Climate Trends, Projections, and Impacts

The world's climate is warming, a trend that is expected to accelerate with increasing concentration of the greenhouse gases that trap heat in the atmosphere. Each community will experience the impacts differently depending upon location and geography, economic circumstances, and local preparedness.

Trends

The 2017 Montana Climate Assessment analyzes trends in temperature and precipitation for seven regions of Montana. Scientists at the University of Montana and Montana State University examined data beginning in 1950, which is when climate records became widespread and reliable. That period also coincides with the observed trend of temperature increase in Montana and a rising rate of global carbon dioxide emissions.[1]

Longer fire seasons are the result of current climate trends.

PHOTO: Courtesy of Ed Lieser

Northwest Montana Climate Trends 1950 – 2015 By the Numbers

2.5°F increase in annual average temperature

- Spring heated up 3.3°F
- 12 more frost-free days per year

3.77 inches decrease in annual precipitation

- Winter average decline was 3.76 inches – likely due to more frequent El Nino events, which tend to cause warmer, drier winters in Whitefish
- No significant trend for other 3 seasons

Observed impacts since 1950:

- Longer fire season
- Extended growing season
- Lower summer stream flows
- Earlier snow melt – roughly 2 weeks earlier

DOUG FOLLETT
Glacier National Park Ranger and Whitefish Resident
PHOTO: Chris Peterson/Hungry Horse News

"We haven't always been able to talk about climate change in Glacier National Park. Now it's unavoidable. The plants and the animals are suffering."

- Doug Follett, age 91, has been a Glacier National Park ranger since 1959. He completed his 56th season in the park in 2017 and plans to return in 2018.

Melting Snowpack

When examining long-term trends in snowpack, scientists typically use snow measurements on April 1 to represent peak snowpack for the winter. Warmer spring temperatures are the primary reason that April 1 snowpack levels have declined. High-elevation snowpack has been less affected than snowpack at lower elevations.

Across western Montana since the 1930s, April 1 snowpack declined by an average 23 percent below 6,000 feet and 12 percent above 6,000 feet.[2] Figure 1 shows April 1 snowpack trends since 1955 at five snow course stations in northern Flathead County.[3]

STATION NAME	ELEVATION (FEET)	% CHANGE TREND
Mineral Creek	4,000	- 40.4%
Logan Creek	4,300	-29.9%
Emery Creek	4,350	-28.3%
Desert Mountain	5,600	-26%
Hell Roaring Divide	5,770	-24.1%

FIGURE 1. TRENDS IN APRIL 1 SNOWPACK, NORTHERN FLATHEAD VALLEY, 1955-2016. Spring snowpack is melting roughly two weeks earlier, more so in mid elevations than high elevations.

FIGURE 2. LOCATION OF FIVE LONG-TERM SNOW COURSE SITES IN NORTHERN FLATHEAD COUNTY.
SOURCE: Natural Resources Conservation Service via EPA Climate Indicators[4]

Witnesses to Change

Whitefish High School student Luca Welle discusses Whitefish Lake's past and future with Dewey Hartman, Charlie Abell, and Sandra Hartman.

PHOTO: Karin Hilding

As a child in the 1940s, Charlie Abell spent many hours at his grandmother's cabin on Whitefish Lake. Together they would keep track of the weather and record their observations. "She kept good records," Abell recalls. "I remember looking at the thermometer once and it was 51 degrees below zero. We don't see that anymore."

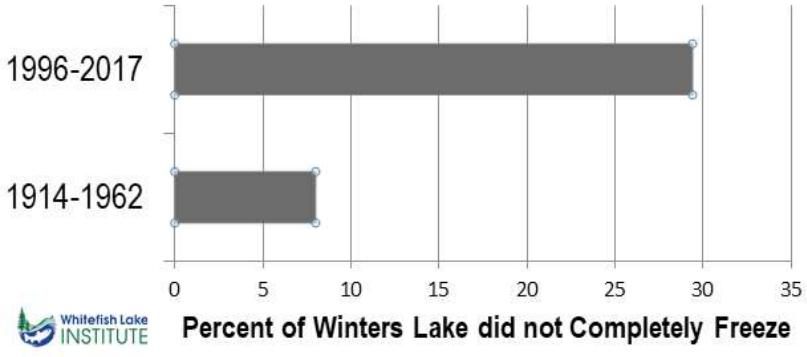
On a warm September afternoon, Abell sat on the deck of his longtime neighbors, Dewey and Sandra Hartman, to reflect on decades of living on Whitefish Lake. Asking the questions was Luca Welle, a Whitefish High School student, who has been an advocate for clean energy and emission reductions. "What changes have you observed since you were young?" Welle asked.

