NEWS IN FOCUS

LYNN M. STONE/NATURE PICTURE LIBRARY

The grey wolf, protected for more than 30 years, could see its endangered status removed nationwide.

CONSERVATION

Grey wolves left out in the cold

US plan to remove federal protection elicits howls of protest.

BY CHRIS WOOLSTON

Central Kentucky is coyote country. But the 33-kilogram animal shot by a hunter near Munfordville this spring was definitely not a coyote. Its huge paws, broad snout and massive build suggested that it was a grey wolf (*Canis lupus*) — the first to be shot in Kentucky in more than 150 years. DNA tests confirmed the animal's identity in August.

The animal, a possible stray from hundreds of kilometres away in Michigan or Minnesota (although it cannot be ruled out that it was once captive), was also a player in a growing debate that mixes science, politics and passionate public opinion. From Kentucky to California, wolves are forcing biologists and policy-makers to re-examine the US Endangered Species Act (ESA) and the very definition of an 'endangered' species.

The act, introduced in 1973, was a landmark piece of legislation. Its purpose has been contentious ever since, but it is intended to save species "in danger of extinction throughout all or a significant portion" of their range. Although wolves have never been at risk of extinction in the United States as a whole, those in the 48 contiguous states were classified as endangered in 1978.

➲ NATURE.COM
Why the US wildlife service wants to list a new wolf species:
go.nature.com/7nujx9

After decades of federal protection and reintroduction programmes, the US Fish and Wildlife Service (FWS) undertook a comprehensive review, which found that wolf populations near the western Great Lakes and the northern Rocky Mountains had recovered sufficiently to warrant removing ESA protection (see 'Wolf pack'). (There are now about 4,000 wolves in the Great Lakes area and nearly 1,700 in the northern Rockies.) Wolves in these areas were 'delisted' between May 2011 and August 2012.

But in June this year, the FWS proposed removing ESA protection from all US grey wolves, citing the earlier review as evidence of their recovery and arguing that the original listing had erroneously included regions outside the species' historical range. The agency says that by delisting the rest of the US wolf population, it can concentrate its resources on ESA protection for the Mexican wolf (*Canis lupus baileyi*), a subspecies of the grey wolf.

The proposal marks a turning point for the grey wolf. A century ago, the animals had been hunted almost out of existence south of the United States–Canada border. Now, as a result of the partial delisting, six states have wolf-hunting seasons. In Montana, 225 wolves were legally trapped or shot in the 2012–13 season.

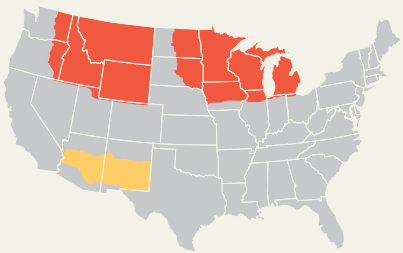
Grey wolves removed from the ESA programme would be managed by states, some of which have in the past shown little interest in protecting wolves or expanding their territory. Delisting the wolves would essentially prevent them from reclaiming large parts of their historic range in places such as California, the southern Rockies and the northeast, says John Vucetich, a forest scientist at Michigan Technological University in Houghton. And, as the appearance of the wolf in Kentucky suggests, pushing boundaries is a wolf speciality.

"The Fish and Wildlife Service is essentially saying that this is the best that wolves can do, and it's not even close," he says. "Wolves are on the verge of setting a precedent for the Endangered Species Act."

Robert Wayne, an ecologist and evolutionary biologist at the University of California, Los Angeles, says that wolves need broad ranges and large populations to return to their historic ▶

WOLF PACK

By October 2012, grey wolf populations in six US states had recovered such that they no longer needed protecting by the Endangered Species Act.



SOURCE: US FISH AND WILDLIFE SERVICE

levels of gene flow and diversity. In 2005, he and his colleagues analysed mitochondrial DNA from specimens collected before wolves were decimated in the 1900s, and found that it contained twice as many variations as DNA from modern wolves (J. A. Leonard *et al. Mol. Ecol.* **14,** 9–17; 2005). The researchers estimated that the wolf populations in Mexico and the western United States had once reached 380,000 individuals. "Wolves have not recovered over a large part of their range," Wayne says.

But Gary Frazer, assistant director for endangered species at the FWS in Arlington, Virginia, says that the service exceeded its own minimum targets for wolf recovery as early as 2001, and thus it is a case of mission accomplished. "That was the plan from the beginning: to declare recovery, to delist the species, and to move on to other species that need our attention," he says, noting that the agency's resources are limited.

