FINAL PERFORMACE REPORT

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Science with Solutions: Documentation, Reclamation and Monitoring of the Ecological Impacts of Marijuana Cultivation on Endangered Species

Cite as

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Final Performance Report

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ABSTRACT:

From 2014-2016 we documented the environmental impacts of illegal marijuana cultivation through a multi-faceted approach. First, we intensively assessed the environmental damage and collected biotic and abiotic samples for toxicology analyses at 9 trespass cultivation sites prior to and 1-year post reclamation. We also performed one time assessments of 55 additional trespass sites. Results from visits and analysis showed that fertilizers, insecticides, and rodenticides are commonly used at these sites, and surrounding vegetation, soil, and water are contaminated with many of these toxicants. We also documented that many species of wildlife regularly use the camps, dumps and trails that the growers create, and prey species may be adversely affected by cultivation activities. Second, we conducted reclamation of 29 sites, both to finalize best practices for reclamation and to mitigate the observed impacts. Over 50.7 miles of irrigation pipe and 61,174 pounds of trash, pesticides and fertilizer were removed. Thanks to leveraging of strong partnerships with CDFW Law Enforcement Division, U.S. Forest Service Law Enforcement and Investigations, Bureau of Land Management law enforcement program, California National Guard, California Department of Justice, and several local law enforcement agencies, as well as complementary funding sources, we reclaimed 20 more sites than originally proposed and assessed 55 more sites than originally proposed. Finally, we used the data collected from this work to scale up our findings to the landscape level by developing a predictive Maximum Entropy Model (MAXENT) model to spatially map relative likelihood of trespass marijuana cultivation on public and tribal lands. When overlayed onto habitat maps for fisher and northern spotted owl, we found that 44% of high-quality fisher habitat and 26% of high-quality northern spotted owl habitat was overlapped by areas predicted to be of moderate to high likelihood for grow site presence. By estimating environmental impacts at the landscape and population scales, our model predictions demonstrate the enormous scale of this problem and the need for continued concerted multi-institutional efforts to prevent illegal cultivation and reclamate damaged public and tribal lands.

3. Location of work:

Work was performed at trespass cultivation sites located in Humboldt, Trinity, Shasta, Siskiyou, Tehama, Lake, and Plumas Counties, California. The lists of all sites visited during the performance period are provided in Tables 1 and 2. We focused our investigations on cultivation sites that occur within sensitive and listed species' range and habitats (fisher, northern spotted owl, Humboldt marten), in true-oak woodland, tanoak, mixed hardwood-coniferous, mixed coniferous, true fir, and redwood habitats. The majority of public and tribal lands in northern California where illegal marijuana cultivation sites occur are in these habitats.

4. Objectives and Expected Results:

The objectives of the project were to:

1. Document the types and quantity of all toxicants found at marijuana grow sites on public and private lands and investigate toxicant impacts to biotic and abiotic resources through environmental sampling. Laboratory work (necropsies and toxicology analyses) were done by our collaborative partner, the California Animal Health and Food Safety Laboratory (CAHFS) at UC Davis to help accomplish this objective.

2. Remediate dismantled cultivation sites to restore habitat and remove toxicant and other risks to wildlife.

3. Determine if there are long-term impacts of toxicants on the abiotic and biotic community at illegal cultivation sites following reclamation.

4. Use toxicant, fertilizer, and animal mortality data collected from nine cultivation sites assessed under Section 6 in addition to six cultivation sites assessed under other programs to model landscape-scale risk to wildlife habitats.

Expected Results
During the first two years of this grant we planned to gain access to nine trespass marijuana cultivation sites on public and private lands. We expected to find several wildlife carcasses at the sites that could be necropsied and screened for toxicants, and we anticipated detecting toxicant presence in at least some of the abiotic (soil and water) and invertebrate samples collected at the these sites. We planned to fully remediate all nine of these sites and collect data including: 1) photo documentation of wildlife species using camps, dumps, and trails at sites before and after reclamation; 2) abiotic samples for toxicant screening; and 3) information on cause of death of any carcasses found at or near grow sites. On sites that were remediated, we expected to find fewer wildlife visits than at comparable control sites, as documented with remote cameras.

By leveraging partnerships, including a Tribal Wildlife Grant, a Rocky Mountain Elk Foundation Grant, and logistical assistance from many local, state and federal agencies, we met and in most cases exceeded our objectives. We remediated more sites than promised and visited and collected data at many more sites than originally expected. However, due to safety issues and concerns about equipment safety at grow sites, we were seldom able to monitor wildlife use of grow sites using remote cameras prior to reclamation for adequate periods of time. Unfortunately, we also discovered that the scope of toxicant contamination and mortalities exceeded initial predictions.

5. If the work in this grant was part of a larger undertaking with other components and funding, present a brief overview of the larger activity and the role of this project.

This grant is a significant part of a large scale, multi-organizational effort to investigate the environmental impacts of trespass marijuana grow sites throughout California. This project is highly synergistic with a Tribal Wildlife Grant (TWG) to the Hoopa Tribe/ IERC for grow sites on Hoopa Tribal lands. Section 6 and TWG funding sources were complementary and did not overlap due to their different geographic areas of work and differing objectives. The TWG grant was limited to Hoopa Tribal lands and also provided support to fisher monitoring. Additionally, TWG funding did not support re-visits to cultivation sites after reclamation to assess long-term persistence of toxicants in the environment. This Section 6 project is the first effort to implement a newly developed protocol for sampling environmental variables (developed with TWG funding) at grow sites across a wider geographic area and spectrum of land management to assess the scope of environmental damage. With additional refinement based on the large number of sites we visited for this grant, we created a final "Initial Investigations Protocol" (Appendix A). This Section 6 effort was also the first project to assess the effectiveness of current reclamation protocols and improve on them where necessary, and to develop a predictive model at the landscape scale. Initial site visit data funded by TWG and Section 6 projects has been combined to develop predictive models in this grant that allow for greater applicability of findings statewide. Additionally, complimentary projects include a grant to IERC from the Mule Deer Foundation to investigate exposure of hunter-harvested game animals to toxicants, a grant from the US Fish and Wildlife Service to IERC to investigate toxicant exposure of barred and northern spotted owls, a USFWS-funded project to develop the predictive model more extensively through ground-truthing and expanded geographic scope, a Rocky Mountain Elk Foundation Grant to remediate 3 sites in elk habitat, and a CDFW Big Game Funded project to test for anticoagulant residues in bear, deer and wild pig statewide.

6. Describe how the objectives were met.

During the first two years of this grant (2014 and 2015), we concentrated on implementing Objectives 1, 2 and 3: assessing grow sites (Obj. 1), reclamation of contaminated sites (Obj. 2), and re-visitation of grow sites that were first assessed in

2014 (Obj. 3). In our final year (2016), we completed small-scale investigations at many grow sites in California (Obj. 1), completed our re-visitation of grow sites originally assessed in 2015 (Obj. 3) and completed the modeling project (Obj. 4).

Objective 1 - Document the types and quantity of all toxicants found at marijuana grow sites and investigate toxicant impacts to biotic and abiotic resources through environmental sampling and laboratory analyses.

Objective 3: Determine if there are long-term impacts of toxicants on the abiotic and biotic community at illegal cultivation sites following remediation. One year after remediation, the nine study sites will be revisited to sample and document any change in environmental conditions, either positive or detrimental. Revisits and resampling will occur approximately one year following the remediation date of each site and are expected to be completed by December 2015.

****For this section, we first present results from Objective 1 as indicated by the subheading "Initial Monitoring". Results from efforts towards Objective 3 are indicated by the subheading "1-Year Post-reclamation Monitoring".

Through close coordination with several law enforcement agencies including California Department of Fish and Wildlife, Humboldt and Trinity County Sheriff's Offices, United States Forest Service, Bureau of Land Management, California Department of Justice and the Army National Guard, we were able to locate and conduct a full sampling effort at eight trespass marijuana grow sites during the 2014 field season (July through December). All eight sites were located in Humboldt and Trinity Counties within Six Rivers National Forest, Shasta-Trinity National Forest, and the Trinity Alps Wilderness. In 2015, four additional sites located in the Shasta-Trinity National Forest received a full assessment. We were able to conduct 1-year follow up assessments on 9 of these 12 sites; then, 3 sites were dropped from follow up due to winter accessibility and safety concerns leaving us with 9 sites that were fully assessed and sampled for two consecutive years (Figure 1, Table 1).

The detailed assessment protocol included: monitoring of wildlife use through remote cameras; soil and water sampling for contamination; and full quantification of fertilizers and toxicants detected at grow sites. Additionally, rodent abundance sampling was conducted at 6 of these sites. Details of sampling and significant results to date follow.

<u>1.1 – Toxicants, Fertilizer and Environmental Damage Documentation During Initial Site Assessments</u>

Documentation of impacts during initial site visits varied due to safety concerns at each site. Several sites we initially documented immediately following initial Law Enforcement team visits to the site. Due to safety concerns, data collection on initial days at some sites was not as intense as other sites where law enforcement raids had occurred days or weeks earlier. Therefore, in order to ensure uniform collection of data that would be available for future analysis, we created an "**Initial Investigations**"

protocol (Appendix A) to guide data collection and review safety checks.

Data collected under our standardized Initial Investigation Protocol included:

- Documentation of all fertilizers and pesticides with each container being permanently marked in order to avoid double counting items in subsequent visits.
- Determination of grow patch size by mapping the perimeters of sites using a GPS unit.
- Determination of the diameters of all live trees cut by growers.
- Collection of abiotic (soil/water) and biotic (invertebrates, vegetation and carcass) samples.
- Photographic and georeferenced record of all items and areas of concern so they could continue to be assessed in any subsequent visits.
- Creation of a record of any material that may have been hauled off the site by helicopter and by Law Enforcement teams.
- Assessment of water diversion by estimation of the volume of each water cistern encountered, flow rates of irrigation lines feeding grow patches, and collection of data from any irrigation timers that were found. These data allowed us to develop "potential daily water use per plant" estimates once specific grow sites plant counts were assessed.

We also conducted partial sampling at 55 additional grow sites (including the 3 that were discontinued for full monitoring efforts) throughout northern California in 2015 and 2016 (Table 2). One or more of the following types of sample were collected at these sites: plant, soil, or water contamination; wildlife use of sites through remote cameras; dead animal toxicology, but not all sites had all samples collected.

In conjunction with two additional complementary grants and agreements (Tribal Wildlife Grant, Hoopa Tribal Forestry; Plumas and Lassen National Forests participating agreement), we compiled information from full assessments conducted at 77 grow sites across northern California. The results of this compilation are shown in Table 3.

1.2 Assessment of Toxicant Exposure in Wildlife, Water and Soil

Wildlife Sampling

Numerous animal carcasses were discovered at grow sites over the 3-year period of this grant. In total, carcasses were discovered at 34 of 59 (58%) grow sites we investigated. The most common species found dead within grow sites was black-tailed or mule deer (*Odocoileous hemionus*), which were found at 16 of 49 (33%) grow sites fully investigated for dead wildlife. The majority of animals discovered appeared to be shot, but many also were suspected of poisoning. The list of dead animals found and their suspected or confirmed causes of mortality are shown in Table 4.

In addition to wildlife carcasses found at grow sites, we collected rodent carcasses that died during capture and handling while conducting rodent trapping at these sites. In 2014, seven of eight liver samples (88%) from rodent carcasses tested positive for the presence of at least one anticoagulant rodenticide (AR) compound. In 2015, 0 of 14 rodent carcasses tested positive for AR.

Because we did not observe wildlife carcasses at each grow site suitable for testing, we also investigated whether feces found at or near grow sites could be used to detect AR exposure in animals using areas in around grow sites. We first tested feces from fisher carcasses known to have died from AR poisoning. Of nine fisher fecal samples tested, three (33%) were positive for brodifacoum, a second generation AR compound. Results for analysis of nine fecal samples from fishers that died of other causes, but had AR residues in their livers all tested negative. In 2015, several fecal samples from Leporids, deer, other carnivores and rodents were tested for AR, but were all negative.

Finally, we randomly sampled live invertebrates from grow plots within the sites. Early data from a previous project (Tribal Wildlife Grant, Hoopa Tribe) indicated that brodifacoum was present in tissues from some grasshoppers and snails collected within the grow patches. We tested seven pooled samples (one to five invertebrates per pool) from four grow sites (Brush Mountain 2013, Hobo Road 2014, Big French Creek Huffman, and Oak Knob) for the presence of ARs. No AR compounds were detected in our initial invertebrate sample set. We did not conduct invertebrate sampling in 2015 or 2016.

Water Sampling

Initial Monitoring

We utilized Polar Organic Chemical Integrative Samplers (POCIS) in order to determine if surface water flowing just below grow sites was contaminated with either polar or hydrophilic water soluble organic chemicals including a wide array of insecticides, rodenticides, and herbicides. These samplers are deployed in the environment for weeks to months at a time and screen flowing water for the presence of toxicants. At each site, we utilized the small POCIS holder which accommodated three POCIS membranes (Figure 2). Nine POCIS samplers were deployed at nine sites undergoing the full monitoring program (one at each site; Table 5). Two of the six sites were located within the designated Trinity Alps Wilderness Area (Hobo Road 2014 and Big French Creek Huffman, Figure 1) while the other eight sites were on National Forest Service Lands managed by the United States Forest Service (Brush Mountain 2013, Brush Mountain 2014, Oak Knob, Oak Knob Complex, Road 16, Telephone Ridge 1 and Telephone Ridge 2). Six POCIS were initially placed in November 2014, two of which were deployed prior to site reclamation while the remaining four were deployed post-reclamation. Six POCIS were checked and had their individual POCIS membranes changed once before removing the samplers in late February 2015. Three more samplers were placed in watersheds for an initial deployment in October 2015 (Telephone Ridge sites) and December 2015 (Road 16).

Toxicology testing was completed for all placement periods for all nine POCIS. Of these, three (33%) tested positive for the presence of the organophosphate insecticide, diazinon, during the first sampling period. None of the samplers tested positive for the presence of carbamates or anticoagulant rodenticides at any time period. All sites were negative for the second sampling period. The documentation of diazinon in these waterways is significant; diazinon used to be a household pesticide but was banned from over the counter use due to water contamination concerns. It is highly toxic to fish, aquatic invertebrates and amphibians.

One-year Post-reclamation Monitoring
In 2015 and 2016, POCIS were deployed again at the nine sites sampled in 2014 and 2015 for one or two sampling periods. All results are indicated in Table 5.

Additional Monitoring
POCIS were also deployed at the three other sites (Bonta Creek, Cedar Creek, Hayshed) for a single season of monitoring. Noteworthy is a positive carbofuran result for the Cedar Creek POCIS deployed mid-winter and removed during the spring. Through continued funding through Plumas National Forest, we continue to monitor this watershed, due to the safety concerns with this result.

Discussion
In order to determine if monthly precipitation may have contributed to a flushing of toxicants into the water, precipitation amounts were estimated for each location. Monthly precipitation amounts based on each POCIS location was determined by the National Weather Service Western Region monthly precipitation map portal (http://www.wrh.noaa.gov/wrh/precip_map/) (Figure 3). Four of the POCIS sites were in close proximity to each other and the map portal assigned them identical precipitation amounts. These sites were labeled as coastal sites for further analysis. The other two sites had identical assigned precipitation levels due to location proximity and were given the assignment of Interior Sites.

