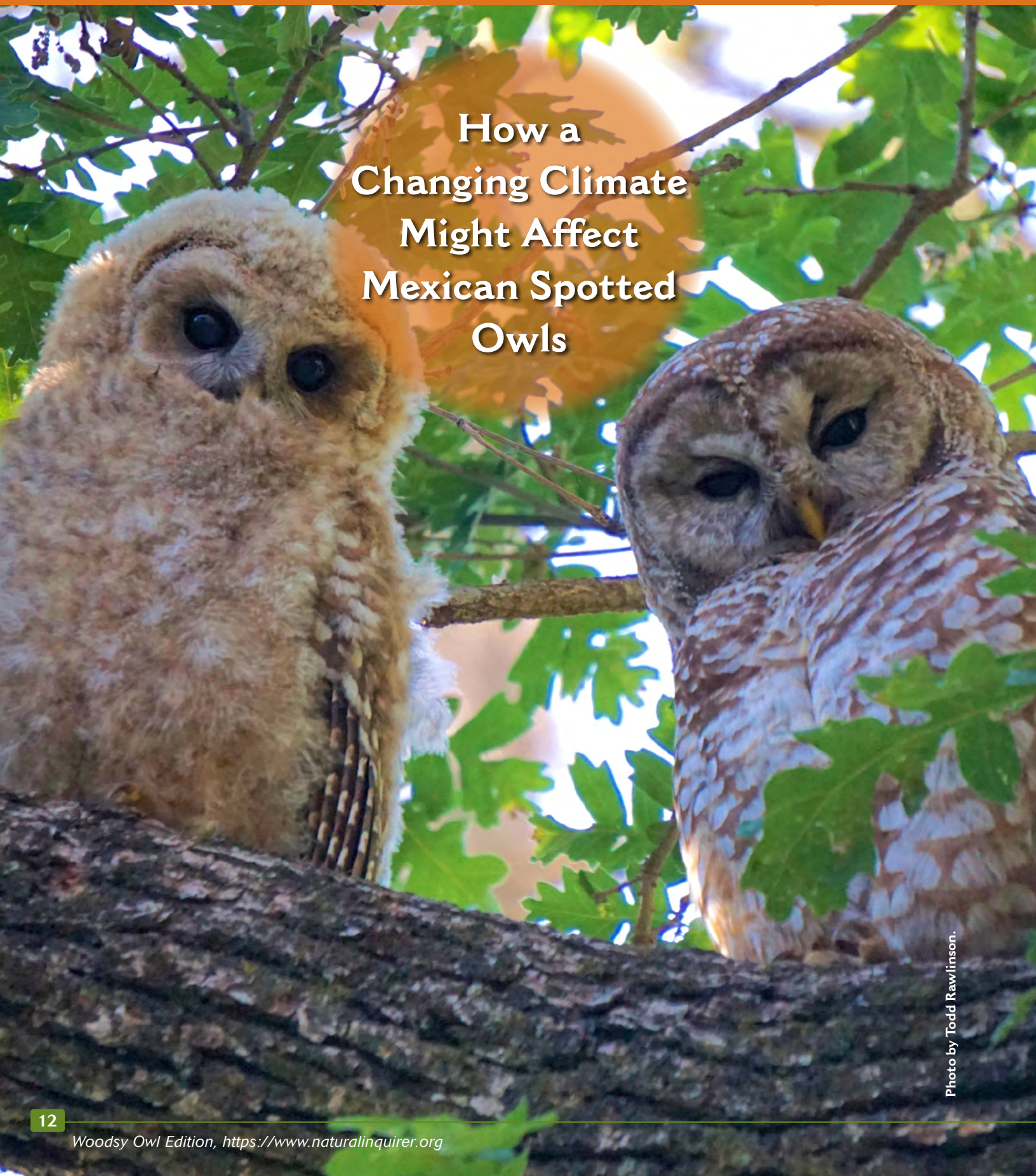
Owl-ch!



How a Changing Climate Might Affect Mexican Spotted Owls

Photo by Todd Rawlinson.

Meet the Scientists

▶ **Joe Ganey,** Wildlife Ecologist: In a long career in field ecology, I have had so many amazing moments that it is difficult to pick a single highlight. I vividly remember the first time I found a nesting pair of Mexican spotted owls. These owls are a species I ultimately studied for close to 40 years. Owls typically don't build nests but instead rely on existing structures. This was a nest, however, and it contained two **downy** owlets. The nest was on a ledge on a red sandstone cliff. The cliff was in a canyon cut into the Coconino (kō kō **nē** nō) Plateau. **Lush riparian** vegetation filled the canyon bottom, and old-growth **coniferous** forests grew in between the rocky cliffs. It was a typical southwestern landscape. This experience inspired me to spend the next four decades as a scientist. I gathered scientific knowledge to support conservation of this and similar landscapes, along with their plants and animals.

