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"Science affects the way we think together."
Lewis Thomas

Striving for Balance: Maintaining Marten Habitat While Reducing Fuels

Mark Linnell

*A young marten and mother with a miniature GPS tracking collar outside their den, a cavity in a large, old red fir (*Abies magnifica*) in Lassen National Forest, California.*

IN SUMMARY

Martens are small forest carnivores associated with dense, mature forests. They are important indicators of a forest's biodiversity and are vulnerable to management activities such as fuel reduction treatments that open the forest canopy or remove fallen branches and other woody debris that could fuel a wildfire. Until recently, the effect of these changes to stand structure on marten behavior was unknown.

Katie Moriarty, a research wildlife biologist with the Pacific Northwest Research Station, and colleagues recently conducted a study on martens in the Lassen National Forest. The researchers fitted martens with GPS collars and tracked their behavior to learn how the animals responded in forest stands that differed in structural complexity—variability in tree size, depth and overlap of crowns, and distance and uniformity of spacing among trees. The martens traveled several miles a day in search of food, but they avoided open areas and thinned stands (forest areas where small-diameter trees and understory have been removed), most likely because they were more vulnerable to predators in those spaces. They thrived in forests with complex canopies and connected stands, which allowed them to move more freely in search of food with less risk of predation.

This information provides an opportunity for forest managers to create new silviculture treatments that help maintain marten populations while also reducing fire risk.

"We shall never achieve harmony with the land, anymore than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve but to strive."
—Aldo Leopold, *Round River: From the Journals of Aldo Leopold*

The marten is a small member of the weasel family, weighing between 1 and 3 pounds. But despite their small size, martens can provide great insight into the health of the montane mixed-conifer forests in which they live.

They are "dietary generalists," meaning they eat anything and everything, including birds, small mammals, berries, fish, carcasses of larger animals, and more. In winter, they rely on nonhibernating mammals as prey. They're prodigious eaters, consuming a quarter of their body weight every day.

The Pacific marten (*Martes caurina*), a cousin of the American marten (*M. americana*), lives west of the Rockies, as far north as southeast Alaska, and south into California. The Pacific marten is reported to be fairly well distributed

in high-elevation forests of inland mountain ranges. In coastal forests of California, Oregon, and Washington, however, it occupies only 5 to 10 percent of its historical range. In Washington, only six coastal Pacific martens have been detected in the past few decades. Coastal populations of Pacific marten in northern California were thought to be extinct until 1996 when a population was rediscovered. Projections indicate climate change could result in a 40 to 80 percent reduction in Pacific marten habitat throughout California. Forest management may also be contributing to the decline because logging and fire suppression practices—such as thinning—are changing their habitat.

In 2010, research wildlife biologist Katie Moriarty with the U.S. Forest Service Pacific Northwest Research Station designed a study with colleagues from Oregon State University and the Pacific Southwest Research Station to evaluate how changes in forest structure affected the day-to-day lives of martens. The team wanted to know if marten behavior in managed forest stands differed from their behavior in more complex, diverse forest stands. And if the martens behaved differently in managed stands, what might that say about their health and prospects for survival?

The key was to capture martens and fit them with miniature global positioning system (GPS) collars to track their movements. GPS devices have been around a long time, and they've been used to research deer, lions, wolves, and other animals. But not for mammals as small as martens—until Moriarty's study.

"These animals are about the size of a squirrel, and they live in dense forest where GPS technology might not work well, so it was hard to do," she says.

