Lessons From The Wolf

By Jim Robbins, Scientific American Magazine, June 2004.

Several scrawny cottonwood trees do not usually generate much excitement in the world of ecology. But on a wind-whipped August afternoon in Yellowstone National Park's Lamar Valley, William J. Ripple, a professor of botany at Oregon State University, stands next to a 12-foot-high cottonwood tree and is quietly ecstatic. "You can see the terminal bud scars," the bespectacled Ripple says, bending the limber tree over to show lines that mark a year's growth of a foot or more on the broom-handle-size trunk. "You can see that elk haven't browsed it this year, didn't browse it last year and, in fact, haven't browsed it since 1998."

Ripple gestures at the sprawling mountain valley around us and points out that although numerous other cottonwoods dot the landscape, this knot of saplings comprises the only young ones--the rest of this part of the Lamar is a geriatric ward for trees. The stately specimens that grow in the valley bottom are 70 to 100 years old, and not a newcomer is in sight to take their place. On the hillside, aspen trees present a similar picture. Groves of elderly aspen tremble in the wind, but no sprouts push up in the understory.

These trees could have died out entirely, some experts believe, if wolves hadn't shown up in Yellowstone. And therein lies a fascinating tale of how ecosystems work, and how making one change can produce all sorts of surprises.

In the dead of winter in 1995 the National Park Service and the U.S. Fish and Wildlife Service brought 14 wolves into Yellowstone by truck and sleigh. Gray wolves (Canis lupus) from Canada, these were the first to call Yellowstone home since the creatures were hunted out of existence there early in the 20th century. A year later 17 more Canadian wolves were added.

Biologists hoped that the reintroduction would return the mix of animals to its more natural state. They expected, for instance, that the wolves would cull many of the elk that lived in the park. When the wolves--once the region's top predator--were gone, the elk population had burgeoned. And the new generation of Canis behaved as predicted. Sixteen packs of wolves, each composed of about 10 animals, now roam the park, and each pack kills an average of one elk a day. The elk population, which had swollen to 20,000 by the 1990s, is now less than 10,000.

The wolf introduction has had numerous unexpected effects as well. The animals' impact on the flora and fauna in the park has been profound. Indeed, the breadth of change has been so far-reaching that researchers from around the country have come to study the alterations. "Wolves are shaping what you see here," says Douglas W. Smith, leader of the Yellowstone Wolf Project. "In 30 years, when you drive through the park, it will look very different."

The Ecology of Fear

Ripple, for one, is hoping for more trees. "I like aspen trees," he remarks over coffee in a cozy log restaurant near a cabin just outside Yellowstone where he stays during field research. "I am

passionate about them." Among other things, he explains, they are biodiversity hot spots in the West, home to a variety of songbirds. When he heard in 1997 that aspen trees were on the decline in Yellowstone and no one knew why, he was drawn to the park to try to solve the mystery.

Ripple points to some black-and-white photographs taken of the same spot in the Lamar Valley more than 50 years apart. "You can see that young aspen and willow were abundant in the early 1900s. By the 1930s the trees had stopped regenerating, and there are no young ones.

"I had a lightbulb," he continues. He took core samples from 98 aspen trees and discovered that only two had begun to grow after the 1920s--around the time the last substantial populations of wolves were killed or driven off. And these two were in places that elk would be hesitant to frequent for fear of being attacked by predators. Ripple found big trees and tiny trees but nothing in between, because nothing new grew from the 1930s to the 1990s. It was the first concrete evidence of a "wolf effect."

The wolf-effect theory holds that wolves kept elk numbers at a level that prevented them from gobbling up every tree or willow that poked its head aboveground. When the wolves were extirpated in the park as a menace, elk numbers soared, and the hordes consumed the vegetation, denuding the Lamar Valley and driving out many other species. Without young trees on the range, beavers, for example, had little or no food, and indeed they had been absent since at least the 1950s. Without beaver dams and the ponds they create, fewer succulents could survive, and these plants are a critical food for grizzly bears when they emerge from hibernation.

