WINGS

ESSAYS ON INVERTEBRATE CONSERVATION

THE XERCES SOCIETY SPRING 2021

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This year we are celebrating our fiftieth anniversary. Since it was launched in 1971, the Xerces Society has grown to become a widely respected organization, leading the way on the protection of insects and invertebrates in North America and beyond. The articles in this issue reflect our growth and achievements over the last half century.

The Xerces Society Celebrates Fifty Years Of Science-Based Conservation

Scott Black

Fifty years ago, the Xerces Society started out as a volunteer-run conservation organization with big ideas and goals. From those small beginnings, we have developed into a professional nonprofit working across vast geographies with major successes. The foundation for Xerces' conservation and advocacy efforts—and for our decades of success—is our use of applied and community science to inform our education and outreach, technical assistance and advocacy, and policy work. I say this often at the beginning of my many lectures as a way of quickly telling people how Xerces works. But what does this really mean?

Taylor's checkerspot finally gained federal protection after more than a decade of study and advocacy. Photograph by the Xerces Society / Candace Fallon.

First and foremost, the Xerces Society is a science-based conservation organization. Science underpins all we do. For effective conservation you need to understand the species—sometimes, species groups—and what they need to survive and thrive: what they eat, where they live, any specific habitat needs that help them complete their life cycle, and human impacts that are of concern. For example, to effectively manage a meadow for butterflies, we know the system needs disturbance, but should that disturbance be in the form of fire or mowing or grazing? And how frequently and at what time of year should this be done to improve the habitat while minimizing impacts on the butterflies? Further—and layered over all other considerations—what role is climate change playing and how can we implement nature-based climate solutions in these habitats? Questions like these need to be answered for every species and species group, as well as for every landscape.

To achieve our goals, we work with hundreds of academic scientists from around the globe on applied research projects and on presenting their research in a format that is accessible to conservation practitioners. We also harness tens of thousands of volunteers to help us understand species distributions and requirements. Invertebrates are incredibly diverse and have a wide

array of habitats and habitat needs. Even with our network of academic scientists, there is no way we can gather enough data to fully understand these systems. By working with community scientists, we can gain access to tremendous amounts of information that otherwise simply would not be available.

This data has been used to shape both habitat-restoration projects and policy initiatives to protect species. For example, Bumble Bee Watch and our regional bumble bee atlases are informing restoration priorities and practices across three hundred thousand square miles, with the additional benefit that many community scientists become outspoken advocates for conservation, and can share our conservation message in their own communities.

Amplifying our conservation science message is vital if we hope to protect, restore, and better manage habitats in different regions and landscapes. Xerces has outreach and education mechanisms that are proven to connect with people. Recognizing that it is important to present solutions, we seek out many audiences—farmers, park managers, gardeners, educators, and policy makers—and for each we craft messages that resonate. To date, our staff and ambassadors have met more than a hundred and forty thousand people through workshops, presentations, and other events, and we have reached hundreds of millions through media and publications. In addition, our Bee City USA and Bee Campus USA affiliates connected with more than eight hundred thousand people last year alone. For conservation efforts to be successful and sustainable, all communities and people should be included and engaged. By ensuring that we reach out broadly, we will be better able to achieve our goals.

Beyond these efforts, we know that successful conservation comes when people have increased access to information and can ask questions. Whether our staff are working with those from an agricultural agency or we are helping a farmer plant habitat to meet Bee Better Certified requirements, the ability to provide guidance and assist with implementation ensures success. We also work in towns and cities, providing resources and assistance to help our Bee City USA and Bee Campus USA affiliates restore habitat, curb pesticide use, and expand outreach in their communities.

We believe that it is important to advocate for invertebrates and to push for invertebrate-friendly policies at all levels of government—improving pesticide policies; drafting and passing federal, state, and local legislation to fund restoration; and writing detailed, accurate listing petitions under the Endangered Species Act. In all of this, science aids our work to protect the rarest species as well as entire invertebrate communities.

Since its origins in 1971, Xerces' work has resulted in more than two and a half million acres of habitat protected and restored, and policies and practices to improve invertebrate conservation across hundreds of millions of acres. But if we are to maintain an environment with monarch butterflies, freshwater mussels, bumble bees, tiger beetles, and the other myriad species that grace our world, we need to keep working.

Protecting such a diverse group of animals is a formidable task. With your help, however, we can continue our efforts to meet this challenge over the next fifty years.

Helping Bees by Growing a Better Food System

Eric Lee-Mäder

There's a saying within the food industry that goes like this: "A supply chain is called a chain because you can only pull on it, you can't push it."

At the heart of this expression is the notion that consumer demand ultimately pulls along our entire food supply. The more of us who crave oat milk or avocados, the more those desires trigger a series of upstream responses on the part of food companies—responses around marketing, packaging, processing, labor, and the ways our food is grown. For example, a strong enough consumer demand for fewer pesticides in our breakfast cereal can ultimately trickle all the way back to the farms where the grain comes from, especially when consumers have a range of alternative options from which to choose.

Environmental, health, and social-justice advocates have long recognized the power of this dynamic and have helped to fuel various food and farming

The Xerces Society's Bee Better Certified program rewards and celebrates growers who make their farms better for bees. Aerial view of part of a mile-long habitat corridor planted through almond orchards, photographed by the Xerces Society / Cameron Newell.

Native bees play an important role in crop pollination. Ensuring that farmed landscapes are able to support them is a core purpose of Bee Better Certified. Mining bee, photographed by Bryan E. Reynolds.

certifications that shine a spotlight on products that align with their activist goals. When successful, certifications have the potential to increase product sales, command premium pricing, and ultimately incentivize large-scale changes in our food system. At their best, food certifications represent a net positive for everyone.