Courtesy photo from Joe Ganey.

▶ **James P. Ward,** Wildlife Ecologist: My favorite science experience is difficult to choose—there are so many incredible moments I've enjoyed "in the field" studying wildlife and in particular, spotted owls. A clear and memorable high-point of my career would be working with a team of subject-matter experts to develop a plan to recover the Mexican spotted owl from a threatened condition. That experience entailed bringing scientific information about wildlife ecology and forest management together and applying it for conservation purposes. Giving managers and other decision makers science-based recommendations for conserving natural resources has been a guiding theme for my career choice and purpose in this ever-changing world.

Courtesy photo from James Ward.

Glossary words are bold and are defined on page 25.

▶ **Todd Rawlinson,** Wildlife Biologist: While studying forest habitats, wildlife species, and wildland fires, we now understand that the greatest risk to most forest species is catastrophic, high-intensity wildfire. During my career, I have learned that corridors or pathways to wet meadows can play a key role in buffering or helping with natural disturbances such as fire. These nutrient-rich environments provide vital food and habitat for many insects, amphibians, reptiles, birds, and mammals. Moderate- to low-intensity fire can displace wildlife species for short periods of time, but wet meadows can provide a "recovery zone" for many species like spotted owls during fire disturbances.

Courtesy photo from Todd Rawlinson.

▶ **Sean Kyle,** Wildlife Biologist: I have been lucky to work with rodents, birds, bats, reptiles, amphibians, and all the way up to big game across 12 States. I earned a bachelor's degree in zoology from Southern Illinois University and a master's degree in forest ecology from Northern Arizona University. I've worked for the U.S. Forest Service, two State fish and wildlife agencies, nonprofit conservation organizations, and environmental consulting firms. My favorite science experiences of my career were spotted owl surveys, living out of a tent for close to a decade in beautiful places across the West, and working with great biologists and field technicians over the years.

Courtesy photo from Sean Kyle.

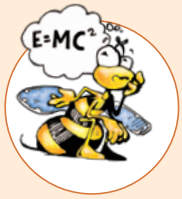
▶ **Ryan Jonnes,** Wildlife Biologist: The great outdoors has had a lasting impact on my life. The outdoors has shaped my hobbies, work, and family. I like to fish, hunt, camp, and hike. In 2005, I took a biological science technician job that changed my life. During this job with the Forest Service, I realized that I wanted to make New Mexico my home. I have held several wildlife jobs, but one thing has remained constant. I have focused my career on the conflicts between humans and wildlife. I have worked to protect wildlife while balancing the effects of industries like timber, livestock grazing, and oil and gas. Currently, I manage large, privately owned ranches for the sustainability of wildlife in southeastern New Mexico.

Courtesy photo from Ryan Jonnes.

What Kind of Scientist Did This Research?

Wildlife Biologist: This scientist studies the biology, behavior, and habitats of a variety of animal populations in the wild.

Wildlife Ecologist: This scientist studies the relationship of different kinds of wildlife with each other and with their living and nonliving environment.



Thinking About Science

Climate change offers new challenges for natural resource scientists. In particular, wildlife scientists are curious about how a changing climate may affect different wildlife species. As environmental conditions change, scientists discover new questions to answer. In this research, for example, scientists realized that the impact of a changing climate on a particular owl species is unknown.

This owl species is already threatened by other environmental conditions. These other environmental conditions include the loss of forest habitat from timber harvesting and wildfire. Climate change may impact the owl species in two ways. First, a changing climate may further change the forest where the owls live. Second, a changing climate may directly impact the physical well-being of individual owls.

Many of the questions natural resource scientists are asking today would not have been asked in the past. Changing conditions always present new scientific questions. Name one changing environmental condition of which you are aware and identify a research question that will address a possible impact of the changing condition.

Thinking About the Environment

All birds and mammals, including you, are endothermic (en də **thər** mik). Endothermic animals can, and must, maintain a somewhat constant body temperature regardless of the air temperature around them. In the summer, you perspire to cool off on hot days or when you are active in sports, for example. When the weather is cold, you may begin to shiver to stay warm. Humans also wear coats, hats, and gloves to stay warm.

Unfortunately, coats, hats, and gloves are not an option for birds when it gets cold. To stay warm, birds fluff their feathers (**figure 1**). Fluffing creates air spaces that provide a layer of warmth between the bird's skin and the outside air. Birds may also crowd together on a limb to stay warm.

