WINGS

ESSAYS ON INVERTEBRATE CONSERVATION

THE XERCES SOCIETY FALL 2020

CONTENTS

Forests and woodlands are valued worldwide for their environmental benefits and economic products. In this issue we explore three very different forest environments and the insects they support: old-growth coniferous forests in the Pacific Northwest, eastern broadleaf forests in New Jersey, and ancient woodlands in England.

Forests, Fires, and Insects

Scott Black

Forests and woodlands are vital for life on earth. Unfortunately, climate change is bringing additional challenges for these areas and their wildlife as well as for human communities. This has been brought into sharp focus by the wildfires that raged on the West Coast this year. More than four million acres have burned in California, a million acres in Oregon, and more than seven hundred thousand acres in Washington. Many other states have suffered smaller fires.

We are still coming to terms with the full scope of this tragedy, and my heart goes out to all the people who have lost loved ones or property to these fires.

It is important to note that, in the western United States, fire has always been part of these ecosystems, but the fires we are experiencing now are bigger and hotter than they used to be. This is partly because of years of fire suppression, but is also a result of the changing climate. Mammals, birds, and amphibians are all at risk. Similarly, invertebrates from caddisflies to slugs to bees and butterflies are likely negatively affected, but we still have much to learn about the effects on these populations.

To try to grasp the potential impact of these fires, it is important to understand their extent and intensity as well as the life history of invertebrates. Xerces has a very large data set about invertebrates in the Pacific Northwest, and we have records of many, many rare and sensitive species within the footprint of fires in Oregon and Washington. This includes numerous species of snails and slugs, which are unable to move away from fire, meaning that there is the potential for fires both to directly kill individuals and to destroy their habitat, thereby damaging or destroying entire populations. There are also several rare caddisflies, mayflies, and stoneflies that live in streams and rivers within the burned areas. Fire's impacts on aquatic systems can be severe, especially in fragmented streams and in poorly managed

Wildfires ravaged communities and wildlife in the western United States during 2020. The impacts on insects are not fully clear. Photograph by the Oregon Department of Transportation.

watersheds or those that have been subjected to indiscriminate salvage logging.

Bees are also probably impacted by these fires. Can they flee them? Some may be able to, but many species have short flight ranges and the scale and speed of fires like this year's could easily overwhelm them. The longer-term impact will depend on whether nests survive. The majority of bees are solitary—that is, each female makes her own nest, typically by digging a narrow tunnel in the ground or occupying an existing tunnel in a snag—and many such species may be somewhat protected because they will have completed their nests and are not active when the fires start. The degree to which their dormant offspring are vulnerable, however, would depend on the location of any given nest. About 30 percent of solitary species nest in holes in trees and twigs, which are more exposed to direct harm from fires. The other 70 percent nest underground. Although common wisdom is that soil insulates the nests from fires passing overhead, today's hotter fires penetrate deeper into the ground.

Bumble bees and other social species—those that live in colonies—usually nest at or just below ground level, and thus live in the most hazardous zone. But the lasting impact of this year's fires on social species is not from the destruction of their nests—their colonies are seasonal and were probably reaching the end of their cycle—but of the new queens. Social bees have longer active periods than solitary bees do, and are more likely to still be foraging when fire season arrives. Those that were beginning hibernation will have been in the soil relatively close to the surface or even in the vegetation around trees. If a queen is killed, there will be no nest from that individual next year.

Of special concern are several imperiled bumble bees in the West. Recent fires have burned over historic and contemporary sites for Franklin's bumble bee, the western bumble bee, and Crotch's bumble bee. If queens of these species were affected, it may be difficult for them to recolonize those areas.

More research is sorely needed on the subject of bees' survival during wildfire outbreaks. Studies have shown that bees respond relatively quickly after fires, recolonizing to take advantage of the flush of post-fire bloom, which is encouraging—but most research looked at controlled fires that result in relatively low soil temperatures. Hotter wildfires are less studied but the research that has been done may offer hope. Recent work in southern Oregon by Dr. Sara M. Galbraith from Oregon State University and colleagues found greater abundance and diversity of wild bees in areas that experienced moderate and severe forest fires compared to areas with low-severity fires. If enough bees survive the more severe fires, it could have a net benefit for some species. Those that cannot recolonize easily could be most impacted.

As our climate continues to warm and fires become even hotter, will forests recover? I went to Yellowstone National Park annually for several years before and after the 1988 fires. The recovery was remarkable. However, there is emerging data that suggests that with warmer temperatures and less precipitation some forests just will not recover. The new era of fires either induced or intensified by climate change means that the future of our forests—and the insects that call them home—is uncertain.

In Search of the Elusive Johnson's Hairstreak

Candace Fallon

Picture this scene: It is early summer in the maritime regions of the Pacific Northwest, and you are hiking through a remnant stand of old-growth forest. Giant Douglas-firs and hemlocks tower above you. Dappled sunlight tumbles through occasional breaks in the canopy, and here and there along the trail are little patches of wildflowers in muddied soil. Everything is draped in moss and duff, the branches above laden with mistletoe. You walk through this hushed habitat, a kingdom of owls and bears, and suddenly a slight movement on the yellow flowers of an Oregon grape catches your eye. You move closer. And there, in this forest of oversized life and deep shadows, you see a small brown butterfly. You take one more step and it startles, shooting straight up into the canopy. The butterfly is gone.

Old-growth forests are not exactly the habitat that comes to mind when you think of butterflies. Meadows? Yes. Forest edges? Sure. But deep in old-growth forests? Somewhat surprisingly, there are a few butterfly species that, in the Pacific Northwest, call these habitats home, including the thicket hairstreak (*Callophrys spinetorum*) and Johnson's

Closely associated with coniferous forests, Johnson's hairstreak is considered an old-growth obligate in part of its range. Photograph by Neil Bjorklund / butterfliesoforegon.com.

hairstreak (*C. johnsoni*). Both live in the treetops, their larvae munching away at sprigs of mistletoe. But, while the thicket hairstreak is widespread throughout the West, Johnson's hairstreak is far rarer and is restricted to a smaller range. It is found in forests from southwestern British Columbia—where the original

The shade of a Pacific Northwest old-growth forest may not be where you'd expect to find butterflies, but between the patches of sunlight on the forest floor and the sun-warmed branches above, a couple of species of hairstreaks find what they need for sustenance. Photograph by Matthew Shepherd.