While the power of the consumer is a force we all understood at Xerces, it was never in our plans to launch our own product certification. That changed one day in 2017, when we were approached by several food-industry professionals who wanted to help create an authentic and measurable impact for pollinators within their own supply chain. At first, we entertained the conversation with a high degree of skepticism: *Is this really something consumers want? Can we manage something of this scale? Do people even think about bees when they are buying groceries?*

To test the waters, we partnered with the USDA Natural Resources Conservation Service through their Conservation Innovation Grant program and with Oregon Tilth, a leading nationwide auditing organization that specializes in the certification of organic farms. With additional guidance from a steering committee of scientists, farmers, and food-industry stakeholders, the pieces started to fall into place.

The process turned out to be tough and time-consuming. First, we needed to define what a grower must do to be certified, a set of criteria known as the production standards. We also had to create a name and a brand that would clearly and immediately communicate how those standards—and thus our certification—helps pollinators. Moreover, we needed to develop the complex and essential business infrastructure for a farm to apply for certification through Oregon Tilth, for Xerces to manage how a food company uses the label on its packaging, and for the intricate systems of accountability to ensure that raw ingredients from certified farms are indeed going into the products that claim to be using them.

Although daunting, the process got underway, with a huge amount of support from our partners. Within the first six months, we managed to create much of the basic framework. We even had an ice cream company and a blueberry packer ask us to help their supplier farms become certified so that

they could use the certification seal on their packaging. Somehow, it seemed as though the idea might actually fly.

Still, the question of a name for the certification lingered. The breakthrough came during a staff discussion, when pollinator program co-director Mace Vaughan observed that our certification "would be better for bees" than some of the unverifiable claims that we were starting to see in the marketplace. Within the alliteration of that phrase was the answer to our naming conundrum, and "be better" became "Bee Better Certified."

With the name settled, a logo for use on product labels quickly followed—and Bee Better Certified grew quickly. Within three years, first under the leadership of Hillary Sardiñas, then Cameron Newell, more than twenty thousand acres of farmland were certified, growing crops as diverse as almonds, blueberries, cranberries, tree fruits, vegetables, wine grapes, grains, flax, and oilseeds. Products such as ice cream, vinegar, wine, and fruit with the Bee Better Certified seal began appearing in major retailers and club stores nationwide.

Despite occasional and inevitable setbacks, Bee Better Certified continues to expand. By early 2020 we were fielding large numbers of international inquiries, particularly from the Southern Hemisphere, where many produce companies specialize in supplying the U.S. market with fruit during our winter months. It's possible that Bee Better Certified may end up playing as large a role in South America as it does in North America.

This growth trajectory represents a substantial conservation win. At the core of Bee Better are its standards. Certified farms are required to maintain at least 5 percent of their land base in flowering habitat for pollinators. Typically, this consists of such features as flowering field borders or hedgerows, as well as flowering cover crops. This habitat also has to be protected from pesticides, and all permanent habitat features (though not temporary cover crops) must consist of locally native plant species. Additionally, practices such as chemical soil fumigation are prohibited, as are the highest risk pesticides, such as the nitroguanidine neonicotinoids. Other specific requirements include the adoption of non-chemical pest-management practices, the reduction of tillage to protect soil invertebrates, and a prohibition against the use of commercially reared bumble bees for the pollination of field crops. This last requirement is one that we hope will limit the spread of diseases

Our Bee Better Certified logo now appears on a growing number of food products in grocery stores. Photograph by the Xerces Society / Matthew Shepherd.

from artificially raised bumble bees into wild bee populations.

Thankfully, we've been able to successfully grow Bee Better Certified and now have a broad cross-section of stakeholders all pulling on the supply chain together. At the consumer level, market research conducted by several universities has confirmed what we are seeing: consumers really do care about pollinators, and they are enthusiastic about supporting products that create a better food system for bees. Moreover, retailers and food companies are eager to be part of the solution. It's easy to view companies as being single-mindedly focused on profits, but the best companies are themselves made up of consumers—people who want to eat well and feed their kids well and want to care for our planet's ecosystems in the process. Even at the farm level we've been able to strike a balance between making a significant conservation impact and creating a system that doesn't burden farmers with unrealistic expectations and massive amounts of paperwork. Critical to our success has been the presence of smart, forward-thinking farmers on the Bee Better steering committee, including Anna Jones-Crabtree, a grain grower in Montana; Andrew Dunham, an Iowa vegetable farmer; and Morgan Wolfe, from the California almond industry.

Still, even with our progress, potential challenges always loom on the horizon. Among these is the phenomenon of "beewashing"—greenwashing that

Creating habitat requires a significant commitment of time and resources by growers. Workers at this site in California have installed irrigation and are placing a wire cage around each plant to protect it from browsing deer. Photograph by the Xerces Society / Jessa Kay Cruz.

uses bees to promote business operations that may not actually support pollinator conservation. For example, there are "self-certification" programs that allow farmers or food companies to simply fill out a superficial application, pay a fee, and receive certification, without an independent auditor actually verifying that they are doing what they claim. Such dubious accreditations muddy the waters and are difficult to navigate for even the best-intentioned consumers.

Another challenge is simply the ever-growing number of claims that are made for grocery products. A trip to the store reveals a huge list of options: organic, grass-fed, free-range, dolphin-safe, biodynamic, non-GMO, fair-trade, heart-healthy, pasture-raised, zero trans fats, and scores of others. Many of these claims—"all-natural," for instance—can be essentially meaningless and are not actually certifications in any legitimate sense of the word. Real claims, those that have substance, are backed by specific criteria that are independently audited and verified for accuracy, such as "USDA Organic."

Like beewashing, one predictable outcome of this welter of product claims is public confusion about what they all mean. This in turn can lead to the phenomenon we refer to as "certification fatigue"—apathy and a feeling of indifference toward the numerous assertions competing for public attention.

Despite such challenges, legitimate product certifications remain among the best tools that consumers have for understanding how to pull the supply chain in a direction that improves our food system for people and bees alike. Our hope is that consumers keep the faith and continue to use their significant collective power. With that in mind, a few strategies can help identify which product certifications are fostering authentic change.

