Monica Turner was not sure what to expect as she boarded a helicopter in Yellowstone National Park. After months of planning, she had come to Wyoming with hopes of studying the ecology of the park’s pristine wilderness. But that was before the fires. Now the park was ablaze, grappling with its largest fires ever, and her intended research subject was going up in smoke. That 1988 “summer of fire” made Yellowstone history.

Early blazes, sparked in June by a combination of lightning and human activities, burned for several weeks without raising much concern. As the summer got hotter and drier, though, the situation quickly turned. In July, “we had active fires spread, but nothing that we hadn’t previously experienced,” recalls Roy Renkin, a Yellowstone biologist. “But then, here came August. … Then things started to really pick up and go.”

Fueled by drought conditions and raging winds that topped sixty miles per hour, the fires began to sweep through the park. As the flames blazed out of control, they consumed the beauty of this symbol of the rugged American West and threatened the iconic Old Faithful geyser. The extent and ferocity of the fires — surprising even to park managers and scientists — riveted the public. Fiery images dominated television sets and headlines across the nation with a horrifying message: the crown jewel of America’s National Park System was in trouble.

Defying all attempts to curtail its spread, the inferno raged for months, forcing temporary park closures and launching the nation’s single largest firefighting effort, which drew more than twenty-five thousand firefighters from across the country. A reporter for the Washington Post likened the sights and sounds...
in the Yellowstone basin to a war zone in Vietnam. Before finding under a mid-September snowstorm, the record-breaking fires engulfed more than 1.2 million acres in the greater Yellowstone area, comprising more than one-third of the park. Lingering flames would smolder into November.

Arriving in Yellowstone in October 1988, Turner, today on the UW faculty, and her colleague Bill Romme, a forest ecologist now at Colorado State University, steered themselves for their first look at the remains of the park. But as the copter lifted them over the charred landscape, they were immediately taken by the presence of lush, green islands dotting the sea of black. Even in the areas most severely affected by the flames, large chunks of the forest appeared virtually untouched.

That variation of black and green, burned and unburned, was exactly what Turner was looking for. A pioneer in the burgeoning field of landscape ecology, she had spent several years studying the relationships between a region’s physical features and its ecosystems — the workings of a forest on a ridge versus in a valley, for example, or the ecological impacts of being near a road or stream. The complex patterns of damage left by the vast 1988 burns offered an unprecedented opportunity to study how such variation might affect the landscape’s recovery.

In the twenty years since these historic fires, research undertaken by Turner — now a zoology professor and the Eugene P. Odum Professor of Ecology — has grown and developed along with the recovering forest, such reshaped and redefined in unpredicted ways by the fires. Guided by her unflagging curiosity and a keen eye for the unexpected, she has provided the first insights into how a large ecosystem responds to such a major event and unearthened the answers to dozens of ecological questions — many of which no one else had even thought to ask.

A Bleak Beginning

In the early aftermath of the fires, the ground-level view of Yellowstone was of a black-and-white world. Many burned areas were stripped of every sign of life.

Turner and Romme began working in the park in summer of 1989 under challenging conditions. With no funding, they recruited volunteer labor. The two, former students, and family members pitched in when they could. Even Turner’s mother spent her two weeks of vacation in the park measuring burned trees. The fire was dusty and brutally hot, with the sun’s heat radiating from the black ground and the black trees, and no shade in sight. “It was like being in an oven,” Turner says. “You would come out of working in the field looking like a chimney sweep — just black, everywhere.”

Despite the land’s desolate appearance, they scoured it to see what — if anything — would grow back. Their persistence was rewarded as bits of green appeared among the ashes. Beneath the forest’s blackened facade, the fire had penetrated less than an inch into the soil and left surviving roots, rhizomes, and seeds. Other plants resided from unburned forest patches. Initial sprouts emerged in 1989, followed by an incredible profusion of wildflowers in 1990. By 1991, seedlings of native plants had taken hold throughout the burn region.

“When we first went there, the vegetation [was] so sparse it was hard to believe it was a forest,” says Turner’s mother, M. Turner. “It was dusty and brutally hot, with the sun’s heat radiating from the black ground and the black trees, and no shade in sight.”

That whole programmatic [let-it-be] approach could have been shut down from the highest levels of government,” says park service biologist Renkin, who has been involved with Yellowstone’s fire program for thirty years. “They could have reverted back to policies that were implemented early in the 1900s.”

But they didn’t. In fact, Turner says, fire is a natural and vital step in this forest cycle and fires like those in 1988 — though the largest to date in the park’s 156-year history — are not unusual in the context of the ecosystem. “This type of

The Aftermath

Nearly one-third of Yellowstone National Park, shown here in red, was ablaze during the 1988 “summer of fires,” which raged for months. It left a landscape ripe for study by researchers, including the UW’s Monica Turner.

