



Silent Forests?

RODENTICIDES ON ILLEGAL MARIJUANA CROPS HARM WILDLIFE

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Credit: Timothy Archibald

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Another mortality signal on the radio collar of a fisher (*Martes pennanti*) pulses on a wet spring morning, and fear of a repeat of the previous spring's mortalities looms in the backs of our minds. Hoopa tribal biologists scramble to recover the fisher quickly so that a necropsy can be performed to determine cause of death. The field crew reports back that the fisher is not dead but lethargic and lurching on the ground when it attempts to seek cover from approaching biologists. A conference call among researchers, a wildlife pathologist, and a veterinary toxicologist follows to determine the next course of action. Unfortunately, the consensus is humane euthanization. Though testing is ongoing, this is likely the sixth monitored fisher in California that has died from second-generation anticoagulant rodenticide (SGAR) toxicosis since 2009.

Linking SGARs to multiple deaths of a rare forest carnivore has been an alarming discovery. Even

more unsettling: We've learned that these deaths appear to be linked to illegal marijuana cultivation on community and public lands—a finding that raises serious concerns for the health of many species of wildlife including fishers, an Endangered Species Act candidate.

A Growing Concern

Beginning in 2008, full necropsies including toxicological screens—done at the University of California-Davis School of Veterinary Medicine and the California Animal Health and Food Safety Laboratory (CAHFS)—have been conducted to determine proximate and ultimate causes of mortality for fishers from the Hoopa Valley Reservation Fisher Project (HVRFP), Sierra Nevada Adaptive Management Project (SNAMP), and the U.S. Forest Service (USFS) Kings River Fisher Project (KRFP). These ongoing, long-term demographic projects encompass both tribal community forests within the HVRFP and public lands including Yosemite National Park and Sierra National Forest in the SNAMP and KRFP study areas.

Toxicology screening of 58 fishers from these community and public lands revealed that nearly 80 percent of the fishers had been exposed to anticoagulant rodenticide (AR) poisons, with 96 percent of those exposures being SGARs—results that we published recently in *PLoS ONE* (Gabriel et al. 2012). Concerned about this trend, we led an interdisciplinary collaboration including multiple stakeholders from the Hoopa Tribe, Integral Ecology Research Center, USFS, U.S. Fish and Wildlife Service, CAHFS, UC-Davis, SNAMP, and California Department of Fish and Wildlife, pooling together resources and expertise for a comprehensive approach to evaluate this emerging threat.

The fisher (*Martes pennanti*) is a cat-sized carnivore found in coniferous and mixed conifer and hardwood forests across Canada and in four regions of the United States, including New England, the Great Lakes, the northern Rockies, and the Pacific Northwest. Now a candidate species for listing under the Endangered Species Act, fishers in California are falling victim to rodenticides used on illegal marijuana crops scattered throughout the state's public and tribal lands.



Credit: John Jacobson/Washington Department of Fish and Wildlife

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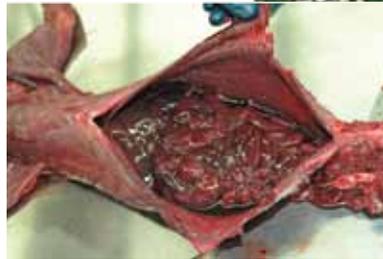
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Spatial modeling suggested that fishers were exposed to SGARs ubiquitously throughout the study areas, contradicting current thought that wildlife are at greatest risk to these toxicants near agricultural, urban, or peri-urban settings, where the pesticides are legally used to eradicate or suppress rodent pest populations. However, lifetime monitoring of the California fishers showed that most of the exposed or poisoned individuals never overlapped any of those land-use types. In addition, the use of SGARs within the study areas, in adjacent timberlands, or within campgrounds would violate current state and federal regulations. As a result, our suspicions gravitated towards undiscovered illicit uses throughout the project areas. These suspicions were essentially confirmed after federal, state, and local law enforcement officers verified that the poisons were present at most marijuana cultivation sites found on public and tribal lands.