Figure 1. This bird is fluffing its feathers to stay warm. ©Chuck Murphy, http://boywithcamera.com.

When the air temperature is high, some birds use a type of panting behavior to cool off. The bird opens its beak and flutters its neck muscles. This behavior also increases evaporation, causing greater water loss from the bird. Birds may also seek shaded environments to stay cool in hot weather.

In this research, the scientists were interested in learning if a species of owl might need to adapt its behavior to keep its body temperature stable in a changing climate.

Introduction

The Mexican spotted owl is one of the largest owls in North America (**figure 2**). Its wingspan is 45 inches, or just under 4 feet. The Mexican spotted owl is a **subspecies** of spotted owl that lives in the canyonlands and old-growth forests of Mexico and the southwestern United States. The owl lives in old-growth forests of white fir, Douglas-fir, and ponderosa pine. These trees have high, closed canopies that create cooler air temperatures due to deep shade. Mexican spotted owls nest in tree **cavities**, caves, and potholes in cliff ledges (**figure 3)**.

Many known Mexican spotted owl territories are on USDA Forest Service lands in Arizona and New Mexico (**figure 4**). These owls sometimes migrate and may move between 12 and 30 miles or to lower **elevations**.

A female owl lays between one and four eggs during early spring. She stays on the nest to care for the owlets while the male brings in food. The owls hunt at night. They eat small mammals, such as wood rats, mice, voles, rabbits, pocket gophers, and bats. They also eat birds, reptiles, and insects. About 60 percent of these owls' water intake comes from eating their prey. Owlets stay in the nest for about 5 weeks. At 8 weeks, they can hold and eat prey on their own. The parents continue to feed the owlets until they become fully independent hunters at 4 to 5 months (**figure 5**). The survival rate of young Mexican spotted owls is low, and the owls' lifespan is about 17 years. The Mexican spotted owl population contains a little more than 2,000 individuals now living within their United States range.

Most of the threats to Mexican spotted owls are actually threats to their habitat. A habitat is where a plant or animal finds enough food, water, shelter, and space to survive. Threats to Mexican spotted owl habitats include logging, wildfires, urban development (buildings and roads), and livestock grazing. Livestock grazing destroys the grass cover needed by the owl's **prey**. This owl species was listed as threatened under the Endangered Species Act of 1973. This species was listed as threatened because its habitat had been broken into smaller parts by wildfires and timber harvesting.

The Mexican spotted owl is facing another possible threat. Climate change may further threaten this owl indirectly. A changing climate may cause the owl's habitat to become warmer and drier, increasing the number of wildfires. In the longer term, a warmer and drier climate will

Figure 2. This pair of Mexican spotted owls sits on a tree branch. USDA Forest Service photo.

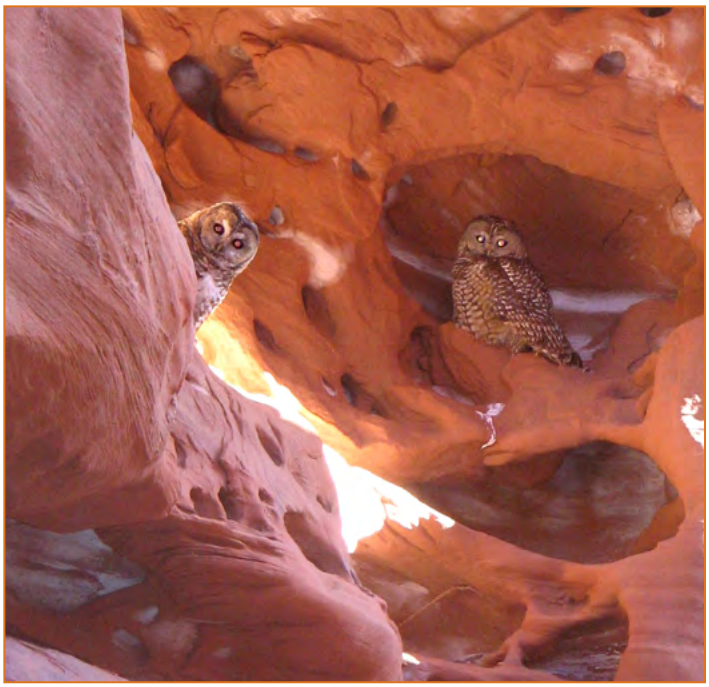


Figure 3. The Mexican spotted owl nests in a variety of places, including potholes in cliff ledges. U.S. Fish and Wildlife Service photo by Amie Smith.

