



2024

THE MOUNTAIN LION  
FOUNDATION'S  
ESSENTIAL GUIDE TO RECENT  
SCIENTIFIC RESEARCH ON  
MOUNTAIN LIONS



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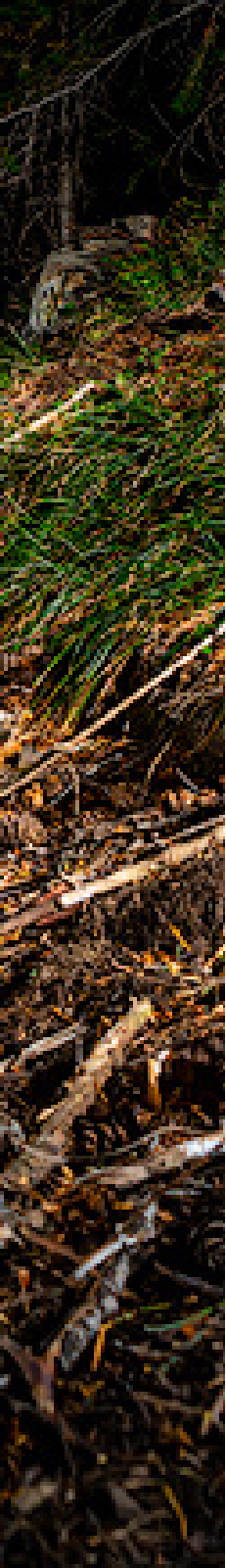
# INTRODUCTION

The mission of the Mountain Lion Foundation is to ensure that America's lion survives and flourishes in the wild. Peer-reviewed science and science-based conservation strategies are crucial resources that we rely on to help protect lions and their habitat.

This Guide answers the most frequently asked questions posed by community members and journalists who are eager to learn more about living safely and peacefully with lions. To answer these questions, we cite peer-reviewed research, most of which has been published in the last five years.

## **WHY IS THIS GUIDE IMPORTANT?**

The scientific literature on mountain lion biology, ecology, management, and coexistence has grown rapidly in recent years. Advances in genetics, GPS tracking technology, trail cameras, and other tools for research have opened new windows into these elusive animals' behavior. This has expanded and deepened our existing knowledge of how mountain lions hunt, mate, rear their young, interact with other species, and disperse across the landscape as they mature.



In other cases, new research has upended longstanding beliefs about the species. Recent studies, for instance, have revealed that mountain lions are not nearly as solitary as they have long been believed to be. While mountain lions are still understood to be solitary hunters, we now know that they sometimes share food and socialize, cultivating complex social networks.

We hope you find this Guide useful and informative. This discussion does not represent a comprehensive review of the rapidly-growing research literature on mountain lions, but emphasizes recent and influential papers that can serve as a starting point for deeper reading. For full citations and additional studies that have evolved our collective understanding of lions, see Further Reading at the end. Contact the Mountain Lion Foundation ([info@mountainlion.org](mailto:info@mountainlion.org)) for assistance obtaining copies of any of these or other papers if you would like to dive deeper into this research literature.

## WHAT MAKES MOUNTAIN LIONS A KEYSTONE SPECIES?

SOURCES: ALLEN, ET AL. (2016); LABARGE ET AL. (2022), BARRY ET AL. 2019; PEZIOL ET AL. 2023.

As LaBarge et al. (2022) show, mountain lions have “what may be the most diverse set of biotic relationships documented for any species in the world.” This is partly a reflection of their wide geographic range, a fact which also explains why they have more common names than any other species. But it also reflects their role as a keystone species throughout their range, affecting everything from carrion beetles and other insects that rely on cached carcasses (Barry et al. 2019) to complex changes to vegetation, soil nutrients, and riverbanks due to mountain lions’ effects on deer populations (Peziol et al. 2023).

Scientists use terms like keystone species, ecological brokers, and ecosystem architects to refer to species, like mountain lions, that are especially important to ecosystem health and preserving biodiversity.