After the wolves' reintroduction in 1995 and 1996, they began to increase their numbers fairly rapidly, and researchers began to see not only a drop in the population of elk but a change in elk behavior. The tall, elegant mahogany-colored animals spent less time in river bottoms and more time in places where they could keep an eye out for predatory wolves. If the wolf-effect hypothesis is correct, and wolves are greatly reducing elk numbers, the vegetation should be coming back for the first time in seven decades.

Hiking along the purling Lamar River, not far from a den of one of the wolf packs, Ripple walks by a small rise and parts a dense green curtain of booth willows to make a point. There on the ground lie the bleached skull, ribs and spine of an elk. And all around, the willows are much taller than Ripple, some more than three meters high. Ripple and his colleague Robert L. Beschta, a forester at Oregon State University, have indeed found trees and willows rebounding in Yellowstone as wolf numbers have climbed--but that is only part of the change occurring in the park.

Trees are coming back most dramatically in places where a browsing elk doesn't have a 360-degree view; these willows, for example, sit below a rise that blocks the animals' view. A look at the plants shows they have not been browsed at all in several years. Elk don't feel safe here, Ripple contends, because they can't see what is going on all around and are nervous about spending time in this vicinity. Just 50 meters away, however, where the terrain is level and wide open and the elk enjoy a panoramic view, the willows are less than a meter tall and have been browsed much more heavily over the past three years. "It's the ecology of fear," Ripple says.

The Long Reach of the Wolf

Other changes accompany the regrowth of vegetation taking place along the Lamar. Just upstream is a small beaver dam, one of three--the first dams documented on the river in 50 years. Slough Creek, a tributary of the Lamar, has six dams. Both Ripple and Smith believe that because of the regrowth, beavers have something to eat again. "Their food caches are full of willow," Smith says. And other changes are in the offing. As more woody vegetation grows along the Lamar, it will stabilize the banks and stop some erosion. More vegetation, Ripple predicts, will also shade and cool the stream. It means, too, more woody debris in the Lamar, which will slow the river, cause water to pool, and improve the trout habitat, leading to more and bigger fish.

Although the scientific focus so far has been on vegetation, the wolf seems to have an incredibly long reach into other parts of the Yellowstone food web as well. One of its most dramatic effects has been on coyotes. For three years before the reintroduction of wolves, Robert Crabtree, now chief scientist at the Yellowstone Ecological Research Center, a nonprofit organization based in Bozeman, Mont., and his wife, Jennifer Sheldon, who are both canid biologists, gathered baseline data on the park. Coyotes, they have found, have sacrificed a great deal to make room for the much larger wolves.

The number of coyotes in the park is down 50 percent and in core wolf areas has dropped 90 percent. Male coyotes are smaller than they were before the wolves arrived, perhaps, Crabtree says, because "the larger ones were more aggressive and challenged the wolves and lost." With fewer coyotes, their prey--voles, mice and other rodents--have exploded in number. That has benefited red fox and raptors. But red fox prey on songbirds as well, and more foxes could mean a greater toll on birds.

Wolves have also thrown the doors to the Yellowstone meat market wide open. Rarely do grizzly bears or cougars attack full-grown elk, although they eat calves or feed on the winter-killed carcasses. Wolves, on the other hand, pull down big ones all the time. After they eat their fill, they wander away, meat drunk, to sleep it off, or they get pushed off the kill by a grizzly. The presence of wolves has meant that much more meat is available on the ground. All manner of scavengers make a living on these carcasses, and an increase in numbers of everything from grizzly bears to magpies reflects these newfound riches. The largest number of ravens on a wolf kill ever recorded (135) was here. "We see bald eagles, golden eagles, coyotes, ravens and magpies on every kill that's made," Smith says. "I don't know what they did before wolves showed up."

