

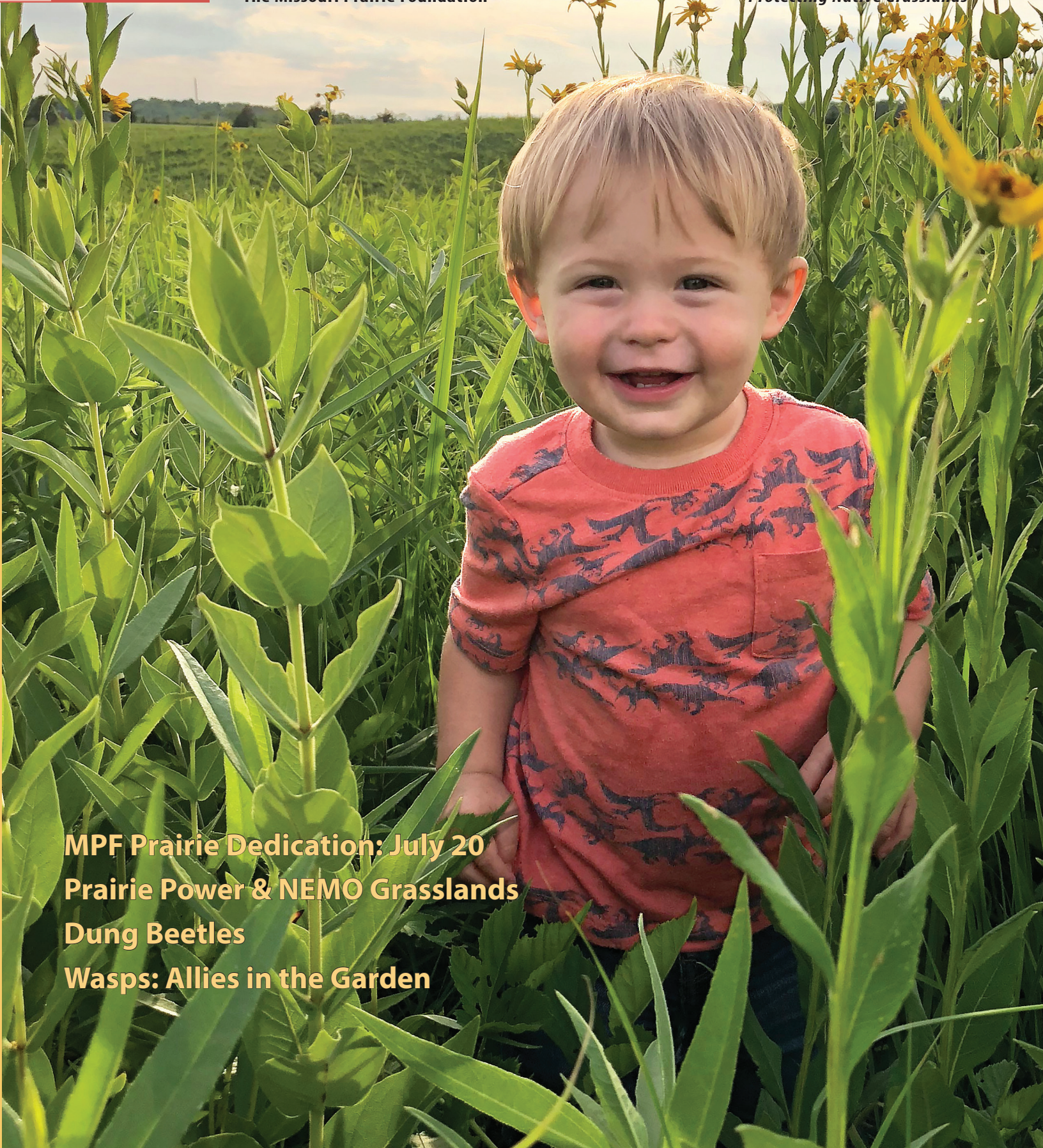


SUMMER
2019
VOLUME 40
NUMBER 2

Missouri Prairie Journal

The Missouri Prairie Foundation

Protecting Native Grasslands



MPF Prairie Dedication: July 20
Prairie Power & NEMO Grasslands
Dung Beetles
Wasps: Allies in the Garden

Message from the President

June and July are great months to get the family outdoors and visit prairies. The wildflowers are blooming, birds are singing and nesting, and the prairies are in their full glory. After a hard winter and cool wet spring, it is time to enjoy some summertime activities outdoors. I hope you can take the opportunity to relax, explore, and appreciate our well managed Missouri Prairie Foundation (MPF) prairies.

This issue of the *Missouri Prairie Journal* features an article on dung beetles and their role in prairie ecology. I remember as a kid growing up on the farm, that we had these little beetles in abundance in our cattle feedlot. We called them tumblebugs because they roll dung balls with their hind legs (and backwards) into their nests in the ground. Many years later as our farming practices changed and we no longer had cattle, they all disappeared. That was not alarming at the time, but now we are just beginning to understand the importance of these insects and thousands of others to the overall ecology and agricultural health of our world. Go to page 18 to read the article on these “pooper scoopers” and learn about these fascinating little beetles.

Many people make MPF the successful organization it is, from contributing authors to this magazine, to members and other donors, board members, staff, and dedicated volunteers. This past winter and spring, volunteers helped with tabling events, plant sales, prescribed burning, merchandise sales, workshops, and many other occasions and functions. I try to get to as many of these activities as possible. When I interact with these volunteers, it is clear to me that they are knowledgeable, dedicated, and enthusiastic MPF members who love telling people about our work and the need to conserve a disappearing habitat. On behalf of our dedicated Board of Directors and staff, I want to thank all our volunteers for their role in making MPF a great organization.

We have many upcoming events planned in the next few months, including the dedication of our newest prairie acquisition in Lawrence County on July 20 and our Annual Dinner & Silent Auction on August 10—find details on these and many other events on the back cover. I look forward to seeing you there.

Please know that your support is extremely important to MPF. Your membership and donations make our work possible. If you are reading this and you are not a member, or your membership expired, please join or renew today. Call us at 888-843-6739 if you need help.

Happy Trails,
David Young



Many thanks to hard-working MPF volunteers who spent long hours assisting with MPF prescribed burns this past burn season, including the cheerful crew at Snowball Hill Prairie in early February, above left. MPF is grateful to all dedicated volunteers, including those who worked at the MPF and Grow Native! booths at St. Louis Earth Day, above right, and at plant sales including the May 18 MPF Native Plant Sale (at top) in Kansas City, with MPF President David Young pictured center back.



The mission of the Missouri Prairie Foundation (MPF) is to protect and restore prairie and other native grassland communities through acquisition, management, education, and research. MPF also promotes the use of native plants through its Grow Native! program and supports the identification and control of invasive plant species through its Missouri Invasive Plant Task Force.

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Summer

2019 VOLUME 40, NUMBER 2



ISAAC COY

12: Neighbors helping neighbors improve grassland habitat in NEMO



FRANK OBERLE

8: Methane is slated for production from prairie plantings like this in northern Missouri.



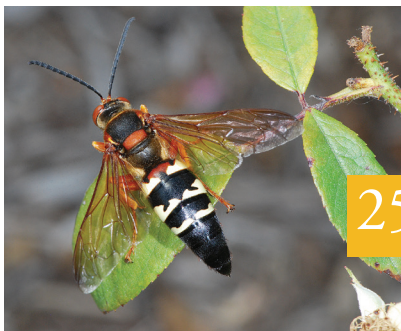
PAUL COX

15: What was the role of indigenous people in Missouri's fire history?



RACHEL STONE

18: Dung beetles have dirty jobs, but they are undeniably champions of grassland health.



ED STEVAK

25: Female cicada killer wasps (*Sphecius speciosus*) hunt cicadas. She takes one to her burrow to lay an egg on top of it. The egg hatches and the larva then feeds on the still fresh cicada. It remains in that burrow through the winter until the following year, emerging as an adult to start the cycle again.

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The *Missouri Prairie Journal* is mailed to Missouri Prairie Foundation members as a benefit of membership. Please contact the editor if you have questions about or ideas for content.

Membership dues to MPF may be contributed once a year or in monthly increments. To become a member, to renew, or to give a free gift membership when you renew, send a check to

MEMBERSHIP ADDRESS:

Missouri Prairie Foundation
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P.O. Box 856
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or become a member online at
www.moprairie.org

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Questions about your membership or donation? Contact Kelley Klor, who administers MPF's membership database, at info@moprairie.org.

On the cover:

Three-year old Sawyer Coy, son of Zack and Casey Coy, enjoying a prairie in northeastern Missouri (NEMO). Read about his dad's work to improve habitat in NEMO on page 12, and about Roeslein Alternative Energy's next phase of development, involving prairie plantings on a massive scale, also in the region, on page 8. Don't miss the MPF Annual Dinner on August 10, where speaker John Murphy will speak about prairie remnants and reconstructions in NEMO. See back cover for details. Photo by Zack Coy





Missouri Prairie Foundation

YOU MAKE IT POSSIBLE: Conservation, Education, and Outreach

The Missouri Prairie Foundation's work to protect prairie and educate about the importance of prairie and native plants is critical. Thanks to you, our loyal members and other supporters, we are able to sustain and grow important prairie acquisition and stewardship as well as outreach and education endeavors.

MPF's presence at partner events, festivals, and trade shows expands our reach to new audiences. New partnerships, as with Missouri's Future Farmers of America (FFA) chapters, help us broadcast the prairie conservation message to more people as well.

Thanks to a 2019 matching gift from Susan Lordi Marker for MPF Outreach & Education, you can help us continue to spread the important message of prairie conservation and share more information about the many benefits of native plants. Please see page 7 for details on how you can participate in this special fundraising opportunity.

We look forward to seeing members and other prairie supporters at the MPF Annual Dinner on August 10, 2019 in Jefferson City, as well as many other events coming up this summer and fall.

Please enjoy this summer 2019 update, featuring highlights of our work—all made possible by you—as well as the feature articles in this issue.

—Carol Davit, Executive Director and Missouri Prairie Journal editor



CAROL DAVIT



JIM PHILLIPS

Missouri Prairie Foundation Joins Missouri Bicentennial Alliance

In January 2019, MPF became a member of the Missouri Bicentennial Alliance. Up to and throughout the bicentennial year of 2021, this coalition of government agencies and nonprofit organizations is creating timely projects and events for the people of Missouri as a means of increasing understanding of Missouri's history and culture and its role in national and world history and affairs.



At the core of MPF's mission is the protection of original, unplowed prairie, which was abundant as recently as our year of statehood, but is now reduced to less than one-half of one percent of its original extent. The remnants of this once vast ecosystem that figures so dramatically into the natural, historical, and economic history of Missouri are still vital habitat for prairie wildlife, still very much part of the fabric of the state's landscape, and must continue to be protected for the benefit of all Missourians.

As a regular part of its operations, MPF will be planning many events to connect citizens to Missouri's prairie legacy, and these activities take on enriched meaning in the context of the state's auspicious upcoming anniversary. To learn more about the Missouri Bicentennial Alliance, visit <https://missouri2021.org>.

Agriculture teacher Aaron Medsker, of DeKalb High School in northwestern MO, at top, with a native plant kit provided by the Missouri Prairie Foundation (MPF), made available through grant funding from the Natural Resources Conservation Service. Medsker was one of 38 teachers with FFA chapters who requested a kit of 43 prairie and other native plant species to establish plots at their schools, as FFA chapter members at Stockton High School, pictured above, are doing with the kit they received. These native plant plots—along with study guides developed by MPF—are intended to help students identify the plants, observe their use by pollinators, and learn how to harvest their seed. The ultimate goal of this project is to encourage agriculture students to incorporate native plants on farms—for their ecological benefits as well as to develop specialty crops of native seed. The kits were delivered to teachers at the statewide FFA convention in Columbia on April 25, 2019.

Prairie Stewardship

MPF's prairie stewardship is made possible thanks to the financial contributions of our loyal members and other generous supporters. Here are some highlights of recent stewardship and restoration accomplishments so far in 2019, carried out or overseen by MPF's Director of Prairie Management Jerod Huebner.

- Since January 1, MPF burned a total of 747 acres on portions of MPF's Gayfeather, La Petite Gemme, Snowball, Stilwell, Schwartz, Friendly, Drovers', Stark, Pleasant Run Creek, and Lattner prairies. MPF also carried out a prescribed burn at the Ozark Regional Land Trust's Woods Prairie, at a private prairie in Pettis County, and at the Joplin Urban Prairie site, the ownership of which has now been transferred, per prior agreement, from MPF to the City of Joplin. Thanks to Huebner's excellent

planning and help from volunteers, burns on all MPF remnant prairies for the 2018/2019 burn season were completed by March 1, 2019.

