state of Montana has a population of only about 1.1 million people, which helps put those visitor numbers and the impact of that National Park visitation into perspective.[73]

As the climate in Montana gets warmer earlier in the year and drier in the summer, there will be an increased frequency of forest fires in Montana and surrounding states and Canadian provinces.[74] As Pederson points out in his study on a century of climate and ecosystem changes in Western Montana,[75] consecutive days of high temperatures combined with earlier snowmelt and a longer dry summer season led to increased forest fires. In the late spring of 2017, events conspired to create one of the worst droughts in decades:

> "In May 2017, the northern Great Plains region was mostly drought-free, and at least average summer precipitation was forecast. By July 2017, the region was experiencing severe to extreme drought, resulting in fires that burned 4.8 million acres (1.9 million hectares) across both countries. U.S. agricultural losses alone exceeded $2.6 billion dollars."[76]

The fire regime of Montana is driven by temperature and precipitation. Increases in temperature and decreases in summer precipitation will leave Montana forests more vulnerable to forest fires. Between 2000 and 2010, some 45% of the forested landscapes in Montana were impacted by forest fires and tree-killing insect outbreaks covering approximately 11.5 million acres of the 25 million total acres of forest in Montana.[77] The top five, for years with the largest wildfire acreage burned in the U.S. as a whole, have all happened since 2006, with the top three

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[71] USGS. How the 2022 Yellowstone flood affected a monitoring site on the Gardner River. USGS News from the Yellowstone Volcano Observatory. 12.12.2022. https://www.usgs.gov/observatories/yvo/news/how-2022-yellowstone-flood-affected-a-monitoring-site-gardner-river#:~:text=The%20previous%20record%20flooding%20event,50%2C000%20cubic%20feet%20per%20second.

[72] Brown, F. The top 10 most visited US National Park sites in 2022 are…CNN. 3.1.2023 https://www.cnn.com/travel/article/most-visited-us-national-park-sites-2022/index.html

[73] US Census. Montana Quick Facts. Accessed on 3.23.2023. https://www.census.gov/quickfacts/MT

[74] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. Page 173.

[75] Pederson et al. A Century of climate and ecosystem change in Western Montana: what do temperature trends portend? *Climate Change*. 98:133-154. 2010. Page 149.

[76] Adams A, Byron R, Maxwell B, Higgins S, Eggers M, Byron L, Whitlock C. 2021. Climate change and human health in Montana: a special report of the Montana Climate Assessment. Bozeman MT: Montana State University, Institute on Ecosystems, Center for American Indian and Rural Health Equity. 216 p. https://doi.org/10.15788/c2h22021. Page 19.

[77] Kolb, P. Climactic Influences on Forests across Montana-Strategies for Conservation and Functional Retention. Montana State University Extension Forestry Specialist. 2010. Accessed 3.22.2023. https://www.montana.edu/extension/forestry/publications/publications/Climate%20Change%20Impacts%20on%20Montana%20Forests_PK.pdf

all occurring since 2017.[78] For Montana, the top five, for years with the largest wildfire acreage burned, have all happened since 2004, with 2008 narrowly being edged out of the top 5.[79] The predictions for future fire conditions indicate that the future may be far smokier than it has been. According to Steve Running, Regents Professor of Ecology at the University of Montana, wildfire activity in the Northern Rockies, including Montana, may double by 2100.[80] In a report published by the U.S. Forest Service in August 2015, the agency responsible for managing the National Forest System commented that:

> "Climate change has led to fire seasons that are now, on average, 78 days longer than in 1970. The U.S. burns twice as many acres as three decades ago and Forest Service scientists believe the acreage burned may double again by mid-century."[81]

The result of the longer fire seasons and more acreage being burned is that the forests of Montana may switch from being carbon sinks to carbon sources. In fact, according to a 2023 report from Domke of the USFS, Montana has begun emitting more carbon from its forests than it stores.[82] According to this research, Montana is among a handful of western states that are all currently emitting more carbon than they sequester.

In the summer of 2003, 10% of the acreage in Glacier National Park burned. During that same summer, the visitation during August, which is typically Glacier's busiest month, fell off by 50%.[83] In 2015, wildfires again burned in Glacier National Park during August, closing for two weeks the popular Going to the Sun Highway that transverses the park. This time, visitation during August dropped 14% while overnight stays declined by 43%. This almost certainly reduced visitor expenditures.[84]

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[78] Congressional Research Service. Wildfire Statistics. 3.1.2023. https://sgp.fas.org/crs/misc/IF10244.pdf
[79] Global Forest Watch. Tree Cover Loss Due to Fires in Montana, United States. Accessed 7.13.2023. Based on data, which only covers 2001-2019, from Tyukavina, A. et al. Global Trends of Forest Loss Due to Fire From 2001 to 2019. Frontiers in Remote Sensing. 2022. https://www.frontiersin.org/articles/10.3389/frsen.2022.825190
[80]Running, S. Impacts of Projected Climate Change on Pacific Northwest Ecosystems: Analyzing Carbon/Water Balance Vulnerability to 2100. Final Report to Stratus Consulting and National Commission on Energy Policy. March, 31 2009. Page 43.
[81] USDA. The Rising Cost of Wildfire Operations: Effects on the Forest Service's Non-Fire Work. P.2, August 4, 2015.
[82] Domke, Grant M.; Walters, Brian F.; Giebink, Courtney L.; Greenfield, Eric J.; Smith, James E., Nichols, Michael C.; Knott, Jon A.; Ogle, Stephen M.; Coulston, John W.; Steller, John. 2023. Greenhouse gas emissions and removals from forest land, woodlands, urban trees, and harvested wood products in the United States, 1990-2021. Resour. Bull. WO-101. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 10 p. https://doi.org/10.2737/WO-RB-101.
[83] Saunders, S. and Easley, T. Glacier National Park In Peril The Threats of Climate Disruption. Prepared by the Rocky Mountain Climate Organization and National Resource Defense Council. April, 2010. Page 25.
[84] National Park Service. report period: August 2015; August 2014 to August 2015 comparison. https://irma.nps.gov/Stats/SSRSReports/Park Specific Reports/Park YTD Version 1?RptMonth=8/1/2015&Park=GLAC Accessed 5.2.2023.

Even in years where there are no major fires *in* National Parks, but there are fires in the surrounding region that are producing heavy smoke, forest fires can impact park visitation in parks that are dozens or hundreds of miles away. Glacier National Park's neighbor in Canada, Waterton Lakes National Park, for example, saw a 7%, 17%, and 15% decline in visitation during the months of July, August, and September (respectively) during the summer of 2003 when much of Glacier National Park, across the border in the U.S., burned even though there were no fires in that Canadian Park itself. Kim studied the impact of wildfires on National Park visitation and found:

> "The visibility, safety, and health effects of seasonal wildfires may affect recreational visits to national parks (NPs), even if fires occur outside of park boundaries... Results show that wildfire has negative and statistically significant effects on visitation in four of the five NPs."[85]

As residents in the western U.S. are becoming all too familiar, forest fires that burn in the region produce smoke that is distributed by complex wind currents to areas hundreds of miles away. As a result, areas where people are living or visiting, quite some distance from the actual fires, can become very uncomfortable from the thick smoke trapped in valleys that obscure vistas, block sunlight, and irritate people's breathing. This is not "just" an aesthetic concern. Wildfire smoke is bad for human health, and individuals living in the West inhale a disproportionate amount of small particulates from wildfire smoke. "Recent estimates indicate that up to half of PM2.5 exposure in some parts of the western United States is attributable to wildfire smoke."[86] In the recent Montana Climate Assessment, they state that "smoke events in the western U.S. from 2004-2009 were associated with a 7.2% increase in respiratory hospital admissions among adults over 65 yr. of age."[87]

Forest fires are projected to increase in future years as Montana's climate changes. Those changes may have a dramatic effect on Montana's tourist economy. The state's very attractiveness as a place to live and visit is tied to its natural beauty and its outdoor recreation potential. If the future is smoky, and one in which the danger of wildfire is regularly very high for a longer part of the year, then the quality of life in Montana will be diminished and people will have to weigh that diminished quality of life when they consider Montana as a place to live or visit.

