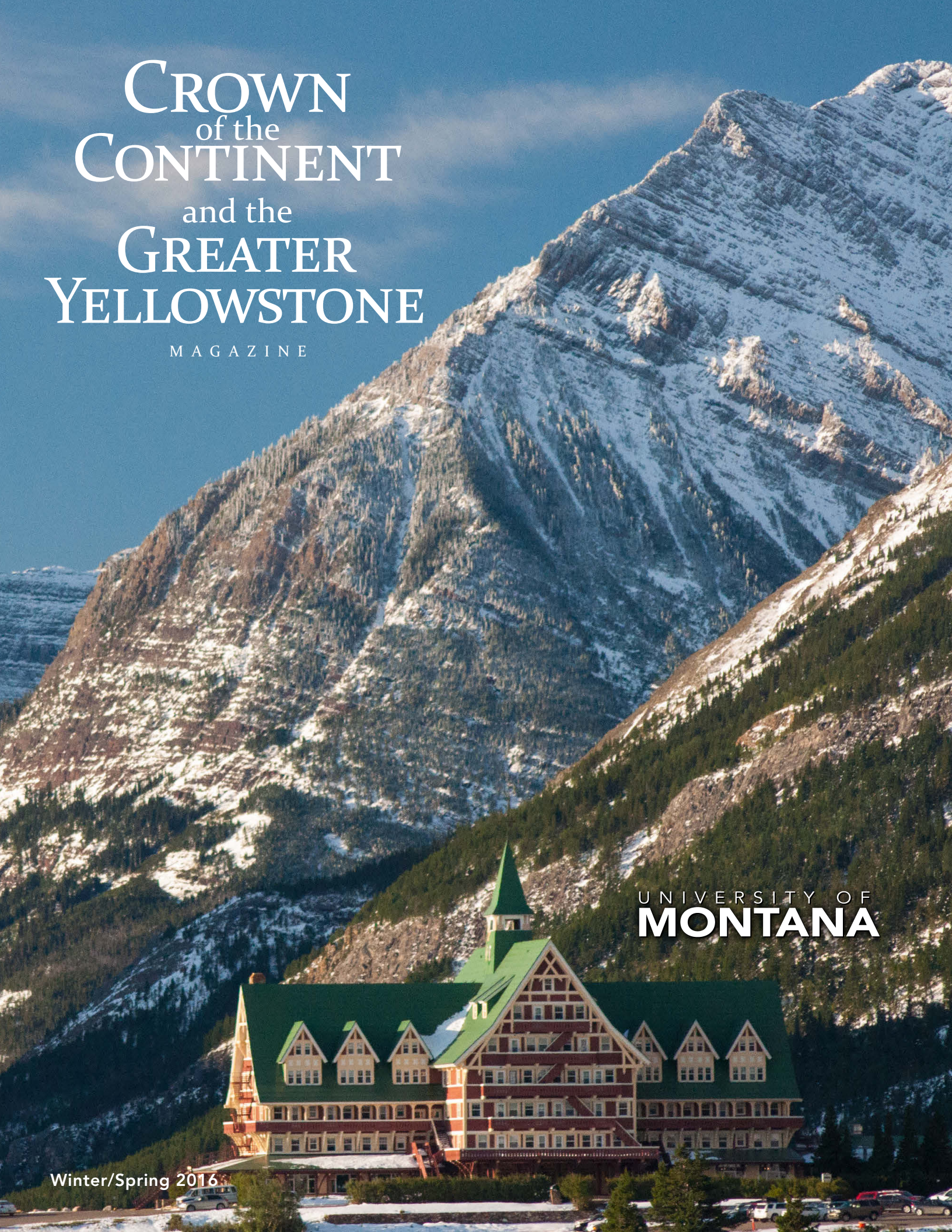
Crown of the Continent and the Greater Yellowstone

MAGAZINE



UNIVERSITY OF MONTANA

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A Deadly Game of Hide and Seek

by **L. Scott Mills**

Camouflage is one of nature's most marvelous adaptations. It's everywhere, hiding creatures in plain sight. Cryptic coats cloak insects, snakes, birds, mammals, lizards – really, species from any animal group you could imagine. Why? Because, in nature, where every animal kills something to survive, camouflage makes the difference between life and death. Deep study of animal camouflage by naturalists and artists in the late 1800s led to principles that revolutionized military camouflage patterns by World War I. In turn, hunters and nature watchers ever since have benefitted from the rich tapestry of commercial camouflage patterns, ranging from "real-tree" brown to "winter white" patterns.