Dewey Hartman recalls colder winters. "The ice on the lake always got very thick. That's been a big change. We get a lot more years now when the whole lake doesn't even freeze over." The summers are different, too, Sandra Hartman says. "We used to get two or three hot days every summer, in the upper 80s or even into the 90s. But mostly the temps were in the 70s. We get a lot more hot days now. I don't remember many wildfires until about 20 years ago, and now we seem to get a lot more fire and smoke."

Less summer rain, too, according to Abell. The month of June used to be wet and cool, but not so much anymore, he said. "My grandma and I kept track of rainy days in June when I was a kid. Over the three or four years that we did this together, it averaged 28 days of rain during the month of June."

Changing weather conditions over so many years tell us the climate is shifting, Abell said. "We need to encourage the science and technology. Maybe tax incentives for energy-efficient buildings and renewable energy projects."

Reflecting on the afternoon of stories, Welle said it was an eye-opener. "They provided a lot of insight into how things have changed locally. The science tells us that these changes are only going to accelerate if we don't act quickly to make it right. For me personally, I want to make a difference so we don't degrade our way of life and our ecosystems, both local and global."



*No data exists from 1963-1995. Multiple factors are involved for the lake to freeze.

FIGURE 3. WHITEFISH LAKE ICE SUMMARY, TREND TOWARD ICE FREE CONDITIONS. The number of winters that Whitefish Lake freezes over has declined since the early part of the last century.

SOURCE: Whitefish Lake Institute

Projections

Projections for temperature and precipitation changes depend primarily upon future greenhouse gas emissions. The future climate outlook in this chapter is based upon the 2017 Montana Climate Assessment, which used an ensemble of 20 global computer models. The Montana Climate Assessment considers two emission scenarios in projecting future change:

- **Stabilization Scenario:** Assumes that greenhouse gas emissions peak around 2040, then gradually decline. This scenario, known as RCP 4.5, comes closest to meeting the international goal of limiting global temperature increases to 2°C (3.6°F).[4]
- **Business-as-Usual Scenario:** Global emissions continue to rise steadily at the current trajectory. This scenario, known as RCP 8.5, models what will happen if we fail to curb our emissions.

These projections for Northwest Montana represent the median point within a range of values produced by the 20 climate models. Scientists have a high degree of confidence in the general magnitude of future temperature increases. The climate models have a greater level of disagreement about future precipitation, so scientists are less confident about these projections.

Wild Card: Weirder Weather

Climate modelers have high confidence in future temperature projections. They are less confident in predicting severe weather. However, researchers have documented a recent increase in extreme weather events.

Some scientists expect a future Montana with more windstorms, blizzards, and hail.[5] Factors include:

- The Arctic is warming much faster than the temperate regions of North America, which appears to make the jet stream wavier and pulls cold Arctic air farther south.[6]
- Warming ocean temperatures and melting ice sheets may disrupt ocean currents.[7]
- Warmer air holds more water vapor and warm oceans evaporate more quickly, both fueling bigger storms.[8]

Temperature and Precipitation Projections By the Numbers

Projected **Temperature** increases relative to a historical (1970 – 1999) 30-year average:

STABILIZATION SCENARIO

4.5°F by mid-century (2040 – 2069)

5.6°F by end of century (2070-2099)

BUSINESS-AS-USUAL SCENARIO

6°F by mid-century (2040 – 2069)

9.8°F by end of century (2070-2099)

Projected **Precipitation** increases relative to a historical (1970 – 1999) 30-year average:

STABILIZATION SCENARIO

1.3 inches by mid-century (2040 – 2069)

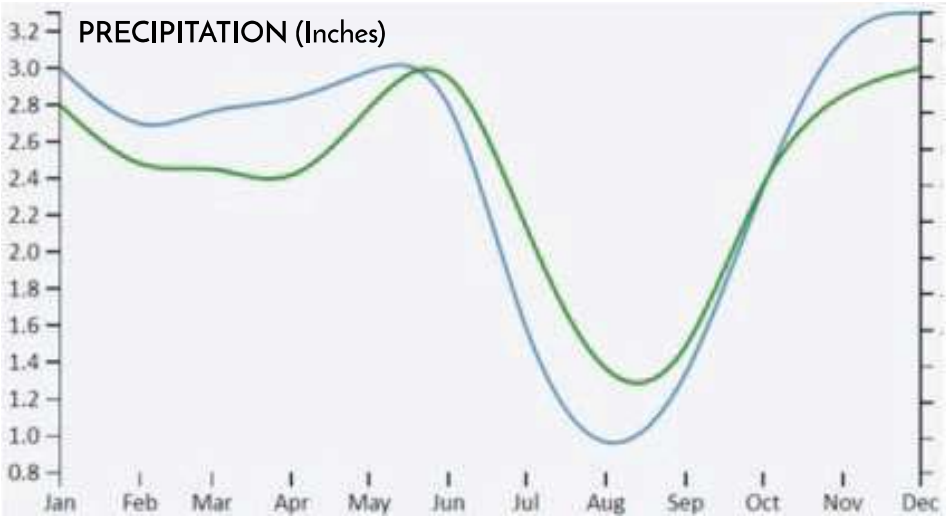
2.3 inches by end of century (2070-2099)