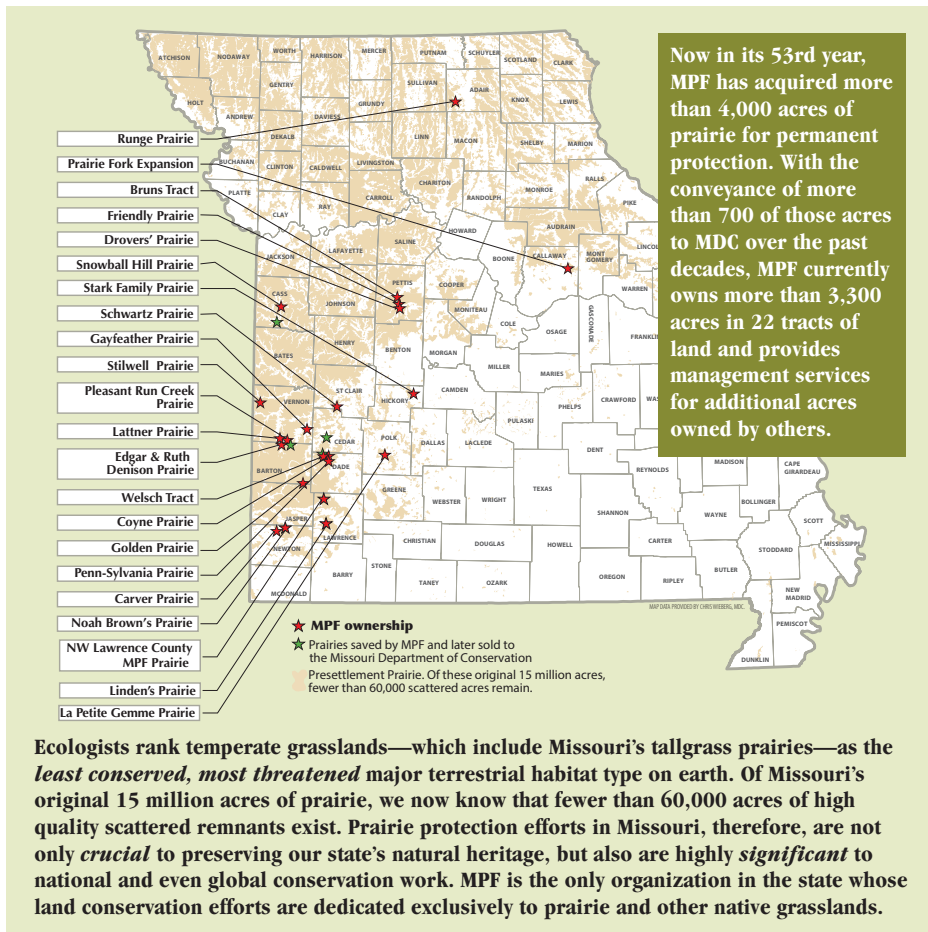
- Using a hammer mill (equipment used to clean/free seeds from pods) purchased in 2018, Huebner cleaned more than 200 pounds of bulk seed—harvested at MPF prairies with a flail-vac seed harvester—and broadcast it at prairie reconstruction sites totaling 155 acres at Pleasant Run Creek, Snowball Hill, Schwartz, and Carver prairies, as well as at city park property in Joplin and a private prairie in Pettis County. Huebner also cleaned hand-collected seed for plug propagation and eventual transplanting on several MPF prairie reconstruction sites.
- Huebner has completed initial construction of a gravel parking lot at Snowball Hill Prairie. The parking lot, on a non-prairie portion of the property, will accommodate visitors to this original prairie gem 35 miles south of Kansas City.

- Huebner and volunteer Scott Lenharth scouted MPF's Penn-Sylvania, Coyne, Welsch, Stilwell, Linden's, Carver, Noah Brown's, Pleasant Run Creek, Denison, Lattner, Gayfeather, and Snowball Hill Prairies for invasive plants, spot treating poison hemlock, multiflora rose, and non-native thistles.



JEROD HUEBNER PHOTOS

Stewardship and restoration snapshots, since January 2019, from top: broadcasting prairie seed at the Snowball Hill Prairie reconstruction site, a prescribed burn at MPF's La Petite Gemme Prairie, and a non-native thistle at Snowball Hill Prairie spot-sprayed with herbicide and blue dye.



giveSTLDay.org
 POWERED BY THE St. Louis Community Foundation

Many Thanks, Give St. Louis Day Donors!

MPF is grateful to an anonymous donor who provided a \$5,000 Give St. Louis Day matching gift, and to all other donors whose gifts exceeded this amount by \$611. A total of \$10,611 was raised for MPF on May 1 during the Give St. Louis Day of online charitable giving. Many thanks to all who contributed to MPF during Give St. Louis Day 2019.

Outreach & Education

Since the beginning of 2019, MPF has had a presence at numerous events across the state, and carried out many education and outreach activities. Here are a few highlights:

- MPF organized a lecture, free and open to the public, on prairie soil mycorrhizal fungi, presented by Dr. Alice Tipton, January 26 in Columbia, attended by more than 60 people.
- Staff and board members delivered presentations on prairie during the Missouri Land Trust workshop at the MO Natural Resources Conference, a Gateway Professional Horticulturist Association meeting in St. Louis, and the Lincoln/Pike County Women in Agriculture group.
- MPF enjoyed the following media coverage this spring: MPF Executive Director Carol Davit was interviewed by KCUR public radio in Kansas City



JEROD HUEBNER

On May 3, teachers and students from the Wonders of the Ozarks Learning Facility (WOLF) School in Springfield, MO went on a field trip to MPF's La Petite Gemme Prairie Natural Area near Bolivar, MO. With teachers, MPF members and WOLF school volunteers Bob and Barb Kipfer, and MPF Director of Prairie Management Jerod Huebner, students studied insects, plant identification and diversity, and had fun observing amphibians, reptiles, and crayfish that live in tunnels in prairie soil.

- in April on the importance of prairie. The interview was featured in Google news and other media outlets. On May 16, MPF Vice President of Science & Management Bruce Schuette was interviewed on FOX2 news in St. Louis about National Prairie Day and the importance of prairie, and on May 18, MPF Director of Prairie Management Jerod Huebner was featured on a news segment of KY3 television in Springfield, filmed at Penn-Sylvania Prairie and highlighting the world-record breaking plant diversity of the prairie.
- MPF engaged in important advocacy this spring: In April, MPF signed on to a letter from the National Wildlife Federation to the USDA in support of prioritizing native plants in federal cost-share conservation practices, and helped recruit other signatories from Missouri. The National Wildlife Federation issued a news release on the letter that included a quote from MPF Executive Director Carol Davit. On May 1, Davit testified at the Missouri State Capitol in opposition to a proposed Constitutional Amendment requiring the one-eighth of one percent Conservation Sales Tax to be placed on the ballot, citing overwhelming citizen support for conservation programs, the positive economic impact to the state from the tax, and the paucity of public support for the proposed amendment.
 - For the third year in a row, Director of Prairie Management Jerod Huebner mentored hunters at Carver Prairie during spring turkey season, in partnership with the National Wild Turkey Federation. On April 6 and 7, two youth first-time hunters called in a tom, but were unsuccessful in harvesting a bird. They did, however, learn about turkey and prairie biology during the weekend.
 - MPF awarded five \$800 Prairie Garden Grants to the Watershed Committee of the Ozarks, The Terrace Retirement Community in Columbia, Holy Cross Lutheran Church in St. Louis, City of Branson—City Hall Project, the Farm School at Gibbs Road in Kansas City; and one \$715 grant to the Kansas State Research and Extension Master Naturalist Program.



CAROL DAVIT PHOTOS

An estimated 45,000 people attended the St. Louis Earth Day Festival in Forest Park on April 27–28, where MPF staff and volunteers interacted with visitors at the MPF and Grow Native! booths, featuring educational resources, games, plants, and merchandise for sale. Many thanks to volunteer Linda Ballard, in turquoise shirt, above, who offered a \$250 Earth Day weekend donation challenge to visitors—more than \$500 in donations were received for MPF. Festival-goers learned about the depth of prairie roots, top, with a root game conceived by Marypat Ehlemann of St. Louis Wild Ones and constructed by MPF Outreach & Education Coordinator Felicia Ammann. Since the beginning of 2019, staff and volunteers have also had booths at Shaw Nature Reserve's annual native plant sale, a beekeepers conference, Maritz Corporation's Green Vendor Fair, Missouri Tree Farm Conference, Pheasants Forever & Quail Forever statewide meeting, Conservation Federation of Missouri's annual convention, Arrow Rock's Birds & Bees Festival, and the Missouri Natural Resources Conference.

- Hikers visited Carver Prairie in Joplin for a spring wildflower walk in early May with Director of Prairie Management Jerod Huebner.
- MPF organized native plant sales in Columbia, Jefferson City, Kansas City, and Valley Park, where Grow Native! professional members sold native trees, shrubs, vines, wildflowers, grasses, and sedges, donating a percentage of sale proceeds to benefit MPF or its Grow Native! program.

Prairie Outreach & Education \$18,000 Match Gift from Susan Lordi Marker



DENNIS MARKER

MPF member Susan Lordi Marker invites all prairie supporters to make a gift to support MPF's outreach and education work, and will match all gifts to a total of \$18,000 by the end of 2019.

MPF carries out a robust outreach and education program—offering hikes, workshops, presentations, and other outreach activities—to help introduce more people to the importance of prairie and benefits of native plants. MPF's *Missouri Prairie Journal*, in continuous publication since 1979, fills an important role in the conservation community by sharing results of prairie research and the ecological importance of prairie and native plants. Gifts in 2019 to support MPF's outreach & education endeavors will help fund MPF's outreach, research, education, and Grow Native! programming. Thanks to a generous match gift from Susan Lordi Marker, all gifts of any amount will be matched to a total of \$18,000.

"MPF does wonderful work protecting original prairie," said Lordi Marker, "and MPF's outreach and education is extremely important to help people understand the importance of prairie protection and native plants. Please join me in supporting MPF so the organization can continue and expand its active outreach and education program."

To make a gift to support MPF's outreach and education, please send a check to: Missouri Prairie Foundation, c/o Bank of Missouri, P.O. Box 856, Mexico, MO 65265-0856, and write "outreach & education" on the memo line, or make a donation online, selecting the "Susan Lordi Marker Outreach & Education Match" option, at www.moprairie.org.



Keeping Nature Near®

PROGRAM UPDATE

MPF's Grow Native! native plant education and marketing program has carried out many successful activities so far this year, and continues to expand with more than 150 Grow Native! professional members throughout the lower Midwest. Grow Native! also houses the Missouri Invasive Plant Task Force (MoIP), a multi-agency, multi-disciplinary group of professionals working to make early detection and control of invasive plants a statewide priority.

Some highlights of Grow Native! program activity since January 1 are as follows:

- Two "Mingle with Native Plant Professionals" gatherings took place in St. Louis and Kansas City where Grow Native! professional members met with home gardeners to discuss all things native.
- Grow Native! program sponsor Bellefontaine Cemetery in St. Louis hosted a Grow Native! Native Tree Walk; more native walks at Bellefontaine are planned for summer and fall.
- Volunteers and/or staff provided educational materials at First Lady Parson's Roots and Blossoms Garden Party at the Governor's Mansion; the Kansas City Native Plant Initiative's "Meet the Experts" event and several KCNPI workshops; Conservation Day at the Capitol; and other partner meetings and events.
- At the Missouri Natural Resources conference, MPF Executive Director Carol Davit spoke at and moderated an Invasive Species workshop where MoIP member Dr. Quinn Long unveiled the group's Statewide Invasive Plant Assessment—the first of its kind in the state. Staff also gave presentations on native and invasive plants at the Missouri Tree Farm Conference, Western Landscape & Nursery Association conference, the Missouri Parks & Recreation Association Conference,



NATE KEENER

On March 22, the Grow Native! Southwestern Illinois committee organized a *Native by Design: Layered Landscapes* workshop focusing on plant community design with natives, soil health, and local projects. More than 250 landscape professionals and home gardeners learned from seven speakers, including keynotes from Thomas Rainer, pictured here, and Scott Peterson. More Grow Native! workshops in Albany, Monett, and Springfield, MO are planned for summer.

Jefferson City Rotary Club, Master Gardeners of Kansas City, and Illinois Master Gardeners.

- In April, as part of its 2019 callery pear awareness campaign, MoIP partnered with Grow Native! professional member Forest ReLeaf of Missouri on a callery pear "buyback" program, offering residents a free native tree in exchange for a photo of themselves with a cut down callery pear, to reduce the sources of invasive callery pears. The campaign reached more than 120,000 people via social media, and the buyback program was featured on St. Louis television and radio stations.

A new Did You Know Fact Sheet from Grow Native! features native plants that support insects important for pollinating fruits and vegetables on farms and in gardens. The two-sided publication is available for free download at grownative.org.





RAE and Smithfield Foods have created a joint venture called Monarch Bioenergy to produce renewable natural gas from swine manure.

PRAIRIE POWER: Roeslein Alternative Energy Moves Toward Horizon 2

by Brandon Butler

Roeslein Alternative Energy (RAE) is through its initial phase as a startup company and is now tackling the challenge of a startup's second phase—growth. With renewable natural gas (RNG) production underway from the anaerobic digestion of animal waste, RAE continues to look to the future and is implementing the plan for Horizon 2, which focuses on RNG production from the digestion of plant biomass from prairie plantings.

Conservation interests are diverse among the six million of us who call Missouri home. This fact became clear to me during the five years I served as Executive Director of the Conservation Federation of Missouri. Primarily a sportsman when I arrived in 2014, the education I received from countless leaders of natural resource organizations, like the Missouri Prairie Foundation, provided an incredible opportunity to learn about conservation initiatives taking place across the state, thus changing my mentality from that of a mostly consumptive user to one of a landscape steward. Yet, nothing moved me more during my tenure than the story of Roeslein Alternative Energy (RAE).

RAE is a renewable energy company with three areas of focus: energy production, ecological services, and wildlife benefits. The company offers a market-based solution to improve our environment by producing a renewable natural

gas (RNG) used mainly to power transportation vehicles, but also many other applications. In partnership with Smithfield Foods, RAE converts animal waste through a process called anaerobic digestion into a clean energy biogas. This process produces a valuable product while stopping a highly potent greenhouse gas from entering our atmosphere and contributing to climate change. RAE will soon be using the same process to convert biomass from a diversity of plants from prairie plantings to biogas.

The RAE model also brings numerous ecological services to our landscape that benefit mankind and wildlife. RAE has a vision of restoring 30 million acres of native prairie plants to marginal lands over the next 30 years. This will be accomplished by converting highly erodible lands to native prairie plantings instead of row crops, instituting cover crop programs on agricultural land, installing riparian buffers at

river and stream banks, and planting contour native plant buffer strips to absorb rainfall and fertilizer runoff. All of these landscape improvements will significantly curb soil erosion and nutrient load in streams.

As my knowledge of issues surrounding pollinators, clean water, healthy soil, sustainable agriculture, and climate change grew, I became increasingly enthralled with RAE CEO and Missouri Prairie Foundation member Rudi Roeslein's vision for renewable natural gas production from the digestion of livestock waste and prairie plant biomass. The resulting ecological services and wildlife benefits should appeal to anyone who cares about our environment and the conservation of wildlife and native lands. Ultimately, I approached Rudi about joining the team at RAE. What I have learned since doing so has only multiplied my excitement for the company and our mission—*To help individual landowners and society as a whole collaboratively discover and implement alternative biomass and energy solutions, in both ecologically and economically sustainable ways to protect and restore our environment and ecosystems.*

Start-Up Phase Done: On to Growth

Founded in 2012, RAE, like most start-ups, has faced numerous challenges. Some were typical of a new company, like proving the concept to viable partners. Others were less controllable, like the Porcine Reproductive and Respiratory Syndrome virus in 2016 that drastically affected gas production and a tornado in 2017 that wiped out early operations and tested the resolve of the company's future. But the team at RAE persevered and overcame those challenges, and today is experiencing growth that indicates an incredibly bright future for the company.