Growing on branches, sometimes hundreds of feet up, western dwarf mistletoe (*Arceuthobium campylopodum*) is the caterpillar host plant for Johnson's hairstreak. Photograph by David A. Hofmann.

specimens from which the species was described were collected—south to the Sierra Nevada mountains of northern California. The majority of site records for this species are found west of the Cascade Range in Oregon and Washington, although disjunct populations occur in several other ecoregions, including the Blue Mountains in northeastern Oregon and western Idaho.

Johnson's hairstreak is often associated with old growth and has been described as an old-growth obligate, but this may be true in only part of its range. In fact, the species can be found in a variety of habitats, from moist forests of western hemlock to dry woodlands of ponderosa pine. And it can occur in a wide variety of elevations, from near sea level in Washington's Puget Lowlands to as far up as 6,700 feet (1,525 meters) at the summit of California's Yuba Pass. Mistletoe, a parasitic flowering plant that attaches to the stems and branches of other plants and is typically associated with older forests, is a key component of Johnson's distribution and is its required larval host plant.

Many different species of mistletoe are found throughout the world, but Johnson's hairstreak relies on just one, the western dwarf mistletoe (*Arceuthobium campylopodum*). Taxonomically, dwarf mistletoe used to comprise more species, but recent changes combined several of these—including hemlock dwarf mistletoe (*A. tsugense*) and fir dwarf mistletoe (*A. abietinum*)—into the single species. It may grow on western hemlock (*Tsuga heterophylla*), ponderosa pine (*Pinus ponderosa*), Brewer's spruce (*Picea breweriana*), and true firs (*Abies* spp.). If you have ever walked through an old-growth hemlock forest in the western Cascades, you have probably seen evidence of mistletoe's parasitic existence in the form of swelling branches and witches' brooms, deformed branches that form dense clusters in the canopy.

Dwarf mistletoes are native components in many forests, where they provide important food sources and nesting sites for a wide variety of invertebrates, birds, and small mammals. The plants spread by launching their seeds with an explosive mechanism that flings them out at speeds up to sixty miles per hour and can propel them as far as fifty feet. Covered in a highly sticky substance, the mistletoe seeds adhere when they collide with trees, whereupon they germinate and send small root-like structures into their new host, seeking water and nutrients. It can take several years before visible shoots emerge, and a few more years after that to produce flowers.

It is those visible shoots that Johnson's hairstreak caterpillars depend on for survival. Dwarf mistletoes tend to be mostly leafless, composed instead of knobby, succulent growths that provide the perfect camouflage for the yellowish-green caterpillars. The caterpillars will go through several instars, or molts, as they grow, eventually pupating to wait out the winter. Adults emerge in late spring or early summer and can be found for several months, and, depending on elevation, even into early fall. While they appear to spend much of their time in the canopy, they will descend to the understory to sip nectar from such flowering plants as dogwood (*Cornus*), Oregon grape (*Berberis*), ceanothus (*Ceanothus*), and dewberry (*Rubus ursinus*); or to puddle, when males gather essential nutrients from a

A second butterfly that relies on dwarf mistletoe as a caterpillar host plant is the thicket hairstreak. Found from the Rockies westward, it lives in a wider range of forest and woodland types than Johnson's hairstreak. Photograph by Mathesont.

Dewberry (*Rubus ursinus*), also called trailing blackberry, is an important nectar source that grows in the ground layer of a forest. Photograph by Kirill Ignatyev.

variety of sources such as saturated soil, animal scat, or as the term suggests, muddy puddles.

It is likely that Johnson's hairstreak occurs in higher numbers and at more sites than is currently known. Accurate assessments of its population distribution and densities are difficult, since its larvae live in the forest canopy and the adults are rarely seen. Although butterfly surveys typically occur in some kind of open meadow or edge habitat where the surveyor moves along a transect, identifying species on the wing or with the help of binoculars or a net, these butterflies require something a little different. Because they are so secretive, spending most of their time in the tree canopy and only occasionally descending to the forest floor, they do not show up very often in transect surveys.

The U.S. Forest Service has developed and tested several survey protocols specifically for Johnson's hairstreak, comparing approaches for surveying adults with those for larvae. Researchers have found that adult surveys have a low rate of detection, while larval ground surveys lead to a much higher probability. These entail accessing mistletoe from the ground, whether in blow-down or low-hanging branches, and clipping small clumps to bring back to the lab or office to monitor them for larval activity. If larvae are present, they can be reared to adulthood, which allows for positive species identification, or they can be sent in for genetic analysis to distinguish between the caterpillars of Johnson's hairstreak and the nearly identical ones of the thicket hairstreak.

You can probably imagine that there are difficulties with this survey method as well. Physical signs of dwarf mistletoe parasitization (including swelling branches and witches' brooms) can be relatively easy to observe from the ground, but detection of live dwarf mistletoe is more difficult. Ground surveyors can use binoculars to aid in seeing live clumps in tree crowns, but this does not solve the problem of how to access those clumps. Larval surveys may prove to be the most effective approach in western regions of Oregon and Washington where host plants can be found lower to the ground.

Finding live mistletoe clumps can be challenging in ponderosa forests east of the Cascade Range, where mistletoe is typically found much higher in the canopy. The challenge is even greater in places like Oregon's Blue Mountains, where the ponderosa pines often have few low branches, and reaching the clumps can feel impossible. And how accurate is a method that is biased toward trees with low-growing mistletoe? Are the butterflies using microhabitats higher in the canopy? Should surveyors be climbing trees? That would add a whole new element to this task.

These difficulties, coupled with the lack of any kind of historical baseline of species distribution and abundance, make it tough to determine the population status of the butterfly. Has it declined in recent decades? Prior to 1900, Johnson's hairstreak is thought to have occurred throughout much of the old-growth coniferous forests in the Pacific Northwest. But over the ensuing decades logging and other timber-management activities have severely reduced or degraded the available habitat. Less than 10 percent of old-growth forests remain in Oregon and Washington.