Put somewhat differently, climate change is already imposing costs on Montanans, visitors to Montana, and the Montana economy in the form of more wildfires, more intense fires, and fires extending over a longer fire season. In the most intense events, the growing impacts of wildfire

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[85] Kim, M, and Jakus, P. Wildfire, national park visitation, and changes in regional economic activity. *Journal of Outdoor Recreation and Tourism*. 2019.
[86] Gellman, J., Walls, M., and Wibbernmeyer, M. Wildfire, Smoke, and Outdoor Recreation in the Western United States. Resources for the Future. Working Paper 21-22. August 2021.
[87] Adams A, Byron R, Maxwell B, Higgins S, Eggers M, Byron L, Whitlock C. Climate change and human health in Montana: a special report of the Montana Climate Assessment. Bozeman MT: Montana State University, Institute on Ecosystems, Center for American Indian and Rural Health Equity. 216 p. https://doi.org/10.15788/c2h22021. 2021. Page 38.

are likely to raise the question of just how habitable parts of Montana actually are. This is a serious cost to residents as well as a serious threat to part of the tourist and recreation economy, and the projections are that it will only get worse. In fact, according to the MCA, Montana will see an increase of 8-10 days of "extreme fire danger" by mid-century.[88]

Disease and increased beetle kill are also predicted to increase due to the warmer winters and lack of extreme cold winter temperatures, which are needed to kill insect larvae and reduce the prevalence of some bacterial and fungal diseases. As Montana's ecosystems come into equilibrium with their new climate reality, it is likely that habitats will change. Grasslands will become sagebrush, Douglas fir may become spruce fir, and the sub-alpine environment as well as the low land forests of Ponderosa Pine and Douglas fir may become dominated by spruce fir.[89] Fire and beetle kill will alter the natural environment, speeding the process of turnover between the different species of vegetation. During this long transition, recreation and tourism are likely to be negatively impacted by landscapes covered by dead trees and tangles of fallen trees, widespread wildfires, heavy smoke, and large areas of burned vegetation.

The nature and character of Montana's forests and grasslands may be changed forever. We do not contend to cast judgment on one type of ecosystem over another, but we must note that these changes are increasingly likely to take place. Montana will not be ecologically "ruined" by these types of changes; similar changes have been happening over millions of years. However, Montana will be different and this time, the climate change will be human-caused.[90]

II. The Relative Importance of Different Sectors of the Montana Economy

1. Measuring the Relative Importance of Different Sectors of a Local Economy

The relative importance of outdoor recreation and other tourist activities recognizes that a state as large as Montana has attractive natural landscapes that draw recreationists not only from outside of Montana but also from other parts of Montana itself, stimulating economic growth in destination cities, counties, and regions of the state. Although the economic impact of those traveling Montana residents may be limited on a statewide basis, their travel and spending may have a significant positive impact on the economic vitality of high amenity locations within the

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[88] Adams A, Byron R, Maxwell B, Higgins S, Eggers M, Byron L, Whitlock C. Climate change and human health in Montana: a special report of the Montana Climate Assessment. Bozeman MT: Montana State University, Institute on Ecosystems, Center for American Indian and Rural Health Equity. 216 p. https://doi.org/10.15788/c2h22021. 2021. Page 41.

[89] Keane, R. Climate change effects on historical range and variability of two large landscapes in western Montana, USA. *Forest Ecology and Management*. 254 375-389. 2008.

[90] Milankovitch cycles are widely accepted to be the reason that the earth experiences ice ages due to changes in the amount of solar radiation that the earth receives. Buis, A. Milankovitch (Orbital) Cycles and Their Role in Earth's Climate. Nasa's JPL. Accessed 4.11.2023 https://climate.nasa.gov/news/2948/milankovitch-orbital-cycles-and-their-role-in-earths-climate/#:~:text=A%20century%20ago%2C%20Serbian%20scientist,glaciation%20periods%20(Ice%20Ages).

state which attract visitors as well as, possibly, new residents. Figure 1, below, shows how important the visitor economy *within* Montana can be to particular counties.

Here, we will investigate many different sectors of the Montana outdoor economy and the recreation that happens in it. We will begin with simply having outdoors, public land to recreate on. We will then transition into the more traditional sectors of the outdoor recreation economy that people will readily recognize, such as visitation to National Parks, nature viewing, hunting, fishing, skiing, etc. Using the best available science, we will then examine how climate change may impact those different sectors and what the economic impacts of those physical impacts will be.

2. The Economic Value of High-Quality Environments

For many decades, there has been considerable controversy over how placing legal restrictions on the commercial development of natural landscapes in order to protect certain attractive qualities of those natural landscapes from the impacts of logging forest lands, developing mineral resources, or converting those natural landscapes to other commercial purposes impacts the local economy. Those favoring commercial development of natural landscapes and opposing protective legal restrictions on the use of those lands have pointed at the expected loss of some or all of the commercial resource values if those natural landscapes are “locked up.” Those seeking to protect the natural landscapes from development emphasize the reality of the environmental values and natural goods and services that protected landscapes could continue to provide if not degraded in the pursuit of commercial resources values.

Note that the opposing parties make similar economic assertions about the alternative land-use values that might be pursued. One focuses on commercial development that would boost local economic well-being by adding, possibly, a high-paid industry to the local area’s economic base. The other advocates pointed to the local economic vitality the area was already enjoying as a result of being surrounded by world-class recreation opportunities that made the local area an attractive place to live, work, raise a family, or operate a business. One group saw the local economy being impoverished by restrictions on natural resource development. The other saw a different natural resource opportunity associated with high quality natural amenities that directly and indirectly supported local economic vitality. It’s worth noting that resource development and conservation are not mutually exclusive, and both can and do exist on a spectrum across Montana’s public and private lands.

This disagreement over two different types of natural resource development on public lands should be open to empirical exploration and resolution. One effort to clarify the local economic impacts of restrictions seeking to protect natural landscapes focused on restrictions placed on federal land managers, e.g., the U.S. Forest Service, Bureau of Reclamation, National Park Service, etc. Those agencies manage different types of restricted federal land that we are all familiar with like national parks, wilderness areas, and national monuments to name a few. The hypothesis offered to explain the relatively high measures of local economic vitality in some areas despite protective landscape management was that those lands were managed for conservation purposes by federal agencies, and this assured that those protected federal lands

provided a wealth of recreational opportunities to residents and visitors, some of whom became residents and helped the local economies to maintain their residents, supporting modest ongoing growth.

This hypothesis – that protected natural landscapes would stimulate local economic vitality – was analyzed in a 2013 study appropriately titled "The Effect of Protected Federal Lands on Economic Prosperity in the Non-metropolitan West."[91] In this study, "protected" lands were public lands managed by federal government agencies for conservation purposes rather than commercial extractive activities: National Parks, Wilderness areas, Wildlife Refuges, and Wild and Scenic Rivers are examples of such "protected federal lands." In this study, it was not only National parks like Yellowstone and Glacier, but the much more numerous and expansive Wilderness areas that dominate the analysis. While there is vast wealth created around the National Parks, there are simply far more Wilderness areas, and other protected lands, in their study than National Parks.

