

SNOW SCIENTISTS SAY OUR SKI SEASONS ARE GETTING WARMER, WETTER, AND LESS SNOWY. THE GOOD NEWS? SKI RESORTS AND CLIMATE ACTIVISTS SAY THIS IS THE GREATEST OPPORTUNITY TO PROVOKE CHANGE THE SKI INDUSTRY HAS EVER HAD.

By Megan Michelson

Saving Winter

Randall Osterhuber is standing chest-deep in a snow pit of his own digging. When he crouches down to take a snow sample, he disappears completely.

“Our precipitation is below average, but not dramatically,” he tells me from within his pit. He cuts a chunk of snow with a metal edge and dips down again, now shouting from below the surface. “Our snow depth is about 50 percent of average for today’s date and snowfall is about 65 percent of average for the year.”

Osterhuber, a snow scientist, can cite a lot of numbers and data sets from memory. He can easily tell you this area’s five highest snowfall years in recent history (“That would be 1952, 2006, 1983, 2011, and 1982,” he says off the top of his head). Recording this information is what he’s been doing on a daily basis for nearly 30 years.

Today he’s testing the density of the snowpack on a warm spring day on California’s Donner Summit. It’s been a dry and mild winter in Tahoe, and his long-term findings indicate that it’s all part of a rather scary trend: Total precipitation is going up, snowfall and snow depths are going down, and the maximum air temperature is increasing. In other words, our winters are getting warmer, wetter, and less snowy.

“We’re getting a slightly higher percent of our annual precipitation from rain and a slight increase in our nighttime lows. These are subtle changes for now,” says Osterhuber, who’s 53 and has the lean look of a backcountry skier. He spends many of his days at work climbing peaks on his skis to gather snow data from remote field stations.

“The Sierra is already a warmer mountain range compared to others,” he adds. “But as you start to raise the snow line in elevation, the effects of droughts and floods are going to be more severe, with more midwinter rains and less snow.”



Some of the first snowflakes to be captured on film, photographed by Wilson Bentley around the turn of the 20th century.

NOAA



“Under the microscope, I found that snowflakes were miracles of beauty; and it seemed a shame that this beauty should not be seen and appreciated by others. Every crystal was a masterpiece of design and no one design was ever repeated. When a snowflake melted, that design was forever lost. Just that much beauty was gone, without leaving any record behind.”
—Wilson Bentley, snow photographer, 1865–1931

Osterhuber isn't a radical environmentalist and he isn't preachy or extreme. He's just stating the facts as he's found them.

Behind the pit he's standing in is an old building with faded yellow paint, nestled into a grove of lodgepole pines. Around the building, tall, metallic hydrometeorological instruments stick up out of the snow like windmills. This is the Central Sierra Snow Laboratory.

The data collected here is logged and streamed online. That information is then used by backcountry skiers and ski resorts, government agencies, academic researchers, nonprofit organizations, and more. The lab's research ranges from forecasting avalanches to studying trends in climatology, snowpack, solar radiation, wind, snow temperature, and humidity.

Sifting through the data online and in the lab's boxes of paper files can feel overwhelming. After all, nearly 50 years' worth of information on all things winter is compiled here. But if you ask Osterhuber what the overarching trend is, the one thing he's seeing in the snow's scientific makeup that is the most alarming, he'll tell you it's the changing temperatures, the gradual warming effect that climate-change experts have been warning us about for years.

"If all of these climate effects change the snowmelt, that impact is going to be exaggerated," Osterhuber says. "There's going to be less snow and it's going to melt sooner. The implications will be widespread."

Osterhuber seems genuinely concerned with how ski resorts and skiers are going to face the future. After all, he's a skier too.

"When we have a couple of these modest snowfall years in a row, you look at the ski areas and you think, 'Are they responding to this? Or are they just going to make more snow?'" Osterhuber says. "It does look like the ski areas are starting to collect more information. They are trying to figure out a strategy if the climate continues to change."

Many ski resorts are making both drastic and subtle changes to prepare for a different kind of winter in the years to come. For now, nobody knows exactly what the future of skiing will look like, what our winters will

bring in, say, the year 2030 or 2075. But snow scientists like Osterhuber have more clues than you think.