Wolves might occupy only a fraction of their historic range, but they are not in danger of extinction, adds Mark Boyce, a biologist at the University of Alberta in Edmonton, Canada. "We have 6,000 wolves in Alberta alone," he says. "Except for Mexican wolves, the populations in the lower 48 states add nothing to the genetic diversity of the species." Boyce believes that any expansion of the wolves' range would be costly for ranchers. In 2011, he co-authored a study that tracked wolves using the Global Positioning System, showing that each wolf pack in southwestern Alberta killed an average of 17 cattle every year (A. T. Morehouse and M. S. Boyce *Front. Ecol. Environ.* **9,** 440–445; 2011).

The wolf controversy highlights the strained relationship between science and politics. Vucetich and Wayne, along with Roland Kays of the North Carolina Museum of Natural Sciences in Raleigh, were, they claim, dropped in August from a panel to review the FWS proposal because they had publicly opposed the wolf's delisting. "I'm not mad about not being on the panel, but it doesn't seem like they were following proper procedure," Wayne says. "It was punitive," he claims.

The review process has since been restarted. "We still haven't figured out how to handle a situation where experts have outspoken views," Frazer says. "We are not an academic institution. We're trying to implement federal law." The public consultation period will close in October, but because the panel's peer review will not be complete by then, Frazer plans to reopen public comments in January 2014. "People are very passionate about wolves," he says. The final decision may take a year or more.

The future of US wolves will hinge mainly on public acceptance of their delisting. Groups such as Defenders of Wildlife in Washington DC protest against wolf hunting, whereas those affiliated with hunters and ranchers want wolves to be aggressively controlled. Some individuals have made death threats to ranchers who legally shot wolves that attacked livestock.

Vucetich thinks that the government is eager to pass the issue on to the states. "It saps the energy of people working on it," he says. ■

MATHEMATICS

Physicists net fractal butterfly

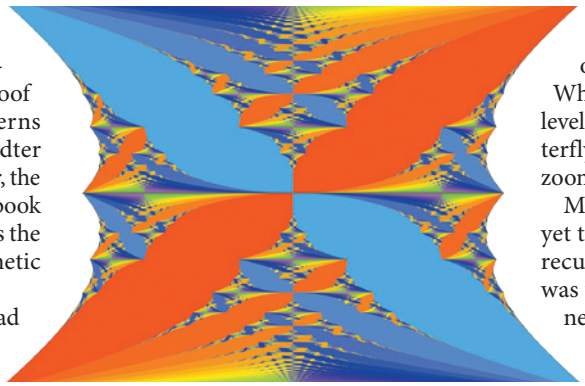
Decades-old search closes in on recursive pattern that describes electron behaviour.

BY DEVIN POWELL

After a nearly 40-year chase, physicists have found experimental proof for one of the first fractal patterns known to quantum physics: the Hofstadter butterfly. Named after Douglas Hofstadter, the Pulitzer prizewinning author of the 1979 book *Gödel, Escher, Bach*, the pattern describes the behaviour of electrons in extreme magnetic fields.

To catch the butterfly, scientists have had to fashion innovative nets. Since May, several groups have published experiments that sought the pattern using hexagonal lattices of atoms; last month, others reported seeking it with atomic laser traps. Some physicists say that studying the pattern could help in the development of materials with exotic electric properties. But the main point of the chase was to check whether the butterfly looks as predicted.

"Hofstadter's concept was initially disturbing to a lot of people," says Cory Dean, an experimental physicist at the City College of New York. "Now we can say his proposal wasn't so crazy after all."



Hofstadter's butterfly describes electron motion.

DOUGLAS HOFSTADTER

Hofstadter, now a cognitive scientist at Indiana University Bloomington, sketched out the pattern in the 1970s while a graduate student in physics. It was known at the time that electrons under the influence of a magnetic field would race around in circles. But Hofstadter found that in theory, if the electrons were confined inside a crystalline atomic lattice, their motion would become complicated.

As the magnetic field was cranked up, the energy levels that define the motion of electrons would split again and again. When represented on a graph, those energy levels revealed a pattern that looked like a butterfly — and continued to do so, even when zoomed in to infinitely small scales.

Mathematician Benoit Mandelbrot had yet to popularize the term 'fractal' for such recursive patterns, and Hofstadter's adviser was unimpressed. "He scornfully called the nesting pattern that this upstart youngster claimed to see, 'mere numerology'," says Hofstadter. "He even told me that I would be unable to get a PhD for this kind of work." Hofstadter published[1] his description of the butterfly in 1976, after finishing his PhD.

The idea was difficult to test. The strength of the required magnetic field depends on the spacing between the atoms in the lattice. In conventional materials, in which atoms are separated by less than one-billionth of a metre, the pattern can emerge only in fields on the order of tens of thousands of tesla. The best available magnets can reach only about