BUSINESS-AS-USUAL SCENARIO

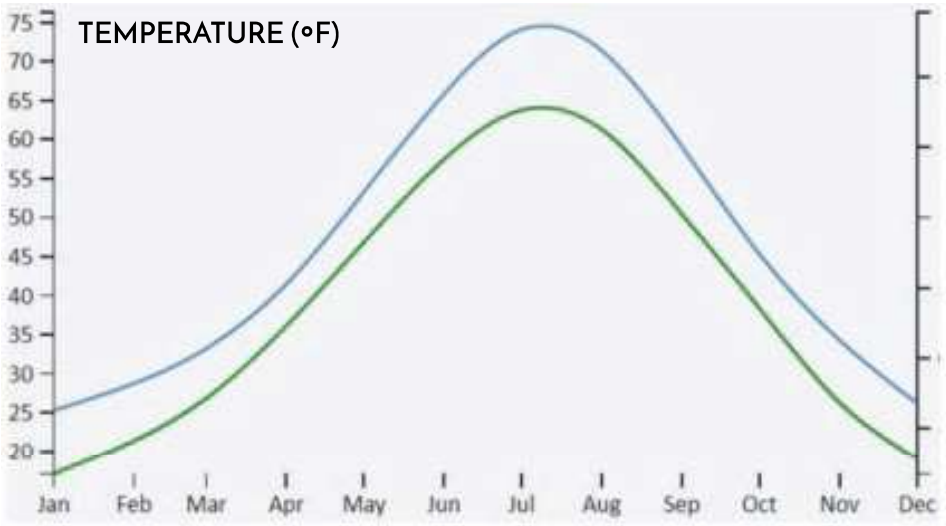
1.6 inches by mid-century (2040 – 2069)

2.5 inches by end of century (2070-2099)

Projections for Whitefish



BLUE: 2071-2090 PROJECTED GREEN: 1986-2005 HISTORICAL



BLUE: 2071-2090 PROJECTED GREEN: 1986-2005 HISTORICAL

FIGURE 4. SEASONAL PROJECTIONS – WHITEFISH 2071-2090.

SOURCE: National Center for Atmospheric Research - https://gisclimatechange.ucar.edu/inspector

"Montana's rapid shift in 2017 from a wet spring to a very hot dry summer is precisely what we expect to see from climate change."

- Montana State University Professor Cathy Whitlock, lead author of Montana Climate Assessment

PHOTO: Courtesy of Cathy Whitlock

Seasonal Precipitation

The timing of precipitation during the year is perhaps more important than annual average precipitation levels. The Montana Climate Assessment projects a shift in seasonal patterns.

Winter

- Warmer and wetter
- More rain-on-snow
- Less low-elevation snowpack by mid-century and less overall snow by 2100

Spring

- Warmer and wetter
- Earlier snowmelt and earlier peak stream flow

Summer

- Hotter and drier
- More frequent flash droughts
- Bigger fires, more smoke

Fall

- Warmer with more rain

The Future of Skiing

Future winter precipitation and rain-snow elevation levels are difficult to predict. But two recent reports examine a more reliable predictor of future snow conditions: Winter temperatures above freezing. The freezing point is important for ski areas because it determines whether precipitation falls as rain or snow, and sub-freezing temperatures are required for artificial snowmaking.