In early 2019, RAE took a huge step toward solidifying our future through the formation of a joint venture with Smithfield Foods. This partnership is called Monarch Bioenergy. Smithfield Foods is the world's largest hog producer doing \$15 billion in business annually. They lead the world in pork processing and offer popular brands, like Smithfield, Eckrich, Farmland, and my favorite, Nathan's Famous hotdogs.

"The last six months has been a real uptick in optimism based on the results of our performance," said Chris Roach, President of RAE. "The consummation of our joint venture with Smithfield and the capital they have invested is not only a validation of what we are doing, but also a financial infusion that allows us to build out the remaining farms and to attract additional capital. We are on the cusp of having a very successful operating year in terms of producing biogas."

In northern Missouri, Smithfield has nine finishing farms with 88 lagoons. There is an annual potential of producing about 1.2 million dekatherms of energy from the manure of 2 million hogs. This amount of energy is the equivalent of offsetting approximately 10 million gallons of diesel fuel or 130,000 gasoline vehicles. Currently, 20 lagoons are producing renewable natural gas. In 2019, we are adding 17 lagoons to take us to 37, and we'll add 17 more in 2020. We plan to finish installing impermeable covers over the rest of the lagoons in 2021.

"RAE is in the second phase of a startup where you're past the



ROESLEIN ALTERNATIVE ENERGY PHOTOS

At top, Roeslein Alternative Energy (RAE) has overcome numerous challenges during the start-up phase, including a devastating tornado in 2017. Above, RAE is nearing the completion of a 1,000-acre prairie planting on farmland owned by Smithfield Foods in northern Missouri.

Roeslein Alternative Energy (RAE) is a pioneer of "firsts" in the production of renewable natural gas (RNG). Our current list of firsts includes:

- RAE is the first company to register with the EPA for a Swine Manure Digester Registration for RNG.
- RAE has been awarded the first EPA "Cluster" Registration for RNG production from multiple sites.
- RAE is the first RNG producer to have an EPA Virtual Pipeline Registration for moving RNG in Compressed Natural Gas transportation trailers.
- RAE is the first company to achieve the California Air Resources Board Swine Pathway Registration for RNG production.
- RAE has achieved the lowest Carbon Intensity Score ever certified for the production, transportation, and usage of renewable natural gas.
- RAE has received the highest price ever for a cellulosic Renewable Identification Number.



ROESLEIN ALTERNATIVE ENERGY



MDC NOPPADOL PAOTHONG



MDC NOPPADOL PAOTHONG

Benefiting wildlife is a core aspect of the mission of RAE. The restoration of 30 million acres of prairie landscape—Roeslein’s ultimate vision—would also alleviate a significant amount of flooding on marginal agriculture lands.

critical point of survival, of proving a business model, and have shown we are going to make it," said Roach. "Now we have to manage growth and how we run our business to become a long-term successful energy producer while adhering to our principles of ecological services and wildlife benefits. We are beginning to answer the questions: how do we contract with landowners, how do we create this economic return we talk about in our vision."

Monarch BioEnergy & Manure

Concentrated animal feeding operations (CAFOs), are controversial to say the least. It seems no one wants a CAFO in their backyard, yet most people love bacon and baby back ribs. With our world population expected to hit nearly 10 billion by 2050, there is certainly a dilemma over how to conduct sustainable agriculture in a way that produces enough food for so many people, while not causing further damage to our environment. Fights continue to take place in our Missouri legislature over the existence of CAFOs and their effects.

"This joint venture represents our continued commitment to doing business in a way that is good for our planet and its people," said Kenneth M. Sullivan, President and CEO for Smithfield Foods. "This innovative collaboration creates value for our company and our partners, and benefits the environment as we work to feed the world's growing population."

For reference, a CAFO is an operation with more than 1,000 animal units. An animal unit is equivalent to 1,000 pounds live weight. The number of animals held in one location is often staggering, with some hog operations holding over 10,000 animals.

"CAFOs, when operated correctly, provide the efficient conversion of feed, and the best biosecurity for the industry," said Roeslein. "China is currently suffering a dramatic destruction to their hog production from African Swine Fever, due primarily to a lack of biosecurity in the feed chain and production process."

At Smithfield Foods, animals are kept more than 45 days in the enclosed feed operations. An immense amount of manure is generated from these operations. Dealing with this manure is a challenge. Monarch Bioenergy has produced a system of addressing these challenges by eliminating odor and reducing excrement, while creating a new valuable commodity.

Michael Rainwater, General Manager of Smithfield Hog Production, said, "We believe there is a right way and a wrong way to do things. Sustainability is not something we talk about. It's something we do. We have to sustain the environment, because we don't want to be in business for the next five years, we want to be in business for the next hundred years and beyond."

The concentration of Smithfield's Missouri facilities is about 600 square miles, and Rainwater says they have about a \$1.5 billion dollar impact on the local economy. They produce about 2 million hogs annually in Missouri, and mill about 14,000 tons of feed per week, grinding about 16 million bushels of corn annually. Their operations use between \$125,000 and \$175,000 worth of energy a month.

A significant success for the entire operation was recently announced. The gas Monarch Bioenergy is producing received the lowest Carbon Intensity (CI) Score ever recorded for RNG at -374. As defined by the California Air Resources Board, a CI score is expressed as the amount of life cycle greenhouse gas emissions per unit of fuel energy in grams of carbon dioxide equivalent per megajoule (gCO₂e/MJ). CIs include the direct effects of producing and using this fuel, as well as indirect effects that may be associated with how the fuel affects other products and markets.

Basically, the lower the CI score, the more valuable the gas. RAE has thus produced the most valuable RNG available today in the California market, where it is actively being used to power transportation vehicles.

Natural Gas from Prairie Plants

While the production of RNG from the digestion of manure is already happening, RAE is continuing to move forward with our plans to implement Horizon 2, which is centered on the production of RNG from the digestion of native prairie plants.

While the manure digestion takes place in lagoons, the prairie plant digestion will take place in aboveground digesters. These have not yet been installed, but progress is being made as we establish prairie plantings on a number of Smithfield's farms.

"Manure digested in lagoons is what is driving our very favorable CI score. We don't want to modify that approach," said Roach. "The prairie plant digestion will take place in separate digestion systems. They will be co-located with the lagoons so that they'll share water, gas storage, and cleaning, and interconnect with the pipelines. So both manure and prairie will be digested on the same farms, but physically the digestion will be in two separate reactors. They're coming."

RAE's research and development group, led by Dr. Hassan Loutfi, is working with several technology providers and universities on the best process. RAE is working with the California Air Resources Board on a preliminary CI score.

RAE has been working hard to move forward with the prairie reconstruction aspects of our mission. Led by John Murphy, RAE Wildlife and Ecological Services Manager, these efforts are being supported by the Environmental Defense Fund and Smithfield Farms. RAE Conservation Coordinator Connor Woods is working with Murphy to bring the company's ecological services vision to reality.

"We are nearly complete with our 1,000-acre prairie reconstruction project across five different Smithfield farms," said Woods. "We are working with Smithfield and the Environmental Defense Fund to identify the last 300 acres. On these acres, we are using a seed mix with four grass and 15 forb species. But we are also working with scientists from Iowa State to determine the best native seed mix. On some acres, we are planting both high diversity and low diversity mixes. Across both, we have stuck with a mix of six grasses, but have fluctuated the number of forbs—between 15 and 31. When Iowa State does their monitoring, they will see whether or not a high diversity is more beneficial for pollinators, grassland birds, and other species of wildlife."

Cover crops also remain a focus for future gas production. On the RAE north farm, a variety of cover crops are being planted. Species vary depending on whether the land is going into corn or beans, but winter ryes, triticale, wheat, Austrian winter peas, turnips, and radishes have all been planted after a cropping season ends. All of these provide ecological services, including improving soil health and reducing water runoff. Cover crops also provide numerous benefits for wildlife, like food and cover.

In all, the future is looking very bright for Roeslein Alternative Energy. The company has made enormous strides in the last couple of years and is now diving into a new set of challenges surrounding growth and expansion. This unique partnership between Smithfield Foods and RAE, involving energy,



Construction is now complete on numerous farms in northern Missouri, and renewable natural gas production is underway.

agriculture, and conservation, is rapidly developing into a model for North American agriculture and energy production in a safe, sustainable way.

"From their leadership in creating renewable energy and in conservation, Smithfield is changing what it means to be a food company," said Rudi Roeslein. "Smithfield's willingness to embrace the power of prairie proves the industry can play a meaningful role in seizing the economic benefits of conservation. We are extremely grateful that Smithfield is committed to this vision. It begins with converting methane from hog manure to renewable natural gas. But that's the tip of the iceberg. We hope to show the agriculture community, with the help of our joint venture partner Smithfield, how to take all these steps and make an enormous impact for energy, the environment, and wildlife."

As RAE continues to grow, we fully expect to be digesting prairie biomass into RNG in the near future. By creating a market-based solution to the question of how we convince farmers to adopt more landscape-friendly practices, we are going to see improvements in soil health and water quality, and ultimately human health and quality of life. All Missouri citizens will be better for it.

Brandon Butler is the Director of Communications for Roeslein Alternative Energy. He joined the company in February of 2019.

Learn more about grassland habitat and the work of Roeslein Alternative Energy (RAE) in northern Missouri at the MPF Annual Dinner in Jefferson City on August 10, with after-dinner speaker John Murphy, who is the Wildlife and Ecological Services Manager for RAE. Details on back cover.



Members of the Pure Air Wildlife Management Cooperative—a group of neighbors helping neighbors—at one of many prescribed burns the cooperative has conducted.

The Pure Air Wildlife Management Cooperative

Neighbors and friends come together to improve land for wildlife in northeastern Missouri.

AN INTERVIEW WITH ZACK COY

People are the critical factor in sustaining and enhancing prairie and other native grasslands. Prairie burns and control of woody growth and other invasive plants are crucial.

Nonprofit groups like the Missouri Prairie Foundation (MPF) and conservation agencies rely on staff, contractors, and volunteers to carry out this work. For individual landowners who own prairie, savanna, open woodlands, or planted native grasslands, however, finding the time, energy, and other resources to get this important work done can be daunting.

In northeastern Missouri, one group has formed to address this challenge and help landowners manage the grasslands they love: the Pure Air Wildlife Management Cooperative (PAWMC), of which MPF is a proud partner.

Zack Coy, president of the group, took time out of his busy schedule to conduct an interview with me via email to discuss the good work of PAWMC.

—Carol Davit, executive director, Missouri Prairie Foundation, and editor, *Missouri Prairie Journal*

DAVIT: What are wildlife management cooperatives?

Coy: Wildlife management cooperatives are formed when a group of people—usually neighbors and/or friends—come together for a greater cause, or to work towards a common goal. Pure Air Wildlife Management Cooperative started as a Deer Management Cooperative, and we have since broadened our focus to all wildlife and its habitats.

When and why did you start PAWMC? Are you the ringleader?

Pure Air Wildlife Management Coop was founded in 2015, as a way for neighbors to find common ground and get to know the management goals and dreams of other neighbors in the area. After facing a devastating outbreak of Epizootic Hemorrhagic Disease (EHD), a virus affecting our deer herd in the region, I felt we needed to come together and start making like-minded management decisions for the area. You can call me the ringleader; I was voted president at our first meeting that I organized. It is a great privilege to serve this area and the awesome residents that reside within.

Your Cooperative takes the name of the Adair County town of Pure Air. How many landowners belong to the Cooperative, and is everyone from the town or nearby?

PAWMC is named after Pure Air, a once thriving town in western Adair County. Currently, PAWMC encompasses over 5,000 acres

and 26 landowners. The acreage count is impressive, but not as impressive as the people who belong to the cooperative. Some live in the area or nearby and some live across the state or in other states. I also have lots of help from people who don't even own land within the coop boundaries; they are simply good people who want to help or want to learn more about our management strategies and goals.

Describe the habitats where you work. How many properties and total acres have you worked on to date?

The PAWMC area is a blissful mix of remnant prairie and woodland habitats. We manage this mix with prescribed fire—we burn 3,500 to 4,000 acres a year. In addition to appreciating the importance of fire, our members also value timber stand improvement projects. On any given year nearly 30 acres within the coop have some sort of woodland restoration project practiced. Also many acres are planted back to prairie each year.

What PAWMC project has been especially rewarding?

The most rewarding project isn't even habitat related—it's getting older and younger generations to come together and share the same vision of what we can have with like-minded management practices and goals.

The most rewarding habitat project has by far been our prescribed fire season spring of 2018. We burned nearly 4,000 acres with ZERO escapes or "spot overs." When you look at a group of guys burning this much land a year there is a certain level of risk. PAWMC members are well trained and committed to the safety of themselves and everyone around them. Each member has a solid understanding of fire behavior and it's quite impressive to watch!

Tell us about some memorable natural events that members of PAWMC have witnessed while conducting habitat work.

In the spring of 2017, our coop was conducting a prescribed fire on a truly stunning piece of remnant tallgrass prairie. As usual, our burn lasted into the dark hours of the night. As the head fire was crossing the rolling hills, it started snowing. We all gathered up around our rigs and watched the snow fly as the fire raced together in the middle of the unit. Also memorable are the beautiful sunsets our group has watched on multiple occasions while burning.

What is magical about northeastern Missouri for you? Why should everyone visit the area?

Growing up in northeastern Missouri (NEMO), I have been blessed with many opportunities to enjoy the outdoors. From camping, fishing, and hunting too many game species to list, I've been able to do them all! And the great thing about NEMO is that if you're willing to put in the effort and time, you can. We are blessed as Missourians to have plentiful game populations and great public land to pursue game or just go out and watch the sunset. NEMO is also home to incredibly diverse native plant communities. With prairie from this region quickly disappearing from the landscape, the survival of these species should be a concern for everyone.



Zack Coy, president of the Pure Air Wildlife Management Cooperative (PAWMC) after a successful turkey hunt.

ISAAC COY

Everyone should visit NEMO and find a prairie to watch a sunset over. Many if not all Missouri Department of Conservation areas in NEMO have remnant prairies, savannas, and woodlands as well as several designated Missouri Natural Areas. If you want to visit a prairie within PAWMC, visit the Missouri Prairie Foundation's Runge Prairie, anytime of the day, any month of the year, and this rich remnant won't disappoint.

What is your day job, and how do you have time for the cooperative?

