

On Scotland's Cairngorms this mountain hare blends into the alpine plateau – but when the snows retreat how well will it time a return to its summer coat?

Mark Hamblin/PA



A mountain hare's winter coat is vital for survival, but it needs to time its transformation perfectly. **Amy-Jane Beer** asks if climate change is forcing this species out of sync with the seasons.

RUNNING OUT OF TIME?

Photos by
Mark Hamblin



Mountain hares are largely nocturnal and crepuscular. During the day they tend to rest in 'forms' – shallow hollows – emerging at dusk to feed in groups of up to 70.

Some of the most dramatic seasonal changes on the planet occur in uplands across temperate regions of the northern hemisphere. The transition from late summer to winter whiteout, and from thick blankets of old snow to glorious, full-blown spring, can take place in a matter of days. So for mammals that rely on a change of coat for winter camouflage, such as the mountain hare and its American cousin the snowshoe hare, timing is everything.

For millennia these two lagomorphs have got it more or less right. But what if the rules of the game were to shift? In fact it's happening already: climate change is rapidly reducing the average duration of winter snow cover. In Montana, USA, biologist Scott Mills began to notice camouflage failures in the snowshoe hares he studies. "With snow not lingering as long, we started seeing more and more white hares on a brown background. It suddenly dawned on us that, amazingly, no one had yet studied seasonal coat colour in connection with climate change."

The phenomenon of winter whiteness, also known as seasonal crypsis, is seen in a variety of largely unrelated northern mammals and birds, including the arctic fox, collared lemming and several species of stoat, ptarmigan and hare – including our own mountain hare.

In summer life is relatively easy for Britain's only truly native lagomorph (brown hares were probably introduced here by the Romans 2,000 years ago). Food is plentiful, and even on expanses of open moorland there is shelter to be

found among rocky outcrops and natural hollows, or among the woody stems of heather.

Unlike rabbits, mountain hares seldom use burrows for breeding or shelter, and instead rely on athleticism and camouflage to avoid predation. Even in the open they're tough to spot until they move – their grey-brown fur is a superb match for upland vegetation. Come winter, when grey-brown camo just won't do, the summer coat is shed. The pelage that replaces it has finer hairs that are more densely packed than in summer and tend to lack pigment, appearing bluish-white. As long as snow lies on the ground, the hare's camouflage is perfect – an excellent defence against visual predators such as golden eagles.

But in low winter sun even a perfectly camouflaged animal casts a long shadow, and on an even slope or flat plateau this highlights its position to aerial predators like a giant pointing finger. To address this Achilles heel, hares prefer to rest on rough or hummocky terrain, nesting in natural or self-excavated dips in the ground.

The hares' strategy works so long as the costume switch coincides with the arrival and disappearance of snow cover. But with climate change predicted to cut average snow cover duration in temperate zones by up to two months by 2100, what will happen if the hares find themselves wearing mismatched white coats on snowless land year after year?

TESTING TIMES

Mills and his student Marketa Zimova are investigating the timing of seasonal coat changes. They started with North America's snowshoe hare – a species for which life is particularly tough. For almost every individual the question is not if it will be caught and eaten, but when. A staggering 85–100 per cent of snowshoe hare mortality is due to predation – its enemies include Canada lynx,

SEASONAL COLOUR CHANGE

Most mammals in temperate climates display winter adaptations of one kind or another, such as weight gain, food hoarding, migration, hibernation or torpor. Seasonal moulting is usually triggered by the length of daylight hours, known as photoperiod. This is the most accurate means by which an organism can perceive seasonal change, because temperature and other weather conditions are much

more variable. The transformation isn't necessarily complete – for example, snow leopards moult from buff-coloured to white but keep their spots, while stoats adopt a coat of pure white except for their tail-tip.

Mountain hares may retain a variable amount of buff or brown (especially on the head), while the tips of their ears also remain black.

Clockwise from top right: stoat, mountain hare and ptarmigan are three familiar Scottish species that turn white in winter.



2 x Mark Hamblin/NPL; stoat: Eriend Haarberg/NPL

fishers (a type of mustelid), coyotes, wolves and birds of prey. So for a snowshoe hare to survive long enough to breed, a timely switch in coat colour is critical.

Mills and Zimova's concern was largely borne out. "We now know that hares start their spring and autumn moults at the same time each year, with only a limited ability to speed up or slow down the rate in spring to match weather conditions that year," says Zimova. "For snowshoe hares the problem of seasonal mismatch is getting worse. What's more, they don't know it. A white hare will sit exposed on a brown background, behaving as though it is perfectly camouflaged."