The Central Sierra Snow Laboratory is one of the last snow labs of its kind left standing.

The Army Corps of Engineers and the Weather Bureau, which is now the National Weather Service, built the lab in 1946, well before Interstate 80 blasted over Donner Pass.

They chose this site because it's one of the snowiest spots in the Sierra Nevada and it's at the mouth of several prominent watersheds. Two identical labs were built in Oregon and Montana, but they have

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since been shuttered. The University of California, Berkeley, funds the Tahoe lab, while the U.S. Forest Service owns a few acres of the surrounding land and the lab's building.

Osterhuber started working at the Central Sierra Snow Laboratory in the 1980s, when there were seven employees. Now, because of an ever-dwindling budget, Osterhuber is the lab's only full-time staffer. He spends his days usually alone, tinkering outside with instruments or entering data on his computer. Visiting graduate students, researchers, and state and federal government employees drop in occasionally to use the facility.

To get to this remote lab, you'll take Interstate 80 from Truckee or Sacramento and get off the highway at the tiny California town of Soda Springs (pop. 97). You'll park in a dirt lot alongside Donner Pass Road, less than two miles from Sugar Bowl ski area, at an elevation of about 6,800 feet. You'll walk less than a quarter of a mile

uphill on a snow-covered path in the woods until you reach the two-story building that houses the Central Sierra Snow Laboratory. There are no signs marking your destination.

Inside the lab, the downstairs is basic and neat: a hostel-like kitchen, one desk with a computer and a bunch of papers. A separate room is plastered with posters of snowfall data, recent avalanche incidents, and a photo of the historic 1982 avalanche that killed seven people and took out the Alpine Meadows base lodge. A nearby table is stacked with duct tape, wrenches, and other tools.

Upstairs, three plain bedrooms provide sleeping quarters for visiting researchers and for Osterhuber when he gets snowed in and can't make his commute home.

It is from this modest dwelling that some of the U.S.'s most profound snow-science research from the last 50 years has emerged. The work done here has enabled us to track the changes in temperature and snowpack over five decades in one particularly snowy region.

Osterhuber is not alone in his findings of rising temperatures. Snow scientists around the world are collecting similar data and drawing the same conclusion: Our winters are getting warmer. Countless studies have been done in recent years at snowy areas around the world and most have determined more or less the same thing.

"It's obvious that temperatures are rising. You can't argue with that," says Grant Statham, an internationally certified mountain guide and a mountain risk specialist for Parks Canada, who recently did a study with the University of Calgary looking at snow depths and temperatures on British Columbia's Rogers Pass. "Skiing in the short term, we won't see a lot of impact. But put another 50 years on, and if these trends are going to continue, you're going to see less and less snow in the valley bottoms."

A few years ago, Brian Lazar, a senior scientist with a Colorado-based consulting group, was hired to do a few studies for ski resorts, including Colorado's Aspen



According to Protect Our Winters, a foundation set up by pro snowboarder Jeremy Jones, the U.S. has already lost \$1.07 billion due to low-snowfall years over the last decade.



Avalanche Prone

WILL RISING TEMPERATURES INCREASE AVALANCHE ACTIVITY?

A few recent studies have looked at how rising temperatures could affect snow stability at ski resorts and in the backcountry. The bad news first. Studies found trends toward warmer temperatures and increased rainfall in early winter. This could lead to more early-season rain crusts, which could create deep layers of instability in the snowpack. Also, wet avalanches, which typically occur late in the spring, may happen earlier in the season.

Now the good news. Researchers have not found a direct link between warming temperatures and increased naturally occurring avalanches. "The snow depths are going down at lower elevations and we're seeing more rain," says Grant Statham from Parks Canada, who conducted a study last winter on British Columbia's Rogers Pass. "More snow usually means more avalanches." —M.M.



Tahoe's Five Deepest Winters

RANK	YEAR	TOTAL SNOWFALL (INCHES)
1	1952	812
2	2006	710
3	1983	671
4	2011	643
5	1982	624

1. The lab's data is used by backcountry skiers, ski resorts, researchers, government agencies, nonprofits, and more.

2. Pro snowboarder Jeremy Jones founded the nonprofit Protect

Our Winters in 2007.