Preliminary results clearly demonstrate that surface water and potentially ground water immediately below these grow sites are contaminated (Table 5). In addition, these data points bring up additional questions of whether the toxicant compounds detected in surface water are at a concentration that may be lethal to invertebrates, herpetofauna or fish inhabiting watercourses below these sites. This also raises concerns if these water courses pose a risk to not only terrestrial wildlife but potentially humans. Unfortunately, with the POCIS deployment methods we've used, we are unable to quantify the concentrations present in the water. Because our study focused on simply trying to determine if any toxicants were present, our study design did not allow us to determine the toxicant contaminations present in our samples. In order to assess concentrations, a flow meter in conjunction with the POCIS would be required, which would allow us to evaluate how much water flowed through the membranes, and thus, the overall concentration of the toxicant in the water. Future studies should incorporate this technology.

Soil Sampling

Initial Monitoring
We sampled soil at 7 grow sites during or shortly after eradication (Table 6). Soil was sampled within the actual grow plots where we hypothesized that pesticide presence would most likely be, in addition to within campsites. Control sites in similar habitat but outside of the plots or camps, were also sampled. A trace amount of the second-generation AR, brodifacoum, was detected in a soil sample from a grow plot at the Brush Mountain 2014 site in its initial monitoring season. Trace amounts of the carbamate carbofuran were found two soil samples from the Telephone 2 site. All other soil samples were negative for rodenticides and insecticides.

One-year Post-reclamation Monitoring
We re-sampled soil at three of the seven sites sampled in the initial year: Oak Knob, Brush Mountain 2014 and Telephone 1. We also collected soil samples at Oak Knob Complex, Brush Mountain 2013, Road 16, and Hobo 2014, constituting the one-year post-reclamation monitoring. Additionally, we sampled soil at Hayshed, Little Bear Wallow, Paradise, Bonta Creek and Paradise (single-year assessment sites).

Soil samples from Oak Knob Complex, Brush Mountain 2014, and Paradise (all one-year post-reclamation samples) tested positive for carbofuran (Table 6). Additionally, soil samples from Brush Mountain 2014 tested positive for Diphacinone and Chlorophacinone, both first-generation ARs that were not detected in samples collected during initial monitoring. A Hobo 2014 soil sample tested positive for Difenacoum, a second-generation AR. All of these sites were vacant throughout the years and growers never re-visited. Though all sites were remediated, these compounds likely leached into the soil while the grow sites were still active, and the remediation and interval between contamination and sampling was not sufficient for the compounds to dissipate.

1.3 Assessment of Wildlife Use and Potential Biodiversity Impacts

Wildlife Detections at Grow Sites

Initial Monitoring
In order to determine whether wildlife visited trespass marijuana grow sites, we deployed Remote Infrared Wildlife Cameras (RWC) to capture either a high-resolution photo or video at all nine of the full-monitoring grow sites. In addition, 10 single-year monitoring sites had RWCs deployed (see Table 2). Cameras were programmed to take three photos at one minute intervals or video at three minute intervals. Cameras were placed at grow sites to record wildlife that visited these sites and had the potential to be exposed to toxicants or be more likely to come into contact with humans. Camera data were also obtained to evaluate how often wildlife visited areas thought be an attractant on grow sites, like trash dumps, human camps etc., representing how wildlife might continue to visit sites that are not cleaned up. A total of 44 remote game cameras were deployed at nineteen trespass grow sites. The number of cameras ranged between one

to five per site.

Four of the nine full-monitoring sites had RWCs operational before the reclamation. Four of the remaining five sites had the RWCs placed and operational on the day of reclamation, while one site's RWCs were placed three weeks post-reclamation. For the 10 sites with a single year of monitoring with RWCs, five were placed prior to reclamation (or the sites are still un-reclaimed) and five were placed on the day of reclamation. The delay of placing RWC after reclamation at these sites was due to safety concerns. The range of operational days for all 44 RWCs ranged from 7 to 232 days. Appendix B shows a sample of photos taken at grow site camps and trails.

Species detected via RWC included black-tailed deer (*Odocoileus hemionus columbianus*), American black bear (*Ursus americanus*), mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), fisher (*Pekania pennanti),* raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), striped skunk (*Mephitis mephitis*), western spotted skunk (*Spilogale gracilis*), western gray squirrel (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), deer mouse (*Peromyscus maniculatus*), chipmunk (*Tamias* sp.), dusky –footed woodrat (*Neotoma fuscipes*), snowshoe hare (*Lepus americanus*), common raven (*Corvus corax*), varied thrush (*Ixoreus naevius*), Steller's jay (*Cyanocitta stelleri*), and dark-eyed junco (*Junco hyemalis*).

One-year Post-reclamation Monitoring
Remote cameras were deployed in the same locations for all nine of the full-monitoring sites, The same species were detected during surveys at one-year post-reclamation, with the addition of band-tailed pigeon (*Patagioenas fasciata*) and American robin (*Turdus migratorius*). Remote camera data continues to show that native wildlife including listing candidate species and fully and specially protected species are present at trespass grow sites. Continued analysis of camera data will examine wildlife presence and attraction to these sites.

Prey Biodiversity Assessment

Rodent trapping was conducted by IERC under their existing CDFW Scientific Collecting Permit at six of the nine fully-sampled grow sites included in the Section 6 funded work and paired control sites to test for differences in abundance, diversity, and likelihood of rodent presence between grow and similar control sites chosen to represent the habitat and abiotic conditions which would normally be present at the grow sites. We expected that abundance and diversity of rodents would be lower at grow sites due to the heavy use of rodenticides at camps and plots within grow sites. Each grow or control site had three to five 120m transects (depending on size of the grow) placed parallel to each other with either Sherman or Tomahawk traps located at every 10 meters along the transects with a total of 20 traps per transect.

Six grow sites were sampled for rodents (Brush Mountain 2014, Oak Knob, Huffman,

Oak Knob Complex, Road 16 and Telephone 1). For the first three sites listed, we noticed a difference in diversity of species captured between the grow and the matched control sites. At grow sites, only small-bodied rodents (*Peromyscus spp.*, *Microtus spp.*) with the exception of a single northern flying squirrel (*Glaucomys sabrinus*) were captured, while at the control sites, both small and large-bodied rodents were captured (*Peromyscus* spp., *Microtus* spp., dusky-footed woodrats, chipmunks, Douglas' squirrels, northern flying squirrel). Also noteworthy, at 2014 sites, the seven rodents that died during handling were all captured at grow sites, six of which were positive for anticoagulant rodenticides (1st generation = 3 positive; 2nd generation = 4 positive). A single animal (mountain quail, *Oreortyx pictus*) died at a control site (it was caught in the trap door) and it was also positive for 2nd generation anticoagulant rodenticides. For the two sites sampled in 2015 (Road 16 and Telephone 1), 14 rodents died during handling (8 at grow sites, 6 at control sites). Twelve of these were tested for anticoagulant rodenticides, and all were negative.

Objective 2 - Remediate dismantled grow sites to restore habitat and remove toxicant and other risks to wildlife.

For all eight sites assessed in 2014, training for reclamation crews was conducted at two sites during September 23-24, 2014 for the October 2014 reclamation effort and one site on December 12, 2014 for an April 2015 reclamation effort. We conducted full reclamation and removal of all trash and grow infrastructure via helicopter, and dismantled all water diversions during operations on October 13-16, 2014 and April 1-2, 2015. During the first reclamation operation in October, seven sites were remediated (Figures 4 and 5). Out of these seven sites a total of 104 pounds of rodenticide, 560 gallons of insecticide, and 8,188 pounds of fertilizer were documented and removed (Table 7). In addition, infrastructure that was diverting a minimum of 67.5 million gallons and weighing over four tons was removed.

The April 2015 reclamation had over 8,000 feet of irrigation line removed and over 9,000 pounds of fertilizer, pesticides and trash removed from the final remaining site (Oak Knob Complex). Details of the partners, collaborators, and achievements of the operations are exhibited in Appendix C. All operations were highly successful, removing thousands of pounds of fertilizers, trash, toxicants and many miles of irrigation line piping from National Forest and Wilderness and eliminating significant water diversions from streams.

During grow site reclamation at Brush Mountain 2013, two unlabeled plastic sprayers were discovered with unknown contents. To test whether these sprayers contained substances that could be harmful to wildlife and humans, we sampled the contents. One of the sprayers tested positive for carbofuran, carbaryl, and the metabolite 3-Hydroxycarbofuran. As noted above, carbofuran is a carbamate insecticide that is highly toxic and has been banned in the United States since 2009. Carbaryl, also a carbamate insecticide, can be purchased over the counter, however it's presence on a trespass grow is illegal. When used per instructions, carbaryl has low-moderate toxicity, but

toxicity is variable and carbaryl can be highly toxic to certain fish species, aquatic invertebrates, tadpoles, and honeybees – all of which would be a concern at these sites (Carbaryl Fact Sheet, National Pesticide Information Center; npic.orst.edu/factsheets/carbgen.pdf.)

A total of 11 sites were remediated post documentation in late 2015. Sites were located in both Trinity and Plumas Counties and were all located on public lands managed by the US Forest Service. All of the sites within Trinity County were within the Shasta-Trinity National Forest and sites in Plumas County were within the Plumas National Forest. All 11 sites were documented before reclamation operations were initiated. The Plumas operation in partnership with other USFS efforts was held on September 12-15th, 2015. The second operation was conducted in Trinity County on October 26-30th and November 19th, 2015. The November date was scheduled due to the overwhelming amount of material at sites and weather restrictions for flight operations. Infrastructure, fertilizers and pesticide amounts varied for each operation. In total, 85 pounds of rodenticides, 11,857 pounds of fertilizer, and 38,184 pounds of garbage and infrastructure were removed (Table 7).

Two additional grow sites were remediated after documentation in 2016: Deer Lick Springs and Dubakela (included in Table 7). Matching funds from the Rocky Mountain Elk Foundation and CalRecycle were used to cover much of the labor and helicopter costs.

Objective 4. Use toxicant, fertilizer, and animal mortality data collected from nine cultivation sites assessed under Section 6 in addition to six cultivation sites assessed under other programs to model landscape-scale risk to wildlife habitats.

Integral Ecology Research Center received a complementary grant from the Yreka Field Office of the USFWS which allowed us to expand the modeling effort and conduct an accuracy assessment phase (ground-truthing). This funding was used in conjunction with Section 6 funding to build a base model upon which we integrated the empirical data collected under our previous Tribal Wildlife Grant, Section 6 grant, and continuing documentation efforts in northern California to build an extensive cumulative impacts model across California's landscape. With its past and current close collaboration with federal, state, and local law enforcement (LE) divisions, IERC has been entrusted with sensitive information on the locations of trespass grow sites documented and eradicated by law enforcement between 2010 and 2014. Unfortunately, LE agencies and public land managers understand that these sites represent only a fraction of the many sites actually out there inflicting damage on our environment.

This objective was to use existing LE data on marijuana grow site locations throughout forested regions of California and southwestern Oregon to model additional likely areas of grow site activity based on biotic, abiotic, and anthropogenic features. Our goal was to relate the likelihood of grow site presence to habitats essential for sensitive species

including the Pacific fisher, northern spotted owl, and Humboldt marten throughout California and southern Oregon. Maximum Entropy (MAXENT) modeling was chosen as the modeling framework for this work because it requires only presence locations (as opposed to both presence and confirmed absence locations).

Model Development

IERC received data from LE agencies of locations of trespass marijuana grow sites throughout public and nearby private lands that were detected and eradicated by local, state, and federal LE officials between the years 2010 – 2014 (in the Sequoia-Kings Canyon National Park and southern Oregon, data dated back to 2007). In June 2015, IERC conducted a meeting and presentation to inform local and regional policy-makers, natural resource managers, and law enforcement of our project's goals and objectives. During this meeting, we presented our law enforcement-sensitive dataset of all known trespass marijuana grow site locations throughout California's public lands and explained how we intended to use the data to create a predictive model of likelihoods of trespass marijuana cultivation in areas outside of known grow site locations. We received feedback from outside experts and stakeholders knowledgeable about modeling, criminal behavior, and on-the-ground reconnaissance of typical characteristics of trespass cultivation sites.

Through several phone conferences between IERC ecologists Greta Wengert and Mourad Gabriel, Hoopa Tribal Biologist Mark Higley, and Conservation Biology Institute ecologists and modelers, Wayne Spencer and Heather Rustigian-Romsos (the "modeling team"), a list of candidate variables was selected for modeling at 90m pixels, and these variables were averaged over a 450m moving window to approximate the resolution of the grow site locality data. The modeling team met at the Conservation Biology Institute office in Corvallis, OR on August 5-7, 2015 to begin the actual modeling effort. Initially, the modeling team divided the grow site locality data into 5 ecoregions encompassing all of the forested lands of northwestern California, Southern Cascades and Sierra Nevada mountain ranges and extending into southwestern Oregon. The 5 ecoregions represented our entire Area of Interest (AOI) as it included the entire range of fisher, marten, northern spotted owl and much of the range of California spotted owl in California. Once the region-by-region approach was completed for all 5 ecoregions, we compared the results to a single, seamless model obtained by modeling all of the 5 ecoregions together (i.e. our entire AOI). We determined that modeling the entire AOI produced a better-fit and more conservative map of risk than the region by region approach. Therefore, we have focused our ongoing efforts on refining the model for the entire AOI.

The list of variables initially evaluated in the modeling effort included:

Mean basal area weighted stand age

Mean tree canopy cover (%)

Mean tassel-capped greenness

Mean tassel-capped wetness

Mean distance to nearest disturbance (4-12 years previous)

Proportion disturbed (4-12 years previous)

Mean distance to nearest disturbance (8-12 years previous)

Proportion disturbed (8-12 years previous)

Mean latitude adjusted elevation

Mean elevation (m)

Mean solar insolation index

Mean percent slope

Standard deviation percent slope

Mean value of transformed slope aspect

Average daily maximum temperature July 1981 - 2010

Average annual precipitation

Proportion in public conserved land

Mean distance to nearest private lands

Mean distance to nearest fresh water

Mean distance to nearest perennial fresh water

Mean distance to nearest road

Mean distance to major road

Mean distance to nearest populated place

This list was narrowed to exclude highly correlated variables and the final list included 11 variables which advanced to the model-pruning stage. These variables were: mean basal area, weighted stand age, mean tree canopy cover, mean distance to nearest disturbance (6-10 years prior to 2013), mean latitude adjusted elevation, mean percent slope, mean distance to nearest private lands, mean distance to nearest fresh water, mean distance to nearest road, mean distance to nearest populated place, mean value of transformed slope aspect, and average annual precipitation.