Might other species that use seasonal crypsis face similar problems? Mills and Zimova realised that finding out would mean venturing into new branches of science. "It was exhilarating yet daunting. We would be studying this phenomenon across an unprecedented range of disciplines, from climate science to field ecology, genetics and evolutionary biology," says Mills. "We knew we needed collaborators." So an international team was assembled, including Portuguese geneticist Paulo Alves and mountain hare specialists Glenn Iason and Scott Newey of the James Hutton Institute in Aberdeen.

Zimova also approached wildlife photographer Mark Hamblin, who has been photographing mountain hares in the Cairngorms for 15 years. His beautiful pictures – some of which illustrate this article – are geo-referenced and date-stamped, and often feature the same recognisable individuals, adding scientific value to aesthetic appeal.

In fact some of the groundwork in Scotland had already been done. During the 1960s and 70s, Scottish ecologists Adam Watson, Ray Hewson and John Flux published painstaking studies of coat colour in mountain hares. Just as Mills and Zimova found in Montana, Watson reported

that the timing of the moult was fixed at any given site. Dates varied with altitude, and the return to a brown coat could be accelerated if spring was unusually warm, but the start date seemed immutable. Mills and Zimova hoped that the historical data could provide a benchmark against which modern records of snow cover and the seasonal change of coat colour could be compared.

The international team is now beginning to replicate some of the historic field studies that were carried out in the Scottish Highlands, observing when hares change colour at particular sites and comparing these dates with those recorded well over half a century ago. But going back isn't always easy. Land ownership changes, and some sites have been planted with trees, no longer supporting any hares at all.

Scott Newey and Marketa Zimova check the moult times of mountain hares near the village of Tomintoul in the Cairngorms.



LIFE IS PARTICULARLY TOUGH FOR THE SHOWSHOE HARE. THE QUESTION IS NOT IF IT WILL BE CAUGHT AND EATEN, BUT WHEN.



TACKLING THE IRISH QUESTION

In Ireland mountain hares *Lepus timidus* are often known as Irish or blue hares, and rarely turn white in winter. Whether this is a result of random mutation or an inherent genetic flexibility it's not yet possible to say, but the difference is a factor prompting a call to promote the Irish hare to a full species. "There's an element of national pride in such decisions," says ecologist Glenn Iason. "But there are also practical conservation reasons, because full species are more likely to be protected."

The long-running debate over what constitutes a species is a thorny one. Irish and Scottish mountain hares could interbreed, given the opportunity – but then so can mountain and brown hares, which often hybridise in Sweden (where the latter were introduced).

Dublin Airport hares, Cathal McKeaghton/Reuters/Corbis

When Scott Newey joined the project he was already researching the problem of how to monitor mountain hare numbers. Data gathered by the BTO and the Game and Wildlife Conservation Trust (GWCT), together with an extraordinary 60-year survey by Adam Watson, indicate that the species is undergoing a sustained decline. Yet on some moorland estates, where the management controversially involves predator control and rotational heather burning, numbers sometimes boom. Many gamekeepers, though, consider that high hare populations threaten red grouse stocks by competing for food and acting as a reservoir for a tick-borne viral disease called louping ill, leading to contentious hare culls (see box, p78).

SURVEY TECHNIQUES

Newey and Iason's remit, in collaboration with GWCT, is to establish a reliable method for counting mountain hares so that in future population trends can be rigorously monitored. The ideal approach will require neither special equipment nor prior species expertise, because it's hoped that hare-monitoring data will eventually come from a range of sources, including volunteers as well as wildlife and land-management professionals. The project team is trialling several methods side by side and comparing them with the results of reliable – but expensive – capture-mark-recapture surveys.

Methods under investigation include distance sampling (walking transects, counting the hares seen and measuring their distance from the transect), night-time transects using powerful torches to pick up eyeshine, thermal imaging and dung counts. A number of other techniques have already been discounted, including counting hares flushed by dogs.

In the end choosing the best method will come down to a range of scientific, economic and practical considerations. Newey suspects that dung surveys will be the easiest and most effective. "But it's also the least

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attractive option to most people," he admits. "Who wants to spend hours crawling around hillsides to count poo?"

The coat colour project has added a new strand to Newey's fieldwork, and he has already spent one season hiking the same high-altitude circuit every two weeks, recording snow cover, hares and their moult stage. He's also logging the animals' proximity to areas of snowpack to see whether anecdotal evidence indicating that white individuals gather around patches of snow holds true. If so, this may indicate that Scottish mountain hares – unlike showshoe hares in Montana – do have some awareness of their coat condition.

