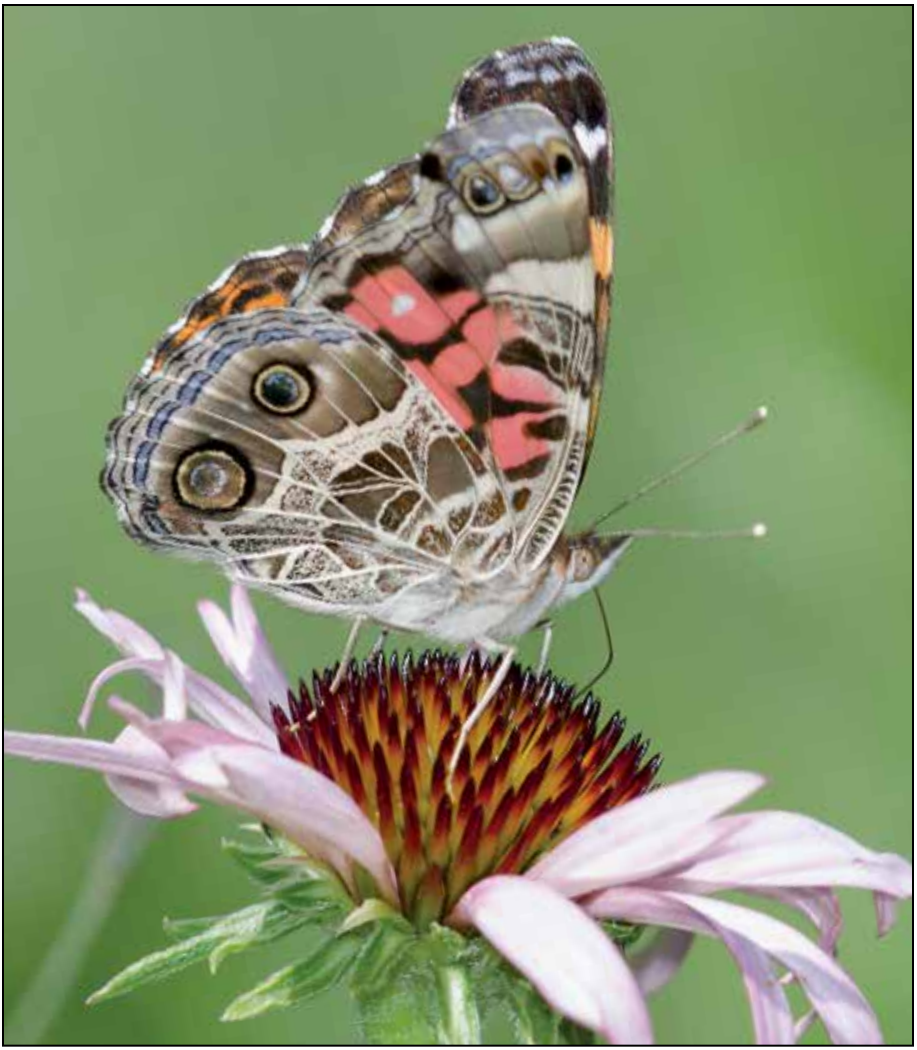
WINGS

ESSAYS ON INVERTEBRATE CONSERVATION



THE XERCES SOCIETY SPRING 2018

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Grasslands are among the most threatened habitats; easy to build upon or plow up, they are often the first to go. This issue of *Wings* looks at the beautiful wildlife that grasslands support, and some of the management problems faced by conservationists.

Can Robobees Solve the Pollination Crisis?

Eric Lee-Mäder and Scott Hoffman Black

Recently, Walmart filed a patent application for drones that are designed to pollinate crops by carrying pollen from one plant to another, detecting flower locations with sensors and cameras. Although Walmart is not the first organization to explore such an idea as a way to address the alarming decline in honey-bee populations, it seems highly unlikely that "robobees" could actually provide a solution.

First, in crop plants alone there are myriad varieties of flower shapes, sizes, and arrangements. For a sense of this diversity, just think of squash flowers, sunflowers, apple blossoms, and tomato flowers. Bees have coevolved with plants to collect and transport pollen efficiently. How many different types of drones would one farmer need? We are a very long way from having technology that will accomplish the task that bees already perform.

And the problem is more complex than just crops. At least 85 percent of all terrestrial plant species either require or strongly benefit from some form of animal pollination, and the idea of robotic pollinators ignores the many wild plants in meadows, prairies, hedgerows, and forests. Focusing solely on crop pollination and failing to take the pollination of native plants into account may well lead to a deterioration in the plant communities that make up the very fabric of our environment.

A further issue is that the western honey bee is just one of the thousands of species of bees—not to mention the flies, beetles, butterflies, and many

How many robotic drones would it take to replace the honey bees in just this almond orchard alone? Photograph by the Xerces Society / Matthew Shepherd.

other species that make up the community of pollinators. Developing a technological substitute for honey-bee pollination barely scratches the surface of global plant–pollinator interactions. In fact, a recent study, published in *Science* by a team led by Dr. Rachel Winfree of Rutgers University found that to provide pollination of crops alone we need a large diversity of bees, both common species and less common ones.

An essay by Dr. Claire Kremen of the University of California Berkeley in the same issue of *Science* underscores the changes we need to make to ensure that our landscapes can support the diversity and numbers of bees our crops require. Kremen points out that it is vital that we move away from monocultures and fencerow–to-fencerow cultivation toward regenerative farming that incorporates hedgerows, flowering strips, and other conservation practices to build soil fertility and support much-needed pest control and pollination services.

Another aspect of this discussion should focus on the cost, and whether robotic bees are the best investment—or even a reasonably effective one—at a time when the threats are real and seem to be growing. What could be achieved by funding sustainable solutions rather than pursuing technological approaches? As one of the world's largest retailers, Walmart has global procurement power that could provide incredible opportunities, both to restore pollinator populations by encouraging biologically diverse and regenerative agriculture practices of its suppliers, and to promote a more diverse range of food choices.

The first of these has an existing precedent. The Xerces Society works closely with several major food companies to restore habitat for pollinators and beneficial insects, protected from pesticides, on large-scale farms. The results are farm operations that increasingly produce and sustain their own wild resident pollinator populations.

The second opportunity, providing a broader diversity of food choices, would also be a powerful model for re-engineering our overly simplified food system. Products made from buckwheat, flax, carob, lentils, jackfruit, grain amaranth, and countless other less common crop species typically require few pesticides, and many are highly productive food sources for bees and other beneficial wildlife. A food system designed for such choices would inherently be built upon a biologically diverse and resilient landscape. These ecologically beneficial models are already proven in agroforestry, alley cropping, silvopasture, and other diversified farm systems. Moreover, such models arguably provide people with delightful food that is both healthier and more interesting.

The flower-rich meadows that support bees, butterflies, and most other pollinators bring benefits beyond crop pollination. If we consider the fact that an aesthetically beautiful wildflower habitat that supports wildlife, sequesters carbon, and produces oxygen can be established in most parts of the United States for around ten cents per square foot, then the best return on investment is clear. Rather than build drones that don't do any of those things, we should plant meadows.

Scott Hoffman Black is Xerces' executive director. Eric Lee-Mäder is co-director of the pollinator conservation program.