The fires also acted as a creative force, reshaping the Yellowstone wilderness and setting the stage for nature’s own rebirth and healing processes. As Turner watched this “natural experiment” at work, new research questions arose as quickly as the sprouting plants. Undaunted when these questions ranged into scientific fields beyond her expertise — entomology, botany, soil chemistry — she has assembled an impressive array of collaborators from the UW and across the continent.

“She excels at getting the right team of people together to address complex questions about landscapes,” says Phil Turner, a UW-Madison associate professor of forest and wildlife ecology and Turner’s colleague. “She’s really the glue that holds them together.”

This interdisciplinary approach has generated studies spanning all levels of the Yellowstone forest ecosystem, from tiny microbes in the soil to tree seedlings and from bark beetles to browsing elk. The researchers’ identification of unfamiliar green shoots as aspen seedlings turned on its head the prevailing dogma that Rocky Mountain aspen reproduce only from existing roots. The thick carpets of pine seedlings guided studies on plant growth and mid-successional cycling, helping them identify a critical role of soil bacteria in priming the ground for new trees.

Turner’s two-decade connection to the park has led to the development of the Yellowstone Fire exhibit, open to the public for the first time in 2008. Her work is being featured in the exhibit, which tells the story of the fire and the forest’s recovery. One of her former graduate students, Dan Kushlan PhD’92, was intrigued by the differences between regions of sparse and crowded young pine trees. “What’s going to happen to these patches of seedlings as they grow up?” asks Kushlan, now an assistant professor at Wayne State University. While conducting his dissertation research in the park, he reconstructed past examples of similar types of regional variation and found that fire-forced patterns have a lasting footprint.

With “a series of fires like the ones in 1988, obviously they shape the landscape today,” says Turner, “but they’ll probably leave their mark for at least two hundred years.”

Let It Burn?

The 1988 burn nearly left a similar mark on the park’s fire management policy, sparking an intense nationwide debate about the natural fire management plan implemented in Yellowstone in the early 1970s. Many critics blamed the severity and extent of the 1988 fires on this so-called “let it burn” policy, which dictated allowing most naturally started fires to run their course without intervention.

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Turner's two-decade connection to the park has also given her team the perspective time as it charts the forest's recovery.
severe, large fire is the natural fire regime in Yellowstone,” she says. “The forests have burned in this way since the Pleistocene — so for the past ten thousand years — in intervals of one hundred to four hundred years or so.” She also suggests that earlier suppression attempts in 1988 probably would not have changed the outcome. “There’s a relatively narrow window where you can effectively suppress fires,” she says. “This was well beyond that.”

The work of people like Turner helped uphold the hands-off approach for the Greater Yellowstone area. “I think the educational component of the fires of ’88 was a positive influence on society and really resulted in a lot of people’s curiosity,” Renkin says. “It really height-ened their awareness and understanding of fire ecology.”

In addition, Turner and her col- leagues determined that the 1988 conflagration was a product of extreme climate conditions. “In ’88, it was very dry — it was the driest summer ever recorded there — winds of sixty miles an hour, and the fuels were burning so intensely, it didn’t matter if there was a lot of fuel or a little fuel. It didn’t matter if the forest was young or old, it didn’t matter if there was a road in the way; it didn’t matter if the Grand Canyon [of the Yellowstone] was in the way. The fires just blew across the canyon,” she says. “They were really a weather, climate-driven phenomenon, and that’s true for this type of system.”

The role of climate in this fire regime lends urgency to Yellowstone fire research. Other scientists have recently linked rising temperatures and earlier spring snowmelt to more frequent intense fires, suggesting that severe conflagrations may become more common as the world warms. Turner has already compared many of her findings from the 1988 fires against more recent, smaller Yellowstone burns.

“From what we learned in 1988, can we predict what happens in this burn in 2007?” she asks. “And how well does our knowledge transfer — what things are different, what things are the same, what things are different, and why?”

Such work “contributes greatly to a fundamental understanding of how these systems work, and that is important because it helps feed into making man-agement decisions,” says Renkin. Not all ecosystems respond to fire in the same way, he emphasizes, and “what works or is prescribed in one area may not fit to be prescribed in another area.”

Fire management remains an active issue. In 2006, Turner presented a summary of the role of fire in different ecosystems at a briefing on Capiti- tol Hill. Renkin hopes that fire policy will continue to be guided by science. In resource management, he says, often “there’s no ecological rationale for imple-menting a particular treatment, especially at the landscape level. […] [But] man-agement activities can fit and dovetail with ecological considerations.”

Seeing the Big Picture

Yellowstone’s forests have provided a relatively simple ecosystem for tackling big questions, with only a few major tree species and animals in the mix, but the past twenty years have shown that even relatively simple ecology can be unexpectedly complex. By establishing ways to approach landscape-level questions, Turner’s studies have valuable applica-tions far beyond forest fires.

