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2017 Final Report for USFWS Agreement F16AP00732

"Illegal marijuana cultivation impacts on prey and carnivore community dynamics in fisher, Humboldt marten, and Northern spotted owl habitat"

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Research conducted through our recently completed research grants has shown that toxicant exposure in fisher populations being monitored for research is common and has increased due to carnivores and rodents being maliciously poisoned by illegal marijuana growers on public and tribal lands. Contaminants are present in small mammal and invertebrate prey, in soil and water sources emanating from grow sites; and prey abundance and diversity is lower at grow sites compared to carefully selected control sites. Scaling up our data using MAXENT (Maximum Entropy) models indicates large proportions of northern spotted owl, Humboldt marten, and fisher habitat are located in moderate to high-likelihood areas for illegal cultivation.

We have documented large amounts of banned and restricted-use toxicants at a large majority of grow sites we visit, and have frequently documented fishers and other forest carnivores using these sites through remote cameras placed after eradication. We have also shown that sensitive forest species are at risk of direct mortality due to toxicants utilized at these sites. As of late 2015, 13 radio-collared fishers died directly from toxicosis attributed to grow site toxicants (Gabriel et al. 2015). Since that publication in late 2015, two more fisher deaths from the southern Sierra Nevada and one more from northwestern California were attributed to toxicosis and yet another in 2013 not included in the paper died due to malicious poisoning with a restricted-use carbamate pesticide. Even more telling are the six black bears, four gray foxes, and many rodents and birds discovered dead from toxicosis from just five of the many grow sites investigated under our current Section 6 grant in 2014 and 2015. Pilot data also supports the premise that ESA-listed, candidate, and other species of concern including northern spotted owl and Humboldt marten (*Martes americana humboldtensis*), are likely equally at risk from the many environmental impacts associated with illegal cultivation. In a related pilot study to assess rodenticide risks to northern spotted owls, closely related (non-endangered) barred owls living sympatric with spotted owls were tested for exposure to anticoagulant rodenticides (ARs). Approximately 60% of the 158 sampled barred owls and three of four northern spotted owls were exposed (M.W. Gabriel, J.M. Higley, unpublished). Since barred owls have a similar prey base and live in the same habitat as the threatened northern spotted owl, it is likely that rodenticide exposure risk is similar between these two species.

In current research, we documented carnivore use of grow sites using remote cameras set up at camps, plots, and trails. Preliminary results also suggest that carnivores, including fisher, are regularly using grow sites likely because of the massive food stores kept by the growers and associated trash piles. We suspect rates of predation on fishers by their main predators (bobcats, *Lynx rufus*, and mountain lions, *Puma concolor*) are increased due to heightened competition for less-abundant shared prey species (Wengert et al. 2014), sublethal effects of anticoagulant rodenticide exposure in fishers making them more vulnerable to predation, and heightened activity and likelihood of interaction among the three species near grow sites. This data coupled with high rodenticide exposure rates in fishers (currently, about 85%) suggest carnivore community dynamics and activity patterns might be affected.

Preliminary results from our current grant also showed that prey populations are affected within the grow sites. Prey base impacts are likely concentrated in and around grow sites, but we suspect that prey communities are affected outside the immediate grow site footprint. Furthermore, the cumulative impacts of prey depletion across hundreds of sites each year are probably substantial. We also do not know how long any effects to prey abundance last after a grow site is cleaned-up. In this proposal, we plan to investigate these questions and obtain critically needed information on the extent of impact to the forest's prey base.

Goals and Objectives

Our overarching goal is to quantify the combined effects of prey depletion and toxicant contamination from trespass marijuana grow sites on the density, species ratios, and activity of fishers, martens, owls and their main predators in public land forests. The first goal of this specific proposal was to <u>initiate</u> a longer-term research program by sampling for the first of three years the spatial and temporal extent of fisher, marten, and spotted owl prey depletion due to grow sites. A second goal is to initiate a pilot study on the activity and spatial patterns of carnivores in and around grow sites.

Objective 1: Determine the spatial and temporal extents of grow-site induced prey depletion by live-trapping rodents to assess species diversity and abundance at 4 grow sites and 4 comparable control sites for the first of 3 years. We will determine how far outside the footprint of a grow site impacts to the prey community extend by trapping a radius of 300m from each grow site and its matching control site. Ultimately and contingent on further funding, we will determine how long any impacts to abundance and diversity remain after the grow site is eradicated by conducting annual live-trapping efforts over three years post-eradication.