Keeping the Lights Burning: The Status Of Fireflies in the United States and Canada

Candace Fallon

Fireflies. If you spent any time as a child in the eastern United States, it is likely that the word immediately conjures up memories of dusky summer nights, soft flashes in the understory, bare feet on warm grass. Fireflies are celebrated all over the world. They are found in art, literature, and cultural origin stories. To some, they merely signal the start of summer. To others, they symbolize the souls of the departed, or bad luck, or hope in the darkness. Unlike many other insects, fireflies give off a friendly vibe. They do not sting or bite. They will not eat your crops or become a pest in the garden. They have an almost magical quality of lighting up the dark.

Fireflies are not flies but are actually beetles, in the family Lampyridae. They use bioluminescent light to communicate with each other, primarily to attract mates, but sometimes to signal alarm, or send a warning, or even to attract food—in the form of other fireflies! The light comes from an organ on the underside of the abdomen, in which oxygen reacts with a light-emitting biological pigment called luciferin in the presence of an enzyme called luciferase to emit photons, elementary particles of light.

Fireflies create light in a pair of abdominal segments. They flash with distinctive patterns to attract a mate of the right species. Photograph of common eastern firefly (*Photinus pyralis*) by ivkuzmin / iStock.

Fireflies are found in many countries, but particularly in tropical climates. More than two thousand species have been described, over 160 of which can be found in the United States and Canada. More species are being discovered and described each year. Here in the United States, Florida and Georgia are our most species-rich states, boasting more than fifty each. As someone who grew up in Florida, this was news to me. I do not have a single memory of fireflies until my family moved to South Carolina, where fireflies gathered in our yard every summer evening at dusk. Where were those Florida fireflies? Did I live in places that were too urbanized? Were our resident fireflies more active late at night, when I was tucked away in bed? How could I have missed them?

If you have similarly thought that you live in a place devoid of fireflies, you may be surprised to learn that fireflies actually occur in all of the lower forty-eight states and in many Canadian provinces. If you live in the West (as I do now) and wonder why you have never seen a firefly, it is probably because many of our western species are active during the day, potentially communicating with pheromones rather than light. In other species, the larvae or adult females may glow, but adult males do not produce light. Take, for example, the Douglas fir glowworm (*Pterotus obscuripennis*), whose larvae and flightless females can be found casting a soft, greenish light in its namesake forests. Flashing species may be rare west of the Rockies, but they can still be found in some pockets. Only a few years ago, researchers in Utah were excited to find populations of flashing fireflies in marshy areas of the desert—living confirmation after a thirty-year search.

Fireflies live in a wide variety of habitats, although many of these tend to have one particular feature in common: moisture. They can be found in wetlands, swamps, riparian areas, abandoned fields, forests, chaparral, and scrublands. Some species, such as those Utah flashers, are even found in deserts where the microhabitat is just right.

Larval fireflies hunt through soil and leaf litter for slugs, snails, and other soft-bodied invertebrates. Photograph by Bryan E. Reynolds.

Photographed just as it was taking flight, this female clearly shows its one pair of wings and the pair of hardened wing covers that identify fireflies as beetles, not flies. Photograph by Bryan E. Reynolds.

Life histories of fireflies are varied. The females of many species are flightless—they do not have wings and actually look more like grubs than true adults. They live in burrows in the ground and emerge at night to glow softly, waiting for males. Most larvae also live underground. In some species, such as those in the genus *Pleotomodes*, this subterranean lifestyle is taken to the extreme—both larvae and female adults live in ant nests. In contrast, the larvae of some species of *Pyractomena* forgo underground living and instead pupate on the bark of trees. This allows some of them to emerge much earlier in the year, but also makes them more at risk from temperature fluctuations, desiccation, and predation.

The diet of firefly larvae is composed primarily of soft-bodied invertebrates such as snails, slugs, and earthworms. Many species do not eat during their short time as adults, but there are exceptions. Among the most notable are females of the genus *Photuris*, which flash not only for their own males but also for those of another species. When an unsuspecting male arrives expecting to mate, he is instead eaten by the female; this behavior has earned *Photuris* females the nickname *femmes fatales*.

Fireflies are well loved, but they may be in trouble. Across the globe, people are reporting that fireflies appear to be less common than they used to be, and some researchers have documented local extirpations at their field sites. Unfortunately, there has been little systematic monitoring of species population sizes and trends, making it difficult to determine quantitatively whether and to what extent populations are in decline. Even so, we know that some of the habitats that fireflies depend on are disappearing, and several other threats have been identified, including light pollution, pesticides, poor water quality, drought, overcollection for the medical trade, and

Females in the genus *Photuris* are unusual in that they eat as adults—and they dine on other fireflies. Mimicking flash patterns of other species, they lure unsuspecting males for a surprising dinner date. Photograph by wplynn / Flickr.

invasive species. Climate change and associated droughts, as well as rising sea levels for some species that occur in coastal areas, are of particular concern. Because fireflies live as adults for only a few weeks and spend most of their lives—sometimes up to two years—in the larval stage, impacts on larval habitat can be especially critical.

In some parts of the world, fireflies may be loved too much, with dramatic increases in firefly tourism negatively affecting populations. The lights from cameras, cell phones, and vehicle headlights can interfere with their mating signals. Wetland firefly habitats are highly sensitive to trampling, and in very crowded areas fireflies themselves can be crushed underfoot.

Prompted by such anecdotal reports, the Xerces Society has embarked on an effort to evaluate the current state of knowledge on the conservation status and extinction risk of fireflies in the United States and Canada. While many studies have been published on firefly reproduction, behavior, and physiology, relatively little information exists on the status of populations and the life histories of individual species. As with so many invertebrates, firefly taxonomy is in flux, with a number of well-known groups awaiting reassessment and newly discovered but undescribed species not yet named.

Compounding the difficulty, fireflies are tricky to identify and many species are active only at night. Firefly fieldwork, while seemingly romantic, often involves long, dark nights enduring humidity, rain, poison ivy, and mosquitoes—sometimes even alligators. Add to this the fact that some species may flash for just a few minutes at a time and only during a two-week period each year, making them easy to miss. Decoding each species' unique flash and glow patterns takes time, and, although such recent books as Lynn Faust's *Fireflies, Glow-Worms, and Lightning Bugs*

are making this information considerably more accessible, there is still no single guide for species identification in the United States and Canada. As we piece together what is known from the literature and what we can learn directly from firefly researchers, enthusiasts, and citizen scientists, we are beginning to identify a list of species that may be of conservation concern.

The species on this list tend to share certain traits, such as female flightlessness. The *Pleotomodes* fireflies, for instance, comprise just three known species, all associated with ants; the adult females do not fly but instead live with their larvae in ant nests underground. The anthill firefly (*P. knulli*) is a small, rare species reported from Florida and Arizona; both the larvae and females glow, but the males rarely produce light. The ant-loving scrub firefly (*P. needhami*) is associated with scrub habitat and is known only from Archbold Biological Station in Florida. Adult females and larvae live in the nests of two species of ants, one of which cultivates underground fungus gardens. The ants appear to ignore the fireflies, and the fireflies have not been observed to feed on the ants or their brood. Both larvae and adults glow, even when underground in the ant colonies. A third species, *P. pulsator*, is known from Arizona and Mexico. These species and others with flightless females cannot easily disperse from an area and may therefore be particularly susceptible to threats.