PHOTO COURTESY OF SEAN HOOVER

## ARE MOUNTAIN LION POPULATIONS INCREASING? ARE LIONS MOVING CLOSER TO CITIES?

SOURCES: BENSON ET AL. 2021; ELBROCH, L. M., PETRACCA, L. S., O'MALLEY, C., & ROBINSON, H., 2022; KERTSON AND KEREN, 2022; RILEY, SIKICH, AND BENSON 2021.

In some western United States, there is a perception that mountain lion populations are increasing, or that they are coming closer to towns. While Elbroch et al. (2022) found that available evidence on mountain lion populations in states with breeding populations likely generally indicates either a stable or declining population, some measures suggest population growth in certain places. Even a population that is in overall decline may include spots where numbers are increasing. Individual states estimate populations through a range of methods, and most states record no significant rise in population, while others are managing populations with a goal of reducing overall population size.

Regardless of overall population trends, mountain lions avoid people when possible. In Washington state, Kertson and Keren (2022) found that mountain lions generally avoid people and towns. While they might pass through human developments to get from one wild area to another, they spent as little time near people as possible, even at times when the lion population in neighboring wilderness grew. This matches results from research on pumas in the Los Angeles hills (Riley, Sikich, and Benson 2021; Benson et al. 2021) and many other observations throughout the West. So, where does this largely erroneous idea of mountain lion populations being “on the rise” come from?

There are several factors driving this perception. Growing numbers of people live along the wildland-urban-interface, bringing them close to wildlife, including mountain lions (and the deer they prey upon). Also, the recent explosion in the last ten years of high quality phone cameras, trail cameras, and home-surveillance cameras (such as Ring cams), along with our ability to share those images easily and instantly on social media, has flooded our lives with more lion images than ever before, even in areas where lion populations are declining. In almost every case, it is more likely that humans are simply seeing more mountain lions, not that there are more mountain lions, or that mountain lions are behaving differently.

## **WHAT ARE THE MOST EFFECTIVE TOOLS FOR MANAGING MOUNTAIN LION CONFLICT WITH PEOPLE, LIVESTOCK, PETS, AND OTHER LIONS?**

**SOURCES: OHRENS, BONACIC, AND TREVES, 2019; SMITH ET AL. 2017; TREVES ET AL. 2024**

While tools like fencing, flashing lights, noisemakers, range riders, and livestock guardian dogs are all standard tools for livestock owners to deter carnivores, it is only recently that peer-reviewed studies have systematically tested these techniques to find which are most effective. For instance, Ohrens, Bonacic, and Treves (2019) showed that flashing lights can be an effective tool for deterring predation on livestock by mountain lions and other carnivores.

Drawing on research which shows that mountain lions avoid humans, Smith et al. (2017) tested whether recordings of human voices were effective at scaring away mountain lions. The experiment showed that human voices, unlike recordings of frogs, tended to chase mountain lions away from a cached kill. Ranchers have often observed that a simple AM radio, tuned to a talk station, can be effective at keeping livestock safe from mountain lions, but adding scientific rigor to these findings can give ranchers, hikers, and others confidence that this and other proven techniques can be effective at protecting themselves and their animals.

Research on these tools and techniques that allow humans and livestock to coexist safely with mountain lions has been incredibly hard to conduct and continues to be so. Coexistence strategies may be effective with one species of carnivore but not another. Certain methods may work better or worse based on environmental variation, or even based on an individual animal's personality, such as in the case of livestock guardian dogs. Results are also dependent on the type of livestock species being protected and at what scale. Instances of mountain lions preying on livestock are also relatively infrequent, making research challenging. All of these factors have resulted in a scarcity of "gold standard" studies, though Treves et al. (2024) find a growing body of high-quality, experimental studies. As a result, much of coexistence practice relies on personal and traditional ecological knowledge of the land, the kinds of animals being protected, and the wildlife dynamics of the area for effective management.