But unlike humans who have to buy separate brown or white camouflage patterns to fit the occasion, some animals carry a full set of different coat colors in their genes. At least twenty species worldwide undergo seasonal molts where their hair turns from brown in summer to white in winter to match the predictable seasonal passing of snow, making them some of nature's most charismatic creatures: Arctic fox, weasels, hares, and some lemming and hamster species to name a few. Here in the Crown of the Continent, snowshoe hares, white-tailed jackrabbits, and three species of weasels, all undergo seasonal color molts.

I have been studying snowshoe hares continuously since 1998. My questions at the beginning were both basic – understanding the controls on numerical changes and population fluctuations of wild animal species – and also very applied, because the hare is the nearly sole prey of the Canada lynx, a species listed as federally threatened in 2000. My students and I live-trapped, radio-collared, and observed

Caught still wearing winter white after the early onset of snowmelt, a snowshoe hare is easy prey. Sneed B. Collard III

hares across the West year-round, learning where they moved, where they hid, who ate them and how often. We studied them across different forest types and full moons and blizzards and heat waves. Really, what we did, year after year on snowshoes and snowmobiles, up and down steep slopes with mosquitoes in our ears, was to learn – scientifically speaking – the implications of the many ways that hares can die.

Over time, we increasingly saw bright white hares hopping around on a snowless brown forest floor in late October or mid April. We had been studying the ways that predation shaped hare behaviors and population trends, but those mismatched, light bulb bright critters got my mind spinning. Paul Griffin, my PhD student back in 2000, found that hares died more in fall and spring than in deep winter or summer. We wondered: Why? Could it be because they have mismatched coat colors on snowless ground?

A perfect match for winter. Mills Research

First week of June molting stage. Nate Steiner/Flickr

For me, these early musings about the potential costs of coat color mismatch eventually collided with emerging findings from the field of climate science in a reverberating "ah-ha!" moment. Pouring out of climatology labs from around the world (including Steve Running's at the University of Montana) came clear evidence that the duration of seasonal snow cover is decreasing fast. And the thing is, you don't need to believe in any climate model to know this is true. Just go anywhere in the world with seasonal snow (Montana, Maine, Mongolia, Alberta, Scotland, Italy), find a person who has spent a lifetime observing the seasons (perhaps a hunter, birdwatcher, logger, or skier), and ask them if the duration of winter is shorter now, on average, than when they were young. I'll bet 50 bucks they say yes.

With the realization of the globally shortening snow duration, I dug into what was known about seasonal coat color. Lab studies had shown the timing of the coat color molt was, like migration, hibernation, and other seasonal (phenological) traits, driven by changing day length. This makes sense, as day length is a reliable cue, long term, of the comings and goings of snow. Over time, snow has come early or late in different years, but on average, the shortening days of fall indicate that snow will soon arrive, and the lengthening days of spring herald the coming thaw.

What does it mean if the timing of the molt is set by photoperiod, but snow duration is rapidly decreasing? Will coat color mismatch increase in the future? Does mismatch make animals easy targets for predators, and could it lead to the eventual decline of a species? Do animals have tricks (we call it "plasticity") up their furry sleeves that help them deal with mismatch, perhaps by adjusting molt timing year to year or behaving in ways to minimize mismatch or its consequences? Could natural selection change the timing of the molt, prompting "evolutionary rescue" that decreases mismatch fast enough to prevent species declines? In the end, will climate change be likely to send coat color changing species toward oblivion, or will they be able to adapt? These are questions that have yet to be answered for snowshoe hares, or for that matter, any species facing climate change.

