

# The Night Shift

*Unseen and unheeded, Baja Arizona's many bat species provide our local food producers with natural pest control.*

BY CHARLES C. HOFER | ILLUSTRATIONS BY ROBERT J. LONG

BENEATH THE Campbell Avenue Bridge, the acrid smell of ammonia mingles with humid air still lingering from the afternoon's monsoon. It's shortly after 7 p.m., and a scattered crowd with a mood of anticipation has gathered along the river path. Tucson's most dependable natural phenomenon is about to begin.

The bridge is home to a colony of Mexican free-tailed bats (*Tadarida brasiliensis mexicanus*), the smallish bats commonly seen patrolling backyards and parks, washes and open desert during the summer months in Baja Arizona. Each spring these bats return from Sonora, Mexico, where they've spent the winter in caves hidden away in the Sierra Madre. By early summer, they've returned and formed a massive colony. During the day, they pack their tiny bodies between the one-inch slats that run the length of the bridge. At dusk they emerge and disappear into the night to feed on flying insects.

Like all large colonies of free-tails, this is a maternal gathering, where thousands of female bats have converged to raise their pups together each breeding season. (Male free-tails opt for less theatrics, gathering in modest bachelor colonies.) Every night, as the sun dips behind the mountain, the raucous chatter grows. The staging begins, and hundreds, then thousands, of bats swarm beneath the bridge. The cacophony reaches its climax; there's a

mysterious cue and 20,000 individuals emerge in an impressive plume, flying westward, a river of wings stretching toward the Tucson Mountains.

After the emergence, these free-tailed bats will spend the night foraging on winged insects, devouring a nighttime bounty from large sphinx moths to the legions of mosquitoes that arrived with the monsoon. Arizona is home to 26 species of bats, creating a robust diversity of nocturnal winged predators that naturally control local insect populations.

Bats are misunderstood mammals. To some, bats are nocturnal oddities. To others, they are vectors of disease. But healthy and diverse bat populations provide immediate benefits to our food supply. Bats help suppress outbreaks of pests that can devastate crops. They reduce our reliance on pesticides and slow pests' eventual resistance to those chemicals. For millions of years, bats have ruled the night as nocturnal insectivores. From our earliest agrarian cultures to our modern factory farms, bats have helped us along the way, performing a thankless task under the cover of night. As our agricultural landscapes are squeezed under increasing pressures, we need bats now more than ever.

Ecosystem services are benefits provided by wildlife or natural systems that have direct or indirect benefits to people. (For example, preserving wetlands that naturally clean our water



*Townsend's big-eared bat.*

supply or bee populations that help pollinate crops.) Of the 1,100 or so bat species that occur worldwide, many are important seed dispersers of agricultural plants. Meanwhile, two pollinator species found here in Baja Arizona play a critical role in the reproduction of agave plants. (You can thank them for tequila.) But the most critical ecosystem service bats perform is helping to limit populations of insect pests. By suppressing outbreaks of agricultural pests, bats provide our food producers a natural insurance policy against seasonal fluctuations in pest populations.

Studies of pest suppression by bats have mainly focused on free-tailed bats due to the species' abundance and distribution throughout the Southwest. Free-tailed bats have insatiable appetites for winged insects: A single free-tailed bat consumes up to 75 percent of its own body weight in flying insects nightly. With free-tailed bat colonies regularly hosting 10,000 or more individuals, their nightly consumption of winged pests can be staggering. Considering that free-tailed bats are only one of many insectivorous bats occurring in southern Arizona, our native bat populations consume tons of winged pests every night during summer months.

Nearly a third of the free-tailed bats' diet consists of adult Lepidoptera, the order of insects that includes moths and butterflies. Many lepidoptera are nocturnal pests like the corn earworm moth (*Helioverpa zea*) and the fall armyworm (*Spodoptera frugiperda*). Their larval caterpillar stage devours crop leaves and damages stems, from cotton to corn and horticultural plants like tomatoes, which can be devastating to both small and large producers.

Bats offer our agricultural economy a quantifiable cost-avoidance benefit. In this case, pest suppression by bats allows agricultural producers to avoid using some pesticides and, in turn, not incur additional costs during periods of pest outbreaks.

Estimates of the agricultural value of bats across the United States range widely, from \$3.7 billion to \$53 billion each year, but these values consider only immediate pest control and money saved from reduced pesticide use. These figures don't consider future, indirect effects of natural pest control, such as long-term public health risks resulting from the increased use of pesticides. Nor do these estimates consider cascading effects, like the eventual emergence of pesticide-resistant insects.

At the University of Arizona, Laura López-Hoffman studies the economic value placed on bats. She found that bats become less "valuable" in economic terms as their effectiveness at pest

control diminishes—which ignores other, less quantifiable contributions bats make to both natural and agricultural ecosystems.