Other species of concern include those that emit light only during true dark, or that have restricted ranges or strict habitat requirements. For example, the dark-active Florida intertidal firefly (*Micronapsis floridana*, the sole described species in the genus) is known only from salt marshes and mangroves along coastal regions of Florida and some northern islands of the Bahamas. This medium-size flashing firefly is threatened by coastal development, light pollution, agricultural activities (including introduction of a nonnative nematode), and pesticides. Hurricanes also pose a threat, although the larvae are able to float like little boats, which may aid in their survival. Researchers believe that some populations are now extirpated, including those near Sarasota. Like the Florida intertidal firefly, the tropic traveler (*Tenaspis angularis*) is the only species known in its genus. It appears to be very rare, observed just once or twice every ten years, although it is possible that this species has been overlooked because it does not flash or glow. Until recently it was thought to be a tropical species found only in Florida and Texas, but it has now been tentatively reported from Missouri.

The relatively large genus *Photuris*, with fifty-seven described species, includes at least eight species or subspecies that may be at risk of extinction. These flashing fireflies are primarily known from freshwater marshy areas, sand dunes, hammocks, floodplains, and alluvial banks. Specific threats include rising sea levels, increased light pollution, exotic plants, spraying to control adult mosquitoes, and forest succession. One such species, the Bethany Beach firefly (*P. bethaniensis*), is known only from threatened interdunal wetlands that occur along Delaware's Atlantic coast. Another species, *P. potomaca*, may now be extirpated from the Potomac Valley above Washington, D.C., where it was once abundant.

Mason jars filled with magical light have enchanted countless generations of children. Care should be taken to avoid harming captured fireflies, and it is important to release them after a short time. Photograph by Benjamin Lehman / Flickr.

Much more research and monitoring are needed to understand fully the causes and extent of firefly declines and to know which species—rare, broadly distributed, or somewhere in between—may be most at risk. Protecting their habitat, whether woodland or prairie or marsh, is essential to conserve fireflies. These entrancing insects aren't limited to wild places, however, and there are some simple steps you can take to help them in your neighborhood. One of the easiest actions is to reduce or eliminate outdoor lighting. Light pollution directly competes with and often outshines firefly signals, making it challenging for fireflies to find each other and to communicate. Shield any outdoor lights that must remain on, or consider changing your bulbs to provide more firefly-friendly lighting. When possible, limit the amount of area that is lit, as well as the number of hours that lights are kept on. Eliminating pesticide uses that can directly kill fireflies or alter their habitat is also important. Keep some areas of your yard unkempt and remember that different species will use different habitats, including water sources, undisturbed soil, and native vegetation of different heights.

If you or people you know catch fireflies as generations have before, handle them in a way that will help ensure that they can survive and find a mate once they are released. Do not put them in direct sun or in cold conditions. Release them as soon as possible—less than twenty-four hours from capture—in the same place they were caught. If you keep them overnight in a jar or other container, add some moistened tissue to provide the humidity they need. You can also use these interactions to help advance our understanding by making such occasions into more than just a nocturnal encounter. Keep notes on the fireflies you see, and share this information with citizen-science efforts such as Firefly Watch.

If there is one thing we have discovered during our assessment effort, it is that there is still much to be learned about the world of fireflies. Xerces will continue to seek a better understanding of these enchanting animals and how best to protect them. May their lights shine on for their sakes, and for ours.

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*Candace Fallon is a senior conservation biologist in Xerces' endangered species program. She recently had the honor of having a butterfly named after her, Candace's copper (*Lycaena mariposa candia*).*

The Striking Beauty of Oklahoma's Butterflies

Ray Moranz

I grew up near the foothills of the Appalachian Mountains, amid tall forests of beech, maple, and oak. If you had asked me back then to describe Oklahoma, I would have guessed that it was flat, brown, and dusty. (Cincinnati was the farthest west I traveled in those days.) Now that I've lived here for fourteen years, I know how wrong I was. Much of the state is hilly—some areas are downright mountainous—and most of the state is verdant during spring, summer, and early fall. Rather than being full of dust, Oklahoma skies are often full of butterflies. Of the twenty-seven states I've visited or lived in, this is one of the best for butterfly watching, blessed with a great diversity and a particularly high abundance.

Oklahoma's impressive butterfly fauna of more than 170 species includes the nation's largest (the giant swallowtail) and the smallest (the western pygmy blue), and representatives of all six major butterfly families: Papilionidae (swallowtails), Pieridae (whites and sulphurs), Lycaenidae (gossamer-wings), Hesperiidae (skippers), Riodinidae (metalmarks), and Nymphalidae (brush-foots). Such variety is primarily a result of the state's range of ecosystems and vegetation types—from the shortgrass prairie of the Panhandle in the northwest corner of the state to the towering forests of shortleaf pines that drape the Ouachita Mountains in the southeast. In addition, Oklahoma's geographic position near the center of the lower forty-eight brings us butterfly species from most regions of the country—the Northeast, the Southeast, and the Southwest, as well as the Rocky Mountains—to complement those that are most at home in Oklahoma's climate, which is sunny and warm much of the year and conducive to supporting populations of many butterfly species. We even get the occasional subtropical butterfly from southern Texas and northern

Oklahoma plays host to the largest butterfly in the United States, the giant swallowtail (*Papilio cresphontes*), shown here—and to the smallest, the western pygmy blue (*Brephidium exilis*). Photograph by Bryan E. Reynolds.

Mexico. In 2006, one of these, the common mestra (*Mestra amymone*), showed up in my Stillwater backyard, quite an unexpected treat!

Eight swallowtail species have been recorded in Oklahoma, including our state butterfly, the black swallowtail (*Papilio polyxenes*). We have four widespread species (black, tiger, giant, and pipevine), two that are limited to the eastern forests (spicebush and zebra), and two vagrants (two-tailed and Thoas).

At least twenty-two species in the family Pieridae occur in Oklahoma. Three of the most widespread are the orange sulphur, the dainty sulphur, and the checkered white. But sleepy oranges and little yellows come to my garden each year to lay eggs on wild senna, and the large and brightly colored cloudless sulphur shows up each year to lay eggs on partridge pea. Cloudless sulphurs are very strong flyers, and exhibit a significant southward migration each fall.

The blues, coppers, and hairstreaks of the gossamer-wing family (Lycaenidae) tend to be small, but they often have striking colors—iridescent blues, greens, or coppery oranges—and intricate color patterns. Most of the hairstreaks lay eggs on oak trees and most of the blues lay on legumes, particularly lupines, but host plants also include dock for gray coppers and bronze coppers, and eastern redcedar for juniper hairstreaks. In addition to the United States' smallest butterfly, the western pygmy blue, this family includes the country's only carnivorous one, the harvester (*Feniseca tarquinius*), whose caterpillar host "plants" are woolly aphids!

The most species-rich butterfly family in Oklahoma is the Hesperiidae (skippers), with nearly seventy species. The majority of them are tiny, barely larger than your thumbnail, and extremely

The common mestra (*Mestra amymone*) is a subtropical butterfly that puts in an occasional appearance in Oklahoma, including in the author's backyard. The mix of species from different regions makes the state a great place to watch butterflies. Photograph by Bryan E. Reynolds.