Highbush blueberries are a crop that is best pollinated by native bees. Photograph by Nancy Lee Adamson.

First, the best product certifications, such as USDA Organic—and Bee Better Certified!—have a set of standards that are publicly accessible and that describe in detail the exact requirements that need to be fulfilled for certification.

Second, good certification systems operate under the direct, transparent oversight of diverse stakeholders. In the case of USDA Organic, the program is guided by the National Organic Standards Board, a committee of farmers, scientists, food-industry professionals, and environmentalists who advise on any changes to certification criteria and work to ensure the integrity of organic certification. Similarly, with Bee Better Certified, oversight is provided by a steering committee of Xerces conser-

Some Bee Better Certified growers integrate habitat fully through their cropped areas. This vineyard in Washington state allows prairie plants to grow around and under its vines. Photograph by the Xerces Society / Liz Robertson.

vationists, university-based pollinator researchers, farmers, and food-industry professionals.

Finally, consumers need to be aware that any certification without independent third-party auditing and inspection isn't really certification at all. Most of us would not be comfortable with an automobile manufacturer certifying for itself the safety of its vehicles. We'd prefer to have an independent organization test their cars' brakes to ensure that they actually work. We should expect no less from claims made by a food or beverage company that its products are helping our planet's biodiversity.

A lot of us frequently point to the failings of our food system: its environmental impact, its over-production of unhealthy options, its abuse and neglect of the people and animals upon which it is built. But it is also a system of our own making. Author and food-system observer Michael Pollan has noted that "perhaps more than any other, the food industry is very sensitive to consumer demand." Pointing out the failings of our food system is easy, while pulling the chain in a different direction takes more work. But it is an effort well justified by the end results, and in which we can all participate with the power of our wallets.

Eric Lee-Mäder, co-director of the Xerces Society's pollinator program, is involved with large-scale habitat restoration, native-seed research and development, and outreach to farmers and private businesses.

Using Community Science to Conserve Bumble Bees: From Small Beginnings to a Continent-Wide Effort

Rich Hatfield

For generations bumble bees have captured our attention and piqued curiosity. They share our farm fields, meadows, backyards, and parks. Their fuzzy bodies, colorful patterns, and benign nature have endeared them to us and have embedded them throughout our culture—from science to music, home décor to books. Charles Darwin studied "humble-bees" in the fields around his home at Down House. Rimsky-Korsakov's *Flight of the Bumblebee* is one of the most familiar orchestral pieces. Dumbledore, the paternal wizard who guided and protected Harry Potter in the books and movies, is an old name for bumble bee. The list could go on, leaving no doubt that we have an affection for and connection to bumble bees.

Bumble bees are ubiquitous across the Northern Hemisphere and in South America. Globally, there are around 250 species, with their center of diversity in the Himalayan region of Asia, where these insects originated before diversifying and dispersing to colonize other parts of the world. Generally, they are cold-weather specialists, although they are present almost anywhere that flowers are found, from deserts and river

Community science has become an essential method for gathering information that is used to inform conservation efforts for bumble bees. Brown-belted bumble bee on eastern redbud, photographed by Bryan E. Reynolds.

Observations of which flowers bumble bees visit help to guide habitat-creation projects. Photograph by Bryan E. Reynolds.

valleys to alpine and Arctic tundra. Here in North America, we have nearly fifty species, with the greatest diversity found in and around the Cascade Range in the Pacific Northwest and the Rocky Mountains.

Unfortunately, our fascination with bumble bees has not yet led to practices to protect them from other, less desirable facets of our culture—chemical-based and mechanized agriculture, sprawling cities, and lifestyles that are changing the climate. Research from around the world suggests that up to a quarter of bumble bee species are at some risk of extinction. In the United States, two species are protected under the Endangered Species Act thanks in part to the Xerces Society's scientific research and advocacy, but many other imperiled species are in need of conservation attention.

Gaps in our knowledge limit us from taking rapid, effective conservation action for bumble bees. These gaps range from not knowing the particulars of nesting and overwintering needs, to a lack of understanding of the complex biology of certain species, to a paucity of the baseline information needed to assess population health.

Given these deficits, Xerces has adopted a multi-pronged approach to bumble bee conservation, as we do for all of our work. We use outreach and education to engage and inform new audiences. Our staff use applied research to ensure that habitats are managed in a way that minimizes impacts on these species, and we provide technical assistance to partners to guide habitat restoration on farms, in parks, on roadsides, and in gardens. We also work to ensure that these habitats are protected from pesticide use and that they provide climate resiliency. We use advocacy to get the attention of federal, state, and local conservation agencies, and submit petitions to secure protection for the most imperiled species under state and fed-

eral endangered-species laws. Concurrently, we are working with research partners around the world to help close the knowledge gaps and to ensure that our conservation efforts maximize the benefits to these species.

At the forefront of this work is the Herculean task of finding and measuring populations. Bumble bees often have large geographic ranges and establishing where individual species are present can be excruciatingly difficult. Even more difficult is determining where individual species are not present. From the beginning, we recognized that a small group of scientists could not do this work alone and that to be successful we needed to involve more people. In 2008 we began a pilot project focused on the rusty patched bumble bee (*Bombus affinis*), Franklin's bumble bee (*B. franklini*), the western bumble bee (*B. occidentalis*), and the yellow-banded bumble bee (*B. terricola*). Community scientists were encouraged to submit their sightings—a photograph with location information—via email. We advertised this project in our talks and short courses and through "wanted" posters, and almost immediately we were inundated with observations from all over the continent.