Figure 4. The Mexican spotted owls' range includes Colorado, Utah, Arizona, and New Mexico as well as Mexico. FIND Outdoors map by Leslie Shaw Design.

Figure 5. In this photo, an adult Mexican spotted owl sits on the right, and an owlet sits on the left. The owlet still has downy feathers. Photo by Todd Rawlinson.

What Is Meant by "Threatened" under the Endangered Species Act of 1973?

The Endangered Species Act of 1973 defines a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." An endangered species is "any species which is in danger of extinction throughout all or a significant portion of its range." Threatened and endangered species are protected under the law.

likely change the type of tree species and where the trees are growing within the owl's habitat. Currently, the owls use the dense shade of old-growth trees to help keep them cool. These indirect threats may cause further challenges for the Mexican spotted owl.

A changing climate may also directly impact Mexican spotted owls. Recall that under a changing climate, the owls' habitat will likely become warmer and drier. Mexican spotted owls may have a low tolerance for heat. These owls seek shaded, cooler environments to roost (rest) and nest. These environments are either in canyonland bottoms under the shade of cliffs or in the dense shade of old-growth forests (**figure 6**).

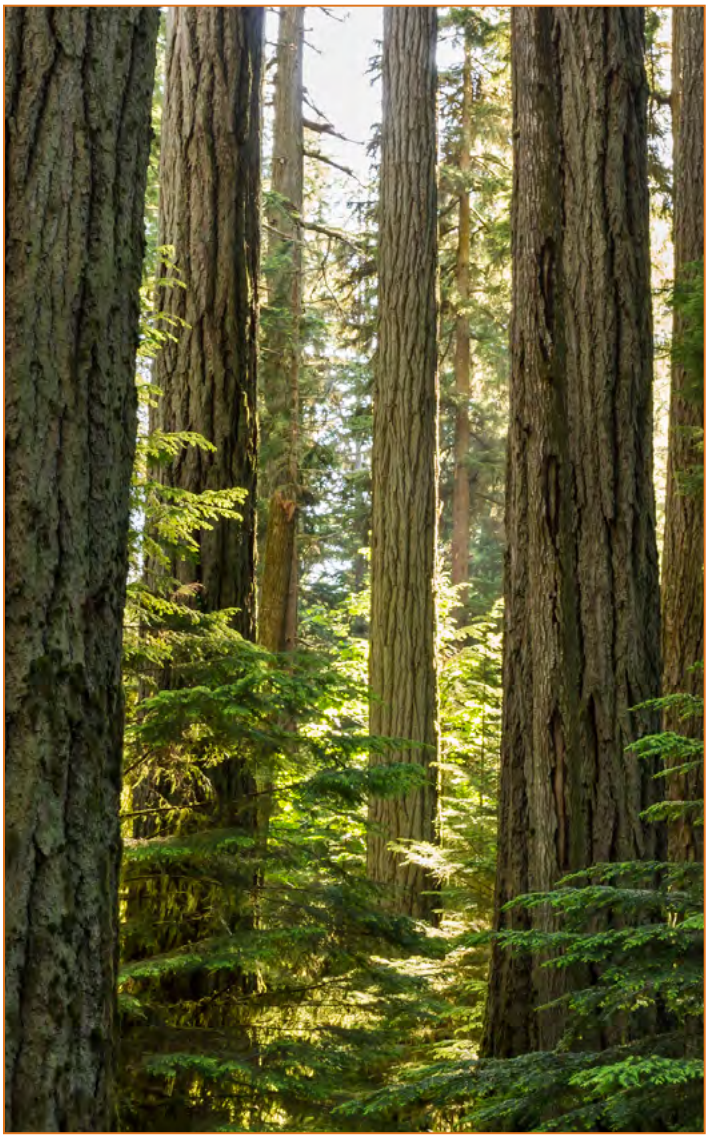


Figure 6. Old-growth forests contain trees that are hundreds or sometimes thousands of years old. Adobe Stock photo.

Mexican spotted owls are endothermic, just like you. When the air temperature is too hot or too cold, these owls take action to maintain a steady and safe body temperature. You already know that these owls seek cooler, shaded environments for roosting and nesting. But what might happen as the air temperature continues to rise in a changing climate? The scientists in this study were interested in exploring this question. The scientists wanted to know how warmer air temperatures might affect an owl's individual energy use and the amount of water evaporation an individual owl might experience.

Reflection Section

- In your own words, state what questions the scientists in this study wanted to answer.
- When your body gets too hot, what does your body do to cool you down? Do you lose water in this way? Where do you get more water to replace what you have lost? If you were a Mexican spotted owl, would replacing lost water be more challenging than it is for you as a human? Why?