If imitation is the sincerest form of flattery, the soldier (*Danaus eresimus*) must admire the monarch (*D. plexippus*) a lot! Caterpillars of both species feed on milkweed. Photograph by Bryan E. Reynolds.

quick, flitting from flower to flower to flower in a second or two. They can be very difficult to identify. I once watched two butterfly experts debate the identity of a skipper that was kind enough to stay perched on a flower twelve inches from their faces. After half an hour, they still weren't sure what it was.

In contrast, we have only three species of metalmarks (Riodinidae): the little metalmark (*Calephelis virginiensis*), the northern metalmark (*C. borealis*), and the swamp metalmark (*C. muticum*). All are restricted to the eastern edge of the state.

The brush-footed butterfly family (Nymphalidae) is loaded with big, brightly colored species. Painted ladies (*Vanessa cardui*) and American ladies (*V. virginiensis*) can be found in great abundance, particularly during migration. Oklahoma is far enough south for us to be blessed with rare visits from zebra longwings (*Heliconius charithonia*) and julias (*Dryas iulia*), tropical species that lay their eggs on passionflower. Our passionflowers, though, are most often fed upon by larvae of another longwing, the gulf fritillary (*Agraulis vanillae*). Any garden in Oklahoma that has healthy, native passionflower vines is likely to host gulf fritillaries and, last summer and fall, my two vines helped to feed hundreds of their larvae.

The family Nymphalidae includes what is likely the most popular butterfly genus, *Danaus*, the milkweed butterflies: the monarch (*D. plexippus*) and two close relatives, the queen (*D. gilippus*), which typically breeds in scattered locations across the state, and the soldier (*D. eresimus*), a few of which have wandered up from the subtropical climes of south Texas. We have monarchs in abundance every year, although old-timers have told me that they used to see many, many more when they were young. Oklahoma and other southern states are where monarchs returning from their winter sojourn in the mountains

Skippers can be difficult to identify with certainty, as with this individual nectaring on narrow-leaved purple coneflower (*Echinacea angustifolia*). Photograph by Bryan E. Reynolds.

of central Mexico first arrive in spring to search for milkweeds, lay eggs, and die. By June, monarchs move northward and become sparse here. They show up again in August, and breed prolifically again where milkweed is available to produce a "fifth" generation. For a few weeks beginning in late September, Oklahoma becomes one of the most exciting places for a monarch watcher to be, as waves of millions of monarchs pour through from the Northern Plains, the Midwest, and the Great Lakes.

But, for me, the most fascinating butterflies are the fritillaries of the genus *Speyeria*. These large, showy brush-foots are among the most beautiful butterflies in North America—many have shining silver spots on their underwings—and perhaps no other genus demonstrates the advantage of our central location, even though only four species have been recorded in the state. The great spangled fritillary (*S. cybele*) occurs from coast to coast in the United States, but Oklahoma is about as far south as it is found. Edwards' fritillary (*S. edwardsii*), is a species of the Rocky Mountain states that has been recorded in the far western Panhandle. The other side of Oklahoma lies on the western frontier of two eastern species, the Diana fritillary (*S. diana*) and the regal fritillary (*S. idalia*).

Adult Diana fritillaries are colossal (although not as large as giant swallowtails), and they exhibit striking sexual dimorphism: the males are brilliant orange and brown, whereas the females are metallic blue and black. Regal fritillaries are also special—orange and purplish-blue above, while the undersides of the wings are orange and copper punctuated by bright white spots. Certainly deserving of the name "regal"!

The Diana and regal have intriguing natural histories. Like many fritillaries, both require violets as their host plants, but these two differ greatly in their habitat requirements. Dianas occupy moist woodlands and forests, and those within Oklahoma are thus restricted to the tree-covered Ozark and Ouachita mountains, in the eastern part of the state—or at least so we thought. One surprising development in the last decade is the appearance of Dianas west of these mountain ranges, first in the Tulsa metro area, but later at the edge of the Flint Hills in Osage County, and even on occasion in central Oklahoma. Unlike the Diana, the regal fritillary is a true grassland specialist and, unfortunately, it is in trouble. Once found in thirty-two states, it has been extirpated

from fourteen and is secure in only a handful. Famed lepidopterist Lincoln Brower once told me that he chased after regal fritillaries during his boyhood in New Jersey. Sadly, today's New Jerseyans cannot replicate that experience.

The main cause of the regal fritillary's decline is loss of grasslands, due to urban development, conversion to agriculture, or succession to forest. In Oklahoma, the regal fritillary is critically imperiled, and in the last five years it has been recorded in just a couple of counties in the northeastern part of the state. It appears that the Nature Conservancy's Tallgrass Prairie Preserve in Osage County is the best place to find them, and that is where they first enchanted me. In 2004, during my first summer in Oklahoma, I was conducting plant-community research at this forty-thousand-acre preserve, when I saw a beautiful butterfly zoom by. That was my first regal, and I was so impressed with it that I decided to conduct research on that species for my PhD. Eventually, I followed regals to research sites in Missouri, Kansas, and Iowa; I've never tired of hiking through shade-free prairies on hot summer days to see them.

One critical issue is the effect of grassland management on regal fritillary populations. Multiple earlier studies had indicated that the prescribed fires commonly set to kill young trees that try to invade prairie country likely also kill the fritillaries' immature stages. Although my research did not address that question directly, I found that adult regal fritillaries were more abundant in areas that had been recently burned, and that this was likely due to the stim-

A chance encounter with a regal fritillary (*Speyeria idalia*)—like the one shown here between two pearl crescents (*Phyciodes tharos*)—moved the author toward a career focused on butterflies. Photograph by Bryan E. Reynolds.

This juniper hairstreak (*Callophrys gryneus*) shows many features of the family Lycaenidae: small size, intricate patterns and shapes, and striking (often iridescent) colors. Photograph by Bryan E. Reynolds.

ulative effects of fire on the blooming of nectar-rich native wildflowers—pale purple coneflower, butterfly milkweed, prairie blazing star, and others—on which adult regals love to feed. Alternatives to burning include haying, mowing, and grazing, each of which have different effects on the grassland structure and suitability for regal fritillaries. Given the impact that management has on regals in their different life stages, care must be taken not to treat an entire site in a single year and to extend the rotation over a long period—in the case of fire, five or more years between burns.

There is a great need to identify the habitat that remains for regal fritillaries, to preserve it, and to figure out what other circumstances are contributing to the declines in abundance. Without a concerted effort, the state is likely to become the fifteenth from which the butterfly has disappeared.

Despite the threats that many species face, butterfly watching in Oklahoma is still superb, and if you've never been, I urge you to come. A good time to visit is in June, for the emergence of the Diana and regal fritillaries. Another is during the first half of October, when strong winds from the south (which are common) cause populations of migratory butterflies to build up and you have a good chance of seeing huge numbers of monarchs, as well as sulphurs, skippers, common buckeyes, and gulf fritillaries, before the southerlies die away, releasing the migrants to continue their journeys. For me, the peak of fall butterfly migration in Oklahoma is a source of bliss, annually renewed.