Most of the observations we received, however, were not of the target species. Rather, they were sightings of species that bore some resemblance to them, and more often were of common species that frequent backyard gardens. Due to staff capacity, we could process—verify, georeference, and manually enter—observations of only the target species into our conservation database, leaving thousands of other sightings unused. Even so, the submitted observations of our target species dramatically improved our localized conservation and advocacy efforts, particularly for the western and rusty patched bumble bees. Unfortunately, this effort had an unintended side effect. While we were gaining valuable information about where rare species were persisting, over time we recognized that our practice of recording only rare species was having the effect of making them appear more common than they actually are. Because we lack the data necessary for comprehensive estimates of bumble bee populations, we often use relative abundance (the abundance of an individual species compared with all other species of bumble bees) as a proxy for popula-

Wanted posters were created in 2008 to recruit volunteers to search for four species of imperiled bumble bees. (Artwork by Elaine Evans.)

tion estimates. What we needed was a broader approach to collecting data on all bumble bee species.

To address this issue, we collaborated with Dr. Sheila Colla (then at Wildlife Preservation Canada, now at York University) and the team at eButterfly to build a community-science project to track and conserve North America's bumble bees. The culmination of this joint effort was Bumble Bee Watch, which launched in 2014 and tracks *all* bumble bee species. Using an online platform, individuals can upload their photographs, compare them to an identification key, enter the locations and dates of their observations, and submit them to the database. Xerces staff and Bumble Bee Watch partners, relieved of the time-consuming task of data entry, can then check and verify the identity of the bees.

Bumble Bee Watch took off immediately, and since its inception has attracted thousands of registered users, who have submitted more than seventy-five thousand observations. These photographs and associated data have vastly expanded our understanding of bumble bees throughout North America. We have documented species well outside of their previously known ranges, helped discover populations of rare species, and gathered valuable information about the plants that bumble bees are visiting in different regions. One pattern we noticed as the data accumulated was that bumble bee distributions largely reflected human population density and transportation corridors. This was

The author shows participants in the Pacific Northwest Bumble Bee Atlas how to catch the insects so that they can be photographed and identified. Photograph by Steve Lenz.

not exactly the most natural assessment of bumble bee health we were hoping to amass, but it is a common problem when data collection depends on volunteer participation: people tend to look where they live or can easily travel to.

Seeking to improve on the situation, the Xerces Society collaborated with stakeholders in Idaho, Oregon, and Washington to launch the Pacific Northwest Bumble Bee Atlas in 2018. By dividing the region into grid cells that individuals could adopt, and by encouraging people to search beyond their backyards and venture into remote parts of the region, we could overcome this geographic bias. Community scientists heard and responded to our call to action! From 2018 to 2020, more than six hundred volunteers conducted more than fifteen hundred surveys and contributed more than twenty-two thousand bumble bee observations. Our understanding of Pacific Northwest bumble bees has increased dramatically, and we now have data at the appropriate scale to inform targeted conservation action. We are currently working to develop evidence-based recommendations for land management and conservation to benefit bumble bee populations, particularly for imperiled species.

The Pacific Northwest Bumble Bee Atlas has provided a model for further efforts. With regional partners we launched atlas projects in Nebraska in 2019 and Missouri in 2020, and this spring we are expanding to California. These projects will advance our understanding of bumble bee ecology, which in turn will inform conservation management. Moreover, the information that they generate in the form of observations can serve as baseline data to which future conditions can be compared. We hope to have additional atlas projects in other states and regions in the future, expanding our capacity to direct conservation efforts where they are needed most.

Each step in this process has been accompanied by uncertainty. We live in a busy world with no shortage of options for information and activity, and at each iteration it was possible that our call to action would fall into the void. Yet every time we asked for help, people responded in ways that surpassed our expectations, devoting valuable time and energy to help tiny creatures that are easily taken for granted. We can measure the many direct benefits that have emerged—bumble bee observations, habitat surveys, acres planted—which will certainly make a difference in conservation.

Just as significantly, however, our bumble bee atlases and other community-science projects have created a growing conservation community dedicated to bumble bees. Thousands of people have viewed our training materials and attended our workshops and are now equipped with greater knowledge; many of them are hard at work in their neighborhoods and hometowns raising awareness and pursuing grassroots conservation opportunities. These efforts, regardless of their form, are making a difference in conservation and will benefit future generations.

Rich Hatfield is a senior endangered species conservation biologist with the Xerces Society. His work, encompassing all aspects of understanding and protecting bumble bees, is internationally recognized.

Protecting Grassland Ecosystems from Insecticides

Scott Black

It was as a kid—on vacation with my family in the Pine Ridge region of northwestern Nebraska—that I first really noticed grasshoppers. I was already interested in anything that crawled, walked, or flew, but where I lived, in Omaha, I rarely encountered grasshoppers. The state park we were visiting, though, was a mix of ponderosa pine and prairie habitats, and as I walked through the tall grass I was amazed at the number of grasshoppers that launched themselves into the air or scurried away from my approach. Of course, I had to catch some for a closer look! It was cool to see that they came in different sizes and colors—green and brown, with delicate markings in black and patches of red or blue—and I was intrigued to find that some had wings (usually boldly patterned and brightly colored) and some did not.

At the time, I did not know much about insect development and didn't understand that the ones without wings were juveniles. Actually, as I subsequently learned, they did have wings, but they were not yet fully developed. Grasshoppers are among the groups of insects that undergo incomplete metamorphosis, also called *hemimetabolous* development. Such insects emerge from eggs into nymphs (referred to as larvae by some entomologists) that look like the adults except for their lack of fully developed wings. They pass through

Many grasshoppers reveal bold markings or bright colors when they leap or fly. This grasshopper nymph has yet to develop wings, but already has a touch of blue on its legs. Photograph by Bryan E. Reynolds.

Among the many birds that rely on grasshoppers for a major part of their diet are burrowing owls, which as fledglings hunt and eat them. Photograph by Wendy Miller.

several nymphal stages (instars) as they grow, before their final molt into the winged adult form. (In contrast, butterflies, bees, beetles, flies, and many other insects undergo complete or *holometabolous* metamorphosis, in which the immature stages look nothing at all like the adults.)

There are just under seven hundred species of grasshoppers in North America and about eleven thousand species worldwide. In North America only a small number, ten to fifteen species, are actually pests—and then only under certain conditions.

