

Summary: Ecological and Economic Impacts of Climate Change on Teton County

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Introduction

2014 marked the world's warmest year on record. In the same year, the Intergovernmental Panel on Climate Change – with contributions from over 1,000 of the world's best climate scientists – released its most strongly-supported report to date. Climate scientists are now virtually certain (99-100% probability) that global temperatures have risen since pre-industrial times and agree that it is extremely likely (>95% probability) that this is due to human emissions of greenhouse gases.

In a place such as Teton County, where cold weather defines so much of the local ecology and economy, climate change poses an existential crisis for the future. In *The Coming Climate: Ecological Impacts of Climate Change on Teton County*, the Charture Institute and the Teton Research Institute have put together a comprehensive report detailing the most current and evidence-based knowledge about the possible impacts of climate change on the Teton region over the remainder of the 21st century. Here, we summarize the highlights of the full report.

Regional and Local Climate Trends

Temperature Patterns

Average annual minimum temperatures in Teton County have increased by 1.3° F and maximum temperatures by 1.6° F since 1948 (with most of the warming since 1980). Minimum temperatures and temperatures below freezing govern many important processes such as growing season length, mountain pine beetle population growth rate, and the number of nights that local ski resorts can make snow. At weather stations across the GYE, including the Philip's Bench station on Teton Pass, we are seeing fewer days below freezing, a longer frost-free season, more unusually hot days in the summer, and fewer unusually cold nights in the winter. Stream temperatures in the GYE have also risen by 1.8° F (1° C) during the 20th century.

Precipitation and Aridity Patterns

These warming temperatures are leading to important changes in precipitation patterns. Total precipitation has not changed, but the way it falls has. Around the GYE, April 1 snow-water equivalent (a measure of total winter snowpack) has declined significantly at more than 70% of snow measurement stations. This is because more winter precipitation is falling as rain, instead of snow, and more snow is melting because of warmer temperatures. In the summer, warmer weather is causing drier growing conditions for local trees and shrubs – stressing their growth rates and increasing the likelihood of fires.

Projected Changes

All of these changes to date are predicted to intensify and accelerate over the rest of the 21st century, particularly if global greenhouse gas emissions are not curbed aggressively. Considering a range of emissions scenarios from “best case” (aggressive curbing of emissions) to

“worst case” (continued pattern of increasing emissions with little regulation), climate models indicate that temperatures in the GYE in 2100 will be on average 3.5° F (1.9° C) to 6.2° F (3.4° C) higher than 1900-2010 baseline temperatures. That is *three to six times* the warming that has already occurred.

As a consequence of this warming, November and March precipitation, even at higher elevations, is predicted to fall mostly as rain rather than snow. The total amount and duration of snow cover is expected to shrink significantly. Earlier spring melt is predicted to lead to low summer stream flows; together with warming temperatures, this is predicted to cause stream temperatures to rise by another 1.8°-5.4° F (1-3° C) by mid-21st century (2050-2069). On land, warm summers are expected to produce increasingly dry forests that are highly vulnerable to fire. The climatic conditions necessary to support mega-fires (on the order of the 1988 Yellowstone fires) are predicted to occur in almost all years by 2100, instead of every 100-300 years. All of these changes would have far-reaching ecological and economic impacts for Teton County and the broader GYE.

Ecological Impacts

Teton County is part of one of the most uniquely intact ecosystems in the world. In North America, the GYE stands out as one of the last places where elk, moose, mule deer, pronghorn, and bison are still abundant; where wolves and grizzly bears roam; and where hundreds of bird, plant, insect, and smaller mammal species make their home. However, changes in temperature, snowpack, and growing season are already affecting many species of plants and animals in the region. These impacts can only be expected to become stronger and more numerous as temperatures warm. Because ecological systems are complex, climate change is likely to have a variety of different impacts on different species – some stronger than others, some negative and some positive, depending on the species.

Cold-Dependent Species

Species that are very dependent on cold or snow are likely to decline substantially or go locally extinct. These include snow-dependent wildlife such as wolverines, Canada lynx, and pika, as well as heat-intolerant species such as moose. Many native fish species, including the Yellowstone cutthroat trout, also depend on cold temperatures. The combination of warmer stream waters and competition with non-native fish (which tolerate warmer water better) are predicted to cause a more than 60% decline in Yellowstone cutthroat trout populations by the end of the 21st century – potentially leading to declines among the more than 40 species of birds and mammals that eat these fish.

Whitebark Pine

Whitebark pine is another highly vulnerable species. This ecologically important high-altitude tree species has already declined over large areas of the GYE because of white pine blister rust (a non-native fungus) and mountain pine beetle (a native beetle that is killed by cold weather but thrives in warmer winters). There is a very low chance that this tree species will be able to persist – outside very small pockets of forest – if warming trends continue. The loss of this tree species could be very harmful for many mammals and birds – including grizzly bears and Clark’s nutcrackers – that make heavy use of whitebark pine seeds as a food source.

Wildfire and Forests

Perhaps the most significant and sweeping expected ecological impact of climate change is more frequent and more intense wildfires. Under the “worst case” emissions scenarios, climate conditions would be right for most areas of the GYE to burn *at least every 10 years* by the second half of the 21st century. At this frequency of fires, many trees would not be able to regenerate, and most forested areas would become shrublands or grasslands (which might or might not continue to burn just as frequently). Such a dramatic loss of forest habitat would have far-reaching impacts – mostly negative – for a very large number of species of birds and mammals that live in Teton County and the GYE. Some species, such as mule deer and pronghorn, might benefit from the additional shrubland and grassland habitat; however, the drier plant growing conditions would probably harm these species populations more than the benefits of added habitat extent.