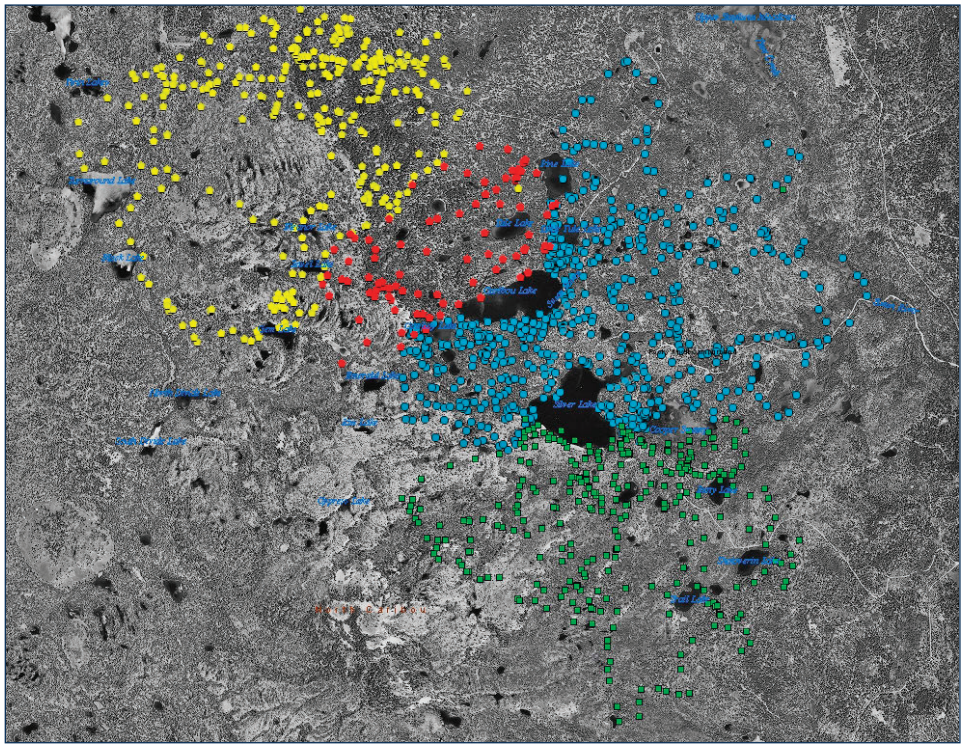
Her team set live traps in Lassen National Forest in northern California. Each trap was equipped with a hamster water bottle and food and was fitted with a canvas tube called a "capture cone." When the martens tried to get away from their captors by scurrying down the cone, they would be squeezed in place, allowing the biologists to administer an

KEY FINDINGS

- Twenty-two martens, outfitted with GPS collars avoided openings and forest stands that had been treated to reduce small-diameter trees, understory plants, and logs in Lassen National Forest.
- During the summer breeding and kit rearing season, martens were 1,200 times less likely to be detected in openings and almost 100 times less likely to be detected in areas structurally simplified by fuel-reduction treatments compared to structurally complex forest stands in the study.
- Marten behavior was more erratic, with increased speeds and decreased complexity of movements, in open and simplified stands compared to forested and structurally complex stands.
- Martens move 3 to 4 miles daily, which is energetically demanding and increases their vulnerability to predation compared to animals that have a smaller daily range.

Mark Linnell

One of the 22 martens fitted with GPS collars in the Lassen National Forest study. Martens are a member of the weasel family and travel 3 to 4 miles a day, as revealed by this research.



GPS data points revealing the movements of four collared martens in the Lassen National Forest between February 18 and March 13, 2012.

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immobilizing shot of a chemical anesthetic in their thigh.

"That gave us about 10 to 20 minutes to collect blood for genetics and disease testing, collect parasites, and take measurements," Moriarty says. "Capturing martens is rare, so we collected as much information as possible. We took hair samples to evaluate isotopic signatures. We'd pull a tooth to get an exact age. Afterwards we'd feed them organic strawberry jam—they had had a rough day—and then we released them."

In the process, they fitted the animals with special collars that provided both very high frequency radio (VHF) and GPS tracking. The collars transmitted a VHF tracking beep every 1.5 seconds. The GPS tracked location every 5 minutes. Martens are wide ranging and elusive, so having both kinds of tracking gave the scientists the redundancy they needed to cross-check and get a multidimensional picture of the animals' movements.

"We followed them around every day, all day, over a period of around 10 months per marten and over 3 years for the project," she says.