Most grasshopper species play a central role in food webs, both as consumers and as prey. Herbivory by grasshoppers is an essential ecosystem function and speeds up the flow of energy and cycling of nutrients from plants. Dead plants take a long time to decay and return their nutrients to the soil, but both the grasshoppers' fecal pellets and the plant clippings they drop when feeding are more quickly broken down, which aids nutrient recycling.

Grasshoppers are a vital part of the diet of dozens of species of birds, small mammals, reptiles, and amphibians as well as spiders, robber flies, and other invertebrates. These insects make up 30 to 90 percent of the diet of grassland birds. For instance, more than 70 percent of the food that chestnut-collared longspurs feed to their nestlings are grasshoppers. Burrowing owls benefit from grasshoppers; although the adults usually feed small mammals to their young, when the young leave their burrows they capture large numbers of grasshoppers and other insects. Even

Under the right conditions a few species of grasshopper can become pests, particularly when large populations occur in areas of grazing or crops. Both federal and state agencies apply pesticides to control them. Photograph by Anson Eaglin, USDA APHIS.

such large mammals as coyotes prey on grasshoppers, and grasshoppers are eaten by people of many cultures.

Some grasshopper species are beneficial in that they help control unwanted vegetation. Turnbull's grasshopper (*Aeoloplides turnbulli*) is also called the Russian thistle grasshopper because it prefers Russian thistle—tumbleweed—and other weedy members of the goosefoot family.

Although grasshoppers are vital to the ecosystems where they live, some species can at certain times become pests, particularly if they move into areas where people are growing crops. Because of their pest potential in western grasslands, the U.S. Department of Agriculture's Animal Plant Health Inspection Service (APHIS) maintains a program to control grasshoppers and their close relative, the Mormon cricket (*Anabrus simplex*). In many years, APHIS and other federal and state agencies apply pesticides across hundreds of thousands of acres of both public and private lands in an effort to control these native insects. These toxic chemicals can be devastating to non-pest grasshopper species and to a great many other important insects, including bees and butterflies.

In fact, it was an APHIS proposal that led to grasshoppers again coming into focus for me in my early days at Xerces. The agency had plans to spray insecticides on up to twenty million acres of mostly public lands in Idaho.

Xerces joined with the Idaho Conservation League and other groups in suing APHIS. I provided an expert declaration on the potential impact of this spraying on pollinators and, because APHIS's initial proposal allowed spraying directly over some streams, on the major impact this could have on aquatic invertebrates. Ultimately, we resolved the lawsuit with an agreement that allowed APHIS to use only pelleted carbaryl bait, and that enforced buffers along all streams in the area, prohibiting applications adjacent to these waterways. APHIS was also required to limit application in proximity to areas with endangered species such as the Bruneau hot springsnail (*Pyrgulopsis bruneauensis*). Because of our efforts, bait was applied to just over twenty thousand acres, a tiny fraction of the area in the original plans.

While a wide variety of insecticides have been used to suppress grasshopper populations over the years, currently APHIS relies mostly on an insect growth regulator (diflubenzuron) and continues to use bait laced with carbaryl. Applied both on the ground and by air, these chemicals can harm a broad assortment of insects and other invertebrates. Aerial applications of diflubenzuron are especially concerning because of the potential of this insecticide to drift, sometimes over long distances.

Diflubenzuron prevents the formation of chitin, an important component of an insect's exoskeleton, interrupting its normal development. The chemical is lethal, even at extremely small quantities, to most insects in their larval stage. Butterflies, moths, bees, and beetles can all be affected, as can many aquatic insects that spend most of their life cycle as larvae. Mayflies, for instance, are adults out of the water for just a brief period, from less than a day to a few

The differential grasshopper can be found in weedy places, including in vacant lots and urban greenspaces. It is one of a few species that can be a pest. Photograph by Bryan E. Reynolds.

weeks; they spend the rest of their lives (sometimes more than a year) as larvae in streams and rivers. If drift from diflubenzuron enters these waters, it can disrupt the development of or kill mayflies and many other aquatic insects, as well as crustaceans, snails, and freshwater mussels.

Carbaryl inhibits the action of the enzyme acetylcholinesterase, which is an essential component of the nervous systems of insects, birds, fish, and mammals. It is known to be extremely toxic for terrestrial invertebrates (including butterflies), aquatic invertebrates, and fish. APHIS recently approved the use of a relatively new insecticide, chlorantraniliprole, which leads to paralysis by changing how muscles use calcium, and is considered to be of low toxicity to honey bees—although there is some conflicting evidence as to its degree of toxicity, and we are uneasy about its potential impact based on results from toxicological tests on bumble bees and butterflies. In the western United States, where populations of the western bumble bee have declined and those of the monarch butterfly have plummeted, the expanding use of chlorantraniliprole is of major concern.

The use of any of these chemicals to control native insects over wide areas should be a worry to all of us, as they can adversely affect a broad range of nontarget species that are food for wildlife, pollinate wildflowers, and help control the very "pests" that the chemicals are intended to suppress. Many natural enemies that normally regulate grasshopper populations are vulnerable to these insecticides, and disruption of their populations could result in outbreaks that are worse in decades to come.

Over the years, Xerces has commented on treatment programs on public lands in many western states. In many cases, though, this is a difficult

Found in most parts of the United States and southern Canada, the two-striped grasshopper feeds on both grasses and broadleaf plants. Photograph by Bryan E. Reynolds.

The Xerces Society's advocacy against extensive spraying of public lands to control grasshoppers has prevented streams from being sprayed and protected rangeland pollinators. Photograph by Greg Shine / BLM.

issue to work on, because grasshopper outbreaks are cyclical and geographically varied, which means that APHIS control programs are as well. Pesticide treatments may occur in Montana one year, and in Utah or Wyoming the next. On top of this, APHIS makes it difficult to track where it is proposing to use pesticides and where it has actually applied them. Our recent requests to APHIS for maps of its planned applications have met with resistance.