Model Findings

After the model pruning process, all variables remained in the final model except distance to nearest populated place, which negligibly contributed to the accuracy of the model. We then overlayed the resulting map onto GIS layers delineating high-quality fisher habitat (Spencer et al., 2015) and high quality spotted owl habitat (USDA Forest Service, 2006) throughout California. We found that 44% of high-quality fisher habitat and 26% of high-quality northern spotted owl habitat was overlapped by areas predicted

to be of moderate to high likelihood for grow site presence. A final likelihood map of the resulting model was generated including locations indicating original grow site locality data (see Figure 6 for most recent version).

Model Testing: Ground-truthing (additional, complementary funding from Yreka Field Office of the USFWS supported this aspect of the modeling effort, but it is reported here for completeness)

Using a geospatial layer of all of California's watersheds, we randomly selected 15 named streams within the Klamath Basin, most ranging in size from about 13 – 52 km of stream kilometers. Experienced ground-truth surveyors walked as much of the streams as possible, and while considering safety and feasibility, searched for any evidence of trespass marijuana cultivation. For streams within high likelihood areas for cultivation, and during periods of the year with greater risk for grower-presence, state, tribal, and federal law enforcement agents assisted with surveys for safety reasons.

Sixteen trespass marijuana cultivation sites previously undetected by law enforcement were discovered by the search teams during the ground-truthing efforts. Evidence found included irrigation pipe, planting plots, and trash left by growers at camps. For 14 sites where we could identify the exact grow location, 9 were in high-likelihood areas (64%), 3 were in moderate-likelihood areas (22%), and 2 were in low-likelihood areas (14%). We felt this validated the accuracy of the model quite well such that we did not need to rerun the model.

7. Discuss differences between work anticipated in grant proposal and grant agreement and that actually carried out with Federal Aid grant funds; include differences between expected and actual costs.

Work carried out for this project using Federal Aid grant funds differed only slightly from that proposed in the proposal and agreement. All tasks and objectives proposed were carried out. We found and collected fewer animal carcasses at grow sites than we had anticipated. To address this limitation, we conducted toxicant testing on fecal samples in addition to animal carcasses collected at grow sites. By analyzing both feces and carcasses, we hope to develop a method of detecting wildlife toxicant exposure, even when carcasses are absent or too decomposed for analysis.

Additionally, it was difficult to deploy remote cameras prior to reclamation for personnel and equipment safety reasons. Ideally, we had hoped to deploy cameras at the time of eradication, or within a few days after eradication. However, in two instances, cameras deployed at these times were stolen by returning growers. It was also often difficult and dangerous to return to the sites prior to October, as growers often returned several times, even after eradication. Therefore, we only occasionally were able to deploy cameras prior to reclamation (which usually took place around the time it was relatively safe to return) in a few instances. In most cases, cameras were deployed a few days

prior to reclamation, or at the time of reclamation.

In our grant agreement, we proposed to remediate nine grow sites with costs approximated at $8,000 per site. Our extensive collaborations and partnerships with volunteer groups and law enforcement agencies allowed us to secure the assistance of 20+ volunteers, law enforcement officers, and California National Guardsmen each day of our reclamation efforts 2014, 2015 and 2016, in addition to use of the National Guard's Pave Hawk and California Department of Fish and Wildlife Law Enforcement helicopter to haul-out trash. The total cost to this grant for reclaiming 29 sites was $37,322.77 with an average of $1287 per site.

8. List any publications or in-house reports resulting from this work.

Publications:

One publication has been generated using data collected under this grant (Gabriel et al. 2015; https://doi.org/10.1371/journal.pone.0140640). This publication used data from fisher necropsies conducted under this grant.

Gabriel, M.W., G.M. Wengert, L.W. Woods, N. Stephenson, J. M. Higley, C. Thompson, S. M. Matthews, R.A. Sweitzer, K. Purcell, R.H. Barrett, S.M. Keller, P. Gaffney, M. Jones, R. Poppenga, J.E. Foley, R.N. Brown, D. Clifford, and B.N. Sacks. 2015. Patterns of natural and human-caused mortality factors of a rare forest carnivore, the fisher (*Pekania pennanti*) in California. *PLoS ONE* 10(11): e0140640. doi:10.1371/journal.pone.0140640

Publications in Prep:

Several publications will be generated and submitted in 2017 and 2018 based on data collected in this grant. They include:

Gabriel, M.W., G.M. Wengert, L. Woods, J.M. Higley, R. Poppenga, D.L. Clifford, and S. McMillin. Poisoning with Restricted Use Carbamates of Wildlife at Trespass Marijuana Cultivation Sites on California Public Lands. *Submittal expected summer 2017.*

Gabriel M.W.,, G.M. Wengert, J.M. Higley, D.L. Clifford, S. Frick, R. Gaske, D. Little, P. Jordan, B. Lynch, R. Poppenga, C. Holland, M. Filigenzi, S. McMillin, and D. Clayton. Current and Projected Toxicant and Fertilizer Use at Marijuana Cultivation Sites on Public Lands in California and Southern Oregon: Four Year Trends of Landscape Impacts to Watersheds and Forest Lands. *Submittal expected summer 2017.*

Gabriel M.W., G.M. Wengert, M. Filigenzi and R. Poppenga. The feasibility and reliability of field testing of plants, water and unknown substances for cholinesterase inhibitor pesticides in forest landscapes. *Submittal expected fall 2017.*

Gabriel M.W., G.M. Wengert, J.M. Higley, R. Poppenga, M. Filigenzi, S. McMillin, and D.L. Clifford. Soil and Water Contamination from Toxicants Associated with Marijuana Cultivation in California Forests. *Submittal expected fall 2017.*

Wengert G.M., M.W. Gabriel, J.M. Higley, H. Rustigian-Romsos, W. Spencer, and D.L. Clifford. Predicting Marijuana Cultivation on Public Lands in California: A Maximum Entropy Model with Ground Confirmation. *Submittal expected summer 2017.*

Wengert G.M., J.M. Higley, M.W. Gabriel, and D.L. Clifford. Impacts to small mammal communities from activities at illegal marijuana cultivation sites on California public and tribal lands. *Submittal expected 2018.*

Awards, Presentations & Outreach

Below is an abbreviated list of awards and presentations that team members have given to or received from policy makers, agencies, conferences, students/academia, and members of the public during the reporting period.

Awards

1. **Executive Office of the White House**: **Scientific Contribution towards Marijuana Cultivation Impacts on the Environment:** Office of National Drug Control Policy, High Intensity Drug Trafficking Area (HIDTA), Washington D.C. February 17th and 18th 2016. Awarded to the following team members; Department of Justice California, United States Forest Service Law Enforcement and Investigations, California National Guard Counter Drug, California Department of Fish and Wildlife Law Enforcement and Integral Ecology Research Center. Drs. Mourad Gabriel and Greta Wengert were present to receive the award.

2. **2015 California Department of Fish and Wildlife Employee Excellence Award for Partnership**: Team member, CDFW law enforcement officer Lt. R. Paul Gaske received a California Department of Fish and Wildlife Employee Excellence Award for his work on this project. Specifically, the Lieutenant was recognized for his ability to initiate, collaborate with and maintain cooperative and successful relationships with external partners.

Special Symposium

One of our priorities and stated deliverables is education and outreach, and project team members made substantive contributions in this area by organizing a **full-day special symposium "Marijuana Cultivation and its Impacts on Wildlife, Habitats and the Wildlife Profession" on January 27, 2015 at the Western section of The Wildlife Society annual conference held in Santa Rosa, California**. This symposium was well attended with over 200 attendees and Team Principal Investigator Dr. Mourad Gabriel was the symposium director. This symposium had numerous talks from professionals immersed in the field of environmental impacts associated with marijuana cultivation including co-investigators Dr. Greta Wengert and Mark Higley. Abstracts from this symposium are included as **Appendix D**.

Presentations and Lectures (*) Indicates Invited Talks

***Gabriel, M.W.*, A Growing Problem on Our Public Lands (TEDx)**
*TED TALK Yosemite, CA 2016

***Wengert G.M.et al.*, Modeling to Predict the Probability of Trespass Marijuana Cultivation Site Presence in Fisher, Northern Spotted Owl and Humboldt Marten Habitat.**
*Humboldt State University Ecology Series, Arcata CA, 2016
Unites States Fish and Wildlife Office, Arcata CA 2015
*Klamath Basin Conservation and Management Meeting, Yreka CA, 2015
The Western Section California Fisher Working Group, Pomona CA. 2016
Southern Sierra Fisher Working Group, Fresno CA, 2016

***Gabriel, M.W.*, Keeping it Safe: Understanding Toxicant Hazards to the Environment, Public and Law Enforcement from marijuana cultivation sites in order to make smart, safe and informed decisions in the field**
*Northern California Water and Environment Enforcement Summit, California District Attorney Association (CDAA), Redding CA, June 2016
*Southern California Water and Environment Enforcement Summit, California District Attorney Association (CDAA), Riverside CA, June 2016
*National Park Service Law Enforcement Annual Training, Redwood National Park, May 2016
*United States Forest Service Law Enforcement and Investigations Annual Training, Sacramento CA, May 2016
*California Department of Justice Marijuana Enforcement Teams, Sacramento CA, February 2016
*ONDCP-Central Valley High Intensity Drug Trafficking Area (HIDTA), Rancho Cordova CA, April 2016
*CDAA Law Enforcement Training on Marijuana Environmental Laws and Impacts Sacramento CA, December 2015

***Gabriel, M.W.*, Marijuana Cultivation and Environmental Impacts on R5 USFS Lands**
*United States Forest Service Region 5 Manager Office and R5 Forest Leadership Team Sacramento CA, 2016
*Shasta-Trinity National Forest, USFS Leadership Team Meeting, Redding CA, 2016
*Plumas National Forest, USFS Leadership Team Meeting, Beckworth CA, 2016

***Gabriel, M.W., G.M. Wengert, J.M. Higley, D.L. Clifford and S. McMillian*. Progress and Update on the Science with Solutions Section 6 USFWS Grant**
The Western Section California Fisher Working Group, Pomona CA. 2016
Southern Sierra Fisher Working Group, Fresno CA, 2016

***Gabriel, M.W.,* Conservation Perils from Marijuana Cultivation in California**
*University of California Davis, California Animal Health and Food Safety Laboratory Invited Lecture Series, Davis CA, 2016
*Explorit Science Lecture Series, Davis CA, 2016
*Humboldt State University Carnivore Conservation Class, Arcata CA, 2016
*Klamath Basin Conservation and Management Meeting, Yreka CA, 2015
*Humboldt County Board of Supervisors, Eureka CA, 2015
*Trinity County Board of Supervisors, Weaverville CA, 2015
*Humboldt State University Ecology Series, Arcata CA, 2014

***Clifford, D.L., Gabriel, M.W., Wengert, G.W., Higley, J.M, Poppenga, R. and Woods, L.W. Ecosystem Health Impacts of Illegal Marijuana Cultivation in California**. UC Davis One Health Seminar & One Health and Wildlife Radio Talk (September 2014), Davis, CA.

***Gabriel, M.W., Wengert, G.W., and Higley, J.M. Current Research and Efforts Addressing Trespass Marijuana Cultivation in California**. Bureau of Land Management and Office of National Drug Control Policy, National Review Summit, (September 2014), Washington D.C.

***Gabriel, M.W., Conservation Perils from Marijuana Cultivation in Northern California** (November 2014). Humboldt County Board of Supervisors, Arcata CA. (December 2014). Trinity County Board of Supervisors, Arcata CA.

***Gabriel, M.W., Wengert, G.W., and Higley, J.M. Current Research and Efforts Addressing Trespass Marijuana Cultivation in California**. High Intensity Drug Trafficking Area Organization, (December 2014) Ranch Cordova, CA

***Gabriel, M.W., Wengert, G.W., and Higley, J.M. Current Research and Efforts Addressing Trespass Marijuana Cultivation in California**. California Board of Forestry, (December 2014) Sacramento, CA.

***Gabriel, M.W., Rat Poisons and their Impacts on Wildlife,** (January 2015), Sequoia Park Zoo, Eureka, CA.

Gabriel, M.W., Special Policy Summit: Environmental Impacts and Public Safety Issues Arising from Illegal Marijuana Grow Sites (April 2015), League of California Cities, Capital senate Room, Sacramento CA.

Gabriel, M.W., Invited Panelist on "Current Cannabis Policy", Hosted by Congressman Jared Huffman, and Lt. Gov. Gavin Newsome (April 2015), Garberville, CA.

***Gabriel, M.W., Conservation Perils from Marijuana Cultivation on Public, Tribal and Community Lands in California.** (May 2015), California Geographical Society Annual Conference, Arcata, CA.

Gabriel, M.W., Invited Panelist on "California Cannabis Policy", Hosted by Lt. Gov. Gavin Newsom and Congressman Jared Huffman, (June 2015), Garberville, CA.

McMillin, S.C., Trespass Cannabis Grows: Wildlife, Environmental, and Regulatory Issues. (March2015). Pesticide Applicators Professional Association: Vertebrate Pest Control Conference, Salinas, CA.

9. Name, title phone number, and e-mail address of person compiling this report

Co-Principal Investigator and CDFW Grant Manager: Dr. Deana L. Clifford, Senior Wildlife Veterinarian, Wildlife Investigations Laboratory, California Department of Fish and Wildlife, (916) 358-2378, deana.clifford@wildlife.ca.gov

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Literature Cited:

Spencer, W.D., S.C. Sawyer, H.L. Romsos, W.J. Zielinski, R.A. Sweitzer, C.M. Thompson, K.L. Purcell, D.L. Clifford, L. Cline, H.D. Safford, S.A. Britting, and J.M. Tucker. 2015. Southern Sierra Nevada fisher conservation assessment. Unpublished report produced by Conservation Biology Institute.

USDA Forest Service. 2006. Spatial data layer,SNV_CASpotOwlHmRngCore03_1. Prepared by USDA Forest Service - Pacific Southwest Region - Remote Sensing Lab for Sierra Nevada Forest Plan Amendment Environmental Impact Statement; http://www.fs.fed.us/r5/snfpa/final-seis/rod/

Table 1. List of trespass marijuana grow sites selected for full (repeated) sampling for USFWS Section 6 grant "Science with Solutions" towards Objectives 1 and 3. Monitoring of wildlife use through remote cameras, soil and water sampling for contamination, and full quantification of fertilizers and toxicants detected was conducted at these sites. Rodent sampling was also conducted at six sites.