Another reason for the two types of tracking is that when one system failed, the other, hopefully, would still be working. And they failed a lot. Moriarty says the VHF signal on a GPS collar would go out about 30 percent of the time, so if they put collars on 10 animals, they might only hear back from 7 of them.

"When they don't work, it's very frustrating. But when they do work, it's very exciting. You can't get this information any other way," she says.

In the years since Moriarty performed the study, the technology remains so fickle that no other organization has been able to replicate the volume or the quality of the data she and her team collected during their 2010 to 2013 study.

MOVEMENT UNDER COVER

Moriarty's data showed that martens relied heavily on the cover of structurally complex forest stands to hunt for food while avoiding predators such as hawks, owls, and bobcats. Trees of different ages and sizes, different layers of canopy, and a diverse understory, including downed logs, snags, grasses, and shrubs, all provided cover for martens. In this environment, they could easily move from one area to another, sneaking up on prey and remaining inconspicuous to predators.

Martens behaved differently in thinned stands and areas that had been managed to reduce the risk of fire occurrence and severity. In those area, with less vegetation to hide in and around, martens' movements became quicker and less complex. Instead of moving circuitously from snag to shrub to tree, they tended to make beelines to get through exposed areas as quickly as possible.

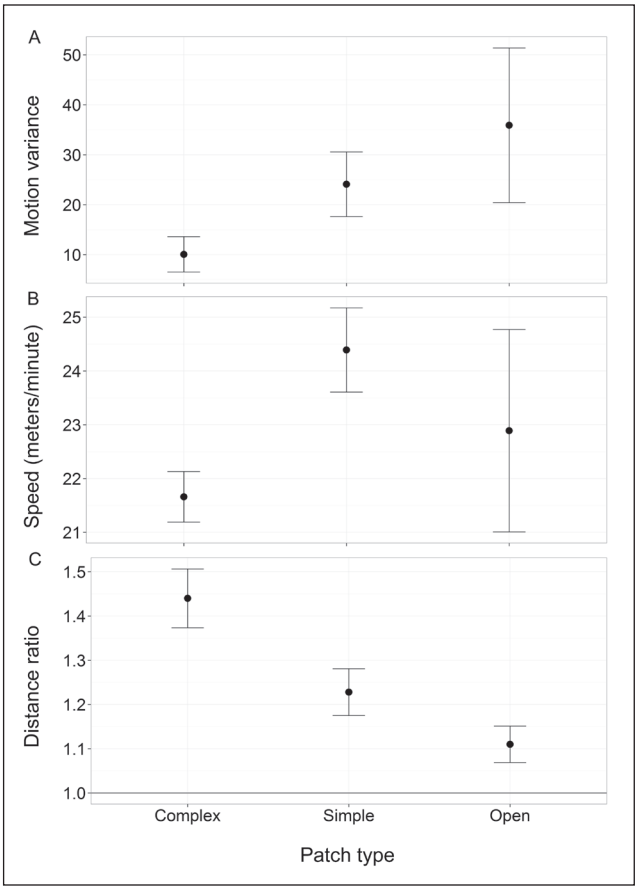
In many areas, management practices transformed broad, continuous forest into segmented islands separated by open areas. Watch any prison escape movie to get an idea of how a marten feels in this environment: It waits undercover at the edge of one section, sees (or hopes) that the coast is clear, then runs like mad to get to the other side of the clearing. Instead of searchlights and guard towers, the marten is racing in fear of something that could swoop down and grab it in its talons.

Martens cover considerable ground no matter what their environment—often more than bobcats or bears, despite the fact that those animals are many times larger—and that burns a lot of calories. But in dense forest, there's a bigger payoff. They can expend more effort hunting prey and less effort becoming prey. Open areas and thinned forest may yield less food that is harder to get. This likely results in fewer martens in thinned and disconnected stands.

"Given this mobility, increasing connectivity of stands with complex structure should reduce movement distances, increasing martens' probability of survival," Moriarty says. "We need more data to demonstrate that empirically."