The study found that counties with higher concentrations of nearby protected federal natural landscapes tended to experience higher average incomes, not lower incomes The study focused on the 284 non-metro counties in the western U.S., containing 46.2 million acres of protected public lands. Thirty-seven of those non-metro Western counties that contained protected federal lands were located in Montana.[92] The sum of the higher average income per person due to the protected lands in non-metro Montana counties was $2.35 billion in 2021 dollars. The average income per person was $3,770 per year more than counties not adjacent to protected areas. This represented an average 11% greater annual income per person in non-metro Montana counties. That higher income, associated with protected landscapes, ranged from 24% to near zero depending on the county. These are the general findings of that report:

> "• Higher-wage services industries, such as high-tech and health care, are leading the West's job growth and diversifying the economy.
>
> • Entrepreneurs and talented workers are choosing to work where they can enjoy outdoor recreation and natural landscapes.
>
> • Increasingly, chambers of commerce and economic development associations in every western state are using the region's national parks, monuments, wilderness areas and other public lands as a tool to lure companies to relocate.
>
> • High-wage services industries also are using the West's national parks, monuments, wilderness areas and other public lands as a tool to recruit and retain innovative, high-performing talent."[93]

[91] Rasker, Ray et. al. 2013 The Journal of Regional Analysis & Policy, 43(2):110-122, MCRSA.
[92] Montana has 56 counties. Given the study's focus on non-metropolitan counties that contained protected federal lands, Montana's metropolitan counties were not included nor were the counties containing no protected federal lands.
[93] Rasker, R. West is Best: How Public Lands in the West Create a Competitive Economic Advantage. Headwater Economics. November 2012. Page 1.

The study's conclusion was that average income per person would be significantly higher than it otherwise would have been if the counties had no protected federal lands. The study documented those higher levels of average income across the non-metro western United States including Montana.[94]

3. Different Measurements of the Relative Size of the Outdoor Recreation Economy

Montana's natural landscapes and wildlife draw large numbers of visitors. Yellowstone and Glacier National Parks are the most dramatic examples of this. In 2022, there were 3.29 million recreation visits[95] to Yellowstone National Park and 2.9 million recreation visits to Glacier National Park.[96] In 2021, visitor spending at Glacier and Yellowstone was large and impactful for Montana:

> "In 2021, 5.9 million park visitors spent an estimated $729 million in local gateway regions while visiting National Park Service lands in Montana. These expenditures supported a total of 11.2 thousand jobs, $369 million in labor income, $562 million in value added, and $1.1 billion in economic output in the Montana economy."[97]

This type of visitation – to enjoy the particular natural or cultural amenities of a region – is often labeled "tourism." However, people visit local areas for many reasons. Sometimes they are just passing through on their way to somewhere else. Sometimes they visit friends and relatives. Some of the visitors are there on business. Others may come to engage in shopping that is not possible in their home communities. In 2021, of the people who visited Montana, 40% were on vacation, 21% were visiting friends and relatives, 24% were passing through, and 11% were in Montana on business.[98]

Nearly 12.5 million non-residents visited Montana in 2021.[99] Non-resident visitors spent an estimated $5.22 billion and supported an additional $4.42 billion in economic activity, and "travel, tourism and hospitality" supported 68,630 jobs and contributed $2.038 billion in

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[94] Headwater Economics. Protected Federal Lands in the Non-Metro West Increase Per Capita Income. January 2013. Accessed 5.2.2023. http://headwaterseconomics.org/land/protected-public-lands-increase-per-capita-income/

[95] A recreation visit is defined as the entry of a person into lands or waters administered by the National Parks Service except for non-reportable and non-recreation visits. NPS. Visitor Use Statistics Definitions. https://www.nps.gov/subjects/socialscience/nps-visitor-use-statistics-definitions.htm

[96] Brown, F. The top 10 most visited US National Park sites in 2022 are… CNN. 1.3.2023. https://www.cnn.com/travel/article/most-visited-us-national-park-sites-2022/index.html

[97] NPS. Visitor Spending Effects-Economic Contribution of National Park Visitor Spending. 7.12.2022. Visited 4.11.2023. https://www.nps.gov/subjects/socialscience/vse.htm#:~:text=In%202021%2C%20297%20million%20park.Service%20lands%20across%20the%20country.

[98] Grau, K. 2021 Nonresident Visitation, Expenditures, & Economic Impact Estimates. University of Montana. May 2022.

[99] Visit Montana. Visit Montana Celebrates the Future of Travel. 5.3.2022. Visited 4.11.2023. https://www.prnewswire.com/news-releases/visit-montana-celebrates-the-future-of-travel-301539077.html#:~:text=A%20critical%20driver%20of%20the,million%20nonresident%20visitors%20in%202021

employee compensation."[100] It is the total impact of all non-resident visitors' impacts that is typically studied, as it was by the Institute for Tourism and Recreation Research at the University of Montana that produced the jobs referenced here, and not the impact of the narrower "tourism" sector. This is the usual focus because it is difficult to separate the different types of visitors when they are engaged in spending in the same types of Montana businesses.

The non-resident visitor economy was the source of about 10% of employment in Montana in 2021.[101] The relative importance of the visitor economy is calculated by comparing the 2021 total jobs supported by tourism and to the total jobs in Montana as reported by the Bureau of Labor Statistics. The smallest estimate of the relative importance of the non-resident visitor economy is obtained by comparing the direct impacts of visitor spending to the whole of the Montana economy without singling out one set of economic activities as the primary engine driving the local economy (and implicitly demoting most economic activities in the state to secondary importance). As a part of the total Montana economy, the direct impact of the visitor economy is the source of a little more than 3% of all employee earnings but a little less than 7% of all jobs. The difference between the relative importance as a source of jobs and relative importance as a source of labor earnings is tied to the relatively low annual pay associated with many of the jobs in the visitor economy sectors (See Table 1)

Table 1.

	Non-Resident Visitor Impacts	Total Montana Economy	Relative Importance of Visitor Supported Industry in Montana
A. Percent of Total Montana Economy: Direct Impacts Only			
Number of Jobs	47,810	709,342	6.7%
Employee Earnings	$1,305,010,000	$38,034,685,000	3.4%
B. Total of Direct, Indirect, and Induced Impacts: Multiplier Impacts Included			
Number of Jobs	68,630	709,342	9.7%
Employee Earnings	$2,038,910,000	$38,034,685,000	5.4%

Source: Grau, K. 2021 Nonresident Visitation, Expenditures, & Economic Impact Estimates. University of Montana. May 2022. And the Bureau of Labor Statistics. State Personal Income: Revised Estimates for 2021. https://apps.bea.gov/regional/histdata/releases/0922spi/index.cfm

[100] Visit Montana. Visit Montana Celebrates the Future of Travel. 5.3.2022. Visited 4.11.2023. https://www.prnewswire.com/news-releases/visit-montana-celebrates-the-future-of-travel-301539077.html#:~:text=A%20critical%20driver%20of%20the,million%20nonresident%20visitors%20in%202021

[101] Bureau of Labor Statistics. Montana. Economy at a Glance. Visited 4.11.2023 https://www.bls.gov/oes/current/oes_mt.htm and Brand MT and the Montana Department of Commerce. 2021 Economic Impact. Visited 4.11.2023. https://brand.mt.gov/_shared/Office-of-Tourism/docs/Fast-Facts-Funding-20B.pdf

An analysis including the estimated indirect and induced impacts associated with the spending by non-resident visitors indicates an intermediate result: Non-resident visitor spending is the source of about 5.4% of all employee earnings in Montana and about 9.7% of all jobs. Again, the reason for the larger employment impact compared to the impact on earnings –the employment impact being almost twice as large – is that the annual earnings associated with jobs in the visitor economy are low given that many of the jobs are part-time or seasonal and pay entry-level wages. See Table 1 above for these results and their sources.