Additionally, parasites and disease, the use of pesticides such as Btk, mistletoe suppression (the plant is considered a blight in forestry), and potentially even hybridization with the thicket hairstreak in some parts of its range are thought to be negatively impacting Johnson's populations. Stochastic events, particularly wildfires, may also negatively affect this species, which is already suffering from fragmented habitat and disjunct populations, and climate change is likely to have long-term consequences. This year wildfires have impacted one million acres in Oregon, and more than seven hundred thousand acres in Washington. Conservation of a species like Johnson's hairstreak can feel daunting, but management actions that take into account the needs of the butterfly in this region—such as old-growth forests with intact mistletoe—may serve to maintain habitat conditions needed in the core of its range and thus help to alleviate threats to extant populations.

The list of challenges and research questions surrounding this butterfly are long. Is Johnson's hairstreak truly a rare species, or is it just rarely encountered? How do we best survey for it? Which factors are most limiting to this species' populations? What are its microhabitat needs? How will climate change and associated increases in wildfire frequency and severity affect this butterfly and its host plant? And, ultimately, how do we as conservation biologists accurately assess the needs and conservation status of an elusive species that is dependent upon a parasitic plant that lives high in the tree canopy?

Candace Fallon is a conservation biologist at the Xerces Society whose work focuses on protecting at-risk invertebrates on public lands. She has extensive experience with inventory and monitoring of rare species, including Johnson's hairstreak, and with providing conservation advice to land managers.

Bees of the Eastern Forests

Rachael Winfree

People generally think of bees as creatures of open habitats, frequenting places with sunlight and plenty of flowers. And in general, that's probably true. But shouldn't there be some bee species that specialize on forest habitat? This is something I began wondering about more than fifteen years ago, when I was doing my first field work on native bees in New Jersey, a state that had once been blanketed in forest. In those studies, I found that the total number of bee species—and likewise the total number of individual bees—was roughly the same in landscapes that were largely forested as they were in deforested landscapes dominated by agriculture or suburban development. In fact, in one study, there were significantly more native bee species in the deforested landscapes. From an ecologist's point of view, this seemed odd, given that throughout most of recorded history, eastern North America was extensively forested.

Even though I found no evidence that bees as a whole benefited from the

New Jersey was once covered with forest, home to a community of bees adapted to a flora dominated by spring flowers. As the forest area shrank and the landscape became more open, the assemblage of bee species has changed too. Photograph by Nicholas A. Tonelli.

native type of vegetation, it seemed likely that the particular species found in the different habitats were different, and that, as forests were converted to human use, the loss of forest-associated species was compensated for with a gain in open-habitat species. I was curious about which species were the original forest bees—particularly because these species were likely the dominant native bee fauna in my study region prior to widespread deforestation by settlers. (The forest was largely intact until the mid-1600s, when two centuries of intense clearing for agriculture and towns began. More than half of the total forest area of the northeastern United States was lost during this period, with much of the rest cut over.) At the time I did this research, the habitat associations of most North American bee species, including the four hundred or so native to New Jersey, were unknown.

The opportunity to answer this question of the identity of the forest bee species came years later, when two excellent young scientists, Tina Harrison and Colleen Smith, working towards their PhDs in my research group at Rutgers University, studied native bees across New Jersey, Pennsylvania, and New York, and then published some of the first studies on forest bees. (Both received doctorates; Tina is now at the University of Louisiana and Colleen is at the University of Ottawa.) Tina designed a vast field-research project that allowed her to identify bees' habitat associations for the first time. A challenge for this type of work is that many bee species can readily fly a kilometer (six-tenths of a mile) or more while foraging; thus, the fact that a bee is found in a particular habitat type does not necessarily mean that it is dependent upon, or even associated with, that habitat. Tina got around this problem by choosing study sites in places where the surrounding landscape—defined as the land within fifteen hundred meters (nine-tenths of

Most sweat bees nest in the ground. The pure gold-green sweat bee (*Augochlora pura*) excavates its nests in rotting logs, a hint that it is a forest specialist. Photograph by Bryan E. Reynolds.

The common eastern bumble bee (*Bombus impatiens*) may be better able to adapt to a changing landscape than are many forest bees. Photograph by Bryan E. Reynolds.

a mile) of the site, an area of just over seven square kilometers (2.7 square miles)—was either predominantly (at least 80 percent) forested, predominantly agricultural, or predominantly urban and suburban development. Thus, at any site where she sampled bees, Tina could be reasonably certain that the bees she collected were associated with the surrounding habitat type. Almost all of the species that Tina and Colleen classified as forest associated were at least ten times as abundant in the forested landscapes as they were in agricultural and developed landscapes, and some species were up to three hundred times as abundant. In other words, these species are dependent on forests, and they are unlikely to persist in places where forests have been cleared.

Tina and Colleen found that roughly a third of all species that could be statistically analyzed—thirty-eight out of 118 species—were forest associated. Most of these species come from a small number of genera—*Andrena* (mining bees), *Nomada* (brood parasites of mining bees), *Colletes* (plasterer bees), *Osmia* (mason bees), *Bombus* (bumble bees), and *Lasioglossum* (sweat bees)—and often share some natural-history traits that match the seasonal timing of their habitat. In eastern deciduous forests there is a brief but intensive bloom of spring ephemeral wildflowers, as well as trees and shrubs, in April and May. This bloom ends by June when the trees leaf out and shade the forest understory.

A minority of forest-associated species—*Bombus* and some of the *Lasioglossum* species—are social, maintaining colonies in which multiple overlapping generations are raised throughout the spring and summer. These species have long flight seasons, and may use nonforest habitats once flowers are scarce in the forest. But most forest-associated bee species have short periods of adult

New Jersey's original forest has been fragmented and reduced by housing, industry, and agriculture. The community of bees that the landscape supports has also changed, with a shift away from forest-specialist species. Photograph by Dan Schenker.

activity and flight seasons corresponding to that period of brief springtime bloom; they emerge in March or April and disappear by June. As is typical of short-season species, three-quarters of these bees are solitary, with each female building her own nest in which she lays and provisions her eggs before she dies.

By comparison, a very different set of bee species are associated with the agricultural and suburban landscapes. These human habitats are dominated by species in the family Halictidae (sweat bees), and include many more social species with long flight seasons. As Tina put it in her published paper, "The dominant species in the native forest landscapes are solitary spring-flying bees and their associated brood parasites. In agricultural and urban landscapes these species are replaced by late-season bees from different phylogenetic lineages, many of which are social."