The challenge of open areas was particularly apparent during the marten's summer breeding and kit-rearing season. Moriarty found that the odds of detecting a marten was 1,200 times less likely in openings and almost 100 times less likely in areas treated to reduce fuels, compared to structurally-complex forest stands.

In the winter, the food supply in the forest diminished as the presence of marten predators – especially birds such as goshawks and owls, which appear to migrate to lower elevations. Moriarty conducted an experiment in the Lassen National Forest to see if a reduction in predators changed how the martens behaved. Using bait in and around open areas, she found that martens are much more apt to venture into the open in the winter. Hunger



Moriarty et al. (2016)

Marten movement patterns differed among forest stands with complex, simple, and open structure. For example, martens covered more ground, but moved more slowly, and with less erratic movements in complex stands compared to simple or open stands. This means martens expend less energy in complex stands as they forage for food.

Mark Linnell

Martens selected home ranges within structurally complex stands such as this one.

Katie Moriarty

Marten movements were more erratic and quicker in structurally simple stands, such as this one treated to reduce fuels.

was a big incentive, and heavy snow provided a protection for the small animals, essentially adding connectivity between stands. Martens have large pads compared to their body size—like wearing snowshoes—so they're far more efficient moving in snow than animals like bobcats or coyotes.

But Moriarty found that in the winter of 2012, when the area had an unusually low snowpack, there was virtually no difference in the martens' movement from summer to winter. The added connectivity that snow provided was lost. This underscores the need to plan for more complex, connected forest stands, Moriarty explains, because climate change is expected to reduce winter snowpack in the study area by more than 30 percent, further decreasing functional connectivity for martens.

Other factors in the martens' decline not related to Moriarty's study include the fact that, like spotted owls, martens often give birth in tree cavities, which are associated with old trees and can take a century or more to develop.

"Marten populations are unique and appear to be very sensitive to changes in their environment. Whole populations have gone extinct when as little as 30 percent of the forest cover has been removed," Moriarty says.

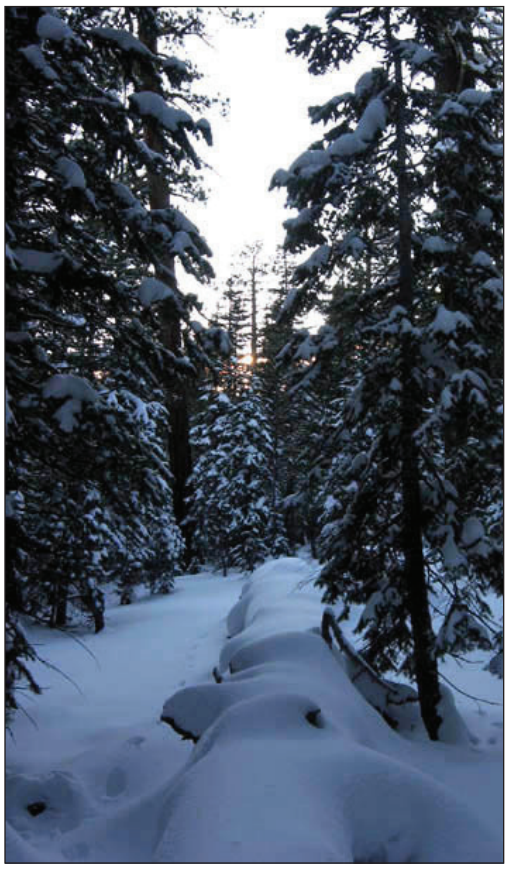
MARTEN HABITAT AND FOREST MANAGEMENT

Moriarty says the findings could prompt foresters to rethink the way they manage for reducing fire hazards. One consideration may be to focus fuel reduction efforts at lower elevations where martens are less common, and human communities tend to be, or to find ways to increase structural complexity within all forest stands.