By the way, right about here some folks will say: "of course these rabbits will be fine, because they breed like rabbits!" But, hares are *not* rabbits. Hares are born above ground—exposed to predators from birth—and have modest litter sizes compared to rabbits.

Therefore, my research team is throwing everything, including the kitchen sink, at answering the question of whether or not wild animals can locally adapt to rapid climate change. Over the past six years, we have radio-collared more than 300 snowshoe hares so we can find their locations once per week. If they're dead, we figure out who killed them, and where. If they're alive, we record their coat color so we can quantify the timing and speed of the coat color change, and we record snow around each hare to quantify the mismatch between the hare and the ground. We also measure behaviors to test whether or not hares can perceive their own mismatch and act to decrease the chance of becoming someone's next meal.

Out in the field with my graduate students Marketa Zimova and Alex Kumar and dozens of hard-core field helpers and collaborators, we've already learned a lot. The fall molt to white starts with the ears and lower abdomen, then spreads through the body, with the face and back the last to turn white; spring molt is roughly in reverse order, except more splotchy and mottled. The total time from start to finish is about 40 days for both the fall and spring molts. As expected, for a seasonal trait timed to changing day-length, we do not see a chameleon-like ability to adjust the beginning date of the color molt in years when the snow comes late or leaves early. Whether it was the monster long snow year of 2010-2011 or the historically short snow year of 2009-2010, the molt in the western Montana Seeley Lake hares begins like clockwork about October 10 and the spring molt about April 10.

We also find the coat color change is adapted to track local average snowpack. In our Gardiner study site outside Yellowstone National Park—about twice the elevation of our western Montana study site and with much longer snow duration—hares remain white about five weeks longer.

When hares are mismatched, they are indeed more vulnerable to being killed by raptors, lynx, bobcats, foxes, coyotes, and marten that prey on them. Our field

Researchers use telemetry to locate collared hares in the rugged Swan Mountains. Mills Research

studies show that for every week a hare is mismatched, it is seven percent more likely to be killed than other individuals who are matched against their background. As to whether hares can perceive that they are mismatched and then take actions (like hide, or flee, or pick a spot to be better matched), they don't seem to know what's going on.

What happens when we put the cost of mismatch up against the rigorous, locally downscaled climate change projections of shortened winters in the future? Assuming the color molt timing stays as it is now, over the next 50 or so years, the number of days that white hares will be mismatched on a snowless background will be four to eight times more than it is now, and that mismatch will be deadly.

Snowshoe hare education in the field.
Sneed B. Collard III

But wait… we also found that within hare populations, individuals are remarkably variable in their coat color timing and rate of molt—some start earlier, or later than others. This is exactly what you would expect: because snow has always differed in when it comes and goes each year, an inconstancy in coat color timing has allowed the persistence of these populations through those long and short winters. And the within-population variability is mirrored across populations, where we find that molt timing is shaped to local snow conditions like Seeley Lake versus Gardiner.

Could evolution rescue species from the rapidly shifting conditions of climate change by altering the timing of the molt to track reduced snow duration? We are pushing hard to answer this question. In addition to the field-based measurements, another key piece includes unravelling the genetic basis of the coat color change. For this part, I am collaborating with Dr. Jeff Good at the University of Montana and Drs. Paulo Alves and Jose Melo-Ferreiro at the University of Portugal. Also, here at North Carolina State University we've built a one-of-a-kind experimental facility where animals can be kept in photoperiod and sub-zero temperature controlled conditions like those found in the north. We have Montana and Washington hares undergoing their normal color molts, allowing us to tease out key questions regarding genetic inheritance, ability for animals to adjust behaviors or molt, and other questions. We're also expanding the project globally, with new coat color change research collaborations underway in the Northeast on weasels, in Scotland and other parts of Europe on mountain hares, and in Sweden on Arctic foxes.

The charismatic poster-child of climate change is mismatched white animals on a brown snowless background. On the one hand, the picture underscores a direct and real consequence of climate change. But on the other, it implies that natural selection may play a powerful role in determining how this story unfolds in the years ahead.