What about the bee species that are typical of open natural habitats, such as grasslands and meadows? We don't know for sure, because we couldn't study them. In the three-state region where we conducted our studies, there are no seven-square-kilometer areas where the landscape consisted predominantly of these habitats. They occur, but only at small scales. We suspect, however, that the bee species from our study system that once used open natural habitats, including the larger open areas created by Native Americans through burning, are found today in the disturbed open habitats created by agriculture and development. Places such as pastures, agricultural field margins, disused fields, residential yards, utility easements, and roadsides bloom throughout the summer and into fall, thus having seasonal timing very different from forests, but similar to that of open natural areas.

Once we knew the identities of the forest-associated bee species, we wanted to know how well they are persisting in today's fragmented and degraded forests. Colleen set out to answer this question in her PhD research. She worked in central New Jersey, a region densely populated not only with people but also with white-tailed deer, which degrade forests by browsing the understory wildflowers. In these heavily impacted areas she still found thirty-one of the thirty-eight forest-associated bee species, and forest species as a group were common across all of her forested study sites.

Interestingly, the forest bees and generalist bee species, which use both human habitats and forests, responded differently to forest size. Whereas the habitat generalists were similarly abundant in both large forests and smaller forest fragments, the forest bees were more abundant in the larger blocks of forest. This finding suggests that, as is the case for many other plants and animals that specialize on forest habitat, conserving large areas of forest is important for the wellbeing of forest bees.

Because their flight period coincides for the most part with the bloom of early-season trees and shrubs, forest bees are important pollinators of commercial fruits such as blueberries, apples, and cherries. Farmers have long been aware that honey bees, which originated in Africa or Asia, don't fly much in the cold, wet weather that typifies early spring in the Northeast. In contrast, the native forest bees are adapted to this climate, giving farmers an added incentive to manage for them.

Recent work led by Dr. James Reilly, a researcher in my lab group, found that wild bees are as important as honey bees in pollinating early-season fruit crops. Furthermore, these crops were often pollination-limited, meaning that they receive insufficient pollen to achieve full fruit set. This points to an opportunity to develop conservation and management guidelines for forest bee species, which could be useful for farmers seeking increased pollination.

Sadly, pollinator-habitat management as currently practiced in eastern North America is unlikely to support forest bees, for two reasons. First, it isn't done in the right place. The focus of management actions has been on enhancing pollinator habitat in open areas, such as agricultural fields and backyards, where forest-associated species are less likely to be found. Second, it focuses on the wrong time of year. The plants used to improve pollinator habitat in the eastern United States bloom in the summer, after most of the forest bees are no longer active.

The good news is that we have a wide-open opportunity to learn more about how we can manage forests to support our original native bee species.

Rachael Winfree is a professor in the Department of Ecology, Evolution, and Natural Resources at Rutgers University. Her lab's research program focuses on native pollinator biodiversity, conservation, and the relationship between biodiversity and ecosystem services. She serves on the Xerces Society's board of directors.

England's Ancient Woodlands: Living Time Capsules

Matthew Shepherd

To many people, the roar of a chainsaw is a sound of alarm, not conservation. But for England's surviving ancient woodlands, the chainsaw has become a valuable tool. The noise ripping through the serenity of a winter's day means the possibility of a springtime walk amidst a carpet of bluebells, conflicting images that encapsulate the story of woodlands that have seen centuries of human use.

As the last glaciation receded from Britain, woodlands spread across most of the landscape. This wildwood was a mixture of trees that included birch, willow, pine, oak, ash, hazel, beech, and lime (known in America as basswood). Dominant trees varied from region to region. For example, in southern England, lime was most common, with a smaller presence of hazel, elm, and oak. The wildwood began to be altered around 4000 BCE as Stone Age settlers opened up the land around their homes, and, as tools improved with the arrival of the Bronze and Iron Ages, so did the rate and extent of clearance. By 500 BCE, half of the country had been cleared.

Our understanding of the early history of the English landscape is based on analysis of pollen deposits in soil, but we gain greater clarity about its evolution once evidence of land ownership began to be written down. Starting in the late seventh century, a body of documentation known as the Anglo-Saxon charters recorded gifts of land—frequently royal grants, such as to help the founding of a monastery. The first comprehensive record, the Domesday Book, was created in the late eleventh century by the French nobleman William of Normandy following his successful invasion. It documents that just 15 percent of the country was wooded.

Subsequent records and the advent of detailed maps make tracking landscape change easier. Over the next several centuries, the income generated by woodland products for domestic use, as well as supplies for small-scale industries that historically manufactured farming tools, barrels, wagon wheels, and many other items, exceeded that from farmland, giving some stability. Even the advent of the Industrial Revolution in the mid-1700s didn't lead to significant loss. Iron smelting required charcoal, while leather tanning created a market for oak bark, and such demands led to changes in the management and structure of woodlands, but not necessarily their destruction.

Then, in the early 1800s, a boom in agriculture initiated a long, slow decline in the amount of woodland. Much of it that wasn't lost was dramatically changed by conversion to plantations of exotic species and softwoods. By 1919 England's woodland cover reached an all-time low of just 5 percent.

Because England's woodlands were the source of many things that were central to everyday life, almost all of them were managed intensively for centuries. (Those that weren't are inaccessible on steep hills or cliffs.) Woodsmen in all areas traditionally harnessed what Oliver Rackham described in his seminal 1986 work, *The History of the Countryside*, as the "self-renewing power of trees." When cut, nearly all trees will regrow from the stump or root, and with care an indefinite number of cropping cycles can be harvested from a woodland. There were two ways in which this was done, coppicing and suckering. In coppicing, a tree is cut to a stump, which remains alive and becomes a "stool" from which shoots regrow. Trees that adapt well to coppicing include ash, hazel, and chestnut. With the second method, suckering, the stump dies after cutting but the roots remain alive and send up new poles. Aspen, cherry, and elm all sucker well.

Woodlands provided many products, with different trees suited to different purposes: hazel supplied hedge stakes, bean rods, and thatching spars; ash was good for tool handles and hay rakes; chestnut was used for fence stakes and gate hurdles; and oak was preferred for wheel spokes, barrels, and construction (and its bark was stripped for the leather-tanning industry). An area might be cut every ten to twenty-five years, the rotation varying with the species of tree and how fast it grows to a usable size. Large trees, frequently oaks, were allowed to grow above every-

You probably can't imagine the English landscape without woodlands. A source of wood products for centuries, traditional woodland management has resulted in conditions suited to rare wildlife. Photograph by kitmasterbloke.