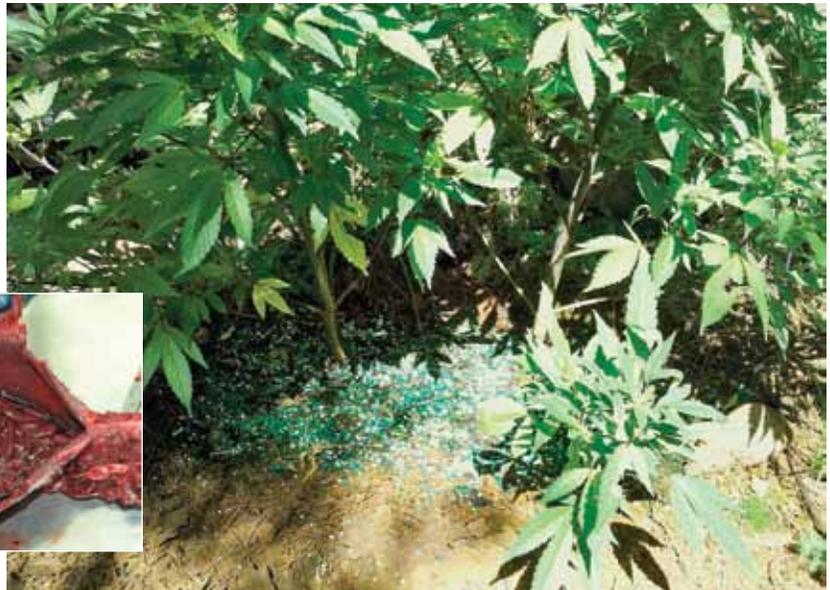


Credit: Mourad W. Gabriel

All of our documented SGAR fisher mortalities occurred from late April through early June, which is prime-time for marijuana seedling planting in California and likely the period of heaviest toxicant use to protect young plants from rodent damage. Regrettably, this is also a key time for female fishers to rear their kits. That unfortunate timing materialized when we discovered a lactating female fisher dead from SGAR poisoning in the Southern Sierra Nevadas. (California currently has two isolated native fisher populations, one within the northwestern coastal mountains, where population estimates are unknown, and another within the Southern Sierra Nevadas, where estimates suggest fewer than 300 adults [Spencer et al. 2011]). Presumably, the dead mother's kits also died due to den abandonment.

In a separate instance, a rescue attempt on an abandoned fisher kit still dependent on its mother's milk was unsuccessful, and the kit was found dead of starvation. Most disconcerting was that SGARs were detected in the kit's tissues. This unexpected finding verified a transplacental or milk transfer of a SGAR from mother to kit, raising concern about fetotoxic or bioaccumulation effects of these pesticides, which are currently unknown.

These findings underscore the need to understand not only the direct impacts of these toxicants, but other possible indirect impacts that fishers and other wildlife may face at the population level. For example, we detected an average of 1.6 different types of ARs per fisher, with some fishers testing positive for four different toxic compounds. There



Courtesy of Mourad W. Gabriel

are no data on the possible interactions of two, three, or even four different ARs, or the effects they might have on animal health. Furthermore, we cannot yet determine whether a threshold level of exposure exists beyond which an animal cannot recover, since some fishers died with low levels of SGARs while others displayed no clinical signs even with much higher exposures. We wonder if these toxicants at sub-lethal doses lower resistance to environmental stressors, as seen in other studies, and whether the distribution of SGARs within the landscape will limit prey availability and create sink habitats near cultivation sites. This is just the beginning of a long list of potential cascading impacts now being discussed in California.

Problem Spreading Like Weeds

Illegal marijuana growing is not just a problem for wildlife. The High Sierra Volunteer Trail Crew is a nonprofit trail-maintenance crew that has spent the past seven years maintaining and cleaning trails throughout the Sierra Nevadas' national forests. In the mid-2000s, the group realized that risks associated with large-scale marijuana production

Pellets of anticoagulant rodenticide litter the ground beneath marijuana plants at an illegal grow site within occupied fisher habitat. Placed to kill rodents that might eat the valuable plants, these poisons—particularly second-generation anticoagulant rodenticides—have been linked to numerous deaths of fishers. The rare forest carnivores likely die of internal hemorrhaging (inset) after ingesting the anticoagulants or preying on rodents that have fed on the toxicants.



throughout most, if not all, California national forests threatened backcountry use of public lands. Since then, the trail crew's Environmental Reclamation Team (ERT) has remediated more than 600 large-scale marijuana cultivation sites on public lands. The numbers are daunting, especially when considering that these 600 sites were in only two of California's 17 national forests and may constitute only a fraction of the actual marijuana cultivation sites that exist in these forests. Tommy Lanier, Director of the National Marijuana Initiative, a White House supported program, states that "60 percent to 70 percent of the national marijuana seizures come from California annually, and of those totals, about 60 percent comes from public lands."