Thanks to the support of Xerces members and private foundations, we are now fortunate to have dedicated staffing to help educate the public and land managers about this issue and to advocate for protection of public rangelands and the wildlife they support. As with all of our efforts, we use a holistic conservation-science approach. We are working to understand grasshopper ecology and the potential risks of currently used insecticides, as well as which grasshopper-management methods minimize impacts to non-target species. We are also investigating possible options for managing grasshoppers with minimal or no pesticide use. Studies suggest that overgrazing may exacerbate grasshopper outbreaks, and leading researchers have questioned whether impacts on grasshoppers' natural enemies mean that periodic insecticide

The green-striped grasshopper has two color forms, one that is largely green and another that is brown, shown here. Photograph by Bryan E. Reynolds.

treatments actually impede control. Some researchers have pointed out that improving range conditions and increasing perennial grass and forb cover in western rangelands could boost the numbers of highly insectivorous birds, such as longspurs, meadowlarks, and grasshopper sparrows, that help to regulate grasshopper densities.

Xerces also effectively uses outreach and technical assistance to help restore and manage habitat with insects in mind. In the near future we will be presenting webinars and workshops to land managers and landowners, and working directly with agencies and individuals that want to explore alternatives to the current practice of large-scale use of toxic insecticides to suppress grasshoppers. We will also continue to advocate for more tolerance of these native insects on public lands. Allowing intensive insecticide use over hundreds of thousands of acres of public and private lands across the west with minimal oversight or transparency is just not acceptable, and we will work with partners to seek legal and policy remedies.

When I was a kid, I found grasshoppers to be both engaging and beautiful. These animals may not excite and inspire people the way that bees and butterflies do, but they are equally important. The control measures currently used are blunt instruments that can harm many of our other important insects on which humans depend for such ecosystem services as pollination, as well as the animals that rely on those insects for sustenance. Grasshoppers and their habitats deserve to be protected, and we are committed to continuing our efforts on their behalf.

Ecologist Scott Black is the executive director of the Xerces Society, which under his leadership has become the premier invertebrate-conservation organization in North America.

Robert Michael Pyle, Founder

In our fiftieth year, who should be recognized for significant contributions to our conservation work other than our founder, Robert Michael Pyle? Bob, as he's known to many, is a remarkable individual whose work has touched and inspired people across the globe.

Bob may be best known as a writer, speaker, and teacher. He has published more than twenty books, in which he blends science, nature observation, poetry, and personal experience. He travels widely on book tours, as well as to speak at conferences and field days, spreading his enthusiasm for butterflies and the natural world. Bob is also a scientist with many academic papers to his name, and an ardent conservationist who has campaigned to protect at-risk species and the places they live. He was founding chair of the International Union for Conservation of Nature's Lepidoptera Specialist Group and co-author of the first IUCN Red Data Book for invertebrates, landmark work that led to an honorary fellowship with the Royal Entomological Society.

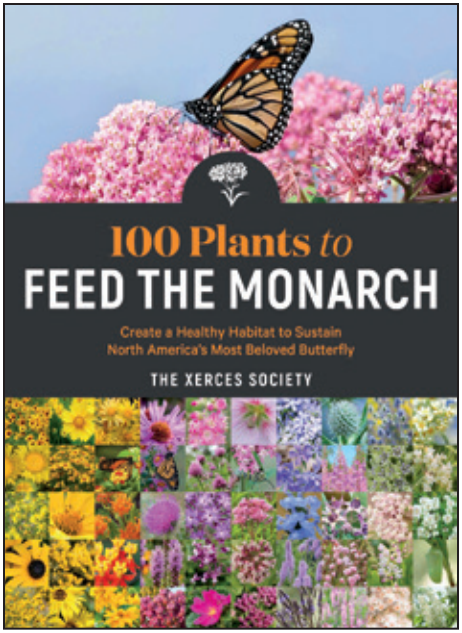
In 1971, while in England thanks to a Fulbright Scholarship, Bob attended a lecture in London about the large blue, which was on the brink of disappearing from Britain. Recalling that America had itself already lost such a butterfly, the Xerces blue, he set about forming a butterfly conservation organization, the Xerces Society. Bob soon returned to the United States, and under his leadership Xerces members advocated for at-risk species, created fact sheets, published a journal, *Atala*, and started a black-and-white newsletter, the first incarnation of *Wings*. In 1975, Xerces launched the Fourth of July Butterfly Count; in 1984, it initiated the Monarch Project. At that point the society realized that it needed paid staff to achieve its goals, and Bob helped guide the transition toward a professionally run organization.

Although Bob now has a lower-profile role, he has remained involved in the Xerces Society for its entire history. He serves as a scientific advisor and a reviewer of *Wings* articles. He is also a Xerces booster, talking about the Society wherever he goes—and he proudly carries Xerces business cards that state simply "Founder."

INVERTEBRATE NOTES

A New Book from Xerces: *100 Plants to Feed the Monarch*

We are excited to announce the release of our new book, *100 Plants to Feed the Monarch*. The plight of the monarch has captured public attention and led to widespread interest in helping to save its dwindling populations. In this in-depth portrait of the monarch butterfly—covering its life cycle, its remarkable relationship with milkweed, its extraordinary migration, and the threats it now faces due to habitat loss and climate change—detailed instructions on how to design and create monarch-friendly landscapes are enriched by guidance for observing and understanding the butterfly's behavior and habits.



This new volume is a great addition to a growing collection of books written by Xerces staff members. It is a direct partner to *100 Plants to Feed the Bees*, and either of those would make a fine companion to two of our previous books, *Attracting Native Pollinators* and *Gardening for Butterflies*. Our fifth book is *Farming with Native Beneficial Insects*. All of these volumes result from a highly productive partnership with two publishers, Storey Publishing and Timber Press, both part of the Workman group.

Declining Insect Populations and What We Can Do

Between them, a pair of recently published journal articles highlight the severity of insect declines, while also offering steps we can take to reverse them.