In a coppiced woodland, the trees are cut on a regular rotation. Stems regrow from the stump, providing a sustainable harvest of small-diameter wood that supplies a range of commercial uses. Photograph by Martinvl.

thing else, creating a structure known as coppice with standards. When trees of greater size were needed, the standards were felled and converted into timber.

This degree of management meant that woodlands were places of constant disturbance and change. And yet conversely, these were also places that fostered long-term stability. Some of these areas have been woodland since trees colonized the country after glaciation, surviving millennia of clearance and regrowth. Within their boundaries, they are dynamic landscapes, but, within the broader countryside, stable.

After centuries of industrial use, woodlands are now seen as an essential part of the landscape, a valuable wildlife resource, and important for the recreational opportunities they offer, and their future is fought over in the courts of law and of public opinion. This shift in values has resulted in the resumption of coppicing and other traditional management practices to restore the conditions that earlier were continually sustained. Woodlands still provide many traditional products, but conservation and recreation have become core values.

Many of the woodlands that are seeing renewed attention are designated "ancient woodland," a term that has a specific meaning in England: documented to have been woodland since at least 1600 CE. But given the history of the countryside, such areas have probably always been woodland, a direct connection back to the wildwood. Currently, just over 2 percent of England is ancient woodland, though not all of even that small amount is in the seminatural condition of long-coppiced woods in which the trees occur naturally but their growth is managed.

More than a quarter of "ancient" woodlands are actually classified as "plantations on ancient woodland sites"—meaning that the original trees have been removed and replaced with a plantation, frequently of nonnative species. The best woodlands represent less than 1.5 percent of the country, an area of roughly five hundred thousand acres (two hundred thousand hectares), and even that is fragmented. Many ancient woodlands are small; very few exceed one hundred acres (forty hectares), and many are thirty acres (twelve hectares) or less. With so many pressures on them, it might seem remarkable that any ancient woodlands have survived—but they have, and these places support rich communities of plants and animals.

The regular cycle of cutting and removal of the coppiced or suckered underwood creates patches that are intermittently open and sunny and that burst forth in spring flowers in the years following a cut. Bluebells may be the best known, but there are also vast blooms of primroses, oxlips, and red campion, as well as smaller numbers of dog violets and bugle. Some are closely associated with ancient woodlands and function as indicator species, their presence or absence determining whether or not the woodland is ancient.

Wooded areas also provide refuge for animals, from roe deer (*Capreolus capreolus*) and badgers (*Meles meles*) to the lemon slug (*Malacolimax tenellus*), a rare species that feeds on fungi that are plentiful in ancient woodlands. As with flowers, the presence of lemon slugs can be regarded as an indicator of a woodland's antiquity.

A host of insects call ancient woodlands home, including the violet click beetle (*Limoniscus violaceus*), the larvae of which feed on rotting wood, and the stag beetle (*Lucanus cervus*). One of Britain's most impressive insects, an

The male stag beetle (*Lucanus cervus*) has fearsome-looking "horns," but they are harmless. The beetle uses them to flip other males during combat over females. Photograph by Greg_Men.

adult male stag beetle can be up to three inches (seventy-five millimeters) long. Its larvae are even larger—more than four inches (one hundred millimeters) long—but seldom seen because they live in rotting wood underground. They can take five or more years to develop, so they benefit greatly from the long-term stability of a woodland environment.

Butterflies are a more obvious component of the insect fauna. A woodland might have thirty-five to forty species, an impressive number considering that fewer than sixty species altogether are resident or regularly recorded in Britain. Many of the species are common and can be found in numerous other places, but some are more specialized. The pearl-bordered fritillary (*Boloria euphrosyne*) frequents open areas in woodlands, where the adults fly low, nectar on spring flowers, and lay eggs near their preferred caterpillar host plant, dog violet. Considered highly threatened in England, this fritillary has declined rapidly since the 1950s; a major factor in its decline was the cessation of coppicing in many woods. The silver-washed fritillary (*Argynnis paphia*) also has a close association with woodlands. It too lays its eggs near violets, but usually a few feet up an adjacent tree trunk. Another butterfly of ancient woodlands is the purple emperor (*Apatura iris*). It is not rare, but is rarely seen because the adults spend most of their time in the treetops, where they feed on sap and aphid honeydew. Its caterpillars munch on goat willow, typically found in wetter areas of woods.

These butterflies have all benefited from the resumption of coppicing in woodlands, but none have gained as much as the heath fritillary (*Melitaea athalia*), which, without the efforts of conservationists, likely would have been extirpated from Britain. The sunny, warm, sheltered conditions of newly coppiced woodlands provide ideal conditions. Its common name

Pearl-bordered fritillary (*Boloria euphrosyne*) nectaring on bugle. This species has disappeared from woodlands that lost their coppice rotation and have become too shaded. Photograph by Gilles San Martin.

Colonies of the heath fritillary (*Melitaea athalia*) can increase to thousands of individuals within a few years in a sunny clearing created by coppicing. When the trees regrow, the butterflies move on to other freshly cut areas. Photograph by Juri Kowski.

may not reflect the essential relationship between butterfly and coppice, but its habit of appearing in freshly cut plots gave rise to the alternative name "woodman's follower."

Having grown up in Britain, my own connections with ancient woodlands come from childhood wildflower walks; volunteering as a student, during which I was first introduced to coppicing; and several years working in southern England, where I had the good fortune to help manage such areas in Bedfordshire, Oxfordshire, and Essex, three counties with magnificent ancient woodlands. Those jobs allowed me to immerse myself in the sounds, smells, and feel of these special places. I worked with landowners and land managers to reintroduce coppicing, with local councils to influence policy to preserve woodlands, and with government agency staff to find ways to support good management, and thus had the opportunity to witness efforts to achieve long-term change. I've also, I admit, put myself physically in the path of bulldozers to protect valuable sites.