Ecological “Winners”

Although a few other native species of plants and animals might benefit from warmer, drier conditions, many of the beneficiaries are likely to be non-native or invasive species. These species are “generalists” that are tolerant of a wide range of climatic conditions and can colonize a new area rapidly in the vacuum left by species that are declining, going locally extinct, or shifting their range upslope. One invasive species that is particularly threatening and worrisome is cheatgrass. Cheatgrass has wreaked ecological and economic havoc on much of the Great Basin. It aggressively replaces native grasses and herbs, effectively pushes out sagebrush and other shrubs by dramatically increasing fire frequency, and has very little forage value. Although cheatgrass is not currently a major problem in Teton County, warmer, drier conditions are very likely to create conditions that favor this and other “weedy” species like it.

Economic Impacts

Every year, three to four million visitors pass through Teton County. Between August 2013 and 2014, Teton County’s economy generated \$1.115 billion in total taxable sales, with an estimated 35% to 45% of this attributable to visitors. Accommodation and food services are the county’s largest employers by sector. Tourism in Teton County is intimately linked with the local ecology and ecosystem services; visitors come to enjoy the scenery and wildlife, to ski, and to fish and hunt. Given the many impacts that climate change is expected to have on the local ecology and ecosystem services, it is likely that climate change will also impact tourism and the economy of Teton County.

Winter Recreation and Tourism

Winter recreation and tourism, in particular, are likely to be impacted by warming temperatures and reduced snowpack. Over the 2013-2014 winter, there were approximately 700,000 skier-days at Teton County’s three ski areas—Jackson Hole Mountain Resort, Grand Targhee Resort and Snow King Mountain. Each skier-day is estimated to generate approximately \$82.59 in revenue, suggesting that resort-based skiing in Teton County generates approximately \$57,813,000 in direct revenue. Loss of skier-days due to shorter ski seasons would thus substantially reduce revenues. Ski resorts with the capacity to increase snowmaking may be able to partially compensate for shorter winter seasons, but other types of winter recreation that draw tourists (such as back-country skiing, snowmobiling, and snow-coach tours) do not have this capacity to adapt.

Depending on the rate of warming and change in the quantity or quality of snow, it is possible that the ski industry in Teton County will benefit from climate change over the next few decades – as ski conditions become relatively worse in warmer parts of the country such as California and Colorado. It remains unclear whether more skier-days in the heart of winter would compensate for lost skier-days on the shoulders of the ski season.

Summer Recreation and Tourism

Summer tourism may also be impacted by climate change in a number of ways. While the relatively cool climate of the Tetons in the summer might attract more visitors who are escaping hotter places, declines in the quality of the visitor experience may keep many visitors away. Fewer fish to catch, stream closures due to warm temperatures, or reduced populations of iconic large game (such as moose and elk) could make this a less appealing destination for many visitors. Lower stream and river levels are also likely to decrease the number of scenic and whitewater float trips that can be operated on the Snake River, leading to lost revenues for float trip operators. Frequent fires are also likely to harm the tourism industry. In 1988, for example, visitation to Yellowstone National Park dropped from 2.3 million to 1.7 million visitors, resulting in an estimated \$21 million loss (26% less visitor expenditures than expected). Because fires have a long-lasting impact on the scenery, tourism is likely to be reduced for several years following a major fire.

Costs of Wildfires

If fires become more frequent, the costs in terms of property damage and fire-fighting may be very high. In Teton County, there are currently about 3,000 dwelling units located within the fire-prone wildlands-urban interface (out of a total of about 12,000 units in Teton County), and this number continues to rise. The estimated cost of fighting the 2012 Little Horsethief Canyon fire (which threatened houses around Jackson) was approximately \$8 million, \$5 million of which was paid for by Federal funds and \$3 million of which was paid for by the State of Wyoming. Although the costs of fighting wildfires are currently not borne by local and county-level agencies, this may change in the future as federal funds become increasingly limited or spread thin (since fire frequency is expected to rise substantially across the West). If such costs are absorbed locally, they could have a significant impact on the local economy.

Real Estate

Conversely, climate change may have positive effects on the local real estate market. In summer, high temperatures in other parts of the country may increase the appeal of Teton County's relatively cooler climate. This may attract more permanent and part-time residents to a region with an already-vigorous real estate market. In 2013, total real estate sales amounted to \$740 million, with construction and related retail sales comprising a significant portion of the county's economic activity.

Conclusion

The potential effects of climate change on Teton County are numerous and far-reaching. Although there are likely to be economic and ecological winners and losers – on varying temporal and spatial scales – it is clear that climate change is likely to substantially impact this region. Understanding these impacts, and untangling the net effects of climate change on different aspects of our ecology and economy, will require further study and long-term

monitoring of a diverse set of indicators of change. However, understanding the suite of potential impacts is an important first step towards becoming a more prepared and resilient community. We hope that *The Coming Climate: Ecological Impacts of Climate Change on Teton County* will stimulate further discussion and pro-active efforts to mitigate global climate change and reduce its negative impacts on Teton County.