## IS HUNTING A NECESSARY TOOL TO MANAGE MOUNTAIN LION POPULATIONS?

SOURCES: DELLINGER ET AL. 2021; ELBROCH AND TREVES 2023; LAUNDRÉ AND PAPOUCHIS 2020; LENNOX ET AL. 2018; PEEBLES ET AL. 2013; TEICHMAN, CRISTESCU, AND DARIMONT 2016; WIELGUS, ET AL., 2013.

In the last two decades, research has challenged the longstanding assumption that hunting (whether recreational or conducted by paid hunters) is an effective tool to prevent conflict between mountain lions and people, pets, or livestock. Laundré and Papouchis (2020) assembled a large dataset comparing California with various other states, finding that California, where mountain lion hunting was outlawed in the 1970s, does not have more conflict than states with high hunting rates. Their analysis also found no substantial difference in the health of deer and elk populations in the state. Other researchers, working with datasets from state wildlife agencies in the United States and Canada, have found that not only does killing mountain lions not reduce conflict, but it may cause increased rates of conflict in subsequent years.

The reasons for this pattern are still being studied, but multiple hypotheses have emerged to explain it. One hypothesis is known as the “troubled teen” hypothesis. This hypothesis, drawing on work including Wielgus, et al. (2013), attributes most conflict to young, inexperienced males dispersing into an area. When mountain lion populations are heavily hunted, they exhibit a younger age structure than minimally hunted populations. This is largely due to young dispersing animals filling vacant territories that were opened up when hunters removed the larger, well-established males.



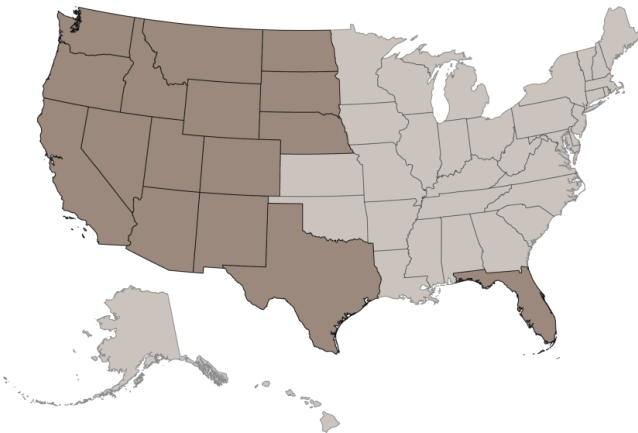
Another hypothesis centers on the impacts of killing female lions with dependent young. Females spend around three quarters of their life pregnant or raising their young. These kittens and young lions may struggle to hunt for deer and other wildlife, and due to hunger and inexperience, may attempt to attack livestock or come too close to people in towns or on trails. Under normal circumstances, those young animals will be taught to hunt and navigate human-altered landscapes by their mother for up to two years.

Young male mountain lions dispersing from their maternal home range will travel long distances until they find an area that is not defended by a mature resident lion, and thus do not stay in new areas near livestock or people for long. Hunting (including killing and relocation by wildlife management agencies or law enforcement) opens up territories on the landscape, which creates room for these more conflict-prone individuals, who can then become concentrated in those areas. The counterintuitive increase in conflict in areas with more mountain lion hunting may be explained by this combination of desperate acts by starving orphans and disruption to the social behavior of the lions. Additionally, some hypothesize that the opportunistic nature of mountain lion hunting makes all types equally likely to be involved in conflict and is more related to individual behavior. Indeed, all these hypotheses may be at play, and should be considered.

## WHAT ARE THE BEST STRATEGIES FOR SCIENCE-BASED MANAGEMENT OF MOUNTAIN LION POPULATIONS?

SOURCES: BEAUSOLEIL ET AL. 2013; BEAUSOLEIL ET AL. 2021; COOLEY ET AL. 2009; ELBROCH ET AL. 2022; ELBROCH AND HARVESON 2022; LBROCH AND HARVESON 2022; LOGAN 2019; MURPHY ET AL. 2022.