A national survey of the relative economic impact of outdoor recreation estimated a significantly smaller impact than indicated in Table 1 above. The total jobs associated with outdoor recreation in Montana were estimated at 27,584[102] about 40% of the 68,630 jobs estimated above to be associated with all non-residential visitors' spending. The labor income associated with these outdoor recreation jobs was about 58% of the total non-resident employee earnings from Table 1 above.[103]

Any approach to estimating the relative importance of the visitor economy in Montana indicates that the visitor economy is a major source of earnings and jobs. The low-end estimate suggests that $1.17 billion dollars of labor earnings and 27,584 jobs are generated by the spending of visitors to the state. At the upper end, the spending of those visitors is the source of $2.04 billion dollars in earnings and 68,630 jobs.

Evaluated in the context of Montana's "economic base," non-residential visitor expenditures in 2021 were the source of about 10% of the jobs and more than 5% of the employee earnings. Serious damage to the visitor economy would clearly have major impacts on the overall Montana economy.

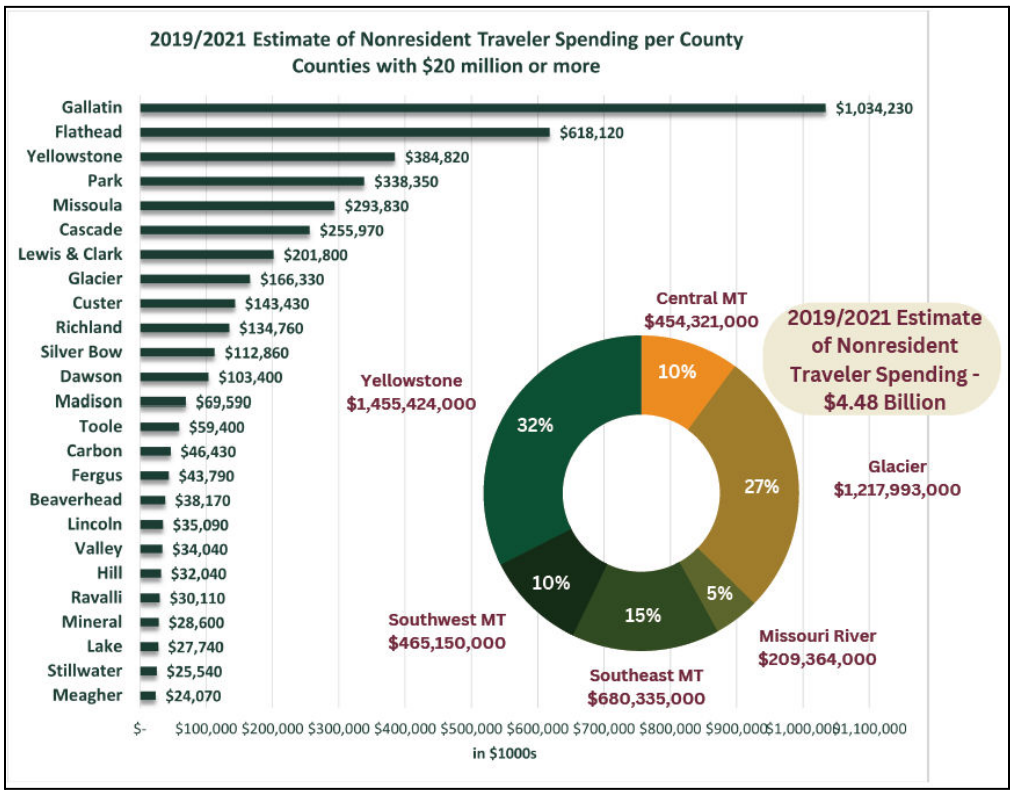
4. The Importance of Recreation-Tourist Expenditures on Local Economies

There is not really a "Montana economy." Rather, there are a variety of interconnected local and regional economies. Different industries play considerably different roles in different local economies. The relative importance of agriculture, wood products, mining, energy production, visitor expenditures, and other industries vary considerably. As a result, some local economies are more reliant on visitor expenditures than others.

A recent analysis of the Non-Resident Visitor spending in all Montana counties where that spending exceeded $20 million per year showed the diversity of relative impacts on county economies.

[102] BEA. Outdoor Recreation Satellite Account, U.S. and States, 2021. 11.9.2022. Accessed 4.12.2023. https://www.bea.gov/data/special-topics/outdoor-recreation
[103] BEA. Outdoor Recreation Satellite Account, U.S. and States, 2021. 11.9.2022. Accessed 4.12.2023. https://www.bea.gov/data/special-topics/outdoor-recreation

Figure 1.



Source: Grau, K. Montana Travel Regions & Counties- Economic Contribution of 2019/2021 Averaged Nonresident Travel Spending. March 2023. Page 2.

The Montana counties most dependent on non-resident visitor spending for jobs and earnings are relatively rural counties such as Park (Yellowstone National Park), Glacier (Glacier National Park), Toole, Carbon (Yellowstone National Park), Custer, Beaverhead, Madison, Richland and Dawson. Some of Montana's more urban counties are also heavily dependent on visitor expenditures, led by Gallatin County (Bozeman area, Yellowstone National Park) and followed by Flathead County (Kalispell area, Glacier National Park). See Figure 1 above.

5. The Role of Different Segments of the Outdoor Recreation Sector in the Montana Economy

A. A Summary of the Role of Different Segments of the Outdoor Recreation Sector in the Montana Economy

Before discussing several important segments of the Montana recreation-tourist economy, we summarize our findings here as a preview and guide.

Table 2.

Value Added by Popular Conventional Outdoor Activity		
	Value Added	% of total
Total	$ 951,769,000	100.0%
Multiuse Apparel and Acc.	$ 281,651,000	29.6%
Boating/Fishing	$ 163,099,000	17.1%
RVing	$ 160,381,000	16.9%
Hunting/Shooting/Trapping	$ 85,062,000	8.9%
Other Conventional	$ 61,558,000	6.5%
Equestrian	$ 58,410,000	6.1%
Snow Activities	$ 54,694,000	5.7%
Motorcycling/ATVing	$ 37,906,000	4.0%
Climbing/Hiking/Tent Camping	$ 35,018,000	3.7%
Bicycling	$ 9,648,000	1.0%
Recreational Flying	$ 4,342,000	0.5%

Source: BEA. Outdoor recreation satellite account, U.S. and States, 2021.
https://www.bea.gov/data/special-topics/outdoor-recrea

Table 3.

Jobs by Industry in Montana Outdoor Economy		
	Jobs	% of total
Total	27,583	100%
Arts, Hotels, Food Service	13,031	47%
Retail Trade	7,889	29%
Wholesale Trade	1,613	6%
Government	1,026	4%
Manufacturing	834	3%
Warehousing, Transportation	792	3%
Construction	711	3%
Real Estate, Finance, Utilities	574	2%
Eduction, Healthcare	471	2%
Fishing, Hunting, Agriculture	416	2%
Professional Services	226	1%

Source: BEA. Outdoor recreation satellite account, U.S. and States, 2021.
https://www.bea.gov/data/special-topics/outdoor-recreation

The people who visit Montana and the people who live in Montana recreate in different ways. The Bureau of Economic Analysis (BEA) tracks this outdoor recreation and offers a series of metrics that we can use to describe outdoor recreation in Montana. Examining Table 2 above,

we can see the Value Added by different popular conventional activities in Montana.[104] Value Added presents the relative value of different outdoor activities. Unfortunately, all of this becomes rather complicated in a hurry. What is presented in Table 2 above is a view of the "conventional" outdoor activities that most Montanans will readily identify as being part of the outdoors. Unfortunately, these only represent 37% of the outdoor industry in Montana that the BEA measured. 48% is considered "support", and 15% is considered "other." "Other" includes amusement parks, festivals, field sports, and things like golf and tennis, which all generally happen outside, but are not considered traditional outdoor recreation activities. Support activities include the restaurants that people eat in, the lodging and transportation that they use when they are recreating in the outdoors, as well as some of the federal and state government services which include the staffing at National and State Parks. What is most important here is the value of purchases like multiuse apparel (almost $300 million annually), boating/fishing that brings in more than $163 million annually, and RVing, which is almost as large as boating/fishing.