For the good of both humans and non-humans, we clearly must continue to address the underlying causes of climate change. However the potential role of natural selection implies very real steps that could be taken in the meantime to foster evolutionary rescue. Adaptive evolutionary change requires populations to be relatively large, with connectivity across the landscape with other populations, and with reduced stressors coming from other factors (such as land use change, invasive species, and habitat fragmentation). While we fill in the details of the science behind this story, we can say for sure that any actions taken to foster evolutionary response by maintaining large, connected populations will increase the chance for wild animals to persist in the face of rapid climate change. That's the hands-on, hopeful story that the hares have told me.

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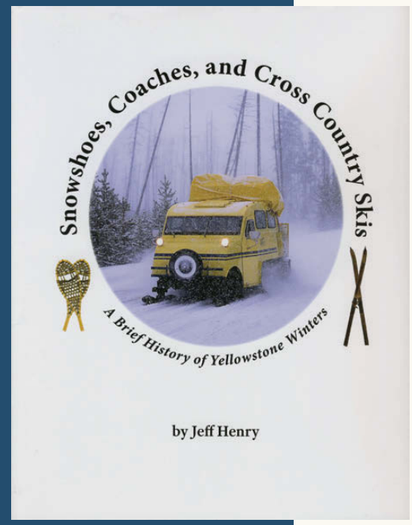
BOOK REVIEWS



SNOWSHOES, COACHES, AND CROSS COUNTRY SKIS. A BRIEF HISTORY OF YELLOWSTONE WINTERS

by Jeff Henry. Emigrant, MT: Roche Jaune Pictures, Inc. 2011.

While we were beginning to think about the Winter issue of the magazine, I picked up a copy of this marvelous book in Yellowstone Park, thinking that it looked like a good book to read, and also a possibility for a review. Was I ever right about that! What I stumbled across turned out to be an exceptionally informative, fun, and well-written history of the glories and challenges of Yellowstone in winter, beginning with a short discussion of the pre-historic ice age and the glacial legacy it left behind, moving chronologically through an anthropological and archaeological glance at how "Yellowstone's First Peoples" most likely wandered through and hunted in the area, and ending with the final chapter portraying more contemporary subjects, 20th and early 21st century transportation, construction, "winterkeeping," and the now vast range of winter activities that take place in the park, work-, scientific-, and recreation-related.

The book, obviously born of a love affair and extensive experience with the park by the author, Jeff Henry, a tremendous photographer whose photos, as well as an impressive collection of outstanding art by a large number of artists, add a visual richness that will charm and inspire readers of all kinds. Henry himself has spent over 30 winters in the park where he has been, among other things, a seasonal ranger, wildlife researcher, and "winterkeeper." He has published two earlier books as well: The Yellowstone Winter Guide (revised in 1998) and Yellowstone Winterscapes (2004).

As the title of this book suggests, his focus here is in answering the question "how have people, and how do people, travel in and around the park during the several months of winter?" Yet, as he discusses the use and impact of the various means of transport in and through the wintery land, from early day snowshoes and long wooden skis in the late 19th century to the various (and often controversial) motorized vehicles of the late 20th and early 21st centuries, the reader learns about other pieces of history: about the explorers who "discovered" and mapped it, the early "managers" and protectors (the US Army and those who pioneered the US Park Service here on the ground), those who built the structures that allow visitors and workers not only to move about in winter, but to spend nights and even weeks there, and about the animals that live, roam, and search for food during the challenging winters for which Yellowstone is famous.

If you have ever visited Yellowstone in winter and experienced the special magic of the place in this long season, or are contemplating doing so, this is a book that you should check out of your library, purchase, and both read and browse through over and over. In my most recent visit to Yellowstone this January, having spent time with this book beforehand helped me see and appreciate a lot more in this mostly white landscape than I ever had prior to taking it into my hands. This "Brief History of Yellowstone Winters" is a real gem, and at a price of $24.95, hardback and large format, it's a great bargain!