"There's risk in only using ecosystem services," says López-Hoffman. "The risk is if you get people to think that nature only counts if we're here to enjoy it, or if it's giving us some quantifiable economic benefit. Only thinking of the direct benefits to people would be counter-productive to the argument for conserving species."

López-Hoffman points to the cotton market as an example. For two decades, producers nationwide have relied on a modified strain of cotton called Bt (named for the fungus *Bacillus thuringiensis* which produces a toxin to ward off destructive pests). As the use of Bt cotton became more widespread, the economic value of bats declined sharply. But nothing remains static and pest species are already showing resistance to Bt cotton, resulting in the once-again increased value of bats and the services they provide.

"Even if pests develop resistance to pesticides, natural predators continue to provide pest control," López-Hoffman says. "While bats provide pest control for farmers, they also help slow down the evolution of resistance in pests from their high levels of predation on agricultural pests."

Bats, with their diversity and voracious appetites, are an insurance policy against the pesticide-pest tug-of-war.

But our history of bat conservation does not bode well for future policy holders.

During the late 1970s, bat populations in Arizona bottomed out as the use of organochloride pesticides like DDT became widespread. Many nonmigratory bird and bat populations rebounded after the United States banned DDT in 1972, but the losses continued for long-distance migrants, as Mexico didn't ban the use of the pesticide until 1992. The proof was in the decimation of free-tailed bat populations in southern Arizona, a dramatic die-off that Tucson author Charles Bowden captured in *Blue Desert*.

In 2006, white-nose syndrome, or WNS, caused by a fungus, burned through bat populations in the eastern United States, destroying up to 95 percent of some colonies. The outbreak's march westward eventually slowed but the specter of WNS remains.

Plagues like DDT and WNS demonstrate the importance of pest control by bats as a matter of scale. Because bats are so mobile—for some species foraging more than 50 miles in a single night or migrating hundreds of miles each spring and fall—they offer continent-wide pest control from Maine to Arizona.



Canyon bat. (Western pipistrelle)



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**B**AJA ARIZONA exists in a transboundary zone, where many of the ecological services we benefit from are shared across our border with Mexico. Winged pest species, and the predators that feed on them, regularly pass across the border both for nightly foraging and seasonal migrations. Cooperative international conservation efforts to protect bat habitats on both sides of the border are imperative to ensure the future of our bats and the ecological services they provide.

In the spring of 2015, the United States, Mexico, and Canada developed a Letter of Intent to informally coordinate international bat conservation efforts under the auspices of the North American Bat Conservation Alliance. The effort will bring together federal, state/provincial, and local governments to

coordinate and implement conservation strategies across international boundaries. Although birds have enjoyed the success of international efforts for more than 90 years under the Migratory Bird Treaty Act, bats have had no such luxury.

The conservation of wildlife species and protection of their habitats costs money. Sometimes, it costs a lot of money. However, the future of North American bat populations does have one thing on its side: Bats have a direct, quantifiable benefit to local, state, and regional agriculture—an advantage that most other wildlife in need of conservation do not possess. The persistence and diversity of bat species and their supplementary role as pest control helps ensure the future of our own food supply—without pesticides.





Back at the Campbell Avenue Bridge, the crowd has dissipated. The show has ended and the bats have disappeared deep into the night. Nocturnal insects will soon take to the wing and the nightly race will resume. By dawn, the bats will have finished their nighttime raids, satisfied and exhausted, and return to secret themselves away beneath the bridge, ignorant to our daytime rituals. In the fields and in the valleys, the work will begin again.

*Charles C. Hofer is a wildlife biologist and writer based in Tucson.*

## *Masters of Flight*

**I**N THE 500 million years since vertebrate animals first appeared on this planet, the power of flight has evolved on only three separate occasions. First, there was the Pterosaurs, the massive winged dinosaurs that vanished alongside the other giant lizards 65 million years ago. With dinosaurs out of the way, birds raced to the top of the food chain. During this period, mammals were still small, timid creatures. Eventually they grew larger, diversified, and replaced birds as Earth's dominant life form. Somewhere in that timeline, a small shrew-like mammal left the treetops on modified forelimbs that looked like wings.

As flying insects continued to evolve and diversify, birds were not far behind, eager to exploit the expanding resource and have little competition in doing so. But the vast majority of insectivorous birds, then and now, are diurnal animals, meaning they are strictly active during daylight hours. Even today, only one of the 400 avian species that occur in Arizona regularly feed on nocturnal insects, the only exception being the lesser nighthawk (*Chordeiles acutipennis*).

This evolutionary oversight left an opening for bats. Thanks to echolocation, bats eventually occupied the niche of nocturnal insectivores. In doing so, bats diversified to take advantage of the seemingly endless resources found under the cover of night. And they've been alarmingly successful. With more than 1,100 species worldwide, bats make up nearly 25 percent of all known mammal species living today.

*(From left) Pallid bat, California myotis bat, Mexican free-tailed bat.*



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