“So many of the questions that we face in ecology and the environmental sciences are about phenomena that occur over a large area, whether it’s changing land use patterns or climate change,” she says. Her approaches can be generalized to ask similar questions about ecosystem impacts and recovery following other large and infrequent disturbances, such as floods, hurricanes, or even volcanic eruptions. “The fires of Yellowstone … provided opportunities to study things at scales that ecologists simply hadn’t worked at before,” she says.

With her Yellowstone work, Turner has also established an impressive legacy in the field of landscape ecology, offering the first glimpse into how a major distur-bance like fire shapes an ecosystem over space and time. In recognition of her tre- mendous contributions to a growing field, Turner was elected in 2004 to the National Academy of Sciences — one of the highest honors available to an American scientist.

With UW-Madison collaborators Phil Tiverson and Ken Raffa, Turner is now studying the interplay of wildfires and the Yellowstone forest’s other natural major disturbance: bark beetles. Trees damaged or killed by beetle outbreaks were long thought to be more susceptible to future fires. “For years, people just assumed that if you had a bark beetle outbreak, that meant a fire was almost certain to happen,” says Raffa, an entomologist and expert on the insect. “Monica’s work and the work of her colleagues have shown that it’s a lot more com-plicated than that — there’s a lot of heterogeneity in the response due to the landscape, due to weather, due to a variety of factors.”

The complexity of this interaction has called into question the common practice of using fire history to understand land use and vegetation patterns. “Fire frequency is likely to increase, not decrease, in the Yellowstone forest,” Turner says. “It sometimes is argued that by harvest-ing the wood, you’ll reduce the likelihood of a subsequent disturbance, but there are very few data on that.”

She and her students are now explor-ing the management side of forestry and ecosystems, with ongoing projects investi-gating salvage logging in the national forest areas near Yellowstone’s boundary.

“There’s a mismatch between public perception of these interactions and the evidence,” explains Jake Griffin PhD ’99, one of Turner’s graduate students. Working at a landscape level is critical to help resolve such differences, he says, because it allows researchers and resource man-agers to understand the landscape and the processes that characterize it. “For policies, from a management and conser-vation perspective, anything that crosses ecosystem boundaries has a better chance of being sustainable,” agrees fellow gradu-ate student Martin Smiard PhD ’09.

The need to study landscapes as a whole emphasizes the value of Yellowstone and other protected wilderness areas as irreplaceable natural labora-tories. “Most of Yellowstone is very wilderness-like in character and hasn’t been very strongly affected by manage-ment,” Turner says. “Those [properties] give us the opportunity to understand the baseline conditions of how our ecosys-tems are responding — even to big drivers like global climate change — in the absence of the much more intensive modifications that characterize so much of our landscapes.

“We learn a lot about the mechanisms of nature without our intervention. How does it work? How does it recover from events like this? How does that help us manage large landscapes?” she asks. “And what does that mean for the future?”

Twenty years is just a blink of an eye for a dynamic forest ecosystem, and rising global temperatures are likely to affect Yellowstone’s recovery and future patterns in ways yet to be discovered. “Fire frequency is likely to increase, not decrease, in the Yellowstone forest,” Turner says. “Long-term studies like ours may help us understand what we can expect in the future.”

Even after two decades of working in the park, Turner doesn’t look like she’ll be slowing down anytime soon. For every question she answers, another springs forth. — like new life emerging from Yellowstone’s ashes.

**Nature’s Rx for Recovery**

“Why were we really surprised that the system — without any intervention from us — recovered very quickly, it’s much more resilient than anyone expected,” Turner says.

**Pine trees**

As the fires swept through the park, they released the seeds of a new generation of lodgepole pines, the predominant tree in the Yellowstone forest. Some lodgepoles produce serotinous cones, which were sealed shut with resin until melted apart by the intense heat of a fire. Turner and her collaborators found that trees baring these fire-adapted cones are typically killed off by fire; lodgepole regeneration varies with the frequency of past burns. In essence, she says, the trees have adapted based on historic patterns of forest fire. “I think the public expected we’d have to go into the park and plant trees, but grow grass [after the 1988 fire],” Turner says. “But the fact is, we don’t have to fix it.”

**Ground cover**

The Yellowstone fires traveled quickly through the canopy of the forest, consuming pine needles and small branches but leaving trunks and larger branches merely scorched. Logs that were down prior to the fire were charred, but did not burn through, Turner says, having little impact on the young trees. The bark was burned only shallowly, leaving many surviving roots and seeds. Life returned quickly to the blackened forest, with green sprouts appear-ing among the ashes the next spring, caused by carpets of wildflowers. Despite worries that invasive species would infiltrate the forest, Turner and her colleagues found that native plant communities returned and out-competed the few invaders.

**Elk**

Yellowstone’s large animal populations mostly unharmed by the fires, adjusted quickly to life in the recovering forest. Turner’s group found that elk seem to frequent the young stands of trees spring-ing up in burned areas, despite the dense growth and fallen logs that often make for-est regeneration difficult. The researchers think that the thick vegetation and obstacles may provide protection from wolves.