But are wolves really the engine driving these changes? Most scientists think so. Smith says that "wolves are to Yellowstone what water is to the Everglades"--the primary force shaping the ecosystem. In Banff National Park in Canada, scientists have documented changes brought by wolves that returned on their own in the 1980s: willows reappeared, the diversity and abundance of songbirds doubled. Now researchers are coming to Yellowstone to tease out some of the first evidence of the impact that wolves are having on areas near the riverbanks; at least six projects are gathering data.

Some researchers, however, are agnostic about the effects of the wolf. Crabtree, for example, says that yes, willows are rebounding and imaging data show the regrowth dramatically. But a strong correlation between the return of wolves and the new growth is far from demonstrated. "Claiming wolves are responsible verges on bad science," he states. "The ecosystem in Yellowstone is a multicausal interactive system, and there's never a single cause. Even a predominant cause is rare. At the same time the wolf numbers were coming back, there was flooding along the river, and the climate is a lot warmer. Wolves probably have a role, but it is confounded by those factors. It will take 20 years or more before we know definitively."

Duncan Patten is a research ecologist who served on a National Academy of Sciences study of Yellowstone published in 2002. Yellowstone has not had a hard winter since wolves reached high levels, he observes, and elk may not have needed to resort to trees for food: "When winters are hard, elk take a lot of chances to put something in their belly. Give me two hard winters in a row, and I'll buy the argument."

The debate over the wolves' influence on the elk is fanning a long-standing argument over the proper way to manage Yellowstone's elk. At one time the park service also believed elk were too numerous and in the 1960s sent rangers to trap and shoot them by the thousands in a program called "direct reduction." By the end of the decade the total number of elk was down to an estimated 4,000. Public outcry ended the shooting, and in the 1970s the park service adopted a policy of natural regulation in

wilderness parks such as Yellowstone, a management philosophy that would lift the heavy hand of humans and manage the parks as "vignettes of primitive America." Ever since, the elk numbers have climbed.

For decades now, critics, including the state of Montana, have denounced the National Park Service for allowing so many elk to crowd the vast stretch of native grasses. Letting nature take its course in what is a decidedly unnatural situation is folly, the critics argue. Few elk would spend the winter at such a high altitude, they add, if the animals could migrate onto the plains. Instead hunting pressure in the surrounding area compresses them into the park.

Some researchers assert that the return of vegetation along the riverbanks--brought on by a reduction in the number of elk--undermines the long-running contention of the park service that Yellowstone's elk population is within natural limits. But Smith defends the park's view and suggests that there are other ways to look at the situation. Elk numbers are going to fluctuate wildly over time, he says, and although numbers might have been, and still are, high, "they're within natural limits over the long term."

Countering this defense, Alston Chase, author of the 1986 book Playing God in Yellowstone, which was harshly critical of the policy of natural regulation, says for the park service to make such an argument is absurd. He found little evidence of large elk populations on the Yellowstone Plateau in the past. Between 1872 and 1920, he points out, the park was established, poaching was stamped out, the Native Americans were evicted, and the U.S. Biological Survey was killing wolves. That is when elk numbers started to soar--and it was a wholly unnatural irruption.

Unwitting Restoration Biologists

Although the jury is still deliberating the effects of wolves, early evidence strongly suggests that the canids are unwitting restoration biologists. By simply doing what they do--mainly preying on elk--they are visiting great changes on the Yellowstone ecosystem. Many of the changes are positive for those things humans value, and for experts to accomplish some of these same goals would be hugely expensive.

Wolves have brought other lessons with them. They dramatically illustrate the balance that top-of-the-food-chain predators maintain, underscoring what is missing in much of the country where predators have been eliminated. They are a parable for the unintended and unknown effects of how one action surges through an ecosystem. More important, the Yellowstone wolves are bringing into focus hazy ideas of how ecosystems work in a way that has never been so meticulously documented. Just as the actions of the wolf echo through Yellowstone, they will reverberate into the future as they help to increase the understanding of natural systems.