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Ups and Downs of English Chalk Grasslands

Matthew Shepherd

"Lack of concentration inhibits standard and rate of work." Schoolteachers in Britain didn't mince their words in 1970—or at least mine didn't! In my defense, they shouldn't have had a geology map on the classroom wall. The bold colors and intriguing patterns were much more interesting than math and spelling to an easily distracted seven-year-old. I didn't know much about geology back then, but I did know that the red patches were where volcanoes had erupted and that dinosaurs had been walking around when the rocks in the big blue area were forming. How could learning multiplication tables be expected to compete with that?

One of the more obvious features of a geology map of Britain is the broad bands of color that sweep across the southeastern portion of the country, in contrast with the disjointed and fragmented patterns to the north and west. One of these bands, often colored green, stretches nearly half the length of the island, forking and then forking again to reach the sea in at least four places, representing the chalk that underlies some of the country's most iconic landscapes: the mystical settings of Stonehenge

Chalk downlands are one of southern Britain's classic landscapes. The short grass and open conditions result from centuries of grazing, and support a great diversity of wildflowers and associated butterflies. Photograph by Natural England / Chris Gomersall.

and Avebury, which contain millennia of human history; the rounded hills of southern England, dotted with sheep; and the White Cliffs of Dover, which stood as a symbolic bulwark against Hitler during the Second World War.

Geologically speaking, chalk is a very soft limestone, almost pure calcium carbonate. It was created at the bottom of warm tropical seas, the accumulated remains of billions of marine plankton, "coccoliths," that died and settled on the seabed over a period of thirty million years. After Africa bumped into Europe about sixty-five million years ago—an event that created the Alps—this layer slowly bent and rose upward, dispersing the sea and becoming the hills that form the skeleton for what is now southern Britain. A bit confusingly, these uplands are known as downs (derived from *dūn*, the Old English for hill).

Although the English downlands contain several characteristic habitats—the beech woods of the Chiltern Hills, for example—the grasslands are the most distinctive. From afar, downs typically look bare and rounded. The chalk is porous, so rainwater percolates quickly, leaving the hills dry. In addition, the soils are shallow and infertile, partly from that percolating water leeching out nutrients. Add a layer of human history—centuries of sheep grazing, assisted by wild rabbits established after being brought to Britain by the Romans—and the overall result is a landscape in which trees struggle and grassland dominates.

Chalk grassland is short due to the grazing. The sward is seldom more than four inches high and in places less than an inch, very different from the image of grasslands that one might have formed based upon hay meadows or tallgrass prairie. Because the grass is so short, flowers face less competition, and these grasslands support a remarkable diversity of plants, upwards of forty species in a square yard. And the wildflowers are such beauties: meadow clary, bell flower, cowslip, kidney vetch, devil's-bit scabious, salad burnet, round-headed rampion, burnet saxifrage, and several orchids, including bee, spider, man, fragrant, and pyramidal. Sitting on a sun-drenched slope surrounded by such diversity is always a treat, but the major delight of any summer's day on the downs is the butterflies.

About a third of Britain's sixty resident butterfly species may be encountered on chalk grasslands, including small skipper, green hairstreak, small copper, meadow brown, Duke of Burgundy, and marbled white, but it is a handful of blues—common, chalkhill, small, and Adonis—that may be most

The vibrant colors of the Adonis blue (*Polyommatus bellargus*) light up chalk grasslands, the only place in Britain where they can be enjoyed. Photograph by gailhampshire / Flickr.

characteristic of this habitat, the latter two in particular, as in Britain they are found only on chalk or limestone grasslands. In a good year on a good site there may be thousands of them in a blue haze above the sward.

For a landscape whose character was so determined by human activity, it should be no surprise that the loss of chalk grasslands has also been caused by human enterprise. Beginning in the late 1700s, the changing economics of farming led to a transition on the downs from sheep pasture to cropland. This conversion continued into the twentieth century, accelerating after the Second World War with the advent of more-powerful machinery and the introduction of chemical fertilizers.

Cumulatively over the past two centuries more than 80 percent of chalk grassland has been lost. Where it once stretched from horizon to horizon it has been reduced to increasingly isolated patches, frequently on hillsides too steep for the plows, and neglect has thus allowed the grass to grow taller, smothering the flowers. In the county of Wiltshire, for example, which in the region around Stonehenge formerly contained some of Britain's largest areas of downland, nearly half disappeared in the three decades prior to 1970, around the time when I was staring at that classroom map. I didn't realize it then, but I would come to spend significant parts of my career on chalk grasslands, working on sites whose recent history illustrate the threats these habitats face.

By the mid-1980s I was studying land management as a post-graduate student, and my weekends were spent volunteering with a conservation group doing practical tasks of habitat management. Many of those duties involved clearing scrub from chalk grassland, experience that helped in one of my first jobs out of college at the National Trust's estate on White Horse Hill in the southwest corner of Oxfordshire. This site is home to the world-famous Uffington White Horse, a three-thousand-year-old chalk figure carved into the hillside, which is topped with Iron Age fortification. By the late twentieth century, White Horse Hill had been hemmed in by arable fields, leaving less than three hundred acres of ancient grassland. Fortunately, because of the horse and the hillfort, this land had not been abandoned and the slopes were still carpeted with flowers. In recognition of its rich flora, the hill had been declared a Site of Special Scientific Interest (SSSI, a national designation). My daily responsibilities included ensuring that the sheep were grazing the proper areas of grassland to maintain the short sward without damaging it, controlling problematic weeds such as invasive thistles, and containing the spread of hawthorn scrub.

Some years later, after working in Essex and then overseas in Kenya, I returned to the English chalklands, this time in Kent, where they meet the sea. There I helped with managing surviving grasslands on the Folkestone Downs, on Dover's Western Heights, and at the top of the White Cliffs, as well as with the creation of new grasslands along the foot of the White Cliffs, at Samphire Hoe. Unlike White Horse Hill, these places had not had a conservation-minded landowner, and the grasslands had suffered the declines that were typical for postwar Britain. Where it was flat enough, the land was now covered with crops, and any remaining grassland had

been "improved" with fertilizer and herbicides. Because they were at the edges of urban areas, housing bit chunks out of their lower levels and unstructured recreation intruded everywhere, making it increasingly difficult to keep livestock. Grazing had stopped in the years after the Second World War and scrub gradually encroached. Compounding this, the myxomatosis virus reached Britain in the 1950s, killing some 95 percent of the rabbit population over the next decade and a half, leaving nothing to keep the remaining grass short. Even so, the steeper slopes still supported significant areas of unimproved grassland and, maybe more remarkably, colonies of chalkhill and Adonis blues. As a result, the Folkestone Downs had been designated an SSSI.

Luckily for these hills, the British terminus of the Channel Tunnel was built at the foot of the Folkestone Downs. This meant that Eurotunnel became the benevolent landowner that the hills needed and, in partnership with the city councils of Folkestone and Dover, it launched the White Cliffs Countryside Project, with the intention of conserving the disappearing grasslands. By the mid-1990s, weekly volunteer efforts were dedicated to restoration, including removing the scrub. Carefully managed grazing by cattle and sheep helped provide long-term management, with project staff working in close cooperation with local farmers to ensure that grazing was done at the appropriate interval and intensity. This was often accomplished employing rare livestock such as Dexter cattle, a particularly small breed that could better thrive on the relatively poor forage and needed little more than a bush for shelter during bad weather.