England's woodland cover has rebounded from its low point in the early decades of the twentieth century, and has now reached 10 percent. (The figures are slightly different across the United Kingdom, with 15 percent cover in Wales, 19 percent in Scotland, and 9 percent in Northern Ireland.) There has been considerable government funding for woodland planting on private land through farm-support programs as well as a dozen Community Forests estab-

A newly cut coppice plot. Such cutting might seem harsh, but the burst of woodland flowers that follows a cut provides habitat for several rare butterflies. In the background is a regrowing plot with standards. Photograph by Natural England / Peter Wakely.

lished in the 1990s. Recently, the British government declared a goal of thirty thousand hectares (seventy-four thousand acres) of new woodlands in England to mitigate climate change. While this is a good plan, considerable care must be taken not to plant trees on habitats such as meadows, heathlands, and chalk downlands, areas that support their own unique wildlife that would be destroyed by conversion to woodland.

In time, new plantings will provide homes for woodland plants and animals, but the ancient woodlands remain of utmost importance and the need for vigilance is ongoing. There is constant threat from development, with woodlands lost bit by bit to housing, roads, and other construction. We need to conserve and carefully manage the surviving ancient woodlands, for which the chainsaw is the modern version of the ax and the crosscut saw, allowing a continuation of the traditions that stretch back for centuries.

Matthew Shepherd's conservation career spans three and a half decades. He worked in England and Kenya before moving to the United States. He is the Xerces Society's director of communications and outreach.

CONSERVATION SPOTLIGHT

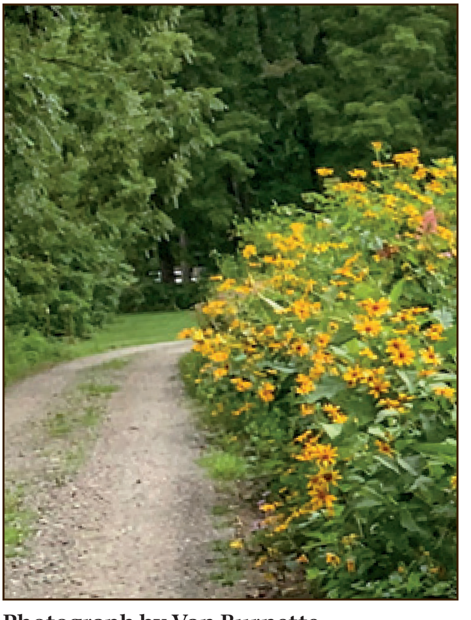
USDA National Agroforestry Center

Although most of the management practices associated with agroforestry—windbreaks and hedgerows, silvopasture, forest farming, alley cropping—have been around for centuries, many people may never have heard of them. Agroforestry combines agriculture and trees to build more profitable, sustainable, and weather-resilient farms, ranches, and communities. Growing trees and crops together offers many opportunities to support the conservation of natural resources; over recent years, these increasingly include the conservation of pollinators. It was at this convergence—seeking to understand and promote pollinator conservation within agroforestry—that the partnership between the USDA National Agroforestry Center and the Xerces Society started.

In 2007, our teams began collaborating to produce a ground-breaking series of publications on pollinator conservation and agroforestry. Since then, we have worked together to develop ways to improve or design agroforestry practices with pollinators in mind. Analysis of the scientific literature indicates that agroforestry not only provides habitat, forage, and sites for nesting and egg laying, it also enhances habitat connectivity and can mitigate pollinators' exposure to pesticides. This research lays the groundwork for making agroforestry practices better for pollinators, while improving agricultural production and environmental stewardship across North American landscapes.

Through our partnership we have provided tools, training events, and technical assistance to thousands of farmers and other agricultural professionals, enabling them to take action to support these small but valuable insects.

Research landscape planner Gary Bentrup and agroforester Kate MacFarland have guided much of the National Agroforestry Center's efforts on pollinators and have been great to work with. We are excited to continue our collaboration to raise awareness about the value of agroforestry and the ways that it can be fine-tuned to help pollinators and other beneficial insects while contributing to successful crop production.



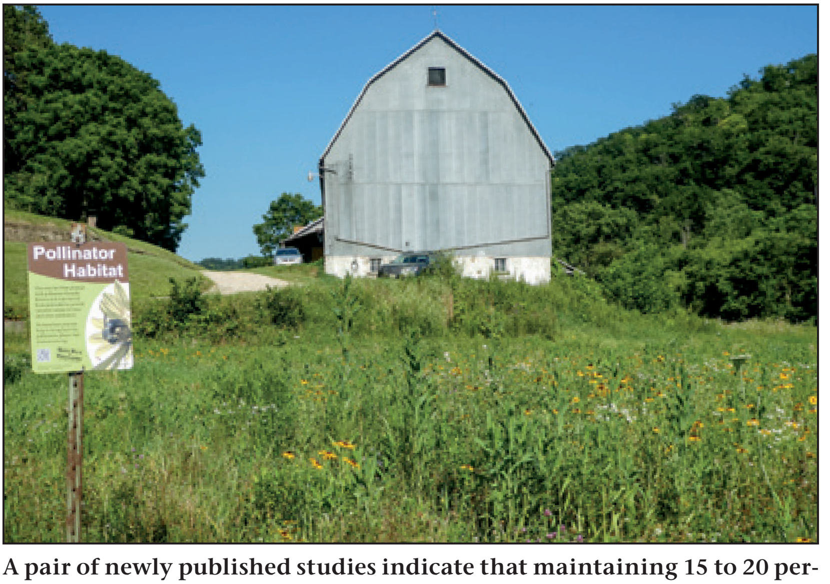
Photograph by Van Burnette.

How Much Habitat is Needed in Working Landscapes?

Two new research papers provide information about the amount of habitat necessary to support wildlife in working landscapes. Both came from large research groups with scientists participating from institutions around the world.

Strassburg et al looked at how much habitat restoration is needed to achieve the greatest benefit for the conservation of biodiversity and mitigation of climate change. Looking at land converted to cropland or pasture, the assessment found that if 15 percent of these lands were restored to habitat, more than 90 percent of the maximum biodiversity benefit and more than 80 percent of the climate-mitigation gains would be met. ("Global priority areas for ecosystem restoration," *Nature*.)

Garibaldi et al looked at areas largely used for farming, ranching, or forestry. They recommend that 20 percent of these working landscapes should be habitat, though not necessarily separate from farming or ranching. Grazing, mowing, or harvesting are okay where they are consistent with conservation. Besides supporting biodiversity, these changes will bring additional benefits such as reducing soil erosion, supporting pollinators, providing flood control, and mitigating climate change. ("Working landscapes need at least 20 percent native habitat," *Conservation Letters*.)