Objective 2: Characterize trends in anticoagulant rodenticide (AR) exposure over time in California's fisher and Humboldt marten populations, and barred owls as a surrogate for northern spotted owl. We will analyze up to 20 barred owl, Humboldt marten, and fisher livers for AR exposure collected between 2016 and 2017 and add the data to a long-term dataset on these metrics initiated in 2007 (fishers) and 2012 (barred owls and Humboldt marten). Current, additional funding is supporting AR analyses for other owl and fisher projects. Prevalence of AR exposure will be calculated each year of the series and evaluated for significant increasing or decreasing trends in exposure over time and space.

Objective 3: Determine impacts to fishers and martens and their predators' activity patterns, distribution, and population and community dynamics due to grow site toxicant use, and grower-constructed trails, camps and clear-cuts. After the grow season of 2016 for 3-6 months we will assess fisher, bobcat, mountain lion and other carnivore species activity patterns along trails, camps, and grower-created clearcuts to determine whether these anthropogenic features increase activity and consequently, likelihood of interaction between fishers and martens and their predators. This will be accomplished with remote cameras.

Approach and Results

Approach for Objective 1. Investigation of impacts to prey communities through rodent-trapping occurred in Humboldt and Trinity Counties after grow sites were deemed safe by Law Enforcement, which happened between the months of November through March. Rodents were live-trapped at 3 grow site-control site pairs. Trapping at a fourth grow site was initiated in November; however, it's elevation and early snowfall prevented us from completing the site.

The main trap-grid consisted of 3-4 transects spaced 50m apart extending through the grow site. Each was 120-m in length with a combination of 20 Tomahawk and Sherman traps placed at 10m intervals. We also trapped 4 radial transects starting just outside the perimeter of the grow patches and extending out 300m with Tomahawk traps at 30m intervals and a Sherman trap 20m adjacent to each Tomahawk. Each radial transect extended from the grow site patches at roughly 90° from each other (see Figure 1), resulting in 80 additional traps beyond the grow site's perimeter. This schematic was matched at a nearby control site (with no nearby historical grow sites) with matching habitat, terrain, aspect, and forest management characteristics. This design has been implemented in similar rodent-abundance estimate programs and is a valid method to evaluate spatial distribution of rodent populations (Parmenter et al. 2003, Gerber and Parmenter 2015). Captured rodents were weighed, measured, species and gender identified, age-class identified, ear-tagged and released at their sites of capture. Traps were opened for 4 nights and checked in the early morning, and again in the late afternoon. Bait consisted of dry cob and sunflower seeds.

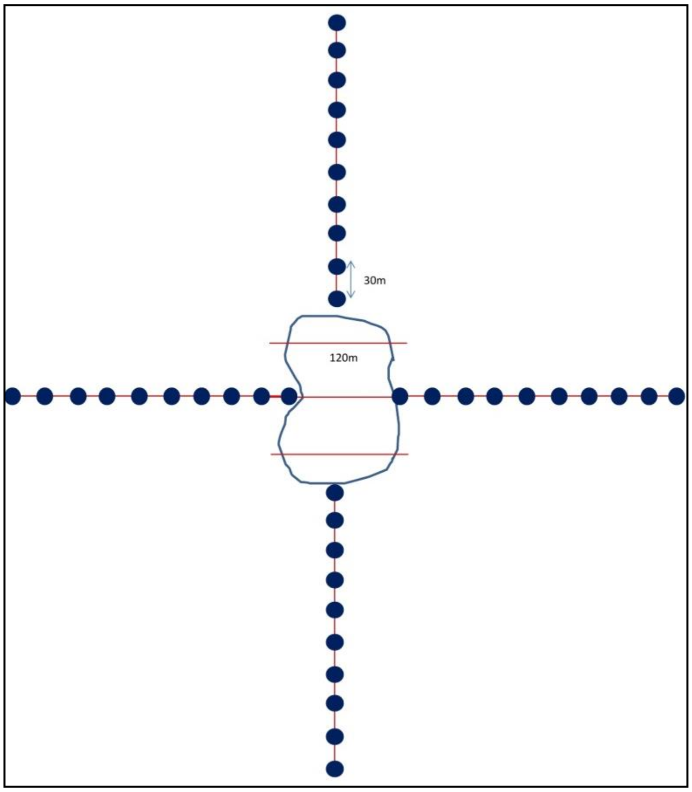

Figure 1. Rodent-trapping schematic: the three red lines on top of the grow site polygon each have traps at 10m intervals (Tomahawk and Sherman traps).The radial transects extend 300m out from the periphery of the grow plot polygon and have Tomahawk traps and an adjacent Sherman (20m from center) at 30m intervals (represented by blue dots).