Based on data from ERT-remediated sites, at least 50 percent of them have SGARs. Beyond finding anticoagulant rodenticides, the team and other

uses are occurring in California, where marijuana cultivators place pourable carbamate pesticides in opened tuna or sardine cans in order to kill black bears, gray foxes, raccoons, and other carnivores that damage marijuana plants or raid food caches at grow-site encampments.

In many cases, law enforcement officers approaching grow sites observe wildlife exposed to what officers call "wildlife bombs" due to their high potential for mass wildlife killing. For example, as federal and state officers approached a grow site in Northern California, they discovered a black bear and her cubs seizing and convulsing as they slowly succumbed to the neurological effects of these pesticides. Because toxicants are usually dispersed throughout cultivation sites, it is remarkably difficult to detect and remove all pesticide threats.

Funding to document, quantify, and remediate the damage caused by illegal marijuana cultivation on public and tribal lands has been difficult to secure through state or federal agencies or even private foundations, possibly due to the common misperceptions that illegal marijuana cultivation is not an environmental but rather a social issue, and that it is not a significant threat to wildlife. Yet we propose that funding is strongly warranted to help researchers investigate toxicant exposure and implications throughout the forests' trophic levels, and to study impacts on all species of conservation concern, including fishers and the northern spotted owl.

Another common misperception is that it is the responsibility of law enforcement to not only protect our natural resources at illegal marijuana sites, but also to remove pesticides and remediate the sites. In truth, there is currently no standardized system for grow-site remediation. Recently, for example, we encountered more than 10 pounds of SGARs and 20 pounds of metaldehyde and carbamates from a single site that law enforcement officers had dismantled within fisher and northern spotted owl territories. Most of these toxicants were left untouched out of concern for the safety of the officers, who are not trained to handle and transport these highly toxic chemicals, especially in the frequent situation where these chemicals are unlabeled. Accordingly, without documentation of the environmental damage and threats from toxicants, and without funding for properly trained personnel, most poisons will continue to be left at grow sites, where they remain a catastrophic threat to wildlife.



Credit: Mourad W. Gabriel

Accompanied by armed escorts for security, Hoopa Tribe wildlife biologist J. Mark Higley (in green hard hat) documents corn stalks likely planted to provide food for growers of illegal marijuana (right foreground). Clearings for food crops, water diversions, fertilizers, and debris left by growers cause damage to natural wildlife habitat.

remediation groups frequently find and remove restricted and banned pesticides including organophosphates, organochlorines, and carbamates as well as thousands of pounds of nitrogen-rich fertilizers. Many of the discovered pesticides have been banned for use in the U.S., Canada, and the European Union, specifically certain carbamates, which gained notoriety worldwide after an explosion of public awareness about their use to kill African wildlife. Unfortunately, these same malicious



Effects Extend beyond Poison

Environmental threats from large-scale marijuana cultivation are certainly not limited to toxicant contamination. At most grow sites, it is standard practice to clear patches of forest within riparian corridors in order to provide enough sunlight for growing plants. The cumulative impact of these practices across the California landscape is unknown, but disheartening in its potential. Last year, at a site within the Hoopa Valley Indian Reservation in northern California, where 26,600 marijuana plants were removed, several acres of hardwood-conifer and alder forest had been cleared along one of the most productive Chinook and Coho salmon-bearing streams in the area. Under no circumstance would this clearing be allowed under the Tribe's management plans or current state or federal regulations established to protect habitat for the salmon.

Because growers prefer areas with a constant and abundant water supply, it is these sensitive habitats that suffer the greatest impacts from marijuana cultivation. Water diversions and pesticide-filled cisterns within streambeds feeding miles of plastic irrigation lines are all-too-familiar a sight. Human waste throughout these sites is also widespread, and because many of the sites on public and tribal lands are inhabited for several months of the year by drug-traffic organizations, extensive camp systems are set up with associated trash dumps and human latrine sites just meters away from water sources.