I have a wonderfully fast-paced career as a technician at Roeslein Alternative Energy, an engineering firm from Missouri*. With a goal to restore 30 million acres of prairie landscape in the next thirty years, we stay busy. I make time for the cooperative. My wife Casey is very supportive; even when I track my muddy boots into the house with pockets full of woodchips from running a chain saw all day or leave my burn clothes on the laundry room floor after getting home at midnight after a full day of burning, she's supportive. It is very important to me that as a group we are successful at any task at hand. I think more than anything I do it for the future, not only my future, but also for the coming generations. I have a wonderful son, Sawyer, who will turn 3 in August. He tags along with me quite often while at other coop members properties. Seeing the sparkle in his eyes when he sees a turkey take flight or finds a cool rock in the creek—that's why I make time. Because if we don't, our children won't see what we have enjoyed.

How many Wildlife Management Cooperatives exist in Missouri? Should every part of the state have one, and if so, why?

It would be irresponsible of me to put a number on wildlife management cooperatives in Missouri. There are many pockets of the state where landowners come together and work toward common wildlife habitat goals. Some may not have names or a formal structure, but they are doing great things, and managing a lot of acres. A good example is our state's PBAs (Prescribed Burn Associations). These groups come together and safely implement several thousand acres of prescribed fire across the state.

I encourage other conservation-minded people to start a coop in their neighborhoods. It is very rewarding to the landowners and very beneficial to the wildlife in the area. Alone we can go fast; together we will go far.

What is your advice for individuals or groups who want to start a Wildlife Management Cooperative?

The hardest part of starting a coop is knocking on the first door, but once you have one neighbor willing and interested the others will come. I encourage anyone who wants to start a management cooperative to contact a local cooperative specialist. Alex Foster with Quality Deer Management Association has been priceless. He has helped structure the coop and also helped us make great contacts with other conservation organizations that might be of assistance to us. If anyone would like to contact me about PAWMC, they can call me at 660-341-5492 or email me at zack_coy@yahoo.com.

*See article on Roeslein Alternative Energy on page 8.



In addition to carrying out prescribed burns, PAWMC also conducts timber stand improvement; woodland restoration, including removal of eastern redcedar; and tree planting as appropriate, as pictured above, in the mosaic of prairies, savannas, and woodlands that make up the northeastern Missouri landscape.

ISAAC COY PHOTOS

To Put Out Fire

How critical was the role of intentional burning by indigenous people in sustaining open grassland in Missouri?

By Mary Nemecek

There has long been an idea that, until man intervened in harmful ways, nature existed on its own in a splendid state, undisturbed and separate from humanity. Nature is often conceived to be a place we visit, skirt around the edges, survive its fury, marvel at its beauty—existing apart from us and if allowed to persist in its own cycles of divine perfection, will function flawlessly.

The once vast grasslands that covered over 170 million acres in Canada and the United States appear not to have been simply the design of nature, however, but rather the result of the interplay between the land management practices of indigenous people—depending on region in the continent—along with regional climate patterns, lightning frequency, and soils. The extent to which fire and other practices of Native Americans manipulated the landscape has long intrigued and perplexed many anthropologists, archaeologists, botanists, ecologists, and land managers. There is no time machine to go back and peek into life of indigenous people and the ecology of the plains pre-European settlement, but that doesn't mean there isn't evidence about the relationship of the prairie and the people that lived on it.

CLUES FROM CANADA

Henry Lewis, in the mid-twentieth century, recognized the growing evidence that hunters and gatherers were not at all victims of their luck, and countered prevailing thought of the time: “. . . most anthropologists still hold that hunters and gatherers are dependent upon the natural disposition and abundance of resources.” (Lewis 1982). At the time of Lewis' work, the indigenous people of the Great Plains were too far removed from any collective memory of how their ancestors had lived off the land before the fur trappers and homesteaders came through.

There were, however, in the northern reaches of Canada, those who were not yet generations past the

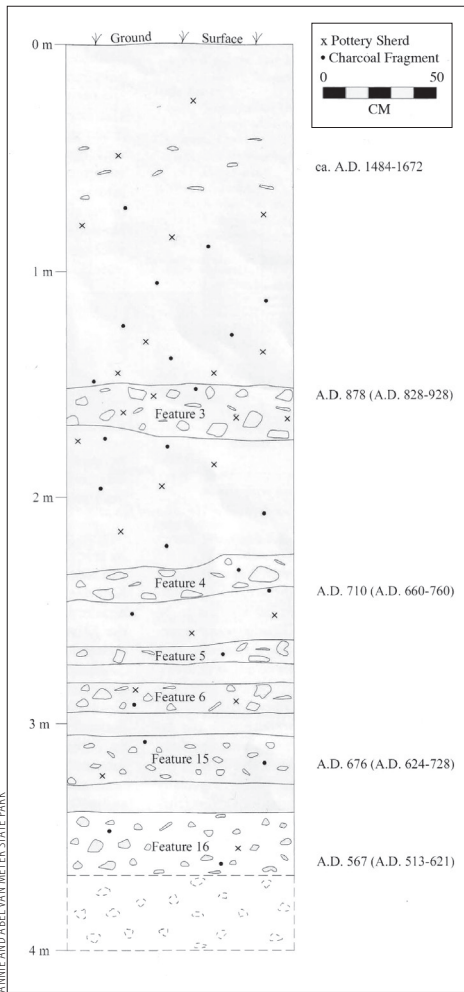
initial influence of Europeans. They were of course not isolated, but they had memories from early in their lives when traditional practices and storytelling portrayed the lives of their ancestors. In the late summer of 1974, Lewis began interviews to learn about the use of fire in maintaining the forests and meadows of Northern Alberta. Over the following three summers he would interview 57 informants, both of European and native ancestry.

Some of the interviewees were hesitant to talk as there had been decades of backlash against burning—including prosecution—but as Lewis began to unlock their stories, they told about the meadows that used to be there, ranging from several to more than 600 acres. There was consensus that fire played an integral role in maintaining these grasslands: “They emphasized the fact that if the meadows were not periodically burned, they would be taken over by brush and forest, and that the loss of grasslands to brush and trees resulted in increased fire danger.” (Lewis 1982)

The timing and place of the fire was not haphazard. The fires were almost always set in the spring when the snow melted from the meadow, but usually still blanketed under the timber and brush, or at the least the forest held significantly more moisture, creating built-in fire lines. There was some value in the rare fall burn as it created a faster green up in the spring, but was usually reserved for areas farther away that they could not reach during the ideal burn time at the waning edge of winter. The hesitance over fall fire came from its unpredictability in containment and the absence of forage for an entire winter, leaving an area devoid of game.

It was noted that moose would return just hours after a burn. They not only enjoyed the warm, barren ground to lie or roll on, but were seen eating the charred twigs and leaves. This was attributed to a lack of sodium in the diets of moose in the north. The assumption was that they found in the burned vegetation the minerals they lacked.

It was not just attracting wildlife to the lush spring growth that made the frequent, sometimes annual, fires an important part of subsistence. Burning allowed



ease of movement either for tasks such as setting traplines or moving a settlement: "Used to be we lived in teepees all year long. Moved round a lot. One place in the fall we'd burn, another place in the spring we'd burn that . . . Country was a lot more open then and wasn't so hard to travel. Not like now. You can hardly travel in the bush and it's not so good for hunting. I haven't been on the trapline in a long time now. So much brush you can hardly get through." (Cree, 70, Fort Vermillion area; Lewis 1982)

Burning provided firewood as the forest would gently retreat with the frequent fire, and the fire would dry out the damp wood and eliminate the need for harvesting green timber that did not burn well or took a long time to dry out. It eliminated the fire danger that came with unpredictable summer lightning strikes and brought life back to wind-damaged areas with large numbers of downed trees that were a cache of dangerous fuel with little value in attracting wildlife.

Frequent fire contributed to the health of wild and domesticated animals, making forage more plentiful. Abundant grazing opportunities meant that animals didn't have to graze areas twice, where they could leave a parasite or disease

that would be picked up by another. It allowed for wide trails that would warm quickly and soon dry, so travels were not overburdened with dampness.

Burning in the dormant seasons decreased the risk of a fire getting out of control and reduced the damage fire does to growing plants and crops. It eliminates the potential for real disaster by reducing fuel and allowing regeneration in areas stymied by dead trees.

FIRE HISTORY IN MISSOURI

Tales of fire used to drive herds of game or to burn out the enemy dot early accounts of life on the Great Plains. In Missouri, there are few records of how fire was used before the waves of European settlers arrived. There are, however, some scars left in places not readily visible, but that nonetheless tell us a story of frequent fire, typically in the dormant season.

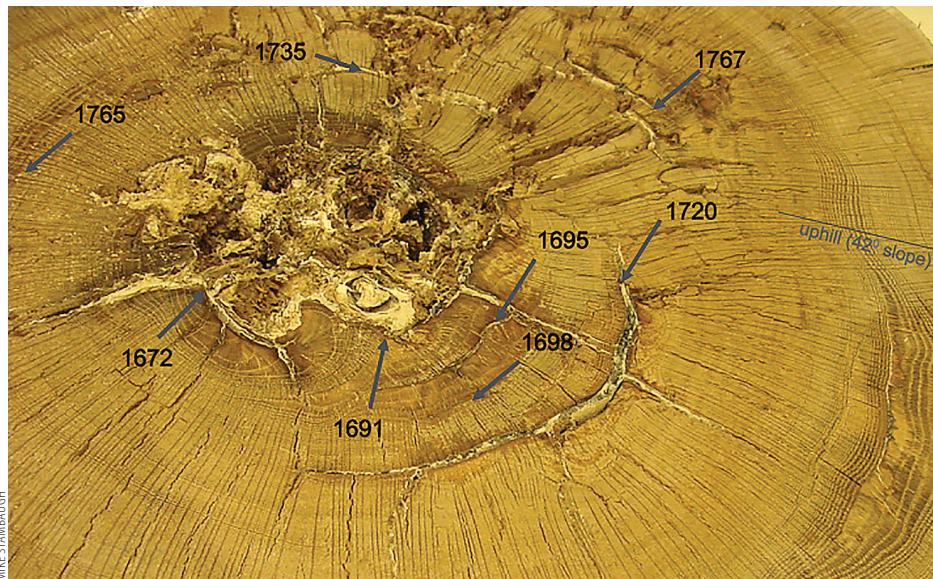
A 2006 study of fire-scarred trees in the loess hills of northwestern Missouri examined 33 trees from the Brickyard Hill Conservation Area in Atchison County. The tree-ring record dated from 1671 to 1980. The first fire scar came from 1672, just after the first tree ring in the study.

Overall, it was determined that there were 60 fire years present on part or all of the study area.

There were only three years that showed fire had occurred during the growing season: 1682, 1714, and 1826. All other fires occurred during the dormant season, which is defined generally as September through March. A fire was present on the entire study area in only 1782, 1818, and 1869.

Because northwestern Missouri lies west of the boundary for land acquired in the Louisiana Purchase, it was settled later than areas to the east and did not join the U.S. until after the Platte Purchase in 1838. The frequency, or mean fire interval, of the study trees pre-1820 was 6.6 years. Interestingly, there was an increase in the fire interval to 2.0 years from 1825 to 1850. The question remains if this was intentional fire used to clear land for agriculture and grazing or accidental. The only fire scar after 1950 was in 1980.

A little further south, in Van Meter State Park, standing guard over the



Above, scars of wild fires, identified here by year on a cross section of bur oak by Dr. Mike Stambaugh from the University of Missouri, indicate fire history. This tree grew in the time and territory of the Oto and Iowa tribes, who lived along the Missouri River, including the loess hill region of northwestern Missouri. At top, a depiction showing the stratification of charcoal fragments and pottery sherds recovered from the Burlington chert mining site (Test Units 1 and 3) in the Pinnacles, along the west side of Annie and Abel Van Meter State Park in northern Saline County, MO. The charcoal fragments indicate a history of frequent fire in the area.



Steep loess hills in northwestern Missouri feature dry prairie and encroaching trees. A 2006 study of tree rings in the loess hills provides clues to the region's fire history.

Missouri River are bluffs known as “The Pinnacles.” The upper slopes contain loess blown in from the time of the glaciers, and the lower slopes contain high quality Burlington chert—the coveted rough material for tools during the Stone Age.

This area is rich with the history of the indigenous people who mined chert and lived nearby. An excavation of the chert mine found high concentrations of charcoal fragments—remnants of frequent burns that kept the Pinnacles free of trees and shrubs. These predate the time of the Oneota and Missouria in the area, and radiocarbon dating of fragments showed them to date back as far as A.D. 710. A Middle Woodland or Hopewell earthen enclosure and mound complex known as the “Old Fort” sits atop the Pinnacles within the park boundary.

The deeply timbered Pinnacles give few hints that they once included a noteworthy prairie. Field notes from surveyors contributing to the General Land Office Survey in June and July of 1817 showed prairie on the Pinnacles and a mile-wide belt of timber along the Missouri River channel. Additional early travelers, a few years prior to the survey, also spoke of a prairie above the river. By 1862 a new survey of the area reported it as timber. G. C. Broadhead reported in 1872 that “Blackoak trees 3 to 5 ft in diameter were growing over the walls, ditches, and inner

area, and the whole surface was covered with a dense and luxuriant growth of bushes, vines and trees.” (Broadhead 1880)

There was farming conducted inside the earthen enclosure in the late 19th century, but a study of tree rings outside the area previously plowed found trees that began growing around 1840. It is worthy to note that the trees studied by Ward F. Weakly in 1971 had maximum diameters of around 4 feet, short of the diameters reported by Broadhead in 1872, lending to perhaps an exaggeration of the tree size reported at that time. It's believed that rapid forestation occurred once fire suppression began. This is exactly the same sentiments shared by the subjects of Lewis's interviews in the northern reaches of the continent: “It used to be all prairie here; now it's mostly forest. My father told me that long time back there were plenty of buffalo here, all the way (north) to Cold Lake. We were Plains Cree, not like those bush people up north. Now it's all bush here too.” (Cree, 72, Frog Lake area; Lewis 1982)

Just as any great craftsman would use his tools in the right place at the right time, in many parts of North America with prairie and other grasslands, fire gave indigenous people the ability to hew out of the environment a system that allowed some control over the landscape that provided their subsistence. Depending on the land for all their needs, indigenous

people often molded and maintained many grasslands of North America. It may have just been this desire to keep the prairie open that doomed it to the plow, for tilling a forest would have been a much more formidable task, but in the open, the soils of grasslands—made rich by thousands of years of deep root activity, and with minerals returned to them for centuries through fire—agriculture thrived.