Methods

The scientists studied Mexican spotted owl habitat in the Sacramento Mountains of New Mexico (**figure 7**). The Sacramento Mountains are comprised of a large montane ecosystem. These mountains are like a forested island surrounded by a desert "sea" (**figure 8**). Montane ecosystems are found on mountain slopes. They are moist, cool environments and have large, often coniferous, trees. The montane ecosystem studied by the scientists contained a mix of conifers, including white fir and Douglas-fir.

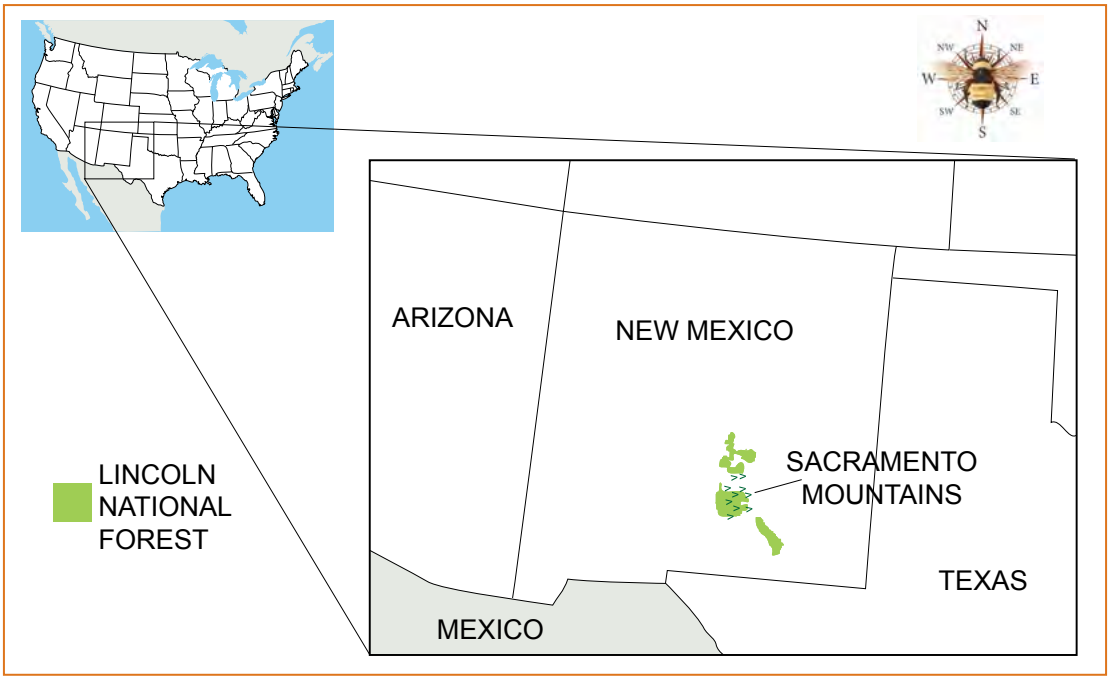


Figure 7. The Sacramento Mountains are located in the Lincoln National Forest in south-central New Mexico. FIND Outdoors map by Leslie Shaw Design.

Figure 8. The Sacramento Mountains are a montane forest ecosystem surrounded by desert. Photo by Ryan Jonnes.

Figure 9. Fourteen mobile weather stations similar to this one were placed throughout the study area. Adobe Stock photo.

The scientists established 14 mobile weather stations within the forest (**figure 9**). These weather stations recorded weather data every hour, 24 hours a day, for 5 years (including only part of 2 years, equaling about 4 total years). The weather data used by the scientists included the outdoor air temperature in degrees Celsius (°C) and relative humidity, or how much moisture is in the air. Relative humidity is measured from 0 percent (no moisture) to 100 percent. A rainy day may have between 90 and 99 percent relative humidity.

The weather stations were located in eight Mexican spotted owl territories, and the average percentage of **canopy cover** over the weather

Number Crunch

- Approximately how many weather observations did the weather stations collect?

  Hint: Calculate ***the number of hours in a day*** × ***the number of days in a year*** × ***the number of total years*** × ***the number of weather stations****. Remember that observations were collected for only about 6 months in each of 2 years.*

stations was 90.4 percent (**figure 10**). The scientists used precipitation data for the study area that were collected by the National Weather Service. These data included rainfall and snowfall.

The scientists used existing information about how much energy similar species of spotted owls use when they are at rest. They began with a measurement called resting metabolic rate. Resting metabolic rate is the amount of energy required by an animal's body (including yours!) to perform the most basic functions when at rest, such as breathing, circulating blood, or basic brain functions. Resting metabolic rate may be different at different air temperatures.