Marijuana Grow Site Name	Ownership/Location	Year Full Sampling Initiated	Year Second Sampling Conducted
Brush Mountain 2013	Six Rivers National Forest	2014	2015
Brush Mountain 2014‡	Six Rivers National Forest	2014	2015
Oak Knob Site‡	Six Rivers National Forest	2014	2015
Oak Knob Complex‡	Six Rivers National Forest	2014	2015
Huffman‡	Trinity Alps Wilderness: USFS	2014	2015
Hobo Gulch 2014	Trinity Alps Wilderness: USFS	2014	2015
Road 16‡	Shasta-Trinity National Forest	2015	2016
Telephone Ridge 1‡	Shasta-Trinity National Forest	2015	2016
Telephone Ridge 2	Shasta-Trinity National Forest	2015	2016

‡ Rodent sampling conducted

Table 2. List of additional grow sites (beyond the 9 full-sampling sites) assessed in 2015 and 2016. Full initial assessment included fertilizers, toxicants, and dead animals. Other samples collected and processed included: (WAT=water sampling through POCIS; SOIL=soil contamination; PLT=plant contamination; WLDF=wildlife monitoring using remote cameras; DEAD=dead animal toxicology; UNK=unknown substance in sprayer or unmarked container)

Marijuana Grow Site Name	Ownership/ Location	County	Full Initial Assessment	Other Samples Tested
Hayshed	Shasta-Trinity National Forest	Trinity	YES	WAT, WLDF, SOIL
Hobo 2013	Trinity Alps Wilderness	Trinity	YES	WLDF
Big French AUSA	Shasta-Trinity National Forest	Trinity	YES	WLDF, PLT
Bonta Creek	Plumas National Forest	Plumas	Yes	WAT, WLDF, PLT, DEAD
Cedar Creek	Plumas National Forest	Plumas	Yes	WAT, WLDF, PLT
Clear Creek	Plumas National Forest	Plumas	Yes	WLDF, PLT
Long Valley Creek	Plumas National Forest	Plumas	Yes	WLDF, PLT, DEAD
Corral Bottom	Shasta-Trinity National Forest	Trinity	Yes	
Big French 15	Trinity Alps Wilderness	Trinity	Yes	WLDF, PLT
Rattlesnake Peak	Plumas National Forest	Plumas	Yes	
Little Bear Wallow	Shasta-Trinity National Forest	Trinity	Yes	PLT, SOIL
McCarthy SPI	Sierra Pacific Industries	Tehama	Yes	
Mill Creek	Lassen National Forest	Tehama	Yes	PLT
Boat Gunwhale	Ishi Wilderness	Tehama	Yes	PLT
Potato Patch	Lassen National Forest	Tehama	Yes	PLT, DEAD
Tedoc 2	Shasta-Trinity National Forest	Trinity	Yes	PLT
Mosquito Creek	Shasta-Trinity National Forest	Trinity	Yes	PLT
Paradise	BLM King Range Conservation Area	Humboldt	Yes	WLDF, SOIL, PLT
Offield Mountain	Klamath National Forest	Siskiyou	No	PLT
Offield Saddle	Klamath National Forest	Siskiyou	Yes	DEAD, PLT
Go Road	Six Rivers National Forest	Humboldt	Yes	WLDF, DEAD
Big French Wild	Trinity Alps Wilderness	Trinity	Yes	PLT, DEAD
Red Cap	Six Rivers National Forest	Humboldt	Yes	PLT, DEAD
Benbow	Private timber	Humboldt	No	PLT
Sidewinder	Klamath National Forest	Siskiyou	No	PLT
Swede	Mendocino National Forest	Lake	No	PLT
Elk Mt	Mendocino National Forest	Lake	No	PLT
MNF #2	Mendocino National Forest	Lake	No	PLT
MNF #3	Mendocino National Forest	Lake	No	PLT
Lime Dyke	Shasta-Trinity National Forest	Trinity	Yes	PLT, DEAD, UNK
Screwdriver	Lassen National Forest	Shasta	Yes	PLT
Prairie Cr 2	Shasta-Trinity National Forest	Trinity	Yes	
Big French 6	Shasta-Trinity National Forest	Trinity	Yes	
China Peak	Shasta-Trinity National Forest	Trinity	Yes	PLT, DEAD, UNK
Big French 7	Shasta-Trinity National Forest	Trinity	Yes	
Deerhorn	Hoopa Valley Indian Reservation	Humboldt	Yes	PLT
Big French 4	Shasta-Trinity National Forest	Trinity	Yes	
Big French 2	Shasta-Trinity National Forest	Trinity	Yes	PLT, UNK
Saddle Gulch	Shasta-Trinity National Forest	Trinity	Yes	PLT
Wildwood	Shasta-Trinity National Forest	Trinity	Yes	PLT, UNK
Dottysprings	Lassen National Forest	Tehama	No	DEAD
Galnor	Six Rivers National Forest	Humboldt	Yes	PLT, UNK
Prairie Cr 1	Shasta-Trinity National Forest	Trinity	Yes	
Hayman	Shasta-Trinity National Forest	Trinity	Yes	
County Line	Sierra Pacific Industries	Trinity	Yes	
Big French 3	Shasta-Trinity National Forest	Trinity	No	
Carbo Plot/ Windy Cut	Sierra Pacific Industries	Tehama	No	PLT
Dubakella	Shasta-Trinity National Forest	Trinity	Yes	
Jim Jam	Shasta-Trinity National Forest	Trinity	No	PLT
Long Ridge	Six Rivers National Forest	Humboldt	No	
Oak Knob 16	Six Rivers National Forest	Humboldt	Yes	
Pecwan	Six Rivers National Forest	Humboldt	Yes	PLT
Russ Ranch	Private timber	Humboldt	Yes	PLT
Underwood	Shasta-Trinity National Forest	Trinity	Yes	
Denny 3	Shasta-Trinity National Forest	Trinity	No	UNK

Table 3. Fertilizers, rodenticides, and pesticides discovered at trespass marijuana grow sites in northern California, 2014-2016. For this analysis, 77 grow sites were investigated thoroughly enough to be able to ascertain the approximate amount of these substances. The 77 grow sites also include sites visited through other projects and not necessarily funded through this Section 6 grant. AR=anticoagulant rodenticide.

Substance	Number of Sites at which Discovered (out of 77)	Mean Amount Discovered per site	Standard Error
Dry Fertilizer (lbs)	77 (100%)	1268.2	153.6
Liquid Fertilizer (oz)	33 (43%)	1353	554.3
Bromethalin (lbs)	16 (21%)	8.7	2.3
1st generation AR (lbs)	18 (23%)	16.7	4.1
2nd generation AR (lbs)	24 (31%)	8.6	2
Phosphide rodenticide (lbs)	12 (16%)	4.4	1.7
Carbamates (oz)	31 (40%)	48.1	8
Organophosphates (oz)	26 (34%)	82.2	17.1
Pyrethroids (oz)	42 (55%)	205.0	47.9
Avermectin (oz)	4 (5%)	90.0	56.5
Neonictinoids	3 (4%)	21.3	5.3
Molluscicide	4 (5%)	21.0	9.98

Table 4. List of dead wildlife found at 34 marijuana grow sites and suspected or confirmed causes of mortality. Fifteen additional grow sites were thoroughly investigated for dead wildlife (total n=49), but none was found; thus, dead wildlife was found at 58% of grow sites investigated.

Marijuana Grow	Ownership/ Location	Sampling Initiated	Dead Wildlife	Field/Tox Results
Red Cap	SRNF	2013	Fisher, 2 gray fox	poison
Hobo Gulch 2013	TAW	2014	doe skull, two rattlesnakes	shot
Brush Mountain 2013	SRNF	2014	2 deer (does), 2 bears,1 thrush	Shot, poison
Oak Knob Complex	SRNF	2014	2 (3x4, 3x3)bucks, 1 bear	Shot, suspect poison
Bonta Creek	PNF	2015	2 bears,2 ground squirrels	poison
Go Road	SRNF	2015	3 gray foxes	poison
Long Valley Creek	PNF	2015	Bear, gray fox, towhee	poison
Big French 15	TAW	2015	1 buck (2x3), 1 fawn	shot
Rattlesnake Peak	PNF	2015	2 bucks (4x4)(3x3)	shot
Big French Wild	TAW	2015	2 does, 1 buck (2x2)	shot
Telephone Ridge Complex	STNF	2015	Raven	Shot
Road 16	STNF	2015	Ringtail	shot
Cedar Creek	PNF	2015	1 buck (3x3)	shot
Boat Gunwhale	IW	2015	Great horn Owl, gray fox	shot, suspect poison
Offield Saddle	KNF	2015	2 gray foxes	Suspect Poison
Mill Creek	LNF	2015	3 mice	Suspect Poison
LymeDyke1	STNF	2016	2 gray fox, 1 rabbit	poison
Potato Patch Complex	LNF	2016	Bear, gray fox, 2 vultures, 2 woodrats, 2 does	poison, shot
Antelope	TNF	2016	rabbit	poison
Screwdriver	LNF	2016	1 bear, 2 does	shot
Prairie Cr 2	STNF	2016	2 bucks (2x2)(2x3)	shot
Big French 6	STNF	2016	2 does	shot
China Peak	STNF	2016	black bear, buck (3x3)	shot
Big French 7	STNF	2016	Buck (2x2)	shot
Deer Horn	HVIR	2016	Buck (3x4)	shot
Big French 4	STNF	2016	doe, buck (2x3)	shot
Big French 2	STNF	2016	gopher snake, doe, buck (5x7)	shot
Saddle Gulch	STNF	2016	rattlesnake	shot
Wildwood	STNF	2016	Ringtail	shot
Dotty Springs	LNF	2016	gray fox	suspect poison
Gainor	SRNF	2016	bear	suspect poison
Prairie Cr 1	STNF	2016	gray squirrel	suspect poison
Hayman	STNF	2016	yellow legged frog	suspect poison
County Line	SPI	2016	woodrat (trapped)	Trapped

Table 5. Anticoagulant rodenticide, and organophosphate and carbamate insecticide toxicology testing results from Polar Organic Chemical Integrative Sampler (POCIS) units placed in watercourses below trespass marijuana grow sites in Fall/Winter 2014-2016.
* Levels were so low that GC-MS or LC-MS were unable to differentiate between the organophosphates fonofos, disulfoton, and monocrotophos
‡ POCIS were only placed in these locations for Year 1

Grow Site Name	Year 1 Placement Date	Year 1 First Assessment Date	Tox Result/ Analyte	Year 1 Removal Date	Tox Result/ Analyte	Year 2 Placement Date	Year 2 First Assessment Date	Tox Result/ Analyte	Year 2 Removal Date	Tox Result/ Analyte
Brush Mt. 2013	11/14/14	1/3/15	Negative	2/23/15	Negative	11/16/15	2/2/16	Negative	2/19/16	Negative
Brush Mt. 2014	11/7/14	12/20/14	**Positive/ Diazinon**	2/23/15	Negative	11/16/15	2/2/16	**Trace OP***	2/19/16	**Trace OP***
Oak Knob Complex	11/26/14	1/8/14	Negative	2/23/15	Negative	12/1/15	1/7/16	Negative	2/18/16	Negative
Oak Knob	11/10/14	12/20/14	**Positive/ Diazinon**	2/23/15	Negative	12/1/15	1/7/16	Negative	2/18/16	Negative
Huffman	11/14/14	12/30/14	Negative	2/22/15	Negative	11/16/15	NA	NA	2/4/16	**Trace OP***
HOBO Road 2014	11/5/14	12/13/14	**Positive/ Diazinon**	2/22/15	Negative	11/16/15	NA	NA	2/26/16	**Trace OP***
Road 16	12/07/15	NA	NA	2/26/16	**Trace OP***	10/25/16	NA	NA	12/21/16	Negative
Telephone Ridge 1	10/28/15	1/11/16	Negative	3/5/16	Negative	10/27/16	NA	NA	12/6/16	Negative
Telephone Ridge 2	10/28/15	1/11/16	Negative	3/5/16	Negative	10/27/16	NA	NA	12/6/16	Negative
Hayshed Downstream‡	7/1/15	10/26/15	Negative	12/18/15	Negative					
Hayshed Upstream‡	10/26/15	NA	NA	12/18/15	Negative					
Bonta Creek‡	9/14/15	11/17/15	Negative	5/2016	Negative					
Cedar Creek‡	9/14/15	11/17/15	Negative	5/2016	**Positive/ Carbofuran**					

Table 6. Soil toxicology results for samples collected at trespass marijuana grow sites on Six Rivers National Forest (SRNF), Shasta-Trinity National Forest (STNF), Trinity Alps Wilderness (TAW), BLM King Range National Conservation Area, and Plumas National Forest in 2014 – 2016, Also shown is the number of days since eradication that the samples were collected, indicating long-term persistence of these toxicants in soil in many cases.

Grow Site Name	Ownership/ Location	Erad Year	# Samples at Eradication	Toxicology Results	# Samples Post-Eradication	Toxicology Results	# Days Since Eradication
Brush Mt 2013	SRNF	2013	0		3	NEG	>400
Huffman	TAW	2014	2		0		NA
Oak Knob	SRNF	2014	2	NEG	7	1 POS-Brodifacoum	527-569
Brush Mt 2014	SRNF	2014	6	1 POS-Brodifacoum **Not tested for Carbamates/OPs	5	1 POS-Diphacinone+ Chlorphacinone 3 POS-Carbofuran	476
Hobo 2014	TAW	2014	0		10	1 POS-Difenacoum	~574
Oak Knob Complex	SRNF	2014	0		6	1 POS-Carbofuran	>120
Telephone 1	STNF	2015	3	Negative	12	NEG	215
Telephone 2	STNF	2015	2	2 POS-Carbofuran	0		NA
Little Bear Wallow	STNF	2015	2- pooled	NEG	0		NA
Paradise	BLM King Range	2015	0		18	2 POS-Carbofuran	188
Bonta Creek	PNF	2015	1	NEG	0		NA
Hayshed	STNF	2015	0		6	NEG	230
Road 16	STNF	2015	0		12	NEG	171

Table 7. Summary of the total amounts of rodenticides, fertilizer, and trash removed, total length of irrigation pipe removed and personnel effort for trespass marijuana grow site reclamation efforts 2014 – 2016.