Table 3 presents the jobs created by the outdoor industry in Montana, according to the BEA. The largest portion of those jobs – almost half – is in Arts, Hotels, and Food Service.[105] These industry classifications include businesses that provide services in recreational activities, as well as businesses that exhibit or preserve objects and sites. The category, as the name implies, also includes all of the hotels and food services that people use when they are recreating in the outdoors. This is particularly relevant to tourists traveling from outside Montana, or Montanans who travel a long distance to recreate and do not return home nightly. Other large portions of the Montana outdoor recreation supporting economy are retail trade which is included because people require various forms of gear and clothing to recreate outdoors in Montana.

B. The Role of the Yellowstone and Glacier National Parks in the Montana Economy

Yellowstone and Glacier National Parks play a vital role within the overall Montana visitor economy. Averaged across 2019 and 2021, the top three counties in Montana in terms of non-resident visitor expenditures are the primary gateway communities for the two national parks: Flathead County is adjacent to Glacier, and Gallatin and Park Counties are adjacent to Yellowstone. The next two counties with high non-resident visitor expenditures are the two metropolitan areas closest to each of the parks: The Yellowstone Metropolitan Statistical Area (MSA) for Yellowstone National Park and the Missoula MSA south of Glacier National Park. About half (53%) of all Montana non-resident visitor expenditures take place in these five counties.[106]

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[104] "The gross output of an industry or a sector less its intermediate inputs; the contribution of an industry or sector to gross domestic product (GDP). Value added by industry can also be measured as the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus". https://www.bea.gov/help/glossary/value-added

[105] BEA. Industries at a glance. NAICS 71 and 72. https://www.bls.gov/iag/tgs/iag71.htm and https://www.bls.gov/iag/tgs/iag72.htm

[106] Grau, K. Montana Travel Regions & Counties- Economic Contribution of 2019/2021 Averaged Nonresident Travel Spending. March 2023. Page 2.

If we focus on Yellowstone and Glacier National Park as “travel regions”, then we see that Yellowstone and Glacier National Parks received the highest percentage of non-resident travel spending in 2019/2021, with 32% and 27% respectively. This use of travel regions allows us to amalgamate a series of counties into one travel region. Here we are following the methodology of Grau in assigning, for example, 8 western Montana counties into the “Glacier Country” travel region.[107] This is a way to break the state of Montana into 6 contiguous pieces that are associated with geographic natural attractions like Glacier and Yellowstone National Park. Remember here that we are discussing a combined total of almost 60% of the non-resident travel spending, which adds up to more than $2.5 billion dollars (see Figure 1 above). Glacier Country received almost 12,000 jobs and almost $315 million in labor earnings from nonresident travel expenditures in 2021 and Yellowstone Country received more than 13,000 jobs and almost $400 million in labor earnings.[108]

C. The Role of Wildlife Viewing in the Montana Economy

Every five years, the U.S. Fish and Wildlife Service conducts a national survey of fishing, hunting, and wildlife-associated recreation in cooperation with state fish and wildlife agencies and conservation groups. The most recent study covered 2016 and was published in 2018. Among the reports based on that survey are economic impact analyses of different types of wildlife-related recreational activities including wildlife viewing.[109] Unfortunately, these data are no longer broken down at the state level, so the Montana segment cannot be isolated. However, we can see from national wildlife-watching data that wildlife-watching has been increasing in recent years. The number of wildlife-watchers increased by about 20% when comparing 2011-2016, the days away from home watching wildlife increased by about 15% from 2011-2016, and the total wildlife-watching expenditures increased by almost 30% from 2011-2016.[110]

Since we do not have Montana-specific data, we have chosen to keep wildlife-watching at the same level that it was reported in the 2013 estimates and simply change to dollar values to represent 2021, which is the year that we are presenting all of the other data in. Since wildlife-watching increased between 15 and 30%, depending on which national metric is being used, this will present a rather conservative estimate of wildlife-watching in Montana in 2021. In Montana, there were an estimated 406,000 wildlife watchers 16 and older.[111] The 2013 estimated Montana population of those 16 and over was 816,000.[112] That suggests that about

[107] Glacier Country consists of Lincoln, Flathead, Glacier, Sanders, Lake, Mineral, Missoula, and Ravalli. Yellowstone Country consists of Gallatin, Park, Sweet Grass, Stillwater, and Carbon Counties.
[108] Grau, K. Montana Travel Regions & Counties- Economic Contribution of 2019/2021 Averaged Nonresident Travel Spending. March 2023. Pages 6 and 10.
[109] U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. 2018.
[110] U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. 2018. Page 53.
[111] Ibid.
[112] US Census Bureau. American Community Survey, 2013, population by age.

half of that part of the Montana population engages in some wildlife-watching. The estimated economic impacts on Montana of wildlife viewing in 2021 (including multiplier impacts) were about 11,100 jobs and $295 million in salaries and wages.[113]

Of course, it is not only wildlife that leads residents and visitors to explore Montana's natural landscapes. The diversity and beauty of those natural landscapes also draws people away from their homes to enjoy "Big Sky Country." We do not have a quantitative measure of that sight-seeing, but it certainly is an important part of outdoor recreation. In that sense, our focus primarily on wildlife-watching is a very conservative proxy for all visits to explore Montana's natural landscapes.

D. The Role of Hunting in the Montana Economy

Working with the data from the 2016 National Survey of Fishing, Hunting and Wildlife-Associated Recreation carried out by the U.S. Census Bureau for the U.S. Fish and Wildlife Service, we can see that Big game hunting nationally dropped off by 16% in terms of number of hunters, 35% in terms of number of hunting days, and 26% in terms of hunting expenditures.[114] Since the national survey no longer has a Montana-specific portion, and since there was a drop in usage, we do not feel comfortable adjusting the previous statistics on jobs and monetary contributions. However, Montana Fish, Wildlife, and Parks produced their own survey in 2016 that estimated that Big game hunting in Montana produced 3,300 jobs and $324 million in expenditures annually, or about $366 million in 2021 dollars.[115] To estimate labor income, we used the pay-per-job from the previous national analysis that included state level impacts and escalated them to 2021 dollars.[116] These impacts are significantly lower than those that we found in the last iteration of this report.[117]Although hunting nationally has dropped off significantly, as we stated above, the national drop does not make up for the drop in expenditures and jobs discrepancy when we compare the 2011 values to the 2016 values. We have state level data on hunting licenses, but unfortunately that data does not show how many people actually spent money hunting and engaged in hunting in Montana. As the hunting counts from 2022 show, when compared to the licenses purchased, the number of people that hunt do not always follow the number of licenses sold. We are again opting for more conservative values when we present this data.

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[113] Op. cit. Wildlife Watching in the U.S., 2011, Table 6. We used the St. Louis CPI to inflate the 2011 dollars to 2021. Federal Reserve Bank of Minneapolis. Consumer Price Index, 1913-. Accessed 4.13.2023. https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1913-

[114] U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. 2018. Page 34.

[115] Montana Fish, Wildlife, and Parks. The Economics of Big Game Hunting in Montana. 2016. https://mtfwp.maps.arcgis.com/apps/Cascade/index.html?appid=0fa1de4222074cdeb7dbf0710ecb2ee0 and Federal Reserve Bank of Minneapolis. Consumer Price Index, 1913-. Accessed 4.13.2023. https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1913-

[116] Southwick Associates. Hunting in America: An Economic Force for Conservation. Produced for the National Shooting Sports Foundation in partnership with the Association of Fish and Wildlife Agencies. 2012.p. 12.

[117] Op. cit. Power Consulting, December 2015, prepared for the Montana Wildlife Federation.