The scientists used equations to estimate the resting metabolic rate of these owls at each recorded air temperature value. These equations were different depending on whether the air temperature was within, above, or below a special range of air temperatures. This special range is called the thermoneutral (**thür** mō **nū** trəl) zone, or TNZ (see page 22).

The scientists now had a resting metabolic rate for each of the approximately 500,000 hours of data collection. Each resting metabolic rate was connected to an air temperature value. The scientists used another equation to estimate how much energy an owl would need to use to maintain its healthy body temperature at every temperature value.

The scientists then used another equation to estimate how much water an owl would lose from evaporation at each of the approximately 500,000 air temperature values. This estimate is called evaporative water loss, or EWL. Recall that more water is lost at higher air temperatures.

The scientists now had estimates for:

(1) How many observations were within, above, and below the owl's TNZ.

(2) How much energy an owl would use at rest at every observed temperature above, within, and below the TNZ.

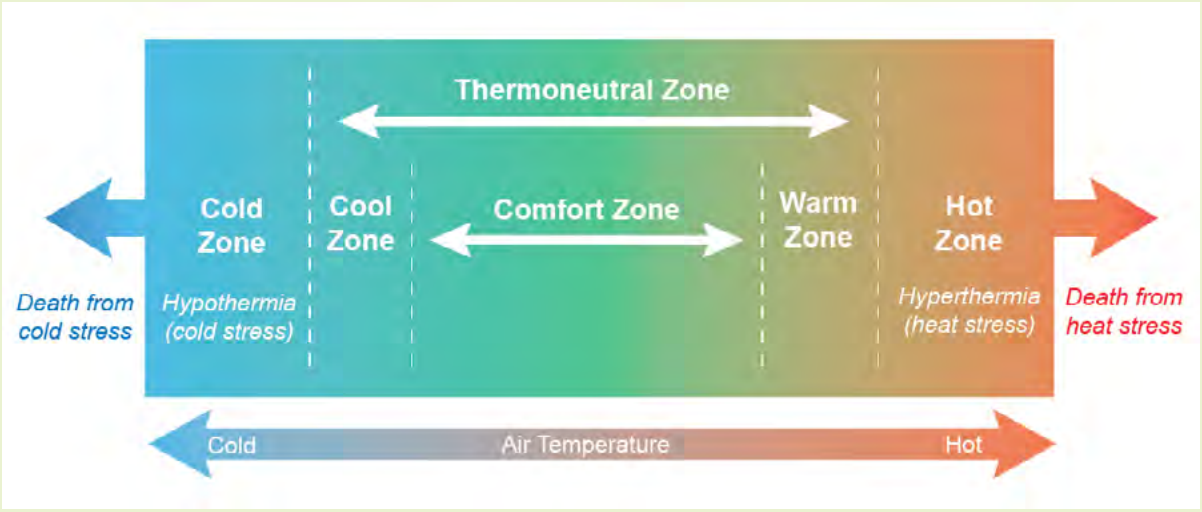
(3) How much water an owl would lose to evaporation in air temperatures above, within, and below the TNZ.

They then predicted the owl's energy use and water loss in 2070 and 2099.

Figure 10. (**A**) The scientists used a piece of equipment called a densiometer to measure the amount of canopy cover in the forest. (**B**) Canopy cover is the amount of tree cover in a particular area. Figure 10B is an Adobe Stock photo.

What Is the Thermoneutral Zone?

All endothermic animals, including you, have a range of air temperatures within which they prefer to stay. This range of air temperatures is called the thermoneutral zone, or TNZ. Within this range, a healthy adult animal can maintain its normal body temperature while at rest. If the air temperature is above the TNZ range of temperatures, an animal must spend energy to lower its body temperature. In the case of humans, for example, a person perspires. A dog pants. An owl flutters its neck muscles. In all cases, the animal will lose water as they cool off. If the air temperature is below the TNZ range of temperatures, an animal must spend energy to raise its body temperature.



FIND Outdoors illustration by Liz Sisk.

Reflection Section

- Based on what you know about climate change predictions, do you think the scientists expected to find more future changes in resting energy use and water loss for temperatures above or below the Mexican spotted owls' TNZ? Why?
- Do you think animals spend more or less energy when they are not at rest compared to when they are at rest? Why?
- Explain why you think it would be difficult for the scientists to estimate the owls' energy use when not at rest.