Basic ecological theory, the history of wildlife in North America, and more recent research all suggest that hunting is not necessary to manage mountain lion populations. Nonetheless, all states with breeding populations of mountain lions (Washington, Oregon, California, Arizona, Nevada, Idaho, Montana, North Dakota, South Dakota, Nebraska, Wyoming, Colorado, Utah, New Mexico, and Texas) permit recreational hunting, except Florida (where the population is federally listed as endangered) and California (where voters outlawed recreational hunting). While management of mountain lions ought to include consideration of the many ways humans can harm or benefit the species, most discussion of mountain lion management happens through the lens of hunting regulation.



**THERE ARE 16 STATES WITH BREEDING POPULATIONS OF MOUNTAIN LIONS.**

Beausoleil et al. (2013) used extensive research in Washington and other western states to build a framework for science-based management of mountain lion hunting. The principles proposed in 2013 have since been adopted into policy in Washington, and similar policies have been adopted in other states as well. Key findings that informed the policy are that maintaining mountain lion mortality at or below its intrinsic growth rate is ideal for the preservation of cougar social behavior, older age structures, and stable populations. In Washington, Wielgus et al. (2013) identified the intrinsic growth rate as 14 percent (+/- 2 percent). Other mountain lion populations in North America have exhibited growth rates between 11 and 17 percent.

Subsequent research has supported these findings and shown that this approach to mountain lion hunting can be an effective way to reduce conflict and maintain healthy ecosystems (Beausoleil et al. 2021). Given the high mobility of mountain lions, it can be difficult to detect overhunting without the sort of detailed fieldwork and careful regulation that the Beausoleil framework recommends. Even in the face of high hunting rates, population numbers can seem high because of immigration of young dispersers, but the population does not compensate for high hunting mortality with additional reproduction or higher survival rates of cubs (Cooley et al. 2009; Logan 2019).

Another management strategy for mountain lions has hinged on source-sink dynamics. Due to mountain lions' wide dispersal patterns, it is possible to hunt heavily in some areas (sink populations) but maintain stable numbers if there is a nearby source population that produces enough dispersing mountain lions to bolster the sink population's numbers. This management strategy has been widely accepted across the West as a way to manage hunting by relying on the apparent resilience of mountain lions. However, this approach is limited in that it primarily focuses on managing the demographic numbers of mountain lions without preserving age structure, social behavior, or aiming to reduce human-wildlife conflict. Researchers including Robinson, et al. (2008) and Beausoleil et al. (2013) suggest that source-sink management can thus be less effective at maintaining healthy mountain lion populations, balancing ecosystems, or minimizing conflict with humans and livestock.

In Texas, the only state where mountain lion hunting is currently unregulated, scientists and others are pushing for implementation of similar approaches (Elbroch and Harveson 2022), and wildlife management agencies in other states have adopted many of these same principles. Unfortunately, wide variations among the states in what data they gather on mountain lion populations and how they regulate hunting of the species makes it difficult to assess the overall health of mountain lion populations in the face of widespread hunting (Elbroch et al. 2022; Murphy et al. 2022).

## IN ADDITION TO HUNTING, WHAT ARE THE BIGGEST THREATS TO MOUNTAIN LION POPULATIONS?

SOURCES: BENSON ET AL. 2019; BLAKEY ET AL. 2022; GUSTAFSON ET AL. 2019; HUFFMEYER ET AL. 2022; RILEY, ET AL. 2007; ROAD ECOLOGY CENTER 2023; WULTSCH ET AL. 2023; ZELLER ET AL. 2023

Mountain lions face significant risks well beyond the direct effects of overhunting. In Florida, the only remaining population on the East Coast was one of the first species listed under the Endangered Species Act, and low genetic diversity, continued habitat loss, and deaths from car strikes have hindered recovery of the population. Research in Washington state (Wultsch et al. 2023; Zeller et al. 2023) and California (Benson et al. 2019; Gustafson et al. 2019; Huffmeyer et al. 2022) has documented harm caused by low genetic diversity in mountain lion populations isolated by major highways.