Reclamation Dates	Ownership	# of Sites	Total Amount of Trash Removed	Total Length of Irrigation Pipe Removed	Total # Personnel per Day
October 13-16, 2014	STNF & SRNF	7	8,000 lbs	8.5 miles	50
April 1-2, 2015	SRNF & HVIR	6	6,100 lbs	5.25 miles	20
September 12-15, 2015	PNF	4	13,789 lbs	3.98 miles	16
October 26-30, 2015	STNF	7	24,395 lbs	25.96 miles	18
May 24, 2016	STNF	4	7350 lbs	5.13 miles	33
September 7, 2016	STNF	1	1540 lbs	1.88 miles	14

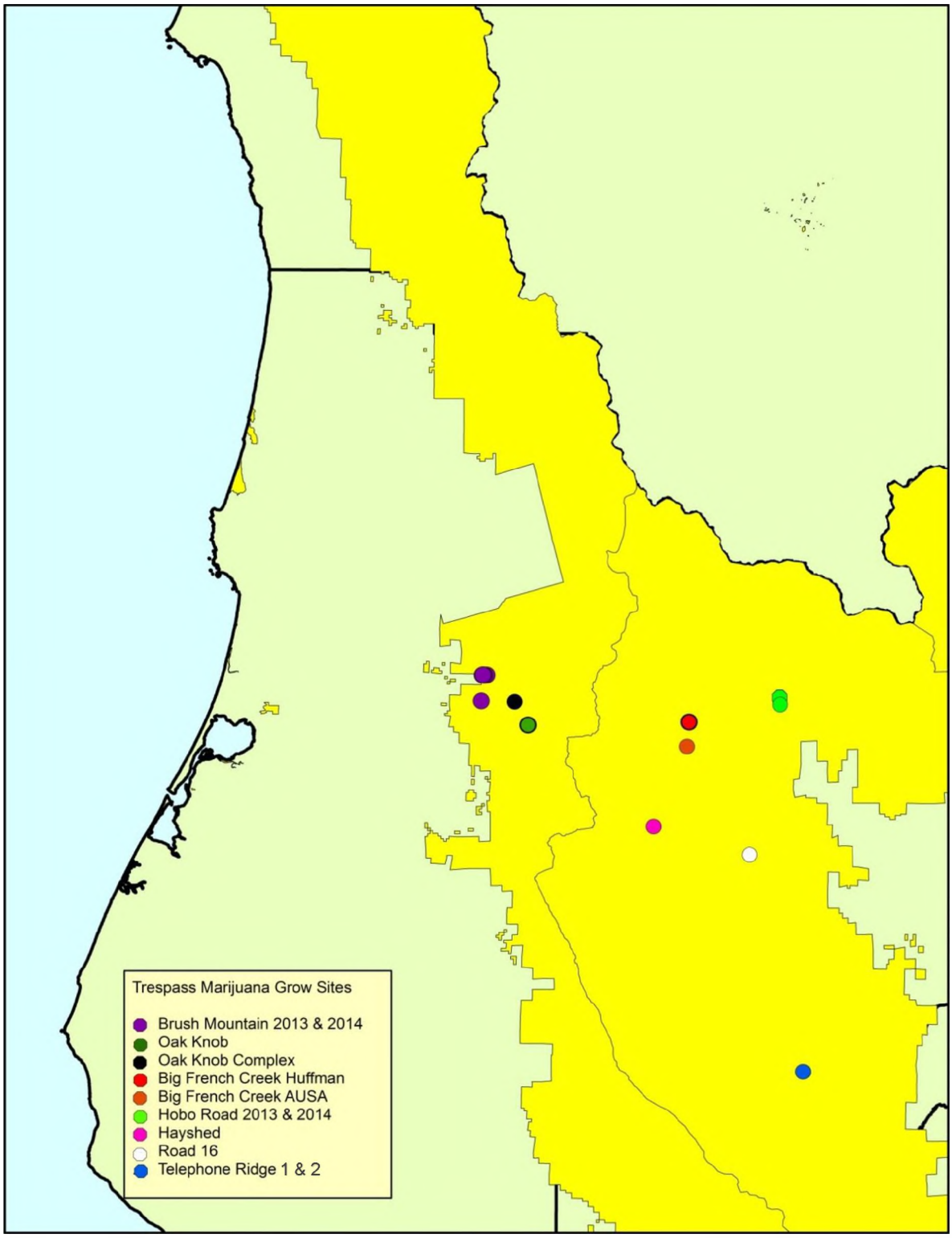


Figure 1. Locations of twelve trespass marijuana grow sites that were remediated and sampled for environmental impacts in Fall/ Winter seasons of 2014 – 2016 for a U.S. Fish and Wildlife Service funded Section 6 grant to California Department of Fish and Wildlife and Integral Ecology Research Center. National Forest lands are highlighted in yellow.

Figure 2. Examples of Polar Organic Chemical Integrative Samplers (POCIS) that were utilized to monitor water contamination by either polar or hydrophilic water soluble organic chemicals. POCIS units were placed in the streams immediately below trespass marijuana cultivation sites on Public Lands during the 2014-2015 season.

A: A small POCIS holder which accommodated three POCIS membranes was used at each monitoring point.

B: Photograph of a POCIS sampling unit secured by a three-foot steel rod in the creek bed with a large rock buffering flow in order to minimize potential damage to POCIS membranes.

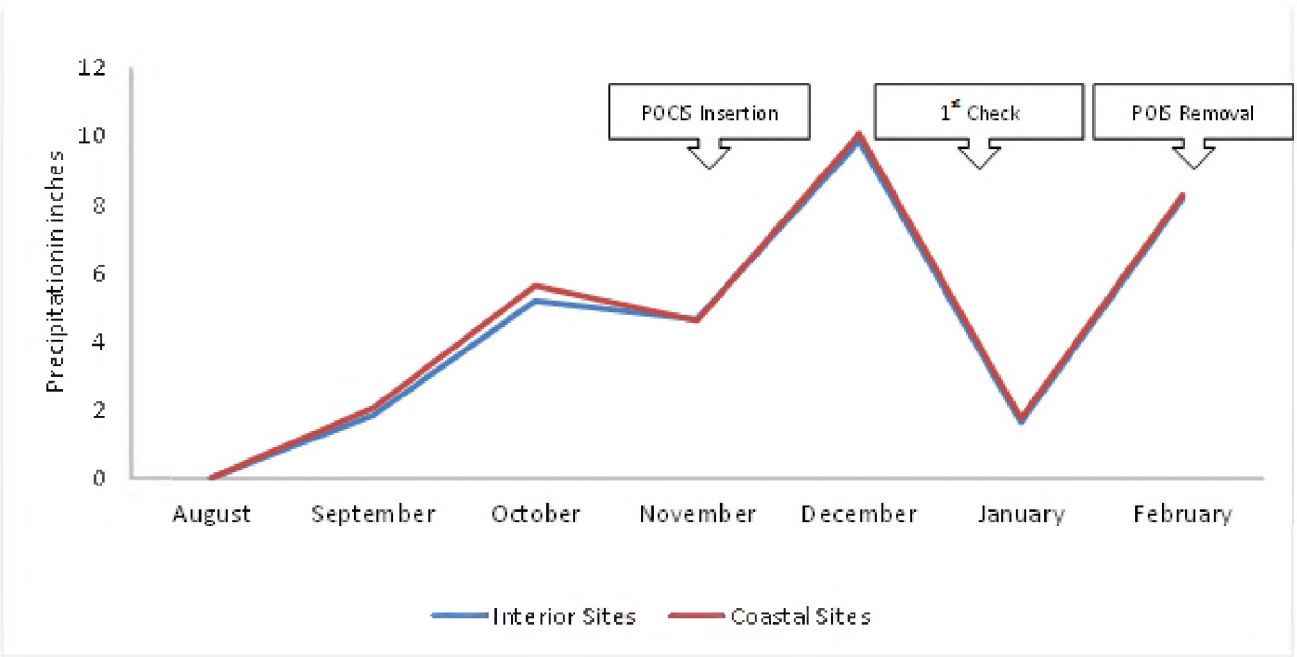


Figure 3. Monthly precipitation map generated from the National Weather Service Western Region monthly precipitation map portal. Labels represent when POCIS water samplers were inserted, when they were checked with the first set of mebranes removed, and finally whn the POCIS were removed and second set of membranes collected.

Figure 4. A 40 yard long garbage bin is full of irrigation piping and trash after reclamation of only three trespass grow sites on National Forest lands in October of 2014. (Photo credit – IERC)

Figure 5. Community volunteers, Section 6 team members, CDFW, USFS and local law enforcement and National Guard work to transfer trash collected from reclamation of a trespass grow site to a site where the garbage can be hauled out of the forest via helicopter. Many trespass grow sites are in remote areas, making reclamation efforts logistically and physically challenging. (Photo credit – IERC)

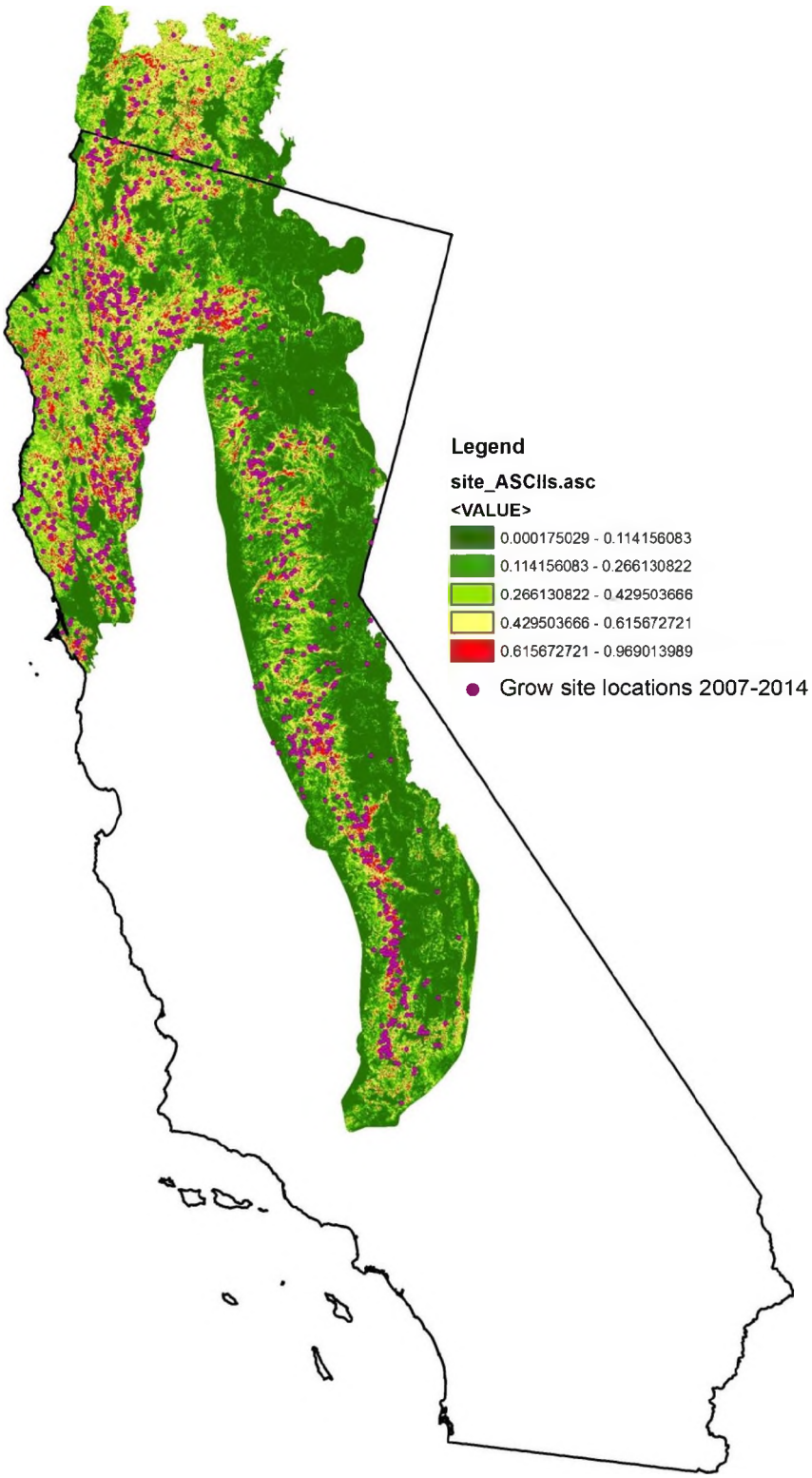


Figure 6. Final map of likelihood of grow site presence based on MAXENT predictions using known grow site localities and several biotic and abiotic features as predictors. Red areas represent highest relative likelihood of grow sites presence, while yellow is moderate likelihood, and green is low-likelihood.

Appendix A. Initial investigations protocol that was developed under a previous Tribal Wildlife Grant awarded to Hoopa Tribe, and refined and finalized under this Section 6 Grant, which was used to sample environmental variables and impacts at trespass marijuana grow sites in northern California, 2013-2017.

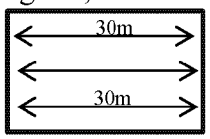
Version 2.0 7.22.2016

Trespass Grow Sites: Scientific Documentation
Protocol for Initial Tasks

DATA COLLECTION

1) **Planting Plots**
    a. GPS center of each plot
    b. Map with Trimble Juno (area file – by walking perimeter)
    c. Label each plot in GPS files (i.e. Beardsley plot 1)
    d. Count the trees cut by the growers and identify estimated DBH
2) **Camp/ Hooch, Trash Dumps, Drying Sites or Prep/ Work Areas**
    a. GPS and label (i.e. Bearsley 1, Camp)
    b. Map with Trimble Juno (point file)
    c. Photos of site and specific items
    d. Count number of sleeping bags
    e. Estimate number of 55 gal bags of trash
    f. Count number of propane tanks
    g. Food Present (Yes or No)/ Intact or damaged by wildlife
3) **Water Cisterns**
    a. Record the following data for each water cistern
        i. GPS cistern (Lat and Long DDM)
        ii. Photo of cistern
        iii. Source of water (within creek or man-made structure)
        iv. Water present within cistern (yes or no)
        v. Cistern active? (water flowing into/ out of cistern, yes or no)
        vi. Apparent water quality (clear, murky, color tinted)
        vii. Map using Trimble Juno (point file)
    b. Rectangle/Square Cisterns
        i. Length and Width
        ii. Depth (Deepest and Shallow if applicable)
    c. Circular cistern
        i. Radius or Circumference
        ii. Depth (Deepest and Shallow if applicable)

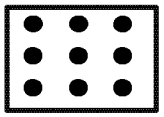
4) **Water source lines**
    a. Identify pipe size (½" or ¾" or 1", etc)
    b. Walk source line until source is found (with prior approval of LE or PI)
    c. GPS source point and label (i.e. Beardsley 1, water source point)
    d. GPS each diversion point
    e. Map with Trimble Juno length of source to upper most plot (line file)
    f. Measure flow-rates just below source, if applicable
    g. Estimate total length of pipe within grow plots (per diagram, 3 rows X 30m =90m total pipe)



5) **Fertilizer Bags/ Containers**
    a. Photo of each container
    b. Mark each bag with bright colored aerosol paint "obvious dot or X " as you document
    c. Record the following data
        i. Weight of bag (in lbs., or gallons or liters if liquid)
        ii. Percentage remaining in bag (options: empty, ½, full)
        iii. Component ratio (X-X-X)
        iv. Soluble, liquid/organic (dilution ratio)
6) **Pesticides**
    a. Photo of each container
    b. Do not touch any pesticides, rodenticides, or unlabeled containers
    c. Record the following
        i. GPS the toxicants (in batches, if applicable)
        ii. Type-Manufacture-volume
        iii. Percentage remaining in bag (options: empty, ¼, ½, ¾, full)
    d. Mark each container with bright colored aerosol paint "obvious dot" as you document
7) **Grower trails (between camps, plots, etc.)**
    a. Map with Trimble Juno (line files)
    b. Label Trail 1, 2, 3

SAMPLE COLLECTION

1) GPS all samples collected (can use recreational grade GPS)
2) Soil
    a. 10 samples throughout plots



or

3) Dead wildlife
    a. Take several photographs
    b. If qualified and trained, swab braincase and mouth, if possible
4) Invertebrates
    a. Collect whole, live invertebrates; store in ethanol or freeze

5) Sprayers or unknown pesticide containers/ applicators
    a. Take several photographs
    b. If qualified and trained, safely swab contents or tips of sprayers
6) Mark all samples with grow site name, current date, identity of samples (i.e. swab of dead fox mouth), and your initials

Appendix B. Selected photos from remote wildlife cameras set at trespass marijuana grow sites in 2015-2017 in northern California. Photo 1 shows a ringtail visiting a trash pit next to a grower camp. Photo 2 shows a mountain lion traveling along a trail constructed by growers.