E. The Role of Sport Fishing in the Montana Economy

A 2021 study of the economic role of sport fishing in all 50 states was carried out for the American Sportfishing Association. It estimated the total job impact (including multiplier impacts) in Montana in 2020 was about 6,282. The salaries and wages associated with those jobs was about $205.3 million,[118] though this is larger compared to what we reported in our previous analysis of climate change impacts in Montana. The national data about sport fishing also shows an increase: The number of anglers in the U.S. increased from 2013 to 2023 by 15% and in Montana, from 2013 to 2023, there was an increase of 16%.[119]

F. The Role of Winter Sports in the Montana Economy: Skiing, Snowboarding and Snowmobiling.

Winter outdoor recreation in Montana extends beyond downhill skiing, snowboarding, and snowmobiling. It includes cross-country skiing, snowshoeing, backcountry skiing and camping, ice climbing, among other winter activities. Unfortunately, there is detailed data and analysis in Montana only of downhill skiing, snowboarding, and snowmobiling. Thus, our focus on this particular set of winter outdoor recreation underestimates the overall importance of winter outdoor recreation.

Burakowski and Hill looked at the economic contributions of winter sports in a changing climate in 2018.[120] In that report, they present a compelling narrative about how winter sports in the U.S. will change in the face of climate change. Central to their narrative is that people ski and snowmobile less when there is a low snow year, and they ski and snowmobile more when there is a high snow year. They show that there is a significant drop in skier days and expenditures on the lowest snow years and a rise during the highest snow years. Burakowski and Hill looked at the five highest snow years nationally and compared them to the lowest 5 snow years nationally between 2001 and 2016. They also modeled the impact of skiing and snowmobiling for all of the states that have winter tourism for those sports. Using that modeling, Montana, in 2016, was the source of 5,093 jobs, $342 million in value added in 2021 dollars, and $184 million in labor earnings.[121]

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[118] Southwick Associates. Sportfishing in America: A Reliable Economic Force. Produced for the American Sportfishing Association. March 2021. Page 9.
[119] U.S. Fish & Wildlife Service. Fishing Licenses, Holders, and Costs by Apportionment Year. Accessed 9.26.2023.
https://us-east-1.quicksight.aws.amazon.com/sn/accounts/329180516311/dashboards/602cf050-6e11-4da5-9917-7229fd08648b?directory_alias=tracs-quicksight
[120] Burakowski, E. and Hill, R. Economic Contributions of Winter Sports in a Changing Climate. Protect Our Winters, Boulder, CO, USA. 2.23.2018.
https://scholars.unh.edu/cgi/viewcontent.cgi?article=1190&context=ersc
[121] Burakowski, E. and Hill, R. Economic Contributions of Winter Sports in a Changing Climate. Protect Our Winters, Boulder, CO, USA. 2.23.2018. Page 14.
https://scholars.unh.edu/cgi/viewcontent.cgi?article=1190&context=ersc

III. Estimated Impacts of Climate Change on the Recreation-Tourism Economy

Having described the likely future impact of climate change on the natural landscapes of Montana and the importance of those natural landscapes to the state and local economies, we now turn to the estimation of the potential economic impact of a "business-as-usual" public policy strategy that makes no attempt to moderate or reduce the cumulative impact of greenhouse gas (GHG) pollutants on natural landscapes, and the wildlife, recreation, and tourist activities that are dependent on those natural landscapes.

Both climate change and economic impacts are difficult to calculate. Both require professional judgment based on the best evidence available. In debates over public policies aimed at reducing human releases of GHG, there tends to be a heavy emphasis on the economic *costs* associated with adopting those policies. When these costs of controlling GHG emissions are discussed, there is rarely a similar discussion of the economic *benefits* that are the objective of those climate change public policies, namely avoiding the future costs associated with climate change. The result is a cost-only analysis that typically produces very large quantitative measures of the costs associated with policies aimed at reducing future human-caused climate change.

There is a vehicle that allows us to look at the economic costs of climate change, and that is the Social Cost of Carbon (SCC).[122] Recently, the Environmental Protection Agency (EPA) has updated the SCC as a member of the working group that is attempting to incorporate all of the new science and economic impacts of climate change. Unfortunately, the SCC does not include tourism or recreation.[123] It is important to attempt to quantify those industries that are not accounted for in the SCC *until* those industries are included in the SCC review.

A "cost only" analysis of climate change policy cannot be categorized as a holistic *economic* analysis as it does not account for the benefits of such policies. Typical cost-only analyses of reducing future impacts of climate change assume that the benefits of reducing human-caused climate change are known in precise, quantitative, detail, and namely, that they are zero. The overwhelming scientific evidence is that this precise quantitative value of slowing or stopping human-caused climate change is wrong, and therefore this assumption should not be applied. The future costs associated with climate change that could be avoided are greater than zero.

In the analysis below, we combine the quantitative information that is available with expert judgment to produce estimates of the likely economic costs associated with climate change in Montana if no steps are taken to reduce human GHG pollution. That expert judgment is tied to a

[122] EPA. Social Cost of Carbon. EPA Fact Sheet. 2016. https://www.epa.gov/sites/default/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf
[123] EPA. Supplementary Material for the Regulatory Impact Analysis for the Supplemental Proposed Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review". September 2022. Table 3.2.1 Page 73.

half-century of experience analyzing the Montana economy, the role that natural and social amenities have contributed to economic vitality in Montana, and long-run economic trends within the state and region. In our professional judgment, these estimated economic costs of projected climate change in Montana are far more reliable and accurate than the explicit alternative assumption that there are zero costs associated with that ongoing climate change in Montana.

1. Visitation to Yellowstone and Glacier National Parks

The physical threat of wildfire; smoke damage to visibility, comfort, and health; and the changes in the character of the post-fire landscapes have negative implications for visitation to Montana's Yellowstone and Glacier National Parks.

Although impacts from climate change are already underway in Montana, the ultimate breadth of its impact on National Park visitation has not yet been apparent. Thus far, there have been intermittent years of "unexpectedly" large fires in and around these two National Parks that have significantly reduced park visitation. Because these were "unexpected" events and visitors had already planned their trips, the visitors often arrived anyway and coped as best they could with closures and smoke that eliminated the possibility of viewing the parks from a distance. In fact, there is new science that bears this out. Gellman[124] found that the cancellation rate for people that had already arrived at a smoky campground was about 15% of those that canceled before they arrived due to smoke. In other words, people were about seven times more likely to cancel because of smoke beforehand, than they were to cancel once they had arrived to find a smoky campground. As wildfire and smoke in and around these National Parks and hundreds of miles of surrounding landscapes become a common occurrence, people are less likely to make reservations to visit these parks and more likely to adjust their travels as the extended fire season develops. Some will shift their visitation to other natural landscapes that do not face regular threat from wildfire and smoke.

Climate change will bring other changes to the landscapes of Yellowstone and Glacier National Parks. Glacier National Park will continue to lose its iconic glaciers. Fires and insect infestations will regularly kill large acreages of trees, leading to tangled masses of deadfall trees on the ground which makes hiking both difficult and dangerous and the landscape more prone to extreme fires.[125] Lower elevation forests will be displaced by grasslands or shrublands, including sagebrush, and forests will change with some species, such as the Whitebark pine and Grand fir, at a much higher risk of displacement and potentially extirpation.[126] As will be discussed when we focus on angling and fisheries, the opportunities inside Montana's two National Parks to pursue native species will also decline.

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[124] Gellman, J., Walls, M., and Wibbernmeyer, M. Wildfire, Smoke, and Outdoor Recreation in the Western United States. Resources for the Future. Working Paper 21-22. August 2021.
[125] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. 2017. Pages 172-180.
[126] Whitlock C, Cross W, Maxwell B, Silverman N, Wade AA. 2017 Montana Climate Assessment. Bozeman and Missoula MT: Montana State University and University of Montana, Montana Institute on Ecosystems. 318 p. doi:10.15788/m2ww8w. 2017. Page 160.