Major road crossings are planned, or in construction, to address these genetic bottlenecks and allow cougars and other wildlife to safely cross these roadways, but even more crossings are needed, and further study on the effects of these and similar barriers elsewhere in the species range will be necessary. Roads also pose a significant risk to mountain lion survival: a study in California found that two mountain lions die from car strikes in an average week in the Golden State alone (Road Ecology Center 2023).

Road crossings are crucial tools, but can only reduce the harm caused by road-building and development in mountain lion habitat. In addition, Riley, et al. (2007) and subsequent researchers have shown that exposure to rodenticides can cause serious health problems for mountain lions, including death from mange. Wildfires, especially in the increasing drought and heat resulting from human-caused climate change, drive out mountain lions and disrupt their populations and their prey availability (Blakey, et al. 2022).

## **WHAT IS CHRONIC WASTING DISEASE (CWD)? IS IT SPREADING, AND WHAT DOES IT HAVE TO DO WITH MOUNTAIN LIONS?**

**SOURCES: BAUNE ET AL. 2021; KRUMM ET AL. 2010; MILLER ET AL 2008; WILD ET AL. 2011.**

Krumm et al. (2010) and Miller et al (2008) showed that mountain lions, unlike human hunters, are more likely to kill deer infected by the prion-caused Chronic Wasting Disease. Researchers have also found that the cougar digestive systems are efficient at destroying the deadly disease agent (Baune et al. 2021), and research suggests that this predation could be sufficient to eradicate the disease (Wild et al. 2011).

Chronic Wasting Disease is an emerging disease in deer and elk, currently found in 32 US states and in Canada. State wildlife agencies are working hard to control its spread, as it can devastate populations of key game species, including white-tailed deer, mule deer, and elk. It is spread by a prion – a malformed protein like that which causes mad cow disease – not by a bacterium or virus, and CWD is not preventable or treatable by vaccines or antibiotics.

## WILL MOUNTAIN LIONS RETURN TO THEIR EASTERN RANGE? WHAT IS HAPPENING IN STATES WHERE THEY HAVE ALREADY RETURNED?

SOURCES: BAUNE ET AL. 2021; KRUMM ET AL. 2010; MILLER ET AL 2008; WILD ET AL. 2011.

Hawley et al. (2016) showed that a mountain lion found as a roadkill in Connecticut had spent two years traveling nearly 2,000 miles (over 3,200 km) from the Black Hills of South Dakota, making it the longest dispersal by any mammal on record. This remarkable journey took the young male through Wisconsin, across Ontario, across the St. Lawrence River to New York state, and from there to Connecticut.

The fact that this record-setting journey went through so many different habitat types highlights the adaptability of mountain lions, a key feature in their survival through the era of bounty hunting that extirpated wolves from nearly all the continental United States, sent grizzly bears into endangered status, and drove black bears and jaguars out of much of their historic range. Female mountain lions generally don't disperse as far as males, though some have been shown to make remarkable journeys (Stoner et al. 2008). The slower dispersal of females explains the relatively long amount of time that it took even to colonize Nebraska from South Dakota (LaRue and Nielsen 2016).

Yovovich et al. (2023) is the most recent research team to assess where and how mountain lions might return to their eastern range. Like prior research teams (LaRue, Nielsen, Dowling, et al. 2012; Larue, Nielsen, and Pease 2019; LaRue and Nielsen 2016; 2011; 2008; Glick 2014; Gantchoff et al. 2021; J. B. Smith, Nielsen, and Hellgren 2016; O’Neil, Rahn, and Bump 2014; Laundré 2013), they found that there are substantial areas with adequate habitat to sustain healthy mountain lion populations, and there is evidence that mountain lions are slowly recovering at the eastward edge of their current range, returning to the Dakotas and Nebraska in recent decades.

Gilbert et al. (2017) found that the return of mountain lions to South Dakota has reduced traffic accidents to a significant degree. This happens because mountain lions reduce deer overpopulation, which in turn means fewer wildlife collisions. Based on that result, they estimated that reintroduction of mountain lions to the eastern US could prevent over 21,400 human injuries, 155 fatalities, and could save \$2.13 billion in avoided costs within 30 years of the species’ recovery.



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