Photo 1

Photo 2

Appendix C. Summaries and statistics of various reclamation efforts conducted 2014-2016 in northern California with full or partial support from this Section 6 grant to investigate and remediate environmental impacts of trespass marijuana grow sites.

Appendix D. Announcement and Abstracts for 2015 Impacts of Marijuana Cultivation Symposium held at the 2015 Annual Conference of The Western Section of The Wildlife Society in Santa Rosa, California.

Appendix C

Operation Synopsis: October 13-16th, 2014

Project Name: *Science with Solutions: Documentation, remediation and monitoring of the ecological impacts of marijuana cultivation on endangered species within California's Public and Tribal Lands*

Reclamation Organizers: Dr. Mourad Gabriel and Dr. Greta Wengert (IERC); Lt. R. Paul Gaske, Capt. Holly Spada, Capt. Nathaniel Arnold (CDFW-LED); Josh Smith (Watershed Center); Rick Fleming (ERT); Dan Ehresman (NEC); Craig Benson (RCAA); Alex Cousins (TCRCD)
Grant Principal Investigators: Dr. Mourad Gabriel, Dr. Greta Wengert (IERC); Dr. Deana Clifford (CDFW-WIL); Mark Higley (Hoopa Tribe)

Organizations Involved:
Governmental: California Department of Fish and Wildlife (Law Enforcement Division & Wildlife Investigations Laboratory), US Forest Service, Army and Air National Guard, and Hoopa Tribe
***Non-Governmental*:** Integral Ecology Research Center (IERC), The Watershed Center, Trinity County Resource Conservation District (TCRCD), Redwood Community Action Agency (RCAA), Northcoast Environmental Center (NEC), Weaverville Volunteer Fire, and Environmental Reclamation Team of the High Sierra Volunteer Trail Crew (ERT)

Support: Logistical and financial support was contributed by the above-mentioned entities. Funding for the scientific documentation and reclamation of trespass marijuana sites was provided through a Section 6 grant from the US Fish and Wildlife Service to the California Department of Fish and Wildlife and Integral Ecology Research Center with the following goals:

1. Document all toxicants found at marijuana cultivation sites on public and private lands and investigate all impacts to biotic and abiotic resources
2. Remediate dismantled cultivation sites to restore habitat and remove risks to wildlife
3. Determine if there are long-term impacts of toxicants on the environment
4. Model landscape-scale risk to wildlife habitats using data collected at sites

Additional funding for reclamation was provided by a CalRecycle grant.

Number of trespass sites cleaned: 7
Location of sites: Six Rivers National Forest, Humboldt County (3 sites); Shasta-Trinity National Forest (1 Site), Trinity Alps Wilderness (3 sites),Trinity County
Watershed impacted: Trinity River
Personnel per day: 50 (14 Law Enforcement; 11 National Guard; 25 Science Team & Volunteers)
Total water diversion restored to watersheds: 67.5 million gallons (per grow season)
Total amount of fertilizer used at sites: 8,188 pounds
Total amount of rodenticide used at sites: 104 pounds
Insecticide used at sites: 560 gallons of usable insecticide
Carbofuran used at sites: 68 ounces of concentrated carbofuran (reconstitute to 60-70 gallons)
Garbage removed: 205 bags (50 gal) and 8.5 miles of irrigation line (collective total of 4 tons)
Net loads: 32 net loads (average: 250 pounds per net)
129th ANG Rescue HH-60G Pave Hawk refuels during net load operations: 1 (total for week)

Operation Synopsis: April 1-2nd 2015

Executive Summary: A two-day operation on United States Forest Service and Hoopa Tribal Lands resulted in six trespass marijuana cultivation sites being fully remediated. All six sites had all of their material pre-staged for pick up by California Department of Fish and Wildlife Law Enforcement Division (CDFW-LED), Army National Guard, Integral Ecology Research Center (IERC), Hoopa Tribe and Northern California Reclamation Coalition previously in 2014. In the current operation on April 1-2, 2015, CDFW-LED provided air support to remove the infrastructure while ground support was provided by CDFW-LED, Army National Guard, IERC, Hoopa Tribe and US Forest Service (USFS). Over 5 miles of irrigation line and 3 tons of trash were removed from these sites in these two days. Several creeks that were 100% diverted had their water supplies restored as a result of this effort.

April Reclamation Organizers: Dr. Mourad Gabriel and Dr. Greta Wengert (IERC); Lt. R. Paul Gaske (CDFW-LED), and Mark Higley (Hoopa Tribe)
Grant Principal Investigators: Dr. Mourad Gabriel, Dr. Greta Wengert; Dr. Deana Clifford (CDFW-WIL); Mark Higley

Organizations Involved:
Governmental: California Department of Fish and Wildlife (Law Enforcement Division & Wildlife Investigations Laboratory), Army National Guard, Hoopa Tribe and US Forest Service.

***Non-Governmental*:** Integral Ecology Research Center, The Watershed Center, Trinity County Resource Conservation District, Redwood Community Action Agency, Northcoast Environmental Center, and Environmental Reclamation Team of the High Sierra Volunteer Trail Crew

Logistic and Financial Support: Support was contributed by the above-mentioned entities. Funding for the scientific documentation and reclamation of trespass marijuana sites on USFS lands was provided through a Section 6 grant from the US Fish and Wildlife Service to the California Department of Fish and Wildlife and Integral Ecology Research Center. Additional funding for reclamation was provided by a CalRecycle grant. Funding for the scientific documentation and reclamation of sites on Hoopa Tribal lands was provided by US Fish and Wildlife Service Tribal Wildlife Grants and the Bureau of Indian Affairs.

Air Support: Support was provided by CDFW-LED Air Team, Robinson R44 Helicopter.

Number of trespass sites cleaned: 6

Location of sites: USFS Six Rivers National Forest (1 site: large multi-plot, multi-year complex), Hoopa Tribal Lands (5 sites within the Mill Creek and Supply Creek drainages)

Watershed impacted: Trinity River

Personnel: 20 (5 CDFW-LED, 2 USFS-LED, 4 National Guard, 7 Science Team, 2 CDFW Air Support)

Total amount of irrigation line removed: 27,700 ft (5.25 miles)

Garbage removed: 133 bags (55 gal each)

Estimated amount of trash removed: 6,100 lbs

Net loads: 67 net loads

Deer Lick Springs Trespass Grow Site Complex
Operation Synopsis

Prepared by: Mourad W. Gabriel MS, PhD and Greta M. Wengert MS, PhD

Background

Northern California is home to numerous wildlife species which are dependent on the unique critical habitat attributes that public lands within this bioregion provide. Some species of conservation concern that inhabit this region include Northern spotted owls, fishers, and Coho salmon. It is also home to numerous terrestrial big game species including black-tailed deer, American black bear and elk. Therefore, in addition to non-game wildlife benefits this area offers, game species are reliant on the large tracts of public lands in order to sustain viable populations for both natural resource and recreation use benefits. Specifically, all three Roosevelt Elk (*Cervus canadensis roosevelti*) hunt zones are located within this area. Unfortunately, northern California is also experiencing a sizeable amount of clandestine marijuana cultivation on public lands, much of it entrenched in prime elk habitat.

These illegal cultivation sites on public lands have a long list of deleterious impacts towards natural resources upon which many wildlife species are dependent. They divert large amounts of water, fragment landscapes in order to cultivate marijuana plants, and contaminate native plants, soil and water resources with either legal or illegal pesticides not intended for use in remote forested areas. Finally, due to the clandestine nature of this activity, armed growers occupy many of these sites for several months who in turn poach and maliciously poison wildlife.

For example, in 2015, Integral Ecology Research Center (IERC) and Law Enforcement agencies discovered several black-tailed deer does and bucks that were illegally harvested or poisoned at grow sites. In addition to deer poaching, IERC research staff documented several black bears and non-game species like gray foxes maliciously poisoned. Occurrences of fawns bedded down in contaminated plots or deer illegally snared were also common and frequently documented (Figure 1). Finally, remote camera systems have detected numerous game species browsing within cultivation plots, raising the question of the potential contamination risks these sites may pose towards human-harvested game.

In 2015, a large multi-year public land trespass marijuana cultivation complex named Deer Lick Grow was discovered on the Shasta-Trinity National Forest managed by the United States Forest Service

(Figure 2). Law Enforcement teams eradicated over 9,000 marijuana plants within the 2015 cultivation plots, and several nearby historical plots were also discovered. This site is situated in occupied Roosevelt elk habitat within the California Department of Fish and Wildlife (CDFW) Marble Mountain Elk Hunt Zone. For this zone, CDFW allocated 52 tags in 2015 (either sex, muzzleloader, antlerless and bull) for which 2,061 applicants applied. The success rate for these tags is significantly high with bull, antlerless and either sex having a 50% success rate and muzzleloaders 100% success.

One standalone factor for much of this success is the public land access for hunters using their public lands. However, this emerging clandestine and dangerous activity of marijuana cultivation on public lands poses a novel risk to not only hunters who want to enjoy a safe hunting experience, but to game species like elk that may either be poached or contaminated through the large amounts of toxicants used at these sites.

Wildlife Species at Risk from Deer Lick Complex

This complex is located in USFWS critical habitat for the threatened Northern Spotted Owl, occupied habitat for fishers and is also a refugia for state and federally listed salmon species like coho and steelhead. The complex also overlaps habitat occupied by several big game species such as Roosevelt Elk, black-tailed deer and black bear.

Deer Lick Springs Reclamation Synopsis

Organizations Involved

Governmental: California Department of Fish and Wildlife Law Enforcement Division (CDFW-LED), Trinity County Sheriff's Office (TCSO), California Army National Guard (CANG), U.S. Forest Service, and Hoopa Tribe.

***Non-Governmental*:** Integral Ecology Research Center (IERC), Rocky Mountain Elk Foundation (RMEF), The Watershed Center (TWC), Trinity County Resource Conservation District (TCRCD), Douglas City Volunteer Fire, and Sierra Pacific Industries (SPI)

Reclamation Organizers: Drs. Mourad Gabriel and Greta Wengert (IERC); Warden Brenden Lynch (CDFW-LED); Detective Nathanial S. Trujillo (TCSO); SFC N. Medler (CANG); Tom Evans (TWC); Donna Rupp (TCRCD)

Support: Logistical and financial support was contributed by the above-mentioned entities. Specific funding for the reclamation of this trespass marijuana cultivation complex was provided by The Rocky Mountain Elk Foundation and a Section 6 grant from the US Fish and Wildlife Service to the California Department of Fish and Wildlife and Integral Ecology Research Center.

Number of trespass sites cleaned: 1 complex with four large satellite sites

Location of sites: Shasta-Trinity National Forest

Watershed impacted: Trinity River

Personnel: 33 total; TCRCD(6), Hoopa (5), RMEF (4), CANG (4), IERC (4), TWC (3), TCSO (3), CDFW-LED (3), SPI (1)

Total water diversion restored to watersheds: 8.1 million gallons (per grow season)

Total amount of fertilizer used at sites: Unknown

Total amount of rodenticide used at sites: 13 pounds (Figure 3)

Insecticide used at sites: 256 gallons of usable insecticide (Figure 3)

Grow site infrastructure removed: 7,350 lbs (3.67 tons) (Figure 4)

Irrigation pipe removed: 27,093 ft (5.13 miles) (Figure 4)

Long-line loads: 21 loads (7 nets and 14 cobiners at an average of 350 pounds each)

Figure1: **A:** A doe caught in a trespass marijuana cultivator's snare on public lands. **B:** A fawn bedded down under a trespass marijuana plant on public land. **C:** Poached black-tailed deer bucks on USFS lands within a trespass cultivation campsite.

Figure 2: Deer Lick Grow complex on Shasta-Trinity National Forest in Trinity County, California within the Marble Mountain Elk Hunt Zone for Roosevelt Elk.

Figure 3: Neurotoxicant rodenticides and organophosphate pesticides detected in one of the Deer Lick Camp sites. Over 5,800ft of unused irrigation tubing discovered in one of the camp sites.

Figure 4: One of several loads of grow site infrastructure removed from the Deer Lick grow site complex.

Plumas National Forest Operation Synopsis
September 12-15, 2015

Project Name: *Science with Solutions: Documentation, remediation and monitoring of the ecological impacts of marijuana cultivation on endangered species within California's Public and Tribal Lands*

Reclamation Organizers: Dr. Mourad Gabriel and Dr. Greta Wengert (Integral Ecology Research Center, IERC); Special Agent Scott McIntrye (USFS-LEI), Lt. R. Paul Gaske (CDFW-LED)
Grant Principal Investigators: Dr. Mourad Gabriel, Dr. Greta Wengert (IERC); Dr. Deana Clifford (CDFW-WIL); Mark Higley (Hoopa Tribe)

Organizations Involved:
Governmental: United States Forest Service, California Department of Fish and Wildlife (Law Enforcement Division & Wildlife Investigations Laboratory), Plumas Sheriff's Office
***Non-Governmental*:** Integral Ecology Research Center (IERC)

Support: Logistical and financial support was contributed by the above-mentioned entities. Funding for the scientific documentation and reclamation of trespass marijuana sites was provided through a Section 6 grant from the US Fish and Wildlife Service to the California Department of Fish and Wildlife and Integral Ecology Research Center

Number of trespass sites cleaned: 4
Location of sites: Plumas National Forest, Plumas County
Watershed impacted: East Branch of the north Fork and Middle Fork of the Feather River
Personnel per day: 16 (9 Law Enforcement; 7 Science Team)
Total water diversion volume from cisterns discovered: 28,710 gallons
Estimated daily water usage across four sites: 105,342 gallons per day
Estimated water usage per season (150 day season): 15.8 million gallons
Minimum amount of fertilizer used at sites: 3,845 pounds
Minimum amount of rodenticide used at sites: 33 pounds
Unknown pesticide, presumed Carbofuran: 4 bottles (total of ~10 ounces)
Garbage removed: 28 cubic yards (13,789 lbs or 6.9 tons)
Irrigation line removed: 21,000ft (3.98 miles)
Dead wildlife discovered: 3 black bears, 1 gray fox, several rodents and birds

IERC is collecting the following data at each site in conjunction with their USFWS/ CDFW-funded Section 6 grant: water quality, soil contamination, and wildlife use.

Cedar Creek Grow: Plumas National Forest

Figures (from left to right): One of several water cisterns detected at the Cedar Creek Grow; one of numerous piles of used fertilizer bags; an unknown pink colored toxicant found.



Bonta Creek Grow: Plumas National Forest

Figures (from left to right): One of several piles of empty rodenticide packages found; one of two dead bears discovered; an unknown pink colored toxicant found.



Clear Creek Grow: Plumas National Forest

Figures (from left to right): A large campsite with large amounts of trash and materials; an unknown pink colored toxicant found.


Long Valley Grow: Plumas National Forest

Figures (from left to right): A dead bear skull discovered near a poison bait pile; sampling poison bait pile; a dead gray fox near poison bait pile.



Reclamation: Plumas National Forest

Figures (from left to right): A trailer full with one site's infrastructure; helicopter transporting a net load of trash to the landing zone; amount of trash and infrastructure from one site.