A pair of newly published studies indicate that maintaining 15 to 20 percent of working landscapes as habitat will support wildlife while bringing many other benefits. Photograph by the Xerces Society / Sarah Foltz Jordan.

Ancient Woodlands and HS2

Related to the article in this issue about England's ancient woodlands, we note with great concern that more than forty such sites are under threat by the construction of HS2, a high-speed rail line that will connect London and Birmingham. Construction of HS2 was approved by the government earlier this year and work began in September. Since then security guards have fenced off woodlands and the bulldozers have moved in.

In some places, a controversial technique known as "translocation" is being tried. The idea is that by moving root wads, deadwood, and soil, it is possible to move a woodland ecosystem. The reality is that you may keep some trees and wildflower seed in the soil, but you lose the invertebrates and fungi, the delicate food webs and species relationships, the shade and dampness of the mature woodland. Even HS2 officials admit that there is little evidence that translocation can succeed.

Quoted by the BBC, David Coomes of the University of Cambridge noted that the process "is like tearing up a Turner masterpiece and tossing little bits of it in to a new art installation and hoping people don't notice the difference."

Remembering John Anderson

We are sad to note the recent passing of Dr. John Anderson, a pioneer in California grassland restoration and founder of the famed California native-plant nursery, Hedgerow Farms. It would be hard to overstate the impact that John had in both the early pollinator-conservation work of Xerces, and his larger impact on habitat restoration in California.

After graduating from the University of California at Davis in 1970 with a degree in veterinary medicine, John specialized in primates, but had an all-encompassing love of wild animals and nature, a love that he maintained throughout his life. When he and his wife, Marsha, settled in a dusty and intensively farmed rural area of Yolo County, California, in the 1980s, John immediately noticed the absence of wild animals. Through years of steady work, he planted hedgerows of native trees and shrubs along his property edges, then patches of native grasses and wildflowers. He watched the incremental return of wildlife, including butterflies, bears, and rare songbirds that had not been seen in prior decades. This rewilding project eventually became the foundation of Hedgerow Farms, which specializes in producing seeds of native grasses and wildflowers.

Ever generous with his time and knowledge, John volunteered as a board member of various conservation agencies and organizations, and he conducted regular field tours of his property, freely sharing advice and experience on habitat restoration. For many of us at Xerces he was an important mentor, friend, second father, and model of decency. He was also often subtly and unintentionally funny, like when you would be walking through a grassy field with him and he would tell you to watch out for rattlesnakes. Not to caution you, but because he hoped to see one.

—Eric Lee-Mäder

STAFF PROFILE

Mary Ann Lau, Accounting and Human Resources Specialist

What got you interested in insects? In my early twenties, I began learning about organic gardening and beneficial insects. From then on, I no longer saw insects as pests or as something to be feared or eradicated but as a critical part of an ecosystem.

How did you hear of the Xerces Society? Honestly, the first I heard of Xerces was when I saw the job posting for my position. I was so excited about the possibility of working for an organization with such a unique and valuable mission.

What made you want to work here? It was important for me to be part of an organization that aligned with my core values and to work with people who share a common purpose of doing good in the world.

What's the best thing about your job? Working with the kindest, smartest, and most interesting people I've ever met!

Who's in your family? My husband, Matthew, who co-owns two cafés here in Portland; my twelve-year-old daughter, a budding clarinet player; and our pets: Lola, a Chihuahua mix, as well as two cats, Willow and Tangerine, and a lot of freshwater fish.

What's your favorite place to visit? I love any freshwater environment, like the rivers and lakes in our nearby Mt. Hood National Forest, but I'm also fond of high-desert ecosystems, for instance the Central Oregon area around Bend.

What do you do to relax? Gardening has saved my mental health during this pandemic! Other than that, hiking, kayaking, and camping with my family are what give me peace and happiness.

Who is (or was) your environmental hero? Since *Silent Spring* was one of the first and most impactful environmental books I read in my college days, I'd have to say Rachel Carson. I can honestly say that the concept of ecology transformed my relationship with the environment and changed my life.

What college did you attend? I graduated from UC Berkeley with a degree in social work, so it makes perfect sense that I ended up doing accounting and HR for a conservation organization, right? You never know where life will take you. . . .

XERCES NEWS

Protection Sought for a West Coast Tiger Beetle

In early November, Xerces joined with the Center for Biological Diversity to file a petition with the U.S. Fish and Wildlife Service seeking Endangered Species Act protection for the imperiled Siuslaw hairy-necked tiger beetle (*Cicindela hirticollis siuslawensis*).

This tiger beetle lives on beaches adjacent to river estuaries, and was once found scattered along the Pacific Coast from northern California to Washington. It is now restricted to just seventeen sites within an eighty-two-mile stretch of Oregon's coast, and two sites in Washington. At nearly all locations, surveys have found fewer than fifty individuals.

Seven of Oregon's remaining sites are concentrated along a ten-mile stretch of the New River Area of Critical Environmental Concern. Other Oregon sites occur in the Oregon Dunes National Recreation Area (part of the Siuslaw National Forest), as well as in state parks in Oregon and Washington. The beetle spends much of its life burrowed in the sand, which makes it very vulnerable to trampling and disturbance.

Sarina Jepsen, petition coauthor and endangered species director at the Xerces Society, noted that the Siuslaw hairy-necked tiger beetle now exists only where beaches remain largely untouched, and particularly in places that provide critical habitat for the federally threatened western snowy plover.

The tiger beetle is severely threatened by habitat loss, off-road vehicle use, climate change, coastal erosion, inbreeding, and invasive species. Listing under the Endangered Species Act will ensure that the federal and state agencies that manage the remaining populations of the Siuslaw hairy-necked tiger beetle protect them from these threats.

The Siuslaw hairy-necked tiger beetle survives at fewer than twenty sites. Photograph by the Xerces Society / Candace Fallon.

Conservation Achievement by the Numbers: 2019–2020 Highlights

During the past year, significant changes have happened that necessitated Xerces transforming the way we operate. We know that even during a pandemic the crucial work of sustaining the diversity and vitality of the natural world cannot be put on hold, understanding that human health is inseparable from that of our planet. When we protect invertebrates and their habitats, we are also protecting clean water and air, rich soils that grow nutritious food, and an incredible web of plants and animals that bring meaning to our lives. Among our recent achievements:

♦ 350,000 acres of pollinator habitat have been created or restored on farms.