Indigenous people used to “put out fire” to keep the plains and meadows free of trees and shrubs for all the benefits open grasslands bring. Sometime in the past 150 years, these words came to mean something very different. Before the meaning changed, not that long ago, with purpose and intent, there was fire on the landscape, and the grasslands were vast.

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MPF member **Mary Nemecek** is President of the Burroughs Audubon Society of Greater Kansas City, and an affiliate board member of the Conservation Federation of Missouri.

Dung Beetles

The Unsung Heroes of Grassland Health

By Rachel Stone

I can still remember the first time I saw a dung beetle. It was an industrious little critter, busily rolling a ball of dung across an open patch of prairie. I was struck by its dogged determination in pushing a carefully shaped sphere of waste, easily many times heavier than itself, across a treacherous path.

The old idiom, “One man’s trash is another man’s treasure” never rang truer to me than in that moment. Over the years, I’ve come to develop quite an affinity for these strange, stout little tanks with their

questionable taste in food. It might not be a glamorous job, but the dung beetle provides the incredibly important service of breaking down and recycling waste that would otherwise quickly pile up, smothering plant life and potentially spreading disease. And for that, we owe this group of beetles a great debt of gratitude.

Dung Beetle Biology

Beetles found within the taxonomic family Scarabaeidae are called scarabs and exhibit many different feeding strategies including phytophagy (plant-feeding), saprophagy (detritus-feeding), coprophagy (dung-feeding), and even necrophagy (carrion-feeding). The dung-feeding specialists are just one subset of this diverse scarab group and are called, perhaps unsurprisingly, dung beetles.

The life cycle of dung beetles is typical. The adults lay eggs, from which the larvae will hatch. The incubation period for eggs is highly variable, depending on the species as well as soil temperature, ranging from one week to several months. Dung beetle larvae are called grubs and, as

they are closely related, look very similar to lawn grubs with a cream-colored, C-shaped body that you might find while gardening. The larvae are equipped with powerful mandibles that allow for efficient grinding of coarse plant materials found in dung. As the larvae grow, they go through three stages, referred to as instars. In the third larval instar, the grub will form a protective chamber from its own dung in which it will pupate. An adult beetle arises from the pupal form and will emerge from the soil to search for fresh dung. The beetles must feed as adults to mature their ovaries or testes before mating. Adult mouthparts are more delicate than larval mouthparts and are used to feed primarily on dung juices rather than fibrous content.

Once the gonads have matured, the adults are ready to breed. Breeding, like feeding, is centered around excrement. Breeding pairs will meet and mate at a pile of fresh dung. After breeding occurs, dung beetle behaviors quickly diverge into the following behavioral guilds: rollers, tunnellers, dwellers, and kleptocoprids. While these groupings are not necessarily evolutionarily informative, they are functionally meaningful.

Rollers form a ball of dung from the larger heap, using their heads and forelegs as shovels, then roll the ball away from the dung pat (and competing beetles), before

concealing it underground for use as a brood ball. While rollers are frequently observed by passersby, there are few species that exhibit this remarkable behavior in the United States.

Tunnellers are more common; this group excavates burrows immediately below the dung pat, which they then provision with the dung from above and then will deposit their eggs.

Dwellers are endocoprophagous, meaning they live and feed within the dung pat itself. Aphodiinae, a subfamily comprised of typically small, temperate dung beetles, represent the bulk of the dwellers, which tunnel directly into dung and deposit their eggs in the dung pats without any kind of relocation behavior.

Kleptocoprids are generally small beetles within the subfamily Aphodiinae that have evolved the sneaky strategy of breeding in the dung already buried by other dung beetles. While dung beetle guilds are diverse, they all exhibit the exceptionally rare insect behavior of parental care. The adults ensure their young are off to a good start by provisioning their nests with dung that the larvae will feed on immediately upon hatching, repeating the life cycle once again.

Keeping Grasslands Healthy

The most easily observed benefit of dung beetle activity is the removal of dung from the soil surface, which reduces the smothering of plant life. Not as easily observed is the cascade of benefits that result once the dung beetles bury their dung. The burial of dung induces significant changes in the available nutrients below the soil surface. Dung

FROM POOP TO PROFITS

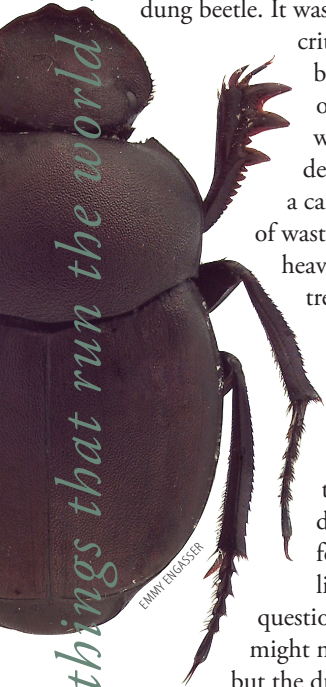
Dung Beetle Management for Farms & Ranches
July 1–2, 2019 in Ottawa, Kansas

Space is limited! Register now at <https://www.tallgrassnetwork.com/calendar>

Farmers and ranchers wishing to learn more about dung beetles—and how to encourage them in a healthy, profitable ecology—are encouraged to participate in this two-day workshop. This hands-on, holistic management workshop will feature two nearby farms. We will learn about dung beetle biology and hunt through dung for specimens. Rancher Spencer Smith (Surprise Valley, California) will discuss why management for dung beetles is vital for livestock health and wealth. Participants will examine their path toward better management, soil health, profits, and cash flow. Join us! Contact Julie Mettenburg at tallgrassnetwork@gmail.com for more information.

Invertebrates: the little things that run the world

–E.O. Wilson





RACHEL STONE

EMMY ENGASSER

Left to right, *Cantbon pilularius*, a native prairie dung beetle, rolling its prized possession. *Phanaeus vindex*, also known as the rainbow scarab, is a beautiful dung-tunneling prairie native.

burial increases levels of plant nutrients such as phosphate, nitrate, sulfur, ammonia, and organic carbon. Field and laboratory studies have found that the addition of dung beetles to dung on the soil surface improves soil nutrient levels and increases plant production.

The physical action of tunneling also efficiently aerates soils, making them less dense and providing channels for water to enter the ground. Land utilized by tunneling dung beetles is considerably more permeable to rain. When soil is more permeable, the loss of water due to run-off is substantially reduced. These effects of increased water infiltration and storage within the soil give grassland systems a much higher degree of drought resiliency. Aerated soils also have the added benefit of allowing for better root penetration. Both the tunneling of soils and the introduction of dung into the soil system increase soil organic carbon, resulting in deep fertile soil and a higher capacity for plant growth. Further enhancing the dung beetle's work in aerating soils, studies have found a marked increase in earthworm activity in the soil under dung pats where dung beetle communities are well established.

Dung beetles have evolved with native grasslands for tens of millions of years, and they fill the important niche of nutrient recycler in nearly every landscape where there are mammals to provide dung. The Great Plains have undergone significant alterations since the arrival of intensive agriculture, and it is highly likely that

dung beetle communities of this region have adapted to their changing habitats.

Unfortunately, very little is known about the role of dung beetles in native prairies; ecological studies are heavily biased toward dung beetle impacts on agricultural systems utilizing livestock. The introduction of livestock necessitated dung beetle research to help us understand how to maximize the degradation of the resulting unnaturally high accumulations of animal dung. In native prairie areas, dung abundance is substantially reduced compared to conventional livestock operations (although high abundances of dung found in agricultural systems does not always mean high availability—the traditionally used antibiotics and parasiticides in livestock farming can make dung unpalatable to dung beetles and at the worst can kill them).

While native prairie systems undoubtedly have a wide range of animal dung available at any given time, we lack the data to precisely predict how much and at what rate dung is being degraded by dung beetles. However, it has been observed that within prairie systems lacking introduced grazers, the dung of native mammals, such as coyote and deer, are completely removed within 1 to 2 days. Dung beetles are very efficient at removing dung. In fact, dung beetle larvae are able to eat their body weight in dung each day until they reach pupation. Most dung beetles in the Midwest prairies are generalist feeders, meaning that they do

not feed solely on one type of dung, but rather on the dung of all mammalian animals including, but not limited to mice, rats, prairie dogs, rabbits, opossums, raccoons, deer, and coyotes.

Regardless of the dung type available, the benefits of introducing the dung back into the ground provide the same soil enhancements. Decomposers, like dung beetles, are some of the most important contributors to any ecological system, salvaging raw materials and resources that are tied up in waste and rendering them biologically available to the community. The efficient tunneling and burying of dung performed by these beetles keeps grassland communities healthy. Dung beetles encourage landscape resilience through aerating soils and increasing levels of plant nutrients in the soil, enhancing plant productivity, and maximizing rain permeability. They are indisputably the unsung heroes of grassland health.

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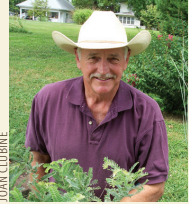


Native Warm-Season Grass News

A Landowner's Guide To Wildlife-Friendly Grasslands with Steve Clubine

New Research on Native Forage & Cattle Weight Gain

If you get a chance to hear Dr. Patrick Keyser speak on native warm-season grasses for grazing, don't miss it. Keyser is professor and director of the Center for Native Grassland Management at the University of Tennessee Institute of Agriculture, and he's



JOAN CLUBINE

been a featured speaker the last few years here in Missouri, at the Kirksville Livestock Symposium, Mid-Missouri Grazing Conference, and most recently, Spring Forage Conference at Springfield, which also featured Dr. Temple Grandin on low-stress stock handling, Dr. Allen Williams on forage cocktails for soil health and

grass-finished beef, and Walt Davis on land and natural resource stewardship. Backed by some great research on forage production and animal gain, Keyser's message had some real impact at the Spring Forage Conference. Keyser has also presented his native warm-season grass (NWSG) grazing research at several Eastern Native Grass Symposiums (Erie, PA; Charlottesville, VA; Evansville, IN; and Lexington, KY).

Keyser has compared two stocking strategies, one involving a heavier stocking rate early, then reducing it when native warm-season, perennial grass growth slows in early July. The other strategy involves stocking lighter and continuously for about 107 days. There were no statistical differences in animal performance or beef production per acre between the two strategies. Season-long average daily gains were 2.18 lb. for continuous grazing and 1.98 lb. for heavier initial stocking, double what could be expected on tall fescue at that time of year. Gain per acre was also similar, 342 lb. for continuous and 303 lb. for the latter. (Some researchers claim they can get this much gain per acre on tall fescue and clover using Management-intensive-Grazing, but it takes eight to nine months instead of three or four.)

I stock lighter than Keyser did in the studies, i.e., lower total pounds per acre (645 lb./ac. in 2018; 509 lb./ac. in 2019) in part because several of my animals are lighter weight. My gain per acre has been almost identical to Keyser's over the last four years. My gain per acre has been less because of fewer animals and lower total pounds stocked. I also stock more conservatively, about an animal per acre, because I want to ensure bobwhite quail nesting success. Nest lost to trampling is a concern at an animal per acre (potentially 20%) and increases with each additional animal per acre.

In a study similar to Keyser's at North Carolina State University (NCSU), Burns and Fisher (2013) got phenomenal gains on eastern gamagrass (1.91 lb. average daily gain [adg]; 671 lb./ac), switchgrass (2.0 lb. adg; 748 lb./ac.), and big bluestem (1.6 lb. adg; 573 lb. ac.).

Keyser has gotten great production per acre and per animal on mixtures of big bluestem and Indiangrass, nearly comparable production on monocultures of eastern gamagrass, but much greater gains on 'Alamo', which is a selection of switchgrass originating



STEVE CLUBINE

'Kanlow' switchgrass provides healthy forage and helps screen properties.

from species collected from Live Oak County, TX. The cost per pound of gain was lowest on the big bluestem/Indiangrass mixture. Part of the reason for the greater gains on switchgrass may be because 'Alamo' switchgrass is so productive that he is stocking heavier. North Carolina also has a cultivar of lowland switchgrass called 'Performer', released by the NC Agriculture Research Service, NCSU, and the U.S. Department of Agriculture (USDA), and was the switchgrass probably used in their trials.

There are two general types of switchgrass—those originating from upland ecotypes and those from lowland ecotypes. 'Alamo' and 'Performer' are lowland types. Upland ones have hair in the leaf axial, whereas lowland types are glabrous in the axial. The other significant distinguishing factor of both types is longevity. The upland types last around 12 to 15 years before dying out or practically so. I have never seen a lowland type die out in 50 years.

'Alamo' matures about 30 days later than either of our commonly used switchgrasses, which are 'Cave-in-Rock', and 'Kanlow'. 'Cave-in-Rock' is an upland type collected from Cave-in-Rock State Park, IL, and released by the USDA Elsberry Plant Materials Center in MO. 'Kanlow' is a cultivar developed from collections made near Wetumka, Oklahoma, and released by the USDA Manhattan, KS, Plant Materials Center. Switchgrass in general can tolerate long periods under water without dying. I've seen upland types flooded in reservoir backwaters for 40 to 50 days without dying, and lowland types well beyond that. (In contrast, little bluestem may only survive 3 to 5 days of inundation; big bluestem and Indiangrass may survive 7 to 10 days under water.)

I searched seed companies in four states before finding a pound of 'Alamo' switchgrass seed last spring. It is not a heavy seed producer and may also be experiencing increased demand because of Keyser's research. I am at the north end of its range for seeding here in west-central Missouri, but I was successful in getting some

stands for evaluation on Truman Reservoir lands years ago. I plan on comparing animal grazing of 'Alamo' and 'Kanlow' in a wet swag on my property.

Another use of 'Kanlow' switchgrass is for screening. I recommended it to several clients who wanted to screen the interior of their property boundary from the road from potential deer poachers. It remains upright throughout the winter and, if the border is at least 12 feet wide, a person can't see through it.

I rode from Clinton to the Spring Forage Conference with Jef Hodges and a couple local livestock producers he knew. At least one is already talking about converting 40 acres of fescue pasture to native warm-season grasses within a year. We also overheard a couple hallway conversations from other producers. One fellow asked another if he had any native warm-season grasses. "No, but I'm thinking about planting some after what I just heard," he replied.

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Keyser, P.D., C.A. Harper, G.E. Bates, J. Waller, and E. Doxon. 2011. Native Warm-Season Grasses for MidSouth Forage Production. University of Tennessee Center for Native Grassland Management. SP731-A.

