New feral swine research helps pinpoint anthrax risk zones

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Feral swine have been called the "rototillers" of nature. Their long snouts and tusks allow them to rip and root their way across America in search of food. Unfortunately, the path they leave behind impacts ranchers, farmers, land managers, conservationists, and suburbanites. Credit: NASA, courtesy of USDA APHIS

A microscopic anthrax spore can lie dormant in the soil for decades until it ends up in a suitable host. Factor in feral swine and their natural tendency to root and wallow, and whose exploding population is estimated at over six million in the U.S. alone, and a concerning scenario emerges.

Rachel Maison, a Ph.D. student in Colorado State University's Department of Biomedical Sciences, recently published an innovative study that tested feral swine blood samples for the presence of anthrax antibodies in and around the "anthrax triangle," an area of southwest Texas where high numbers of anthrax cases have occurred in domestic livestock and farmed deer populations. This promising research, never before done in the U.S., was featured on the Centers for Disease Control and Prevention podcast as well as its March 2022 Zoonoses & One Health Updates webinar and provides an important tool for better monitoring and responding to the dangerous pathogen.

"Rachel's work is a stellar example of how important it is to bring together humans, animals, and the environment when assessing the threat of zoonotic diseases," said Angela Bosco-Lauth, Maison's adviser and an assistant professor in the Department of Biomedical Sciences. "From management practices to invasive species to environmental conditions, we can't ignore the impact that each factor has on disease risk. And as an individual, Rachel's background in conservation, wildlife, and disease make her the ideal researcher to tackle these complex topics."

A conservation mindset

Maison grew up in Glenwood Springs, Colorado, where she developed a passion for wildlife conservation. After earning a bachelor's degree in fish, wildlife, and conservation biology from CSU, she was hired as a biological science technician with the USDA National Wildlife Research Center's National Wildlife Disease Program and later joined its National

Feral Swine Damage Management Program, which works to protect agricultural and natural resources, property, and animal and human health and safety by managing damage caused by feral swine.

Through this work she was introduced to her now co-advisers, Bosco-Lauth and Richard Bowen, a professor in the Department of Biomedical Sciences, who both closely collaborate with the USDA in their wildlife, zoonotic, and infectious disease research efforts. Maison's research centers around investigating pathogens that might be carried or influenced by feral swine in the U.S. and focused on anthrax for this study.

"Because pigs in general are pretty resistant to developing anthrax, they seem to be a good species for mapping out risk regions," Maison said. "I knew through my undergraduate coursework that feral swine were a very problematic invasive species. Working with the USDA inspired me to further pursue wildlife disease surveillance work and to look at how invasive species might contribute to not only human health, but also the health of native wildlife populations and threatened or endangered species."

An ancient—and stealthy—disease + a destructive invasive species

Anthrax, caused by the bacteria Bacillus anthracis, is a rare but serious infectious disease that is thought to date back to at least 700 B.C. While uncommon, it can infect humans, and sporadic outbreaks occur in wild and domestic animal populations. It is also an extremely important pathogen to track and better understand due to its past and potential use in bioterrorism attacks.

Anthrax infections can occur when B. anthracis is inhaled, ingested, or

comes into contact with broken skin. Ruminant species like cattle and deer are very susceptible to even small doses of anthrax spores and will often quickly fall fatally ill after exposure. Their bodies may then be scavenged by other animals, which can release spores back into the environment.

Once B. anthracis vegetative cells are exposed to oxygen, they expertly enter a dormant state and become spores that are highly resistant to environmental degradation, allowing them to be present on the landscape for indefinite lengths of time. Once they enter a new host, they can quickly come back to life and resume the infectious cycle.

About half of the nation's six million feral swine live in Texas, home to the anthrax triangle, and though they spend a great deal of time rooting around in the soil with their long snouts, they are mostly resistant to the disease.

Not your average farm pig, feral swine are typically more aggressive, can run up to 30 miles per hour, and often sport thick skin, coarse hair, and sharp tusks. They descended from escaped or released pigs that were first brought to the U.S. in the 1500s as a food source and Eurasian wild boars introduced in the 1900s for sport hunting.

Feral swine eat and destroy field crops such as corn, milo, rice, watermelon, spinach, peanuts, hay, turf, and wheat. Credit: USDA APHIS photo Craig Hicks

Highly adaptable opportunistic omnivores, feral swine lack natural predators and can produce litters of up to 10 pigs year-round. This, combined with their propensity to eat or displace wildlife species and destroy ecosystems and human property, makes them a very good invasive species—and their population explosion a very big problem. Feral swine are estimated to live in at least 38 states in the U.S. where they cause an estimated $2.5 billion in agricultural damage each year.

And while the anthrax triangle region of Texas has experienced a high number of anthrax cases in livestock and deer, areas just outside of the

region have rarely or never had outbreaks.

"Part of the difficulty in identifying anthrax risk zones is that unless you actively sample the soil or know of an outbreak that occurred in the past, you likely won't know that bacteria is present until it's too late and you start seeing dead or dying animals," Maison said.

Further complicating current models of anthrax risk zones is the fact that some outbreaks have been known to occur up to 40 years apart. And the response to anthrax outbreaks in livestock has largely been reactionary once animals are already getting sick.

Serosurveillance as an early warning sign

Maison's study aims to help improve the management of and response to anthrax through serosurveillance, a process of testing blood samples for the presence of antibodies against a specific disease that can help experts predict potential outbreaks and plan vaccination efforts.

"By examining feral swine blood for anti-anthrax antibodies, we may use this as an early warning sign for anthrax bacteria in an area," Maison said. And since feral swine are known to have relatively small home ranges between one and five square kilometers, the data could be used to map potential regions where the bacteria might be present.

Maison's study analyzed 478 samples from the USDA National Wildlife Research Center's archives, half from within the anthrax triangle region and half from outside of it. Results showed a higher prevalence of anthrax antibodies in the triangle region, yet relatively high positivity rates in all of the samples, which indicated exposure occurring in feral swine throughout Texas due to anthrax-causing bacteria, including outside of the high-outbreak anthrax triangle zone.

In places known to be endemic for anthrax, or in areas where outbreaks have occurred in the past, preventative management has mainly consisted of ranchers vaccinating their livestock, which is effective and can also be used during an outbreak to protect other animals. An anthrax vaccine for people exists as well, though it is only given to those who could potentially be exposed occupationally, such as laboratory personnel who work with the bacteria.

"I think ranchers and landowners would be interested in knowing ahead of time if there is a risk facing their livestock, or to know if the region they're in is in fact contaminated with anthrax-causing bacteria, as people often won't vaccinate their livestock unless their herds are actively being affected by anthrax—which is usually too late," Maison said.

She hopes to continue building on this work by contributing to a series of important next steps, including working to determine the levels of bacteria feral swine were potentially exposed to as well as when the exposures actually took place. "Given that anthrax can go years without being observed in a particular area, it would be nice to know if when you see an antibody-positive animal, you could work backwards and see when that exposure happened in real time."

And because feral pigs are here to stay and naturally act like rototillers in the soil, Maison is interested in looking deeper into the various potential ways they may be playing an active role in spreading spores on the landscape, and if their actions result in more infections occurring in other species.

"I think identifying risk factors and educating stakeholders and the general public about anthrax is really useful," Maison said. "Even though humans are not really afflicted by this disease, it is unfortunately a concern for many livestock owners in endemic regions, so it's important

to bring this information to those people and also to keep a better handle on where anthrax is hiding—I'm excited to see what comes of this in the future."

Provided by Colorado State University

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