♦ 9 farms, covering 20,000 acres of farmland, became Bee Better Certified.

♦ 11,000 freshwater mussels were saved in Northwest rivers and streams.

♦ 6 imperiled species—4 bumble bees in California, the island marble butterfly in Washington, and the western glacier stonefly in Montana—gained protection as a result of our advocacy.

♦ 170 species of fireflies were evaluated for extinction risk, and conservation actions were identified to protect them.

♦ 51,000 plants for monarch butterflies and pollinators were distributed in critical habitat areas in California.

♦ 5 research studies were published about insect declines and advanced science-based conservation methods.

♦ 3,800 people were reached through Xerces Society webinars.

♦ 225 city and campus communities are improving habitat for pollinators and spreading awareness about these essential animals.

During the past year, Xerces has worked with farmers, agencies, and communities to create and enhance habitat. Photograph by the Xerces Society / Jessa Kay Cruz.

♦ 780 volunteers contributed more than 12,000 records of bumble bees.

♦ 21,000 people learned how to conserve invertebrates through our outreach and education programs.

Protecting the millions of invertebrates and the natural world upon which we all depend is a big job and we could not do it without you. Thank you for your support and participation. To read more, visit xerces.org/annual-reports/2019.

Long-horned bee (genus *Melissodes*), photographed by Bryan E. Reynolds.

Tax-Wise Giving

At the end of each year, we look to you, our loyal and generous donors, to provide the foundation for us to continue our essential work into the new year. For those of you looking to make a tax-wise gift with a significant impact, we want to share with you a few giving tips:

♦ Gifts of appreciated securities or publicly traded stock that have increased in value and that you have owned for more than one year may provide greater tax benefits than giving cash.

♦ If you are seventy and a half years of age or older, you may give through your individual retirement account (IRA) to take advantage of tax savings. The maximum total amount of qualified charitable distributions is $100,000 per person each year without incurring income tax on your withdrawal.

Before making a charitable donation, please reach out to your personal tax or legal advisor for advice about your situation, and on how to properly execute a gift. Gifts should be initiated well in advance of the end of the year to ensure that they fall within the intended tax year.

The Xerces Society does not render tax or legal advice. If you would like to notify us of a gift you have planned or need our brokerage account information to complete a stock transfer, please email us at membership@xerces.org.

Thank you for your support!

Advancing Our Understanding of Pesticides

The Xerces Society is at the forefront of advocacy to restrict pesticide use. Our scientists are respected for their expertise, in part because they are involved directly in building knowledge on the ways that pesticides are impacting our pollinators and other invertebrates.

In June, the findings from a study begun a year earlier were published in the journal *Frontiers in Ecology and Evolution*. In the summer of 2019, our pesticide staff partnered with researchers from the University of Nevada, Reno, to gather samples of milkweed leaves from California's Central Valley. More than 225 such samples were collected from plants growing along farm field edges, in natural areas, and on urban sites, and were also taken from plants purchased at retail nurseries. All of the samples were tested for residues of insecticides, herbicides, and fungicides.

The results were startling even to us. Every sample was contaminated with at least one pesticide and most contained multiple pesticides. A total of sixty-four different chemical products were found, with an average of nine per sample. The samples from farmland and nurseries generally had more residues than those from wildlife refuges and urban locations. Some pesticides almost always appeared: Five were found in more than 80 percent of our samples, and two insecticides—chlorantraniliprole and methoxyfenozide—were in more than 90 percent of them.

Figuring out the true effect of such residues on butterflies is tricky, as surprisingly little research has been done into the toxicity of these chemicals. We were able to locate data relating to butterflies and moths for just sixteen of the sixty-four pesticides we found, but 47 percent of our samples contained one or more of those sixteen chemicals at a level known to be harmful for butterflies and moths.

In 32 percent of our samples, levels known to harm monarch butterflies were exceeded. Even the incomplete picture from this limited toxicity data suggests that pesticides could be a contributing factor in monarch declines.

Scott Black Passes Twenty-Year Milestone as Executive Director

This fall marks twenty years since Scott Black joined the Xerces Society as executive director. This achievement was recently recognized with a virtual celebration. At the event, board secretary Sacha Spector spoke about the impact Scott has had on both the organization and invertebrate conservation. His comments are edited here for length:

The honor has fallen to me to say a few words to celebrate Scott on behalf of the board.

When Scott joined the organization as executive director in 2000, the future of the society and its prospects for making gains on behalf of invertebrates were anything but certain.

Scott, across two decades of remarkable growth and expanding reach, you have created a home for an entire generation of invertebrate conservationists—going from a staff in what we might call the "mid single digits" to more than fifty of the most dedicated experts on endangered species, sus-

tainable farming, outreach and communications, pollinator biology, federal policy, fiscal management, and more. The team you have assembled and lead so humanely now creates impact on a scale I would guess was at best a glimmer in your eye back in the year 2000.

The result of your leadership is that the Xerces Society has become a universally respected and deeply effective conservation organization, known for its rigor, integrity, strategy, and partnership—all reflections of who you are as a person.

Through your dedication, sweat, wisdom, and force of will you have allowed Xerces to spread its wings. You, Scott, are a true champion for life in all its glorious variety, with the more legs, eye facets, and life stages the better.

So on behalf of the board, we salute you and celebrate this milestone. It's an honor to be connected in even a small way to you and to the work of the entire Xerces family, and an equal honor to count you as a friend. We walk in your footsteps and look forward to twenty more years of inspired leadership.

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For information about membership and to learn about our conservation programs for native pollinators, endangered species, and aquatic invertebrates, as well as our efforts to reduce the impacts of pesticides, contact us:

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION
628 Northeast Broadway, Suite 200, Portland, OR 97232
toll-free 855-232-6639 fax 503-233-6794 www.xerces.org

Metallic wood-boring beetles are also called jewel beetles because of their shiny coloring. Larvae of many species live in the roots, trunks, and stems of trees. *Lampetis drummondi*, photographed by Bryan E. Reynolds.

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On the cover: Where conditions allow—conducive soil, adequate moisture, the right temperature range—forests will blanket the landscape. Photograph by Getty Images / iStockphoto.

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