How Prairie Plant-Fed Beef Could Be Superior

Alan Newport, an agriculture reporter for whom I have great respect, recently wrote an article for *Beef Producer* summarizing a paper published in *Frontiers in Nutrition* by Dr. Fred Provenza, professor emeritus at Utah State University, and two other scientists. Provenza, has studied the importance of plant diversity and phytochemically rich landscapes available for animal diets to ensure the richness of meat and dairy foods for human and environmental health.

Provenza has long championed the importance of compounds contained in plants—some of them toxic by themselves or at extremely high levels—and the “nutritional wisdom” and ability of foraging animals to select diets for health and self-medication. The more diverse their habitat, the better job they do at making the proper selections. Humans, in turn, benefit from eating animals and products from diverse habitats. Humans, however, have almost lost the ability to select foods that are rich in healthy compounds or, perhaps, never had the ability. There is evidence, claims Provenza and his coauthors, that humans have become “confused” by processed foods, nutrient imbalances, and acclimation to bland diets.

“Phytochemical richness of herbivore diets increases markedly from livestock fed cereal grains in feedlots to grain-pasture mixtures on botanically diverse pastures,” Provenza and his coauthors wrote. “Yet, epidemiological and ecological studies

critical of red meat consumption do not discriminate among meats from livestock fed high-grain rations versus livestock foraging on landscapes of increasing phytochemical richness. We found much circumstantial evidence to support the hypothesis that phytochemical richness of herbivore diets influences biochemical richness of meat and dairy and human and environmental health.”

Newport listed the following points from the authors' report:

- Phytochemically rich diets for herbivores and biochemically rich diets for humans include not only so-called primary compounds such as energy, protein, minerals, and vitamins, but also a host of so-called secondary compounds—including, but not limited to, phenolics, terpenoids, and alkaloids. All have health benefits, though most can be toxic in excess.
- Animals living in and attuned to a diverse landscape are adept at meeting their nutritional needs and at self-medicating. On monoculture pastures or simple plant mixtures, however, they are much less able to do so. Same with feedlots where they eat only total mixed rations.
- Animals attuned to a diverse habitat are healthier than those unattuned, or those living in simplified habitats.



STEVE CLUBBINE

Pastures with a diversity of plants help cattle meet their nutritional needs and self-medicate.

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- Animals foraging on phytochemically diverse pastures require fewer anthelmintics (dewormers) and antibiotics than those in feedlots or foraging on monoculture pastures.
- Herbivore diets influence the flavor and biochemical richness of meat and dairy such that laboratory analyses can distinguish animals eating diets of increasing phytochemical richness, ranging from cereal grains to grain-pasture mixes to pastures. For example, tannins in herbivore diets improve the flavor of meat by reducing rumen bacteria that produce off-flavors from skatole, a mildly toxic organic compound produced from tryptophan in the mammalian digestive tract, and they affect rumen biohydrogenation of polyunsaturated fatty acids, which changes fatty acid profiles in meat. Humans can taste these compounds, as well.
- People unaccustomed to biochemical richness may not care for these flavors, but those accustomed to eating such products prefer them.
- As for the evidence that meats cause systemic inflammation in people, the researchers showed when herbivores eat phytochemically rich diets, plant compounds they consume protect their meat and dairy products from the protein oxidation and lipid peroxidation that cause inflammation when consumed in human diets.

From Newport, Alan. April 3, 2019. Beef Producer.

Are Warm-Season Grasses Lower Quality than Cool-Season Grasses?

Jim Gerrish wrote an article with the above title for his “GrassRoots for Grazing” section of *Stockman Grass Farmer*, March 2019 issue. For those who don't know, Gerrish was a forage agronomist at the Forage Systems Research Center at Linnaeus, MO, for many years and is now a forage consultant living in Idaho. His article was partially in response to a previous article I had in that magazine in which I had suggested that the editors publish articles on native warm-season grasses, especially on their value for growing and finishing grass-fed beef and grassland wildlife.

Gerrish wrote, “In my early years at the University of Missouri, the perceived low quality of native warm-season grasses was a common topic of academic discussion. Laboratory analysis repeatedly returned lower results for the warm-season grasses. Producer experience, however, consistently showed animal performance well above what the laboratory analysis predicted. Some agronomists eventually figured out that the perceived low quality of native warm-season grasses was largely an analytic mismatch.”

Low forage quality tests on native warm-season grasses (NWSG) compared to cool-season grasses have been brought up in many prairie and forage workshops in which I've been involved with over the years. Gerrish wrote that he had heard the low quality perspective expressed many times in his 30- to 40-year career and suggested it might originate from how forage quality is defined.



STEVE CLUBINE

This grazed big bluestem grass provides nutritious, drought-tolerant forage for livestock.

“It is true that at comparable stages of maturity, warm-season grasses are typically lower in crude protein than are cool-season grasses,” wrote Gerrish. “However, there are a few other things we need to consider when we speak of forage quality than just crude protein. More often than not it is the energy content of our forages that limits performance, not crude protein. Then we also have to take into consideration the mineral content of the forage and its palatability.”

Gerrish went on to write “It is important to understand that [fiber of] warm-season grasses and cool-season grasses . . . is not digested through exactly the same process. Most of our laboratory tests for assessing things like fiber digestibility, net energy, or Total Digestible Nutrients were developed for assessing cool-season forages, specifically alfalfa.”

These tests may be valid for comparing different harvest dates of alfalfa or cool-season grasses and perhaps different varieties of alfalfa or a species of cool-season grass, e.g., smooth brome grass. They aren't valid, however, for comparing species of cool-season grasses and certainly not for comparing cool-season grass to native warm-season grass. Native warm-season grasses are structurally different than cool-season grasses, and they are broken down in the rumen by different bioflora and enzymes. This is commonly ignored or misunderstood by many forage agronomists who downplay the value of NWSG for livestock grazing.

Gerrish also wrote, “Warm-season grasses and cool-season grasses essentially evolved in soils with different inherent nitrogen characters.” North American soils that supported native warm-season grasses and forbs developed very high organic matter due to centuries of turnover of deep roots, but they had relatively low inherent nitrogen, which was reflected in significantly lower protein in forage tests.

Native warm-season grasses are not protein deficient if they are initially grazed when new growth begins (May). If grazing is delayed until they are in late maturity stage (late June or July) or in the dormant (winter) season, that's another matter. However, forage analysis samples are commonly taken when the grasses are mid-maturity, not when they have just begun growth. That may be okay for consideration for hay harvest, but it is not for analyzing grazing quality.

Another consideration is that much of the warm-season grass research throughout the southern states and the University of Missouri has focused on introduced warm-season grasses like bermudagrass and bahiagrass, and these grasses are decidedly lower quality than native warm-season grasses. They originated in heavily leached subtropical soils.

Gerrish wrote "Those non-native species...were imported from the subtropics and tropical regions, evolved in very nitrogen-poor environments and under higher average temperatures. The result is many do tend to be lower in both protein and energy when compared to cool-season forages."

Pastures of Old World bluestems also result in low animal performance. These grasses didn't originate from subtropical or tropical soils, but were collected in more temperate parts of Europe and Asia, and had been subjected to severe, continuous grazing for thousands of years. In my opinion, they were virtually the only plants remaining that animals wouldn't eat, which attests to their low forage quality. That those who collected them and brought them to North America didn't think about that defies my logic.

Relatively few researchers have conducted comparative animal performance studies between native and introduced warm-season grasses, but those who did showed significantly lower animal gain on the introduced warm-season grasses than native warm-season grasses (at least 0.4 lb. average daily gain) when animals are forced to eat them (data collected at MDC's Talbot Demonstration Farm in the early 1980s attest to this).

Gerrish wrote that soil differences also cause differences between native ecotypes from northern and southern prairie soils: northern origin ecotypes and northern cultivars of big bluestem show higher forage quality or maybe higher animal performance than southern ecotypes or cultivars. "Because the North is cooler, ecotypes that evolved in the northern prairies tend to be higher in protein than ecotypes of the same species from the southern prairies."

However, I would also add that one must respect inherent maturity periods from which a species originates. Range conservationists caution about moving a pure species or a cultivar originating from specific ecotypes more than 150 miles south or more than 250 miles north from its origin because moving it too far south will result in the forage maturing too early or too late in the growing or grazing season. Moving a selection too far north may mean it will not have time to complete growth, carbohydrate root storage, and seed maturity before frost.

Perhaps because of Keyser's work and presentations, or maybe because of more recent studies at the University of Missouri, MU put out a news release this past winter saying that producers

might want to consider using NWSG in their grazing systems. Unfortunately, the release said they were more difficult to establish and needed careful management, preferably using Management-intensive-Grazing (MiG), neither of which is true in my experience. Keyser uses a very simple three-paddock rotation and I use no paddocks, only patch-burn grazing. MiG for NWSG may be okay for cow-calf operations—and if the operator already knows the late-season grazing needs of NWSG, but does not produce optimum gain on stockers. In other words, if cattle producers manage NWSG as if they are fescue, their pasture will be a wreck.

Gerrish, J. Are Warm-season Grasses Really Lower Quality than Cool-season Grasses? Grassroots for Grazing. The Stockman Grass Farmer, Ridgeland, MS, Vol. 19, # 3, March, 2019.



Native Pasture Walks

Just to keep the momentum going, I had or will host four native pasture walks this summer. One was for a group of producers north of Columbia that my old friend and retired NRCS grassland specialist Maurice Davis brought down; two are for the Missouri Prairie Foundation (June 20 and July 18), and one for Amy Hamilton's Top of the Ozarks grazing group. I may repeat these in 2020 if there's interest.

Not only am I having more fun grazing my native warm-season grasses and forbs and talking to folks about it than when I was the grassland biologist for the Missouri Department of Conservation, the management is easier than I ever described it would be.

I planted another 4 acres this spring. The planting is on a wet site with some creek overflow and side-hill seeps. Spraying the fescue last fall was pretty easy, but burning the dead thatch off this spring, getting the second spraying on, and seeding, was challenging after such a wet winter and spring.

**Keep the long grasses growing,
Steve Clubine**



CYNTHIA COBBLE

Spiders: Inquiry to Food Chains

Nature may be complicated is a message that students working outdoors often discover. The more we observe, our expectations of nature do not always ring true.

Life science studies in third, fourth, and fifth grade often include food chains. Classroom research and student observations may be based at first on a straightforward food chain. As a student more closely examines each placeholder in the chain, he or she begins to learn about that species' suite of adaptations for survival, which are engaging to study and write about. Students understand and appreciate a species' niche the more

they understand the mechanisms of adaptations and predator/prey relationships. This understanding comes from awareness of each placeholder's significance, and from exposure to and research about the relationships of these placeholders with other organisms in the food chain.

Students may

first write inquiry statements to investigate the subject(s) of their choice. The teacher may designate a study area (small-scale habitat) on the schoolyard and/or a native grassland field trip destination. The habitat sites may be compared and contrasted.

Spiders make an ideal subject for food chain or web studies. Spiders should be at hand on the playground, around a school's native flower garden, and certainly during a prairie field experience. Students will be fascinated by the diversity, number, and hunting strategies of spider species. Data recorded in students' science notebooks may include microhabitat site selection linked to specific spiders. Higher level, critical-thinking comes into play when the students realize how plentiful this group of organisms is in our environment. They may discover that many of the same spiders that are predators are also prey—as diagrammed on a student's food chain strands. Several or all students sharing their food chain strands allows the class to examine the whole spider community in a particular area.

Undeniably, the students' observations may be complicated as they discover the complexity of spider ecology. To add to the

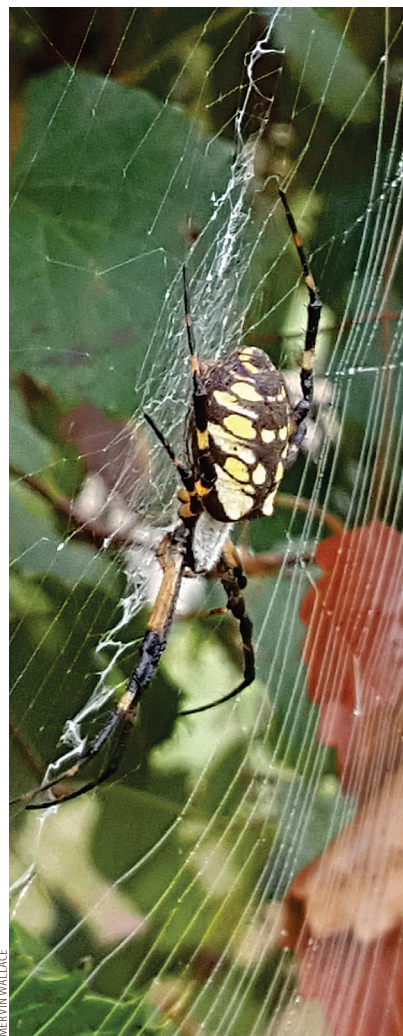
inquiry exercises, the educator may challenge students to address “What if?” statements. For example: What if the temperature were 20 degrees different? What if plant stem density were crowded around a spider web? What would happen if spider silk were standard for all spider species instead of being diverse (sticky, smooth, thin, thick, fuzzy, etc.)? What if the spinnerets (a spider adaptation student research topic) were standard for all spider species? If an orb spider rushes to the center of the web to seize small, entangled prey, what happens if a hornet flies in?

Food chains and webs are often taught in school with little thought other than “who eats what?” Framing this study with an inquiry approach can expand this elementary grade concept into an exercise about ecological complexity.



CHRISTOPHER HEINS

The diversity and abundance of spiders—on prairies and in the school yard—make them readily available subjects for learning about the complexity of food chains.



MERVIN WALLACE



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Some spiders, like the crab spider above, often hide in flowers and ambush insect prey. Orb weavers, like the one at the left, catch prey with circular webs while other spiders have funnel-shaped or other web forms.

Missouri State Learning Standards: K.LS1.C.1, 3.LS3B.1, 3.LS3.D.1



Wasps: Allies in the Garden

Wasps and other predatory insects provide many benefits.

By Susie Van de Riet

The basic definition of *beneficial* means *favorable or advantageous, resulting in good*. The term beneficial insect, then, refers to an insect whose behavior results in good for us. The beneficial insect category typically includes insect pollinators such as bees, flies, wasps, butterflies, beetles, and moths—they (and some vertebrate pollinators) benefit us by pollinating 85% of plants on Earth. Some pollinating insects, including wasps, are also predatory, which benefits farmers and gardeners alike.