Throughout the species range where reduction of high-risk fuels accumulation is a priority, the challenge is in deciding how much emphasis to put on protecting existing marten habitat when planning fuel treatments, knowing that left untreated, a severe wildfire could completely destroy their habitat. The level of fire risk in a particular forest type and proximity of an area to human communities is a key consideration.

Moriarty's work not only sheds light on marten behavior and how it relates to different forest environments, but also demonstrates that GPS technology is a powerful tool in studying small animals in the field.

Before Moriarty's research, scientists had a general idea that martens moved about a lot in the course of their day, but they didn't know how much. Moriarty's work brought their



Katie Moriarty

Martens move efficiently through snow, and snow can provide insulated resting locations, like snow caves. Martens were more likely to venture into snow-covered open areas than open areas without snow.

movement patterns into sharp focus and quantified it. Her work also sheds light on their territoriality and energy demands. Moreover, the findings can be applied to other animals in the same family as martens, such as fishers, minks, and wolverines.

Josh Chapman, a Forest Service wildlife program leader for the Pacific Northwest Region, says Moriarty's work is already changing the way the Forest Service is monitoring wildlife.

"We have a carnivore monitoring protocol that is more than 20 years old. But now, as a result of Katie's work, we are using more technologically advanced remote cameras, we're placing them in higher densities, and we're keeping those cameras in place longer to increase our chances of detecting target carnivore species," he says.

Moriarty's work in California, Oregon, and Washington has resulted in a better understanding of the distribution of small and mid-size carnivores—including foxes, fishers, and bobcats—and has highlighted how much more intensive survey efforts need to be to accurately document their presence, Chapman adds.

"The Forest Service is using this advancement to increase project-level survey sample densities. Moriarty's work has been essential in decisions about potential species listings, from fishers and martens to foxes. Her marten work in the Sierras is also being used to inform silvicultural and fuels reduction prescriptions in order to maintain treated stands as functional marten habitat," he says.

Her findings are being applied in several national forests. The Siuslaw National Forest used Moriarty's marten movement data to inform restoration activities, including decreasing management in areas with marten activity. Lassen National Forest managers are combining her data with laser mapping technology to further understand habitat characteristics and reduce treatment impacts. And the Bureau of Land Management and the Rogue River-Siskiyou National Forest used the technological aspects of Moriarty's study to understand how a similar species, the fisher, moves in a landscape "checkerboard" of mixed federal and private ownership.

The Lassen National Forest is incorporating Moriarty's data into the design of several forest projects. The forest managers are locating their thinning treatments in areas with less marten activity, and for the first time, they have den locations which they can protect in addition to the area surrounding them. They also are integrating more structural complexity into their plans for the benefit of marten populations.

"We're trying to get an idea of the martens' territories, especially those of breeding females. Katie's ongoing research is giving us more information every day," said Coye Burnett, a wildlife biologist with the Lassen National Forest.

Burnett said it's rare to have such detailed information on forest carnivores because they are so elusive.

"For spotted owls, we can go to a stand, hoot for the owl, put out a mouse, and then follow the owl back to its nest. For forest carnivores, it's a lot more intensive," she said. "But because Katie and her team performed this work, we have some of the only known marten den sites in the Sierra Nevada."

LAND MANAGEMENT IMPLICATIONS

- Martens selected home ranges with fewer openings and avoided stands with reduced structural complexity. Marten populations would benefit from increased stand connectivity within home ranges and at a landscape scale.
- Focusing fuel reduction efforts at lower elevations where martens are less common, or increasing structural complexity within stands would benefit marten populations.
- Climate change and the decreased snowpacks resulting from warmer temperatures likely will negatively affect marten movement and dispersal, and thus their survival.
- Miniature GPS collars provide a new tool for learning about the movements and habitat selection of martens and fishers. They will be particularly useful in providing new information in light of federal and state petitions to list these species in parts of their range.

"Conservation is the foresighted utilization, preservation, and/or renewal of forests, waters, lands, and minerals, for the greatest good of the greatest number for the longest time."

—Gifford Pinchot

FOR FURTHER READING

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