A 2018 report published by the Climate Impact Lab projects the future number of days below freezing in Flathead County compared to the 1981-2010 period based on the Stabilization and the Business-as-Usual scenarios. The average number of sub-freezing days is determined by average temperatures at Hungry Horse Dam, so the actual number of days below freezing at Whitefish Mountain Resort will be greater.[9]

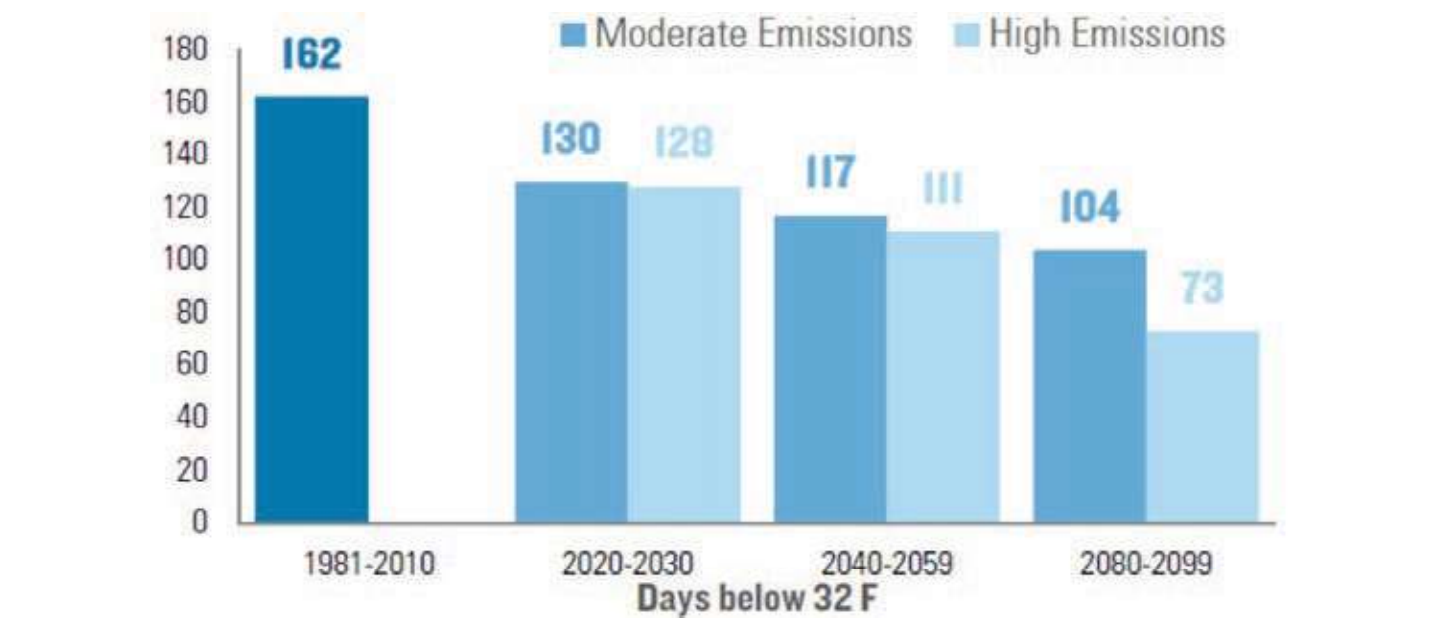


FIGURE 5. CURRENT AND FUTURE DAYS PER YEAR BELOW FREEZING.

SOURCE: Climate Impact Lab, America's Shrinking Ski Season

A preliminary report by Professor Anne Nolin, Director of the Oregon State University Mountain Hydroclimatology Research Group, takes a seasonal approach to predict the future frequency of warm winters. Her research uses the Access1.0 global climate model for these calculations. "Frequency of a Warm Winter" is calculated as the percentage of winters out of 30 winters during which the mean monthly temperature exceeds 32°F during any of the core winter months (December-February).[10]

Possible impacts of climate change for winter recreation:

- Ski and snowmobile season begins later and ends earlier.
- More rain-on-snow and freeze-thaw conditions.
- Whitefish Mountain Resort may have a competitive advantage compared to lower-elevation or lower-latitude ski areas that may face greater negative climate impacts.
- Less reliable low- and mid-elevation snow for Nordic skiing.
- Fewer opportunities for wild ice skating and ice fishing.

WHITEFISH MOUNTAIN LOCATION	1970-1999 HISTORICAL	2040-2069		2070-2099	
		STABILIZATION SCENARIO	BUSINESS AS USUAL	STABILIZATION SCENARIO	BUSINESS AS USUAL
BASE	0	30	33	47	93
MID-MOUNTAIN	0	23-27	23-30	23-40	70-83
SUMMIT	0	3	3	17	60

FIGURE 6. FREQUENCY OF WARM WINTERS FOR WHITEFISH MOUNTAIN. Future winter months are more likely to be warm compared to the historical period.

SOURCE: Anne Nolin, Oregon State University. [Note: Unpublished data - Do not cite without permission.]