Beneficial Predatory Insect Primer

Insects and other arthropods can be beneficial to us in numerous ways. Many—I’ll call them “beneficials” for simplicity—are predators and parasitoids of agricultural and garden pests, such as aphids. These predatory beneficials include wasps, as well as mantises, true bugs, lacewings, spiders, predatory mites, and harvestmen (a.k.a. daddy longlegs).

These beneficials feed on, or feed their young with, many of the pest arthropods in our landscapes. Beneficials keep invertebrate populations in check. For example, many caterpillars eat crops. This can be a problem if there is nothing to keep the caterpillars from getting out of control. This is where beneficials like wasps come to the rescue, because many of them use caterpillars to feed their young, keeping caterpillar populations in balance. In this case, a wasp’s ability to keep pest populations in check can mean



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Many wasps benefit us not only by preying on pests, but also by pollinating flowers as they feed. While gathering nectar from butterfly milkweed, this great black wasp (*Spbex pensylvanicus*) unwittingly extracted a structure bearing pollen packages called *pollinia*, attached to its leg. The *pollinia* are like “keys” that insects like wasps pull from the “locks” of flowers and then fortuitously insert them into other milkweed flowers, enabling pollination.

the difference between a successful crop production and a crop that goes to waste.

This predator-prey relationship can be important to agriculture, but also for native plants, and even non-native ornamentals.* In the garden, the following groups of beneficials do this predatory work for us:

- True bugs (Order: Hemiptera) include minute pirate bugs, assassin/ambush bugs, and predatory stink bugs. These may target some or all of the following: thrips, mites, scales, aphids, plant lice, small caterpillars, various insect eggs, and sometimes beneficials.
- Mantises (Order: Mantodea) are generalist predators meaning they will eat many different arthropods—beneficials and pests alike.

- Lacewings (Order: Neuroptera) include green and brown lacewings, also known as “aphid lions” because lacewing larvae travel up to 100 feet in search of prey and can consume up to 400 aphids each week. That said, lacewings have many other targets as well, including other beneficials.

- Beetles (Order: Coleoptera) include firefly beetles. The adults feed on nectar/pollen and the larvae feed on snails/slugs, caterpillars, worms, and other small soft-bodied insects. Beetles also include lady beetle larvae and adults who specialize on aphids, scales/mealybugs, and a variety of others.

- Flies (Order: Diptera) include the flower fly, whose larvae feed on aphids (among others) and whose adults feed on nectar.

- Spiders (Order: Araneae) include

*Attracting native predatory arthropods to the yard to help solve pest problems is not always the quickest solution. Sometimes spraying or treating plants with an insecticide is another option, but many of these products do not discriminate between beneficial and non-beneficial creatures. There is much information and research available on this subject, and I encourage anyone who is going to use a more immediate solution to a pest problem to do sufficient research on the intended and unintended consequences of those actions.

spiders such as the wolf spider, jumping spiders, orb weavers, and sheet weavers who go after an array of various insects—beneficials and pests.

- Predatory mites (Order: Acari) target a variety of pest species.
- Harvestmen, a.k.a. daddy-long legs, (Order: Opiliones) feed on a number of slow-moving insects.
- Wasps (Order: Hymenoptera) are the stars of this show!

The above information and much more detail can be found in the Xerces Society's Habitat Planning for Beneficial Insects resource (Xerces Society 2016).

Wasps: Not Interested in You

When I give a presentation to a group and start talking about how great wasps are, many people cringe or roll their eyes, and almost on cue, I hear audible groans signaling disapproval and disgust. So, let's talk facts and truth about these often misunderstood, misrepresented living beings whose benefits to us often continue to be unrecognized.

When you read "wasp," what insect do you picture? Maybe you already love or appreciate wasps as I have come to. Maybe you already appreciate the huge variety of wasp species—115,000 globally and 18,000 in North America, according to insectidentification.org—and how so many of them go about their business, paying no attention to us. But, perhaps you had a negative run-in with a yellow jacket wasp nest at one time in your life, or heard others talking about a run-in with a yellow jacket nest, or heard others talking about the possible attack that could happen IF you had a run-in with a yellow jacket nest. I argue that much of the fear surrounding wasps is unfounded.

Most wasp species are not social like yellow jacket wasps, but are solitary (O'Neill 2001). This distinction is important because social insects will often be more defensive when they are guarding a colony. So, when you get too close to a yellow jacket nest, or run over it with a mower, it causes quite a stir because the yellow jackets kick into "protect the nest and let that large possible predator know that we are here" mode.

Working in the green industry and



SUSIE VAN DE RIET



SUSIE VAN DE RIET

spending a lot of time around yellow jackets and other wasp colonies, I can tell you that they aren't quite as reactive as one would believe. Moving slowly around them, watching out for them, and leaving them alone can do wonders. Heeding their warning signals (buzzing loudly in your face or around your body) and moving away slowly have helped me avoid many a follow-up notification of their presence, that is, a sting (Schmidt 2016).

Solitary wasps like black and yellow mud daubers, potter wasps, and great black wasps behave somewhat differently.

The female (other than mating with a male) is on her own, responsible for foraging for food for her young. Her stinger is primarily used for hunting and paralyzing prey for her young. She will often feed on things like nectar from flowers and sap.

If the female gets into a stinging match with a human, her entire reproductive potential gets wiped out if she gets squished. No other wasps are going to come to her aid. So she picks her battles wisely and is not so defensive unless provoked (i.e., you go poking at her with



SUSIE VAN DER RIET

At left, clockwise: ① While weeding her yard, the author stirred up this *Ichneumon* wasp in the *Anomalon* genus. The wasp being so tiny, she almost didn't pay attention to it, then realized what it was. ② This potter wasp (*Eumenes* sp.) collects pollen on its head while visiting a yellow passion flower, transferring it from flower to flower as it feeds. Potter wasps are quite timid, creating beautiful pottery-type nests (inset) in all kinds of locations. ③ This common thread-waisted wasp (*Ammophila procera*) is nectaring on goldenrod. These gentle (to people) wasps sip nectar and take down insects to feed their larvae in underground tunnels. ④ This great golden digger (*Sphex ichneumoneus*) wasp is a ground nester that keeps to itself, sipping nectar during the summer, and provisioning its underground tunnels with prey for its young.

These wasps may target aphids, stinkbugs, caterpillars, beetle larvae and adults, fly larvae and adults, true bug nymphs and adults, grasshoppers, and spiders (including black widow spiders!).

Predatory wasps include, but aren't limited to, cicada killers, great black, mud daubers, paper wasps, yellow jackets, bald faced hornets (a type of yellow jacket), thread-waisted wasps, and great golden digger wasps. The cicada killer wasp is one of my favorites to observe. They are about half the diameter of their prey—cicadas. As the annual cicadas start to emerge, cicada killers also emerge. First, they mate, then the female does her thing: she seeks out a cicada, stings it to paralyze it, and then grabs the cicada and flies—or glides, if you will—down to the ground in search of her burrow. She then takes the cicada down into their burrow and lays an egg on top of it. The egg hatches and the larva then feeds on the still fresh cicada and remains in that burrow through the winter until the following year, emerging as an adult to start the cycle again as the cicada symphony begins.

Parasitoid wasps, which actually kill their hosts (unlike fleas for example), lay their eggs on or in the host. The parasitoid wasp eggs hatch, and the larvae will feed on the host until eventually they kill it and emerge from it. These wasps target insects like aphids, bagworms, elm-leaf beetles, emerald ash borers, lace bugs, pine-tip moths, whiteflies, scales/mealybugs, caterpillars of many butterflies



CAROL DAVIT • INSECT SUSIE VAN DER RIET

your finger or accidentally sit on her). I have followed many solitary wasps around and have walked through aggregations of solitary cicada killer wasp nests, all without being stung. In fact, the reaction from many of these wasps is to fly away from me or simply ignore me. That said, if you are allergic to stings, always have a back-up plan in case you do get stung. (If you want to read some fascinating information about the varying severity of wasp stings—someone has actually tested many of them and ranked them!—there is a great book called *The Sting of the Wild*,

which gives much detail on the subject. Often, some of the larger wasps don't have that painful of a sting [such as the cicada killer]).

Wasps: Allies and Warriors in the Garden

Now that we've covered some information to give us a better understanding of wasps, let's look at how they control specific pests.

Predatory and parasitoid wasps have different feeding styles. Predatory wasp females collect prey to bring back to their nests as food for their carnivorous larvae.

and moths, flies, beetles, leafhoppers, and many other insects.

Ichneumonidoidea-type parasitoids (like *Ophion* spp. or *Anomalon* spp. wasps) are larger in size, while Chalcidoidea parasitoids (like *Torymus* spp. wasps) are tiny. The long ovipositors of many parasitoids look like stingers, but pose no threat to humans and are used to place their eggs precisely where they need to go. Some parasitoid wasps are extremely tiny, measuring less than 5 mm, and others are quite large—up to 20 mm. Their own life cycles are closely synchronized to their hosts' (Xerces Society 2016).

One parasitoid wasp that specializes on subterranean beetle larvae (including Japanese beetles) is the scoliid wasp.

Wasp Conservation

There are several strategies we can deploy to support a variety of wasp species in gardens, farms, and native plant areas. One is known as Conservation Biological Control, which entails providing habitat to support natural enemies.

Habitat is key. For wasps, ideal habitat requirements are similar to what we need: food, shelter, space, and a pesticide-free (poison-free) zone. Wasp adults need a

constant source of nectar through the whole growing season. Shallow flowers, like Robin's plantain and mountain mint, as well as plants with extra-floral nectaries (glands on plants that secrete nectar), like elderberry and partridge pea, are good nectar sources for wasps. Maximum benefit will come from having 25% or more of your yard planted with nectar sources (Xerces Society 2014). See the listing on page 30 for a list of other natives you can use to encourage wasp populations.

Food for wasp larvae is important as well, and will be provided in the form of pest populations including aphids, spiders, beetles, and other invertebrates. So, you most likely have your bases covered with food for their young if you have any insects or insect pests in your space.

In addition to providing food sources for wasp larvae and adults, there are landscaping practices you can carry out that will also encourage specific wasp populations. For shelter, resist the urge to tidy up your landscape. Hollow stems, rotting wood (holes/cavities), nesting blocks, and patches of bare soil are all places where wasp adults and/or larvae will take shelter and often overwinter. Low-growing vegetation such as native bunch grasses like prairie dropseed can provide needed shelter from the elements. Many people like to cut back spent, standing vegetation, but leaving it standing (cutting back no more than two-thirds of the height) until spring green up again is ideal. (The Xerces Society suggests waiting until you put your winter coat away to remove dormant vegetation).

For nesting, brush piles create amazing habitat for wasps and many other little creatures. In addition to provided nesting areas, they serve as fantastic hunting grounds and shelter for wasps. Rotting wood, hollow stems, dormant growth, nesting boxes, and stem bundles will provide nesting areas. Leave some bare patches of soil between plants for ground nesting wasps. Try to limit your tilling to little or none to reduce disruption to the ground nesters and microbes as well.

While prescribed burning of plantings is important for native plant growth and flowering, burning should be limited or

WASP HABITAT



SCOTT WOODBURY



SUSIE VAN DE RIET



PAUL COX

At left, clockwise, prescribed burns of original and planted habitat should be carried out on a rotational basis so that an entire area is not burned in a single year. In this photo at the Missouri Prairie Foundation's Stilwell Prairie, for example, prairie in the background will not be burned, so that arthropods and other animals have refuge in winter. In addition to needing a diversity and abundance of native flowering plants and insects for food, wasps and other predatory arthropods need shelter and nesting areas. Standing dead vegetation, rotted wood, fallen leaves, and brushy areas are important elements of their habitat.

put on a rotation schedule. This allows some wasp populations to remain in plant materials as a refuge, allowing for a faster rebound since not everything is being wiped out if an entire area is burned. Other important considerations are to avoid burning during critical nesting seasons (usually spring and summer), and, after vegetation is established, to limit burning or mowing to no more than 30% of an area in one year to ensure enough undisturbed shelter and food for wasps (Xerces Society 2014).

Be informed about insecticides and avoid them whenever possible. Take time to research alternative solutions if you need a more immediate result than what Biological Conservation methods afford.

Another helpful strategy to keep in mind to outsmart pests and encourage wasps to thrive is a trap crop. Trap crops attract pests away from your primary crop or ornamental. You can place a trap crop amongst native plant habitat, where you hope to attract wasps.

You also can intersperse crops/ornamentals with native plants that are nectar sources, such as with rows or hedgerows of flowering natives. It is important to know exceptions where certain native plants may not be helpful because they are alternate hosts to crop pests. For example, in the case of apples, pears, and the apple maggot, hawthorn and wild plum are alternate hosts and should not be planted near apples and pears. Likewise, elderberry and willows are hosts of leafhoppers/sharpsshooters and should not be planted along with grapes. Lastly, wild plum, elderberry, and wild raspberry are hosts to the spotted-wing drosophila and ought not be planted near cultivated berry plants.

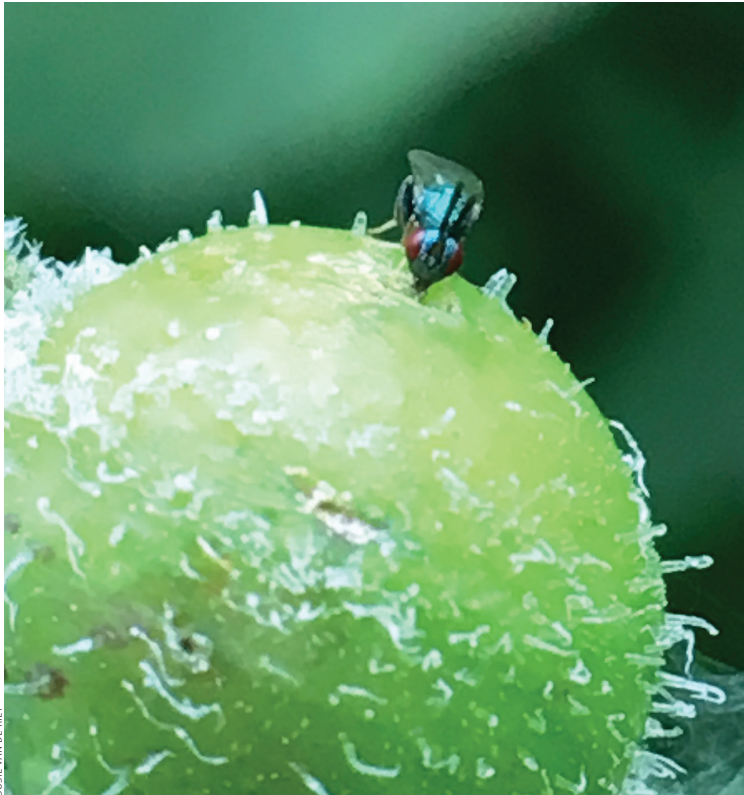
Wasps are beneficial insects that behave as our allies—and they can do their job the best when we know and understand them better, so we can maintain ideal habitat for them. They are the “checks and balances” for so many insects and insect pests, and they also are food for others in the food

web. In addition, they are important pollinators of certain natives. The next time you see a wasp or something that resembles a wasp, instead of running away from it, I invite you to give in to the curiosity that begs you to watch, observe, understand, and ultimately appreciate these beautifully diverse little beings.