Shasta-Trinity National Forest Reclamation Synopsis
October 26-30, 2015

Project Name: *Science with Solutions: Documentation, remediation and monitoring of the ecological impacts of marijuana cultivation on endangered species within California's Public and Tribal Lands*

Reclamation Organizers: Dr. Mourad Gabriel and Dr. Greta Wengert (Integral Ecology Research Center, IERC); Warden Brendan Lynch (CDFW-LED), Josh Smith (The Watershed Center), Donna Rupp (Trinity County Resource Conservation District)

Organizations Involved:
Governmental: California Department of Fish and Wildlife (Law Enforcement Division & Wildlife Investigations Laboratory), United States Forest Service Law Enforcement and Investigations, California National Guard, Trinity County Resource Conservation District, Hoopa Tribal Forestry
***Non-Governmental*:** Integral Ecology Research Center, The Watershed Center

Support: Logistical and financial support was contributed by the above-mentioned entities. Funding for the scientific documentation and reclamation of trespass marijuana sites was provided through a Section 6 grant from the US Fish and Wildlife Service to the California Department of Fish and Wildlife and Integral Ecology Research Center and a Cal-Recycle grant to the Trinity County Resource Conservation District and The Watershed Center

Number of trespass sites cleaned: 7
Location of sites: Shasta-Trinity National Forest, Trinity County
Personnel per day: 18 (8 Law Enforcement; 4 Scientist, 6 Reclamation)
Watershed impacted: Tributaries to the South Fork Trinity River
Estimated daily water usage across four sites: 292,992 gallons per day
Estimated water usage per season (150 day season): 39.4 million gallons
Minimum amount of fertilizer used at sites: 8,012 pounds
Minimum amount of rodenticide used at sites: 51 pounds, 11ounces
Unknown pesticide, presumed Carbofuran: 32 ounces
Garbage/infrastructure removed: 24,395 pounds or 12.2 tons (69.7 cubic yards)
Irrigation line removed: 25.96 miles or 137,040ft

IERC is collecting the following data at each site in conjunction with their USFWS/ CDFW-funded Section 6 grant: water quality, soil contamination, and wildlife use.

Shasta-Trinity National Forest

Figures (from left to right): One of over 15 camps with trash and toxicants strewn about. The same camp after extensive effort from law enforcement, National Guard, scientists and reclamation teams

Figures (from left to right): One of over 15 camps with trash and toxicants strewn about. The same camp after extensive effort from law enforcement, National Guard, scientists and reclamation teams

Figures (from left to right): One of several cultivation plots riddled with irrigation pipe, fertilizer, trash and toxicants that extend all the way to the stream channel. A large campsite with large amounts of trash and materials.

Figures (from left to right): One of several plots using sprinkler irrigation to maintain a trespass marijuana cultivation plot within Shasta-Trinity National Forest. The amount of line to maintain one cultivation plot.

Figures (from left to right): One of numerous trailer loads of trash and irrigation pipe removed from trespass marijuana cultivation sites within Shasta-Trinity National Forest.

Dubakella Trespass Grow Site Complex
Operation Synopsis
Prepared by: Dr. Mourad W. Gabriel and Dr. Greta M. Wengert

Background

Shasta-Trinity National Forest is home to numerous game species and non-game wildlife which are dependent on the unique critical habitat attributes that public lands within this bioregion provide. In late June 2016, a large public land, trespass marijuana cultivation complex named Dubakella Grow was discovered on the Shasta-Trinity National Forest managed by the United States Forest Service. Dubakella Grow Site lies on the Salt Creek Watershed which contributes to the South Fork Trinity River, a Hydrological Unit with a salmonid population that is functionally independent with a high risk of extinction (NMFS 2014). The Salt Creek watershed is considered to be adversely impacted by illegal water withdrawals, and nutrient and pesticide loading that is associated with outdoor marijuana cultivation (NMFS 2014). This cultivation site lies within United States Fish and Wildlife Service delineated Critical Habitat for the Northern Spotted owl (*Strix occidentalis caurina*) that is listed as Threatened under the Endangered Species Act (ECOS 2016). Finally, adjacent previous cultivation sites (<1mile) which Integral Ecology Research Center (IERC) is currently monitoring have detected Pacific fishers, which are a species of conservation concern, both state and federally.

The Dubakella site was quickly eradicated by federal, state and local Law Enforcement in order to disrupt the continued misuse of these public lands and over 15,000 plants were removed from an affected area of 2.96 acres. Research scientists from IERC were brought into the site to document and ascertain the magnitude of impact that this trespass grow had. During initial documentation of the site, an estimated several thousand feet of irrigation line, numerous substantial water diversions, significant tree removal, hundreds of pounds of fertilizer and several containers of illegal and restricted use pesticides were recorded. The site was placed on a high-priority list for documentation and reclamation due to these factors, and correspondingly was placed as a site for long-term monitoring for potential legacy influences. Reclamation operations were completed September 7, 2016.

Environmental Conservation Online System. 2016. United States Fish and Wildlife Service http://ecos.fws.gov/ecp/ accessed September 2016.

National Marine Fisheries Service. 2014. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service. Arcata, CA.

Dubakella Reclamation Synopsis

September 7, 2016

Organizations Involved

Governmental: Trinity County Sheriff's Office (TCSO) & U.S. Forest Service

Non-Governmental: Integral Ecology Research Center (IERC), Trinity County Resource Conservation District (TCRCD), The Watershed Center (TWC),

Reclamation Organizers: Drs. Mourad Gabriel and Greta Wengert (IERC); Donna Rupp (TCRCD); Tom Evans (TWC)

Support: Logistical and financial support was contributed by the above-mentioned entities. Specific funding for the reclamation of this trespass marijuana cultivation complex was provided by the California Department of Resources Recycling and Recovery Grant to TCRCD and a Section 6 grant from the US Fish and Wildlife Service to the California Department of Fish and Wildlife and Integral Ecology Research Center.

Number of trespass sites cleaned: One large complex

Location of site: Shasta-Trinity National Forest

Watershed impacted: South Fork Trinity River

Personnel: 14 total; TCRCD(4), IERC (6), TWC (3), USFS (1)

Total water diversion restored to watersheds: 11.25 million gallons (per grow season)

Total amount of trees cut: 149 trees

Total amount of fertilizer used at site: 430 pounds

Total amount of rodenticide used at sites: 6.6 pounds; illegal containers of zinc phosphide; aluminum phosphide (restricted-use pesticide)

Insecticide used at sites: 32 oz of banned toxicant Carbofuran in an illegal container.

Grow site trash removed: 1,540 lbs

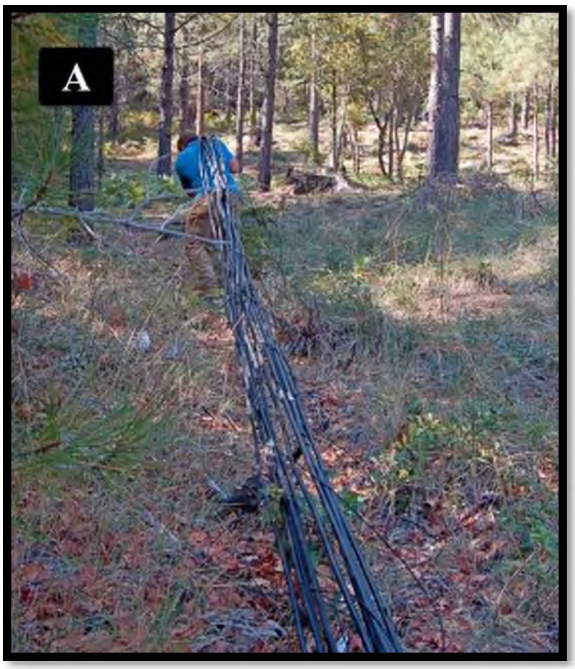
Irrigation pipe removed: 9,940ft (1.88 miles)

Estimated Cost for Reclamation: $8,920

Figure 1: [**A**] Substantial water diversion of 9,418 gallons (12.5ft x 16.8ft x 6.1ft) discovered on eradication day on the Dubakella grow site on the Shasta-Trinity National Forest in Trinity County. [**B**] Post-removal of the cistern by reclamation team members.

Figure 2: [**A**] Lower portion of the 2.96 acre cultivation plot in the Dubakella grow site on the Shasta-Trinity National Forest in Trinity County where 15,000 plants were eradicated. [**B**] Upper portion of Dubakella cultivation plot. [**C**] Several of the 149 trees cut down by cultivators. [**D**] Toxicant pile containing Carbofuran, zinc and aluminum phosphide as well as several hundred pounds of soluble fertilizer less than 10 feet from Salt creek tributary.

Figure 3 : [**A,B**] Irrigation line being removed from the Dubakella grow site on the Shasta-Trinity National Forest in Trinity County. [C] Aerial photo of a portion of the 1.88 miles of irrigation line removed.



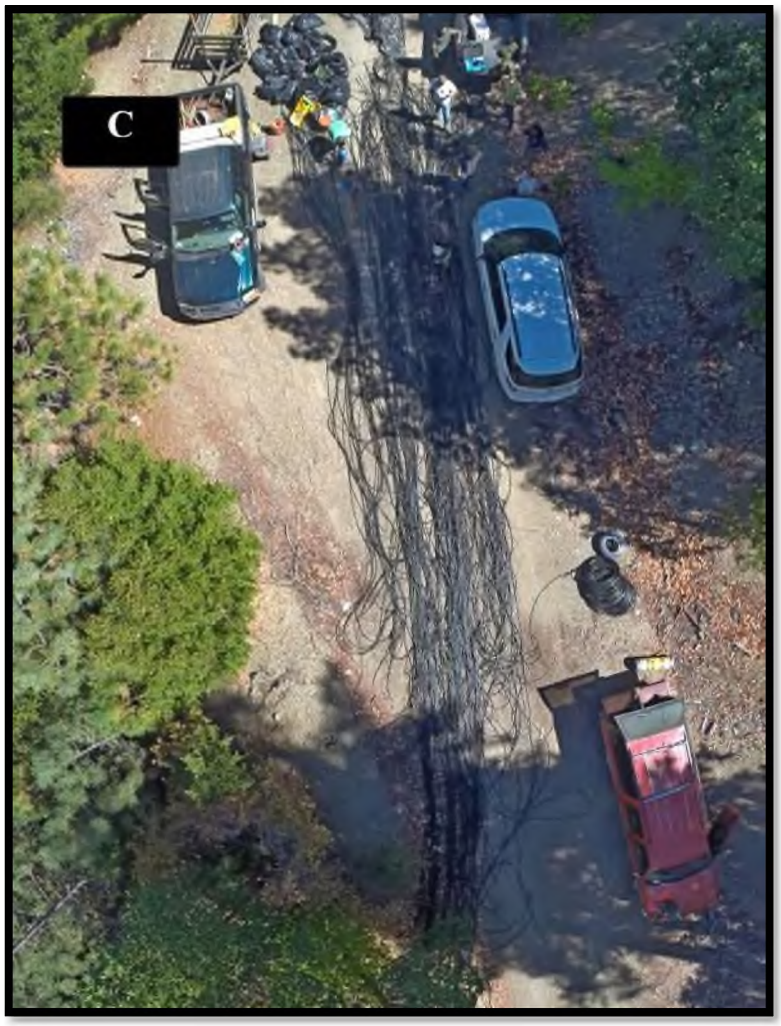


Figure 4 : [**A,B**] Pre (A) and post (B) reclamation of over 1,540 lbs. of trash removed from the Dubakella site on the Shasta-Trinity National Forest in Trinity County. [**C**] Final photo of Reclamation Team post successful operation.

Lassen National Forest Trespass Marijuana Cultivation Site
Reclamation Plan and Preliminary Environmental Assessment Report

Prepared by:

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&
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Prepared for the Lassen National Forest

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EXECUTIVE SUMMARY

Two large trespass marijuana complexes and an additional single grow site were assessed by Integral Ecology Research Center's Science Team (IERC), USFS-LEI and California National Guard Counterdrug CBRN Task Force September 20-23, 2016. Both complexes (named "Screwdriver Complex" and "Potato Patch Complex") as well as the Alder Creek grow site are located on the Lassen National Forest. Screwdriver Complex falls within Shasta County and Potato Patch and Alder are located in Tehama County. A total of 23 camp sites and 24 trash pits were discovered among all sites. It is estimated that approximately 442 bags of trash will be generated at these complexes with a combined weight of 17,680 lbs. In addition, combined there is an estimated 40 miles of irrigation line present with an estimated combined weight of 16,000 lbs. This will require a minimum of 35 net loads and 32 cobiner loads for removal. Operational time for completion for each complex is highly dependent on personnel experience, health and weather conditions. A short operational window is feasible with numerous personnel; however, a more pragmatic and safe approach will require a 3-4 day operation per site with a total of 20 people. Presumptive pesticide tests on pipe infrastructure at all cultivation sites, standing marijuana plants as well as personnel clothing and gear post assessment each day yielded negative results for the detection of either carbamate or organophosphate pesticide residuals. Based on the massive size of the complexes, the level of water theft, food and refuse left behind in addition to numerous accounts of restricted and banned toxicant use, it is imperative that these complexes are completely reclaimed in order to detour further Drug Trafficking Organization impacts within these watersheds.

Top to bottom: Unknown bottles placed in buckets with “Danger and Warning” flagging and placed in a visible location within Screwdriver1 plot; back-back sprayers near Screwdriver1 Camp; and finally, bucket with unknown bottles near Screwdriver1 Camp.

Top to bottom: Screwdriver2 Campsite with nearby trash pits; unknown bottles placed in buckets with “Danger and Warning” flagging and placed in a visible location within Screwdriver3 plot; partial view of the 4.3acre plot of Screwdriver3.

Top to bottom: One of several campsites within the Potato Patch complex with nearby trash pits; the level of water diversions and amount of pipe directed to cultivation plots.

Appendix D

Marijuana Cultivation and its Impacts on Wildlife, Habitats and the Wildlife Profession

THE WILDLIFE SOCIETY
WESTERN SECTION

The Wildlife Society
Western Section
CONSERVATION IN THE
COLLABORATION ERA
2015
Santa Rosa
California

A full-day symposium, immediately before the 2015 Annual Conference of The Western Section of The Wildlife Society

Symposium Overview & Exposure and Poisoning in Forest Carnivores: Beyond Fishers

Presented by: Dr. Mourad Gabriel, Integral Ecology Research Center, Blue Lake, CA

Abstract: In today's complex ecological systems where anthropogenic influences are substantial, the role of interdisciplinary collaborations are pivotal in contemporary wildlife research. An emerging threat to California wildlife and their habitats is the escalating environmental repercussions from clandestine and unregulated marijuana cultivation, and addressing this issue requires collaboration among many different professional groups with different goals and mandates. The aim of this symposium is to highlight not only the current data being collected or the tools used by scientists, natural resource managers and law enforcement, but discussions on how we can propel forward and avoid exploitation California has previously endured that has had legacy effects. This symposium will most likely not be the final one for our profession, but should serve as a platform to inform, educate and develop a foundation for wildlife professionals to develop future relationships to address this pressing issue.