As discussed above, wildfire and smoke has impacted National Park visitation in the past, reducing visitation by as much as 50% during the time of the fires. Even the smoke from distant fires reduced visitation by 10-20%. If climate change proceeds with no decrease of GHG and the fire frequency, size, intensity, and season all increase in length and severity, these impacts on visitation will increase and be more frequent. If the cumulative impact is that there will be significant wildfire and smoke problems every few years, *planned* visitation will decline. Thus, in addition to the declines in visitation when fires actually close parts of the parks, there will be a decline in visitation overall as people seek to avoid parks and areas that are known to be regularly smoky and where vacationers regularly get turned away because of frequent fires. If visitation continues to decline because of the threat of fire and smoke *and* if there are major wildfires and smoke in the parks or on surrounding natural landscapes once every few years, we model visitation and associated expenditures could decline by about 15%. This impact is twice what was reported by Gellman for pre-arrival cancellations.[127] It is also important to note that Gellman found an increase in cancellations in places like Montana where the visitation season was shorter and there was more persistent smoke. These impacts are shown in Table 4 below.

Table 4.

Projected Impact of Climate Change on Yellowstone and Glacier National Park Visitation		
	Jobs	**Labor Earnings (millions $)**
Size of Economic Sector at Risk: Montana National Park Visitation	25,540	$714
Loss of Jobs and Income Due to Climate Change	**3,831**	**$107.0**

Source: Grau, K. Montana Travel Regions & Counties- Economic Contribution of 2019/2021 Averaged Nonresident Travel Spending. March 2023.

Changes of this magnitude over time in the visitation to Glacier and Yellowstone National Parks are not beyond the historical record. In 2003, visitation to Glacier National Park was 74% of the 2000s average and about 16% below the 2002/2004 average.[128] We see almost the exact same trend for 2008 and for 2011. If we look at Yellowstone and Glacier National Parks' combined visitation, then we routinely see drops in visitation that are 5%-10% in year-to-year variation. We will not attempt to assign causality to fires for the decline in visitation, since many other scientists have also studied this issue. What those scientists have found is that there is a

[127] Gellman, J., Walls, M., and Wibbernmeyer, M. Wildfire, Smoke, and Outdoor Recreation in the Western United States. Resources for the Future. Working Paper 21-22. August 2021. Table 4.
[128] National Park Service. Historical GNP statistics on visitation. Accessed 4.14.2023.https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20(1904%20-%20Last%20Calendar%20Year)?Park=GLAC

correlation between wildfires, smoke from wildfires, and decreased visitation.[129] Our projection is that visitation to these National Parks will decline over the next 40 years to levels that were common 25 years ago in Glacier National Park and 40 years ago in Yellowstone National Park as fires in and around the parks become larger and more frequent. The character of the parks, absent any intervention, will be degraded by climate change and will change the experiences of visitors.

It is plausible that warmer weather that comes earlier and stays later could also allow an extension of the time period that Yellowstone and Glacier National Parks may be open, although this may not align well with the traditional summer tourist season where the parks see most of the visitation concentrated. Also, as discussed above, wildfire is still an "unexpected" occurrence in Yellowstone and Glacier National Parks. Visitors have to make their visitation plans well ahead of time or risk not being able to find a place to stay in the park or surrounding communities during peak summer visitation times. As wildfires become a recognized risk associated with planning summer visitation to these National Parks, one can expect planned visitation to fall off as travelers plan to visit locations where their vacation will not be degraded or ruined by wildfire and accompanying smoke. In Table 4 above, we show the impact of a 15% decline in visitation to Yellowstone and Glacier National Parks due to wildfire and wildfire smoke. That impact results in the loss of more than 3,800 jobs and $107 million in labor earnings.

2. Wildlife-Watching and Other "Sight-Seeing" Activities

Wildlife-watching will be affected by all of the climate change impacts that are likely to reduce visitation to Montana's National Parks; Active fires and fire suppression activity, heavy smoke from fires, and reduced visibility all make it unhealthy to engage in outdoor activity. One cannot "watch wildlife" or "see sights" through dense smoke. Large tracts of dead trees from insect infestations and wildfire would make these areas less attractive to wildlife watching and sight-seeing. In addition, wildlife is expected to move up the mountains and stay longer in the high country to access a cooler environment. This may put much wildlife viewing outside the existing transportation infrastructure. High and extreme temperatures throughout summer and into spring and autumn for longer periods will make strenuous outdoor activity less pleasant and attractive. Finally, during the most active parts of the extended fire season, public lands are often closed to visitors to reduce the likelihood of human caused wildfires.

We expect a similar reduction in wildlife-watching and sightseeing activities as we projected for National Park visitation in Montana. With a larger range of alternative sites in Montana to visit for wildlife-watching, we have reduced the percentage impact from what we projected for Montana's National Parks to 15%. Recall, however, that our measure of impact is based only on wildlife-watching. Other exploration of Montana's natural landscapes and non-wildlife sight-seeing are being ignored in estimating the impact of climate change. Recall also that we are speaking only of people who go out to see wildlife and not the impact of climate change on

[129] Gellman, J., Walls, M., and Wibbernmeyer, M. Wildfire, Smoke, and Outdoor Recreation in the Western United States. Resources for the Future. Working Paper 21-22. August 2021. And Cai, C. Wildfire and Visitation in U.S. National Parks. https://www.chang-cai.com/files/JMP.pdf

the wildlife resource itself. As habitat is diminished, there will be less wildlife to watch even if people were not impacted by the heavy smoke that scientists predict. For those reasons, this estimate is quite conservative. The loss associated with climate change is projected to be more than 1,600 jobs and more than $44 million in labor earnings. See Table 5 below.

Table 5.

Projected Impact of Climate Change on Wildlife Watching and Sight-Seeing in Montana		
	Jobs	**Labor Earnings (millions $)**
Size of Economic Sector at Risk: Montana Wildlife Watching	11,100	$295
Loss of Jobs and Income Due to Climate Change	**1,665**	**$44.3**

Sources: For size of sector see "Wildlife Watching in the U.S.: The Economic Impacts on National and State Economies in 2011 Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife –Associated Recreation, U.S. Fish and Wildlife Service, Report 2011-2.Table 6. And Federal Reserve Bank of Minneapolis. Consumer Price Index, 1913-. Accessed 4.13.2023. https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1913-

3. Hunting

As discussed earlier, climate change will make current big game hunting seasons in late October through late November more difficult and less productive for hunters. Warmer temperatures and lack of snowfall during that period will lead elk to stay in the high country more distant from roads and may make tracking animals more difficult. These are public lands but are largely inaccessible to the average hunter. Pressure may also grow for wildlife managers to reduce big game conflicts when elk and deer concentrate on private lands outside of hunting season, when winter snows finally push the animals down into the valley bottoms. Movement of elk from the high-country to the valley bottoms may not happen during the currently scheduled rifle season in Montana. Following this logic, elk would move quickly from largely-inaccessible public lands to private lands, which require permission to hunt, reducing hunter opportunity. As was discussed previously, the number of elk in Montana is about two times FWP's current objectives, which has led the agency and their associated commission to open shoulder season hunting to reduce the statewide elk population.

We project that big game hunting could decline by a fifth to a quarter. As mentioned above, 69% of all of the expenditures on hunting in Montana are associated with big game hunting. If upland bird and waterfowl hunting are also similarly affected by climate change, the economic cost would be a 20%-25% decline in hunting's employment and labor earnings impact. If, on the other hand, upland bird, waterfowl, and small game hunting are unaffected by climate change, this would mean that hunting expenditures would decline by 14%-17%. Conservatively, we have used a 15% decline in Table 6 to show the impact of climate change in reducing the economic

activity associated with hunting in Montana. We project that there will be a decline of 495 jobs and a loss of almost $15 million in labor earnings.

Table 6.