Results from Objective 1. Several species of rodents were captured, processed, marked, and released at their sites of capture in the three grow site-control site pairs sampled. Diversity and abundance of rodents captured will be analyzed at the close of a 3-year study to be completed under a different grant. However, raw data are shown in Table 1.

Approach for Objective 2. For the past decade, Integral Ecology Research Center has facilitated and conducted full necropsies on fishers and martens from several different telemetry projects throughout California, also incorporating toxicological analyses to test for AR exposure. Additionally, we have collaborated with several of the projects implementing barred owl removal as a recovery action for northern spotted owl and have screened over 100 barred owl livers for AR exposure. We continue our collaborations with these projects by continuing to screen these species for AR exposure and assess exposure prevalence in fisher, Humboldt marten and barred owl populations. Livers are processed by California Animal Health and Food Safety Laboratory.

Results from Objective 2. We received 10 barred owl livers from within the range of the northern spotted owl in Oregon. Four of 10 (40%) were positive for AR exposure, three of which were positive at a trace level for brodifacoum and one was positive for bromadiolone. Both of these toxicants are second-generation AR.

Table 1. Results of rodent-trapping efforts at three trespass marijuana grow site-control site pairs on Six Rivers and Shasta-Trinity National Forest, winter 2016-2017. NEFU=*Neotoma fuscipes*, PETR=*Peromyscus truei*, PEMA=*Peromyscus maniculatus*, MICA=*Microtus californicus*, TASE=*Tamias senex*, SPGR=*Spilogale gracillis*, BAAS=*Bassariscus astutus*

	NEFU	PETR	PEMA	MICA	TASE	Shrew	SPGR	BAAS
Lime Dyke Treatment	4	12	15		2			
Lime Dyke Control	5	5	12			1		
Lime Dyke Radials	3	12	7		1			2
Oak Knob 16 Treatment	13	11	13		2			
Oak Knob 16 Control	1	18	15	3			1	
Oak Knob 16 Radials	11	12	7					1
Gainor Treatment	3	17	25					
Gainor Control	4	25	11	1				
Gainor Radials	11	18	24	1		1	1	

Approach for Objective 3. We assessed the activity patterns of carnivores in relation to grow site trails and camps using remote cameras. Six grow site and control site pairs were surveyed using non-baited camera stations along trails and near camps, with the controls placed in similar habitat within 50m of the trail, but without anthropogenic features. Cameras were checked approximately once per month and remained in place between 1 week (removed due to grower activity in the area) to 3 months post-eradication. Camera survey results were assessed for diversity and temporal proximity of fishers and their predators.

Results from Objective 3. Table 2 shows the results for each pair of camera sets. Overall, trail sets had higher diversity than control sets. Additionally, one trail set (Gainor) detected fisher as well as their main predators, bobcats and mountain lions, while its paired control set detected only bobcat.

Table 2. Results from remote wildlife cameras set on trails and comparable control sites at 5 trespass marijuana grow sites in Six Rivers National Forest. Codes for species are: D = Black-tailed deer, BB = Black bear, VT = Varied thrush, DS = Douglas squirrel, M = Peromyscus mouse, WR = Dusky-footed woodrat, Q = Mountain quail, BR = Brush rabbit, RT = Ringtail, RC = Raccoon, GF = Gray fox, FI = Fisher, ML = Mountain lion, BC = Bobcat, FS= Northern Flying Squirrel, GS= Western Gray Squirrel, AC= Allens Chipmunk, UB=Unknown bird species, R= Robin.

	# days operational	# species	Species present
Gainor Treatment	50	8	D,GS,WR,GF,FI,ML,BC,BB
Gainor Control	50	3	BC,D,GS,M,WR,GF,UB
Oak Kob Complex 2016 Site 2 Treatment	85	7	DS, AC, M, GF, RT, UB, Q
Oak Kob Complex 2016 Site 2 Control	85	7	DS, FI, M, D, R, RC, RT
Oak Knob Complex 2016 site 1 Treatment	85	5	D, M, RT, GF, GS
Oak Knob Complex 2016 site 1 Control	85	6	D, FS, BB,M, VT,WR
Oak Knob Complex 2014 Treatment	49	9	D,VT,DS,GS,M,WR,RT,GF,FI
Oak Knob Complex 2014 Control	49	5	D,GS,RC,RT,WR
Oak Knob Site Treatment	40	8	D,BB,VT,DS,M,WR,Q,BR
Oak Knob Site Control	33	6	D,BB,VT,DS,M,RT

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