Findings

Recall that the 14 weather stations recorded the air temperature every hour. The **median** temperature was higher than the 30-year average (or normal) air temperature across all years (**figure 11**). Despite the warmer temperatures, the air temperature never went higher than the upper range of the owl's TNZ (35.2 °C). In contrast, over 90 percent of the temperatures were below the owl's lower limit of the TNZ (18.2 °C). The lowest air temperature values were recorded in the winter, and the highest air temperature values were recorded in June and July. Median maximum daily air temperatures were less than 18.2 °C for all months except June and August. The median minimum daily air temperatures were less than 18.2 °C for all months.

The National Weather Service reported precipitation that was equally higher and lower than the normal precipitation values. Most precipitation occurred from May through October. Relative humidity under the forest trees was highest from July through October and lowest during the nesting season, which is April through June.

The scientists estimated the owls' resting metabolic rate and evaporative water loss (**figure 12**). The owls' resting metabolic rate was highest in winter. The resting metabolic rate declined in the spring, was lowest in summer, and then increased in the fall. Evaporative water loss (EWL) followed a pattern somewhat opposite from resting metabolic rate. EWL was lowest during the winter months and highest during the warmer and wetter summer months.

Number Crunch

- What is 18.2 °C in Fahrenheit?

  Hint: Use this formula to find out:
  °F = (°C × 9/5) + 32

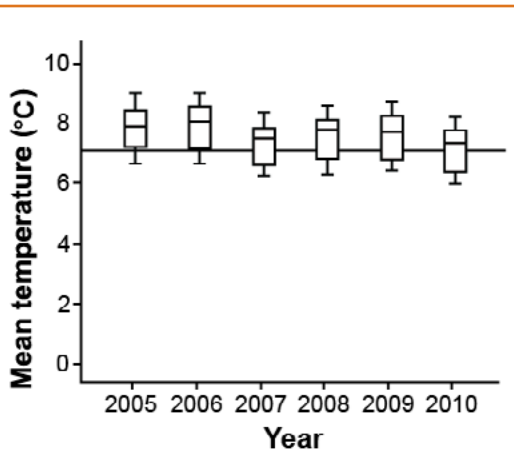


Figure 11. Average and median air temperature per year in degrees Celsius (°C). The long horizontal line represents the average air temperature over 30 years. Within each box, the horizontal line represents the median air temperature for the year. The box represents the 25th to the 75th percentile (the interquartile range). The small lines above and below the boxes represent the lowest and highest recorded air temperatures. FIND Outdoors illustration by Liz Sisk, taken from this study (see citation on page 25).

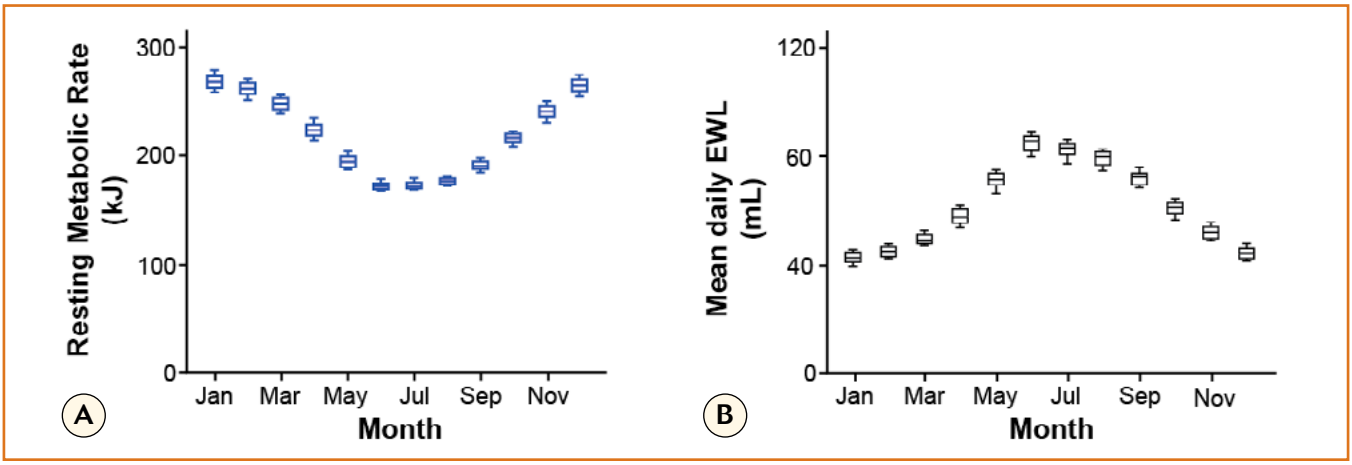


Figure 12. (A) This graph shows the yearly trend in resting metabolic rate for Mexican spotted owls. (B) This graph shows the yearly trend in evaporative water loss (EWL) for Mexican spotted owls. FIND Outdoors illustrations by Liz Sisk, taken from this study (see citation on page 25).