The camps and plantations are often guarded by armed drug traffickers, so concern for the safety of field crews, students, and biologists working on these lands is ever pressing. Wildlife professionals are fearful of unwittingly running into armed growers at active grow sites, with good reason. Recently, a federal biologist in the southern Sierra Nevada was chased by armed growers for 40 minutes through the national forest. "When we lost radio contact at one point for 10 minutes, we feared that the biologist was captured or possibly dead," says project supervisor Jodi Tucker of Sequoia National Forest. In another incident in the 2012 field season, biologists surveying for northern spotted owls on the Hoopa Reservation were

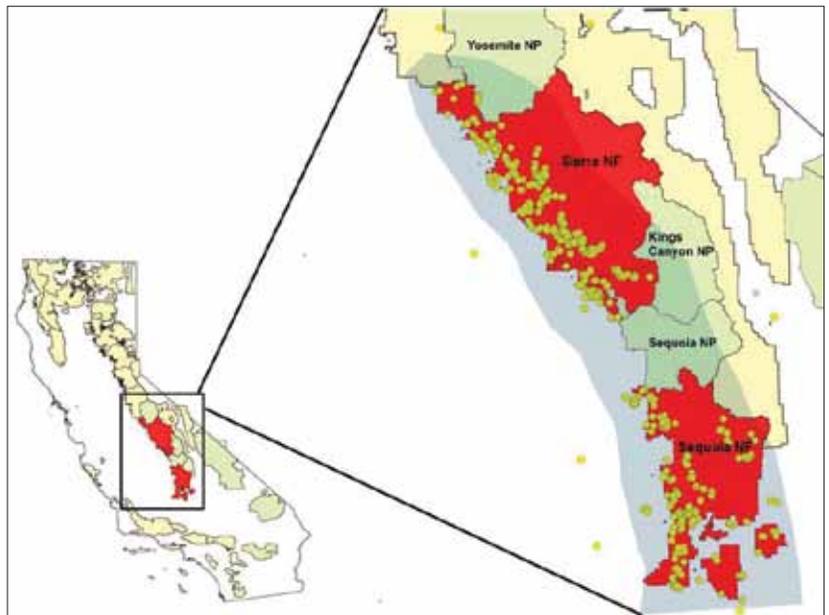


Credit: Environmental Reclamation Team



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Volunteers with the Environmental Reclamation Team display thousands of pounds of garbage, chemicals, and other debris gathered at an illegal marijuana cultivation site in the Sierra Nevada Mountains. Plastic bottles refilled with unlabeled substances (left) sometimes contain carbamates, banned chemicals that growers use to kill bears, foxes, raccoons, and other animals that may harm pot plants or raid growers' food caches.



Credit: Greta M. Wengert

Dots scattered through California's Sierra and Sequoia National Forests represent some 600 illegal marijuana grow sites reclaimed by crews who removed trash, hazardous chemicals, water diversions, and rudimentary shelters left by growers. Blue shading represents current range of the fisher within the southern Sierra Nevada, where the population is estimated at fewer than 300 adults.



shot at by suspected illegal growers with high-caliber assault rifles. Luckily, no one was injured, but biologists avoided the survey area until the threat was addressed.

Due to heightened safety concerns and emerging patterns like these over the past several years, wildlife crews now are often composed of two individuals, whereas before, biologists worked independently in the field. The effects of these changes have not been fully ascertained, but it can be assumed that increased labor costs coupled with increased equipment and vehicle

expenditures are affecting the size, duration, and thoroughness of data for many studies on California's public and tribal lands.

Because wildlife biologists are also avoiding some study areas due to safety concerns, study designs are now being altered to avoid known grow sites, thus further impacting quality and completeness of data. Research ecologist Craig Thompson from the USFS Pacific Southwest Research Station estimates that during each field season, 10 to 25 percent of the Kings River Fisher Project area becomes inaccessible due to safety concerns. In another telling example during the 2010-2011 field season, two radio-collared fishers in this study area pulsed mortality signals but could not be recovered due to their locations near known grow sites. Eventually, under escort by armed law enforcement officers, biologists recovered the collars, yet the carcasses—and any evidence of cause of death or rodenticide toxicosis—were long destroyed.

In his *Science* editorial “The Tragedy of the Commons,” Garret Hardin lamented the loss of our public resources due to the greed and inconsideration of some individuals (Hardin 1968). We believe the vast and ever-growing misuse of our public and tribal forests for the financial benefit of a few individuals is an enormous threat to these resources and a deplorable tragedy of the commons. Our public and tribal land and agencies are being hit on two fronts: first by having to endure the illegal use, take, and destruction of natural resources without our permission, then having to support the financial burden of renewing these lands from the disastrous ecosystem degradation that illicit cultivation produces. Regrettably, most of this is occurring without the knowledge of the public, whose land it is. Though this is a sad story that often brings surprise, disgust, and a feeling of helplessness in those hearing it for the first time, in the words of Rachel Carson, “The public must decide whether it wishes to continue on the present road, and it can do so only when in full possession of the facts.” ■

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