Writing in *Science*, Matt Forister (University of Nevada, Reno) and coauthors report on the alarming loss of butterflies across the American West. The authors found that the number of butterflies seen each year fell by 1.6 percent, a pace consistent with those reported for insect groups in other parts of the world. The decline was estimated using data from seventy-two locations with at least ten years of data per location; the average length of time studying individual sites was twenty-one years, and the total time span encompassed is forty-two years (1977 through 2018). More than 260 butterfly species

were represented in the data.

To identify the most influential predictors for these pervasive losses, the researchers considered changes in land use as well as climate measures. They report that rising autumn temperatures may be the biggest factor, advancing our understanding of the impacts of climate change. The authors suggest that conservation efforts should not focus on individual species but rather on suites of species with similar habitat characteristics or host-plant associations. They also note that protection of open spaces is not enough to counter insect declines without steps to limit the effects of climate change. (Forister et al, 2021, "Fewer butterflies seen by community scientists across the warming and drying landscapes of the American West," *Science*.)

The second paper was published in the *Proceedings of the National Academy of Sciences* by Akito Kawahara and a group of co-authors that includes Xerces Society executive director Scott Black. By proposing eight simple actions that many people can undertake on their own, the authors show that no matter where you live, what you do, or what your background is, you can help slow the rate of loss in insect populations.

Among the eight suggestions are that people should convert 10 percent of their lawns to pollinator habitat. With more than forty million acres of lawn or turf grass in the United States alone, this change would add four million acres for bees, butterflies, and birds. How about replacing some of your nonnative ornamental plants with native plants? Evidence shows that many different kinds of insects rely on native plants as a food source or for nesting sites. Because these insects are in turn food for birds and other wildlife, native plants indirectly attract many vertebrates. For example, almost all songbirds feed insects to their young, and declines in suburban backyard birds have been linked to an increased number of nonnative plants.

Even such common species as the silvery blue are in decline. Photograph by Candace Fallon.

There is also a need to cut back on pesticides, particularly insecticides, which kill even beneficial insects—and there is no need to use insecticides in a garden setting. Lights harm night-flying insects such as moths and fireflies, and adding motion sensors and using red-colored lights are ways you can help.

The paper also details ways to raise awareness of the importance of insects for all age groups. It has been downloaded more than fifty thousand times since it was published in January of this year. (Kawahara et al, 2021, "Eight simple actions that individuals can take to save insects from global declines." *Proceedings of the National Academy of Sciences*.)

STAFF PROFILE

Melody Mackey Allen, Executive Director, 1984 to 2000

What got you interested in insects? In the 1970s and early '80s I worked at the Nature Conservancy, where among other things I managed a protection project at Eight Dollar Mountain in southern Oregon. That landscape was home to assemblages of very rare and endangered plants, all of which were dependent on equally rare and endangered insects. I was hooked!

How did you hear of the Xerces Society? Xerces Society founder Bob Pyle knew me from my tenure at the Conservancy, and suggested that Xerces—then an all-volunteer organization—hire me to direct the Monarch Project, dependent on my securing funding. I was able to do so, with tremendous help from my longtime mentor in the conservation field, Spencer Beebe, who had hired me at TNC and who went on to found and direct Ecotrust. Success in growing the Monarch Project led to my becoming executive director of the Xerces Society.

What stays with you from your work here? My years with Xerces were the most rewarding and energizing of my nearly four decades working in conservation. It was exhilarating to take on the project of moving beyond Xerces' butterfly-enthusiast origins and beginning to address difficult conservation challenges across multiple invertebrate groups.

Early in that process we were able to mount only small-scale or somewhat obscure conservation efforts because of the modest funding available in what was then the mostly uncharted territory of global invertebrate conservation. Even so, we received incredibly positive responses in support of Xerces pursuing a broad invertebrate-conservation agenda. That was hugely inspiring.

The key was having such people as E. O. Wilson, Miriam Rothschild, Tom Eisner, and Claire Kremen, along with other significant scientists and the Smithsonian Institution, embrace what we were doing. It was the dedicated support and counsel of these preeminent invertebrate researchers that made possible Xerces' successes—and ultimately made it appealing to Scott Black to assume the helm.

Now, for me, it has been a pure joy to watch him grow the Xerces Society over the past twenty years, taking it to a level beyond what anyone imagined.

Xerces Engages in Monarch Conservation Across North America

There has been a lot of news about monarchs over the last six months, and, unfortunately, most of it has not been good. During the 2020 Western Monarch Thanksgiving Count, volunteers scoured hundreds of overwintering sites from northern California to the Mexico border and recorded fewer than two thousand monarchs, a decline of more than 99.9 percent since the 1980s. Monarchs east of the Rocky Mountains are also suffering, although their situation is not as critical. The eastern population has decreased by more than 80 percent, and the World Wildlife Fund Mexico reported continued declines at Mexican overwintering sites this winter.

These awful circumstances are compounded by the fact that the U.S. Fish and Wildlife Service has decided that although the monarch butterfly meets the criteria for Endangered Species Act protection, it is not a sufficiently high priority and so will not be protected.

The situation may seem bleak, but the Xerces Society is not giving up. In the western states our conservation efforts focus on the places where monarchs are most vulnerable. We are protecting overwintering sites and restoring habitat in early-season breeding areas, and also increasing public participation in habitat restoration through initiatives such as our habitat kits.

We have pollinator specialists across the Midwest and Northeast who are collaborating with local communities to create habitat and reduce pesticide use. Our goal is to work with farmers, park managers, gardeners, and others to plant millions of milkweed and nectar plants in order to provide high-

Xerces staff members are active across the United States in protecting the monarch butterfly. Photograph by Jennifer Hopwood.

value habitat across monarch breeding areas and to protect them from pesticides. These plants will help not just monarchs, but also many other species of butterflies and bees that are at risk.