Glenn Iason has been working with mountain hares for the past 30 years, and is full of admiration for his hardy study subjects. "They're unbelievably tough, with an extraordinary life history," he says. "They'll eat almost anything, including woody material that other animals would look at as junk. And, despite the harsh conditions, they manage to gain weight throughout the winter, so they hit peak condition in January ready for courtship and breeding."

Being remarkably unfussy about its diet is just part of the story. A hare also ensures that no energy is wasted. ▶



Above: grassy sward at Dublin Airport (pictured) and Belfast Airport supports a thriving Irish hare population. Above left: golden eagles commonly prey on mountain hares in Scotland. Opposite: a hare's winter coat isn't always pure white – it can be patchy brown, often with a darker nose and ears.



CULLING CONTROVERSY

Scotland's mountain hares have been killed for food and sport for centuries, but surveys in 1995–6 and 2006–7 suggested that the total number taken increased by 32 per cent in the intervening period, and that reasons for the killing are changing. In the first survey, 60 per cent of hares killed were shot for sport; 10 years later, that figure had fallen to 40 per cent, surpassed by culling for management purposes. One reason cited for the culls was to limit the spread of the tick-borne viral disease louping ill (which infects both grouse and hares) on managed grouse moors.

Scottish conservationists including Adam Watson and Roy Dennis have

condemned this practice, and Scottish Natural Heritage, Scottish Land & Estates, and the Game and Wildlife Conservation Trust have urged restraint in the use of large-scale hare culls, because scientific opinion suggests that such culls are unlikely to help control the disease in grouse.

However, the extent to which less intensive culling might be influencing mountain hare populations is in dispute – in large part due to a lack of statistically rigorous information on population size. Mountain hares are also killed in the Peak District National Park – as 'bycatch' in snares set for foxes and, allegedly, by shooting, with dead hares used as bait to lure foxes closer to the snares.

THE SCOTTISH HIGHLANDS ARE NOT ONLY THE CLOSEST THING WE HAVE TO TRUE WILDERNESS. THEY ARE AN ECOLOGICAL FRONTIER.

At rest it adopts a ball-like posture, with fur fluffed up for maximum insulation, and reduces the flow of blood to the extremities where it might become chilled. That's just as well: in the Cairngorms the temperature during the winter can drop below -20°C .

Over in their Portuguese lab, Paulo Alves and his colleagues will be comparing genetic material collected from mountain hares in the middle of the last century with more recent samples. They are able to analyse small quantities of DNA extracted from either fresh or dried hare skins, which means samples from hares killed for management purposes can be compared with those taken from historical collections, such as the one in the University of Aberdeen Zoology Museum. The researchers are looking for the genes that control colour change, and trying to identify factors that affect the expression of these genes.

HARE STYLES

The mountain hare study might yield completely different insights to the USA's snowshoe hare research. Though both mammals are important prey species in their respective ecosystems, the conditions they face are quite different. For a start, Scottish winters are not like those in Montana, where a continental climate means a fairly clear transition from winter to summer. In the Highlands seasonal change is often a case of two steps

forward, one step back, with extended periods of patchy snow cover where brown, white and two-tone hares might all be camouflaged – as long as they sit still.

In addition Scotland's mountain hares face nothing like the predation pressure of their American counterparts. Adults are really only targeted by golden eagles, foxes and, most significantly, humans. In fact the main impact of mismatch in Scotland might not be linked to camouflage – it could, speculates Scott Newey, involve another factor, such as the pelage's insulating properties.

It will be fascinating to see how mountain hares cope with their unique set of challenges, but the research project won't end there. Mills and Zimova are hoping that other species sporting winter white will soon be included in the study, and are already talking to scientists in Sweden, Austria and Russia, where there are at least six colour-moulting species. Meanwhile Mills has a sophisticated new lab at North Carolina State University, where his group is able to study captive showshoe hares and other animals in artificial conditions that mimic the day-length and temperature conditions of any season.

Climate change will undoubtedly affect us all, but it's likely to be the species living at the limits of their ecological range that feel the effects first. The Scottish Highlands are not only the closest thing we have to true wilderness in Britain. They are also an ecological frontier. For mountain hares and other members of the arctic flora and fauna in this raw, spectacular landscape, there's no doubt that the battle to adapt is already well and truly underway. 🐾

AMY-JANE BEER is a naturalist and writer. Read her *Nature Table* column on p14.

FIND OUT MORE

See more of Mark Hamblin's brilliant photos of hares on our website: www.discoverwildlife.com

Early snow melt results in some hares standing out against dark vegetation in their pale winter pelage.



Mark Hamblin/NPL