This is also the place where I be-

Attentive management has pushed back encroaching scrub and reintroduced grazing, returning the Folkestone Downs to their former glory after years of neglect. Photograph by residents_parking / Flickr.

came a pollinator nerd. The Folkestone Downs are among the few places where one of Britain's rarest plants, the late spider orchid (*Ophrys fuciflora*), grows. In 1990, when the White Cliffs Countryside Project reintroduced grazing, there were only six such plants. By the time I worked there the number had increased, thanks to habitat restoration work done up until then, but we were still spending time pollinating orchids by hand. Spider orchids have a pollination method known as "pseudocopulation." The lower petal on each flower resembles a bee closely enough to entice a male bee to try to mate with it. During the attempt, packets of pollen, "pollinia," get attached to the bee, which transfers them to another flower. (Apparently, one failed effort to mate isn't enough to deter the bee from trying its luck multiple times!) At the Samphire Hoe site, I had the chance to watch bees in action on a closely related plant, the early spider orchid (*O. sphecodes*). I soon came to learn that both those bees (genus *Andrena*) and their counterparts (genus *Eucera*) that were no longer present to pollinate the late spider orchids on the Folkestone Downs are solitary, ground-nesting bees. For me, who at the time thought bees lived only in hives, this was a revelation, and one that led indirectly to a career shift and a focus on pollinator conservation.

Chalk downland is just one example of declining grassland habitat. Wherever they occur, whatever they are called—meadows, prairies, savannahs, heaths—grasslands are among the most threatened habitats, prone to plowing, "improvement," development, and loss of diversity through simple neglect. Maintaining them often relies on stopping the encroachment of scrub or woods, preventing the grass from becoming overgrown, and keeping nutrient levels low, but the reward is some of the most strikingly beautiful landscapes, awash with color from flowers and insects.

Discovering that the late spider orchid (*Ophrys fuciflora*) was pollinated by male solitary bees was a revelation that inspired the author to become a pollinator nerd. Photograph by Björn S / Flickr.

And my school reports? Despite my poor showing in math, I rated much better in geography ("an intelligent interest taken") and nature study or science ("good"), so, in the end, I guess that green band on the geology map did lead me in the right direction.

Matthew Shepherd has enjoyed opportunities to work in and manage beautiful places on three continents. He is currently the Xerces Society's communications director.

Iowa's Living Roadway Trust Fund

The sea of tallgrass prairie that once dominated Iowa's landscape has been converted to farmland or built on. Less than 0.1 percent of the prairie remains, and Iowa now leads the nation as the state with the most altered landscape.

A surprising champion of prairie restoration is the Living Roadway Trust Fund of the Iowa Department of Transportation. The Iowa Legislature created this fund in 1988, for "the vegetation of Iowa's roadsides to be preserved, planted, and maintained to be safe, visually interesting, ecologically integrated, and useful for many purposes." The result is a vibrant program of roadside habitat management and restoration, and efforts to educate the public about the importance of this work and prairie habitat.

The trust fund offers annual grants to city and county agencies as well as to universities and nonprofits. Almost fifteen hundred grants—more than $17 million in total—have been disbursed since 1990. Many of the grants fund vegetation management activities, including research into habitat restoration techniques and seed and plant selection, but they also support demonstration projects and conferences to share knowledge between roadside and conservation professionals.

In addition, the trust fund supports production of education and outreach materials targeted at audiences from school students to adults. This has included working with Xerces staff to develop a series of posters that are available for free from Iowa DOT's website, www.iowadot.gov/lrtf.

Bees in Urban Parks and Gardens

It's been known for a long time that parks and other greenspaces in towns and cities can support bees, sometimes in surprising diversity. New research from Poland, published in *Urban Ecosystems*, shows not only that urban parks can provide a home for bees but that their diversity of species may rival that of natural areas.

A team of researchers led by Weronika Banaszak-Cibicka, of Poznań University of Life Sciences, surveyed bees at two sites in the city of Poznań—a large park and a botanical garden—and compared those with records previously gathered at Wielkopolska National Park, about ten miles outside the city. The total number of species was 118 from the city park (almost a quarter of Poland's bee diversity), 101 from the botanical garden, and 110 from the national park. The surveys recorded a similar abundance of bees from each site.

When the researchers looked more closely at the species represented, however, they found distinct differences between urban and rural. The urban locations had a greater abundance and diversity of social species than the national park, perhaps because these bees are better adapted to forage from a wide range of flowers and thus able to cope with disturbed conditions. A second difference was that the city park and garden had fewer bee species in late spring and summer than did the national park. This likely reflects the seasonal shift in flower availability; the urban sites had many spring-flowering trees and shrubs, but fewer flowers overall later in the year due to mowing. The number of rare species was similar between the three sites, although there were fewer individuals from those species in the urban ones.

Indiana Adopts a State Insect

In March, Governor Eric Holcomb of Indiana signed a bill declaring Say's firefly (*Pyractomena angulata*) to be the state's official insect. This came about as the result of a four-year effort by a group of second-graders from Cumberland Elementary School in West Lafayette. Remarkably, this was not the work of a single group of students but several "generations" of determined seven- and eight-year-olds in Mrs. Samudio's class.

The students didn't set out to pursue a state insect. Their quest began in a geography lesson, when research on other states sparked the question: A lot of these states have state insects; why can't we have one? The class soon discovered that in the 1990s entomologist Tom Turpin of Purdue University had proposed Say's firefly as the state insect. This species had a strong connection to Indiana—it was named by Posey County naturalist Thomas Say in 1824—and the students decided to push for it again.

Their letter-writing campaign gained the support of state senators and

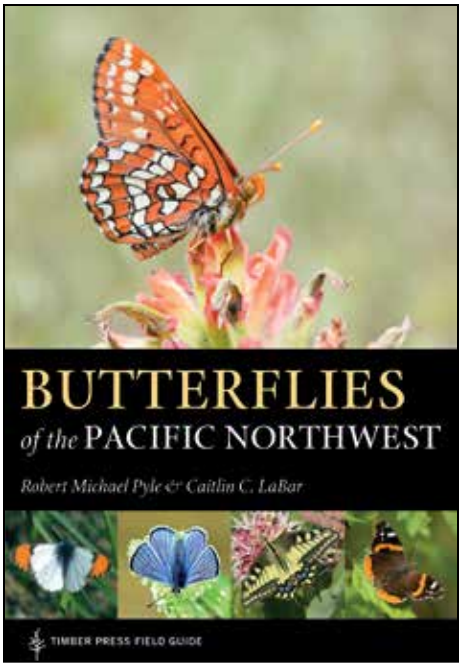
representatives, but the bills got stuck in committee.

A new class of media-savvy second-graders launched a social-media campaign and sent another round of letters. This time they caught the interest of the governor, who promised to share their letters with lawmakers. Thanks to this extra encouragement, a bill finally cleared the state assembly.

In recognition of the students' efforts, Governor Holcomb held the official bill-signing ceremony at Cumberland Elementary. With the school gym in darkness, everyone waved flashing green lights in celebration!