Recall that the scientists added 3 °C and 6 °C to each of the recorded temperatures to evaluate the impact of climate change on the Mexican spotted owl. The impact of increasing temperatures reduced the proportion of air temperature values that were below the TNZ and increased the proportion of air temperature values that were within the TNZ. Even when 6 °C was added to each recorded air temperature value, the air temperature rarely went above 35.2 °C. In these climate change **scenarios**, the overall effect was to reduce the amount of energy required by an owl to keep its body temperature within the TNZ, as compared with current energy use.

Increases of 3 °C and 6 °C resulted in greater EWL, however. Adding 3 °C resulted in an increase in estimated water loss of 14 percent and adding 6 °C resulted in an increase in estimated water loss of 29 percent.

Reflection Section

- The recorded air temperatures never went higher than the owl's upper TNZ level. In contrast, over 90 percent of the recorded air temperatures were below the owl's lower TNZ level. In your own words, describe what this finding means for an owl's attempts to keep its body temperature within the TNZ.
- The scientists expected to find that higher future temperatures would directly impact the owls by making it harder for them to stay cool. What did they find instead?
- The findings indicate that in the future, owls will experience greater water loss because of higher temperatures. Is increasing water loss a good or bad thing for the owls? Why?

Discussion

The scientists discovered that owls living below the cool forest canopy rarely experienced air temperatures that were too high. Rather, most of the air temperatures were low enough to cause the owls to use energy staying warm. The owls needed and used more water during the summer months. However, this time **coincided** with the greatest availability of water and high relative humidity. Thus, it appears that Mexican spotted owls are currently well adapted to their habitat.

As the climate changes, however, the situation for Mexican spotted owls may change. Evaporative water loss (EWL) is expected to increase as air temperature increases. Rising temperatures may also change the habitat of small mammals. If this occurs, the owls' food may be harder to find. About 60 percent of an owl's water comes from its food. The owls may need to depend more on surface water, such as streams, rivers, and ponds. Unfortunately, obtaining water from streams, rivers, and ponds is not an option for baby owls still in the nest, where they spend the first 5 weeks of their lives. Lowered amounts of precipitation in the future, therefore, may result in an overall decrease in the population of Mexican spotted owls.

Currently, forest managers are working to keep and develop patches of old-growth forests that have thick canopies. This strategy of protecting patches of older and cooler forests may provide protective habitat for Mexican spotted owls. Such protection may provide a **refuge** for these owls as the climate continues to warm.

Reflection Section

- Mexican spotted owls are well adapted to cool air temperatures. Unlike many birds, these owls have feathers on their legs which help to keep them warm in cool temperatures. Explain why this adaptation is a benefit to Mexican spotted owls.
- Explain why lowered amounts of precipitation in the future may result in an overall decrease in the population of Mexican spotted owls.

Glossary

canopy cover (**ka** nə pē **kə** vər): The layer of tree leaves, branches, and stems that provide tree coverage of the ground when viewed from above.

cavity (**ka** və tē): A hollowed-out space.

coincide (kō ən **sīd**): To occupy the same place in space or time.

coniferous (kä **nə** fər us): A type of tree having (pine) cones.

downy (**daụ** nē): Covered with down, a covering of soft fluffy feathers.

elevation (e lə **vā** shən): The height of a place or thing above sea level.

lush (**ləsh**): Having full and healthy growth.

median (**mē** dē ən): The number that is halfway between in a list of numbers arranged smallest to largest.

prey (**prā**): An animal hunted for food by another animal.

refuge (re **fyüj**): A place that provides shelter or protection.

riparian (rə **per** ē ən): Areas along streams and rivers.

scenario (sə **ner** ē ō): A description of what could possibly happen.

subspecies (**səb** spē shēz): A category in biological classification that ranks immediately below a species; designates a population of a particular geographic region that is genetically distinguishable from other such populations of the same species. A subspecies is capable of interbreeding successfully with other populations of the same species where its range overlaps theirs.

*Accented syllables are in **bold**. Marks and definitions are from https://www.merriam-webster.com/. Definitions are limited to the word's meaning in the article.*

Adapted from Ganey, J.L.; Ward, J.P.; Rawlinson, T.A.; Kyle, S.C.; Jonnes, R.S. 2020. Annual climate in Mexican Spotted Owl habitat in the Sacramento Mountains, New Mexico: Implications for responding to climate change. Journal of Field Ornithology. 91(3): 225–240. https://doi.org/10.1111/jofo.12337.