3. Thirty years ago there were seven employees at the Central Sierra Snow Lab. Now, due to shrinking budgets, there is only one.

4. Randall Osterhuber

sees one overarching trend: Our winters are getting warmer.

5. This modest operation has produced some of the U.S.'s most profound snow research during the past 50 years.

According to a recent study commissioned in part by Park City Mountain Resort, Utah, climate change could noticeably affect snowpack in as few as 50 years.



The Future of SNOW?

Brian Lazar, a senior scientist with a Colorado-based consulting firm and executive director of the American Institute for Avalanche Research and Education, recently conducted studies for several ski areas in the West, including Park City Mountain Resort. What he found may surprise (and terrify) you.

year
2030

4.5° F
INCREASE IN TEMPERATURE

2 weeks
Reduction of the ski season at PCMR

650
Feet the midwinter snow line will climb

year
2050

36%
SNOWPACK LOSS AT ALL ELEVATIONS

\$27.2 million
Lost earnings due to decreased snowfall

year
2100

16.2° F
INCREASE IN TEMPERATURE

zero inches
Depth of midwinter snowpack at all elevations

Skiing Company, Utah's Park City Mountain Resort, and Oregon's Mt. Bachelor. Each resort had the same burning question: If climate change is happening, what will our ski resort look like in the long-term future?

"There's a range of possibilities for what ski areas are going to look like in, say, 2030—depending on variations in greenhouse-gas emissions, variations in the models, and the location of the ski area—but it's likely that we will see warmer average winter temperatures," says Lazar, who's also the executive director of the American Institute for Avalanche Research and Education. "It's not rocket science. If temperatures get warmer and precipitation stays the same, you'd expect more of that precipitation to fall as rain and not snow. You'd expect snow to start falling later in the fall and melting earlier in the spring."

According to Lazar's studies, which were first published in 2006, by the year 2030, average temperatures are estimated to increase 4.5 degrees Fahrenheit at both Aspen Mountain and Park City. By 2100,

The Central Sierra Snow Laboratory was founded in 1946 by the Army Corps of Engineers and the Weather Bureau. It's less than two miles from Sugar Bowl.

that spike could jump as high as 16.2 degrees from today's temperatures. By 2030, Lazar estimates the length of the ski season will be shortened by around one or two weeks, and the snow line will climb roughly 650 feet at both Park City and Aspen.

At Park City, by 2050, the resort's snowpack will shrink by six to 36 percent of average, according to the study. By 2100, a more severe model shows that Park City could lose all of its snowpack at all elevations. The Mt. Bachelor results were never made public, but Lazar says the findings there were similar.

The shortened ski season may not have a huge impact on skiers, but the resorts will feel the burden on the bottom line. By 2050, Lazar's study finds, the potential economic impact at Park City could be around \$27.2 million in lost earnings and 1,520 lost jobs.

Some of those economic impacts have already been felt. A December 2012 study by Protect Our Winters, a foundation set up by pro snowboarder Jeremy Jones, and the Natural Resources Defense Council found that the U.S.'s currently estimated \$12.2 billion winter tourism industry has lost \$1.07 billion in revenue between low and high snowfall years over the past decade.

"We may be pretty old by the time this

stuff really impacts us," says Lazar. "But I've got two kids and I'd like them to grow up and have powder days too."

Ski resorts can sense the change.

The last two winters in a row, ski areas from Vermont to California have suffered from record low snowfalls and Caribbean-like temperatures. But elsewhere, the news hasn't been all bad.

In Alaska and the Pacific Northwest last winter, snowpacks were slightly above average and the storms seemed to come in more frequently and more ferociously. Climate experts say the wild fluctuations in temperatures and severer storms are part of the change.

When I speak with Brent Giles, the chief sustainability officer for Powdr Corp, the company that owns Park City Mountain Resort, Copper Mountain, Killington, Mt. Bachelor, and more, it's a warm spring day in April and it's just snowed 15 inches overnight in Park City, where Giles is based.

"The snow is a little heavy," Giles admits, "but at least it's here."