Book Review

Luckily for butterfly enthusiasts in Oregon and Washington, *Butterflies of the Pacific Northwest* (Timber Press, 2018) reached the bookstores just in time for this year's butterfly season. This is a successor to *The Butterflies of Cascadia*, a much-loved volume that has been out of print for several years. The two books share an author, Robert Michael Pyle, who was joined by coauthor Caitlyn C. LaBar for the new guide.



Butterflies of the Pacific Northwest begins with an introduction covering subjects as diverse as the structure of butterflies and their distinguishing features; their ecology and conservation; how the region's varied geography and climate affect butterfly distributions (and thus what to expect in different areas); how to understand butterfly names; and enjoying butterflies through watching, gardening, photography, and citizen science. It's well worth reading before diving into the field guide proper.

The species treatments include the detailed information about each butterfly that you'd expect from a field guide: how to identify it, its preferred habitat and caterpillar host plants, distribution, and when it can be seen. There are excellent photographs for each of the more than two hundred butterflies, as well as a series of side-by-side comparisons of similar species—an aid in differentiating potentially confusing butterflies.

What makes this volume a special pleasure are the narrative paragraphs, sometimes extensive, that accompany each description. These include anecdotes from the field, hints on when or where to find particular butterflies, who they were named for, and similar tidbits. Butterfly lovers will not be disappointed with this useful and entertaining book.

STAFF PROFILE

Candace Fallon, Endangered Species Conservation Biologist

What got you interested in insects? I grew up in the South, where insects are everywhere. My two younger brothers and I would spend hours climbing trees, collecting insects, planting gardens, and roaming through the woods. My childhood memories are peppered with insect encounters, from evading giant palmetto bugs to chasing fireflies, petting my first bumble bee, and coaxing ants into homemade ant farms. I was obsessed with plants and the insects that visited them, and would stalk butterflies with nets my mom made out of hangers and pillowcases.

What made you want to work at the Xerces Society? I knew I wanted to work for a mission-driven, small conservation organization that focused on my two great loves: plants and insects. At the time, I could find no other group that blended invertebrate research with applied conservation practices. One summer I was able to volunteer with Xerces for some butterfly surveys, and when a position opened on the endangered species team a few months later, I applied.

What's your favorite place to visit? There are too many incredible places to pick a single favorite, but I'll tell you about one of them: a small valley in south-central Nevada called Tikaboo. In this valley, the skies stretch on for days. You can watch the arrival of every storm and sunrise. The landscape is a mosaic of Joshua trees and fossil deposits and cholla forests. Darkling beetles amble through blackbrush while horned lizards dart about, licking up ants. Pronghorn, jackrabbits, and coyotes make guest appearances. There are very few other people, and miles of desert to explore. I've spent weeks at a time camping in this place, slowly becoming one with the dust and the rocks, and it will always feel like a piece of home to me.

Who's in your family? My partner Corey, our two somewhat neurotic cats Marvin and Salix, and a number of houseplants that have somehow survived the ages.

What book are you currently reading? Fredrik Sjöberg's *The Fly Trap*. It is a memoir by a Swedish entomologist who has dedicated his life to studying hoverflies. It's a short, charming book, and I find some of the passages hilarious and reflective of my own life as a biologist.

XERCES NEWS

Bee City USA Adds Strength to Xerces' Conservation Efforts

We are very happy to share the news that the Xerces Society is joining forces with Bee City USA.

Bee City USA, together with its sister initiative, Bee Campus USA, has achieved remarkable things over the last six years. What began as a spark ignited by a single individual has grown into a nationwide network of communities and college campuses dedicated to promoting and protecting pollinators.

Bee City USA, run by Phyllis Stiles with the support of a small group of generous donors, has become an established organization that now boasts more than 115 affiliate cities and campuses, with new ones coming on board every month. Each city affiliate agrees to a set of commitments that include raising awareness of pollinators, creating habitat, and reducing pesticide risks. Affiliates adopt a resolution, a public statement of what they stand for and what they will do. College campuses also draw pollinators into their service-learning program and courses.

Beginning in June, Bee City and Bee Campus will be a project of the Xerces Society. By becoming part of Xerces, Bee City acquires the capacity to continue its growth and to maintain the momentum of the Bee City movement. Phyllis will become a Xerces staff member, ensuring continuity through this transition and allowing her to focus on coordinating and expanding the network of affiliates.

The strength of Bee City and Bee Campus comes from a grassroots desire to make the world safer for pollinators. The involvement of every affiliate is driven by its local members, who organize events and celebrations, make habitat improvements, and engage friends and neighbors. We are thrilled to enter into this new partnership and to be able to engage directly with and provide support for this network of activists.

Conservation Guidelines for Freshwater Mussels and Monarchs

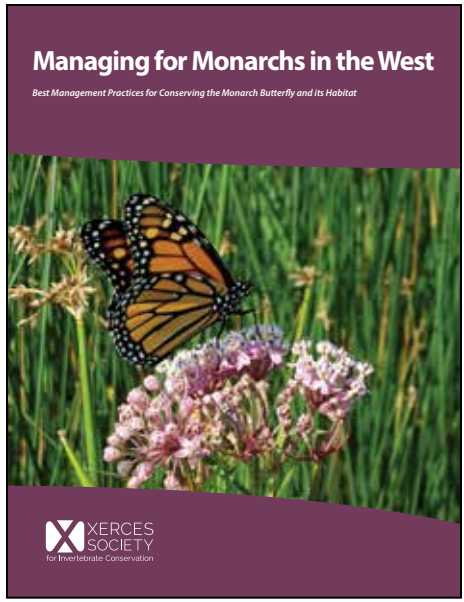
Xerces Society scientists recently completed two major reports to help guide conservation efforts in western North America.

Freshwater mussels are an important component of our natural heritage, improving water quality for wildlife and people. The declines of mussels in rivers and lakes of eastern North America is widely known, and there are many efforts to protect them and their habitat. In the West, however, freshwater mussels have been largely ignored, despite their importance to such high-profile wildlife as salmon. These mussels face many threats, and they are declining from Alaska to Mexico due to habitat degradation, lower water quality and quantity, and, perhaps surprisingly, the effects of construction activities and dewatering associated with river-restoration projects.

To improve things for mussels, the Xerces Society has published *Conserving the Gems of Our Waters: Best Management Practices for Protecting Native Western Freshwater Mussels During Aquatic and Riparian Restoration, Construction, and Land Management Projects and Activities*. This publication provides guidance and resources for a range of topics, including incorporating freshwater mussels into project planning, surveying for mussels, implementing best management practices, and performing salvages and relocations at restoration sites.

We are grateful to the members of the Pacific Northwest Native Freshwater Mussel Workgroup, western restoration practitioners, and aquatic biologists who shared their expertise and time in assisting with these guidelines.

The monarch butterfly also faces threats throughout its range in western North America. What was once a huge number of monarchs that converged on overwintering sites in coastal California has fallen by more than 95 percent since the 1980s, with declines also observed in breeding populations during the spring and summer.