In 2012, the fisher (*Pekania pennanti*) became the flagship species elucidating the mounting issue of environmental impacts clandestine marijuana cultivation has on wildlife. Before these published findings, anecdotal information on these environmental impacts was available but largely unknown to the core body of wildlife professionals. Since 2012, some additional papers have emerged and swelling media coverage on the topic has highlighted this as a significant issue not only for the fisher but for many other wildlife species. We present recent fisher data that describes new cases of mortality and an increase in exposure to toxicants since earlier publications. Exposure rates have increased from 79% of all California fishers to 86%, with some fisher populations displaying 90% exposure rates. Toxicant mortality cases for fishers have sprung to a total of 14 fishers, up from the 4 fisher mortalities documented in 2012. Finally, new data has demonstrated that other forest carnivores such as American and Humboldt

martens, bobcats and black bears have been exposed to or maliciously poisoned by toxicants in remote forestlands in California.

Barred owl exposure to anticoagulant rodenticides: likely sources of poisons and potential for impacts to northern spotted owls

Presented by: Mr. Mark Higley, Hoopa Tribal Forestry, Wildlife Department, Hoopa CA

Abstract: Barred owls have been identified as a serious threat to northern spotted owls and experimental barred owl removal projects designed to determine the feasibility and potential conservation benefit to spotted owls have begun. The method of removal has been lethal removal and thus, has provided a large sample of specimens available for a variety of research opportunities. We have tested liver samples taken from 155 barred owls collected in Humboldt and Del Norte Counties within the northern California coastal and Klamath Provinces. Barred owls have been collected from sites and within habitats used by northern spotted owls on both private timber company land (Green Diamond Resource Company) and the Hoopa Valley Indian Reservation. Fifty percent of barred owls tested have been exposed to one or more second generation anticoagulant rodenticides. Exposure rate was significantly higher ($p<0.008$) among the samples collected at Hoopa (n=71, 44 (62.0%) exposed) than those collected at Green Diamond (n=84, 34 (40.5%) exposed). Sources of exposure to these human created chemicals may include proper and improper use near human habitation and illegal use at trespass marijuana cultivation sites.

Up in Smoke: Can we recover imperiled fish stocks in watersheds full of weed?

Presented by: Mr. Scott Bauer, California Department of Fish and Wildlife, Eureka CA [DFW]),

Abstract: Large-scale marijuana cultivation has proliferated in northwestern California since the mid-1990s. The environmental impacts of marijuana cultivation appear substantial, yet have been difficult to quantify because cultivation is clandestine. We interpreted high-resolution aerial imagery to estimate the number of marijuana cultivation sites, greenhouses, and plants in four watersheds in northwestern California, USA. Low-elevation fixed-wing aircraft flights and cultivation site visits in the region validated assumptions used in aerial imagery interpretation. We estimated the water demand of marijuana irrigation and the potential effect water diversions could have on streamflow patterns. According to our estimates, water demands from marijuana cultivation have the potential to divert substantial proportions of the flow in our study watersheds, with our least impacted watershed seeing a maximum potential flow reduction of almost 23 percent, and other streams predicted to dry up entirely under certain diversion scenarios. These predictions are supported by field observations in our study watersheds documenting diminished or nonexistent flows during the summers in recent years. Diminished stream flow due to marijuana cultivation is highly likely to have lethal or sub-lethal effects on state and federally-listed fishes and further decline of sensitive amphibian species. Our paper entitled, "Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds," will be published in the online journal PlosOne in the spring of 2015.

Practical considerations of working around illegal cultivation sites: logistical impacts to wildlife research projects.

Presented by: Dr. Craig Thompson, United States Forest Service, Pacific Southwest Research Station, Fresno CA

Abstract: The sad reality is that anyone working on public lands in the western United States these days is likely to encounter illegal marijuana cultivation sites. Encounters may be as simple as footprints in an unlikely place, or they may involve gunfire and threaten researchers lives. Wildlife research professionals need to incorporate this information into project planning, as it impacts budgets, safety concerns, and other logistics. Here, I present some of our experiences and summarize some of the things project managers and field technicians need to consider. Awareness and education is of paramount importance in order to be both effective and safe in this new paradigm of wildlife research.

California Department of Fish and Wildlife Law Enforcement Natural Resource Protection Efforts

Presented by: Lieutenant R.Paul Gaske and Lieutenant DeWayne Little, California Department of Fish and Wildlife Law Enforcement Division

United States Forest Service Law Enforcement and Investigations

Presented by: Assistant Special Agent in Charge Kent Delbon

Abstract: It is the mission of the US Forest Service to manage National Forests "*to sustain the health, diversity and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.*" The attributes that make the National Forest lands excellent producers of wildlife habitat and clean water are also prized by illegal marijuana growers.

From fiscal year 2005 through fiscal year 2013, US Forest Service Law Enforcement and Investigations data indicates that in California alone, approximately 3,356 marijuana cultivation sites, containing over 16 million marijuana plants, were eradicated on National Forest System lands.

One marijuana grow site often can impact an area up to 50 acres. Growers routinely live in a grow site for multiple growing operations from early spring to late fall. Human waste and trash are widespread in these grow sites. Growers clear native vegetation before planting and installing miles of plastic tubing to transport large volumes of water from creeks and other natural water sources for irrigation. In addition to the water diversion, growers will often overuse of fertilizers and rodenticides, some banned in the United States, to facilitate their growing operations. The arrival of winter rains and runoff creates severe soil erosion and washes the poisons, chemicals, human waste, and trash into streams and rivers. The rodenticides often will have entered the food chain and subsequently affects and/or kills native wildlife in the forest.

A typical marijuana cultivation site produces hundreds of pounds of trash and debris. In fiscal year 2013 alone, over 118,901 pounds of trash, 80.5 miles of tubing, 244 propane tanks, and 61 car batteries, 17,091 pounds of fertilizer, almost 40 gallons of liquid pesticides, and over 5 gallons of banned poisons were removed from National Forest grow sites in California.

HIDTA's NMI and Public Lands-Past Present and Future

Presented by: Director Ed Shemelya

Abstract: The National Marijuana Initiative and the HIDTA's have been actively engaged in combating trespass grows on our Nation's Public Lands for well over a decade. We will examine the extent and scope of this issue from a historical context and look at how HIDTA in cooperation with our Public Lands Agency Partners are combating the continued exploitation of our Public Lands by illicit cultivators and drug trafficking organizations.

We will examine the challenges that the medical/legalization movement present to Law Enforcement and Public Lands Agencies in our attempts to remove this activity from our Nation's Public Lands. Finally will examine how NMI and the Public Lands Agencies can aid and assist the scientific endeavors that are ongoing to ascertain the full extent that of the damage being done to our Nation's Public Lands.

Maximum Entropy Modeling to Predict the Probability of Trespass Marijuana Cultivation Site Presence and Potential Risk of Exposure of Fishers and Spotted Owls to Toxicants

Presented by: Mr. Mark Higley, Hoopa Tribal Forestry, Wildlife Department, Hoopa CA

Abstract: Illegal trespass marijuana cultivation sites established primarily by drug trafficking organizations have proliferated on public, tribal and at times on private lands throughout California over the last decade. Such sites often use toxicants and chemical fertilizers to protect and grow their illegal crop. Toxicants used range from over-the-counter household insecticides to banned chemicals such as carbofuran and DDT. In all cases they are used illegally and outside of the manufacturer's directions. In recent years researchers have discovered that fishers (*Pekania pennanti*) (federally proposed for threatened status) have been exposed to and killed by first and second generation anticoagulant rodenticides (AR) which they encounter most likely at trespass marijuana cultivation sites. In addition, there is recent, unpublished data documenting exposure of barred and northern spotted owls to second generation AR. Due to the clandestine nature of the cultivation activities it is impossible to know the number and distribution of such sites each year. Law Enforcement agencies collect location information at the time of eradication efforts each year and using such data in combination with a variety of geographic covariates we have developed maximum entropy models which estimate the probability of cultivation site presence. High probability of use areas have been intersected with high probability fisher and spotted owl habitat models to estimate potential risk of exposure of animals to cultivation site activities and toxicants within the northern California range of both fishers and spotted owls.

Indirect and covert impacts of trespass marijuana cultivation on public and tribal lands

Presented by: Dr. Greta Wengert, Integral Ecology Research Center, Blue Lake CA

Abstract: The direct impacts on wildlife from trespass marijuana cultivation on public and tribal lands have only just begun to be uncovered over the past few years. Water diversions, wildlife poisonings, and clearing of habitats are now understood to be common at cultivation sites throughout California. There are, however, more clandestine ecological disturbances that may affect sensitive wildlife populations indirectly, or be delayed with more substantial consequences yet to be seen. Through two large-scale projects focused on documentation of trespass cultivation sites in northern California, we are collecting data which may shed light on the more covert and indirect ecological impacts faced by forest biotic communities. For instance, data from our initial rodent trapping efforts at six cultivation sites indicate that prey populations are indeed being affected by rodenticides disbursed throughout the planting patches and growers' camps, which in turn may cause more stress on the carnivores that depend on them. We are also collecting data on more covert impacts including pesticide residues in soil and water, pesticide bioaccumulation in invertebrates, enhanced predator movement along grower-constructed trail systems, and increased congregating of species at garbage dumps within the sites. Our preliminary data show that rodenticides remain in the soil months after the sites are abandoned, likely leaving invertebrates and the species that prey on them vulnerable to exposure. When considered at the regional scale across hundreds of trespass cultivation sites on California's public and tribal lands each year, the cumulative impacts could be substantial. Future efforts will incorporate these less evident ecological effects into landscape-scale models to estimate the cumulative impact over years and throughout known and projected locations of cultivation sites in California.

Techniques for measuring surface water quality near marijuana grow sites

Presented by: Dr. Michelle L. Hladik and **Mr. James L. Orlando**,
United States Geological Survey, 6000 J Street, Placer Hall, Sacramento CA

Abstract: One of the many environmental concerns associated with illegal marijuana cultivation is the contamination of water and soil by pesticides, and the potential for these pesticides to cause toxicity. Collecting water-quality samples near areas of illegal marijuana grow activities can be difficult and potentially dangerous. There has been an interest in the use of passive samplers to document pesticide runoff from grow sites to nearby creeks and streams. Passive samplers offer advantages over traditional water sampling techniques because they can be deployed for longer periods of time resulting in fewer site visits by personnel, and can be placed in remote areas where it may be difficult to sample during a storm events. There are many types of passive samplers; some of the most commonly used are semi-permeable membrane devices (SPMD) for more hydrophobic contaminants, and polar organic chemical integrative samplers (POCIS) for more water-soluble compounds. Both SPMD and POCIS have been used extensively in many types of waters, and information is known about the uptake of a variety of organic contaminants. Some drawbacks to these samplers are that they need to be continually submerged, which may be difficult to achieve in small creeks; sample analysis can be costly; and, the samplers are expensive if lost. Polyethylene devices (PED) are another type of passive sampler and consist of common plastic sheeting affixed to a holder. PEDs have the advantage of being relatively inexpensive, which is useful in areas where loss of the sampler might be high (theft, vandalism, high-flow events). The different types of passive samplers vary in their ability to give qualitative (presence/absence) and quantitative (concentration) data. Knowing the benefits and disadvantages of varying sampling devices can help guide how to use them for water-quality monitoring.

Illegal Marijuana Cultivation on Public Lands: Management Perspectives

Presented by: Dr. Matt Brownlee, Natural Resources Recreation Planning and Management Department of Parks, Recreation and Tourism, University of Utah, Salt Lake City, UT

Abstract: Illicit marijuana cultivation (*Cannabis sativa*) on U.S. public lands impacts environmental, social, and economic resources. However, preventing, mitigating, and responding to marijuana cultivation is a significant challenge for land management agencies. This research aimed to a) understand public land managers' challenges, successes, ideas, and experiences regarding marijuana cultivation, and b) highlight specific drivers that prohibit, assist, and influence the prevention, mitigation, and response to marijuana cultivation on public lands. The investigators conducted, recorded, and disseminated the results of 29 on-site and telephone semi-structured confidential interviews (*M* = 46 minutes) with a variety of key informants involved in addressing marijuana cultivation on public lands. Participant responses were grouped into six non-distinct themes: *Collaboration, grows and growers*, *challenges of interdiction*, *ecological impacts*, *complexity*, and *future concerns*. The interconnectedness between themes suggests that collaboration, good investigation, and removal of infrastructure contribute to eradication success but are performed inconsistently across and within agencies. Secondly, ecological impacts and safety also influence the efficacy of eradication but are not well-understood and under-researched. All six themes appear to be influenced by limited financial, human, and physical resources, which according to respondents consistently plague eradication efforts and subsequent success of addressing the issue. Finally, tactics and policies are influenced by inadequate resources, are inconsistent across and within agencies, and are not well-understood. Ultimately, the agglomeration of the elements noted above, and their interrelationships, result in a complex problem requiring intensive resources, research, training, formal education, and substantial public outreach. Results also indicated a need within and across land management agencies for further research, including an

extensive quantitative population assessment of managers' engagement with illegal marijuana cultivation, as well as research into growers' perspectives.

Local Regulation of Cannabis Cultivation: Opportunities and Obstacles

Presented by: Mr. Scott Greacen, Friends of the Eel River, Humboldt County, California

Abstract: The increasing environmental impacts of marijuana cultivation in California's Emerald Triangle have become an important driver of efforts to legalize and regulate cannabis cultivation. The rise in the number and scale of operations in the region since the 1996 passage of Proposition 215 has been so rapid that the era has become known as the "Green Rush." Of particular concern to watershed and fisheries advocates have been increased sediment inputs from roads and land clearing and increased water diversions from already-overallocated and declining surface flows. Together, these impacts threaten to overwhelm restoration efforts and to drive threatened species even closer to extinction in the region.

A proposed Humboldt County land use ordinance is being pitched as providing solutions to these problems. However, the proposal would allow cannabis cultivation on much larger scales than even today's inflated operations, and as a principally permitted use in essentially all rural areas. It also being proposed as a county initiative. The initiative process would preclude the use of CEQA analysis to identify potentially significant impacts of such a dramatic increase in cultivation, as well as mitigation measures that might be necessary to reduce those impacts.

Remediation of Public and Tribal Land Grow Sites: Cost, and Community involvement

Presented by: Mr. Rick Fleming, The High Sierra Volunteer Trail Crew, Fresno CA

High Time for Conservation: Adding the Environment to the Debate on Marijuana Liberalization

Presented by: Ms. Nancy Smith, the **N**ature Conservancy, San Francisco

Abstract: Liberalization of marijuana policies including legalization of medical and recreational marijuana is sweeping the United States and other countries. Marijuana cultivation can have significant negative collateral effects on the environment that are often unknown or overlooked. Focusing on the state of California where ~70% of the marijuana consumed in the United States is grown, we argue that (1) the environmental harm caused by marijuana cultivation merits a direct policy response, (2) current approaches to governing the environmental effects are inadequate, and (3) neglecting discussion of the environmental impacts of cultivation when shaping future marijuana use and possession policies represents a missed opportunity to reduce, regulate, and mitigate environmental harm.