We are working with Senator Jeff Merkley and Congressmen Jimmy Panetta and Salud Carbajal to reintroduce the Monarch Action, Recovery, and Conservation of Habitat (MONARCH) Act of 2021, which would provide $25 million per year for five years in grants for conservation of western monarchs, and the Monarch and Pollinator Highway Act, which would provide $5 million each for fiscal years 2022 through 2028 for grants to benefit pollinators on roadside and highway rights-of-way.

Working State by State to Protect Invertebrates

An unexpected benefit from the pandemic has been that state legislatures have been conducting business online. The widespread use of video conferencing has made it much easier for Xerces staff to help craft legislation and provide expert testimony, no matter the state.

In Maine, we've been part of a team working on a bill to halt the use of neonicotinoids in residential settings. In Nebraska, Illinois, and Minnesota, Xerces staff members are helping with bills that respond to the very real risks posed by the disposal of pesticide-treated seed. In Oregon, we're part of an effort to have a stretch of the Williamson River designated as Wild and Scenic, which will protect habitat for three species of freshwater mussels. In Washington state, members of Xerces staff participated in

A Wild and Scenic designation was requested for the Williamson River in southern Oregon to protect freshwater mussels. Photograph by the Xerces Society / Emilie Blevins.

Support Xerces Through our Online Gift Center

Support conservation and spread the word about the importance of pollinators by displaying this sign in your yard. Unique to the Xerces Society, this durable and sturdy sign is designed for outdoor use. You can place it in your garden, on your farm, or in a park, or give it to a friend.

> *"I wanted to tell you how much I love it! It is absolutely beautiful and right on the mark in every way—size, number of words, colors, selection of pollinators and plants. I will be proud to display it in my garden."*

You can find the pollinator habitat yard sign—in either English or Spanish—along with *100 Plants to Feed the Monarch* and our other books, available for a tax-deductible donation in our online gift center: xerces.org/gifts.

a task force that provided the legislature with recommendations for protecting pollinators. The resulting bill includes multiple important provisions, such as restricting the use of nonnative commercial bumble bees and promoting pollinator habitat.

Our pesticide team has also initiated the Bee-Safe Nursery Plants campaign, with the aim of helping people figure out whether the plants they want are free of pesticides and encouraging garden centers to reduce their reliance on pesticides. We've released two new fact sheets, *Buying Bee-Safe Plants* and *Offering Bee-Safe Plants: A Guide for Nurseries*, and presented an online workshop. This led up to two days of action in March and April, during which individuals went to local garden centers to talk directly with their staff about pollinator health and pesticide reduction.

Xerces Introduces Two New Board Members

Throughout its history, the Xerces Society has been fortunate to have remarkable people serve on its board of directors, and our current board is no exception. We are proud to announce two new members who will help the organization meet the challenges of biodiversity loss, climate change, and more.

Betsy López-Wagner is principal and chief strategist at López-Wagner Strategies, an equitable communications agency working with mission-driven individuals, organizations, and companies to develop—and execute—equitable and inclusive strategies and to enhance their communications abilities to strengthen collective impact for social good. Her expertise is in environmental, bilingual, and equitable communications, media relations, and campaigns, as well as inclusive grantmaking with a racial justice lens. She is a DEI practitioner and facilitator. Additionally, she serves as the strategic communications partner for ALRAS Digital.

Betsy has worked alongside attorneys, lobbyists, and coalition partners to safeguard the health of communities, protect clean air and water, fight arctic drilling, and protect the oceans' resources. And she's co-devised strategies alongside advocates and grassroots activists to ensure that their power is seen, heard, and felt from regional to national levels by developing a culture of storytelling that elevates authentic personal narratives to emotionally connect with audiences and inspire action.

She is the parent of a six-year-old lepidopterist and climate activist, and the partner of a stay-at-home dad, gardener, and environmental education advocate; together they farm. Their family hosts Amigos for Monarchs, an annual pollinator project providing seed kits to loved ones and perfect strangers across the nation every spring.

Jay Withgott is a science writer with a background in research and teaching who authors leading textbooks in environmental science. With college-level books in their sixth and seventh editions and other versions for high-school, international, and digital audiences, Jay

works to keep pace with a rapidly changing field and constantly seeks to develop new and better ways to help students learn about the world around them.

To make science accessible and engaging for all readers, Jay draws on his academic experience in ecology and evolutionary biology, his professional grounding as a reporter and editor for daily newspapers, and his personal passion as a naturalist. A lifelong birder, Jay notes that his love of insects was sparked in early childhood by raising monarchs and black swallowtails from his family's garden.

He holds degrees from Yale University, the University of Arkansas, and the University of Arizona. He and his wife live in Portland, Oregon, where the Xerces pollinator habitat sign in their front yard has inspired many conversations—and perhaps a few conversions.

Conservation Assessments Published for North American Fireflies

In March, more than 120 status assessments of North American fireflies were published on the IUCN Red List of Threatened Species, the result of a collaboration between Xerces scientists and researchers from the Albuquerque BioPark and the IUCN Firefly Specialist Group. The team spent many months gathering information on fireflies in the United States and Canada to be able to assess their extinction risk.

At this point 77 percent of the firefly species in these two countries have been evaluated. Of those that have been assessed, fourteen are threatened with extinction (categorized as Endangered or Vulnerable). Although the threats vary for each species, the main drivers of decline appear to be habitat loss and degradation, light pollution, and drought and sea-level rise associated with climate change.

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For information about membership and about our conservation programs for native pollinators, endangered species, and aquatic invertebrates, as well as our efforts to reduce the impacts of pesticides, please visit our website.

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THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

xerces.org toll-free 855-232-6639

Distinctive markings make the painted grasshopper instantly recognizable. Its colors gave rise to an alternate name, barber-pole grasshopper. Photograph by Bryan E. Reynolds.

A $35 per year Xerces Society membership includes a subscription to *Wings*. Please join, renew, or donate at xerces.org/donate.

On the cover: The plains lubber grasshopper is a large, flightless species found in the central United States and northern Mexico. Photograph by Bryan E. Reynolds.

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