To guide conservation efforts, the Xerces Society has published *Managing for Monarchs in the West: Best Management Practices for Conserving the Monarch Butterfly and its Habitat*. This report combines the best available science with accumulated knowledge from land managers to provide recommendations for managing monarch breeding and migratory habitat. Invasive nonnative and noxious plant species are addressed, as are the impacts of recreation and climate change. If land managers follow these guidelines they can mow, burn, graze, or otherwise manage land, confident that they are minimizing the negative effects on monarch populations.

Both documents are available from our website, xerces.org.

Northern metalmark (*Calephelis borealis*), photographed by Bryan E. Reynolds.

Gifts Through Your IRA

If you are seventy and a half years of age or older, and looking for a "tax-wise" way to support the work that matters most to you, you can make a tax-free distribution from your Individual Retirement Arrangement (IRA) directly to the Xerces Society. The maximum total amount of Qualified Charitable Distributions is $100,000 per person each year without incurring income tax on the withdrawal.

Please reach out to your personal tax or legal professional for more information and advice about your situation before making a charitable gift. The Xerces Society does not render tax or legal advice. To notify us of a legacy gift you have planned, please email us at membership@xerces.org.

Thank you for your support!

The First Bee Better Certified Farm: Sran Family Orchards

Last November, Sran Family Orchards, the world's largest grower of organic almonds, became the first Bee Better Certified farm. The Sran family has long had a commitment to sustainable farming, and for years has been working to establish flower-rich pollinator habitat within their almond orchards in California's Central Valley. With 23.5 acres of permanent pollinator habitat and 116 acres of flowering cover crops spread strategically across ten locations, it was an easy additional step to fulfill the requirements of Bee Better Certified.

Bee Better Certified is the only third-party food and farming certification program in the world that is focused specifically on pollinator conservation. The Xerces Society launched the program in collaboration with national nonprofit organic certifier Oregon Tilth in June 2017, with the goal of giving bees a healthy place to live.

Oregon Tilth evaluates farms against strict production standards and certifies them based upon habitat created and an assessment of their pest management strategies to protect crop pollinators.

Although Bee Better Certified's focus on habitat is unique among farm certification programs, it is compatible with any farming operation. Growers who want to be certified are required to dedicate part of their land to flowering habitat, and to mitigate exposure to pesticides through a combination of preventive techniques for pest management and the elimination of high-risk pesticide chemicals.

Pacific Northwest Bumble Bee Atlas

If you live in Washington, Idaho, or Oregon—or visit those states frequently enough—you can contribute to a new citizen-science project, the Pacific Northwest Bumble Bee Atlas. Over a three-year period, the project will create a detailed picture of the diversity and distributions of bumble bees in the three-state region.

While this project will gather data on all of the region's nearly thirty species of bumble bees, there are three whose population declines are of particular concern: the western bumble bee (*Bombus occidentalis*), Morrison's bumble bee (*B. morrisoni*) and the Suckley cuckoo bumble bee (*B. suckleyi*).

We hope that this project will lead to a better understanding of where bumble bees occur in remote locales. Much of what we currently know about bumble-bee distributions is focused on places where people live or travel—towns, cities and near to roads—as well as in such key conservation areas as national parks. Getting better information about which species of bumble bees occur in other areas will help researchers to see more clearly what types of habitat different species are associated with, ultimately supporting the conservation of those most at risk.

It could take a small army of volunteers to reach all corners of these three

states, which is why the participation of local residents (and visitors) is so important. The minimum involvement is to take photographs of bumble bees wherever you are and whenever you can, and then to submit them to Bumble Bee Watch. This will help to build the database of observations.

For people with more time available, we encourage you to adopt one of the grid cells in the project area and then visit it at least twice each year to look for and record bumble bees. There is no need to scour the entire area of a partiular cell. Just having observations from as many of them as possible means a good geographic spread across the region. You can find more information and learn how to sign up to adopt a cell at pnwbumblebeeatlas.org.

The Pacific Northwest Bumble Bee Atlas is a partnership between the Idaho Department of Fish and Game, the Washington Department of Fish and Wildlife, Oregon State University, and the Xerces Society.

With fewer than two hundred surviving adults, the island marble (*Euchloe ausonides insulanus*) is one of the most imperiled butterflies in the world. Photograph by Karen Reagan / USFWS.

The USFWS Proposes Protection for the Island Marble

Proving that species protection requires dogged determination, the U.S. Fish and Wildlife Service announced in April that it was proposing endangered species protection for the island marble butterfly—more than fifteen years after the Xerces Society first submitted a petition. In the intervening years, Xerces scientists continued to monitor this butterfly and to advocate for its protection. The new decision comes as the result of a second Endangered Species Act petition submitted in 2012, which the USFWS declined at the time, saying that listing was "warranted, but precluded by higher priority listing actions." We applaud the USFWS for now acting on the need for protection, but we are disappointed that the delay may have led to fewer options for recovery of this species.

The island marble (*Euchloe ausonides insulanus*) is among the most imperiled animals in the world. Fewer than two hundred adults were observed during surveys in 2017, and the butterfly's habitat faces continued threats. It is restricted to a cluster of islands in the Salish Sea, a coastal waterway that straddles the border between British Columbia and Washington state and includes the Strait of Georgia, the Strait of Juan de Fuca, and Puget Sound. In recent years, the butterfly has been extirpated from Vancouver and Gabriola islands in British Columbia and from Lopez Island in Washington. It is now found only on Washington's San Juan Island.

Host plants for the island marble are the native tall peppergrass and two related weedy nonnatives, field mustard and tall tumble mustard. Eggs and larvae have also been observed on sea rocket, but because none of those developed to maturity, sea rocket is not considered a potential host. The island marble is restricted to open habitat, which includes a range of disturbed places such as sheltered shorelines, sand dunes, roadsides, and agricultural land. All three of its host plants are annuals, and require soil disturbance to reseed.

Significant threats to this butterfly are habitat loss due to development, road maintenance, and invasive species; damage to remaining habitat from deer browsing, mowing, or insecticide use; and agricultural practices. Because island marbles use weedy mustards as host plants, they lay eggs in farm fields, and eggs and caterpillars may be destroyed during harvest or plowing.

It is imperative that the USFWS moves quickly to finalize protection and implement a recovery plan, which must include adequate areas of designated critical habitat.

***WINGS*, Spring 2018** **Volume 41, Number 1**

Wings is published twice a year by the Xerces Society, an international, nonprofit organization dedicated to protecting the diversity of life through the conservation of invertebrates and their habitat. A Xerces Society membership costs $35 per year (tax-deductible) and includes a subscription to *Wings*; the magazine can also be downloaded from our website as a PDF.

 Xerces Society Executive Director: Scott Hoffman Black. *Editors*: Scott Hoffman Black, John Laursen, and Matthew Shepherd. *Design and Production*: John Laursen. Printed on recycled paper.

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:

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By tucking in their heads when threatened, caterpillars of the eastern tiger swallowtail (*Papilio glaucus*) can make their eyespots prominent to startle an attacker. Photograph by Bryan E. Reynolds.

A $35 per year Xerces Society membership includes a subscription to *Wings*.

On the cover: The intricately patterned American lady (*Vanessa virginiensis*) can be found in most regions of the United States, although it is most commonly encountered in the eastern states. Photograph by Bryan E. Reynolds.

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