Powdr Corp has been preparing for a warming climate for years now—it has invested \$6 million at its various resorts over the last six years in environmental initiatives, such as solar and wind projects, more-efficient snowmaking, and powering the gondola at Killington on energy harvested from cow manure.

"We believe that the ski industry is going to suffer from climate change, increased temperatures, and less snow," Giles says. "And we believe it's our moral duty to do something about it."

The resorts that have the budget to do so continue to pour money and time into major and minor green projects. Around 20 ski resorts in the U.S. have signed on to the National Ski Area Association's Climate Challenge, a program that helps resorts reduce greenhouse-gas emissions.

Whether they're doing it for their bottom line, for marketing's sake, or for the planet, nobody can say for sure. "Many ski areas have already responded to the changing climate with an increase in snowmaking and snow management," says Jordy Hendrikx, director of the Snow and Avalanche Laboratory at Montana State



11

Number of the 12 warmest years (in global surface temperature) since 1850 that have occurred since 1995



\$12.2 billion

ESTIMATED VALUE OF THE U.S. WINTER TOURISM INDUSTRY

Climate Challenge

The first eight U.S. ski resorts to sign on to the NSAA's 2011 Climate Challenge, a plan to reduce greenhouse-gas emissions:

- ALTA, UTAH
- ARAPAHOE BASIN, COLO.
- CANYONS, UTAH
- JACKSON HOLE, WYO.
- JIMINY PEAK, MASS.
- MT. HOOD MEADOWS, ORE.
- PARK CITY MOUNTAIN RESORT, UTAH
- TELLURIDE, COLO.

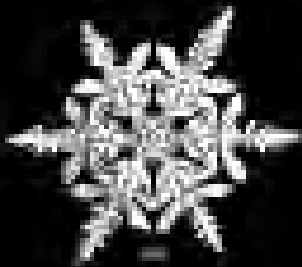


Degrees Fahrenheit by which the annual mean temperature around the world could rise by the year 2100

11.5

88

Percentage of ski areas belonging to the National Ski Areas Association that are using snowmaking to supplement natural snow cover



27,000

Jobs lost in the snow-sports industry due to diminished snowfall in the past decade

Minimum proportion of average snowfall we're estimated to lose by the end of this century

(25%)



“We may be pretty old by the time this stuff really impacts us. But I’ve got two kids and I’d like them to grow up and have powder days too.”

Brian Lazar, executive director for the American Institute for Avalanche Research and Education.

University. “But in many cases, this is to ensure that they have sufficient snow in a bad year, rather than in direct response to projected climate change.”

Auden Schendler, the vice president of sustainability for Aspen Skiing Company and a longtime advocate for climate change policy, says that adaptation plans—improved snowmaking, improving the resort’s summertime offerings—are not real solutions. “If making snow is your response to climate change, then you’ve got a problem,” Schendler says.

Schendler’s answer, and something Aspen Skiing Company is leading the charge on in the ski industry, is public policy to stop climate change. Last spring, Aspen Skiing Company joined over 30 major corporations, including Starbucks, IKEA, Nike, eBay, and others, in signing a climate declaration that served as a call to action for the U.S. government.

“Climate change is a dauntingly big problem,” Schendler says. “But this is not a doom-and-gloom thing; it’s the greatest opportunity the ski industry has ever had. We just want to keep our beloved sport going. We have all the technology today we need to solve it. All we need is the political will.”

Fast-forward 100 years. Perhaps the most extreme forecasts will come true. Perhaps we won’t react in time. Maybe temperatures will continue to rise and rain will fall where snow once did. Low-elevation resorts may turn into summer destinations only. Perhaps the skiing we know today will be gone, changed or depleted, and in its place there will be something entirely different.

As skiers, we could look at this situation with despair. Or, as Schendler suggests, we could look at it as an opportunity. We could take the results that snow scientists like Randall Osterhuber and others are finding and work together to advocate for a solution. As skiers, we have a chance to change the course of the future.

Perhaps in 100 years, the skiers of that era will look back and be proud. Everything worked out just fine, they’ll say. And then they’ll drop into a cold, dry powder turn in the middle of a long, white winter. ●

CHRISTOPHER D. THOMPSON