Projected Impact of Climate Change on Big Game Hunting in Montana		
	Jobs	**Labor Earnings (millions $)**
Size of Economic Sector at Risk: Montana Big Ganme Hunting	3,300	$100
Loss of Jobs and Income Due to Climate Change	**495**	**$15.1**

Montana Fish, Wildlife, and Parks. The Economics of Big Game Hunting in Montana. 2016. https://mtfwp.maps.arcgis.com/apps/Cascade/index.html?appid=0fa1de4222074cdeb7dbf0710ecb2ee0 And Southwick Associates. Hunting in America: An Economic Force for Conservation. Produced for the National Shooting Sports Foundation in partnership with the Association of Fish and Wildlife Agencies. 2012. And Federal Reserve Bank of Minneapolis. Consumer Price Index, 1913-. Accessed 4.13.2023. https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1913-

Hunting in Montana is a way of life for many residents. If the experience becomes degraded to the point that hunters are discouraged from participating in it, then Montana hunters will lose a significant part of their quality of life.

4. Angling and Sport Fishing

As discussed above, lower winter snowpack, rain-on-snow events during the winter and spring, and warmer springs and early summers will shift peak streamflow to earlier in the year, leaving summer stream flows lower while summer temperatures are hotter and extreme for longer periods of time. Water temperatures in streams and lakes will rise, stressing native fish populations. This will lead to more limitations on fishing in the form of reduced daily hours when fishing is allowed or outright closure of streams and lakes to fishing, which is already happening in Montana and adjacent states and provinces. The frequency and duration of these limits on angling will continue to increase.

With lower stream- and river-flows, there may also be conflicts between water users, especially between instream flows for fish and the water rights of farmers to divert water from streams to irrigate summer crops. Stream flows will be further reduced where agricultural water rights are superior to the claims for instream flows. Stress on these fisheries will increase mortality. There may be significant summer fish losses as a result, which would lead to lower angling success.

The stress will likely be more acute for native fish that are less adaptable to warmer water temperatures. This may increase the successful competition of non-native fish, as well as increased hybridization of native and non-native fish. This loss of the iconic native fish that anglers pursue may reduce the interest in fishing Montana's "blue ribbon" trout streams, in turn

reducing the economic activity associated with one of Montana's premier outdoor recreational activities.

Finally, the increased frequency, size, and intensity of wildfires and the expanded duration of the wildfire season will remove vegetation from stream and riverbanks, increasing water temperatures further and degrading water quality. Post-fire sediment and debris flows combined with extreme events such as floods and droughts will further degrade fish habitat.

As discussed above, we know that fish closures during hot weather and low stream-flows can reduce angling-days by 25-40%. We know that the collapse of popular fisheries can reduce angling activity by 60%. The high quality associated with Montana trout fishing is tied to the attraction of native species that are increasingly threatened and may be lost. We estimate that as a warmer, drier spring and summer climate continues to develop, at least 30% of the angling activity may be lost. Table 7 shows that economic impact. We project a loss of almost 1,900 jobs and a decline of more than $60 million in labor earnings.

Table 7.

Projected Impact of Climate Change on Fishing in Montana		
	Jobs	**Labor Earnings (millions $)**
Size of Economic Sector at Risk: Montana Fishing	6,282	$205
Loss of Jobs and Income Due to Climate Change	**1,885**	**$61.6**

Sources: Cline, T. et al. Socioeconomic resilience to climatic extremes in a freshwater fishery. *Science Advances*. September 2022. https://www.science.org/doi/10.1126/sciadv.abn1396 and Southwick Associates. Sportfishing in America: A Reliable Economic Force. Produced for the American Sportfishing Association. March 2021. Page 9.

5. Winter Sports: Skiing, Snowboarding, and Snowmobiling

Less snowpack and no snow at lower elevations combined with warmer winters with more precipitation falling as rain threatens to undermine the attractiveness of downhill skiing and snowboarding in Montana. Additional snow-making equipment can be used if the temperature is low enough. This is unlikely at many ski areas' lower elevation base areas. At higher elevations, more snow-making may be possible, though this is costly and will require additional water rights to expand, something that may be difficult to acquire in periods of drought when there is conflict over the use of reduced stream- and river flows.

Poor snow conditions lead to dramatically lower skiing activity and skiers' expenditures. In the future, skiers may be less likely to make skiing reservations given the increasing risk of poor ski conditions. The result will be that some ski areas will open later and close earlier or, in some

years, may not open at all. We project that the impact of poor snow conditions on skiing activity will be twice that observed thus far.

Snowmobiling may face even more of a challenge. Snow-making is not practical for linear trails that are miles long. Road closures to vehicles may make access to trailheads impossible or require miles of driving snowmobiles on dirt roads, something many snowmobilers will not do.

As with hunting in Montana, winter sports are directly tied to residents' quality of life. Again, the quantification of the impact of the loss or simply the degradation of the winter sports experience is difficult. People choose to come and live in Montana because they can engage in winter sports. If the quality of the winter sports becomes so poor that residents no longer take part, then the quality of life for those user groups can dramatically decline. This loss to residents cannot be ignored while focusing only on the minority of out-of-state visitors' expenditures on winter sports in Montana. The quality of life for Montanans and the attractiveness of Montana as a place to live are directly tied to the quality of winter recreation in Montana.

As a result of this loss of reliable snow cover, we project the loss of 19% skier and snowmobiling days and spending. This loss is predicted by the modeling work of Lackler presented above that showed a 19% decrease in skiing days averaged across all Montana ski areas. We project that almost 1,000 jobs will be lost and a decline in labor earnings of about $35 million. Table 8 shows the impact of that on Montana economic activity. It should be pointed out that there are other winter sports that are not included in this total, such as cross-country skiing and snowshoeing, which are also likely to be negatively impacted.

Table 8.

Projected Impact of Climate Change on Skiing, Snowboarding, and Snowmobiling in Montana		
	Jobs	**Labor Earnings (millions $)**
Size of Economic Sector at Risk: Skiing and Snowmobiling	5,093	$184
Loss of Jobs and Income Due to Climate Change	**968**	**$34.9**

Sources: Size of economic sector: Lackler, C Geerts, B, and Wang, Y. Impact of Global Warming on Snow in Ski Areas: A Case Study Suing a Regional Climate Simulation over Interior Western United States. American Meteorological Society. February 2021. And Burakowski, E. and Hill, R. Economic Contributions of Winter Sports in a Changing Climate. Protect Our Winters, Boulder, CO, USA. 2.23.2018. https://scholars.unh.edu/cgi/viewcontent.cgi?article=1190&context=ersc

IV. Conclusions

Table 9 shows a loss of $263 million dollars in labor earnings and the loss of more than 8,800 jobs annually because of climate change in Montana. The largest predicted impact is visitation

to the two National Parks in Montana, Glacier National Park and Yellowstone National Park, which is about 43% of the total impacts for jobs and about 41% of total impacts on labor income.

Table 9.

Projected Economic Losses Due to Climate Change in Compnents of Montana Recreation and Tourism Activities		
	Jobs	**Labor Earnings (millions $)**
Glacier and Yellowstone NP Visitation	3,831	$107
Wildlife Watching	1,665	$44
Big Game Hunting	495	$15
Fishing	1,885	$62
Skiing and Snowmobiling	968	$35
Total	**8,843**	**$263**

Sources: See Tables 5 through 9 above.

Collectively these losses highlight what is at stake for Montana with respect to climate change: Montana will lose critical jobs and labor income in industries that define the state. Every Montanan has a close connection to at least one of these outdoor recreation industries and likely many, if not all of them. When we consider the family members and friends that are dependent on these industries, and the time that we personally invest in each of these different sectors, the impact is no longer an academic exercise. It is fundamental to the ways we define ourselves and our communities. Our ability to recreate will change with the climate, and that realization should be carefully considered and acted upon.

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