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Susie Van de Riet, a Grow Native! professional member, is owner/designer/educator of St. Louis Native Plants LLC and horticulturist with Forest Park Forever. She works to connect people with native plants and wildlife.



Left to right, this Chalcid (*Chalcidoidea*) wasp parasitizes gall insects that develop in plant tissue (in this case, a goldenrod species). Bald-faced hornets (*Dolichovespula maculata*) like this one typically build their nests high up in trees and don't bother you unless you approach the nest closely and aggressively. The author has parked her doorless/windowless work vehicle within 10 to 15 feet of a nest not too high in a tree, and the hornets flew through her vehicle to and from the nest, disinterested in her.

Natives that Benefit Wasps and other Predatory Insects

For the following plants, sun/shade requirements and bloom time ranges are provided.

WILDFLOWERS



Purple poppy mallow

Groundcover/Under 2 feet

- **Robin's plantain** (*Erigeron pulchellus*); lt/med shade; mid–late spring
- **Pussytoes** (*Antennaria* spp.); sun/med shade; mid spring–early summer
- **Purple poppy mallow** (*Callirhoe involucrata*); sun; early–mid summer



Aster



Bee balm

2–4 feet

- **Golden alexanders** (*Zizia* spp.); sun/med shade; mid spring–early summer
- **Lanceleaf coreopsis** (*Coreopsis lanceolata*); sun/lt shade; late spring–early summer
- **Mountain mint** (*Pycnanthemum* spp.); sun/lt shade; mid summer–early fall
- **Partridge pea** (*Chamaecrista fasciculata*); sun; early–late summer
- **Asters** (*Symphyotrichum* spp.); sun/med shade; late summer–mid fall
- **Bee balm** (*Monarda bradburiana*); sun/shade; late spring–early summer



Butterfly milkweed



Goldenrod



Rattlesnake master

4 feet or more

- **Milkweeds** (*Asclepias* spp.); sun/med shade; late spring–early fall ; some species shorter
- **Rattlesnake master** (*Eryngium yuccifolium*); sun/lt shade; mid–late summer
- **Goldenrods** (*Solidago* spp.); sun/shade; late summer–mid fall
- **Late figwort** (*Scrophularia marilandica*); part sun/med shade; late summer–mid fall
- **Prairie dock** (*Silphium terebinthinaceum*); sun/lt shade; late summer–early fall

SHRUBS/TREES



New Jersey tea

To 4 feet

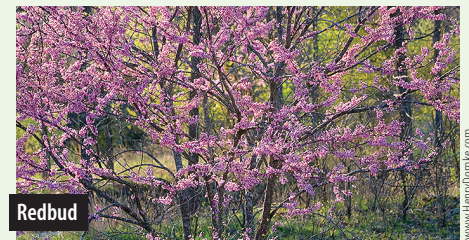
- **Prairie red root** (*Ceanothus herbaceous*); sun/lt shade; late spring

- **New Jersey tea** (*Ceanothus americanus*); sun/lt shade; early summer
- **Leadplant** (*Amorpha canescens*); sun/lt shade; early summer
- **Wild hydrangea** (*Hydrangea arborescens*); shade/part sun; early–mid-summer
- **Shrubby St. John's wort** (*Hypericum prolificum*); sun/med shade; early–late summer

TALLER SHRUBS & TREES



Ninebark



Redbud

- **Ninebark** (*Physocarpus opulifolius*); sun/shade; early summer
- **Elderberry** (*Sambucus canadensis*); sun/shade; early–mid-summer
- **Wild plum** (*Prunus* spp.); sun/lt shade; early–mid spring
- **Serviceberry** (*Amelanchier arborea*); sun/med shade; mid-spring
- **Redbud** (*Cercis canadensis*); sun/med shade; early–mid-spring
- **Hawthorn** (*Crataegus viridis*); sun/lt shade; late spring
- **Sassafras** (*Sassafras albidum*); sun/lt shade; mid-spring
- **Basswood** (*Tilia americana*); sun/lt shade; early summer

News from **Feaster Glade**



CÉCILE LAGANDRÉ

Concerning Feaster Glade—the Benton County, MO property whose wildlife considers my husband and I its own humans—I am shamefully reporting that the removal of ubiquitous redcedar trees (*Juniperus virginiana*) has almost come to a stand still.

Let's pretend that pure and simple laziness is not even a fifth of the reason—I am not yet ready to fess up. Instead, blaming the narrow window of opportunity sounds like a good alternative. To avoid noise pollution and allow

the benefit of standing snags, the year-round guillotine doesn't fell our redcedars. Instead, they are girdled manually and delicately when the soil is saturated and the outside temperature enables photosynthesis to pump upward a significant amount of sap. In these conditions, at least one—sometime more—outside wood layers overflow with water, which lubricates their interstitial spaces and permits their easy peeling from older layers. The result is a clean and shiny girdle scar.

Now, what's the problem? Well, there are very few weekends when both I am present at Feaster Glade and the required weather happens. Moreover, I can perform an average of only three redcedar surgeries per half-day before becoming distracted by one thing or another.

Once upon a dry fall morning last year, I removed 20 cm of bark all around a trunk, including all bright red and purple layers, but stopped there because the first wood layer was uncooperative—firmly bonded to the previous ones. This spring, not surprisingly, I found this tree still green, since redcedars do not become brown from a summer or fall girdling over the following winter—a wet spring "rite of passing" is necessary. However, this bark girdle was uniformly covered by resin through which bright red was visible. In this case, resin provided protection to the layer of undifferentiated tissue, which was able to produce a new bright red layer of phloem—tissue transporting sap downward.

The wood of girdled redcedar trees, over the time of their slow demise, fills with resin in the voids created by their dried-up transportation tissues, becoming naturally treated wood in the process. This phenomenon can easily be observed on the dead lower branches of redcedar trees that have become extraordinarily strong and resistant to decay. A drawknife is the next tool I am going to try using in the hope of accelerating my pace of glade restoration.

MPF member **Cécile Lagandré** and her husband Dave Van Dyne have the privilege of calling Feaster Glade their own. Lagandré shares tales of its restoration in the *Missouri Prairie Journal*.

Tributes

February 6 through May 17, 2019

♦MPF thanks Mary Zoeller for her gift in memory of her son, **Tracey Zoeller**.

♦MPF thanks Barb, Erin, and Hope Zehnder for their gift in memory of **Fergus Cardwell**.



♦MPF thanks Nathaniel Barnicle for his gift in honor of **Terri Barnicle** for Mother's Day.

♦MPF thanks the children of **MPF Past President and Emeritus Board member Warren Lammert** for their gift in honor of his birthday.

♦MPF thanks Pat and Jill Hardman for their gift in honor of **Deborah Borek, MD** on her birthday.

♦MPF thanks Matthew Broderick for his gift in honor of **MPF Emeritus Board member Bill Davit**.

♦MPF thanks Katherine Corwin for her gift to MPF's Grow Native! program in honor of **Grow Native! Committee member Paula Diaz**.

You Can Help MPF Grow

MPF's loyal members help our prairie conservation efforts in important ways. Membership dues provide vital income to our operations, and the greater our membership, the stronger our advocacy efforts on behalf of prairie conservation and native plant promotion.

If you are not a paying member now, please consider joining, or give the gift of membership to a loved one. Dues for all membership levels may be paid in a lump sum or in monthly increments.

Student member: \$20

Coneflower member: \$35 (or \$3 monthly)

Henslow's Sparrow member: \$50 (or \$5 monthly)

Ornate Box Turtle member: \$100 (or \$9 monthly)

Northern Harrier member: \$250 (or \$20 monthly)

Prairie Sunrise member: \$500 (or \$42 monthly)

Lifetime member: \$2,000, lump sum

You can become a member, renew your membership, or give a gift membership by sending a check and member postal address to: Missouri Prairie Foundation, c/o Bank of Missouri, P.O. Box 856, Mexico, MO 65265-0856, or by visiting www.moprairie.org, or by calling 888-843-6739.

BRUCE SCHUETTE

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PLEASE NOTE that your MPF membership expiration date is printed with your address. Renewing promptly will save MPF costs of mailing renewal reminder letters. To renew, see page 3.

You Are Invited to these Prairie & Native Plant Events

These are events organized by MPF, its Grow Native! program, or in participation with other groups. Details are available at www.moprairie.org and www.grownative.org. Need help registering? Call 888-843-6739.

Saturday, August 10—MPF Annual Dinner & Silent Auction in Jefferson City at Capitol Plaza Hotel

Join us for this special evening. Shop for outdoor equipment, artwork, and outdoor experiences; enjoy a meal with fellow prairie supporters; and learn from our guest speaker, John Murphy. Murphy is Wildlife and Ecological Services Manager for Roeslein Alternative Energy in northeastern Missouri. During his talk *Prairie Remnants, Restorations, and Promise*, Murphy will share his love for the prairie gems of northeastern Missouri and holistic prairie restoration landscape ecology.



Table sponsor (table for 10): lifetime members: \$450; non-lifetime members: \$550. Individual dinner reservations: MPF member: \$55; non-MPF member: \$65. Lifetime members receive two complimentary tickets and patrons receive tickets commensurate with current patron level. Price includes two drink tickets. Reserve now at www.moprairie.org or watch for your invitation in the postal mail. RSVP so payment is received by August 1. Hotel rooms are available for a special rate of \$89; for room reservations, call (573) 635-1234 and mention the Missouri Prairie Foundation. Special field trips for dinner guests to nearby Missouri Wildflowers Nursery and the Prairie Garden Trust are also being planned for the weekend. See www.moprairie.org for details.

Saturday, July 13—Registration full: Tour of MPF member Chan Mahanta's prairie garden atop the Missouri River Bluffs in Florissant, MO.

Thursday, July 18—Grazing Steers on Native Grasses and Forbs Tour with Steve Clubine near Clinton, MO. Free. Register at www.moprairie.org.

Saturday, July 20—Join us as we dedicate MPF's newest prairie acquisition in northwestern Lawrence County, near the towns of Lockwood and Golden City, MO. Enjoy brief remarks, refreshments, and a guided tour of the prairie at 2:00 p.m. RSVP to 636-303-7418 or email outreach@moprairie.org. Directions: From I-44 head north on Hwy 97 at the Stotts City, MO exit. Go approximately 15 miles to Hwy. NN. Take NN west 1.5 miles to County Road 1040 and turn to

the south. After 1 mile on 1040, you will see Providence Prairie Conservation Area to the west, and County Road 2010 to the east. Take 2010 east for 1 mile and the MPF prairie will be on the north side of the road. (You can also Google directions to Providence Prairie Conservation Area and go east on 2010 from there.)

August 15, 2019—Grow Native! Workshop in Monett, MO: *Native Plants for Soil Health, Pollinator Enhancement, Livestock Production, and Specialty Crops*. Hobby farmers, recreational landowners, row crop farmers, livestock producers, and wildlife enthusiasts can learn about the many benefits native plants provide

for improving soil health, creating pollinator and wildlife habitat, producing nutritious livestock forage, and establishing specialty crops. NRCS provided funding for this workshop. Register at www.grownative.org.

Thursday, September 5—Grow Native! Mingle with Native Plant Professionals at Bridging the Gap in Kansas City.

Saturday, September 7—Guided hike at MPF's Golden Prairie Natural Area, in recognition of Missouri's forthcoming bicentennial. Join MPF Director of Prairie Management for a walking tour of the 320-acre National Natural Landmark, and get a glimpse of what much of Missouri looked like at the time of statehood. Golden Prairie is near the towns of Golden City and Lamar in southwestern Missouri. Free. RSVP at www.moprairie.org, or call 888-843-6739.

Wednesday, September 18—Native Shrubs and Trees Walk at Bellefontaine Cemetery and Arboretum. Free. Register at www.grownative.org.

Friday, September 27—Grow Native! workshop in Springfield, MO in partnership with Drury University. Four native plant professionals will speak during this *Plants with Purpose: Native Landscapes for Beauty & Biodiversity* workshop, focusing on preparing and maintaining seeded landscapes, and creating formal gardens with natives, edible native plants for pollinators and people, and native trees and shrubs. Registration and details at www.moprairie.org.

Saturday, September 28—*Why Prairie Matters* presentation with MPF Executive Director Carol Davit, hosted by the artist Bryan Haynes in his studio in Washington, MO. Meet acclaimed New Regionalist painter Bryan Haynes and learn about the importance of prairie to Missouri. Limited seating; registration fee to support MPF. Watch for details at www.moprairie.org or call 888-843-6739.

Saturday, October 19—Save the date! MPF Annual Member Meeting and Evening on the Prairie at Snowball Hill Prairie near Harrisonville, 35 miles south of downtown Kansas City. Watch for details.



MPF PLANT SALES

MPF is partnering with two hosts this fall, where vendors will sell a variety of native wildflowers, grasses, sedges, vines, shrubs, and trees, donating a portion of their proceeds to benefit MPF. Visit www.moprairie.org for lists of vendors, pre-order information, and other details.

Saturday, September 7: 10:00 a.m. to 2:00 p.m. World Bird Sanctuary, Valley Park, MO.

Saturday, September 21: 9:30 a.m. to 2:30 p.m., Anita B. Gorman Discovery Center, Kansas City, MO

E-news alerts provide MPF members with news about more events. Send your e-mail address to info@moprairie.org to be added to the e-news list. MPF does not share e-mail addresses with other groups.

Events are also posted at www.moprairie.org.

